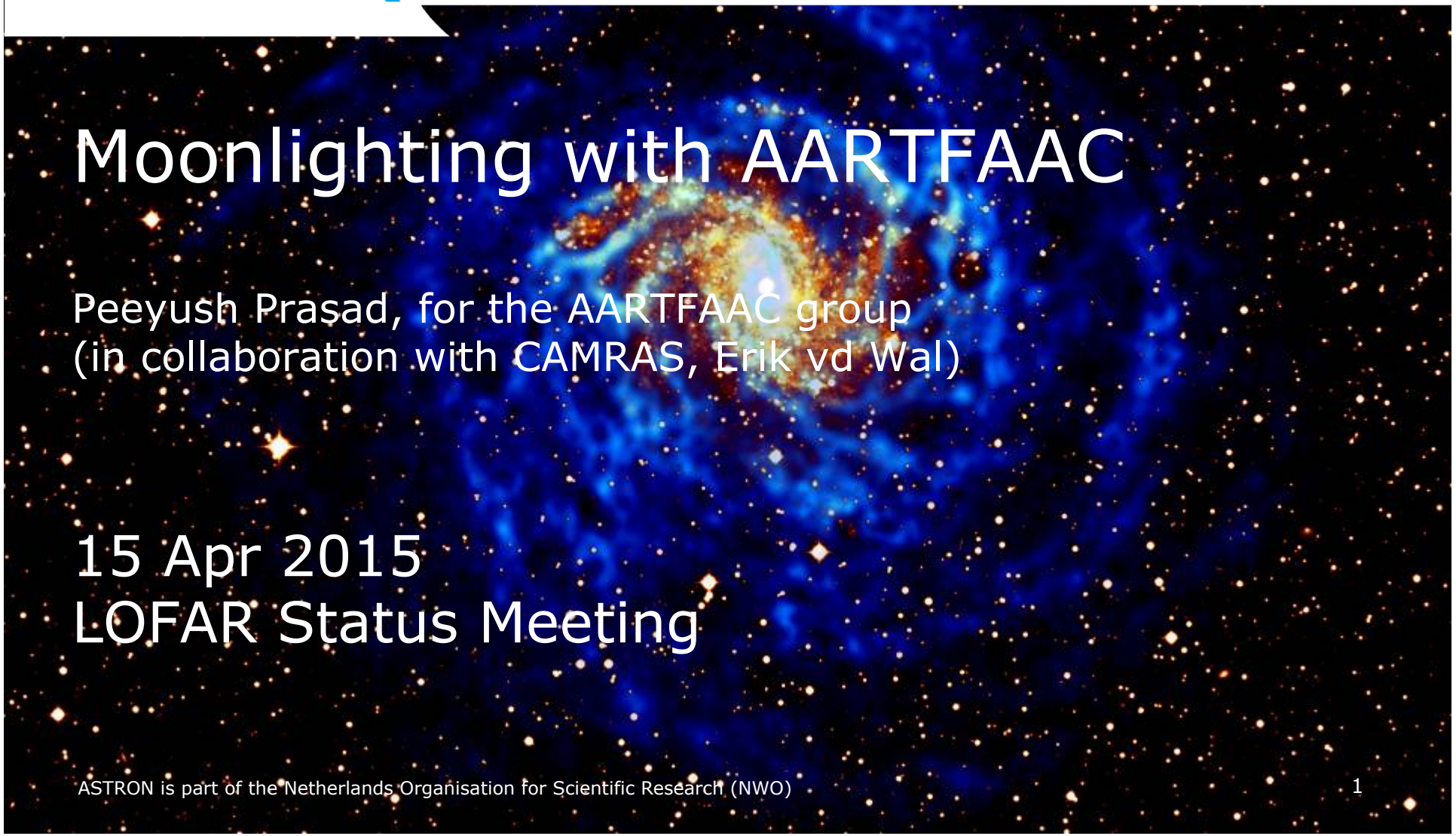
ASTRON

Netherlands Institute for Radio Astronomy

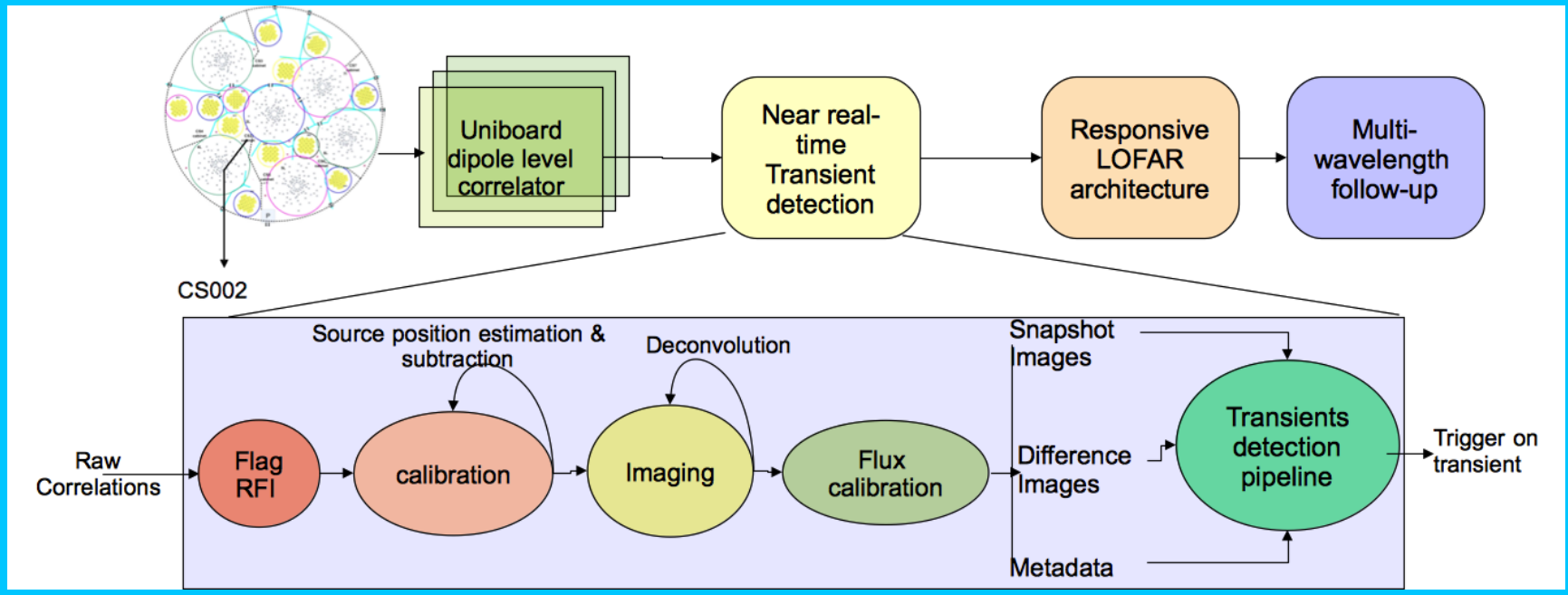


Moonlighting with AARTFAAC

Peeyush Prasad, for the AARTFAAC group
(in collaboration with CAMRAS, Erik vd Wal)

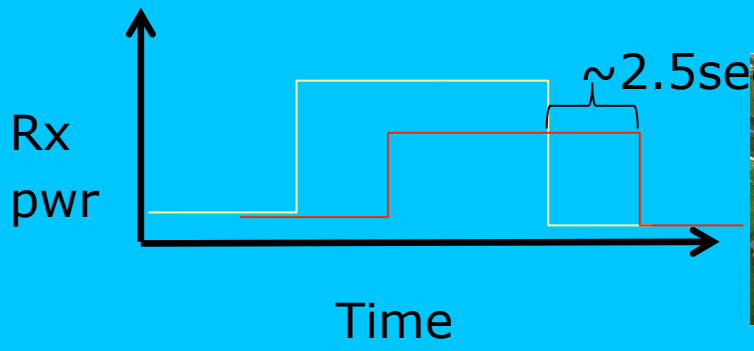
15 Apr 2015
LOFAR Status Meeting

Motivation: Why



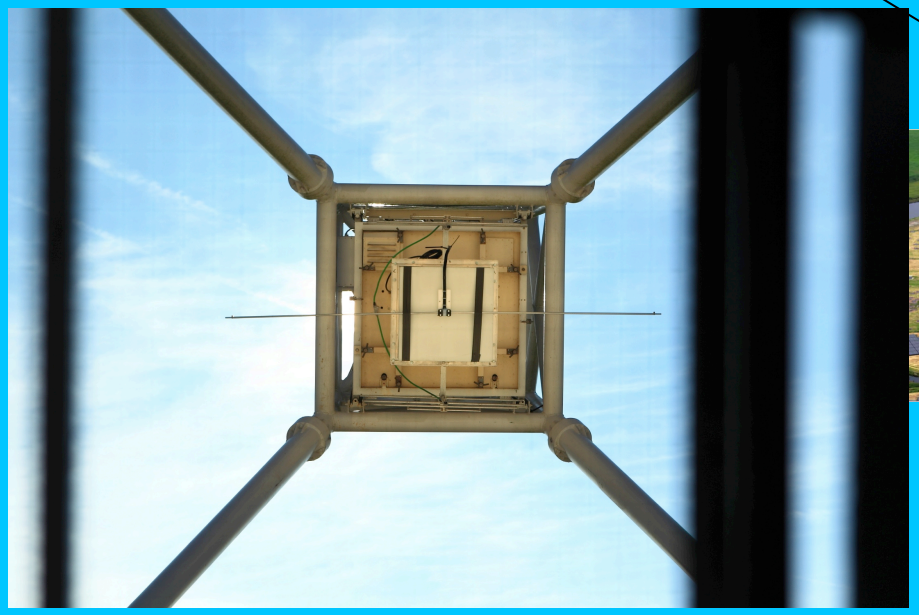
- Generate artificial transients.
- End to end test of transient detection pipeline
  - Effect of a bright transient on autonomous calibration
  - Transient detection accuracy of TraP
  - Establish detection thresholds

Motivation: How



- Receive a far-field signal, with control on amplitude modulation.
- CAMRAS: Transmit on ~50 MHz HAM band, receive with AARTFAAC via moon-bounce.

Motivation: How



- Modify Dwingeloo dish to Tx at 50 MHz. Dipole design, fabrication and installation by CAMRAS.
- Dipole poorly matched to dish, expect low directivity.

Motivation: Link budget

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- Max. Tx power : 100W
- Max. Directivity $(I/D)^2$: ~16
- Max. output power: 1600W
- Expected path (+ albedo) loss : ~240dB@50MHz
- Expected receive flux : ~40Jy@3kHz
- Expected sky noise : ~40Jy

  (Off Galactic plane, 3kHz bandwidth)
- AARTFAAC measured noise@3kHz : ~70Jy

- Expect to see the moon-bounce echo with integration.
- Differencing (temporal,spectral) reduces noise floor (confusion dominated).

Observations:

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- Instrument configuration (AARTFAAC):
  - Stations : LBA_OUTER, choose relevant subband
  - Correlator: 3kHz, 1sec. resolution, RT dump to disk.

- Instrument configuration (CAMRAS):
  - PTT Tx, CW@100W
  - 0.5-1 min. Tx pulse width
  - Tx @50.5MHz/54MHz

- Observations: 28Oct14 (4st. Moon in Galactic plane),
  06Jan15 (4st.)
  - 23Feb15 (6st., Moon ele: ~50deg)

Processing:

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- **Eigenspectrogram:** Uncalibrated data, check for very bright sources.

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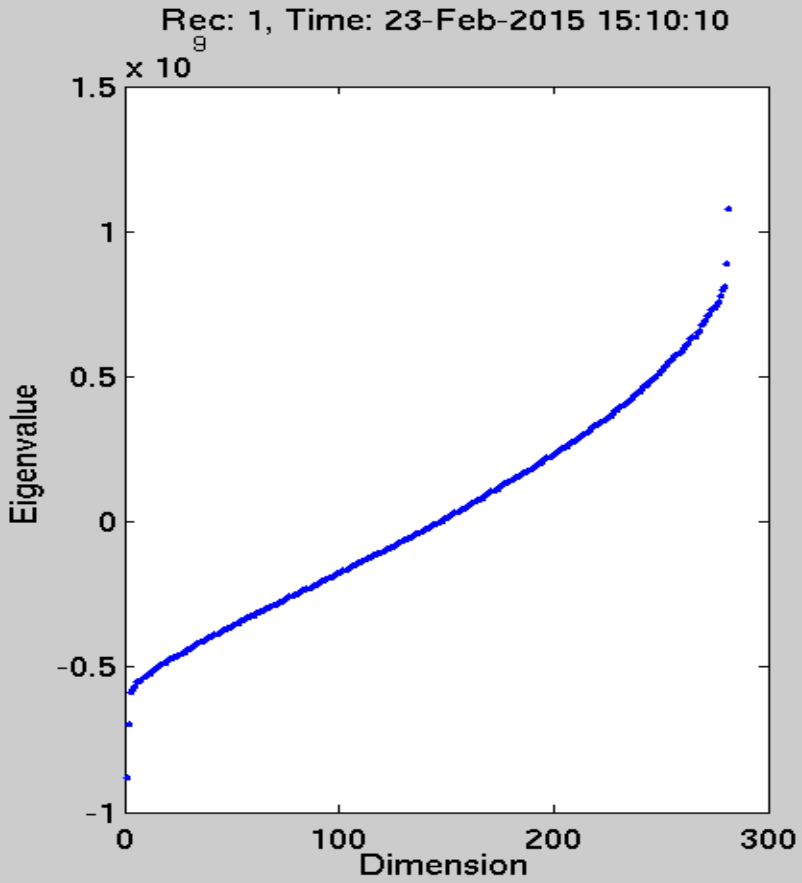

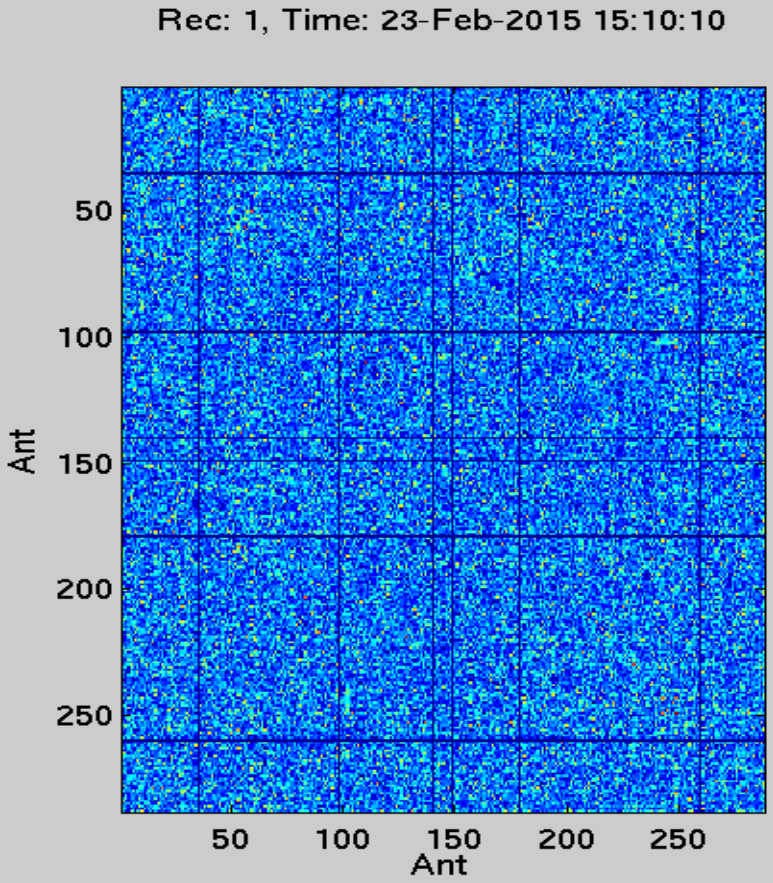

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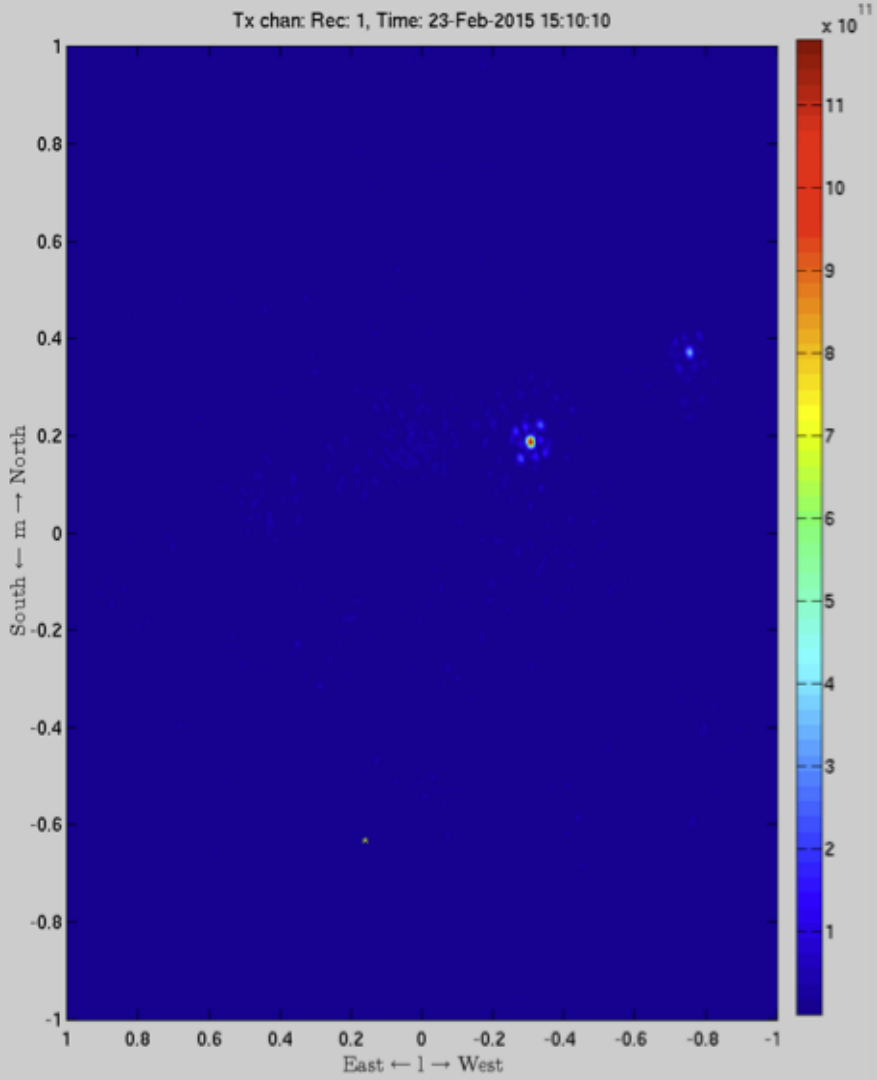
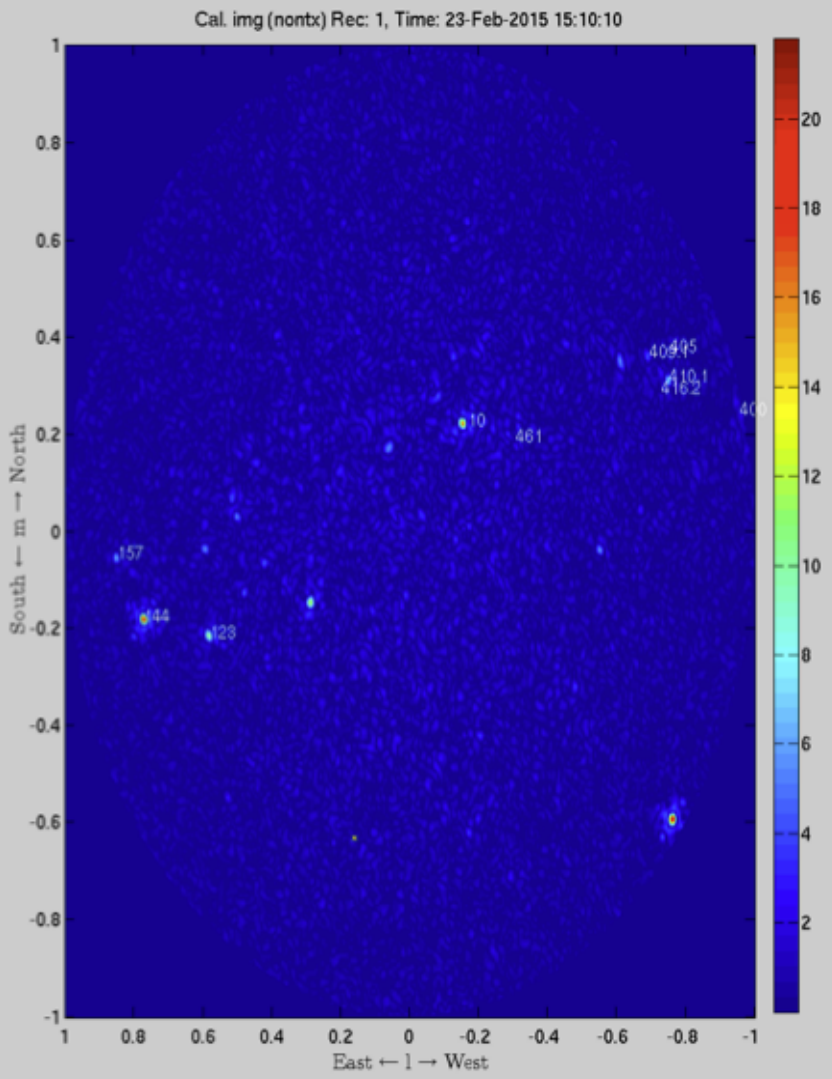
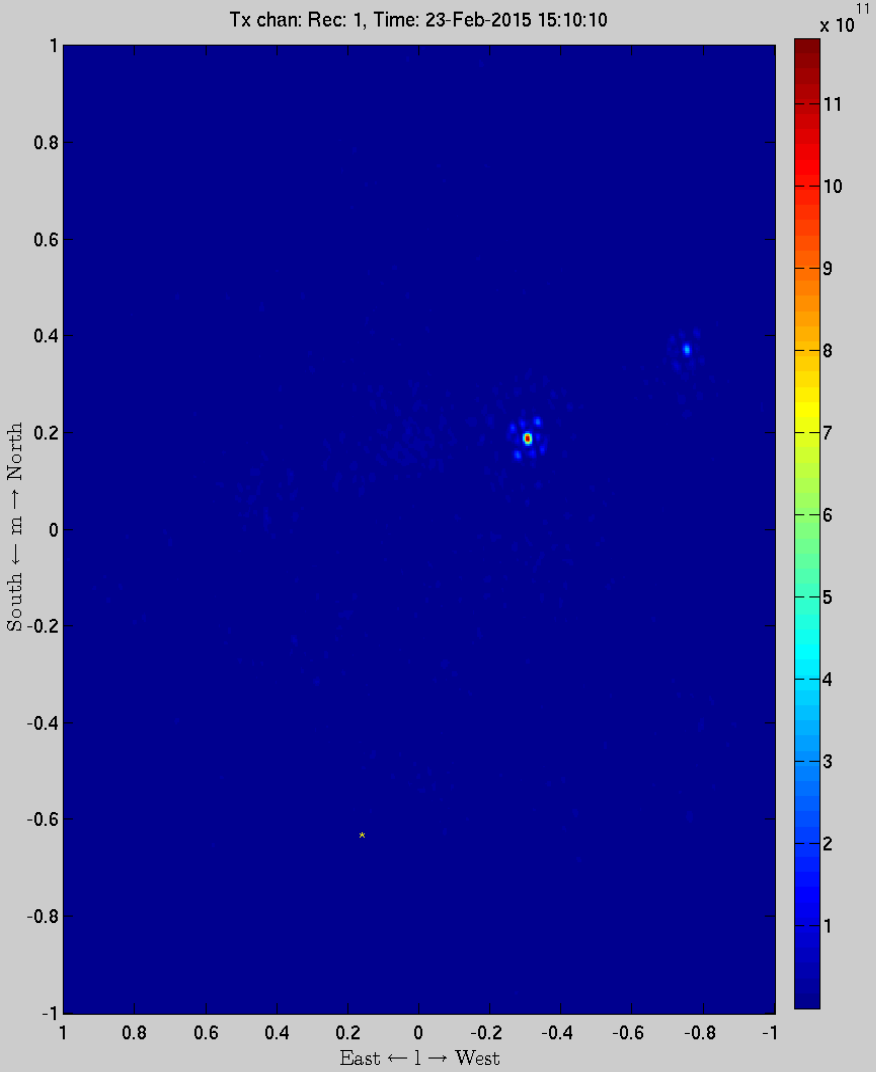
- **Eigenspectrogram:** Uncalibrated data, check for very bright sources.
- **Direct imaging:** See if echo appears at the right place.
  - Calibrate on non-tx channels, apply on tx channel

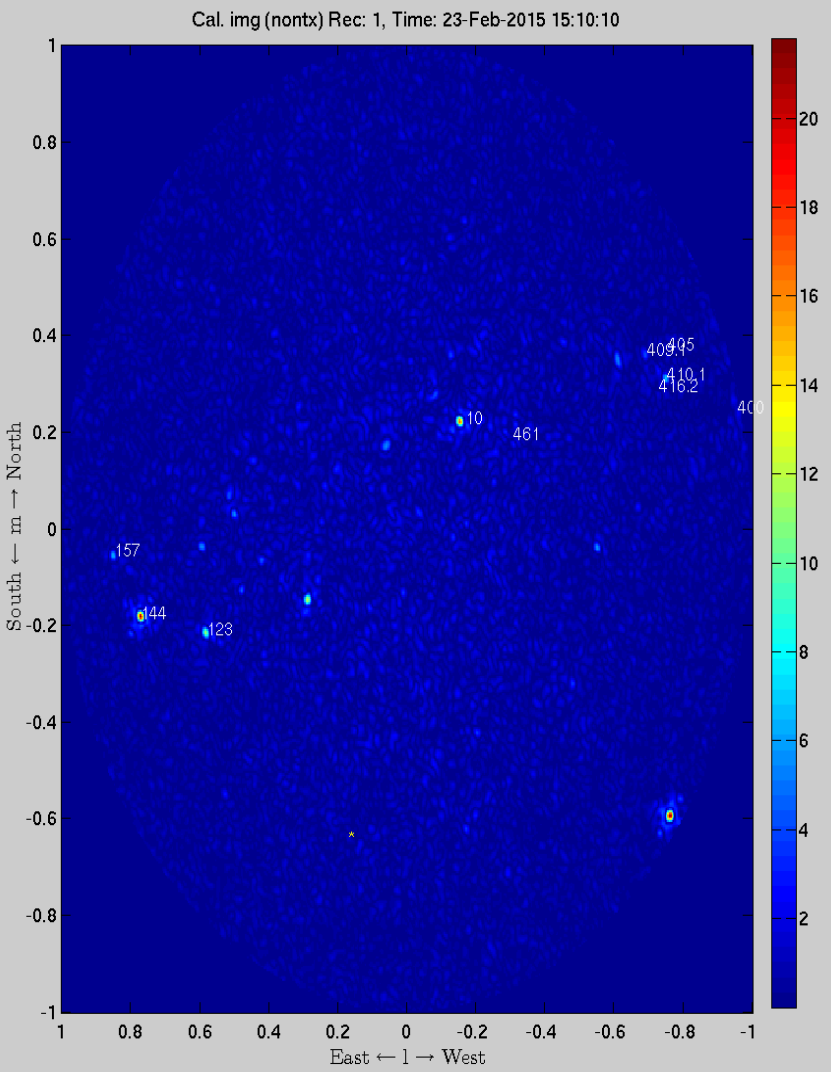
Observations: 23Feb15



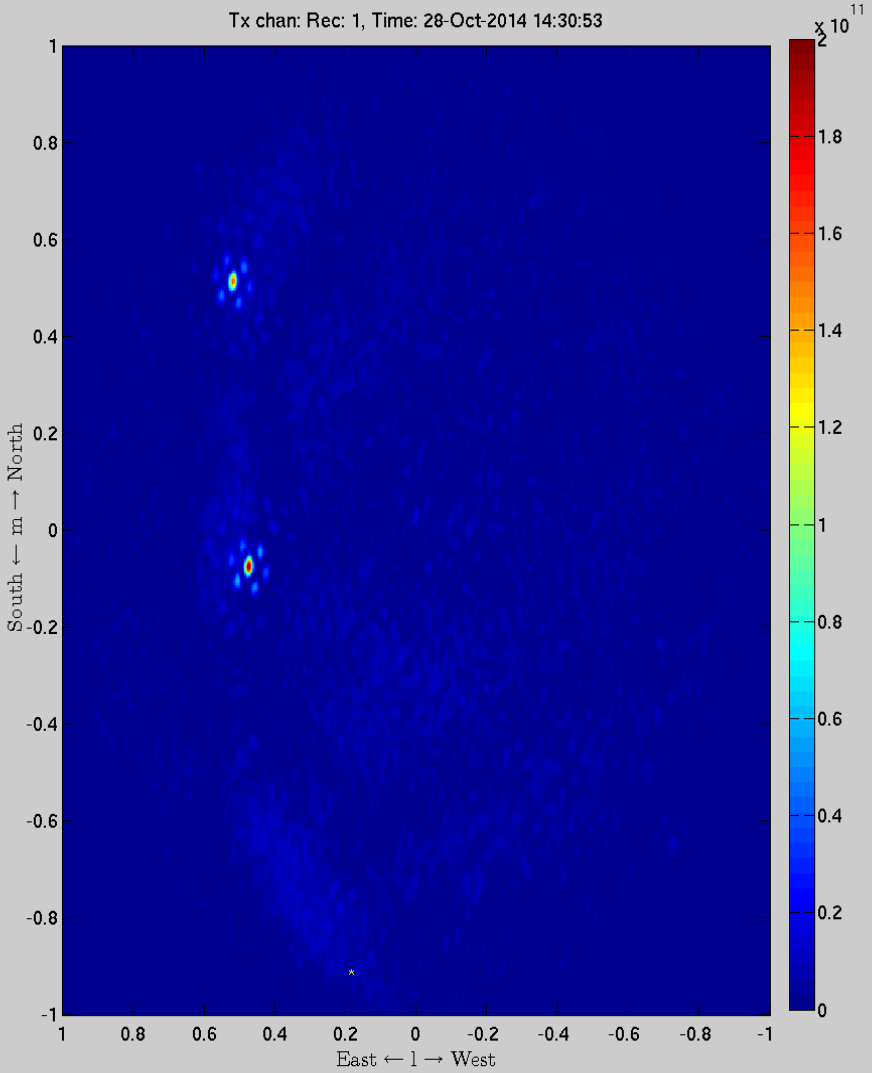


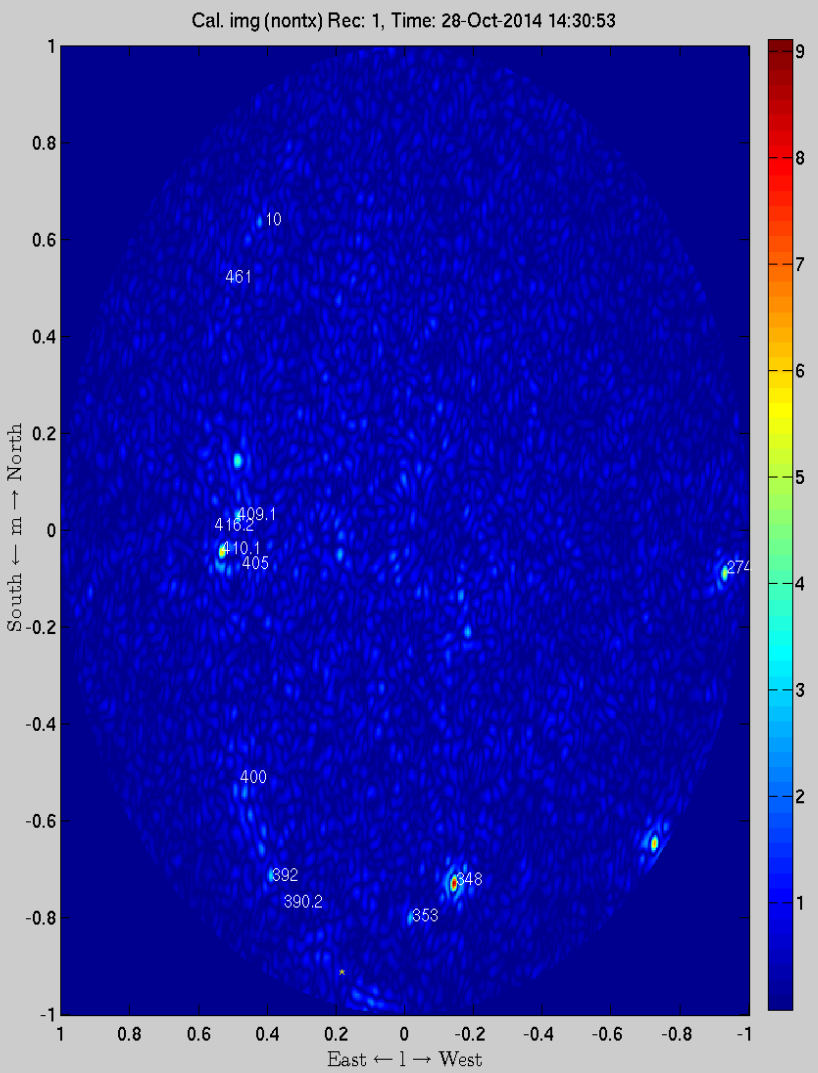
Observations: 23Feb15





Observations: 28Oct14





Observations:

~34 Km

LOFAR azi = 73deg

- Direct Line of Sight (LoS) signal is much stronger. (10-100x)
- Probably due to poor illumination/back reflector on radiator.

Processing:

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  - Not seen. Direct Tx signal too bright. Needs to be subtracted.

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- **Temporal differencing:** Cancels direct tx, reduces SCN.
  - Also cancels echo, except for last sample before switch off. Not seen.

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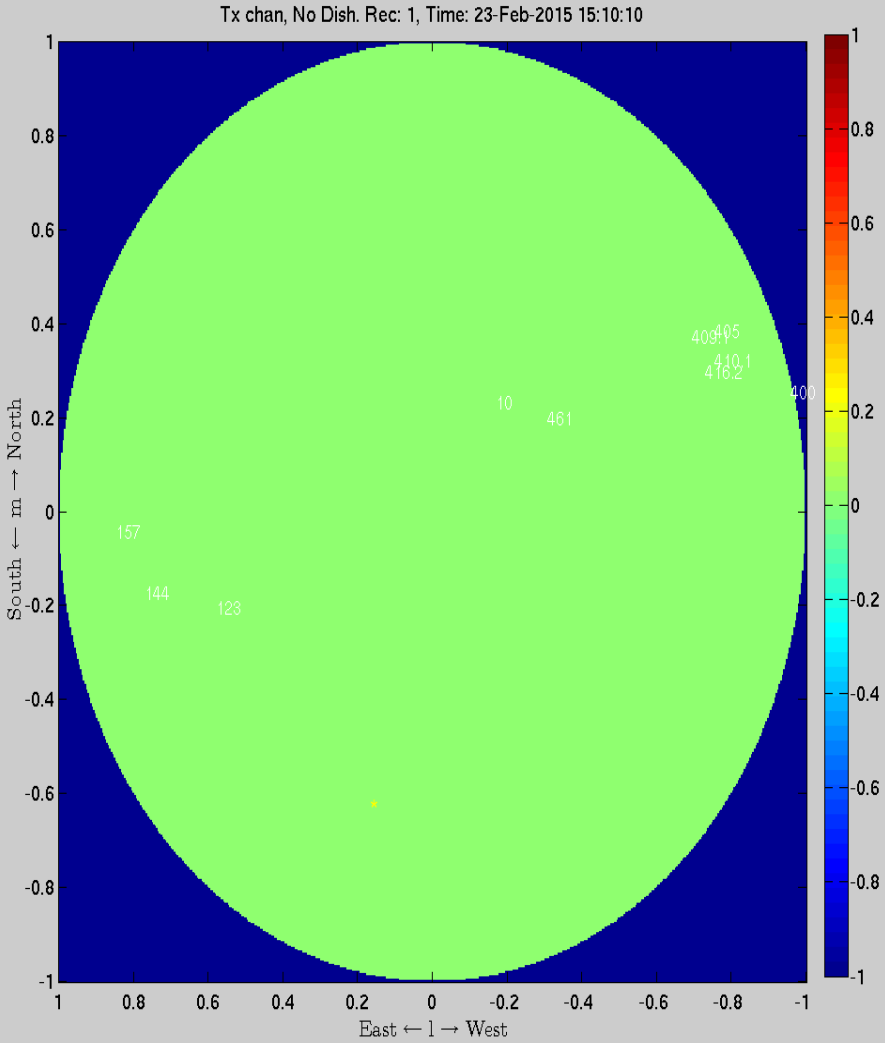
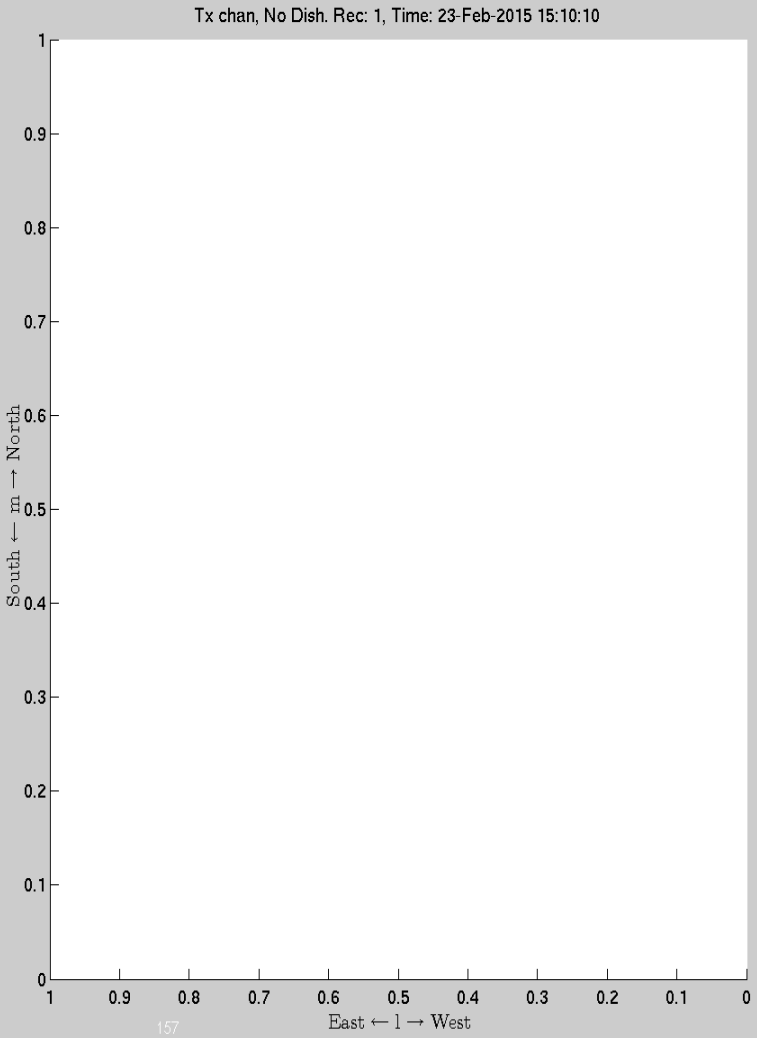
- **Eigenspectrogram:** Uncalibrated data, check for very bright sources.
- **Direct imaging:** See if echo appears at the right place.
  - Calibrate on non-tx channels, apply on tx channel
  - Not seen. Direct Tx signal too bright. Needs to be subtracted.
- **Temporal differencing:** Cancels direct tx, reduces SCN.
  - Also cancels echo, except for last sample before switch off. Not seen.
- **Spectral differencing:** Cancels sky signal, reduces SCN.
  - Calibrate on direct Tx signal, subtract via modeling.

Observations: 23Feb15





Conclusions

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- Dish based transmission inefficient, but echo should be visible after a little integration.
- Transmission leakage appears as strong source in AARTFAAC, detrimental to integration.
- Leakage from dish can be successfully modeled and subtracted.
- Leakage signal illuminates a large area, causing reflections off aircraft to be detected at lower levels (difficult to model).