Time in Aladin

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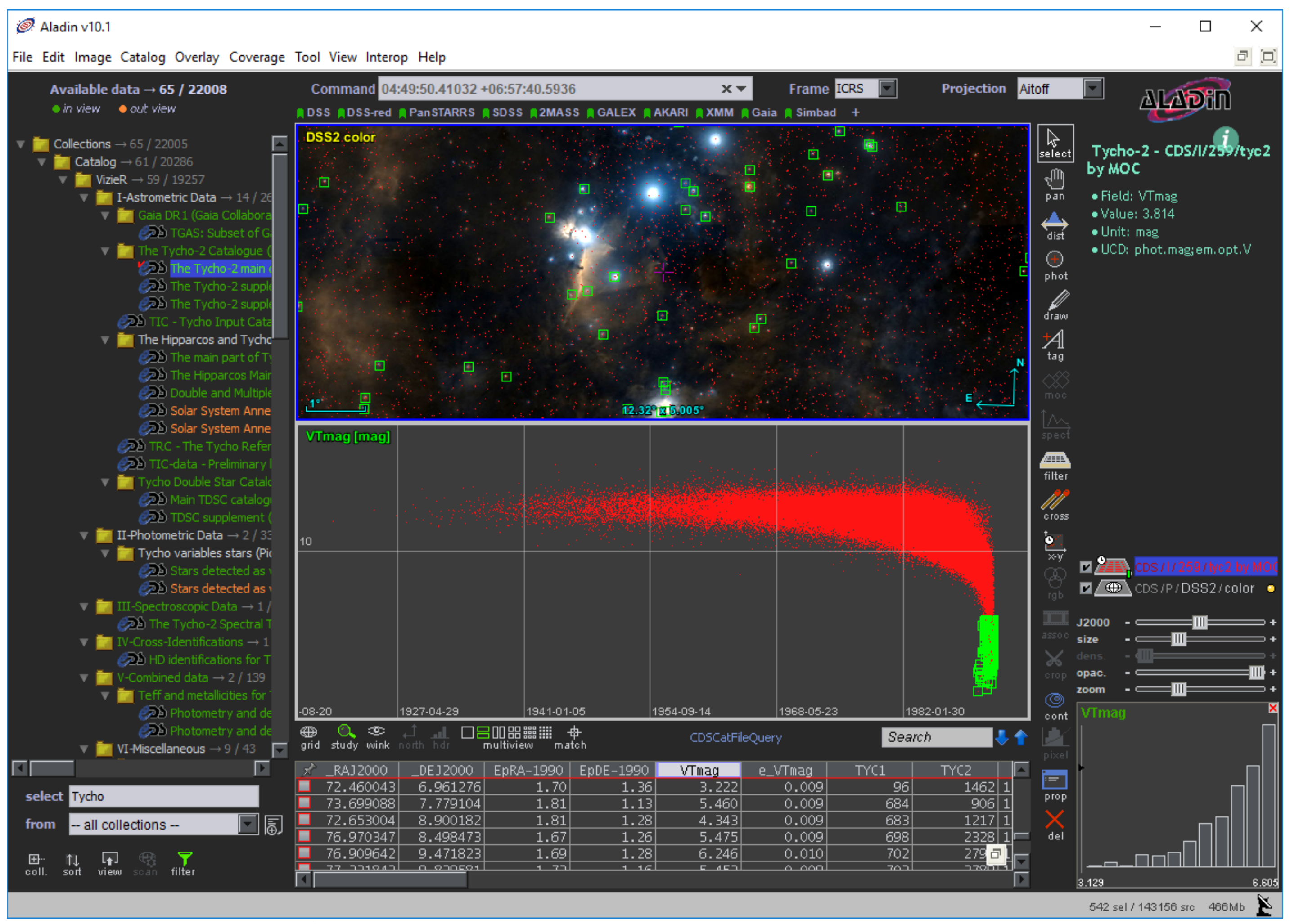
Aladin was originally designed to visualise astronomical data in terms of spatial coordinates. Based on the same technology, we have incorporated a new dimension in Aladin: the time. A new Aladin **prototype**, based on the core of Version 10, incorporates **two new components**: a “time view” window and a “time coverage” capability.

Time view



Vmag vs epoch observations for Tycho2 objects around Orion

The “Time View” window is a simple extension to Aladin’s graphic window originally designed to handle longitude VS latitude plots. This new graphic mode is now capable of **drawing scatter plots** where the primary axis is time and the secondary axis is selected by the user and could use any of the accessible quantities like magnitude, flux, radial velocity, etc. This new graphic mode is **fully interoperable** with Aladin’s spatial window so selected objects markers are visible on both windows simultaneously.

First issue

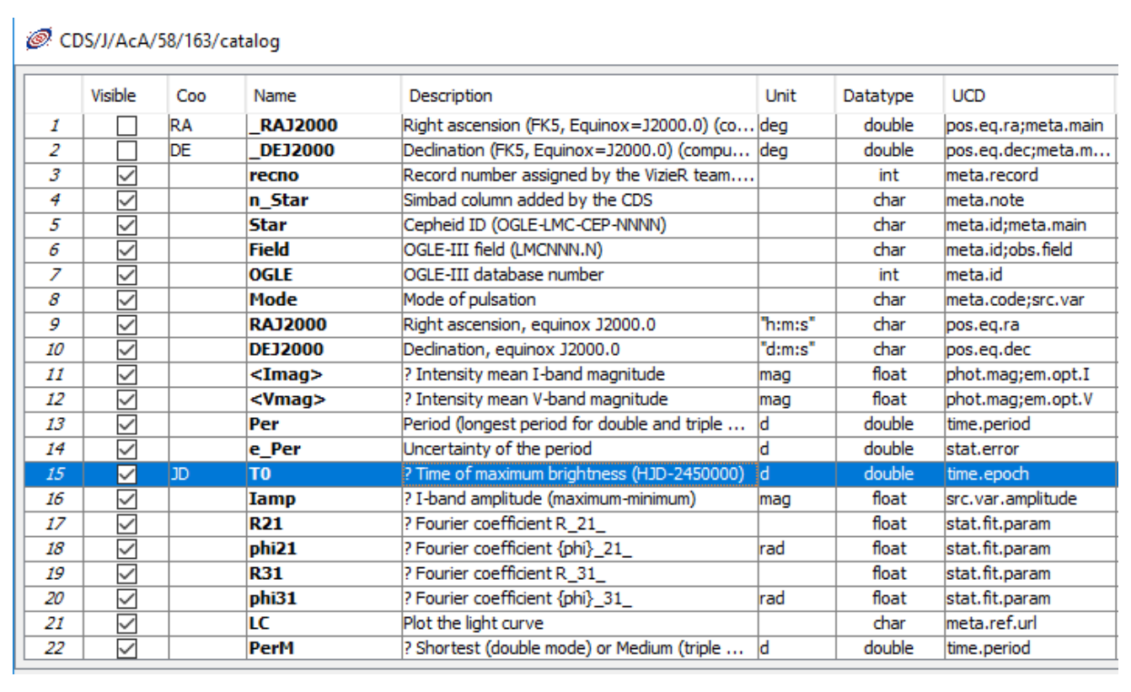
How does Aladin discover the time system of a given entity (format, scale, offset, observer location) from the VOTables or FITS files? As of today, there is NO time meta information standard.

→ Aladin prototype is using **heuristics** algorithms to “guess” the time fields and the associated reference systems. But this method is prompt to error.

→ A **formal description** using a **TIMESYS** tag in VOTable standard would ease tremendously this problem.

```
VOTable format
.Table J/AcA/58/163/catalog
  -assuming Time column 15 (proba=90.0%) timesys unknown (assuming TDB/Barycentric)
  -assuming RADEC in degrees column 1 for RA and 2 for DEC
    [RA=0 (proba=100.0%) DE=1 (proba=100.0%) PMRA=-1 (proba=0.0%) PMDEC=-1 (proba=0.0%)]
  -Coordinate system references found:
    ID="J2000" => eq_FK5 Eq=J2000
    => RA/DEC coordinate conversion not required: ref="J2000" => FK5(J2000.0) to ICRS
  -found CSV DATA (field sep=Tab record sep=\n)
  -Found 3 lines CVS header with dash separator
  -assuming Time format:JD timeOffset: 2450000.0
```

Aladin VOTable heuristic parser log for J/AcA/58/163/catalog



CDS/J/AcA/58/163/catalog

	Visible	Coo	Name	Description	Unit	Datatype	UCD
1	☐	RA	**_RAJ2000**	Right ascension (FK5, Equinox=J2000.0) (co…	deg	double	pos.eq.ra;meta.main
2	☐	DE	**_DEJ2000**	Declination (FK5, Equinox=J2000.0) (compu…	deg	double	pos.eq.dec;meta.m…
3	☑		**recno**	Record number assigned by the VizieR team.…		int	meta.record
4	☑		**n_Star**	Simbad column added by the CDS		char	meta.note
5	☑		**Star**	Cepheid ID (OGLE-LMC-CEP-NNNN)		char	meta.id;meta.main
6	☑		**Field**	OGLE-III field (LMCNNN.N)		char	meta.id;obs.field
7	☑		**OGLE**	OGLE-III database number		int	meta.id
8	☑		**Mode**	Mode of pulsation		char	meta.code;src.var
9	☑		**RAJ2000**	Right ascension, equinox J2000.0	"h:m:s"	char	pos.eq.ra
10	☑		**DEJ2000**	Declination, equinox J2000.0	"d:m:s"	char	pos.eq.dec
11	☑		**<Imag>**	? Intensity mean I-band magnitude	mag	float	phot.mag;em.opt.I
12	☑		**<Vmag>**	? Intensity mean V-band magnitude	mag	float	phot.mag;em.opt.V
13	☑		**Per**	Period (longest period for double and triple …	d	double	time.period
14	☑		**e_Per**	Uncertainty of the period	d	double	stat.error
15	☑	JD	**T0**	? Time of maximum brightness (HJD-2450000)	d	double	time.epoch
16	☑		**Iamp**	? I-band amplitude (maximum-minimum)	mag	float	src.var.amplitude
17	☑		**R21**	? Fourier coefficient R_21_		float	stat.fit.param
18	☑		**phi21**	? Fourier coefficient {phi}_21_	rad	float	stat.fit.param
19	☑		**R31**	? Fourier coefficient R_31_		float	stat.fit.param
20	☑		**phi31**	? Fourier coefficient {phi}_31_	rad	float	stat.fit.param
21	☑		**LC**	Plot the light curve		char	meta.ref.url
22	☑		**PerM**	? Shortest (double mode) or Medium (triple …	d	double	time.period

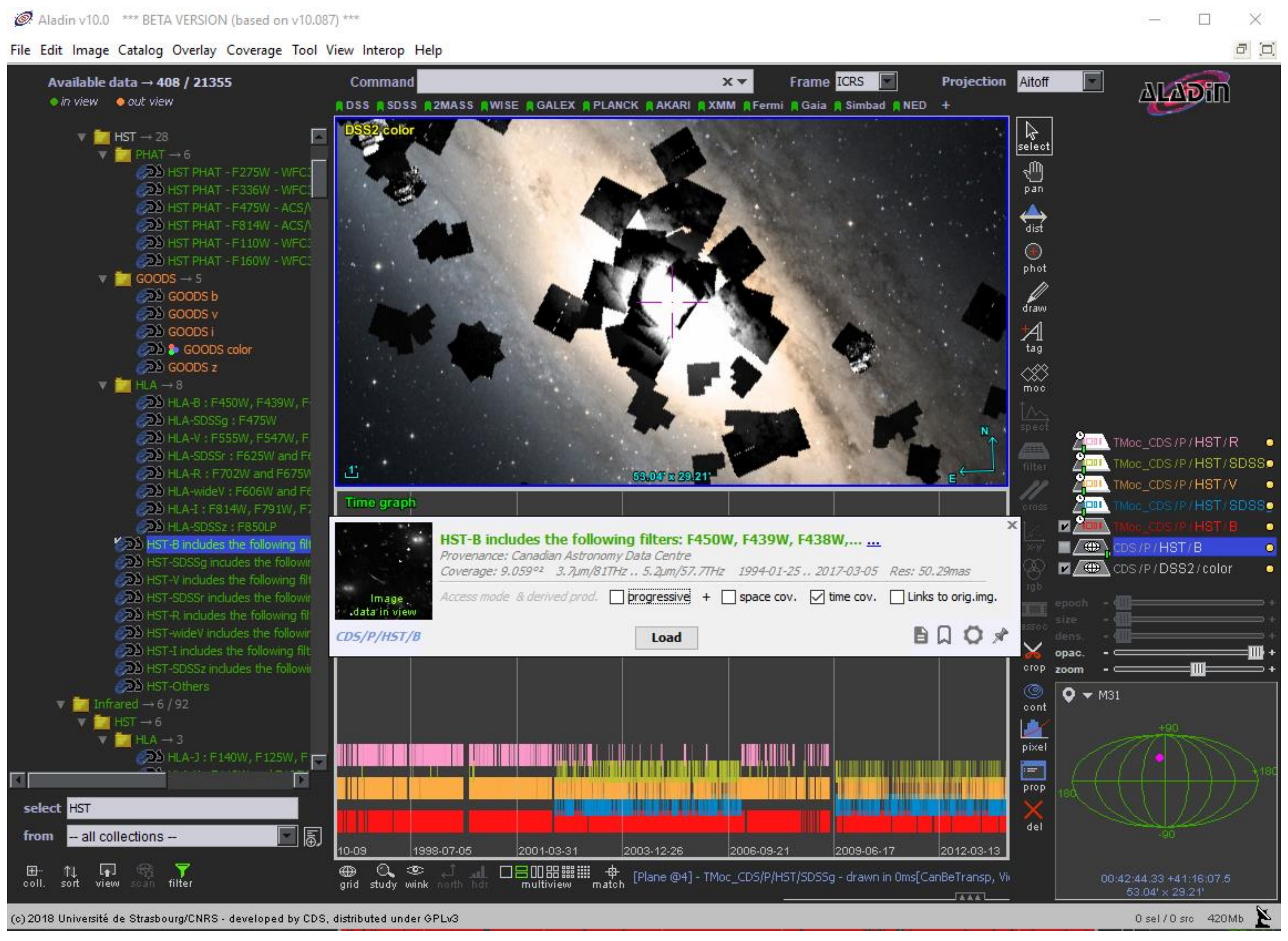
Second issue

In order to ease interoperability, which reference time system should we standardize on?

→ Aladin prototype uses **JD(TDB,Barycentric)**

Time coverage

The “time coverage” capability is based on the technology supporting the Multi-Ordered Coverage (MOCs), replacing the HEALPix space **discretisation** with a **time scale** instead. Thus the user is then able to manipulate the time coverage the same way he/she was able to manipulate the space coverage using the standard Aladin. So the user can perform time coverage manipulation like intersections or unions of different time coverages, generate new time coverage from catalog. For this to be possible, Aladin prototype is introducing a new version of MOC files dedicated for the time axis called **T-MOC**. Creating T-MOCs was made possible with a very simple modification of the basic MOC java library.


Aladin v10.0 *** BETA VERSION (based on v10.087) ***
Available data → 408 / 21355
Command
Frame ICRS
Projection Aitoff
DSS2 color
Time graph
HST-B includes the following filters: F450W, F439W, F438W,...
progressive
space cov.
time cov.
Links to orig.img.
Load
select HST
from -- all collections --
1998-07-05
2001-03-31
2003-12-26
2006-09-21
2009-06-17
2012-03-13
grid
study
wink
multiview
match
(c) 2018 Université de Strasbourg/CNRS - developed by CDS, distributed under GPLv3

T-MOC comparison for HST image collections: HST-B, HST-V, HST-R, HST-SDSSr, HST-SDSSg

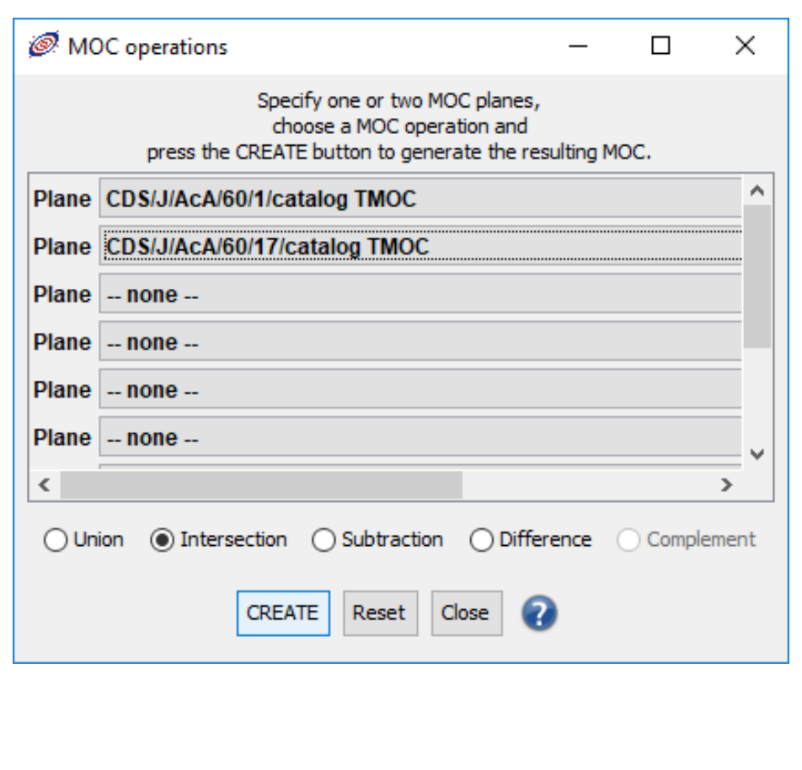
Third issue

What are the **standards** we should use to produce T-MOC which are interoperable?

→ Using **JD(TDB,Barycentric,no offset)** => requires Time conversion library

→ Using **1 µs for order 29** T-MOC resolution hence covering **9133** years if we use JD=0 (Monday, 4713 B.C. Jan 1, 12:00:00.0) as a starting point.

Note: for unknown system, the T-MOC will be created at a lower resolution for covering the system imprecision (typically 16min)



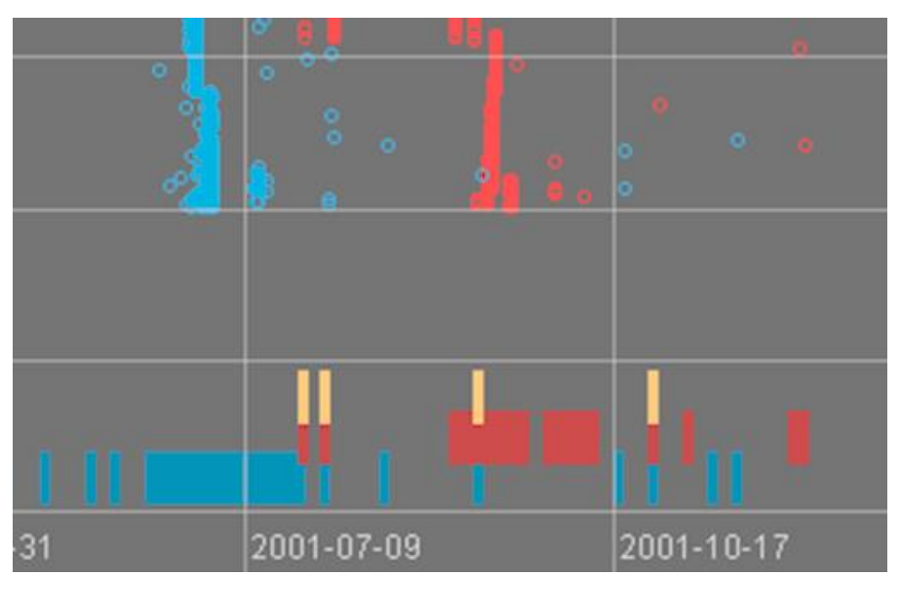
MOC operations

Specify one or two MOC planes,
choose a MOC operation and
press the CREATE button to generate the resulting MOC.

Plane CDS/J/AcA/60/1/catalog TMOC
Plane CDS/J/AcA/60/17/catalog TMOC
Plane -- none --
Plane -- none --
Plane -- none --
Plane -- none --

○ Union ● Intersection ○ Subtraction ○ Difference ○ Complement

CREATE Reset Close ?



T-MOC logical operations

These new capabilities are **already implemented** in the Aladin Beta version available on the Aladin CDS Web site
http://aladin.u-strasbg.fr

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