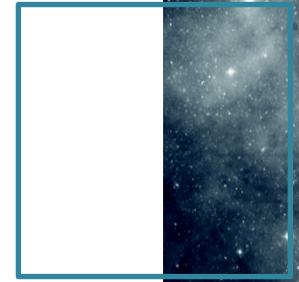


DADI contribution to IVOA TimeSeries priority



F.Bonnarel (CDS)

On behalf of DADI TimeSeries group



Summary of presentation

- DADI in IVOA Working groups
- Work so far
- Use cases
- Discovery
- Accessing
- Data representation



PEOPLE involved

- Ada Nebot, Mireille Louys, Jiri Nadvornik, Laurent Michel, Marco Molinaro, Dave Morris, Juan Manuel Alacid, Jesus Salgado, Sébastien Derrière, Thomas Boch, Gilles Landais, Baptiste Cecconi, François Bonnarel



DADI in IVOA Working Groups

- IVOA Work on TimeSeries. Working group chaired by DADI partners.
 - TDIG = Ada Nebot, Dave Morriss
 - DM = Mark Cresitello, Laurent Michel
 - DAL = François Bonnarel, Marco Molinaro
 - Planetary IG: Baptiste Cecconi
- Projects : GAVO + Prag, VizieR, Gaia, SVO, LSST
- Weakness of non european participation



Work so far ?

- Was an IVOA priority. Actual work started around Trieste interop meeting fall 2016.
 - Note By Jiri Nadvornik (Prag + GAVO)+ prototypes
 - Teleconfs during 2016/2017 winter
 - ASTERICS DADI/CLEOPATRA meeting and Tech Forum in March 2017
 - First discussion on Jiri proposed serialization
 - First overall discussion on TimeSeries Discovery metadata
 - TDIG/DAL/DM sessions in Shangai interop (May 2017)
 - Issues
 - Ideas for solutions
 - Participation of SVO and VizierR
 -



Work so far ?

- TDIG/DAL/DM sessions in Santiago Interop (October 2017)
 - Use cases and experience
 - DAL view
 - New model proposal
 - Serializations
- DADI meeting in Strasbourg (last week)
 - Progress on metadata
 - Progress on modelling
 - Progress on serializations attempts convergence



Use cases

- Gaia : multiband light curves in DR1
- SVO light curves
- VizieR : catalogs have time information ; heterogeneous
 - Photometry, relative photometry, radial velocities, etc...
 - Catalog = TimeSeries for a single object
 - Catalogs merging several object TimeSeries
 - TimeSeries as associated data to the main catalog (links)



Use cases

- GASP (exoplanets)
 - Star features important for discovery and analysis
- XMM :
 - TimeSeries of spectra
 - TimeSeries of TimeSeries
- Planetary data (Euro Planet)
 - Planetary data have strong evolution aspects → time
 - EPNCORE has more characterisation details on the Time axis than ObsCore



Metadata : for discovery and other purposes

- Time Frame (see STC, WCS):
 - Scale : TT, TDB, TAI...
 - Reference position : barycenter ...
 - Time Origin (if representation is « time offset »)
- Time Representation (see STC, WCS)
 - JD, MJD, ISO, or « Time offset »



Metadata : for discovery and other purposes

- Discovery Consensus so far :
 - Most of Obscore is fine
 - TARGET as alternative to ICRS position
 - Cadence and exposure time min max at sample level
- Discussion
 - How to describe what is varying with time ?
 - (multi-valued) o_ucd ?
 - Dataproduct_subtype ? Mandatory ? Fixed list ?
 - Periodicity and phase characterisation description ?
 - Let this to data representation ? Data analysis ?



TimeSeries discovery

- 3 discovery modes
 - Source driven (direct or via DataLink)
 - ObsCore/SIAV2-like driven (are extensions needed ?)
 - Physical Content driven (project specific?)



Source driven (Use case : GAIA)

- We retrieve sources via a TAP or an SCS service
- For each source an URL retrieves TimeSeries
- How do we put a standard tag on this URL ?
 - Utype on a single FIELD ?
 - LINK feature with new « content » attribute ?
 - Service descriptor (DataLink) towards a TimeSeries retriever ?
 - Links to TimeSeries in a {link resource} (DataLink) associated to the source ?



Obscore-like driven (use case :SVO, planets, GAIA, all)

- CoordSystem is ICRS, TT, BARYCENTER
- Obscore allows discovery of « data_product=TimeSeries » datasets with other constraints
- What should be added
 - See above (cadence , sample exposure time)
- Close to previous SSA-like approach (SVO)



Physical Content- driven (INAF exoplanets, ESA missions)

- List of metadata
 - Signal periodicity
 - Periods
 - Object type candidate (exoplanet, variable star, etc..)
 - Transiency
 - Artefacts
 - Etc...
- Requires specific analysis
 - Project specific
 - Additional physical content metadata table.
 - Joins to Obscore-like table



DAL perspective

- Consensus so far
 - Keep « multi-d DAL framework » as a basis (ObsCore/TAP, SIA2, DataLink,SODA)
 - TimeSeries Extensions (see above) for ObsCore, SIAV2, SODA
 - TimeSeries DataModel and serialization is a spec
- Points to discuss
 - How to proceed for these extensions ?
 - Generic and specific Extensions mechanisms as Light spec new versions or endorsed notes ?
 - A « TimeSeries discovery and access » specification is created
 - Must rely on all other specs



How DAL can tackle all this ?

- **Discovery : Obscore :**
 - set a new TimeSeries extension table of the ivoa TAP schema.
 - More columns
 - Restriction/extensions on existing columns
- **Access : Data Representation :**
 - Requires modelling and serialization
 - ---> It's a DM task (see tomorrow)



How DAL can tackle all this ?

- SODA : TimeSeries generation :
 - Add a « DataProductType attribute » to SODA (to generate TimeSeries instead of Cubes)
 - Add resampling parameter(s) to SODA interface
- SIAV2 :
 - Reflect new Obscore-like attributes in the SIAV2 query parameters
 - Virtual data discovery capability
 - « access reference » is no more a « retrieval » URL but a « SODA » URL



DAL perspective

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- **Points to discuss**
 - **How to proceed for these extensions ?**
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Must rely on all other specs



Data Model

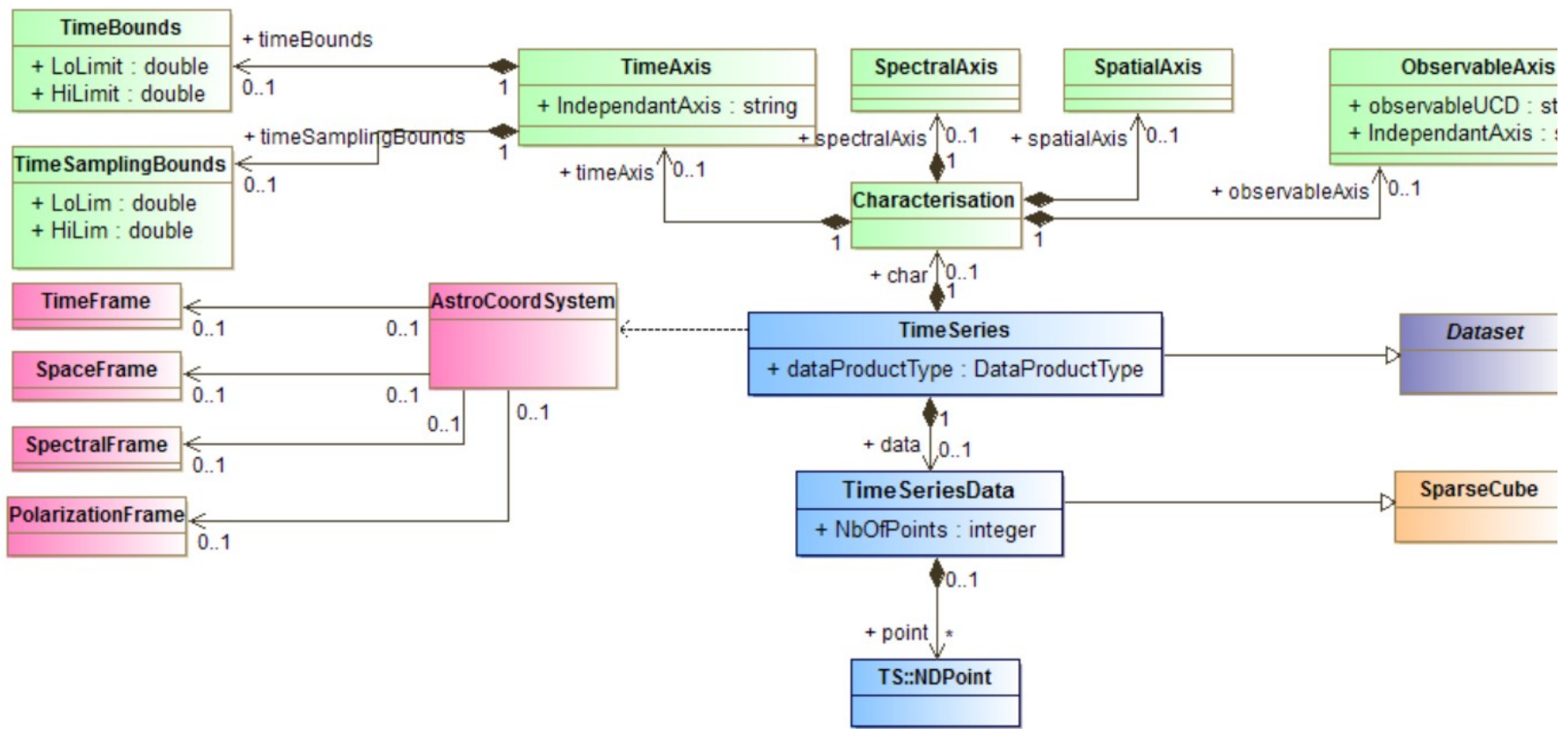
- Consensus so far :
 - TimeSeries data model is
 - based on CubeDM.
 - VO-DML-XML document due
 - Time as independant axis
- Points to be discussed
 - Which dependant axes ?
 - How to describe them
 - Cube model / axis agnosticity ?



GOAL

- Here is a sketch for representing metadata involved in the discovery and analysis of time domain information.
- Time series is considered in a large sense as a collection of data samples, taken along a sequence of time stamps.
- $F=f(t)$, with F being
 - a simple value for a measure,
 - a structured value for a measure , and its error, precision , etc.
 - Multiple values (e.g. multi wavelength)
 - A dataset itself , e.g. the data product resulting of a full observation.





TimeSeries Datamodel UML diagram (M.Louys)

Discovery
→ Characterisation DM

Legend

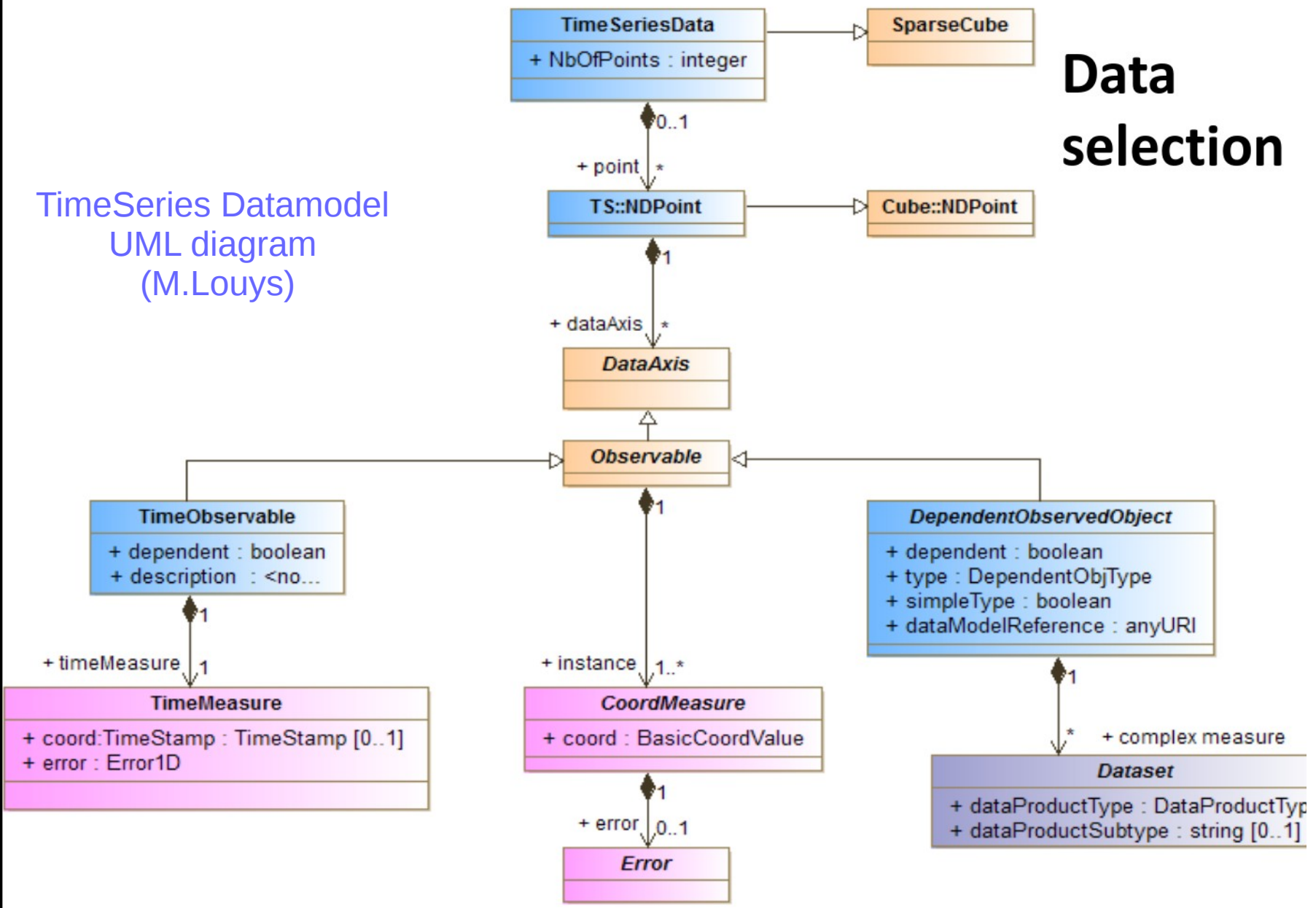
- is associated to →
- derives from →▷
- is composed Of →◆

Color code for classes

- TimeSeries_DM
- Characterisation_DM Class
- Cube_DM Class
- STC_DM Class

Data selection

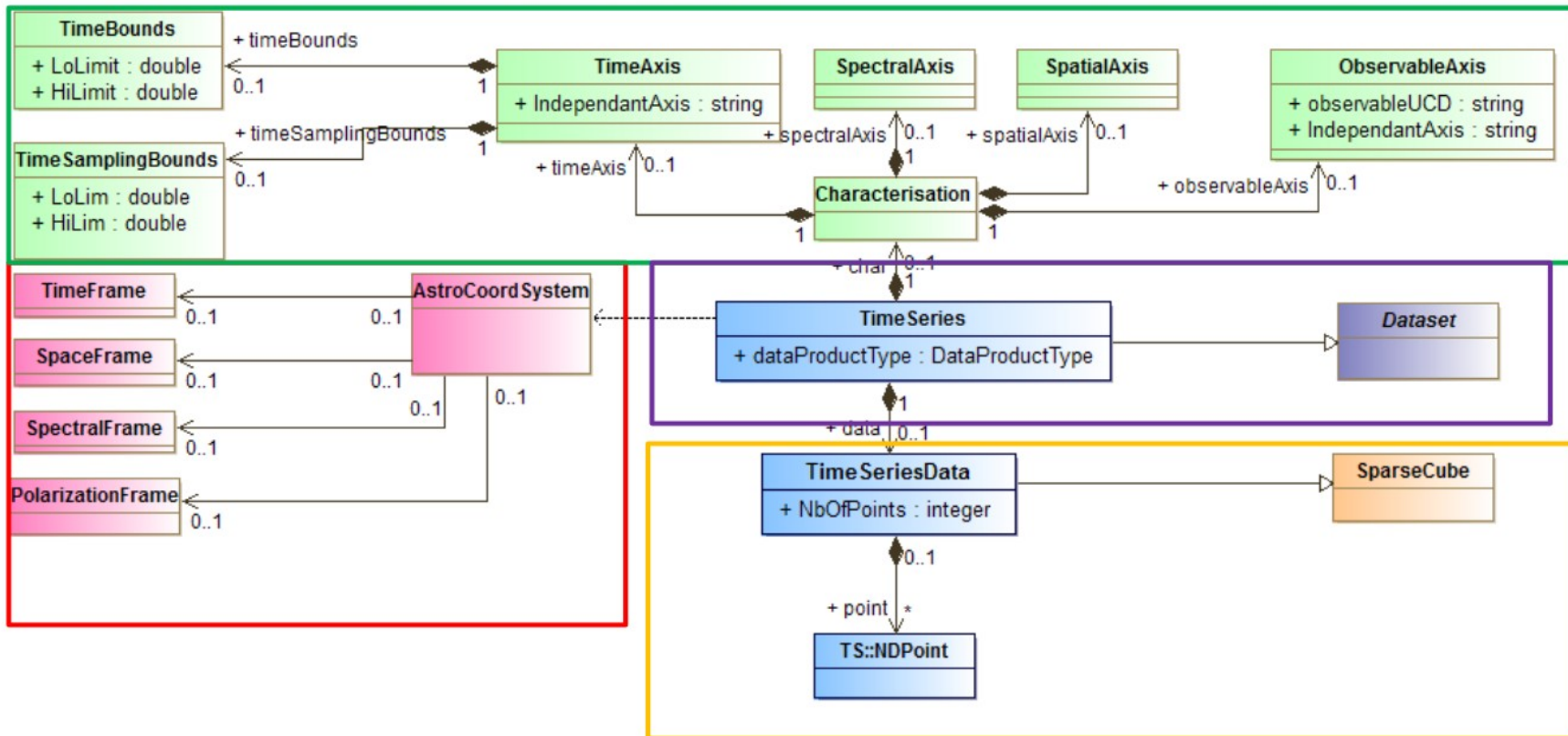
TimeSeries Datamodel
UML diagram
(M.Louys)



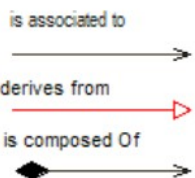
TimeSeries representations DataModel serializations

- Data organization :Main data tables + additional Tables/GROUPS of PARAMS (for metadata)
- Which DataModel Mapping ? Several proposals to be discussed
 - Utypes (all role and meaning information conveyed at the column level)
 - Classical one (long composed utypes on FIELDS/columns)
 - GROUP/FIELD separation (utypes on both on GROUP, FIELD)
 - VO-DML mapping (rebuild model objects from VOTable)
 - Light (L.Michel)
 - Full mapping (Cresitello)

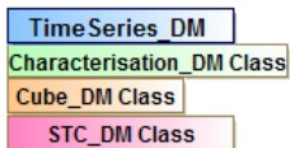




Legend



Color code for classes



Purple : TimeSeries – Dataset

Green : characterisation

Pink : Coord Systems

Yellow : (TimeSeries)Data

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□ Data section

```
- <GROUP utype="ts:TimeSeriesData" name="TimeSeriesData">
  <FIELDref utype="ts:TimeSeriesData.NDPoint.TimeObservable.TimeMeasure.MJD" ref="HJD"/>
  - <GROUP name="spatial">
    <FIELDref utype="ts:TimeSeriesData.NDPoint.dependantObservedObject.Position2D.SpatialValue2D[0]" ref="raj2000"/>
    <FIELDref utype="ts:TimeSeriesData.NDPoint.dependantObservedObject.Position2D.SpatialValue2D[1]" ref="dej2000"/>
  </GROUP>
  - <GROUP name="Flux">
    <FIELDref utype="ts:TimeSeriesData.NDPoint.dependantObservedObject.CoordMeasure.PhotometryPoint" ref="FLX"/>
    <FIELDref utype="ts:TimeSeriesData.NDPoint.dependantObservedObject.CoordMeasure.PhotometryPointError" ref="FLXERR"/>
  </GROUP>
  - <GROUP>
    <FIELDref utype="ts:TimeSeriesData.NDPoint.dependantObservedObject.CoordMeasure.PhotometryPoint" ref="MAG"/>
    <FIELDref utype="ts:TimeSeriesData.NDPoint.dependantObservedObject.CoordMeasure.PhotometryPointError" ref="MAGERR"/>
  </GROUP>
</GROUP>
- <FIELD ID="HJD" datatype="double" name="HJD" ref="tif" unit="d" ucd="time;obs.exposure">
  <DESCRIPTION>Epoch at midpoint of observation in heliocentric modified julian date</DESCRIPTION>
</FIELD>
- <FIELD ID="raj2000" datatype="double" name="raj2000" ref="posf" unit="deg" ucd="pos.eq.ra">
  <DESCRIPTION>Observed RA of the object</DESCRIPTION>
</FIELD>
- <FIELD ID="dej2000" datatype="double" name="dej2000" ref="posf" unit="deg" ucd="pos.eq.dec">
  <DESCRIPTION>Observed declination of the object</DESCRIPTION>
</FIELD>
- <FIELD ID="FLX" datatype="float" name="FLX" ref="phot" unit="erg/s/cm2/std" ucd="phot.flux">
  <DESCRIPTION>Photon Flux</DESCRIPTION>
</FIELD>
+ <FIELD ID="FLXERR" datatype="float" name="FLXERR" ref="phot" unit="erg/s/cm2/std" ucd="stat.error;phot.flux">
- <FIELD ID="MAG" datatype="float" name="MAG" ref="phot" unit="mag" ucd="phot.mag">
  <DESCRIPTION>Magnitude of the object</DESCRIPTION>
</FIELD>
- <FIELD ID="MAGERR" datatype="float" name="MAGERR" ref="phot" unit="mag" ucd="stat.error;phot.mag">
  <DESCRIPTION>Error of the magnitude</DESCRIPTION>
</FIELD>
- <DATA>
  - <TABLEDATA>
```

TimeSeries representations DataModel serializations

- Data organization :Main data tables + additional Tables/GROUPS of PARAMS (for metadata)
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Mapping in a VOTable

VO-DML light mapping
(L.Michel)

This VOTable contains a time series

```
<MODEL>
  <NAME>lmtimeserie</NAME>
  <URL>http://volute.g-vo.org/svn/trunk/projects/dm/vo-dml/models/tesselation/lmtimeserie.vo-dml.xml</URL>
  <IDENTIFIER>ivo://ivoa.org/dm/sample/LMSource/0.1</IDENTIFIER>
</MODEL>
<MODEL>
  <NAME>lmoobservable</NAME>
  <URL>http://volute.g-vo.org/svn/trunk/projects/dm/vo-dml/models/tesselation/lmoobservable.vo-dml.xml</URL>
  <IDENTIFIER>ivo://ivoa.org/dm/sample/LMObservable/1</IDENTIFIER>
</MODEL>
```

Resolve the model namespace

```
<TEMPLATES tabref=" _table1">
  <TUPLE dmtyp="lmtimeserie:TimeSerie">
    <TUPLE dmrole="lmtimeserie:TimeSerie.TimeAxis" dmtyp="lmtimeserie:TimeAxis">
      <VALUE dmrole="lmtimeserie:TimeAxis.TimeFrame" table_ref=" _0117pYWsEJmSbhJP" />
    </TUPLE>
    <TUPLE dmrole="lmtimeserie:TimeSerie.ObservableAxis" dmtyp="lmtimeserie:ObservableAxis">
      <VALUE dmrole="lmtimeserie:TimeSerie.ObservableModel" source="child">lmoobservable</VALUE>
    </TUPLE>
    <COLLECTION dmrole="lmtimeserie:TimeSerie.Points" dmtyp="lmtimeserie:Point" arraysiz="*">
      <TUPLE dmtyp="lmtimeserie:Point">
        <VALUE dmrole="lmtimeserie:TimeAxis.TimeStamp" table_ref="timestamp_100" />
        <TUPLE dmtyp="lmoobservable:Observable">
          <VALUE dmrole="lmoobservable:Observable.long" table_ref="pos_ra_csa_100" />
          <VALUE dmrole="lmoobservable:Observable.lat" table_ref="pos_dec_csa_100" />
          <VALUE dmrole="lmoobservable:Observable.velocity" table_ref="velocity_100" />
          <VALUE dmrole="lmoobservable:Observable.imag" table_ref="image_100" />
          <VALUE dmrole="lmoobservable:Observable.magnitude" table_ref="magnitude_100" />
        </TUPLE>
      </TUPLE>
    </COLLECTION>
  </TUPLE>
</TEMPLATES>
```

Reference to the dependant axis mode

WARNING: Annotations have been simplified for the purpose of this talk.

Perspectives

- DAL chair/vice-chair to propose a DAL guideline as an IVOA note ---> IVOA discussion to be driven
- Model details to be discussed further before writing a common draft
- Discovery metadata proposals to be exposed and discussed
- Serialization proposals to be exposed and commented on volute/ IVOA site
- Next face to face meeting : March (DADI tech forum Edinburgh?)
- Drafts may appear around May IVOA interop in Victoria

