Parkes & the SKA

Technology for the future

Jimi Green

OzSKA 3 | 08th May 2017

Overview

Parkes recognised as an SKA Pathfinder in 2016 for phased array and wide-bandwidth feed technology development

Parkes also undertaking science geared towards the science priorities of the SKA

The 'Dish'

Phased Array Feeds

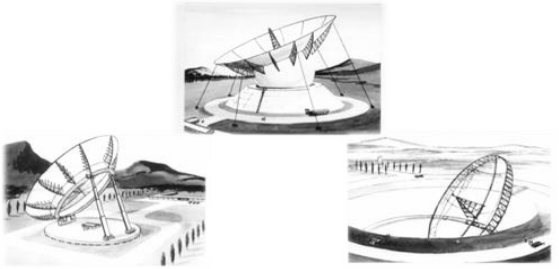
Wide-bandwidth Feeds

SKA Science with Parkes

‘The Dish’

Brief History

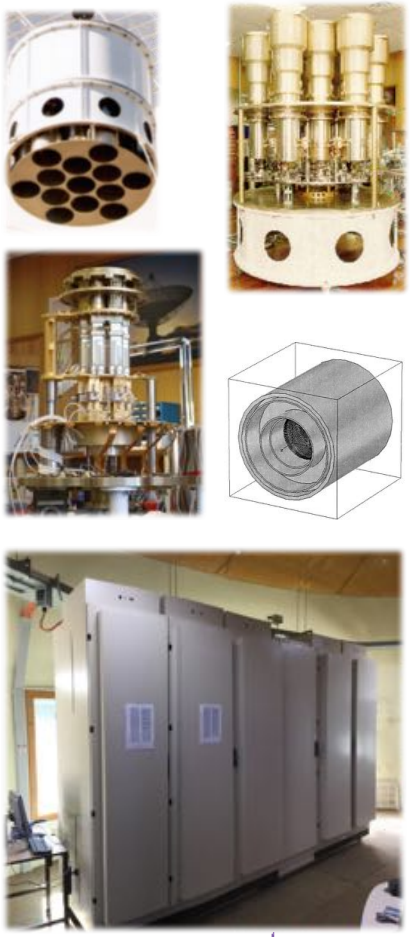
- 64 m radio telescope, ~380 km west of Sydney, ~20 km north from town of Parkes
- Three years to design and two years to build - officially opened on 31 October 1961
  - 55 years young last year!
- Continual upgrades & evolution have been key (new surfaces, new focus cabin, new receivers e.g. multibeam,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



‘The Dish’

Current Capability

- ‘Front-ends’:
  - 700MHz -> 22 GHz through numerous receivers including the 10/50 and the 13-beam multibeam
- ‘Back-ends’:
  - 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”)
  - For Very Long Baseline Interferometry, VLBI (“DAS” & “Mk-V”)
- Part of Long Baseline Array



LBA

Phased Array Feeds

Phased Array Feeds (PAFs)

SKA Perspective

- 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, e.g. ->
- 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

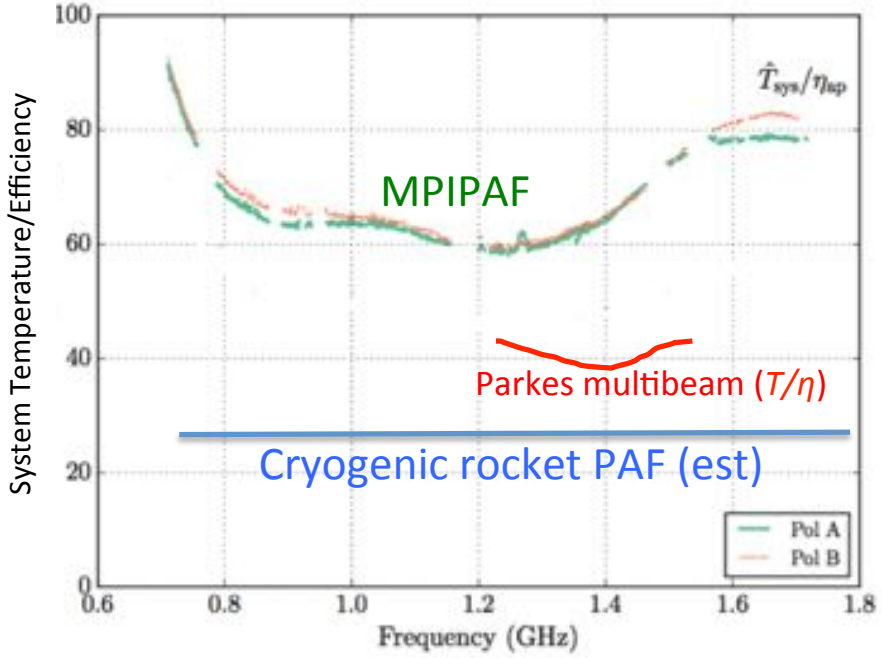
Phased Array Feeds (PAFs)

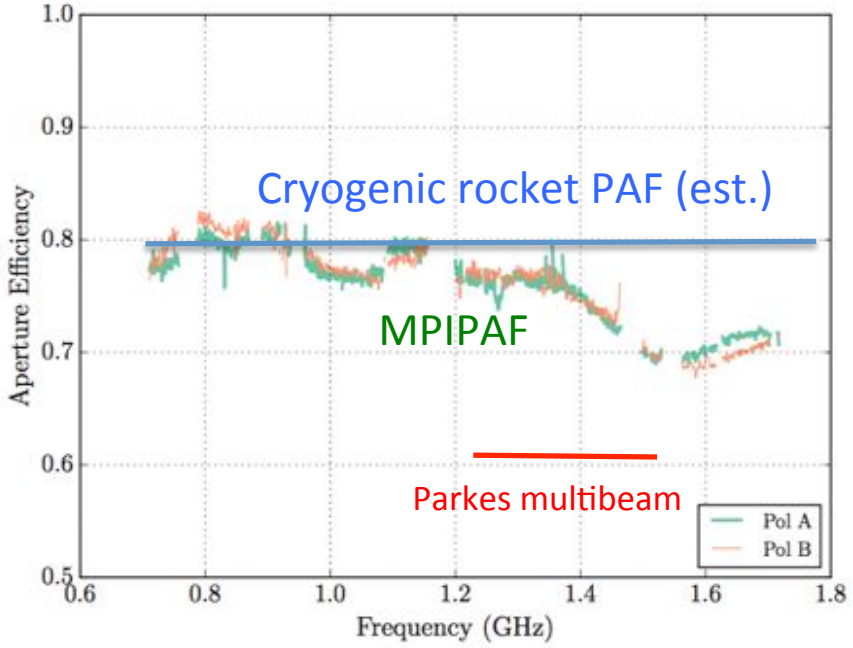
CSIRO & Parkes Development

- Max Planck Institute (MPIfR) Phased Array Feed - Re-purposed 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

Phased Array Feeds (PAFs)

CSIRO & Parkes Development



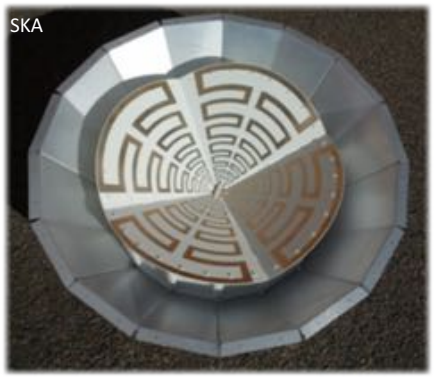


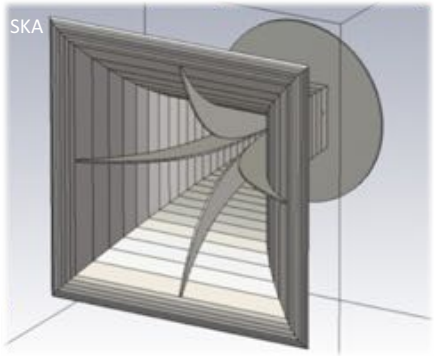
Wide-bandwidth Feeds

Wide-bandwidth Feeds

SKA Perspective

- 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 ~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

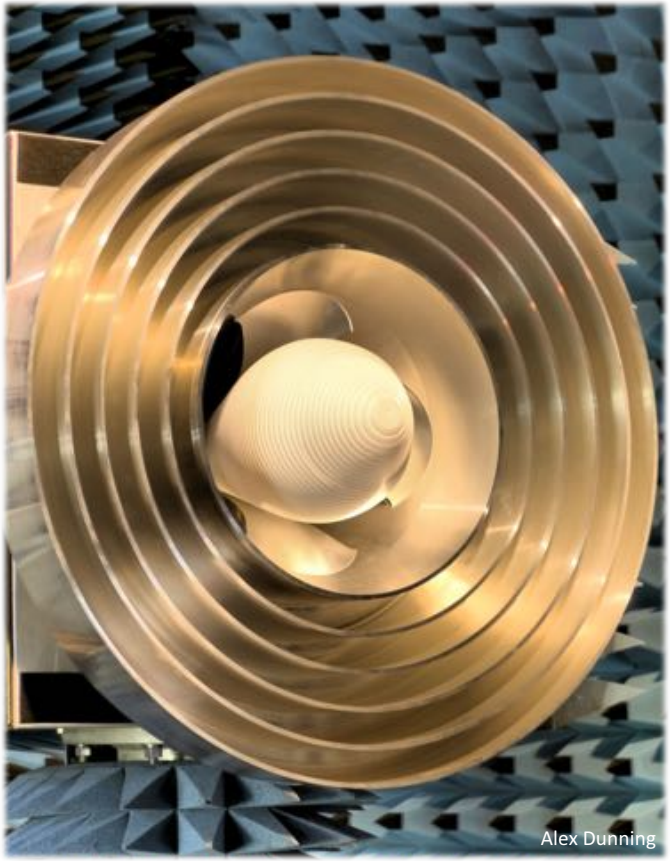




Wide-bandwidth Feeds

CSIRO & Parkes Development

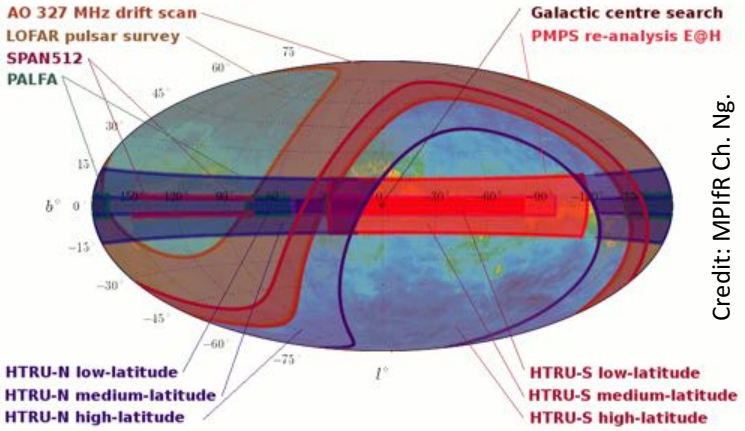
- Ultra-Wideband Low Frequency Single Pixel Feed
  - Quadridge structure with dielectric spear
  - 0.7—4.0 GHz
  - Partly funded through Australian Research Council LIEF grant
  - Scheduled for completion and installation late 2017
  - Ultra-Wideband Mid/High Frequency Single Pixel Feed(s) in planning
  - 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


Alex Dunning

SKA Science with Parkes

SKA Science

Pulsars and Transients



Credit: MPIfR Ch. Ng.

- Pulsar Searching
  - Detection machine >1500, ~1/2 of all
  - Cryo-PAF – larger field of view + localisation

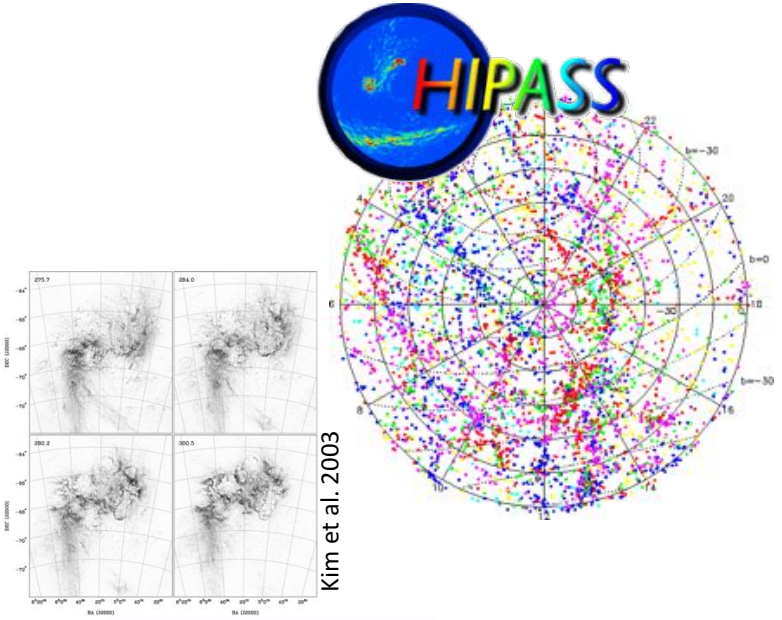
- Parkes Timing
  - Parkes Pulsar Timing Array (PPTA): decade of high precision measurements
  - Ultra-Wideband – increased sensitivity / improved Time-Of-Arrivals

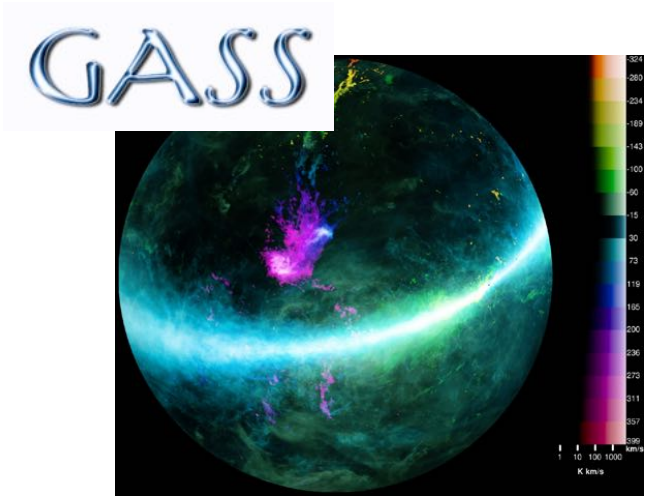
- Transients - Fast Radio Bursts (FRBs)
  - First FRB discovered with Parkes (Lorimer et al. 2007)
  - >=21 of >=26 to date discovered with Parkes
  - Major search campaigns, e.g. SUPERB real-time detection project
  - Cryo-PAF – larger field of view + localisation

SKA Science

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

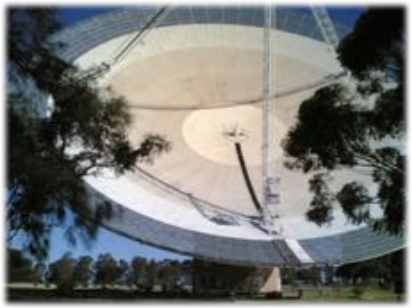




SKA Science

Search for Extraterrestrial 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 to be installed June 2017
- Open access to data planned (through Pawsey)
- Targeted observations, Galactic plane survey, transients/FRBs



BREAKTHROUGH LISTEN

BERKELEY SETI RESEARCH CENTER

Berkeley UNIVERSITY OF CALIFORNIA SETI INSTITUTE

CSIRO

SKA Science

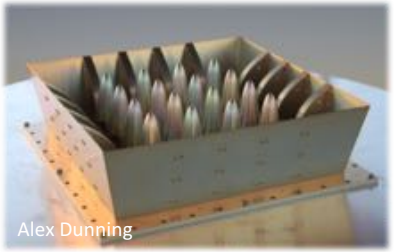
Preparing the astronomers of the SKA era

- 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

- Undergraduate Extension to the programme
  - **O**bserving with **P**arkes, **T**raining and **I**ntroduction, **M**odule for **U**niversity **S**cience: OPTIMUS
  - Part of CSIRO's 'ON PRIME' development scheme
  - Undergraduate level training package including Parkes telescope time
  - Extending/varying science to include other aspects
  - We'd love your input on developing this – please contact Rob Hollow or myself!

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



Thank you

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