

# MeerKAT International Giga-Hertz Tiered Extragalactic Exploration (MIGHTEE)



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SPARCS Catania 2014

# MeerKAT



- Phase 0 of SKA Mid dishes
- 64 offset parabolic antennas with single-pixel feeds



# The MIGHTEE Team

## Kurt van der Heyden & Matt Jarvis



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# Proposal



Tier	Frequency (GHz)	Sensitivity (rms)	Resolution (arcsec)	Area (degree <sup>2</sup> )	Time (hours)	MeerKAT Phase	Key Science Drivers	Other Drivers
Tier 1	1.4	5.0 $\mu$ Jy	8.5	1000	2400	Phase 1	Evolution of clusters, relics, haloes, LSS, rare sources, RM map	HI absorption <i>Herschel</i> IDs
Tier 2	1.4	1.0 $\mu$ Jy	8.5/3.5	35	1950	Phases 2-3	Star formation/AGN evolution, Evolution of Clusters Deep RM map	HI absorption Weak Lensing <i>Herschel</i> IDs
Tier 3	1.4	0.1 $\mu$ Jy	3.5	1.0	1700	Phase 4	Star formation/AGN evolution, Weak Lensing, Deep RM map	HI absorption Proto-clusters
Tier 4	12	1.0 $\mu$ Jy	3.2/0.4	0.25	700	Phases 2-3	AGN/starburst morphology	<i>Herschel</i> IDs
Tier 5	12	0.2 $\mu$ Jy	0.4	0.01	440	Phases 3-4	AGN/starburst morphology	RM map



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# Continuum Proposal



**Tier-1:** 1000 square degrees to  $5\mu\text{Jy}$  rms ; possible fields VISTA-VIKING and KIDS fields. large-scale structure of the Universe at  $z \sim 1$ ;  
Time estimate: 1250 hours

**Tier-2:** 35 square degrees to  $1\mu\text{Jy}$  (rms); possible fields Elais-S1 (0037-43), XMM-LSS (0218-05), ECDFS (0332-27) and COSMOS (1000+02). sensitive to starbursts of  $100 M \text{ yr}^{-1}$  at  $z \sim 4$  and SCUBA-type galaxies with  $> 500 M \text{ yr}^{-1}$  up to  $z > 7$ .  
Time estimate: 1950 hours

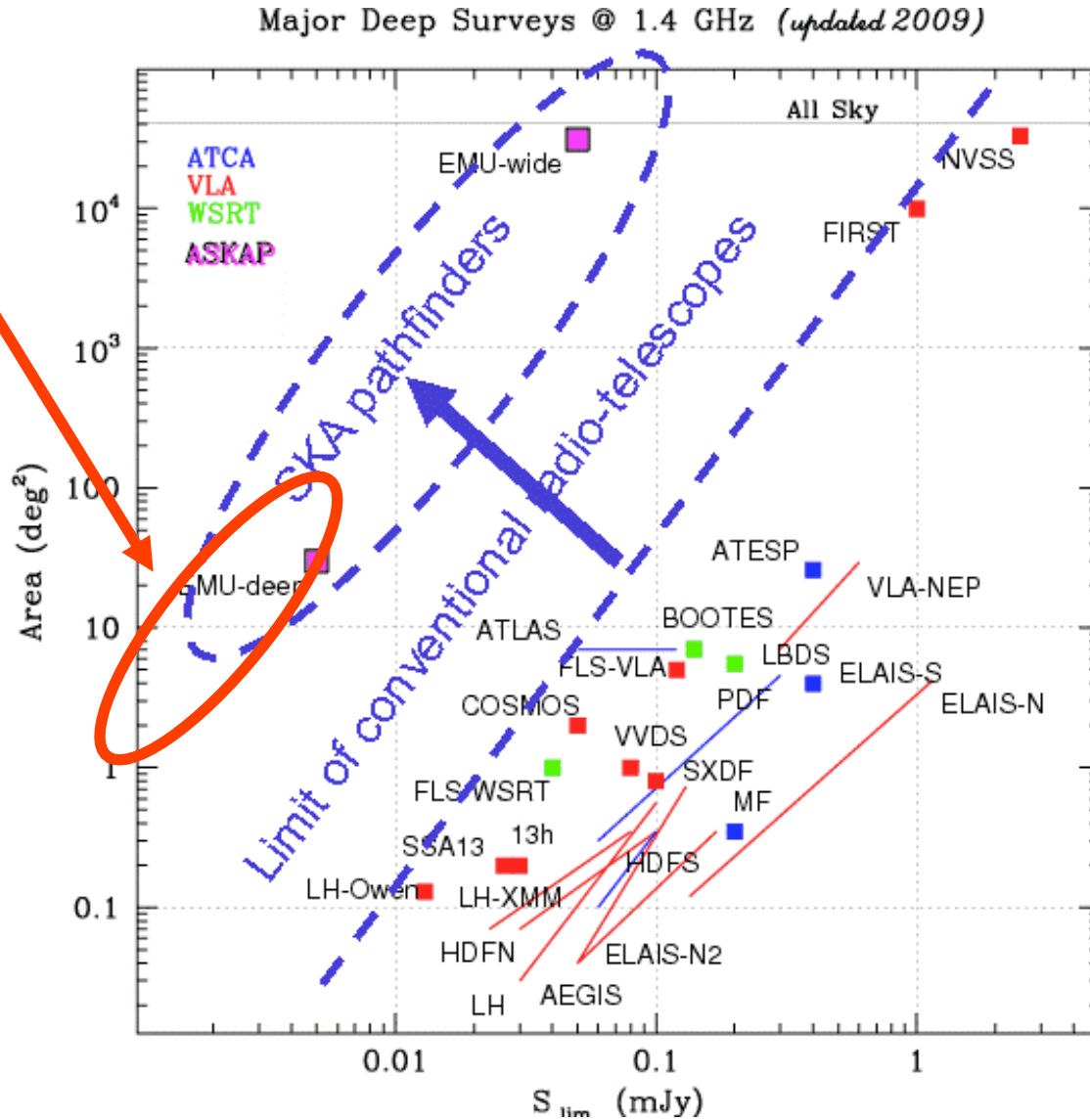
**Tier-3:** A single pointing to  $0.1\mu\text{Jy}$  (rms), possibly over Chandra-Deep-Field South - push the telescope to its limit and studies of star-formation and AGN activity to levels  
Time Estimate: 5000 hours

**Tier-4:** 0.25 square degrees @ 12 GHz to  $1\mu\text{Jy}$  (rms), Study AGN/ Starburst morphology

# Sensitivities



MeerKAT



Borrowed from:  
Norris et al

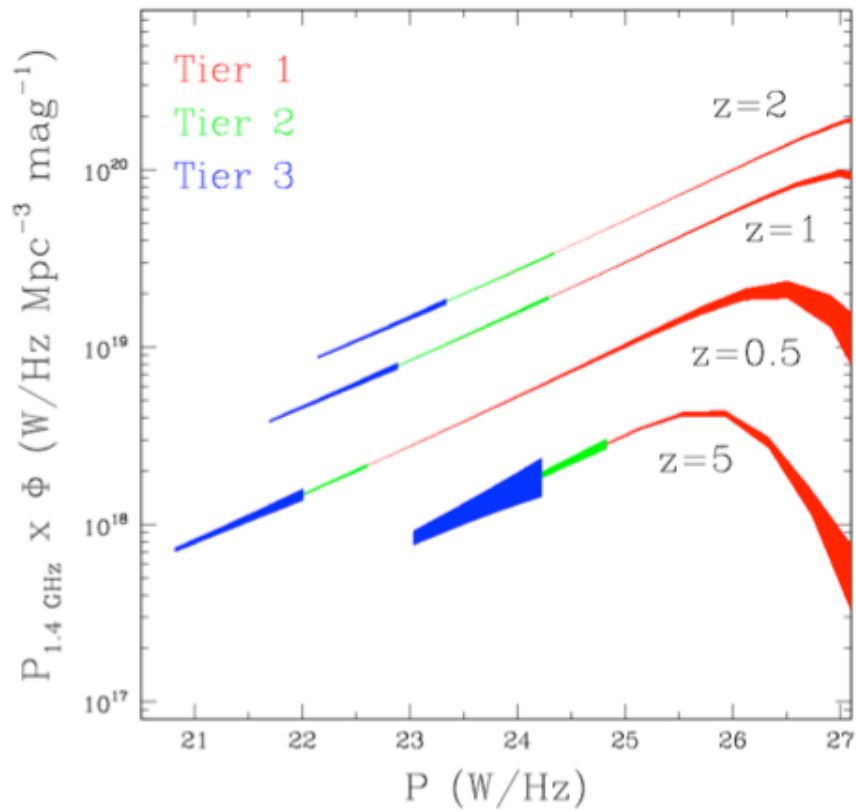


# Some key Science goals

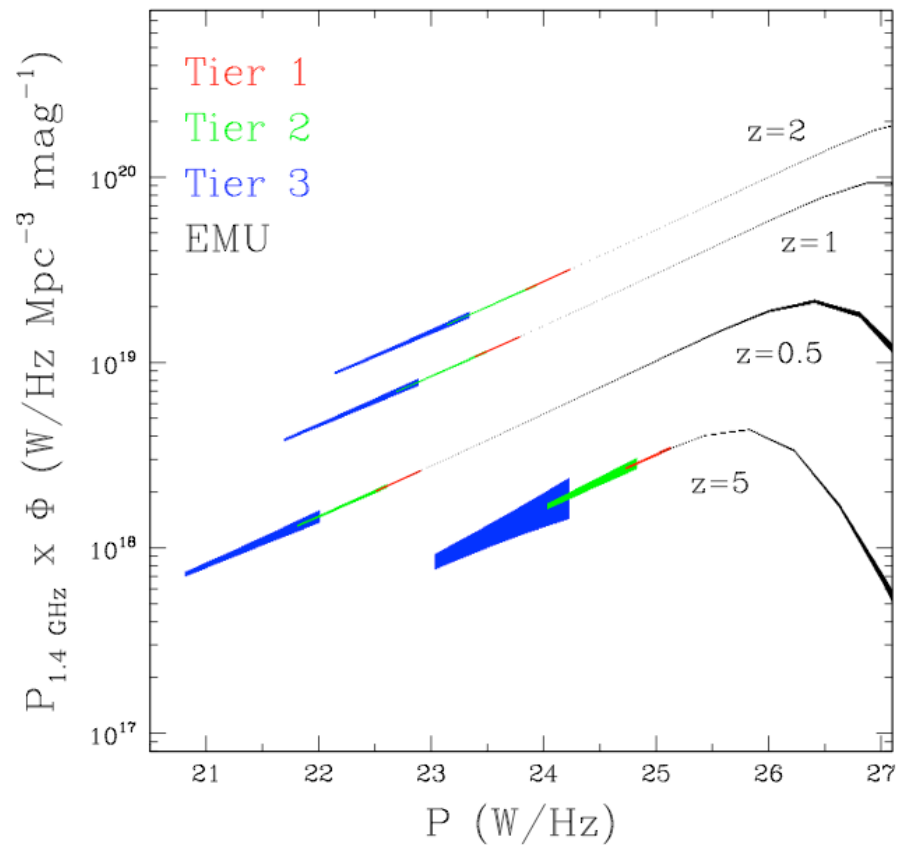
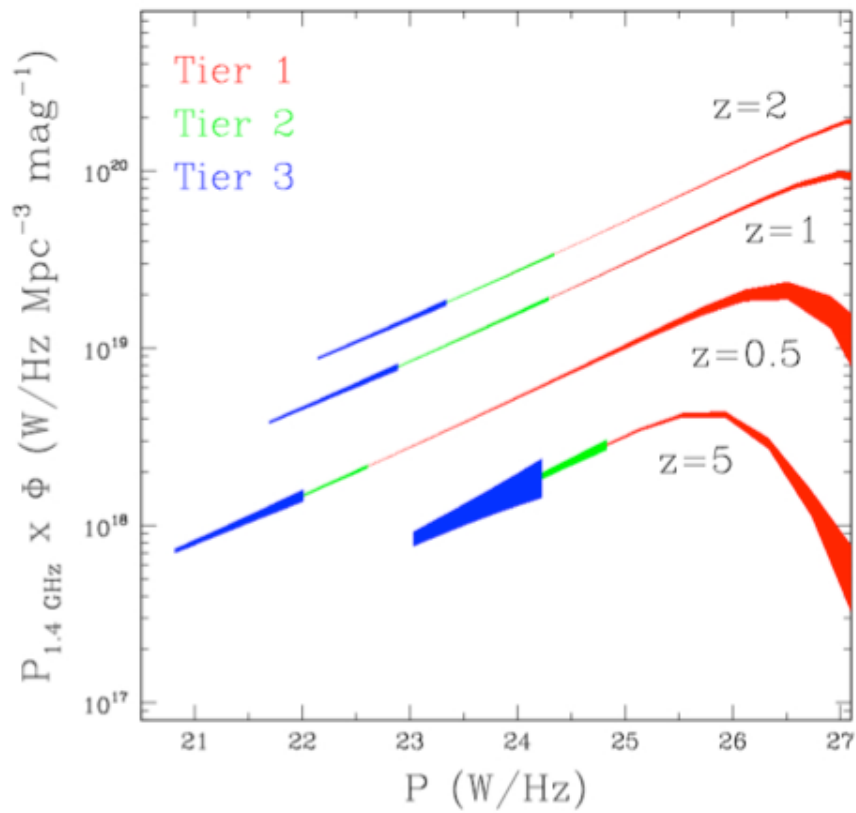


- To trace the **evolution** of strongly star-forming **galaxies** from  $z \sim 6$  to the present day, and quiescent star forming systems from  $z=1-2$ , using a wavelength unbiased by dust or molecular emission.
- To trace the **evolution** of **super-massive black holes** throughout the history of the Universe, and understand their relationship to star-formation.
- assess the **AGN** mechanical **feedback** and environmental impact on the intergalactic medium
- emergence of **magnetic fields in galaxies**, the **magnetic properties of AGN** over cosmic time, and detection of the **cosmic magnetic web**

# The AGN luminosity function with MIGHTEE

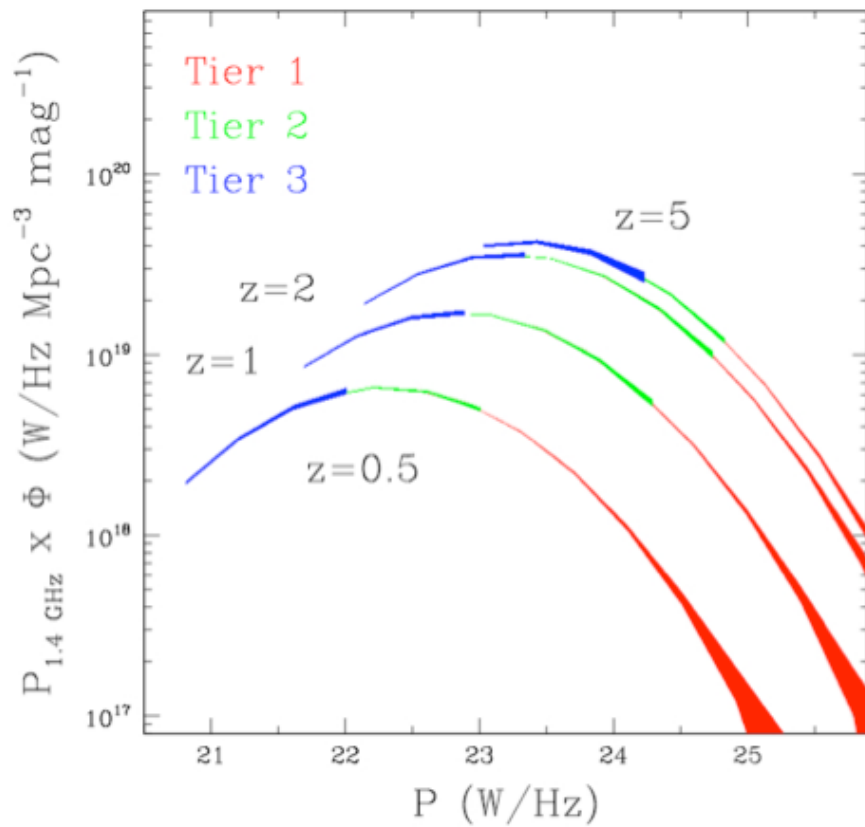


# The AGN luminosity function with MIGHTEE + EMU

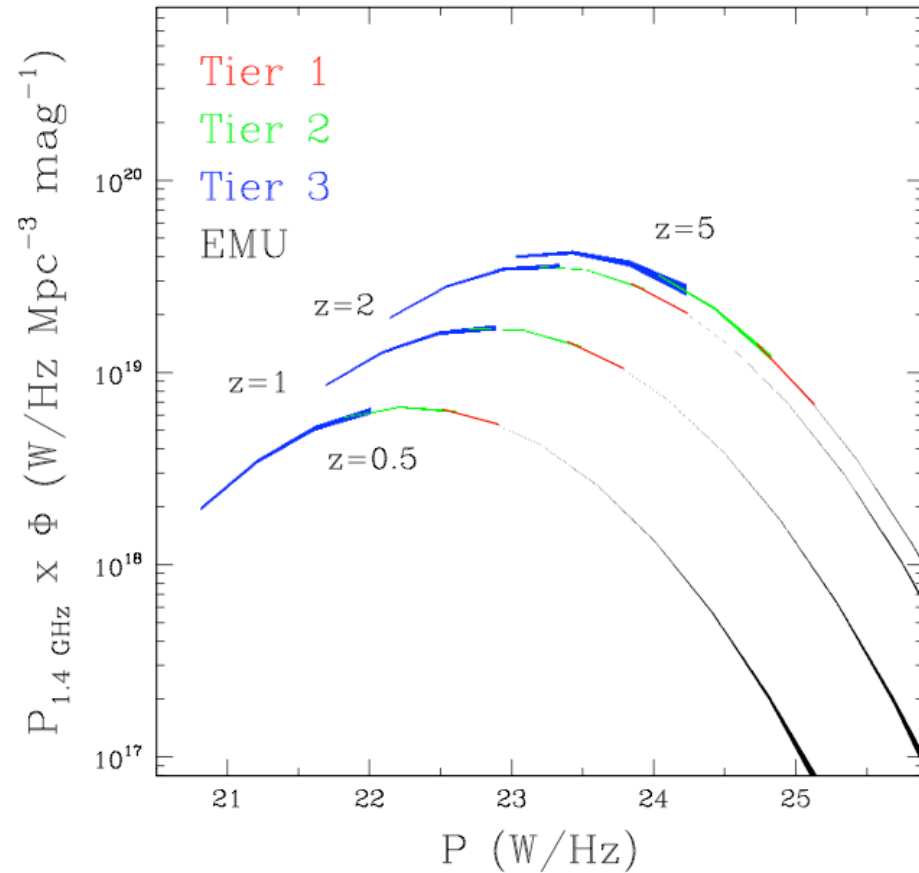
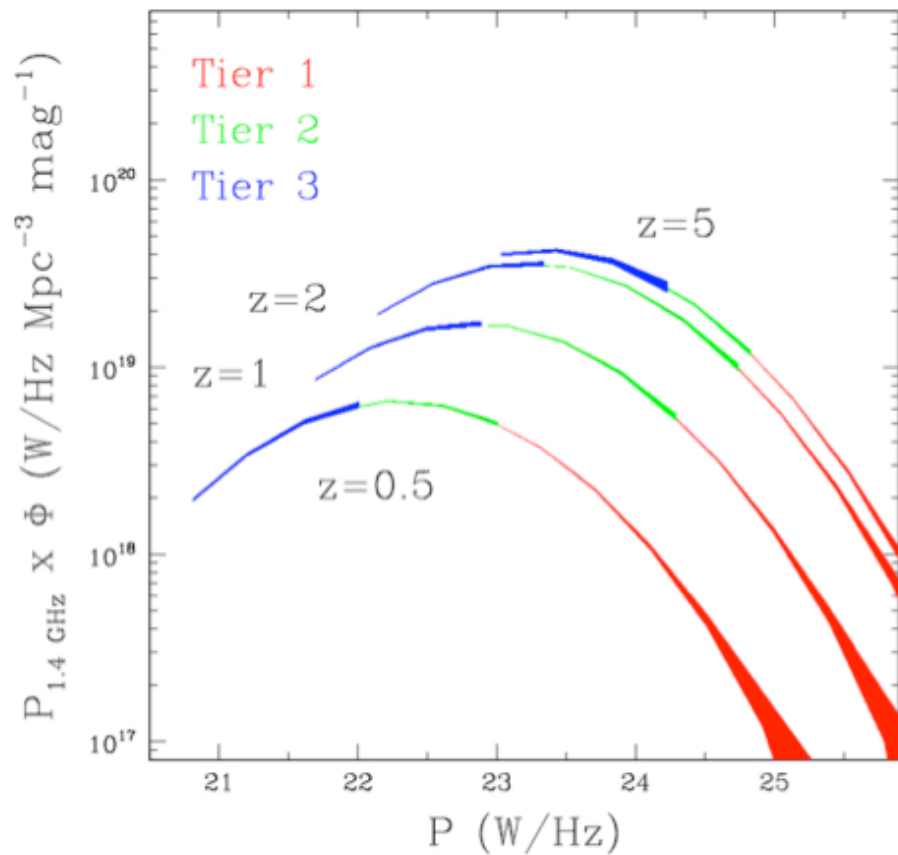




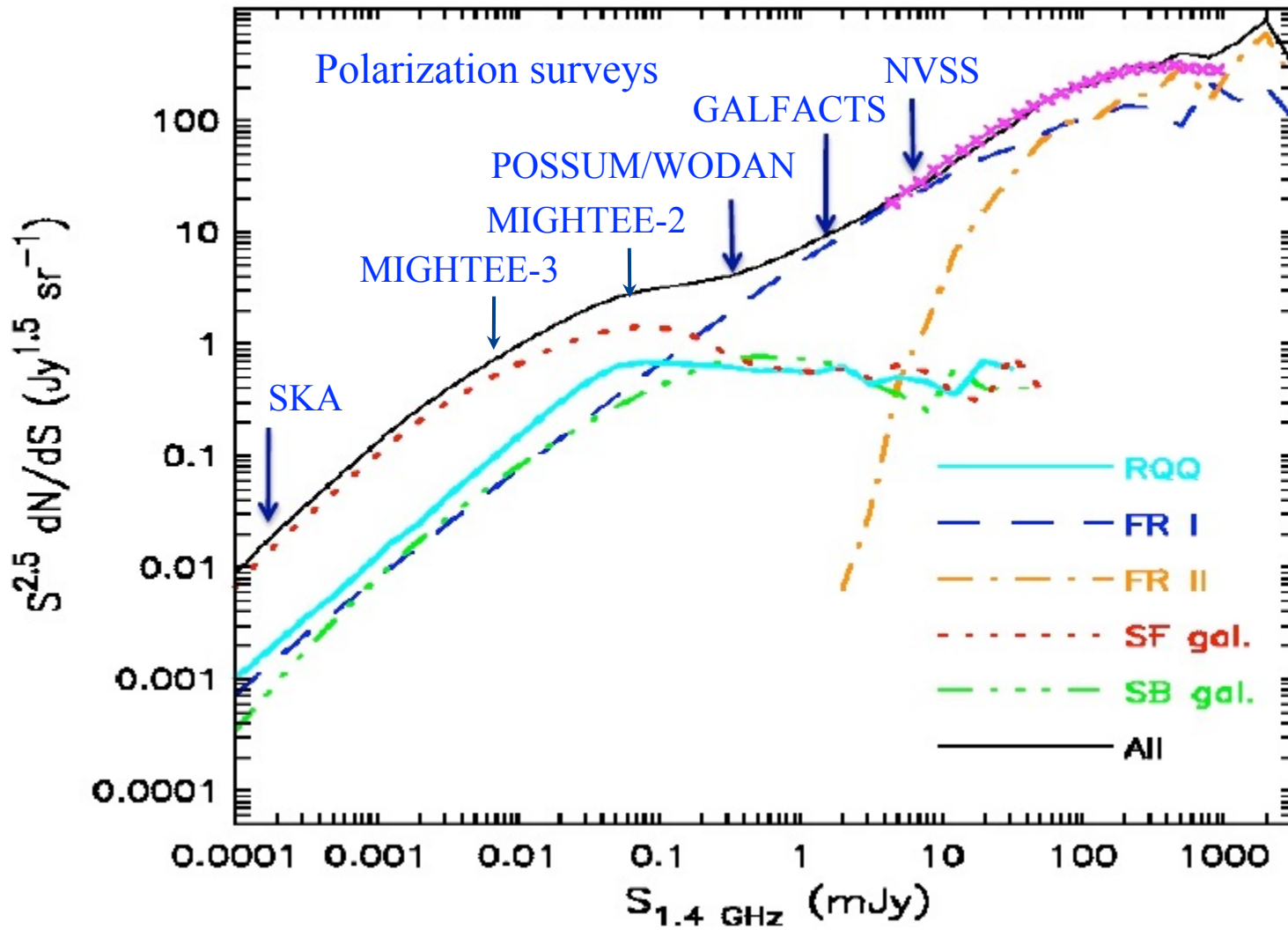
# The star-forming galaxy luminosity function with MIGHTEE



# The star-forming galaxy luminosity function with MIGHTEE + EMU



# Polarization Surveys





# Antenna delivery



**Contract awarded July 2012** - to a South African company with backing of one of the best international antenna suppliers in the world.

- Design done in Germany/USA - SKA SA owns all IP and license to background IP related to design
- 75% local content contractual condition
  
- CODR – Aug 2012
- PDR – April 2013
- Delta PDR – November 2013
- Control System FATS – 20 Jan 2014
- 1<sup>st</sup> antenna installed on site – 26 March 2014
  - Some rework being done
  - Re-installation early Jun2014
- 1<sup>st</sup> antenna handed over to SKA SA
  - Mid July (not fully qualified)
  - SKA SA makes progress with RTS testing
- 2<sup>nd</sup> antenna handed over to SKA SA
  - End October 2014

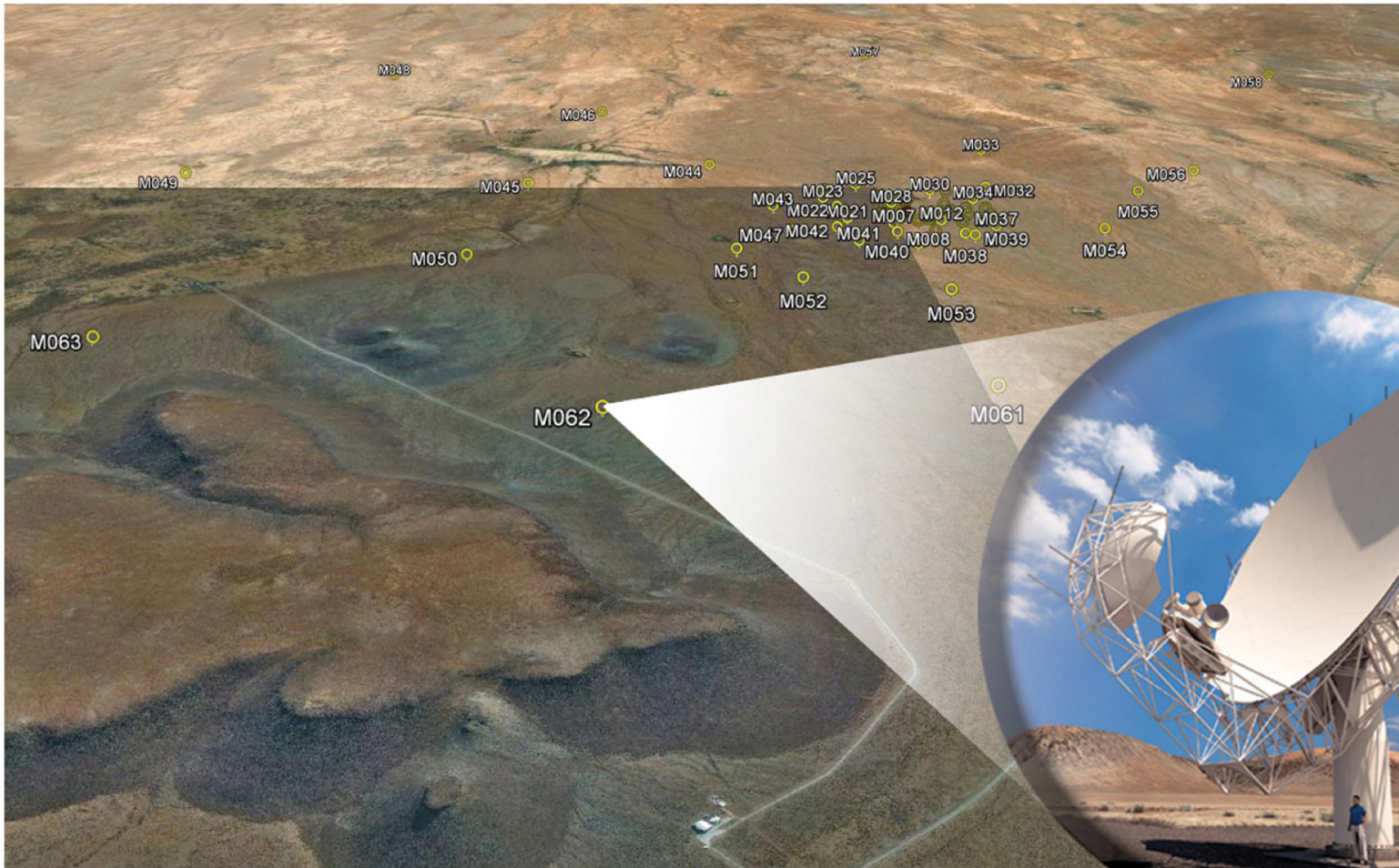


# First Antenna Installation





# MeerKAT Configuration Layout





# MeerKAT Core Stations





# MeerKAT Central Processing Site



# MeerKAT Receivers



- L-band receiver development and design completed
  - EMSS Antennas
    - Leads SKADC L/S band feed/LNA development and optical design
  - Example of successful industry participation in SKA
- Value Engineering (no cost/schedule impact):
  - Sensitivity spec – 220 m<sup>2</sup>/K
  - Expected performance – 311 m<sup>2</sup>/K (L-band)
  - 41% improvement in sensitivity
  - Survey speed of MeerKAT doubled
- PDR August 2012
- Qualification of receiver in Karoo (image)
- CDR successfully completed January 2014
- UHF Band receiver development near completion
  - CDR scheduled June 2014
- Manufacturing tender issued (L and UHF) – award July 2014

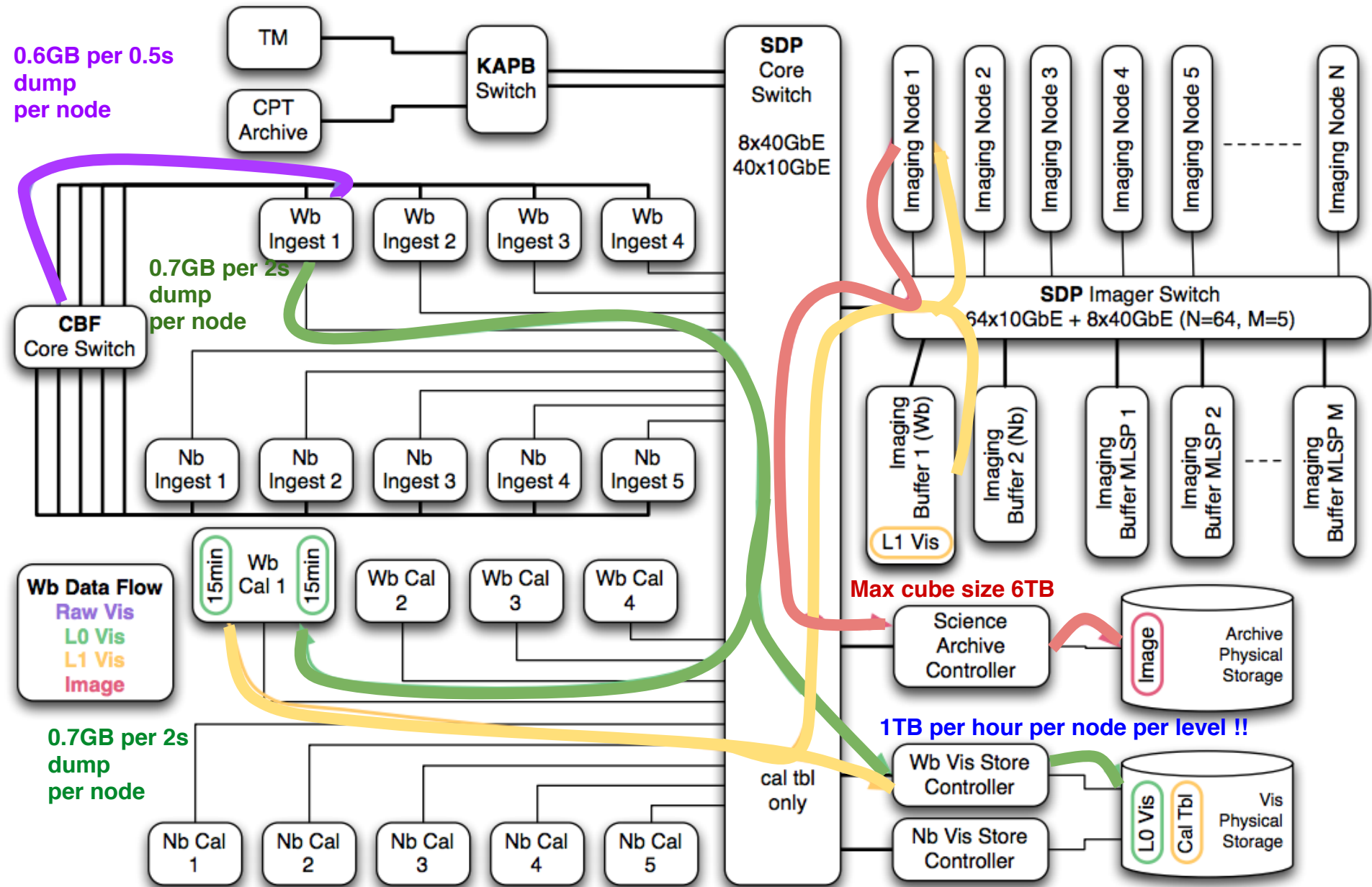




# Correlator channelisation

Name	Bandwidth/[MHz]	Number of channels	Channel width/[kHz]	Correlator integration/[s]
Wideband Course ( <b>wc</b> )	856 : 720 usable	4096	209	0.5
Wideband Fine ( <b>wf</b> )	856 : 720 usable	32768	26 (5km/s)	0.5
Narrowband Fine ( <b>nf</b> )	5 x (856/64=13.4)	4096	3.3	0.5
Narrowband Double ( <b>nd</b> )	5 x (856/128=6.7)	4096	1.6	0.5
Pulsar timing	TBD	TBD	TBD	0.5
VLBI	$2^N * 500 * 32$	32	$2^N * 500$	0.5
Incoherent beam total power	856	4096	209	0.001
Antenna voltage buffer	TBD	TBD	TBD	N/A
TA (x4) voltage	TBD	TBD	TBD	N/A
TA (x4) correlation products	TBD	TBD	TBD	0.5
Fly's eye transient search	TBD	TBD	TBD	TBD

# Science and data processing rates



# MeerKAT Timeline



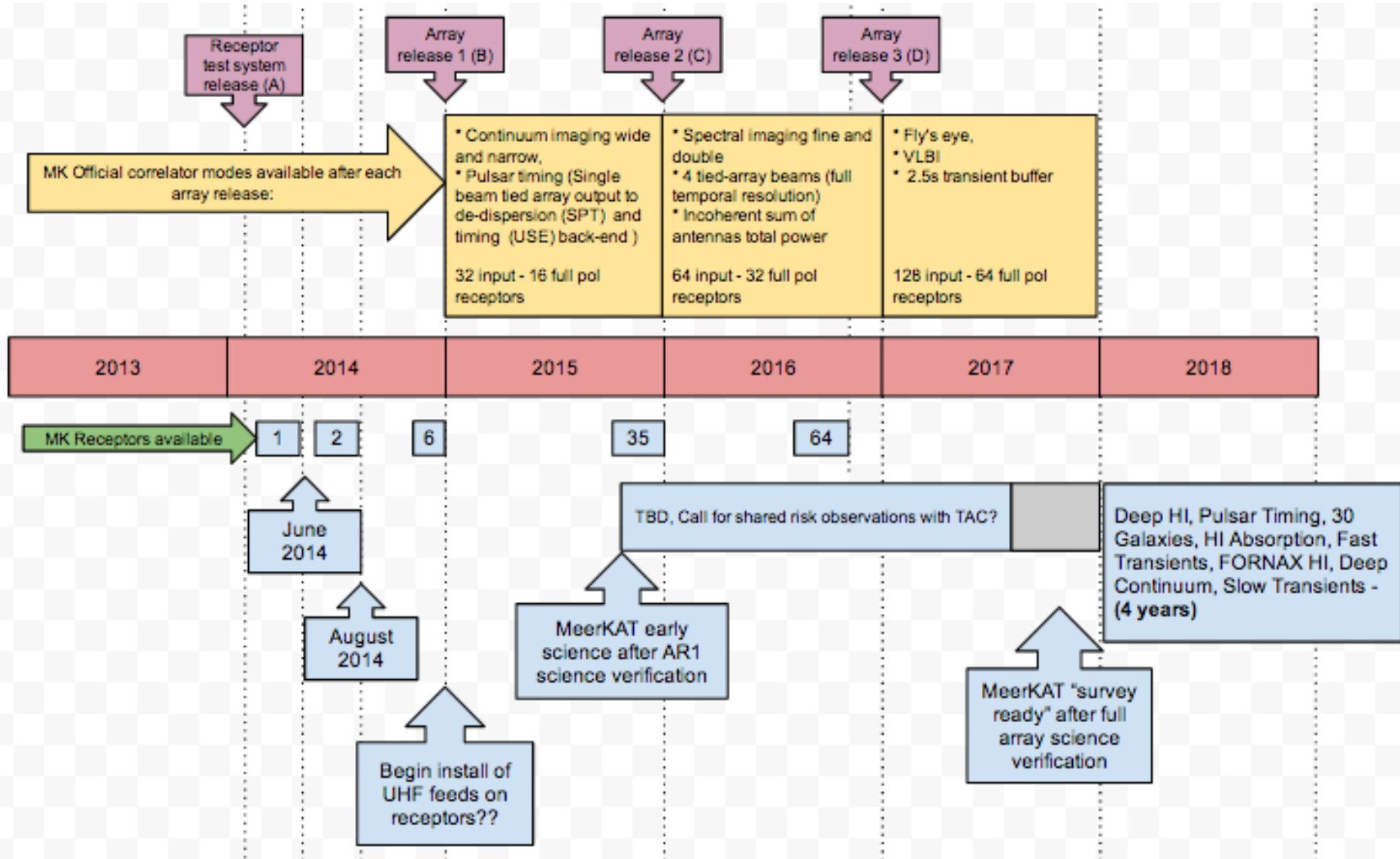
- Antenna 1 ready for RTS Integration mid July 2014
- Antenna 2 ready for RTS Integration : end Oct 2014
  - 1<sup>st</sup> 2 antennas = RTS (Receiver Test System)
- RTS Testing completed end of 2014
- Antenna Qualification completed Jan 2015
- Antennas 3 and 4 installed Feb 2015
- Array release 1 (Antenna 1-4) I&V complete: 29 June 2015 (depends above)
- Array release 1 science commissioning complete: 28 Sept 2015
- Array release 2 (Antenna 5-32) I&V complete: 14 March 2016
- Array release science commissioning complete: 13 June 2016
- Array release 3 (Antenna 33-64) I&V complete: 15 Dec 2016
- Full Array available for science: 17 April 2017

I&V Complete = Ready for Science Commissioning

Science ready = Science Commissioning completed

Functionality required from various subsystems for various array releases has been defined.

# MeerKAT Timeline

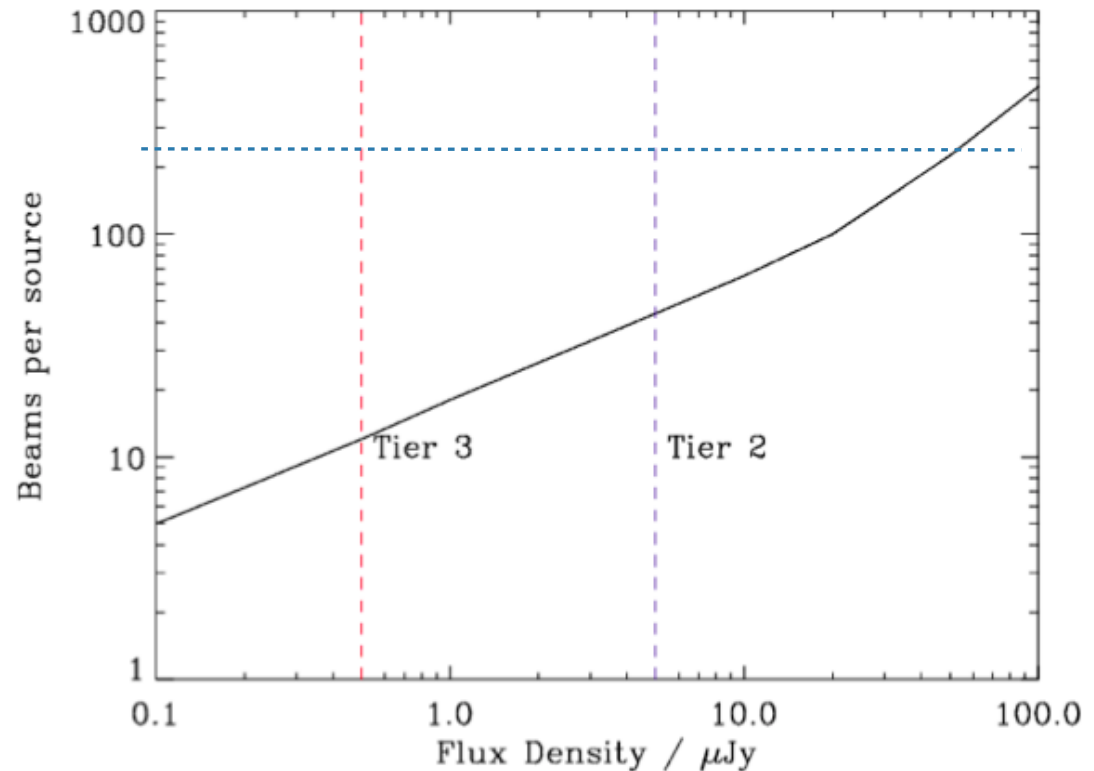
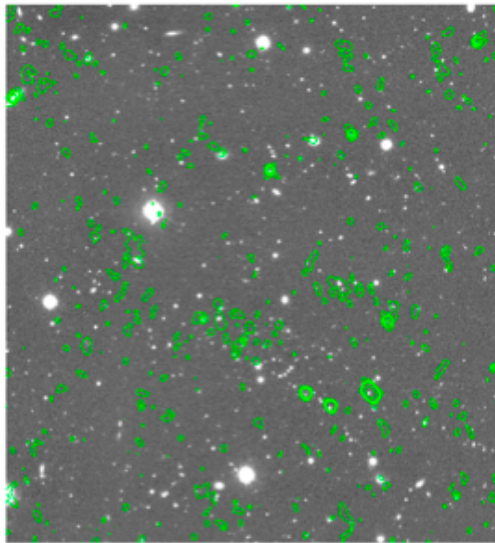


# MIGHTEE issues



Longest baseline is 8 km. Unless extended we will be working in a confusion limited regime in Stokes I (probably OK for polarization..)

Need to learn how to work in the confusion regime





# MIGHTEE issues

## Ramp up survey planning activity

- MIGHTEE has been largely inactive since the proposal
- Review of survey strategy. It has been several years now since the proposal. Review science goals and strategy.
- Alignment and synergy with other survey project (SPARC)
- Early science plan, technical demonstration and data processing

