EMBRACE Status and Results

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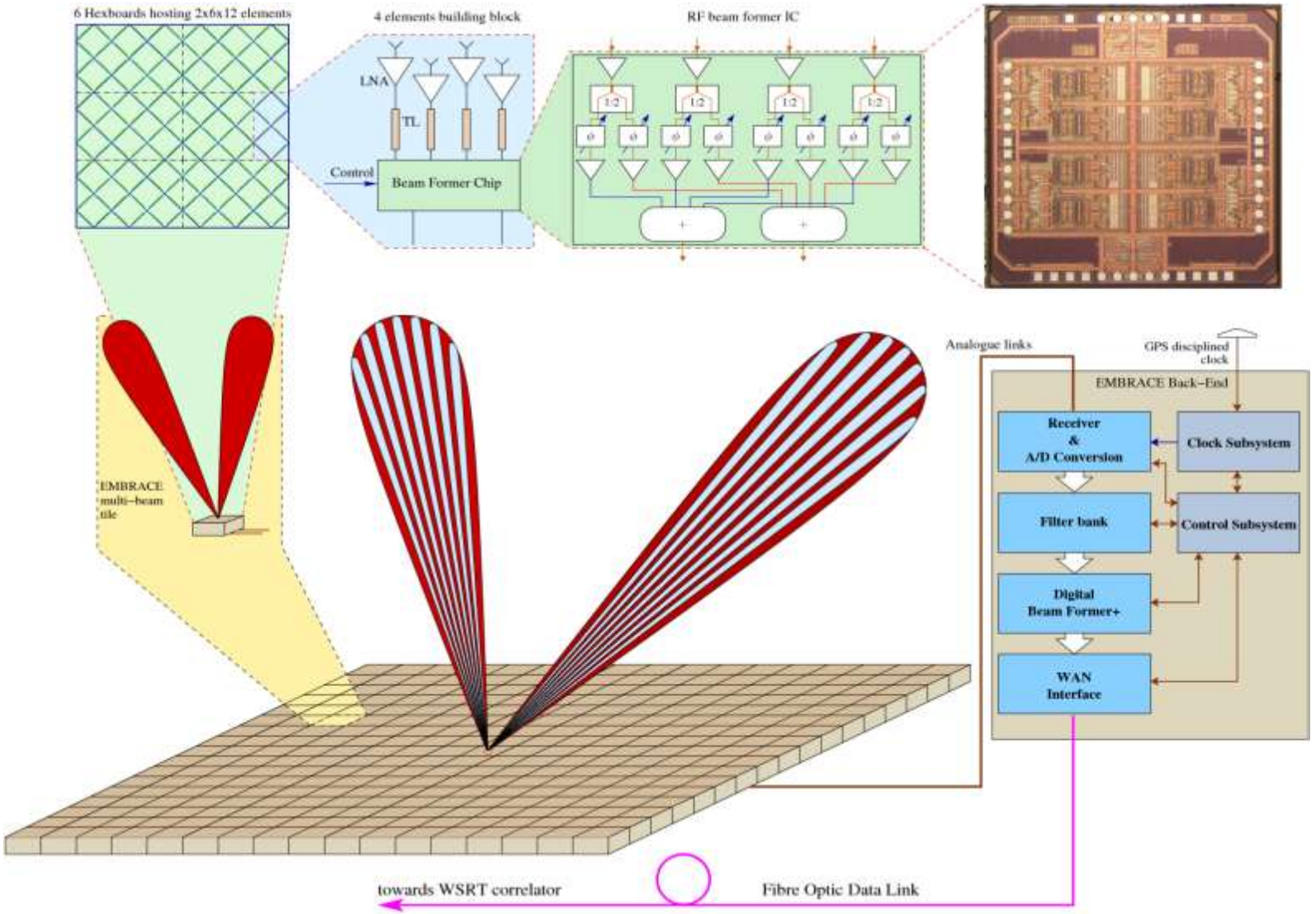
on behalf of the EMBRACE team
ASTRON, OPAR, INAF, MPIfR

EMBRACE Architecture overview

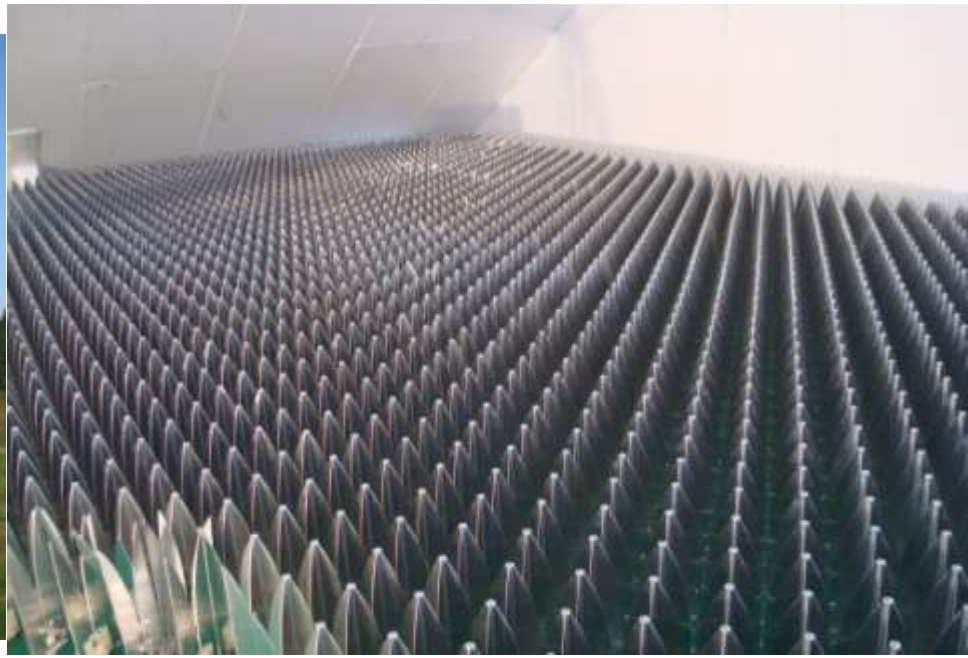


EMBRACE Specifications

Frequency range	500 MHz - 1500 MHz.
Polarisation	Single polarisation*
Physical Collecting area	~160 m2 WSRT / 90 m2 Nançay
Aperture Efficiency	> 80%
Electronic Scan Range	>+-45 deg
T	100K @ 1GHz
Element phase control accuracy	3 bit (also time delays)
Instantaneous bandwidth	40 MHz Output bandwidth
Dynamic range A/D Converter	60dB (effective # of bits ~10)
Number of independent FoV (RF beams)	2
No of digital beams	8+

* Antenna design is dual polarized

EMBRACE
Station at Westerbork



Station at Nançay

image by SATorchinsky

Status Nançay Station

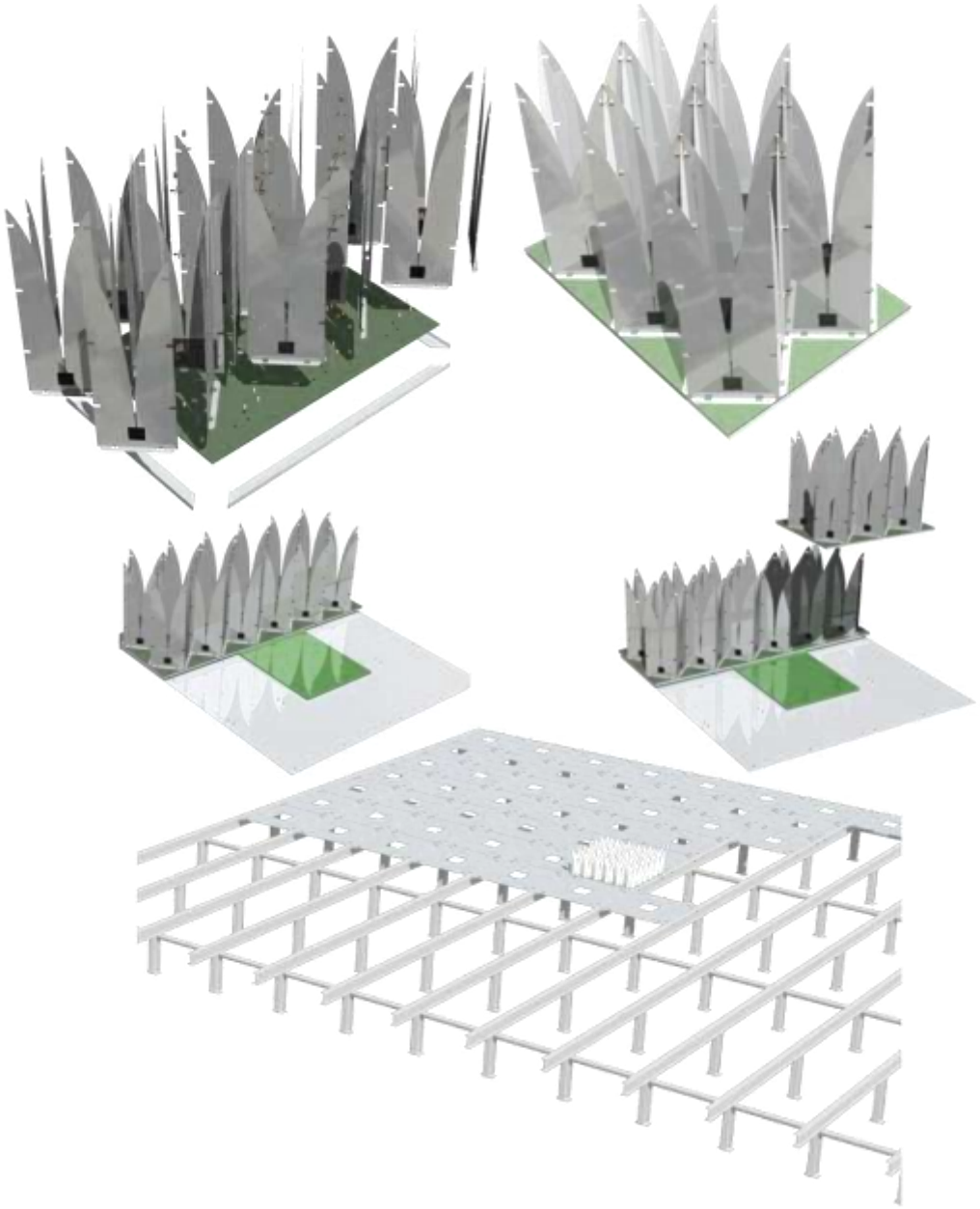
- ~ 62 m^2 area 56 Tiles
- 4032 Vivaldi elements (single linear polarisation)
- Currently 48 tiles cabled up end-to-end
- Grouped into tilesets of 4 tiles
- 64 tiles to be installed by end 2010
- Ultimately, 80 tiles in early 2011

Status Westerbork Station

- 64 Tiles, (~70 m^2)
- 25 Tiles online in a 3x3 and 4x4 array configuration
- Merging control software with latest LOFAR devel
- Ultimately 144 Tiles in 2011

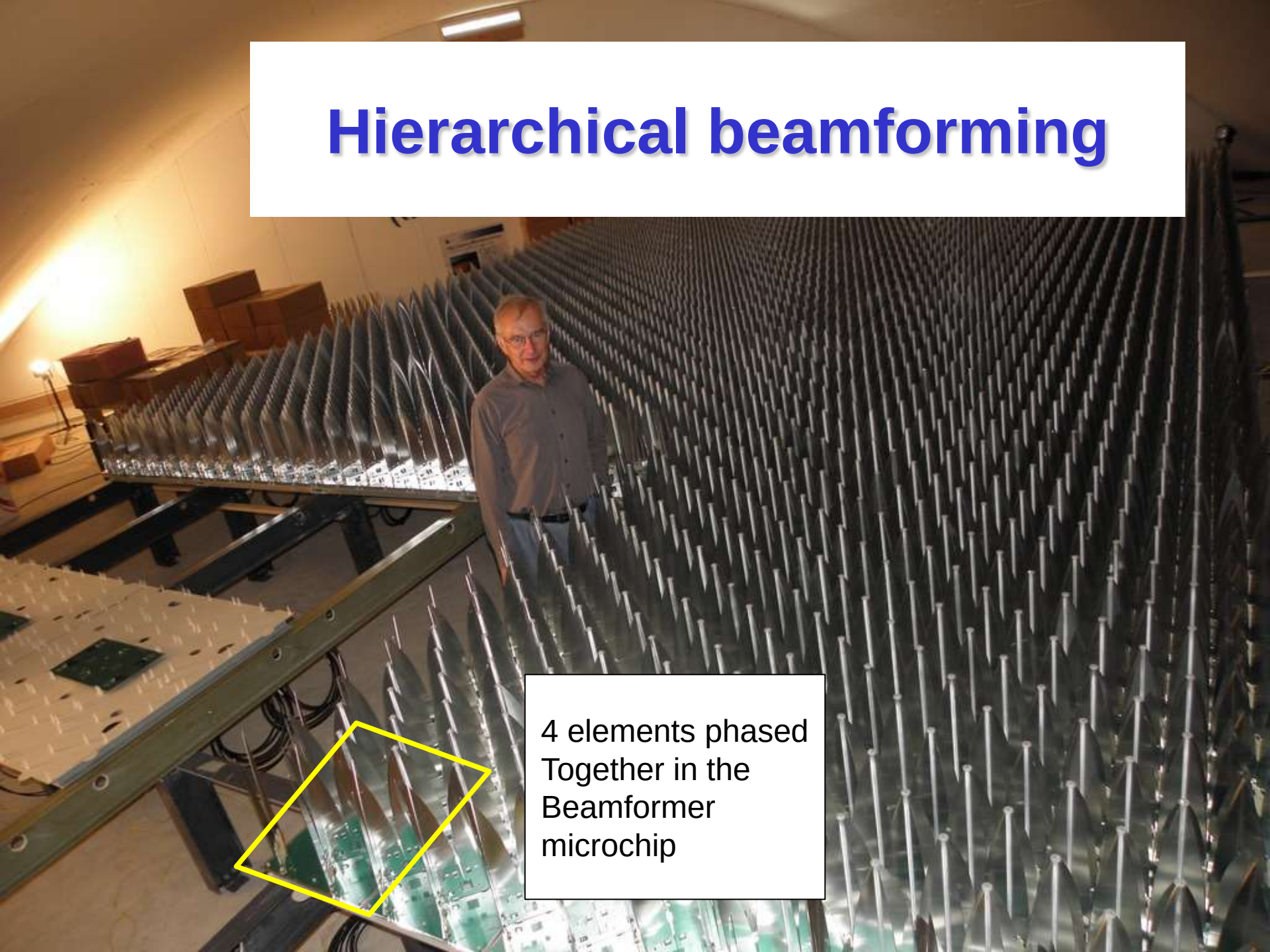
Current measurement objective:

- Pulsar detection
- Simulteneous detection of pulsar and HI

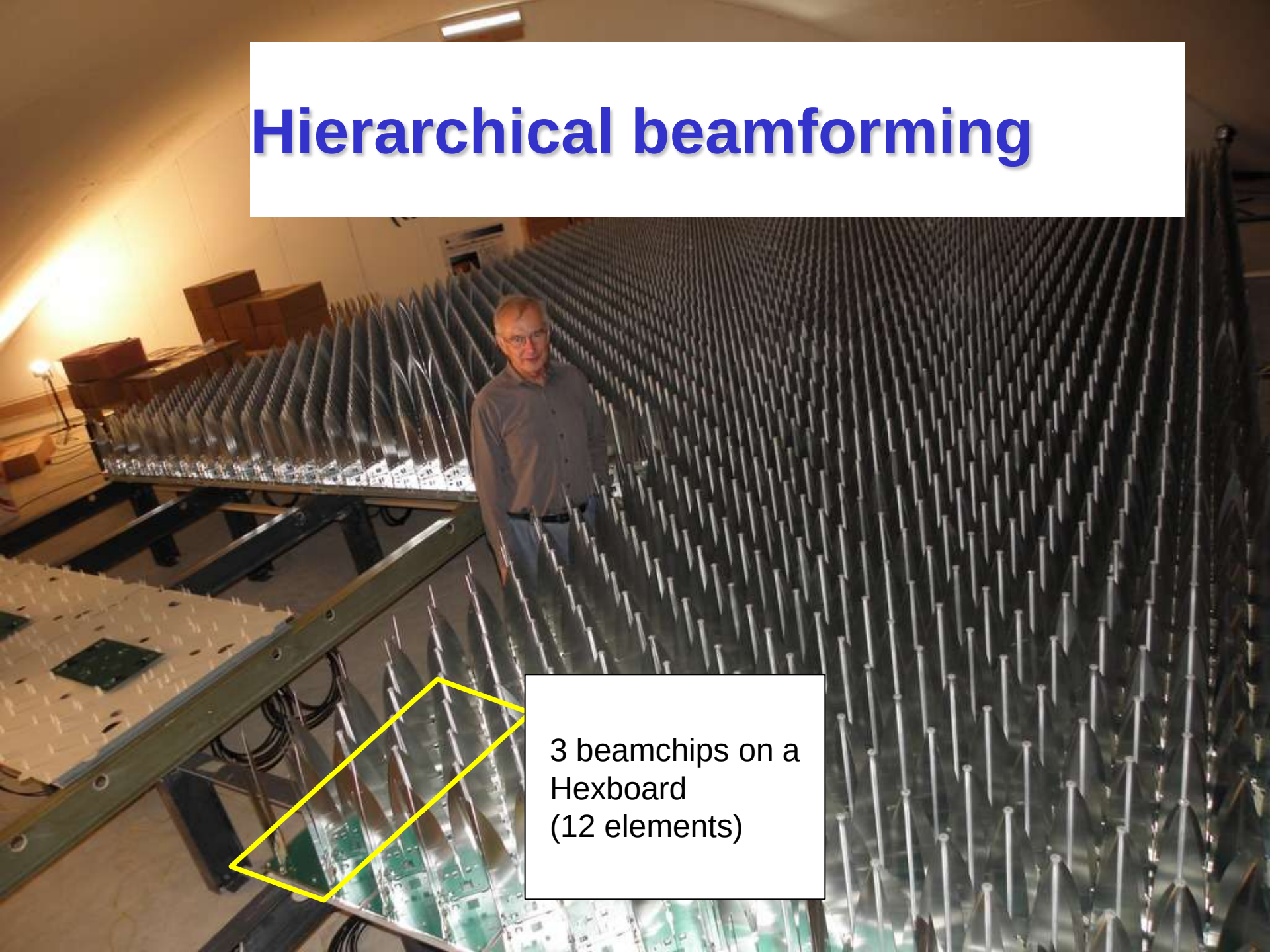


Mechanical break down of EMBRACE array

Hierarchical beamforming

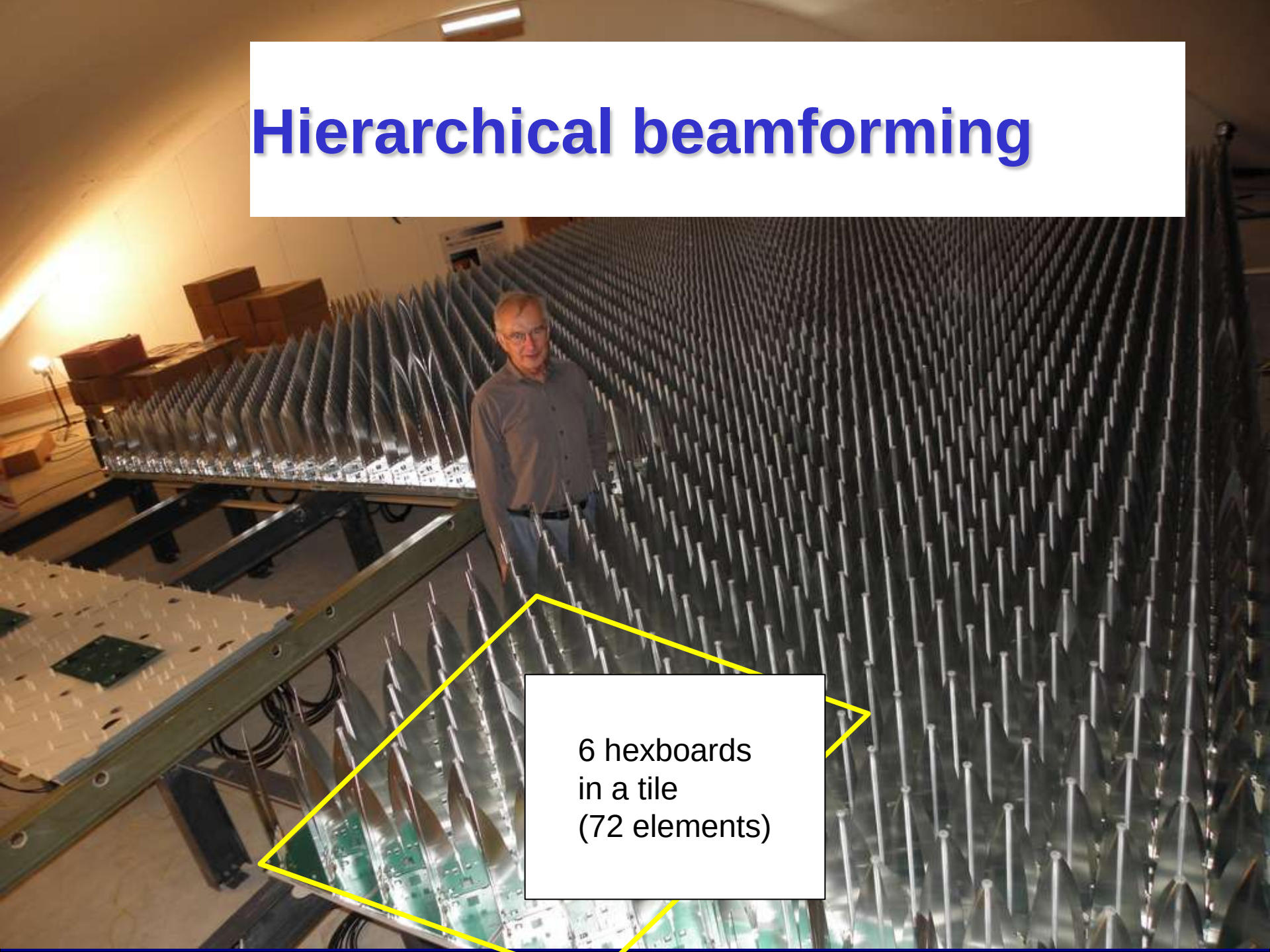


Hierarchical beamforming

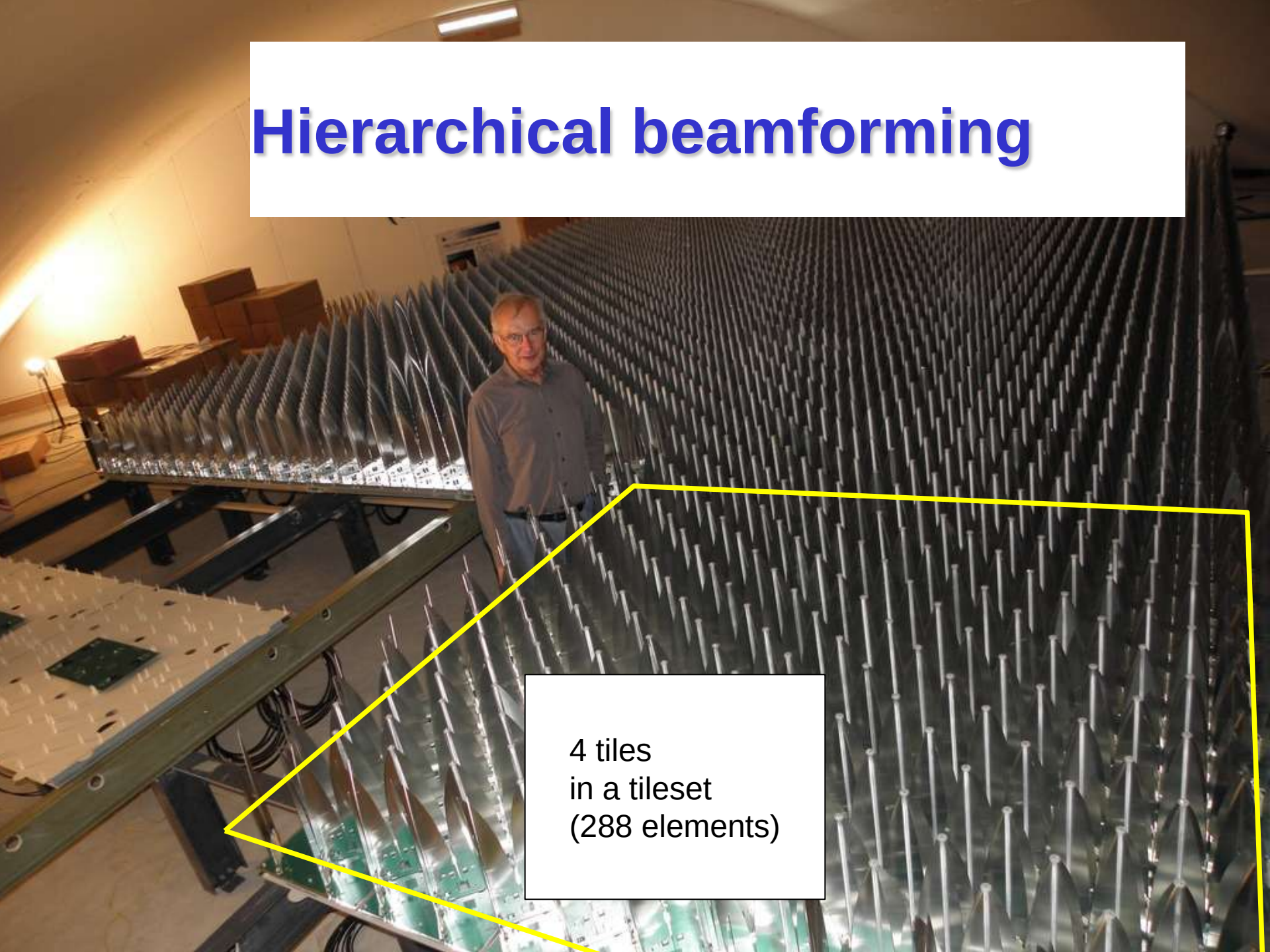


3 beamchips on a Hexboard
(12 elements)

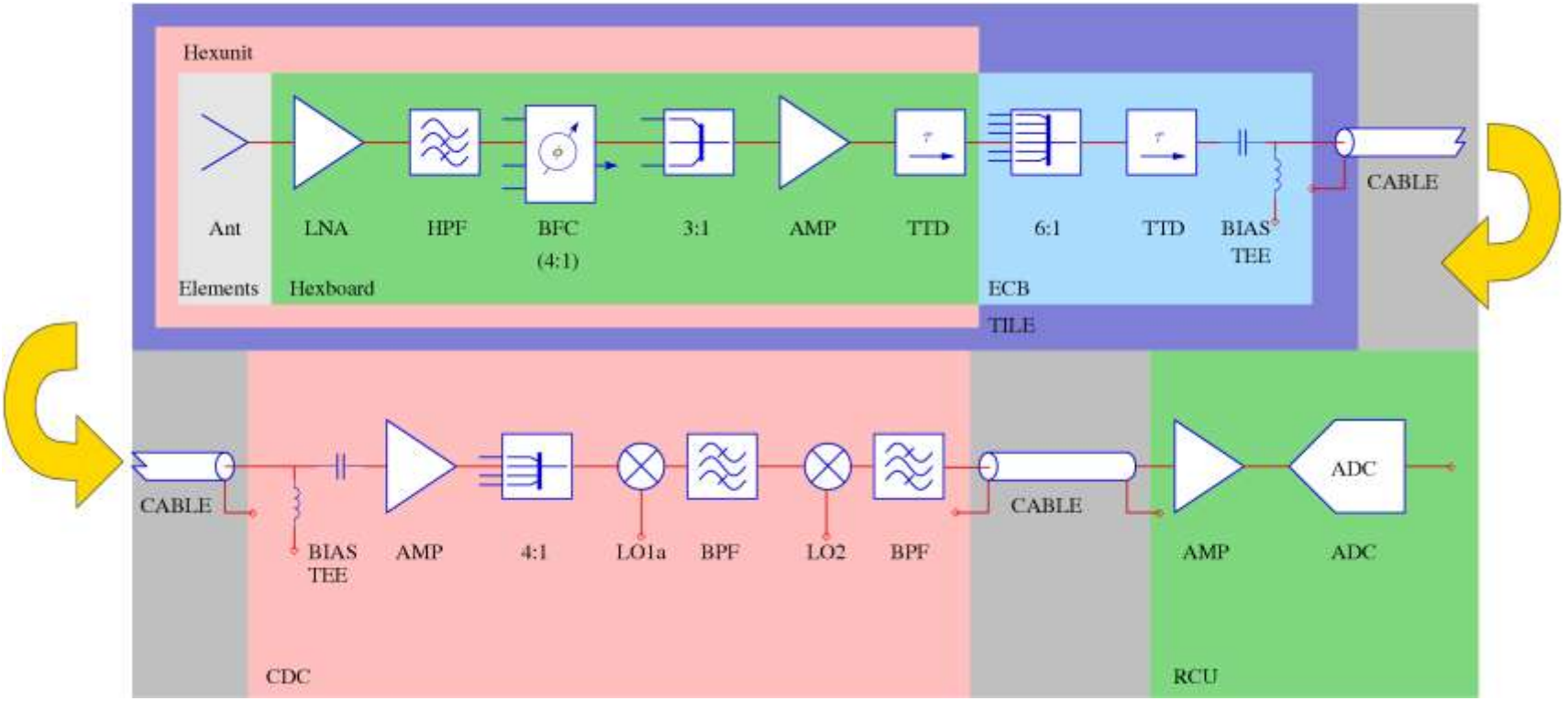
Hierarchical beamforming



Hierarchical beamforming



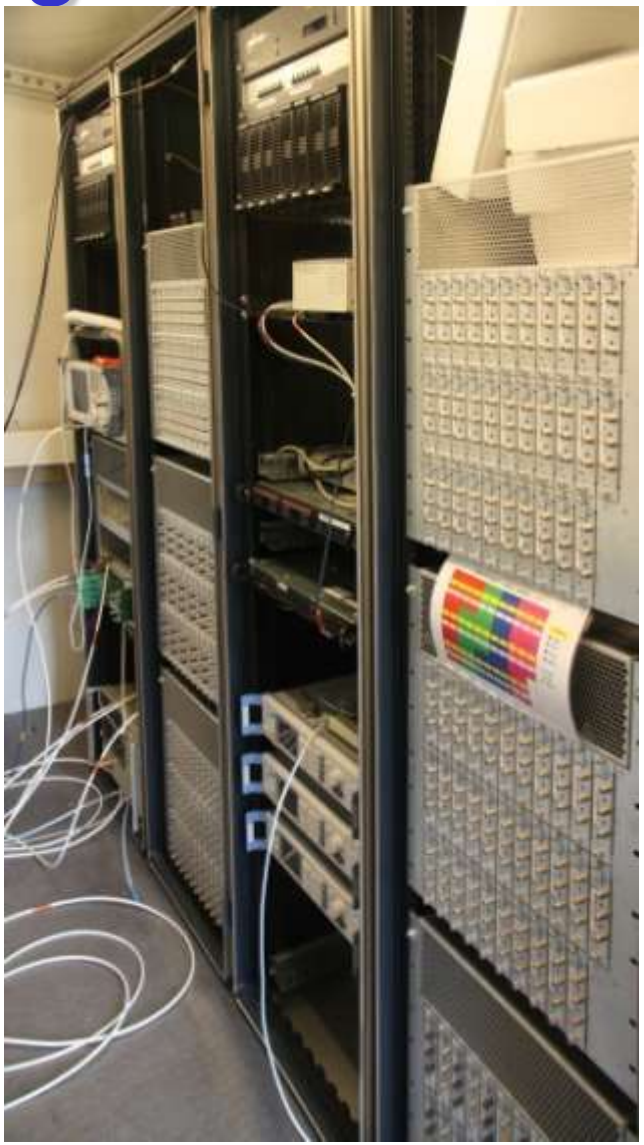
EMBRACE
Signal flow block diagram



Control & Down Conversion

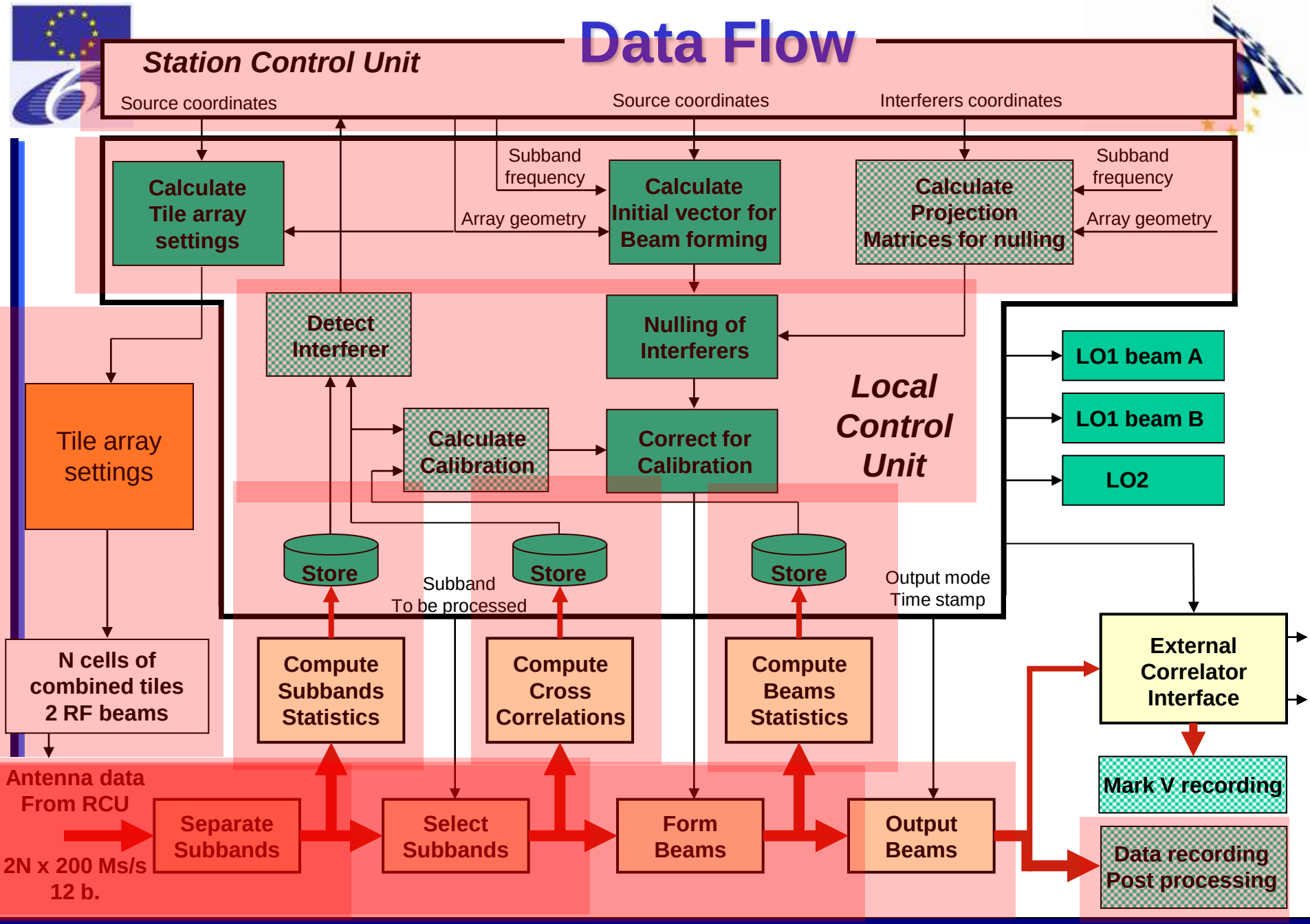
- CDC cards group 4 tiles together (tileset)
- RF and control/command multiplexed
- Currently debugging

Back end processing

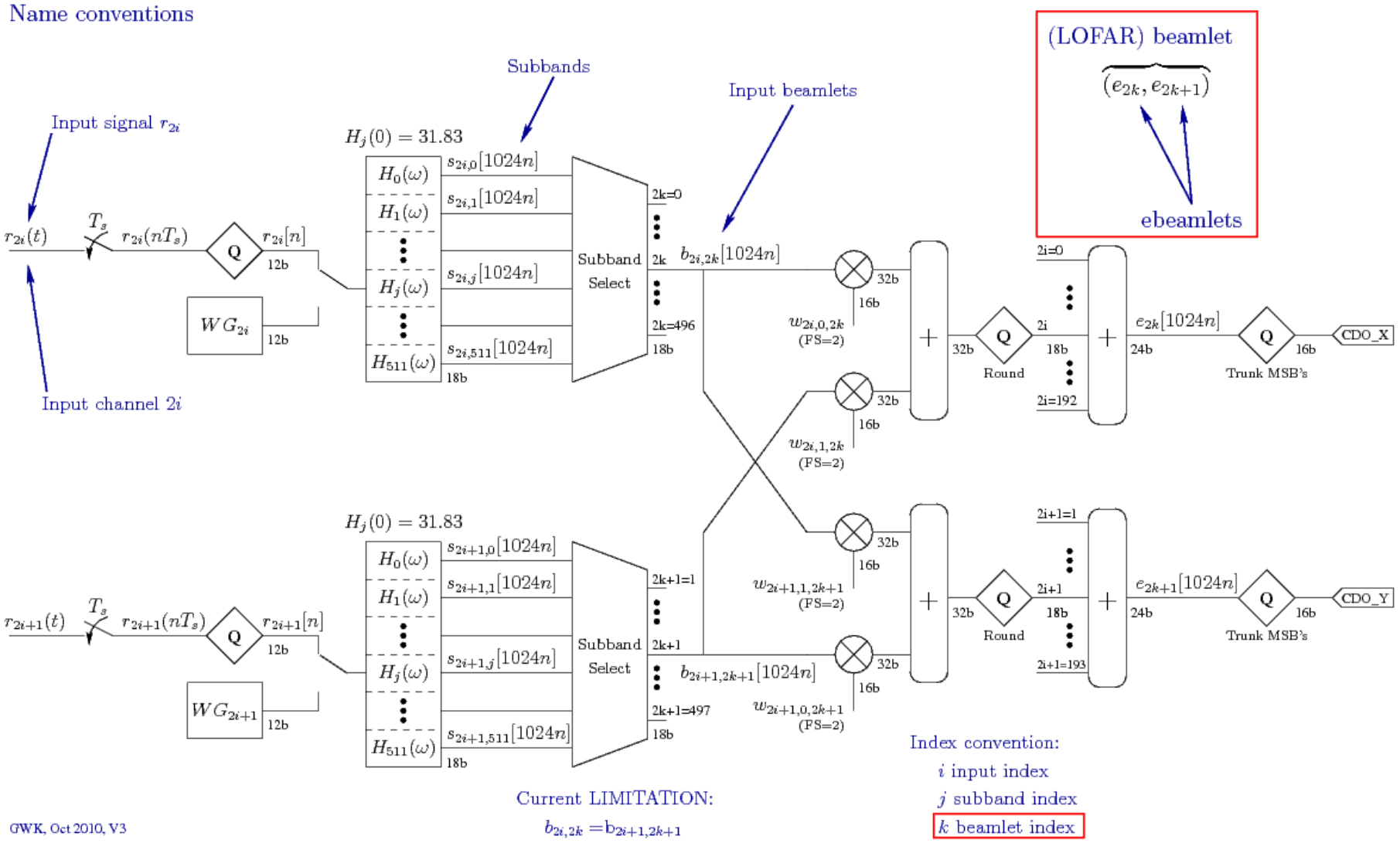


- Control and Down Conversion (CDC) Rack
- Back end Rack Layout (right)

Data Flow

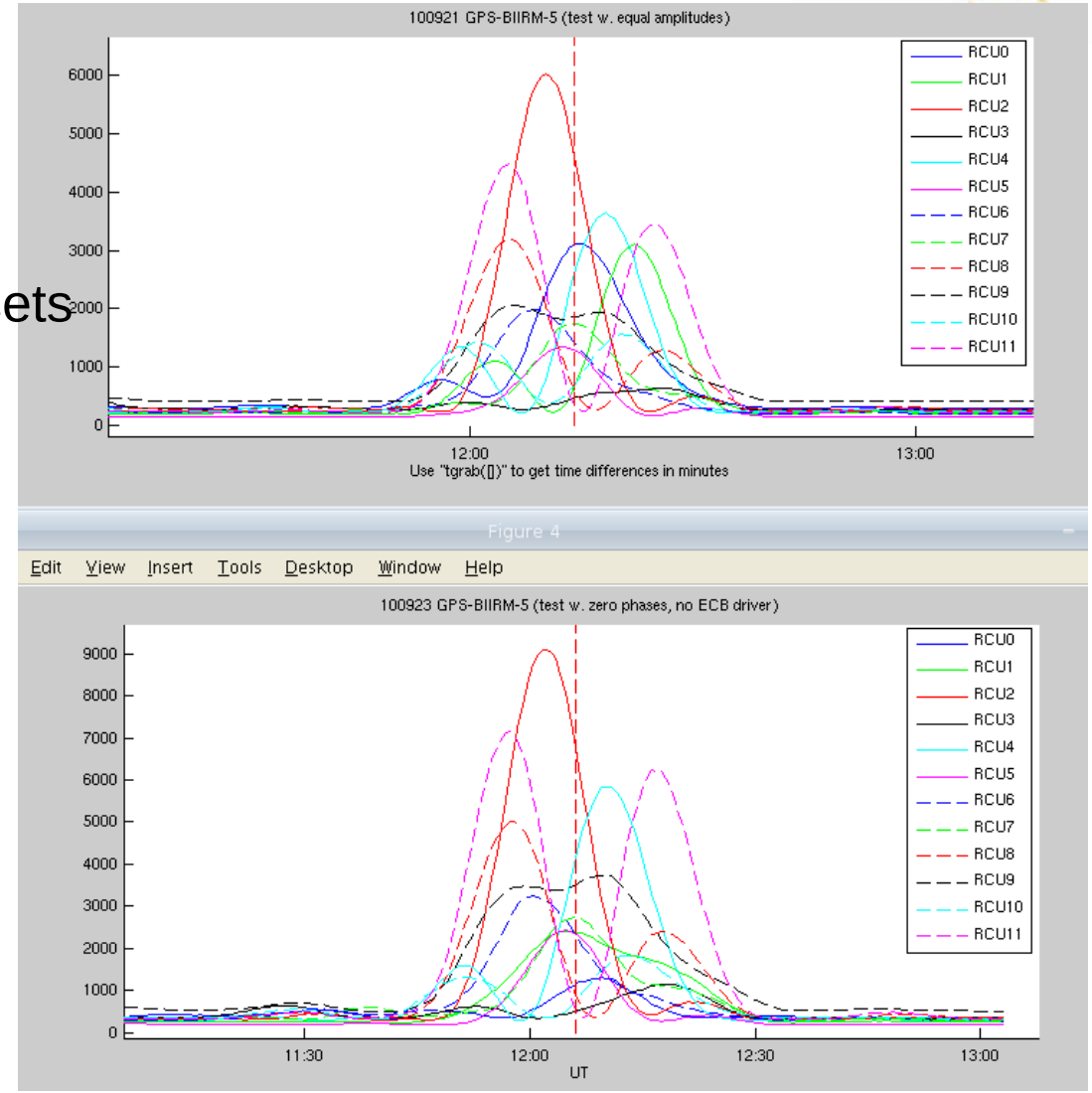

Station Control Unit
Source coordinates
Source coordinates
Interferers coordinates
Calculate Tile array settings
Subband frequency
Array geometry
Calculate Initial vector for Beam forming
Calculate Projection Matrices for nulling
Subband frequency
Array geometry
Detect Interferer
Nulling of Interferers
Local Control Unit
LO1 beam A
LO1 beam B
LO2
Tile array settings
Calculate Calibration
Correct for Calibration
Store
Store
Store
Subband To be processed
Output mode Time stamp
N cells of combined tiles 2 RF beams
Compute Subbands Statistics
Compute Cross Correlations
Compute Beams Statistics
External Correlator Interface
Mark V recording
Antenna data From RCU
2N x 200 Ms/s 12 b.
Separate Subbands
Select Subbands
Form Beams
Output Beams
Data recording Post processing

Digital beam former details



Drift scan of GPS satellite

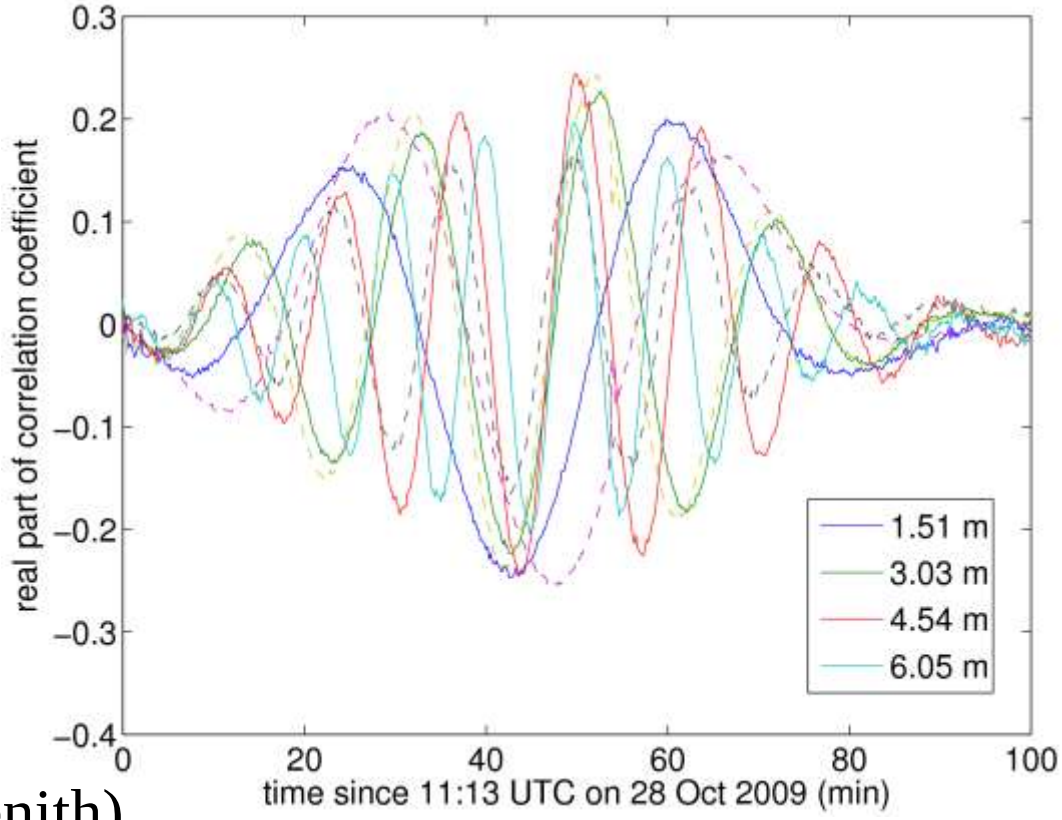
- Strong carrier at 1227MHz
- Subband statistics
- Pointing offset between tilesets
  - problem with commanding phase settings
  - CDC + centre board driver



Early highlights: solar fringes

Interferometric measurement with 10 tiles

- two E-W ULAs
- frequency: 1179 MHz
- integration: 10 s
- bandwidth: 195 kHz

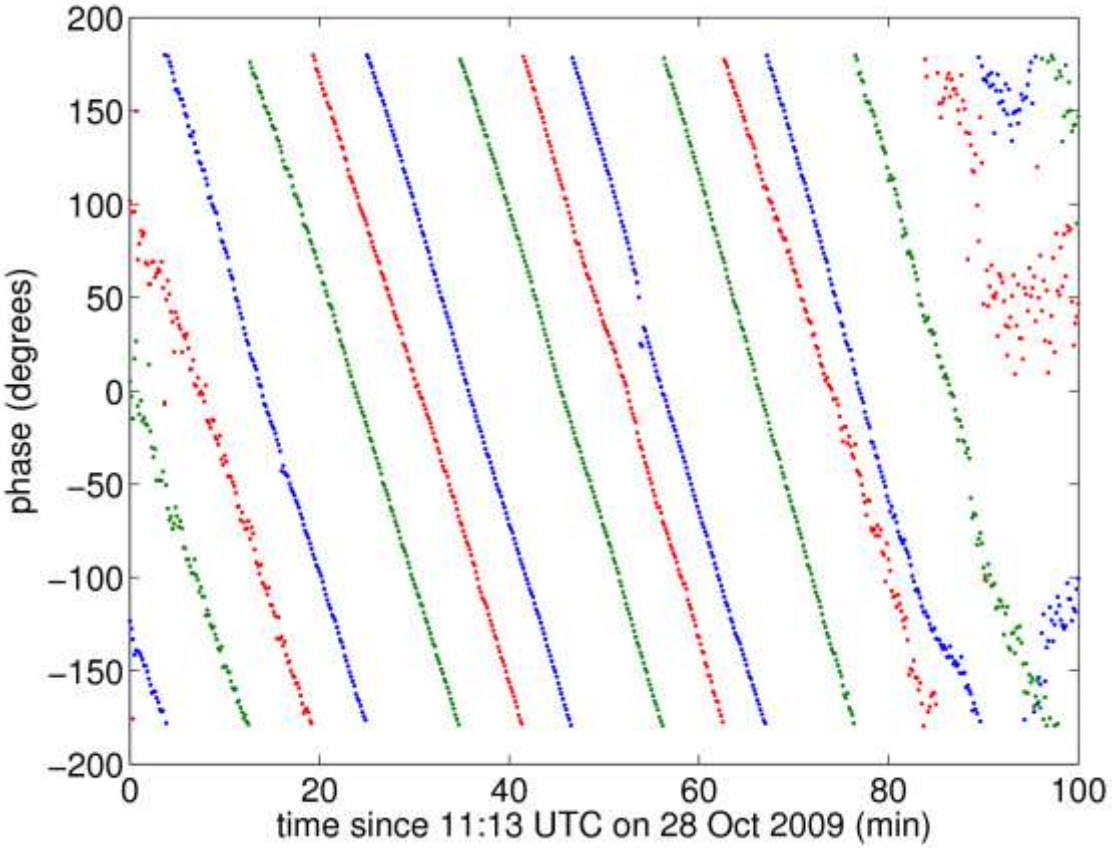


Initial performance est.

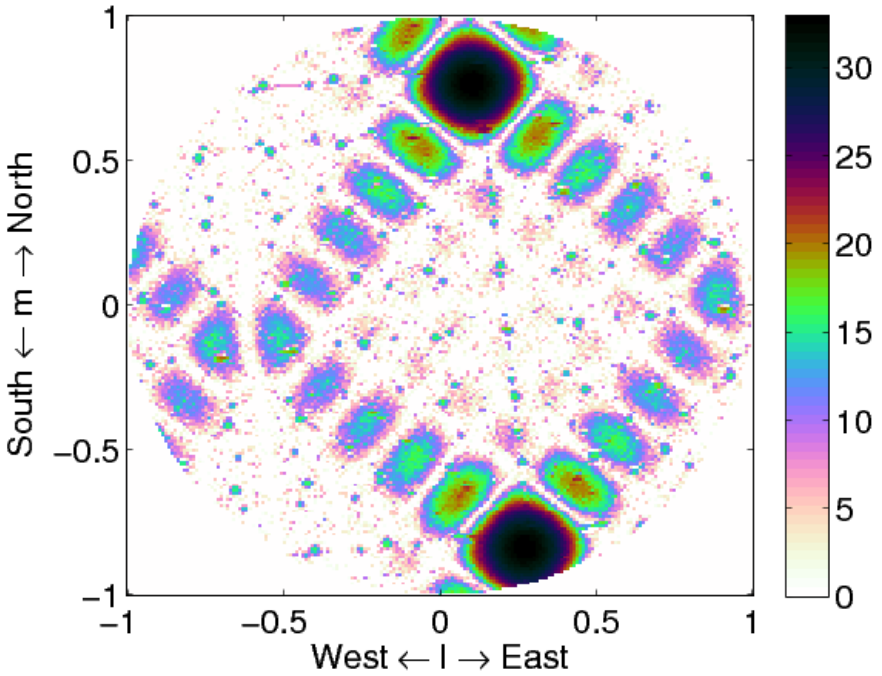
- A/T = $4.7 \cdot 10^{-3}$ (to sun)
- Tsys = 103 – 117 K (to zenith)

Early highlights: instrument quality

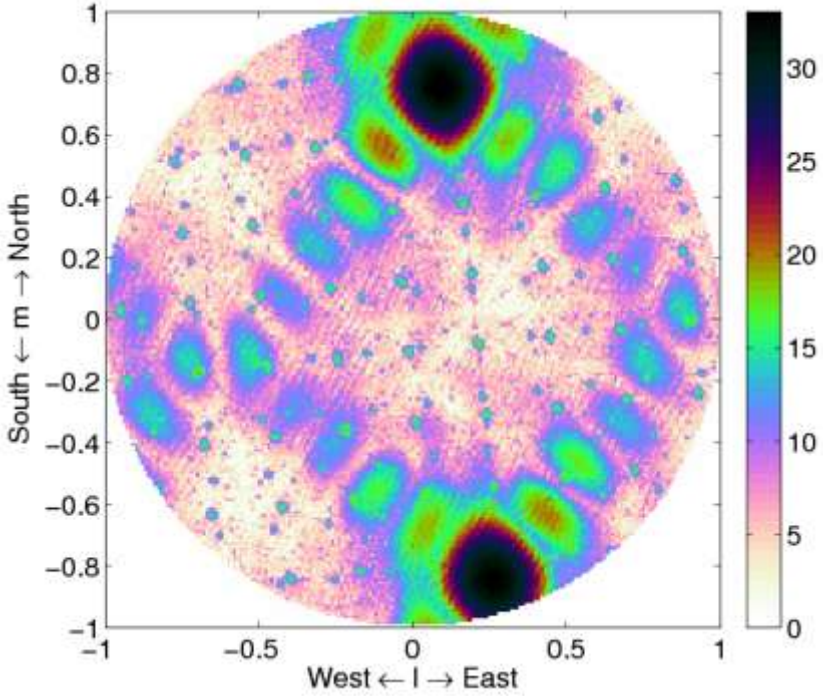
- **Redundant baselines produce redundant visibilities**



Scanned Tile Beam pattern measured on Afristar satellite



Model

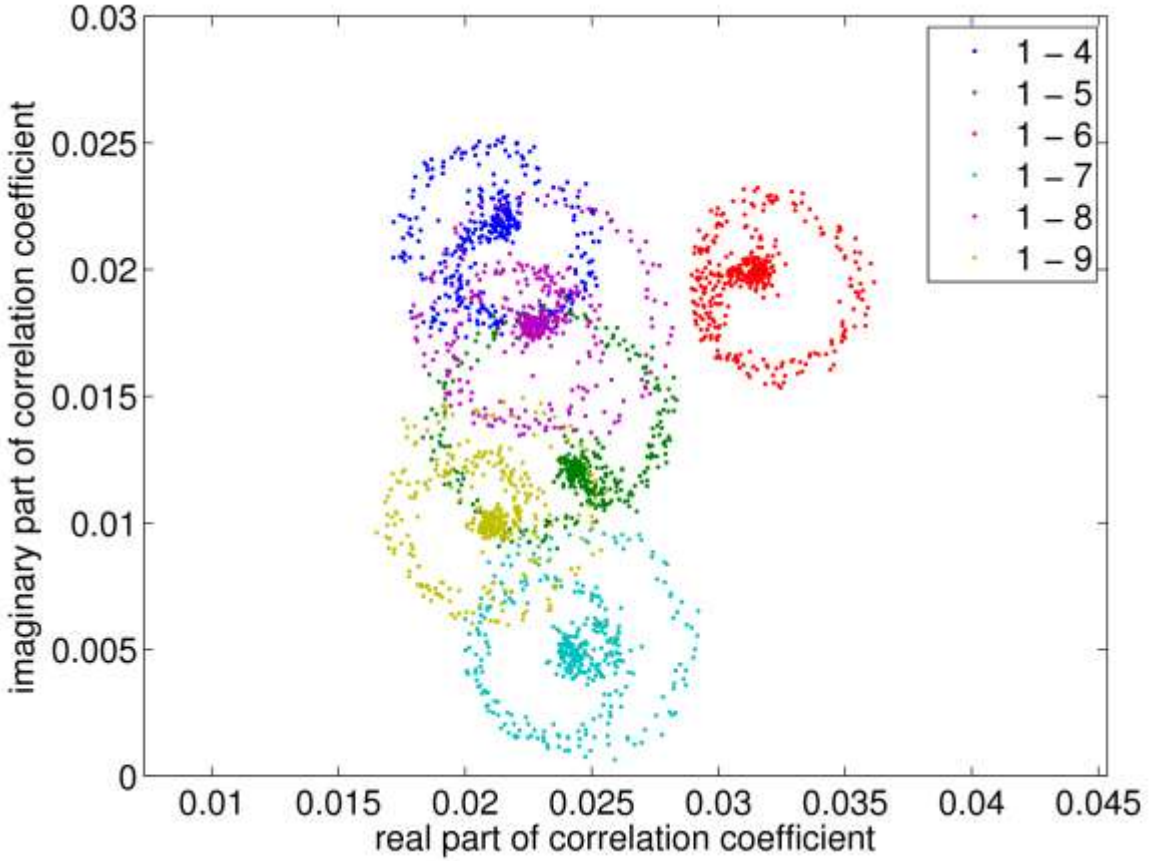


Measurement

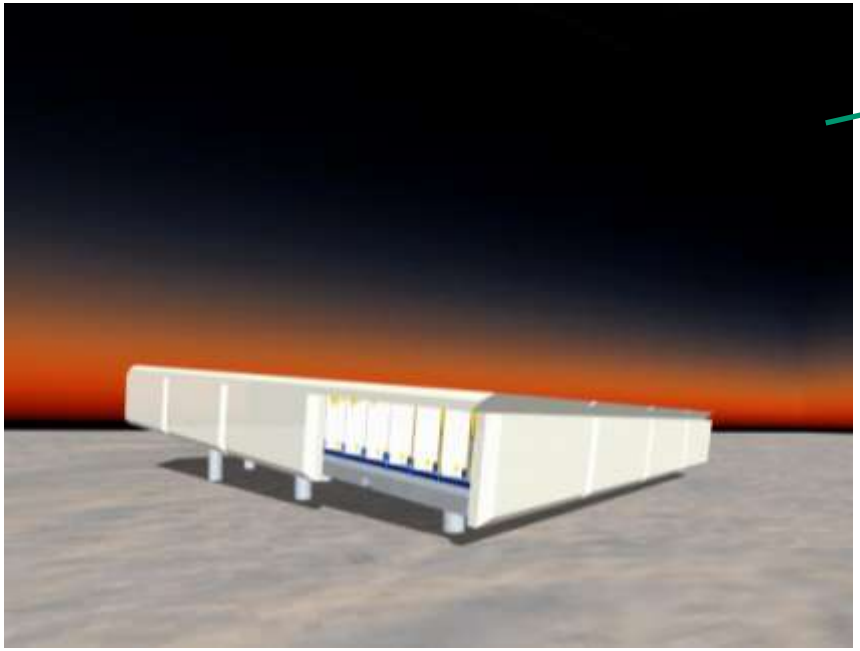
Fringes of Cas A!

- **Experimental settings**
- 3x3 array
- 1254 MHz
- 30 s integration
- 195 kHz bandwidth

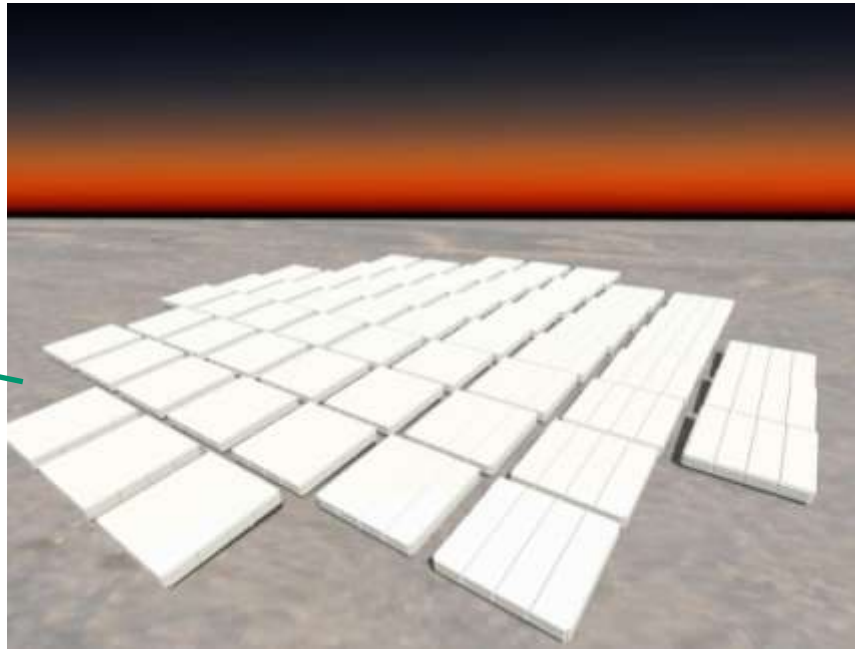
- **Initial conclusions**
- Confirms A/T
- Correlation offsets



AAVS Design



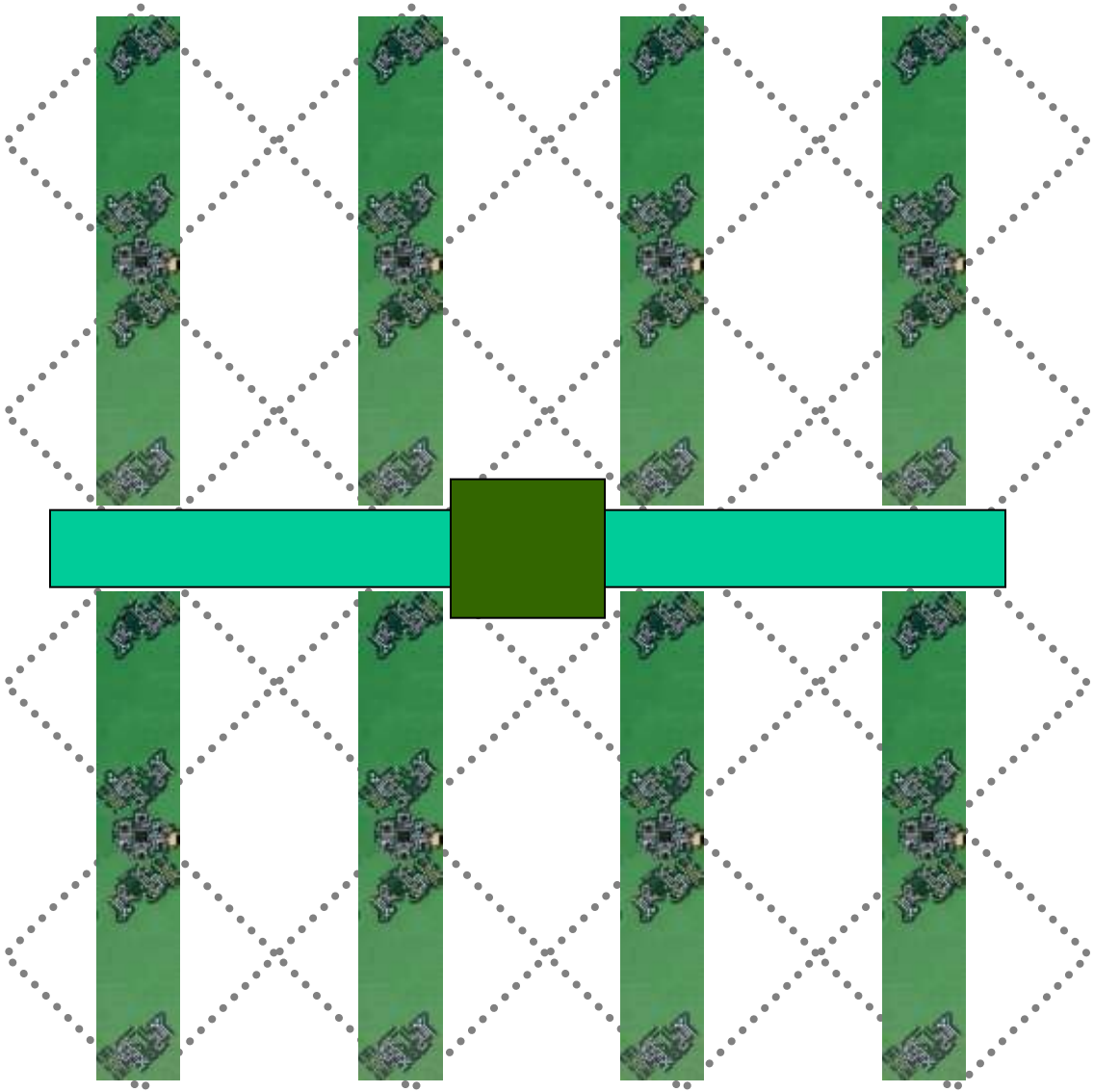
- XX “tiles” in a substation.
- Every substation slightly tilted.
- Substation closed by EPS wall en top.
- Passive cooling by ground connection through poles.



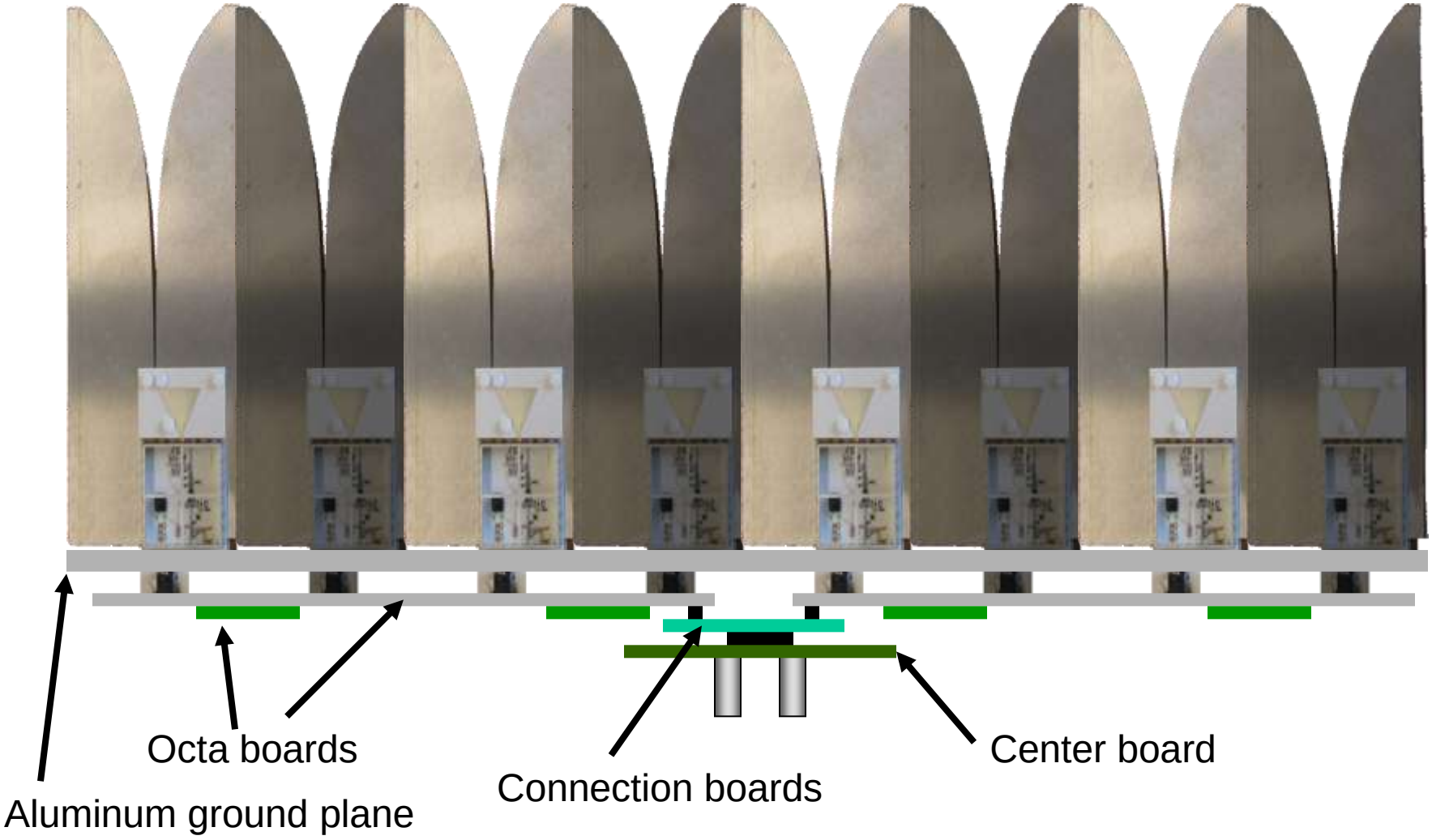
- SKA station formed by multiple substations.
- Walkable spaces between substations.
- 56m diameter

288.000 antenna elements

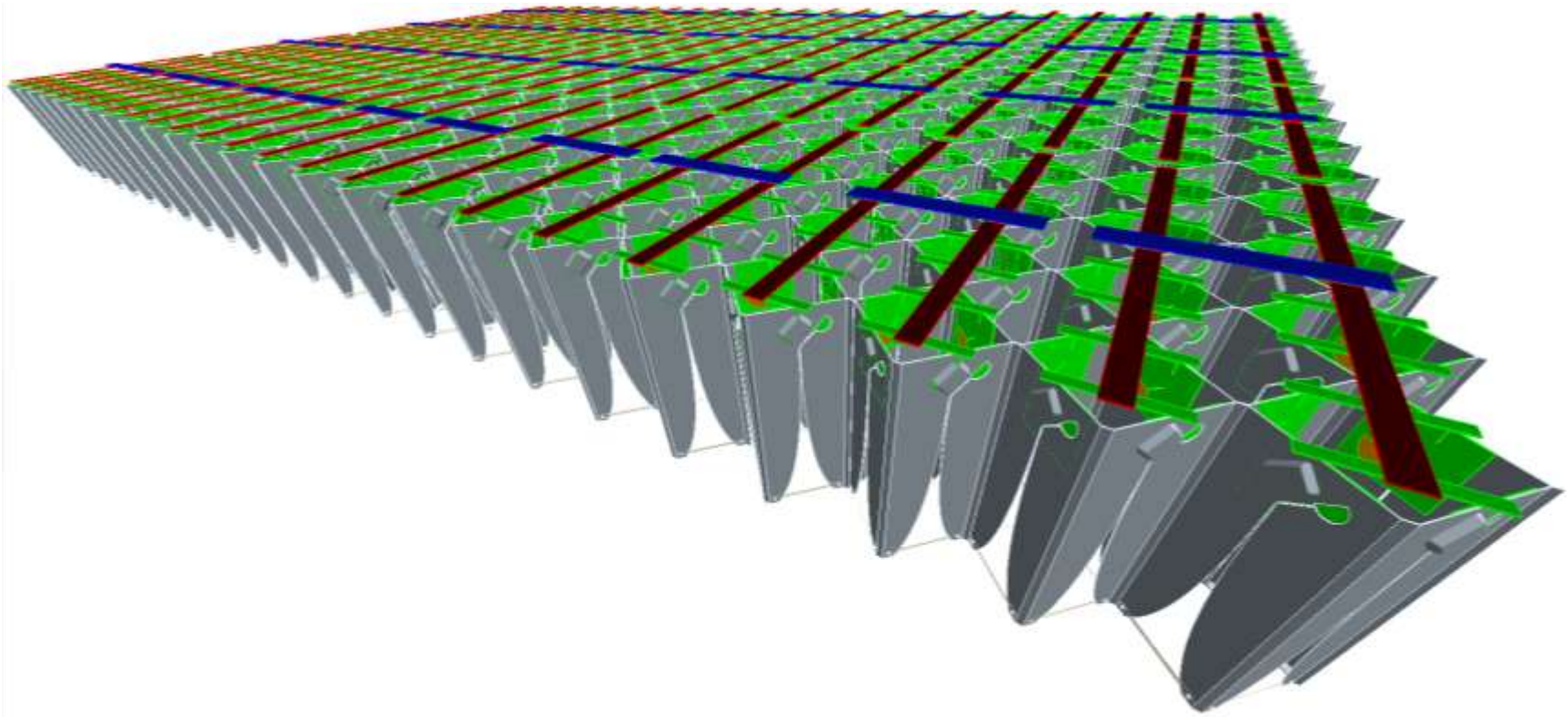
AAVS Octa concept; bottom view



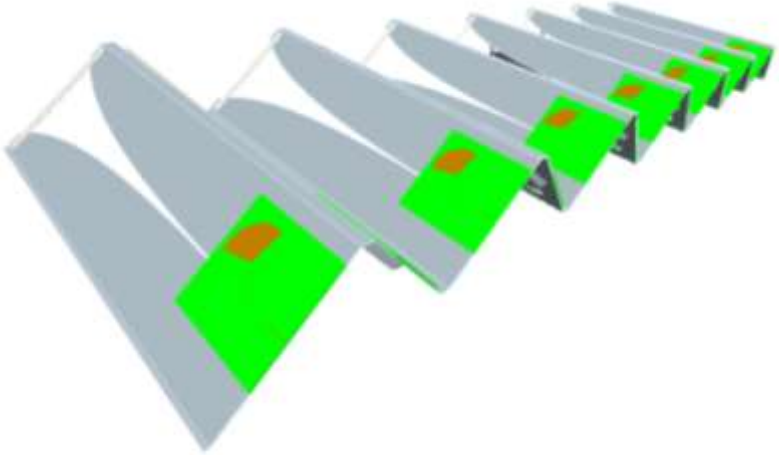
AAVS Octa concept; side view

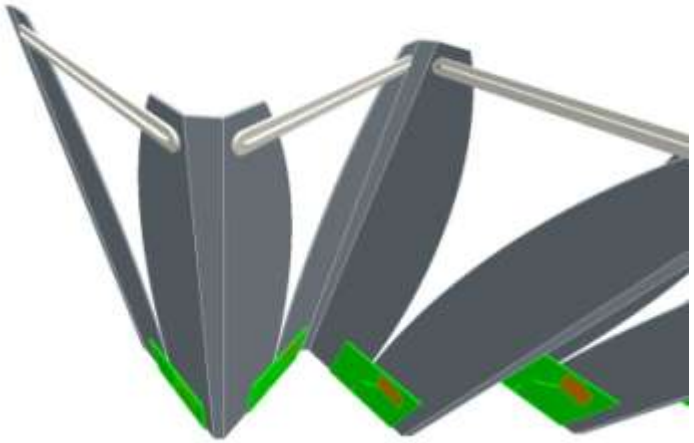


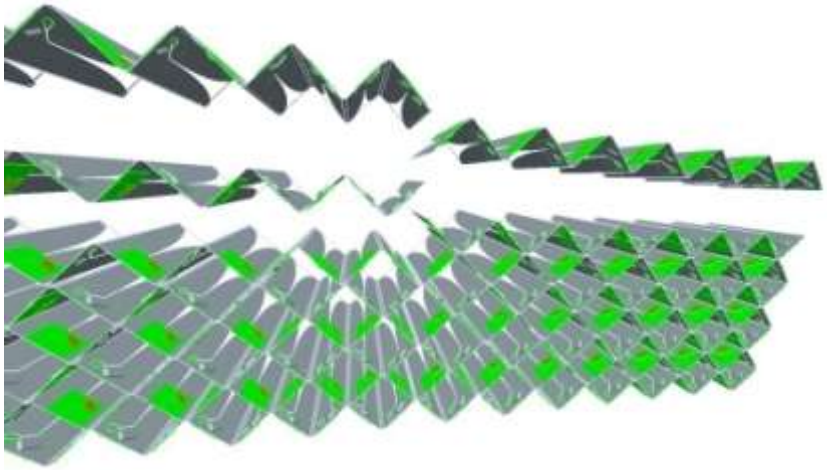
AAVS Octa Concept; 3D bottom view



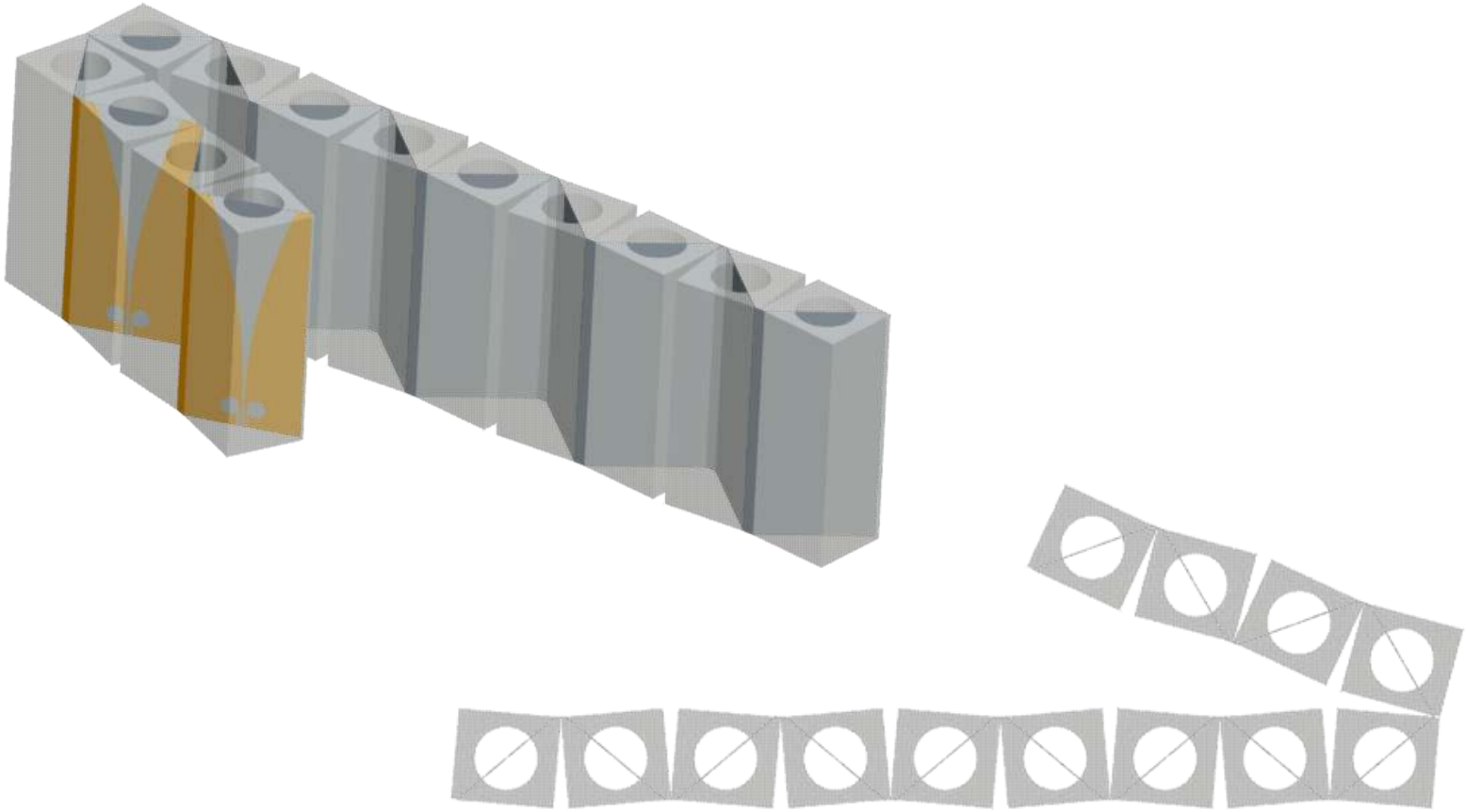
AAVS antenna concepts
Aluminium plate based







AAVS antenna concepts Foil based



Conclusion

- Both EMBRACE Stations are finalised
- First results are available and much more to come
- EMBRACE evaluation is continued in the framework of AAVP
- EMBRACE will be used as a basis for AAVS development

Questions?

ASTRON

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