



# The Characterisation DM applied to the Infrared Space Observatory Archive

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# Rationale

- ❑ Infrared Space Observatory (ISO)
  - Operational from 1995 to 1998
  - Post operational phase ended in 2006
    - ISO Archive qualifies as a mature and stable archive, a perfect case
  
- ❑ Characterisation Data Model (CharDM)
  - Well developed concepts
  - List of CharDM UTYPEs
  - About to reach IVOA Recommendation status
  - Tutorial on how to publish image products using CharDM
  - Version 1 in particular covering Data Discovery aspects

**Aim: VO-standardised data discovery for ISO archived products using CharDM**



# ISO Metadata & Products

- ❑ Physical Data Model of the ISO Post Mission Archive (ISOPMA)
  - Detailed description of each database table and attribute
  
- ❑ ISO Data Products
  - ISOCAM (imaging), ISOLWS and ISOSWS (spectra), ISOPHOT (photometry)
  - Current effort limited to some modes (aka, AOTs): C01, L01, S01, P40
    - **C01** is a multi-wavelength mode in its nature  
each of the binary table cells contains a 1-filter image  
For simple VO protocols, it was decided long ago to offer only 1 of such images -as if it were a normal 2d image taken in 1 filter
    - **L01** grating range scan with 5 SW and 5 LW detectors 43-197 um
    - **S01** has got 12 detectors which were scanning the spectral range (2-45um) using three “parallel” apertures via specific telescope jitter manouvers
    - **P40** will be our next challenge, requires proper DM for photometry



# VO perspective

- ❑ The ISO Physical Data Model perfectly answers all the ISO requirements
  
- ❑ Going VO, though, is a different story...
  - VO, in its quest for interoperability, establishes new standards for coherent data and metadata access...
  - In so doing, the VO is de facto enforcing a list of (optional) metadata that the original missions/observatories might not have claimed relevant by their own community.
  
- ❑ What is needed to go from an internal model to an IVOA model?
  - 1) Data Providers might need to find what the missing bits are;
    - *more metadata might be needed*
  - 2) Mapping from internal model to the IVOA model of interest



# Mapping ISO and CharDM

It involves a carthusian work of going through element by element of the CharDM, finding the proper correspondence to one or more internal attributes, as in:

$$\text{Value( CharDM.utype[n] )} = f( \text{ISO.attribute[1]}, \text{ISO.attribute[2]}, \dots )$$

for each of the instrument modes.

Examples:

`time.coverage.bounds.extent => observations.utc_end - observations.utc_start`

`spatial.coverage.support.area => f( pointing.ra, pointing.dec, pointing.roll, observations.aperture )`

Once the data provider delivers the mapping recipes ...



# Mapping ISO and CharDM

## ❑ ESAVO DMMapper

- maps (both ways) data models to database table columns

```
<?xml version="1.0" encoding="UTF-8"?>
<TablesConfig xmlns="http://www.ivoa.net/wsdl/DMMapper/v0.1">
  <MetaTable>
    <Name>observations</Name>
    <Description></Description>
    <PrimaryKey>obsno</PrimaryKey>
    <Rows></Rows>
    <Rank></Rank>
    <Relations>
      <Relationship>
        <ForeignKey>obsno</ForeignKey>
        <Table>iso_chardm</Table>
      </Relationship>
      <Relationship>
        <ForeignKey>obsno</ForeignKey>
        <Table>obs_pointing</Table>
      </Relationship>
      <Relationship>
    </Relationship>
  </Relations>
</MetaTable>
</TablesConfig>
```

```
<?xml version="1.0" encoding="UTF-8"?>
<ColumnsConfig xmlns="http://www.ivoa.net/wsdl/DMMapper/v0.1">
  <Table name="iso_chardm">
    <MetaColumn>
      <Name>err_pos_ref</Name>
      <Unit>deg</Unit>
      <Description></Description>
      <UCD>pos.errorEllipse</UCD>
      <DataType>float</DataType>
      <Precision></Precision>
      <ByteSize></ByteSize>
      <Rank></Rank>
    </MetaColumn>
  </Table>
</ColumnsConfig>
```

```
<?xml version="1.0" encoding="UTF-8"?>
<XPathQLConfig>
  <property name="spatial.sampling.location.refval" value="iso_chardm.pos_sam_ref"/>
  <property name="spectral.coverage.bounds.min" value="iso_chardm.wav_cov_min"/>
  <property name="spectral.coverage.bounds.max" value="iso_chardm.wav_cov_max"/>
  <property name="time.coverage.bounds.min" value="observations;utc_start/86400 + 47527.0"/>
  <property name="time.coverage.bounds.max" value="observations;utc_end/86400 + 47527.0"/>
  <property name="time.coverage.bounds.extent" value="observations;(utc_end-utc_start)/86400."/>
</XPathQLConfig>
```



## DB ↔ UFI mapping

The DMMapper uses a configuration file where the **mapping between the internal ISO database structure and the external IVOA data model** occurs:

```
<XPathQLConfig>
<property name="spatial.sampling.location.refval" value="iso_chardm.pos_sam_ref"/>
<property name="spatial.sampling.bounds.min" value="iso_chardm.pos_sam_min"/>
<property name="spatial.sampling.bounds.max" value="iso_chardm.pos_sam_max"/>
<property name="spectral.coverage.bounds.min" value="iso_chardm.wav_cov_min"/>
<property name="spectral.coverage.bounds.max" value="iso_chardm.wav_cov_max"/>
<property name="time.coverage.bounds.min" value="observations;utc_start/86400 + 47527.0"/>
<property name="time.coverage.bounds.max" value="observations;utc_end/86400 + 47527.0"/>
<property name="time.coverage.bounds.extent" value="observations;(utc_endutc_start)/86400."/>
```

Note: those are not the official CharDM UFIs, because UFIs are being discussed.

As soon as the official UFIs will become available, we will make use of them.

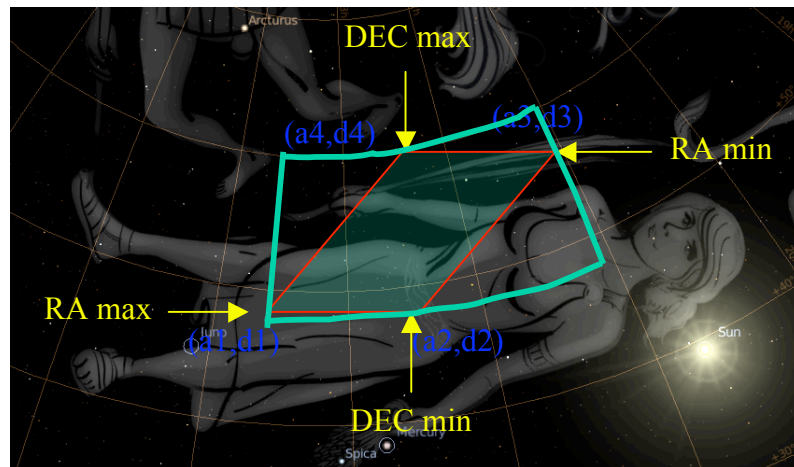
For example, instead of **spatial.coverage.bounds.min** I should have written something like...



# Spatial bounds explained

CharDM likes to define a bounding box:  
spatial.coverage.bounds.limits  
(ra min, ra max, dec min, dec max)

where spatial.coverage.bounds.limits  
is of type:  
stc:Coord2VecInterval type



```
stc:AstroCoordArea.Coord2VecInterval
- LoLimit2Vec.C1 : stc:SCValue
- LoLimit2Vec.C2 : stc:SCValue
- HiLimit2Vec.C1 : stc:SCValue
- HiLimit2Vec.C2 : stc:SCValue
```

«datatype»  
stc:SCValue

Food for thoughts: UFI discussion

RA Min:

spatialAxis.coverage.bounds.limits[stc:AstroCoordSystem.ID="UTC\_ICRS\_TOPO"]\  
.stc:Coord2VecInterval.LoLimit2Vec.C1 ?

spatialAxis.coverage.bounds.limits[stc:AstroCoordSystem.ID="UTC\_ICRS\_TOPO"]\  
.CharBox.stc:Value2.C1 ?





# ISO and CharDM mapped!

- Once the mapping is engineered...

```
<?xml version="1.0" encoding="UTF-8"?>
<TablesConfig xmlns="http://www.ivoa.net/wsdl/DMMapper/v0.1">
  <MetaTable>
    <Name>observations</Name>
    <Description></Description>
    <PrimaryKey>obsno</PrimaryKey>
    <Rows></Rows>
    <Rank></Rank>
    <Relations>
      <Relationship>
        <ForeignKey>obsno</ForeignKey>
        <Table>iso_chardm</Table>
      </Relationship>
      <Relationship>
        <ForeignKey>obsno</ForeignKey>
        <Table>obs_pointing</Table>
      </Relationship>
    </Relations>
  </MetaTable>
</TablesConfig>
```

```
<?xml version="1.0" encoding="UTF-8"?>
<ColumnsConfig xmlns="http://www.ivoa.net/wsdl/DMMapper/v0.1">
  <Table name="iso_chardm">
    <MetaColumn>
      <Name>err_pos_ref</Name>
      <Unit>deg</Unit>
      <Description></Description>
      <UCD>pos.errorEllipse</UCD>
      <DataType>float</DataType>
      <Precision></Precision>
      <ByteSize></ByteSize>
      <Rank></Rank>
    </MetaColumn>
  </Table>
</ColumnsConfig>
```

```
<?xml version="1.0" encoding="UTF-8"?>
<XPathQLConfig>
  <property name="spatial.sampling.location.refval" value="iso_chardm.pos_sam_ref"/>
  <property name="spectral.coverage.bounds.min" value="iso_chardm.wav_cov_min"/>
  <property name="spectral.coverage.bounds.max" value="iso_chardm.wav_cov_max"/>
  <property name="time.coverage.bounds.min" value="observations;utc_start/86400 + 47527.0"/>
  <property name="time.coverage.bounds.max" value="observations;utc_end/86400 + 47527.0"/>
  <property name="time.coverage.bounds.extent" value="observations;(utc_end-utc_start)/86400."/>
</XPathQLConfig>
```



# Data Discovery: ADQL on CharDM

## ❑ ESAVO DMMapper

It allows queries without\* prior knowledge of db structure by

- Resolving an ADQL query containing Unique Field IDs  
[mapping back UFIs to database columns]
- Performing the database query
- Returning VOTable with the UTYPEs (or UFIs?)  
[mapping database columns to UTYPEs]

All one needs to know is the CharDM UTYPEs/UFIs

\* almost... keep listening...



## Simple query (astronomer viewpoint)

- “Please return (spatial, spectral, and time) CharDM information for all ISO observations which have an area greater than 0.5 sq. deg.”

# Data Discovery: ADQL on CharDM



## □ Example:

```
<?xml version="1.0" encoding="utf-16"?><Select xmlns:xsd="http://www.w3.org/2001/XMLSchema"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://www.ivoa.net/xml/ADQL/v0.7.4"> <Restrict Top="40" />
<SelectionList>
  <Item xsi:type="columnReferenceType" xpathName="char.observation_id" />
  <Item xsi:type="columnReferenceType" xpathName="time.coverage.location.refval" />
  <Item xsi:type="columnReferenceType" xpathName="spectral.coverage.location.refval" />
  <Item xsi:type="columnReferenceType" xpathName="spatial.sampling.location.refval" />
  <Item xsi:type="columnReferenceType" xpathName="spatial.coverage.bounds.ra.min" />
  <Item xsi:type="columnReferenceType" xpathName="spatial.coverage.bounds.ra.max" />
  <Item xsi:type="columnReferenceType" xpathName="spatial.coverage.bounds.dec.min" />
  <Item xsi:type="columnReferenceType" xpathName="spatial.coverage.bounds.dec.max" />
  <Item xsi:type="columnReferenceType" xpathName="spatial.coverage.support.area" />
</SelectionList>
<Where>
<Condition xsi:type="comparisonPredType" Comparison=">">
<Arg xsi:type="columnReferenceType" xpathName="spatial.coverage.support.area.extent" />
<Arg xsi:type="atomType"> <Literal xsi:type="integerType" Value="0.5" /> </Arg>
</Condition> </Where></Select>
```

# Data Discovery: ADQL on CharDM



Note 1: CharDM does not supply a UTYPE for the observation ID

```
<Item xsi:type="columnReferenceType" xpathName="char:observation_id" />  
<Item xsi:type="columnReferenceType" xpathName="obs:observation_id" />
```

We cannot wait until the obsdm is ready...

Note 2: default vs explicit units?

```
<Condition xsi:type="comparisonPredType" Comparison=">">  
<Arg xsi:type="columnReferenceType" xpathName="spatial.coverage.support.area.extent" />  
<Arg xsi:type="atomType"> <Literal xsi:type="integerType" Value="0.5" /> </Arg>  
</Condition>
```

`spatial.coverage.support.area.extent[unit="deg**2"] < 0.5 ?`



# DMMapper output

```
<VOTABLE version="1.1" xmlns="http://www.ivoa.net/xml/VOTable/v1.1">
<RESOURCE type="results">
<INFO name="QUERY_STATUS" value="OK"/>
<TABLE>
<FIELD ... ucd="meta.id;meta.dataset" utype="char.observation_id" />
<FIELD ... ucd="time.epoch;obs" unit="MJD" utype="time.coverage.location.refval" />
<FIELD ... ucd="em.wl.central" unit="um" utype="spectral.coverage.location.refval" />
<FIELD ... ucd="pos.wcs.scale" unit="deg" utype="spatial.sampling.location.refval" />
...
<FIELD ... ucd="?" unit="deg" utype="spatial.coverage.support.area" />
<DATA>...
```

Should the output VOTable contain UTYPEs or UFIs?

VOTable standard knows about UTYPEs not UFIs, a problem?



## Demo (part 0)

A humble demo could be:

```
wget "http://esavo02.esac.esa.int:8080/ISOCharDMMapper/performQuery" \  
--post-file=your.adql -O votable.xml
```

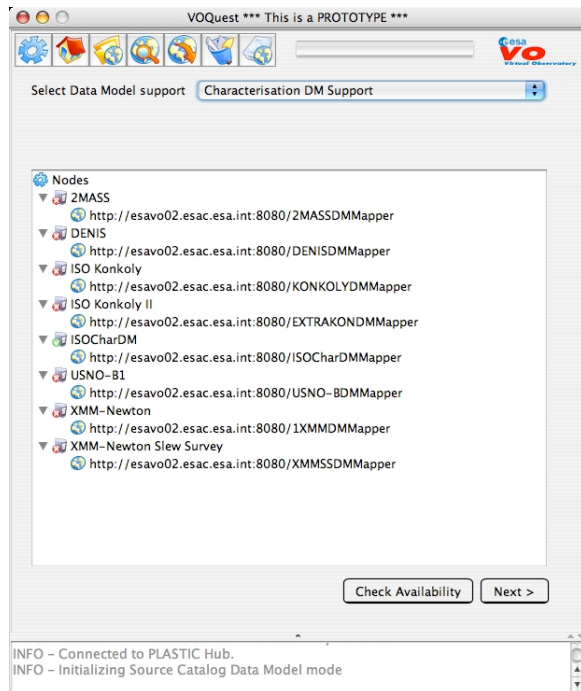
and that would be it.

We prefer something fancier...

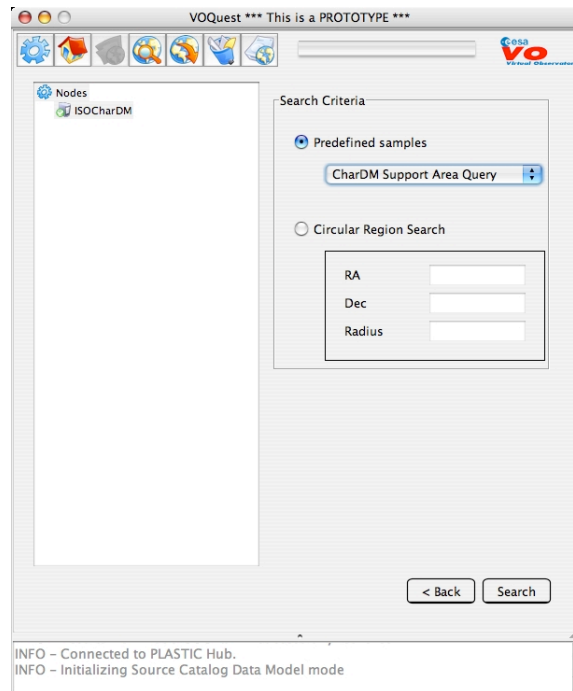


# Demo (part 1)

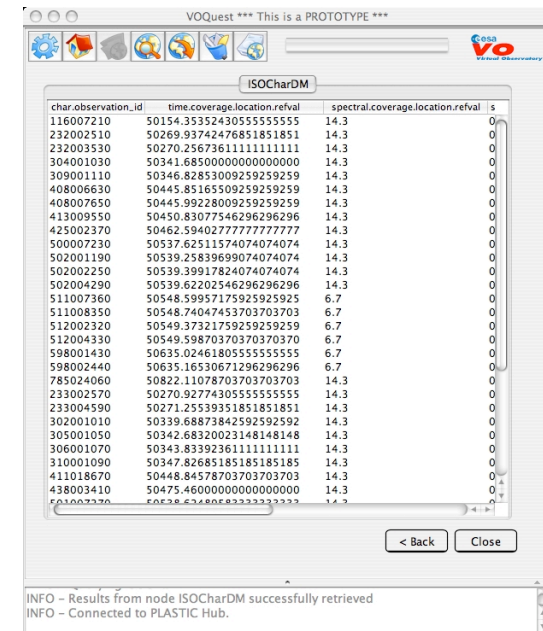
## VOQuest prototype



a) Which of the various services does **support CharDM**? (query by utype)



b) The **ADQL** previously shown is hardcoded in the **VOQuest** prototype



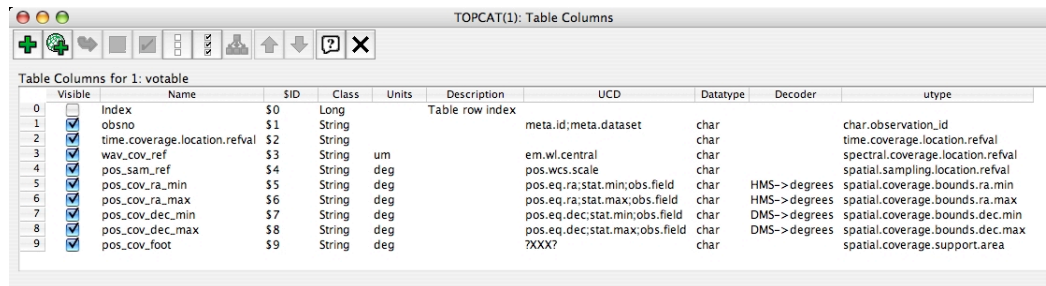
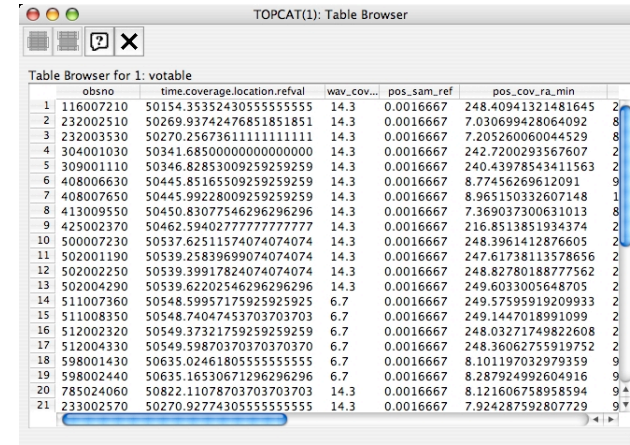
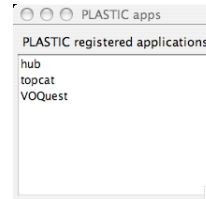
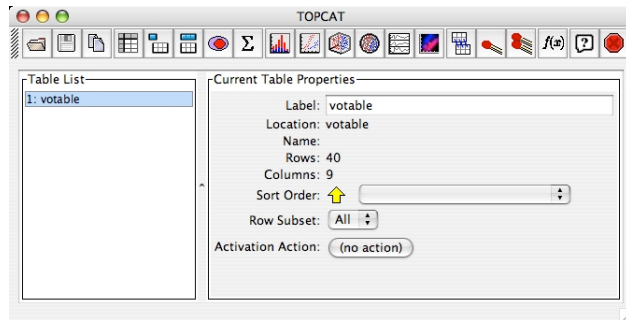
c) VOQuest sends the query to the **DMMapper**, which does the mapping and returns a **VOTable**





# Demo (part 2)

## Passing results to TOPCAT

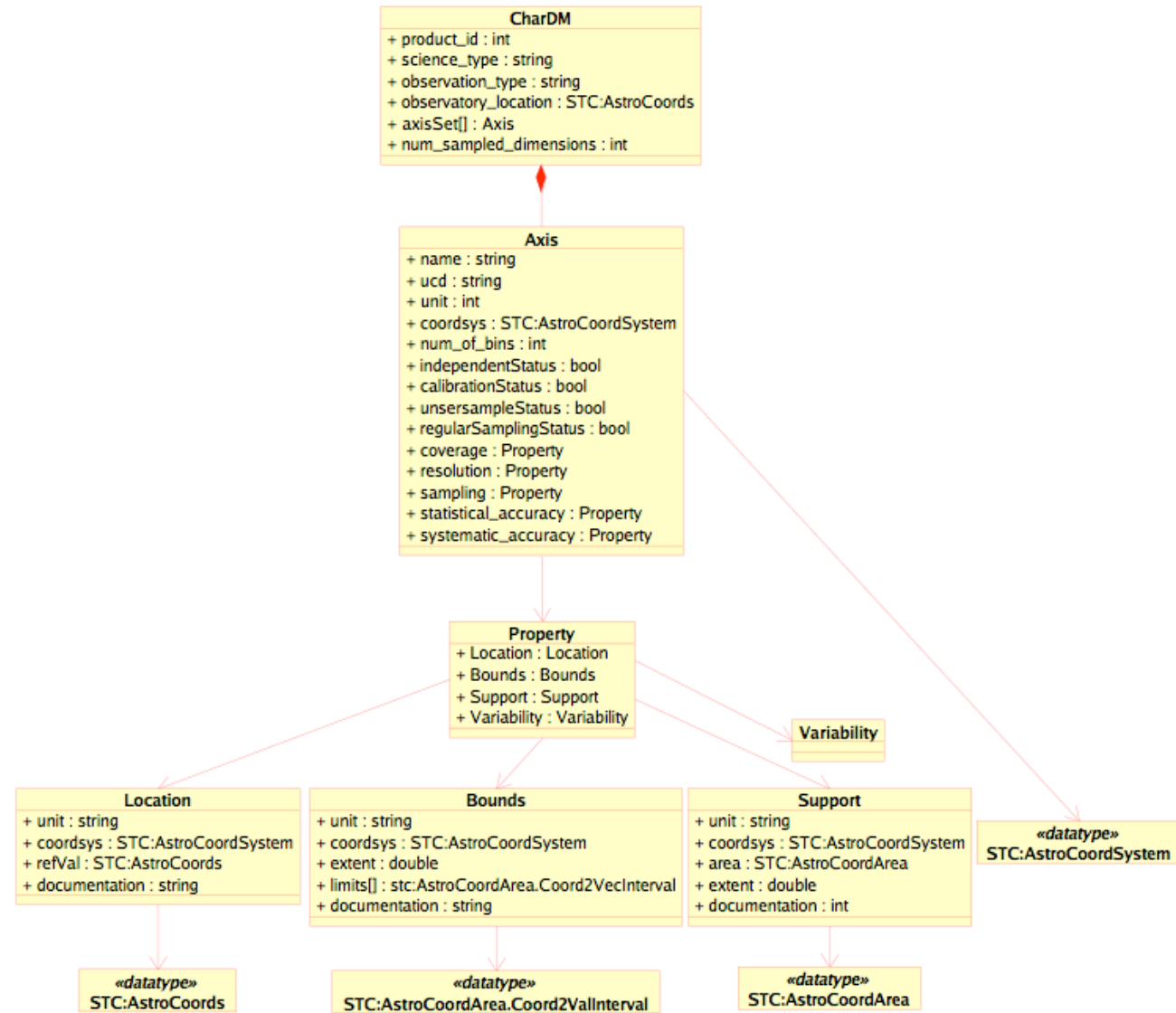


Via PLASTIC, the ISO CharDM information is passed to TOPCAT, or any other VO Application, for visualisation, analysis, and interpretation.



# Simplified Characterisation DM UML

Internal UML used to engineer our system





# Conclusions

## Recap

What we did was to:

- ❑ map the ISO internal model to the IVOA CharDM
- ❑ assign (provisional) UFIs to each attribute
- ❑ formulate ADQL queries using only UFIs (no prior DB knowledge)

To demonstrate the concept:

- ❑ VOQuest queries are passed to the DMMapper
- ❑ DMMapper maps ADQL to the actual ISO internal model
- ❑ Returned information is mapped back to (provisional) CharDM UFIs
- ❑ VOTable with UFIs is passed via PLASTIC to an application (TOPCAT) for analysis.



## Conclusions (2/2)

Main conclusion:

- ✓ No need to know the internal DB structure, applications can make use of UFIs, Astronomers and developers can concentrate on the science case not on specific implementations at different data centres.

Caveats:

- UFIs are now the main item on our table
- VOTable + STC in the making...
- VOTable currently knows about UTYPES, not UFIs