The n3He Experiment: Current Status

for the n3He Collaboration
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DNP 2014 Hawaii

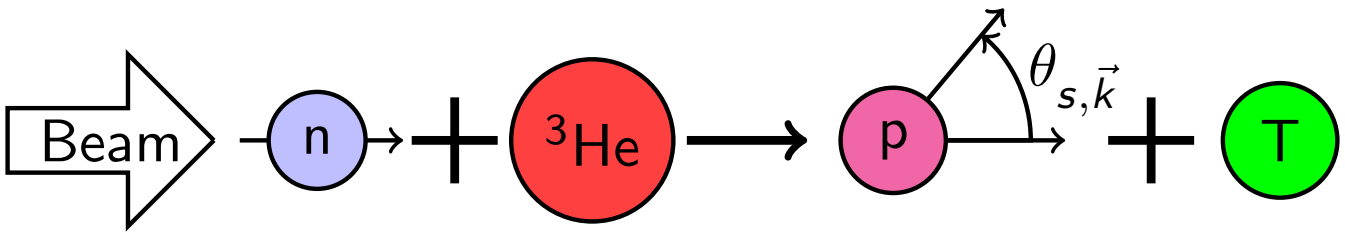
The n3He Experiment: Current Status

- Motivation for n3He
- n3He Setup
- n3He Parts
  - Target Chamber
  - Preamps
  - ADC
  - Spin Flipper
  - Collimator
- Beam Scan

n3He Introduction

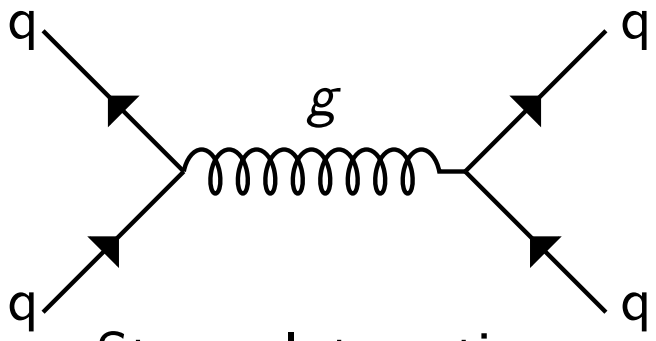
n3He probes the weak nucleon-nucleon interaction by measuring the parity violating directional asymmetry between the polarization direction of the incoming cold neutrons and the direction of the outgoing protons in the reaction

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

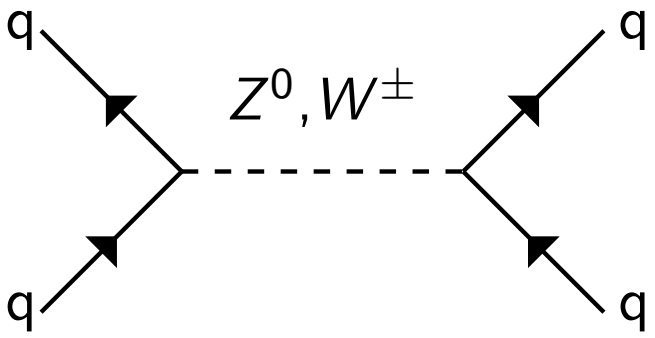


The asymmetry is expected to be small around 10^{-7} and out goal is to measure it to 2×10^{-8}.

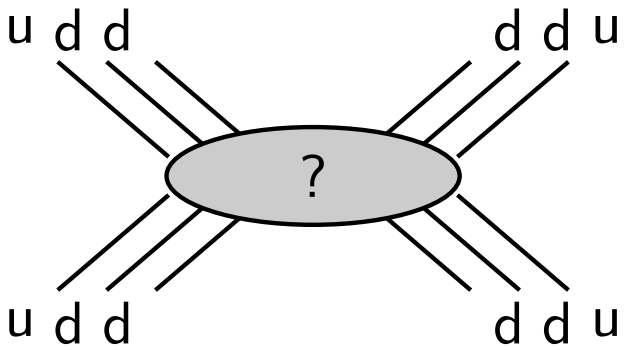
Theoretical Motivation



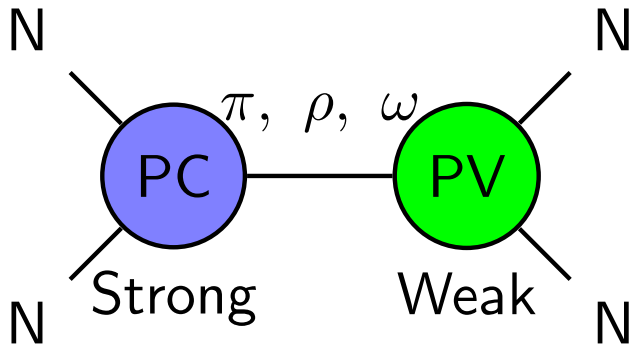
Strong Interaction



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

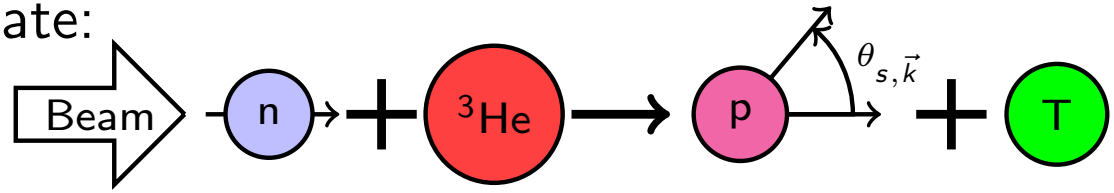
Under a parity transformation P polar vectors such as the momentum transform as

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

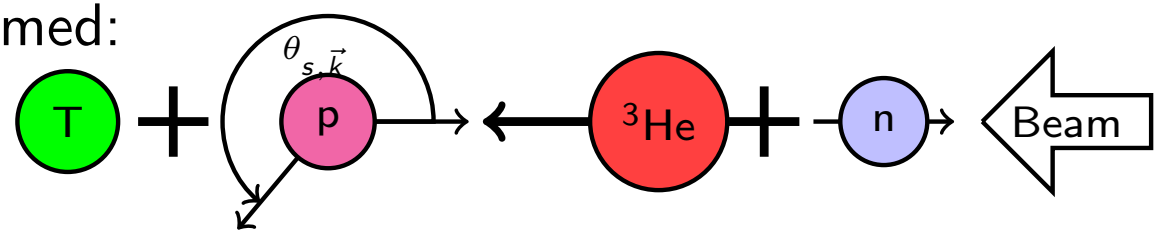
but axial vectors, such as the neutron spin, remain unchanged

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

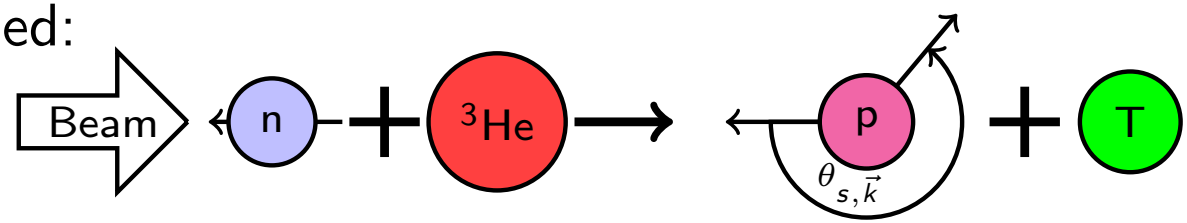
Orignal State:



Parity Transformed:



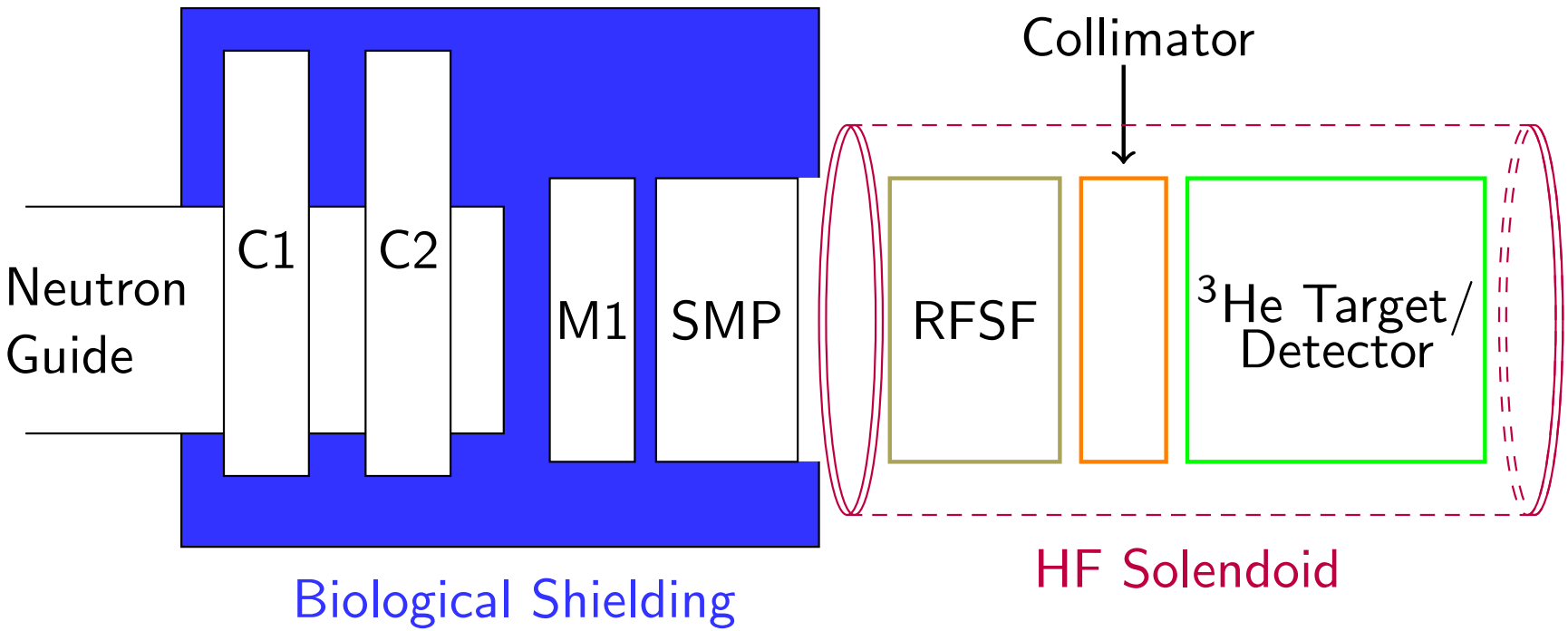
Spin Flipped:



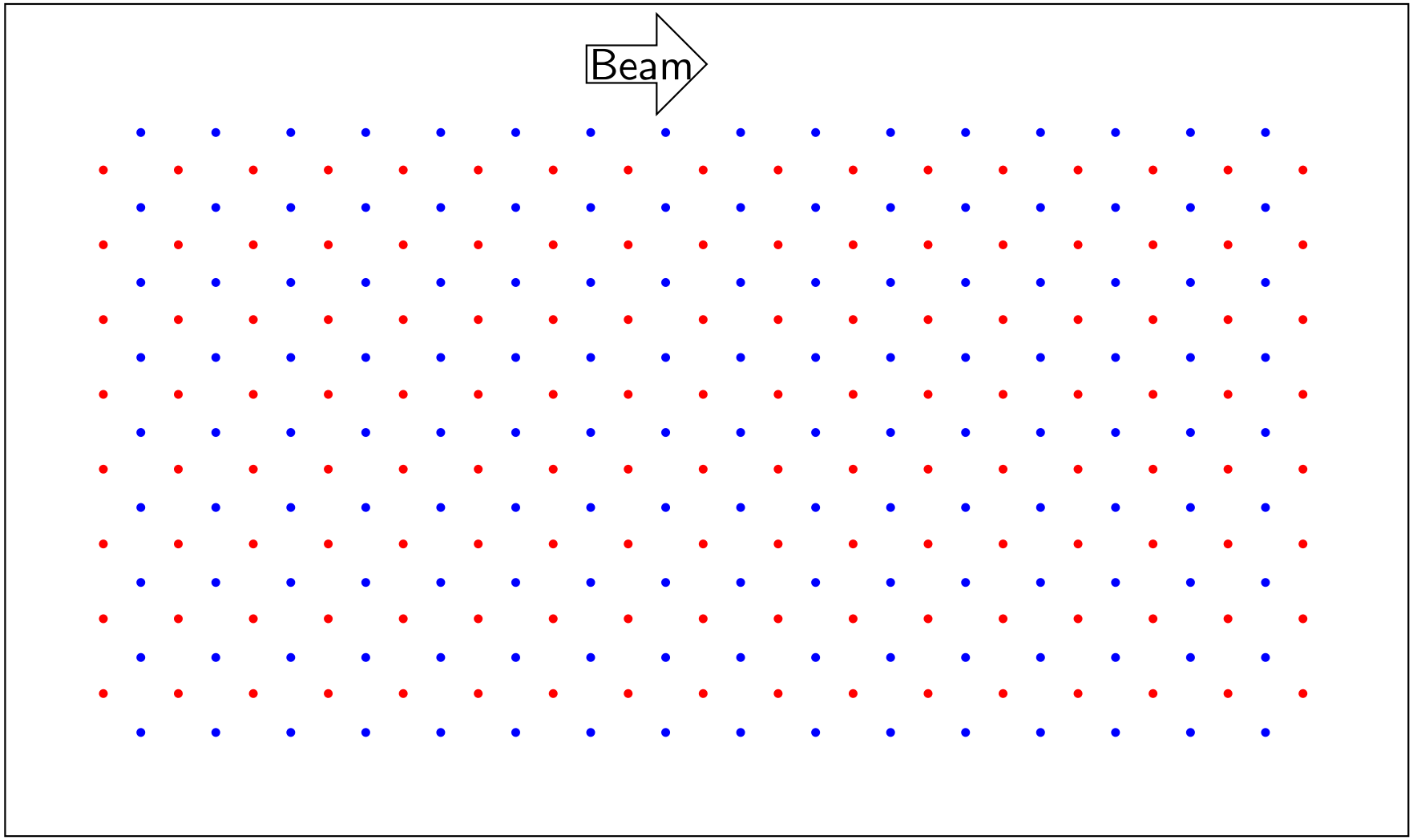
Spallation Neutron Source

- 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

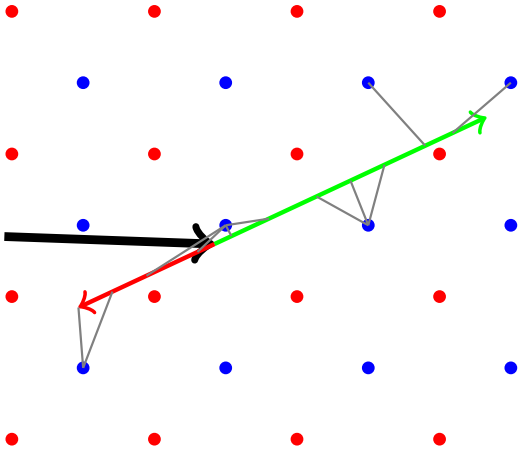


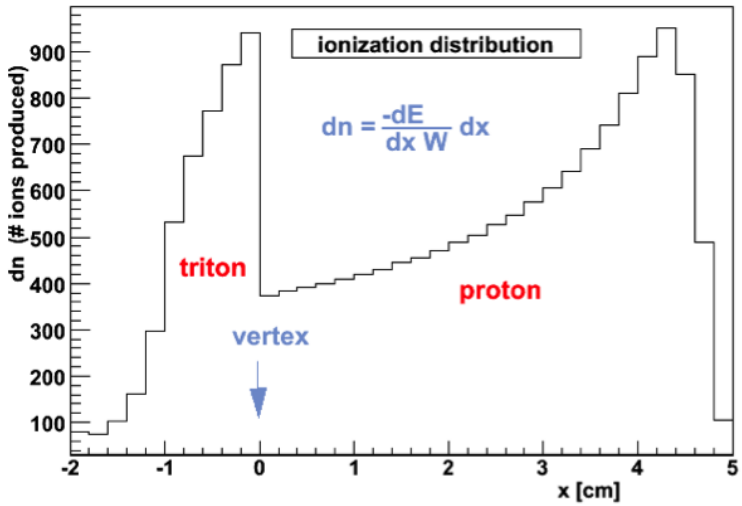
- HV 17 HV Frames with 8 wires each
- Signal 16 signal Frames with 9 wires each

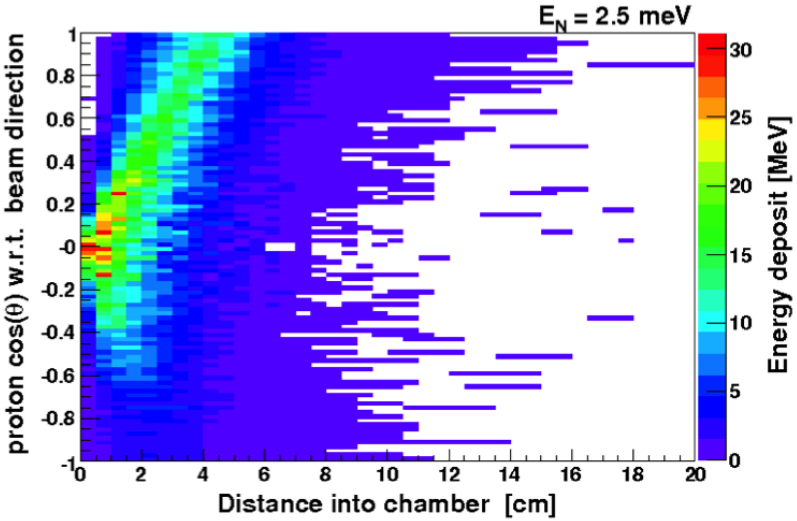
Helium-3 Fill Gas

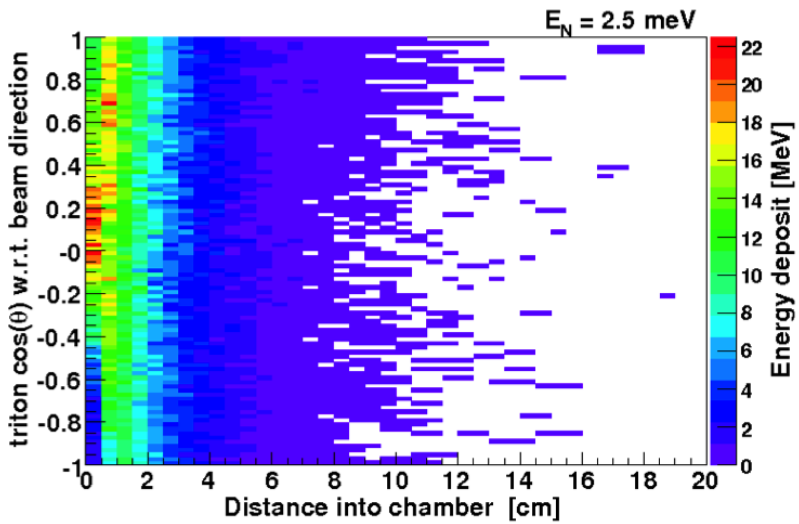
Proton Asymmetry in Chamber

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

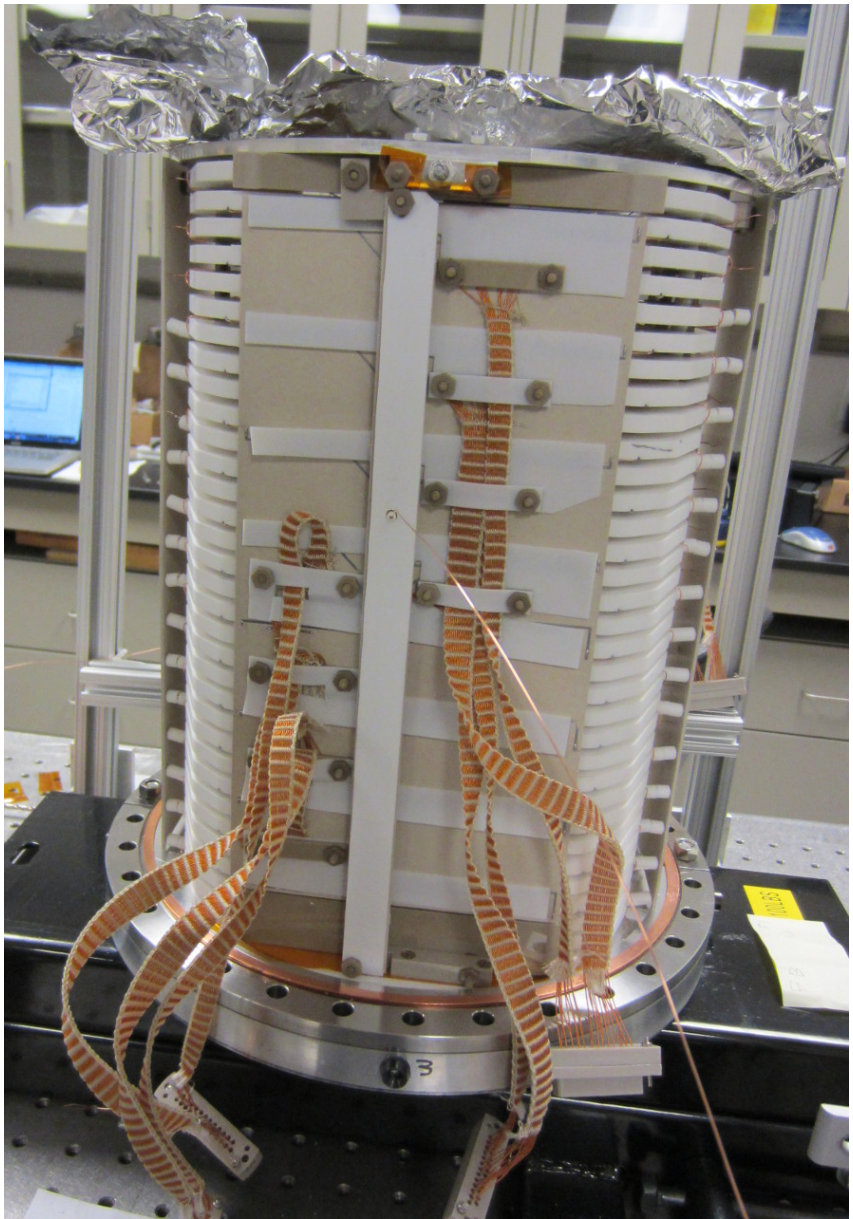






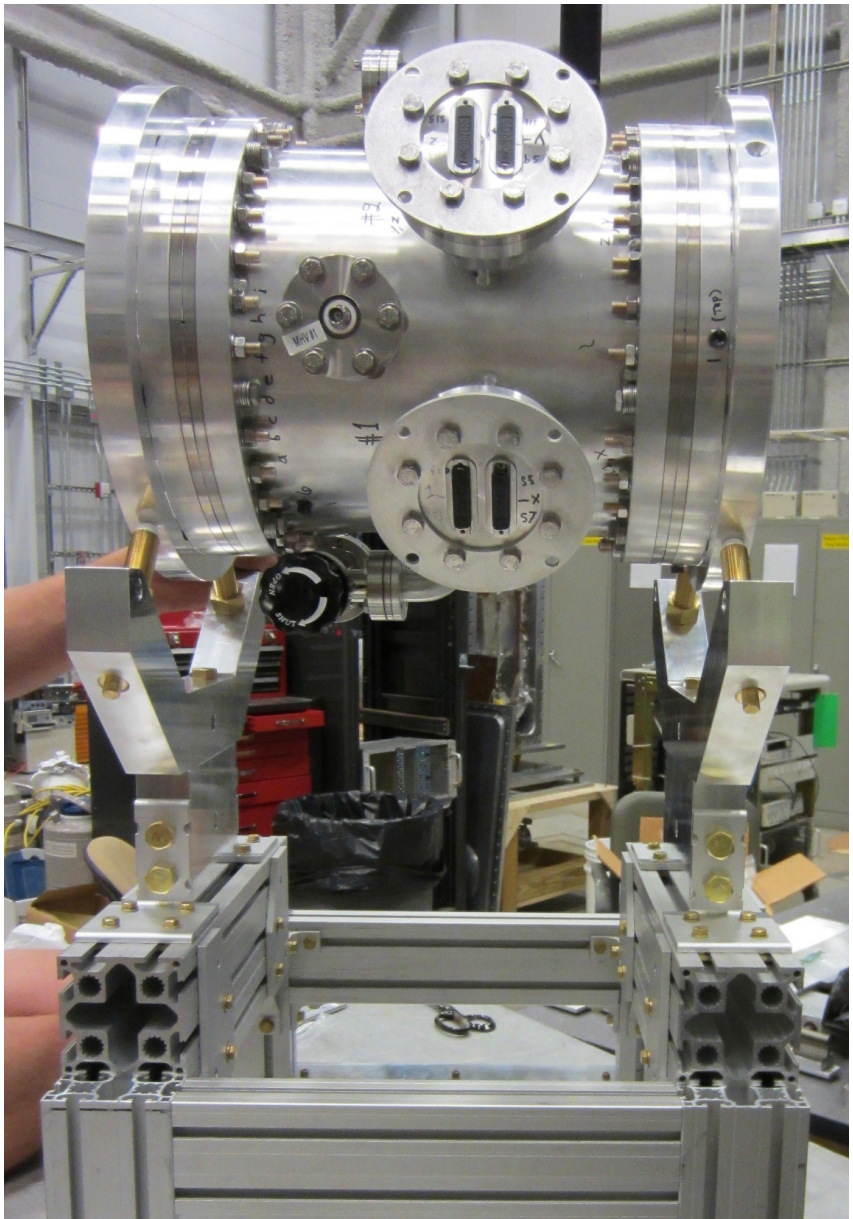


Frame Stack Assembly



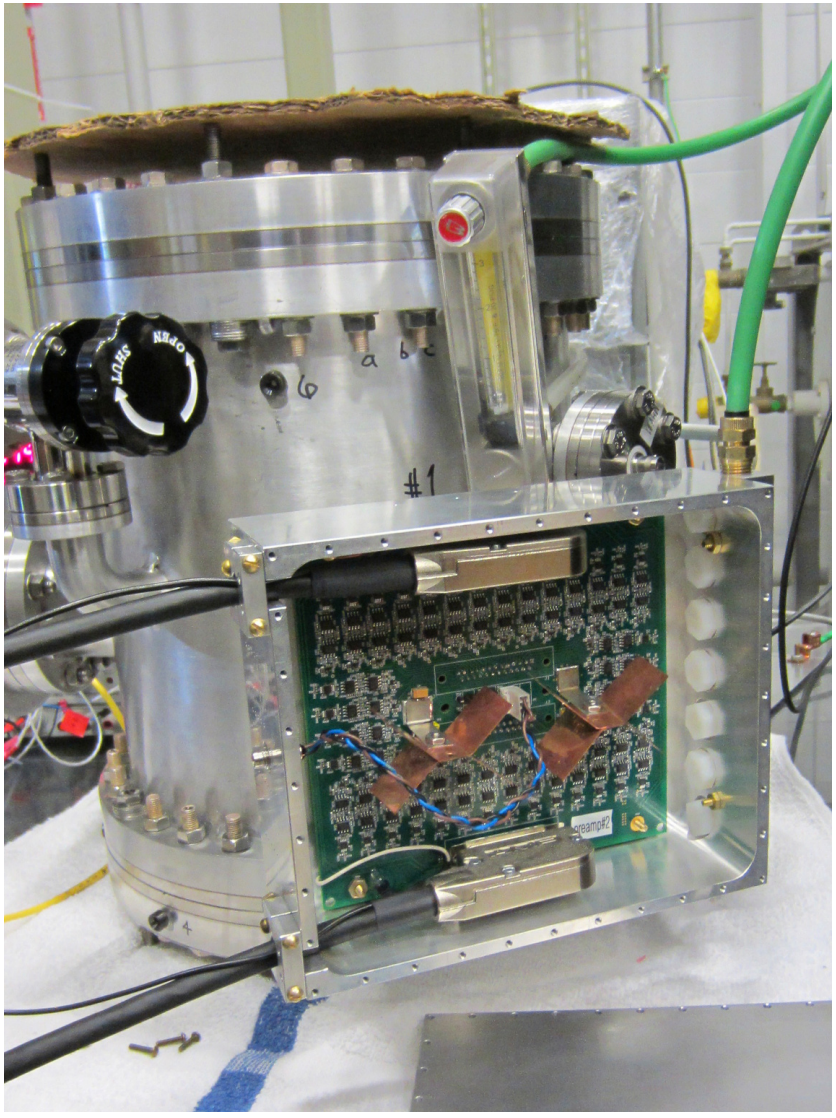
- 33 wire planes
- Machined from macor ceramic
- 3 point mount between planes
- 144 signal wires readout individually
- Teflon and Kapton used for HV shielding
- Kapton Insulated ribbon cable used to connect to signal feed thrus

Chamber Assembly



- 1mm aluminum windows
- 4 signal feed thrus
- 2 gas feed thrus
- 2 HV feed thrus
- Helium Leak Checked at 10e-10 mBar l/s
- HV Tested to 1100V in He-4
- 4 point stand allows roll, pitch, yaw, and height adjustments

Signal Preamps



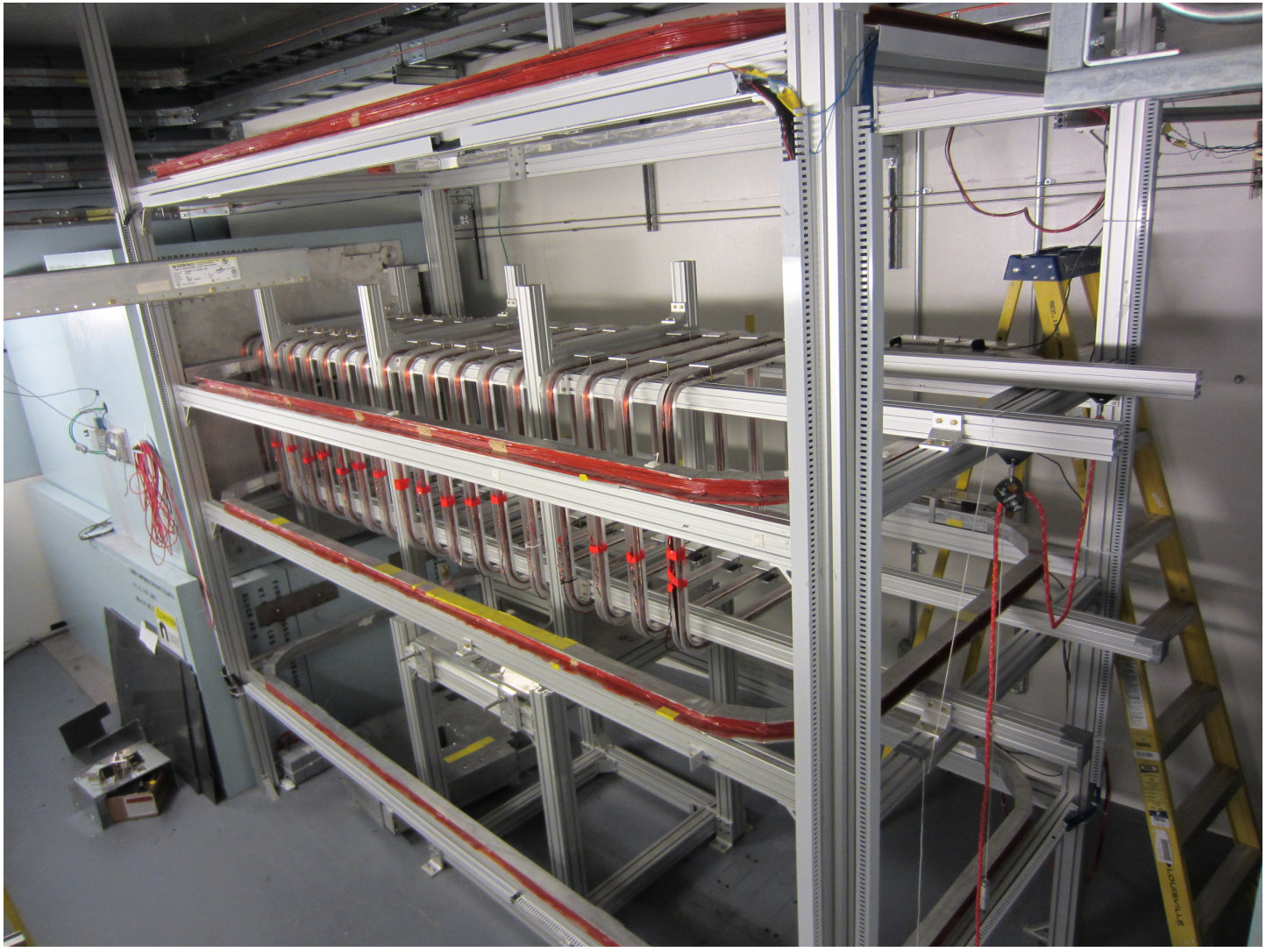
- 4 preamp boards
- 36 channels/board
- plugs directly to chamber feed thru
- 44 pin plugs out to ADC
- Forced air cooling to control temperature
- testing of preamp performance with chamber underway.

Delta Sigma ADC from d-tAqc Solutions

- current to voltage preamps
- 24 bit resolution
- Two 24 channel inputs
- 5 DAQs to be used

- 4 for chamber signal readouts
- 1 for other signals
- Has small instrumental asymmetries $\sim 10^{-10}$

Magnetic Holding Fielding Coils

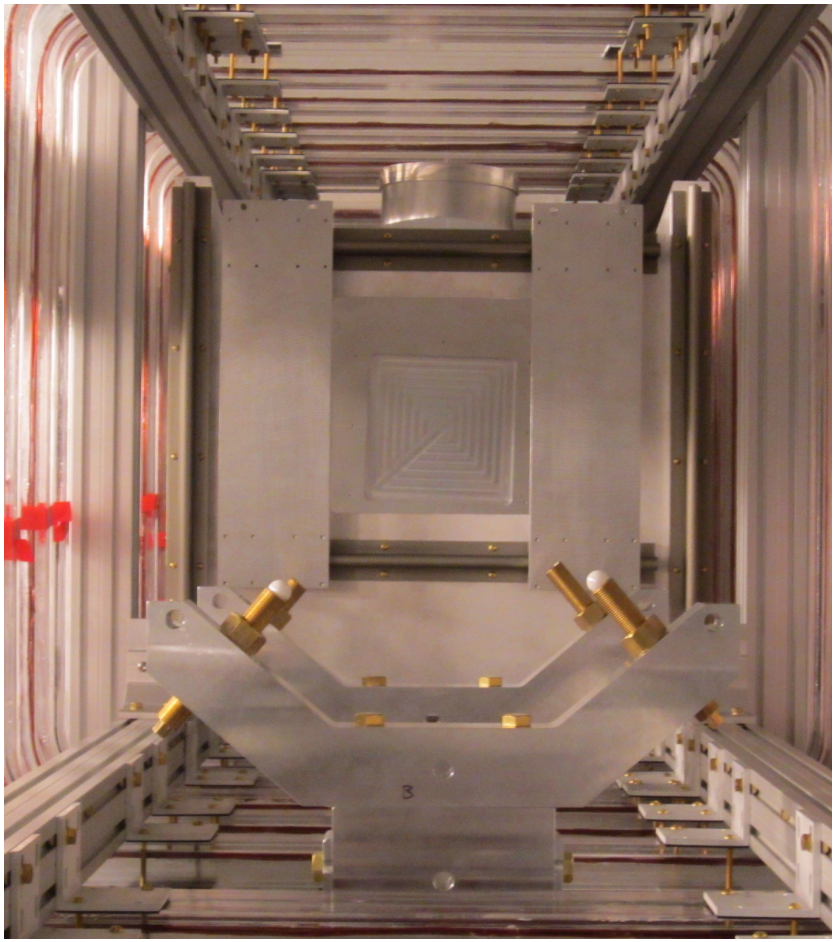


Two sets of magnetic holding field are present that can be used to maintain a transverse or longitudinal neutron polarization.

Radio Frequency Spin Flipper

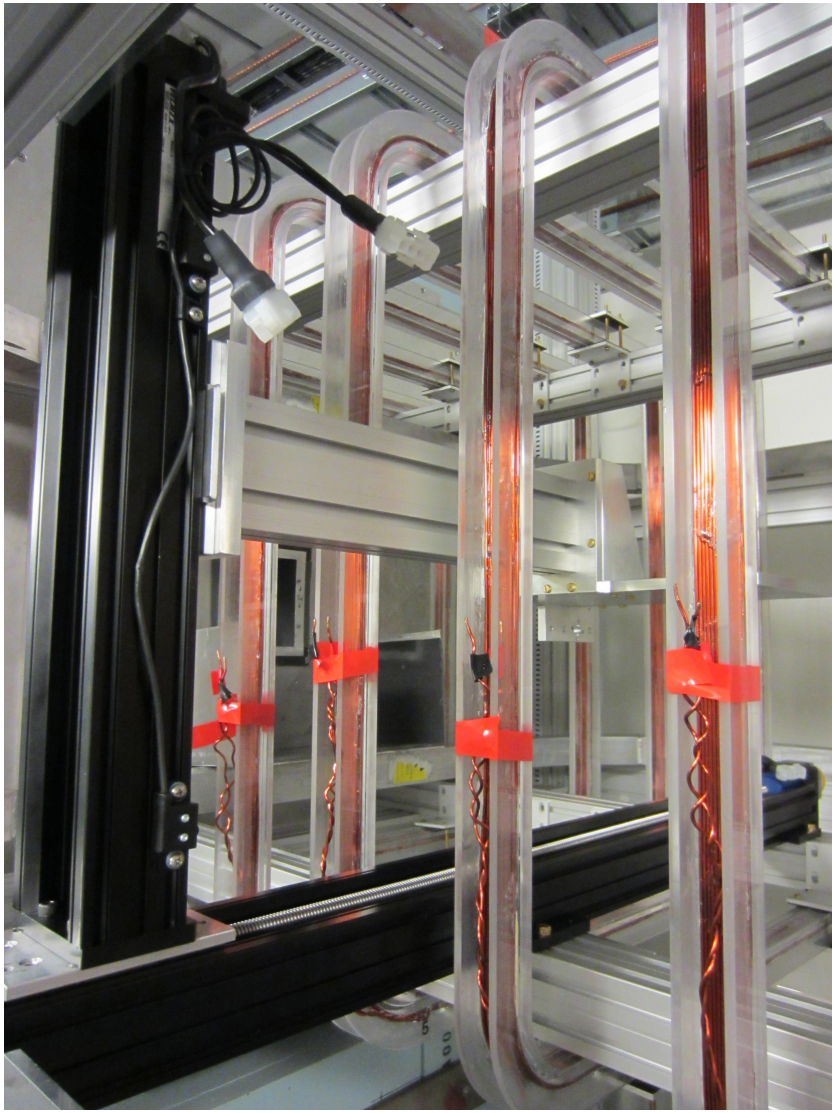
- Used to flip neutron spin in a sequence to control systematic effects.
- Constructed with double Cosine-Theta coils
- homogeneous internal field
- near zero external field will not interfere with other components
- Electrical testing is completed

4 Jaw Collimator



- Collimator used to control beam area
- Li plastic over Cadmium metal
- 4 jaws are independently adjustable

Neutron Beam Scan



- Experiment components needs to be aligned to beam center and direction.
- Two xy tables will be used to scan for beam center
- Laser system used to reference centers
- Scanner hardware assembled
- Control software in progress

Summary

- Magnetic Field Coils in Place
- Spin Flipper Assembled
  - Electrical Testing Completed
- Collimator Assembled
- Chamber Assembled
  - HV testing complete
  - Helium leak testing passed
- Chamber Being Tested with preamps and ADC
- Magnetic Field uniformity testing underway
- Neutron beam scan to find centroid planned
- Before end of year expect to see neutrons on target.

n3He Collaboration

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