

Signature
N. Green

Future Plans for the Parkes Radio Telescope in the era of the SKA

2017 Asia-Pacific Regional IAU Meeting

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CSIRO ASTRONOMY AND SPACE SCIENCE
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Overview

The CSIRO Parkes Radio Telescope, the ‘Dish’

Square Kilometre Array **technology** with the Dish

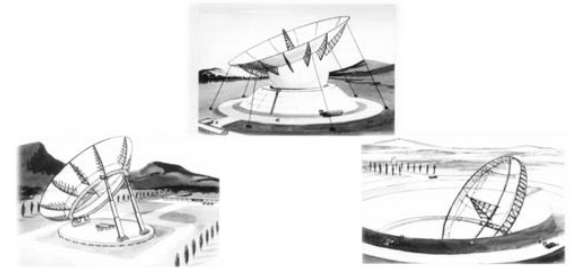
Square Kilometre Array **science** with the Dish

Square Kilometre Array **education** with the Dish

Parkes Radio Telescope, 'The Dish'

Brief History

- 64 m radio telescope, ~380 km west of Sydney, ~20 km north from town of Parkes, owned and operated by CSIRO
- Three years to design and two years to build - officially opened on 31 October 1961
 - Operating for more than 55 years
- Continual upgrades & evolution have been key (new surfaces, new focus cabin, new receivers e.g. multibeam, backend systems)
- Multitude of scientific discovery
- Other activities - space craft tracking ('The Dish')



Parkes Radio Telescope, ‘The Dish’

Current capabilities

- 700 MHz to ~25GHz across 8 receivers
 - Including 13-beam ‘multibeam’ system
- Spectral and temporal back end capabilities
 - For single-beam time domain (events < 1s) and spectrometry (“DFB4”)
 - For single-beam time domain and new limited piggyback spectrometry (“CASPSR”)
 - For multi-beam (13 beams) time domain and spectrometry (“HIPSR/BPSR”)
 - Real-time Fast Radio Burst detection
 - For Very Long Baseline Interferometry, VLBI (“DAS” & “Mk-V”)



SKA Technology with the Dish

Phased Array Feed Development



- Crucial to enabling high survey speeds for large-area/all-sky science
- Consortium working on PAF designs, part of Advanced Instrumentation Programme -> Observatory Development Programme
- Various designs/technologies being explored
- Australian SKA Pathfinder Phased Array Feeds
 - Initial 'BETA' used CSIRO 1st generation, "MKI", PAFs
 - 30 now outfitted with 2nd generation, "MKII" PAFs -> 36

The teams from Canada (NRC), the Netherlands (ASTRON) and Australia (CSIRO) with their respective Phased Array Feed designs



SKA Technology with the Dish

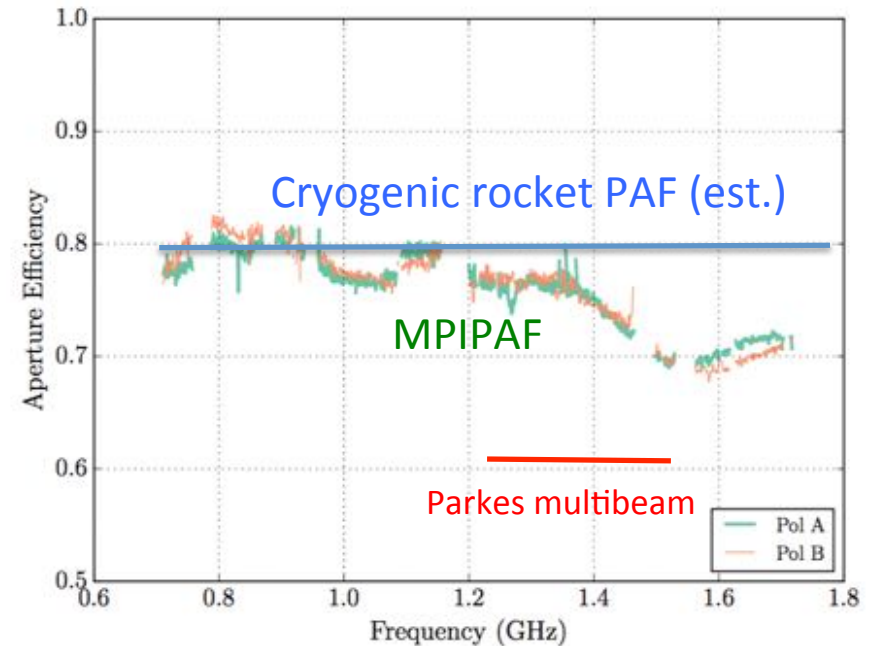
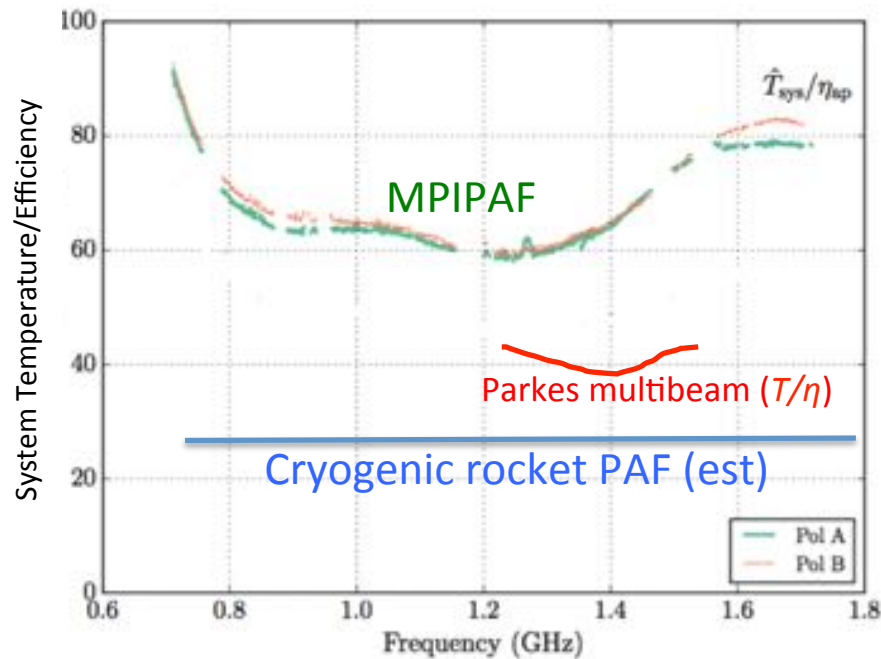
Phased Array Feed Development

- Max Planck Institute (MPIfR) Phased Array Feed - Repurposed ASKAP feed (“MKII”), commissioned on Parkes in 2016
 - Timed 3 Pulsars simultaneously
 - Spectral line observations - very flat and stable bandpass
- 12-m antenna monitoring Vela pulsar (“MKII” PAF)
- ‘Rocket’ Phased Array Feed (third generation)
 - Prototype on dish testing (plus aperture tests) May 2016 - very encouraging for purpose built version
 - 700MHz – 2GHz, 3 x MB field of view, sub-20K Tsys
 - LIEF proposal submitted for funding for 2018 construction



SKA Technology with the Dish

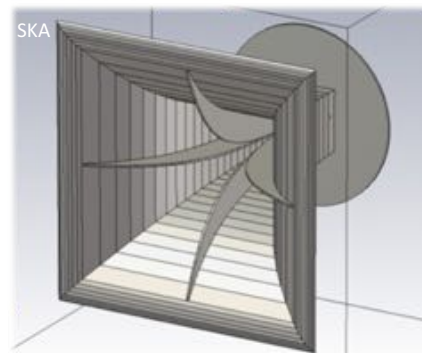
Phased Array Feed Development



SKA Technology with the Dish

Wide-bandwidth feeds

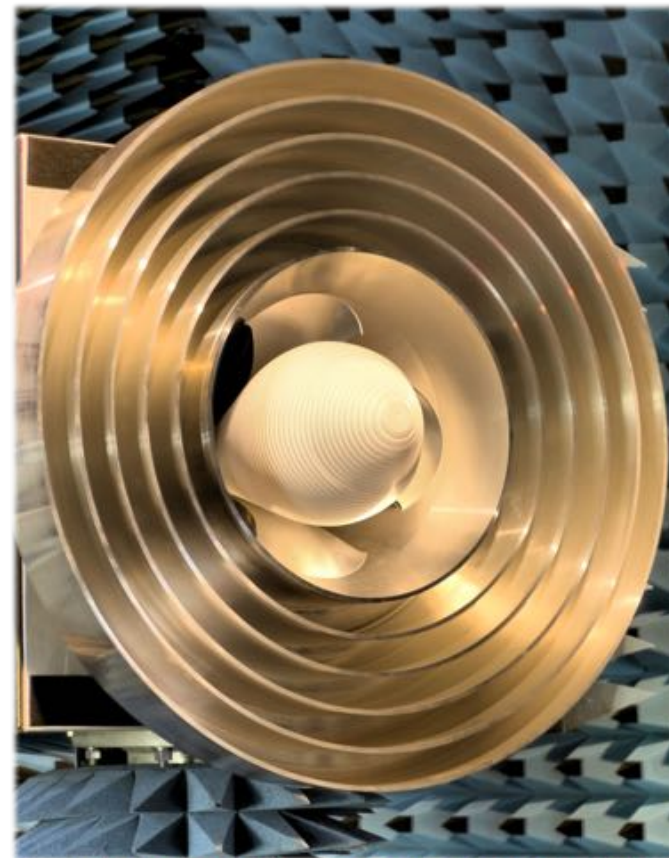
- Enables affordable frequency agility and more science!
- SKA consortium dedicated to this activity ('WBSPF'), part of Advanced Instrumentation Programme
- Typical receivers have an 'octave' bandwidth ratio of $\sim 1:1.85$, e.g. H-OH receiver is 1.2 to 1.8 GHz
- 'Wide-bandwidth' pushes technology to ratios of 1:3, 1:5, 1:10....
- Reduces need for multiple receivers and provides more frequency coverage simultaneously



SKA Technology with the Dish

Wide-bandwidth feeds

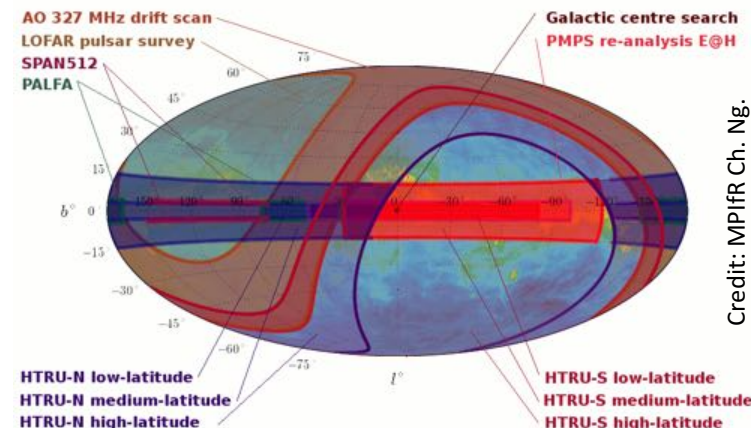
- Ultra-Wideband Low Frequency Single Pixel Feed
 - Quadridge structure with dielectric spear
 - 0.7—4.0 GHz
 - Partly funded through Australian Research Council LIEF grant
 - Scheduled for completion and installation late 2017
- Ultra-Wideband Mid/High Frequency Single Pixel Feed(s) in planning
- One or two feeds to cover 4 GHz up to 25 GHz
- Wideband feeds share 'pan': focus cabin with 1 PAF + single pixel coverage 0.7 -> ~25 GHz



SKA Science with the Dish

Pulsars and Transients

- Pulsar Searching
 - Detection machine >1500, ~1/2 of all
 - Cryo-PAF – larger field of view + localisation
- Parkes Timing
 - Parkes Pulsar Timing Array (PPTA): decade of high precision measurements
 - Ultra-Wideband – increased sensitivity / improved Time-Of-Arrivals
- Transients - Fast Radio Bursts (FRBs)
 - First FRB discovered with Parkes (Lorimer et al. 2007)
 - >=21 of >=26 to date discovered with Parkes
 - Major search campaigns, e.g. SUPERB real-time detection project
 - Cryo-PAF – larger field of view + localisation



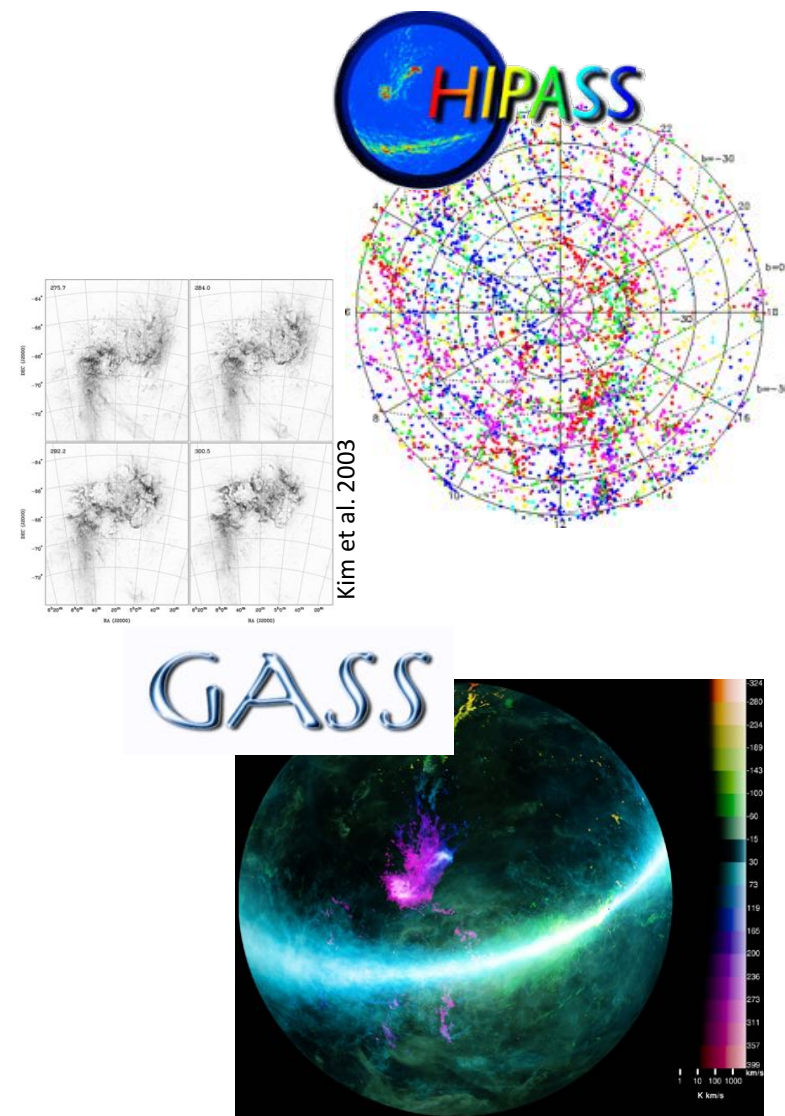
Credit: MPIfR Ch. Ng.



SKA Science with the Dish

Hydrogen over cosmic time

- HI Parkes All Sky Survey (HIPASS), Southern Galactic Plane Survey (SGPS), Galactic All Sky Survey (GASS)
- Parkes surveyed own Galaxy, Magellanic clouds, 1000s of nearby Galaxies, pushing further in redshift
- Observations made with MPIfR PAF
- Cryo-PAF HI - intended for galaxy gas content, cosmic web, intensity mapping



SKA Science with the Dish

Search for Extra Terrestrial Intelligence: Breakthrough Listen

- 5-year programme, multi-year investment for telescope time
- Officially began observing October/November 2016
- Observing blocks each day, stepping in time (Local Sidereal Time) through the week
- Dedicated backend managed by University of California, Berkeley
 - Initial test system installed Feb/Mar 2016
 - Single beam system installed Sept & Dec 2016
 - Multibeam system installed June 2017
- Open access to data planned (through Pawsey)
- Targeted observations, Galactic plane survey, transients/FRB simultaneous searches



BREAKTHROUGH
LISTEN



SKA Education with the Dish

PULSE@Parkes and OPTIMUS

- PULSE@Parkes programme
 - Pulsar focused, secondary-level education programme with real-time access to, and control of, Parkes Telescope
 - ~1500 high school students to date, ~130 schools, sessions across Australia, plus Canada, China, England, Japan, South Africa & Wales
- **O**bserving with **P**arkes, **T**raining and **I**ntroduction, **M**odule for **U**niversity **S**cience, **OPTIMUS**, programme
 - Undergraduate/postgraduate extension
 - Part of CSIRO's 'ON **PRIME**' development scheme
 - Undergraduate level training package including Parkes telescope time
 - Extending/varying science to include other aspects
 - Please contact Rob Hollow, George Hobbs or myself



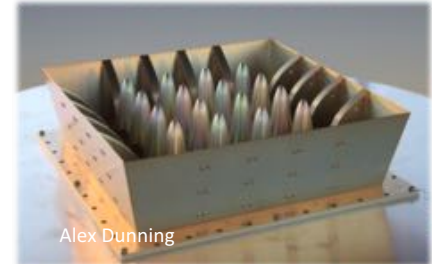
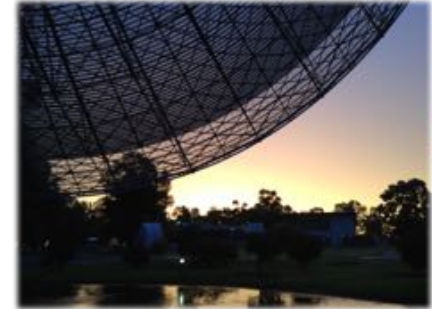
See Robert Hollow's talk on Thursday



Summary



- Parkes formally recognised as SKA Pathfinder
- Wideband feed(s) coming to Parkes
- Cryogenically cooled Phased Array Feed proposed for Parkes
- SKA oriented science underway & enabled by technology
- Training avenues for future SKA scientists
- Telescope time available, proposal & purchase





Thank you

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