n3He: A Measurement of Parity Violation in the Capture of Cold Polarized Neutrons on He-3

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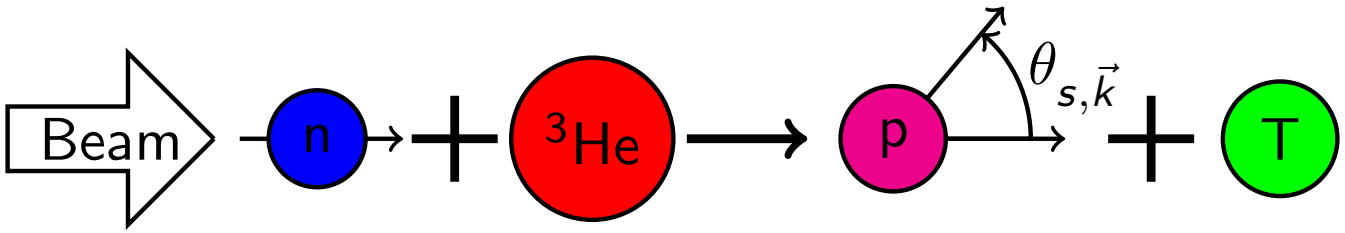
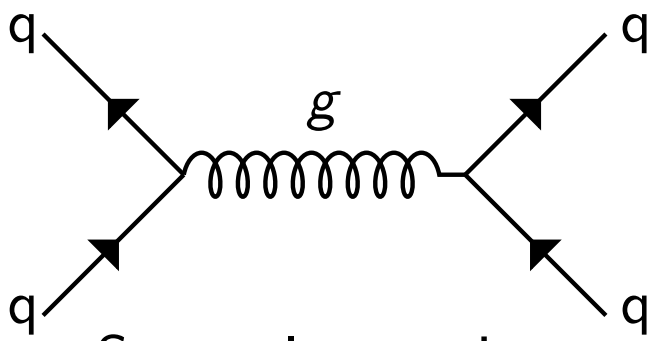
Introduction

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

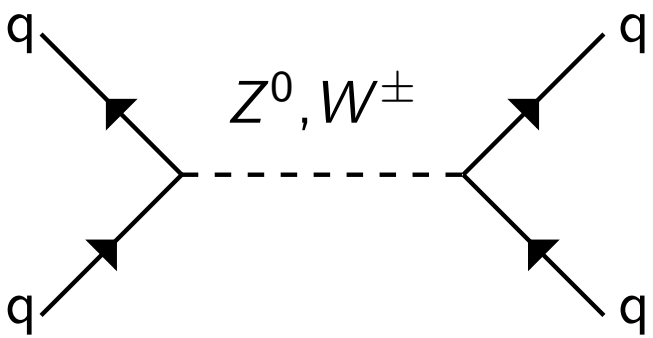


n3He probes the low energy strong interaction, using the weak interaction by measuring the parity violating directional asymmetry in the proton recoil from the reaction

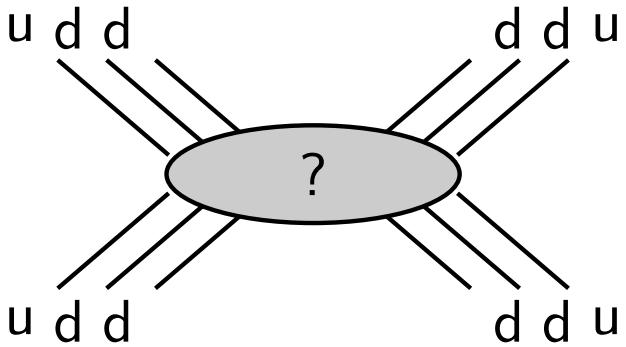
Theoretical Motivation



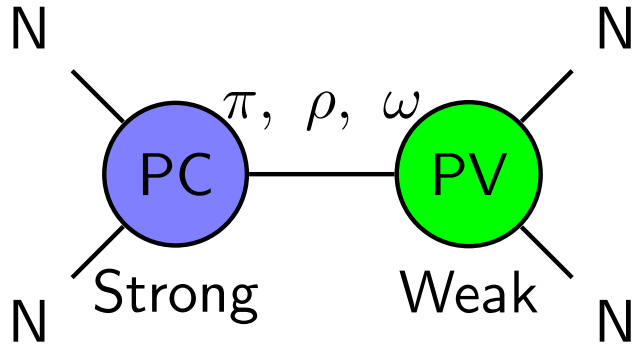
Strong Interaction



Weak Interaction



Uncertain HWI



DDH Parameterization

DDH Meson Exchange Parameters:

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

Esimation of the n3He Observable

From a full four-body calculation of strong scattering wave functions

- $A_p^{\vec{n},^3He}(th.) \approx (-9.4 \rightarrow 2.5) \times 10^{-8}$
- n3He aims to measure this to 2×10^{-8}

DDH Weak Coupling	$(A_Z^P)n^3He \rightarrow tp$
a_π^1	-0.189
a_ρ^0	-0.036
a_ρ^1	0.019
a_ρ^2	-0.006
a_ω^0	-0.0334
a_ω^1	0.0413

M. Viviani, R. Schiavilla, Phys. Rev. C. 82 044001 (2010)
L. Girlanda et al. Phys. Rev. Lett. 105 232502 (2010)

Importance of the n3He Experiment

$$A_p = -0.189\mathbf{h}_\pi^1 - 0.036\mathbf{h}_\rho^0 + 0.019h_\rho^1 - 0.006\mathbf{h}_\rho^2 - 0.0334\mathbf{h}_\omega^0 + 0.0413h_\omega^1$$

- $\Delta I = 1$ are not important due to small contribution
- 4 parameters remain ($\mathbf{h}_\pi^1$, $\mathbf{h}_\rho^0$, $\mathbf{h}_\rho^2$, $\mathbf{h}_\omega^0$)

Using:

- ^{18}F measurement
- elastic p-p scattering at two energies
- odd-proton nuclear measurements
- NPDGamma

along with the n3He result the system can be over constrained to check the model.

A Brief Introduction to Parity

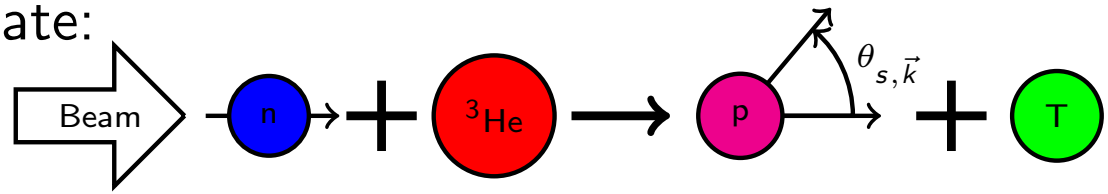
Under a parity transformation P polar vectors such as the momentum transform as

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

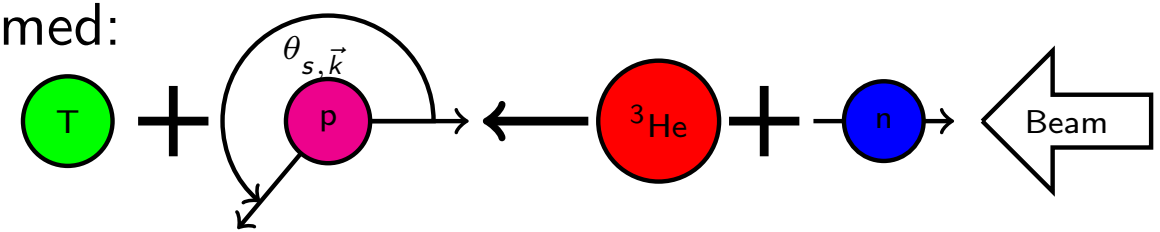
but axial vectors, such as the neutron spin, remain unchanged

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

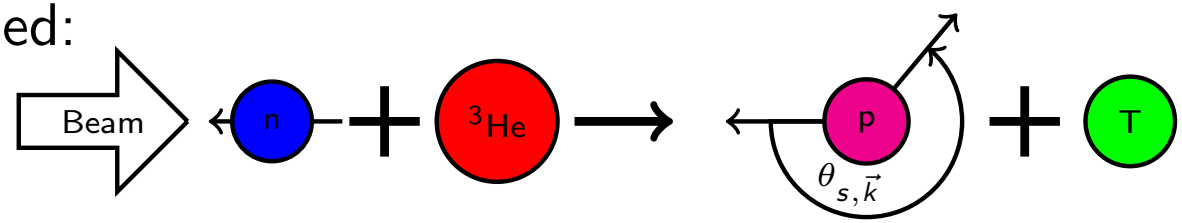
Orignal State:



Parity Transformed:



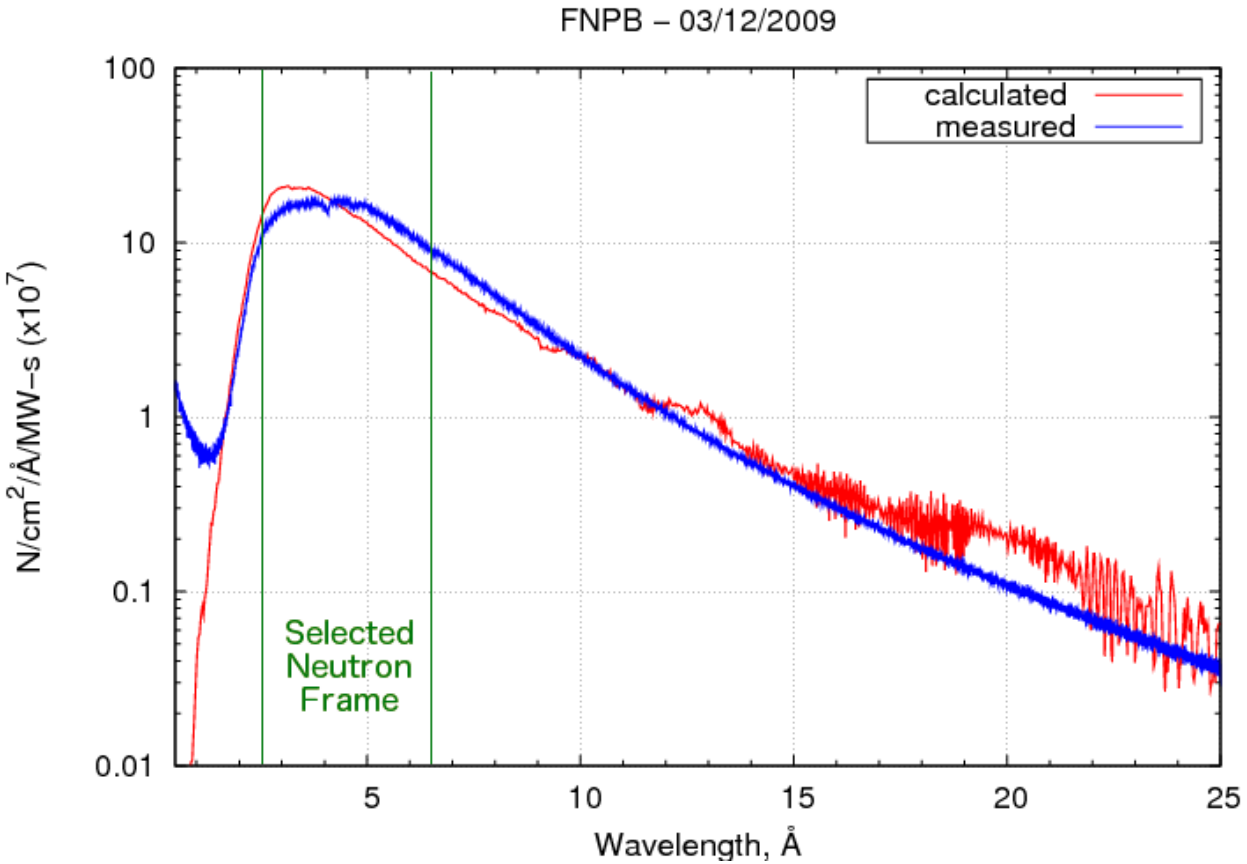
Spin Flipped:



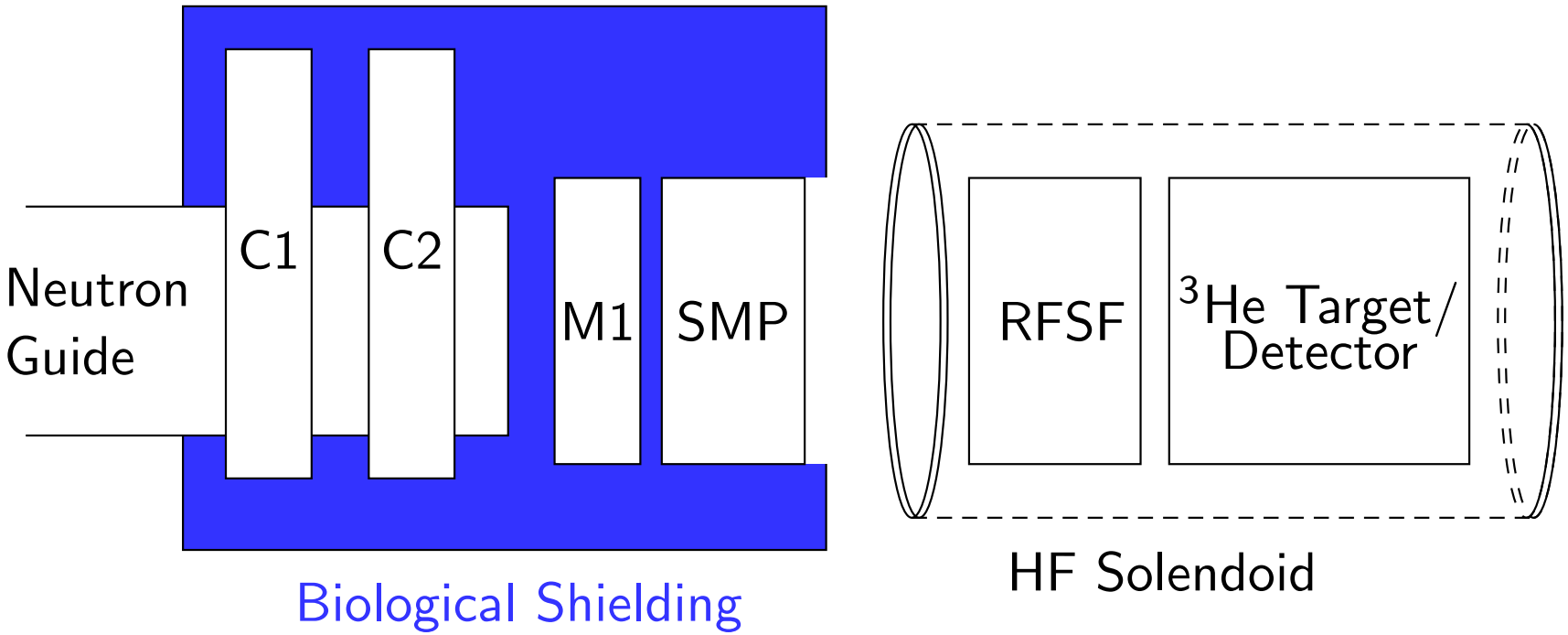
Spallation Neutron Source

- 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

Neutron Pulse - Unchopped

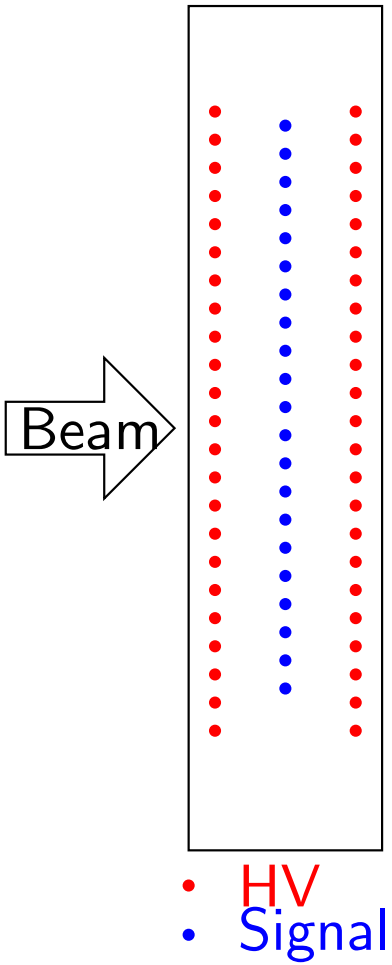


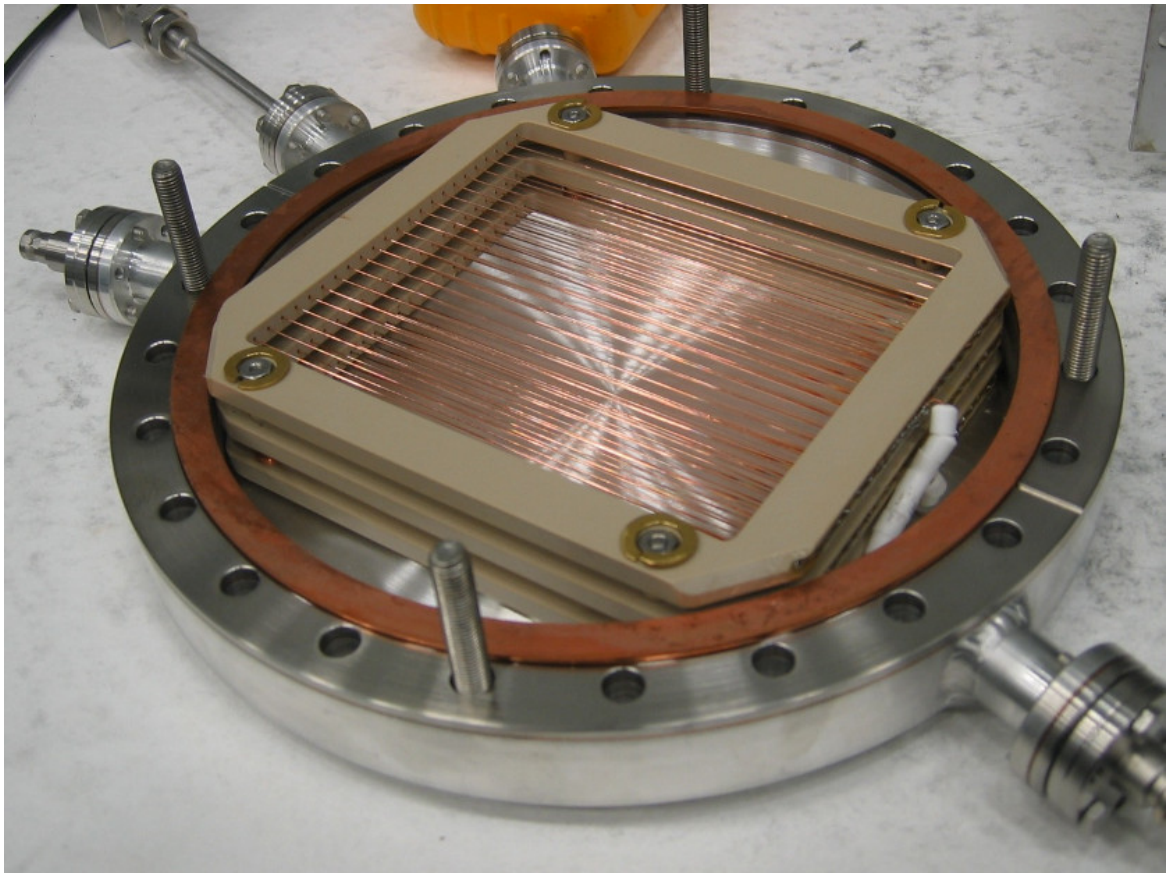
n3He Schematic Diagram



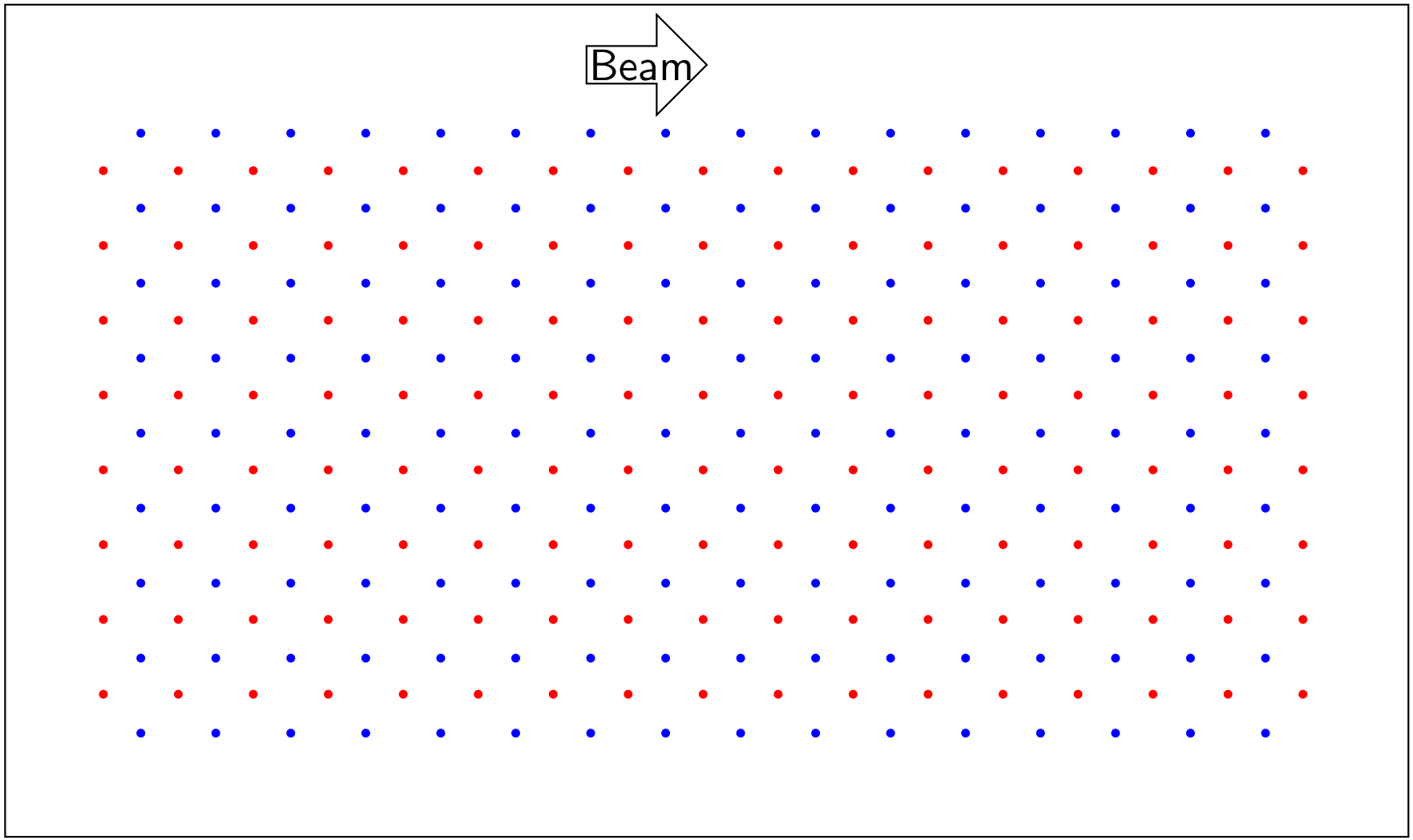
FnPB Cave with NPDGamma Apparatus Installed

Prototype Monitors





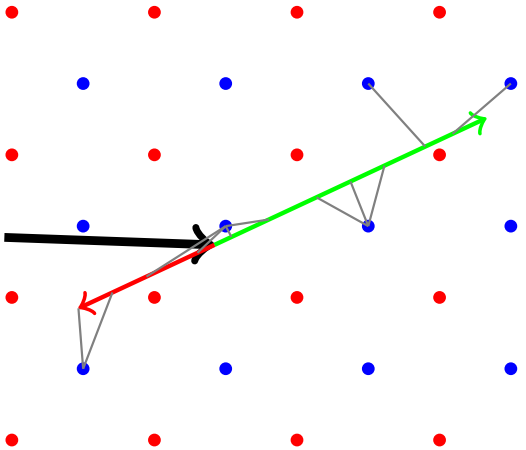
n3He Target Chamber



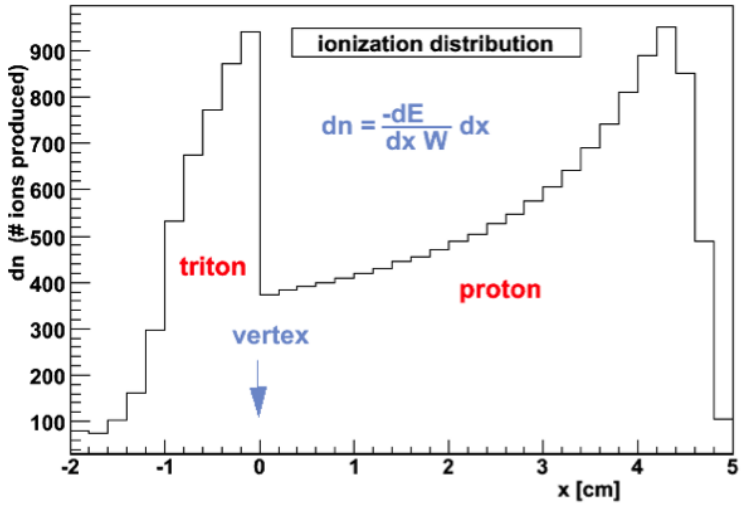
- HV 17 HV Frames with 8 wires each
- Signal 16 signal Frames with 9 wires each

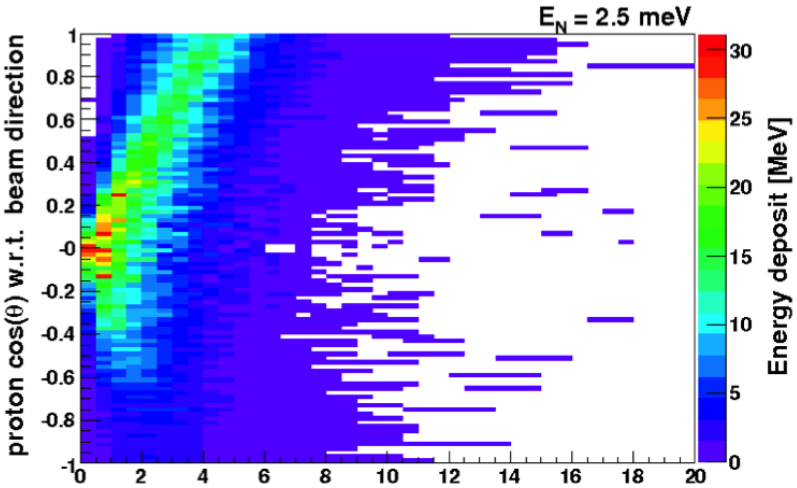
Proton Asymmetry in Chamber

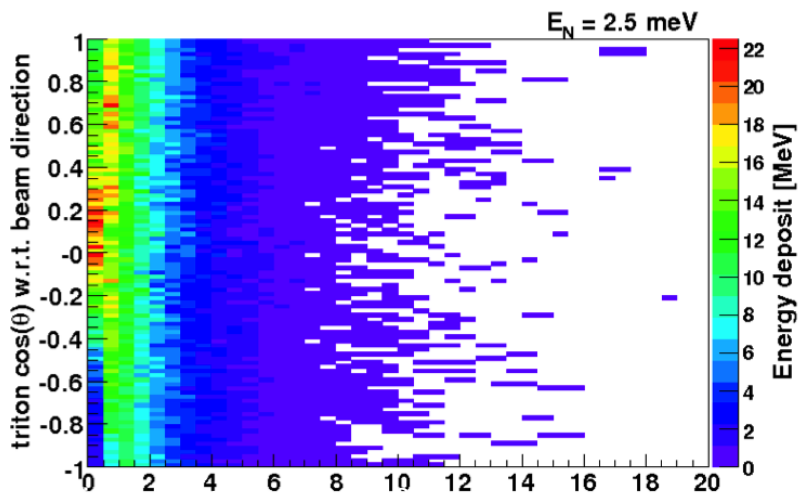
$$\vec{n} + {}^3He \rightarrow p + T + 765keV$$



neutron proton Triton
Charge Collection



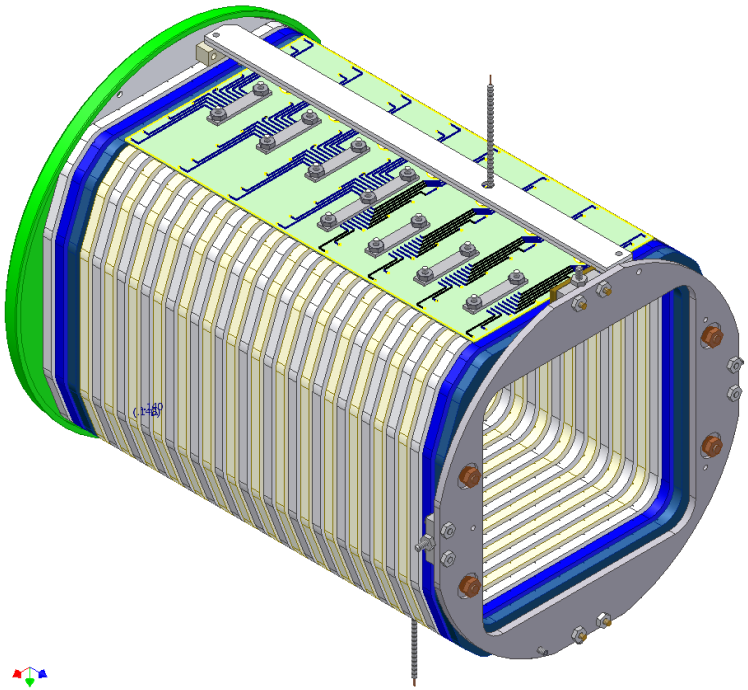




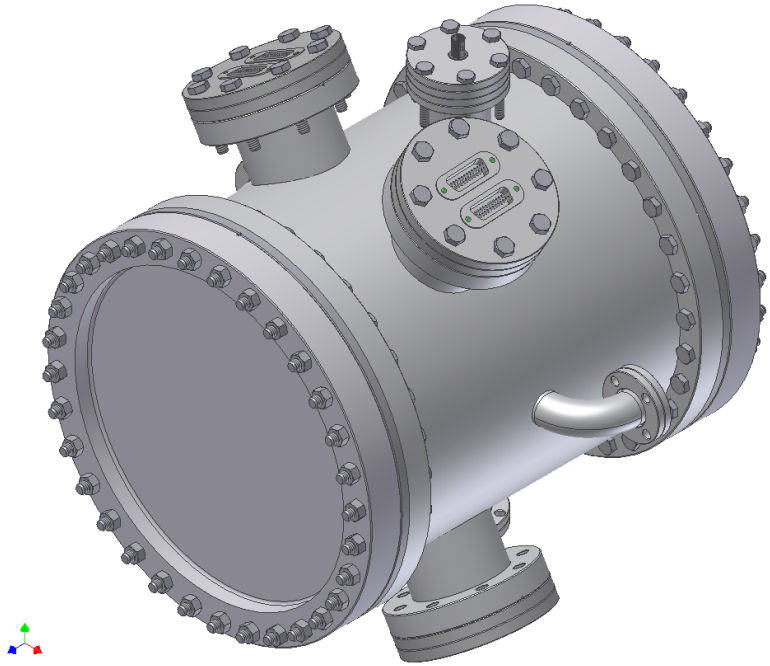
Target Housing

- 10" conflat end flanges
- windows are 1mm thick Al
- 4 data feed thrus
- 2 gas feed thrus
- 2 HV feed throughs

Target CAD Drawing

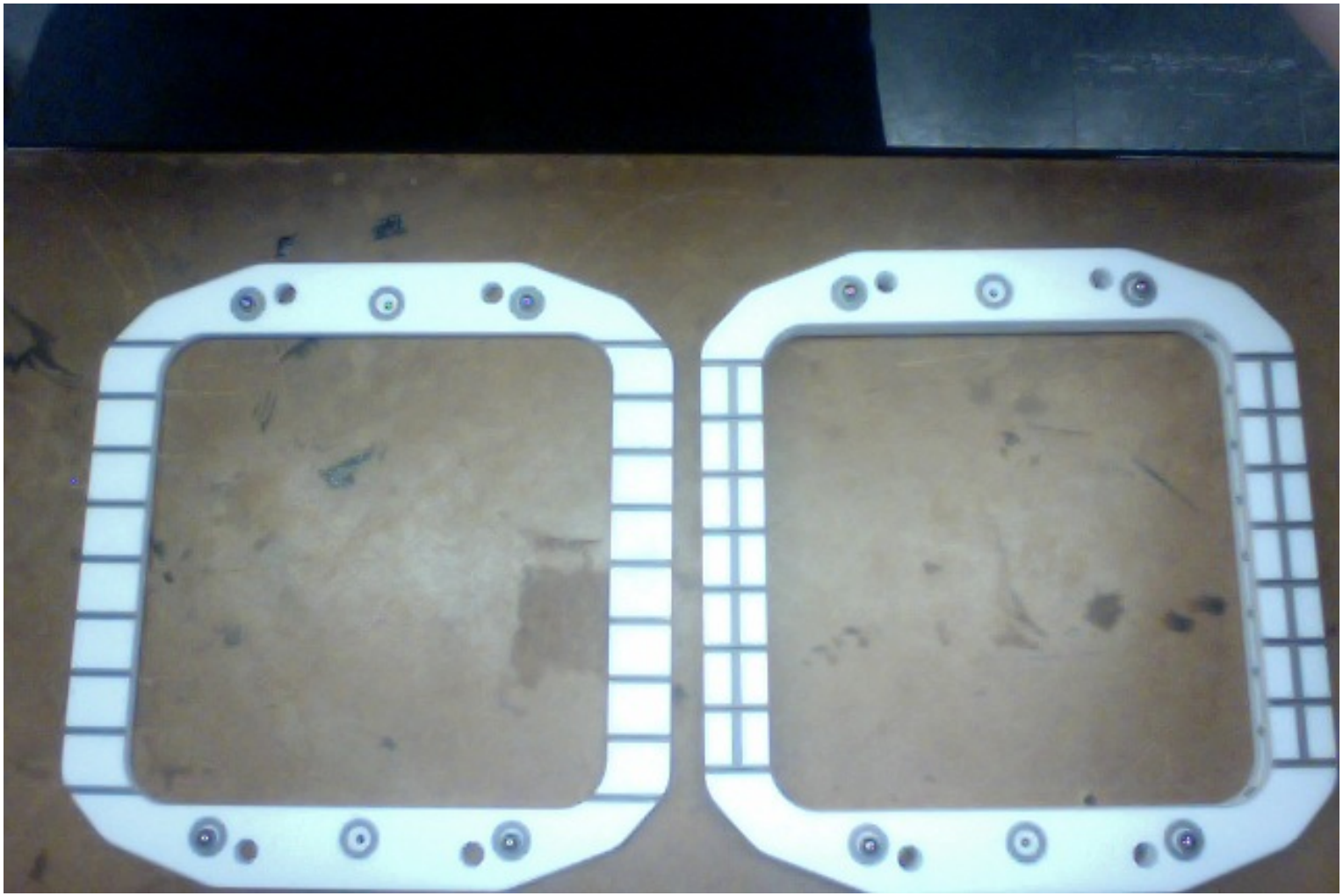


Frame Stack with signal and HV PCB on mount plate



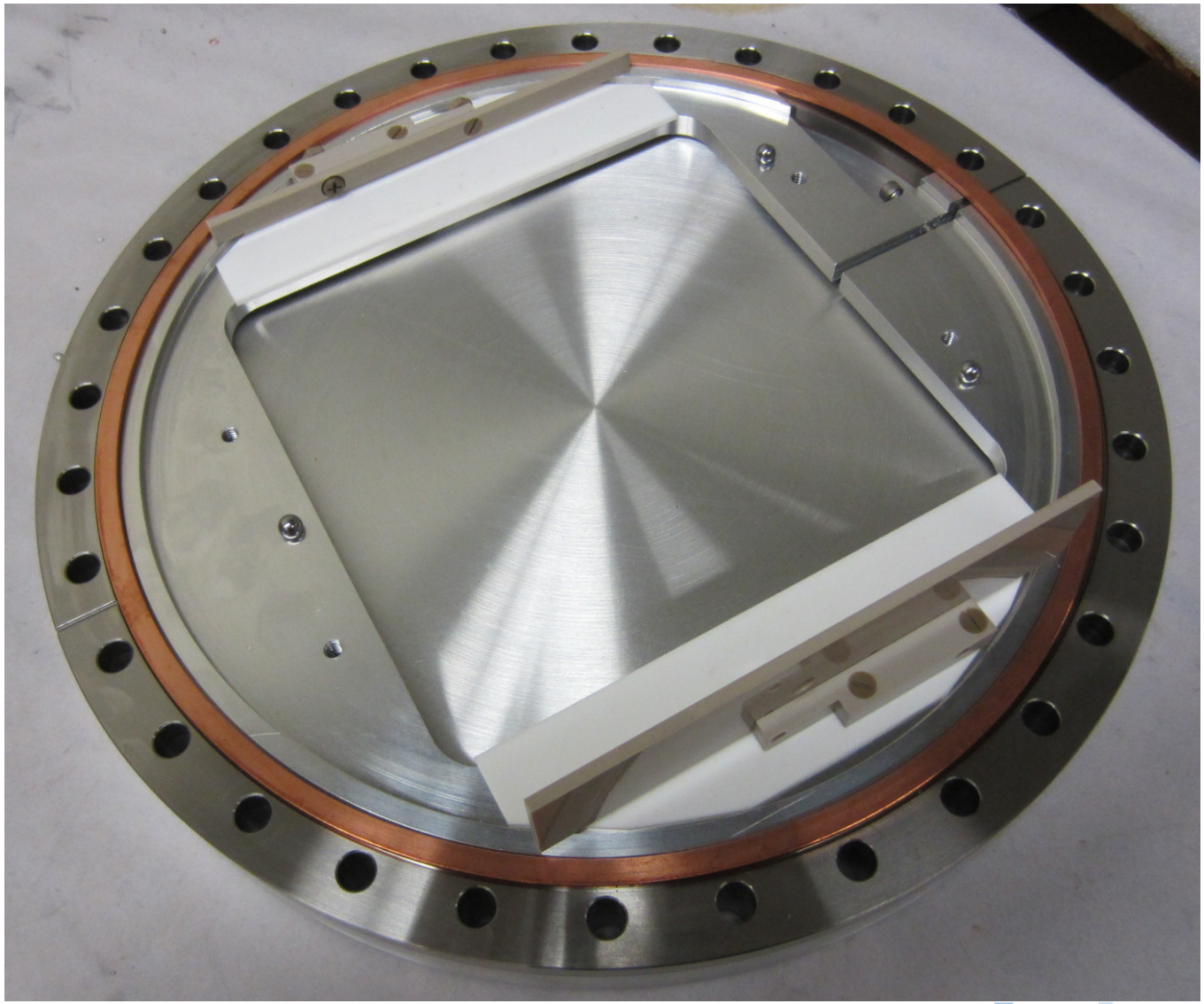
Chamber exterior with all flanges in place.

Target Frames

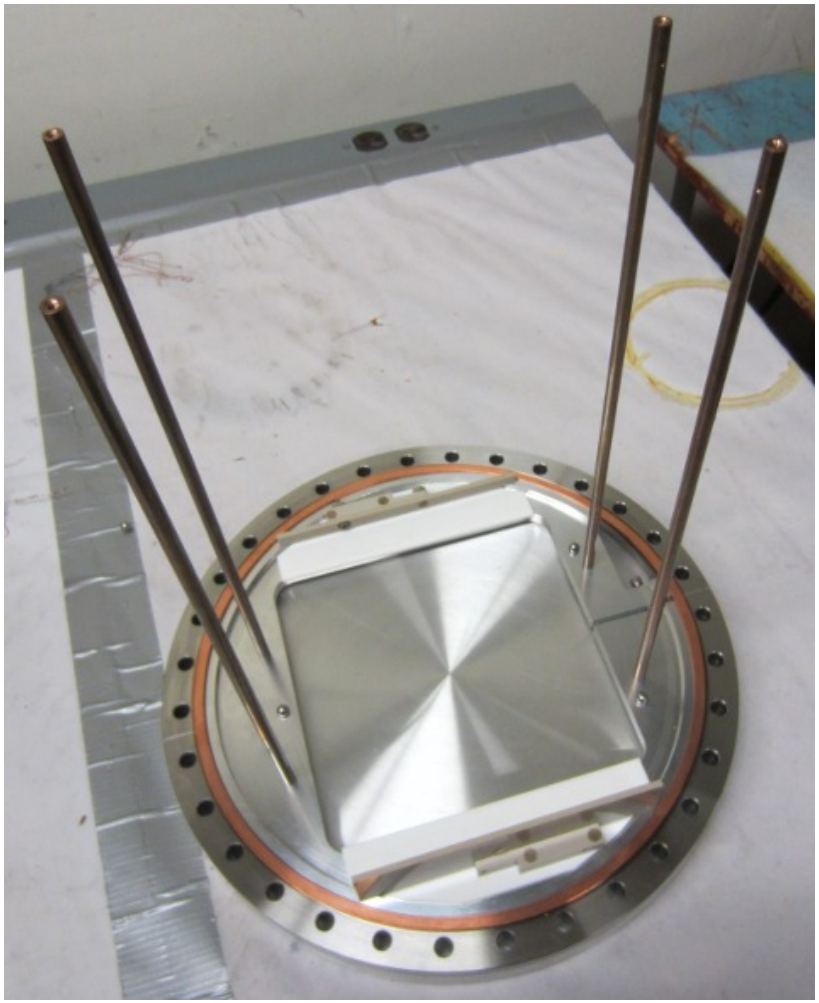


Signal Frame HV Frame

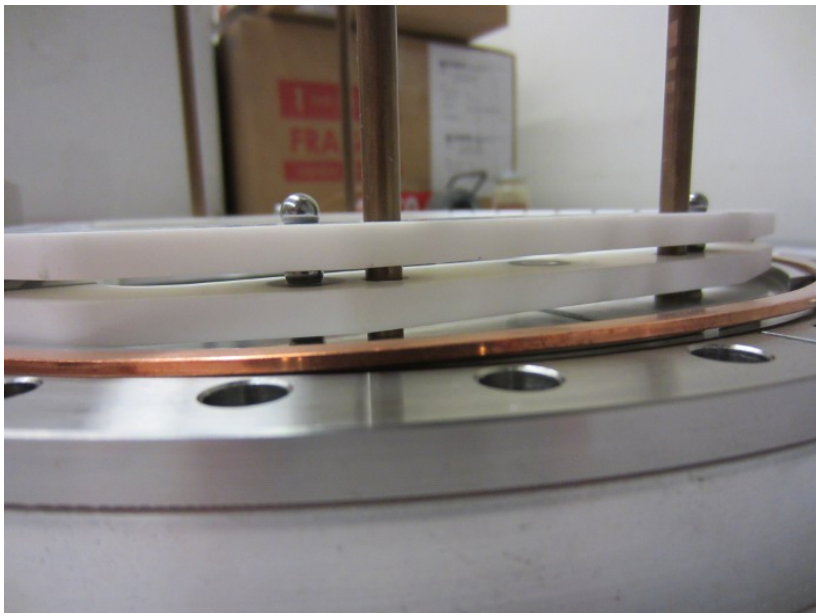
Flange Mount and Shielding



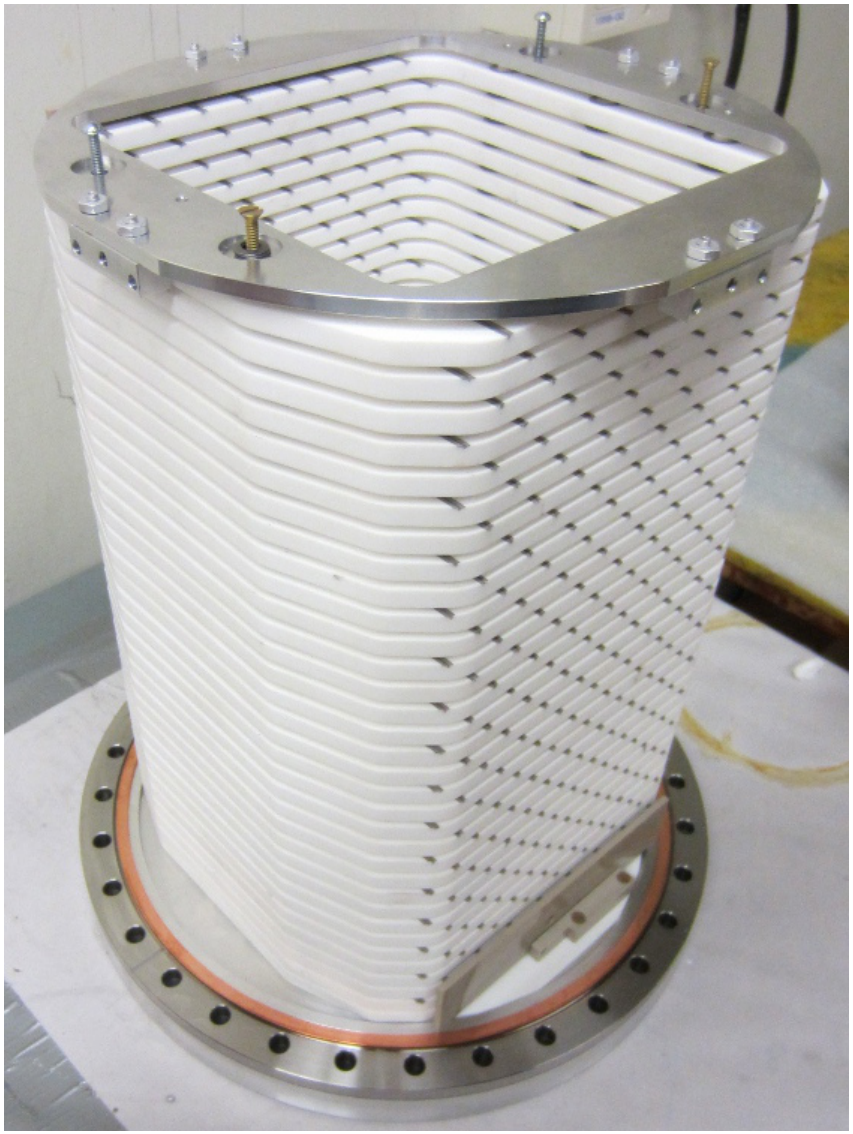
Wire Frame Alignment



- mount plate seats in flange
- 4 compression rods
- 3 point mount sets frame spacing and aligment

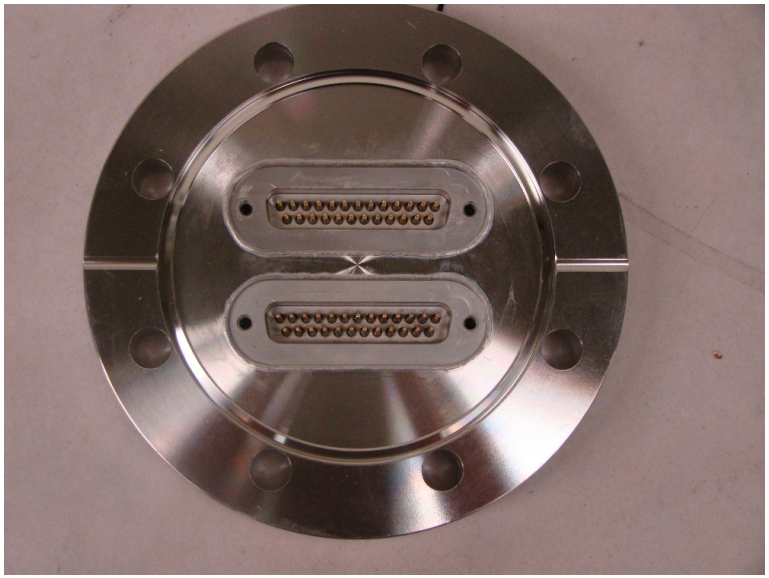


Test Assembly of Frame Stack



- 17 HV frames
- 16 signal frames
- 144 signal wires
- approximate 14 inch height

Signal Feed Thrus and Cables



- 4 Signal Feed Thrus
- Two 25 pin Sub-D cables per flange
- maximum 200 connections, 144 used.
- kapton, PEEK, macor, and copper materials

Current Status

- All parts are on hand.
- Frame Wiring to start end of October.
- Chamber planned to be assembled by end of year
- Testing with electronics to start next year.

n3He Collaboration

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