# VO-DML Annotation for the Hubble Source Catalog

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# VO-DML Use Case Analysis

How much effort are the following tasks?

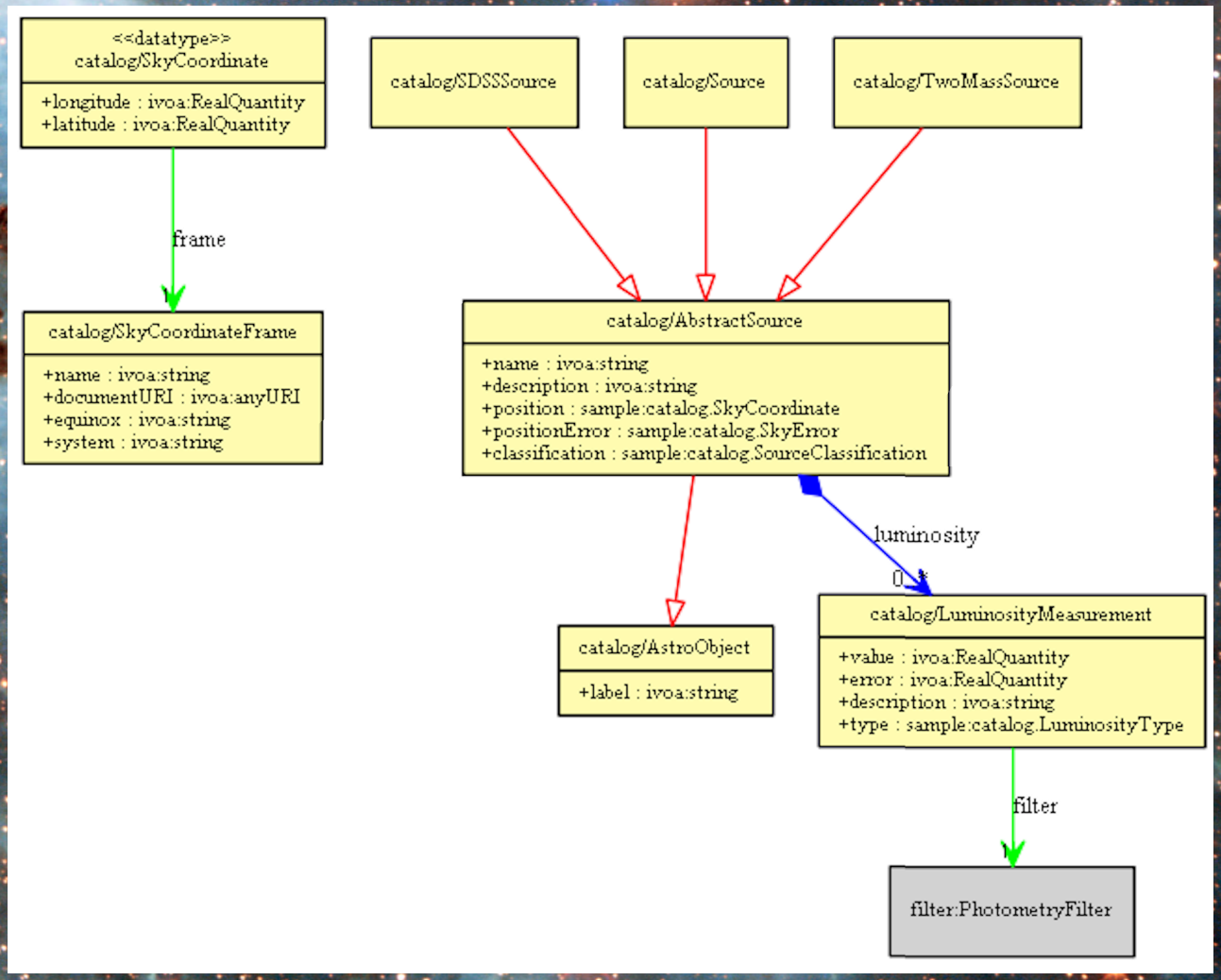
(And how useful are they?)

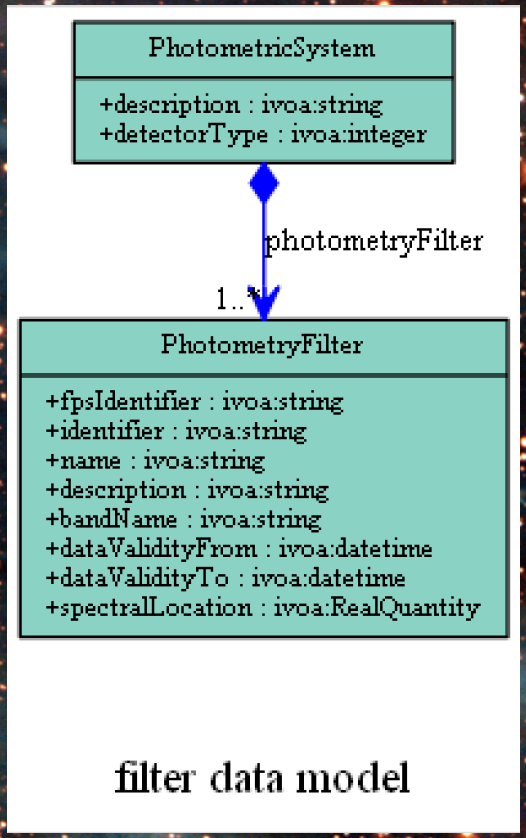
- Data provider annotating Hubble Source Catalog (HSC) results with VO-DML
- Client parsing/consuming that VO-DML
  - Instantiating HSC source objects
- Client doing something useful with those objects

# HSC Overview

- Source detections were extracted from most HST imaging observations.
  - Each observation uses one filter.
  - HST has >100 filters
- The crossmatch of those detections are stored as "matches" in the HSC.
  - Each match has a magnitude for each filter.
  - In VOTABLE results, FIELDs that are all null are not included.

# Sample Source and Filter Models




- http://volute.g-vo.org/svn/trunk/projects/dm/vo-dml-org/models/sample/sample/Sample.vo-dml.xml
- http://volute.g-vo.org/svn/trunk/projects/dm/vo-dml-org/models/sample/filter/Filter.vo-dml.xml

# HSC Annotations

## Global Filter Instances

```
<INSTANCE ID="_W2_F218W" dmtype="filter:PhotometryFilter">
        <ATTRIBUTE dmrole="filter:PhotometryFilter.name">
                <LITERAL value="W2_F218W" dmtype="ivoa:string"/>
        </ATTRIBUTE>
        <ATTRIBUTE dmrole="filter:PhotometryFilter.bandName">
                <LITERAL value="U" dmtype="ivoa:string"/>
        </ATTRIBUTE>
        <ATTRIBUTE dmrole="filter:PhotometryFilter.spectralLocation">
                <LITERAL value="218" dmtype="ivoa:RealQuantity"/>
        </ATTRIBUTE>
</INSTANCE>
<INSTANCE ID="_W2_F450W" dmtype="filter:PhotometryFilter">
        <ATTRIBUTE dmrole="filter:PhotometryFilter.name">
                <LITERAL value="W2_F450W" dmtype="ivoa:string"/>
        </ATTRIBUTE>
        <ATTRIBUTE dmrole="filter:PhotometryFilter.bandName">
                <LITERAL value="B" dmtype="ivoa:string"/>
        </ATTRIBUTE>
        <ATTRIBUTE dmrole="filter:PhotometryFilter.spectralLocation">
                <LITERAL value="450" dmtype="ivoa:RealQuantity"/>
        </ATTRIBUTE>
</INSTANCE>
```

# HSC Annotations (2)

Source ID and Position templates

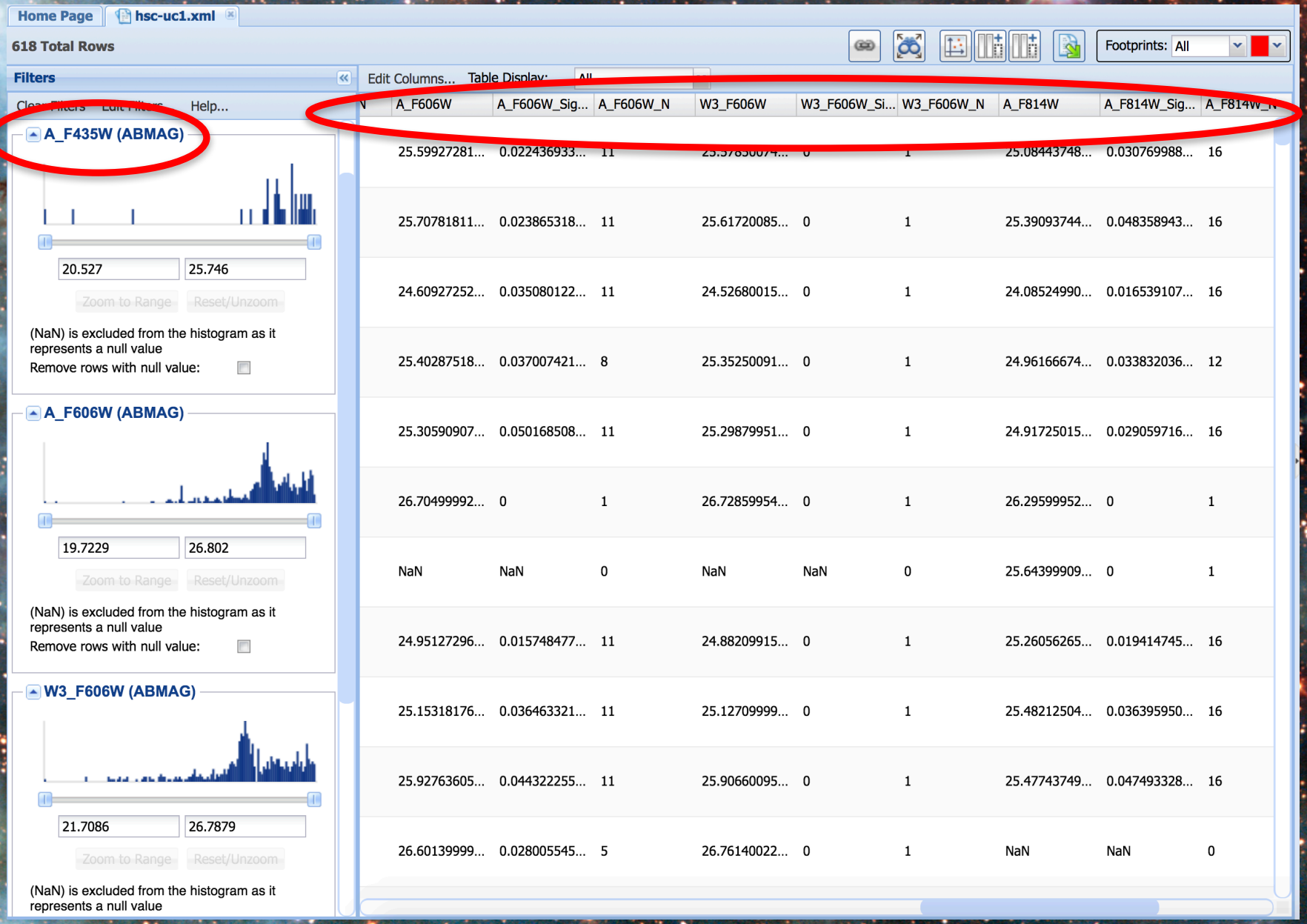
```
<INSTANCE ID="_source" dmtype="sample:catalog.Source">
    <PRIMARYKEY>
        <PKFIELD>
            <COLUMN ref="MatchID" dmtype="ivoa:string"/>
        </PKFIELD>
    </PRIMARYKEY>
    <ATTRIBUTE dmrole="sample:catalog.AbstractSource.name">
        <COLUMN ref="MatchID" dmtype="ivoa:string"/>
    </ATTRIBUTE>
    <ATTRIBUTE dmrole="sample:catalog.AbstractSource.position">
        <INSTANCE dmtype="sample:catalog.SkyCoordinate">
            <ATTRIBUTE dmrole="sample:catalog.SkyCoordinate.longitude">
                <COLUMN ref="MatchRA" dmtype="ivoa:real"/>
            </ATTRIBUTE>
            <ATTRIBUTE dmrole="sample:catalog.SkyCoordinate.latitude">
                <COLUMN ref="MatchDec" dmtype="ivoa:real"/>
            </ATTRIBUTE>
            <REFERENCE dmrole="sample:catalog.SkyCoordinate.frame">
                <IDREF>_icrs</IDREF>
            </REFERENCE>
        </INSTANCE>
    </ATTRIBUTE>
```

# HSC Annotations (3)

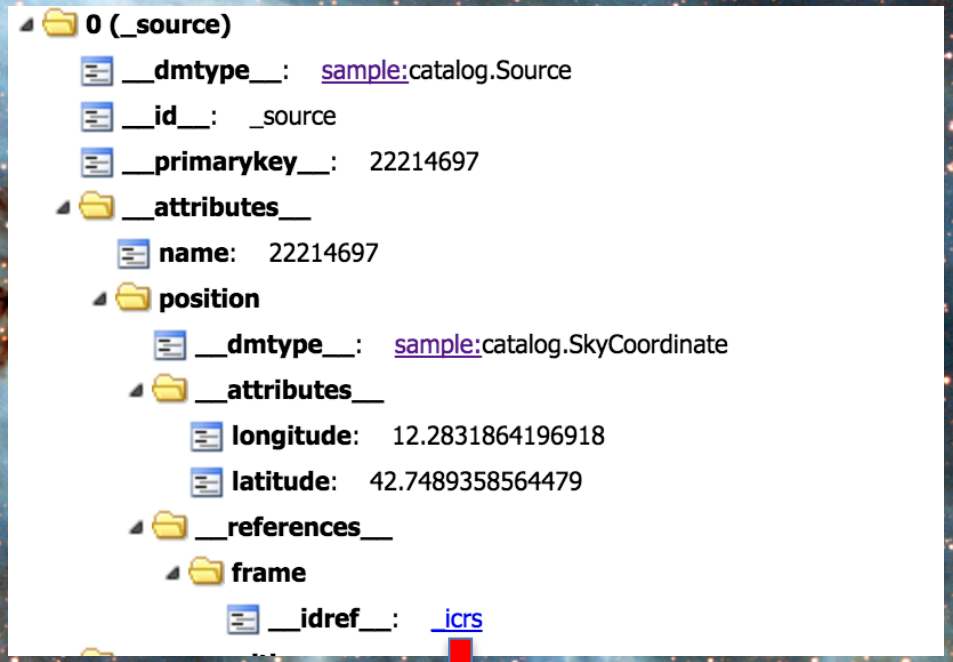
## Source Luminosity templates

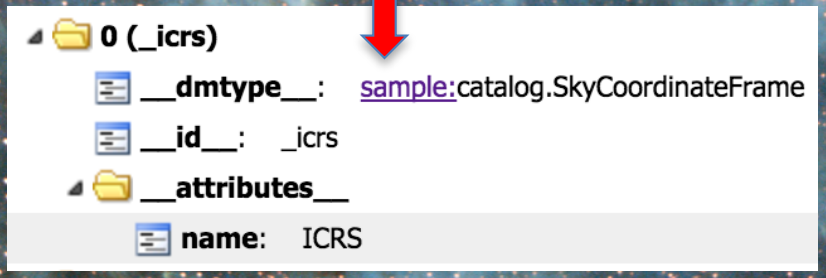
```
<COMPOSITION dmrole="sample:catalog.AbstractSource.luminosity">
    <INSTANCE dmtype="sample:catalog.LuminosityMeasurement">
        <ATTRIBUTE dmrole="sample:catalog.LuminosityMeasurement.value">
            <COLUMN ref="W2_F218W" dmtype="ivoa:real"/>
        </ATTRIBUTE>
        <ATTRIBUTE dmrole="sample:catalog.LuminosityMeasurement.error">
            <COLUMN ref="W2_F218W_Sigma" dmtype="ivoa:real"/>
        </ATTRIBUTE>
        <ATTRIBUTE dmrole="sample:catalog.LuminosityMeasurement.type">
            <LITERAL value="magnitude" dmtype="sample:catalog.LuminosityType"/>
        </ATTRIBUTE>
        <REFERENCE dmrole="sample:catalog.LuminosityMeasurement.filter">
            <IDREF>_W2_F218W</IDREF>
        </REFERENCE>
    </INSTANCE>
    <INSTANCE dmtype="sample:catalog.LuminosityMeasurement">
        <ATTRIBUTE dmrole="sample:catalog.LuminosityMeasurement.value">
            <COLUMN ref="W2_F450W" dmtype="ivoa:real"/>
        </ATTRIBUTE>
        <ATTRIBUTE dmrole="sample:catalog.LuminosityMeasurement.error">
            <COLUMN ref="W2_F450W_Sigma" dmtype="ivoa:real"/>
        </ATTRIBUTE>
        <ATTRIBUTE dmrole="sample:catalog.LuminosityMeasurement.type">
            <LITERAL value="magnitude" dmtype="sample:catalog.LuminosityType"/>
        </ATTRIBUTE>
        <REFERENCE dmrole="sample:catalog.LuminosityMeasurement.filter">
            <IDREF>_W2_F450W</IDREF>
        </REFERENCE>
    </INSTANCE>
```

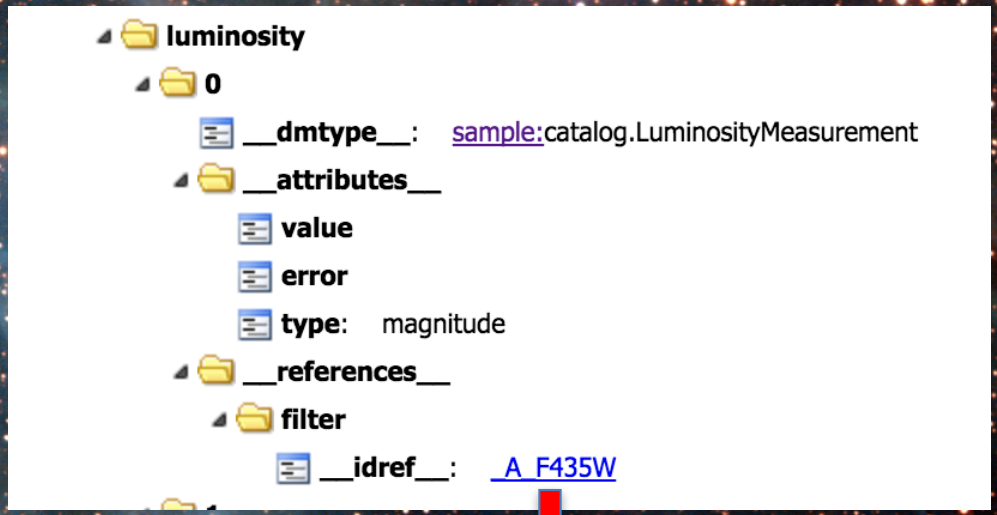
# Client Side: Ignoring VO-DML

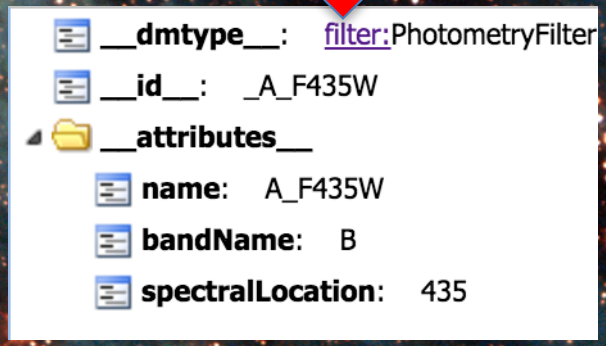


# Client Side: ParsingVO-DML



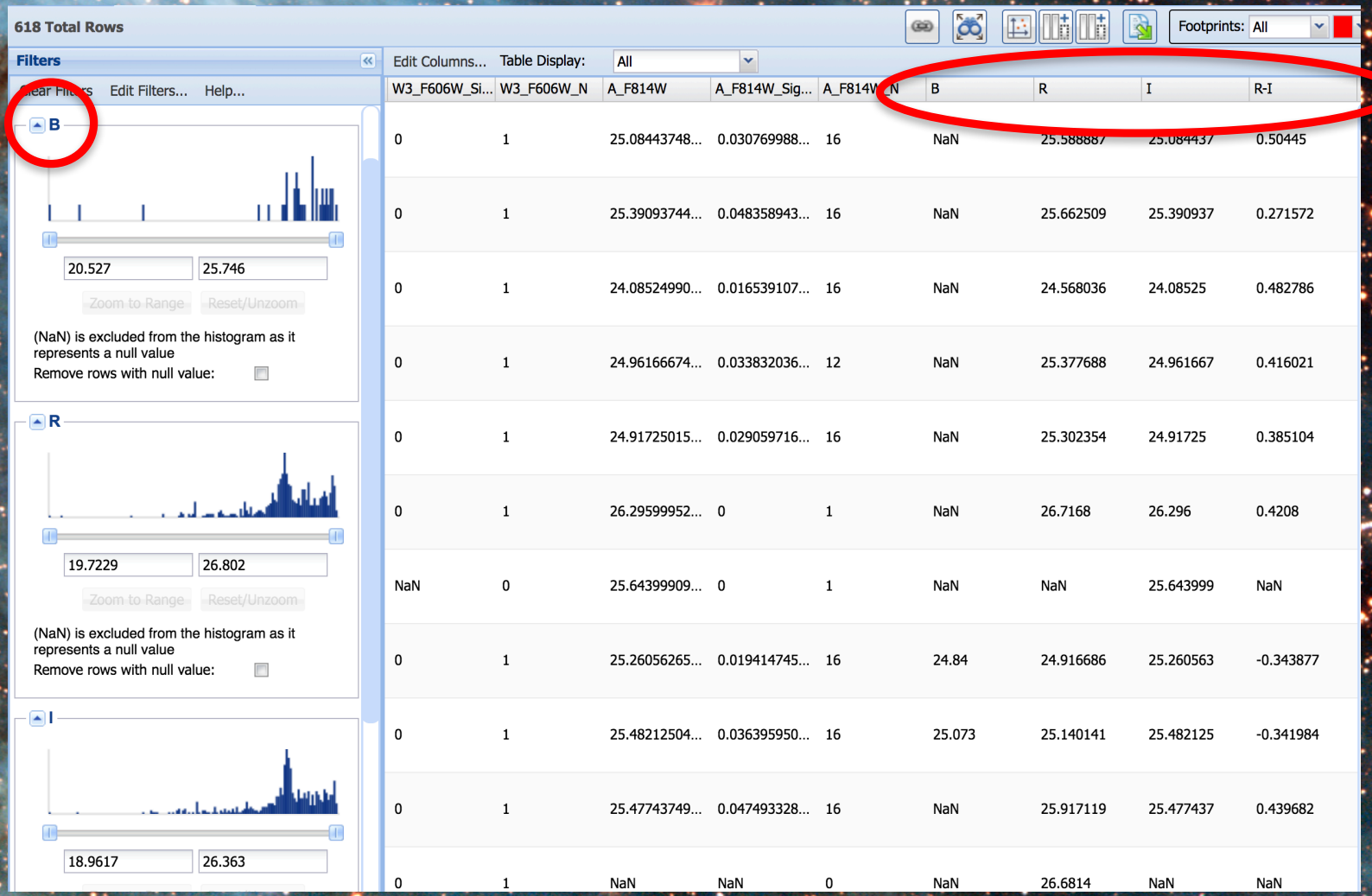



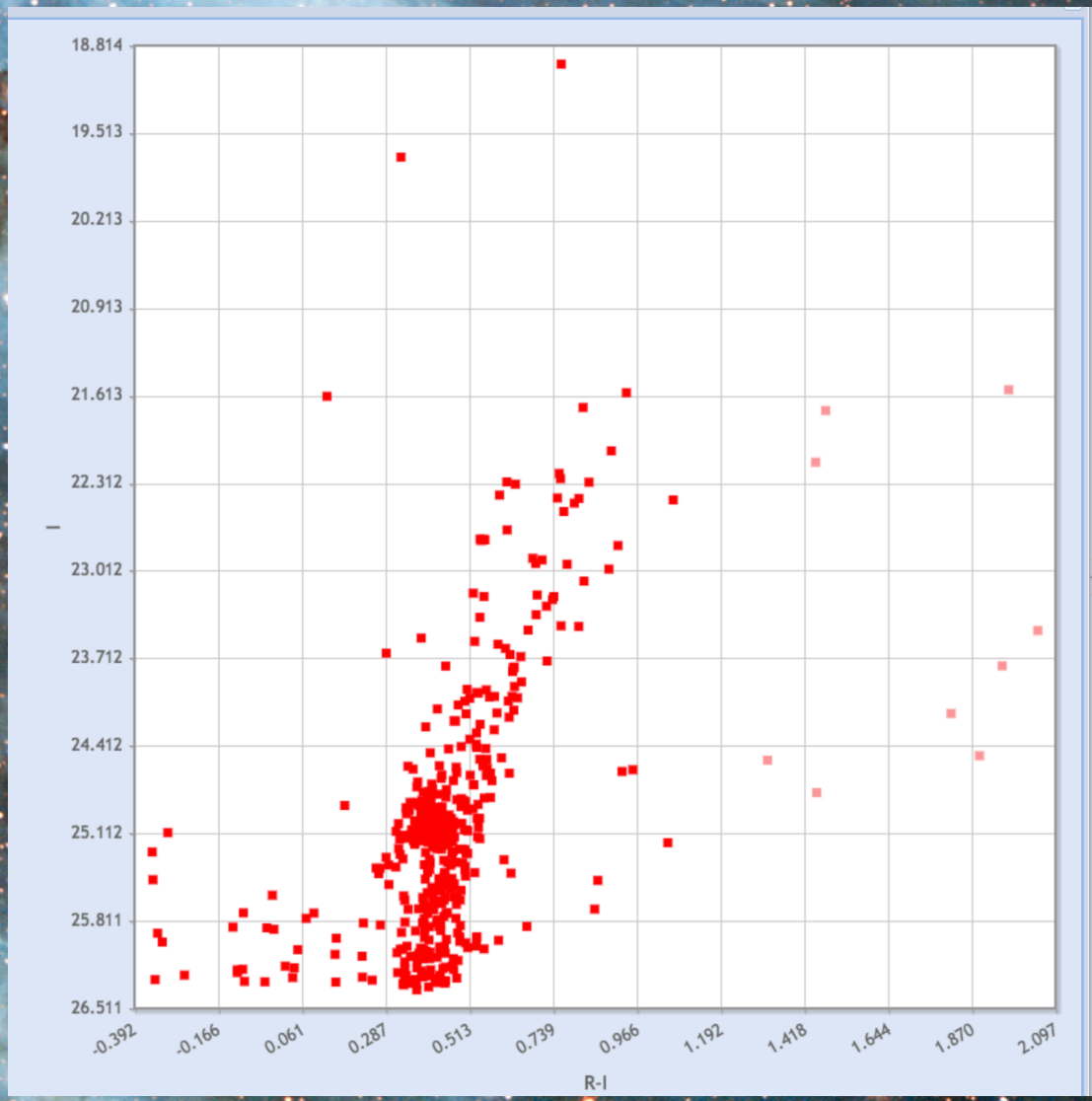
# Client Side: Something Useful?

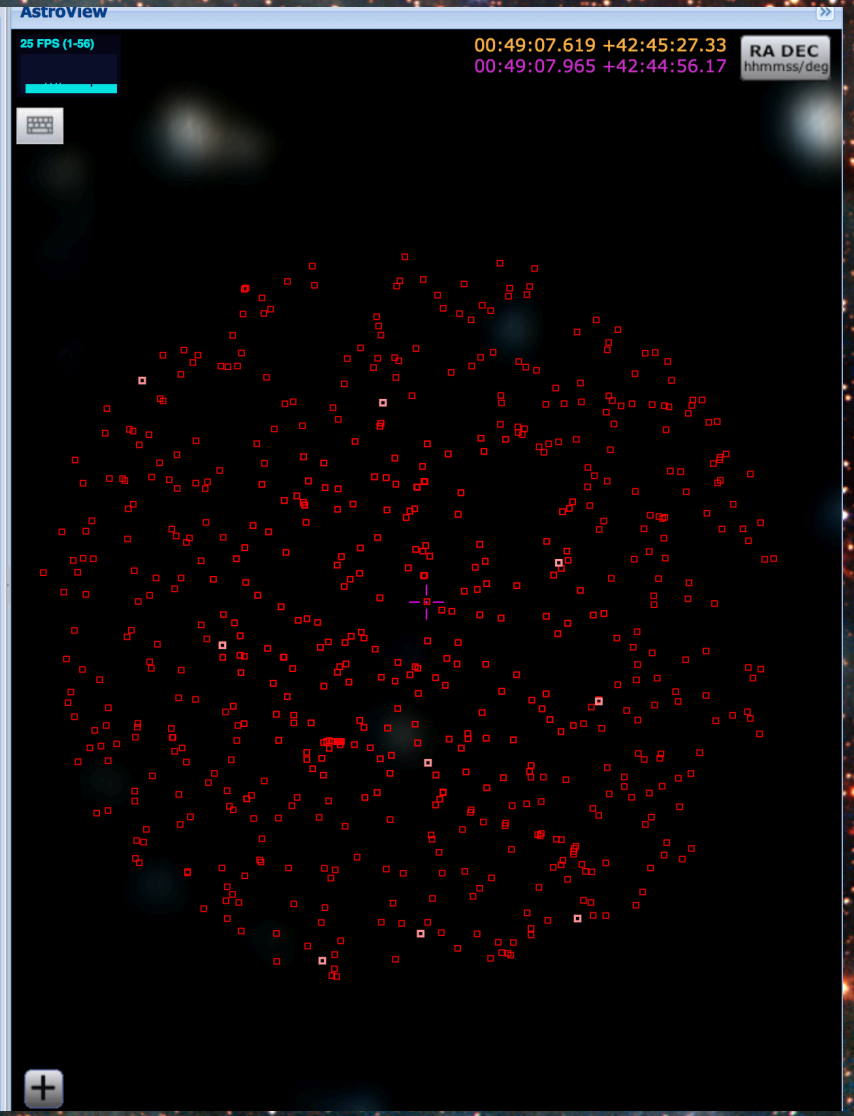
Use model information (filter band) to create “generic” band columns



# Client Side: Something Useful? (2)

## Color-Magnitude Plot



# Natural Extensions

- Annotate more source catalogs
  - Show that same client code can understand and use luminosity information.
- Annotate crossmatch results
  - Very clear which attributes go with which sources
  - May need a simple crossmatch model

# Challenging Parts

- Provider: It was challenging to construct the annotations from document alone.
  - Examples were crucial for clarifying different cases.
- Client: Many different elements to parse
  - Directly matches concepts from VO-DML itself
  - Writing basic parser (tokenizing) is tedious
  - But(!) handling semantics is straightforward and unambiguous.
- Client: Resolving references is never all that easy.

# Conclusions(?)

- Annotating existing VOTABLE results with VO-DML source models can:
  - Increase comprehensibility (thus interoperability) of data.
  - Enable client features that were not possible before.
- Learning curve for VO-DML and mapping was a bit painful, but achievable, at least for this use case.
- Defining, and experimenting with, other specific (and useful) cases could:
  - Identify improvements to syntax and documentation.
  - Help us ensure we agree on the actual goals of VO-DML annotation.