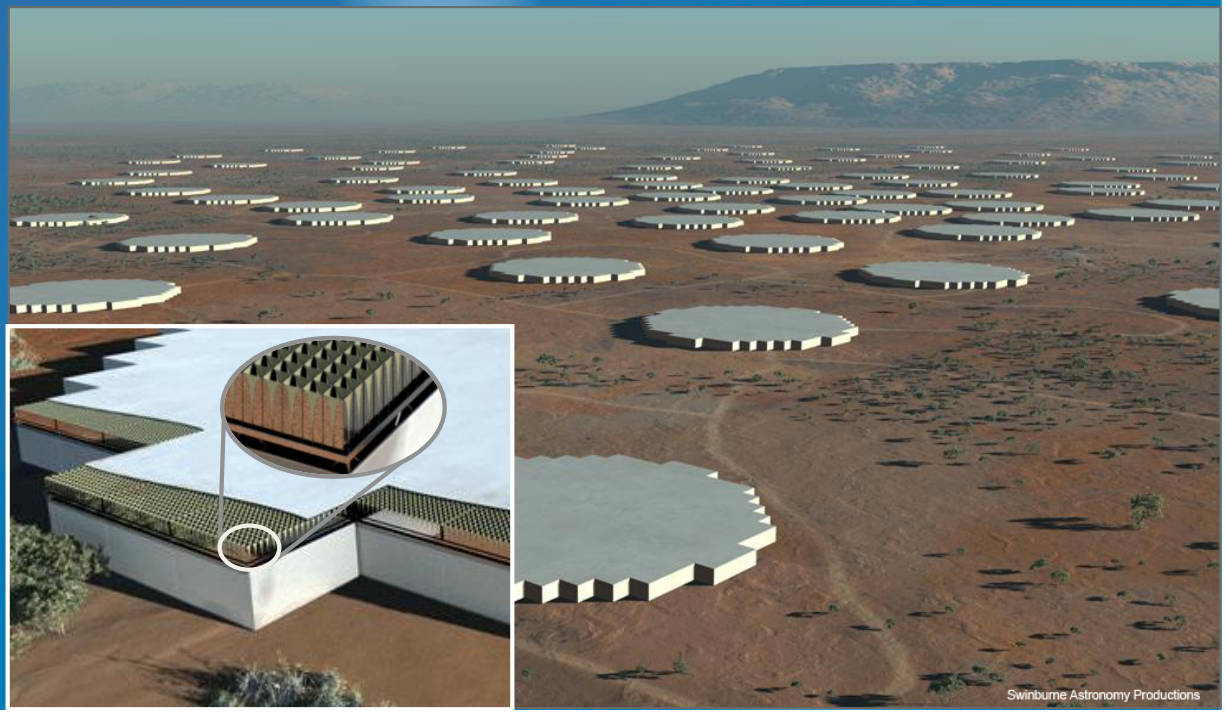
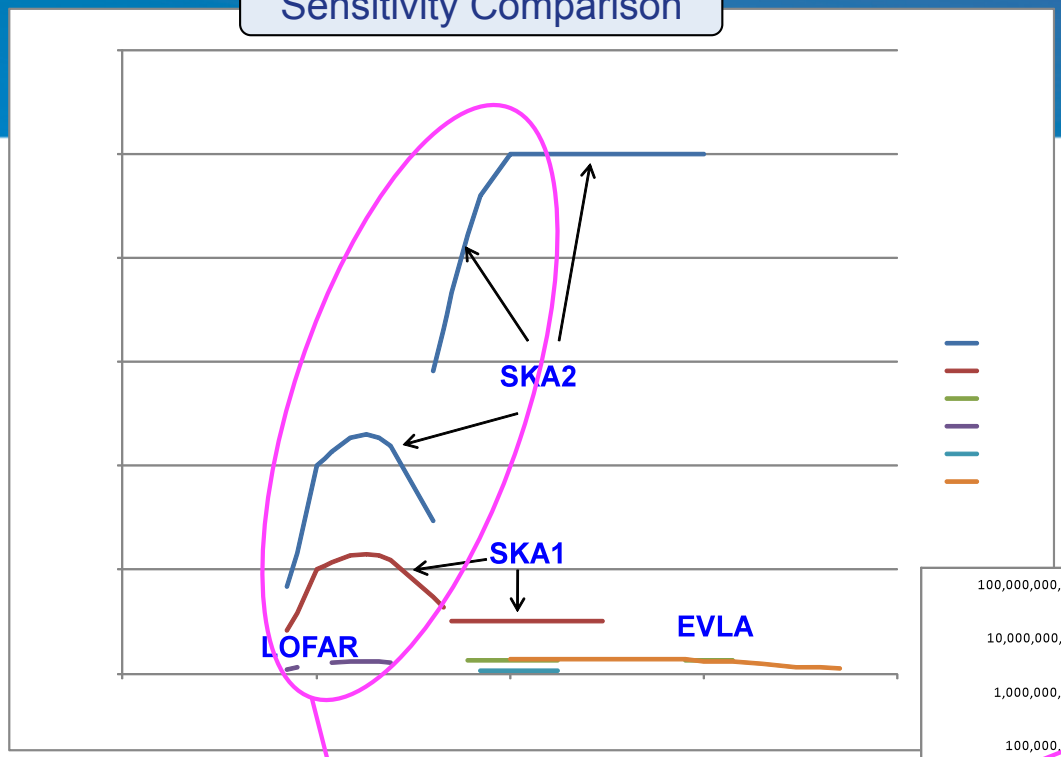
SKA Aperture Arrays

Jan Geralt Bij de Vaate ASTRON
Ilse van Bemmel

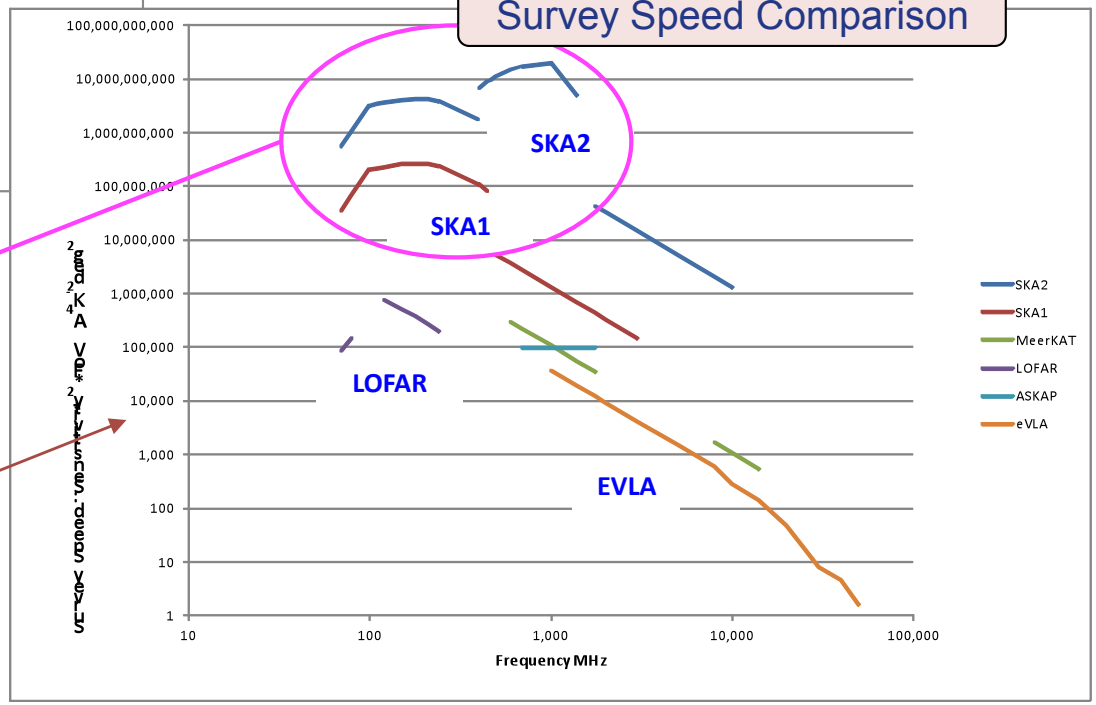


Sensitivity Comparison



SKA_1 & SKA_2 will have much higher sensitivity & survey speed than existing instruments

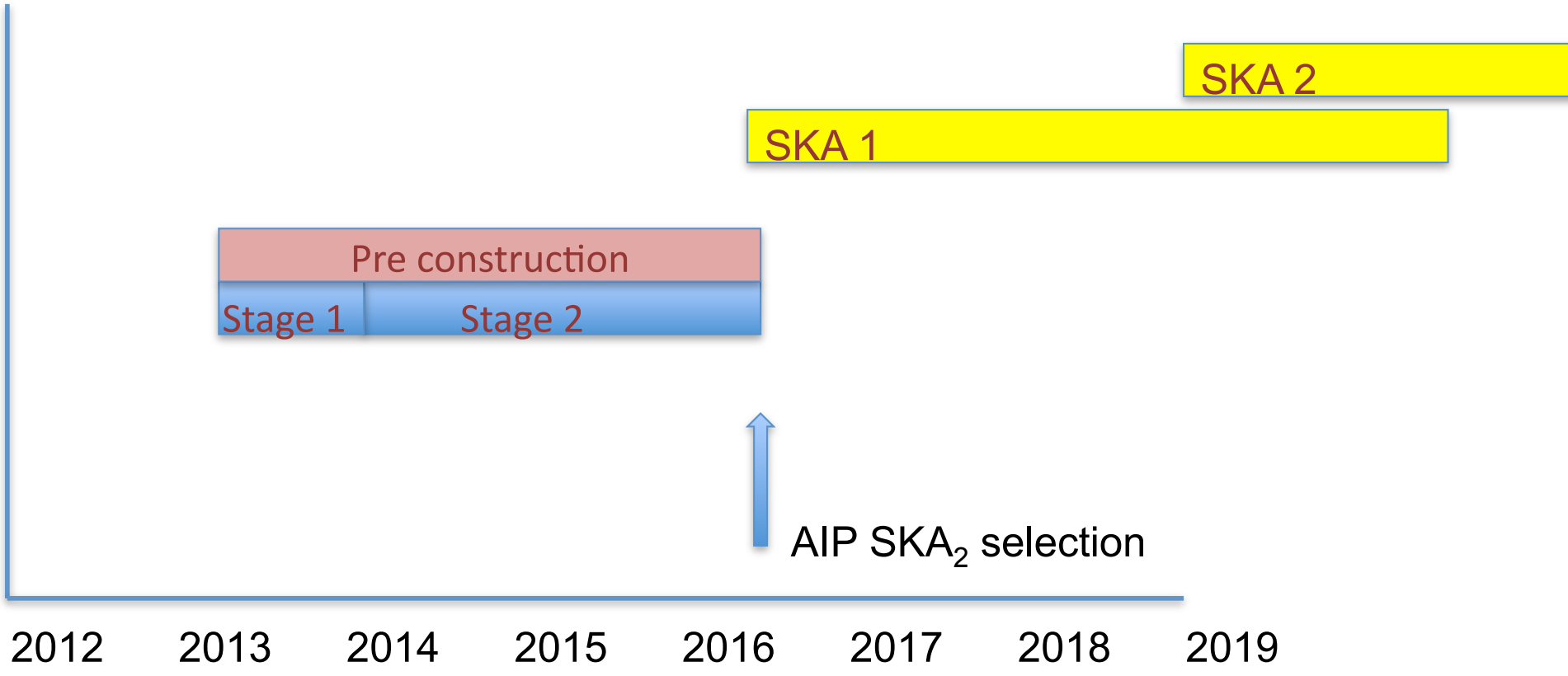
Survey Speed Comparison

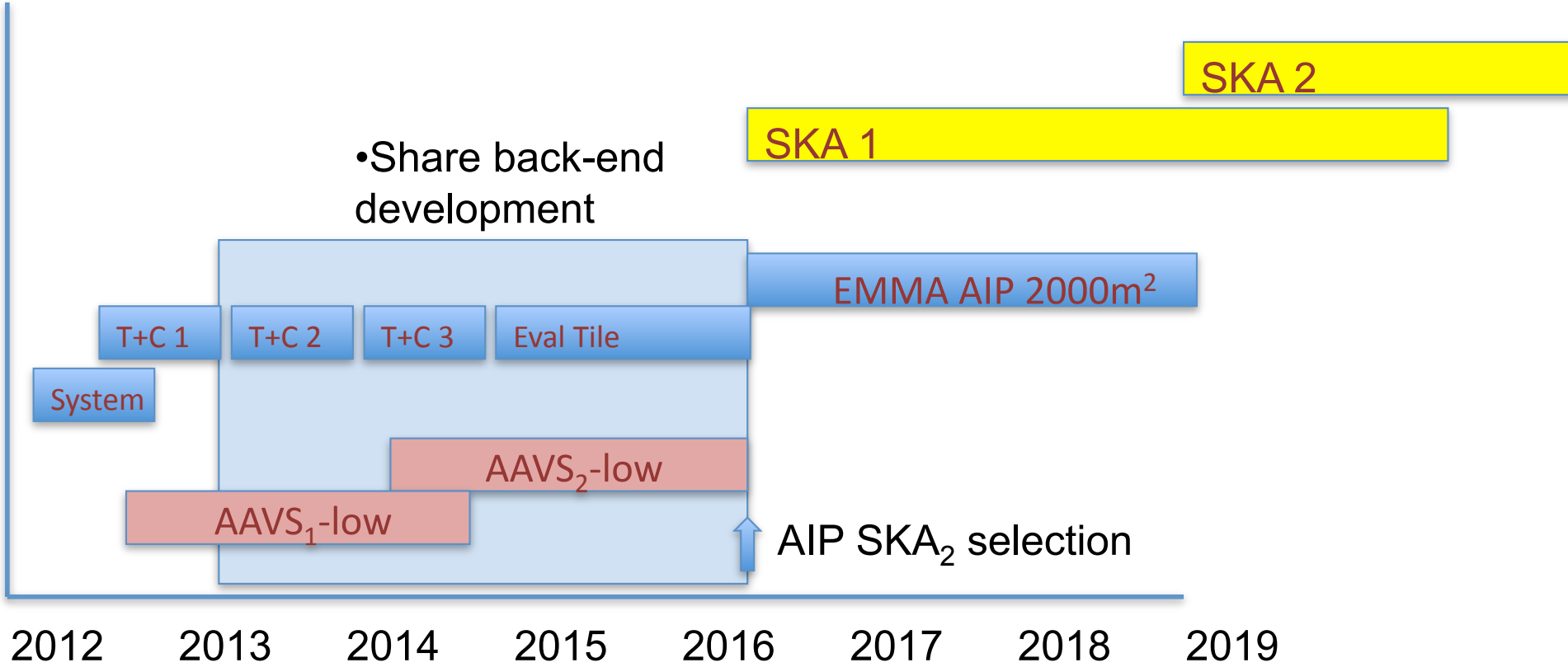


Aperture Arrays

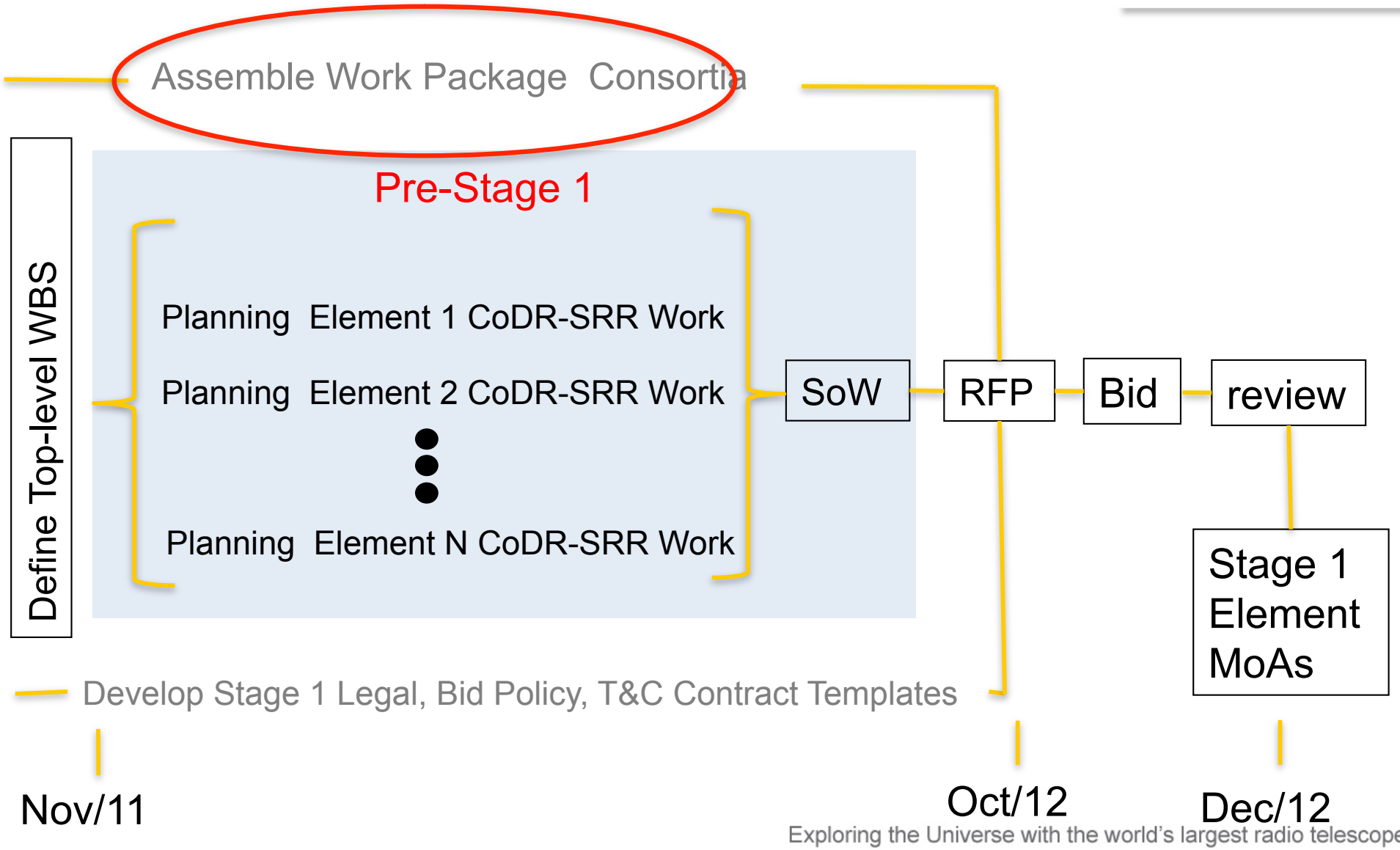
Note: log scale!

SKA Schedule




SKA 2
SKA 1
•Share back-end development
EMMA AIP 2000m²
T+C 1
T+C 2
T+C 3
Eval Tile
System
AAVS2-low
AAVS1-low
AIP SKA2 selection
2012
2013
2014
2015
2016
2017
2018
2019

Assembling Element Level RFPs for Stage 1 Work



Expressions of Interest

- EoI's semi public
- 133 respondents
- No real surprises

Low Frequency Aperture Array (LFAA)

80 Respondents

(* Lead = Expression of interest to lead Element; Full = full coverage of the work within the Element; Cons = Consortium; Y = Yes; N = No; P = Participate)

- Adaptive Array Systems Limited
- Agilent Technologies UK
- Alberta Centre for Advanced Micro&Nanotech Products
- Altera
- ARiYA Project Managers
- Arup
- ASTRON (Lead: Y; Full: Y; Cons: Y)*
- Aurecon (Lead: P; Full: N; Cons:N)*
- BCF Solutions
- Bigen Africa Services
- Callisto Limited/Callisto France
- Cambridge Consultants Ltd
- Canadian SKA Industry Consortium (NRC led)
- CCD Design & Ergonomics
- Cisco International Limited
- Clearspeed Technology Limited
- Cobham Technical Services
- CommAgility Limited
- COMMUNICATIONS AUDIT UK
- DA-Integrated
- Daniels Electronics Ltd.
- Denel Aerostructures a Division of Denel Group
- e2v SAS
- EnSilica
- Filtronic Broadband Limited
- Fluor Ltd
- FormaShape
- Fujitsu Semiconductor Europe GmbH
- GE Intelligent Platforms
- GHD Pty Ltd
- Hatch Associates
- IBM
- IBM United Kingdom Limited
- INAF - Istituto Nazionale di Astrofisica
- Institute for Radio Astronomy & Space Research
- Instituto de Física de Cantabria (IFCA, CSIC-UC)
- Jet Propulsion Laboratory
- Lockheed Martin Australia
- MARAND PRECISION ENGINEERING
- METHODE ELECTRONICS
- Micreo Limited
- Minex Engineering Corp.
- Mott MacDonald Ltd
- National Institute of Aerospace Technique
- National Instruments
- National Physical Laboratory
- National Research Council of Canada
- NCRA-TIFR
- Nexeya Systems
- Norsat International Inc
- NXP Semiconductors
- Observatory Sciences Ltd
- Omnisys Instruments AB
- Parsons Brinckerhoff
- Prudent Energy Corporation
- Reutech Radar Systems
- RFEL Ltd
- Roke Manor Research
- Sanyati Holdings (Lead: Y; Full: N; Cons:N)*
- SCISYS
- SELEX Galileo
- SELEX Sistemi Integrati S.p.A.
- Siemens Industry
- Siemens Nederland
- SKA South Africa (Telescope manager)
- SSI Engineers and Environmental consultants
- STFC – Technology Department
- STFC RAL Space Department
- Systems Engineering & Assessment
- Tata Consultancy Services
- TEK Microsystems
- Teledyne Defence Limited
- Telespazio VEGA UK Ltd
- The Boeing Company
- Tronicon Industries Inc.
- UNIVERSIDAD CARLOS III DE MADRID (UC3M)
- Universidad de Cantabria. Dept of Communications Engineering
- University of Cambridge
- University of Malta
- WorleyParsons Europe Limited (Lead: Y; Full: Cons:N)*

Aperture Arrays

- LFAA + MFAA
  - ASTRON lead
  - ICRAR
  - INAF-IRA
  - JIVE
  - Observatoire de Paris
  - Raman Research Institute
  - Université de Bordeaux 1
  - University of Cambridge
  - University of Malta
  - University of Manchester
  - University of Oxford

LFAA Planning

- AAVS0: several elements
- AAVS1: 256 elements
  - 4 x 64 or 16 x 16
- AAVS2: 11500 elements (2% SKA1)
  - 23 x 500

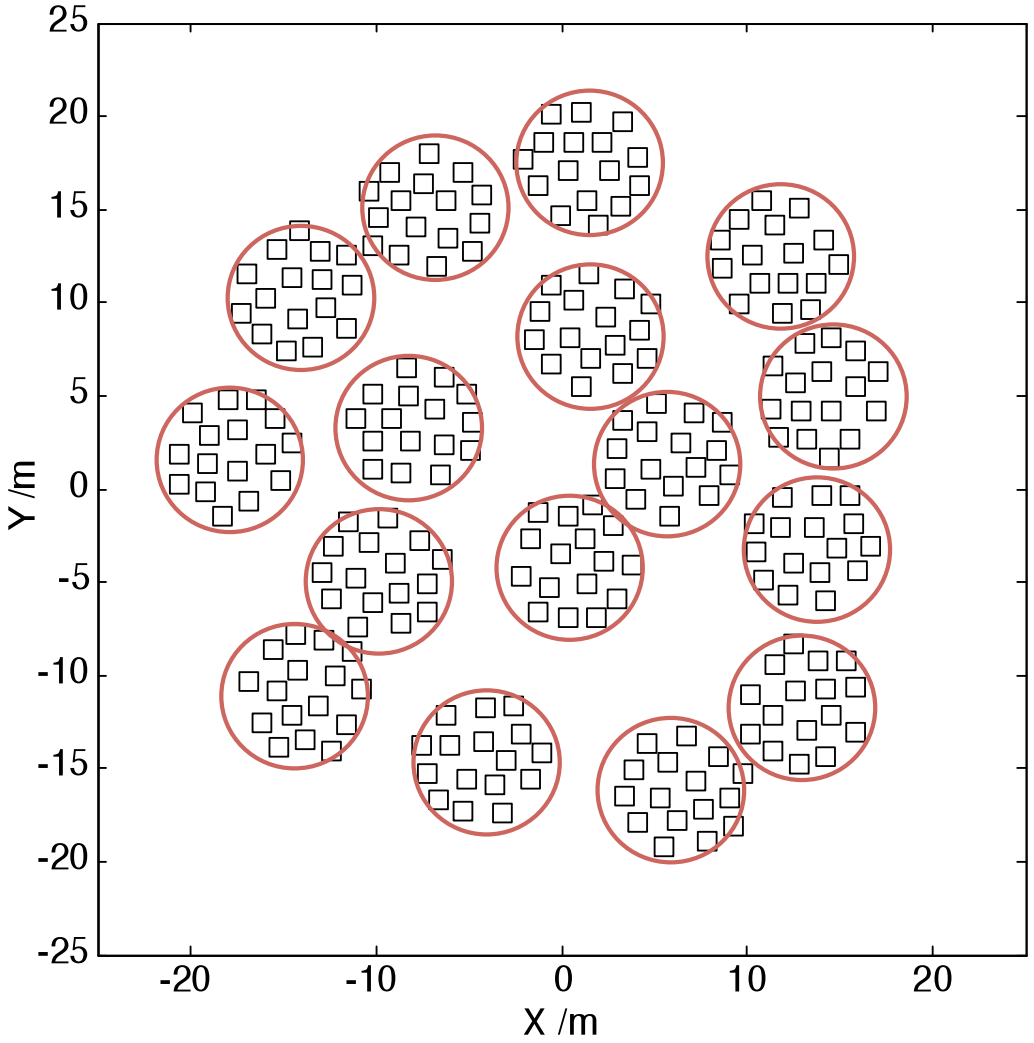
AAVS0: Log Periodic Dipole

radio telescope

AAVS0: Vivaldi

LFAA AAVS1

Possible AAVS1 configuration suitable for beamforming and correlating



LFAA AAVS1: system tests

- Electronics
- Beamformer
- Stability (gain)
- Reliability (time stability)
- A/T
- Calibration

(input from Nima Razavi)

LFAA AAVS1: astronomical verificat on

- Pulsar detection
- Drift scans of bright sources
- Tracking bright sources
- Imaging capability
- Beam switching experiments?
- Multi-beam experiments?

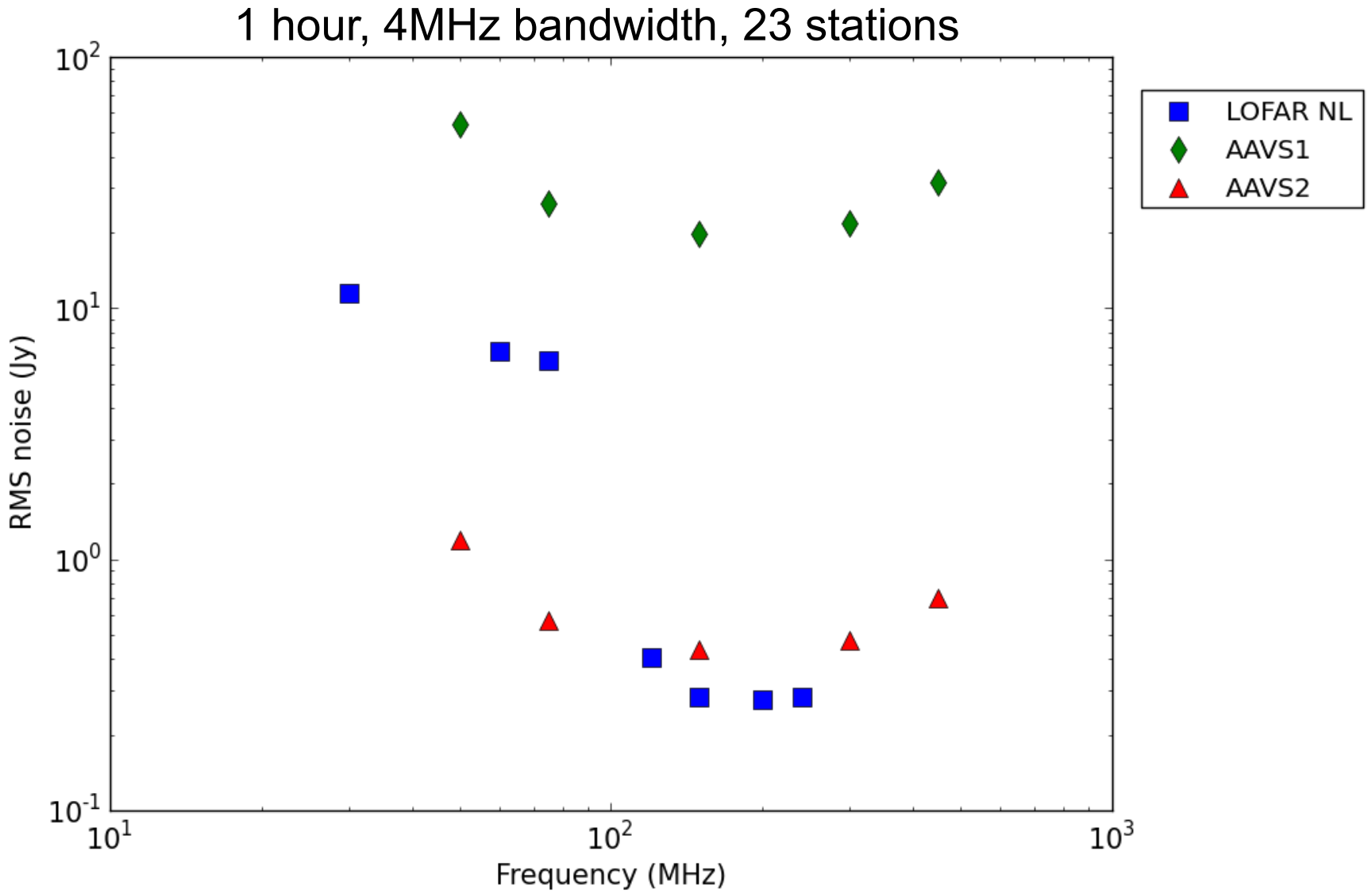
AAVS2

Exploring the Universe with the world's largest radio telescope

LFAA AAVS2 technical tests

- Signal transport
- Calibration
- System stability
- Correlation modes
- Post processing
- Beam

LFAA AAVS2

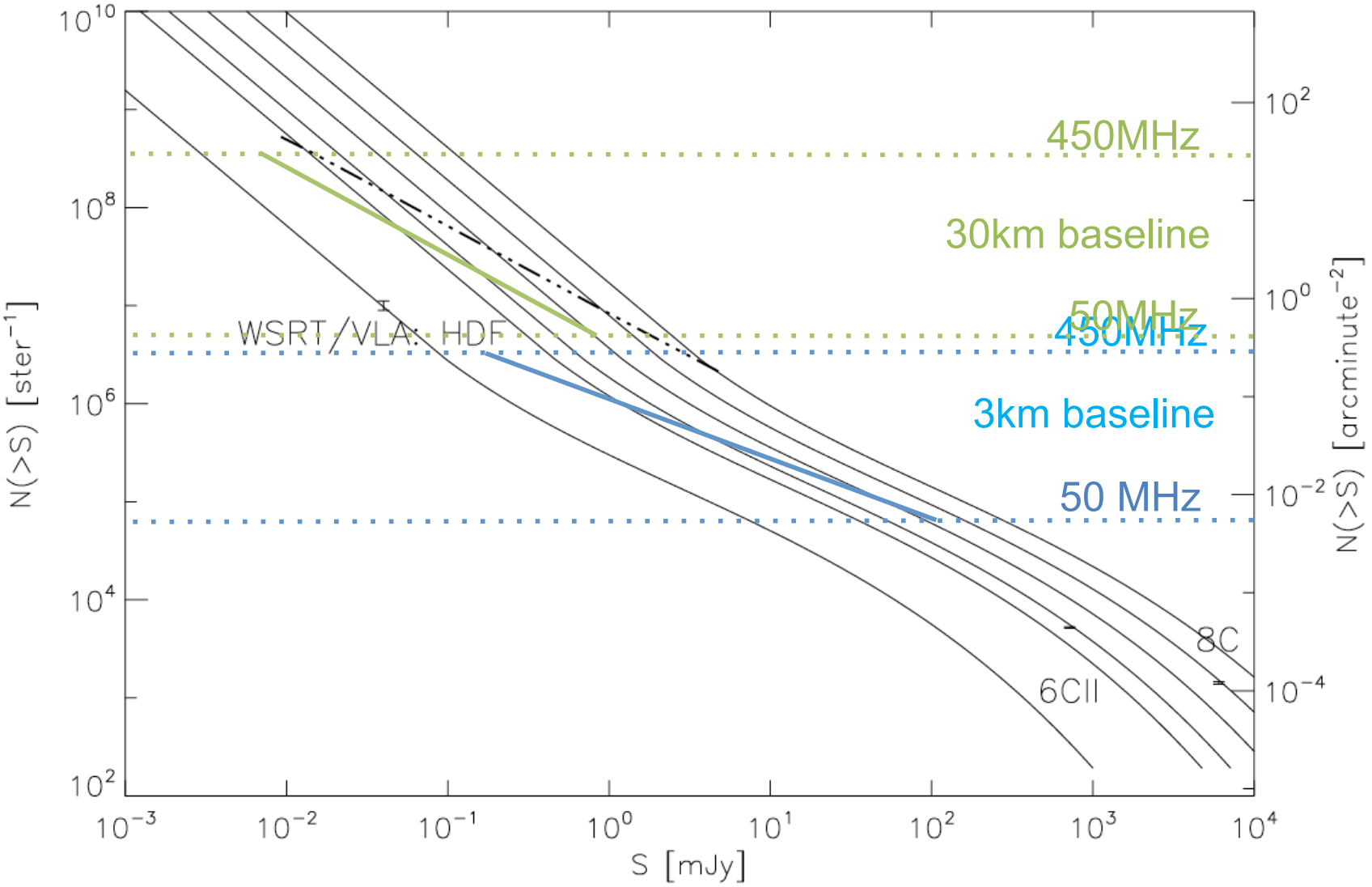

1 hour, 4MHz bandwidth, 23 stations
RMS noise (Jy)
Frequency (MHz)
10^2
10^1
10^0
10^{-1}
10^1
10^2
10^3
LOFAR NL
AAVS1
AAVS2

LFAA AAVS2 astronomical verificat n

- Imaging
- Polarization (RM synthesis)
- Pulsars
- Solar system (dynamic spectra)
- Ionosphere and space weather

LFAA AAVS2 is science capable!

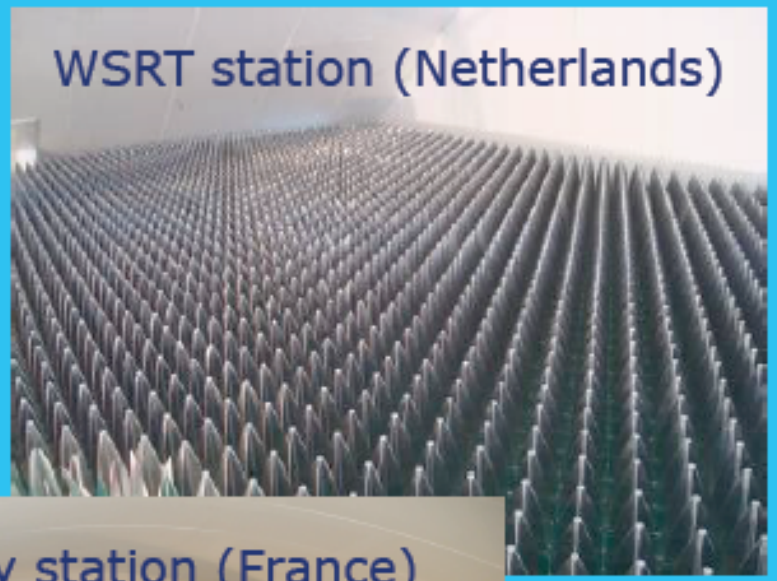
LFAA AAVS2 confusion limit



EMBRACE: AA-mid technical demonstrator

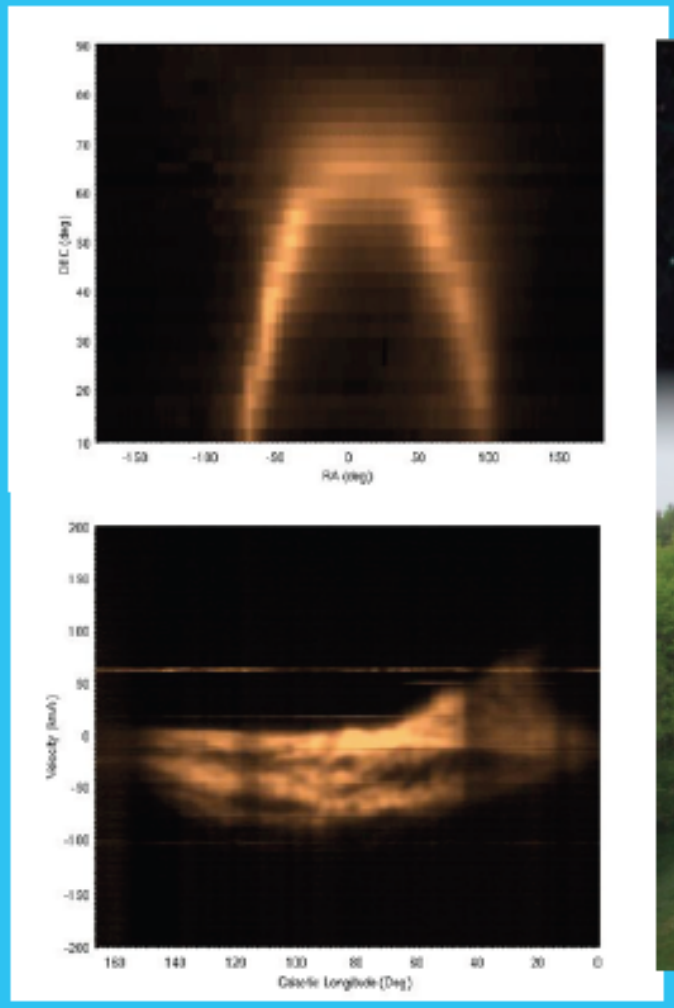
ASTRON

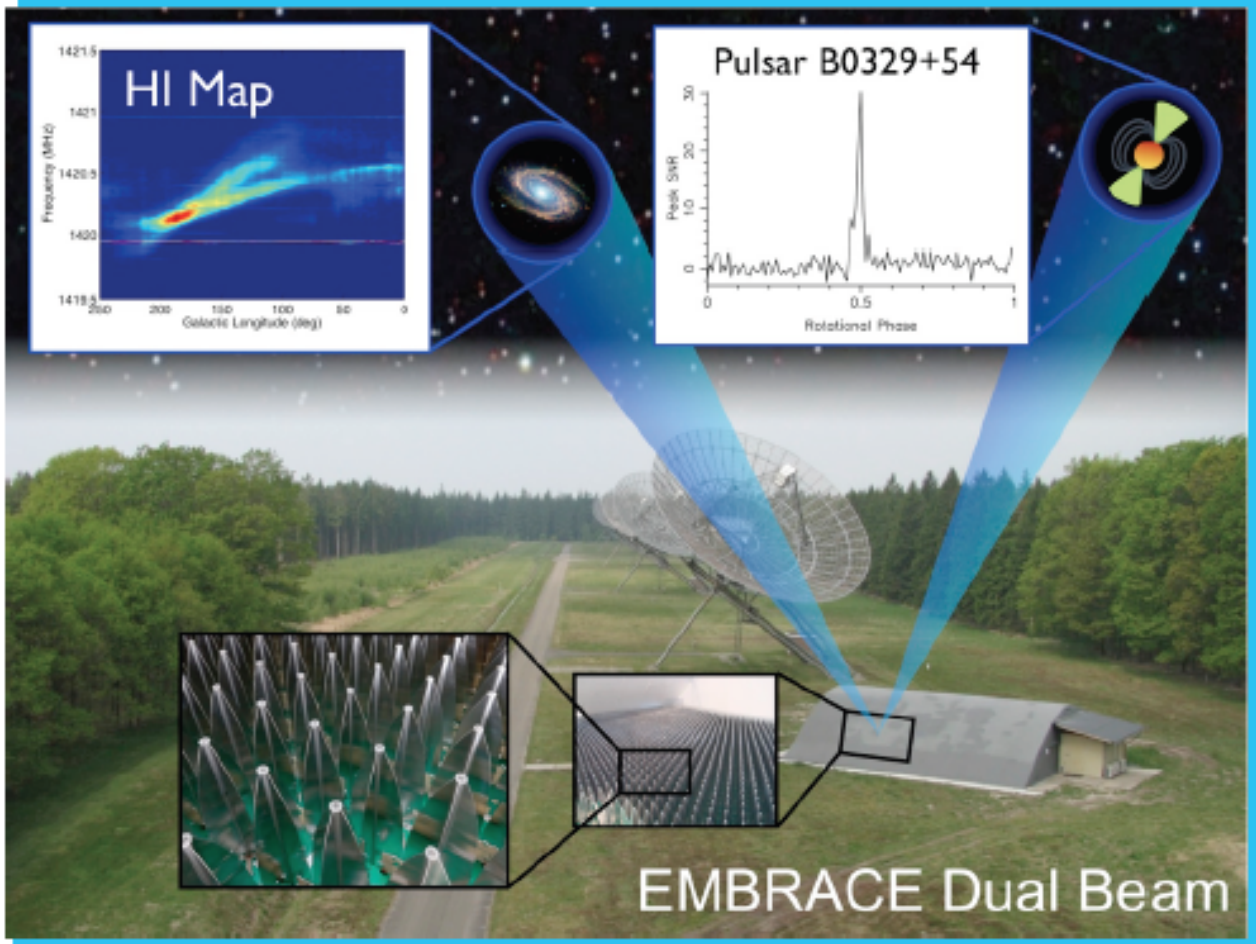
- A/T ~ 1 m^2/K
- 400-1500MHz
- TWO analogue beams
- ~200 digital beams (195.3kHz wide)
- ~40MHz bandwidth
- single pol



EMBRACE results: WSRT

ASTRON





EMMA specs

ASTRON

- 2000m^2 (A/T ~ 40 m^2/K)
- multiple stations
- full Stokes
- 2 FoV, 64 digital beams
- ~80 deg^2 per FoV
- 450-1450 MHz
- T_{sys} ~50K
- bandwidth 500MHz

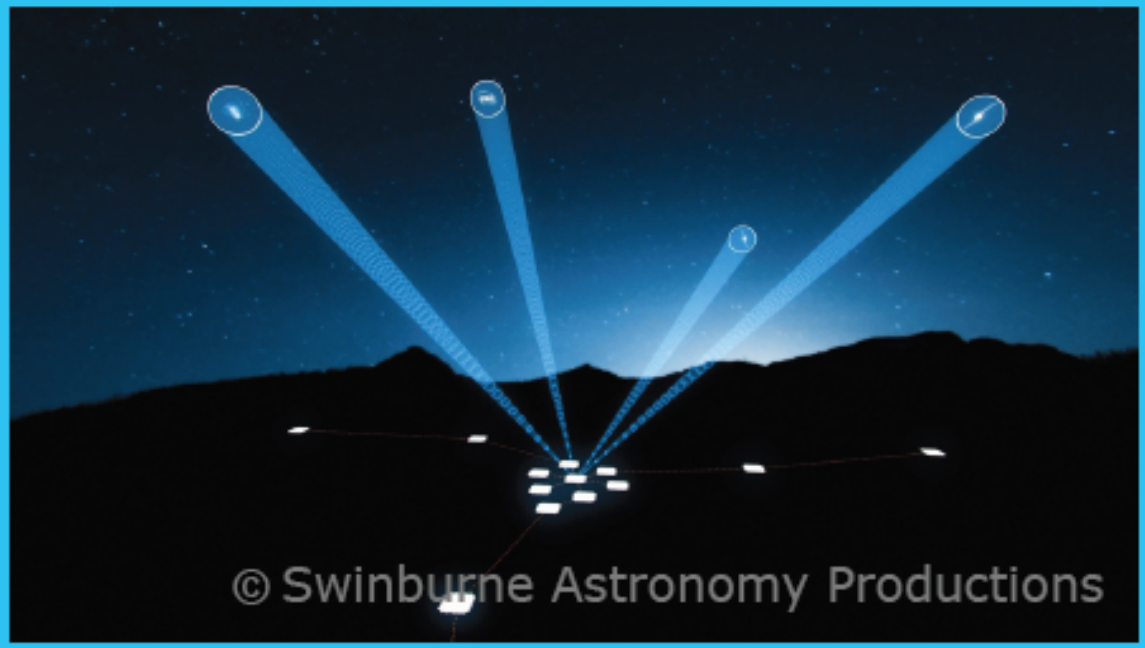
SKA single station

© Swinburne Astronomy Productions

EMMA configuration

ASTRON

- 14 stations
- 13.5m diameter
- central core: >50%
- longest baseline between 300-1000m



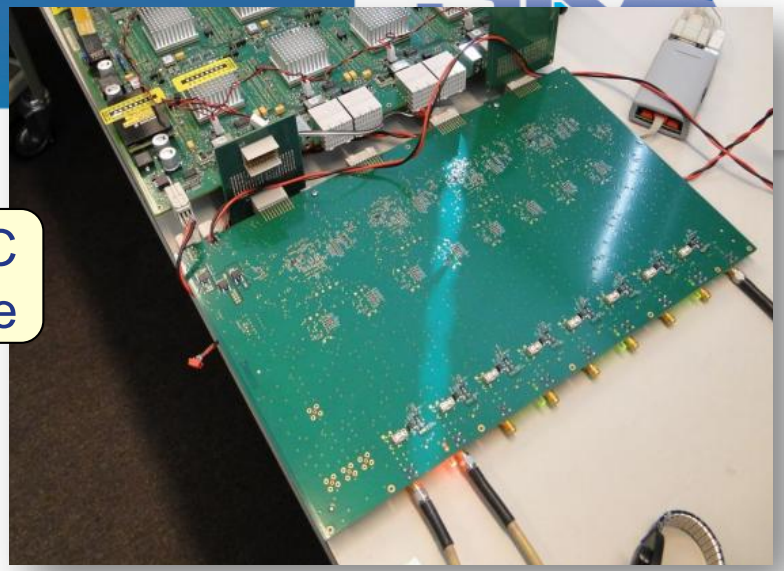
Comparison

	EMMA	APERTIF	ASKAP	EVLA	MeerKAT-1
Frequency (GHz)	0.4-1.45	1.0-1.7	0.7-1.8	1.0-50	0.9-1.75
Bandwidth (GHz)	0.5	0.3	0.3	0.5 (8.0)	0.35
FoV (deg^2,1.4GHz)	78	8	30	0.3	0.6
z_{max} for HI absorption	2.55	0.42	1.03	0.42	0.58
S_{rms} (μJy, 1h, full BW)	37	30	35	7.6	14.6
S_{rms} (μJy, 1h, 100MHz)	84	49	61	17	27
S_{rms} (mJy, 1h, 5 km/s)	5.5	3.7	4.0	1.1	1.8
A/T (m^2/K)	40	105	58	246	150
SSFOM x10^4 ($m^4/K^2/ deg^2$)	12.5	8.9	13.8	1.8	1.4
SSL($\tau < \tau_o$)/N_t	1	0.92	0.73	5.3	5.6

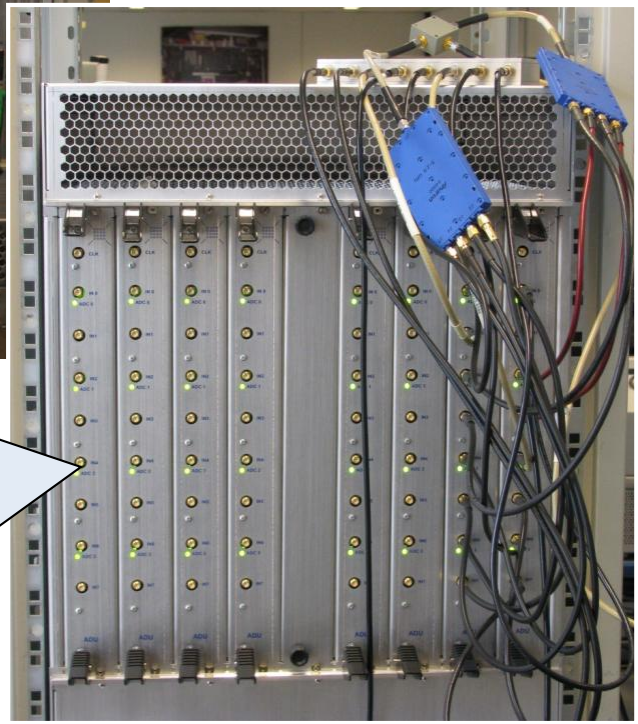
based on online information of late 2011

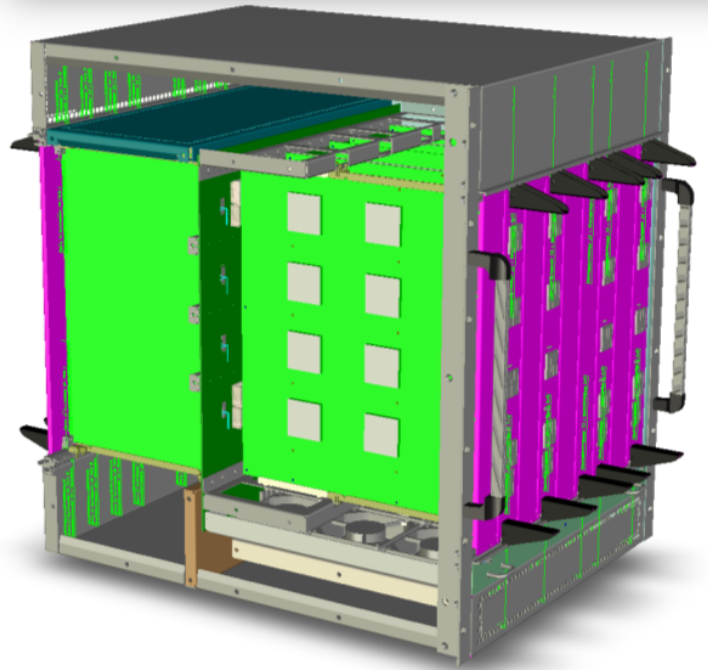
ASTRON

Uniboard Implementation



ADC Interface





Shelf:

- 4 Processors
- 8 ADC interfaces
- 64 inputs (32 elements)

Today

- To use the outcome of the meeting to shape-up our plans to get to the specification, design/development and verification of AA's
- To identify risks in the current approach and work out alternatives if needed

Leading up to:

Aperture Array Design and Construction Consortium
AADC