DEUTERIUM ARRAY MEMO #021

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To: Deuterium Array Group

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Subject: Test sources for initial 4×4 array

1] Initial 4x4 sensitivity

Each array element has a gain of about 9 dBi which corresponds to a collecting area of about 0.5m^2 and a corresponding sensitivity of about 2×10^{-4} K/Jy. The inner 4×4 elements with 0.8λ spacing has a collecting area of about 9m^2 and 3.3×10^{-3} K/Jy.

2] Sun

The average flux density of the Sun at 327 MHz is about 250,000 Jy and is highly variable.

From the sensitivity of the 4×4

$$T_{sun} \simeq 50K \text{ for single element}$$
$$\simeq 825K \text{ for phased-up array}$$

3] Cassiopeia A

The flux density of CasA at 327 MHz is 6000 Jy.

$$T_{cas} \simeq 1.2K \text{ for single element}$$
$$\simeq 20K \text{ for phased-up array}$$

The sun should be best for phasing-up the array but is highly variable on all time scales so that it is not a good calibrator. Cas A is strong enough to be easily detected but the array beam is large and includes a large contribution from the diffuse Galactic emission. For this reason Cas A continuum is also unsuitable for calibration.

4] Carbon recombination line in Cas A

The C270α carbon recombination line is seen in emission in Cas A at -47 km/s (Ap.J. 341, 890-900) with 3 km/s width and a strength of 2×10^{-3}. Since the Tsys in the

direction of Cas A will be about 120 K the strength will be diluted to about 3×10^{-4} and a 10 sigma detection with 244 Hz resolution would take 53 days of integration free from RFI. With both polarizations of a 5×5 array this time will be reduced to 10 days or about 8 hours with the full array of 32 stations. With reduced resolution of 1 kHz (1 km/s) a high quality spectrum could be produced in 2 hours with the full array. This emission is stable and therefore might ultimately provide the best calibration.

5] 0329+54 Pulsar

PSR 0329+54 is strongest pulsar that can be seen from Haystack. It has an average flux density of 1.65 Jy and a peak flux with the 6 ms of the 50% pulse width of about 150 Jy. The peak temperature with phased 4×4 will be about 0.5K out of a Tsys of about 60K. A 10 sigma detection, assuming a 150 J in a 4 ms pulse averaging bin every 0.72 seconds should take only 20 minutes. Unfortunately the flux of 0329+54 can vary by a large amount (see Caspi and Stinebring Ap.J, 392: 530-542) so that 0329+54 cannot serve as a calibrator. However, with the 5×5 and dual polarization the sensitivity should be adequate to detect another pulsar with more stable flux density.