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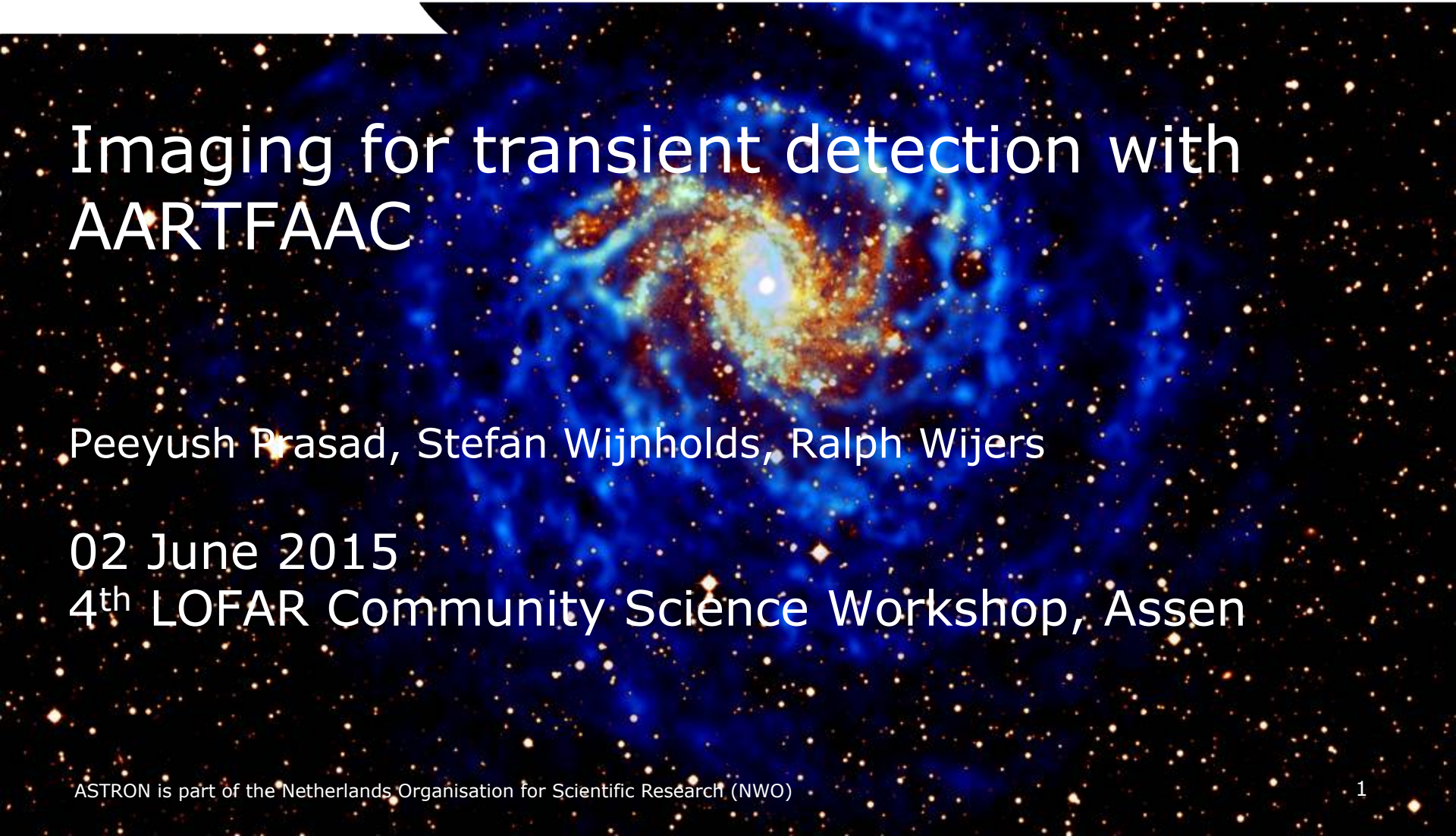
Netherlands Institute for Radio Astronomy



Imaging for transient detection with AARTFAAC

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02 June 2015
4th LOFAR Community Science Workshop, Assen

Outline

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- Introduction to AARTFAAC All-Sky monitor.
- Array configurations, impact on imaging.
- PSF tuning for transient detection.
- Instrumentation status update.
- Conclusions.

AARTFAAC and its aims

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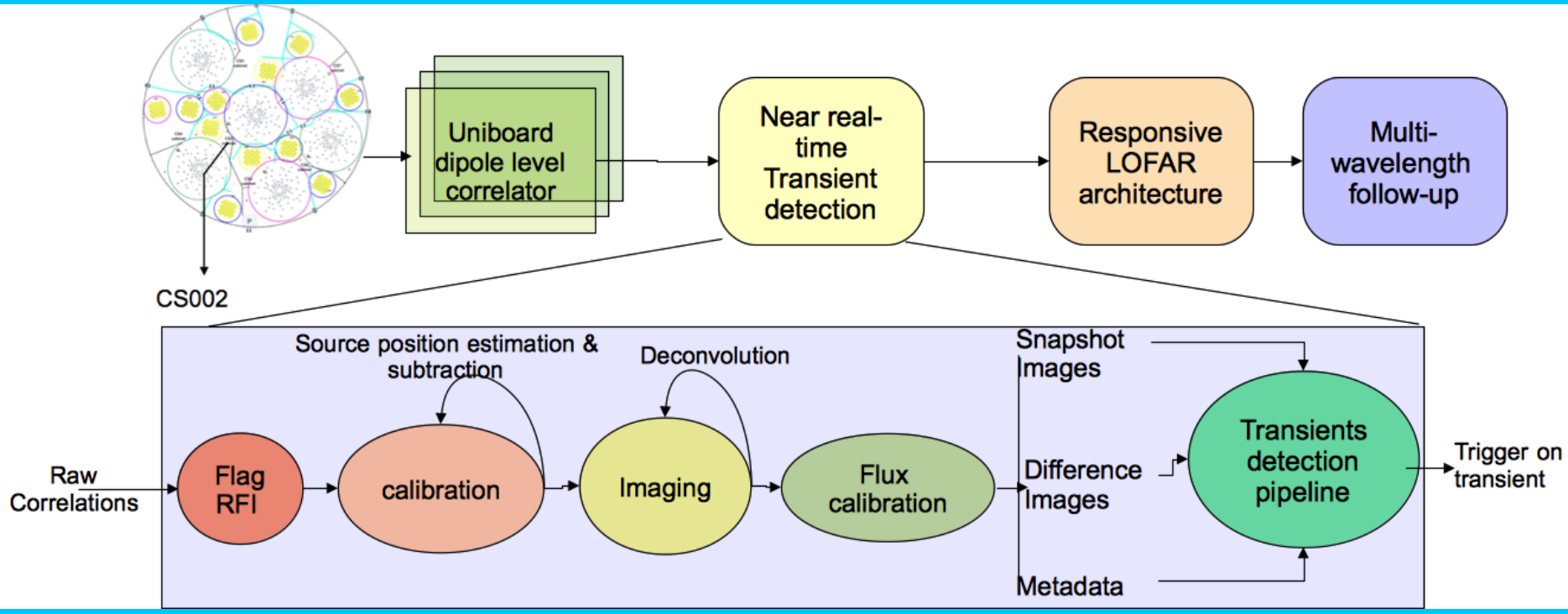
- 24/7 Radio Sky Monitor, uses central 6 (soon 12) LOFAR stations.
- Low resolution, low sensitivity, All-sky FoV, all the time (Piggyback with LOFAR).
- Low latency, near real-time response.

Pipeline components



- Correlate all 288 LBA dipoles within the SuperTerp, full stokes.
- 4 MHz band over 30-90 MHz, 12 KHz resolution.
- Zenith pointing, snapshot imaging mode.

Transient detection: Requirements

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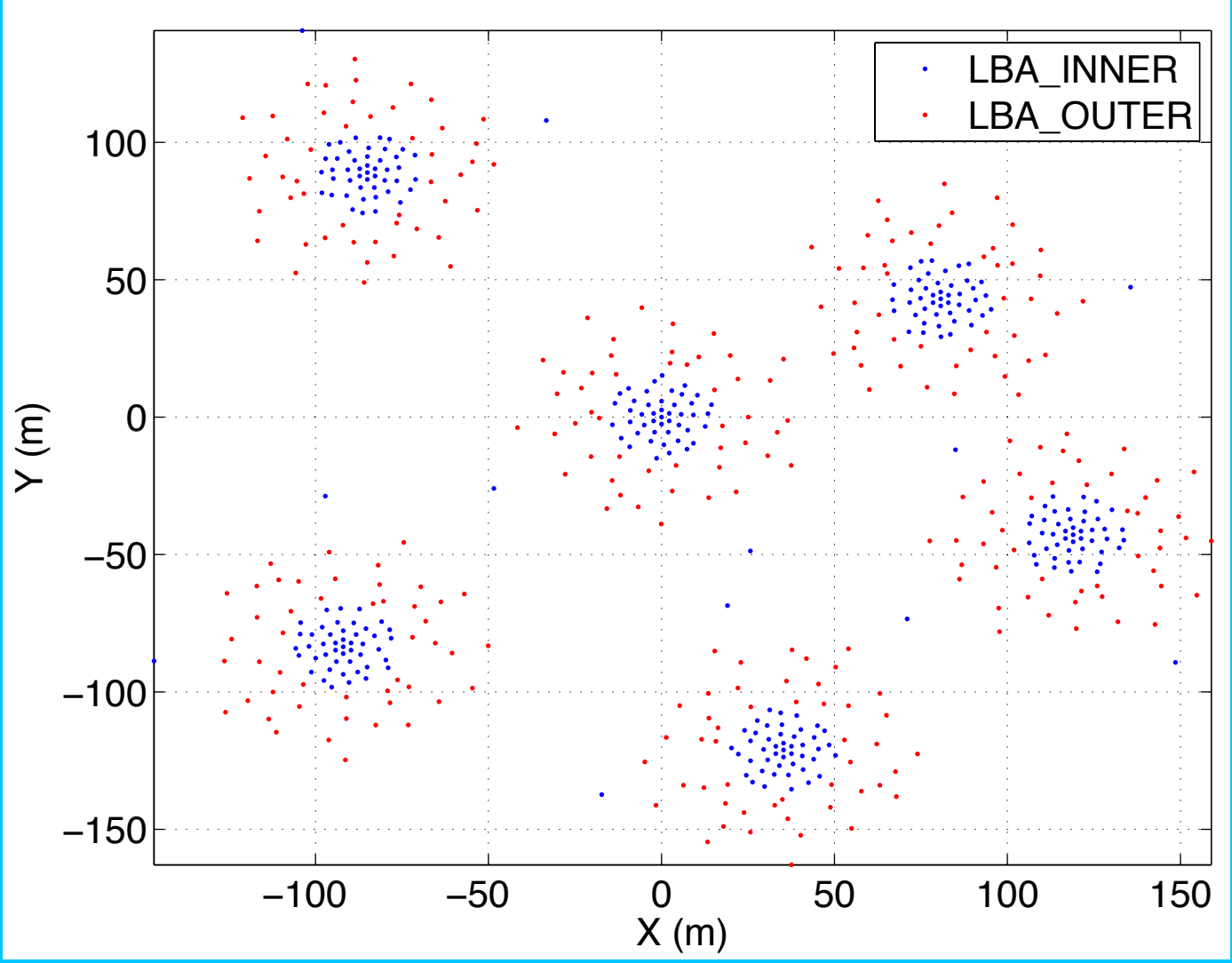
- Point source sensitivity: Natural weighting.
- Point-source skymodel for rapid calibration convergence.
- Low sidelobe confusion noise: tapering of instantaneous UV coverage. Also required for calibration.

AARTFAAC All-sky monitor: Array configurations, UV coverage



AARTFAAC All-sky monitor: Array configurations, UV coverage

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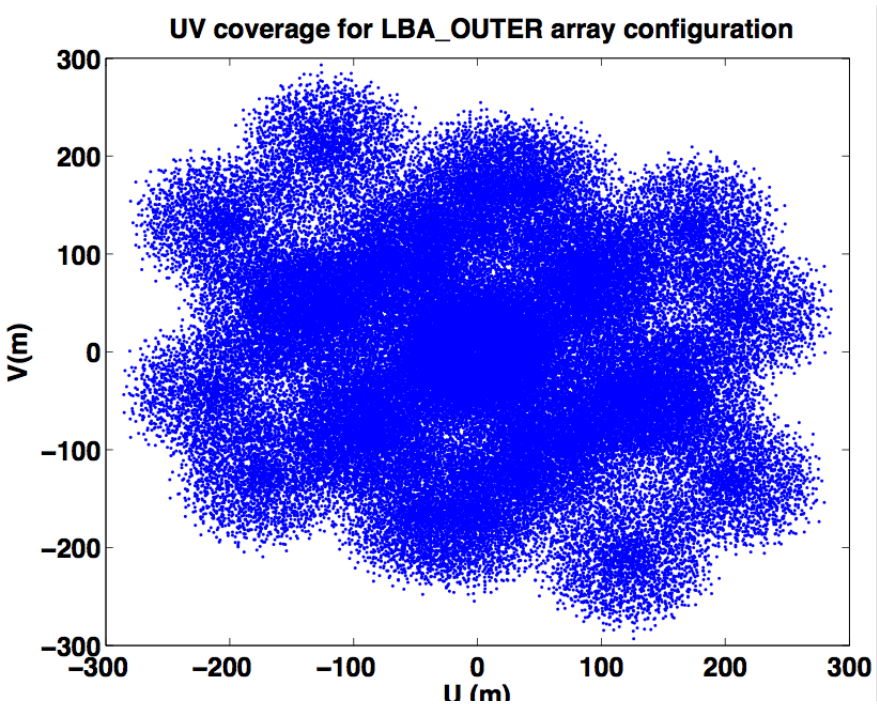

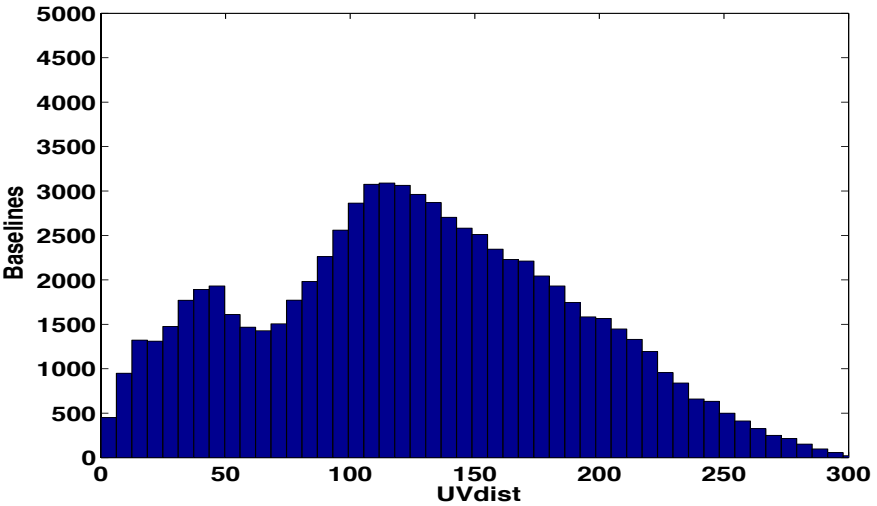

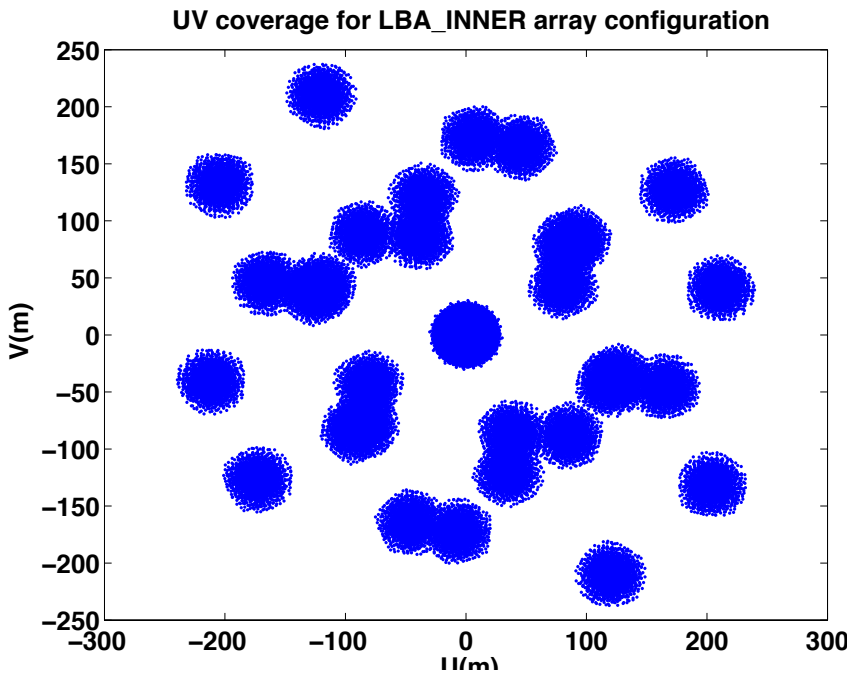

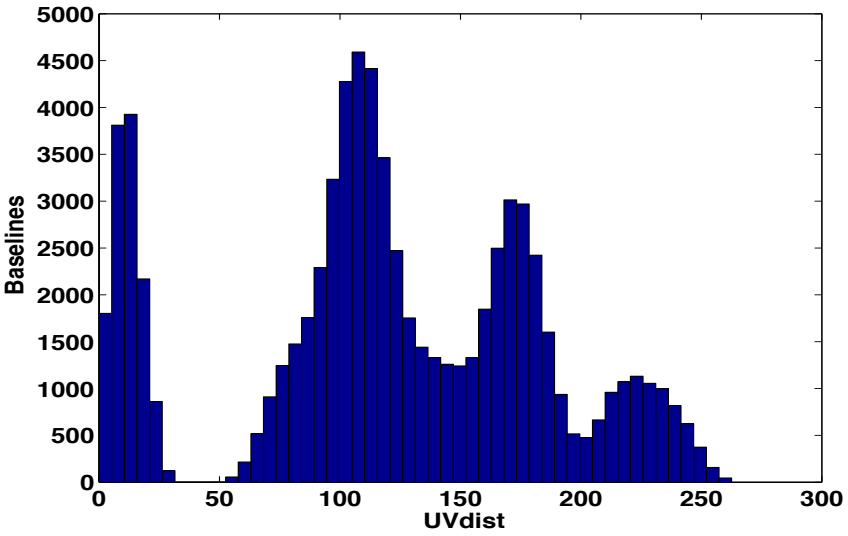

AARTFAAC All-sky monitor: Array configurations, PSF

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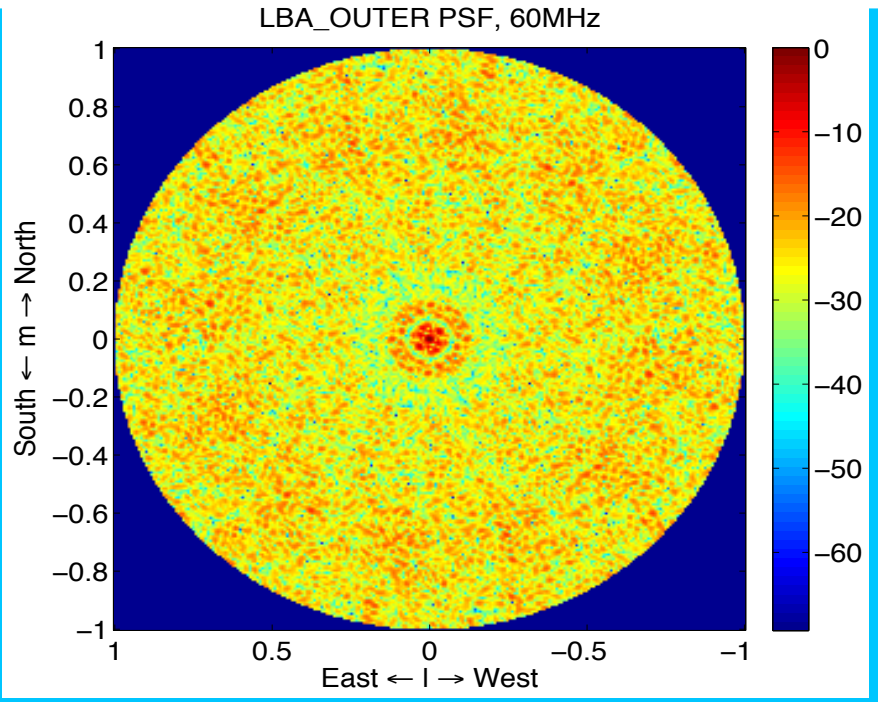
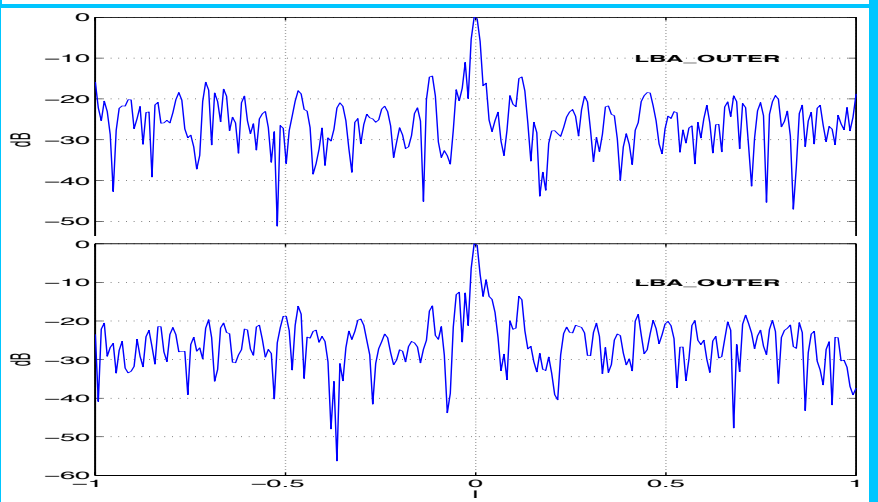
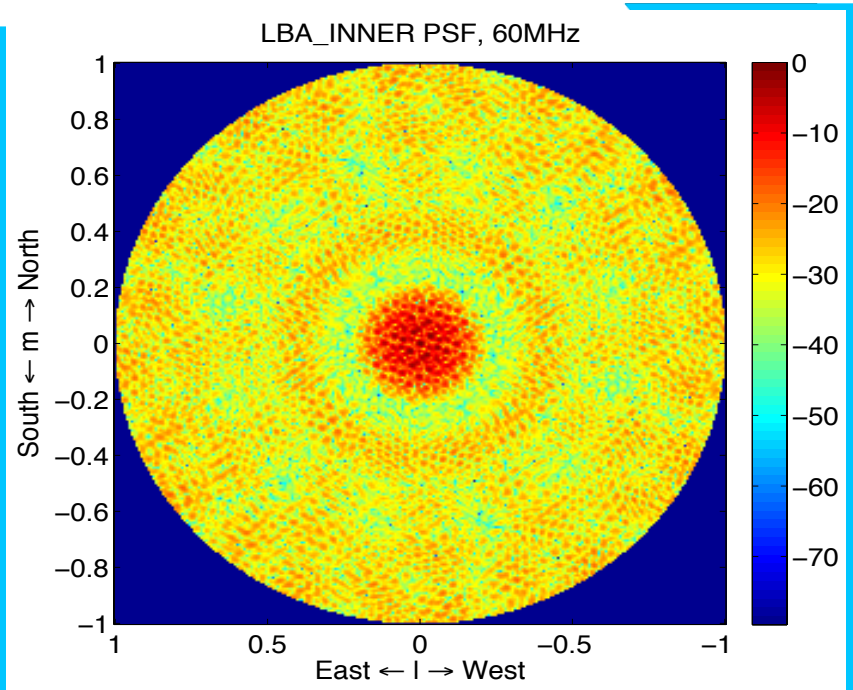
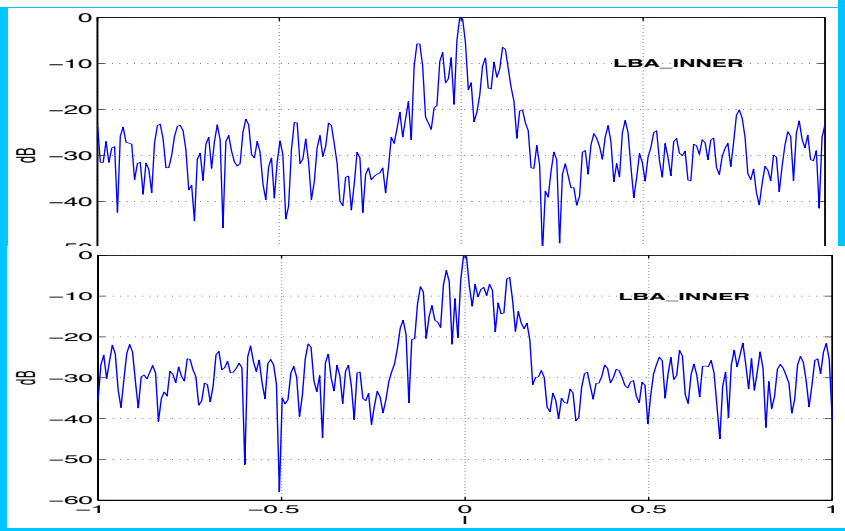
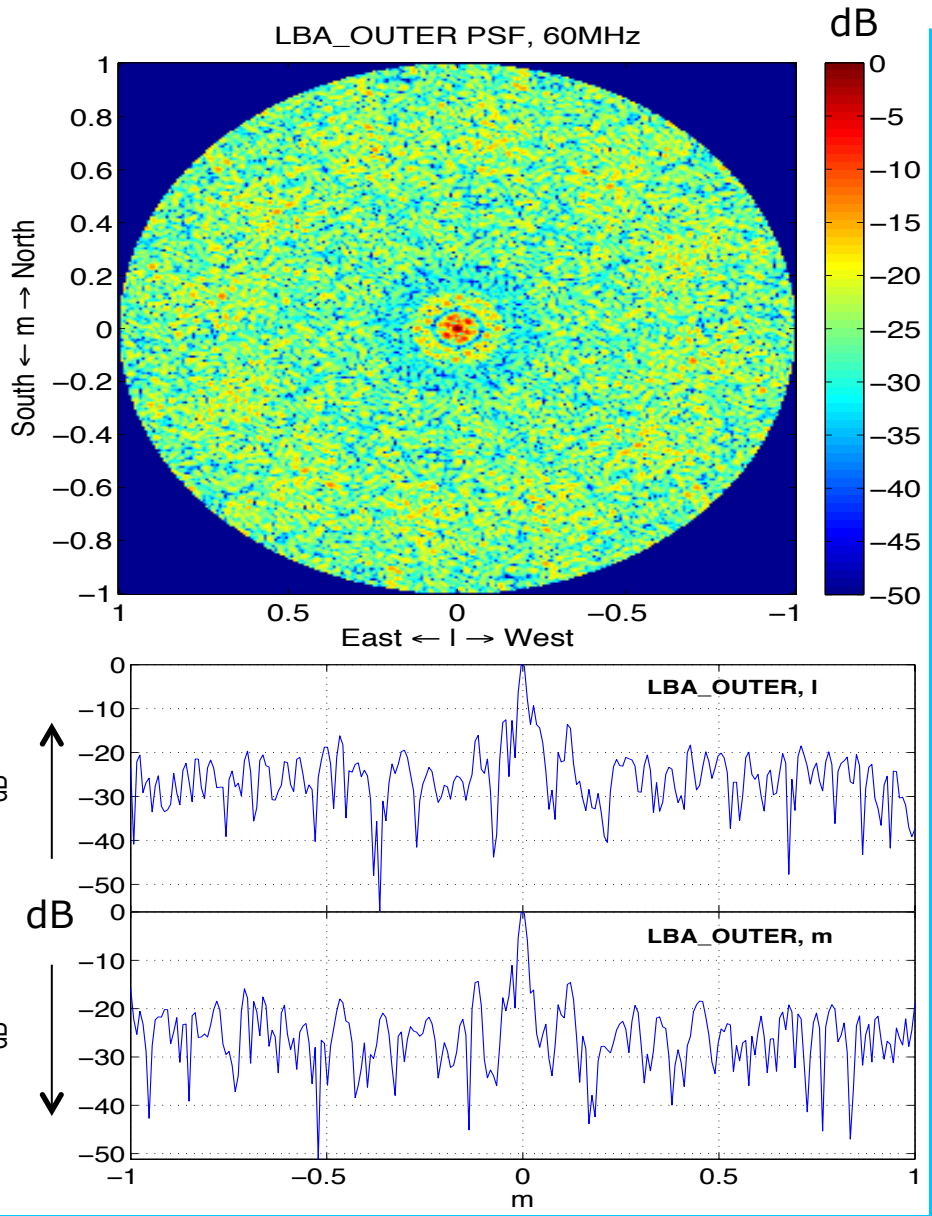


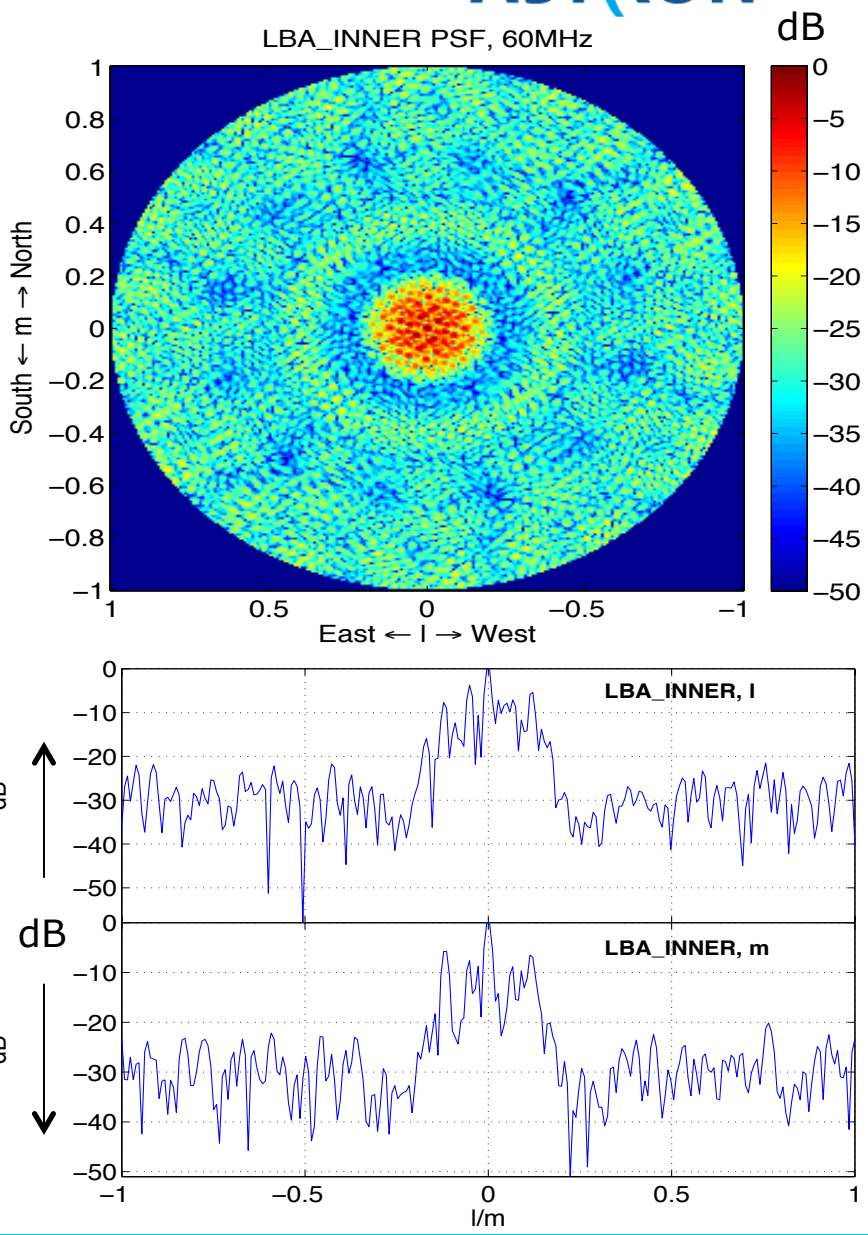




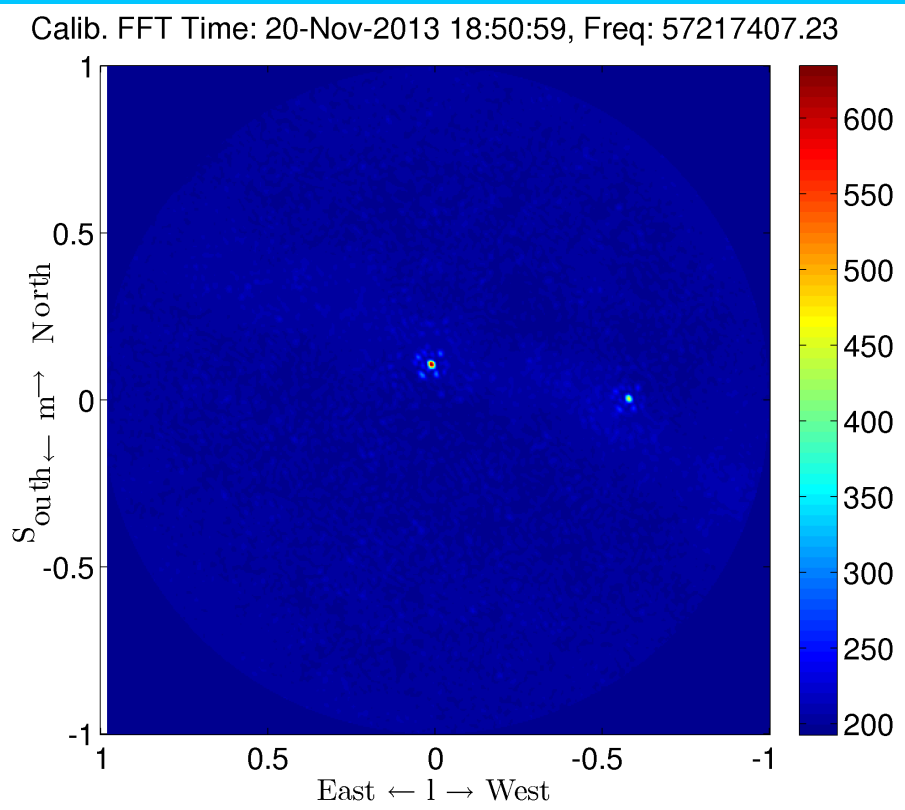


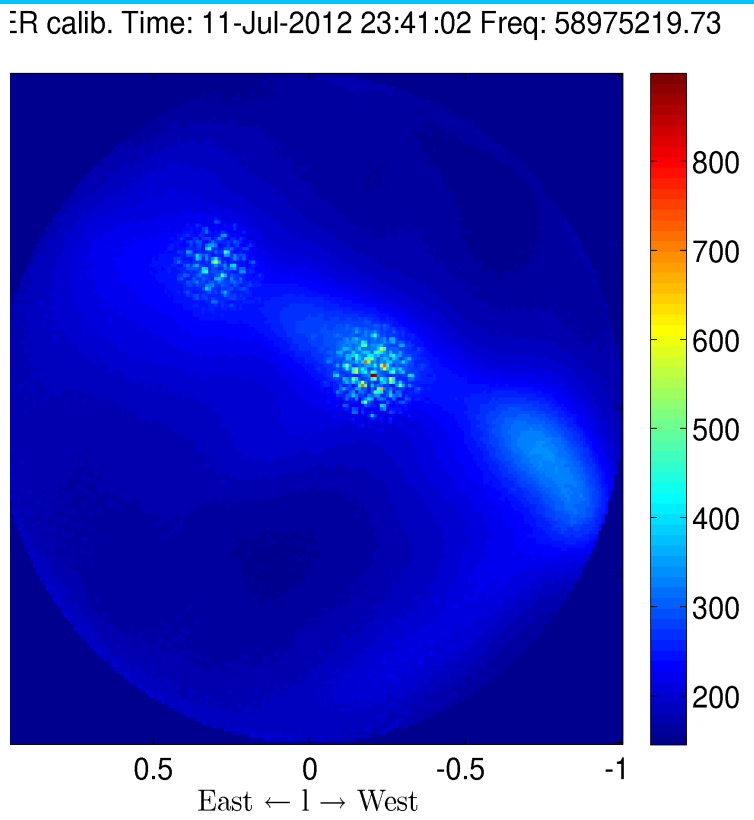
AARTFAAC All-sky monitor: Array configurations, PSF



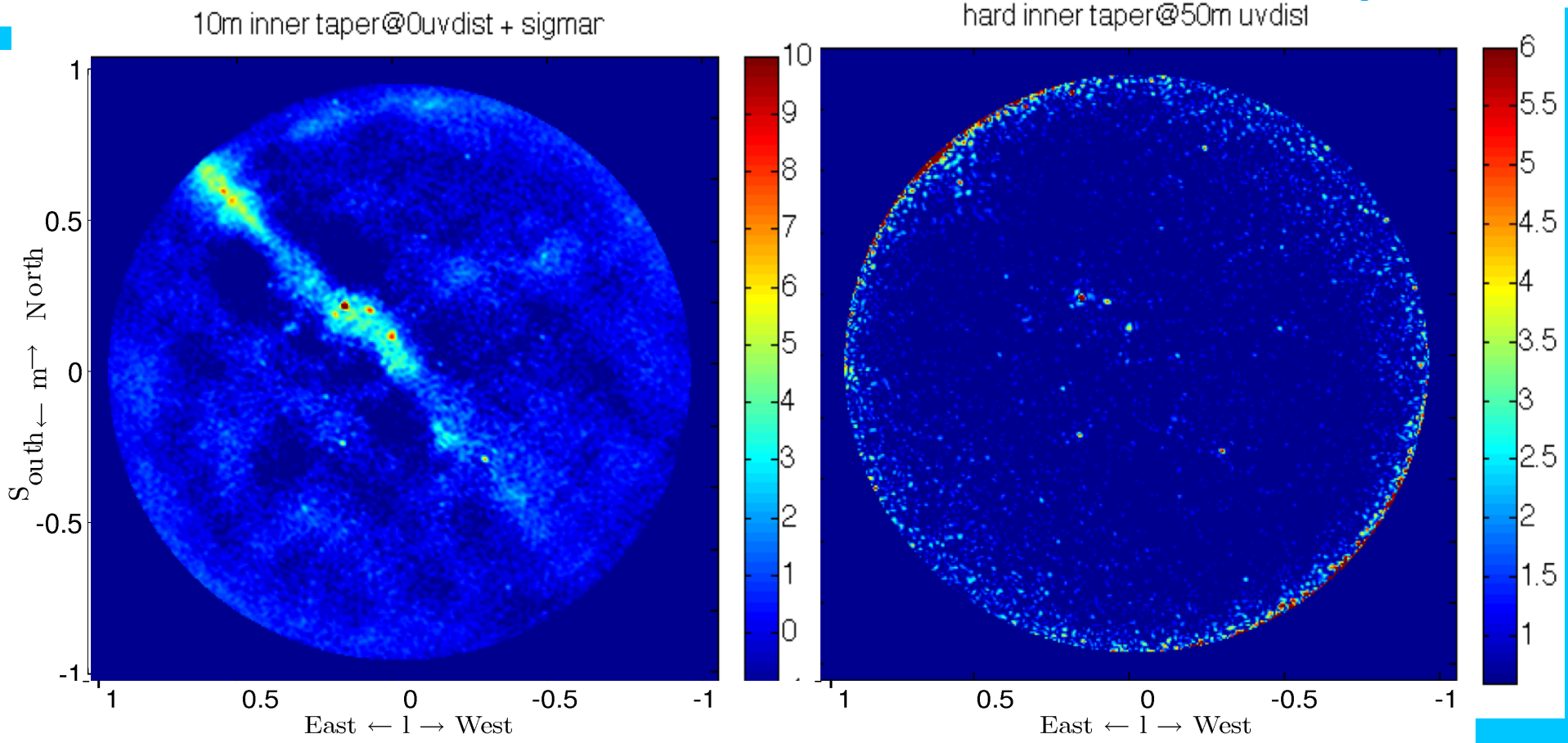


AARTFAAC All-sky monitor: Array configurations, Images



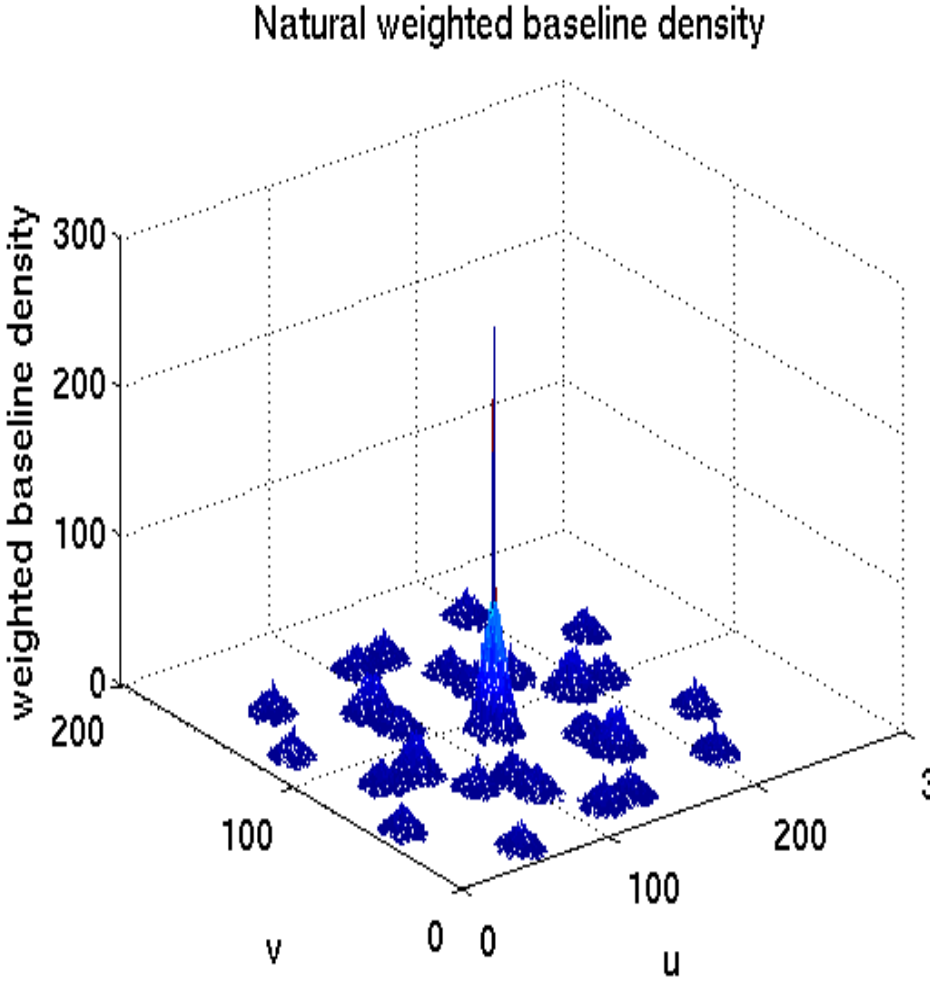


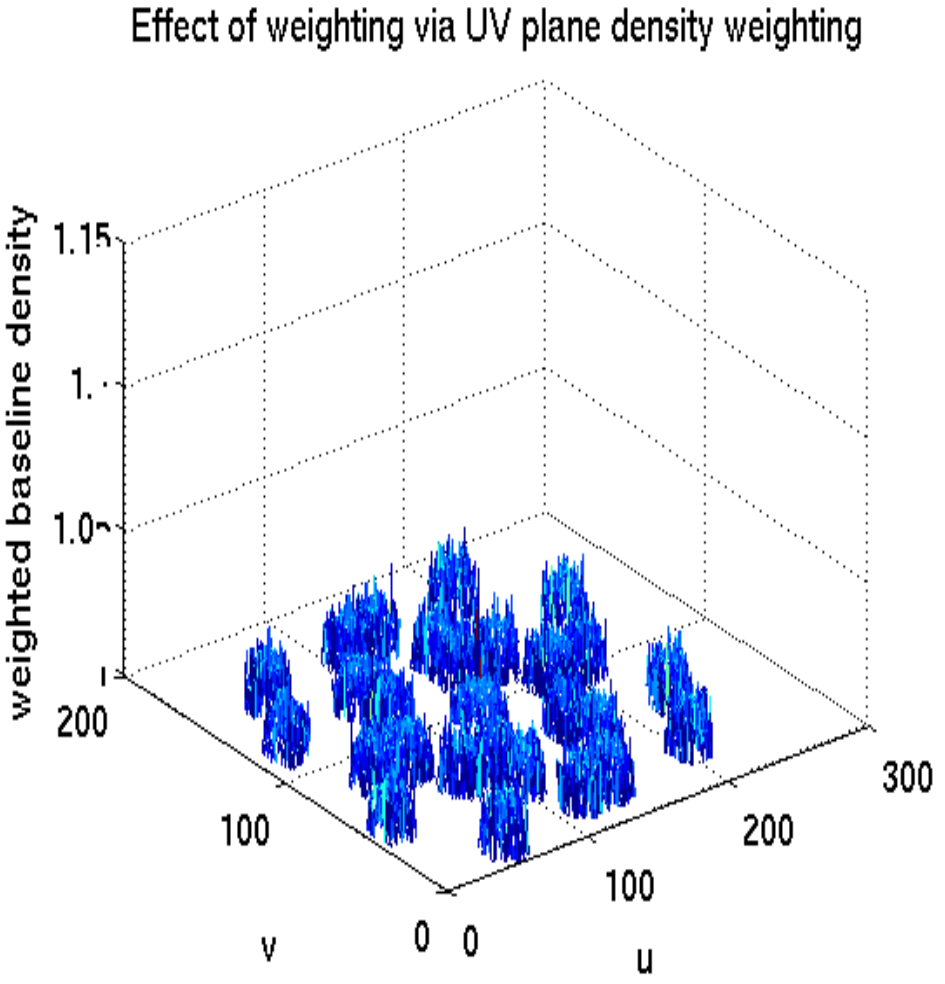
Transient detection: Challenges



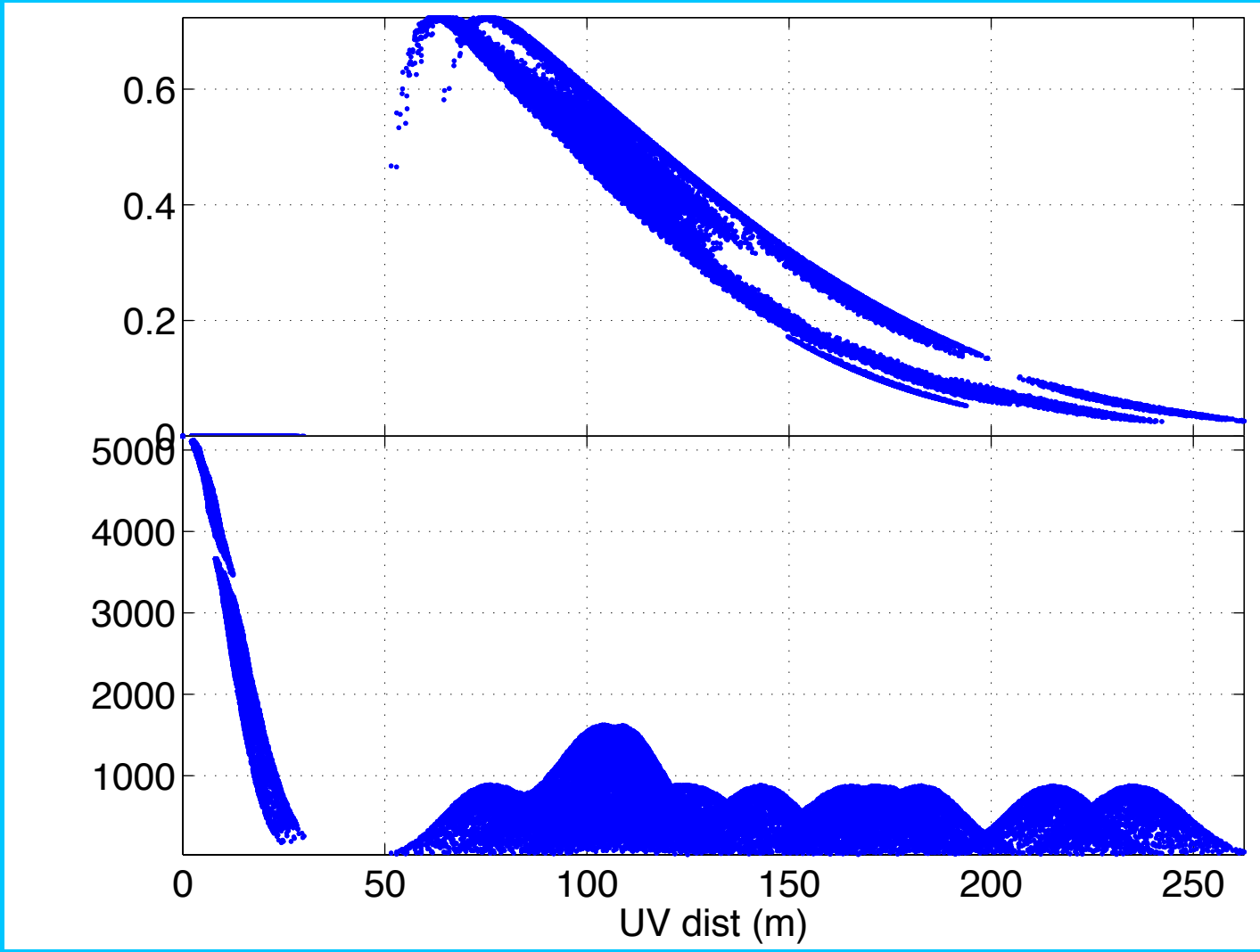
- Calibration: spatial filtering of diffuse emission reduces sensitivity, increases gaps in instantaneous UV coverage.
- Inaccurate source subtraction due to ionospheric wander contributes sidelobe confusion noise.

PSF Optimization parameters: Weighting





PSF Tuning: Taper and Weighting



AARTFAAC All-sky monitor: Array configurations, PSF

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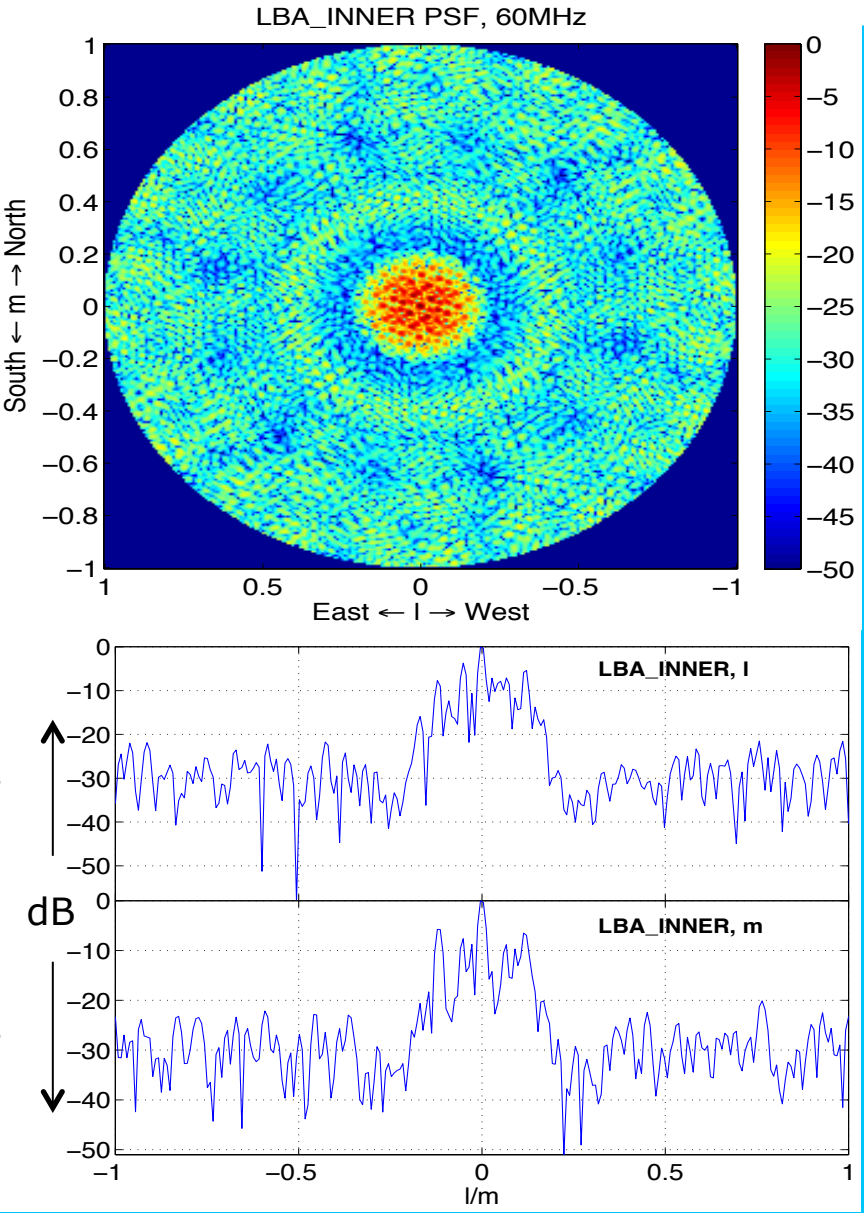

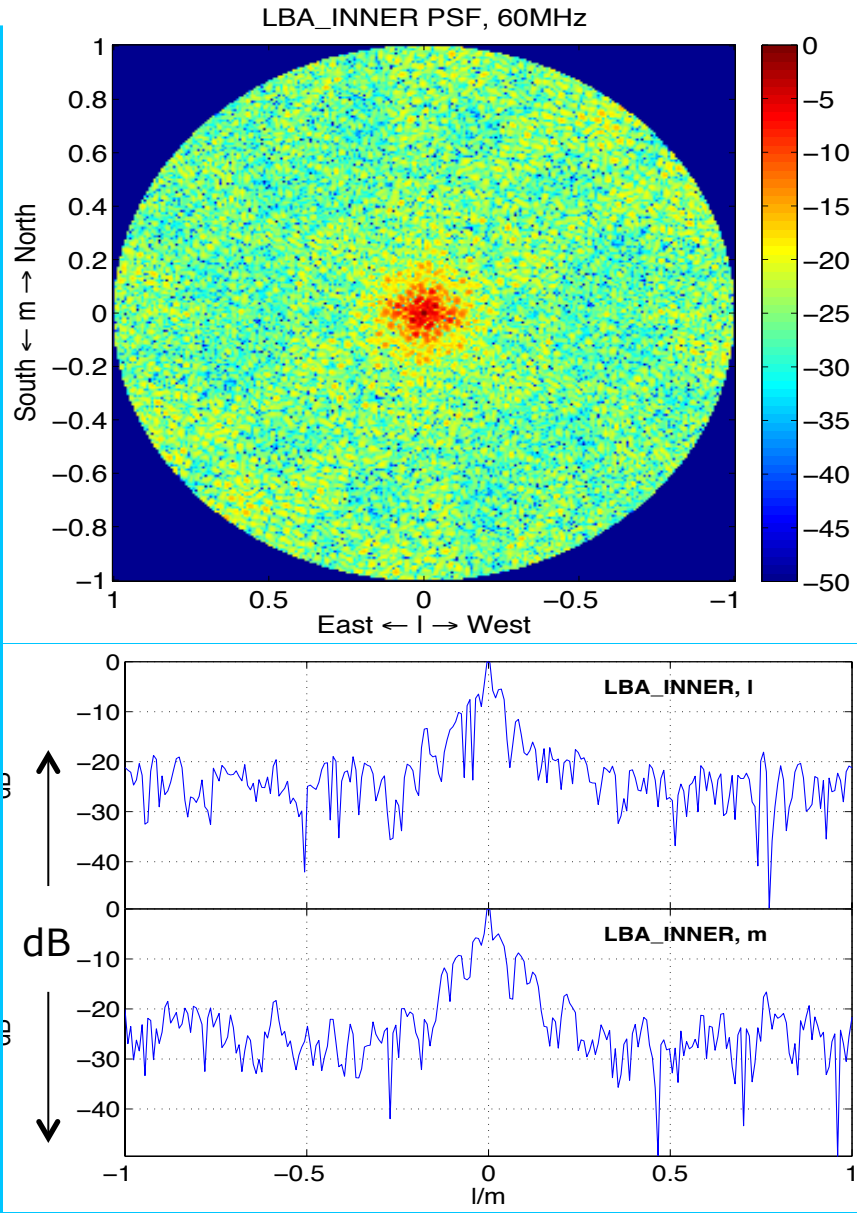

AARTFAAC All-sky monitor: Imaging specs.

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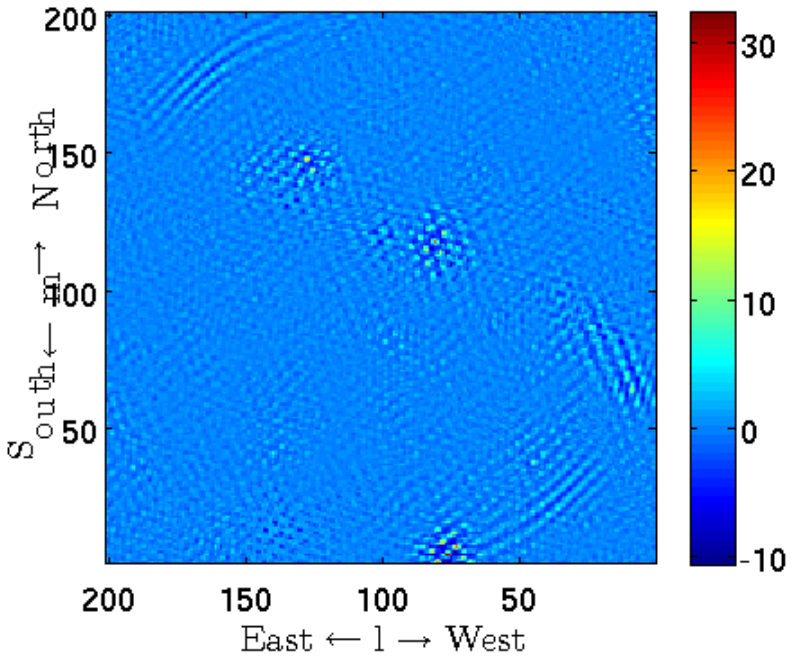
	AARTFAAC	12st,minw	12st,uniform uvcov	10st.	Comment
Elements	288	576	576	480	In a single config
Longest baseline (m)	300	1400	1000	850	In LBA_INNER
Resolution (deg)	1	0.2	0.3	0.33	At 60 MHz
Sensitivity (m^2/K)	0.72	1.4	1.4	1.2	
Thermal noise (Jy)	29	14	14	17	For 1sec/16kHz
Confusion noise (Jy)	4	0.28	0.57	0.8	For resolution shown above
Max. w-component (m)	0	0.2	1	0.25	relative to Superterp
Max. phase error (cycles)	263	1228	877	745	For 120deg FoV at 60 MHz.

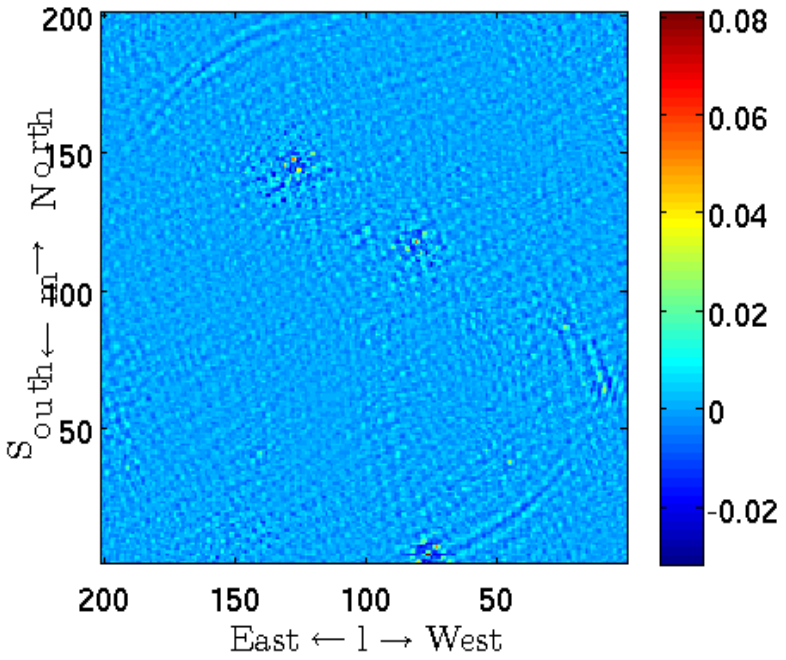
- Instrument description from the imaging pov: min/max baselines, filling factor, baseline distribution.
- Add LOFAR usage of LBA_INNER/OUTER

PSF Optimization parameters: Weighting

LBA_INNER: Natural Weighting



LBA_INNER: Uniform Weighting



All Sky images

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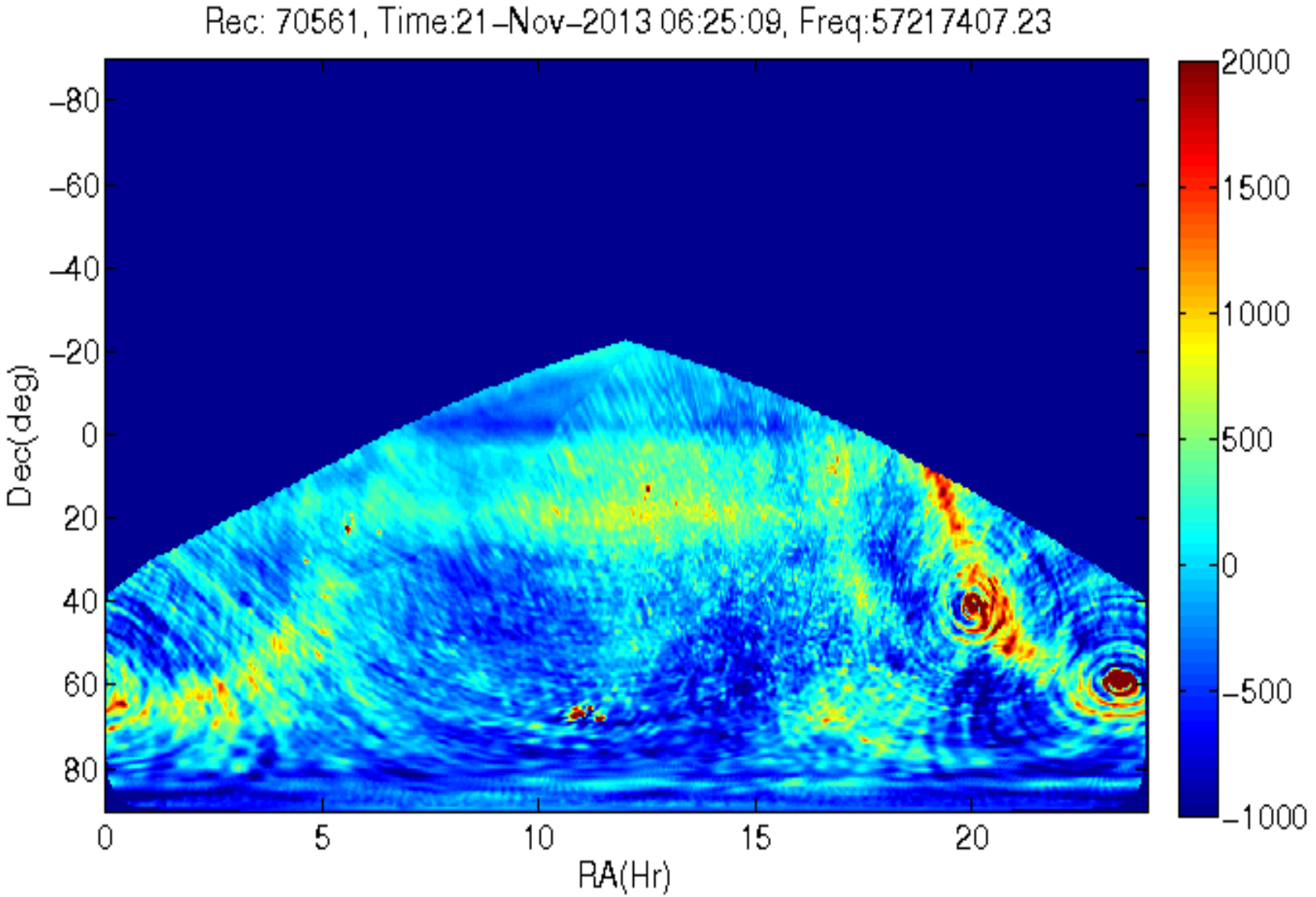

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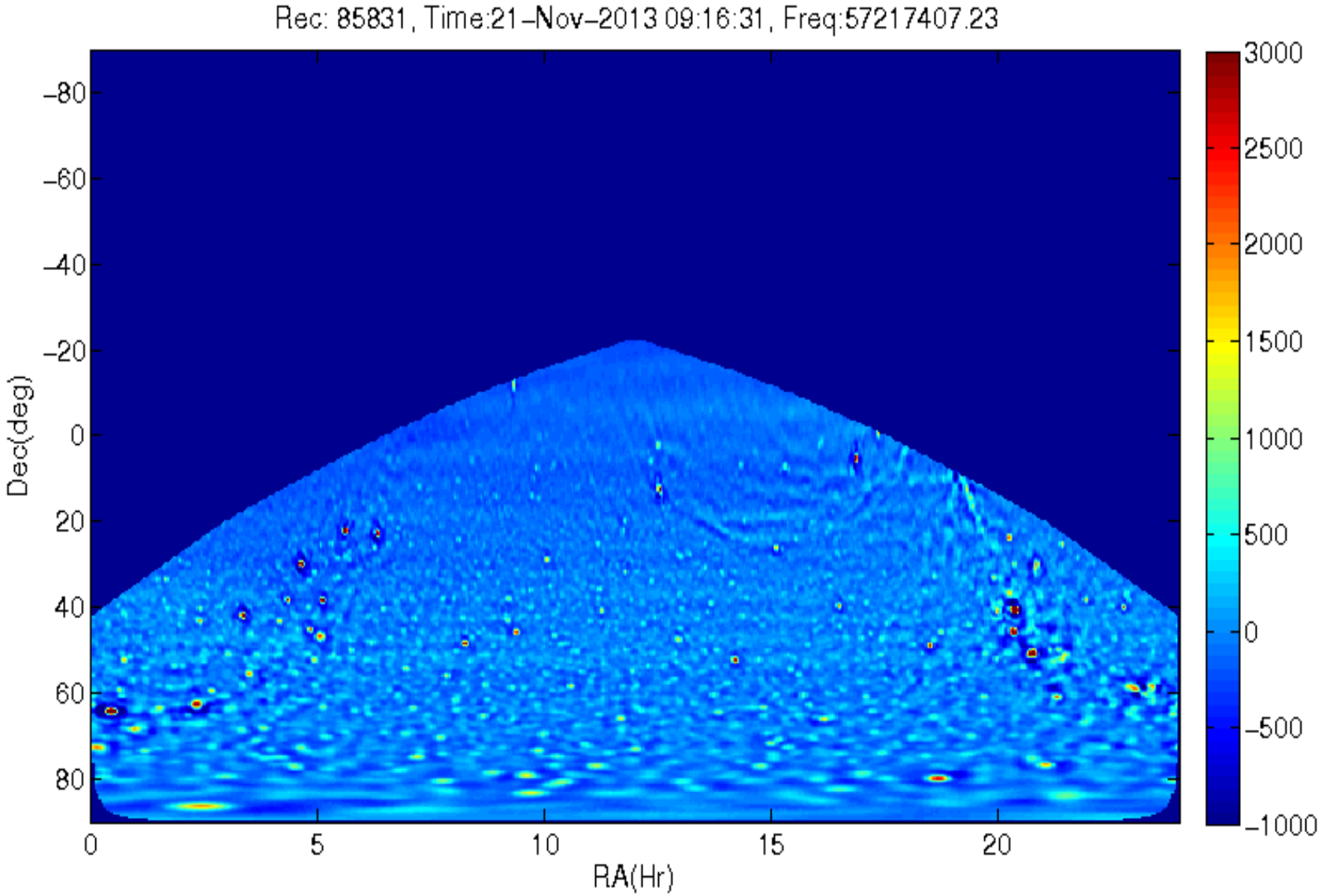

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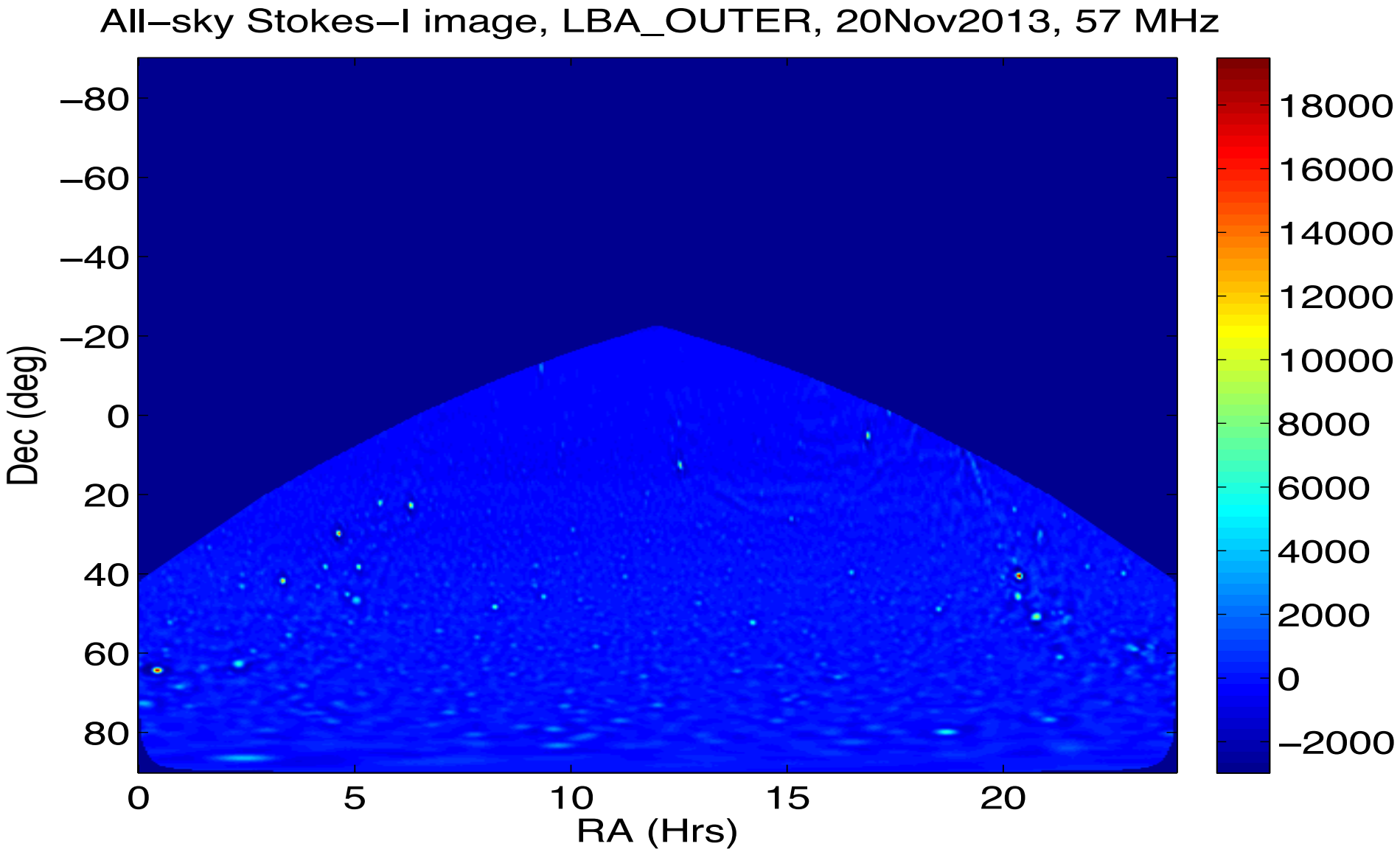
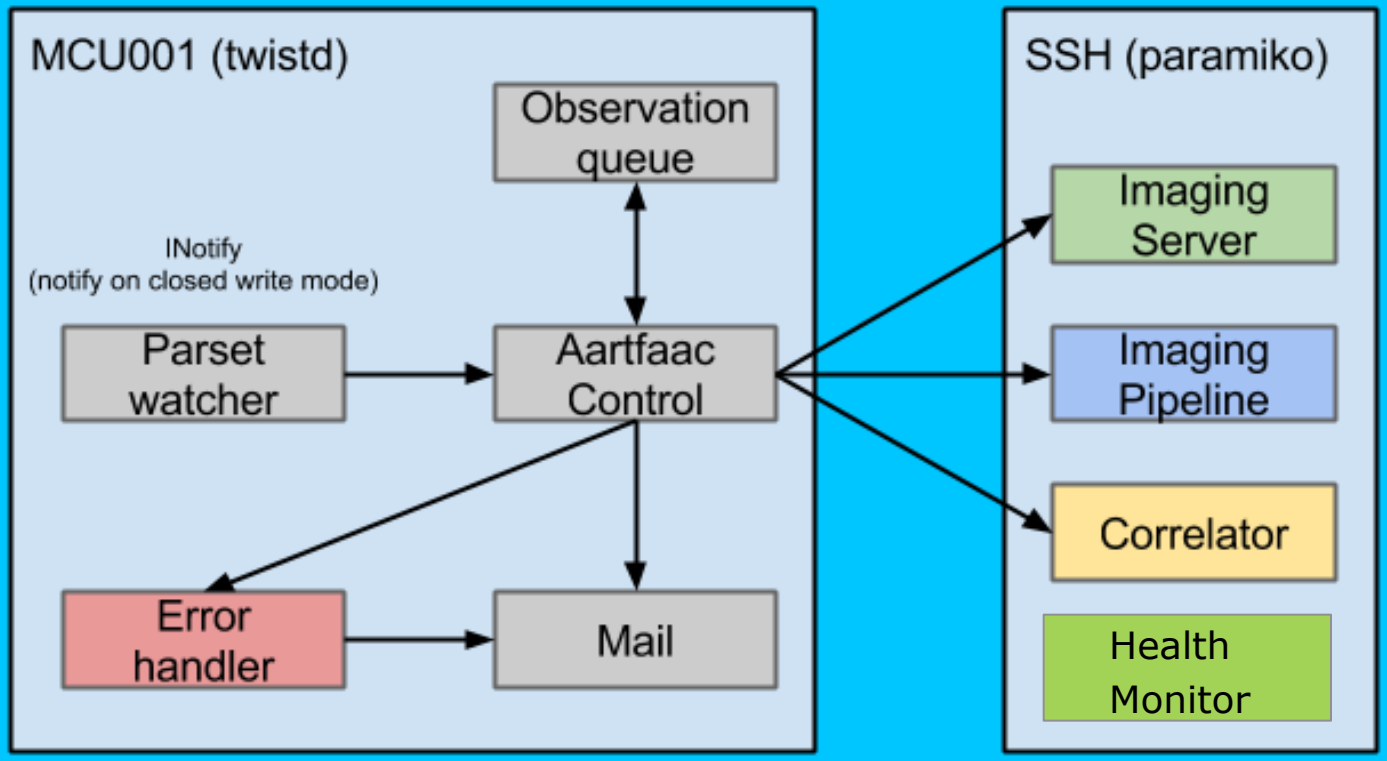


Current Status



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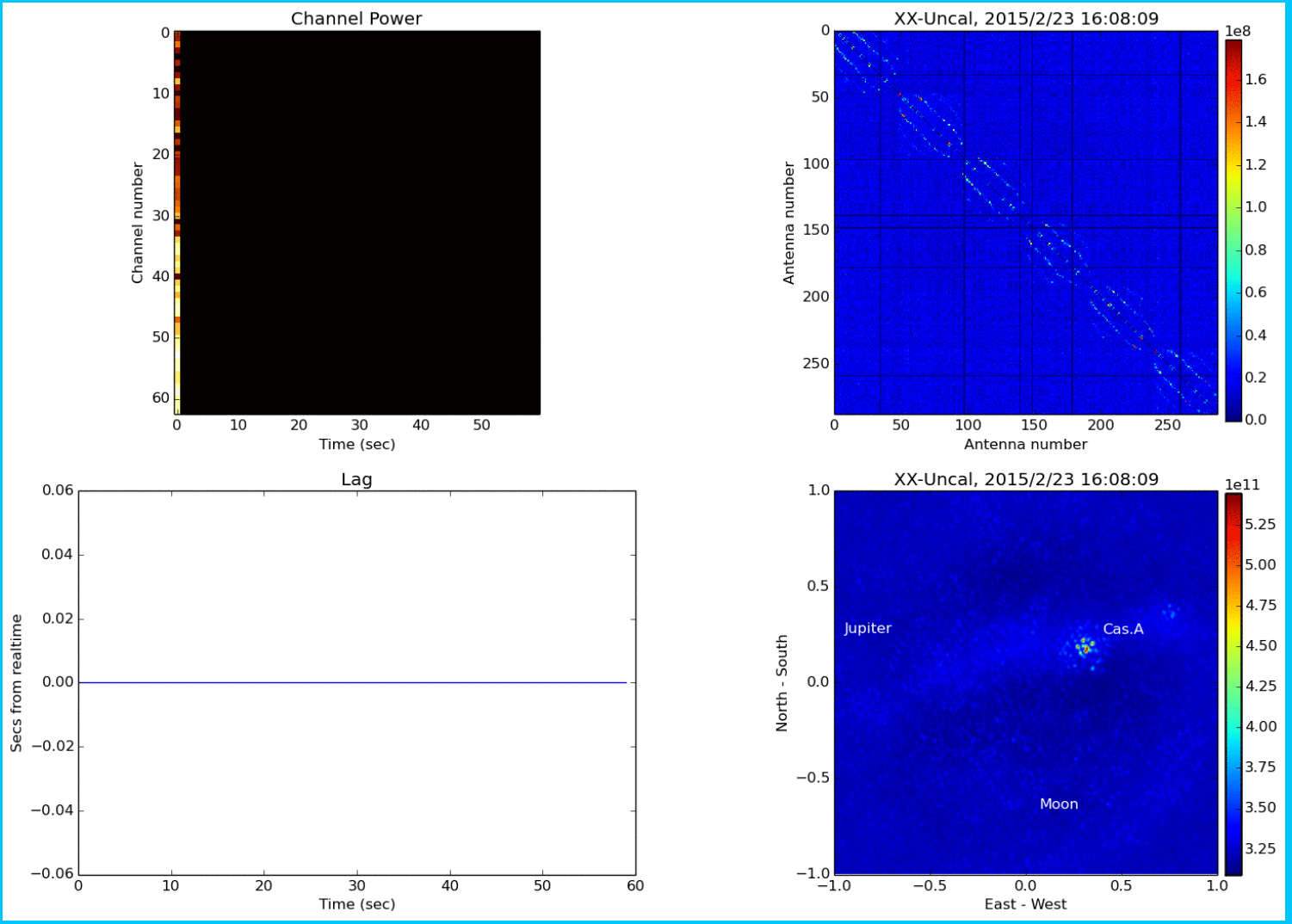
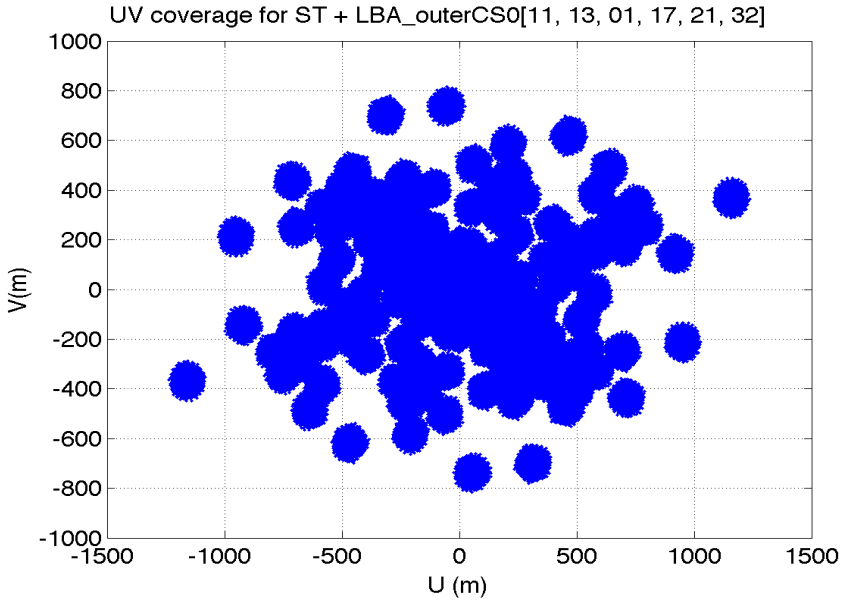
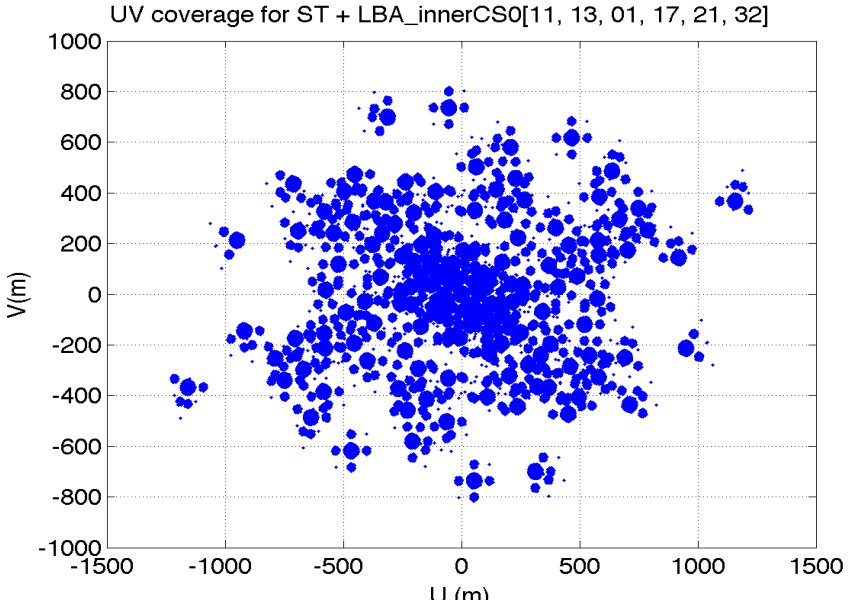
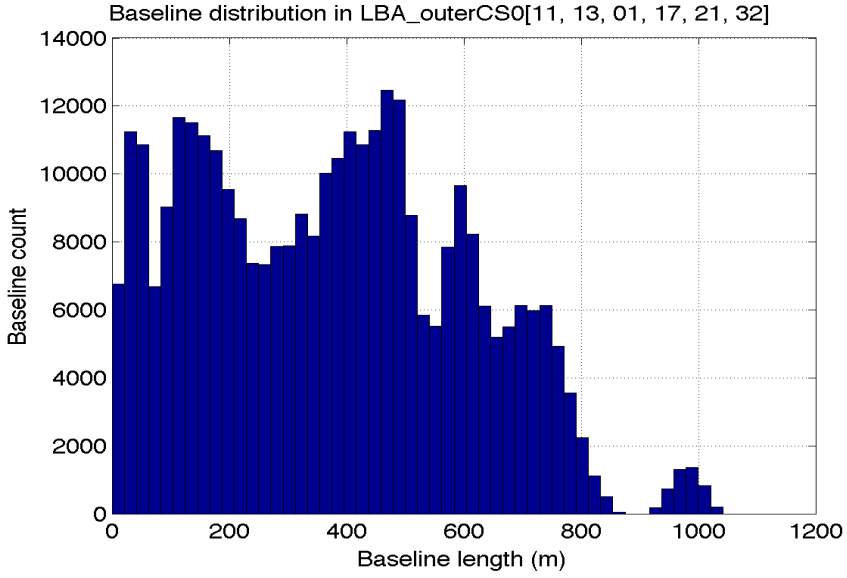
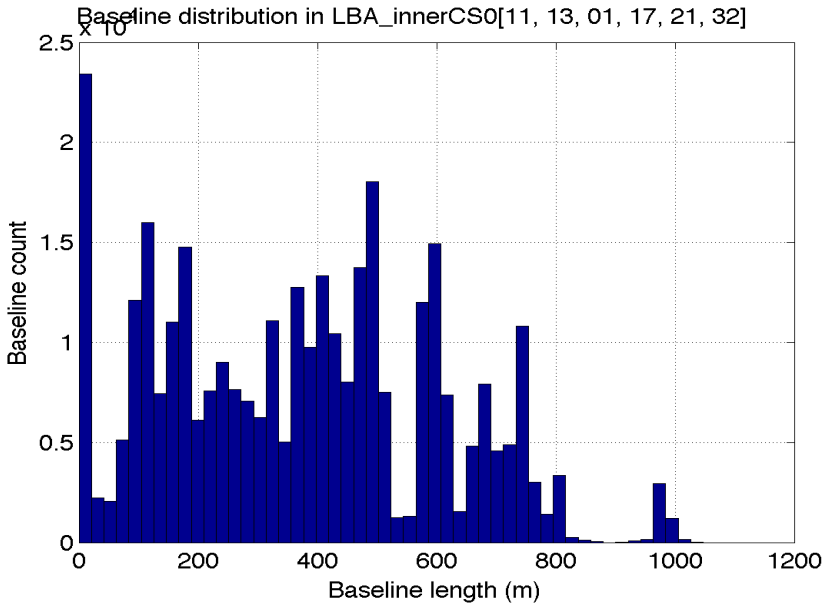


E-AARTFAAC: Extension to 12 stations









E-AARTFAAC: Extension to 12 stations

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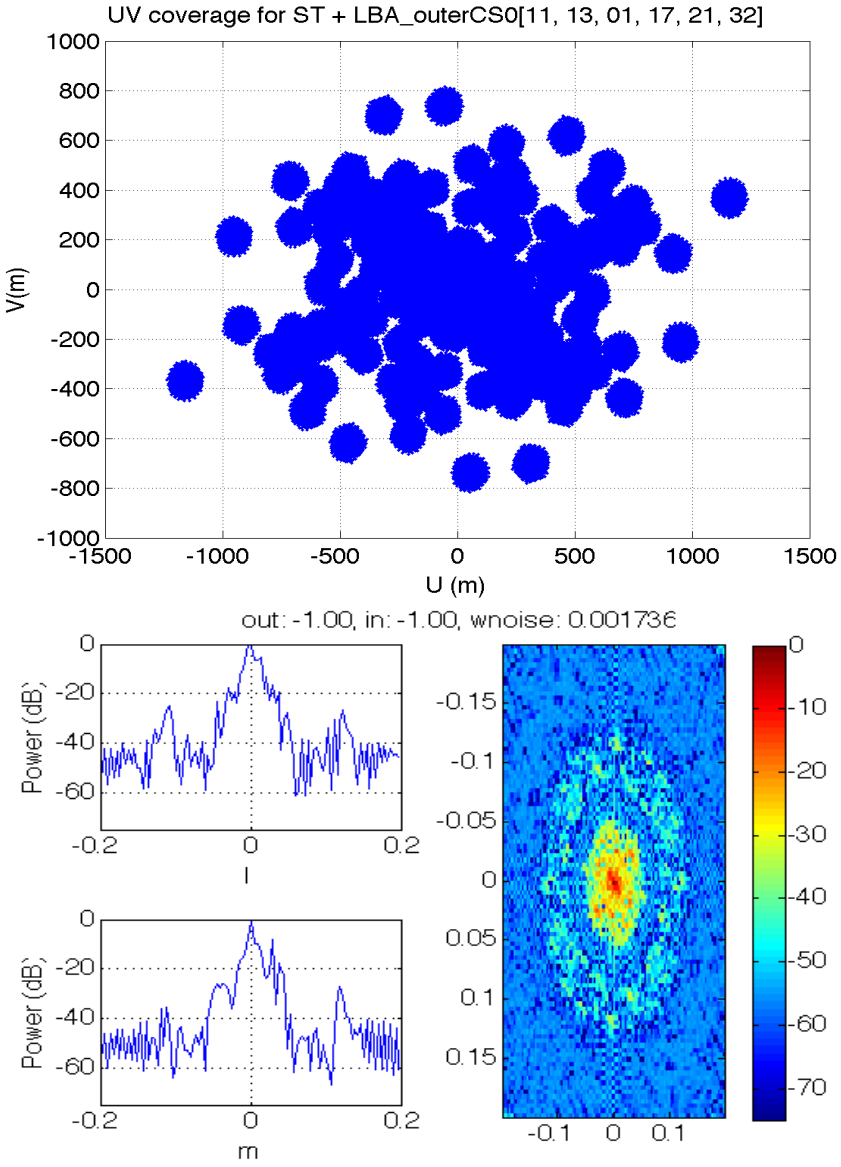

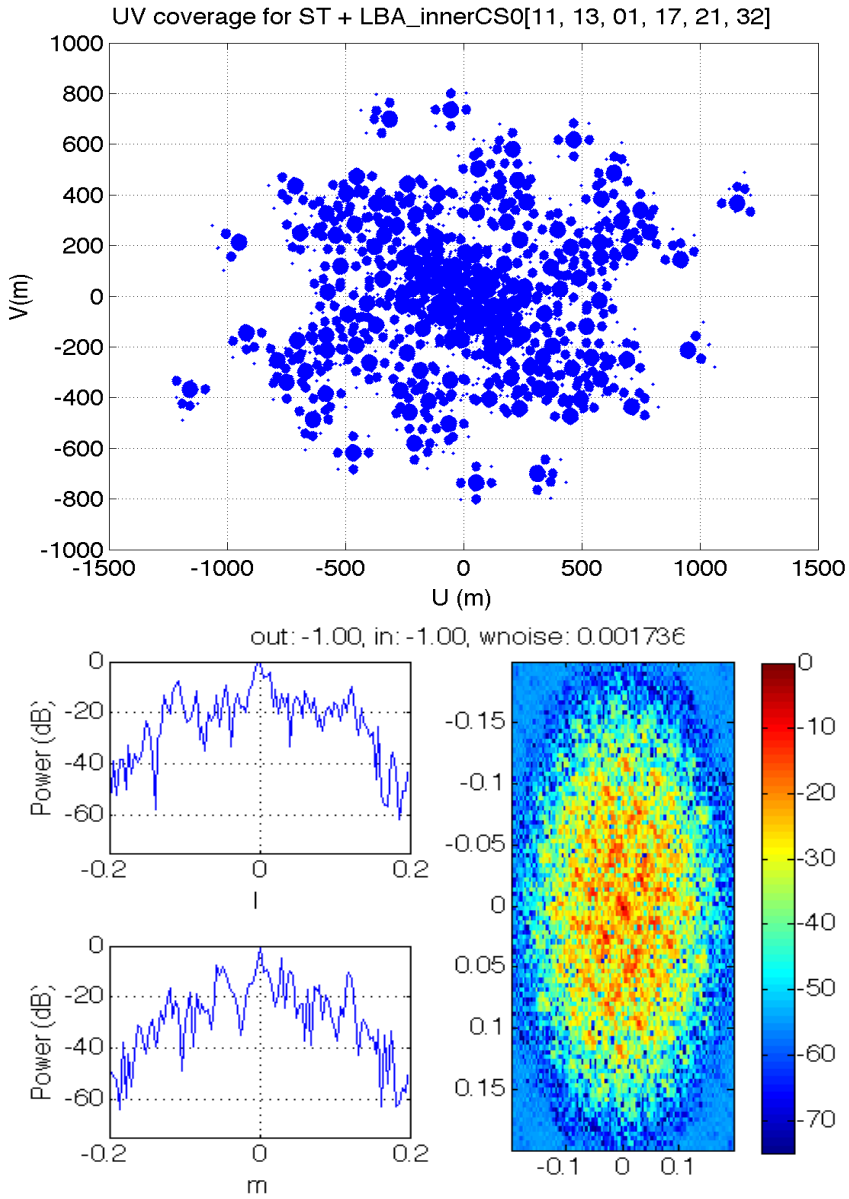

Conclusions

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- AARTFAAC ASM well suited for transient detection observations.
- LBA_INNER mode can be optimized for successful calibration, reasonable point source sensitivity.
- The extended AARTFAAC doubles sensitivity, not expected to be confusion noise limited. In an advanced state of deployment.