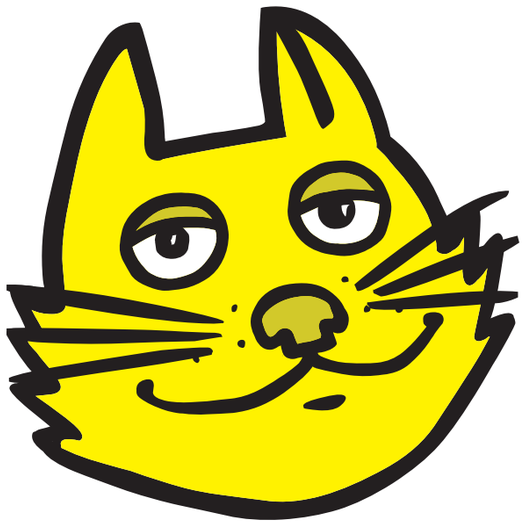
TOPCAT HAPI Client

Mark Taylor (University of Bristol)



HAPI developers meeting
Zoom

22 April 2024

$Id: tchapi.tex,v 1.14 2024/04/22 08:53:09 mbt Exp $

Summary

- What is TOPCAT?
- Why HAPI?
- What does it look like?
  - Demo
- Implementation comments

TOPCAT Overview

TOPCAT = Tool for OPerations on Catalogues And Tables

"Does what you want with tables"

Suitable for:

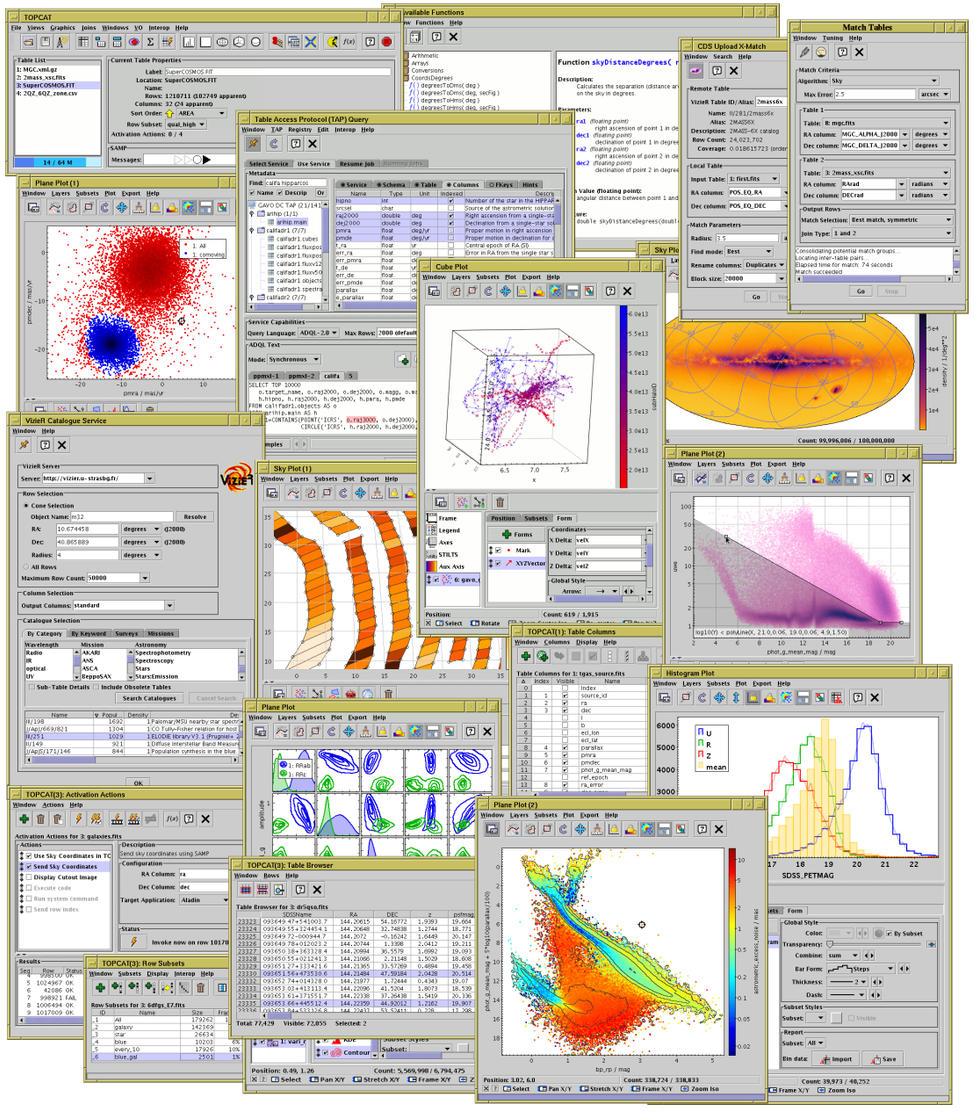
- Quick look at unfamilar data
- In-depth analysis

Features:

- Interactive visualisation
- Large datasets (millions of rows, hundreds of columns)
- I/O (external services, file formats)
- Calculations (expression language)
- (+ more ...)
- (+ command-line sibling STILTS)

Overall aim:

- Makes table manipulation easy,
  so users can concentrate on doing science



TOPCAT Context

History

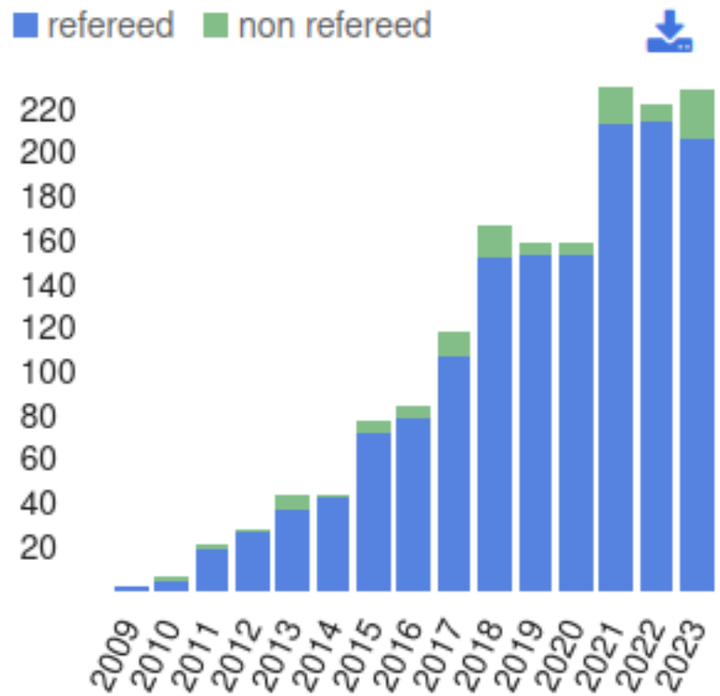
- Developed more or less continuously since ∼2003
- Funded by numerous agencies/projects
- Associated with Virtual Observatory – early adopter of many IVOA standards

Development

- Platform: desktop pure Java *(easy deployment)*
- Open source, currently (L)GPL: `https://github.com/Starlink/starjava/`
- Development team: just me *(easy project management)*
- Short development cycle, encourage user involvement

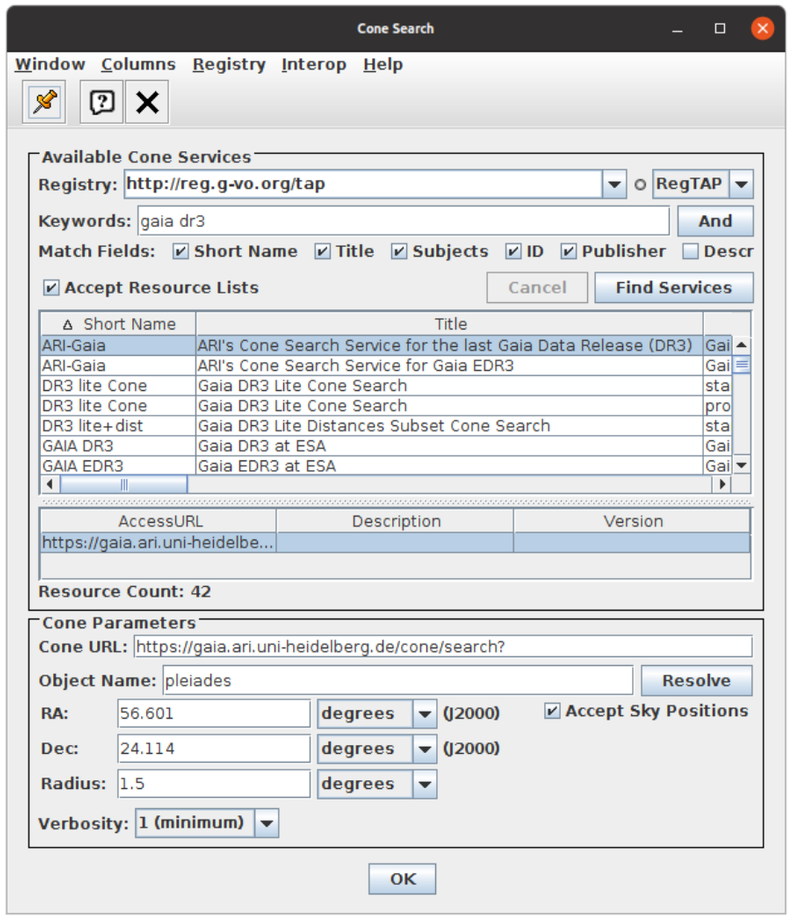
Usage

- Cited by ∼1700 papers (2005ASPC..347...29T)
- Run from a few hundred unique IP addresses per day
- Mostly astronomers
  - ▷ But some users in planetary science, heliophysics (EPN-TAP, PDS4)
- Typically source catalogues
  - ▷ But other tables too: event lists, simulations, SSOs, spectra, time series, anything in a DB, ...



Citations (ADS)

Example


Cone Search
Window Columns Registry Interop Help
Available Cone Services
Registry: http://reg.g-vo.org/tap
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ARI-Gaia
ARI's Cone Search Service for Gaia EDR3
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AccessURL
Description
Version
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Resource Count: 42
Cone Parameters
Cone URL: https://gaia.ari.uni-heidelberg.de/cone/search?
Object Name: pleiades
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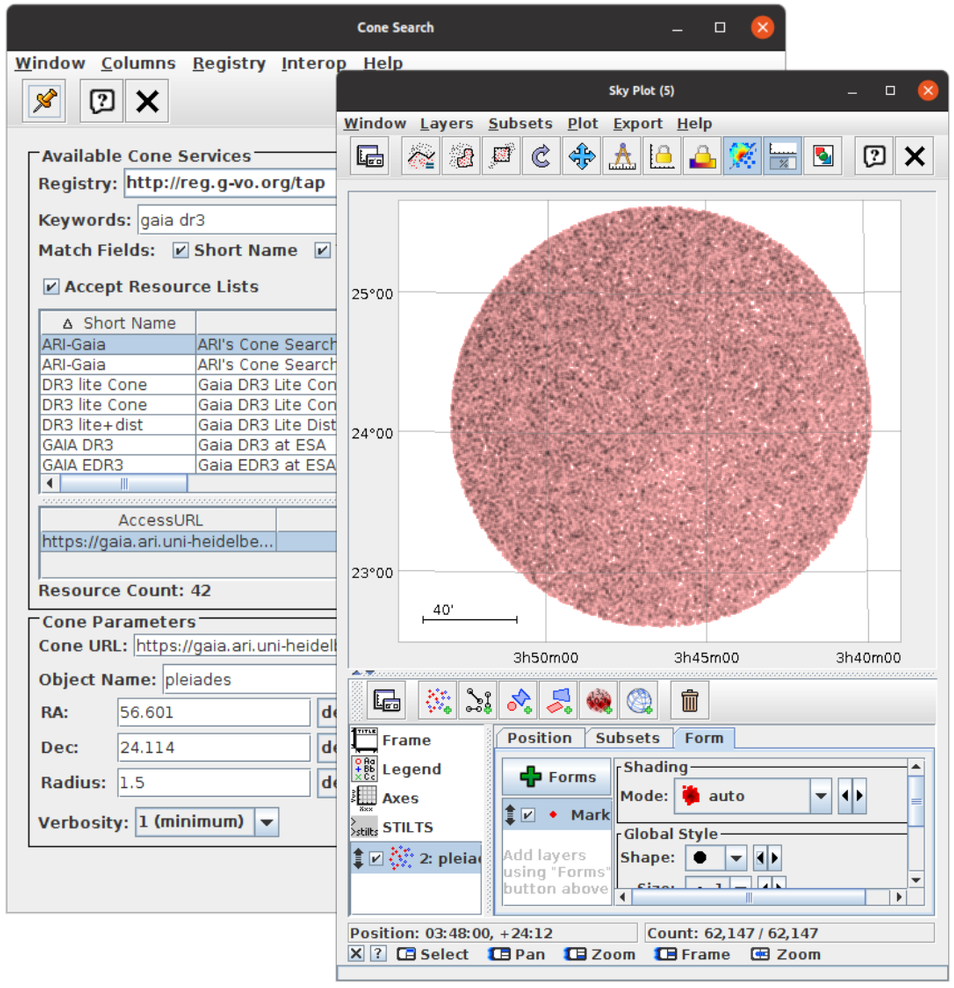
Accept Sky Positions
Dec: 24.114
degrees
(J2000)
Radius: 1.5
degrees
Verbosity: 1 (minimum)
OK

Example


Cone Search
Window Columns Registry Interop Help
Available Cone Services
Registry: http://reg.g-vo.org/tap
Keywords: gaia dr3
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Sky Plot (5)
Window Layers Subsets Plot Export Help
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Count: 62,147 / 62,147
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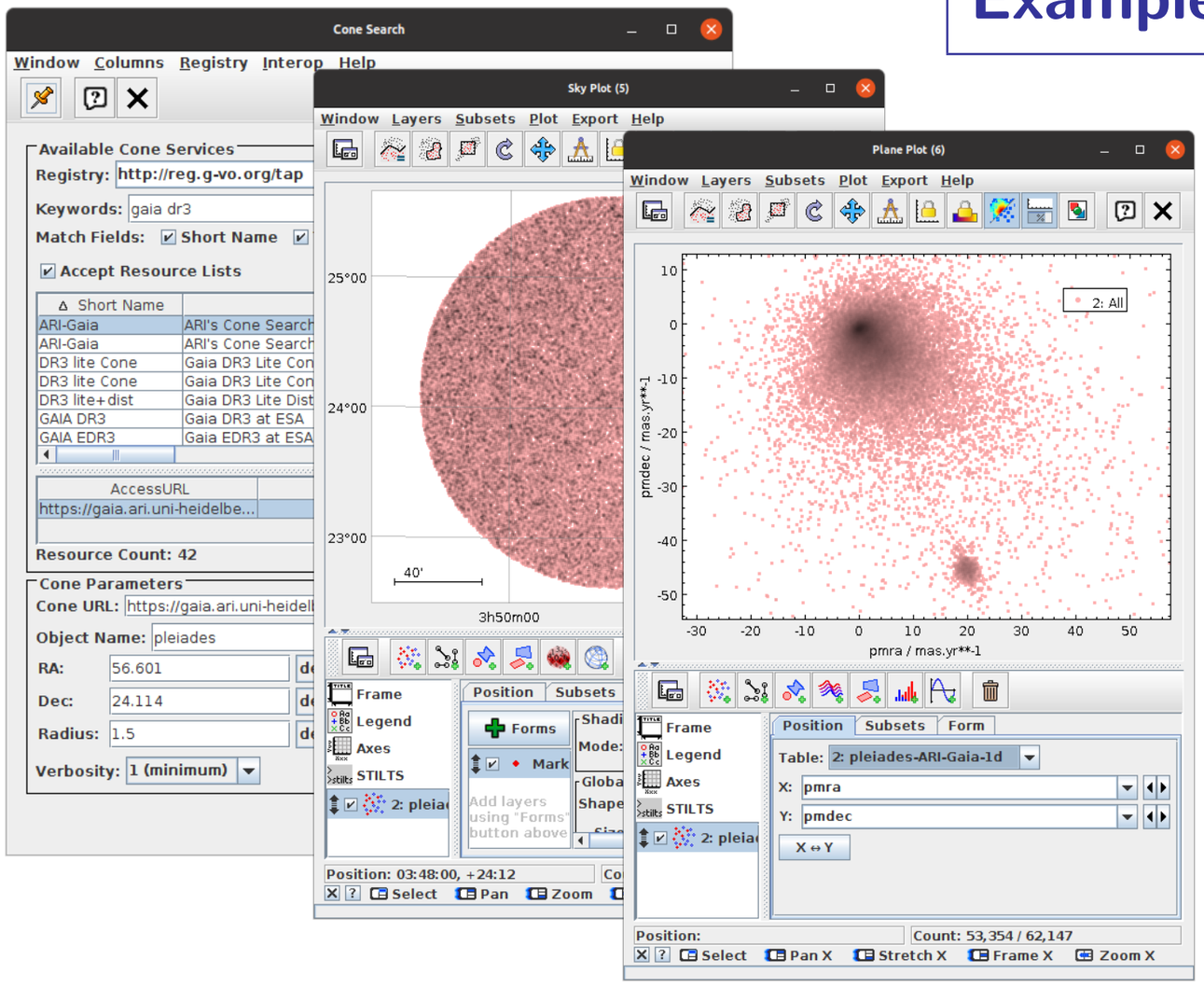
Example


Cone Search
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Plane Plot (6)
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pmra / mas.yr**-1
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Position Subsets Form
Table: 2: pleiades-ARI-Gaia-1d
X: pmra
Y: pmdec
X ↔ Y
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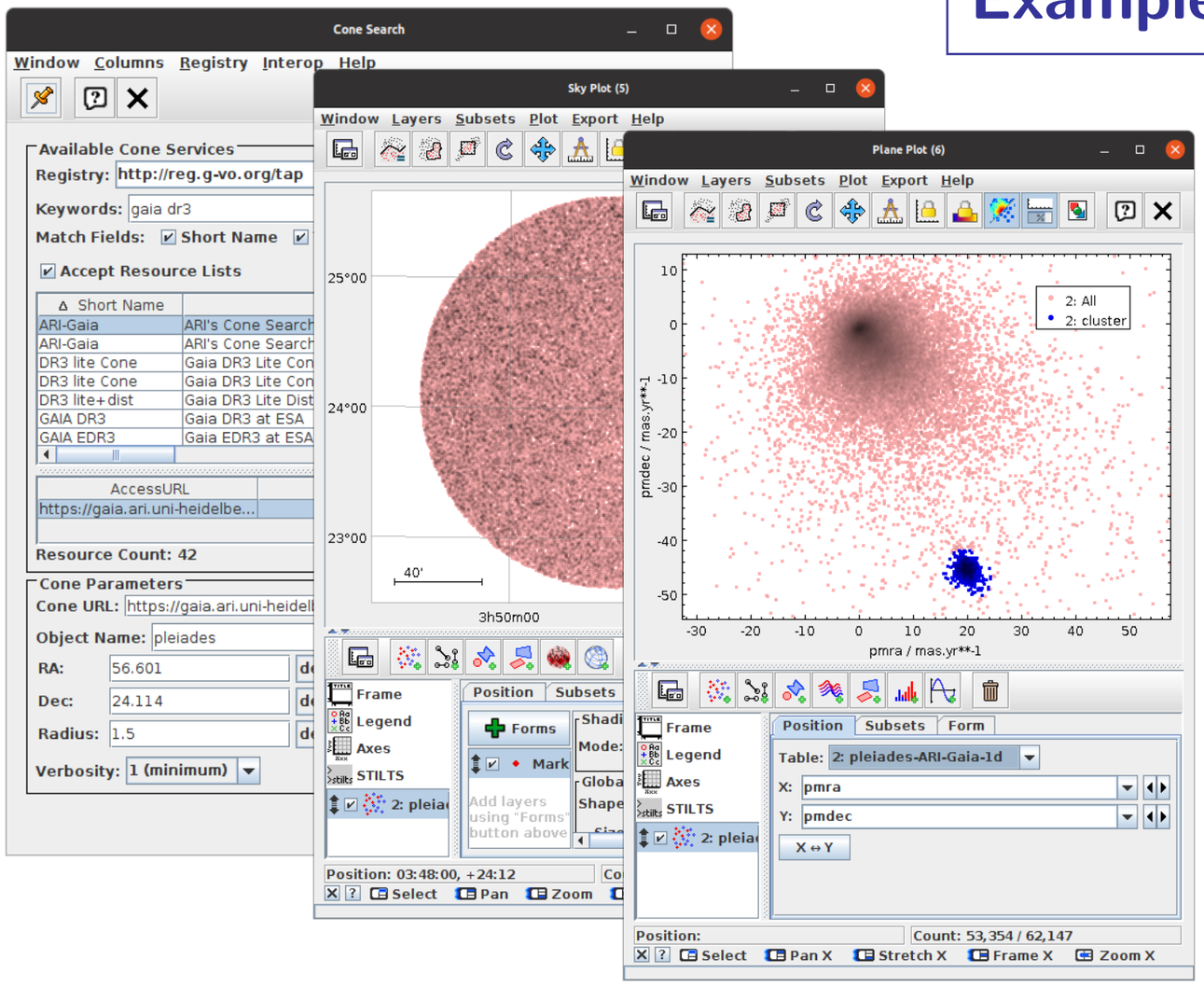
Count: 53,354 / 62,147
Select Pan X Stretch X Frame X Zoom X

Example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Axes
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Position Subsets Form
Table: 2: pleiades-ARI-Gaia-1d
X: pmra
Y: pmdec
X ↔ Y
Position:
Count: 53,354 / 62,147
Select Pan X Stretch X Frame X Zoom X

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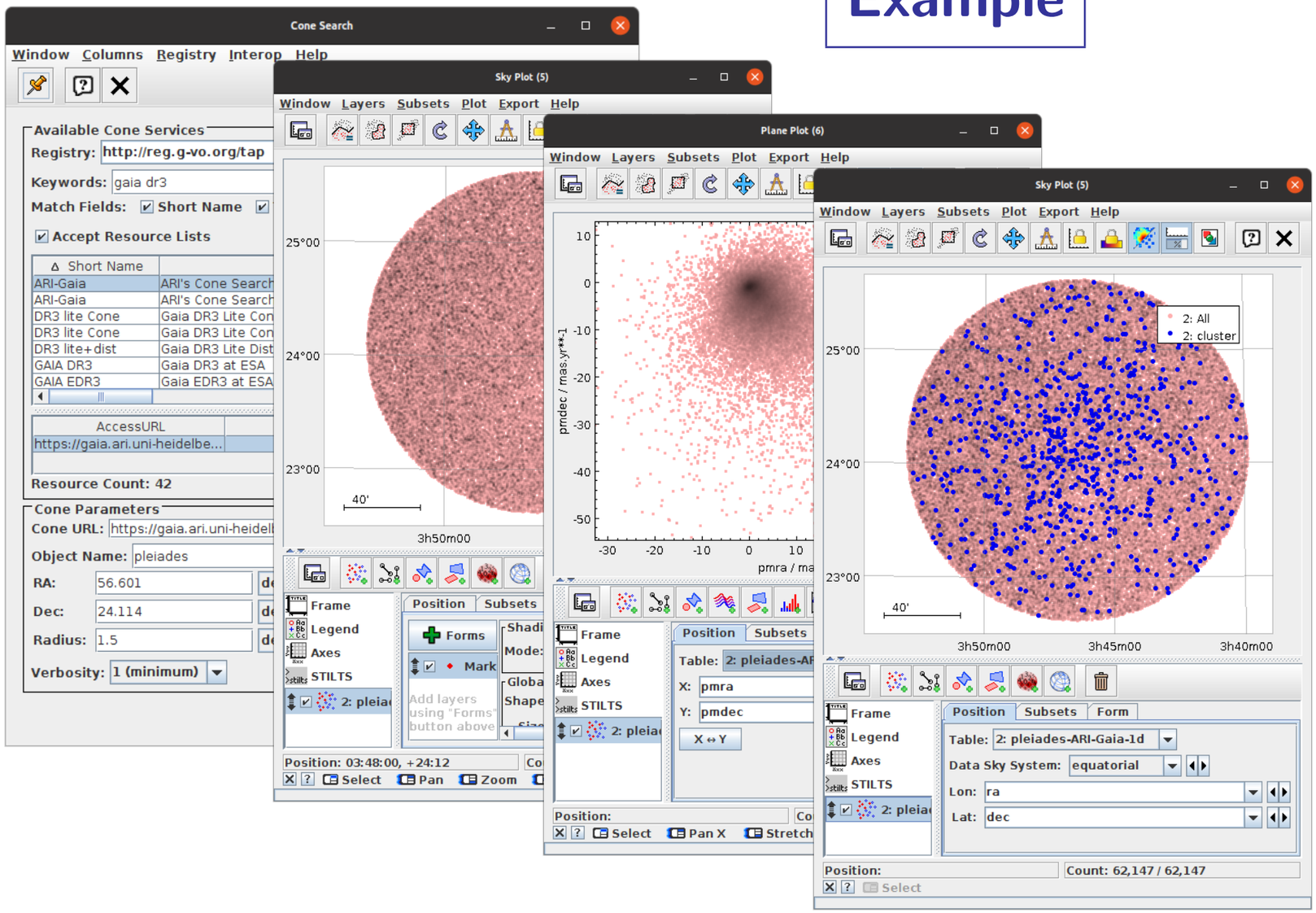
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Y: pmdec
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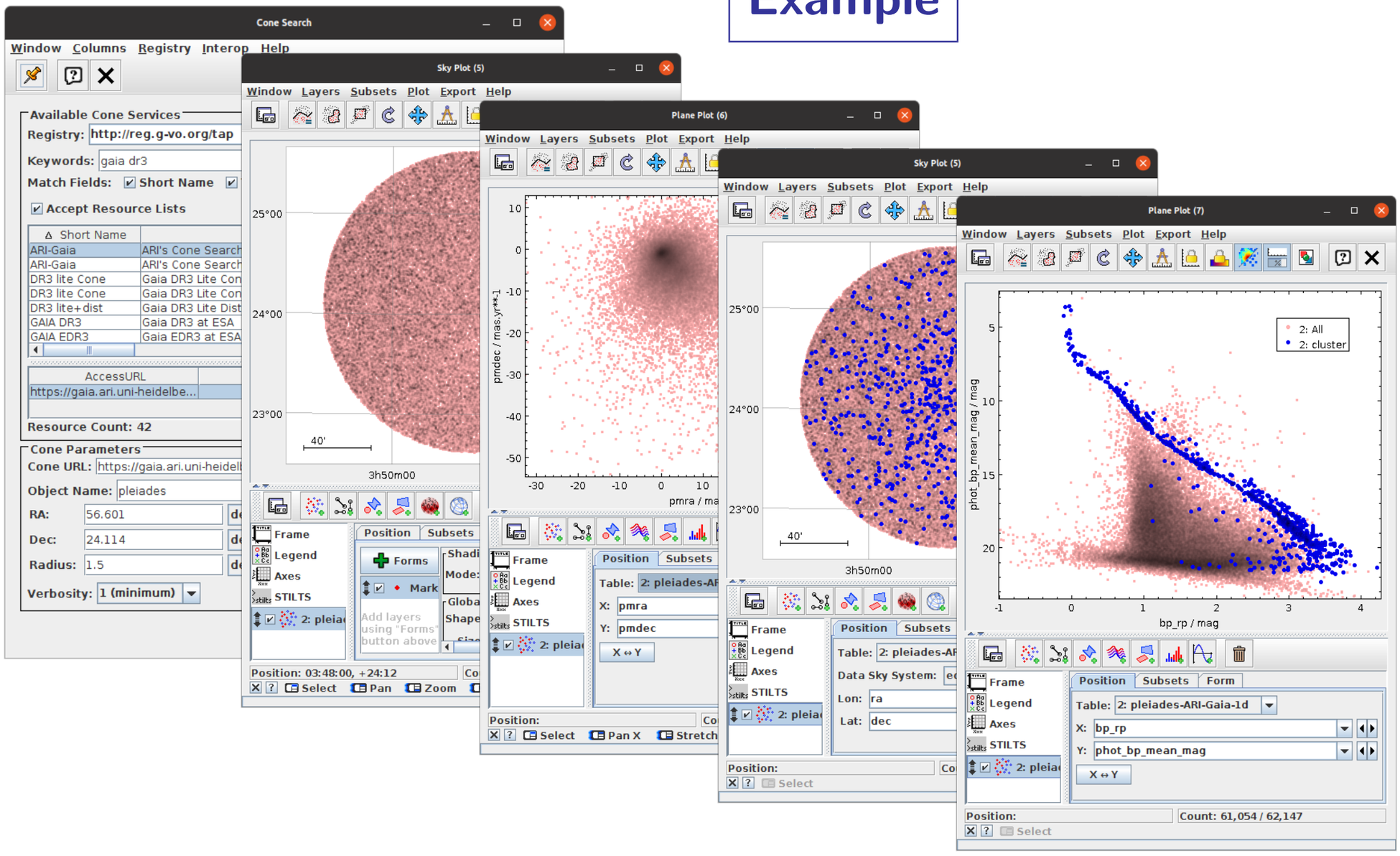
Table: 2: pleiades-ARI-Gaia-1d
Data Sky System: equatorial
Lon: ra
Lat: dec
Position:
Count: 62,147 / 62,147
Select

Example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Y: pmdec
X ↔ Y
Select Pan X Stretch
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Window Layers Subsets Plot Export Help
Data Sky System:
Lon: ra
Lat: dec
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Plane Plot (7)
Window Layers Subsets Plot Export Help
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Position Subsets Form
Table: 2: pleiades-ARI-Gaia-1d
X: bp_rp
Y: phot_bp_mean_mag
X ↔ Y
Count: 61,054 / 62,147
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Example

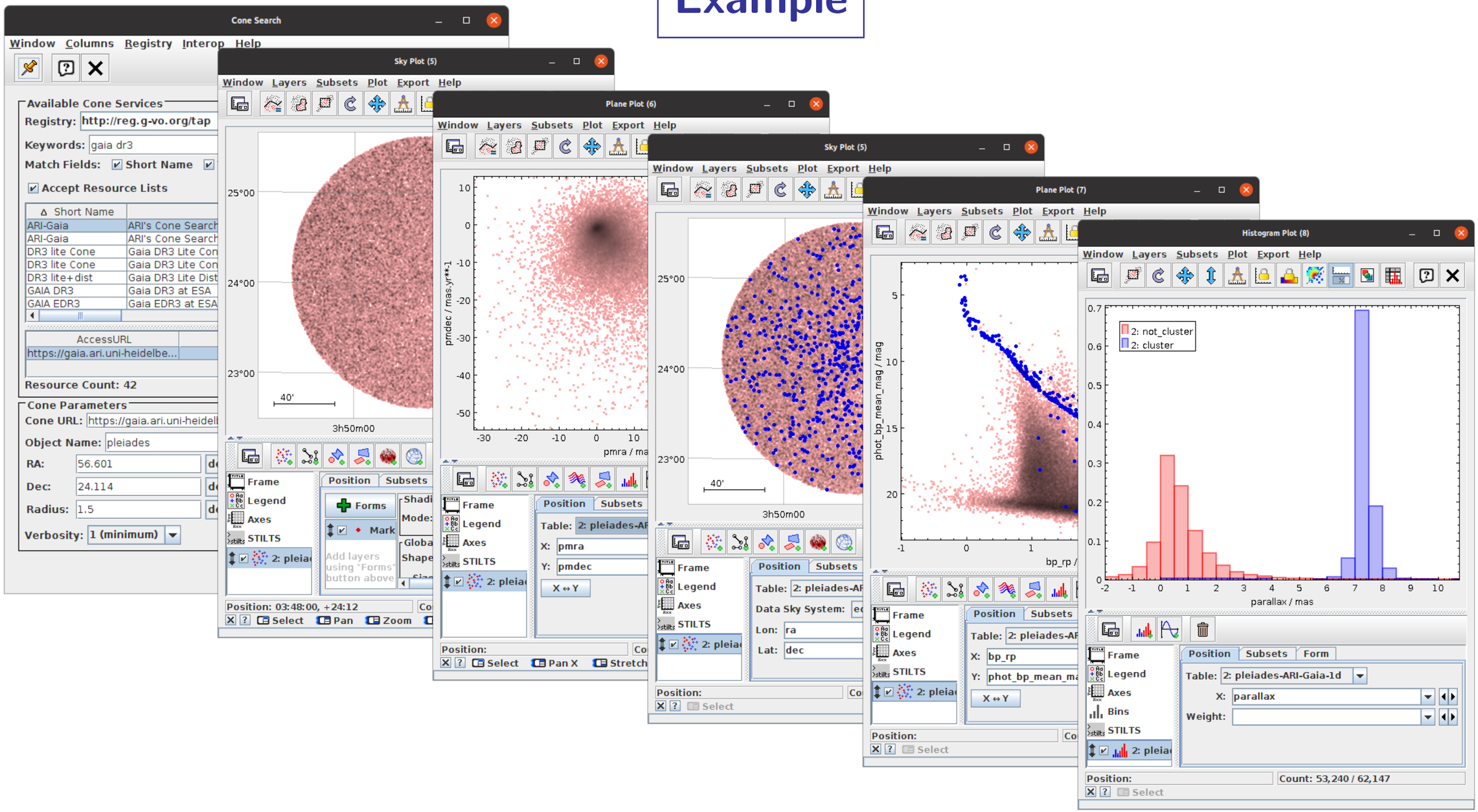
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Table: 2: pleiades-AR
X: pmra
Y: pmdec
X ↔ Y
Position:
Select Pan X Stretch
Sky Plot (5)
Window Layers Subsets Plot Export Help
Table: 2: pleiades-AR
Data Sky System:
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Plane Plot (7)
Window Layers Subsets Plot Export Help
phot_bp_mean_mag / mag
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Y: phot_bp_mean_ma
Histogram Plot (8)
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2: not_cluster
2: cluster
parallax / mas
Position Subsets Form
Table: 2: pleiades-ARI-Gaia-1d
X: parallax
Weight:
Count: 53,240 / 62,147

Why HAPI in TOPCAT?

Reasons to implement HAPI client in TOPCAT

- TOPCAT likes getting astro-like data from remote services
- Time series are a kind of table
  - ▷ There is already some limited time series functionality in TOPCAT
- Heliophysics is a neighbouring discipline to astronomy
  - ▷ There may be some overlap of users
- IVOA may adopt/recommend HAPI for time series data
  - ▷ Baptiste Cecconi talk in Tucson Nov 2023
- HAPI looked like a nice clean standard to implement

Will people use HAPI in TOPCAT?

- I don't know ...
- ... I am **not** expecting heliophysics users to ditch Autoplot for TOPCAT
- TOPCAT may offer some relevant features not available from other HAPI tools?
  - ▷ 3D plots, large datasets, format conversions, linked views, column calculations, ...
- It might help IVOA to work with HAPI?

Opening TOPCAT HAPI Window

Download and run TOPCAT from http://www.starlink.ac.uk/topcat

- e.g. `curl -OL http://www.starlink.ac.uk/topcat/topcat-full.jar; java -jar topcat-full.jar`
- v4.9-1 or later required (29 Feb 2024)

Select **HAPI** toolbar button in **Load Window**

- there are other ways - e.g. search for "HAPI" in Help browser

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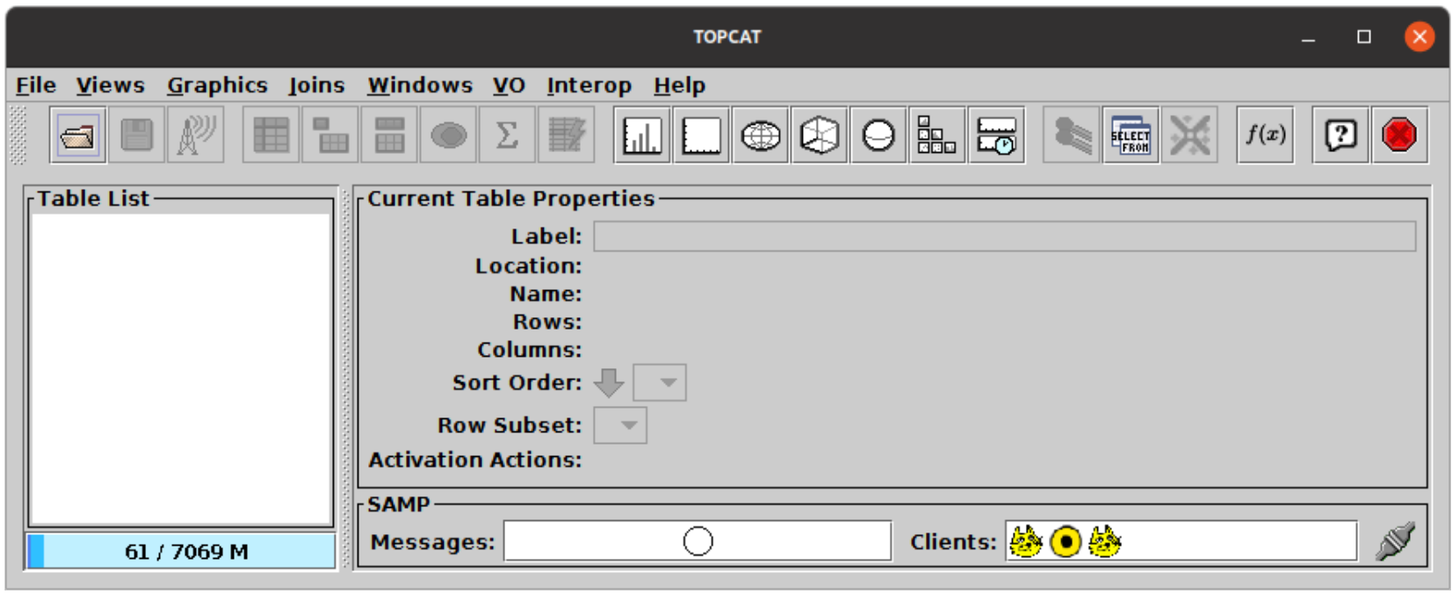

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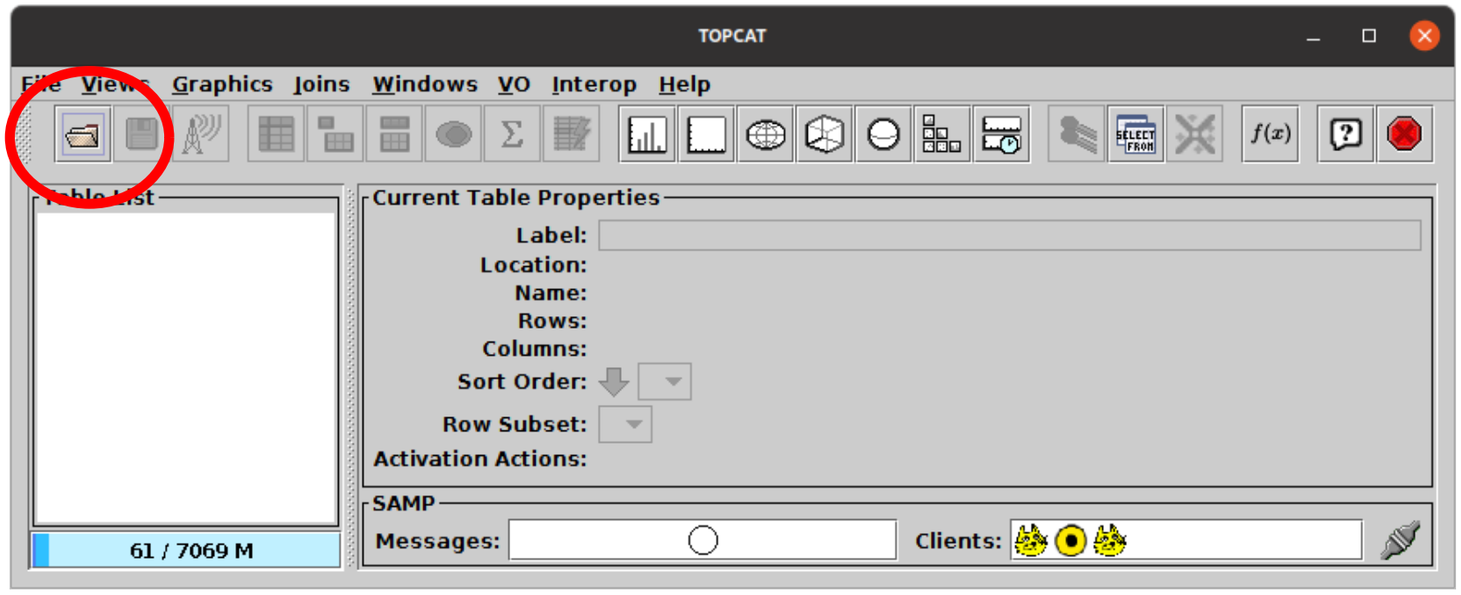

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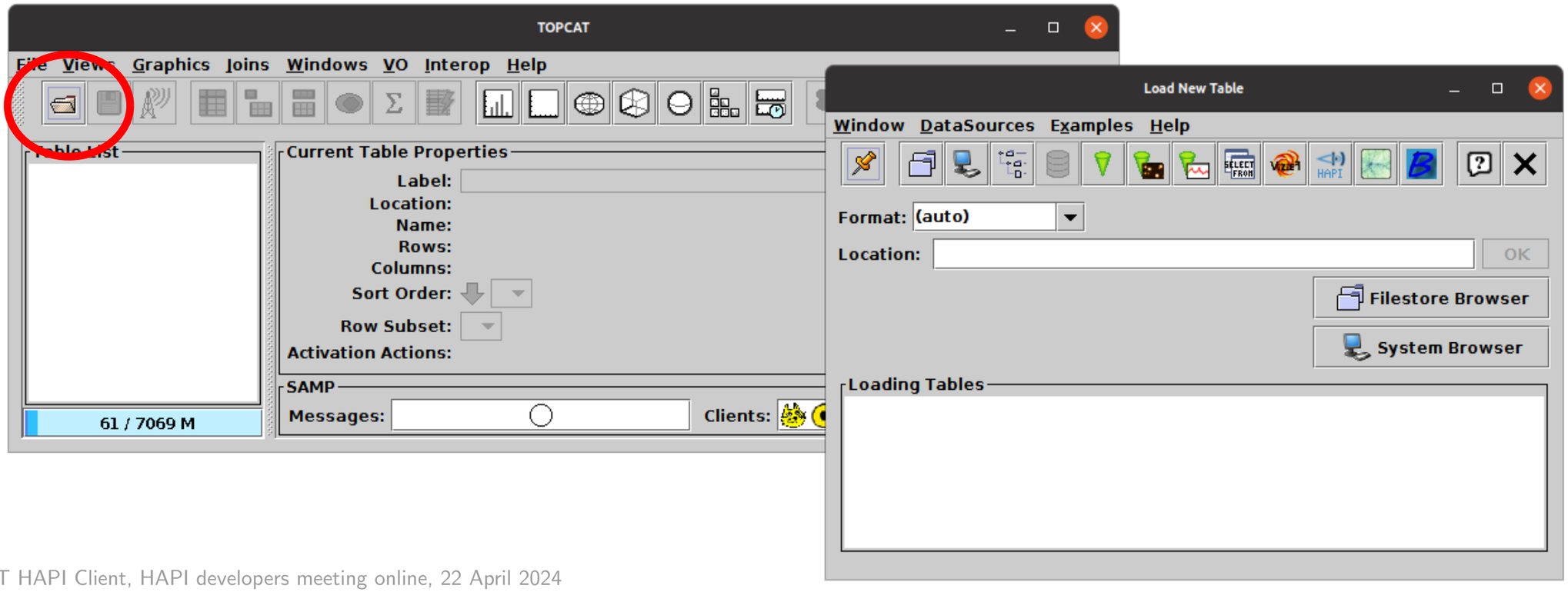

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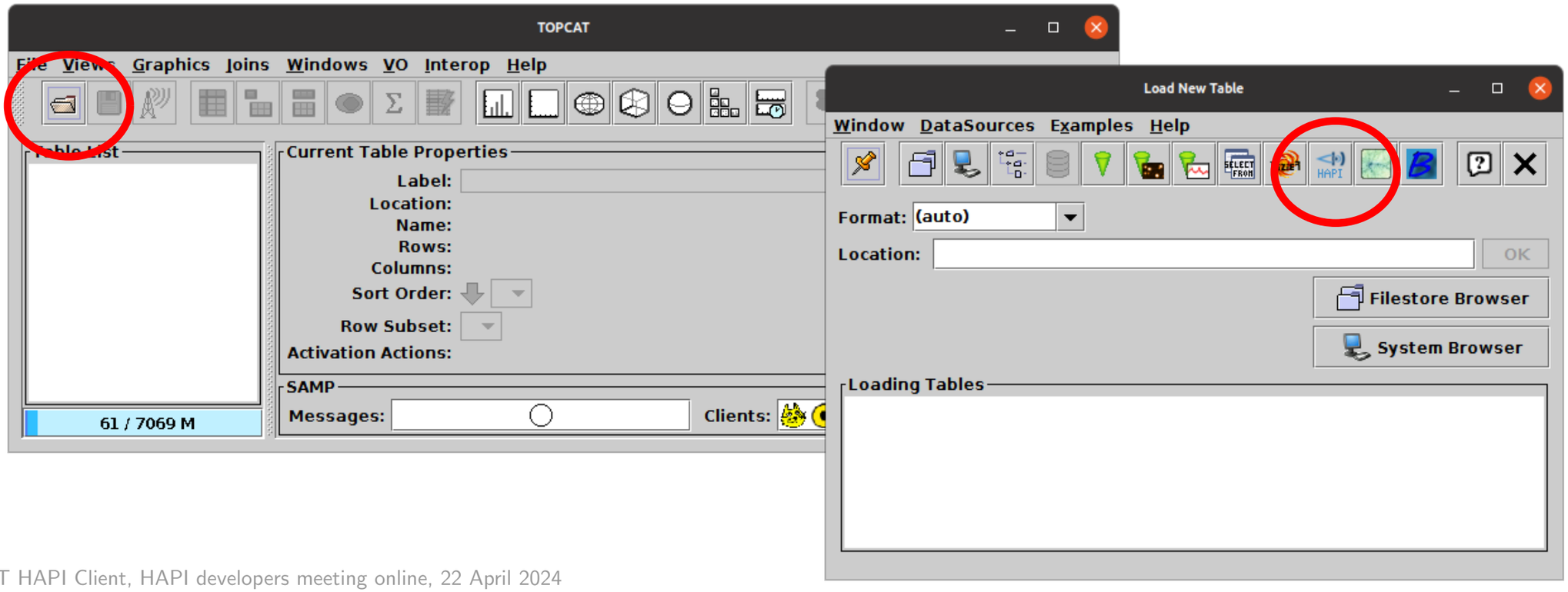


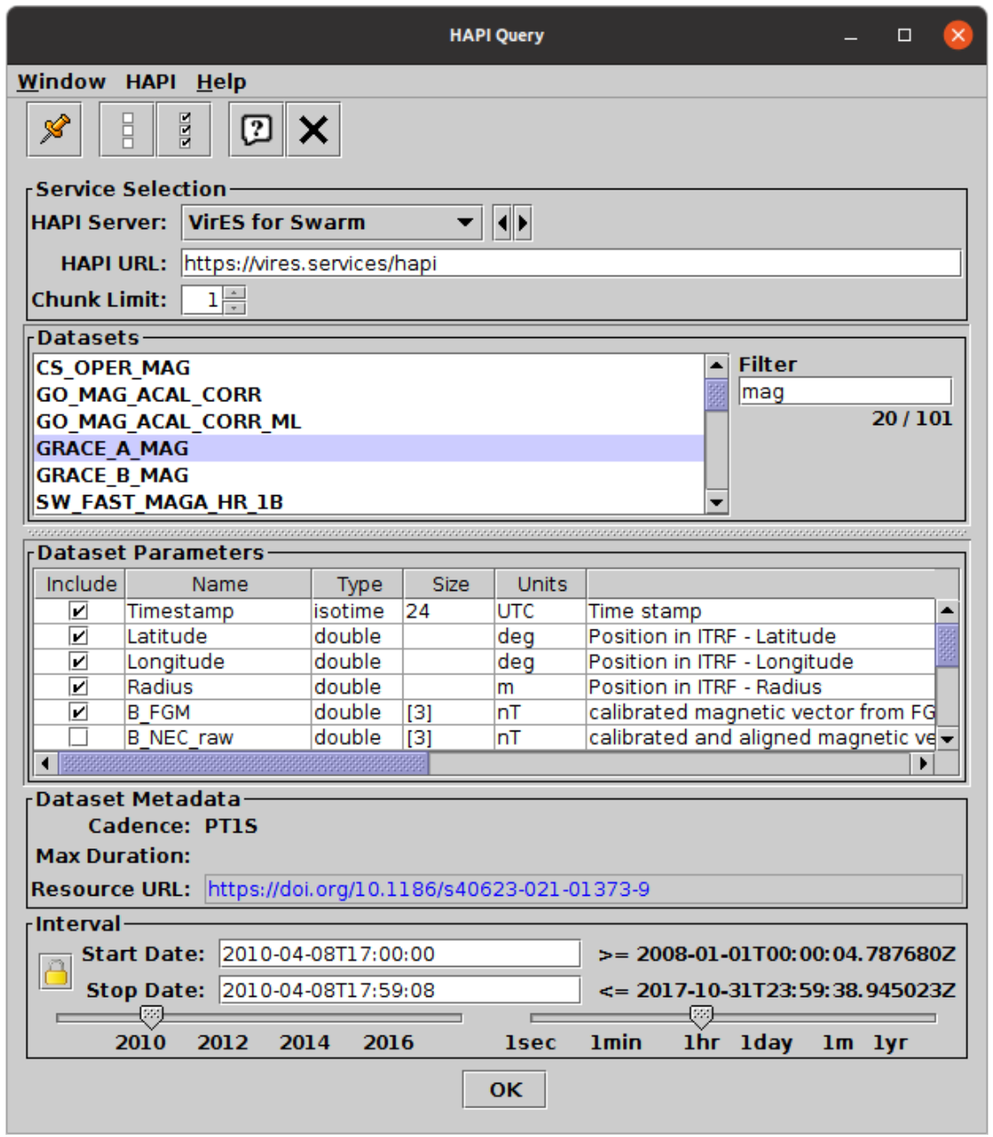
Querying HAPI in TOPCAT

Make HAPI query

- Open HAPI window
  - ▷ Server list downloaded from https://github.com/hapi-server/servers
- Select server from list
  - ▷ Capabilities and Catalog downloaded from server
- Select dataset (browse or search list)
  - ▷ Dataset info downloaded from server
- Select/restrict parameters with checkboxes (also Select/Deselect All)
- Choose date range using Start/Stop fields or Start/Duration sliders
- Optionally adjust **Chunk Limit** for large samples
- Hit **OK** and wait for download

Use data

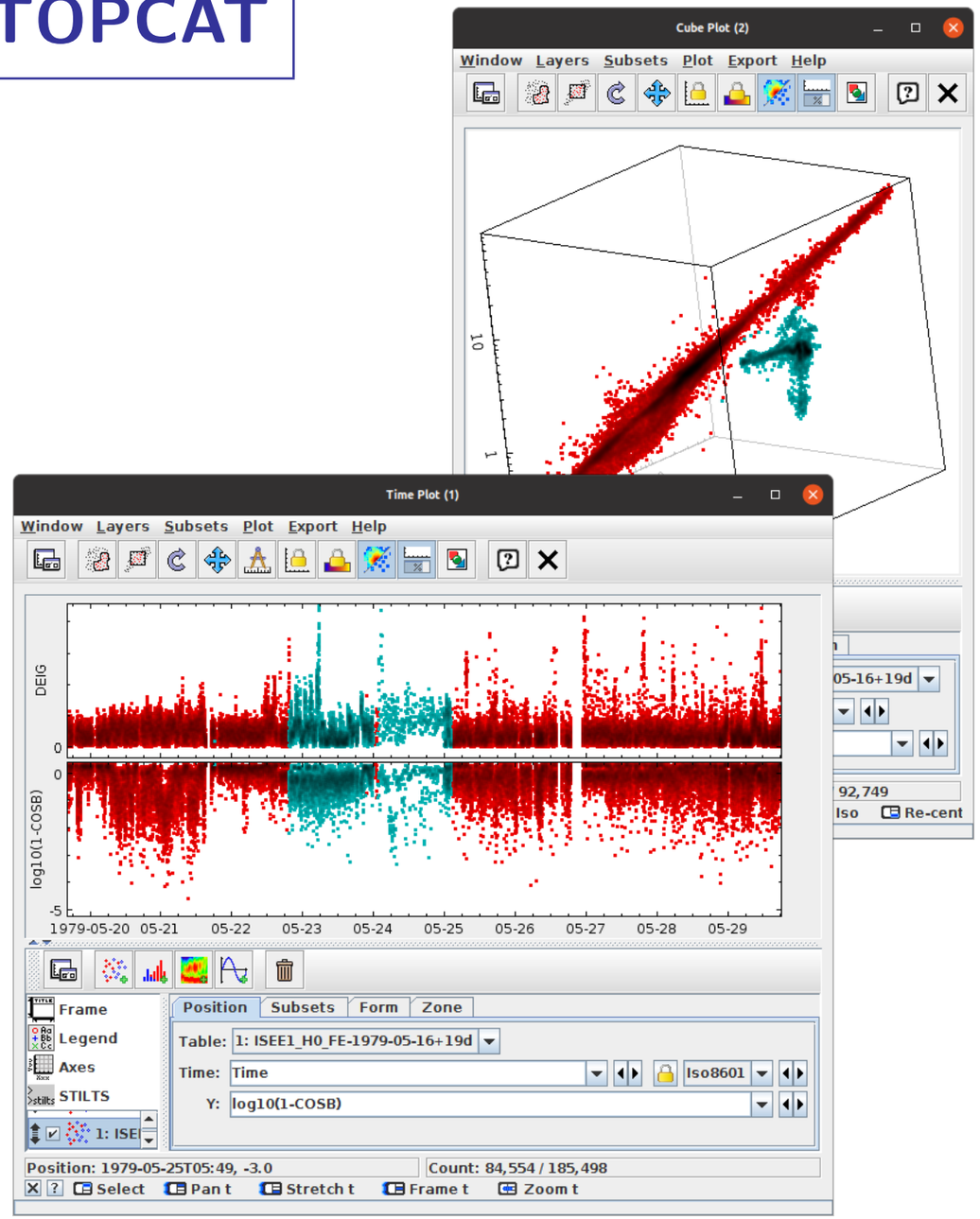
- Table loaded into TOPCAT: plot, save, edit, analyse, ...



Using HAPI Data in TOPCAT

Things you can do with HAPI data in TOPCAT:

- Plot dots/lines vs. time
- Plot spectrograms vs. time
- Stack time plots vertically (different params/datasets)
- Non-time plots (3D, Sky/sphere, Corner, histogram; lots of options)
- Interactive pan/zoom on multi-million row datasets
- Column calculations (very flexible)
- Statistical calculations
- Select regions of interest (linked plots)
- Save/export data in different formats (FITS, [E]CSV, VOTable, ...)
- Exchange data using SAMP



HAPI Implementation

Code

- Coded from scratch in Java: javadocs, source code
- Parser ∼4 000 lines, GUI ∼2 000 lines
- ∼2.5 weeks work

Experience

- Standard (v3.1.0) generally clear and nice to work from
  - ▷ Only a few minor typos/broken links/inconsistencies
- Request size limiting took a bit of getting used to
  - ▷ Equivalent functionality in VO always returns rows but may truncate (with overflow indicator)
- Some services didn't behave as expected (fixed now?)
- Jeremy Faden has been very helpful!

Any feedback welcome!