User's manual

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1 Introduction

1.1. What is TopCal 21?

TopCal is a program designed to make computations and to solve topographic and geodetic problems. Its easy-to-handle tools allow solving all kinds of difficulties when working in topography.

TopCal 21 works with Windows 32 bit operative systems. Since it works with projects, its jobs will be organized with folders and it is capable of managing more than one point file and one observation file at the same time. It also has a new data viewing screen or user interface as a computation sheet. All its tools are presented with guided dialog boxes that will help the user in the computations.

The program supports a large list of different file formats from topographic total stations and graphic files for its importation or exportation.

The output files are in ASCII format separated by spaces, DXF, ASCII of Digi and BIN of Digi, DGN or HTML.

TopCal 21 has the usual tools, such as:

- Computations of triangulations made by intersections or resections, using angles or distances
- Orientations

- Traverses
- Radial survey
- Surface computation
- Generation of drawings from points
- Transformation of coordinates between different systems
- Generation of data information of vertex or control points
- Computation of longitudinal profiles and cross sections
- Volume computation
- Computation of cuts and fills
- Compensation of topographic networks by least squares
- Automatic retrieval of the sketch from encoding on the field
- Geometric calculations of intersections of different elements (lines, arcs, circles…), transformation from polar coordinate to rectangular coordinates and vice versa, etc.

1.2. System requirements

TopCal 21 is executed in the Microsoft Windows operative system. To install and start using TopCal21 the following hardware and software is necessary:

- Intel Pentium II (300 MHz or more), or equivalent with Windows 200, XP or Vista
- RAM of at least 128 Mb
- 15 MB of free disk space
- CD-ROM unit
- Monitor (that supports at least 1024x768 pixels and 16 bits of colour quality, million colours is recommended).
- USB port for the hasp protection key

1.3. Installation

1.3.1. Installing TopCal 21

This help topic will describe how to install the program TopCal 21 in the hard disk and how to start the application. Before starting, please verify that your system meets the requirements listed in the previous topic.

Installation:

- Insert the CD in the CD_ROM unit of your computer
- The CD contains an automatic start up program which will show a list with the different programs available for the installation
- Select TopCal21 from the list.
- Follow the instructions shown by the installer.

1.3.2. Installation of drivers and protection key manager

If it is the first time that you install TopCal21 in your computer, you will need to install the driver for the HASP protection key.

- From the programs listed in the CD, select HASP protection Key Driver.
- Follow the instructions shown by the installer.

- Connect the HASP key to one of the USB ports of your computer.
- Open again the list of programs available on the CD and select InfoLlave 2007.
- Follow the instructions shown by the installer.
- Execute the application by going to Start → Programs → Digi21.net → InfoLlave. The program will show the following window:

- Press on the button that says Browse for local dongle in case you have a local key plugged in your computer, or press on Browse for network dongle in case you work with a network dongle plugged into a server.

- If it is the first time this Hasp key is activated on your computer, the program will show a message referring to the License file. Please contact our technical support and follow the instructions to activate your HASP key.

1.3.3. Starting with TopCal 21

The installation program for TopCal 21 created a shortcut icon on your Windows desktop and a folder in the menu in the Windows Start up programs.

To start TopCal 21 you have two options:

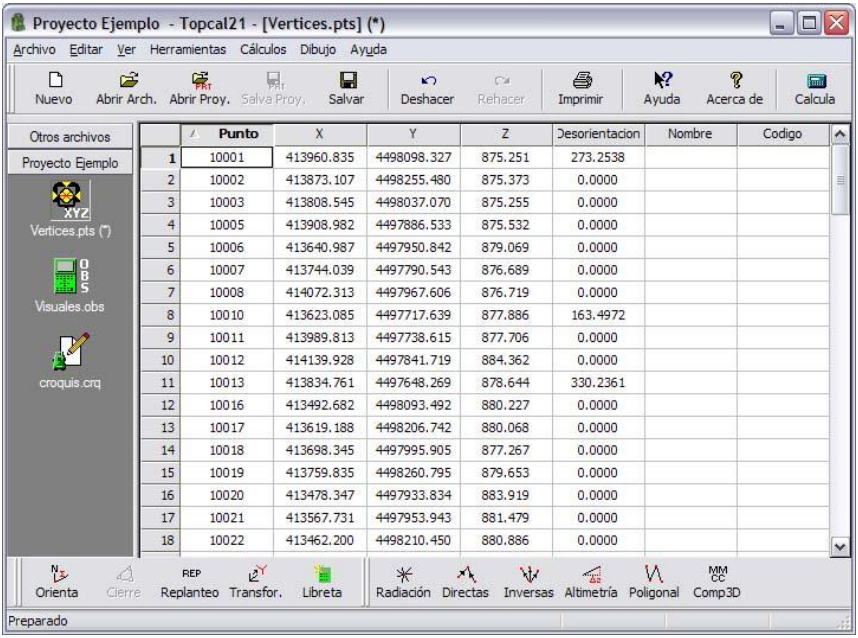
- Double click with the mouse on the TopCal 21 shortcut of your desktop.
- Go to Start → Programs → Digi21.net → TopCal21 → Topcal21

1.3.4. Update download

1.3.5. Uninstalling

1.4. User Interface

The program shows a screen which is split up in two distinct parts: one on the left, displaying the open files and projects and another one on the right, presenting the content of the files with a spreadsheet.



The interface also displays several toolbars on the upper and lower part of the window. These toolbars can be moved or closed, but will certainly help the user with the main commands of the program.

The spreadsheet that shows the contents of the files, will allow the user to enter data manually in a fast and effective way. It also allows the user to select which data to show of each file and its arrangement.

To enter data the user only has to select the record to modify and write the value.

If one wants to modify an existing field, one needs to press ***Enter*** first to start editing.

If the user needs to enter a value with decimals, the character that separates the decimals will be the point.

The units with which the user has to enter the data, are shown in the file definition, these can be *meters* or *feet* for lineal units, and *degrees*, *grads* or *pseudo-decimal degrees*[1] for the angle units. If the user wants to change the units of the current file he/she needs to go to the file properties. For more information on this topic, please read any of the following help topics depending on the file type: 8.7 for point files and 8.8 for observation files.

By default, the point files are arranged increasing the *Point number* and the observation files by the *Station number* and *Target number*. If the user wants to arrange the file by any other field value, he just needs to click on the heading of that field, by doing so, file will arrange the values first increasingly and if clicked again decreasingly.

It is also possible to arrange the data by going to the menu View-> Sort data, explained further in topic 8.6.

One can delete records of the spreadsheet, by selecting the record and pressing on the Delete key, or clicking with the right button of the mouse on the cell and selecting the command ***Delete record***. TopCal 21 also considers a record as deleted if its identification is cero. This means there can be no point with the *Point Number* as zero.

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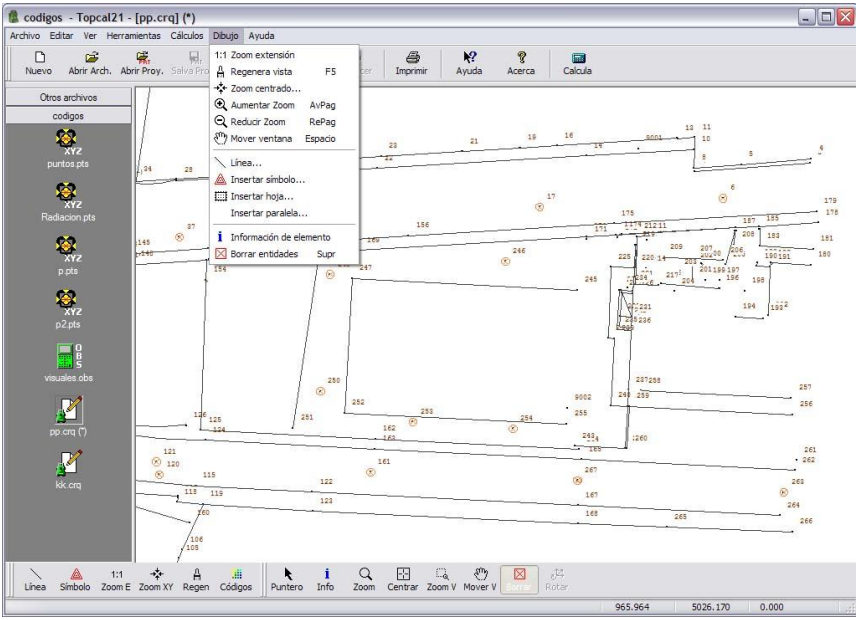
[1] To enter angles in pseudo-decimal format, you will need to enter the degrees, the point (decimal separator), and then the minutes and last the seconds. For example, angle 90 degrees 38 minutes and 45.67 seconds, will be entered as 90.384567

If a record is deleted the program will keep showing the value but this time in red, this happens only if this option has been activated in the menu *Edit → Preferences*, explained in the topic 8.1. At the same time it is possible for the user to retrieve a value that has been deleted previously by clicking with the right button of the mouse over it and selecting the option ***Retrieve record***.

The program also allows multiple selections of records with the keys CTRL or SHIFT, or clicking with the left mouse button and without releasing extending the windows over the records one wishes to select.

This way of presenting the data allows copying, cutting and pasting among different windows, even among different programs. For example, it is possible to select several records and paste them in an open spreadsheet of Microsoft Excel, and vice versa.

When opening a sketch file, the layout of the program is like the layout of a drawing application and several drawing tool bars will be activated, to edit the drawing.



With this view, the application works like any graphic application. When the user moves the cursor over the drawing the coordinates shown by the status bar will change in real time.

When a certain command prompts the selection of elements, this selection should be done with the left button of the mouse. Then the program will search entities in the surroundings of the cursor.

If an entity is found, this entity will be highlighted with a colour and the program will prompt the user to verify the selection (by clicking again on the left button of the mouse) or cancel this selection to look for other entities nearby (clicking on the right button of the mouse) or ending the search (by clicking on Esc).

If the mouse has a central wheel, the user can use it to increase or decrease the zoom of the current view.

The structure of topographic data in TopCal 21 is as follows:

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Point file: In this type of file, the point coordinates and their orientations will be stored as well as their names and codes, as the case may be. In every topographic computation, one starts from the known coordinates of a series of points, and through computations using field observations, the other point coordinates are obtained.

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Observation file: These files will contain the observations done with any surveying instrument. These observations are used to compute the unknown point coordinates. They are made up of *station number*, *target point*, *horizontal angle*, *vertical angle*, *slope distance*, *instrument height*, *reflector height* and a *code*, if it was registered.

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Sketch file: In this type of file, the geographic entities taken at the time of point collection are stored. In this way it will be possible to establish a relation between points by means of lines, so as to represent linear entities or to represent symbols by means of singular points. These files are only generated within projects and they depend on the point files they represent, so that if these change, the drawing will also change.

-  ***Project file***: These files contain an account of the previous files regarding a same kind of job. Each project file creates a folder where the files will be stored. A project should be created for each job. The main TopCal 21 tools can be used while keeping the project active, computing traverses, intersections, etc. You will be able to have as many point files, observation or sketch files for each project as you may wish.

As many opened projects as wanted may be handled by TopCal 21. Point or observation files not to be found in any particular project may also be opened. They will be shown in a folder named *Other files*.

The TopCal 21 tools may be used in accordance with the type of selected file or project. So those tools requiring point or observation files for computations will need an active project. Other tools only require a point or observation file, and no active project.

All TopCal 21 tools or utilities are to be found throughout the different menus, i.e.:

- Menu *File*: Contains all the commands that manage files or print. For more information read topic 4.1.
- Menu *Edit*: This menu contains all the commands referring to the editing of data with the spreadsheet, viewing options of that data and the tools to manage reference systems and surveying instruments. For more information read topic 4.2.
- *Menu View*: Contains all the commands for the visualization of the tool bars, icons of the files and properties of different objects. For more information read topic 4.3.

- *Menu Tools*: This menu contains the main tools for the topographic computations offered by the program. For more information read topic 4.4.
- *Menu Computations*: Contains the different geometric computation that can be done with points, such as operations with visuals, coordinate transformations, etc. For more information read topic 4.5.
- *Menu Drawing*: This menu contains the different commands used for the editing of field sketches and data. For more information read topic 4.6.
- *Menu Help*: Contains the commands related with the help of the application and its tools. For more information read topic 4.7.

In the command bar, the most commonly used commands for a fast execution can be easily reached. They display an icon representing the corresponding function. By lightly placing the mouse pointer on each icon, the program will display the name of the associated command. By pressing on the icon, the command will be executed. The included toolbars are:

- *Toolbar MainTool*
- *Toolbar TopCalTool*
- *Toolbar Coordinates*
- *Toolbar Drawing*
- *Toolbar Palette*

In the status bar, information about the selected tool will be shown as well as request messages for the user. Also when a sketch file is active, the cursor coordinates are offered.

2 File Structure

2.1. Create a New File

From this dialog box a new file can be created: project, point file, observation file or sketch file. The type of file to be created should be selected in the list of icons displayed on the upper side of the dialog box.

If the user decides to create a new project by clicking on the first icon, the dialog box will have the following appearance:

If the user selects any other of the three options, the dialog box will look like this:

The fields shown are as follows:

- File Type:
  - ***Project file***: This file defines the relation among the different files that compose the project. For more information read topic 2.2.
  - ***Point file***: This is the file where the surveyed points are stored. For more information read 2.3.
  - ***Observation file***: This file contains the field observations. For more information read topic 2.4.

-  ***Sketch file***: This file contains the geographic entities generated when joining point previously saved in the point file. For more information read topic 2.5.

- ***Filename***: The filename needs to be entered for saving.

- ***Job name***: If creation of a new project is selected, an description text could be given. It is optional.

- ***Add to Project***: If the user creates a point file, an observation file or a field shot file (sketch file). He will also have the option to add that file to any open project at that moment. These projects are shown in the list below. If the user does not want to add the file to any project, the file will be created in the section *Other files*.

- ***Folder***: The folder in which the file is going to be created need to be indicated here. If you want to make a new project, a new folder will be created from this location. This location can be changed; the user can select another by clicking on the [...] button.

2.2. Project file

This file defines the relations among the different files that compose the job or project. The user should create a project for each job, where the different files and computations will be saved. These projects may have several point files, observation files or sketch files.

Generate a file for each computation, by doing this, the later processes will be easier and the job will be better organized. For example:

- Traverse.pts: File with the stations of the traverse.
- Adjustment.pts: File with the coordinates adjusted by least squares of the polygonal.
- COGO.pts: File with the coordinates of the points radiated from the stations of the polygonal.
- Observations.obs: Visuals taken from the transverse.

When creating a new project file, another folder is also created with the name of the file, in a way that when creating new files (points, observations, sketches) and are added to the project, they are created in this folder. The same happens with the output files.

The project files of TopCal 21 have the extension PRT by default.

2.3. Point file

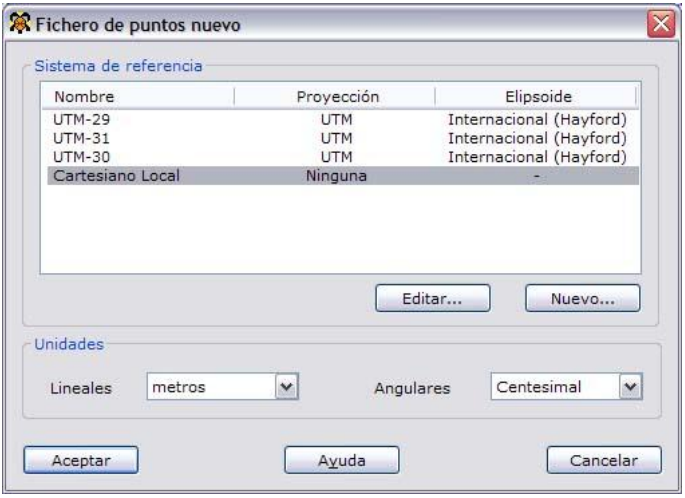
As indicated by its name, this type of file keeps topographically taken points. Points whose coordinates are referred to the coordinate system defined in the file creation.

These points are defined by:

- ***Point number***: It must be numerical and should unequivocally identify each individual point. In other words, it is the field that identifies a point. The program does not allow the existence of two points with the same number. If you give the point the number cero, the program will regard it as deleted and won't use it in the computations.
- ***ENH coordinates***: They are coordinates either entered manually or computed by the program. These three fields are numerical and admit decimals. The coordinates are referred to the coordinate system defined in the file and in the same units.
- ***Orientation***: It is the angular orientation either entered manually or computed by the program in the theodolite (total station) at the time of establishing a station on that point. This value is entered in the same angle units as defined in the file.
- ***Name***: Alphanumerical name of the point.
- ***Code***: Code registered on the field belonging to the geographic entity the point is a part of. In order to know which codes are registered in the work session, look up the dialog box *Code library* at section 8.4.1.

It will be possible for you to choose the fields you want to see in the current view. For that purpose, go to the dialog box *Preferences* in the *Menu Edit*.

When the user decides to create a new point file, the application will show the following dialog box, where you can specify the coordinate system to which the coordinates of the points are referred and the units for the rest of the fields.



In this dialog box you need to select the following parameters:

- ***Reference system***: The reference system corresponds to the coordinates of the points and is composed by a projection and a reference ellipsoid. The dialog box shows the reference systems previously saved in the program. These can be edited or added by using the buttons in the lower part of the window. When editing, the user will access another dialog box which is explained in the topic 9.2.

- ***Lineal units***: Here the user selects the units for the point coordinates. He/she can choose between meters or feet.
- ***Angular units***: Here the units for the orientations of the points are saved. These can be *degrees*, *grads* or *pseudodecimal degrees*.

Once the parameters are chosen and defined, the main window of the program is activated which shows the spreadsheet to start editing the points. The fields are variable and the user can select which ones to show. This can be done by going to the *Preferences* in the *Edit Menu*, explained in the help topic 8.1, or clicking on the right mouse button over the data heading and selecting the option *View fields*.

The point files used by TopCal 21 have the extension PTS by default.

2.4. Observation file

As indicated by its name, this type of file contains the observations that have been stored upon data taking.

The topographic observations are defined by:

- ***Station***: This field identifies the station point where the topographic instrument was placed at the time of data taking. If this record has the value cero, the program will assume this observation is deleted and won't use it for the computations.
- ***Target***: This field identifies the point sighted with this topographic observation. If this record has the value cero, the program will assume this Target point is deleted and won't use it for the computations.
- ***Horizontal***: This field identifies the value of the horizontal angle registered upon data taking, in the angular units defined for this file.
- ***Vertical***: This field identifies the value of the vertical or zenith angle registered upon data taking, in the angular units defined for this file.
- ***Distance***: This field identifies the value of the slope distance registered upon data taking, in meters or feet depending on the parameters defined for this file.
- ***Reflector***: This field identifies the value of the height of the rod or prism at the time of data taking, in meters or feet, depending on the file definition.

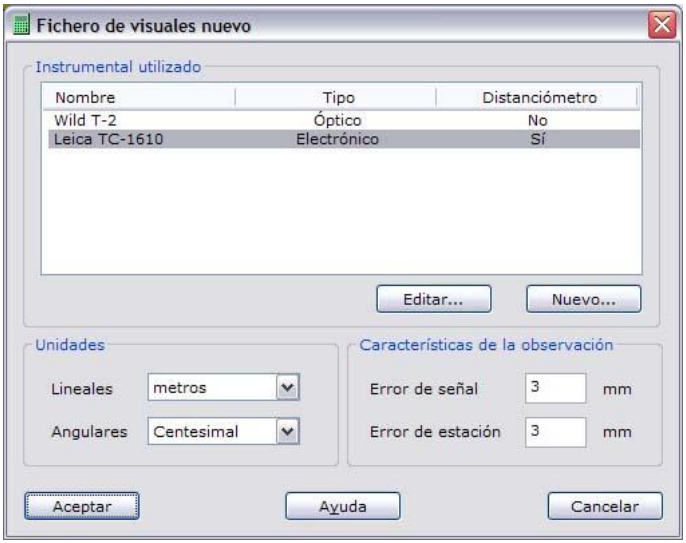
- ***Instrument***: This field identifies the value of the instrument height at the time of data taking, in meters or feet, depending on the parameter definition for this file.

- ***Code***: Code registered on the field belonging to the geographic entity the Target point is a part of.

In order to perform topographic computations, the program relates the point files to the observation files by means of the field *Number* of the first, and the fields *Station number* and *Target number* of the second. For example, when a radial survey is performed from a station, this station should have stored the coordinates in the point file with a certain number. This number must coincide with the field *Station* of the observation menu. After the computations have been carried out, as many points as observations made will be stored in the point menu, with the number indicated by the field *Target Point* of those observations.

The program allows saving in the same file, several observations from the same station to the same target point, like when the operator repeats the observation to improve the output, or when direct and inverse observations are done to correct systematic errors from the instrument, using the Bessel rule. For this the user needs to activate this option by going to *Menu Edit → Preferences*. This dialog box of *Preferences* is explained with detail in the topic 8.1.

When the user chooses to create a new observation file, the application will show the following dialog box where he /she can specify the used survey instruments, the conditions during the data observation and the used units:



In this dialog box you can define the following parameters:

- ***Instruments***: The program will show a list of the surveying instruments saved in the application. The user can select one of these or define and add a new instrument by using the buttons below. If the user chooses to create a new instrument or edit one that already exists, he/she will access a dialog box called *Surveying Instrument* explained in detail in the topic 9.1.

- ***Linear Units***: The units of the distances, reflector height and instrument height is entered here, the user can choose *meters* or *feet*.

- ***Angular units***: These are the units of the horizontal and vertical angles measured by the instrument. The available options are: *grads*, *degrees*, or *pseudodecimal degrees*.

- ***Observation features***: This is the error committed when reading the observation and when setting the station, usual values are 3 or 5 mm for each.

Once these parameters are set the main window is activated with the spreadsheet ready to start entering or editing observation values. The fields are variable and the user can select which ones to show. This can be done by going to the *Preferences* in the *Edit Menu* explained in the help topic 8.1, or clicking on the right mouse button over the data heading and selecting the option *View fields*.

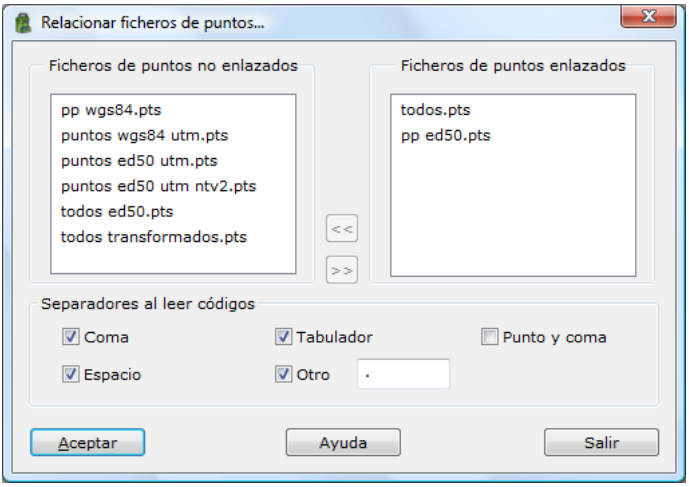
The observation files used by TopCal 21 have by default, the extension OBS.

2.5. Sketch file

The sketch files or field shot files can contain the drawing of the point files the user wants. Geographic entities can be registered by joining the previously saved points. It is also possible to automatically generate field shots from the registered codes in the field observations.

The coordinates of the points saved in the point files are directly used by the program to draw registered entities in such a way, that if any coordinates are edited by the corresponding editor, the drawing file are going to be updated in real time.

For this it is necessary to define the correspondence between the sketch file and the point files. This relation is defined with the following dialog box:



In this dialog box you will find the following parameters:

- ***Point files that are not linked***: This is the list holding all the point files of the current project and that are not yet, linked to the sketch (field shot) file. The user can link as many point files as he wishes to the sketch file.
- ***Point files linked to the sketch file***: these are the point files of the current project that are linked to the sketch file.
- ***Separators when reading codes***: Here the user can select the different characters used to separate the different codes of a point.

The sketch files (field shot files) used by TopCal 21 will have by default the extension CRQ.

3 Toolbars

3.1. Toolbar MainTool

This toolbar consists of the following commands:

- ***New***: It is of use to create an existing document: project, point, observation or sketch file.
- ***Open File***: It opens an existing point or observation file, adding it to the folder *Other files*.
- ***Open Project***: It opens an existing TopCal project.
- ***Save Project***: It saves the current project. If it was not previously saved, the program would open the Windows explorer for a name and a destination folder. This option would only be active if the document had been modified.

-  ***Save***: It saves the current document. If it was not previously saved, the program would open the Windows explorer for a name and a destination folder. This option would only be active if the document had been modified.
-  ***Insert***: It inserts a point file or observations in the current project.
-  ***Delete***: It deletes a point file, observations or sketch from the current project.
-  ***Add***: It combines existing files with the current one.
-  ***Undo***: It cancels the last operation.
-  ***Redo***: It redoes the last cancelled operation.
-  ***Delete***: It puts an erasure mark on the actual register or on the selected registers.
-  ***Retrieve***: It retrieves the selected erased registers.
-  ***RefSist***:
-  ***Instrum***:
-  ***Print***: It prints the current document.
-  ***Calculator***: It shows the system's calculator for easy calculation operations.
-  ***Help***: It shows the program's help. If the user presses on one of the items, it will display information about it. If the user presses on any location of the screen, general information about the program will show up.

- ***About...***: It shows information about the version of TopCal 21.

3.2. Toolbar TopCalTool

This toolbar consists of the following commands:

- ***Orienta***: It is of use to compute the orientation of a point on the basis of observations of other known coordinated points. This option will only be available if there is a current active project.

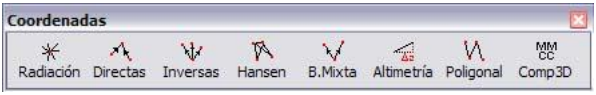
- ***Closure***: It is of use to compute the closure of triangles formed by a set of observations made between points. This option will only be available if there is a current active observation file. However, a point file is not needed.

- ***Stakeout***: It is of use to generate a file with the observations of angle and distance necessary to locate new points on the ground in order to stake out. This option will only be available if there is a current active project.

- ***Transfor.***: It is of use to transform the coordinates of a point file into a system or to transform a certain system into another set of points in another file, out of the knowledge of common points between both systems. This option will only be available if there is a current active project.

- ***Observa***: It is of use to generate an observation file starting from the known coordinates of a set of points. This option will only be available if there is a current active project.

3.3. Toolbar Coordinates



This toolbar consists of the following commands:

- ***COGO***: It is of use to compute the coordinates of new points from the coordinates of a station and the respective observations of angle and distance. This option will only be available if there is a current active project.

- ***Intersec***: It is of use to compute the coordinates of new points from the observations of angle performed from at least two known coordinated points. This option will only be available if there is a current active project.

-  ***3-Resect***: It is of use to compute the coordinates of new points from the observations of angles performed to at least three known coordinated points. This option will only be available if there is a current active project.

-  ***Hansen***:

-  ***2-Resect***:

-  ***Altimetry***: It is of use to compute the height of a set of points from the observations carried out in an altimetric network, starting from at least a point with a known height. This option will only be available if there is a current active project.

-  ***Traverse***: It is of use to compute the coordinates of new points from the chain of observations performed between these points and at least one with known coordinates. This option will only be available if there is a current active project.

-  ***Comp3D***: It is of use to adjust, by the mathematical method of least squares, a network made up of a set of points between which angular and/or distance and/or altimetric observations have been carried out. This option will only be available if there is a current active project. In order to do this, it is necessary to have already computed estimated coordinates of the non-fixed points making up the network.

3.4. Toolbar Drawing

This toolbar consists of the following commands:

- ***Line***: It shows a dialog box allowing registration of geographic entities (lines or arcs) as a junction between the points in the files that are related to the sketch. This option will only be available if there is a current active sketch file.
- ***Circle***:
- ***Square***:
- ***Rectang***:
- ***Symbol***:
- 1:1 ***ZoomE***: It fits the view to see the current drawing document enhanced. This option will only be available if there is a current active sketch file.
- ***ZoomXY***: It centres the current window on a certain point or on certain coordinates. This option will only be available if there is a current active sketch file.
- ***Refresh***: It refreshes the window including the view of the current drawing document. This option will only be available if there is a current active sketch file.

- ***Codes***: It shows the list of drawing codes.
- ***Skecth***: It shows the list of automatic sketching codes.
- ***SimbLib***:
- ***Sheet***:

3.5. Toolbar Palette

This toolbar consists of the following commands:

- ***Pointer***: This option is selected by default. It has no specific function.
- ***Info***: It is of use to give information about the selected item. The selection is made with the left button, and then accepted. With the right button, the selection is cancelled or another entity may be searched for in the same location.
- ***Zoom***: It is of use to increase or decrease the size of the view. With the left button the image is brought nearby, with the right button it is moved away.
- ***Centre***: With this option the image is centred on a point.
- ***Zoom W***: With this option the view is adjusted to a desired window which has been selected with the left mouse button.

-  ***Move W***: With this option the view can be moved in real time by pressing the left button without releasing, and displacing the mouse.

-  ***Erase***: It is of use to erase drawing elements.

4 Application menus

4.1. Menu File

This menu contains the following commands:

-  ***New***: It is of use to create an existing document, a project or a point, observation or sketch file.
-  ***Open***: It opens an existing point or observation file, adding it to the folder *Other files*.
-  ***Save***: It saves the current document. If it was not previously saved, the program would open the Windows explorer for a name and a destination folder. This option would only be active if the document had been modified.
- ***Save as***: It saves the current document with a different name and destination folder. The program will open the Windows explorer for a name and a destination folder.
-  ***Close***: It closes the current document. This option will only be available if there is a current active element of the folder *Other files*.
-  ***Open project***: It opens an existing TopCal project.

-  ***Save project***: It saves the current project. If the project was not previously saved, the program would open the Windows explorer for a name and a destination folder. This option would only be active if the document had been modified.
- ***Save All***: It saves all modified files as well as the project.
- ***Close Project***: It closes the current project.
-  ***Insert File***: It inserts a point file or observations in the current project.
-  ***Delete File***: It deletes a point file, observations or sketch from the current project.
- ***Import***: It imports data coming from other types of files. There are several kinds depending on the type of file where the data will be imported to, i.e. point or observation file.
- ***Export***:
-  ***Add file***: It combines existing files with the current one. Having an active digital model, only files of this type can be added. Having an active drawing file, BIN, DXF or DGN drawing files can be added to it. The program will open the Windows explorer for selection of the files to be added. In this dialog box, a single file or several of them can be selected using the keys SHIFT LOCK and CONTROL.
-  ***Print***: It prints the current document.
- ***Print preview***: It shows on screen how the current document would get printed.

- ***Print setup***: It sets the printer's output device.
- ***Recent files***: It shows a list of a maximum of five files with the last used documents. It is a fast way of opening already generated documents.
- ***Recent projects***: It shows a list of a maximum of five projects with the last ones used. It is a fast way of opening already generated projects.
-  ***Exit***: It exits the application. In the event an opening document had not been saved, the program will query about it.

4.2. Menu Edit

This menu contains the following commands:

-  ***Undo***: It cancels the last operation.
-  ***Redo***: It redoes the last cancelled operation.
-  ***Cut***: It copies the currently selected data to the Windows clipboard, erasing them from the file.
-  ***Copy***: It copies the currently selected data to the Windows clipboard.
-  ***Paste***: It pastes the data of the Windows clipboard to the current file.
- ***Select All***:

- ***Invert selection***:
-  ***Erase Register***: It puts an erasure mark on the actual register or on the selected registers.
-  ***Retrieve Register***: It retrieves the selected erased registers.
- ***Compact File***: It definitively deletes the registers with erasure mark from the file.
- ***Renumber points***:
- ***Renumber observations***:
- ***Preferences***: It shows the application's general options.
- ***Preferences of sketch***: It shows the application's drawing general options.
-  ***Drawing Code List***: It shows the list of drawing codes.
-  ***Sketching Code List***: It shows the list of automatic sketching codes.
-  ***Symbols Library***:
-  ***Reference Systems***:
-  ***Topographic Instruments***:
- ***Link Point Files***: It links a sketch file to the point files of the current project.

4.3. Menu View

This menu contains the following commands:

- ***Toolbars***: It shows a dialog box allowing selection of the toolbars and knowledge of their appearance.
- ***Status Bar***: It is of use to activate or deactivate the status bar on the bottom of the application's window, where the program's messages to the user are viewed.
-  ***Arrange Data***: It shows a dialog box that allows putting in order the current file in any of its fields.
- ***Refresh***: It refreshes the current view, presenting the data again.
- ***Small Icons***: It shows the folder's elements with small icons.
- ***Big Icons***: It shows the folder's elements with big icons.
- ***Arrange Icons***: It allows arranging the current folder's elements by name, type, size or date. Furthermore, it may arrange them automatically.
-  ***Project Properties***: It shows a dialog box with the properties of the present project.

-  ***Object Properties***: It shows a dialog box with the properties of the current element (point, observation or sketch file).

-  ***Calculator***: It shows the system's calculator to perform easy computation operations.

4.4. Menu Tools

This menu contains the following commands:

-  ***Orientations***: It is of use to compute the orientation of a point on the basis of observations of other known coordinated points. This option will only be available if there is a current active project.

-  ***Closure of triangles***: It is of use to compute the closures of triangles formed by a set of observations taken between points. This option will only be available if there is a current active observation file. However, point files are not needed.

-  ***COGO***: It is of use to compute the coordinates of a station and the respective angle and distance observations. This option will only be available if there is a current active project.

-  ***Traverses***: It is of use to compute the coordinates of new points starting from the chain of observations taken between these points and at least one with known coordinates. This option will only be available if there is a current active project.

- ***Alternate traverses***:

-  ***Intersections***: It is of use to compute the coordinates of new points from angle observations taken at least from two points with known coordinates. This option will only be available if there is a current active project.

-  ***3-point resections***: It is of use to compute the coordinates of new points from observations of angles carried out to at least three points with known coordinates. This option will only be available if there is a current active project.

-  ***2-point resections***:

-  ***Hansen's problem***:

-  ***Altimetry computation***: It is of use to compute the height of a set of points from observations carried out in an altimetric network, starting from at least a point with a known height. This option will only be available if there is a current active project.

-  ***Stakeout***: It is of use to generate a file with the observations of angle and distance that must be taken to locate new points on the ground in order to stake out. This option will only be available if there is a current active project.

-  ***Generate observations***: It is of use to generate an observation file from the known coordinates of a set of points. This option will only be available if there is a current active project.

- ***Observations sketches***:

-  ***Least Squares***: It is of use to adjust, by the mathematical method of least squares, a network made up of a set of points between which angular and/or distance and/or altimetric observations have been performed. This option will only be available if there is a current active project. In order to do, it is necessary to have previously computed estimated coordinates of the non-fixed points making up the network.

-  ***Coordinates Transformation***: It is of use to transform the coordinates of a point file into a system or to transform a certain system into another set of points in another file, starting from the knowledge of common points between both systems. This option will only be available if there is a current active project.

4.5. Menu Computations

This menu contains the following commands:

- ***Rectangular to polar***: It computes the azimuth and the distance from the coordinates of two points. This option will only be available if there is a current active point file.

- ***Polar to rectangular***: It computes the coordinates of a point from the ones of another point, an azimuth and a distance. This option will only be available if there is a current active point file.

- ***Intersection of lines***: It computes the coordinates of a point-intersection of two straight lines. These straight lines may be defined by two points or a point and an azimuth. This option will only be available if there is a current active point file.

- ***Intersection of line and circle***: It computes the coordinates of the intersections generated between a straight line and a circle. The straight line may be defined by two points or by a point and an azimuth. The circle may be defined by three points, two points, the centre and the radius or the centre and a point on the circumference of the circle. This option will only be available if there is a current active point file.

- ***Intersection or circles***: It computes the coordinates of the intersections generated between two circles. These may be defined by three points, two points, the centre and the radius or the centre and a point on the circumference of the circle. This option will only be available if there is a current active point file.

- ***Computation of arcs***: It computes an arc defined by three points. It allows storage of its centre coordinates. This option will only be available if there is a current active point file.

- ***Computation of distances***: It computes the distance between two points in UTM projection or as defined by geographic coordinates.

- ***Triangle solver***: It computes the elements of a triangle from the knowledge of three of these elements, either sides or angles.

- ***Maximum and minimum***: It computes the maxima, minima and coordinate increments of a set of points. This option will only be available if there is a current active point file.

- ***Area computations***: It computes the surface of a closed entity formed by a certain set of points. This option will only be available if there is a current active point file.

- ***Profiles***: It generates drawing files with longitudinal or transversal profiles formed by a certain set of points. This option will only be available if there is a current active point file.

- ***Transformations***: It is of use to perform a 2D or 3D transformation from the knowledge of the transformation parameters. This option will only be available if there is a current active point file.

- ***Generate data information***: It generates, from photos, an HTML file with the sketches of the control points or vertices. This option will only be available if there is a current active point file.

- ***Compute average Face1/Face2***: It computes the systematic errors of an instrument from the observation in DC and IC between a set of points. This option will only be available if there is a current active observation file.

- ***Compute average of series:***

- ***Compute accidental errors***:

- ***Levelling***:

- ***Compensation levelling network least squares***:

4.6. Menu Drawing

This menu contains the following commands:

- 1:1 ***Fit window***: It adjusts the view to see the current drawing document enhanced. This option will only be available if there is a current active sketch file.
- ***Refresh View***: It regenerates the window including view of the current drawing document. This option will only be available if there is a current active sketch file.
- ***Zoom Centred***: It centres the current window on a determined point or coordinates. This option will only be available if there is a current active sketch file.
- ***Zoom In***:
- ***Zoom Out***:
- ***Move Window***:
- ***Add line***: It displays a dialog box for registration of geographic entities (lines or arcs) as a junction between file points related to the sketch. This option will only be available if there is a current active sketch file.
- ***Add square***:
- ***Add rectangle***:
- ***Add circle***:

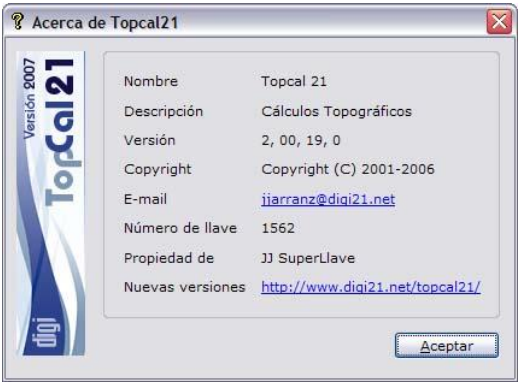
-  ***Add symbol***:
-  ***Add sheet***:
- ***Add parallel***:
- ***Add by keyboard***:
  -  ***Line***:
  -  ***Square***:
  -  ***Rectangle***:
- ***Split line***:
- ***Join line***:
- ***Reading sketches files***:
-  ***Element information***:
- ***Delete entities***:

4.7. Menu Help

This menu contains the following commands:

- ***Help Topics***: It shows the program's help.

- ***About TopCal 21***: It shows information about the version of TopCal 21.



5 Tools

5.1. Orientations

This tool is of use to compute the orientation of a station out of the observations to other points. In order to do it, the existence of coordinates for the station point and the Target point is essential. With those coordinates, the azimuth is computed, and the orientation is computed with the Horizontal angle to the point.

The tool is constructed in 3 steps, leading the user in the computation:

- *Step 1: Enter Input Data* Files
- *Step 2: Station Selection*
- *Step 3: Observations Selection*

The user may move from step to step forward and backward, modifying the data or the selections, making the computation easier.

5.1.1. Step 1: Enter Input Data Files

This is the first step in the orientation. The data required are as follows:

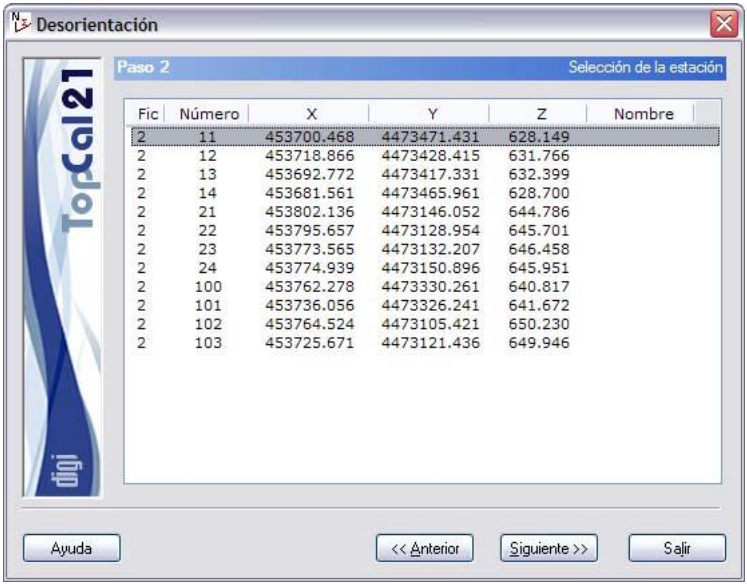
- ***Point files***: The project's point files to be used in the intersections should be selected.
- ***Observation files***: The project's observation files containing the observations used in the computation should be selected.

After these data have been introduced, pressing the button Next will lead to *Step 2: Station Selection*.

5.1.2. Step 2: Station Selection

This is the second step in the orientation.

A screen is shown displaying the points with their coordinates stored in the point files selected in Step 1. On this list, the station whose orientation is going to be computed should be selected.



The list displayed contains the following fields:

- ***File Index***: It indicates the index of the point file where the point is stored. If this field is equal to 0, it means that the point does not currently have any coordinates, consequently it is not stored in any file, but observations from or to known coordinated points exist.
- ***Point number***
- ***ENH coordinates***

- ***Name***

After having selected the station, pressing the button Next will lead to *Step 3: Observations Selection*. Pressing the button Back will lead to *Step 1: Enter Input Data* Files.

5.1.3. Step 3: Observations Selection

This is the third and last step in the orientation.

A screen is shown displaying the observations stored in the observation files selected in Step1.

The list displayed contains the following fields:

- ***File index***: It indicates the observation file index where the observation is stored.
- ***Station point number***
- ***Target point number***
- ***Horizontal angle***
- ***Orientation***

Multiple observations may be selected using the key CTRL and pressing the left mouse button on the desired observations. If an already selected observation is pressed, it will be cancelled.

Observations ordered by ranges can also be selected by pressing the key SHIFT LOCK and the left mouse button on the limit observations defining the range.

Also the buttons All or None may be used to select or cancel all observations.

Depending on the selected observations, the mean orientation will be simultaneously computed and it will be shown in the field ***Mean Orientation***. Select or cancel observations in order to obtain the optimal mean orientation.

After the output data have been set up, the process can be finished by pressing the button Compute. Alternatively, by pressing the button Back, we go back to Step 2: Station Selection.

5.2. Closure of Triangles

This tool is of use to close triangles through the observations taken between the points, whereupon gross errors in those views can be found, since the triangles have to close in 200 grads. Only triangles can be closed if there are direct and reciprocal observations between the points.

The tool is constructed in 3 steps, leading the user in the computation:

- *Step 1: Observation Selection*
- *Step 2: Repeated Non-Reciprocal Observations*
- *Step 3: Resulting Closures*

The user may move from step to step forward and backward, modifying the data or the selections, making the computation easier.

5.2.1. Step 1: Observation Selection

This is the first step when computing the closure of triangles formed by a set of observations. A dialog box is shown with the observations contained in the file. The ones to be used in the computation should be selected.

The list shown contains the following fields:

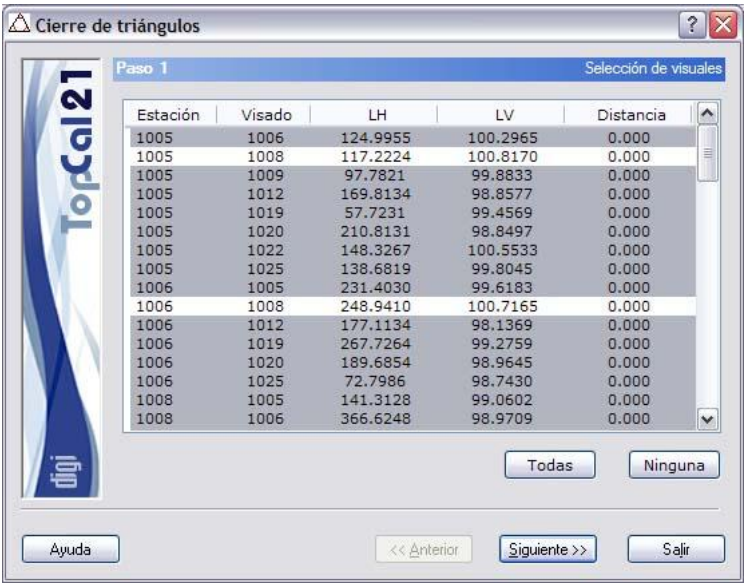
- ***Station point number***
- ***Target point number***
- ***Horizontal angle***

- ***Vertical angle***
- ***Distance***

Multiple observations may be selected using the key CTRL and pressing the left mouse button on the desired observations. If an already selected observation is pressed, it will be cancelled.

Observations ordered by ranges can also be selected by pressing the key SHIFT LOCK and the left mouse button on the limit observations defining the range.

Also the buttons All or None may be used to select or cancel all observations.



After having selected the desired observations, we can carry on to *Step 2: Repeated Non-Reciprocal Observations*, by pressing the button Next.

5.2.2. Step 2: Repeated Non-Reciprocal Observations

In the second step of closure of triangles, an informative dialog box is displayed with the non-reciprocal and repeated observations which were selected in the previous step.

If not in agreement with the data, we can turn back to *Step 1: Observation Selection* by pressing the button Back, or we may want to carry on with the computation, going forward to *Step 3: Resulting Closures*, by pressing the button Next.

5.2.3. Step 3: Resulting Closures

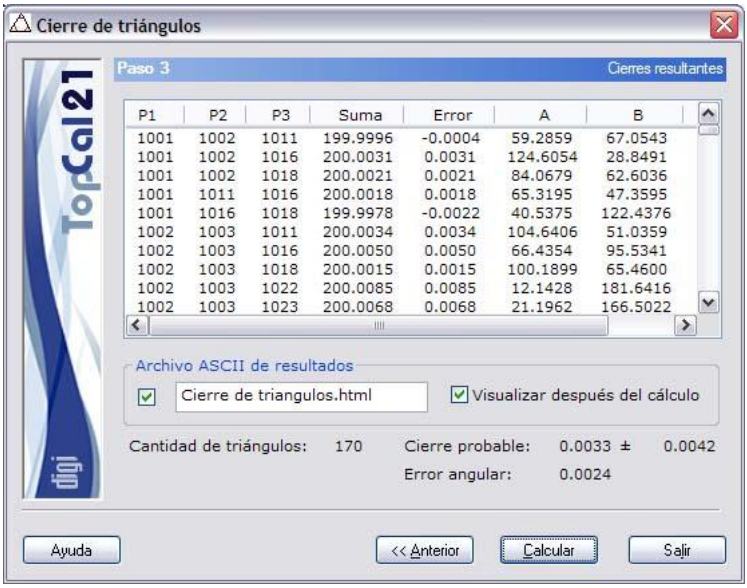
This is the last step in the computation of closure of triangles. A report is shown about the formed triangles and the resultant closure of each of them.

The list shown contains the following fields:

- ***Point 1***
- ***Point 2***
- ***Point 3***
- ***Angle A***, formed by the observations 1-2 and 1-3
- ***Angle B***, formed by the observations 2-1 and 2-3
- ***Angle C***, formed by the observations 3-1 and 3-2
- ***Sum of the three angles***
- Error, as a difference of the sum less 200^{g}

The program shows the number of triangles it has been able to close and the probable closures, as a mean of all of them.

The results can be saved in an ***ASCII Output file*** that needs to have the output file name. After the computation, this file can be viewed with the assigned viewer by activating the checkbox on the bottom named ***Show after computation***. If we do not want to create this file, we will have to deactivate the checkbox on the left of its name. The file will be created in the project directory.



After the output data have been set up, the process can be finished by pressing the button Compute. Alternatively, by pressing the button Back, we turn back to *Step 2: Repeated Non-Reciprocal Observations*.

5.3. Altimetry Computation

This tool is of use to give the height to a series of points when we know the coordinates of at least one of them, starting from multiple observations between the different points making up a network, with or without a known height.

The tool is constructed in five steps, leading the user in the computation:

- *Step 1: Enter Input Data* Files
- *Step 2: Point Selection*
- *Step 3: Observation Selection*
- *Step 4: Results and Generated* Residuals
- *Step 5: Output Data Setup*

The user may move from step to step forward and backward, modifying the data or the selections, making the computation easier.

5.3.1. Step 1: Enter Input Data Files

This is the first step to compute an altimetry compensation of a set of points. The required data are as follows:

- ***Point files***: The project's point files to be used in the compensation should be selected.
- ***Observation files***: The project's observation files containing the observations used in the computation should be selected.

- ***ASCII Output file***: The name of the ASCII output file should be written with the results of the computation. After the computation, this file can be viewed with the assigned viewer by activating the checkbox on the bottom named ***Show after computation***. If we do not want to create this file, we will have to deactivate the checkbox on the left of its name. The file will be created in the project directory.

After having introduced these data, we carry on to *Step 2: Point Selection*, by pressing the button Next.

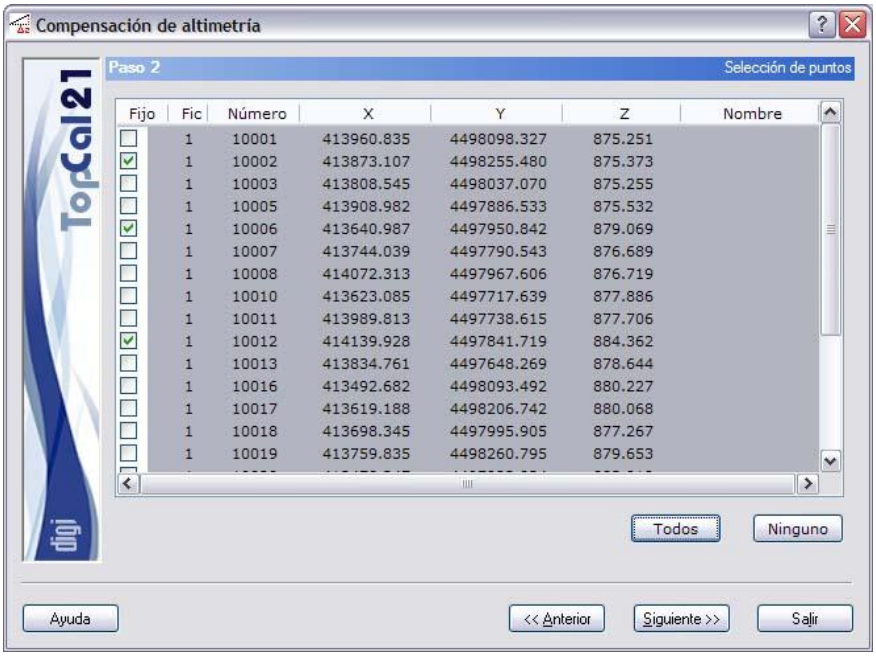
5.3.2. Step 2: Point Selection

This is the second step in the computation of altimetry compensation.

A screen is shown displaying the points with coordinates stored in the point files selected in Step 1, as well as the points which are sighted from these points, or that sight those points, whose observations are in the observation files selected in Step 1.

The list shown contains the following fields:

- ***Checkbox Fixed***: This checkbox indicates whether the point is fixed or not. To activate it or deactivate it, double click with the left mouse button on the desired point.
- ***File index***: It indicates the index of the point file where the point has been stored. If this field is equal to 0, it means that the point does not currently have any coordinates, therefore it is not stored in any file, but there exist observations from or towards points with known coordinates.
- ***Point number***
- ***ENH Coordinates***
- ***Name***



Multiple points may be selected using the key CTRL and pressing the left mouse button on the desired points. If an already selected point is pressed, it will be cancelled.

Points ordered by ranges can also be selected by pressing the key SHIFT LOCK and the left mouse button on the limit points defining the range.

Also the buttons All or None may be used to select or cancel all points.

After having selected the desired points, we carry on to *Step 3: Observation Selection* by pressing the button Next, otherwise we could turn back to *Step 1: Enter Input Data* Files, by pressing the button Back.

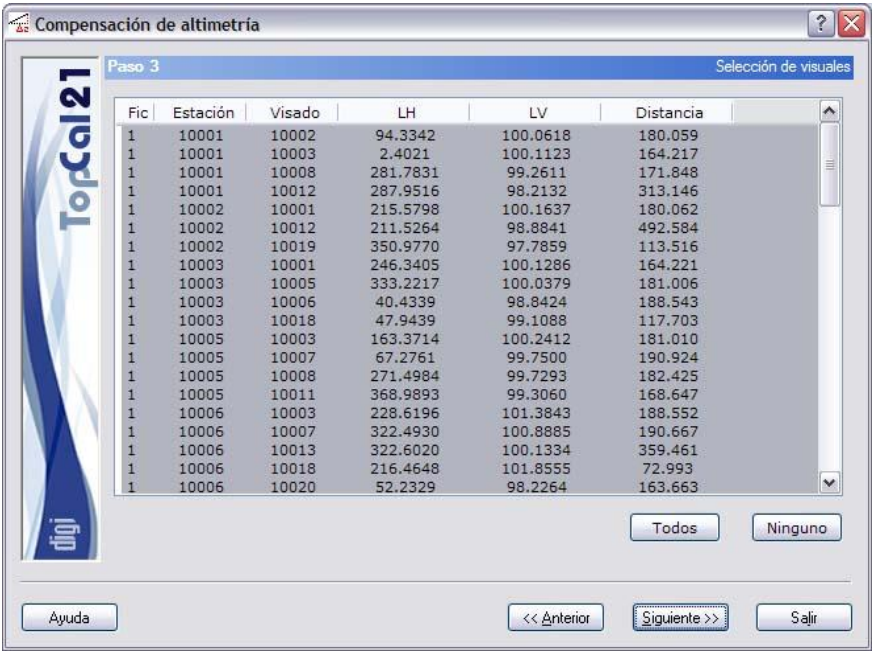
5.3.3. Step 3: Observation Selection

This is the third step in the computation of altimetry compensation.

A screen is shown with the observations stored in the observation files selected in Step 1, to which points contribute that were selected in Step 2.

The list shown contains the following fields:

- ***File index***: It indicates the observation file index where the observation is stored.
- ***Station point number***
- ***Target point number***
- ***Horizontal angle***
- ***Vertical angle***
- ***Distance***



Multiple observations may be selected using the key CTRL and pressing the left mouse button on the desired observations. If an already selected observation is pressed, it will be cancelled.

Observations ordered by ranges can also be selected by pressing the key SHIFT LOCK and the left mouse button on the limit observations defining the range.

Also the buttons All or None may be used to select or cancel all observations.

After having selected the desired observations, we carry on to *Step 4: Results and Generated* Residuals by pressing the button Next, otherwise we could turn back to *Step 2: Point Selection*, by pressing the button Back.

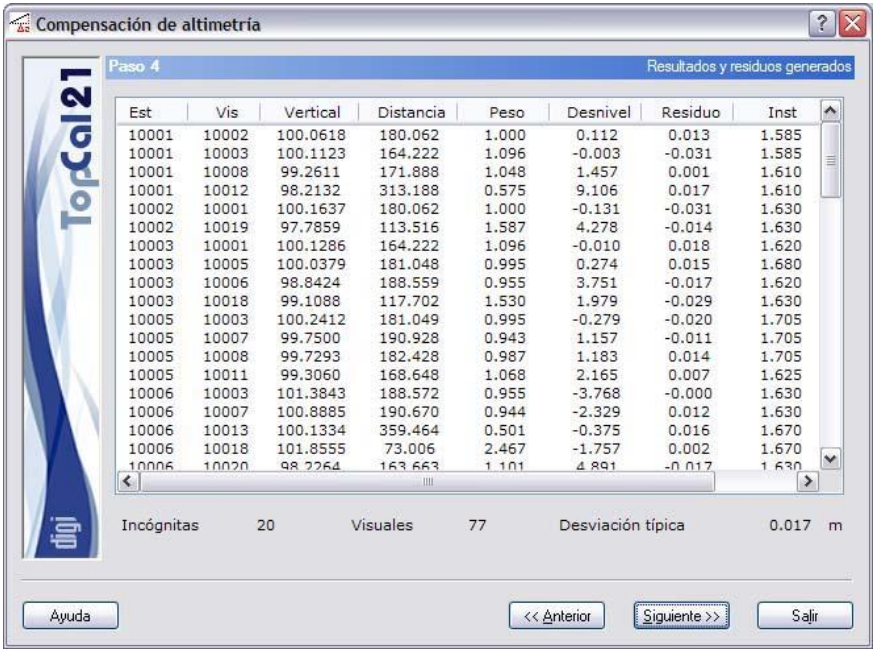
5.3.4. Step 4: Results and Generated Residuals

This is the fourth step in the computation of altimetry compensation.

A screen is shown with the different observations used in the computation. Also shown is the number of unknowns and observations used, as well as the variance of the series.

The following fields are offered:

- ***Station number***
- ***Target point number***
- ***Vertical angle***
- ***Distance***
- ***Weight***: The first observation is assigned weight 1. The remainder of the weights that are assigned are inversely proportional to the distance difference.
- ***Elevation difference***
- ***Residual***
- ***Instrument height***
- ***Reflector height***



Depending on the residuals obtained in the different observations, on the system's variance a posteriori and on the user's precision demands, it may become necessary to go back to the previous step in order to cancel any observation with too large a residual.

This is just an informative step. It is not necessary to select anything. Therefore, you may carry on to *Step 5: Output Data Setup*, by pressing the button Next, or you may turn back to *Step 3: Observation Selection* by pressing the button Back.

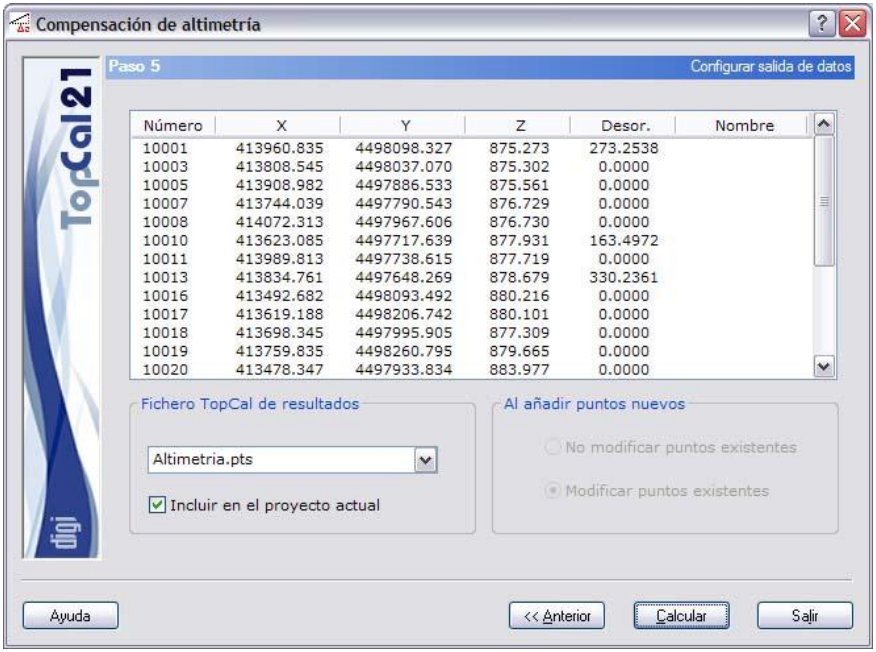
5.3.5. Step 5: Output Data Setup

This is the fifth and last step in the computation of altimetry compensation.

A screen is shown with the final computed coordinates and the way these have to be saved. The following fields appear:

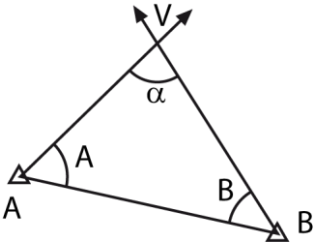
- ***Final coordinates***: A list shows up with the new computed points, their coordinates and orientation.
- ***TopCal output file***: The name of the TopCal file where the points will be stored can be selected. Any of the existing points can be chosen or a new file generated. If we wish to generate a new file, we may or may not add it to the current project.
- ***Adding new points***: If the point file is not new, we may or may not modify the points with the same number they have in the chosen output file.

After the output data have been set up, the process may be finished by pressing the button Compute, or we may turn back to *Step 4: Results and Generated* Residuals, by pressing the button Back.


Compensación de altimetría
Paso 5
Configurar salida de datos
Número X Y Z Desor. Nombre
10001 413960.835 4498098.327 875.273 273.2538
10003 413808.545 4498037.070 875.302 0.0000
10005 413908.982 4497886.533 875.561 0.0000
10007 413744.039 4497790.543 876.729 0.0000
10008 414072.313 4497967.606 876.730 0.0000
10010 413623.085 4497717.639 877.931 163.4972
10011 413989.813 4497738.615 877.719 0.0000
10013 413834.761 4497648.269 878.679 330.2361
10016 413492.682 4498093.492 880.216 0.0000
10017 413619.188 4498206.742 880.101 0.0000
10018 413698.345 4497995.905 877.309 0.0000
10019 413759.835 4498260.795 879.665 0.0000
10020 413478.347 4497933.834 883.977 0.0000
Fichero TopCal de resultados
Altimetria.pts
Incluir en el proyecto actual
Al añadir puntos nuevos
No modificar puntos existentes
Modificar puntos existentes
Ayuda
<< Anterior
Calcular
Salir

5.4. Intersections

This tool is of use to give coordinates to points through intersections. In order to be able to give coordinates to a point, at least two observations are needed from known coordinated points. It is also necessary that in those points be possible to compute the orientation with observations to other points of known coordinates.



As first computation point, the tool will choose the one having most observations to other points of known coordinates. It will then successively give coordinates to all new points.

The tool is constructed in six steps, leading the user in the computation:

- *Step 1: Enter Input Data* Files
- *Step 2: Point Selection*
- *Step 3: Observation Selection*
- *Step 4: Computed Results*
- *Step 5: Generated Residuals*
- *Step 6: Output Data Setup*

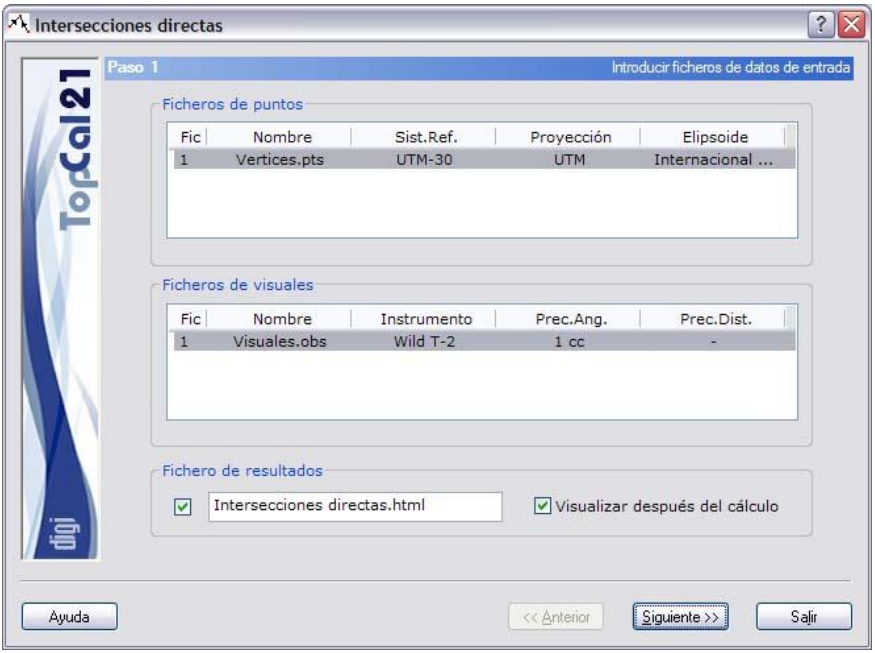
The user may move from step to step forward and backward, modifying the data or the selections, making the computation easier.

5.4.1. Step 1: Enter Input Data Files

This is the first step to compute intersections. The data required are as follows:

- ***Point files***: The project's point files to be used in the intersections should be selected.
- ***Observation files***: The project's observation files containing the observations used in the computation should be selected.
- ***ASCII Output file***: The name of the ASCII output file should be written with the result of the computation. After the computation, this file can be viewed with the assigned viewer by activating the checkbox on the bottom named ***Show after computation***. If we do not want to create this file, we will have to deactivate the checkbox on the left of its name. The file will be created in the project directory.

After these data have been introduced, the button Next may be pressed to carry on to *Step 2: Point Selection*.



5.4.2. Step 2: Point Selection

This is the second step in the computation of intersections.

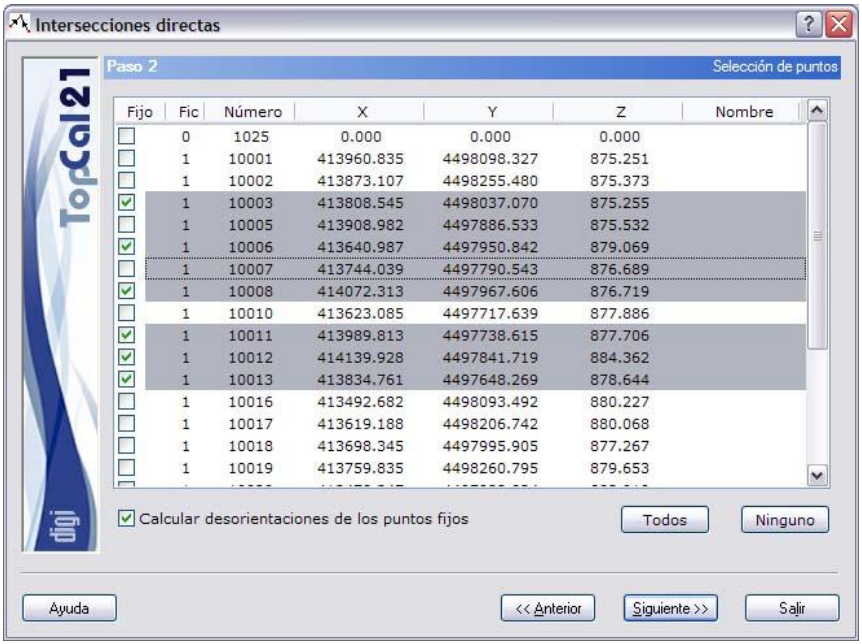
A screen is shown displaying the points with coordinates stored in the point files selected in Step 1, as well as the points which are sighted from these points or that sight those points, whose observations are in the observation files selected in Step 1.

The list shown contains the following fields:

- ***Checkbox Fixed***: This checkbox indicates whether the point is fixed or not. To activate it or deactivate it, double click with the left mouse button on the desired point.

- ***File index***: It indicates the index of the point file where the point has been stored. If this field is equal to 0, it means that the point does not currently have any coordinates, therefore it is not stored in any file, but there exist observations from or towards points with known coordinates.
- ***Point number***
- ***ENH Coordinates***
- ***Name***

Multiple points may be selected using the key CTRL and pressing the left mouse button on the desired points. If an already selected point is pressed, it will be cancelled.



Points ordered by ranges can also be selected by pressing the key SHIFT LOCK and the left mouse button on the limit points defining the range.

Also the buttons All or None may be used to select or cancel all points.

After having selected the desired points, we carry on to *Step 3: Observation Selection*, by pressing the button Next, otherwise we could turn back to *Step 1: Enter Input Data* Files, by pressing the button Back.

5.4.3. Step 3: Observation Selection

This is the third step in the computation of intersections.

A screen is shown with the observations stored in the observation files selected in Step 1, to which contribute points selected in Step 2.

The list shown contains the following fields:

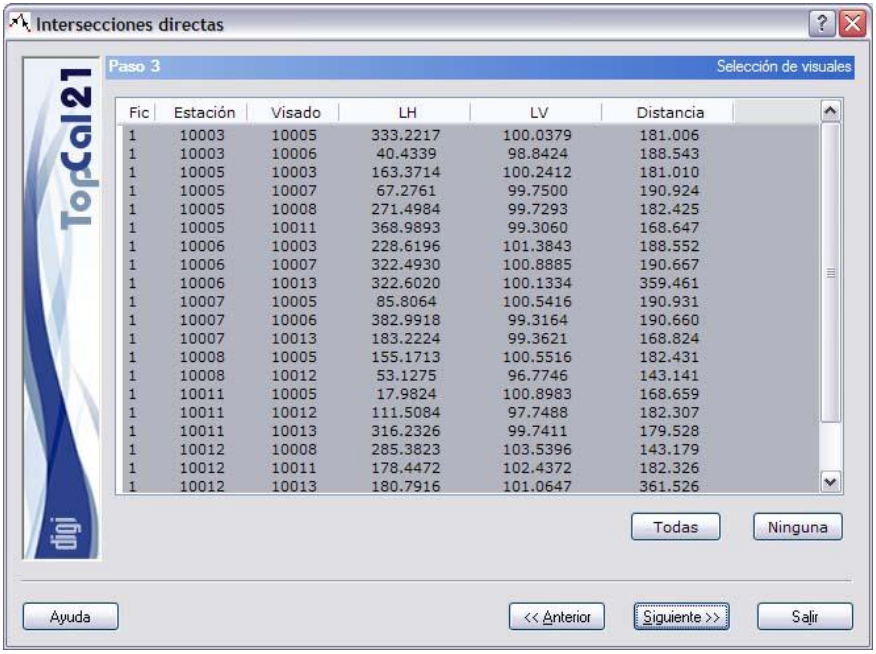
- ***File index***: It indicates the observation file index where the observation is stored.
- ***Station point number***.
- ***Target point number***.
- ***Horizontal angle***.
- ***Vertical angle***.
- ***Distance***.

Multiple observations may be selected using the key CTRL and pressing with the left mouse button on the desired observations. If an already selected observation is pressed, it will be cancelled.

Observations ordered by ranges can also be selected by pressing the key SHIFT LOCK and the left mouse button on the limit observations defining the range.

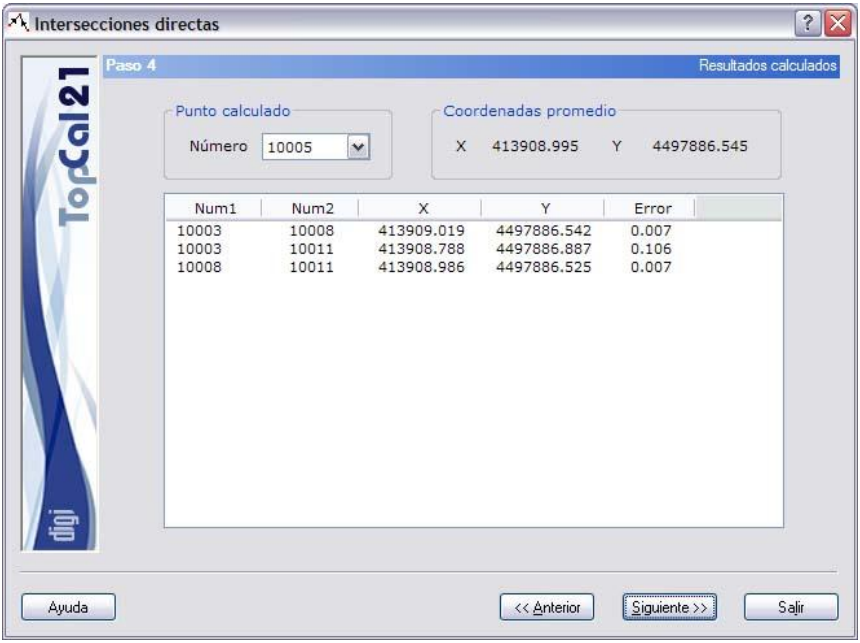
Also the buttons All or None may be used to select all the observations or to cancel them.

After the desired observations have been selected, the button Next may be pressed to carry on to *Step 4: Computed Results*, or the button Back can be pressed to turn back to *Step 2: Point Selection*.



5.4.4. Step 4: Computed Results

This is the fourth step in the computation of intersections.



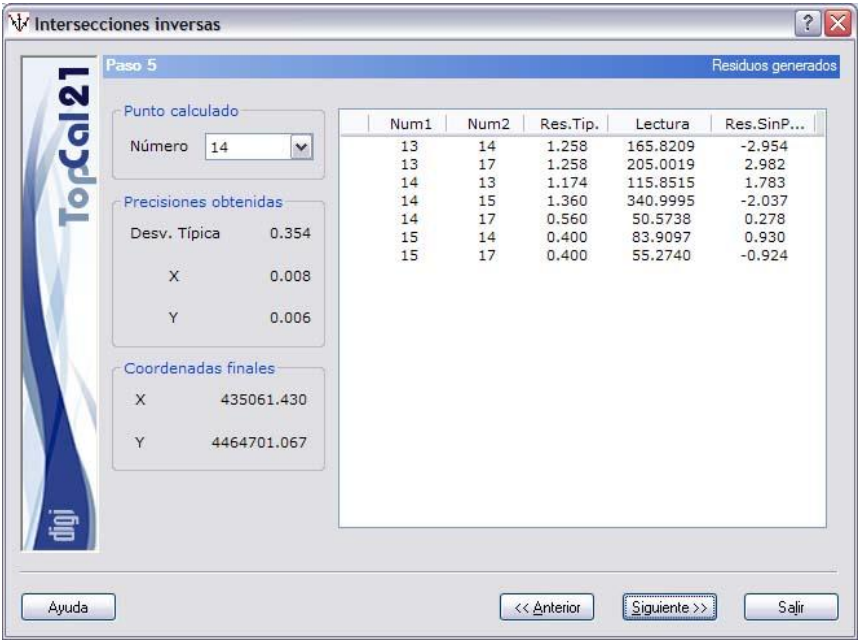
A screen is shown displaying the computed points through intersections. These are the fields offered:

- ***Point number***: A list is given with the different computed points.
- ***Intersections***: A list is shown with the fixed points used in the direct intersections, with the coordinates obtained.
- ***Average coordinates***: Coordinates resulting from averaging the different solutions of all possible intersections at the point.

This is just an informative step. It is not necessary to select anything, so you can carry on to *Step 5: Generated Residuals* setup by pressing the button Next, or turn back to *Step 3: Observation Selection* by pressing the button Back, if any change wants to be made.

5.4.5. Step 5: Generated Residuals

This is the fifth step in the computation of intersections.



A screen is shown displaying the observations used for the computation by least squares. These are the fields offered:

- ***Point number***: A list is given with the different computed points.

- ***Observations***: A list is shown with the different and observations, which could take part in the least square computation of the point coordinates. The station point, Target point and the residual of the observation are shown. If the standardized residual is greater than 3.29, it will be indicated with a mark (#). You should erase this observation from computation to improve the accuracy.

- ***Final coordinates***: Coordinates resulting from applying a least square adjustment to all observations that could help in the computation of the point coordinates.

This is just an informative step. It is not necessary to select anything, so you can carry on to *Step 6: Output Data Setup* by pressing the button Next, or turn back to *Step 4: Computed Results* by pressing the button Back, if any change wants to be made.

5.4.6. Step 6: Output Data Setup

This is the sixth and last step in the computation of intersections.

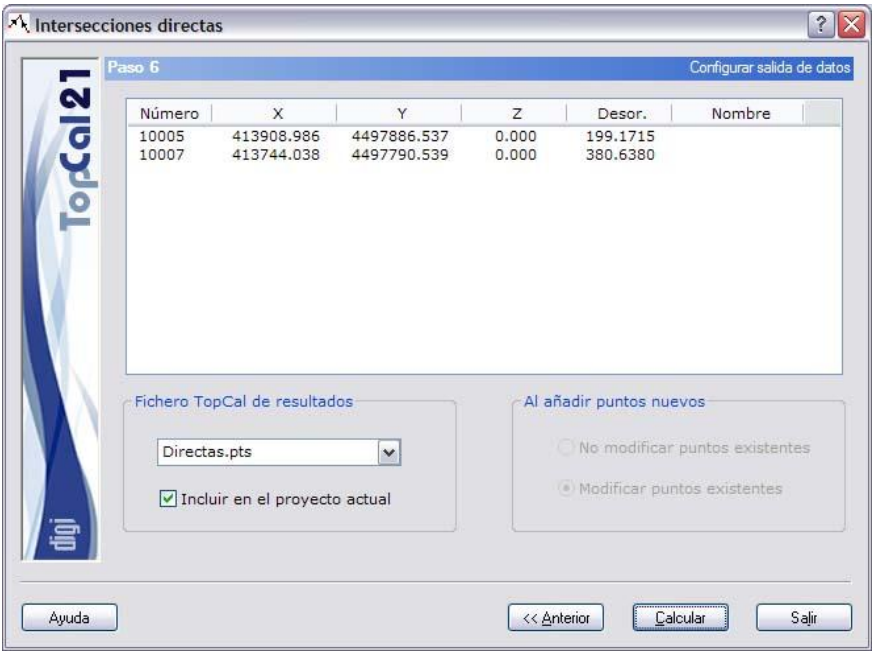
A screen is shown displaying the computed final coordinates as well as the way they should be saved. The following fields appear:

- ***Final coordinates***: A list with the computed new points, their coordinates and orientation is shown.

- ***TopCal output file***: The name of the TopCal file where the points will be stored can be selected. One of the existing points can be chosen or a new file generated. In the latter case, it may or may not be added to the current project file.

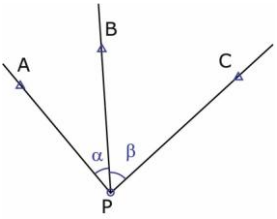
- ***Adding new points***: If the point file is not new, the points with the same number lying in the chosen output file may or may not be modified.

After having set up the output data, the process may be finished by pressing the button Compute, or we may turn back to *Step 5: Generated Residuals*, by pressing the button Back.



5.5. 3-point Resections

This tool is of use to give coordinates to points by means of 3-point resections. In order to be able to give coordinates to a point, at least three observations to points of known coordinates are needed.



The tool will choose as the first computation point the one having more observations to known coordinated points. It will then give coordinates to every new point in succession.

The tool is constructed in six steps, leading the user in the computation:

- *Step 1: Enter Input Data* Files
- *Step 2: Point Selection*
- *Step 3: Observation Selection*
- *Step 4: Computed Results*
- *Step 5: Generated Residuals*
- *Step 6: Output Data Setup*

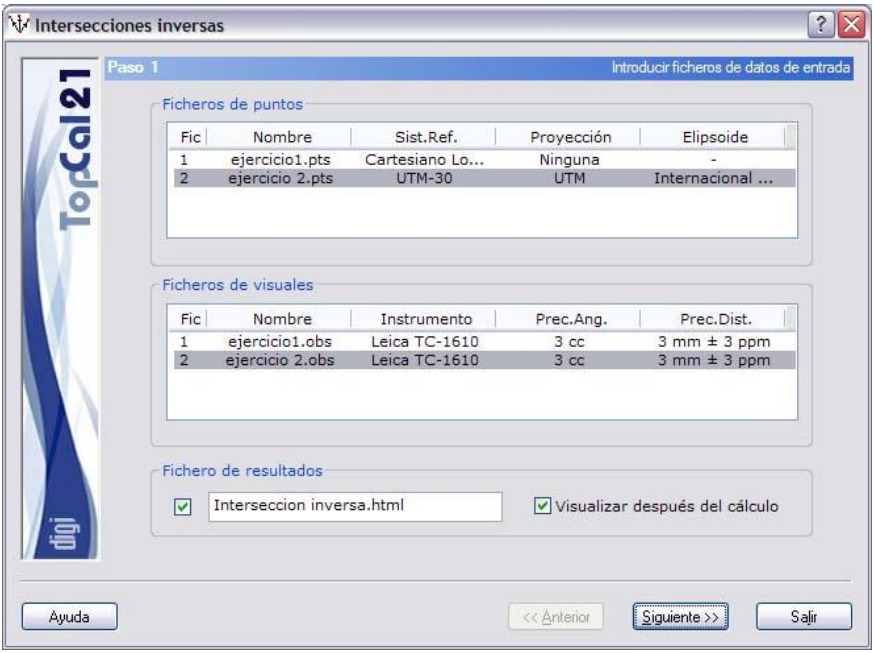
The user may move from step to step forward and backward, modifying the data or the selections, making the computation easier.

5.5.1. Step 1: Enter Input Data Files

This is the first step to compute 3-point resections. The required data are as follows:

- ***Point files***: The project's point files to be used in the intersections should be selected, at least one of them, so as to be able to go on with the computation.
- ***Observation files***: The project's observation files containing the observations used in the computation should be selected, at least one of them, so as to be able to go on with the computation.
- ***ASCII Output file***: The ASCII output file name should be written with the results of the computation. This file can be seen after the computation with the assigned viewer by activating the checkbox on the bottom named ***Show after computation***. If you do not wish to create this file, the checkbox on the left of the name should be deactivated. The file will be created in the project directory.

After having introduced these data, the button Next can be pressed to carry on to *Step 2: Point Selection*.



5.5.2. Step 2: Point Selection

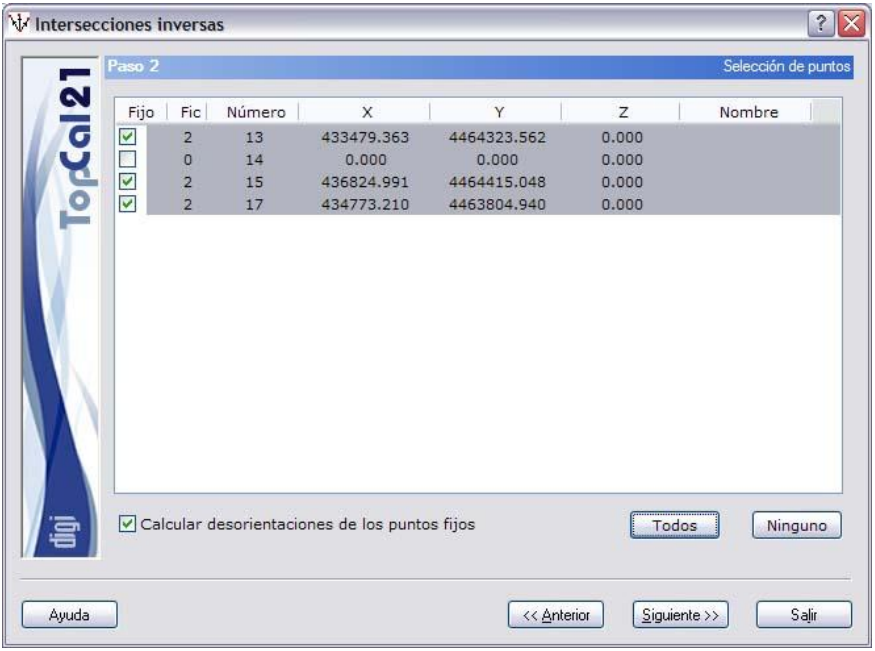
This is the second step in the computation of 3-point resections.

A screen is shown displaying the points with coordinates stored in the point files selected in Step 1, as well as the points being sighted by those points or that sight them, and whose observations are in the observation files selected in Step 1.

The list displayed contains the following fields:

- ***Checkbox Fixed***: It indicates whether the point is or is not fixed (activated or not activated). A double click on the desired point with the left mouse button will accomplish one or the other.

- ***File index***: It indicates the index of the point file where the point is stored. If this field is equal to 0, it means that the point does not currently have any coordinates, therefore it is not stored in any file, but there exist observations from or towards points with known coordinates.
- ***Point number***
- ***ENH Coordinates***
- ***Name***



Multiple points may be selected by using the key CTRL and pressing on the desired points with the left mouse button. If an already selected point is pressed, it will be cancelled.

Points ordered in ranges may also be selected by pressing the key SHIFT LOCK and the left mouse button on the limit points defining the range.

Also the buttons All or None may want to be used to select or not to select all points.

After the desired points have been selected, the button Next can be pressed to carry on to *Step 3: Observation Selection*, or we can turn back to *Step 1: Enter Input Data* Files, by pressing the button Back.

5.5.3. Step 3: Observation Selection

This is the third step in the computation of 3-point resections.

A screen is shown displaying the observations stored in the observation files selected in Step 1, which the selected points in Step 2 take part of.

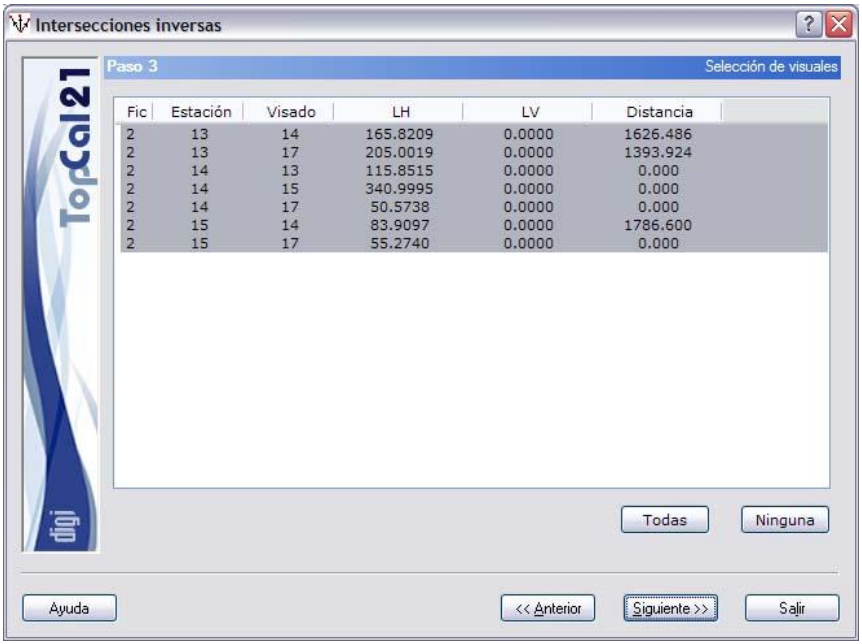
The list displayed contains the following fields:

- ***File index***: It indicates the observation file index where the observation is stored.
- ***Station point number***
- ***Target point number***
- ***Horizontal angle***
- ***Vertical angle***
- ***Distance***

Multiple observations may be selected by using the key CTRL and pressing on the desired observations with the left mouse button. If an already selected observation is pressed, it will be cancelled.

Observations ordered in ranges may also be selected by pressing the key SHIFT LOCK and the left mouse button on the limit observations defining the range.

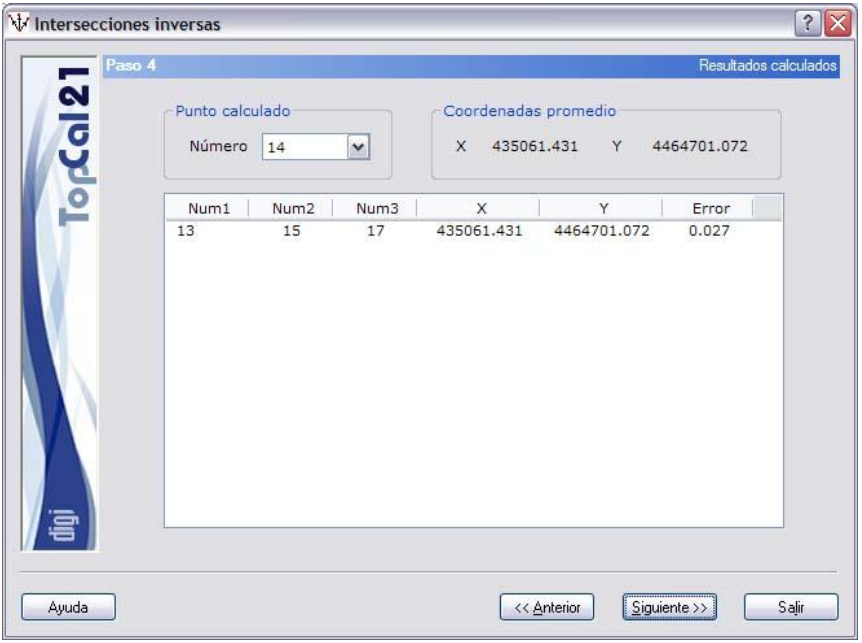
Also the buttons All or None may want to be used to select or not to select all observations.



After the desired observations have been selected, the button Next may be pressed to carry on to *Step 4: Computed Results*, or we may turn back to *Step 2: Point Selection*, by pressing the button Back.

5.5.4. Step 4: Computed Results

This is the fourth step in the computation of 3-point resections.



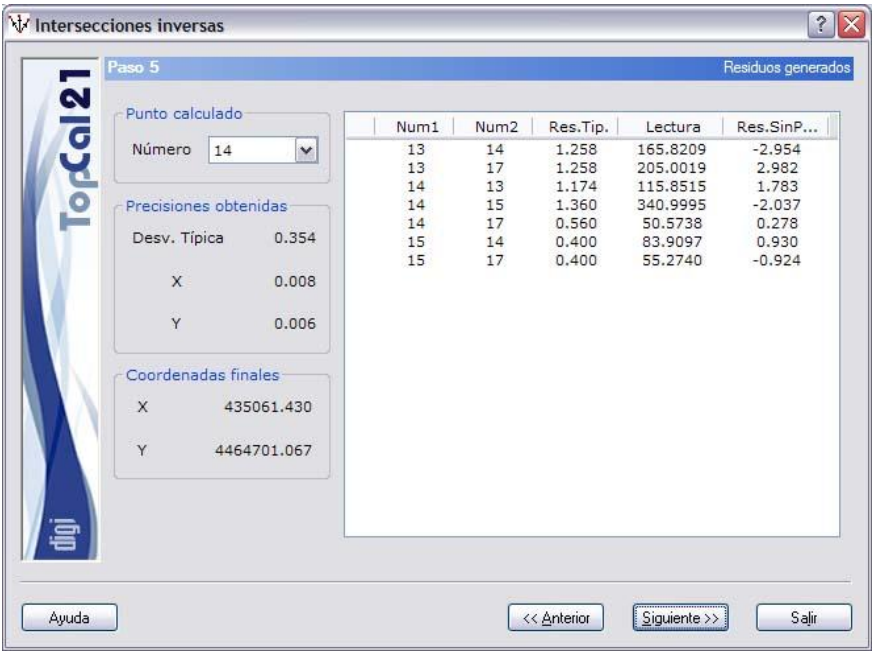
A screen is shown displaying the computed points. The fields offered are as follows:

- ***Point number***: A list is given with the different computed points.
- ***Resections***: A list is shown with the fixed points used in the resections, with the coordinates obtained.
- ***Average coordinates***: Coordinates resulting from averaging the different solutions to all possible direct intersections at the point.

This is just an informative step. It is not necessary to select anything, so you may go ahead with *Step 5: Generated Residuals* by pressing the button Next, or we may turn back to *Step 3: Observation Selection*, by pressing the button Back if any change is necessary.

5.5.5. Step 5: Generated Residuals

This is the fifth step in the computation of 3-point resections.



A screen is shown displaying the observations used for the least square computation. The fields offered are as follows:

- ***Point number***: A list is given with the different computed points.

- ***Observations***: A list is shown with the different and observations, which could take part in the least square computation of the point coordinates. The station point, Target point and the residual of the observation are shown. If the standardized residual is greater than 3.29, it will be indicated with a mark (#). You should erase this observation from computation to improve the accuracy.

- ***Final coordinates***: Coordinates resulting from applying a least square adjustment to all the observations that could help in the computation of the point coordinates.

This is just an informative step. It is not necessary to select anything, so you may go ahead with *Step 6: Output Data Setup* by pressing the button Next, or we may turn back to *Step 4: Computed Results*, by pressing the button Back if any change is necessary.

5.5.6. Step 6: Output Data Setup

This is the sixth and last step in the computation of 3-point resections.

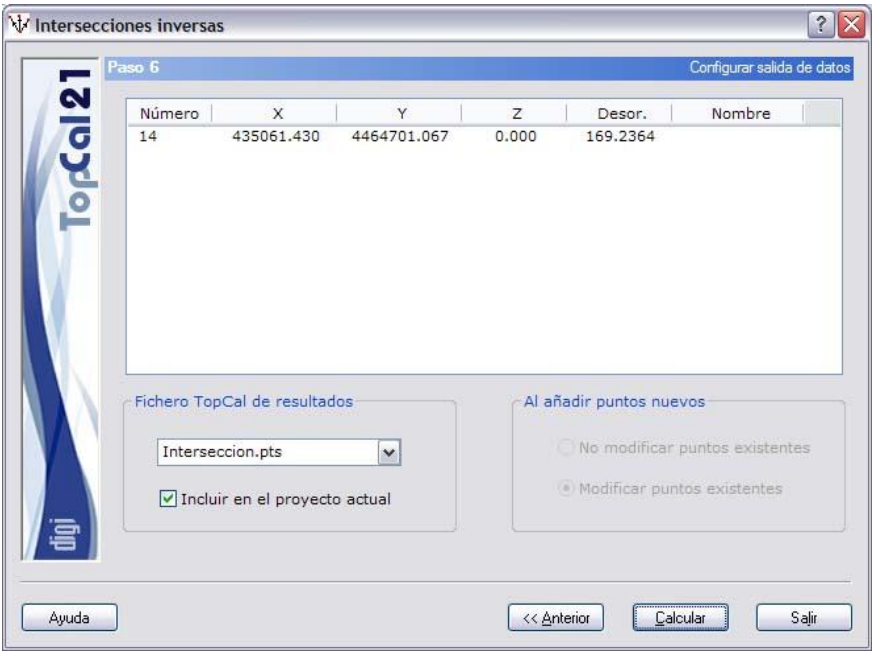
A screen is shown with the computed final coordinates and the way to save them. The following fields are shown:

- ***Final coordinates***: A list is displayed with the computed new points, their coordinates and orientation.

- ***TopCal output file***: The TopCal file name where the points will be stored can be selected. One of the existing points may be chosen or a new file generated. If you wish to generate a new file, you may or may not add it to the current project.

- ***Adding new points***: If the point file is not new, the points with the same number lying in the chosen output file may or may not be modified.

After having set up the output data, the process may be finished by pressing the button Compute, or we may turn back to *Step 5: Generated Residuals*, by pressing the button Back.



5.6. Hansen's problem

5.7. 2-point resection

5.8. Traverses

This tool is of use to compute and compensate topographic traverses.

Traverses may have an axis or several of them and they may be closed-loop, closed in between two stations of known coordinates and orientations, or open.

The tool is constructed in four steps, leading the user in the computation:

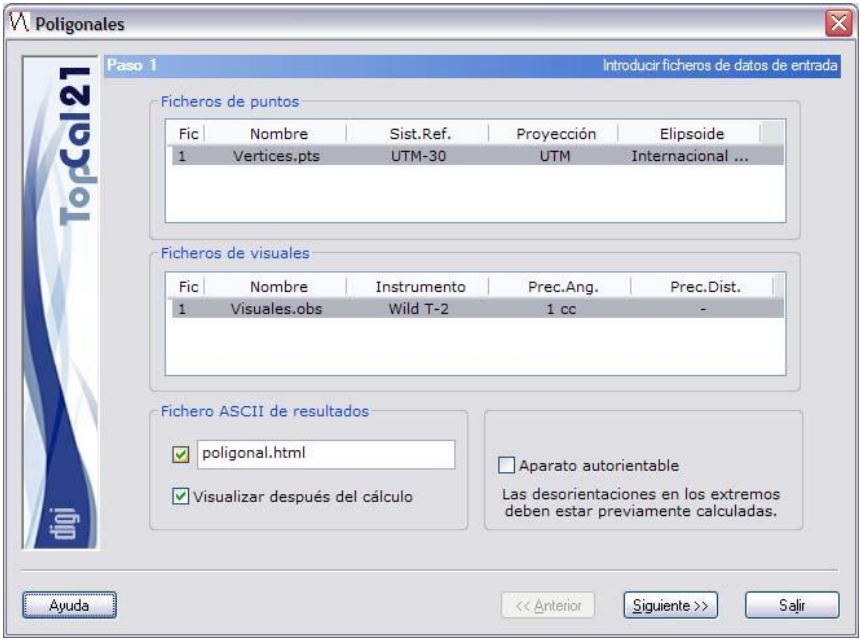
- *Step 1: Enter Input Data* Files
- *Step 2: Point Selection*
- *Step 3: Comparison of distances and height differences*
- *Step 4: Results, closures and* tolerances
- *Step 5: Output Data Setup*

5.8.1. Step 1: Enter Input Data Files

This is the first step to compute traverses. The data required are as follows:

- ***Point files***: The project's point files to be used in the traverse should be selected.

- ***Observation files***: The project's observation files containing the observations used in the computation should be selected.
- ***ASCII Output file***: The name of the ASCII output file with the results of the computation should be written. This file can be seen after the computation with the assigned viewer by activating the checkbox on the bottom named ***Show after computation***. If you do not wish to create this file, the checkbox appearing on the left side of the name should be deactivated. The file will be created in the project directory.



After having introduced these data, we may go ahead to *Step 2: Point Selection*, by pressing the button Next.

5.8.2. Step 2: Point Selection

This is the second step in the computation of traverses.

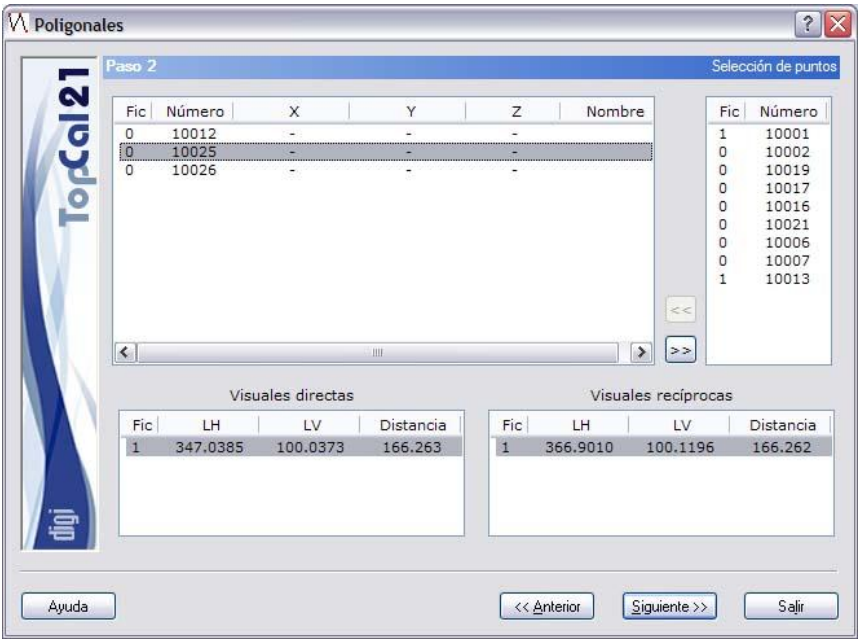
Four lists are shown on screen:

- ***List of available points***: This list is located on the left upper part. It shows all available points in the files selected in Step 1. On this list, the points that are going to make up the traverse should be selected. To add a point to the traverse, double click on the desired point or select it and press the button [>>]. A point can only be added if observations exist between it and the previous one (if it is not the first point). This list gets updated depending on the current station of the traverse, so that only the Target points will be shown from that station. On this list the following fields are displayed:
  - ***File index***: It indicates the index of the point file where the point is stored. If this field is equal to 0, it means that the point does not currently have any coordinates, therefore it is not stored in any file, but there exist observations from the previous station to this point.
  - ***Point number***
  - ***Coordinates ENH***
- ***List of points making up the traverse***: This list is located on the right upper part. It shows the points making up the traverse. They are arranged along the transit of the traverse. A point of the traverse may be deleted by pressing the button [<<]. If a point is deleted in the middle of the traverse, all other points starting from it will be deleted. On this list the following fields are displayed:

- ***File index***: Index of the point file the point belongs to.
- ***Point number***.

- ***List of direct observations (foresight)***: This list is located on the left lower part. It shows the available observations from the last station of the traverse to the point selected on the list of available points. In the event there were several observations, we can choose the one we want to use in the computation. On this list the following fields are displayed:
  - ***File index***
  - ***Horizontal angle***
  - ***Vertical angle***
  - ***Distance***
- ***List of reciprocal observations (backsight)***: This list is located on the right lower part. It shows the available observations from the selected point on the list of available points to the last station of the traverse. In the event there were several observations, we can choose the one we want to use in the computation. On this list the following fields are displayed:
  - ***File index***
  - ***Horizontal angle***
  - ***Vertical angle***
  - ***Distance***

It is only necessary that a distance in each axis exists. In case two distances (direct and reciprocal) exist, they should be reduced and the mean used.



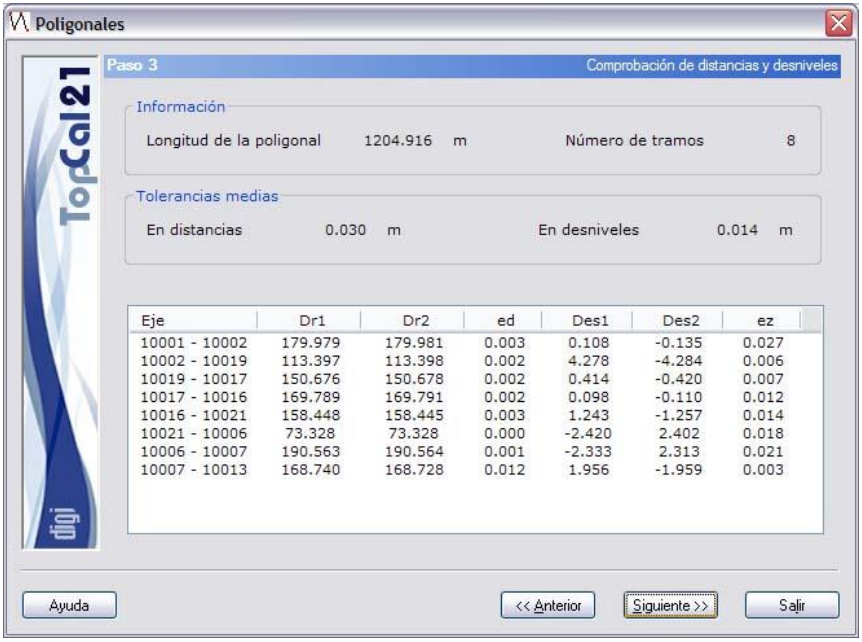
The program allows continuing when there is at least one axis. The traverses may be:

- ***Closed-loop***: A traverse originating and terminating on a single station.
- ***Closed***: A traverse originating and terminating on known coordinated points.

After the traverse has been made up, the button Next may be pressed to carry on to *Step 3: Comparison of distances and height differences*, or the button Back may be pressed to turn back to *Step 1: Enter Input Data* Files.

5.8.3. Step 3: Comparison of distances and height differences

This is the third step in the computation of traverses.



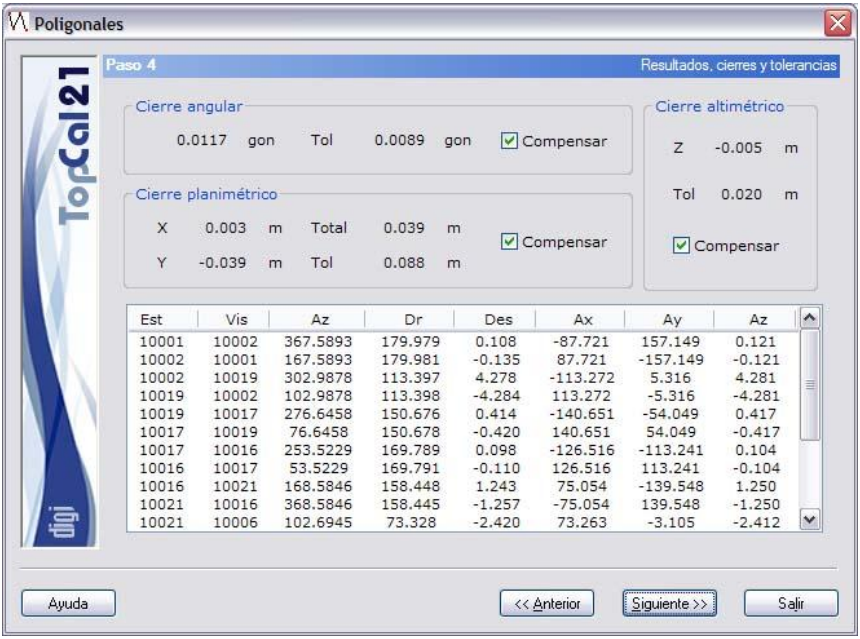
The information is constructed in the following fields:

- ***Length of the traverse***
- ***Number of traverse lines***

If the data obtained are accepted, the button Next may be pressed to carry on to *Step 4: Results, closures and* tolerances, or Back to turn back to *Step 2: Point Selection*.

5.8.4. Step 4: Results, closures and tolerances

This is the fourth step in the computation of traverses. In this step information is displayed about the computed traverse. The different axes and errors of the closures obtained are shown. In the event of not getting the expected results, we can go back to previous steps to make the pertinent changes.



The information is constructed in the following fields:

- ***Angular closure***: Error of angular closure obtained when computing the traverse. This error may be compensated in the different axes by activating the checkbox ***Compensate***. As this checkbox is activated or deactivated, the data are immediately recalculated.

- ***Planimetric closure***: Errors of closure in planimetry obtained when computing the traverse. These errors may be compensated in the different axes proportionally to their distance by activating the checkbox ***Compensate***. As this checkbox is activated or deactivated, the data are immediately recalculated.
- ***Altimetric closure***: Error of closure in altimetry obtained when computing the traverse. This error can be compensated in the different axes proportionally to their distance by activating the checkbox ***Compensate***. As this checkbox is activated or deactivated, the data are immediately recalculated.
- ***List of axes***: The data offered are as follows:
  - ***Station number***
  - ***Target point number***
  - ***Azimuth***
  - ***Reduced distance***
  - ***Elevation difference***
  - ***Horizontal angle***
  - ***Vertical angle***
  - ***Geometric distance***
  - ***Reflector height***
  - ***Instrument height***

If the data obtained are accepted, the button Next may be pressed to carry on to *Step 5: Output Data Setup*, or Back to turn back to *Step 3: Comparison of distances and height differences*.

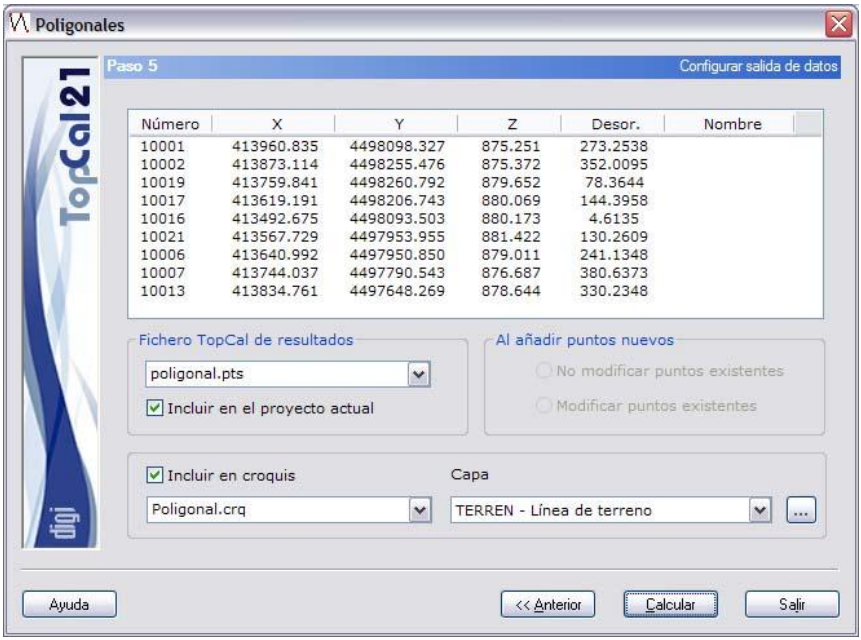
5.8.5. Step 5: Output Data Setup

This is the fifth and last step in the computation of traverses.

A screen is shown with the computed final coordinates and how to save them. The following fields are displayed:

- ***Final coordinates***: A list appears with the computed new points, their coordinates and orientation.
- ***TopCal output file***: The name of the TopCal file where the points will be stored can be selected. One of the existing points may be chosen or a new file generated. If we wish to generate a new file, we may or may not want to add it to the current project.
- ***Adding new points***: If the point file is not new, we may or may not want to modify the points with the same number lying in the chosen output file.

After having set up the output data, the process may be finished by pressing the button Compute, or we may turn back to *Step 4: Results, closures and* tolerances by pressing the button Back.


Poligonales
Paso 5
Configurar salida de datos
Número X Y Z Desor. Nombre
10001 413960.835 4498098.327 875.251 273.2538
10002 413873.114 4498255.476 875.372 352.0095
10019 413759.841 4498260.792 879.652 78.3644
10017 413619.191 4498206.743 880.069 144.3958
10016 413492.675 4498093.503 880.173 4.6135
10021 413567.729 4497953.955 881.422 130.2609
10006 413640.992 4497950.850 879.011 241.1348
10007 413744.037 4497790.543 876.687 380.6373
10013 413834.761 4497648.269 878.644 330.2348
Fichero TopCal de resultados
poligonal.pts
Incluir en el proyecto actual
Al añadir puntos nuevos
No modificar puntos existentes
Modificar puntos existentes
Incluir en croquis
Poligonal.crq
Capa
TERREN - Línea de terreno
Ayuda
<< Anterior
Calcular
Salir

5.9. COGO: Radial Survey

This tool is of use to compute the coordinates of points sighted from another point or station of known coordinates. In order to compute the triad of coordinates of unknown points, horizontal angle, vertical angle and distance are used.

The tool is constructed in four steps, leading the user in the computation:

- *Step 1: Enter Input Data* Files
- *Step 2: Point Selection*
- *Step 3: Observation Selection*
- *Step 4: Output Data Setup*

The user may move from step to step forward and backward, modifying the data or the selections, making the computation easier.

5.9.1. Step 1: Enter Input Data Files

This is the first step in radial survey computation. The data required are as follows:

- ***Point files***: The project's point files to be used in the radial survey should be selected.
- ***Observation files***: The project's observation files containing the observations used in the computation should be selected.

- ***ASCII Output file***: The name of the ASCII output file should be written with the results of the computation. This file can be viewed after the computation with the assigned viewer by activating the checkbox located on the bottom named ***Show after computation***. If we do not wish to create this file, the checkbox appearing on the left of the name should be deactivated. The file will be created in the project directory.

After having introduced these data, the button Next can be pressed to go on to *Step 2: Point Selection*.

5.9.2. Step 2: Point Selection

This is the second step in radial survey computation.

A screen is shown giving the points with coordinates stored in the point files selected in Step 1. The station points should be selected where the remainder of the points will be computed from.

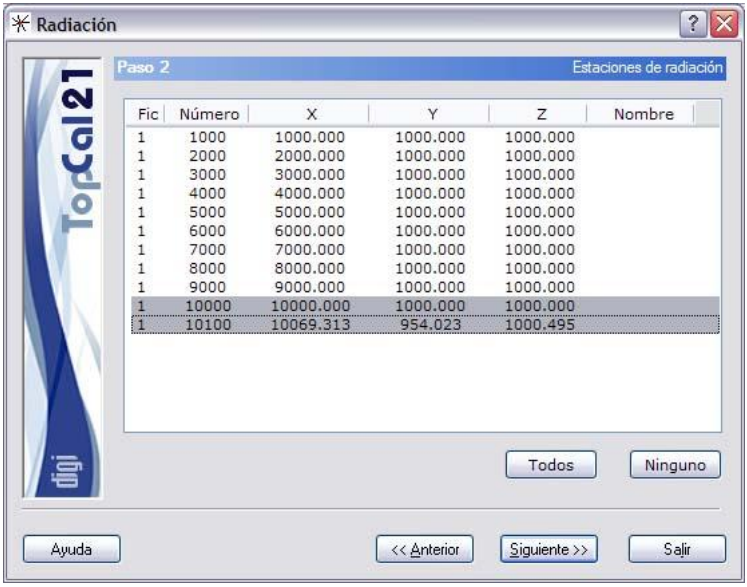
The list shown contains the following fields:

- ***File index***: It indicates the index of the point file where the point is stored.
- ***Point number***
- ***Coordinates ENH***
- ***Name***

Multiple points may be selected by using the key CTRL and pressing on the desired points with the left mouse button. If an already selected point is pressed, it will be cancelled.

Points ordered in ranges can also be selected by pressing the key SHIFT LOCK and the left mouse button on the limit points defining the range.

The buttons All or None can also be used to select or cancel all points.



After having selected the desired points, the button Next may be pressed to carry on to *Step 3: Observation Selection* or the button Back, to turn back to *Step 1: Enter Input Data* Files.

5.9.3. Step 3: Observation Selection

This is the third step in radial survey computation.

A screen is shown with the observations stored in the observation files selected in Step 1, whose stations are the ones selected in Step 2. In this step we should select the points we want to compute and the observations we want to do it with.

The list shown contains the following fields:

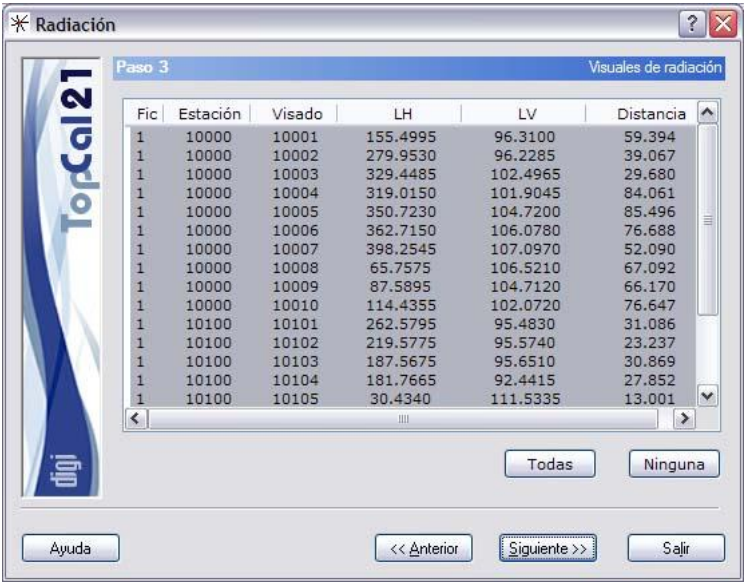
- ***File index***: It indicates the observation file where the observation is stored.

- ***Station point number***
- ***Target point number***
- ***Horizontal angle***
- ***Vertical angle***
- ***Distance***

Multiple observations may be selected by using the key CTRL and pressing on the desired observations with the left mouse button. If an already selected observation is pressed, it will be cancelled.

Observations ordered in ranges can also be selected by pressing the key SHIFT LOCK and the left mouse button on the limit observations defining the range.

The buttons All or None can also be used to select or cancel all observations.



Fic	Estación	Visado	LH	LV	Distancia
1	10000	10001	155.4995	96.3100	59.394
1	10000	10002	279.9530	96.2285	39.067
1	10000	10003	329.4485	102.4965	29.680
1	10000	10004	319.0150	101.9045	84.061
1	10000	10005	350.7230	104.7200	85.496
1	10000	10006	362.7150	106.0780	76.688
1	10000	10007	398.2545	107.0970	52.090
1	10000	10008	65.7575	106.5210	67.092
1	10000	10009	87.5895	104.7120	66.170
1	10000	10010	114.4355	102.0720	76.647
1	10100	10101	262.5795	95.4830	31.086
1	10100	10102	219.5775	95.5740	23.237
1	10100	10103	187.5675	95.6510	30.869
1	10100	10104	181.7665	92.4415	27.852
1	10100	10105	30.4340	111.5335	13.001

After the desired observations have been selected, the button Next may be pressed to carry on to *Step 4: Output Data Setup* or the button Back, to turn back to *Step 2: Point Selection*.

5.9.4. Step 4: Output Data Setup

This is the fourth and last step in radial survey computation.

The following fields are shown:

- ***TopCal output file***: The name of the TopCal file where the points will be stored can be selected. One of the existing files may be chosen or a new file generated. If we wish to generate a new file, we may or may not want to add it to the current project.
- ***Adding new points***: If the point file is not new, we may or may not want to modify the points with the same number lying in the chosen output file.

After having set up the output data, the process may be finished by pressing the button Compute, or we may turn back to *Step 3: Observation Selection* by pressing the button Back.

5.10. Stakeout

This tool is of use to obtain angular and distance observations in order to put back or place non-existent points on the ground. This is called stakeout.

The tool is constructed in three steps, leading the user in the computation:

- *Step 1: Enter Input Data* Files
- *Step 2: Station Point Selection*
- *Step 3: Target point Selection*

The user may move from step to step forward and backward, modifying the data or the selections, making the computation easier.

5.10.1. Step 1: Enter Input Data Files

This is the first step to compute the stakeout data. The data required are as follows:

- ***Point files***: The project's point files to be used in the computation of the stakeout data should be selected.
- ***Stakeout maximal distance***: A stakeout maximal distance should be established in general terms. This distance may be changed afterwards for each particular station. Beyond that distance, the stakeout data from a determined station will not be computed.

- ***ASCII Output file***: The name of the ASCII output file should be written with the results of the computation. This file can be viewed after the computation with the assigned viewer by activating the checkbox on the bottom named ***Show after computation***. The file will be created in the project directory.

After having introduced these data, the button Next can be pressed to carry on to *Step 2: Station Point Selection*.

5.10.2. Step 2: Station Point Selection

This is the second step in the computation of the stakeout data.

A screen is shown giving the points with coordinates stored in the point files selected in Step 1. The station points should be selected. From them the stakeout data of the remainder of the points will be computed.

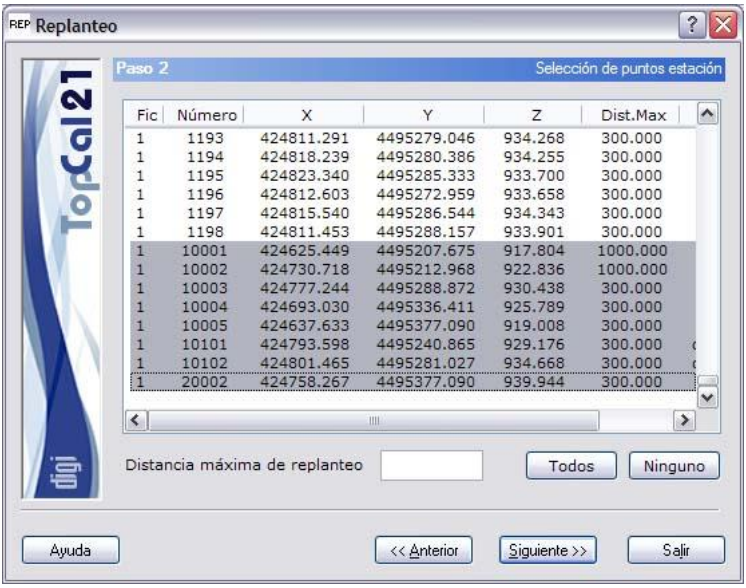
The list shown contains the following fields:

- ***File index***: It indicates the index of the point file where the point is stored.
- ***Point number***
- ***Coordinates ENH***
- ***Stakeout maximal distance***

Multiple points may be selected by using the key CTRL and pressing on the desired points with the left mouse button. If an already selected point is pressed, it will be cancelled.

Points ordered in ranges can also be selected by pressing the key SHIFT LOCK and the left mouse button on the limit points defining the range.

The buttons All or None can also be used to select or cancel all points.



A field called ***Stakeout maximal distance*** also shows up, which is useful to change the distance for each station independently. If we want to change this distance for several points, it is possible to select the ones we want and to write down the new distance, which will be updated for all of them.

After having selected the desired points, the button Next may be pressed to carry on to *Step 3: Target point Selection* or button Back, to turn back to *Step 1: Enter Input Data* Files.

5.10.3. Step 3: Target point Selection

This is the third and last step in the computation of the stakeout data.

A screen is shown giving the points with coordinates stored in the point files selected in Step 1 that have not been selected as station points in Step 2. Now, the Target points should be selected, for which the stakeout data will be computed from the station points selected in the previous step.

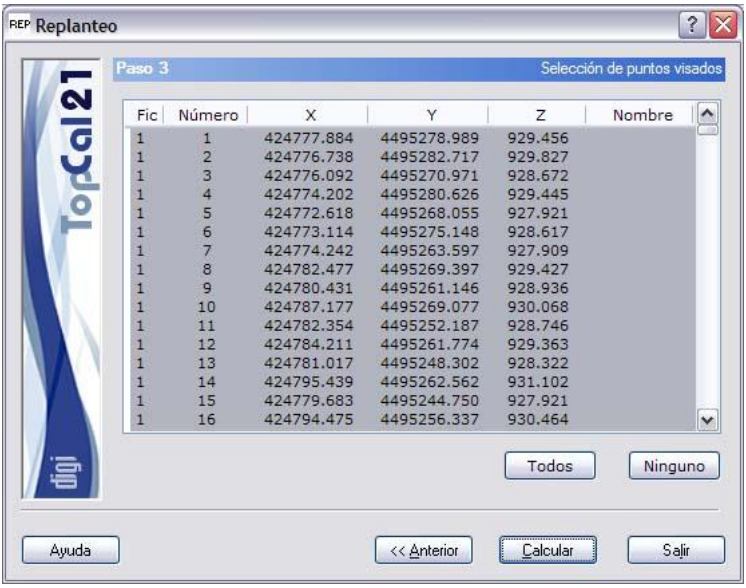
The list shown contains the following fields:

- ***File index***: It indicates the index of the file point where the point is stored.
- ***Point number***
- ***Coordinates ENH***

Multiple points may be selected by using the key CTRL and pressing on the desired points with the left mouse button. If an already selected point is pressed, it will be cancelled.

Points ordered in ranges can also be selected by pressing the key SHIFT LOCK and the left mouse button on the limit points defining the range.

The buttons All or None can also be used to select or cancel all points.



After having set up the output data, the process may be finished by pressing the button Compute, or we may turn back to *Step 2: Station Point Selection* by pressing the button Back.

5.11. Transformation

This tool is of use to transform the coordinates of points stored in a file belonging to a coordinate system into another coordinate system, starting from the coordinates of points that are common to the first system.

Starting from the common data, the application computes transformation parameters that will apply to the remainder of the file points. It will assign them to the new coordinate system.

The tool is constructed in five steps, leading the user in the computation:

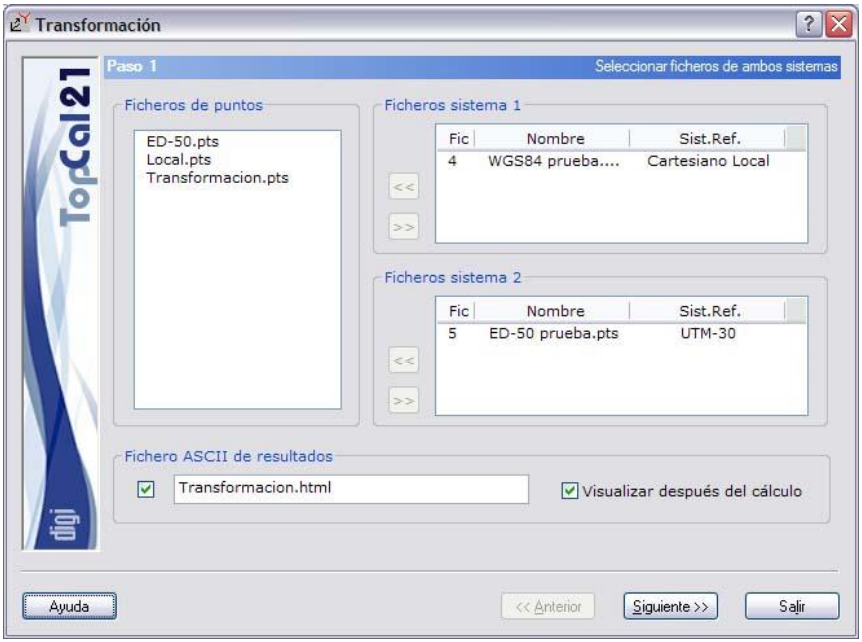
- *Step 1: Reference system files selection*
- *Step 2: Common Points to Both Systems*
- *Step 3: Residuals*
- *Step 4: Transformation parameters*
- *Step 5: Transformed Points and Output*

The user may move from step to step forward and backward, modifying the data or the selections, making the computation easier.

5.11.1. Step 1: Reference system files selection

This is the first step to compute transformation. The data required are as follows:

- ***Point files***: The project's point files to be used in the transformation should be selected. With the buttons >> located on the right side of the dialog box, we should select the files taking part of the coordinate system 1 and the ones taking part of the coordinate system 2.
- ***Files system 1***: These files contain the common points necessary to transform the points of the system 2 into that system.
- ***Files system 2***: These files contain the common points necessary to transform the non-common points of these files to system 1.
- ***ASCII Output file***: The name of the ASCII output file should be written with the results of the computation. This file can be viewed after the computation with the assigned viewer by activating the checkbox on the bottom named ***Show after computation***. If we do not wish to create this file, the checkbox appearing on the left of the name should be deactivated. The file will be created in the project directory.



After having introduced these data, the button Next can be pressed to carry on to *Step 2: Common Points to Both Systems*.

5.11.2. Step 2: Common Points to Both Systems

This is the second step in the computation of transformation.

A screen is shown with the common points to both systems belonging to the point files selected in Step 1. The points with which the transformation will be carried out should be selected.

On the bottom of the dialog box, the type of transformation to be carried out is indicated:

- ***Helmert 2 dimensions***

- ***Helmert 3 dimensions***
- ***Helmert 2 dimensions centroid***
- ***Helmert 3 dimensions*** *¡Error! Marcador no definido.* ***centroid***
- ***Affine 2 dimensions***
- ***Affine 2 dimensions centroid***
- ***Translation EN***
- ***Translation H***
- ***Translation 3D***

The list shown contains the following fields:

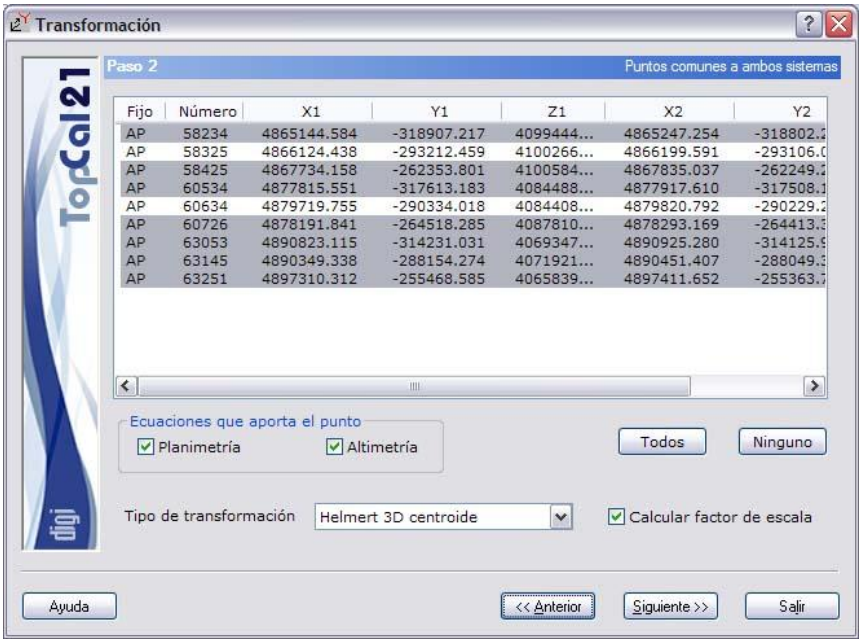
- ***Point number***
- ***Coordinates in system 1***
- ***Coordinates in system 2***

Depending on the type of transformation chosen, E and N coordinates will be shown (2 dimensions) or E, N and H (3 dimensions) in both systems.

Multiple points may be selected by using the key CTRL and pressing on the desired points with the left mouse button. If an already selected point is pressed, it will be cancelled.

Points ordered in ranges can also be selected by pressing the key SHIFT LOCK and the left mouse button on the limit points defining the range.

The buttons All or None can also be used to select or cancel all points.



After having selected the desired points, the button Next may be pressed to carry on to *Step 3: Residuals* or button Back, to turn back to *Step 1: Reference system files selection*.

5.11.3. Step 3: Residuals

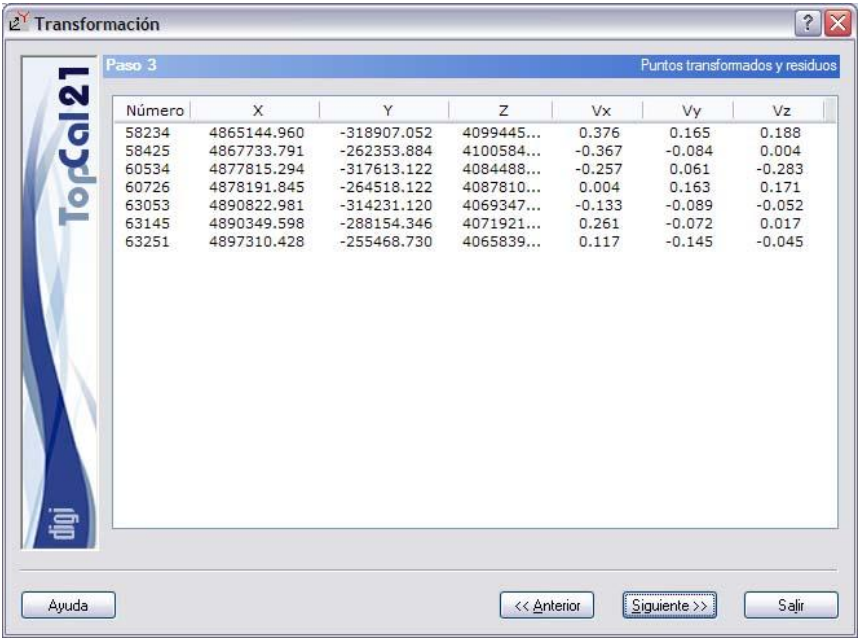
This is the third step in the computation of transformation.

A screen is shown with the residual of the transformed common points. The list shown contains the following fields:

- ***Point number***
- ***Residual of the coordinates***

Depending on the type of transformation chosen in Step 2, on this list only the planimetric coordinates and its residuals will show up or the triad of coordinates and its respective residuals.

If any point had too large a residual, depending on the characteristics and goal of the transformation, it would be adequate; if possible, to reject it for the computation, therefore it would be necessary to go back to the previous step to cancel it.

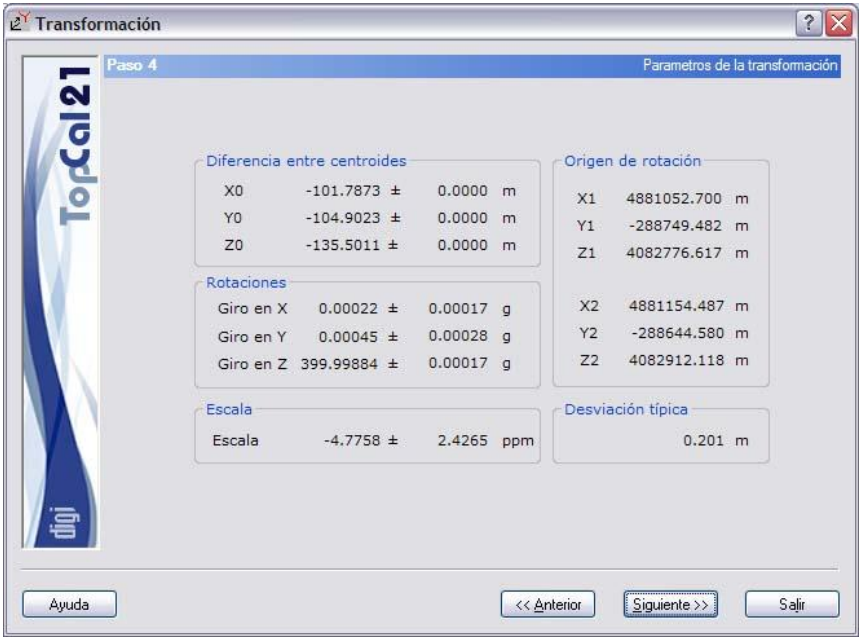


After having accepted the data shown, the button Next may be pressed to carry on to *Step 4: Transformation parameters* or button Back, to turn back to *Step 2: Common Points to Both Systems*.

5.11.4. Step 4: Transformation parameters

This is the fourth step in the computation of transformation.

A screen is shown with the computed transformation parameters: ***rotation angles***, ***translations*** and ***scale factor***.



The transformation parameters shown depend on the type of transformation selected in the previous step, so for the computation in two dimensions the parameters will be: Rotation, X0, Y0 and Scale; and for a computation in three dimensions, they will be: Omega, Phi, Kappa, X0, Y0, Z0 and Scale.

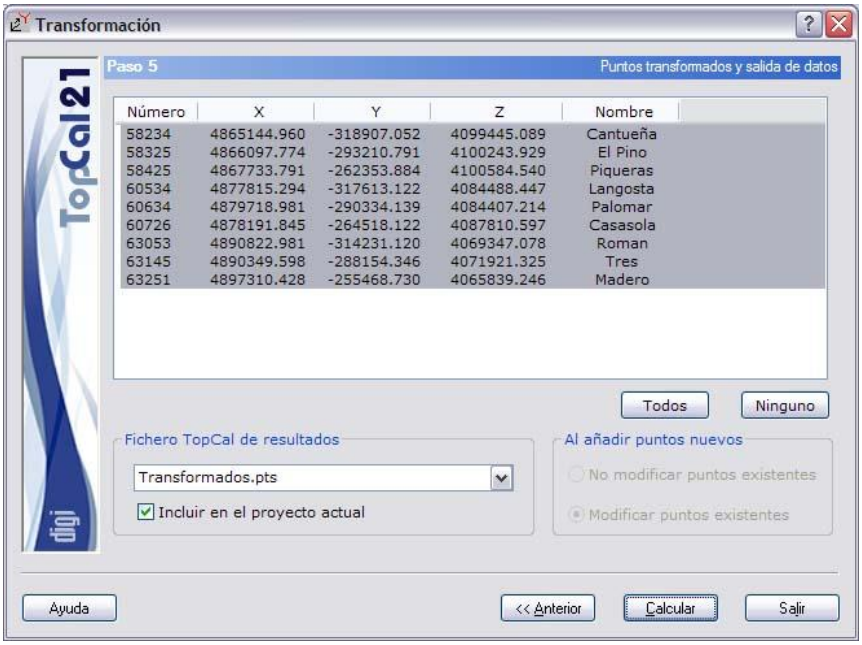
After having accepted the data shown, the button Next may be pressed to carry on to *Step 5: Transformed Points and Output* or button Back, to turn back to *Step 3: Residuals*.

5.11.5. Step 5: Transformed Points and Output

This is the fifth and last step in the computation of transformation.

The following fields are shown:

- ***List of transformed non-common points***: A list of the remainder of points belonging to system 2 is displayed, with the coordinates assigned and already transformed into system 1. On this list it is possible to select the points that will be transformed and stored.
- ***TopCal output file***: The name of the TopCal file where the points will be stored can be selected. One of the existing points may be chosen or a new file generated. If we want to generate a new file, we may or may not want to add it to the current project.
- ***Adding new points***: If the point file is not new, we may or may not modify the points with the same number lying in the chosen output file.



After having set up the output data, the process may be finished by pressing the button Compute, or we may turn back to *Step 4: Transformation parameters* by pressing the button Back.

5.12. Generate observations

This tool is of use to generate a field notebook starting from a set of known coordinated points. In other words, it is the opposite of radial survey.

The tool is constructed in 4 steps, leading the user in the computation:

- *Step 1: Enter Input Data* files
- *Step 2: Station Setup*
- *Step 3: Target point Selection*
- *Step 4: Output Data Setup*

The user may move from step to step forward and backward, modifying the data or the selections, making the computation easier.

5.12.1. Step 1: Enter Input Data files

This is the first step to generate observations. The data required are as follows:

- ***Point files***: The project's point files to be used should be selected.
- ***ASCII Output file***: The name of the ASCII output file should be written with the results of the computation. This file can be viewed after the computation with the assigned viewer by activating the checkbox on the bottom named ***Show after computation***. If we do not wish to create this file, the checkbox on the left of the name should be deactivated. The file will be created in the project directory.

After having introduced these data, the button Next can be pressed to carry on to Step 2: Station Setup.

5.12.2. Step 2: Station Setup

This is the second step to generate observations.

A screen is shown giving the points with coordinates stored in the point files selected in Step 1. Only one station point should be selected where the respective observations will be generated from.

The list shown contains the following fields:

- ***File index***: It indicates the index of the point file where the point is stored.
- ***Point number***
- ***Coordinates ENH***

After having selected the station point, its orientation in grads should be indicated, as well as the heights of the rod and instrument in meters.

After having selected the station, the button Next may be pressed to carry on to *Step 3: Target point Selection* or button Back, to turn back to *Step 1: Enter Input Data* files.

5.12.3. Step 3: Target point Selection

This is the third step to generate observations.

A screen is shown with the points stored in the files selected in Step 1, provided it is not the station selected in Step 2. In this step the points that are going to generate the observations should be selected.

The list shown contains the following fields:

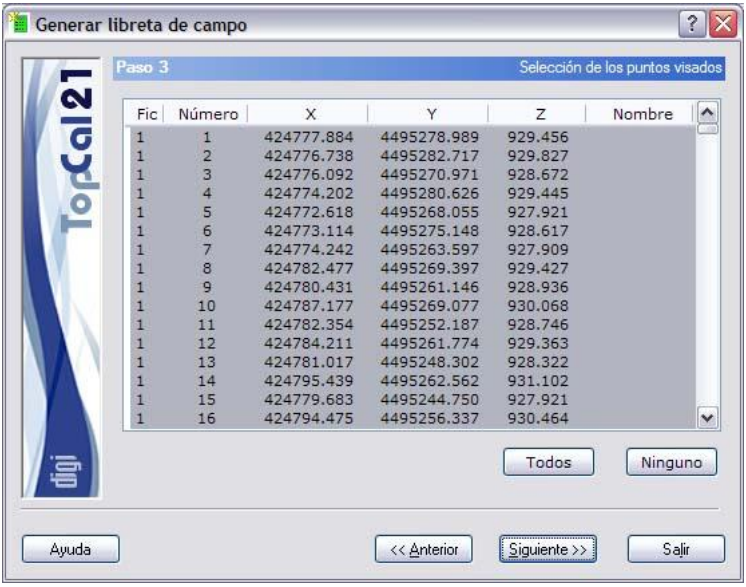
- ***File index***: It indicates the index of the observation file where the observation is stored.
- ***Point number***
- ***Coordinates ENH***

Multiple points may be selected by using the key CTRL and pressing on the desired points with the left mouse button. If an already selected point is pressed, it will be cancelled.

Points ordered in ranges can also be selected by pressing the key SHIFT LOCK and the left mouse button on the limit points defining the range.

The buttons All or None can also be used to select or cancel all points.

A maximal distance in meters may be indicated so as to avoid generation of observations beyond that distance.



After having selected the desired points, the button Next may be pressed to carry on to *Step 4: Output Data Setup* or button Back, to turn back to *Step 2: Station Setup*.

5.12.4. Step 4: Output Data Setup

This is the fourth and last step in the generation of observations.

The following fields are shown:

- ***List with the generated observations***: Here the station number, Target point number, Horizontal angle, Vertical angle and geometric distance are indicated.

- ***TopCal output file***: The name of the TopCal file where the observations will be stored may be selected. One of the existing files may be chosen or a new file generated. If we wish to generate a new file, we may or may not add it to the current project.

- ***Adding new observations***: If the observation file is not new, we may or may not modify the observations with the same stations and same Target point lying in the chosen output file.

After having set up the output data, the process may be finished by pressing the button Compute, or we may turn back to *Step 3: Target point Selection* by pressing the button Back.

5.13. Compensation by Least Squares

This tool is used to give ENH coordinates to points by means of the least square compensation of a set of observations carried out between them. These may be angular observations, distance observations or differences in elevation. It also allows giving weights to these observations according to the characteristics of the material used and properties of the observations themselves.

Once the compensation has been completed, the program performs a statistical test to locate grossly erroneous observations that will allow refining the computation.

In order to perform the horizontal computation it is necessary to previously calculate the approximate coordinates of the points that need to be adjusted. The computation is based on the selection of one or several fixed points, this means, with coordinates that are considered known and immovable, and based on these the rest of the points are calculated.

It is not necessary for the vertical computation to have approximate coordinates. If no distance observations have been recorded, it would indeed be necessary to have horizontal coordinates to calculate those.

The tool is structured in several steps, depending on the compensations to be carried out, guiding the user through the computation. Each step of the process depends on the selected computation type, which means that not all of them are necessary:

- *Step 1: Entering of input files*
- *Step 2: Point selection*

- *Step 3: Network and output lists setup*
- *Step 4: Selection of observations*
- *Step 5: Weights and residuals of the horizontal observations*
- *Step 5.1: Selection of fixed directions*
- *Step 6: Displacements and horizontal accuracy*
- *Step 7: Results of the* horizontal *Baarda test*
- *Step 8: Weights and residuals of the vertical observations*
- *Step 9: Displacements and vertical accuracy*
- *Step 10: Results of the* vertical *Baarda test*
- *Step 11: Output data setup*
- *Step 12: Sketch setup*

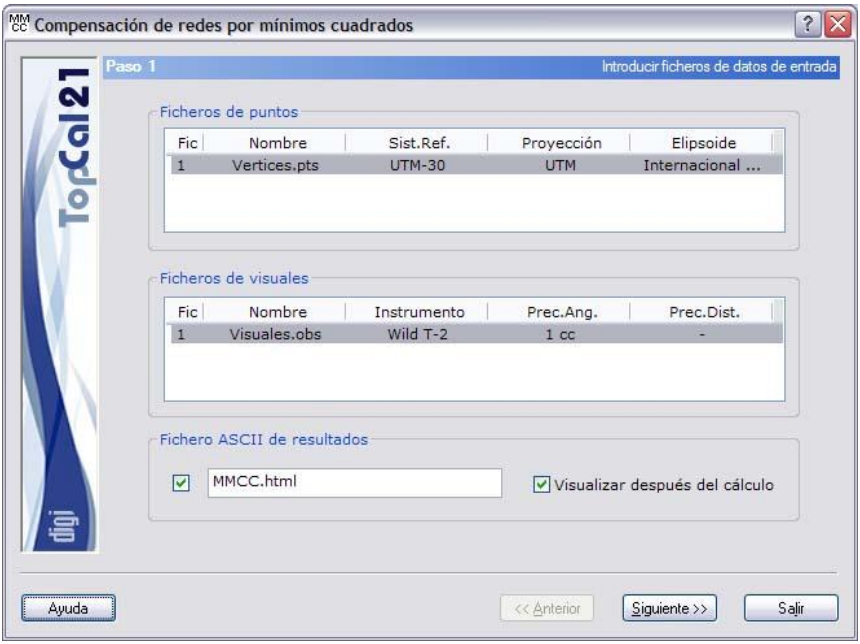
The user may move from step to step forward and backward, modifying the data or the selections, making the computation easier.

5.13.1. Step 1: Entering of input files

This is the first step for the least square computation. The required data is the following:

- ***Point files***: The user will select the point files of the project that he wants to use for this computation. The computation can only progress if all the selected point files belong to the same reference system.
- ***Observation files***: The user has to select the observation files of the project he wants to use in the computation.

- ***ASCII Output file***: The name for the output file is specified here. This file can be in HTML format or ASCII format. In the event the extension of the file is HTM or HTML, the format will be HTML, if not, the format will be ASCII. This file can be viewed (with the application specified in the Preferences dialog box in the Edit menu, explained in the topic 8.1) if the checkbox ***Show after computation*** is marked. If the user doesn't want to create this file, the checkbox on the left side of the name has to be unmarked. The file will be created in the project directory.



In this case the only two files that were available were selected, in both cases the reference system is UTM. The output file will be HTML.

Once this data is entered, one can press the Next button to proceed to *Step 2: Point selection*.

5.13.2. Step 2: Point selection

This is the second step of the computation. A window with the points and their coordinates from the selected files of Step 1 will be shown. As mentioned earlier, it is necessary to have approximate coordinates of the points in order to adjust them. To calculate these coordinates the user should have used the rest of the computation tools that the program offers.

The list will show the following fields:

- ***Fixed checkbox***: This checkbox indicates if the point is considered as accurate and fixed for planimetry and altimetry. If the point is fixed in planimetry the letter P will show, in case it is fixed in altimetry it will be the letter A. In order to assign these characteristics to the point, select the point or points and activate or deactivate the checkbox below the list: ***Fixed point in planimetry*** or ***Fixed point in altimetry***.
- ***File index***: Indicates the point file index where the point is saved.
- ***Point number***
- ***Point coordinates***
- ***Point name***

Several points can be selected by using the CTRL key and the left mouse button. If you select an already selected point, this one will lose its selection.

One can also select ranges of points with the CAPS key and the left mouse button, by selecting the first and the last point of the group.

The user can also utilize the All or None buttons located bellow the list.

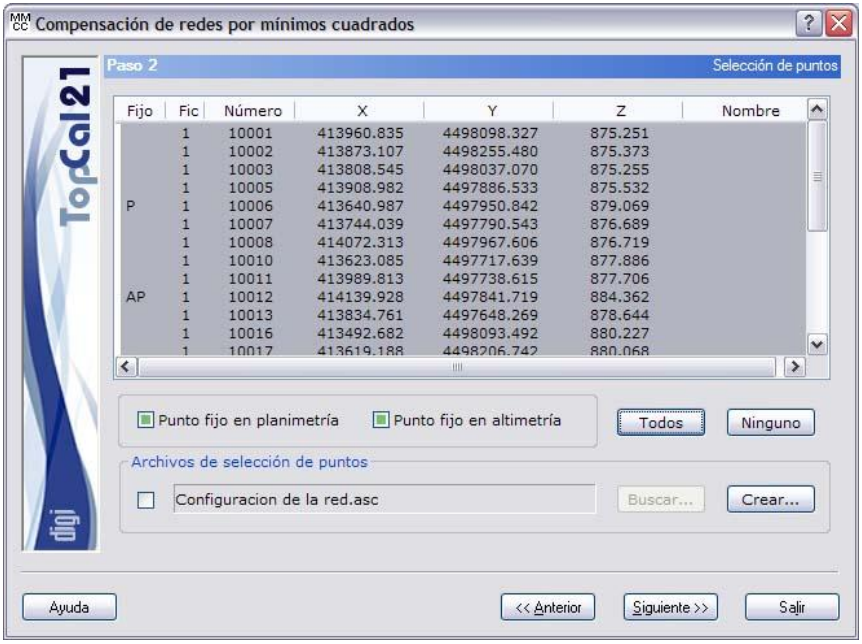
It is also possible to load the network information from an ASCII file by activating the checkbox located on the left of the file name and by pressing the Search button to access Windows Explorer.

If it is the first time the network is setup, one can select the points manually and create a setup file that can be used for later occasions by pressing Create. The program will show the Windows Explorer to save the file, although the default location should be the current project directory.

In order to perform a vertical compensation or adjustment, it only requires one single fixed point, although more are also accepted.

To do the horizontal compensation or adjustment the user will have two options:

- There are two fixed points or more, establishing what is called base of the network. In this case, it is possible to determine the scale factor in order to look for possible errors in the transmission of the scale factor to the network. To this end, two ways of conveying scale should been taken, being the possibilities:
  - More than two fixed points
  - Two fixed points and distance measurements
- That only one point is fixed, which means that it is a free network. In this case, it is essential to have measured distances in order to set the scale of the network, and also to set the direction azimuth that will be set as fixed. This option is specified to the program further along in *Step 5*.



In this example the point 10006 and 10012 have been selected as fixed for the horizontal computations and the point 10012 will also be fixed for the vertical computations. The rest of the points have been selected for their coordinate adjustment. The selection has been done manually since no Point selection file is being used.

Once the desired points have been selected, one can press the Next button to access *Step 3: Network and output lists setup* or press the Back button to go back to *Step 1: Entering of input files*.

5.13.3. Step 3: Network and output lists setup

The third step of the process is the selection of the observations that will be used in the computation and the additional lists that the user wants as a result.

In order to perform the horizontal compensation two different equations can be used: one corresponding *direction* and one corresponding *distance*. If only horizontal angles have been measured, the network will be called a triangulation. If only distances have been measured it is called ***Trilateration***. And in case both directions and distances have been observed the network is called ***Triangulateration***.

It is possible to set up fixed known directions in the calculations. This option allows the user to enter exact azimuths between known points, for example, if observed with a gyroscope.

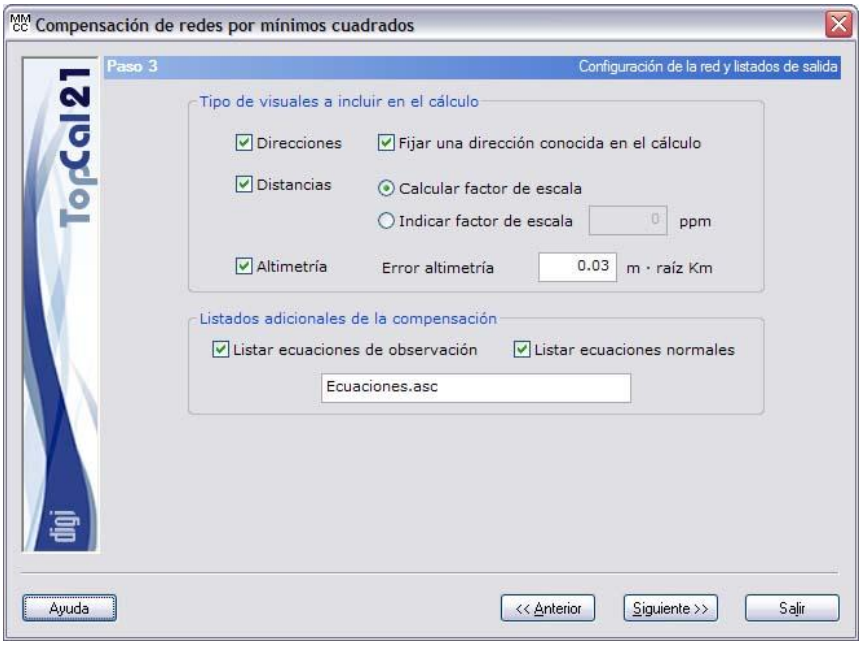
If as commented previously, distances have been taken and there are two or more fixed points, one can calculate the scale difference by means of methods of base and distance.

If the network is free, it is a requirement to select distances to set the network scale.

The network can also be adjusted in heights and for this purpose one has to select the mentioned equations. Traditionally vertical and horizontal networks were treated separately, since vertical and horizontal observations are independent and there is no correlation among EN and H coordinates.

If a vertical adjustment is selected the user will need to specify the kilometric error associated to the visuals in order to weigh them. This value can be calculated with the tool *Computation of random errors*, explained in the topic 6.26.

At last, it is also possible to list and save, in ASCII format, the equations of the process and the different matrix used for is resolution.



In this example you will see horizontal adjustment using direction and distance equations, and the vertical adjustment using the kilometric error of 3cm. Besides, it will show the scale factor computation and will list the different equations used for each case.

Once the corresponding options have been selected one can push the Next button to access *Step 4: Selection of observations* or back to *Step 2: Point selection* by pressing on the Back button.

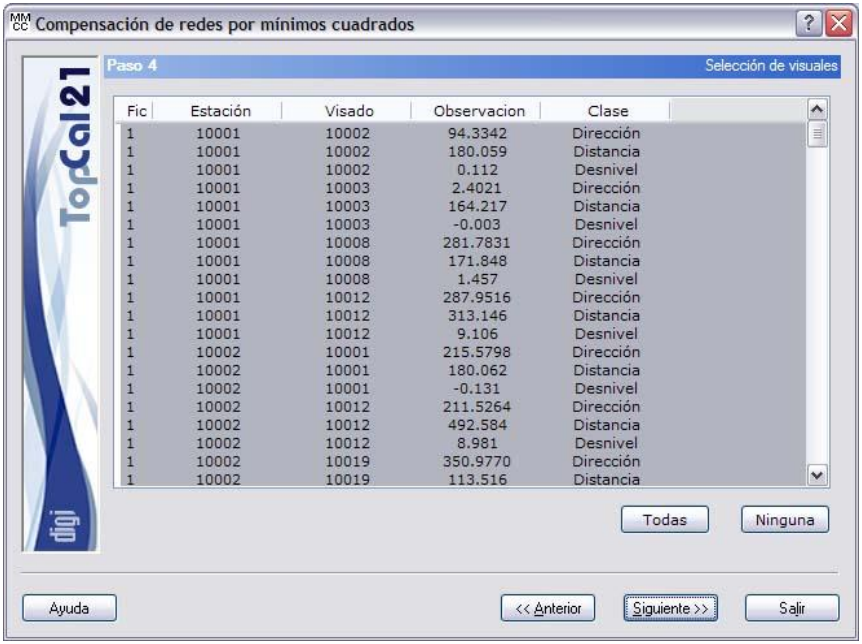
5.13.4. Step 4: Selection of observations

The forth step of the network adjustment is the selection of the observations the user wants to use for the computations.

The program will show a list of the observations from the files selected in Step 1, and will be segregate them depending on their nature. This means, all of the direction observations, all the Distance and all the Leveling observations with their corresponding values will be grouped together.

This way of presenting the observations will allow the user to unmark the visual he does not want to use in the computation depending on its performance in later calculations. For example, the user will be able to use the distance observation form a point, but not the angular observations of the same point.

Besides, the program also offers a checkbox called ***Check not selected observations afterwards***, which allows the user to check the error that the not selected observations would have had. It is quite useful to mark this box, because as you will see later, the program has a reliability test that will detect and cancel erroneous observations. It is always interesting to know, which would be the errors of those observations after using adjusted coordinates. The list with the errors will be shown in the output file after the reliability test.



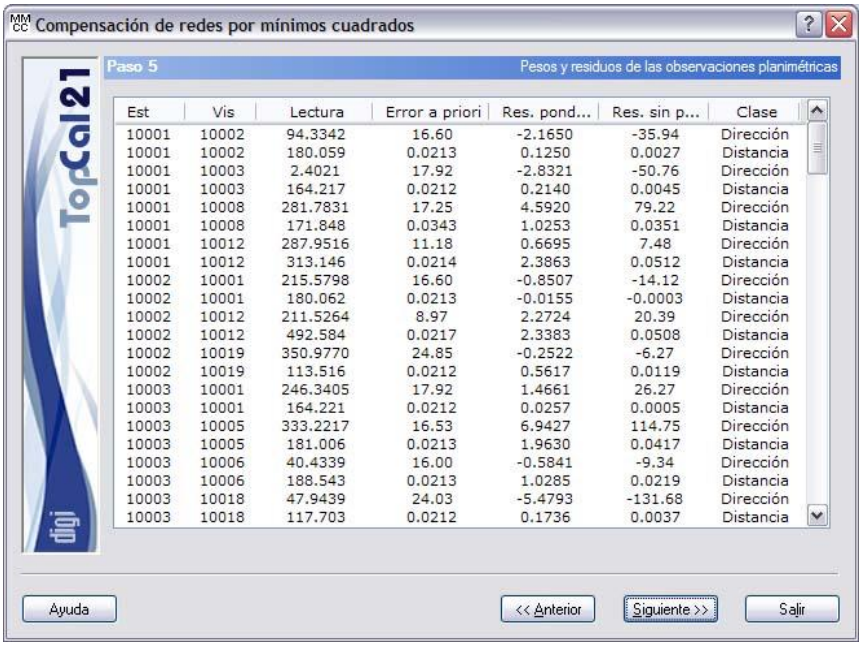
Once the corresponding observations have been selected one can push the Next button to access *Step 5: Weights and residuals of the horizontal observations* or back to *Step 3: Network and output lists setup* by pressing on the Back button.

5.13.5. Step 5: Weights and residuals of the horizontal observations

In this following step of the adjustment, the program will analyze first the a priori horizontal observations that will enter in the computation, showing a list with the following data:

- ***Station***
- ***Target point***
- ***Angle***: the units of this field vary depending on the class of observation: centesimal grads for angles and meters for distances.
- ***A priori error***: This error is the random error the visual has and it depends on the distance of the observation, the instrument used and the stationing and signaling conditions. The units also vary depending of the class of observation, centesimal seconds for angles and meters for distances.
- ***Weighted residual***: This value has no dimension and is the result of dividing the non weighted residual by the a priori error of the observation.
- ***Not weighted residual***: This value is the difference between the observed value (actual observation) and the calculated value (result of using the approximate coordinates of the points). If this value is large, this can be due to an erroneous observation or because the approximate coordinates are not sufficiently accurate. The same as before, the units vary depending on the class of observation we are dealing with; centesimal seconds for angles and meters for distances.

- ***Class (type)***: The class of the horizontal observations can be either Direction or Distance.



Est	Vis	Lectura	Error a priori	Res. pond...	Res. sin p...	Clase
10001	10002	94.3342	16.60	-2.1650	-35.94	Dirección
10001	10002	180.059	0.0213	0.1250	0.0027	Distancia
10001	10003	2.4021	17.92	-2.8321	-50.76	Dirección
10001	10003	164.217	0.0212	0.2140	0.0045	Distancia
10001	10008	281.7831	17.25	4.5920	79.22	Dirección
10001	10008	171.848	0.0343	1.0253	0.0351	Distancia
10001	10012	287.9516	11.18	0.6695	7.48	Dirección
10001	10012	313.146	0.0214	2.3863	0.0512	Distancia
10002	10001	215.5798	16.60	-0.8507	-14.12	Dirección
10002	10001	180.062	0.0213	-0.0155	-0.0003	Distancia
10002	10012	211.5264	8.97	2.2724	20.39	Dirección
10002	10012	492.584	0.0217	2.3383	0.0508	Distancia
10002	10019	350.9770	24.85	-0.2522	-6.27	Dirección
10002	10019	113.516	0.0212	0.5617	0.0119	Distancia
10003	10001	246.3405	17.92	1.4661	26.27	Dirección
10003	10001	164.221	0.0212	0.0257	0.0005	Distancia
10003	10005	333.2217	16.53	6.9427	114.75	Dirección
10003	10005	181.006	0.0213	1.9630	0.0417	Distancia
10003	10006	40.4339	16.00	-0.5841	-9.34	Dirección
10003	10006	188.543	0.0213	1.0285	0.0219	Distancia
10003	10018	47.9439	24.03	-5.4793	-131.68	Dirección
10003	10018	117.703	0.0212	0.1736	0.0037	Distancia

By clicking on the heading of the list it is possible to rearrange the columns from ascending to descending values.

This step is only informative and the user does not have to select any parameters, which means he can click on the Next button to access the next step. This next step will depend on the type of network that is being processed:

- In the event it is a free network or the user has defined a fixed direction, the next step will be *Step 5.1: Selection of fixed directions*.
- In the event it is a common network, the next step would be *Step 6: Displacements and horizontal accuracy*.

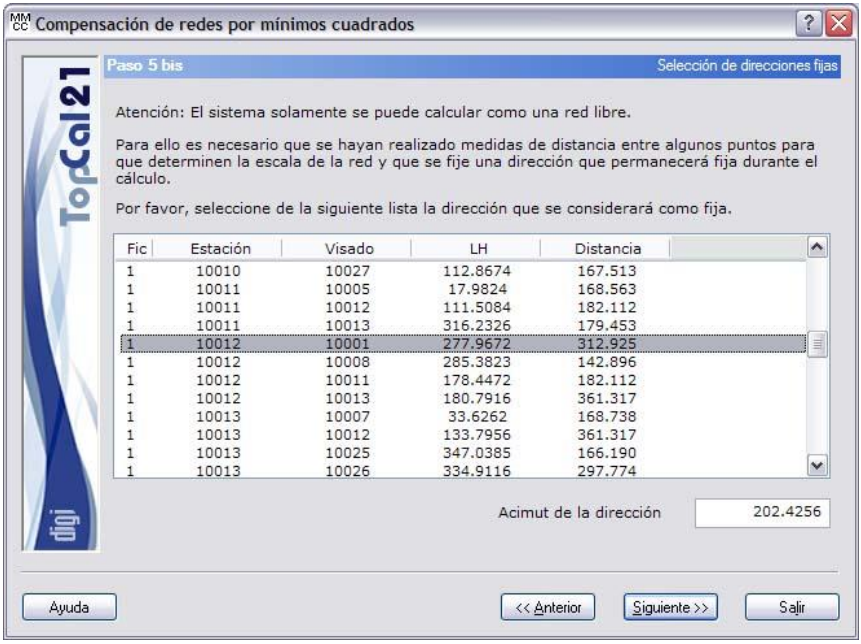
The user can also go back to *Step 4: Selection of observations* by clicking on the Back button.

5.13.6. Step 5.1: Selection of fixed directions

If the network the user is adjusting is free or in the event the user has specified a fixed direction, the next step is to select the direction or directions that will be fixed in the adjustment.

This is done because in a free network you can't deduct the orientation of the network unless you determine a direction and its azimuth. That direction should have the minimum random error, the minimum direction error and be easily and unmistakably identified.

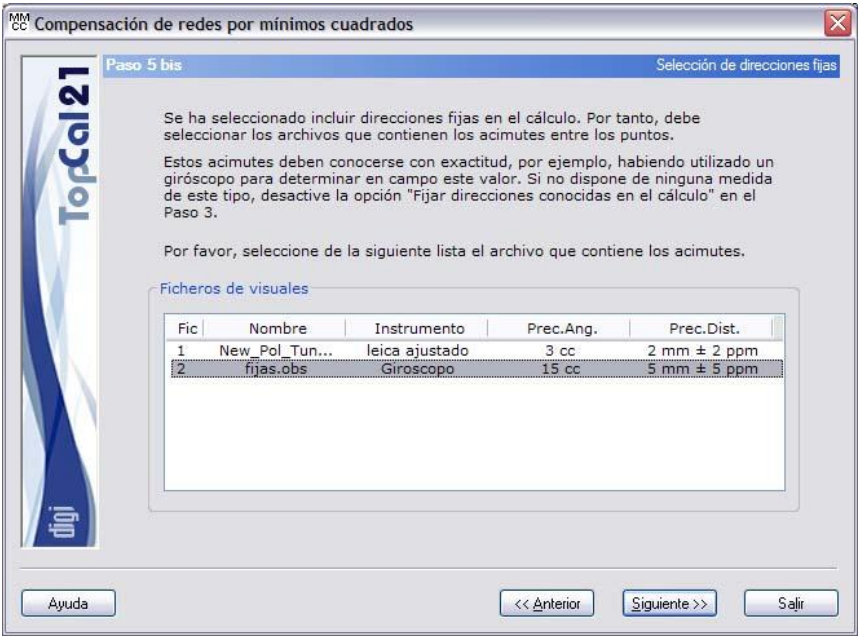
Then, the dialog box will have the following appearance:



If the network would have been free, this is, if only one fixed point in Step2 would have been selected, in this example the direction 10012 to 10001, with value 202.4256 grad would have been selected.

On the contrary, if the user would have several fixed points and decided to define several fixed directions, he should know the azimuth of these directions accurately, for example, by using a gyroscope.

In this case, the dialog box would look like this, where the user has to select the file with those azimuths:



When the needed options have been selected the user can press on the Next button to access *Step 6: Displacements and horizontal accuracy* or go back to Step 5: Weights and residuals of the horizontal observations by clicking on the Back button.

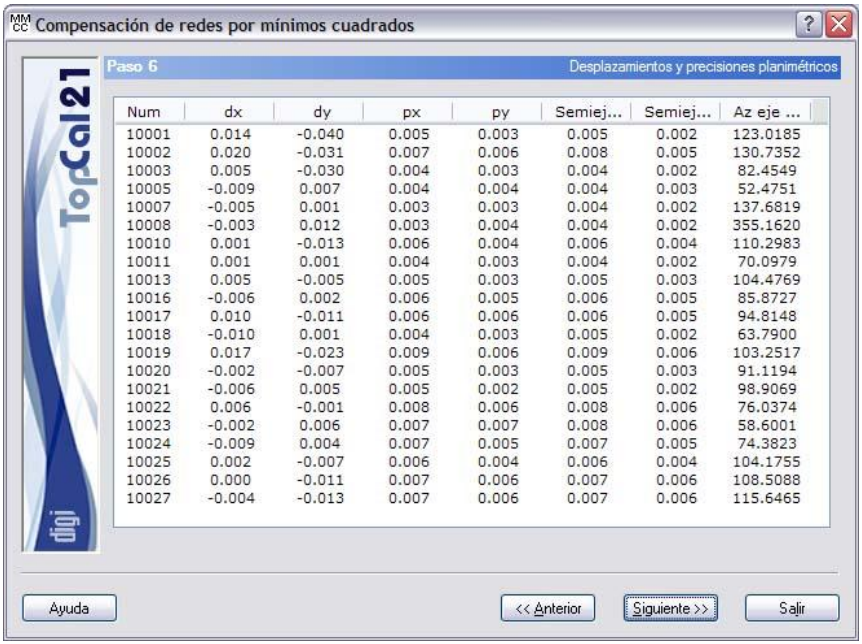
5.13.7. Step 6: Displacements and horizontal accuracy

Once the points, the observations and the network properties have been defined, the program has sufficient information to start the computation. The results of the adjustment of the network is going to be shown in this step, the results are displacements of the points that were not fixed and their accuracy.

The values of the displacements depend directly on the accuracy of the approximate coordinates. However, the value of these approximate coordinates will not affect the value of the achieved accuracy.

- ***Point number***
- ***Displacement for E***: This is the displacement that the approximate Easting coordinate of the point gets, after the adjustment. Its units are meters.
- ***Displacement for N***: This is the displacement that the approximate Northing coordinate of the point gets, after the adjustment. Its units are meters.
- ***Accuracy for E***: This is the accuracy in meters, achieved for the E coordinate.
- ***Accuracy for N***: This is the accuracy in meters, achieved for the N coordinate.
- ***Major semiaxis***: of the error ellipsoid, in meters.
- ***Minor semiaxis***: of the error ellipsoid, in meters.
- ***Azimuth****¡Error! Marcador no definido.* ***of the major semiaxis***: of the error ellipsoid in grads.

By clicking on the header of this list, the user will be able to rearrange the columns from ascending to descending values.



Num	dx	dy	px	py	Semiej...	Semiej...	Az eje ...
10001	0.014	-0.040	0.005	0.003	0.005	0.002	123.0185
10002	0.020	-0.031	0.007	0.006	0.008	0.005	130.7352
10003	0.005	-0.030	0.004	0.003	0.004	0.002	82.4549
10005	-0.009	0.007	0.004	0.004	0.004	0.003	52.4751
10007	-0.005	0.001	0.003	0.003	0.004	0.002	137.6819
10008	-0.003	0.012	0.003	0.004	0.004	0.002	355.1620
10010	0.001	-0.013	0.006	0.004	0.006	0.004	110.2983
10011	0.001	0.001	0.004	0.003	0.004	0.002	70.0979
10013	0.005	-0.005	0.005	0.003	0.005	0.003	104.4769
10016	-0.006	0.002	0.006	0.005	0.006	0.005	85.8727
10017	0.010	-0.011	0.006	0.006	0.006	0.005	94.8148
10018	-0.010	0.001	0.004	0.003	0.005	0.002	63.7900
10019	0.017	-0.023	0.009	0.006	0.009	0.006	103.2517
10020	-0.002	-0.007	0.005	0.003	0.005	0.003	91.1194
10021	-0.006	0.005	0.005	0.002	0.005	0.002	98.9069
10022	0.006	-0.001	0.008	0.006	0.008	0.006	76.0374
10023	-0.002	0.006	0.007	0.007	0.008	0.006	58.6001
10024	-0.009	0.004	0.007	0.005	0.007	0.005	74.3823
10025	0.002	-0.007	0.006	0.004	0.006	0.004	104.1755
10026	0.000	-0.011	0.007	0.006	0.007	0.006	108.5088
10027	-0.004	-0.013	0.007	0.006	0.007	0.006	115.6465

In the event that the accuracy of a point couldn't be calculated due to lack of redundancy, the character "?" will appear on the corresponding fields.

The user can now click on the Next button to access *Step 7: Results of the* horizontal *Baarda test*. The user can also go back, by clicking on the Back button. This step will depend on the network type that is being adjusted:

- In the event it is a free network or the user has defined a fixed direction, the next step will be *Step 5.1: Selection of fixed directions*.

- In the event it is a common network, the next step would be *Step 5: Weights and residuals of the horizontal observations*.

5.13.8. Step 7: Results of the horizontal Baarda test

Once the adjustment has been completed and the results have been shown on screen, the next step is dedicated to a statistical test (Baarda test) that will allow the user to check the goodness of the observations that have been used in the computations. Besides, the user will also be informed of the standard deviation of the adjustment that will also help to evaluate the goodness of fit.

This test detects possible gross errors in observations by means of a dimensionless value called standardized residual. If this value exceeds a threshold of 3.29, it can be assumed that the observation is erroneous with a probability of 99.9%.

In the process of erroneous observation elimination it is recommended to eliminate them one by one, starting by the one that has the worst standardized residual, since one observation can easily affect the observations of its surroundings. This process can be done manually going back to Step4 and unmark the worst observation or by clicking on the Remove worst, where the program detects which is the worst and removes it from the selection.

The result of the statistical test will be presented in a list with the following fields:

- ***Station***
- ***Target****¡Error! Marcador no definido.* ***point***

- ***Standard deviation of the observation***: with the same units as the observations.
- ***Standard deviation of the residual***: with the same units as the observations.
- ***Not weighted residual***: calculated with the new calculated coordinates and whose units are the same as the observations.
- ***Standardized residual***: dimensionless value that should be less than 3.29. If it is more, the symbol # will appear on the right side. In the event the goodness of fit couldn't be checked, the symbol "?" will appear.
- ***Class***: The class can be either Direction or Distance and will help the user to detect the erroneous data of the observation.

By clicking on the header of the list, the user can rearrange the columns in an ascending or descending way.

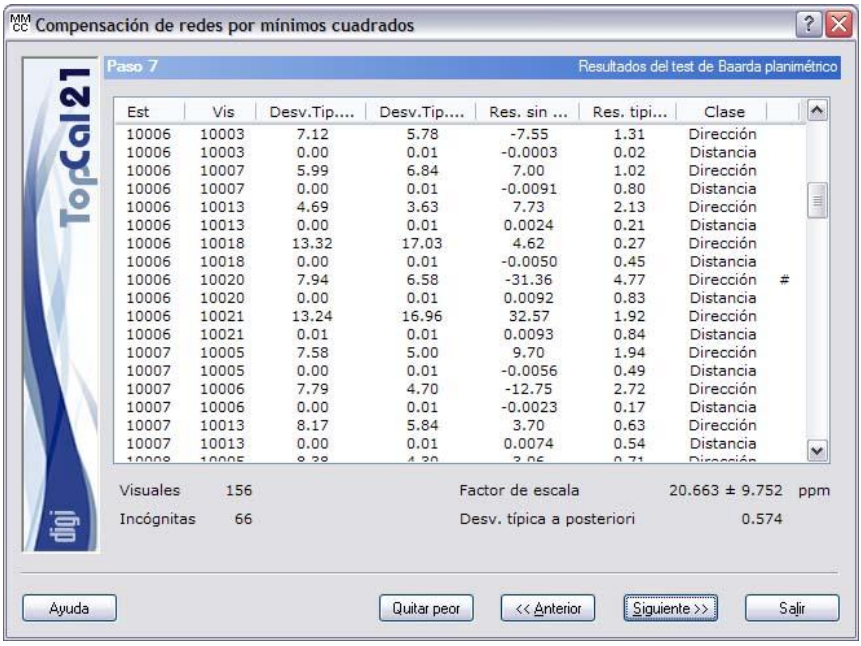
The window also shows the ***number of observations*** used and the number of ***unknown parameters*** that the program has resolved.

In the event the user decided to calculate the ***scale factor***, this value will be shown next to the standard deviation, both values as parts per million.

At last, the program will also show the ***a posteriori standard deviation*** of the system, which value is dimensionless and its interpretation is as follows:

- If it is less than 1: this means that the achieved accuracy is greater than the one expected for the used instruments.
- If it is approximately 1: this means the achieved accuracy is as expected.

- If it is greater than 1: this means the achieved accuracy is less than the one expected for the used instruments.



In the example, when looking at the reached a posteriori standard deviation one can see that the achieved accuracy is quite high. However, one can also see that there are observations with error (direction from 10006 to 10020), which means the computation can be refined even further. The scale factor transmitted by the base and the distances measured with EDM is 20 ppm, which is a small number for this network.

This last step was only informative, the user is not expected to do anything but decide to either go to the next step or go back to Step 6.

By clicking on the Next button the user can access the next step which depends on the type of adjustment that is being performed:

- If the user is doing a heights or vertical adjustment, the next step is *Step 8: Weights and residuals of the vertical observations*.
- If no horizontal adjustment has been selected, the next step would be *Step 11: Output data setup*.

The user can also go back to *Step 6: Displacements and horizontal accuracy* by clicking on the Back button.

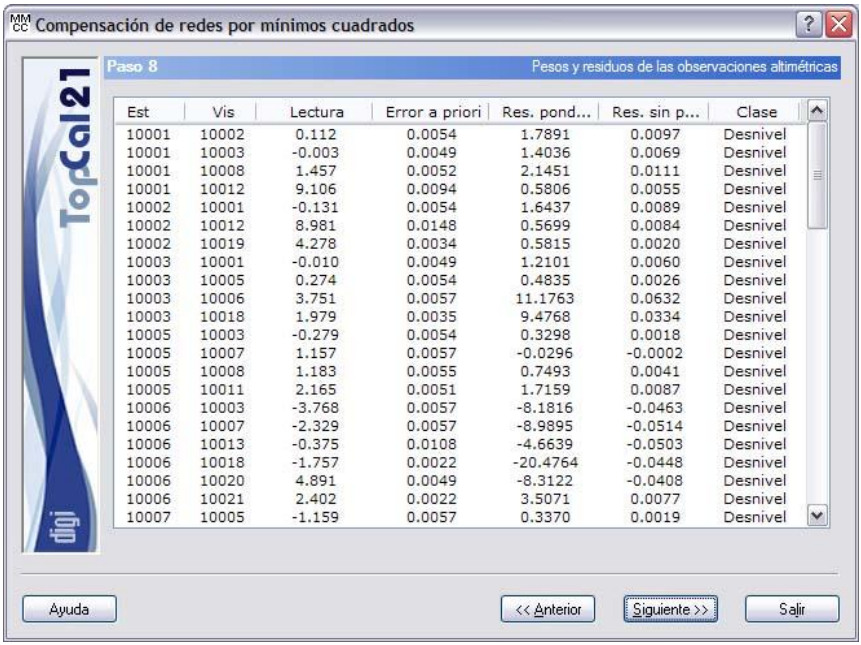
5.13.9. Step 8: Weights and residuals of the vertical observations

In this step of the adjustment the program will analyze a priori the vertical observations that will be used in the computation. A list will be shown with the following data:

- ***Station***
- ***Target point***
- ***Reading***: Height difference in meters.
- ***A priori error***: This error is the random error the observation has and it depends on the distance of the observation, the instrument used and the stationing and signaling conditions. The units for this value are meters.
- ***Weighted residual***: This value is dimensionless and is the result of dividing the non weighted residual by the a priori error of the observation.

- ***Not weighted residual***: This value is the difference between the observed value (actual observation) and the calculated value (result of using the approximate coordinates of the points). If this difference is large, this can be due to an erroneous observation or because the approximate coordinates are not sufficiently accurate. The units for this case are also meters.

- ***Class (type)***: The class of vertical observations is always height differences.



Est	Vis	Lectura	Error a priori	Res. pond...	Res. sin p...	Clase
10001	10002	0.112	0.0054	1.7891	0.0097	Desnivel
10001	10003	-0.003	0.0049	1.4036	0.0069	Desnivel
10001	10008	1.457	0.0052	2.1451	0.0111	Desnivel
10001	10012	9.106	0.0094	0.5806	0.0055	Desnivel
10002	10001	-0.131	0.0054	1.6437	0.0089	Desnivel
10002	10012	8.981	0.0148	0.5699	0.0084	Desnivel
10002	10019	4.278	0.0034	0.5815	0.0020	Desnivel
10003	10001	-0.010	0.0049	1.2101	0.0060	Desnivel
10003	10005	0.274	0.0054	0.4835	0.0026	Desnivel
10003	10006	3.751	0.0057	11.1763	0.0632	Desnivel
10003	10018	1.979	0.0035	9.4768	0.0334	Desnivel
10005	10003	-0.279	0.0054	0.3298	0.0018	Desnivel
10005	10007	1.157	0.0057	-0.0296	-0.0002	Desnivel
10005	10008	1.183	0.0055	0.7493	0.0041	Desnivel
10005	10011	2.165	0.0051	1.7159	0.0087	Desnivel
10006	10003	-3.768	0.0057	-8.1816	-0.0463	Desnivel
10006	10007	-2.329	0.0057	-8.9895	-0.0514	Desnivel
10006	10013	-0.375	0.0108	-4.6639	-0.0503	Desnivel
10006	10018	-1.757	0.0022	-20.4764	-0.0448	Desnivel
10006	10020	4.891	0.0049	-8.3122	-0.0408	Desnivel
10006	10021	2.402	0.0022	3.5071	0.0077	Desnivel
10007	10005	-1.159	0.0057	0.3370	0.0019	Desnivel

By clicking on the heading of the list it is possible to rearrange the columns from ascending to descending values.

This is an informative window the user is not expected to do anything but decide to either go to the next step which is *Step 9: Displacements and vertical accuracy*, or go back to the previous step.

By clicking on the Back button the user can go back to the previous step which depends on the type of adjustment that is being performed:

- If the user is doing a horizontal adjustment, the previous step is *Step 7: Results of the* horizontal *Baarda test*.
- If no horizontal adjustment has been selected, the previous step would be *Step 4: Selection of observations*.

5.13.10. Step 9: Displacements and vertical accuracy

In this step, the program will perform an adjustment of a vertical network and will present as a result, the displacements that the coordinates of the non fixed points have suffered.

The values of the displacements are directly related with the goodness of fit of the approximate coordinates. However, the value of these approximate coordinates will not affect the achieved accuracy. As mentioned at the beginning, in case of a vertical adjustment it is not necessary to have calculated approximate coordinates.

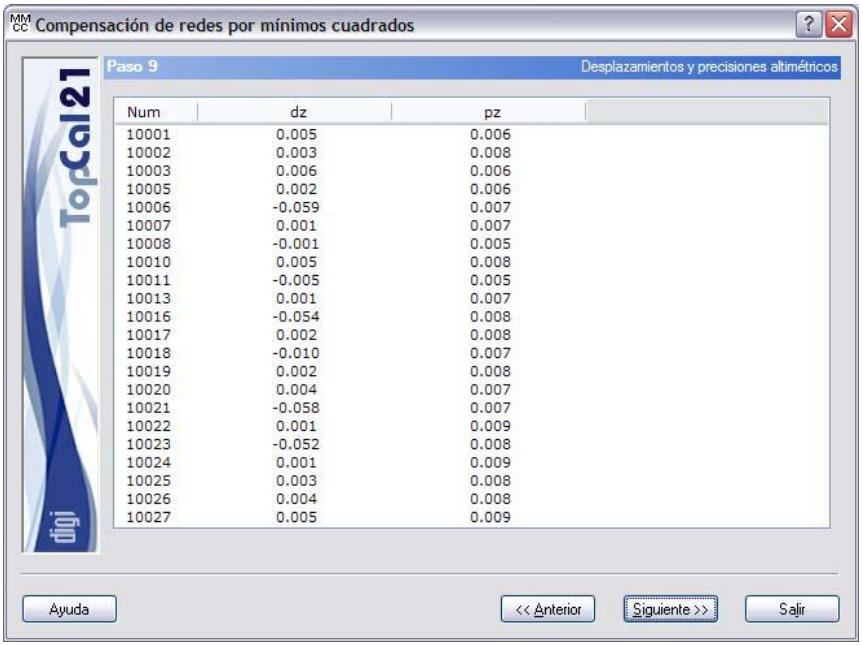
The results will be shown in a list, where each line corresponds to a non fixed point and whose data will be:

- ***Number of point***

- ***H Displacement***: This is the displacement for the approximate Height coordinate after the computation. The units are meters. If there was no approximate value for the H coordinate, the program will use value that coincides with the height of the point.

- ***H Accuracy***: This is the achieved accuracy for the Height coordinate in meters.

By clicking on the heading of the list it is possible to rearrange the columns from ascending to descending values.



If the accuracy of a point could not be calculated due to lack of redundancy, the symbol "?" will appear in that field.

This is an informative window, the user is not expected to do any action but to decide to either go to the next step *Step 10: Results of the* vertical *Baarda test* by clicking on the Next button, or go back to the previous step which is *Step 8: Weights and residuals of the vertical observations* by clicking on the Back button.

5.13.11. Step 10: Results of the vertical Baarda test

Once the adjustment has been completed and the results have been presented, the next step is dedicated to the statistical Baarda test which will allow the user to check the goodness of the observations that have taken part of the computation. Besides, the standard deviation of the adjustment will be shown, with which the goodness of fit can be appreciated.

The Baarda test will detect gross errors in observations by using a dimensionless value called standardized residual. If this value exceeds a certain range, which is 3.29, there is 99.9% chance that that observation is erroneous.

The elimination of erroneous observations has to be done one by one, starting with the one that has the worst standardized residual, since each observation can affect the ones of its surroundings. This process has to be done manually by going back to Step 4: and unmarking the worst observation with the Remove worst button. This button will automatically detect and remove the worst of the list so it does not affect the computation.

The results of the statistical test will be presented in a list with the following fields:

- ***Station***

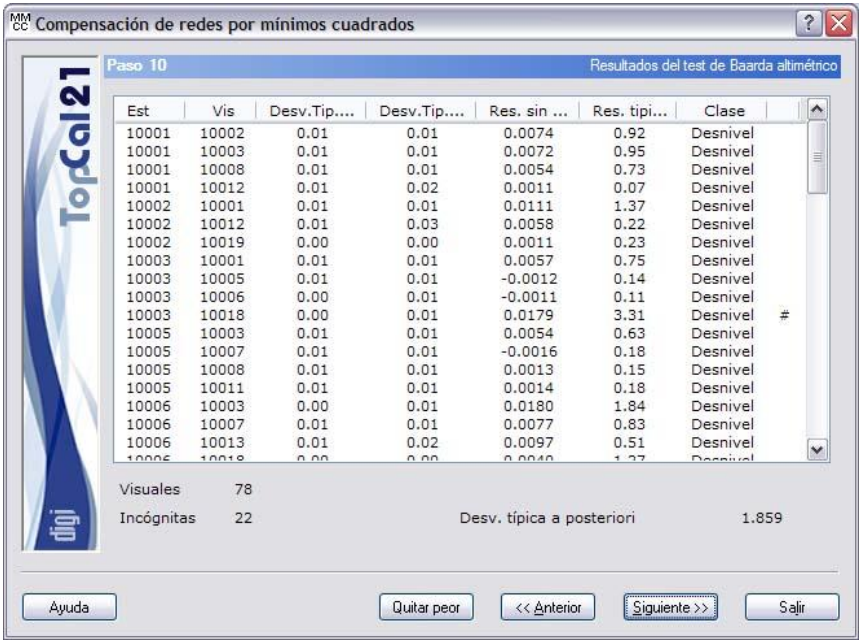
- ***Target point***
- ***Standard deviation of the observation***: with the same units as the observations.
- ***Standard deviation of the residual***: with the same units as the observations.
- ***Not weighted residual***: calculated with the new calculated coordinates and whose units are the same as the observations.
- ***Standardized residual***: dimensionless value that should be less than 3.29. If it is more, the symbol # will appear on the right side. In the event the goodness of fit couldn't be checked, the symbol "?" will appear.
- ***Class***: The class in this case will always be the Height difference.

By clicking on the heading of the list it is possible to rearrange the columns from ascending to descending values.

The ***number of used visuals*** is also shown as well as the number of ***unknown parameters*** that the program has solved.

At last, the program also shows the a posteriori standard deviation of the system, which value is dimensionless and its interpretation is as follows:

- If it is less than 1: this means that the achieved accuracy is greater than the one expected for the used instruments.
- If it is approximately 1: this means the achieved accuracy is as expected.
- If it is greater than 1: this means the achieved accuracy is less than the one expected for the used instruments.



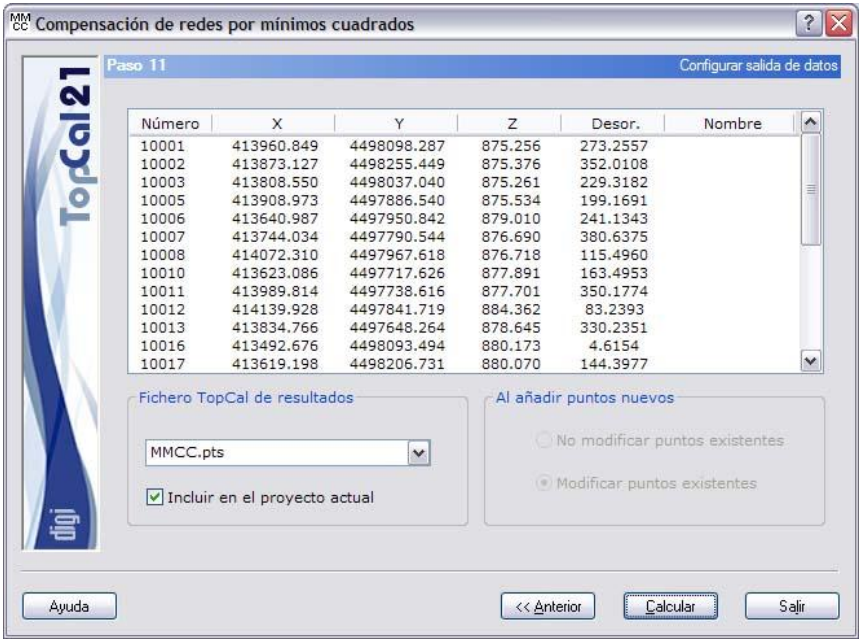
In the example you will see that the a posteriori standard deviation is indicating a lower vertical accuracy. However, you can also see that there are still erroneous observations (from 10003 to 10018), which means that the computation can still be refined further.

This is an informative window, the user is not expected to do any action but to decide to either go to the next step which is *Step 11: Output data setup*, or go back to *Step 9: Displacements and vertical accuracy*.

5.13.12. Step 11: Output data setup

In this step the program presents a window with the final coordinates and the way to save these coordinates. The following fields will be shown:

- ***Final coordinates***: A list with the new calculated points, their coordinates and their disorientation.
- ***TopCal output file***: with the same units as the observations.
- ***Adding new points***: with the same units as the observations.



In this example, the calculated coordinates will be saved in a file called MMCC.pts and will be included in the current project.

Once the output data has been setup, the user can press the Next button to access *Step 12: Sketch setup*, or go back to the previous step. This step back depends on the type of adjustment that has been selected:

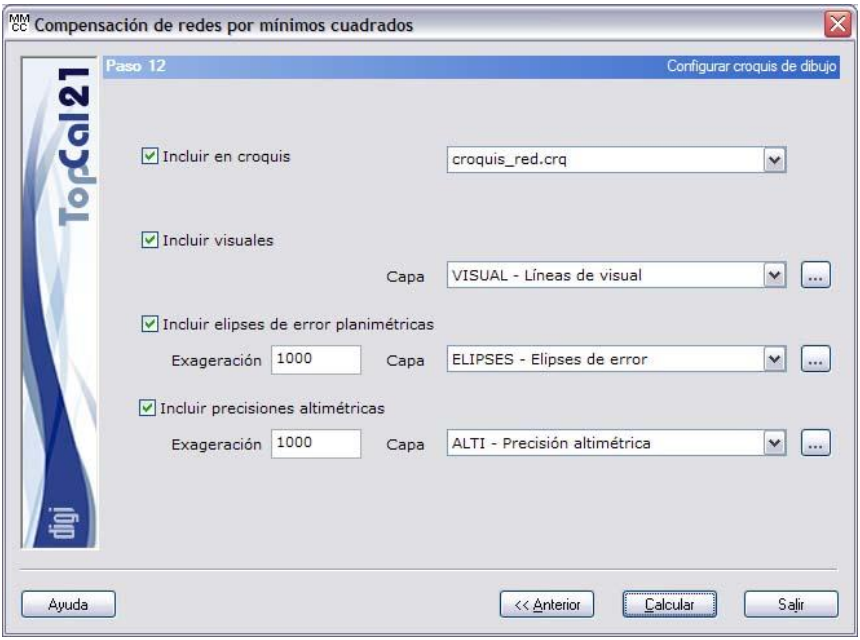
- If the user is doing a vertical adjustment, the previous step is *Step 10: Results of the* vertical *Baarda test*.
- If no horizontal adjustment has been selected, the previous step would be *Step 7: Results of the* horizontal *Baarda test*.

5.13.13. Step 12: Sketch setup

This last step of the network adjustment is dedicated to the creation of a sketch with the observations used in the computation and the achieved accuracy. This sketch will give the user an idea of how the accuracy has been distributed.

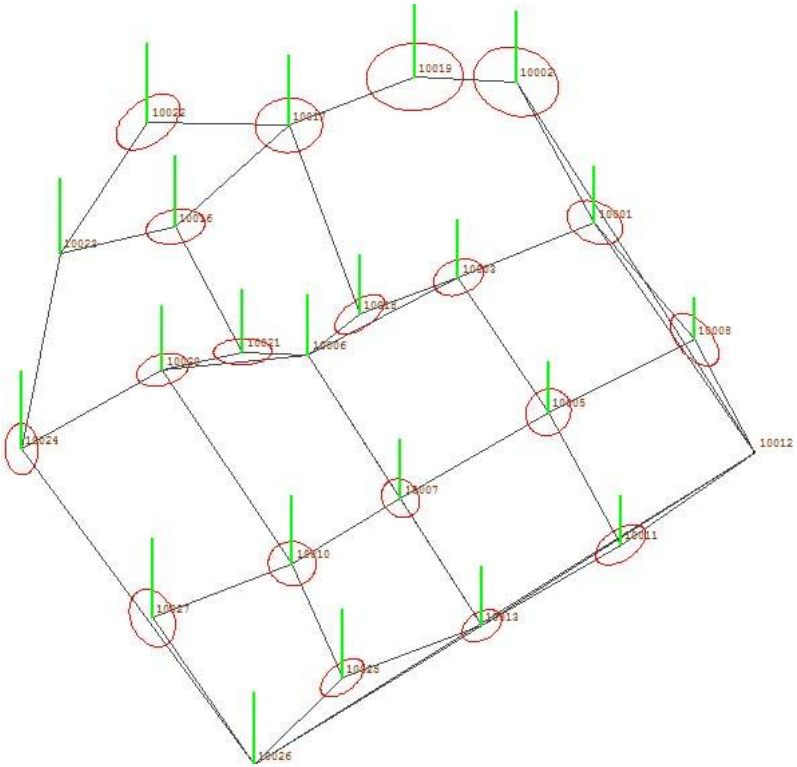
The fields that are shown are the following:

- ***Include in the sketch***: A list with the new calculated points, their coordinates and their disorientation.
- ***Include observations***: with the same units as the observations.
- ***Include horizontal error ellipsoids***: with the same units as the observations.
- ***Include vertical accuracies***:



To complete this example, a sketch file will be generated with the name croquis_red.crq where the lines that represent the observations can be seen. These lines will be in the VISUAL layer, and the horizontal error ellipsoids in the layer ELIPSES and they will be exaggerated a 1000 times for a better appreciation, at last the vertical accuracies will be represented in the layer ALTI and are also exaggerated a 1000 for a better viewing.

Next you will see the graphic of the sketch representing the horizontal and vertical accuracies of the Least squares adjustment.



Once the output data has been set up, the process can be completed by clicking on the Calculate button. The user can also go back to *Step 11: Output data setup* in case he wants to change the settings.

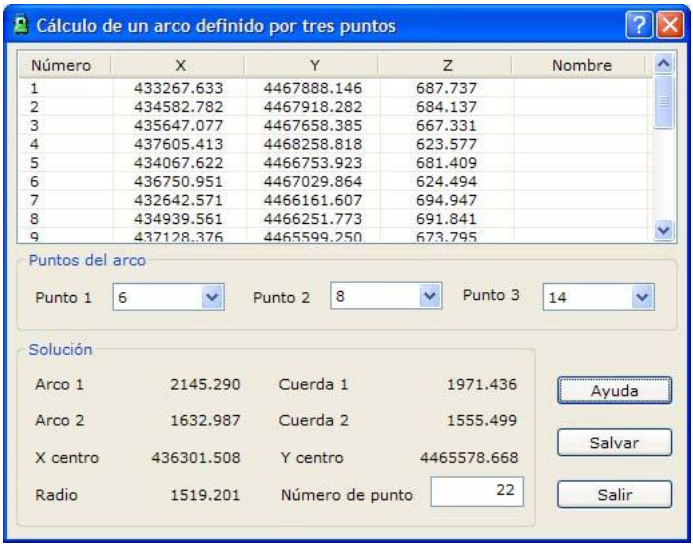
6 Computations

6.1. Arc defined by three points

This tool is of use to compute the arc defined by three points stored in the point file. In order to call up this tool, it is necessary to have a current active point file. The fields shown in this dialog box are as follows:

- ***Point list***: Point list of the current file
- ***Point 1***: The first point of the arc should be selected from the list
- ***Point 2***: The second point of the arc should be selected from the list
- ***Point 3***: The third point of the arc should be selected from the list
- ***Solution***: The two possible solutions are displayed:
  - ***Arc 1***: Arc in meters of the first solution
  - ***Arc 2***: Arc in meters of the second solution
  - ***Chord 1***: Chord in meters of the first solution
  - ***Chord 2***: Chord in meters of the second solution
- ***E centre***: E coordinate of the arc centre

- ***N centre***: N coordinate of the arc centre
- ***Radius***: Arc radius
- ***Point number***: Number of the new point



After having computed the arc, its centre can be saved in the point file, with the point number indicated in the field ***Point Number***, by pressing the button Save.

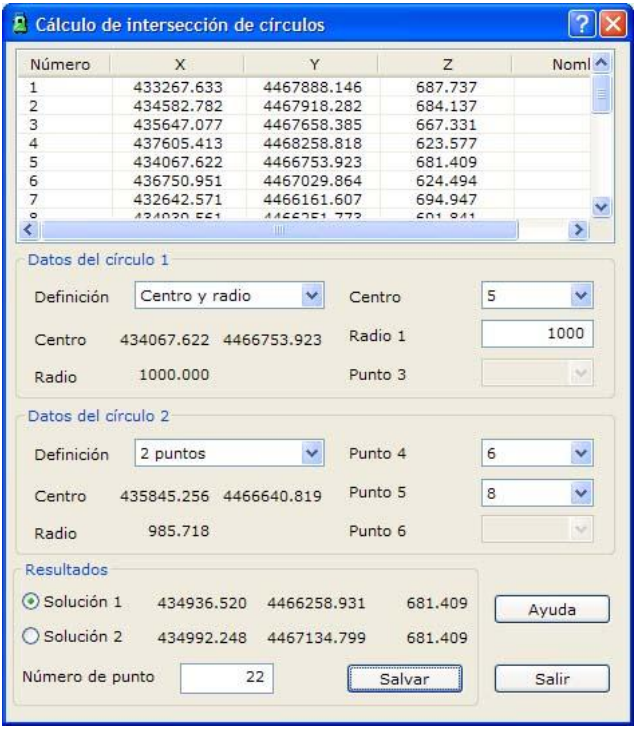
6.2. Distance Computation in UTM Projection

This tool is of use to compute the distance defined by two points in UTM projection. A dialog box shows up to be filled in with the UTM coordinates in meters of both points. The program simultaneously shows the result, also in meters.

6.3. Computation of Geographic Distances

This tool is of use to compute the distance defined by the geographic coordinates of two points. A dialog box is displayed to be filled in with the geographic coordinates (degrees, minutes and seconds) of both points. The program simultaneously shows the result in meters.

6.4. Circle Intersection



This tool is of use to compute the intersection between two circles. These may be defined in any of the following possibilities:

- ***Three points***: Three points on the circumference of the circle
- ***Two points***: Diameter of a circle defined by two points
- ***Centre and radius***
- ***Centre and one point of the circle***: Circle with a centre on one point and another point on its circumference

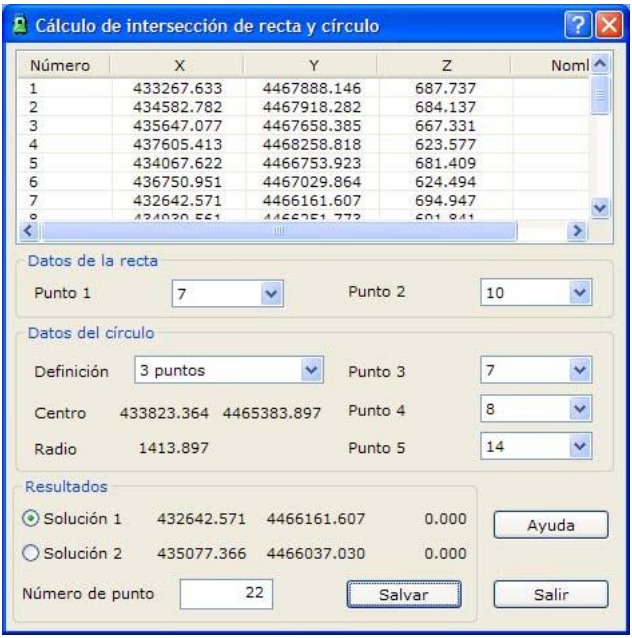
Depending on whether one type of definition or another is selected, the fields corresponding to those definitions will be activated or deactivated. The fields displayed are as follows:

- ***Point list***: Point list of the current file
- ***Data of circle 1***:
  - ***Definition***: Type of definition. The possibilities and fields to be filled in are:
    - ***3 points***: Point 1, Point 2, Point 3
    - ***2 points***: Point 1, Point 2
    - ***Centre****¡Error! Marcador no definido.* ***and Radius***: Centre, Radius in meters
    - ***Centre****¡Error! Marcador no definido.* ***and Point***: Centre, Point of Circle
  - ***Centre***: Computed Centre
  - ***Radius***: Radius computed in meters
- ***Data of circle 2***:
  - ***Definition***: Type of definition: The possibilities and fields to be filled in are as follows:
    - ***3 points***: Point 4, Point 5, Point 3
    - ***2 points***: Point 4, Point 5
    - ***Centre and Radius***: Centre, Radius
    - ***Centre and Point***: Centre, Point of Circle
  - ***Centre***: Computed Centre
  - ***Radius***: Radius computed in meters

- ***Results***:
  - ***Solution 1***
  - ***Solution 2***
  - ***Point***¡Error! Marcador no definido. ***number***

After having computed the intersection, the selected solution can be saved in the point file, with the point number indicated in the field ***Point***¡Error! Marcador no definido. ***number***, by pressing the button Save.

6.5. Straight Line Circle Intersection



This tool is of use to compute the intersection between a straight line and a circle. The straight line may be defined by two points or by a point and an azimuth. The circle may be defined by any of the following possibilities:

- ***Three points***: Three points on the circumference of the circle
- ***Two points***: Diameter of a circle defined by two points
- ***Centre and radius***
- ***Centre and one point of the circle***: Circle with Centre on one point and another point on its circumference

Depending on whether one type of point definition or another is selected, fields corresponding to those definitions will be activated or deactivated. The fields displayed are as follows:

- ***Point list***: Point list of the current file
- ***Data of the straight line***. Depending on the selected option, it may show:
  - Point 1, Point
  - Point 1, Azimuth
- ***Data of the circle***:
  - ***Definition***: Type of definition. The possibilities and fields to be filled in are as follows:
    - ***3 points***: Point 3, Point 4, Point 5
    - ***2 points***: Point 3, Point 4
    - ***Centre and Radius***: Centre, Radius in meters
    - ***Centre and Point***: Centre, Point of Circle.

- ***Centre***: Computed Centre
- ***Radius***: Radius computed in meters

- ***Results***:
  - ***Solution 1***
  - ***Solution 2***
  - ***Point number***

After having computed the intersection, the selected solution can be saved in the point file, with the point number indicated in the field ***Point***¡*Error! Marcador no definido.* ***number***, by pressing the button Save.

6.6. Straight Line Intersection

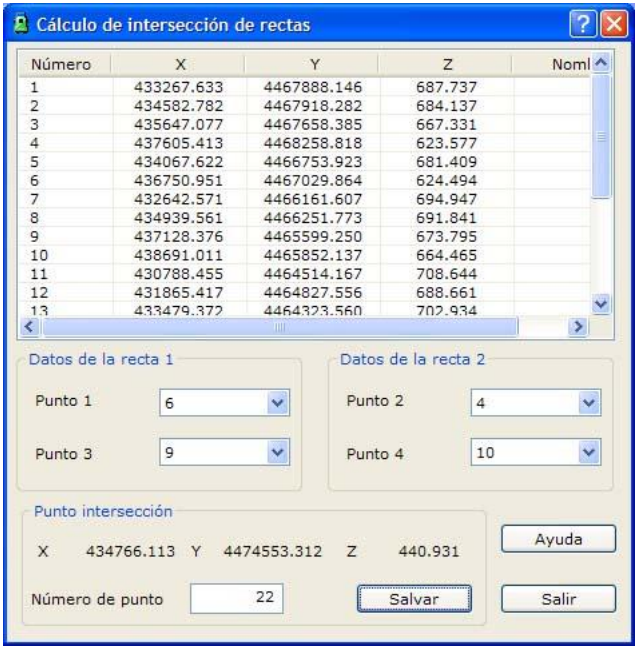
This tool is of use to compute the intersection between straight lines. The straight lines may be defined by two points or by one point and an azimuth.

Depending on whether one definition of the straight line or another is selected, the fields corresponding to those definitions will be activated or deactivated. The fields displayed are as follows:

- ***Point***¡*Error! Marcador no definido.* ***list***: Point list of the current file
- ***Data of straight line 1***. Depending on the selected option, it may show:
  - Point**¡Error! Marcador no definido.** 1, Point 3

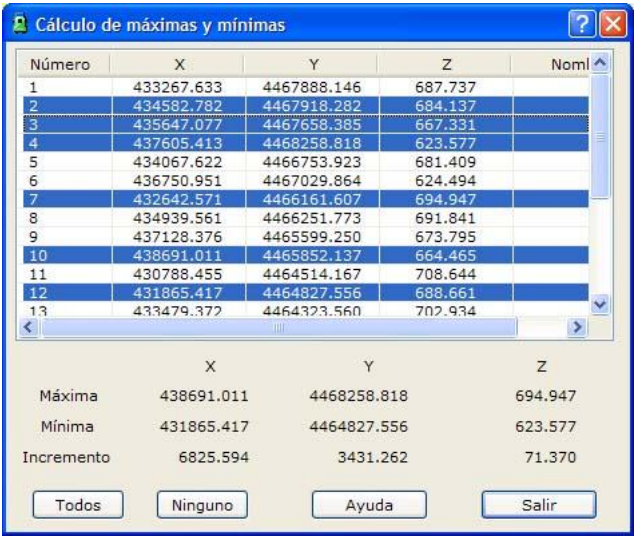
- Point**¡Error! Marcador no definido.** 1, Azimuth 1

- ***Data of the straight line****¡Error! Marcador no definido.* ***2***. Depending on the selected option, it may show:
  - Point 2, Point 4
  - Point 2, Azimuth 2
- ***Intersection point:***
  - ***ENH coordinates***
  - ***Point****¡Error! Marcador no definido.* ***number***



After having computed the intersection, it can be saved in the point file, with the point indicated in the field ***Point number***, by pressing the button Save.

6.7. Maxima and Minima



This tool is of use to compute the maximal and minimal coordinates of a given set of points. The fields shown are as follows:

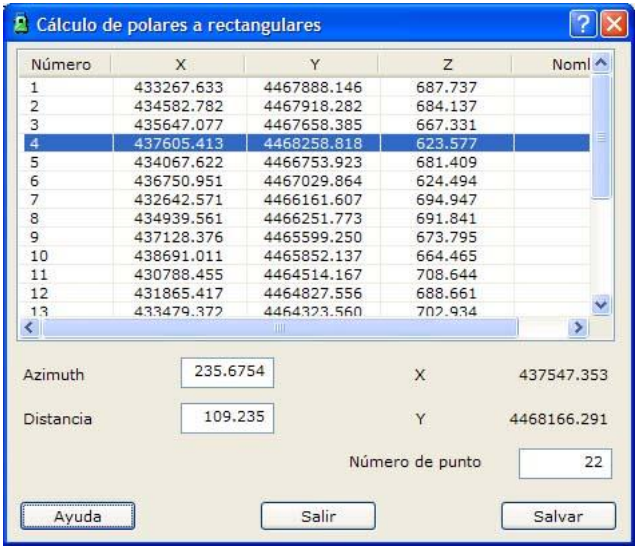
- ***Point***¡*Error! Marcador no definido.* ***list***: Point list of current file
- ***Maximal ENH***: Maximal coordinates of the selected points
- ***Minimal ENH***: Minimal coordinates of the selected points
- ***ENH increments***: Differences between maxima and minima of the selected points

Multiple points may be selected by using the key CTRL and pressing on the desired points with the left mouse button. If an already selected point is pressed, it will be cancelled.

Points ordered in ranges may be selected by pressing the key SHIFT LOCK and the left mouse button on the limit points defining the range.

The buttons All or None may also be used to select or cancel all points.

6.8. Polar to Rectangular Coordinates



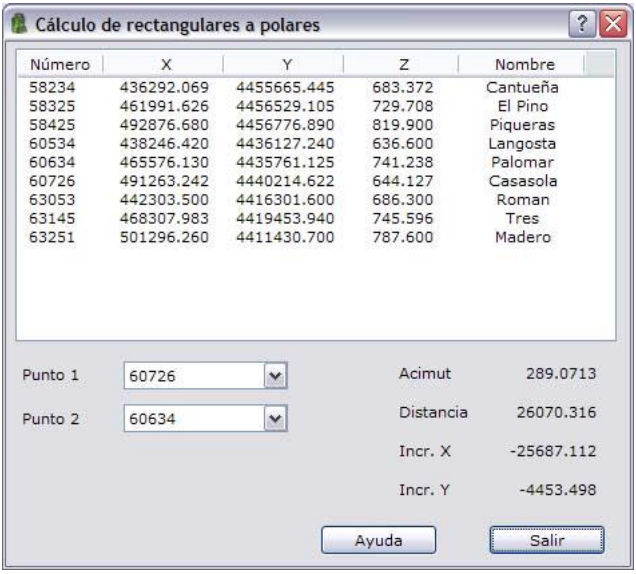
This tool is of use to compute the coordinates of a point from the azimuth and the distance measured from another point of known coordinates. The dialog box displays the following fields:

- ***Point****¡Error! Marcador no definido.* ***list***: Point list of current file. A point should be selected wherefrom the coordinates of the new point will be computed.

- ***Azimuth***: In grads.
- ***Distance***: In meters.
- ***EN coordinates*** of the computed point.
- ***Point***¡Error! Marcador no definido. ***number***

After having computed the point, the point file can be saved, with the point number indicated in the field ***Point***¡Error! Marcador no definido. ***number***, by pressing the button Save.

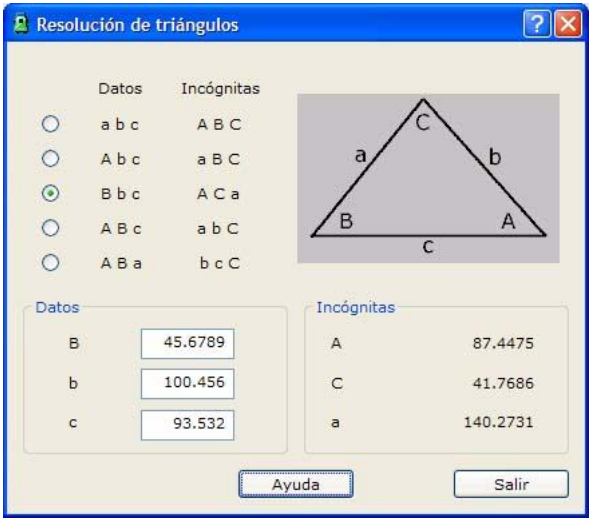
6.9. Rectangular to Polar Coordinates



This tool is of use to compute the azimuth and the distance between two points. The dialog box displays the following fields:

- ***Point***¡Error! Marcador no definido. ***list***: Point list of current file. A point should be selected wherefrom the coordinates of the new point will be computed.
- ***Point***¡Error! Marcador no definido. ***1***: First point to compute the azimuth and the distance.
- ***Point***¡Error! Marcador no definido. ***2***: Second point to compute the azimuth and the distance.
- ***Azimuth***: In grads.
- ***Distance***: In meters.

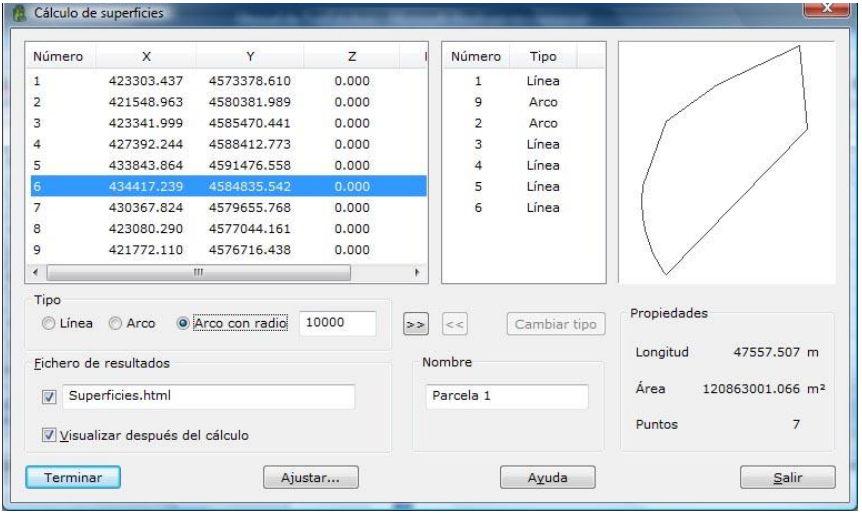
6.10. Triangle solving



This tool is of use to compute the elements of a triangle knowing some of its data. The data corresponding to the sides are shown in lowercase letters and the data corresponding to the angles are shown in uppercase letters, as seen in the figure. The dialog box displays the following fields:

- ***Selection of the data and unknowns***. The options are as follows:
  - If the three sides are known (a, b, c)
  - If an angle and its sides are known (A, b, c)
  - If an angle, one of its sides and the opposing side are known (B, b, c)
  - If two angles and their common side are known (A, B, c)
  - If two angles and a non-common side are known (A, B, a)
- ***Value of the data***: If angles, the values will be given in grads. If sides, they will be given in meters.
- ***Value of the unknowns***: If angles, the values will be given in grads. If sides, they will be given in meters.

6.11. Surface Computation



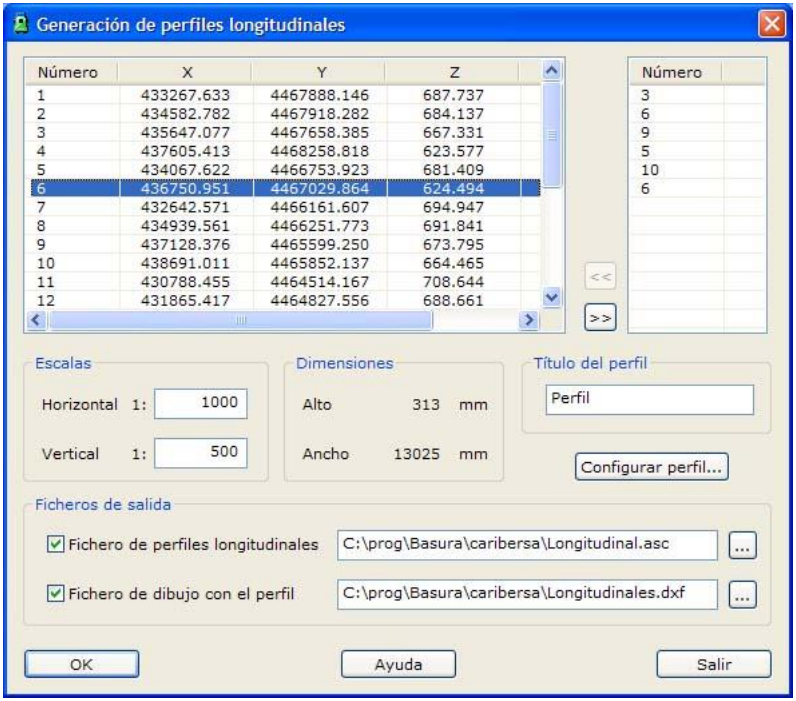
This tool is of use to compute surfaces from points defining them. The definition of the surface may be made with straight or curved stretches. The dialog box displays the following fields:

- ***Point list***: Point list of current file.
- ***List of points making up the surface***: In order to add points to this list, double click over the point on the list on the left side with the left mouse button or press the button >>. If you wish to enter a curved stretch going from one point to another, as you add the first point, you will have to enter the value of the curve radius in the field ***Radius***. If you wish to delete any point from this list, you will have to double click with the left mouse button or press the button <<.

- ***ASCII Output file***: This is an ASCII file with the result of the computation and a list of the points making up the surface. If you wish to generate it, you should activate the checkbox on the left of the filename. If you wish to view it after the computation, you should activate the checkbox below the filename.
- ***Plot name***: Plot name with which the surface will appear in the output file.
- ***Radius***: Radius in meters of the stretch to be introduced.

After having finished with the definition, the button Compute should be pressed to view the data or the button Exit, to exit the dialog box.

6.12. Longitudinal Profile



This tool is of use to compute longitudinal profiles made up by a set of points stored in a TopCal point file.

The program displays a dialog box with the available points showing their coordinates and their point number. To the right of this list the points are displayed that are going to be part of the profile. These can be added by double clicking on the particular point or pressing the button >>. Likewise, it is possible to delete them from the profile with the button <<.

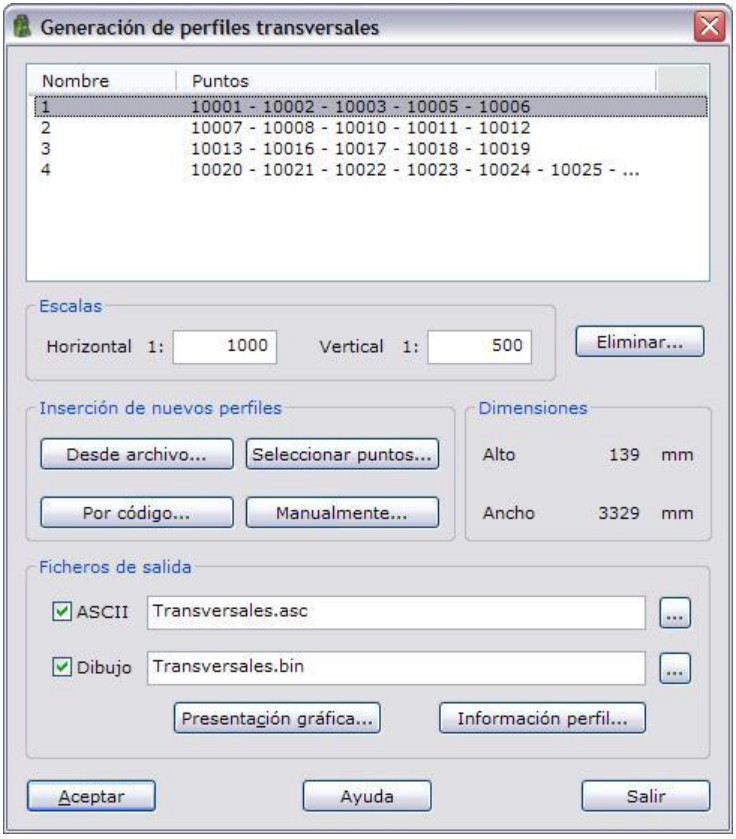
It is possible to indicate the horizontal and vertical scales for the generation of the respective drawing file. Next, the plotting size the profile is going to have will be expressed in millimetres, depending on its length, the scales and the options added to the profile annotation.

The program may generate two types of output files:

- A text file with the list of points making up the profile.
- A drawing file with the longitudinal profile and an annotation with the information relating to it. Through the following dialog box, a custom annotation may be made:

The size of the texts the profile annotation is going to contain can be indicated in this dialog box, as well as the elements to be added, if so desired. It is also possible to change the code or layer where that annotation will be registered, as well as the amount of profile information contained in the annotation and the height of the comparison plane.

6.13. Cross sections



This tool is of use to compute cross sections made up of a set of points stored in a TopCal point file or stored in a text file, where the height and the distance to the axis of the different points had been stored.

The program displays a dialog box with the available points showing their coordinates and their point number. To the right of this list the points are displayed that are going to be part of the profile. These can be added by double clicking on the particular point or pressing the button >>. Likewise, it is possible to delete them from the profile with the button <<.

It is possible to indicate the horizontal and vertical scales for the generation of the respective drawing file. Next, the plotting size the profile is going to have will be expressed in millimetres, depending on its length, the scales and the options added to the profile annotation.

The program may generate two types of output files:

- A text file with the list of points making up the profile.
- A drawing file with the cross section and an annotation with the information relating to it. Through the following dialog box a custom annotation may be made:

The size of the texts the profile annotation is going to contain can be indicated in this dialog box, as well as the elements to be added, if so desired. It is also possible to change the code or layer where that annotation will be registered, as well as the amount of profile information contained in the annotation and the height of the comparison plane.

6.14. Coordinate Transformation

This tool is of use to transform a set of points out of the transformation values introduced by the user. A transformation may be performed in 2 or 3 dimensions starting from the knowledge of the displacement vectors, rotation angles and scale factor; or from the knowledge of the tensors associated with the transformation.

The computation is made up of the following three steps:

- *Step 1: Choose Transformation Parameters*
- *Step 2: Point* Selection
- *Step 3: Output Data Setup*

6.14.1. Step 1: Choose Transformation Parameters

This is the first step in the computation of the coordinate transformation. The type of transformation and the parameters defining it are indicated. The data required are:

- ***Type of transformation***: It may be ***2 dimensions***, ***3 dimensions*** or ***affine***.
- Way in which the data are introduced:
  - ***By transformation parameters***: These parameters are the displacement vector, rotation angles and scale factors. Their number will vary according to the type of transformation previously chosen.

- ***Through a tensor***: This tensor will be 2x2 or 3x3, depending on the type of transformation previously chosen.
- ***By data stored in a file***.

After having introduced these data, the button Next may be introduced to carry on to Step 2: Point Selection.

6.14.2. Step 2: Point Selection

This is the second step in the computation of transformation.

A screen is shown displaying the points with coordinates stored in the current file. The points to be transformed should be selected.

The list shown contains the following fields:

- ***Point number***
- ***Coordinates ENH***
- ***Name***

Multiple points may be selected by using the key CTRL and pressing on the desired points with the left mouse button. If an already selected point is pressed, it will be cancelled.

Points ordered in ranges may be selected by pressing the key SHIFT LOCK and the left mouse button on the limit points defining the range.

The buttons All or None may also be used to select or cancel all points.

After having selected the desired points, the button Next may be pressed to carry on to *Step 3: Output Data Setup* or button Back, to turn back to *Step 1: Choose Transformation Parameters*.

6.14.3. Step 3: Output Data Setup

This is the third and last step in the computation of transformation.

Aside from a list with the coordinates of the transformed points, the following fields are shown:

- ***TopCal output file***: The name of the TopCal file where the points are stored should be selected. One of the existing files may be chosen or a new file generated. In the latter case, you may or may not add the file to the current project.
- ***Adding new points***: If the point file is not new, you may or may not modify the points with the same number lying in the chosen output file.

After having set up the output data, the process may be finished by pressing the button Compute, or we may turn back to Step 2: Point Selection by pressing the button Back.

6.15. Transformation of Geographic Coordinates

This tool is of use to transform a set of points stored in a TopCal file in UTM coordinates into geographic coordinates, with the possibility of setting up the ellipsoid used in the projection.

The computation is made up of the following three steps:

- *Step 1: Enter*¡Error! **Marcador no definido.** Transformation Settings
- *Step 2: Point*¡Error**! Marcador no definido.** Selection
- *Step 3: Transformed Coordinates*

6.15.1. Step 1: Enter¡Error! Marcador no definido. Transformation Settings

This is the first step to compute the transformation of geographic coordinates, in which the ellipsoid used in the cartographic projection of the coordinates is indicated. The data required are as follows:

- ***Reference system***, defined by:
  - ***Ellipsoid***: It may be chosen from the list of predefined ellipsoids or the user may define it by means of flattening or the major semiaxis.
  - ***UTM Zone***.

- ***ASCII output file***: The name of the ASCII output file should be written with the results of the computation.

After having introduced these data, the button Next may be pressed to go on to *Step 2: Point*¡Error! **Marcador no definido.** Selection.

6.15.2. **Step 2: Point**¡Error! Marcador no definido. **Selection**

This is the second step to compute the transformation of geographic coordinates.

A screen is shown displaying the points with coordinates stored in the current file. The points to be transformed should be selected.

The list shown contains the following fields:

- ***Point****¡Error! Marcador no definido.* ***number***
- ***Coordinates ENH***
- ***Name***

Multiple points may be selected by using the key CTRL and pressing on the desired points with the left mouse button. If an already selected point is pressed, it will be cancelled.

Points ordered in ranges may be selected by pressing the key SHIFT LOCK and the left mouse button on the limit points defining the range.

The buttons All or None may also be used to select or cancel all points.

After the desired points have been selected, the button Next may be pressed to carry on to *Step 3: Transformed Coordinates* or button Back, to turn back to *Step 1: Enter*¡Error! **Marcador no definido.** Transformation Settings.

6.15.3. Step 3: Transformed Coordinates

This is the third and last step in the computation of the transformation.

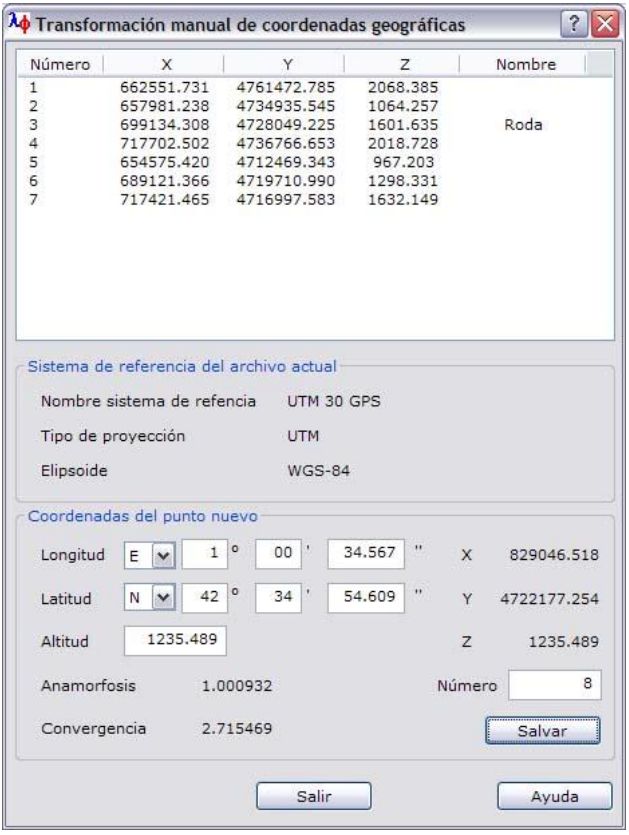
The program displays a list with the geographic coordinates of the transformed points, where the following fields are shown:

- ***Point****¡Error! Marcador no definido.* ***number***
- ***Longitude***, in degrees
- ***Latitude***, in degrees
- ***Linear anamorphosis*** of the projection at this point
- ***Meridian convergence***, in degrees

After having set up the output data, the process may be finished by pressing the button Compute, or we may turn back to *Step 2: Point*¡Error! **Marcador no definido.** Selection by pressing button Back.

6.16. Manual Transformation of Geographic Coordinates

This tool is of use to transform geographic coordinates into UTM coordinates, storing them in the current point file.



The program displays a dialog box where we have to indicate the geographic latitude and longitude of the point, as well as the ellipsoid used in the UTM projection to transform the point.

The ellipsoid may be chosen from the ones predefined by the program or the user may define it by means of flattening or the major semiaxis. It is also necessary to indicate the UTM Zone to which the point belongs.

As the geographic coordinates are introduced, the program automatically computes the UTM coordinates, the linear anamorphosis and the meridian convergence, allowing storing of the new coordinates in the point file.

6.17. Transformation of coordinates from Struve ellipsoid to Hayford

6.18. Transformation of coordinates between different reference systems

6.19. Transformation of coordinates using NTV2 grid

6.20. Transformation of units

6.21. Transformation of heights using grid

6.22. Generate Data Information of Stations

This tool is of use to generate data information of a set of stations stored in a TopCal file. The program generates a file in HTML format from a template predesigned by the user. Nevertheless the program includes a default template.

The computation is made up of the following three steps:

- *Step 1: Point*¡Error! **Marcador no definido.** Selection
- *Step 2: Enter*¡Error! **Marcador no definido.** station information
- *Step 3: Enter*¡Error! **Marcador no definido.** Output Files

6.22.1. Step 1: Point¡Error! Marcador no definido. Selection

This is the first step to generate data information of stations.

A screen is shown displaying the points with coordinates stored in the current file. The points should be selected wherefrom data information are to be generated.

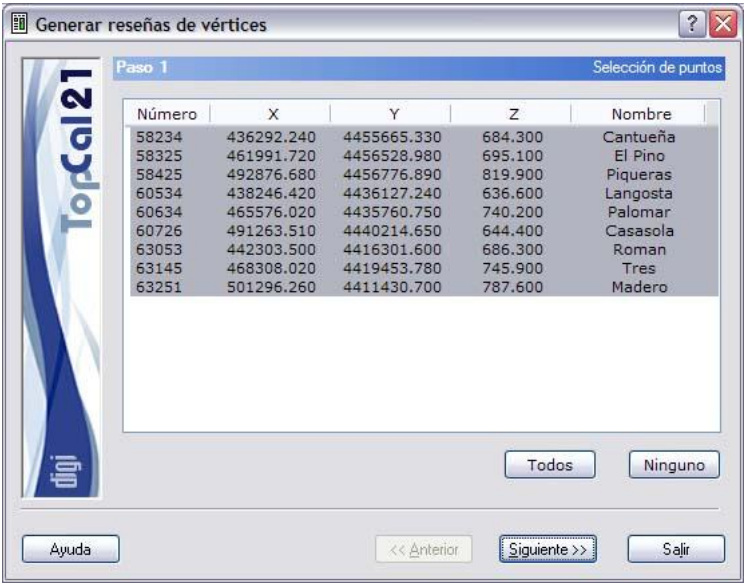
The list shown contains the following fields:

- ***Point****¡Error! Marcador no definido.* ***number***
- ***Coordinates ENH***
- ***Name***

Multiple points may be selected by using the key CTRL and pressing on the desired points with the left mouse button. If an already selected point is pressed, it will be cancelled.

Points ordered in ranges may be selected by pressing the key SHIFT LOCK and the left mouse button on the limit points defining the range.

The buttons All or None may also be used to select or cancel all points.



After having introduced these data, the button Next may be pressed to carry on to *Step 2: Enter*¡Error! **Marcador no definido.** station information.

6.22.2. **Step 2: Enter**¡Error! Marcador no definido. **station information**

This is the second step to generate vertex sketches.

The program displays a list with the points selected in the previous step, where the additional data must be introduced, if this was not done on another occasion, to fill in the vertex file. Likewise, the files containing the photograph and the sketch of the point must be chosen.

Among these fields are the following:

- ***Situation***: Literal description of the point location.
- ***Zone***: Place within the county where the point lies.
- ***Province***: A county should be selected.
- ***Sheet***: National Map Sheet where the point lies.
- ***UTM Zone***
- ***Marker***: Type of sign used to mark the point.
- ***Picture***
- ***Sketch***

After having filled in all the point information, the button Next may be pressed, to carry on to *Step 3: Enter*¡Error! **Marcador no definido.** Output Files or button Back, to turn back to *Step 1: Point*¡Error**! Marcador no definido.** Selection.

6.22.3. Step 3: EnteriError! Marcador no definido.
Output Files

This is the third and last step to generate data information of stations.

The following fields are shown:

- ***Output file***: A name should be indicated for the HTML output file; otherwise it should be located through the Windows explorer that shows up as the button *Search* is pressed.
- ***Template file***: The name of the HTML template used to generate sketches should be indicated. This template may have been created by the user, unless the default one offered by the program wanted to be used.

After having set up the output data, the process may be finished by pressing the button Compute, or we may turn back to *Step 2: Enter*¡Error! **Marcador no definido.** station information by pressing button Back.

UNIVERSIDAD POLITÉCNICA DE MADRID

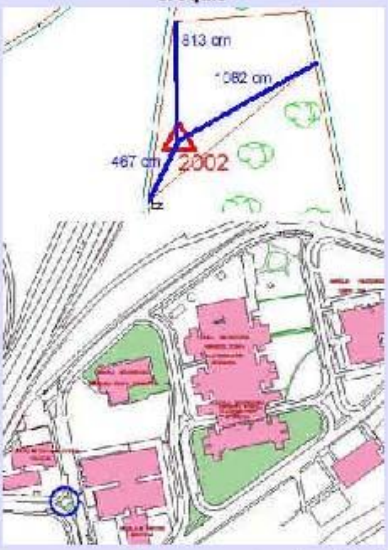
ESCUELA TÉCNICA SUPERIOR DE INGENIEROS EN TOPOGRAFÍA, GEODESIA Y CARTOGRAFÍA

Reseña de vértice

Vértice	2002	Nombre	
X	446553.732	Zona	Campus Sur (Vallecas)
Y	4471199.993	H.M.N.	435
Z	645.568	Provincia	Madrid
Anamorfosis	0.999635156	Huso	30

Sistema de referencia ETRS-89. Altitudes referidas al N.M.M. en Alicante

Croquis



Fotografía

Situación	Se encuentra situado en la calle de la Arboleda, en el triángulo formado por el Colegio de Enseñanza Especial, el INSIA y el Instituto F.P. Palomeras, en la acera situada entre las dos bifurcaciones de la calle. Campus Sur de Vallecas. Carretera de Valencia A-3, Km 7. Empotrado en loseta de acera
Señal	Clavo de acero

6.23. Generate Data Information of Control Points

This tool is of use to generate data information of a set of control points stored in a TopCal file. The program generates a file in HTML format from a template predesigned by the user. Nevertheless, the program includes a default template.

The computation is made up of the following three steps:

- *Step 1: Point*¡Error! **Marcador no definido.** Selection
- *Step 2:*
- *Step 3: Enter*¡Error! **Marcador no definido.** Output Files

6.23.1. Step 1: Point¡Error! Marcador no definido. Selection

This is the first step to generate control point sketches.

A screen is shown displaying the points with coordinates stored in the current file. The points from which sketches are to be generated should be selected.

The list shown contains the following fields:

- ***Point****¡Error! Marcador no definido.* ***number***
- ***Coordinates ENH***
- ***Name***

Multiple points may be selected by using the key CTRL and pressing on the desired points with the left mouse button. If an already selected point is pressed, it will be cancelled.

Points ordered in ranges may be selected by pressing the key SHIFT LOCK and the left mouse button on the limit points defining the range.

The buttons All or None may also be used to select or cancel all points.

After having introduced these data, the button Next may be pressed to carry on to Step 2: Enter**¡Error! Marcador no definido.** station information.

6.23.2. Step 2: EnteriError! Marcador no definido. station information

This is the second step to generate data information of control points.

The program displays a list with the points selected in the previous step, where the additional data must be introduced, if this was not done on another occasion, to fill in the vertex file. Likewise, the files containing the photograph and the sketch of the point must be chosen.

Among these fields are the following:

- ***Description***: Information about the control point characteristics.
- ***Photogram***: Centre of the photogram where the point lies.
- ***Strip***: Strip in which the point lies.

After all point information has been filled in, the button Next may be pressed to carry on to *Step 3: Enter*¡Error! **Marcador no definido.** Output Files or button Back, to turn back to *Step 1: Point*¡Error! **Marcador no definido.** Selection.

6.23.3. **Step 3: Enter**¡Error! Marcador no definido. **Output Files**

This is the third and last step to generate data information of control points.

The following fields are shown:

- ***Output file***: A name should be indicated for the HTML output file; otherwise it should be located through the Windows explorer that shows up as the button *Search* is pressed.
- ***Template file***: The name of the HTML template used to generate sketches should be indicated. This template may have been created by the user, unless the default one offered by the program wanted to be used.

After the output data have been set up, the process may be finished by pressing the button Compute, or we may turn back to *Step 2: Enter*¡Error! **Marcador no definido.** station information by pressing button Back.

6.24. Compute Systematic Errors

This tool is of use to compute the possible systematic errors of the topographic instrument and, after doing it, to be able to apply them to the remainder of observations performed with the instrument.

To compute these errors, it is necessary to have taken observations in direct circle and inverse circle to a set of points.

The tool is constructed in the following three steps:

- *Step 1: Observation Selection*
- *Step 2: Computation of Systematic Errors*
- *Step 3: Output Data Setup*

6.24.1. Step 1: Observation Selection

This is the first step in the computation of systematic errors.

A screen is shown with the observations having direct circle and inverse circle to be able to compute the errors. The observations with which the errors are to be computed should be selected.

The list shown contains the following fields:

- ***Station***
- ***Target****¡Error! Marcador no definido.* ***point***
- ***Horizontal****¡Error! Marcador no definido.* ***angle****¡Error! Marcador no definido.* ***in face 1***
- ***Horizontal****¡Error! Marcador no definido.* ***angle****¡Error! Marcador no definido.* ***in face 2***

- ***Vertical***¡Error! Marcador no definido. ***angle***¡Error! Marcador no definido. ***in face 1***
- ***Vertical***¡Error! Marcador no definido. ***angle***¡Error! Marcador no definido. ***in face 2***

Multiple points may be selected by using the key CTRL and pressing on the desired points with the left mouse button. If an already selected point is pressed, it will be cancelled.

Points ordered in ranges may be selected by pressing the key SHIFT LOCK and the left mouse button on the limit points defining the range.

The buttons All or None may also be used to select or cancel all points.

The ASCII file should also be indicated with the results of the computation. This file can be viewed after the computation with the assigned viewer by activating the checkbox on the bottom named ***Show after computation***. If you do not wish to create this file, you will have to deactivate the checkbox appearing on the left of the name. The file will be created in the project directory.

After having introduced these data, the button Next may be pressed to carry on to *Step 2: Computation of Systematic Errors*.

6.24.2. Step 2: Computation of Systematic Errors

This is the second step in the computation of systematic errors.

A screen is shown with the observations selected in the previous step, with which the listed errors have been computed.

The list shown contains the following fields:

- ***Station***¡Error! Marcador no definido. ***point number***
- ***Target***¡Error! Marcador no definido. ***point number***
- ***Collimation error***
- ***Index error***

Multiple observations may be selected by using the key CTRL and pressing on the desired observations with the left mouse button. If an already selected observation is pressed, it will be cancelled.

Observations**¡Error! Marcador no definido.** ordered in ranges may be selected by pressing the key SHIFT LOCK and the left mouse button on the limit observations defining the range.

The buttons All or None may also be used to select or cancel all observations.

According to the selected observations, the mean errors will be simultaneously computed and it will be displayed in the field ***Computed systematic errors***. Select or cancel observations to obtain optimal mean errors.

After the desired observations have been selected, the button Next may be pressed to carry on to *Step 3: Output Data Setup* or button Back, to turn back to *Step 1: Observation Selection*.

6.24.3. Step 3: Output Data Setup

This is the third and last step in the computation of systematic errors.

The following fields are shown:

- ***List of computed errors with the corrected observations***: With indication of the station number, Target**¡Error! Marcador no definido.** point**¡Error! Marcador no definido.** number, Horizontal**¡Error! Marcador no definido.** angle, Vertical**¡Error! Marcador no definido.** angle and geometric distance.
- ***TopCal output file***: The name of the TopCal file where the observations will be stored may be selected. One of the existing files may be chosen or a new file generated. If you wish to generate a new file, you may or may not add it to the current project.
- ***Adding new observations***: If the observation file is not new, you may or may not modify the observations with the same station and same Target**¡Error! Marcador no definido.** point lying in the chosen output file.

After having set up the output data, the process may be finished by pressing the button Compute, or you may turn back to *Step 2: Computation of Systematic Errors*, by pressing the button Back.

6.25. Computation of average of observations

6.26. Computation of random errors

6.27. Levelling

6.28. Compensation of levelling network using least squares

7 Drawing

7.1. Draw Entity

This tool is of use to register entities in the sketch file from points related to it. To do that, it is necessary to have an entity code that can be chosen from the existing code list. It is also necessary to know the sequence of points making up the entity.

The points may be introduced one by one through a continuous point sequence or by points making up an arc.

The program displays the points making up the entity, its length and, if the entity is a closed one, the area.

7.2. **Insert**iError! Marcador no definido. **symbol**

7.3. **Insert**iError! Marcador no definido. **sheet**

7.4. **Fit view on point**

7.5. **Insert**iError! Marcador no definido. **parallel**

7.6. **Insert**iError! Marcador no definido. **square**

7.7. **Insert**iError! Marcador no definido. **rectangle**

7.8. **Insert**iError! Marcador no definido. **circle**

7.9. **Point**iError! Marcador no definido. **information**

7.10. Planimetry accuracy information

7.11. Altimetry accuracy information

8 Viewing Options

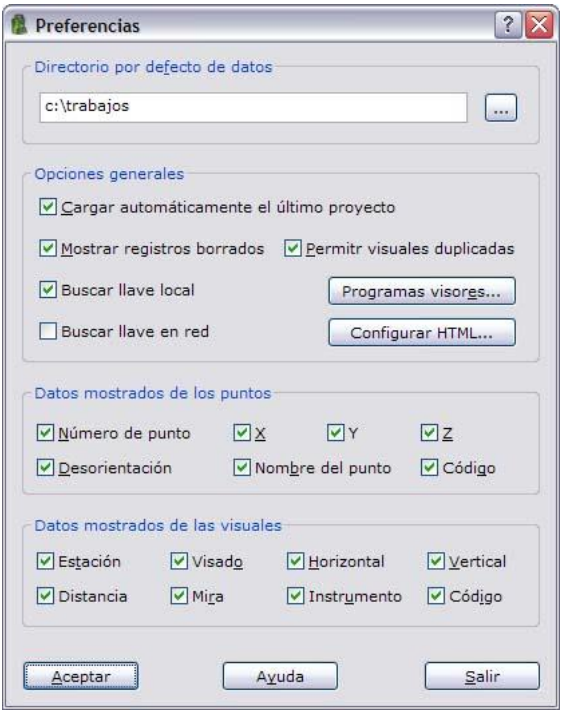
8.1. Preferences

Through this dialog box, the basic options of data viewing (points and observations) can be set up. Likewise, the default directory where the generated projects are going to be stored can be set up, as well as other interesting options as described below:

- ***Default data directory:*** This directory indicates where the folders containing the created projects are going to be generated. A tree with the available units will be displayed by using the right button. A new directory may then be selected. If the directory is keyed in and it does not exist, the application will generate it anew.
- General options:
  - ***Automatic loading of the last project:*** As the program is started up, this option allows automatic display of the last project that was modified last time the program was accessed.
  - ***Display erased registers***: It allows display, in the current list, of those registers that had been marked with the sign of Erased. These registers will be displayed in red.

- ***Duplicated observations***: It allows storage in the observation file of several observations between the same two points. This option is useful if you wish to compute the systematic errors of the topographic instrument, for which it is necessary to have carried out the observations in direct circle and inverse circle.
- ***Key code***: This value is 824 by default. It must not be changed, unless the system manager so indicates.
- ***Viewer programs***: With this button, it is possible to set up the location of the programs to be used and view the output reports with the computations in TXT and HTML formats.

- ***Point****¡Error! Marcador no definido.* ***data displayed***: With this option you may select the point file fields you want to view.
- ***Observation data displayed***: With this option you may select the observation file fields you want to view.



To accept the fields you have worked out and to exit, you have to press the button OK. If you wish to exit without saving the changes, you have to press the button Exit.

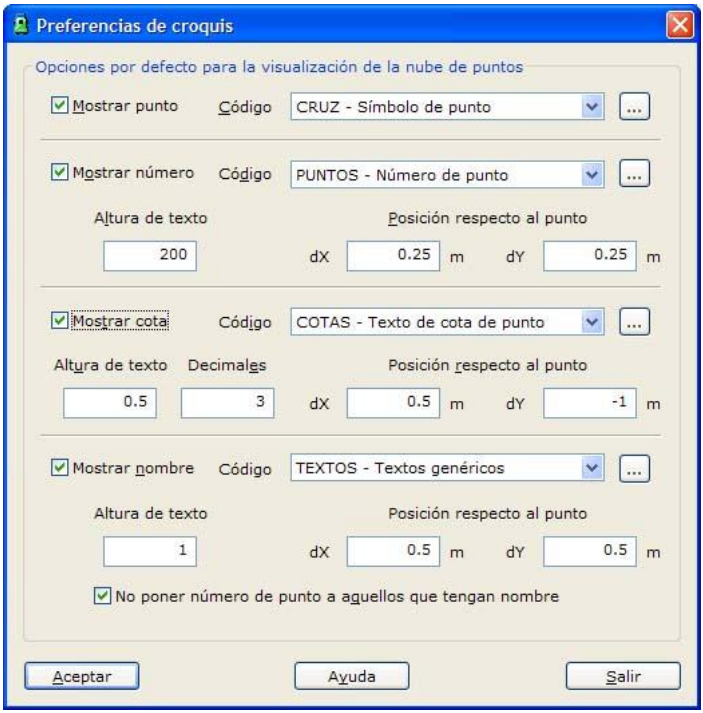
8.2. Sketch Preferences

Through this dialog box it is possible to set up the basic options of viewing a point cloud in a sketch. The data that can be presented for each point are as follows:

- ***Point***: The point is a punctual geographic entity, located in the ENH coordinates, holding the point in the file.
- ***Number***: The point number is the figure identifying it. Its size in meters and the text displacement in relation to the point may be indicated.
- ***Height***: It may be displayed as a text close to the point. Indication may be made of its size in meters and the number of decimals wanted. The text displacement in relation to the point may also be indicated in meters.
- ***Name***: The point name is the text to be stored in the field of the same name in the point file. It is possible to determine its size in meters and the text displacement in relation to the point. If the point has a name showing up, it is possible to activate the option “do not view point number”, so as not to fill up the drawing with texts.

A drawing code may be chosen from the list for all the displayed elements. If the chosen code is not on the list, access can be gained to the drawing code manager in order to add a new one or to modify one already there.

When indicating the text displacement in relation to the point, it has to be taken into account that the coordinates of the texts have their left lower corner as their reference.



To accept the fields you have worked out and to exit, you have to press the button OK. If you wish to exit without saving the changes, you have to press the button Exit.

8.3. Drawing Preferences

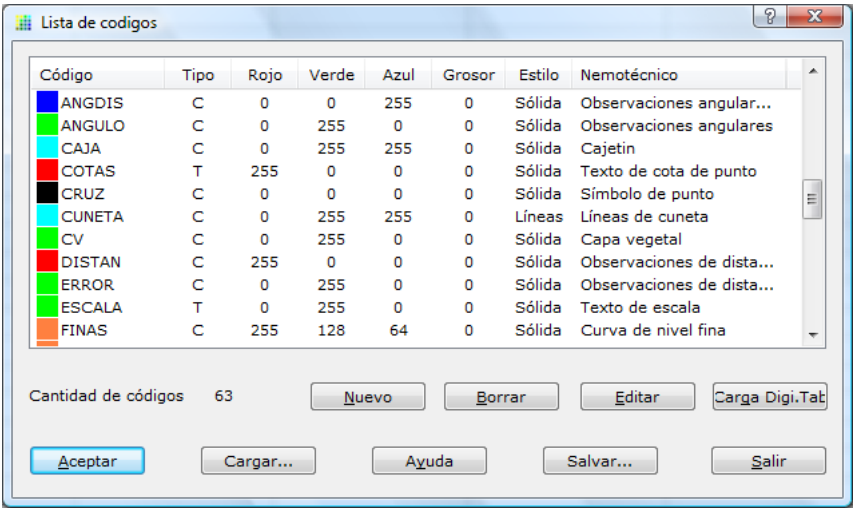
8.3.1. Drawing Code List

In this dialog box the codes appear that the program will use to paint entities on screen. If any of the codes in the documents was not on this list, the colour of the entity would be grey and it would have a default weight.

The listed codes may refer to texts or lines, and the line weight, colour and style may be itemized.

New**¡Error! Marcador no definido.** codes may be added or any of the existing ones edited or deleted.

The codes stored in the table DIGI.TAB, belonging to the DIGI program, may also be loaded. To do that, press the button Load Digi.Tab.



The changes made will only be valid if the button OK is pressed to exit.

8.3.2. **New**¡Error! Marcador no definido. **Drawing Code**

This dialog box shows the following fields to be filled in:

- ***Code****¡Error! Marcador no definido.* ***name***: The name of the new code should be given. If not new, the existing one should be edited.
- ***Type of entity***: It may be line or text.
- ***Weight***: A line weight between 1 and 10 should be itemized.
- ***Line****¡Error! Marcador no definido.* ***style***: It may be Solid (continuous line), Lines (stroke line), Points (point line), Line-Point, Line-Point-Point.

- ***Colour***: A colour should be specified.
- ***Mnemonics***: An explanatory text of the new code may be assigned.

8.3.3. Load Digi.Tab

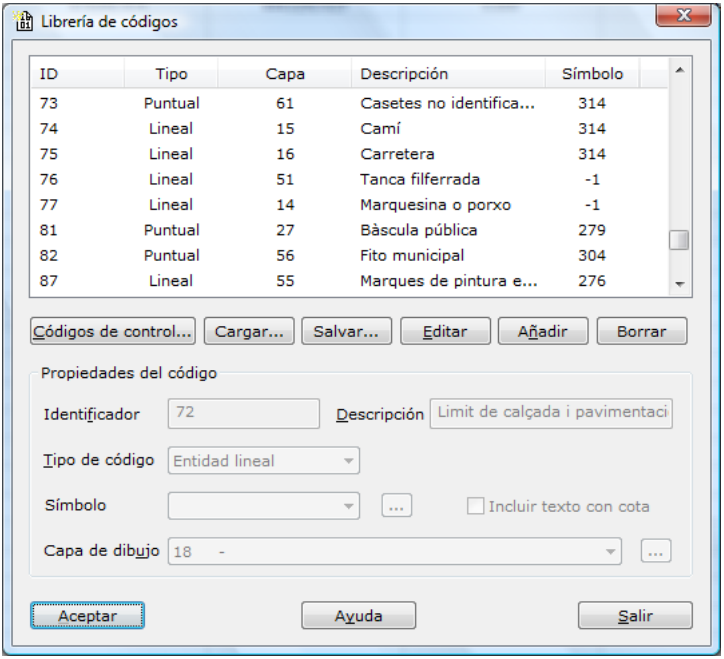
In this dialog box the DIGI view codes may be loaded. To do that, the location of the DIGI.TAB and the DIGI.PAL files, where the colours are defined, should be indicated.

If the DIGI.PAL file is not found, the program will assign the MS-DOS colours.

8.4. Sketching Preferences

8.4.1. Code Library

This dialog box displays a list of the existing codes and the drawing layers where they will be registered when the sketch is made.

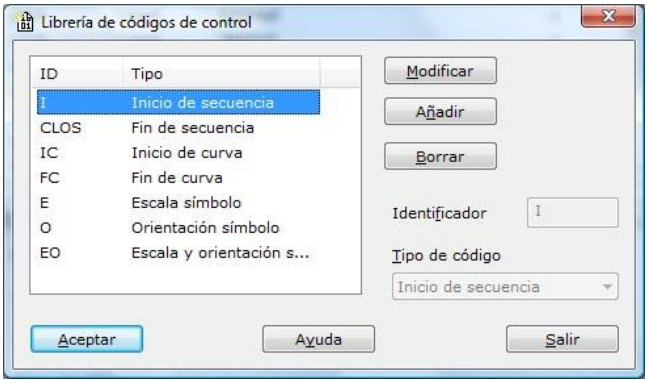


The codes are on-the-field notes together with the observations made, having the purpose of facilitating the office job of mapping workout.

After having finished with the definition, the button OK should be pressed to view the data, or the button Exit to exit the dialog box.

8.4.2. Control Code Library

In this dialog box an account appears of the existing control codes to automatically perform a sketch.



After having concluded the definition, the button OK should be pressed to view the data, or the button Exit, to exit the dialog box.

8.5. Symbol library

8.6. Arrange Data

Through this dialog box, the point file or the observation file may be arranged in terms of any of their fields, in an ascending or descending order.

8.7. Point File Properties

This dialog box displays the current point file properties such as:

- Filename
- Number¡**Error! Marcador no definido.** of point¡**Error! Marcador no definido.**s it contains

- Maxima and minima of the coordinates.

If any parameter is changed and it wants to be saved, the button OK should be pressed. To exit the dialog box, press the button Exit.

8.8. Observation File Properties

This dialog box displays the current observation file properties, such as:

- Filename
- Number**¡Error! Marcador no definido.** of observations it contains

- Number¡Error! Marcador no definido. of stationed points. Maxima and minima of the coordinates.
- Number¡Error! Marcador no definido. of Target¡Error! Marcador no definido. point¡Error! Marcador no definido.s.
- If any parameter is changed and it wants to be saved, the button OK should be pressed. To exit the dialog box, press the button Exit.

8.9. Project Properties

This dialog box displays the current project properties, such as:

- Project name
- Job name
- Folder where it is stored
- Number¡Error! Marcador no definido. of point¡Error! Marcador no definido., observation and sketch files it contains
- Number¡Error! Marcador no definido. of elements, such as number of points, observations, stations and Target¡Error! Marcador no definido. point¡Error! Marcador no definido.s
- Maxima and minima of all coordinates contained in the project's point files

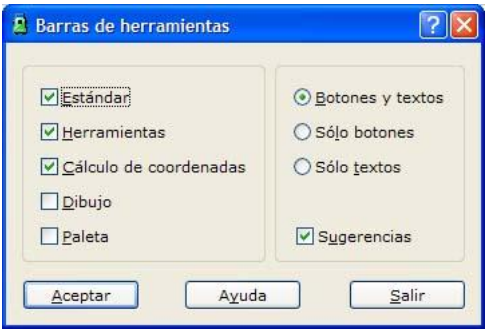
If any parameter is changed and it wants to be saved, the button OK should be pressed. To exit the dialog box, press the button Exit.

8.10. View toolbars

In this dialog box, the view options available in the program may be chosen. They are:

- ***Selection of the desired toolbars***: The toolbars most commonly used may be selected, so that their icons and calls are more easily accessible.

- ***Selection of the toolbar information***: The program offers three possible selections: display only icon, icon with explanatory text and only text.
- ***Selection of additional options***: It is possible to select an additional information display when placing the mouse over the tool, with reproduction of a sound as the computation operations have been concluded.



8.11. View fields

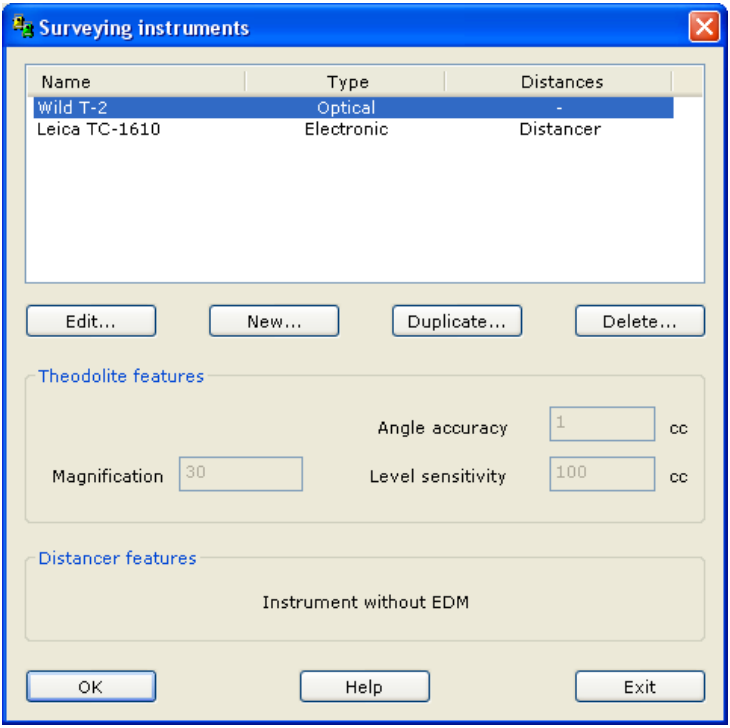
9 Other commands

9.1. Surveying instruments

TopCal 21 allows the user to define the surveying instruments used when doing the observations saved in the files. When creating an observation file the user will specify with which instrument the observations were taken. This will allow the program know with what accuracy the measurements were taken and when to adjust the observations in the computations. For example, when using least squares to calculate coordinates it is usual to adjust the observations proportionately inverted to the accuracy they have. This accuracy is related to the properties of each visual and the accuracy of the instruments.

These definitions are saved in a file that is located in the same folder where the executable file ***Instrumentos.dat*** is.

The program the instruments saved in the following dialog box that you can access form the menu *Edit → Topographic Instruments*:



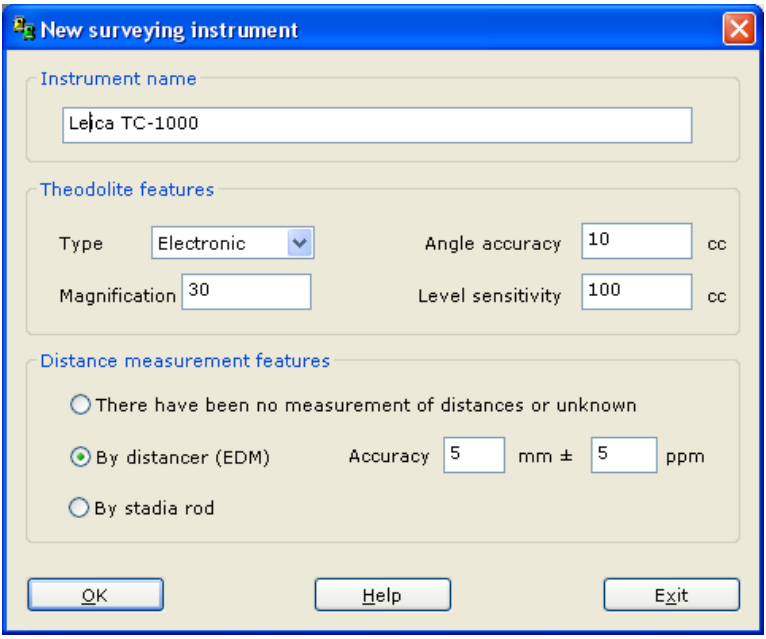
The fields of this dialog box are:

- ***List of instruments***: The different saved instruments are shown, the user will be able to Edit…, define a new one New…, Duplicate… or Delete… on that already exists. In the list you can see the name of the instrument, the type which can be *optical or Electronic* and the *type of distances* it measures.
- ***Theodolite features***: In this part of the dialog box the features of the instrument are defined. These are the Magnification, Angle accuracy and level sensitivity.

- ***EDM instrument features***: In the case of an Electronic instrument the user will define the accuracy of the distance measurer in mm and ppm.

9.1.1. New surveying instrument

The surveying instruments used will allow the program to calculate the accuracy of the different observations. For this reason, if the user wants to adjust the observations rigorously he/she needs to specify the features of the instrument in the following dialog box:



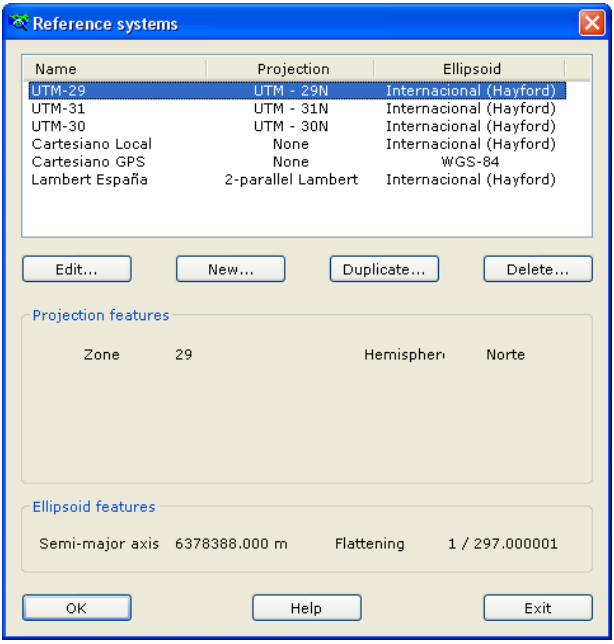
In this dialog box, the following parameters are defined:

- ***Instrument****¡Error! Marcador no definido.* ***name***: The user will specify a unique name for this particular instrument in order to make the selection from any list easier.
- ***Theodolite features***
  - *Type*: The type of theodolite can be either Electronic or Optical. This parameter affects only in the formula used to calculate the reading error of the instrument.
  - *Angle accuracy*: This is the least fraction that is possible to read from the instrument.
  - *Magnification*: This is the magnification of the instrument lenses.
  - *Level sensitivity*: this is the level sensitivity of the instruments.
- ***Distance****¡Error! Marcador no definido.* ***measurement features:*** The user has to select the type of distance measurement done by the instrument. The options are:
  - There have been no measurements of distances or they are unknown.
  - By EDM (Electronic distance measurement): in this case the accuracy of the reading must be specified by mm and ppm.
  - By stadia rod

9.2. Reference Systems

The application allows the creation of point files referred to different coordinate systems. For this, the user needs to previously define the reference systems that are going to be available to create the new point files. This definition allows the program to use certain formulas in the computations processes. These reference systems are going to be saved in a file that is located in the same folder that the executable file called ***Sistema de referencia.dat***.

To access the dialog box that offers the different Reference Systems go to the menu *Edit -> Reference files*.



From this dialog box the user can define new systems that he/she considers necessary for the projects with his coordinate files. He has to take into account that the reference systems are composed by a certain cartographic projection and a reference ellipsoid. In the event the user is handling coordinates that don't belong to any cartographic system, due to the very small extension of the project, he/she can select a local coordinate system where there is no need to select a projection.

The dialog box Reference Systems shows the list with the currently stored reference systems and a series of options to operate with these systems. The options of this window are:

- ***List of existing reference systems:*** This list shows the different systems defined by their name, projection and ellipsoid. From here the user can Edit…, create New…, Duplicate… or Delete… an already existing system.
- ***Projection***
- ***Ellipsoid***

9.3. Joining observations

9.4. Renumber points

9.5. Renumber observations

10 Index

11 Online Help

For any consultation or question not solved by this manual, please get in touch with the Digi21.net development team through e-mail or telephone:

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