The PAON project

LAL-IN2P3/CNRS		IRFU-CEA		Obs. de Paris
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M. Moniez	C. Paillet	*J. Rich*		*J.Borsenberger*
A.S Torento (*)	M. Taurigna	*J.M Legoff*		J. Pezzani
D. Breton		Ph. Abbon		C. Viou
C. Beeigbeder		*E. Delagnes*		F. Rigaud
T. Caceres		H. Deschamps		*S. Torchinsky*

+ the team involved in the construction of the antennas (proto@Meudon + Nançay)
see http://francoisrigaud.olympe.in/paon/

BAOradio projects

R&D on receivers. SAP and CEA team work on the Pittsburg cylinders project.
Test obs. @ NRT (HI obs. of cluster galaxies - JEC talk)

Talk outline :

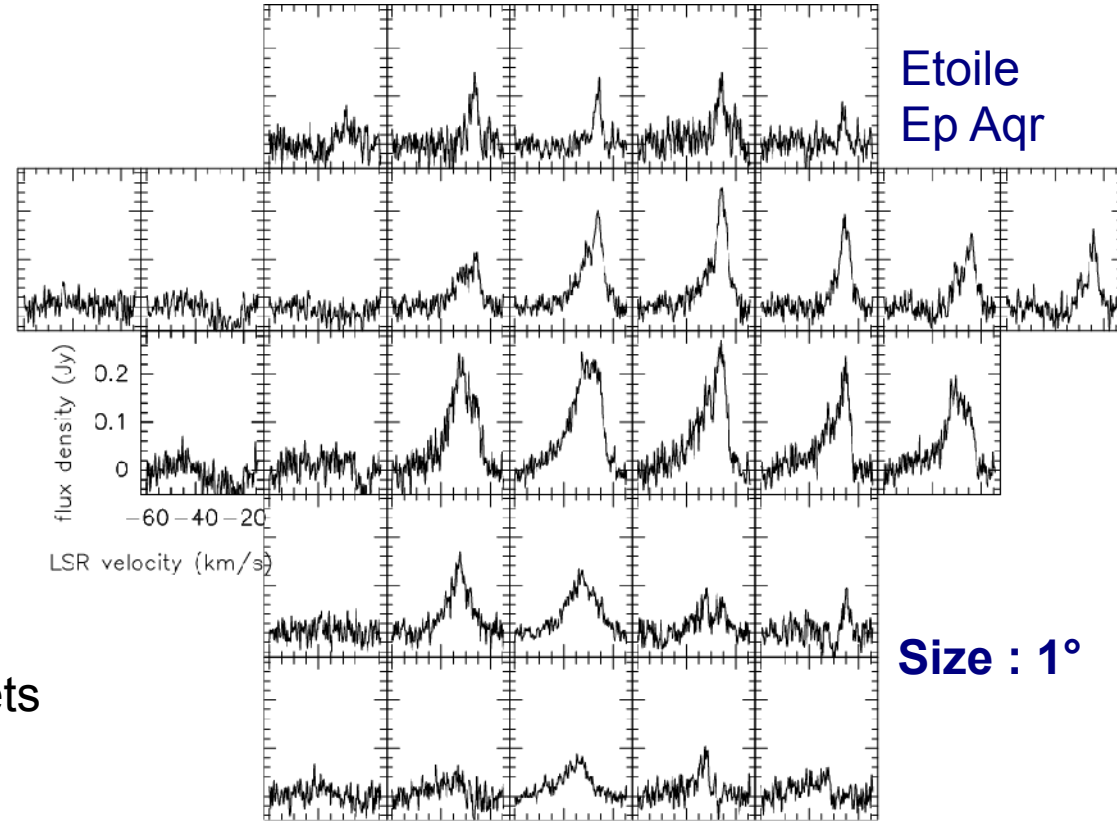
- Suggestion to use a focal array for the NRT for BAO+other projects
- PAON project → PAON2 (2012)
- Construction of a 4 antenna demonstrator: PAON4 (2014)
- Operation and future observations with PAON4

FAN prototype receiver(1)

Present system : 3 SKADS tiles (1m x 3m), 192 Vivaldi antennas grouped by 16 → 12 pixels. Use the BAOradio analog and digital acquisition boards and PCs. Lack of a beamformer.

Needed for a 5 beam FPA (J.Pezzani 2014) 102 pixels of 15cmx60cm x 2 pol.

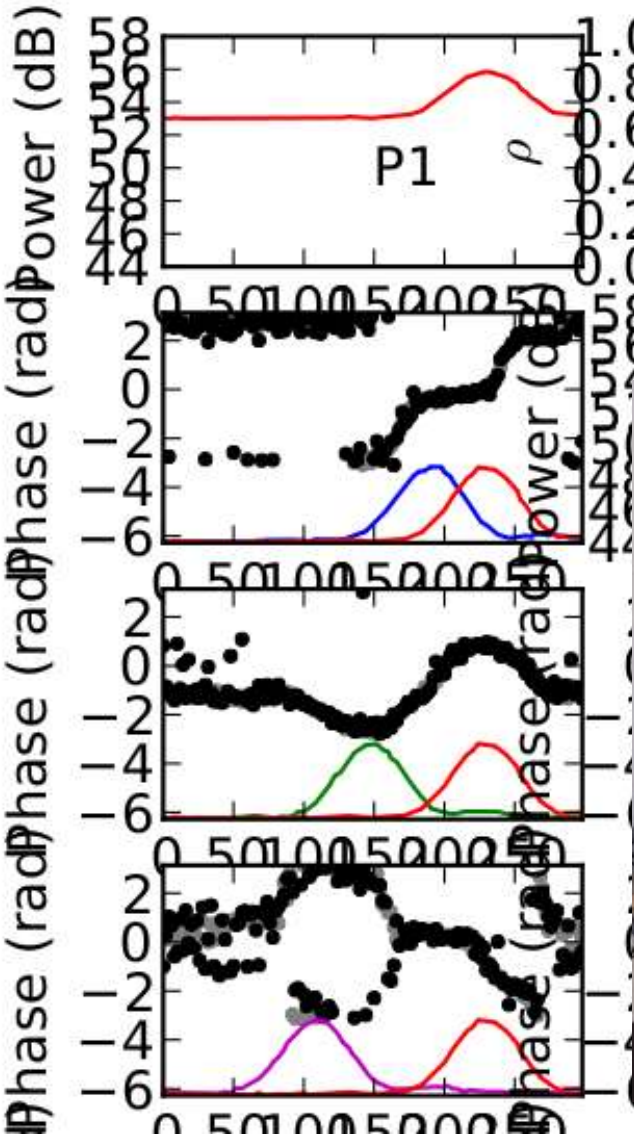
On-going study of a checker board antenna - science definition workshop (sept.)

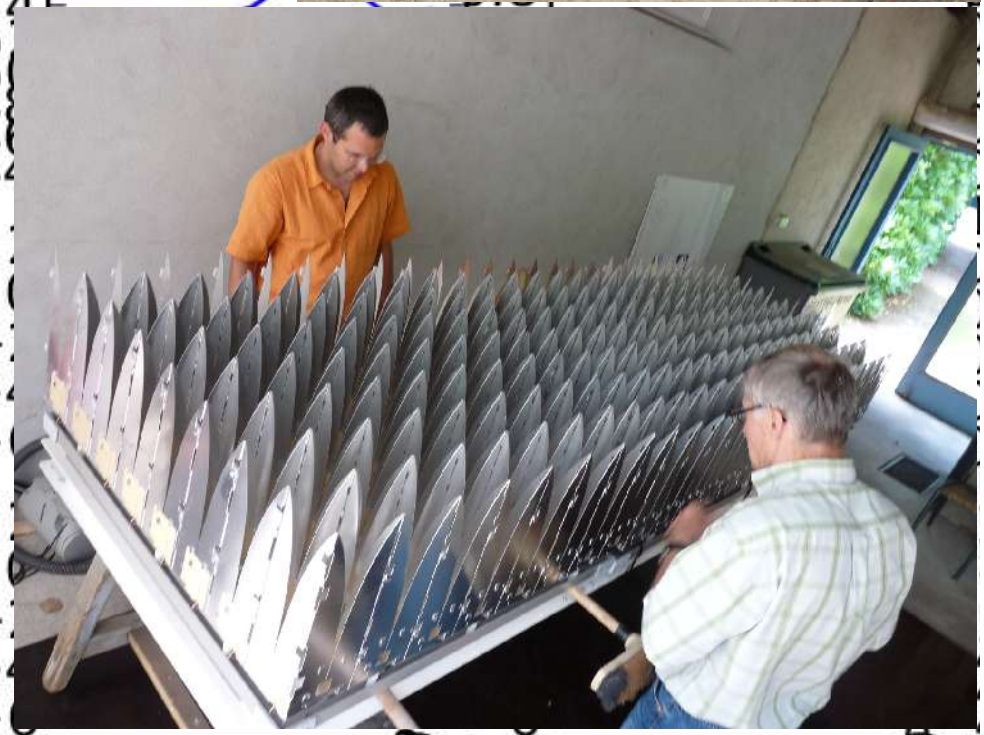


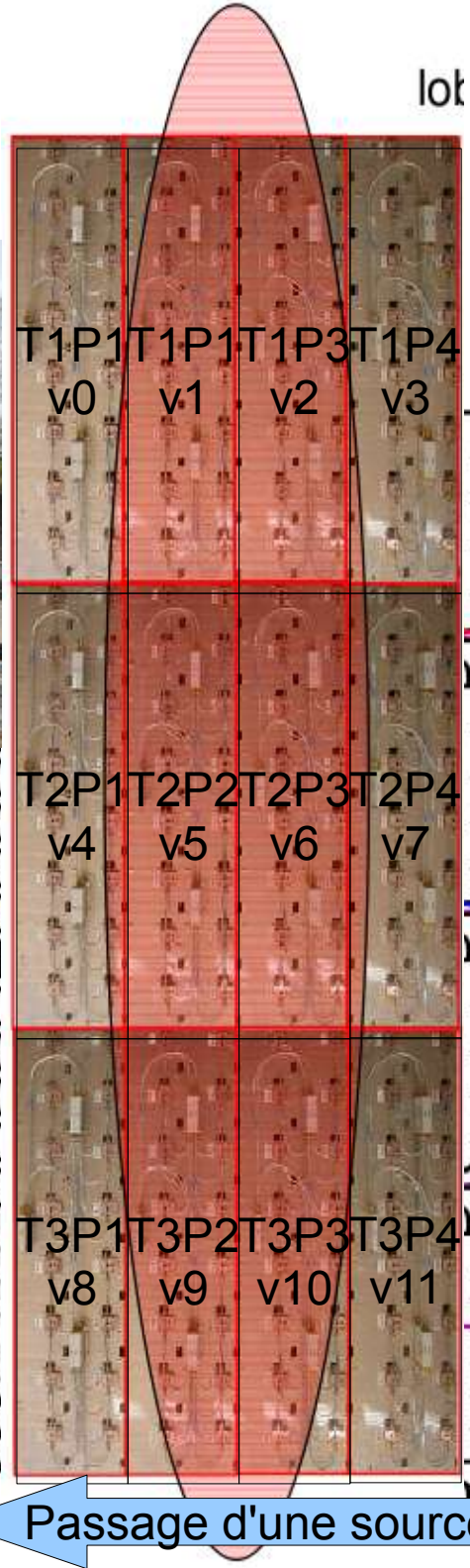
Science objectives:
- BAO (need 100 beams)
- search for transients (PSRs?)
- mapping of extended sources - stellar mass loss (up to 30h/map) – see figure, interaction stellar winds/ISM, bright comets
- complementarity with interferometers

FAN prototype receiver(2)

Processing: waveform acq. on disk
Post processing off-line (C.Dumez-Viou).







The PAON2 interferometer

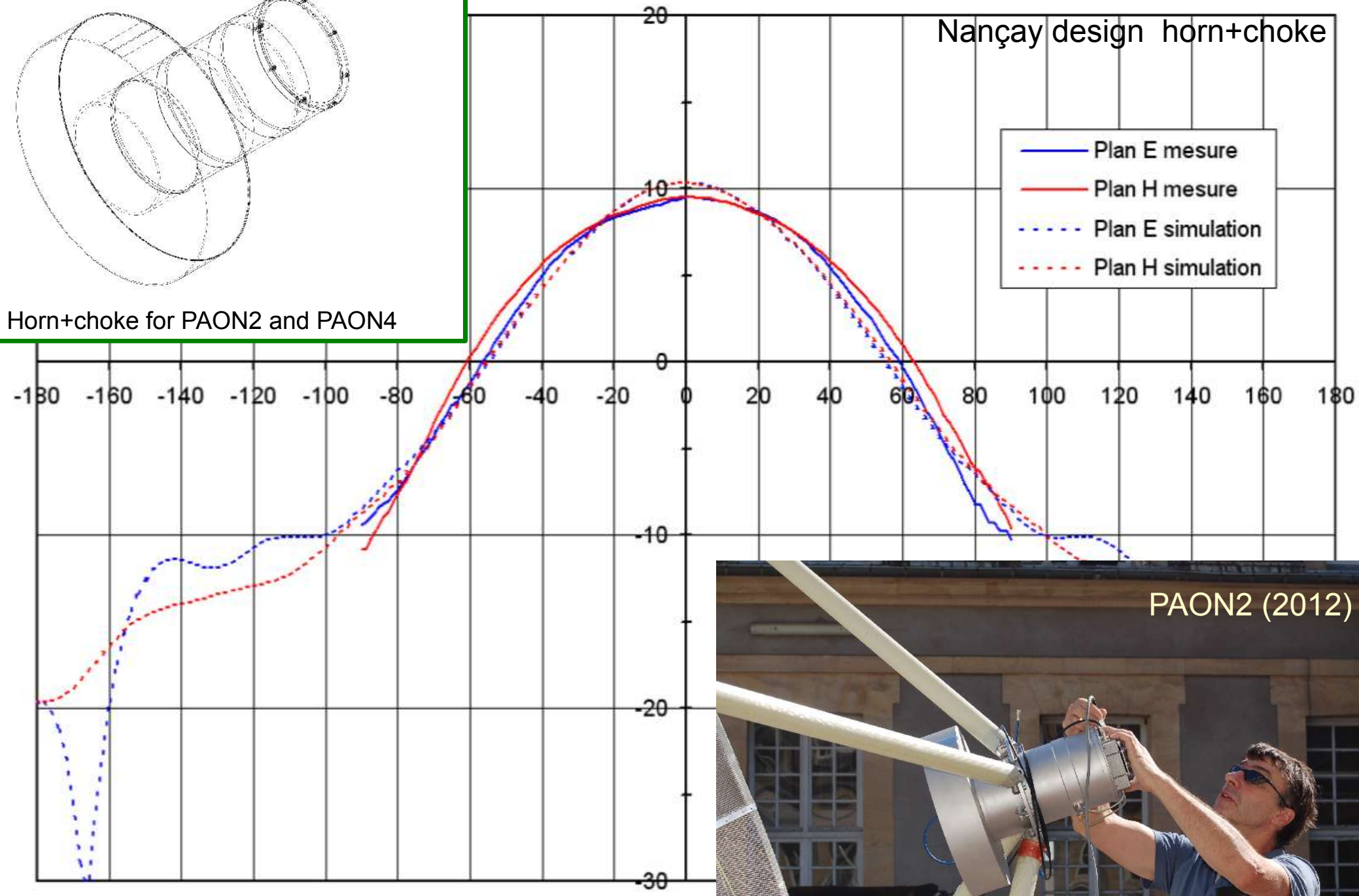
Why? Application for PAON4 submitted early 2012. But, needed to get some first interferometric results with the BAOradio acquisition system

How? 3m dutch antennas+horns designed at Nançay+quick/simple and '~no cost' pedestal mount.

When? autumn 2012- winter 2013. Now back in Meudon to upgrade the 'Master' level training interferometer (replace TV Yagi antennas with the parabolas+ new dipoles for ~860MHz Solar obs.).

Horn+choke for PAON2 and PAON4

Nançay design horn+choke



Horn modeling/measurement: J.Pezzani. Mechanical design: F.Rigaud. Construction: J.B.Vimon+ F.Rigaud (Obs. Paris). LNAs P.Abbon (CEA).

PAON-2

Installed at Nançay

September 2012

PAON-2
Installed at Nançay
September 2012

Sun transit (oct. 2012) : estimation of Tsys: 140-190 K
(depending on channel used, and the determination method).
Confirmed with Cyg A interferogram.

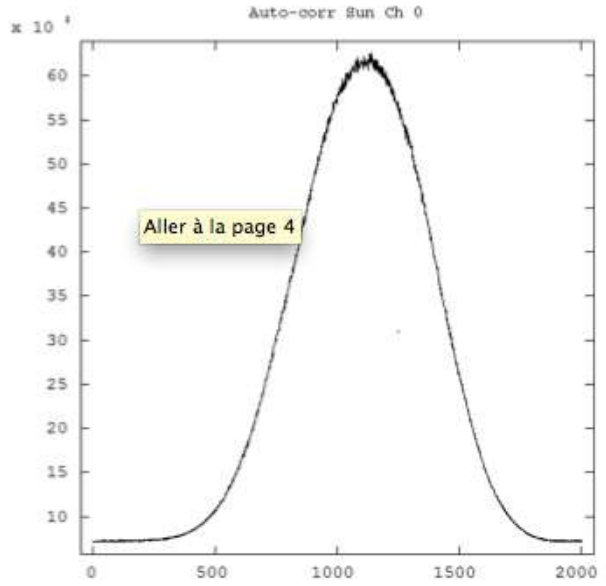


Figure 1 Auto-correlation channel 0 during the Sun transit.

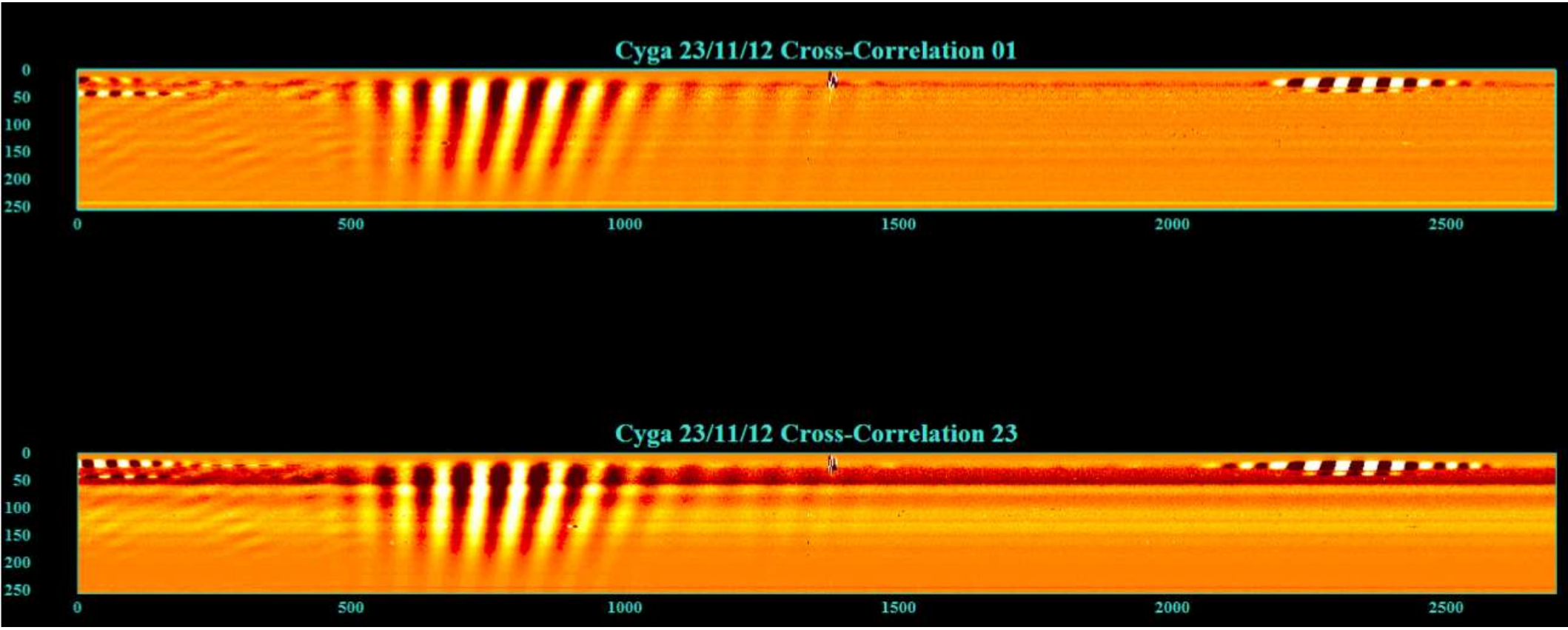


Figure 4: Cross-correlations between aligned polarizations during the observation of Cyga transit. The run in total represents 4h (x-axis). The 250MHz total band is along the y-axis of each image starting on top-left corner at 1250MHz. The main CygA fringes are localized roughly in the bin range [500, 1000] of the image while we see also human induced signals before and after the transit concentrated around 1275 ± 10 MHz (ie. the franges spacing do correspond to Sky rotation).

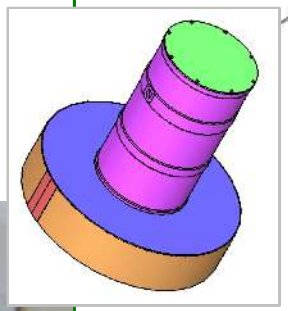
The PAON4 interferometer

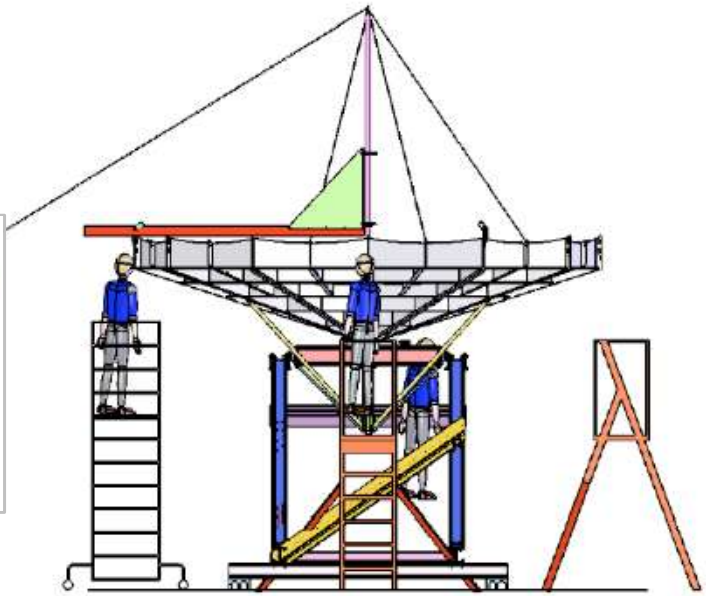
Why? demonstrator - test and improve the electronics + acq. and map making, provide broad band interferometric data at low z. Preparation of Tianlai with parabolas.

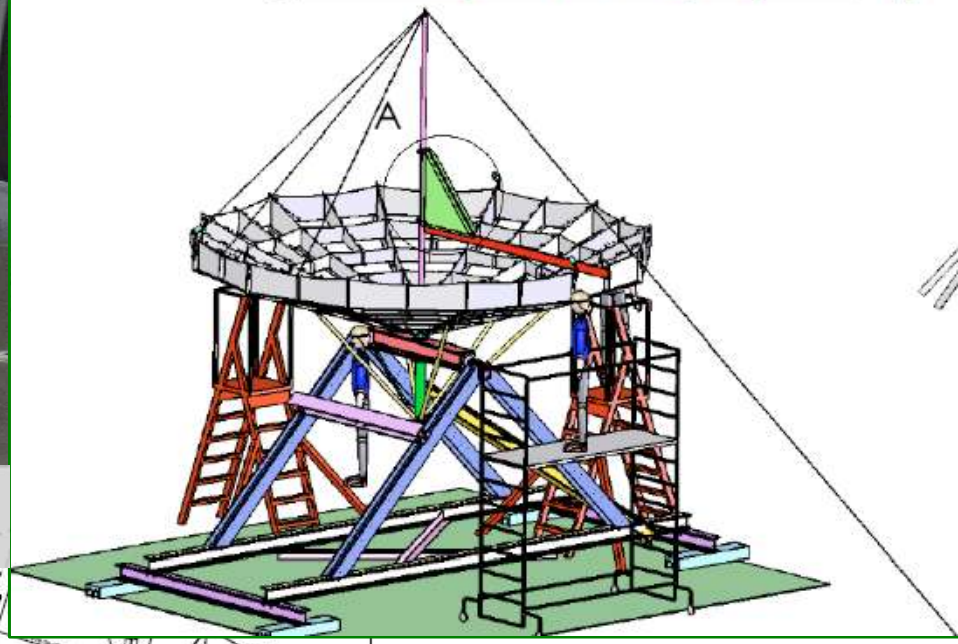
How? resistant and cheap antenna+mount (less than 50.000 € [total] + x months assembly: including 2 months for the mesh). 10 years durability (teaching in the future)

When? funding proposals accepted in 2012. Design updated early 2013 to reduce production costs, Construction finished in June 2014. Tests → end of 2014.

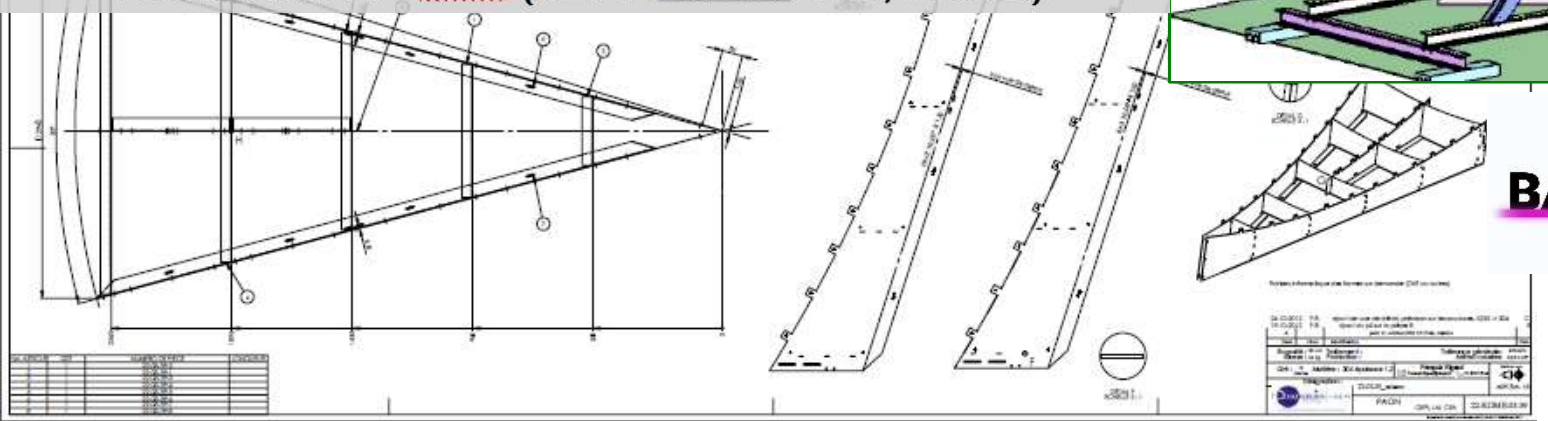
Mechanical study and construction of the PAON4 antennas (BAORadio IN2P3-LAL, CEA-IRFU, Obs. de Paris)





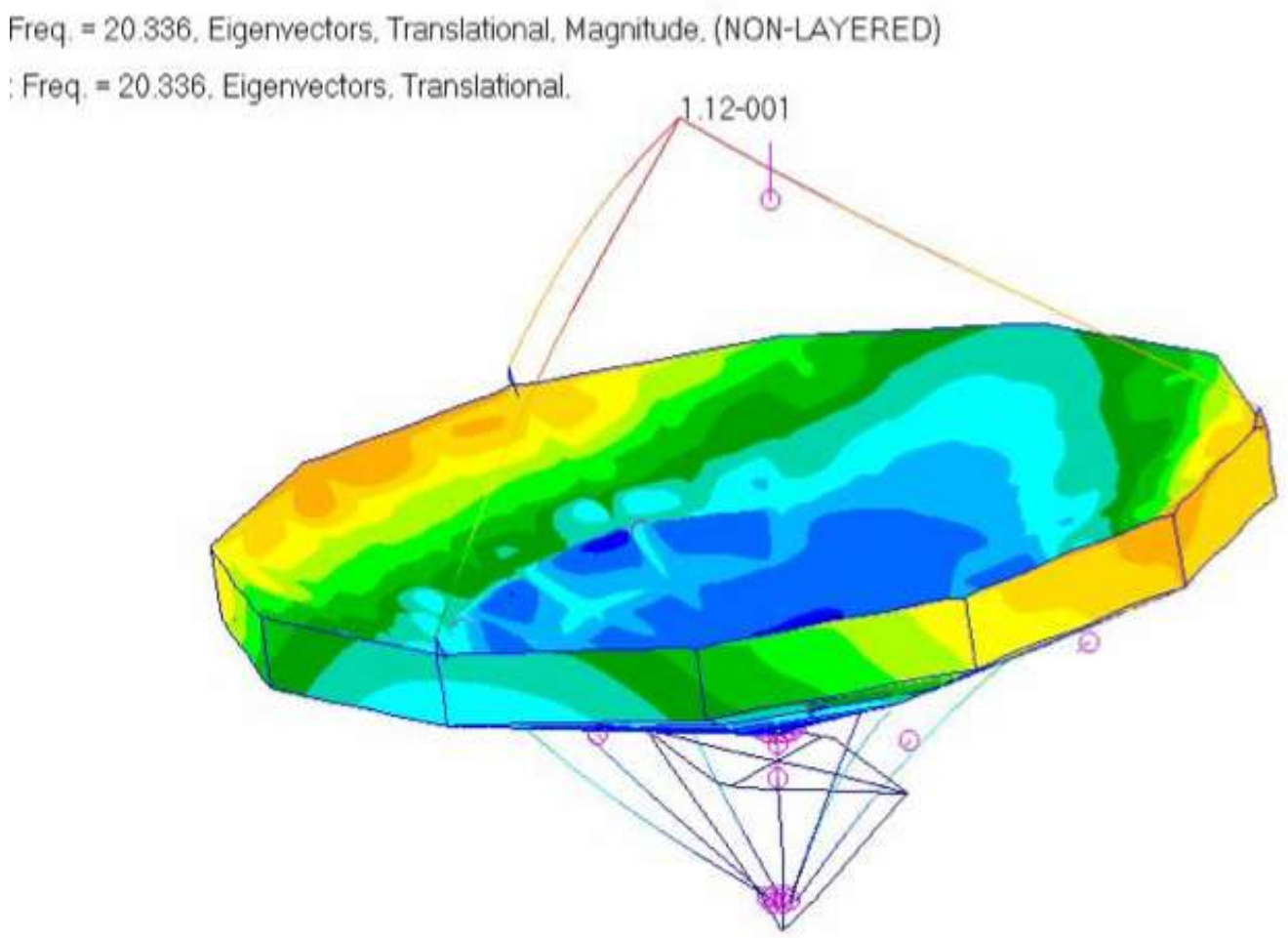


Design F.Rigaud. Assembly J.J.Bousquet, S.Blanc.
Fabrication/FAIT team (GEPI Obs. de Paris, France)

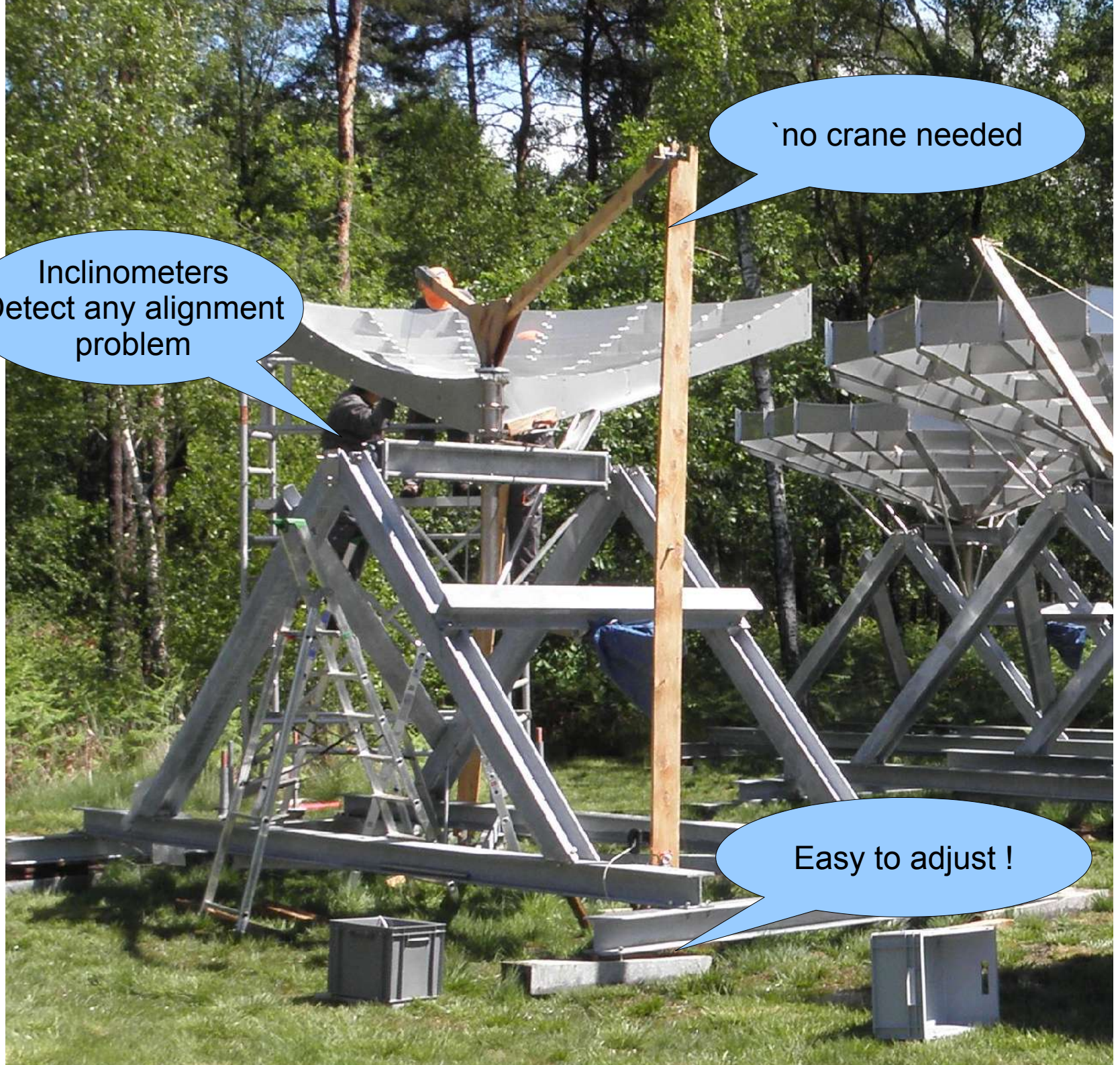


PAON4 - mechanical study

Résistance aux sollicitations dynamiques :



Calcul par éléments finis,
1ére fréquence propre sollicitée : 20 Hz.


`no crane needed
Inclinometers
Detect any alignment problem
Easy to adjust !

PAON-4
Installed at
Nançay
May 2014

PAON4 - identity card

- 4 x **5m** parabolic dishes - mesh reflector (1cm mesh) - horn+choke

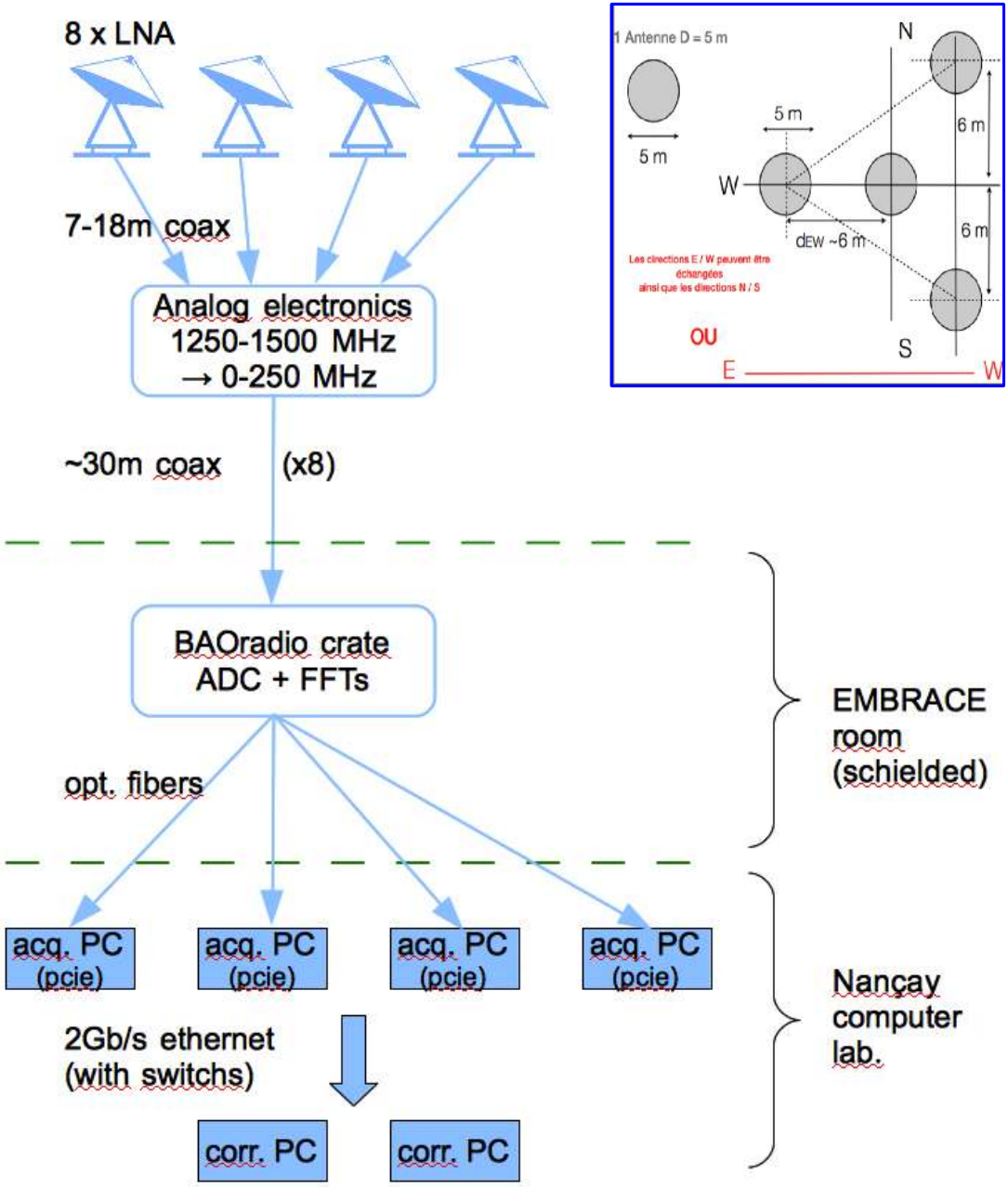
- optimized config. (JZ&RA)

- meridian mounts, 38°S to 15° N (**DEC 10° to 63°**)

- covered band **1250-1500 MHz** useful band **~150-200 MHz**

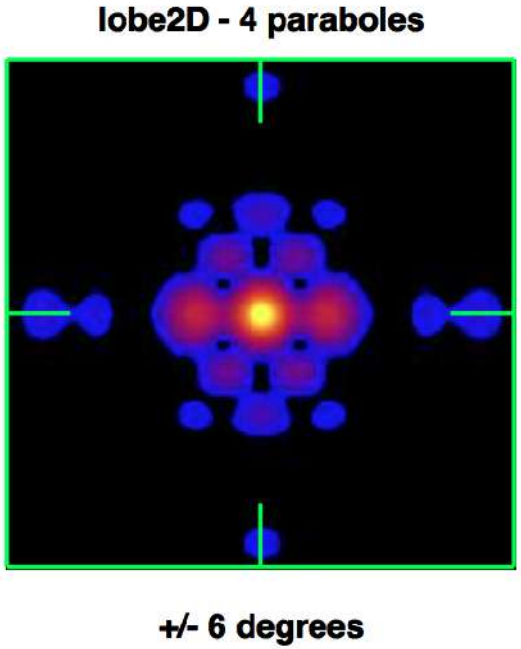
- 4 x **2 polarizations**

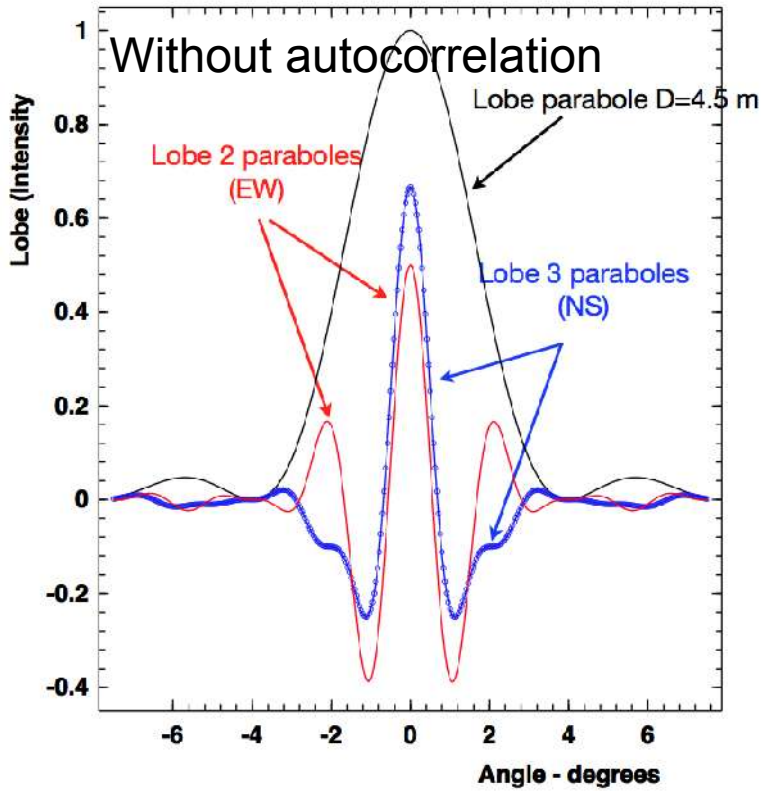
- throughput: 8 channels @ 500 MS/s (**4 GB/s** if 100% duty cycle)

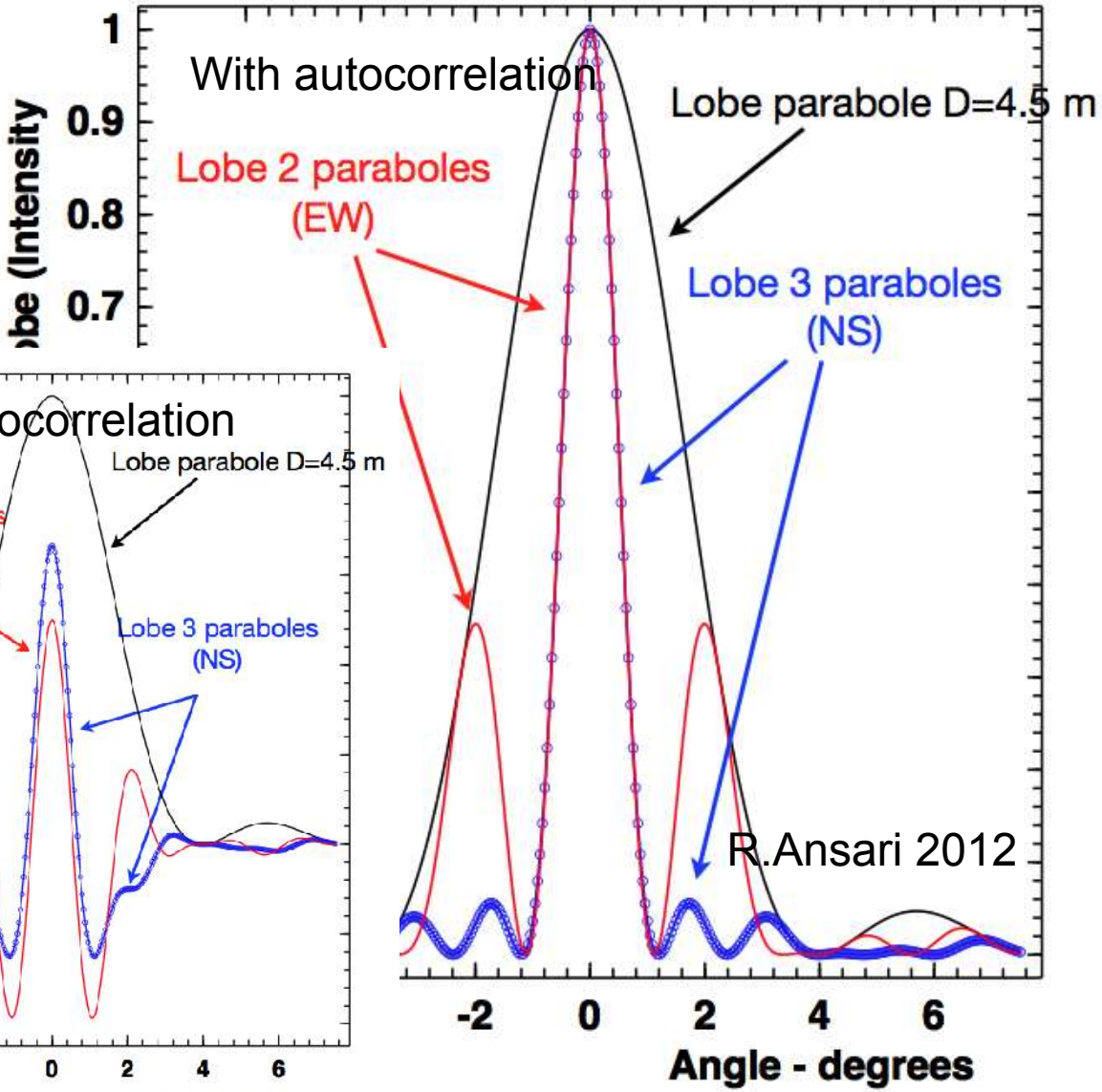


PAON4 - Array configuration (1)

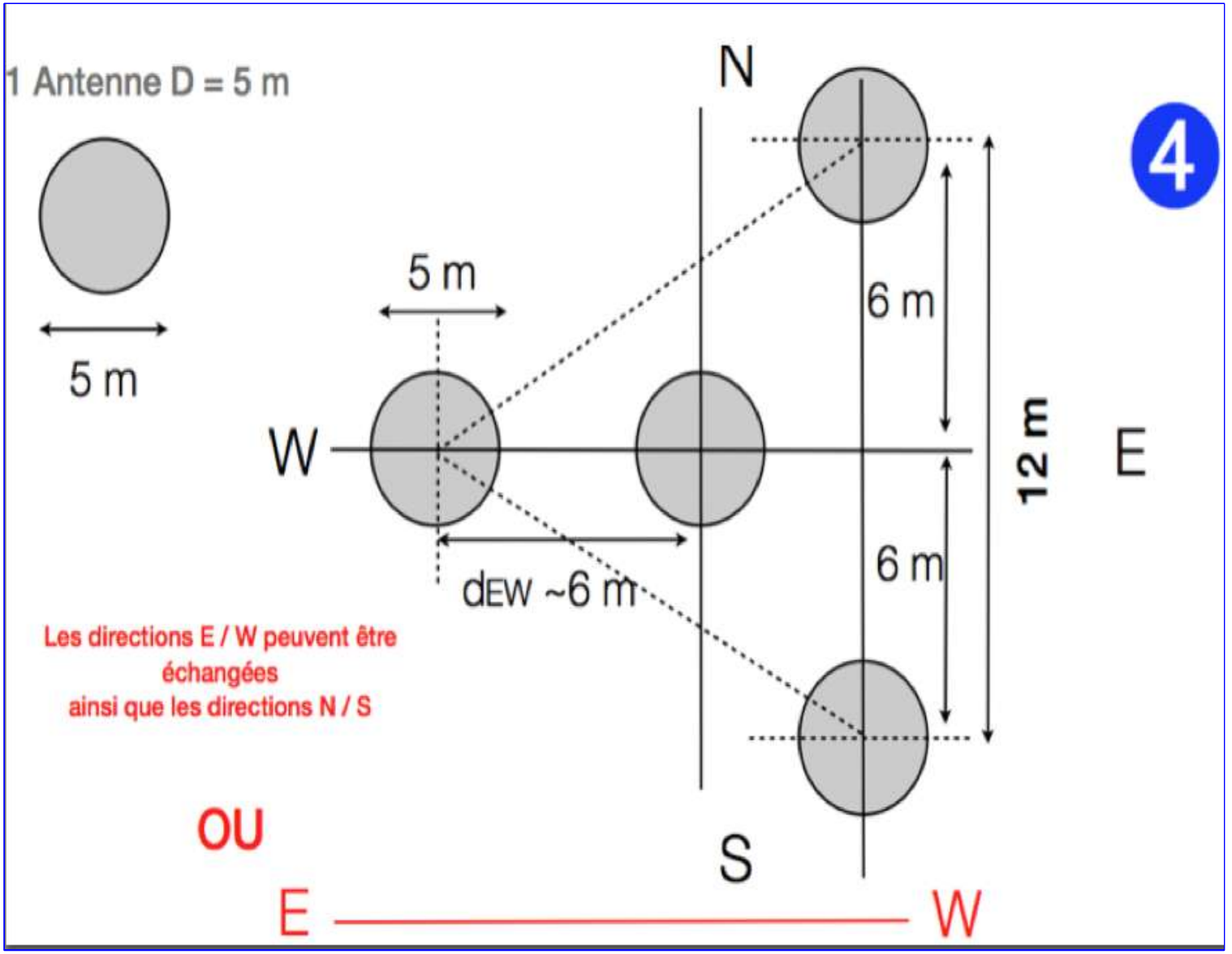
- Antennas at the requested positions (controlled in May 2014)
- Array optimized (J.Zhang, R.Ansari -see Jiao's talk).







PAON4 - Array configuration (2)



J.Zhang
and R.Ansari

PAON4 - test, improvements

- Interferometric tests with EMBRACE ? with the NRT
- **NEBULA project** (LAL-Nançay): new generation ADC + fiber outputs/new data format boards to be installed in each antenna (support from CNRS/INSU, 2014)
- UNIBOARD (RadioNET) processing boards ? (100% on sky)

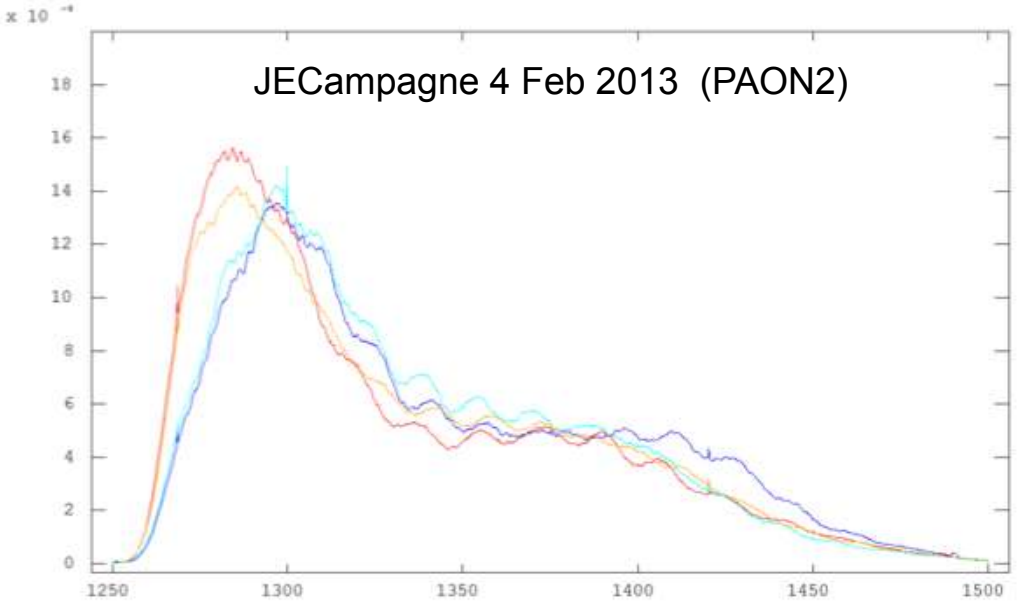
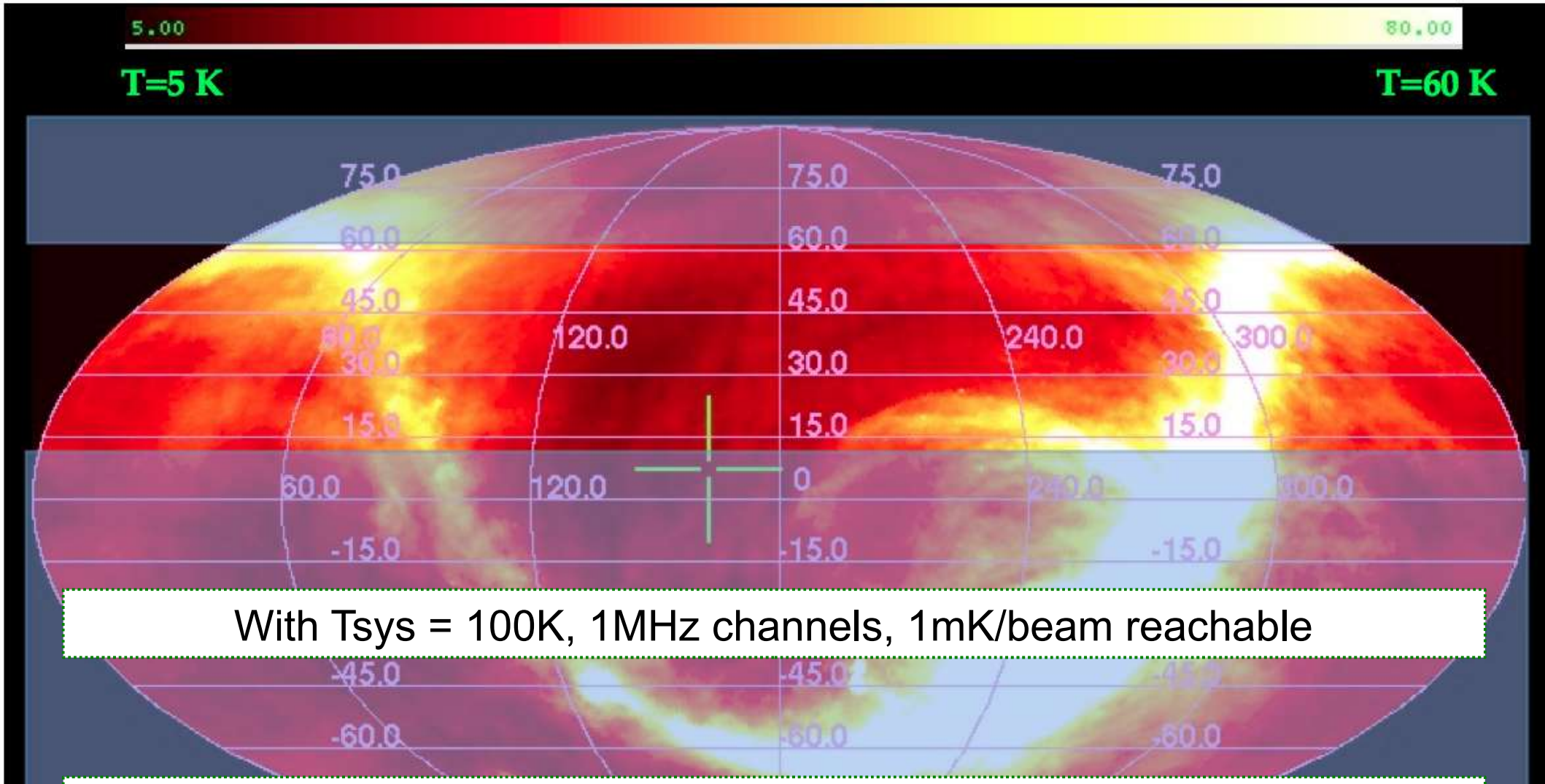


Figure 1 The auto-correlations [1250,1500]MHz averaged over ~7000sec (122kHz) during the noise run of the 21st Nov. 12. The color code stands for blue (Ch0), red (Ch1), cyan (Ch2), orange (Ch3). The histograms are normalized as the sum over the 2048 bins is set to unity. No filtering has been used.

PAON4 - Science test

20° strip: 10 x 2°scans x 10 (100 days of observation)

- need to improve the duty cycle



With Tsys = 100K, 1MHz channels, 1mK/beam reachable

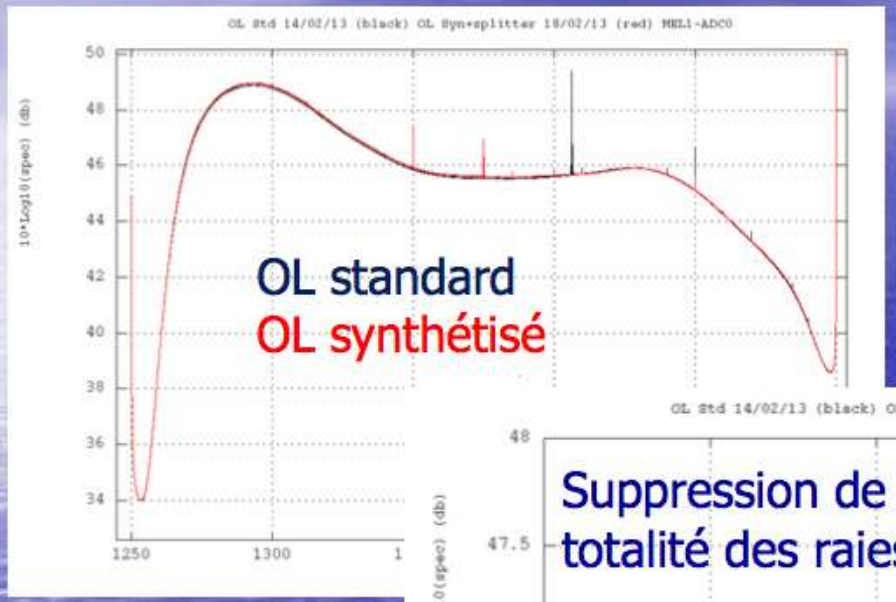
Other possible test observations: extended galaxies, interferometric obs.

Thank you !

additional slides

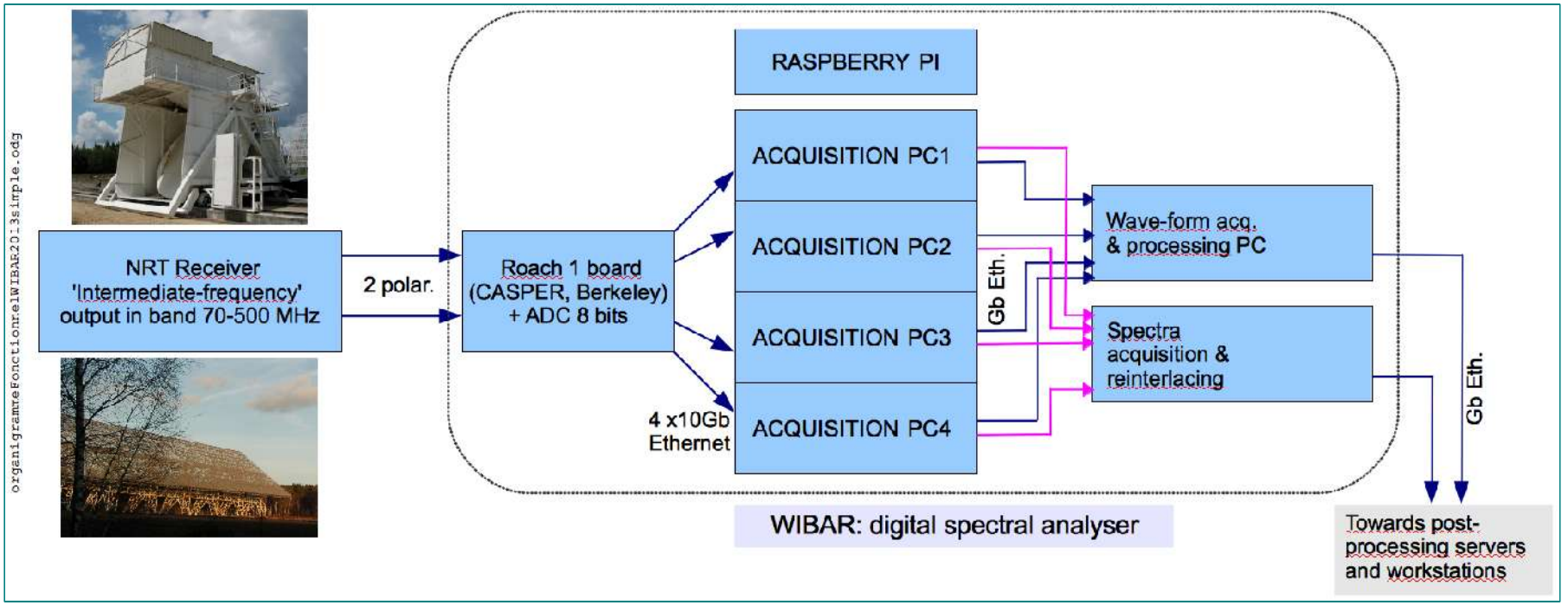
Electronique: BdT @ LAL

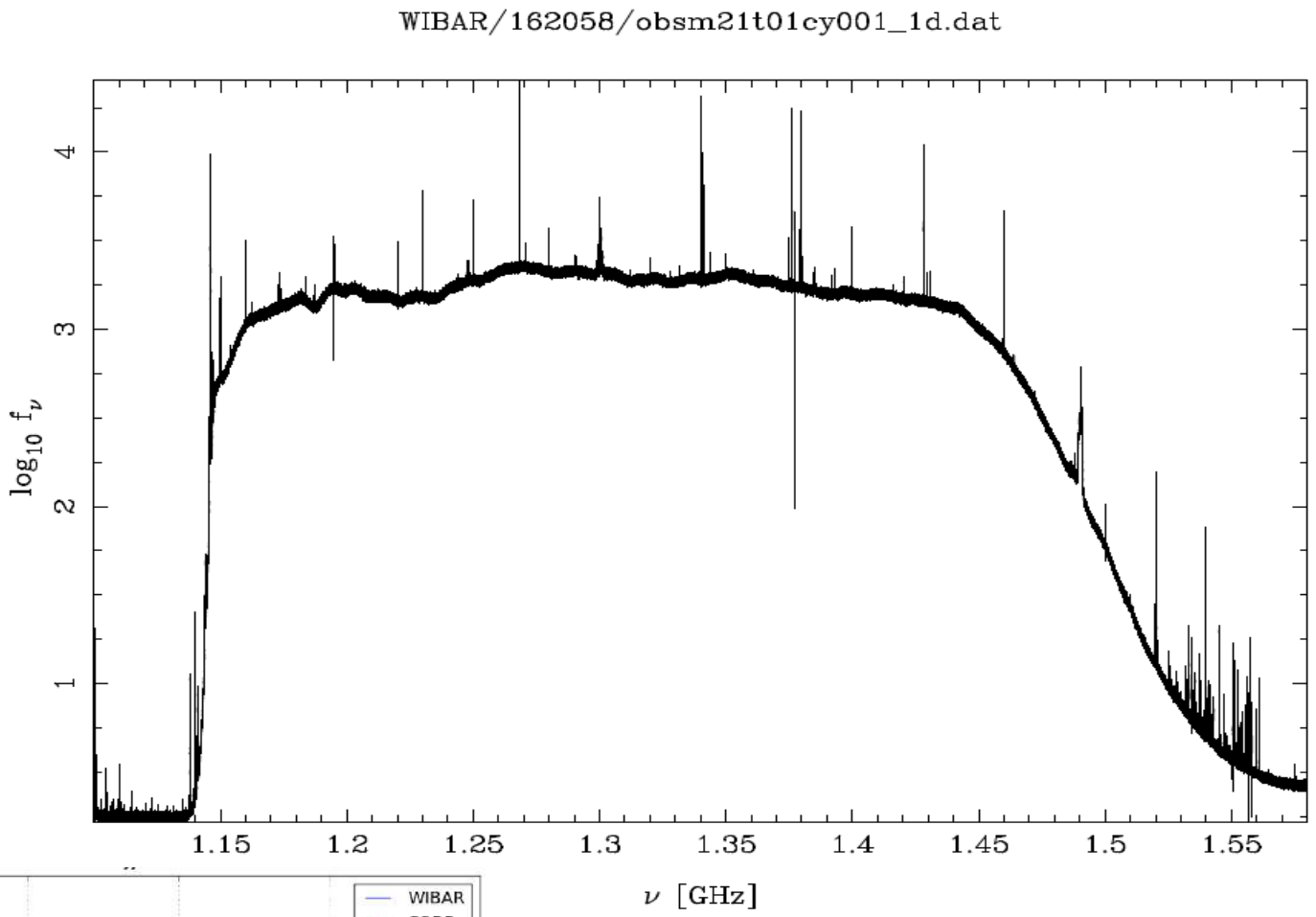
Synthé Agilent: 1250MHz

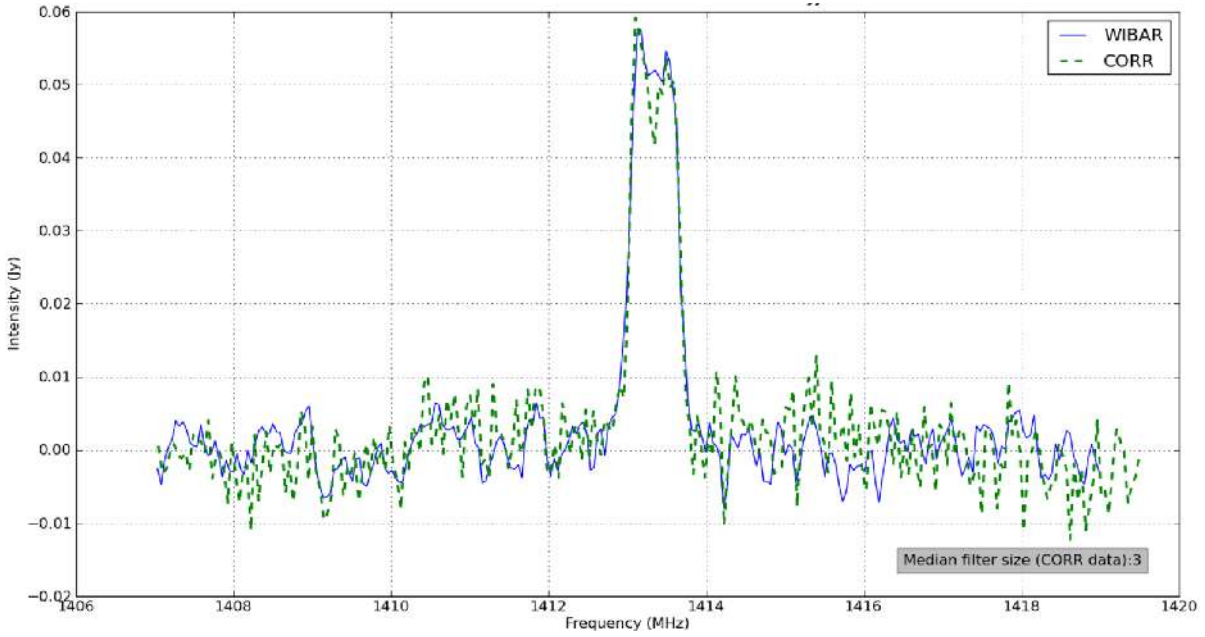


OL/mixer+ADC

WIBAR
- connected to the receiver: two linear or circular polarisation signal
- 70 to 500 MHz band
- Roach1 board (CASPER, Berkeley): 2x8-bits ADC and dedicated firmware (Nançay radio astronomy station)
- incrementally tagged data sent to PC1 and 2 for first pol. PC3 and PC4 for the second polarization signal.
- acquisition PCs process only half of the data flow (960 MS/s)
- spectra calculated in real time by the GPUs or raw data waveforms are stored on internal RAID arrays.
- Data are transfered immediately after acquisition to two off-line computers and, later, to the users' servers.







Galaxy HIPAJ0626+2439 with WIBAR and with the standard NRT correlator