The Submillimetre Spectrum of Mars as seen by Herschel-SPIRE

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On behalf of the HssO Consortium

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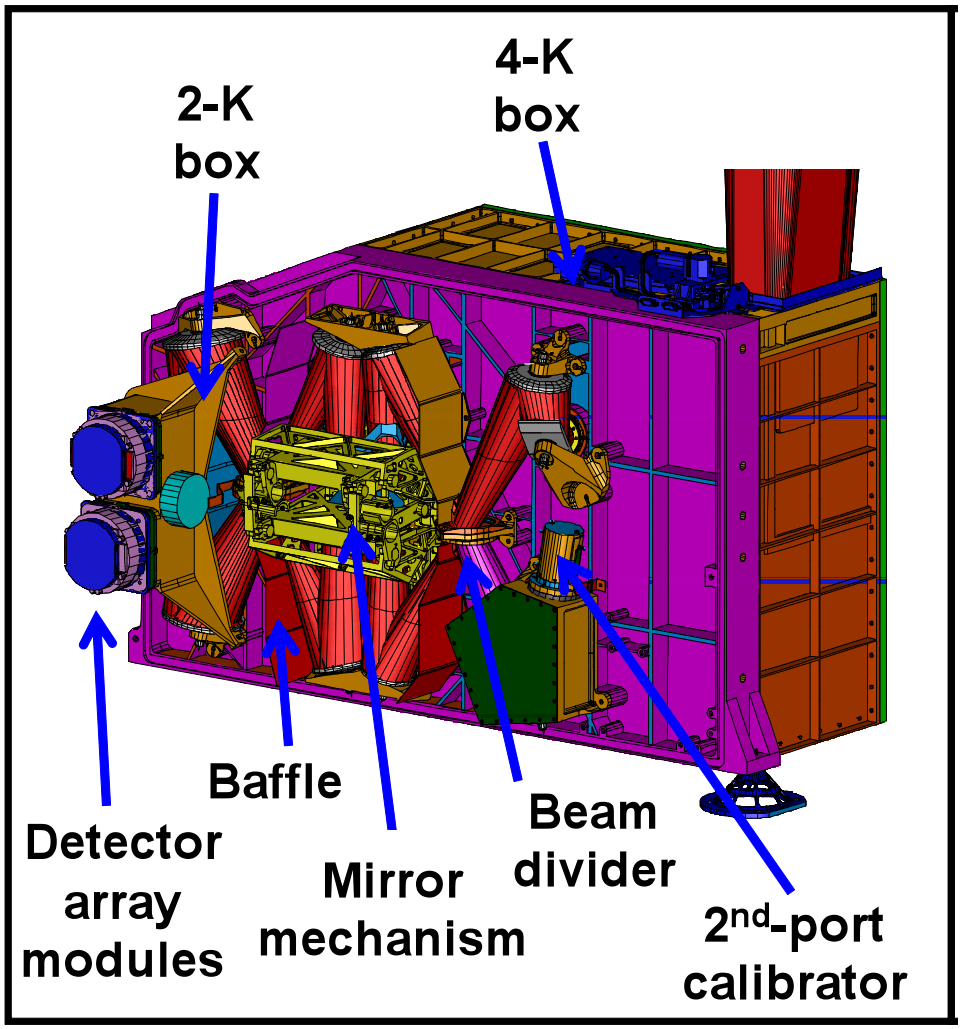
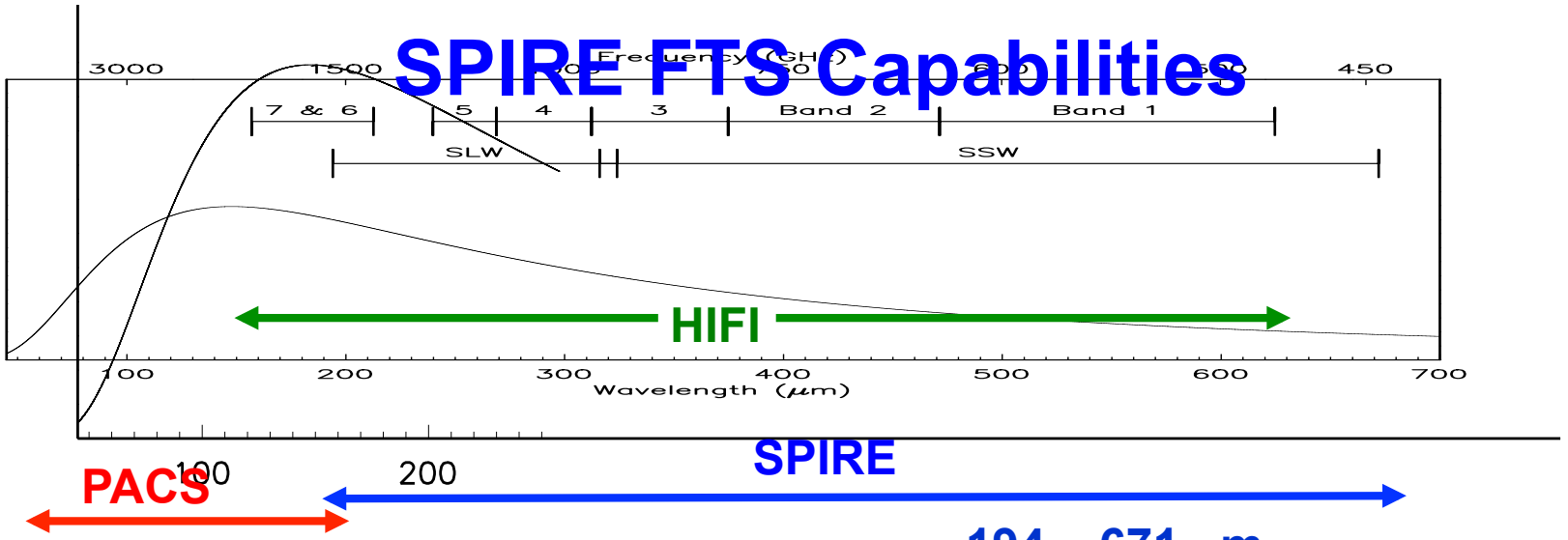
The SPIRE FTS- reminder



SPIRE FTS Capabilities

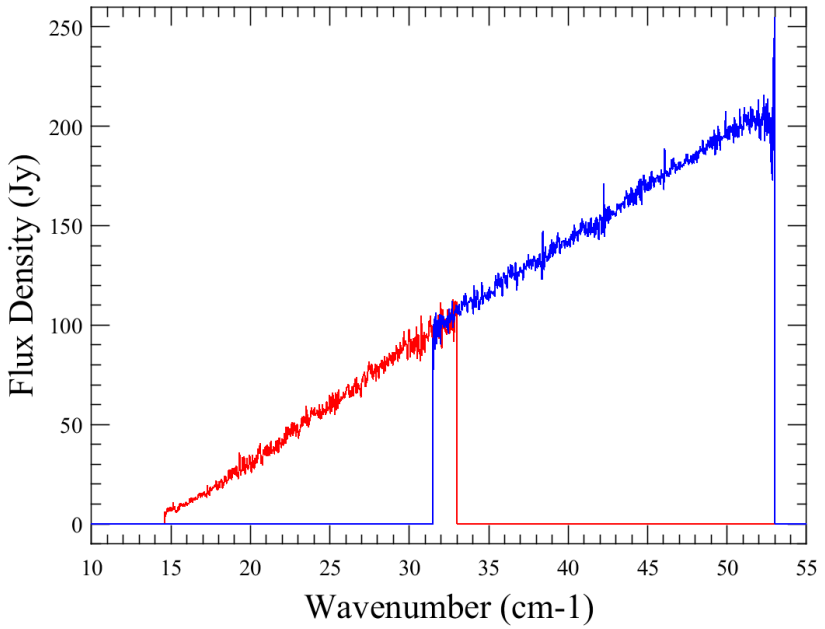


194 – 671 μm
51.5 – 14.9 cm-1
1545 – 447 GHz

- **Entire range covered simultaneously**
- **Continuum measured as well as spectral lines**
- **Adjustable spectral resolution : $\Delta\nu$ (H, M, L) = (1.2, 6.7, 25) GHz**
- **Frequency calibration accurate to < 1/10 resolution element**

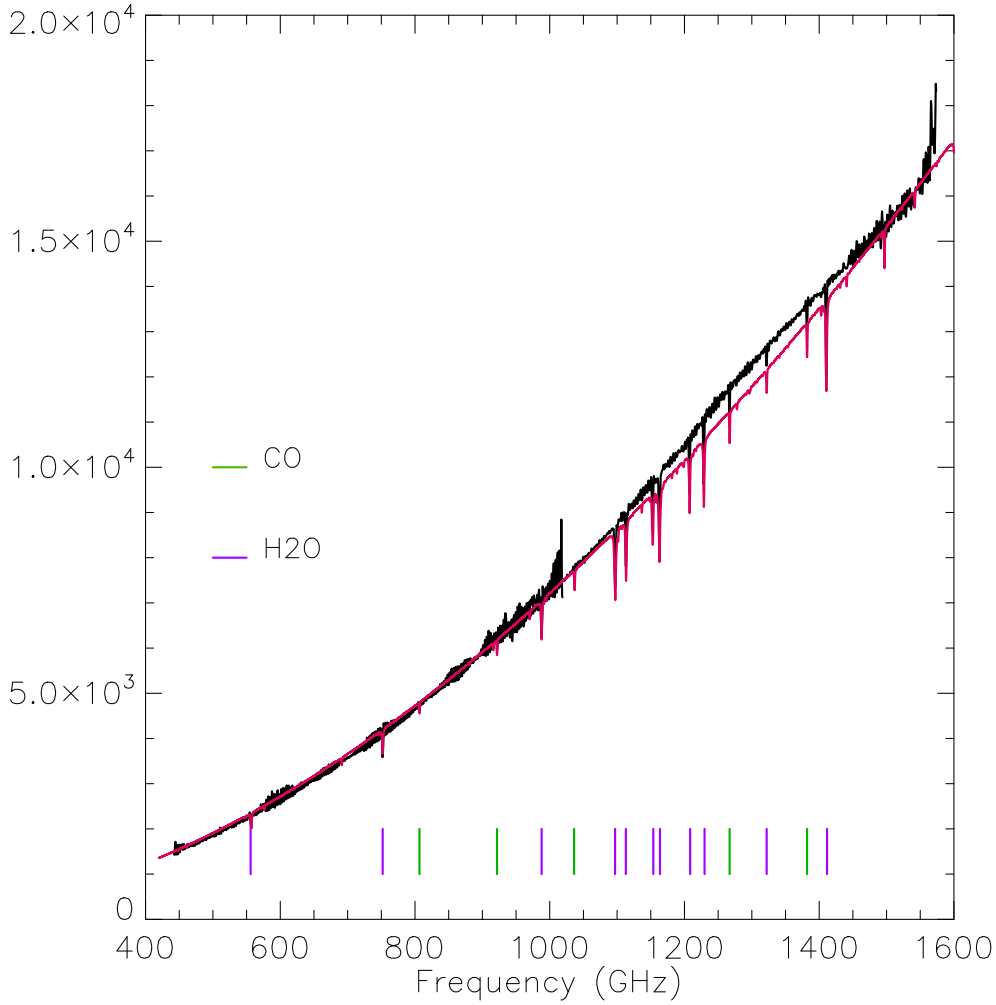
Typical Observations with SPIRE FTS
Bright Source mode

- Instrument designed to be as sensitive as possible
- Telescope represents flux of ~100's Jy
- Sources >> brighter saturate the detector electronics
- Need to reduce gain and/or sensitivity
- Gain variable by putting detector bias out of phase
- Sensitivity variable by increasing the bias
- Test observations to see if it works
- Is it possible to observe Mars?
- Is it possible to calibrate it?



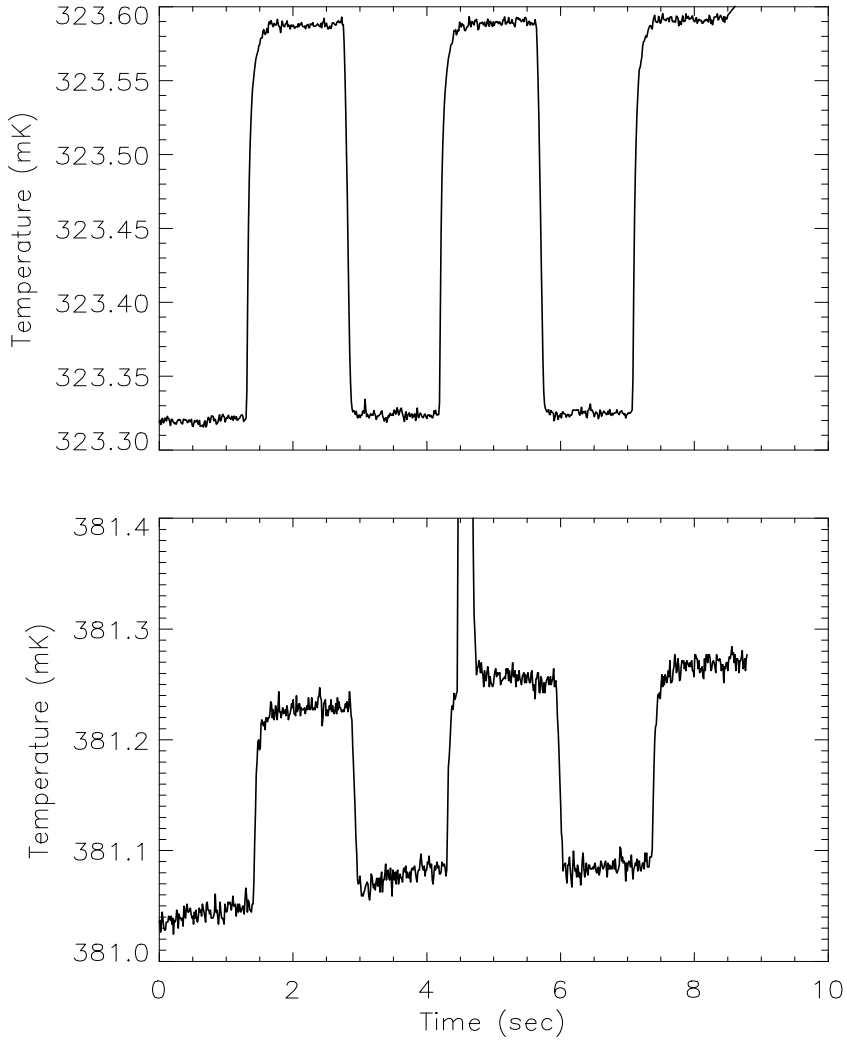
Mars Observed on OD176 (2009 November 6)

- Answer – yes!
- 2 repeats – 264 seconds
- Data processed through non-standard pipeline
- Uranus (Moreno 2010) used as the calibration standard
- Gain correction achieved using calibrator flashes to scale continuum
- Some ”clipping” in the interferogram leads to distortion of SSW spectrum



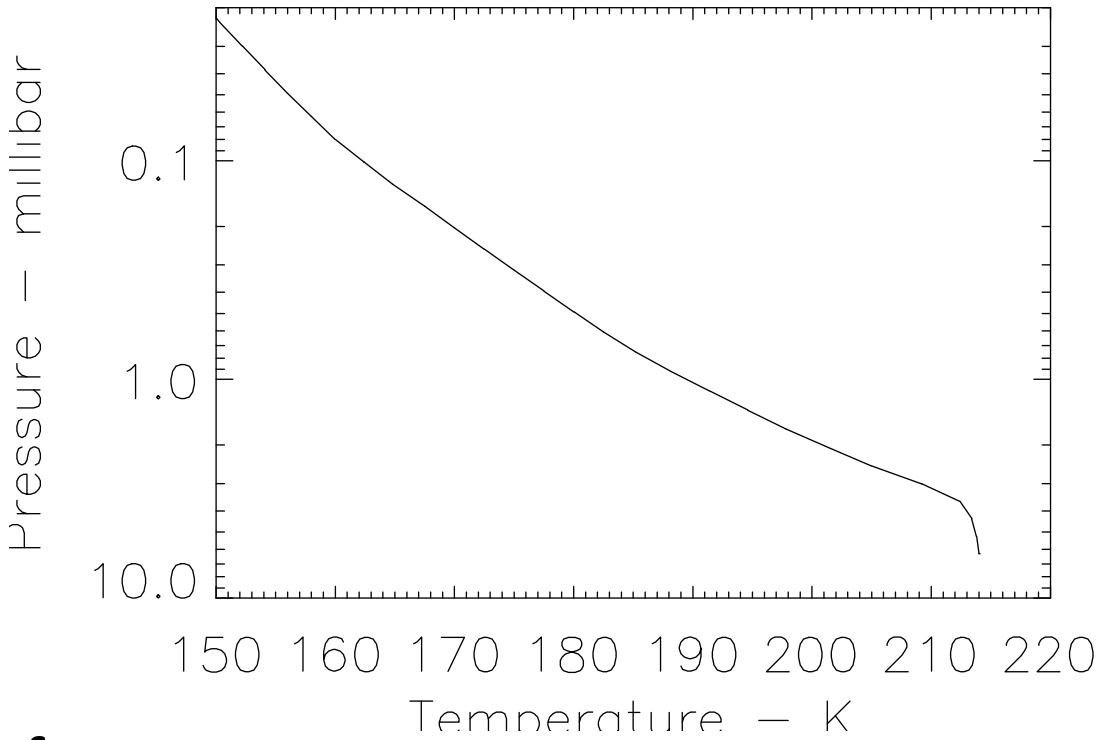
Interferograms and PCAL Flashes

- Detector temperature varies ~linearly with power
- ΔT can be used as linear proxy
- After conversion to spectral domain can scale gain using response to PCAL...
- ..or to the telescope



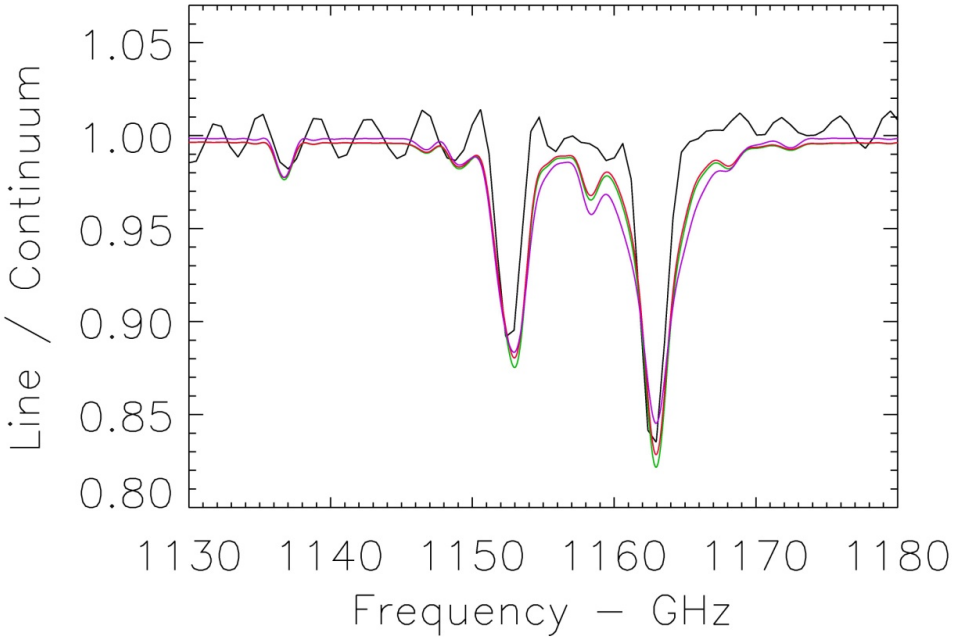
Mars Model in RADTRANS (Irwin 2009)

- Standard thermal profile (Seif 1982)
- Northern “Summer”
- Not quite right for November 2009
- Continuum calculated using Lellouch (2008) model (220 K) and emissivity of 0.95 (Burgdorf et al1998)
- Constant mixing ratios of 1.2×10^{-3} and 9.0×10^{-3}



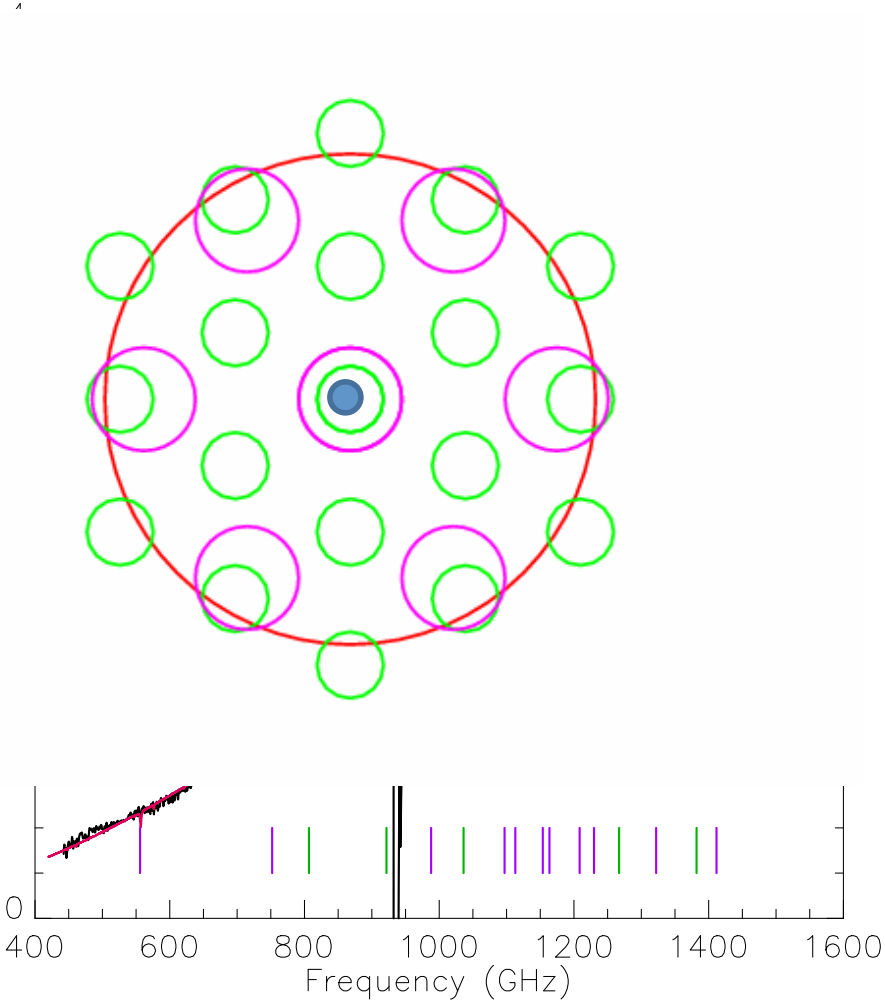
Varying the mixing ratio

- Attempted to get better fit to line widths
- Variation with pressure requires large increase in surface mixing ratio
- Variation with temperature better but still lines are narrower than prediction
- Need HIFI.....

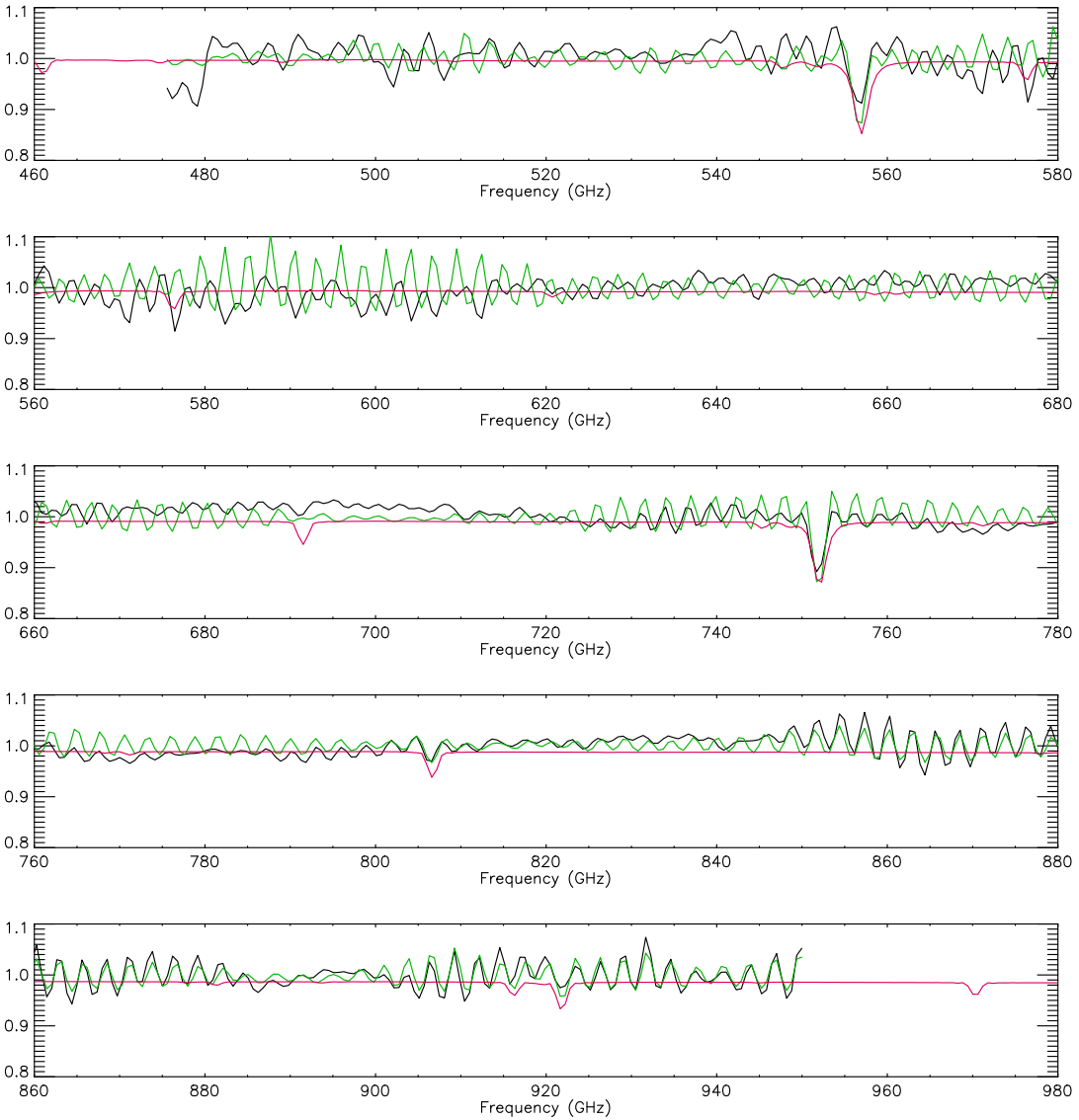


Mars taken on OD327 (2010 April 6)

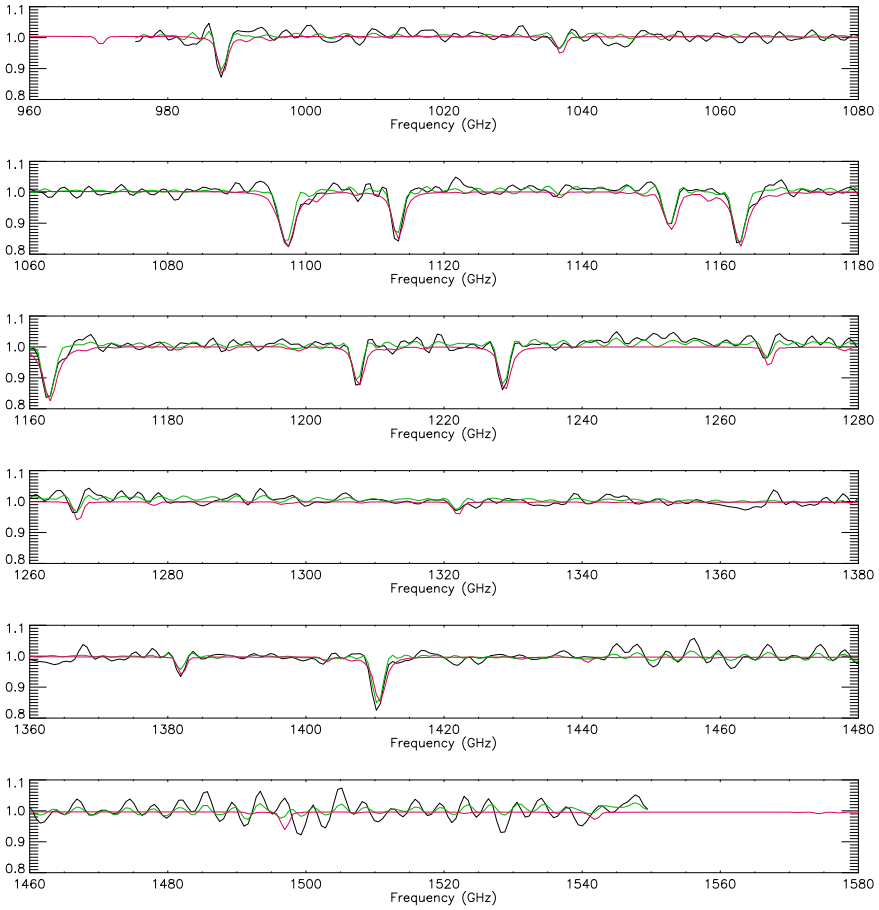
- Using “High Bias” brigh source mode
- On this OD there was a 6” offset in the pointin
- Calibrated using the telescope as fixed source
- Leaves structure in the spectrum

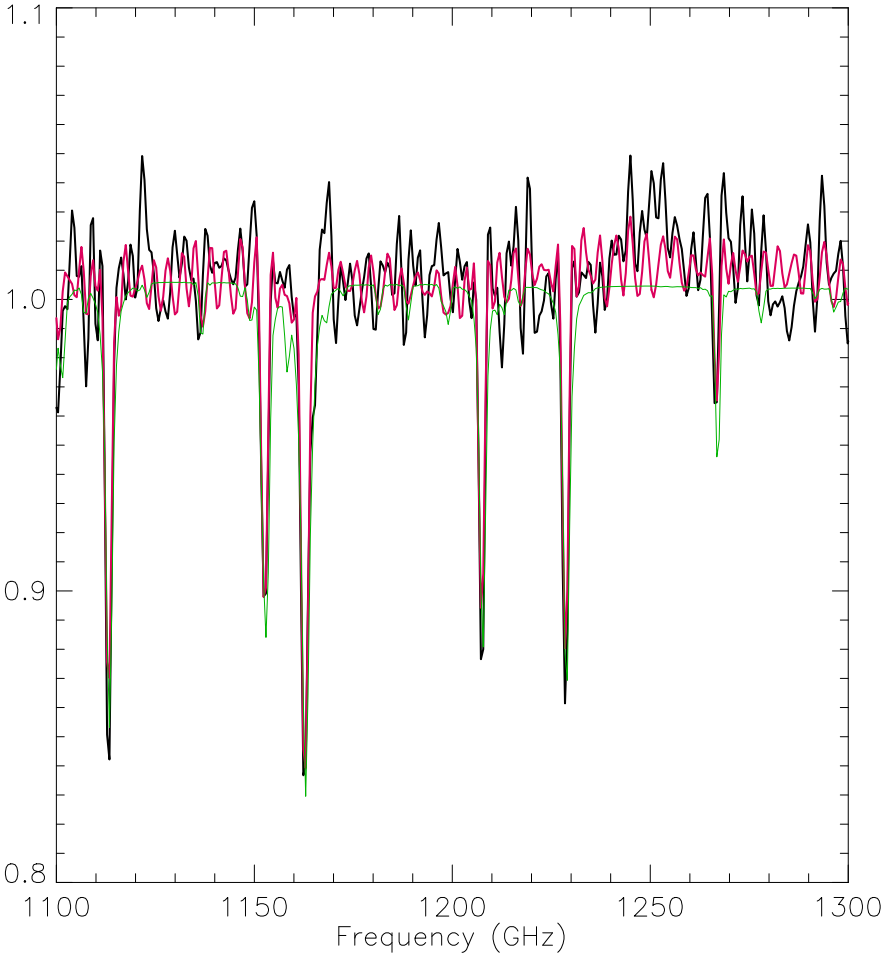


SLW compared to OD176



SSW compared to OD176





Conclusions

- We can use to SPIRE to observe Mars – not an obvious statement
- We can calibrate the spectrum to reasonable accuracy – not an obvious statement
- First order model shows good agreement over most (all?) water and CO observations in spectrum -....
- A second observation off axis seems to show some unexpected emission features
- HIFI observation required to refine modelling and confirm (or not) emission features
- Further observations will look for temporal variability
- Saturn should also be observable with SPIRE