

The IMCCE Virtual Observatory Solar System Portal

**A tool for data mining and
selection of plates to analyze**

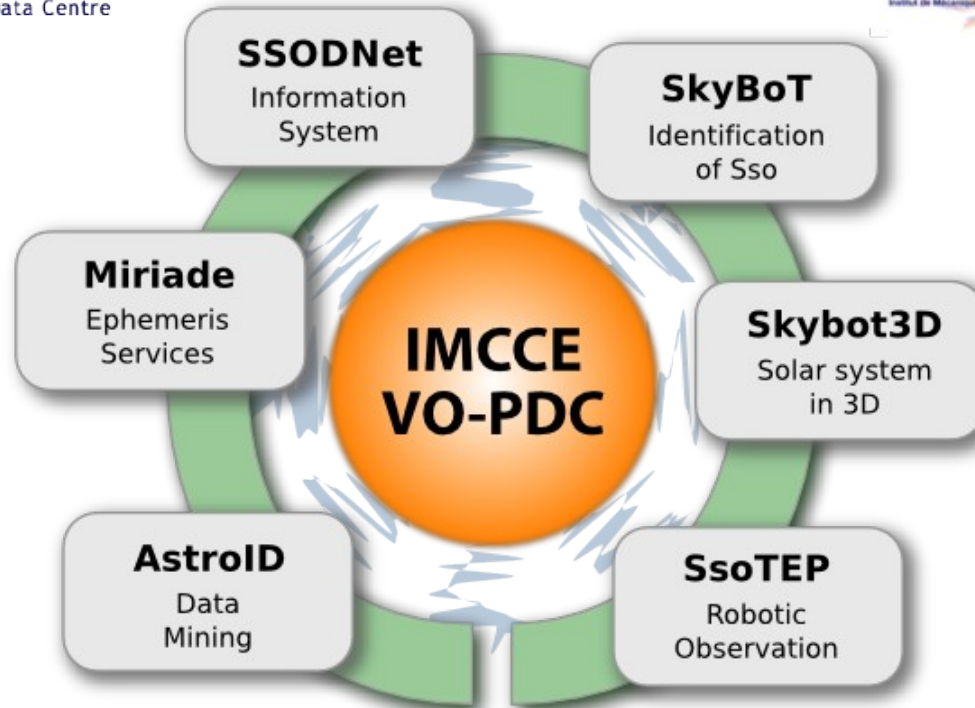
J. Berthier & F. Vachier

Institut de mécanique céleste
et de calcul des éphémérides
Observatoire de Paris / CNRS

<http://vo.imcce.fr/>

VO Solar System Portal

IMCCE / VO Paris Data Centre



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, ...)

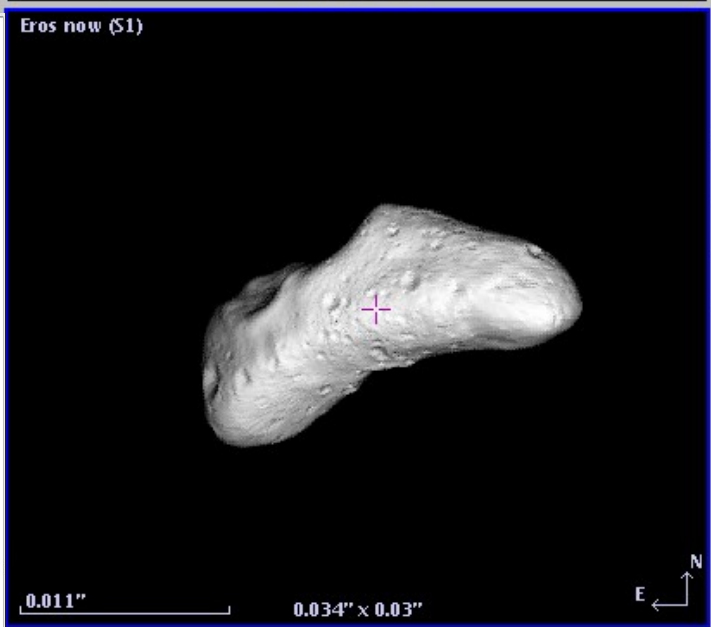
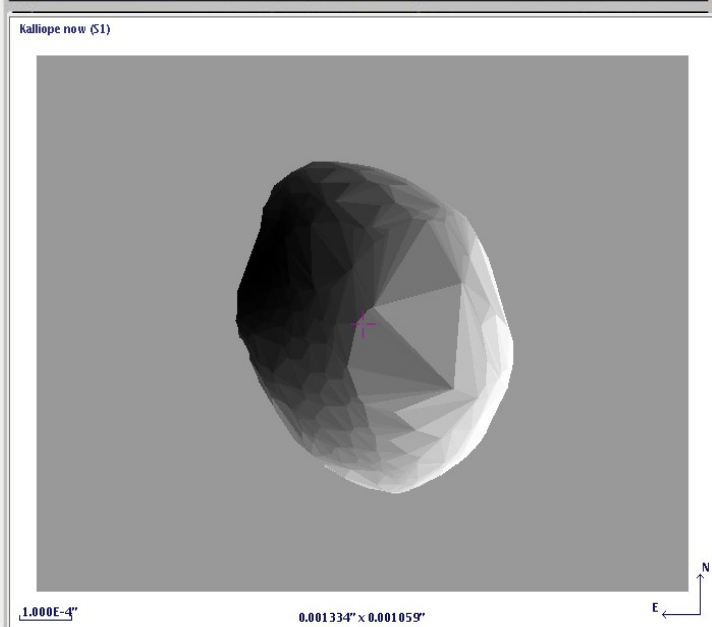
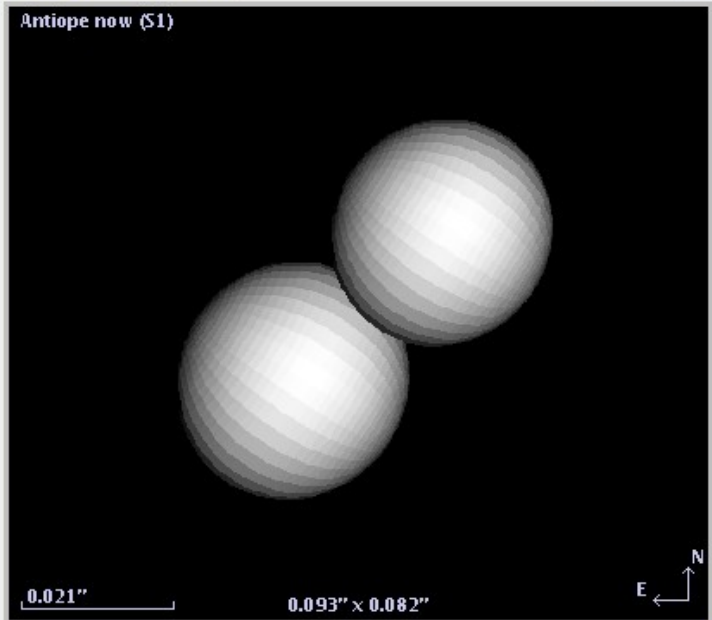
...

- Modelling of the (3D) physical aspect of Sso
- Takes into account their spin and shape models
- Maps: radial velocity, albedo, thermal, elevation
- 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 2013)
(J. Berthier, B. Carry, J.B. Valet)

Location ICRS Pixel full



SSO Ephemeris Calcul

Target
Name: Asteroid

Epoch
Start:
Nb Date:
Step size: hours

Options
Aspect Ephemeris PSF
Spin axis #n
Radial velocity?

Ephemeris
 Position Aspect

Zzz...

Compute Ephemeris

pixel prop del

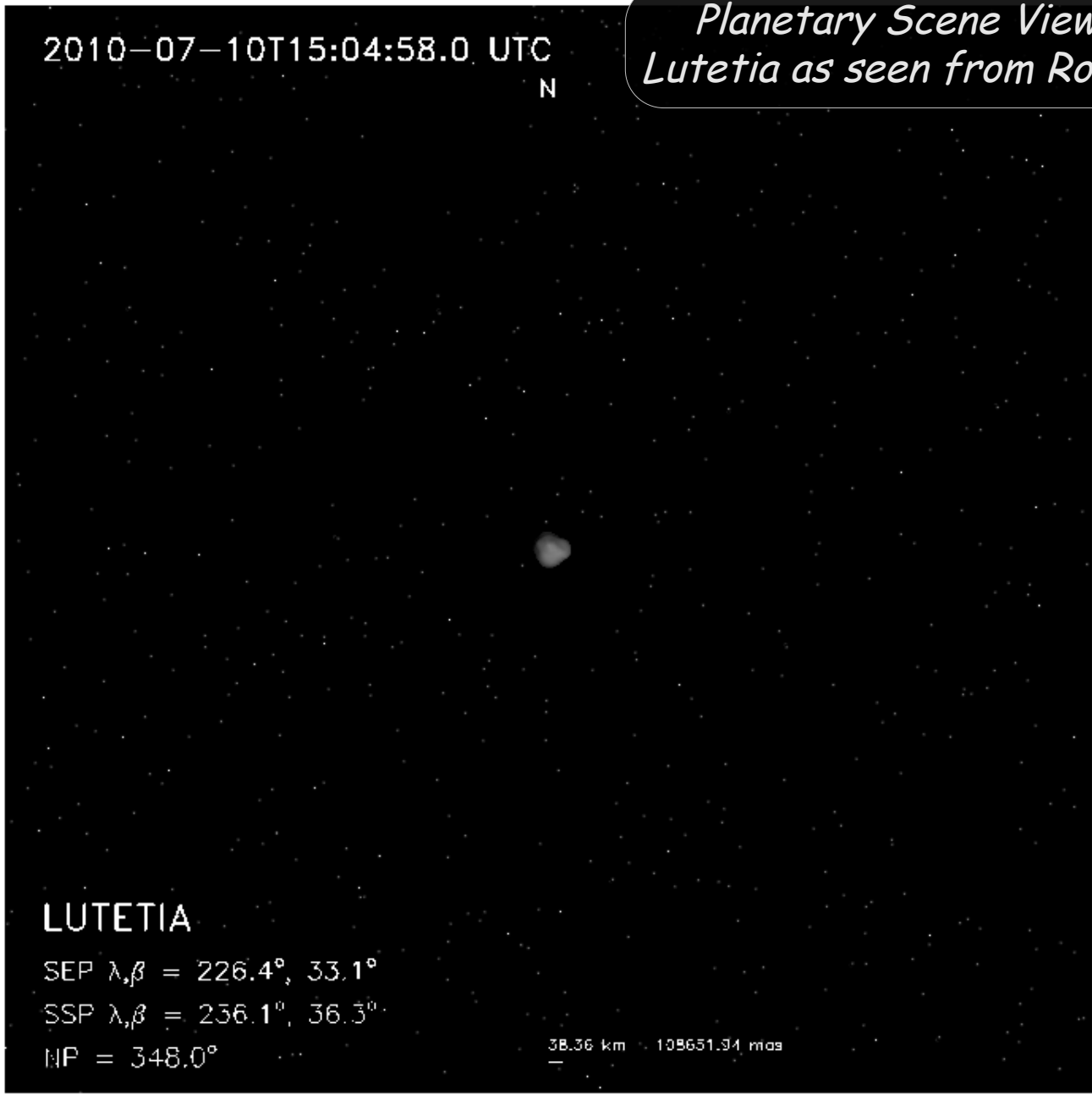
- Moon 2008-4-
- PI-SERC.ER.DSS
- Eros now (S1)
- Kleopatra now
- Antiope now (S1)

Zoom

0.036" x 0.027"

2010-07-10T15:04:58.0 UTC
N

Planetary Scene Viewer
Lutetia as seen from Rosetta



LUTETIA

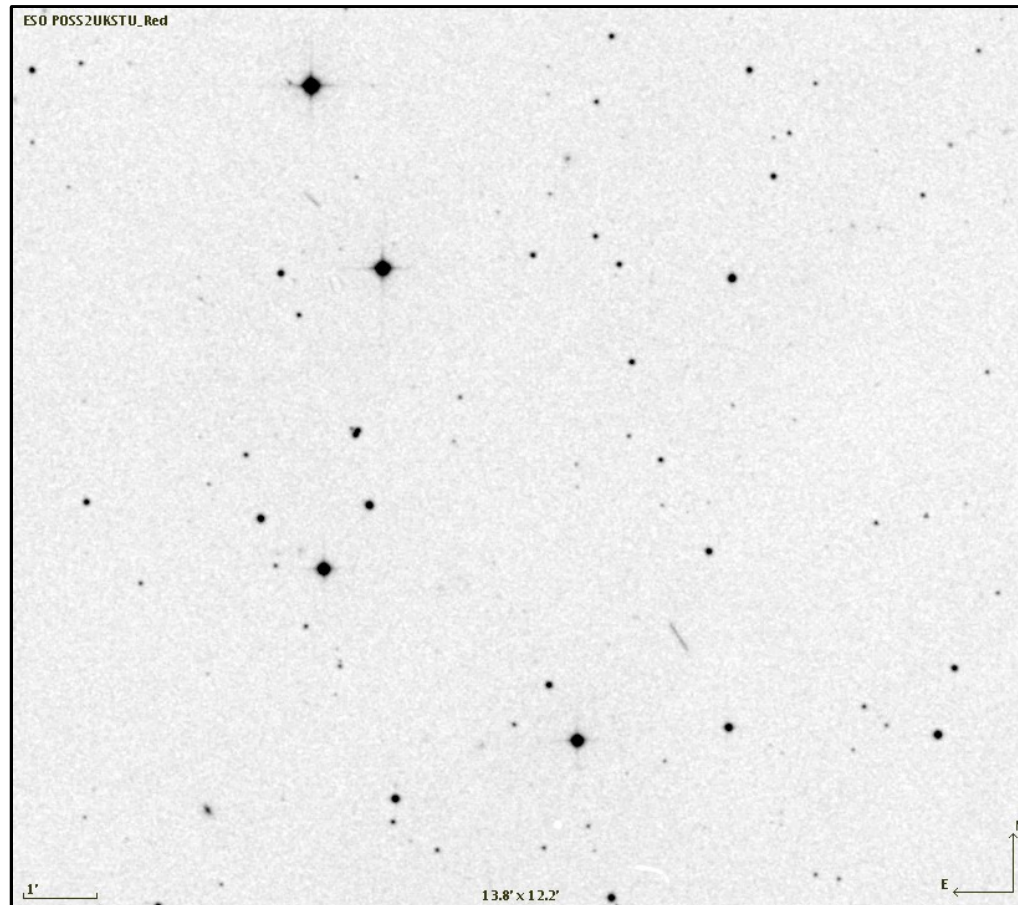
SEP $\lambda, \beta = 226.4^\circ, 33.1^\circ$

SSP $\lambda, \beta = 236.1^\circ, 36.3^\circ$

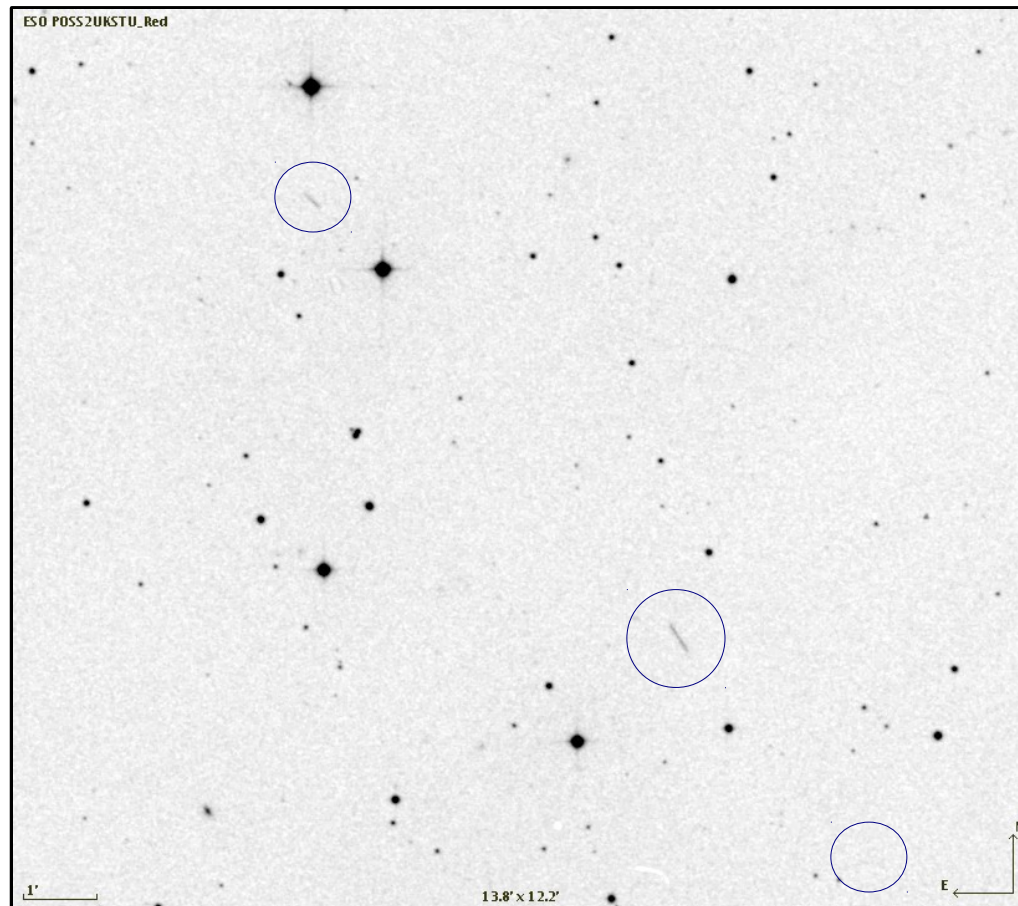
MF = 348.0°

38.36 km 108651.94 mas

Search and identification of Sso in any field of view



Search and identification of Sso in any field of view



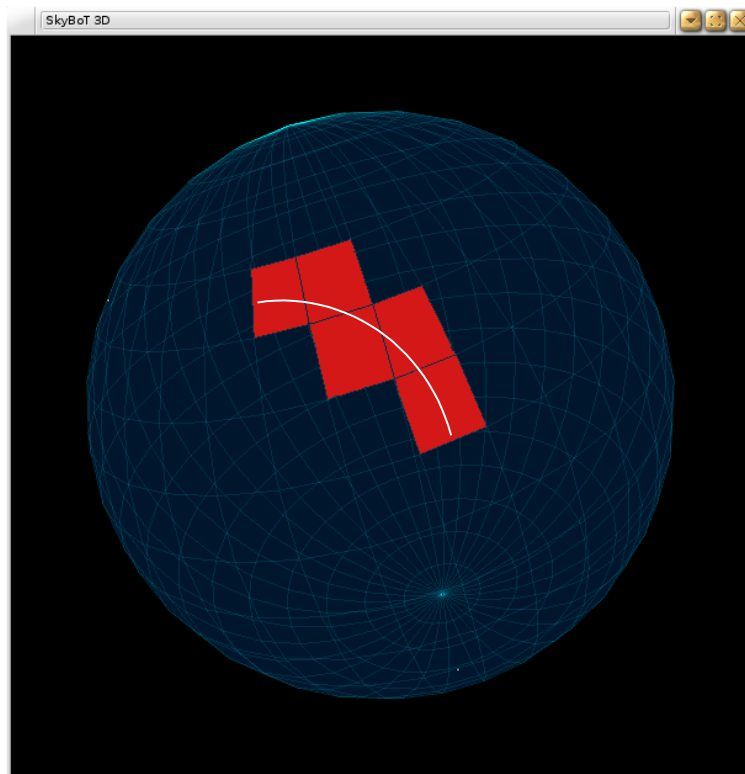
Search and identification of Sso in any field of view

- Pre-computed ephemeris database
- J2000 astrometric [geo|topo]centric equatorial coordinates
- 586 568 asteroids, planets, 33 natural satellites, 1000 comets
- Timespan 1890 - 2060
- Weekly updates

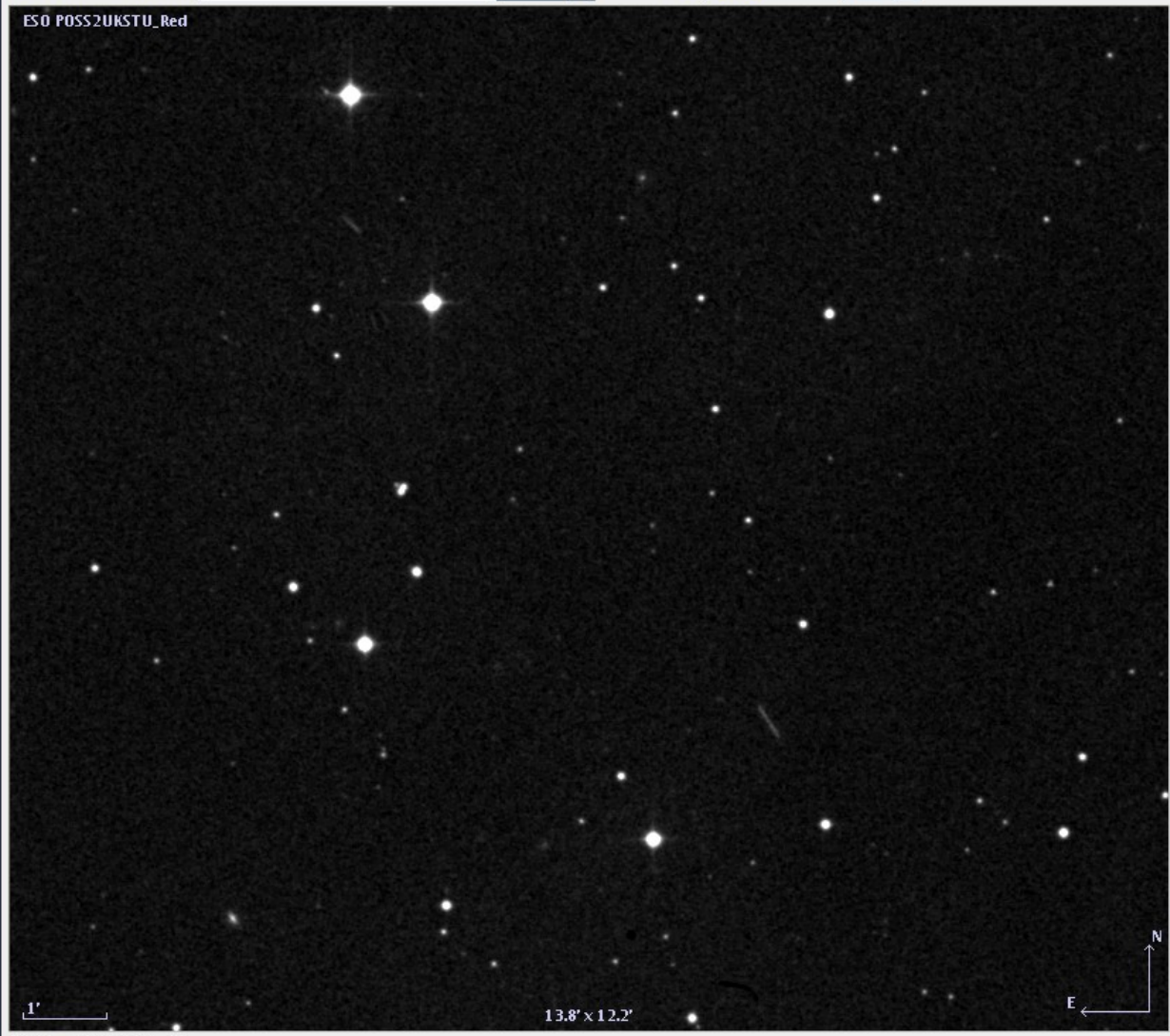
- Access protocol: Webservice, Simple ConeSearch (1.03)
- Output: VOTable, text

How does it work

- Celestial sphere is segmented in boxes ($\sim 40 \times 40$ 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:
 $(\alpha, \delta) \rightarrow \text{box} \rightarrow \text{list of Sso} \rightarrow \text{ephemeris}$



- select
- pan
- zoom
- dist
- draw
- tag
- text
- filter
- cross
- rgb
- assoc
- cont
- mgls
- pixel
- prop
- del

Eye icon

Layer list:

- SkyBoT 1991-1
- ESO POSS2UKST

Zoom 1x

Thumbnail image: 14.9' x 15.0'



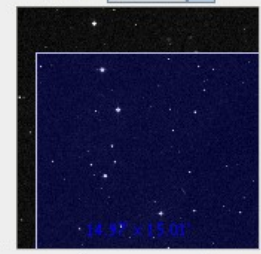
select
pan
zoom
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filter
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cont
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pixel
prop
del

Eye icon

Layer list:

- SkyBoT 1991-1
- ESO POSS2UKSTU

Zoom 1x





select
pan
Z
zoom

Server selector

Others File all-VO FOV SExtractor

Image servers

- Aladin images
- SkyView
- Sloan
- MAST
- CADC
- DSS...
- LA...
- Others...

Catalog servers

- All VizieR
- Surveys
- Missions
- SIMBAD
- NED
- iMCC SkyBot
- Others..

Solar system object database from IMCCE ?

Fill in all these fields and press the SUBMIT button

Target.....

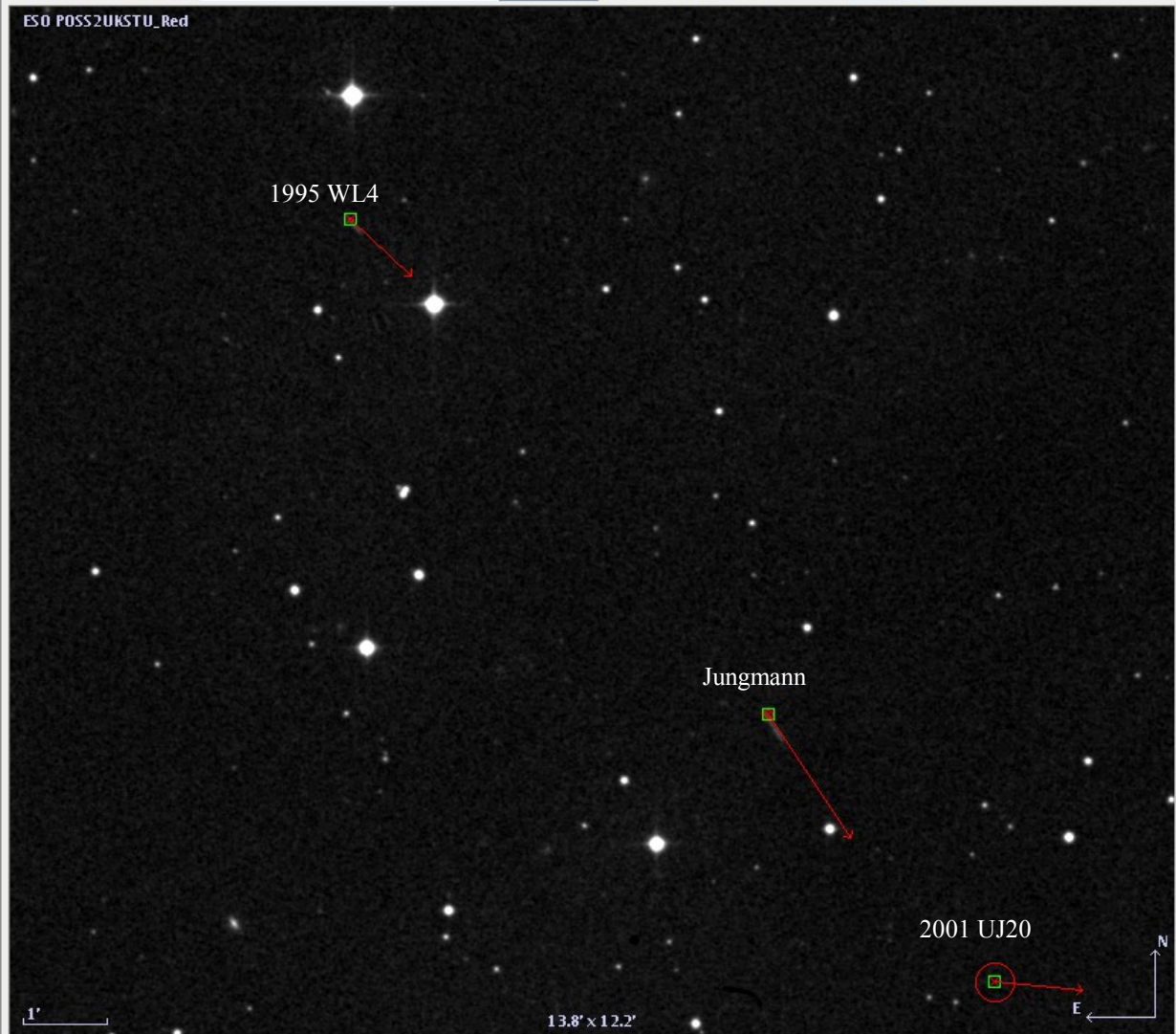
Radius.....

Epoch

Observer location

Max. uncertainty

Display filter.....



Aladin logo

select

pan

zoom

dist

draw

tag

text

filter

cross

rgb

assoc

cont

mlss

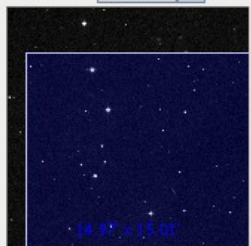
pixel

prop

del

Zoom 1x

SkyBoT 1991-1
 ESO POSS2UKSTU



Num	Name	RA	DEC	Class	Mv	ErrPos	d	dRAcosDec	dDEC
<input type="checkbox"/> 12797	1995 WL4	03 22 42.2933	+13 00 58.647	MB I	18.2	-1.060	134.356	-8.5140	-7.900
<input type="checkbox"/> 40441	Jungmann	03 22 22.0361	+12 55 8.109	MB II	18.1	-0.206	222.958	-11.0145	-17.471
<input type="checkbox"/> -	2001 UJ20	03 22 11.0907	+12 51 58.867	MB	20.3	5.315	415.682	-12.4742	-1.222

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

- Keck telescope (2000 to 3000 requests per day)
- Tarot telescopes (data mining, thousands requests per day)
- 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 of Sso spectra)
- ...

fb0126_cor.fits-1

Apparent motion

Data mining of the
First Byurakan Survey
Identification of
(104) Klymene's spectrum

(104) Klymene

1'

7.95' x 8.1'

N
E

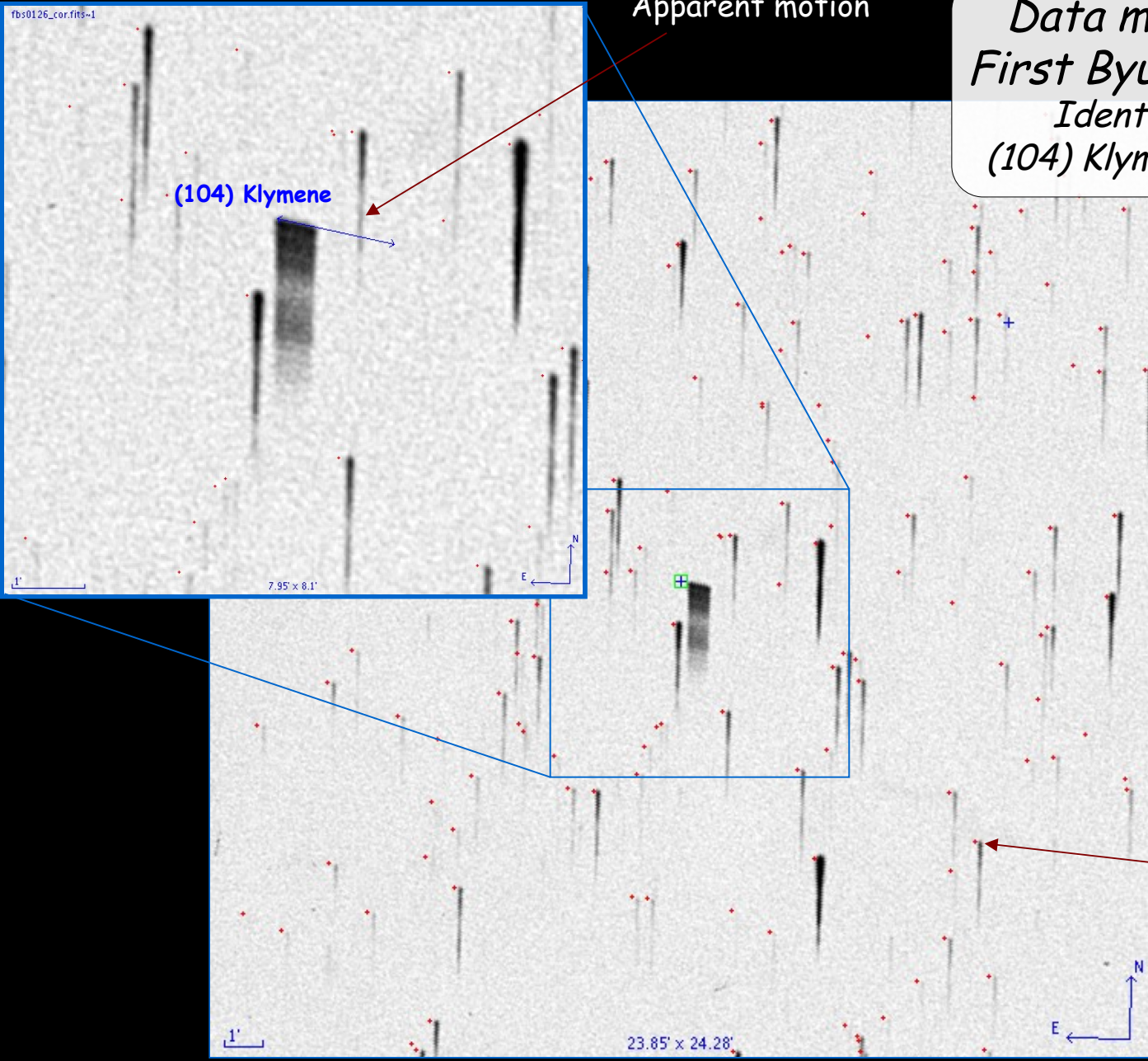
+

1'

23.85' x 24.28'

N
E

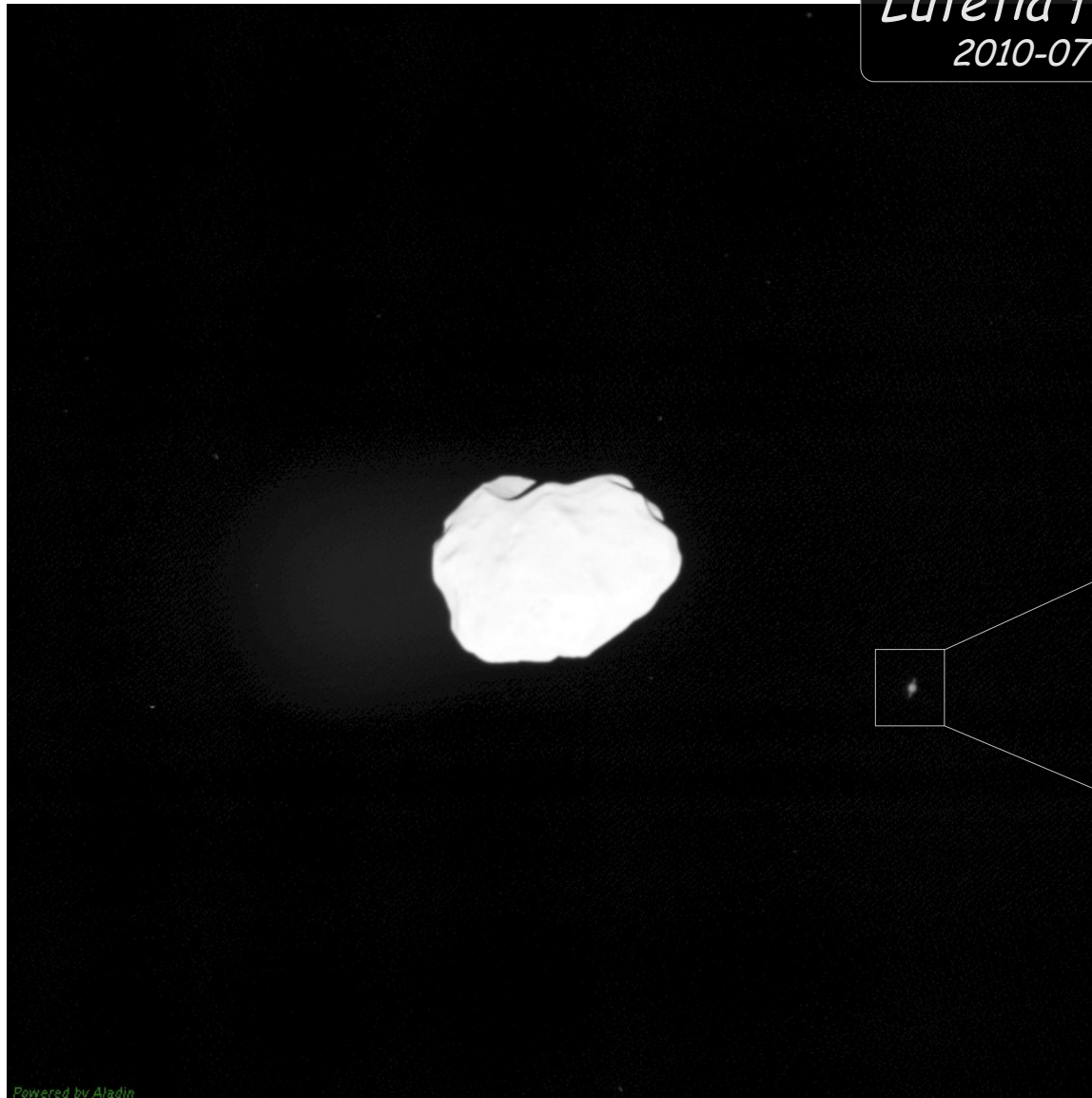
USNO-A2 stars



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
2010-07-10T15:04:39



Powered by Aladin

Lutetia from Rosetta

2010-07-10T15:04:39

Server selector

Others: Allsky, File, all VO, Watch, FOV, Sextractor

Image servers: Aladin images, SkyView, UKIDSS, Sloan, DSS..., VLA..., Archives..., Others...

Target (ICRS, name): 12 15 19.07 +00 24 24.7

Radius: 54.9'

Epoch: 2010-07-10T15:04:39

Search for: Asteroids and Planets

Max. uncertainty: 120 arcsec

Display filter: Arrow of motion

Aladin v7.5 *** BETA VERSION (based on v7.504) ***

File Edit Image Catalog Overlay Tool View Interop Help

Location: 12:14:22.08 +00:24:44.7 Frame: ICRS

Allsky opt Allsky IR DSS Simbad NED PPMX 2MASS

NAC_2010-07-10T15.04.39.0122_ID30_1251276000_F82_calib 1.431E-6

46.95' x 43.53'

1.294° x 1.294°

Aladin Java Measurements frame

SkybotRosettaConeSearch - Name - Solar system object Search

Num	Name	RA	DEC	Class	Mv
<input type="checkbox"/> 21	Lutetia	12 15 21.9590	+00 23 50.854	MB I	4.4
<input type="checkbox"/> 607	Hyperion	12 15 3.8295	+00 43 31.387	Satellite	13.7
<input type="checkbox"/> 603	Tethys	12 14 47.9628	+00 43 33.870	Satellite	9.7
<input type="checkbox"/> 601	Mimas	12 14 47.2383	+00 43 32.443	Satellite	12.4
<input type="checkbox"/> 602	Encelade	12 14 46.8484	+00 43 33.588	Satellite	11.2
<input type="checkbox"/> 604	Dione	12 14 44.7710	+00 43 22.418	Satellite	10.0
<input type="checkbox"/> -	Saturn	12 14 45.1635	+00 43 28.728	Planet	0.3
<input type="checkbox"/> 608	Iapetus	12 14 31.6739	+00 42 11.634	Satellite	10.6
<input type="checkbox"/> 605	Rhea	12 14 38.3173	+00 43 20.259	Satellite	9.2
<input type="checkbox"/> 606	Titan	12 14 34.4423	+00 43 34.382	Satellite	7.8

10 sel / 10 src 87Mb

Lutetia from Rosetta

2010-07-10T15:04:39

File Edit Image Catalog Overlay Tool View Interop Help

Location 12:15:17.43 +00:26:24.0

Allsky opt Allsky IR DSS Simbad NED PPMX 2MASS

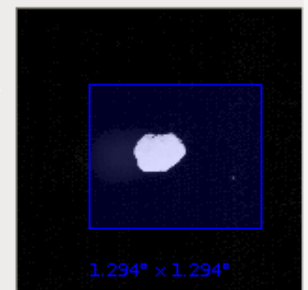


- select
- pan
- zoom
- dist
- phot
- draw
- tag
- filter
- cross
- key
- rgb
- assoc
- crop
- cont
- pixel
- prop
- del



Filter3
SkyBoT@Rose
NAC_2010-07-1

Op... - [slider]
zoom - [slider]



grid north multiview match

Search

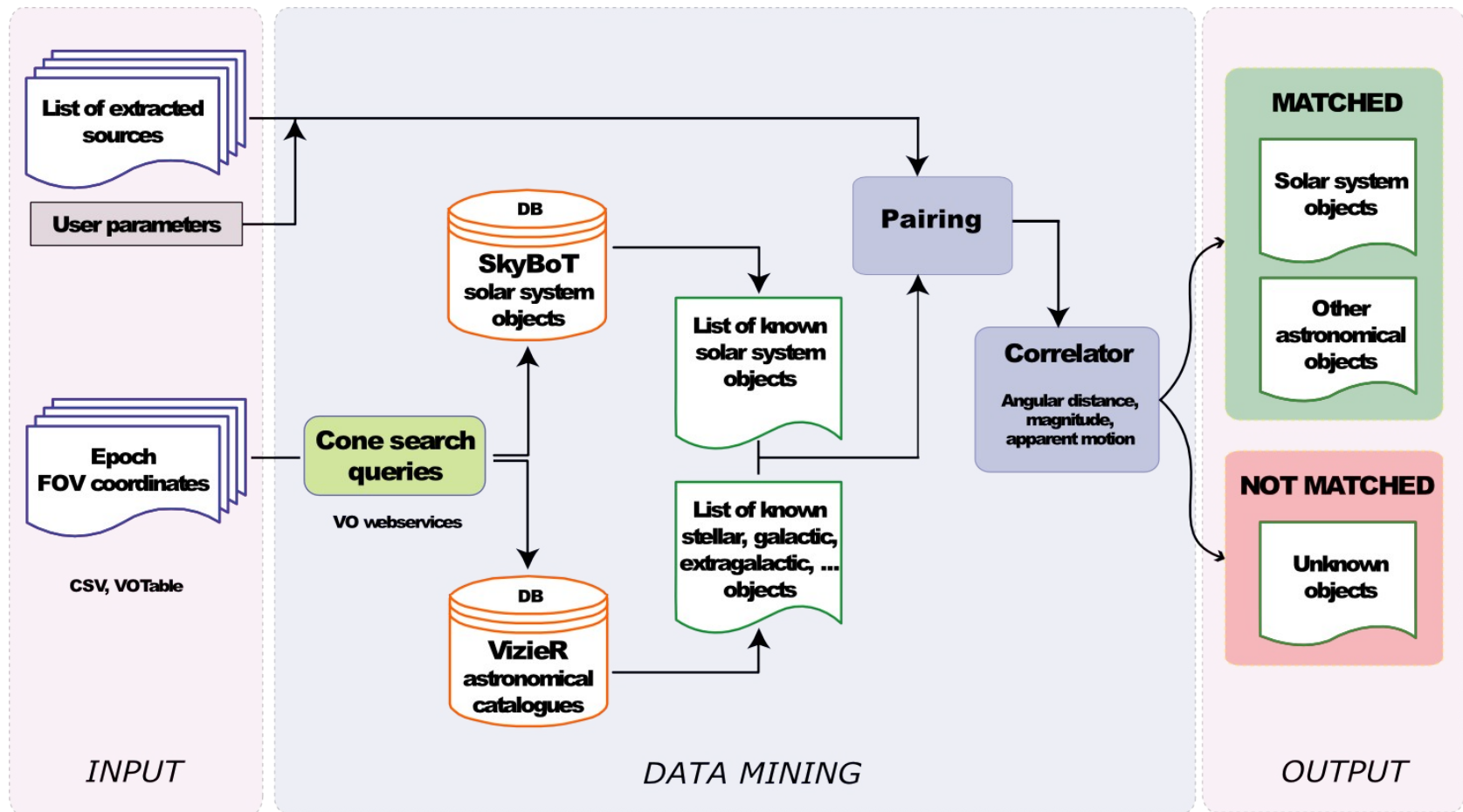
● ↓ ↑ □ ↗

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: lists of identified sources
- Work in progress, available late 2012

AstroId
Solar system data mining tool

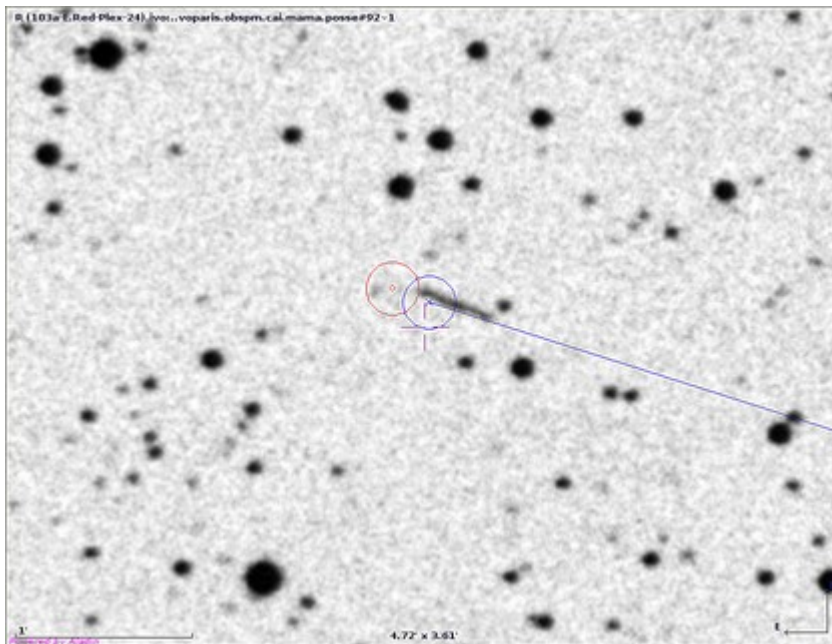
AstroID workflow



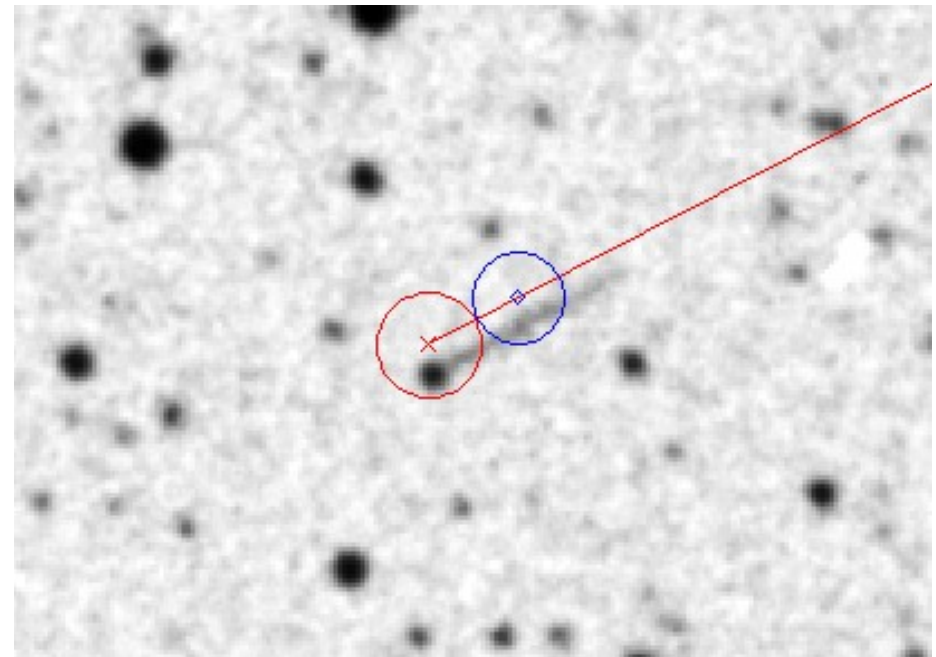
First tests made on Earth-based sky surveys

- **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 (work in progress)
- **First Byurakan Db Survey** (collaboration IMCCE / IPSL / Byurakan Obs.)
 - Spectroscopic survey (Markarian)
 - 20×10^6 spectra ($M_v \sim 17.5$), 2180 plates → ~300 Sso identified
- **EROS** (collaboration IMCCE / IAP / CEA)
 - ~26000 fields which contain $\sim 3 \times 10^5$ stars (work in progress)
 - Unusual (GC, LMC, ...)

Identification of Malaren POSSE0092



Identification of VanDerPol POSSE00503



Identification of (20430) Stout EROS-2 (2001-06-20)

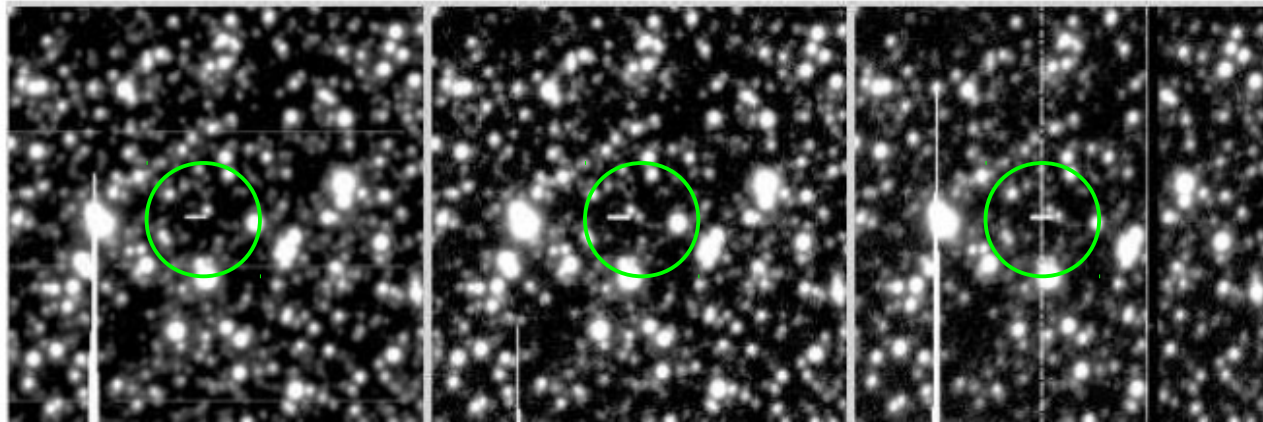



Figure 1: EROS-2 charts (left to right): Red Reference image - Red current image - Blue current image

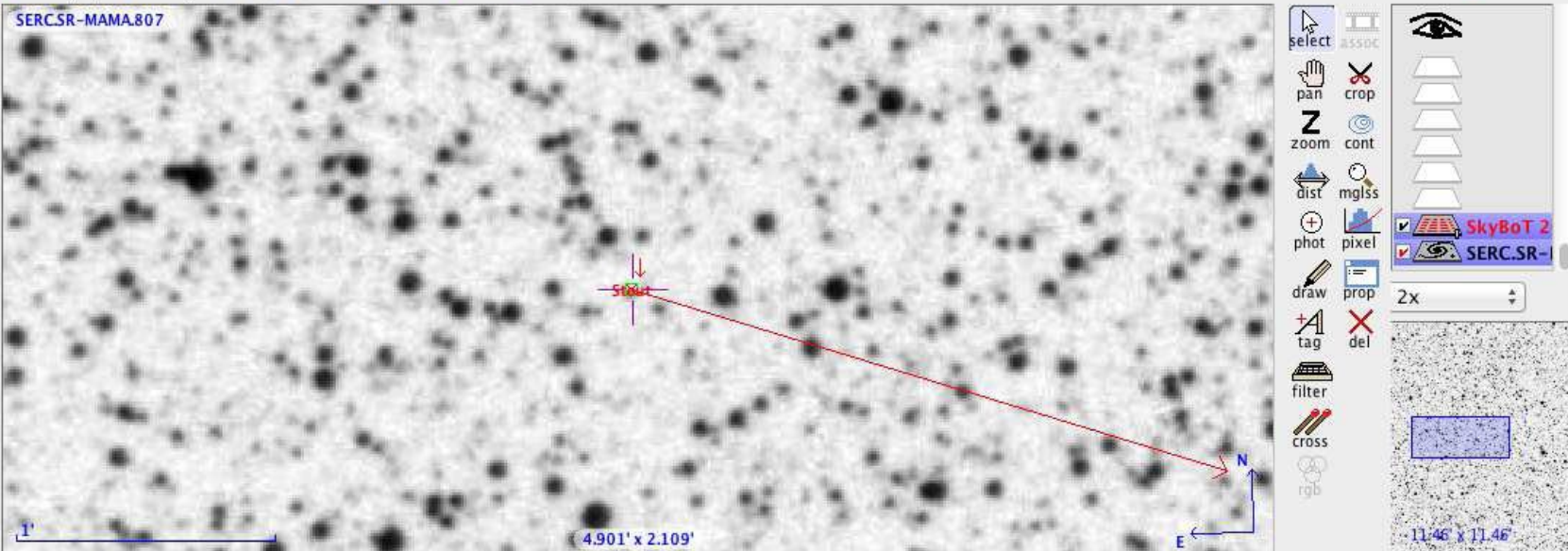
Identification of (20430) Stout EROS-2 (2001-06-20)

Aladin v7.0

Location Clear Frame ICRS 

Allsky opt
 Allsky IR
 DSS
 Simbad
 NED
 PPMX
 2MASS

SERC.SR-MAMA.807



select ASDDC eye
 pan crop eye
 zoom cont eye
 dist mglss eye
 phot pixel SkyBot 2
 draw prop SERC.SR-1
 tag del
 filter
 cross
 rgb

2x

11.46' x 11.46'

grid north multiview match

Search

Num	Name	RA	DEC	Class	Mv	ErrPos	d	dRAcosDec	dDEC	Dgeo
<input type="checkbox"/> 20430	Stout	18 47 28.4190	-07 15 16.725	MB II	17.9	0.327	3.111	-27.2243	-8.277	1.42214

<http://vo.imcce.fr/>

VO Solar System Portal

- Ephemeris generator (Miriade)
- Data Mining (Skybot, AstroId)
- Feedback is welcome (ov@imcce.fr)