Introduction CITT2 plans

E. Orru' and T. J. Dijkema

CITT1 results

- NDPPP direction independent calibration (gaincal,predict,applycal, correction factor for beam...)
- awimager2 (multi-frequency multi-scale, IDG)
- selfcal pipeline
- generic pipeline
- Pre-calibration scheme
- FACTOR

CITT1 results

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Huge thank to George

CITT2 goals

- Develop and implement algorithms that extend the capabilities of the imaging pipelines of the Radio Observatory and reach more users

- **Integration** in the RO pipelines and in the production system of the CITT1 results. NDPPP, awimager2, generic pipeline, pre-calibration strategy, FACTOR.

- **Research** activities aimed to calibrate the LBA and to improve and optimize the algorithm of low level tasks (ndpp, awimager..GPU.)

TEAM

Members

Emanuela Orru'

Tammo Jan Dijkema

Bas van der Tol

David Rafferty

Stefan Fröhlich

Jess Broderick

Collaborators

Tim Shimwell

Francesco de Gasperin

Huib Intema + 2 Phd students

Sarod Yatawatta

Maaijke Mevius

Bram Veenboer

Mentor: George Heald + advisory group

Integration: motivation

Current RO pipelines: Preprocessing, Calibrator, Target, Imaging, Selfcal(v1)., PSR, Long Baseline..LBA and HBA..

Limitation:

- only a selection of parameters can be specified by the users
- use of values different from the default parameters...a new pipeline needs to created and maintained.
- difficult to implement new functionalities
- development is way further with respect to what the RO can offer so far
- not optimized processing time and resources

Integration

CITT2 plan is to integrate in the production system and after in the RO pipelines the generic pipeline.

1) In the production system: to be tested and commissioned. Users will be able to use the generic pipeline in stand-alone for basic steps (e.g. NDPPP, imaging loops) and for more complex calibration recipes like FACTOR.

2) In the RO pipeline: the idea is to use the generic pipeline to run the current production pipelines but with more flexibility in the parameter space and/or adding small functionality e.g clock/TEC separation in the calibrator pipeline.

3) Use the generic pipeline to offer in the production RO pipelines selfcal pipeline and FACTOR.

Some structural changes will be needed e.g. change of the pipeline framework, specification in mom, scheduler etc...

CITT2 members will work in synchrony with the RO developers to make this happen.

Possibly 1) and 2) can be possible using the current pipeline framework

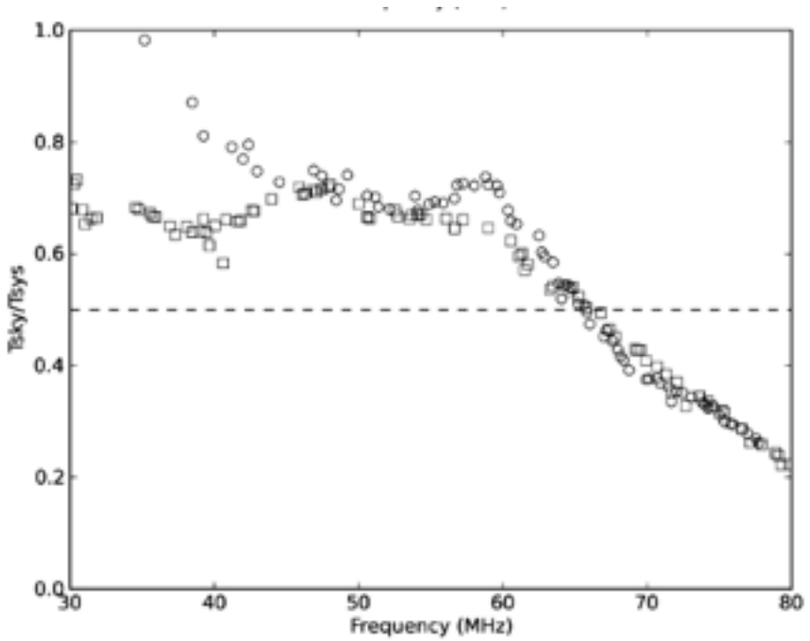
Point 3) will require structural changes.

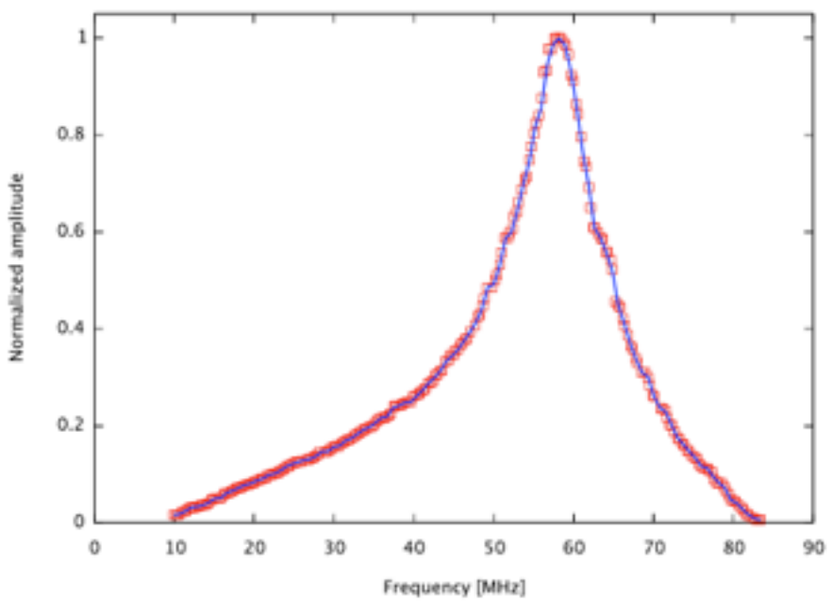
LBA calibration: motivation

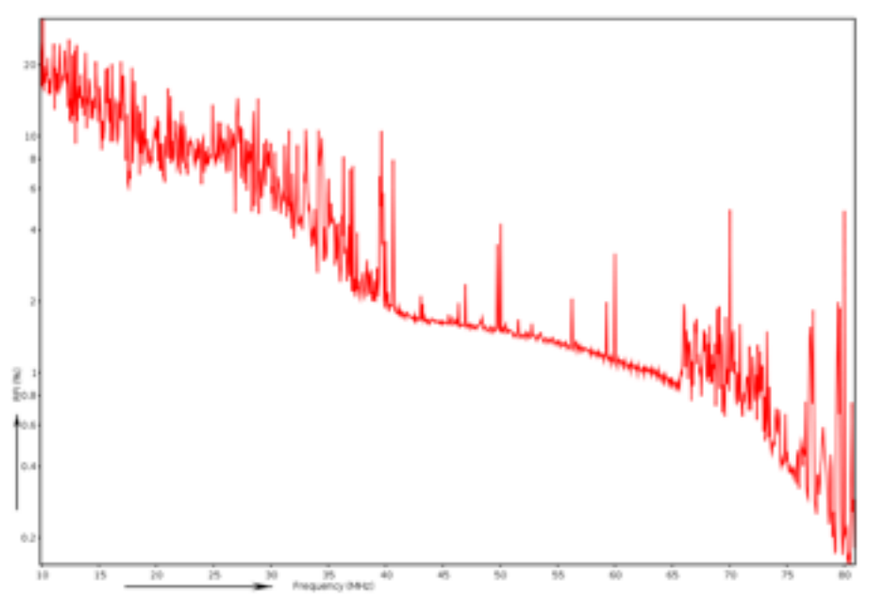
- Interesting science that ONLY LOFAR can do. Will be unique also in the SKA era.
- Road map into the SKA-low challenges
- New territory in terms of calibration algorithms
- Ionospheric science >> telecommunication
- Unknown?

interesting...but...

- ionospheric effects are more severe at lower frequencies
- the system temperature is partly dominated by the instrument noise,
- the bandwidth sensitivity is not constant over the entire frequency range
- the RFI environment makes the station calibration process more difficult and less reliable etc.







FROM J. Bregman PhD Thesis

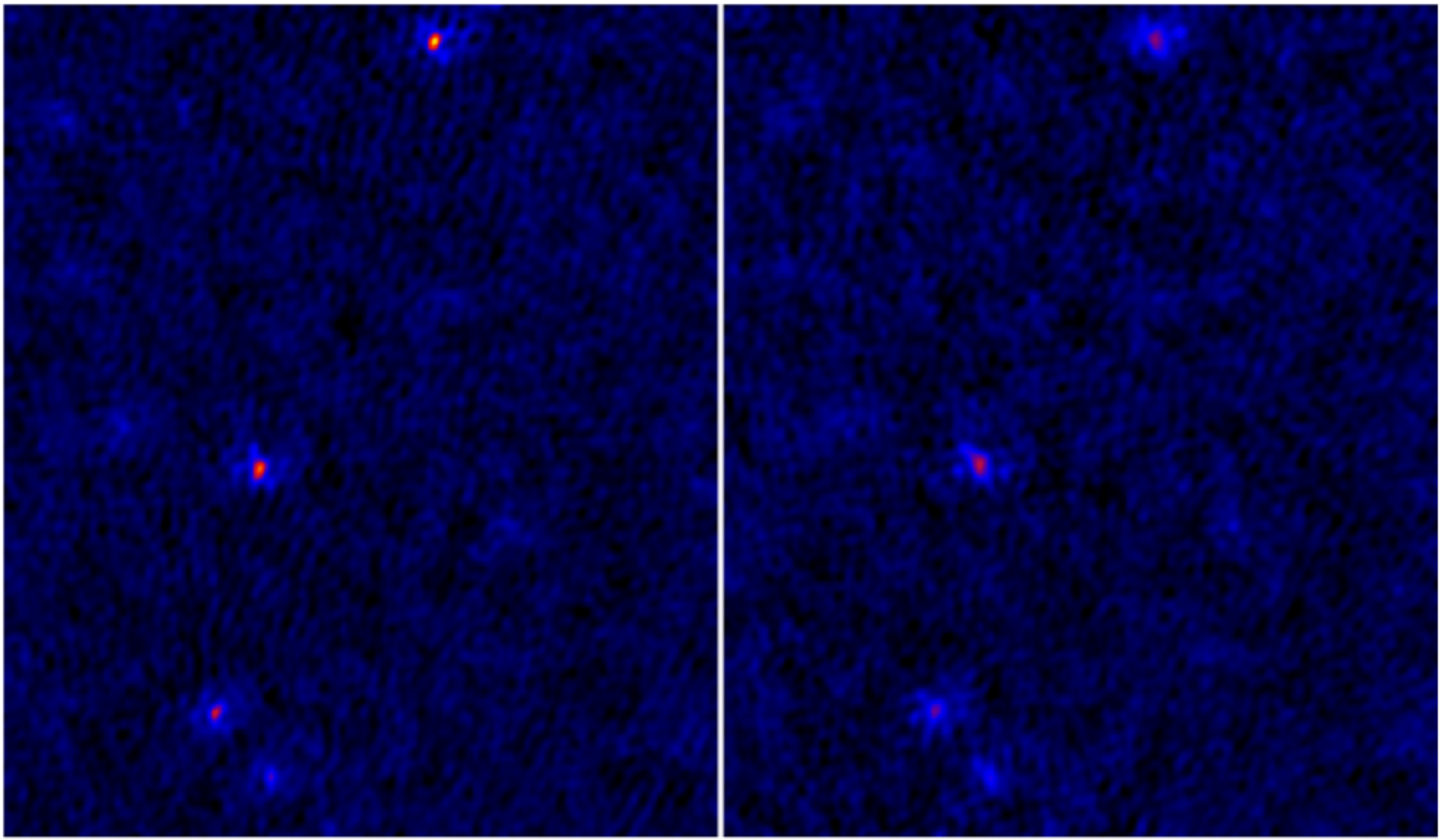
- "**Beam size and sensitivity of all LOFAR LBA stations are marginally adequate to allow self-calibration using 5 sources with SNR > 3 per station beam down to 0.37 of the peak value**. Relative bandwidth of ~20% and integration times of 20-100 s are then required, which is just adequate to correct for the large-scale TID on baselines with a sufficiently low rate of change in the TEC induced delay."

- "To improve the sampling density by self-calibration sources, the LBA stations could **use dense multi-beaming** to provide a delay screen that describes the complete central beam that has a much larger extent than the TID patches."

- "The number of sources per beam could be extended for the European LBA stations by applying a station taper that increases the beam with minor loss of sensitivity and is important for observing at frequencies higher than 50 MHz."

LBA calibration

- Keep high resolution in time and frequency.
- Use FACTOR scheme seems to improve S/N (de Gasperin)
- Use of phase screens demonstrated by D. Rafferty increases S/N. 50% more sources with PhSc.
- Sagecal consensus optimization or Killms Wirtinger calibration.
- To keep the number of free parameters constrained Sagecal or Killms can be used to solve per facet non-DDE problems.



With phase screen

Without phase screen

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Observational strategy

- Give up calibrator band and devote it to the target and increase S/N for usage of consensus optimization option. Bracket the observation with 10 min at the beginning and the end with a calibrator observation (look to George's experiment for LBA)
- Give up calibrator band to use it for flanking field near the target to find phase calibrator to model the phase screen.
- In a simultaneous observations (not supported) observe the same field in HBA and LBA and transfer the ionospheric model derived from HBA to the LBA (tested at the VLA from P to 4 band...not great results)

Discussion

- Where do you want the next improvement taking place? In a short and long term (3m 1 yr 2 yrs)?
- Is there a need to get more work done in HBA before implementing it in the production RO pipelines? How much?
- Are we understanding the ionosphere? Can we use the info collected in phase solutions?
- LBA Ideas? Possible limitations? Do we have all the tools in place?

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