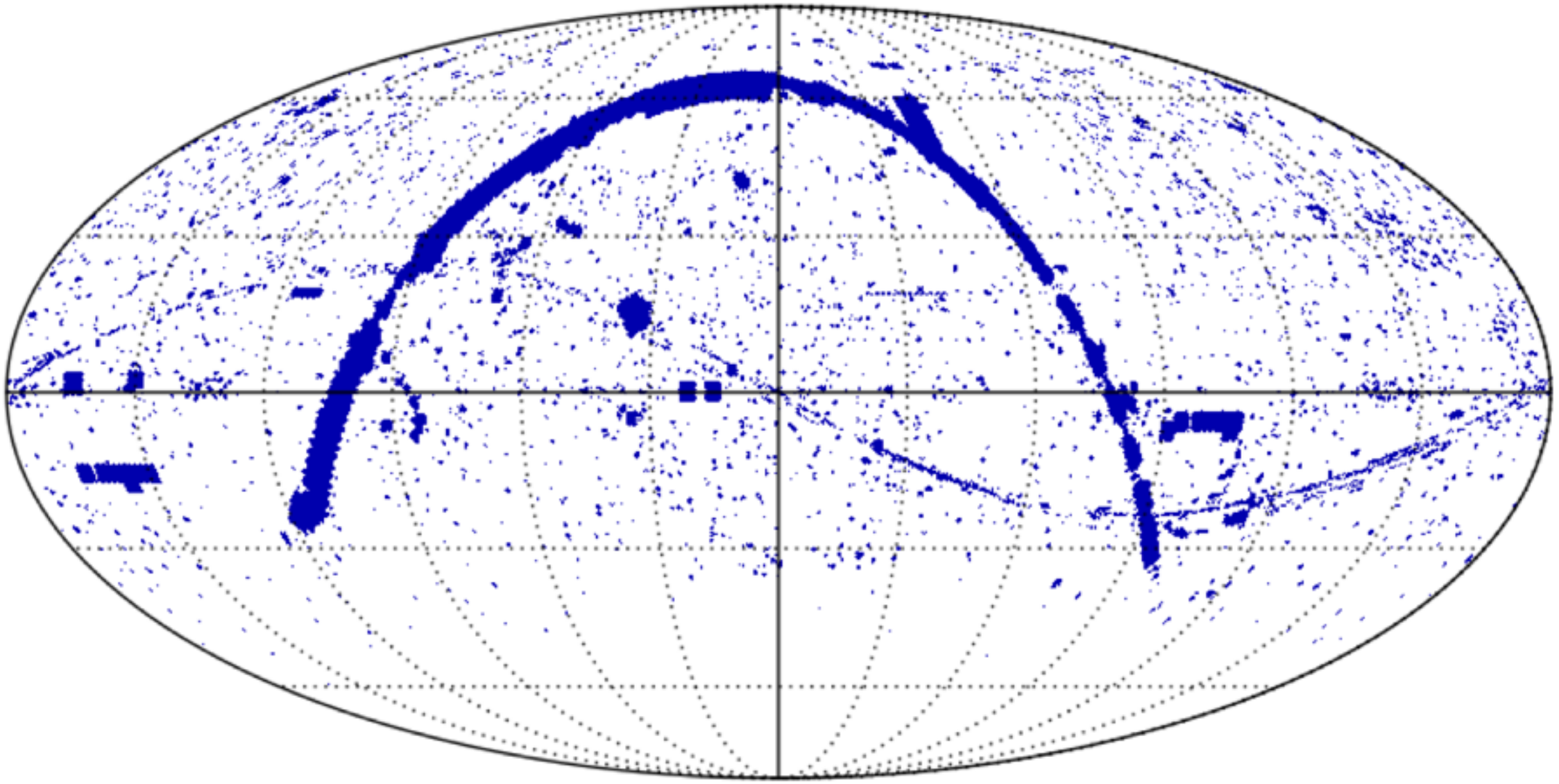
ADVANCED TOPICS FOR JCMT DATA

JCMT SCIENCE ARCHIVE



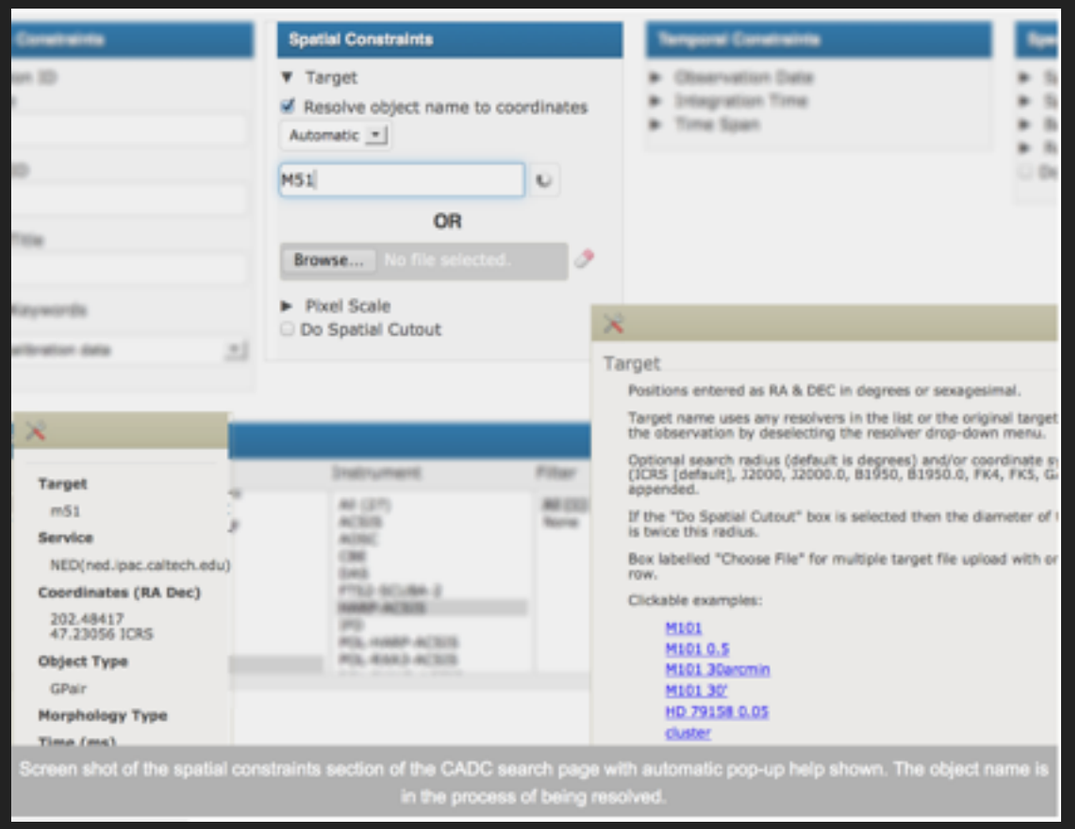
All areas of the sky observed by SCUBA-2 on the JCMT. This includes legacy survey fields as well as publicly available data (as of 2014).

JCMT SCIENCE ARCHIVE: PUBLIC DATA

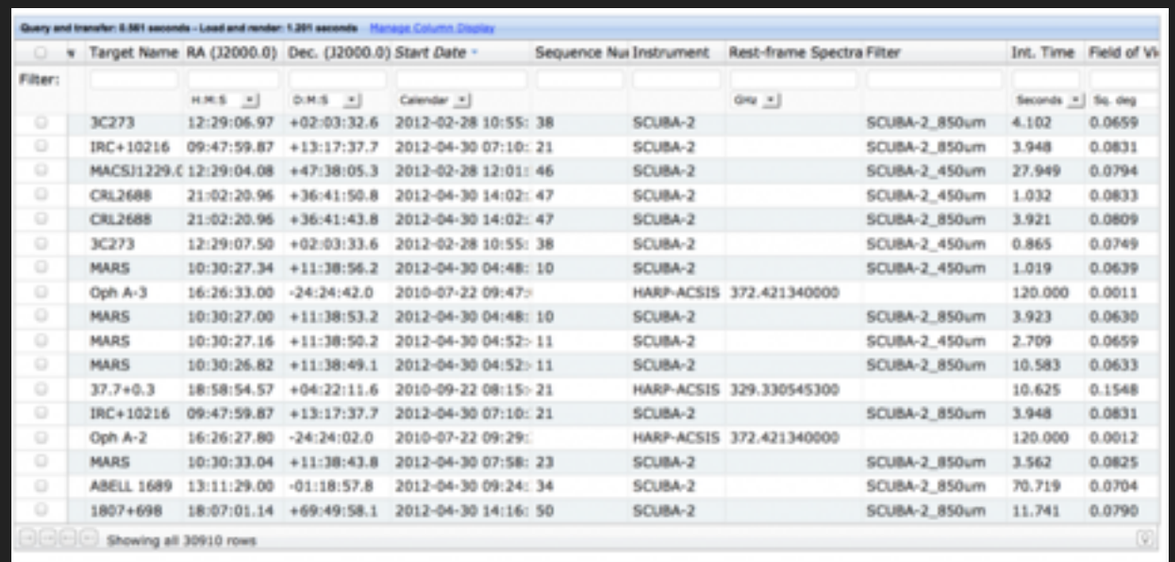
- JSA is the home for all JCMT data, both proprietary and public.
- http://www.cadc-ccda.hia-iha.nrc-cnrc.gc.ca/en/search/
- Available: raw and reduced observations, and nightly coadds.
- Lots of public data: JCMT science observations (usually) become public a year after the end of the semester in which it was taken.
- All JAC/STFC era observations are now public!
- Archival data: do science without having to write a proposal!
- Archival data was recently all re-reduced with current pipelines: high quality products!
- JCMT Legacy Release 1 was on Sep 2015 – see Monday's talk, or JCMT web site.

JSA: HOW TO SEARCH

- Use collection=JCMT to search only JCMT telescope data sets.
- Project search parameters: PI, project ID, project title
- Observation search parameters: source/position, frequency, date
- Telescope specific options: instrument, observation type,
- Other JCMT collections: JCMTLS does/ will contain data products produced by legacy surveys/large programs.



Screen shot of the spatial constraints section of the CADC search page with automatic pop-up help shown. The object name is in the process of being resolved.



Target Name	RA (J2000.0)	Dec. (J2000.0)	Start Date	Sequence Nu	Instrument	Rest-frame Spectra	Filter	Int. Time	Field of Vi
Filter:									
	H:M:S	D:M:S	Calendar			GHz		Seconds	Sq. deg
3C273	12:29:06.97	+02:03:32.6	2012-02-28 10:55:	38	SCUBA-2		SCUBA-2_850um	4.102	0.0659
IRC+10216	09:47:59.87	+13:17:37.7	2012-04-30 07:10:	21	SCUBA-2		SCUBA-2_850um	3.948	0.0831
MACSJ1229.(	12:29:04.08	+47:38:05.3	2012-02-28 12:01:	46	SCUBA-2		SCUBA-2_450um	27.949	0.0794
CRL2688	21:02:20.96	+36:41:50.8	2012-04-30 14:02:	47	SCUBA-2		SCUBA-2_450um	1.032	0.0833
CRL2688	21:02:20.96	+36:41:43.8	2012-04-30 14:02:	47	SCUBA-2		SCUBA-2_850um	3.921	0.0809
3C273	12:29:07.50	+02:03:33.6	2012-02-28 10:55:	38	SCUBA-2		SCUBA-2_450um	0.865	0.0749
MARS	10:30:27.34	+11:38:56.2	2012-04-30 04:48:	10	SCUBA-2		SCUBA-2_450um	1.019	0.0639
Oph A-3	16:26:33.00	-24:24:42.0	2010-07-22 09:47:		HARP-ACSIS	372.421340000		120.000	0.0011
MARS	10:30:27.00	+11:38:53.2	2012-04-30 04:48:	10	SCUBA-2		SCUBA-2_850um	3.923	0.0630
MARS	10:30:27.16	+11:38:50.2	2012-04-30 04:52:	11	SCUBA-2		SCUBA-2_450um	2.709	0.0659
MARS	10:30:26.82	+11:38:49.1	2012-04-30 04:52:	11	SCUBA-2		SCUBA-2_850um	10.583	0.0633
37.7+0.3	18:58:54.57	+04:22:11.6	2010-09-22 08:15:	21	HARP-ACSIS	329.330545300		10.625	0.1548
IRC+10216	09:47:59.87	+13:17:37.7	2012-04-30 07:10:	21	SCUBA-2		SCUBA-2_850um	3.948	0.0831
Oph A-2	16:26:27.80	-24:24:02.0	2010-07-22 09:29:		HARP-ACSIS	372.421340000		120.000	0.0012
MARS	10:30:33.04	+11:38:43.8	2012-04-30 07:58:	23	SCUBA-2		SCUBA-2_850um	3.562	0.0825
ABELL 1689	13:11:29.00	-01:18:57.8	2012-04-30 09:24:	34	SCUBA-2		SCUBA-2_850um	70.719	0.0704
1807+698	18:07:01.14	+69:49:58.1	2012-04-30 14:16:	50	SCUBA-2		SCUBA-2_850um	11.741	0.0790

Showing all 30910 rows

A screen shot of the CADC results pane, showing results for both SCUBA-2 and HARP-ACSIS. There are more columns that cannot be seen without scrolling to the right.

JSA: HOW TO TELL IF THE DATA ARE USEFUL?

- Look at the preview images! These are taken from the reduced data, and should give a first impression of how useful the data are.
- Data marked as ‘BAD/QUESTIONABLE’ in the OMP will have a flag of ‘FAIL’ in the ‘requirements’ column: avoid or use with caution.
- JUNK data is not by default visible through Advanced Search.
- Download and have a look! (NB: Reduced SCUBA-2 data is much smaller in size than the raw data.)
- If in any doubt, always ask EAO for advice: jsa-help@eaobservatory.org, s.graves@eaobservatory.org, or helpdesk@eaobservatory.org

VO-SPACE AND CANFAR

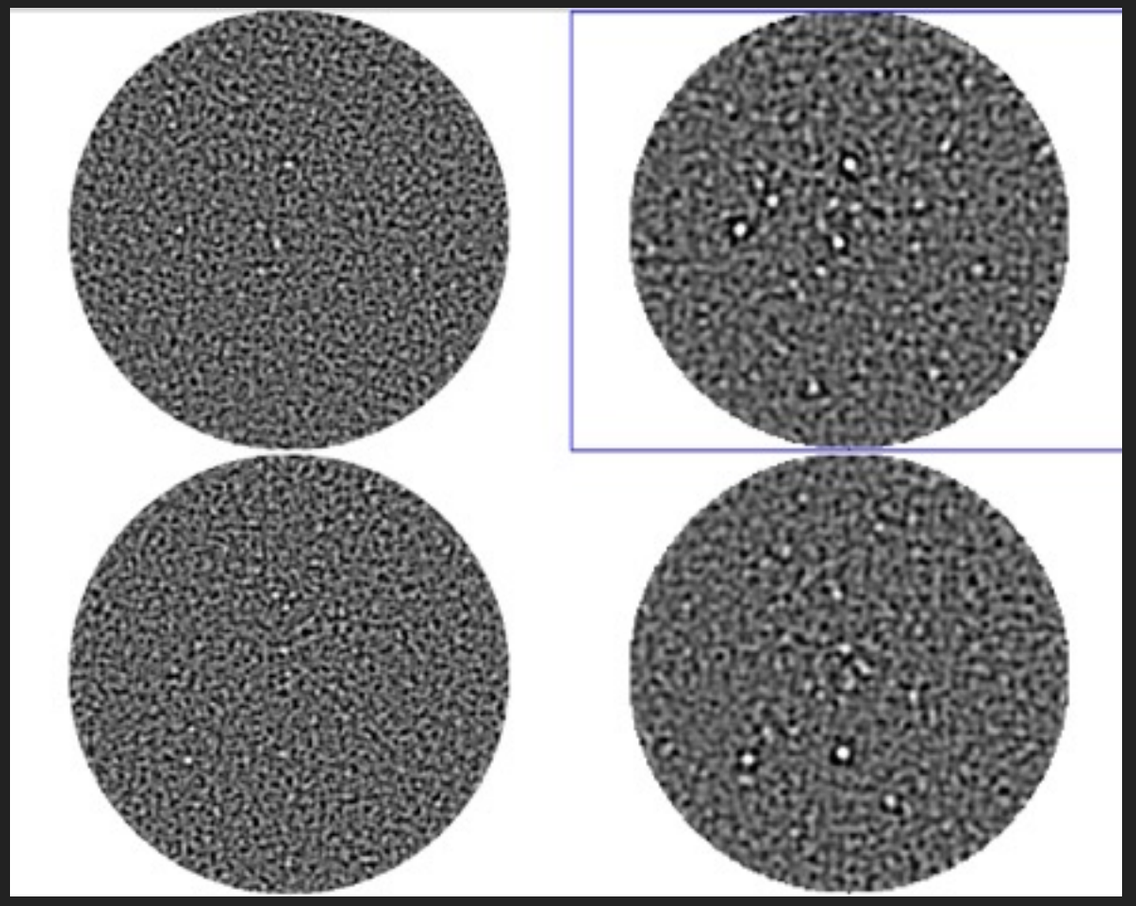
- VOspace: great way of sharing JCMT data sets with your collaborators. Uses CADC names that you already have! Already extensively used by previous Legacy Surveys.
- CANFAR: powerful computation resources available for astronomical research, integrated with VO space and archive.
- See JJ for more information!
- If you want to get started but need help, or are having problems, you can always ask EAO staff, as well as CADC directly.

ADVANCED TOPICS FOR JCMT DATA

MATCHED FILTERS

MATCHED FILTERS

- Wavelet analysis used for optimal point source extraction.
- Requires PSF of the telescope/ instrument to be known (see Dempsey+ 2013)
- Some subtleties in recovered source brightness – careful analysis required.
- See Cayón, L. et al., 2000, Isotropic wavelets: a powerful tool to extract point sources from cosmic microwave background maps, MNRAS, 315, 757



MATCHED FILTERS IN ORAC-DR AND PICARD

- Some ORAC-DR recipes will automatically apply a matched filter to the group co-add product (but not to the individual observation reductions):
  - REDUCE_SCAN_FAINT_POINT_SOURCES
- There is also a PICARD recipe to apply a filter to any reduced SCUBA-2 map:
  - SCUBA2_MATCHED_FILTER
- Summary of method as implemented in ORAC-DR and PICARD:
  1. Smooth the map and the PSF (by default with a 30” Gaussian).
  2. Subtract smoothed images from originals.
  3. Convolve residuals.

MATCHED FILTER TUTORIAL

- An example tutorial showing you how to run the PICARD recipe on a pipeline-reduced file is available.
- (The example observation used for the tutorial is not the most exciting example).
- If you are interested, please also try running the ORAC-DR recipe `REDUCE_SCAN_FAINT_POINT_SOURCES` on raw data containing point sources.

ADVANCED TOPICS FOR JCMT DATA

EXTERNAL MASKS

EXTERNAL AST MASK

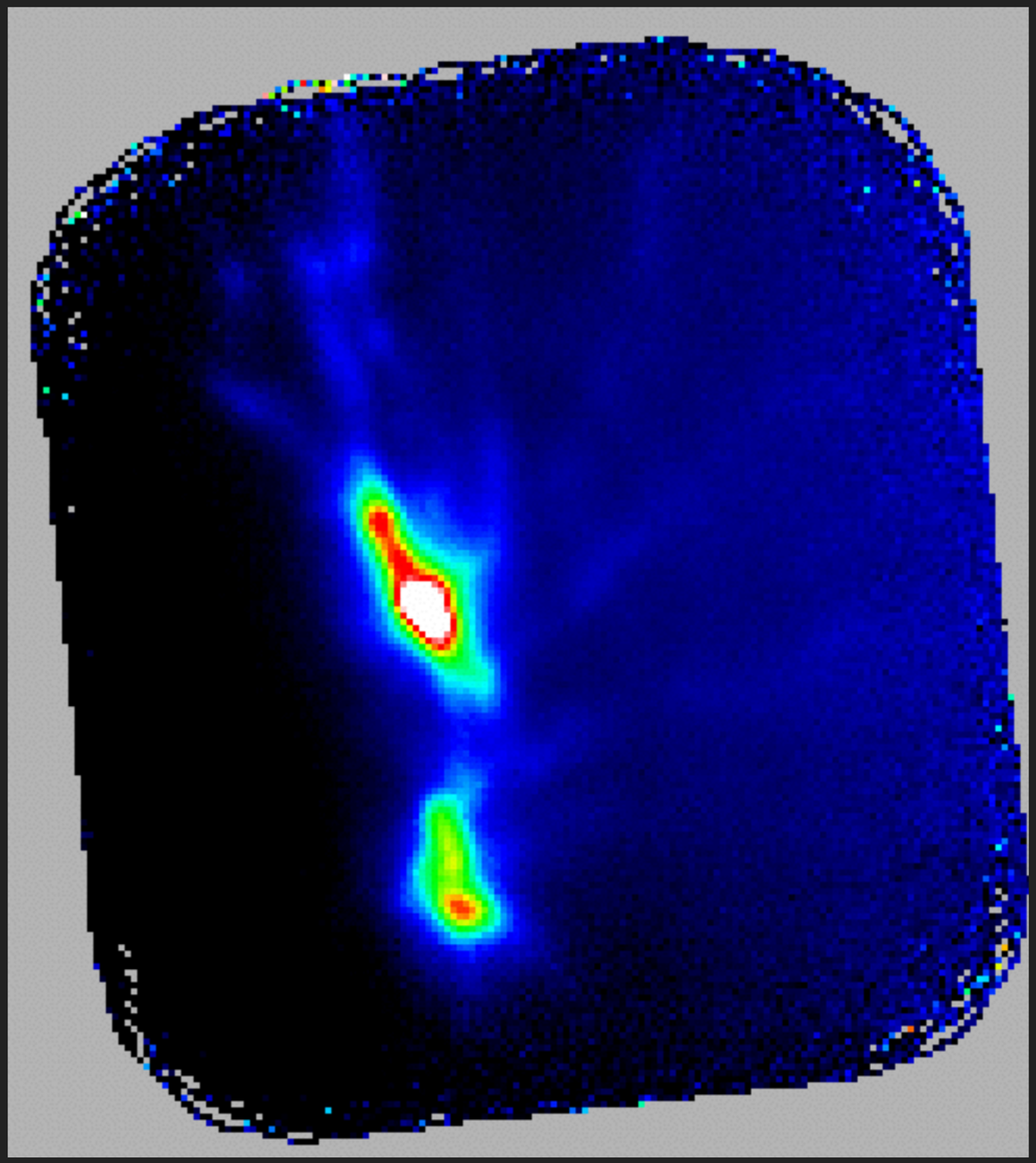
- makemap functions by attempting to iteratively divide bolometer input into different models. (COM, FLT, AST, RES)
- There is degeneracy between the common mode (COM) and the astronomical signal (AST),
- This can produce fake large scale structure across the output map.
- Most of the standard makemap configs automatically derive an AST mask in each iteration, and then force the AST model to 0 outside this mask at the end of each iteration.

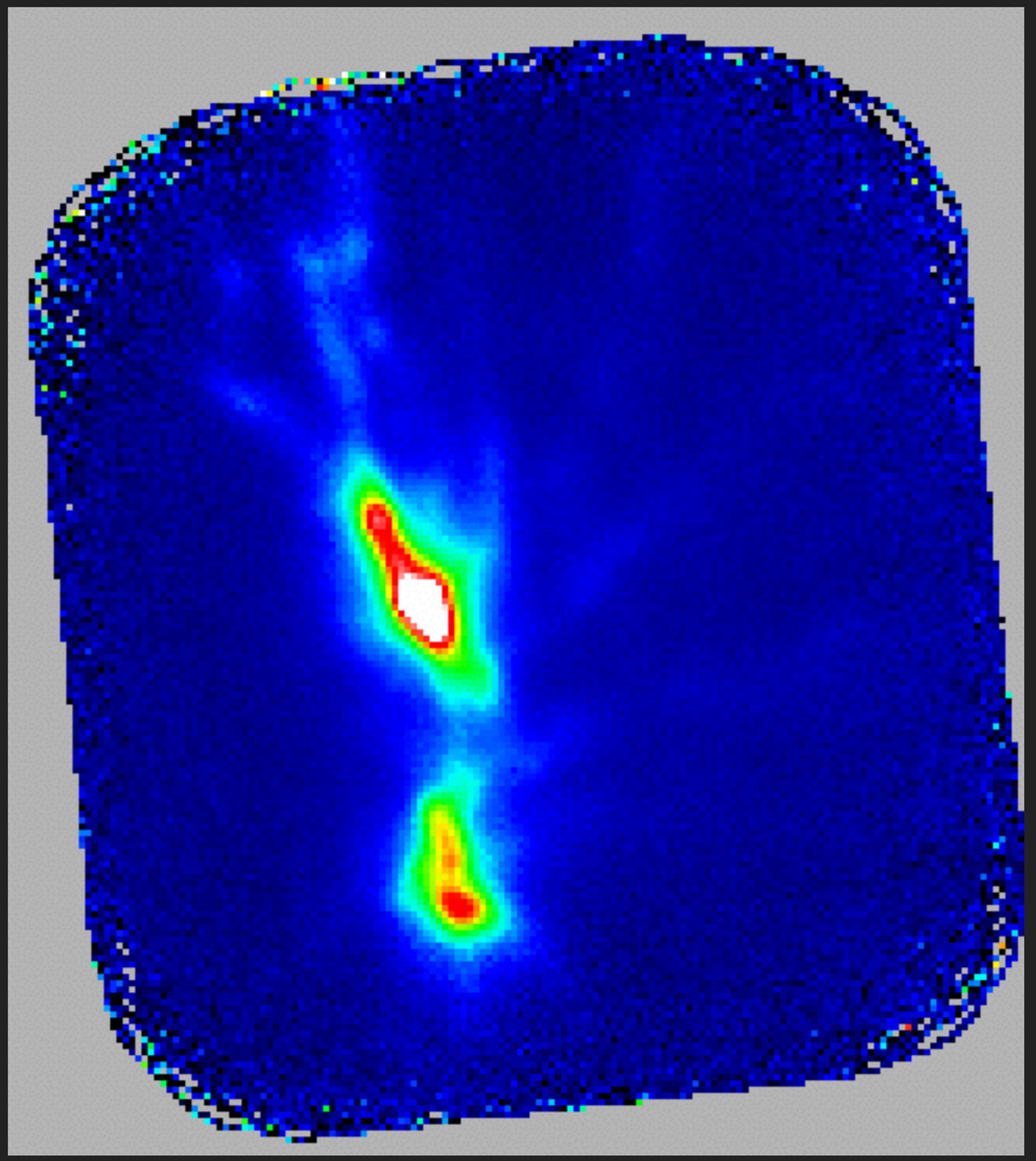
EXTERNAL AST MASKS

- If you already know where the emission will be, you can instead provide an external AST mask to constrain the solution. This can improve your final map.
- You can use either the results of an initial round of SCUBA-2 DR (and mosaicing), or with caution you can use a map from another telescope.
- It is particularly helpful for reducing negative bowling and background structures.
- Usually used when trying to recover as much large scale structure as possible.

MASKING CONSIDERATIONS

- Masking (whether auto-masking or through an external mask) affects the resulting map.
- Source recovery, particularly of extended sources, varies inside and outside the masked region.
- See Mairs+2015 for a detailed comparison of source recovery between two different SCUBA-2 makemap approaches. (comparing GBS with JCMT LR1)
- Identifying masked regions: Examine the quality array of the map, either with GAIA or KAPPA to see where the FLT and AST masks are.
  - See article on the Pipelines and Archives blog: http://pipelinesandarchives.blogspot.jp/2014/06/interpreting-scuba-2-map-quality-arrays.html





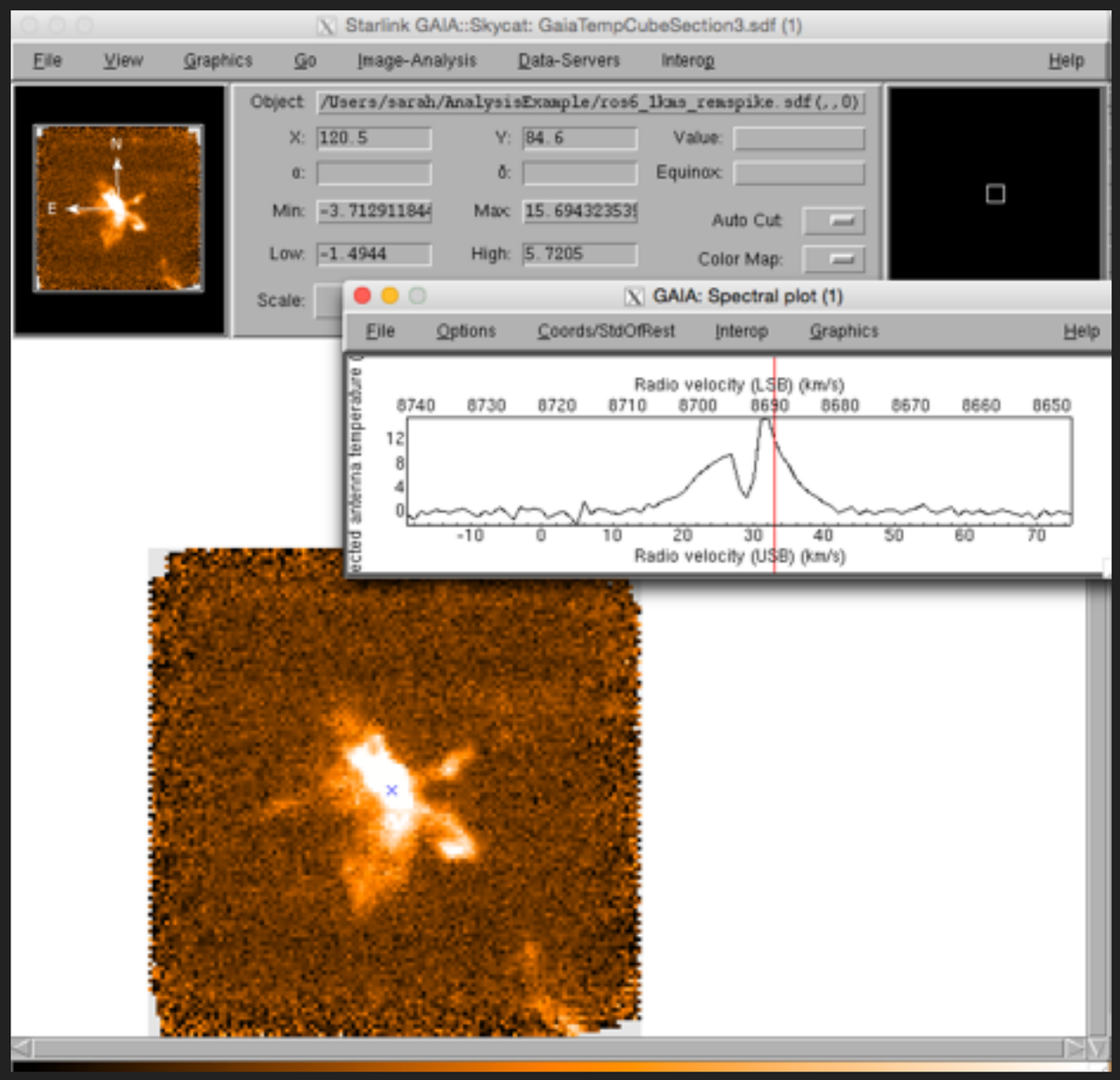
EXTERNAL MASKING: TUTORIAL

- A tutorial guiding you through how to perform external masking has been provided.
- The small example data set we have is not ideal for demonstrating this, but should work on a laptop and allow you to see the method.
- If you are interested, please download a PONG map with complex structure from the archive and try this at home!
- Documentation: see SC/21 section 6.6.

EXAMPLE HETERODYNE ANALYSIS WITH GAIA

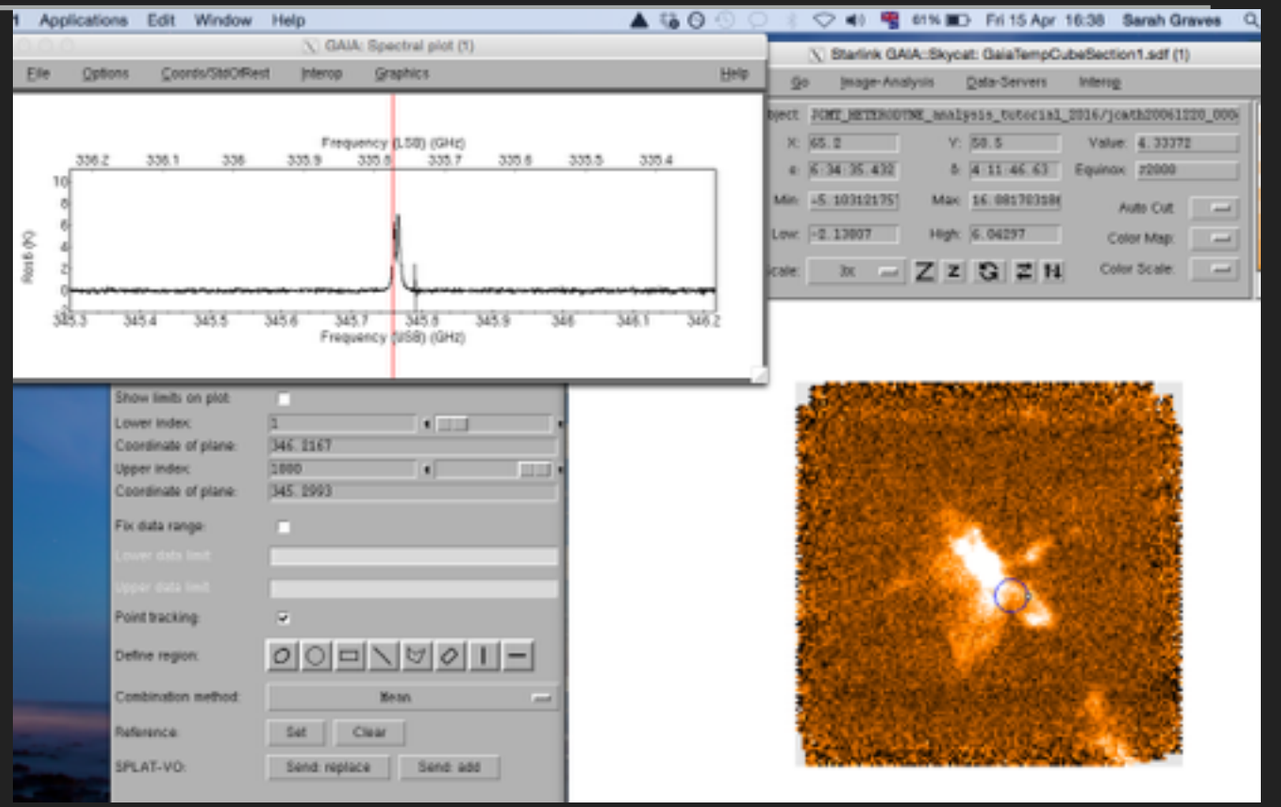
GAIA

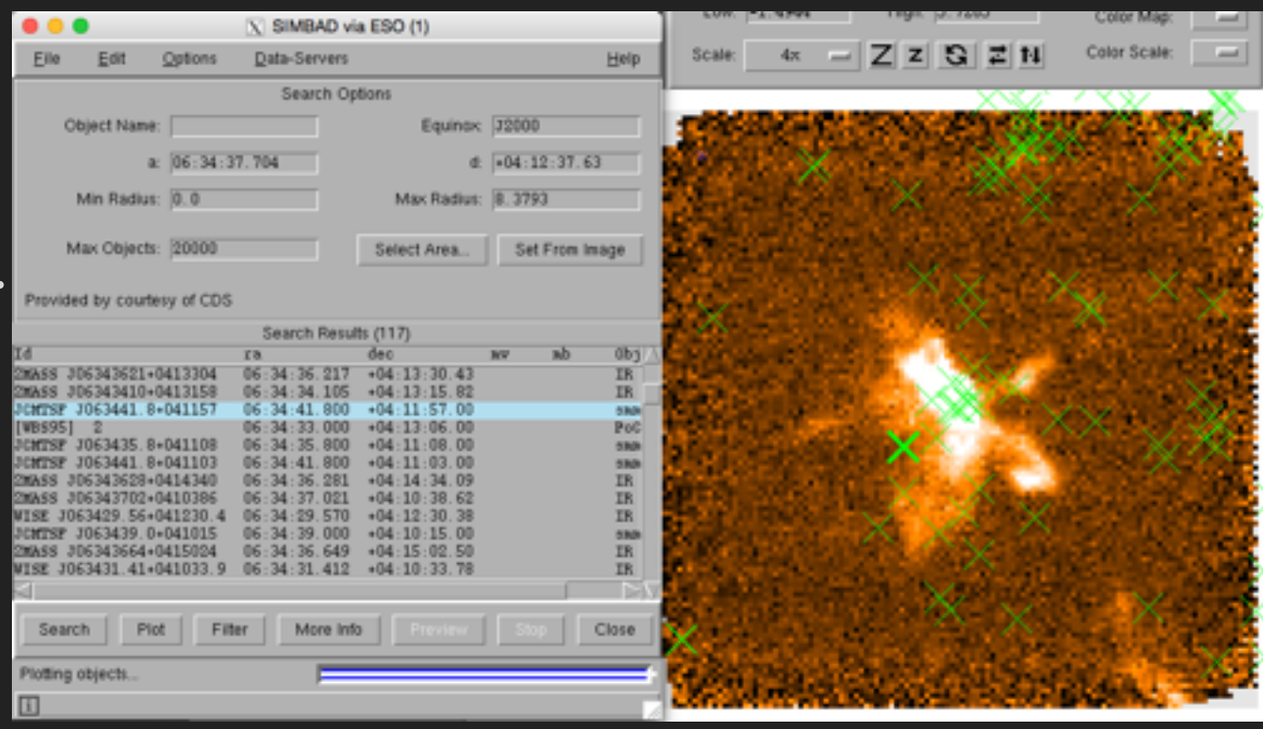
- GAIA is the Starlink visualisation GUI.
- It is great for interactively examining maps and cubes.
- To get you started, these slides list a few of the features you may want to use when examining a new Heterodyne data cube.
- Works on FITS and SDF files.



MITAKA WORKSHOP: ADVANCED TOPICS FOR JCMT DATA

- Open up a cube in Gaia
- (The cube toolbox should automatically appear; if it is accidentally closed do File->Open Cube)
- Left clicking will extract a spectrum from that position. You can also click & drag.
- In the spectral window, you can set the coordinates.
- Use the Define Region button to look at spectra averaged over your chosen region.
- Search SIMBAD or NED for sources through Data Servers->Catalogs->SIMBAD/NED.

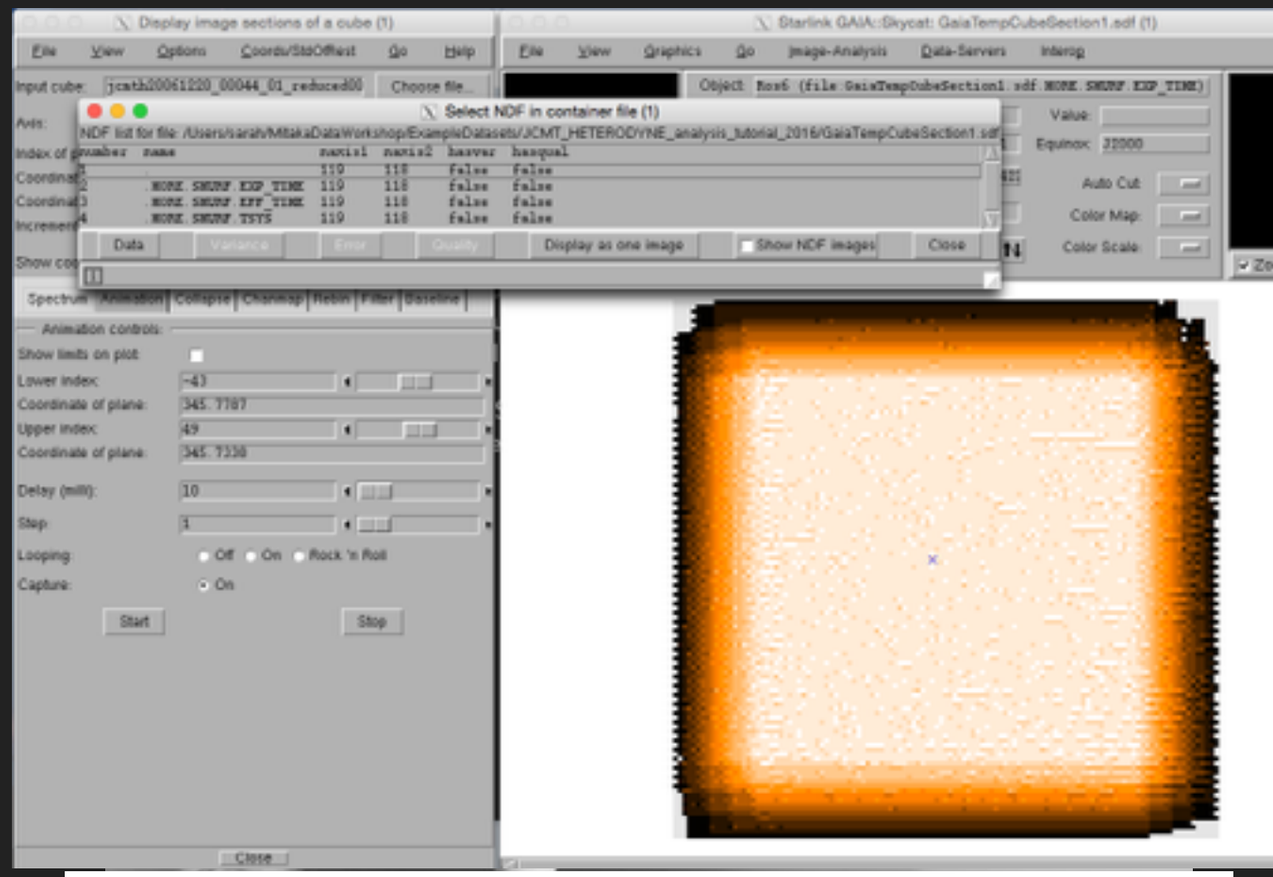




MITAKA WORKSHOP: ADVANCED TOPICS FOR JCMT DATA

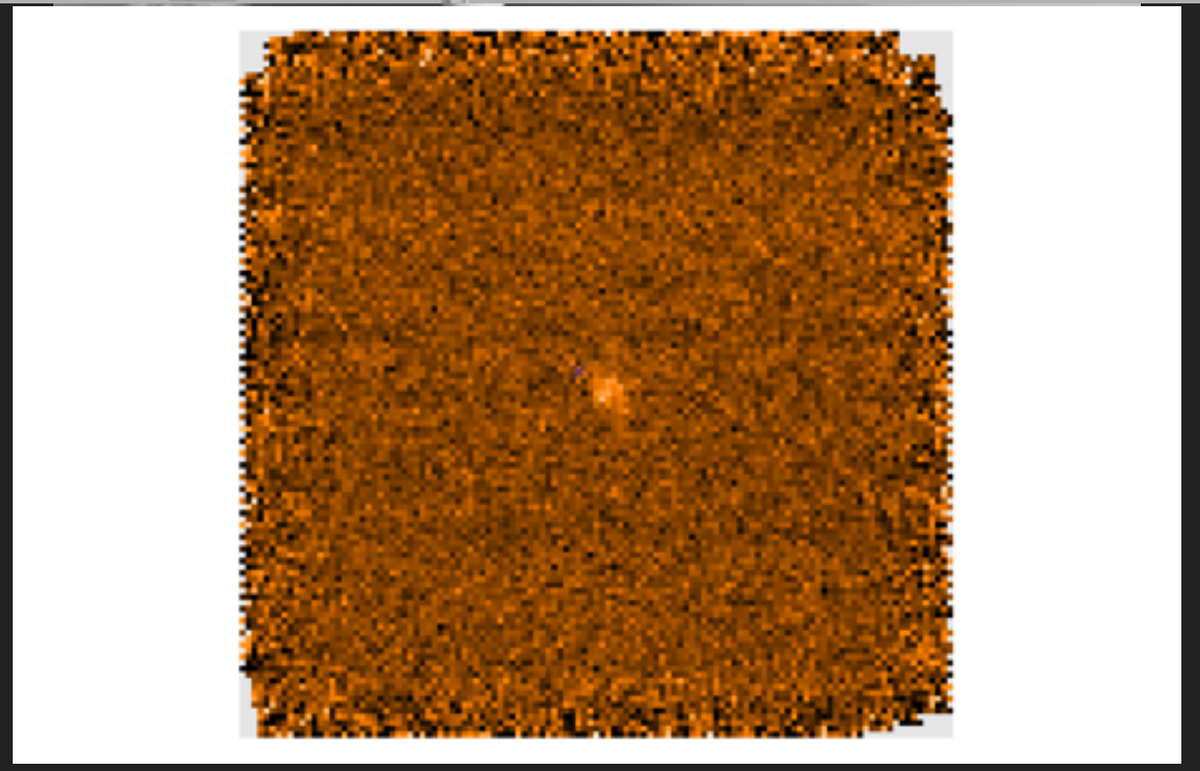
- Look at the exposure time map (may require you to have converted the file to SDF first)

Go to View->Select FITS HDU/NDF, and select exposure time.



- Capture a movie of your spectra.

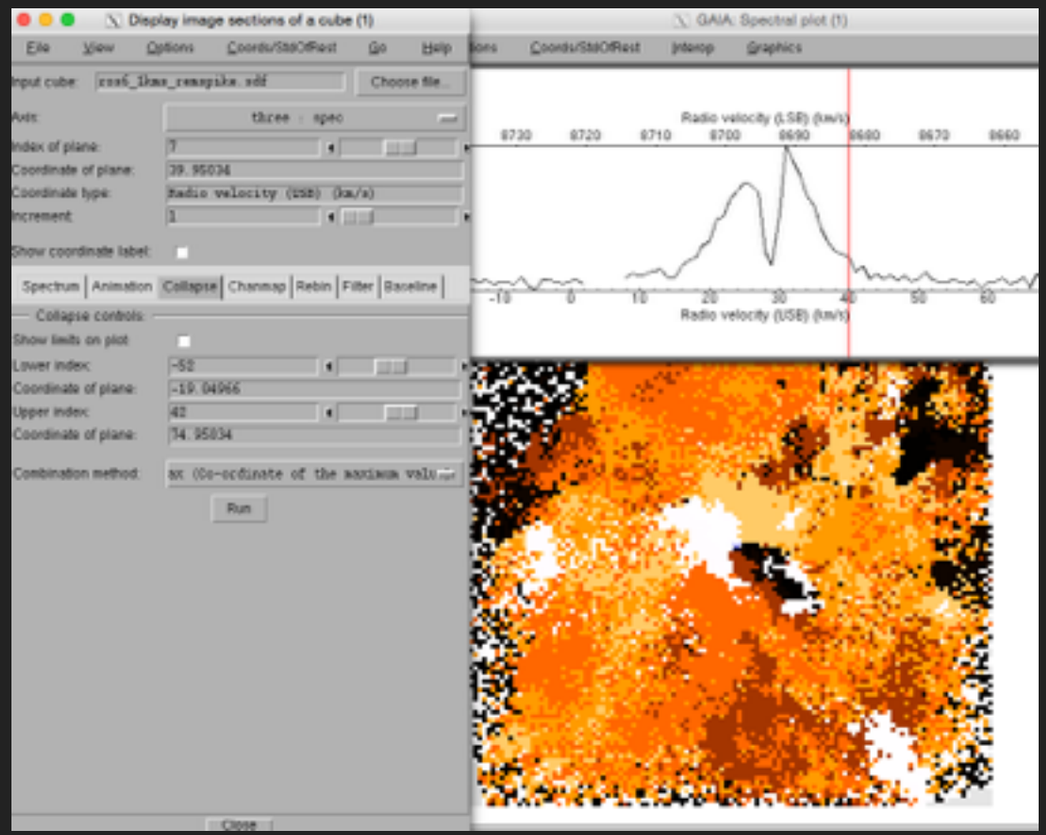
Use the ‘animation’ tab in the cube window and select ‘Capture’ to produce an animated gif (in the working directory).



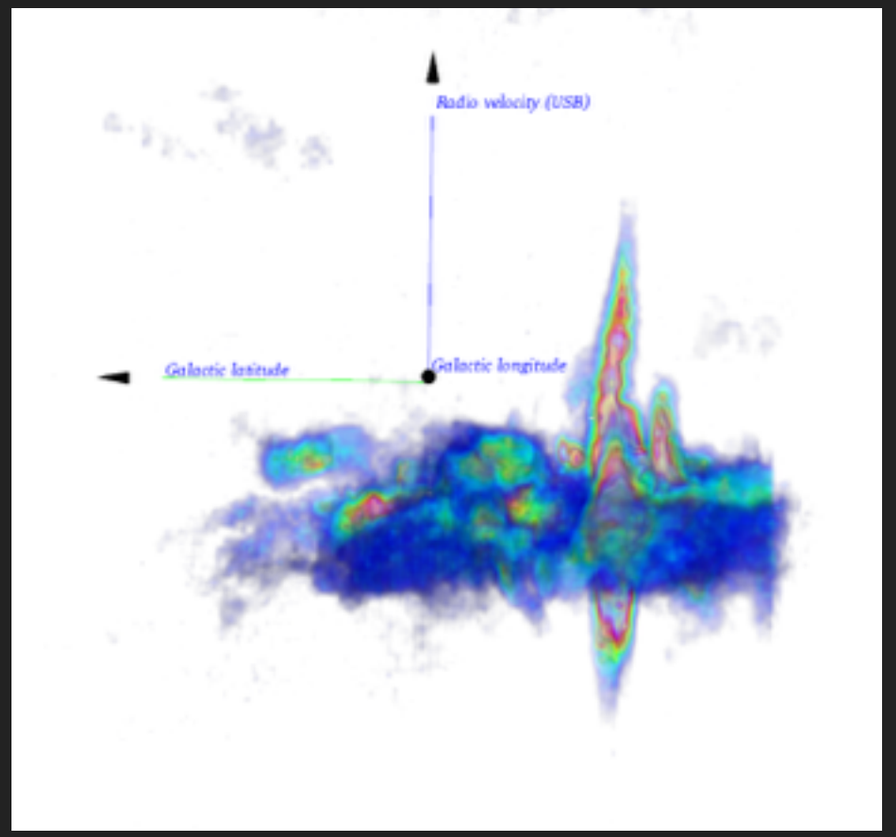
MITAKA WORKSHOP: ADVANCED TOPICS FOR JCMT DATA

- Collapse your map with a variety of different mathematical kernels, to produce e.g. noise maps, intensity maps, first and second moments, coordinate of the max.

  (Shown: coordinate of the peak pixel)



- Create volume rendering or iso surface rendering of your cube (in the cube window do:View->3D visualisation)



Many other features, including:

- Fit baselines to manually chosen regions of your data.
- Create channel maps.
- Detect objects
- Plot custom local catalogs.
- Compare 2 cubes interactively.
- Contouring different maps on top of each other.

EXAMPLE HETERODYNE ANALYSIS: SCRIPTS/SHELL

EXAMPLE SCRIPT FOR SHELL COMMANDS

- A fairly simple example script showing shell usage of Starlink for data analysis is provided on the tutorial page.
- Please use the Starlink documentation to find out more about any of the commands used that look useful.
- Try similar commands out on your own data, or on interesting looking public archive data!

PYTHON SCRIPTING

- We are currently developing a python wrapper package, for calling Starlink commands easily within python scripts.
- If you would be interested in this, please let me (Sarah Graves) know: s.graves@eaobservatory.org
- There is already a package starlink-pyndf available for reading in NDF files into python data arrays, along with their meta data and AST WCS objects.