Calculating the expected sensitivity of an SRT interferometer

The sensitivity of a radio receiver is given by

$$\Delta T = K \frac{T_{sys}}{\sqrt{t\Delta n}} \, , \quad (1)$$

where *DT* is the root mean square (rms) noise in the output, T_{sys} is the system noise temperature, *t* is the integration time and *Dn* is the noise bandwidth. The constant *K* depends on the receiver type. For an interferometer with *N* elements, K will be $1/\sqrt{N(N-1)}$. So for a 2-element interferometer, K is $1/\sqrt{2}$.

For the SRT, the measured antenna temperature (in Kelvin) can be converted to flux in Janskys (1 Jansky = 10^{-26} watts m^{-2} Hz^{-1}) by:

$$S = \frac{2kT}{A_e} \quad (2)$$

Here, *k* is Boltzmann's constant and A_e is the effective antenna area. The SRT has a diameter of 2.3m and an aperture efficiency of 50%. So A_e is $(\pi r^2 \eta_{eff})$, where r is the antenna radius and η_{eff} is the aperture efficiency. So:

$$S = T / 7 \times 10^{-4} \text{ Jy} \ (3)$$

In order to estimate the probability of detecting a source with a known flux with the SRT interferometer, we calculate the Signal to Noise Ratio (SNR). If the SNR is greater than about 10, we can expect a good detection.

The SNR is given by the ratio of the observed antenna temperature to the rms noise (as given in equation (1)).

$$SNR = \frac{T\sqrt{t\Delta n}}{KT_{sys}} \, , \quad (4)$$

or

$$SNR = \frac{7 \times 10^{-4} S\sqrt{t\Delta n}}{KT_{sys}} \quad (5)$$

So, for a 2-element SRT interferometer with an integration time of 100sec, a bandwidth of 4 MHz and a system temperature of 50K, the expected SNR is:

$SNR = 0.4S$ Jy^{-1}

For the double-lobe radio source Cygnus A (the two lobes have an angular separation of 130"), at a frequency of 1420 MHz (the operating frequency of the SRT), the measured flux is ~800 Jy. This would give an SNR of 320 in a 2-element interferometer and would be detectable.