



# March 2010 FEE Engineering Run at CTIO/Tololo

DARK ENERGY  
SURVEY

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- The original purpose was to have the FEE crate and modules connected to the small dewar and running under the three scenarios:
  - Get the FEE electronics/dewar running on the 1M Telescope during observation hours and fix the noise susceptibility problem.
  - Run the electronics next to the telescope in the Schmidt building. Also, check the AC line and the EM noise environment during observation hours.
  - Run the FEE electronics/dewar in the Blanco 4M building off of the UPS power during observation hours.



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- First, operation (without connection to the dewar) with the modified adapter PCB and with the crate modifications was verified at CTIO.
- Second, after Ricardo's and Rodrigo's return on Wednesday (the 2<sup>nd</sup>), verified the modified Dsub cable pinout. Test the readout with the dewar cold on Thursday...all indications look OK.
- Transported the electronics, dewar, and computer to the Tololo site and mounted the dewar and crate on the 1M telescope on Thursday afternoon

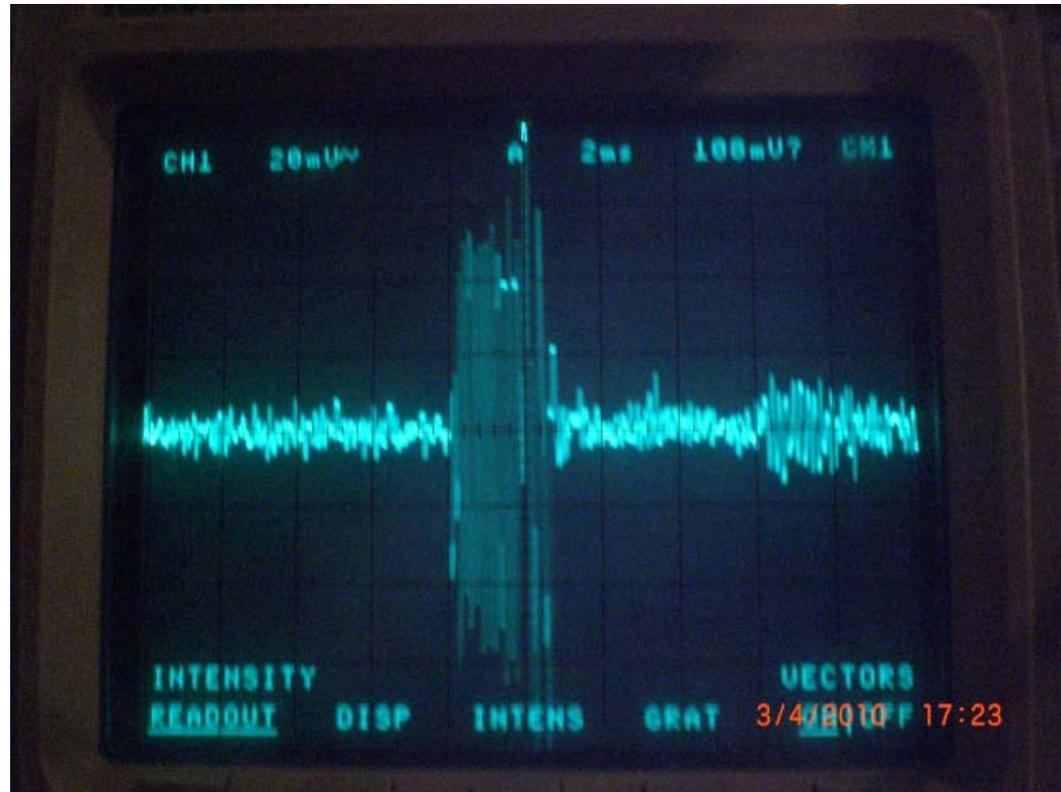


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- The line noise of the UPS outlet, with motor drivers OFF and ON, looked similar to that from last November'09.

CM noise (on GND wire) with MDVRs OFF. Scope triggered on an ESD event while working around the crate. Otherwise, the noise observed is less than 20 mV(p-p).

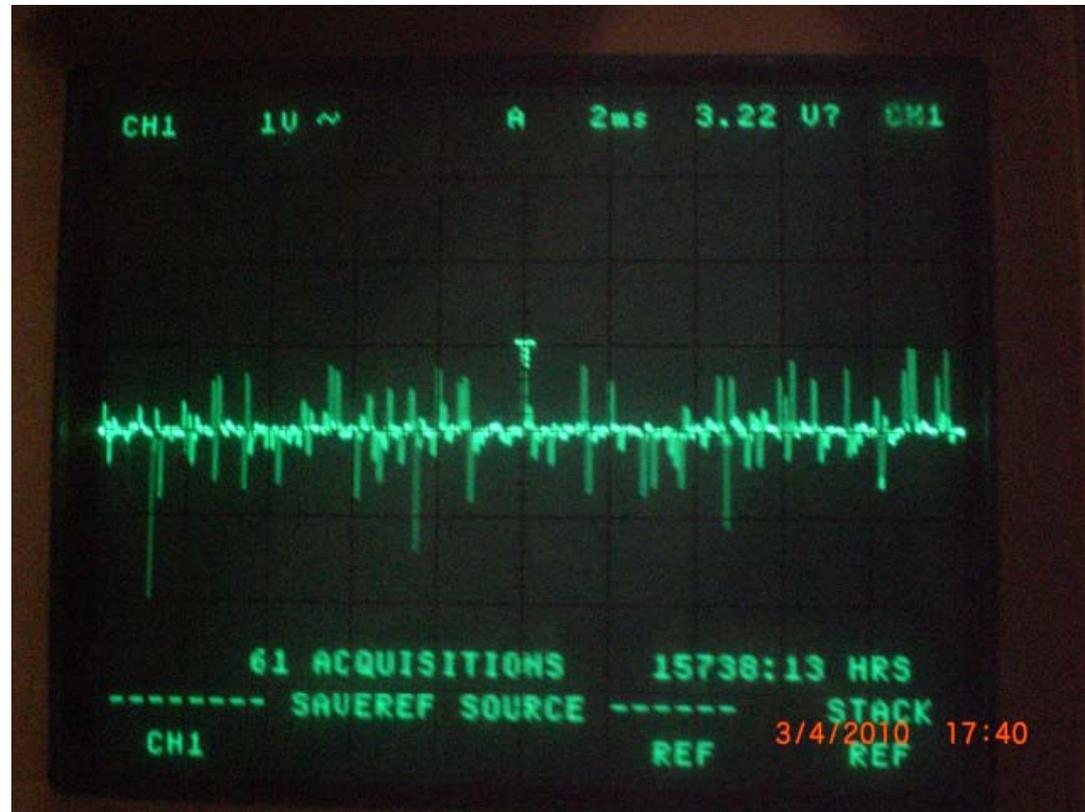




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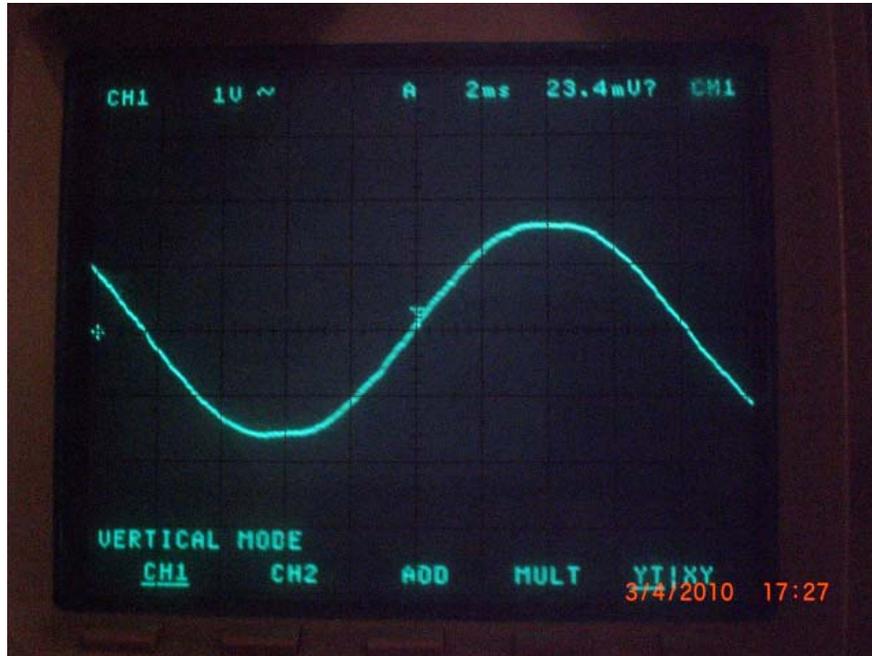
CM noise (on GND wire) with MDVRs ON. Noise observed indicated the familiar spikes in the range of 20-30 V<sub>peak</sub>.



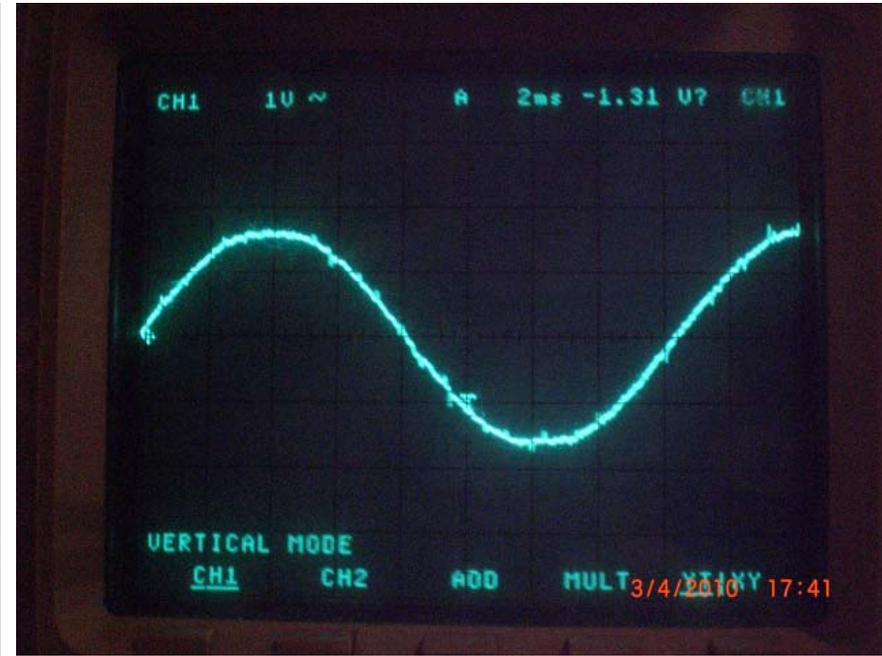


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Line voltage observed with the MDVRs OFF.



Line voltage observed with the MDVRs ON. (Same spikes appeared.)

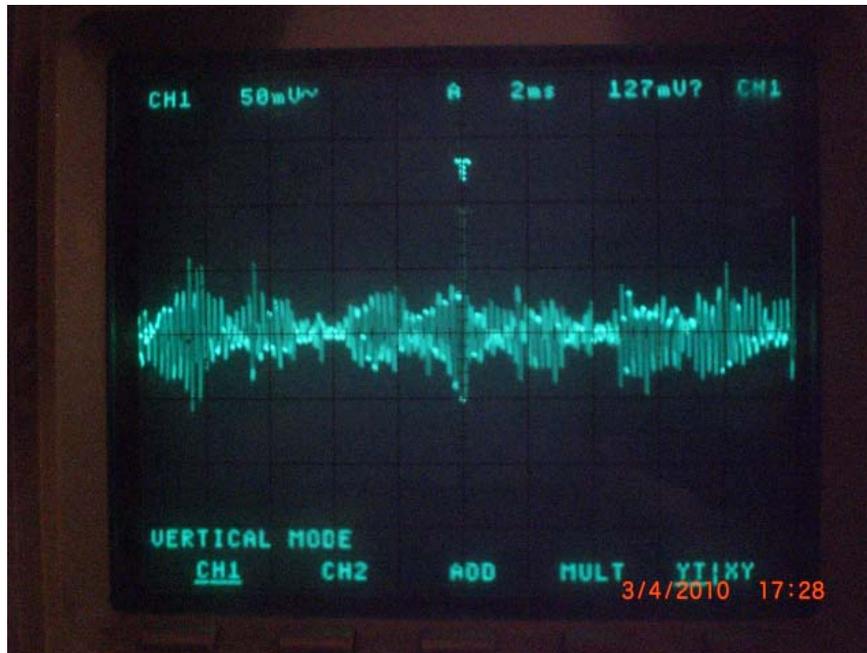


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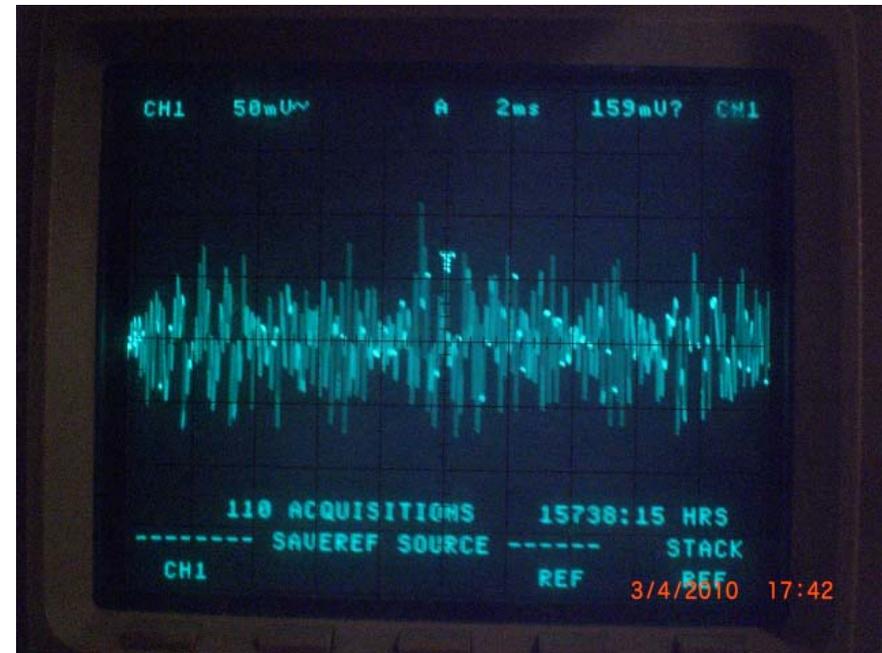
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DM noise (on the neutral wire)  
observed with the MDVRs OFF.



DM noise (on the neutral wire)  
observed with the MDVRs ON.



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- Took initial readouts for noise counts and image examination.
  - With MDVRs OFF, the noise count was 5.9 and 5.1 ADUs. An evaluation of the gain revealed that the ADU to e- gain was around 3. This did not agree with the gain from November '09.
  - With the MDVRs ON, the noise count went to 69.1 and 58.4 and the image had the familiar hash lines in them.
  - These readouts were taken before observation hours (before 21:00).
- Took repeated readouts while changing the braid grounding configurations. These changes only changed the noise counts but they still remained way too high.



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- Observations with the field probes indicated large E-fields but almost no H-fields; again similar to that from November. The shielding then should be working but it was not.
- Next, disconnected the Dsub split cable from the dewar and took readouts with the cable connected/disconnected from the Dsub connector and using grounded or ungrounded inputs.
  - With the Dsub cable disconnected from the Adapter box Dsub connector, the noise count stayed low (between 3 and 6 ADUs). However, these counts were inconsistent and was difficult to discern a pattern.
  - Still, the susceptible area appeared to be the Dsub cable.



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- The next day (Friday and Friday night) the readouts indicated a high noise count but still, after changing the braid and power cord grounding configurations, no pattern could be discerned and no improvement in the noise count could be achieved. Ungrounded power cord definitely made things worse (ADUs >100)
- Checked noise on all bias lines in the cable but there was no difference between them and the video inputs.
  - With the Dsub cable disconnected, the video inputs grounded at the Dsup connector, the noise count was 9.1 and 7.0 (MDVRs ON).
  - Again, the susceptible area appears to be the Dsub cable.



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- On Saturday, returned to CTIO and worked to modify the Dsup cable:
  - Improve the copper shielding on the circular connectors.
  - Added a complete copper shield under the Dsub connector body.
  - Add a 50-ohm resistor in series with the video signal at the circular connector.
  - Shorten the bias/video cable section by half.





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- Returned to the 1M on Monday with the modified Dsub cable. Connected to the dewar, the ADU count with the MDVRs ON was better but still too high: 13.0 – 16.5. The gain was still not right.
- In the process of checking the input resistance to the preamp, it was noticed that the Video(-) lead on the Dsub connector was not connected to GNDA. Further checks determined this to be the case with both channels. Thus, the cable shield for the video signal was floating. There was no return path for the video signal.
- The cause was a cut grounding trace to the preamp's termination resistor that connected it to GNDA.



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- Once repaired and corrected, the Dsub cable was reconnected (but not to the dewar yet) and checked. The ADU counts stayed between 3.9 and 5.7 regardless of how the video inputs were connected (open, grounded, etc.). Also, the hash lines in the image went away.
- Connected the cable to the dewar, the hash lines were not visible in the image but the ADU count was still between 17 and 26. Also, it was important to have the grounding braids properly connected.
- Next, connected a large dual braid to the telescope metal. This brought the ADU count to 12.2 and 16.7. Still no hash lines in the image.



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- Next, mounted a 2-stage inline power filter. This produced a marginally better ADU count to 10.9 and 16.9.
- Took out the 2-stage filter and placed in series with the switched power entry module (PEM), a PEM with an earth choke. This brought the ADU count to 7.1 and 7.3 (MDRVs ON and at about 23:00).
- Verified the gain to be at 1.00 and 1.03. The ADU count for successive readouts stayed between 8.1 and 9.6 for the rest of the night (up to 02:00).
- The CM noise on the line viewer varied a bit but not as much as last November '09. However, the noise count stayed below 9.5.



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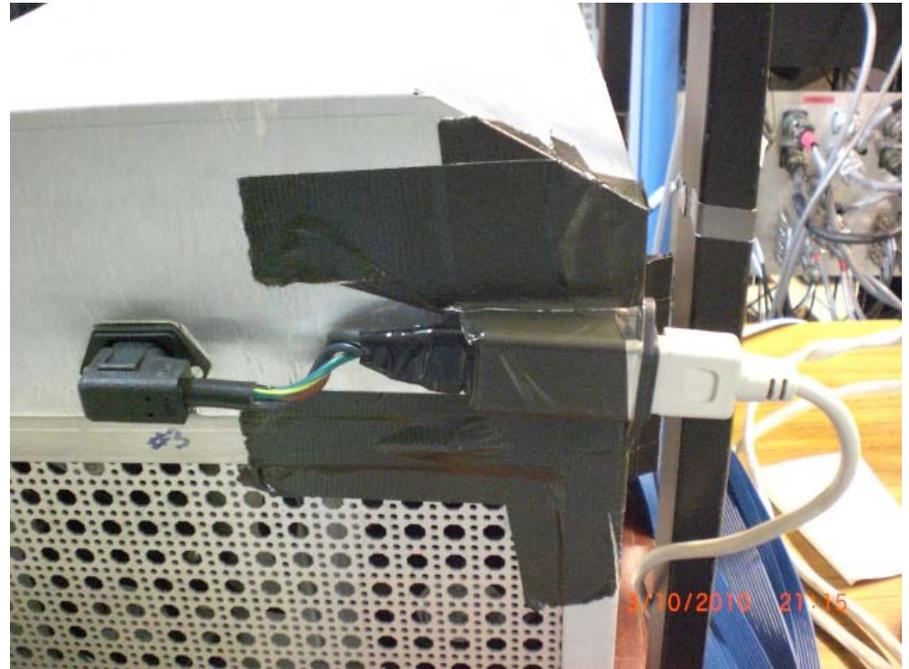
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Create showing braid star grounding point.



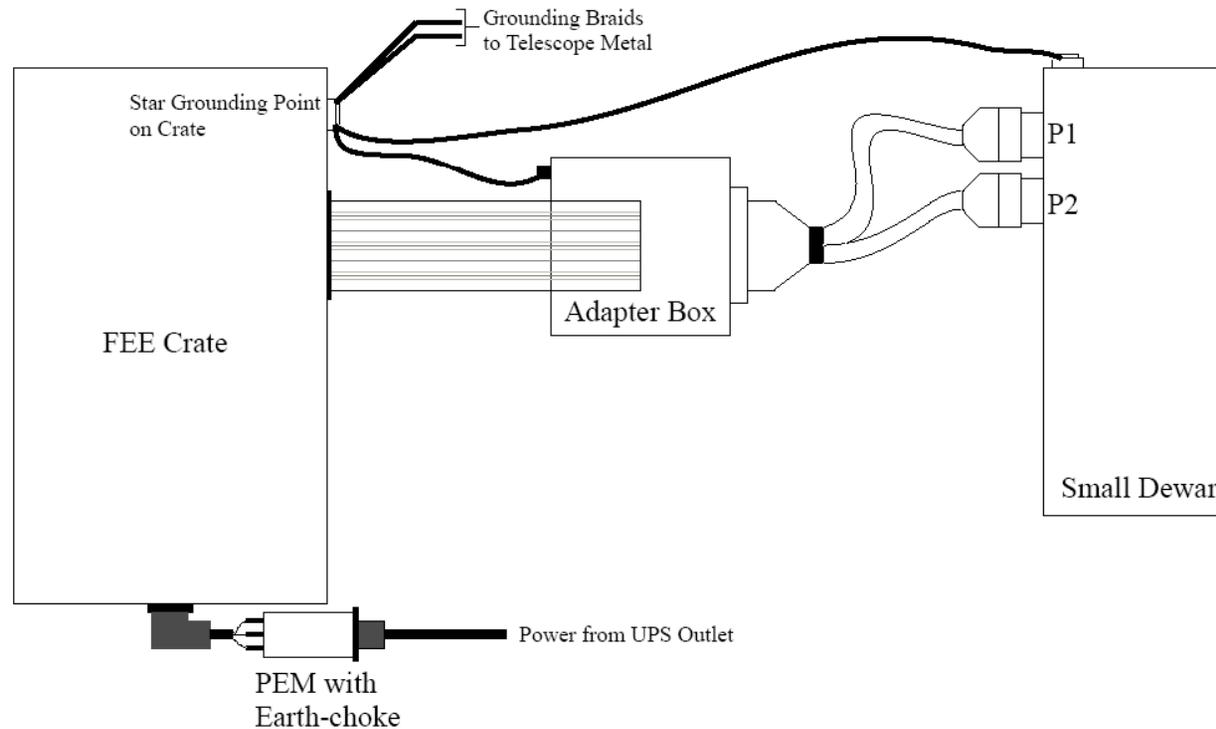
Installation of the PEM with earth-choke.



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## Final FEE Configuration for the 1M Operation



Steve Chappa  
03-17-2010



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- On Tuesday (the 9<sup>th</sup>), moved the FEE electronics/dewar to the Schmidt building next to the telescope.



March 17, 2010



S. J. Chappa



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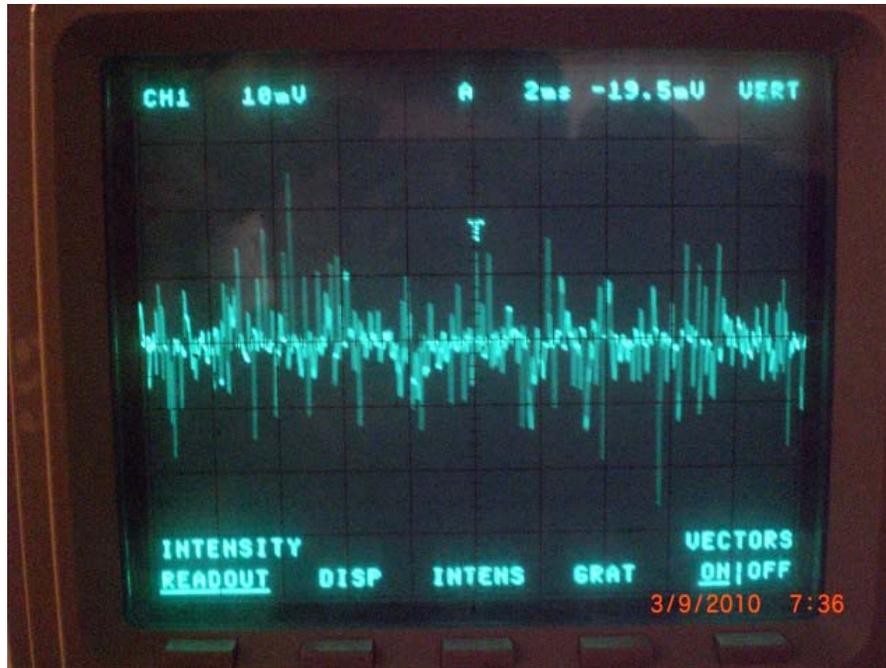
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- Examined the grounding connection from the UPS outlet to the telescope metal. Like the 1M, this looks like a solid connection (less than 0.5 ohms on the DVM).
- Observed the noise on the AC line using the line viewer.
  - The CM noise had peaks of only 250 mV.
  - The CM noise waveform did not noticeably change when the telescope's motor drivers were turned ON.
  - Observed the CM noise during operation of the telescope's positioning motors. Again, no noticeable change observed.
  - The DM noise waveform did change a bit but this change was not correlated with any operation of the telescope.
  - The line voltage waveform looked clean, no distortions with motor drivers ON or OFF.



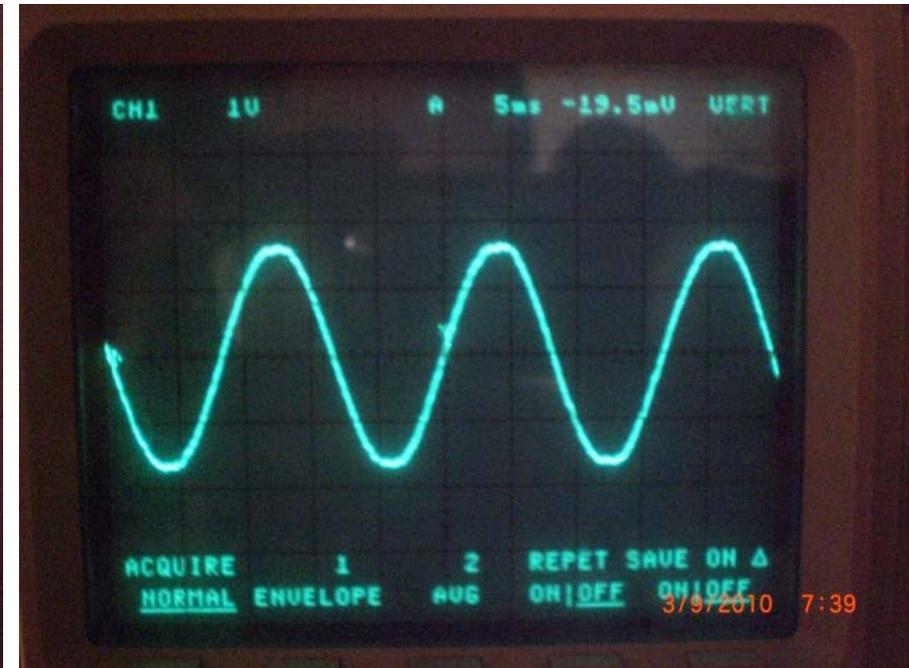
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CM noise viewed with the Schmidt MDVRs ON. The waveform pattern looked similar to that seen at the 1M. This did not change during the night or during observation hours.

March 17, 2010



Line voltage waveform, from the UPS outlet on the telescope, viewed with the Schmidt MDVRs ON. Stayed clean throughout the observation period.

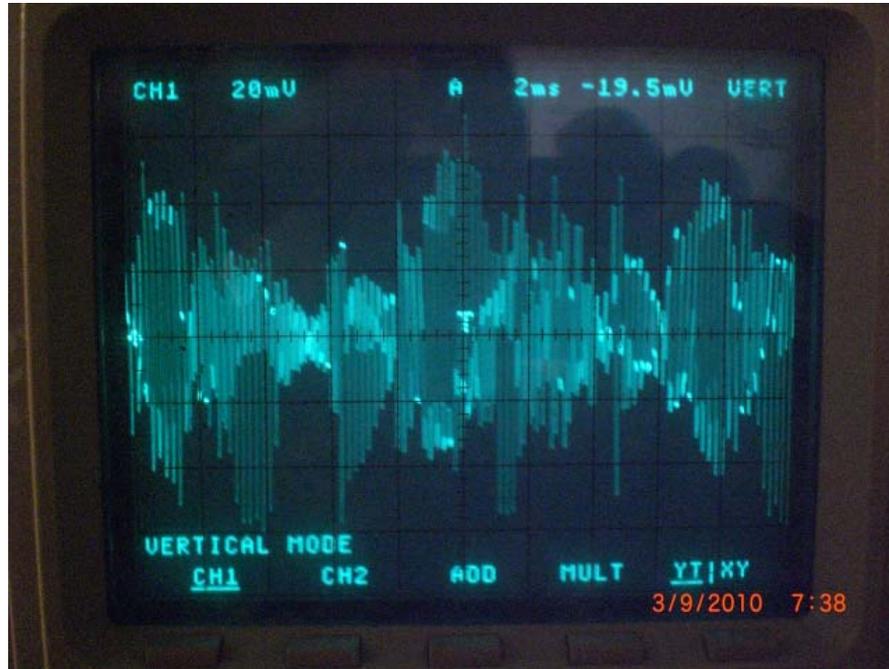
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DM noise viewed with the Schmidt MDVRs ON. The waveform patterns changed while these pictures were taken. Sometimes, the waveform would go flat. However, no large peaks were observed.



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- Using the same setup configuration (ground braids, PEMs, etc.), connected up the dewar and took several readouts at about 11:57. The noise counts were between 6.7 and 7.3. Readout image was very clean; no detectable hash lines or banding.
- Observed small E-fields in the 60 Hz range, using the plate and ball probes. Did not see any detectable H-fields.
- Conducted readouts from 12:40 to 00:15. All readout counts stayed between 6.4 and 7.4.
  - During some of these readouts, changed/disconnected the braid grounding. This made no change in the readout counts.



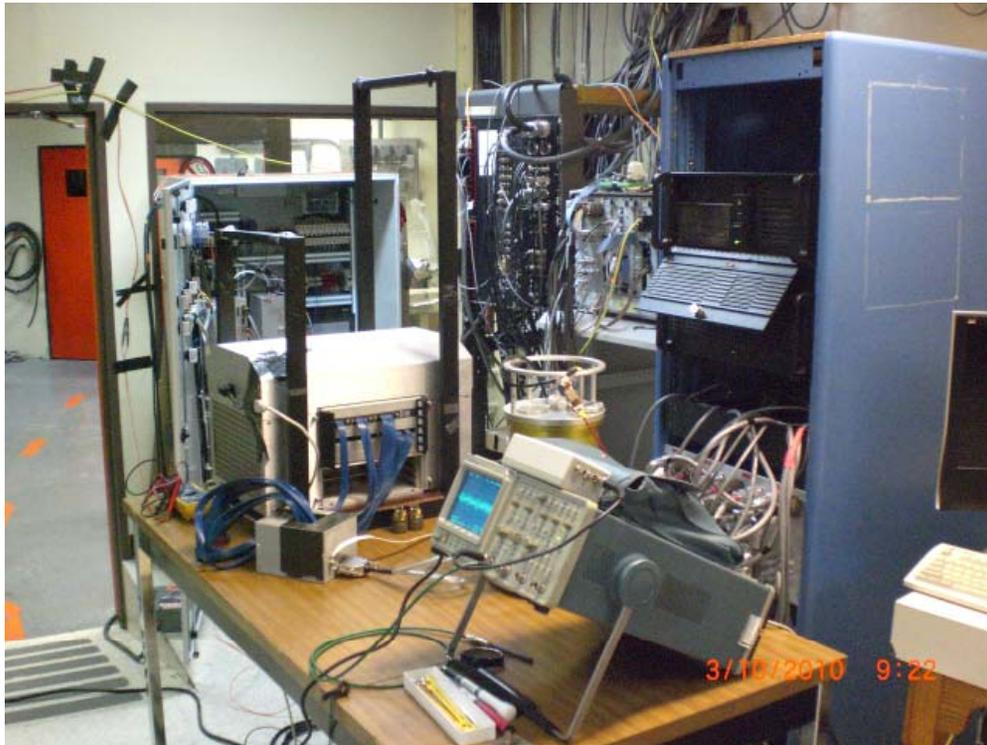
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- On Wednesday (the 10<sup>th</sup>), moved the FEE electronics and dewar to the Blanco building on the P-floor in a room next to all the motor driver gear, switching and microwave gear.



March 17, 2010

S. J. Chappa

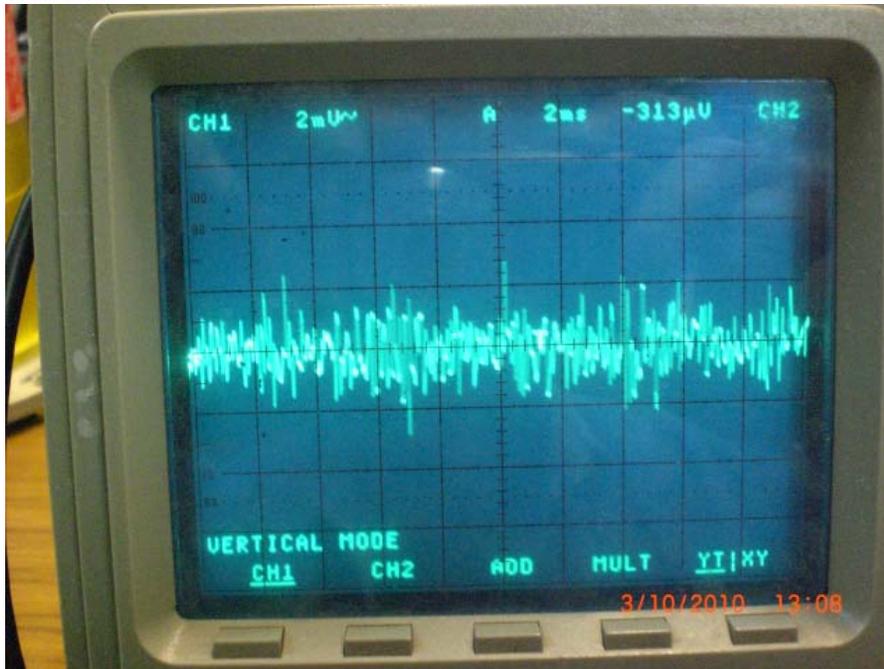


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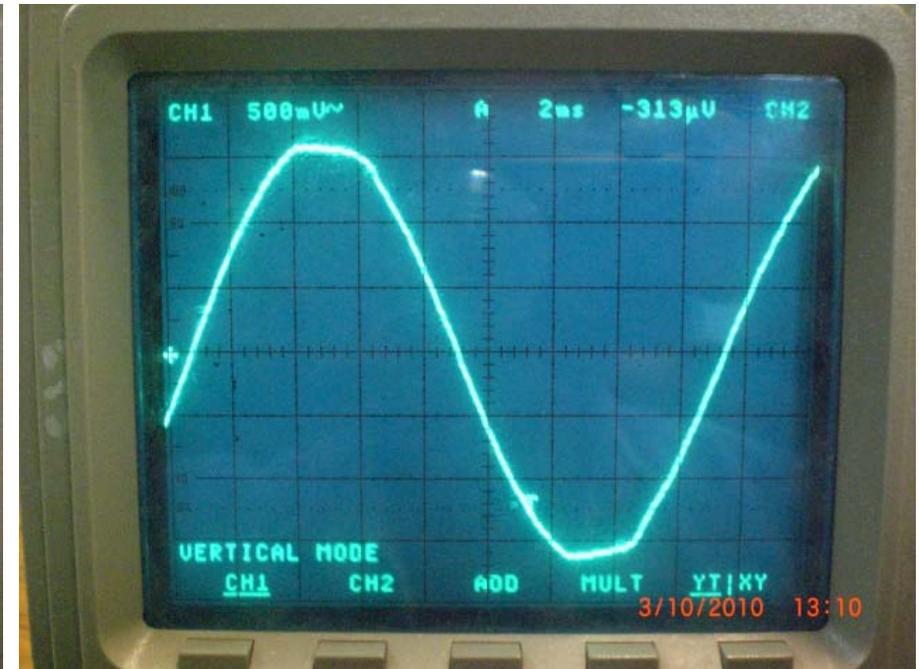


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CM noise viewed in the Blanco 4M. The peaks were less than 30 mV. This did not change when the MDVRs were switched ON or when the telescope motors were running.



Line voltage waveform from the UPS outlet in the Blanco 4M building. Stayed the same throughout the observation period (MDVRs ON or OFF).

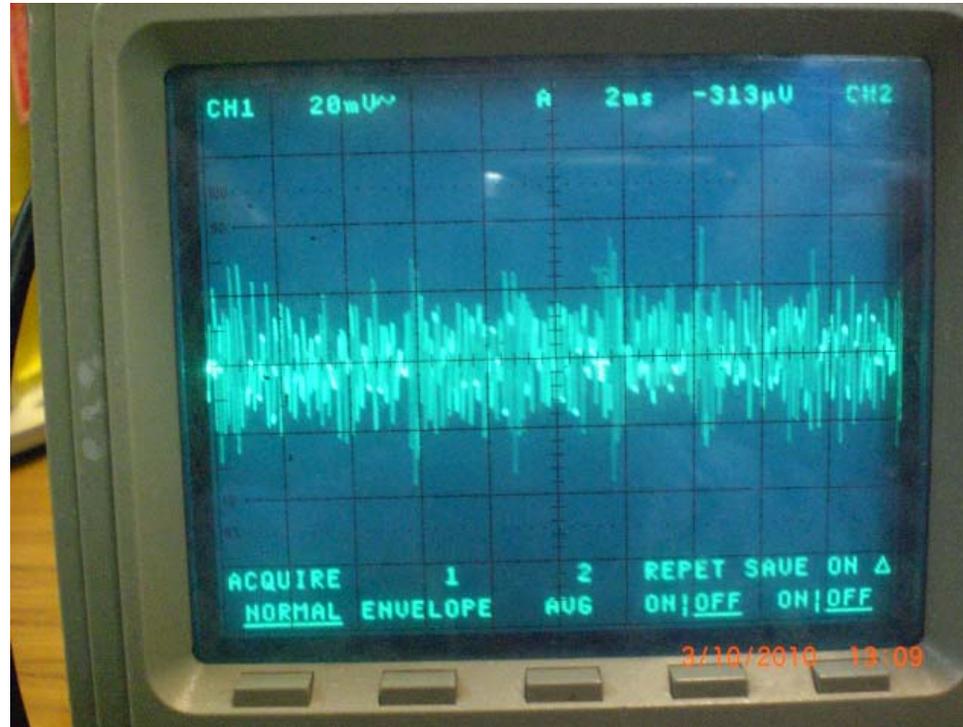


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DM noise viewed in the Blanco 4M building. The waveform also did not change throughout the observation period.



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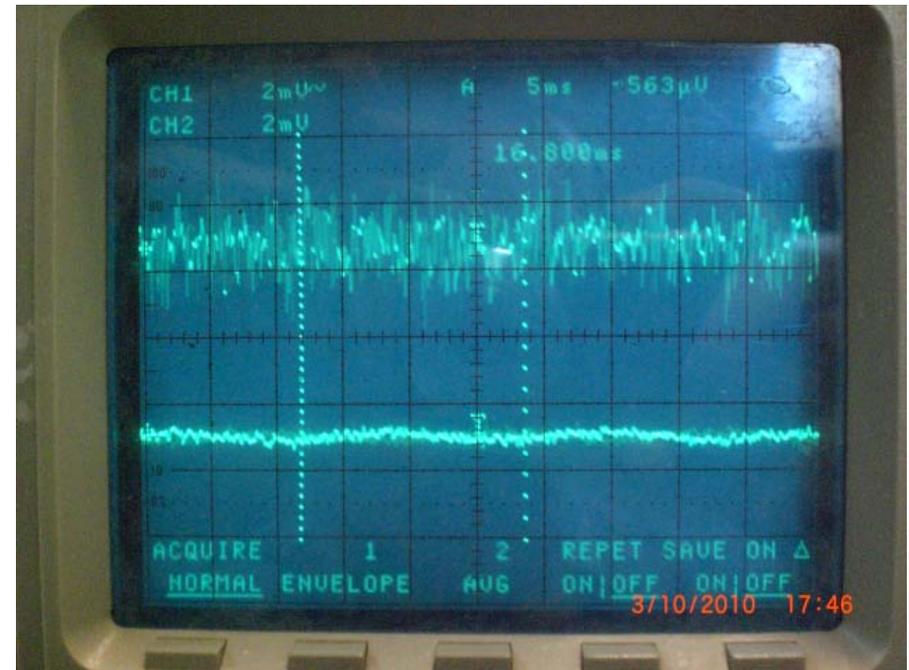
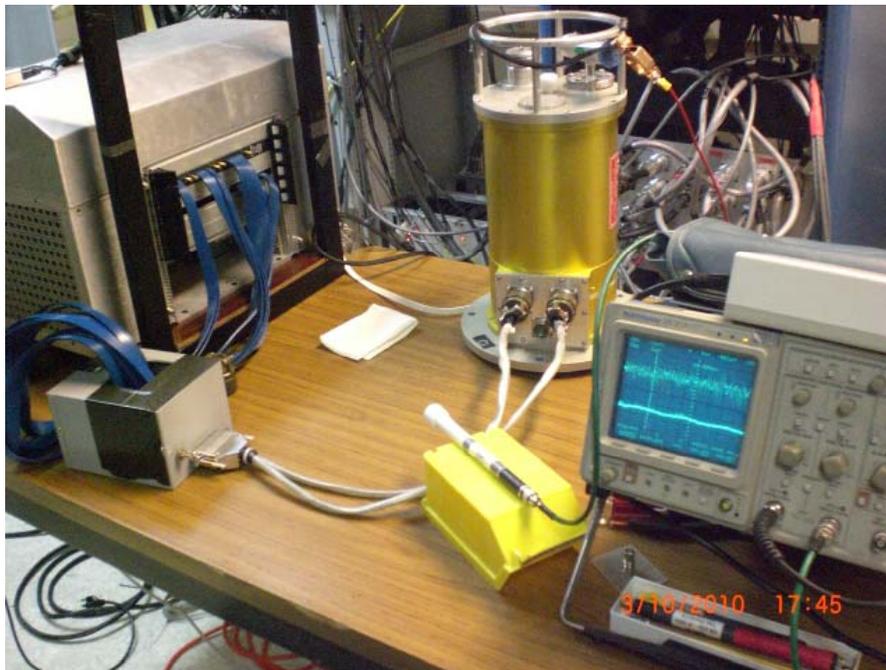
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- Using the same setup configuration (ground braids, PEMs, etc.) as that used in the Schmidt building, connected up the dewar and took several readouts at about 11:57. The noise counts were between 6.7 and 7.1. Readout image was very clean; no detectable hash lines or banding.
- Changed the setup to eliminate the ground braids, removed the PEM with E-choke, install the original unshielded Dsub cable. The noise counts stayed between 6.61 and 6.94. Image stayed clean with no detectable hash lines or banding.



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Checked the CM noise on the line viewer and used an E-field probe to check for fields during the observation. Did not observe any large noise waveforms.



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- Swapped out the V2 ACQ transition card and inserted the V3 ACQ transition card. Readout noise count remained unchanged. At about 22:50, (Wednesday night) ran a series of readouts at 10 minute intervals and the count stayed between 6.56 and 7.01.
- Recharged the dewar with LN2 and initiated a series of readouts to last through the night. Came back at 08:00 the next morning and the dewar was warm. Apparently, the LN2 recharge was insufficient. The readout count stayed low until about 01:15 and then it increased dramatically (100s of counts). Recharged the dewar (properly this time), let it cool and the readout count returned to 6.63 – 6.84.



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- **Conclusions:**
  - The shielding repairs on the adapter PCB did its job. Cutting the trace while installing the shielding created an equally different problem. The result was no apparent change in performance.
  - Check the obvious. Then check it again. Difficulty caused by poor PCB layout practice and an incorrect assumption about the LEMO connector's connection to GNDA.
  - The noise on the AC line and the EM fields in the Schmidt building presented no problems to the readout and it was significantly less than the 1M. The PreCam installation should be OK (famous last words).
  - Likewise, the AC line noise in the Blanco building presented no EMC problems for the readout. The UPS power in this building stayed “clean” throughout the night, even in the “noisiest” room in the Blanco building.