Spectral Baselines at Effelsberg from Secondary Focus at 22 GHz

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Summary

We observed the water maser source T Vir at 22.235 GHz with the secondary focus receiver during an hour and a half of free time on 23.10.2003 to compare the baseline ripple resulting in spectra observed using position switching and frequency switching and with various correlator bandwidths. We found baselines that were perfectly flat, without detectable ripple using position switching for correlator bandwidths of 10 MHz and 20 MHz, and with a simple curvature at 40 MHz and 80 MHz. Frequency switching yielded low−order baseline ripple that could be easily subtracted with low−order polynomials.

Observations

T Vir was chosen for its convenient location and it was not so strong as to compress the vertical scale of our plots.

Setup of receiver and IF distribution was non−standard. A useful setup procedure has to be installed.

Correlator was set up using the following OBSE inputs:

```
set frequency_l 22.235
set nsplit 3 offr
set nchannels 2
set backend_l n
set nbandwidth 20 20 20 20
```

We changed nsplit and nbandwidth as required for the different bandwidths (given in the AK90 documentation).

For position switching we spent 30 s on−source, 30 s off−source, one on−off cycle, offset distance was not logged but was probably a few arcmin, using the 'psw' command.

For frequency switching we used a 40 MHz correlator bandwidth, 20 MHz frequency switching offset and 'symmetric' mode to place the on and off spectra symetrically about the centre of the correlator band. The OBSE command was 'fsw 20 symm /time_l 60'.

Results

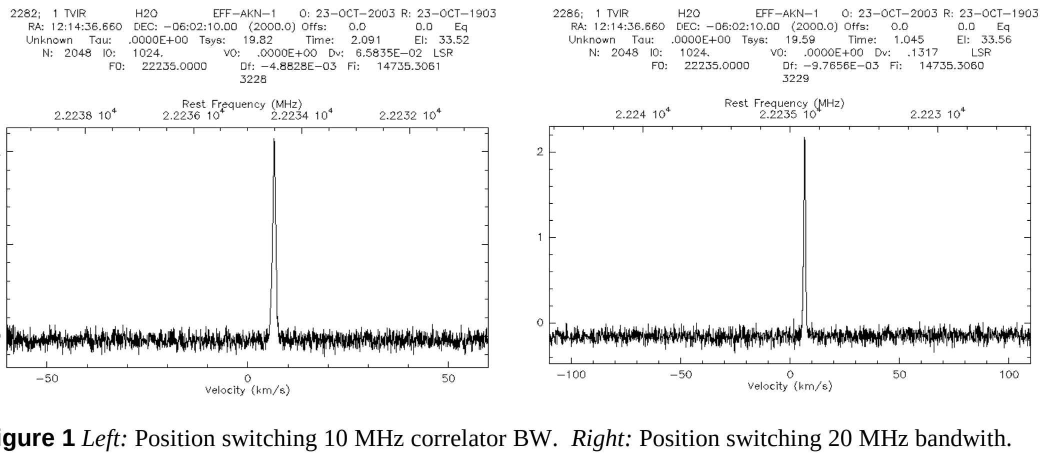

Figure 1 *Left:* Position switching 10 MHz correlator BW. *Right:* Position switching 20 MHz bandwith.

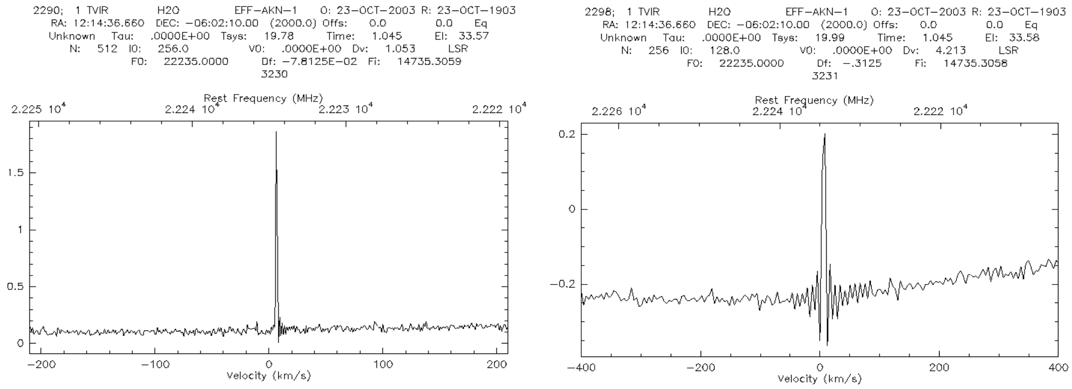

Figure 1 (cont) *Left:* Position switching 40 MHz bandwidth. *Right:* Position switching 80 MHz bandwidth.

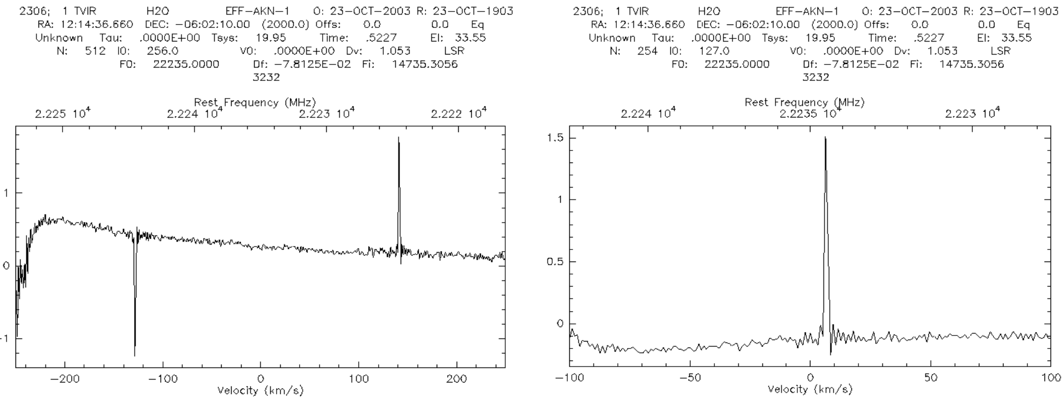

Figure 2 *Left:* Frequency switching 40 MHz bandwidth 20 MHz offset. Right: As for left, but after folding the spectrum. Integration time was 30 s per on or off state and one cycle.

Table 1 Baseline ripple estimated from Figures 1 & 2

Mode	BW	p−p ripple
psw	10 MHz	< 23 mK (< 29 mJy) flat
psw	20 MHz	< 23 mK (< 29 mJy) flat
psw	40 MHz	36 mK (= 46 mJy) barely detectable smooth curve over 40 MHz
psw	80 MHz	45 mK (= 58 mJy) noticeable smooth curvature over 80 MHz
fsw	20 MHz	340 mK (= 440 mJy) smoothly curved slope over 30 MHz
		81 mK (= 104 mJy) after folding the spectrum

Assumes T_{cal} = 4.5 K (from Kraus calibration web page), that spectra were calibrated online using T_{cal} = 10 K, and that sensitivity = 0.78 K Jy^{-1}.

Curiously, the peak maser amplitude was different between the observing modes; 2.4 K for psw and 1.6 K for fsw. The SNR in the spectra were the same (18.4 for psw and 17.0 for fsw after allowing for the different channel bandwidths), so it looks most likely that the online calibration factor, which scales both the signal and the noise, is different between psw and fsw. This should ideally be examined further, though the differences should calibrate away during offline reduction against a standard calibrator source, and so is not critical. To compensate for this error we multiplied the p−p ripple measured from the plots for fsw by the factor 2.4 / 1.6 = 1.5 before quoting in Table 1 to allow direct comparison to psw.

Conclusions

1) Very flat bandpasses are available from secondary focus at 22 GHz using either position or frequency switching.

2) Position switching performs better than frequency switching.

3) The baselines seen in frequency switching mode were smoothly changing over 30 MHz and could be expected to subtract well using a low−order polynomial. The root−two integration time advantage of frequency switching over position switching is probably therefore available to be used.

Were standing waves present between the subreflector and main dish, they should appear with a period, for 30 m subreflector−dish spacing and 13 mm wavelength at 13 mm / 30 m * 22 GHz = 8 MHz. This period would have been easily seen were it present in our measurements.

Still to be tested: absolute calibration at 22 GHz: do position and frequency switching agree on the flux densities?

This quick test looks good for spectroscopy at 22 GHz from secondary focus, and will be important when an active subreflector makes secondary focus attractive for the frequency agility and flat gain curve.