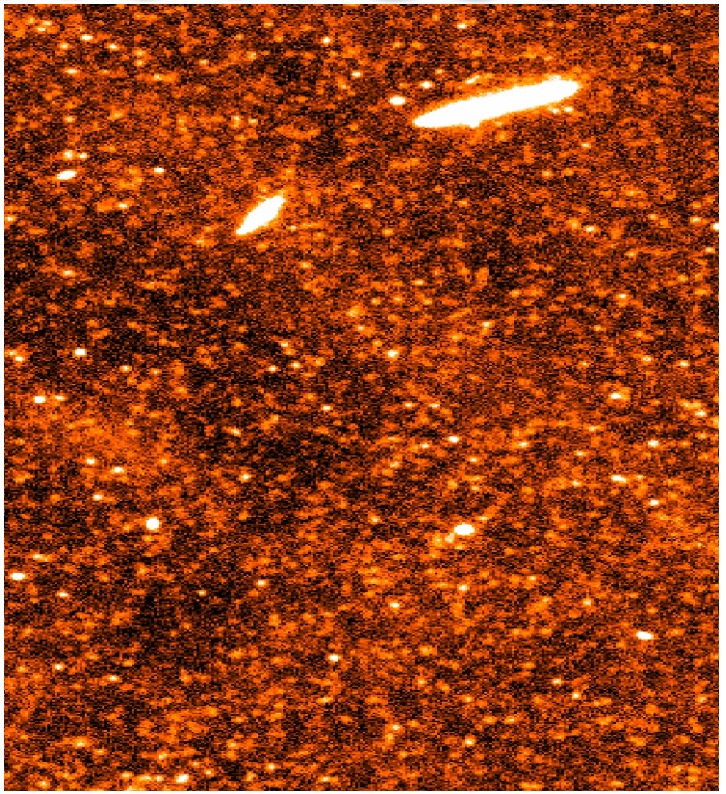
H-ATLAS and HeViCS:

Map-making and Flux Extraction with Parallel Observations (+ more)



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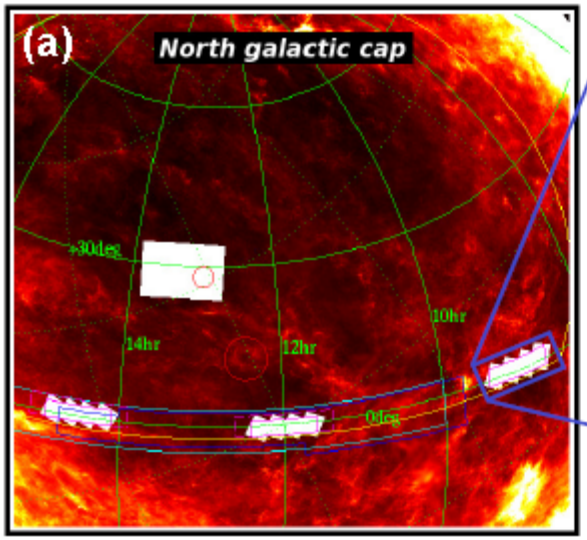
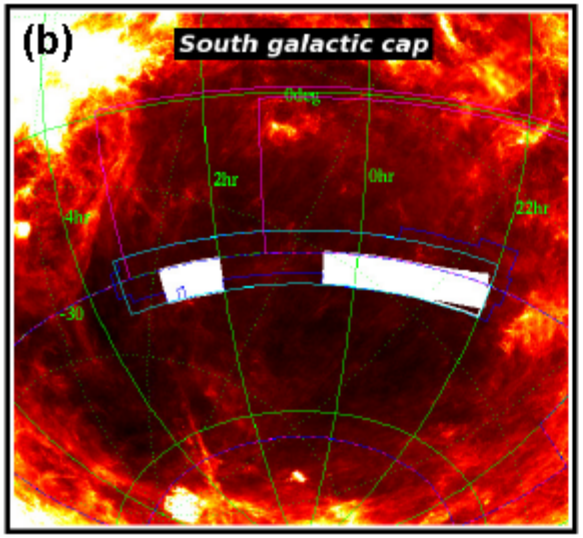
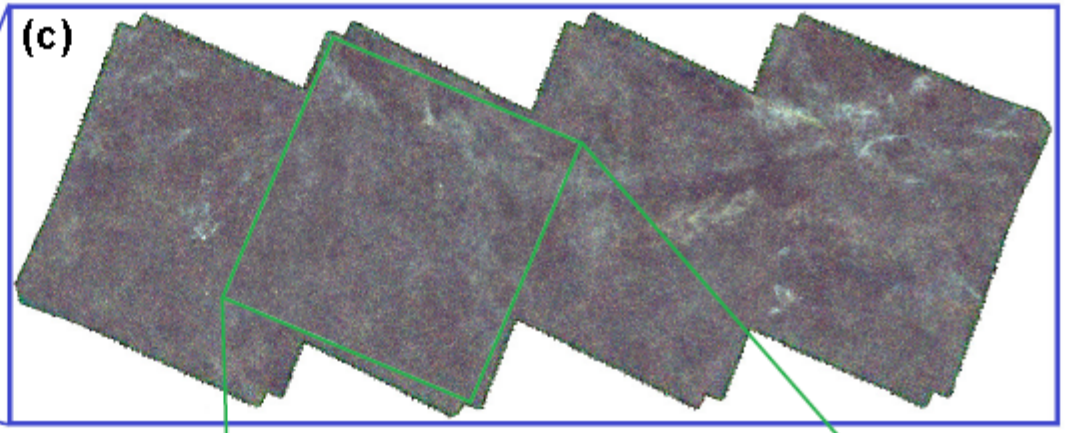
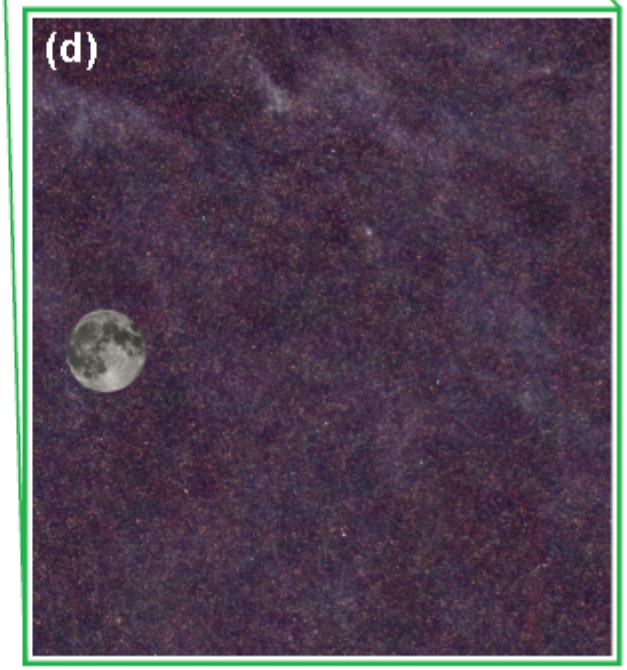
Talk Outline

- The Surveys
- PACS data reduction
  - PP versus Scanamorphos
  - Best of both worlds? (nebuliser + swarp)
- SPIRE data reduction
  - BriGAdE / Alternative thermal drift
  - Developed Tasks
  - Source Extraction





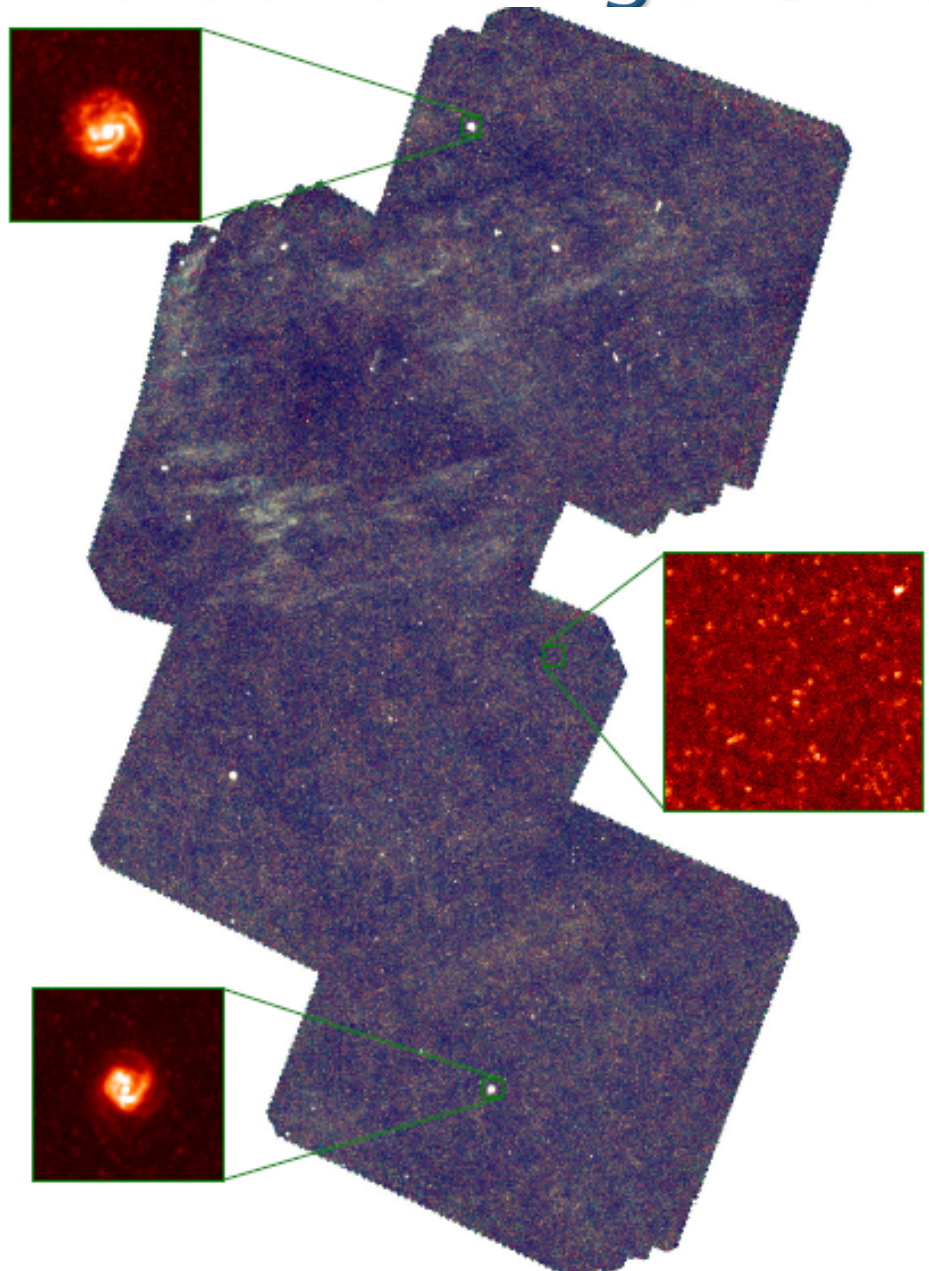




H-ATLAS

- Large, shallow survey
- PACS-SPIRE parallel mode
- ~550 sq. deg

Herschel Virgo Cluster Survey (HeViCS)



- Otherwise known as DAVIES
- 8 parallel scans
- 100, 160, 250, 350 and 500μm
- 80 sq. deg
- Noise ~ 0.3 × confusion for SPIRE

Reduced Data Products

- H-ATLAS
  - http://www.h-atlas.org/
  - Full maps available (DR2 soon)
  - Source Catalogues
  - Cut-outs server (SDSS, UKIDSS and H-ATLAS data)
- HeViCS
  - http://www.hevics.org/
  - Full maps
  - Source Catalogues
- Both sites are linked to Herschel User Reduced Data site

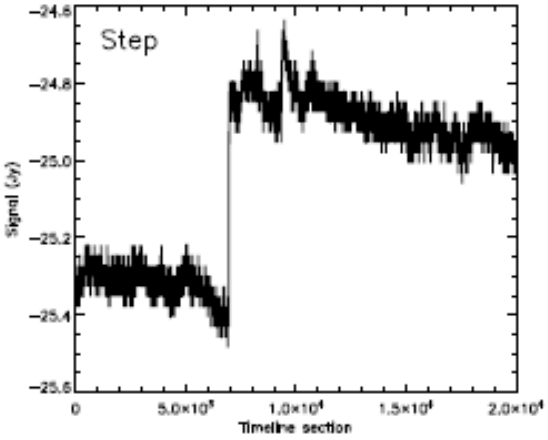
PACS Data Reduction

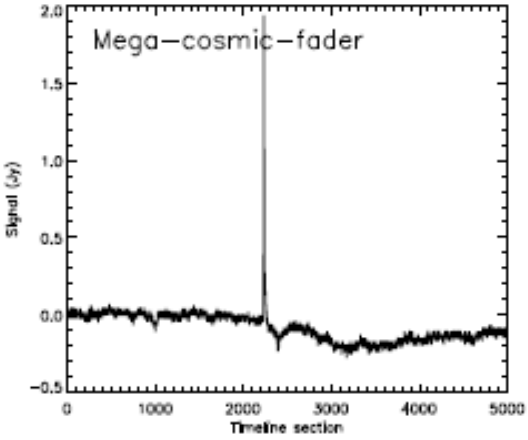
Level 0 to Level 1

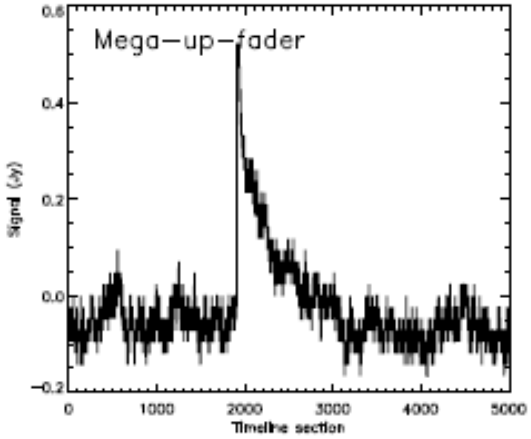
- 1.4×10^5 frames per timeline in a 9hr observing run (~16 sq. deg)
- Require a machine with 150Gb RAM + 100 Gb SWAP memory
- Timelines mostly dominated by 1/f noise
- Astrometry is corrected by matching to SPIRE corrected maps (see later)

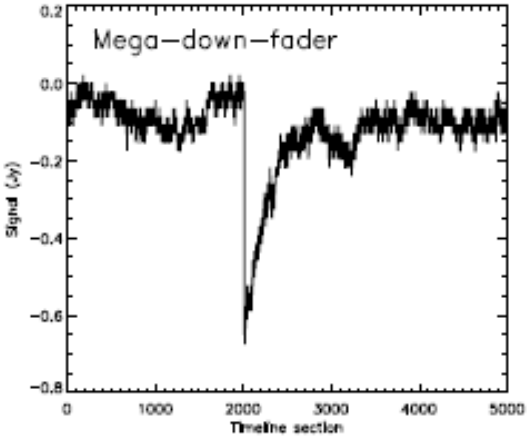
Artefact Identification

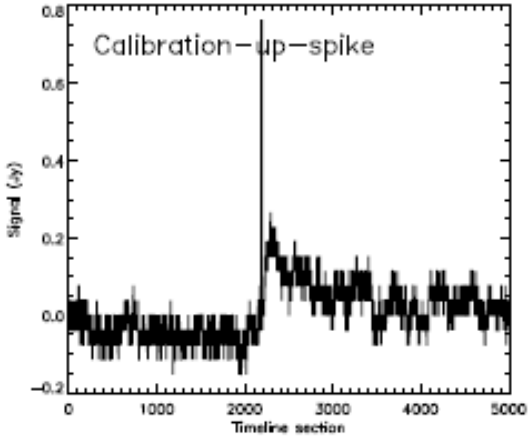
- Challenging stages has been the automatic detection of several features
- Ros Hopwood has written a detection and correction routine
- Downside is time consuming
- Quantify shape of the artefact so can best correct the timelines

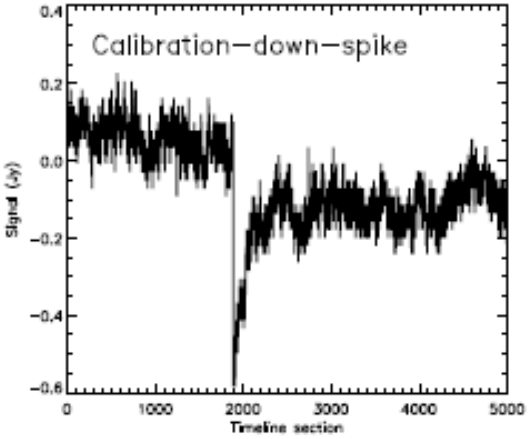






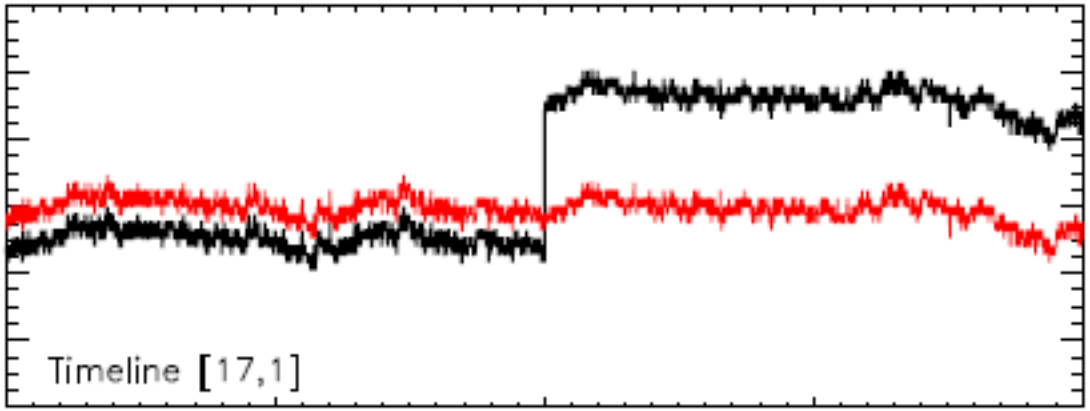


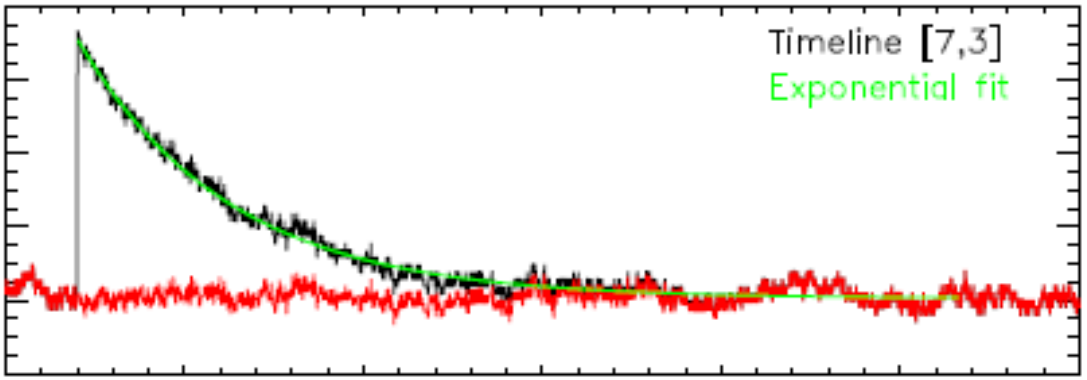


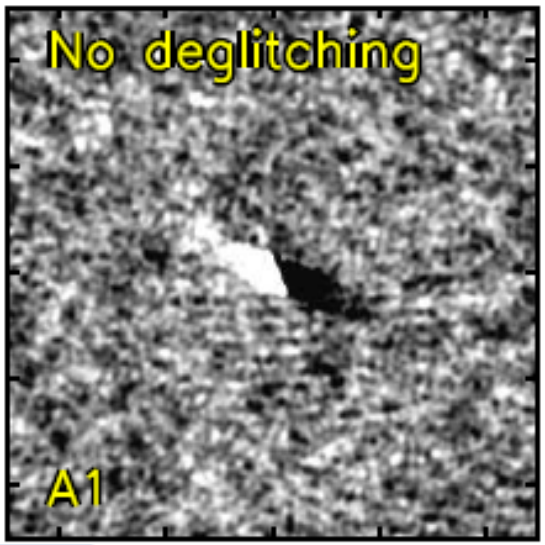


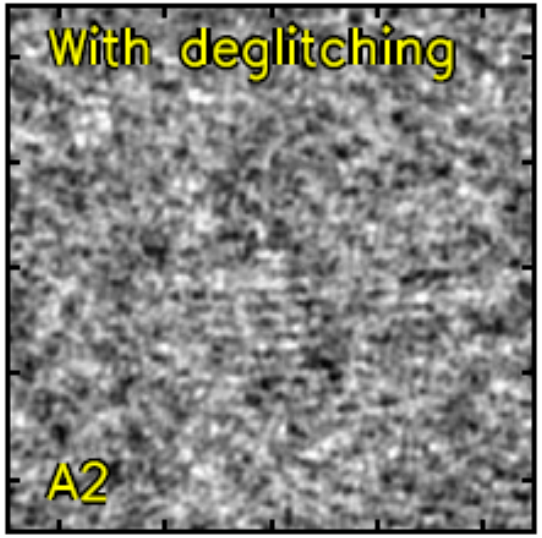
Artefact Identification

- Experimented with identification and reconstruction
- Step like features relatively easy
- Exponential works tends to work well for mega-faders/cal-spikes. If the X^2 is bad the data is flagged

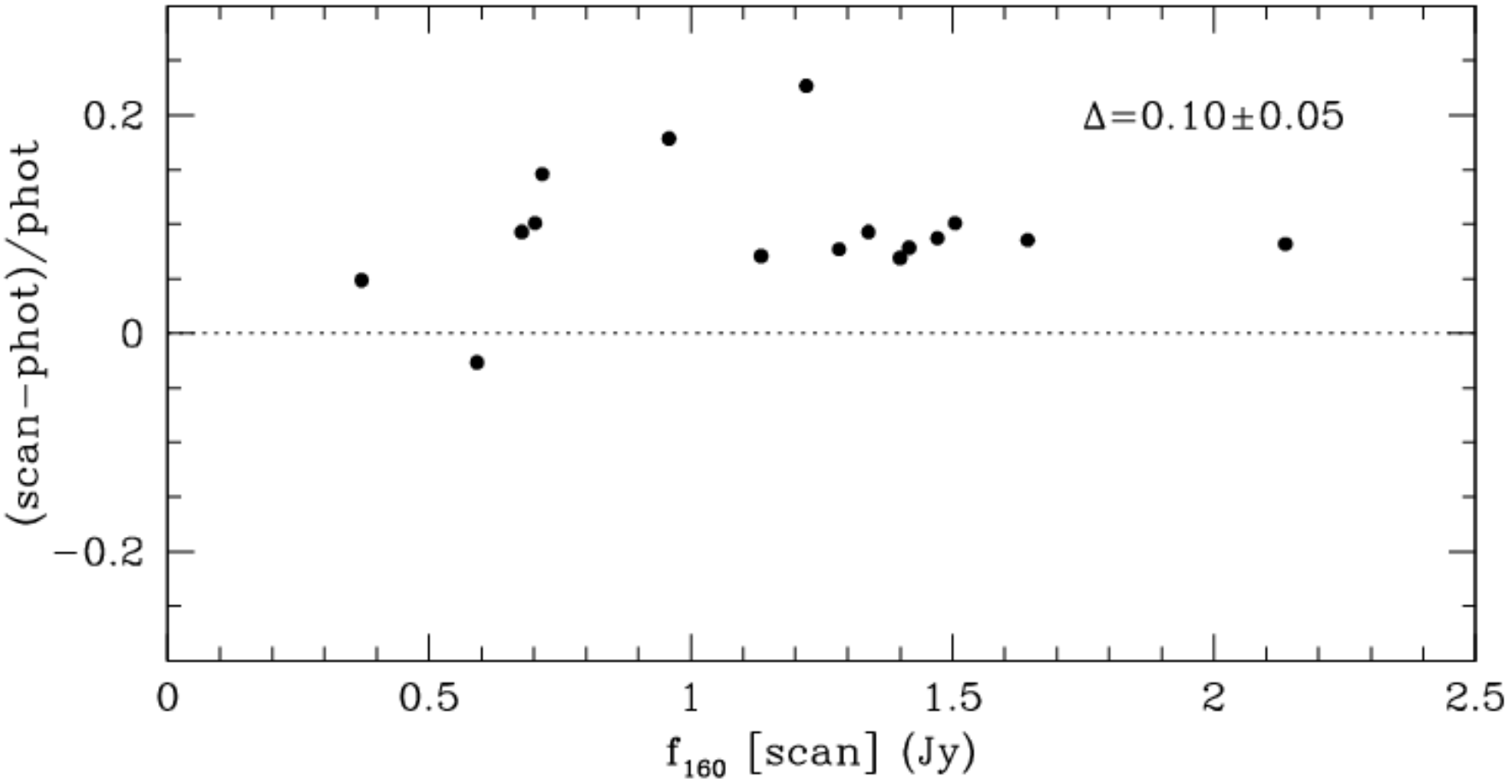








High-Pass Filter Problem



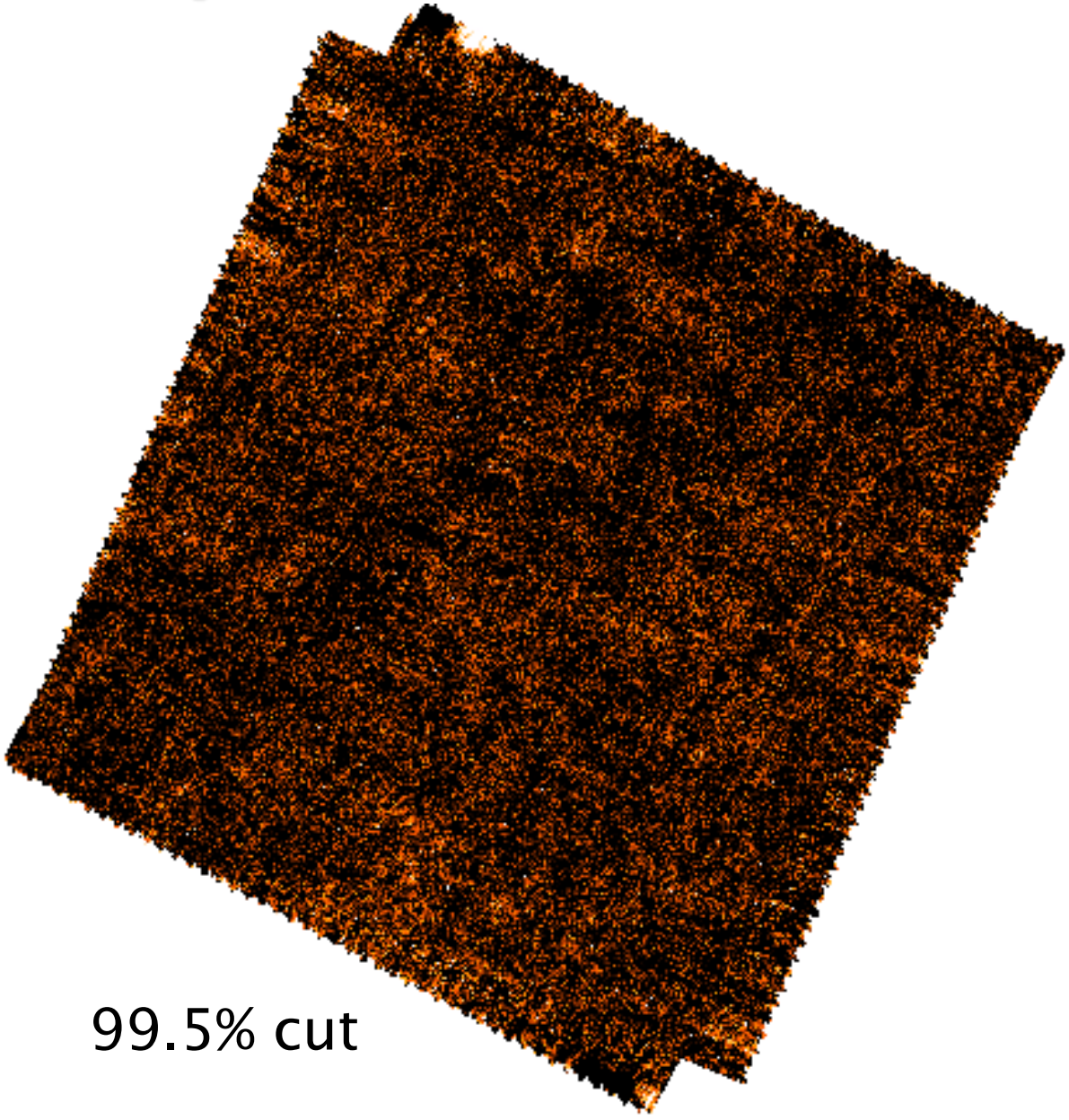
Best of Both Worlds

- ATLAS want a single map with both:
  - Mostly point sources so want good point source sensitivity
  - Many slightly extended structure of galaxies (largest source ~2.5′) – ignoring cirrus
  - Investigating two methods:
    - SANEPIC
    - Alternative method based on scanamorphos – I'll go into detail

- Multi-stage process:
  - Use scanamorphos to create each tile
  - Apply Nebuliser to remove large-scale structure
  - Mask out regions not covered by both scan directions
  - Use swarp to mosaic all the tiles together to give an overall map

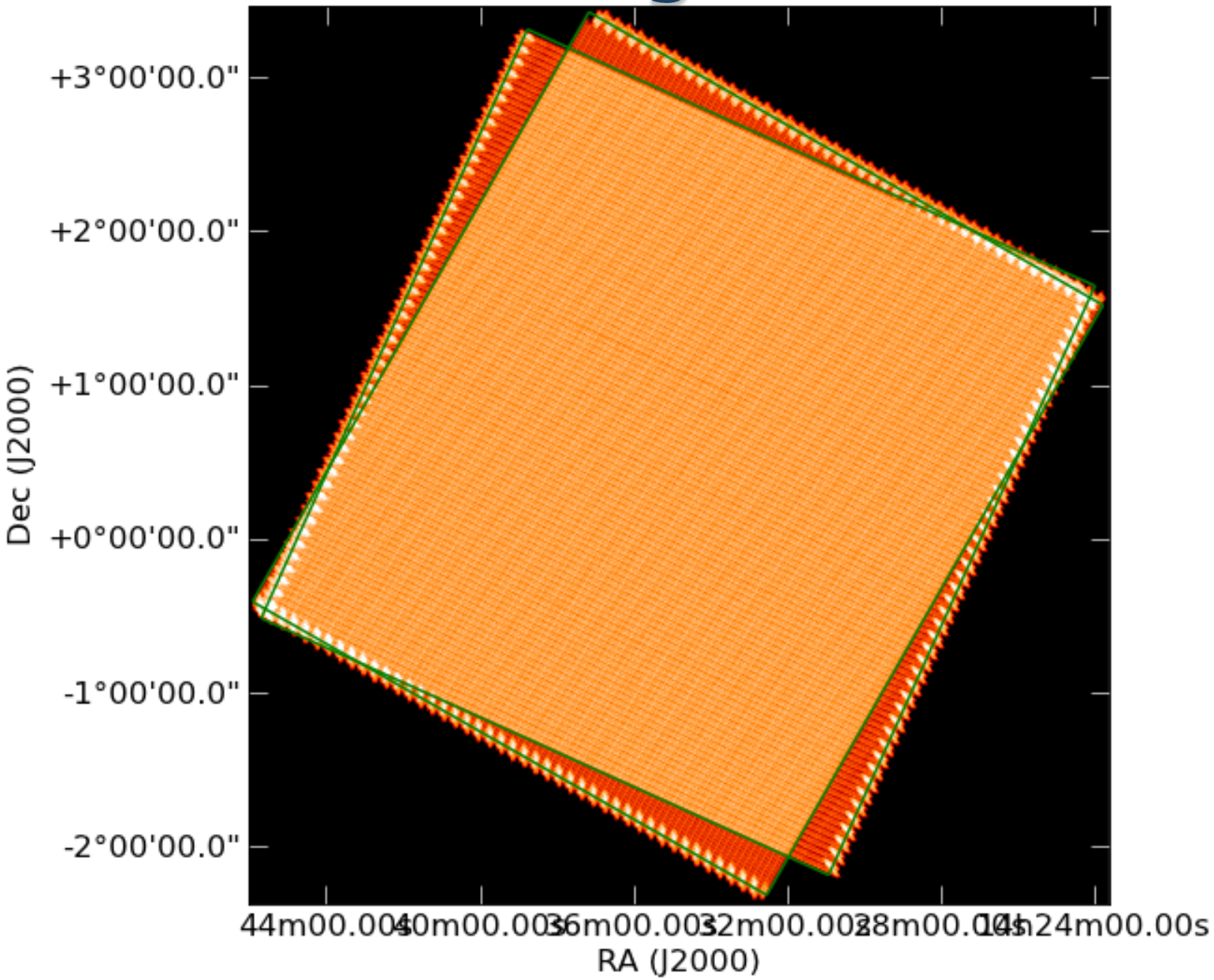
BOBW: Scanamorphos tile

- First run scanmorphos on an individual tile



99.5% cut

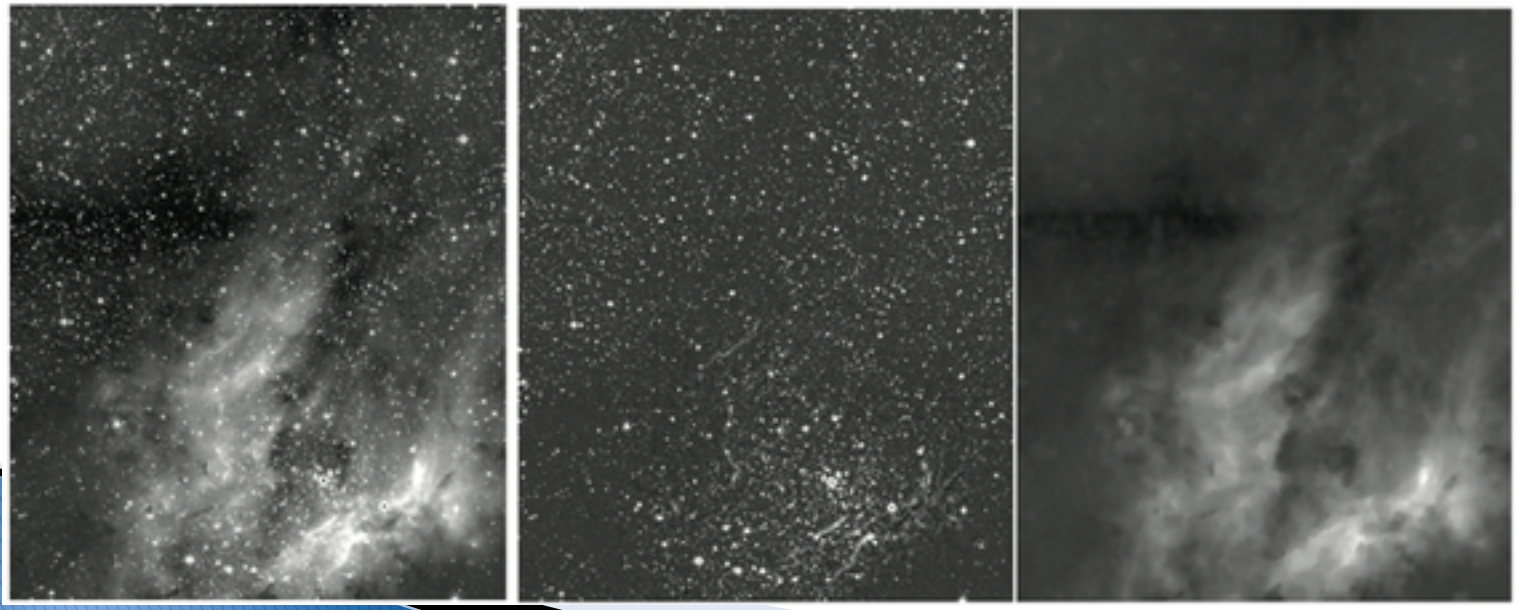
BOBW: 2-Scan Regions



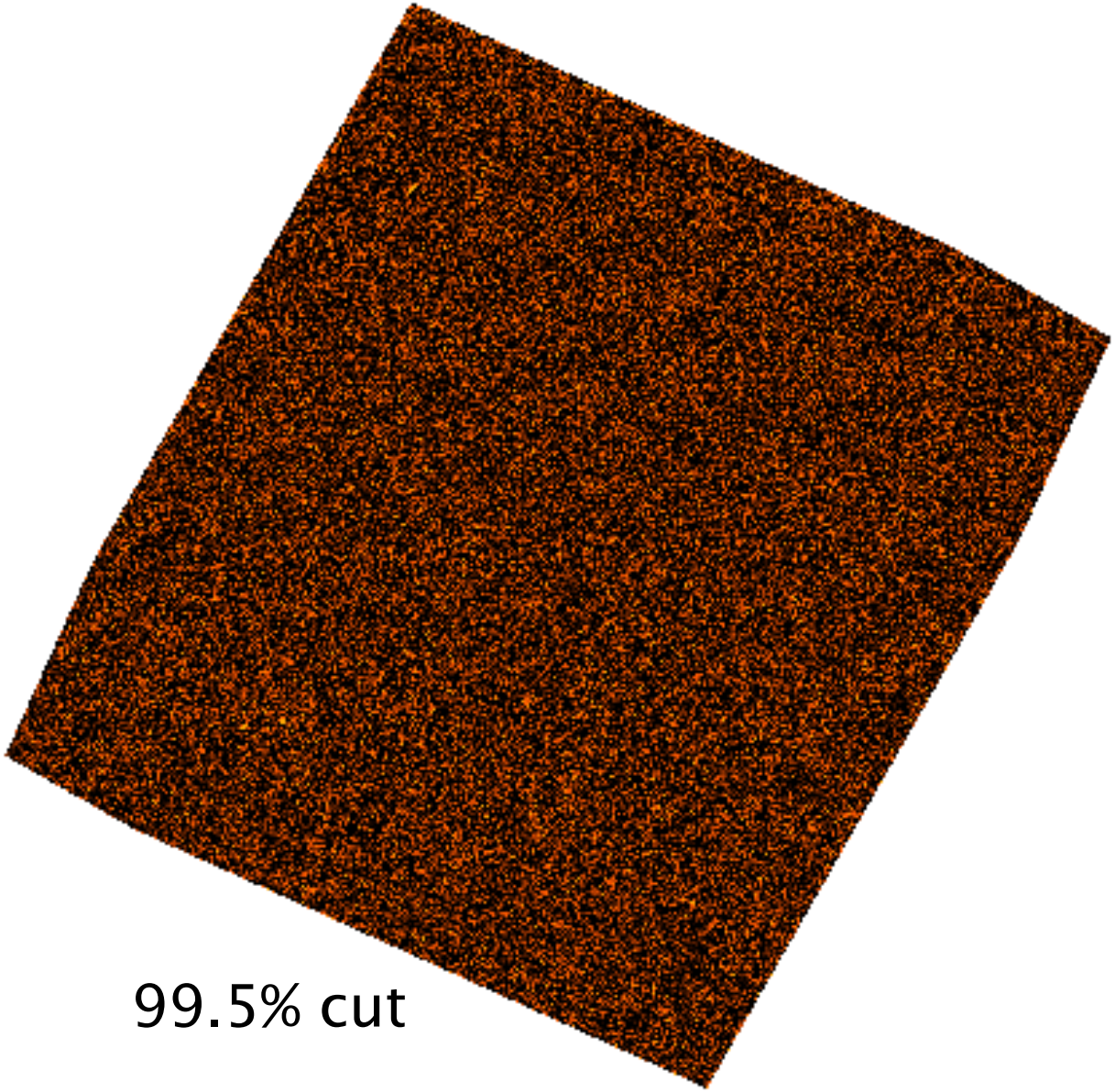
Nebuliser

- Cambridge Astronomical Survey Unit (IoA) http://apm49.ast.cam.ac.uk/

- The background is modelled by a series of interactive sliding median and mean filters that are applied to each axis or to both simultaneously.

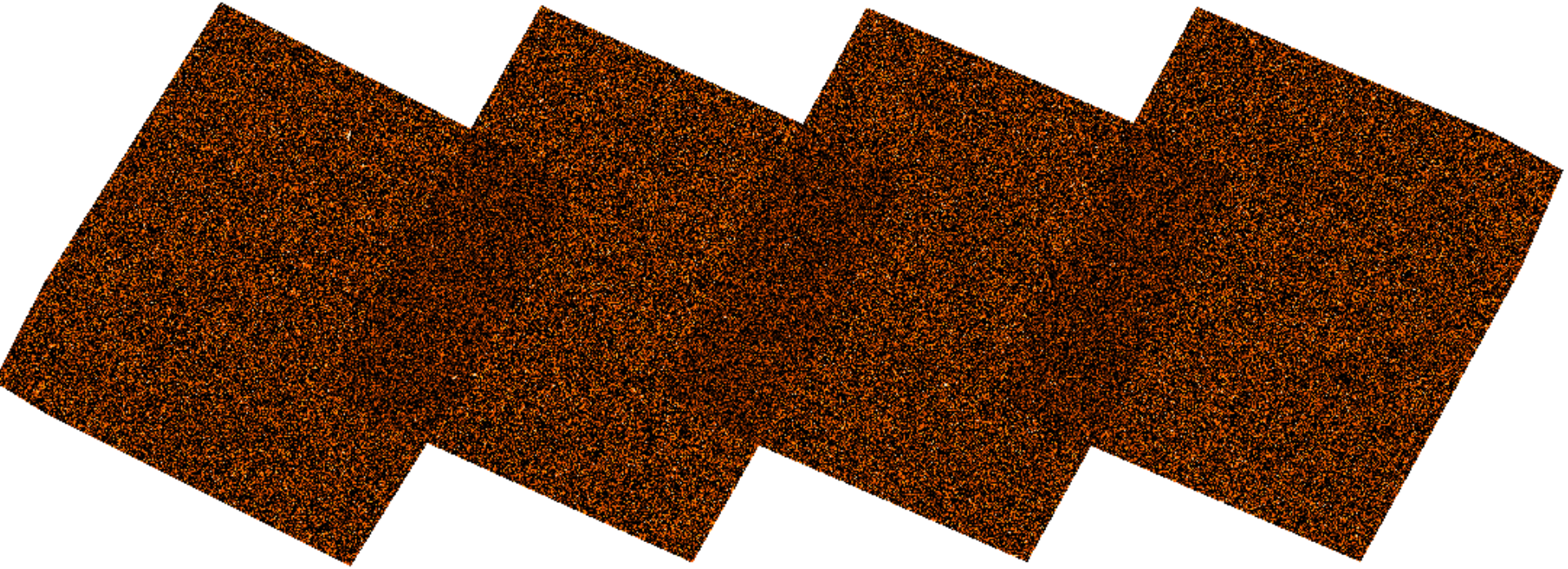


BOBW: Nebulised tile



99.5% cut

BOBW: Swarp Mosaic



- Use SWARP to mosaic the individual tiles into a complete field.
- http://astromatic.iap.fr/software/swarp

How Does It Compare?

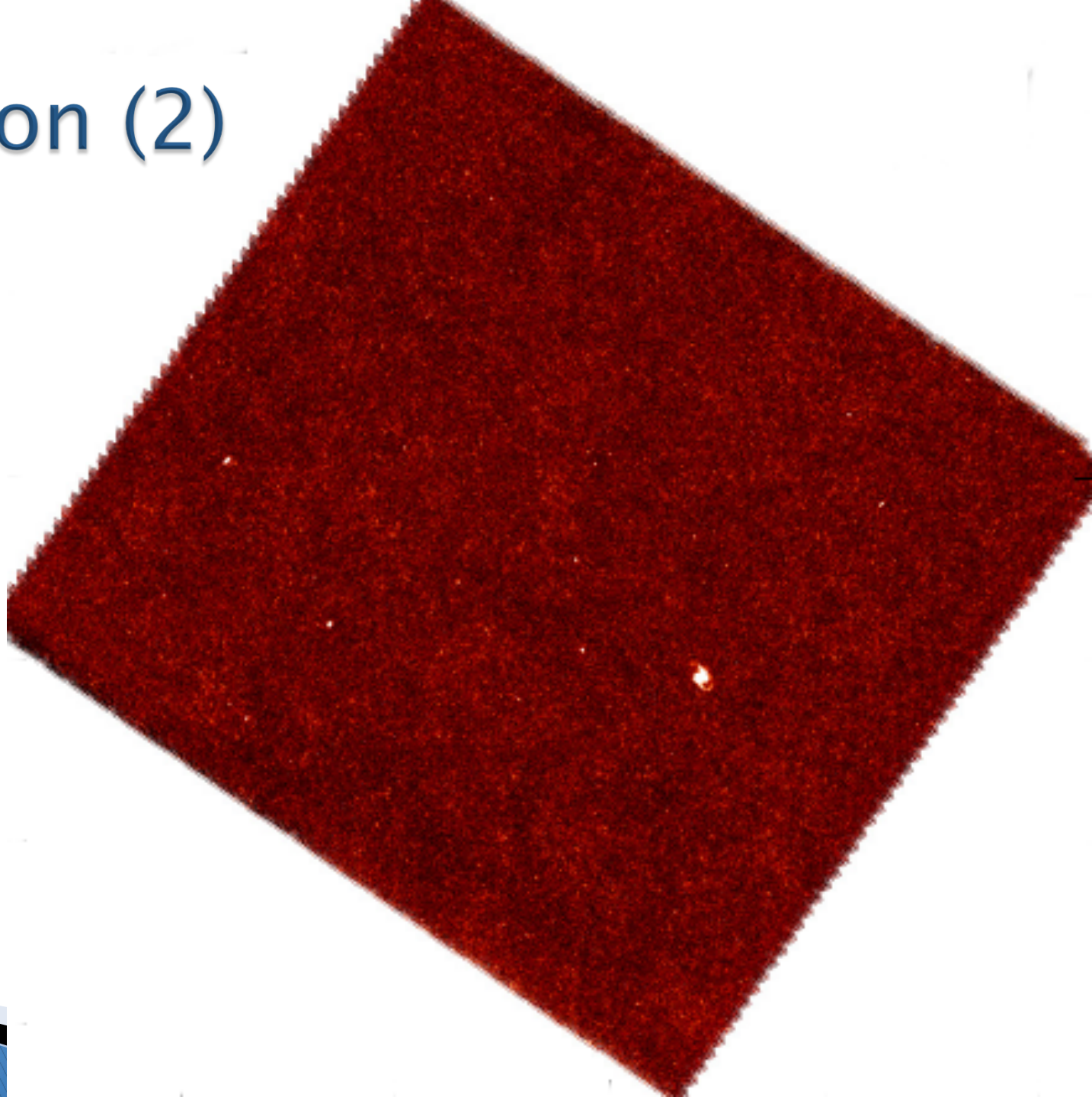
- Initial figures suggest comparable point source sensitivity to high-pass filter map
- Injected sources up to 2.5′ are preserved in the map
- Further tests in the next couple of weeks

SPIRE Data Reduction

Motivation alternative L1-L2

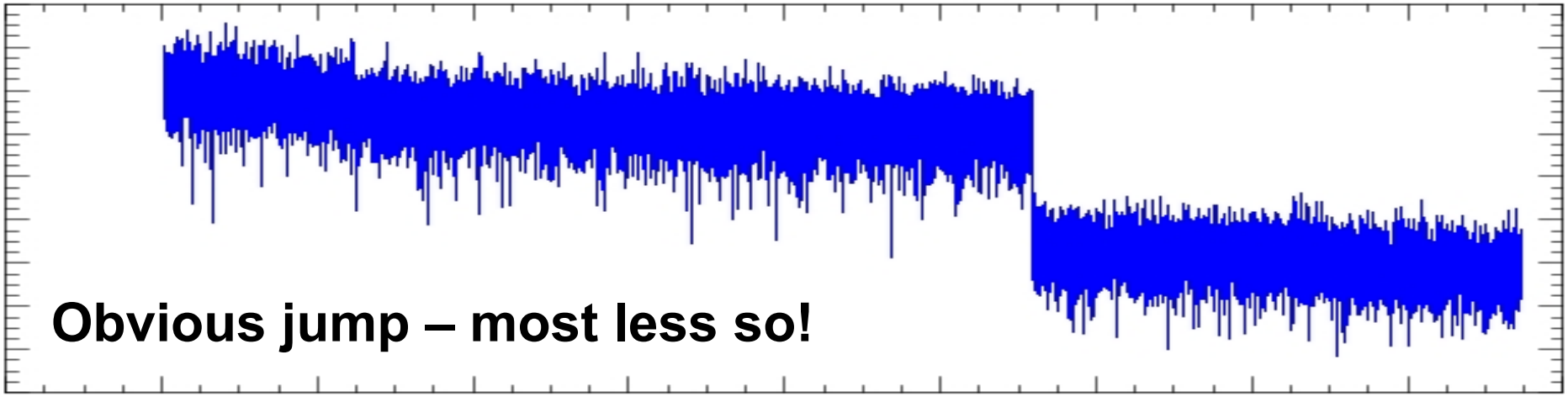
- Optimal strategy for **Extra-galactic fields**
- At time the standard pipeline did not include thermal drift correction
- De-striper only recently became possible but is very time-consuming for these large surveys
- Only change to L0-L1 are:
  - Sigma-kappa deglitcher (better for faster scan rates and lower sample rates)
  - No thermal drift correction applied

Motivation (2)



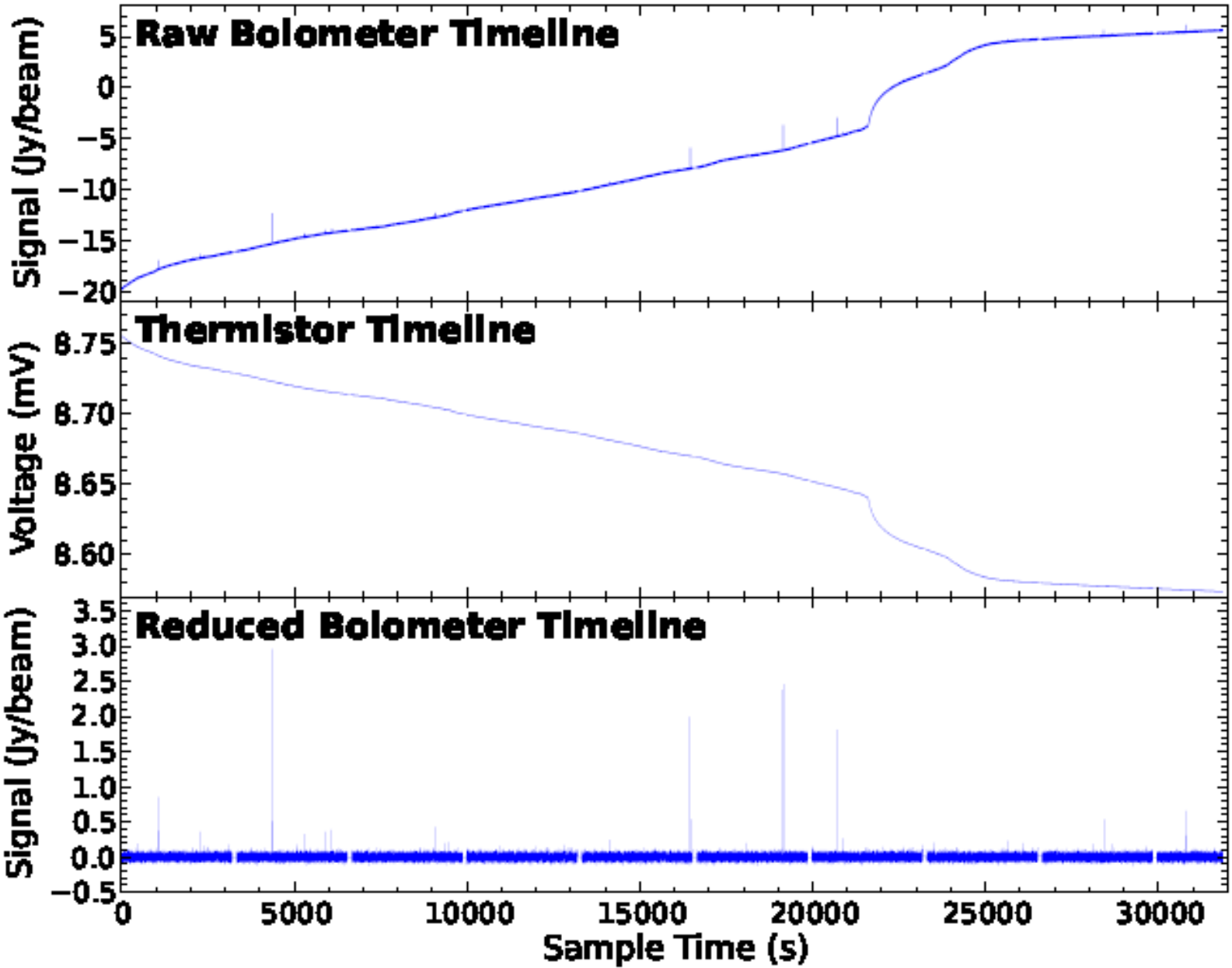
Jump Correction

- All scan legs and turnaround regions are combined to give one continuous timeline
- Thermistor (or dark pixel) ‘jumps’ are manually located (using kst) and **corrected** in the timelines



Obvious jump – most less so!

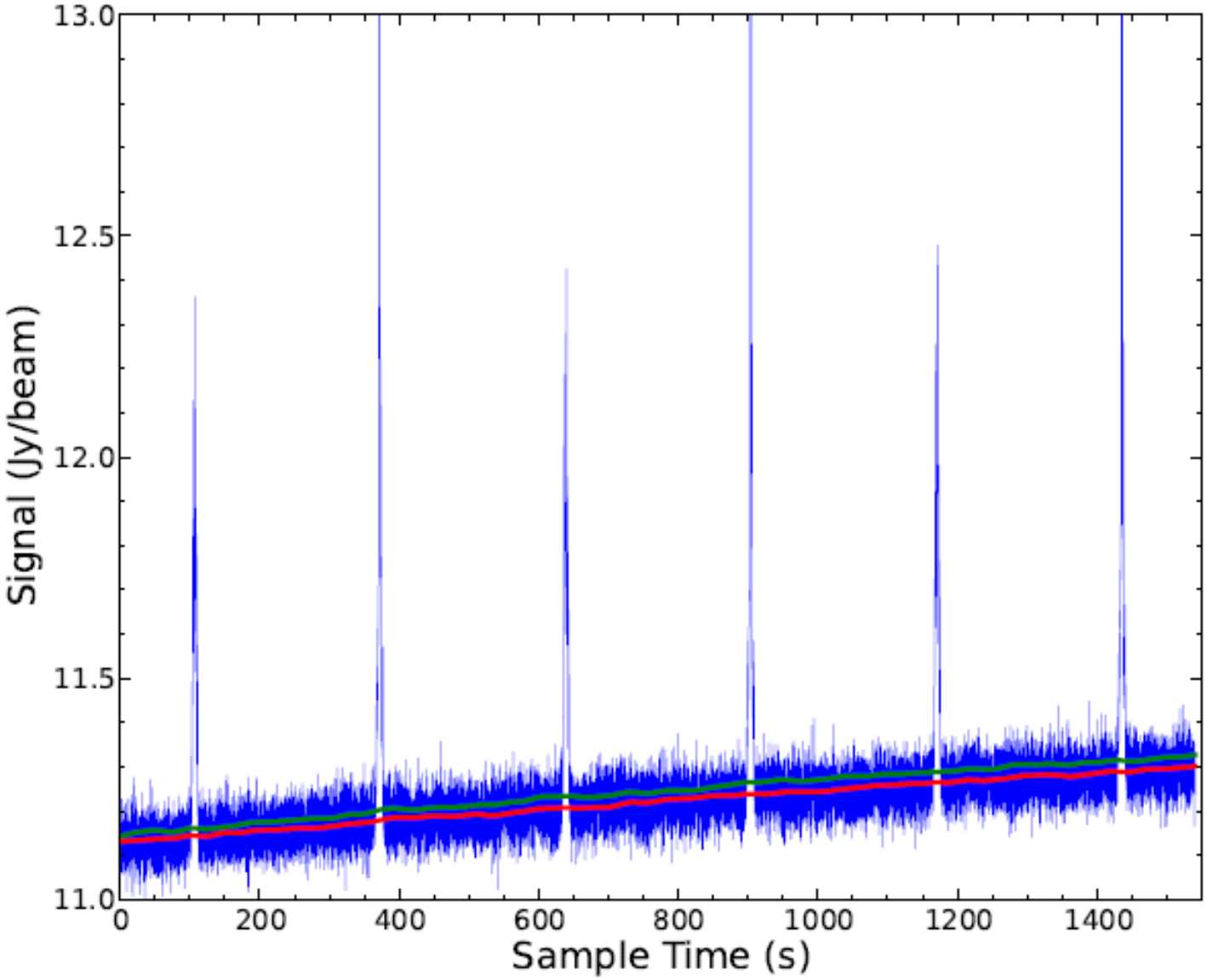
Thermal Drift Correction



BriGAdE (SAG2 + HeViCS)

- Originally developed for SAG2 (i.e., HRS, VNGS, DGS, HELGA)
- Intrinsically corrects ‘cooler burps’
- Uses any combination of two thermistors or dark pixels timelines (usually T1 + T2) to remove thermal drift from bolometer timelines
- Thermistor signal is smoothed (using a low pass filter) to prevent noise being added
- Automatically masks sources

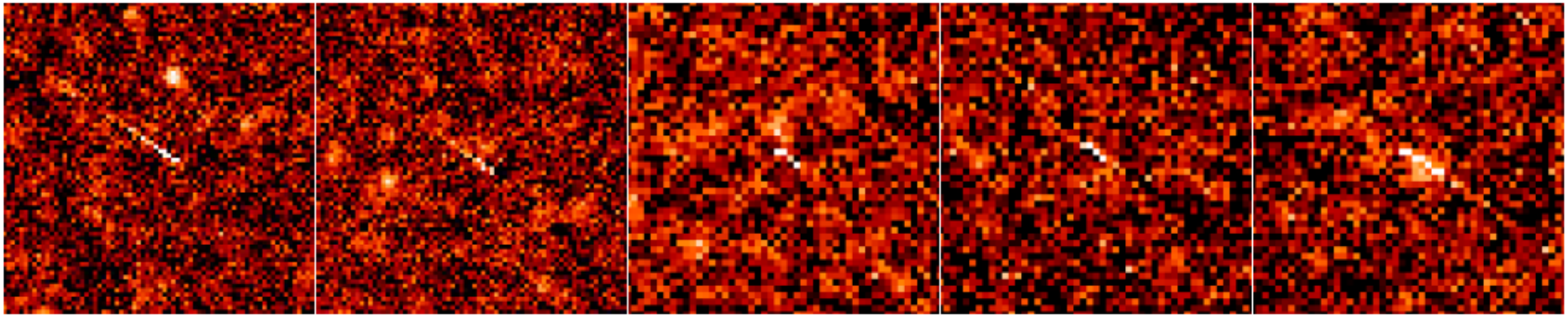
BriGAdE (2)


13.0
12.5
12.0
11.5
11.0
Signal (Jy/beam)
0
200
400
600
800
1000
1200
1400
Sample Time (s)

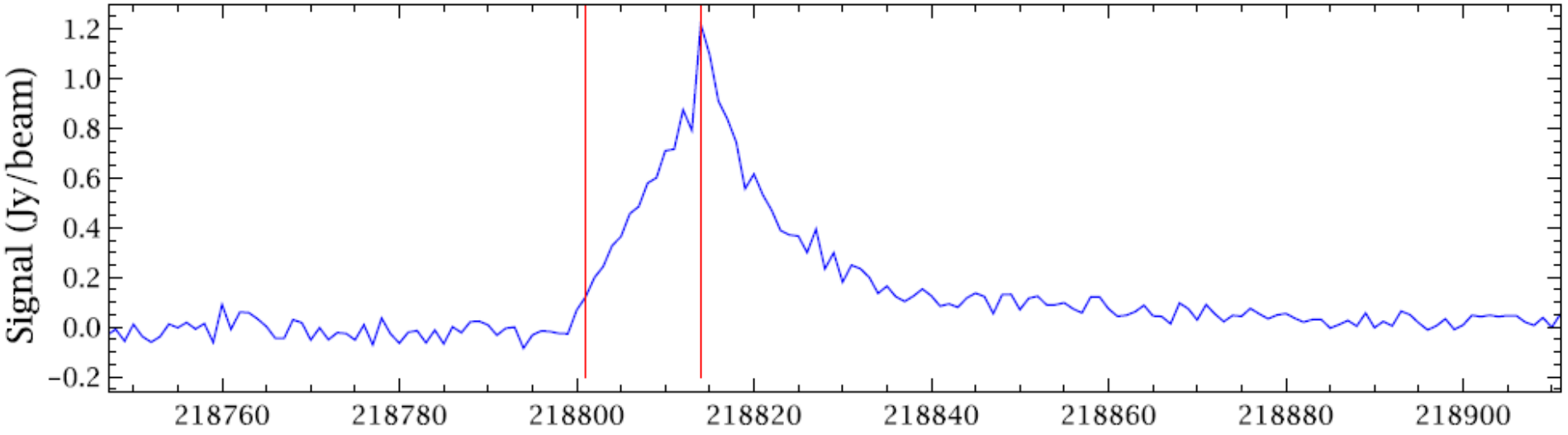
BriGAdE (3)

- Smoothed thermistor timelines are then fit to the bolometer timeline assuming a linear relation.
- The thermistor with the best fit to the bolometer is then used to remove the scaled baseline
- For large maps (i.e., HeViCS) perform the fit on a per-scan basis. Maps of individual objects are done for the whole timeline
- No further baseline removal is required
- Use a default pixel size of 6, 8, 12″.

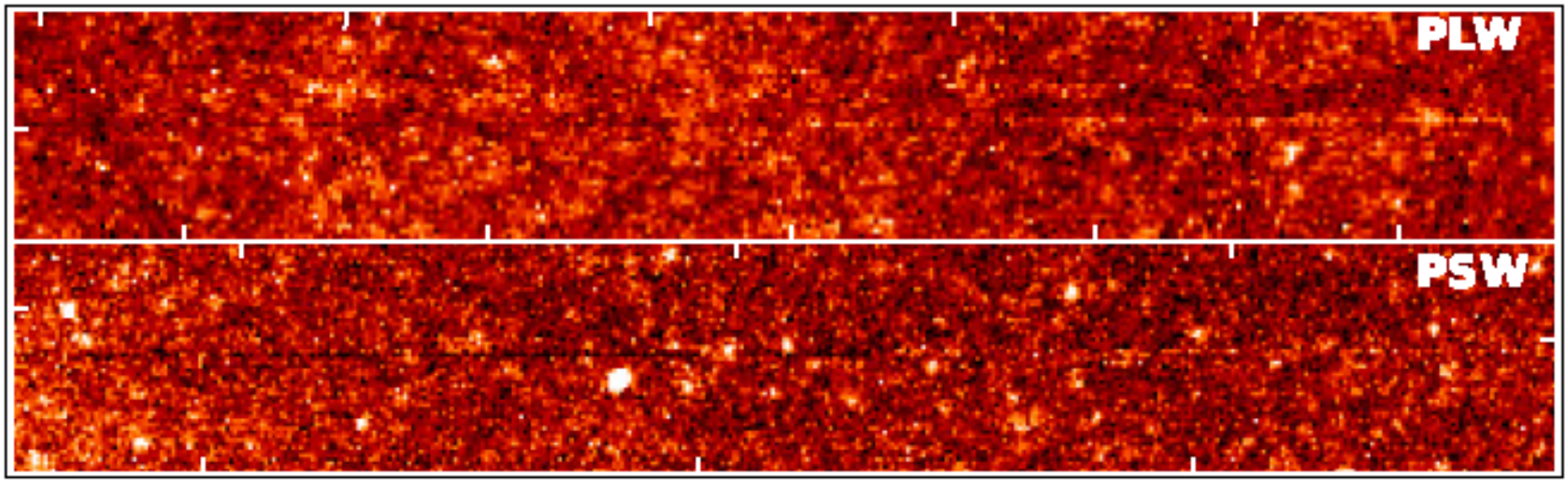
Glitch Tails



- Glitch tails are glitches where the entire glitch has not been masked
- Locate in timelines using script which identifies bolometers crossing pixel and plots an image

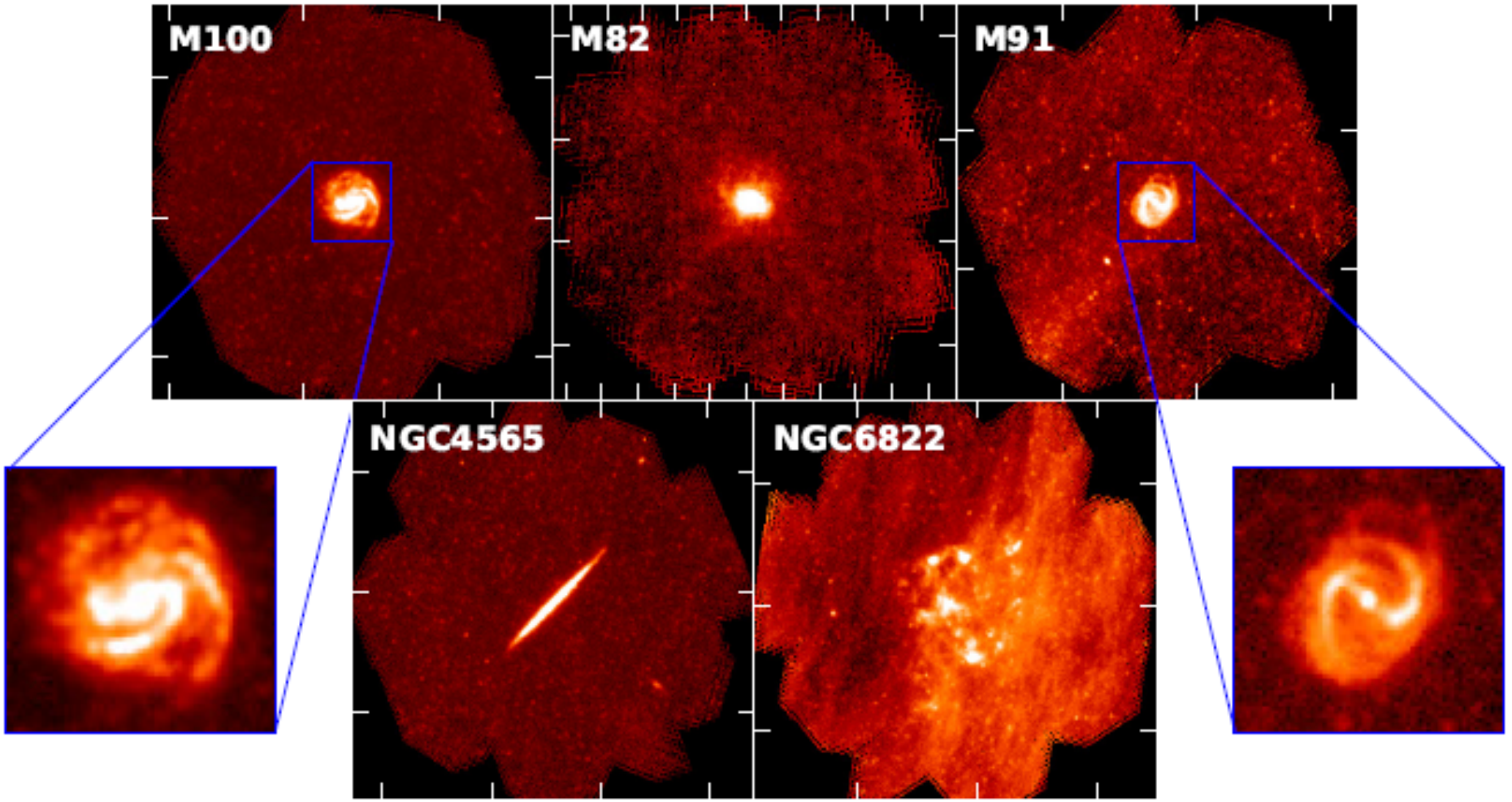


Bolometer Jumps

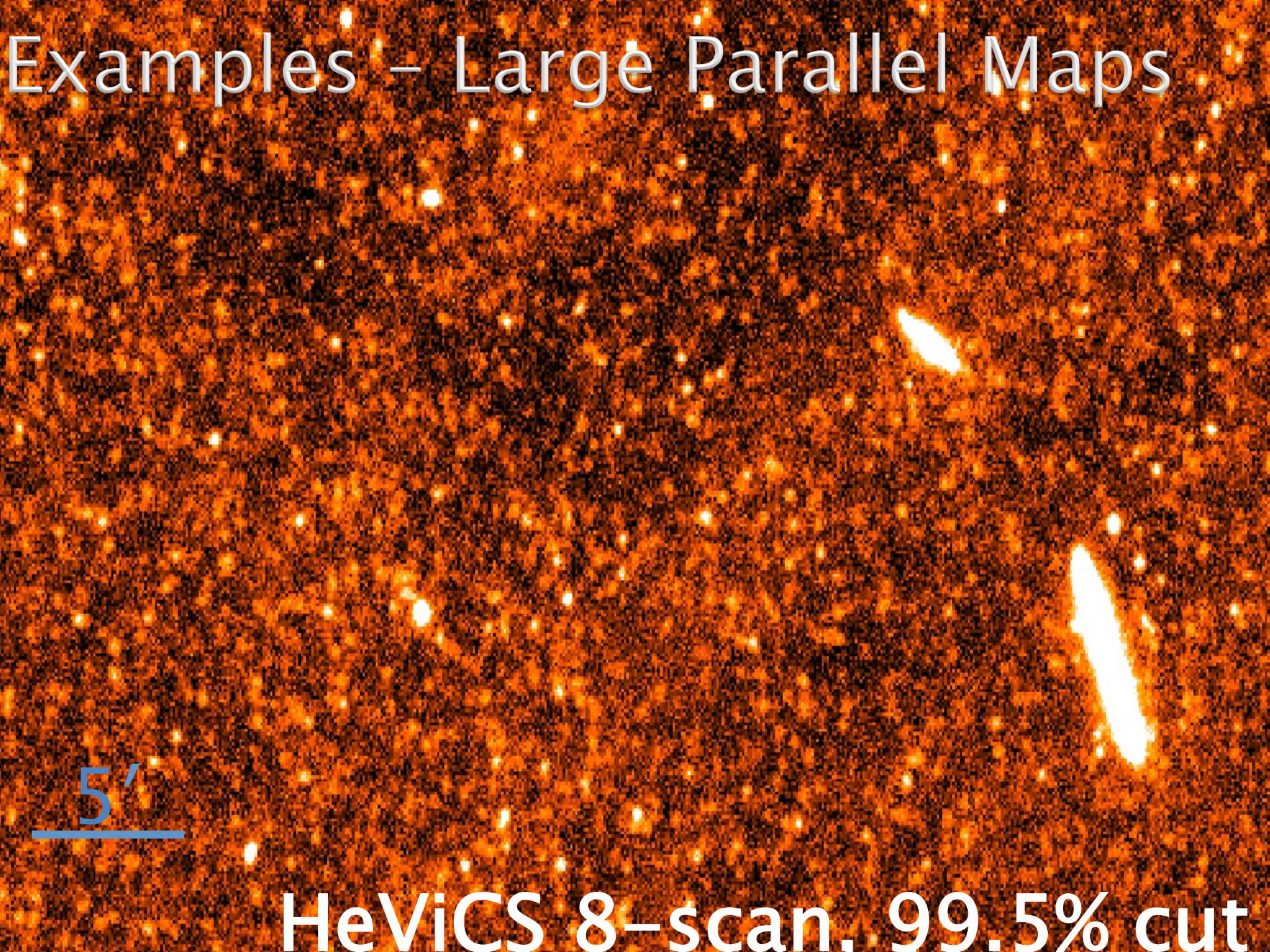


- Too time consuming to check every timeline manually. Use same script to locate the bolometer
- Average rate of ~4 per 8 hour HeViCS observation

Examples – SAG2 maps

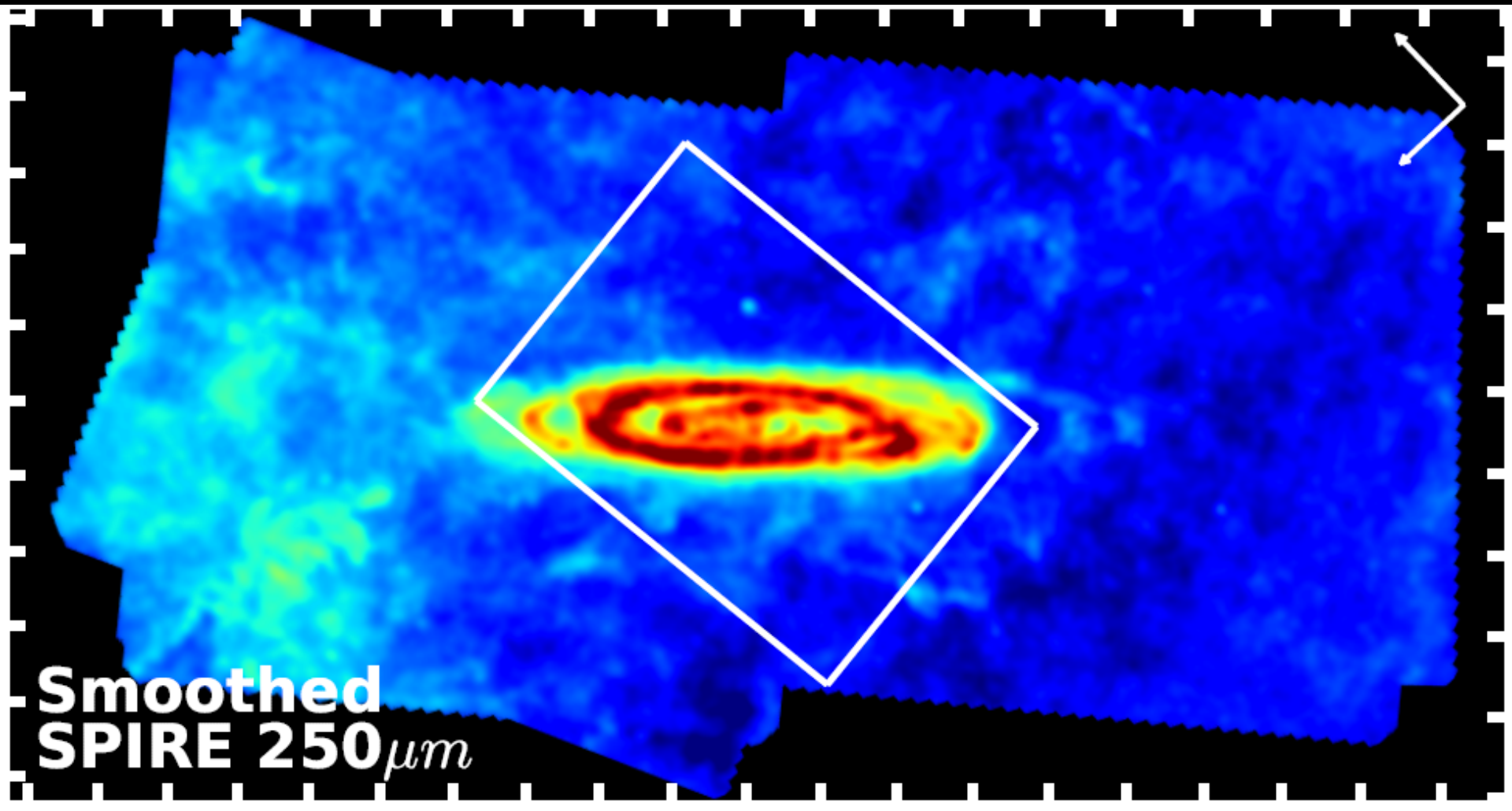


Examples – Large Parallel Maps



HeViCS 8-scan, 99.5% cut

Examples – Large Parallel Maps (2)

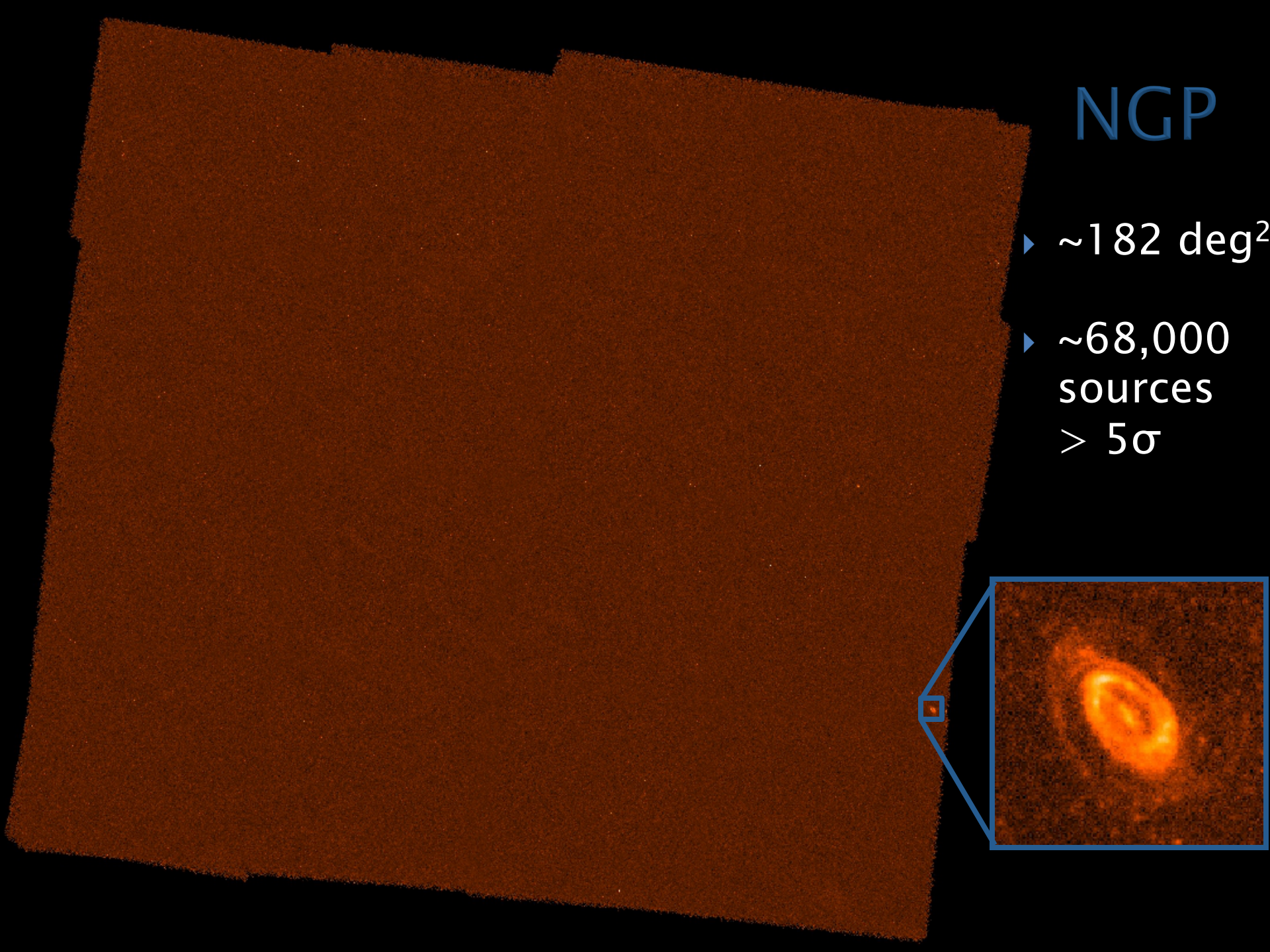


The H-ATLAS pipeline

- Very similar to BriGAdE
- Pascale et al. 2011
- No source masking as bright extended sources are rare.
- Instead of thermistor fitting on a per-scan the whole timeline is used and a 4° high-pass filter

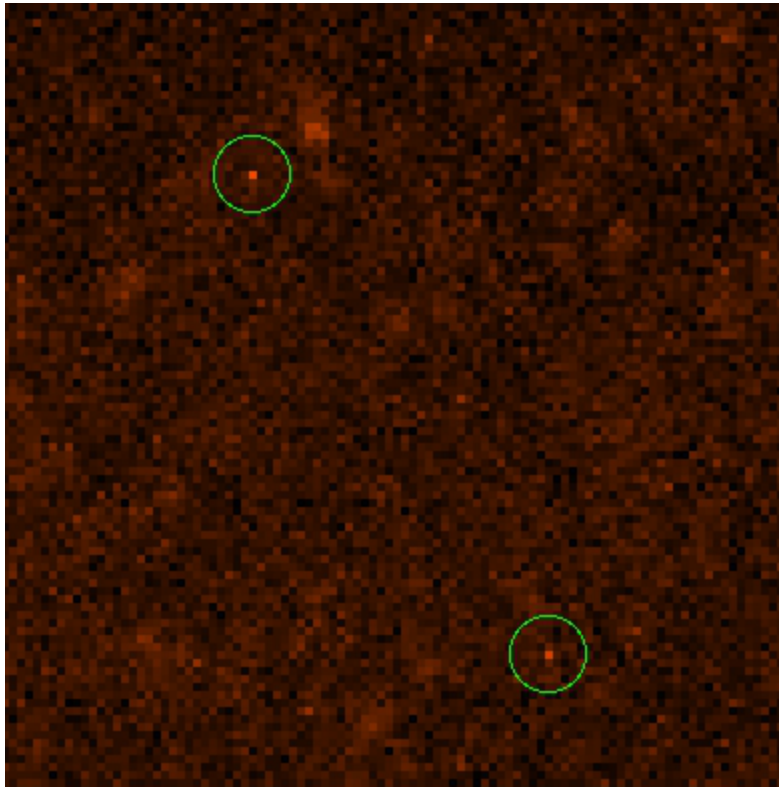
NGP

- ~182 deg^2
- ~68,000 sources $> 5\sigma$



Second order de-glitching

- Manual identification only locates the strongest artefacts.
- Many bright single pixels



Second order de-glitcher (2)

- Script based on one by Andreas Papageorgiou (with some modifications)
- Process:
  - Create low resolution map (PSW:18", PMW:24", PLW:36")
  - Loop over all bolometer samples (exlc. dead/flagged etc)
  - Sample identified as a glitch if,

$$\left| \frac{(Flux_{Sample} - Flux_{Map})}{(Error \times \sqrt{N_{sample}})} \right| > Threshold$$

N_{sample} is from coverage
Error is from error extension

  - Create new map and keep iterating (I set a max of 4)

Second order de-glitching

- HeViCS fields are ideal due to high coverage, but also works well for H-ATLAS
- The data have been reduced with the sigmaKappa deglitcher (as found works better for parallel mode)
- Not efficient to use de-striper as data set is too large
- The process converges with small number iterations (1 8-scan tile ~1.5hr)

For one tile

Iteration	Number Samples
1	146558
2	4336
3	184
4	26

Second order de-glitching (results)

- Difference map shows no tendency to mask sources

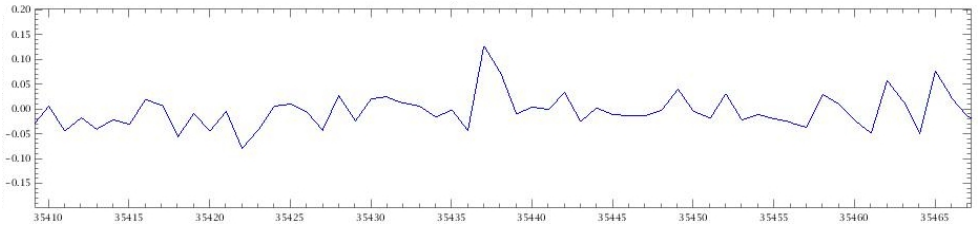
Number of Samples

Significance	Number Samples
Total (any >4σ)	151104
4 – 5 σ	128047
5 – 6 σ	14573
6 – 7 σ	4362
7 – 8 σ	1748
>8 σ	2374

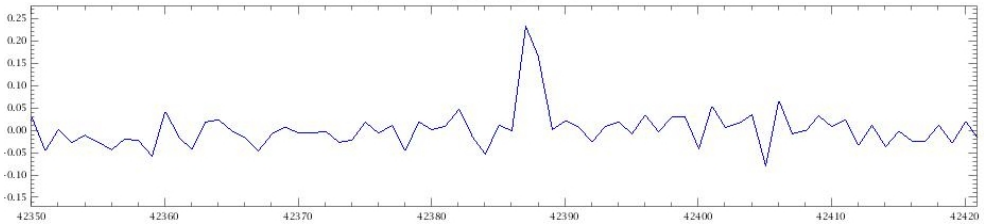
I decided to mask anything 5σ or above

Example of Identified Glitches

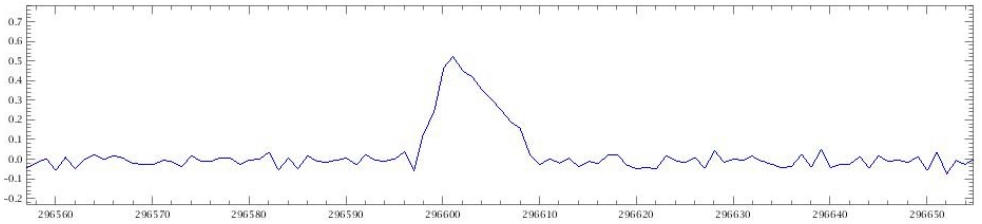
4σ



7σ



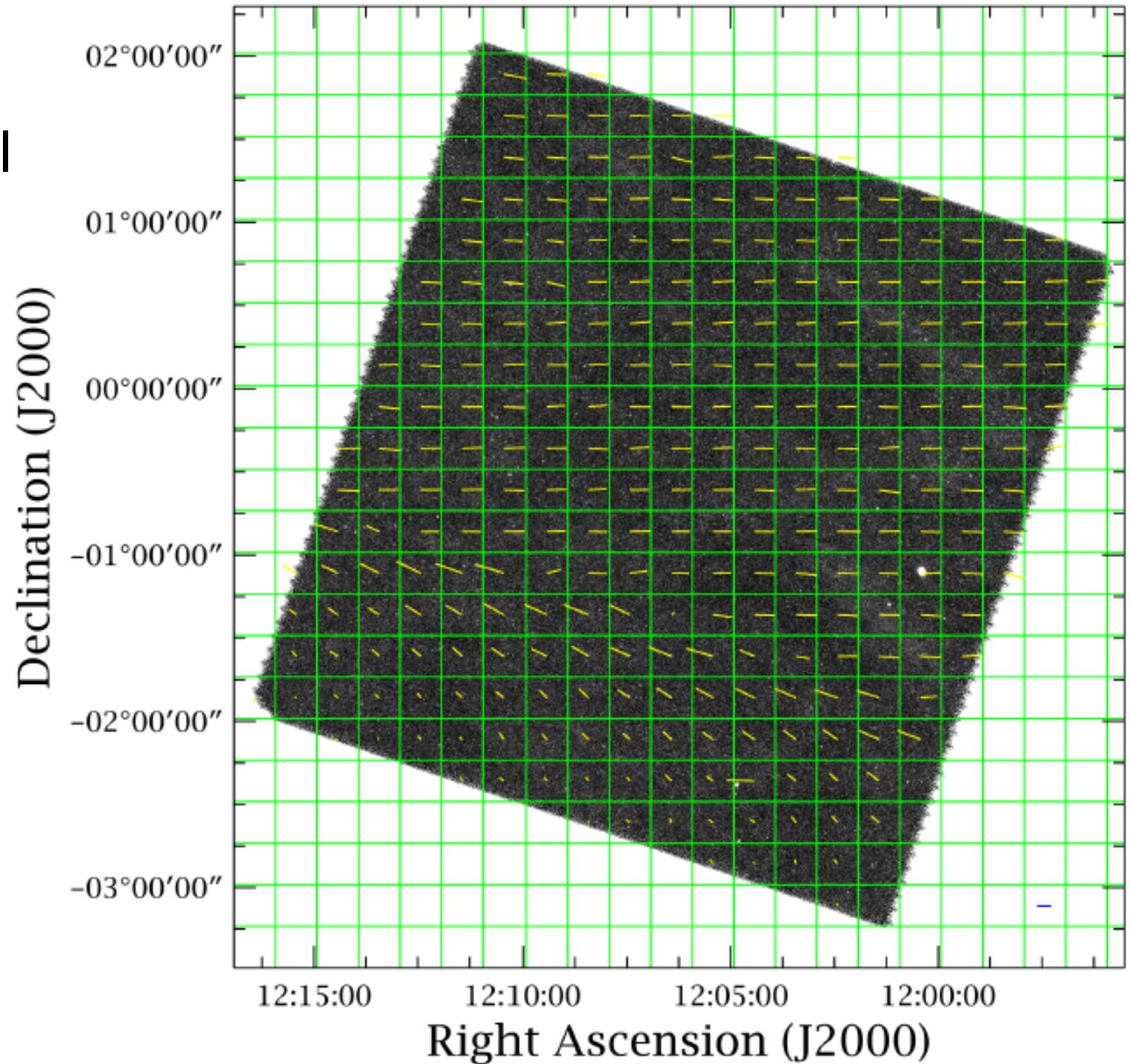
10σ



Astrometry

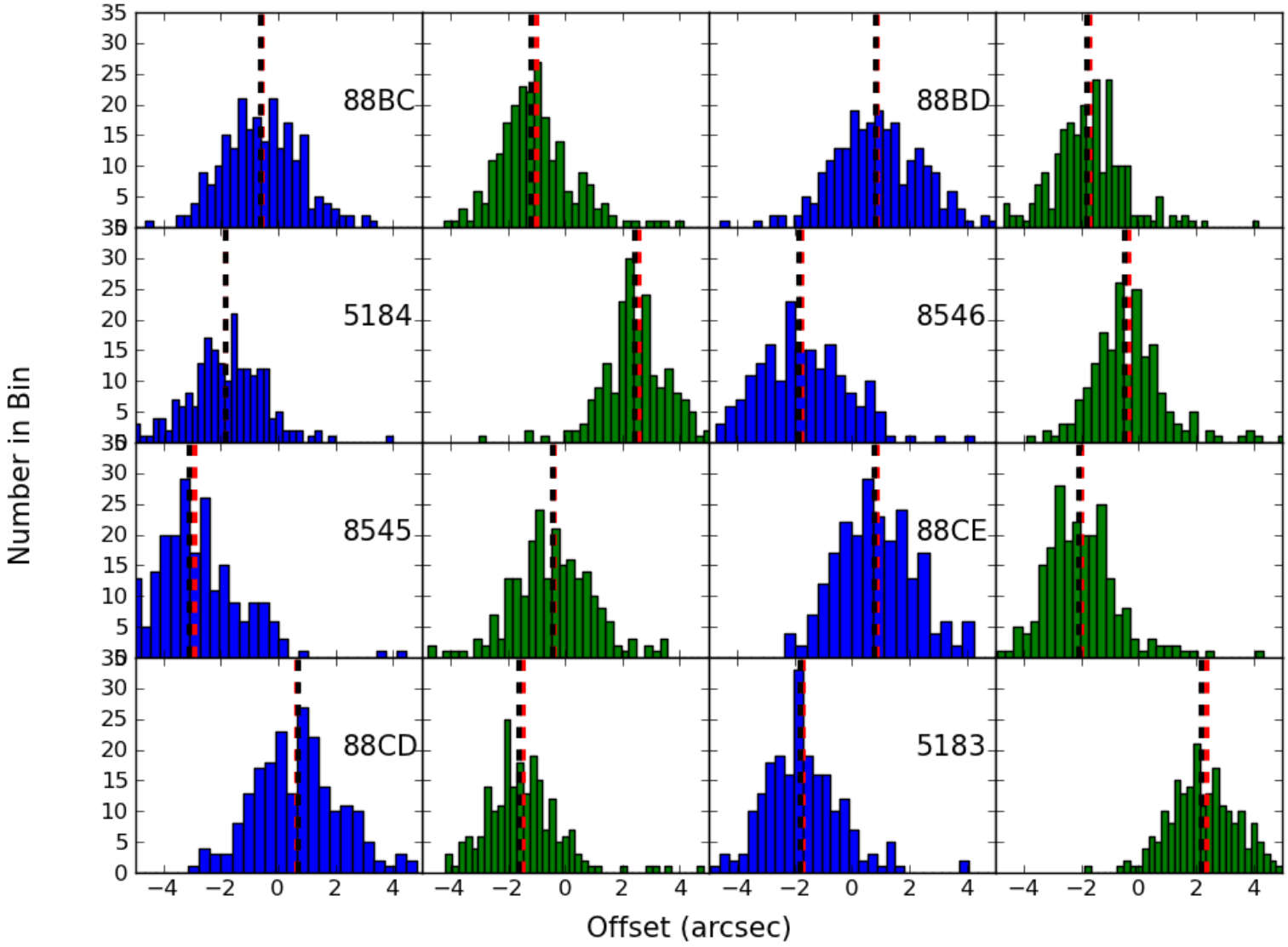
- Both H-ATLAS and HeViCS check the astrometry of each individual tile.
- Usually a fixed offset w.r.t. reference image (no overall rotation).
- Two methods applied:
  - Cross-correlation method
  - Matched point sources to external catalogue
- Usually just done for SPIRE as many more sources

- A special case

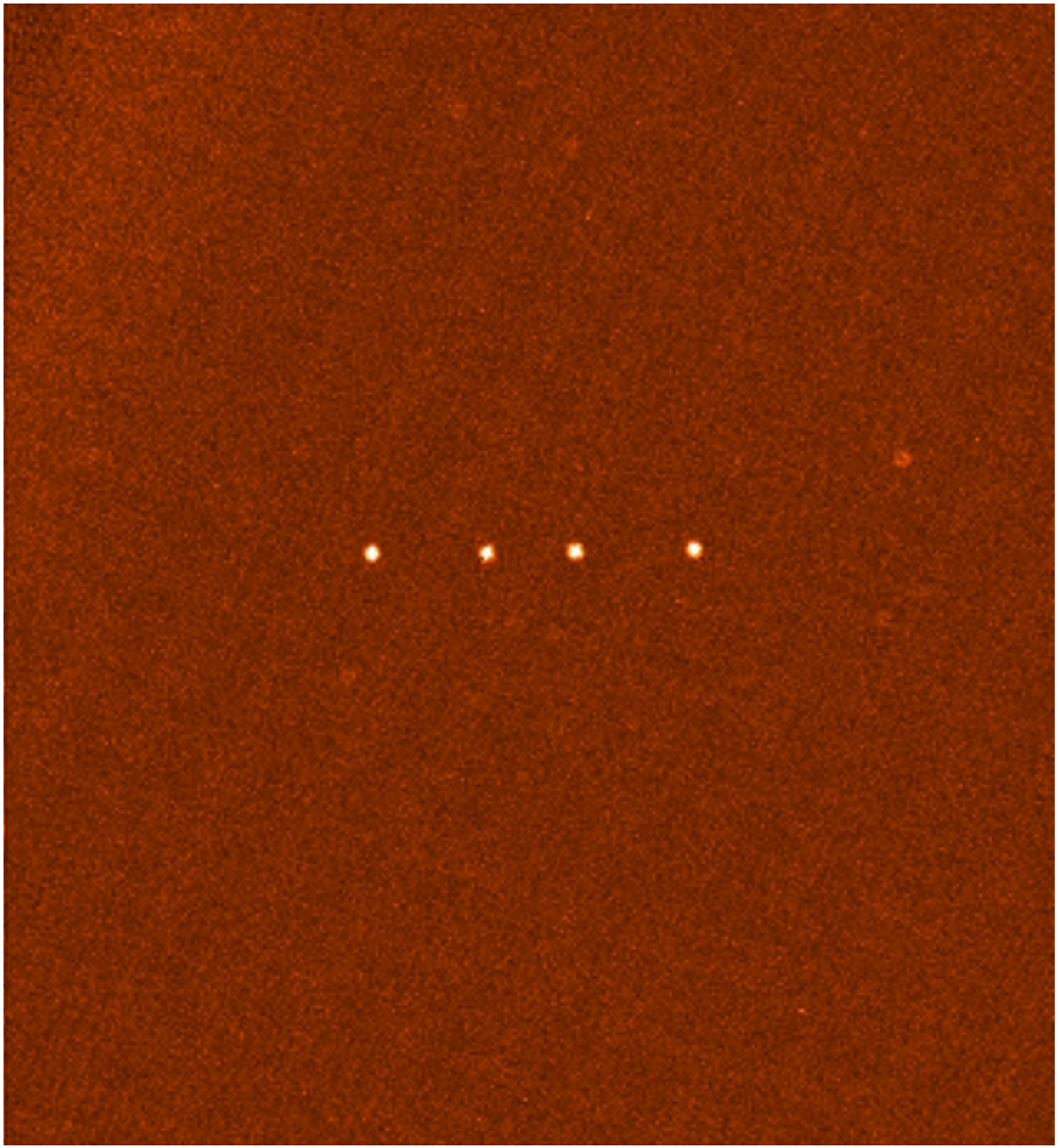


Astrometry (2)

~2" offsets in RA and Dec



Error Maps: they're worth a look



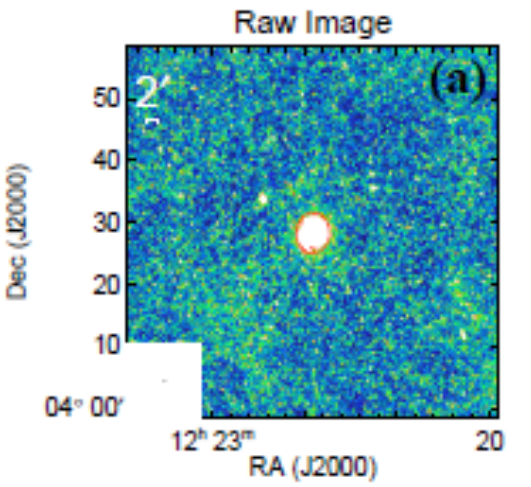
Asteroid: Nemesis

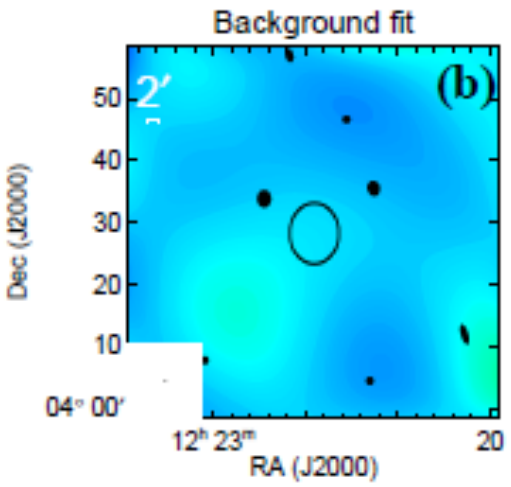
MAD-X Source Extraction

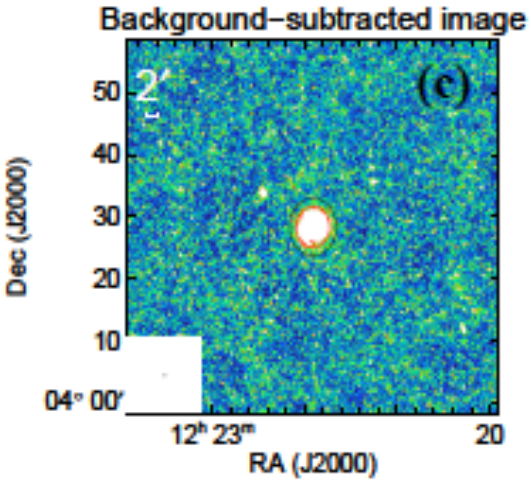
- S. Maddox et al. in prep
- Method to identify point sources on background removed maps
- Convolve each band with the PSF (or for confusion dominated other filters may be better)
- Weight each band, and locate peaks in combined image. (In practice often 250μm)
- Can weight bands differently for specific populations.

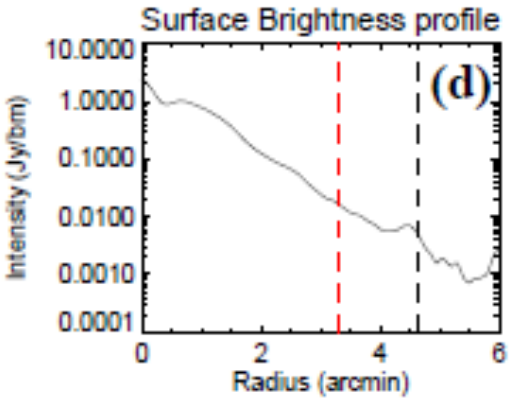
HeViCS Source Extraction

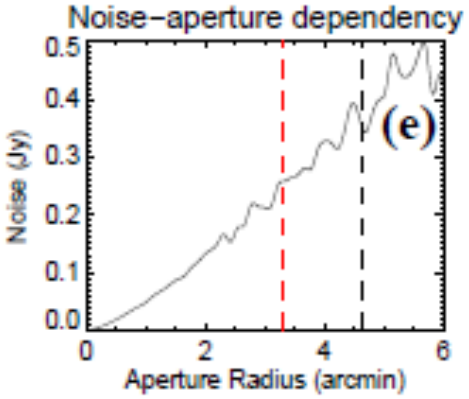
- HeViCS XII: Auld et al. 2012
- 254 of 750 VCC galaxies found
- Fluxes, Dust masse and upper limits fo all VCC objects in the field

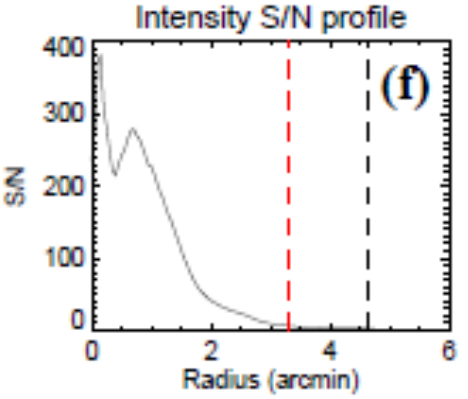




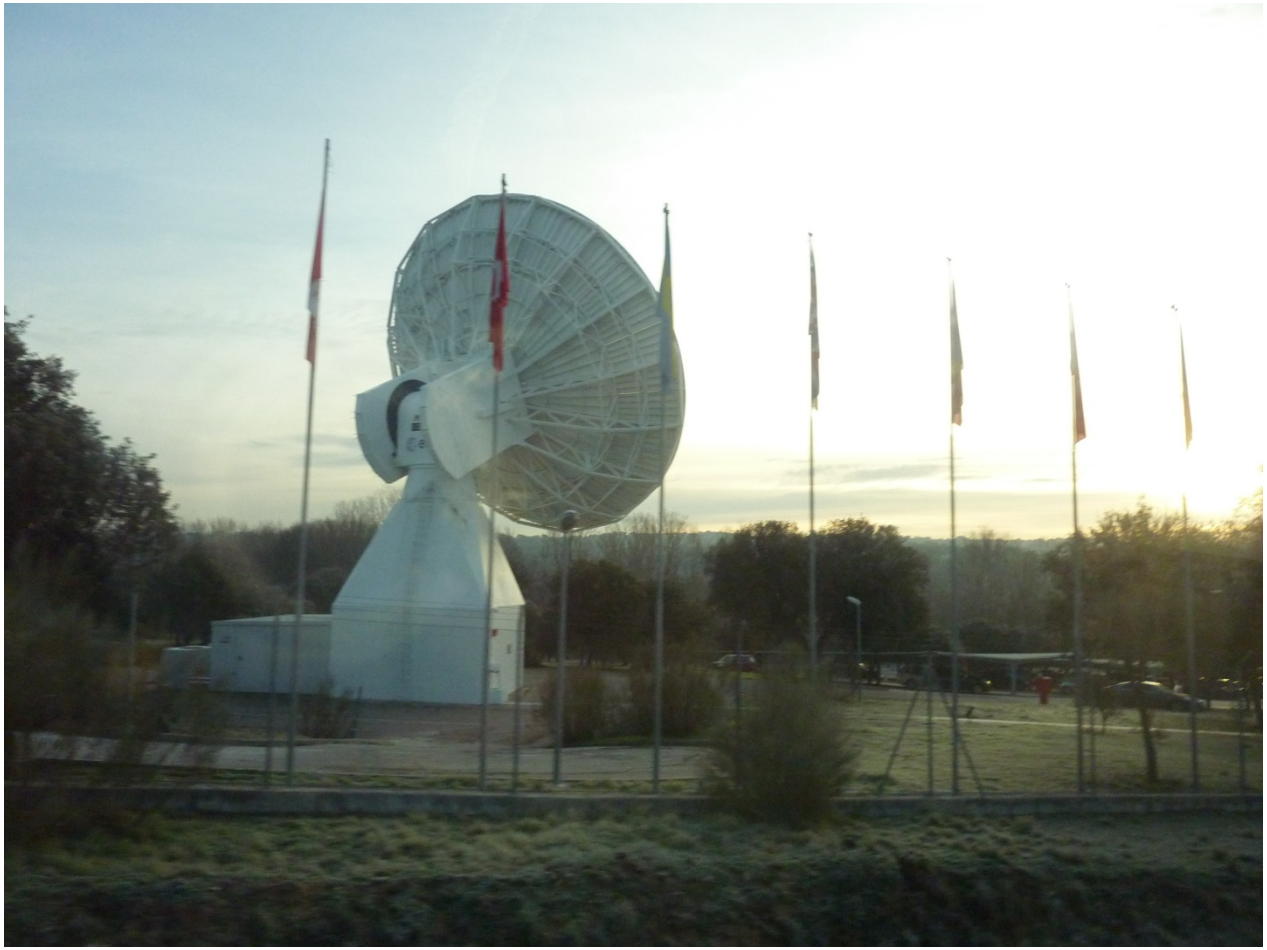








Thank You For Listening



Any Questions?