

# TimeSeries Data serialization: full-utype approach

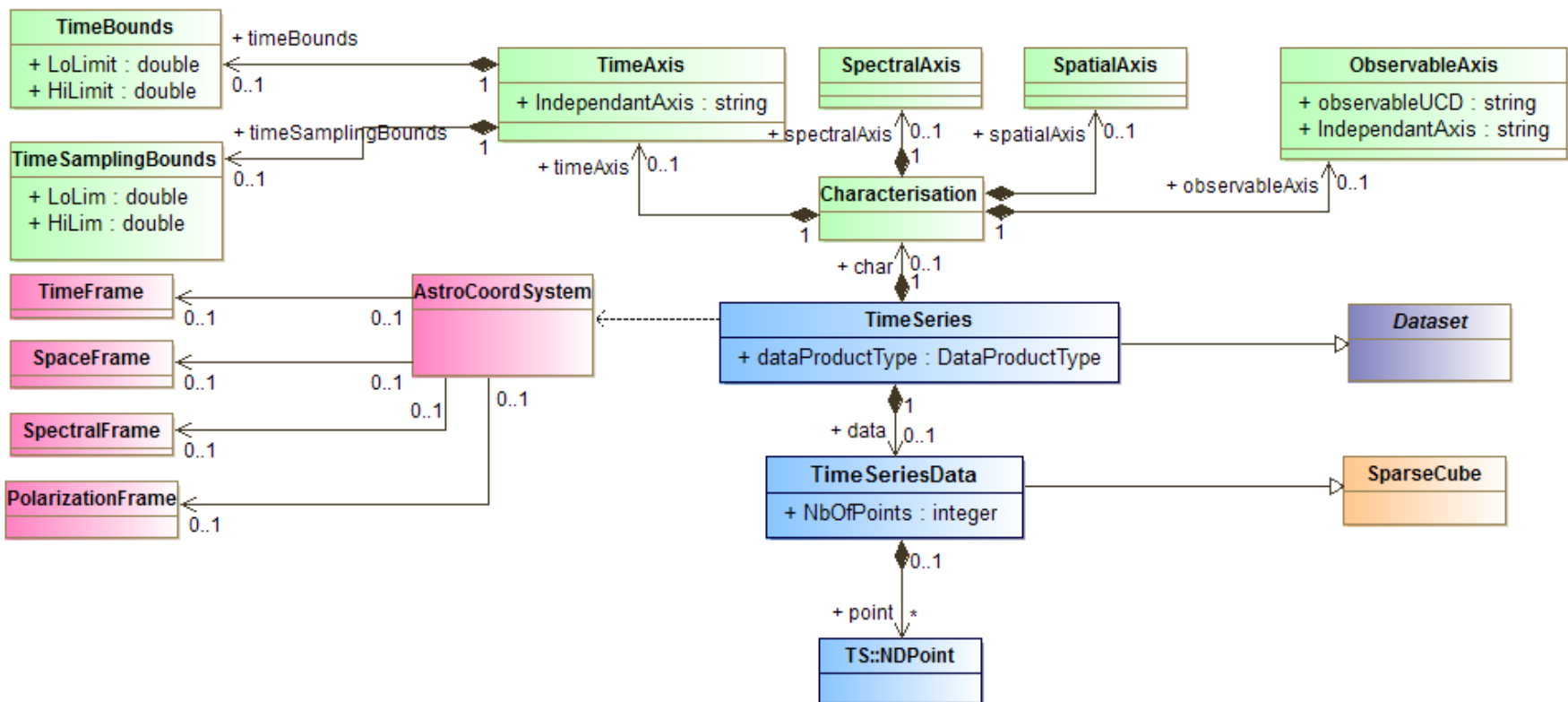


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acknowledges extensive discussions with Ada Nebot,  
Mireille Louys, Laurent Michel , Marco Molinaro, Mark  
Cresitello, Jiri Nadvornik and the VizieR team

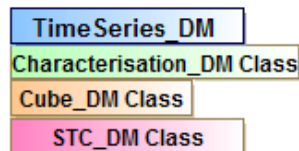




### Legend

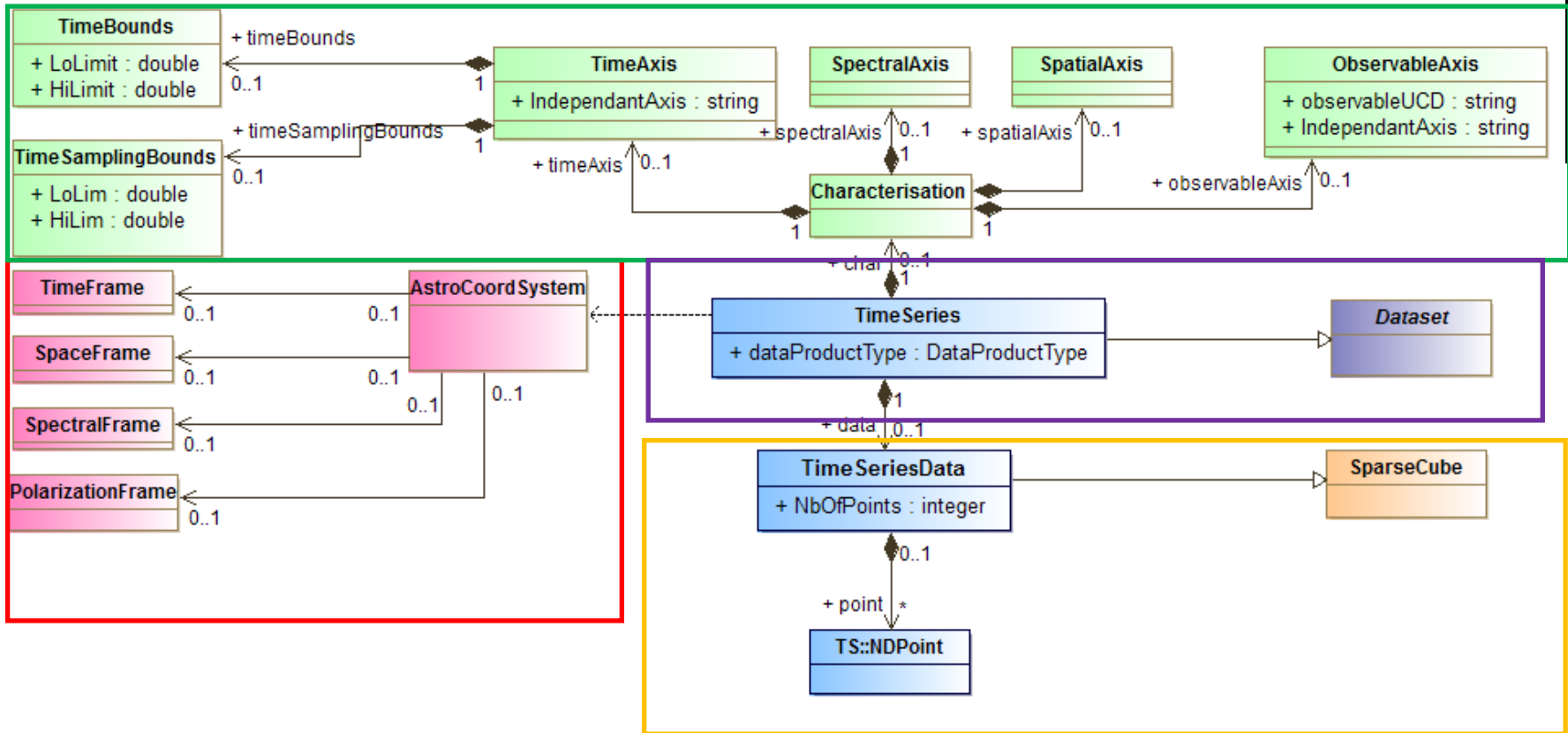
- is associated to
- derives from
- is composed Of

### Color code for classes

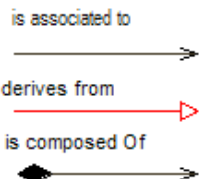


# □ Question (and first answer):

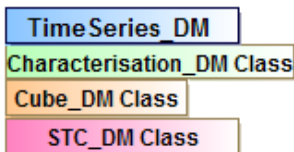
- Can we map this in a simple relational model ?
- Yes by simplification of all the 1 to 1 relationships and references (seen as attributes) : choice of « root » classes.
- In these conditions it's possible to write a « voservice tableset » with four tables and simple foreign keys to mimic ref/id in VOTABLE
- Columns are defined with their metadata (datatype, arraysize, unit, ucd, utype)



## Legend



## Color code for classes

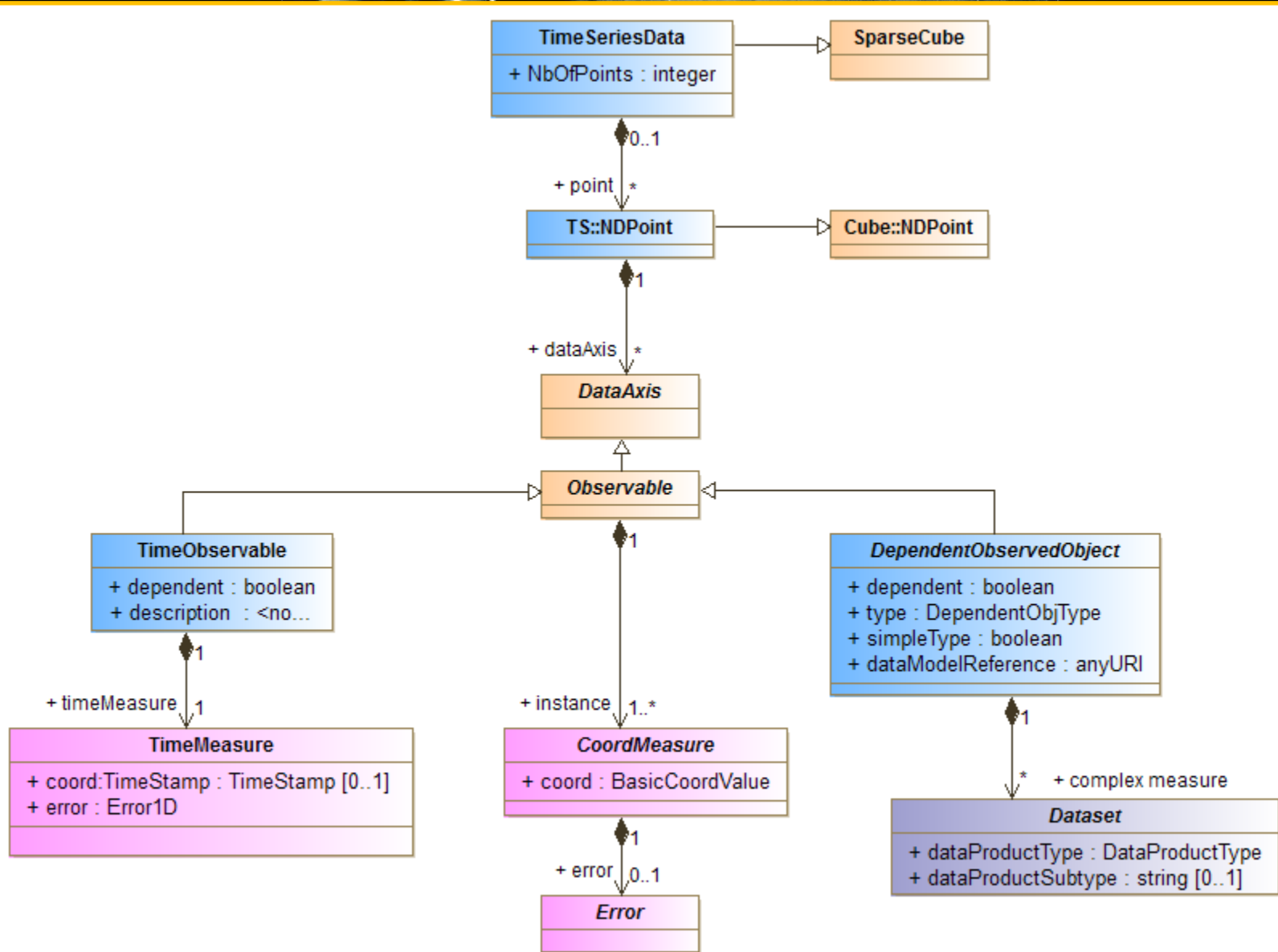


Purple : TimeSeries – Dataset

Green : characterisation

Pink : Coord Systems

Yellow : (TimeSeries)Data



# TimeSeries – voservice table set

```
Most Visited Getting Started http://voiture.g-vo.org...
<data type xsi:type="vot:TADataType">VARCHAR</data type>
<utype>ts:Observation.observationID</utype>
</column>
<column>
<name>TimeScale</name>
<data type xsi:type="vot:TADataType">VARCHAR</data type>
<ucd>time.scale</ucd>
<utype>coord:coordsys.TimeFrame.TimeScale</utype>
</column>
<column>
<name>refpositionT</name>
<data type xsi:type="vot:TADataType" arraysize="2">DOUBLE</data type>
<ucd>pos.eq</ucd>
<utype>coord:coordsys.TimeFrame.refPosition</utype>
</column>
<column>
<name>SpaceRefFrame</name>
<data type xsi:type="vot:TADataType">VARCHAR</data type>
<ucd>pos.frame</ucd>
<utype>coord:coordsys.SpaceFrame.spaceRefFrame</utype>
</column>
<column>
<name>refPositionS</name>
<data type xsi:type="vot:TADataType" arraysize="2">DOUBLE</data type>
<ucd>pos.eq</ucd>
<utype>coord:coordsys.SpaceFrame.refPosition</utype>
</column>
<column>
<name>wavelength</name>
<data type xsi:type="vot:TADataType">DOUBLE</data type>
<ucd>em.wl</ucd>
<utype>photdm:PhotometryFilter.SpectralAxis.Coverage.Location.Value
</utype>
</column>
<column>
<name>filter</name>
<data type xsi:type="vot:TADataType">VARCHAR</data type>
<ucd>instr.filter</ucd>
<utype>photdm:PhotometryFilter.identifier</utype>
</column>
</table>
<table type="output">
<name>TimeSeriesData</name>
<description>instanceof TimeSeries Data Class</description>
<column>
<name>pubDID</name>
<data type xsi:type="vot:TADataType">VARCHAR</data type>
<utype>ts:Observation.observationID</utype>
</column>
<column>
<name>JD</name>
<data type xsi:type="vot:TADataType">DOUBLE</data type>
<ucd>time:obs.exposure</ucd>
<utype>
ts:TimeSeriesData.NDPoint.TimeObservable.TimeMeasure.MJD
</utype>
</column>
<column>
<name>MAGV</name>
<data type xsi:type="vot:TADataType">DOUBLE</data type>
<ucd>phot.flux</ucd>
<utype>
ts:TimeSeriesData.NDPoint.dependantObservedObject.CoordMeasure.PhotometryPoint
</utype>
</column>
</table>
/schema>
osi:tableset>
```

TimeFrame  
SpaceFrame  
Phot System  
Data table

Link to The tableset  
definitions



# Look at dummy examples in VOTable

From the tableset to VOTABLES

- Use the ucd, datatype and unit as they are
- Utypes also given by the tableset.
- Relationship to vodml : see my talk yesterday in DM for a possible solution
- Otherwise defined in the TS datamodel document
- Don't pay too much attention to the current utype « string » construction.
  - Can evolve
  - Has to be stored properly somewhere anyway

# TimeSeries - DATA SET Metadata

```
<?xml version="1.0" encoding="UTF-8"?>
- <VOTABLE version="1.2" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http://www.ivoa.net/xml/VOTable/v1.2">
  - <RESOURCE type="results">
    - <TABLE>
      <!-- This table is the head element TimeSeries. It hooks char, coordsys and TimesSeries data -->
      - <GROUP utype="ts:TimeSeries" ID="ndgnsolidgdea">
        <DESCRIPTION>This is generic dataset metadata</DESCRIPTION>
        <!-- These two Params seem to be useless because we know a TimeSeries derives from SparseCube which itself derives from cube. type and subtype don't
        exist in DataSetMetadata <PARAM name="subtype" utype="ts:TimeSeries.subtype" xtype="ivoa:string" datatype="char" arraysize="*" value="sparsecube"/>
        <PARAM name="type" utype="ts:TimeSeries.type" xtype="ivoa:string" datatype="char" arraysize="*" value="cube" /> -->
        <PARAM utype="ts:TimeSeries.dataProductType" value="timeseries" arraysize="*" datatype="char" xtype="ivoa:string" name="productType"/>
        <PARAM utype="ts:TimeSeries.calibLevel" value="1" arraysize="*" datatype="int" xtype="ivoa:integer" name="calibLevel"/>
      - <GROUP utype="ts:TimeSeries.dataId" ID="ndgnsolommsa" name="dataId">
        <DESCRIPTION>This is dataID metadata</DESCRIPTION>
        <PARAM utype="ts:TimeSeries.observation.observationID" ID="pubDID" value="TestTimeSeries" arraysize="*" datatype="char" name="pubDID"/>
        <PARAM utype="ts:TimeSeries.dataID.creator" value="Jiri Nadvornik" arraysize="*" datatype="char" xtype="ivoa:string" name="creator"/>
        <!-- we can only have a single creator. Others should be contributors -->
        <PARAM utype="ts:TimeSeries.dataID.contributor" value="Markus Demleitner" arraysize="*" datatype="char" xtype="ivoa:string"
        name="contributor"/>
      </GROUP>
      <PARAM utype="ts:TimeSeries.coordsys" value="reference" arraysize="*" datatype="char" name="CoordinateSystem" ref="coosys"/>
      <PARAM utype="ts:TimeSeries.char" value="reference" arraysize="*" datatype="char" name="Characterisation" ref="char"/>
      <PARAM utype="ts:TimeSeries.TimeSeriesData" value="reference" arraysize="*" datatype="char" name="TimeSeriesData" ref="data"/>
    </GROUP>
  </TABLE>
  + <TABLE ID="char">
  + <TABLE ID="coosys">
  + <TABLE ID="data">
</RESOURCE>
</VOTABLE>
```



# Characterisation metadata

```
<?xml version="1.0" encoding="UTF-8"?>
- <VOTABLE version="1.2" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http://www.ivoa.net/xml/VOTable/v1.2">
  - <RESOURCE type="results">
    + <TABLE>
      - <TABLE ID="char">
        <!-- This is the characterisation of the whole TimeSeries. It replaces Jiri's quantity and gavers "statistics" -->
        - <GROUP utype="cha:Char" name="characterisation">
          <PARAM utype="cha:Char.SpatialAxis.Location.Coord.SpatialValue2D[0]" value="12.9" datatype="float" name="SpatLocationRA" unit="deg"
            ucd="pos.eq.ra"/>
          <PARAM utype="cha:Char.SpatialAxis.Location.Coord.SpatialValue2D[1]" value="-72.9" datatype="float" name="SpatLocationDEC" unit="deg"
            ucd="pos.eq.dec"/>
          <PARAM utype="cha:Char.SpatialAxis.Bounds.limits.LoLim2.SpatialValue2D[0]" value="12.5" datatype="float" name="SpatBoundsMinRA" unit="deg"
            ucd="pos.eq.ra;stat.min"/>
          <PARAM utype="cha:Char.SpatialAxis.Bounds.limits.LoLim2.SpatialValue2D[1]" value="-73.3" datatype="float" name="SpatBoundsMinDEC" unit="deg"
            ucd="pos.eq.dec;stat.min"/>
          <PARAM utype="cha:Char.SpatialAxis.Bounds.limits.HiLim2.SpatialValue2D[0]" value="13.2" datatype="float" name="SpatBoundsMaxRA" unit="deg"
            ucd="pos.eq.ra;stat.max"/>
          <PARAM utype="cha:Char.SpatialAxis.Bounds.limits.HiLim2.SpatialValue2D[1]" value="-72.6" datatype="float" name="SpatBoundsMaxDEC" unit="deg"
            ucd="pos.eq.dec;stat.max"/>
          <PARAM utype="cha:Char.SpatialAxis.Bounds.CharBox.Size2[0]" value="0.7" datatype="float" name="SpatBoundsSizeRA" unit="deg"
            ucd="pos.eq.ra;stat.length"/>
          <PARAM utype="cha:Char.SpatialAxis.Bounds.CharBox.Size2[1]" value="0.7" datatype="float" name="SpatBoundsSizeDEC" unit="deg"
            ucd="pos.eq.dec;stat.length"/>
        </GROUP>
      </TABLE>
      + <TABLE ID="coosys">
      + <TABLE ID="data">
    </RESOURCE>
  </VOTABLE>
```

# Coordinate system metadata

```
<?xml version="1.0" encoding="UTF-8"?>
- <VOTABLE version="1.2" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http://www.ivoa.net/xml/VOTable/v1.2">
  - <RESOURCE type="results">
    + <TABLE>
    + <TABLE ID="char">
    - <TABLE ID="coosys">
      <!-- This is the coordinate system of the whole TimeSeries. Photometry was integrated as a FFrame (could also be outside). Frames are referred from the data
      FIELDS -->
    - <GROUP utype="coord:coordsys" name="coordsys">
      - <GROUP utype="coord:coordsys.TimeFrame" ID="tif" name="TimeFrame" ucd="time">
        <PARAM utype="coord:coordsys.TimeFrame.TimeScale" value="TT" arraysize="*" datatype="char" name="TimeScale" ucd="time"/>
        <PARAM utype="coord:coordsys.TimeFrame.refPosition" value="TOPOCENTER" arraysize="*" datatype="char" name="refPosition" ucd="pos"/>
      </GROUP>
      - <GROUP utype="coord:coordsys.SpaceFrame" ID="posf">
        <PARAM utype="coord:coordsys.SpaceFrame.spaceRefFrame" value="ICRS" arraysize="*" datatype="char" name="SpaceRefFrame" ucd="pos"/>
        <PARAM utype="coord:coordsys.SpaceFrame.refPosition" value="TOPOCENTER" arraysize="*" datatype="char" name="refPosition" ucd="pos"/>
      </GROUP>
    </GROUP>
    - <GROUP utype="photdm:PhotometryFilter" ID="phot" name="Phot" ucd="phot">
      <DESCRIPTION>The SED group is made of 4 columns: mean frequency, flux, flux error, and filter designation</DESCRIPTION>
      <PARAM utype="photdm:PhotometryFilter.SpectralAxis.Coverage.Location.Value" ID="wl" value="450" datatype="float" name="wavelength"
      unit="nm"/>
      <PARAM utype="photdm:PhotometryFilter.identifier" ID="fit" value="Johnson_B" arraysize="*" datatype="char" name="filter"/>
    </GROUP>
  </TABLE>
  + <TABLE ID="data">
</RESOURCE>
</VOTABLE>
```

# □ 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>
```

# □ SDSS case

- Check the example and load it into TOPCAT
- One single « dependant » measurement. Easy
- All important Metadata are there
  - NB : strange single row TABLE for general metadata only for visualisation with current tools only)

# □ Beta Lyrae case

- Check the example and load it into TOPCAT
  - No change for Metadata
  - There are « dependant » Times. The utype says
    - It's dependant
    - It's a time
  - Several colors : relationships to « Frames » (or Photometric filters) managed by reference.
- > link to be followed by tools

# □ GAPS case

- Check the example and load it into TOPCAT
- Dependant time and dependant quantities are separated from time but poorly defined
- Because
  - No specific measurement « role »
  - No Frame attached
  - No ucd to give an hint of the nature
  - ->Look at the « description » to know what it is
- We are actually missing a detailed model

# □ Gaia case

- Check the example and load it in TOPCAT
- Reference to the appropriate Photometric system for each of the tables
  - → Tools should follow the link and display PARAMS
- Each table is simple

# □ Conclusion

- Feasible design
- Miss no important metadata
- More information possible if model is complete
- Data producers : have to create a vos:tableset fitting their data
- Clients and applications : work better if they read all the PARAMS and follow the id/ref connection