ObsCore DM Proposed Extension for time series and radio data

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following discussions with Time domain IG and RadioIG
cf former presentation @interop Nov 2020
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Context & Goal

- This work relates to the Time Domain IG/ and RadioIG charters
- Revisit former work presented at November interoperability meeting in 2020.

- What do I need in terms of time properties to query for a time series dataset? for radio datasets ?

- What is not covered by Obscore DM 1.1 specification (2017) ?
- How can I create an extra metadata table to enhance
  - the description of the time axis for such datasets ?
  - the specific properties of signal in radio data

Time series specific properties

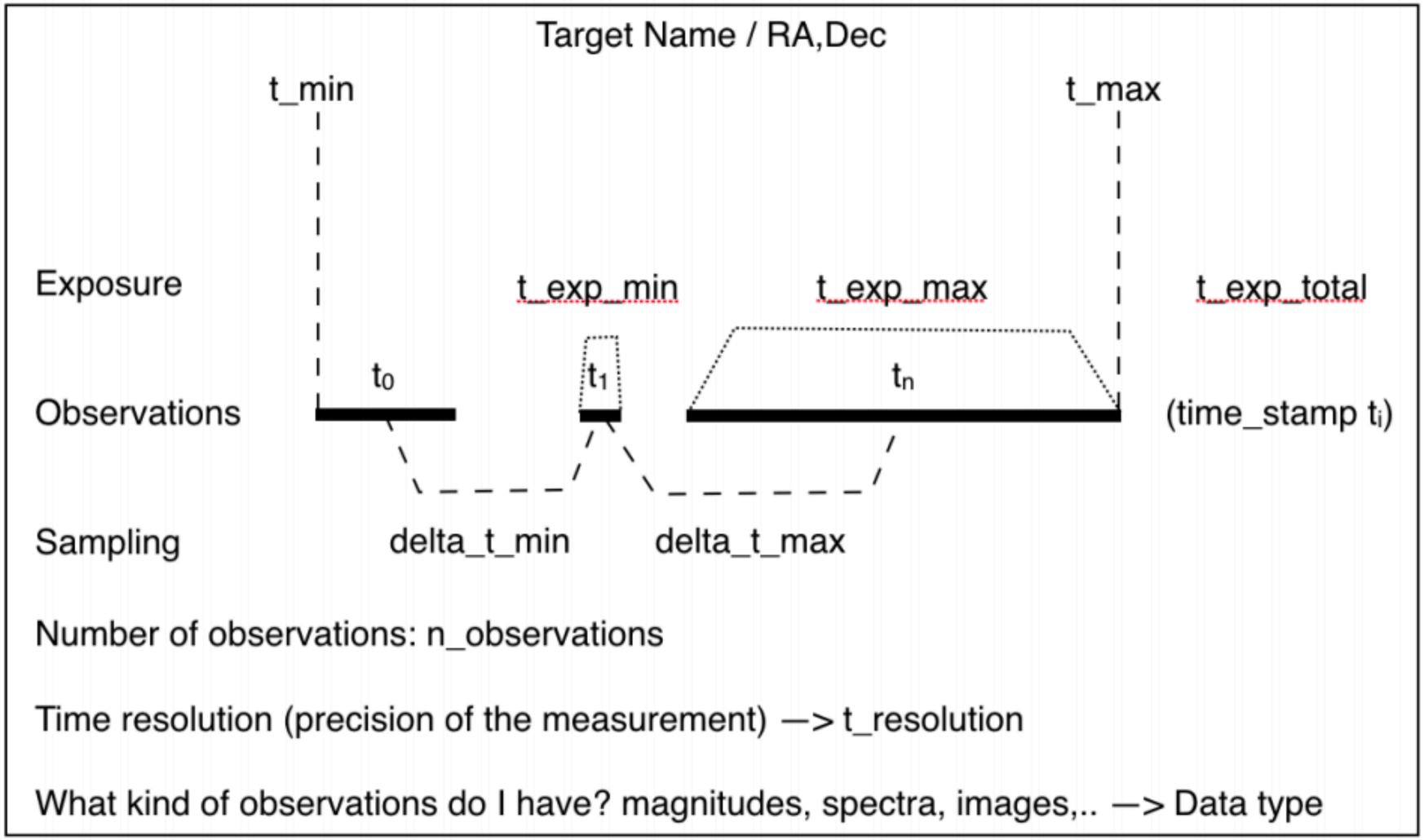


Figure 1: Simple representation of Time Series data.

Thanks to Ada Nebot

Time description in ObsCore

Obscore + TObs	Definition	Utype/datamodel path	UCD	Units	Mandatory/ optional
t_min	Time start of the sequence (MJD)	Char.TimeAxis.Coverage.Bounds.Limits.LoLim	time.start;obs.sequence	d	man
t_max	Time end of the sequence	Char.TimeAxis.Coverage.Bounds.Limits.HiLim	time.end;obs.sequence	d	man
t_exptime	Exposure time (sum of multiple exposures)	Char.TimeAxis.Support.Extent	time.duration;obs.exposure	s	man
t_exp_min	minimal length of time sample (min integration time)	Char.TimeAxis.Sampling.Extent.loLim	time.duration;obs.sequence;stat.min.	s	opt
t_exp_max	maximal length of time sample (max integration time)	Char.TimeAxis.Sampling.Extent.hiLim	time.duration;obs.sequence;stat.max	s	opt
%time space between 2 time samples / cadence					
t_delta_min	minimal length of time interval between 2 observations / cadence (min)	Char.TimeAxis.Sampling.Period.loLim	time.interval;obs.sequence;stat.min.	s	opt
t_delta_max	maximal length of time interval between 2 observations / cadence (max)	Char.TimeAxis.Sampling.Period.hiLim	time.interval;obs.sequence;stat.max	s	opt
t_resolution	minimal interpretable time difference	Char.TimeAxis.Resolution.Refval			
t_xel	nb of time stamps in the series	Char.TimeAxis.numBins	meta.number	null	man

grey cell = current Obscore keywords

add every parameter in blue cells to *ivoa.t_obs* table

Time Coordinate System

- The datasets description in Obscore 1.1 does not constrain to one specific TIME coordinate system.
- In VOTable, the data representation in the time series data rely on a TIMESYS element.
- Is it useful to query on it ?
- At least it is useful to get in the query response and let a client application prepare time coordinates' conversion

add every blue parameters to **ivoa.t_obs** table

Obscore + TObs	Definition	VODML-ID IN Coords DM and TIMESYS attribute	UCD	Units	Mandatory/ optional	Query setup
% Time Coordinate system						
t_origin	Time(frame origin)	TimeOffset.time0 (TBC) timeorigin	time.epoch	?	opt	
t_scale	Time frame scale	TimeFrame.timeScale timescale	time.scale	?	opt	
t_refPosition (barycenter, heliocenter, ...)	Time reference position	TimeFrame.refPosition refposition	?	?	opt	
t_refDirection (e.g. for solar observations)	Time reference direction	TimeFrame.refDirection refdirection	?	?	opt	
%Time representation	ISOtime , MJD, JD , …					
t_format	Time representation	?	time;meta.code.class	null	opt	MJD

Recent mapping for Pulsar data

- Experience on mapping PSRFITS keywords on ObsCore metadata
- cf Baptiste Ceconni's presentation at last Interop meeting
  https://wiki.ivoa.net/internal/IVOA/InterOpNov2021Radio/Radio-PSRFITS-ObsCore.pdf

- How to complete this mapping?
- How to map for other metadata proposed in other data formats: SDFits, FilterBank, others ?

- Polarization metadata : currently ObsCore holds
  pol_states: list the kinds of polarization measures present in the data
  pol_xel: number of samples along the polarization axes

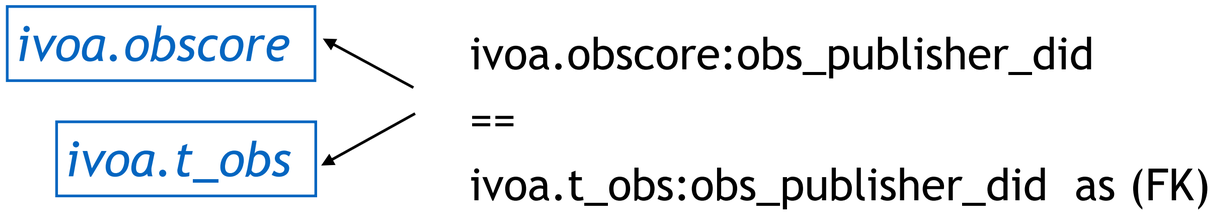
Visibilities & radio data in ObsCore + ivoa.r_obscore

Obscore and R	Definition	Utype	UCD	Units	Mandatory/ Optional	Default
dataproduct_type		ObsDataset.dataProductType	meta.code.class			visibility
% position on sky in ICRS						
s_ra	Position (within a certain area)	Char.SpatialAxis.Coverage.RefVal	pos.eq.ra	deg	man	ICRS
s_dec	Position (within a certain area	Char.SpatialAxis.Coverage.RefVal	pos.eq.dec	deg	man	
s_resolution	Angular resolution	Char.SpatialAxis.Resolution.RefVal	pos.angResolution	arcsec	man	
% observable						
o_ucd	Physical nature attached to observable	Char.ObservableAxis.ucd	meta.ucd	null	man	stat.Fourier
stat.Fourier	Fourier coeff in visibilty as amplitude , phase depending on u,v					
% spectral coverage						
em_min	spectral interval (min)	Char.SpectralAxis.Coverage.Bounds.Limits.LoLim	em.wl;stat.min	nm	man	nm
em_max	spectral interval	Char.SpectralAxis.Coverage.Bounds.Limits.HiLim	em.wl;stat.max	nm	man	nm
em_ucd	Wavelength/ Frequency/ Energy	Char.SpectralAxis.ucd	meta.ucd	null	opt	em.freq
em_unit	Unit along spectral axis	Char.SpectralAxis.unit	meta.unit	null	opt	
f_min	spectral coverage (min) in frequency	Char.SpectralAxis.Coverage.Bounds.Limits.LoLim	em.freq;stat.min	<em_unit>	man	MHz
f_max	spectral coverage (max) in frequency	Char.SpectralAxis.Coverage.Bounds.Limits.HiLim	em.freq;stat.max	<em_unit>	man	MHz
% Polarisation states						
pol_states	Polarization state list	Char.Polarization.List	meta.class	null	opt	
%time features						
t_exp_mean	average length time interval integration time	Char.TimeAxis.Coverage.Support.Refval	time.interval;obs.sequence;stat.mean	s	opt	

add green parameters to an *ivoa.r_obs* table

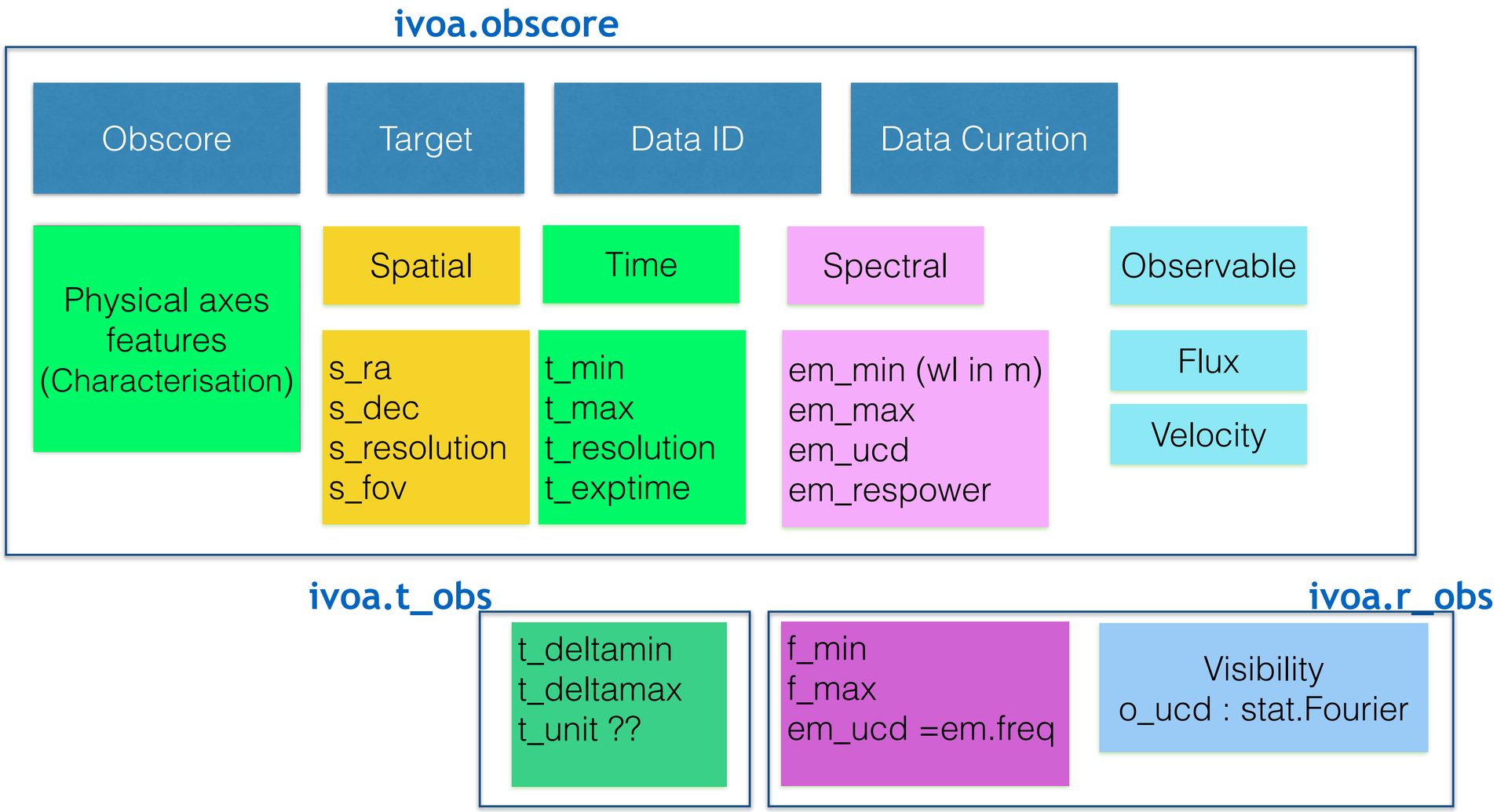
TAP schema extension

- An ObsTAP service can already provide metadata from *ivoa.obscore* table together from complementary tables. (cf CADC ObsTAP)



- A table join allows to search on ObsCore keywords, but also on time specific keywords
- Suggestion:
  - define a ‘time series’ ObsTAP capability when *ivoa.t_obs* is served together with ivoa.obscore
    - ivoa.obscore + *ivoa.t_obs* tables are included in the service TAP_SCHEMA
  - same mechanism can apply for a specific ‘Radio’ feature extensions
  - define a ‘radio’ ObsTAP capability when *ivoa.r_obs* is served together with ivoa.obscore
    - ivoa.obscore + *ivoa.r_obs* tables are included in the service TAP_SCHEMA

Data model extension



What to add to Obscore?

- ObsCore is meant for data discovery in multiple spectral domain
- Metadata extension is needed for various regimes and various types of data products

- optical data :
  - image, cube, spectrum, sed —> covered with ivoa.obscore
  - light-curve —> ivoa.obscore+ ivoa.t_obs
- radio data:
  - image , spectrum, cube , visibility : ivoa.obscore+ ivoa.r_obs
  - pulsar data : —> ivoa.obscore+ ivoa.r_obs+ ivoa.t_obs.
- high energy data:
  - image, spectrum, evenlist —> ivoa.obscore + ???
  - light curve —> ivoa.obscore+ ivoa.t_obs

Thanks for your attention

Comments ? Questions ?