FNAL Engineering Note

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Project: MicroBooNE

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Subject: Faraday Cage Tests with Newport Flash Lamp

Test equipment:
2 channel purity monitor electronics NIM module, serial # 11
NIM Bin with power supply
Tektronix TDS5054B oscilloscope
5 foot RG180 purity monitor cable assembly
Newport Oriel Xe Flash Lamp power supply Model 68826
Newport Oriel Flash Lamp assembly Model #60000 with large Xe bulb #6427
Fermi built Aluminum Faraday cage with isolated AC power source

Test conditions:
The flash lamp assembly is set on top of flash lamp power supply approximately four feet away from NIM bin and scope. The flash lamp power supply was set for a repetition rate of one second and an energy level of 1000 mJ. Initial testing indicated that the radiated noise detected by the PM electronics appeared to be the same at 1000 mJ up to 5000 mJ (maximum setting of flash lamp power supply).

The purity monitor cable assembly is connected to purity monitor (PM) electronics module in standard fashion with the free end of the SHV cable shields connected together and clipped to the 6-foot steel shelving unit of a workbench. This was done to simulate PM signal cables connected to a signal feed through on a cryostat.

When the flash lamp was operated outside of the Faraday cage the scope was triggered by the level of the signal on channel two of the scope (recorded trace). Channel two of the scope was connected to channel two of the PM electronics module. It was observed during the tests that the signal present on channel one of the PM electronics module was identical to channel two for all tests. When the flash lamp was operated inside the Faraday cage, the oscilloscope was triggered by a shielded inductive pickup coil attached to the flash lamp power supply HV cable. This manner of scope triggering is the standard used for LAr purity monitor measurements.

When the flash lamp was operating inside the Faraday cage all 10 clamps on the lid where secured and the front panel access door was closed and secured. A shielded AC line cord was used with the Faraday cage. Separate AC circuits were used for power for the NIM bin, scope and the flash lamp power supply whether operated inside or outside of the Faraday cage.

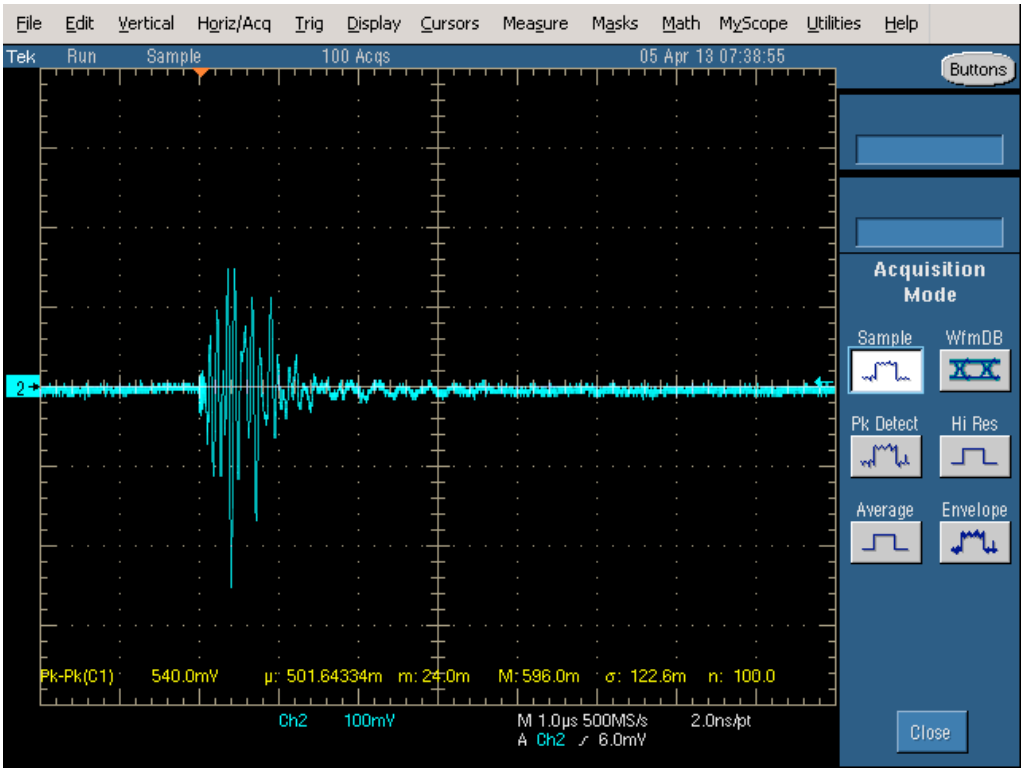

Figure 1. Inputs open, flash lamp out of Faraday Cage, no averages, vertical = 100 mV/major div., horizontal = 1 uSec/major div.

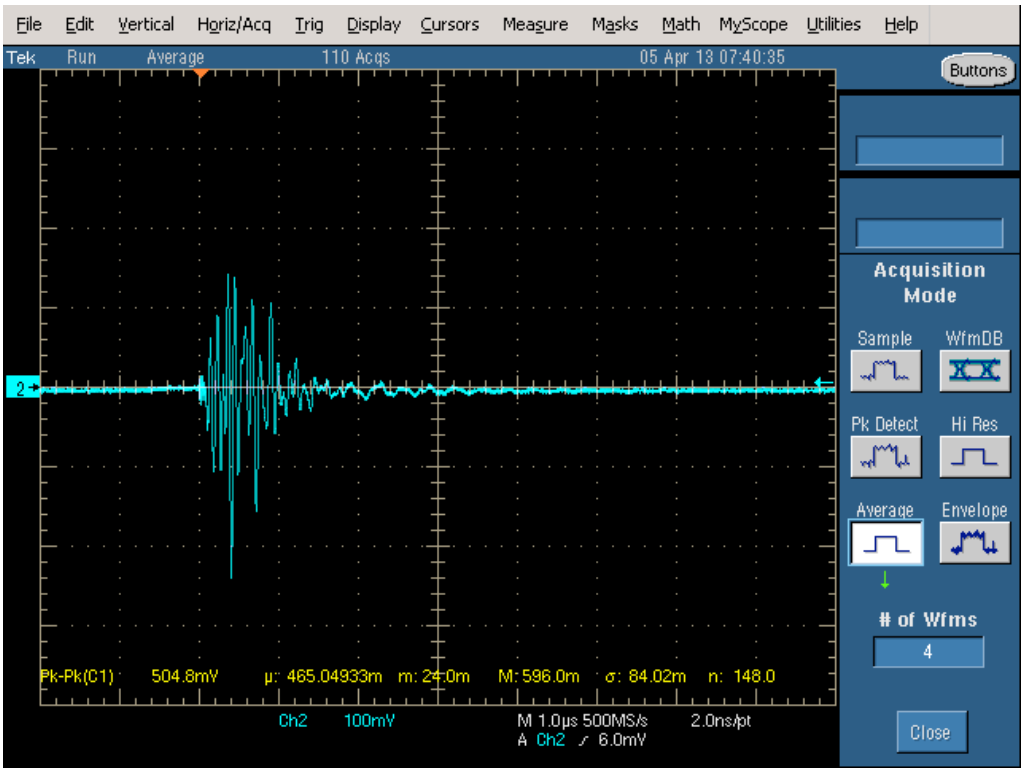

Figure 2. Inputs open, flash lamp out of Faraday Cage, 4 averages, vertical = 100 mV/major div., horizontal = 1 uSec/major div.

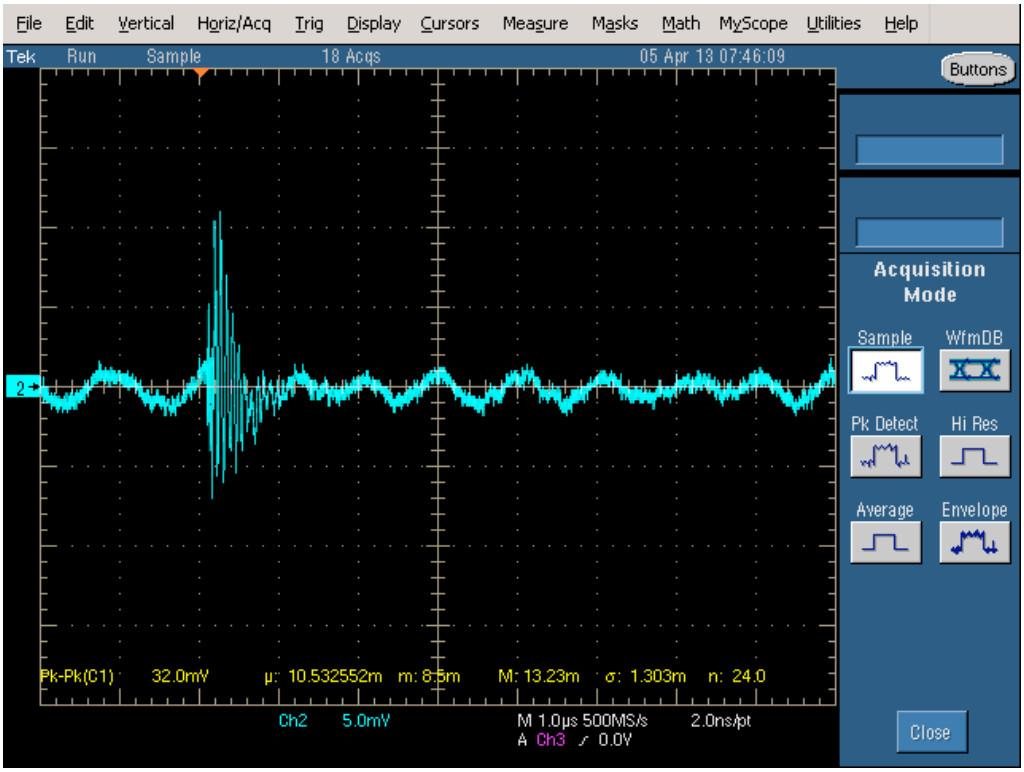

Figure 3. Inputs open, flash lamp in Faraday Cage, no averages, vertical = 5 mV/major div., horizontal = 1 uSec/major div.

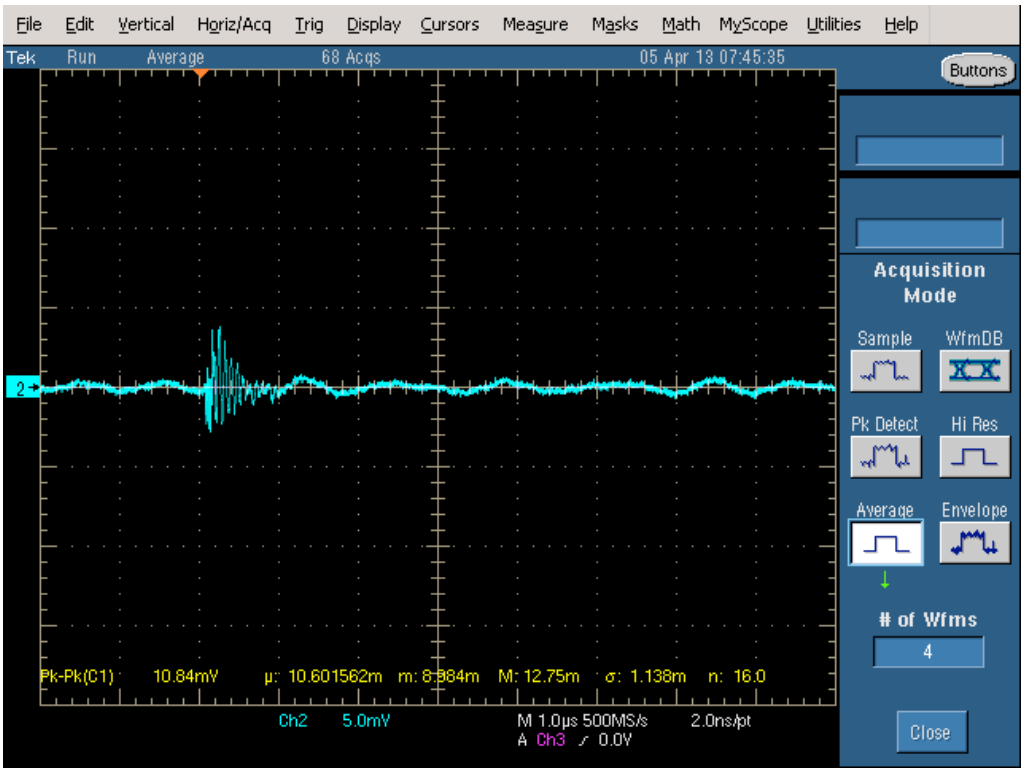

Figure 4. Inputs open, flash lamp in Faraday Cage, 4 averages, vertical = 5 mV/major div., horizontal = 1 uSec/major div.

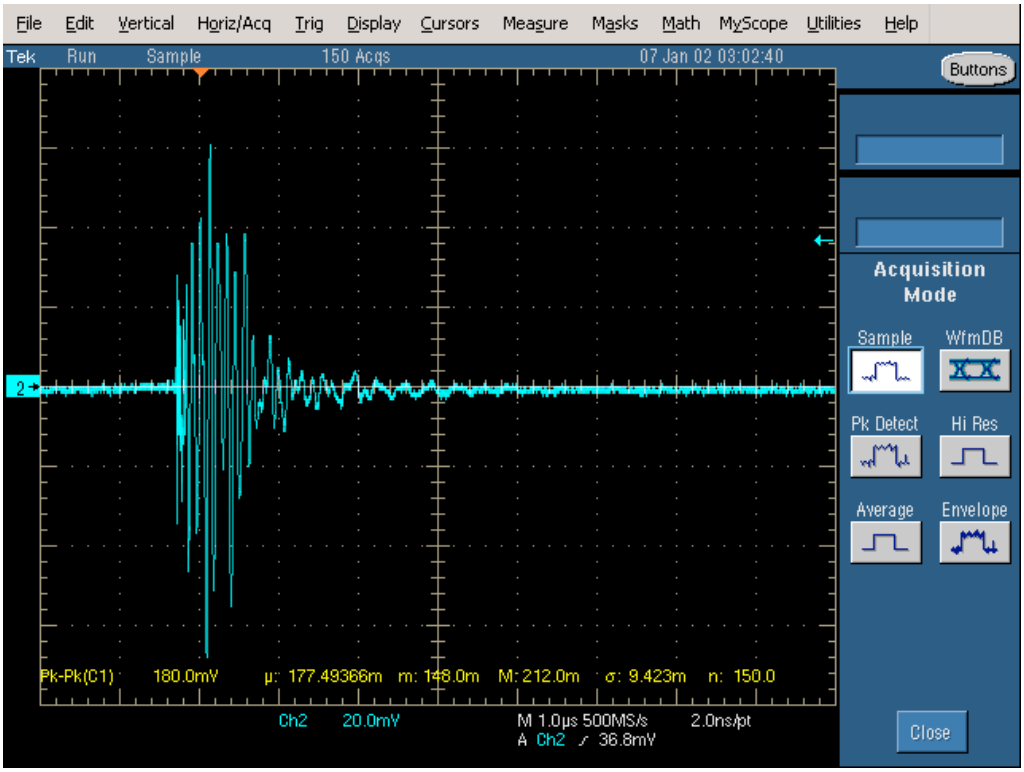

Figure 5. Inputs grounded, flash lamp in open, no averages, vertical = 20 mV/major div., horizontal = 1 uSec/major div.

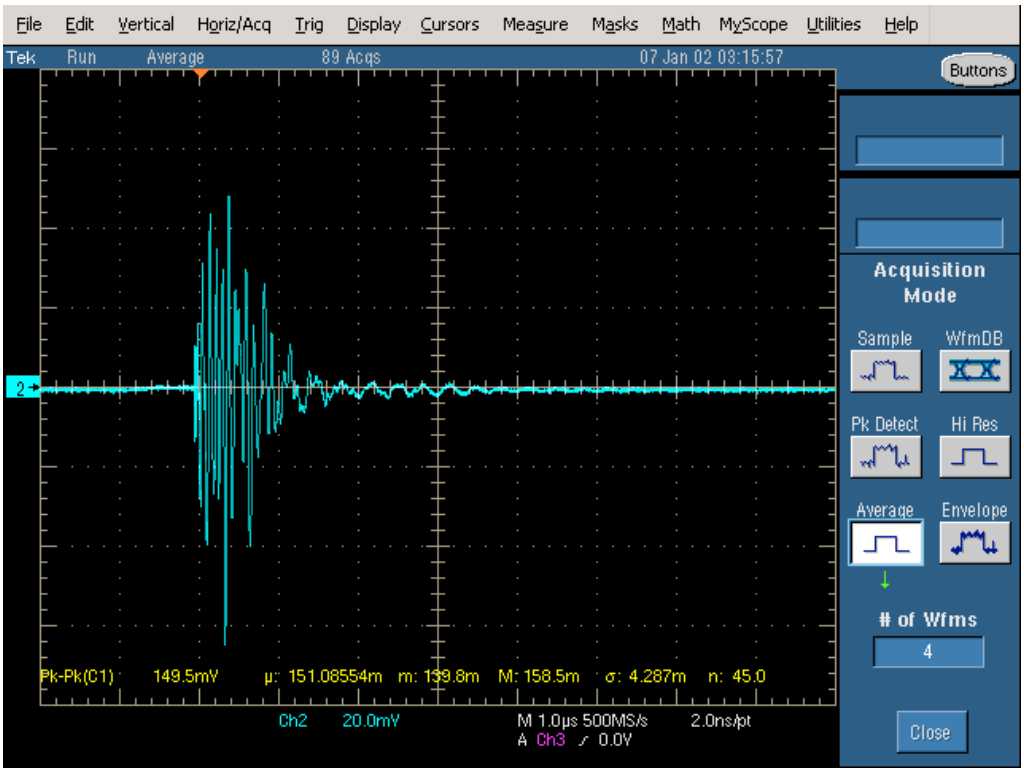

Figure 6. Inputs grounded, flash lamp in open, 4 averages, vertical = 20 mV/major div., horizontal = 1 uSec/major div.

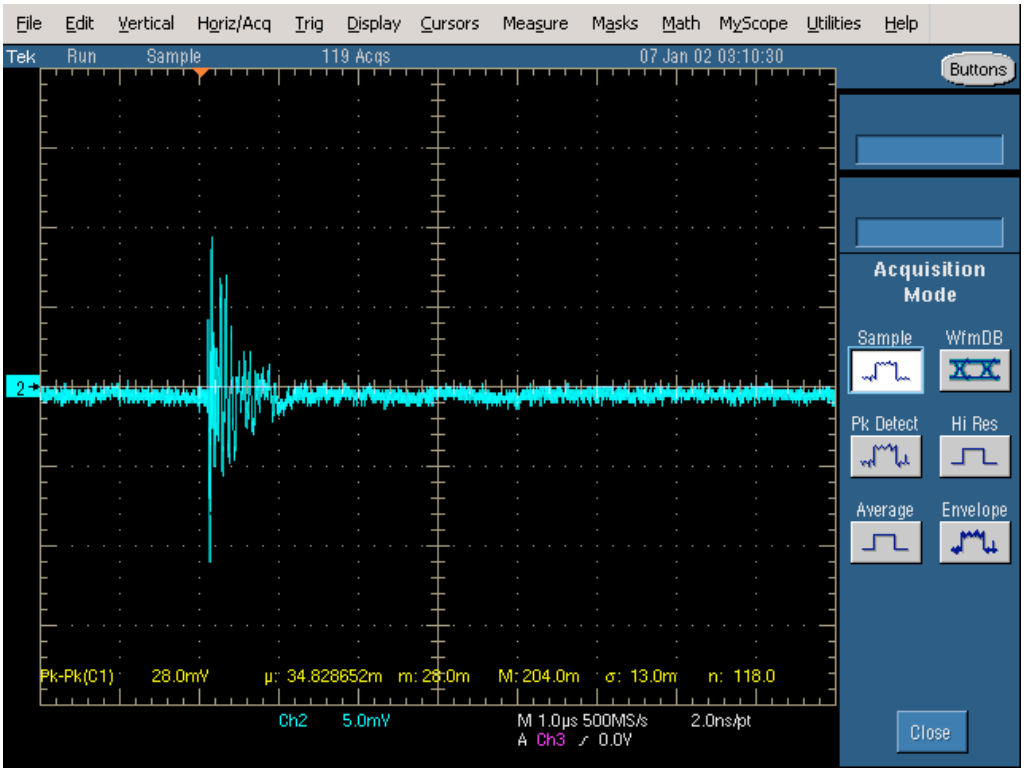

Figure 7. Inputs grounded, flash lamp in Faraday Cage, no averages, vertical = 5 mV/major div., horizontal = 1 uSec/major div.

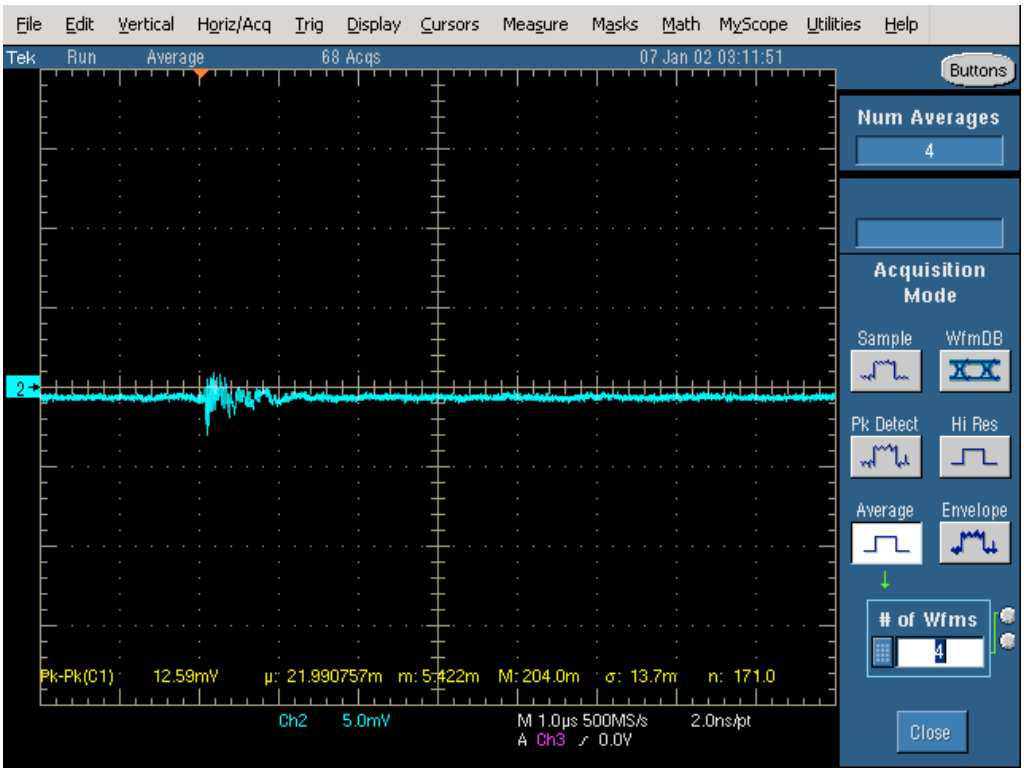

Figure 8. Inputs grounded, flash lamp in Faraday Cage, 4 averages, vertical = 5 mV/major div., horizontal = 1 uSec/major div.

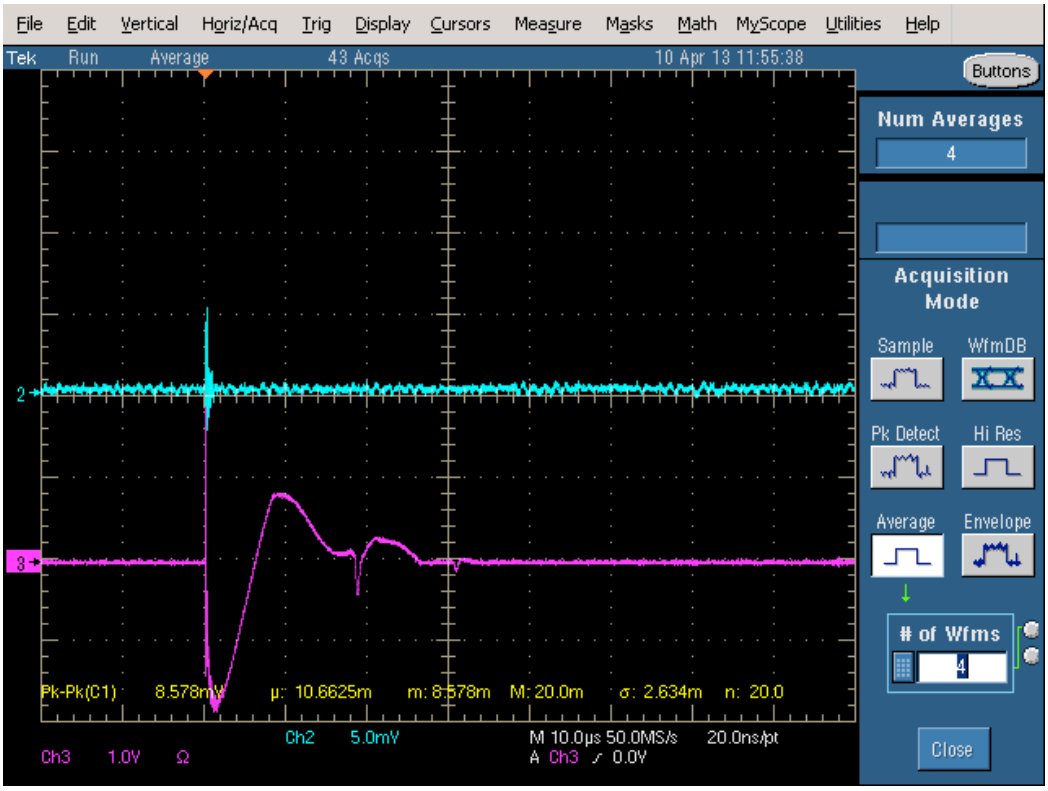

Figure 9. Scope channel 2 - PM electronics output signal, flash lamp in Faraday cage, 4 averages, vertical = 5 mV/major div., horizontal = 10 uSec/major div.
Scope channel 3 - inductive pickup coil signal (50 Ohm term.) used for scope trigger, 4 averages, vertical = 1.0 V/major div., horizontal = 10 uSec/major div.

Observations:

Fig.1 and 2 show the output of the PM electronics module with the flash lamp and power supply operated in the open about 4 feet away from the electronics. Averaging did not make a difference in the observed output noise.

Fig.3 and 4 shows the output of the PM electronics with the flash lamp and power supply operated in the Faraday Cage. Fig.3 is a one-shot captured event that shows a factor of 20 reduction in the peak voltage, Fig.4 with four averages show an addition factor of 62 reduction in the peak voltage.

In Fig.5 and 6 the flash lamp and it's power supply is outside the Faraday Cage. All the input to the PM electronics module are grounded at the module. The peak amplitudes in Fig.5 and 6 are the same but Fig.6 with four averages seems to show less total energy in the ringing.

Conclusions:

It appears that the noise signal observed on the output of the PM charge amplifier electronics appears to be due to the HV trigger of the flash lamp tube and not the discharge current through the flash lamp tube. The discharge current of the flash lamp after the arc has been initiated can be seen in Figure 9, channel 3 as a 66 KHz signal.

The reduction in the noise from flash lamp by use of the Faraday Cage appears to be greater the a factor of 60 (~ -36dB). The flash lamp assembly used was one the had numerous small upgrades in an attempt to reduce the electrical noise. These were on the order of better electrical bonding, common mode inductors and cable shielding.

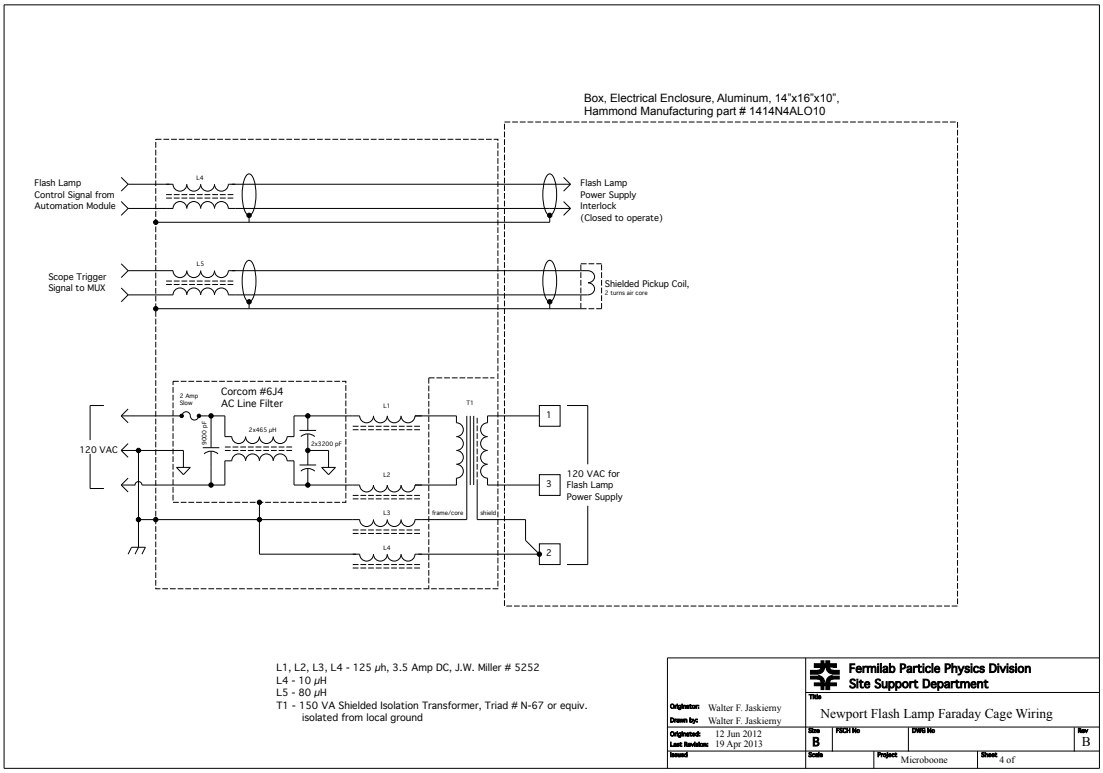

Figure 10. Schematic of Faraday Cage and attached "dog house". Component values for L4 and L5 may vary in future applications.

Figure 11. "Dog House" on back of Faraday Cage

Figure 12. Flash Lamp power supply access door

Figure 13. Access door open


Figure 14. Interior details

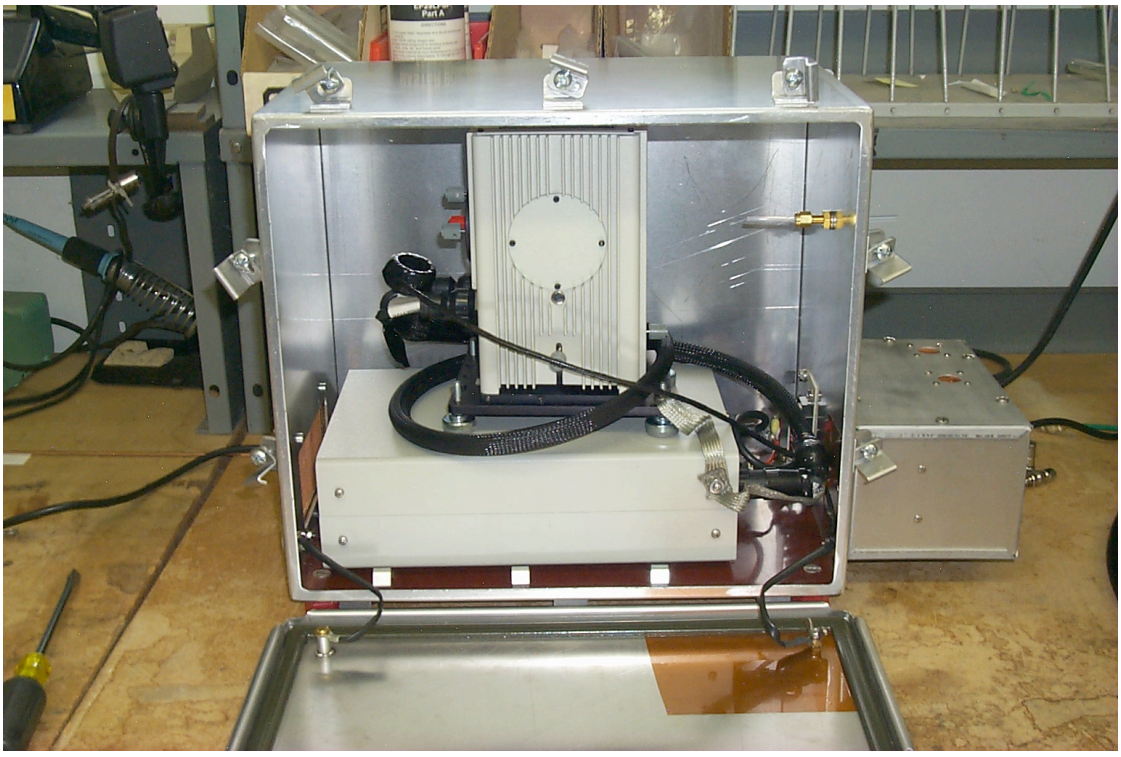
Figure 15. Flash Lamp assembly and power supply in Faraday cage