

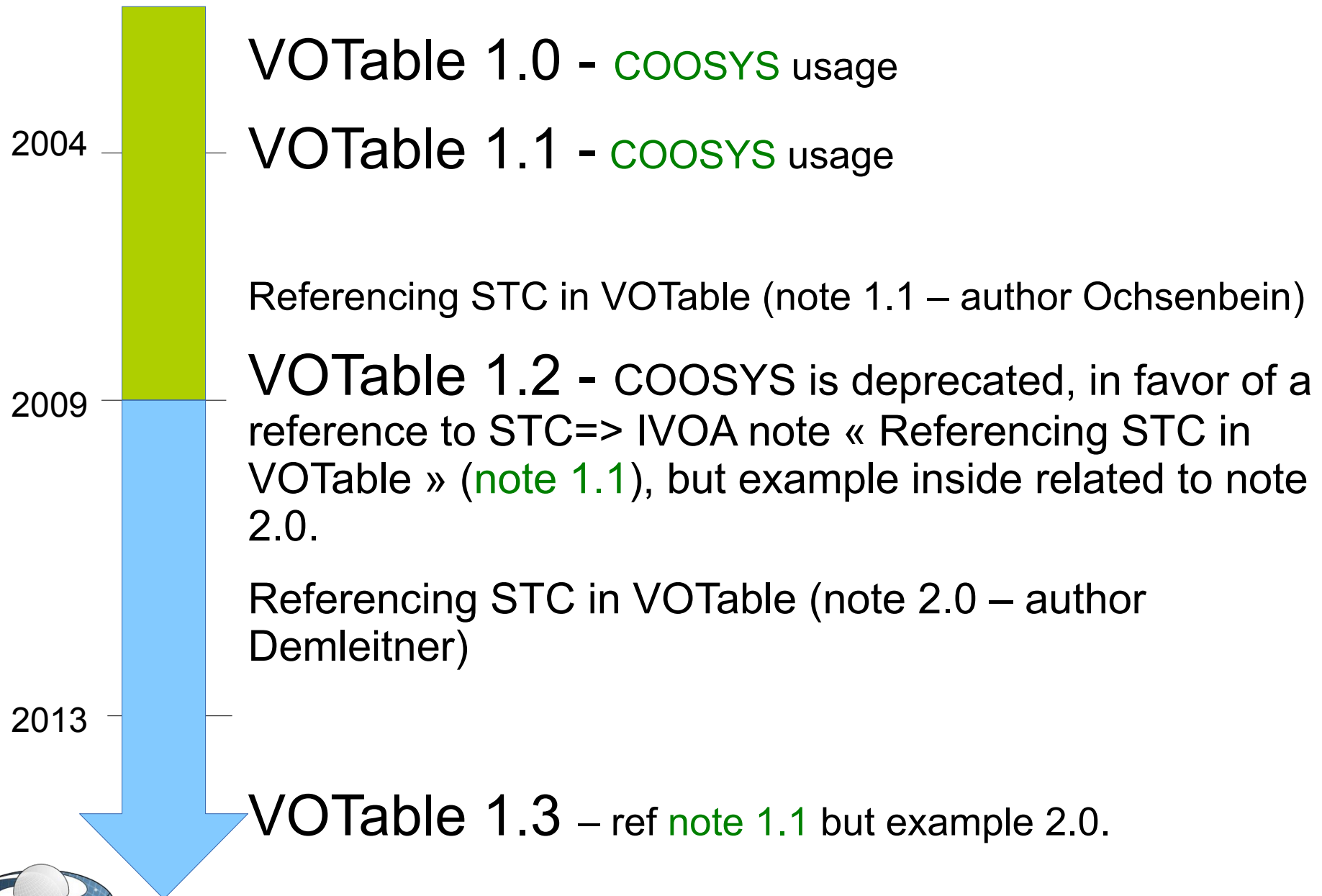
# *Coordinate specification in VOTable*

## *- State of the art -*

*Pierre Fernique - CDS*



# Coordinates story



# COOSYS

*VOTable 1.1 REC example*

```
<VOTABLE version="1.1" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:noNamespaceSchemaLocation="http://www.ivoa.net/xml/VOTable/VOTable/v1.1">
  <COOSYS ID="J2000" equinox="J2000." epoch="J2000." system="eq_FK5"/>

  <RESOURCE name="myFavouriteGalaxies">
    <TABLE name="results">
      <DESCRIPTION>Velocities and Distance estimations</DESCRIPTION>
      <PARAM name="Telescope" datatype="float" ucd="phys.size;instr.tel"
        unit="m" value="3.6"/>
      <FIELD name="RA" ID="col1" ucd="pos.eq.ra;meta.main" ref="J2000"
        datatype="float" width="6" precision="2" unit="deg"/>
      <FIELD name="Dec" ID="col2" ucd="pos.eq.dec;meta.main" ref="J2000"
        datatype="float" width="6" precision="2" unit="deg"/>
    </TABLE>
  </RESOURCE>
</VOTABLE>
```



# COOSYS

VOTable 1.1 REC example

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        datatype="float" width="6" precision="2" unit="deg"/>
    </TABLE>
  </RESOURCE>
</VOTABLE>
```



# STC note 1.1

*VOTable 1.3 REC reference*

```
<GROUP ID="Cool" utype="stc:AstroCoords" >
  <PARAM name="cooframe" datatype="char" arraysize="*" ucd="pos.frame"
    utype="stc:AstroCoords.coord_system_id"
    value="UTC-ICRS-TOPO" />
  <FIELDref ref="ObsStart" />
  <FIELDref ref="RAJ2000"/>
  <FIELDref ref="DEJ2000"/>
</GROUP>
<FIELD name="RAJ2000" ucd="pos.eq.ra;meta.main" ref="Cool"
  ID="RAJ2000" utype="stc:AstroCoords.Position2D.Value2.C1"
  datatype="float" precision="4" unit="deg" />
<FIELD name="DEJ2000" ucd="pos.eq.dec;meta.main" ref="Cool"
  ID="DEJ2000" utype="stc:AstroCoords.Position2D.Value2.C2"
  datatype="float" precision="4" unit="deg" />
<FIELD name="ObsStart" ucd="time.start;obs" datatype="char" xtype="iso8601"
  arraysize="19" unit="s" ID="ObsStart" ref="Cool"
  utype="stc:AstroCoords.Time.TimeInstant.ISOTime" />
<FIELD name="ExpTime" ucd="time.duration;obs.exposure"
  datatype="float" width="6" precision="1" unit="s"/>
```

# STC note 1.1

VOTable 1.3 REC reference

```
<GROUP ID="Cool" utype="stc:AstroCoords" >
  <PARAM name="cooframe" datatype="char" arraysize="*" ucd="pos.frame"
    utype="stc:AstroCoords.coord_system_id"
    value="UTC-ICRS-TOPO" />
  <FIELDref ref="ObsStart" />
  <FIELDref ref="RAJ2000" />
  <FIELDref ref="DEJ2000" />
</GROUP>
<FIELD name="RAJ2000" ucd="pos.eq.ra;meta.main" ref="Cool"
  ID="RAJ2000" utype="stc:AstroCoords.Position2D.Value2.C1"
  datatype="float" precision="4" unit="deg" />
<FIELD name="DEJ2000" ucd="pos.eq.dec;meta.main" ref="Cool"
  ID="DEJ2000" utype="stc:AstroCoords.Position2D.Value2.C2"
  datatype="float" precision="4" unit="deg" />
<FIELD name="ObsStart" ucd="time.start;obs" datatype="char" xtype="iso8601"
  arraysize="19" unit="s" ID="ObsStart" ref="Cool"
  utype="stc:AstroCoords.Time.TimeInstant.ISOTime" />
<FIELD name="ExpTime" ucd="time.duration;obs.exposure"
  datatype="float" width="6" precision="1" unit="s"/>
```

# STC note 1.1

VOTable 1.3 REC reference

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<GROUP ID="Cool" utype="stc: AstroCoords" >
  <PARAM name="cooframe" datatype="char" arraysize="*" ucd="pos.frame"
    utype="stc: AstroCoords.coord_system_id"
    value="UTC-ICRS-TOPO" />
  <FIELDref ref="ObsStart" />
  <FIELDref ref="RAJ2000" />
  <FIELDref ref="DEJ2000" />
</GROUP>
```

stc: AstroCoords

stc: AstroCoords.coord\_system\_id

```
<FIELD name="RAJ2000" ucd="pos.eq.ra;meta.main" ref="Cool"
  ID="RAJ2000" utype="stc: AstroCoords.Position2D.Value2.C1"
  datatype="float" precision="4" unit="deg" />
<FIELD name="DEJ2000" ucd="pos.eq.dec;meta.main" ref="Cool"
  ID="DEJ2000" utype="stc: AstroCoords.Position2D.Value2.C2"
  datatype="float" precision="4" unit="deg" />
<FIELD name="ObsStart" ucd="time.start;obs" datatype="char" xtype="iso8601"
  ID="ObsStart" ref="Cool"
  utype="stc: AstroCoords.TimeInstant.ISOTime" />
<FIELD name="ExpTime" ucd="time.duration;obs.exposure"
  ID="ExpTime" ref="Cool"
  utype="stc: AstroCoords.Position2D.Value2.C1"
  precision="1" unit="s" />
```

stc: AstroCoords.Position2D.Value2.C1

stc: AstroCoords.Position2D.Value2.C1

# STC note 2.0

*VOTable 1.3 REC example*

```
<VOTABLE version="1.3" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://www.ivoa.net/xml/VOTable/v1.3"
  xmlns:stc="http://www.ivoa.net/xml/STC/v1.30" >
  <RESOURCE name="myFavouriteGalaxies">
    <TABLE name="results">
      <DESCRIPTION>Velocities and Distance estimations</DESCRIPTION>
      <GROUP utype="stc:CatalogEntryLocation">
        <PARAM name="href" datatype="char" arraysize="*"
          utype="stc:AstroCoordSystem.href" value="ivo://STCLib/CoordSys#UTC-ICRS-TOPO" />
        <PARAM name="URI" datatype="char" arraysize="*"
          utype="stc:DataModel.URI" value="http://www.ivoa.net/xml/STC/stc-v1.30.xsd"/>
        <FIELDref utype="stc:AstroCoords.Position2D.Value2.C1" ref="col1"/>
        <FIELDref utype="stc:AstroCoords.Position2D.Value2.C2" ref="col2"/>
      </GROUP>
      <PARAM name="Telescope" datatype="float" ucd="phys.size;instr.tel"
        unit="m" value="3.6"/>
      <FIELD name="RA" ID="col1" ucd="pos.eq.ra;meta.main"
        datatype="float" width="6" precision="2" unit="deg"/>
      <FIELD name="Dec" ID="col2" ucd="pos.eq.dec;meta.main"
        datatype="float" width="6" precision="2" unit="deg"/>
      <FIELD name="Name" ID="col3" ucd="meta.id;meta.main"
        datatype="char" arraysize="8*"/>
    </TABLE>
  </RESOURCE>
</VOTABLE>
```



# STC note 2.0

*VOTable 1.3 REC example*

```
<VOTABLE version="1.3" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://www.ivoa.net/xml/VOTable/v1.3"
  xmlns:stc="http://www.ivoa.net/xml/STC/v1.30" >
  <RESOURCE name="myFavouriteGalaxies">
    <TABLE name="results">
      <DESCRIPTION>Velocities and Distance estimations</DESCRIPTION>
      <GROUP utype="stc:CatalogEntryLocation">
        <PARAM name="href" datatype="char" arraysize="*"
          utype="stc:AstroCoordSystem.href" value="ivo://STCLib/CoordSys#UTC-ICRS-TOPO" />
        <PARAM name="URI" datatype="char" arraysize="*"
          utype="stc:DataModel.URI" value="http://www.ivoa.net/xml/STC/stc-v1.30.xsd" />
        <FIELDref utype="stc:AstroCoords.Position2D.Value2.C1" ref="col1" />
        <FIELDref utype="stc:AstroCoords.Position2D.Value2.C2" ref="col2" />
      </GROUP>
      <PARAM name="Telescope" datatype="float" ucd="phys.size;instr.tel"
        unit="m" value="3.6" />
      <FIELD name="RA" ID="col1" ucd="pos.eq.ra;meta.main"
        datatype="float" width="6" precision="2" unit="deg" />
      <FIELD name="Dec" ID="col2" ucd="pos.eq.dec;meta.main"
        datatype="float" width="6" precision="2" unit="deg" />
      <FIELD name="Name" ID="col3" ucd="meta.id;meta.main"
        datatype="char" arraysize="8*" />
    </TABLE>
  </RESOURCE>
</VOTABLE>
```

# STC note 2.0

```
<VOTABLE version="1.3" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://www.ivoa.net/xml/VOTable/v1.0"
  xmlns:stc="http://www.ivoa.net/xml/STC/v1.30" >
  <RESOURCE name="myFavouriteGalaxies">
    <TABLE name="results">
      <DESCRIPTION>Velocities and Distance estimates
    <GROUP utype="stc:CatalogEntryLocation">
      <PARAM name="href" datatype="char" arraysize="*"
        utype="stc:AstroCoordSystem.href" value="ivo://STCLib/CoordSys#UTC-ICRS-TOPO" />
      <PARAM name="URI" datatype="char" arraysize="*"
        utype="stc:DataModel.URI" value="http://www.ivoa.net/xml/STC/stc-v1.30.xsd" />
      <FIELDref utype="stc:AstroCoords.Position2D.Value2.C1" ref="col1"/>
      <FIELDref utype="stc:AstroCoords.Position2D.Value2.C2" ref="col2"/>
    </GROUP>
    <PARAM name="Telescope" datatype="float" ucd="phys.size;instr.tel"
      unit="m" value="3.6"/>
    <FIELD name="RA" ID="col1" ucd="pos.eq.ra;meta.main"
      datatype="float" width="6" precision="2" unit="deg"/>
    <FIELD name="Dec" ID="col2" ucd="pos.eq.dec;meta.main"
      datatype="float" width="6" precision="2" unit="deg"/>
    <FIELD name="Name" ID="col3" ucd="meta.id;meta.main"
      datatype="char" arraysize="8*"/>
  </TABLE>
</RESOURCE>
</VOTABLE>
```

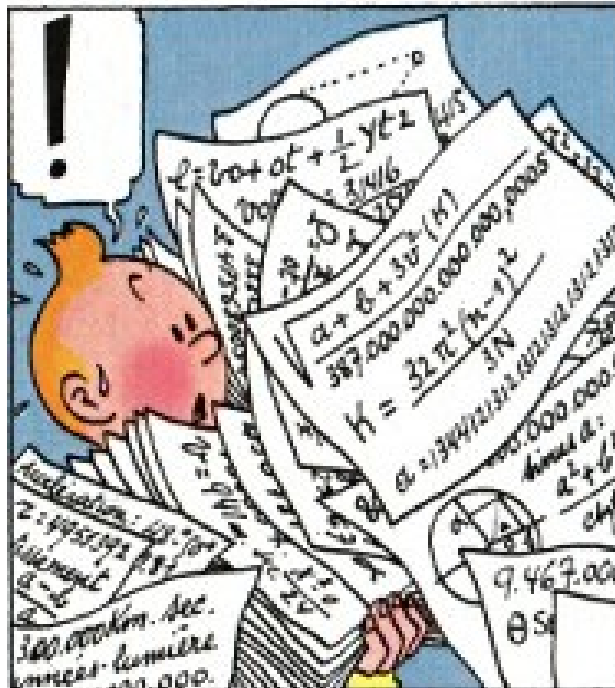
The diagram consists of five grey rectangular boxes with black text, each containing an XML namespace URI. Arrows point from these boxes to specific elements in the XML code above:

- stc:CatalogEntryLocation**: Points to the `<GROUP utype="stc:CatalogEntryLocation">` element.
- stc:AstroCoordSystem.href**: Points to the `utype="stc:AstroCoordSystem.href"` attribute in the `<PARAM name="href"...` element.
- stc:AstroCoords.Position2D.Value2.C1**: Points to the `utype="stc:AstroCoords.Position2D.Value2.C1"` attribute in the `<FIELDref utype="stc:AstroCoords.Position2D.Value2.C1" ref="col1"/>` element.
- stc:AstroCoords.Position2D.Value2.C2**: Points to the `utype="stc:AstroCoords.Position2D.Value2.C2"` attribute in the `<FIELDref utype="stc:AstroCoords.Position2D.Value2.C2" ref="col2"/>` element.
- stc:DataModel.URI**: Points to the `utype="stc:DataModel.URI"` attribute in the `<PARAM name="URI"...` element.

The `<GROUP utype="stc:CatalogEntryLocation">` element and its children are enclosed in a red rectangular box.

# Which standard is really implemented ?

20 providers has been checked last week...



2001

2004

2009

2013

Astrores COOSYS	VOT 1.0 COOSYS	VOT 1.1 COOSYS	VOT 1.2 <i>STC note 1.1</i>	VOT 1.3 <i>STC note 1.1</i>
<ul style="list-style-type: none"> <li>• LEDA =&gt;COOSYS</li> </ul>	<ul style="list-style-type: none"> <li>• GALEX/MAST =&gt; COOSYS</li> <li>• WFPC1/STScI =&gt; COOSYS</li> </ul>	<ul style="list-style-type: none"> <li>• Simbad/CDS =&gt; COOSYS</li> <li>• Chandra/CXC =&gt; COOSYS</li> <li>• NED =&gt;COOSYS + param</li> <li>• VVV/ARVO =&gt; none</li> </ul>	<ul style="list-style-type: none"> <li>• Vizier/CDS =&gt; COOSYS</li> <li>• Archives/ESO =&gt; COOSYS</li> <li>• TAP/GAVO =&gt; note 2.0</li> <li>• Skybot/IMCCE =&gt; note 1.1</li> <li>• PPMX/GAVO</li> <li>• JVO</li> <li>• Chandra/CXC</li> <li>• HST/CADC</li> <li>• Astronet.ru =&gt; none</li> </ul>	<ul style="list-style-type: none"> <li>• IRSA/IPAC =&gt; COOSYS</li> <li>• HEASARC =&gt; none</li> </ul>

Planck/ESA ??

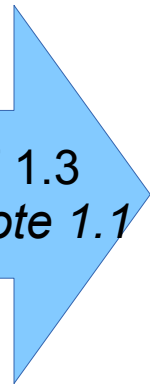


2001

2004

2009

2013



Astrores  
COOSYS

VOT 1.0  
COOSYS

VOT 1.1  
COOSYS

VOT 1.2  
STC note 1.1

VOT 1.3  
STC note 1.1

- LEDA  
=>COOSYS

- GALEX/MAST
- WFPC1/STScI  
=> COOSYS

- Simbad/CDS
- Chandra/CXC  
=> COOSYS

- Vizier/CDS
- Archives/ESO  
=> COOSYS

- IRSA/IPAC  
=> COOSYS

- NED  
=>COOSYS  
+ param

- TAP/GAVO  
=> note 2.0

- HEASARC  
=> none

- VVV/ARVO  
=> none

- Skybot/IMCCE  
=> note 1.1

- PPMX/GAVO
- JVO
- Chandra/CXC
- HST/CADC
- Astronet.ru  
=> none

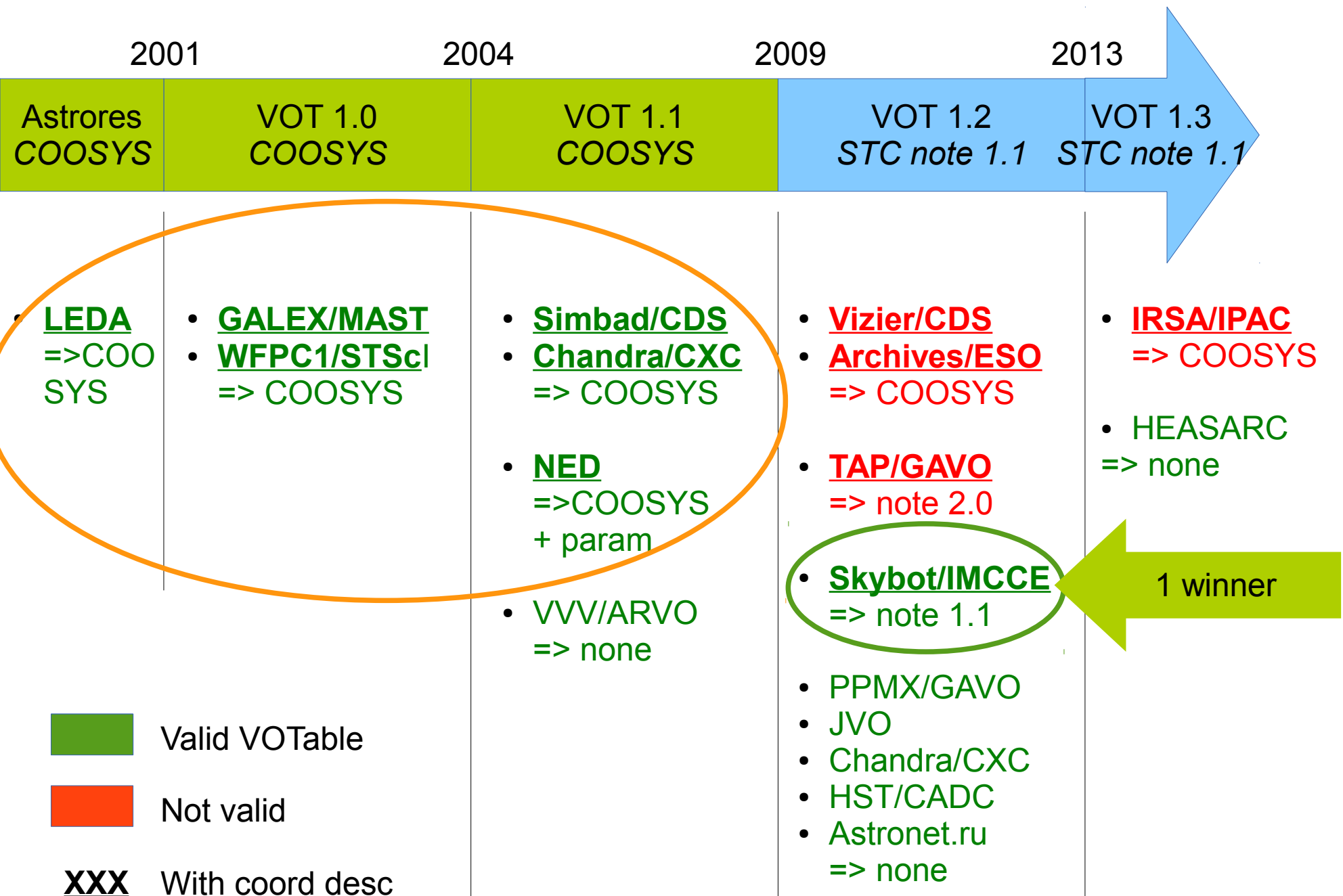
 Valid VOTable

 Not valid

XXX With coord desc

Planck/ESA ??





 Valid VOTable

 Not valid

XXX With coord desc

Planck/ESA ??



# State of the art / Provider side

- Since we deprecated COOSYS (2009), **only IMCEE has been achieved to describe coordinates according to the current standard**
- **A large part of the providers has preferred to keep COOSYS :**
  - either by avoiding to upgrade their VOTable,
  - or by providing erroneous VOTable
- **Other part of providers has just decided to remove coordinate description**
- GAVO implements the STC note 2.0 (the author of the note 2.0)
- NED decided to define its own private method (dedicated param)



# State of the art / Client side

Aladin Desktop & Lite, TOPcat, Stilts, Saada, CDS/Xmatch, VAOportal, DS9, Savot java lib, SAMP java lib, ...

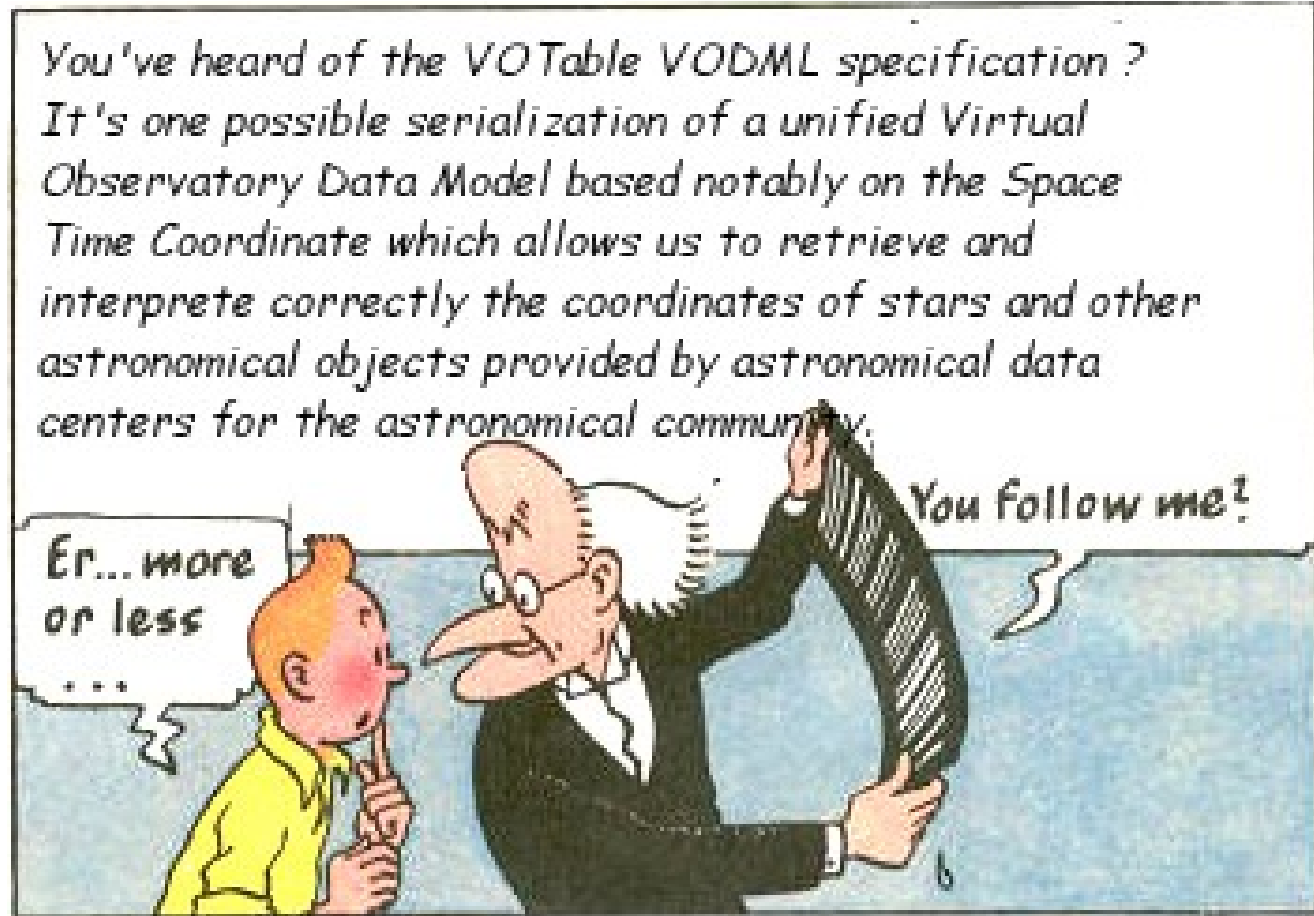
- Most of clients still **uses empirical discovery rules based on column name, UCD, unit.**
- Some clients **use explicit description** (ask the user's help, or via explicit parameters)
- **One client tries to interpret COOSYS and/or STC Note and/or variations**





# Why ?

- 1) Providers and developers are **too lazy ?**
- 2) In fact, **coordinate specification is not really required ?**
- 3) STC note is **too complex ?**
- 4) The **STC « note » status is guilty ?**



- 5) There is a risk that **STC note continues to change?**
- 6) Need **more time** than 5 years ?

# GAIA is observing...

The implicit ICRS/ep2000 default will be no longer a solution

```
<GROUP utype="stc:CatalogEntryLocation">
  <PARAM arraysize="*" datatype="char" name="CoordFlavor"
    utype="stc:AstroCoordsystem.SpaceFrame.CoordFlavor" value="SPHERICAL"/>
  <PARAM arraysize="*" datatype="char" name="coord_naxes"
    utype="stc:AstroCoordsystem.SpaceFrame.CoordFlavor.coord_naxes" value="3"/>
  <PARAM arraysize="*" datatype="char" name="CoordRefFrame"
    utype="stc:AstroCoordsystem.SpaceFrame.CoordRefFrame" value="ICRS"/>
  <PARAM arraysize="*" datatype="char" name="Epoch"
    utype="stc:AstroCoords.Position3D.Epoch" value="2010.0"/>
  <PARAM arraysize="*" datatype="char" name="yearDef"
    utype="stc:AstroCoords.Position3D.Epoch.yearDef" value="J"/>
  <PARAM arraysize="*" datatype="char" name="URI"
    utype="stc:DataModel.URI" value="http://www.ivoa.net/xml/STC/stc-v1.30.xsd"/>
  <FIELDref ref="alpha" utype="stc:AstroCoords.Position3D.Value3.C1"/>
  <FIELDref ref="delta" utype="stc:AstroCoords.Position3D.Value3.C2"/>
  <FIELDref ref="distance" utype="stc:AstroCoords.Position3D.Value3.C3"/>
  <FIELDref ref="mualpha" utype="stc:AstroCoords.Velocity3D.Value3.C1"/>
  <FIELDref ref="mudelta" utype="stc:AstroCoords.Velocity3D.Value3.C2"/>
  <FIELDref ref="radialvelocity" utype="stc:AstroCoords.Velocity3D.Value3.C3"/>
</GROUP>
```

Epoch J2010



# How to improve the situation ?

- 1) Remove any coordinate specification & continue to use empirical discovery rules based on Name/UCD/Unit**  
=> **Easy to do, Imply basic ICRS/ep2000 default, Have to recognize that this issue is too complex for IVOA.**
- 2) Back to COOSYS ?**  
=> **Easy to do, Back to a clean situation, Have to recognize that we failed to improve coordinate specification**



# How to improve the situation ?

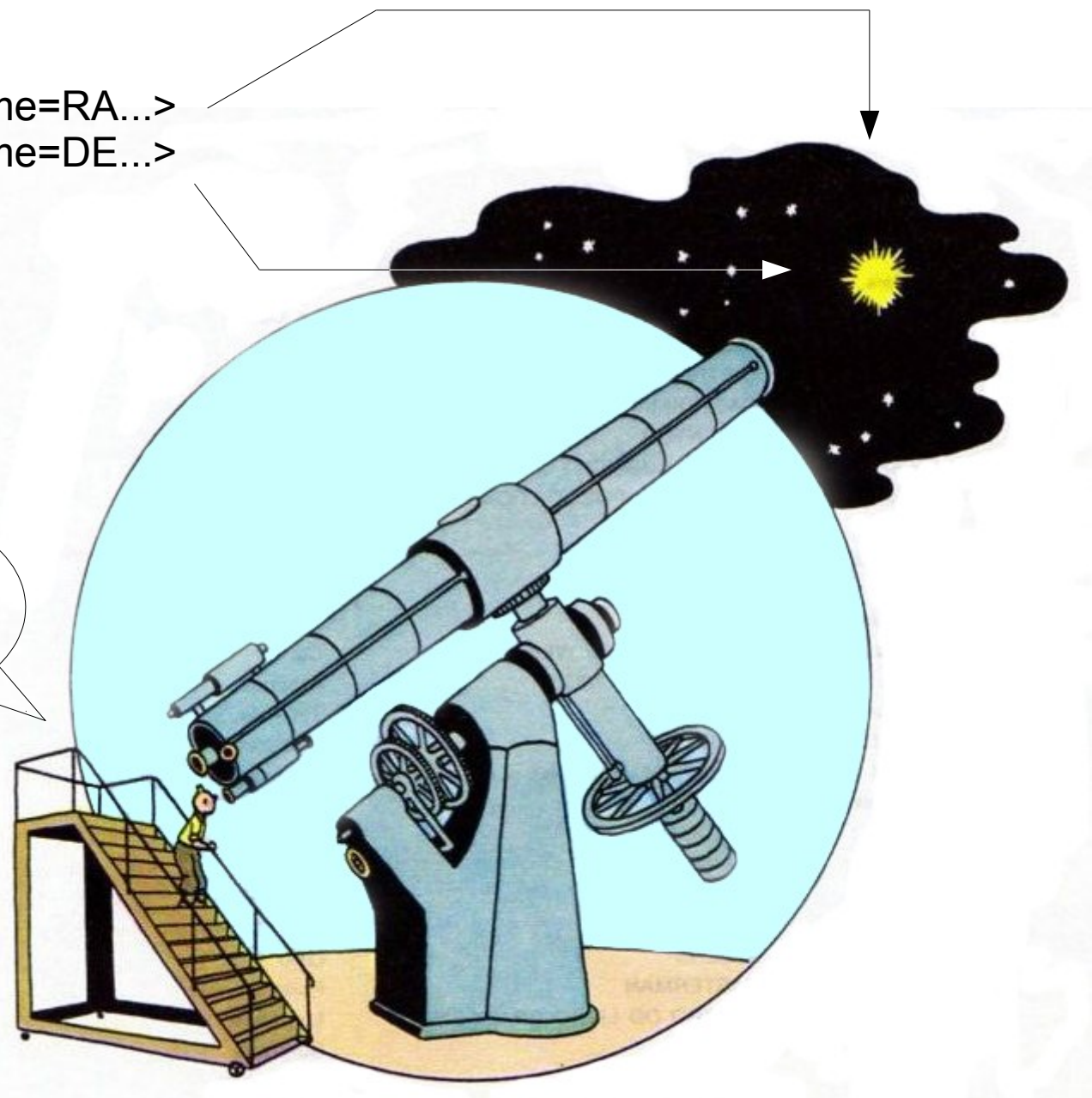
**3) Fix & validate the STC note ?** (thanks to the new note IVOA process)  
=> **Solve the issue**, Re-activate STC note process/debates, **Is there a real chance to succeed ? Will clash with future VODML serialization.**

**4) Deprecate the STC note & wait the future VODML STC2 description of coordinates ?**  
(when it will be ready)  
=> **More elegant/unified solution.** Probably a long process as based on not yet stable DM. Probably complex & difficult to implement. **Is there a real chance to succeed ?**



<FIELD name=RA...>  
<FIELD name=DE...>

*Yes!  
I got it!*



# Suggestion

(pragmatic approach)

- What about 2 + 4 solution ?

*Un-deprecate COOSYS to clean up the situation immediately.*

*Move to VODML when it will be usable (DM effort achieved – notably STC2).*

Note : The 2 methods do not clash and could be used together for a smooth transition.

