Transmission and Reflection Characteristics of the MARSCHALLS Quasi-optical C- and D-Band Filters

Andreas Magun and Vladimir Vasic

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Institute of Applied Physics | Dept. of Microwave Physics

Sidlerstr. 5
CH-3012 Bern
Switzerland

Tel. +41 31 631 89 11
Fax. +41 31 631 37 65
E-mail iapemail@iap.unibe.ch

Abstract

This report presents measurements that have been carried out on the C- and D-band quasi-optical filters for MARSCHALLS. Transmission and reflection measurements were measured for the D-filter between 330 and 425 GHz. For the C-filter only transmission measurements between 305 and 395 GHz with coarse frequency resolution could be made, as this filter was broken early during the transmission measurements.

Contents

1 Measurement setup

Measurements were performed with the ABmm Vector Network Analyzer that, depending on the used source and detector extension, covers a frequency range between 8 and 1000 GHz. Using the ESA1 source (at the 3rd or 4th harmonic) in combination with a D-band harmonic detector (at the 16th to 22th harmonic) gave a dynamic range of approximately 60 db in the investigated frequency range between 305 – 425 GHz. The fundamental and second harmonic of ESA1 below 230 GHz were suppressed by a low-frequency cutoff filter. In order to quickly

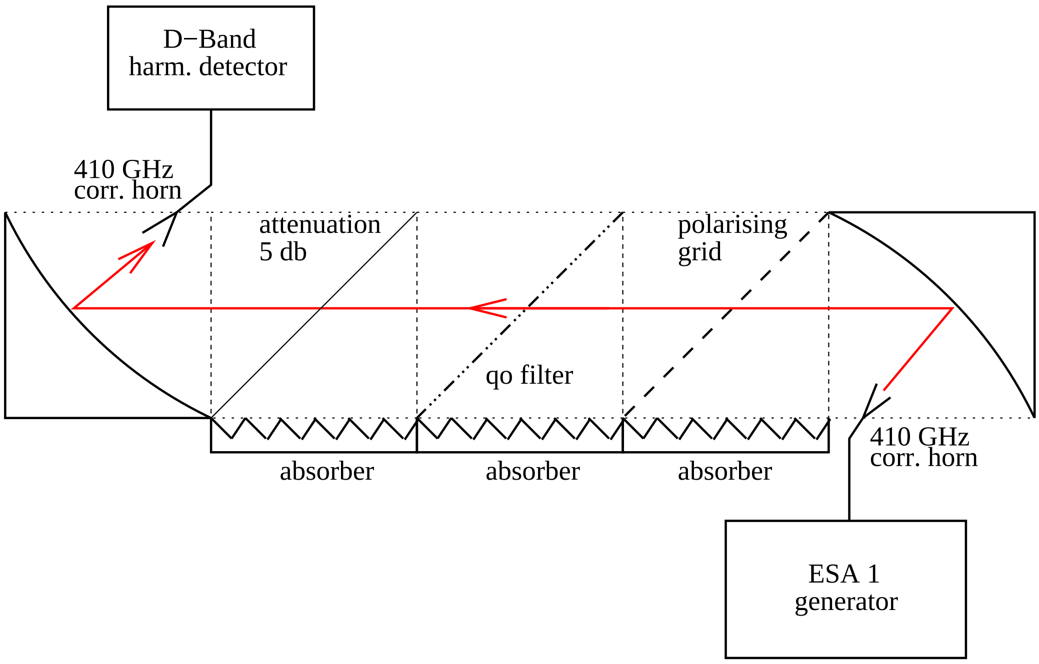

Figure 1: Quasi-optical setup for transmission measurements with the vector network analyzer from ABmm: The transmitter signal with a variable frequency between 305 – 425 is focused onto the quasi-optical filter with an offset eliptical mirror. A second offset mirror focuses the transmitted signal onto the detector. The electrical field is orthogonal to the viewing plane. The polarizing grid gets rid of the cross polarisation of the focusing mirror on the right, and the -5 db attenuation through an absorbing slab reduces standing waves. For each frequency step measurements with and without (reference) filter were made.

explore the whole frequency range between 305 and 425 GHz, measurements were first done in 5 respectively 10 GHz frequency steps, each with an electronic sweep over a bandwidth of 1 GHz[1]. In a second step (D-filter only) the frequency was covered continuously with 1 GHz frequency steps over frequency ranges of largest interest.

For each frequency step the filter had to be removed and reinserted to obtain measurements for the reference and the filter. After subtracting the reference from filter measurements for each scan the results were pieced together over the whole covered bandwith.

The setup for transmission measurements is shown in Figure 1. All quasi-optical components are mounted on a standard test bench from Thomas Keating. The test signal from ESA1 is focused onto the quasi-optical filter (DUT) by a 60 degree offset mirror. The beam waist at the location of the DUT is approximately 10 mm. A second and identical mirror refocuses the beam, so that nearly all power is collected by the receiving horn; both horns (Thomas Keating) are corrugated and are optimized for 410 GHz. The polarisation of the test signal is orthogonal to the bench. A polarisation grid gets rid of the small cross polarisation of the elliptical mirror, and a 5 db absorbing plate supresses standing waves down to a ripple of typically typically less than 1.2 db in the transmission measurements. In the setup for reflection measurements (Fig. 2) a reflecting mirror, that is inserted instead of the DUT, serves as reference.

2 Measurement results

C-Band filter

As already mentioned the C-filter was broken at the end of the transmission measurements with coarse frequency steps. The result of these measurements is shown in Figure 3. Minimum attenuation occurs at a level of -5 db and at a frequency of approximately 325 GHz. Maximum attenuation of more than -55 db occurs at approximately 360 GHz.

D-Band filter

For the D-band filter transmission reaches a maximum between 345 and 350 GHz at a value of -4 db (Fig. 5). The attenuation at minimum transmission is less than -55 db at approximately 380 GHz.

Reflection reaches a sharp maximum at 351.8 GHz (Fig. 6) with a return loss of -32 db. At the band edges (330 and 375 GHz) the return loss reaches it maximum of -1.2 db.

[1]the bandwidth being limited by the gunn source of the ESA1 extension

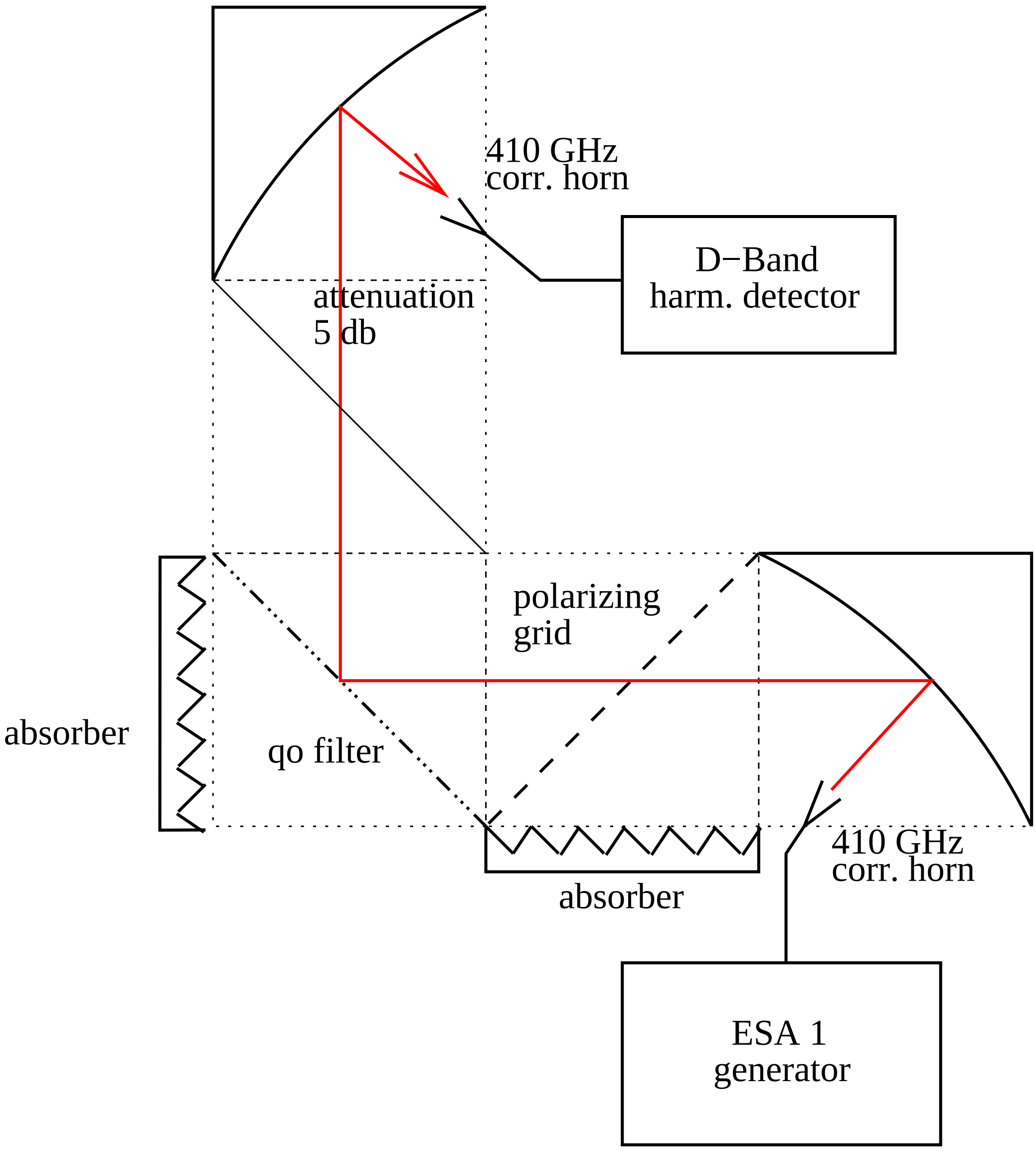

Figure 2: Quasi-optical setup for reflection measurements with the vector network analyzer from ABmm. For each frequency step measurements with the filter and a plane mirror (reference) were made.

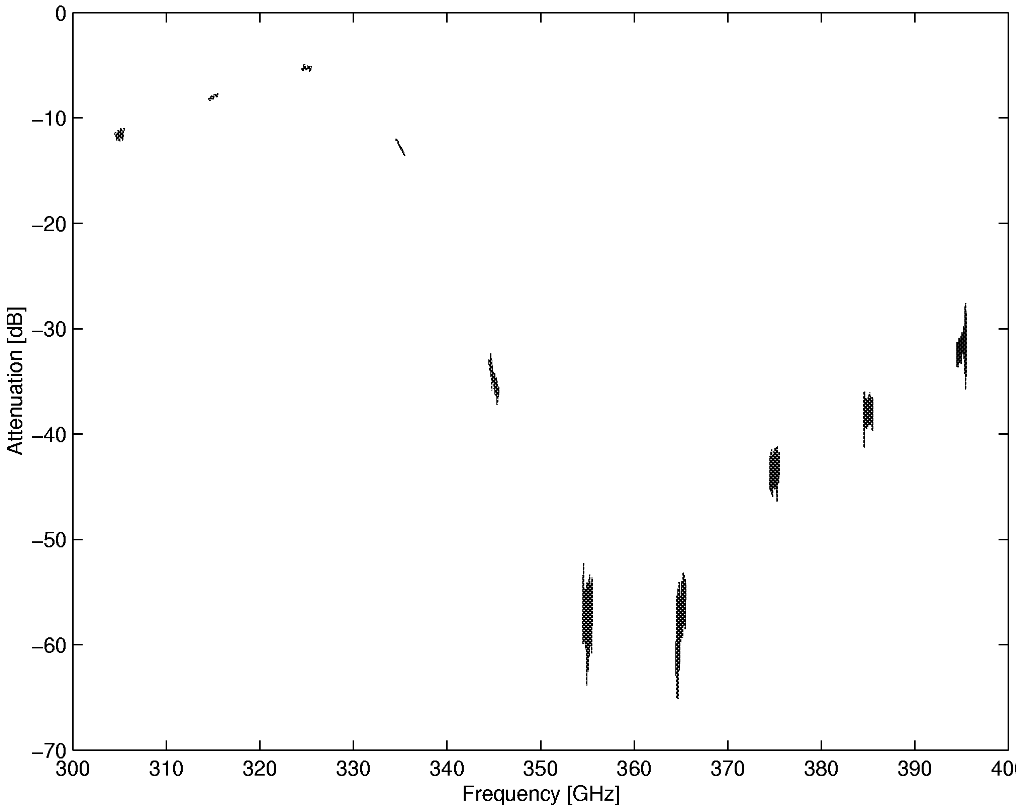

Figure 3: Attenuation of the C-band filter in transmission. For each frequency step a ± 0.5 GHz sweep has been carried out.

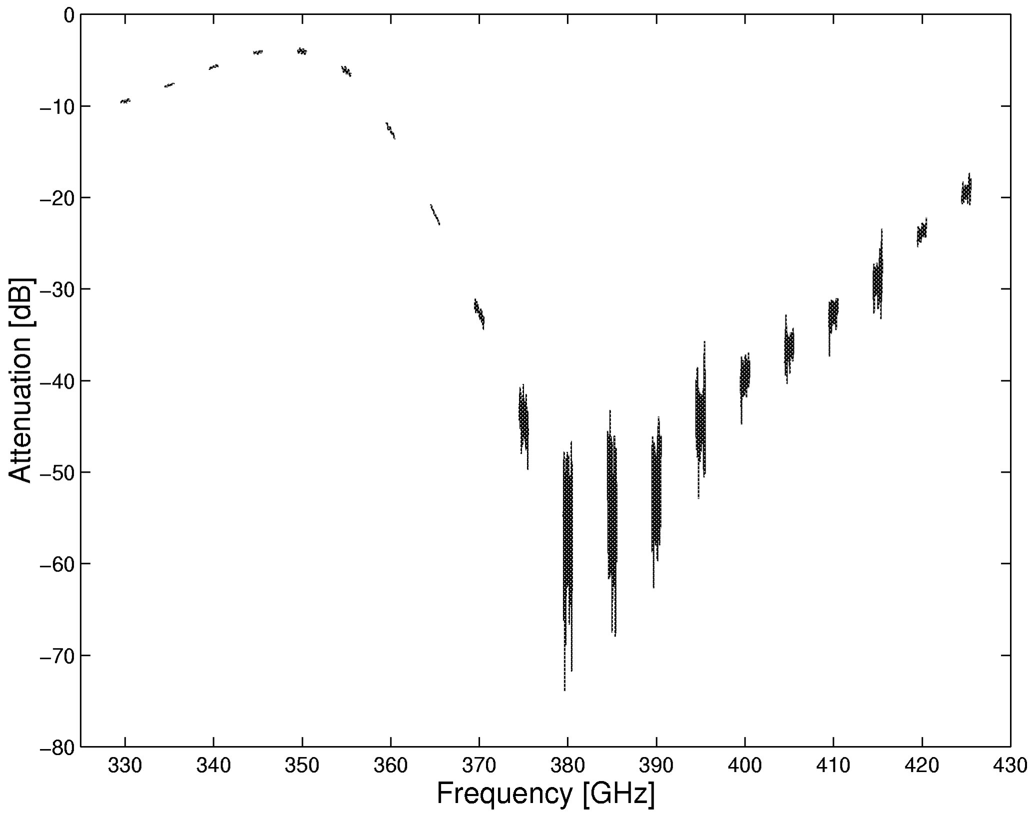

Figure 4: Attenuation of the D-band filter in transmission. For each frequency step a ± 0.5 GHz sweep has been carried out.

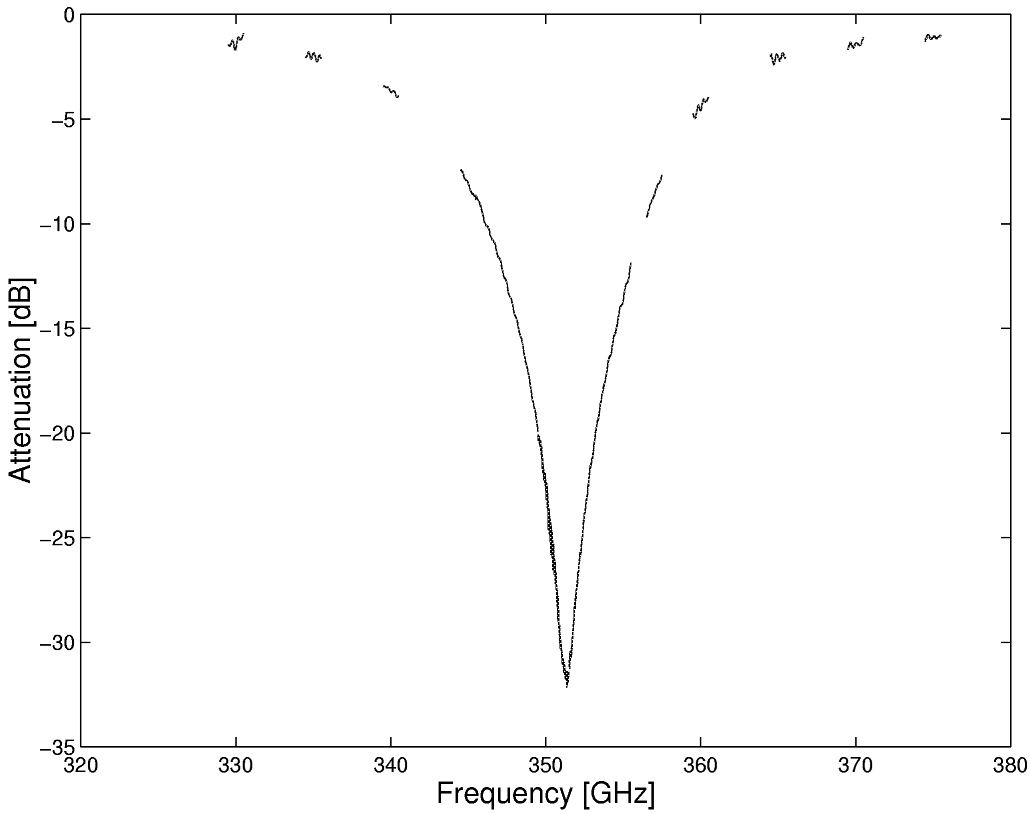

Figure 5: Returnloss of the D-band filter in reflection. For each frequency step a ± 0.5 GHz sweep has been carried out.