# Memorandum

**To:** File ALMA #: FEND-40.02.06.01-032-A-REP

**From:** John Effland
Dave Schmitt

**Date:** 2007-01-31

**Revisions:**

| | | |
|---|---|---|
| 2007-01-23 | jee | Initial, with Gore-Tex IR filters but un-tilted vacuum windows |
| 2007-01-23 | jee | Enlarged graphs |
| 2007-01-24 | dfs | Added additional figures to Section 2 for clarity |
| 2007-01-29 | dfs | Removed Gore-Tex only patterns and added tilted vacuum window patterns |
| 2007-01-31 | jee | Added patterns with Gore-Tex and un-tilted vacuum window |

**Subject:** Comparison of Band 6 Sidelobes with IRAM and Gore-Tex IR Filters and with a Tilted and Un-tilted Vacuum Window

## 1. Conclusions

Pattern differences are small when IRAM's IR filters are replaced with Gore-Tex designs. However, patterns are improved somewhat when the vacuum window is tilted 5°.

The next step is to compare these patterns with those currently undergoing measurement in the Front End Integration Center using RAL's test cryostat.

## 2. Results

Table 2, Table 3, and Table 4 compare beam patterns at signal frequencies of 211, 229, and 265 GHz measured with:

1. IRAM infrared (IR) filters with an un-tilted IRAM quartz vacuum window,
2. Gore-Tex IR filters in place of the IRAM filters with no changes to the vacuum window, and
3. with the vacuum widow tilted 5° from normal.

A summary of the filter replacement and window changes is tabulated in Table 1 and details are provided in Section 4 below.

The measurement frequencies correspond to those where the largest sideslobes were observed on the first measured Band 6 cartridge (B6-001).

Patterns at 211 GHz (Table 2) show perhaps better main beam shape but higher sidelobes when the Gore-Tex IR filters are used. Tilting the vacuum window slightly degrades sidelobes at 211 GHz.

Window tilt significantly improves patterns at 229 GHz (Table 3) and sidelobes drop from 20 dB below beam peak to about 27 dB below beam peak.

Pattern improvement at 265 GHz (Table 4) is marginal, with sidelobe levels dropping from about -20 dB to -22 dB.

The reason for the 5 dB decrease in signal-to-noise ratio at some frequencies when using Gore-Tex filters remains a mystery and cannot be explained by a change in source power level. Table 5 compares the absolute levels of patterns using IRAM and Gore-Tex filters and the total power at beam peak is nearly the same.

**Table 1: Summary of Cryostat Changes**

| Stage | Initial State: IRAM Filters and Windows | IR Filters Replaced | Window Tilted |
|---|---|---|---|
| **15 K Stage** | Single layer of 0.5 mm Mupor mounted flat with a 65 mm clear aperture. | Two layers of 0.5mm Gore-Tex sandwiched together with 65 mm clear aperture, Figure 1. | |
| **110 K Stage** | Molded PFA filter, mounted at an angle of 2.4° to the beam, Figure 2. | Single layer of 0.5 mm Gore-Tex mounted flat to the 110K plate with a 1.58 mm (1/16") G-10 filter ring and a 61 mm clear aperture, Figure 3. | |
| **Vacuum Window** | Quartz vacuum window with 50 mm clear aperture | Quartz vacuum window with 50 mm clear aperture | Tilted 5° perpendicular to the major axis of the beam, Figure 4. Tilt was in the +Y direction as referenced to beam scanner axis, Figure 8 |

## 3. Acknowledgements

The authors would like to recognize Dan Koller for helping to find the replacement IR filters.

## Table 2: Beam Patterns, 211 GHz

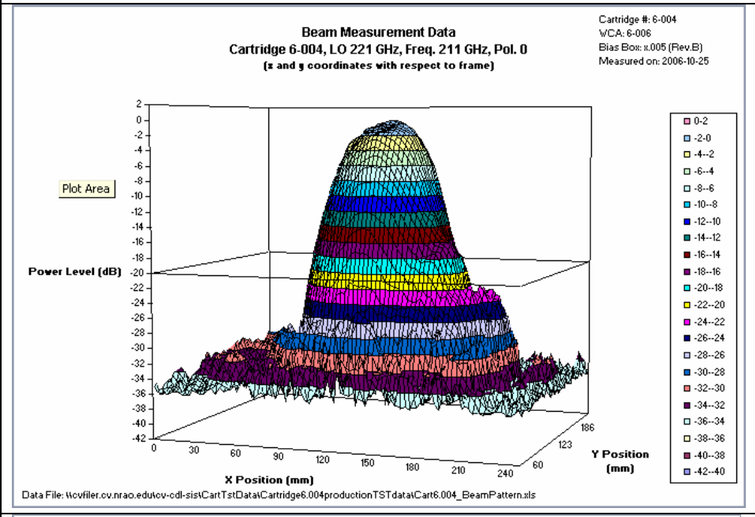
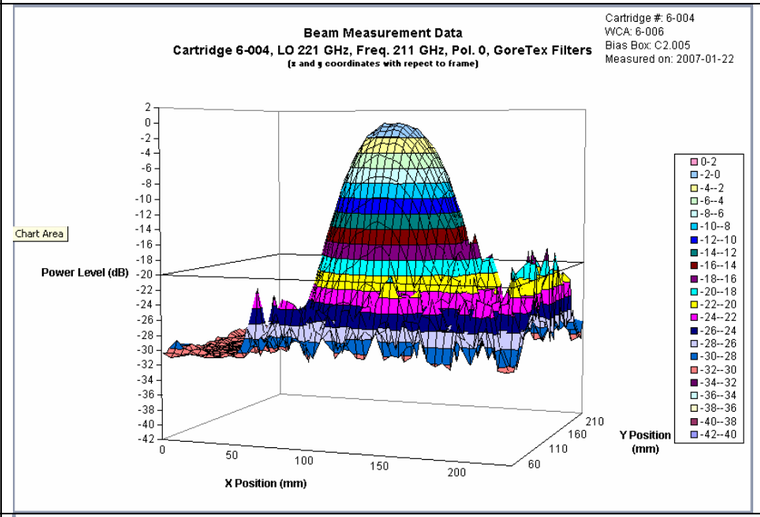
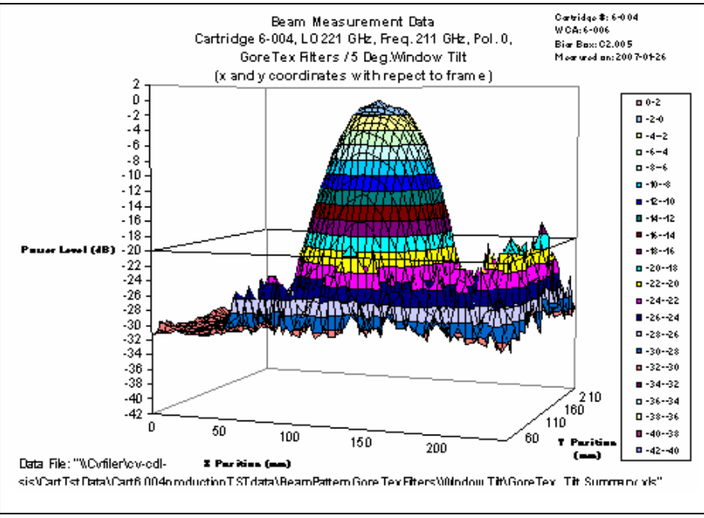
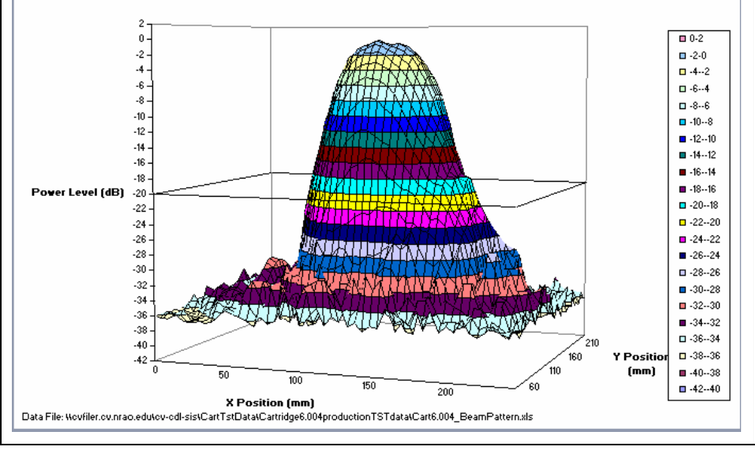
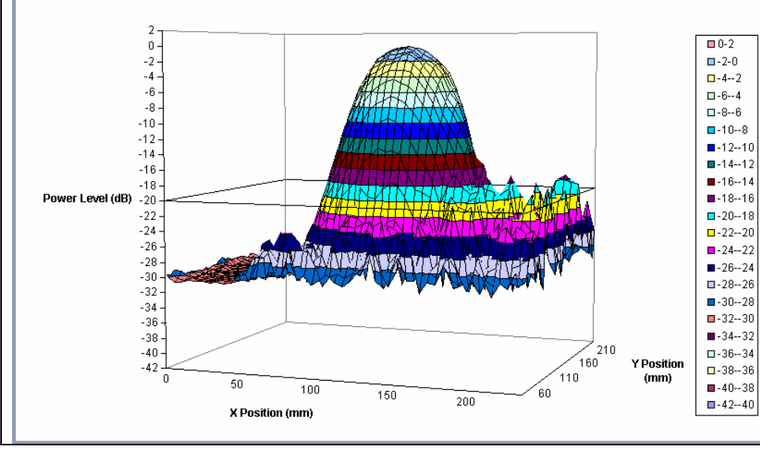
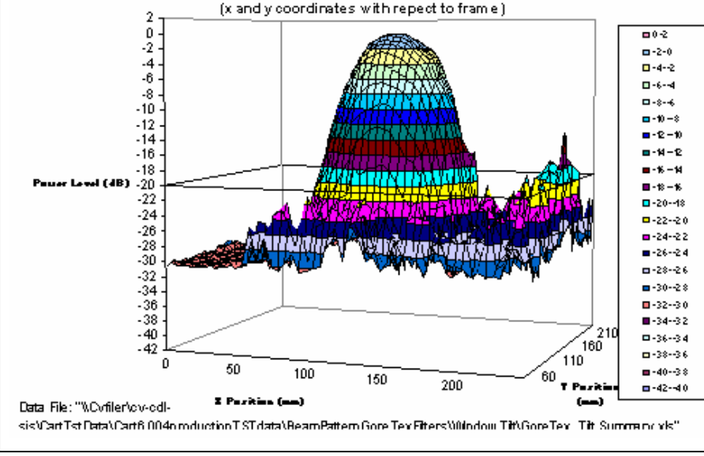
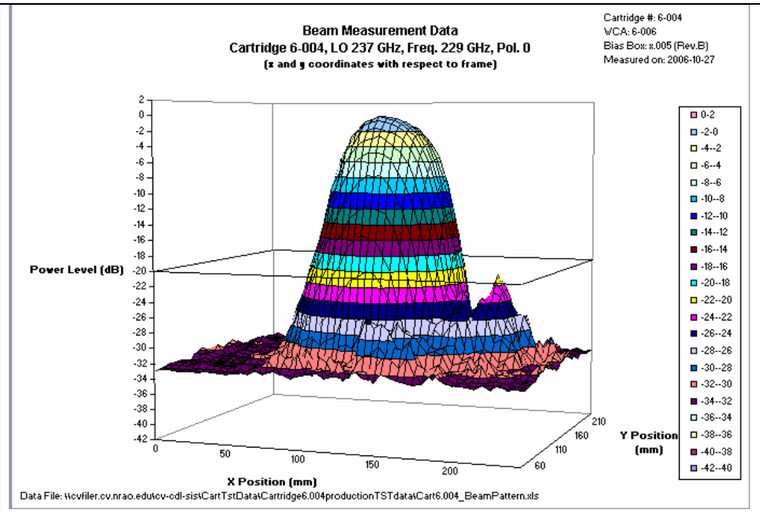
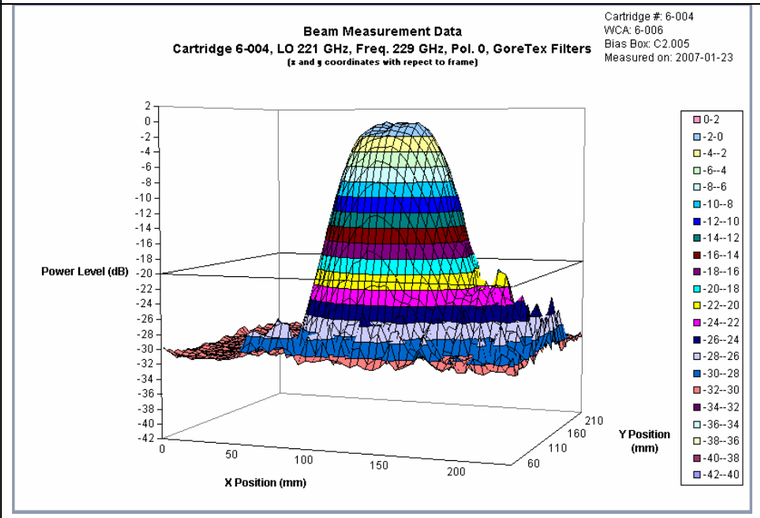
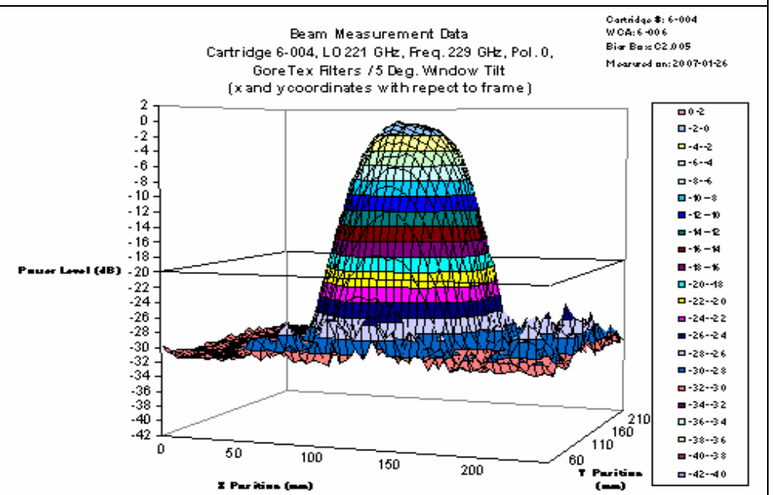
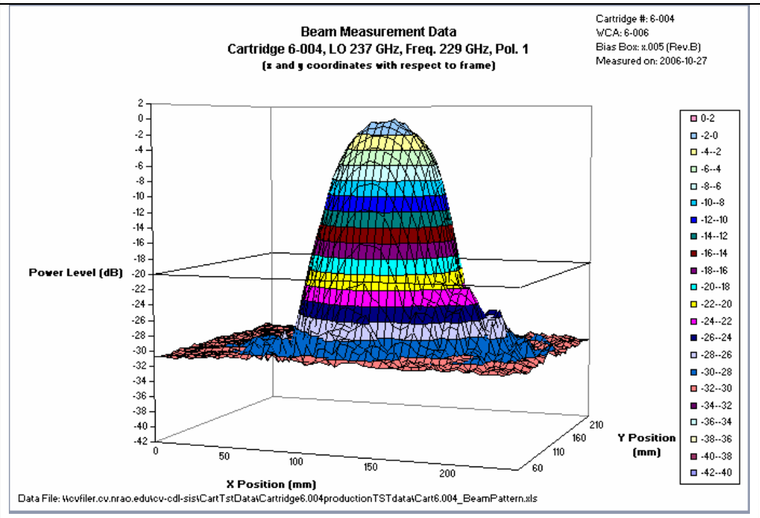
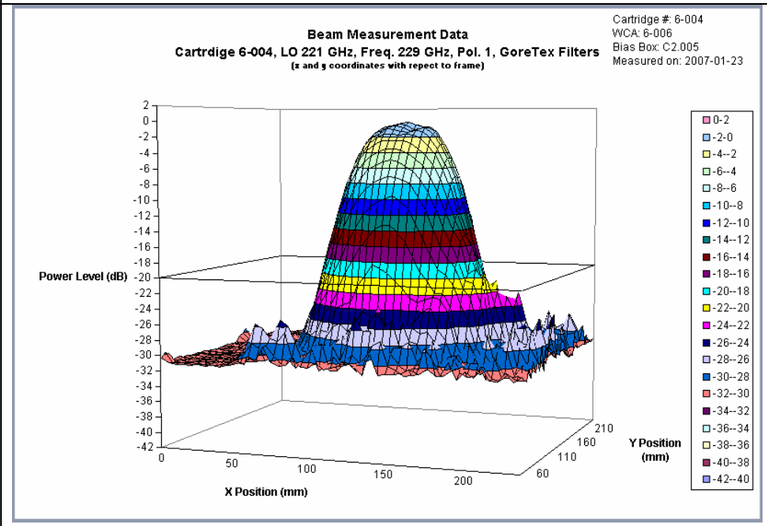
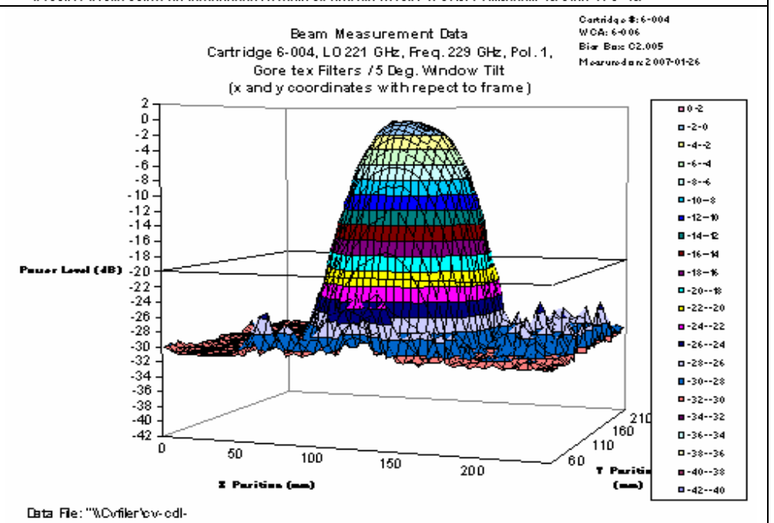
| | RAL IR Filters | Gore-Tex IR filters | Gore-Tex IR filters / Vacuum Window 5 deg. Tilt |
|---|---|---|---|
| Pol 0 |  |  |  |
| Pol 1 |  |  |  |

**Table 3:Beam Patterns, 229 GHz**

| | RAL IR Filters | Gore-Tex IR filters | Gore-Tex IR filters / Vacuum Window 5 deg. Tilt |
|---|---|---|---|
| Pol 0 |  |  |  |
| Pol 1 |  |  |  |

## Table 4:Beam Patterns, 265 GHz

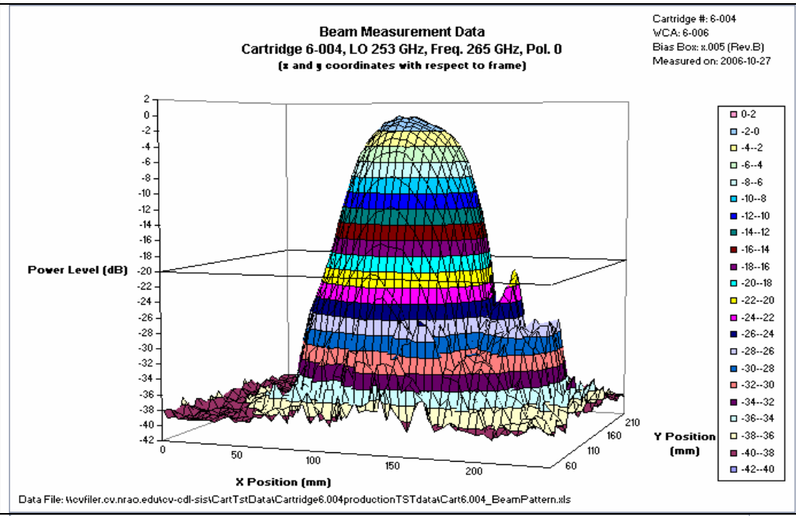
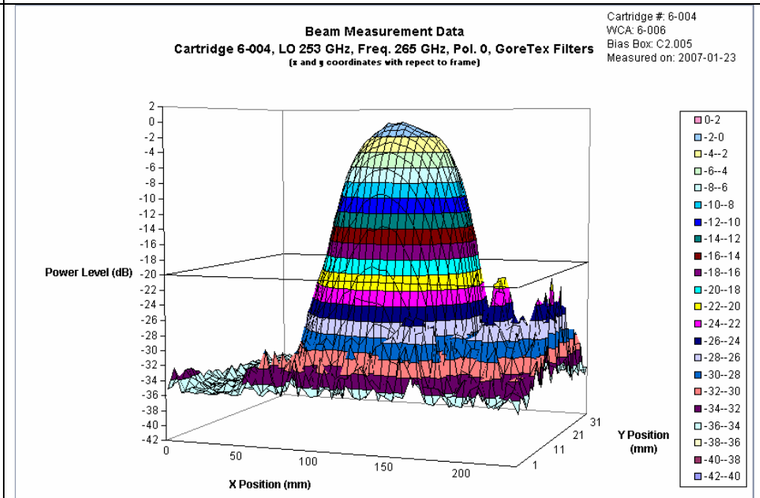
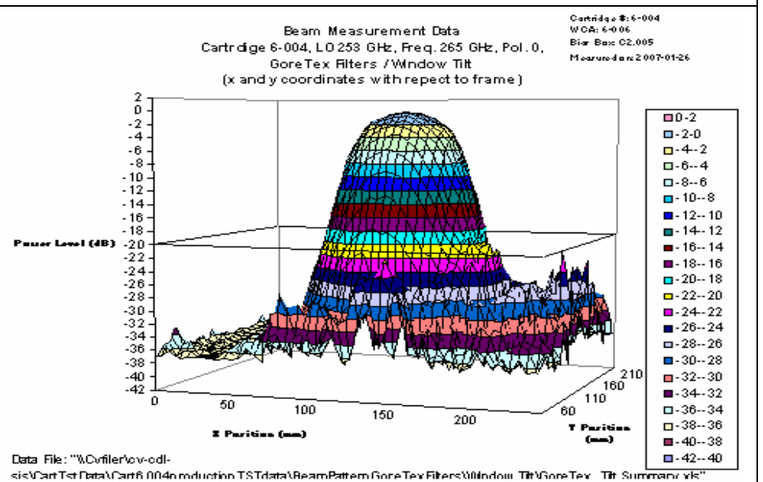
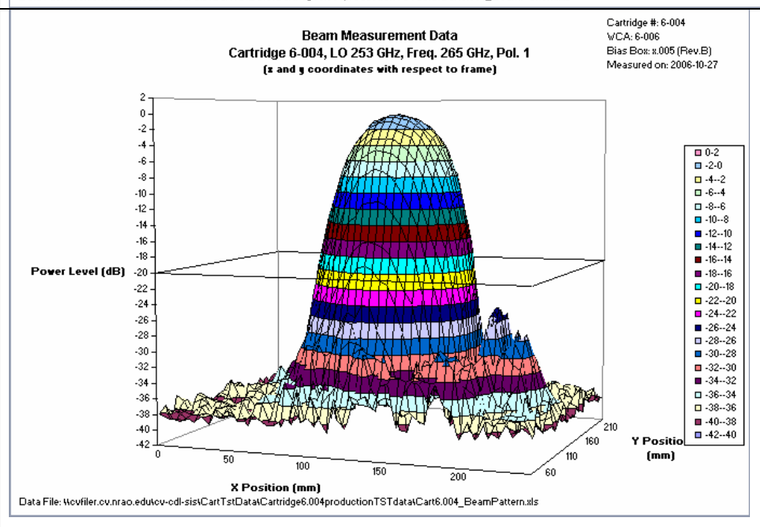
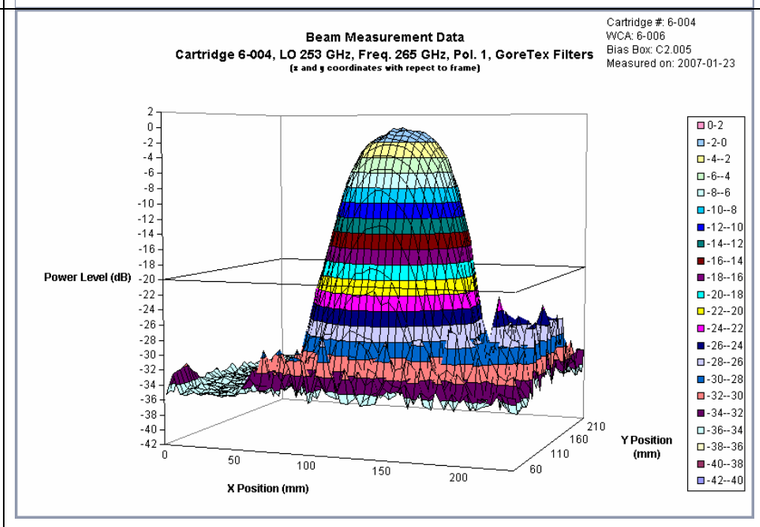
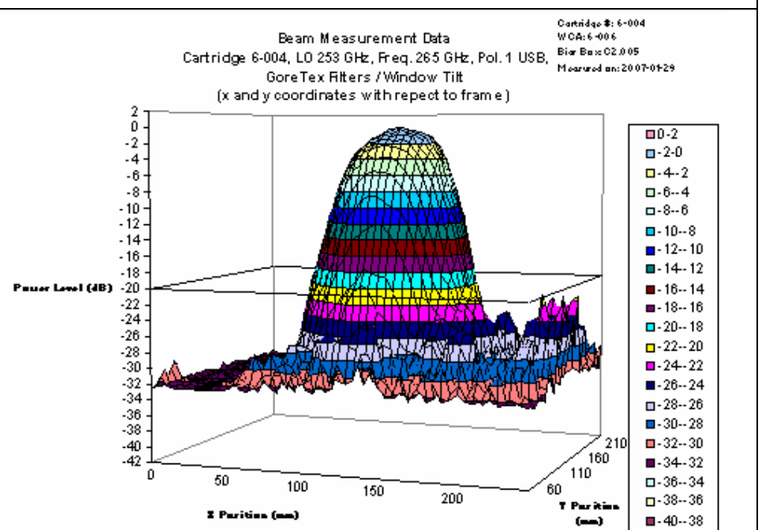
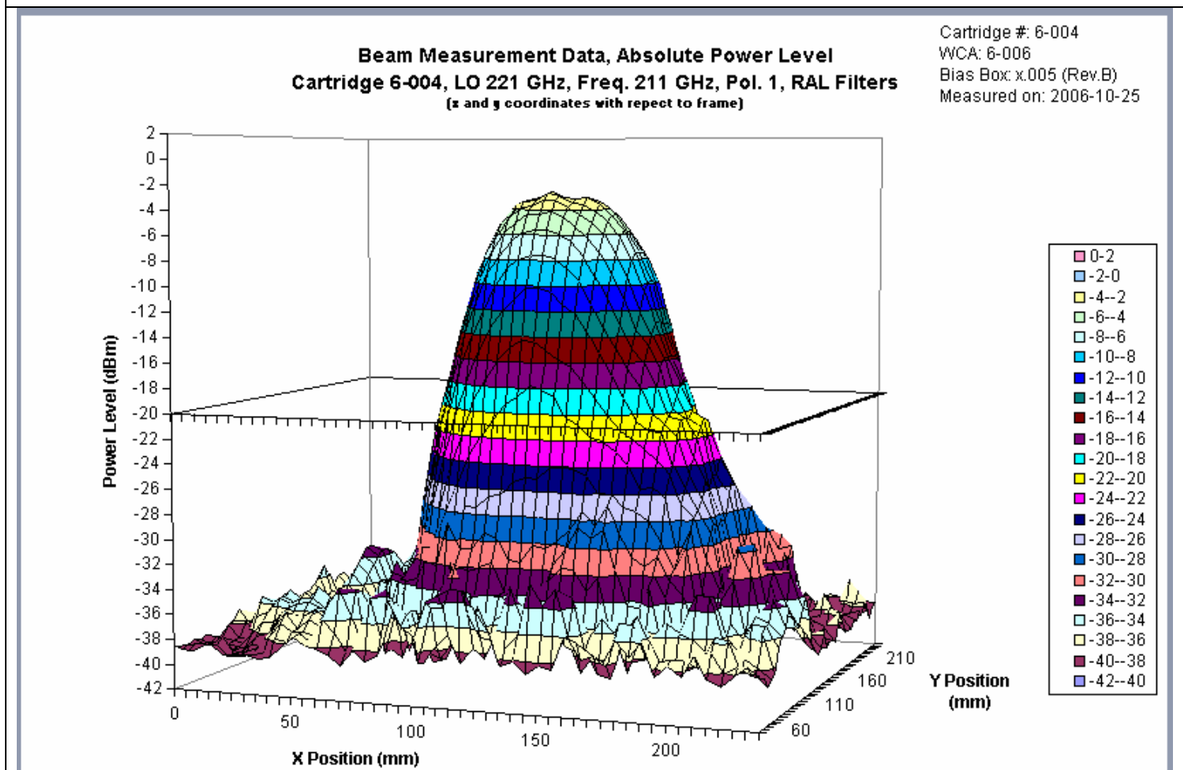
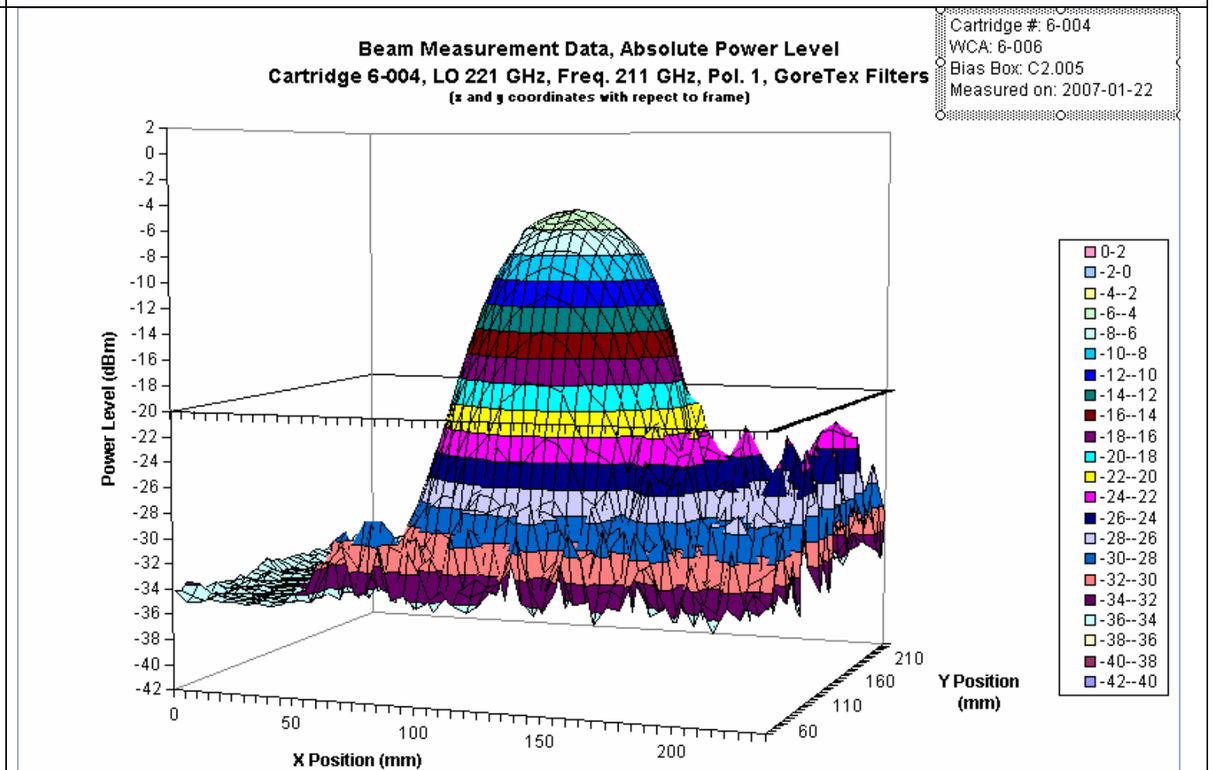
| | RAL IR Filters | Gore-Tex IR filters | Gore-Tex IR filters / Vacuum Window 5 deg. Tilt |
|---|---|---|---|
| Pol 0 |  |  |  |
| Pol 1 |  |  |  |

**Table 5: Absolute Power Level Comparison, 211 GHz, Pol 1**

| RAL IR Filters | Gore-Tex IR filters / Vacuum Window 5 deg. Tilt |
|---|---|
|  |  |

## 4. Filter Changes

The following modifications were made to the optics of the Band 6 cartridge test set cryostat on 2007-01-25.

Replacement of the IR filter on the 15K stage of the cartridge test set dewar consisted of; removing the existing single layer of 0.5 mm Mupor mounted flat with a 65 mm clear aperture. This was replaced with two layers of 0.5mm Gore Tex sandwiched together with the same 65 mm clear aperture, Figure 1.

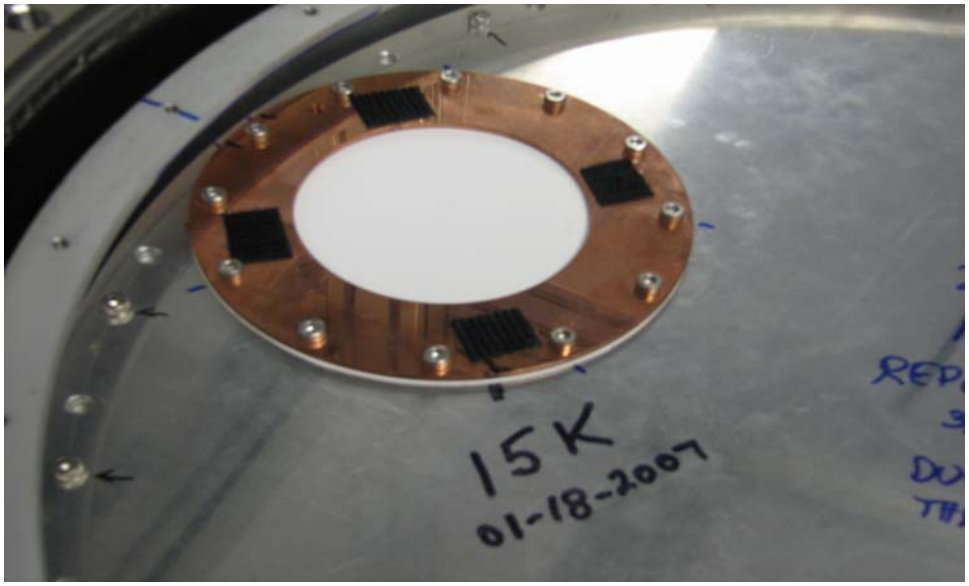



**Figure 1: Filter 15K Stage; 2-layer Gore-Tex**

Replacement of the 110K stage IR filter consisted of; removing the molded PFA filter which was mounted at an angle of 2.4 degrees to the beam, Figure 2.

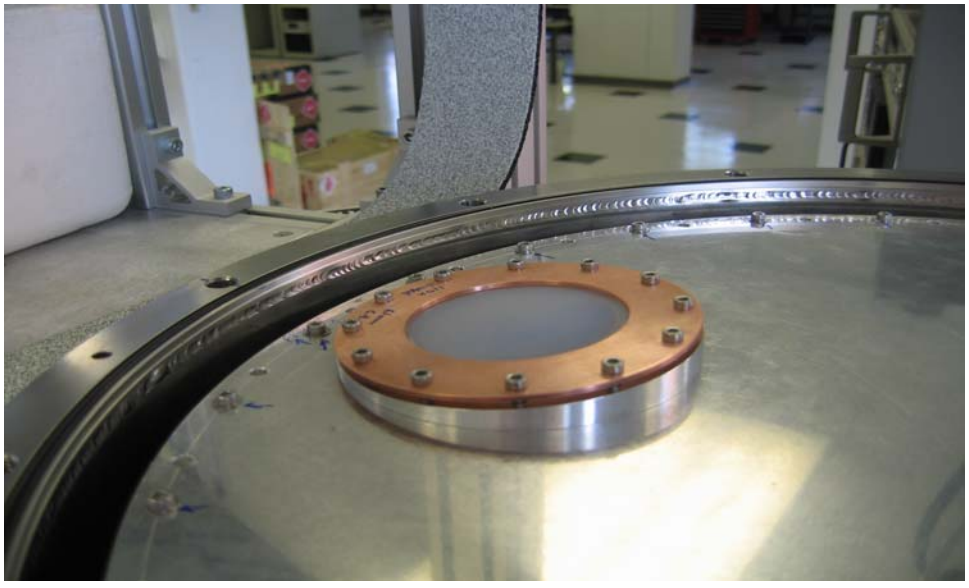


**Figure 2: 110K Stage Filter with PFA Filter**

This was replaced with a single layer of 0.5 mm Gore-Tex mounted flat to the 110K plate with a 1/16" G-10 filter ring and a 61 mm clear aperture, Figure 3.


**Figure 3: Gore-Tex Filter, 110K Stage**

The ALMA quartz vacuum window with a 50 mm clear aperture, was tilted to an angle of 5 degrees in the +Y direction; as referenced to the beam scanner axis, Figure 8, perpendicular to the major axis of the beam, Figure 4.

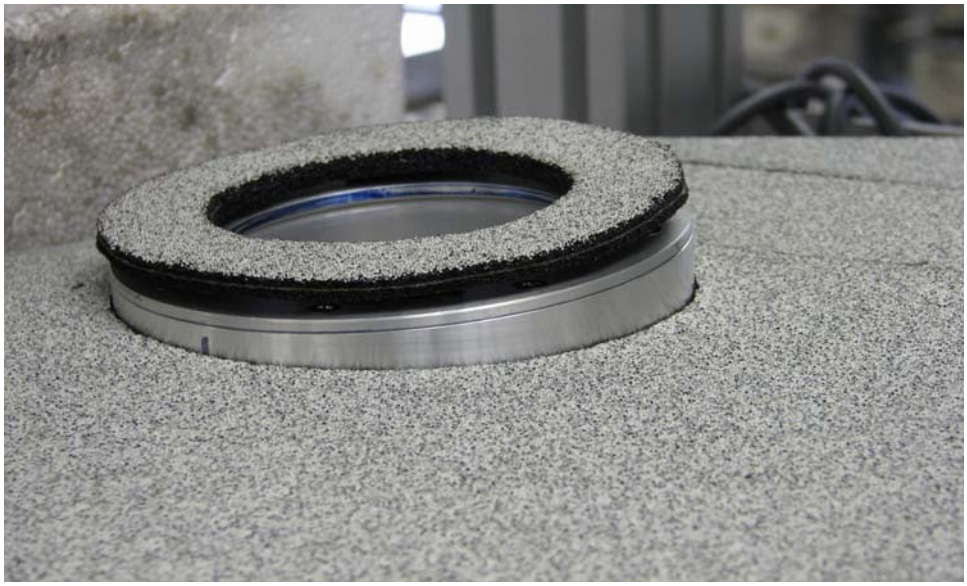


**Figure 4: Vacuum Window Tilted 5 Degrees.**

Also no alterations were made to the absorbing foam that is installed in the test set cryostat at this time, Figure 5, Figure 6, Figure 7. Although the foam mounted on the cold cartridge, as shown in Figure 6, was not installed for this test.

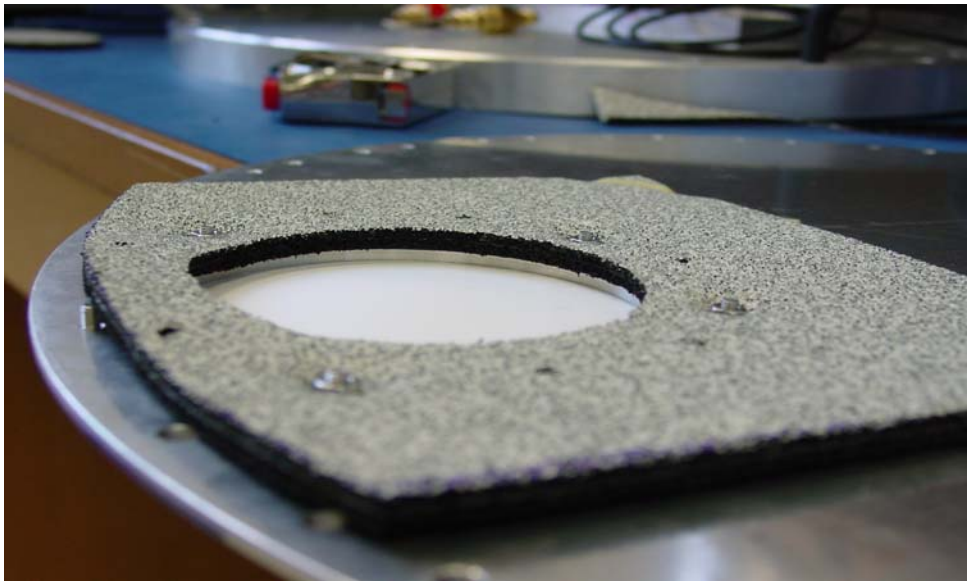


**Figure 5: AN-72 Absorber on Underside of 15K Stage**

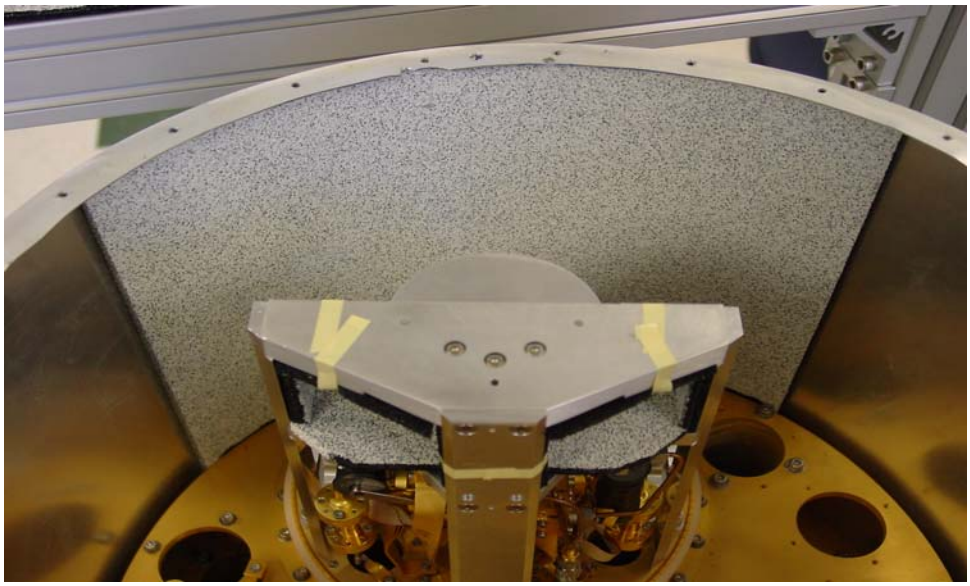


**Figure 6: AN-72 Absorber on Cryostat Wall**

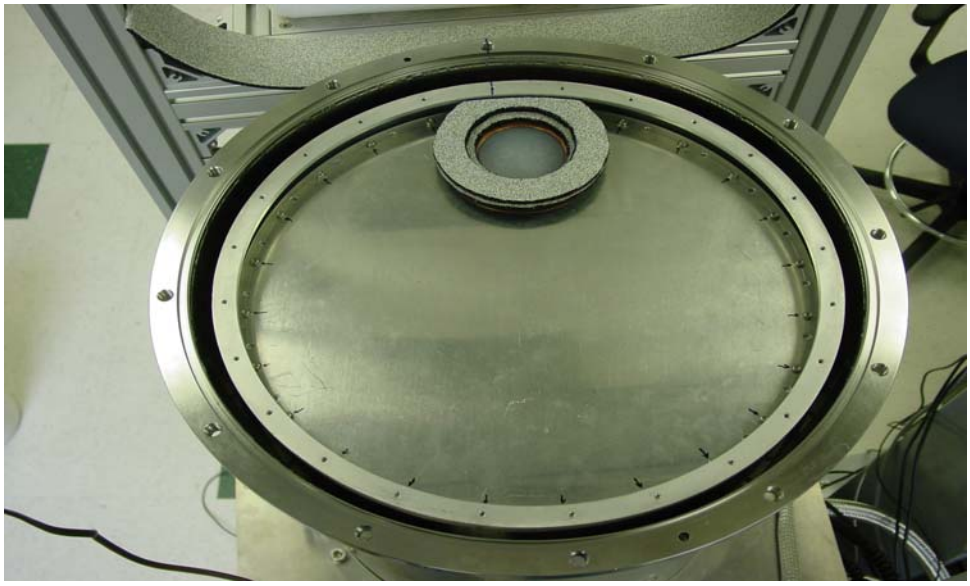


**Figure 7: AN-72 Rings Surrounding IR Filter on Top of 15K Stage**

Figure 8 is a graphical representation of the orientation of the cartridge in the test set, with the present coordinate axis of the beam scanner shown.

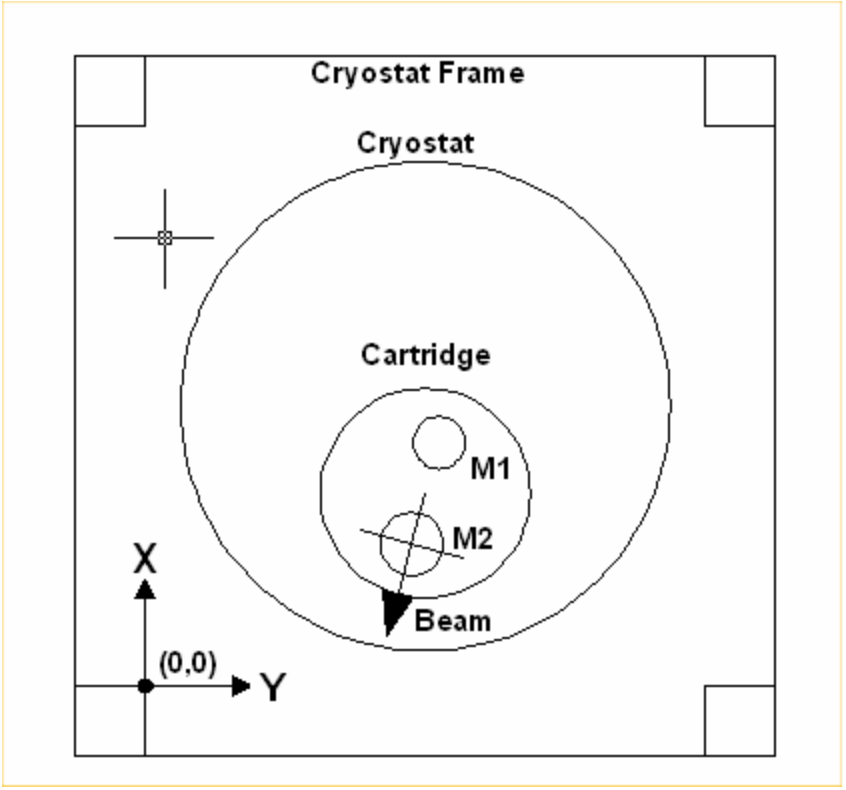



**Figure 8: Orientation of Cartridge in Test Set with Beam Scanner Coordinate Axis Shown.**