

ASKAP

Discovery of a neutral gas outflow in a young radio galaxy

James Allison

Credits

Discovery of H I gas in a young radio galaxy at $z = 0.44$ using the Australian SKA Pathfinder

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Allison et al. (2015) submitted

Australian Square Kilometre Array Pathfinder

CSIRO's next generation radio telescope

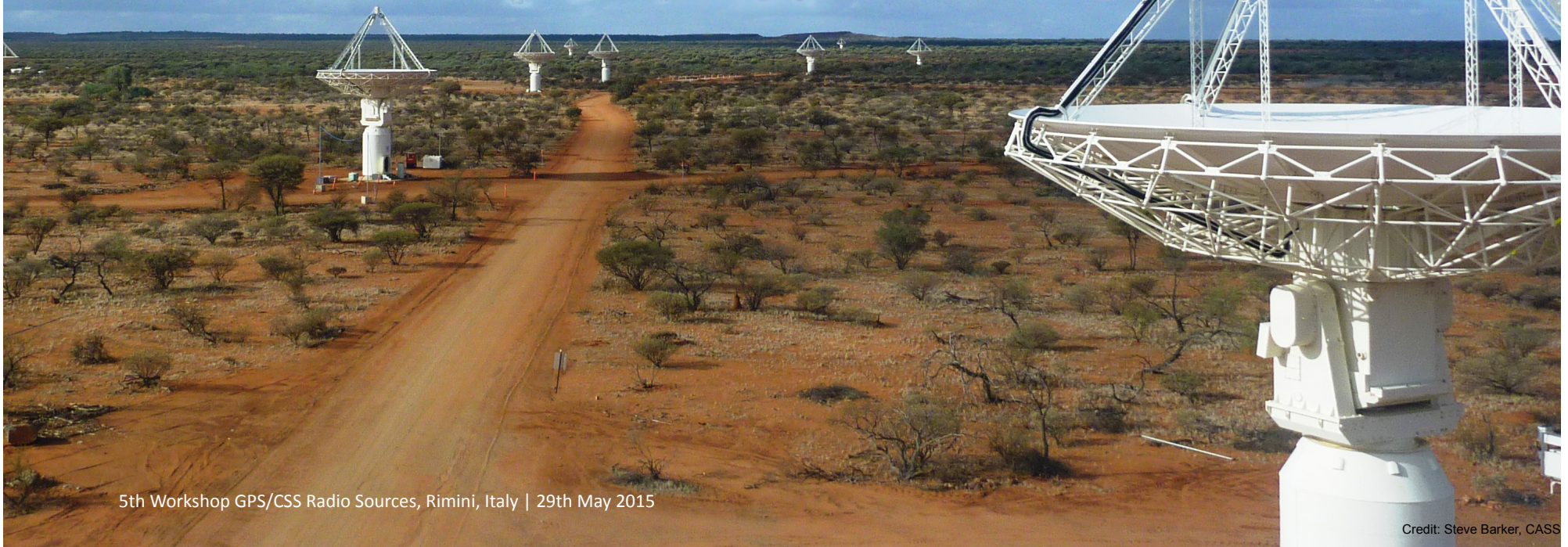
36 x 12m diameter dishes

3rd-axis rotation for excellent imaging performance

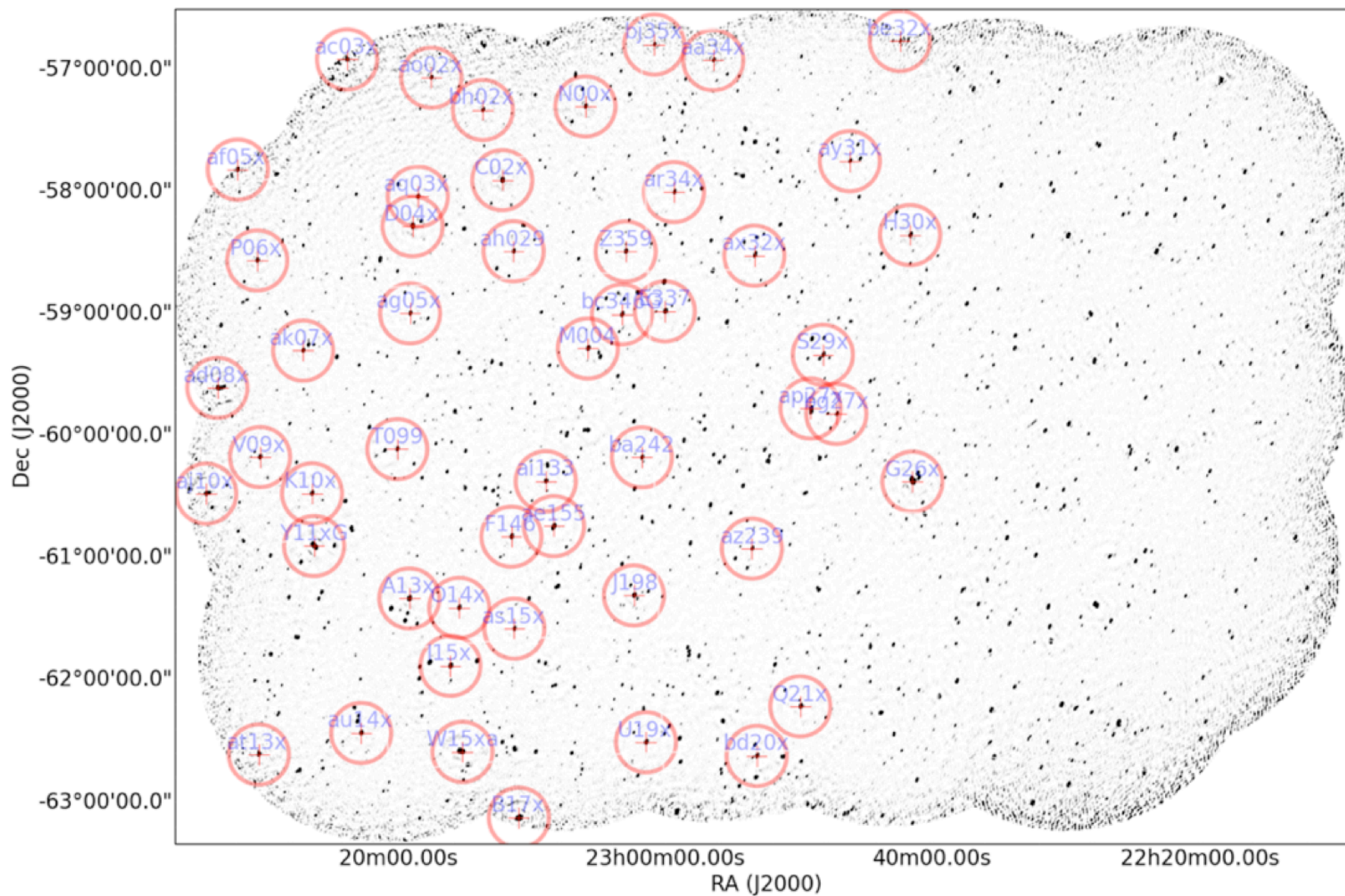
Phased-Array Feed receiver for wide-field coverage

36 beams covering 30 square degrees at once

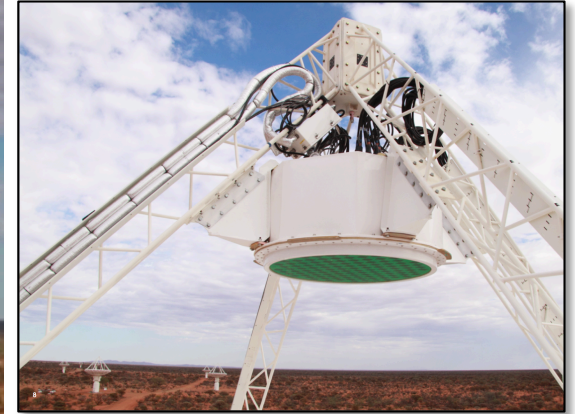
Exceptional radio-quiet environment



The Tucana Field (Ian Heywood and ACES)



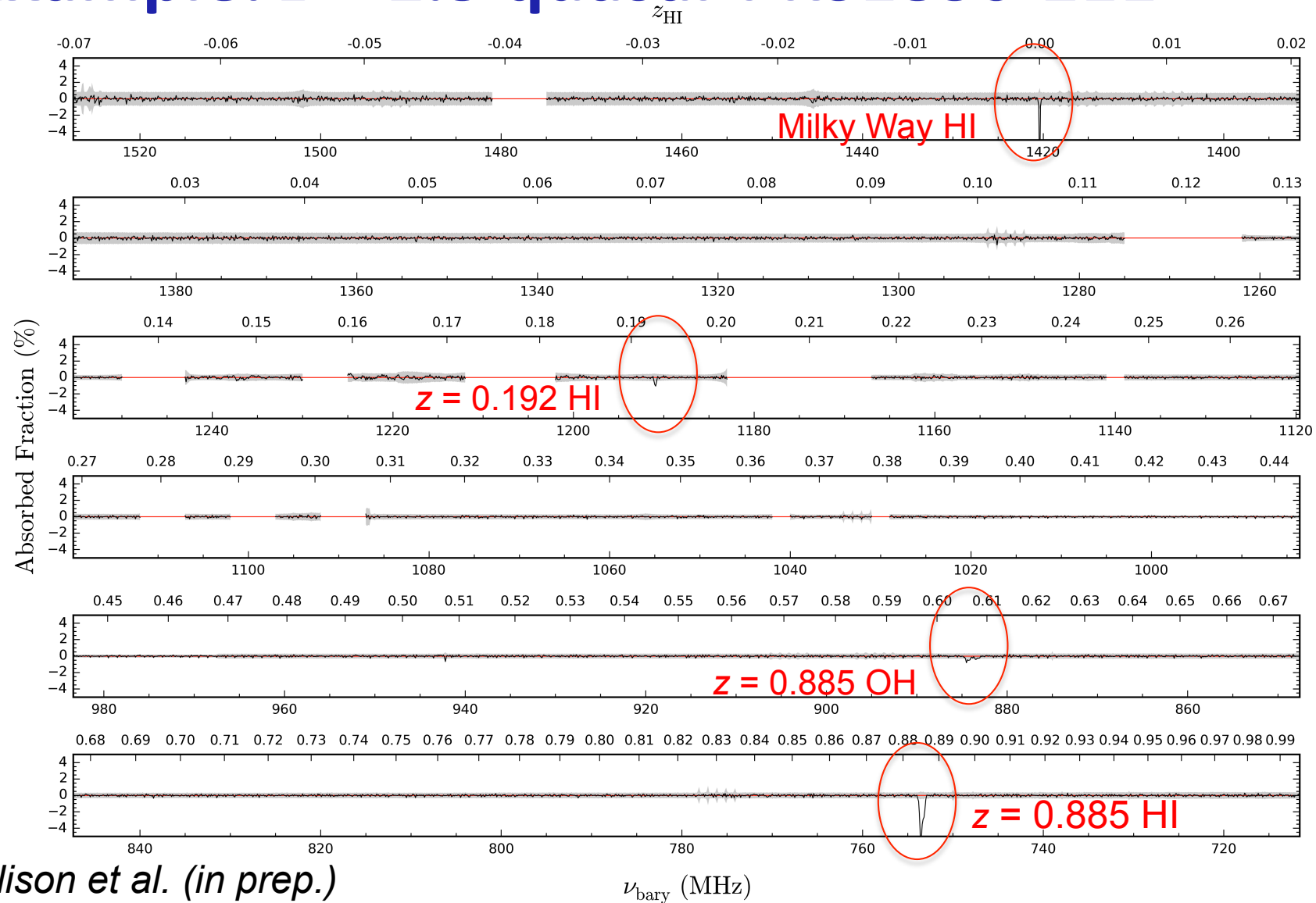
Why HI absorption with ASKAP?



ASKAP opens up an exciting new parameter space for HI absorption searches!

- Wide spectral bandwidth ($0.4 < z < 1.0$ simultaneously)
- Wide field of view (multiple targets simultaneously)
- Radio-quiet site (700-1000 MHz band is RFI-free)

Example: $z = 2.5$ quasar PKS1830-211



Allison et al. (in prep.)

The First Large Absorption Survey in HI

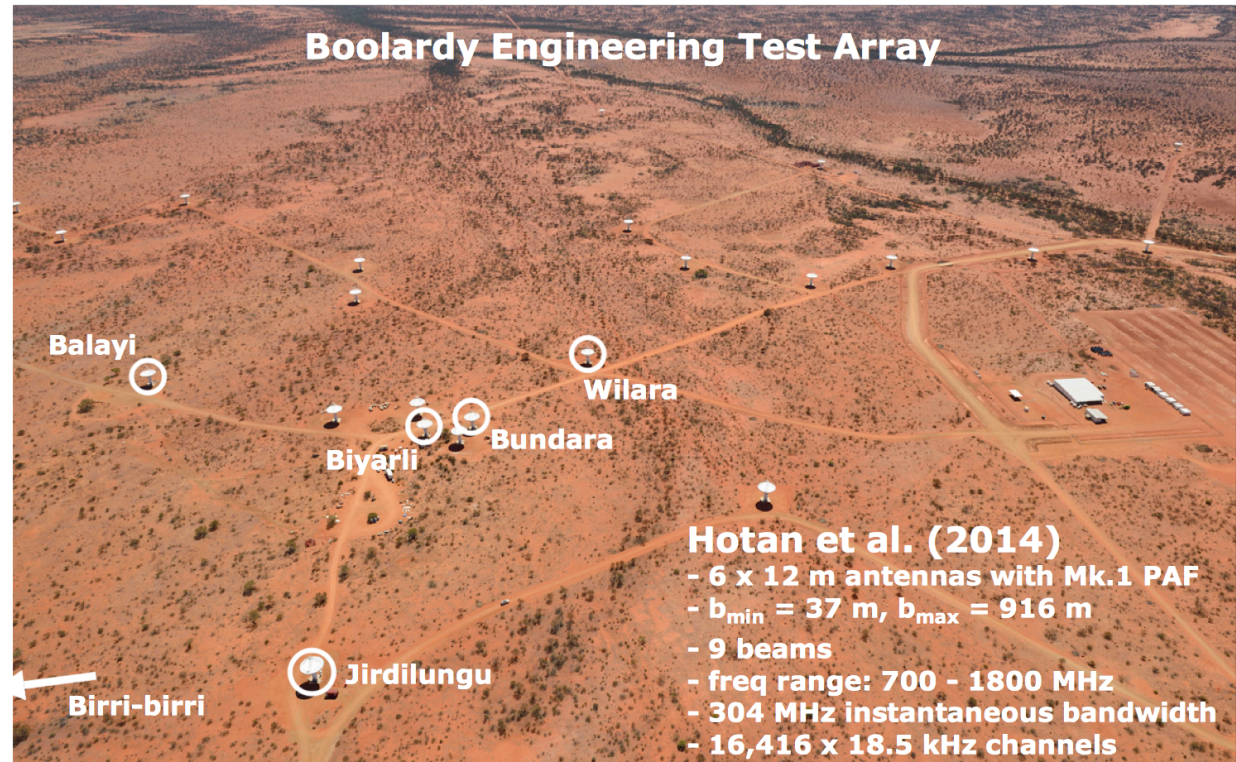
- PI **Elaine Sadler**
- ~ **150,000** sightlines to radio source targets
- > **1000** detections of HI absorption, an order-of-magnitude gain over current surveys
- Main focus is HI in the “**redshift desert**” between $z = 0.5$ and 1.0
- *Associated absorption*: Directly probe the neutral gas in and around radio-AGN, enabling study of the **evolution** of **feeding** and **feedback** processes
- *Intervening absorption*: Will assemble a large ‘HI-selected galaxy sample’ out to $z = 1.0$, plus (if possible) independent constraints on Ω_{HI}



Image credit: CSIRO

FLASH “lite”: Commissioning & Early Science

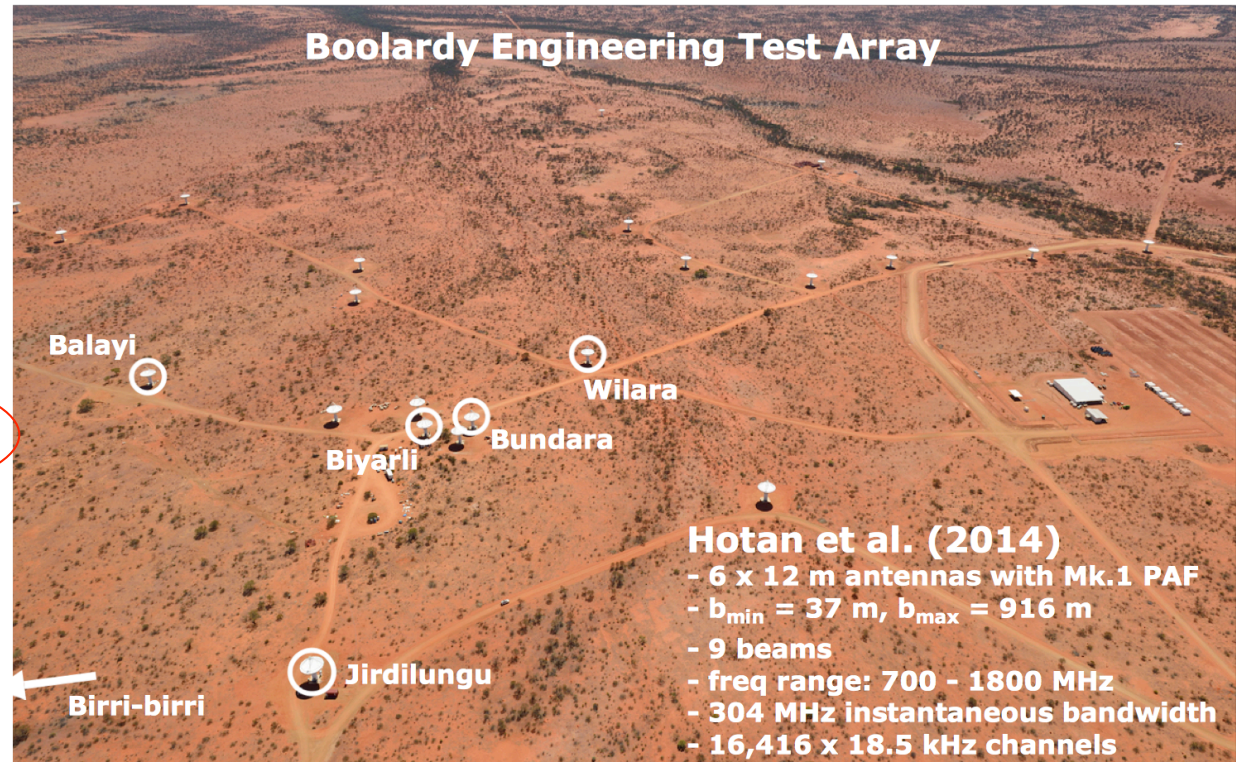
- Select **bright** ($> 1\text{Jy}$), **compact** radio sources in the southern sky
- Observe several sub-samples of source populations including:
 - **GPS/CSS** radio sources (Randall et al. 2011)
 - **Reddened quasars**
 - **The 2Jy radio sources**
 - Radio sources with **absorbed X-ray spectra**
 - Optical damped **Lyman- α** and **MgII** absorption intervening systems



HI absorption search at $0.4 < z < 1.0$: includes radio sources *without a known optical redshift*

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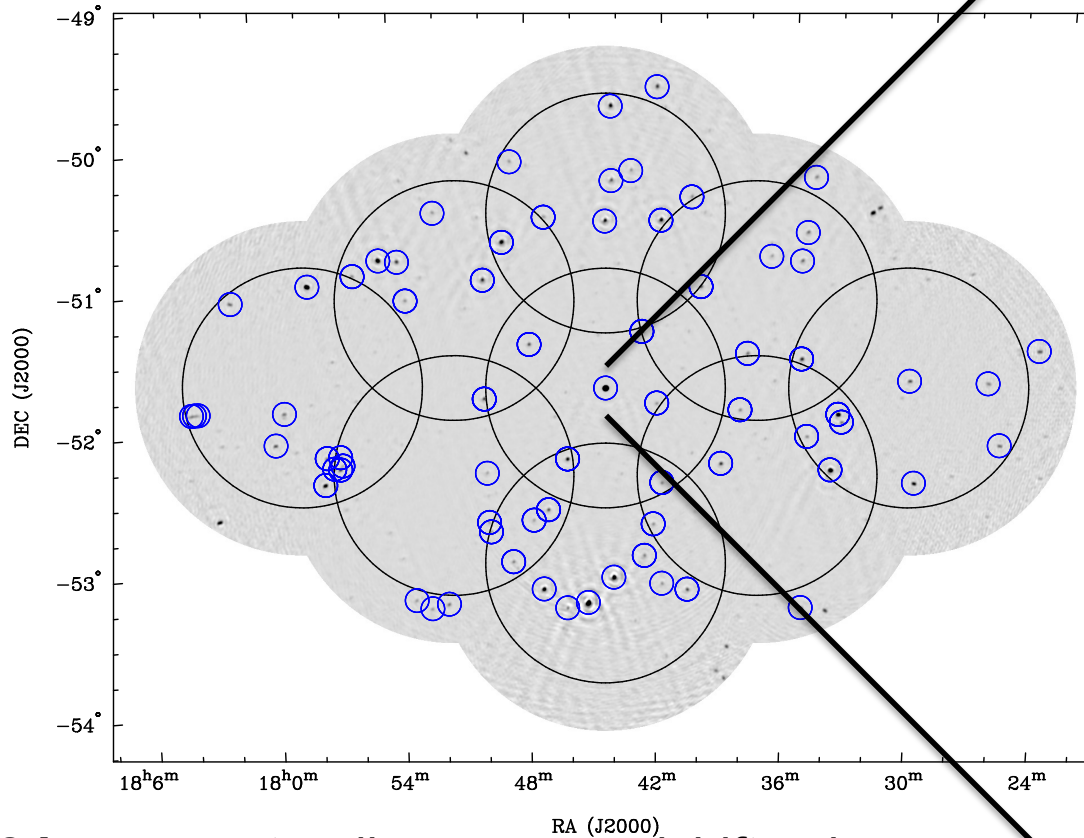
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GPS/CSS Sample

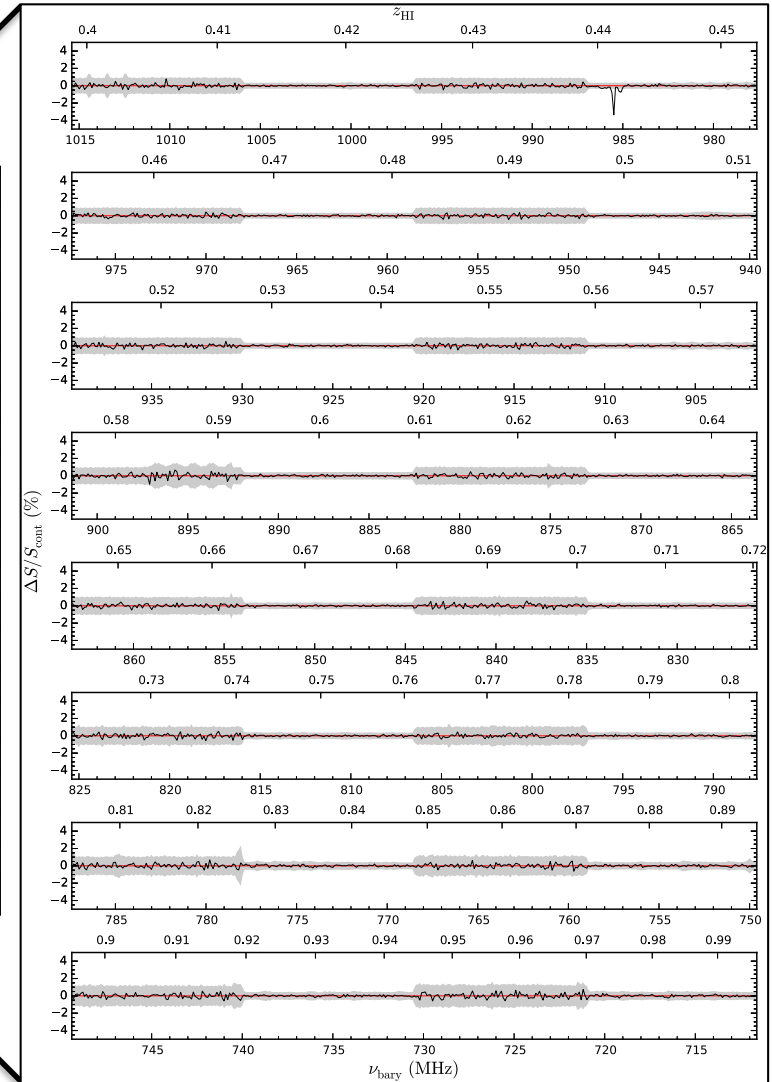
- Study the neutral gas environments of young radio AGN at cosmological redshifts
- Line of sight kinematics → **rotation, infalling gas, outflowing gas**
- Compare with existing results at lower redshift (e.g. Chandola et al. 2011; Geréb et al. 2014)
- Chosen from the **Randall et al. (2011)** bright GPS/CSS sample
- Brighter than **>1.5 Jy @ 2.7GHz**
- Select on redshift in **$z = 0.4 - 1.0$** (within 700MHz-1GHz band)
- All **13 sources** now observed
- Currently processing data concurrently with telescope commissioning and data pipeline development → next week's job!

PKS B1740-517 – first blind detection of HI

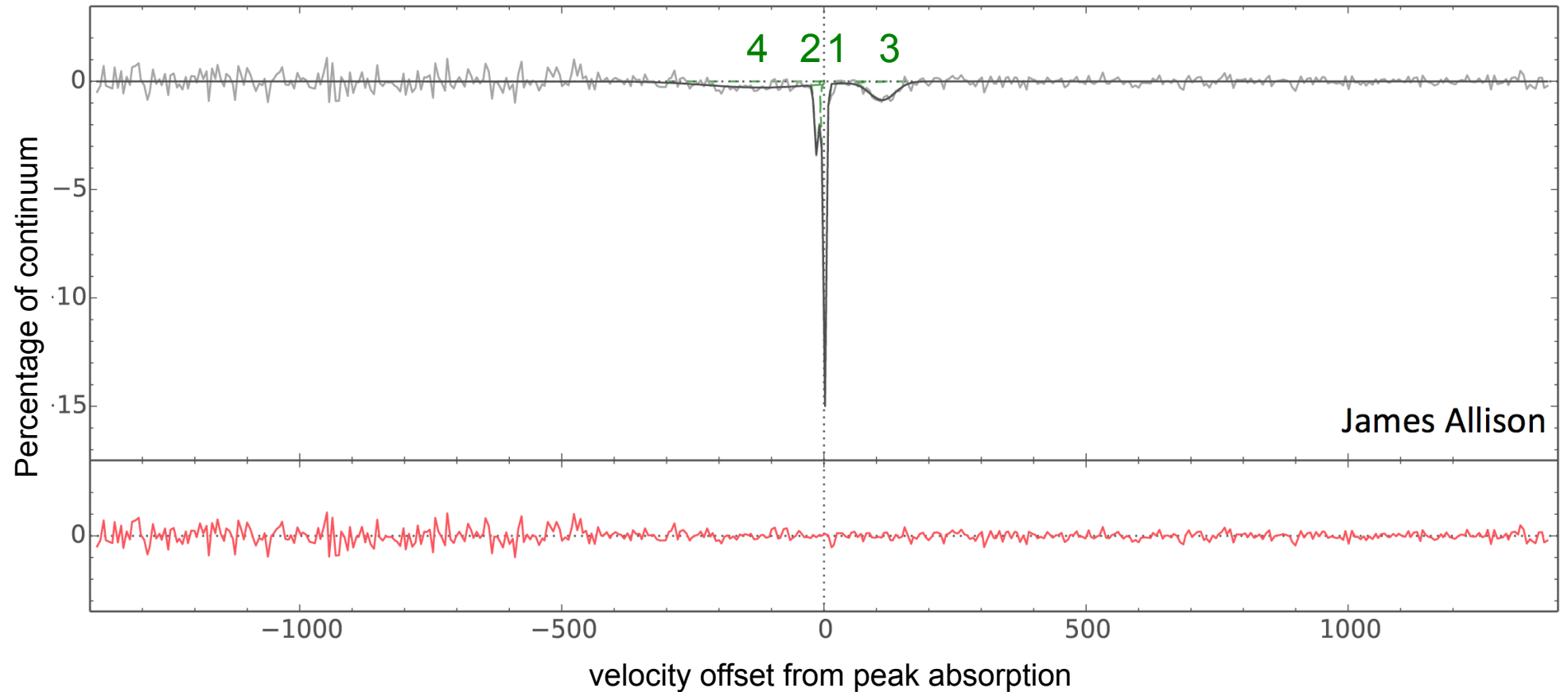
- 711.5 - 1015.5 MHz Band $\rightarrow z = 0.4 - 1$
- 16,416 x 18.5 kHz (~ 5 km/s) channels



8Jy compact radio source, redshift unknown, close to the galactic plane and centre

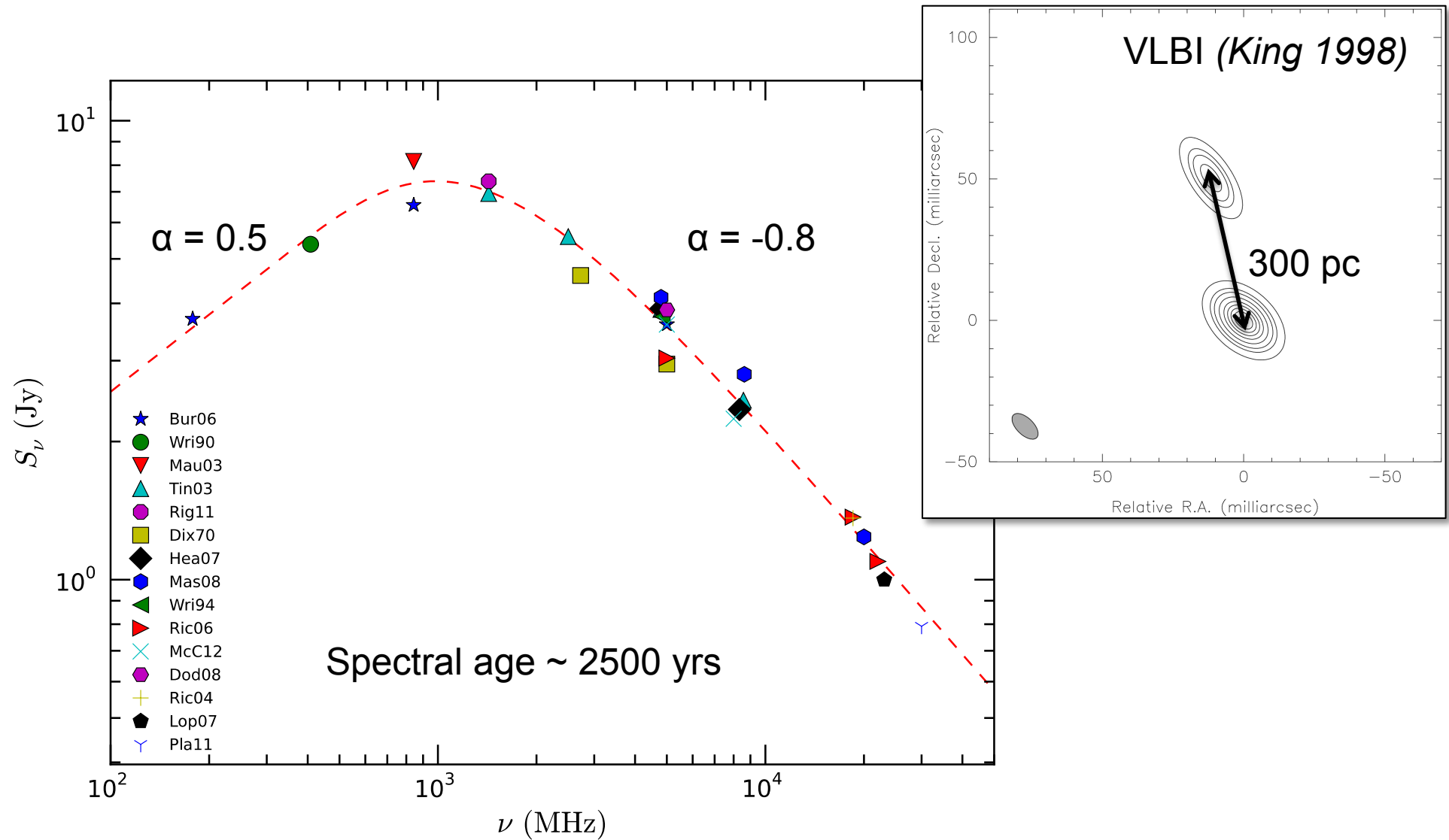


PKS B1740-517 – first blind detection of HI

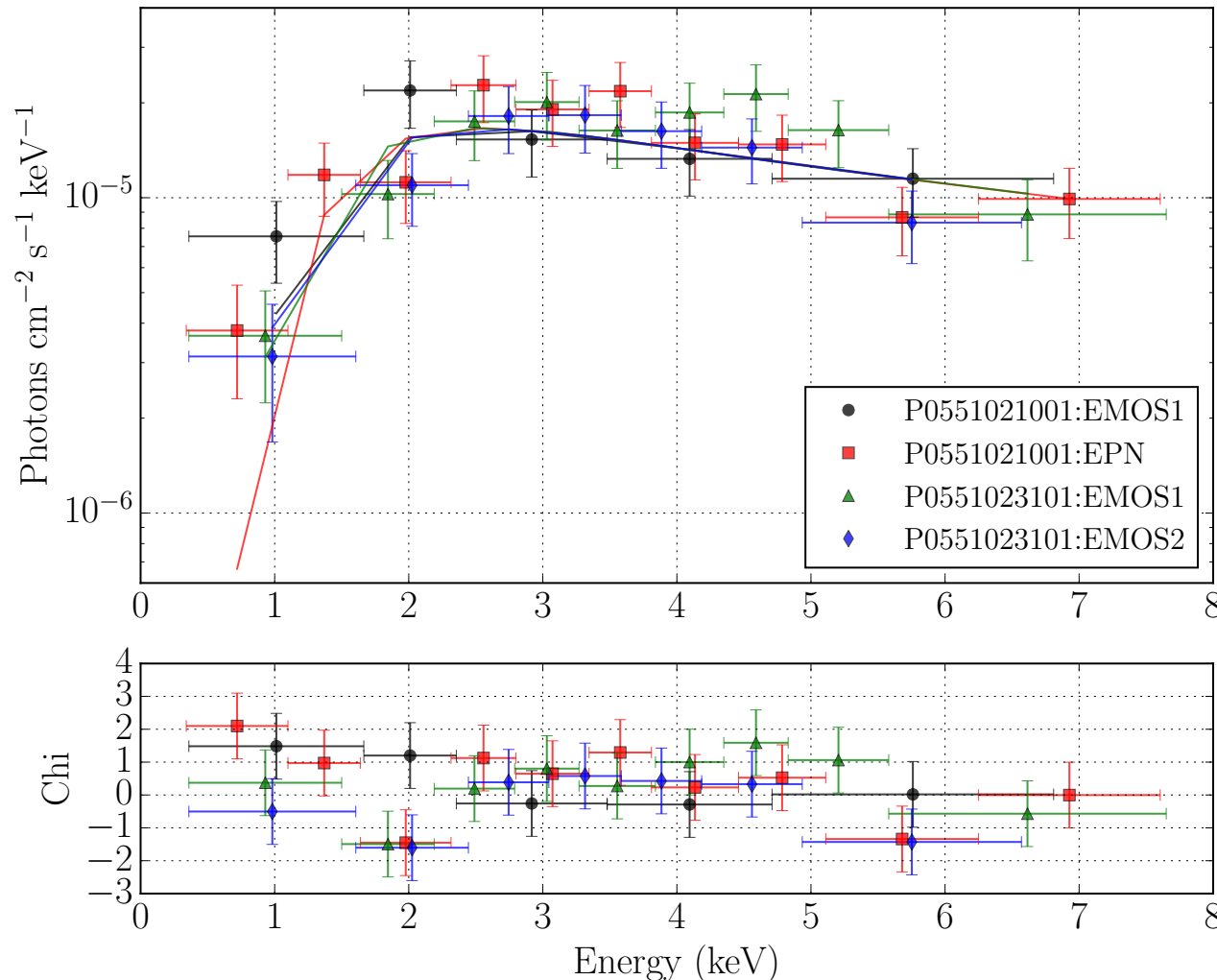


- Excellent quality spectrum with broad HI absorption at ~ 0.2% of the continuum

An archetypal GPS radio source

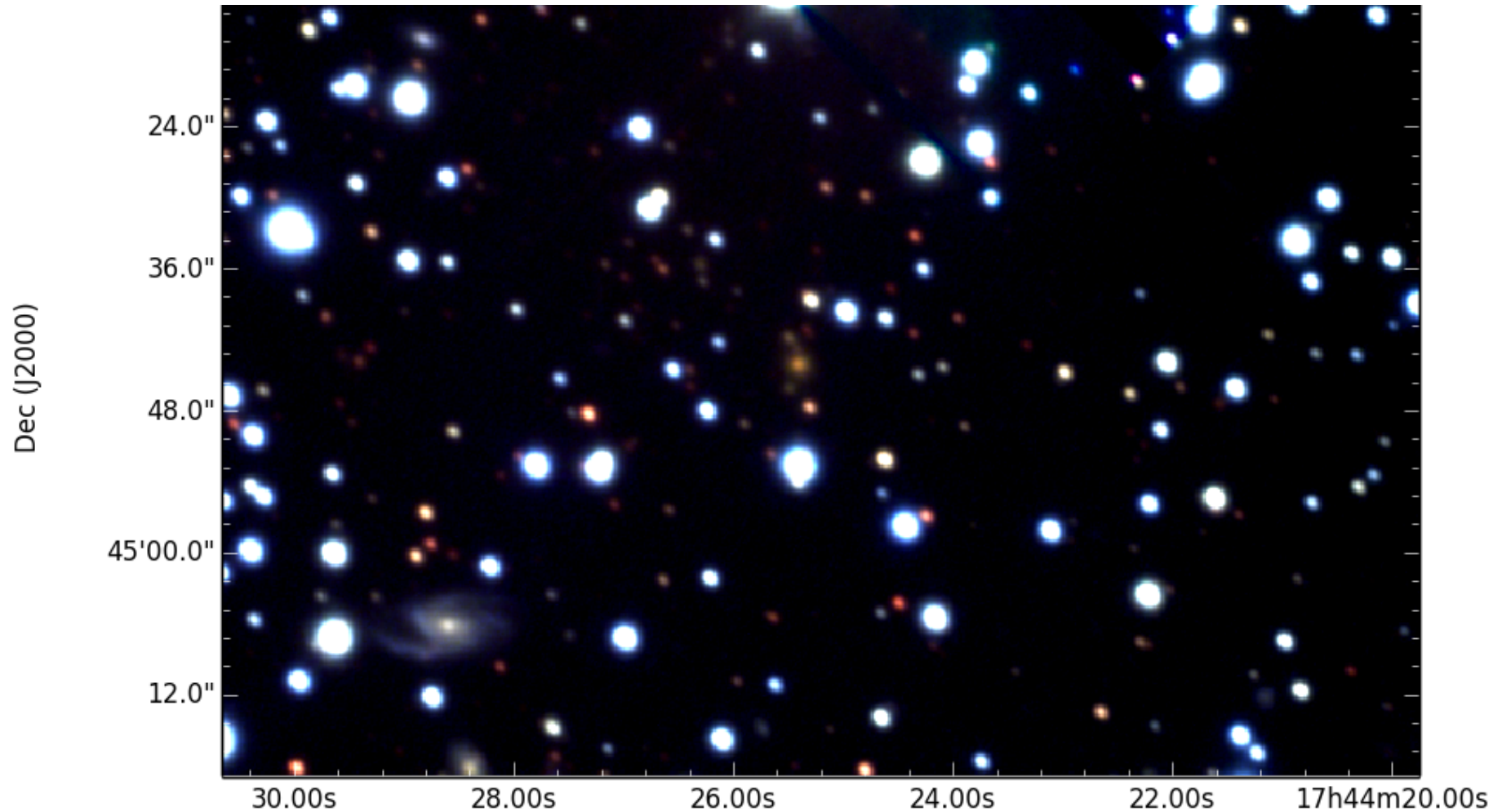


Absorbed X-ray spectrum

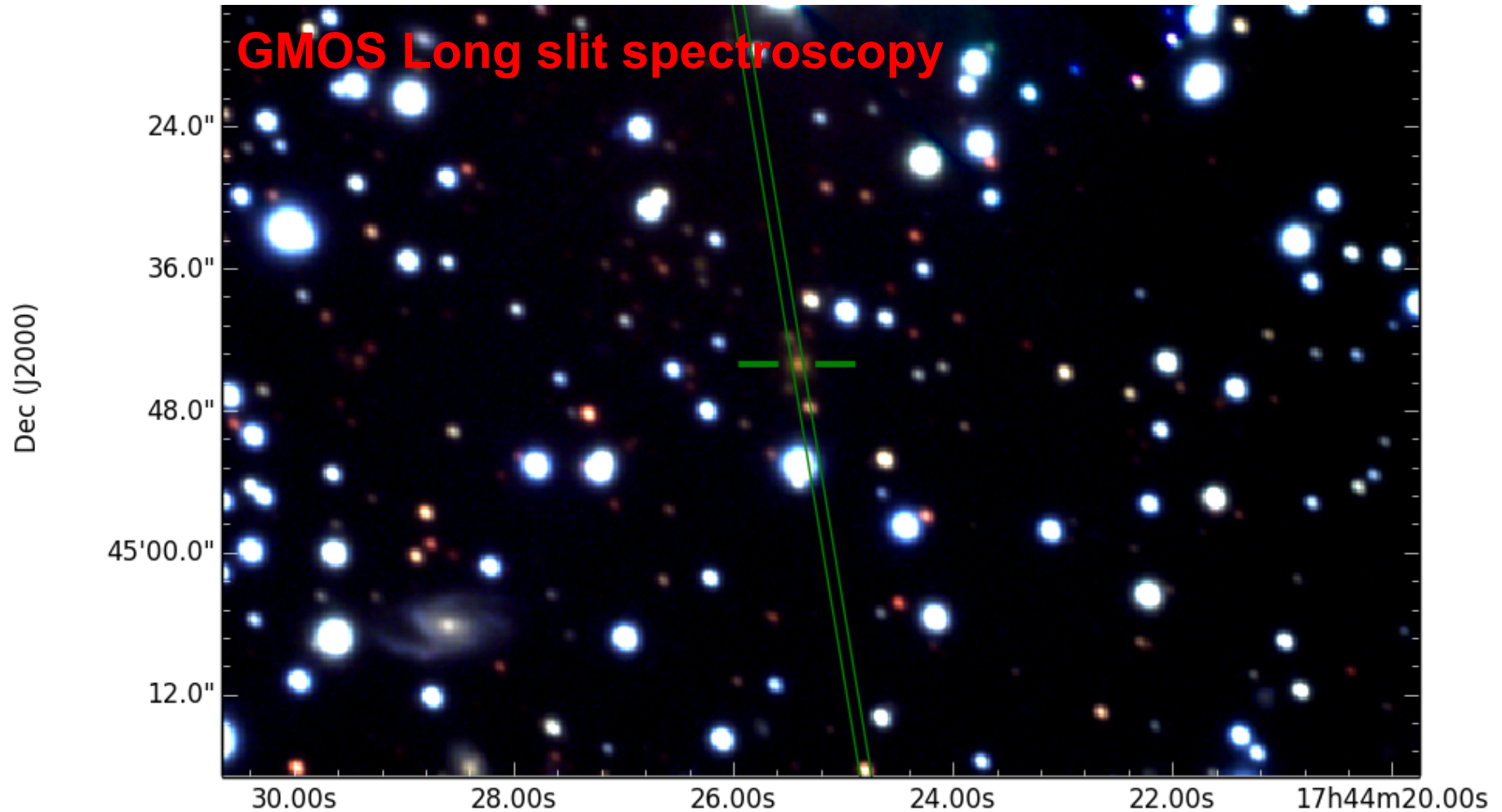


- Archival XMM-Newton data well-fit by a simple **absorbed power law**
- Intrinsic H column density $\sim 10^{22} \text{ cm}^{-2}$ typical of GPS source
- **Hard** X-ray spectrum $\Gamma = 0.8$ (c.f. $\langle \Gamma \rangle = 1.7$ for GPS sources)
- $L_{2-10} = 4 \times 10^{43} \text{ erg s}^{-1}$
c.f. $L_{5\text{GHz}} = 8 \times 10^{43} \text{ erg s}^{-1}$
- Radio and X-ray properties typical of powerful GPS source

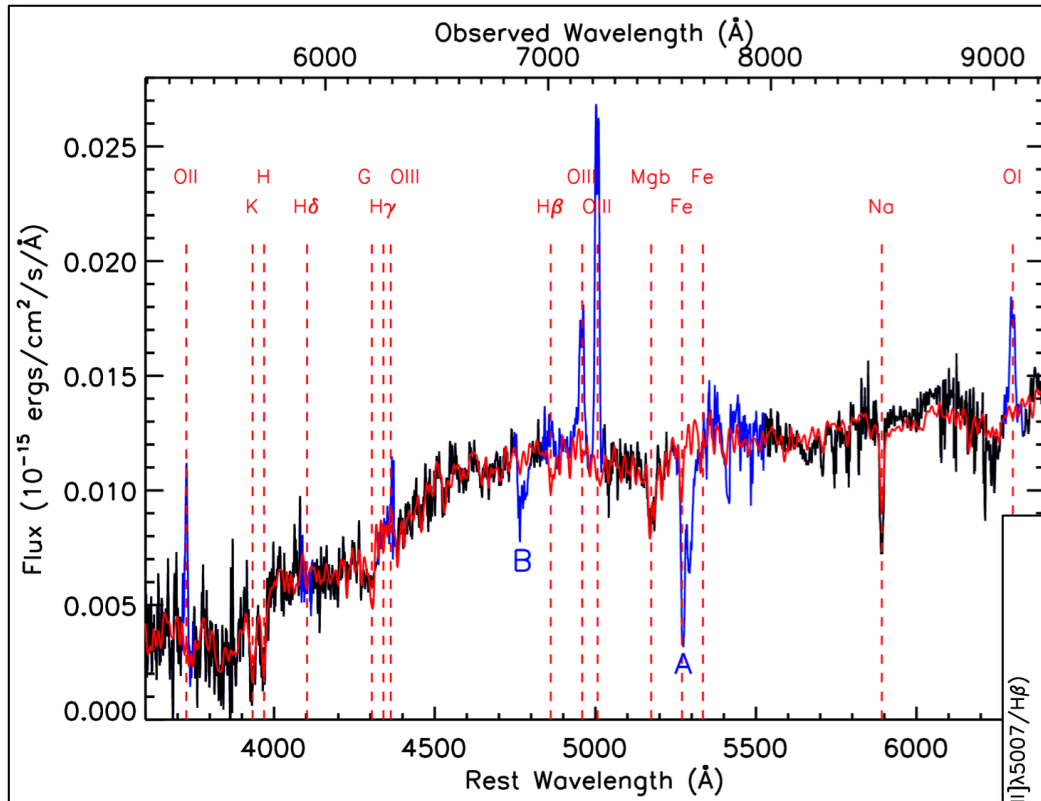
Redshift confirmation with Gemini South



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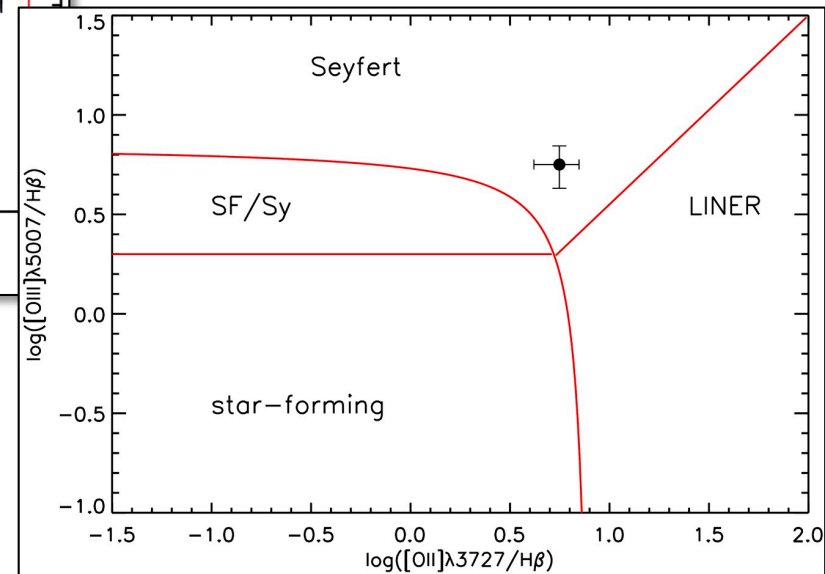
Oxygen to H β emission line ratios consistent with AGN ionisation – probably type-2 nucleus

Strong [OI] emission indicates shocks \rightarrow jet ISM interaction?

pPXF fit to stellar continuum **confirms** HI absorption arising in AGN host galaxy

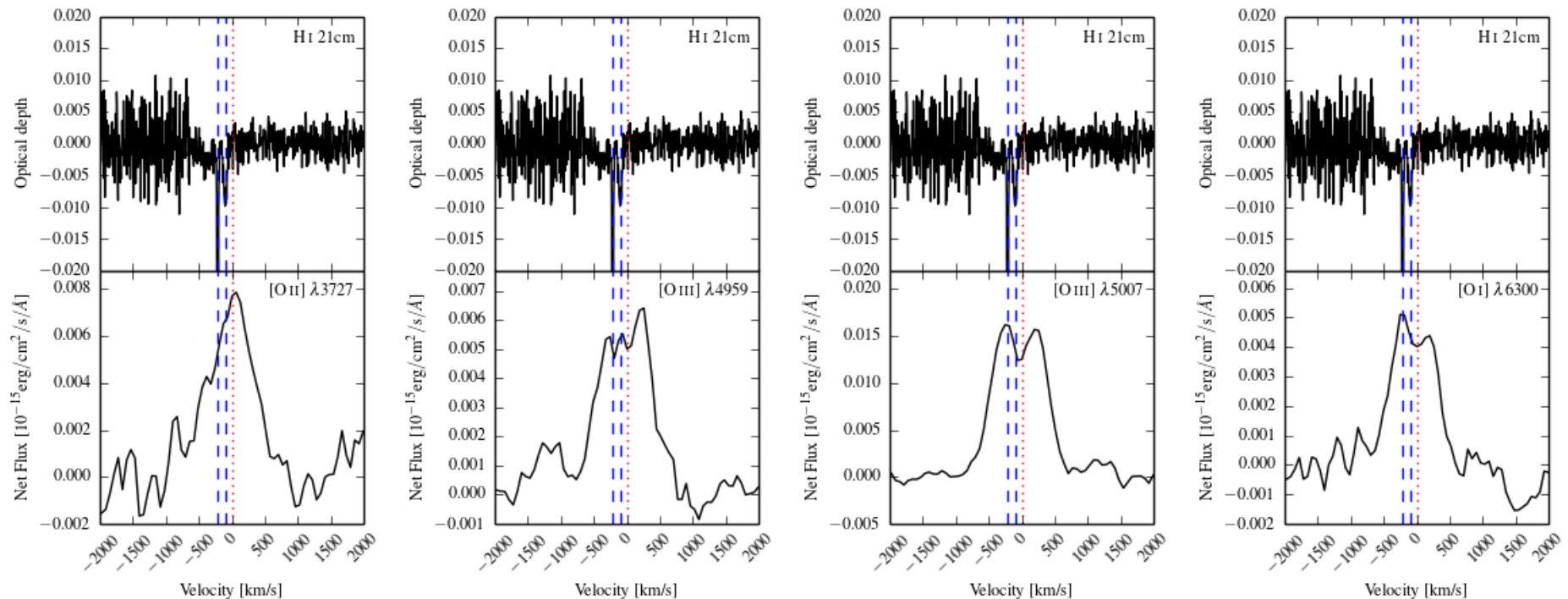
$$z_{\text{HI}} \sim 0.4413$$

$$z_{\star} \sim 0.4423$$

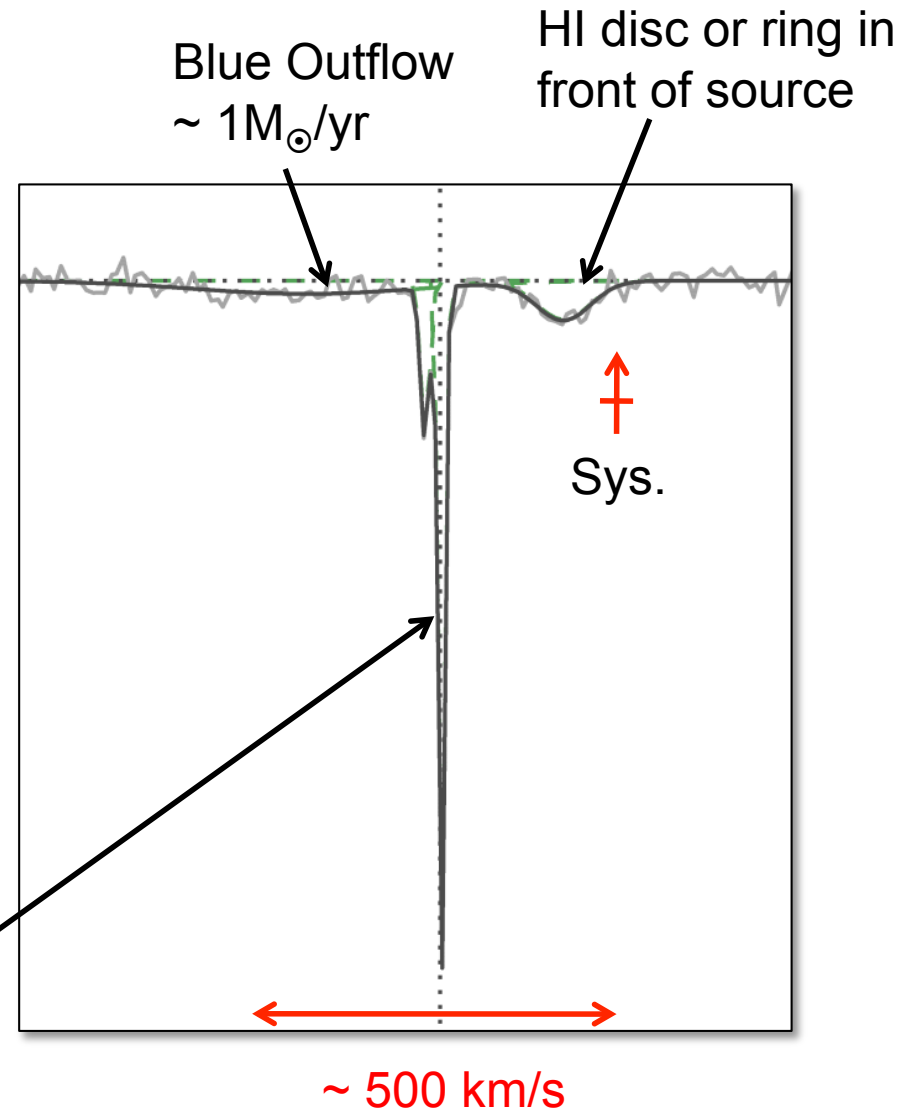
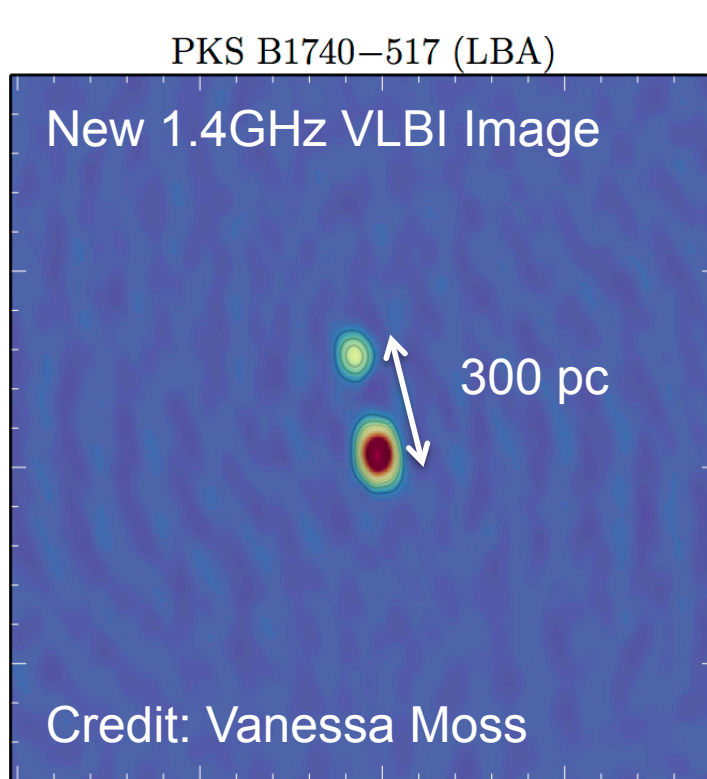


Double-peaked narrow emission lines

The forbidden Oxygen lines show **double peaked** velocity structure
Indicative of **bipolar outflow** or **larger scale rotation** of ionised gas?
Associated with radio jet?
Need more spatial resolution!



HI kinematics – neutral outflow?



Offset narrow absorption line ($\Delta v \sim 5 \text{ km/s}$, $T_k < 500 \text{ K}$)
Cold circumnuclear gas or entrained cloud?

Summary

- The ASKAP BETA telescope is now taking early science data and we can carry out a **blind search for HI** absorption at $z = 0.4 - 1$ in radio sources brighter than **>1Jy**
- Bright GPS/CSS sources selected from **Randall et al. (2011)** sample
- First discovery of HI towards powerful GPS source PKS1740-517
- Optical spectroscopic followup confirms **association** with host galaxy, probably type-2 nucleus and soft X-rays absorbed
- Complex HI profile points to **complicated kinematics** with possible neutral gas outflow driven by young jets