Demo 1 — UFYS-2010 2013-02-28

Note: You can give answers also in Finnish (or Swedish) if you like.

1. The gain drift of a receiver system $\frac{\Delta G}{G}$ is 1%. Receiver temperature $T_R = 100$ K, bandwidth $\Delta\nu$ is 1 GHz and integration time τ is 1 s.

- Antenna is looking at the Sun ($T_A = 7000$ K) and the (Dicke radiometer) reference is at a room temperature (300 K). What is the minimum detectable noise temperature ΔT_{min}?
- What is the ΔT_{min} if the radiometer is properly balanced? How would you balance it?

2. What is the minimum point source flux density (in SFU) on the surface of the Sun ($T = 7000$ K) that can be detected with the Metsähovi 13.7 m radio telescope (assume DPFU = 0.027) and,

- with the Dicke radiometer in question 1 (assume it is fully balanced)?
- with te same (balanced Dicke) radiometer but $T_R = 1000$ K?

3. What are the possibilities of increasing sensitivity (in addition to having a larger antenna) in the case of question 2? What are the tradeoffs?

4. Calculate an estimate of T_a for the Metsähovi (D = 13.7 m) antenna for a 0.5 Jy source at 43 GHz. Illumination efficiency is 60% and surface RMS errors are $\sigma = 50$ μm. What is the DPFU in this frequency?

5. Calculate the minimum gain for the first low noise amplifier ($T_1 = 10$ K) so that total noise temperature of the cascade is ≤ 20 K for a system that has three amplifiers in total: $T_2 = 100$ K, $G_2 = 20$ dB, $T_3 = 500$ K, $G_3 = 30$ dB.

Return by 14.3.2013.