The IVS Technology Development Center at the Onsala Space Observatory

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Abstract

We give a short overview of the activities at the Onsala Space Observatory in its function as an IVS Technology Development Center. We describe the new microwave radiometer and the ongoing development of a new S/X-band feed system for the 20-m telescope.

1. The New Microwave Radiometer at Onsala

The new microwave radiometer developed during the last couple of years at the Onsala Space Observatory (OSO) [1], [2], [3] has been completed and first test measurements were carried out in summer 2000. The new instrument is equipped with narrow beam horns and fast pointing drives. One of its main applications is to study small scale atmospheric structures. We are looking forward to use the two microwave radiometers at OSO collocated with GPS and VLBI for atmospheric studies. Table 1 gives an overview on the specifications of the new instrument. Figure 1 shows a photo of the new instrument and Figure 2 gives a schematic representation of its control and data acquisition systems. Each of the two microwave channels is equipped with a horn antenna, mechanical switch, ferrite switch, mixer IF amplifier, baseband amplifier and A/D converter.

Table 1. Specifications of the new microwave radiometer developed at the Onsala Space Observatory.

Mechanical part		Azimuth	Elevation
	Maximum pointing resolution	0.0072°	0.0144°
	Achieved pointing resolution	0.1°	0.05°
	Pointing range	0–360°	0–360°
	Slew rates of motor drives	$> 20°/s$	$> 30°/s$
Microwave part		Channel 1	Channel 2
	Centre frequency	20.6 GHz	31.63 GHz
	Channel bandwidth RF	380 MHz	380 MHz
	Horn beam width (E/H) plane	2.9°/3.4°	2.0°/2.3°
	Side lobes (5° from boresight)	−18 dB	−23 dB
	Calibrated load stability	100° ± 0.01° C	100° ± 0.01° C
	A/D converter resolution	16 bit	16 bit

First successful measurements with the new instrument have been performed during the summer and fall 2000 [4]. The measurements were carried out at the Esrange Space Centre near Kiruna in northern Sweden where the instrument was collocated with one of the receiving sites in the continuously operating Swedish GPS network.

Figure 3 shows the time series of derived wet propagation delay for the month of August 2000 and a comparison between estimates of the wet propagation delay using the GPS data and the results inferred from the observed WVR sky brightness temperatures.

Figure 1. The new WVR.

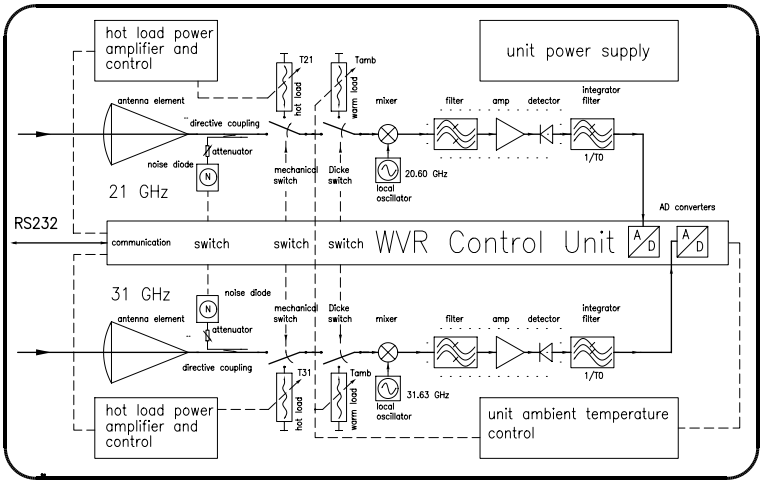

Figure 2. Schematic representation of the control and the data acquisition systems of the new WVR.

As expected the WVR time series contain more short term variations compared to the smooth Kalman filter estimates using GPS data (see Fig. 3). However, we find the white noise in the observed brightness temperatures to be higher than expected and modifications will be made to the software integration algorithms.

There is a clear bias between the GPS and the WVR results (see Fig. 3). The origin of this is unknown but we are investigating the following possible explanations: errors in the observed brightness temperatures; error in the WVR algorithm used to calculate wet delay from brightness temperatures (the algorithm used at Kiruna was derived for the Swedish west coast); error in the GPS estimates; error in the model used to interpolate the ground pressure at the GPS antenna.

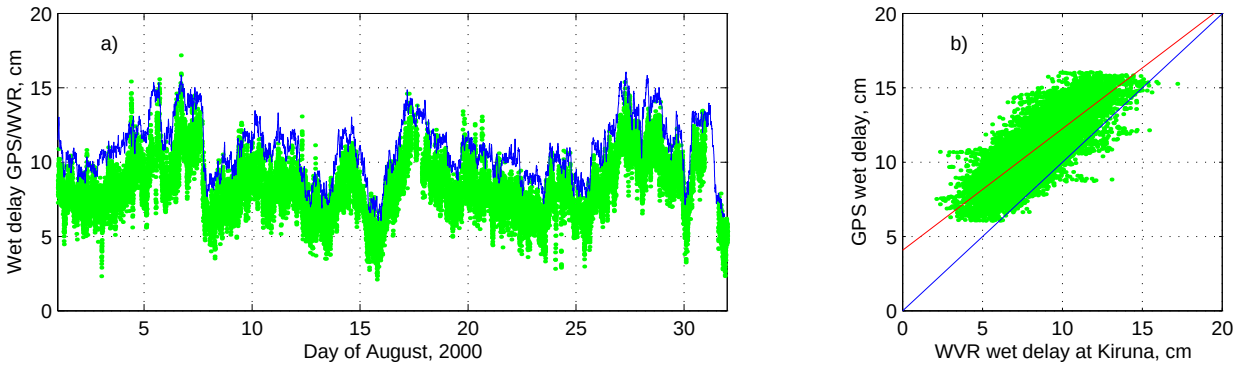

Figure 3. Equivalent zenith wet delay derived from observations with the new WVR and from GPS measurements during August 2000 at the Esrange Space Centre (Kiruna): a) Time series of wet delay results from the new WVR (green/gray dots) and from GPS (thin black/blue line); b) Wet delay results from the two methods GPS and microwave radiometry.

2. Development of a New S/X Feed System

The development of a new S- and X-band feed [5], [6] is ongoing. After the successful re-design of the corrugated horn that resulted in good antenna diagrams the coaxial waveguide transformer (COWAT) was also re-designed since its centre frequency was slightly off the desired value [7].

The re-designed COWAT was manufactured during 2000 with good cross-polarization isolation (24 dB at 8.12 GHz, 38 dB at 8.62 GHz) and good return loss at X-band (-22 dB). However, with only -8 dB for the S-band return loss it did not reach the specifications for S-band. No S-band polarizers have been manufactured yet, so no cross-polarization data are available for S-band.

Currently a re-design of the horn throat is under consideration in order to overcome the return loss difficulties (see Fig. 4). The intention is to make a wider waveguide opening at S-band, improving the return loss, but without affecting the behavior at X-band. The frequency selective surface is supposed to let S-band through, and act as a horn wall for X-band.

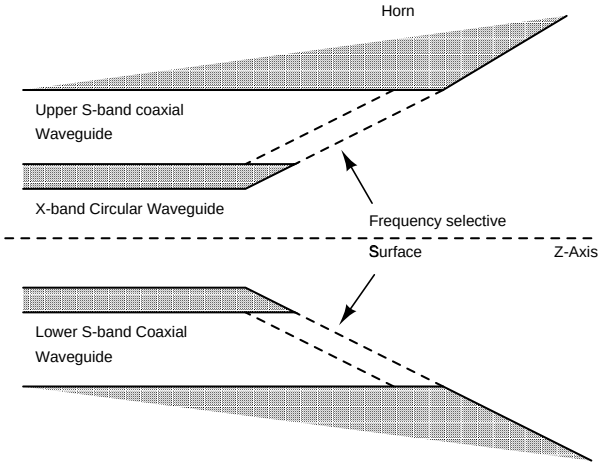

Figure 4. Considered re-design of the horn throat for the new S/X-feed system.

3. Outlook

The IVS Technology Development Center at the Onsala Space Observatory will continue with the development of the new radiometer and the new S/X feed system.

We will concentrate our efforts on the software integration algorithms for the new WVR in order to improve its performance. We will especially investigate the reason for the obvious bias between the radiometer results and GPS results for wet delay obtained from the measurements at Kiruna. Extensive test measurements will be carried out at the Onsala Space Observatory and the results for atmospheric parameters will be compared to results from the other collocated techniques.

The development of the new S/X feed system will focus on the return loss difficulties. A re-design of the horn throat will hopefully solve the problems.

References

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