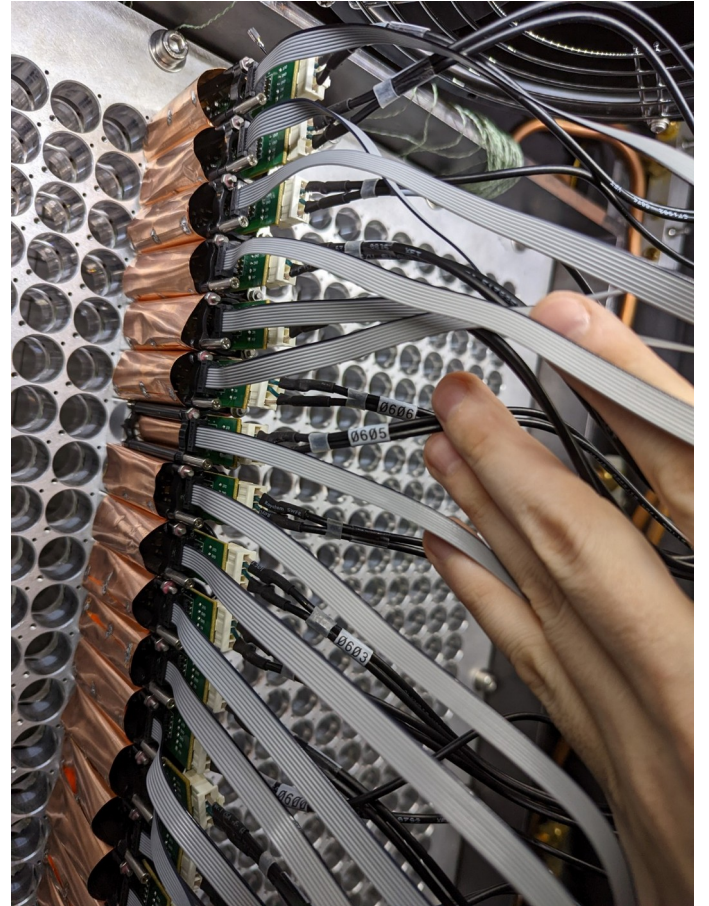
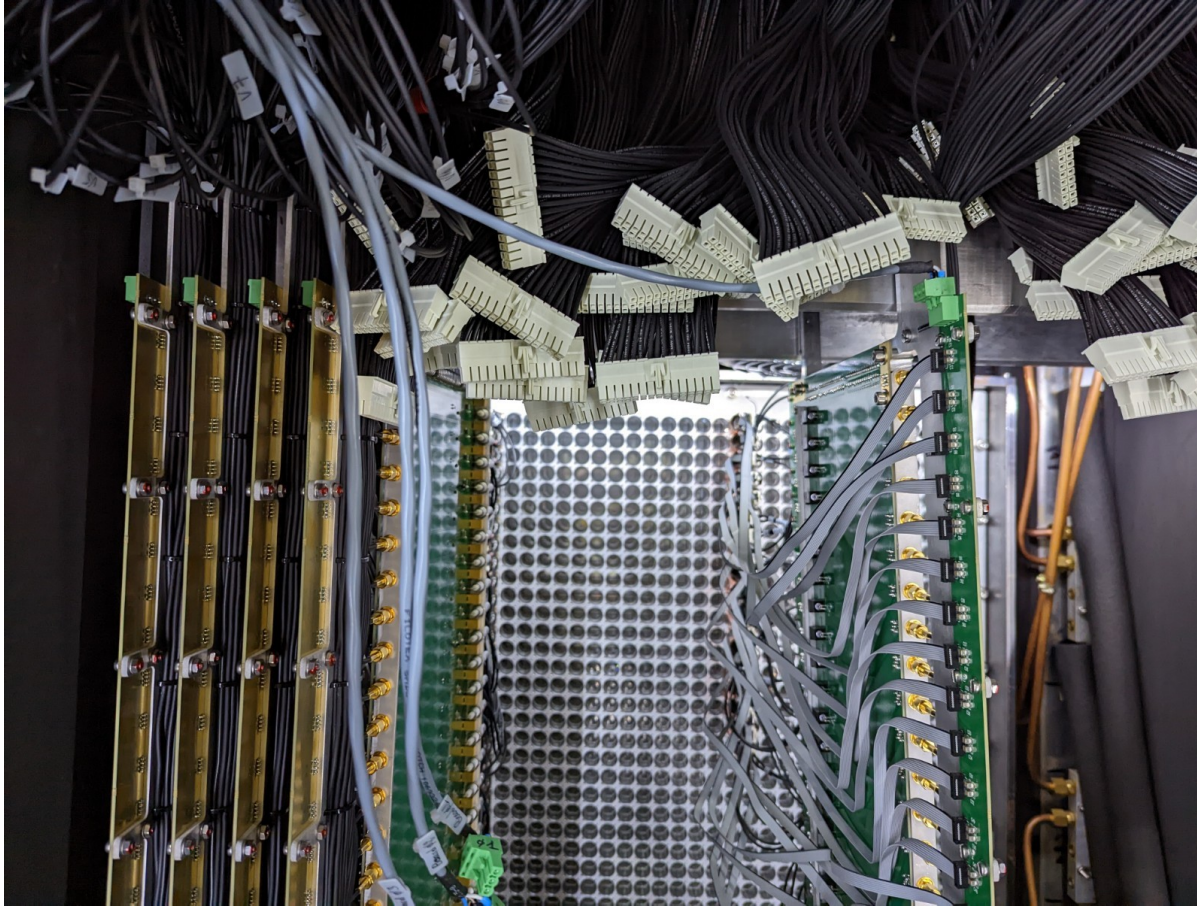


NPS Detector Noise Mitigation Tests (addl. follow-up)

Chris/Brad/Fernando

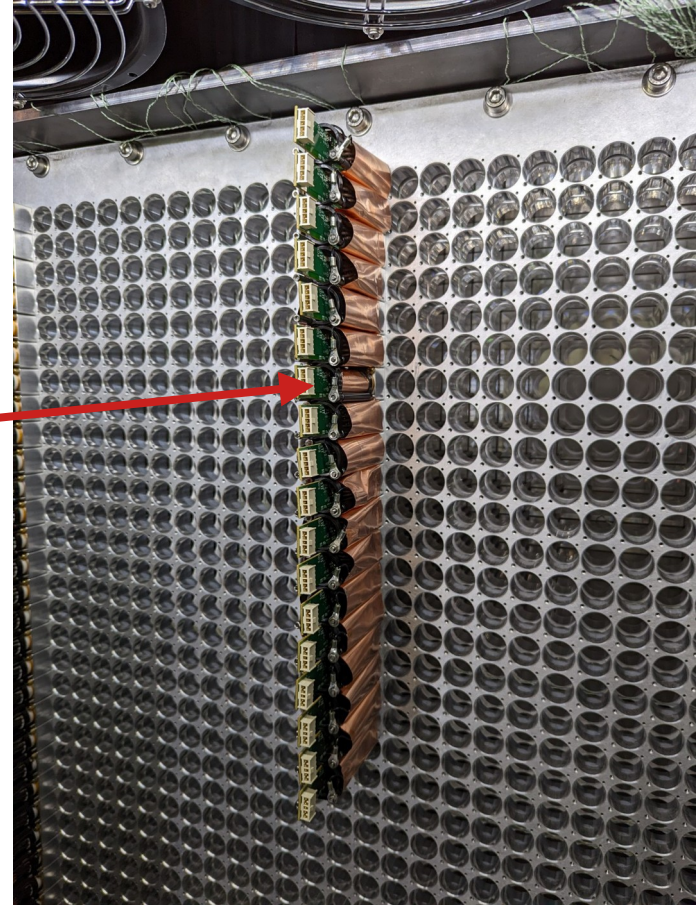
August 26 2022

Inside the NPS (w/ 18 shielded PMTs)



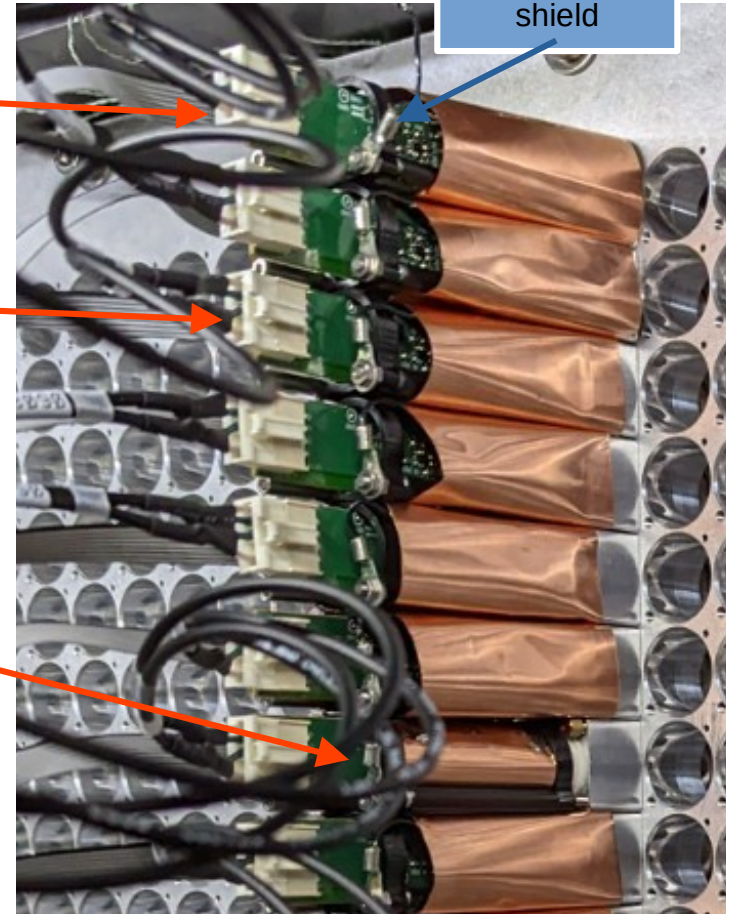
Conditions

- 18 shielded PMTs installed into new column in NPS
 - All PMT shields grounded through support post.
 - 7th PMT has ground shield inside the PMT holder
- Only low voltage applied
- (HV disconnected)



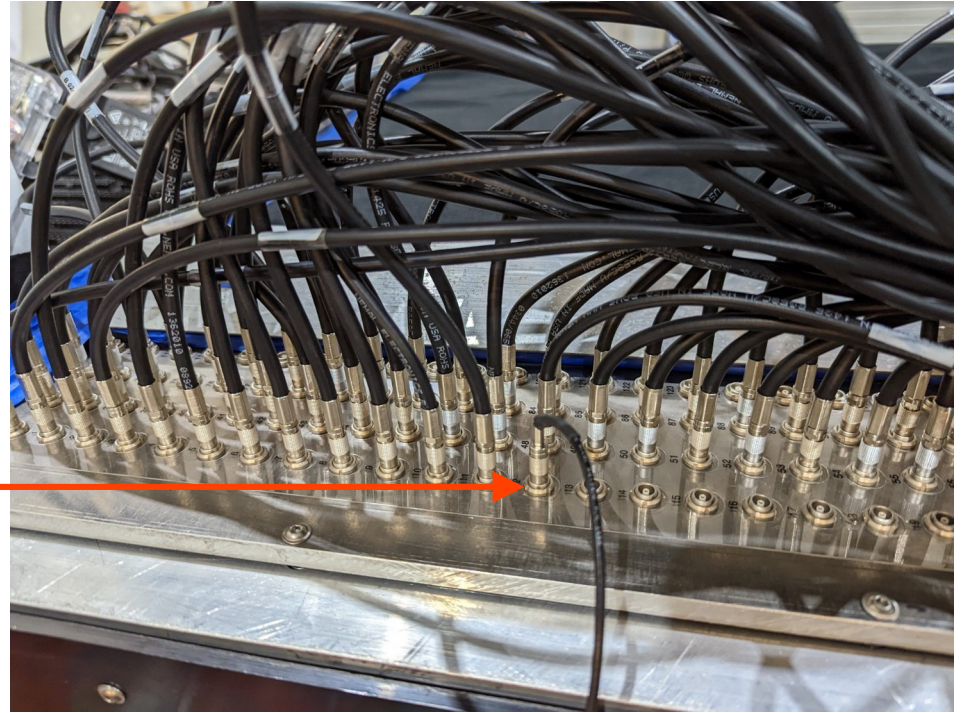
Conditions

- PMT1 / Trace 1 (Top)
 - Same as PMT1 in previous test (Aug 21)
 - Shielding connected to base ground by direct connection to support rod using a crimp lug
- PMT2 (Trace 2)
 - 3rd PMT from top (arb. choice)
 - Same shielding config as above
- PMT3 (Trace 3)
 - 7th PMT from top
 - Shielding foil *inside* the PMT holder, grounded to same crimp lug as others
- Installation was challenging
 - There is zero 'extra' tolerance gap between copper shield material and adjacent PMT assemblies with 'external' shielding
 - See comments/opinions on last slide



Conditions

- PMT4 / Trace 4 / Bot
 - “Before” noise level as reference
 - 1st installed column of unshielded PMTs
 - PMT 12 (column 0)



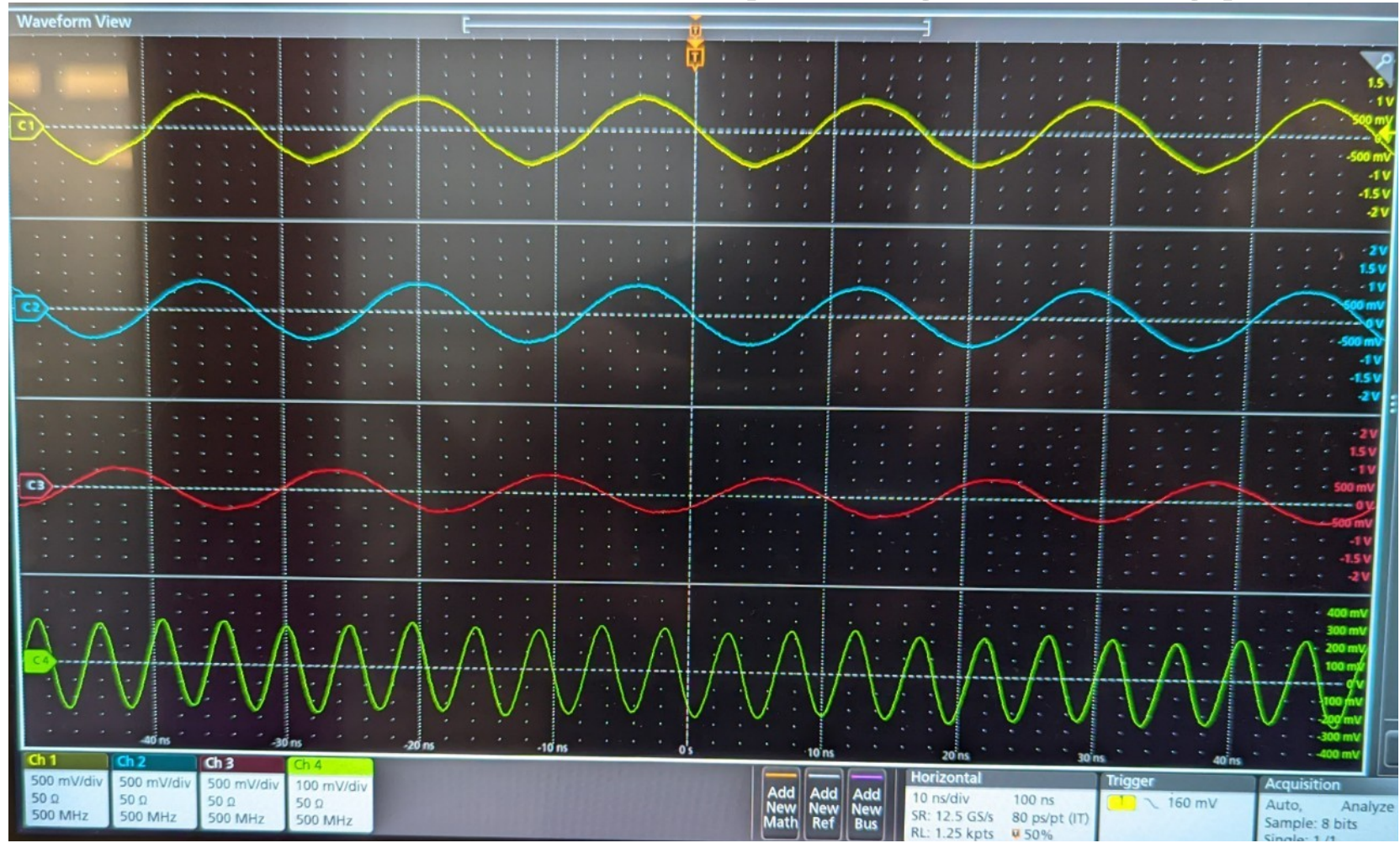
Characteristic Noise (Single Trig)

PMT1
(~2 V Pk to Pk)

PMT2
(~2 V Pk to Pk)

PMT3
(~1V Pk to Pk)

PMT4
(~500 mV Pk to Pk)



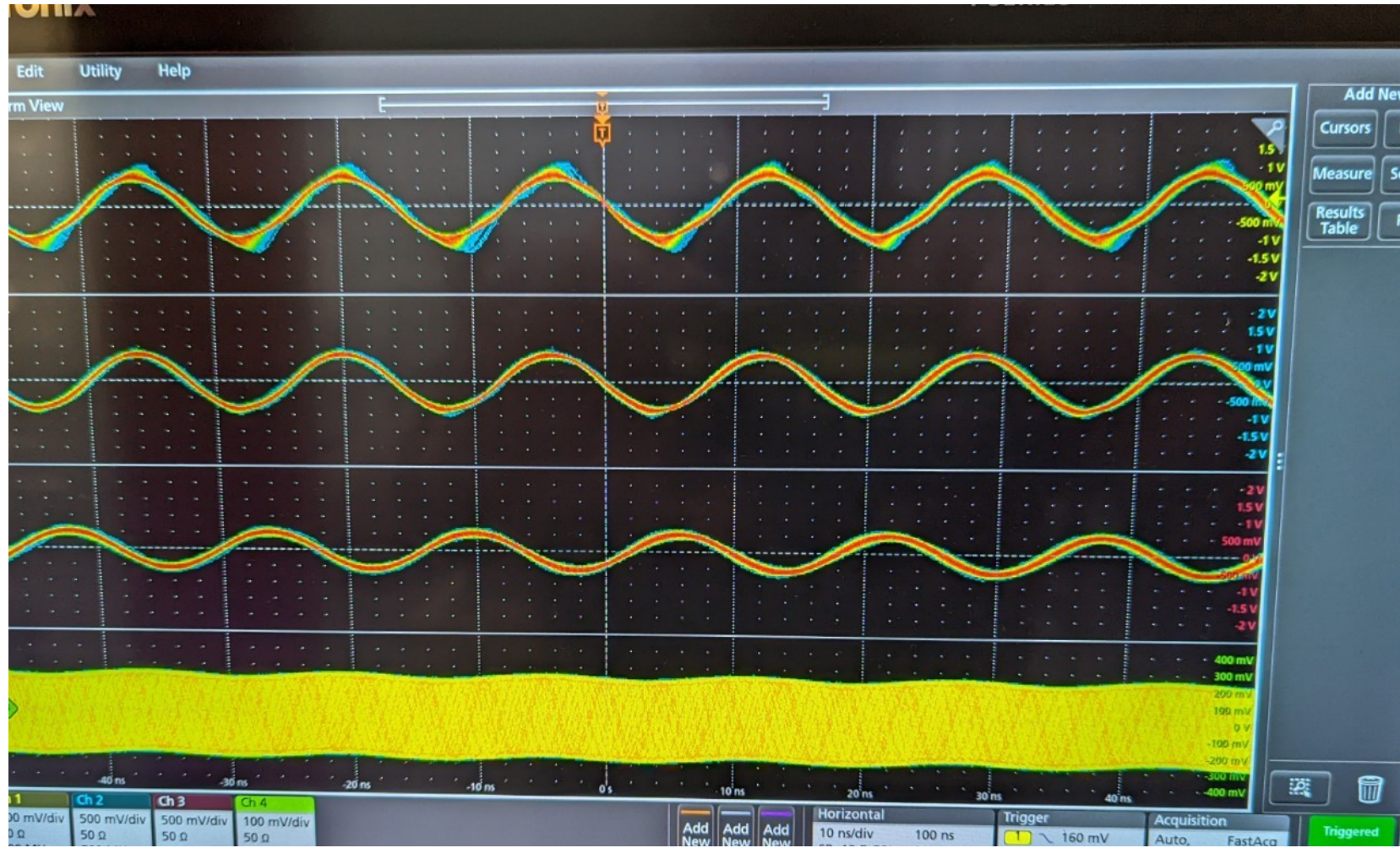
Characteristic Noise (Fast Acq. Mode)

PMT1
(~2 V Pk to Pk)

PMT2
(~2 V Pk to Pk)

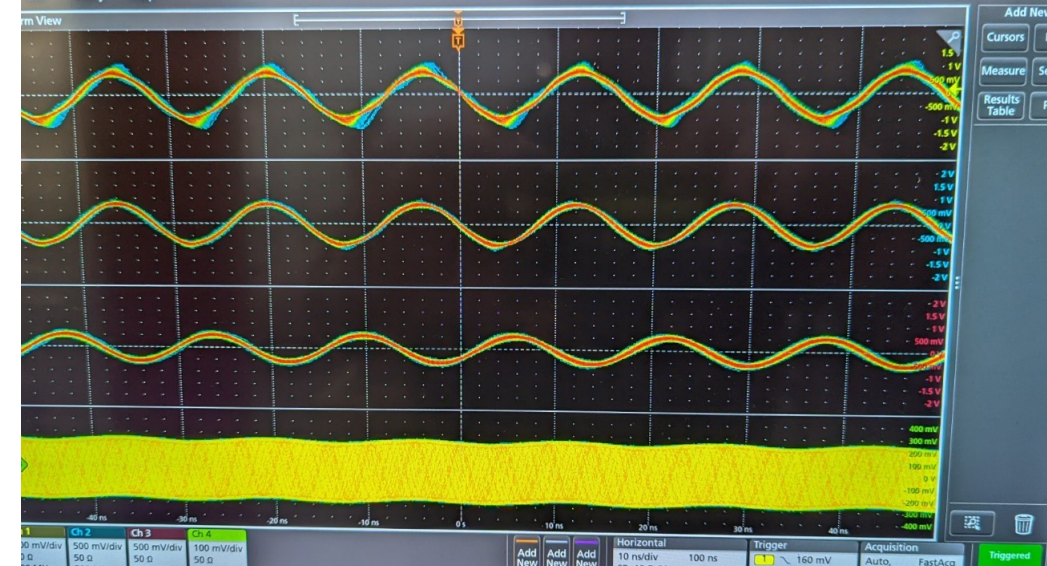
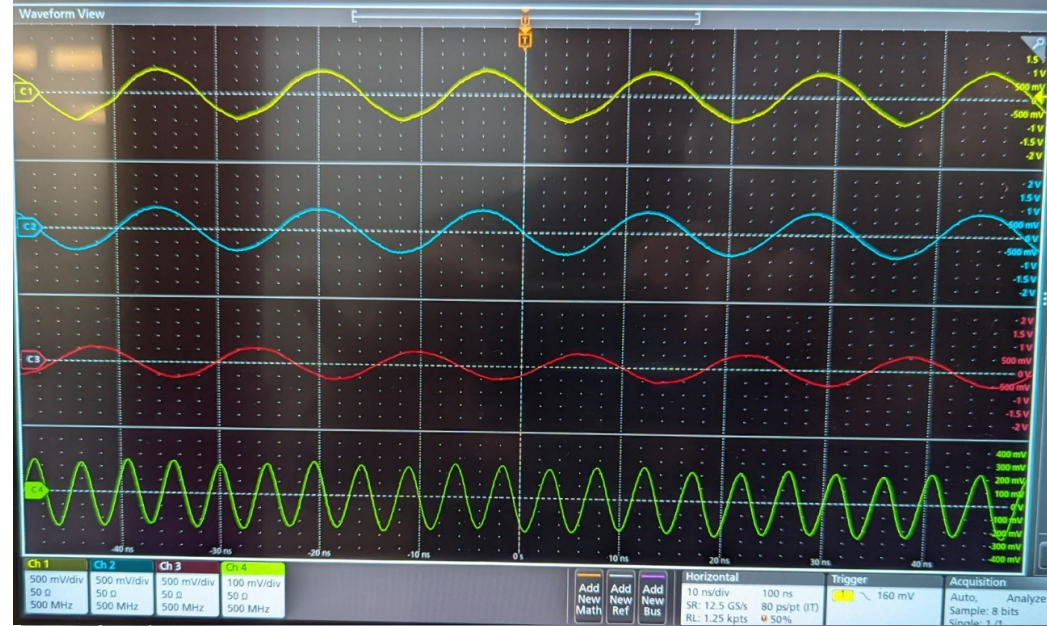
PMT3
(~1V Pk to Pk)

PMT4
(~500 mV Pk to Pk)



Observations

- Noise returns when more PMTs powered up
- Characteristic noise frequency is different in shielded column, interesting...
 - Trace 1–3 in shielded column (~70 MHz)
 - Trace 4 in original column (~200 MHz; as before)
 - Suggests noise is not simple antenna pickup, something in the circuit is ringing?
- Fast Acq. mode indicates triangular wave features
 - Does that tell us anything about the source?
- PMTs are cross talking?
 - Could explain resonant noise in adjacent PMTs?
 - Hints of the 70 MHz ripple is also present as an envelop around Trace 4 from column 0 (ignore phase difference, scope cable lengths were not perfectly matched)
- Noise in a single shielded PMT went away (<1mV) when power removed to 16 bases in new shielded column (leaving only 2 powered)
 - Noise issues is aggravated/induced by signals in nearby PMTs
- We also tried contacting a new thick ground cable to NPS frame and to a solid earth ground to see if it helped
 - No visible effect on noise



To Do List (updated) / Comments

- Assemble and test a full half column of shielded PMTs (**Done**)
 - Noise returned with a vengeance..
 - No point in doing full column at this point.
- Should establish a (different) set of ~18 PMTs “on the bench” using the NPS distribution board currently in Chris’ lab to investigate this issue further. (**To Do**)
- NPS tank is not a Faraday cage due to plastic wall panels (**To Do**)
 - RF pickup is still very noticeable with cell phones (for example), true even for shielded PMTs
 - I suggest either replacing the plastic panels with 1/8” Aluminum or ‘laminating’ the inside of the plastic panels with conductive foil
 - Option A is cleaner (requires fabrication time/\$)
 - Option B is cheaper but fussier (collaboration can do it ourselves though)
- Need more support for cable bundling (then cable installation in EEL/108)
 - Big job, can be done in parallel with noise study work.
 - It would be embarrassing if the noise issue gets addressed and then we have to wait on cables to continue NPS work.
 - Please email Hamlette/Vardan ASAP
- **Comments on assembly / shield installation issues**
 - ONLY the shielding inside the PMT holder will work in a production context.
 - I (personally) think the interleaved copper sheets, while simple to fabricate, will be impossible to install along with the PMTs. Tolerances are very tight, any damage to the copper sheets would be difficult/impossible to repair. Damage to 0.1mm thick copper sheets is certain. Small wrinkles would cause unacceptable tolerance stack-up problems.

