ALMA OT: Sensitivity Calculator

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ALMA OT: Sensitivity Calculator

Brief outline:

- What are we measuring (brief theoretical discussion)

- How to use the sensitivity calculator

- What to look out for

- Minor wrap-up

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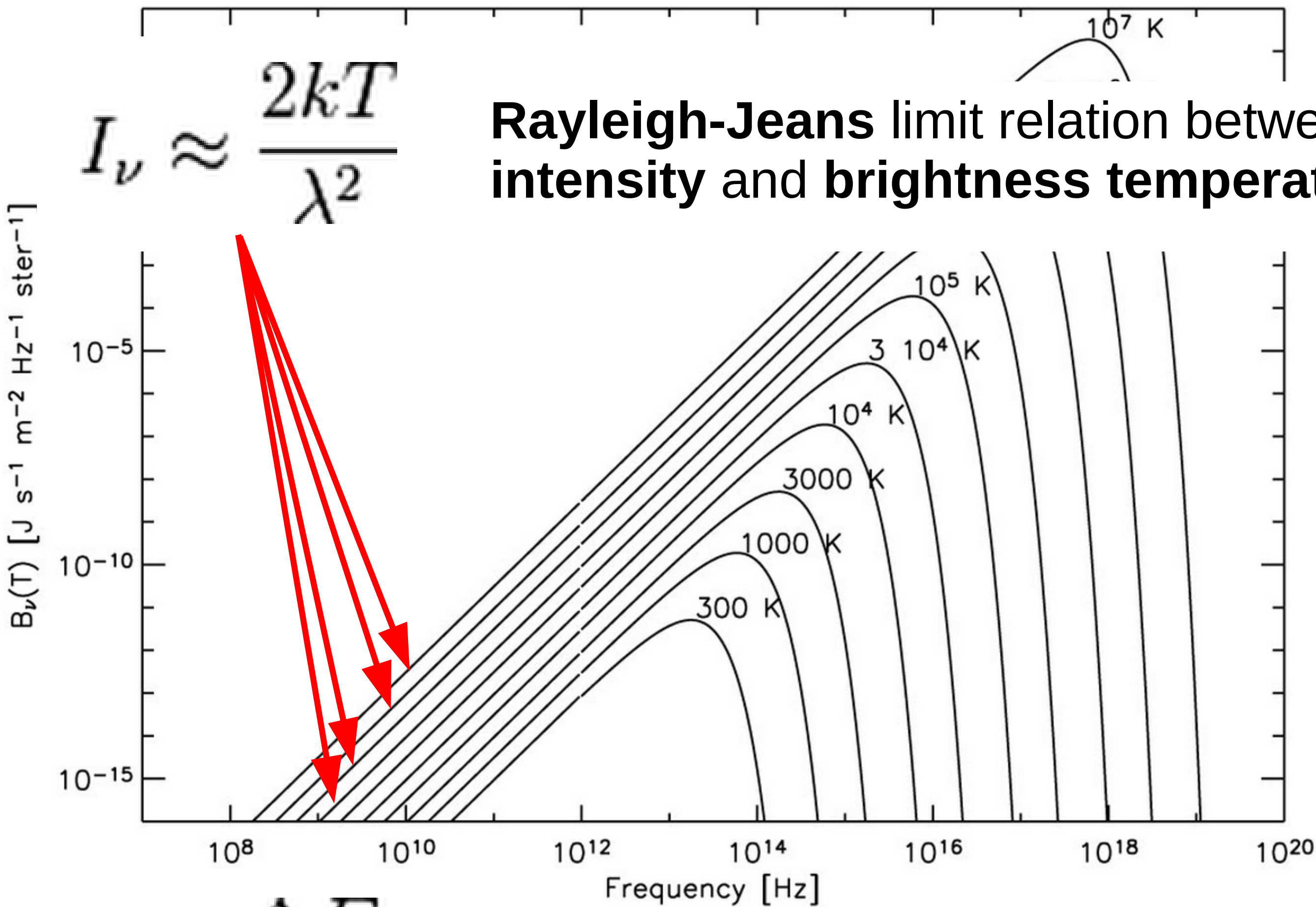
$$I_\nu \approx \frac{2kT}{\lambda^2}$$

Rayleigh-Jeans limit relation between specific **intensity** and **brightness temperature**.



$$I_\nu = \frac{\Delta E}{\Delta\Omega \Delta A \Delta t \Delta\nu} \quad [erg\ s^{-1}\ cm^{-2}\ Hz^{-1}\ Sr^{-1}]$$

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$$P_\nu = I_\nu dA d\Omega$$

$$= \frac{2kT_{src}}{\lambda^2} dA d\Omega$$

$$= 2kT_{src}$$

RJ limit means: power ~ specific intensity ~ (brightness) temperature

$$T_{sys} = T_{sky} + T_{Rx}$$

Something we don't need!

$$T_{sys} >> T_{src}$$

We need T_{src}! What to do?

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$$T_{sys} >> T_{src}$$ ← This is usually the case!

$$T_{src} > T_{rms}$$ ← This is what we need to get a measurement!

$$T_{rms} = \frac{T_{sys}}{\sqrt{N}}$$ ← Reduce T_{rms} by sampling T_{sys}...

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$$T_{rms} = \frac{T_{sys}}{\sqrt{N}}$$

The noise when measuring T_{sys} decreases with increasing N (sampling points)

But what *is* N?

N ~ n(n-1)/2 = number of baselines, n is the number of antennas

~ Δν = frequency range (bandwidth) in Hz

~ t = exposure time (on source time) in seconds

~ 2 = a factor for double polarization mode

$$T_{rms} \simeq \frac{T_{sys}}{\sqrt{n(n-1) \cdot \Delta\nu \cdot t}} [\mathrm{K}]$$

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Back to flux and Jansky... or milliJansky (mJy):

$$\mathrm{SEFD} = \frac{T_{sys}}{(K/Jy)} = \frac{T_{sys}}{A_e/2k}$$

System **E**quivalent **F**lux **D**ensity

$$S_{rms} \simeq \frac{SEFD}{\sqrt{n(n-1) \cdot \Delta\nu \cdot t}} [\mathrm{Jy}]$$

n(n-1) ~ number of baselines, n is the number of antennas
$\Delta\nu$ = frequency range (bandwidth) in Hz
t = exposure time (on source time) in seconds

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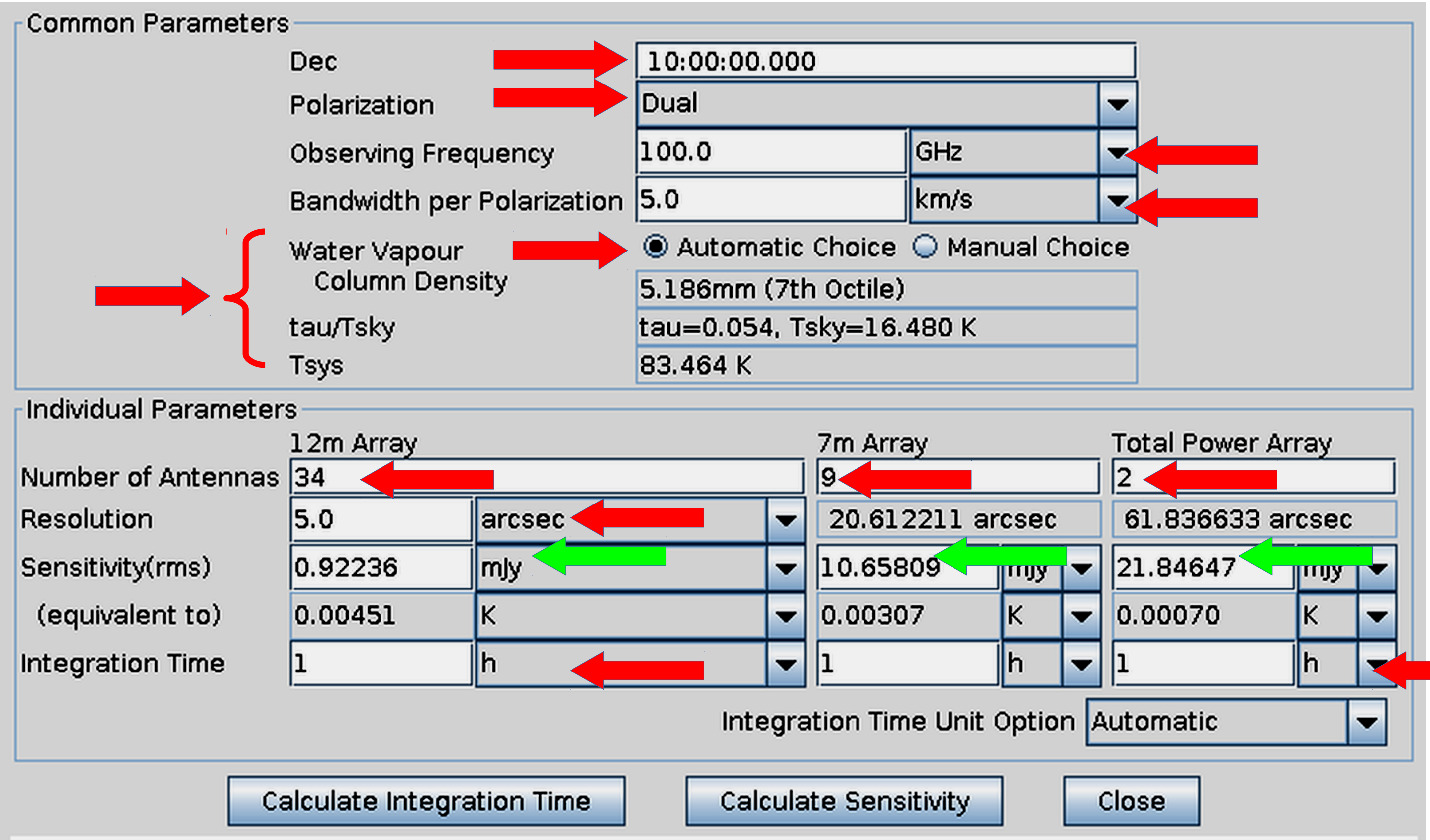
Inputs to calculator:
- declination (for elevation)
- frequency (e.g. for atmospheric absorbtion etc.)
- weather (optional)
- number of antennas (gives number of baselines)
- resolution (gives the Δν)
- integration time (gives the value of t)

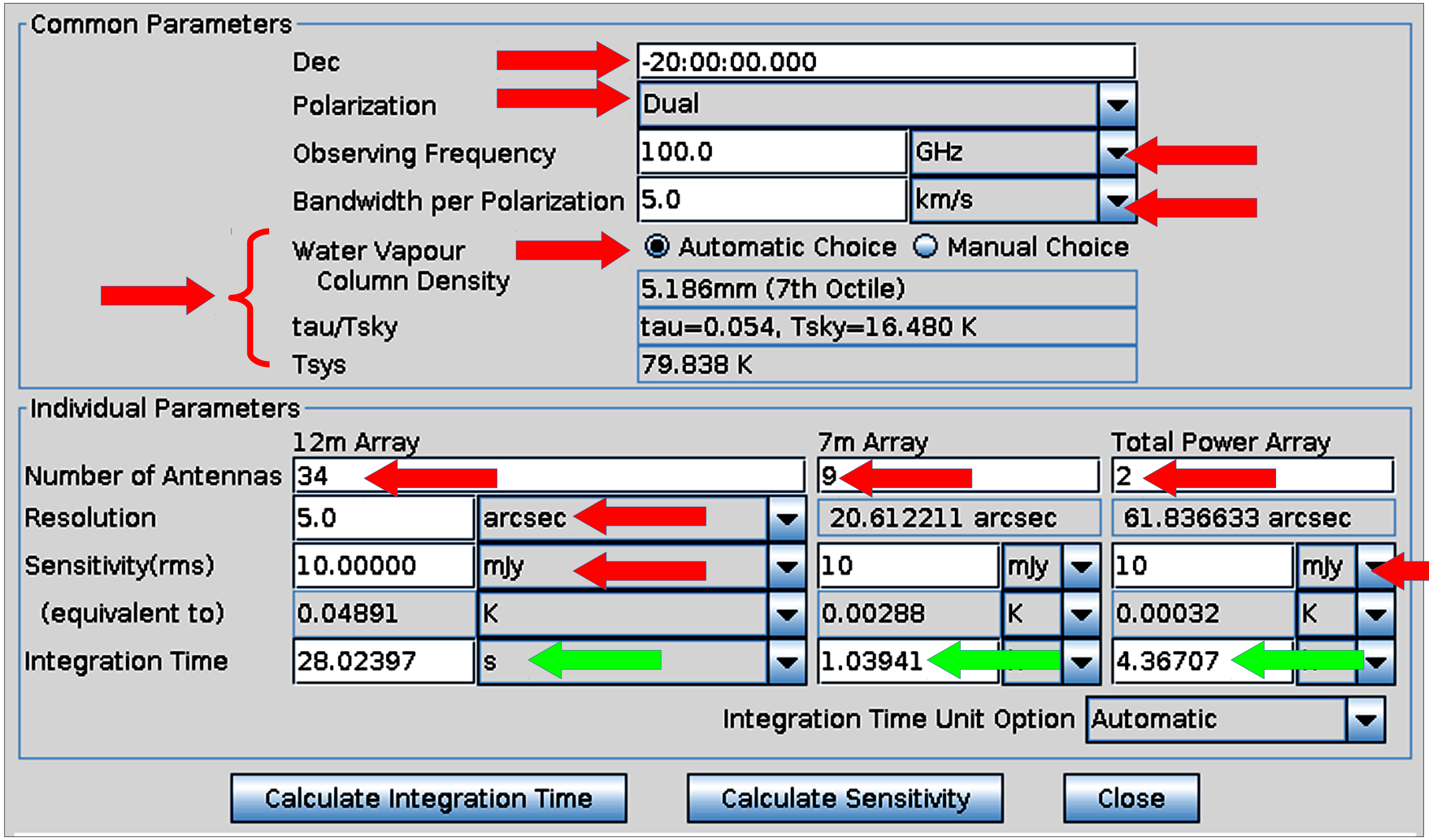
Output:
- Sensitivity reached



ALMA OT: Sensitivity Calculator

Inputs to calculator:
- declination (for elevation)
- frequency (e.g. for atmospheric absorbtion etc.)
- weather (optional)
- number of antennas (gives number of baselines)
- resolution (gives the Δν)
- desired sensitivity (gives the value of S_{rms} or T_{rms})

Output:
- Integration time required



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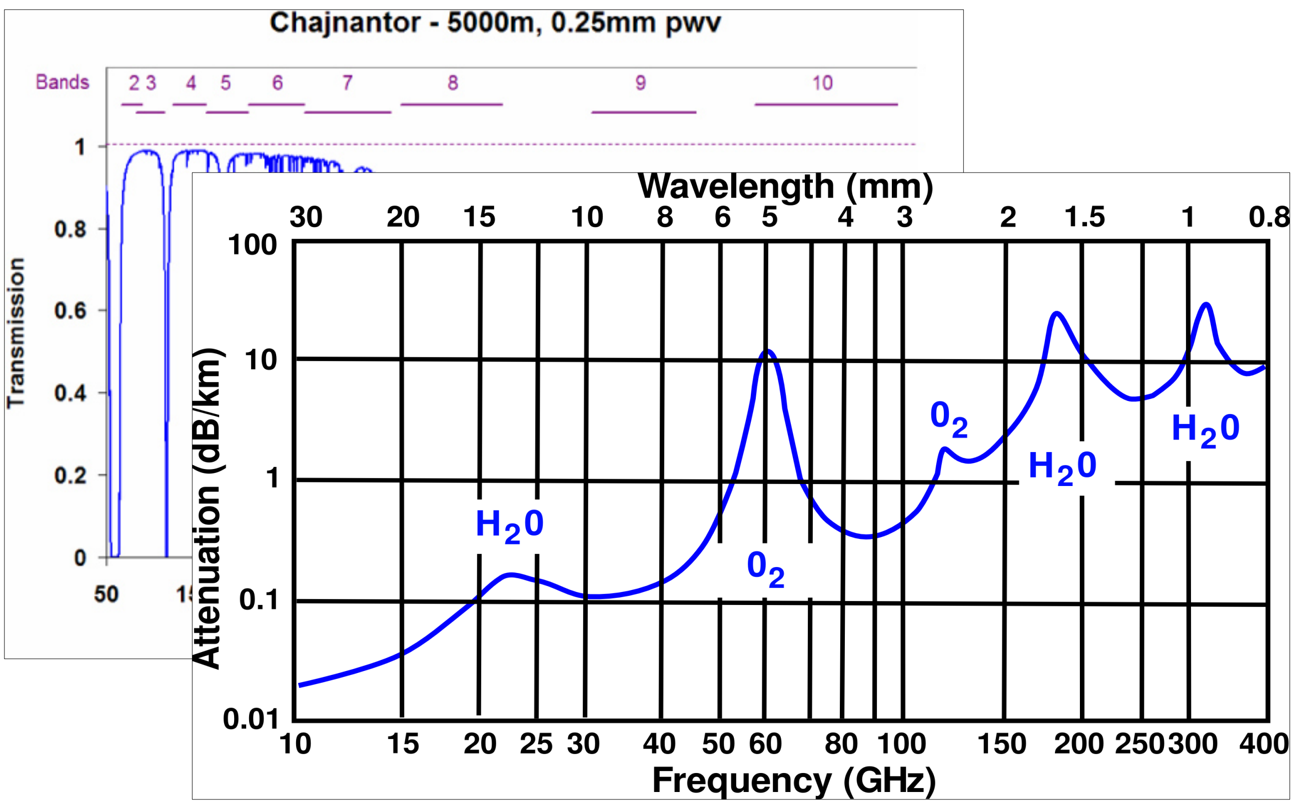
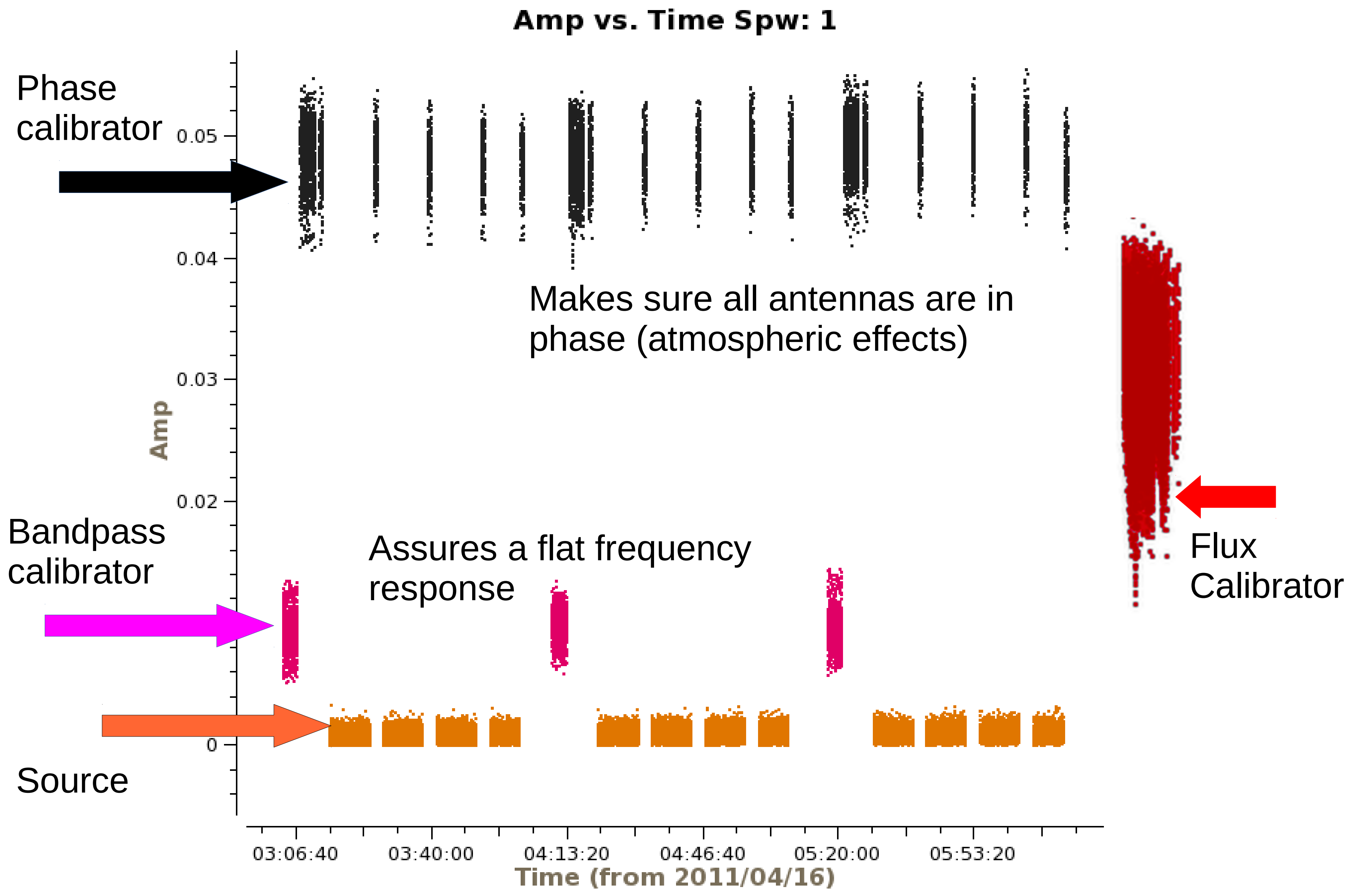
What to look out for?

Atmospheric absorbtion:



Source size:

Notes on calibration:




Thank you,
and make sure to check the summary slides in the afternoon