Low Cost Microwave Radiometer

WP 2600 Design of a Low Cost Radiometer

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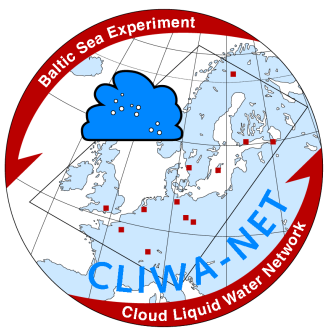
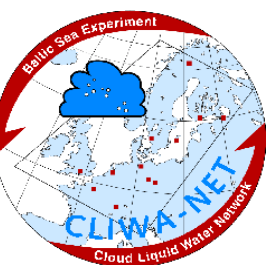


Introduction

- Ground-based microwave radiometer are the most accurate method to determine cloud **liquid water path** (LWP)
- Dual-channel radiometer can simultaneously observe LWP and **integrated water vapor** (IWV)
- Measurements at 90 GHz can strongly improve the sensitivity of the LWP observations
- Microwave profiler which measure the spectral characteristics of the H_2O/O_2 line can observe **water vapor**/**temperature** profiles



MICAM: Microwave Radiometer Intercomparison Campaign

U. Bern, Switzerland

Chalmers U., Sweden

CETP Velizy, France

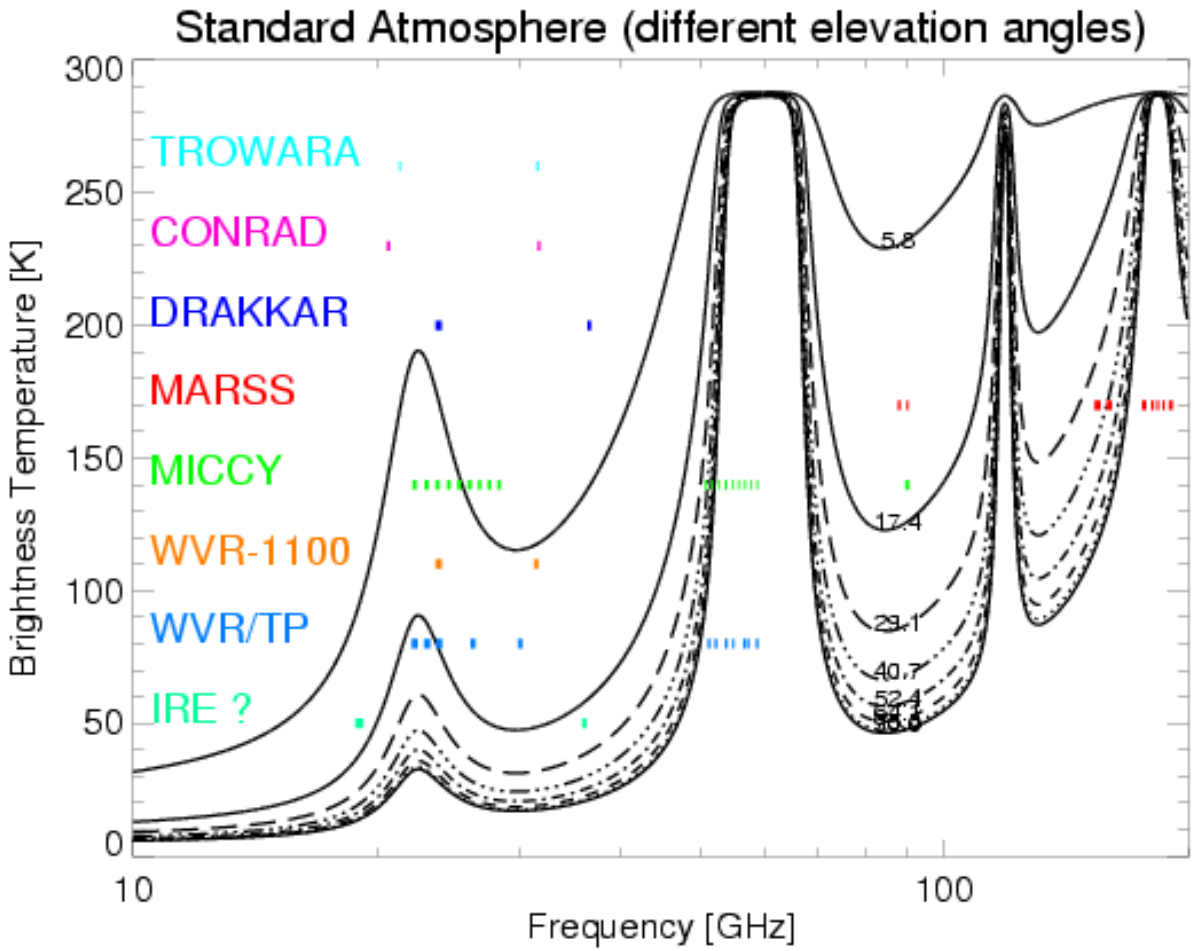
UK Metoffice

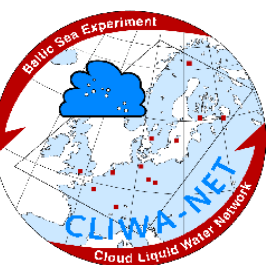
U. Bonn, Germany

German Weather Service

German Weather Service

Inst. Radioeng., Russia

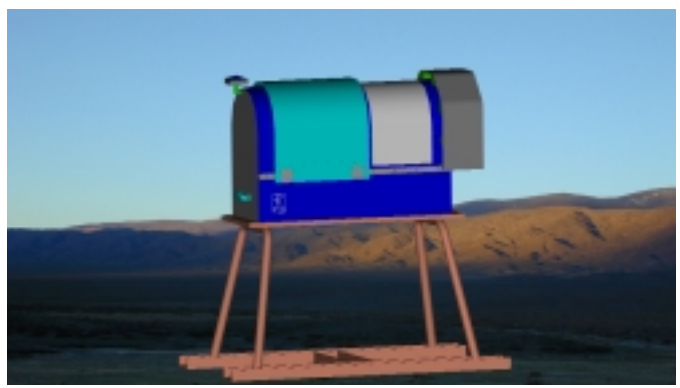




Impressions from MICAM

WP 2600 Description of work

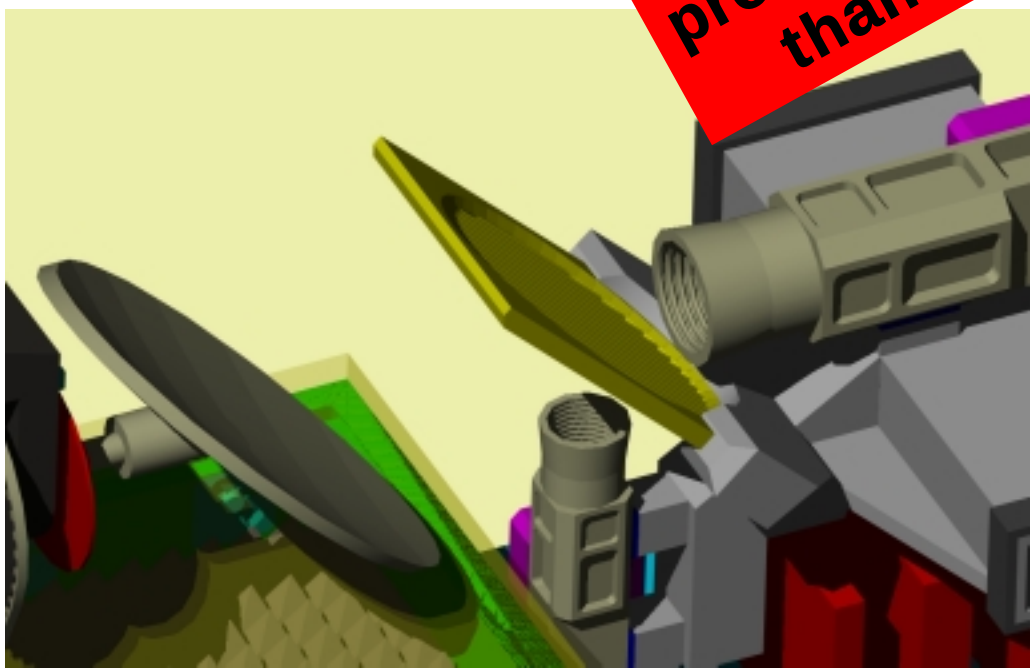
- Design a low cost microwave radiometer for automatic, high accuracy LWP measurement
- Estimation of cost for different levels of LWP accuracy (this includes cost estimate for different frequency configuration and/or inclusion of scanning possibilities)
- Development of a calibration concept to guarantee low maintenance



WP 2600 Results

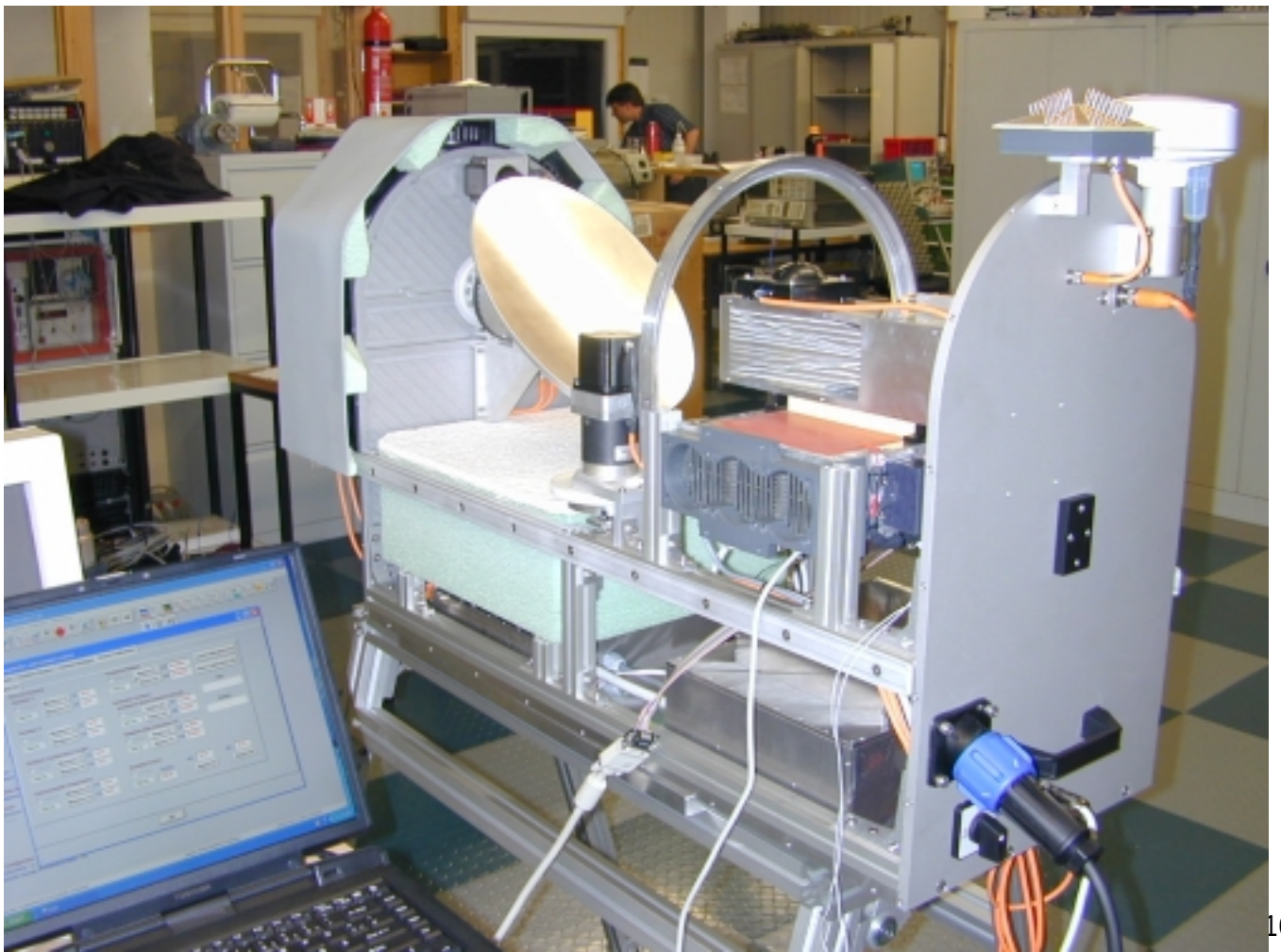
- New optical layout (beam splitter) allows flexible combination of arbitrary frequency pairs:
  e.g. 23.8/36.5 GHz (dual-channel) or
  22-30 GHz/ 50-58 GHz (profiler)

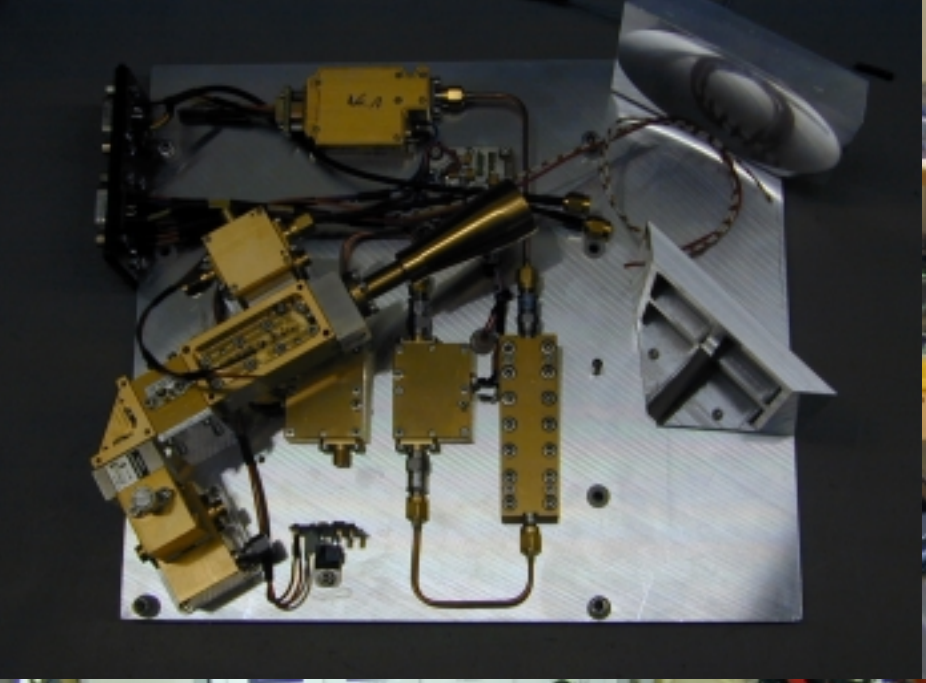
profiler is ~ 15% more than dual-channel

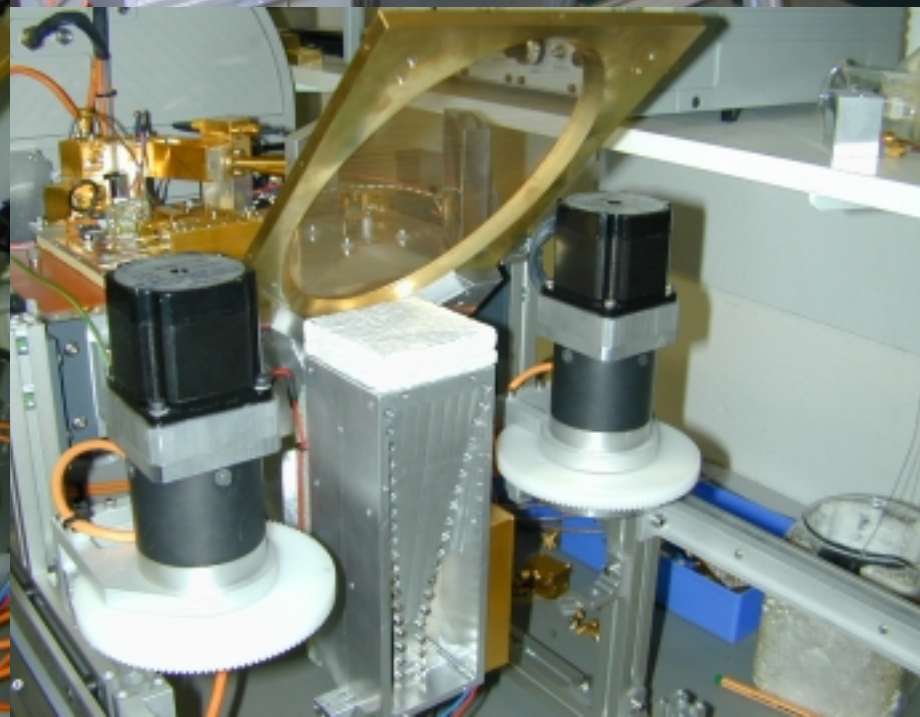


WP 2600 Results

- Additional funding allowed construction of low cost profiler (available for BBC2)

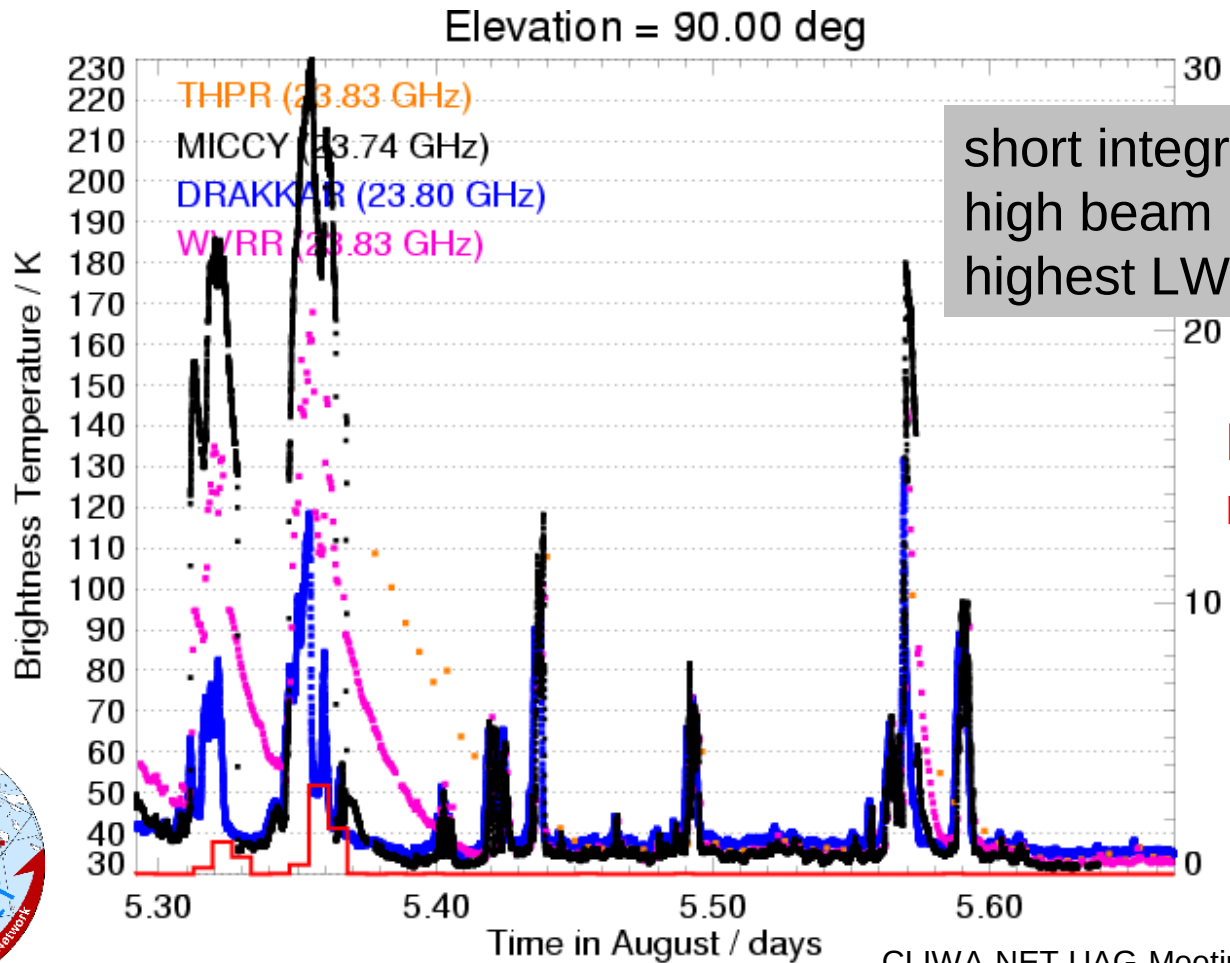






Rain shutter I

- During and after rain events no reasonable measurements are possible, drying up several hours

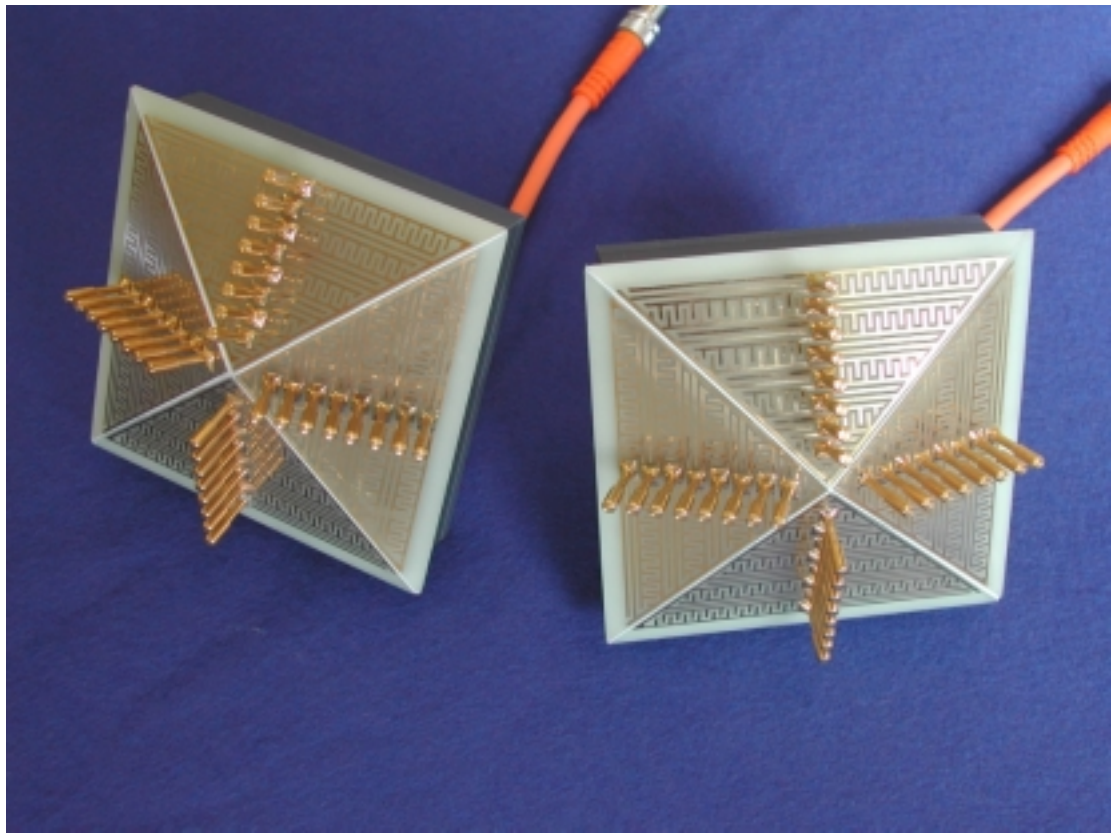


short integration time and high beam resolution give highest LWP values

Rain Rate mm/h

Rain shutter II

- Improvement of rain detector



Radiometer Specifications I

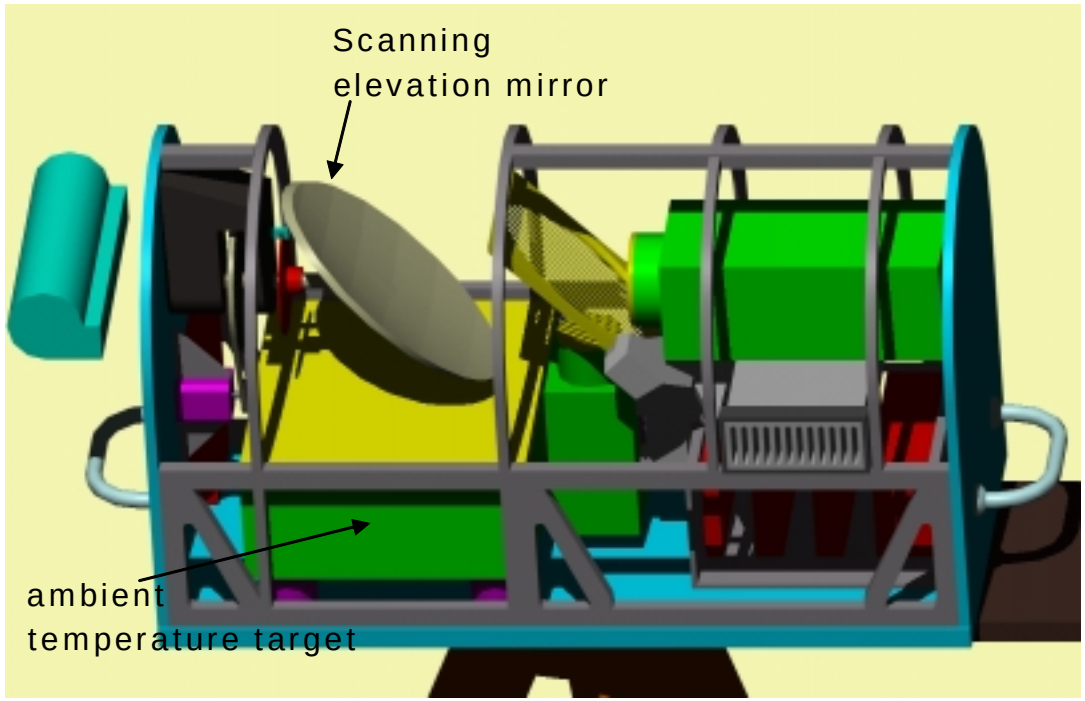
- GPS clock for precision synchronisation to UTC standard time
- Acquisition of radiometric data, automatic calibration procedures, application of retrieval algorithms by embedded PC
- Interfacing (RS232, Data rate 5 Kbytes/sec minimum) with external PC/laptop (Windows and Linux)
- Auxiliary measurements of humidity, temperature, pressure and infrared radiometer (optional)
- Self-adjusting inclinometers to avoid pointing errors

Radiometer Specifications II

- Radiometric resolution 0.2 K RMS @ 1.0 sec int.time
- Absolute system stability 1.0 K, Radiometric range 0-400 K
- Absolute calibration (4-Point, Sky dip), nonlinearity error correction; internal calibration internal ambient & precision noise standard
- Receiver and antenna thermal stabilisation accuracy <0.1 K
- Optical resolution HPBW: 3.5° @23.8 GHz, 2.7° @36.5 GHz
- Pointing speed elev.: 90°/sec, azi.: 10°/sec (optional)
- Operating temperature range -30°C to 40°C
- Power consumption <400 Watts average, 1000 Watts peak
- Input voltage 100-240 V, AC selectable, 50 to 100 Hz
- Weight < 40 kg (without azimuth positioner)
- Dimensions 63 x 40 x 105 cm (without azimuth positioner)

Highlights

- Newly designed tuneable synthesizer
  ⇒ profiler observes LWP, water vapor and temperature profiles every 10 s (8.6 min in current systems)
- Modular setup; combination MASTER/SLAVE



Conclusion

- Flexible radiometer design for use in operational networks
- Several improvements based on experiences from MICAM
- Low maintenance (check every 3 months is required)

- Inclusion of periodic elevation scanning and development of new algorithms for improved profiling of boundary layer
- Further investigation of water vapor absorption and refractive index of super cooled water drops is necessary to improve LWP retrieval