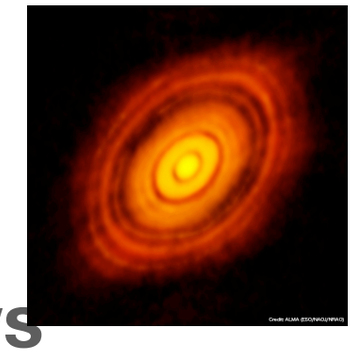
EUROPEAN ARC
ALMA Regional Centre

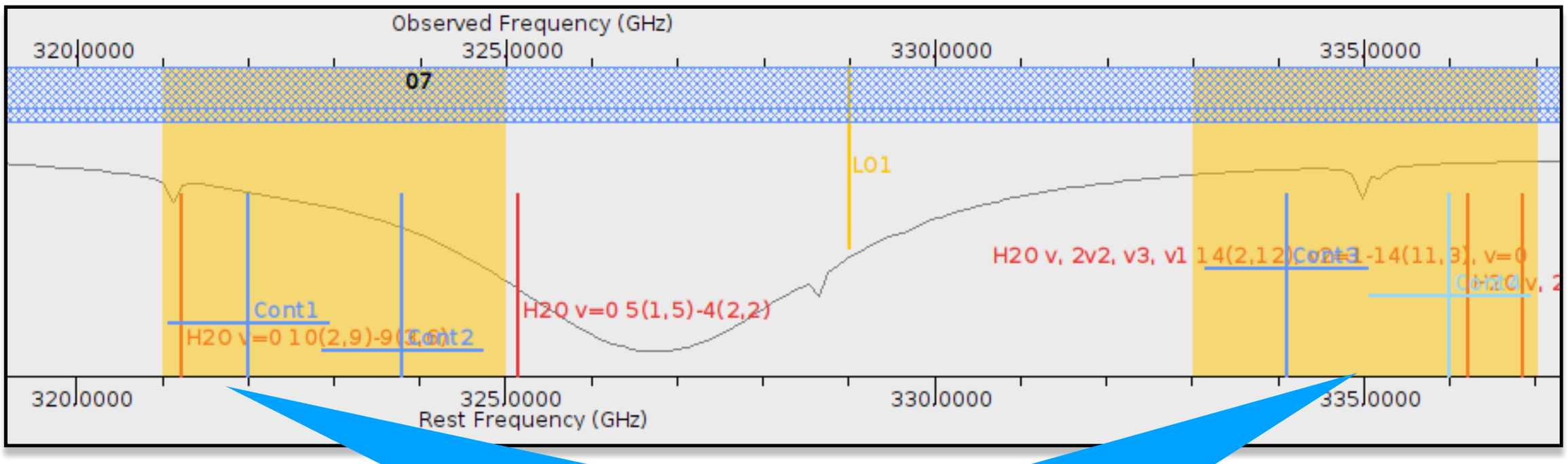
ALMA interferometric calibration basics

Luke Maud - ESO - Garching

What sources are observed and why



- **Target : We want to do science**
  - of course we need to look at our target of interest
  - data would be recorded in our selected **Spectral Windows**



simple
setup with 4x wide ~2GHz
SpWs trying to cover H_2O

What sources are observed and why

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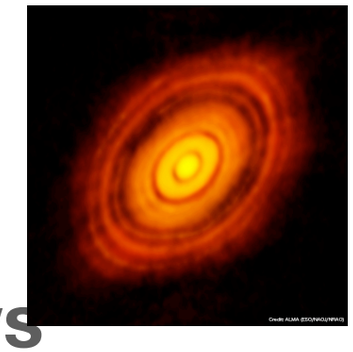
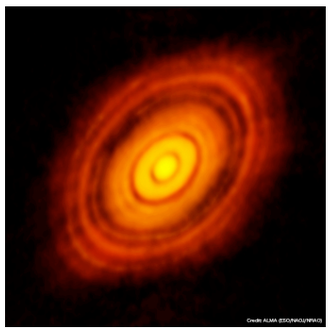


and……we use many antennas, what about instrumental effects or the atmosphere?

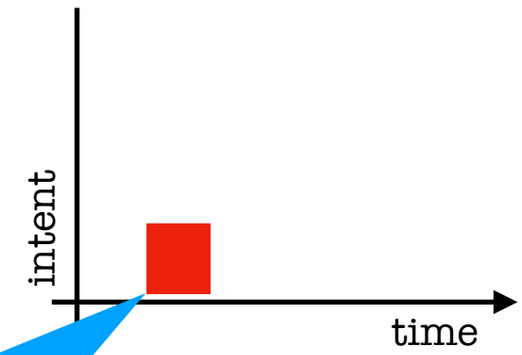
What sources are observed and why



- **Bandpass : We measure over a frequency range**

  - very bright **point-source*** which has no spectral features over our range of interest

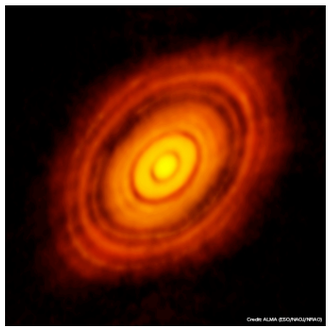
  - corrects variations in antennas and signal path (receivers etc)

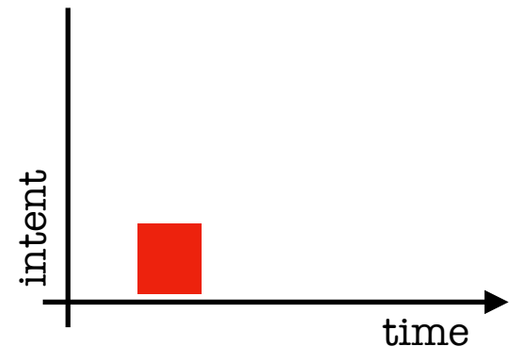


so-called “scan” of a particular intent. Made up of many short 3-6s “integrations”

*we know how the visibility PHASE should look

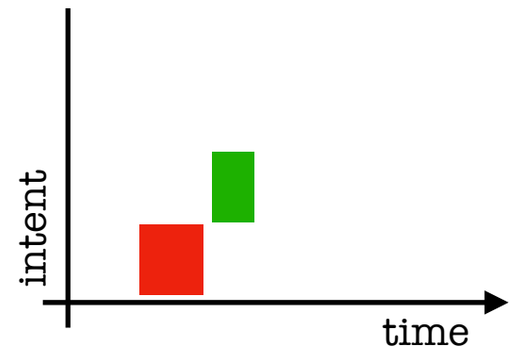
What sources are observed and why





- **Flux : We need to have a corrected flux scale**

  - observe a known ‘flux’ **point-like** or solar system amplitude calibrator**



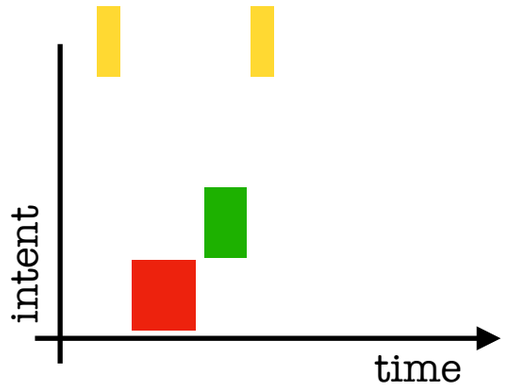
**we know how the visibility PHASE should look*
***can often use the Bandpass if we know it’s flux well*

What sources are observed and why

- **Pointing : We have to ensure we look in the correct direction**

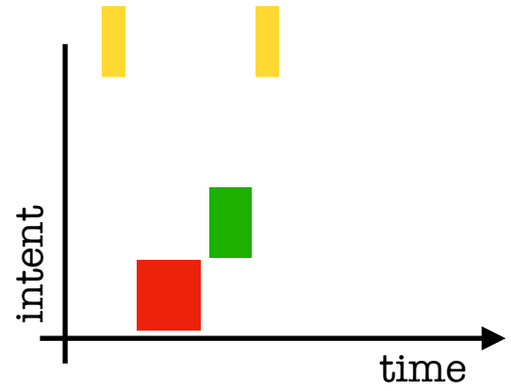
  - the telescope is calibrated to know positions, but we have to check during the observations

  - if antennas don’t respond correctly we need to know



What sources are observed and why

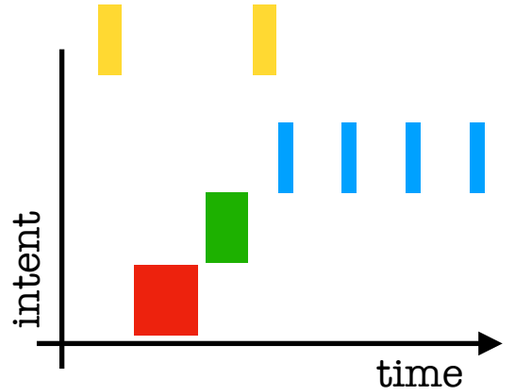
This is fundamental !



- **Gain Calibrator : We are looking through the atmosphere**

  - changes in amplitude and refraction caused by the troposphere with time

  - look regularly at a **point-source** calibrator



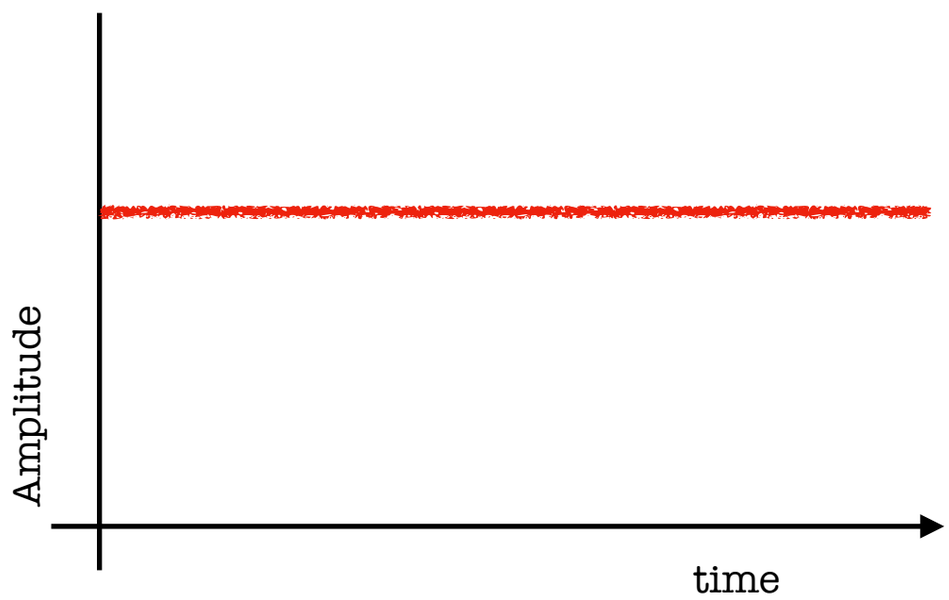
Why are the calibrators point sources?

- **Because we know their visibilities**

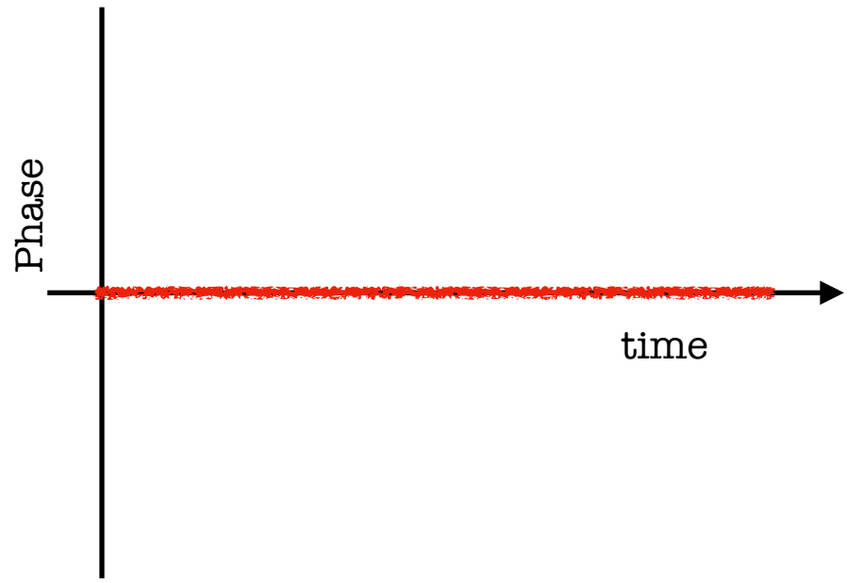
  - amplitude is constant, know how to arrange flux based gains

  - phases should be 0 degrees phase for a point source at the phase center

- **Amplitude is “flux”**

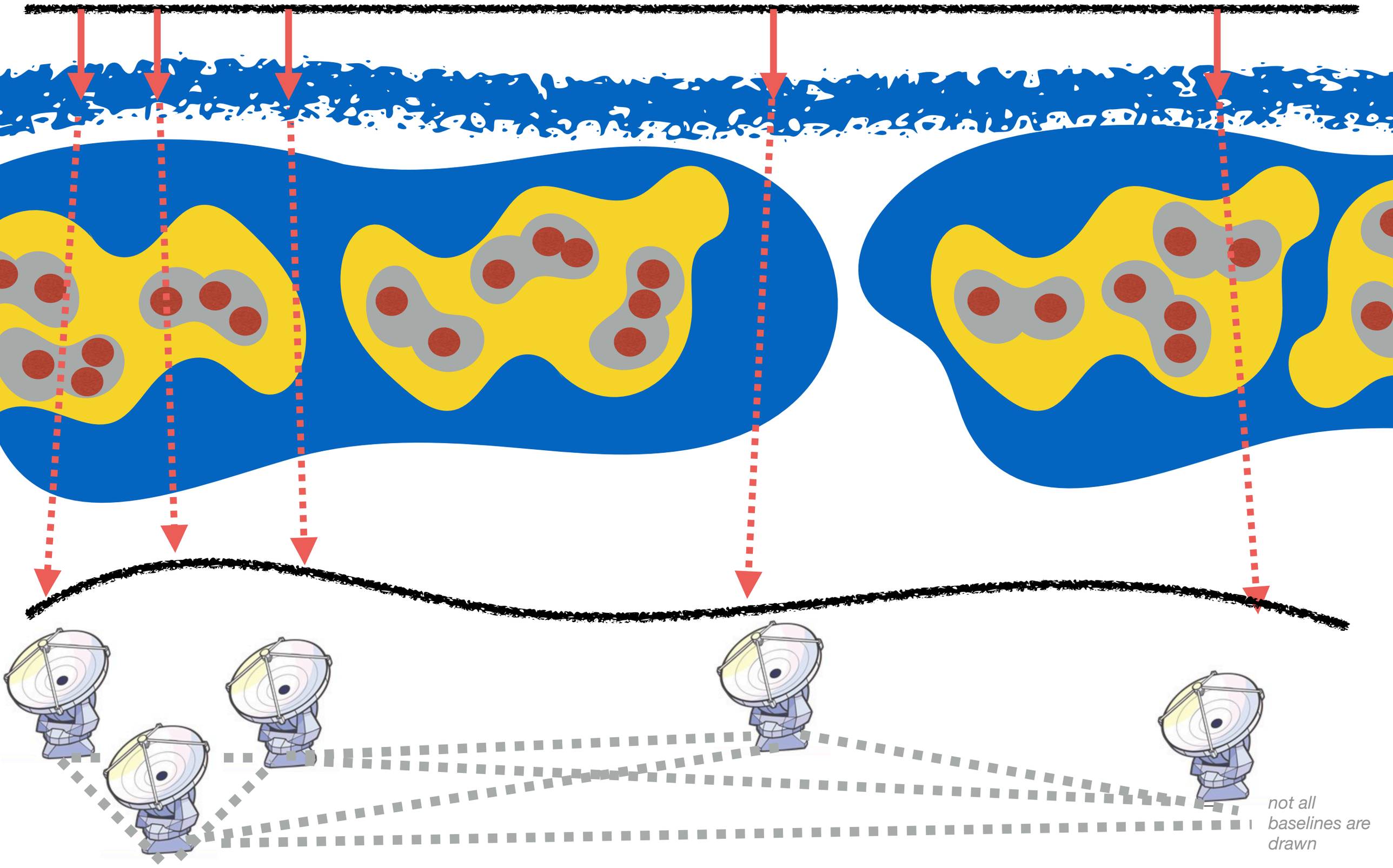


- **Phase is “position”**



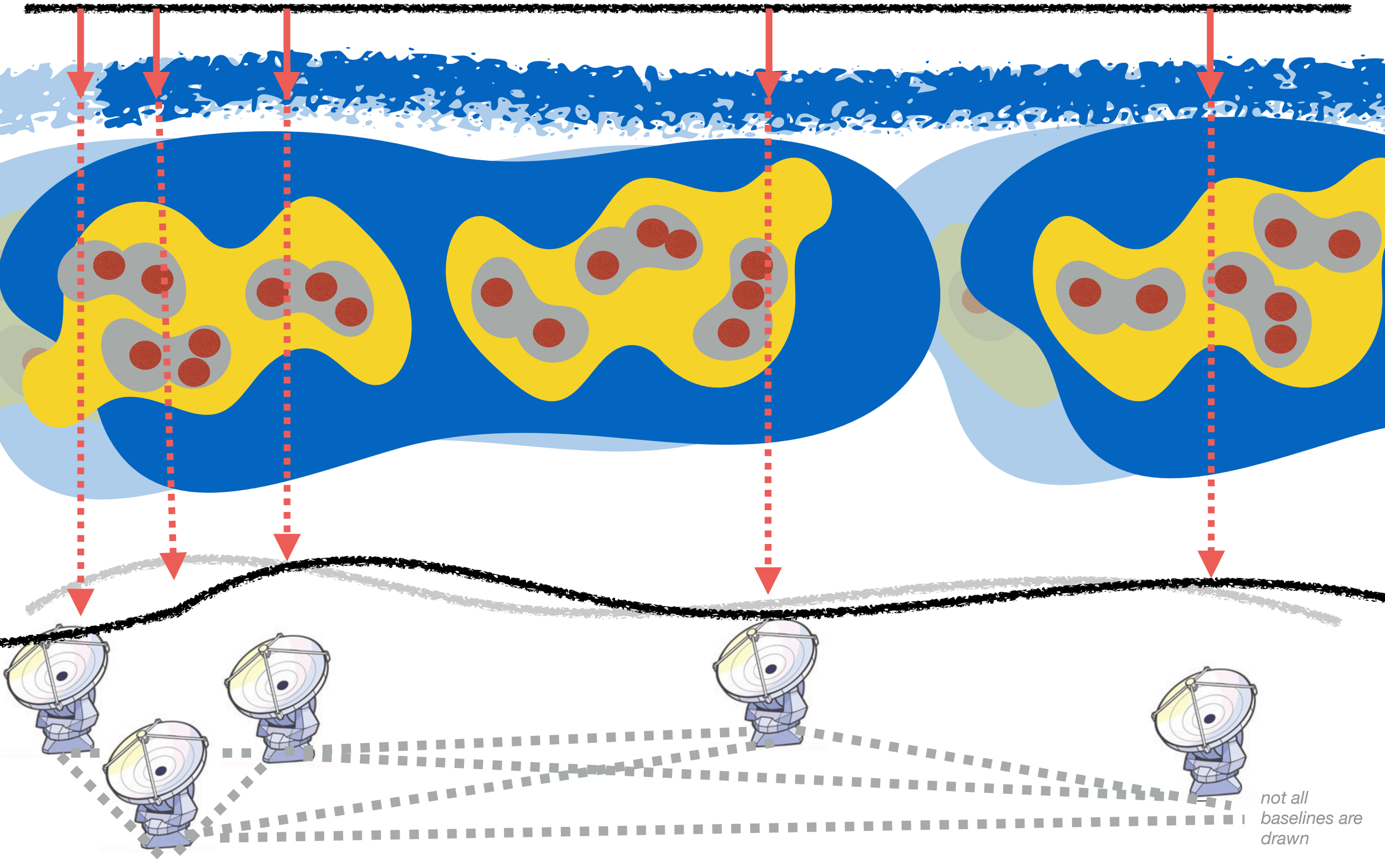
Troposphere

different baselines see different fluctuations causes by variable atmospheric ‘cells’, changes the arrival of the wavefront



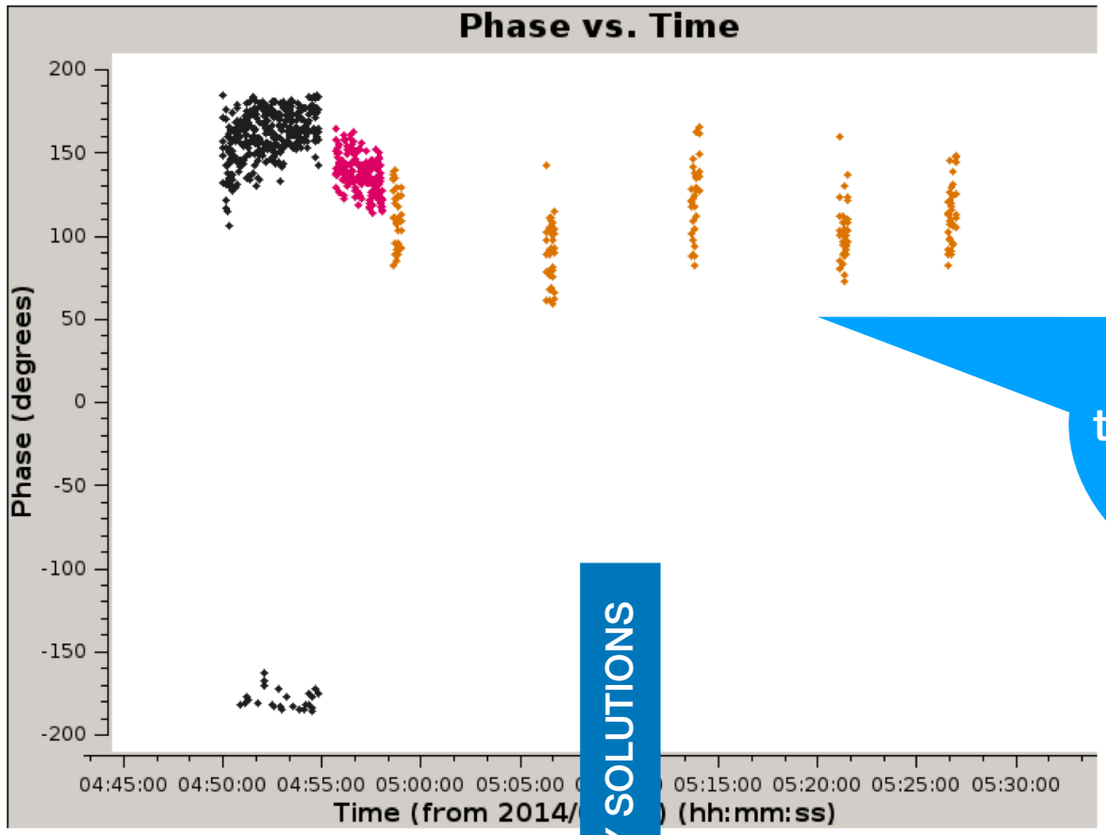
Troposphere

the tropospheric ‘layer’ moves with time (wind) → variable wavefront → variable **PHASE** changes



not all baselines are drawn

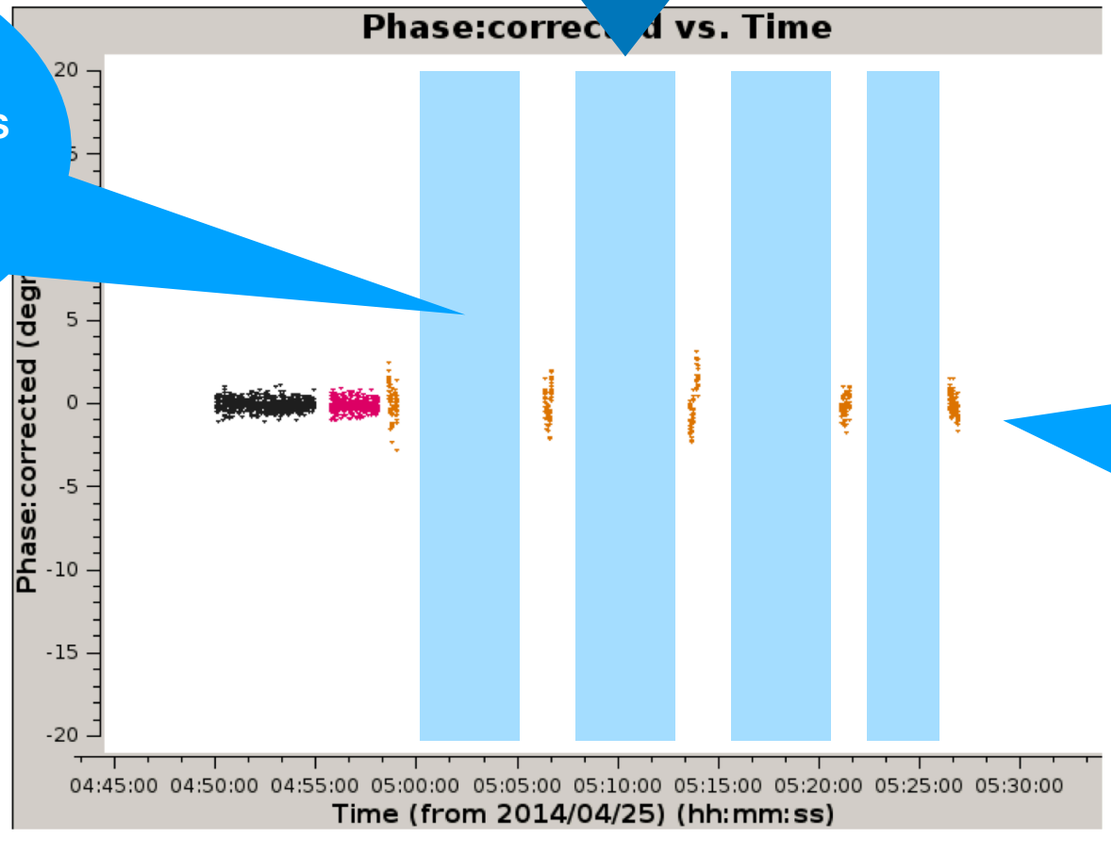
Phases



one baseline, see phases are variable with time - these are point-source - i.e. should be ZERO phase

APPLY SOLUTIONS

these are target scans - we don't know what the targets is doing we INTERPOLATE the phase solutions to correct it



calibrators are ZERO after solutions are applied

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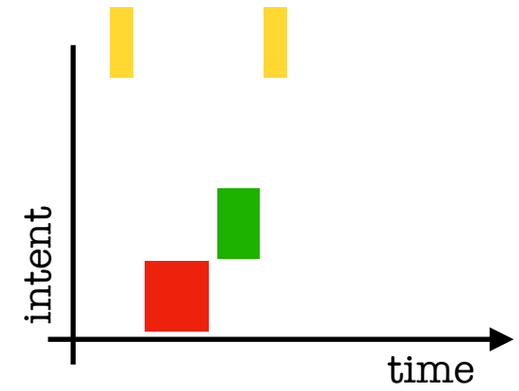
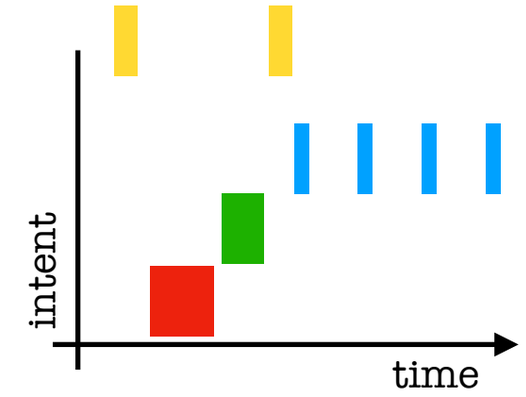
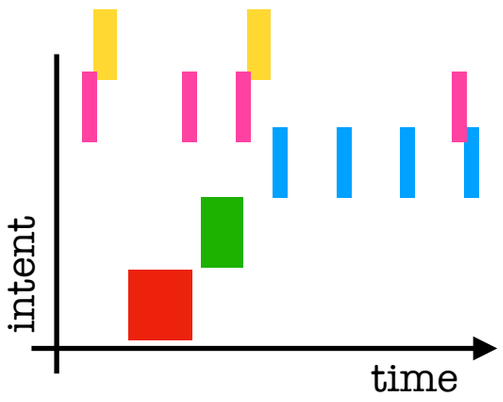




- **System Temperature : Amplitude scale correction for receiver and sky**

  - correctly scale from instrument units to flux also accounting for looking through the atmosphere



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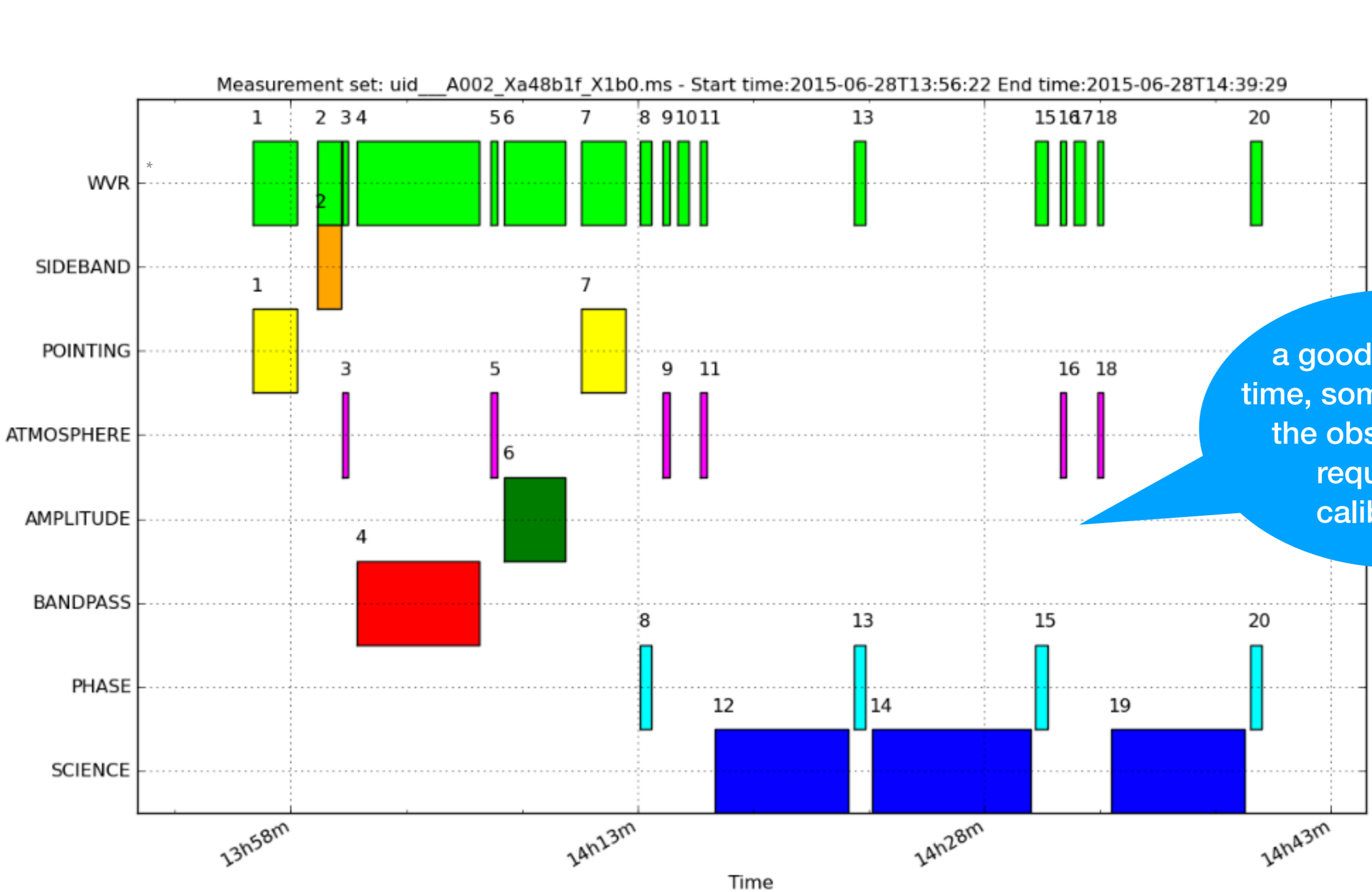
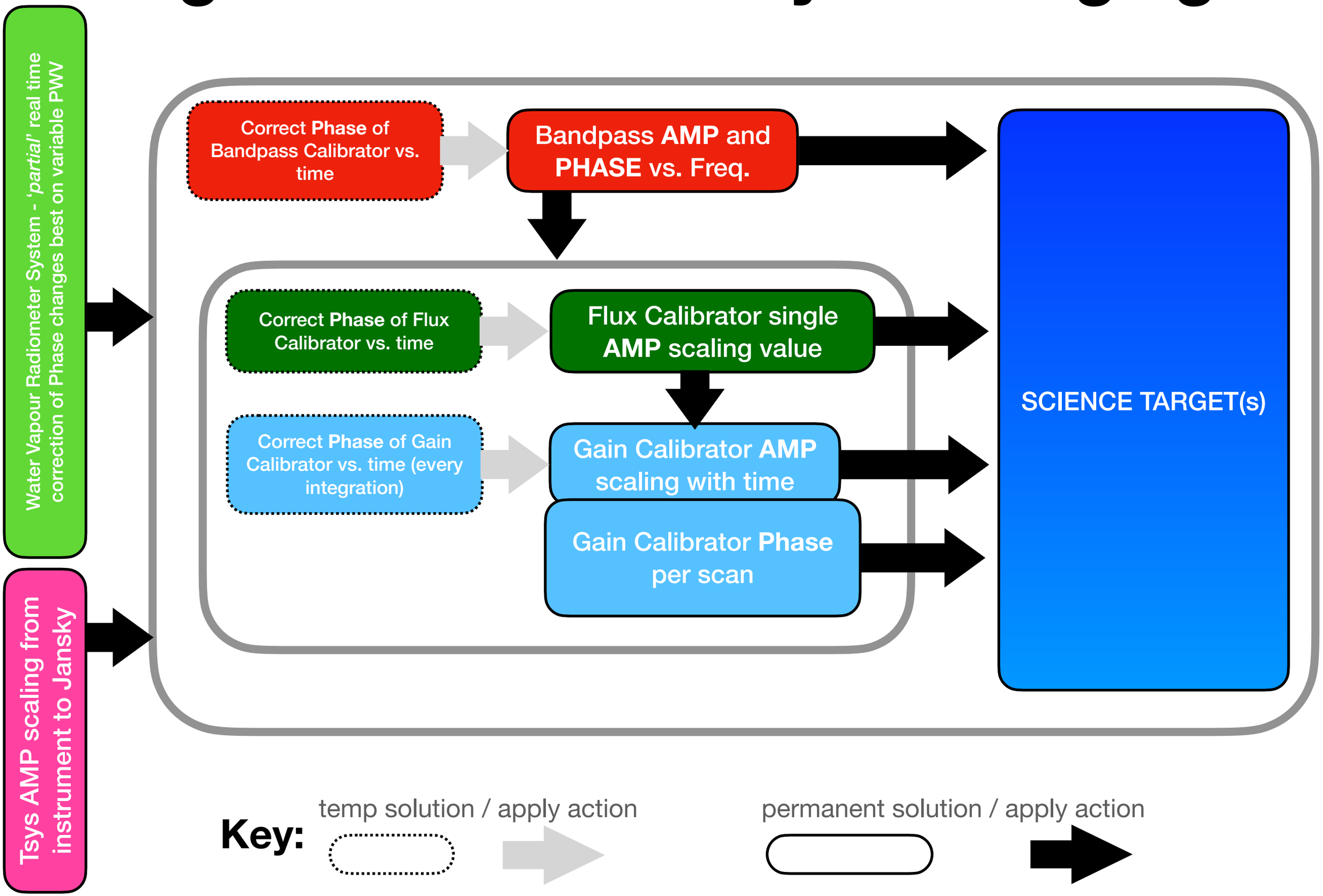


a good fraction of time, sometimes ~half the observation is required for calibrations

** ALMA also can measure the PWV content on different antennas and also proves a 'phase' corrected - this is the WVR system -this is always 'ON' for the 12m array*

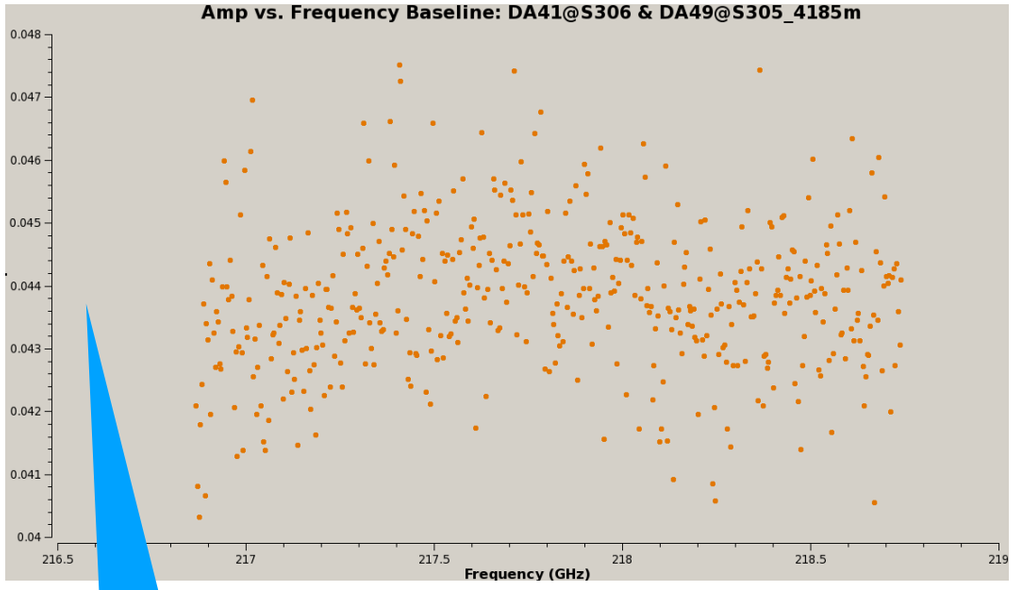
Data get calibrated ready for imaging



Extra Slides

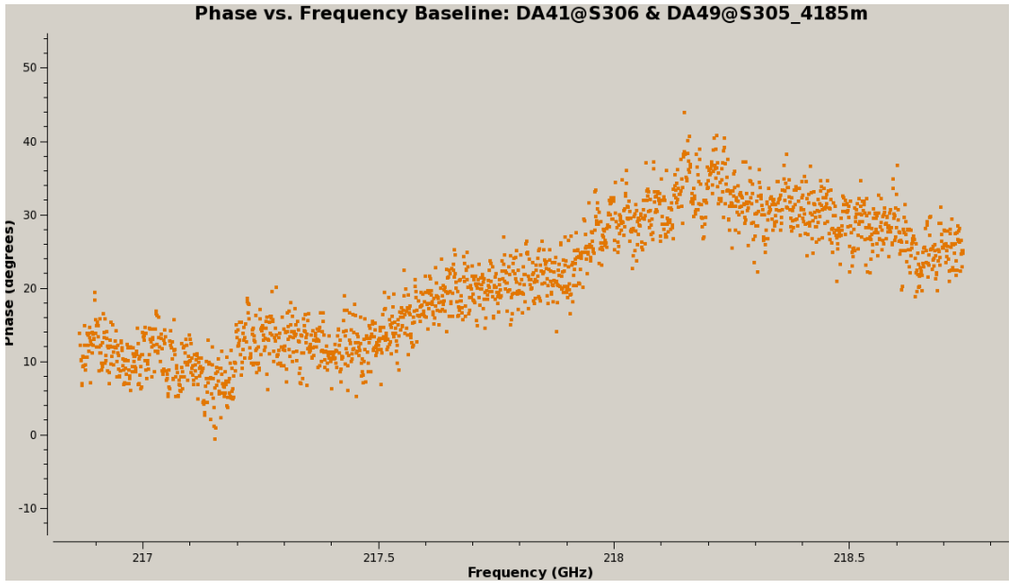
Bandpass correction

- **Per antenna : Solve amplitudes and phases with frequency**



AMPLITUDE

take note of the scale

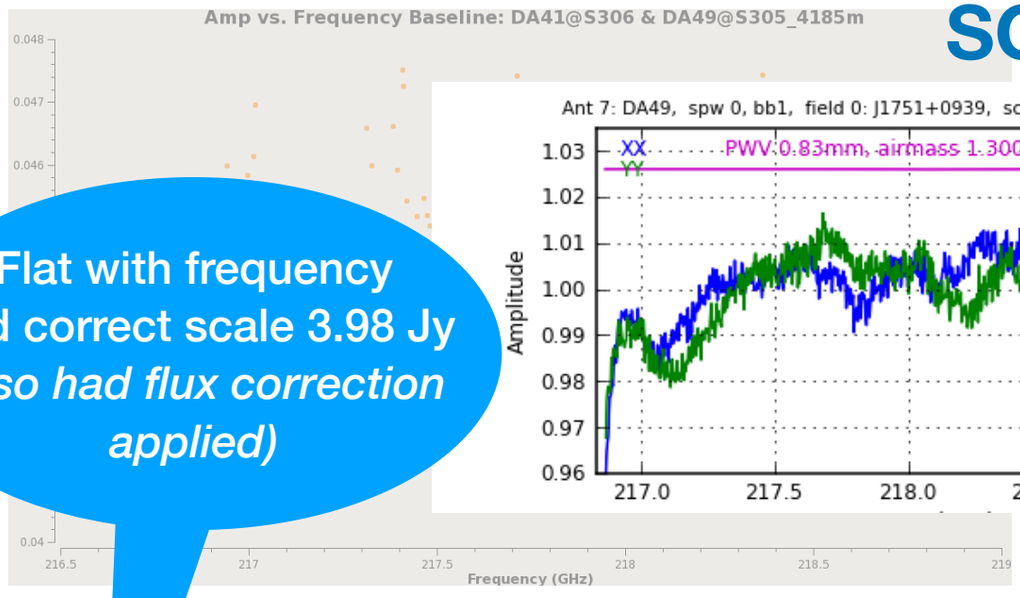


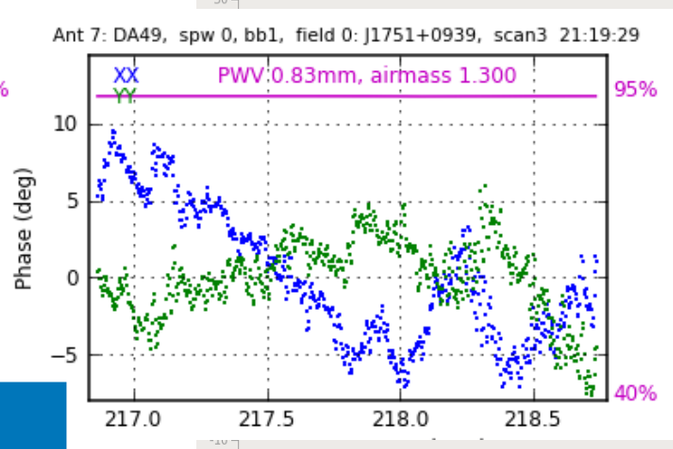
PHASE

Bandpass correction

- **Per antenna : Solve amplitudes and phases with frequency**

SOLUTIONS

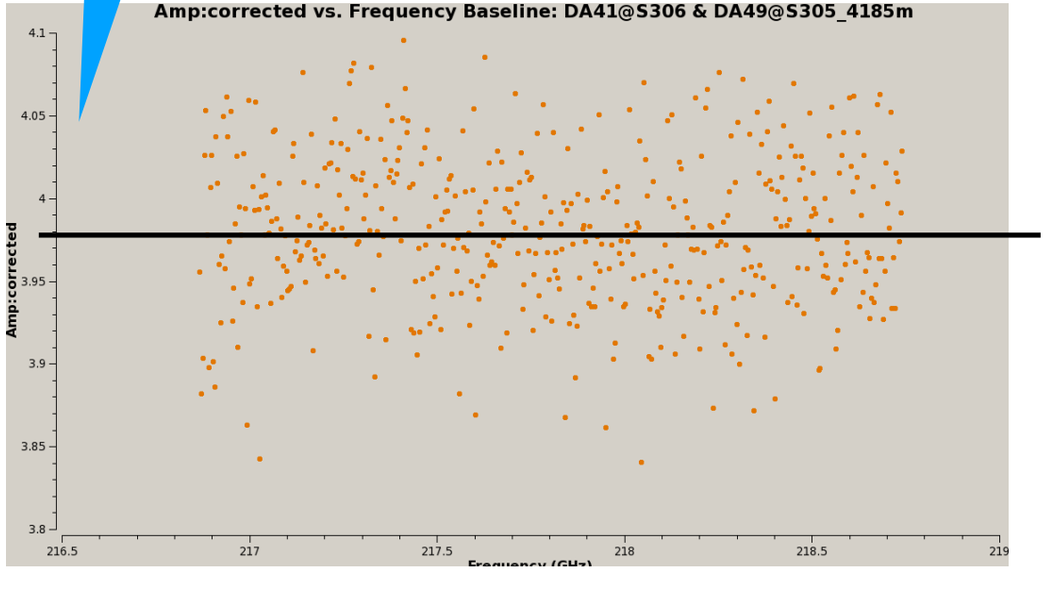




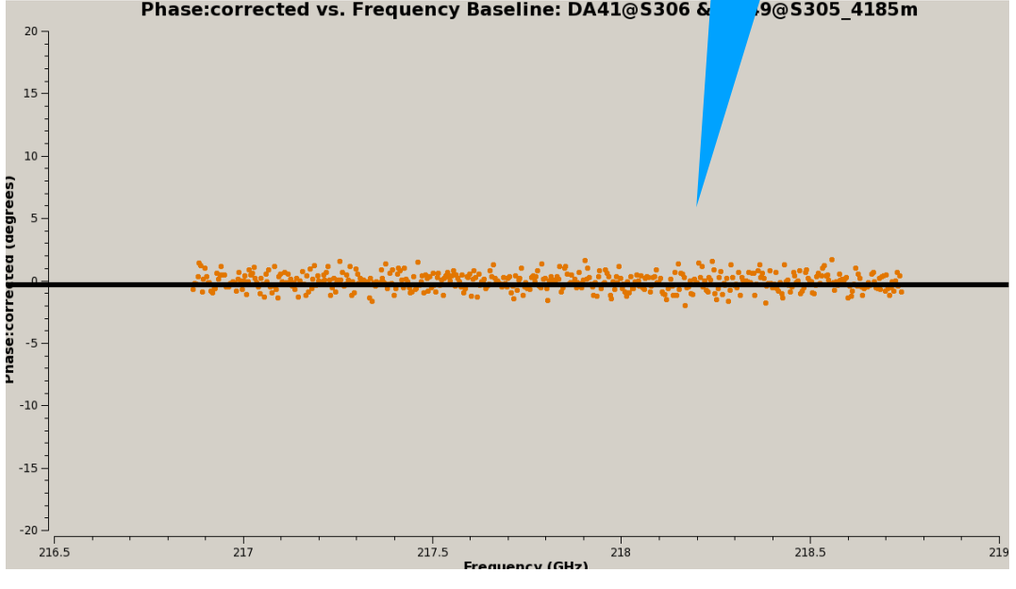
Flat with frequency and correct scale 3.98 Jy *(also had flux correction applied)*

phase at zero - point source at pointing centre

AMPLITUDE



PHASE



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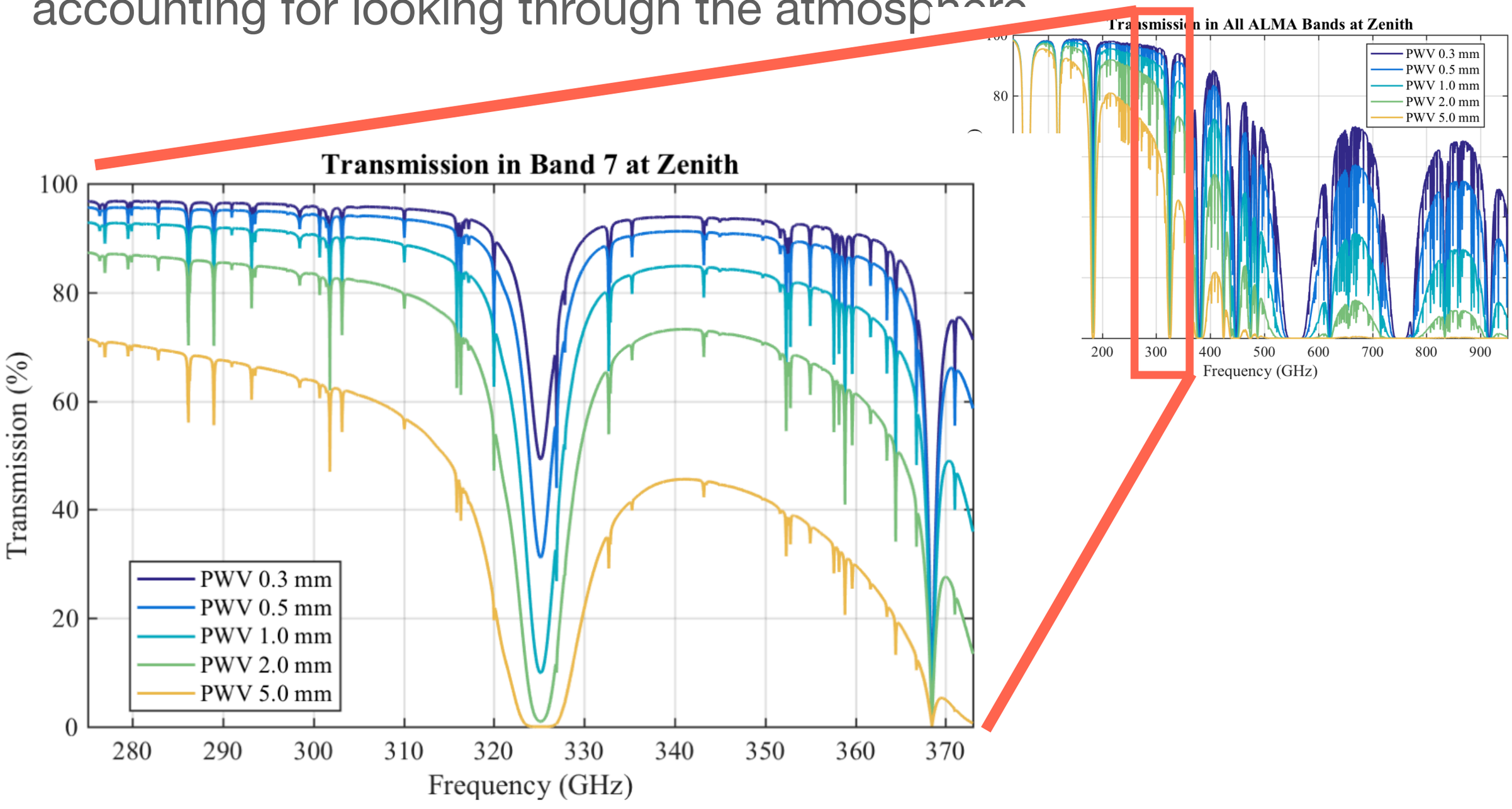

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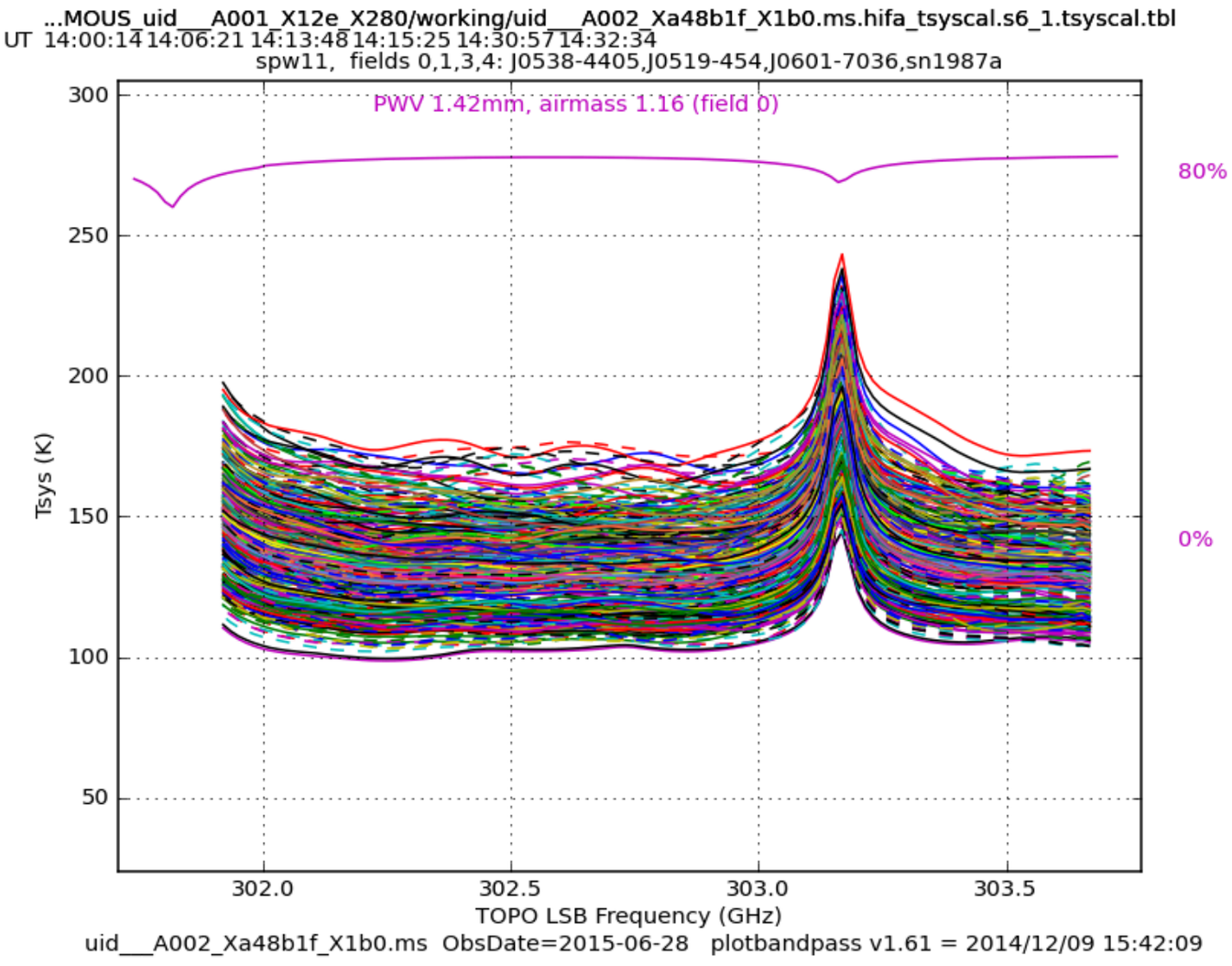

per Antenna/Reciever per SpW

Scaling converts the ratio of **correlated signal** with the total system noise in a Kelvin (or Jansky) unit