Tips for JUPOS Measurers

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Introduction

More than ten years ago, Grischa Hahn developed a module of PC-JUPOS that allowed for measuring Jupiter images directly on the monitor. It was used in 1998 for the first time, and soon became an indispensable tool within JUPOS. I would never have allowed myself to dream how successful the project would be years later. 390.000 positional measures on images taken by more than 150 observers have been gathered since 1998.

The following lines are primarily addressed to measurers who belong to the JUPOS team. Of course, other people interested in the topic will also take away suggestions. The text is a mixture of organisational and technical issues that cross my mind, and are felt to be important. You will read the term "electronic images", that is, Jupiter images taken with webcam or traditional CCD technique. However, this document likewise relates to hi-res chemical photographs that are to be digitized and measured.

A first version of this text was written in April 2002. It has become out-of-date as a lot of experience has been gained in the past seven years; moreover PC-JUPOS was replaced by WinJUPOS. This document is a completely revised version. However, it may be interesting to read also the version of 2002. It is not available on the JUPOS website but has to be downloaded at:

http://jupos.org/etc/JuposThoughts2002_English.pdf
http://jupos.org/etc/JuposThoughts2002_Deutsch.pdf (in German)

Menu items, buttons, etc. in this text are denoted according to WinJUPOS 8.0, and several figures have been produced with that version. Screenshots that focus on Jupiter images, however, were already made with earlier versions 7.2 and 7.3 but not updated as differences to 8.0 are minor.

Jupiter images shown in the screenshots were taken by David Arditti, Stefan Buda, Fabio Carvalho, António Cidadâo, Christopher Go, Guilherme Grassmann, Toshihiko Ikemura, Mark Justice, Isao Miyazaki, Martin Mobberley, Donald Parker, Damian Peach, Jesús R. Sánchez, Maurice Valimberti, Anthony Wesley, and an unknown observer. South is always up.

Essential additions and corrections to the previous version of February 2007 are highlighted grey like this sentence.

Organisational issues

At present, JUPOS has four active measurers: Gianluigi Adamoli and Marco Vedovato (Italy), Michel Jacquesson (France), and me (Germany). A larger number would certainly be beneficial but encounters practical difficulties because each new measurer requires additional organisational efforts. JUPOS consists not only of measuring images but needs much communication between participating people! For example, writing e-mails (or this text) in English can be quite time consuming. I will hardly be able to manage more in the future, compared to the apparitions of 2005 to 2008.

One or two more people who are able to operate largely independently, i.e. who are familiar with concept and methods from the beginning could be a way out. This is also an aim of this document: to deliver a maximum of information to new measurers so that they get acquainted with the topic. People who want to participate as JUPOS measurers have to bring along experience in observing Jupiter's atmosphere, though, and should be familiar with the analysis of jovian observations.

I find it essential that every measurer, especially if he is new, deals with images of several observers. This allows for comparing own results more immediate and directly such that possible error sources can be identified more swiftly. Managing just one observer - mostly he will be identical to the measurer - runs the risk that observer-specific issues, particularly caused by effects of image processing will be detected too late, or not at all. The exception proves the rule!

To compare own results with those of other measurers is just as important. For this reason we have intensified the mutual data exchange in the past few years. Measurers send me their current MEA files about once a month during a Jupiter apparition, I import them into the master database, check for possible

mistakes, and return an archive containing all up-to-date files. A more frequent data synchronisation would be desirable but often fails due to lack of time.

In the first JUPOS years, both jov. longitude and latitude showed a larger scatter. It mostly originated from outline frames choosen too small. Later we started adjusting it also on known latitudes of special features. Data quality has clearly improved since then.

Software

Measurement of images and a good deal of analysis (selection, drift charts, drift computation) were transferred to WinJUPOS already in 2005 and 2006. Now, in early 2009, all essential functions of the DOS predecessor PC-JUPOS have been migrated to WinJUPOS, and many new features are available in the latter. Many thanks to Grischa who has been spending much of his leisure time to software development for years!

JUPOS specific Object and Region codes classify each feature according to appearance, object point, and jovigraphic latitude. (The Region code is automatically assigned when measuring electronic images.) They are explained both in the Project Documentation, and F1 help of WinJUPOS. Notice the special Object codes for, e.g., the GRS and long-lived STB White Ovals. Please apply code WOS-B**C** to Oval BA alias "Red Spot Junior".

Criteria for image selection

If a measurer analyses images of different observers, some of them will often be taken at about the same time. The question arises which images should be measured, and which ones omitted. There is no clear answer for every situation but a few basic rules apply.

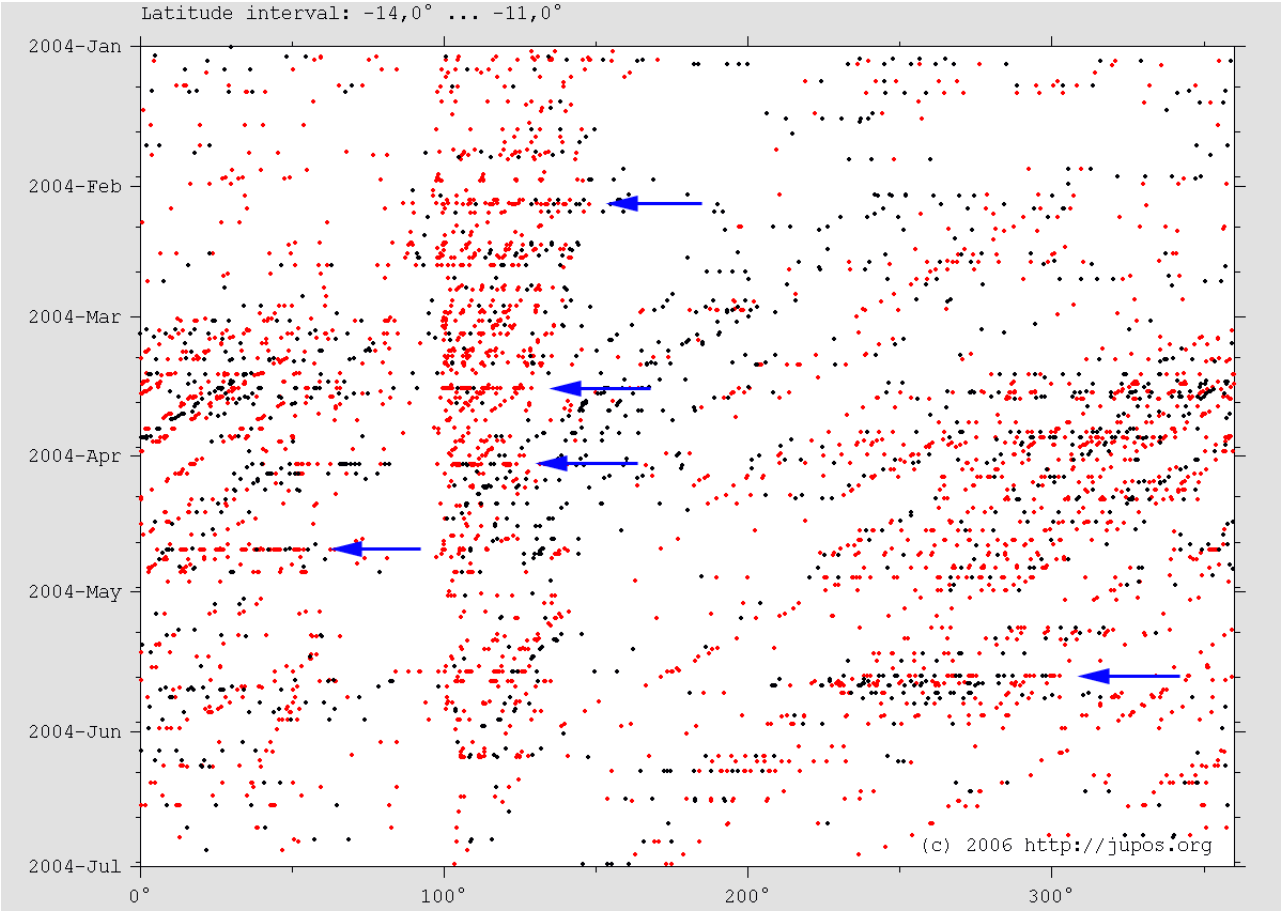
Time

Please measure only one image secured at a particular time. "Particular time" means a period of about one hour. Namely, if too many positional records of the same features exist in parallel, drift charts are overloaded at those times.

Bear in mind that other measures could also analyse images of the same time. Hence, double, triple etc. records of the same object at the same time are unavoidable. But their number can be minimized as each measurer tries to confine to **one** image per hour.

If images separated by 60 to 90 minutes were choosen, they will partly overlap since the planet rotates at 36 degrees per hour. Avoid multiple measures also in this case, please. You may want to create more than one record of special features like the GRS or Oval BA in order to get a more reliable positional average, however this should remain an exception.

The following drift chart of the SEB north part is an example. Red dots represent bright features, black dots are dark features. The blue arrows indicate excessive concentration of data points. (Not only the number of simultaneous measures was too high but much too fine detail was measured at these times, too. See "What to measure, what to omit?" below.)



Duration of exposure

JUPOS is a cartographic project. Images stacked over five minutes or with an erroneous time may look nice but are useless for JUPOS. All individual image frames have to be taken in a period spanning two or three minutes maximum. The UT communicated by the observers has to represent the median time of this period. Clocks must be precisely synchronised. Please stop measuring images that fail to satisfy these requirements also after request.

A guideline for observers can be found under "Important to know - Image requirements" on http://jupos.org .

Spectral range

The visual spectral range and **broad**band infrared are of primary interest for JUPOS. If you can choose, focus on visual colour, monochrome red, broadband infrared, and green (sorted by descending priority). In the blue range, Jupiter's atmosphere shows fewer features in general - except for the GRS.

Narrowband exposures outside the visual spectrum (e.g., in the methane band at 889 nm) and in the ultraviolet are presently out of scope as the planet's atmosphere exhibits a different pattern at those wavelengths. WinJUPOS measurements in these spectral ranges are likewise possible, of course, but will be suppressed when generating selection files and drift charts by default.

Please verify that all RGB channels of images composed from frames in different spectral ranges are mutually congruent, i.e. they must not show any significant mutual displacement. You are able to switch between the individual channels by pressing the F9 key – provided you are on tab *Adjust*. or *Pos.* of the measurement screen.

Quality

Though self-evident, a separate paragraph for the sake of completeness. If you have the choice between several images of the same time, measure the best one. If your vote is undecided, single out the observer who provides the most reliable UT's from your own experience.

JUPOS focuses on regular observers with good image quality and, last but not least, precise timings!

Adjust outline frame

The quality of every measured position rises and falls with an exact adjustment of Jupiter's outline frame. "Exact adjustment" means to choose the following parameters as optimal as possible:

1. transalation (location)
2. size (diameter)
3. tilt (rotation)

Regrettably, this is hardly a trivial matter as:

- except for the opposition time, Jupiter exhibits a slight but noticable phase.
- displayed and true limb seldom coincide.
- position and tilt of the planet's equator have to be estimated just like the true limb.

The basic steps for positioning the outline frame are explained in the F1 help of WinJUPOS. Here are a few additions.

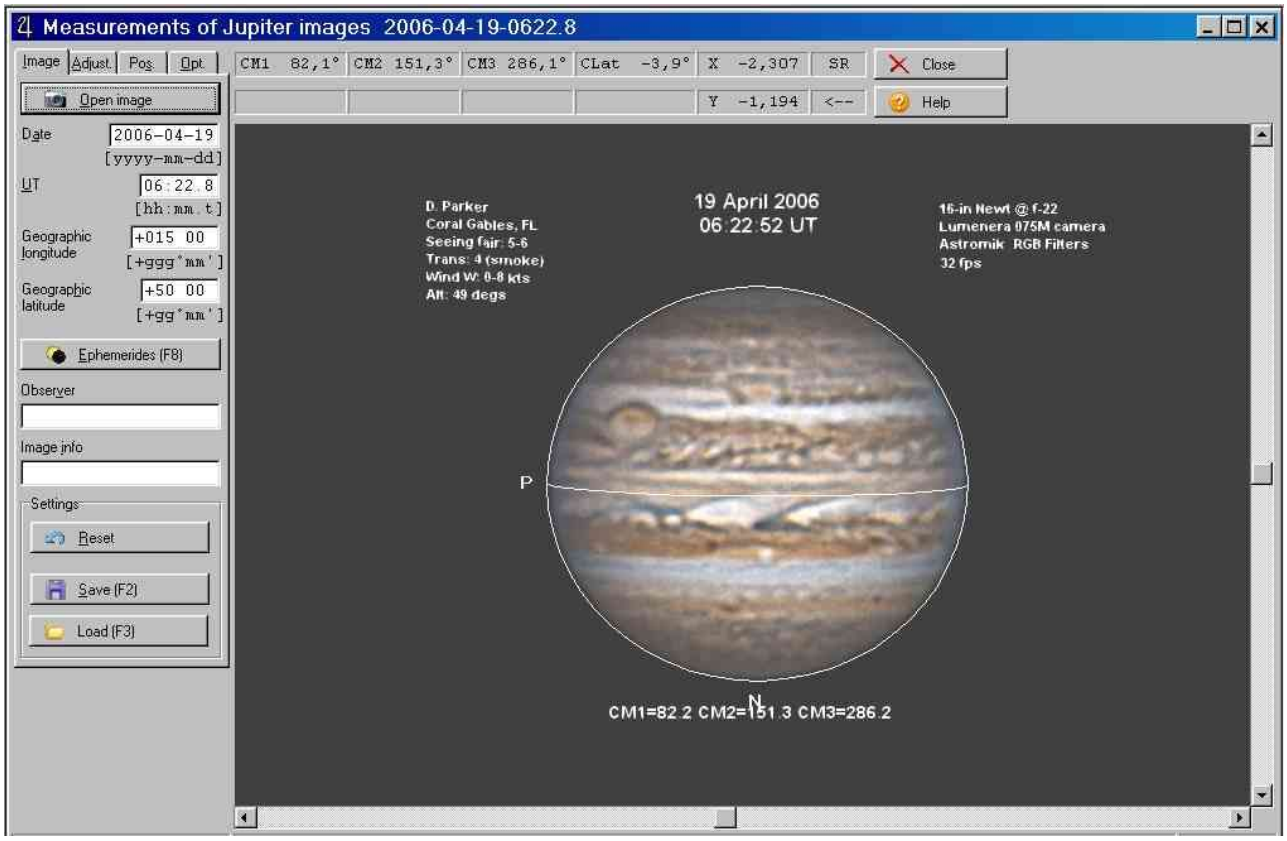
Automatic outline (F11)

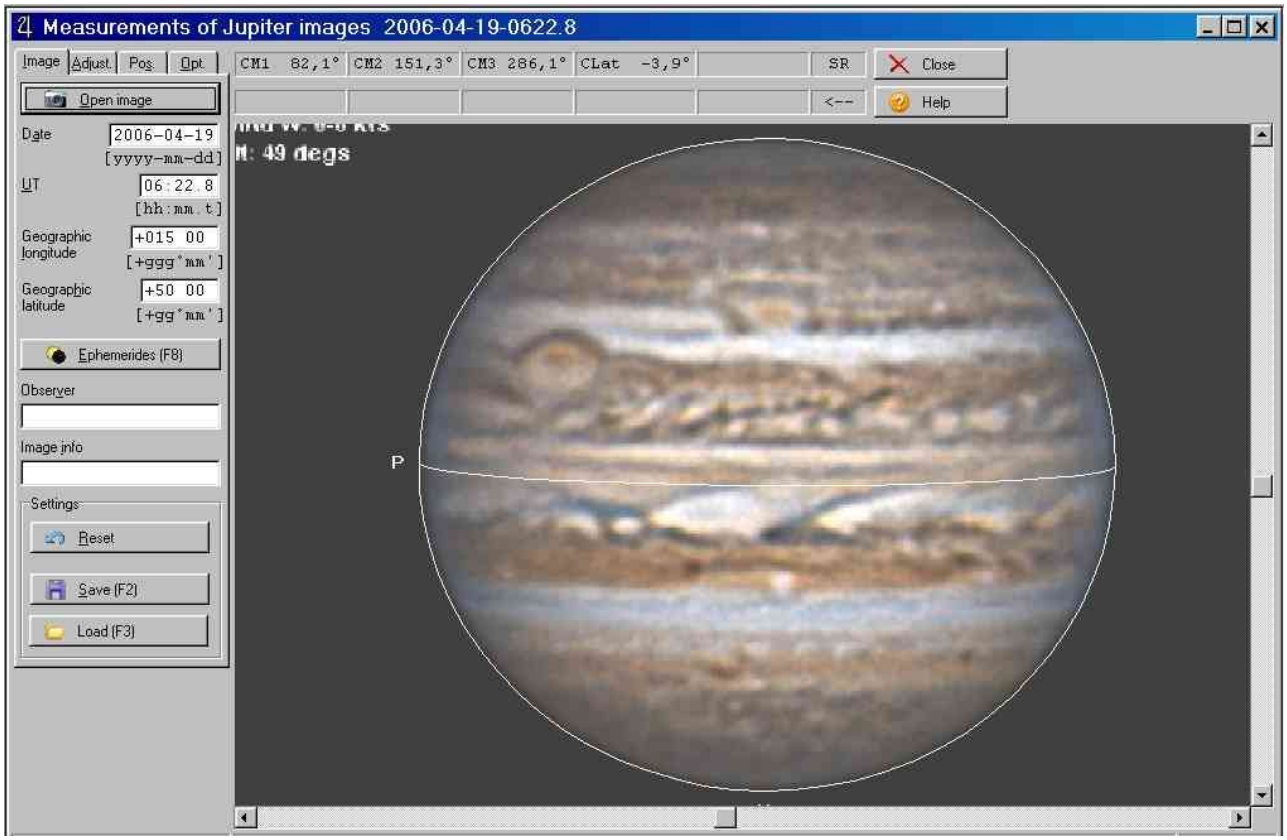
The automatic calculation of the outline frame implemented in WinJUPOS is useful to get a first approximation of its position. However it is not sufficient for precise adjustment! Manual fine tuning is almost always required.

Zoom factor

For high resolution images applies: The larger Jupiter on the WinJUPOS measurement screen is, the higher the potential measuring accuracy becomes. Zoom in as much as possible while Jupiter is completely displayed, without its outer portions getting invisible.

Top, worth to be improved; bottom, optimal!


Measurements of Jupiter images 2006-04-19-0622.8
Image
Adjust.
Pos.
Opt.
CM1 82,1°
CM2 151,3°
CM3 286,1°
CLat -3,9°
X -2,307
SR
Close
Y -1,194
<--
Help
Open image
Date
2006-04-19
[yyyy-mm-dd]
UT
06:22.8
[hh:mm.t]
Geographic longitude
+015 00
[+ggg°mm']
Geographic latitude
+50 00
[+gg°mm']
Ephemerides (F8)
Observer
Image info
Settings
Reset
Save (F2)
Load (F3)
D. Parker
Coral Gables, FL
Seeing fair: 5-6
Trans: 4 (smoke)
Wind W: 0-8 kts
Alt: 49 degs
19 April 2006
06:22:52 UT
16-in Newt @ f-22
Lumenera 075M camera
Astronomik RGB Filters
32 fps
P
N
CM1=82.2 CM2=151.3 CM3=286.2

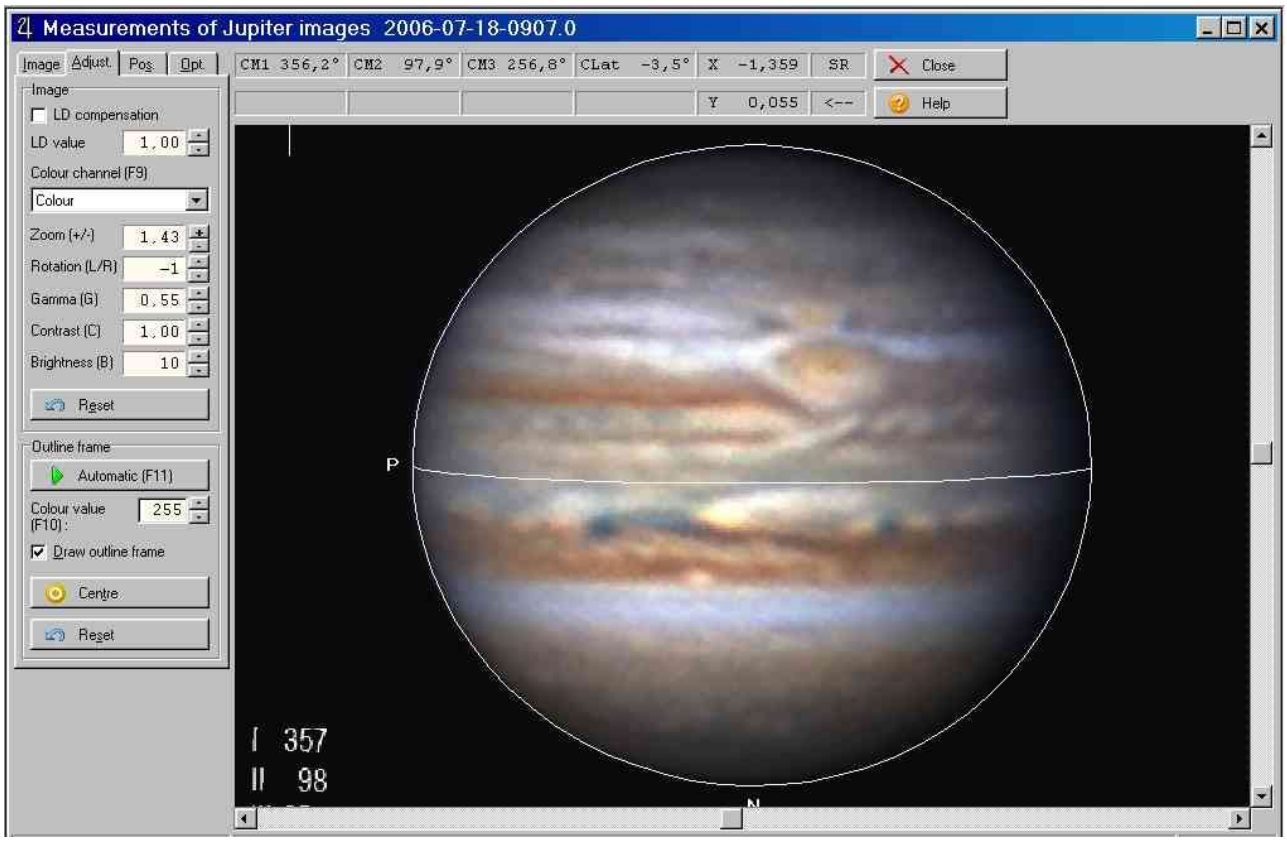

Measurements of Jupiter images 2006-04-19-0622.8
Image
Adjust.
Pos.
Opt.
CM1 82,1°
CM2 151,3°
CM3 286,1°
CLat -3,9°
SR
Close
<--
Help
Open image
Date
2006-04-19
[yyyy-mm-dd]
UT
06:22.8
[hh:mm.t]
Geographic longitude
+015 00
[+ggg°mm']
Geographic latitude
+50 00
[+gg°mm']
Ephemerides (F8)
Observer
Image info
Settings
Reset
Save (F2)
Load (F3)
P

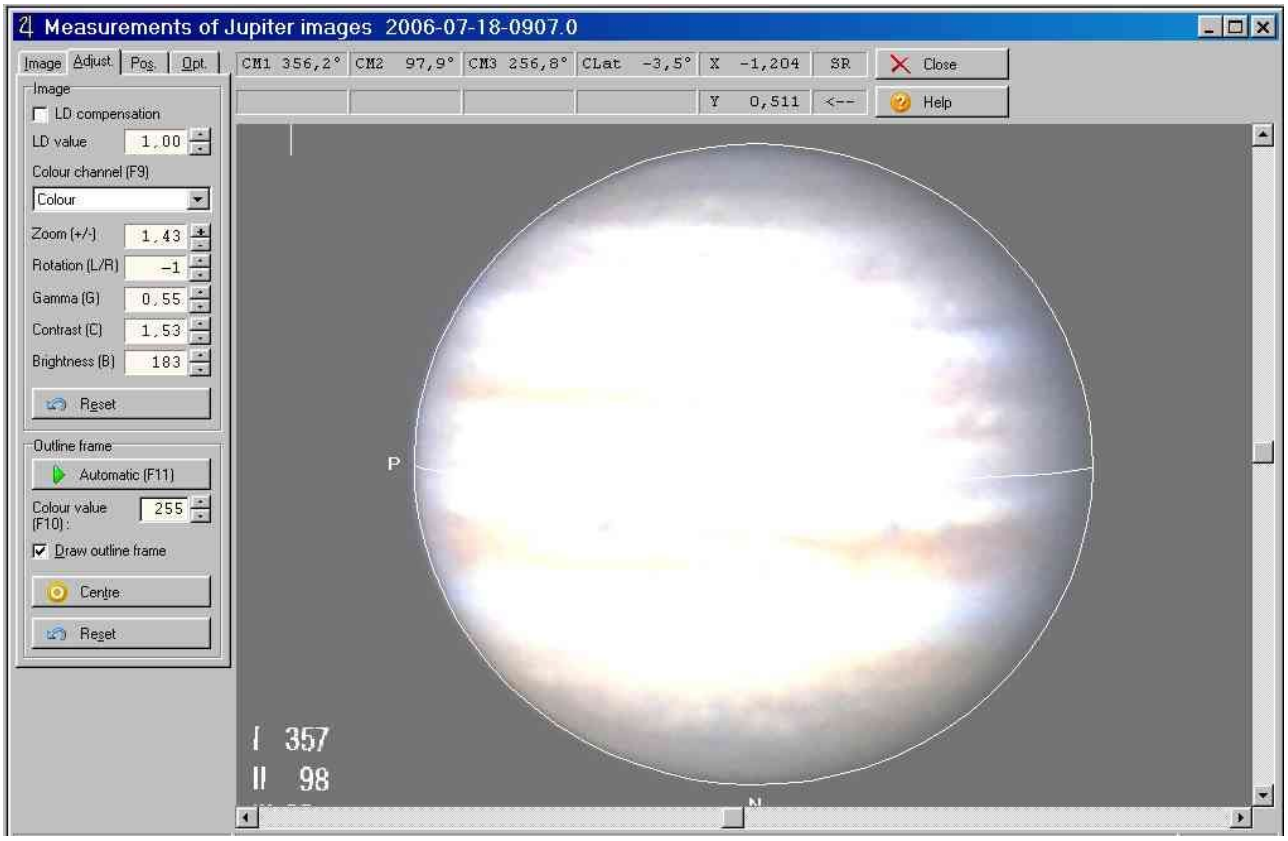
Phase

Always align the outline frame at the **fully illuminated** limb of Jupiter, **never** at the phase-sided one (terminator). The distance between WinJUPOS outline and visible limb must not vary over the 180° circumference, from pole to pole, of the fully illuminated semi-ellipse. The phase is situated on the p. (eastern) limb Jupiter's before opposition, on its f. (western) limb afterwards. The terminator can become completely invisible even on hi-res images at about three months before and after solar opposition. For this reason, the phase-sided part is entirely unusable to adjust the outline frame!

By the way, the outline frame of WinJUPOS always shows the phase-sided limb corrected by the mathematical phase.

The following example is an image of July 2006, two months after opposition, with a distinct phase on the f. limb (at right). The outline frame was aligned at the opposite, phaseless limb of Jupiter. Even exaggerated brightness and contrast do not reveal the terminator (see second screenshot).





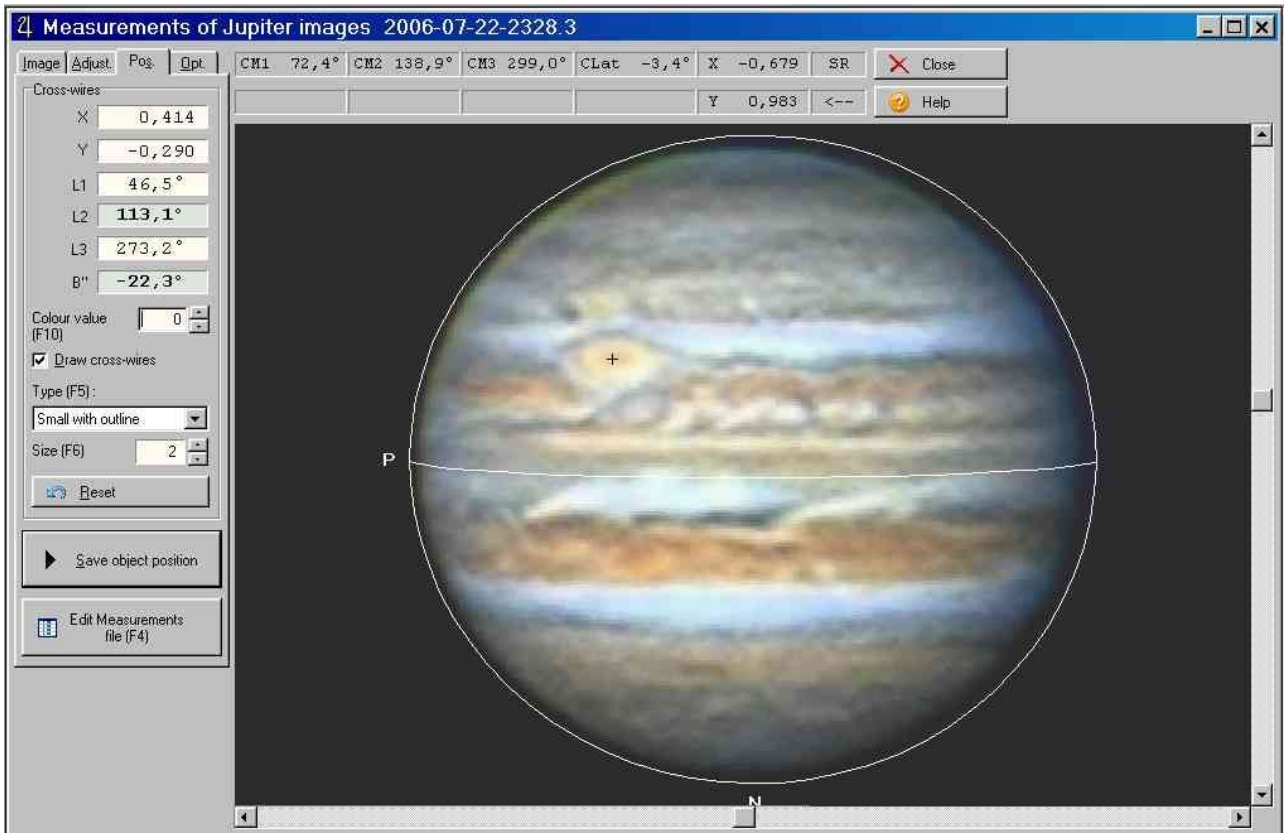
Limb darkening

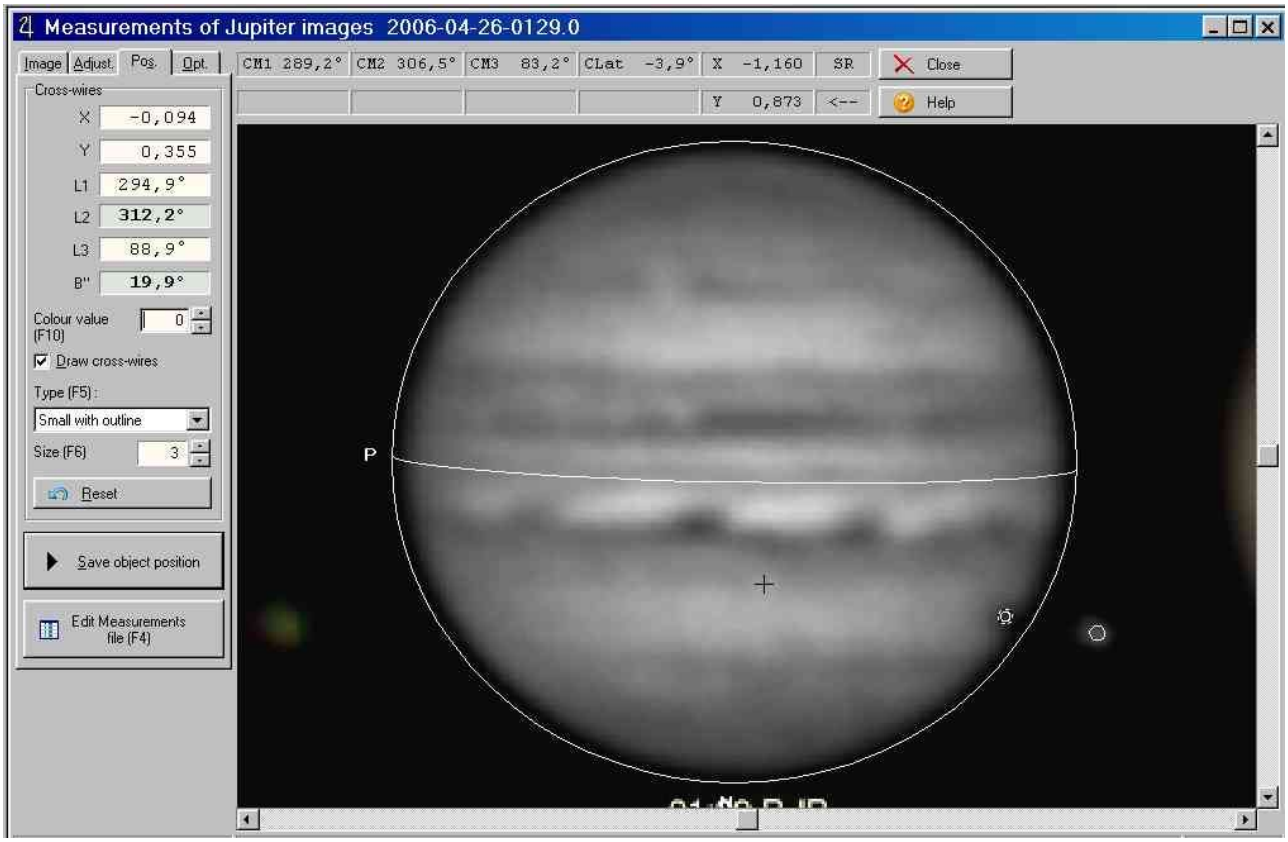
Not only the phase makes outer parts of Jupiter invisible, but also the natural limb darkening of the planet does. Heavy image processing enforces this effect - even on images of higher resolution. As a consequence, the displayed disc is mostly smaller than the true one as a narrow region along the limb has darkened to invisibility.

Jupiter discs that are larger than in reality, with the displayed limb scattered beyond the true one, are rather rare. This applies mostly to images taken under poor seeing conditions.

Aligning WinJUPOS' outline frame at the displayed Jupiter limb can be **completely unreliable** and result in erroneous latitudes (and longitudes). The limb is good for identifing the **centre** of the frame but not necessarily its diameter. Moons or moon shadows, and atmospheric reference features with well-known latitudes yield far better results. More about this below.

The next two examples are images with distinct limb darkening. The outline frame was adjusted as explained below, i.e. by means of known latitudes and a moon position. There are images with even stronger limb darkening!

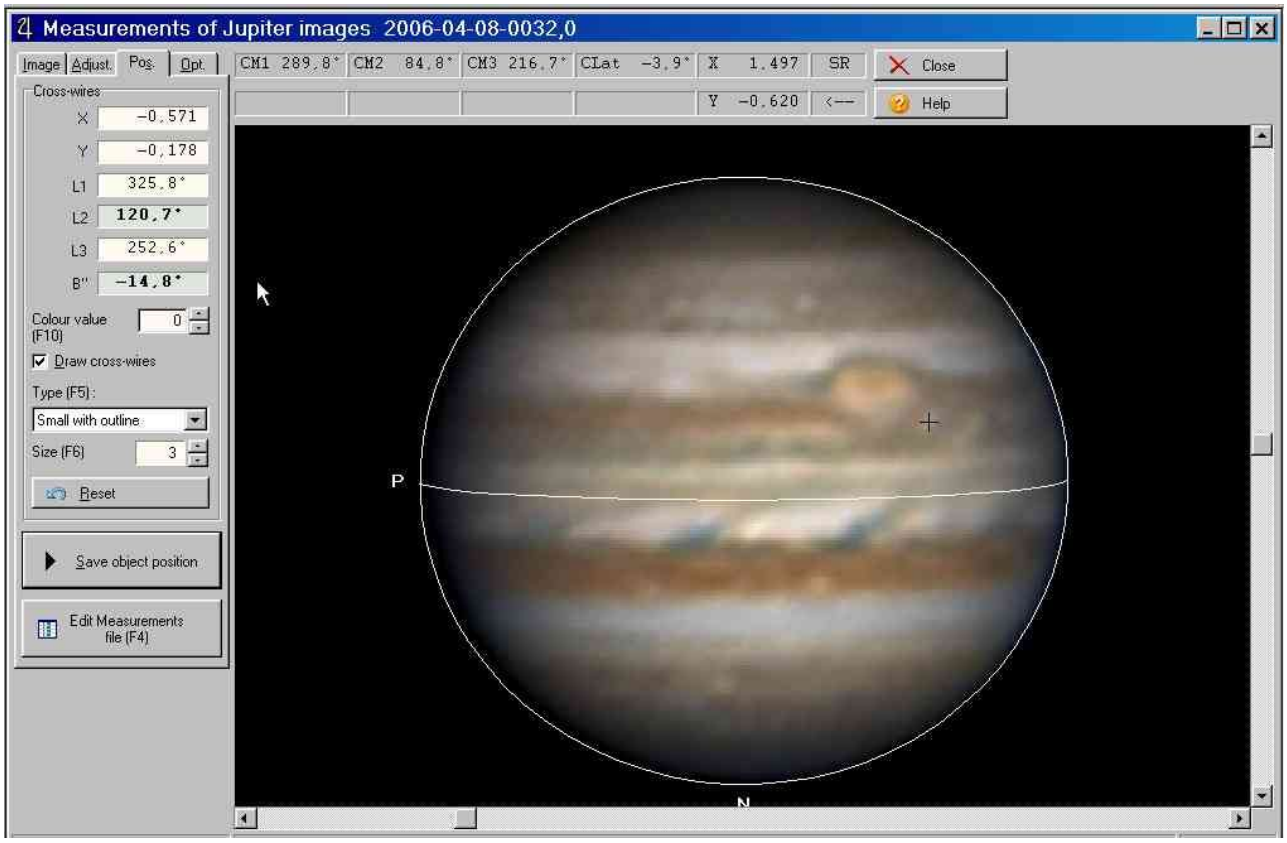

Measurements of Jupiter images 2006-07-22-2328.3
Image
Adjust
Pos.
Opt.
CM1 72,4°
CM2 138,9°
CM3 299,0°
CLat -3,4°
X -0,679
SR
Close
Y 0,983
<--
Help
Cross-wires
X 0,414
Y -0,290
L1 46,5°
L2 113,1°
L3 273,2°
B" -22,3°
Colour value (F10)
0
Draw cross-wires
Type (F5):
Small with outline
Size (F6)
2
Reset
Save object position
Edit Measurements file (F4)
P
N

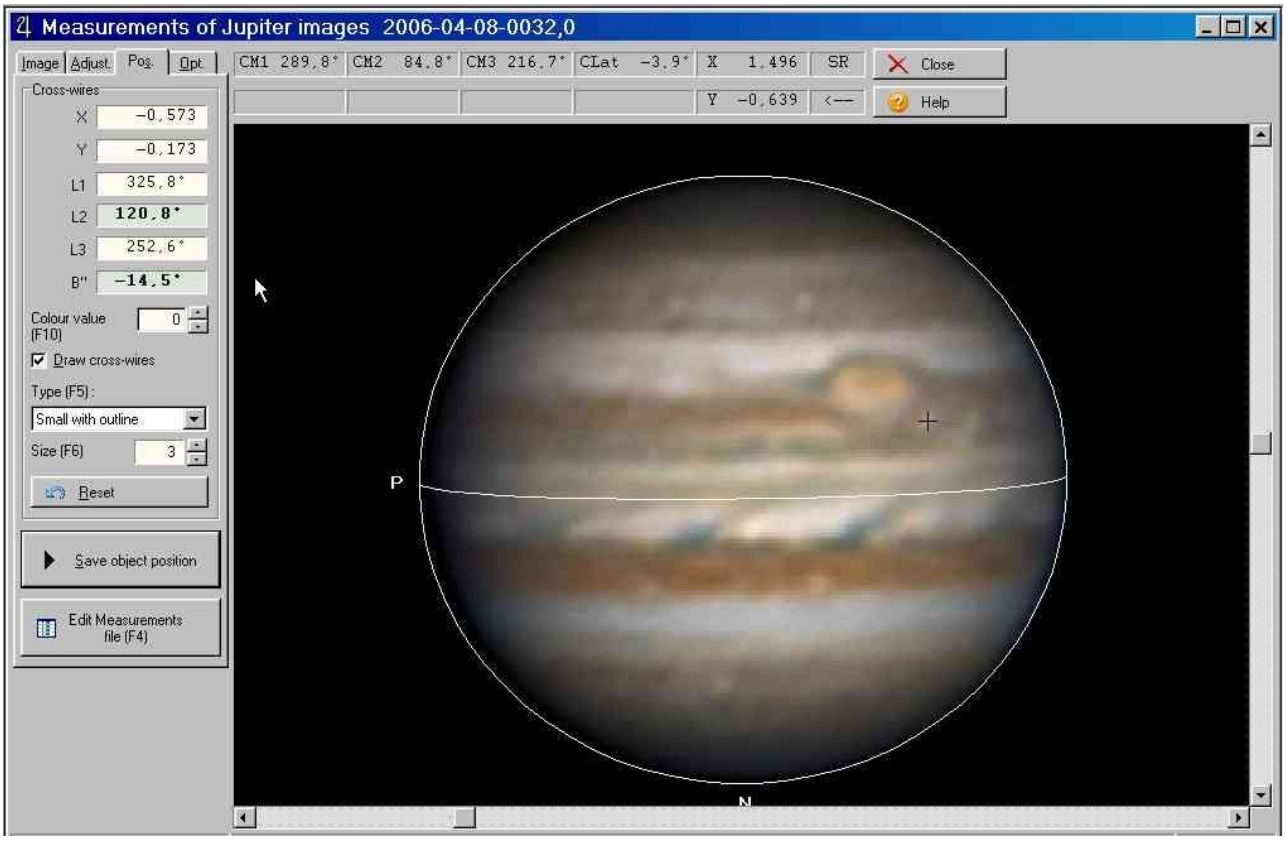

Measurements of Jupiter images 2006-04-26-0129.0
Image
Adjust
Pos.
Opt.
CM1 289,2°
CM2 306,5°
CM3 83,2°
CLat -3,9°
X -1,160
SR
Close
Y 0,873
<--
Help
Cross-wires
X -0,094
Y 0,355
L1 294,9°
L2 312,2°
L3 88,9°
B" 19,9°
Colour value (F10)
0
Draw cross-wires
Type (F5):
Small with outline
Size (F6)
3
Reset
Save object position
Edit Measurements file (F4)
P

Tilt of equator

The equator of the outline frame has to lie exactly parallel to Jupiter's belts and their edges. Sometimes is it not quite simple to find the right inclination. For example, the latitude of the SEB south edge varies with longitude (in the vicinity of the GRS it is often slightly dislocated to the south), and the STB can shift in latitude over a wide longitude range. Nevertheless, a sufficient number of other belts is almost always visible for orientation.

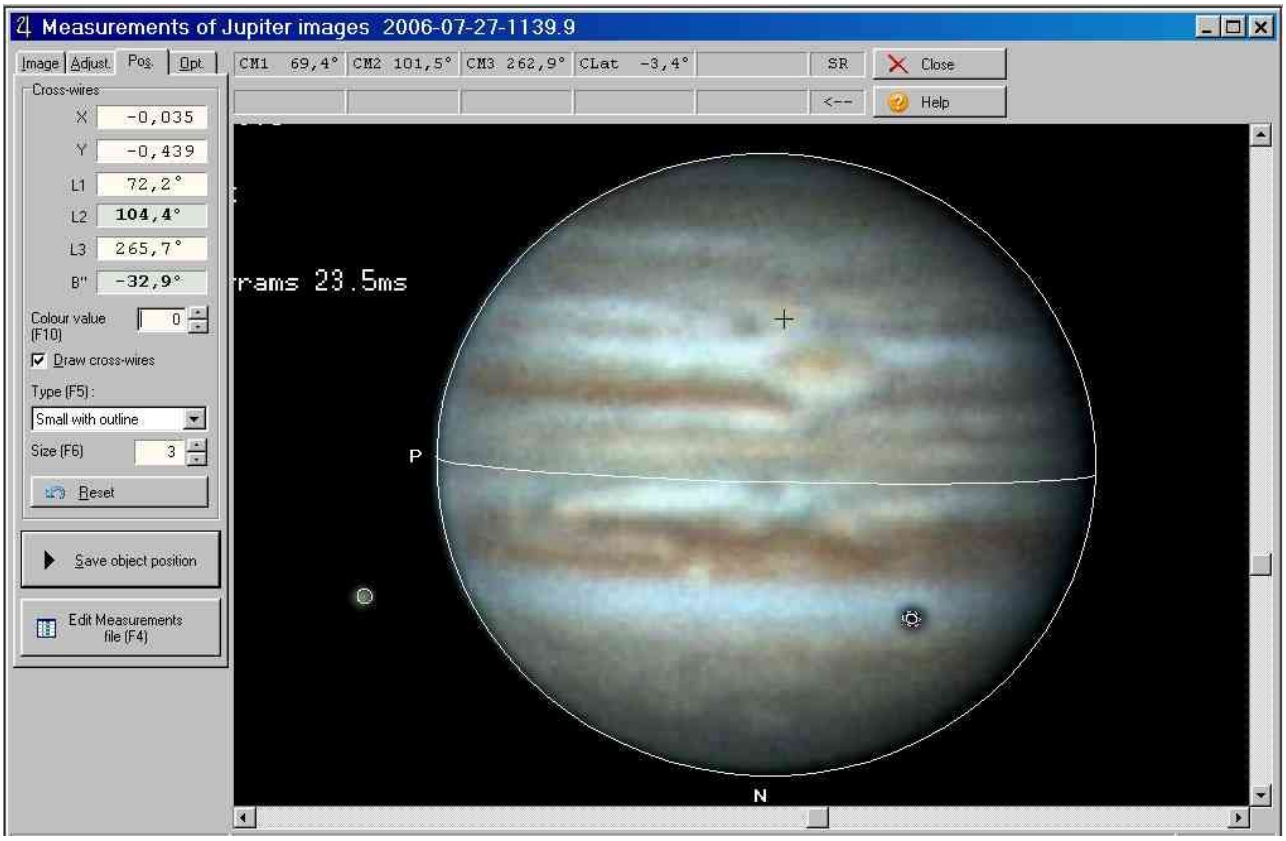
In the upper image the equator is rotated a bit too far clockwise, the lower image shows an improved inclination. Do you see the difference? Compare the latitude of the cross-wires, -14.8° vs -14.5°. They are at exactly the same position on both images, namely, a white SEB spot f. GRS.





Moons and their shadows

If a moon, or moon shadow is visible on an image, make use of it for adjusting the outline frame in any case. Especially useful are the inner moons Io und Europa because their positions are rapidly changing. Of course, Ganymede and Callisto are beneficial as well.



Reference latitudes

Most images do not show a moon (shadow) on or near Jupiter's disc. If there is any reason to assume that the displayed limb is unreliable, you have to align the outline frame at known latitudes of longer-lived features, for example:

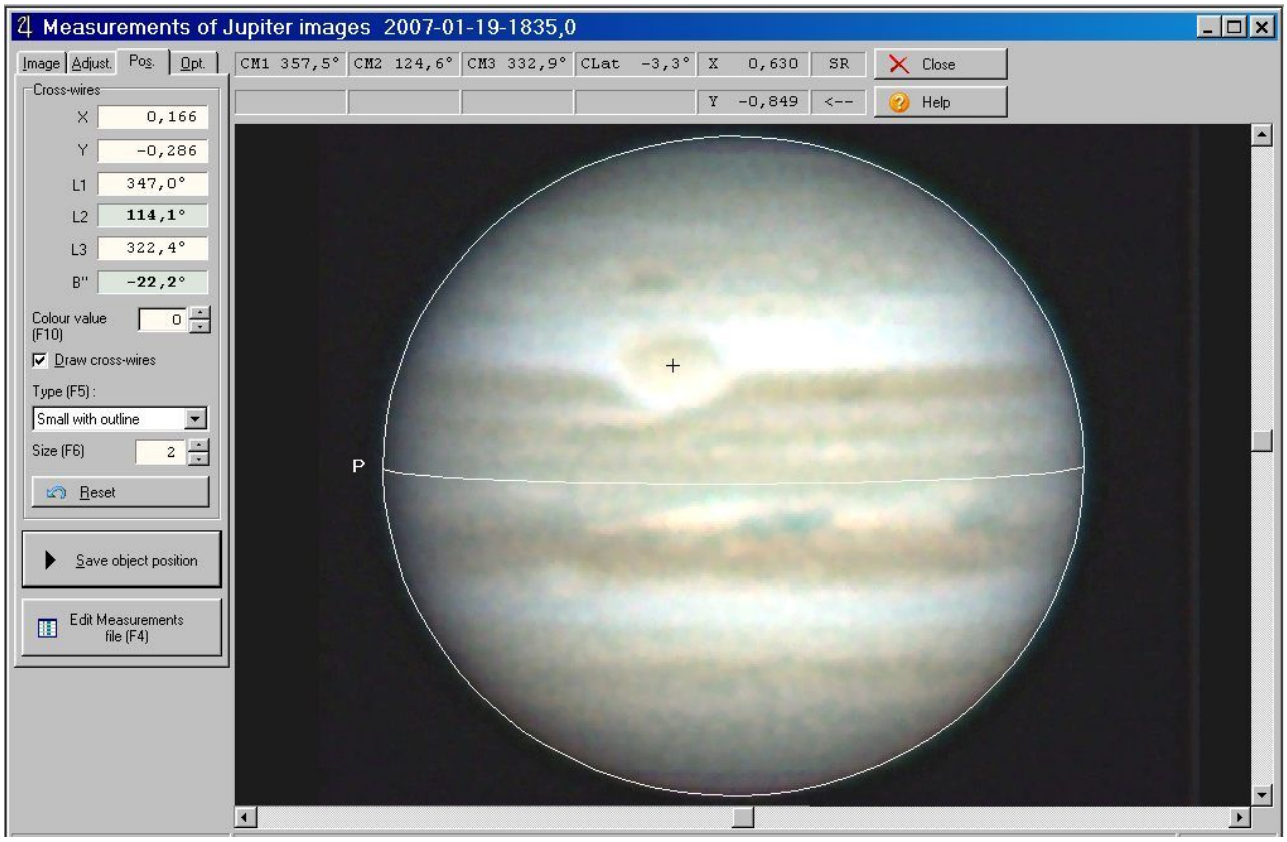
- the bright anticyclonic SSTC ovals at about -40.5° (not to be confused with bright cyclonic spots that occasionally appear some two degrees further equatorwards)
- the centre of the GRS at about -22.3°
- the NTB south edge (NTBs jet) at about +23.7°

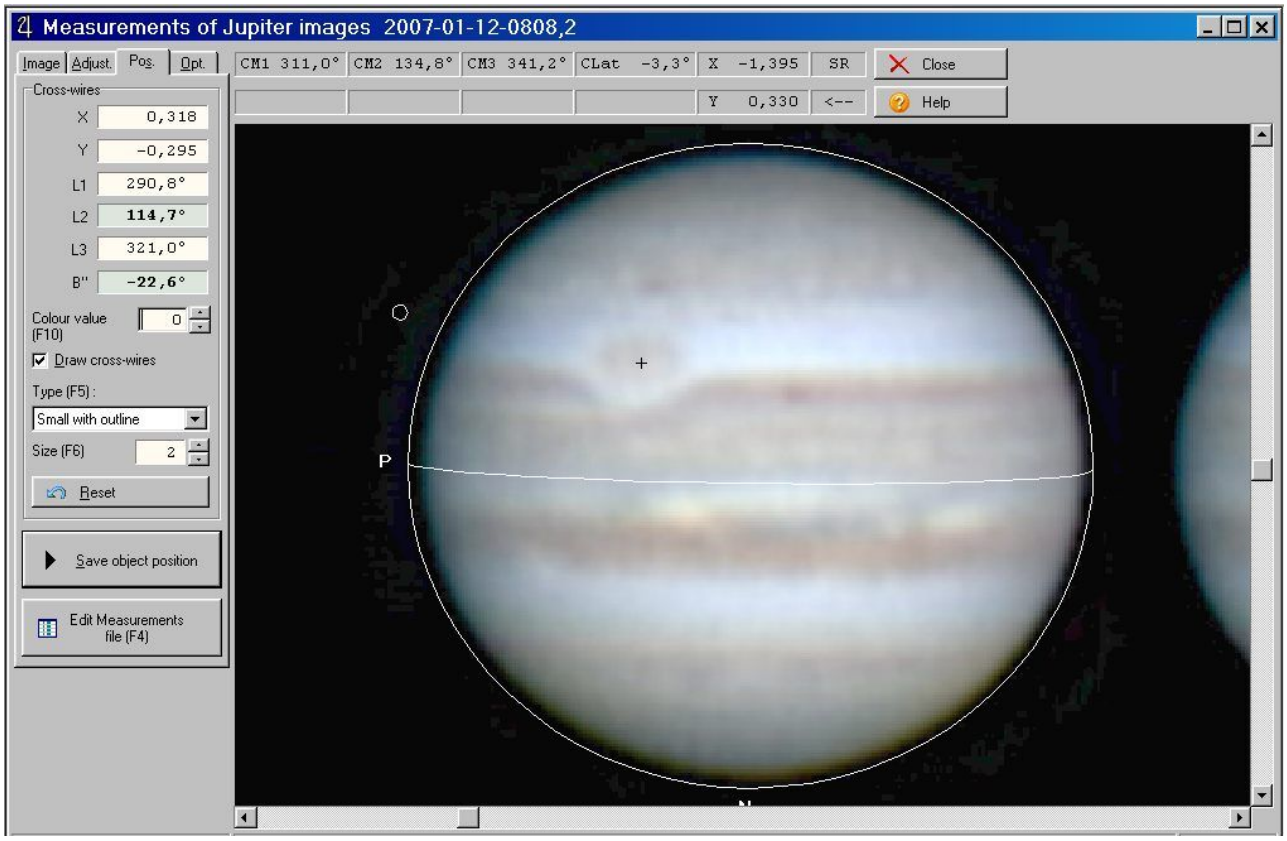
but also on any other feature which has been measured sufficiently often so that a reliable estimate of its true latitude can be determined by averaging.

Of course the above latitudes are only approximate. Suitable reference features and their latitudes have to be re-determined and verified regularly. On the one hand, latitudes of similar objects located within a jovian current can differ by some tenths of a degree (e.g., SSTC ovals). On the other hand, the latitude of a certain feature may vary over time. An example is Oval BA in 2006: While passing the GRS it was situated some 0.5° further south than usual.

Perhaps this method deviates a bit from the strictly scientific approach. However, the bottom line is that it delivers markedly improved results compared to when relying on the displayed limb of Jupiter only.

The following three screenshots are examples of early 2007. While the true limb is well visible on the first image, it is dimmed out on the two others, even at the fully illuminated side of the planet (at right). The cross-wires are on the centre of the GRS, latitude ca. -22.3°, respectively a bright SSTC oval at approx. -40.5°.




Measurements of Jupiter images 2007-01-12-0808,2
Image
Adjust.
Pos.
Opt.
CM1 311,0°
CM2 134,8°
CM3 341,2°
CLat -3,3°
X -1,395
SR
Close
Y 0,330
<--
Help
Cross-wires
X 0,318
Y -0,295
L1 290,8°
L2 114,7°
L3 321,0°
B'' -22,6°
Colour value (F10)
0
Draw cross-wires
Type (F5) :
Small with outline
Size (F6)
2
Reset
Save object position
Edit Measurements file (F4)
P

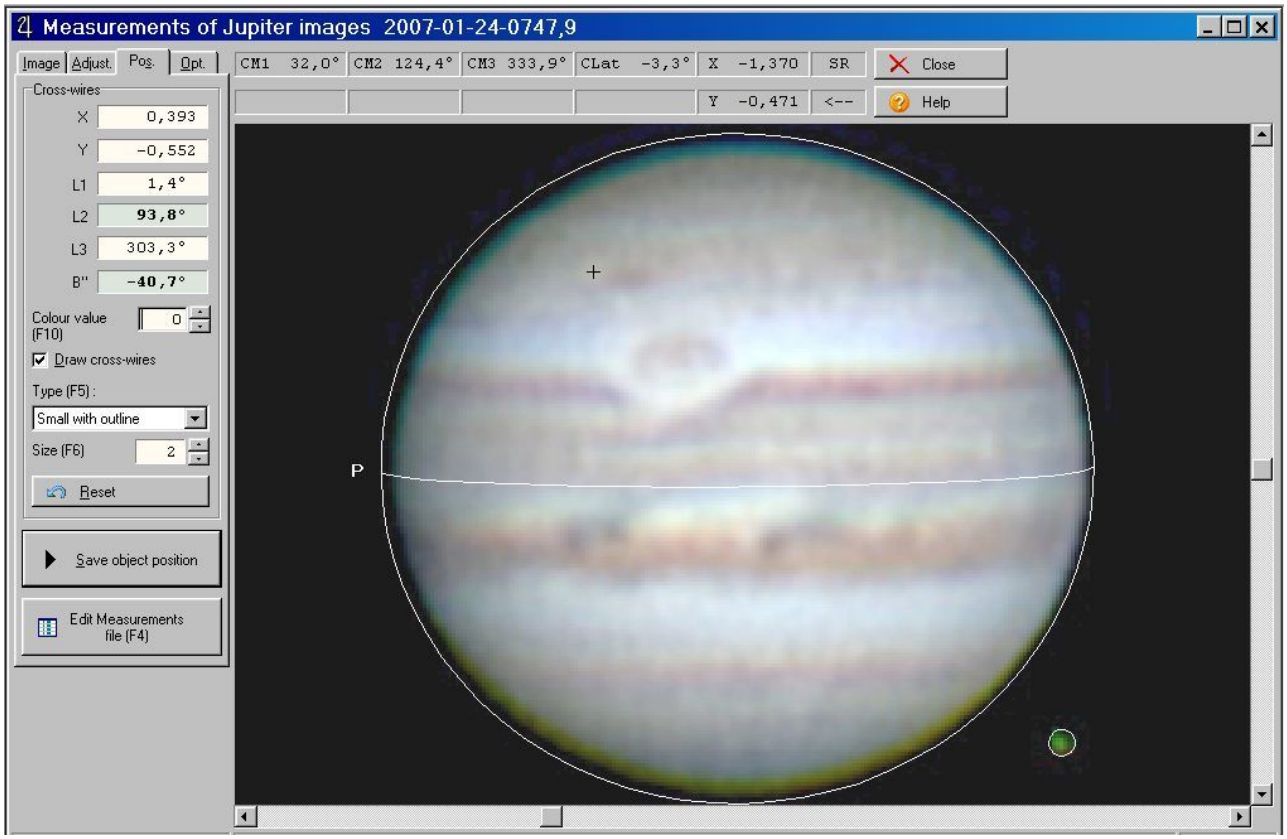
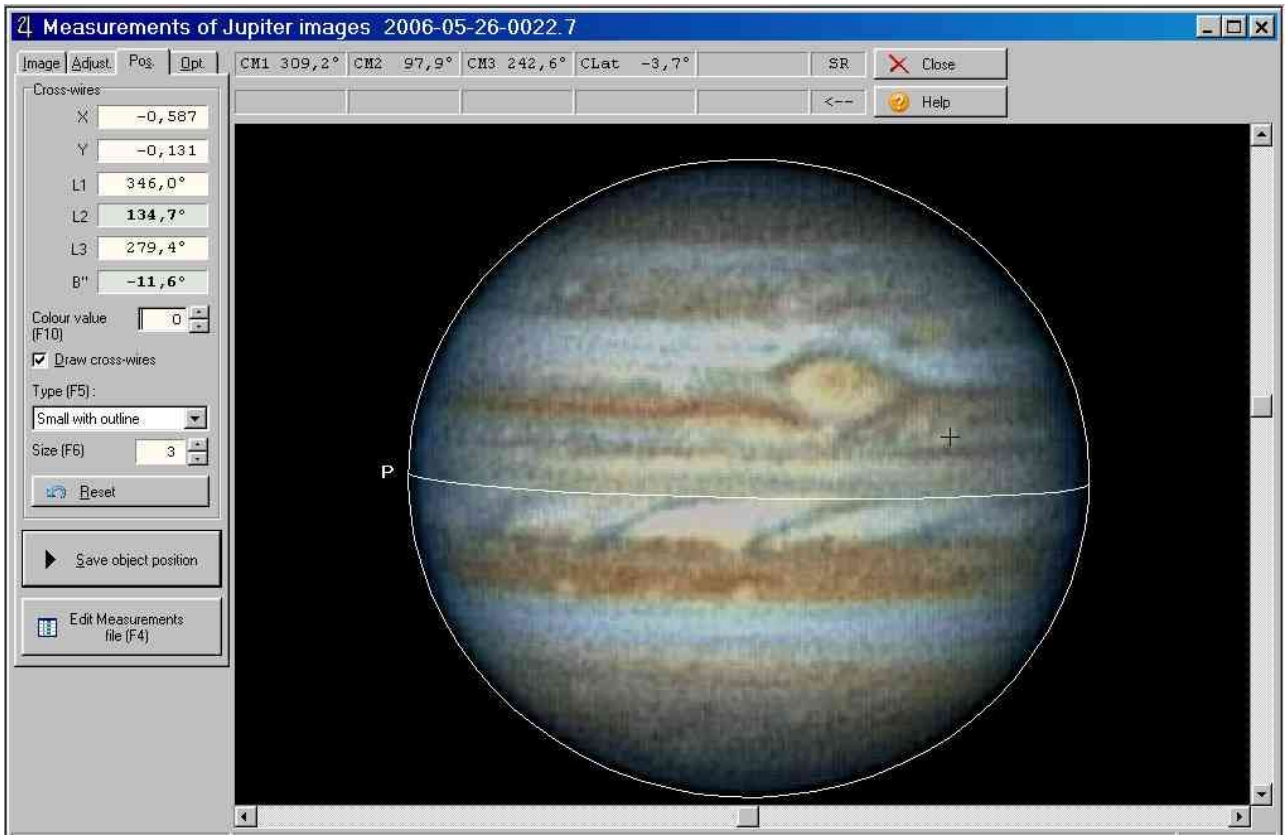

Measurements of Jupiter images 2007-01-24-0747,9
Image
Adjust.
Pos.
Opt.
CM1 32,0°
CM2 124,4°
CM3 333,9°
CLat -3,3°
X -1,370
SR
Close
Y -0,471
<--
Help
Cross-wires
X 0,393
Y -0,552
L1 1,4°
L2 93,8°
L3 303,3°
B'' -40,7°
Colour value (F10)
0
Draw cross-wires
Type (F5) :
Small with outline
Size (F6)
2
Reset
Save object position
Edit Measurements file (F4)
P

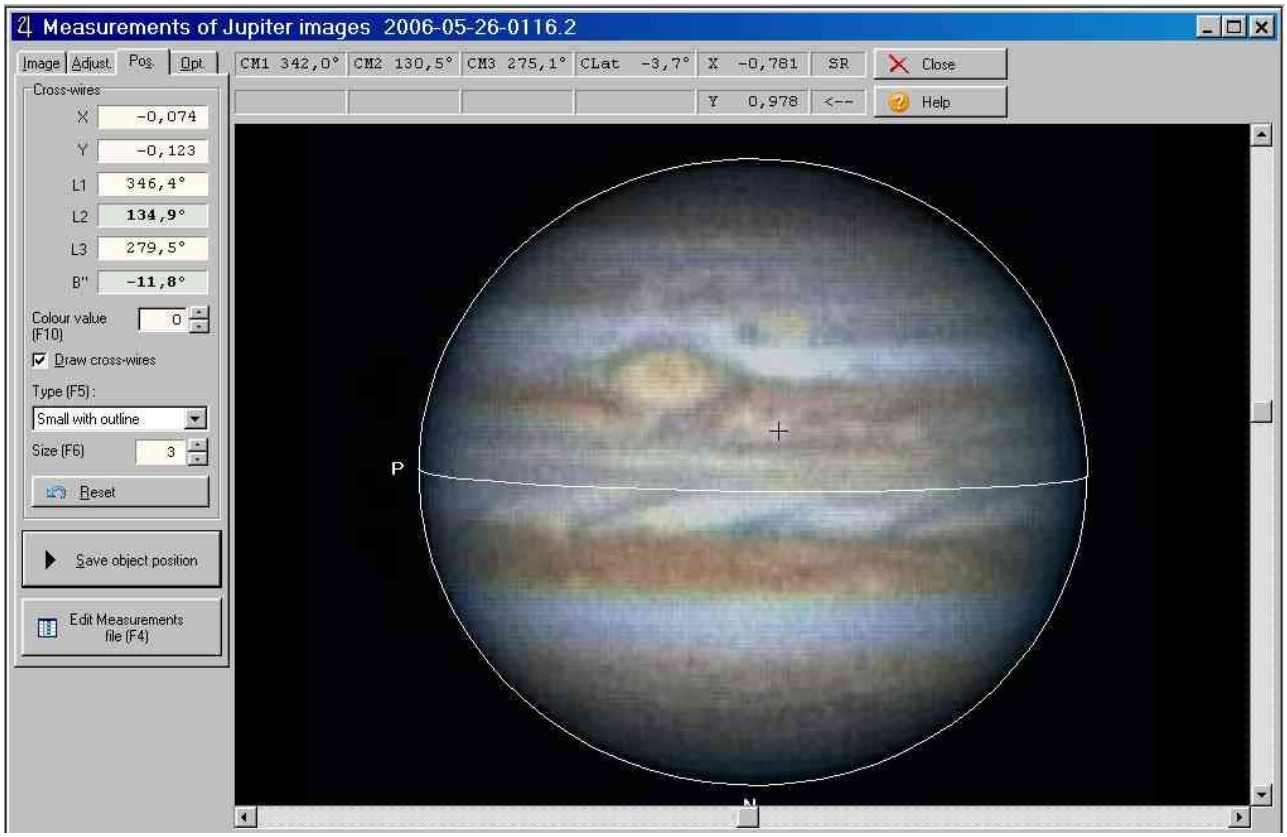
Image series

A series of images taken one to two hours apart is particularly favourable for setting the outline frame. If, for instance, a feature is situated ~30° west (f.) of the C.M. at a certain time, it will be on the opposite side of the C.M. at about the same distance two hours later. Its positions measured on both images have to coincide. A difference of 0.5° in longitude and latitude is still acceptable, but much more than 1° is not.

Slight mistakes when choosing size or inclination of the outline frame can result in perceptible discrepancies in both longitude and latitude. I recommend comparing the positions of at least one feature in northern and southern temperate latitudes, respectively, visible on both images.

The following image pair was taken about one hour apart. Measured positons of the small bright spot in the SEB coincide well.





All OK?

Check your settings

Please do not start measuring the whole image right after the outline frame was, from your point of view, successfully adjusted. Instead, carefully check if frame settings and observational time are indeed correct, or if a mistake crept in.

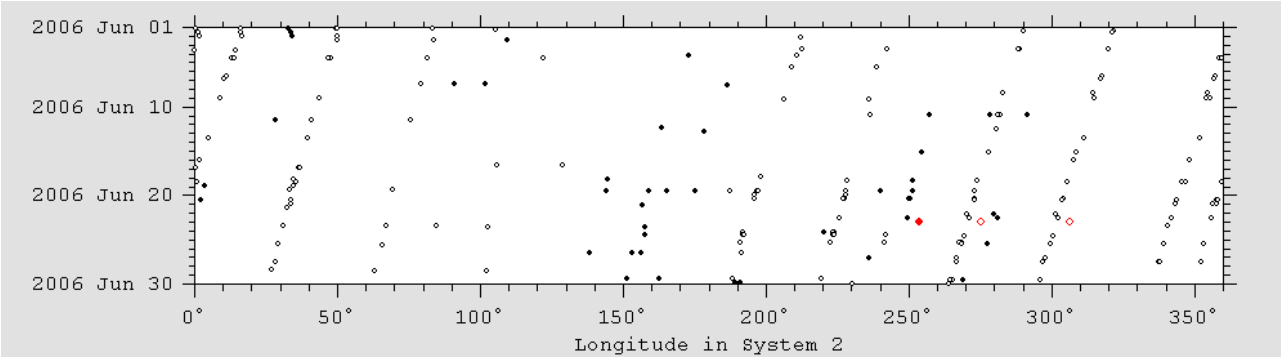
How do you find out whether time and outline frame are OK? My method: First I identify two or three features that are small and well-defined, and were measured sufficiently often. Useful in this regard are, for example, white ovals in the SSTC (at about -40.5° jov. latitude) and on the NEBn (about +19°), or dark spots inside the NEB (about +16°). Measure your test samples and store their positions.

Now generate a WinJUPOS drift chart which displays two Selection files:

- current records of the observer in question only
- measures of all other observers

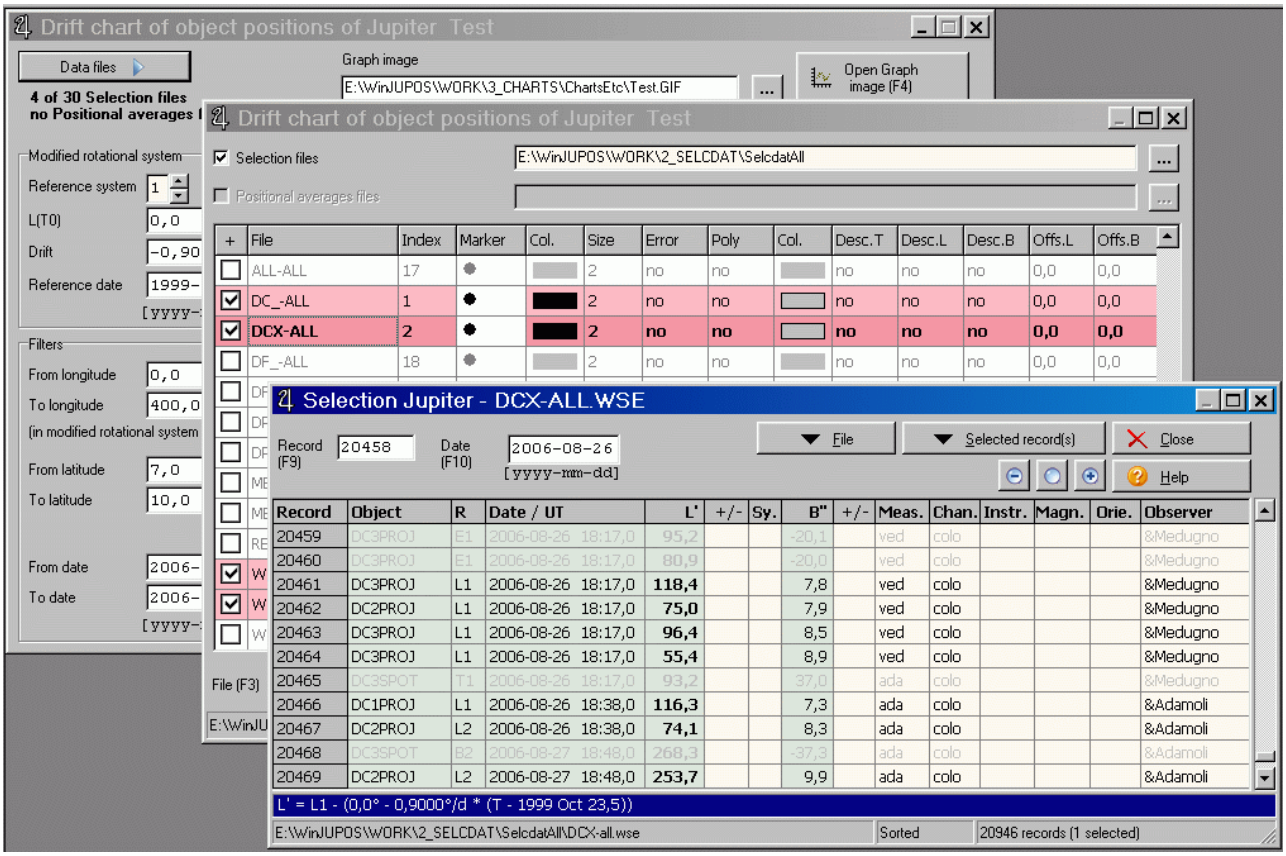
Both Selection files have to be colour-coded so that the records of the test image are fairly discernable, and the resolution of the chart must be sufficiently high in order to detect longitude discrepancies of 1°. It should represent just a narrow latitude range (width about 3°) surrounding the test feature.

In the following example, three test measures are marked red. Solid dots represent dark features, open circles are bright features. A difference of ~4° to records of other observers (black) is obvious. Provided this difference was due to a timing error, UT is about 7 minutes too late!



Of course, the time communicated by the observer can be correct but the measurer made a mistake: either he wrongly entered Date or UT in WinJUPOS, or the outline frame is still imprecise. In any case, you ought to consider first whether it is you who is the error source. If the error was indeed caused by the observer, please contact him as soon as possible and clarify the matter.

This graphical method can also be applied to check jov. **latitudes**. WinJUPOS offers an opportunity to plot latitude positions vs time under *Analysis - Drift charts*. However, interpreting such a graph can become difficult if several features exist in the displayed latitude/longitude interval. Then you have no other chance than inspecting the Selection lists. Quite helpful: If you double-click on a Selection file at *Data files* only those records that are indeed visible in the drift chart are identified by black letters (nos. 20461, 20462, etc. in the example below). All other measures remain grey.



Imprecise timing

Erroneous Dates and UT's are, regrettably, not so rare. In particular, new or occasional observers often have problems with them. A clock anomaly of mere two or three minutes is cleary recognizable in JUPOS! Apart from ordinary typos, three causes can be distinguished:

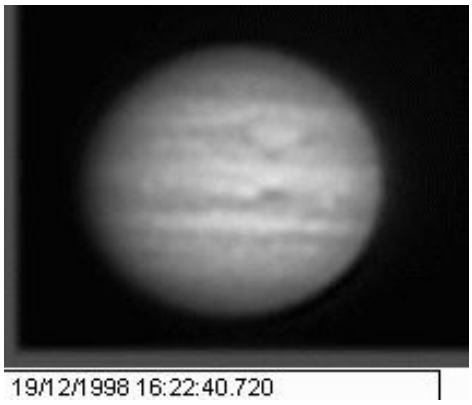
1. Local zonal times are wrongly (or, not at all) converted to UT. This is easy to find out: Either "only" the full hour is erroneous, or/and the date.

2. The computer clock has not been synchronised over a longer period.

3. Exposure of the final image exceeds the recommended two minutes, and observers communicate begin or end of the total period instead of its mid-point.

Laterally reversed images

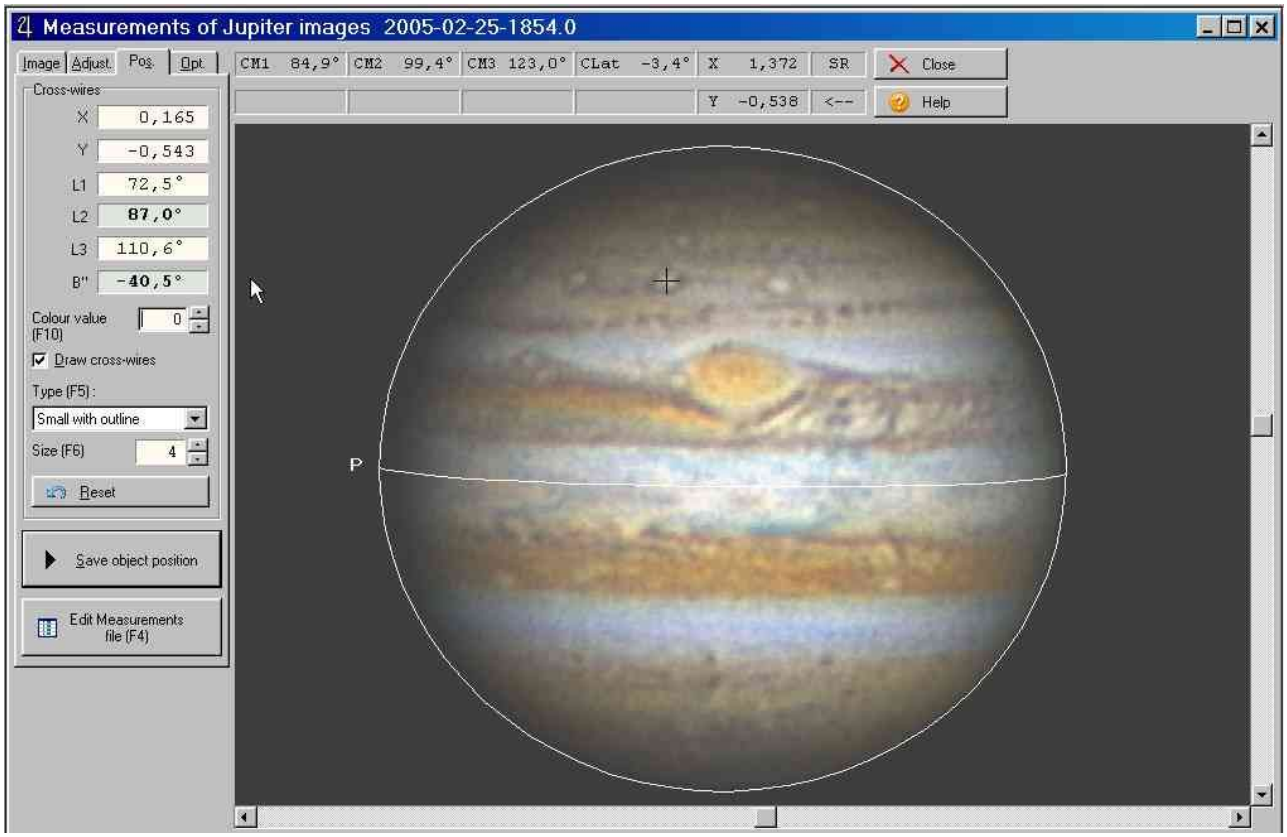
Mirror-inverted images turn up occasionally, but only from new or incidental observers. The following image is an example. Why? Figure it out by yourself …

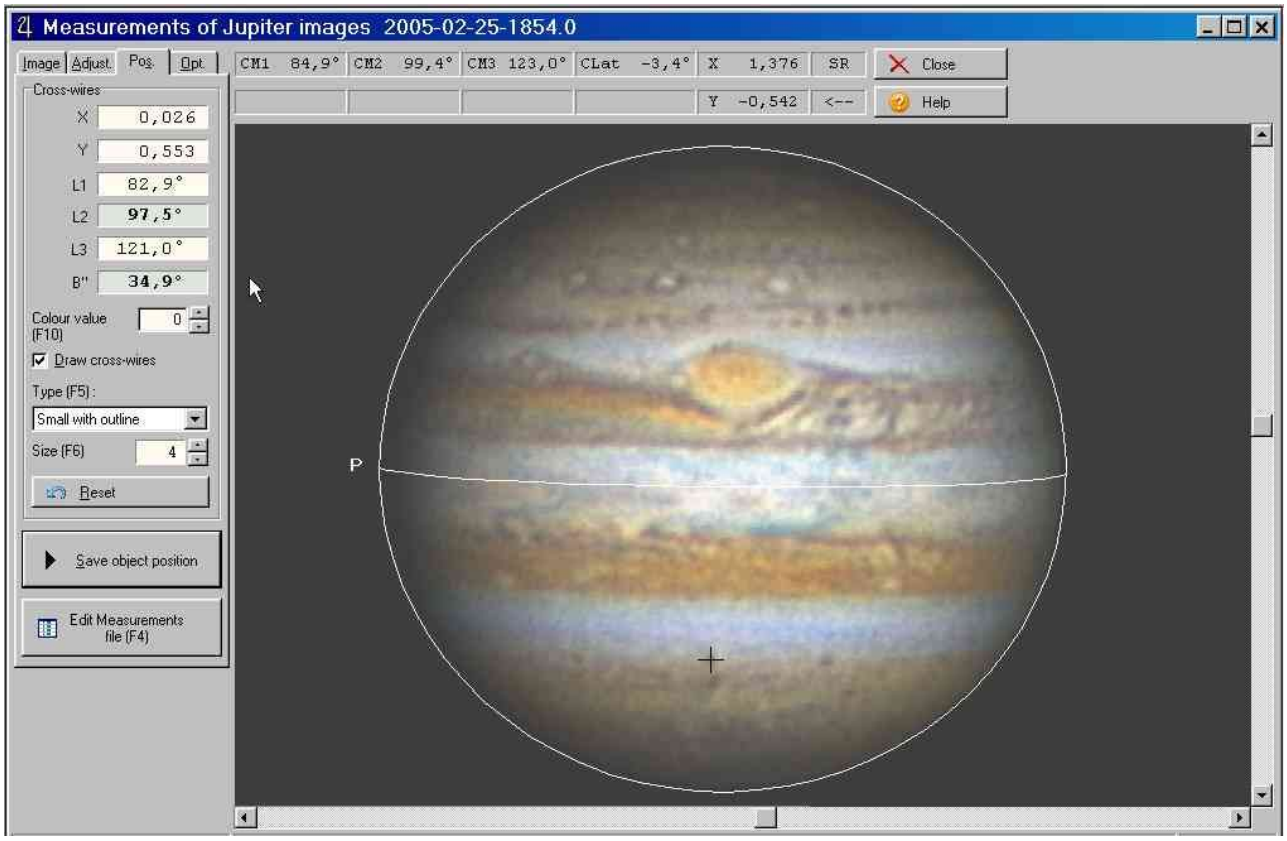


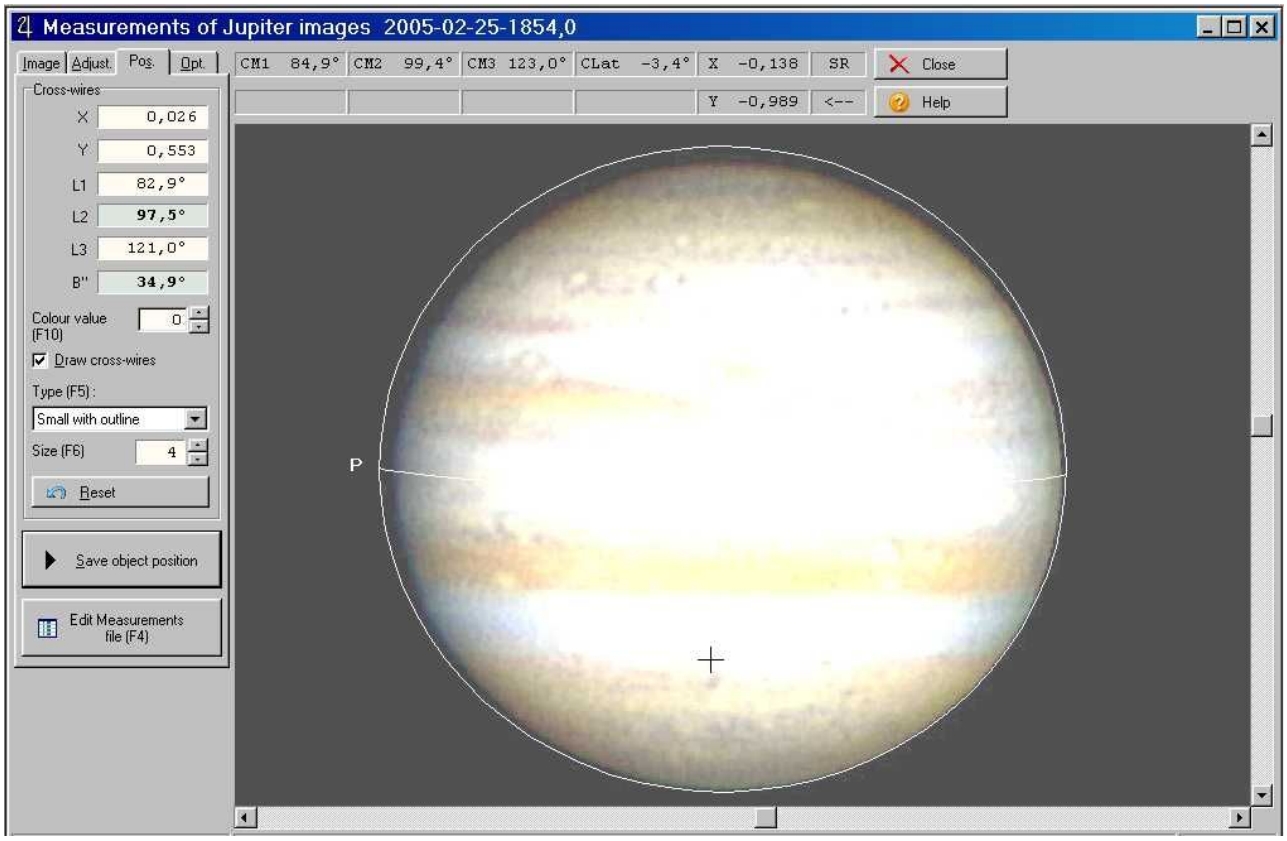
North-south asymmetries

A rare effect that has been detected on a few images since 1998: Not (only) the phase-sided limb is darkened but also the northern **or** southern limb of Jupiter. Indeed, this seems utterly impossible. We were never able to resolve the reason. Probably such asymmetries are due to a shading effect in the optical path, or an odd step in image processing. Despite its rarity: Keep an eye on it!

The following set is an example of February 2005 (i.e., phase at p. limb). Image and outline frame are identical on all three screenshots. On the first two screenshots a bright oval at -40.5° and a dark spot at +34.9° are marked. Apart from a few tenths of a degree, these latitudes are confirmed by many other observations. There is no other way to align the outline frame to obtain these latitudes. Finally, the third screenshot shows the outline frame relative to Jupiter's limb; it is clearly displaced to the south.


Measurements of Jupiter images 2005-02-25-1854.0
Image
Adjust.
Pos.
Opt.
CM1 84,9°
CM2 99,4°
CM3 123,0°
CLat -3,4°
X 1,372
SR
Close
Y -0,538
<--
Help
Cross-wires
X 0,165
Y -0,543
L1 72,5°
L2 87,0°
L3 110,6°
B" -40,5°
Colour value (F10)
0
Draw cross-wires
Type (F5):
Small with outline
Size (F6)
4
Reset
Save object position
Edit Measurements file (F4)
P

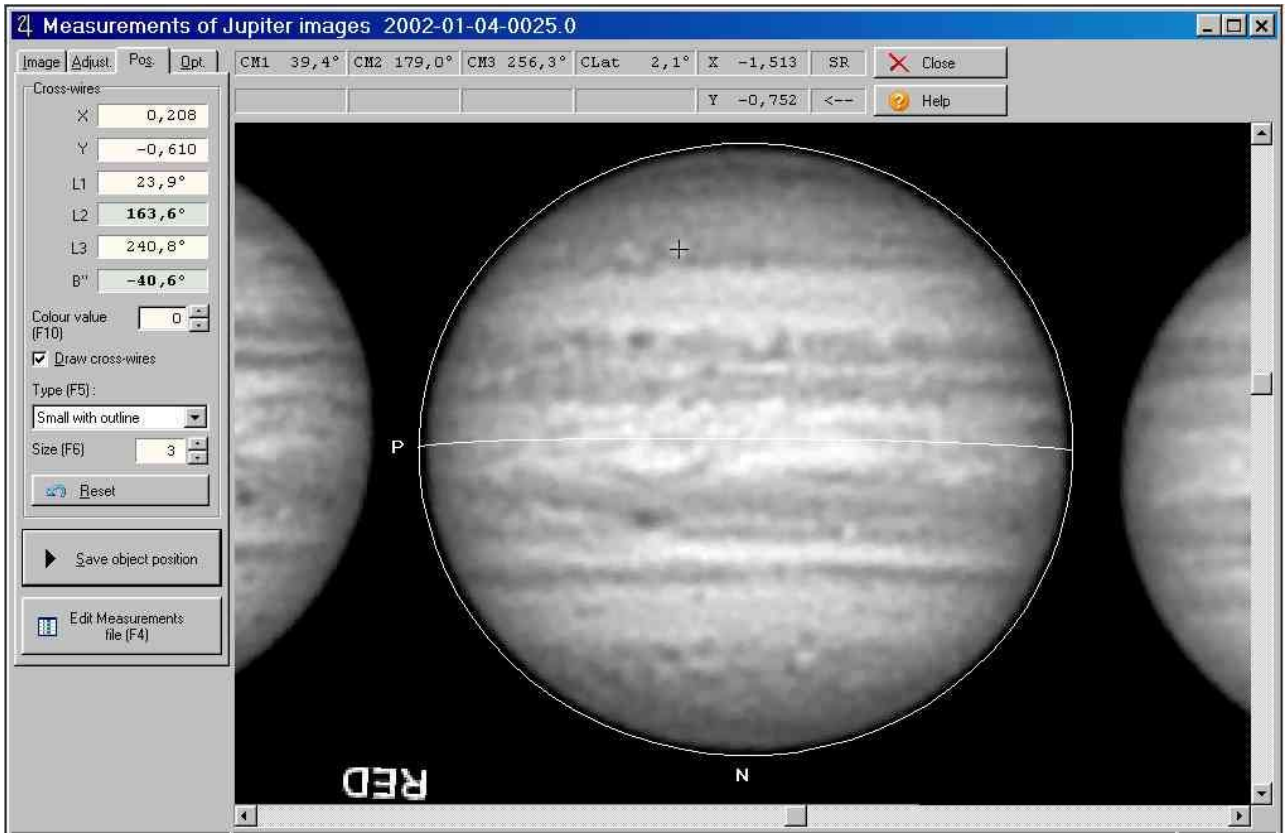

Measurements of Jupiter images 2005-02-25-1854.0
Image
Adjust.
Pos.
Opt.
CM1 84,9°
CM2 99,4°
CM3 123,0°
CLat -3,4°
X 1,376
SR
Close
Y -0,542
<--
Help
Cross-wires
X 0,026
Y 0,553
L1 82,9°
L2 97,5°
L3 121,0°
B" 34,9°
Colour value (F10)
0
Draw cross-wires
Type (F5):
Small with outline
Size (F6)
4
Reset
Save object position
Edit Measurements file (F4)
P

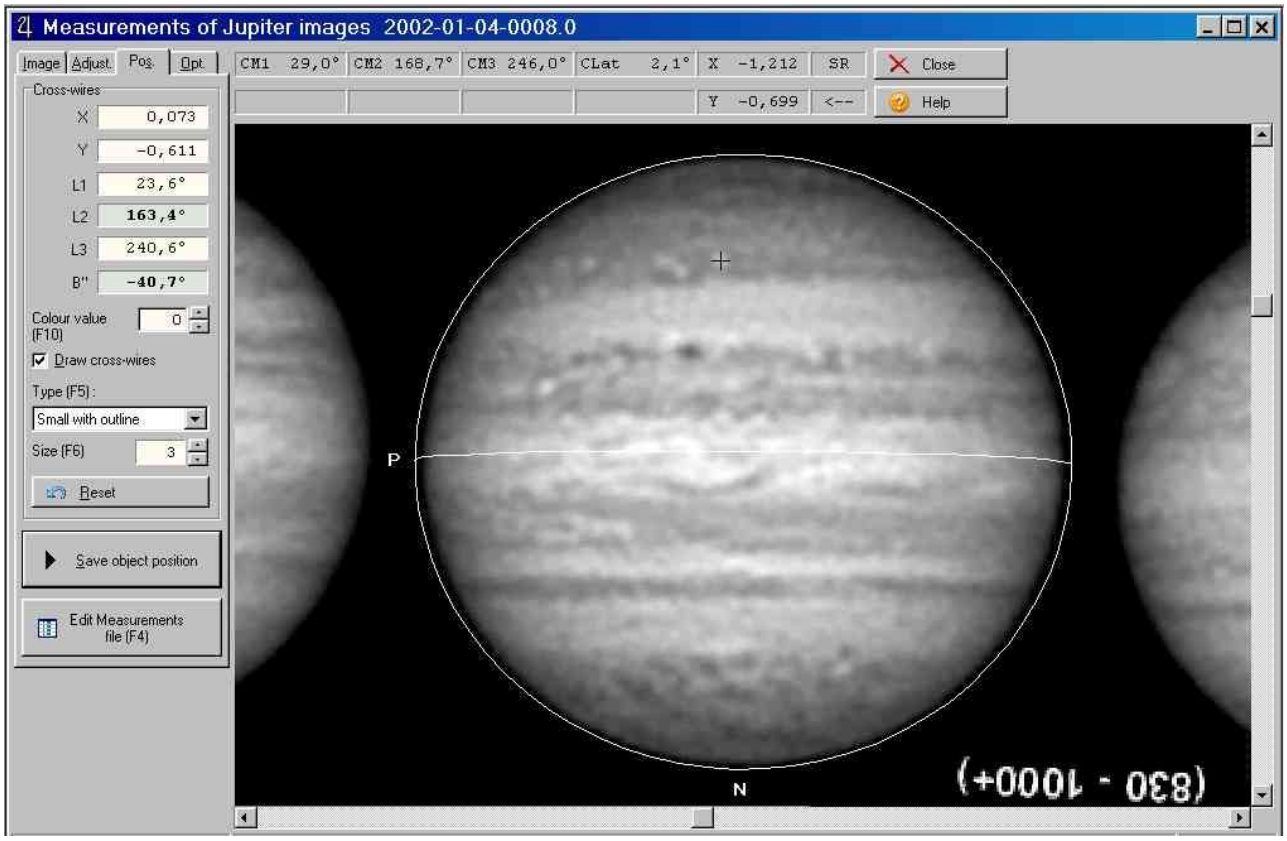


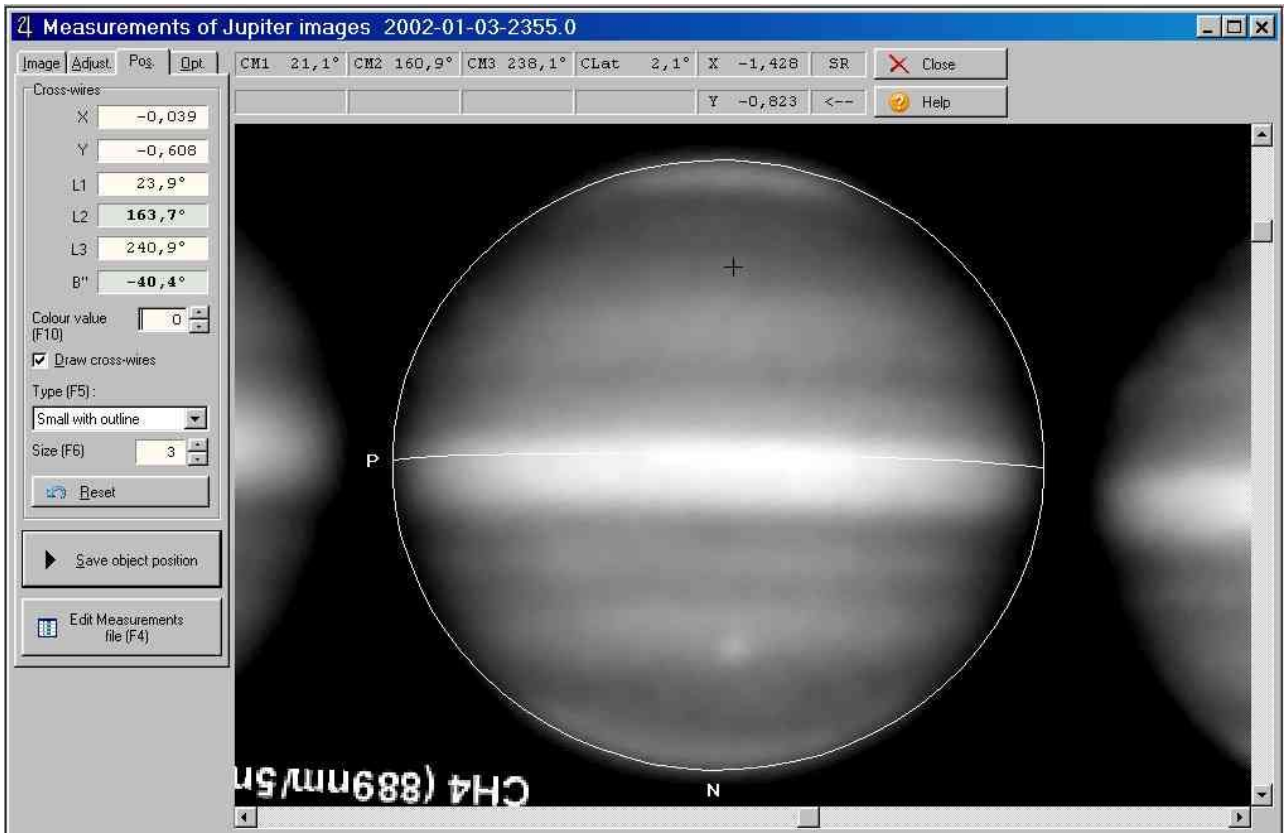
Limb in the infrared

Observations by António Cidadâo in 2002 indicate that even the illuminated limb can display a slight phase in broadband infrared. Perhaps this is an impact of the methane band at 889 nm. Jupiter does not not look flattened at its poles but on its p. and f. limb at that wavelength. So caution is advised also in the broadband infrared!

Top: Reference image taken in the red range of the visual spectrum, Jupiter's limb is evenly shaded to invisibility along its whole circumference. Middle: Broadband 830-1000 nm, p. **and** f. limb are darker than the polar regions. Bottom: Methane band 889 +/- 5 nm, the darkening of p. and f. limb (or brightening near poles) is even more pronounced. All three images were secured in the night of 2002, January 3/4, three days after opposition.


Measurements of Jupiter images 2002-01-04-0025.0
Image
Adjust
Pos.
Opt.
CM1 39,4°
CM2 179,0°
CM3 256,3°
CLat 2,1°
X -1,513
SR
Close
Y -0,752
<--
Help
Cross-wires
X 0,208
Y -0,610
L1 23,9°
L2 163,6°
L3 240,8°
B'' -40,6°
Colour value (F10)
0
Draw cross-wires
Type (F5):
Small with outline
Size (F6)
3
Reset
Save object position
Edit Measurements file (F4)
P
N
RED


Measurements of Jupiter images 2002-01-04-0008.0
Image
Adjust
Pos.
Opt.
CM1 29,0°
CM2 168,7°
CM3 246,0°
CLat 2,1°
X -1,212
SR
Close
Y -0,699
<--
Help
Cross-wires
X 0,073
Y -0,611
L1 23,6°
L2 163,4°
L3 240,6°
B'' -40,7°
Colour value (F10)
0
Draw cross-wires
Type (F5):
Small with outline
Size (F6)
3
Reset
Save object position
Edit Measurements file (F4)
P
N
(830 - 1000+)



Before saving

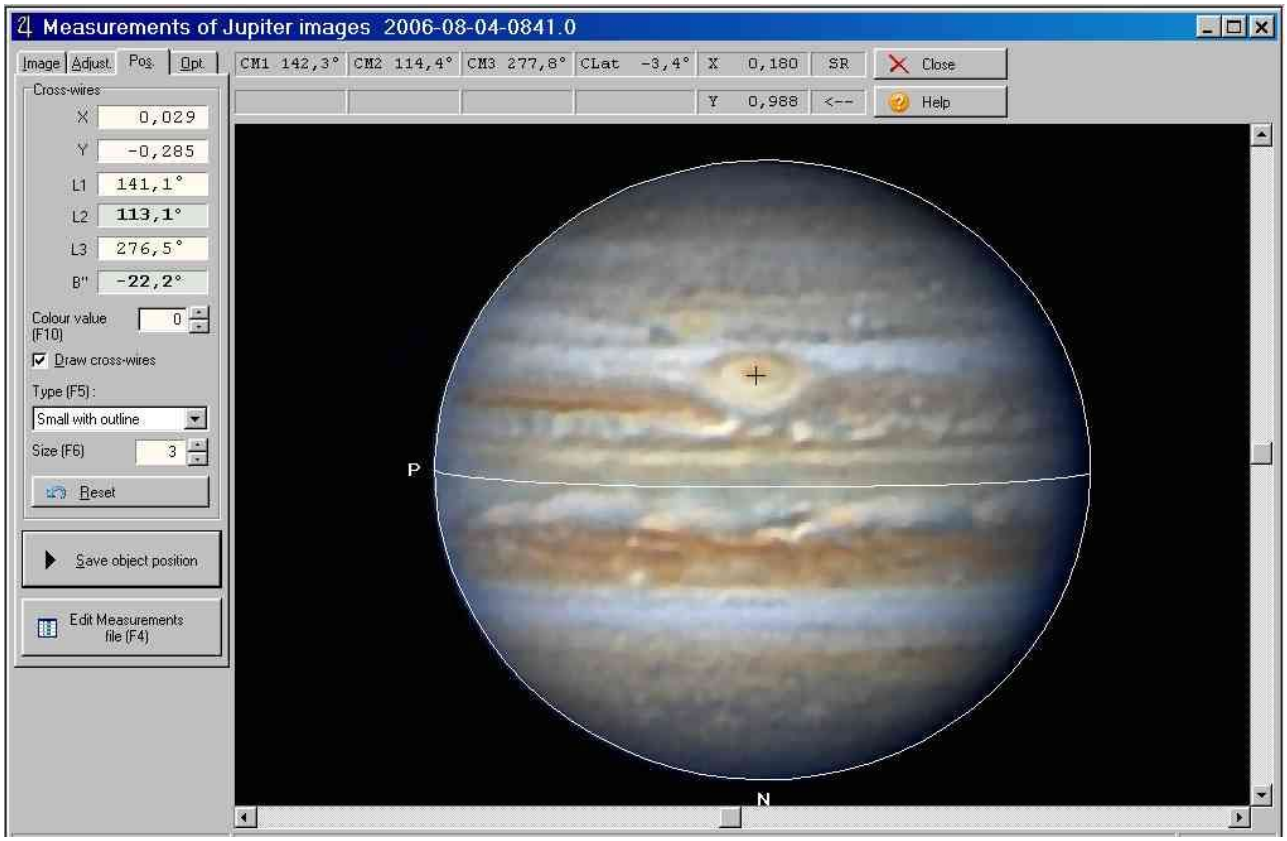
Rotate image

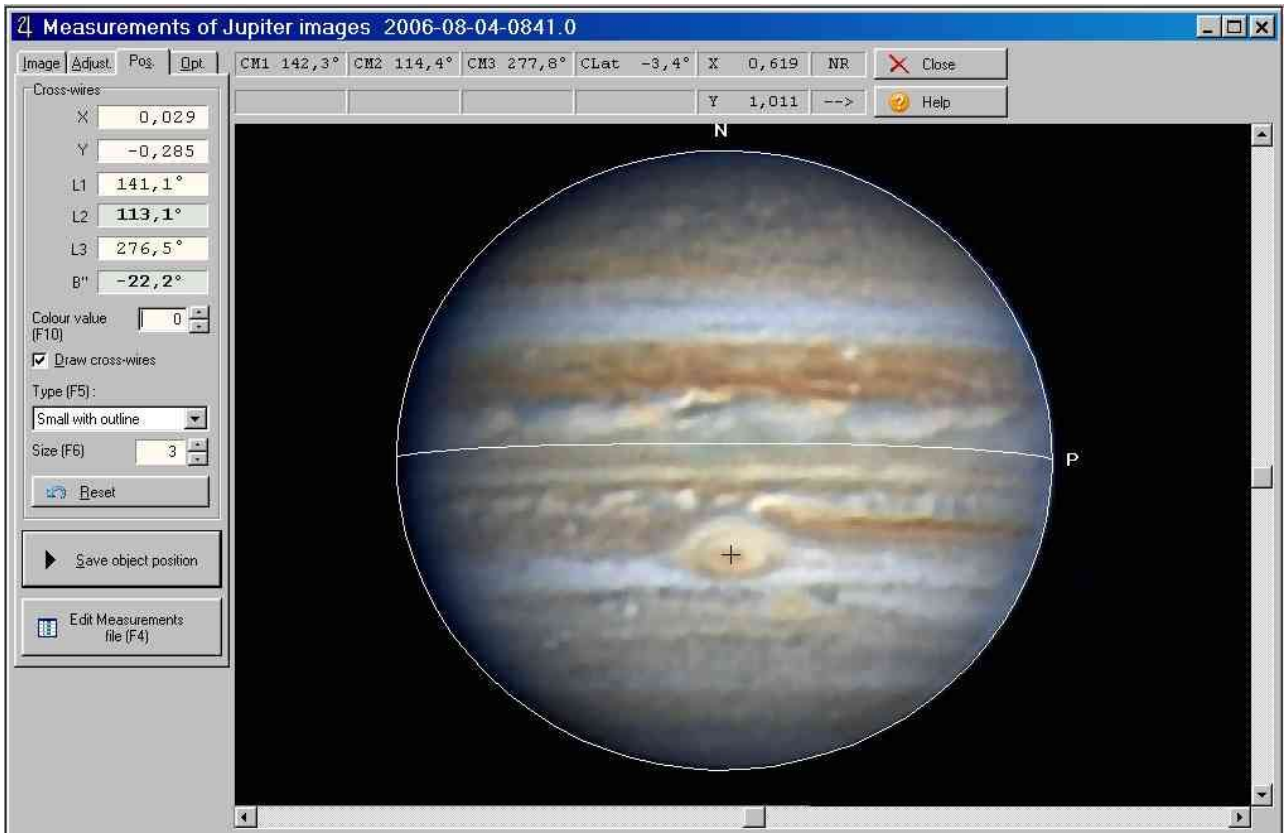
Many people estimate the midpoint of an extended structure somewhat laterally displaced from their true centre, generally too far to the right from my experience. Just try to set the WinJUPOS cross-wires exactly on the centre of the Great Red Spot. Jupiter's belts have to lie horizontally. Now rotate the image by 180° and verify if the cross-wires are still placed at the Spot's midpoint... Are you also among those who have an off-centre asymmetry?

By the way, this effect also occurs with visual estimations of Central Meridian transit times, with the naked eye at the ocular. Here the extended structure is Jupiter's disc, and the Central Meridian is the midway line to be evaluated. Those time estimates often differ from each other remarkably for the same observer, depending on whether the planet rotates from left to right, or vice versa in the eyepiece. German-language readers will find more information about this topic in the PDF "Systematische Fehler bei der Bestimmung jovigraphischer Längenpositionen" which is available on the JUPOS website at "Important to know – Tips for measurers".

The effect can be eliminated if you rotate the image in WinJUPOS by steps of 90° (hotkey Ctrl+Alt+L), and determine the “best” centre by averaging out the individual results.

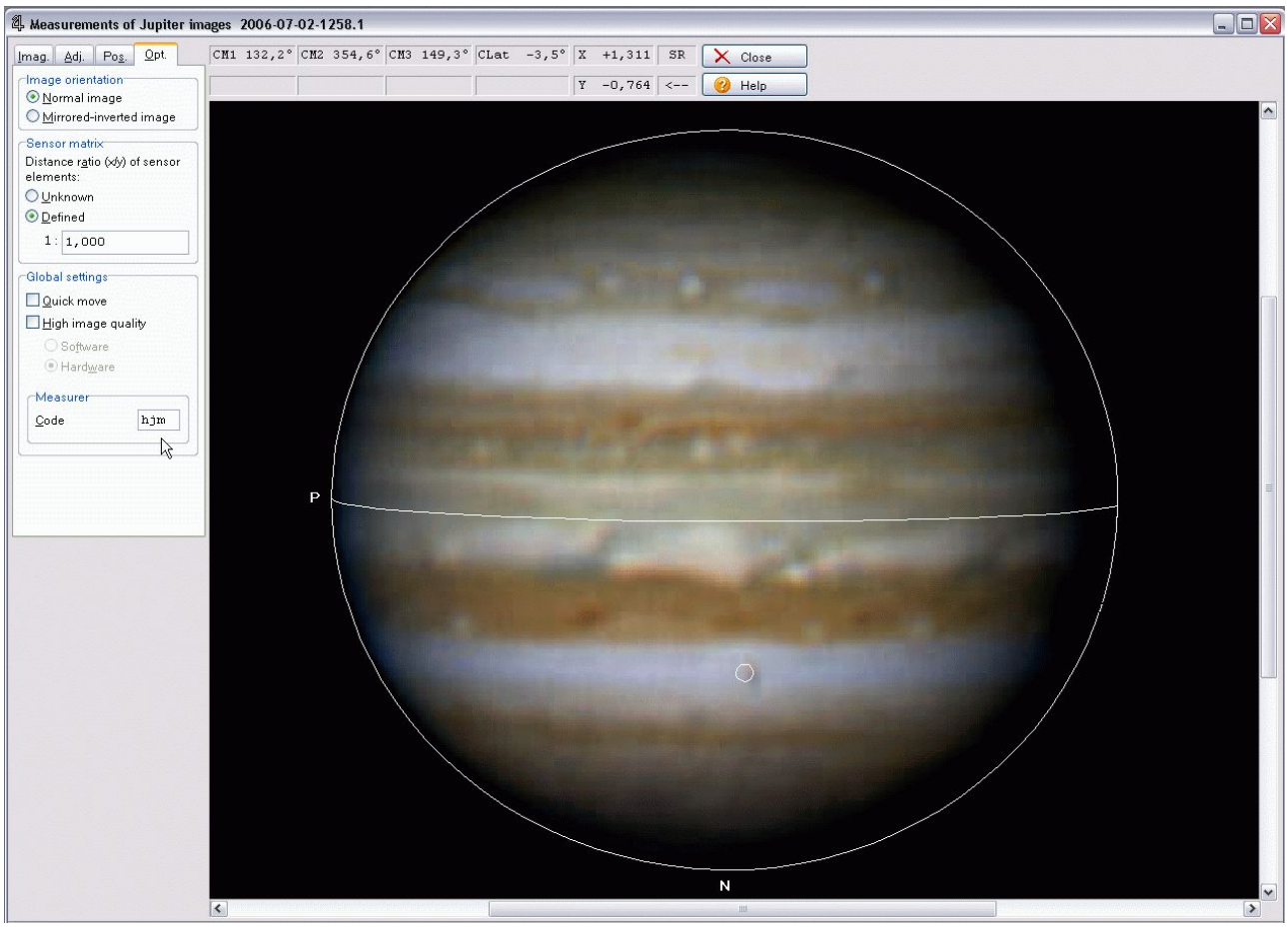
The following screenshots are a personal example. I estimated the centre of the GRS in the upper image and put the cross-wires on it. Now, if I turn the image upside down (lower image), the cross-wires are slightly displaced to the left. What do you see?


Measurements of Jupiter images 2006-08-04-0841.0
Image
Adjust
Pos
Opt
CM1 142,3°
CM2 114,4°
CM3 277,8°
CLat -3,4°
X 0,180
SR
Close
Y 0,988
<--
Help
Cross-wires
X 0,029
Y -0,285
L1 141,1°
L2 113,1°
L3 276,5°
B" -22,2°
Colour value (F10)
0
Draw cross-wires
Type (F5):
Small with outline
Size (F6)
3
Reset
Save object position
Edit Measurements file (F4)
P
N


Measurements of Jupiter images 2006-08-04-0841.0
Image
Adjust
Pos
Opt
CM1 142,3°
CM2 114,4°
CM3 277,8°
CLat -3,4°
X 0,619
NR
Close
Y 1,011
-->
Help
Cross-wires
X 0,029
Y -0,285
L1 141,1°
L2 113,1°
L3 276,5°
B" -22,2°
Colour value (F10)
0
Draw cross-wires
Type (F5):
Small with outline
Size (F6)
3
Reset
Save object position
Edit Measurements file (F4)
N
P

Measurer code

Please take care that the entry field "Measurer code" is filled with your personal three-letter code before saving each positional record (see screenshot after next). Preferably pre-define the *Code* on tab *Opt.* Then it will be automatically populated.



Channel code

Specify the spectral range of the image in the entry field "Channel":

colo	... colour
inte	... integrated light (greyscale)
red	... red
gree	... green
blue	... blue
ired	... broadband infrared

Note: If you measure scanned (chemical) photographs, you have to choose between these six options. Ignore "phot" as this value indicates positions from photographs not derived using WinJUPOS or PC-JUPOS but by any other means.

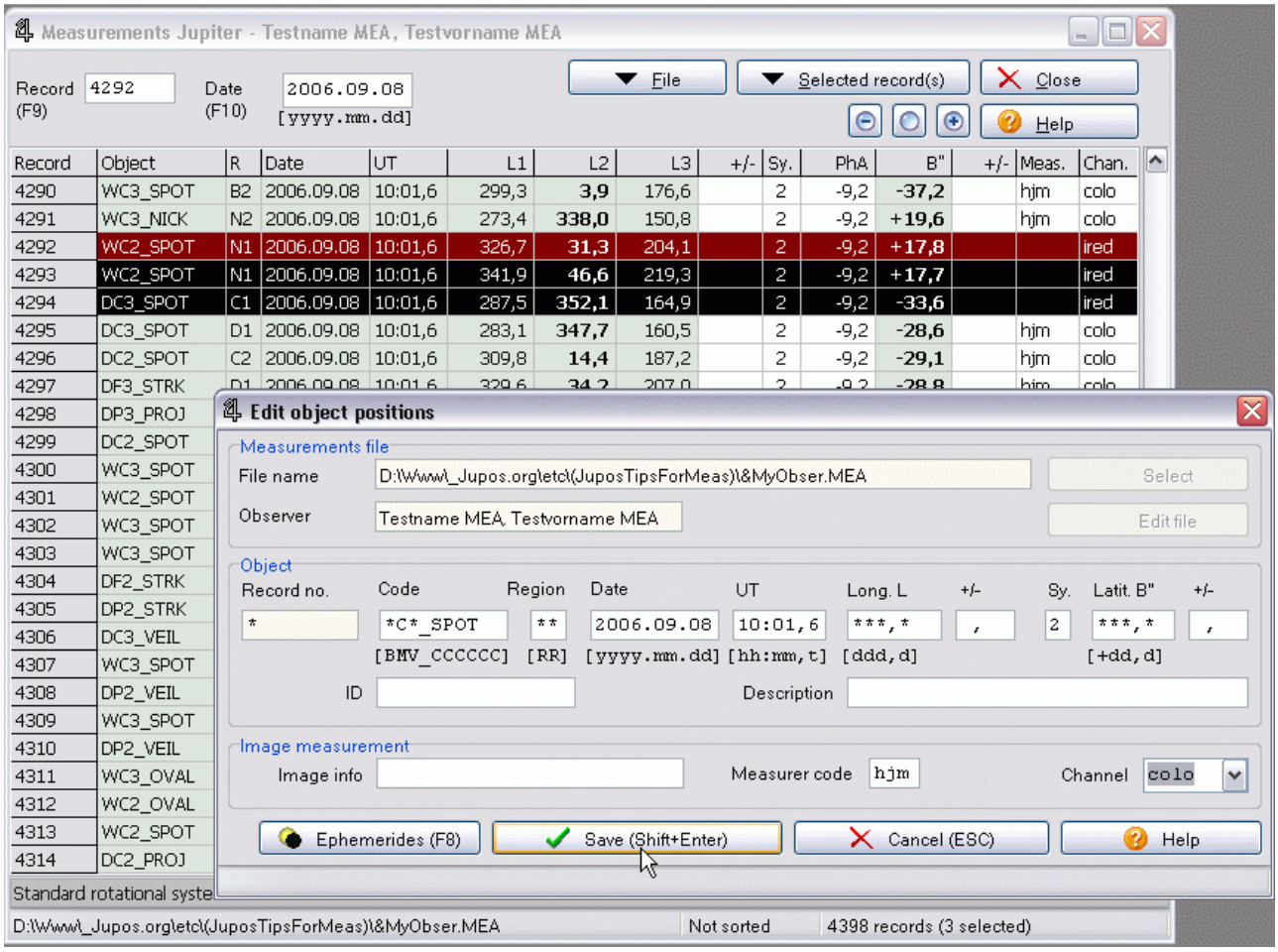
As already pointed out in section "Spectral range", measuring images in non-visual narrowband and ultraviolet wavelengths is not the aim of JUPOS at present. Should, however, such measures be needed one day, select the Channel code as follows:

uv	... ultraviolet
XXX	... median wavelength in nanometers, used for narrowband infrared

The final four codes are reserved for visual observations (e.g., micrometer measurements), and positions from photographs **not** determined by means of WinJUPOS or PC-JUPOS. You will find them in MEA files without prefix &, see section "Create master data file" farther below. Never use them for electronic Jupiter images, please.

phot … photograph
draw … drawing
mmea … micrometer measurement
mest … micrometer estimation

Listing your master data at, for example, *Recording - Measurements/New - (open MEA file),* every record has to contain a channel code (column *Chan.*) and your personal measurer code (*Meas.*). If this information is missing or wrong, you can correct it at any time. Highlight the respective record(s), go to *Selected record(s) - Edit*, and enter the proper value.



What to measure, what to omit?

This topic is a broad one. It is virtually impossible to formulate an advice universally valid in all feasible situations.

The largest and most conspicuous atmospheric structures on Jupiter are not always the most interesting. Small and inconspicuous features can yield exciting results because often they rarely receive attention. Tiny projections of the SEC (South Equatorial Current) that extend from the SEB north edge into the EZ are just an example. However you should beware of measuring finest detail all across the planet, for two reasons:

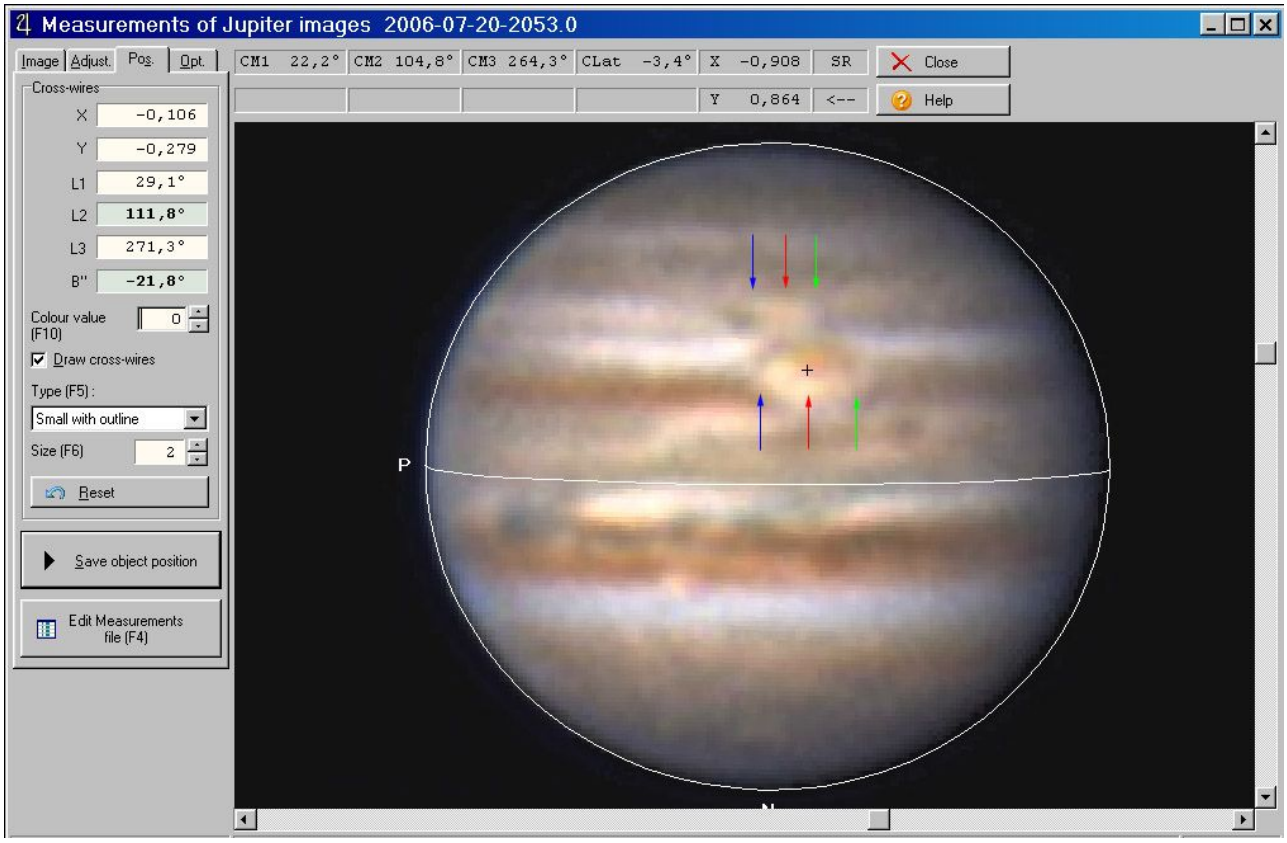
- tiny features are often indistinguishable from image artefacts.
- often they are short-living, and appear as "noise" in drift charts.

As a general rule, avoid measuring features near the limit of detectability!

On images with lower resolution, please concentrate on large-scale features, e.g. NEBs plateauxs, and omit "crucial" features like the GRS or BA as far as possible. Positions of the latter can much better be determined on hi-res images! The same applies to the p. and f. ends of the Great Red Spot and Oval BA: The displayed contour often does not correspond to the true one which becomes clearly visible at higher resolution only.

Of course, a feature's contour can remain poorly defined also at high image resolution. **If there is no distinct outline, it must not be measured as it does not exist!**

The following screenshot indicates the minimum requirement for image quality and contour definition. The p. ends of GRS and BA are indicated by blue; their f. ends, green; and centres, red arrows. Assuming an even more indistinct representation, measuring these ends would have to be left out - however you could, and should measure the centres BA and GRS further on.

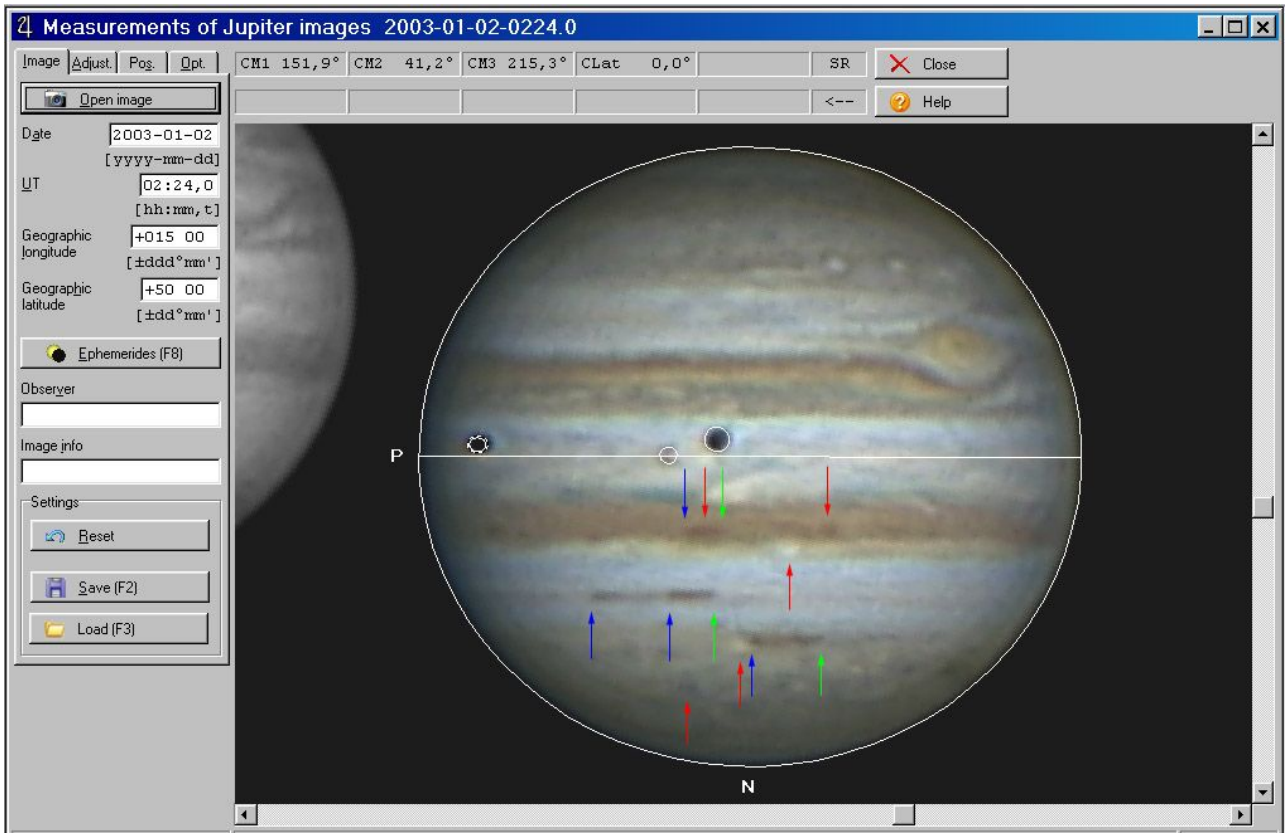


Two questions arise at this point:

1. *How do I distinguish a local, "non-extended" feature whose centre is solely relevant, from an extended one?*
Thumb rule: All features longer than 7° and situated in equatorial or temperate latitudes count as extended. Measure only the centre of features that are shorter than ~7°.

2. *The more extended a features is, the more senseless the term "centre" becomes. When should I only measure the two ends of an extended feature, and when its centre additionally?*
Thumb rule: All three object points are only of interest for GRS and BA. Also in ambiguous cases, where a feature cannot be definitely classified as being local or extended, you can additionally measure the centre. For clearly extended features, i.e. markedly longer than 7°, measure only the p. and f. end, and omit the centre please.

The next example shows dark segments of NTB and NNTB that unambiguously fall into the "extended" category. Thus, centres are **not** to be measured. The NEB barge is a border case. Blue arrows indicate p. ends; red, centres; green, f. ends.

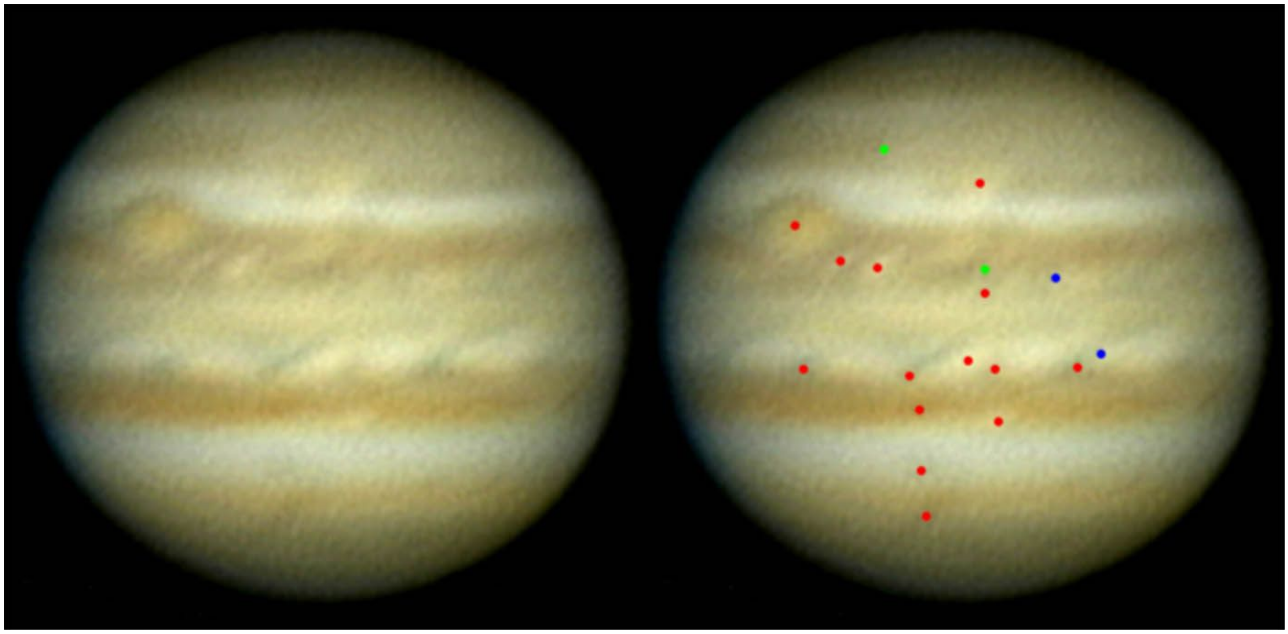


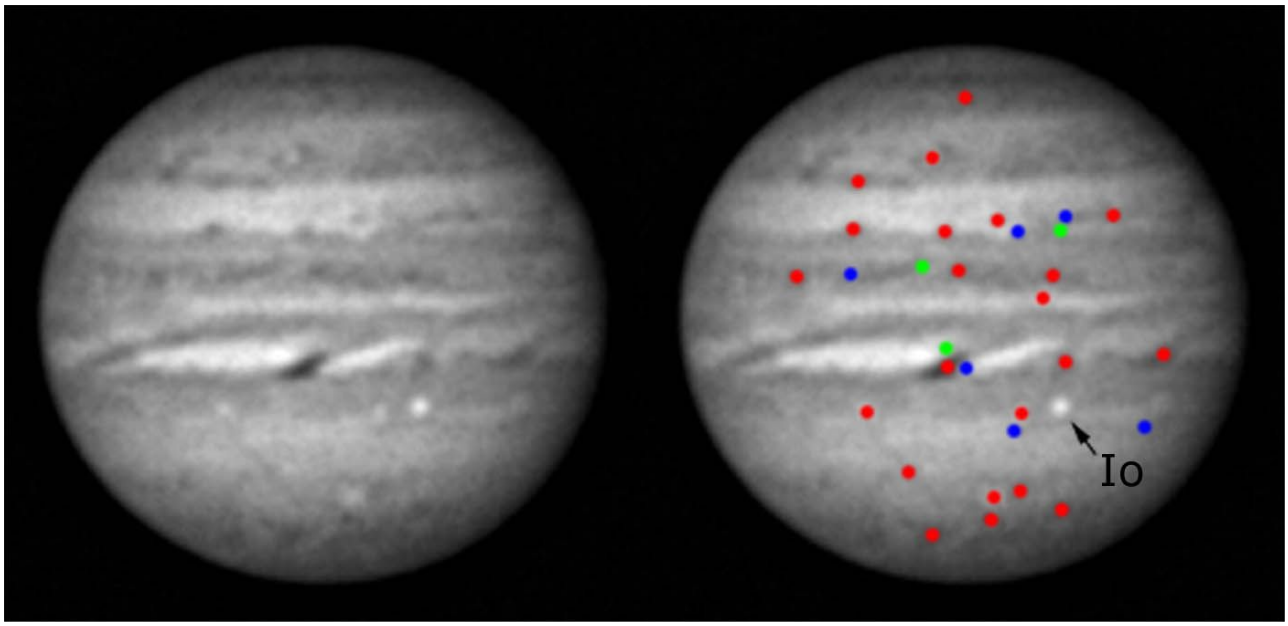
Do not measure features situated too close to the p. or f. limb, otherwise your positions become inaccurate. The measuring range should be limited to +/-45° around the C.M. even on hi-res images. Of course, this restriction does not apply to features near the poles: You will never have a chance to see them near the middle of Jupiter's disc!

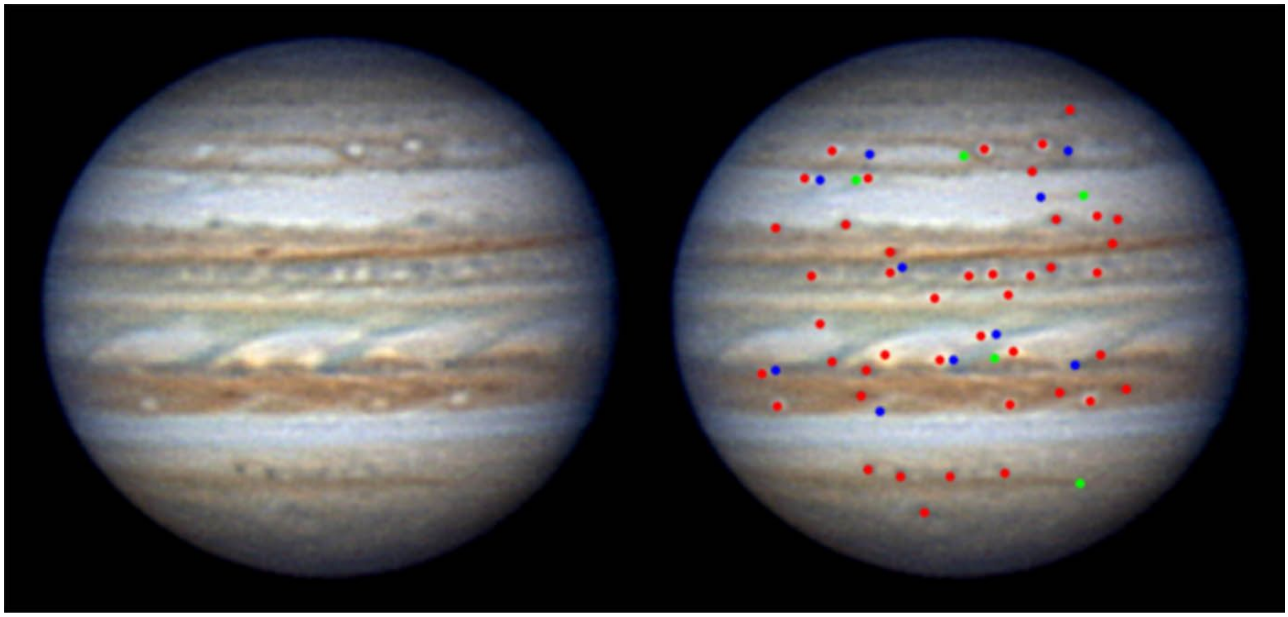
If you want to measure p. and f. ends of a feature that is aligned **strictly parallel** to the equator, please pay attention as far as possible that both ends (and possibly the centre) get the same integer latitude. Has, for example, the p. end of a feature been measured at -12.9°, and the cross-wires on its f. end indicate -13.1°, then please check if you can set the f. end to -12.9° instead (or the p. end to -13.1, or both to -13.0°) without getting a bad feeling. This yields advantages when data have to be selected and displayed graphically.

Objects that clearly change latitude along their east-western extension are not affected, of course. For example: rifts in the NEB that start in the southern part of the belt and peter out after a larger longitudinal distance either in its middle or southern part.

In the following examples, all features that I would measure are colour marked. Red, centres; blue, p. ends; green, f. ends. Symbols do not distinguish between bright and dark features.




Io



Validate data quality

How to identify "outliers"?

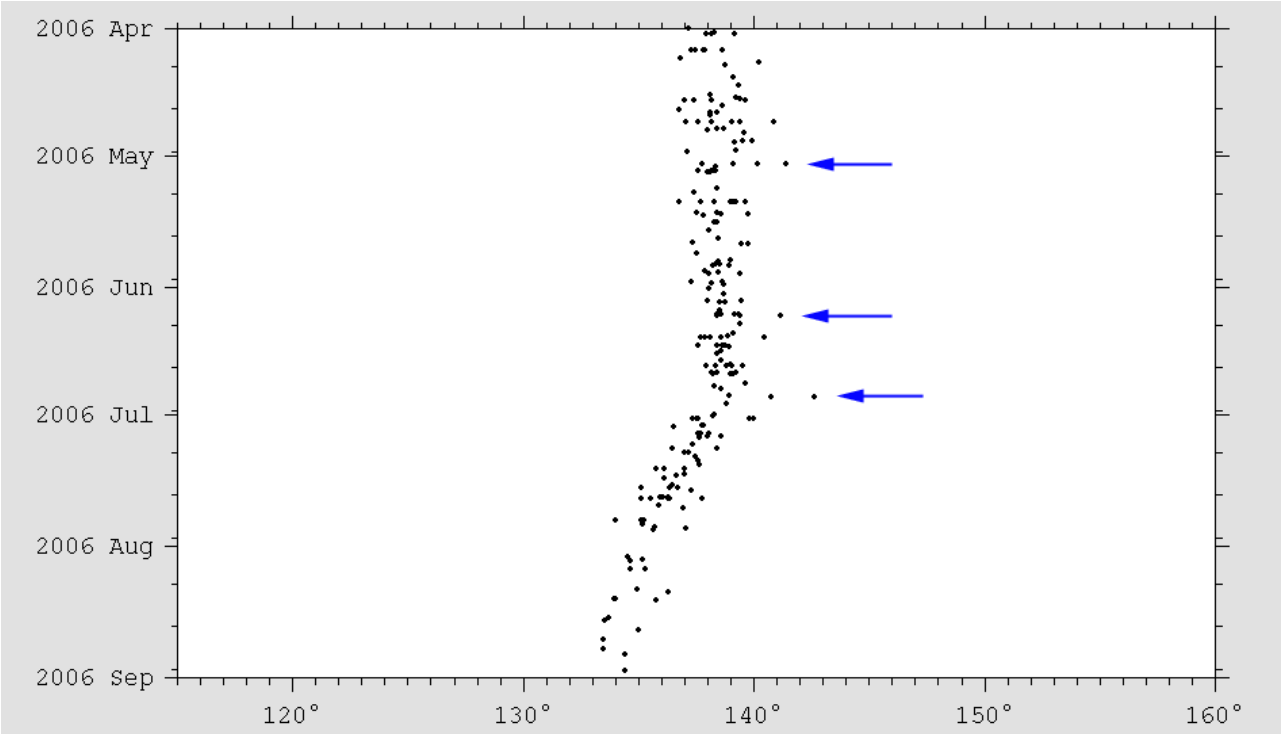
An intention of the project must be to eliminate all gross measurement errors. But what is a rough error in JUPOS?

The achievable accuracy of a "mass data project" like JUPOS is often overestimated. Even measures of superb images of highest resolution show differences of about one degree. I would estimate the standard deviation of all JUPOS longitudes derived from electronic image to be about 1.2°. That is, 70% of all records data are situated within a corridor around the true value which is 2.4° broad. This estimate relates to small, well-defined features like, e.g., the bright SSTC ovals. Diffuse features that are difficult to delimit from their surroundings and, as a consquence, differently interpreted by measurers, naturally exhibit higher deviations.

Rough measurement errors - or "outliers" - are records of well-defined features whose longitude differs **more than ~2.5**° from the apparent true value, i.e., the average of all other observations.

Inspecting drift charts is the only feasible method to detect outliers. Once an apparent outlier has been found, its record has to be identified in the corresponding Selection file as step two.

Below are some examples of outliers.

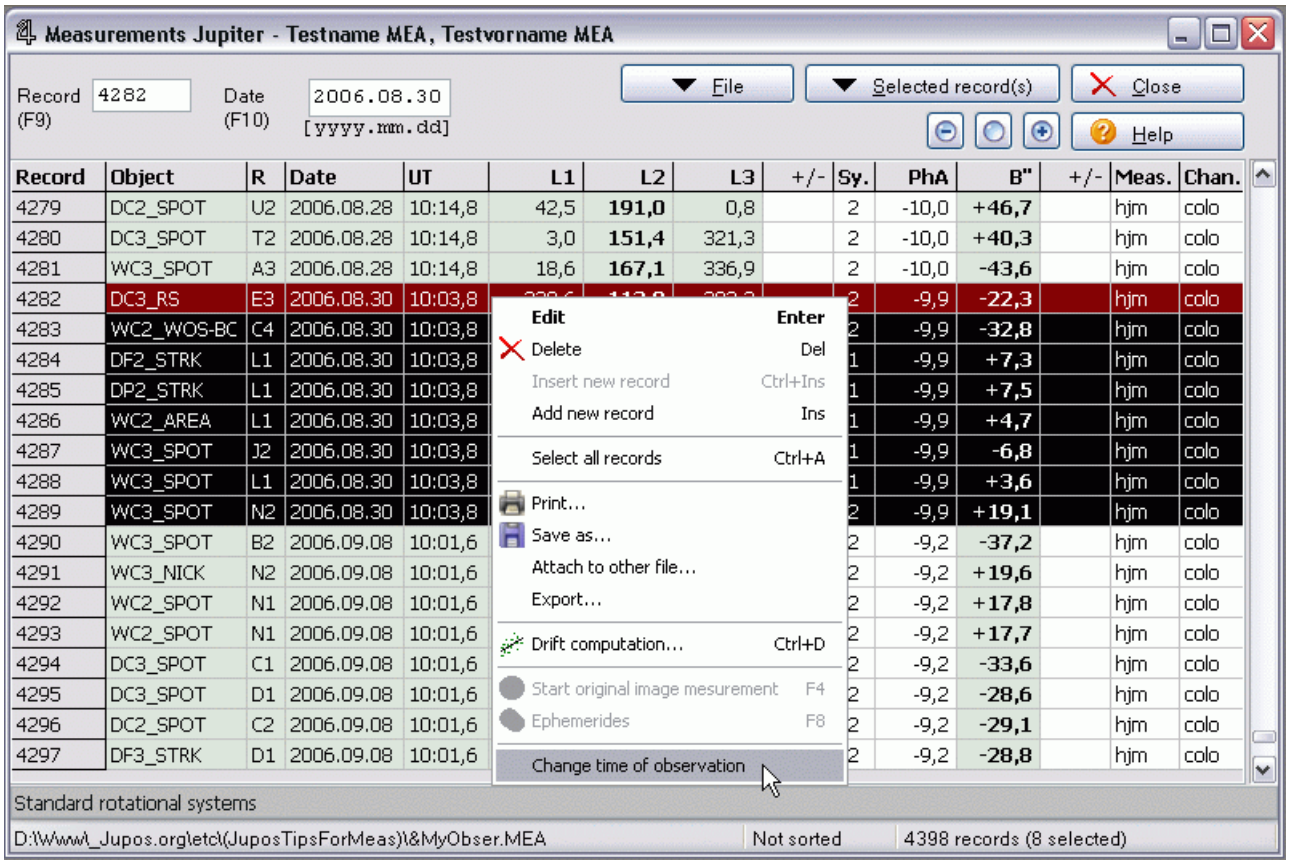


How to remove outliers?

Please attempt to search for outliers in your own data, and to remove them. Outliers are completely eliminated not until they have been deleted from the MEA master data file. It does not suffice to remove them in the Selection file!

If an outlier record has been caused by wrong timing or an inaccurate outline frame, not only this record will be erroneous but likewise all records of the same image. Hence, remove **all** records of the affected image from the master data file, not just the identified outlier(s)!

Should it turn out, however, that Date or UT were wrongly entered but the correct time is known, you do not need to re-measure the whole image. WinJUPOS allows you to select a set of data records and to correct their date and time; longitudes will be re-computed then. The corresponding function you will find at *Recording - Measurements/New - (open MEA file) - Right click (*or *Selected records) - Change time of observation*.



Comparing und sorting

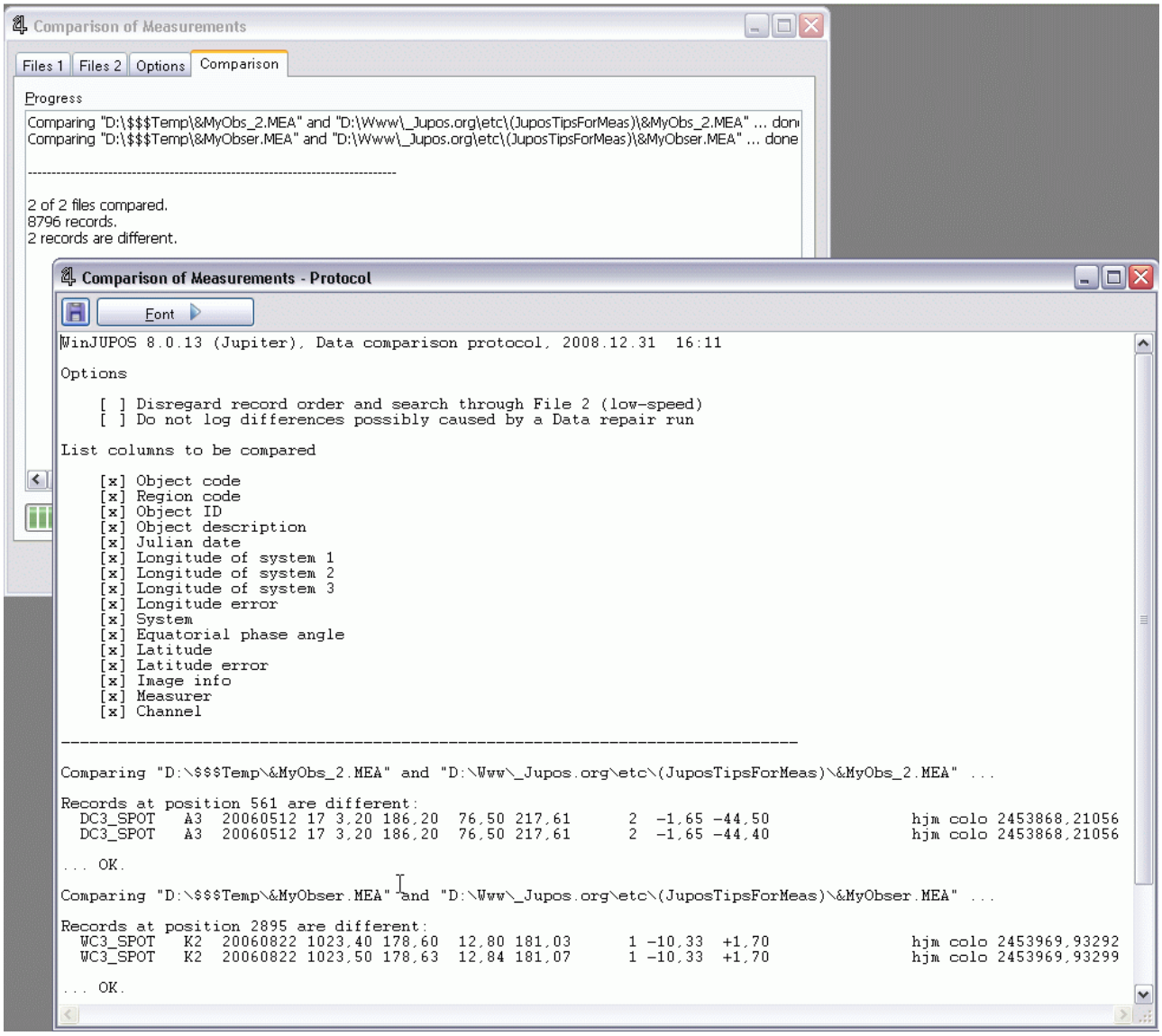
Please bear in mind that WinJUPOS is still under improvement. Bugs cannot be ruled out. Grischa and I will always endeavour to release only well tested versions on http://jupos.org . However, we are unable to regularly check every feature in each new release.

A malfunction in master data maintenance would potentially be most dangerous. Please verify the consistency of your data on a regular base. You are recommended to do this, first of all, in following situations:

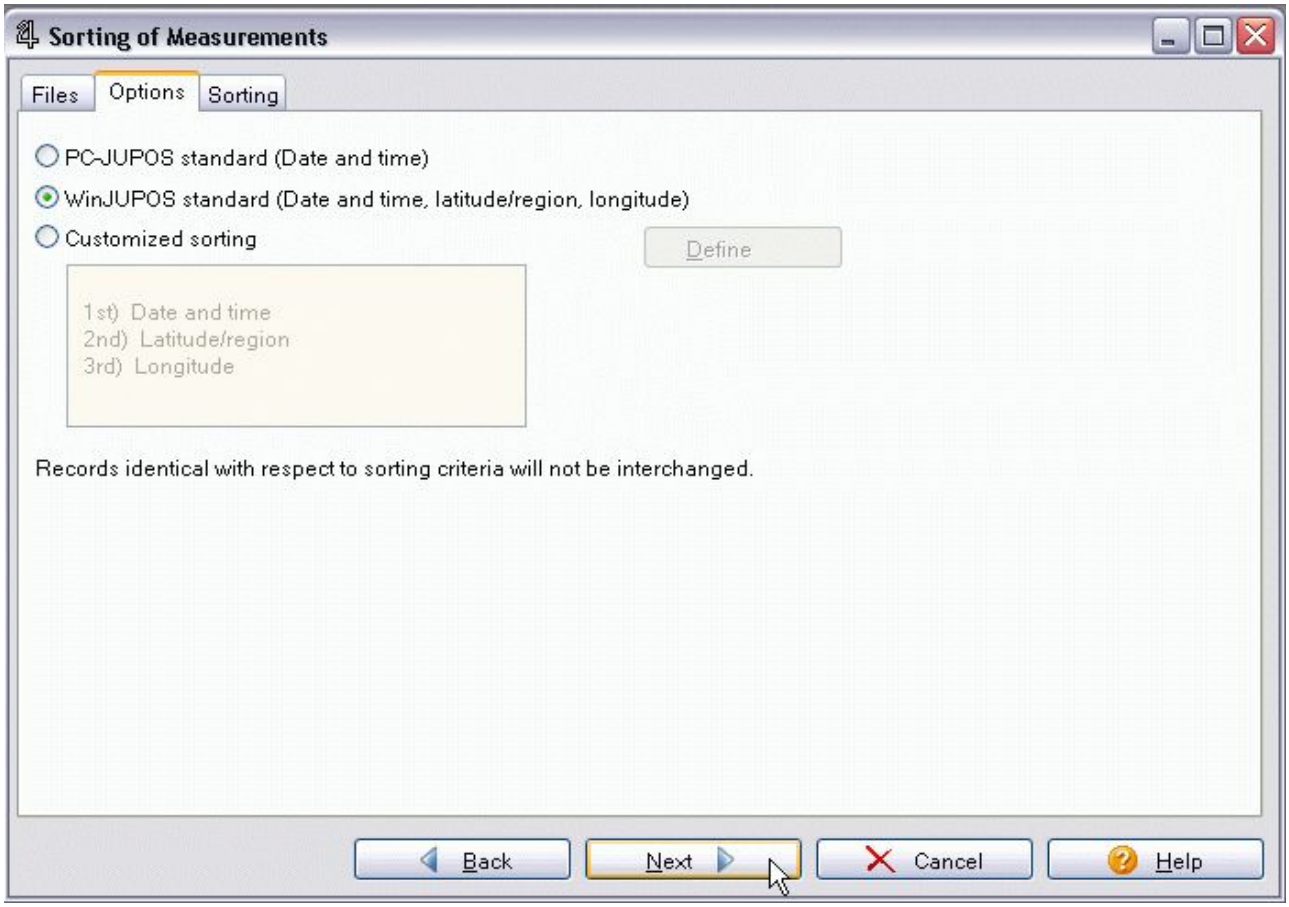
1. After converting MEA to MES, or vice versa (not needed anymore as PC-JUPOS' MES format has become outdated).
2. After new MEA archives have been published (i.e., compare all own master data files on your computer against those published by me).

You can compare individual files or groups of files at *Administration – Data comparison – Measurements*. A detailled list of detected differences will be displayed after pressing the *Protocol* button.

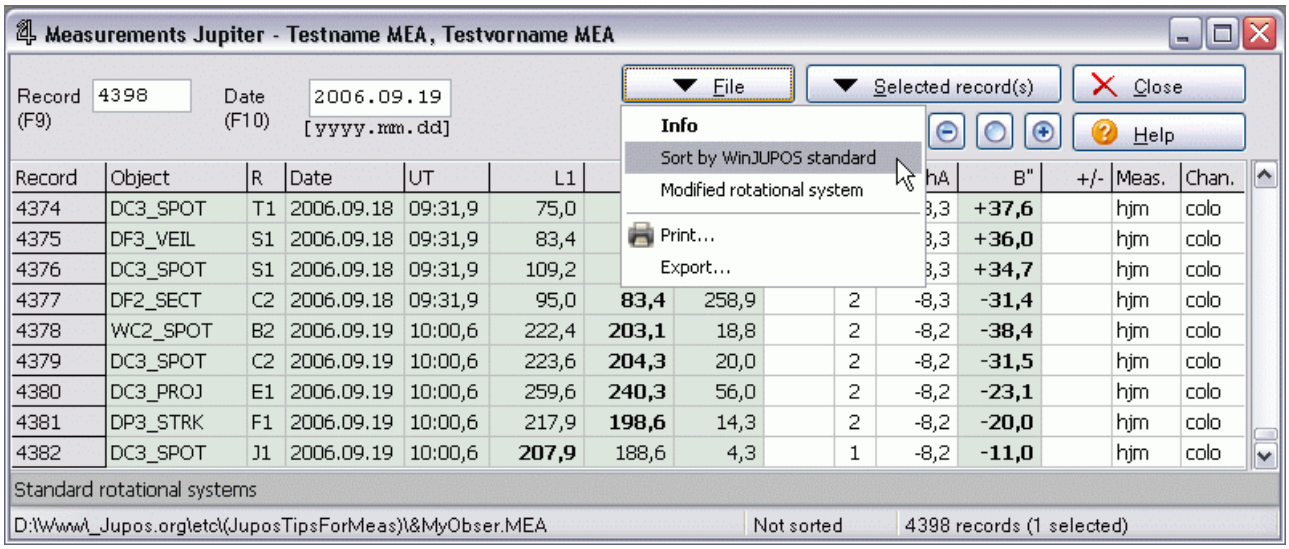
In the following example, &MyObser.MEA and &MyObs_2.MEA differ from copies located in another folder: One record of &MyObser.MEA varies in UT (0.1 min), another of &MyObs_2.MEA differs in latitude (0.1°).



Note that each pair of files to be compared has to have an identical record order. Otherwise, the protocol will list a lot of differences. Measurers often submit chronologically unsorted MEA files but I sort them according to the WinJUPOS standard before I publish new archives. Hence, before starting any comparision you have to sort your local MEA files likewise. This is provided by *Administration – File sorting – Measurements*:



You can also sort at *Recording - Measurements/New - (open MEA file) - File - Sort by…:*



Look at the status line of this window: Either *Sorted* or *Not sorted* is displayed there.

New observer - what to do?

Create master data file

First of all: Please inform me before you want to start measuring a new observer. It might be possible that he was already assigned to another measurer. Double work is annoying.

Since 2008, we have been using the WinJUPOS-specific MEA format for storing positional measures. The MES format of the earlier PC-JUPOS software is not supported anymore.

The option to create a new master data file is a bit hidden in WinJUPOS: Under *Recording - Measurements/ New* a dialogue for opening a file appears. Pick type *WinJUPOS Measurements (*.mea)*, enter a **nonexistent** file name, press *Open* and answer to the question "*File … does not exist. Do you want to create it?*" with Yes.

Though WinJUPOS allows longer file names, do not use more than eight characters to the left of the period. For example, *&MyObser.mea*, **not** &*MyObserver.mea* . The file name should represent the last name of the observer as accurately as possible.

Necessary is the prefix & at first position. We distinguish between two types of MEA files:

1. without prefix, for instance "Lohse.mea". These files contain older visual estimates or measures done by means of a micrometer, partly also from drawings and photographs using transparent grids or similar. They are outside the scope of this document.

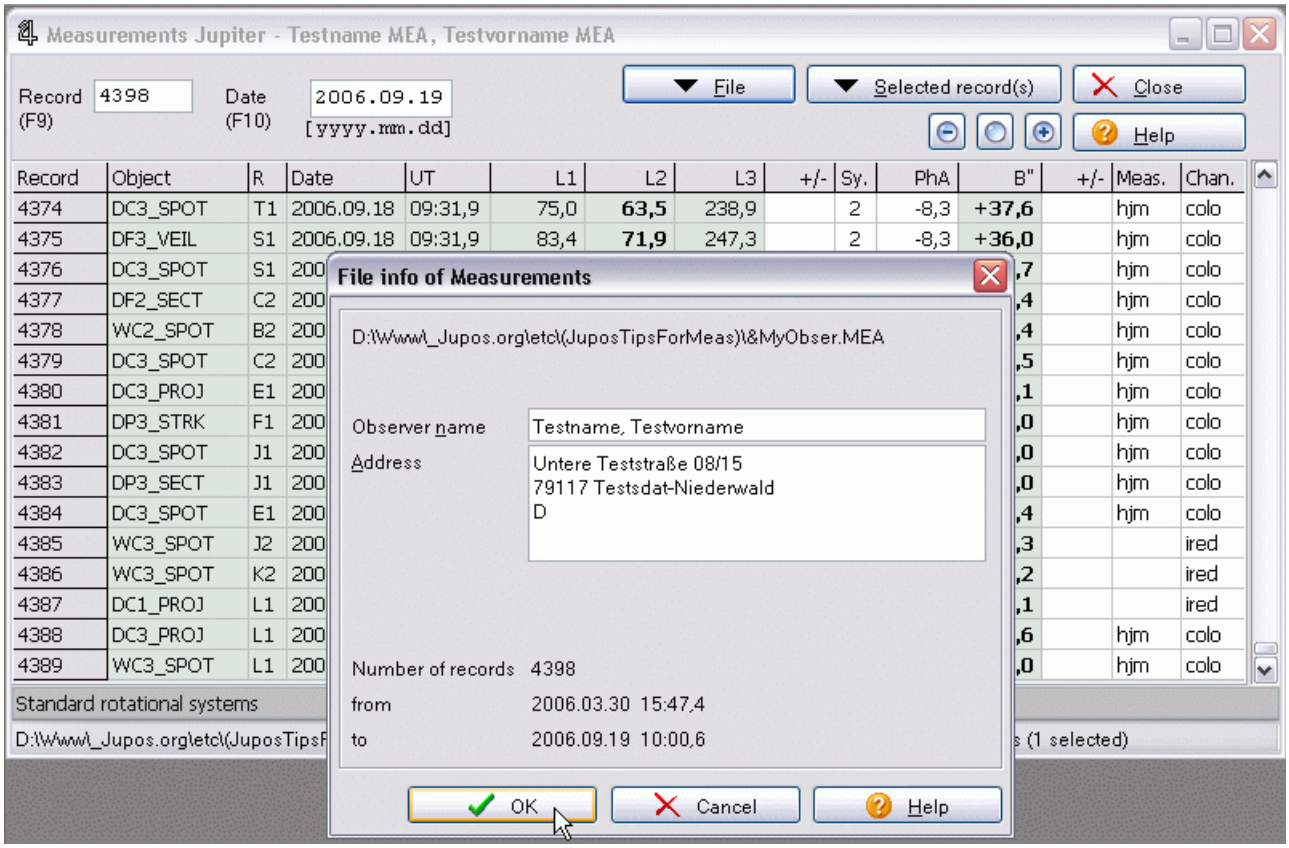
2. with prefix &, for instance "&Lazzaro.mea". They only include measurements of electronic images performed with WinJUPOS or PC-JUPOS. High resolution chemical photos are possible, too.

Maintain observer info

Please maintain information on names and addresses of „your“ observers on your own. These are given in the List of Observers on http://jupos.org. The recommended format is:

Last name, first name
Address line 1 (street or organisation preferred)
Address line 2 (location preferred)
Car country code

The respective window is *Recording - Measurements/New - (open MEA file) - File - Info*. Please limit the content of *Address* to three lines maximum, and do not make a line too long. Otherwise, text could get truncated.



Communicate master data files

Please send me your recent measures only when requested. I send out an e-mail with a proposed date to all regular JUPOS measurers about once a month during a jovian apparition. Please compress your MEA files into a ZIP archive (at highest compression rate if adjustable) instead of attaching them one by one.

The directory where your MEA files are located on your harddisk may also contain files with extension IMR. You do not need to include them in the ZIP.

Data management

Measurement templates

It is very helpful to create a separate Measurement settings file (*Recording - Image measurement* - tab *Image - Save*) that can later be used as a template (… - *Load*) for **each** observer. It contains fixed observer-related parameters, viz. tab *Image - Observer*, tab *Image - Open image - <image directory>*, and tab *Opt. - Measurer code*, but is also useful to initialise other settings like year, brightness, contrast, and so on. All these pre-defined parameters will be in effect immediately after loading the settings template. So you do not need to step through to the proper image directory, and enter year and your measurer code every time.

Folder structure

Contrary to PC-JUPOS where the directories for saving and loading individual file types were "hard wired", WinJUPOS leaves more freedom to the user. If you want to avoid losing track of your environment, an elaborate folder structure is urgently needed. Certainly every measurer has his own ideas on how an optimum configuration looks like. Here my structure as an suggestion:

```
\WinJUPOS\Settings 2004-05\Aman\*.ims      Settings Measurements
                          \Bman\*.ims                 "
                           ...
         \Settings 2005-06\Bman\*.ims                 "
                          \Cman\*.ims                 "
                           ...
         ...
         \0_STAMMDAT\*.cmt            Master data CMT transits
         \0_MESSDAT\*.mea             Master data Measurements
         \1_PARAM\PSelect\*.ses       Settings Selections
                 \PCharts\*.grs       Settings Drift charts
                 \PMittel\*.avs       Settings Positional averages
                 \PFehler\*.ecs       Settings Longitudinal shifts
                 \PProjec\*.mcs       Settings Projection maps
                  ...
         \2_SELCDAT\*.wse,*.wsd       Selection files
         \3_CHARTS\*.gif,*.gts        Drift charts
         \4_MITTEL\*.wad,*.pav        Positional averages
         \5_FEHLER\*.wed              Longitudinal shifts
         \6_PROJEC\*.jpg,*.gts        Projection maps
         \7_MAKROS\*.wjm              Macros
          ...
```

Aman, Bman, etc. indicate names of the individual observers.

Jupiter images should also be arranged according to year, or preferrably apparition, and observer. My folder structure is:

```
...
\Img2004a\Aman\
\Img2004a\Bman\
...
\Img2004b\Aman\
\Img2004b\Cman\
...
\Img2005a\Bman\
\Img2005a\Cman\
...
```

A und b were introduced because a calendar year spans two Jupiter apparitions in general. Img2004a means the main part of apparition 2003/04, and Img2004b, the begin of 2004/05.

Backups

Regular backups of your complete data (at least images, master data files, and makros) go without saying. Otherwise, in case of a hardware failure, you could lose all your work! I recommend at least three generations of full backups burned on CD/DVD once every week or two. Keep them at separate locations.