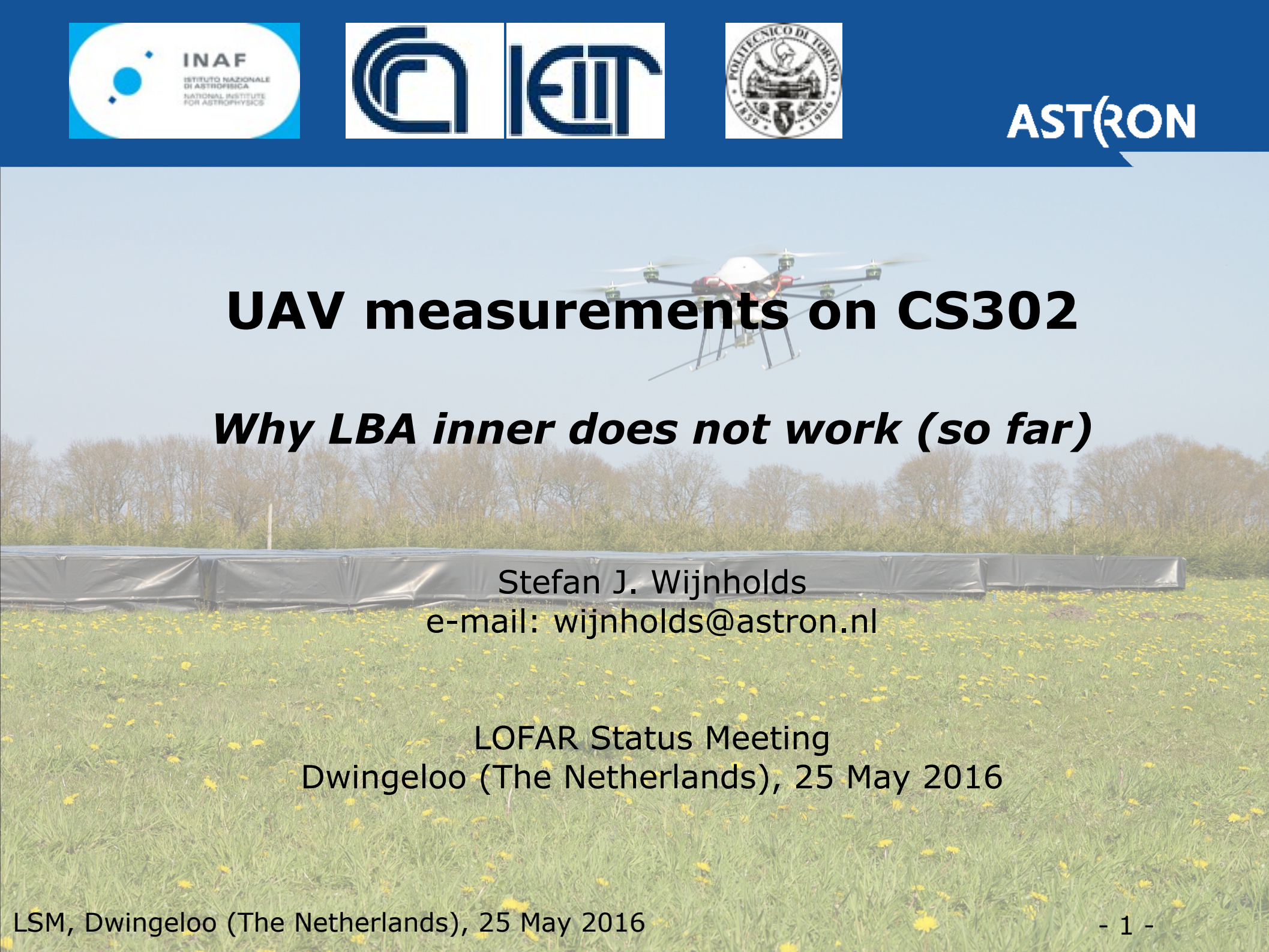

UAV measurements on CS302

Why LBA inner does not work (so far)

Stefan J. Wijnholds
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LOFAR Status Meeting
Dwingeloo (The Netherlands), 25 May 2016

Introduction

ASTRON

- UAV system developed for low frequency (< 500 MHz) AA systems
  - Research contract between INAF and CNR-IEIIT
  - Past campaigns: MAD, SKALA, AAVS0.5, LBA
- LOFAR campaign: 18 – 21 April 2016 on CS302
- Goals of the campaign
  - Measure embedded element patterns to verify EM models
    - all LBAs, individual HBA elements, HBA tiles
  - Measure antenna positions: optical and RF
  - Demonstrate near-field array measurement capability
  - Demonstrate orientation and position calibration for SKA

Team

ASTRON

- Menno Norden
- Stefan Wijnholds

CNR-IEIIT

- Giuseppe Virone
- Fabio Paonessa

INAF

- Pietro Bolli
- Giuseppe Pupillo

Politecnico

- Andrea Lingua
- Paolo Maschio
- Irene Aicardi

UAV system

ASTRON

Multi-frequency transmission

- LBA: (31.7925,) 44.5095, 57.2265 and 69.9435 MHz
- HBA: 124.6449, 152.3438 and 180.0427 MHz

GPS control

- Autopilot, accuracy ~1 m

Differential GPS for telemetry

- actual position, ~1 cm accuracy

IMU for pitch, bearing and roll

Near-field measurement

ASTRON

- Square loop flight on LBA outer: the movie
- Far-field imaging with DFT imager at 44.5 MHz

Overview of activities – day 1

ASTRON

- Put markers on LBA
  - for photogrammetry
- Test new observing mode
  - 1 antenna = 1 beam
  - stream data to CEP
  - 1.9 GB data per ant. per pol. per subband per 10 min
  - filter data to 763 Hz channel on CW signal
  - 7.3 MB data per ant. per pol. per subband per 10 min
- Stationary flight above center of LBA array
  - Used for synchronization of LOFAR backend and telemetry
- Two cross-scan in x-polarization on LBA inner

Overview of flights – day 2

ASTRON

- Stationary flight above center of LBA array
- Cross-scan x-pol LBA inner (at 150 and 300 m altitude)
- Cross-scan y-pol LBA inner
- Spin flight LBA inner
- Square loop flight LBA inner
- Cylindrical scan E_θ-pol LBA inner
- Direct measurement on transmitter
- Dutch wind vs. Italian UAV: 1-0

Overview of flights – day 3

ASTRON

- Stationary flight above center of LBA array
- Cross-scan x-pol LBA outer
- Cross-scan y-pol LBA outer
- Square loop flight
- Cross-scan x-pol HBA single element
- Cross-scan y-pol HBA single element
- Spin flight above HBA array
- Cylindrical scan E_θ-pol of HBA tile main beam

Overview of flights – day 4

ASTRON

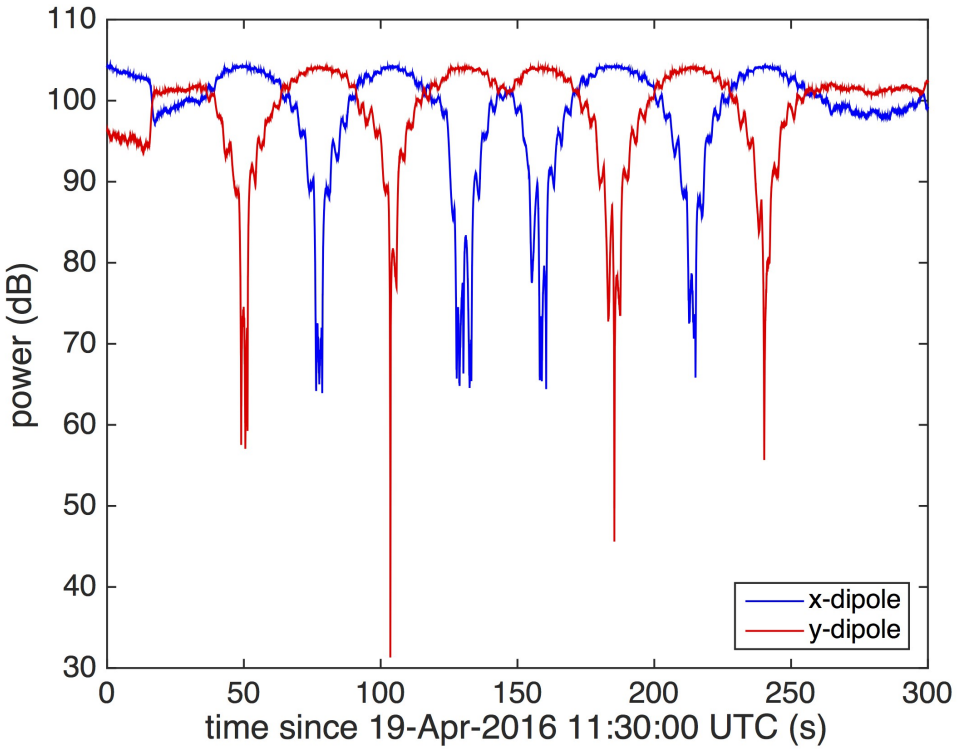
- Cylindrical scan E_φ-pol of HBA tile main beam
- Cylindrical scan E_θ-pol of HBA tile main beam with grating response
- Cylindrical scan E_φ-pol of HBA tile main beam with grating response
- Direct measurement on transmitter at HBA frequencies
- Cylindrical scan E_φ-pol of LBA inner (complements scan day 2)
- Cross-scan x-pol and y-pol LBA inner (repeated from day 2)
- Spin flights LBA outer
- Cross-scan x-pol LBA outer (repeated from day 3)

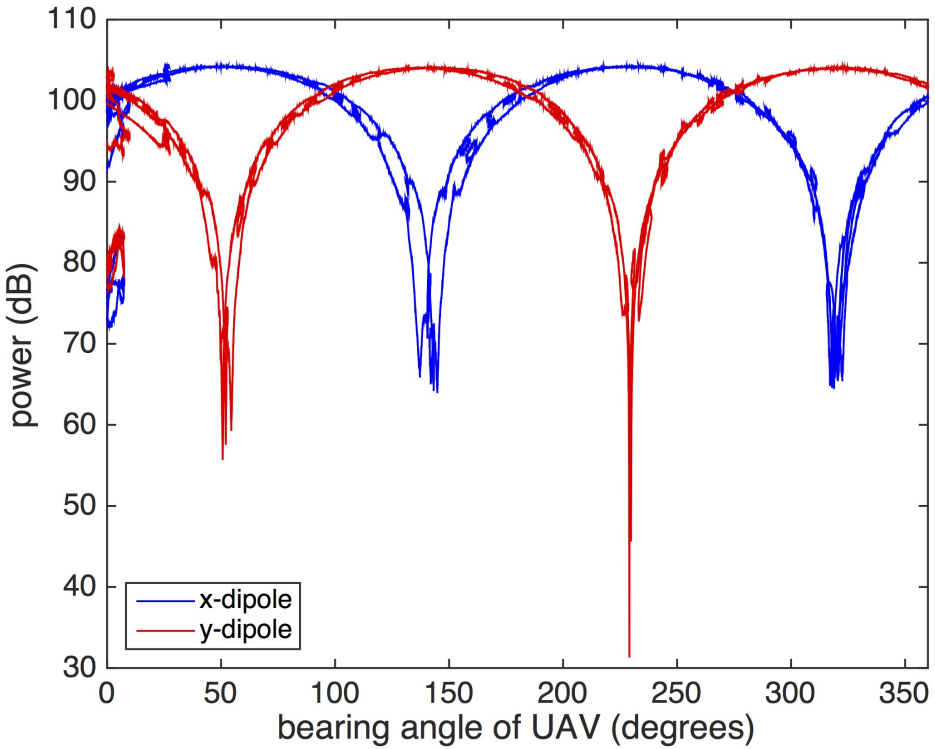
New record: 13 flights on a single working day!

Spin flight example

ASTRON

- Accurate measurement of antenna orientation
- Accurate measurement of cross-pol levels
- Central element LBA inner array at 44.5 MHz

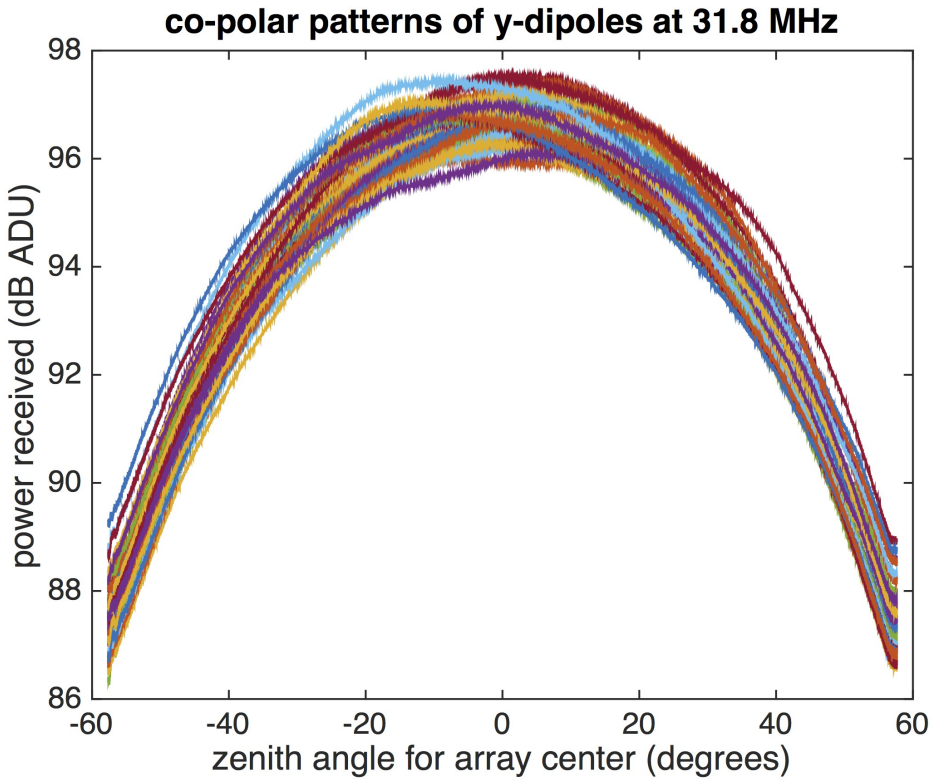


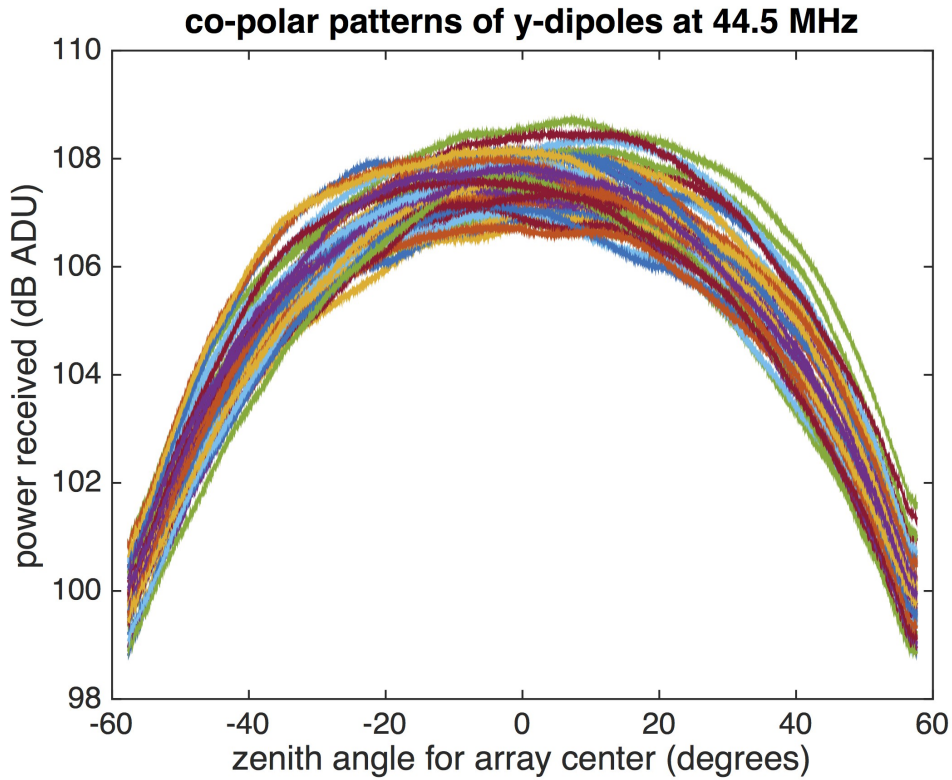


Linear scan on LBA inner (1)

ASTRON

- Dipole on UAV aligned with dipole on the ground
- Linear flight in plane of the dipoles

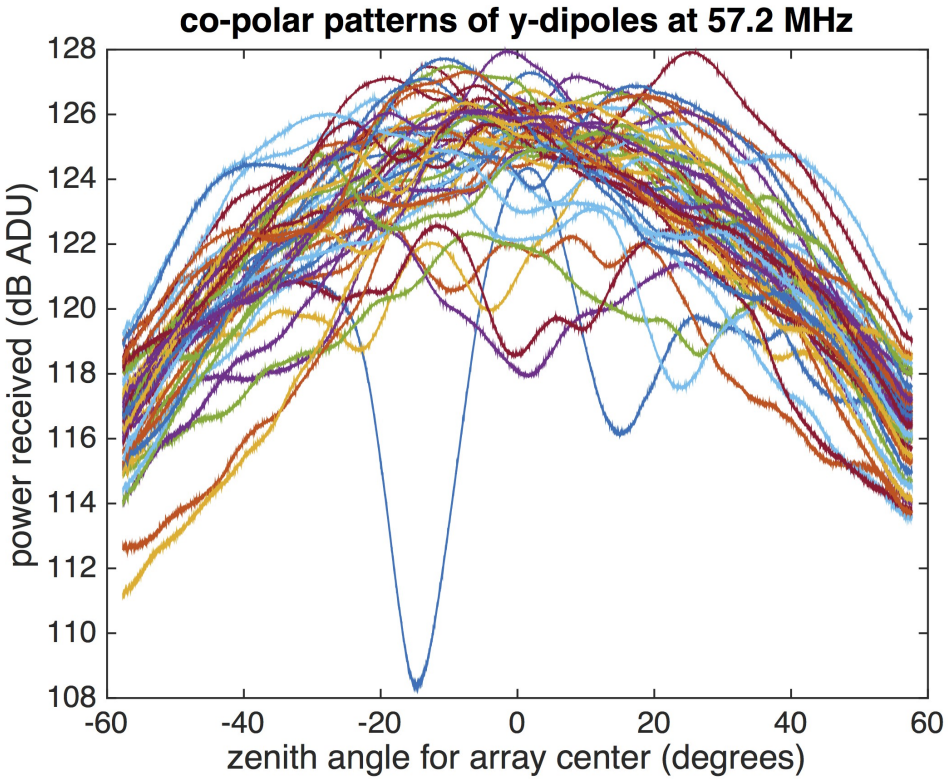


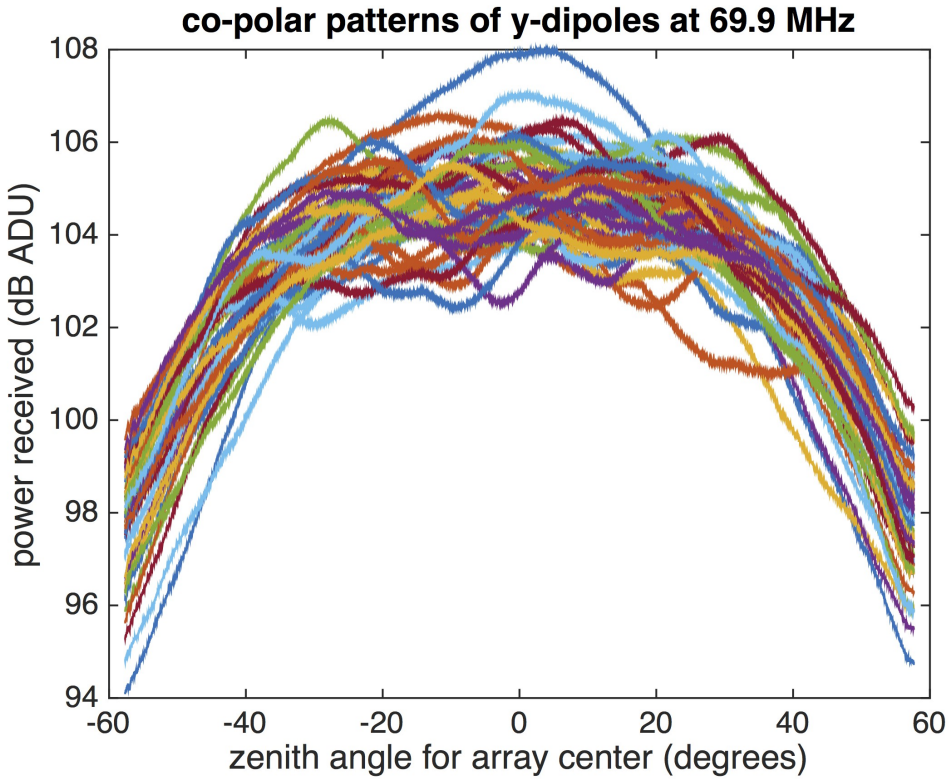


Linear scan on LBA inner (2)

ASTRON

- Same measurement, higher frequency
- Element patterns vary wildly at resonance frequency
- Explanation for poor LBA inner performance?





Conclusions

ASTRON

- **Successful measurement campaign**
  - 31 successful observations
  - Good coverage of LBA inner/outer and HBA
  - New “observing mode” for LOFAR
- **Initial results**
  - LBA dipoles have very good (low) cross-pol
  - LBA inner has serious issue around 57 MHz
- **Ongoing work**
  - Detailed reduction and analysis of data
  - Comparison against EM-model
  - Tests of RF position calibration and absolute calibration