# UFOAnalyzer V2 Users Manual

E001.03 2007/1/27 for UFOAnalyzerV2 V2.00
E002.01.2E 2007/5/16 for UFOAnalyzerV2 V2.07

Translated by masuzawa

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## INDEX

## 1. Outline

UFOAnalyzerV2 is a software to analyze the moving object in the night sky that was recorded by UFOCapture software. It provides you with these advanced features:

- Align the field of view by using star catalog.
- Measure the object position (Az, Alt and RA, Dec).
- Analyze the direction, speed, linearity and magnitude of the moving object.
- Calculate the distance to the object from the observed altitude and assumption height.
- Detect the meteor stream from the meteor stream catalog.
- Draw a trail map and a ground map.
- Draw a field of view of a camera.
- Other auxiliary functions such as making a peak hold image and trimming a video and so on.

UFOAnalyzerV2 is improved from UFOAnalyzerV0 as following:

- Measuring more accurately.
    - Self-adjust the view parameters and calculate the measuring errors.
    - Analyze the deinterlaced fields and calculate the linearity errors.
    - Measure object's magnitude by the comparison with stars that based on color temperature.
    - Self-adjust analysis area and auto retry analyzing.
    - Align the field of view against the atmosphere refraction and the aberration in optical systems with 4th correction formula and reducing the calculation errors at the singularity.
    - Simplify the classification by physical characteristic and adopt azimuth measured from the north toward the east.
- External data
    - The star catalog that contains stars brighter than 10th magnitude is supported.
    - IMO Working list 2007 as the meteor stream list is supported.
    - Installable map data.
- New function
    - Batch process of plural cameras.
    - Edit the mask image.
    - Draw a ground map and field of view.
    - Draw a trail map on great circle.
    - Read clips during the periods and arrange by the elements
    - Estimate distance and absolute magnitude from assumed height.
    - Estimate radiant point and geocentric velocity by multi-point angular velocity measurement.
    - Output a report formed of xml, xsl, which can change the template (V2.07)
    - Move or trash clips. (V2.07)
- Output various data
    - Output the profile data and select one
    - Output specified term to CSV
    - Output UFOAnalyzerV0 compatible M.CSV
    - Output results as XML for each clip

UFOAnalyzer was made by SonotaCo personally. You could use it free for personal use. If you could use in organization, you must be permitted to use in advance by SonotaCo. Although UFOAnalyzerV2 tries to analyze as accurate as possible, it might detect false object or include large error. Judge the validity by yourself for the result.

This manual is based on UFOAnalyzerV2 V2.07 on February 17, 2007. The changes from V2.00 are described as “(V2.07)” in this manual. The changes after V2.07 will be in SonotaCo.com.

## 2. Basic mechanism

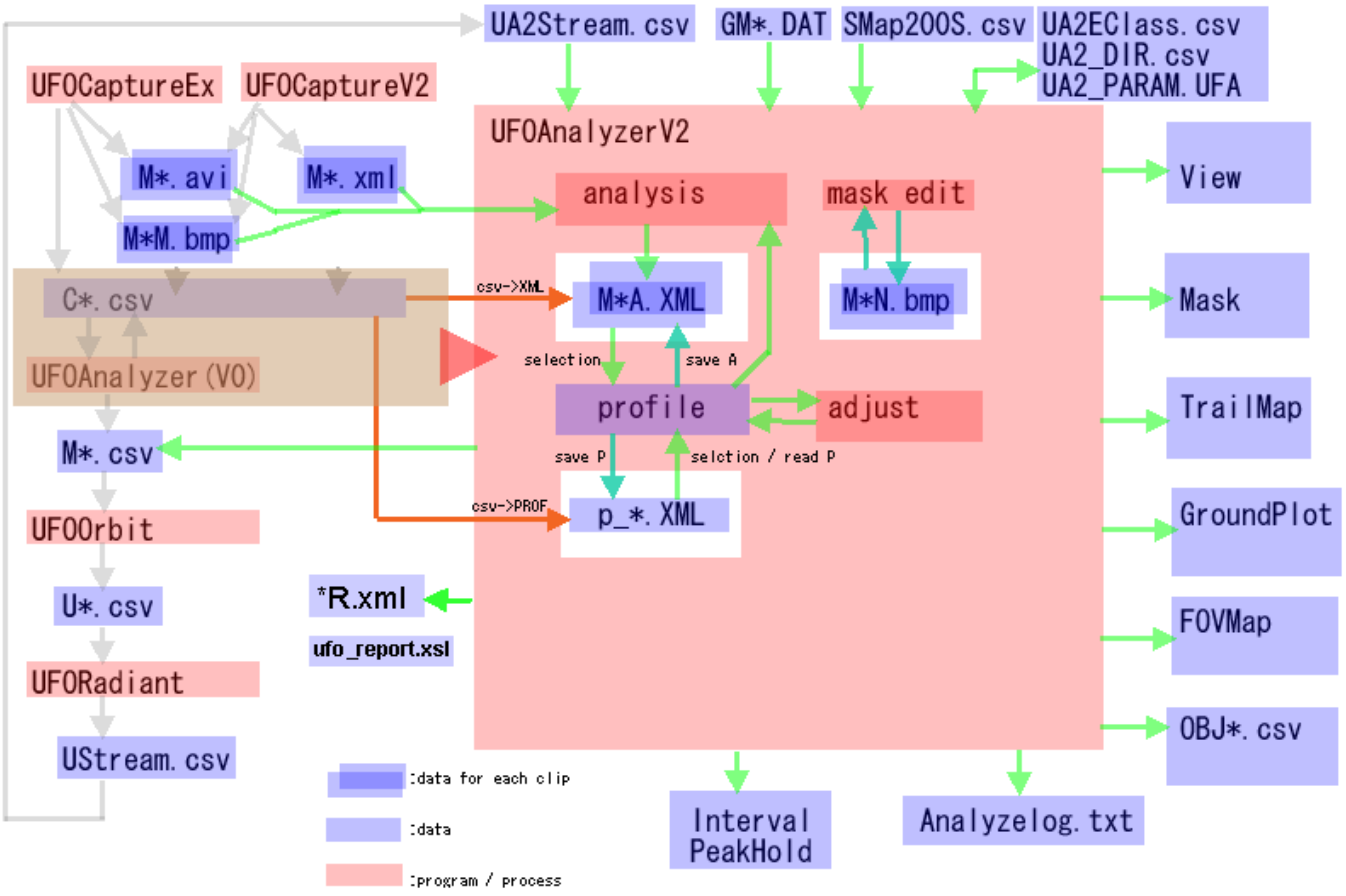
This chapter describes basic knowledge to use UFOAnalyzerV2.

### 2.1 Data flow

Following files are output for UFOAnalyzerV2 instead of C*.csv for V0.

- **Output profiles that contain setting parameters for each camera into p_*.XML.**
- **Output analyzed results and adapted camera profiles for each clip into *A.XML.**

- In addition to captured results (*.avi, *.xml, *M.bmp, etc.), p_*.XML is used to analyze.
- You can create p_*.XML manually from a clip or from C*.csv that was already analyzed by V0. p_*.XML (or each *A.XML) must be created before analysis.
- Once analysis has done, if you could re-analyze, *A.XML is prior to as the profile.
- Once analysis has done, analysis results and profiles are saved in *A.XML. You can re-analyze clips with it. UFOAnalyzerV2 doesn't create C*.csv for V0.
- You can output the analyzed results into OBJ*.csv or M.csv, which is compatible to V0.
- Figure below shows normal data flow as green arrow and migration from V0 as red arrow.

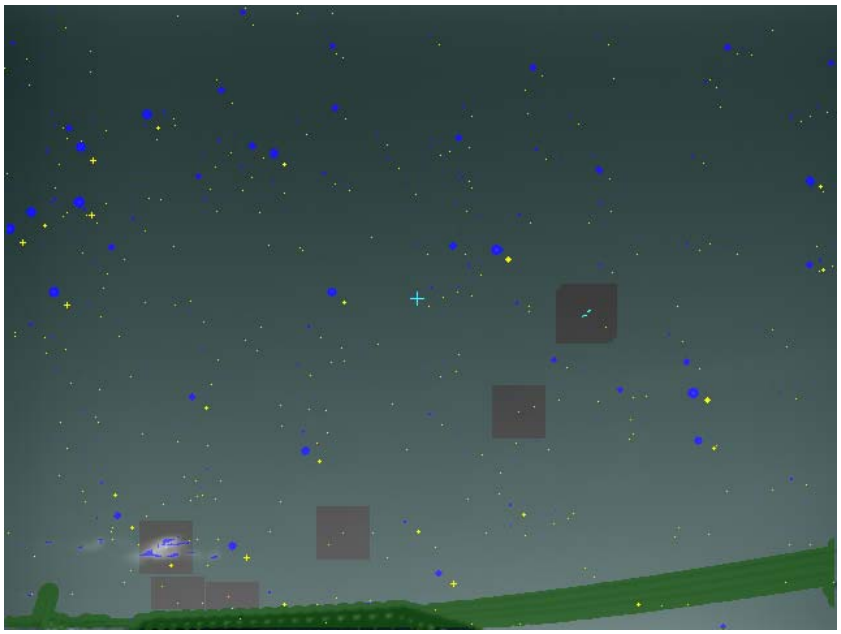



UFOAnalyzerV2 Data Flow

## 2.2 MS link

UFOAnalyzerV2 relates scintillation masks to the reference stars. It is called MS link. As all processing in UFOAnalyzerV2 is based on MS link, it must be created as accurate as possible.

[Before creating MS link]
The blue points are scintillation masks and the yellow points are reference stars.



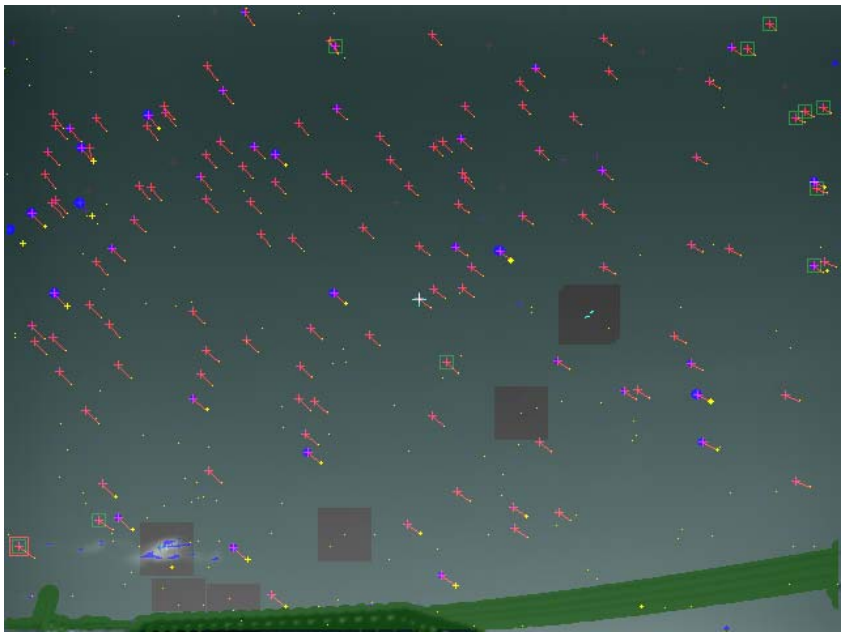
[Sample of including inaccurate MS links]
When creating MS link by automatic links, displays + mark with red as the center of the scintillation mask and connects to related stars with red line. Red + mark is also made by planets, clouds, objects on the ground and so on. If there are too many stars to display (i.e. too lower magnitude to display), it could link another stars.

Mask editor has following functions for building accurate links.

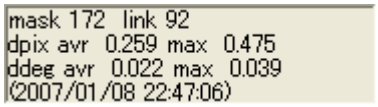
- Set max pixels for link length (“lim” in link)
- Delete the links which difference between one and average of all links is greater than standard deviation ("<SD" in link)
- Set the lowest magnitude for the reference stars.
- Left click to link another star.
- Right click to delete the link.
- Re-create scintillation mask (edit or auto)
- Set the link inhibit area (L-,R-,U-,D-)

During adjustment of the view, it could create link automatically at any time and reduce errors. You have to create as much as accurate links especially when creating the profile.

[sample of including accurate links]
This is after deleting wrong links.

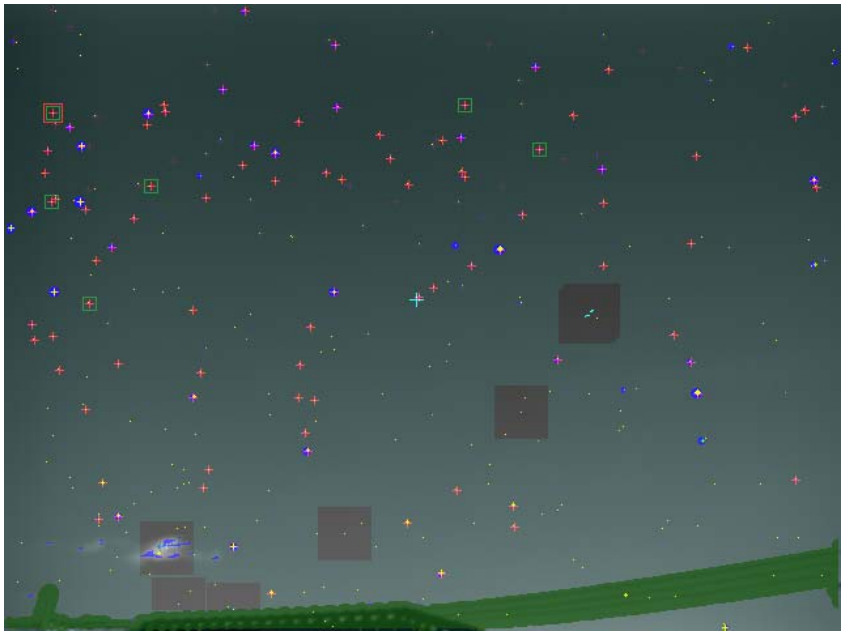


After accurate links are built, you can automatically adjust the parameters for the view by Adjust function in Profile sheet.
During automatic adjustment, it displays the status in Profile sheet as following. For example, there are 92 effective links in 172 masks, average of error between center of the brightness points and reference stars’ coordinate is 0.259 pixels (0.022 degree), max of them is 0.475 pixel (0.039 degree).




It could adjust automatically less than average 0.3 pixels independent on any lenses. It means 0.03 degree in case of 1/2 inch CCD + 6 mm lens.

[After finishing adjustment]
This is after adjusting previous figure. All of the stars are overlaid reference stars.



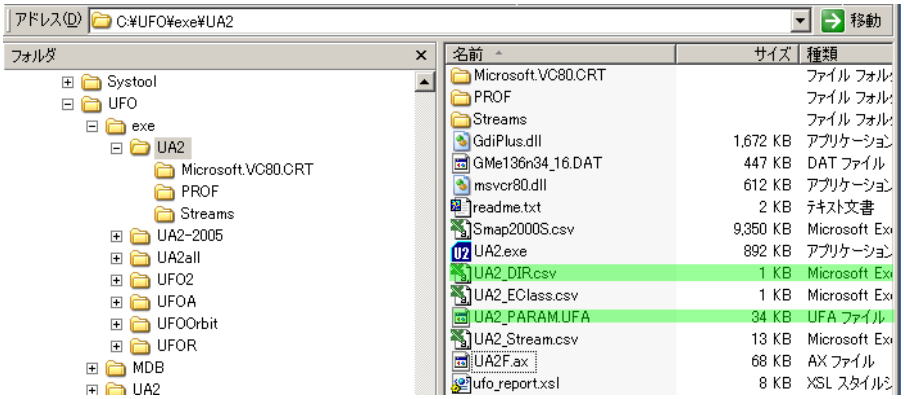
Once adjust the view accurately and preserved as profile, it could link almost accurately in analyzing.
If stars position not matched, it could alarm optionally.

## 3. Quick start

This chapter describes basic operations from installation to analyzing.

### 3.1 Getting started

- Installation
  - To use UFOAnalyzerV2, your system should have Microsoft Windows 2000, Xp, Vista. It is necessary to log on as a user with administrative privileges for the first runtime.
  - DirectX V9.0 or later must be required.
  - Download distribution package UA2xxx.lzh or UA2xxx.zip and expand it into appropriate directory (e.g. c:\UFO\exe).
  - UA2 directory (e.g. c:\UFO\exe\UA2) is execution directory.



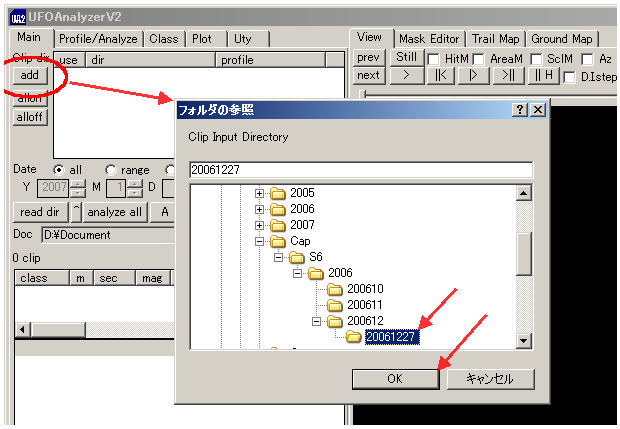

  - UA2_DIR.csv and UA2_PARAM.UFA will create on first execution time.
  - UA2_DIR.csv and UA2_PARAM.UFA contain parameters at execution time. To recovery the initial status, delete these files and PROF directory.

- Uninstall
  - Delete UA2 directory.
- Start
  - Double click UA2.exe in Explore to start the program.
  - If Windows Vista, you have to start as administrator for the first time.
- End
  - Click upper right "X" button to end the program.

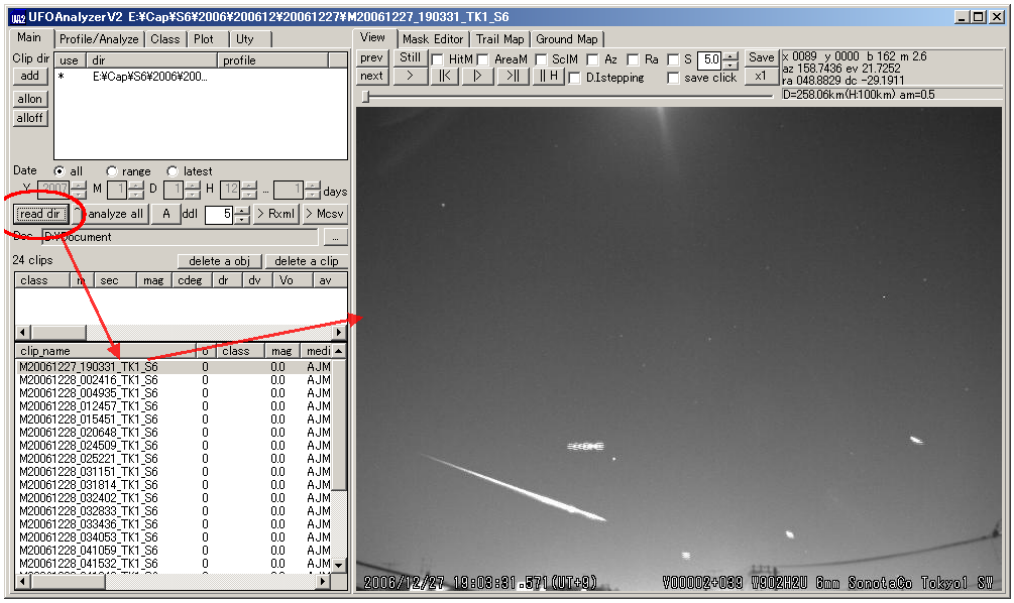
### 3.2 Create profile

The profile is to record camera direction, optical aberration and so on. It must be created for each camera. It must be re-created if camera direction, lens, capture card was changed.
The profile is saved in PROF directory in execution directory. It is related to the directory that is contained clips. The profile could be created from the results C*.csv of UFOAnalyzerV0. It describes how to create manually from clips as following.

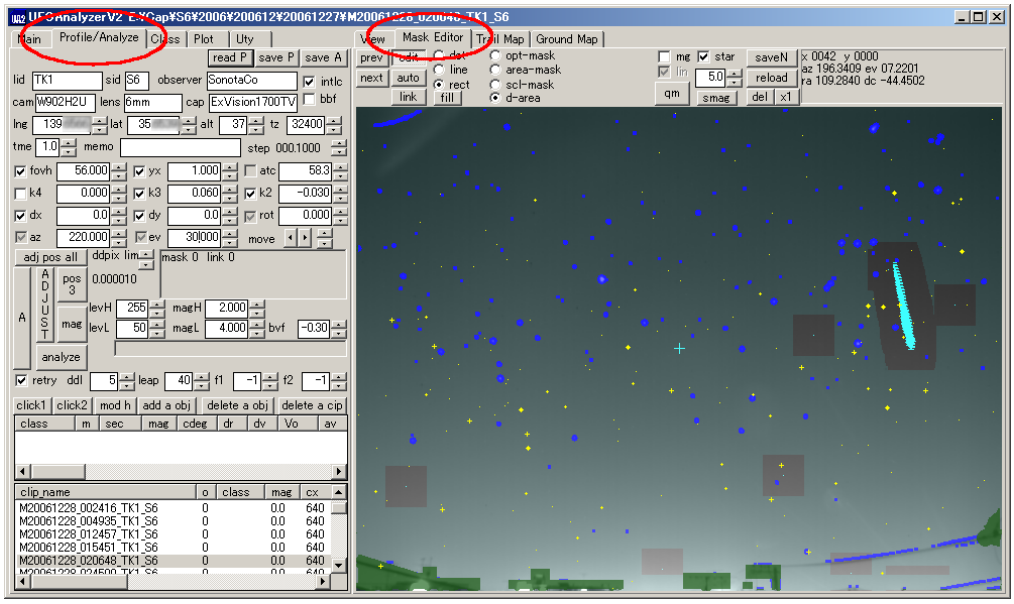
[Step 1. Add source directory]
Click “add” in Main sheet to specify directory, which include observation data. It may be upper layer directory.




[Step 2. Read clips]
Click “read dir” to list up all clips in the directory and display the first clip on the View sheet. Click one in the clip list to find a clip that includes lots of stars.




[Step 3. Overlay the reference stars]
Click Profile/Analyze sheet and Mask Editor to overlay the reference stars. These stars are not aligned yet.

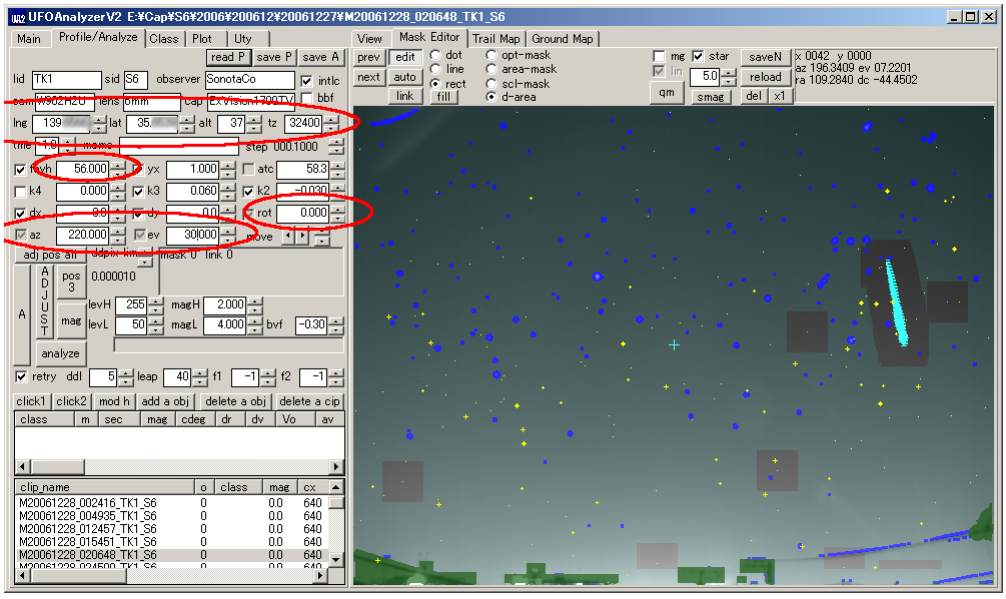


[Step 4. Enter the observing location]
Enter the observing location. Longitude and latitude is angle in degree with floating point. You should enter till the 4th place of the decimal point as accurate as possible.

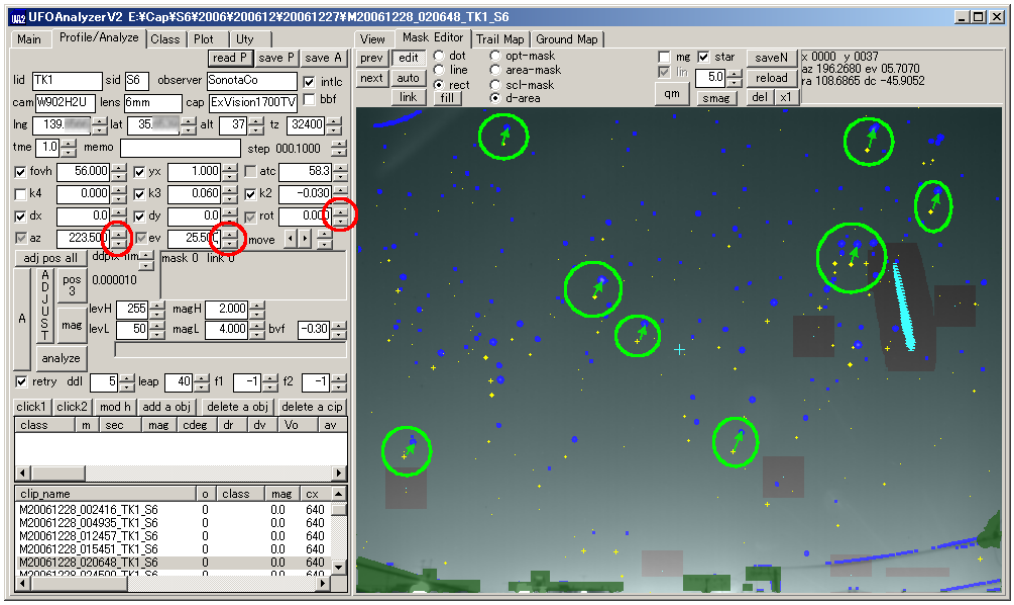
- lng: longitude in degree. Plus if east hemisphere, minus if west hemisphere.
- lat: latitude in degree. Plus if north hemisphere, minus if south hemisphere.
- alt: height above sea level in meter.
- tz: time zone in seconds. 0 if GMT, 32400 (i.e. 9 hours) if JST(Japan).

Enter the camera direction, which may be rough value to find a relation between the blue and the yellow points.

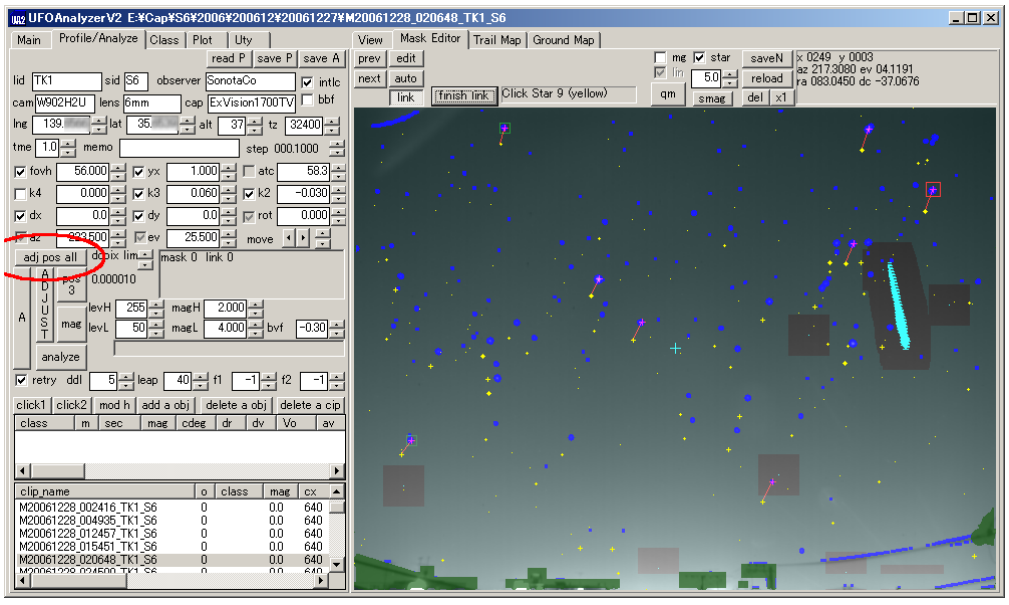
- az: azimuth measured from the north toward the east. (0 for north, 90 for east, 180 for south, 270 for west)  Be careful of being changed from V0.
- ev: altitude toward zenith(90).
- rot: rotation of the view in degree.



[Step 5. Relate to reference stars]
Find the relation between scintillation masks (blue points) and reference stars (yellow points). If necessary, you can change the view settings manually. (Click "az","ev","rot" spin button to change the value in step.) Click “link” and "manual link" on MaskEditor sheet.

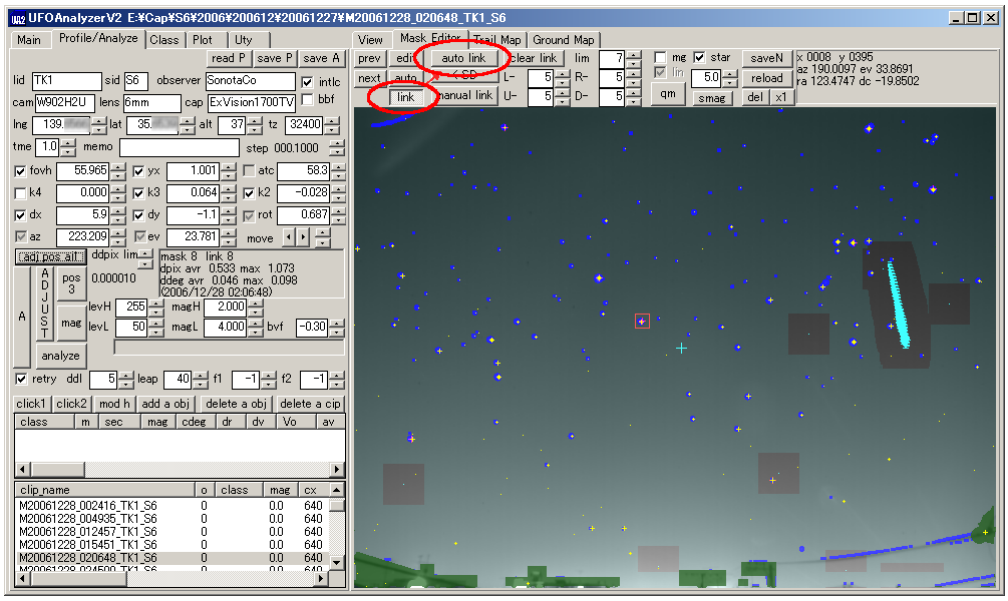



[Step 6. Manual link]
In Mask Editor, left click at the yellow point, drug to the blue point, release left click, and the red link line will appear. Link at least 5 points as mentioned above to scatter on entire screen. The link start point is related to the nearest yellow point automatically, whereas the link end point is put on the mouse released point. You should release the mouse at the center of the star as precise as you can. If you find too many stars, “star” changes number of stars to display. After building links more than 5 points, click "adj pos all" on Profile sheet to start adjusting the auto-view-adjustment. If ddpix on Profile sheet sets greater value, adjust quickly. If the check box k4,k3,k2 turn OFF, they are excluded from the auto-view-adjustment.



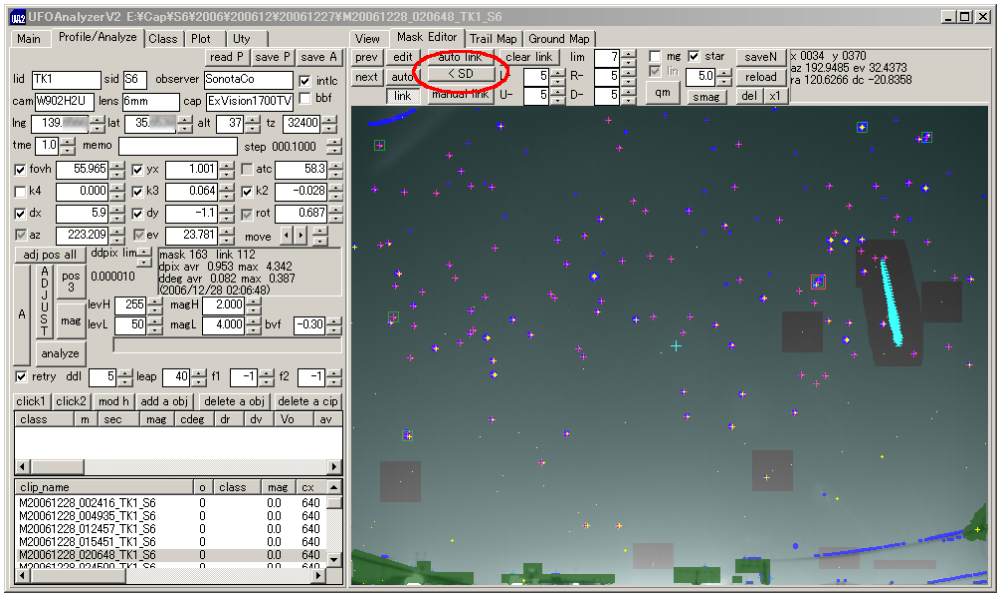

[Step 7. Auto link]

Once auto-view-adjustment executed, almost masks are related to the reference stars. If doubtful, back to Step 6 and retry to link to another stars.
Click “link” and “auto link” to automatically link.

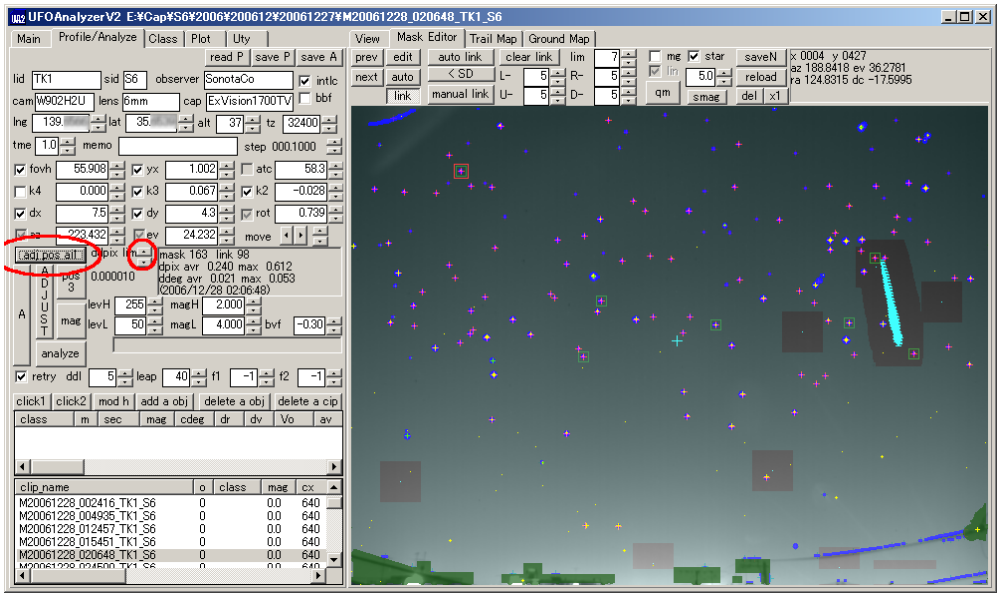


[Step 8. Refine link]
In auto-view-adjustment, it may link to another star or the ground object. If giant star or double star, its center position is so inaccurate that it may include big error. Remove inaccurate links repeating the following steps. After auto-view-adjustment was executed, however, it displays star with red box, which has the biggest error and with green box, which  link difference is greater than standard deviation from the average of all the link.

- Click "<SD" button to delete green box, which has big error. You can use many times.
- Left click on the image to change the link to the other nearest star or to delete the link  If any candidate star is not found.
- Right click on the image to delete the nearest link.
- After changing “lim”, click "auto link" to re-link stars, which their distance is less than “lim”.
- If too many stars displayed, after reducing “star” to display reference stars, it will reduce the links.

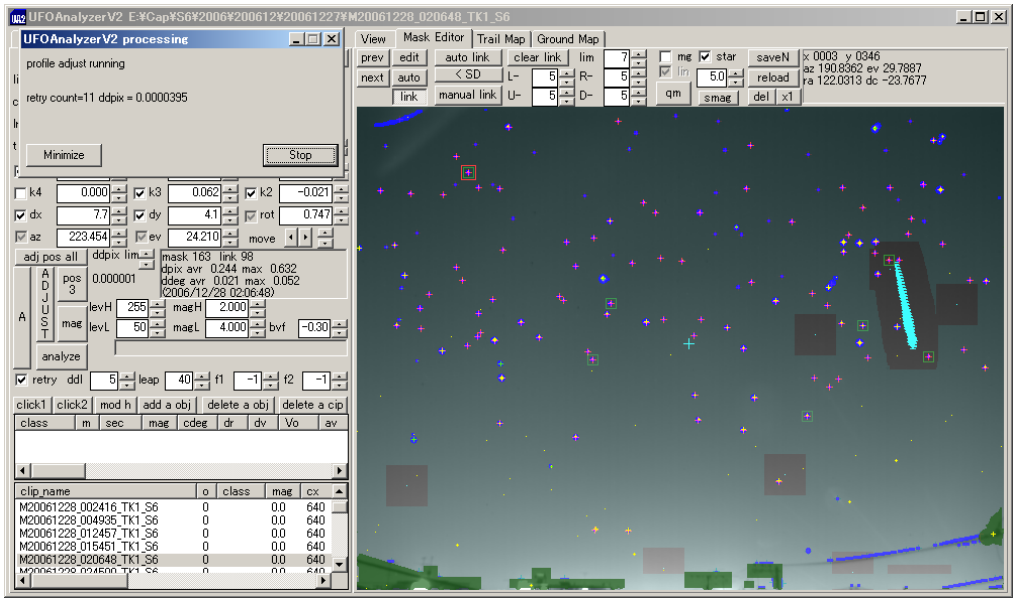


[Step 9. Adjust accurately]
Every time you delete a link, the star with red and green box is moving to another inaccurate link. For example as below, there is a inaccurate link remained on right upper.
After deleting all inaccurate links, set ddpix to the minimum value and click "adj pos all" button.



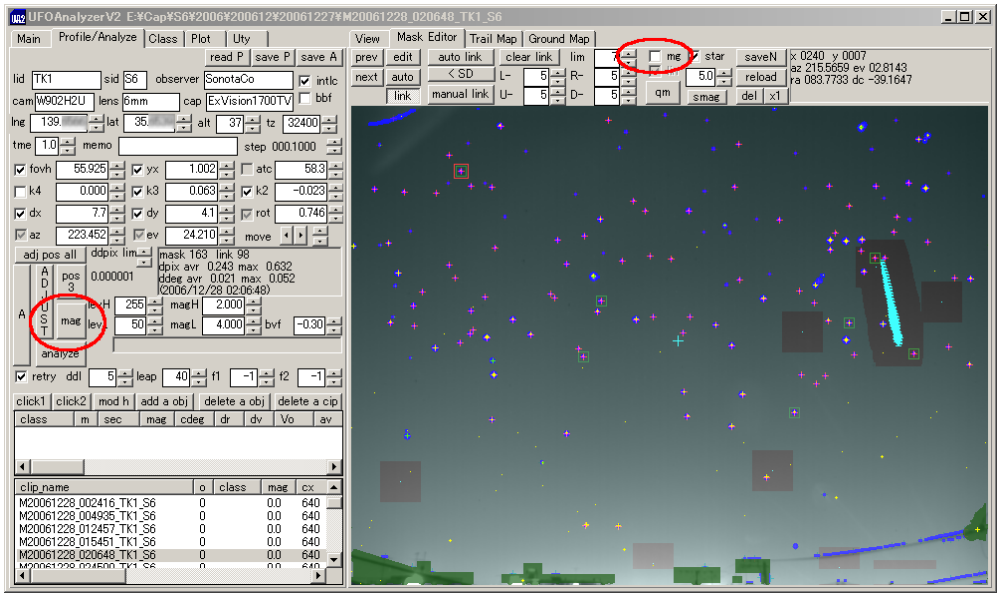

During auto view-adjustment, it displays retry count and status in the dialog box.

- Retry count is up to 500 times.
- Ddpix is indicates error reducing status and it is finished reaching the limit value, which is specified in ddpix lim.
- It can take over 5 minutes if many links exists. Click “Stop” button to cancel.
- If click “Stop”, use the results at that time
- "adj pos all" may be executed many times. The result is different from every times, but the small difference can be tolerate.



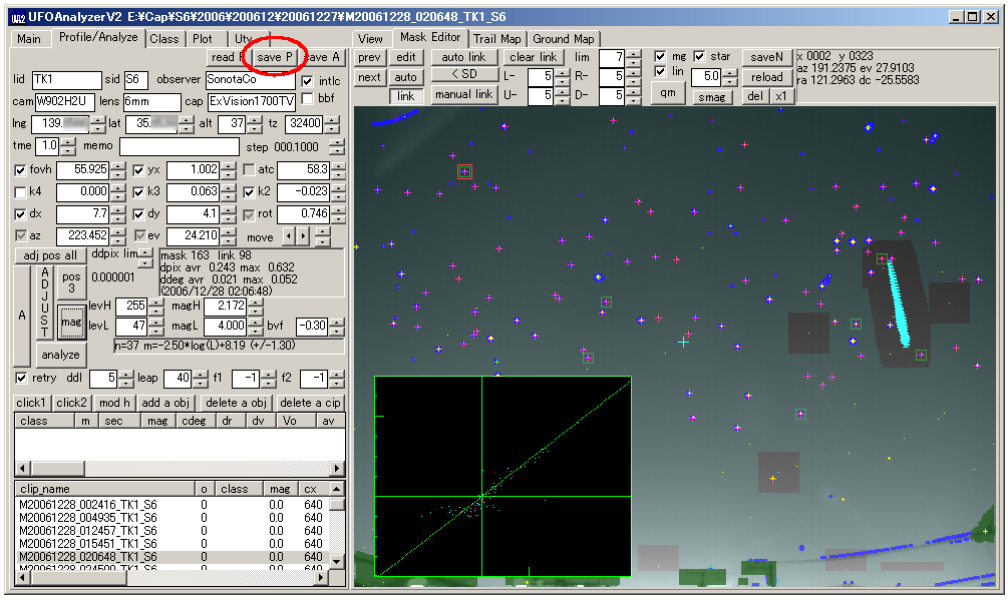

If dpix becomes less than 0.3 for more than about 50 links, auto-view-adjustment is completed.

[Step 10. adjust magnitude]
You can adjust the magnitude of the objects after auto-view-adjustment.
Set "mg" (magnitude graph) check box on MaskEditor and click “mag” button on Profile sheet.

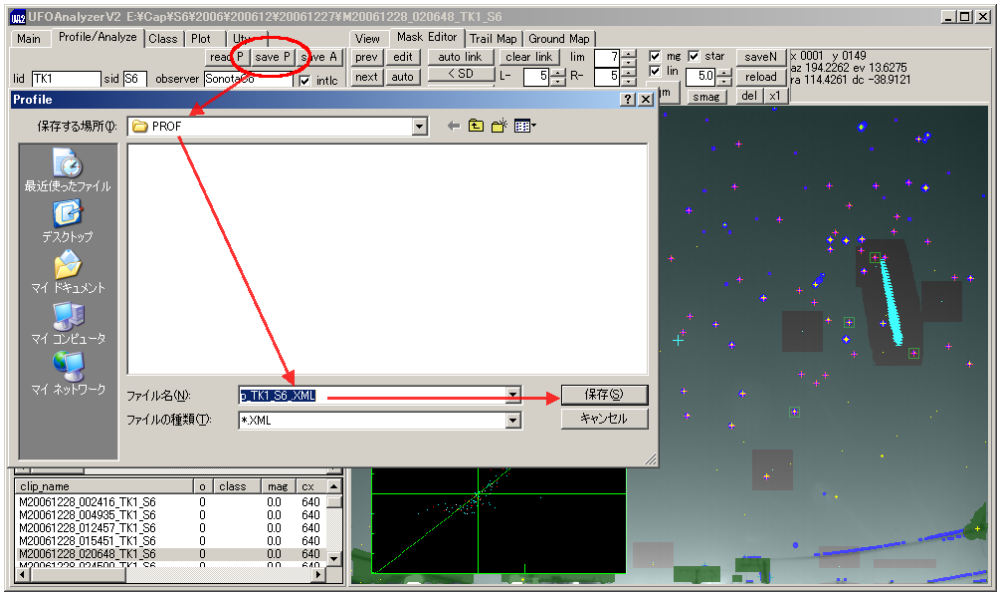


The graph, which is related between brightness of stars in the image and their magnitude of the reference stars. The formula for the least squares approximation is displayed on the Profile sheet.
levL” is the brightness for “magL”, the lowest magnitude. “magH” is the highest magnitude for the brightness 255 in “levH”.
”levH” is saturated brightness level and used to count the saturated pixels. “levH” must be corresponding to the saturated level of the system. The saturated level is 255 for many systems, 235 for rare case depending on capture device.

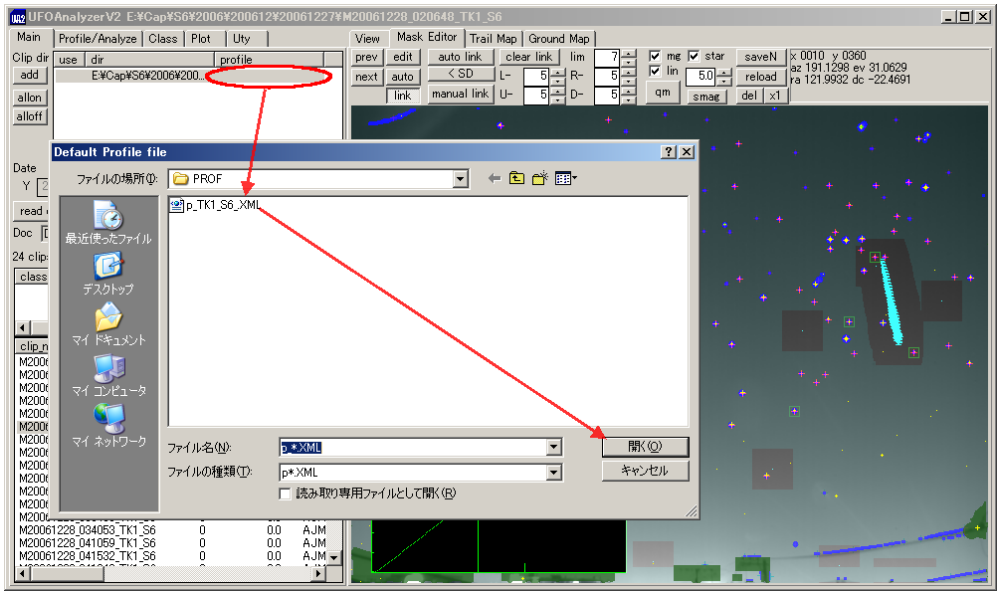
The auto-view-adjustment has completed above. Click “saveP” on Profile sheet to save the profile.



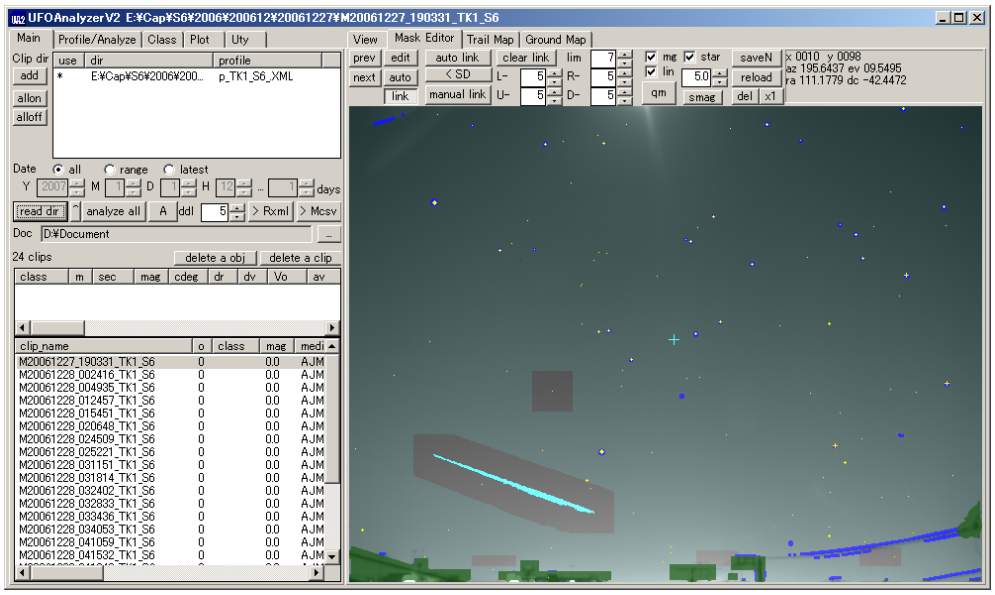
[Step 11. Save the profile]
Click “saveP” to save the profile.




[Step 12. Relate to the profile]
On Main sheet, double click the profile column next to the directory column to select a profile.

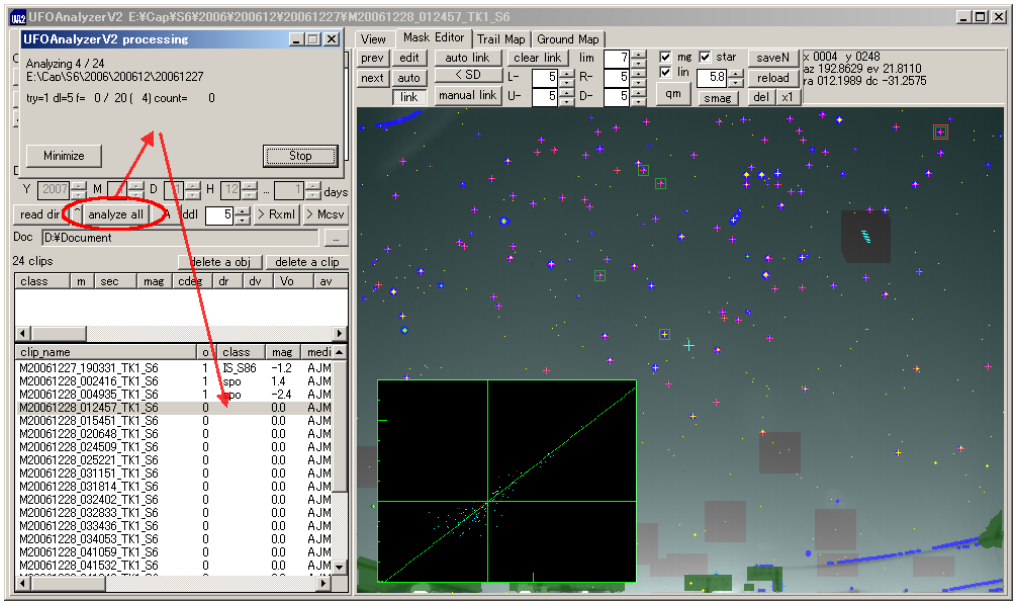



[Step 13. Read clips]
Click “read dir” button to read clips with profile. If camera direction is the same for all clips, the reference stars are overlaid correctly for all clips.
If you set “latest” button on Main sheet, click only “read dir” button to prepare to analyze for the latest night.


UFOAnalyzerV2 E:¥Cap¥S6¥2006¥200612¥20061227¥M20061227_190331_TK1_S6
Main
Profile/Analyze
Class
Plot
Uty
Clip dir
use
dir
profile
add
allon
alloff
* E:¥Cap¥S6¥2006¥200... p_TK1_S6_XML
Date
all
range
latest
Y 2007 M 1 D 1 H 12 .. 1 days
read dir
analyze all
A
ddl 5
> Rxml
> Mcsv
Doc D:¥Document
24 clips
delete a obj
delete a clip
class m sec mag cdeg dr dv Vo av
clip_name o class mag medi
M20061227_190331_TK1_S6 0 0.0 AJM
M20061228_002416_TK1_S6 0 0.0 AJM
M20061228_004935_TK1_S6 0 0.0 AJM
M20061228_012457_TK1_S6 0 0.0 AJM
M20061228_015451_TK1_S6 0 0.0 AJM
M20061228_020648_TK1_S6 0 0.0 AJM
M20061228_024509_TK1_S6 0 0.0 AJM
M20061228_025221_TK1_S6 0 0.0 AJM
M20061228_031151_TK1_S6 0 0.0 AJM
M20061228_031814_TK1_S6 0 0.0 AJM
M20061228_032402_TK1_S6 0 0.0 AJM
M20061228_032833_TK1_S6 0 0.0 AJM
M20061228_033436_TK1_S6 0 0.0 AJM
M20061228_034053_TK1_S6 0 0.0 AJM
M20061228_041059_TK1_S6 0 0.0 AJM
M20061228_041532_TK1_S6 0 0.0 AJM
View
Mask Editor
Trail Map
Ground Map
prev
edit
next
auto
link
auto link
clear link
< SD
manual link
lim 7
L- 5
R- 5
U- 5
D- 5
mg
star
lin
5.0
qm
saveN
reload
smag
del
x1
x 0010 y 0098
az 195.6437 ev 09.5495
ra 111.1779 dc -42.4472

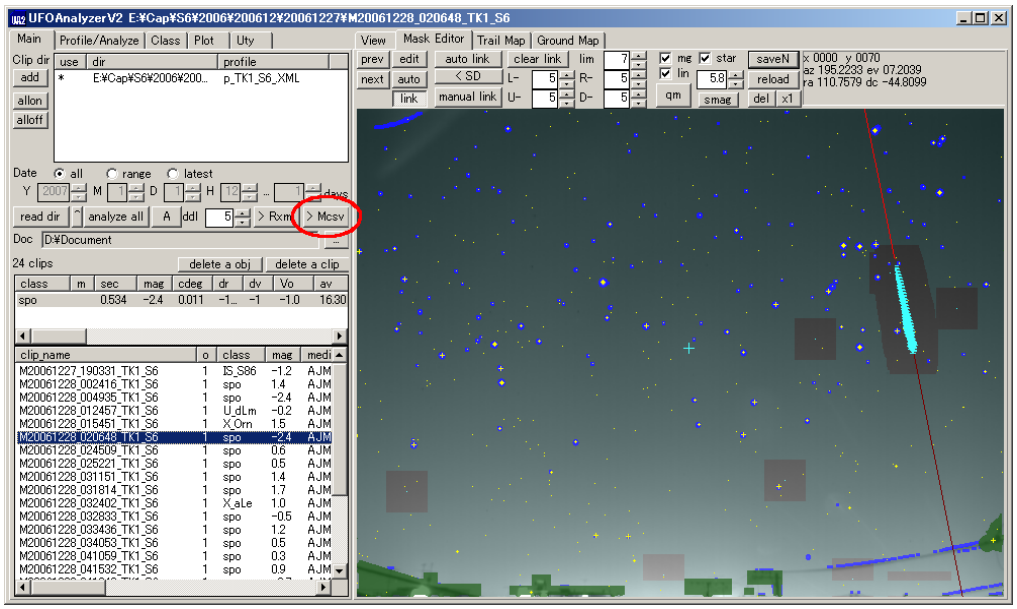
### 3.3 Analyze

Click “analyze all” button on Main sheet to analyze all clips. If the clip is selected, starts analyzing from the selected clip. The analyzed results are immediately saved into *A.XML for each clip.
During analyzing, the status is displayed on dialog.
Click “Stop” button to stop analyzing and click “Minimize” button to minimize the window. (V2.07)
During “analyze all”, MS link is created for each clip and az,ev,rot are adjusted. If it couldn’t adjust, try to re-create masks. If there are enough links in a clip, also adjust the magnitude.



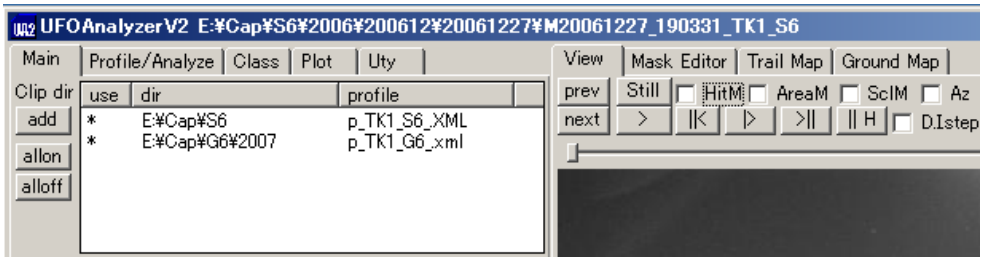

### 3.4 Output M.CSV

After analyzing, click "> Mcsv" button to create M.csv for UFOOrbit.
M.csv is saved into Doc directory specified in Main sheet.
M.csv contains the results for all meteors in the clip list. You can create M.csv for many cameras or for specified period. Click ”>Rxml” button to output  time-magnitude list as XML file. (V2.07)



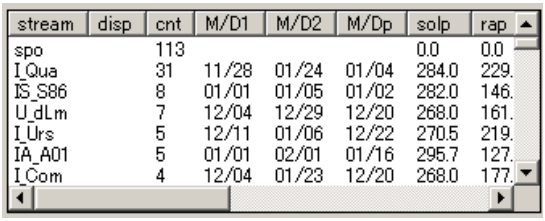
## 4.Reference guide

This chapter describes functions in each sheet.  Click the tab at upper part to change the sheet.



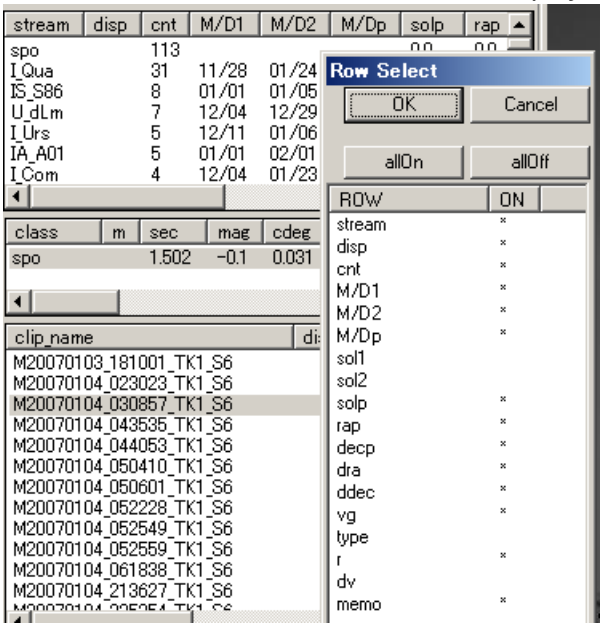

### 4.1 Common functions

There are some kinds of lists as below in each sheet.

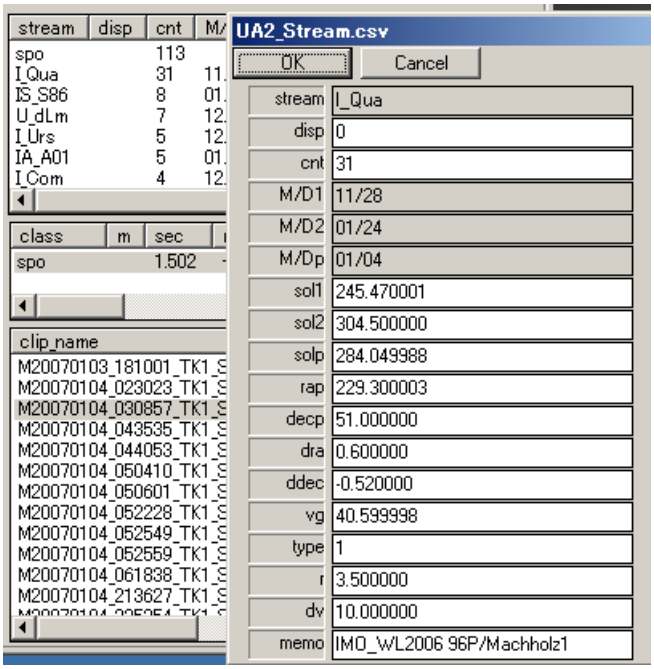



Each list consists of header, scroll bar and body. Header consists of some columns.

- Click the column name to display menu.
  - **Hide**: Click “Hide” in menu to hide clicked row.
  - **Row Select**: Click “Row Select” in menu to display dialog box as below.

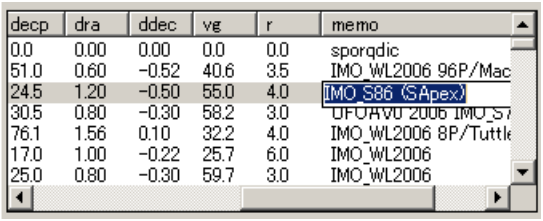



    - In Row Select dialog, click the row name to toggle ON/OFF to display.
    - Click allOn button to display all rows.
    - Click allOff button to hide all rows.
    - Click OK to save the changes.
    - Click Cancel to abort the changes.
  - **Sort+**: Sort the clicked column in ascending order.
  - **Sort-**: Sort the clicked column in descending order.
- Click the line to toggle to select.
  - It is also selected by UP/DOWN key or "prev", "next" button.
- Right click to display all information for the clicked line.




- You can’t change the gray column, which is inhibit item.
- You can change the white column.

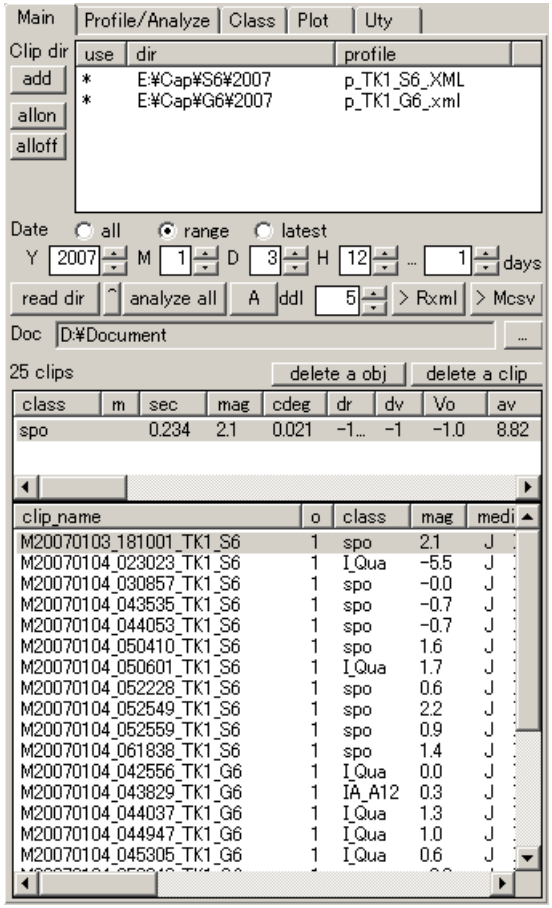
- Double click a column on the list to change the value if it isn’t inhibit item.




- Drug the boundary line to change row width.
- Scroll a bar to move display range.
- Enlarge the window to expand the lowest list size.

### 4.2 Main sheet

In Main sheet, you can read clips with profile during the periods, analyze and output MCSV.




Main sheet has 3 lists as below.

- Directory list (upper part)
  - Directory list contains the list of source directory and profile.
  - Click the line to toggle “use” ON/OFF. Click “read dir” to read the directory for “use” ON.
  - Click “add” button to add the source directory.
  - Click “all on” button to set “use” all ON.
  - Click “all off” button to set “use” all OFF.
  - If you want to delete the source directory list, right click to display a dialog and then click "Delete this item" button in a dialog.
- Objects list (middle part)
  - Object list contains the objects, which are the analyzed results for a selected clip.
  - "delete a obj" button to delete a object for the selected object list. (not delete files)
  - You can add the object manually in Profile sheet.
  - You can change the object class manually in Class sheet.
- Clip lists (lower part)
  - A clip list contains clips to be read.
  - Click "delete a clip" button to delete files for selected clip.
  - Click “^” button to move top of the lists
  - prev/next button (V2.00) is moved to right sheet. (V2.07)。

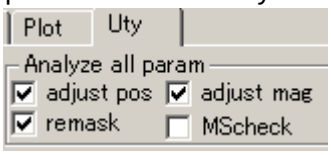
Click “read dir” button to read clips under the directory list and its lower level for “use” ON during the specified periods and display them in clip lists.

- You can specify the periods as following.

    - all: To read all clips in source directories.
    - range: To read clips for “days” starting from Y,M,D,H.
    - latest: To read for “days” until today.
- Click “read dir” to read clips.
    - If you changed the directory or periods, click “read dir” button to read again.
    - If you changed the profile or clip, must be read again.

Click "analyze all" button to analyze from the selected clip. If a clip not selected, all clips are analyzed.

- Set parameters for “analyze all” in Uty sheet.




    - **adjust pos**: If ON, following operations are worked before analyzing. MS-links are built, links with big error are deleted and if links are remained greater than 5, az, ev, rot are adjusted.
    - **adjust mag**: If ON, following operations are worked before analyzing. MS-links are built, links with big error are deleted and if links are remained greater than 20, the magnitude factors are adjusted.
    - **remask**: If ON, adjust pos ON and auto link error is grater than threshold, it will re-make the mask image as auto-smask operation in Mask Editor and try to link again. If there are problems in mask images, e.g. the problems for SMLevel of UFO Capture software, you can analyze after camera direction’s automatic adjustment. If you can’t link yet in case of lots of clouds, automatic adjustment is aborted, and profile is used for analysis. In this case, alert dialog will be displayed if M-S Check ON.
    - **M-S Check**: If ON, following operations are worked before analyzing. MS-links are built, links with big error are deleted and if remained link error is greater than 1.0 pixel, alert dialog is displayed.

Click “A” button, which is the same as one on Profile/Analyze sheet, to analyze automatically for a selected clip. “ddl” is also the same as one on Profile/Analyze sheet. They are to analyze a clip on this sheet when you changed mask or ddl.(V2.07)

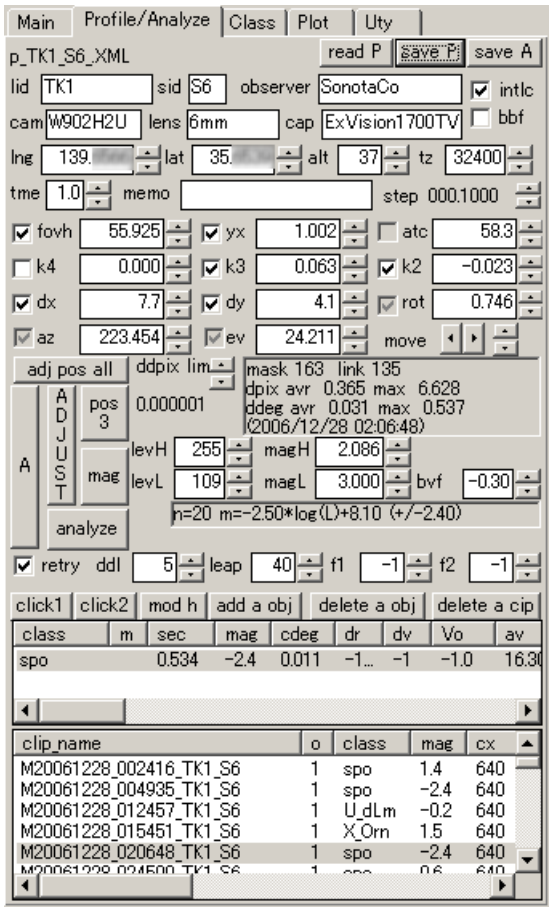
Click "> Mcsv" button to output analyzed results into Mcsv file. (V2.07)

- Mcsv and Rxml are preserved in Doc directory.
- Rxml is displayed If ufo_report.xsl, which is a style sheet, is available.
- If ufo_report.xsl is not exist in Doc directory, it is copied from execute directory. You can make ufo_report.xsl to change display form.
- You can change output directory to click “…” button.

### 4.3 Profile/Analyze sheet

Profile/Analyze sheet has following functions.

- Read, modify and save profile.
- Adjust profile.
- Analyze a clip.
- Add or delete object.
- Calculate the object location.
- Calculate the object height.




[Read profile]

Profile for each clip is made at the read dir timing by following logic.

- if *A.XML for the clip exists, then it is used.
- if *A.XML does not exist, then p_*.XML for the directory is used.
- if *A.XML nor p_*.XML did not exist, then the values that are set in this sheet is used.

Selecting a clip in clip list will recall the profile of the clip to this sheet.

By clicking Read P button, you can read any stored profile to this sheet.

[Modify profile]

- Increasing or decreasing step for spin button is used in “step” value
- If the camera is pointed at the zenith, az and rot are given the same result. In this case, you can move the view horizontally and vertically without rotation by “move” button, which consists of left, right, up and down button.
- When clicking analyze button, the value that are shown in this sheet at the time will be used in analysis and it will be automatically saved as *A.XML.

[Save profile]

- *A.XML is saved automatically by the following operation.
  - Analyze, click1, click2, modh, change class, add a obj, delete a obj
- By clicking Save P button, you can save profile settings as a profile(p_*.XML).
- By clicking Save A button, you can save profile settings as a profile for each clip(*A.XML).

[Adjust profile automatically]

- adj pos all
  - The parameters with check box ON are adjusted.
  - The parameters with check box OFF are used the current value.
  - It is necessary to establish the MS link before.
  - Automatic adjustment was made the pixel errors for all MS link reduced by changing parameters.
    - It is adjusting until the reducing of pixel error average for all MS link reaches ddpix lim.
    - Although it doesn't reach ddpix lim, it stops 500 times retry. In this case, retry from creating the MS link.
    - It may take over 10 minutes for many MS links.
  - Display the results of adjustment in middle of Profile sheet. See Basic mechanism and Quick start for more information.
  - If there are lots of clouds and less links, it may change grater than optimum value. In this case, you may restrict the adjustment parameters by check box or use pos 3.
- pos 3
  - Adjust only az, ev, rot.
  - Must be made MS link with accuracy in Mask sheet.
  - If pixel errors for all MS links are reduced to less than ddpix lim, finish adjusting.
  - Usually this adjustment finishes immediately.
- mag
  - After comparing star brightness and its magnitude of reference star, determine the conversion equation. See Quick start.
  - Must be made MS link with accuracy in Mask sheet.
- ADJUST
  - Execute equivalent to "auto link", 4 times of "<SD" and pos3. If dpix doesn't reach less than 1.0 pixel, it discards link and adjustment. If MS link is greater than 5, execute equivalent to mag. Be careful that it makes re-link or discards it.
- A
  - Analyze after executing ADJUST. Be careful of making re-link or aborting.

[Analyze a clip]

Click analyze button to analyze the selected clip with the profile setting in Profile sheet. Following options are available.

- retry: If ON, repeat to analyze max 5 times under following conditions until finding the objects and calculating angular velocity.
  - 2nd time: reduce ddl 3.
  - 3rd time: reduce ddl more 3.
  - 4th time: change analyzing area around the most differential points.
  - 5th time: reduce ddl more 3.
- ddl: Increase or decrease for the brightness change threshold in detection area. (it was renamed ddl in V2.07)
  - If detected as none, noise, slow, it may detect a object by decreasing ddl.
  - If detected as curve, flash, it may detect only linearity changes by increasing ddl.

    - Default is 5. it may output another results if set 4,3,1,0,etc for retrying by 3 steps.
- leap: max leap pixels between objects to recognize 1 object.
    - Default is 40.
    - If hi-speed moving object was detected as multiple objects, it may be detected as single object by increasing this value.
    - If close pair of meteors is detected as 1 object, it may be separated by decreasing this value.
- f1,f2: frame range to analyze.
    - Default f1=-1, f2=-1 to analyze except head and trail frame.
    - Set frame number to f1, f2 to analyze within the range.
    - This function may be used for big outburst fire ball to analyze partially if it can't be analyzed for all parts.
- If the object was not analyzed correctly, it might be analyzed by changing the mask manually.

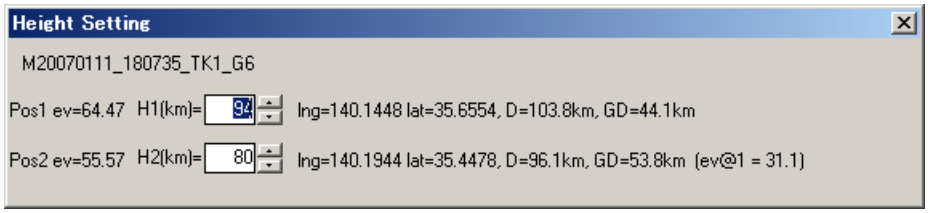
[Add or delete object]
A clip may contain multiple objects. Although these objects are usually separated, it may contain wrong objects. In case of TLE, you may separate to objects to measure individually. In this case, you may add or delete objects as following. If you add objects manually, they can't be analyzed automatically and you must measure the feature points manually.

- add a obj: Add a object for a current clip.
- delete a obj: Delete a selected object. (A clip itself is not deleted.)

[Calculate the object location]
An object has up to 2 measuring points (Pos1, Pos2)
Meteors are usually measured automatically. There is little chance to measure manually.
In case of TLE, you must measure the feature points manually. Follow the steps to measure the feature points.

- Click click1 button, and click on the image to set the position as Pos1. The height of clicked position is assumed as H1 default (Km) on Uty sheet and ground location is calculated.
- Click click2 button, and click on the image to set the position as Pos2. The height of clicked position is assumed as H2 default (Km) on Uty sheet and ground location is calculated.

[Change the object height]
Selecting object, click "mod h" button to change the assumed height in height setting dialog. If Ground Map is displayed at a time, you can check the location for the settings.

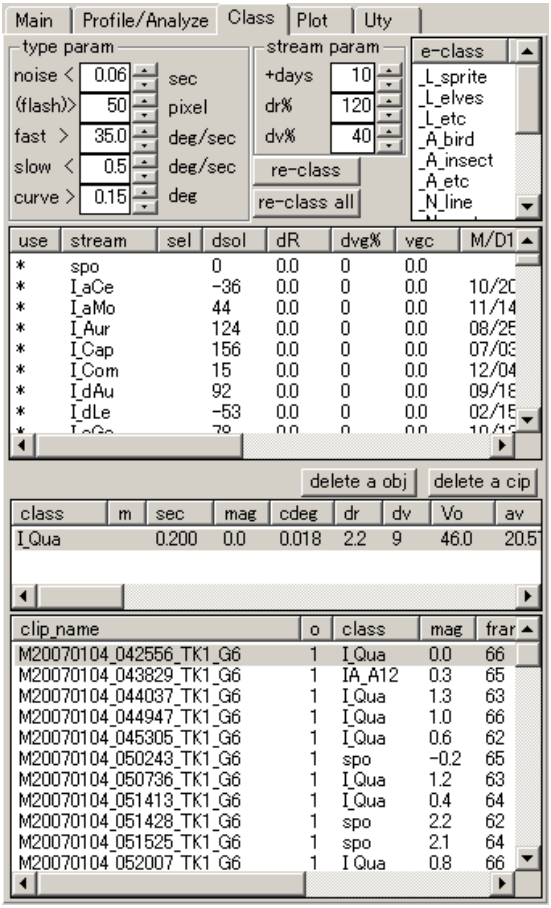



- Pos1 ev and Pos2 ev are the elevation angle at the measuring points for automatic analysis or mouse click.
- H1,H2 are assumed height and can be changed by spin button. If H1,H2 is changed, the following value is re-calculated.
    - lng,lat: longitude and latitude of the object calculated by ev and H.
    - D: Distance to the object
    - GD: Distance to the ground position under the object.
    - ev@1: Elevation angle between Pos2 and Pos1 at Pos1
        - It must be the elevation angle of the radiant point at Pos1 if the object is a meteor.

- For measuring the column sprites, set the upper height to 80Km, adjust H2 to overlay the lower ground position and the upper position, then you can assume the location and lower height.

### 4.4 Class sheet

In Class sheet, you can change the classified condition, re-classify, modify the classified results.




[classify]

The objects are classified by following 2 steps.

(1) Classify with duration time, angular velocity and linearity

- Classify 7 types at the beginning. These names are no modifiable. The threshold is set by “type param”.
    - none: The object was not found.
    - noise: The duration time is shorter than “noise” excluding flash. (e.g. cosmic ray noise)
    - flash: The duration time is shorter than “noise” and detected pixel is grater than “flash”. (e.g. lightening, sprite)
    - fast: The angular velocity is faster than “fast” (e.g. insects)
    - slow: The angular velocity is slower than “slow” (e.g. satellites)
    - curve: The linearity error is greater than “curve”. (e.g. birds)
    - meteor: other than those above

(2) Classify meteors with date, coming direction and velocity based on radiant list

- Classify meteors to possible meteor stream based on radiant list. Specify classification conditions to “stream param” as below.
    - +days: Specify extension days for the period based on the radiant list.
    - dr%: Specify the tolerance of the radiant diameter by % compared to one in the radiant list
    - dv%: Specify the tolerance of the velocity by % compared to one in the radiant list.

[Re-classify]

If you changed the radiant list or classification conditions, you don’t need re-analyze but re-classify as following.

- re-class: Re-classify the selected clip.
- re-class all: Re-classify all the clips.

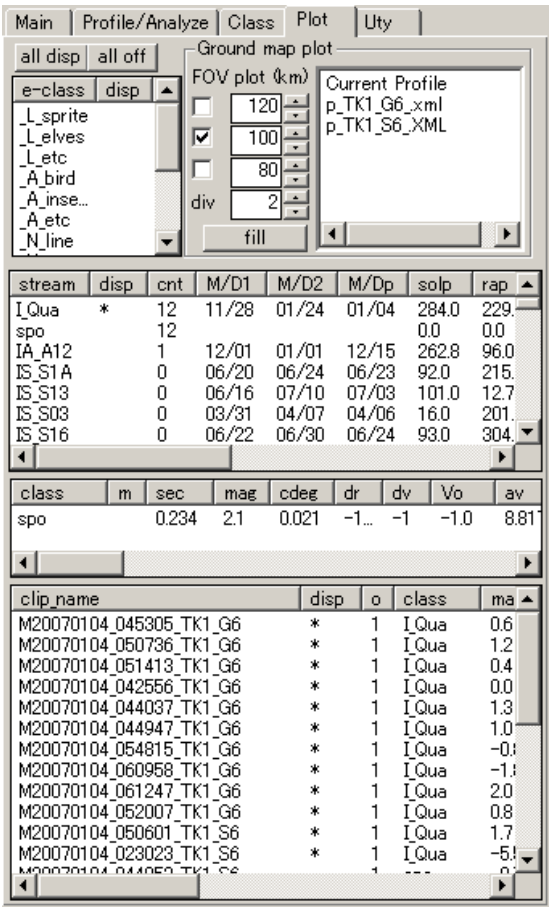
[Set the class manually]
If the object is selected, click the meteor stream name or e-class name to change the class.

- Be careful to click the class name list or e-class list. If you clicked it by mistake, you have to re-analyze the clip.

e-class means remarkable class except meteors. It is added to modify UA2_EClass.csv. It must contain leading 2 characters "__" (leading 3 characters "___" in csv) as a class name.

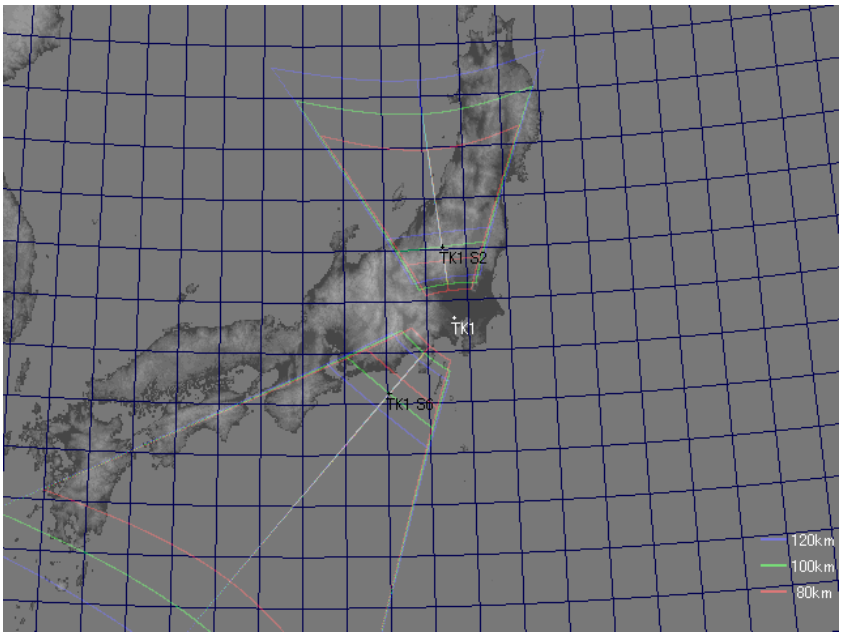
### 4.5 Plot sheet

In Plot sheet, select contents to display in Trail Map and Ground Map.
Selecting object is common to Trail Map and Ground Map.
In Ground Map, shows also FOV plot.

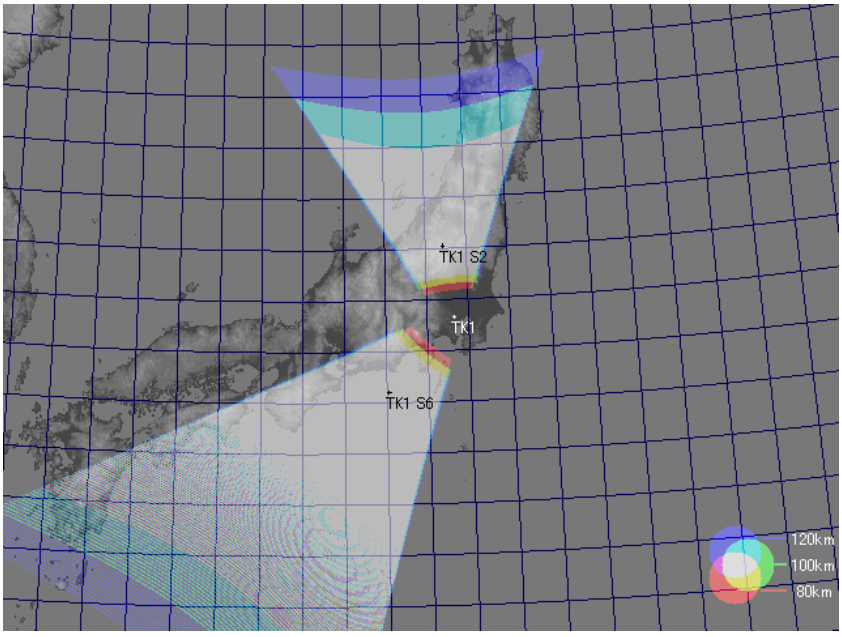


[FOV plot]
Select profile name in Ground map plot to draw FOV plot.

- Plot the horizontal coordinates for the height up to 3.
- FOV is considered of aberration in optical systems and calculated for each pixels in the image.
- Overlay some profiles to adjust camera view for multi station observation.
- Select frame mode, which draws faster, or fill mode.
- In Ground map sheet, text display is selected ON/OFF.
- If you select Current Profile, calculate the view from current settings in Profile sheet. In this case, if area mask exists in M.bmp, display the view except area of area mask.
- In frame mode, select number of divided lines in the view.

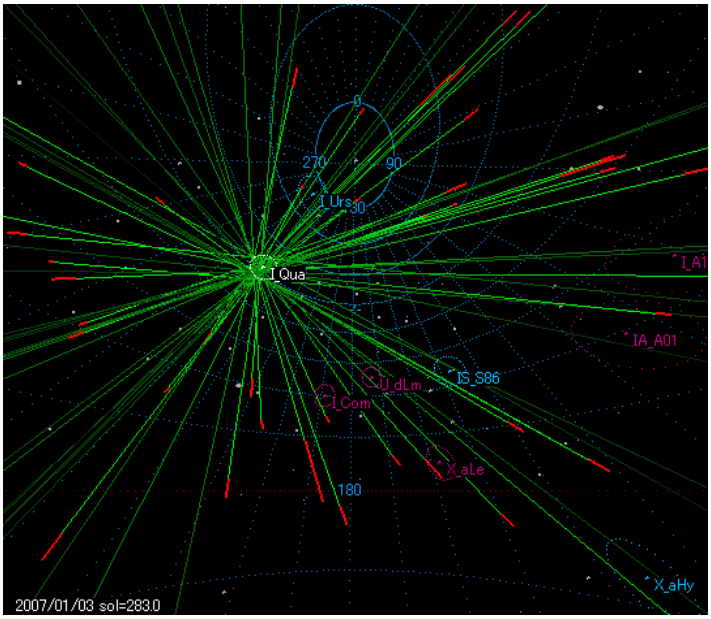



- Click fill button to paint FOV.

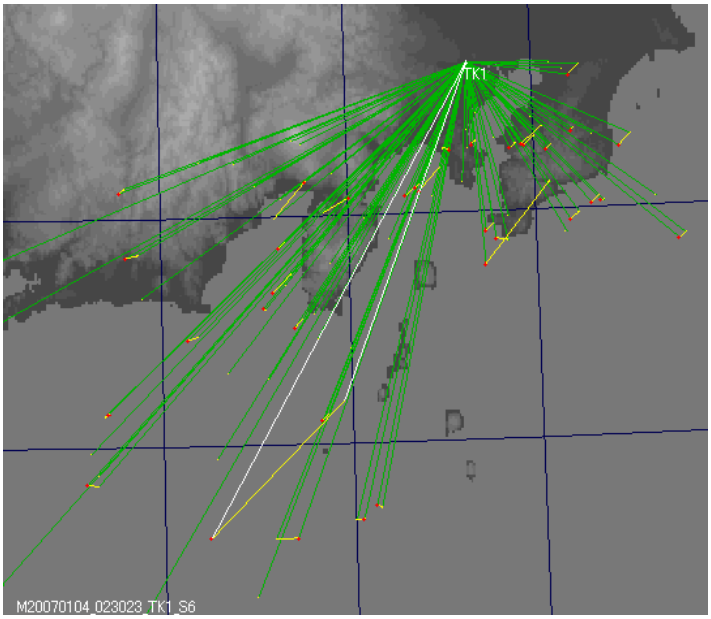


[Plot object]

- In Plot sheet, select objects to draw trail map and ground map for single observation.
- Trail map for example.




- Ground map for example.



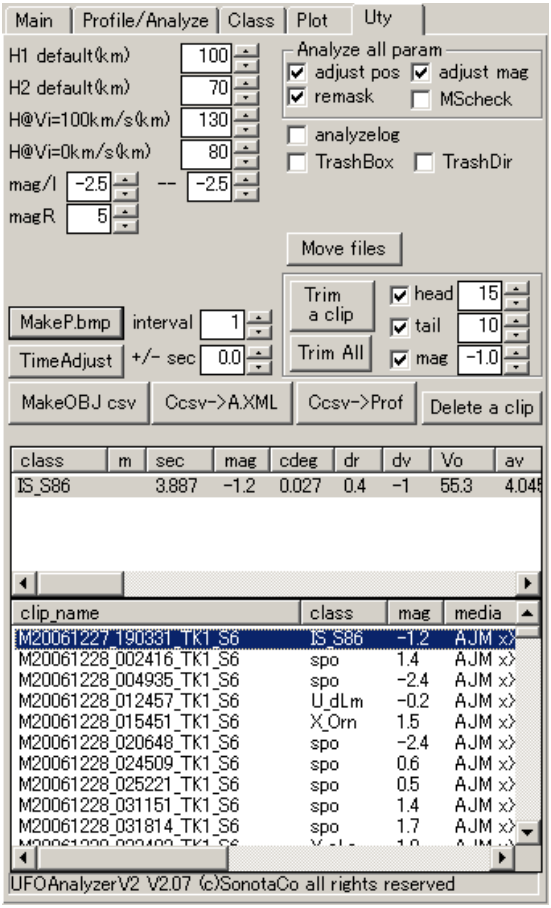

- To select objects
  - select one in clips list
  - Set “*” to double click in disp column
  - Click disp for the desired class in class list to display “*” in disp, then display all clips belong to the class. If meteor’s class is selected, display numbers of meteors belong to the class in cnt.
  - Click “all disp” to set “*” for all objects.
  - Click “all off” to set “ “ for all objects.
- Notes for Trail Map
  - Draw red line for the luminous trail and green line for the coming direction.

    - The coming direction is drawn within 180 degree from the luminous ending point. The far from luminous point, the lighter of color drawn.
    - The coming direction is calculated by polar coordinates from the luminous trail, ignored for zenithal attraction and deceleration by the atmosphere.
- Notes for Ground Map.
    - Ground map is assumed for coming direction by single observation, therefore it isn't match the triangular surveying for multi-station observations.
    - Sporadic meteors are calculated the position assumed that the luminous height is H1 default on Uty sheet, and may contain large error. The end point of sporadic meteors is not calculated and always displays as the point.
    - The end point displays in red.

The selected clip, which is highlighted, is displayed as a white line.

### 4.6 Uty sheet

Uty sheet supports utilities for clips and sets the parameters.




[parameters]

- H1 default(km): assumed height 1
  - It is used for assumed luminous beginning height for sporadic meteor.
  - It is used for assumed height for “click1” in case of sprits on Profile sheet.
  - It is used to calculate to the distance from mouse position on View sheet.
  - The height for setting by click1, 2 can change for each object by “mod h” on Profile sheet.
  - It is recommended 80 for upper part of sprits, 90 for center of elves, 100 for meteor.
- H2 default(km): assumed height 2
  - It is used for the assumed height for lower part for “click2”.
  - 60 to 70 are usually used for the lower part of sprites.
  - The height set by click1,2 is changed for each object by “mod h” on Profile sheet. Changing them on Ground Map, you can conform upper and lower part on the ground, and determine the lower height.
- H@Vi=100km/s(km): luminous height vs. velocity factor 1
  - It is the luminous height if Vi is assumed to 100Km/s. It is recommended to 130 by actual measurement of multi-station observations.
- H@Vi=0km/s(km): luminous height vs. velocity factor 2
  - It is the luminous height if Vi is assumed to 0Km/s. It is recommended to 80 by actual measurement of multi-station observations.
- mag/l: Upper and lower limit of slope of the collinear approximation for calculating magnitude. They are displayed when ADJUST is executed.
  - It’s xxx for m= xxx*log(lev).

    - If the least squares approximation is over than this range, the limit value in this range is used.
    - It is to restrict the result if abnormal slop is calculated for some reason.
    - To calculate magnitude on fixed slope to set upper and lower limit to the same value.
    - The theoretical value is –2.5
- magR: Radius of fixed star image
    - It is used for magnitude calculation.
    - Pixels in the distance of magR to magR*2 pixels from brightness center are treated as background.
    - Default is 5.
- analyzelog
    - If set ON, output the analysis details for a clip as *.txt in input directory.
- TrashBox
    - If set ON, move to system trash box when deleted.
    - For Windows 2000, it is very slow to delete a file if set to ON.
- TrashDir
    - If set to ON, move to sub directory, which is named trash, when deleted.
- Analyze all param
    - It is analysis conditions when Analyze all was executed. See Main sheet.

[time adjust]
Correct the time if PC time is not adjusted.

- Enter seconds to be corrected in +/- sec column and click TimeAdjust button to correct the observation time for all clips that displayed in clip list.
    - For example, if +10 is entered, the clip recorded at 01:23:45 will correct to 01:23:55.
- If C*.csv, *.xml, *A.xml exists, modify the time record.
- The clip name or super imposed time in the image is not modified.
- Enter seconds to be corrected from the results if repeated.

[crate peak hold image]
You can create as *P.bmp still image from a selected clip.

- If the clip has only movie, create P.bmp as interval=1 and analyze by UFOAnalyzerV2.
- If you specify interval to greater value, create a image that emphasize  status of object.

- [peak hold image as usual]


- [peak hold image by interval=10]

[output CSV]
Click MakeOBJ.csv button to concatenate the current clip and object list, and then save to CSV.

- You can create CSV included information selected in RowSelect for each list.
- If clip list is sorted, create CSV in order.
- As this function is for study, these output are not used.

[create profile from V0 analysis]
If C*csv has been created by UFOAnalyzer V0, you can create profile (p_*.XML) and *A.XML for each clip. This function is to migrate profile from V0 to V2. After this function is executed, you must analyze again.

- Ccsv->A.XML: Create *A.XML for each clip from C*csv.
    - This function is used for setting the camera direction frequently for V0.
    - This function doesn't create p_*.XML but *A.XML, which is contained profile for each clip. When you re-analyze for V2, it is referred to *A.XML if available.
    - If a clip was analyzed as Notrail for V0, which doesn't have profile, it uses current profile for V2 .
- Create p_*XML as profile from C*.csv. It is convenient to create profile if the camera was fixed. After create profile, arrange on Profile sheet and save it.
    - The first record in C*.csv must be analyzed not as Notrail.

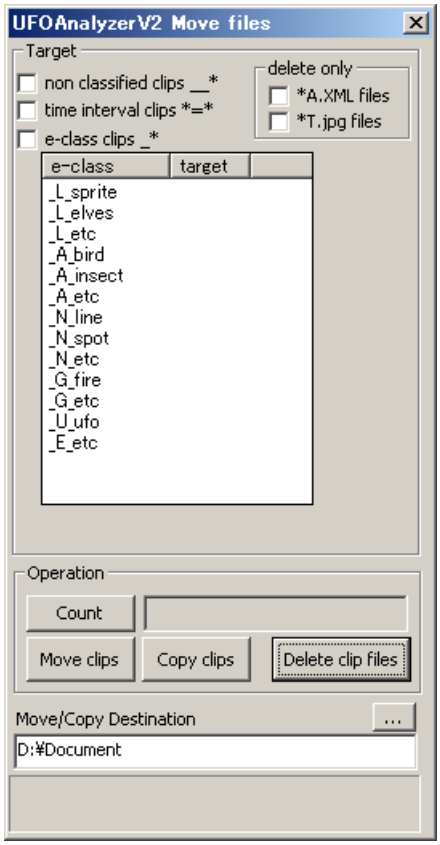
[trim the clip]
A clip recorded by UFOCapture contains Head, Tail time (default 1 second). You can cut off these frames to shorten to 1/3 length of original AVI file.

- Click "Trim a clip" or "Trim All" button with head, trail time and trim frames in head, trail.
    - It must be only non-compressed AVI file.
    - Head must be at least 10 frames for re-analysis.
    - After analyzing, you can trim only dark meteor specified with "mag"
        - If you specify –1.0 as "mag" for example, clips for meteors darker than –1.0 will be trimmed.
    - It will overwrite AVI files. C*csv,*XML related with the AVI also modified simultaneously.

[delete a clip]
Click "Delete a clip" button to delete a selected clip.

- If you sort clips in "MB" as descendant, you can see long clips in a row. It is easy to find airplanes and lightening and delete them.

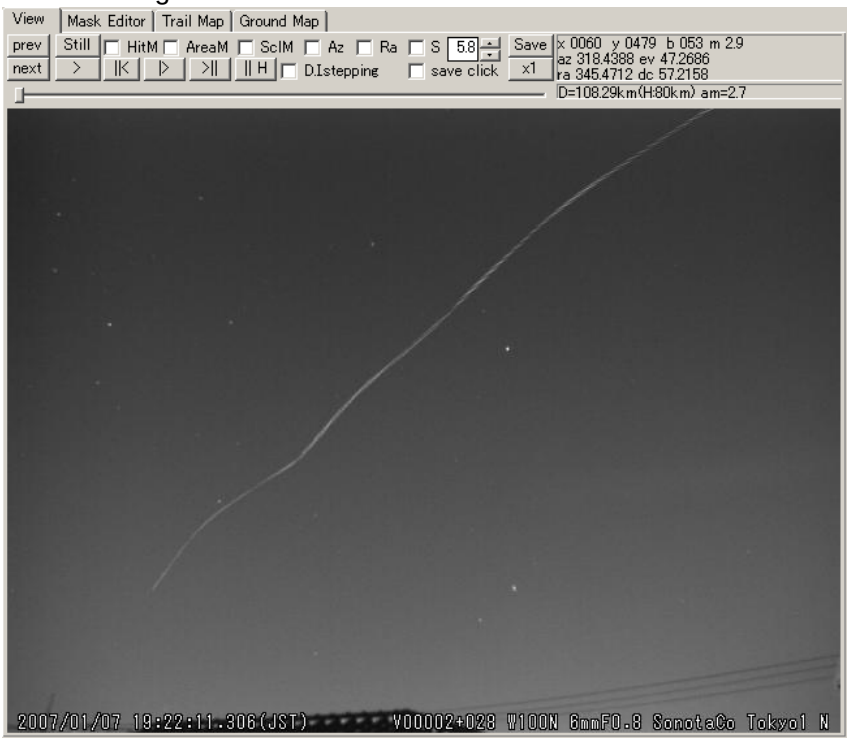
[move/copy/delete clips (V2.07)]
Click “Move files” button to display a dialog as below.




- Target: source file to move/copy/delete.
  - non classified clips: clips for the leading “__” class. (e.g. __none)
  - time interval clips: clips including “=” in its name, which generated by time trigger for UFOCapture.
  - e-class clips: clips for “*” marked in target column.
  - *A.XML files: check here to delete *A.XML files, which contain analyzed results.
  - *T.jpg files: check here to delete *T.jpg files, which used for FTP for UFOCapture.
- Move/Copy Destination: destination directory to move/copy.
  - click “…” button to enter the destination to move/copy.
- Operation: To execute
  - Count: Count clips and total capacity.
  - Move clips: move clips
  - Copy clips: copy clips
  - Delete clip files: delete clips (“Trash Box” or “Trash Dir” is effective)

### 4.7 View sheet

View sheet shows movie and still image for the selected clip. If camera profile was specified, it shows horizontal and equatorial coordinates on the image and also estimates the distance to the object and absolute magnitude.




View sheet has following functions.

- click the image: Play or stop.
- slider bar: Move to frame / field.
- “prev”: Move to previous clip.
- “next”: Move to next clip.
- "Still": Show still image.
- ">":Play movie or pause.
- "||<":Backward a frame / field.
- "|>": Play movie from the top.
- ">||":Forward a frame / field.
- "||H": Move to the object detected frame / field.
- “D.Istepping”: Select to move frame or field. ON: field stepping. OFF: frame stepping.
- "HitM": Overlay detected pixel mark (cyan), coming direction mark (bright red) and moving direction mark (dark rd).
- "AreaM": Overlay area mask.
- "SclM": Overlay scintillation mask in blue.
- "Az": Overlay Az, Alt line.
- "Ra": Overlay RA, Dec line.
- "S": Overlay the reference stars. Change the star’s magnitude to display in right column.
- "save click": Save information for the clicked position on the image as "*_click.csv" in input directory.
- "Save": Save the current image into the directory specified Doc in Main sheet. You can select bmp or jpg in the dialog box.
- "x1": Adjust window size to video size.
- Following information on the mouse position is displayed in the text area at right upper.
    - x: x coordinate
    - y: y coordinate

- b: brightness
- m: magnitude estimated from brightness and profile settings
- az: azimuth
- ev: altitude
- ra: RA
- dc: Dec
- D: distance to the object estimated from the assumed height (H1 in Uty sheet).
- am: absolute magnitude estimated from m and D

### 4.8 Mask Editor sheet

- In the Mask Editor sheet, you can create, delete and modify the mask image and MS link.*M. bmp in input directory is usually used as the mask image.
- If *M.bmp doesn't exist, other still image (e.g. *P.jpg) is temporarily used.
- If the mask image was modified, *N.bmp is saved in the input directory.
- If *N.bmp exists, it is used prior to *M. bmp.
- The MS link information is not preserved.

Mask image is overlaid of the following logical masks and modified immediately by Mask Editor.

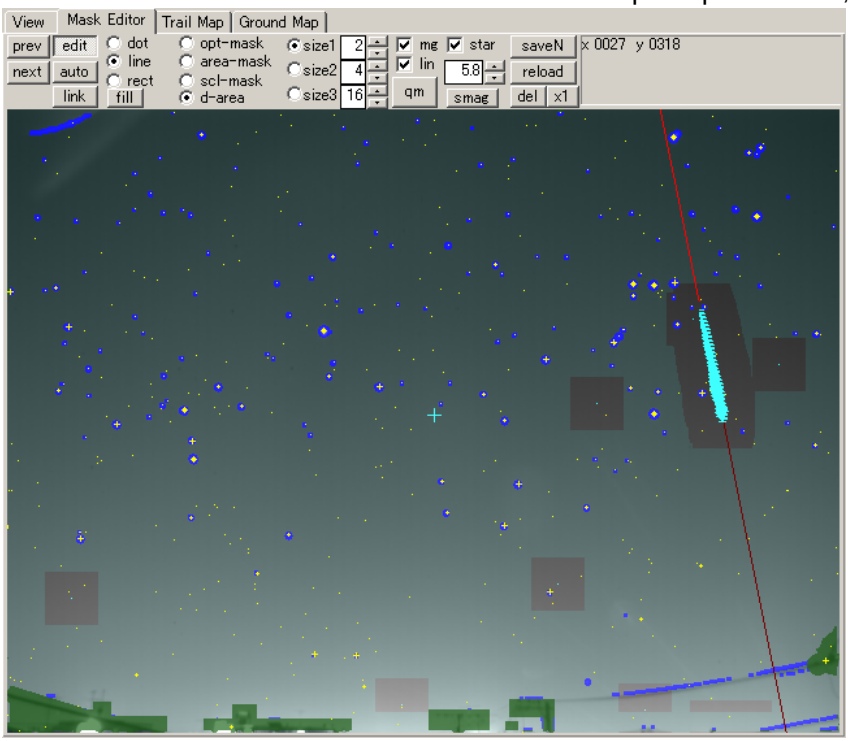
- area mask(green): mask the out of detection area such as ground scenery
- scintillation mask(blue): mask the bright spots such as stars
- opt-mask(light blue): mask the superimposed area and out of detection area that is manually excluded. It is automatically mask the area that excepts around the detection points when reading the clips.

There are 3 modes as following and select one with the upper left button.

- edit: Manual edit mode
- auto: Auto edit mode
- link: MS link mode

The functions below that are common to all the modes.

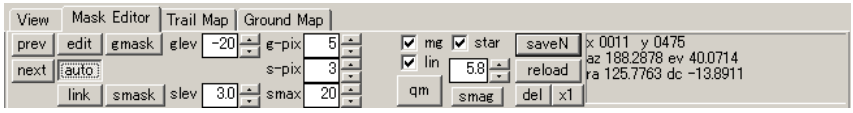
- "save N": save the modified mask into the input directory as *N.bmp.
- "reload": abort the modified mask and reload *M.bmp or *N.bmp.
- "del": delete *N.bmp.
- "x1": fit the window size to video resolution.
- "star": display the stars as the yellow points within the specified magnitude.
- "smag": set the star's magnitude that is to be displayed about 200 stars.
- "mg": display the magnitude-brightness graph if the MS Link was established.
- "ln": add the basis line on the magnitude-brightness graph.
- "qm" (quick mask): drag the rectangle area to enter quick mask mode. The mask for this area is saved as *N.bmp.
    - In quick mask mode, you can also cancel the mask of the superimposed area. If you include the character area in the superimposed area, it may not detect the object.



In manual edit mode, to create the mask manually, select the object mask and the operation.

- Select the object mask as following.
  - opt-mask: set out of detection area (light blue).
  - area-mask: set the non link area or out of detection area (green)
  - scl-mask:stars' position (blue).
  - d-area: use to unconditional detection area.
- Select the operation to edit as followings.
  - dot: Dot drawing mode. Draw a point with selected size.
  - line: Line drawing mode. Draw a line to drug with selected size.
  - rect: Rectangle drawing mode. Draw a rectangle to drug.
  - In each mode, left click to draw or right click to delete.
  - "fill" button is to paint all the screen.

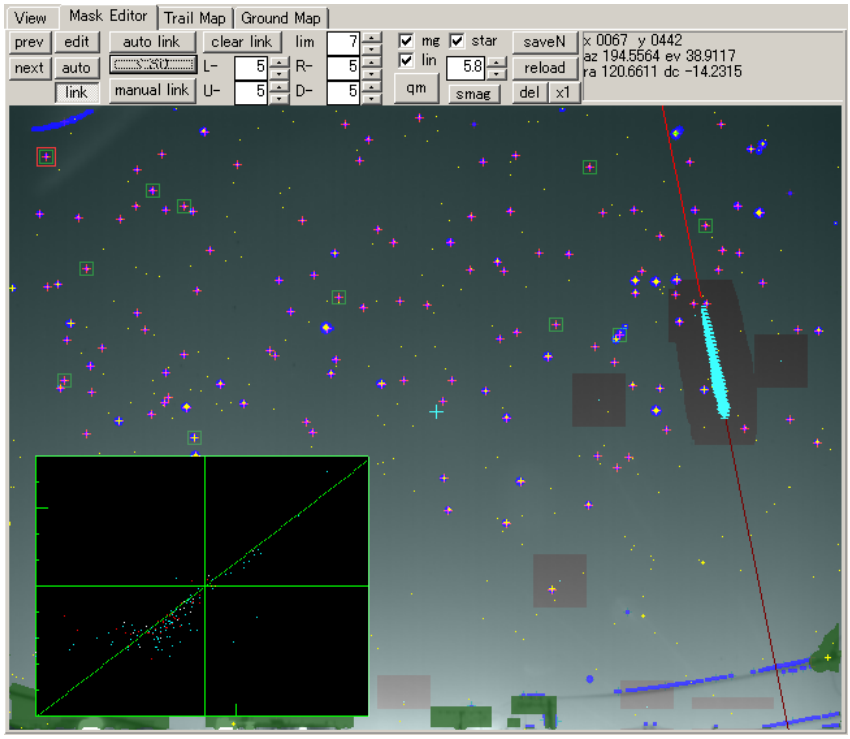
In the auto edit mode, create the mask automatically by image processing.




There are 3 automatic processing in the auto edit mode. (This auto edit mode is used for remaking the mask if it couldn't analyze for abnormal mask. Usually you don't have to use this mode.)

- gmask: Make area mask, which area is darker than surroundings.
  - "glev" is the threshold value of the difference with the surroundings.
  - "g-pix" is the number of pixels that masks at a time.
  - The superimposed area is completed to opt-mask.
- smask: Make scl-mask, which area is as small as the star and brighter than the surroundings.
  - "slev" is the threshold value of the difference from the surroundings.
  - "smax" is the maximum size.
  - "s-pix" is the number of pixels that masks at a time.

In the link mode, you can create, delete, and modify the MS link.

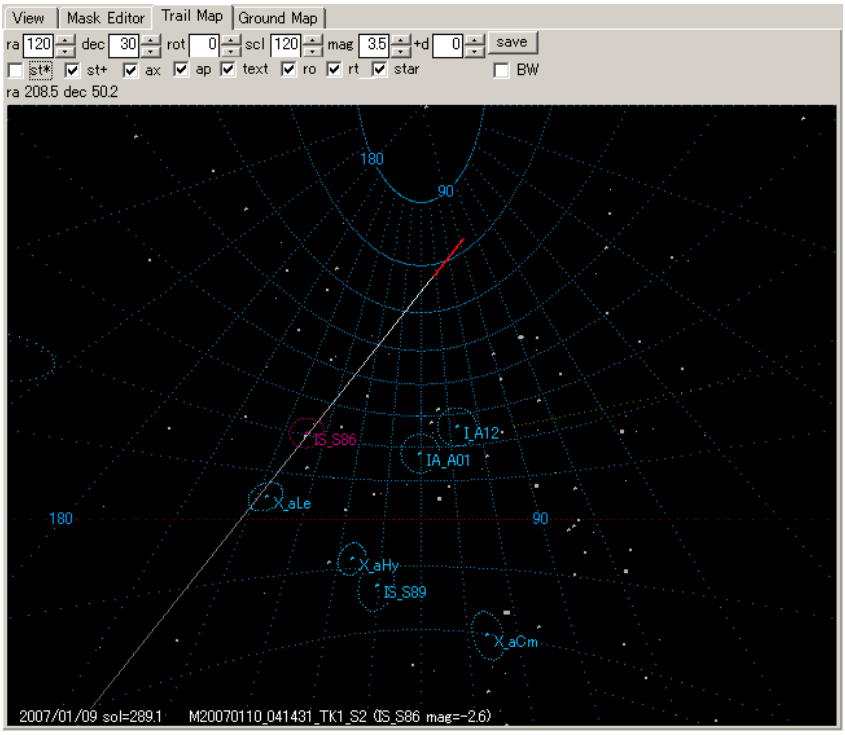


In the link mode, following functions are available.

- "auto link ": Relate scintillation masks (blue points) to reference stars (yellow points) under following conditions.
    - The length of the link is less than “lim”.
    - They are outside the link prohibited area, which 4 sides are specified with L-, R-, U-, D-.
        - L-, R-, U- D- contain number of pixels for the link prohibited area from the left, right, upper,  bottom side.
        - It is used for ignoring ground scenery etc.
    - The reference stars (yellow points) that are displaying on the screen are used. The appropriate number of stars must be adjusted by "star".
- "<SD": Delete the link that is different over the standard deviation from the whole average of length and direction.
- "manual link": Click the image to create the link manually.
    - After click the “manual link”, click the star and drug to the mask position.
- "clear link": Delete all the links.

### 4.9 Trail Map sheet

Trail Map Sheet shows meteor's trail on the star chart.

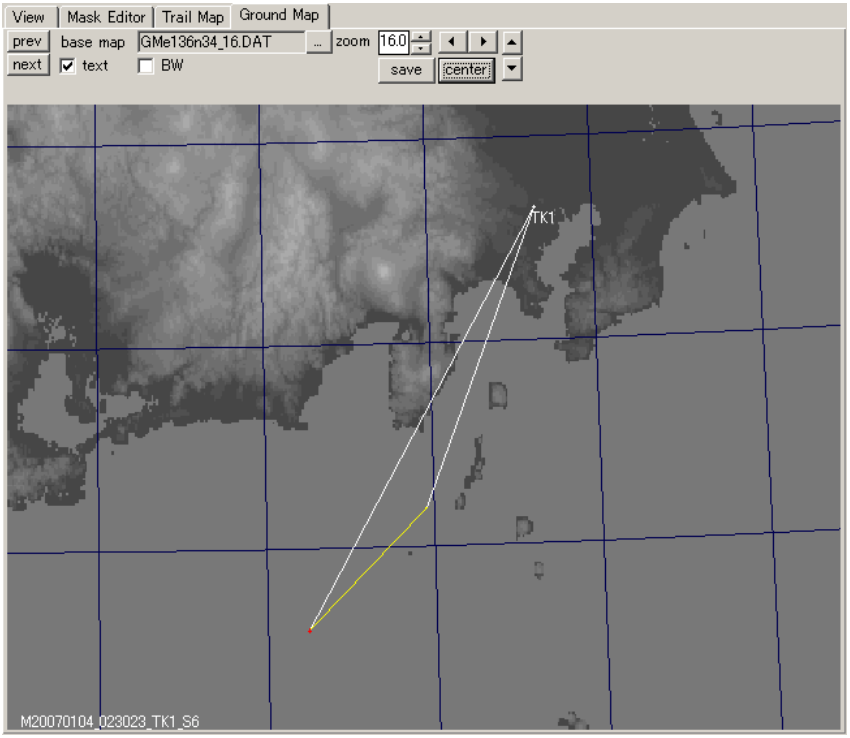



Following functions are available in Trail Map sheet.

- "ra": RA at the center of the star chart.
- "dec": Dec at the center of the star chart.
- "rot ": Rotation degree at the center of the star chart.
- "scl ": Scaling of the image.
- "mag ": The lowest star's magnitude to display.
- "+d ": Day offset from the clip that calculates the radiant point.
- "save": Save the current image as .bmp or .jpg into the directory that is specified in Doc of the Main sheet
- "st*","st+": Select the radiant point to display as followings.
    - If the radiant point exists in the stream list of the Plot sheet, unconditionally display with white.
    - st*=OFF, st+=ON: Display the radiant point with red if the meteors exist within the period or with blue if not.
    - st*=ON, st+=OFF: Regarding to the radiant points with disp ON in Plot sheet, display the radiant point with red if the meteors exist or with blue if not.
    - st*=ON, st+=ON: Display all radiant points in Plot sheet but display with dark blue without period.
- "ax": Draw RA, Dec line.
- "ap": Display the ecliptic, the apex of the Earth's way, the antihelion.
- "text": Display text information.
- "ro": Display the radiant point assumed by the Vo-matching technique as yellow.
- "rt": Display the radiant point corrected for zenithal attraction from "ro" as red.
- "star": Display the stars.
- "BW": Display as monochrome mode.
- Information on the mouse cursor position is displayed at top of the screen.
- When you click on the screen, the coordinate of the x mark and the clicked point are displayed. They are deleted by right click.

### 4.10 Ground Map sheet

Ground map sheet shows meteor's trail on the ground. The map data is necessary to display the map. Only Japan map is included with the program package. Download the other map from the SonotaCo web site.




Following functions are available in Ground Map sheet.

- "base map": Specify the map data to use.
- "zoom": Specify the scale factor.
- up, down, left and right: Move the view.
- "center": Move the map as the observation location and meteor's trail at the center.
- "text: Display text information.
- " BW": Display as monochrome mode.
- "save": Save the current image as .bmp or .jpg into the directory that is specified in Doc of the Main sheet.

## 5. Operation guide

### 5.1 The source directory and the profile

- Enter the directory with the profile into directory list on Main sheet. You can analyze the clips for several cameras at once.
- You shouldn't analyze network drive directly because the processing is very slow.
- Profile must be created whatever system or camera direction was changed.
- If camera direction was changed every day, you had better using Ccsv->AXML instead of creating profile.
- Get the profiles for other sites to draw FOV map collectively.
- To delete the directory list, right click to display dialog.
- It is convenient to use drives as following.
    - The capture directory
        - The capture directory for UFOCapture is created at root directory, which names camera name.
            e.g. D:\S2
            Lower level directory is created automatically.
            e.g. D:\S2\2007\200701\20070127\
        - If you are using multi cameras at the same time (it called dual capture), it is recommended to use multi physical drives for simultaneous writing.
        - If the capture drive becomes full, it is convenient to move old files to the external drive such as USB2.0 or IEEE 1394 drive.
    - Mcsv directory
        - It is convenient to output the directory each month.
        - Create upper level directory as C:\csv for example, then create C:\csv\2006\200601 for a month. It is convenient to load the data for UFOOrbit.

### 5.2 View the clips

- Click "read dir" button to read clips.
    - Check the "use" to specify the directory to read.
    - If you change the directory to lower level in directory list, you can read clips contained in all of the lower directory.
    - Check the "range" to read within the periods.
    - Check the "latest" to read the latest data.
- To view the clips, it is convenient to sort the clips.
    - View the brightness order to sort mag +.
    - View the same meteor shower to sort class.
    - Check the file status to sort MB.
    - View the clips in sorted order.
- In Plot sheet, It is displayed only belong to the class.
- You can arrange the row and change its width in the clip list.

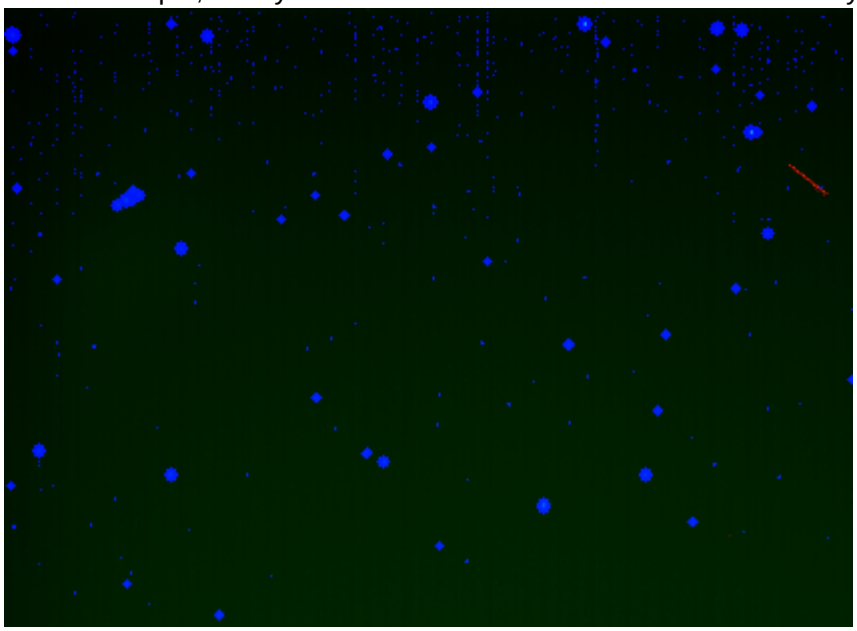
### 5.3 Set the profile

- If the camera was moved more than 10 pixels, create the new profile.
- If the camera was moved some pixels, it is adjusted automatically within some pixels.
- K4 is not necessary not for extremely wide lens.
- Be careful if you want to create UFOAnalyzerV0 compatible profile.
    - Set atc to 0.0
    - Set k4 to 0.0
    - Set k4 checkbox OFF.
    - After once adjusting, round dx, dy to integer and check OFF, then adjust again.

    - Take care of az. It is different 180 degrees from V0.
- If ground objects are included, set them as inhibit area using by D-, R-, etc in Mask Editor to reduce error links.

### 5.4 Analyze

- If intlc ON, analyze each de-interlaced field. This means as double as sampling, improve the measuring accuracy. The processing time is almost the same for high performance CPU.
- If there are lots of abnormal scintillation masks non-star object such as cloud, auto adjust will adjust the parameters..
    - In this case, "analyze all" uses the current profile and don't calculate the error( rstar will be set as 0).
    - If you didn't find the trail in automatic analyzing, try to do as following.
    - It is the efficient way to limit the analysis area by qm.
    - Change ddl.
    - Delete scintillation masks across the trail in Mask Editor.
- If detected many points as curve, increase ddl to re-analyze.
- In case of outburst fire ball, set f1, f2 to exclude explosion parts, then it may be calculated the trail.
- If you analyzed with wrong profile, analyze again after deleting all *A.XML.
- If Smlevel in UFOCapture is too lower and there are many masks more than stars in M.bmp, which are not stars, it can't adjust automatically. In this case, you have to re-make the mask for setting slev to large value (e.g. 3.0) in Mask Editor - auto-smask.
    - As figure below for example, many small blue points prevents the automatic adjustment.
    - For this sample, "analyze all" will re-make masks if remask ON in Uty sheet



### 5.5 Re-analyze old clips

- Usually put clips into the same directory for each camera, create the profile for each directory, then analyze.
- If already analyzed accurately by V0, it can be created individual *A.XML by Ccsv->AXML in Uty sheet, then analyze at once.
    - As all clips are reflected from V0 analysis, you don't have to be care of camera direction.

    - Although camera direction re-adjusts for each clip, the same lens aberration as V0 is used.
    - Recommend creating at least a profile since V0 doesn't have a magnitude parameter.
- If you set remask ON in Analyze all param on Uty sheet, it can be precisely analyzed.
- If you want to analyze for the specified clip, follow the steps.
    - If still image is not exist, create one from movie by "MakeP.bmp" in Uty sheet.
    - If M.bmp is not exist, create N.bmp in Mask Editor as follows.
        - Click edit, select d-area, check rect, and click fill to clear the mask.
        - Click auto, gmask to (green) mask the scenery on the ground.
            - Or click edit and select area-mask to mask all the scenery on the ground.
        - Click auto, smask and change slev to (blue) mask the stars.
            - If the scenery on the ground, clouds or the moon was masked, then area-mask these parts and smask again. Or delete incorrect blue parts for scl mode of edit.
        - Set the detect area, which is transparent, around the object by qm.
        - Click saveN to preserve.
    - Adjust the value of "star" to relate the yellow points (reference stars) to the blue points relevantly on Mask Editor.
    - Make links by Mask Editor - link - auto link.
    - If there are irrelevant links, modify them to "<SD" or click manually.
    - In Profile sheet, check at least fovh, yx, k3, k2, dx, dy, set ddpix lim to minimum (0.000001), then execute adj pos all.
    - In Profile sheet, check dpix avr under 0.3. If not, check the links.
    - In Mask Editor, set mg ON to draw a magnitude graph.
    - In Profile sheet, click mag button to adjust magnitude.
    - Check the magnitude graph.
        - If you want to change the slope of the line, change mag/l in Uty sheet.
        - Change bvf for color temperature.
        - Up the lowest magnitude to relevant position to adjust mag L and execute mag again.
        - If automatic adjustment doesn't work properly, adjust magH, magL and levL manually.
    - Click saveA or saveP to save adjusted profile if you modified profile.
    - Analyze individually for analyze button.
        - Don't click A or ADJUST button or discard the manual adjustment.
    - If not detect the object, change qm, ddl to analyze again.

### 5.6 Draw the FOV map

- Put another site's p_*.XML into PROF directory, you can draw FOV map.

The precise latitude and longitude are included in p_*.XML. Be careful of exchanging the p_*.XML. However it is no problem for Mcsv. Mcsv is encrypted for latitude and longitude.

### 5.7 Analyze TLE

For TLE (Transient Luminous Event) such as sprites, elves, following functions are available.

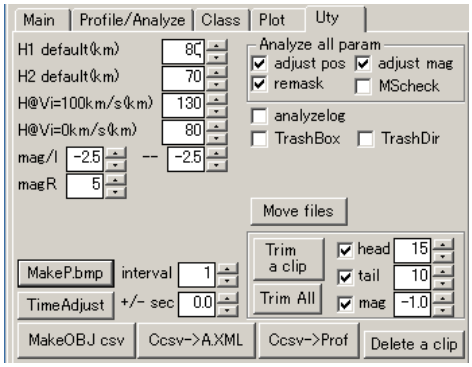
- Align the FOV used by reference star.
- Measure Az, Alt of the feature point.
- Assume the location from Az, Alt and assumed height.
- Plot the location on map.
- Output the data for CSV format.

UFOAnalyzerV2 is not supported the triangular surveying. As Mcsv includes the information for the triangular surveying, it can be measured from the multi-station observations for exchanging Mcsv. Follow the steps for measurement of TLE for example of column sprite.

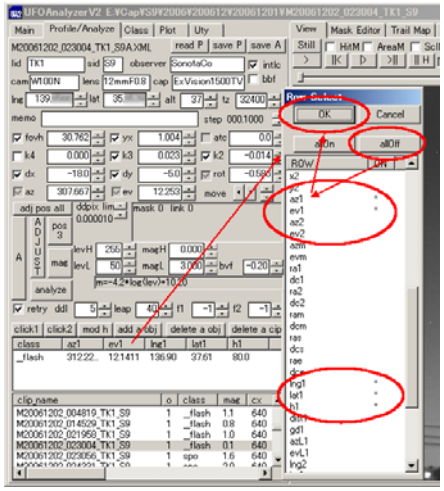
[Create profile]
It is necessary to create the profile for alignment of camera view. The profile is in common for the meteors. See Create profile.
You should use the clip in clear sky to create the profile.

[Analyze]
Analyze the sprite's clip as well as meteor's by "analyze all", etc,

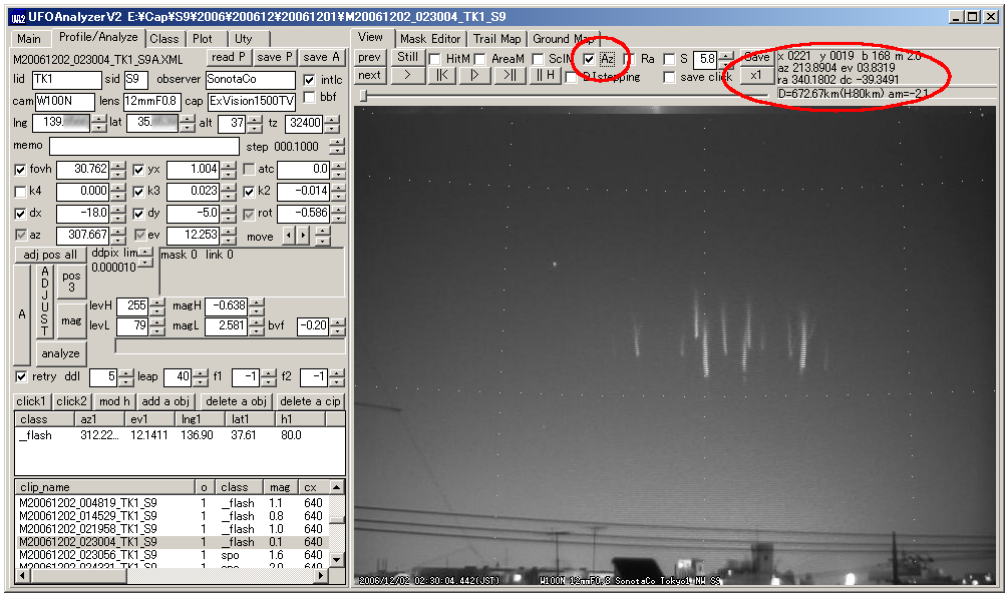
[Prepare to measure sprites]
(1) On Uty sheet, set H1 default to 80km, H2 default to 70km in advance.



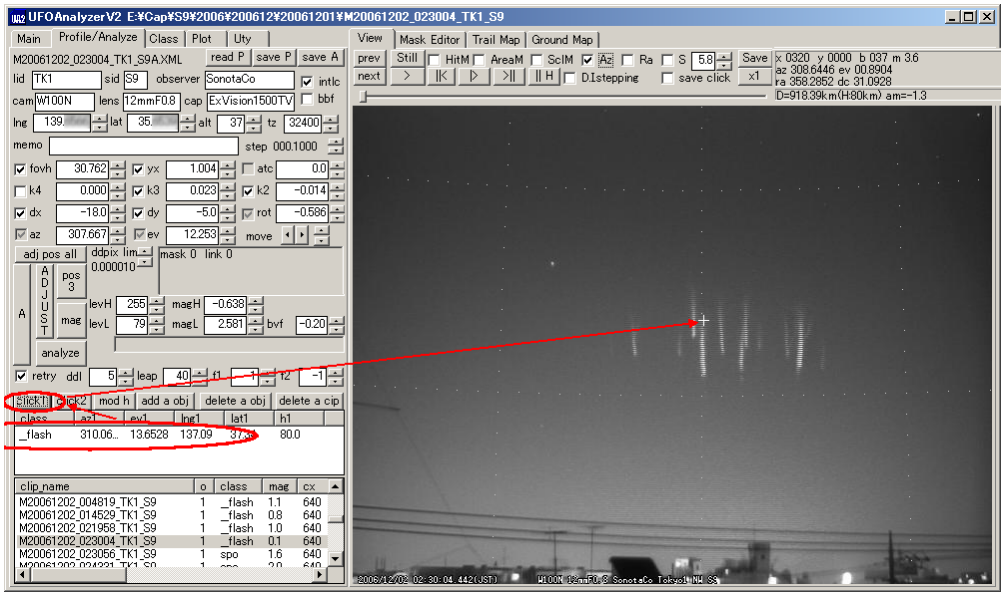

(2)Follow the steps to display sprite parameters. Click the column in the object list in middle of Profile/Analyze sheet, select Row Select in the menu, then display Row Select dialog for object list. Once click allOff and click sprite related parameters such as az1,ev1,lng1,lat1,h1 to mark "*", then click OK.



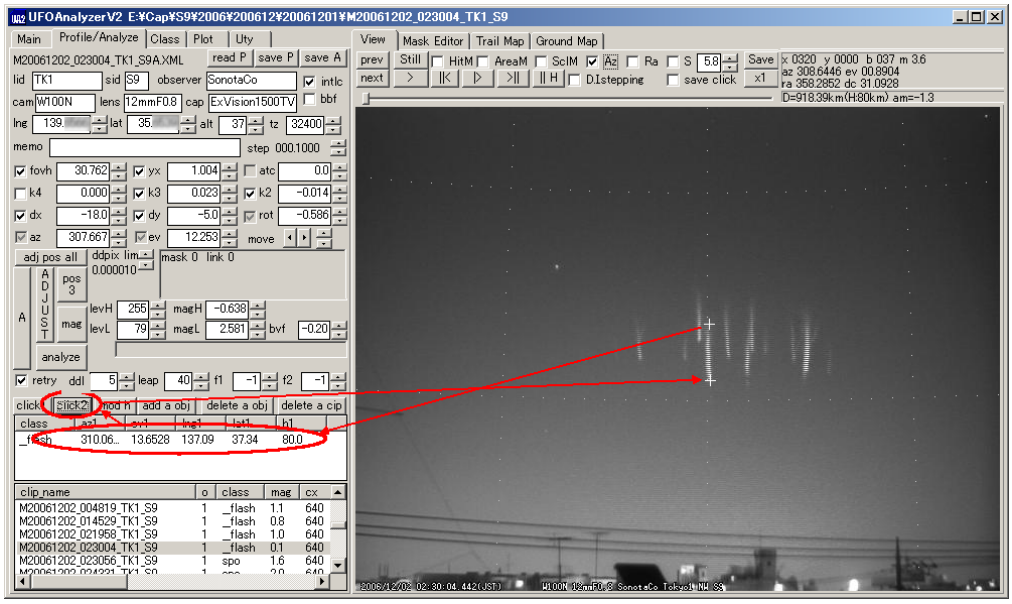
[Determine the measuring points]
Determine the measuring points in the image on View sheet.
If there are multi station observations, exchange the images to determine the measuring points.
Set Az checkbox ON to draw Az and Alt line.
In text box on upper right of the window, Az and Alt of mouse position is displayed. Set save click checkbox ON to record mouse click position. D is the distance calculated for mouse position under the assumption of H1 on Uty sheet. For this sample, describes to measure a column of sprite.



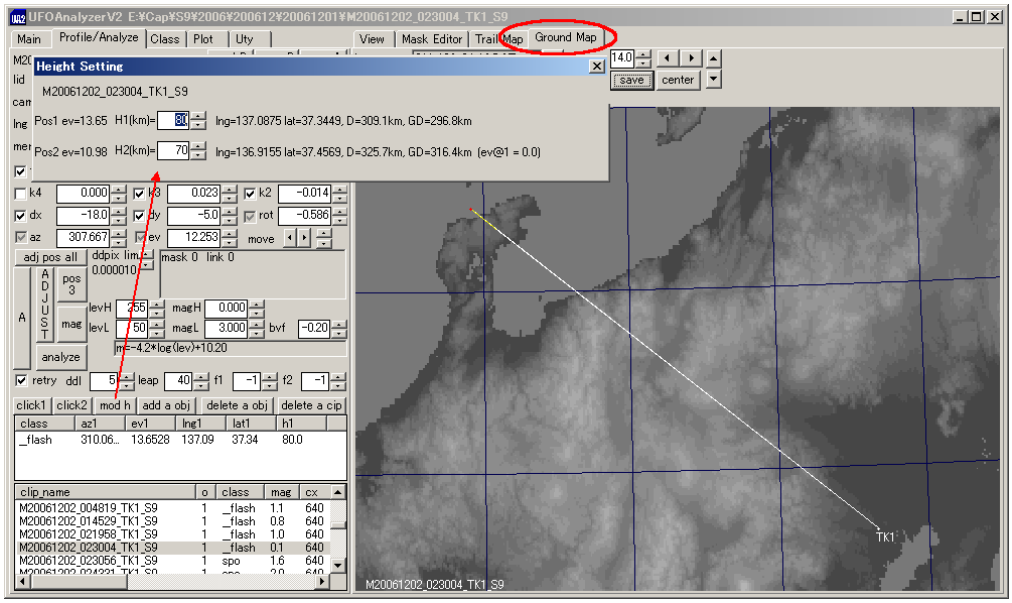
Click the target clip in object list, click click1 button, and then click the upper part of the sprite on the image.



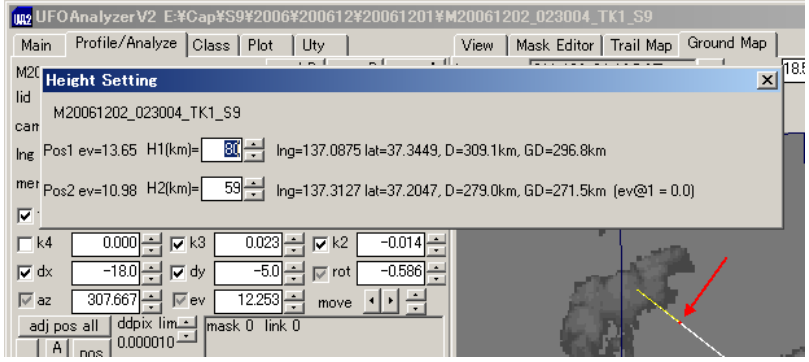
Click the point to mark + at the clicked position and display information of clicked position in object list. Then click click2 to click the lower part of sprite. It has completed to measure Az and Alt for a column of sprite.



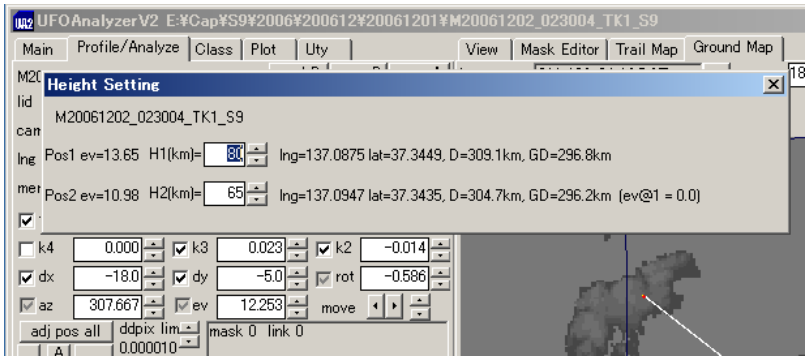
Change to Ground map to display the location calculated by assumed height. Click mod h button to display Height Setting dialog box.



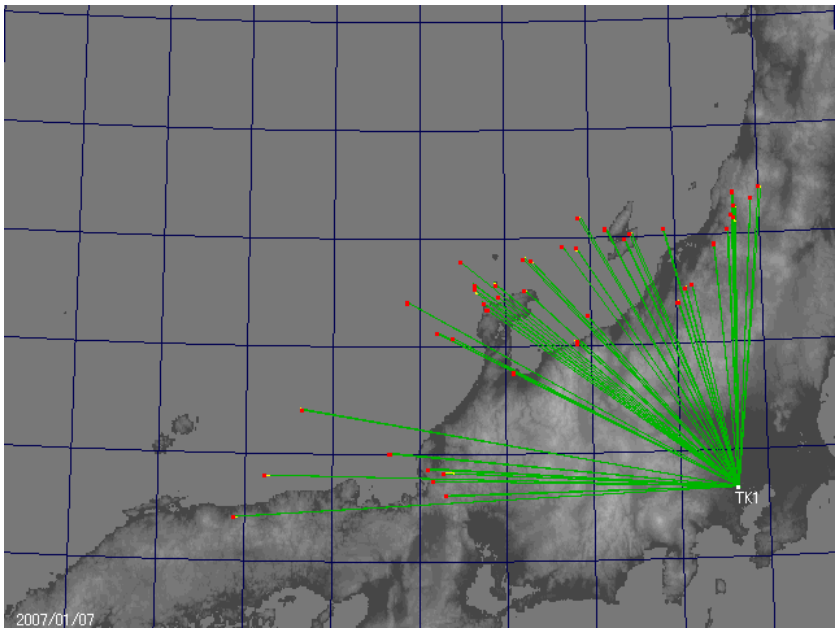
On Height Setting dialog box, change H1 or H2 to move the location on the map. Red point is corresponding to H1.
As the sample below, H2 is so lower that it calculates H2 is closer than H1.



As the sample below, 2 points corresponding to H1 and H2 is the same position. If H1 is assumed to 80Km, it turns out that H2 is 65Km.
If the location is known by triangular surveying, you can know the height of sprits precisely by setting H1 and H2.




Only 2 points are recorded for a object.
If you want to measure many points for a clip, click add obj button to add the object, then measure Az and Alt by click1 and click2 for each object.
If you want to display locations for many TLEs, set the object class in e-class to L_sprite on Class sheet, set disp for L_sprite to ON in Plot sheet.
For example, the figure shows sprites chart on Jan. 6th, 2007.




Assumed height is necessary to measure by multi station observation.
The column sprite is turned out that the upper height is about 80Km from many observations. The elves is assumed its center height to 90Km.

# 6 Appendix

## 6.1 Data format

UFOAnalyzerV2 inputs from or outputs to CSV, XML format.

- 1 byte alpha numeric character must be used. Other characters are not guaranteed.
- Type is d for integer, f for floating point, axx for strings up to xx bytes.
- Add string to leading "_" in CSV. (except Smap.csv)
- All angle is in degree with floating point. (It is not minute, second)
- azimuth is measured from the north toward the east. (0 for north, 90 for east, 180 for south, 270 for west)

[Directory information]

| UA2_DIR.csv | | |
|---|---|---|
| name | type | comment |
| Version | d | 101 (fixed) |
| use | d | 1: valid for "read dir", 0: invalid for "read dir" |
| Dir | a1024 | input clip directory (full path name) |
| profile | a1024 | profile file name |

[External class information]

| UA2_EClass.csv | | |
|---|---|---|
| name | type | comment |
| Version | d | 101(fixed) |
| e-class | a10 | exceptional class name, must begin with "_" |

[Radiant catalog]]

| UA2_Stram.csv | | | |
|---|---|---|---|
| name | type | unit | comment |
| Version | d | - | 301(fixed) |
| SID | d | - | should be 0 (currently ignored) |
| use | d | - | 1:valid for classification, 0: not valid for classification |
| stream | a10 | - | short code of stream. must begin with "w_" for local codes |
| name | a64 | - | official name of meteor stream |
| Sol1 | f | deg | start solar longitude |
| Sol2 | f | deg | end solar longitude |
| solp | f | deg | peak solar longitude |
| Rap | f | deg | radiant ra at solp |
| decp | f | deg | radiant dec at solp |
| Dra | f | deg/day | radiant ra drift at solp |
| ddec | f | deg/day | radiant dec drift at solp |
| Vg | f | km/sec | typical geocentric velocity  (Vg = sqrt(Vi^2+123.2) ) |
| type | d | - | should be 1 (c |
| R | f | deg | half diameter of radiant circle |
| Dv | f | km/s | should be 0.0 (currently ignored) |
| Dd | f | - | should be 0.1 (currently ignored) |
| Typical OID | d | - | should be 0 (currently ignored) |

| | | | |
|---|---|---|---|
| memo | a64 | - | comment |

[Star catalog]

| Smap2000S.csv | | | |
|---|---|---|---|
| name | type | unit | comment |
| Ra | f | deg | ra |
| dec | f | deg | dec |
| Vmag | f | - | visual magnitude |
| B-V | f | - | blue magnitude  minus visual magnitude(Sirius 0.009, Betelgeuse 1.736) |

[Profile information]

| ufoanalyzer_record (profile parameters in p_*.XML, *A.XML) | | | |
|---|---|---|---|
| name | type | unit | comment |
| version | d | - | 200(fixed) |
| clip_name | a64 | - | name of clip ("Myyyymmdd_hhmmss_location_system") |
| O | d | - | object count |
| Y | d | - | year (local time) |
| mo | d | - | month 1..12 (1=Jan,12=Dec,localtime) |
| D | d | day | day 1..31 (local time) |
| H | d | hour | hour 0..23 (local time) |
| M | d | min | minute 0..59 (local time) |
| S | f | sec | second 0.0..59.999 (local time) |
| Tz | d | sec | time zone (+: east, -:west, +9h=32400) |
| Lid | a16 | - | location ID |
| Sid | a2 | - | system ID |
| Cx | d | pixel | size of image width |
| Cy | d | pixel | size of image height |
| fps | f | frame/sec | frame rate, 29.97 for NTSC, 25.0 for PAL |
| interlaced | d | - | 1:interaced, 0: progressive |
| frames | d | frame | frame count of the movie |
| head | d | frame | number of time shifted frames |
| tail | d | frame | number of added frames |
| dlev | d | - | detection level of UFOCapture |
| dsize | d | pixel | detection size of UFOCapture |
| sipos | d | pixel | vertical position of super imposed text |
| sisize | d | pixel | height of super imposed text |
| trig | d | - | trigger type of UFOCapture |
| observer | A64 | - | observer name |
| cam | A64 | - | camera name |
| lens | A64 | - | lens name |
| cap | A64 | - | capture program name |
| u2 | d | - | capture program version |
| Ua | d | - | analyzer program version |
| comment | A64 | - | comment |
| Az | f | deg | azimuth of the center of FOV ( 0:N, 90:E,180:S,270:W) |

| | | | |
|---|---|---|---|
| Ev | f | deg | elevation of the center of FOV (0:ground, 90:zenith) |
| Rot | f | deg | rotation angle of FOV around center |
| Vx | f | deg | horizontal FOV size |
| Yx | f | - | pixel aspect ratio ( Y/X, 1.0=square, 1.25=IEEE1394 NTSC) |
| Dx | f | pixel | optical center offset from center of the screen |
| Dy | f | pixel | optical center offset from center of the screen |
| k4 | f | - | distortion correction parameter 4th order |
| k3 | f | - | distortion correction parameter 3rd order |
| k2 | f | - | distortion correction parameter 2nd order |
| Atc | f | - | atmosphere effect correction parameter |
| BVF | f | - | blue/visual sensitivity factor |
| maxLev | f | - | maximum brightness of the system |
| maxMag | f | - | magnitude that corresponds to maxLev |
| minLev | f | - | brightness that corresponds to minMag |
| minMag | f | - | dimmest magnitude of valid fixed star in the image |
| Dl | d | - | detection level used in analysis |
| Leap | d | - | leap parameter used in analysis |
| Pixs | d | pixel | number of total detected pixels |
| rstar | d | - | number of reference star used |
| ddega | f | deg | average error degree of position measurement |
| ddegm | f | deg | maximum error degree of position measurement |
| Errm | f | - | maximum magnitude measurement error |
| Lmrgn | d | pixel | size of link inhibit area of left |
| Rmrgn | d | pixel | size of link inhibit area of right |
| Dmrgn | d | pixel | size of link inhibit area of bottom |
| Umrgn | d | pixel | size of link inhibit area of top |
| Itlc | d | - | interlaced video flag |
| bbf | d | - | bottom field first flag (IEEE1394 interlaced video) |
| tme | f | sec | time accuracy |

[Object information]

| ua2_object (*A.XML) | | | |
|---|---|---|---|
| name | type | unit | comment |
| Fs | d | - | frame or field of obj start |
| Fe | d | - | frame of field of obj end |
| FN | d | frame,field | number of frame or field |
| Sec | f | sec | duration |
| Av | f | deg/sec | angular velocity at ram,dcm |
| Pix | d | - | total count of detected pixels |
| bmax | d | - | maximum brightness |
| BN | d | pixel | maximum count of saturated pixels |
| Lmax | f | - | peak light amount |
| Mag | f | - | peak magnitude |
| cdeg | f | deg | average linearity error |
| cdegmax | f | deg | maximum linearity error |
| Io | d | - | +1: start point is inside of FOV, +2: end point is inside of FOV |

| | | | |
|---|---|---|---|
| RaP | f | deg | ra of averaged path pole |
| DcP | f | deg | dec of averaged path pole |
| av1 | f | deg/sec | angular velocity used for grouping |
| x1 | f | pixel | start point x |
| y1 | f | pixel | start point y |
| x2 | f | pixel | end point x |
| y2 | f | pixel | end point y |
| az1 | f | deg | az of start point |
| ev1 | f | deg | ev of start point |
| az2 | f | deg | az of end point |
| ev2 | f | deg | ev of end point |
| Azm | f | deg | az of velocity measurement point |
| Evm | f | deg | ev of velocity measurement point |
| ra1 | f | deg | ra of start point |
| dc1 | f | deg | dec of start point |
| ra2 | f | deg | ra of end point |
| dc2 | f | deg | dec of end point |
| Ram | f | deg | ra of velocity measurement point |
| Dcm | f | deg | dec velocity measurement point |
| class | A16 | - | class name |
| M | d | - | 1: class manually assigned, 0: class auto assigned |
| Dr | f | deg | distance from assumed radiant to great circle of path |
| Dv | f | % | (Vo – Voc)/Voc , Voc = sqrt(Vg^2 + 123.2) , Vg is catalog value. |
| Vo | f | km/s | calculated Vo |
| Lng1 | f | deg | longitude of estimated ground start position |
| Lat1 | f | deg | latitude of estimated ground start position |
| h1 | f | km | height of start position |
| Dist1 | f | km | distance from observation point to the start point |
| Gd1 | f | km | ground distance from observation point to the start point |
| AzL1 | f | deg | az of radiant at lng1,lat1,h1 |
| EvL1 | f | deg | Ev of radiant at lng1,lat1,h1 |
| Lng2 | f | deg | longitude of estimated ground end position |
| Lat2 | f | def | latitude of estimated ground end position |
| h2 | f | km | height of end position |
| Dist2 | f | km | distance from observation point to the end point |
| Gd2 | f | km | ground distance from observation point to the end point |
| Len | f | km | path length |
| GV | f | km/sec | len/sec |
| Rao | f | deg | ra of estimated radiant by Vo-matching method |
| Dco | f | deg | dec of estimated radiant by Vo-matching method |
| Voo | f | km/s | Vo of estimated radiant by Vo-matching method |
| Rat | f | deg | ra of zenith attraction modified radiant of rao |
| Dct | f | deg | dec of zenith attraction modified radiant of dco |
| Tse | f | sec | leap time between  point s and e |
| Memo | A64 | - | comment |

[Trail information]

| ua2_objpath (*A.XML) | | | |
|---|---|---|---|
| Name | type | unit | comment |
| Fno | d | - | frame or field number |
| B | d | - | maximum brightness of one pixel |
| Bm | f | - | count of saturated pixels |
| Lsum | f | - | light amount |
| Mag | f | - | magnitude |
| Az | f | deg | az |
| Ev | f | deg | ev |
| Ra | f | deg | ra |
| Dec | f | dev | dec |

### 6.2 Technical information

[Star catalog]
Smap2000S.csv is used for referenced star. It contains almost 300,000 stars brighter than 10$^{th}$ mag. It is adapted from the following.
SKY2000 Master Catalog, Version 4 V/109
Myers J.R., Sande C.B., Miller A.C., Warren Jr. W.H., Tracewell D.A.
<Goddard Space Flight Center, Flight Dynamics Division (2002)>

[Radiant catalog]]
UA2_Stream.csv under executable directory is used for radiant catalog.
There are following catalog under Stream subdirectory. UA2_Stream.csv under executable directory and Stream directory are the same at installation time. You may modify UA2_Stream.csv

- (1)UA2_Streams.csv = (3)+(4)+(6)+(7)+(8)
- (2)UA2_Streams2.csv = (3)+(5)+(7)+(8)
- (3)ULE_IMO_WL2007.csv = IMO working list 2007 (Modified by SonotaCo)
- (4)ULE_IMO_ANT.csv = IMO anti-helion group for all months
- (5)LUE_IMO_SAll.csv = IMC reported possible streams (by Sirko Molau)
- (6)ULE_IMO_SSel.csv = (5) - duplicated streams against (3),(4)
- (7)ULE_U_NEW.csv = Added by SonotaCo network
- (8)ULE_X_ADD.csv = Not duplicated historical streams

(3)(4) is modified from http://www.imo.net/calendar/2007. Vi is converted to Vg, period, velocity, radiant point are replaced by SonotaCo Network's observation data.
(5)(6) is modified from http://www.metrec.org/imc06.pdf as well as (3)(4).
(7) is created from SonotaCo Network's observation data.
(8) is known streams except identification with (3)～(7).

In UFOAnalyzerV2, the radiant point is calculated on assumption that it is moving on great circle through the radiant point on maximum day. Moving distance of the radiant point in radiant catalog is used for the moving vector for each day on maximum day.

[Map data]
Map data GMxXXXxXX_XX.DAT are modified from SRT30, which is created from space shuttle's data. They are used in UFOOrbit.

- You can change the map data, which applies all over the world except South Pole region.

- There may be contained uncertain area between the sea and the land, where is lower than sea level.
- Let me know if you want another maps.

((Following parts have not been translated yet. Please refer Japanese manual ))

### 6.3 Abbreviations

| Abbreviation | Definition |
|---|---|
| Alt | Altitude |
| Az | Azimuth |
| Dec | Declination |
| RA | Right ascension |

## 7. Acknowledgment

((This part has not been translated yet.  Please refer Japanese manual))

Jan. 2007　SonotaCo

**[References]**

(1)SonotaCo Network Forum
http://sonotaco.jp/forum/
(2)UFOCapture publishing site
http://sonotaco.com/
(3)Author's observation site
http://sonotaco.sub.jp/
(4) zenithal attraction
Ichiro Hasegawa, "Determination of Orbits", KOSEISHA KOSEIKAKU CO.,LTD
ISBN4-7699-0325-1 C3044
(5)multi-station observation data
MSS-WG:  http://www004.upp.so-net.ne.jp/msswg/
(6)radiant point list
International Meteor Organization  http://www.imo.net/
http://www.metrec.org/imc06.pdf
http://www.nms.gr.jp/
(7)star catalog
SKY2000 Star Catalog  http://tdc-www.harvard.edu/catalogs/sky2k.html