Progress toward a Measurement of Hadronic Parity Violation in the Capture of Cold Neutrons on Helium-3

for the n3He Collaboration
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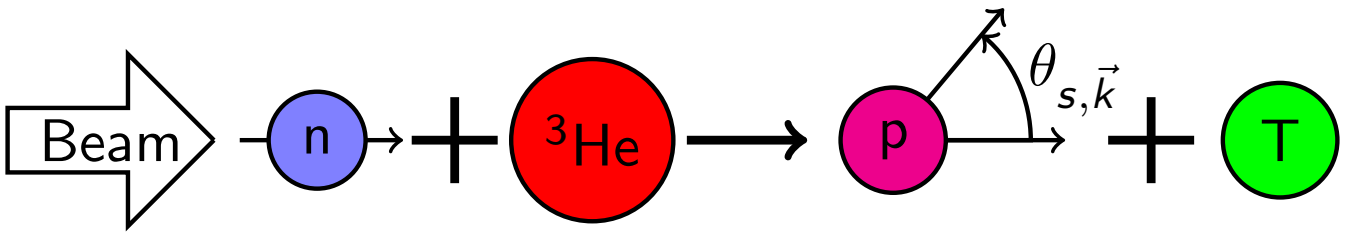
The n3He Experiment: Target Ion Chamber

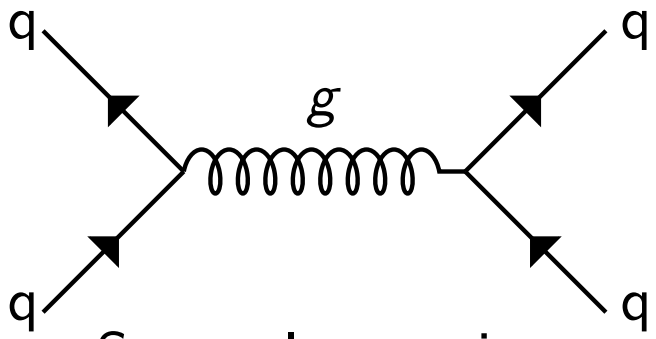
n3He Introduction

n3He probes the weak nucleon-nucleon interaction by measuring the parity violating directional asymmetry between the polarization direction of the incoming cold neutrons and the direction of the outgoing protons in the reaction

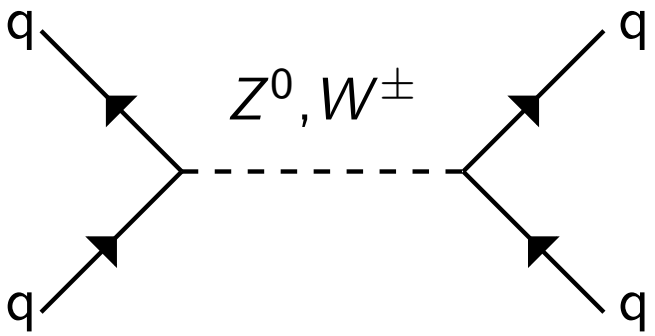
$$\vec{n} + {}^3He \rightarrow {}^4He^* \rightarrow p + T + 765keV$$



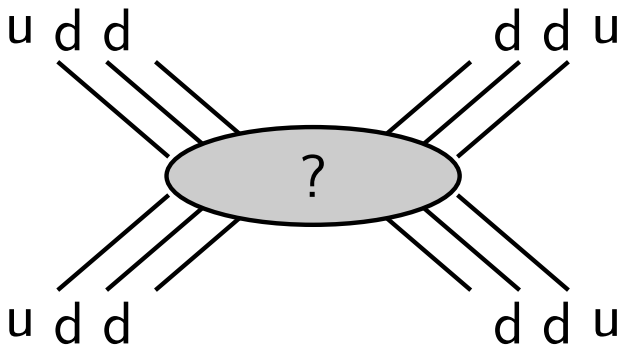
Theoretical Motivation



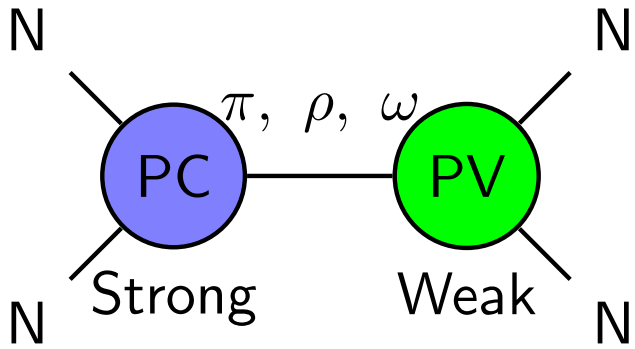
Strong Interaction



Weak Interaction



Uncertain HWI



DDH Parameterization

DDH Meson Exchange Parameters:

$$O_{pv} = a_\pi^1 h_\pi^1 + a_\rho^0 h_\rho^0 + a_\rho^1 h_\rho^1 + a_\rho^2 h_\rho^2 + a_\omega^0 h_\omega^0 + a_\omega^1 h_\omega^1$$

A Brief Look at Parity

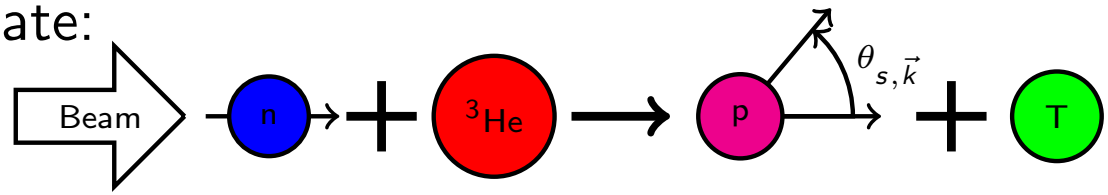
Under a parity transformation P polar vectors such as the momentum transform as

$$P(\vec{k}_n) \rightarrow -\vec{k}_n \qquad \text{and} \qquad P(\vec{k}_p) = -\vec{k}_p$$

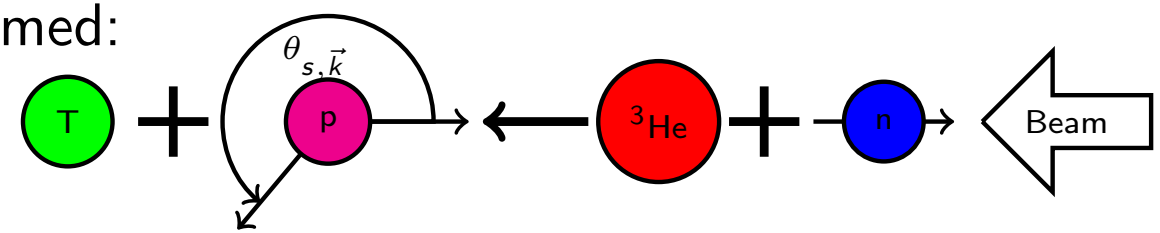
but axial vectors, such as the neutron spin, remain unchanged

$$P(\vec{s}_n) \rightarrow \vec{s}_n$$

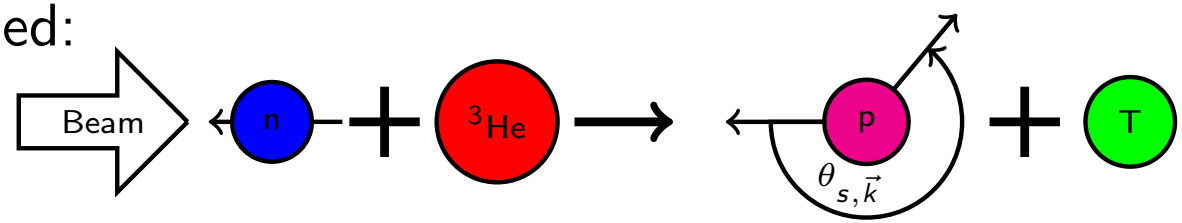
Orignal State:



Parity Transformed:



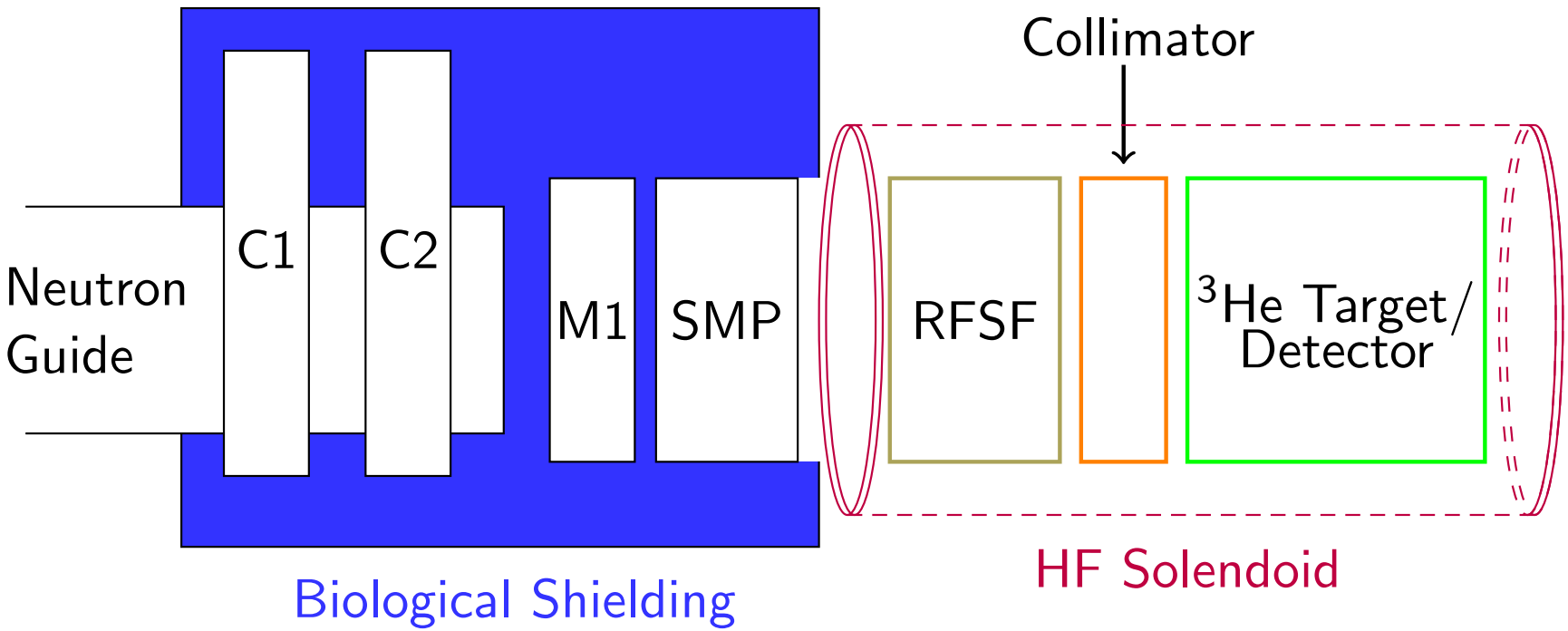
Spin Flipped:



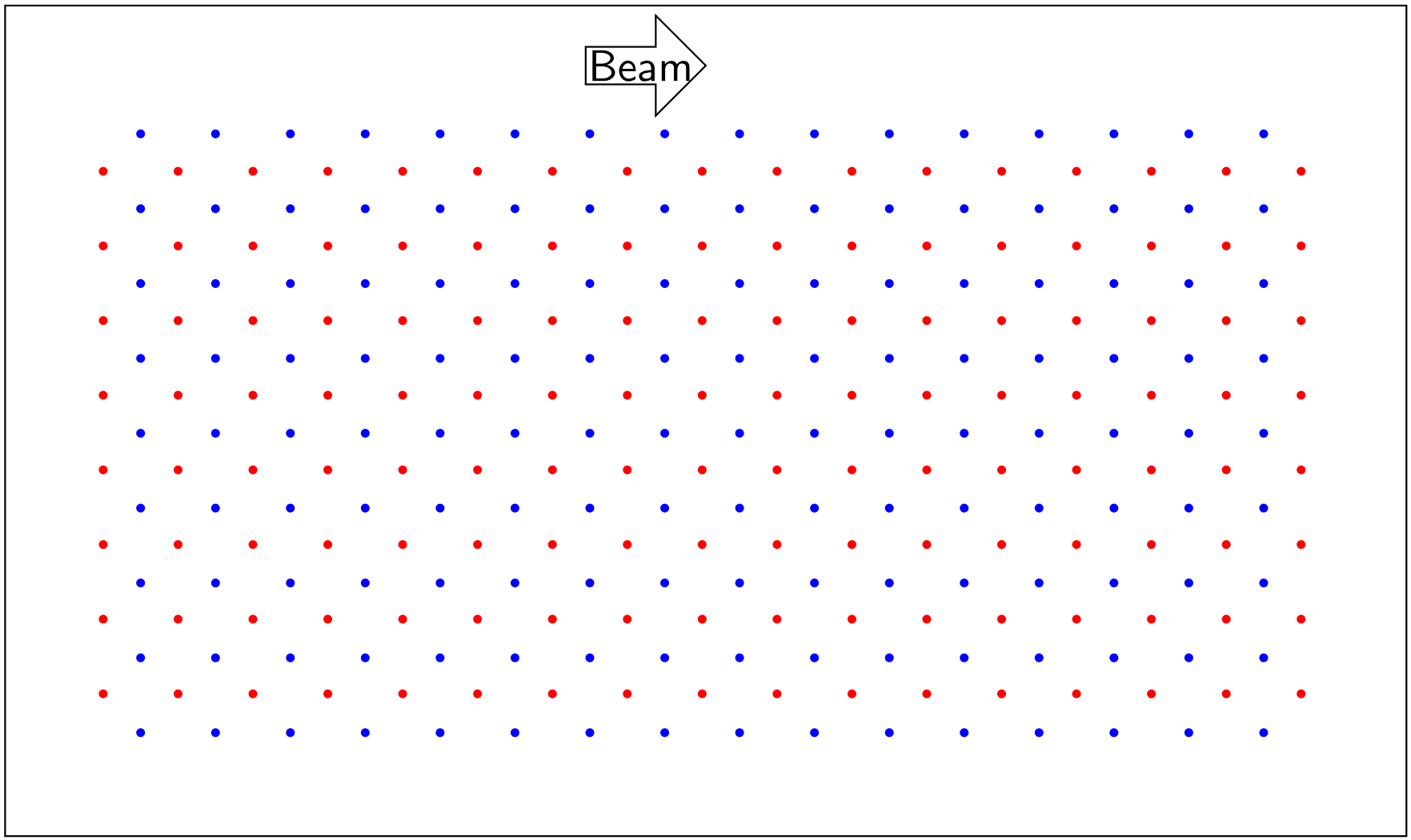
Spallation Neutron Source

- Located at the Oak Ridge National Laboratory (ORNL) in Tennessee
- 60 Hertz pulsed spallation source
- n3He will located at the FnPB
- 20K liquid hydrogen moderator for cold neutron beam lines

n3He Schematic Diagram in FnPB



n3He Target/Detector Chamber

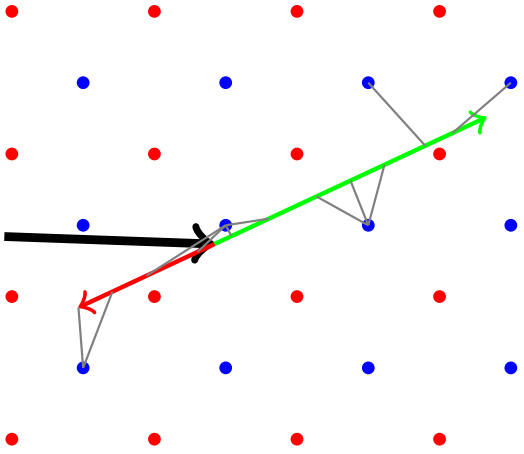


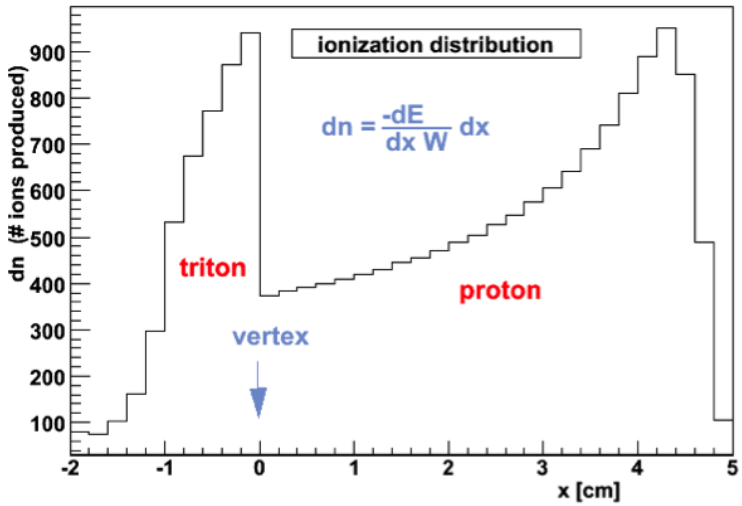
- HV 17 HV Frames with 8 wires each
- Signal 16 signal Frames with 9 wires each

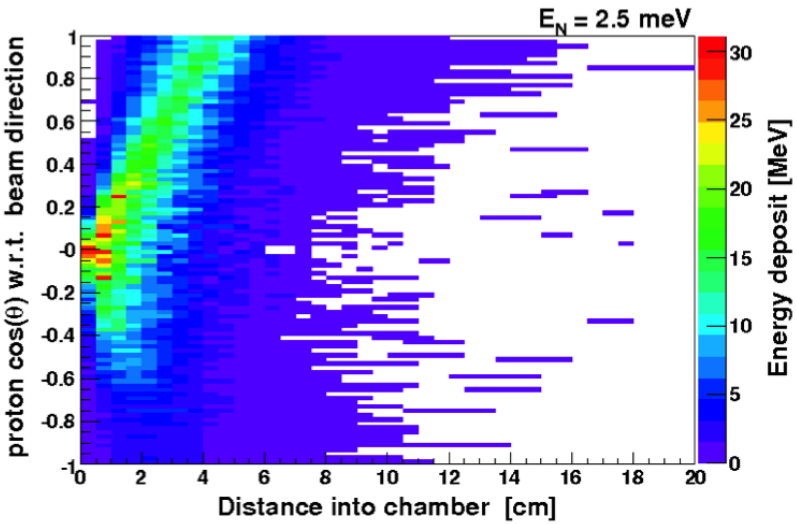
1 atm. He-3

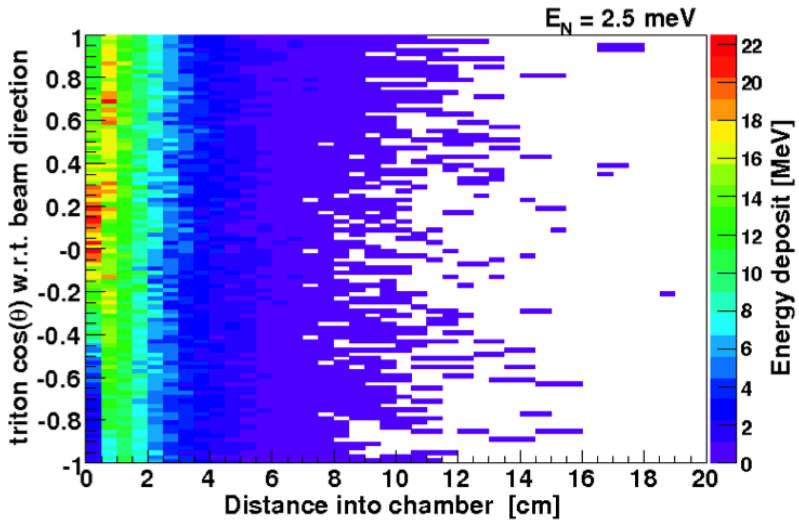
Proton Asymmetry in Chamber

$$\vec{n} + {}^3He \rightarrow p + T + 765keV$$

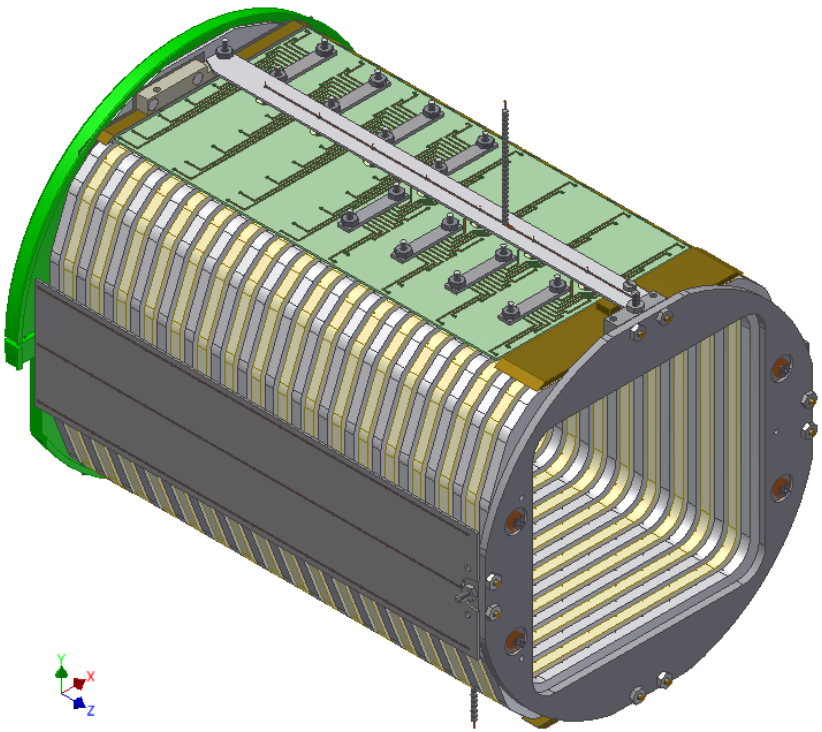




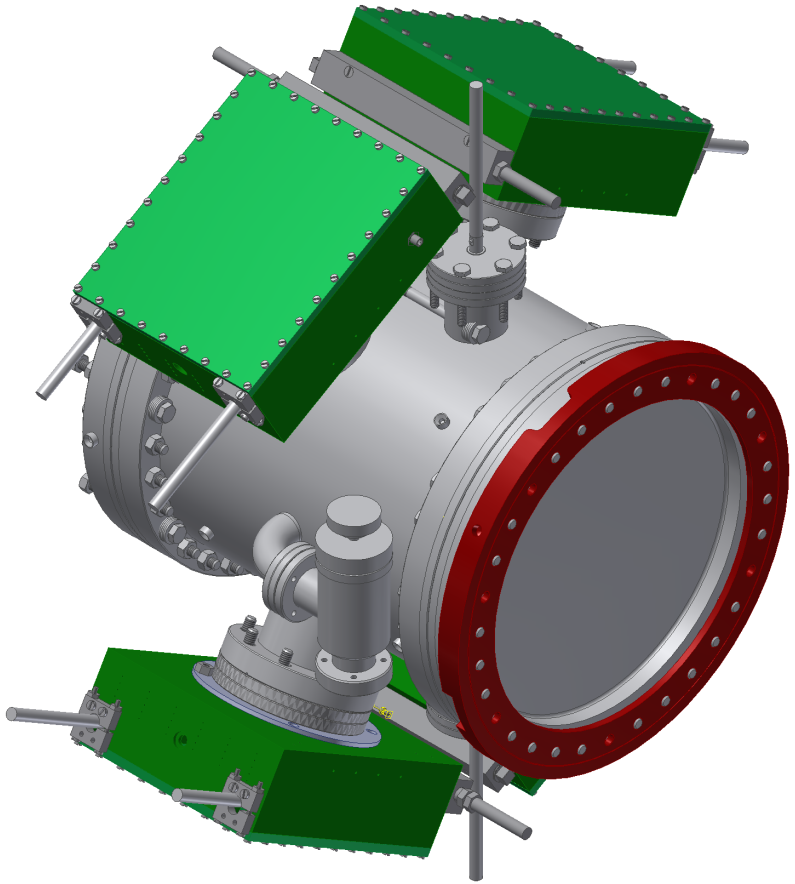




Target CAD Drawing



Frame Stack with signal and HV PCB on mount plate



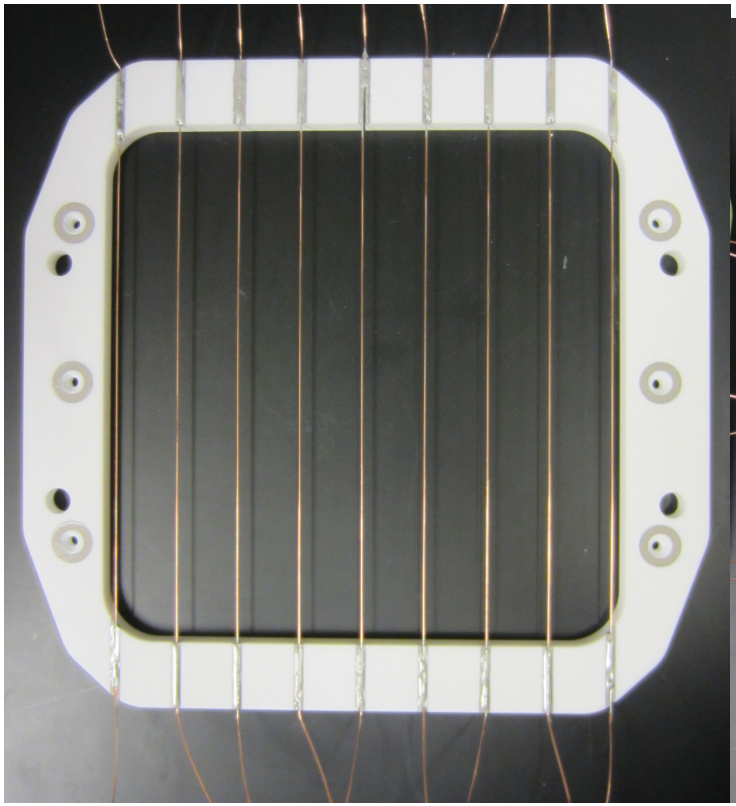
Chamber exterior with all flanges in place.

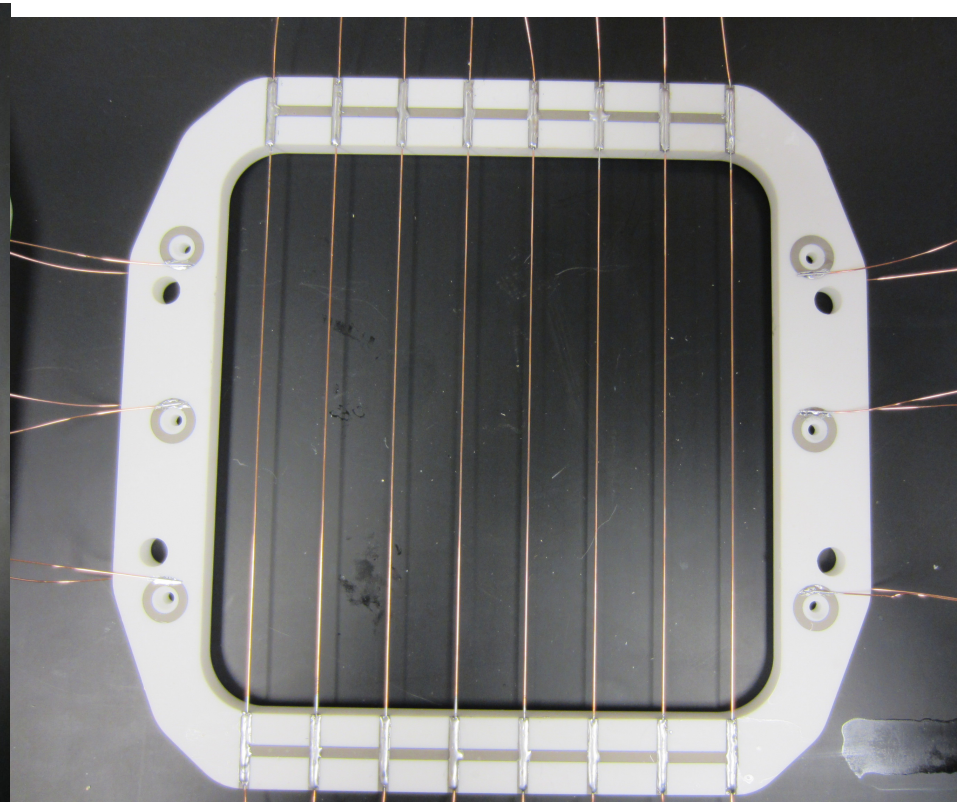
Aluminum Chamber Vessel

- 10" conflat end flanges
- windows are 1mm thick Al
- 4 signal feed thrus
- 2 gas feed thrus
- 2 HV feed thrus
- Al body, SS knife edges

Target Frames

1/4" thick macor ceramic





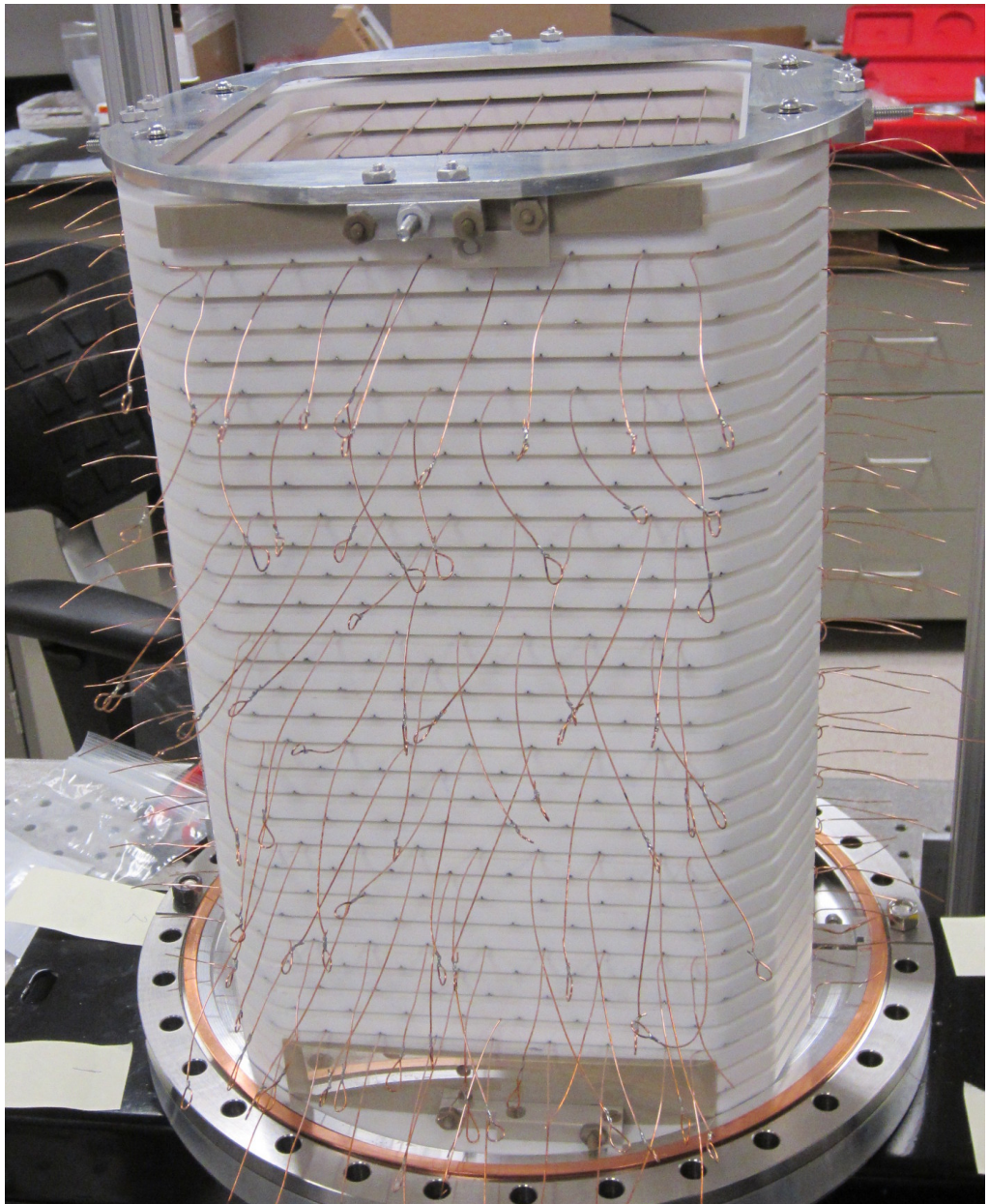
Signal Frame

- 9 wires

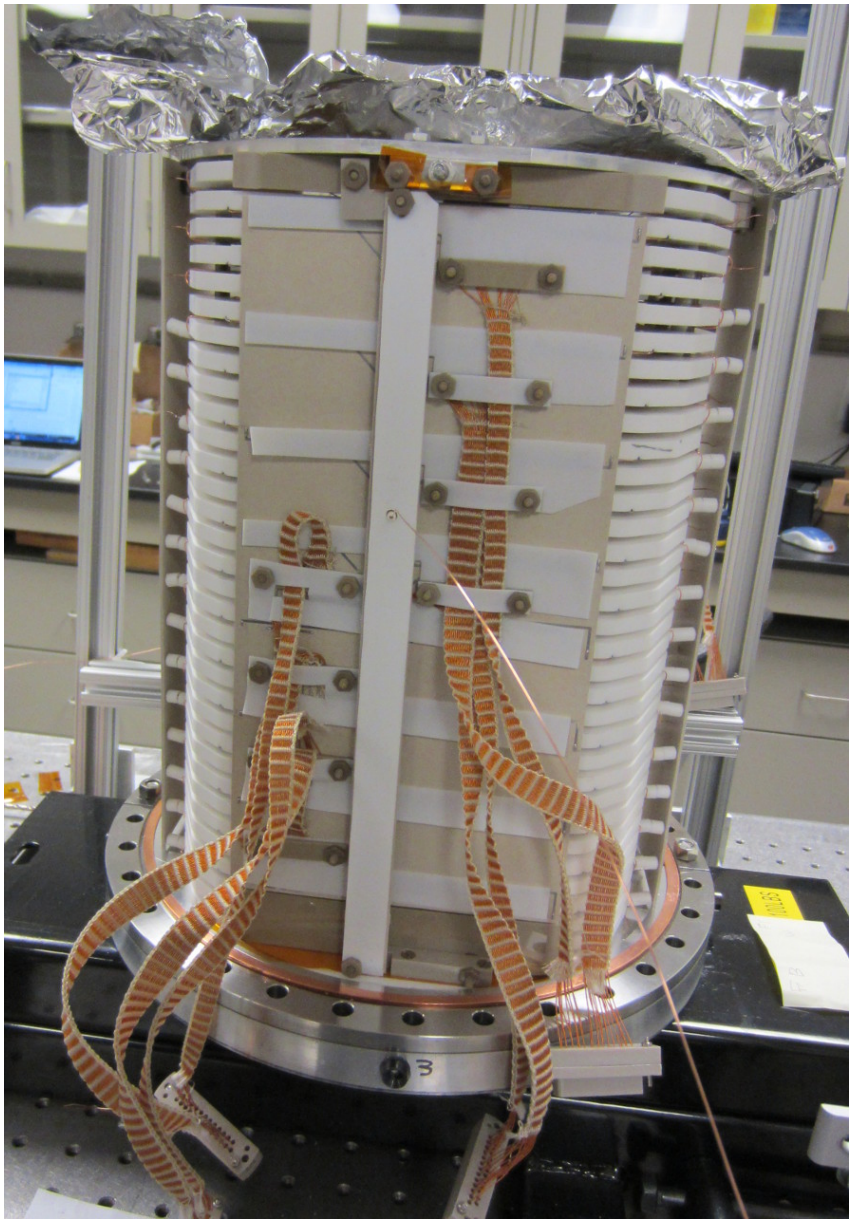
HV Frame

- 8 wires

Assembled Frame Stack

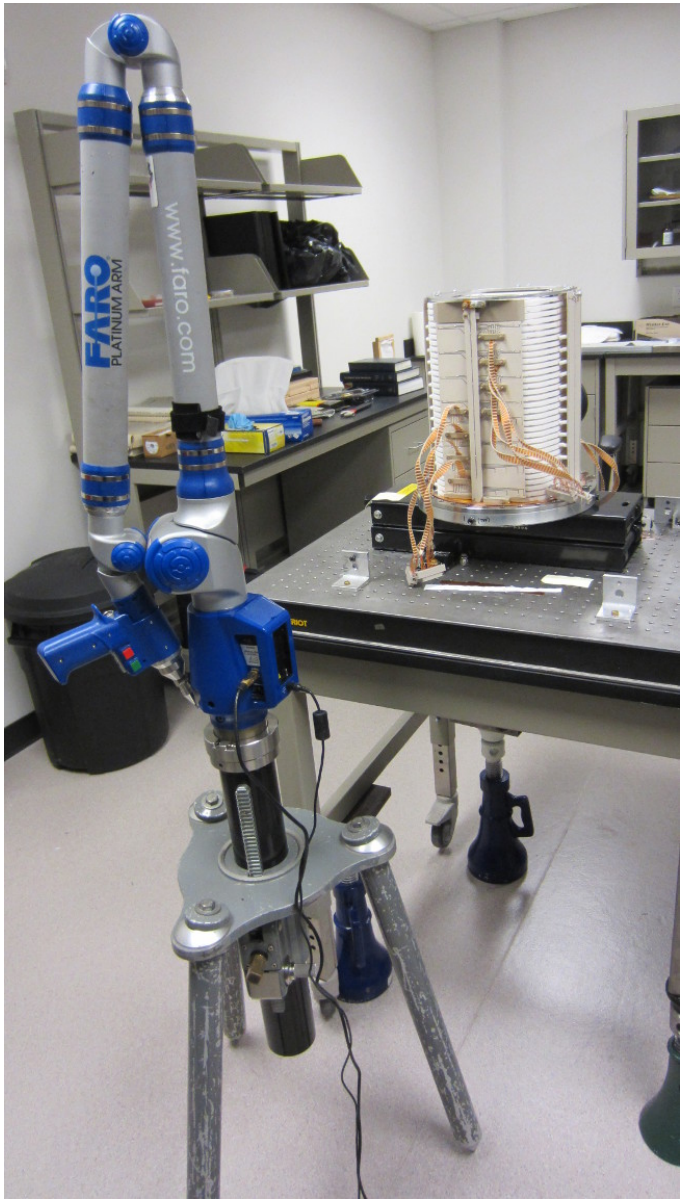


Frame Stack Shielding



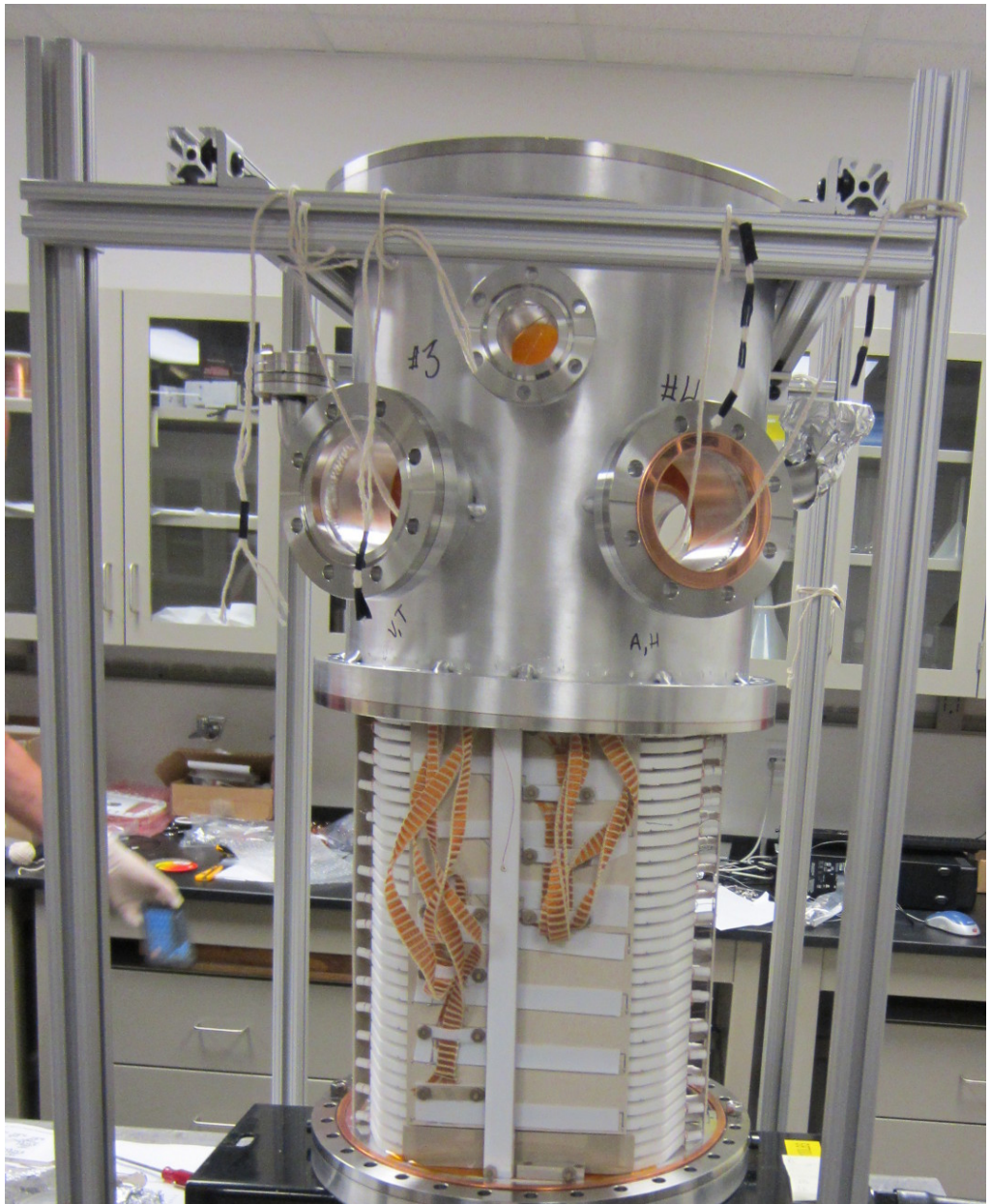
- Teflon Shielding on signal board to stop stray charge collection
- Teflon on HV to stop unwanted discharge
- Kapton around ends to stop stop unwanted discharge
- Ceramic beads on bare wires when possible

Survey and Alignment

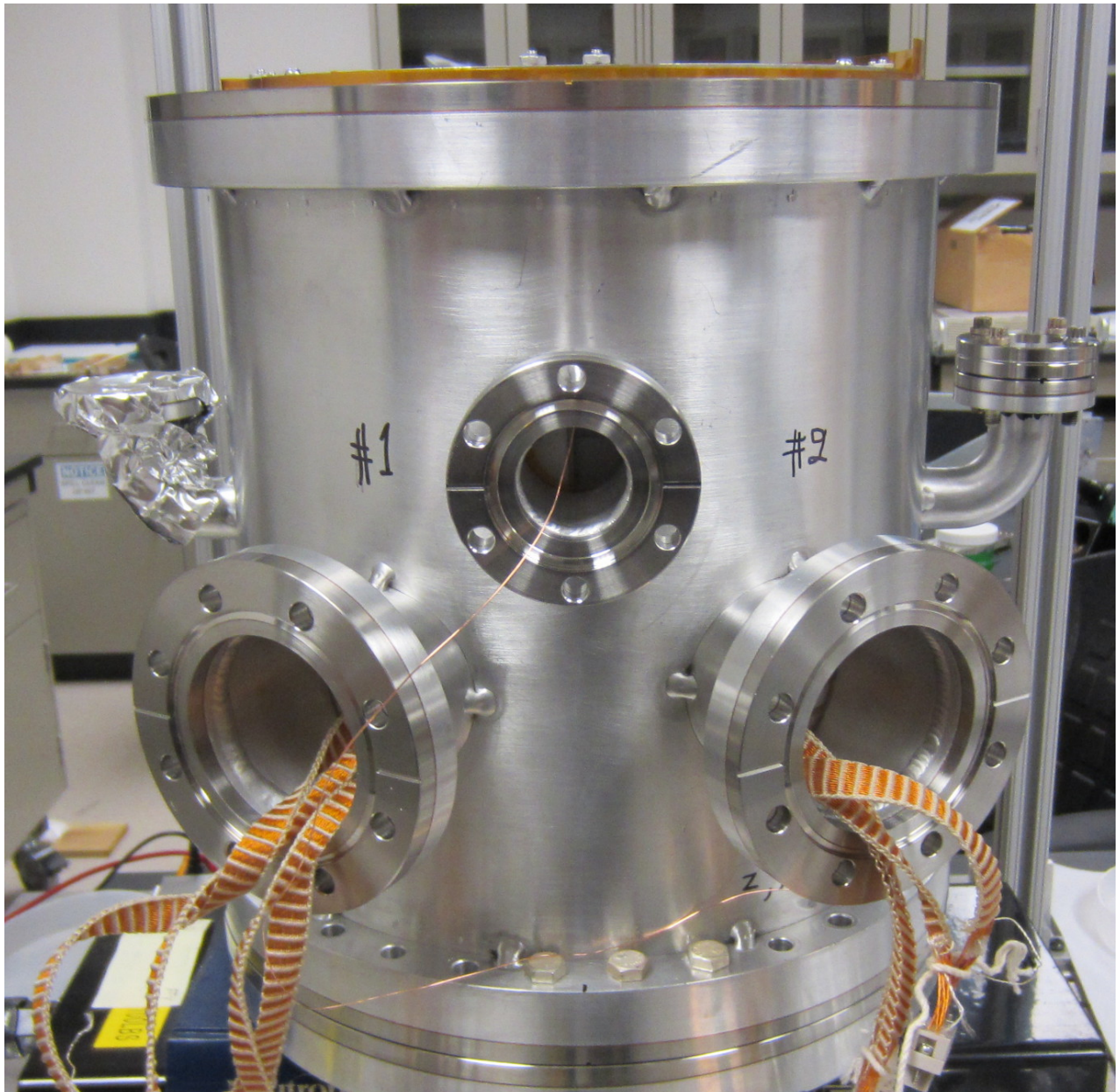


- The position and angle of the frame stack inside the housing needs to be known to align it to the neutron beam.
- Faro Arms are 3D measurement devices.
- Position and angle of frame stack measured to base flange

Mounting Housing on Frame Stack

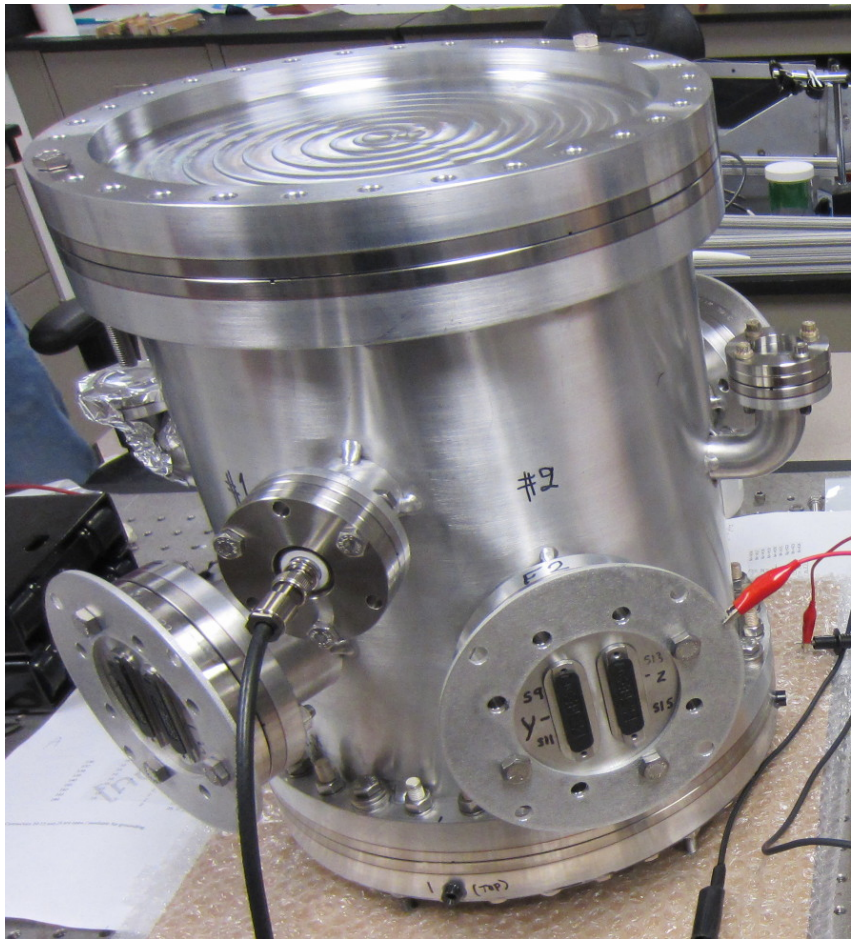


Housing In Place



Chamber Testing

- Helium Leak Checked at 10e-10 mBar l/s
- HV leakage testing in Air
  - 1.5×10^{-8} amps at 1400V from HV to ground
- HV Testing with He Fill Gas
  - MHV FIange Sparked at 580V
  - 940V reached after additional Kapton shielding used in MHV feed thru to prevent sparking to its own ground



Current Status

- n3He Chamber Assembled.
- Initial HV Leakage to ground testing passed
- Initial He leak check passed

Upcoming Tasks:

- Finish HV shielding upgrades (July)
- Fill with He-3 and test with neutrons (August)

n3He Collaboration

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