CAL EMI/EMC Testing History and Plans 14 April 2004

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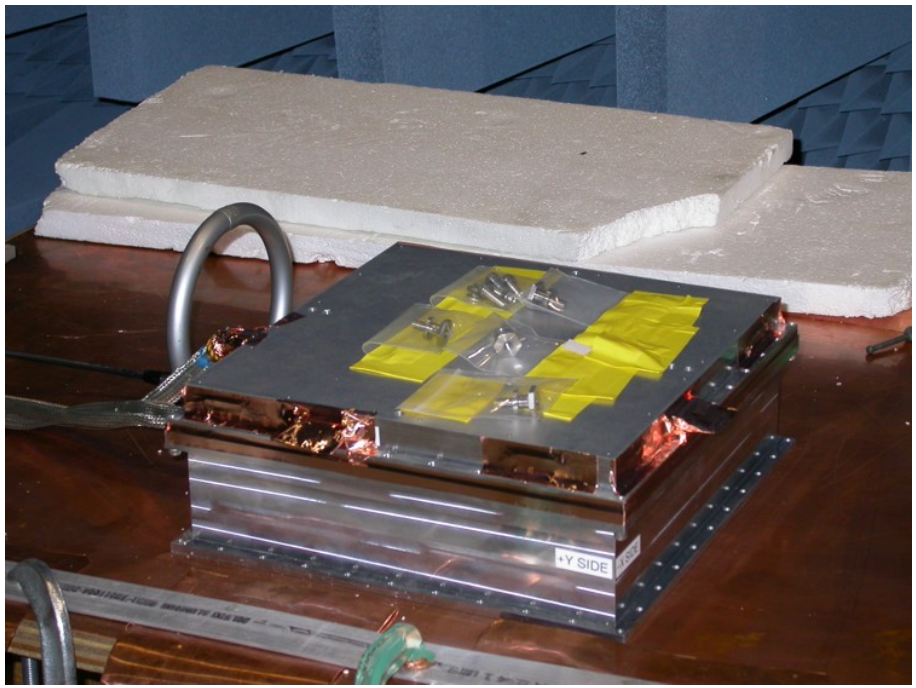
EM CAL Module

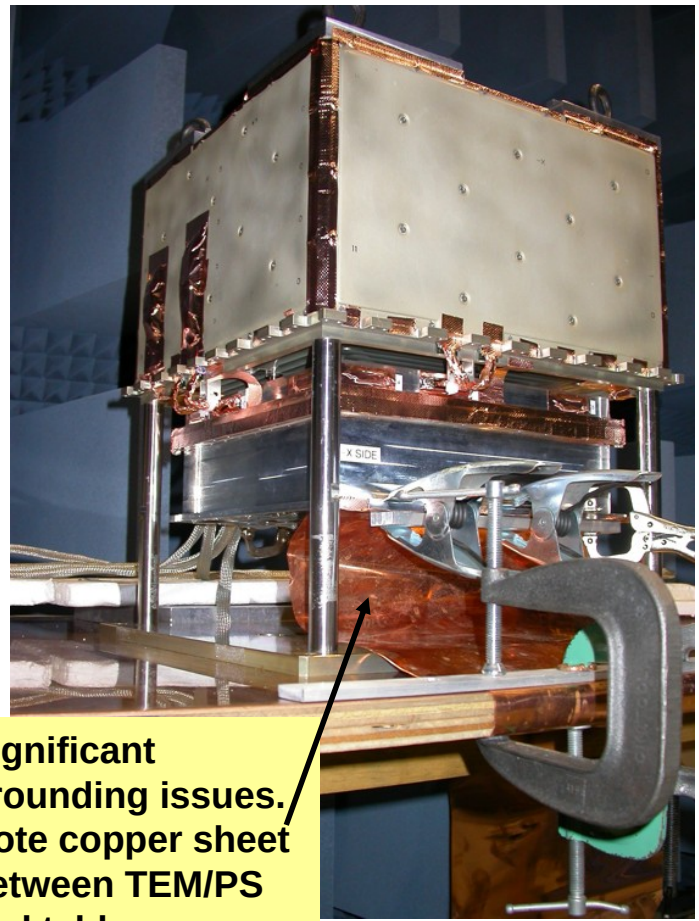
- **Attempted LAT qualification program for EMI/EMC specifications.**
- **Configuration:**
  - EM1 TEM and TEM Power Supply.
  - EM CAL Module.
  - No shielding from GRID or other LAT components.
- **Results:**
  - TEM Power Supply was not of sufficient quality to support EMI/EMC testing.
  - CAL had significant Radiated Emissions and modest Susceptibility – closing CAL joints w/ copper tape improved both.
  - Grounding arrangement of TEM/TPS is very important – copper sheet from TPS to ground improved performance significantly.
- **Actions: Plug the holes**
  - Modify CAL closeouts and side panels for better EMI/EMC containment.

Engineering Model Test Configurations

TEM + PS on Test Table



CAL + TEM/TPS on CAL Stand on Test Table

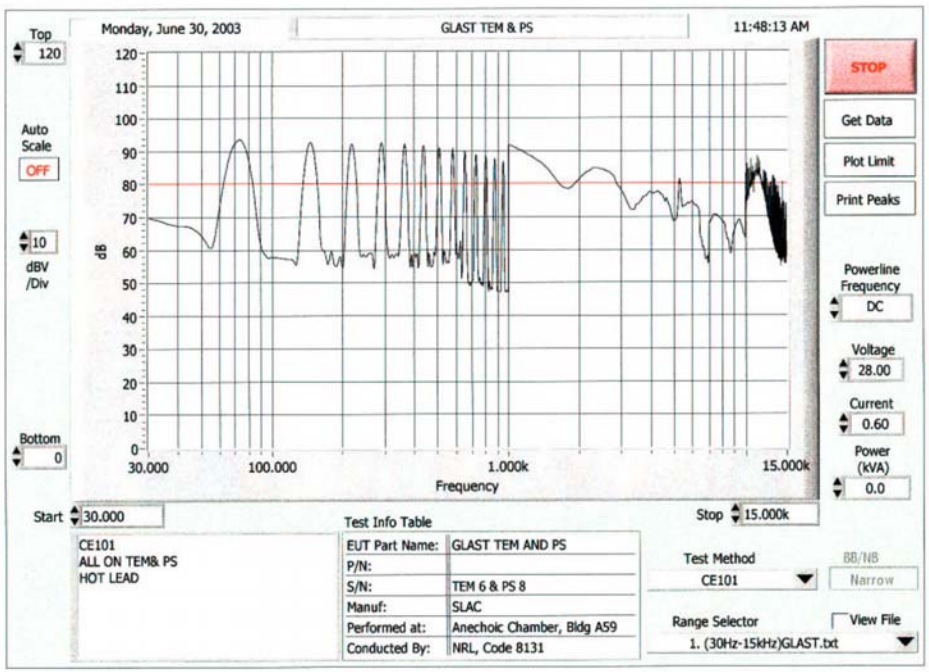


Tests performed on TEM + PS alone and then repeated with CAL + TEM + PS.

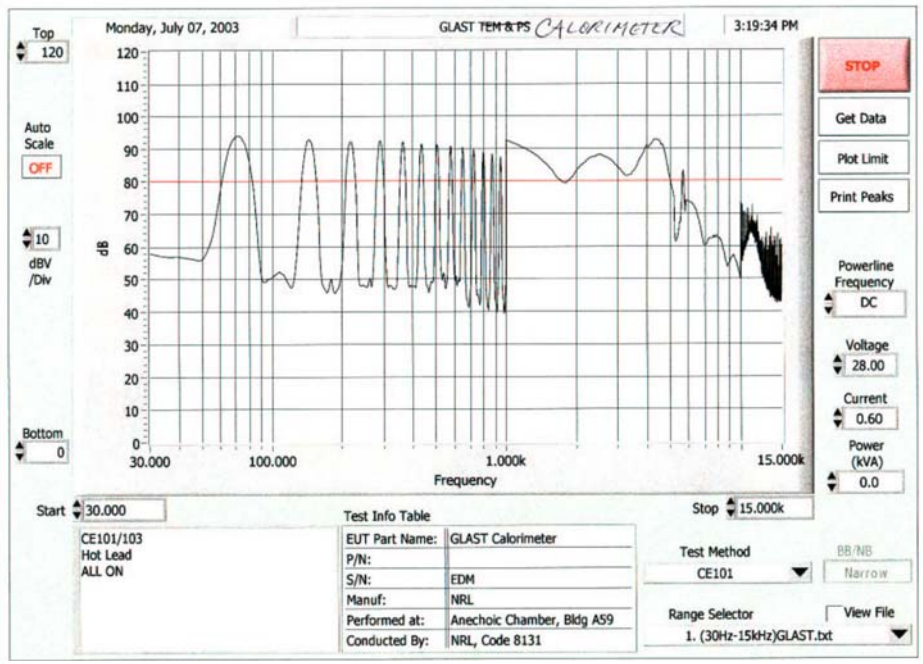
Significant grounding issues. Note copper sheet between TEM/PS and table

CE 101

EM1 TEM/TPS



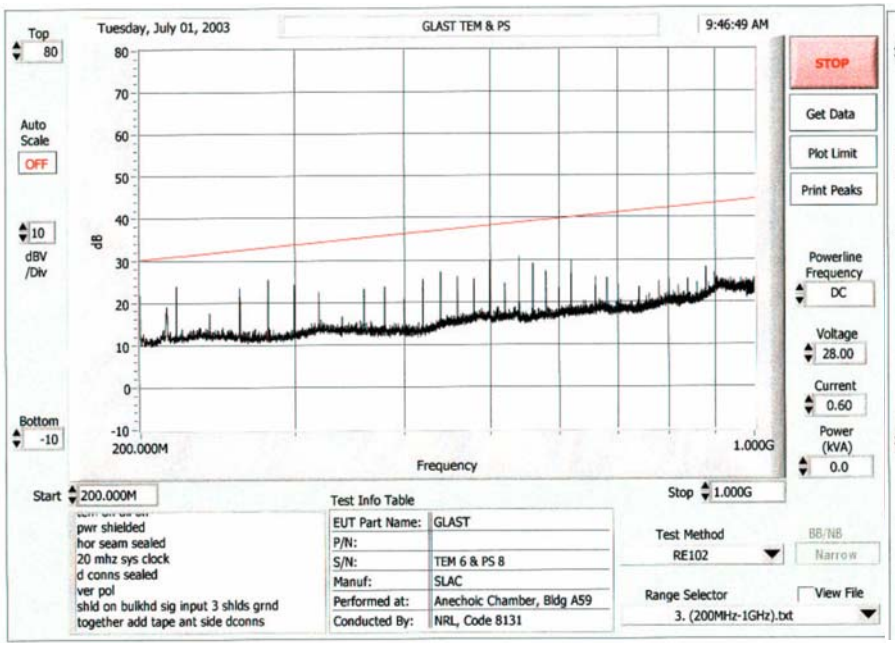
EM CAL + TEM/TPS



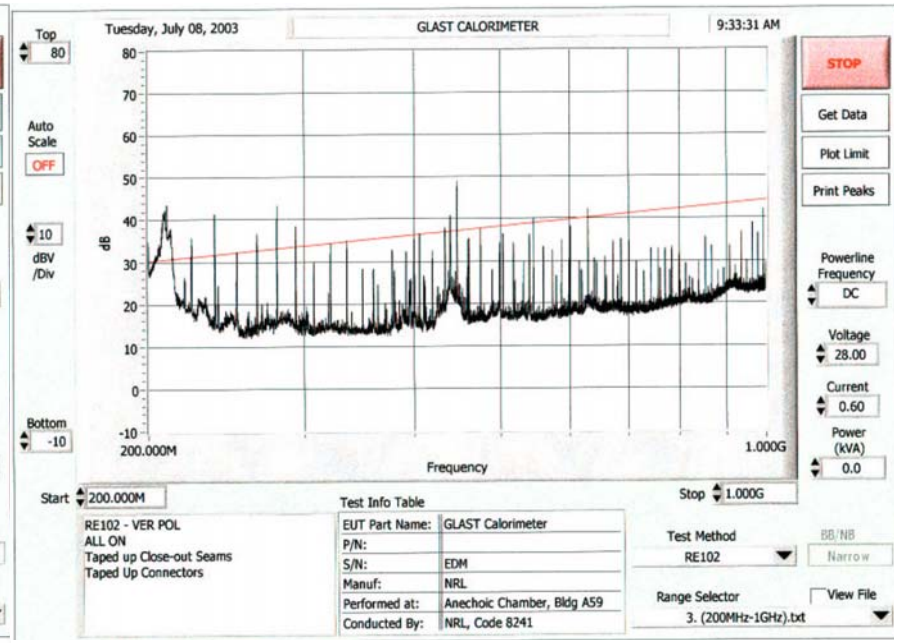
TEM/TPS Emissions dominate CAL

RE 102

EM1 TEM/TPS



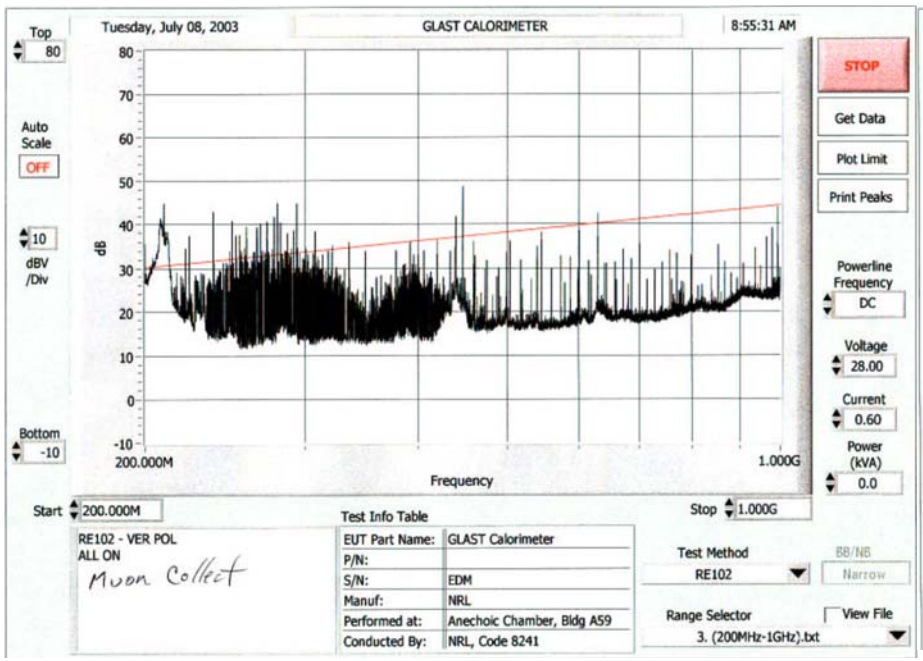
EM CAL + TEM/TPS

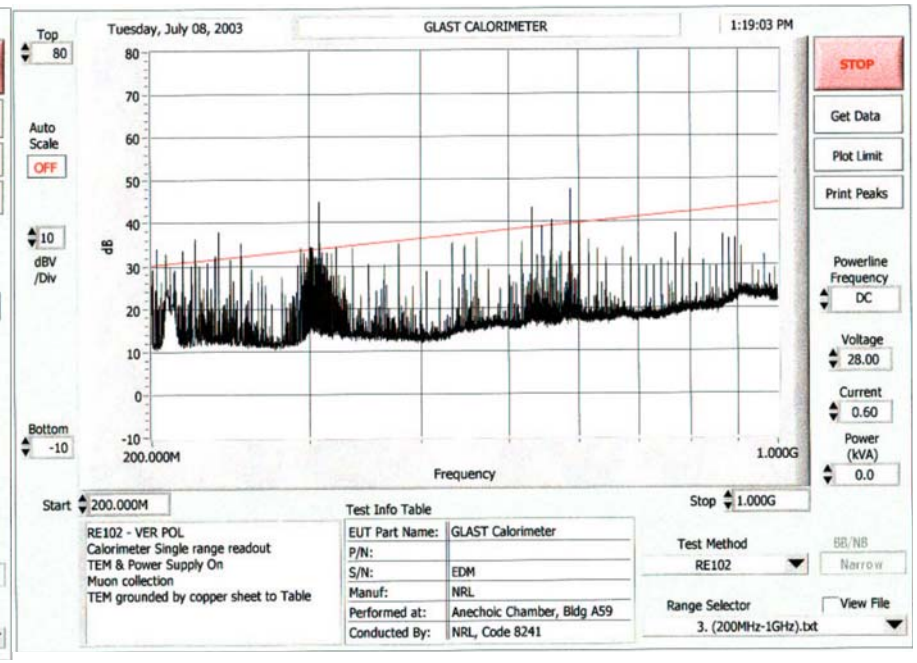


Adding CAL adds many clock harmonics

RE 102

EM CAL + TEM/TPS

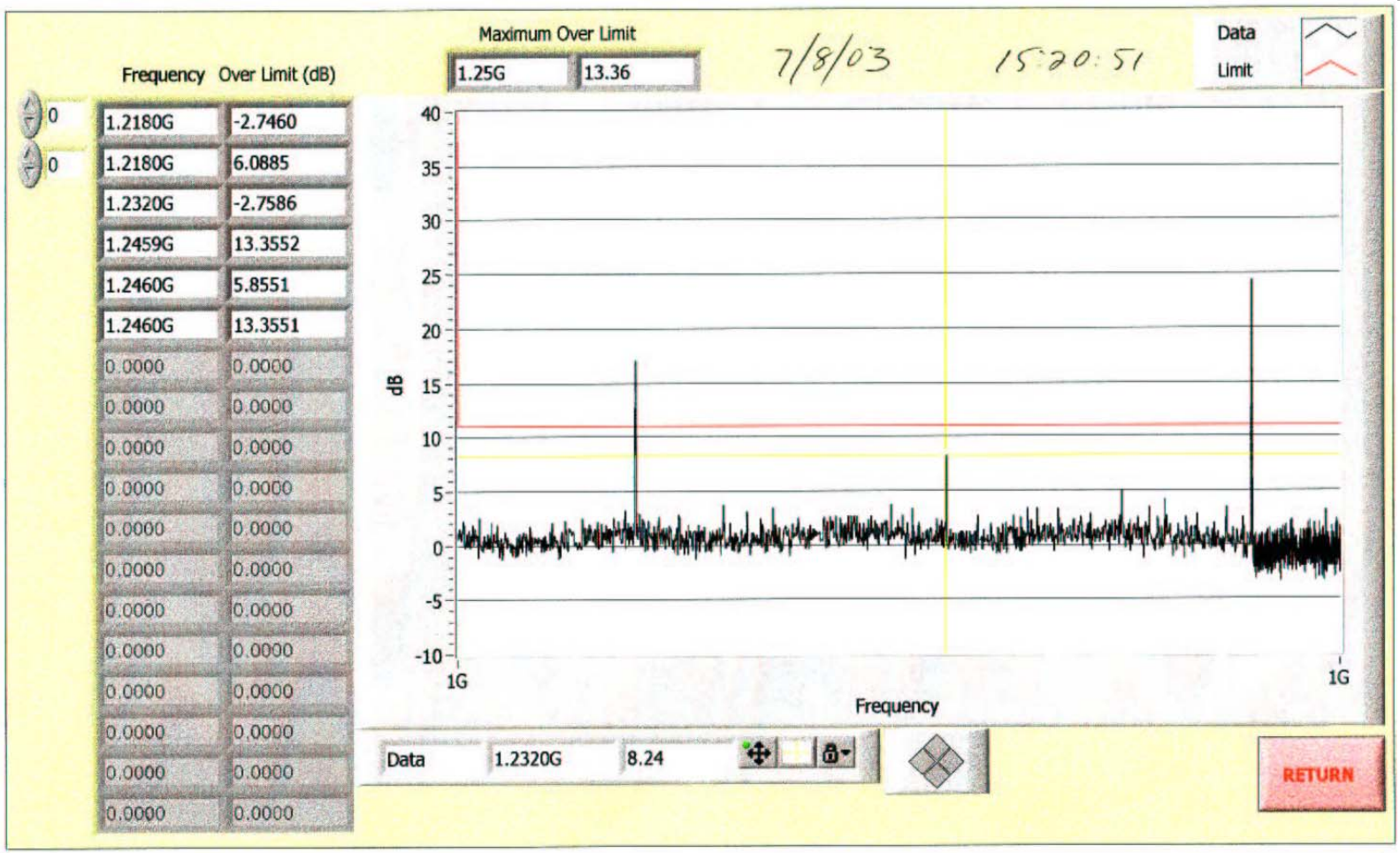




Added Cu sheet - PS to table

Adding extra grounding including large Cu sheet from TEM/PS to table reduces broad band noise – NOT FLIGHT CONFIG.

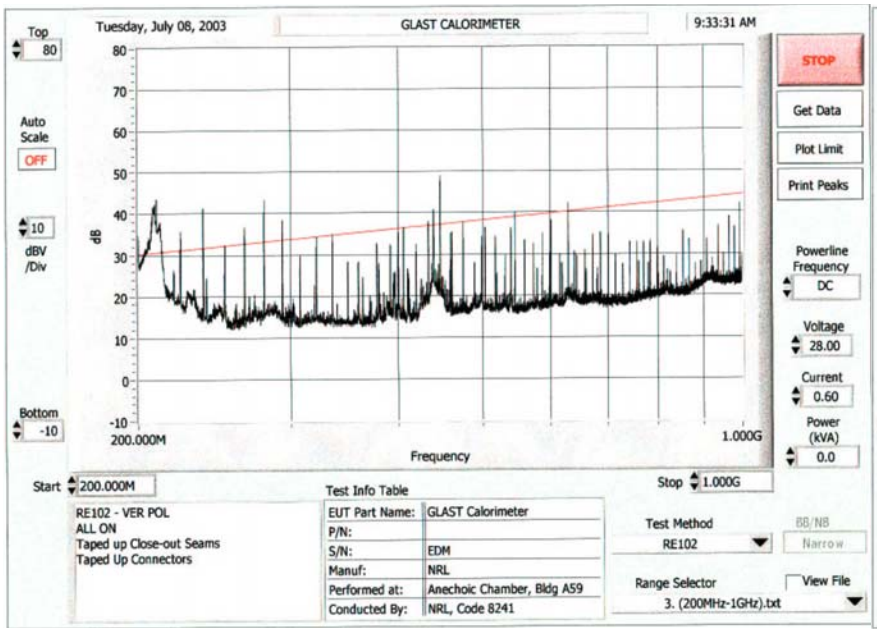
RE 102 – Receiver Notches



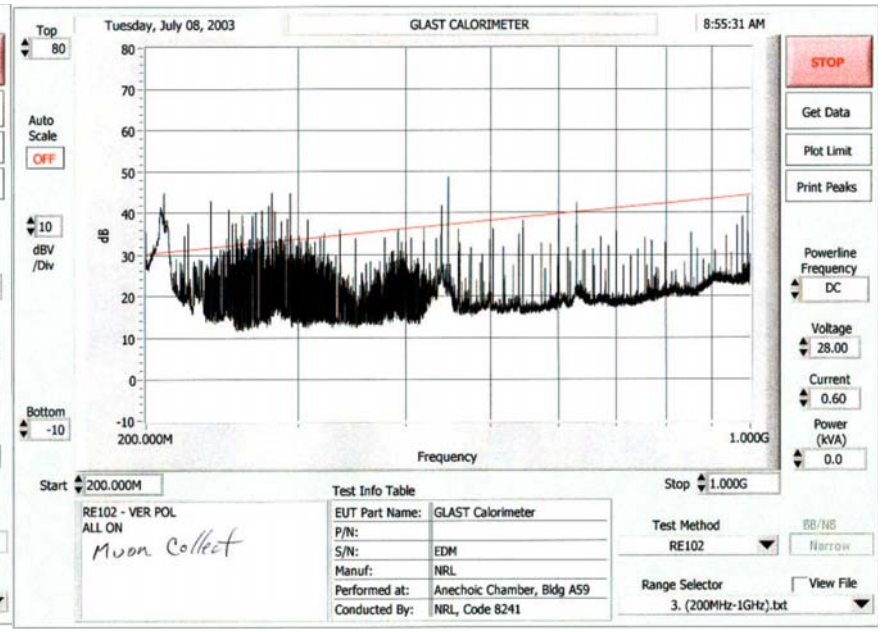
Clock harmonics are above specification.

RE 103

Register Testing



Muon event digitization and readout



CAL ADC readout adds broad band noise.
Appears to be DC-DC converter power supply harmonics.

RS 103

Several Areas of Susceptibility – changes somewhat from day-to-day

- **Vertical polarization**
  - Date: 7/9/03
    - 1.000 – 1.090 GHz: many extra triggers
    - 1.090 – 1.107 GHz: OK
    - 1.107 – 1.176 GHz: many extra triggers
  - Date: 7/10/03
    - 1.000 – 1.179 GHz: extra triggers without ok region in middle
- **Trigger discriminator level setting**
  - For ground test discriminator levels (~ 3 MeV)
    - 900 MHz horizontal, problems at 11 V/m
    - 448 MHz vertical, 1 V/m
  - For flight discriminator levels (~ 100 MeV) the situation is much better but there may still be some issues.
- **Do not see any communications errors.**

Radiated Emissions / Susceptibility

Modifications being incorporated in design

- **Metal part surface treatment**
  - All aluminum parts – electroless nickel.
- **Side Panel attachment**
  - Double number of fasteners
  - Create lip on top frame
  - Use EMI gasket
- **Closeout plate joint in vertical corners**
  - Use EMI O-strip and groove.

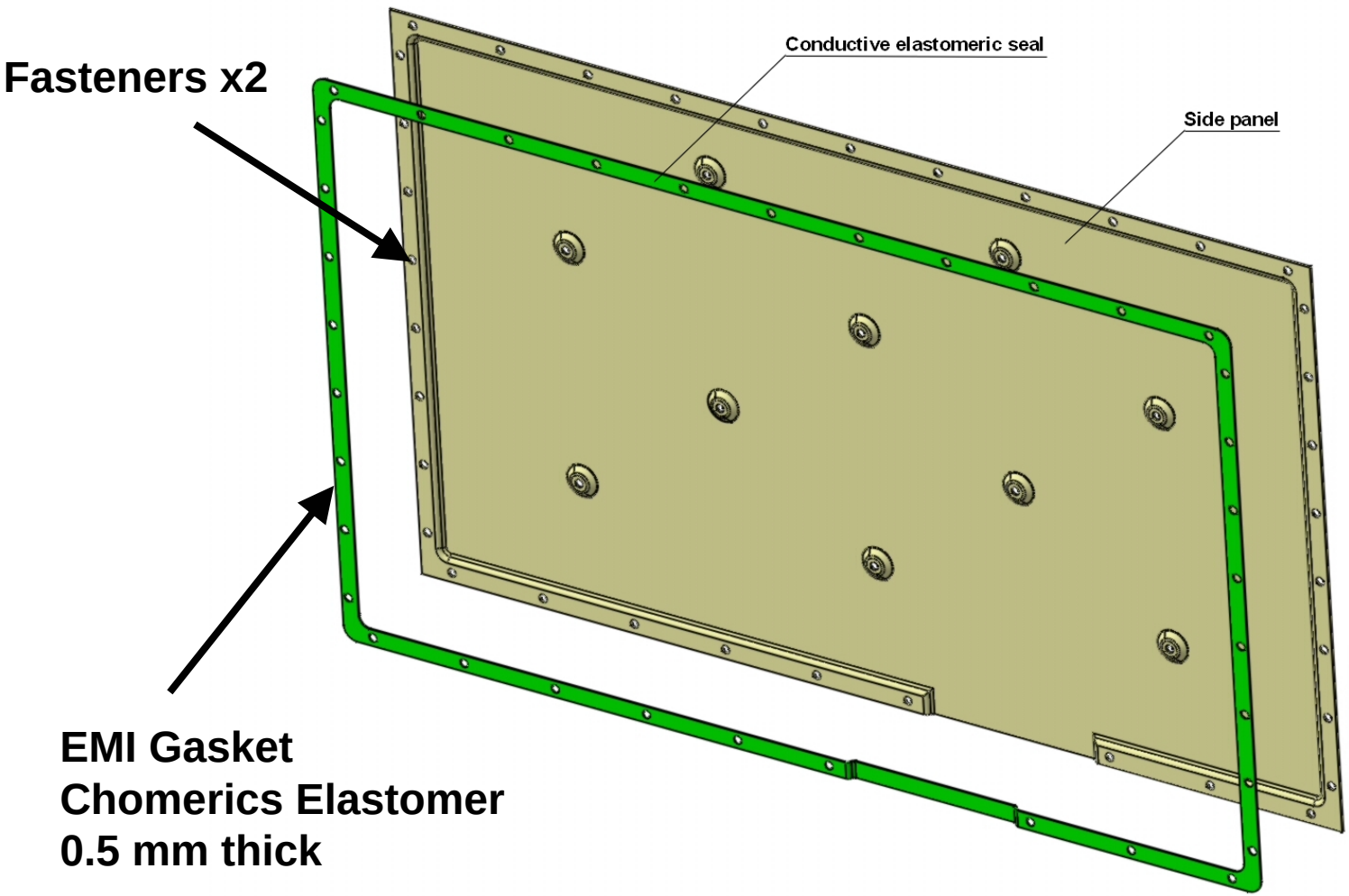
Outstanding Issues – no easy solution

- **Structure EMI shield at base plate tabs**
  - Open area for AFEE cable
  - Open area (the same) for venting
- **AFEE – TEM cable – no connector shells, incomplete shielding**

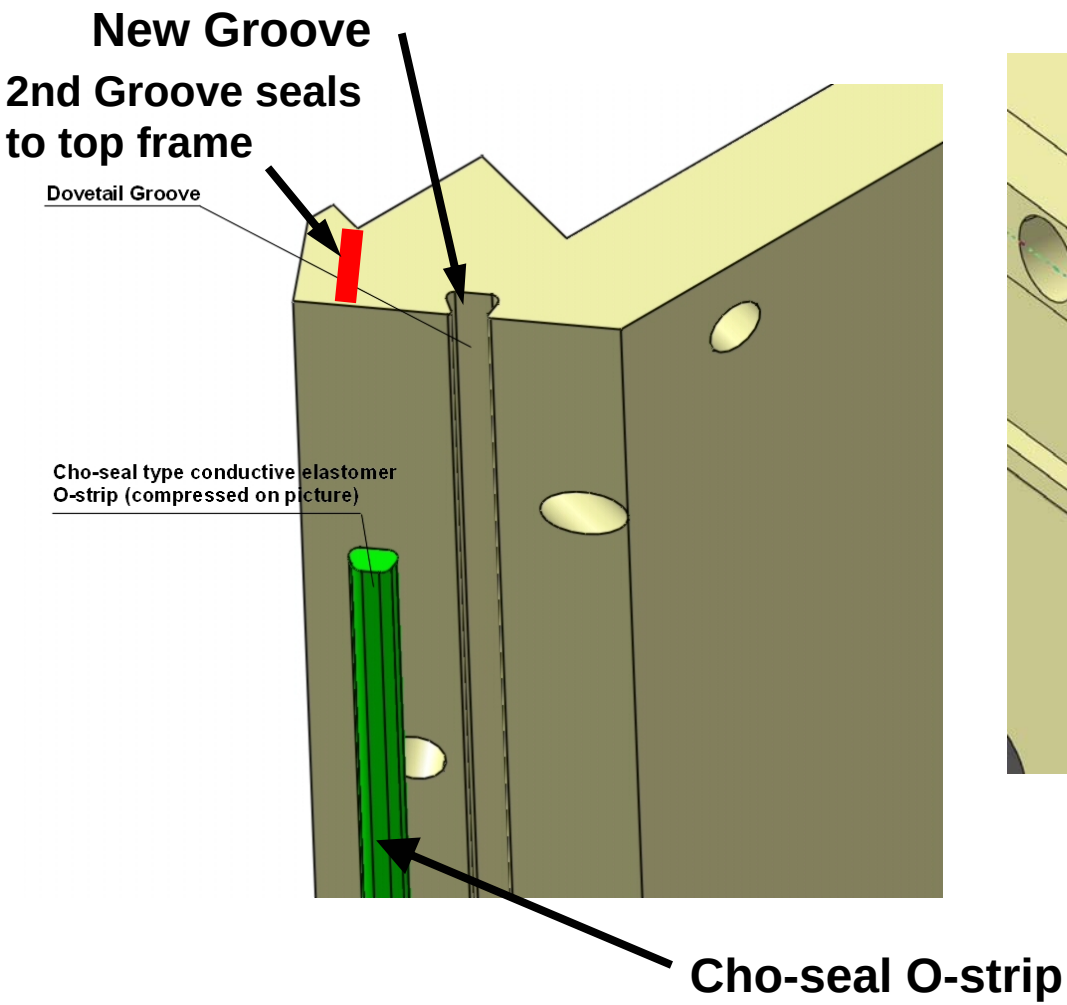
AFEE Card

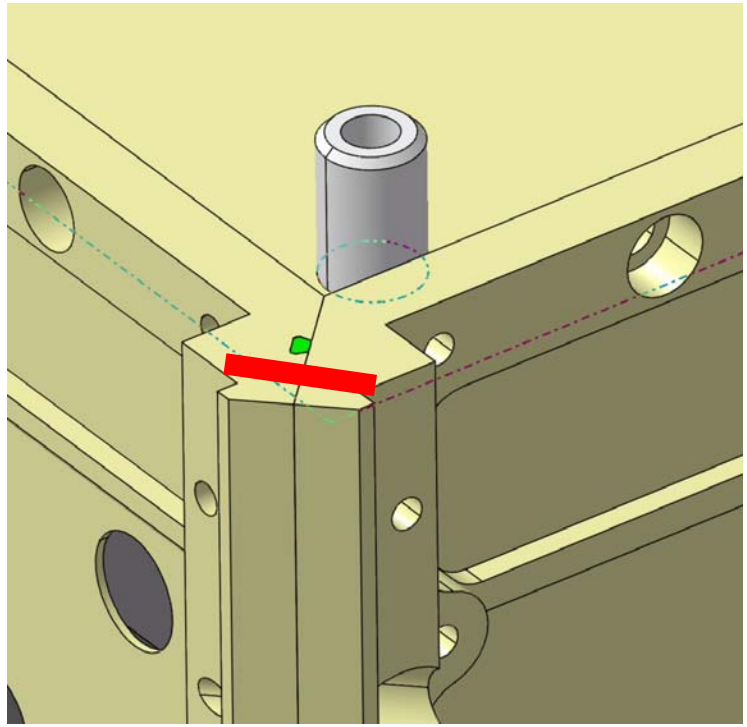
- Added ceramic bypass caps on GCFE digital supply
- Larger ceramic cap on GCRCs
- Split AFEE row group of 12 ADCs into two groups of 6, each group with larger ceramic bypass cap

Side Panel

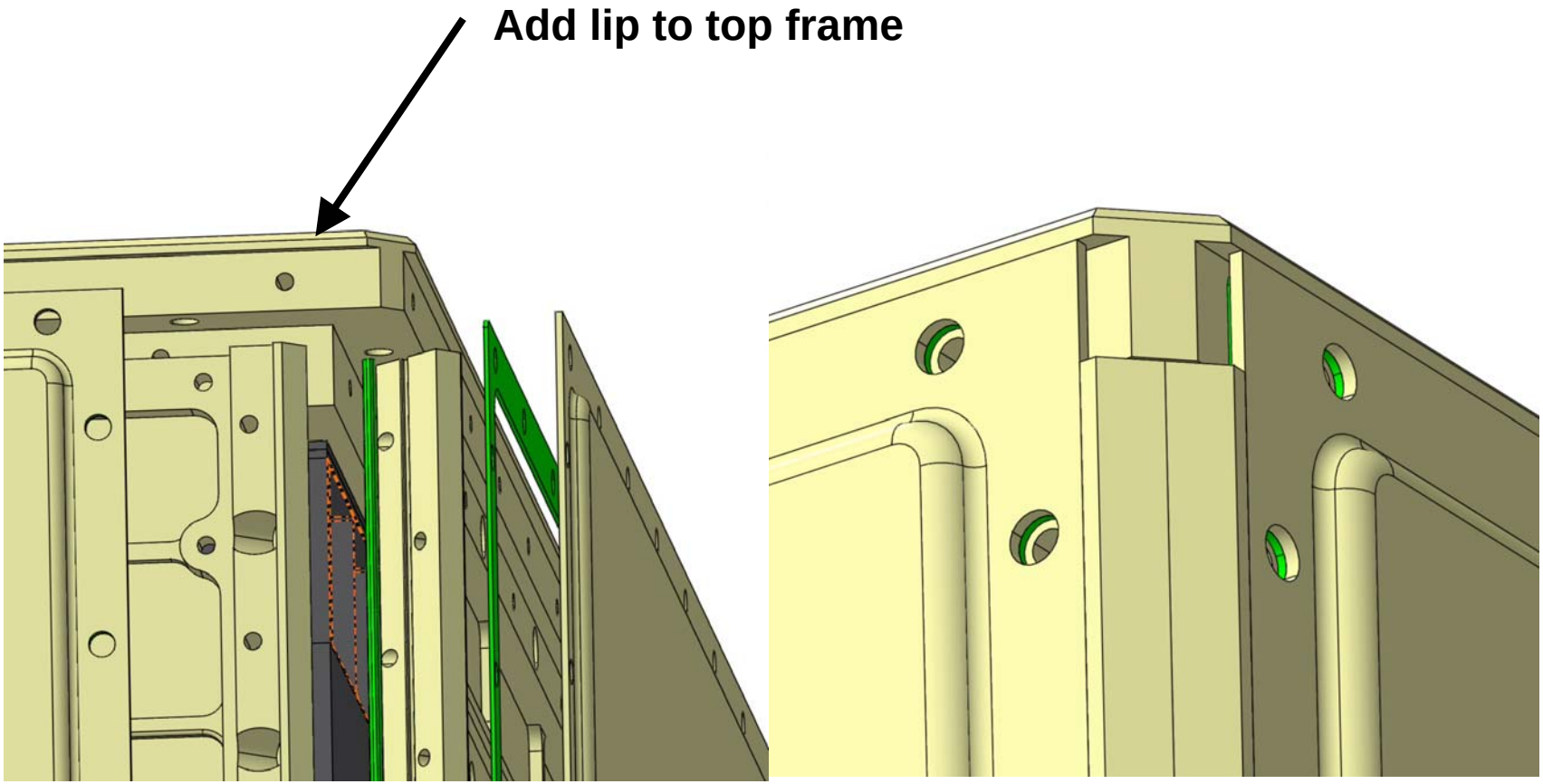

Fasteners x2
Conductive elastomeric seal
Side panel
EMI Gasket
Chomerics Elastomer
0.5 mm thick

Closeout Plates

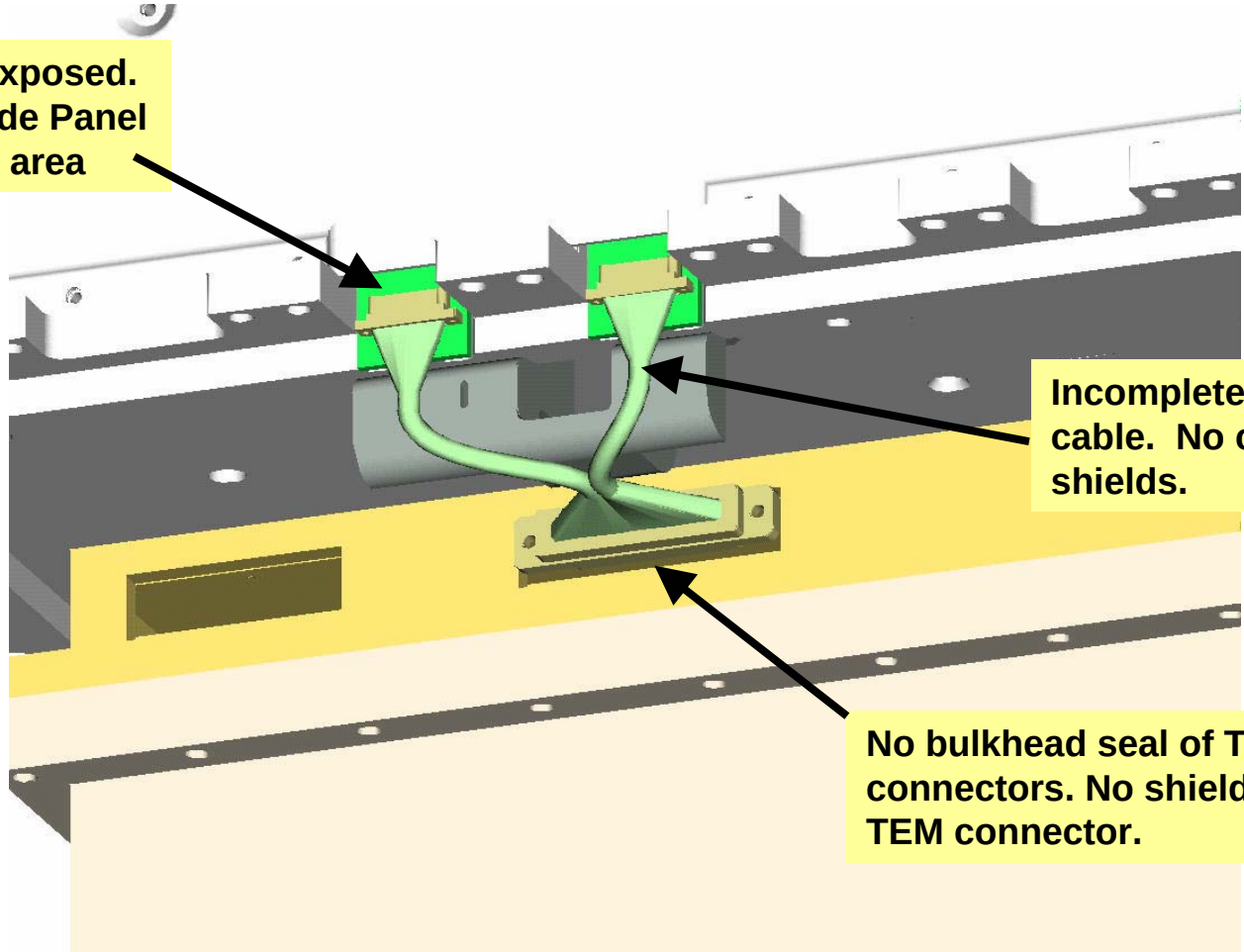




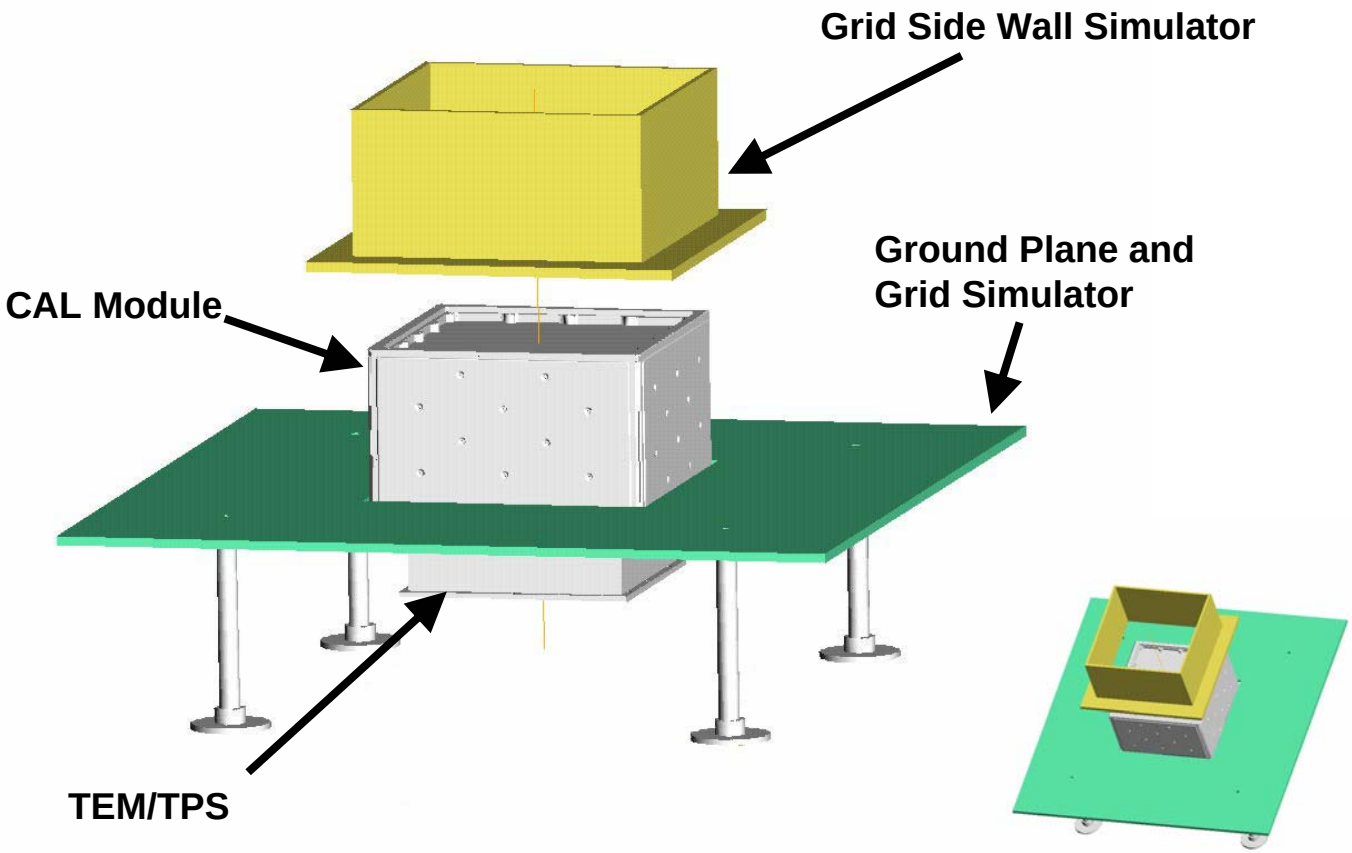
Corner Details



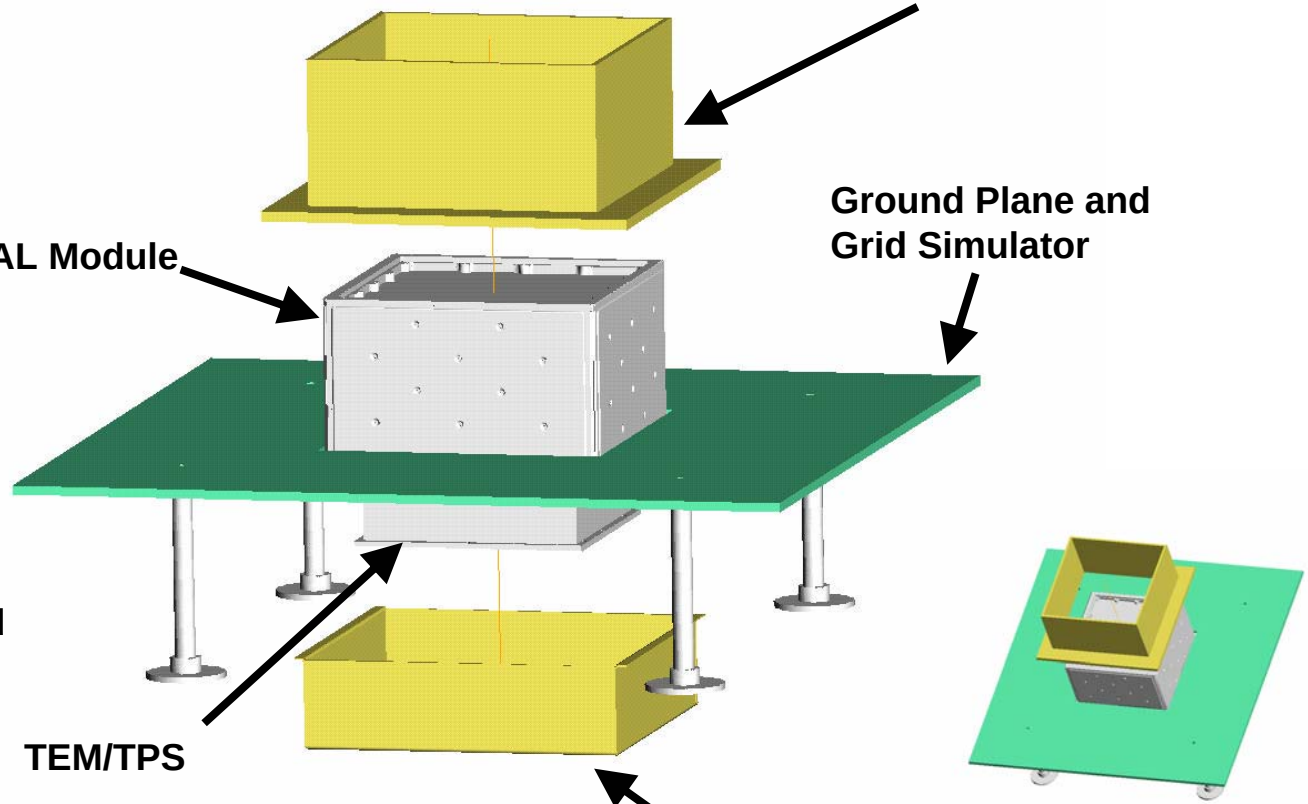
AFEE-TEM Cable Issues



Flight EMI/EMC Test Configuration



Flight EMI/EMC Test Configuration



Copper Sheet ground available from Ground Plane to TPS.

Outstanding Issues

- Shielding of CAL – TEM cable and box attach points.
- Test specification – difficulty in separating CAL and TEM/PS performance issues.
- Test configuration – identification of subsystem configuration which represents LAT environment, shielding, etc.