

## Mid-frequency aperture arrays Current and future developments

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# Outline

- Intro and elements
- Current status of MFAA
- Path to SKA
- Science with MFAA: after lunch

# Why MFAA

- Steve Rawlings' Billion Galaxy Survey
- Survey speed SKA-2:  $10^{10}$  deg<sup>2</sup> m<sup>2</sup>/K<sup>4</sup>
- Large field-of-view
  
- Intrinsic broad-band
- Flexibility
- Multi-beam
- Semi-instant response

# Aperture arrays

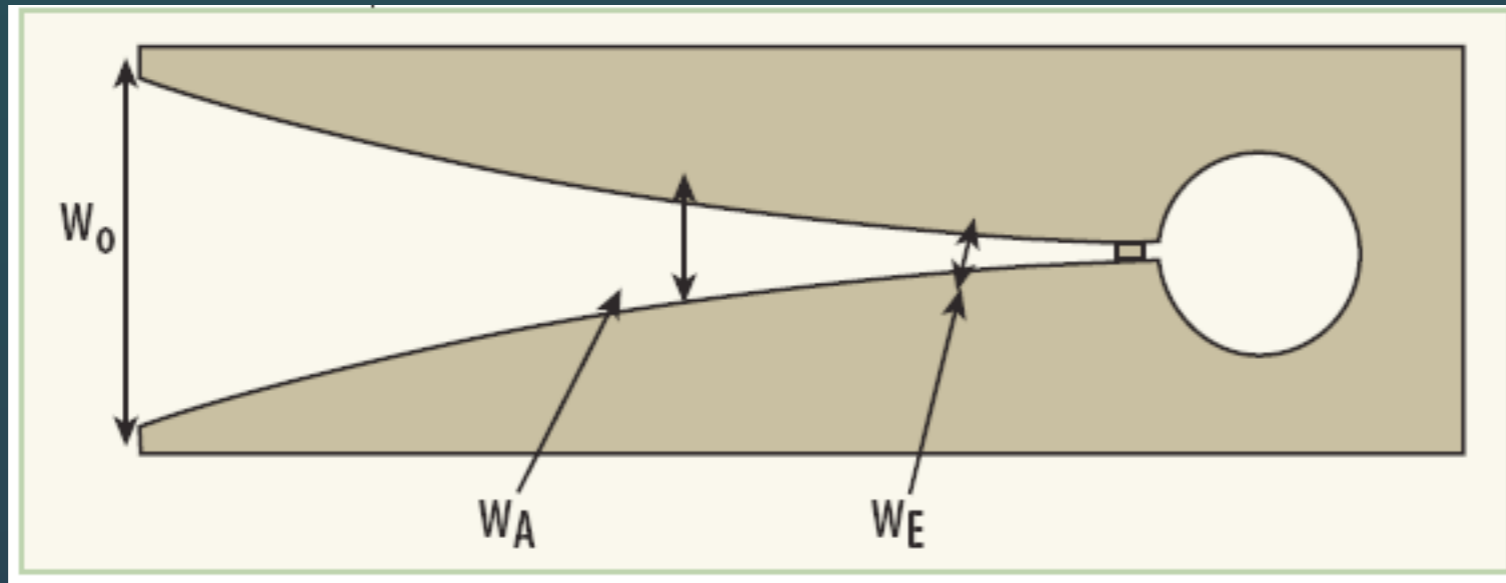


# Antenna elements



# Antenna elements

Shortest wavelength

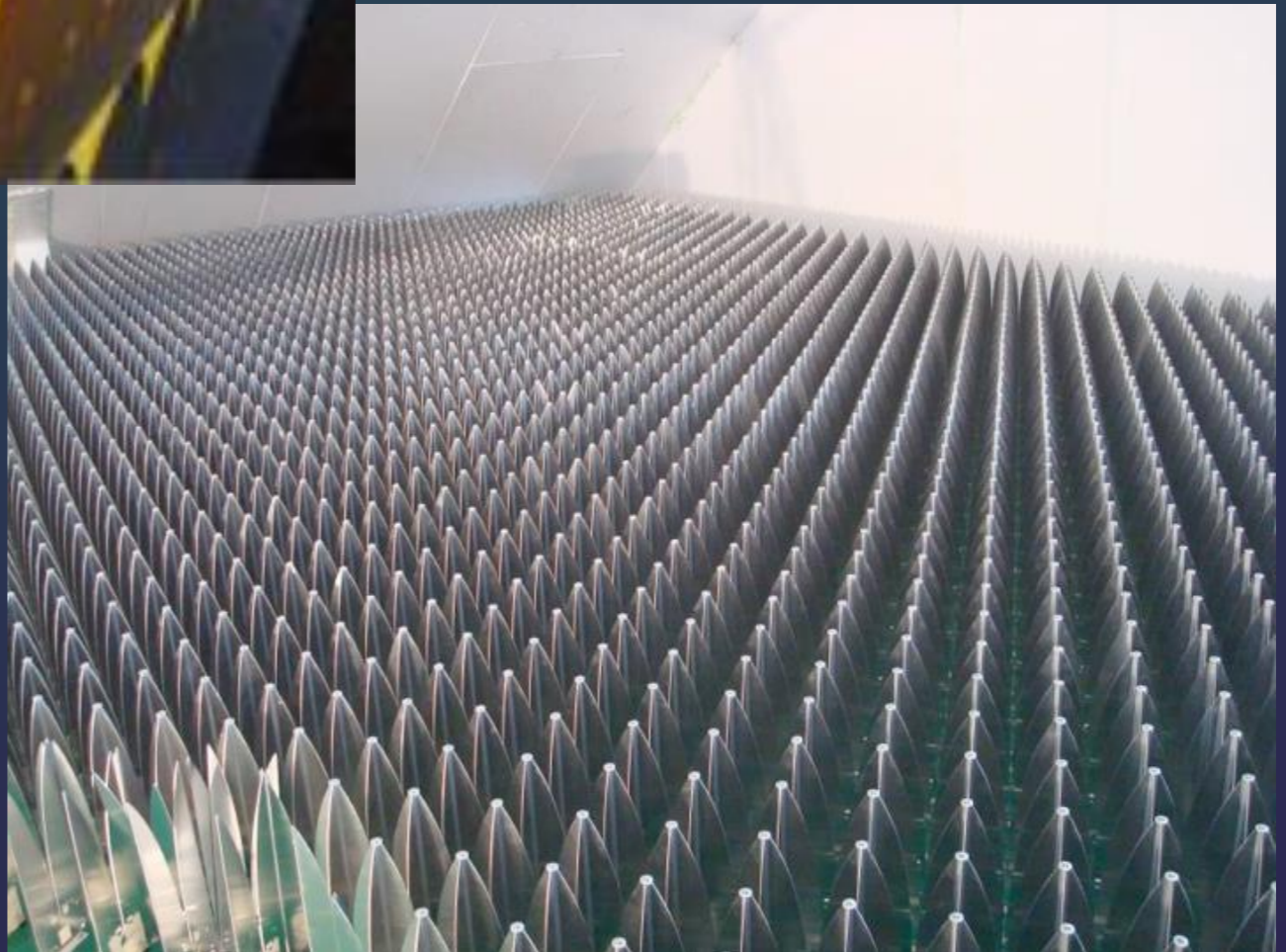


Longest wavelength

Wideband  
Large field of view



# Current MFAA status





# EMBRACE

- 400-1500MHz
- 100 (64) m<sup>2</sup>
- $T_{\text{sys}} \sim 100\text{K}$
- TWO fields of view
- Single pol

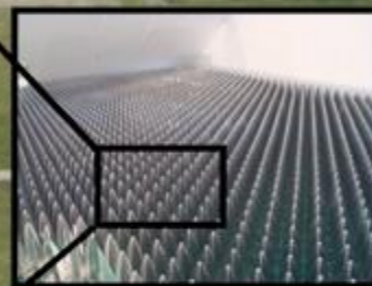
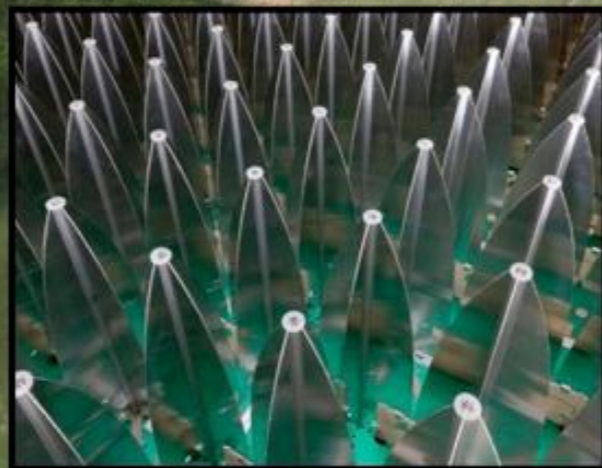
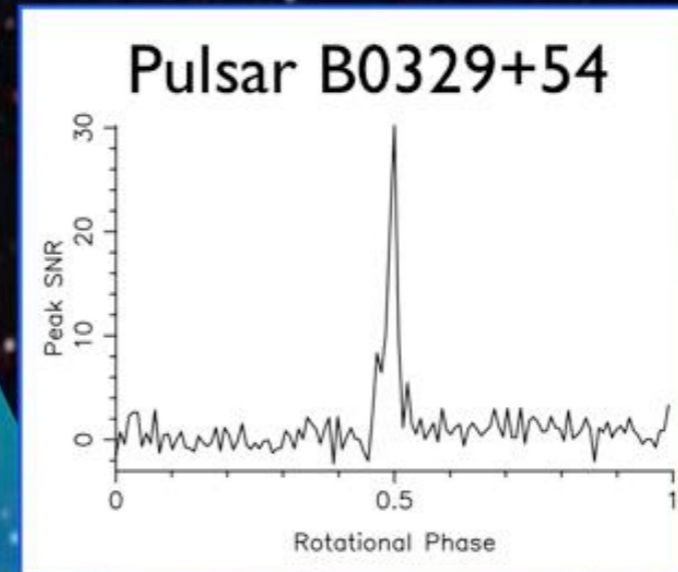
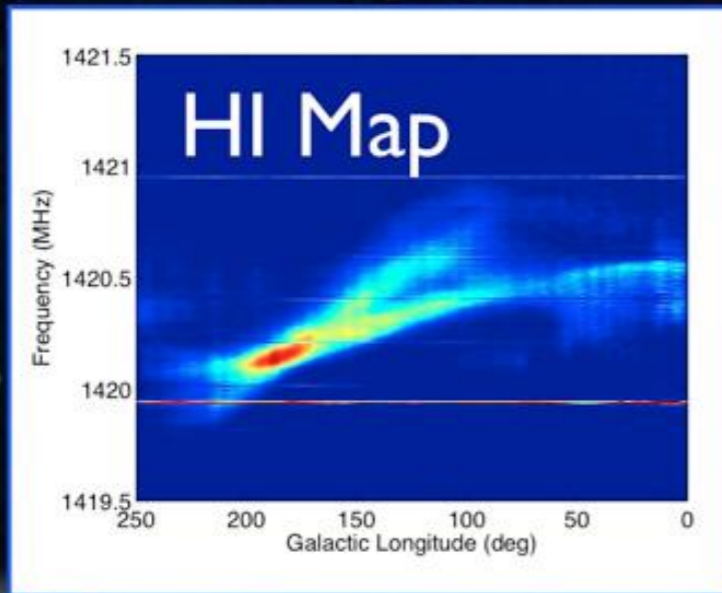
WSRT station (Netherlands)



Nançay station (France)

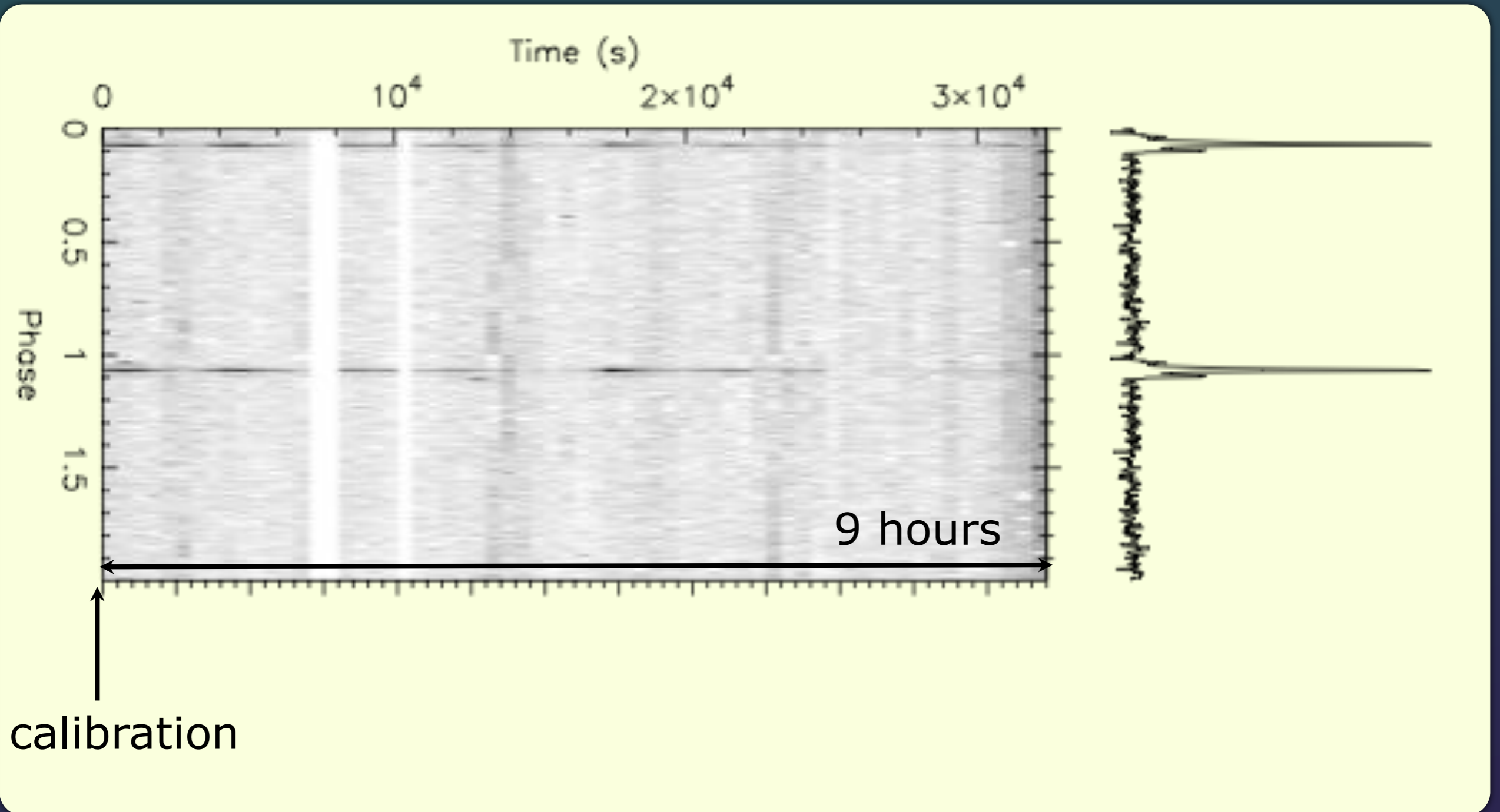


# Multi-beam experiment

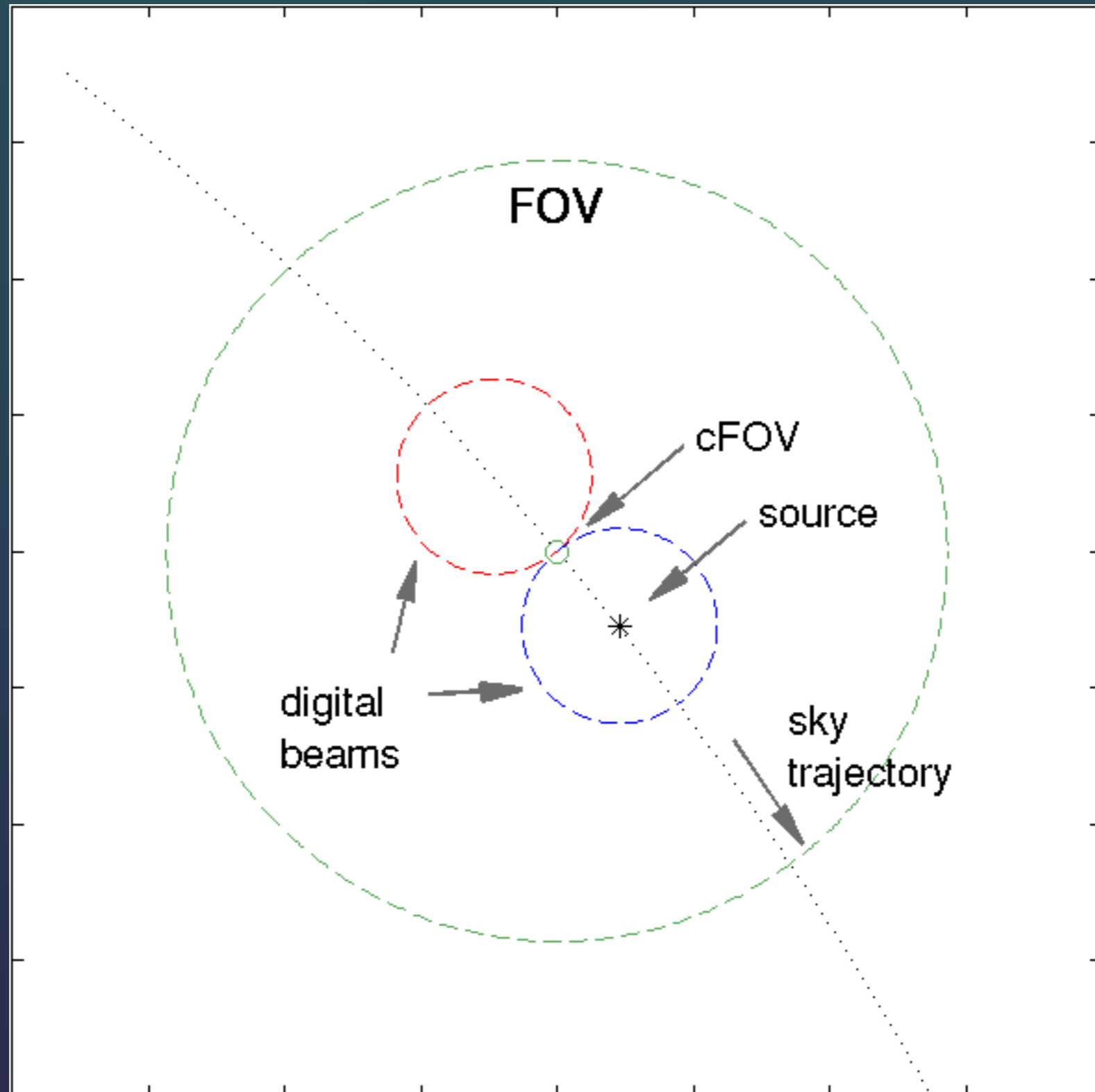


EMBRACE Dual Beam

# Technical issues

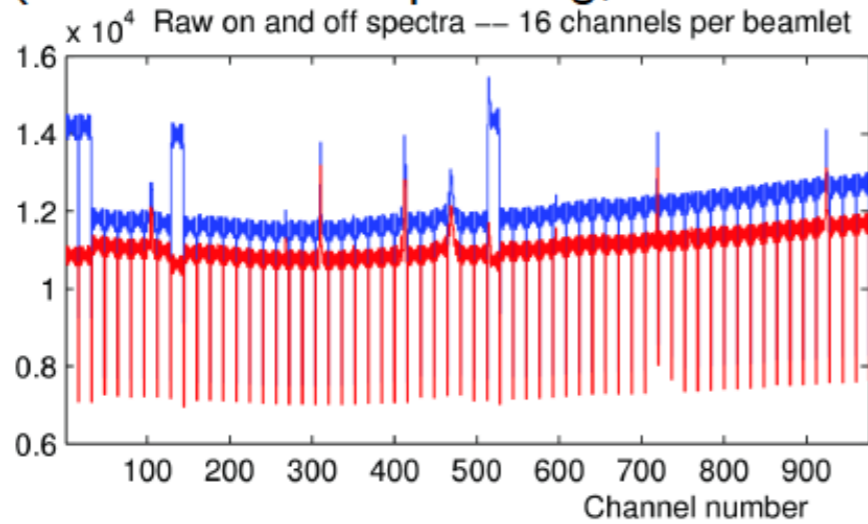


# Extragalactic



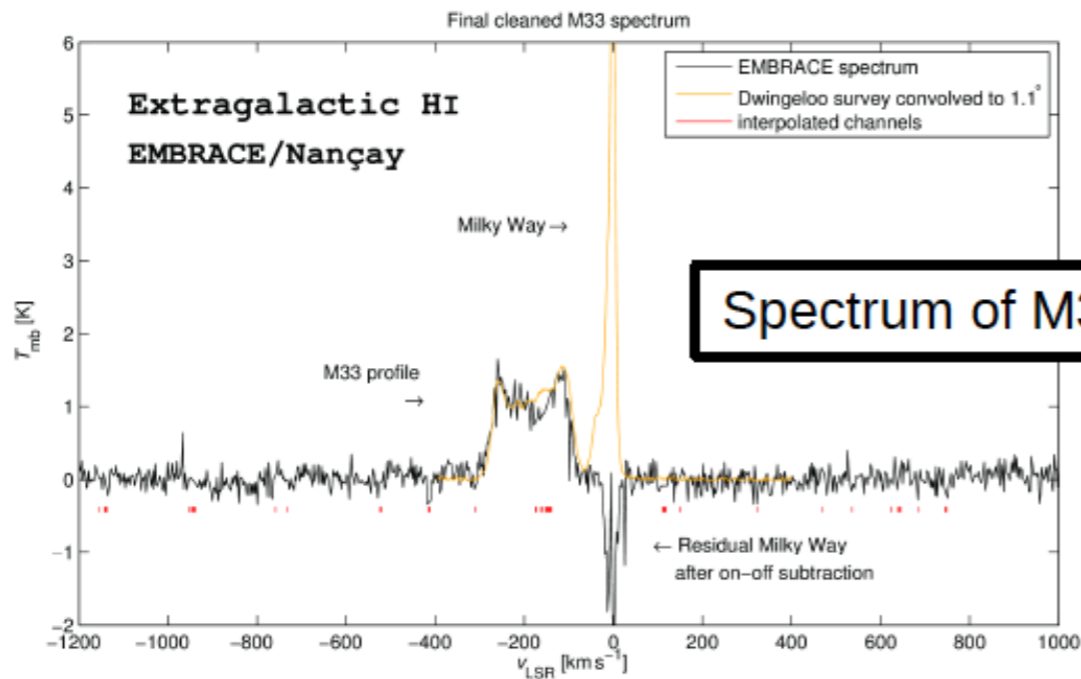
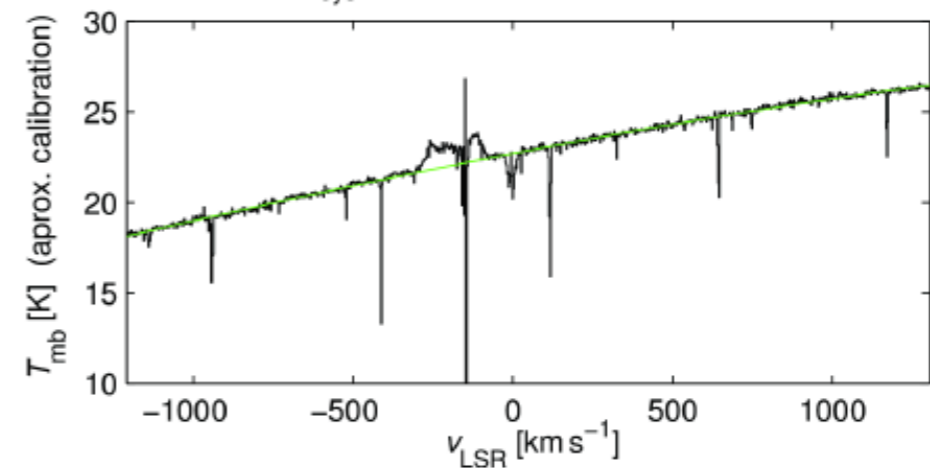
# Extragalactic

OFF timeline shifted to align with ON  
(i.e. same Az-El pointing, earlier time)



$$(ON - OFF)/OFF$$

$(T_{\text{sys}}/\eta) \times (\text{on-off})/\text{off}$  with baseline fit



Spectrum of M33

Baseline fit and interpolate past RFI channels

EMBRACE@Nançay

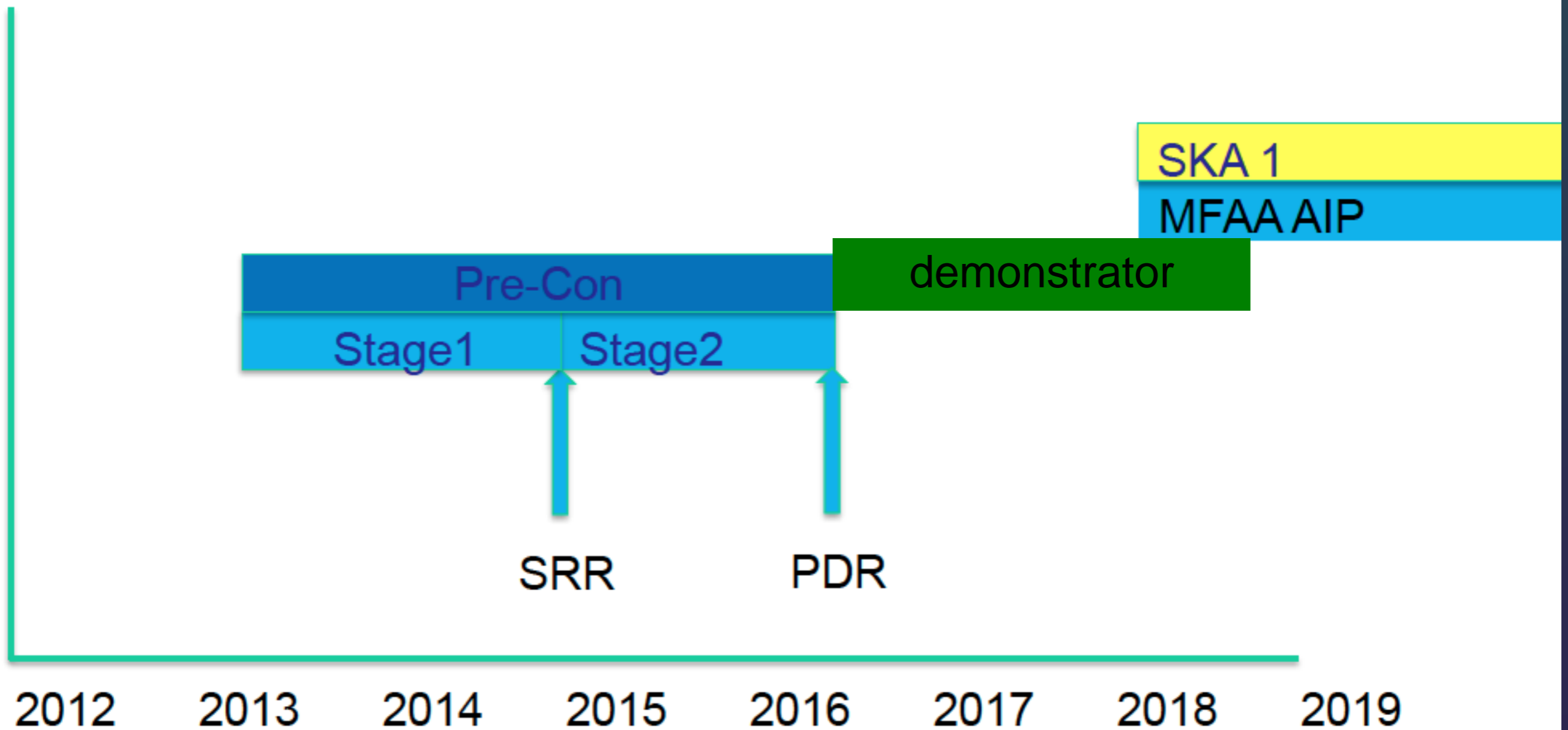
1 done, 999999999 to go...

# Path to SKA

# Open issues for MFAA

- System stability: beam, spectral, time
- Calibratability
- Interferometric imaging
- Polarization
- Wide bandwidth
- Full digital beam-forming
- Data-flow & post-processing

# Design path to SKA





# Next step: AERA<sup>3</sup>

- ~2000m<sup>2</sup>
- $T_{\text{sys}} < 50\text{K}$
- interferometry
- full polarization
- large bandwidth
- 300-1500 MHz
- 2 x 175deg<sup>2</sup>



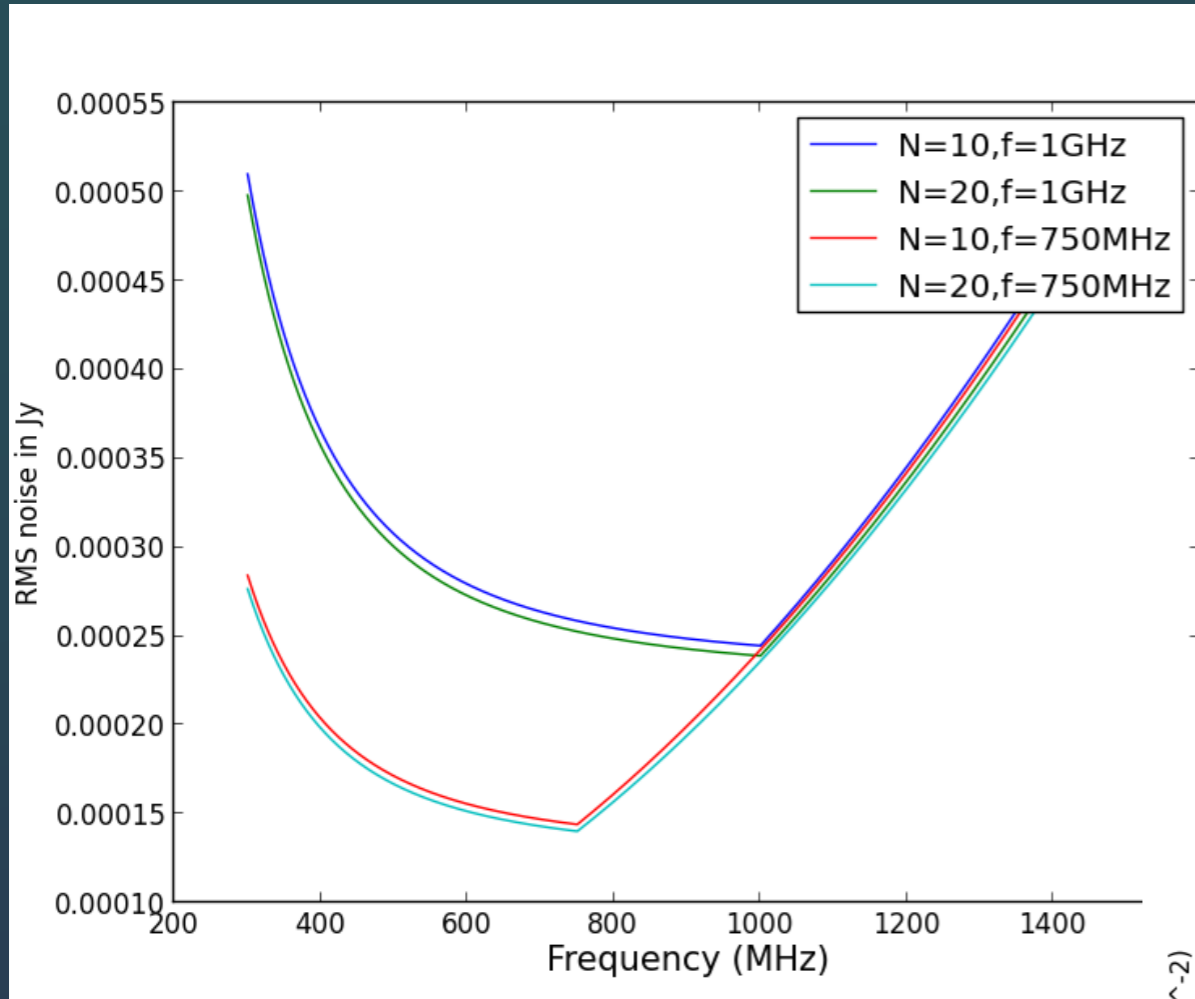
Derek McKay-Bukowski

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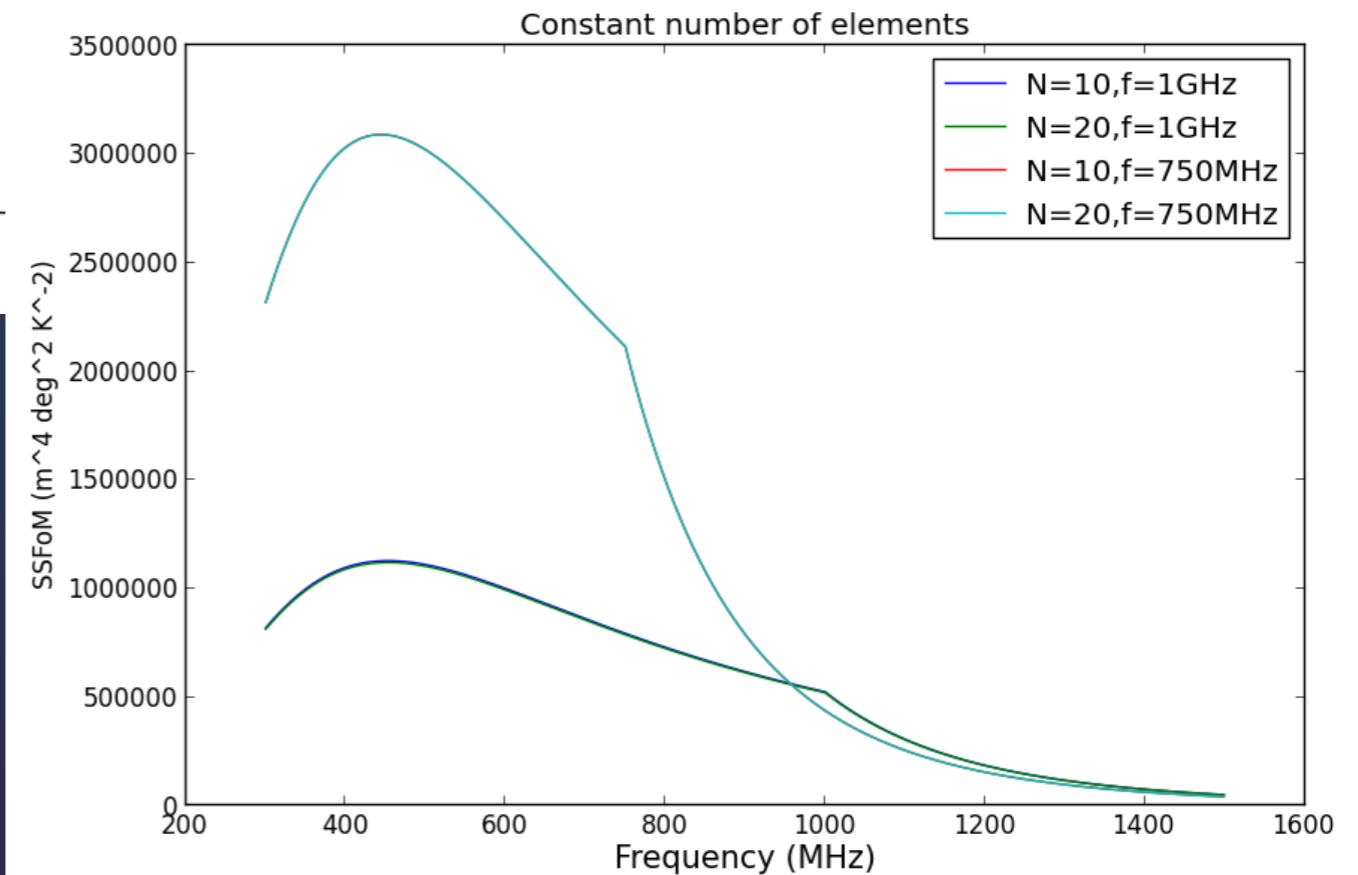
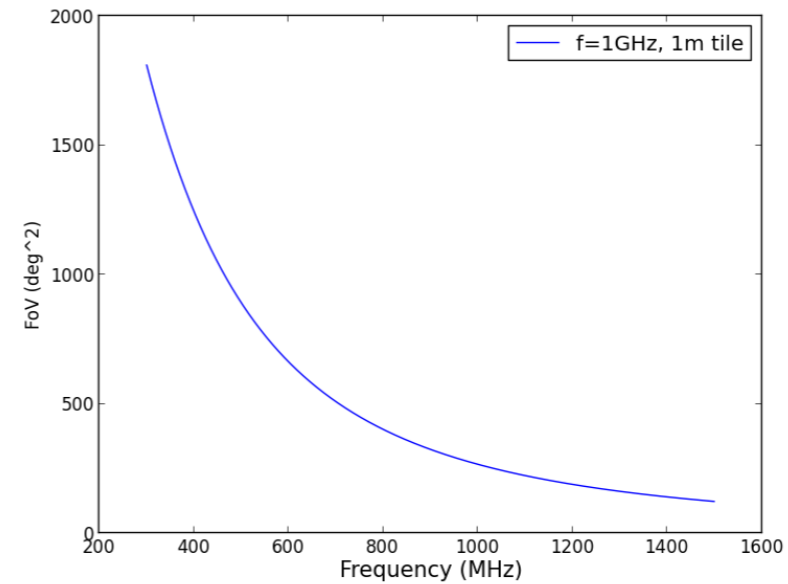
# Performance 1GHz

	<b>AERA<sup>3</sup></b>	<b>MeerKAT</b>	<b>ASKAP36</b>	<b>APERTIF</b>	<b>VLA</b>	<b>SKA-survey</b>
$A_{\text{eff}}$ (m <sup>2</sup> )	<b>2000</b>	9300	4072	5400	13000	14674
$T_{\text{sys}}$ (K)	<b>50</b>	30	50	50	80	50
FoV (deg <sup>2</sup> )	<b>175</b>	1	30	8	0.5	18
Freq (GHz)	<b>0.3-1.5</b>	0.9-1.8	0.7-1.8	0.9-1.5	1.0-50	0.7-1.6
BW (MHz)	<b>300</b>	900	300	200	(200)	500
A/T (m <sup>2</sup> /K)	<b>40</b>	220	81	108	162	293
SSFoMx10 <sup>4</sup>	<b>28</b>	4.8	19.8	9.3	1.3	155

# Performance

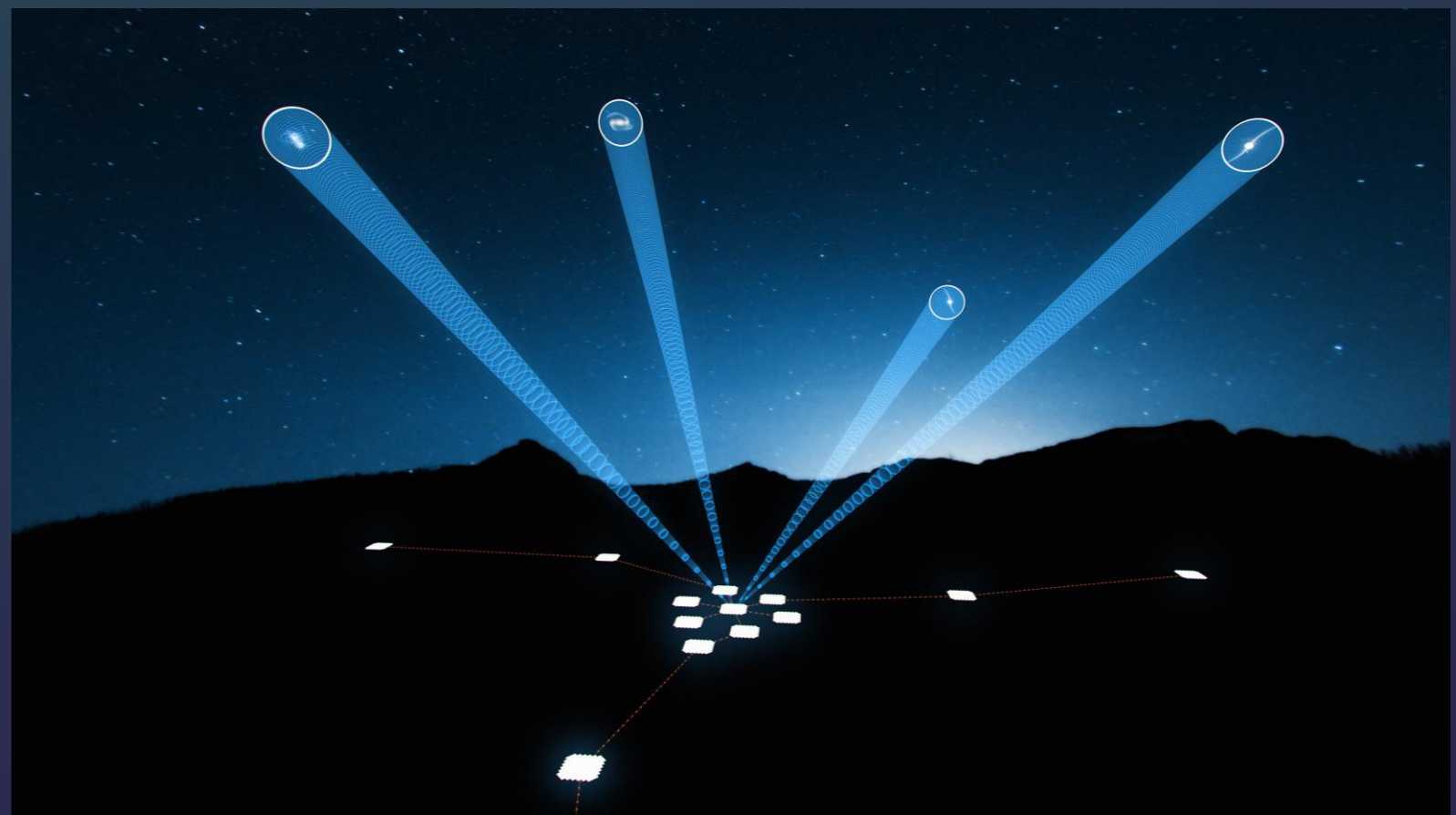


10MHz, 1h



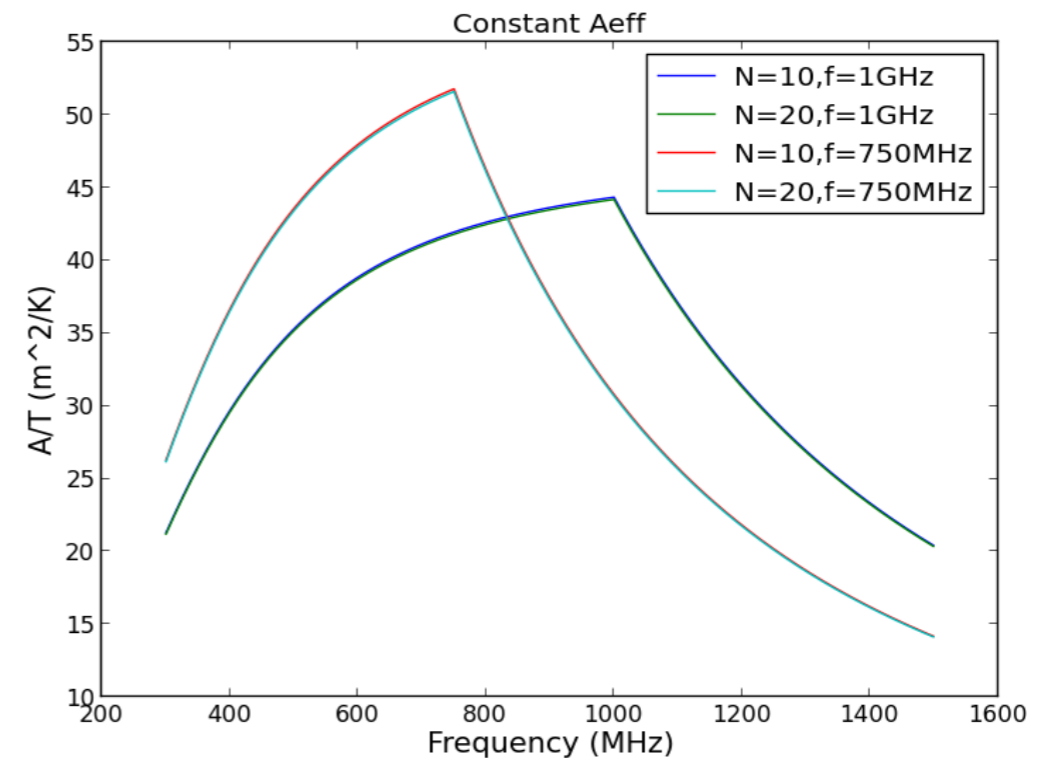
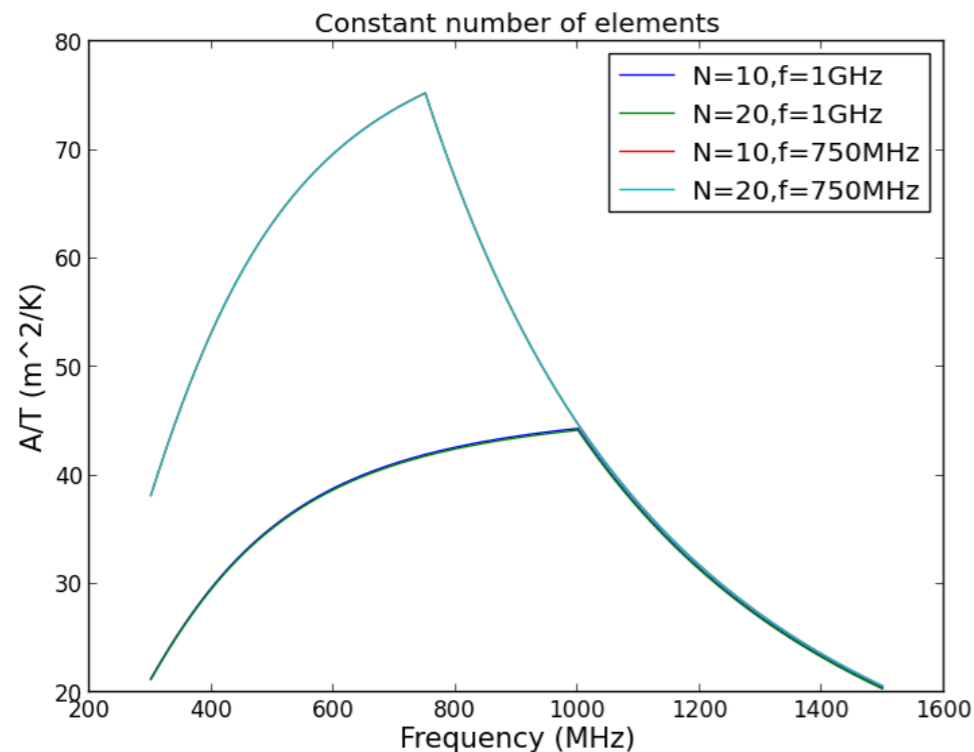
# Performance AERA<sup>3</sup>

- One all-sky survey per day to  $\sim 0.3\text{mJy}$
- Survey speed ready for SKA
- Multi tasking



# Trade-offs

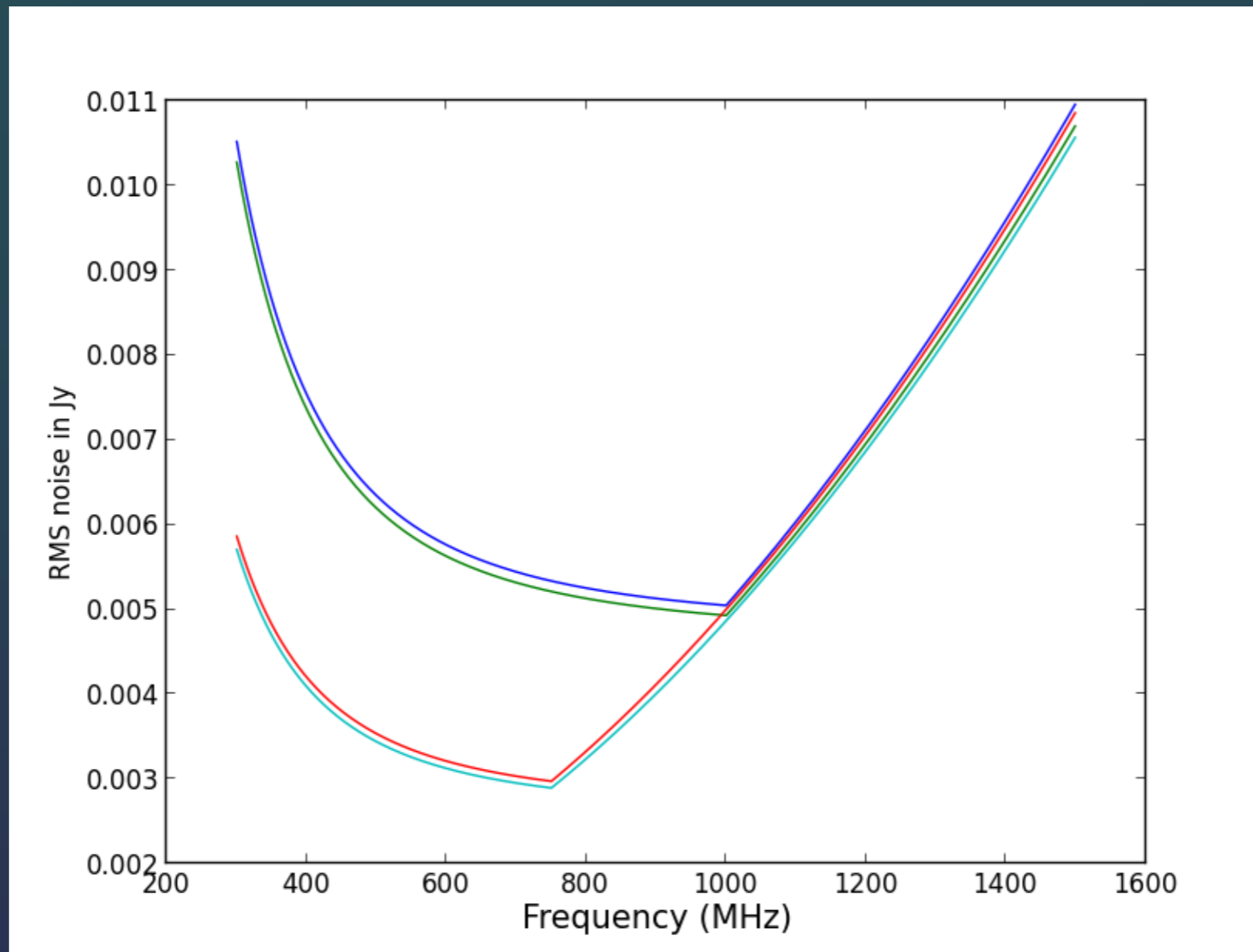
- Bandwidth vs observing time
- Field-of-view vs observing time
- Beam-former vs correlator
- Critical frequency vs sensitivity





Thanks!

# Performance HI



1h, 5km/s