Orientation of airborne images using the software package

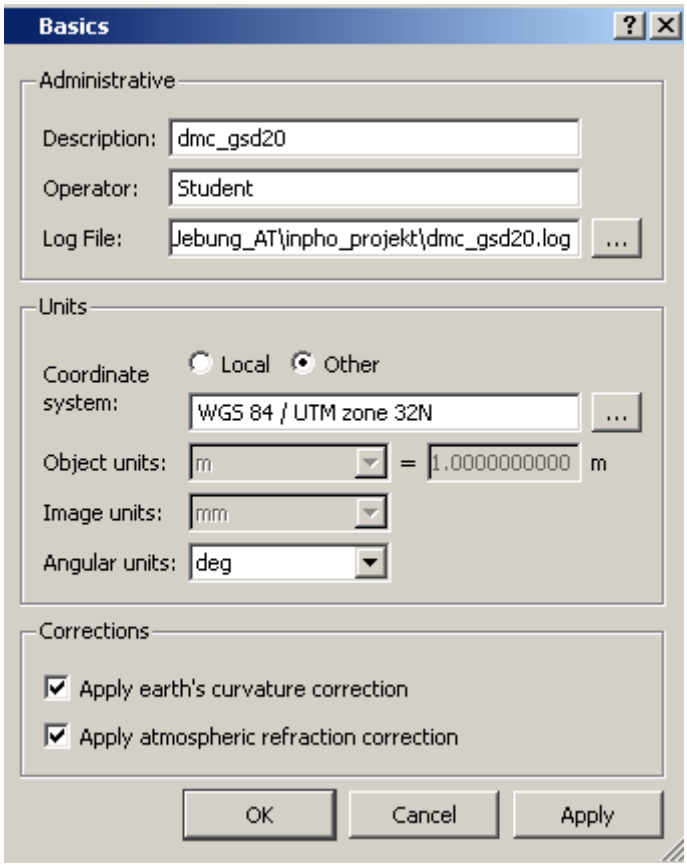
ApplicationsMaster 5.1

This manual only focuses on those topics which are of direct importance to solve the lab exercises in Airborne Data Acquisiton. Major parts of this short manual are copied from the Manual: ***ApplicationsMaster V 5.1 Reference Manual.*** *This Manual is available in the software itself. The information from this short manual should be sufficient for the lab exercises.*

ApplicationsMaster is the core component of INPHO's photogrammetric system which integrates project generation and handling tools as well as application programs (Match-AT, MATCH-T DSM, DT-Master and OrthoMaster) into one working environment.
The user benefits from this combination because each application is based on the same INPHO project file generated during the project setup process. Hence, all steps of a classical photogrammetric processing workflow (starting with aerial triangulation, followed by DEM generation and editing, finalizing with orthophoto production) can be performed within the same environment.
The Software is available at the CIP-Pool. You can start it with Start \ Programme \ Inpho \ ApplicationsMaster 5.1 \ ApplicationsMaster.
The information from this short manual should be sufficient for the lab exercises.

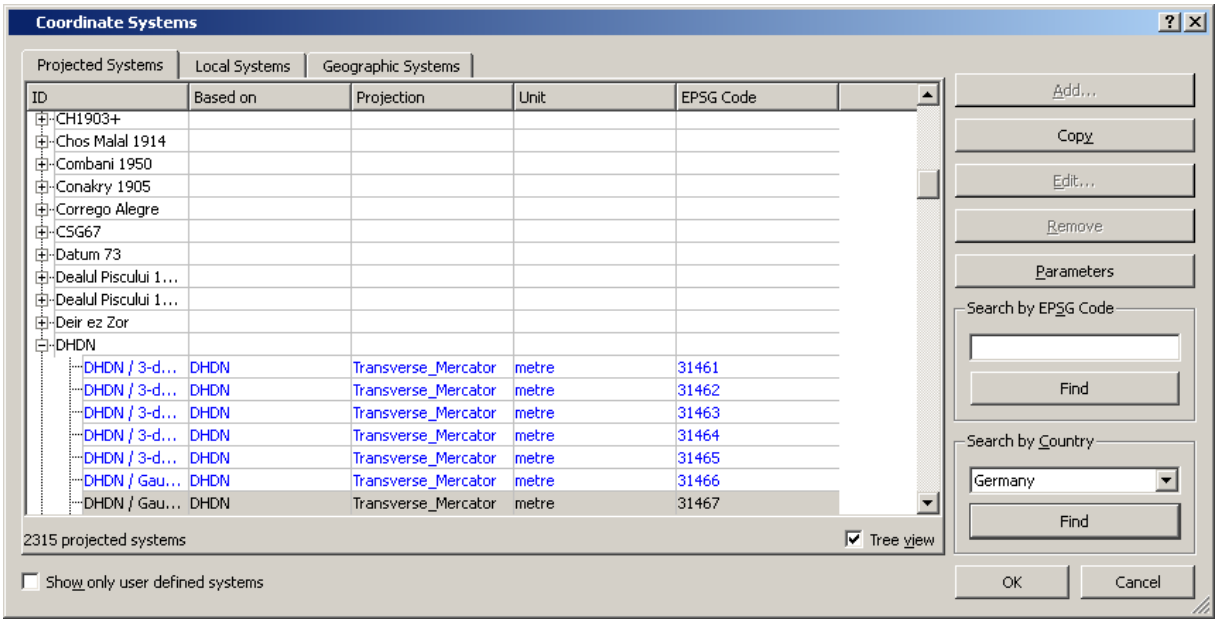
Create a new Project

Setups
File \ New File



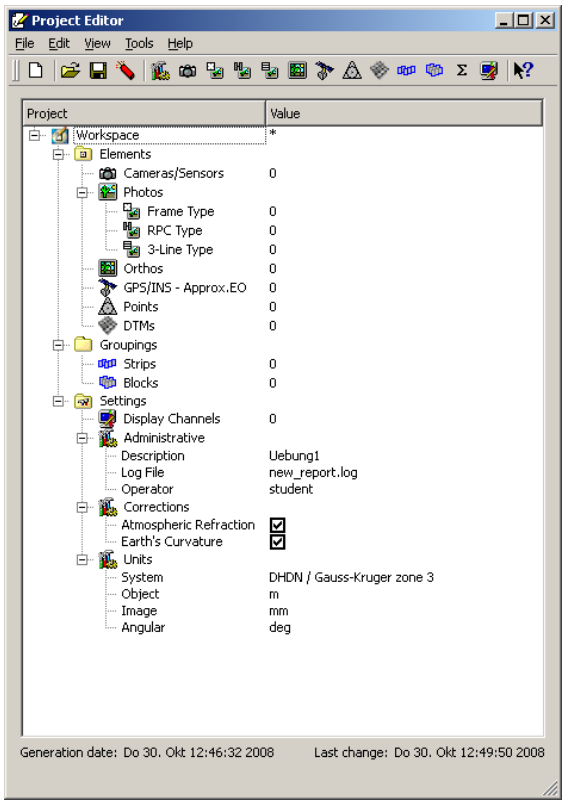
For Log File creation you can either enter a name into the text field or choose one from a file selection box after pressing the Log File button. This file contains all program messages that are also displayed in the terminal window.
The coordinate-system is to set by „Search by Country" (here: DHDN Gauß-Krüger Zone 3)

Choice of Coordinate System („Units")



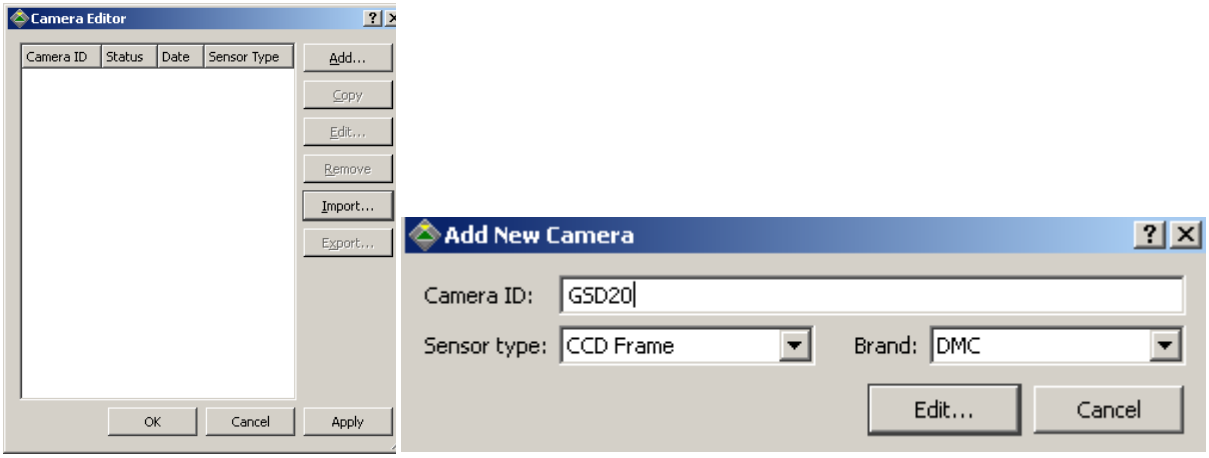
Project Editor

All tasks concerning project definition and management are connected with the "Project Editor". Thus, the corresponding dialog appears immediately after closing the "Basics" window in order to continue the project set up with specifying one or several camera(s), images, GPS/INS data, ground control points, etc..
Provided that a new project has been created or an existing one has been opened, clicking on the item Edit from the "File" submenu of the "Application-Manager" launches the editor window, too. Via this way, a change or an update of project settings or a check of the current project setup is always possible.



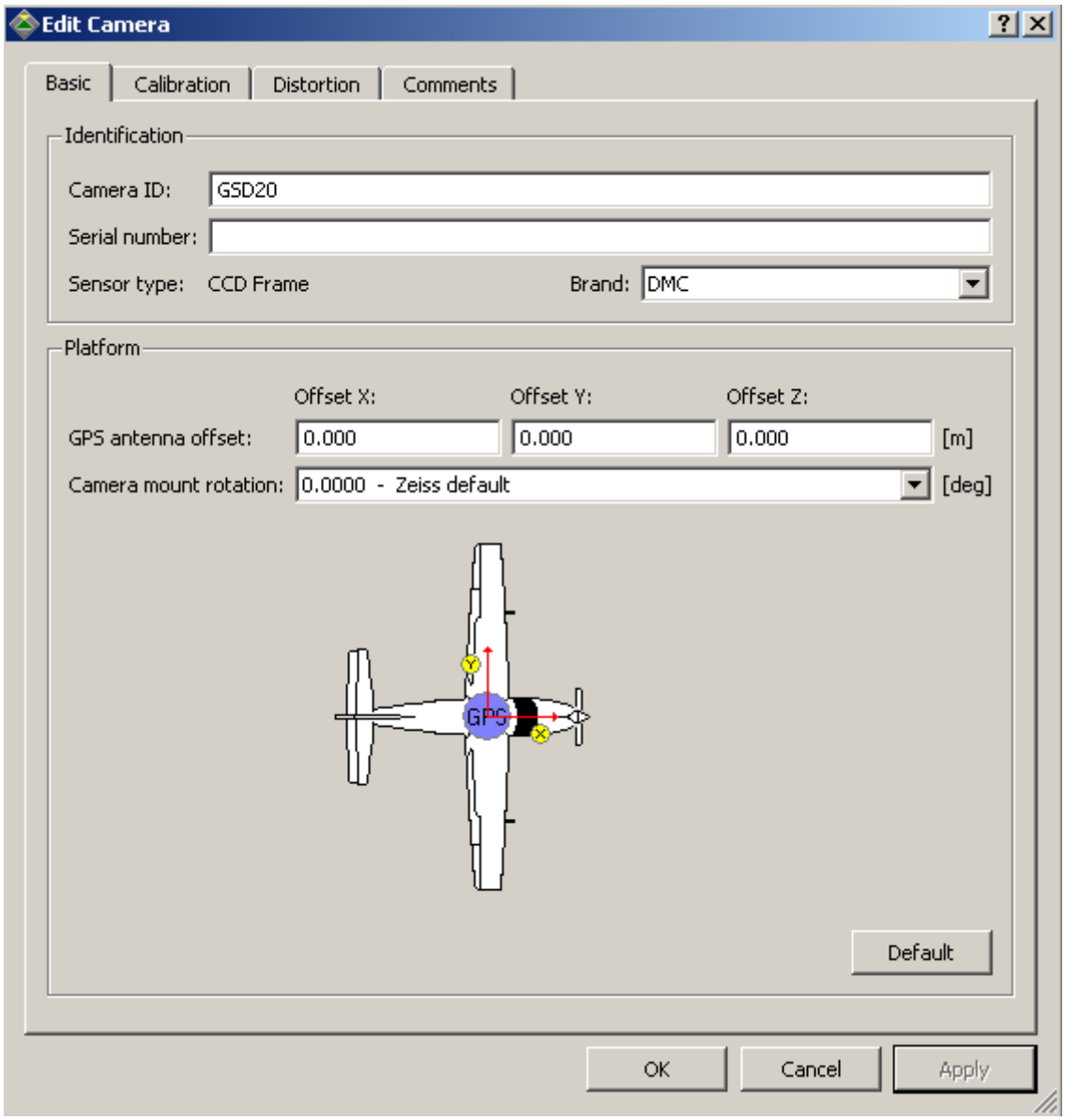
Define camera

By double click on „Cameras/Sensors" you cann choose the camera system.



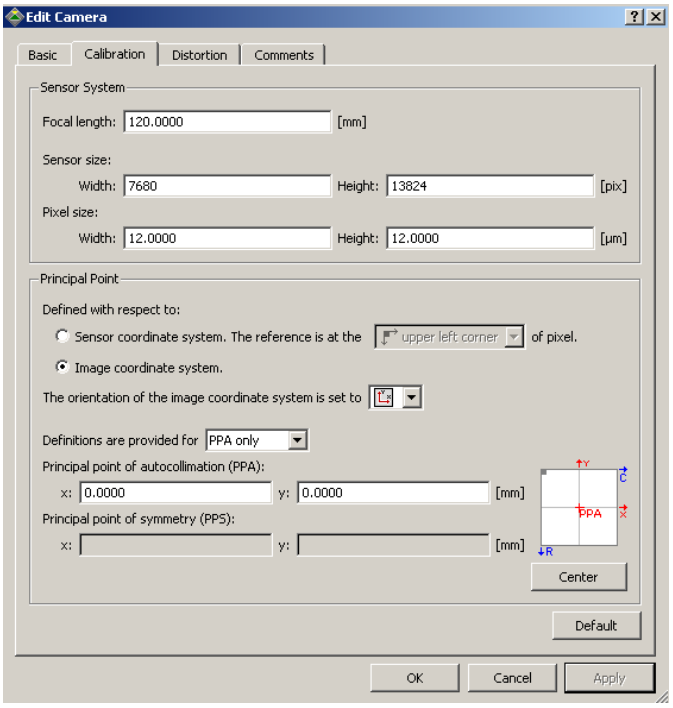
The Camera ID is used to identify the camera, if more than one camera is in use.

Basics



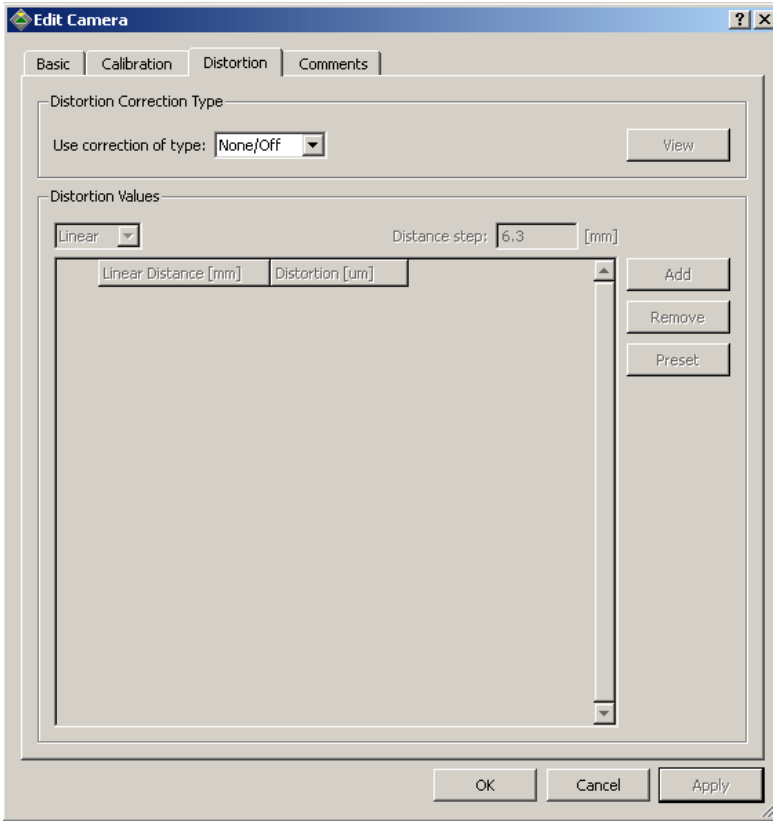
No GPS was used, so you don´t need to insert any offsets.

Calibration



The type of the camera defines all calibration parameters.

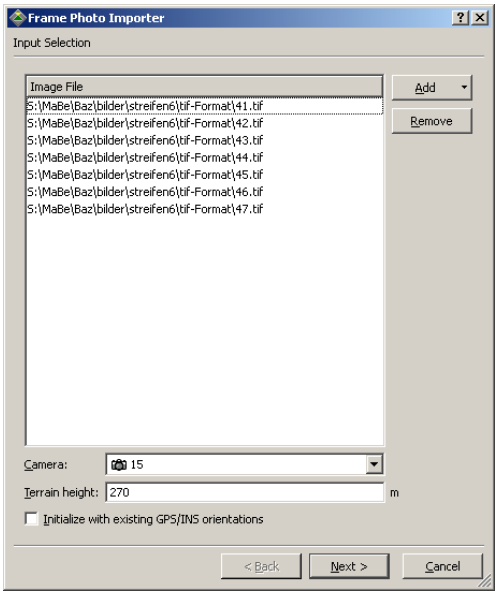
Distortions



There is no distortion in the pictures.

Selection of the Image

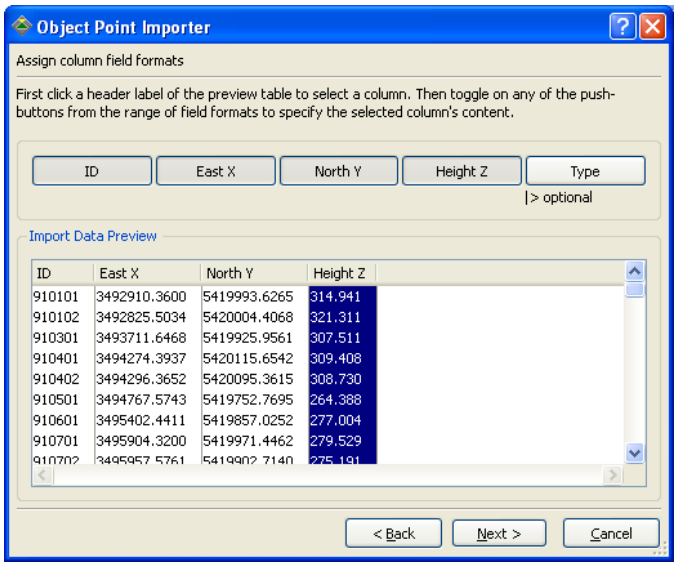
The image (or images) you want to work with have to be copied in the local directory. Click Photos \ Frame Type and in new opened window choose Import \ Image Files. There you can upload the image from the different stripes.



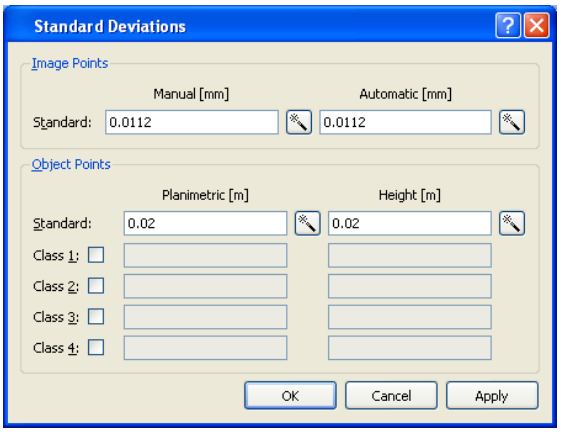
The average terrain height can be estimated from the control point data.
Remove the check from "Initialize with existing GPS/INS orientation" because there are no GPS/INS orientations given (more correctly, not used here).
Label the picture adequate.

Loading the Control Points

Points \ Import
The given control point data has to be imported. Assign the columns to their right intent.

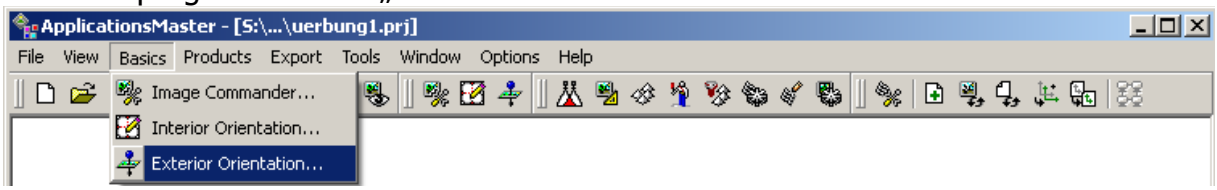


Set the right standard deviation. Click on  and set the pixelsize on 12 µm. The accuracy for object points for planimetric and height have to been set to 0,02m. This is due to the fact, that control points have been measured with static GPS-base line observations in the field, where expected accuracy is within 1-2cm.

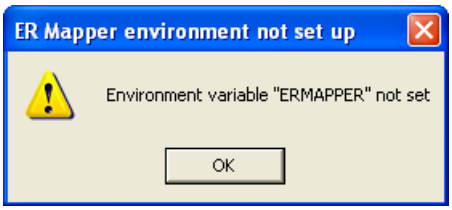


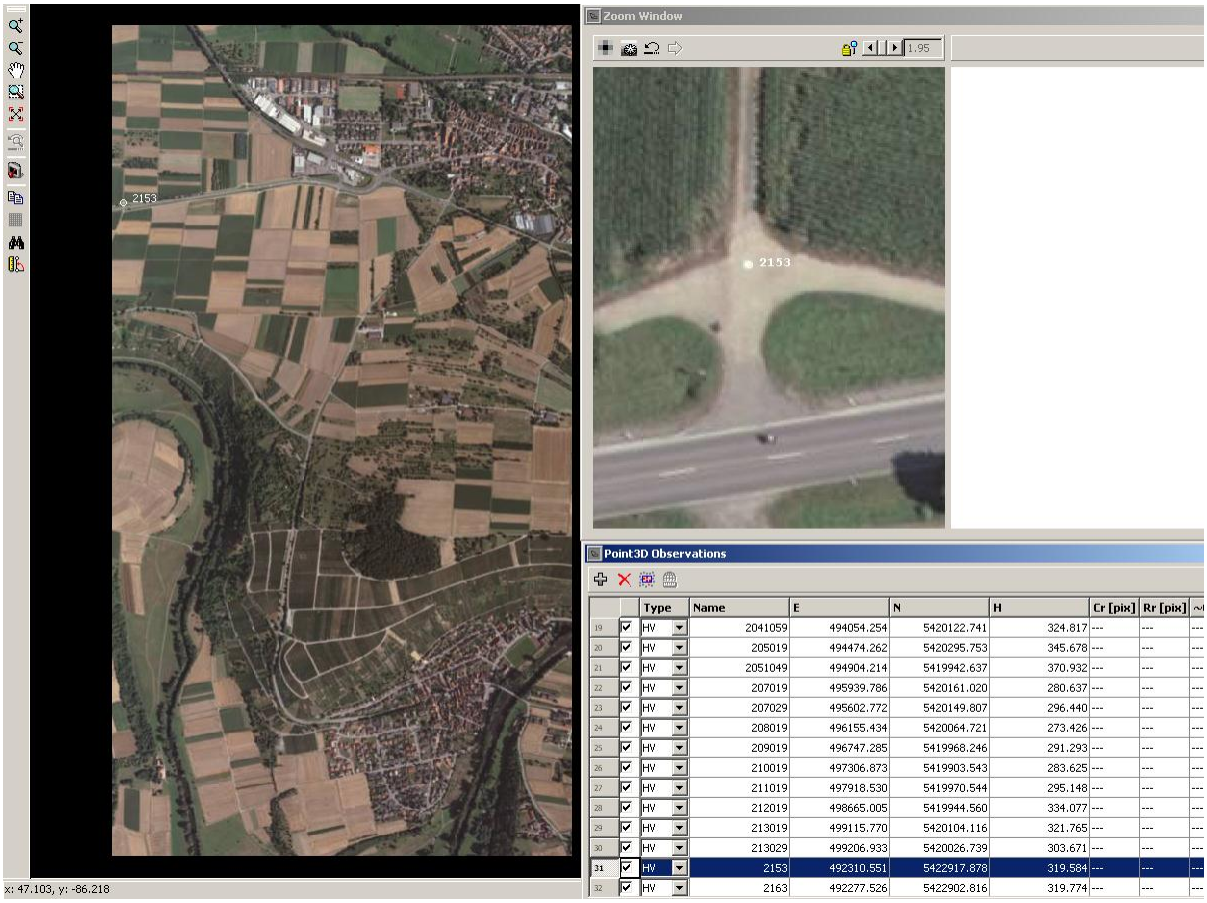
Measurement of the image coordinates

Start the program module „Exterior Orientation".

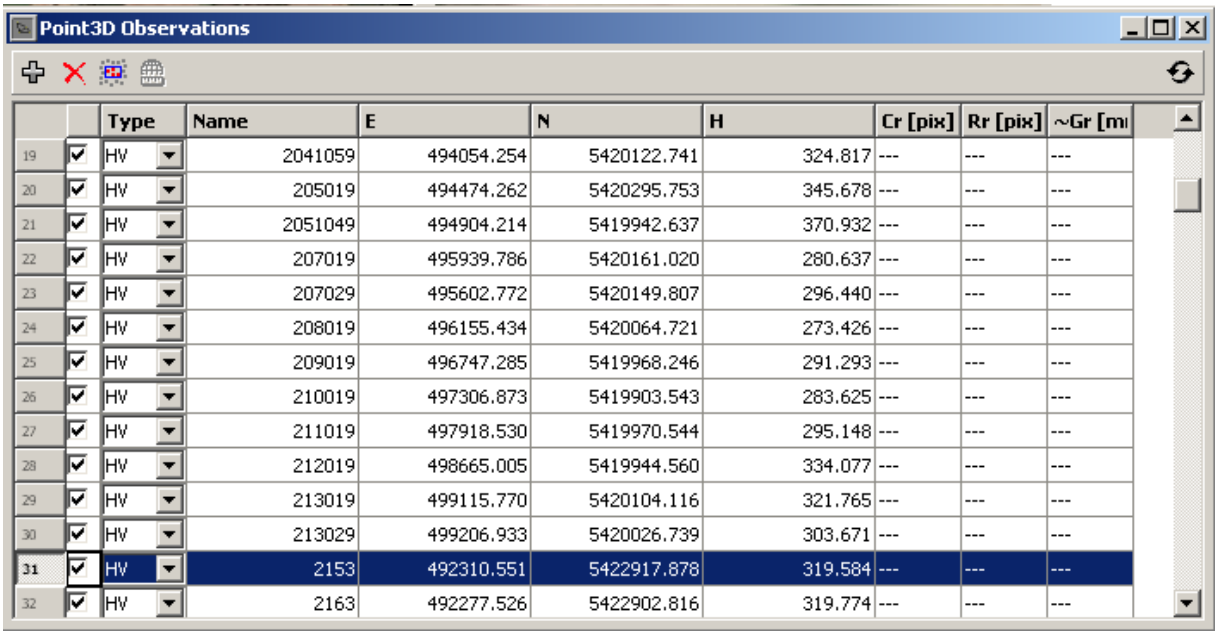


ATTENTION : If there appears a error message just affirm it with OK.





Click the symbol  in the window „Point 3D Observations" and the loaded control points will be shown. To select control points you want to measure click on the gray colored numbers on the left.



		Type	Name	E	N	H	Cr [pix]	Rr [pix]	~Gr [mi
19	☑	HV	2041059	494054.254	5420122.741	324.817	---	---	---
20	☑	HV	205019	494474.262	5420295.753	345.678	---	---	---
21	☑	HV	2051049	494904.214	5419942.637	370.932	---	---	---
22	☑	HV	207019	495939.786	5420161.020	280.637	---	---	---
23	☑	HV	207029	495602.772	5420149.807	296.440	---	---	---
24	☑	HV	208019	496155.434	5420064.721	273.426	---	---	---
25	☑	HV	209019	496747.285	5419968.246	291.293	---	---	---
26	☑	HV	210019	497306.873	5419903.543	283.625	---	---	---
27	☑	HV	211019	497918.530	5419970.544	295.148	---	---	---
28	☑	HV	212019	498665.005	5419944.560	334.077	---	---	---
29	☑	HV	213019	499115.770	5420104.116	321.765	---	---	---
30	☑	HV	213029	499206.933	5420026.739	303.671	---	---	---
31	☑	HV	2153	492310.551	5422917.878	319.584	---	---	---
32	☑	HV	2163	492277.526	5422902.816	319.774	---	---	---

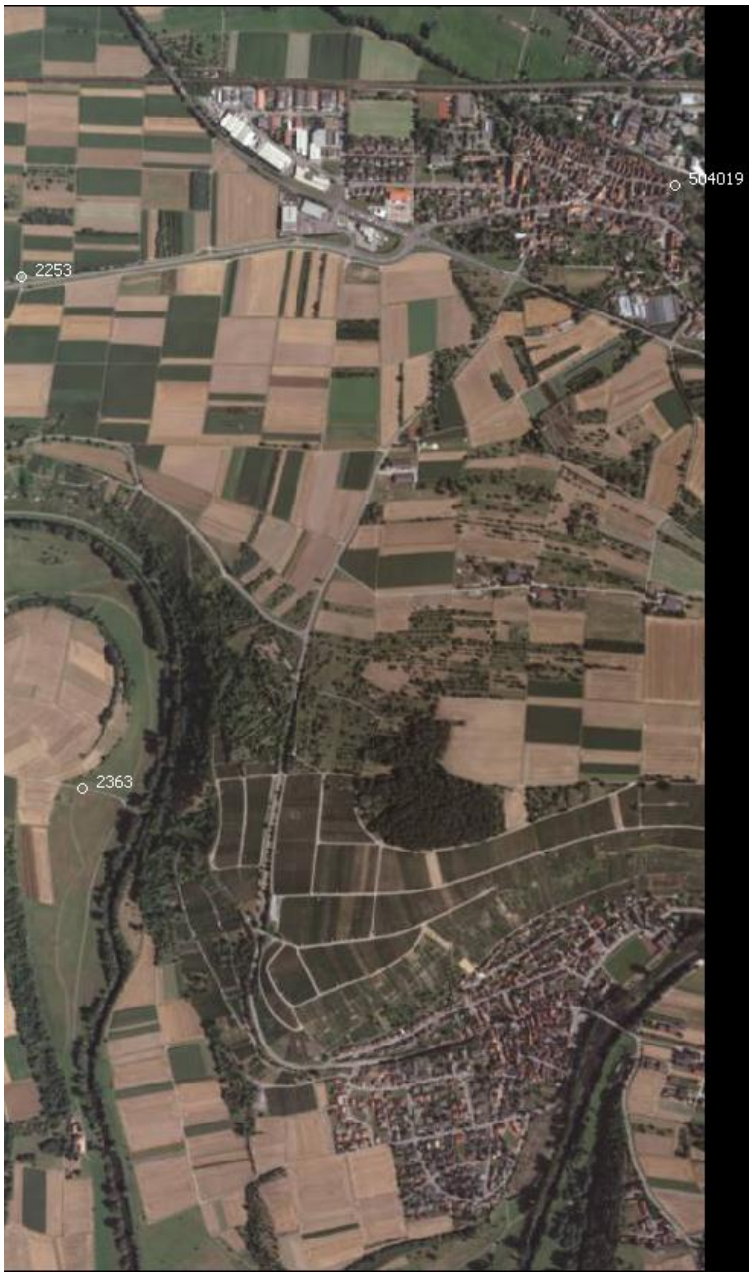
In the zoom window the chosen point in „Point 3D Observations" can be measured. To zoom in and out use the arrows  or the scroll function of the mouse. For navigation in the zoom window press the left mouse button and hold it. You can now slide the picture.


Zoom Window
1.56
504019

Measurement: After selecting the point you want to measure in the control point table by clicking the left, gray colored border with ascending numbers, focus on it in the zoom window and click on it. The point will be labeled with the point number.

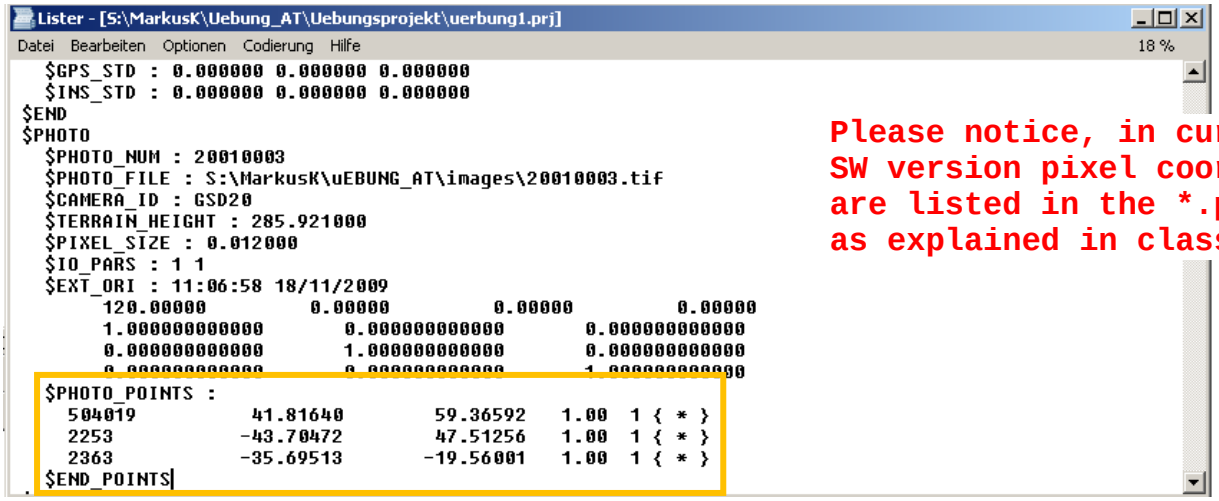
You can move the mark by clicking in the zoom window.

The Overview in the background the measured control points will appear.



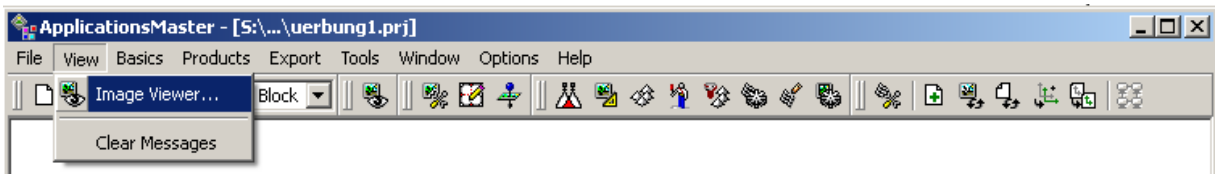
Save the measurement: Project \ Save Project

The coordinates of your measured points will be saved in the project-file. Notice, based on the already known interior orientation of the image, the originally measured pixel coordinates will directly be transformed to the image coordinate system. The originally pixel coordinate measurements are not made available through the ApplicationsMaster software directly.



Measurement of the pixel coordinates

Start the program.



Open the image.

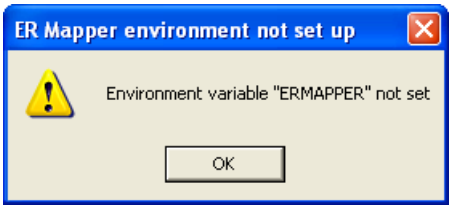
The top of the mouse pointer indicates the current pixel coordinates.

Exterior Orientation

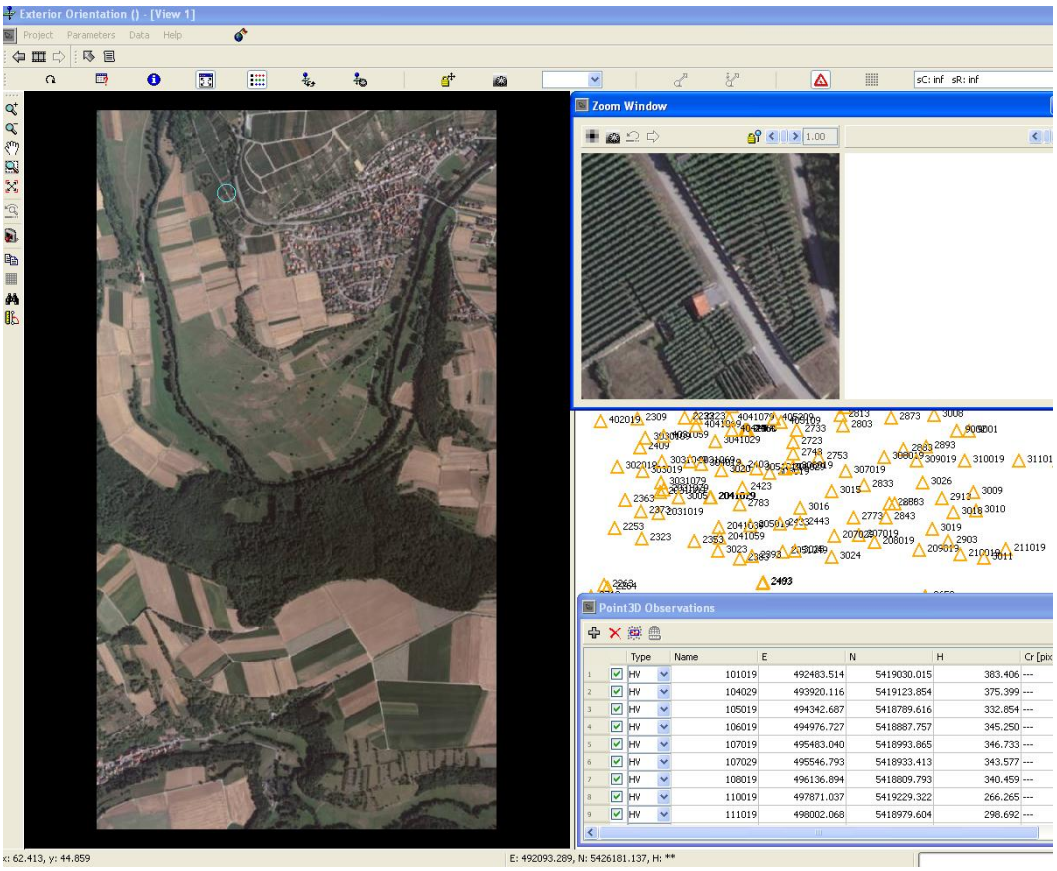
The exterior orientation is the analytic form of orientating one image (Einzelbildorientierung). The execution of exterior orientation presumes that the reconstitution of the interior orientation is already done.
The exterior orientation establishes a relationship between picture and object coordinates.

Basics \ Exterior Orientation

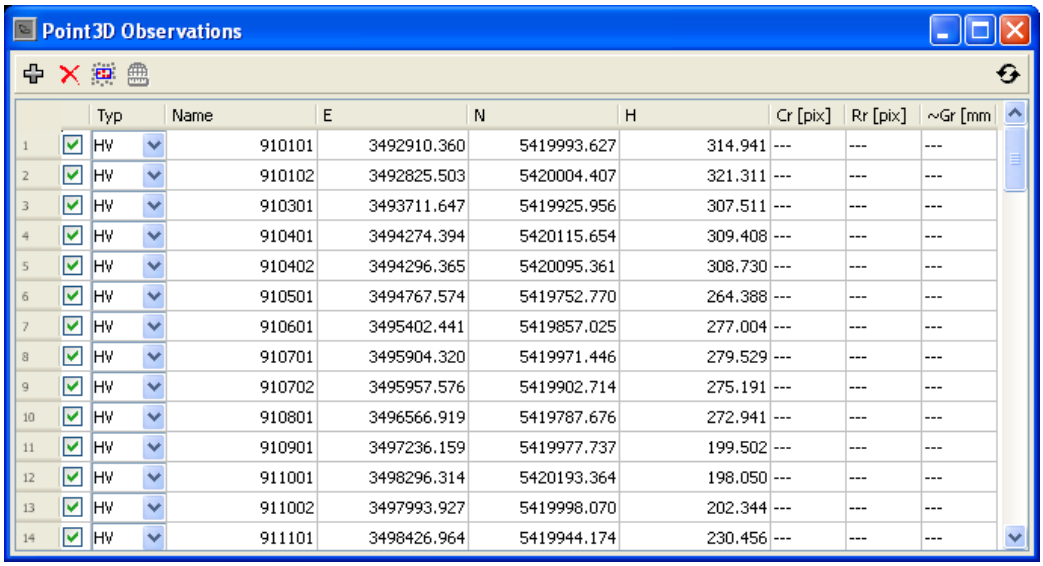
ATTENTION : If there appears a error message just affirm it with OK.



Error message 1

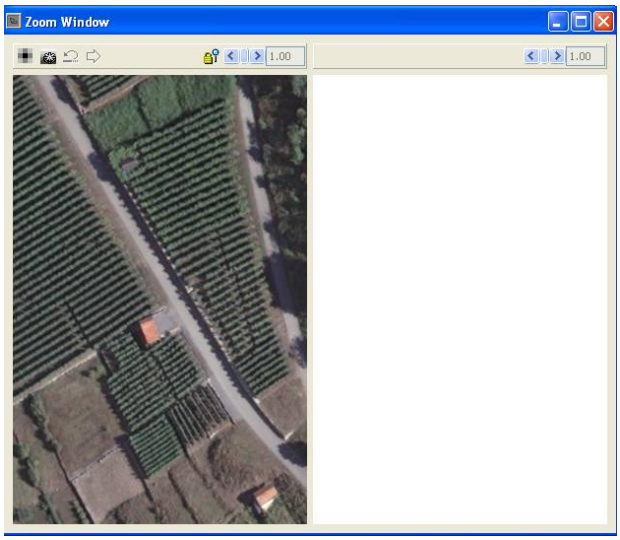


Click the symbol  in the window „Point 3D Observations" and the loaded control points will be shown. To select control points you want to measure click on the gray colored numbers on the left.



		Typ	Name	E	N	H	Cr [pix]	Rr [pix]	~Gr [mm
1	☑	HV	910101	3492910.360	5419993.627	314.941	---	---	---
2	☑	HV	910102	3492825.503	5420004.407	321.311	---	---	---
3	☑	HV	910301	3493711.647	5419925.956	307.511	---	---	---
4	☑	HV	910401	3494274.394	5420115.654	309.408	---	---	---
5	☑	HV	910402	3494296.365	5420095.361	308.730	---	---	---
6	☑	HV	910501	3494767.574	5419752.770	264.388	---	---	---
7	☑	HV	910601	3495402.441	5419857.025	277.004	---	---	---
8	☑	HV	910701	3495904.320	5419971.446	279.529	---	---	---
9	☑	HV	910702	3495957.576	5419902.714	275.191	---	---	---
10	☑	HV	910801	3496566.919	5419787.676	272.941	---	---	---
11	☑	HV	910901	3497236.159	5419977.737	199.502	---	---	---
12	☑	HV	911001	3498296.314	5420193.364	198.050	---	---	---
13	☑	HV	911002	3497993.927	5419998.070	202.344	---	---	---
14	☑	HV	911101	3498426.964	5419944.174	230.456	---	---	---

In the zoom window the chosen point in „Point 3D Observations" can be measured. To zoom in and out use the arrows  or the scroll function of the mouse. For navigation in the zoom window press the left mouse button and hold it. You can now slide the picture.



In this window you can see the cutout of the whole image shown in the background window. This cutout is marked with a yellow circle. With the symbol  the intensity of the cutout in the zoom window can be improved.

Measurement: After selecting the point you want to measure in the control point table by clicking the left, gray colored border with ascending numbers, focus on it in the zoom window and click on it. The point will be labeled with the point number.

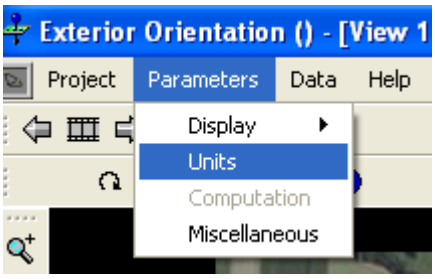
You can move the mark by clicking in the zoom window.

The Overview in the background the measured control points will appear.

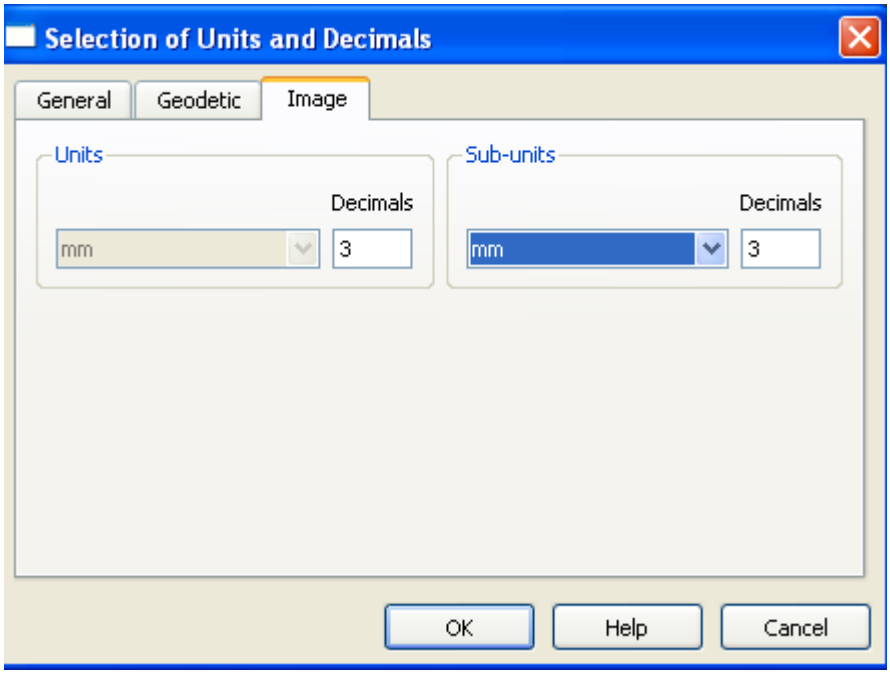
Save the measurement: Project \ Save Project

Setting Units

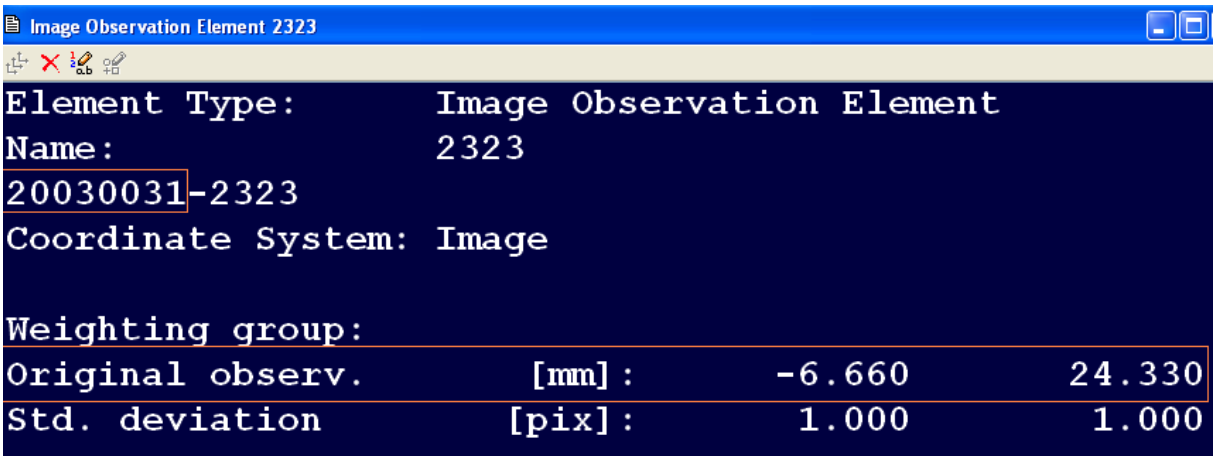
Choose Units in the menu "Parameters"



In the following window set "Sub-Units" to mm and Decimals to 3.



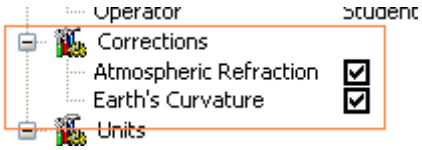
Activate  and click on an arbitrary measured point. The following window will appear:



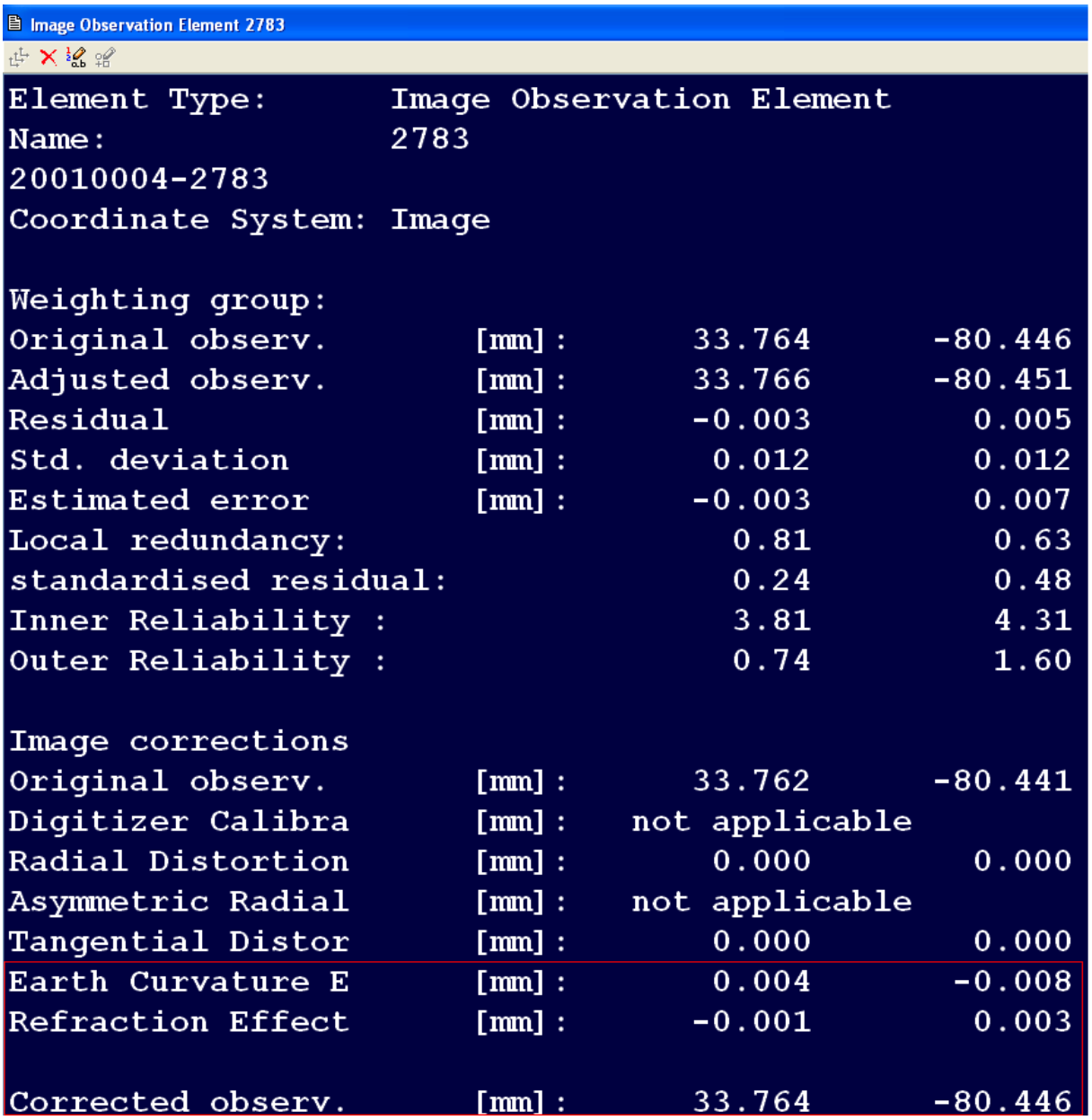
The same information you can get from your project file, where all Points that you had measured are listed (see below).

```
$PHOTO
  $PHOTO_NUM : 20030031
  $PHOTO_FILE : S:\MarkusK\Uebung_AT\images\20030031.tif
  $CAMERA_ID : GSD20
  $TERRAIN_HEIGHT : 325.488000
  $PIXEL_SIZE : 0.012000
  $PHOTO_POINTS :
    104029          45.80935      -50.79692   1.00  1 { * }
    2203            18.69960      -48.41400   1.00  1 { * }
    2409            -7.68120       74.12280   1.00  1 { * }
    2323            -6.66044       24.32971   1.00  1 { * }
  $END_POINTS
```

These observations **are still uncorrected**.
Ensure that in the "Project Editor" the settings "Atmospheric Corrections" and "Earth´s Curvature" are on.

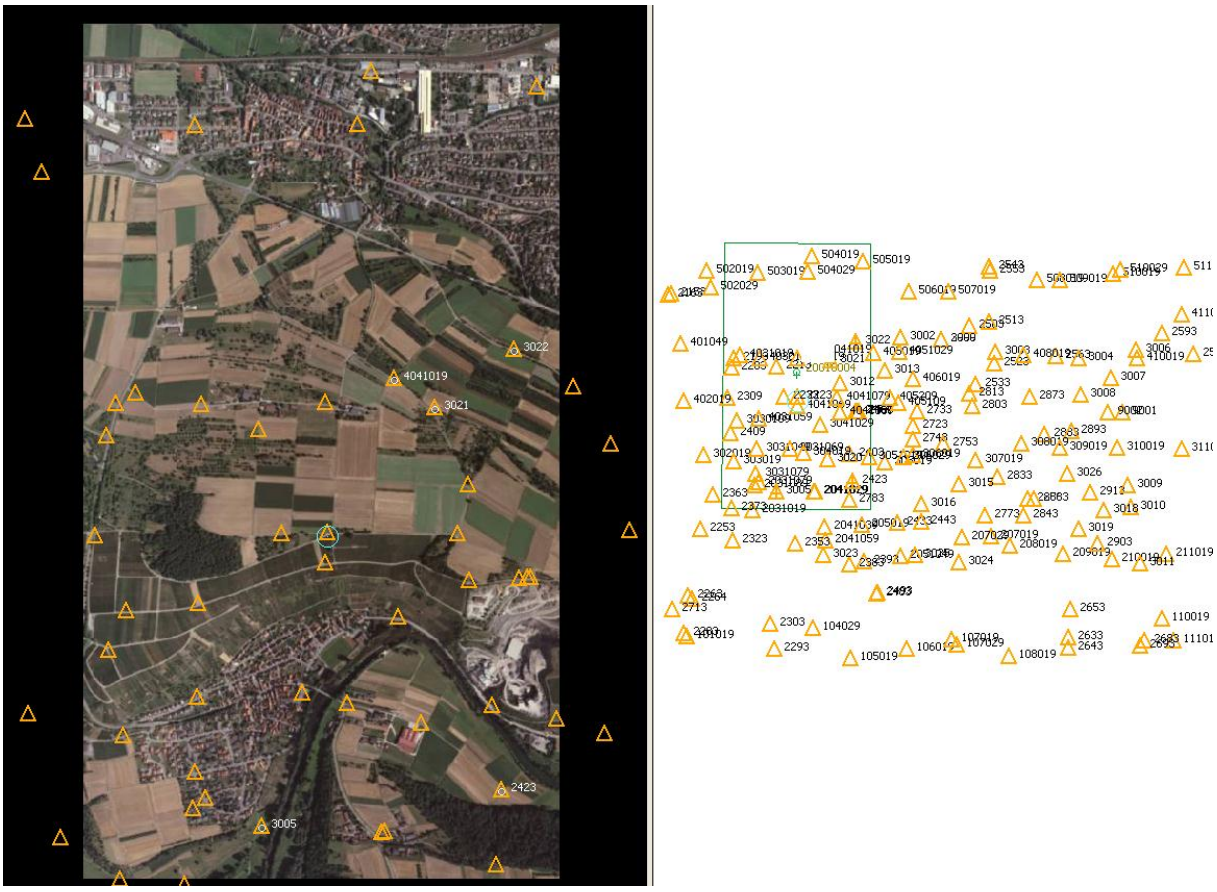


After computation of the exterior orientation the corrections will be shown in the window which appears if you Activate  and click on an arbitrary measured point.



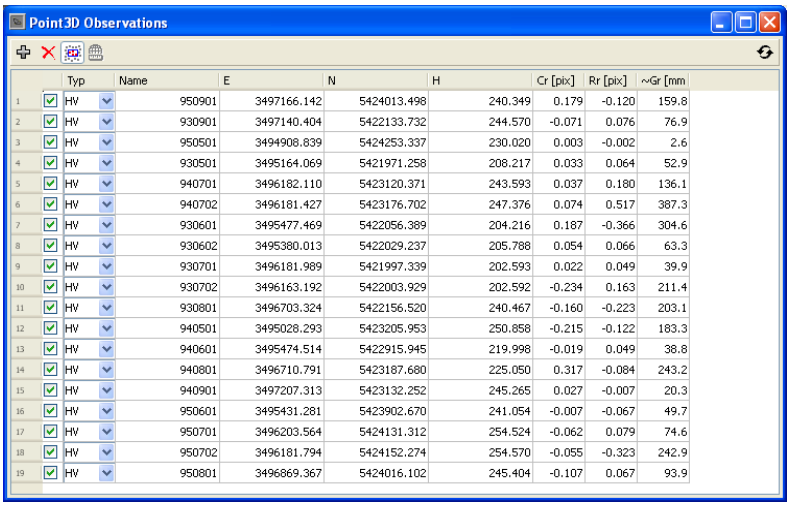
Computation of Exterior Orientation

Measure at least 5 Points and then calculate the exterior orientation. Therefore click the symbol  "Automatic Computation of Orientation".



Measurement of further Control Points

The not jet measured control points in the image are illustrated with yellow triangles. To measure them choose the symbol  "Go to the next unmeasured control point" in the zoom window.
In the main window where the whole image is shown, you can see which triangle is meant. Like this a mix-up with other triangles can be avoided. Furthermore the triangle shown in the middle of the zoom window shows the right control point.
It is easier to capture the point by enlarging the unmeasured control point. By clicking on it, the control point number will be chosen automatically.
After every measurement the chart will be expanded with these new points.



	Typ	Name	E	N	H	Cr [pix]	Rr [pix]	~Gr [mm
1	HV	950901	3497166.142	5424013.498	240.349	0.179	-0.120	159.8
2	HV	930901	3497140.404	5422133.732	244.570	-0.071	0.076	76.9
3	HV	950501	3494908.839	5424253.337	230.020	0.003	-0.002	2.6
4	HV	930501	3495164.069	5421971.258	208.217	0.033	0.064	52.9
5	HV	940701	3496182.110	5423120.371	243.593	0.037	0.180	136.1
6	HV	940702	3496181.427	5423176.702	247.376	0.074	0.517	387.3
7	HV	930601	3495477.469	5422056.389	204.216	0.187	-0.366	304.6
8	HV	930602	3495380.013	5422029.237	205.788	0.054	0.066	63.3
9	HV	930701	3496181.989	5421997.339	202.593	0.022	0.049	39.9
10	HV	930702	3496163.192	5422003.929	202.592	-0.234	0.163	211.4
11	HV	930801	3496703.324	5422156.520	240.467	-0.160	-0.223	203.1
12	HV	940501	3495028.293	5423205.953	250.858	-0.215	-0.122	183.3
13	HV	940601	3495474.514	5422915.945	219.998	-0.019	0.049	38.8
14	HV	940801	3496710.791	5423187.680	225.050	0.317	-0.084	243.2
15	HV	940901	3497207.313	5423132.252	245.265	0.027	-0.007	20.3
16	HV	950601	3495431.281	5423902.670	241.054	-0.007	-0.067	49.7
17	HV	950701	3496203.564	5424131.312	254.524	-0.062	0.079	74.6
18	HV	950702	3496181.794	5424152.274	254.570	-0.055	-0.323	242.9
19	HV	950801	3496869.367	5424016.102	245.404	-0.107	0.067	93.9

The residuals will be indicated by activating the symbol  (blue arrows).

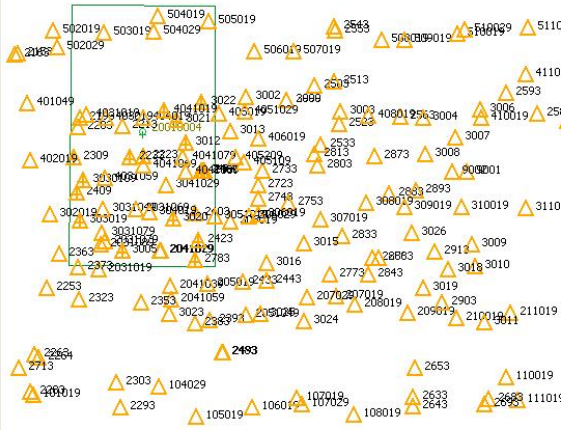
If you activate the symbol  (green arrows) the estimated errors will be denoted. Azimuth and amount of residuals (blue) and errors (green) are displayed in the aerial or satellite image on the left side of main window. Additionally a scale bar can be moved to any location for approximately "measuring" the amount of estimated errors or residuals. - Move the mouse cursor to the scale bar to get information on the distance of bars (in units of reference system).

Residuals:
In general, the observed and adjusted values are not equal in their size, but have small differences, which are called residuals. The terminology comes from least-squares adjustment.

A residual shows the error of the original observation compared to the adjusted observation. In brief: Residual = original observation - adjusted observation

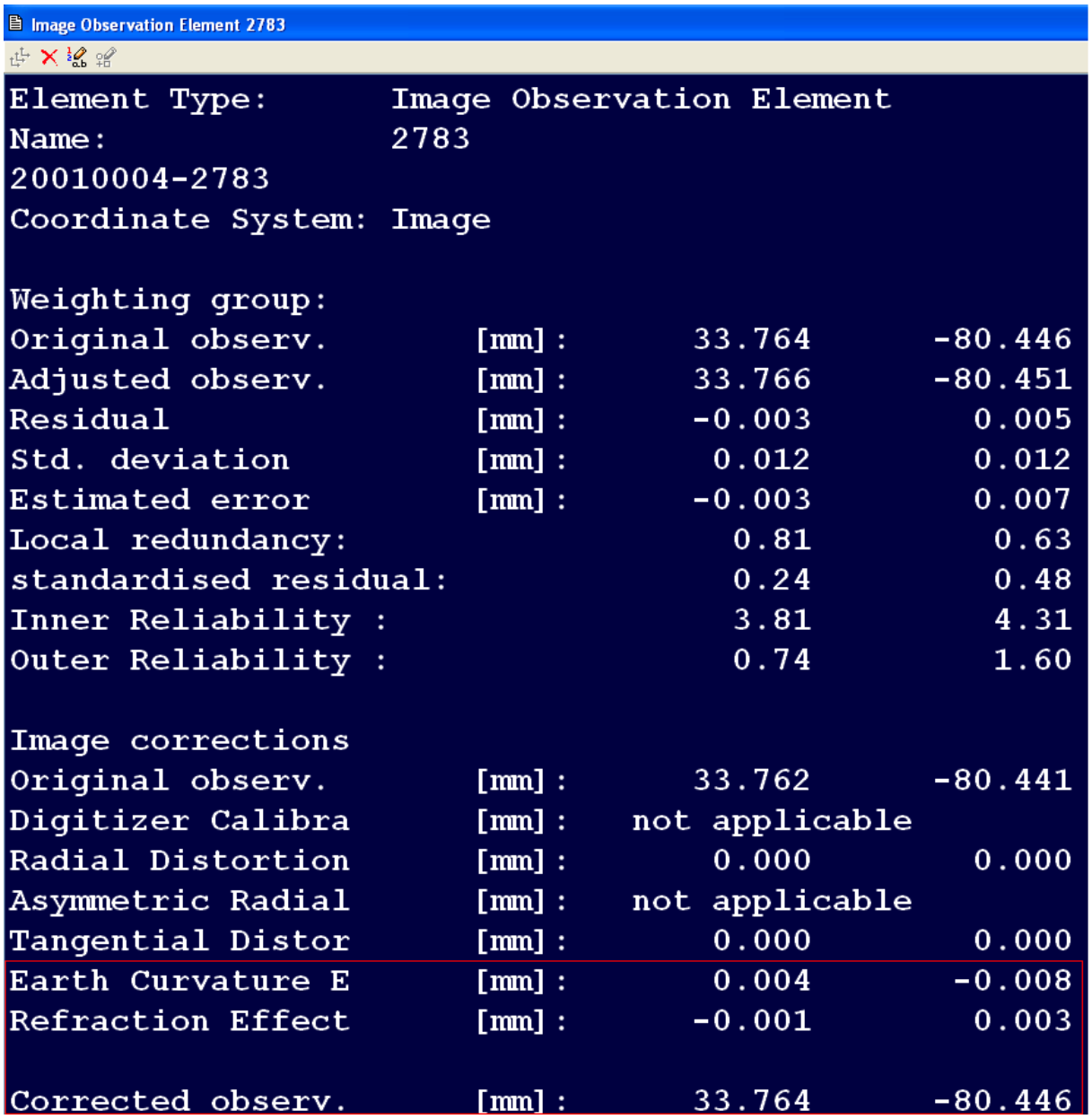
Estimated Errors:
Only a part of the true error shows up in the residual of an observation, other parts are distributed to other observations. To give an estimate for the true error it is necessary to analyze the relation of residuals and the actual error. The true error can be estimated by dividing the residual by the local redundancy of the observation.

This means that if the local redundancy is 0.0 or close to 0.0, the observation is uncontrolled and no gross error is detectable; the size of a blunder (if it exists) may be very big and the error can not be detected. On the contrary, if the loca

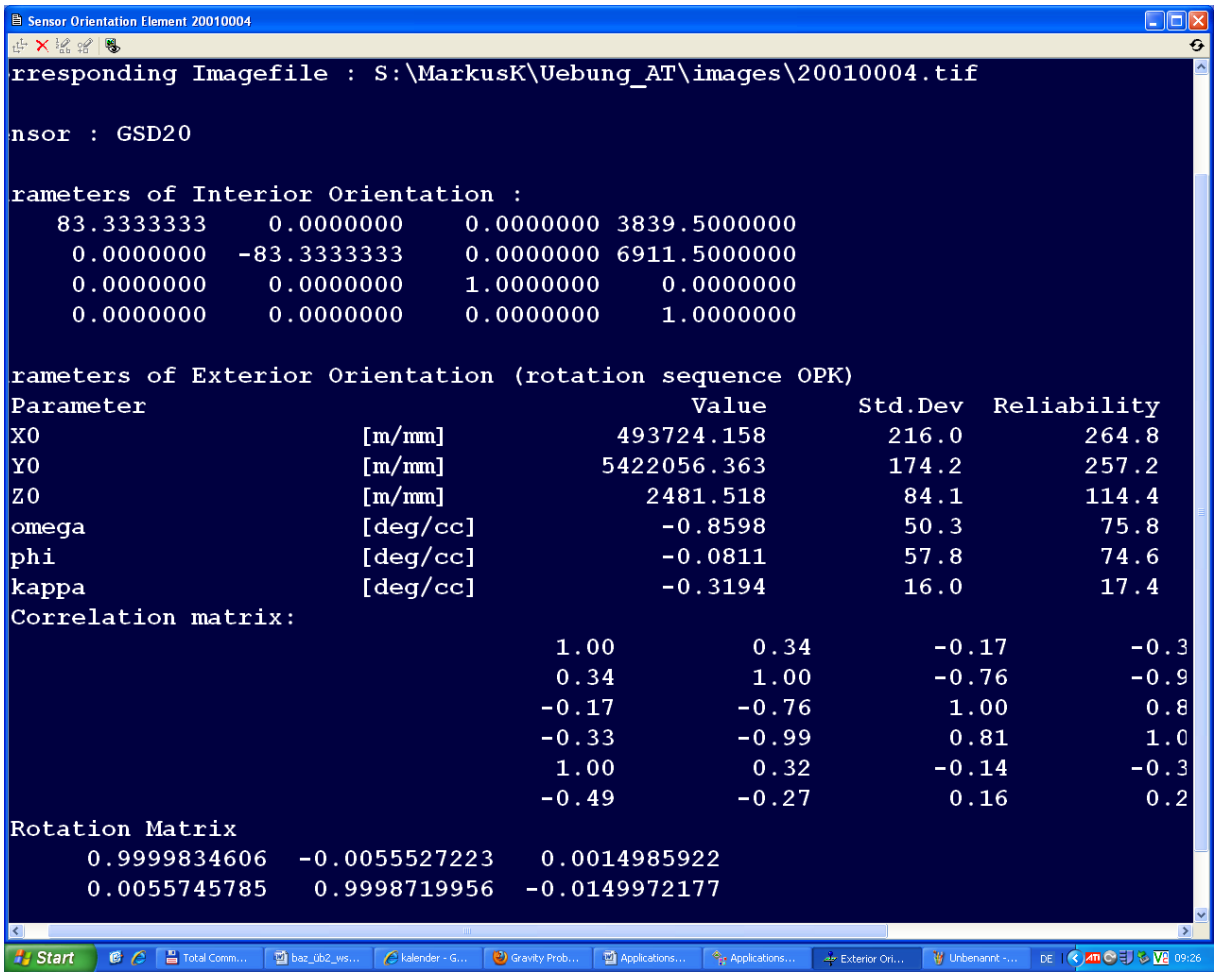


Control points can be removed by deactivating the check in the control point list. They will not be involved in the computation of the orientation and their color will turn gray.
The residuals are shown in the control point list.
Cr = residuals in column, Rr = residuals in row, Gr = residuals in ground system.

Activating the symbol  and clicking on a control point all relevant data of the point will appear. Now the corrected coordinates are listed in the window.



The symbol  will show you the parameters of the current exterior orientation of the image. They will change after deactivating or adding control points.
ATTENTION: This file cannot be saved. Because of this make screen dumps of these parameters with every constellation of control points you have done. Do it after every new computation of orientation.



For measuring further exterior orientations use the symbol  in the main window „Exterior Orientation" to navigate directly to the next Image.

Annotations:

The values for Std. Dev., Reliability and Sensitivity are given in the ground units defined under Parameters \ General.

- Std. Dev.: The standard deviation is defined as the square root of the variance. This means it is the root mean square deviation from the average.

- Reliability: Is the influence of non-detectable gross errors onto the estimated parameters (used as a multiple of the computed standard deviation of the parameter). It can also be seen as a sensitivity measure or robustness of the network against distorting effects in the system.

- Sensitivity: Using all the reliability figures of all observations and assuming that undetected blunders exist just at the limit of being detectable, the influence of these "blunders" onto the parameters is computed. The maximum influence is called the sensitivity of a parameter.

- Rotation Matrix: Shows the rotation matrix of the exterior orientation. It is parameterized as follows:

$$\underline{\underline{R}}(\kappa,\varphi,\omega) = \begin{pmatrix} \cos\varphi\cos\kappa & \cos\omega\sin\kappa+\sin\omega\sin\varphi\cos\kappa & \sin\omega\sin\kappa-\cos\omega\sin\varphi\cos\kappa \\ -\cos\varphi\sin\kappa & \cos\omega\cos\kappa-\sin\omega\sin\varphi\sin\kappa & \sin\omega\cos\kappa+\cos\omega\sin\varphi\sin\kappa \\ \sin\varphi & -\sin\omega\cos\varphi & \cos\omega\cos\varphi \end{pmatrix}$$