Time Series and the VO.

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IVOA Interoperability Meeting 2017
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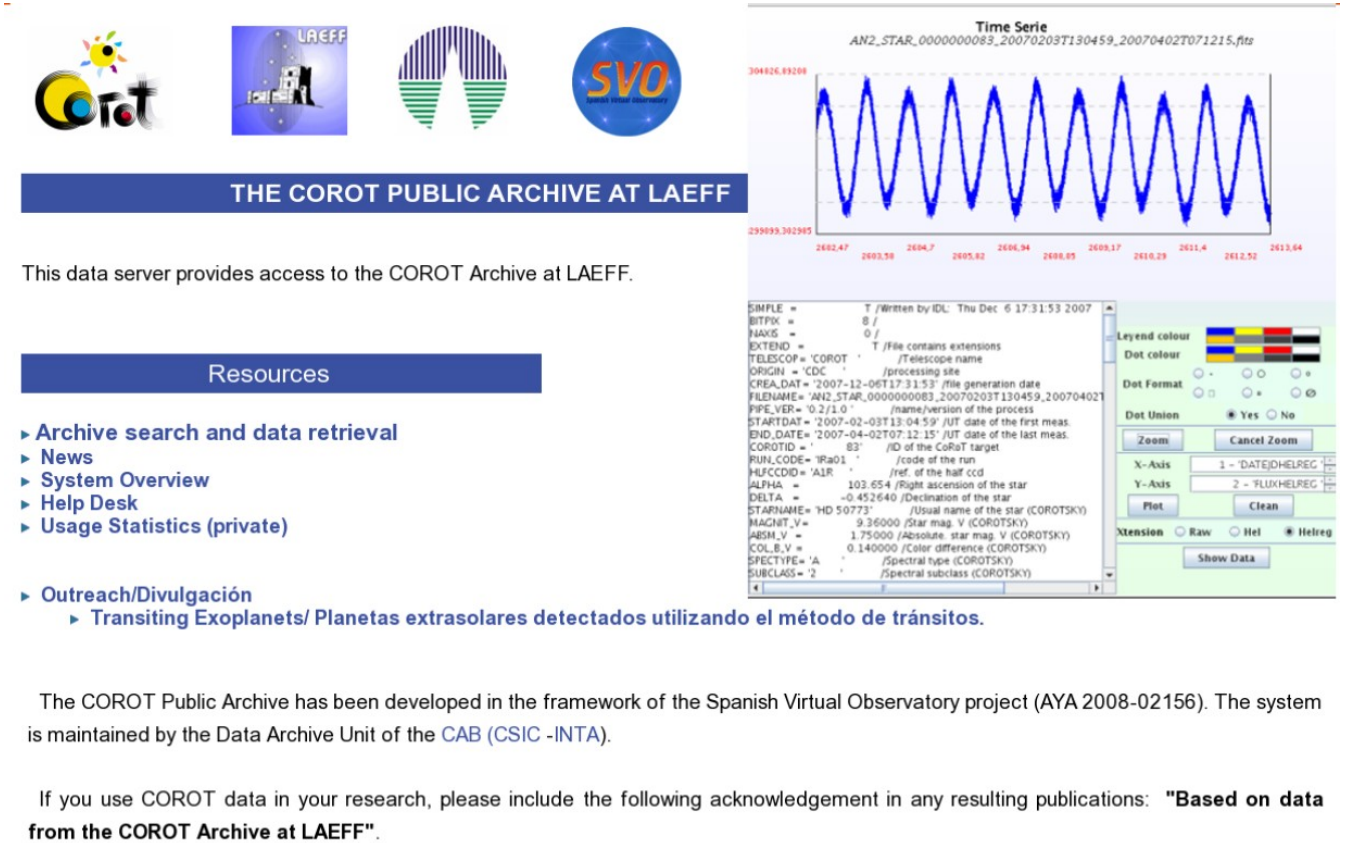
Time Series at SVO

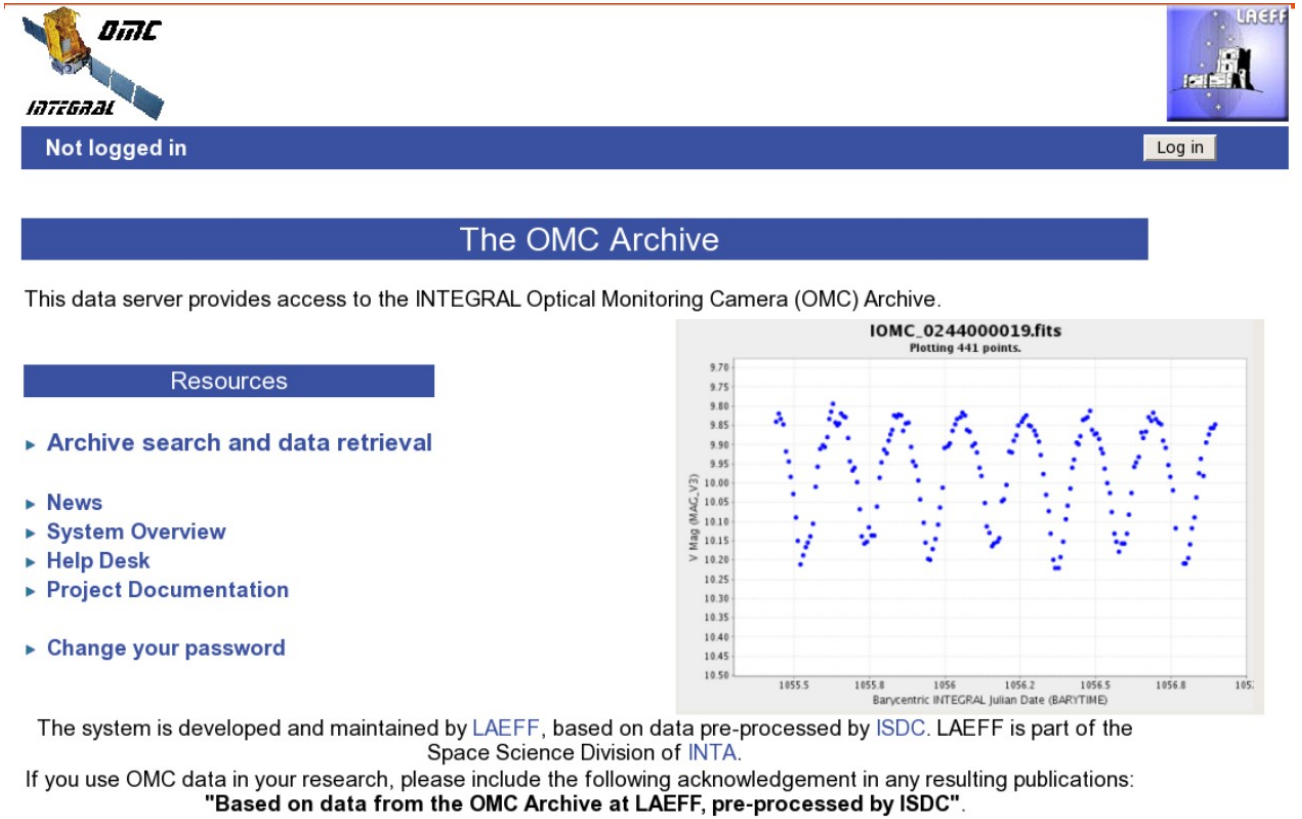
- SVO was the first time series provider in the VO.
- Two services registered as SSAP:
  - **CoRoT** published in September 2009
  - **OMC** published in August 2010

Time Series at SVO



- Available at: **http://sdc.cab.inta-csic.es/corotfa/** since February 2009.
- More than 150.000 light curves.

Time Series at SVO

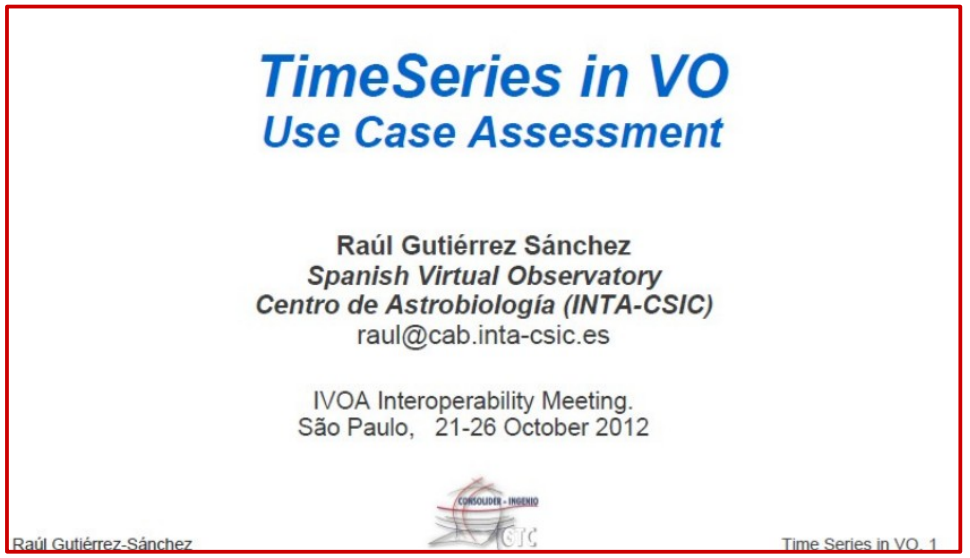


- **OMC**: Available at **http://sdc.cab.inta-csic.es/omc/** since 2003.
- More than 86.000 light curves with more than 50 photometric points.

Time Series at IVOA

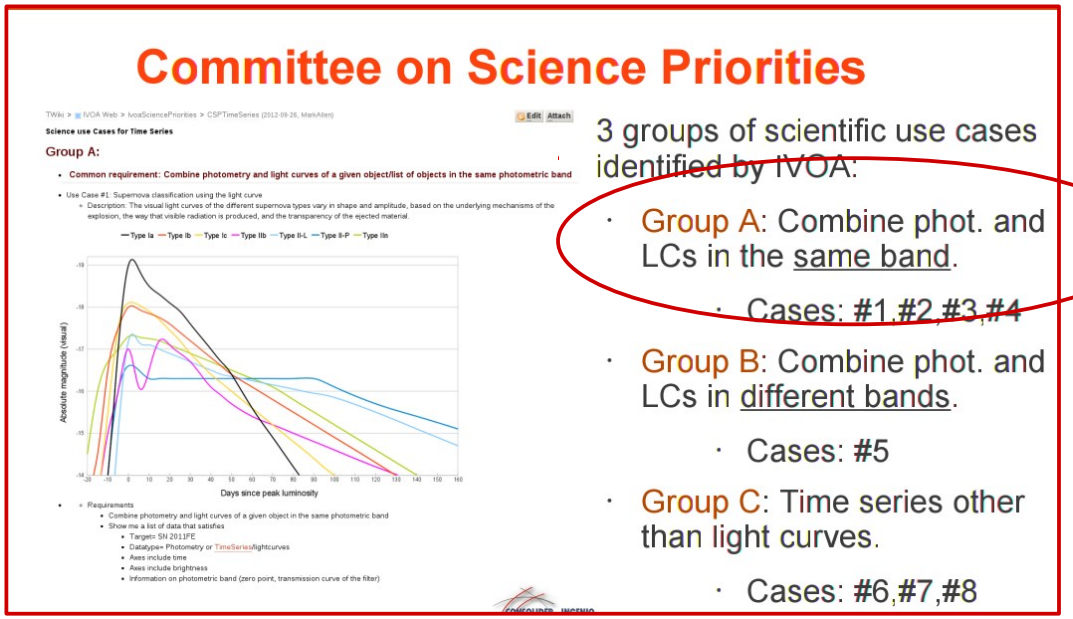
- Time Series identified by IVOA as a *Science Priority*.

- SVO, in its double role of data provider and IVOA member, made in 2012 an assessment on the existing limitations to discover, access and describe time series in the VO:



Data discovery	•Registry
Data access	•SSAP •IVOA note on 'Time Series Data' (Dec 2010) •ConeSearch •TAP
Data model	•SDM 1.1 •SDM 2.0 •IVOA note on 'Time Series Data' (Dec 2010) •DotAstro SimpleTimeseries

CoRoT Time Series



CoRoT: simple Light Curves in the same band.

CoRoT Time Series: Data Access

-SSAP:

SSA is capable of describing most tabular spectrophotometric data, including **time series** and spectral energy distributions (SEDs) as well as 1-D spectra.

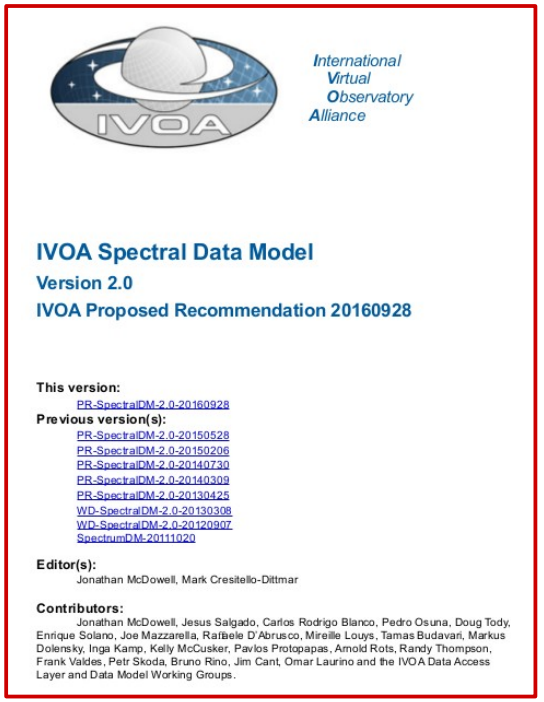
Dataset.Type:

```
−<PARAM ID="Type" name="Type" utype="ssa:Dataset.Type" value="TimeSeries" datatype="char" arraysize="*">
   <DESCRIPTION>Dataset or segment type.</DESCRIPTION>
 </PARAM>
```

According to the SSAP Protocol, the Dataset.Type value must be “Spectrum”

CoRoT Time Series: Data Model

Based in the Spectral DM.



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IVOA Spectral Data Model

Version 2.0

IVOA Proposed Recommendation 20160928

This version:

PR-SpectralDM-2.0-20160928

Previous version(s):

PR-SpectralDM-2.0-20150528
PR-SpectralDM-2.0-20150206
PR-SpectralDM-2.0-20140730
PR-SpectralDM-2.0-20140309
PR-SpectralDM-2.0-20130425
WD-SpectralDM-2.0-20130308
WD-SpectralDM-2.0-20120907
SpectrumDM-20111020

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Metadata information:

Position

```
−<GROUP ID="Char.SpatialAxis" name="Char.SpatialAxis" utype="ssa:Char.SpatialAxis">
   <DESCRIPTION>Spatial Axis Characterization</DESCRIPTION>
   <FIELDref ref="Location"/>
  −<FIELDref ref="Coverage.Bounds.Extent" utype="ssa:Char.SpatialAxis.Coverage.Bounds.Extent" ucd="instr.fov" datatype="double">
     <DESCRIPTION>Aperture angular size.</DESCRIPTION>
   </FIELDref>
 </GROUP>
```

CoRoT Time Series: Data Model

Metadata information:

Time frame

```
−<GROUP ID="Char.TimeAxis" name="Char.TimeAxis" utype="ssa:Char.TimeAxis">
   <DESCRIPTION>Time Axis Characterization</DESCRIPTION>
  −<FIELDref ref="Coverage.Location.Value" name="Coverage.Location.Value" utype="ssa:Char.TimeAxis" ucd="time.epoch" datatype="double">
     <DESCRIPTION>Midpoint of exposure on MJD scale.</DESCRIPTION>
   </FIELDref>
   <FIELDref ref="StartDate"/>
   <FIELDref ref="EndDate"/>
  −<PARAM ID="Calibration" name="Calibration" utype="ssa:Char.TimeAxis.Calibration" value="CALIBRATED" datatype="char" arraysize="*">
     <DESCRIPTION>Type of coord calibration.</DESCRIPTION>
   </PARAM>
 </GROUP>
```

Flux

```
−<GROUP ID="Char.FluxAxis" name="Char.FluxAxis" utype="ssa:Char.FluxAxis">
    <DESCRIPTION>Flux Axis Characterization</DESCRIPTION>
   −<PARAM ID="FluxAxisUnit" name="FluxAxisUnit" utype="ssa:Char.FluxAxis.Unit" value="electrons/s" datatype="char" arraysize="*">
      <DESCRIPTION>Unit for flux</DESCRIPTION>
    </PARAM>
   −<PARAM ID="FluxCalibration" name="FluxCalibration" utype="ssa:Char.FluxAxis.Calibration" value="RELATIVE" datatype="char" arraysize="*">
      <DESCRIPTION>Type of flux calibration</DESCRIPTION>
    </PARAM>
  </GROUP>
```

CoRoT Time Series: Data Model

Metadata information:

Spectral frame

```
-<GROUP ID="Char.SpectralAxis" name="Char.SpectralAxis" utype="ssa:Char.SpectralAxis">
  -<FIELDref ref="Coverage.Location.Value" name="Coverage.Location.Value" utype="ssa:Char.SpectralAxis.Coverage.Location.Value" ucd="instr.bandpass" datatype="double">
     <DESCRIPTION>Spectral coord value</DESCRIPTION>
   </FIELDref>
  -<FIELDref ref="Coverage.Bounds.Extent" name="Coverage.Bounds.Extent" utype="ssa:Char.SpectralAxis.Coverage.Bounds.Extent" ucd="instr.bandwidth" datatype="double">
     <DESCRIPTION>Width of spectrum</DESCRIPTION>
   </FIELDref>
 </GROUP>
```

DataID and Curation

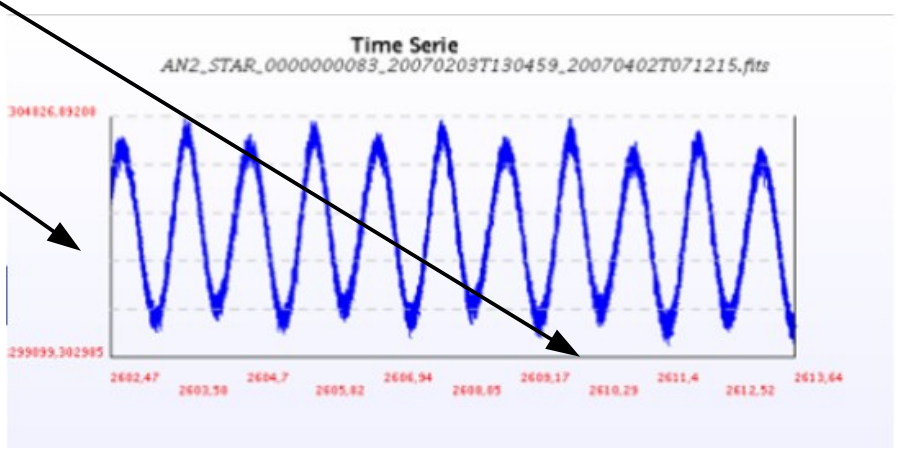
```
-<GROUP ID="DataID" name="DataID" utype="ssa:DataID">
   <DESCRIPTION>Dataset Identification Metadata</DESCRIPTION>
   <FIELDref ref="Title"/>
  -<PARAM ID="Creator" name="Creator" utype="ssa:DataID.Creator" value="IAS CoRoT Data Center" datatype="char" arraysize="*">
     <DESCRIPTION> Dataset creator. </DESCRIPTION>
   </PARAM>
 </GROUP>
-<GROUP ID="Curation" name="Curation" utype="ssa:Curation">
   <DESCRIPTION>Curation Metadata</DESCRIPTION>
  -<PARAM ID="Publisher" name="Publisher" datatype="char" utype="ssa:Curation.Publisher" value="CAB(INTA-CSIC)/SVO(Spanish Virtual Observatory)" arraysize="*">
     <DESCRIPTION>Publisher</DESCRIPTION>
   </PARAM>
  -<PARAM ID="Reference" name="Reference" datatype="char" utype="ssa:Curation.Reference" value="http://sdc.cab.inta-csic.es" arraysize="*">
     <DESCRIPTION>URL or Bibcode for documentation.</DESCRIPTION>
   </PARAM>
  -<PARAM ID="Rights" name="Rights" datatype="char" utype="ssa:Curation.Rights" value="Public Data" arraysize="*">
     <DESCRIPTION>Restrictions on data access.</DESCRIPTION>
   </PARAM>
 </GROUP>
```

CoRoT Time Series: Data Model

Data serialization:

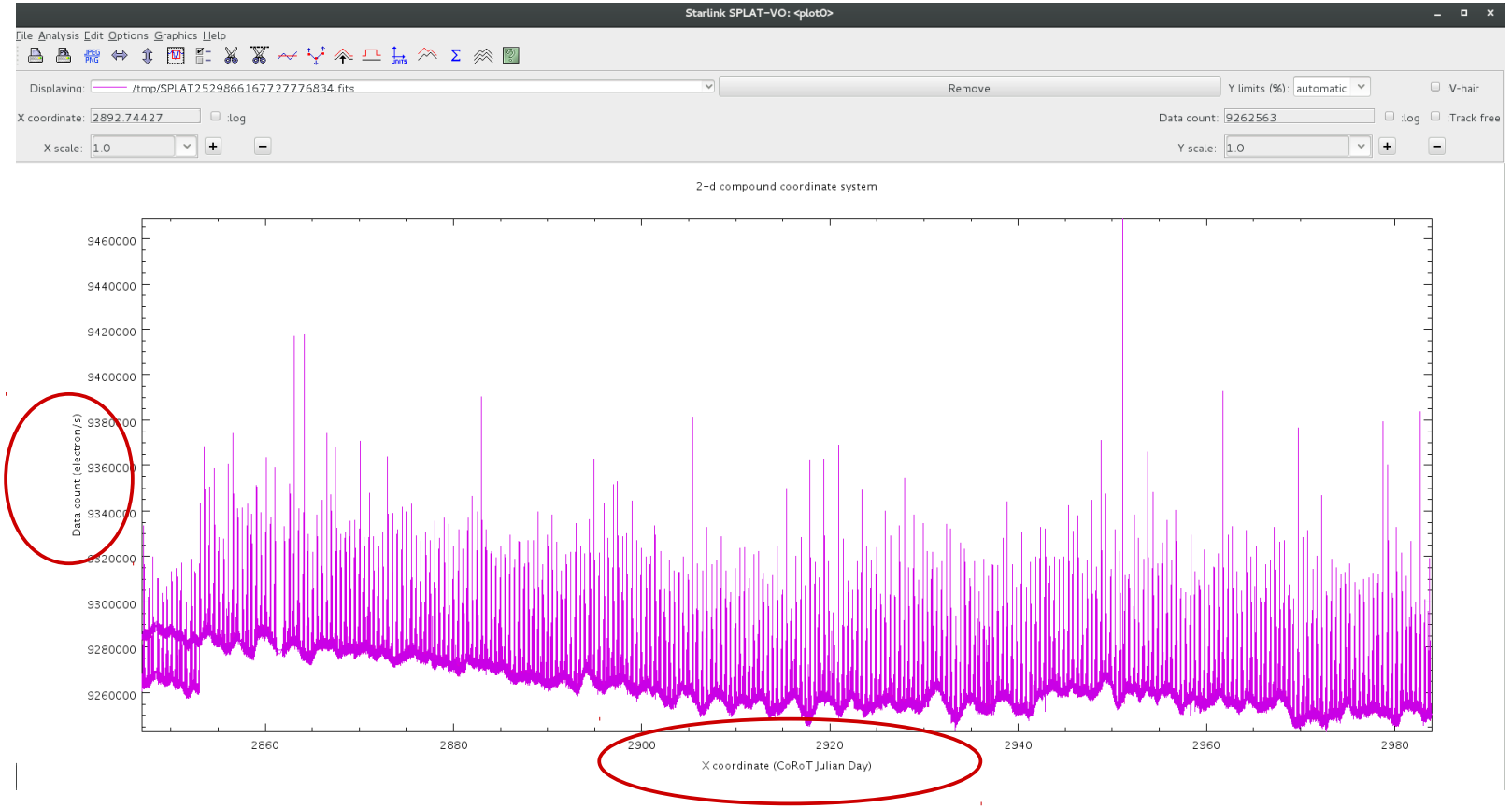
FITS format

```
−<FIELD ID="TimeAxis" name="TimeAxis" utype="ssa:Dataset.TimeAxis" datatype="char" arraysize="*">
    <DESCRIPTION> Table column containing time values </DESCRIPTION>
  </FIELD>
−<FIELD ID="FluxAxis" name="FluxAxis" utype="ssa:Dataset.FluxAxis" datatype="char" arraysize="*">
    <DESCRIPTION> Table column containing flux values </DESCRIPTION>
  </FIELD>
```

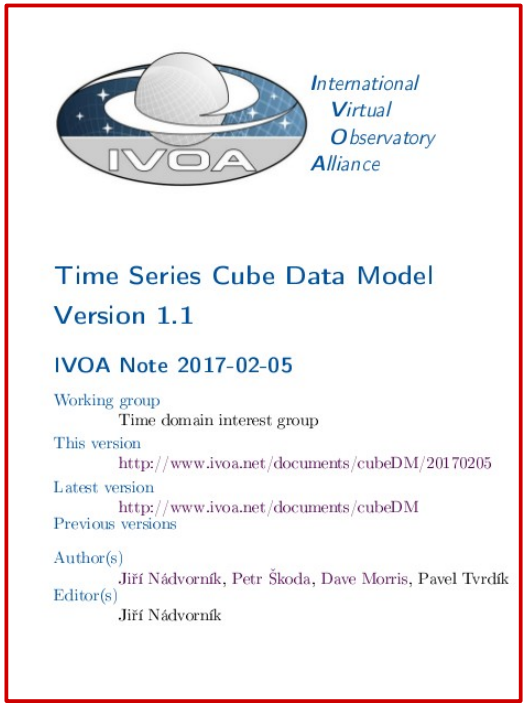


CoRoT Time Series: Data Model

CoRoT light curves described with the Spectral Data Model can be managed with VO tools like SPLAT.



CoRoT Time Series: Data Model



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Time Series Cube Data Model

Version 1.1

IVOA Note 2017-02-05

Working group
Time domain interest group

This version
http://www.ivoa.net/documents/cubeDM/20170205

Latest version
http://www.ivoa.net/documents/cubeDM

Previous versions

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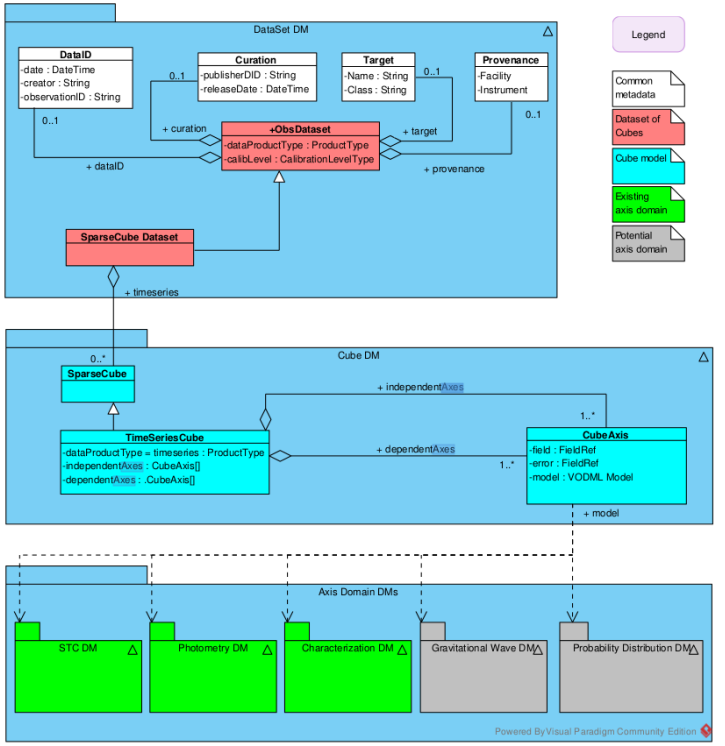
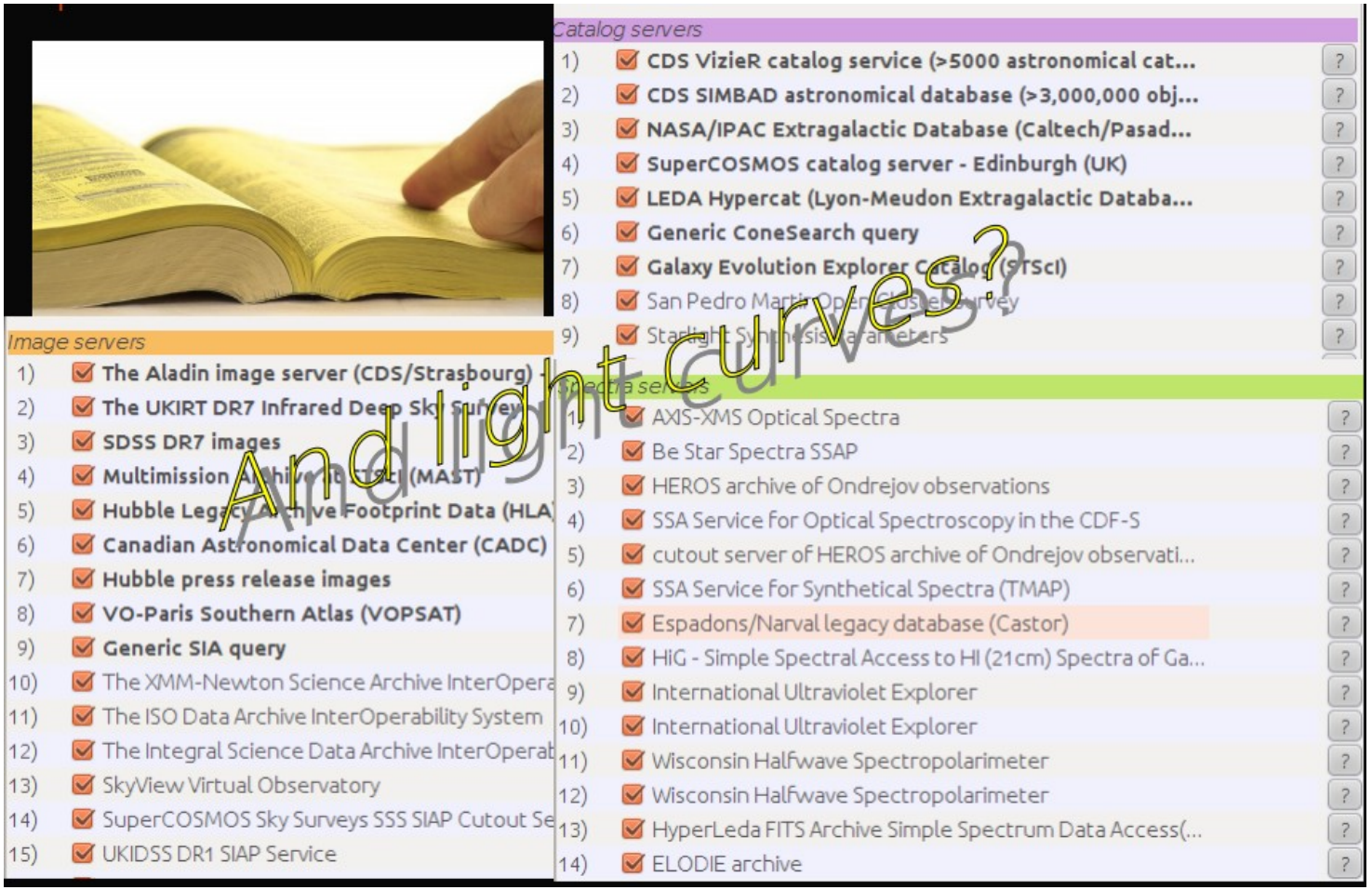
Editor(s)
Jiří Nádvorník



For our case (simple LCs) this new data model does not bring any improvement.

CoRoT Time Series: Data Discovery

- Time Series cannot be discovered at Registry level.



CoRoT Time Series: Data Discovery

- Time Series could be discovered using ObsCore / TAP .

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Observation Data Model Core Components and its Implementation in the Table Access Protocol

A.4. Discovering time series

A.4.1. Use case 4.1

Times series for a sky position, with date, length and exposure constraints

Show me a list of all data which satisfies:

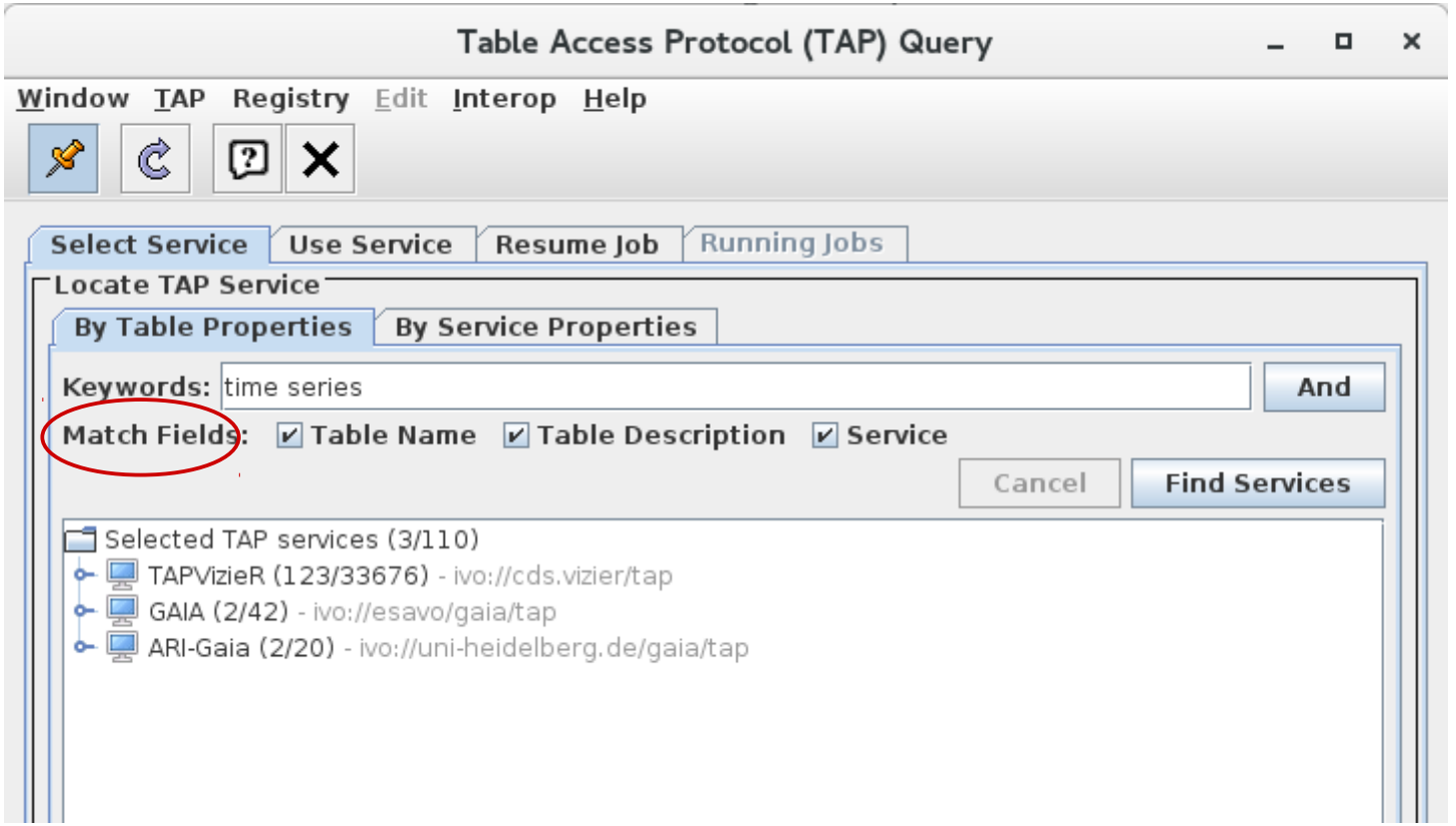
I. DataType=TimeSeries
II. RA includes 16.00 hours
III. DEC includes +41.00
IV. Time resolution better than 1 minute
V. Time interval (start of series to end of series) > 1 week
VI. Observation data before June 10, 2008
VII. Observation data after June 10, 2007

Most of the data providers (at least the VO newcomers) tend to use simple protocols (like SSAP). Therefore, the discover of SSAP Time Series services has to be a must.

CoRoT Time Series: Data Discovery

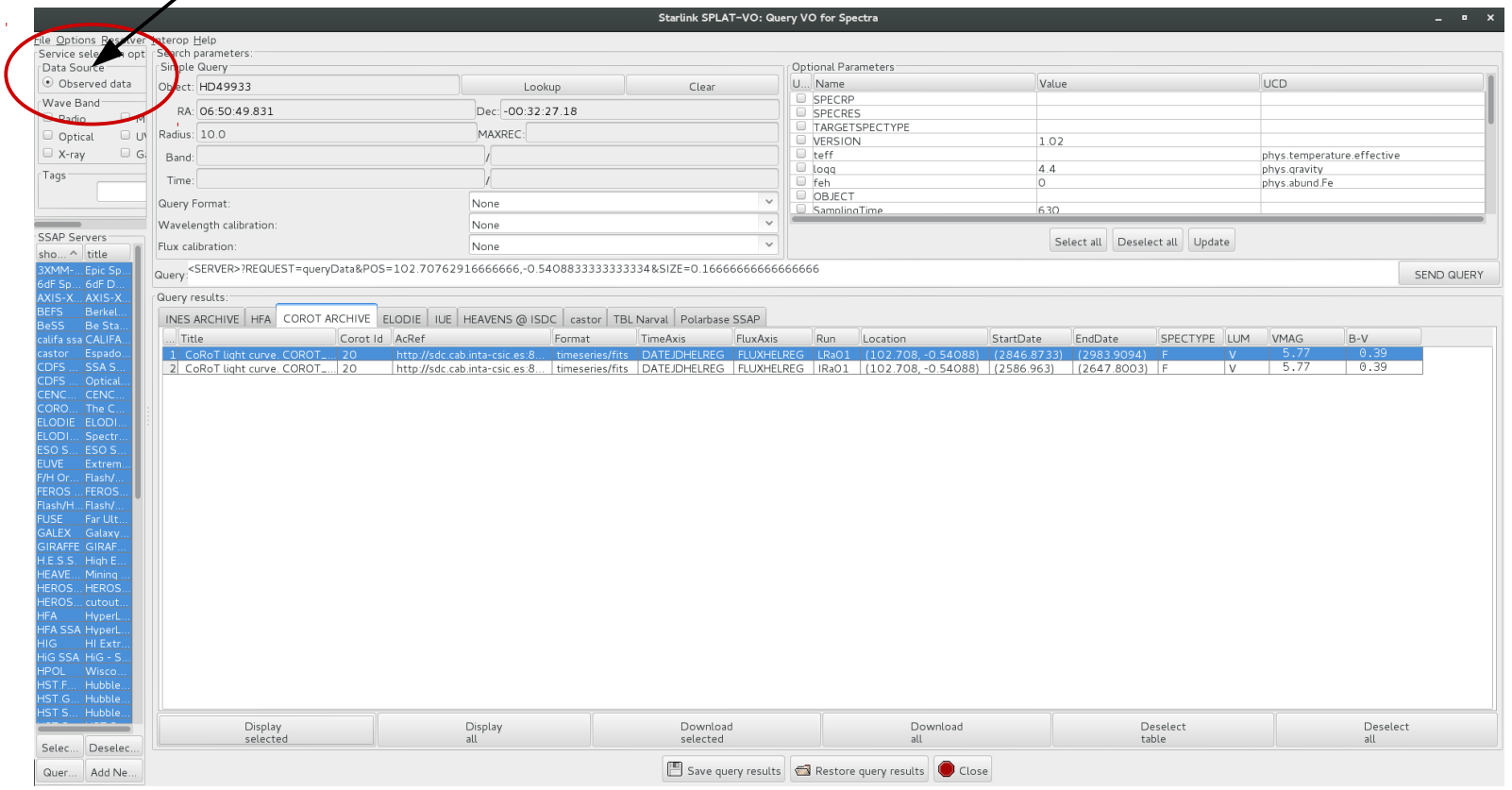
The scientific community uses VO-Tools to discover data

But Datatype is not included in the Match Fields options of TOPCAT.



CoRoT Time Series: Data Discovery

Splat-VO does not have Time Series option



Time Series and the VO

Conclusions:

To repeat the VO success stories achieved with other datasets (tables/TOPCAT; images/Aladin, SEDs/VOSA, spectra/SPLAT...) it is compulsory to provide the scientific community with an easy and transparent access to Time Series through VO tools.

For this, it is absolutely necessary to fix the problems related to data discovery (registry) and data representation (data model).