ASTRON

Netherlands Institute for Radio Astronomy

Apertif

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ASTRON is part of the Netherlands Organisation for Scientific Research (NWO)

Outline

- Instrument overview
- Past results
- Recent developments
- Plans for data flow, reduction and archive
- Science with Apertif

1. Instrument overview

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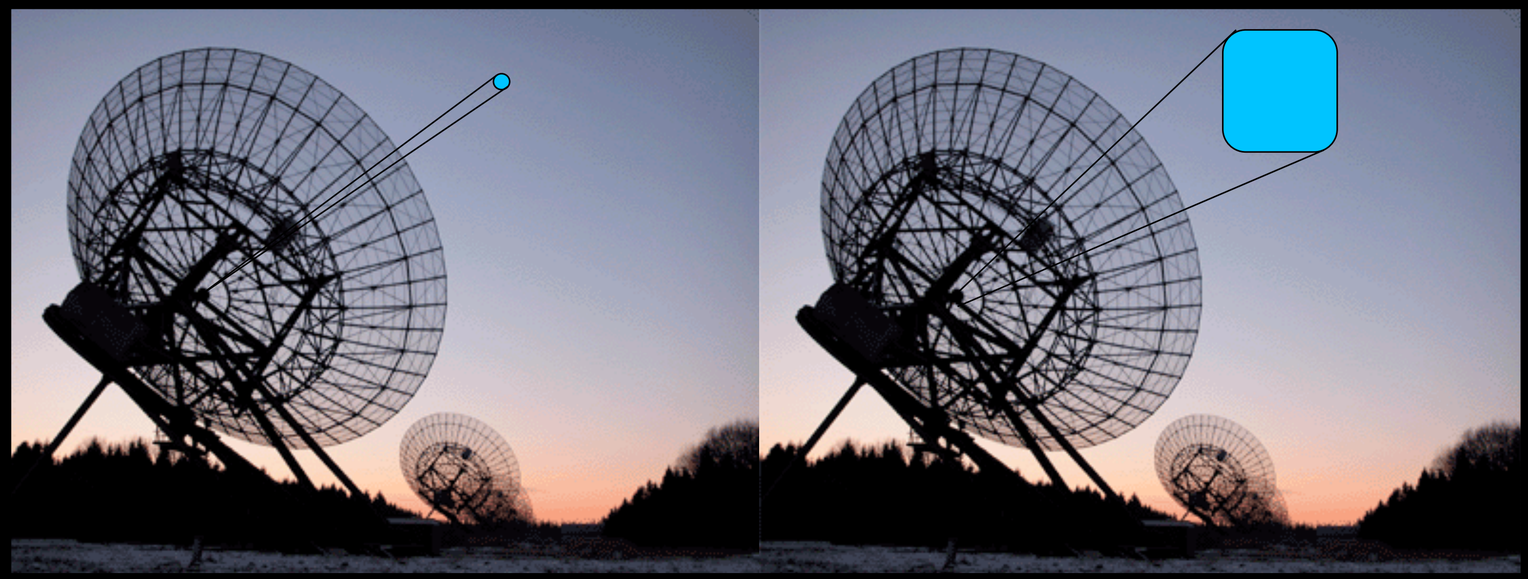
What is Apertif?

Apertif is an upgrade of the WSRT
- 12 (13) 25-m dishes on an east-west array
- equatorial mount
- baselines from 36 m to 2.7 km

Main point: replace single-pixel feeds with phased array feeds
- frequency range = 1-1.7 GHz (strong GSM band below 1 GHz)
- instantaneous BW =300 MHz (decision based on funding, but good for HI)
- expands FOV by a factor 30, increase survey speed by a factor 60 at full BW



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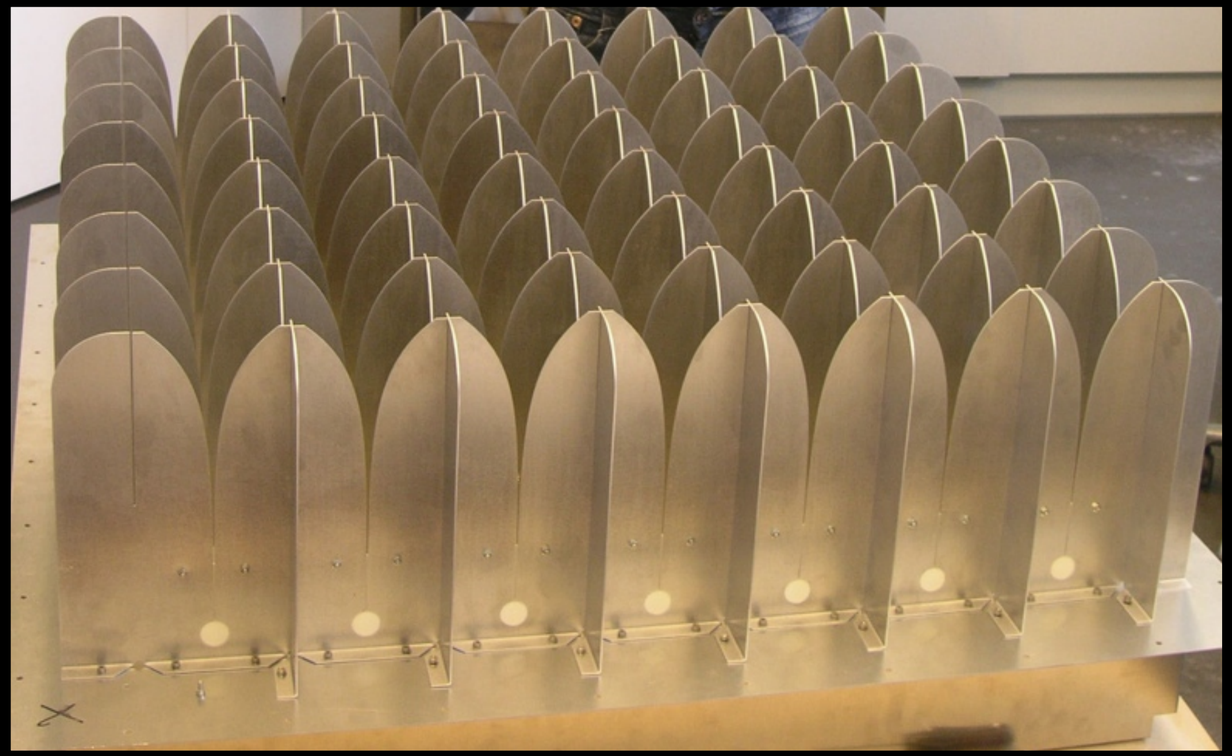
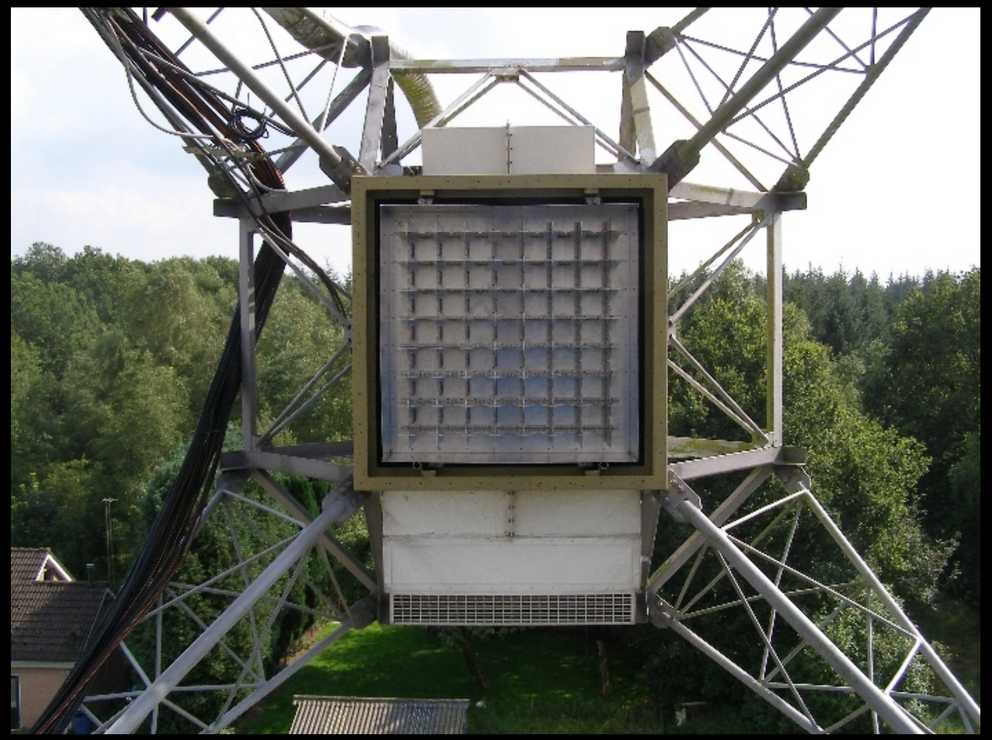
Vivaldi array

56 x 2 receivers



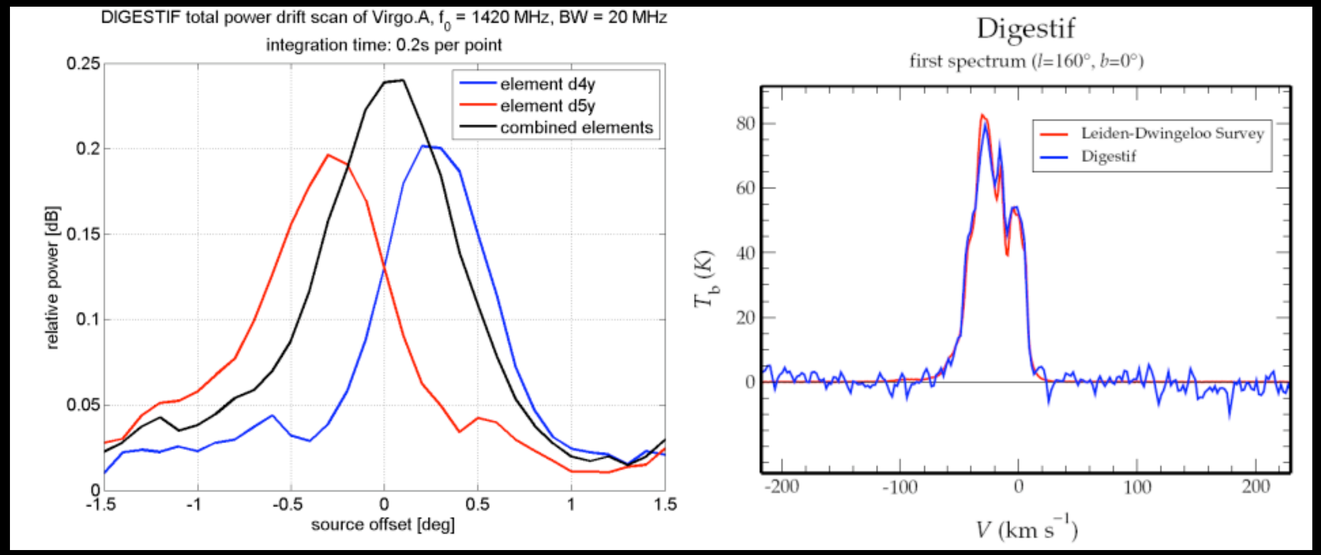


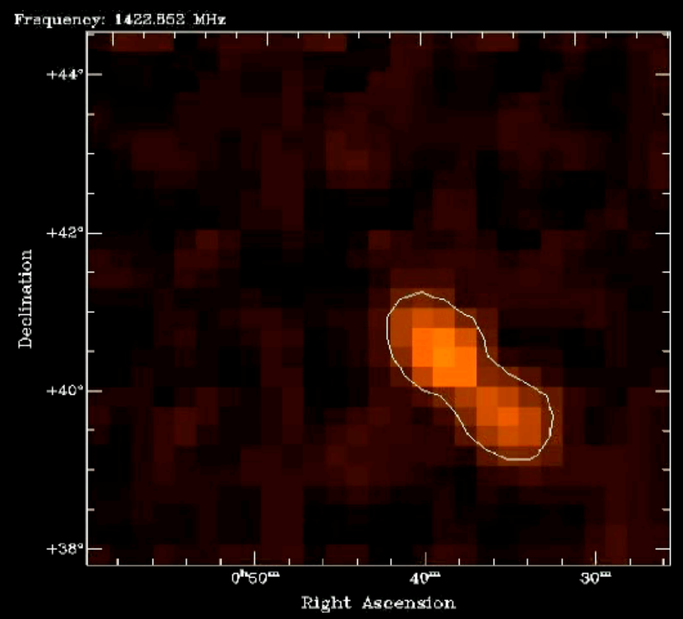
Survey speed

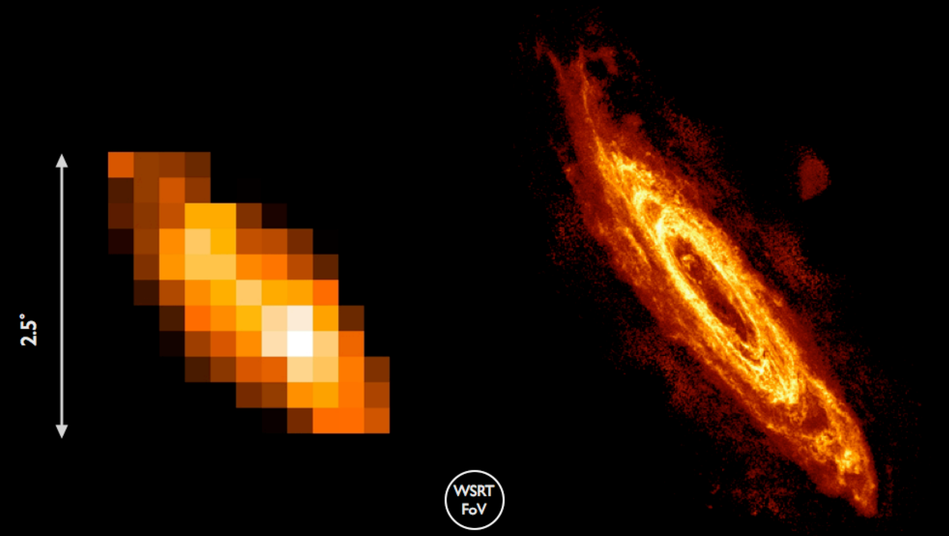
	EVLA	Apertif	MeerKat	ASKAP	WSRT
A/T	2	1	2	0.5	1
FoV	1	30	4	120	1
Bandwidth	3	2	2	2	1
Survey Speed Shallow	4	30	16	30	1
Survey Speed Deep	12	60	32	60	1

2. Past results (“despite” LOFAR)

Beginning 2008: Single dish







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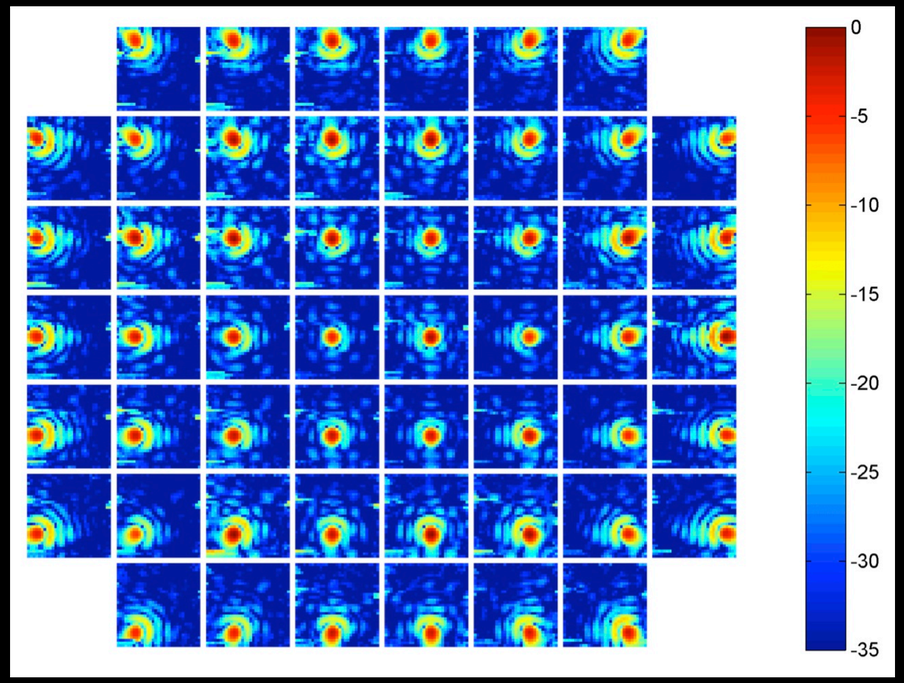
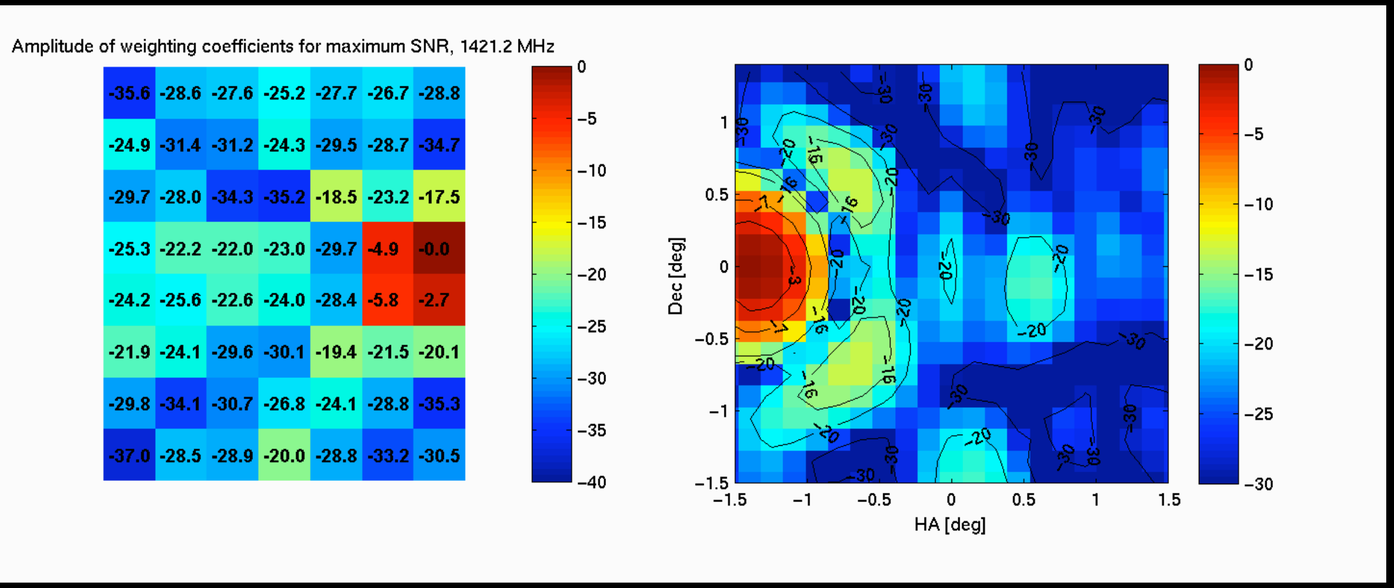
End 2008 - 2009: compound beams

Element beams are ugly...





... but compound beams are very well behaved

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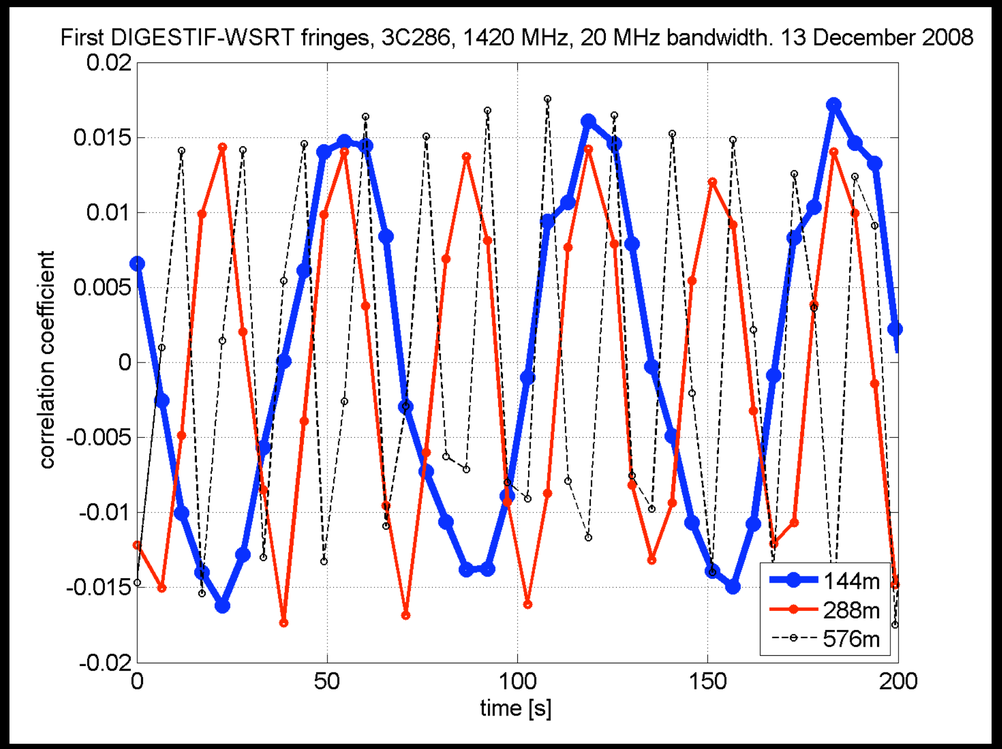
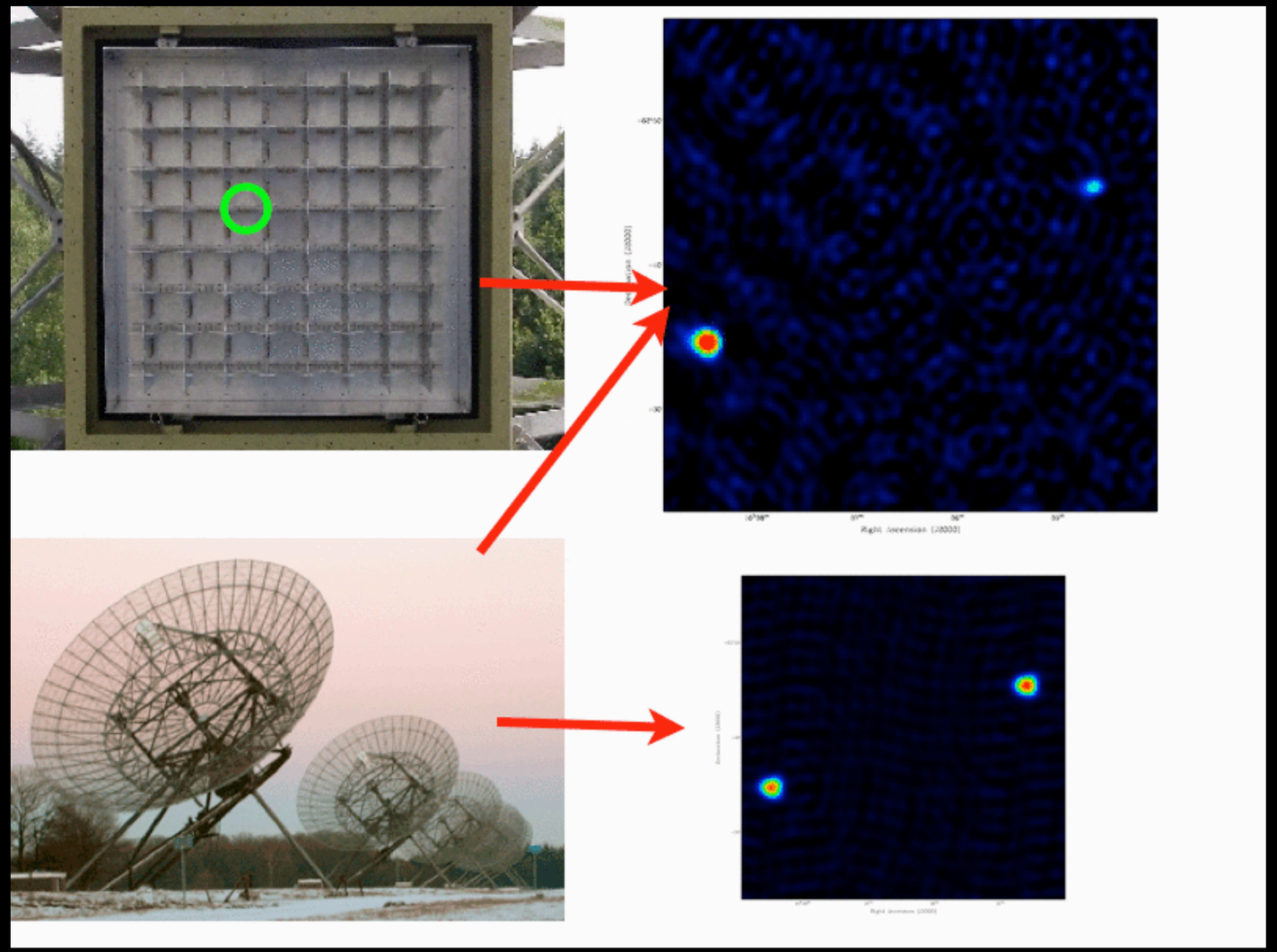
End 2008 - 2009: interferometry with single-element





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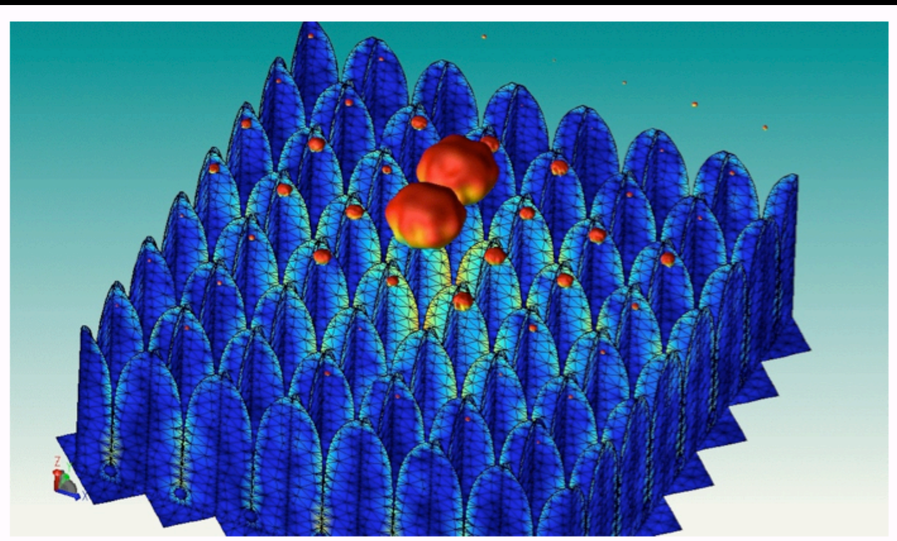
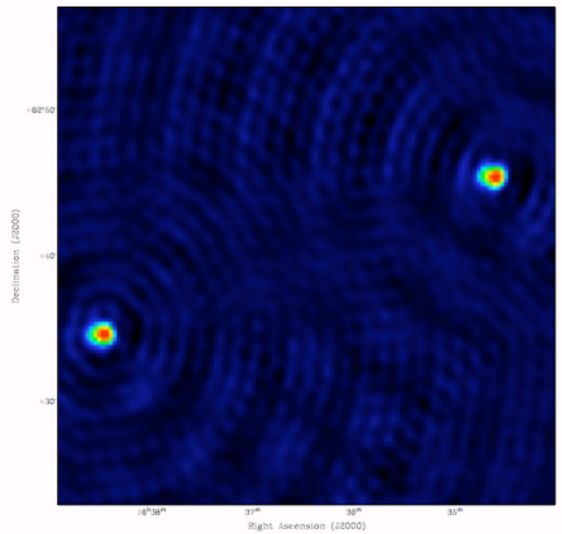
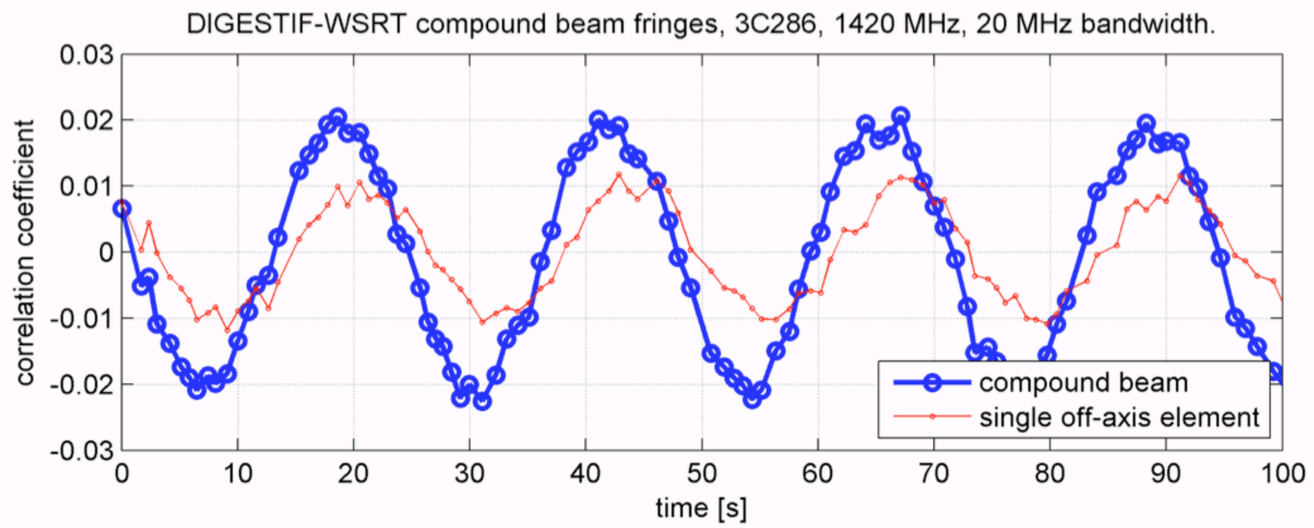
2009: interferometry with compound beam







offset?

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3. Recent developments

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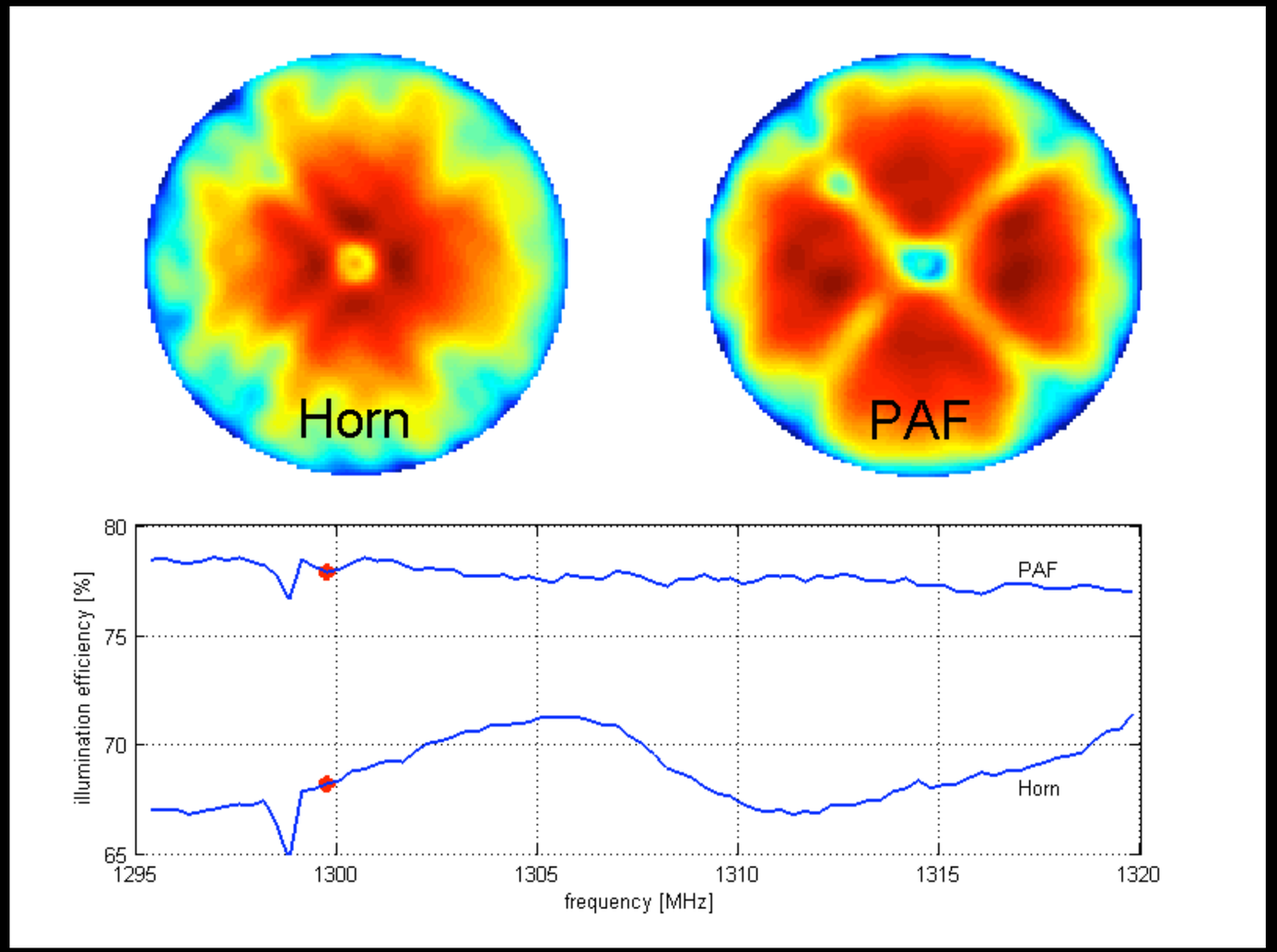
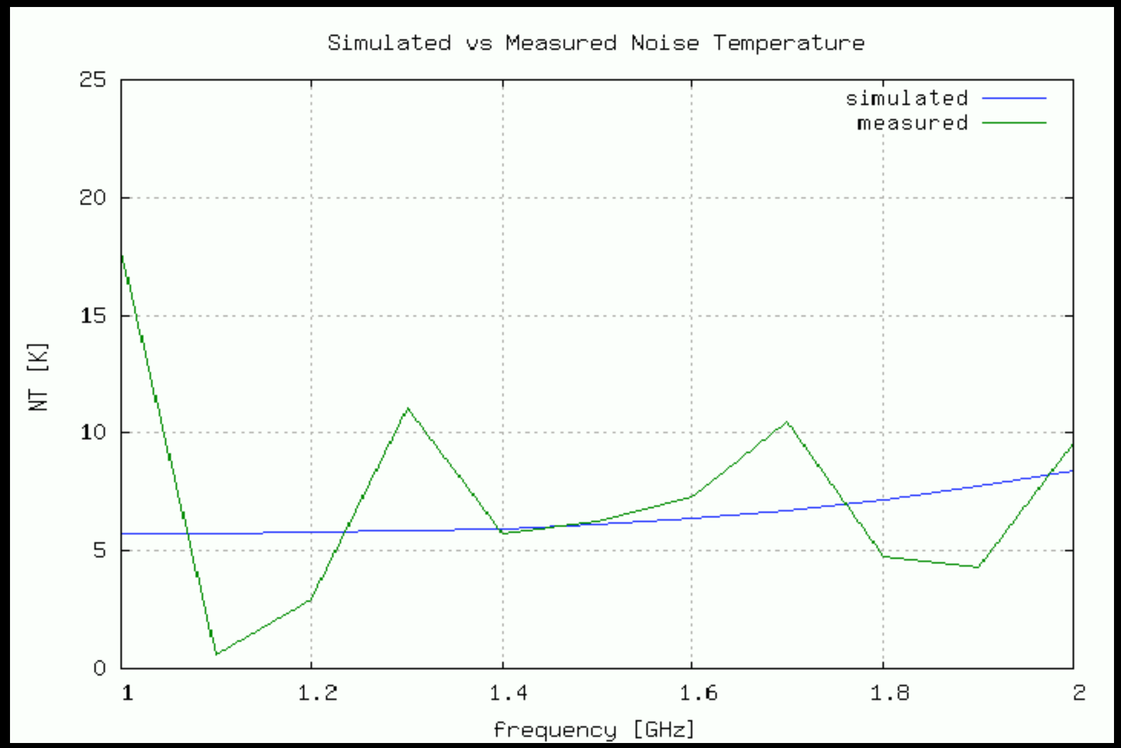
Standing waves no more

Standing waves are a problem common to all dishes
Can PAFs be the solution?



LNA below 10 K



(Not included in current T_{sys}~50 K estimate for Apertif)

And more on-going work...

- Digestif-3 installed:
  - rotated elements to reduce FOV elongation

- Real-time beam former (from LOFAR)

- Funding proposal being evaluated by NWO (correlator, archive, pipeline, people)

- Vivaldi arrays on GMRT (with LOFAR beam former); Effelsberg

- Vivaldi on BETA as part of PAFSKA:
  - test different receivers in same conditions (dish etc.)
  - PAF-PAF interferometry

4. Plans for data flow, reduction and archive

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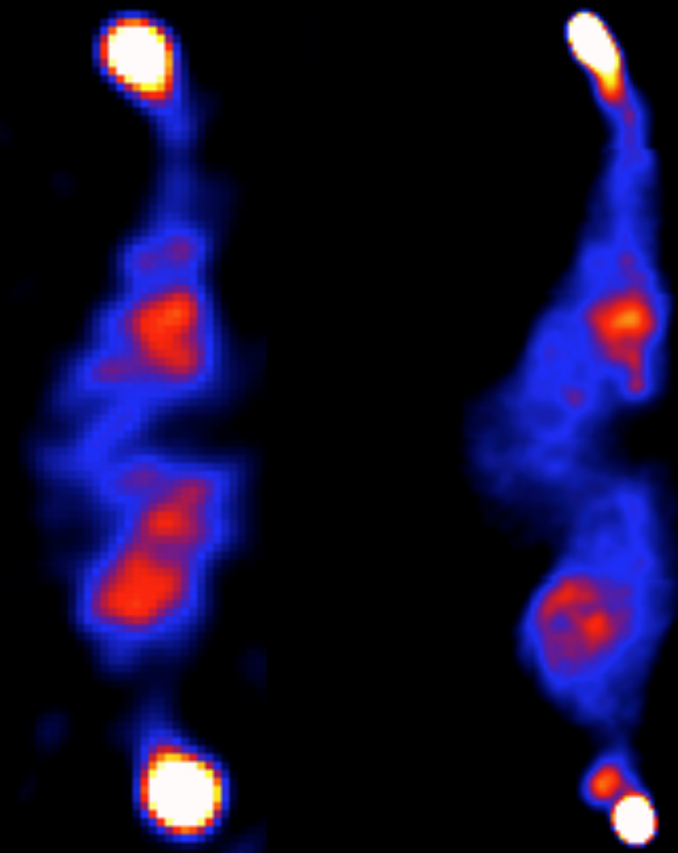
LOFAR for Apertif

LOFAR framework (it works and it's for free!)

- Real-time beam former from LOFAR
  - correlate with signal from all other 13 dishes
  - possibility of full 12-h synthesis
  Ideal to test compound beam stability and understand calibration needs

- Adaptation of existing LOFAR calibration software to WSRT data has started

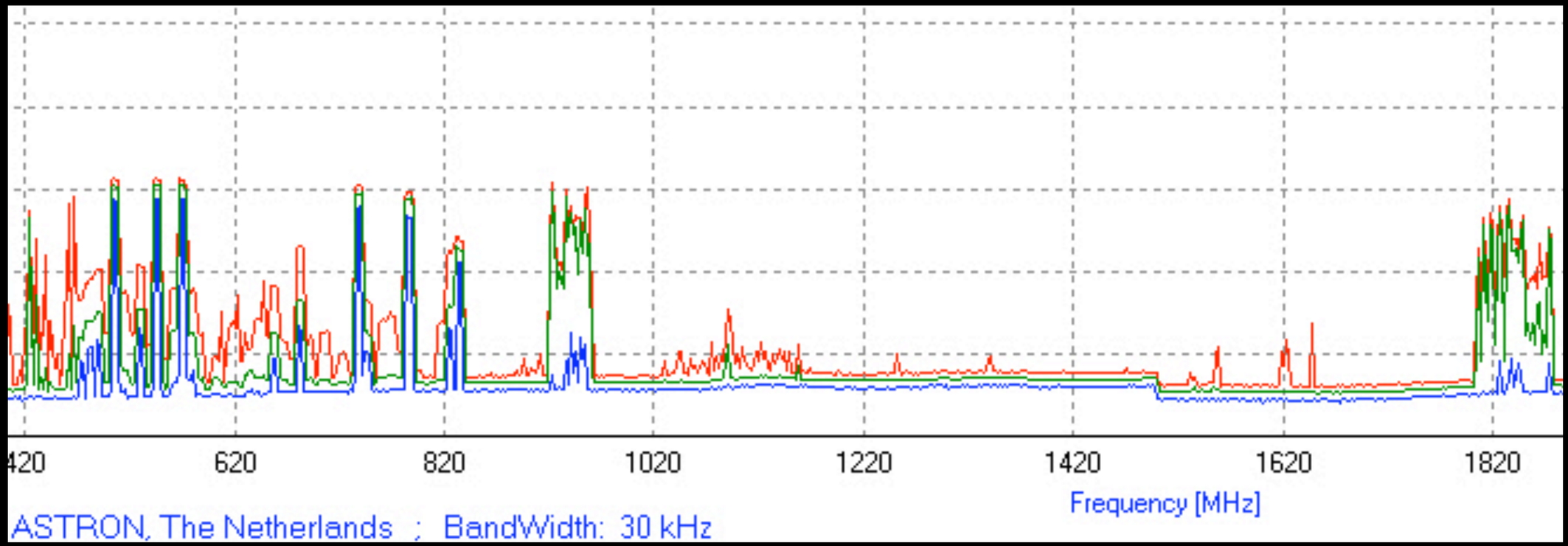
- LOFAR archive usage starting



LOFAR 173 MHz
(van Weeren)

VLA 1.5 GHz
(Leahy & Perley 1991)

Good RFI situation - LOFAR HBA (110-250 MHz) loses only ~5% of the data



5. HI Science with Apertif

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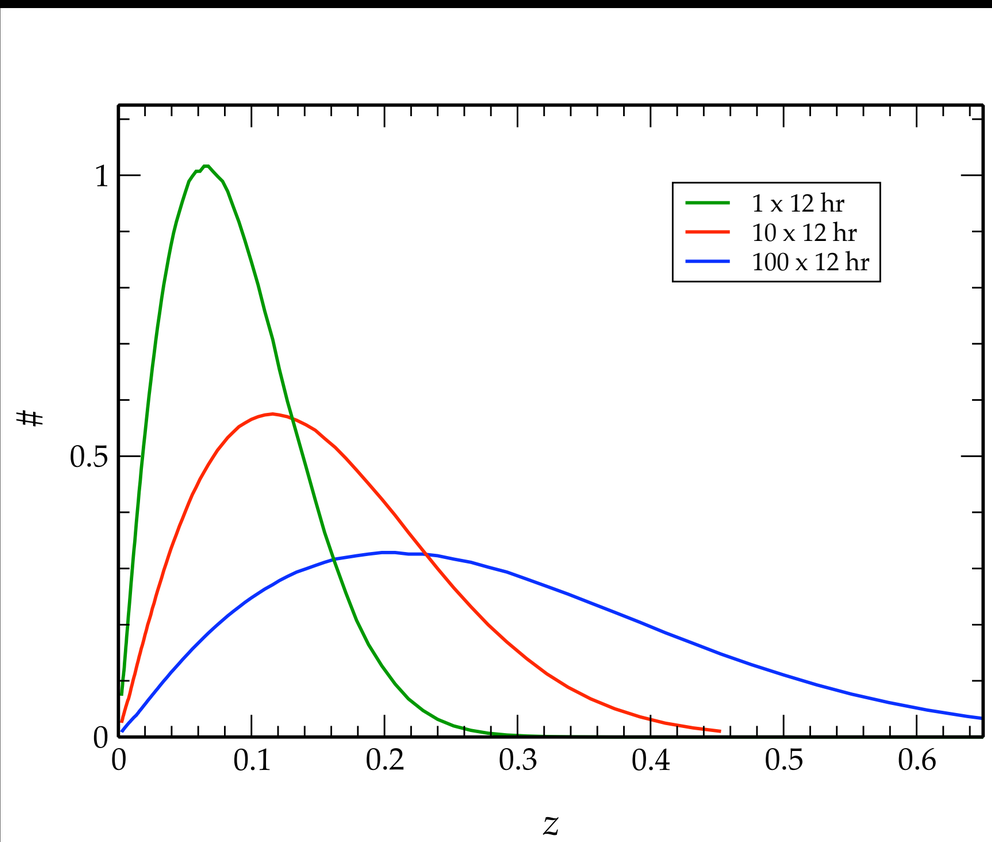
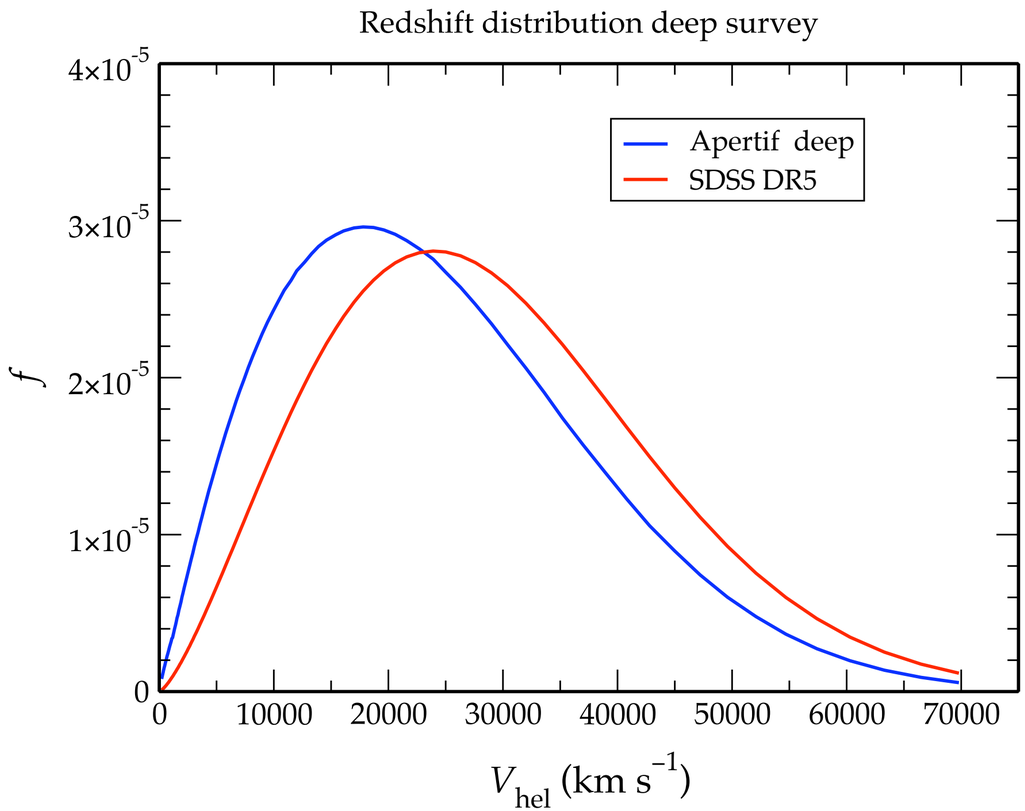
Apertif HI surveys

- shallow all sky matching WALLABY (a few hours per pointing)
- deep to z~0.25 (10x12h over 1000 sq deg)
- ultra-deep to z~0.4 ?

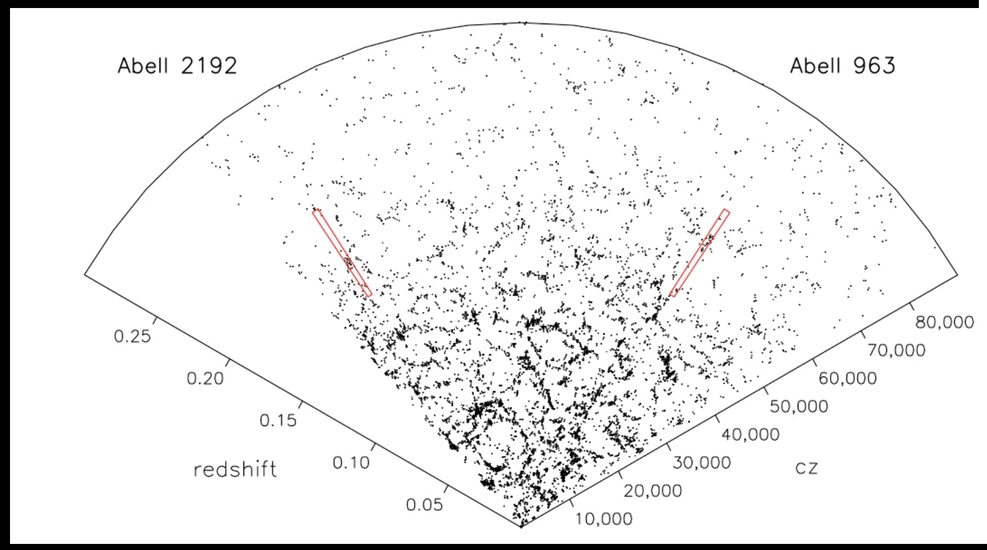


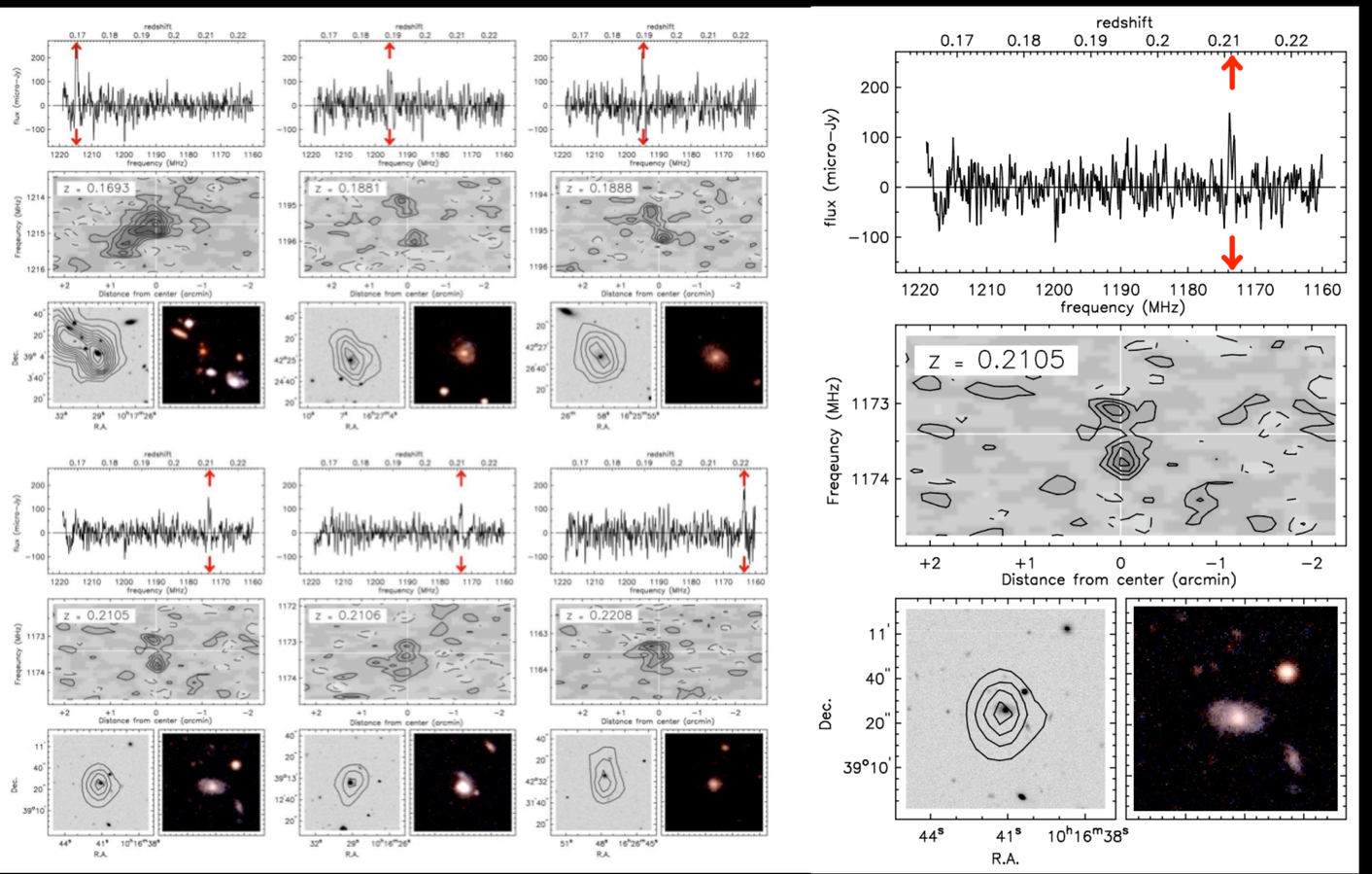


HI at z=0.2 with the WSRT

20 x 12 hr at z = 0.2 (Verheijen et al)
Several dozen detections in single WSRT field
Apertif is 100 times more efficient

Now 100x12 hr on a single field done for this project with > 100 detections





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Conclusions

- Apertif will expand the FOV of the WSRT by a factor 30 at 1-1.7 GHz
- Compound beam properties studied in detail
- First interferometry using Digestif with WSRT MFFEs
- No standing waves
- Digestif on GMRT, Effelsberg, BETA
- Real-time beam forming and full synthesis with whole array coming soon
- LOFAR architecture for calibration, archive