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A proposal for a TIMESYS element in VOTable

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A Proposal for a TIMESYS Element in VOTable

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Working group

Time Domain

This version

<http://www.ivoa.net/documents/timesysnote/20181029>

Latest version

<http://www.ivoa.net/documents/timesysnote>

Previous versions

This is the first public release

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A proposal for a TIMESYS element in VOTable

- Time Domain needs Interoperability
- Unambiguous declaration of metadata for that data
- Minimum metadata: time scale & reference position



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A proposal for a TIMESYS element in VOTable

- Propose a simple means to furnish times in VOTables with the necessary metadata.
- Not intended to replace efforts on full STC annotation using an IVOA-approved data model
- Easily implemented and agreed-upon mechanism until the advanced technologies are sufficiently defined and adopted.



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A proposal for a TIMESYS element in VOTable

- declaration of simple metadata:
 - **spatial coordinates** in VOTables can be declared since before the first version of the standard (Ochsenbein and Williams et al., 2004) through the **COOSYS** element
 - **temporal coordinates ?**
 - a comprehensive data model for space-time coordinates (STC)
 - Neither the data model (Rots, 2007) nor the mechanism to annotate VOTables with the roles defined by it (Demleitner and Ochsenbein et al., 2010) gained sufficient traction in the community (yet?).
 - Ongoing efforts on replacing STC2 and the annotation mechanism (VODML)
 - But the timescale for the wide adoption of these technologies is unclear.



A proposal for a TIMESYS element in VOTable

- **temporal coordinates ?**
 - Several proposals of serialisations (VODML-Lite, utypes, TIMESYS)
 - This note formalises one of them TIMESYS
 - It will be compatible with all of them in the sense that the annotation proposed here will not conflict with further annotation.



A proposal for a TIMESYS element in VOTable

- **Use Case and Scope**

- Combine two time-series
- This requires bringing the two time coordinates into a common frame
 - time scales (e.g., UTC, TT, TDB)
 - reference positions (e.g., instrument, center of the Earth, barycenter of the solar system,...)
 - time origin of the time scale (e.g. offset subtracted to the data)



A proposal for a TIMESYS element in VOTable

- **A TIMESYS element**
 - In keeping with the pattern set by COOSYS:
 - FIELDS (and possibly PARAMs) SHOULD reference the TIMESYS giving their frame using the VOTable *ref* attribute;
 - absent such a *ref*, readers SHOULD assume the lexically first TIMESYS element in the VOTable to be pertinent for time-like quantities
 - The metadata are given in attributes to the element



A proposal for a TIMESYS element in VOTable

- **A TIMESYS element**

- The metadata are given in attributes to the element
 - ***timeorigin*** time origin of the time coordinate, given as a Julian Date for the the time scale and reference point defined.
 - ***timescale*** this is the time scale used (string).
 - We propose this list should reside in an IVOA vocabulary to attach precise meanings and to allow extensions. This list should be in agreement with IAU and BIPM (Bureau international des poids et mesures) resolutions.
 - ***reposition*** this is the reference position (string)
 - We propose this these should also reside in an IVOA vocabulary
- These attribute names correspond to attributes of the frame type in current drafts of the STC2 data model



A proposal for a TIMESYS element in VOTable

- **A TIMESYS element**

- The proposal is ***not* concerned with time representations**
 - Distinction between **times given as a floating point value** (e.g., JD, julian or besselian years, unix times) and as **civil dates** is already effected by VOTable and the **DALI *timestamp* xtype** (Dowler and Demleitner et al., 2017).
 - If **further time representations ever appeared desirable** (e.g., SOFA's high-precision times stored in two double precision floating-point values), they would probably be described with **further xtypes in DALI**.
- This proposal also does ***not* concerned about units**
 - Covered by the existing VOTable standard (Ochsenbein and Taylor et al., 2013) and the ancillary VOUnits standard (Derriere and Gray et al., 2014).
 - As long as these standards are followed, no interoperability problems are foreseen regardless of whether times are given in years, days, seconds or any derivation of them.



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A proposal for a TIMESYS element in VOTable

- **Example usage for FIELD** (time, flux, magnitude, flux_error)

```
<RESOURCE>
```

```
<COOSYS ID="system" epoch="J2015.5" system="ICRS"/>
```

```
<TIMESYS ID="gaia_frame" reposition="BARYCENTER" timeorigin="0" timescale="TCB"/>
```

```
<TABLE name="ts_data">
```

```
<FIELD ID="obs_time" datatype="double" name="obs_time" ucd="time.epoch" unit="d" ref="gaia_frame"/>
```

```
<FIELD ID="flux" datatype="float" name="flux" ucd="phot.flux;em.opt.V" unit="s**-1"/>
```

```
<FIELD ID="mag" datatype="float" name="mag" ucd="phot.mag;em.opt.V" unit="mag"/>
```

```
<FIELD ID="flux_error" datatype="float" name="flux_error" ucd="stat.error;phot.flux;em.opt.V" unit="s**-1"/>
```

```
<PARAM datatype="double" name="ra" ucd="pos.eq.ra" value="45.7164887146879" ref="system"/>
```

```
<PARAM datatype="double" name="dec" ucd="pos.eq.dec" value="1.18583048057467" ref="system"/>
```

```
<DATA>
```

```
<TABLEDATA>
```

```
<TR>
```

```
<TD>2457018.7846388435</TD>
```

```
<TD>168.358</TD>
```

```
<TD>20.12281560517953</TD>
```

```
<TD>8.71437</TD>
```

```
</TR>
```

```
...
```

```
</TABLEDATA>
```

```
</DATA>
```

```
</TABLE
```

```
</RESOURCE>
```



A proposal for a TIMESYS element in VOTable

- **Example usage for FIELD** (time, flux, magnitude, flux_error)

- Gaia light-curves could be annotated by ESAC:

```
<TIMESYS ID =“gaia_time” refposition=“BARYCENTER” timescale=“TCB” timeorigin=“2455197.5”/>
```

- Gaia light-curves could be annotated by GAVO:

```
<TIMESYS ID =“gaia_time” refposition=“BARYCENTER” timescale=“TCB” timeorigin=“0”/>
```

- Gaia light-curves could be annotated by VizieR:

```
<TIMESYS ID =“gaia_time” refposition=“BARYCENTER” timescale=“TCB” timeorigin=“2455197.5”/>
```



A proposal for a TIMESYS element in VOTable

- **Example 2 for PARAM**

```
<TIMESYS reposition="TOPOCENTER" timescale="TT" timeorigin="2400000.5" ID="_MJD"/>
```

```
<PARAM ref="_MJD" name="epoch" datatype="double" value="58424.37"/>
```



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- **What Next?**

- If this or a similar proposal were to be adopted by the IVOA, both **the VOTable specification and its schema would need to be updated.**
- A **draft schema** reflecting the proposal above comes with this note and is available from <http://volute.g-vo.org/svn/trunk/projects/time-domain/timesysnote/VOTable-1.4-draft.xsd>.
- The lists of accepted reference positions and time scales should probably reside in **vocabularies** rather than the schema in the finished specification.
- **Server side** : At this point, there is support on the for the proposal in the DaCHS suite (Demleitner and Neves et al., 2014) as of the 1.2.1 beta.
- On the **client side**, the maintainers of the Aladin (Bonnarel and Fernique et al., 2000) and SPLAT Virtual Observatory clients are considering an experimental adoption.