

Tsys for the HERA broadband system

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In this note the broadband HERA system temperature is computed based primarily on the measured noise parameters of the receiver system and the measured antenna impedance. The relationship between the receiver noise temperature and the system temperature is given by

$$T_{sys} = \eta T_A + \eta(1 - T_{amb}) + T_{rec} \quad (1)$$

where η and T_{amb} are the antenna radiation efficiency and the ambient temperature, respectively. T_A is the antenna temperature and is given by integrating the antenna beam, $|F|^2$, over the sky brightness temperature, T_{sky}

$$T_A(\nu) = \frac{\iint_{4\pi} T_{sky}(\nu, \Omega) |F(\nu, \Omega)|^2 d\Omega}{\iint_{4\pi} |F(\nu, \Omega)|^2 d\Omega} \quad (2)$$

If the radiation efficiency is close to one as in this case, then T_{sys} is simply determined by adding T_A and T_{rec} . Figure 1 shows the receiver temperature against the average sky brightness temperature. This indicates that the system is sky noise dominated across the entire HERA band.

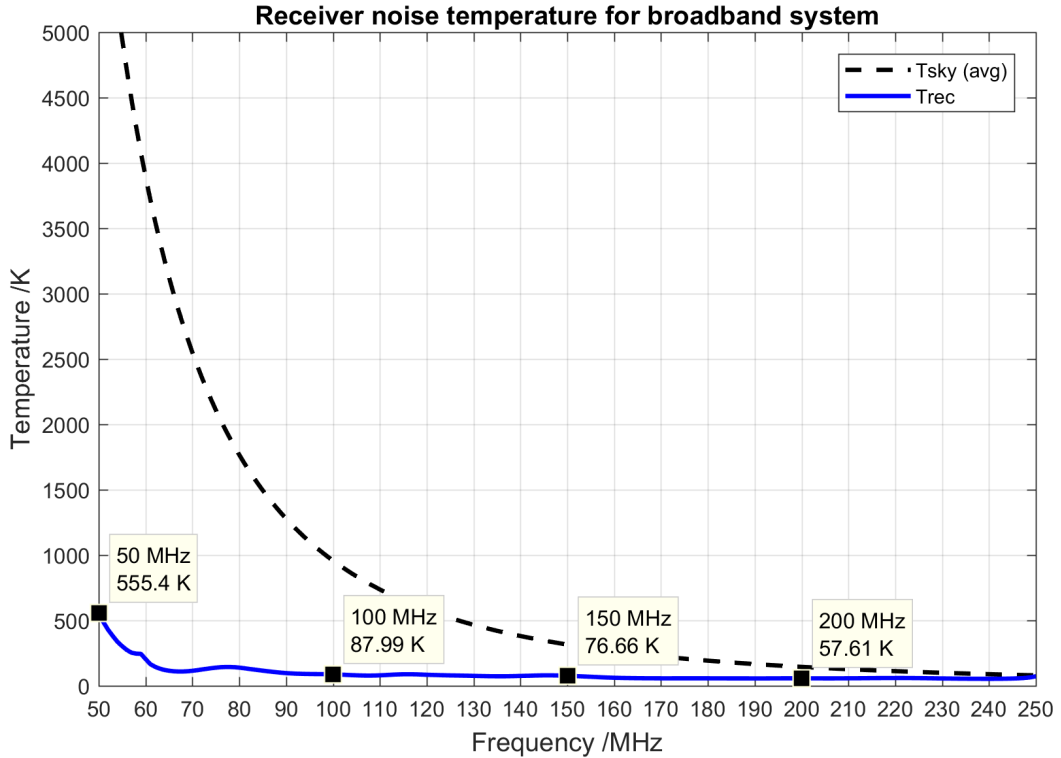


Figure 1: Receiver temperature.

In order to understand the effects on the scan sensitivity, single element (drift scan) simulations were done using the receiver temperature, simulated antenna beams and an all-sky model based on the Haslam 408MHz map. The frequency and time resolution is 1MHz and 10 minutes respectively. Figure 2 shows the expected system temperature across the band.

For point source sensitivity, we tend to use the metric A_{eff}/T_{sys} (Figure 3), however given power spectrum noise is more proportional to T_{sys}^2 , a plot of A_{eff}/T_{sys}^2 is also provided in Figure 4.

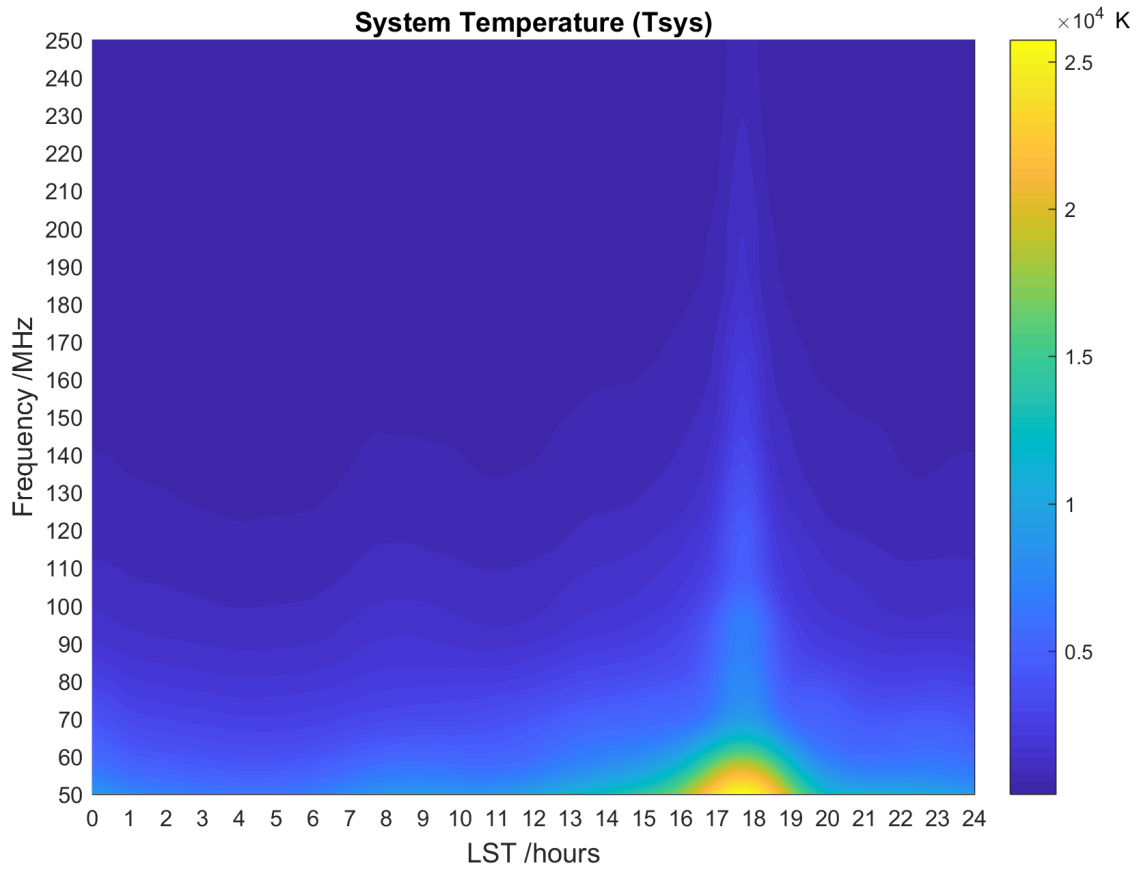


Figure 2: System temperature over time and frequency.

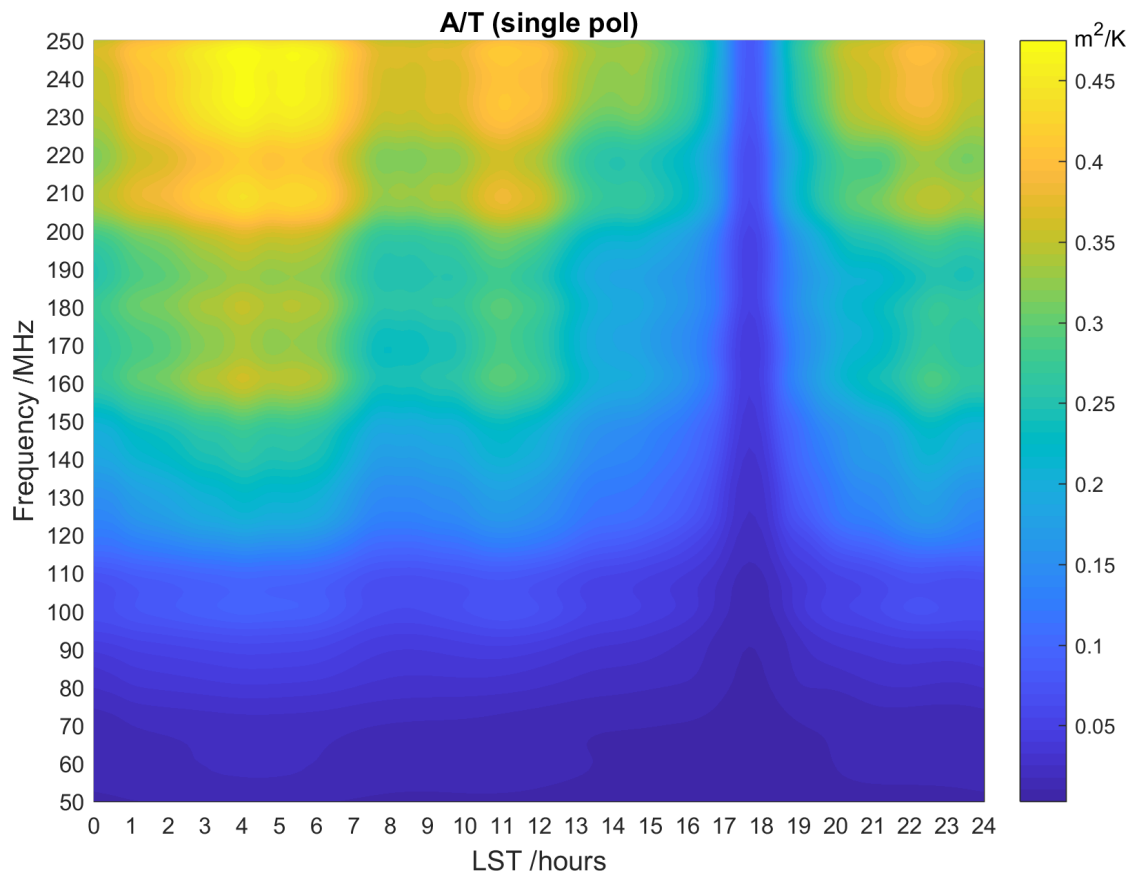


Figure 3: A_{eff}/T_{sys} over time and frequency.

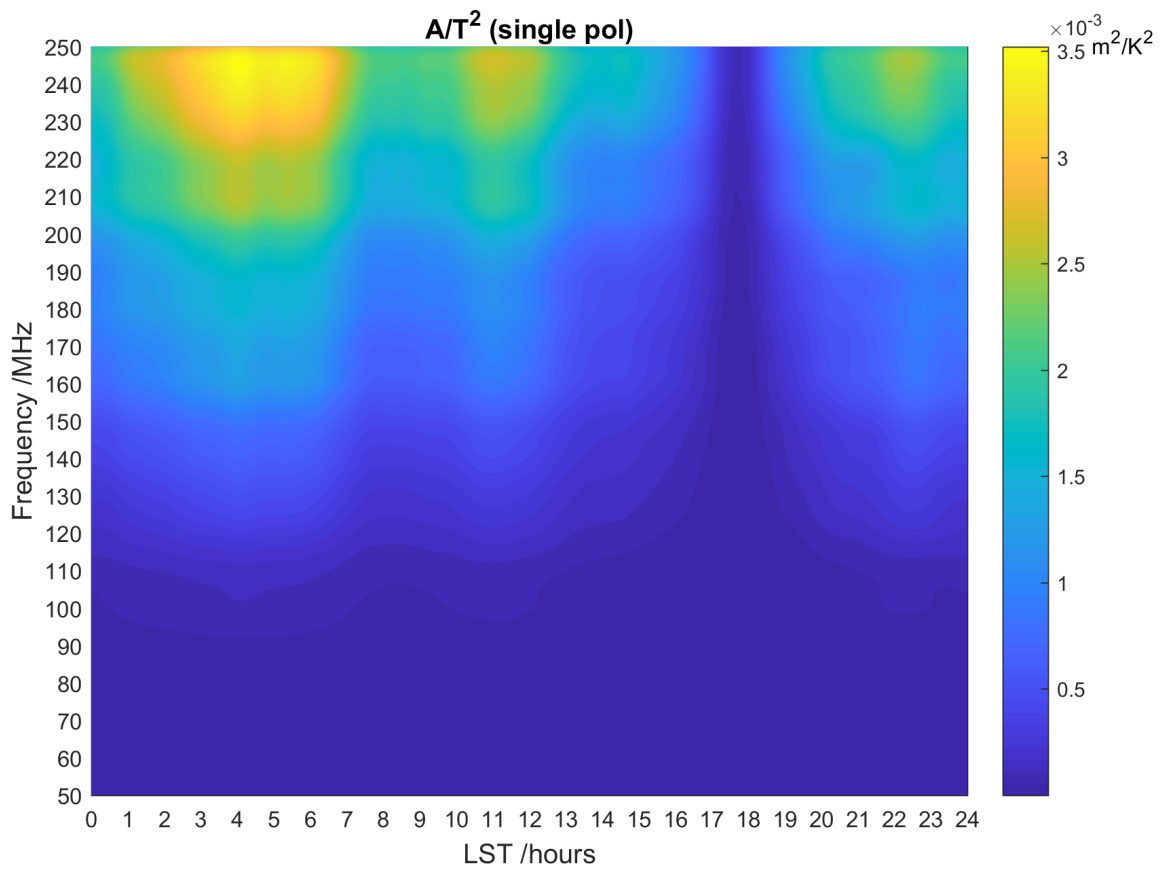


Figure 4: A_{eff}/T_{sys}^2 over time and frequency.