Radiometer Physics
A Rohde & Schwarz Company

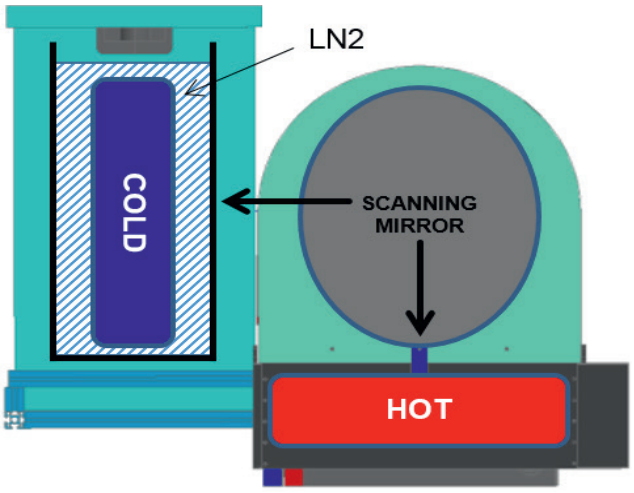
The Precision Target PT-V2 for the Liquid Nitrogen (LN2) Calibration of RPG radiometers

Introduction

Major progress has been achieved in radiometer calibration accuracy and repeatability. RPG has developed a LN2-cooled high-precision calibration target.
The new target effectively eliminates reflections and standing wave contributions during the calibration process. It improves the absolute calibration for all generations of RPG standard radiometers.
In combination with a Generation 5 radiometer (G5), an absolute accuracy of ±0.25 K and a calibration repeatability of better than 25 mK is achieved.

Absolute Calibration of RPG Radiometers

The setup of the new Precision Target (PT) has changed compared to the previously used cold targets. The blackbody absorber is now oriented vertically instead of horizontally. The insulating container is made of a material which is 100% transparent for microwave signals below 200 GHz. This container is cased in a protection housing with handles for carrying and lifting the target. The target is deployed on the sidewall of the radiometer using an easy-to-fix and lightweight frame. Thanks to the radiometer‘s heater and blower module, the radiometer‘s and the target‘s observation windows are kept dry as required for a valid calibration.



Improvements

The old calibration target design suffered from the fact that the microwave beam is partially reflected by the air/liquid interface, leading to a not exactly quantifiable impact on brightness temperatures observed on the cold target. Additionally, the reflective component was modulated by a standing wave that built up between the target and the receivers, while LN2 was evaporating from the target container. Both effects have been observed with the original cold calibration target and required to apply corrections via the operating software. The residual uncertainty of these corrections motivated a new target design, which completely eliminates reflections at the cold target and - as a consequence - also prevents the occurence of standing waves.

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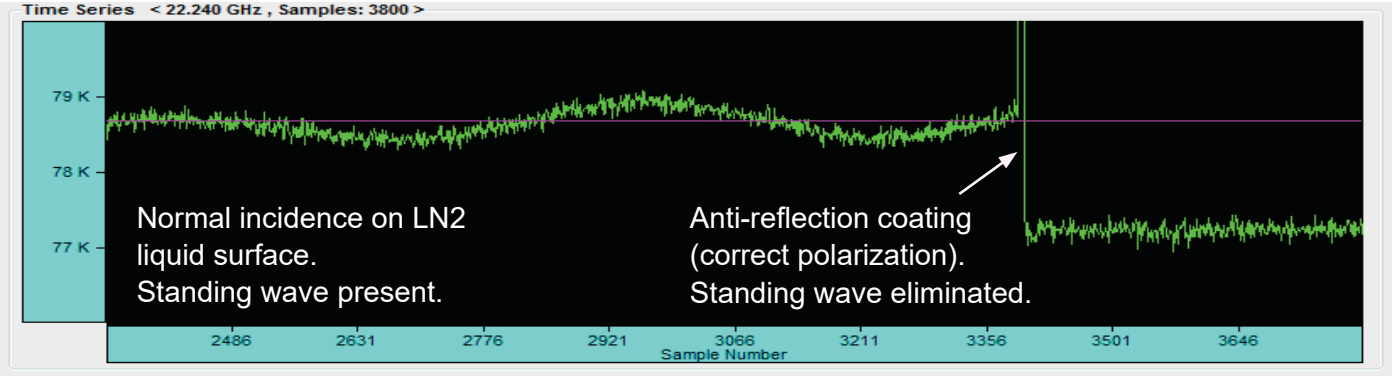
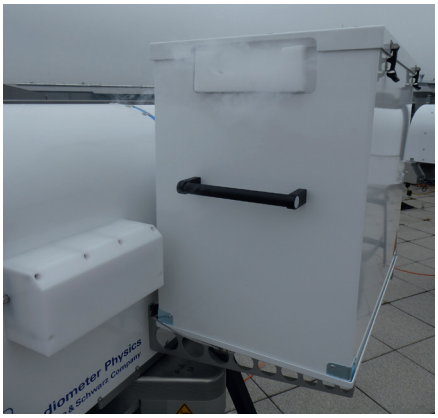


Fig. 1: Comparison of a 22.24 GHz brightness temperature time series measured on an old target with normal incidence and the new precision target.



The new precision target is equipped with an insulation lid to avoid a fast wind-included LN2 evaporation and the entrainment of oxygen from the environmental air. A small channel in the insulation container provides the LN2 gas exhaust, which also effectively prevents the outside air from entering the target.

Recently, the PT-V2 (a redesign of the precision target PT-V1) was introduced. With version 2, the amount of LN2 required per filling is reduced from 40 to 20 L. In addition, PT-V2‘s single observation window can be used to calibration both radiometer receivers (e.g. HATPRO‘s K and V-band receivers). Unlike with the PT-V1, it is not required to turn the target during the calibration process.

Summary

- Major progress in radiometer calibration accuracy (±0.25 K) and repeatability (25 mK).
- Effective elimination of reflections and standing waves at the air/LN2 interface.
- An insulation lid avoids rapid evaporation of LN2 and the entrainment of environmental oxygen.
- Revised target design PT-V2 reduces the LN2 per filling from 40 to 20 L.
- PT-V2 does not require to turn the target during the calibration process.