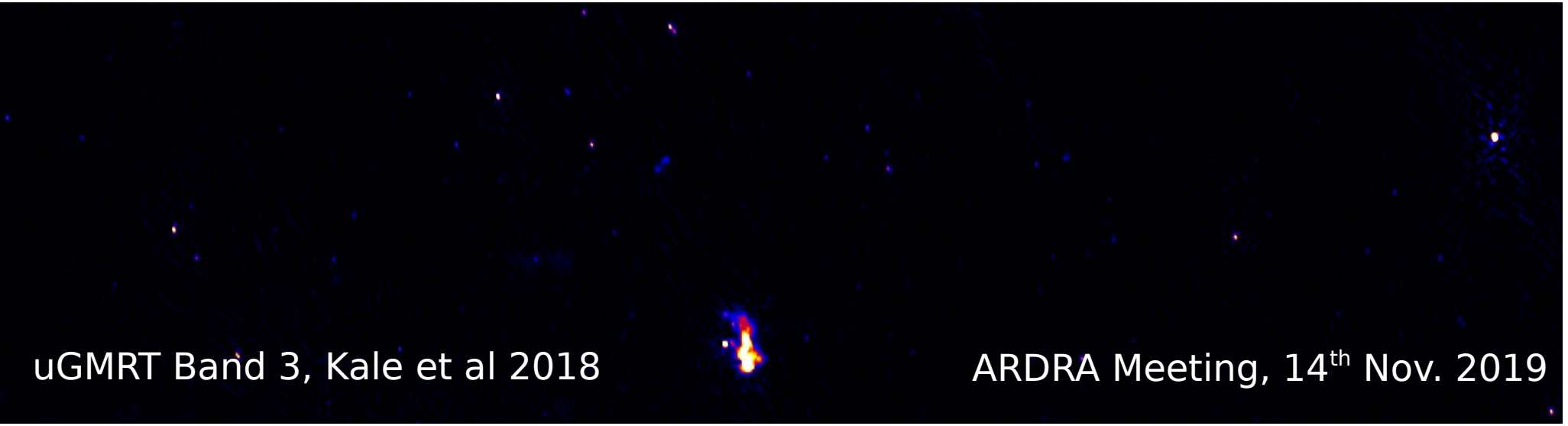


The uGMRT data reduction pipeline: recent developments and further challenges

Ruta Kale

National Centre for Radio Astrophysics,
Tata Institute of Fundamental Research

NCRA • TIFR

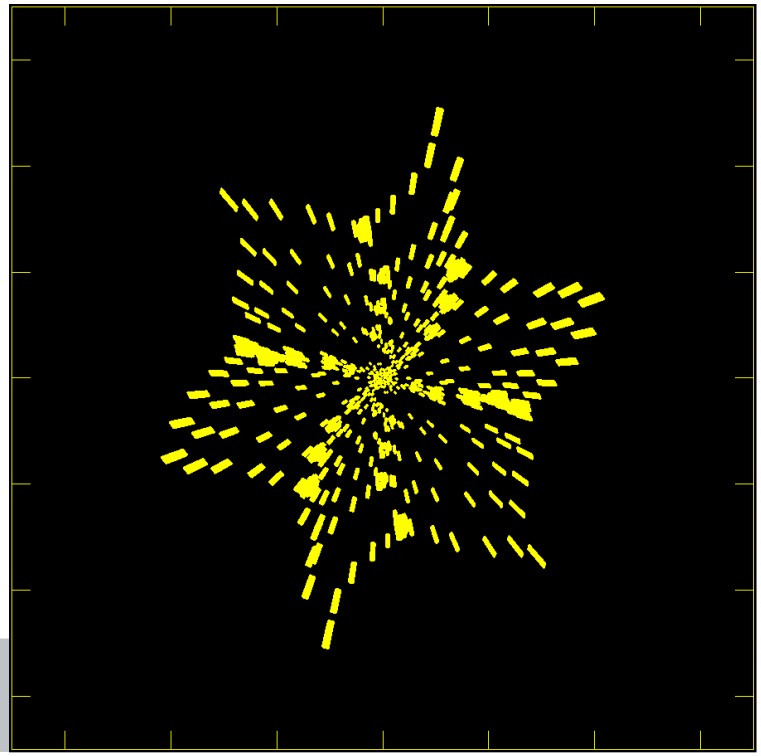
Upgraded GMRT

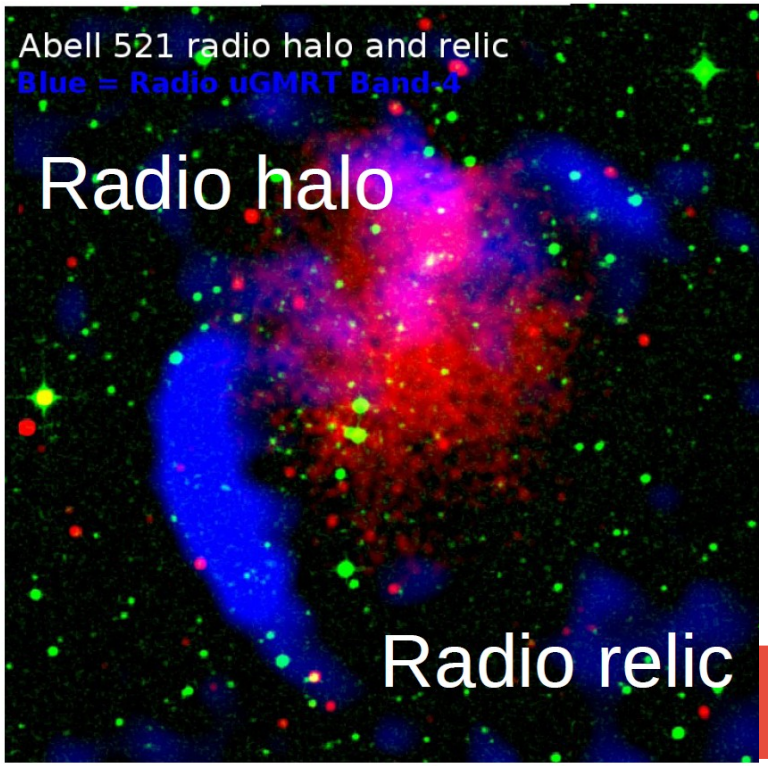
Kale et al 2018;
Kale et al in prep.

Galaxy cluster science with the uGMRT

Direct impact on the imaging of low brightness extended sources such as radio halos and relics in galaxy clusters due to improved uv-coverage.

Deo and Kale 2017

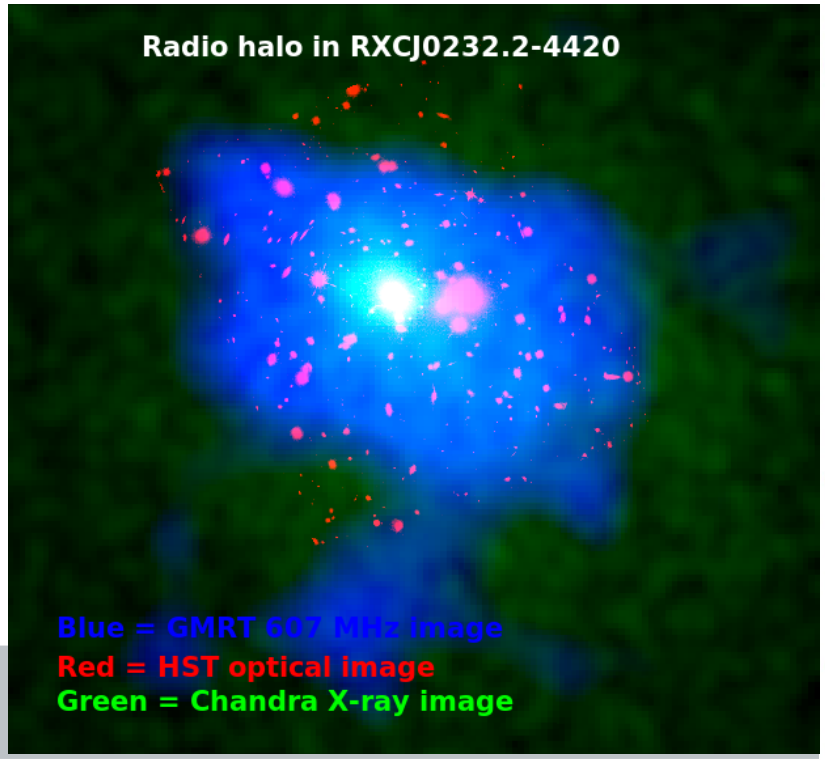


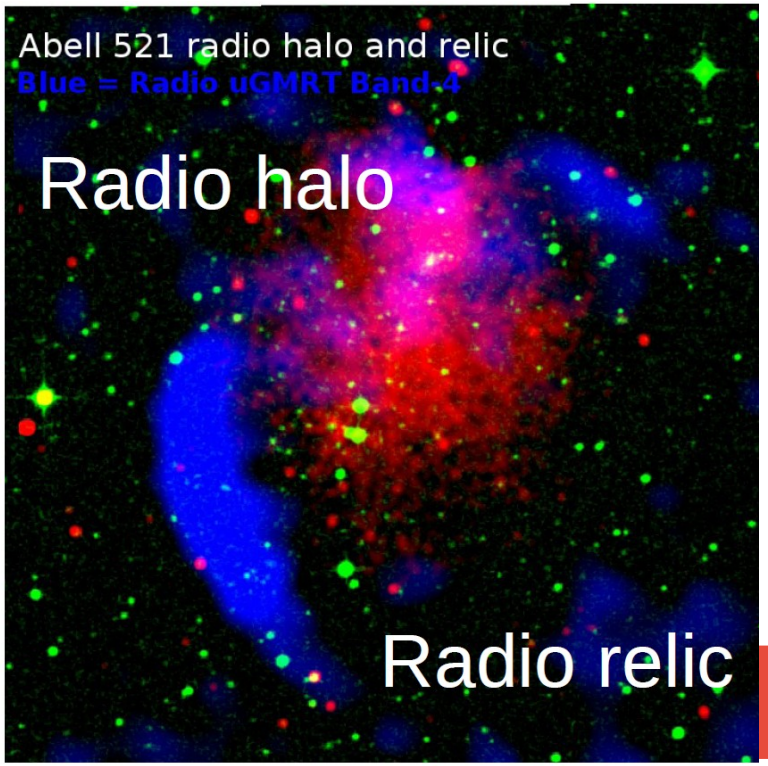


Upgraded GMRT (+ MWA, ASKAP)

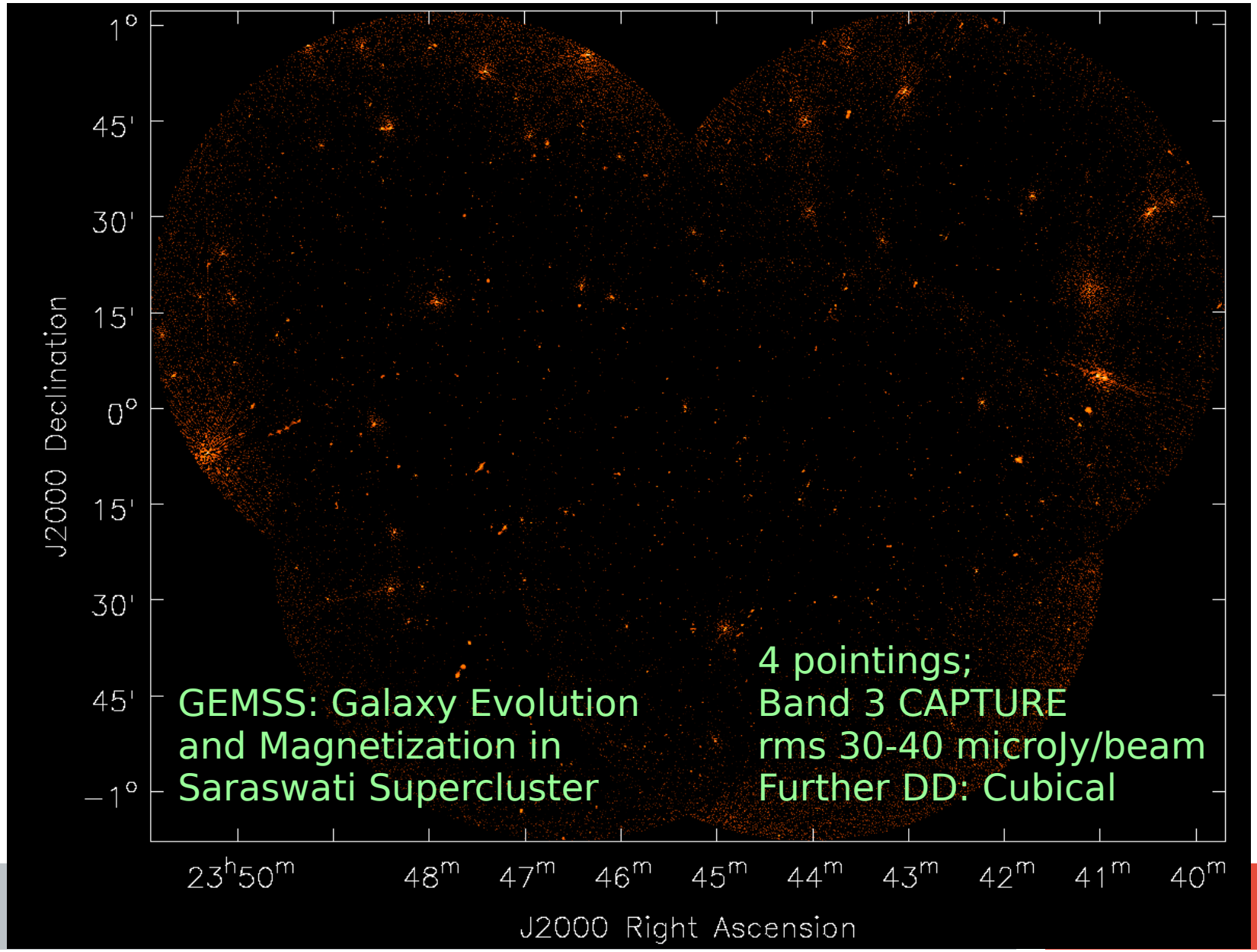
Galaxy cluster science with the

Sky overlap; follow-up of discoveries at either facilities
I. Southern Cluster-Scale Extended Source Survey (SUCCESS: Shende et al 2019; Kale et al in prep.)
II. Super-clusters (Saraswati – GEMSS survey ~50h observation ~10deg^2)





Upgraded GMRT (+ MWA, ASKAP)



“CAPTURE”

A CASA Pipeline-cum-Toolkit for Upgraded GMRT data REduction

https://github.com/ruta-k/uGMRT-pipeline

- CASA based Continuum imaging pipeline for GMRT/uGMRT data
- Tested at bands 3, 4 and 5; band 2 as well but not standard
- No other software dependency – download, edit set-up and run !
- Both end-to-end data processing or step-by-step processing possible
- Can be easily configured for customized analysis of data for a variety of science cases.

“CAPTURE”

A CASA Pipeline-cum-Toolkit for Upgraded GMRT data REduction

https://github.com/ruta-k/uGMRT-pipeline

- CASA based Continuum imaging pipeline for GMRT/uGMRT data
- Tested at bands 3, 4 and 5; band 2 as well but not standard
- No other software dependency – download, edit set-up and run !
- Both end-to-end data processing or step-by-step processing possible
- Can be easily configured for customized analysis of data for a variety of science cases.
- **A factor of 5 faster version using WSCLEAN (Offringa et al 2014; Offringa and Smirnov 2017) being tested.**

UGMRT data analysis challenges

Radio Frequency Interference

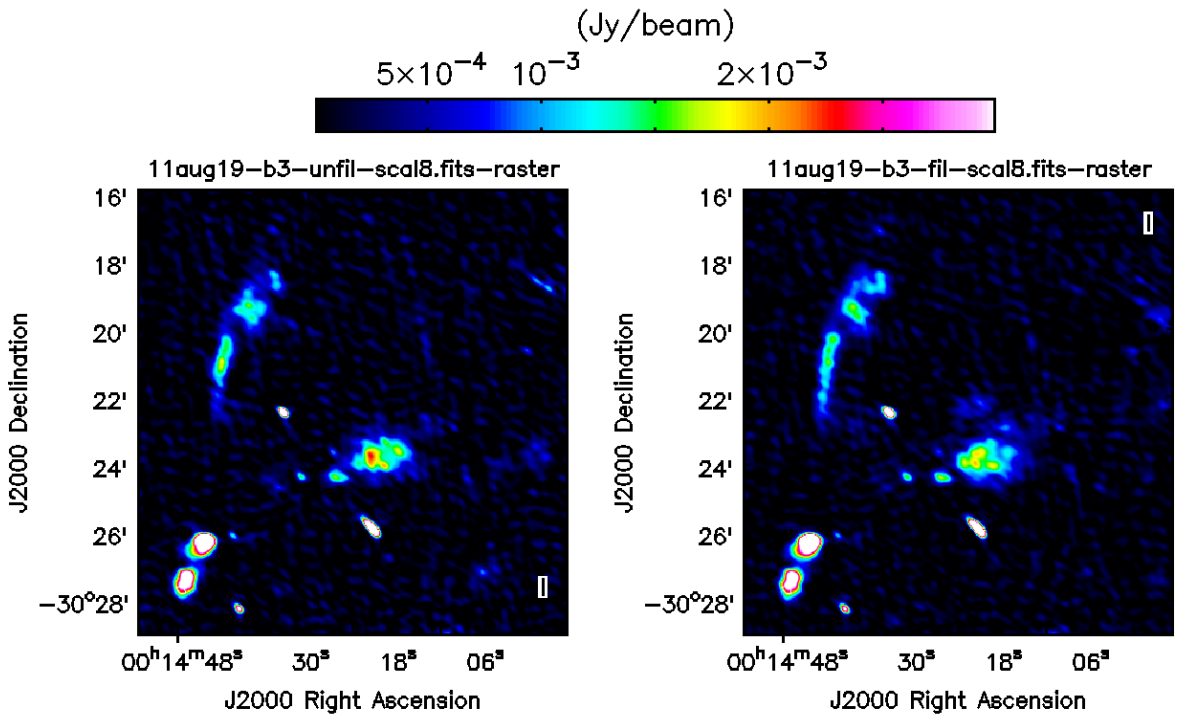
Data size

Direction dependent errors

RFI excision

Real time RFI excision implemented at the uGMRT.

Recommended use at band-3 to excise broadband RFI.



Potential of use at facilities such as the SKA

Improvement in short baseline data: crucial for science with extended sources

Buch et al 2019;
Kale et al in prep.

Data size

Data sizes limiting portability and analysis speed.

Limits on recording high time resolution data for better RFI excision.

Compression techniques:

e.g dysco (Offringa 2016)

MWA and ASKAP strategies ?

e. g. Kitaeff 2014

Direction dependent errors

Ionospheric effects and primary beam asymmetries introduce direction dependent errors: artefacts in the image, limit dynamic range.

Possible solutions:

Peeling based (e. g. SPAM, Intema et al. 2009, 2014 – talk !)

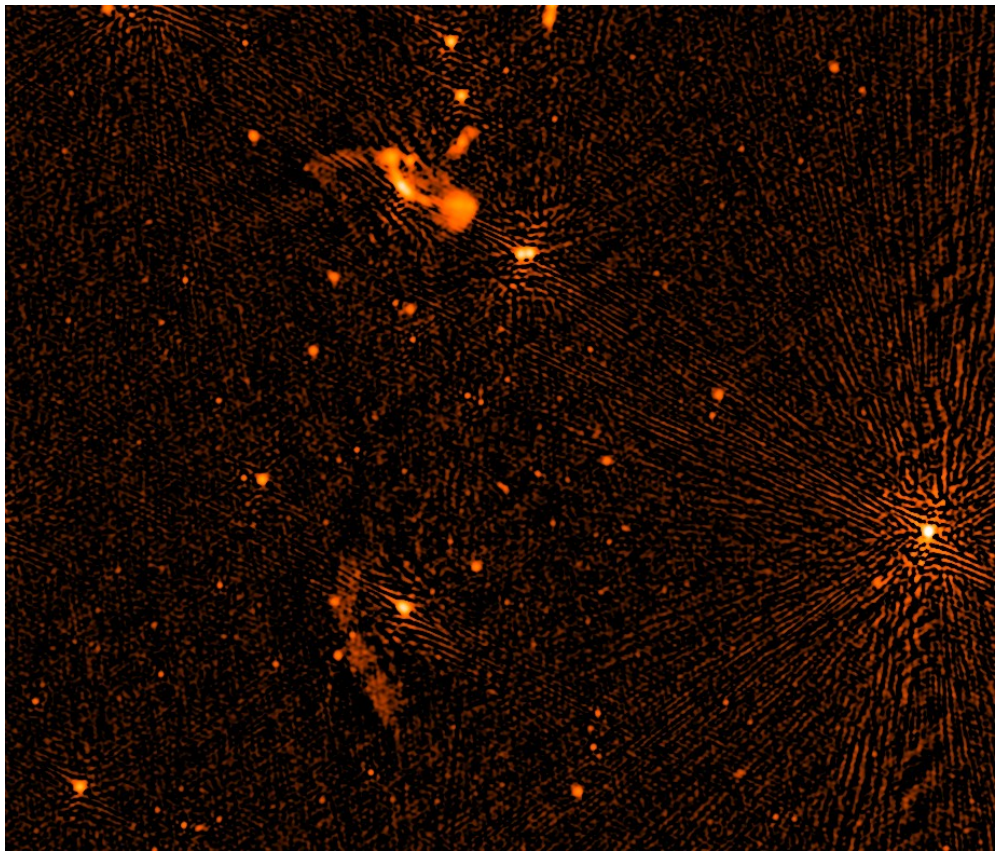
Using DD solvers (e. g Tasse et al 2013, 2014, 2018)

- **CAPTURE+DDF-kMS pipeline** (Kale, Shimwell, Tasse)

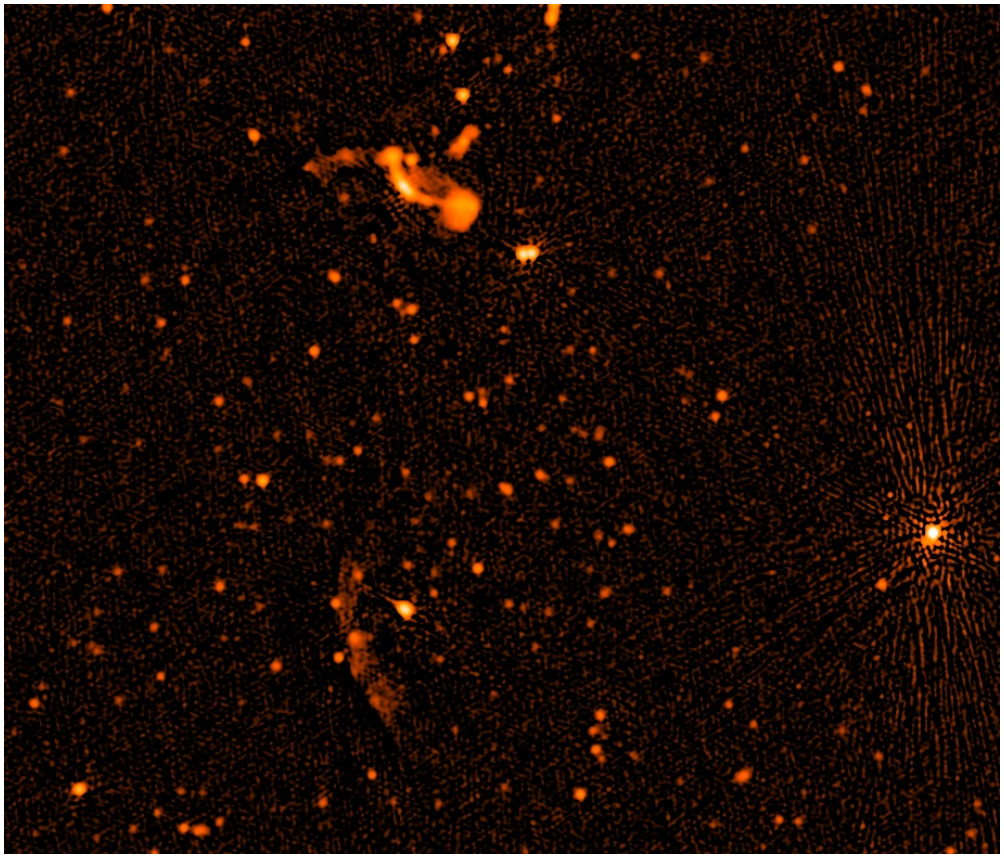
- **CAPTURE+CUBICAL pipeline** (Kale+GEMSS collaboration)

Together with primary beam measurements (talk by D. V. Lal)

CAPTURE+DDF+kMS



DI self-cal

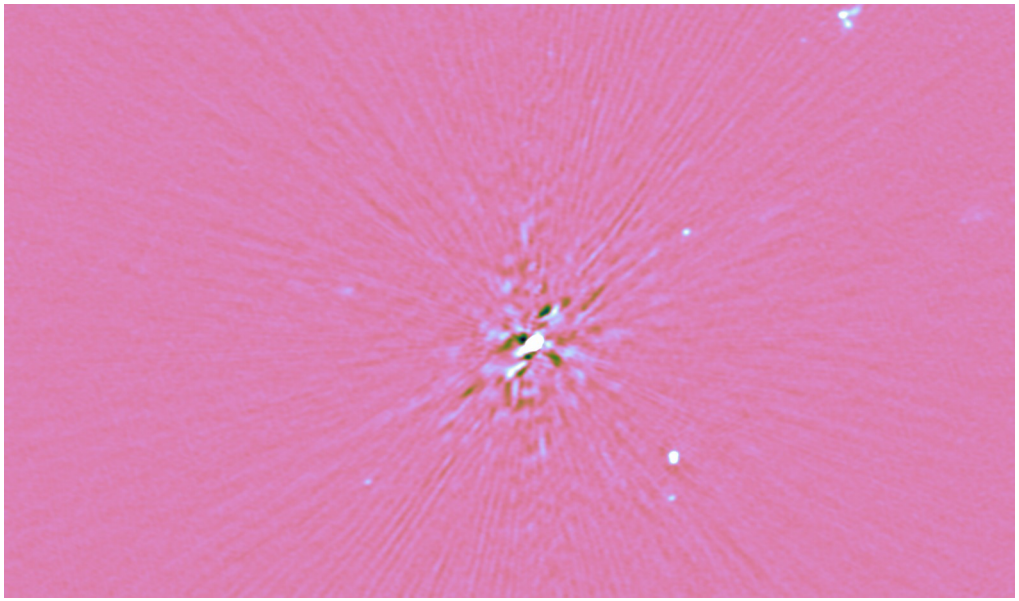


DI + DDF-kMS

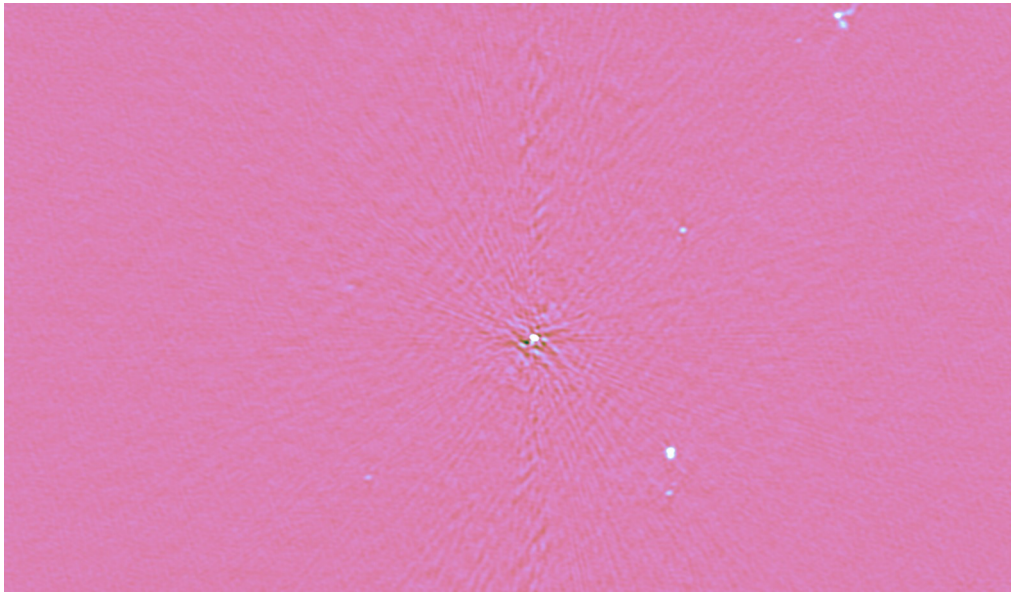
Challenge: Extended emission not preserved

CAPTURE+Cubical

DI only



DI + Cubical



Kale, Thorat + GEMSS collaboration

Direction dependent errors

Ionospheric effects and primary beam asymmetries introduce direction dependent errors: artefacts in the image, limit dynamic range.

Possible solutions:

Peeling based (e. g. SPAM, Intema et al. 2009, 2014 – talk !)

Using DD solvers (e. g Tasse et al 2013, 2014, 2018)

- CAPTURE+DDF-kMS pipeline (Kale, Shimwell, Tasse)

- CAPTURE+CUBICAL pipeline (Kale+GEMSS collaboration)

Together with primary beam measurements (talk by D. V. Lal)

LEAP (Low frequency Excision of Atmosphere in Parallel

Rioja et al 2018)

Possible areas for India-Australia collaboration

Cluster and super-cluster science.

Real-time RFI excision system applications at MWA/ASKAP/SKA.

ASKAP/MWA data compression and analysis pipelines.

Direction dependent calibration strategy.