RPG-4CH-DP
4 Channel Dual Polarisation Radiometer
(18.7 GHz / 36.5 GHz)
(SN: R-4CH-DP-09/001)

Version 6.8 (18. 2. 2009)

Test Report

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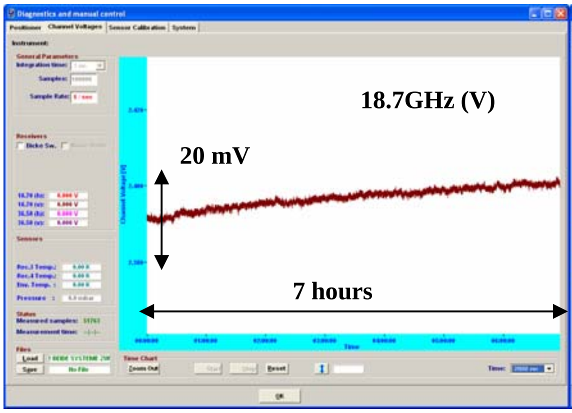
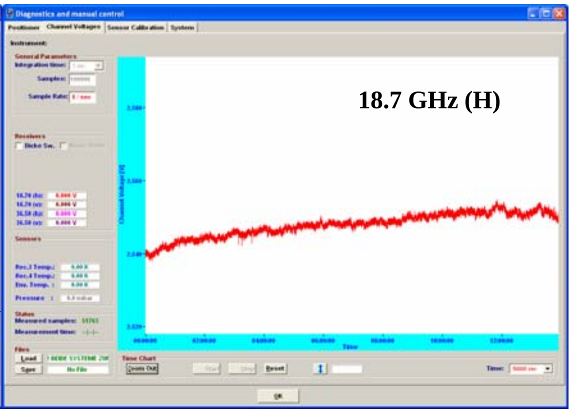
1. Long Term Receiver Stability

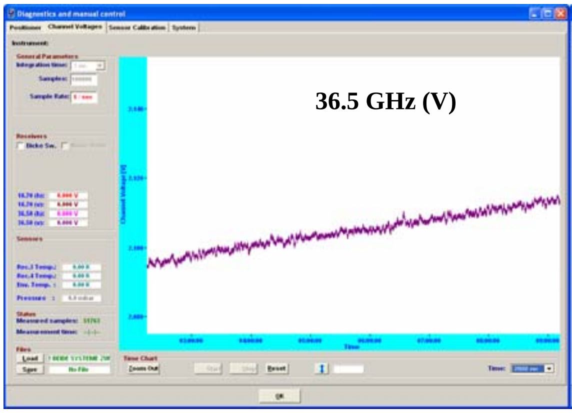
A good indication of the thermal receiver stability is the thermal detector voltage drift as a function of time. The test conditions are:

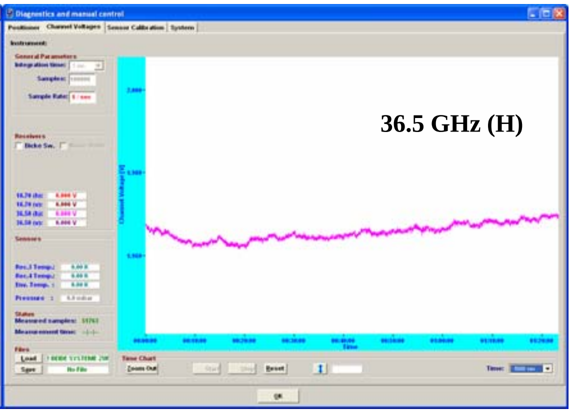
- Receiver input is ‘looking’ into the ambient temperature target.
- Test duration: 50000 seconds
- No gain calibrations during the test. Free running receivers.

The receivers are running without any calibration for a long time period (50000 seconds) and the detector output voltages should not drift more than 50 mV during this period. A 10 mV detector voltage difference roughly corresponds to a brightness temperature difference of 3 K. During a standard measurement, this receiver drift is compensated by the relative gain calibration (noise injection).



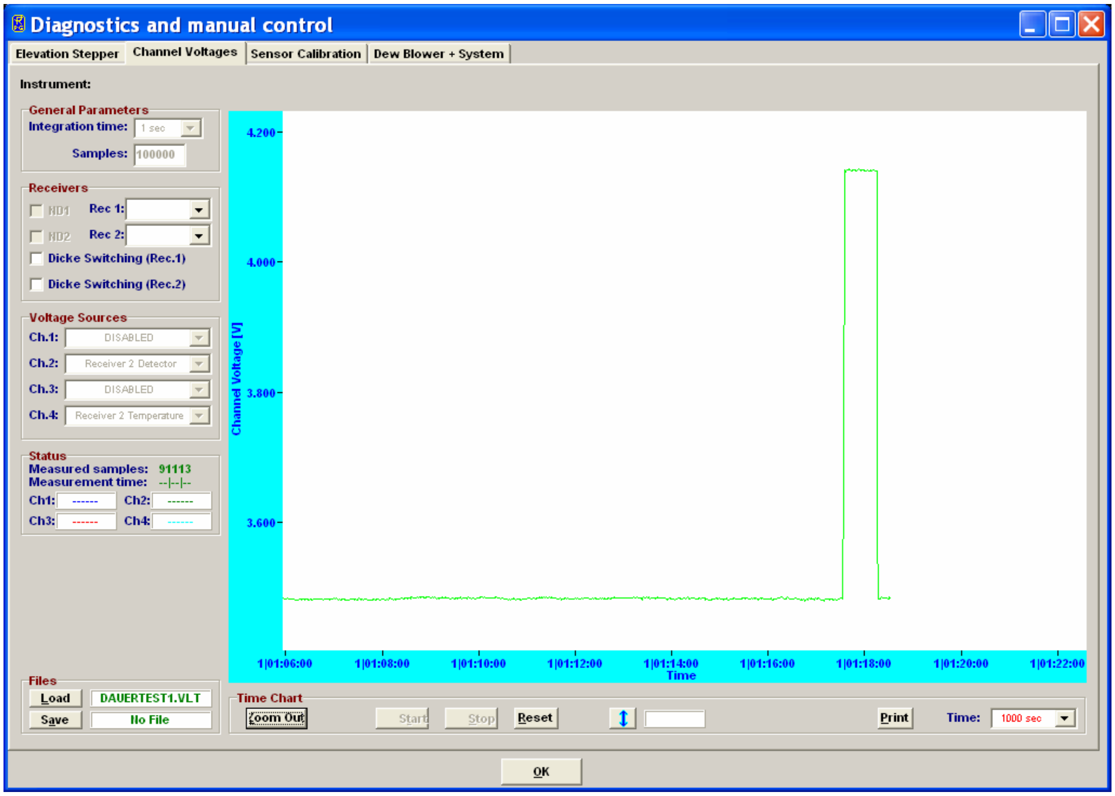






2. Noise Injection Function

The correct operation of the noise injection system can be checked by inspecting the detector voltage response and turning the noise source on and off. The channel response should go up when the additional noise is injected into the receiver input.



Diagnostics and manual control

Instrument:

General Parameters

Integration time: 1 sec

Samples: 100000

Receivers

☐ ND1 Rec 1:

☐ ND2 Rec 2:

☐ Dicke Switching (Rec.1)

☐ Dicke Switching (Rec.2)

Voltage Sources

Ch.1: DISABLED

Ch.2: Receiver 2 Detector

Ch.3: DISABLED

Ch.4: Receiver 2 Temperature

Status

Measured samples: 91113

Measurement time: --|--|--

Ch1: ------ Ch2: ------

Ch3: ------ Ch4: ------

Files

Load DAUERTEST1.VLT

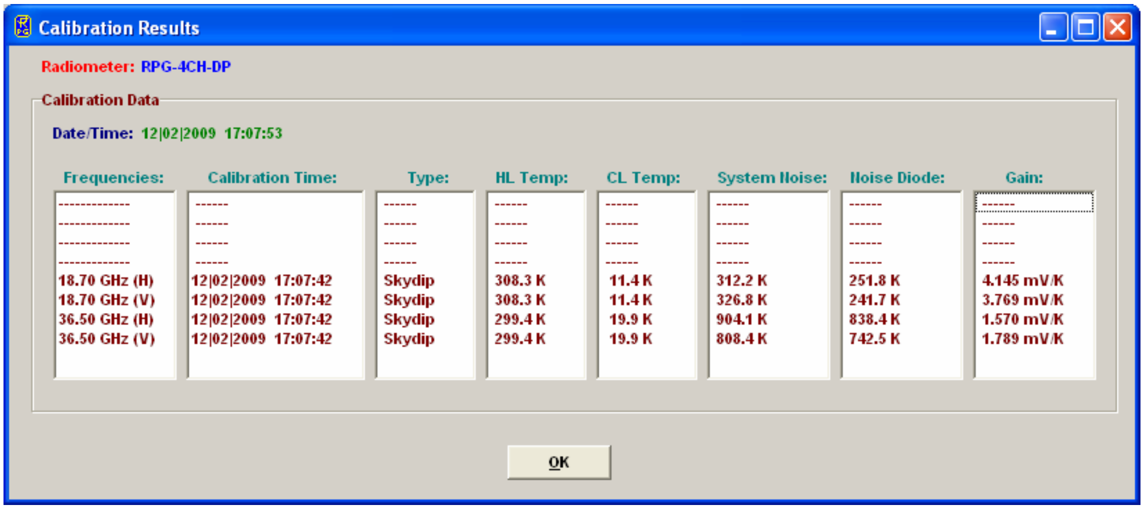
Save No File

Time Chart

Time: 1000 sec

3. Absolute Calibration Results

During absolute calibration (calibration using the built-in ambient temperature target and the external LN cooled target or sky tipping) the gain, system noise, non-linearity correction and noise diode temperature are determined for all channels. Fig.4.1 lists the calibration results. The noise diode temperature is adjusted to be at least 250 K or higher, which is similar to a calibration with a liquid nitrogen cooled target. When the noise standard is used for an automatic calibration instead of the manual absolute calibration, the noise calibration accuracy is then comparable to the absolute calibration procedure.
The receiver noise temperatures are 30-40% better than the system noise temperature listed in Fig.4.1 because the numbers in the table are including the calibration front end (Dicke switches and noise injection coupler, ortho-mode transducer, feed horn). Typical receiver noise temperatures are around 200 K at 18.7 GHz and 600 K at 36.5 GHz.



Radiometer: RPG-4CH-DP

Calibration Data

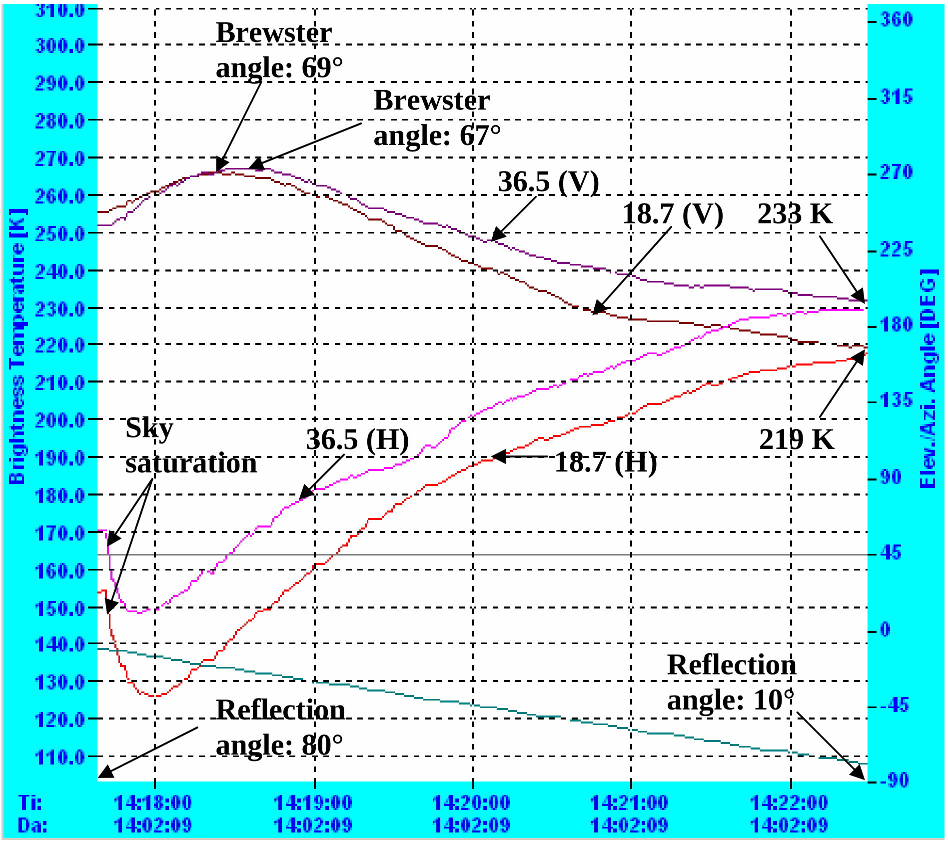
Date/Time: 12|02|2009 17:07:53

Frequencies:	Calibration Time:	Type:	HL Temp:	CL Temp:	System Noise:	Noise Diode:	Gain:
-------------	------	------	------	------	------	------	------
-------------	------	------	------	------	------	------	------
-------------	------	------	------	------	------	------	------
-------------	------	------	------	------	------	------	------
18.70 GHz (H)	12|02|2009 17:07:42	Skydip	308.3 K	11.4 K	312.2 K	251.8 K	4.145 mV/K
18.70 GHz (V)	12|02|2009 17:07:42	Skydip	308.3 K	11.4 K	326.8 K	241.7 K	3.769 mV/K
36.50 GHz (H)	12|02|2009 17:07:42	Skydip	299.4 K	19.9 K	904.1 K	838.4 K	1.570 mV/K
36.50 GHz (V)	12|02|2009 17:07:42	Skydip	299.4 K	19.9 K	808.4 K	742.5 K	1.789 mV/K

Fig.4.1

4. Polarisation Splitting

In order to test the correct polarization splitting of the radiometer, a ground scan is performed. The elevation angle is scanned between -10° and -80°. The result of this scan is the following:



The vertical polarization scan allows to measure the refractive index of the ground medium. As can be seen from the diagram above, the Brewster angle for the 18.7 (V) GHz channel is at 69° which corresponds to a refractive index of n=2.60 (tan(69°)). This is consistent with the observation at normal incidence where the reflection coefficient R is given by R=((n-1)/(n+1))^2 which leads to R=0.2 at 18.7 GHz for normal incidence. With a physical ground temperature Tg of 273K and a sky temperature of Ts=15K we get: Tb=(1-R)*Tg+R*Ts=220K which is really observed. For the 36.5 GHz channel we get: n=2.36 (Brewster angle: 67°), R=0.16, Tb=233 K which is totally consistent with the observations.

Horizontal and vertical polarizations precisely convert at normal incidence to the same brightness temperature (reflection angle 0°, cannot be directly measured).

In the horizontal polarization the Tb is dominated by the reflected sky brightness temperature. The higher the reflection angle, the higher becomes the sky contribution and the lower the total Tb. But with low elevation angle (El) the sky temperature Ts becomes larger, roughly the Ts measured at zenith angle multiplied by the airmass (am=1/sin(El)). At 10° elevation (reflection angle=80°) the sky temperature is close to 6 times higher compared to the zenith angle Ts. Therefore the Ts value at 80° reflection angle is approx. 90 K at 18.7 GHz (cloud free conditions). This is why the TBs at high reflection angles tend to increase which is shown in the diagram above (sky saturation).

5. Zenith Sky Observations

When observing the sky in zenith direction, polarization splitting should be zero, even if clouds are passing the field of view. Falling rain droplets are vertically flattened, but this cannot be seen in zenith direction. Polarisation effects due to falling rain droplets have to be observed under lower elevation angles (e.g. 30°). Therefore, by directing the radiometer to zenith, the polarization difference between V and H should vanish. Fig.5.2 shows the Tbs observed for a cloudy atmosphere and Fig.5.2 is plotting the polarization difference.

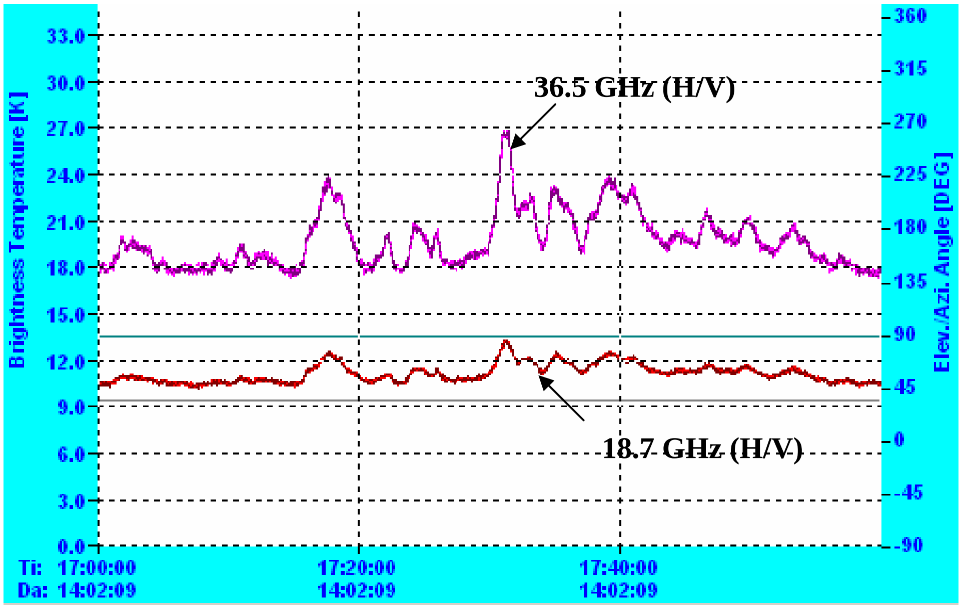


Fig.5.1

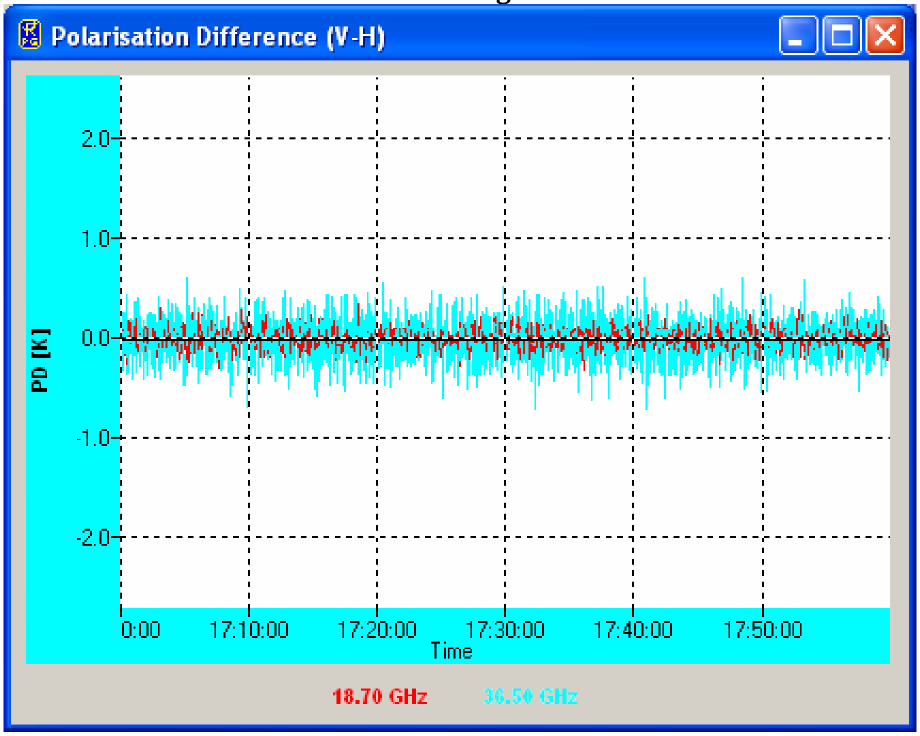
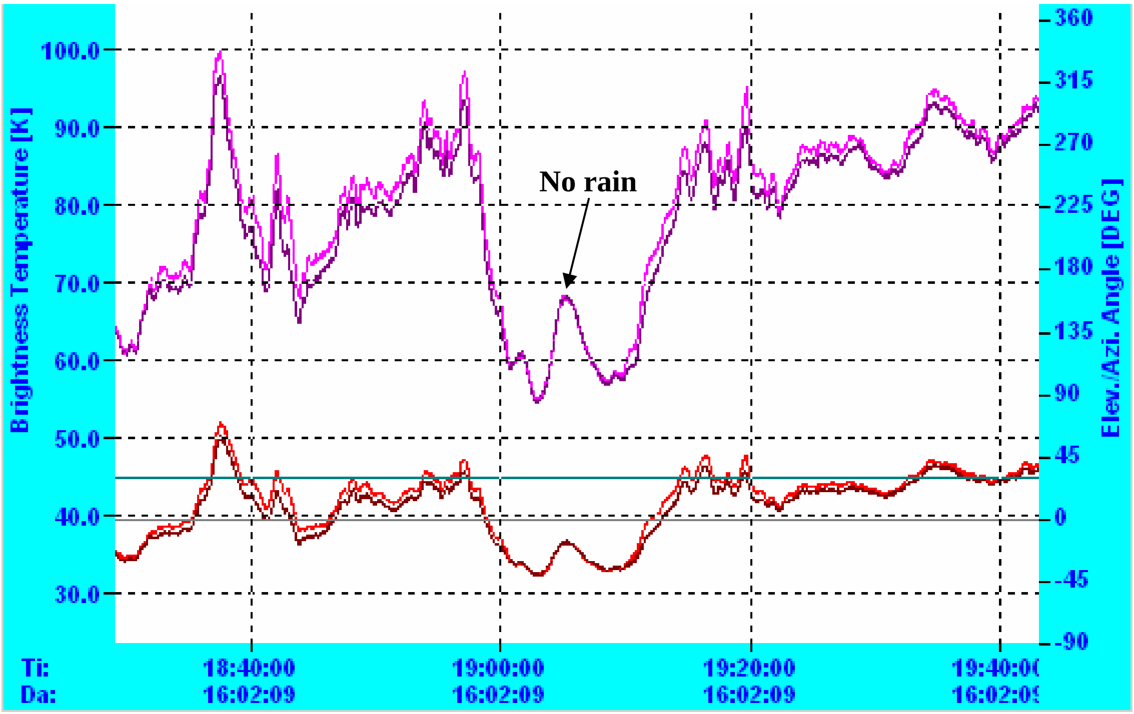
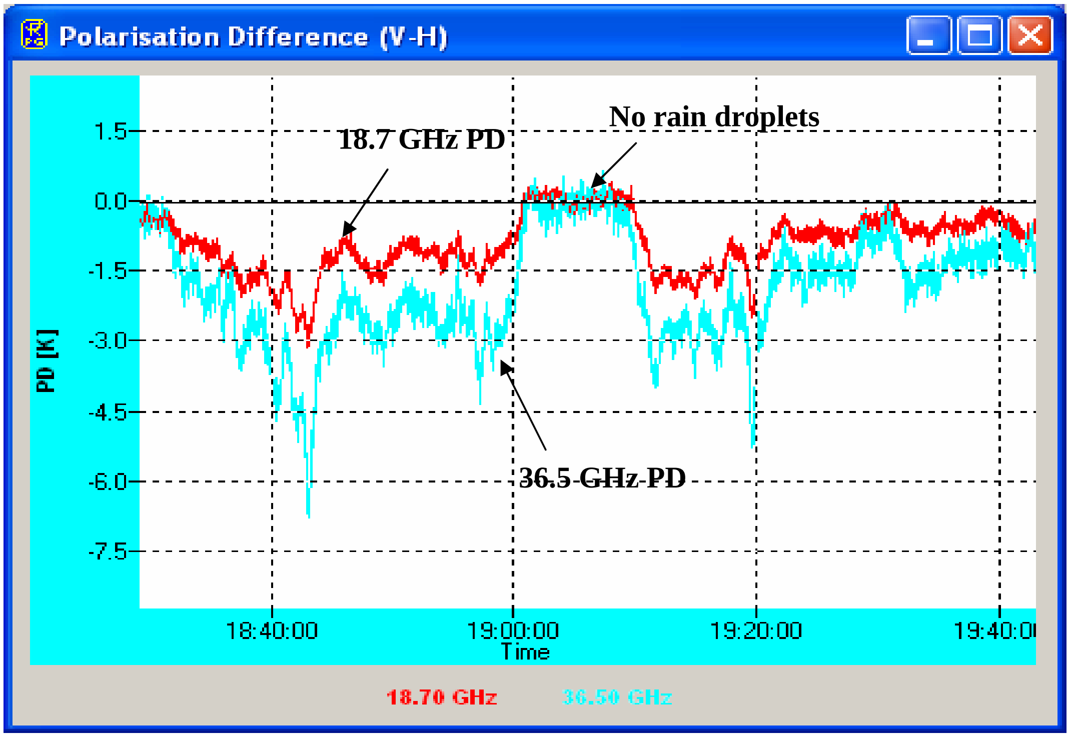


Fig.5.2

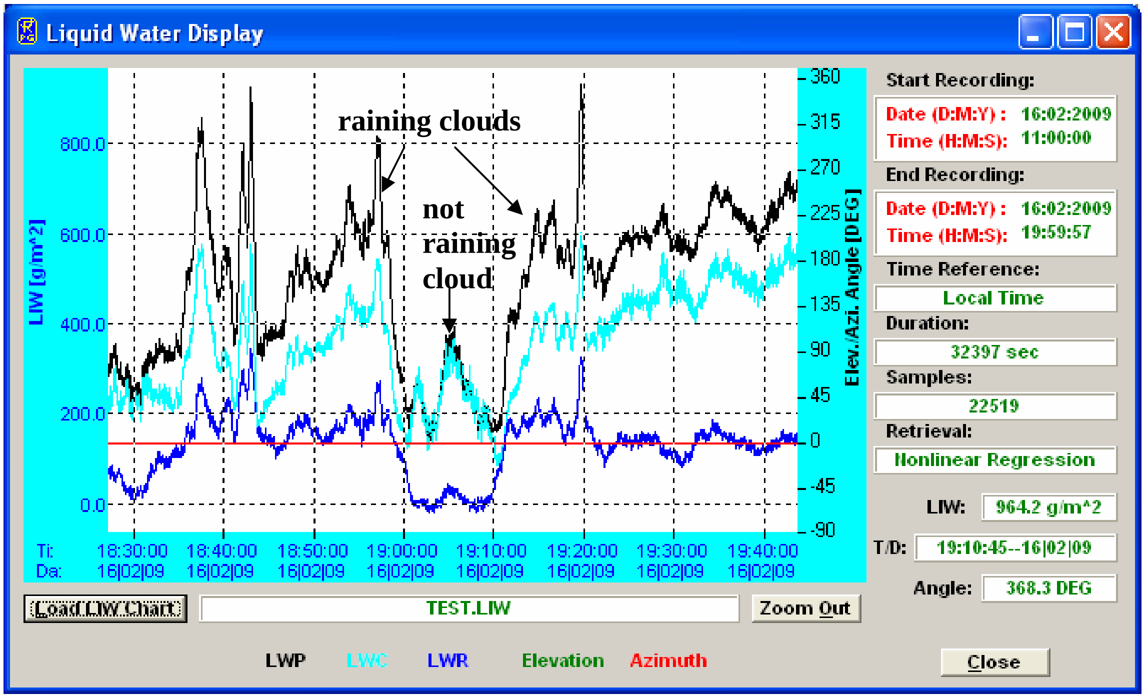
6. Observations Under Low Elevation Angles

The following measurements were performed at 30° elevation angle, observing a raining atmosphere (rain rate 5 mm/h). The polarization splitting is very obvious but immediately drops down to zero, when the rain pauses.





As expected, the 36.5 GHz channels respond much more sensitively to the liquid water and the polarization difference is more exaggerated. The 36.5 GHz channels are used for light rain detection while the 18.7 GHz channels cover the strong rain events with rain rates above 20-30 mm/h when the 36.5 GHz channels are starting to saturate.



Start Recording:
Date (D:M:Y) : 16:02:2009
Time (H:M:S): 11:00:00
End Recording:
Date (D:M:Y) : 16:02:2009
Time (H:M:S): 19:59:57
Time Reference: Local Time
Duration: 32397 sec
Samples: 22519
Retrieval: Nonlinear Regression
LIW: 964.2 g/m^2
T/D: 19:10:45--16|02|09
Angle: 368.3 DEG
TEST.LIW

Fig.6.1

Fig.6.1 shows the retrieval outputs for the Tb time series above. LWR is the liquid water content of the rain droplets, LWC denotes the cloud liquid and LWP is the total liquid water amount. The three time series are consistent even though the three quantities have been derived by three independent retrieval algorithms, one for each product.