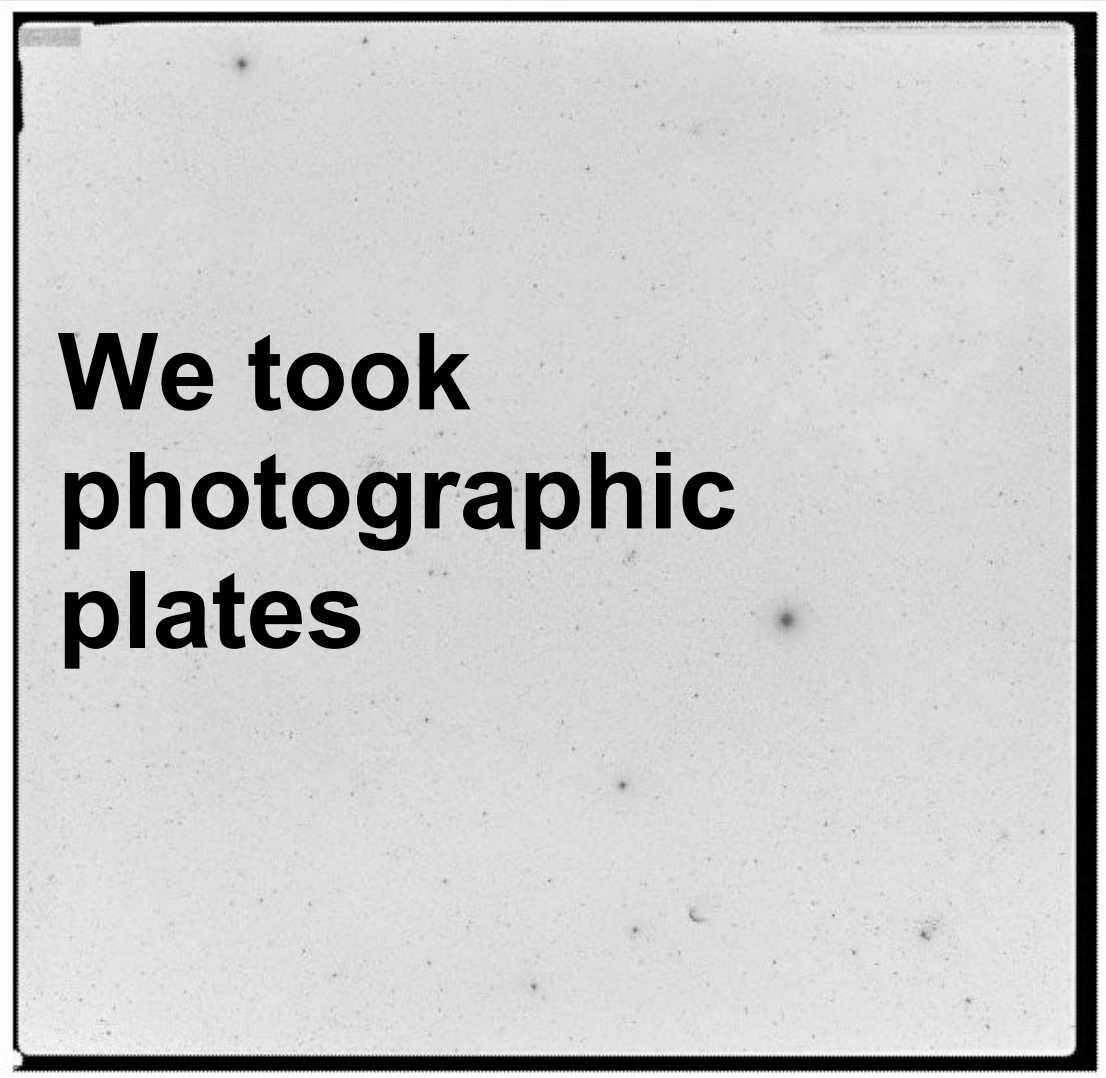
Fixing image observation times with asteroids

IVOA interoperability meeting

Banff, October 10

Once upon a time...



We took photographic plates

But WHEN exactly ???

Curation and preservation of epoch metadata

- Many different data types
  - Calendar date
  - ISO 8601 date+time
  - Julian day
  - Modified Julian day
  - Decimal year (Julian, Besselian ?)
  - Decimal time !!
- Original errors (typos, etc)
- + Errors when converting between formats

Existing metadata

USNO log of plates

Field	Plate	Date	Time	RA (B1950)	DEC	RA (J2000)	DEC	Type	Filt	Exp	H.A.	limits			
0002	UJ06962	1996.6146	08.55	0.000263	1.483413	0.011792	1.488270	IIIaJ	GG385-3	3	1:50E	5.161452	1.147884	1.423711	1.545060
0002	SJ06975	1996.6256	08.97	0.000260	1.483412	0.011790	1.488269	IIIaJ	GG385-3	55	1:10E	5.170616	1.146774	1.423797	1.544626
0002	SF06991	1996.6420	08.32	0.000257	1.483410	0.011786	1.488267	IIIaF	RG610-3	65	1:25E	5.178374	1.133242	1.423002	1.543955
0002	SN07033	1996.7159	06.72	0.000240	1.483403	0.011768	1.488260	IVN	RG9-8	60	1:16E	5.167122	1.152751	1.423897	1.544991
0003	UJ07043	1996.7242	09.85	0.627771	1.483427	0.673306	1.487293	IIIaJ	GG385-3	3	0:25E	5.845194	1.776116	1.422255	1.543128
0003	SJ07034	1996.7159	09.50	0.627081	1.483426	0.672584	1.487294	IIIaJ	GG385-3	65	0:58E	5.846436	1.793580	1.422825	1.543655
0003	SF07073	1996.7734	07.87	0.627728	1.483424	0.673259	1.487289	IIIaF	RG610-3	60	1:14E	5.847180	1.782926	1.422320	1.543316
0003	SN07037	1996.7187	09.12	0.627776	1.483428	0.673311	1.487294	IVN	RG9-8	60	1:17E	5.840965	1.795119	1.422992	1.543915
0004	UJ07107	1996.8118	09.65	1.255491	1.483487	1.320388	1.484843	IIIaJ	GG385-3	3	0:59E	0.232612	2.403875	1.420890	1.541627
0004	SJ07092	1996.7871	10.25	1.255522	1.483488	1.320420	1.484844	IIIaJ	GG385-3	45	0:59E	0.250837	2.396210	1.419984	1.540711
0004	SF07158	1996.9350	06.67	1.255333	1.483483	1.320226	1.484840	IIIaF	RG610-3	40	1:01E	0.242113	2.393890	1.420318	1.540942
0004	SN07591	1998.0575	03.80	1.255172	1.483480	1.320060	1.484837	IVN	RG9-8	50	0:58E	0.246084	2.394174	1.420056	1.540844
0005	UJ07323	1997.2142	03.92	1.884574	1.483548	1.947526	1.481903	IIIaJ	GG385-3	3	0:31W	0.908631	2.981410	1.417306	1.538132
0005	SJ07262	1997.1786	04.68	1.884620	1.483547	1.947570	1.481902	IIIaJ	GG385-3	35	0:26W	0.922919	2.991261	1.417347	1.537913

Existing metadata

- Some VizieR catalogues
  - Observation logs
- Headers of images
  - Aladin image server
- Databases, SIA metadata...

Example : DSS2 POSSII J Plate 538

```
RADESYS = 'FK5     '           / Coordinate system
MJD-OBS =            48513.33 / Modified Julian Date at start of observation
EPOCH   =     1991.70110882957 / Epoch in Julian Year at start of observation
CUNIT1  = 'DEG     '           / RA Coordinate Unit
CUNIT2  = 'DEG     '           / DEC Coordinate Unit
CDELT1  =        0.0068038656 / WCS Coordinate scale matrix
CDELT2  =
PLATE   =
COMMENT St
PLATE   =
BUNIT   =
OBJECT  =
DATE    =
ORIGIN  =
INSTRUME=
NUM     =
PLATEID =
```

```
ORIGIN  = 'CASB -- STScI     ' /Origin of FITS image
PLTLABEL= 'SJ04228           ' /Observatory plate label
PLATEID = 'A085              ' /GSSS Plate ID
REGION  = 'XJ538             ' /GSSS Region Name
DATE-OBS= '1991/09/15        ' /UT date of Observation
UT      = '##################' /UT time of observation
EPOCH   =  1.9917049560550E+0
PLTRAH  =
PLTRAM  =
PLTRAS  =  2.8905147333333E+0
PLTDECSN= '+
PLTDECD =
PLTDECM =
PLTDECS =  1.3517999999996E+0
EQUINOX =  2.0000000000000E+0
EXPOSURE=  6.5000000000000E+0
BANDPASS=
PLTGRADE=
PLTSCALE=  6.7199996948240E+0
SITELAT = '+33:24:24.00
SITELONG= '-116:51:48.00
TELESCOP= 'Palomar 48-in Schm
CNPIX1  =                  608
CNPIX2  =                 1152
DATATYPE= 'INTEGER*2
SCANIMG = 'XJ538_A085_01_00.F
```

```
ORIGIN  = 'STScI/MAST'          /GSSS: STScI Digitized Sky Survey
SURVEY  = 'POSSII-J'            /GSSS: Sky Survey
REGION  = 'XJ538   '            /GSSS: Region Name
PLATEID = 'A085    '            /GSSS: Plate ID
SCANNUM = '01      '            /GSSS: Scan Number
DSCNDNUM= '00      '            /GSSS: Descendant Number
TELESCID=                    3 /GSSS: Telescope ID
BANDPASS=                   18 /GSSS: Bandpass Code
COPYRGHT= 'Caltech/Palomar'     /GSSS: Copyright Holder
SITELAT =                33.356 /Observatory: Latitude
SITELONG=               116.863 /Observatory: Longitude
TELESCOP= 'Oschin Schmidt - D' /Observatory: Telescope
INSTRUME= 'Photographic Plate' /Detector: Photographic Plate
EMULSION= 'IIIaJ   '            /Detector: Emulsion
FILTER  = 'GG395   '            /Detector: Filter
PLTSCALE=                67.20 /Detector: Plate Scale arcsec per mm
PLTSIZEX=              355.000 /Detector: Plate X Dimension mm
PLTSIZEY=              355.000 /Detector: Plate Y Dimension mm
PLATERA =      0.620426630000 /Observation: Field centre RA degrees
PLATEDEC=       20.3204580000 /Observation: Field centre Dec degrees
PLTLABEL= 'SJ04228 '            /Observation: Plate Label
DATE-OBS= '1991-09-14T07:92:00' /Observation: Date/Time
EXPOSURE=                65.0 /Observation: Exposure Minutes
```

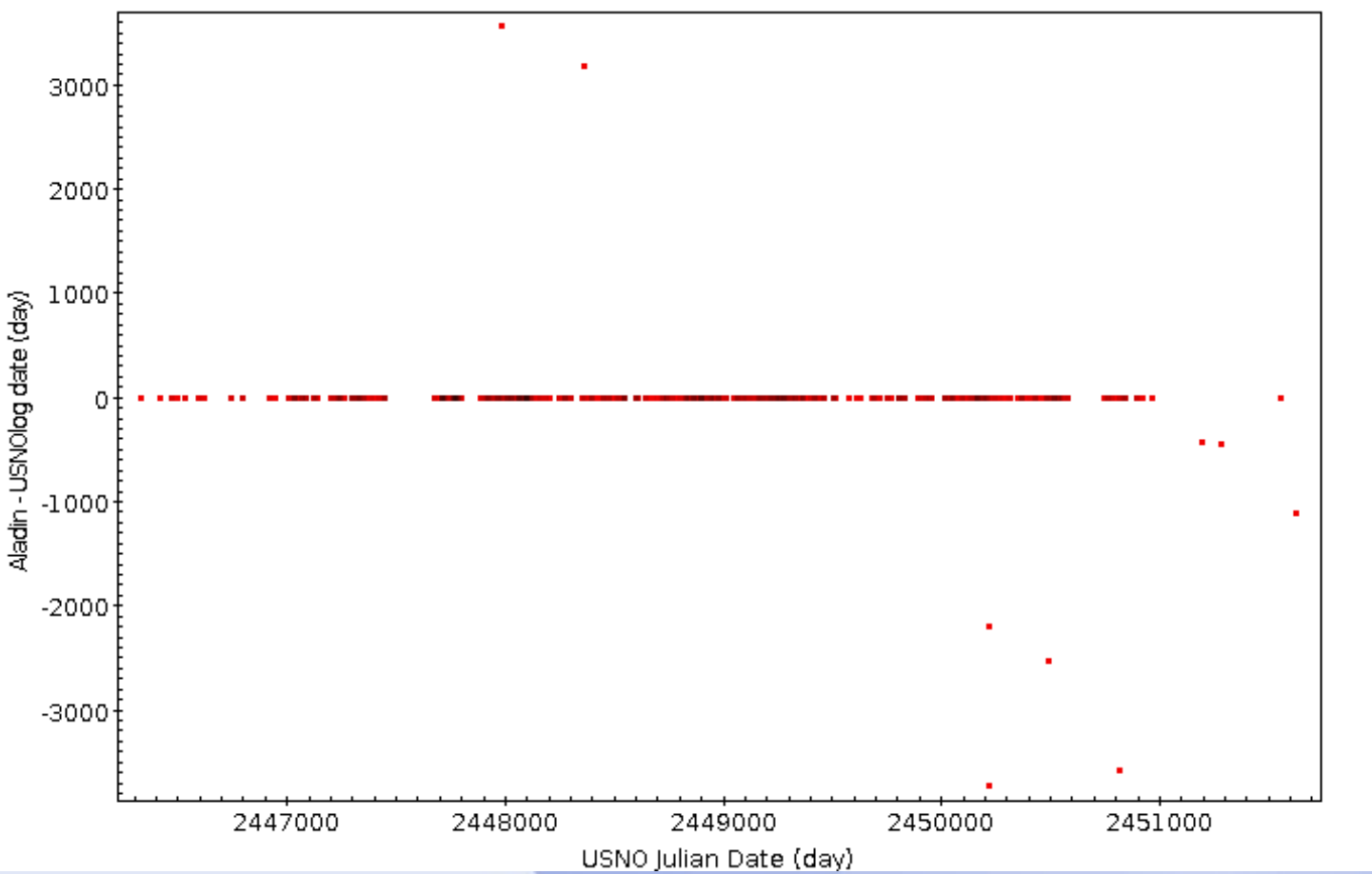
CDS : 1991.7011088

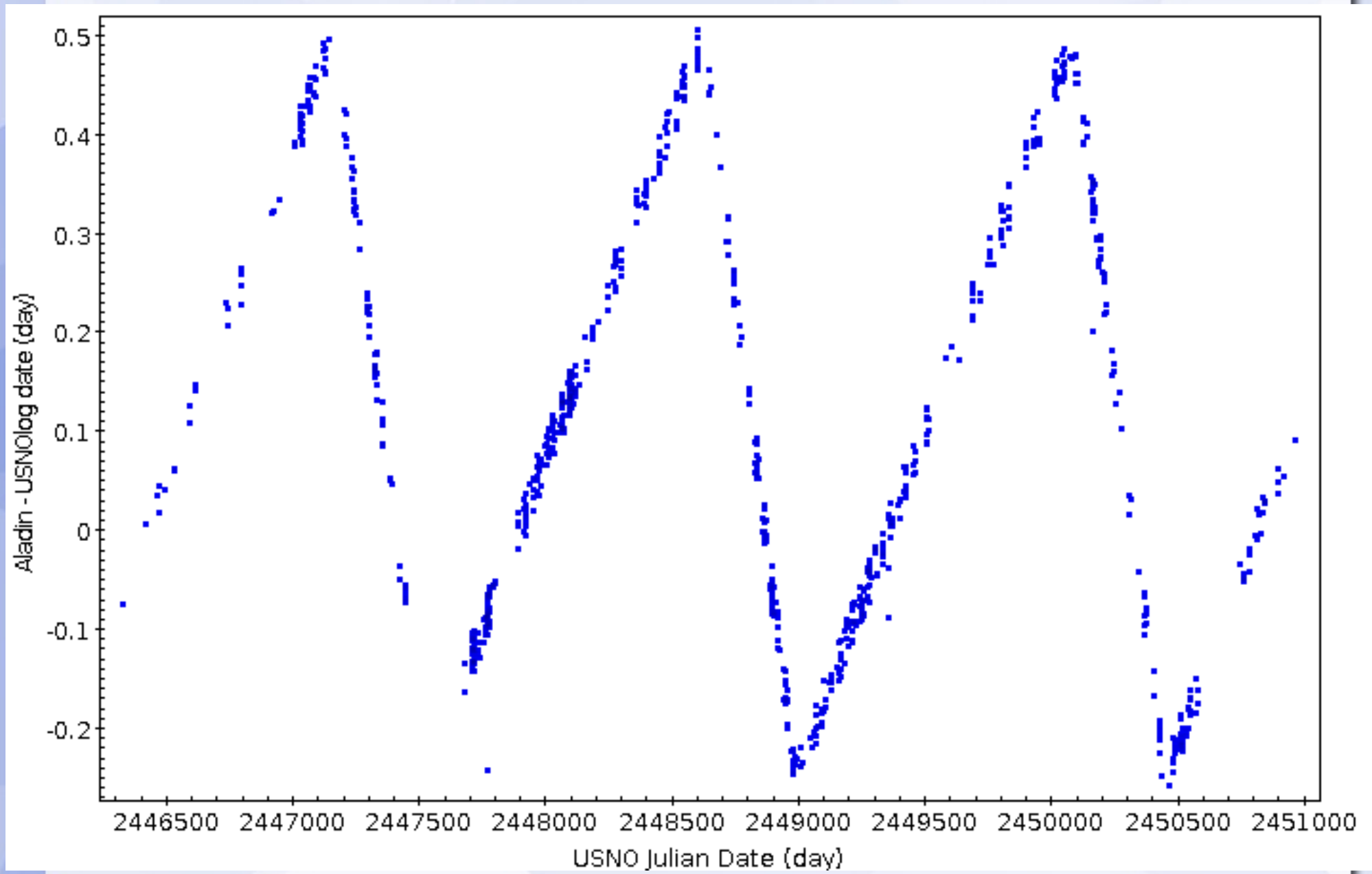
ESO : 1991.704956
1991/09/15

STSci : 1991-09-14T07:92:00

Comparison

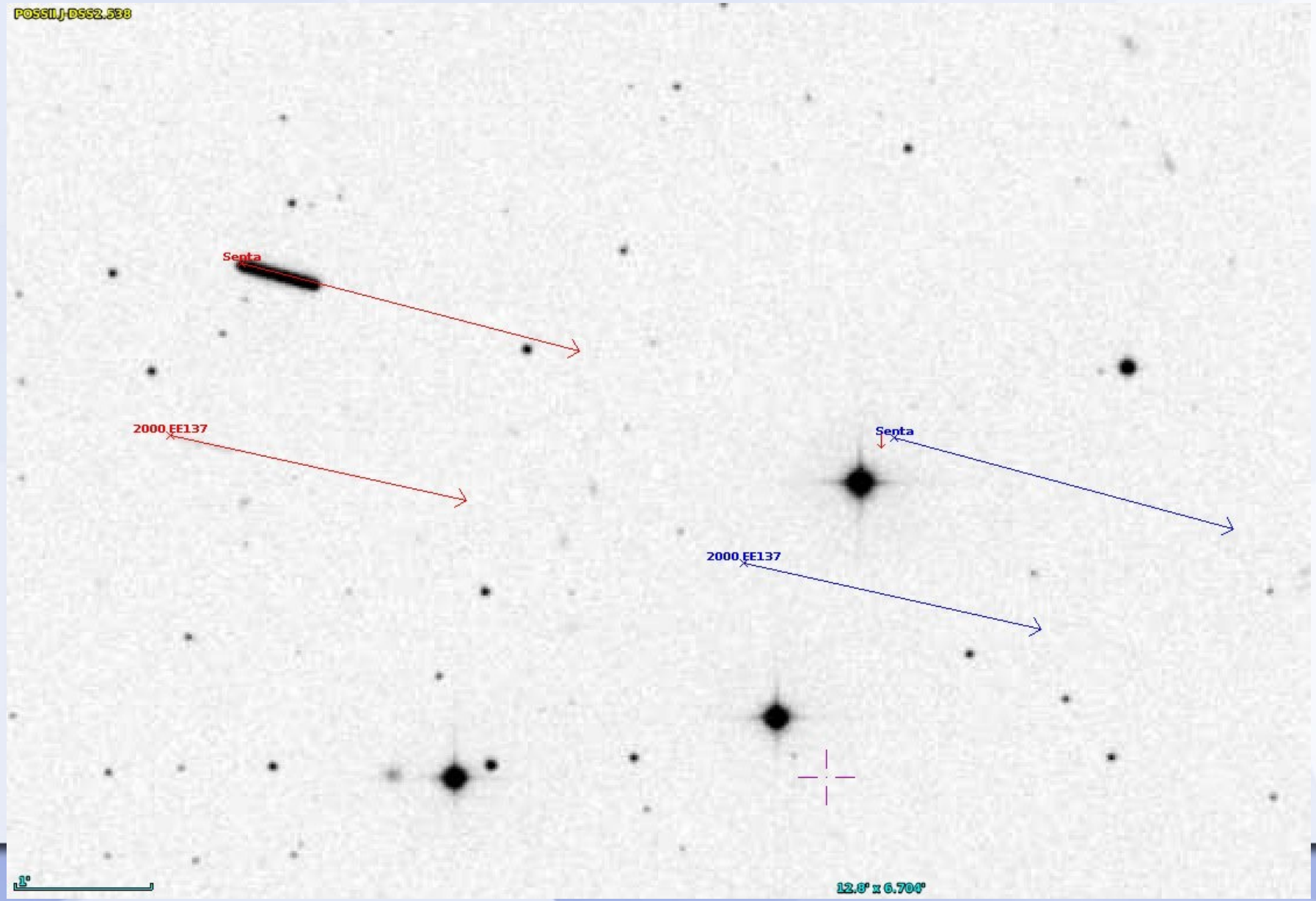
- Cross-match by plate type and number :
  - Allows comparison of epoch values




0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
Aladin - USNOlog date (day)
2446500
2447000
2447500
2448000
2448500
2449000
2449500
2450000
2450500
2451000
USNO Julian Date (day)

But which is right ?

Using asteroids



Conclusion & perspectives

- Curation of metadata
  - Description of metadata (mid-exposure/start)
  - Values
- Possible to fix most of the observation epochs for large plate collections
- Fix Aladin epoch metadata
- Propagate to other collections