Radiometer Physics
A Rohde & Schwarz Company

RPG-HATPRO G5 series
Multi-Channel High-Precision
Microwave Radiometers

HATPRO - Humidity and Temperature Profiler

Direct Detection Filter-Bank Design
100% duty cycle, fast calibrations

Powerful Blower/Heater System
No condensation/wetness on radom

All Weather Proof
All climate regions, all altitudes

Network Suitable
TCP/IP interface

**Integrated IR-Radiometer**
For Cloud base hight
ice cloud detection

Fibre-Optical Data Line
For reliable data transfer
and lightning protection

Fully Steerable
azimuth turn table for 2D mapping

Next Generation G5

Measurement Principle

- Atmosphere emits radiation according to its temperature (Planck's law)
- Radiation intensity depends on spectral absorption and physical temperature
- Multi-channel radiometers observe several channels along wings of absorption features at microwave frequencies:
  → **Humidity**: water vapour molecular lines at 22GHz or 183GHz
  → **Temperature**: oxygen absorption complex at 60 GHz or 118 GHz
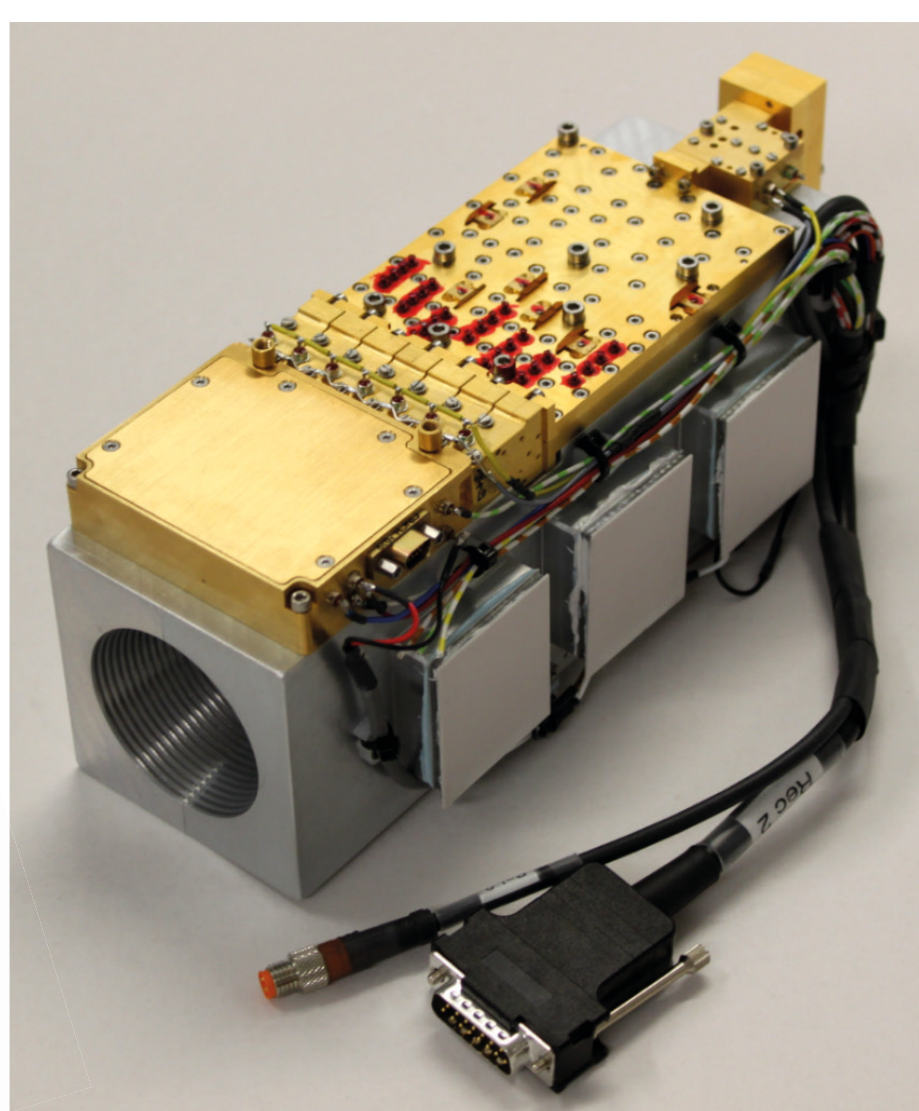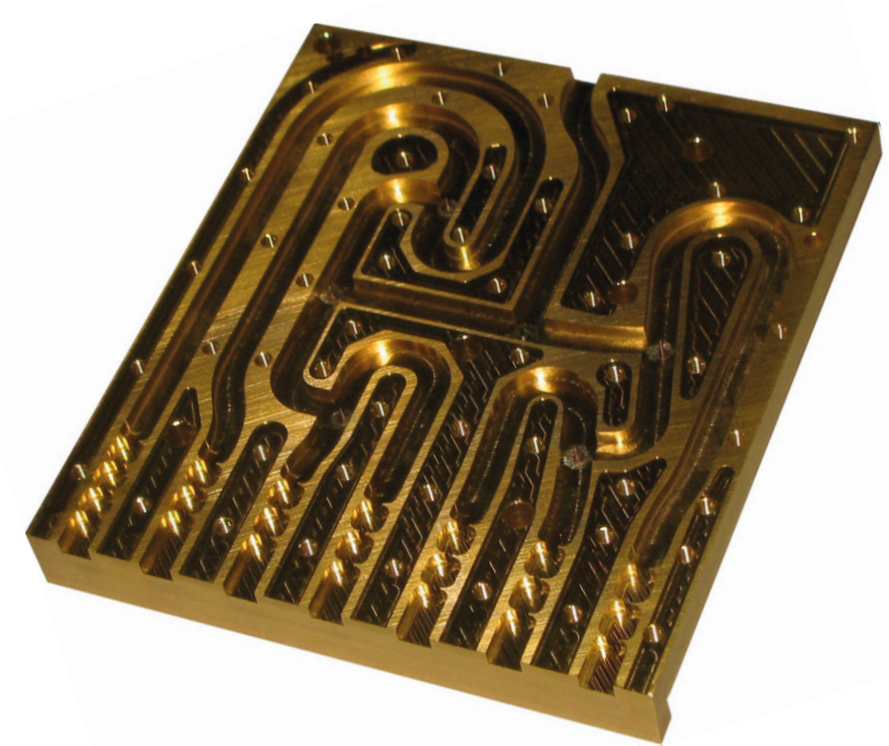 → **Water clouds**: continuum absorption

Atmospheric spectrum of brightness temperatures
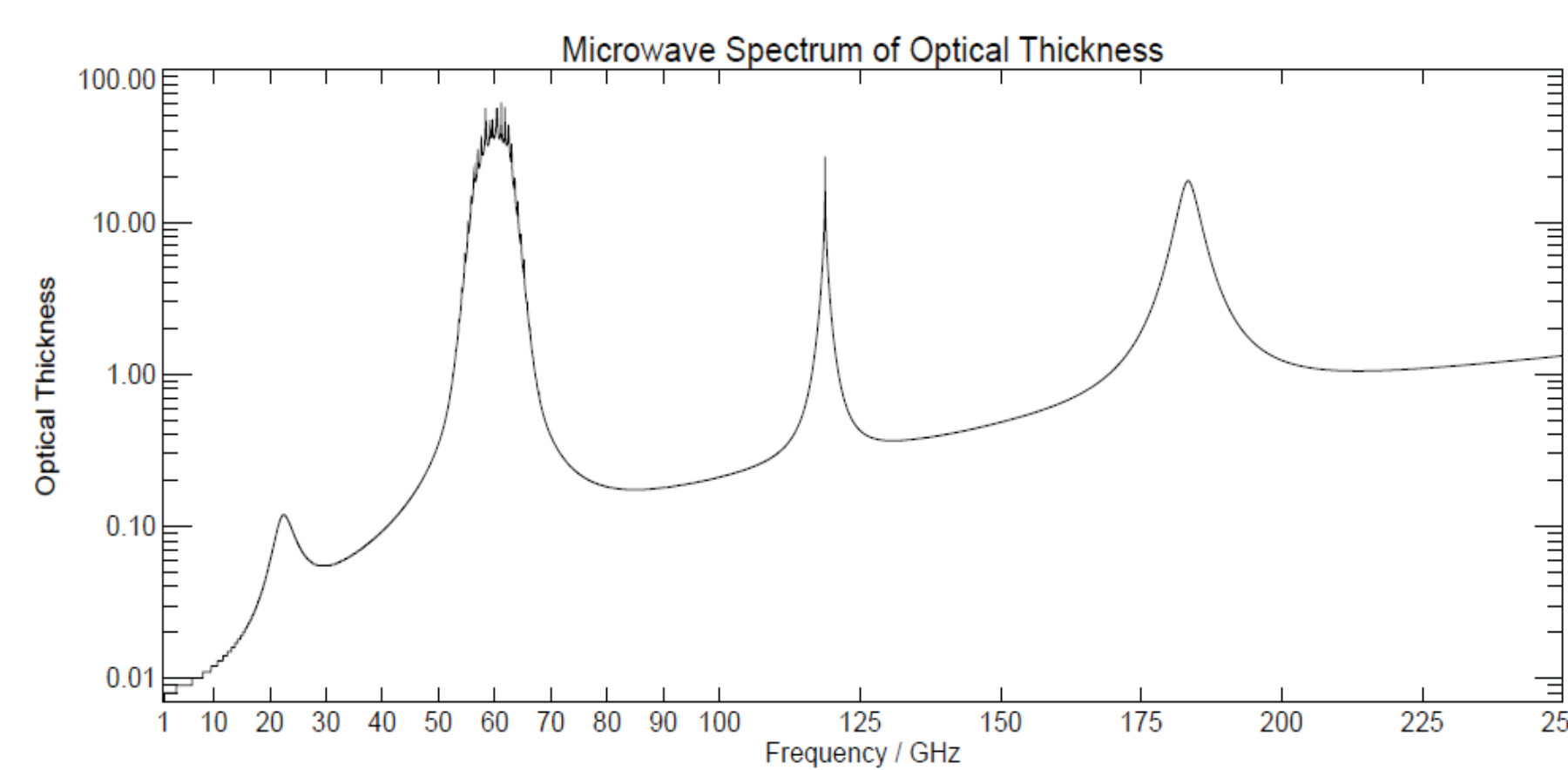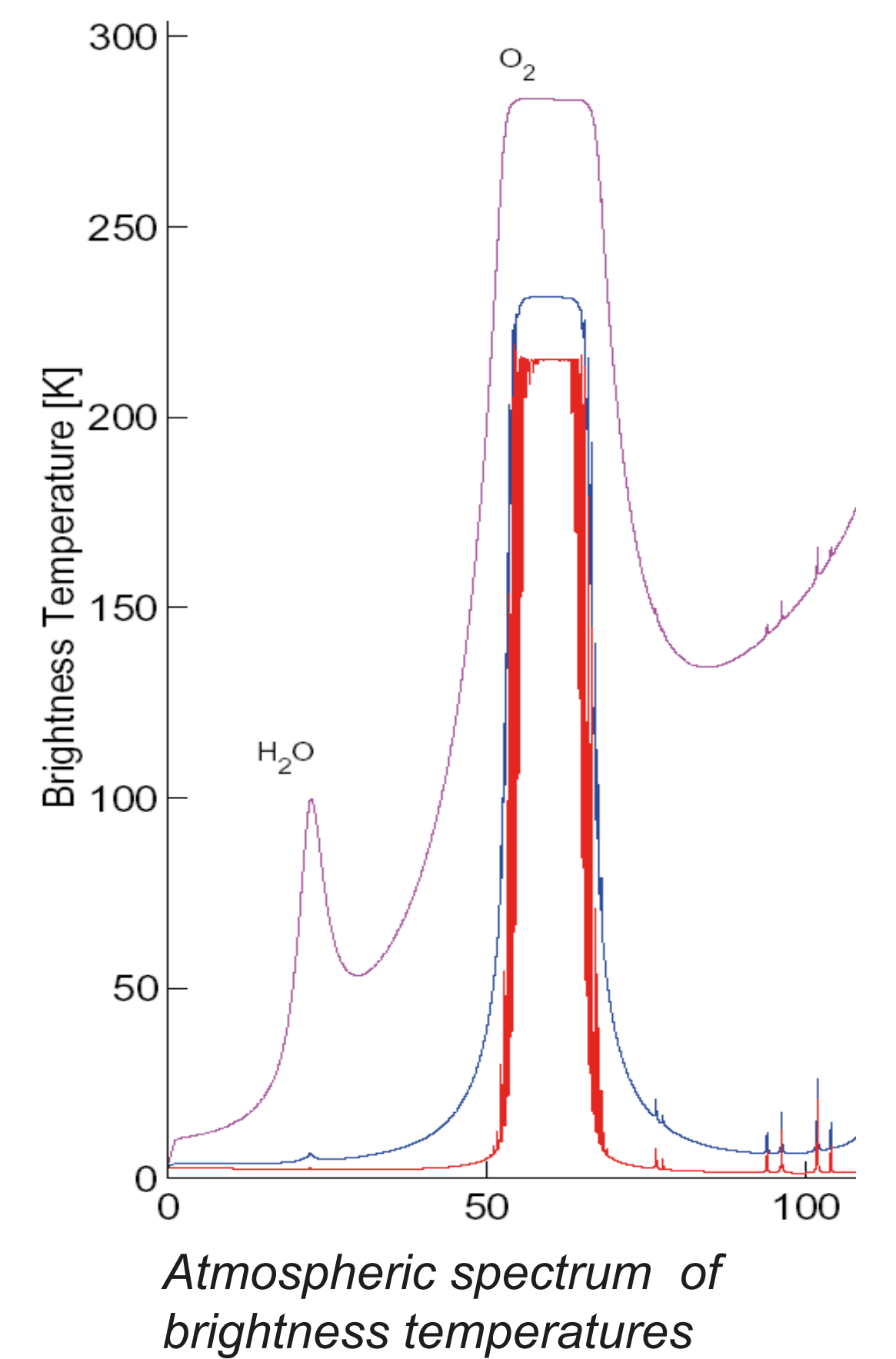
Statistically independent parameters:
2 to 3 on H_2O line at 22 GHz
4 to 5 on O_2 complex at 60 GHz
Information content is completely covered by the 14 HATPRO channels between 22 and 31 GHz and between 51 and 58 GHz (oversampling for redundancy)

Typical microwave spectrum of atmospheric optical thickness

Receiver Design

Direct Detection Filter-Bank Receivers
- Amplification, filtering & detection at 20 and 60 GHz
- No Down-Conversion to low IF → no RFI < 18 GHz
- Parallel data acquisition in all channels

→ fast sky scanning
→ fast calibrations
→ **100% duty cycle**

7 channel V-Band filter-bank   *HATPRO V-Band receiver*

Individual Band-Passes
200 MHz – 2000 MHz
→ optimized TB sensitivity

Large Optics
300 mm primary mirror
→ narrow antenna beam

→ **High-Precision Boundary Layer Temp. Profiling**
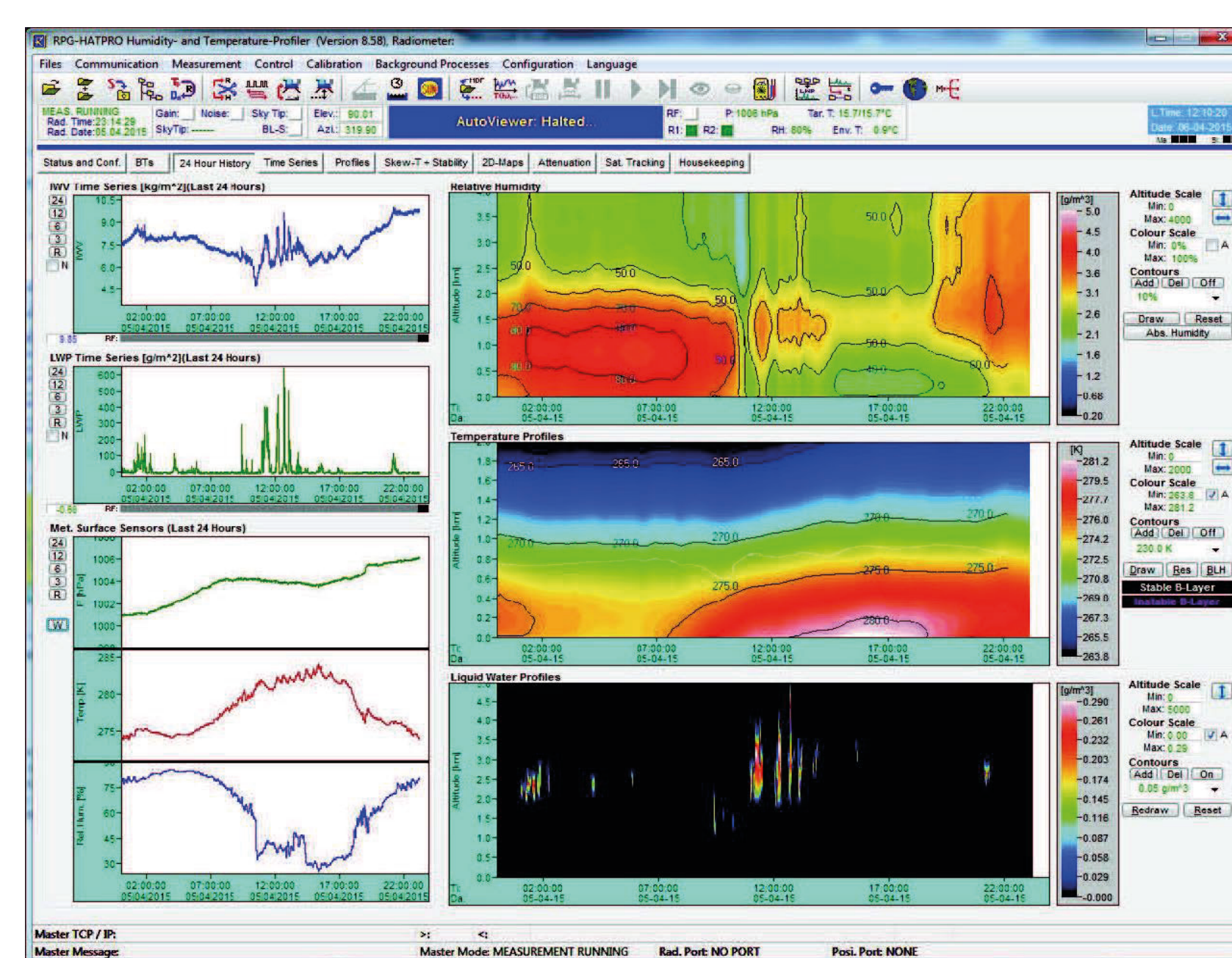
Generation 5 Receivers

Improvements with G5
- 40 times higher data sampling rate
- Rapid Noise switching (64 GHz) used with all radiometer channels
→ Improved noise performance (≤0.05 K RMS @10s integration time)
→ Improved radiometric stability

Software Features

Atmospheric Products
- State-of-the-art ANN (Artificial Neural Network) retrieval algorithms for:
- Profiles of temperature/humidity/cloud liquid
- Integrated Water Vapor (IWV)
- Liquid Water Path (LWP)
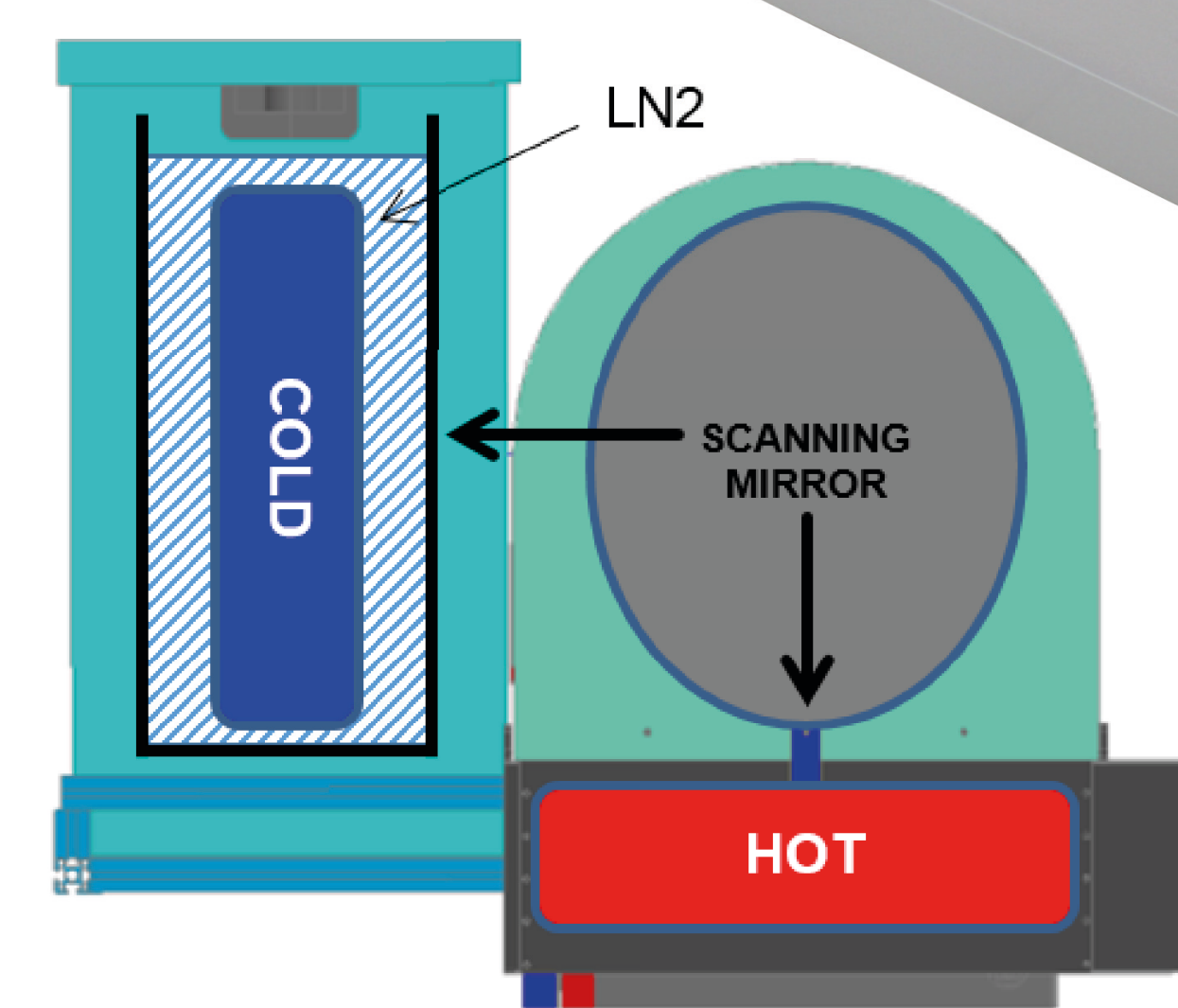- Atmospheric attenuation spectra

Data Processing and Display
- Comprehensive Graphical User Interface
- Detailed housekeeping data
  - including health checks and quality flags
- Various data displays: Thermodynamic diagrams, 24-hour time series, spectra, ...
- Various data formats: Binary, netCDF, BUFR, RAOB®, ASCII.

Calibration Procedures
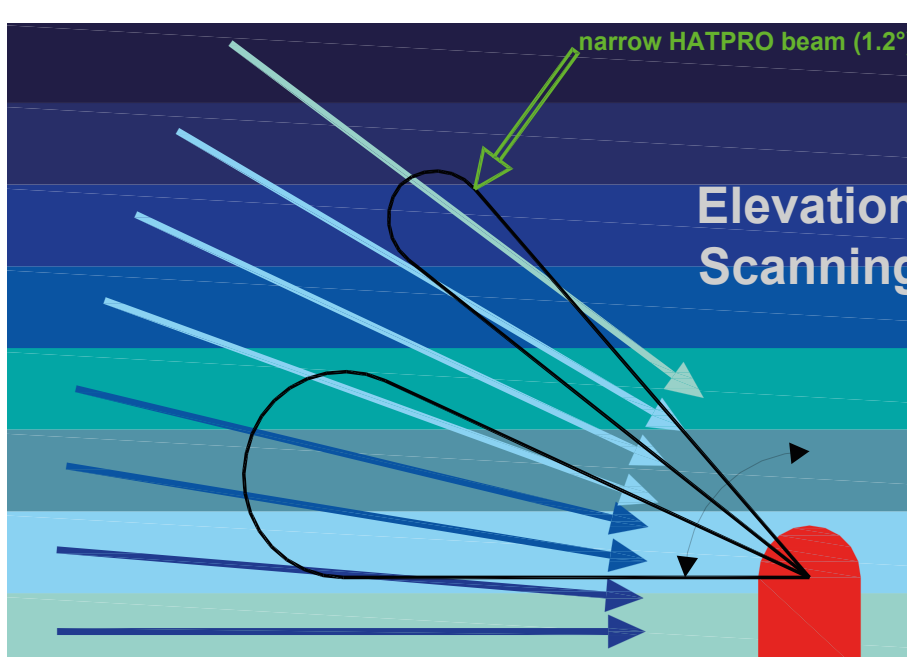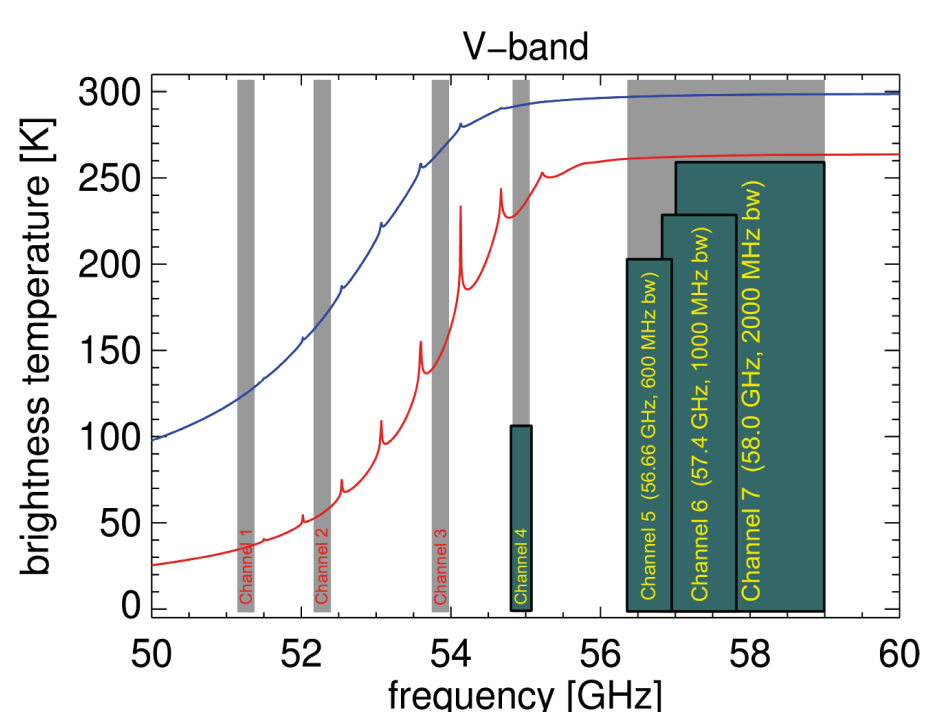
Absolute Radiometer Calibration
- New designed cold calibration target: Precision Target (PT-V1)

→ No reflections at target
→ No standing waves
→ Minimized evaporation of LN2
→ Minimized entrainment of oxygen

→ **Absolute TB Accuracy of ±0.1K** when combined with ultra-stable receivers of RPG's G5 (Generation 5) instruments

Need more details? Take a look at our printed brochures including detailed information on RPG radiometers and the G5 improvements - plus a summarizing note on the new calibration target.