Prototype implementation for EVN Archive

Mark Kettenis

JIVE
Joint Institute for VLBI ERIC

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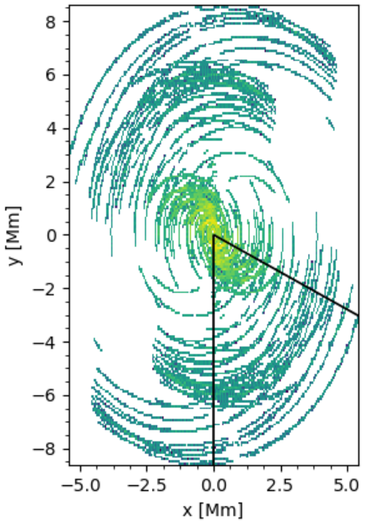
EVN & JIVE

- EVN: European VLBI Network
  - Collaboration between radio observatories in Europe and beyond (South-Africa, Puerto-Rico, China, Korea)
  - Heterogeneous array
  - PI driven
- JIVE: Joint Instutute for VLBI ERIC
  - Support institute for the EVN
  - Operates the EVN correlator and hosts the EVN data archive

UV Characterisation

`uv_distance_min, uv_distance_max, uv_distribution_ecc, uv_distribution_fill`

- Extract UVW coordinates from FITS-IDI file
  - Instead of calculating based on schedule, some antennas may not observe
  - Time consuming (reads entire archive because FITS-IDI)
  - But can be done at the same time as calculating t_exposure
- Code uses Principle Component Analysis (PCA) from scikit-learn (sklearn)
  - Based on code from Mattia Mancini (ASTRON)



Spatial Characterisation

`s_resolution_max, s_resolution_min`

- Easily calculated once you have uv_distribution_ecc
- But somewhat confusing; _min is the “maximum” (best) resoltion
- Alternative is probably worse

`s_fov_min, s_fov_max`

- not implemented yet, should be easy

`s_maximum_angular_scale`

- Easily calculated from “`uv_distribution_min`”

Frequency/Time Parameters

`f_min, f_max, f_resolution`

- Provided by metadata in FITS-IDI files

`t_exp_min, t_exp_max, t_exp_mean`

- While (effective) integration times may vary, the variation is not meaningful for VLBI
- Under active discussion in TDIG. We may drop these from Radio Extension

Instrument Parameters

`intrument_ant_count, instrument_ant_min_dist, instrument_ant_max_dist`

- Can be provided but not really useful for a heterogeneous VLBI array

`intrument_ant_diameter`

- Can’t do; multiple antennas with different diameters

`intrument_feed`

- Can’t do; different receivers on different antennas

EVN Archive VO Service

- We use DaCHs to implement TAP (ObsCore) and DataLink
- FITScrawler script parses FITS-IDI and generates .csv file
- DaCHs resource descriptor populates database from .csv file
  - Creates evn.main table
  - Creates ivoa.obscore “view” on that table

Prototype VO Service

- DaCHs 2.9 provides experimental obs_radio#publish “mixin”
  - No support for `f_min, f_max`
  - `Uses separate ivoa.obscore and ivoa.obs_radio tables`
    `Need to use NATURAL JOIN`
- Added new columns to evn.main table
- Use this “mixin” to create ivoa.obs_radio “view” on evn.main table
  - Only a few additional lines needed in resource descriptor to map columns
- Live at `https://evn-vo.jive.eu/tap`
- Natural joins work great:

```
SELECT obs_id, target_name, uv_distribution_fill FROM ivoa.obscore NATURAL JOIN
ivoa.obs_radio WHERE …
```

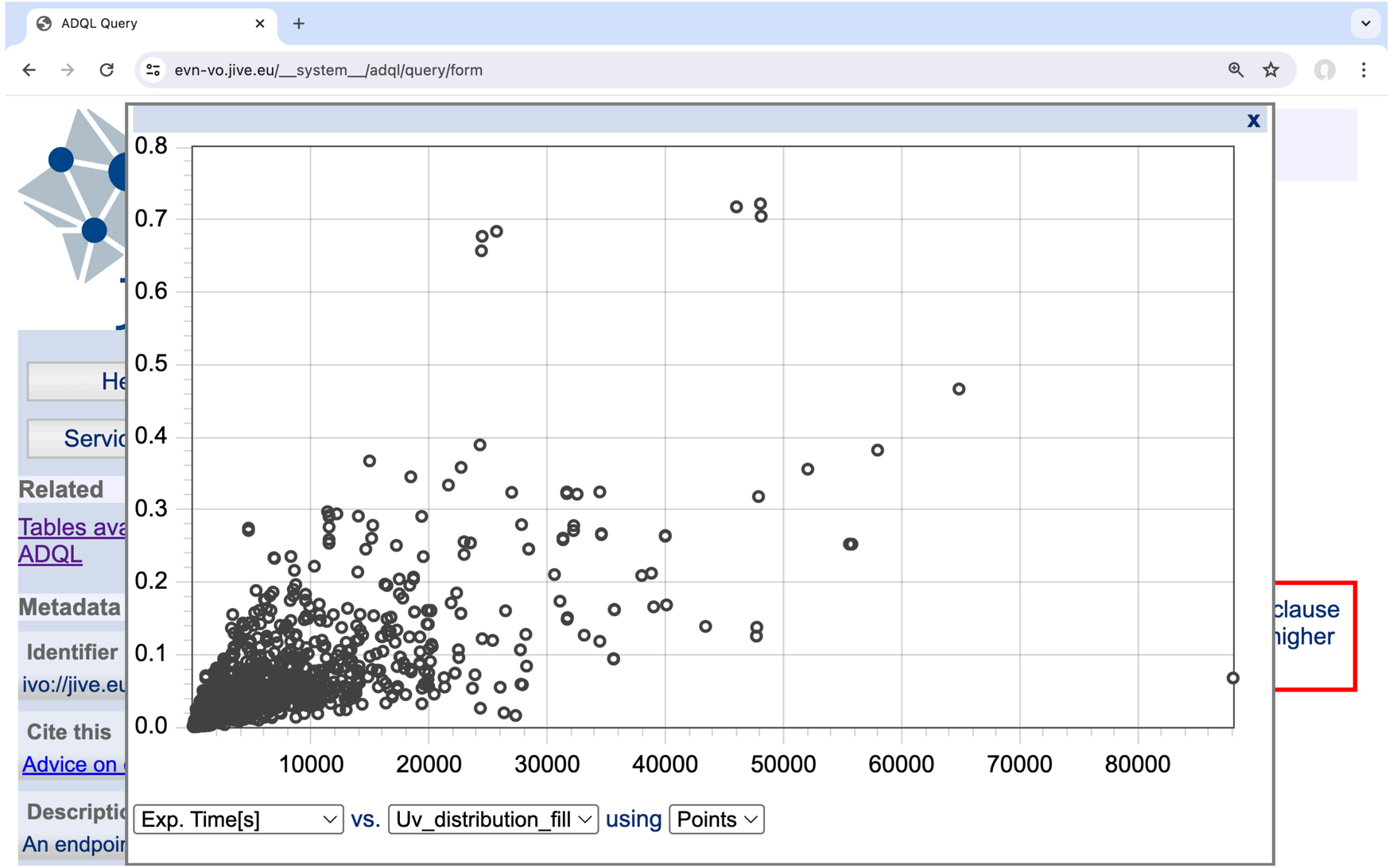
DaCHS configuration changes

```
diff --git a/dachs/q.rd b/dachs/q.rd
index ba79850..5c4eb81 100644
--- a/dachs/q.rd
+++ b/dachs/q.rd
@@ -55,6 +55,16 @@
        tXel="t_xel"
        preview="NULL"
        >//obscore#publish</mixin>
+    <mixin
+       obs_publisher_did="obs_publisher_did"
+       s_resolution_min="s_resolution_min"
+       s_resolution_max="s_resolution_max"
+       s_maximum_angular_scale="s_maximum_angular_scale"
+       uv_distance_min="uv_distance_min"
+       uv_distance_max="uv_distance_max"
+       uv_distribution_ecc="uv_distribution_ecc"
+       uv_distribution_fill="uv_distribution_fill"
+       >//obs-radio#publish</mixin>

     <column name="_nparts" type="smallint" required="True" hidden="True"
             ucd="meta.number" verbLevel="30"/>
@@ -67,6 +77,14 @@
             <property name="anchorText">datalink</property>
     </column>

+    <column original="//obs-radio#obs_radio.s_resolution_min"/>
+    <column original="//obs-radio#obs_radio.s_resolution_max"/>
+    <column original="//obs-radio#obs_radio.s_maximum_angular_scale"/>
+    <column original="//obs-radio#obs_radio.uv_distance_min"/>
+    <column original="//obs-radio#obs_radio.uv_distance_max"/>
+    <column original="//obs-radio#obs_radio.uv_distribution_ecc"/>
+    <column original="//obs-radio#obs_radio.uv_distribution_fill"/>
+
     <LOOP listItems="access_url s_region s_dec obs_publisher_did em_max em_min em_res_power em_xel t_exptime s_fov obs_id pol_xel s_ra access_estsize
s_resolution target_name t_max t_min t_resolution t_xel">
       <events>
        <column original="\item"/>
```

uv_distribution_fill vs. t_exptime



Interferometry Use Cases

- Give me high-resolution data on possible persistent radio sources with an arc second of FRB 121102

```
SELECT * FROM ivoa.obscore NATURAL JOIN ivoa.obs_radio WHERE
CONTAINS(POINT(s_ra,s_dec),CIRCLE(82.99458,33.14794,0.0003)) = 1 AND
s_resolution_max < 0.001
```

- Give me data on extended HI emission around the source 3C84 that can be imaged with reasonable fidelity:

```
SELECT * FROM ivoa.obscore NATURAL JOIN ivoa.obs_radio WHERE
CONTAINS(POINT(s_ra,s_dec),CIRCLE(24.4212500,33.1588889,0.003)) = 1
AND s_maximum_angular_scale > 0.018 AND uv_distribution_fill > 0.2
AND uv_distribution_ecc > 0.5 AND f_max < 1.43e9
```

Conclusion

- Most proposed columns can easily be provided
- Some columns will not be very useful in the VLBI case
- A few columns can’t be provided for an inhomogeneous array
- DaCHS 2.9 support is already mostly there
  - Changes will be needed if we update the standard

Many thanks to Markus Demleitner for making this possible!