The IMCCE Virtual Observatory Solar System Portal

J. Berthier

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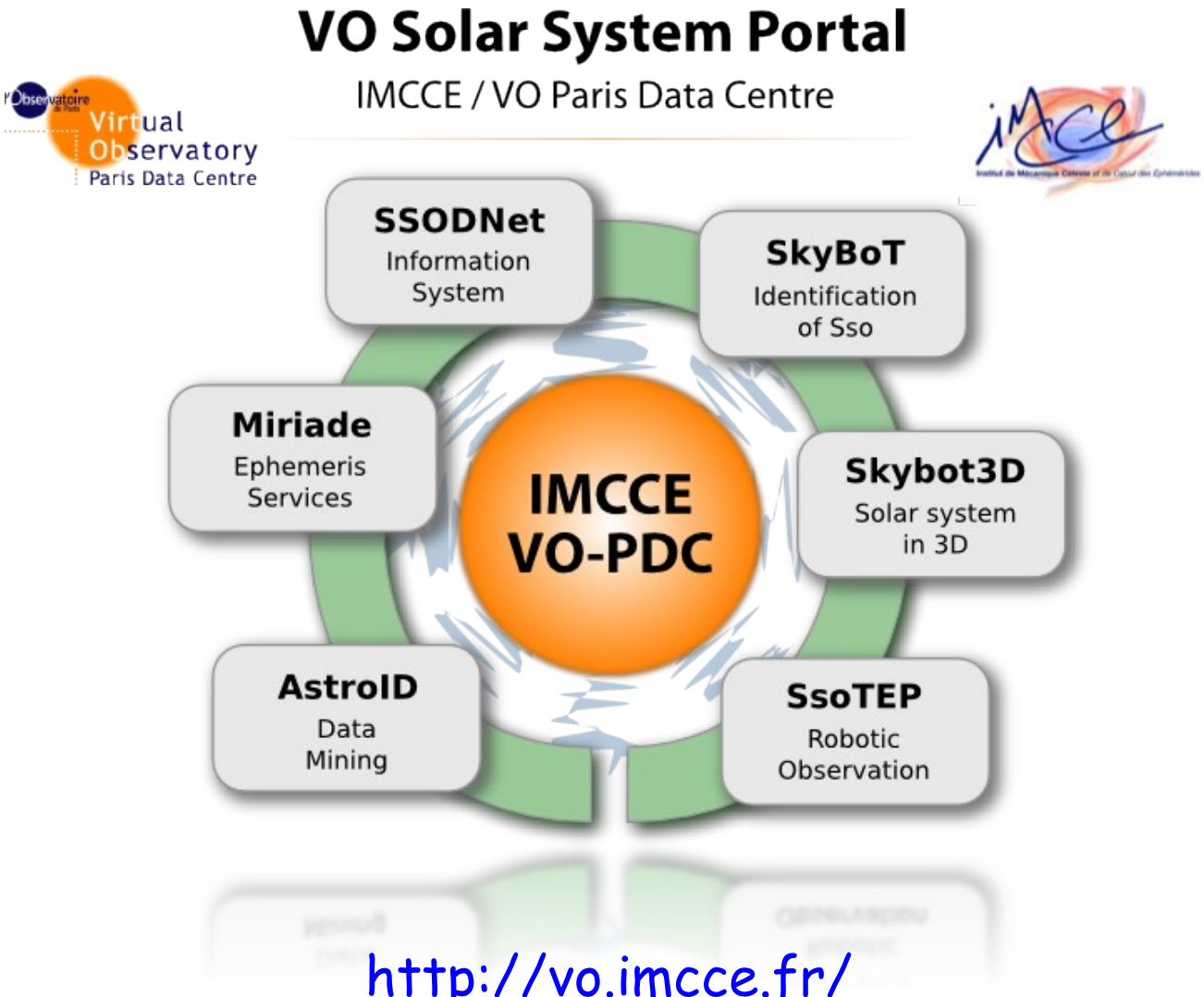
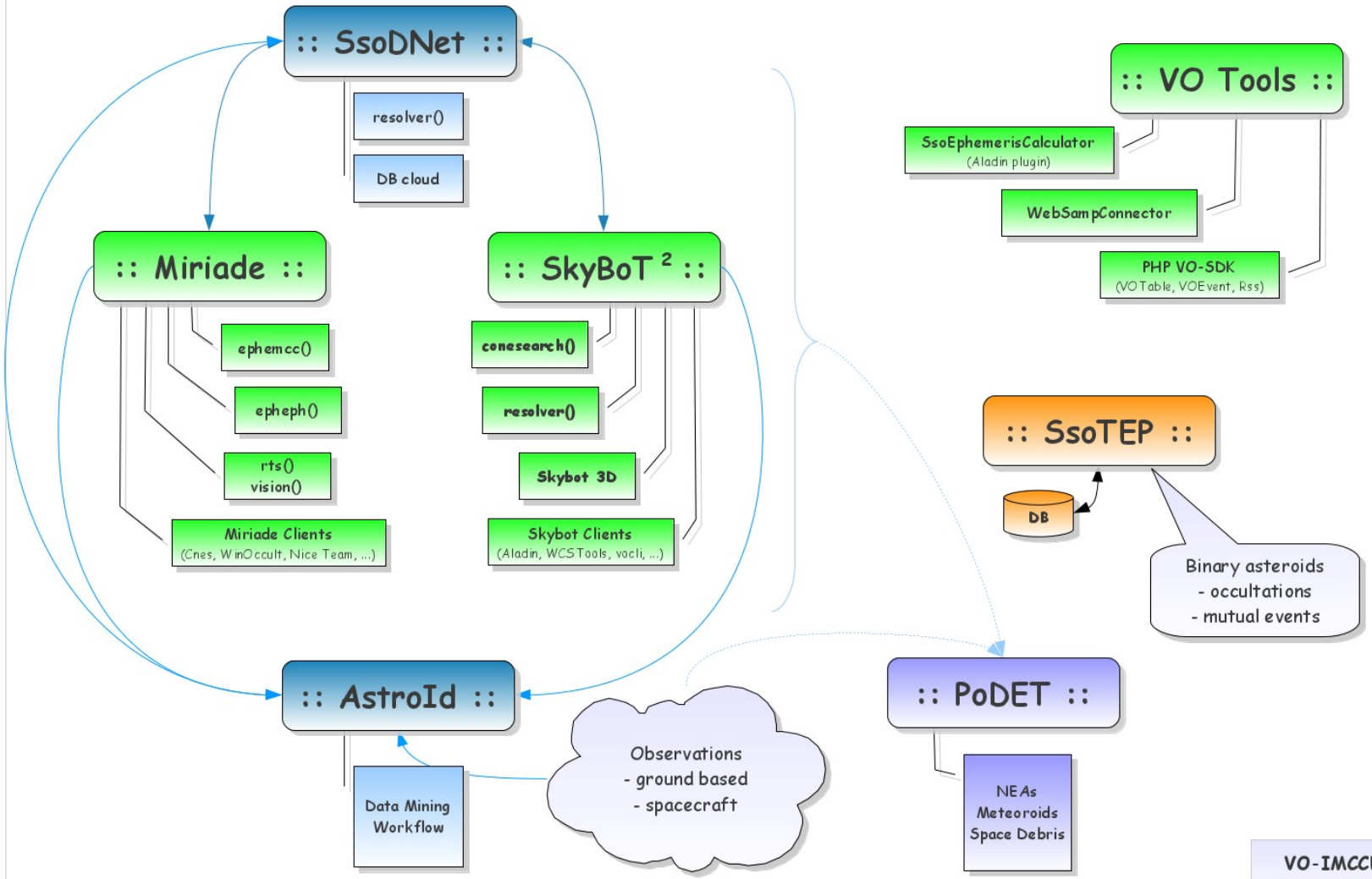
Observatoire de Paris / CNRS



http://vo.imcce.fr/

Architecture of services



Nowadays, many databases concerning solar system bodies exist :

- Some of them provide simultaneously several kinds of parameters, and other ones are (very) specialized
- It is usually necessary to query several databases to find the parameters of interest
- Almost all of them imply to use a web browser to query and display the data
- Almost none of them are VO compliant

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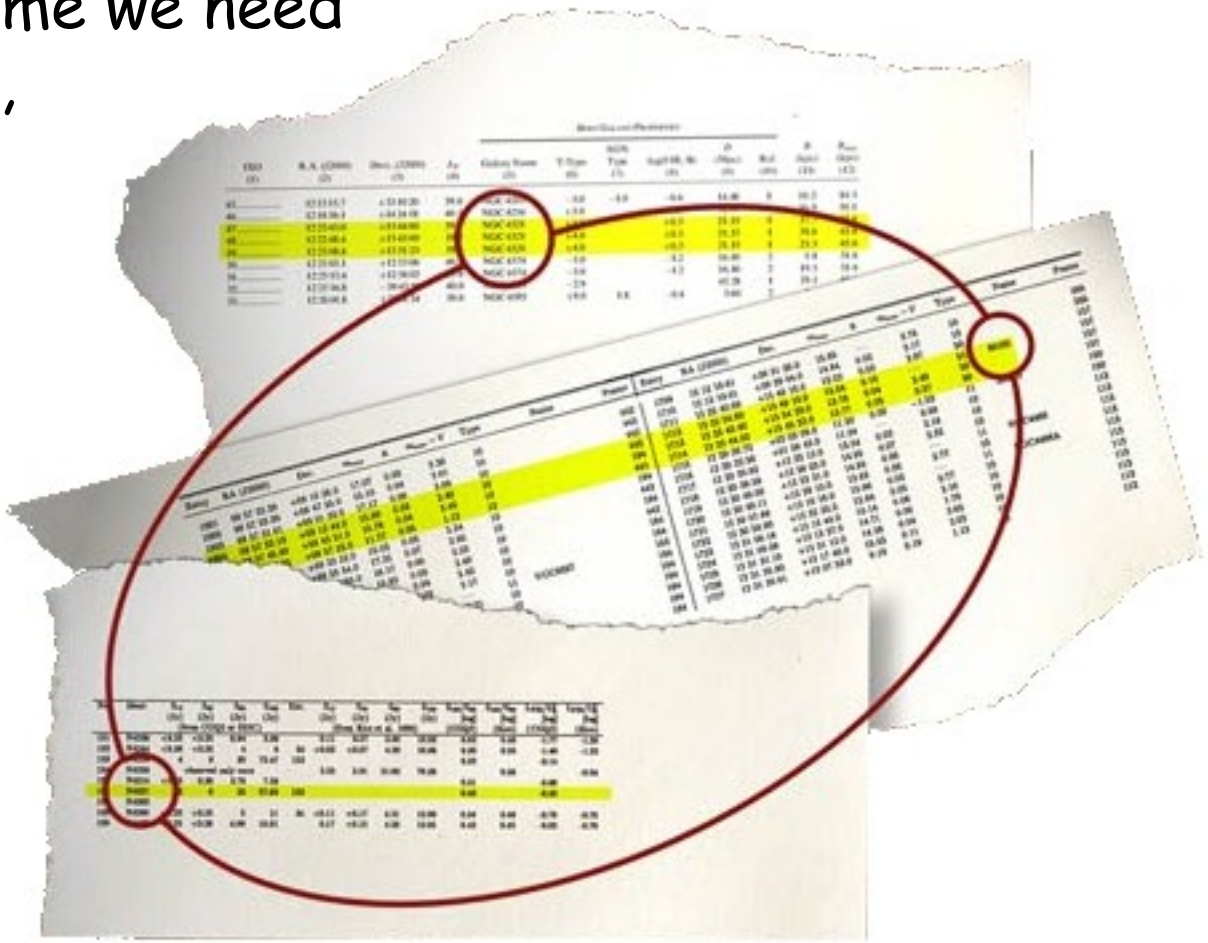
SsoDNet
Solar System Object Database Network

Most of the time we need to cut & paste, transform, format, ...



SsoDNet
Solar System Object Database Network

SsoDNet aim is

- To provide an information system devoted to solar system bodies (small bodies, planets, natural satellites)
- To allow a simple and easy inter-connection / inter-operability between users and existing databases that are distributed around the world
- To propose to users to access Sso databases in a single request, from their desktop or their programs
- To propose to curators of Sso databases to share their databases with the community

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SsoDNet
Solar System Object Database Network

Main concepts

- Provides a name resolver for Sso
- Acts as an aggregator of resources
- Resources (datasets, products) are registered
- EuroPlaNet EPNResource datamodel
- Extension of IVOA VOResource & VODataService schema
- Standard access protocol (WS, EPN-TAP) and output (VOTable)

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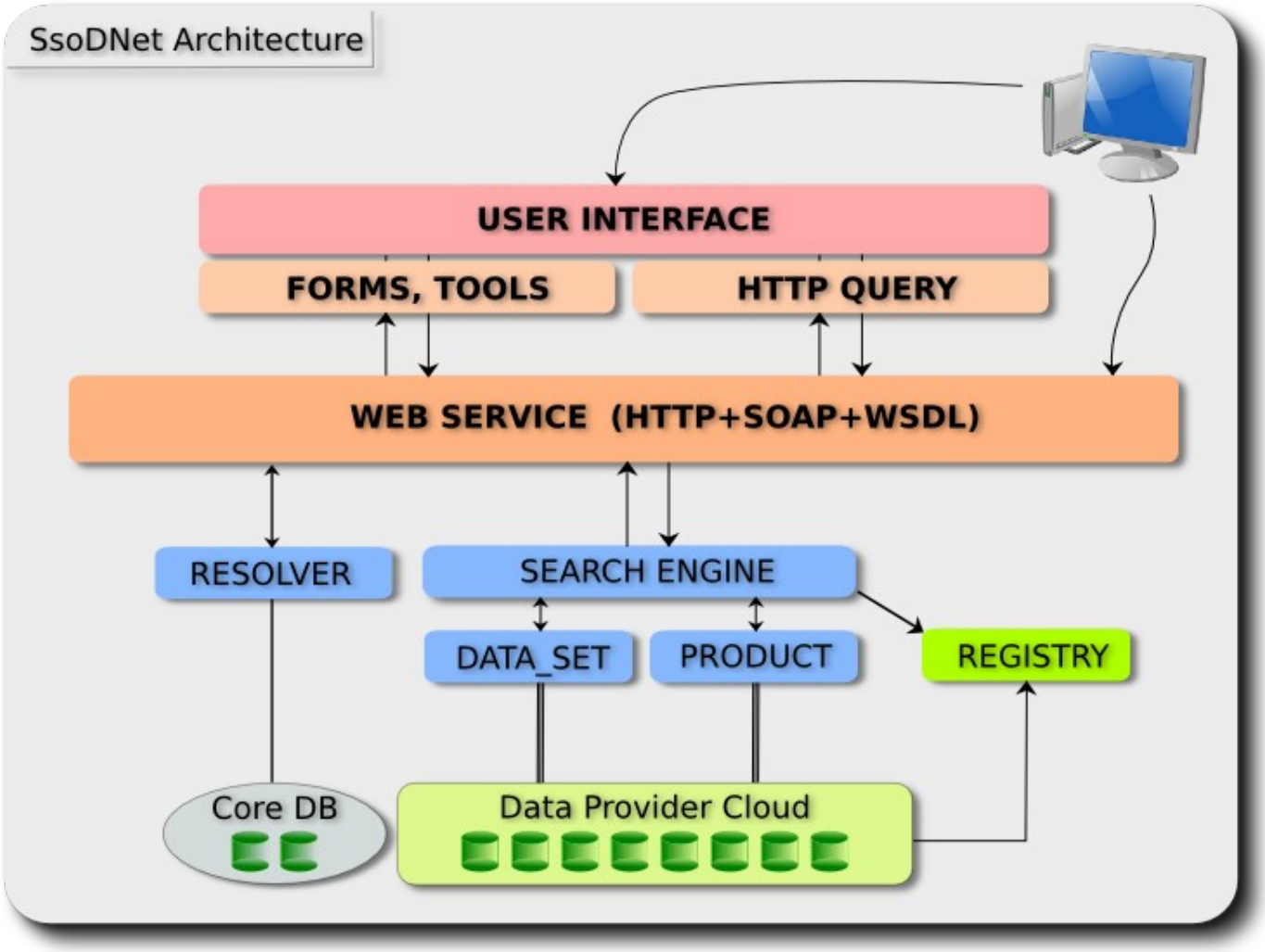
SsoDNet

Solar System Object Database Network



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SsoDNet

Solar System Object Database Network

Information system dedicated to solar system objects

- To resolve names of Sso
- To explore and retrieve Sso data at a glance
- To allow planetary scientists to share their databases

Developped by VO-IMCCE and VO-Paris teams

- EuroPlaNet project (IDIS node Planetary Dynamics and Extraterrestrial Matter)
- International Virtual Observatory Alliance (IVOA)
- International Planetary Data Alliance (IPDA)

- Work in progress, available in late 2012

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Miriade

Solar System Object Ephemeris Generator

Suite of tools to compute accurate positional and physical ephemerides of Sso:

- Planets, natural satellites, asteroids, comets
- Rise, transit, set
- Charts of visibility of Sso (B. Carry)

- For any location on Earth
- And any location in space (Rosetta, HST, SPITZER, Spirit, ...)

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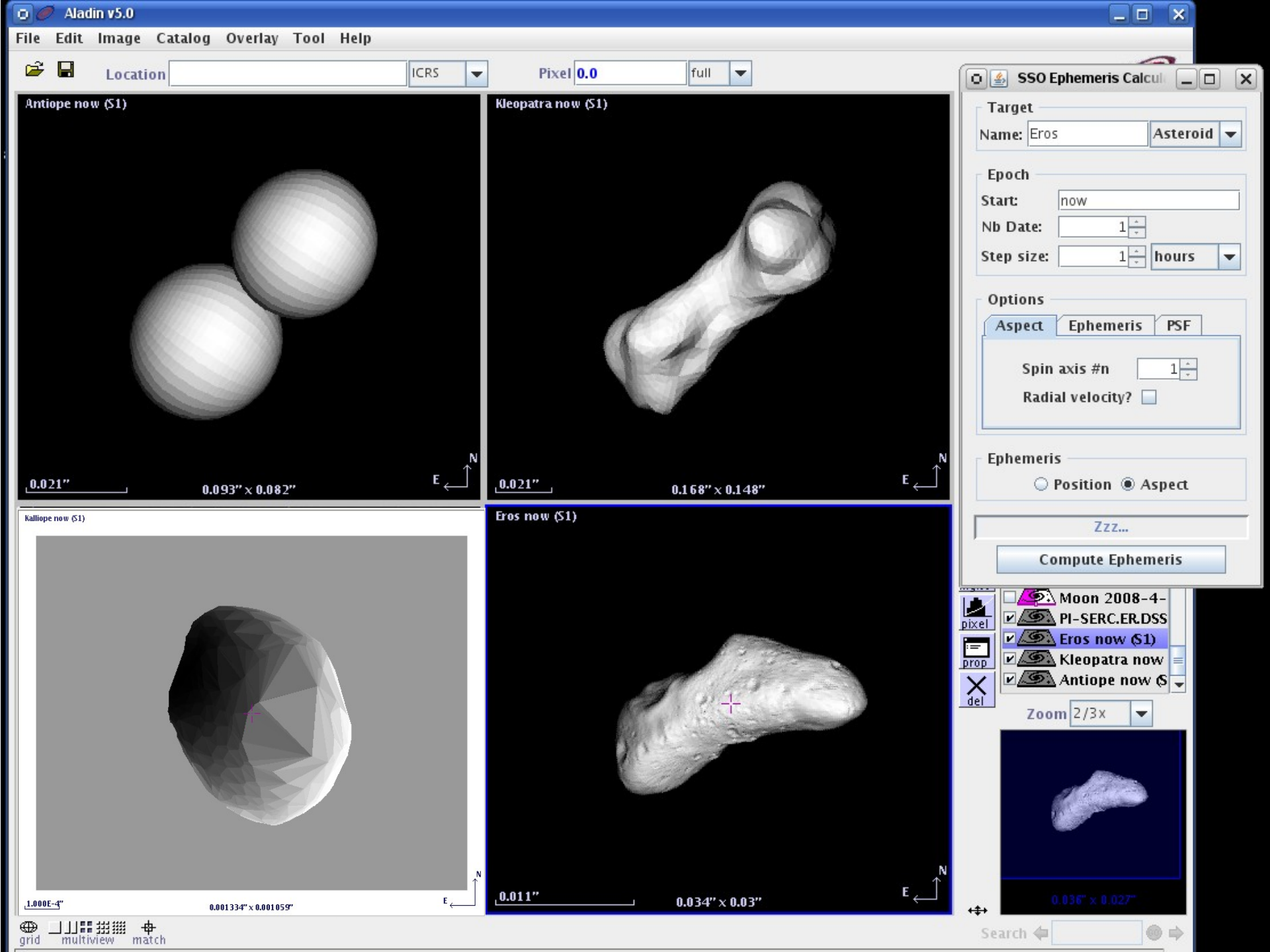
Miriade
Solar System Object Ephemeris Generator

...

- Modelling of the physical (3D) aspect of Sso
- Takes into account their spin and shape models
- Radial velocity map (*albedo, thermal, elevation maps*)
- Different visualizations and data-format outputs

Planetary scene viewer

- FITS cube and AVI showing the size, orientation, brightness distribution, ... of a given target in function of time
- Work in progress (available in late 2012)
  (J. Berthier, B. Carry)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Eros now (S1)
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SSO Ephemeris Calcul
Target
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Asteroid
Epoch
Start: now
Nb Date: 1
Step size: 1
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Radial velocity?
Ephemeris
Position
Aspect
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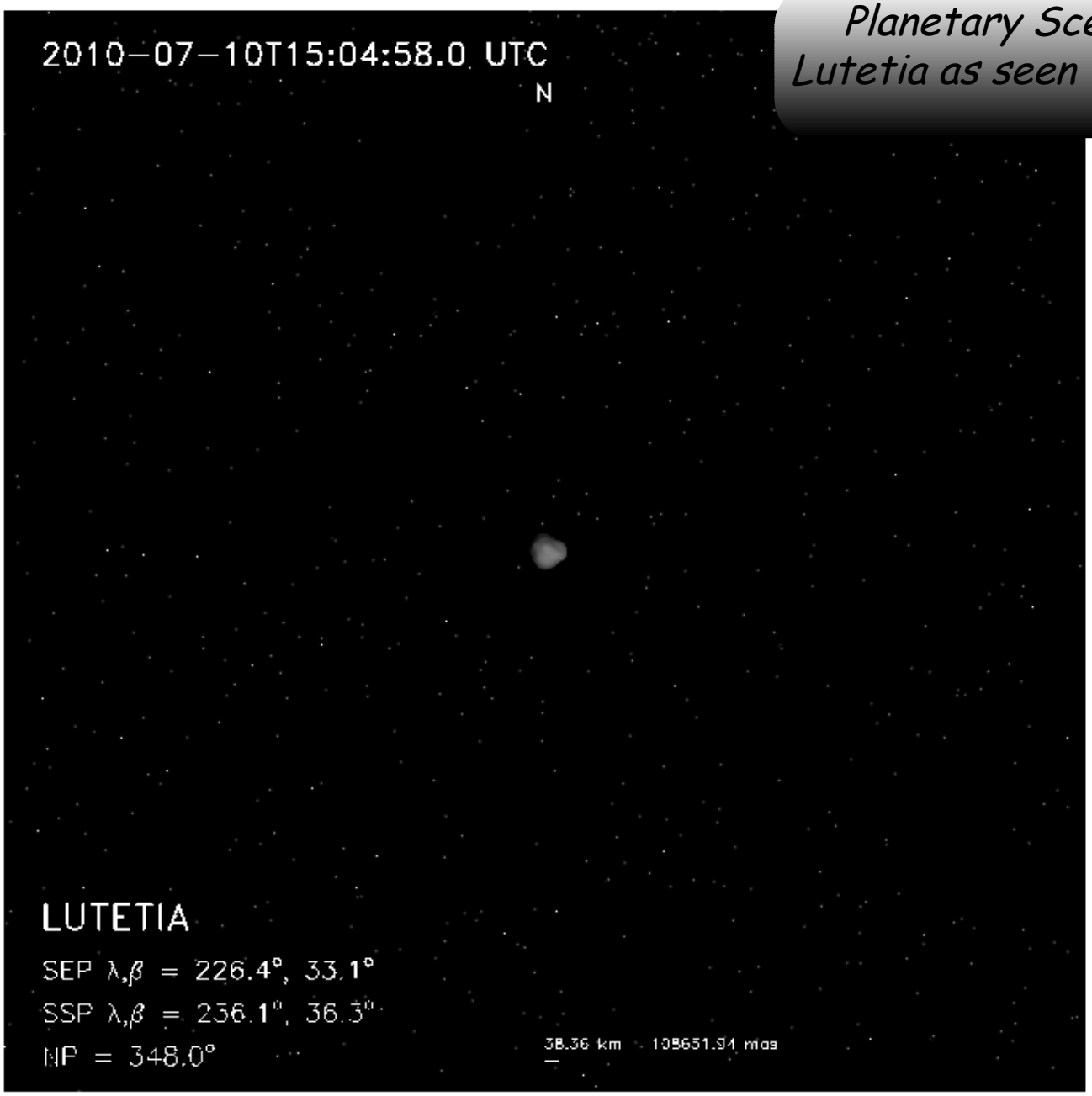
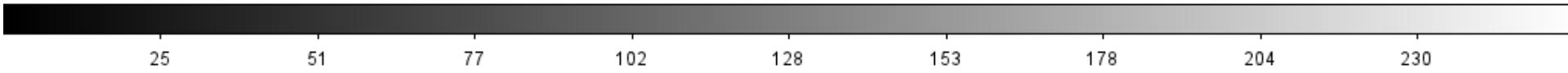
Search

Planetary Scene Viewer
Lutetia as seen from Rosetta





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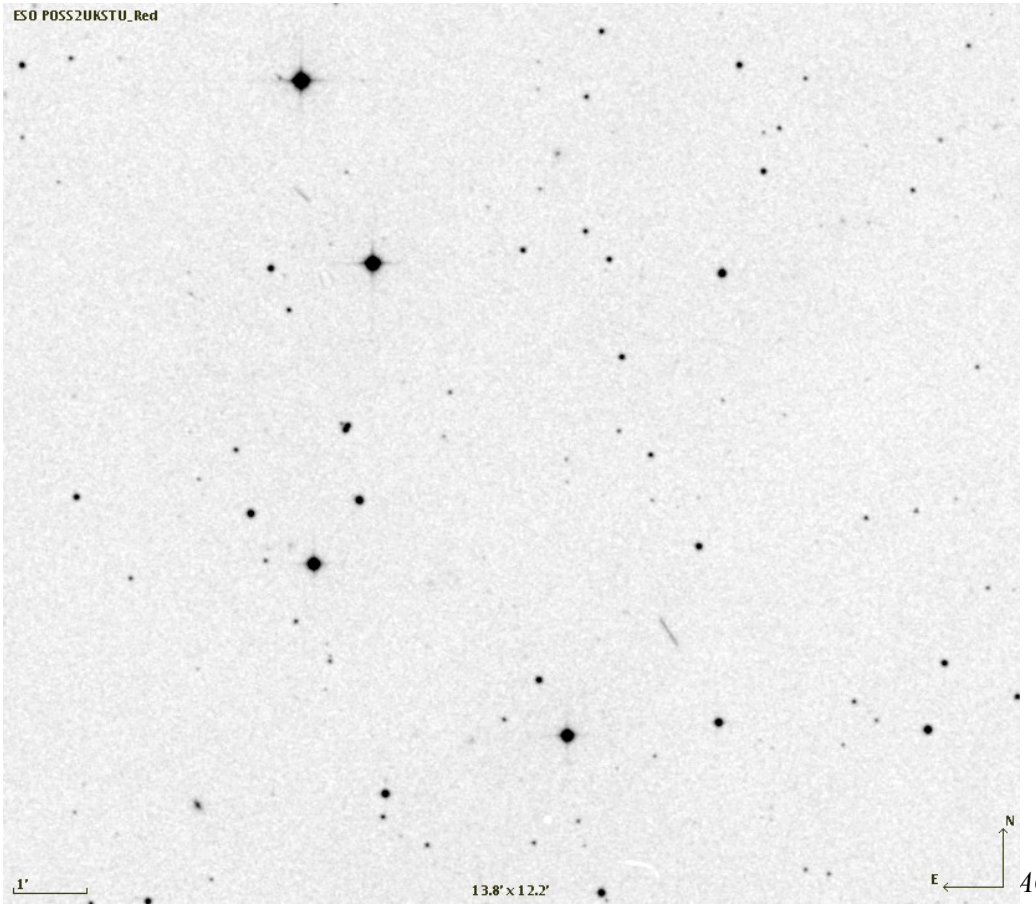
SkyBoT
The VO Sky Body Tracker

Search and identification of Sso in any field of view



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SkyBoT
The VO Sky Body Tracker

Search and identification of Sso in any field of view

- Pre-computed ephemeris database
- J2000 astrometric [geo|topo]centric equatorial coordinates
- 580 000 asteroids, planets, 33 natural satellites, 1000 comets
- Timespan 1890 – 2060
- Weekly updates

- Access protocol: Webservice, Simple ConeSearch (1.03)
- Output: VOTable, text

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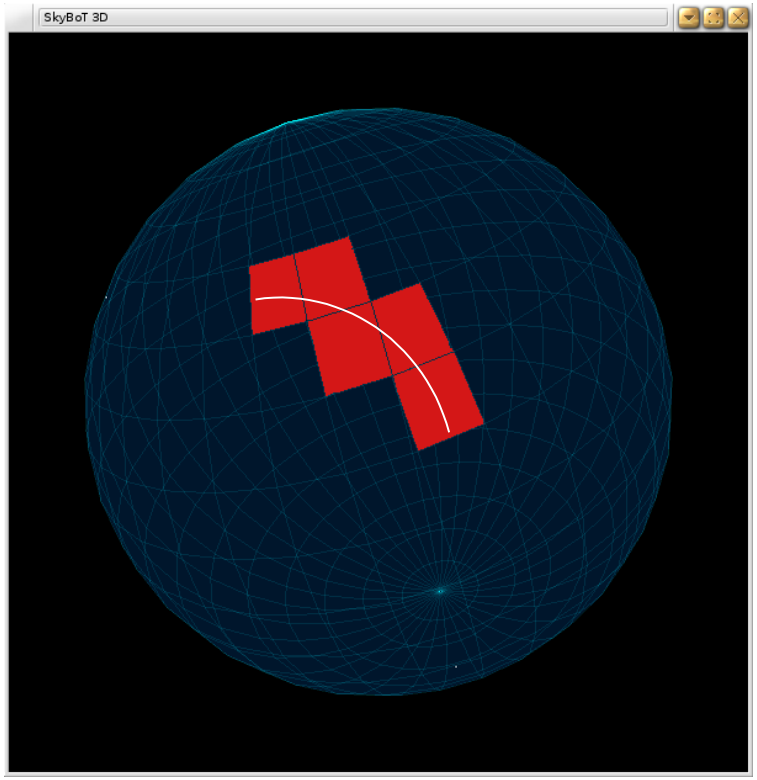
SkyBoT
The VO Sky Body Tracker

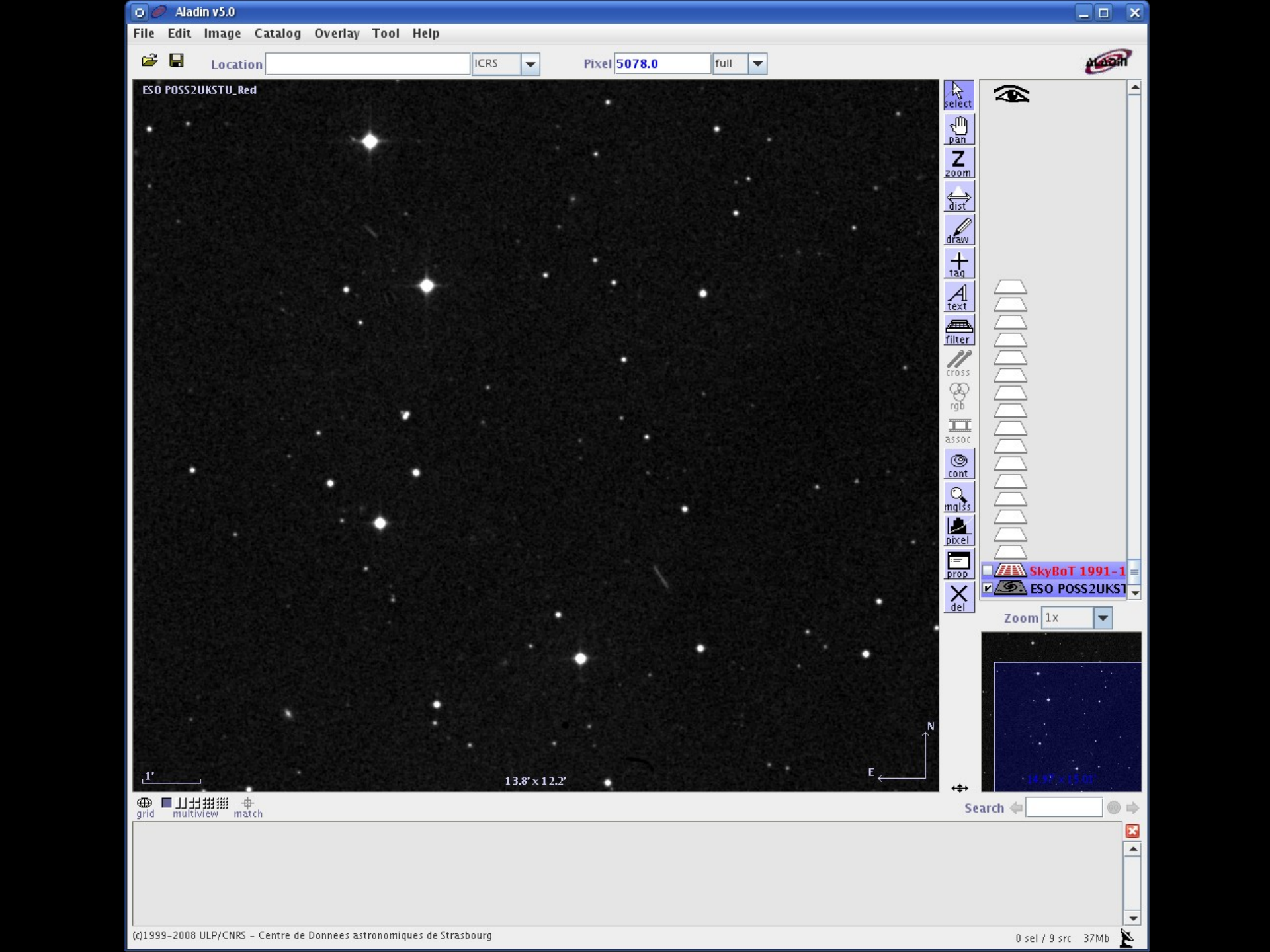
How does it work

- Celestial sphere is segmented in boxes (~40x40 arcmin)



- A given Sso moves across boxes during a given period (e.g. 10 days)
- For this period its position is linked with each crossed box
- Each box contains the ids of all of the Sso that crossed it

- Request:
  (α, δ) → box → list of Sso → ephemeris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SkyBoT 1991-1
ESO POSS2UKST
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Search
(c)1999-2008 ULP/CNRS - Centre de Donnees astronomiques de Strasbourg
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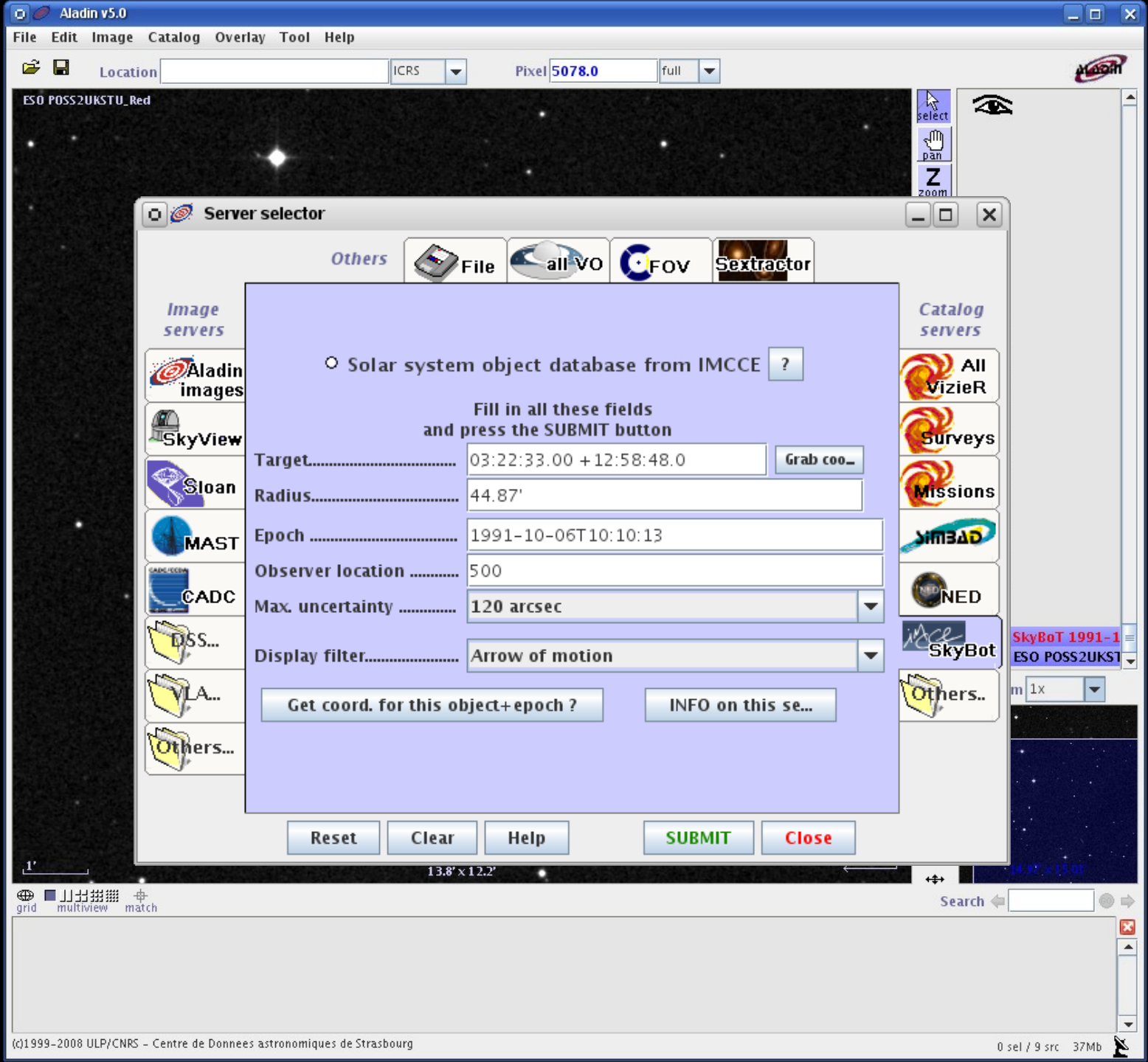
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Catalog servers
Aladin images
SkyView
Sloan
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DSS...
VLA...
Others...
Solar system object database from IMCCE
?
Fill in all these fields
and press the SUBMIT button
Target.....
03:22:33.00 +12:58:48.0
Grab coo...
Radius.....
44.87'
Epoch .....
1991-10-06T10:10:13
Observer location .....
500
Max. uncertainty .....
120 arcsec
Display filter.....
Arrow of motion
Get coord. for this object+epoch ?
INFO on this se...
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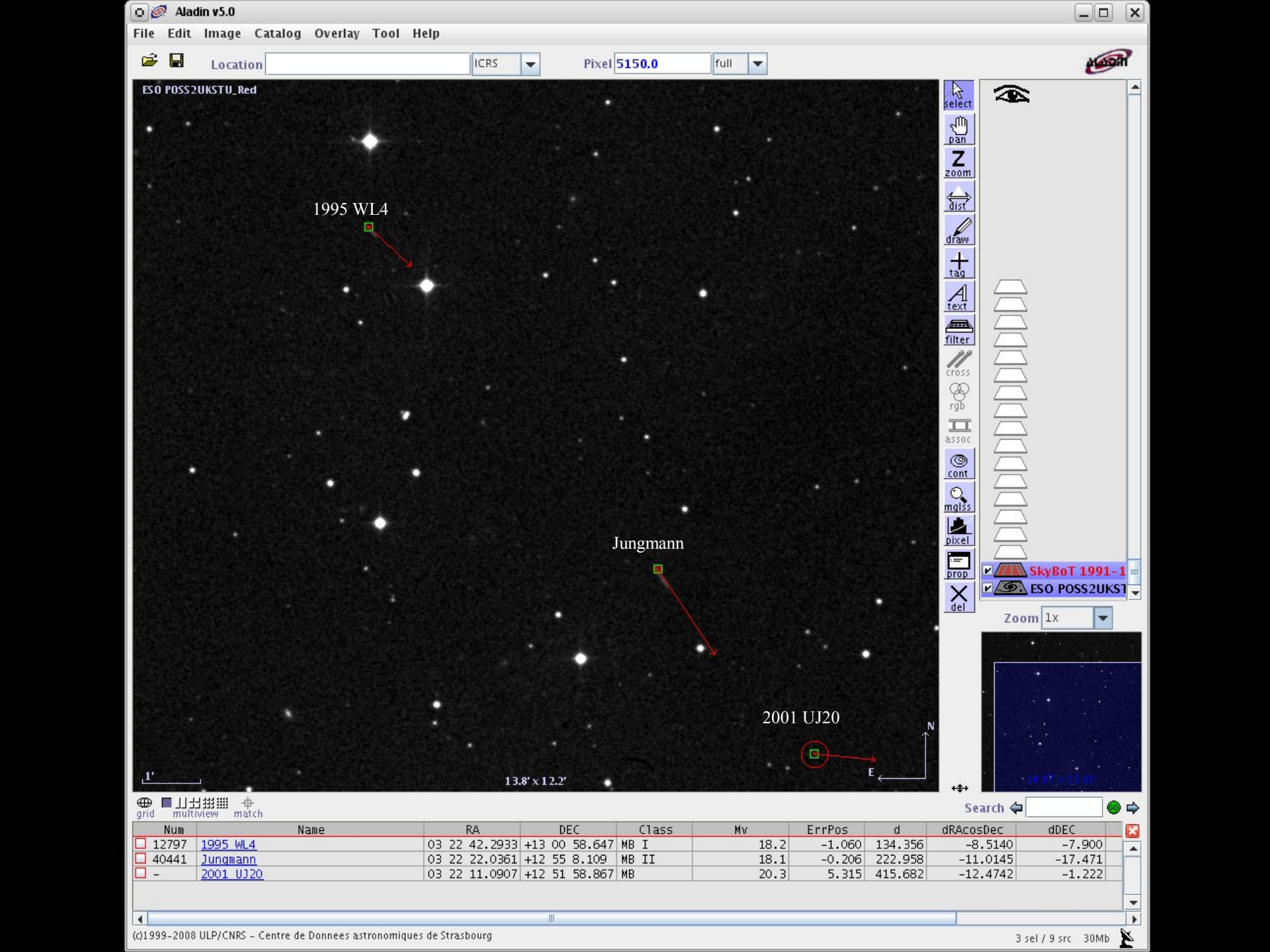
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SkyBoT 1991-1
ESO POSS2UKST
Zoom 1x
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Num Name RA DEC Class Mv ErrPos d dRAcosDec dDEC
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40441 Jungmann 03 22 22.0361 +12 55 8.109 MB II 18.1 -0.206 222.958 -11.0145 -17.471
- 2001 UJ20 03 22 11.0907 +12 51 58.867 MB 20.3 5.315 415.682 -12.4742 -1.222
(c)1999-2008 ULP/CNRS - Centre de Donnees astronomiques de Strasbourg
3 sel / 9 src 30Mb

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SkyBoT
The VO Sky Body Tracker

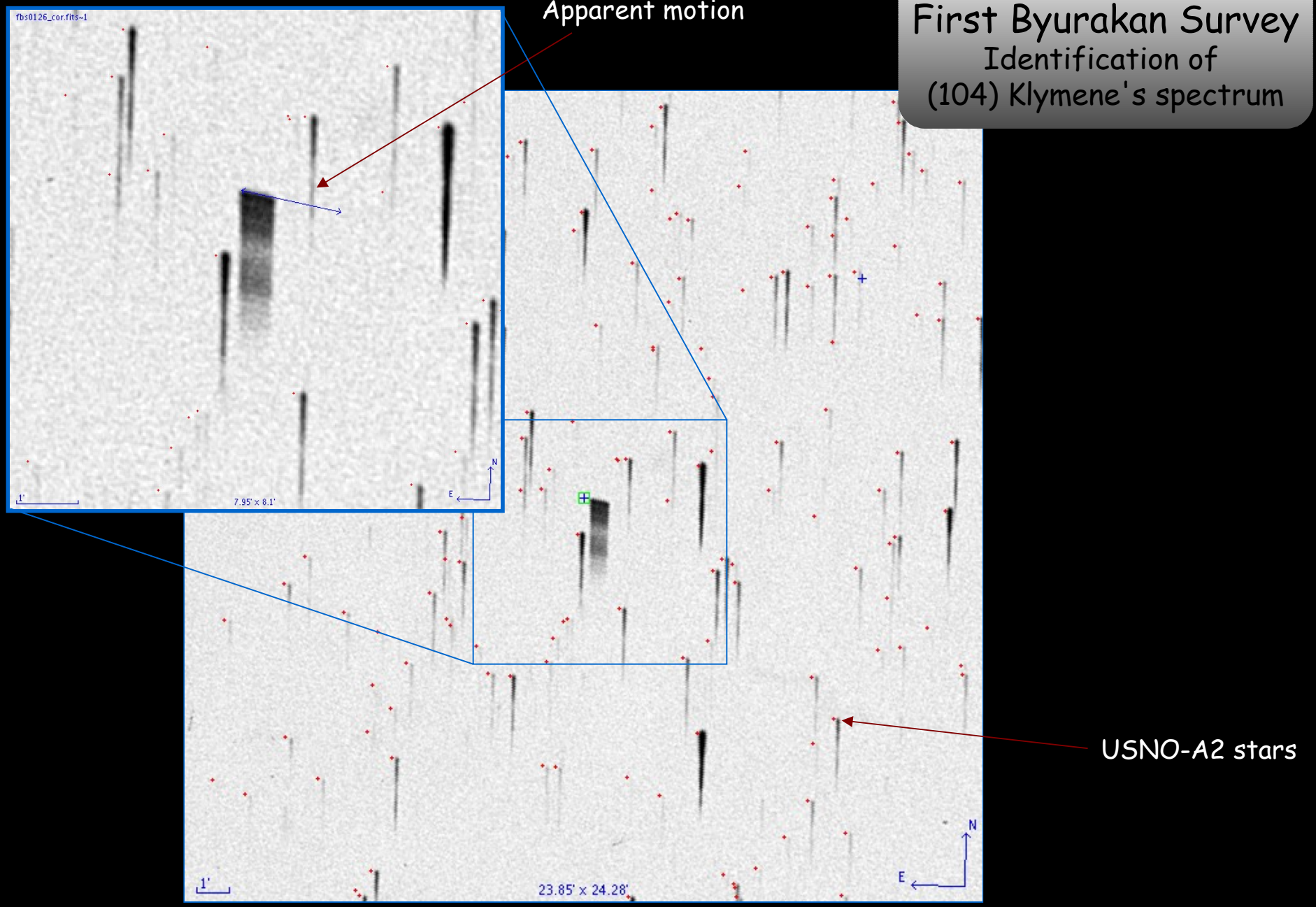
Available from Aladin, WCS tools (SAO), Audela, vo-cli, …, used by many clients (10000 – 30000 req./day)

- Keck telescope (2000 to 3000 requests every day)
- Tarot telescope (data mining)

- Space Telescope European Coordinating Facility (STECF) (36491 ident. of 1140 objects observed by HST)
- Astro-WISE (searching for known Sso in the WFI archive)
- European Near Earth Asteroids Research (EuroNear, archive precovery and recovery for Sso)
- Digitized First Byurakan Survey (data mining, ~1000 asteroids up to mag. 16)
- …

Data mining of the First Byurakan Survey

Identification of (104) Klymene's spectrum

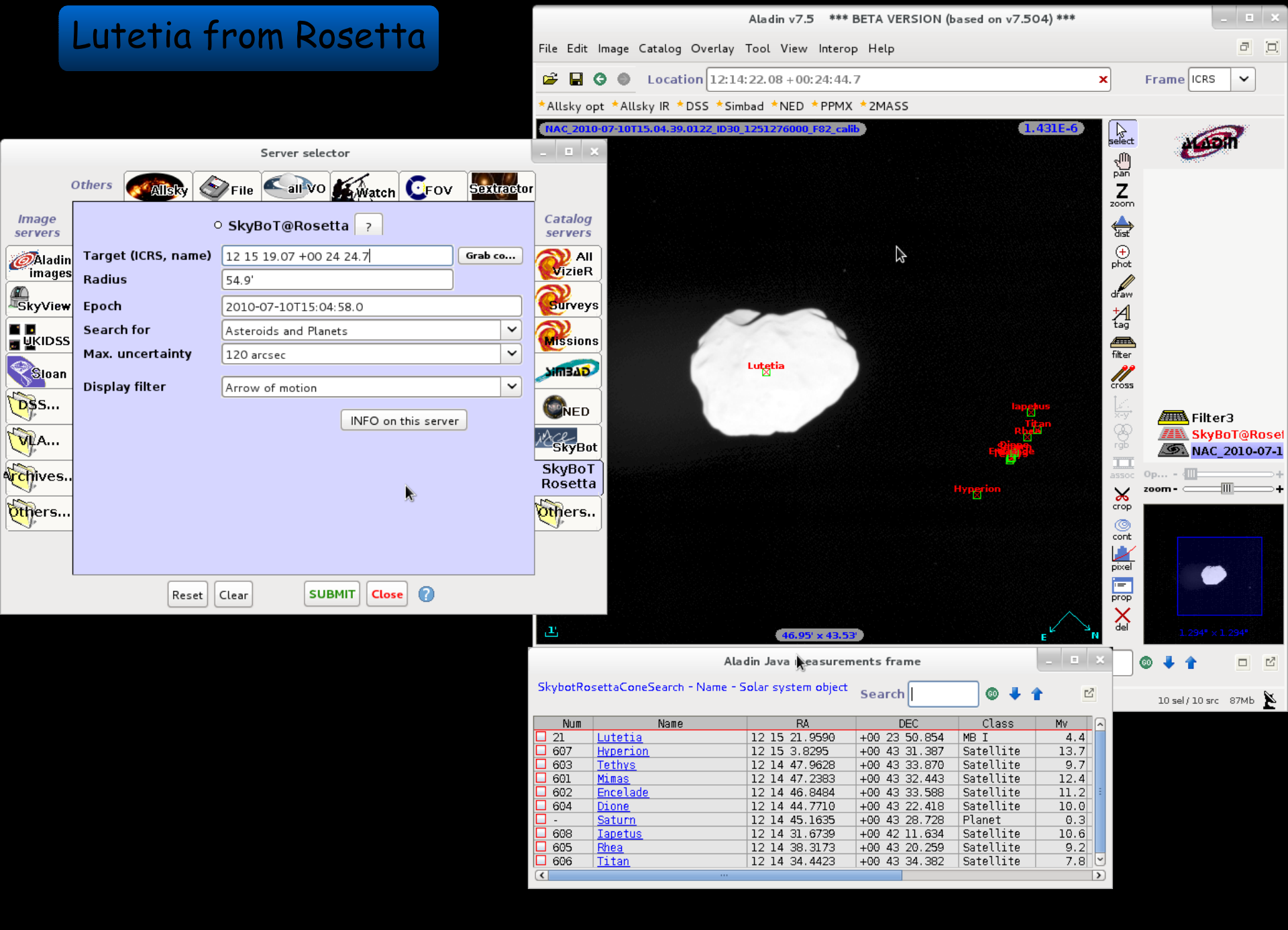


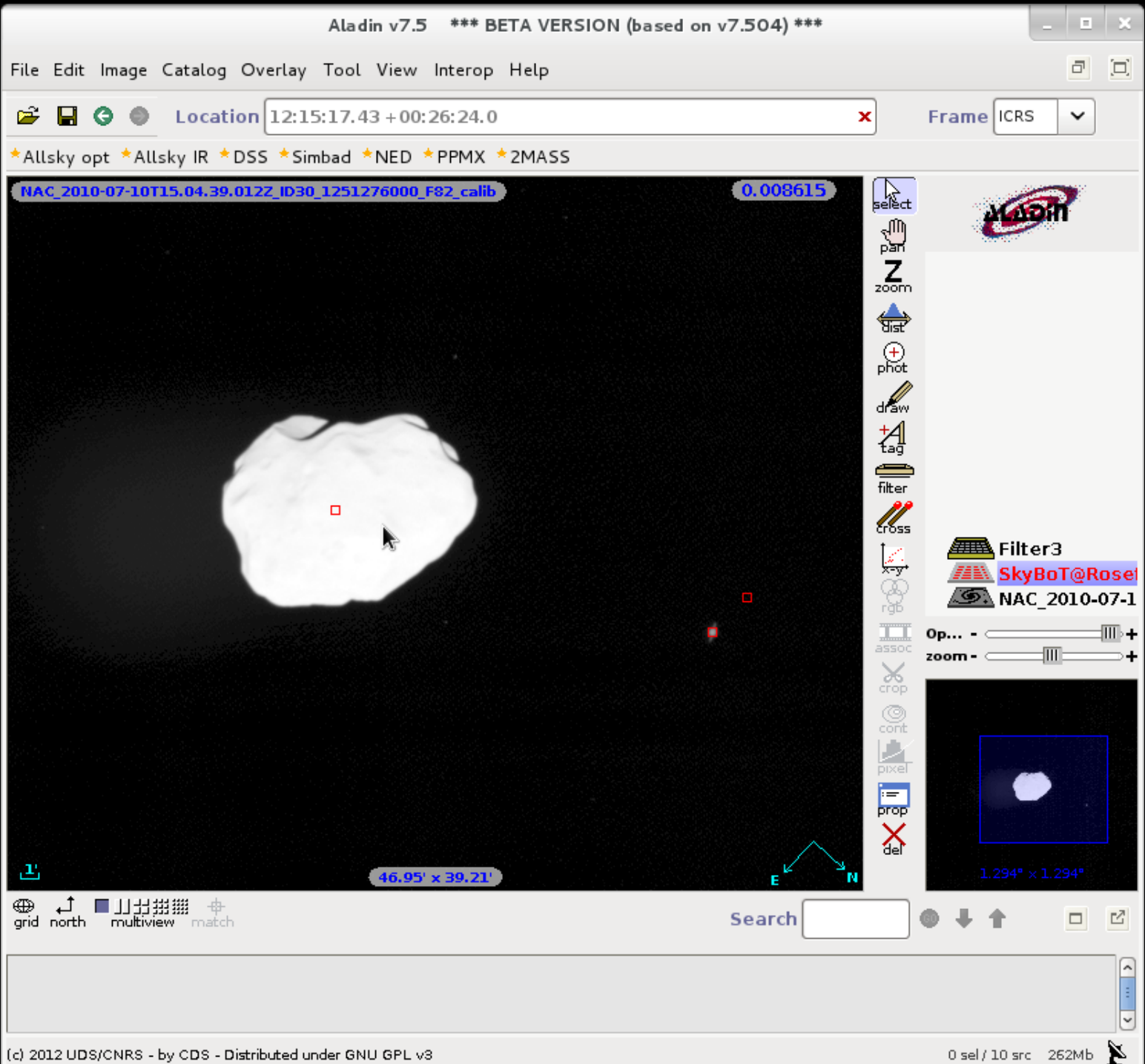
NEW: SkyBoT @ Rosetta

- Data mining of OSINac and OSIWac images
- Mainly asteroids
  - astrometric positions
  - photometry
- Useful to improve orbits and spin/shape determination, because measures span geometries unavailable from Earth

- Work in progress (collab. ESA / IMCCE)
  (M. Küppers, B. Carry, D. Heather, R. Moissl, J. Berthier)

Lutetia from Rosetta

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Frame ICRS
Allsky opt Allsky IR DSS Simbad NED PPMX 2MASS
NAC_2010-07-10T15.04.39.012Z_ID30_1251276000_F82_calib
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Search
(c) 2012 UDS/CNRS - by CDS - Distributed under GNU GPL v3
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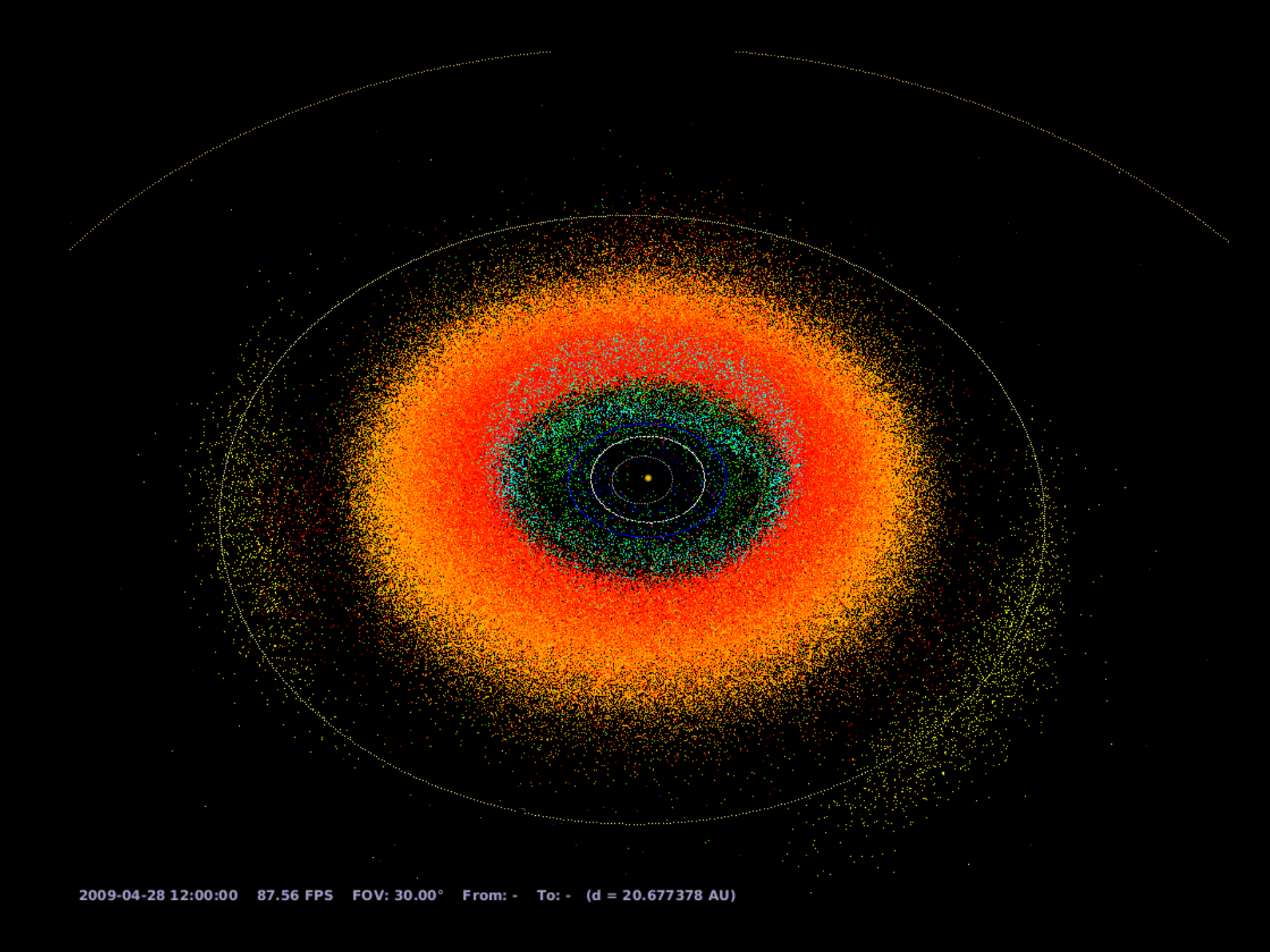
Skybot3D
The Solar System in 3D

Based on SkyBoT db, allows to compute a snapshot of the solar system at a given epoch

- Without computation (each 10 days)
- With computation (any epoch)

- Uses UWS to submit ephemeris computation
- Numerical integration of the perturbed n-body problem
- Positions of ~580000 Sso in less than 10 minutes

- OpenGL software to visualize and to freely navigate into the solar system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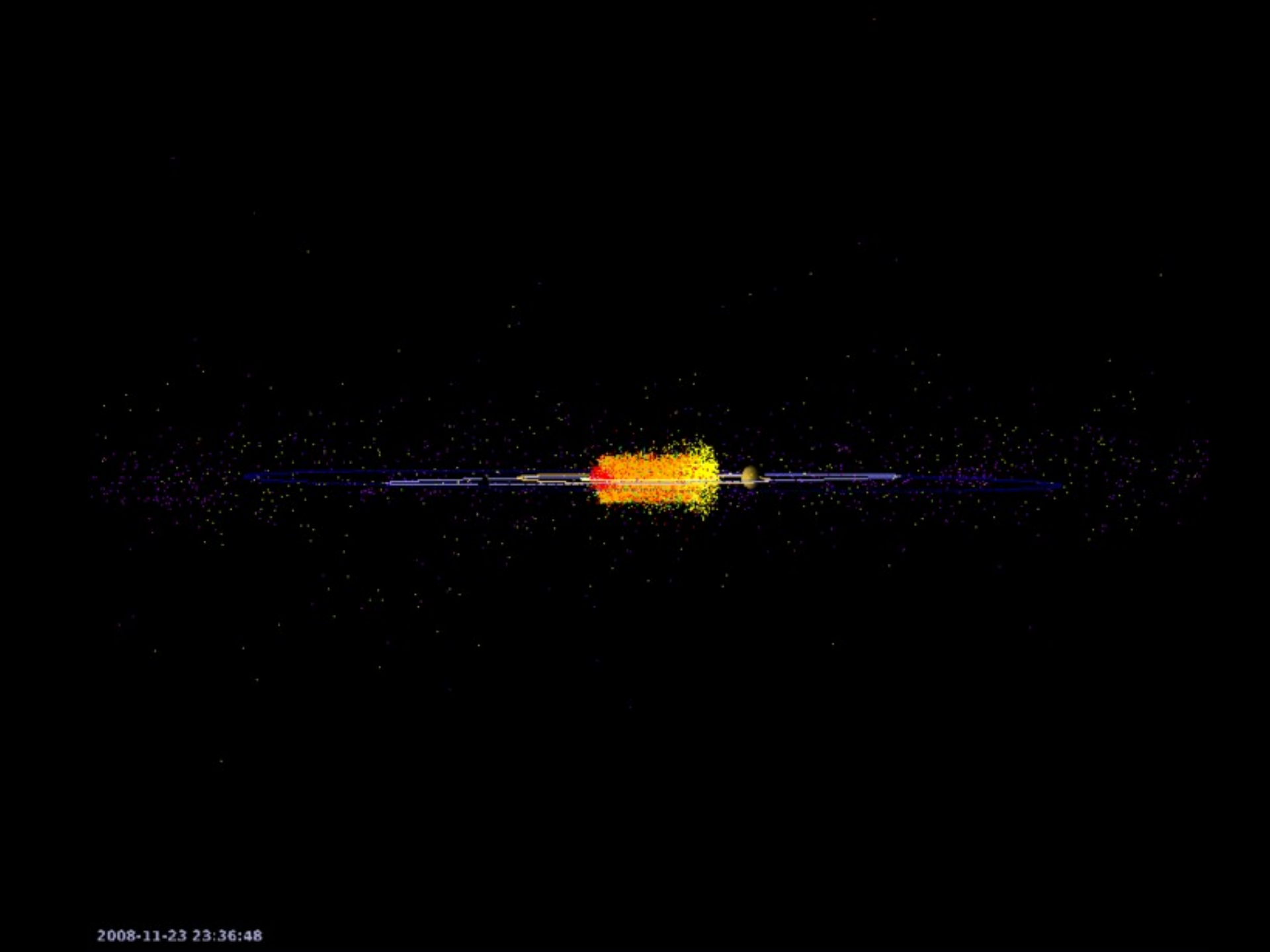
2008-11-23 23:36:48

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Skybot3D
The Solar System in 3D

Apophis, Rendez vous with Earth, Apr. 13, 2029

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AstroId
Solar system data mining tool

Data mining service to identify Sso and stars into archives

- Input: astrometric positions of sources
- Process:
  - Pairing of sources with stars and Sso
  - Correlation of the source vs. star and Sso
- Output: list of identified sources

- Work in progress, available late 2012

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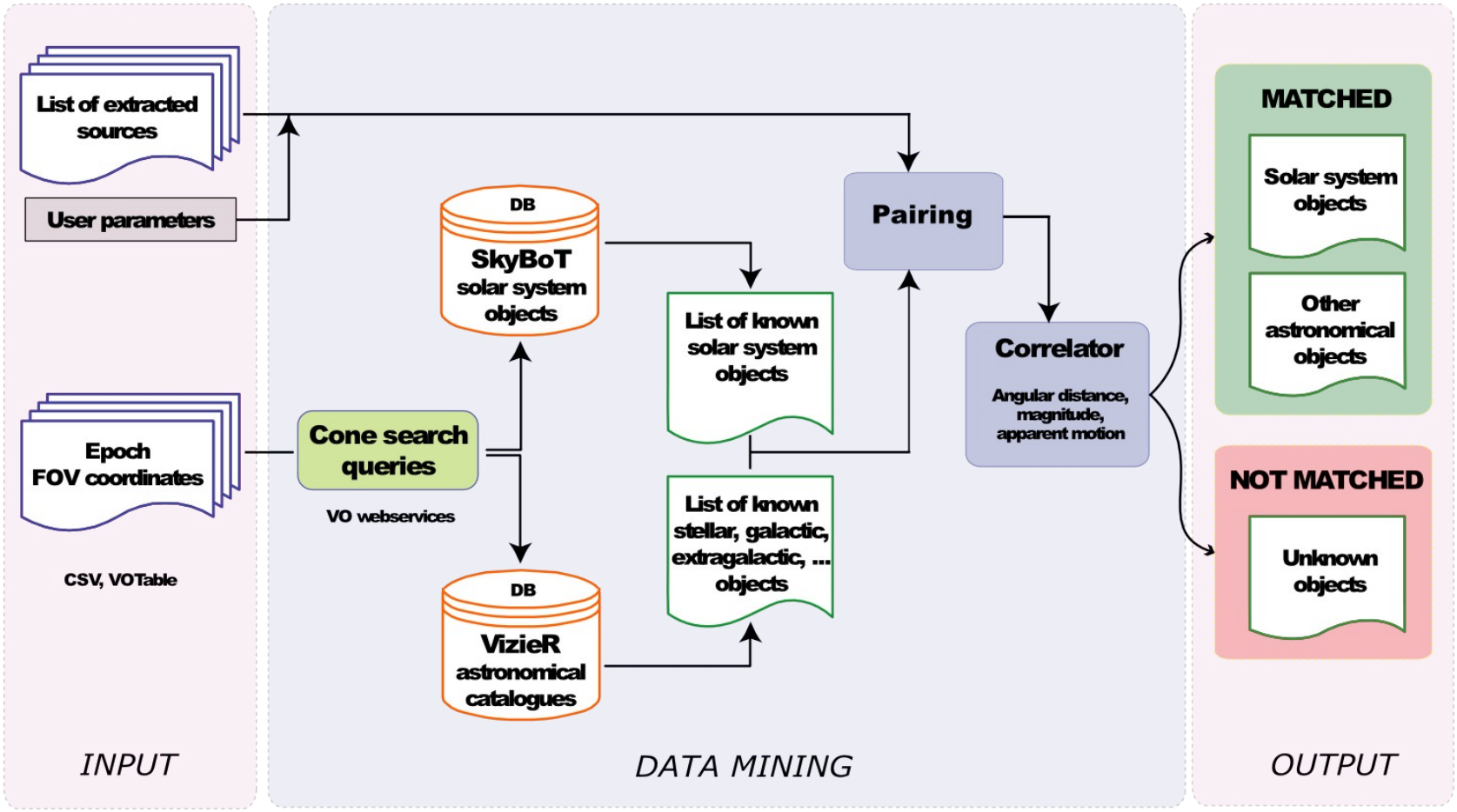
AstroId
Solar system data mining tool

AstroID workflow



First tests made on Earth-based sky surveys

- **Denis** (collaboration IMCCE / GEPI)
  - Similar to 2MASS survey
  - 355×10^6 sources (I, J, K') → ~9400 Sso identified (<200 NEOs)
- **ESO-R, SRCJ, POSS** (collaboration IMCCE / GEPI)
  - Recovery of plate epochs (false datation of almost all plates)
  - Search for Sso (in progress)
- **First Byurakan Db Survey** (collaboration IMCCE / IPSL / Byurakan Obs.)
  - Spectroscopic survey (Markarian)
  - 20×10^6 spectra (Mv~17.5), 2180 plates → ~300 Sso identified
- **EROS** (collaboration IMCCE / IAP / CEA)
  - ~26000 fields which contain $\sim 3 \times 10^5$ stars (work in progress)
  - Unusual

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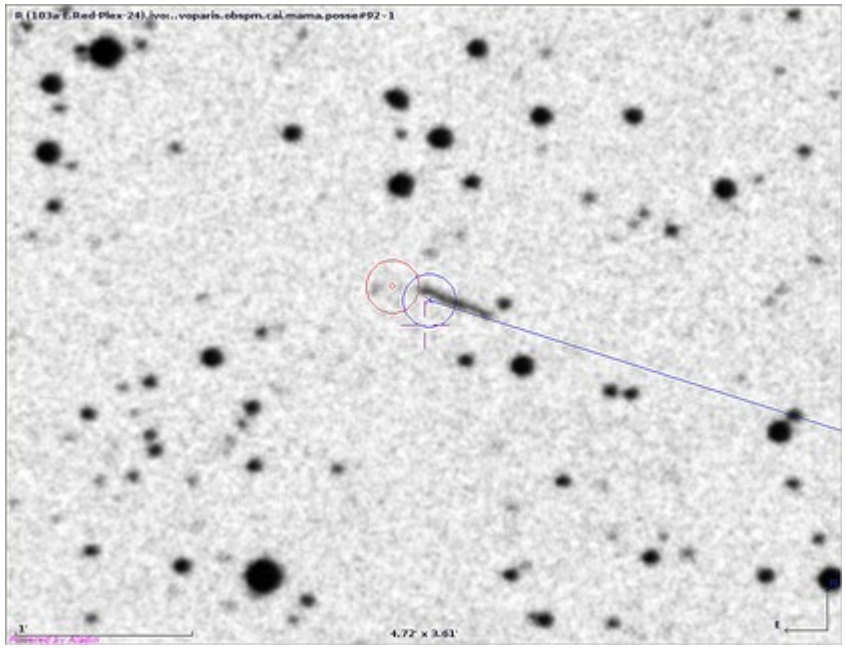
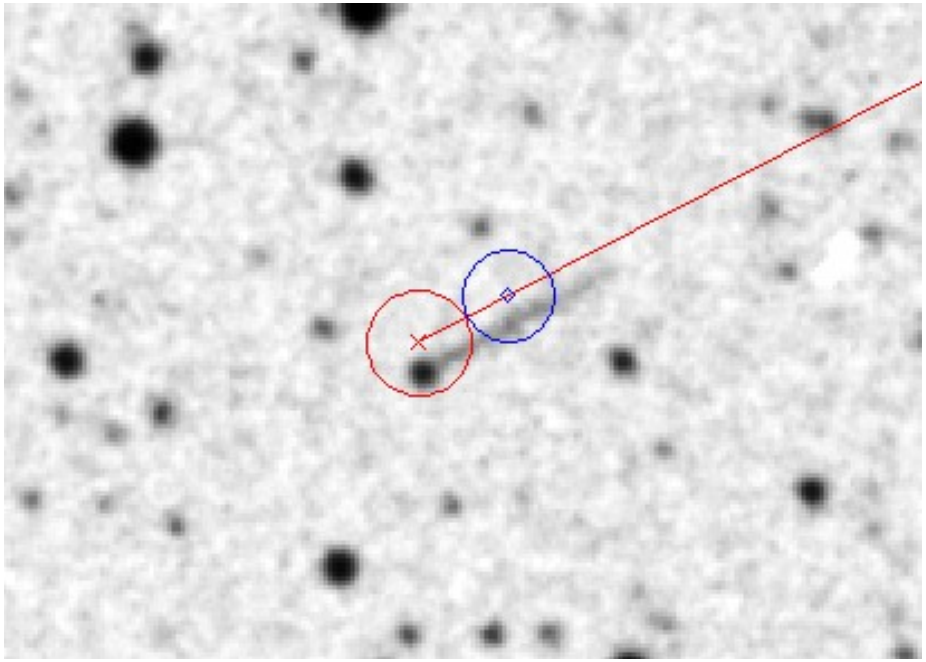
AstroId
Solar system data mining tool

Identification of Malaren
POSSE0092



Identification of VanDerPol
POSSE00503



Identification of (20430) Stout

EROS-2 (2001-06-20)

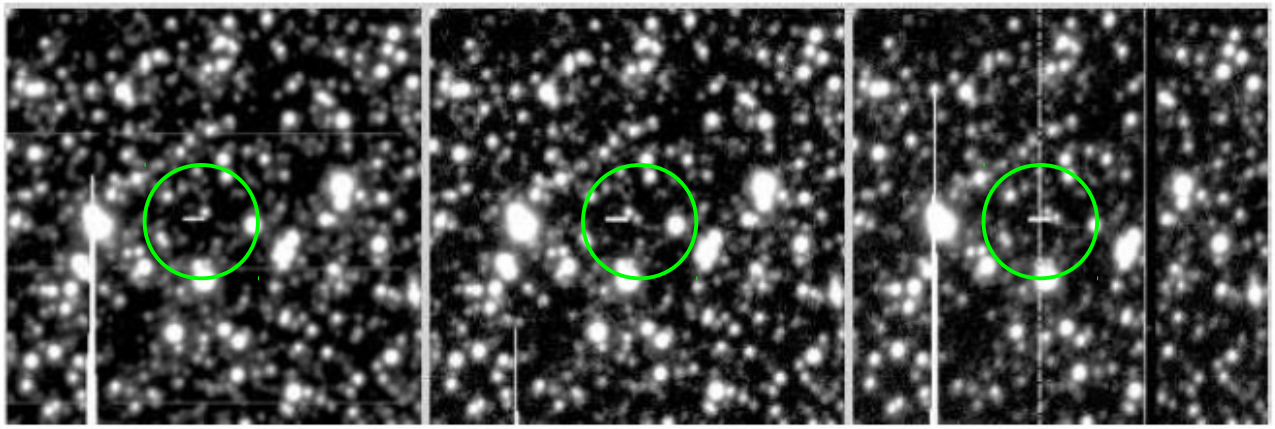


Figure 1: EROS-2 charts (left to right): Red Reference image - Red current image - Blue current image

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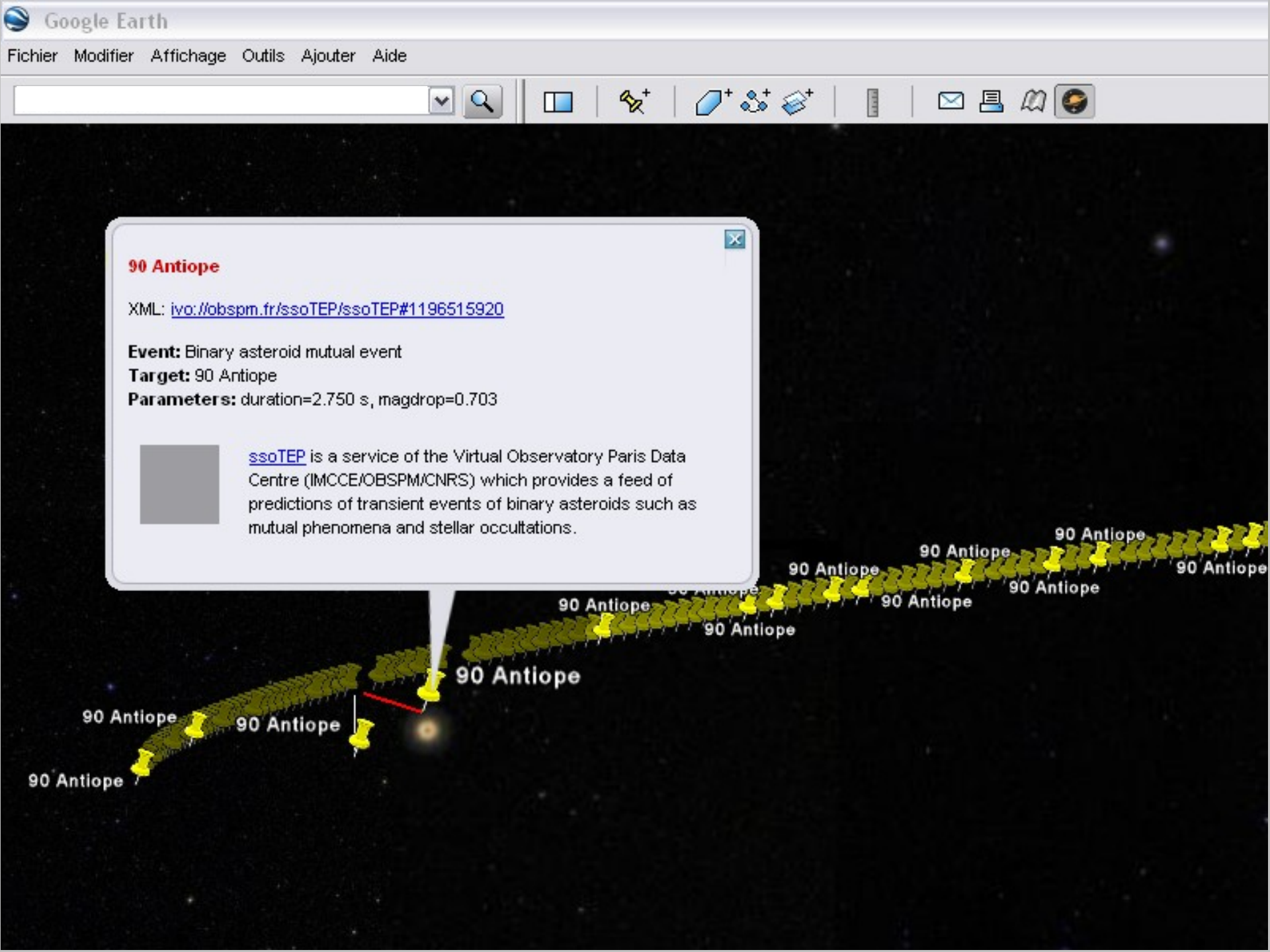
SsoTEP
Sso Transient Event Predictions

Diffusion of requests to observe transient events
(e.g. stellar occultations, mutual events, ...)

- Based on VOEvent (1.0)
  - Defines the content and meaning of a std information packet
  - « Who, What, Where, When, How(, Why) » content format
- RSS, Jabber, GoogleSky, ...
- Robotic telescope
- Observationnal campaigns
- Follow up network

- Only a prototype
- Must be released to follow VOEvent 2.0 standard
- Should be tested during our next Patroclus-2012 campaign

More info about VOEvent, visit **SkyAlert.org**


Google Earth
Fichier Modifier Affichage Outils Ajouter Aide
90 Antiope
XML: ivo://obspm.fr/ssoTEP/ssoTEP#1196515920
Event: Binary asteroid mutual event
Target: 90 Antiope
Parameters: duration=2.750 s, magdrop=0.703
ssoTEP is a service of the Virtual Observatory Paris Data Centre (IMCCE/OBSPM/CNRS) which provides a feed of predictions of transient events of binary asteroids such as mutual phenomena and stellar occultations.
90 Antiope
90 Antiope
90 Antiope
90 Antiope
90 Antiope
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90 Antiope
90 Antiope
90 Antiope

http://vo.imcce.fr/

VO Solar System Portal

- Information system (SsoDNet)
- Ephemeris generator (Miriade)
- Data Mining (Skybot, AstroId)
- Observation requests (SsoTEP)

- Feedback is welcome (ov@imcce.fr)