A Brief Introduction To Single Dish Observing

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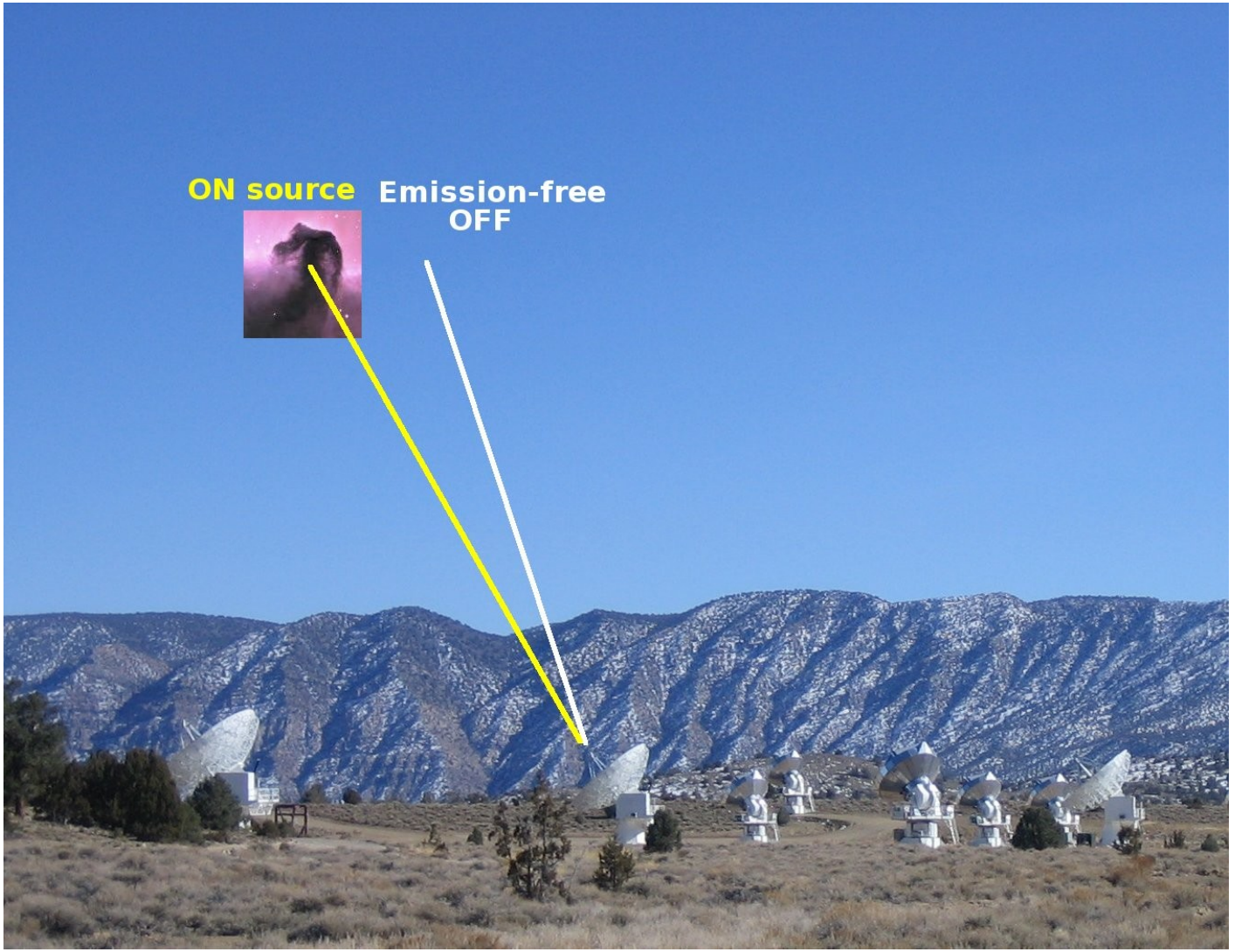
Autocorrelation

- Interferometer not sensitive to structures larger than ~1/3 primary beam size. Large-scale structure is "resolved out."; total flux is not recovered.
- Can recover missing spatial frequencies by cross-correlating an antenna's signal with itself -- a zero length baseline.
- Purely real quantity

Antenna measures total power from source+sky+receiver noise, so we must subtract off the non-source contribution. A common way is to *position-switch* between the source (ON) and a nearby emission-free region (OFF).



Voltage measured in the OFF position

(***G*** = gain in Volts/Kelvin; ***i*** = channel number aka frequency):

$$V^i_{OFF} = G^i \left(T^i_{RX} + T^i_{SKY} + T^i_{GROUND} + T^i_{CMBR} \right) = G^i T^i_{SYS}$$

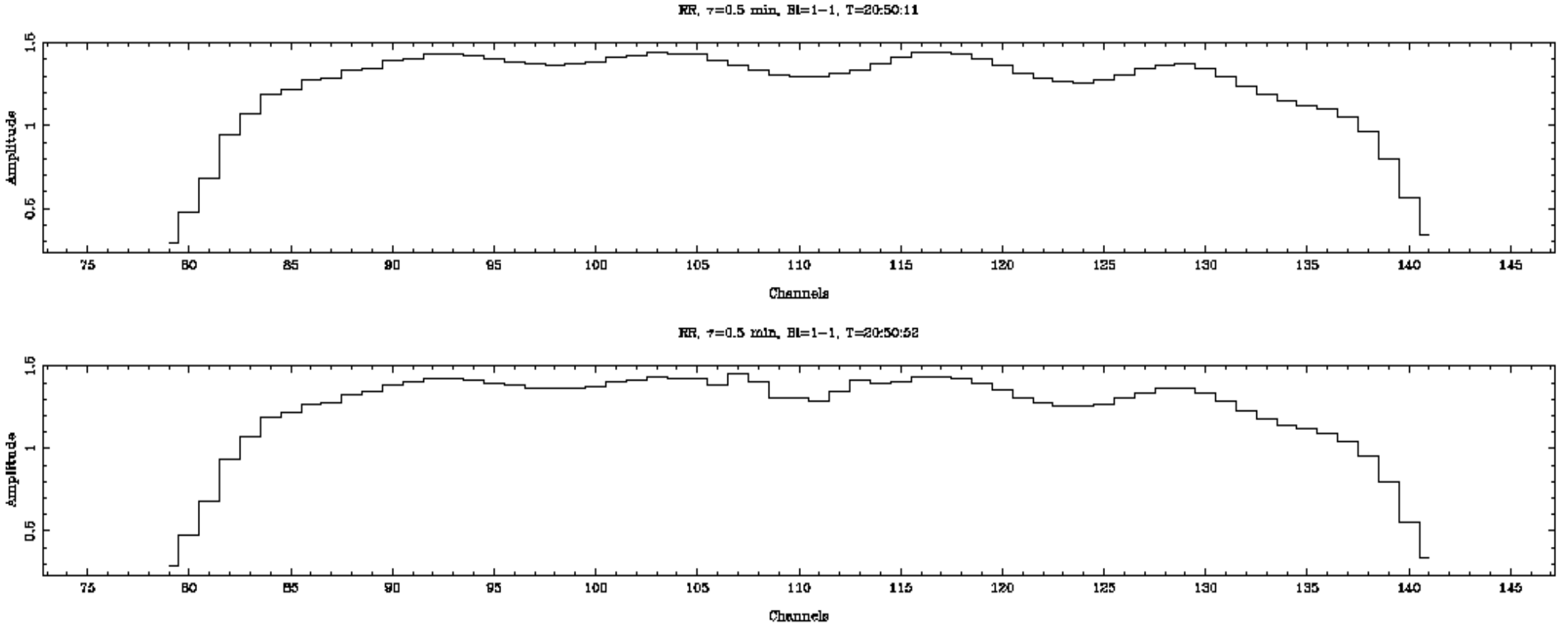
Voltage measured in the ON position:

$$V^i_{ON} = G^i \left(T^i_{RX} + T^i_{SKY} + T^i_{GROUND} + T^i_{CMBR} + T^i_{SOURCE} \right)$$

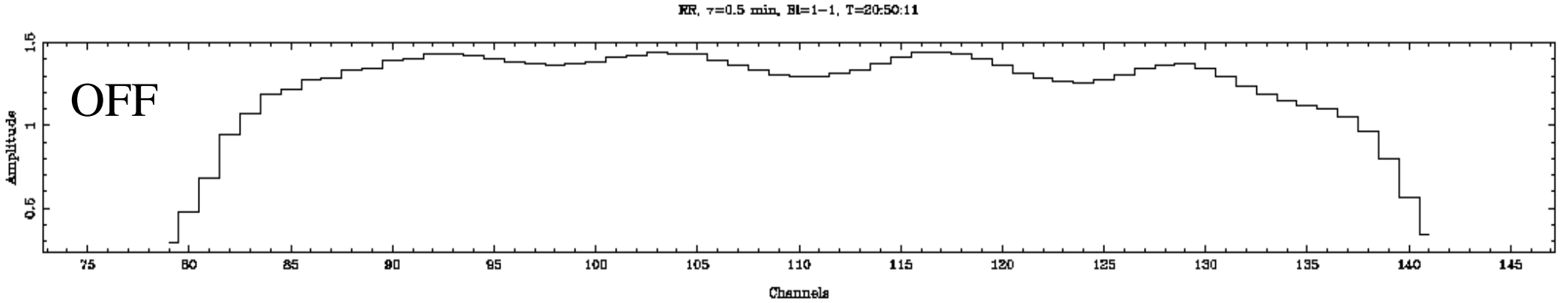
Derive antenna temperature of source:

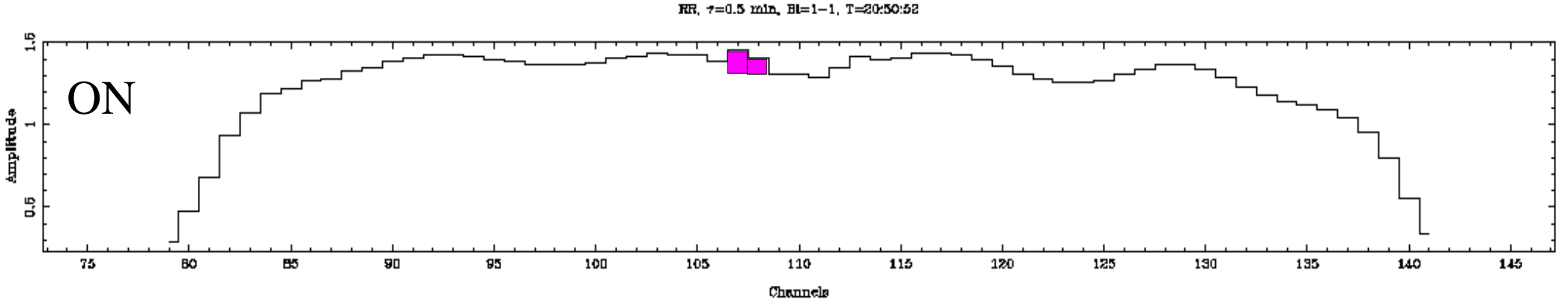
$$T^i_{SOURCE} = T^i_{SYS} \frac{\left(V^i_{ON} - V^i_{OFF} \right)}{V^i_{OFF}}$$

Requires accurate calibration of system temperature!

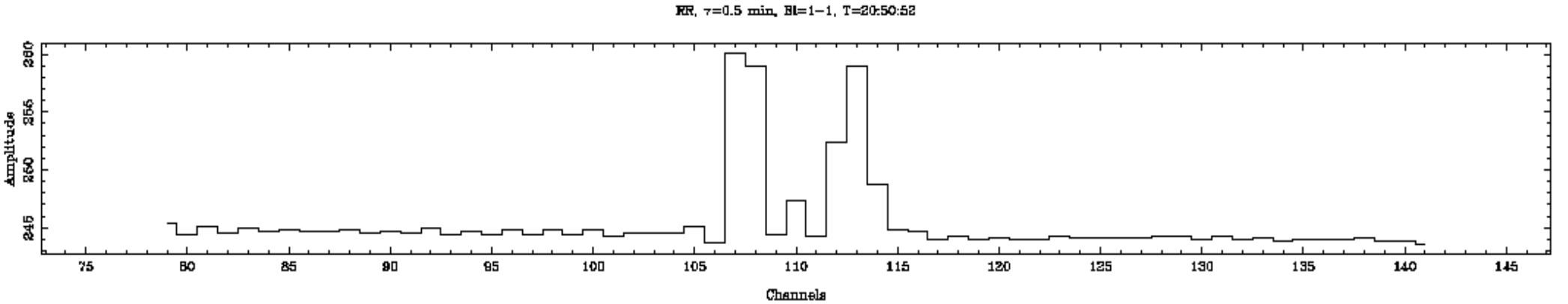


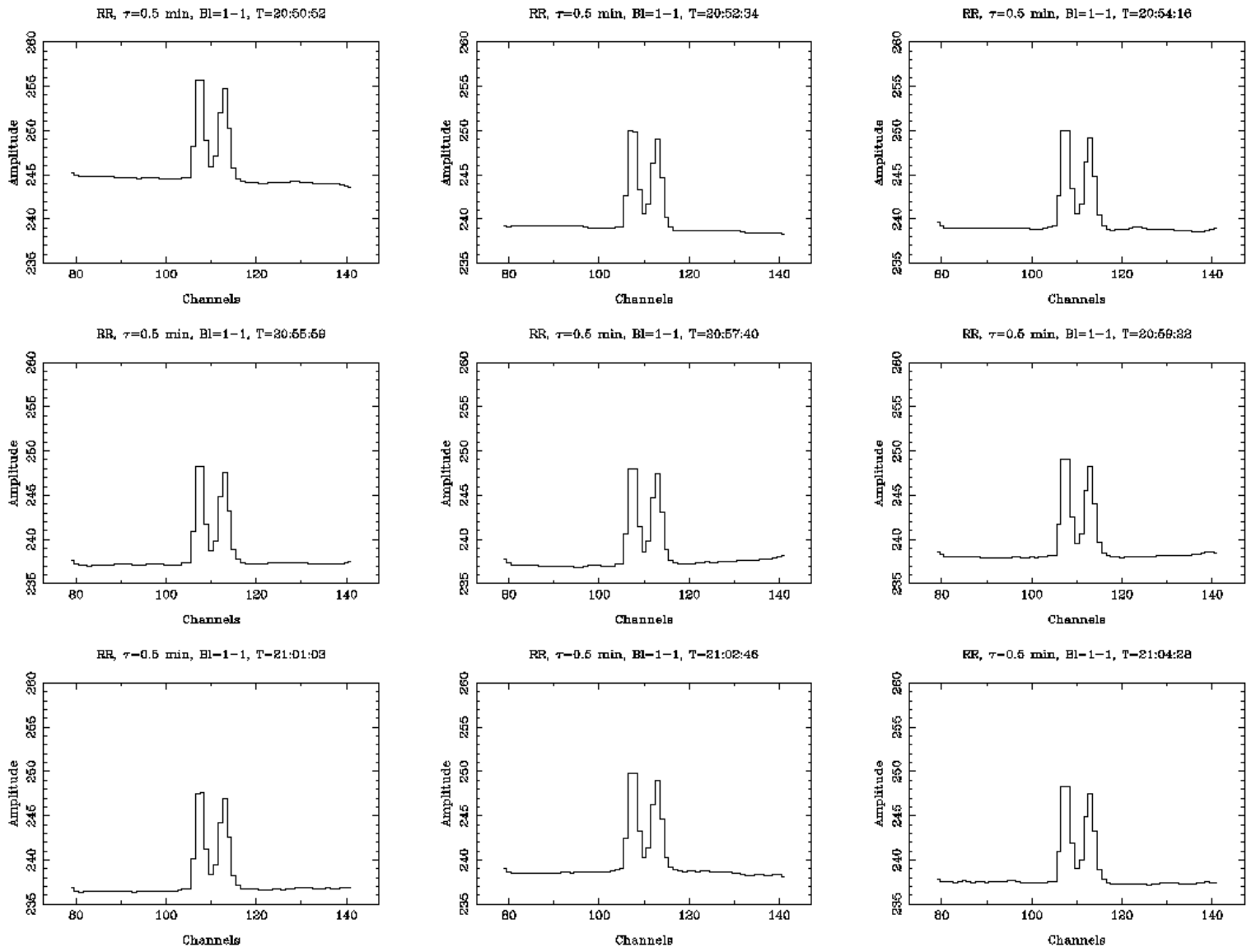
Example ON and OFF spectra, 30 second integration. Which is which?





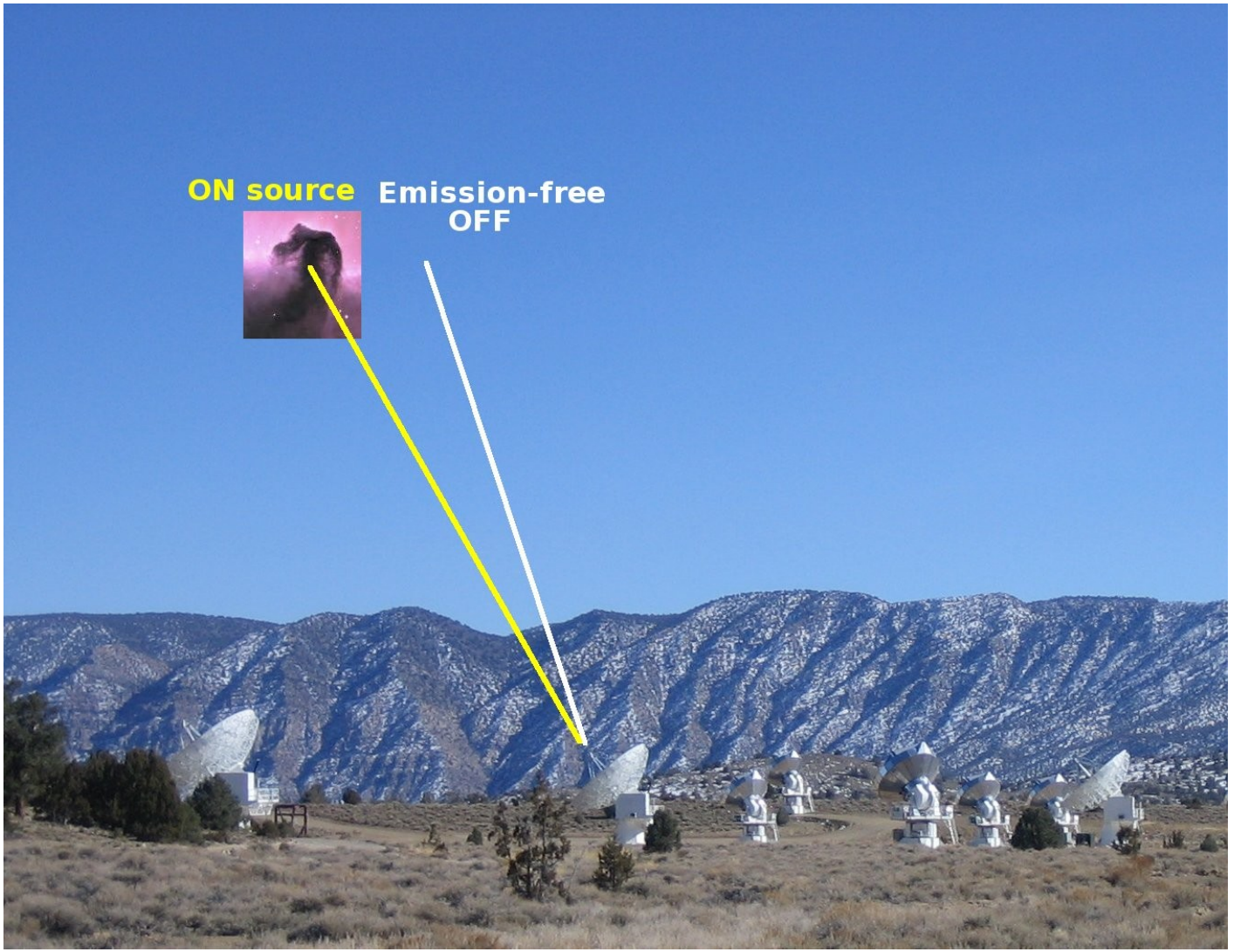
Resultant spectrum - Tsys*(ON-OFF)/OFF :





Due to sky/gain/noise changes between ON and OFF, continuum level is not zero and may vary as a function of channel. Must remove using polynomial fit (hopefully low-order!). MIRIAD tasks ***sinbad***, ***sinpoly***

What's wrong with this picture?



What's wrong with this picture?

Improving observing efficiency

- Multiple antennas -- factor of N reduction in time, $\sqrt{N}$ in RMS
- Multiple ONs per OFF -- factor of a few improvement, but still need to slew and acquire each position.
- On-the-fly mapping - continuously slew across source in raster pattern while integrating. OFFs are at the ends of each row. High data rate; grid and average.
- Beam-switching -- requires nutating subreflector or tertiary. Nutation rate of several Hz gives excellent continuum subtraction. Limited by length of beam throw; good for smaller objects.
- Frequency-switching - Shift 1st LO back and forth to emission-free frequency and subtract. Telescope stays on source. But, FS can introduce artifacts which reduce effective bandwidth.