l'Observatoire de Paris | LESIA

Laboratoire d'Études Spatiales et d'Instrumentation en Astrophysique

Multi-object Instrument for Occultations in the SOlar system and TransitorY Systems

The search for trans-Neptunian stellar occultations with MIOSOTYS,

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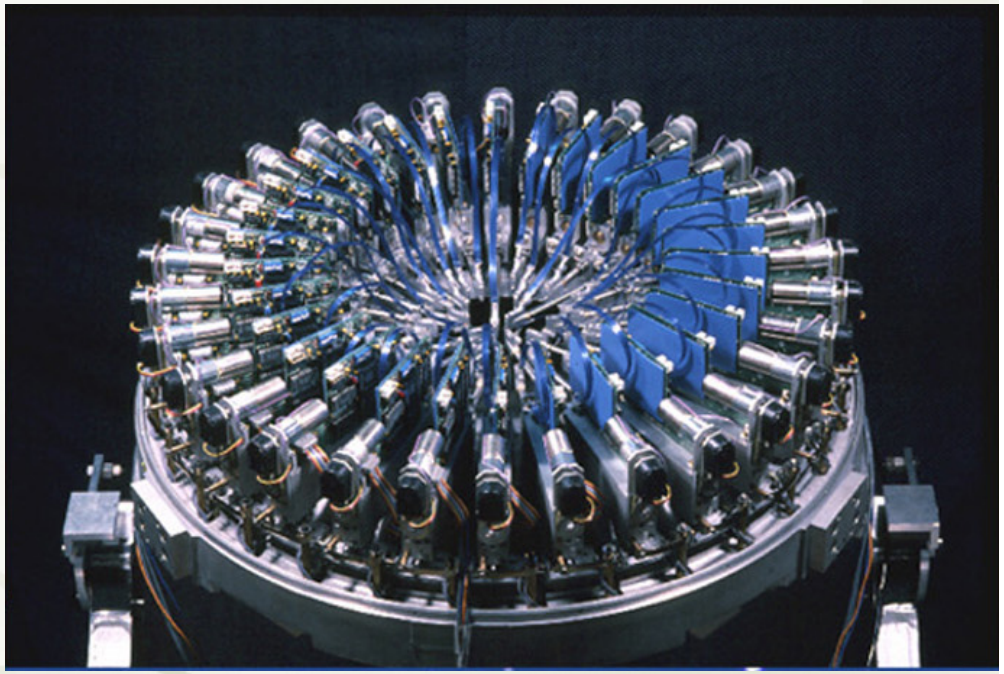
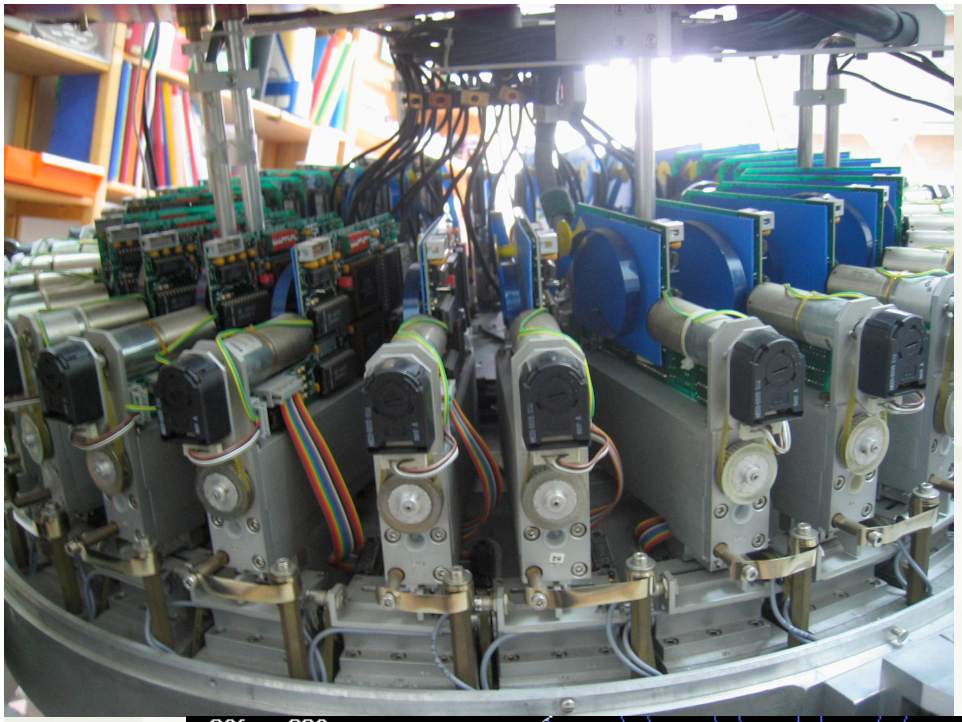
The instrument

- MIOSOTYS: Multi-object Instrument for Occultations in the SOlar system and TransitorY Systems

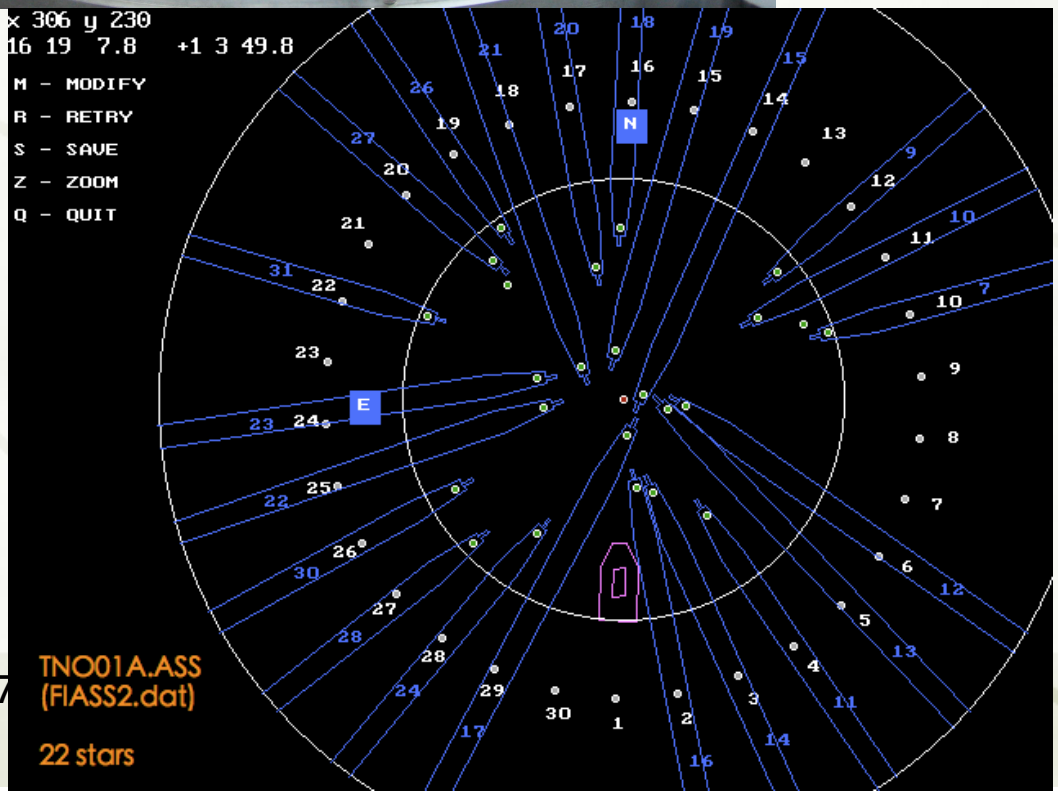
MIOSOTYS is a multi-fiber positioner coupled with a fast photometry camera.
It is an arm positioner using 29 arms in a 26 arc-minute field.
The system is set in a circle like ‘fisherman around a pool’.





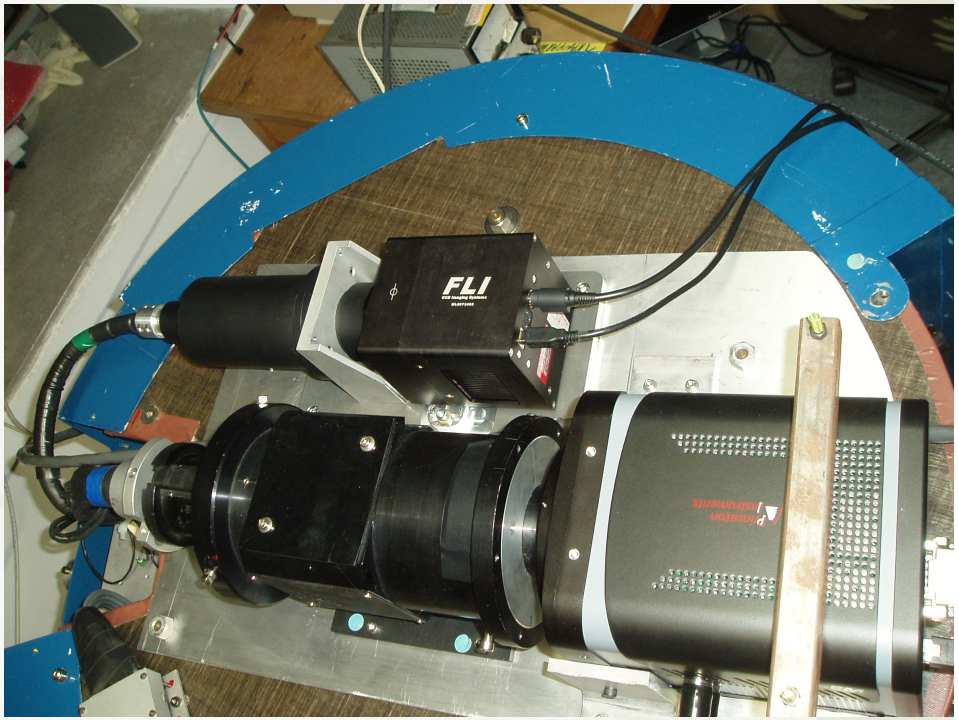
The instrument

- Each arm is equipped with an individual viewing system for accurate setting and carries one individual fiber that intercept 13” arcsec on the sky.



The instrument

- All the 29 fibers are aligned on an CCD for fast photometry acquisition.
- PROEM Princeton Instrument
- frame-transfer EMCCD: very low noise and fast acquisition

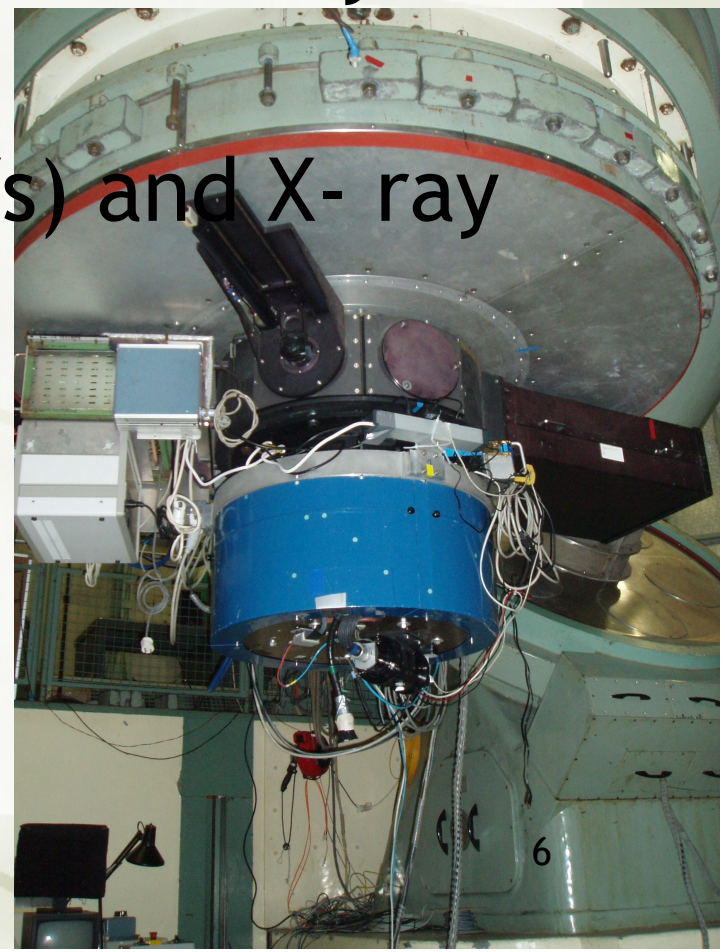


- OHP is situated in southeast France on a plateau at 650m altitude
- Cassegrain (f/15) focus at the 193-cm telescope
- Seeing around 2-2.5 arcsec

Longitude = 5° 42' 44" E
Latitude = +43° 55' 54"

Science Case

- Serendipitous stellar occultation by Trans-Neptunian objects
- Cataclysmic Variables (CVs) and X- ray Binaries (XRBs)
- Transiting exoplanets
- ….

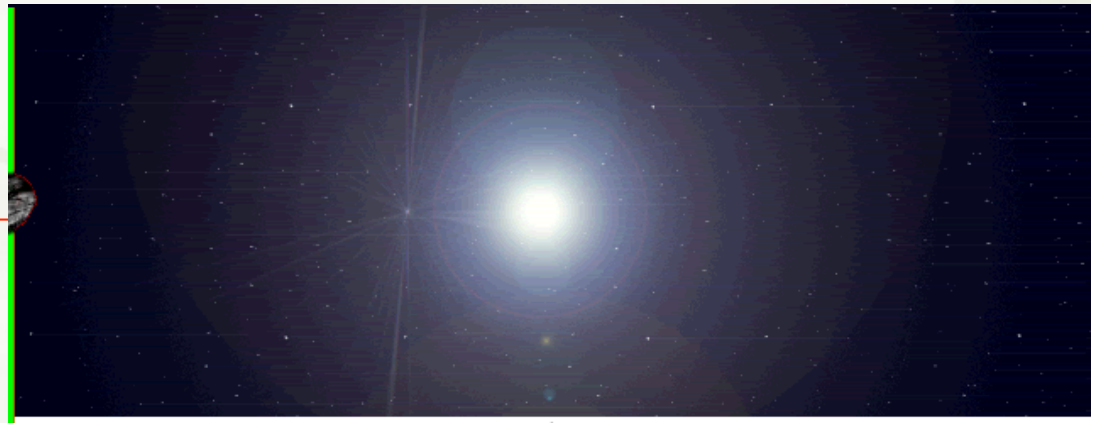


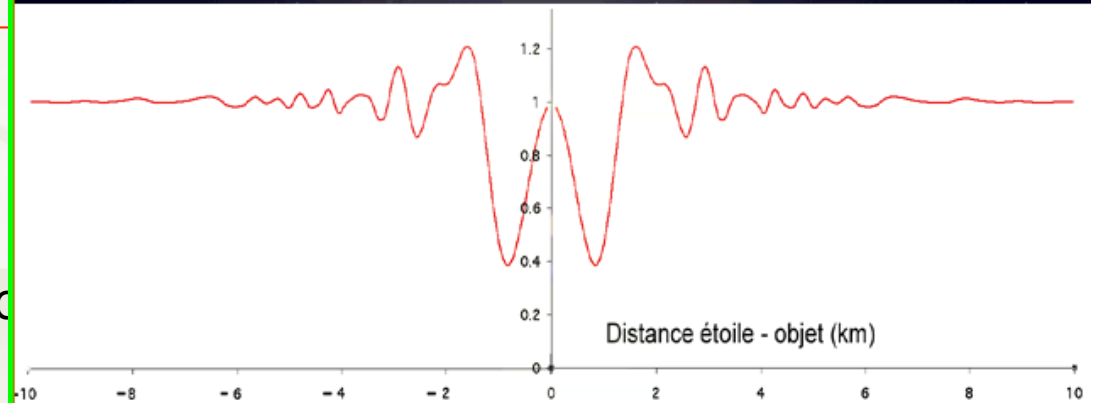
The method : serendipitous stellar occultations

The aim :
- Detection of the diffraction shadow of small (numerous) TNOs
- Simulations : hundreds meters TNOs detectable (Roques et Moncuquet, 2000)

Principles of the method :
- Fast photometry (> 20 Hz)
- small size stars

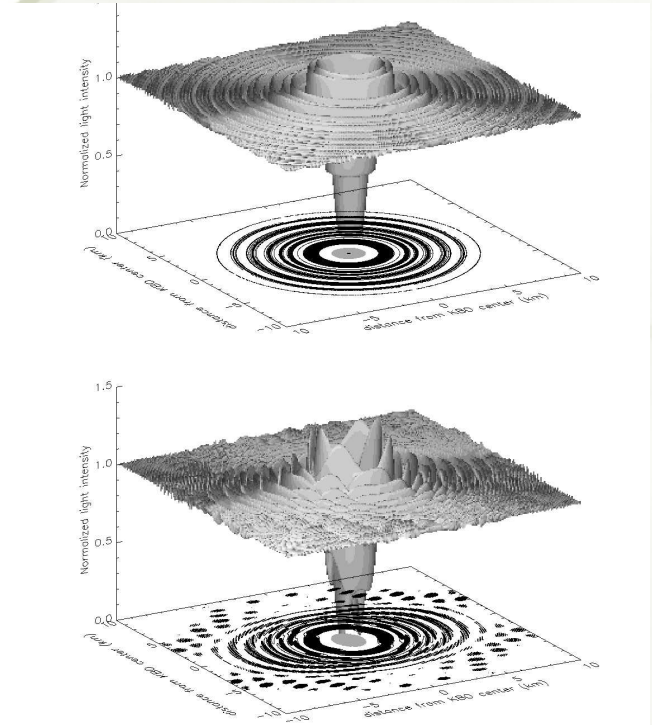
Observations :
- Constraint on the size distribution
- Three events (Roques et al, 2006)





The Fresnel scale

The Fresnel scale is the scaling factor of the occultation



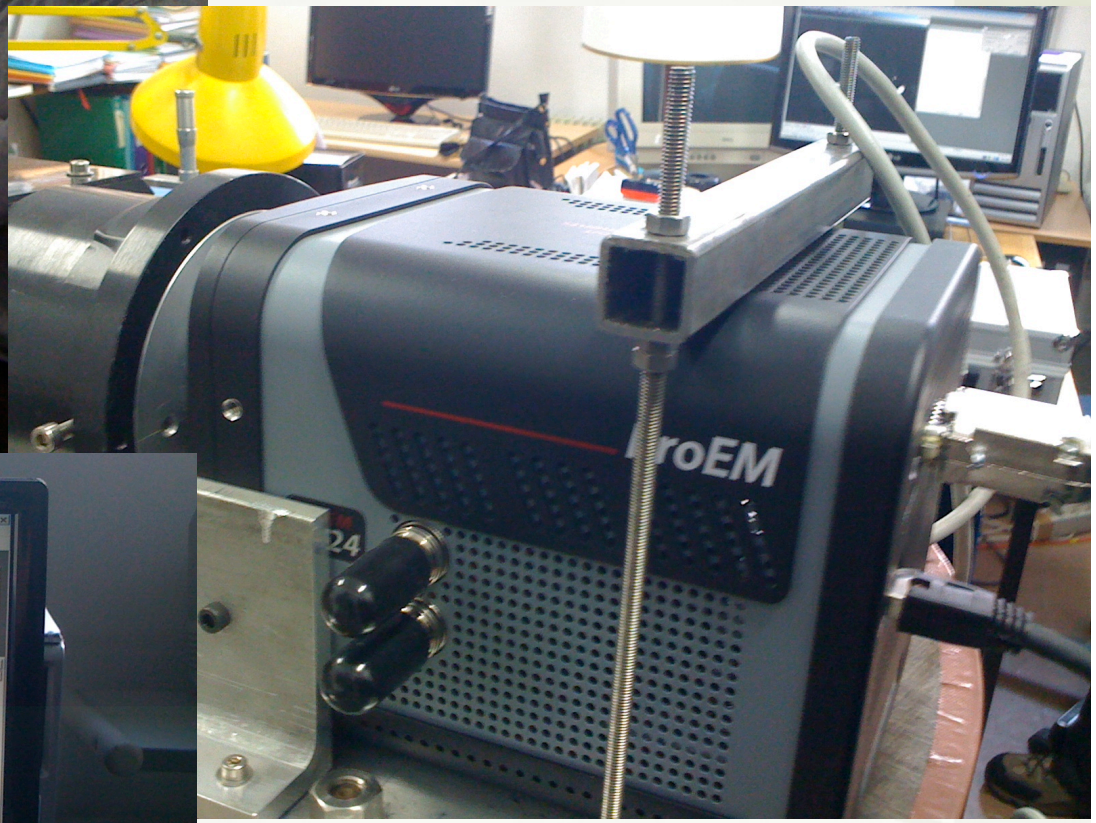
Roques et Moncuquet, 2000

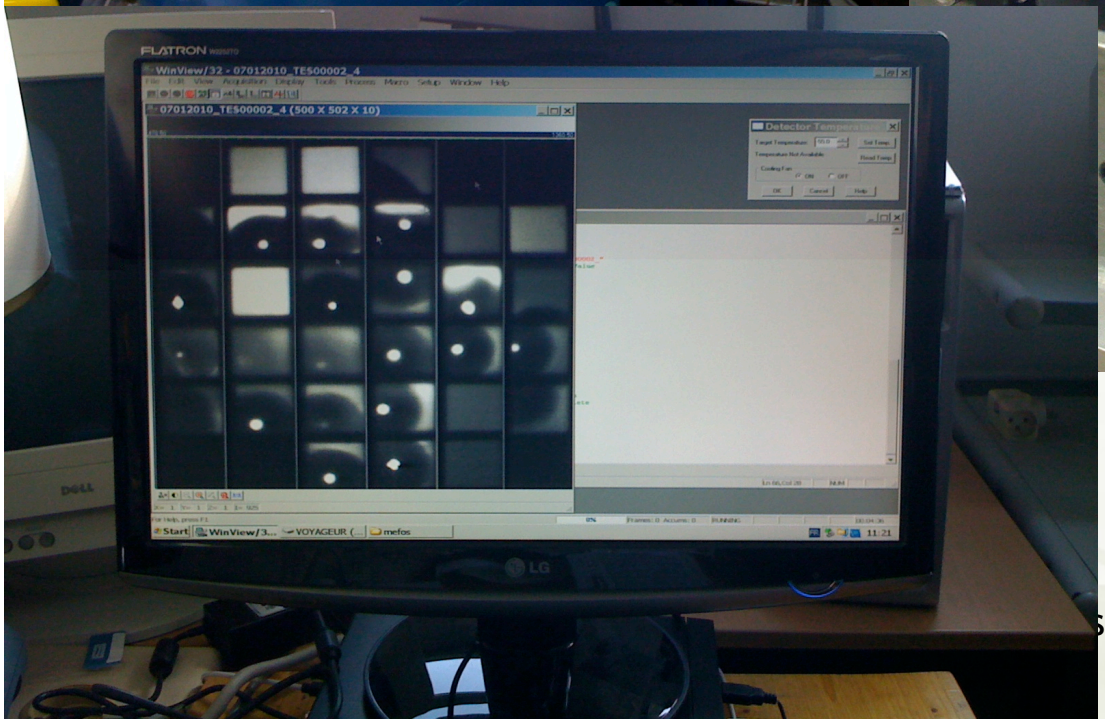
$$F = \sqrt{(\lambda . R/2)}$$

λ: wavelength

R: distance of the TNO

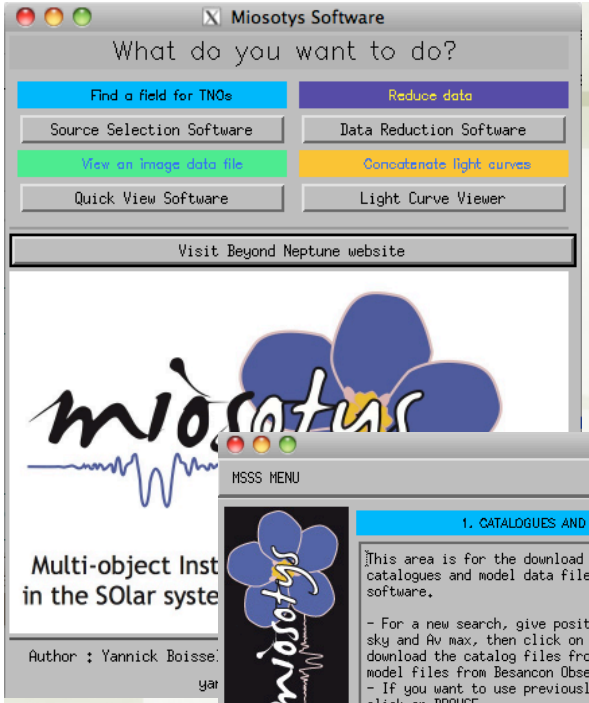
- **R = 3 AU, Fs = 245 m**
- **R = 40 AU, Fs = 1.1 km**
- **R = 10^5 AU, Fs = 55 km**

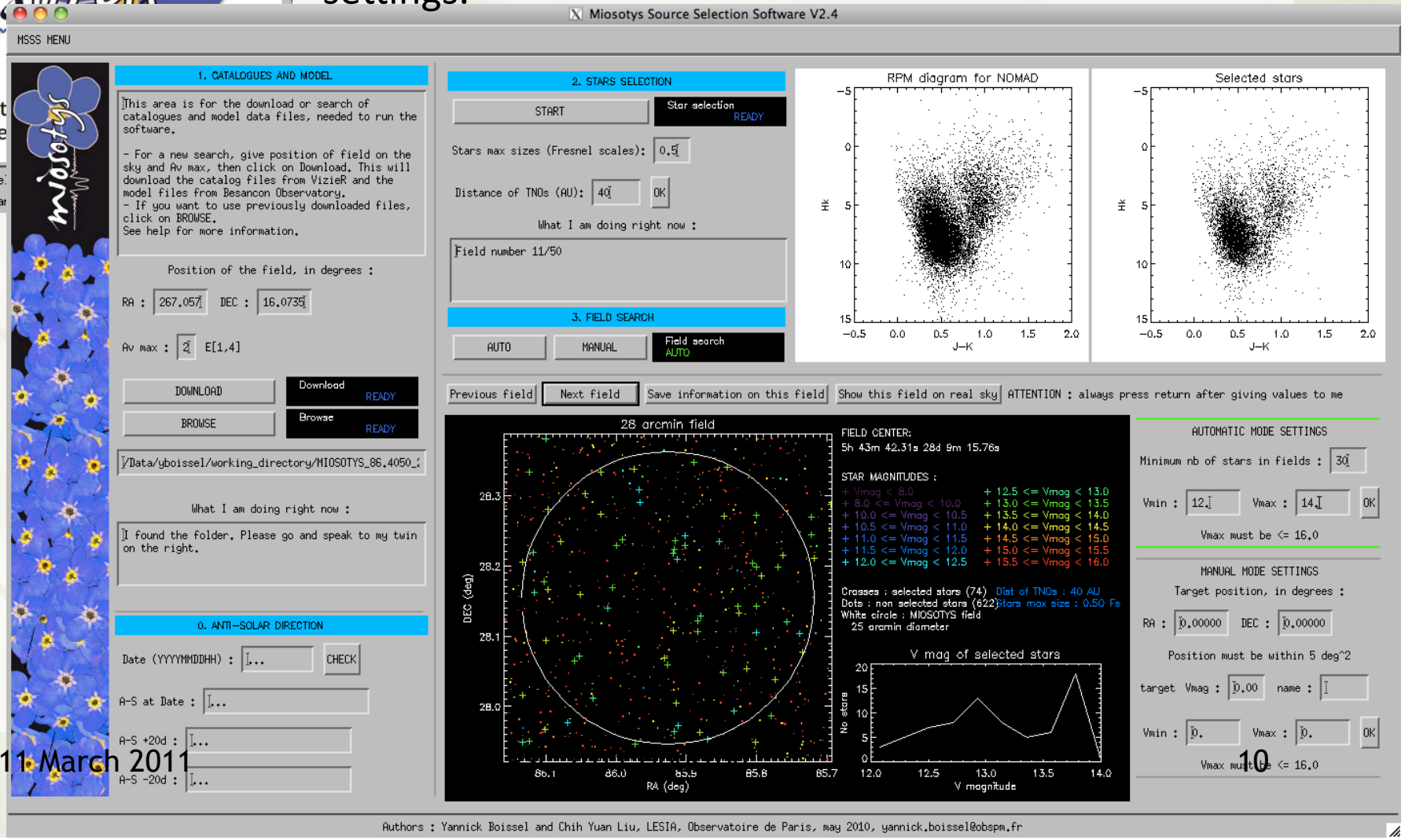

roEM


FLATRON
WinView/32 - 07012010_TE500002_4
07012010_TE500002_4 (500 X 502 X 10)
Detector Temperature
Start
WinView/3...
VOYAGEUR (...
mefos
11:21

Miosotys source selection software

-Automatically downloads catalogs and model of the Galaxy.
- Selects stars with small angular diameter, via reduced proper motions and magnitudes.
- Finds fields to be observed by MIOSOTYS with various settings.



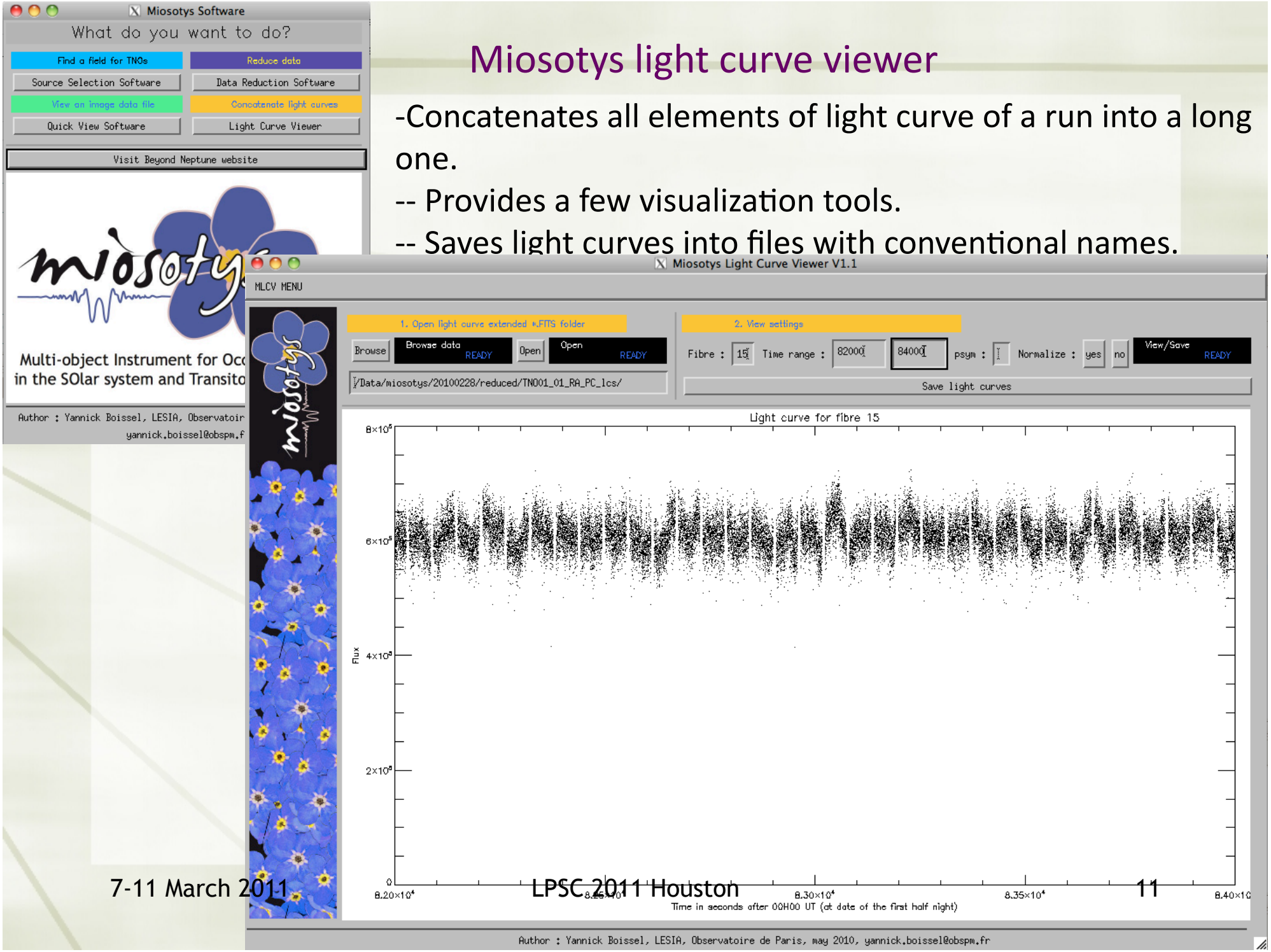


Miosotys light curve viewer

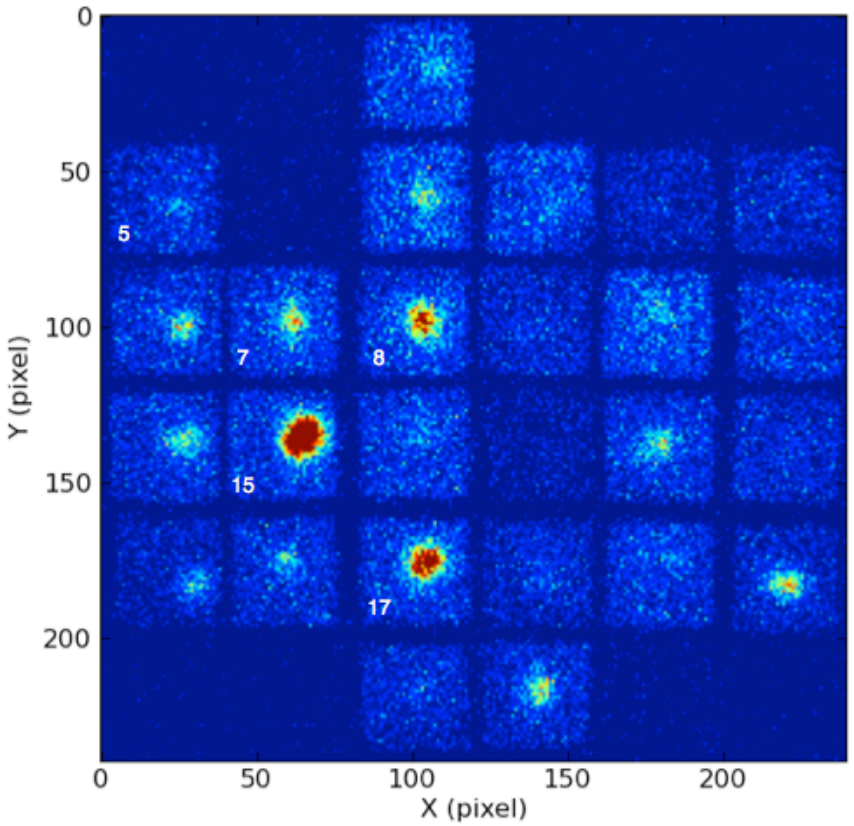
-Concatenates all elements of light curve of a run into a long one.

-- Provides a few visualization tools.

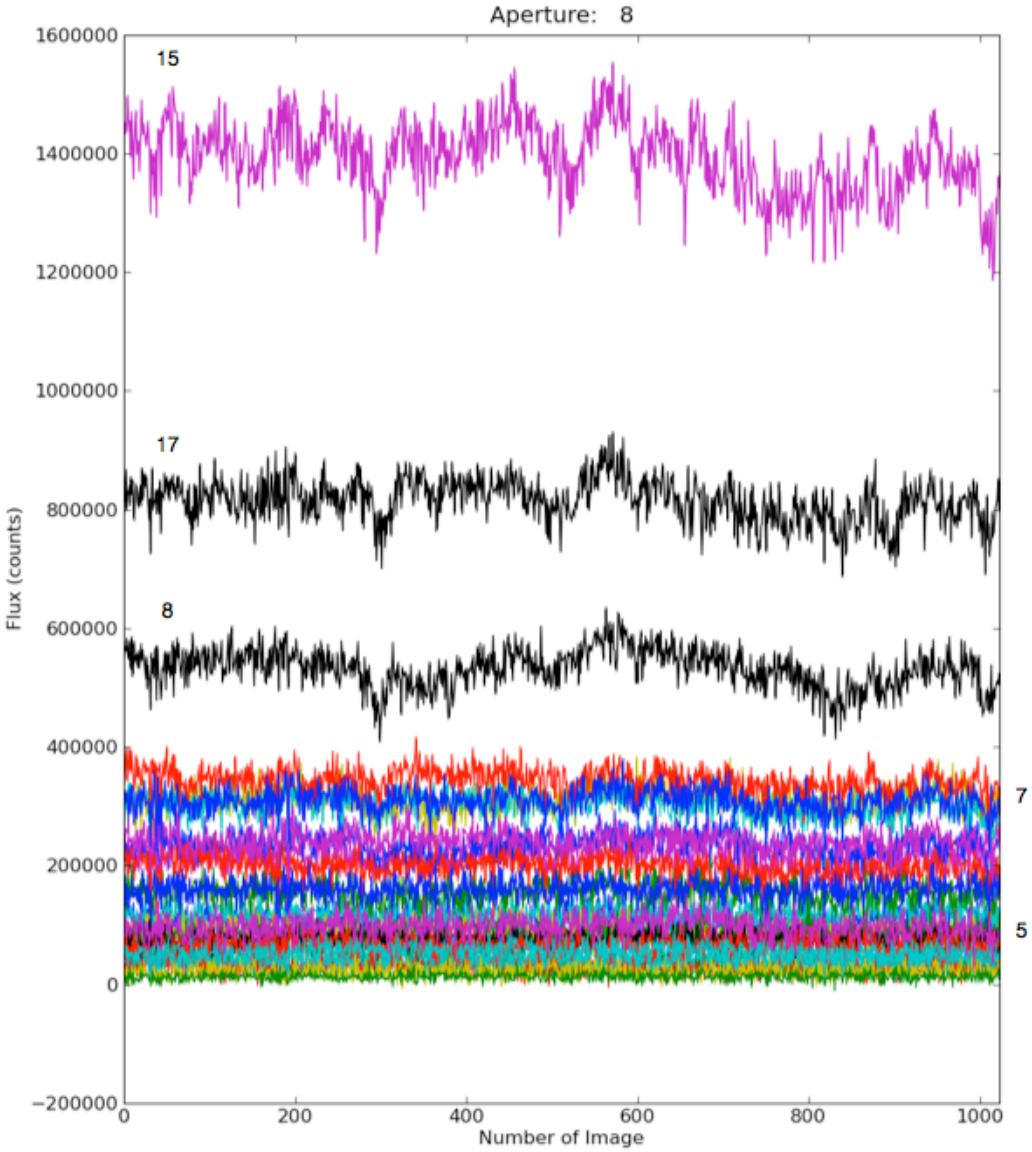
-- Saves light curves into files with conventional names.



First light in March 2010



R.A. (centre)	07:10:15.3
Dec. (centre)	+22:44:12.8
Exposure time	0.1 sec
EM gain stage	500
V Magnitude (NOMAD)	12.2 – 14.5

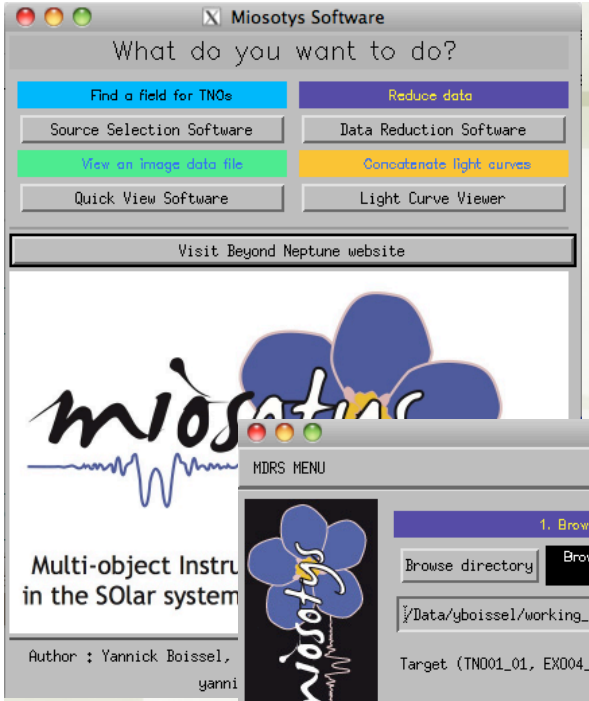


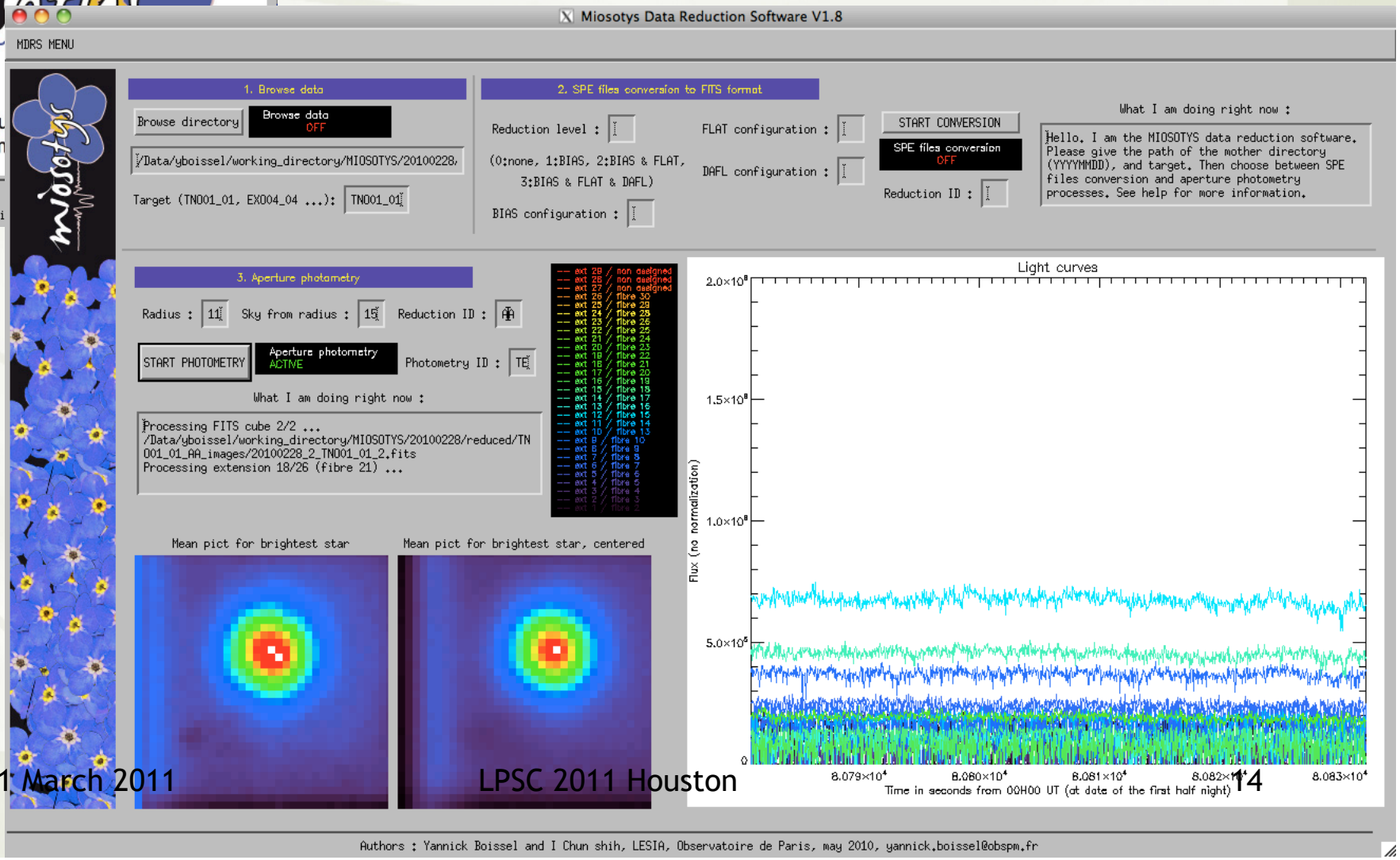
Summary and perspectives

- New promising instrument
- First « dedicated » fiber instrument
- Expected performances:
  - S/N=10-30 @ 20 Hz
  - 12-13 mag stars
- Detection of 0.09 event per night

Miosotys data reduction software

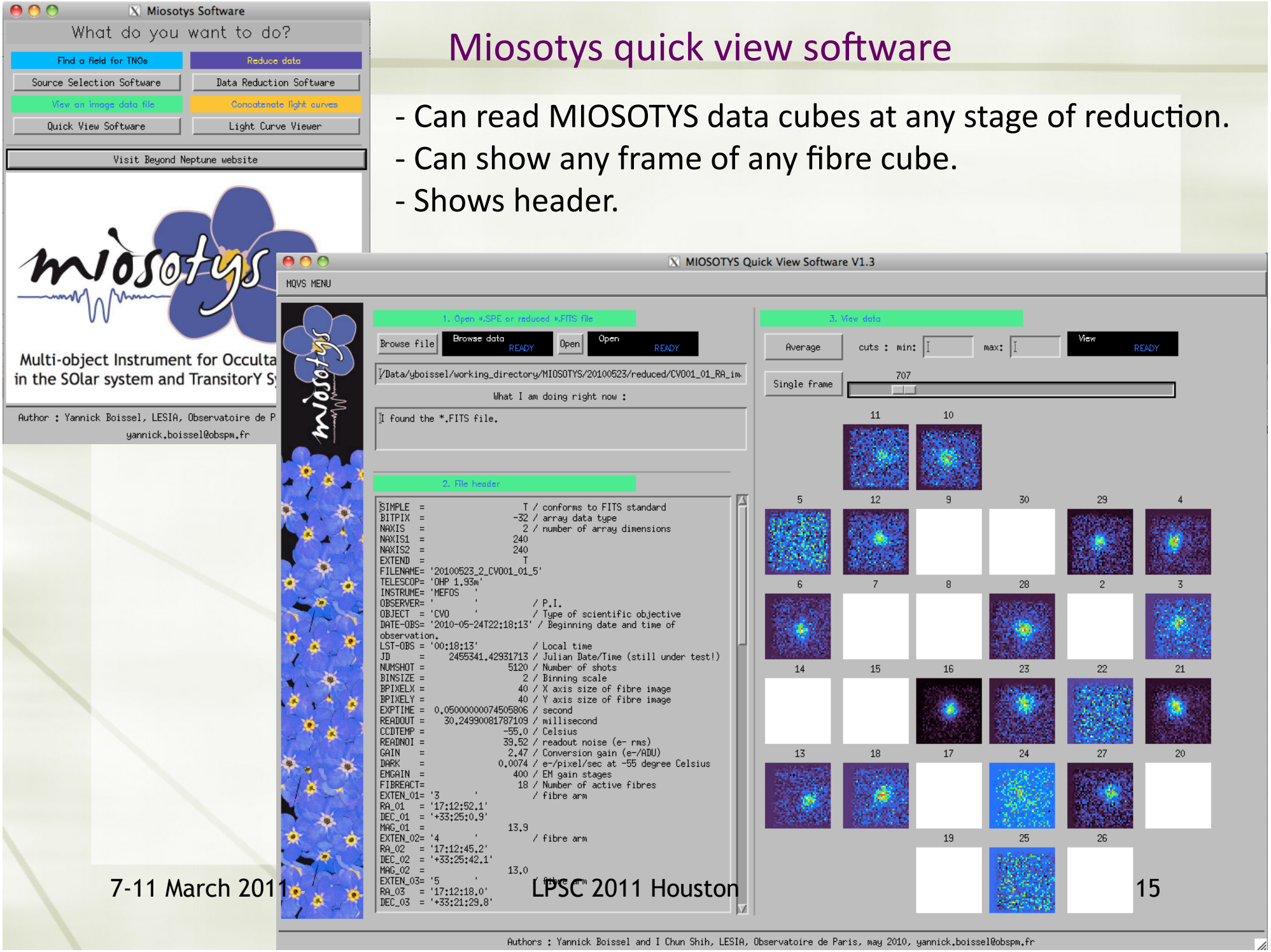
- Converts CCD owned formats to *.FITS.
- Detects stars in each fibre, for all frames via calculation of photocenters.
- Produces light curves via aperture photometry.

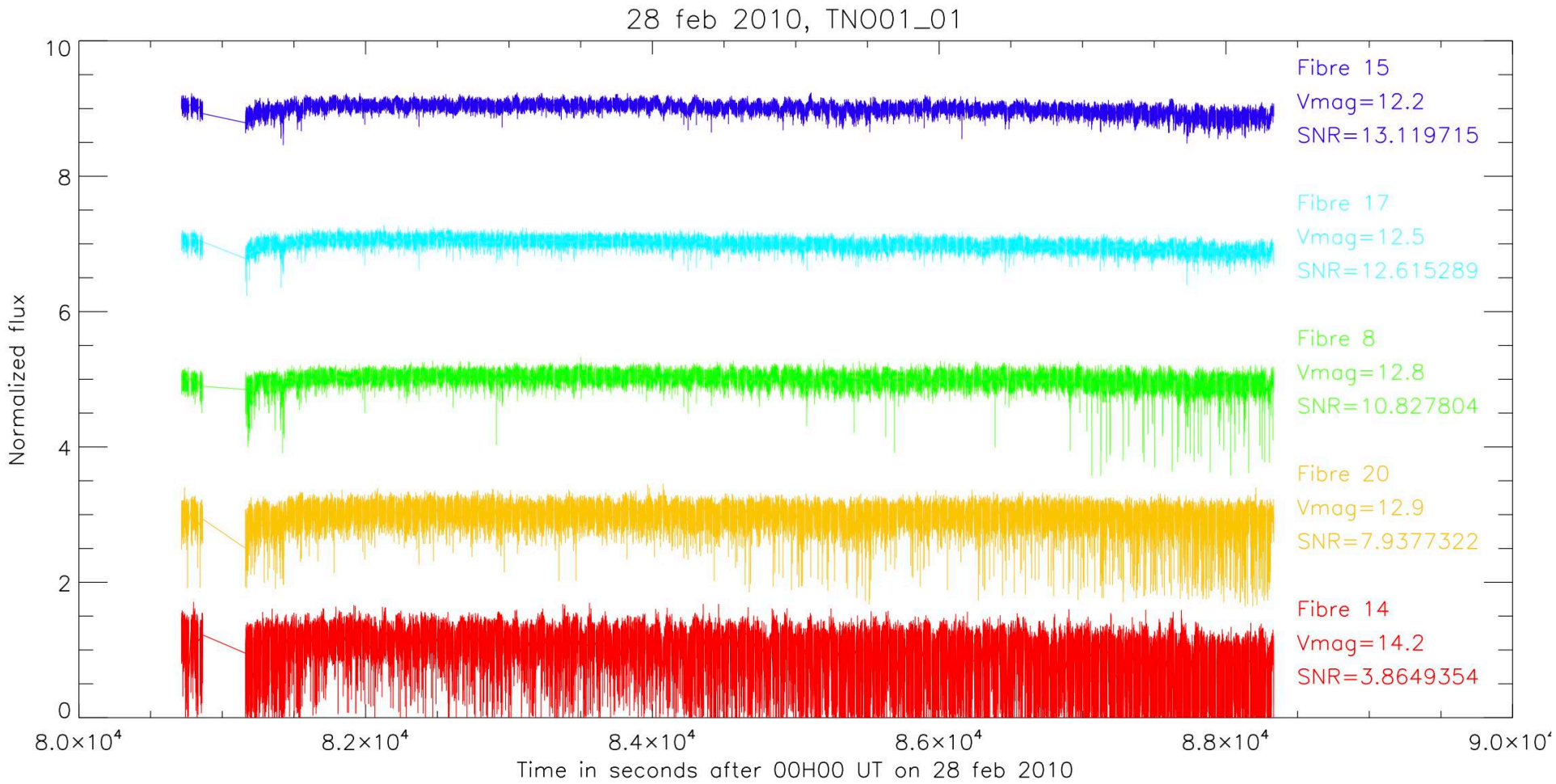




Miosotys quick view software

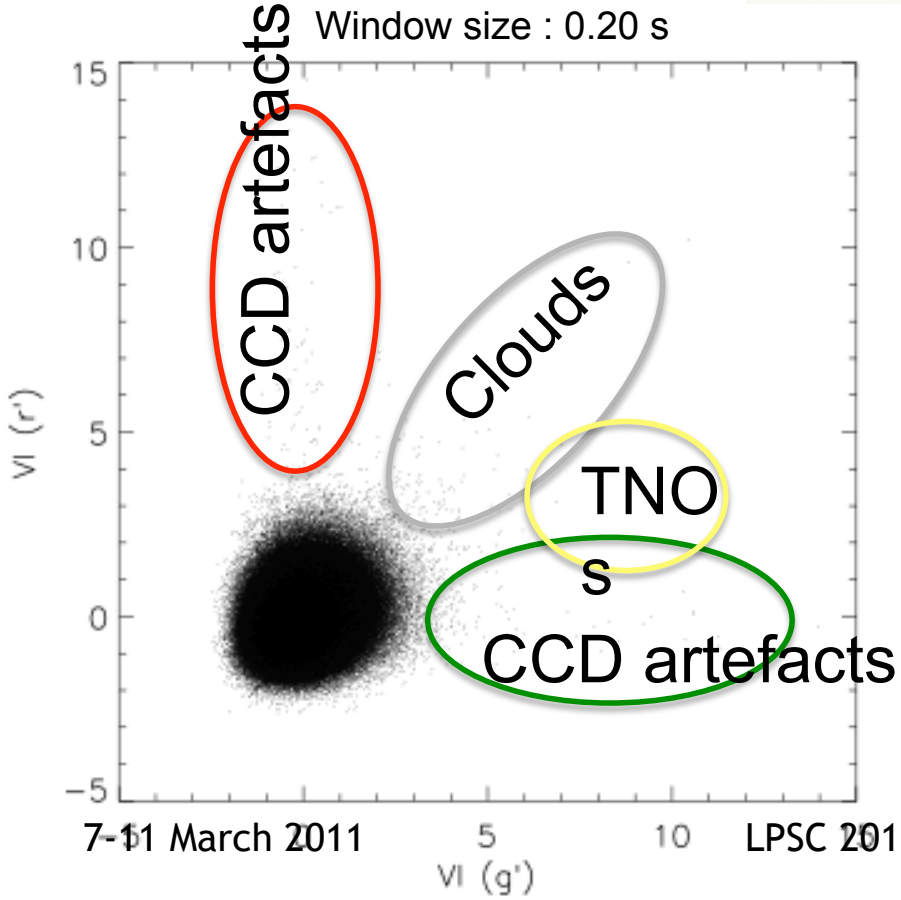
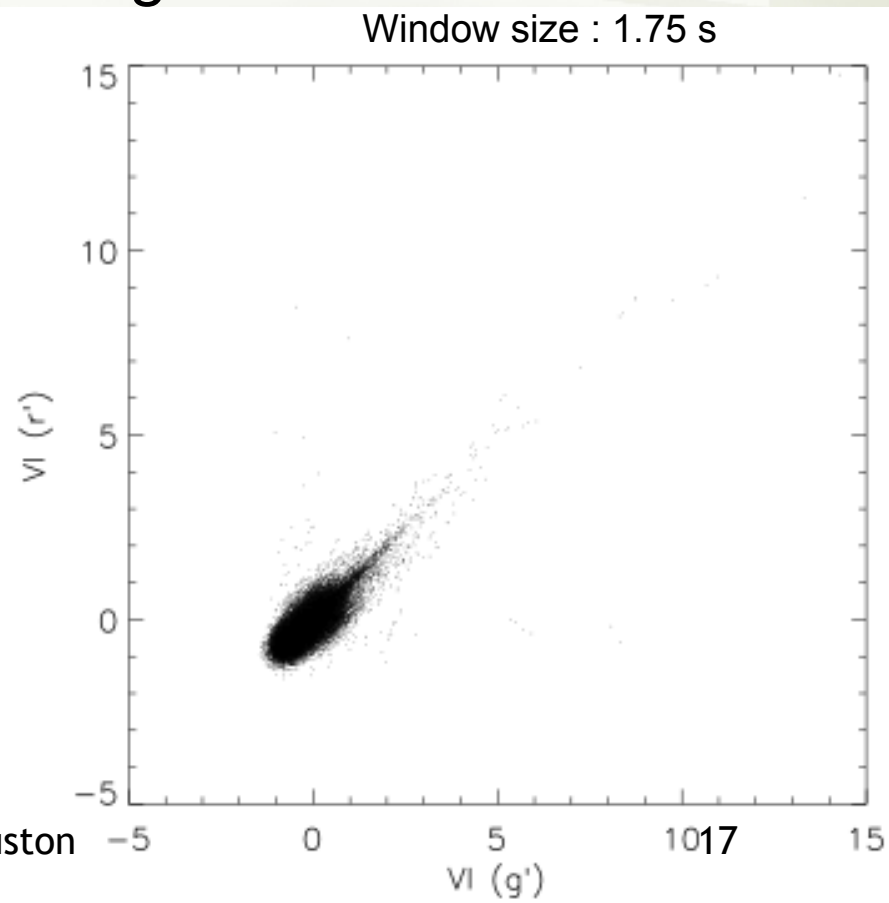
- Can read MIOSOTYS data cubes at any stage of reduction.
- Can show any frame of any fibre cube.
- Shows header.




28 feb 2010, TNO01_01
Normalized flux
Time in seconds after 00H00 UT on 28 feb 2010
Fibre 15
Vmag=12.2
SNR=13.119715
Fibre 17
Vmag=12.5
SNR=12.615289
Fibre 8
Vmag=12.8
SNR=10.827804
Fibre 20
Vmag=12.9
SNR=7.9377322
Fibre 14
Vmag=14.2
SNR=3.8649354

Variability index : example on ULTRACAM/VLT observations (2005)

- Two filters : green (g' : 0.47 µm) and red (r' :0.62 µm).
- 19 hours of data at frequency 61 to 64 Hz.

$$VI_w(i) = \frac{\sigma_w(i) - < \sigma_o >}{\sigma(\sigma_o)}$$

Calculated in a running window on light curves.