New methodologies for Galactic data reduction and analysis

Francesco Cavallaro

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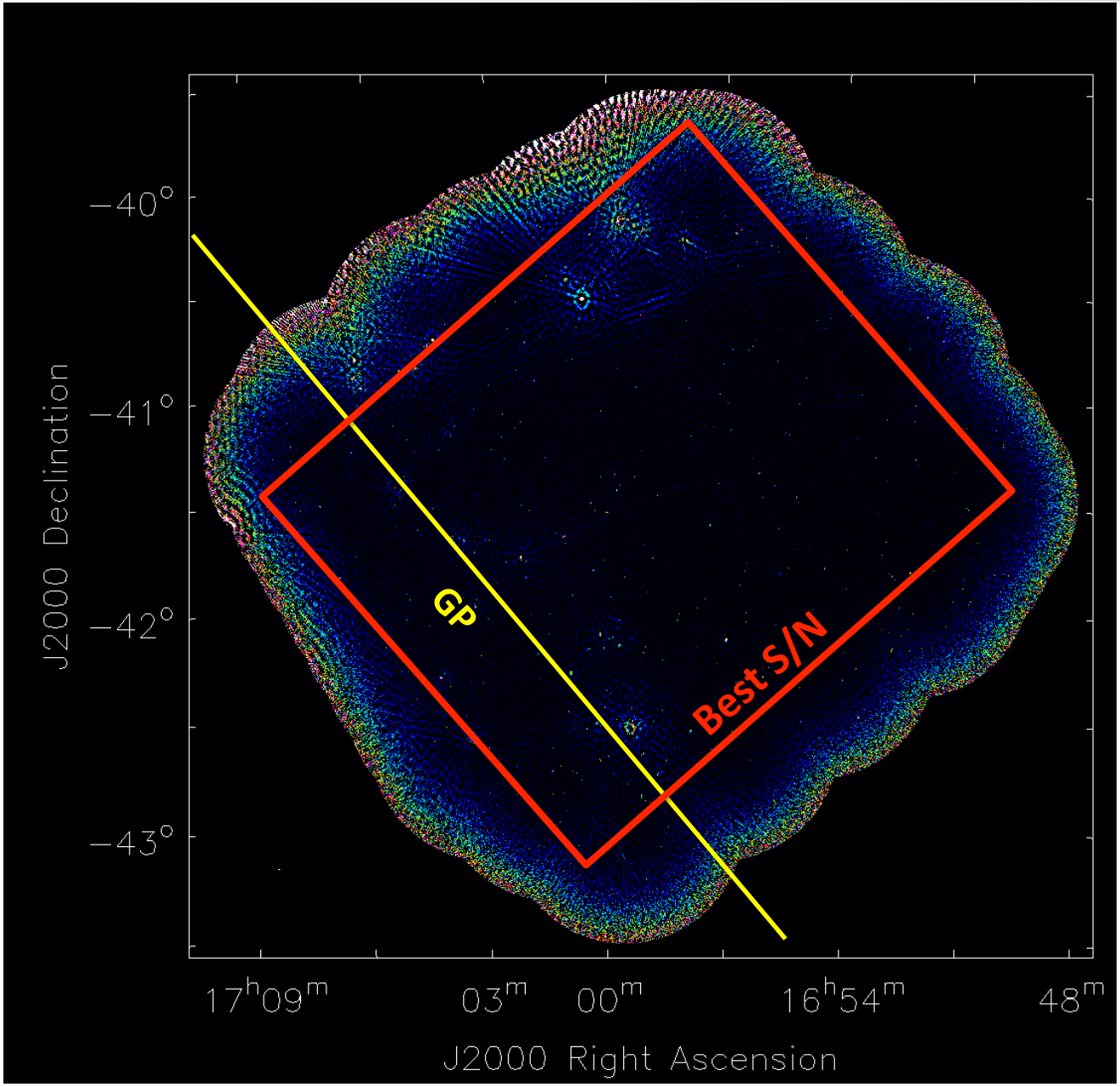
The whole map

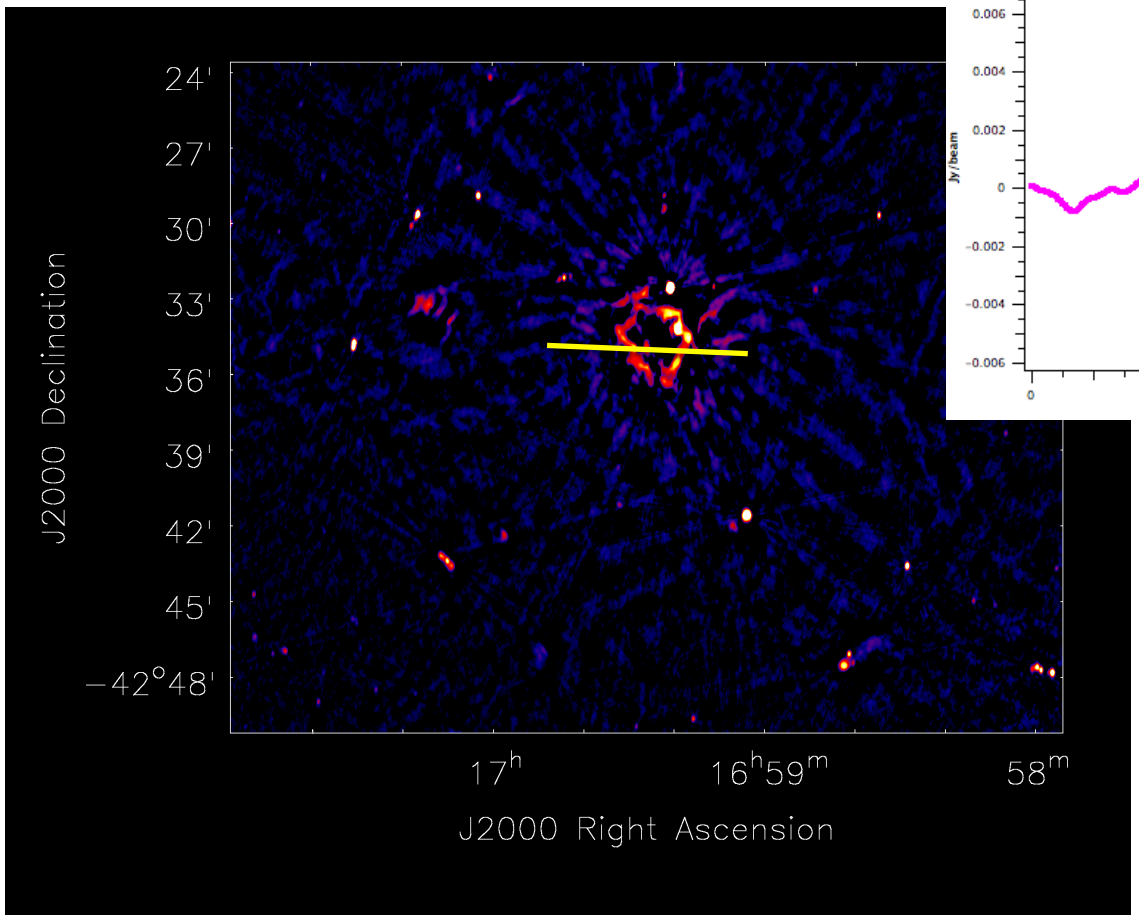


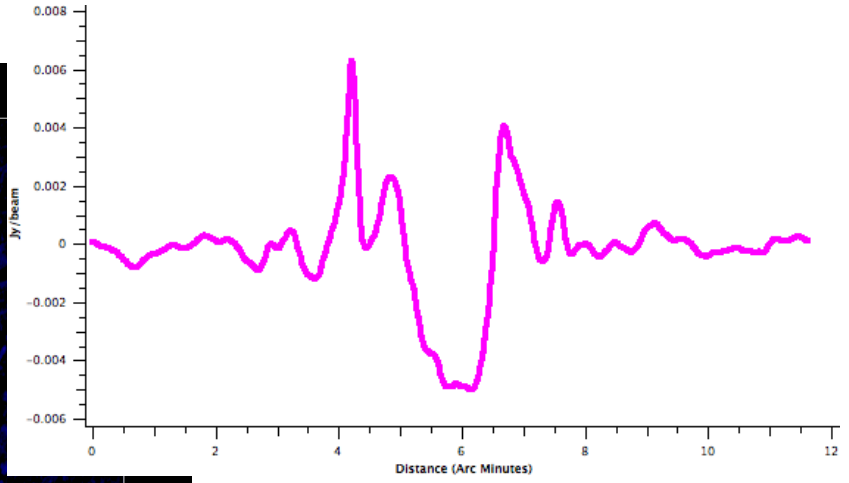
Map analysis in GP

For the two maps with 6a and 6B configs,
LAS is inadequate for the source extension

bubble S17: size 1', 10'

B_{min}= 3 kλ LAS<1'
B_{max}= 40 kλ res=5"





artfacts:

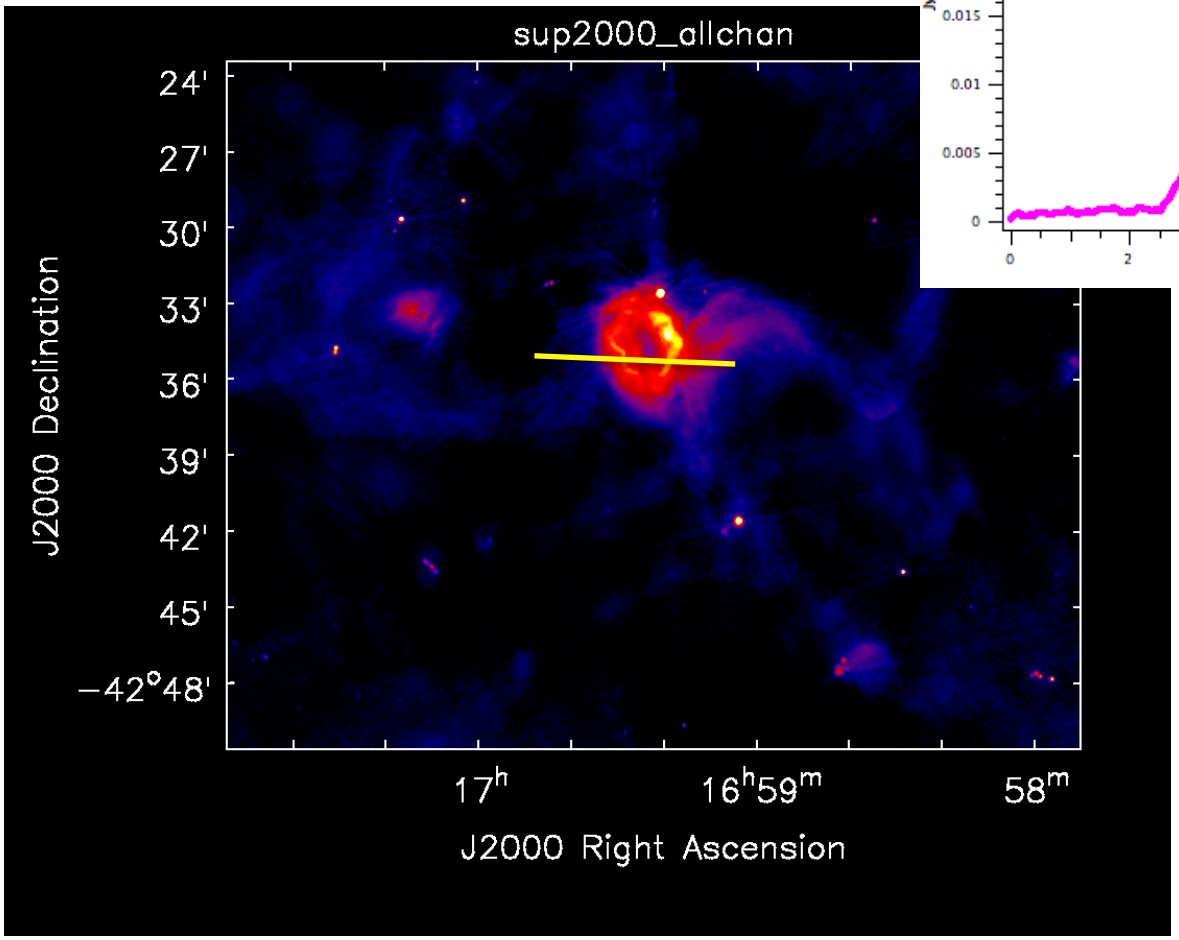
deep negatives
loss of flux in extended sources

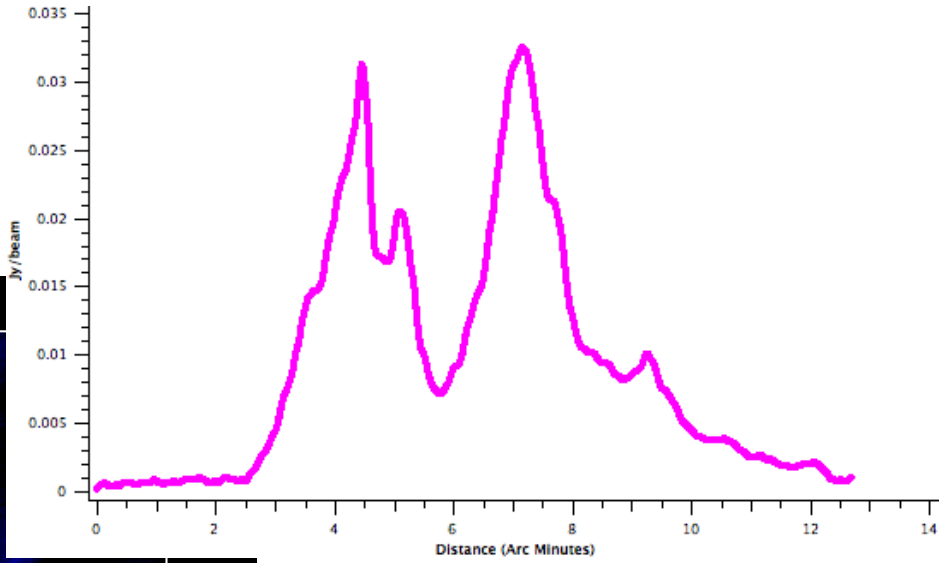
high rms (σ≈150-200 μJy/beam)
prevents to detect point sources

Map analysis in GP

Adding short baseline obs: EW367 config

B_{min}= 400 λ LAS=6’
B_{max}= 40 kλ res=5”

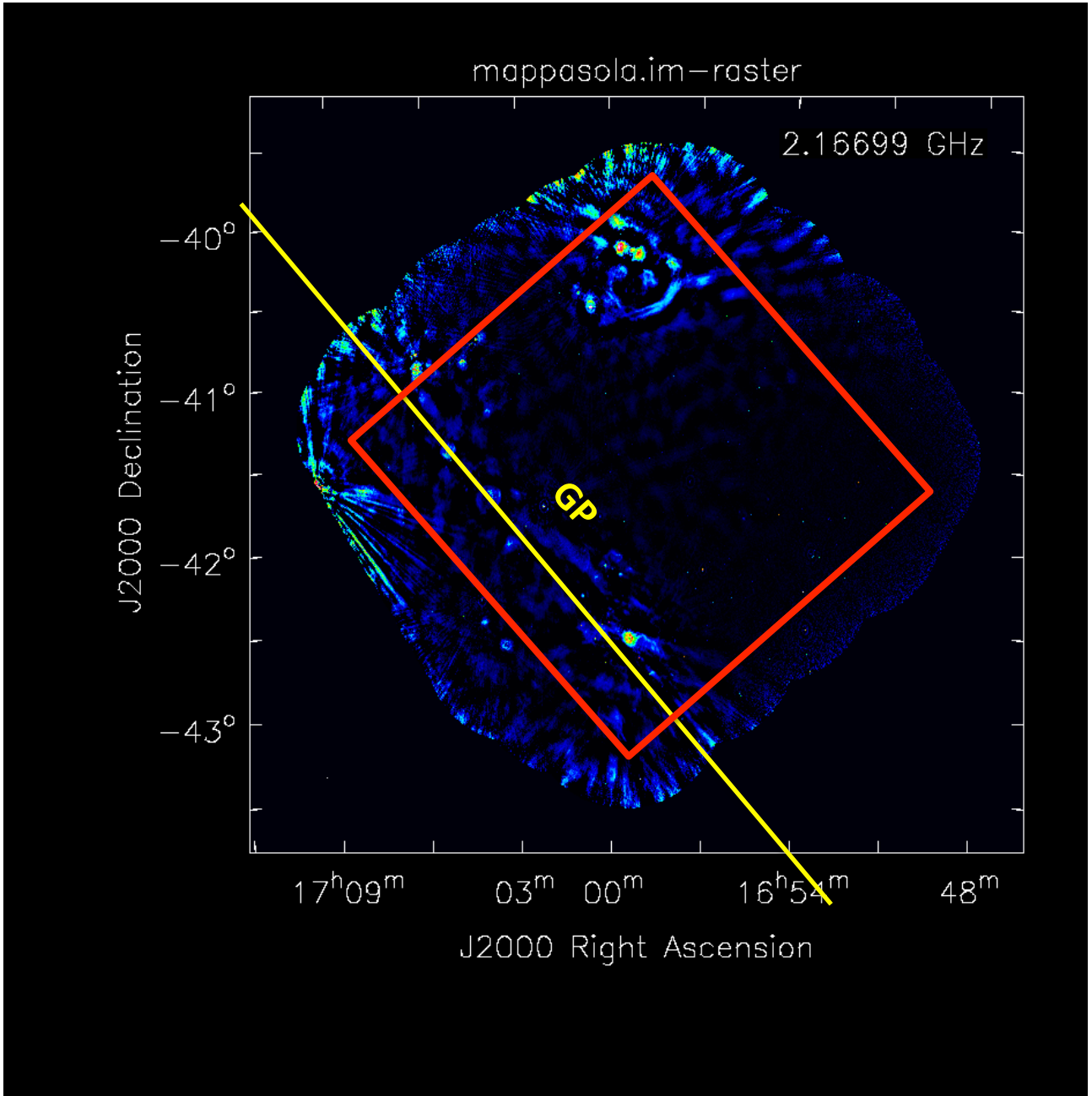


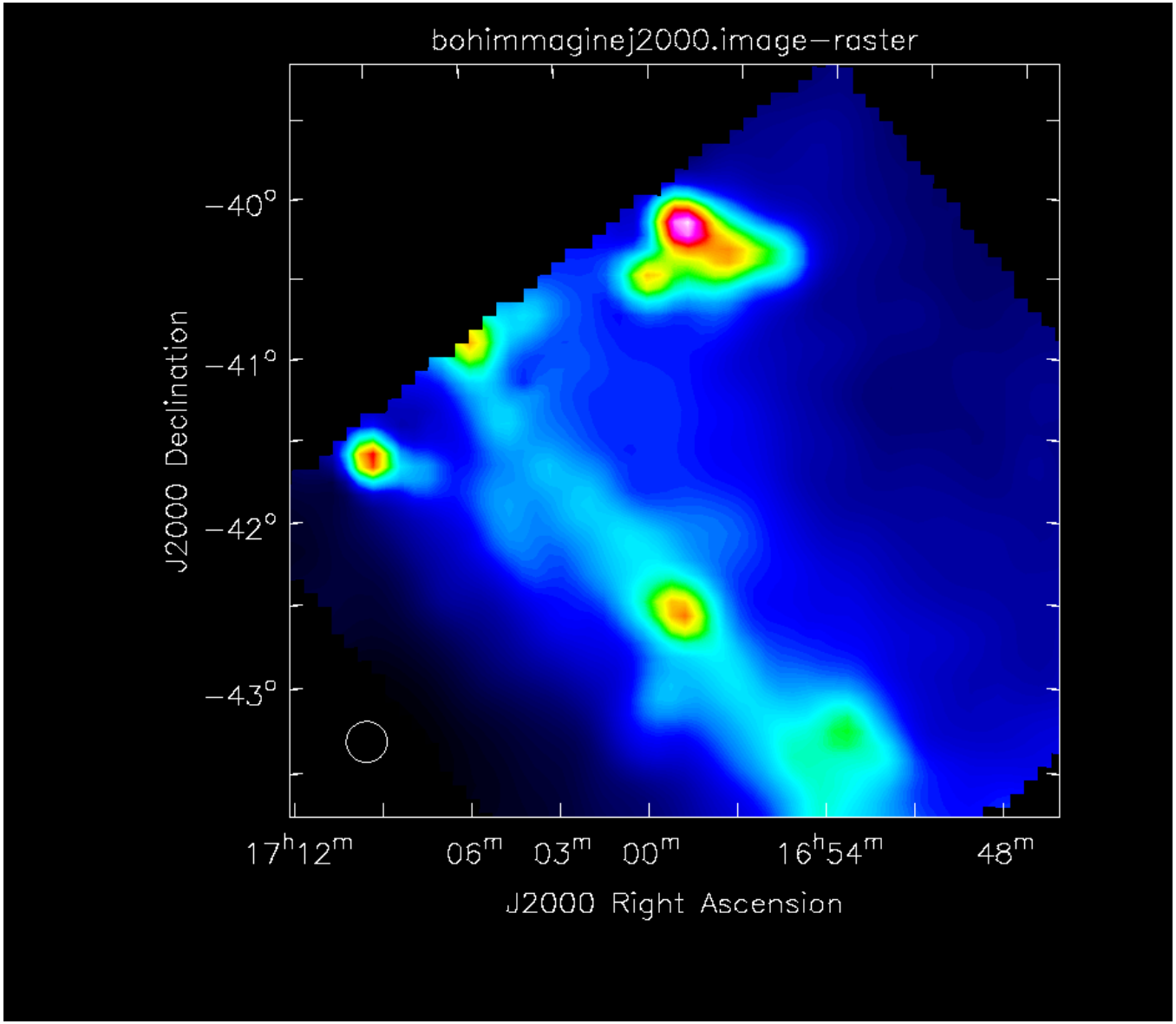


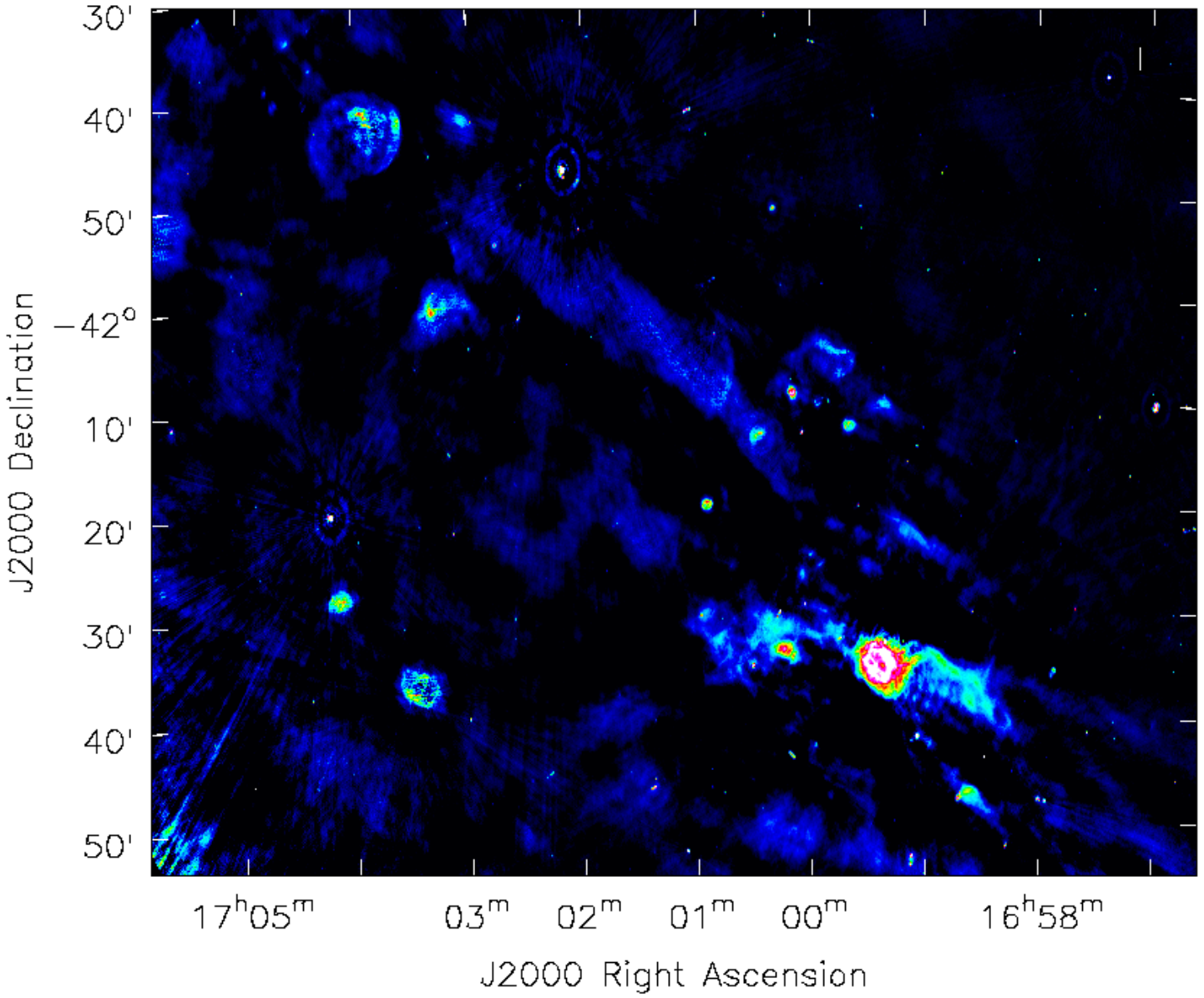
Map obtained in Miriad

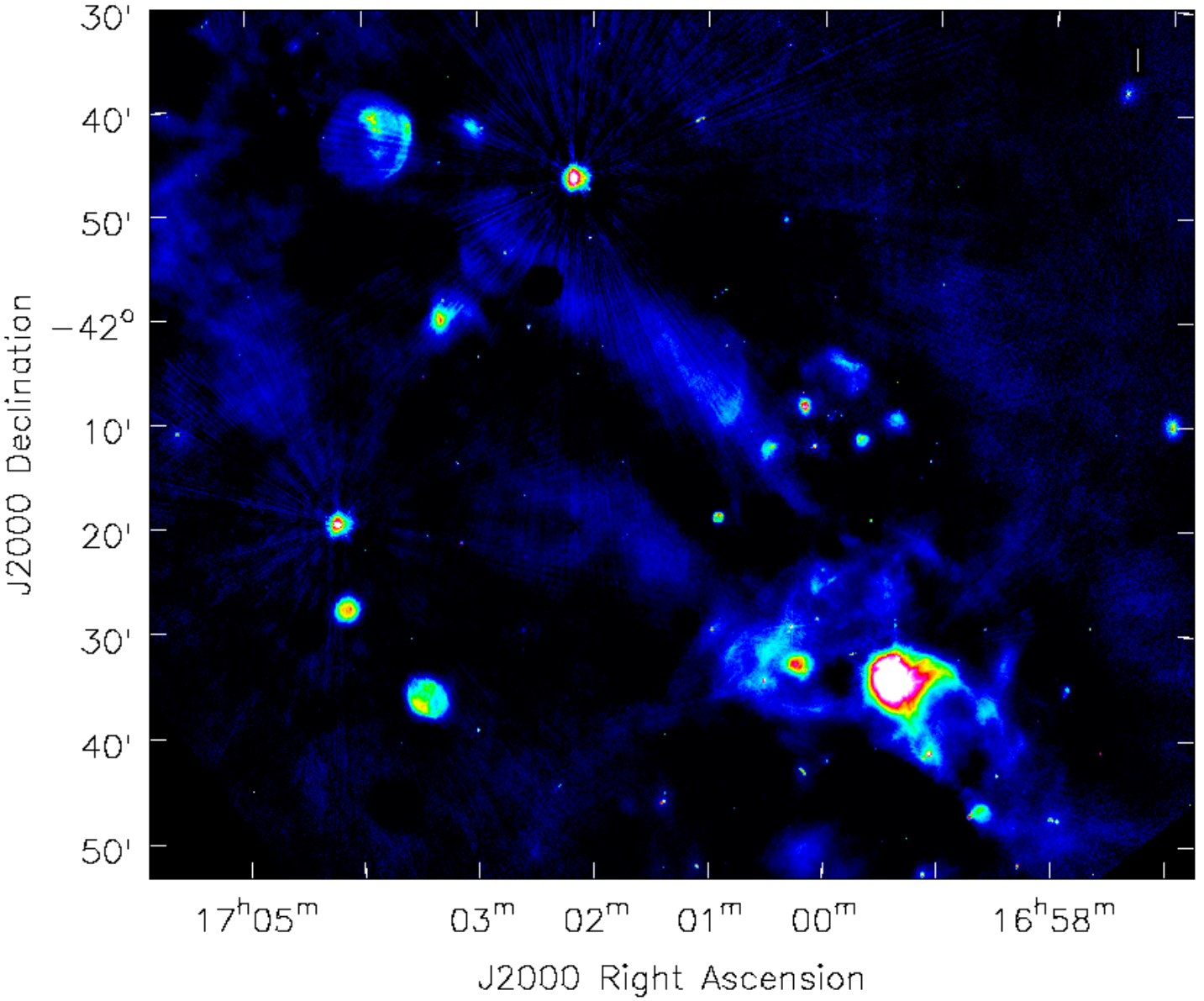
Adequate to bright extended sources

The final map




bohimmaginej2000.image−raster
−40°
−41°
−42°
−43°
J2000 Declination
17h12m
06m
03m
00m
16h54m
48m
J2000 Right Ascension


30'
40'
50'
−42°
10'
20'
30'
40'
50'
J2000 Declination
17h05m
03m
02m
01m
00m
16h58m
J2000 Right Ascension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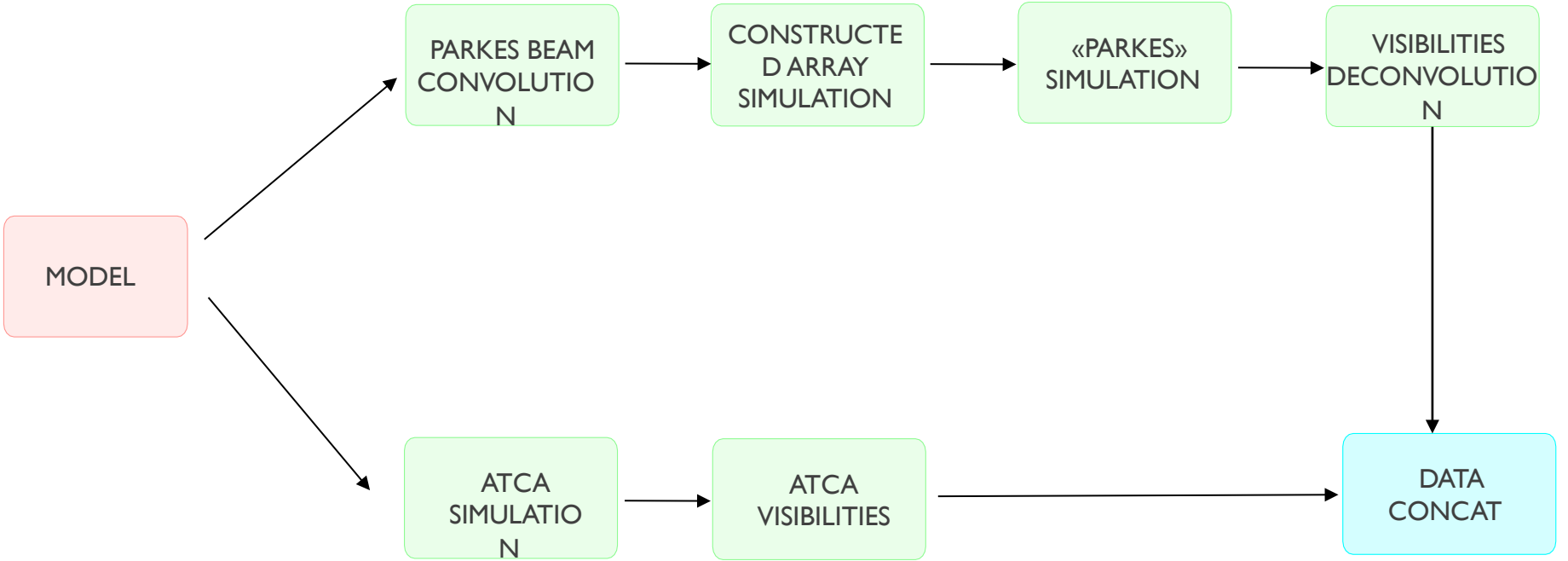
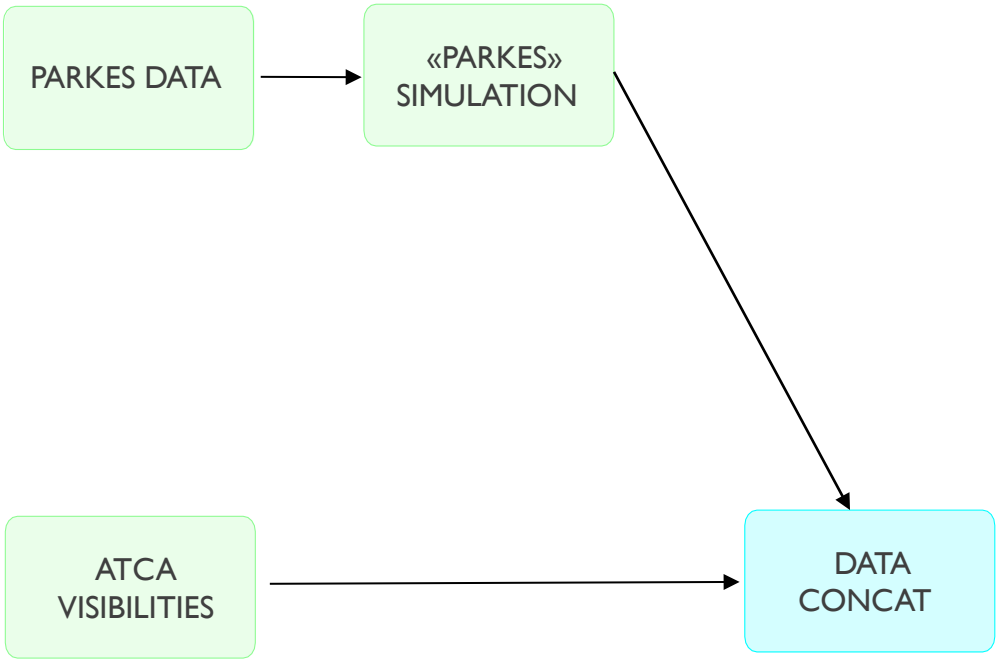
Simulation data flow:

- creating a visibility dataset from single dish images, concatenating with ATCA visibilities, CLEANing



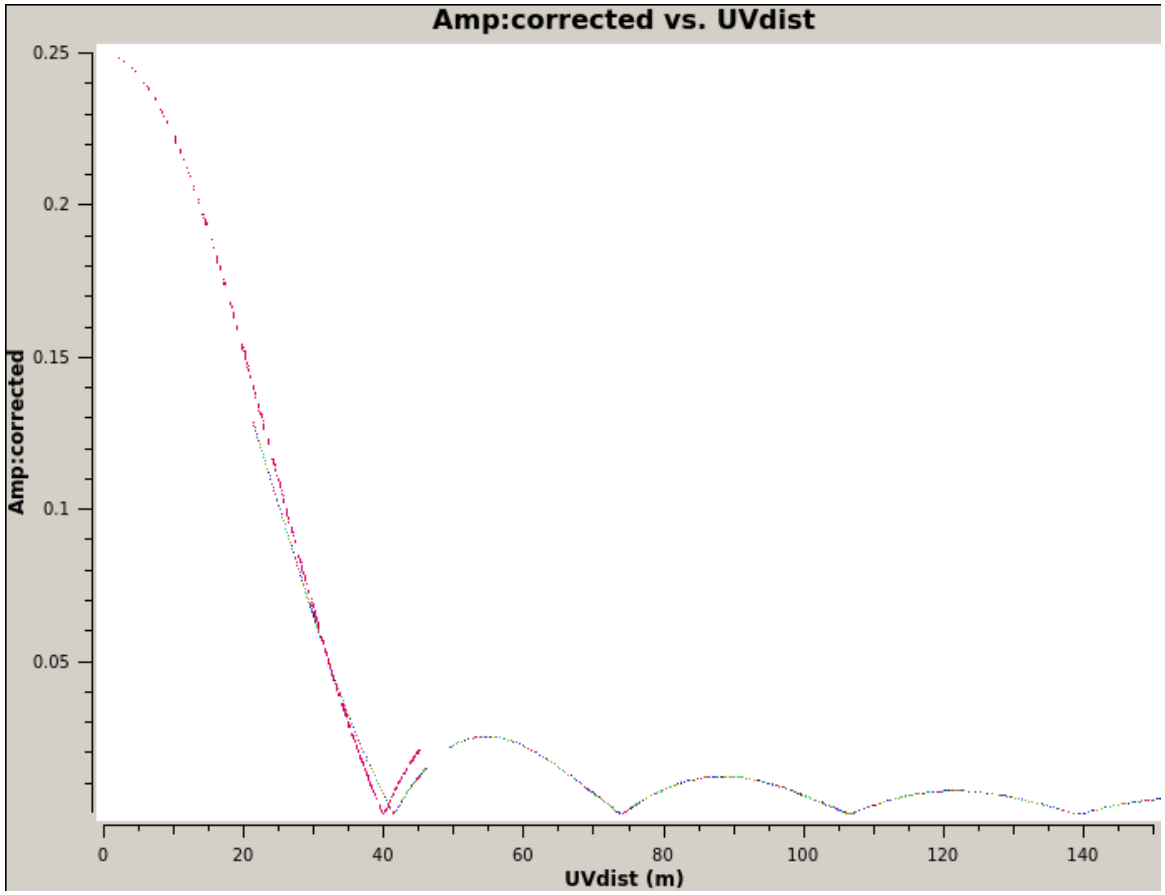
Merging single-dish and interferometric data

- Create a visibility dataset from single dish images
- Concatenate it with interferometric visibilities
- CLEAN the result



Disk model

- Simulating a 15’ disk (LAS ~ 6’) and concatenating ATCA and Parkes simulations



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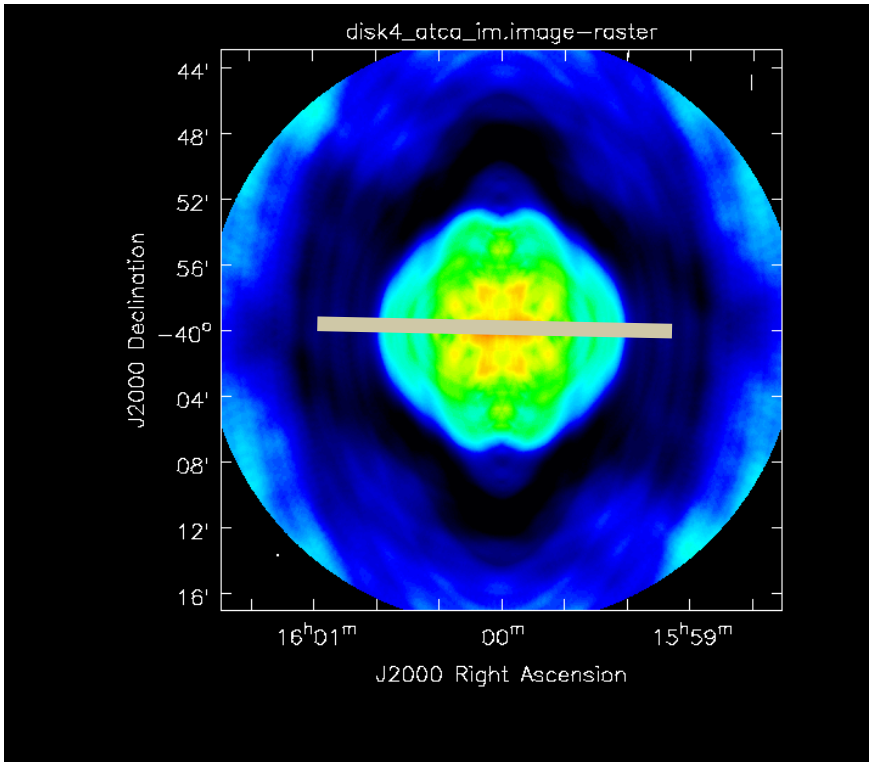
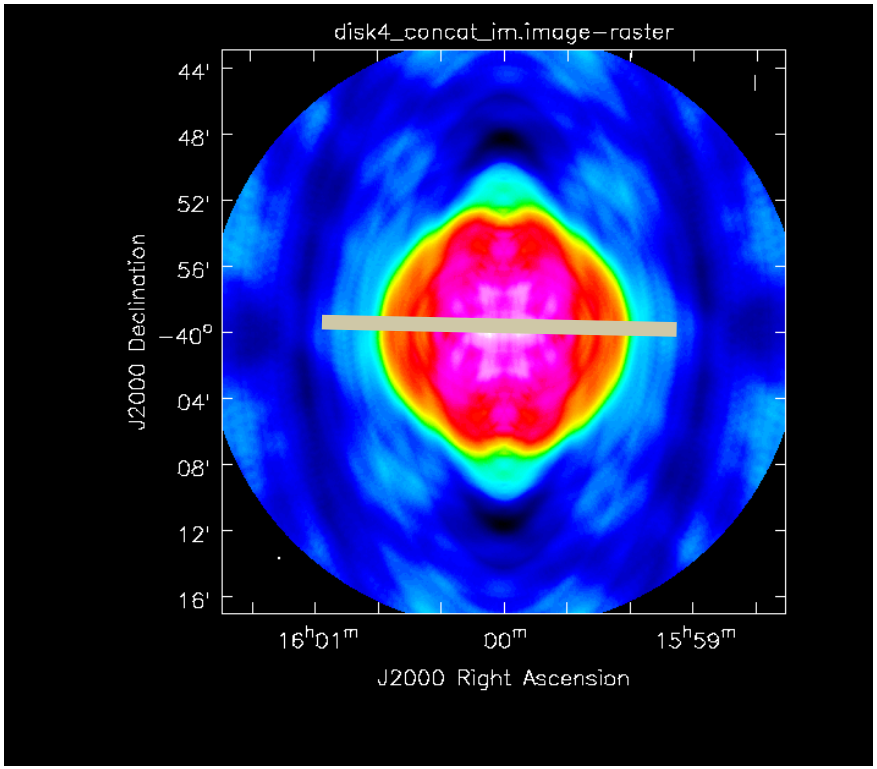
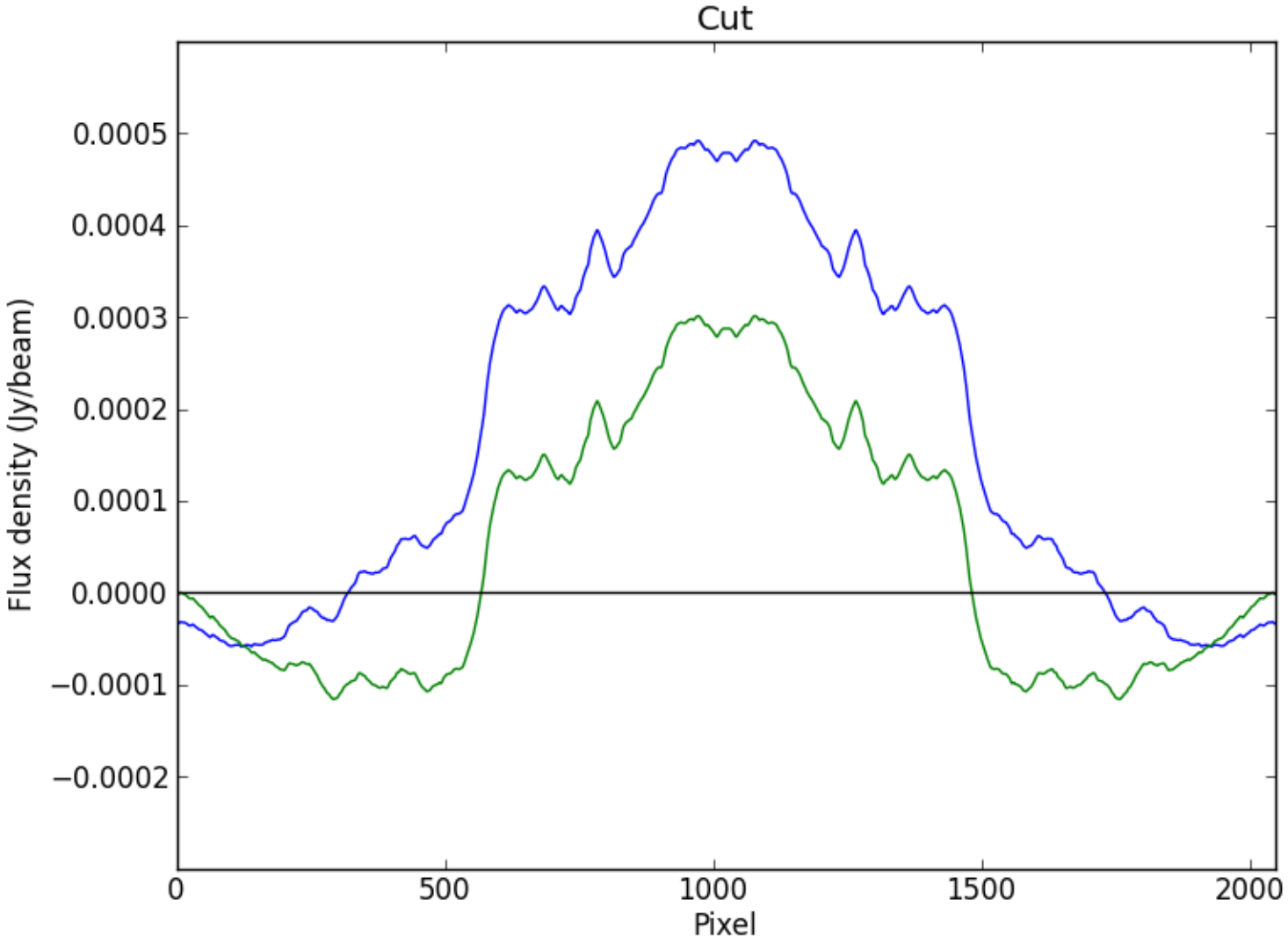


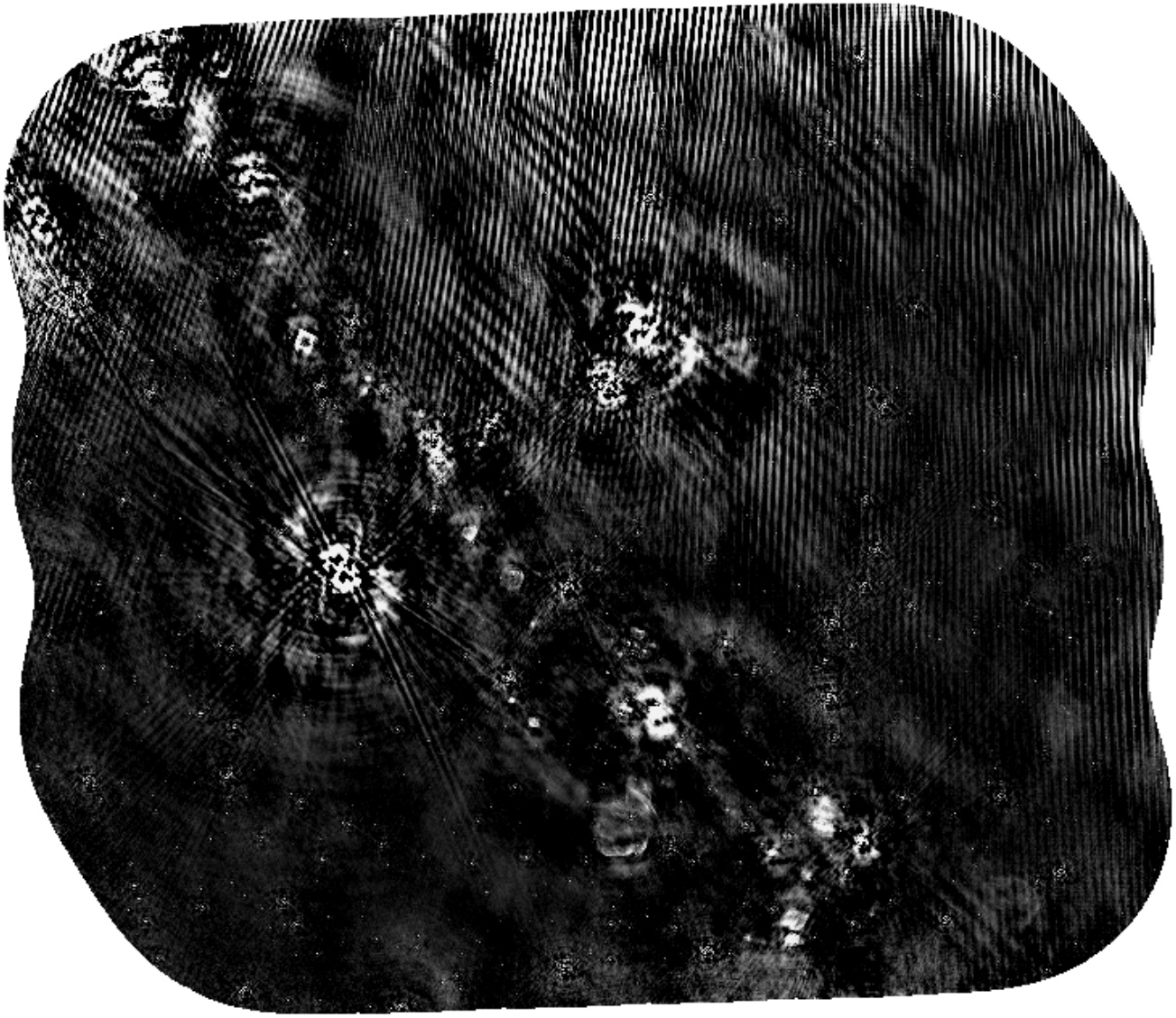


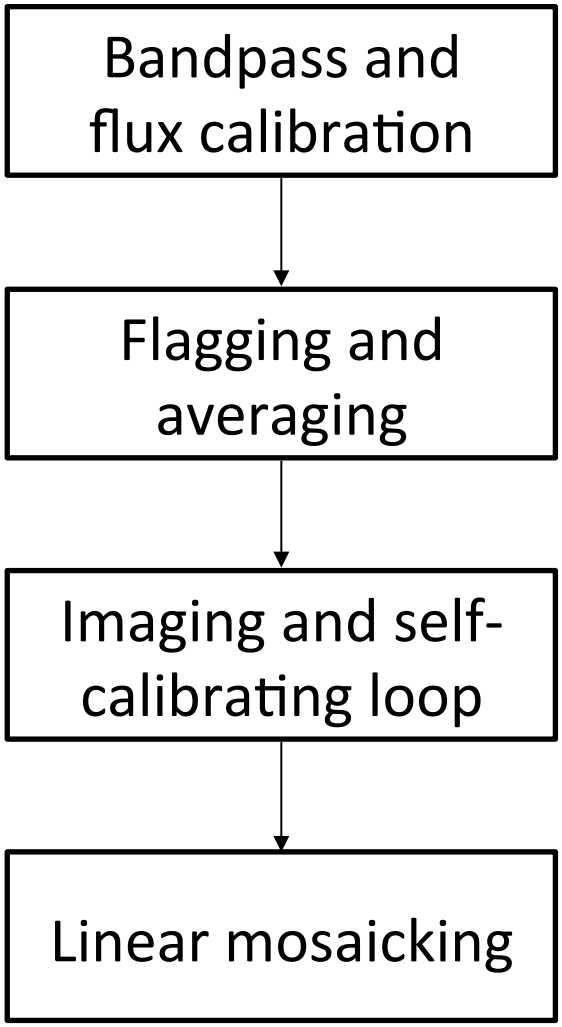

Cut
Flux density (Jy/beam)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
−0.0001
−0.0002
0
500
1000
1500
2000
Pixel

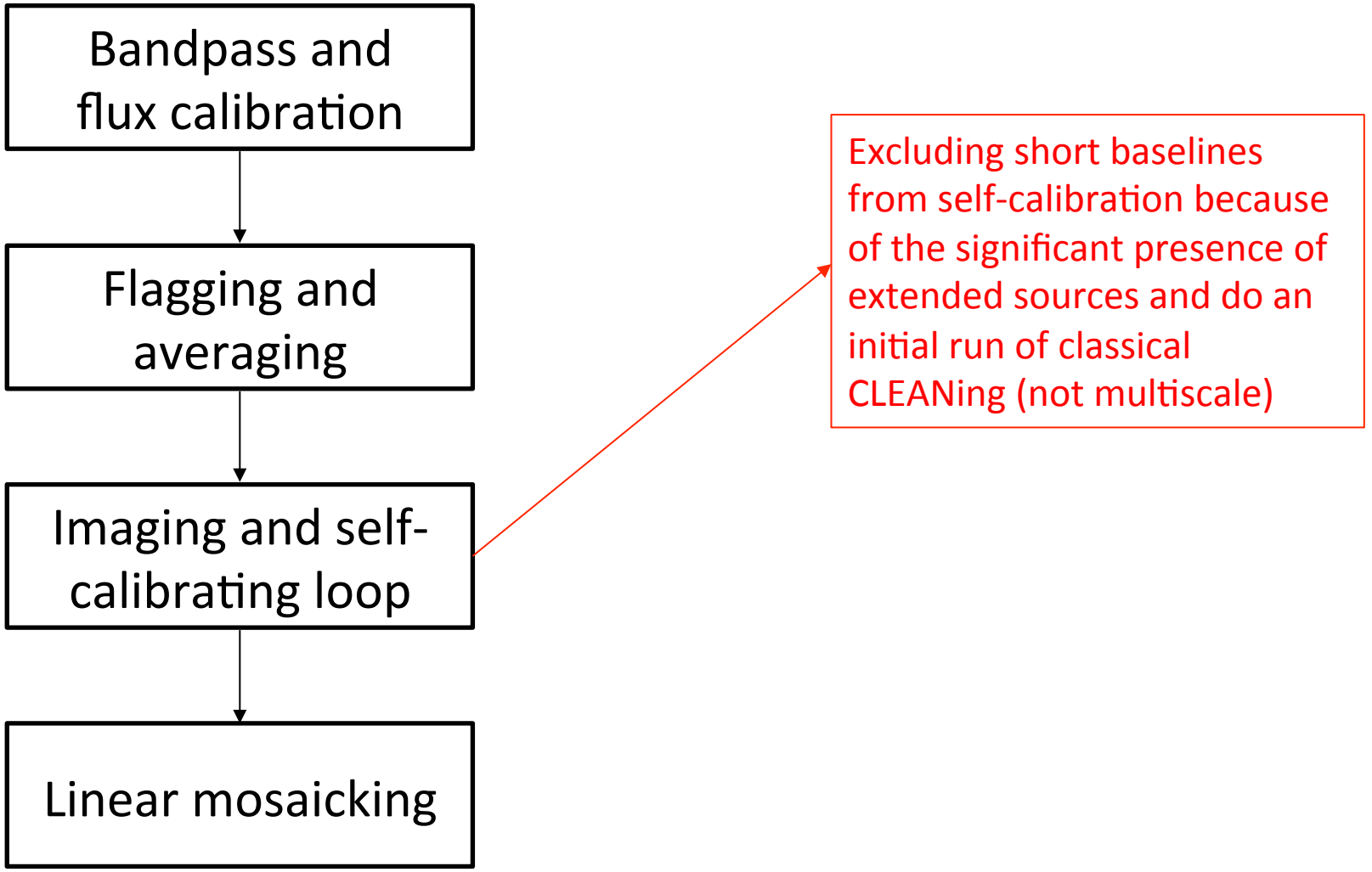
Merging interferometric and single dish data

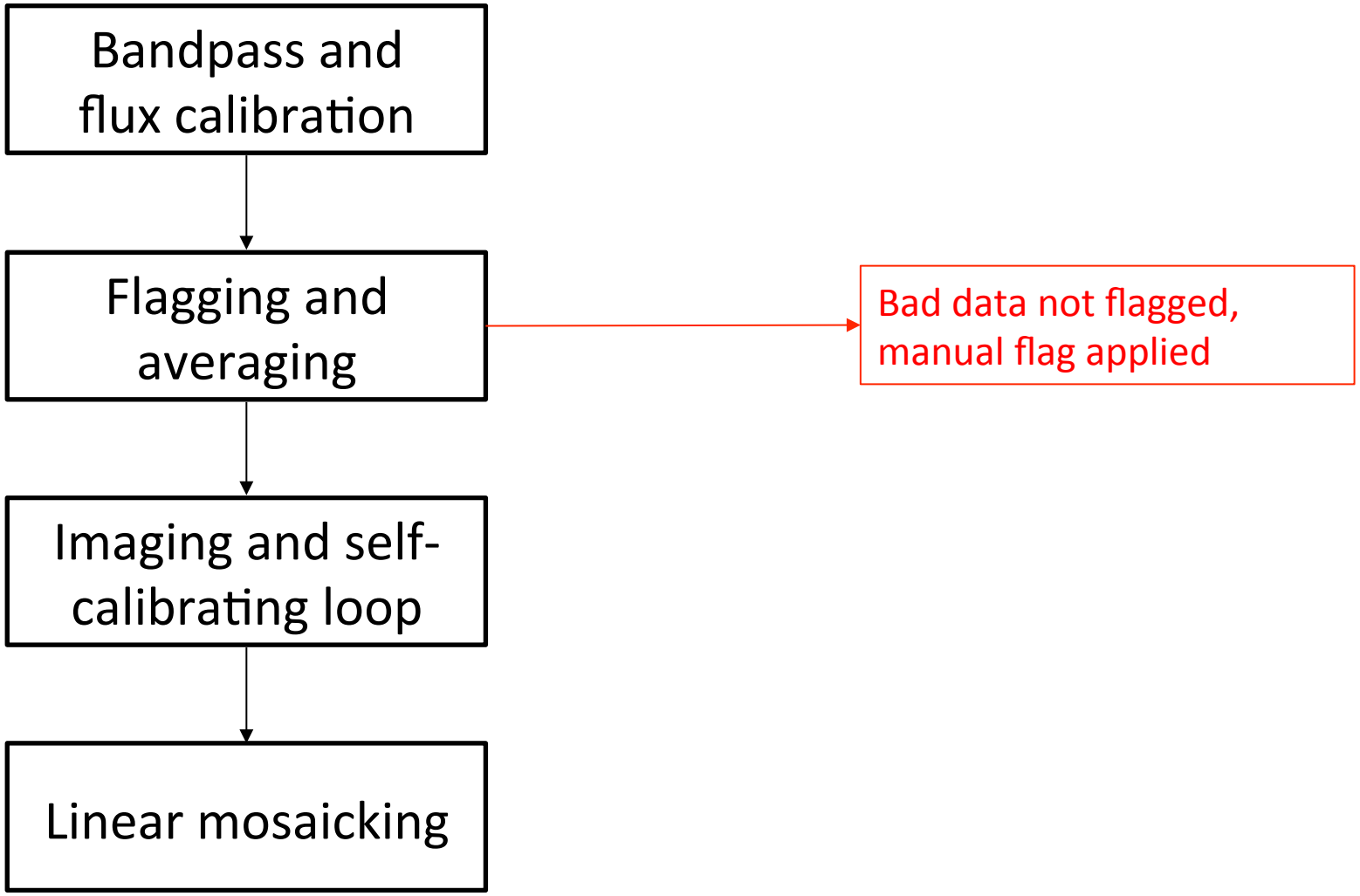
- Simulating a 15’ disk (LAS ~ 6’) and concatenating ATCA and Parkes simulations

Standard ASKAPsoft pipeline

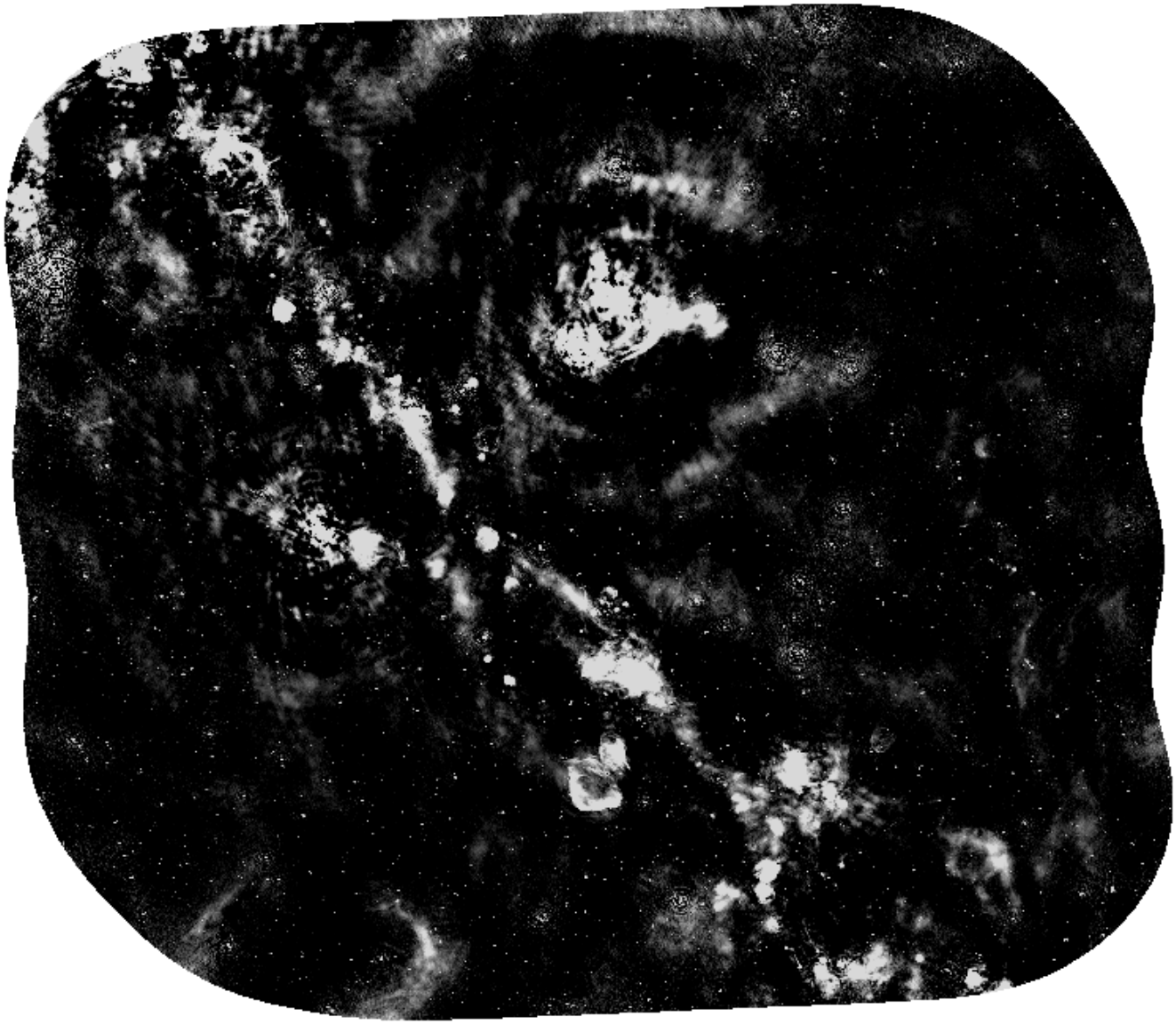



Bandpass and flux calibration
Flagging and averaging
Imaging and self-calibrating loop
Linear mosaicking


Bandpass and flux calibration
Flagging and averaging
Imaging and self-calibrating loop
Linear mosaicking
Excluding short baselines from self-calibration because of the significant presence of extended sources and do an initial run of classical CLEANing (not multiscale)

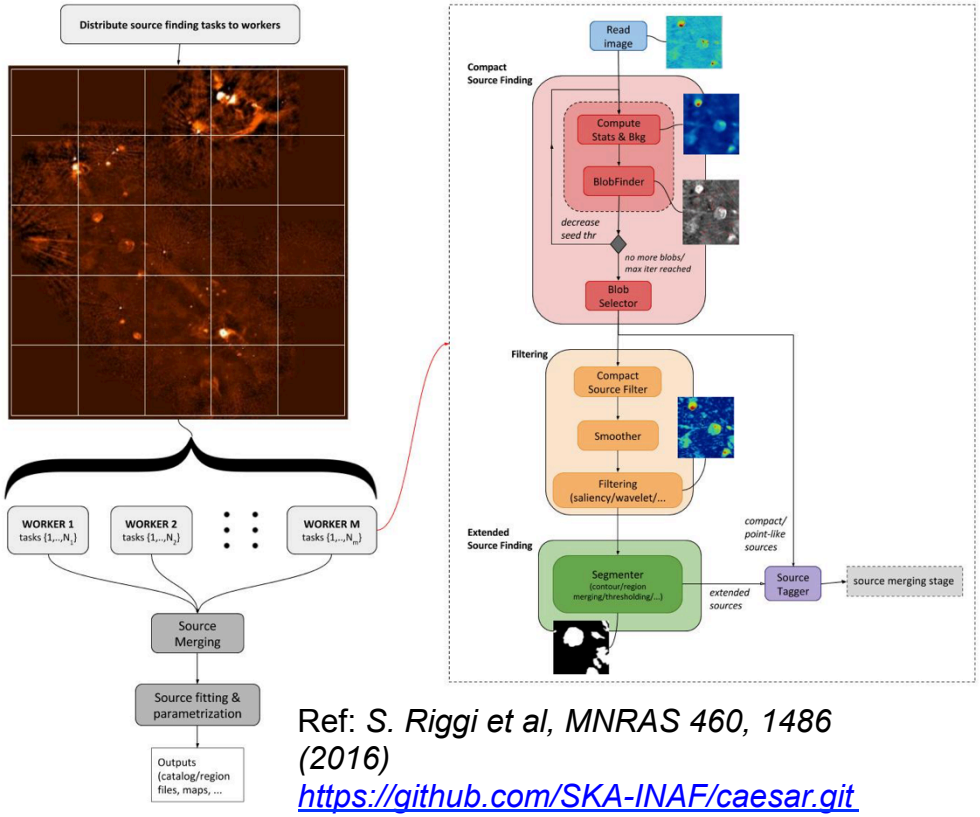

Bandpass and flux calibration
Flagging and averaging
Imaging and self-calibrating loop
Linear mosaicking
Bad data not flagged, manual flag applied

Fine tuned parameters map



Status of existing source finders

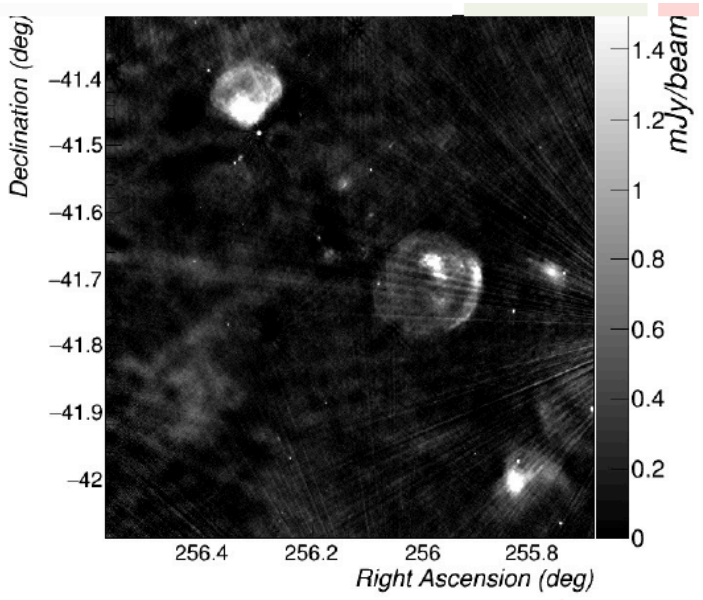
- Comparable performances on simulated extragalactic-like fields (*ASKAP Data Challenge*)
- Current limitations and areas of development
  - Designed for point-like sources, no detailed testing on Galactic fields
  - Reliability, deblending, fit robustness to be improved
  - Lack of scalability (large images, high source densities), support for parallel processing
  - Maintainability and extensions (e.g. few providing an API)

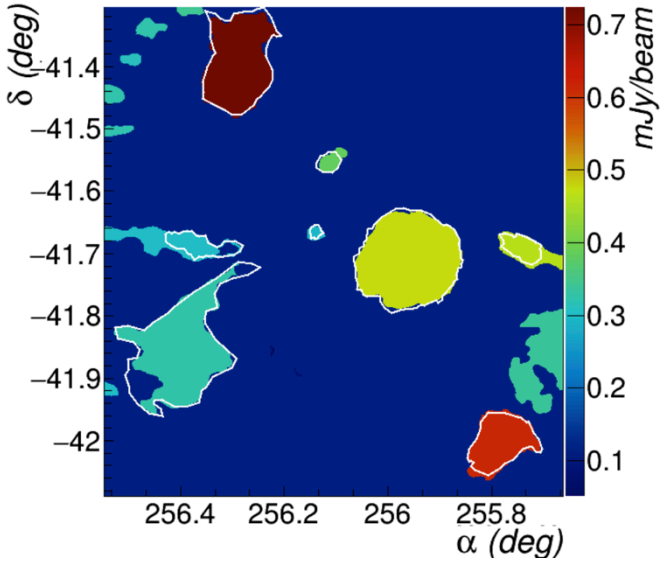


Ref: *S. Riggi et al, MNRAS 460, 1486 (2016)*
https://github.com/SKA-INAF/caesar.git

CAESAR Source Finder

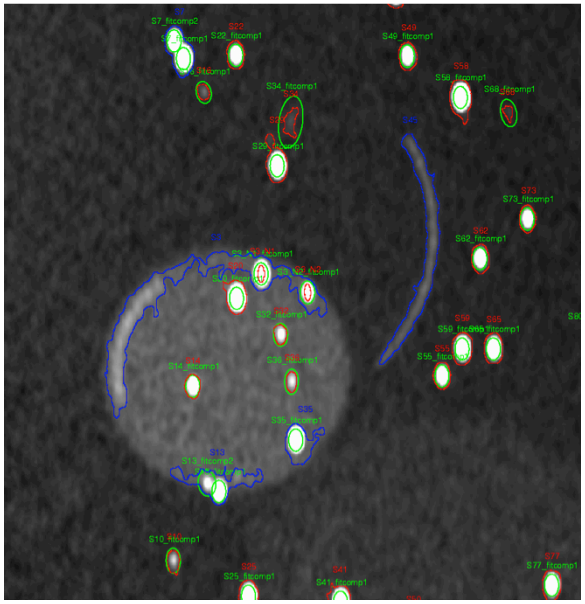
- Developed within SCORPIO & ASKAP EMU surveys
- Main features
  - Both compact and extended source finding
  - Multithread & parallel processing
- Current status
  - Tested with SCORPIO ATCA & ASKAP data
  - Detailed testing and performance evaluation with simulations ongoing

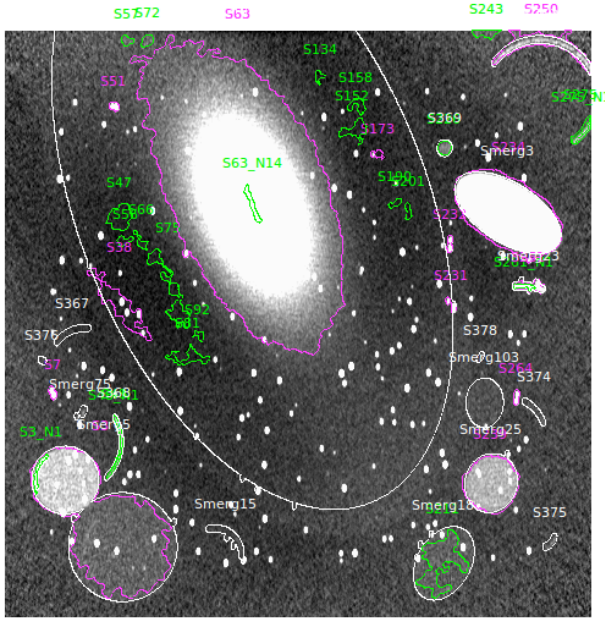




Sample SCORPIO field centred on SNR G344.7-0.1, MSC 345.1-0.2 SNR Candidate

Left: input map
Right: final segmentation (white lines: manual segmentation)





Sample simulated maps

Left: compact sources (zoomed):
- *Red: point-like*
- *Blue: compact*
- *Green: fitted components*

Right: extended sources:
- *Green: extended*
- *Purple: extended+compact*

Conclusions

- To map the Galactic Plane short baselines and single dish are necessary;
- We are developing a tool to merge interferometric and single dish data in the visibility plane;
- Create an image of a GP field is very different from creating an image of an extragalactic one;
- We developed a extended source extractor to better address the Galactic Plane issues