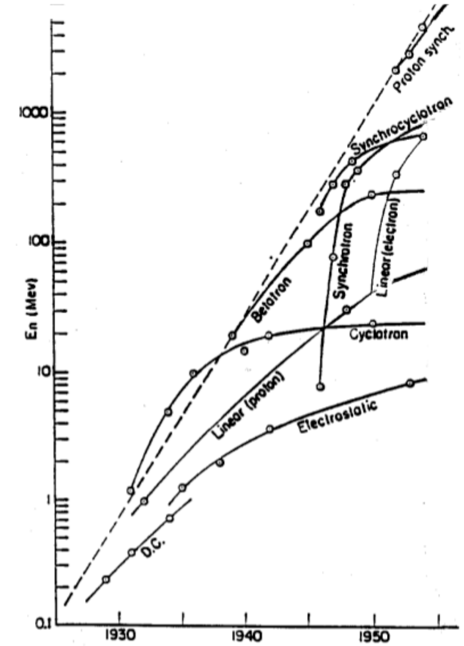
Progress and status of AAMID

Wim van Cappellen, Consortium Lead

Livingstone curves

- Brought to our attention by Ron Ekers and (http://arxiv.org/ftp/arxiv/papers/1004/1004.4279.pdf)
- Most important discoveries in astronomy result from technical innovation [Harwit]
- A single technology saturates in capability
- Innovation is needed to continue exponential growth
- Adopting new technology leads to great rewards



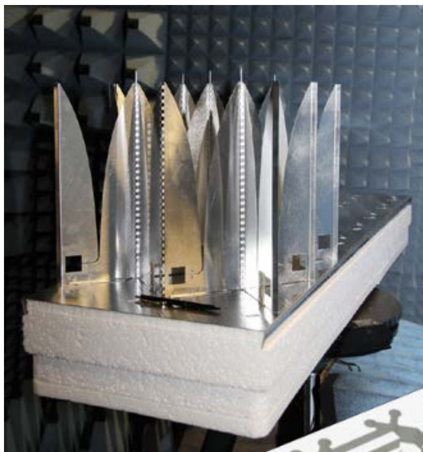
Dishes around 1 GHz are saturating

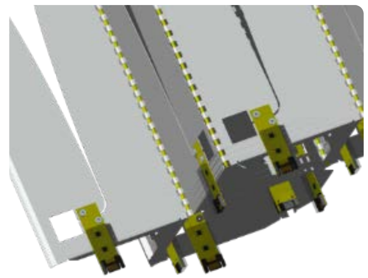
- SKA2-MID:

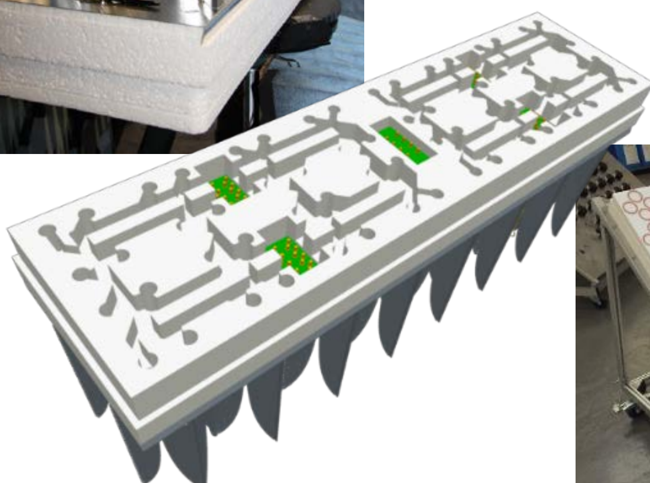
- 1500 – 2000 dishes
- Exponential growth of capabilities is now paired with an exponential growth of costs
  - How to afford 2000 dishes if a 133 dish SKA1 system already costs 400 to 500 M€ ???
  - Operational costs (Maintenance…)

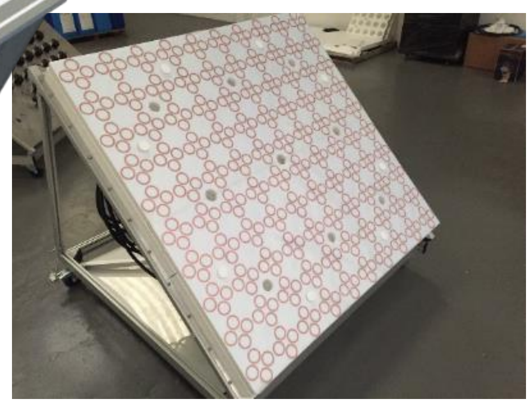
We need innovation!!!

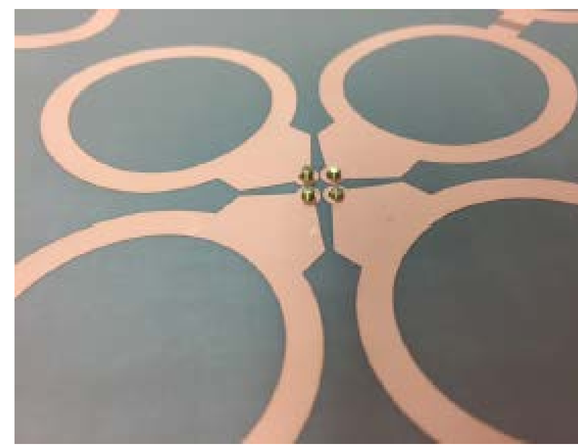
- Mid-Frequency Aperture Arrays





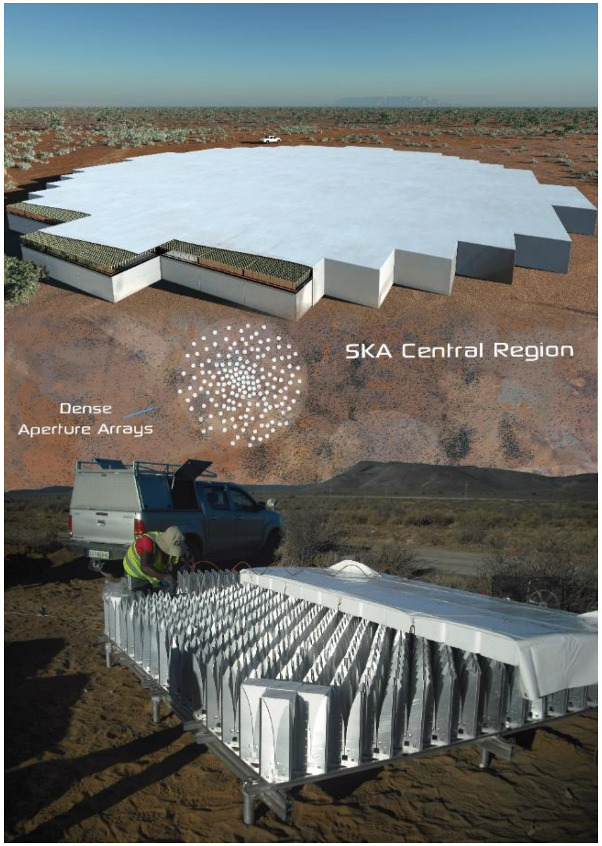






MFAA has

- A very large field of view, and the opportunity of transient buffering
- A fast response time and pointing
- Multiple beams, concurrent observations
- A very high survey speed capability
- High sensitivity < 1.45 GHz
- Relatively low capital and operational costs
  - Low post-processing costs (large stations)
  - No moving parts
  - No vacuum, helium, cryogenics



$$P_{imager} = N_{op} \underbrace{\frac{10^5}{3} \frac{T_{obs} N_{stat}^2}{f_{min}} \frac{B_{max}^2}{D_{stat}^2}}_{\text{number of visibilities}} \left(\frac{\lambda_{max}^2 B_{max}^2}{D_{stat}^4} + N_{kernel}^2 \right)$$

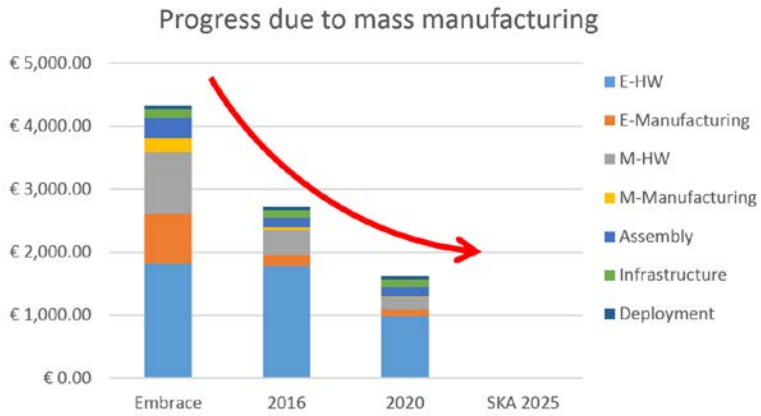
MFAA Rationale

- High sensitivity and survey speed from 1450 MHz down to z ~3
- Very wide field-of-view transient observations, incl. buffering
- Bulk pulsar timing

- Can only be done with an SKA-AAMID telescope

Development progress

- Vivaldi tile costs:
  - 2009: 4200 €/m2
  - 2016: 2700 €/m2
  - 2020: 1600 €/m2
- SKA1-MID dishes: ~7000 €/m2



- Power consumption MFAA tiles:
  - 200
  - 201
  - 202
- SKA1-MID dishes: ~60 W/m2

The SKA-AAMID telescope is within reach

- Receiver temperature
  - 2009: 100 K
  - 2016: 40 K
  - 2025: 30 K

Science demonstrator

- Next logical and essential step for MFAA
- Located on the South African SKA Site
- Huge opportunities:
  - Perform unique science
  - Symbiosis with MeerKAT
  - Demonstration and verification of MFAA technology
  - Educate people for the next generation radio-telescope
  - Involvement of industry

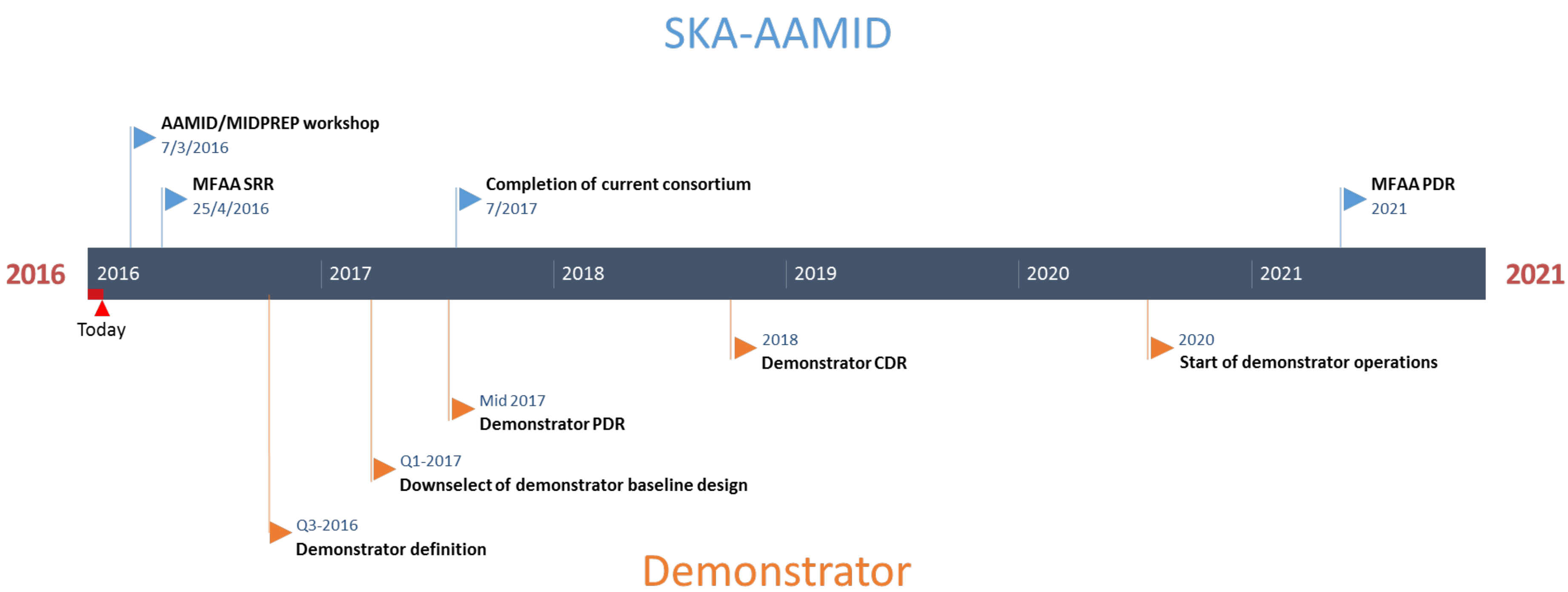
Key challenges

- Reducing power consumption
  - Integration
  - System optimization
  - Sustainable energy
- Reducing the capital costs
  - Design for Mass production
  - Moore's law (although flattening)
- Calibration down to thermal noise needs accurate beam and sky models to calibrate sources in near and far sidelobes
  - Algorithm development
  - Learn from other AA instruments (LOFAR, MWA, SKA1-Low)

What about the dishes?

- Do we need dishes at all?
- Yes, but much less
  - On long baselines
  - Of course with PAFs > 2 GHz

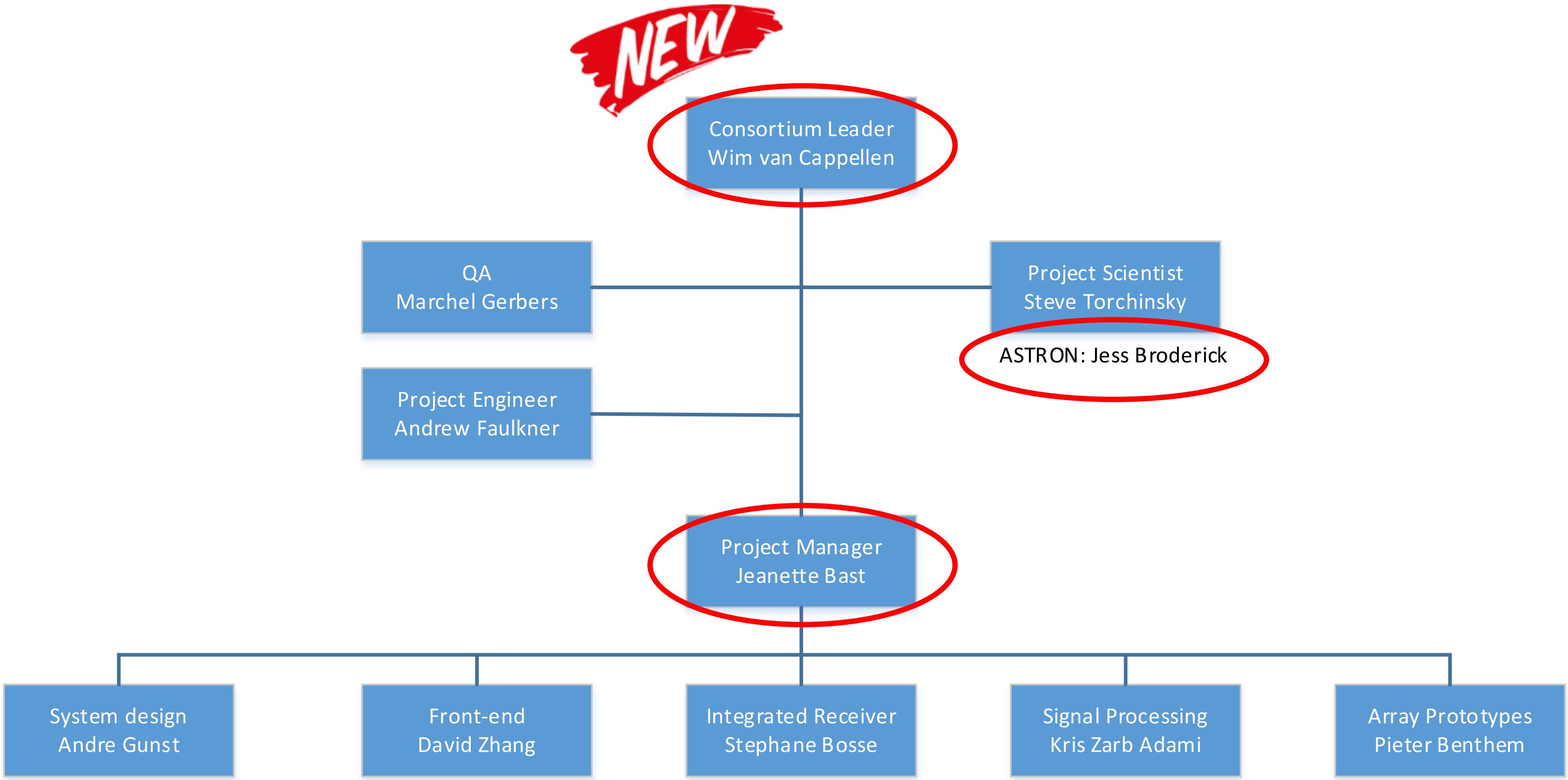
Timeline


SKA-AAMID
AAMID/MIDPREP workshop
7/3/2016
MFAA SRR
25/4/2016
Completion of current consortium
7/2017
MFAA PDR
2021
2016
2016
2017
2018
2019
2020
2021
2021
Today
2018
Demonstrator CDR
2020
Start of demonstrator operations
Mid 2017
Demonstrator PDR
Q1-2017
Downselect of demonstrator baseline design
Q3-2016
Demonstrator definition
Demonstrator

The AAMID Consortium

- The AAMID consortium aims to demonstrate maturity, competitiveness and cost-effectiveness of Mid-Frequency Aperture Arrays for SKA2.
- SKA Advanced Instrumentation Programme (AIP)

Consortium Organization



Consortium partners

Full members

– ASTRON	*System design, prototyping, management*
– China: KLAASA	*Receiver, antenna: 3x3 m^2 array*
– Observatoire de Paris (Nancay)	*Front-end MMIC's*
– Stellenbosch University NEW	*Antenna research*
– University of Bordeaux	*ADC*
– University of Cambridge	*System design*
– University of Manchester	*Front-end design*

Associate members

– ENGAGE SKA (Portugal)	*Renewable energy*
– SKA South Africa	*Site support*
– University of Malta	*Fractal ORA*
– University of Mauritius NEW	*Front-end research*

Workshop Objectives

- To learn from each others ideas, identify opportunities and challenges
- Reflect ideas on SKA-AAMID science and engineering
- **To inspire you, to get you thinking and acting!**

Enjoy your stay in Cape Town!