LOFAR

Max-Planck-Institut
für
Radioastronomie

# First Results from prefactor and Factor

Andreas Horneffer

# LOFAR Calibration

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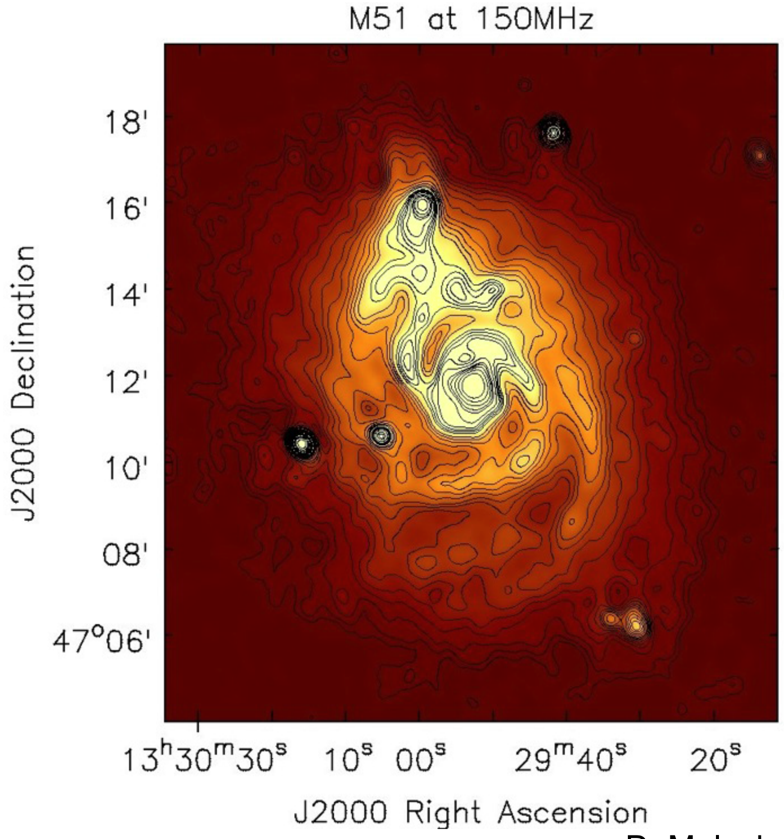
- start with "standard" interferometric calibration
  - amplitudes from calibrator
  - phase calibration against sky-model (from catalog)
  - or start with image from only core-stations
- then lots of manual work
  - flagging bad data
  - refining the sky-model with selfcal
  - peeling of "bad" sources



D. Mulcahy

# Generic Pipeline

- overlay over ASTRON pipeline framework
  - can run on multiple nodes of a cluster

```
# Pipeline for running NDPPP on all files in a directory

#variable parameters
#path to the directory where we are looking for the input data
! input_path = /data/scratch/dummyuser/test-in
# path to the parset
! ndppp_parset = /home/dummyuser/parsets/NDPPP-preproc-parset.proto

pipeline.steps=[createmap,ndppp]

#Step 1: search for all measurement sets in one directory and generate a mapfile
createmap.control.kind              =   plugin
createmap.control.type              =   addMapfile
createmap.control.cmdline.create    =   mapfile_from_folder
createmap.control.mapfile_dir       =   input.output.mapfile_dir
createmap.control.filename          =   input_data.mapfile         # name that the mapfile will have
createmap.control.folder            =   {{ input_path }}           # references the path defined above

#Step 2: run NDPPP with a given parset on all files that the previous step found
ndppp.control.type                    =  dppp
ndppp.control.parset                  =  {{ ndppp_parset }}        # references the parset defined above
ndppp.control.max_per_node            =  4                         # run 4 instances of NDPPP in parallel
ndppp.control.environment             =  {OMP_NUM_THREADS: 6}      # tell NDPPP to use only 6 threads
ndppp.argument.msin                   =  createmap.output.mapfile # the mapfile created in the first step
```

# prefactor

- built on the genericpipeline to automate pre-processing for facet calibration
  - but also useful if no facet calibration is planned
- combination of processing steps developed by many people:

Reinout van Weeren, Wendy Williams, Martin Hardcastle, George Heald, Andreas Horneffer, Jose Sabater Montes, David Rafferty, Timothy Shimwell, Sarrvesh Sridhar

- available at: https://github.com/lofar-astron/prefactor
- documentation start at:

http://www.lofar.org/wiki/doku.php?id=public:user_software:prefactor

- LOFAR data sizes (8h HBA obs.):
  - raw data (64 ch/SB, 1s): 488 x 122 GB = 60 TB
  - pre-averaged (8 ch/SB, 4s): 488 x 6.4 GB = 3 TB
  - pre-cal. (2 ch/SB, 8s, concat.): 49 x 15.3 GB = 750 GB

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# prefactor

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- prefactor scripts the pre-calibration steps
  - subtraction of a-team sources (CasA, CygA, etc.)
  - transfer of amplitudes and station clock from calibrator
  - phase calibration against a given sky-model
  - full FoV imaging and subtraction of all sources
  - diagnostic plots
- version 1 is available
- planned for version 2
  - more / better diagnostic plots (including pngs of the images)
  - wide-band cleaning
  - optional selfcal step
  - using NDPPP gaincal for phase calibration
  - better automatic flagging of bad data

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# Amplitude Plots

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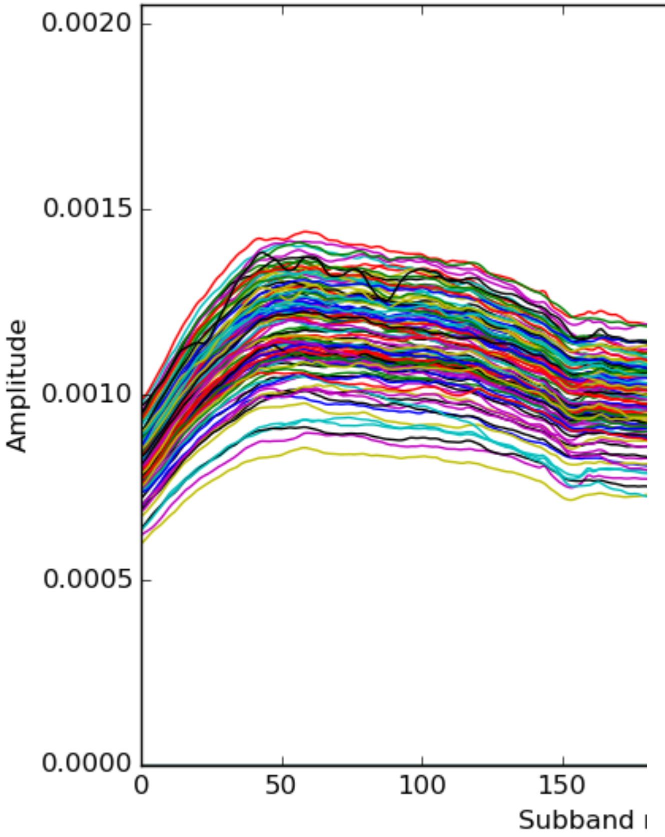
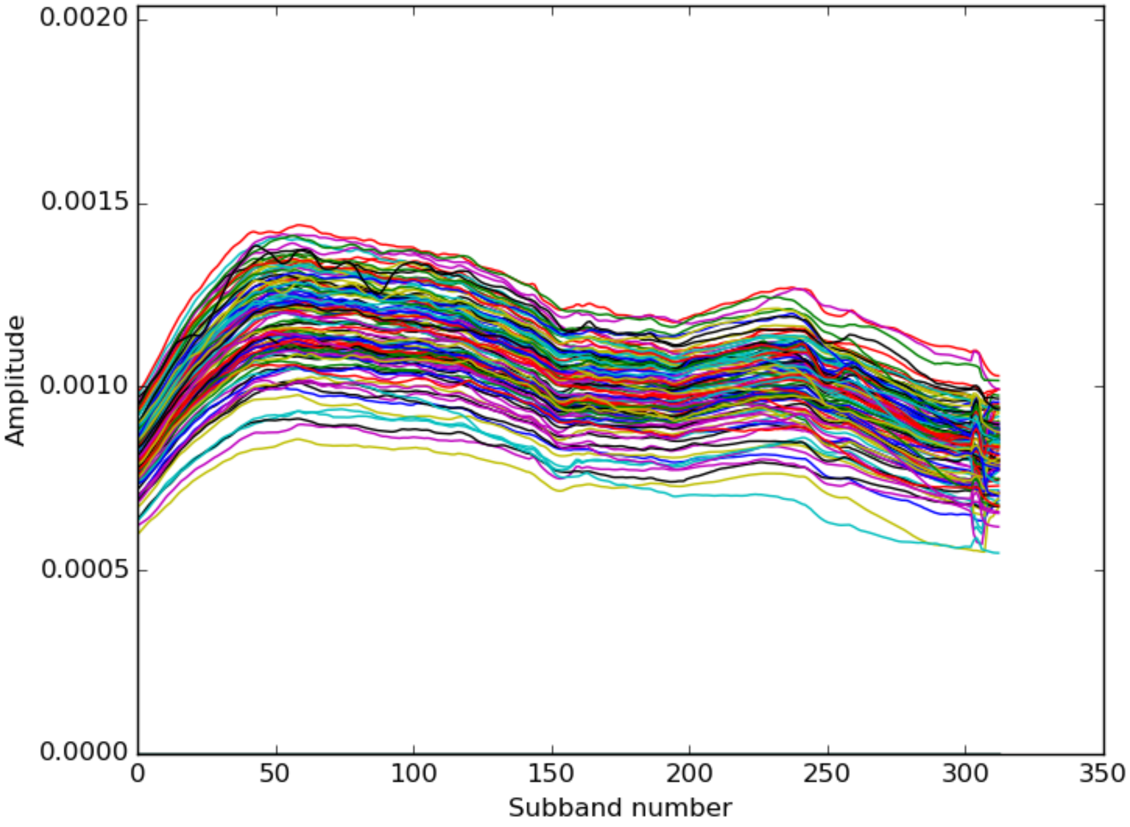
before flagging of bad subband

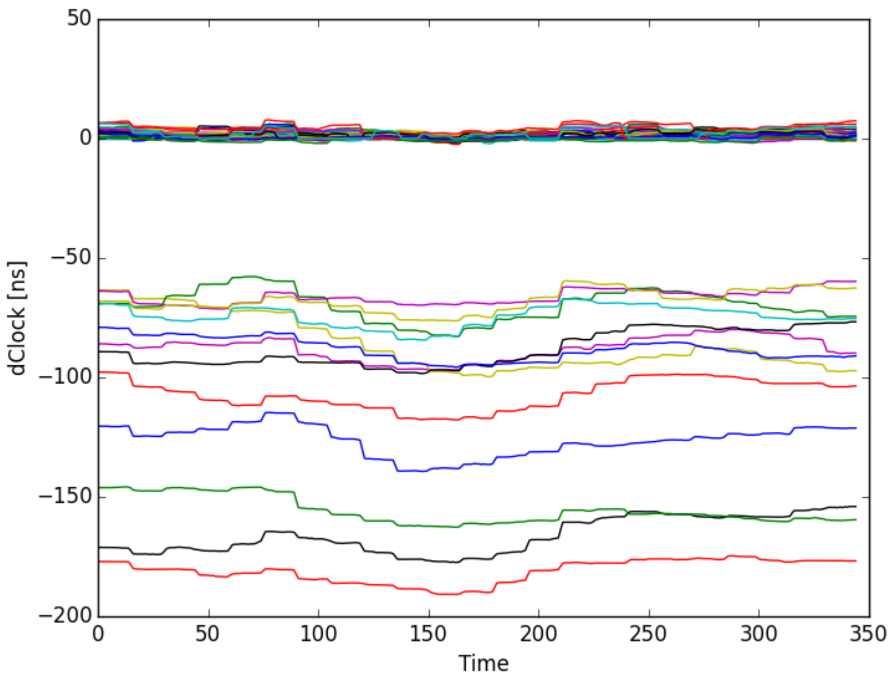


after flagging

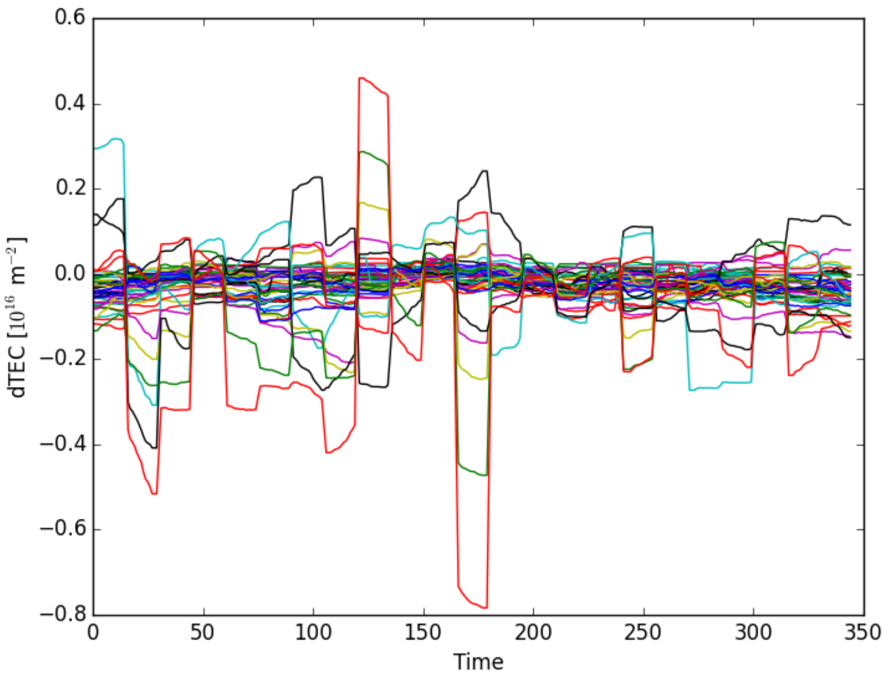


# Calibrator Phase Plots

differential clock (=system)



differential TEC (=ionosphere)



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# XY-Phase Plots

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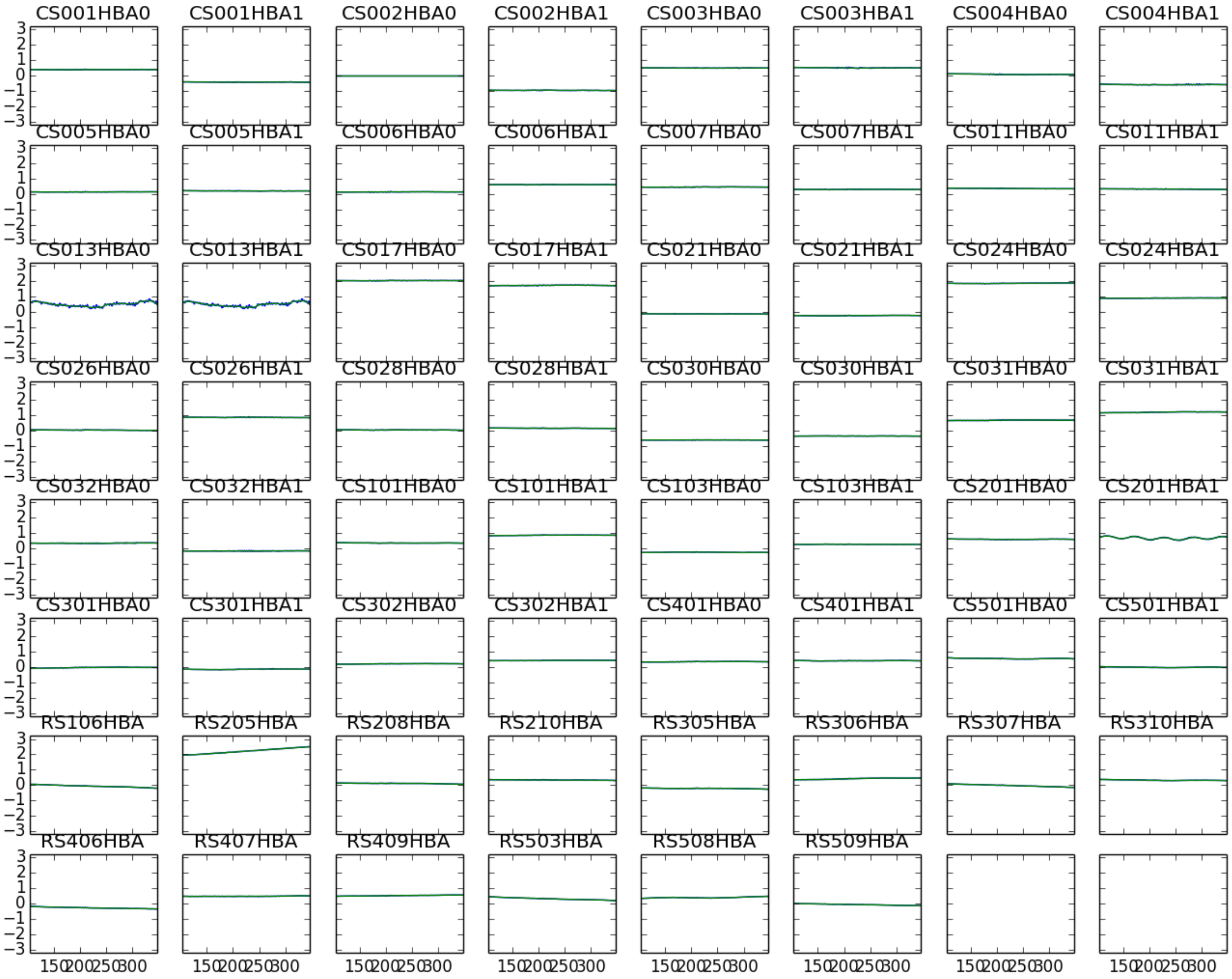

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# Target Phase Plots

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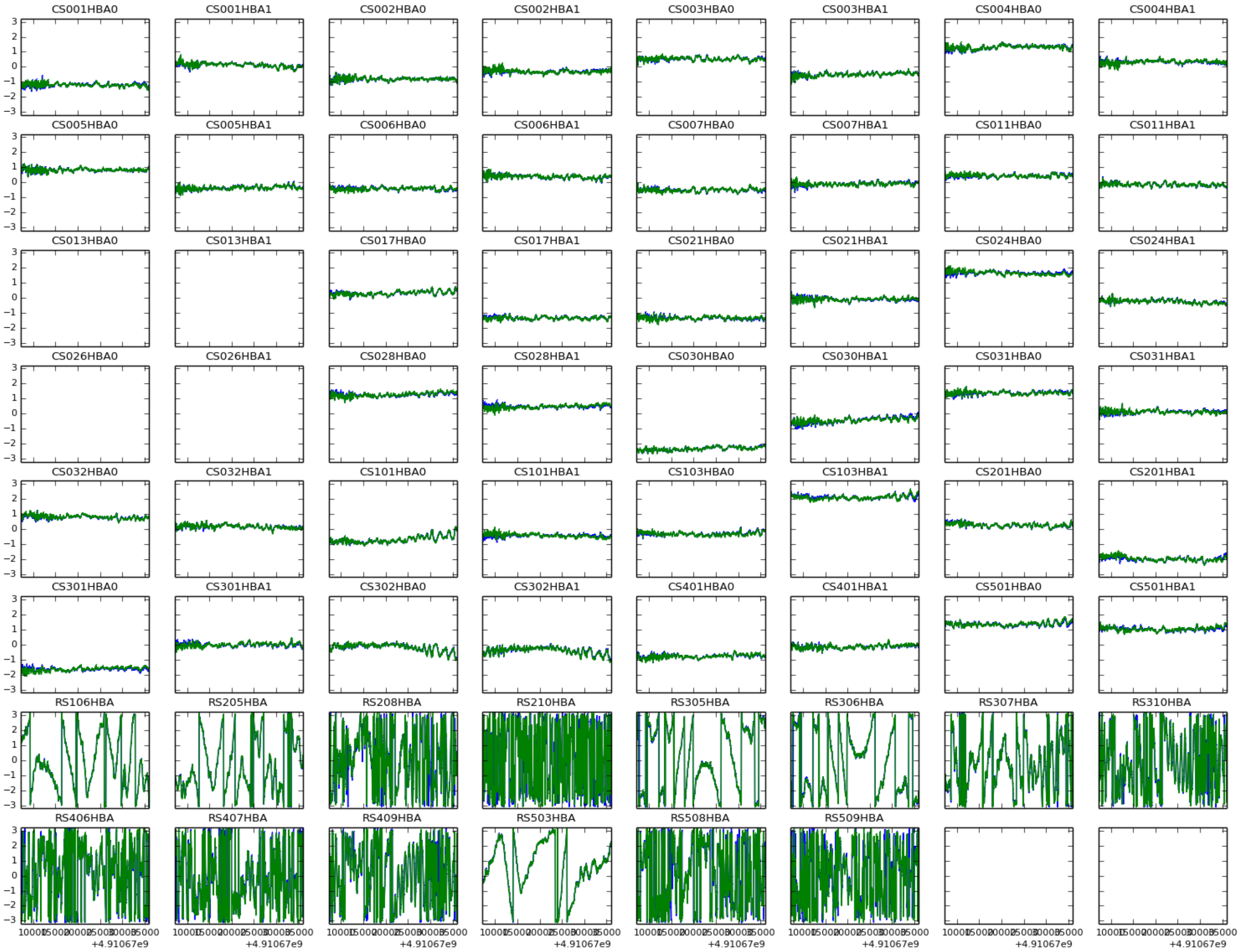
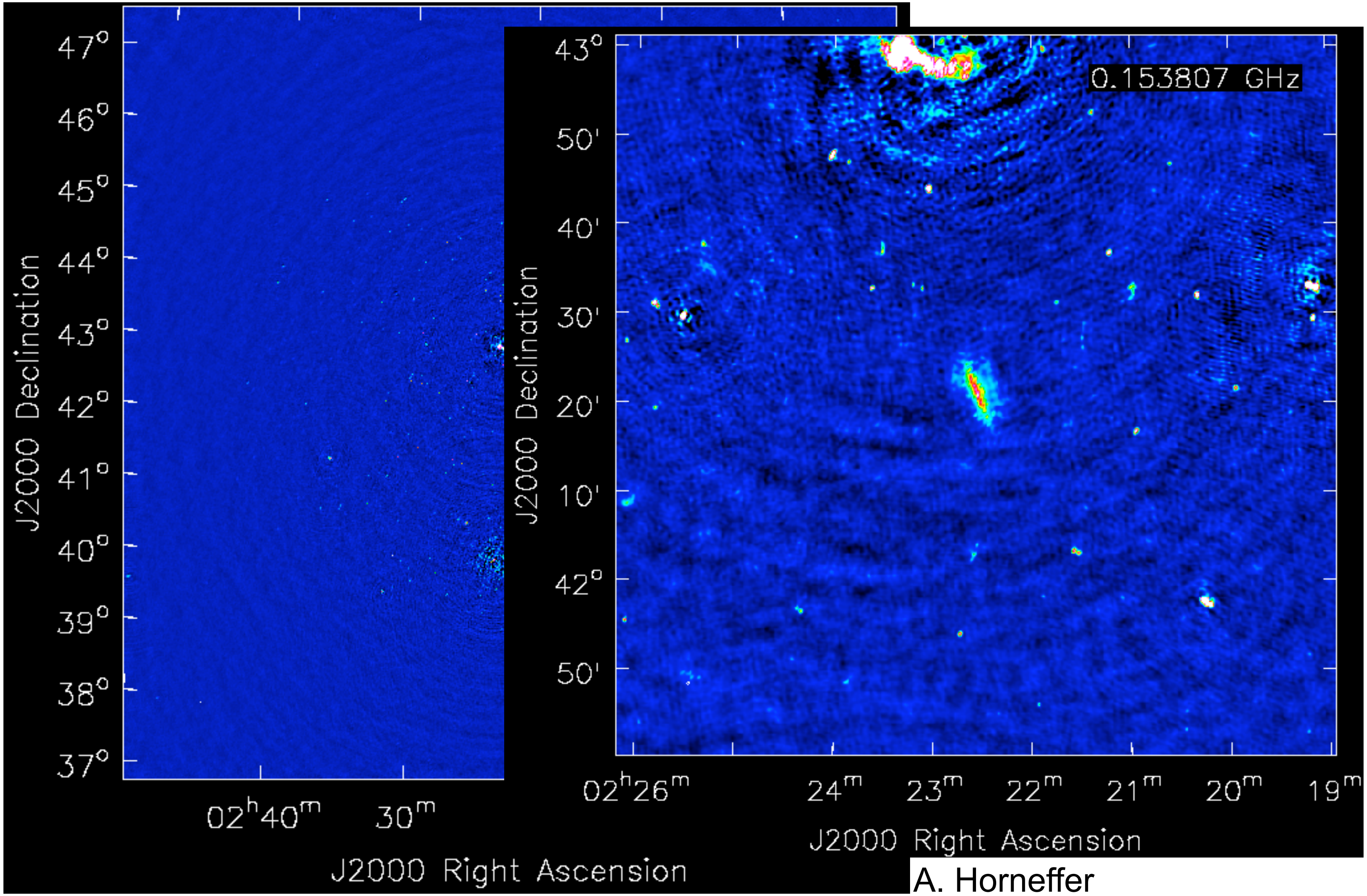


# Initial Subtract



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# Initial Subtract 2

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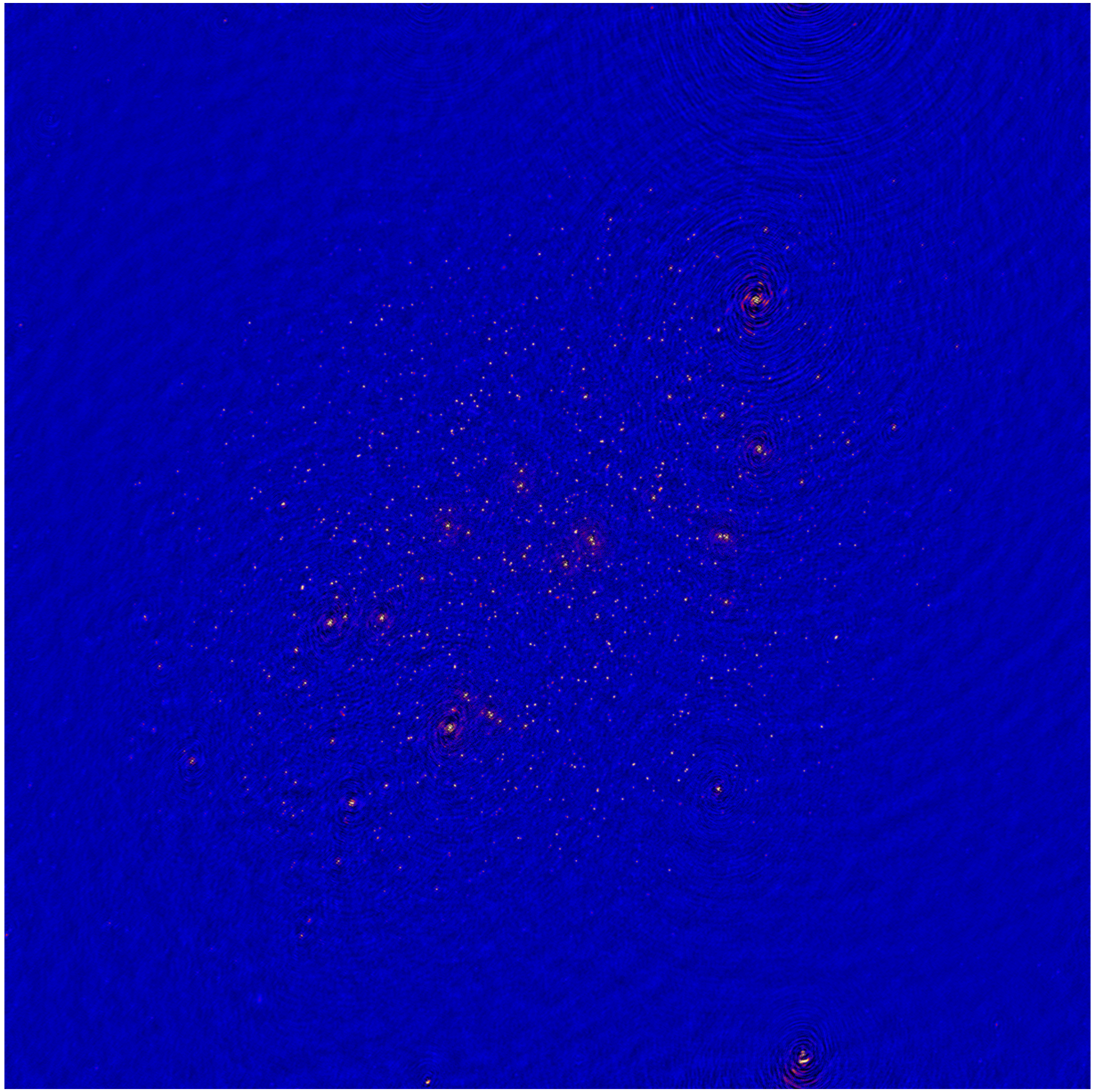
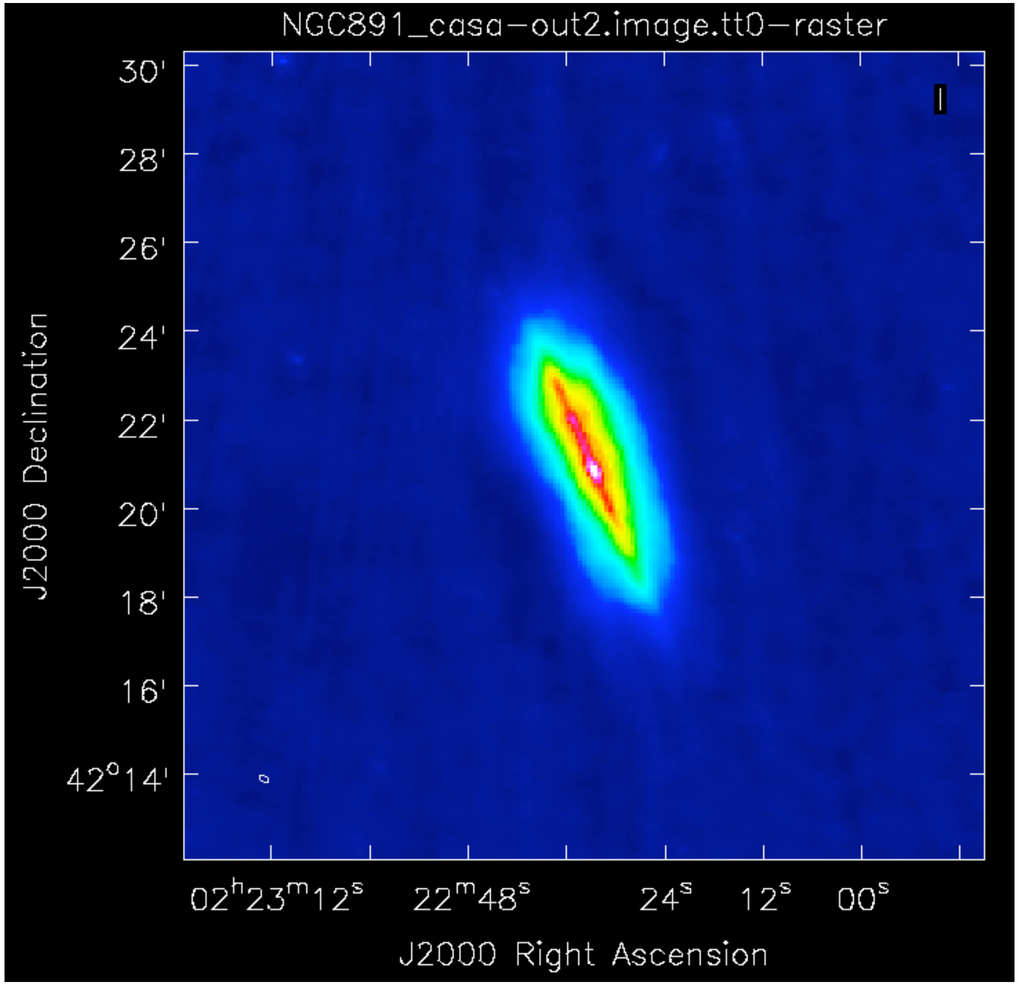
some sources are outside the nominal FoV, so widefield images are needed



D. Rafferty

# prefactor
# Summary

- standard processing compiled into a set of scripts
- mostly automated, only need to check solutions on calibrator
- efficient use of a compute cluster
  - with a shared filesystem
- may replace the current pre-processing and calibration pipelines at ASTRON



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# “Extreme Peeling” as Facet Calibration

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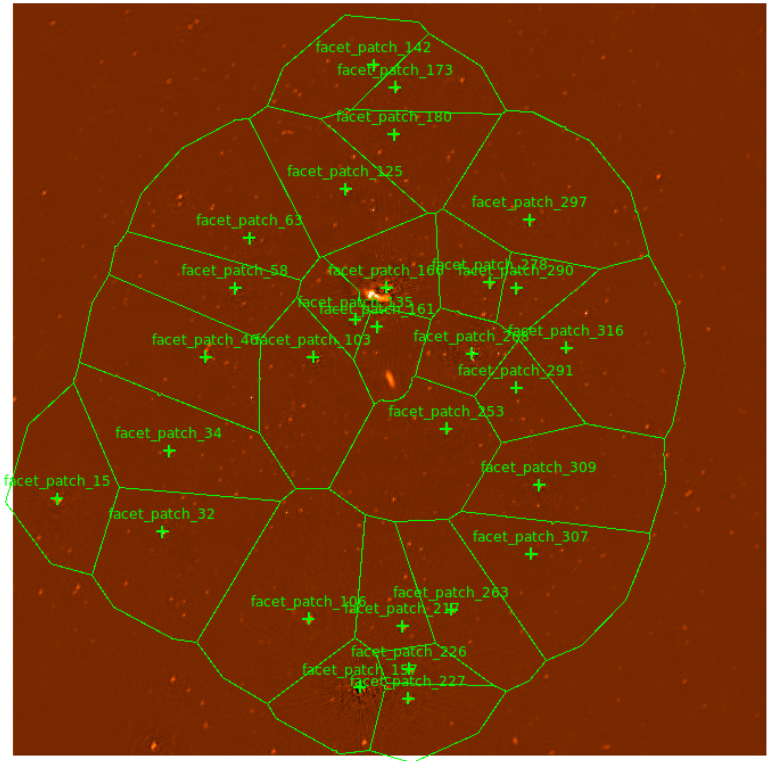
- split FOV into small facets centered around calibrators
- treat each facet independently by subtracting all other sources

- typically 20--60 facets needed
- requires extreme patience or automated pipeline
- first version of pipeline ready to be tested



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# Factor

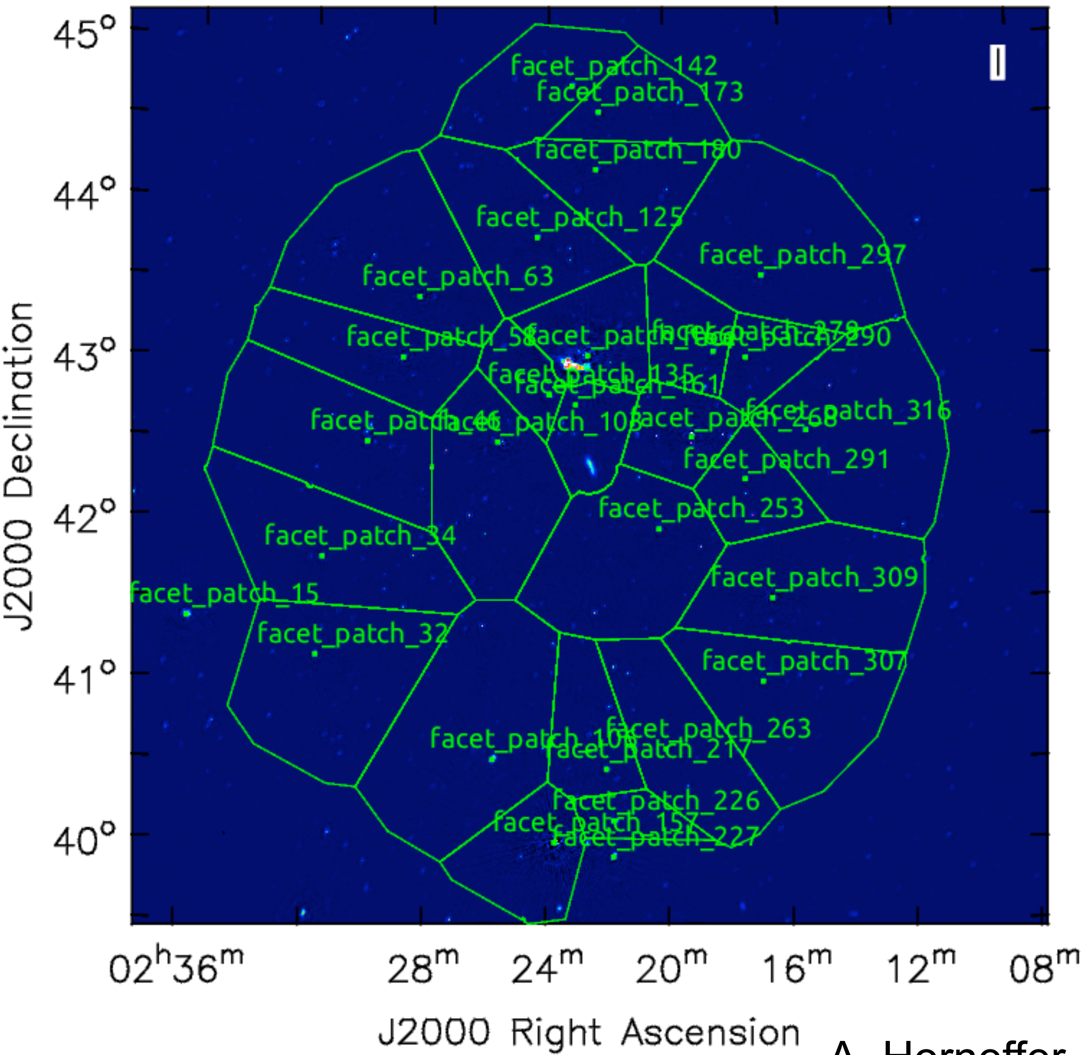
- evolution of facet calibration for LOFAR
  1. project of R. van Weeren
  2. collection of scripts
  3. (semi-)automatic pipeline → Factor
- advantages of Factor
  - data handling
  - cluster usage
  - documentation

  → usable by normal user
- available at:

  https://github.com/lofar-astron/factor

# Facet Setup

- Factor searches for strong and compact sources as facet calibrator candidates
- final selection of facet calibrators best done by user
- Voronoi tesselation defines facets



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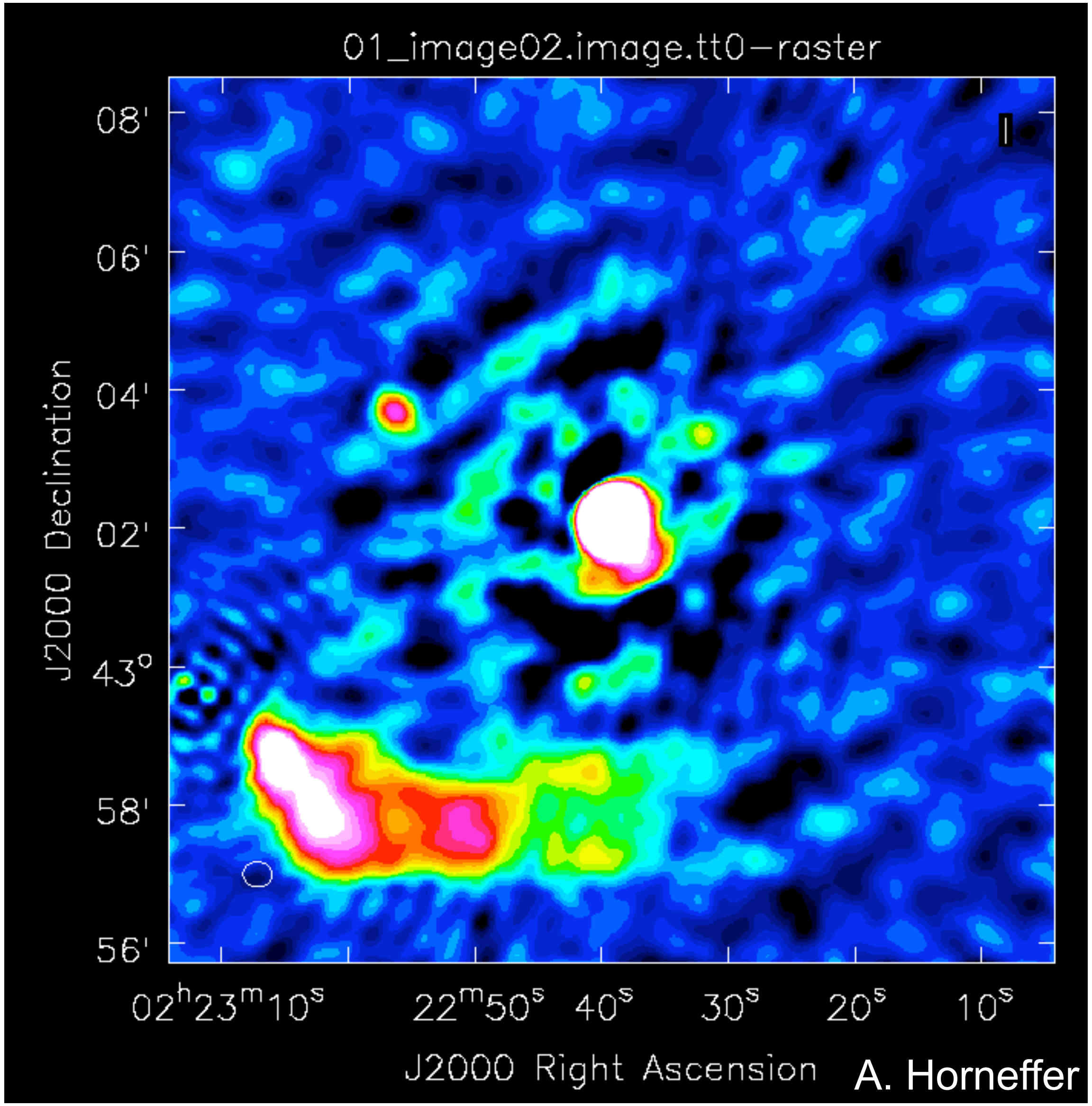
# Selfcal on Facet Calibrator

1. phase-only with low resolution
2. phase-only with intermediate resolution
3. phase-only loop with full resolution
4. amp&phase with full resolution
5. amp&phase loop with full resolution



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# Progress Inspection

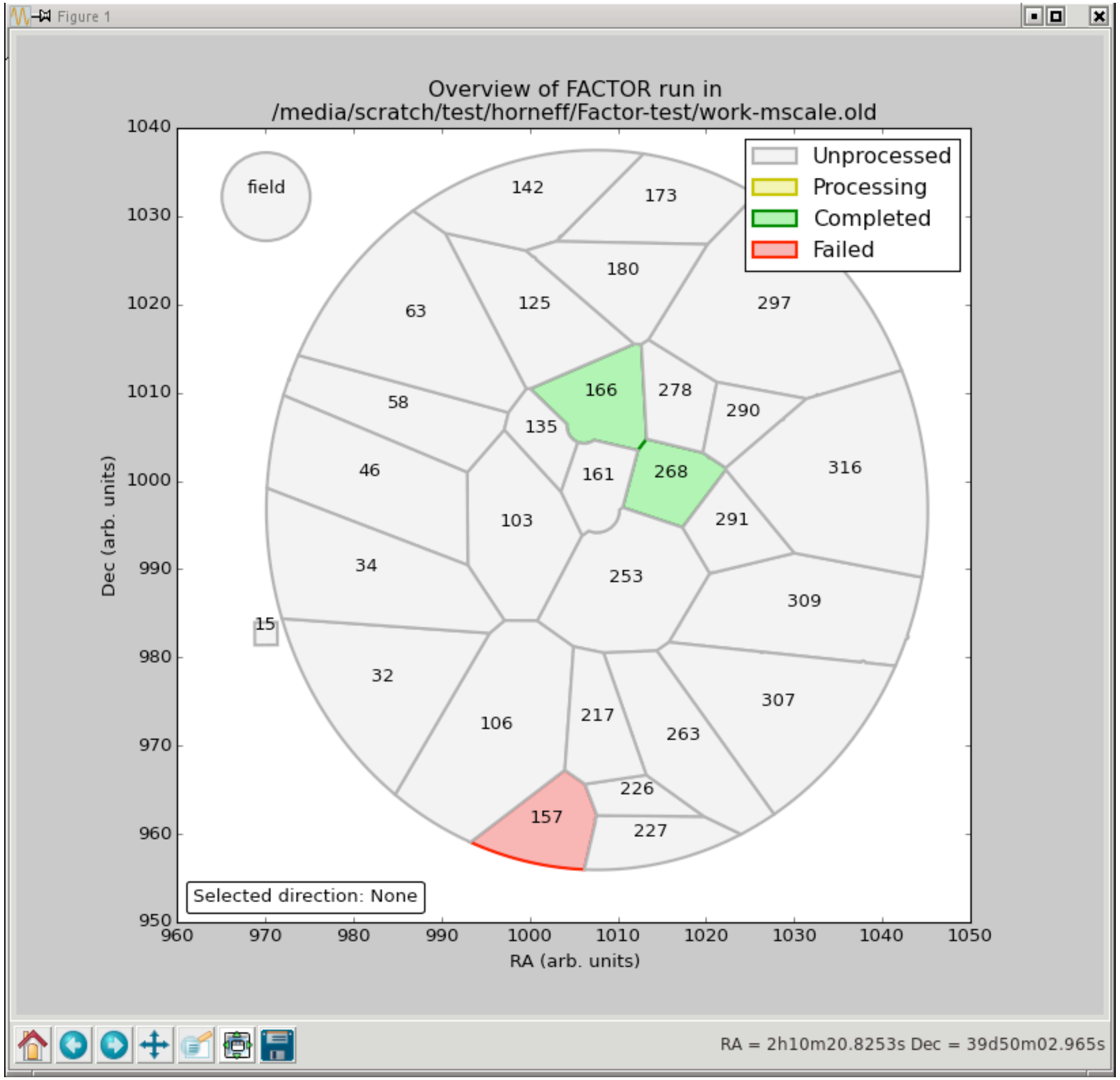

Figure 1

Overview of FACTOR run in
/media/scratch/test/horneff/Factor-test/work-mscale.old

Selected direction: None

RA = 2h10m20.8253s Dec = 39d50m02.965s

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# 3C66 before Facet Calibration

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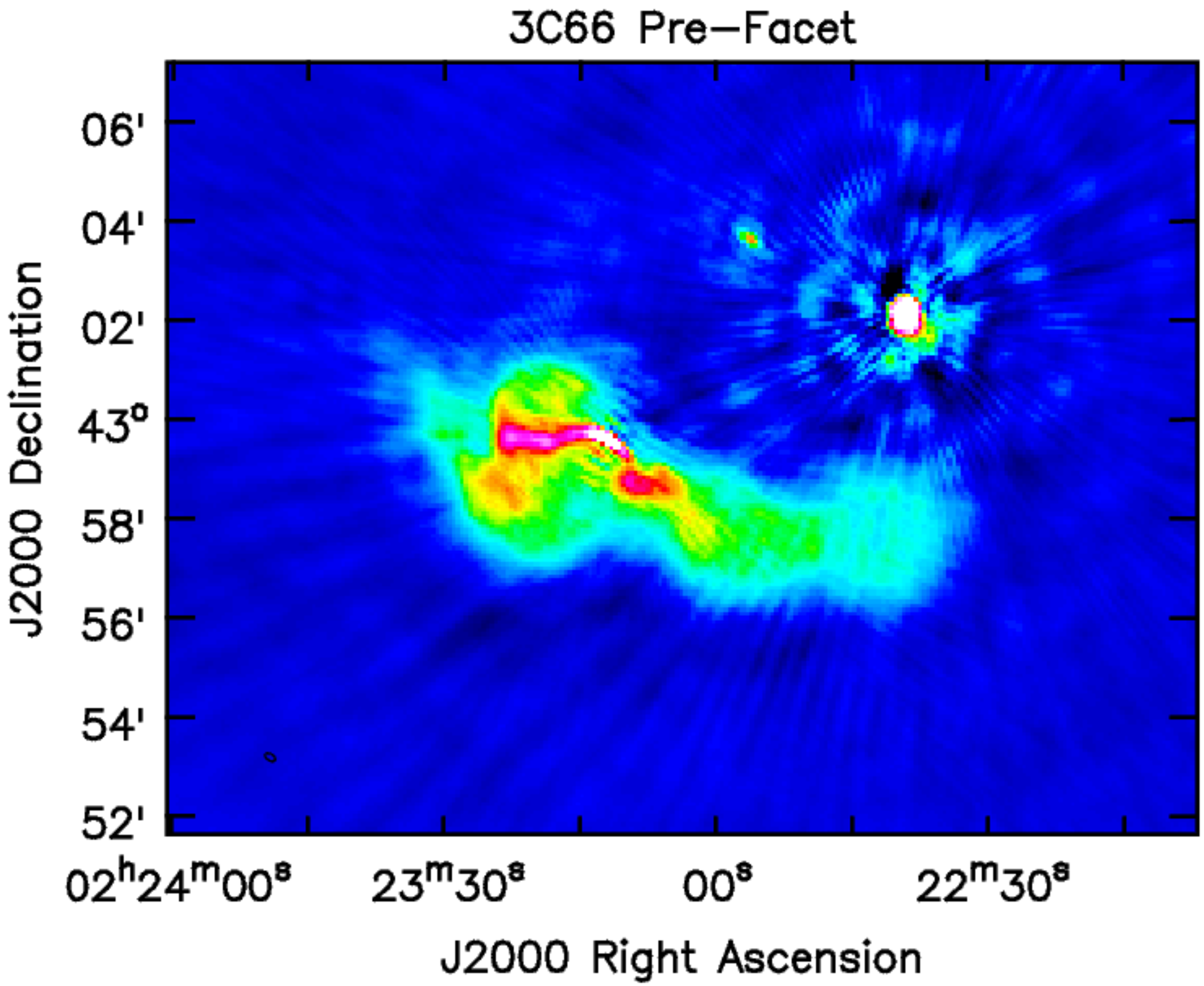

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# 3C66 after Facet Calibration

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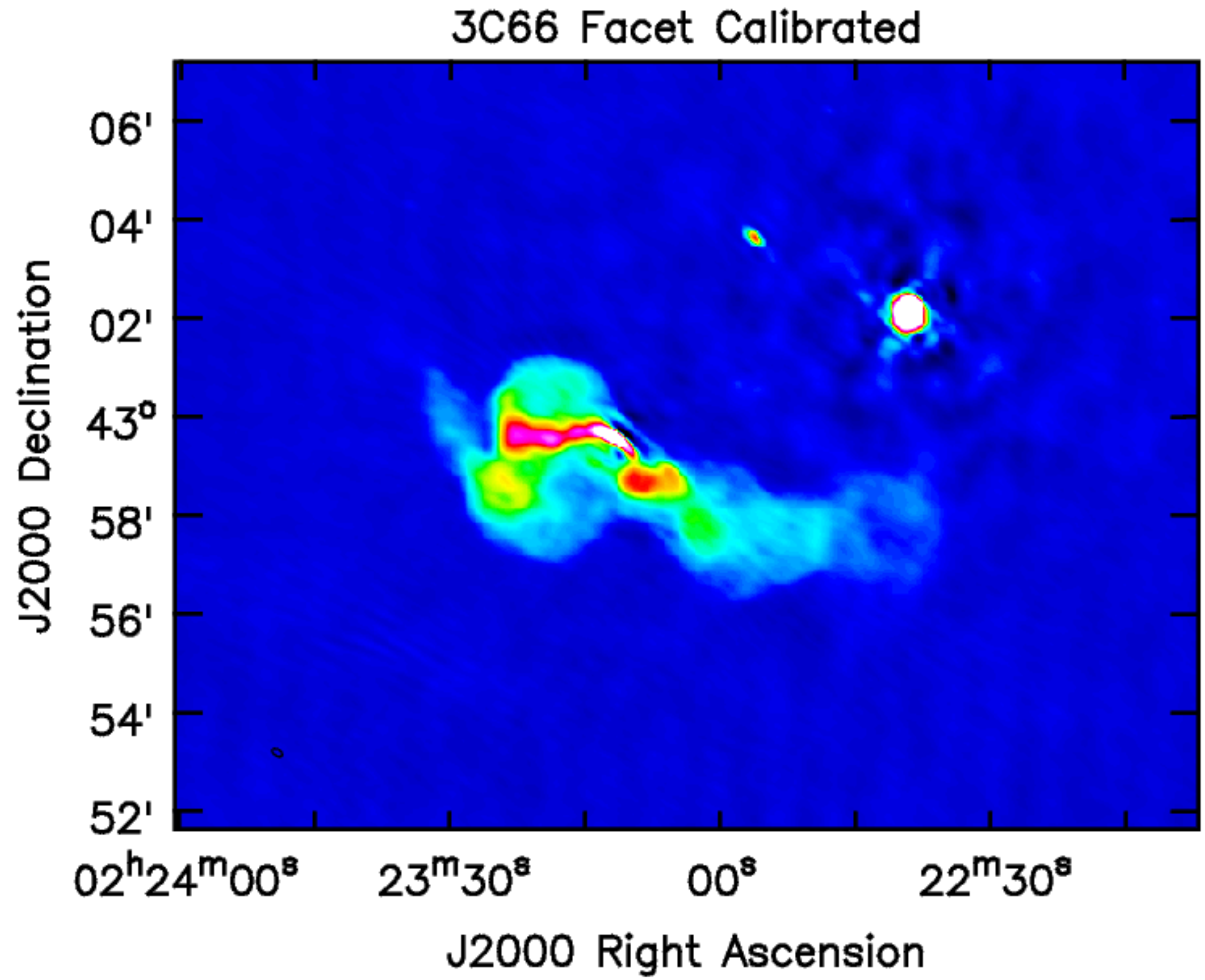

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# Source Detection Problem

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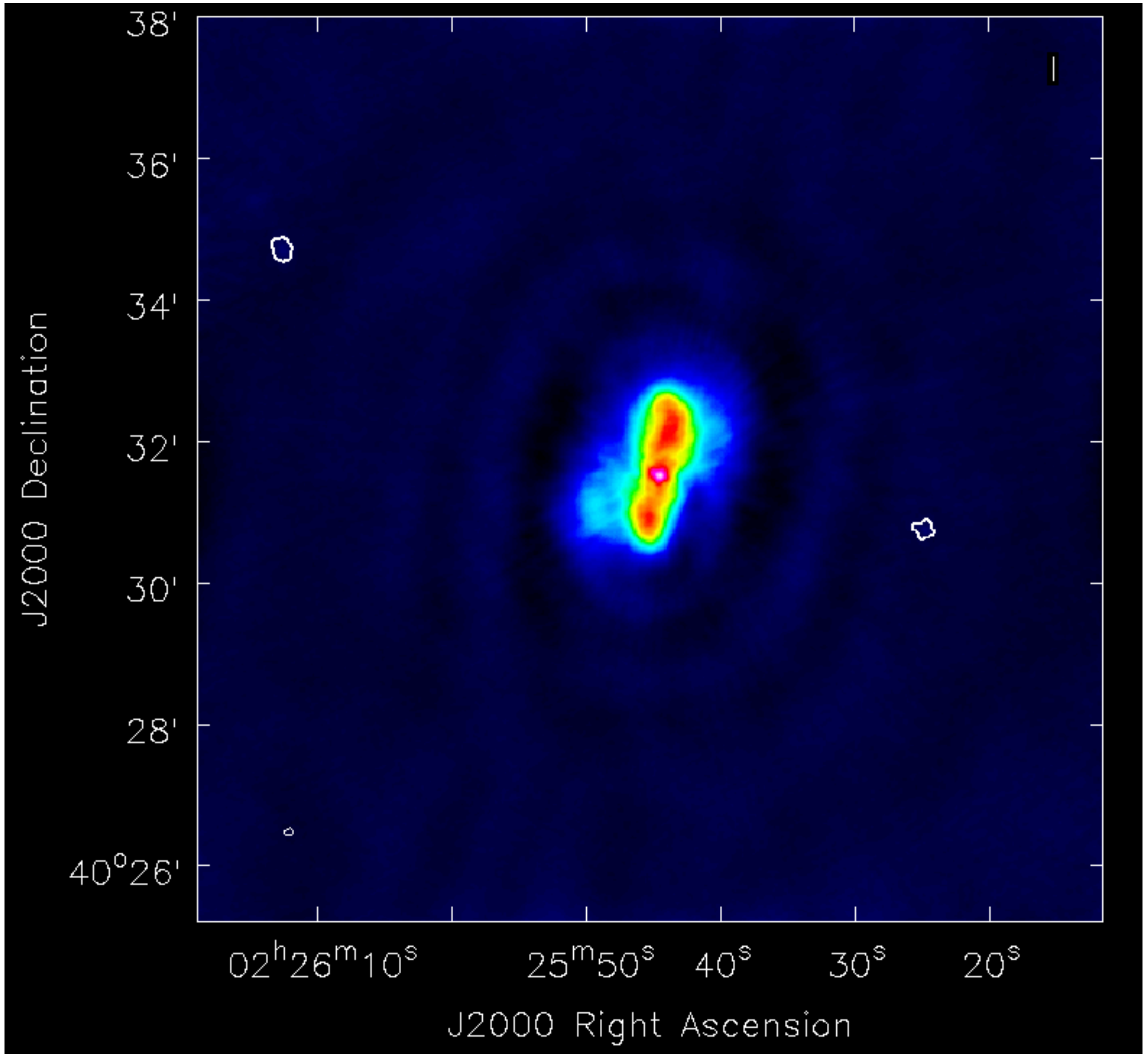
- pyBDSM is used to generate clean-masks
- default parameters sometimes fail
- solution: generate clean-mask by hand



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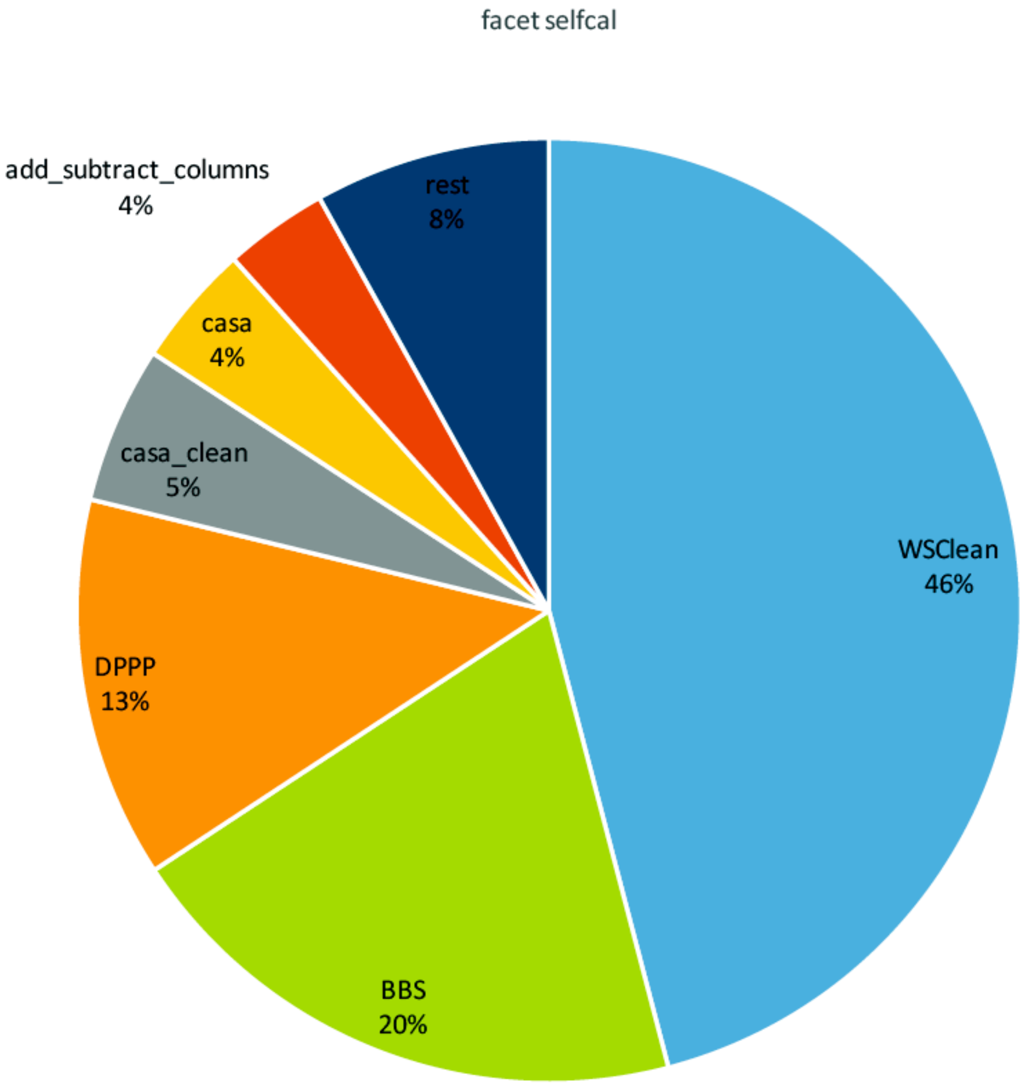
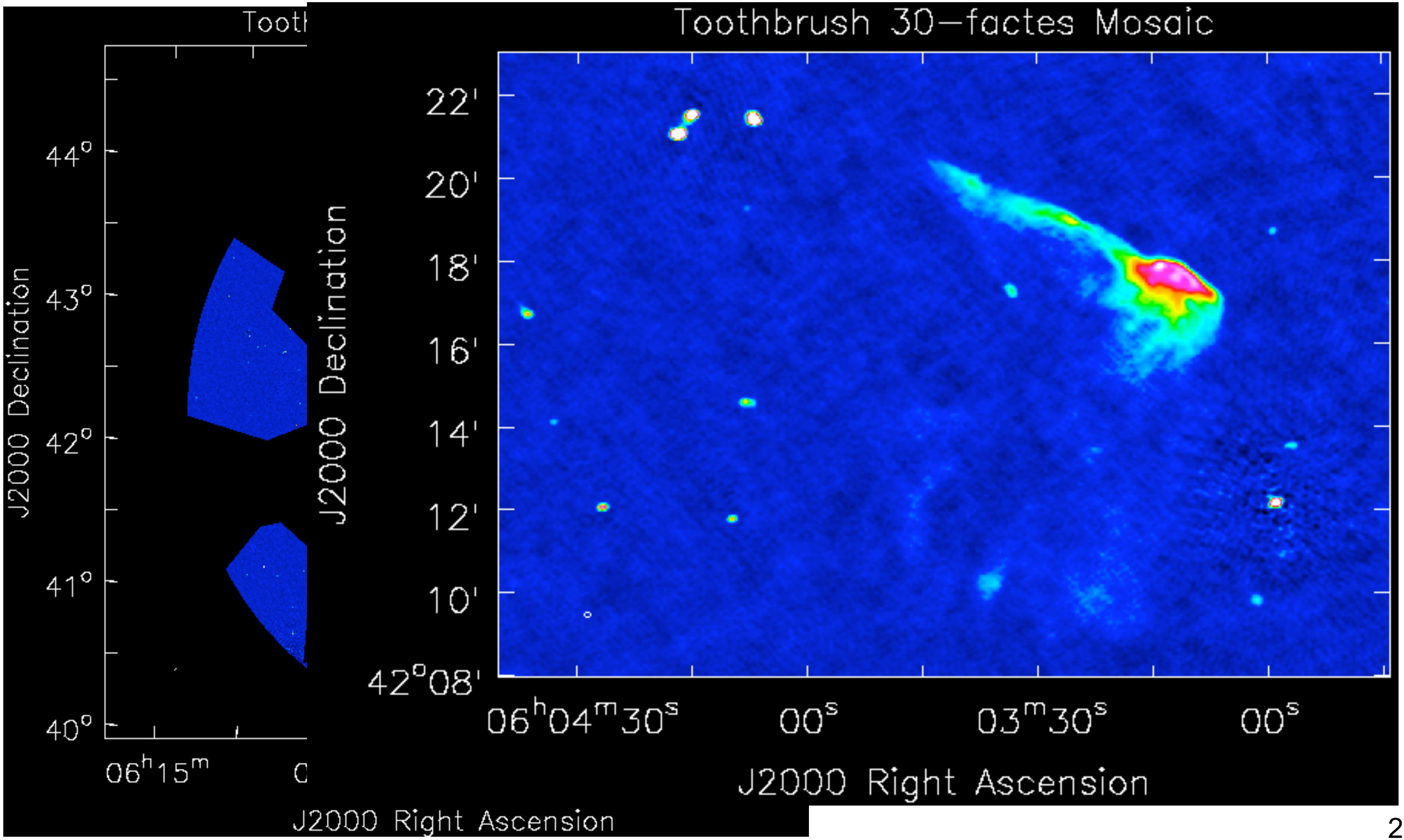
# Factor
# Time Usage

- most time is spent in imaging the full facet
- second largest block is solving for solutions



# Toothbrush


Tootl
44°
43°
42°
41°
40°
J2000 Declination
06h15m
C
J2000 Right Ascension
Toothbrush 30–factes Mosaic
22'
20'
18'
16'
14'
12'
10'
42°08'
J2000 Declination
06h04m30s
00s
03m30s
00s
J2000 Right Ascension

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# Lockman Hole

Soumyajit Mandal

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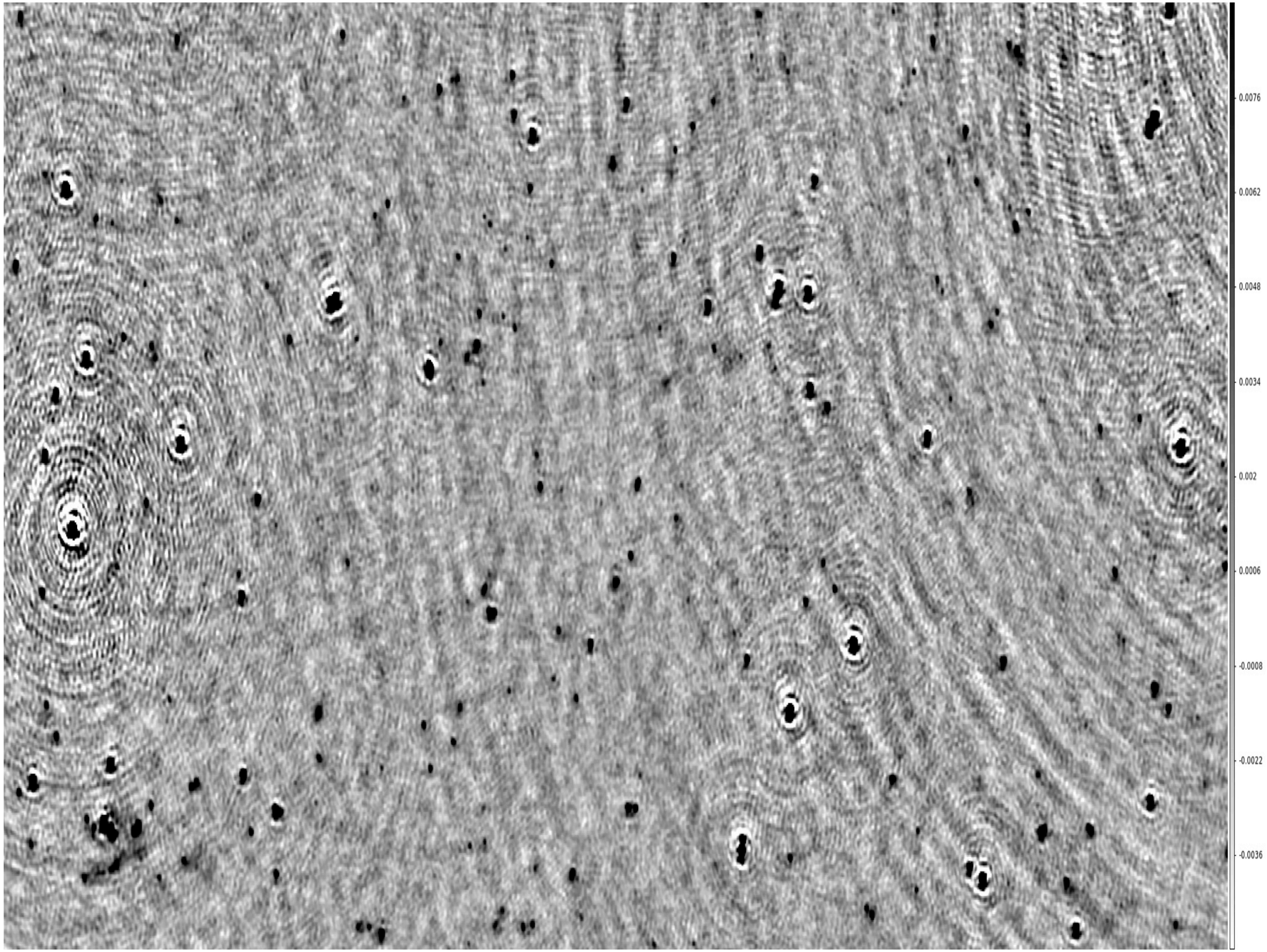

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# Lockman Hole

## Soumyajit Mandal

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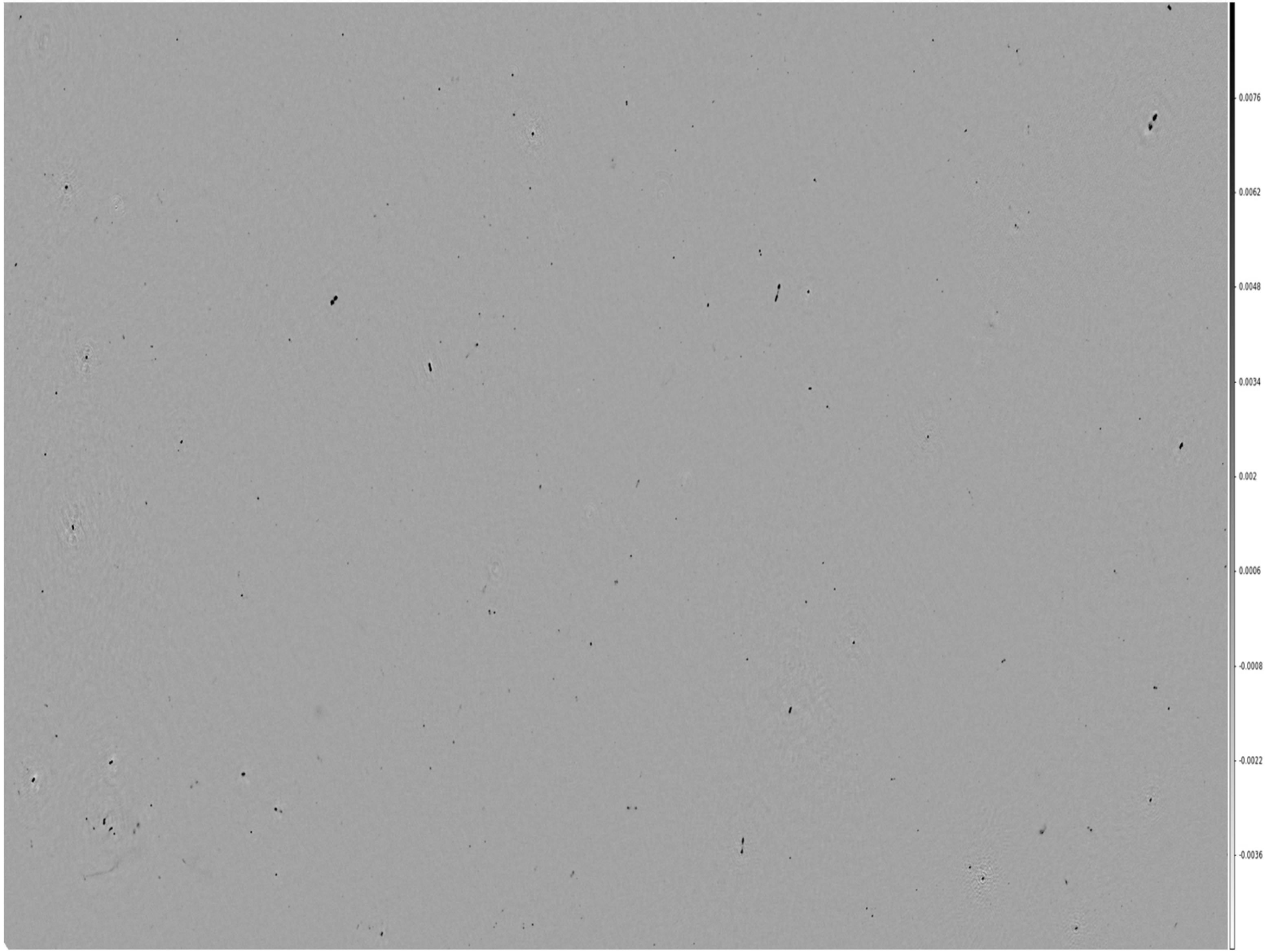

# Summary

- prefactor is a pipeline for initial calibration
  - implements all “standard” pre-processing steps
  - now the recommended pre-processing pipeline
  - may replace the current pre-processing and calibration pipelines of the observatory
- Factor implements facet calibration for HBA data
  - fairly automated and easy to use
  - some “one size doesn’t really fit anybody” issues will probably remain
  - development is continuing, but already now gives good results
  - is planned to become the surveys processing pipeline

# The LOFAR CITT

- first CITT started mid 2013, ended mid 2015
- focused on:
  - awimager
  - stefcal in NDPPP
  - selfcal script
  - testing schemes for direction dependent calibration
  - generic-pipeline framework
- CITT-2 started September 2015
- focus on:
  - getting the results from CITT-1 to the users
  - LBA calibration scheme