

APAF for Parkes

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Outline

Technical Overview assumptions Science Goals:

- HI cosmic web
- HI intensity mapping
- Fast Radio Bursts
- Technical Advantages on other science:
 - Standing wave mitigation
 - OH / HI deep integrations
 - Stray radiation suppression



A Phased Array Feed for Parkes

700 - 1800 MHz

F

 Loose ~100 MHz around 900 MHz

Tsys ~ 50-60 K

efficiency ~ 0.8

FoV ~ 2.2 deg^2

Raw comparison in survey speed with MB: FoV x $(A_e/T_{sys})^2$:

• 1.25x MB



ADE PAF from A. Rispler talk 7 Nov 2013



Diffuse HI mapping

21

20

19

18

17

16

15

14

13

 $log(N_{HI})$ Neutral Hydrogen component



Popping et al (2009)



Galaxies require fresh fuel for their continued star formation

Simulations predict lots of gas at $N_{\rm H} \, ^{\sim} \, 10^{17} \, cm^{\text{-}2}$

Possible to find IGM with sensitive HI observations



Diffuse HI mapping

How much low column density HI is connecting galaxies?

- M31-M33 connection (Braun & Thilker 2005)
- Resolved into low N_H clumps with GBT (Wolfe et al 2013)
 - 50% of mass in clumps and the rest unresolved





HI Intensity Mapping

3D view of HI fluctuations and measurement of w

- Emission from many galaxies blended to create an intensity field
- Measure power spectrum of HI
 - rms fluctuations larger for smaller beam, smaller frequency width







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HI Stacking/Intensity Mapping

- A metric for survey speed is:
- SS = FoV x $\Delta v x (A_e/T_{sys})^2$
- Improvement over current MB plus HIPSR, and...
- Access to higher redshift
- Significant potential gains in systematics
 - Improved bandpass
 - Cleaner beams

	FoV 1.4 GHz $(de g^2)$	Δv (MHz)	A _e (m ²)	T (K)	SS1.4/S Smb	SS 700
MB _{current}	0.8	64	2250	28	1	-
MBhipsr	0.8	220	2250	28	3.4	-
PAF ₃₈₄	2.2	384	2573	50	6	2.9
PAF ₆₀₀	2.2	600	2573	50	9.4	4.5

Modified from Meyer ATUC 2012 talk



Fast Radio Bursts

- Strong (>1 Jy) Millisecond bursts (Lorimer+07, Thornton+13)
- Estimate (0.2 < z< 1)
- event rate of ~1.0 × 10⁴ events sky⁻¹ day⁻¹

Fully sample the focal plane for better localisation

- MB one-off localisation full beam ~30'
- PAF one-off localisation FWHM/S-N
 - For S/N of 10 that's 1.5' !





Technical Advantages

PAF can significantly reduce standing waves

- Parkes affected by wellknown 5 MHz standing wave
- Work with PAF on WSRT shows removal of standing wave
 - Estimate down by a factor x1000! (Oosterloo et al 2010)
 - Probably not quite as good for Parkes



efficiency vs freq for APERTIF PAF (Oosterloo et al 2010)



Technical Advantages: Nicer Beams



Galactic Longitude





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Kalberla et al. (2010)



Technical Advantages: Nice beams

A PAF should allow us to form nice beams for deep, low stray radiation, HI integrations

• Compete with GBT



Doing good things- even better

Diffuse HI:

- extended frequency range
- improved bandpass, better beams
- possibilities for improved RFI rejection

OH:

- Enable fast mapping, not currently possible with MB
- Better bandpass

Polarization mapping

- New frequency window
- Potentially excellent polarization performance (over smaller field of view?) Searching for transients:
- Comparable mapping speed to MB
- Broader bandwidth
- Better localisation



Why a PAF on Parkes is a good thing: I

Extend HI science to higher redshifts

- PAF frequency range 700 1800 MHz allows us to push below current MB redshift range to z=1
- Potential for sophisticated RFI rejection

Diffuse HI mapping:

- Modest gain/break even in survey mapping but:
 - Enormous potential improvement in spectral baselines
 - Improved beamshapes

Fast Radio Bursts

- Ability to improve localisation by factor of ~10 over MB
- Sky coverage is similar to MB, frequency coverage larger Cosmic rays



Why a PAF on Parkes is a good thing: II

Better understanding of PAFs

- Improve our understanding of beam-forming
- How good can they be?!
- How to deal with RFI in an increasing RFI environment
 Demonstrate viability for FAST?
- FAST will be a 500m single dish, imagine a PAF!



PAF minimum requirements

Requirement	Value			
Frequency Coverage	700 - 1800 MHz			
Instantaneous Bandwidth	380 - 600 MHz			
Spectral resolution	<1 kHz over narrow range(s); 5 kHz			
Tsys	50 K			
SKA1 PAF would	l he even hetter			





Build a PAF - Just Do It!



A PAF for PKS | Naomi McClure-Griffiths