Current Status of a Measurement of Hadronic Parity Violation in the Capture of Cold Neutrons on Helium-3

for the n3He Collaboration

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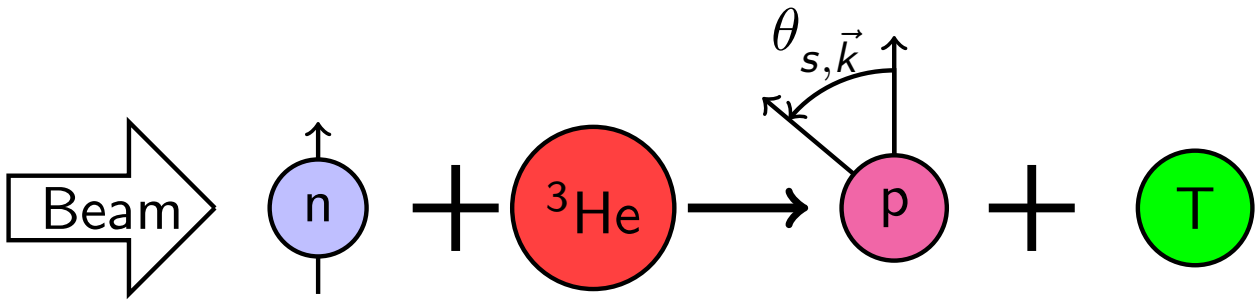
2015 CAP Congress

June 18, 2015

n3He Introduction

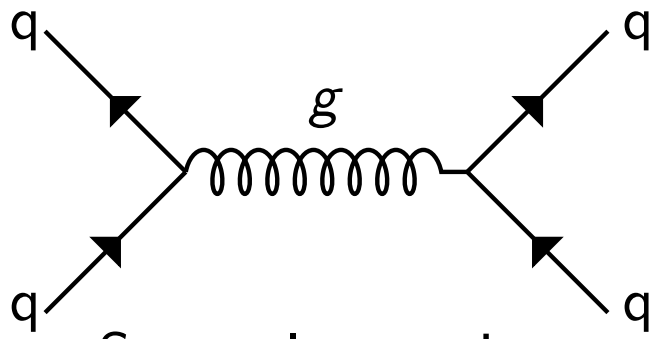
n3He probes the low energy strong interaction, using the weak interaction by measuring the parity violating directional asymmetry in the proton recoil from the reaction

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

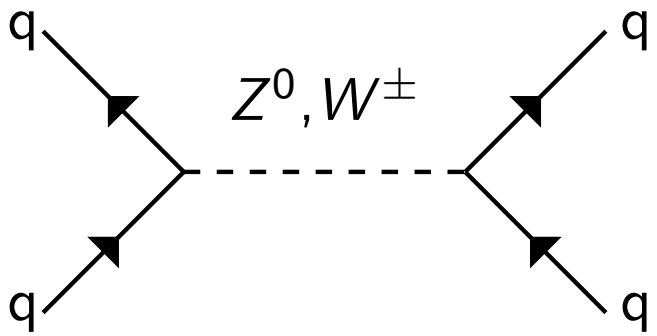


The goal of the experiment is to measure the asymmetry to the 2×10^{-8} level.

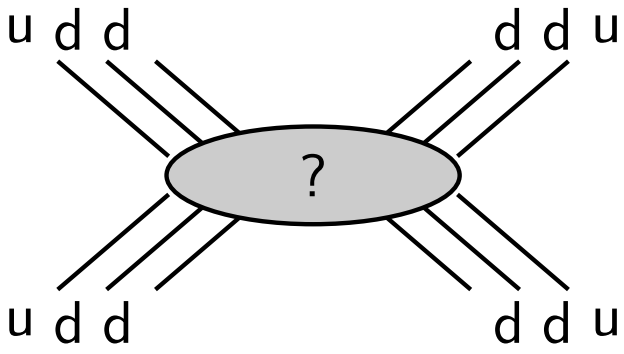
Theoretical Motivation



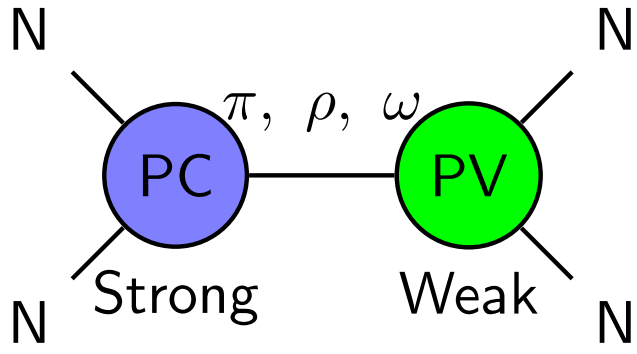
Strong Interaction



Weak Interaction



Uncertain HWI



DDH Parameterization

DDH Meson Exchange Parameters:

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

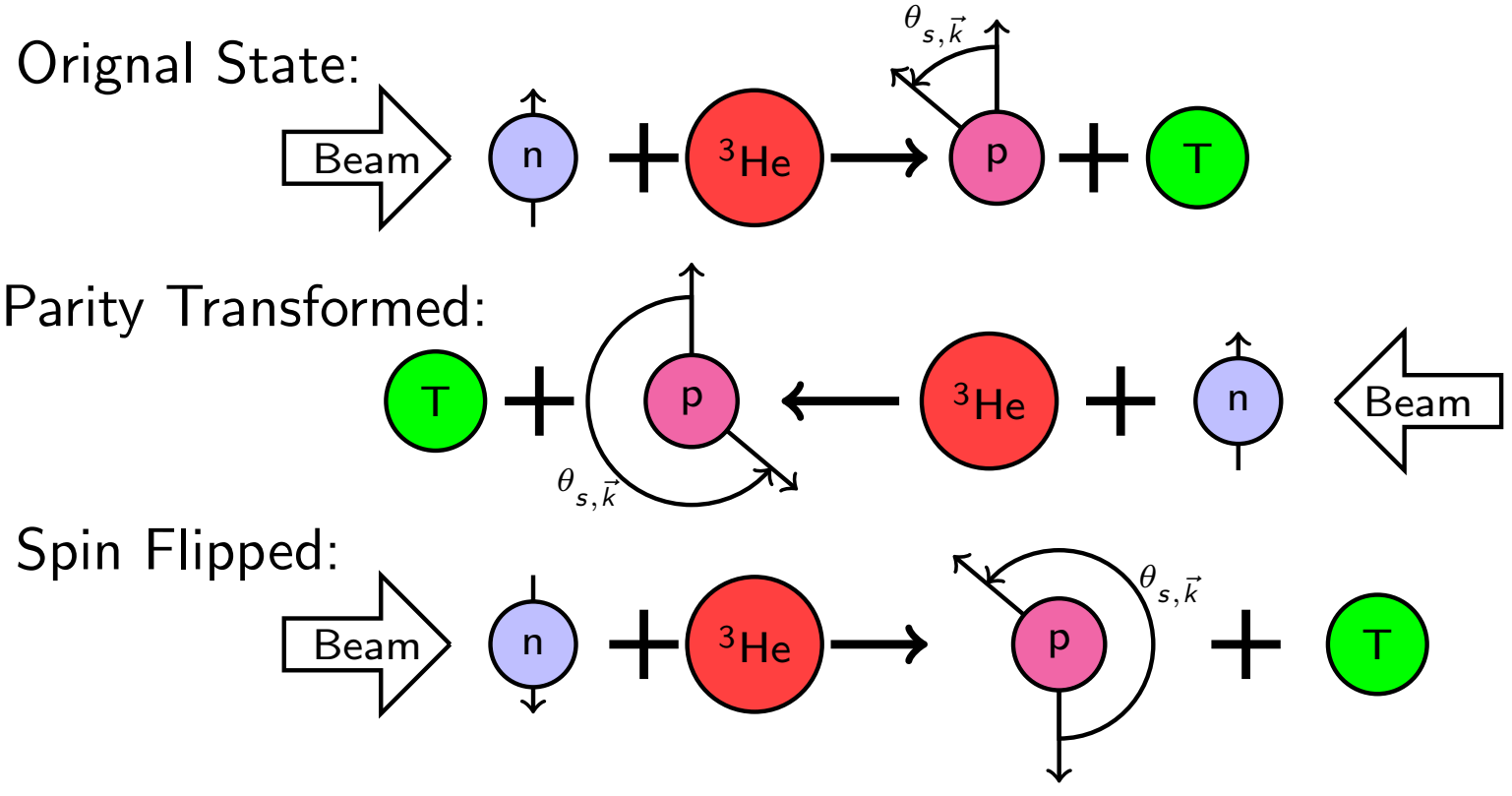
A Brief Look at Parity

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

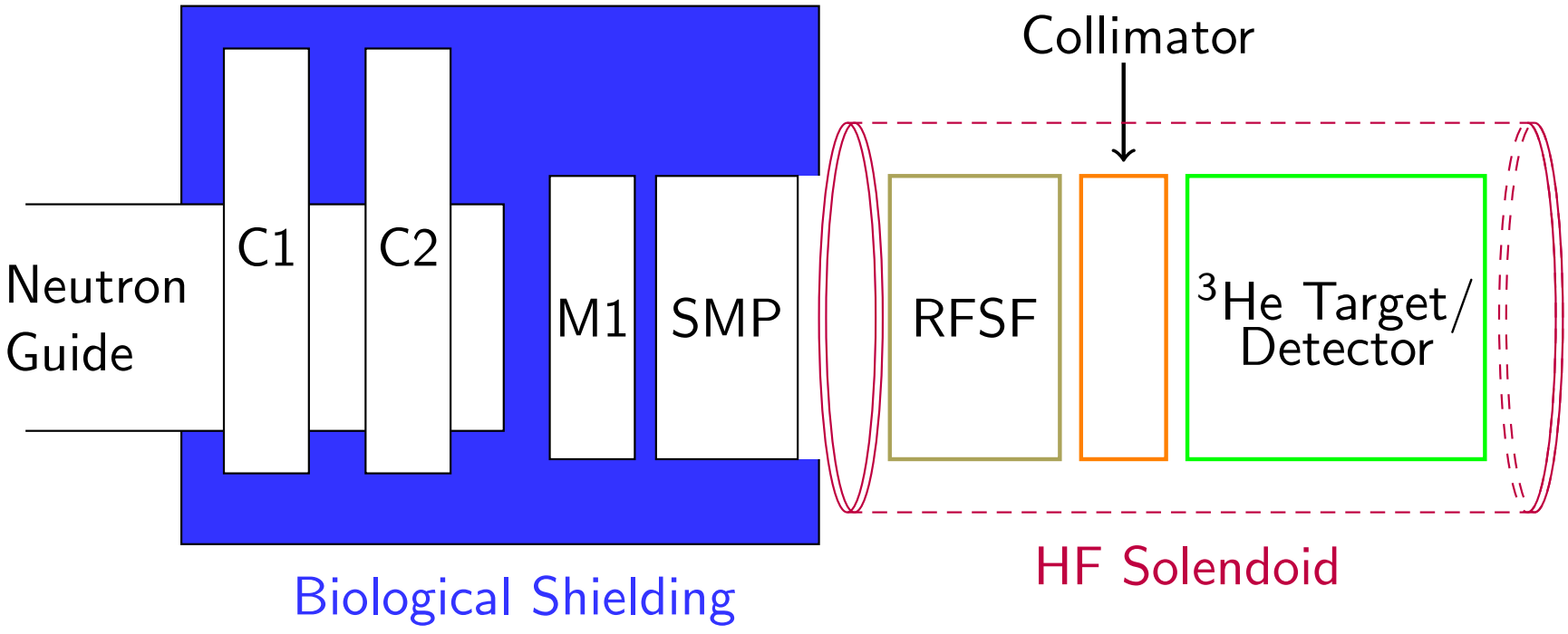
$$P(\vec{s}_n) \rightarrow \vec{s}_n$$



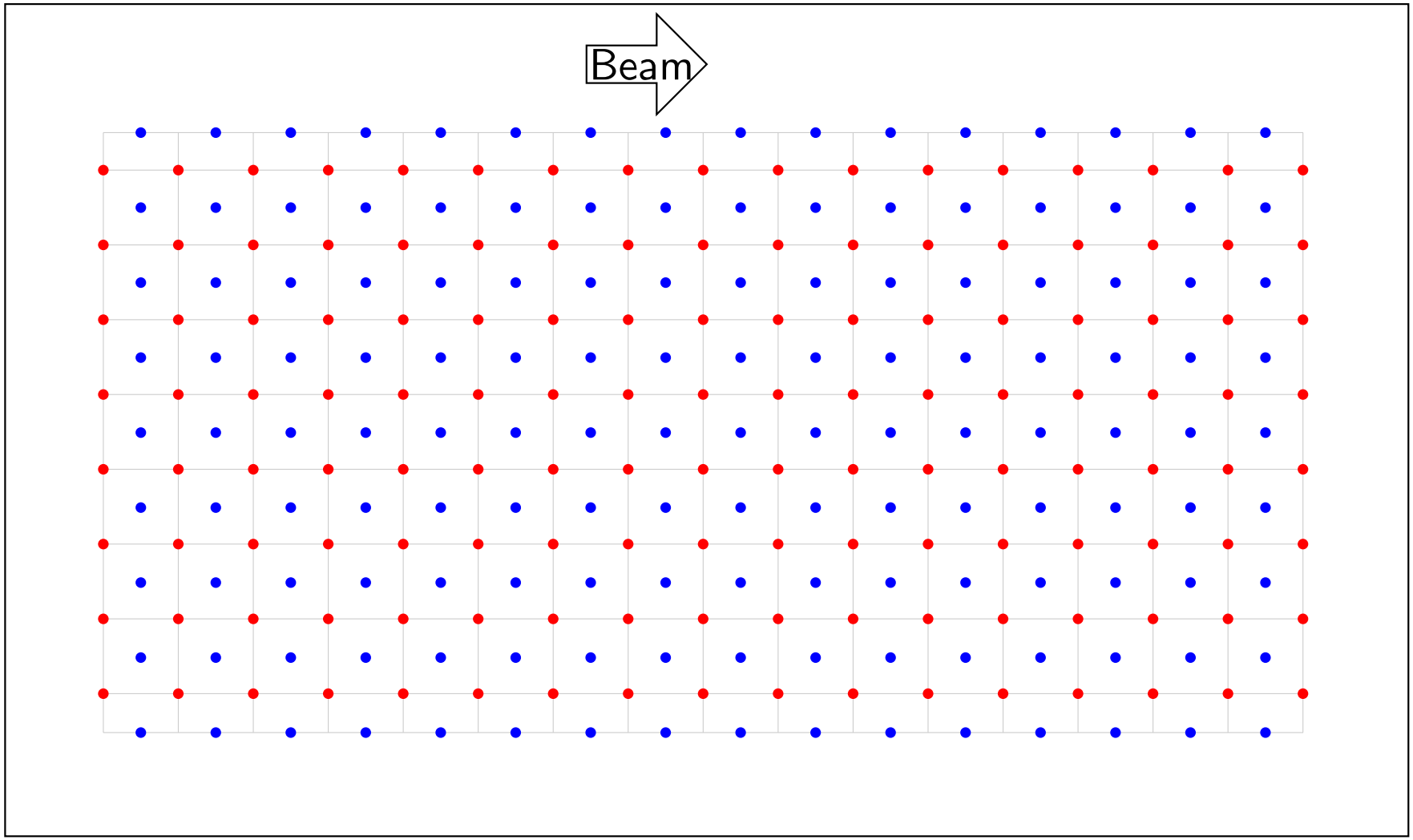
Spallation Neutron Source

- Located at the Oak Ridge National Laboratory (ORNL) in Tennessee
- 60 Hertz pulsed spallation source
- approximately 10^{10} neutrons/second
- n3He is running at the FnPB
- Three 20K liquid hydrogen moderator for cold neutron beam lines

n3He Schematic Diagram

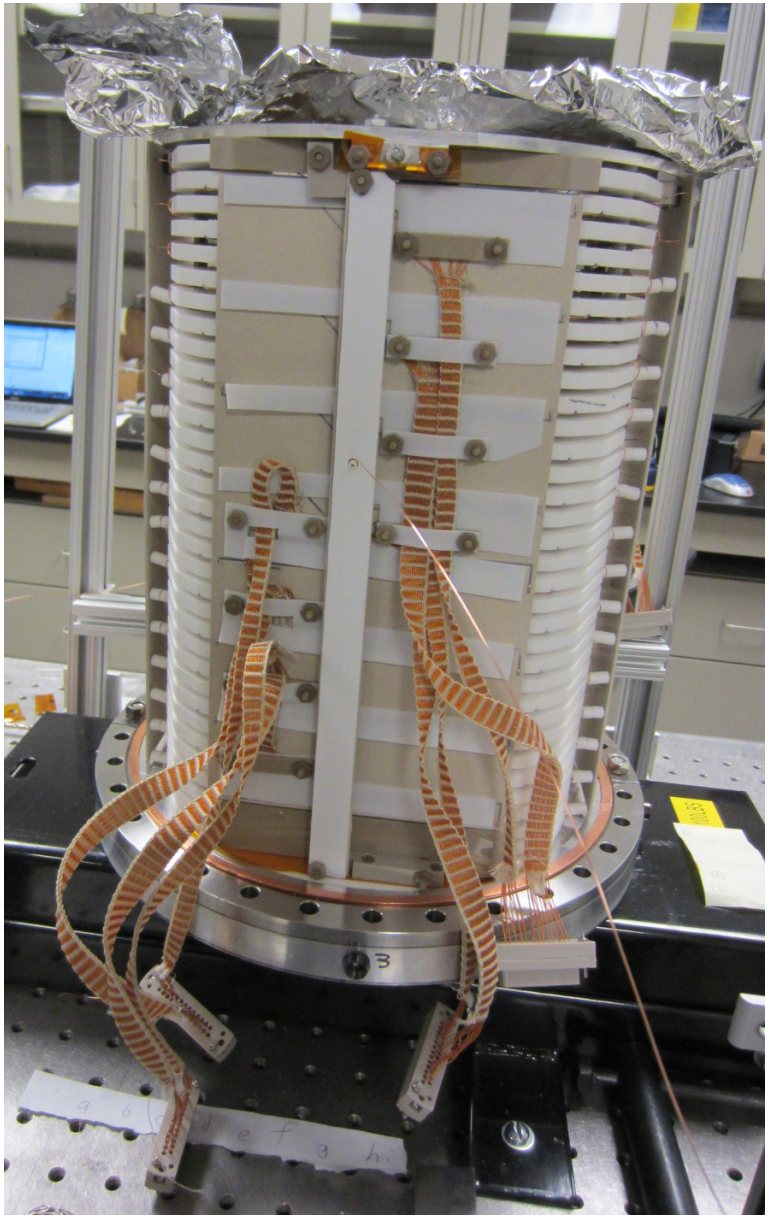


n3He Target Chamber



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

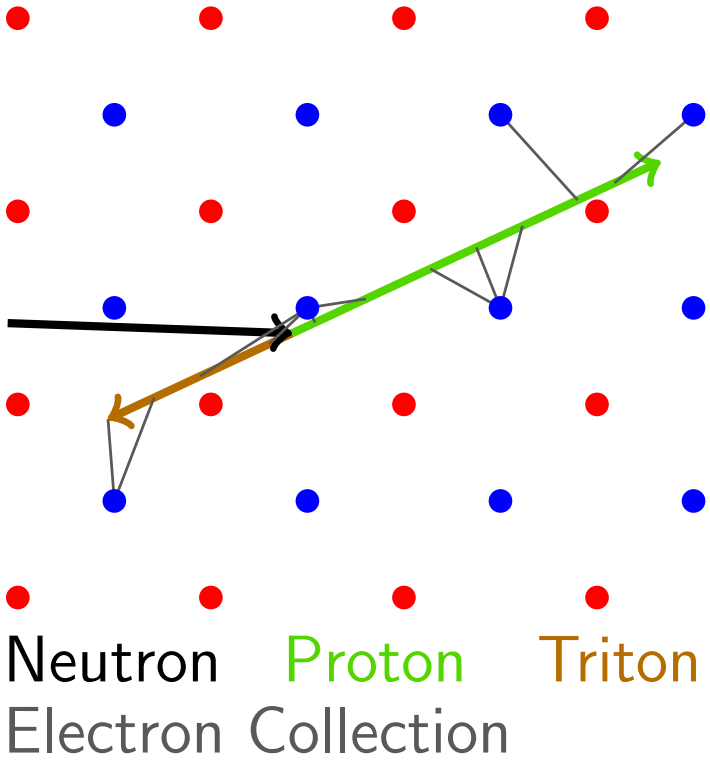
Assembled Frame Stack

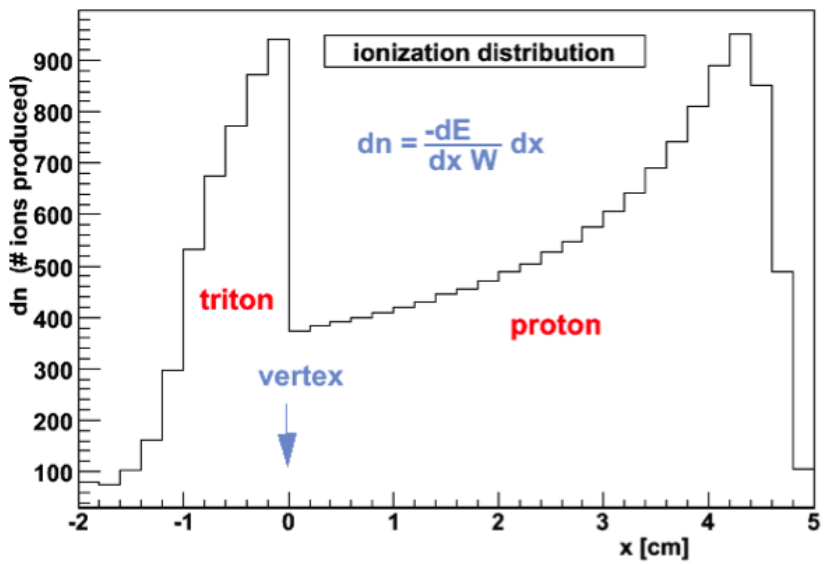


- 17 HV frames
- 16 signal frames
- 9 signal wires per frame
- 144 signals to read out

Proton Asymmetry in Chamber

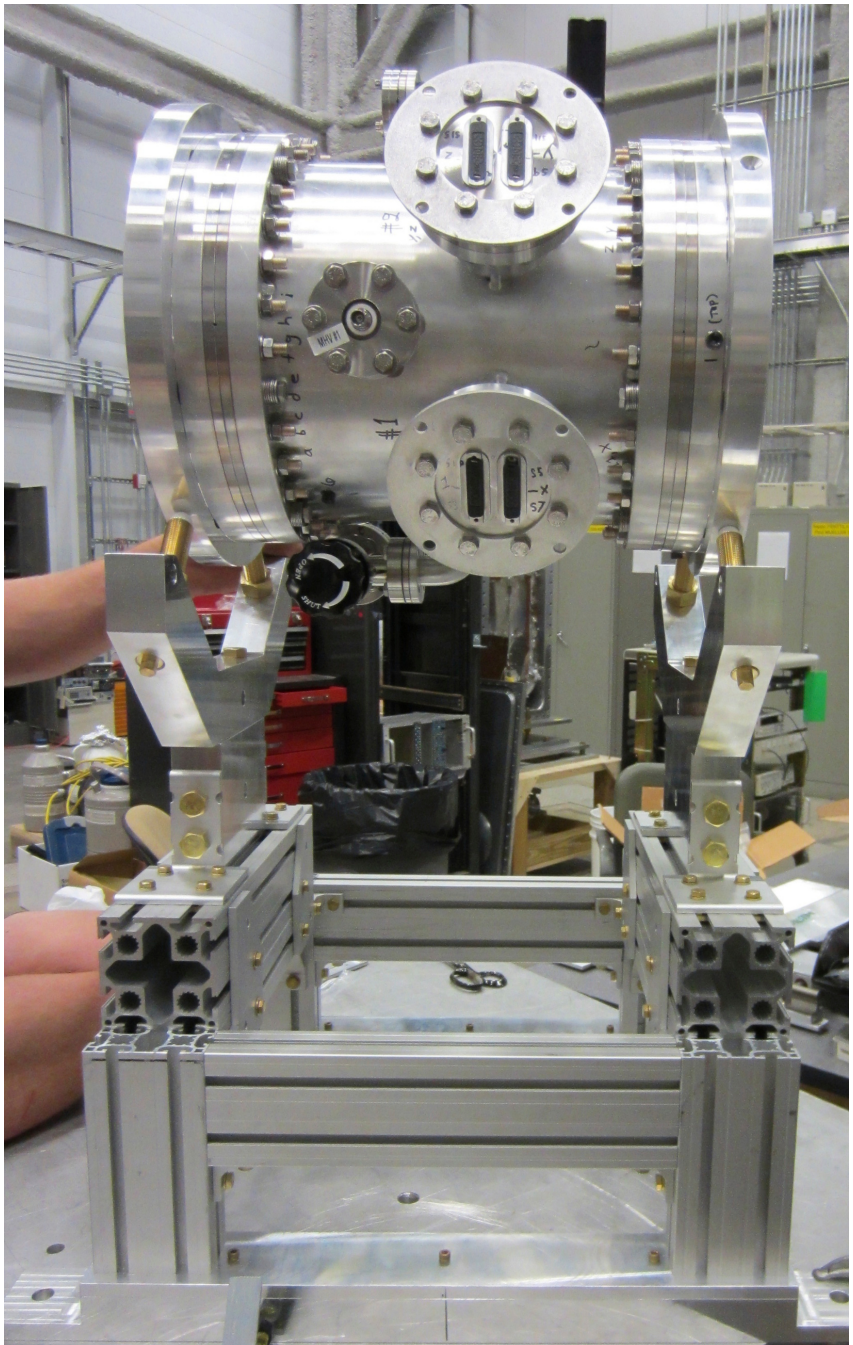
$$\vec{n} + {}^3He \rightarrow p + T + 765keV$$





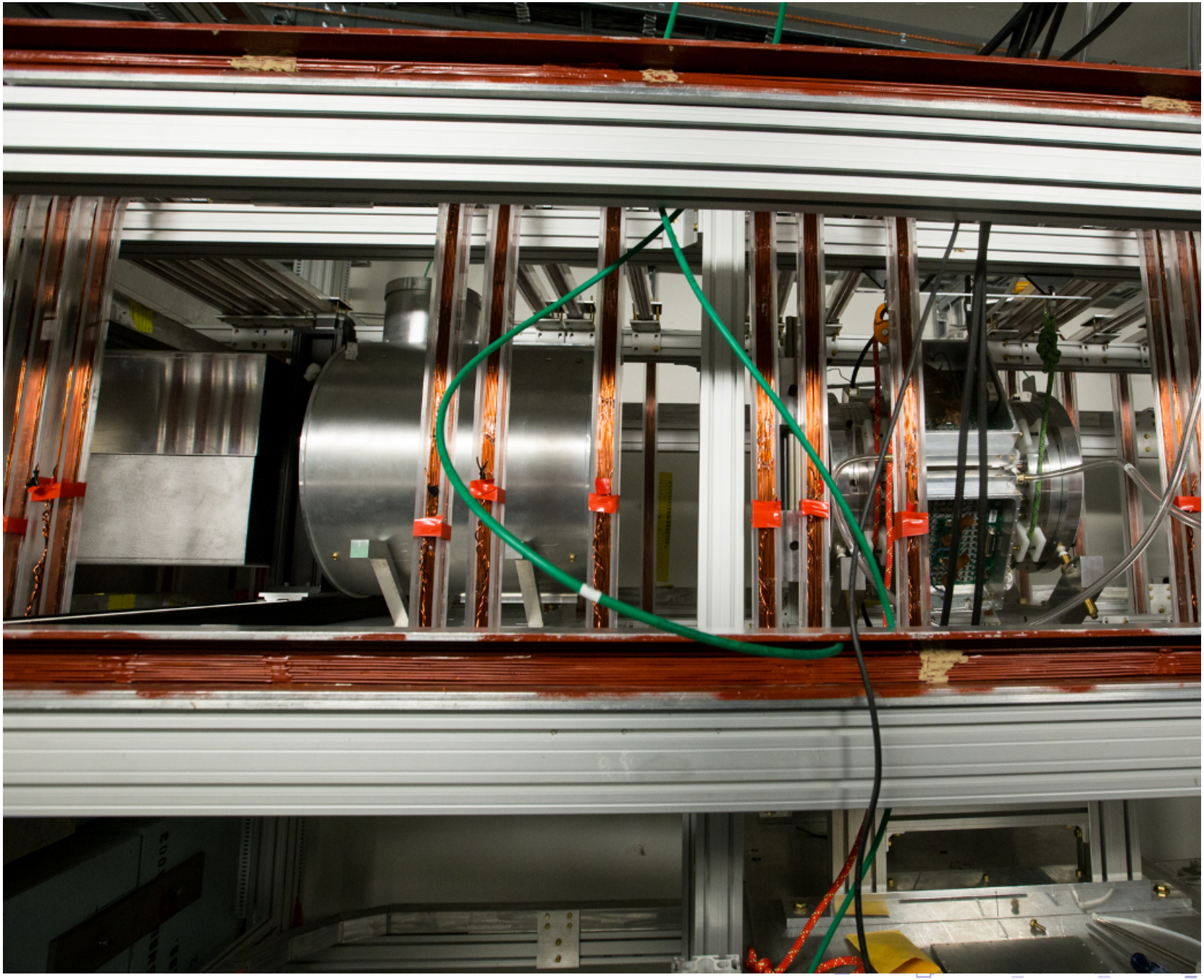
A proton and triton asymmetry occur in the chamber but the longer range of the proton causes its asymmetry to dominate

Target Chamber on Stand

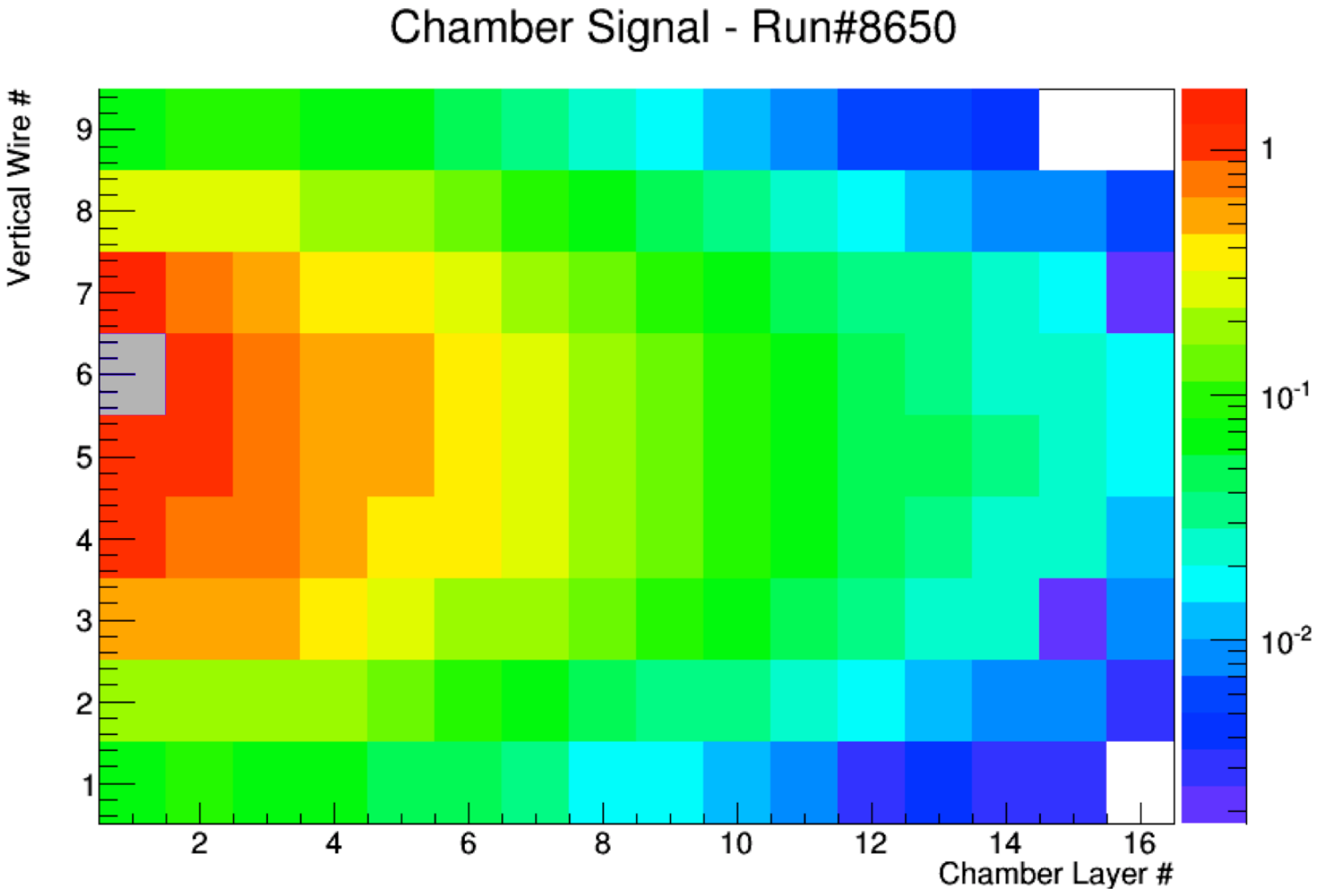


- 4 point adjustable stand
- roll, pitch, height were not independent
- target electrically isolated from stand
- angle block used for initial alignment

Components on Beamline



First Data from Ion Chamber



Ion Chamber Simulation - Garfield++

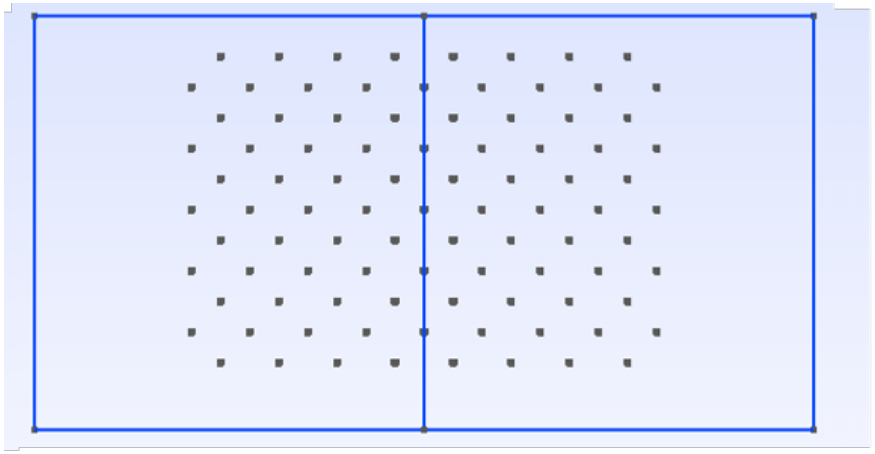
Garfield++ is a toolkit for the detailed simulation of particle detectors that use gas and semi-conductors as sensitive medium.

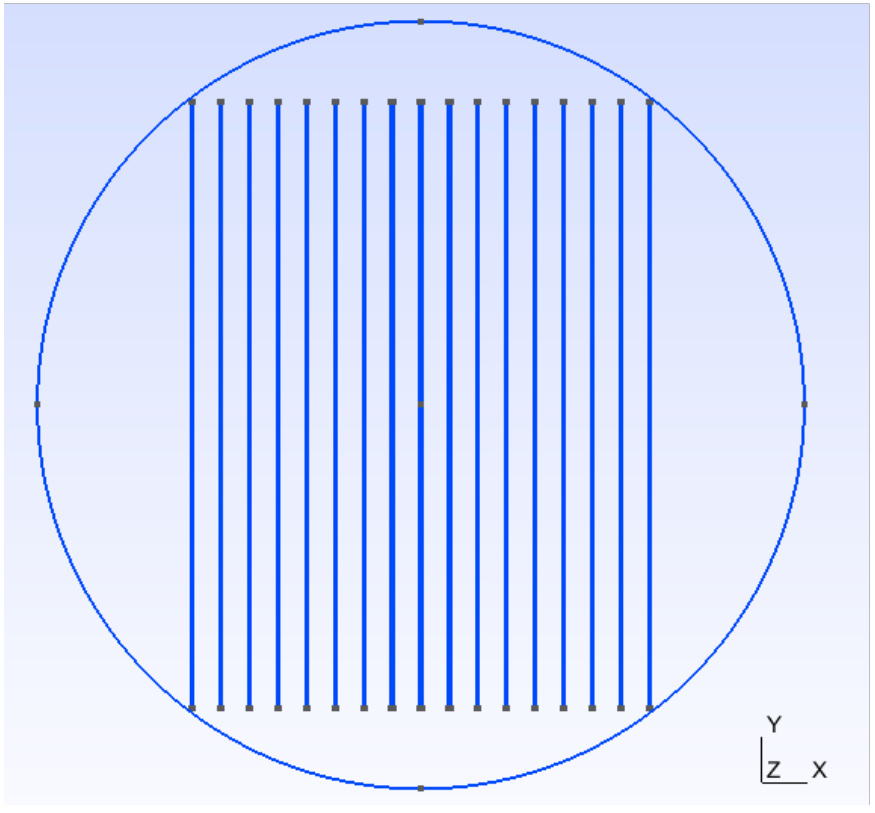
- Gas properties calculated using Magboltz
- Ion Mobility from Data from Atomic Data and Nuclear Data Tables 17, 177-210 (1976)
- Signal calculated with Shockley-Ramo Theorem:

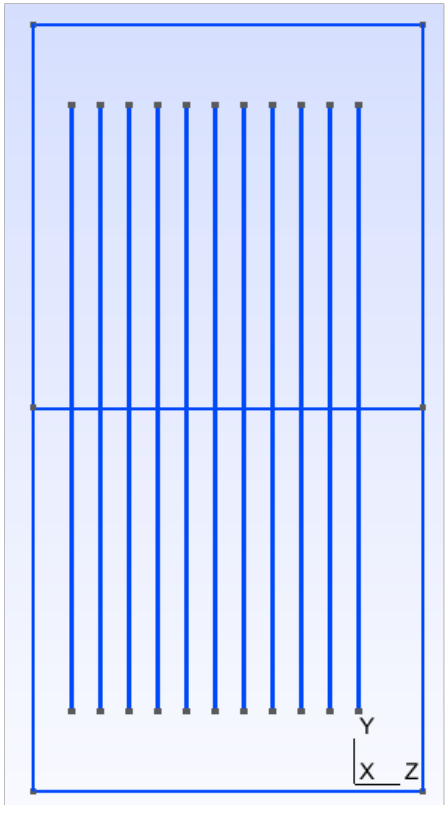
$$i(t) = -q\mathbf{v} \cdot \mathbf{E}_w(\mathbf{r})$$

- $\mathbf{E}_w(\mathbf{r})$ is a calculated weighting field as though the electrode had a potential of 1V and everything else is ignored
- Fields and Electrode locations from Gmsh and Elmer
- Looking at charge collection times and signals

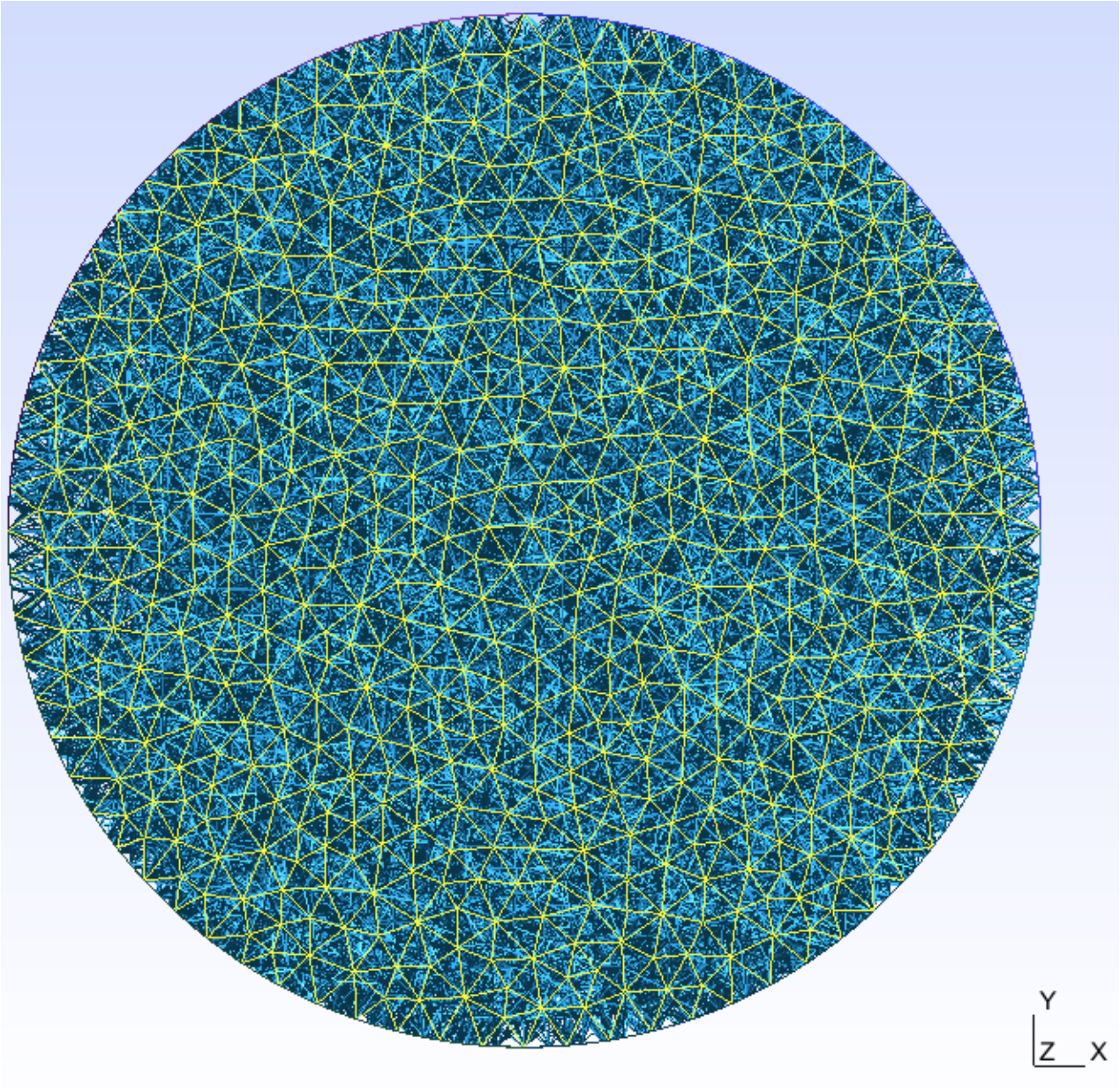
Geometry - Gmsh



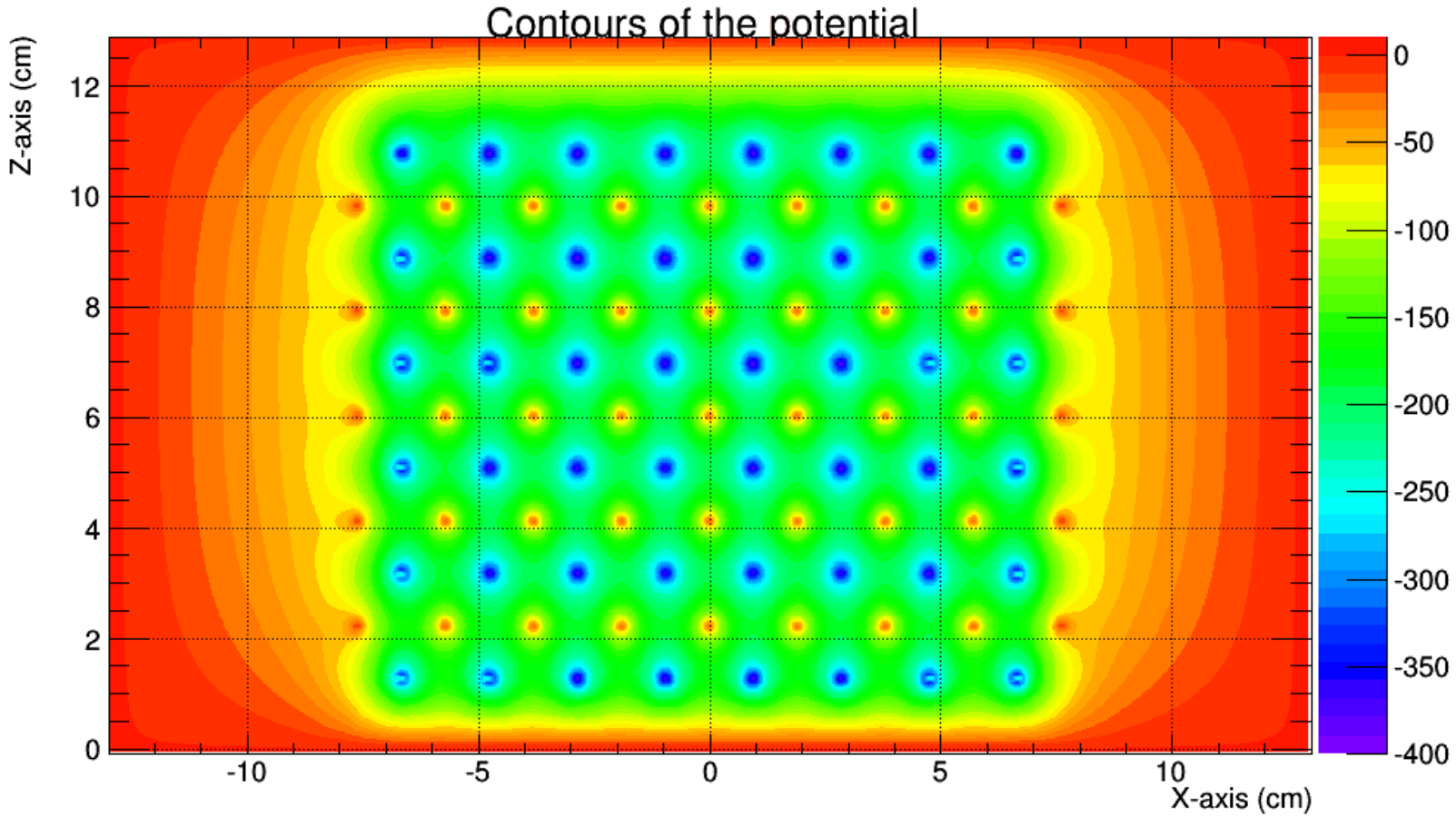




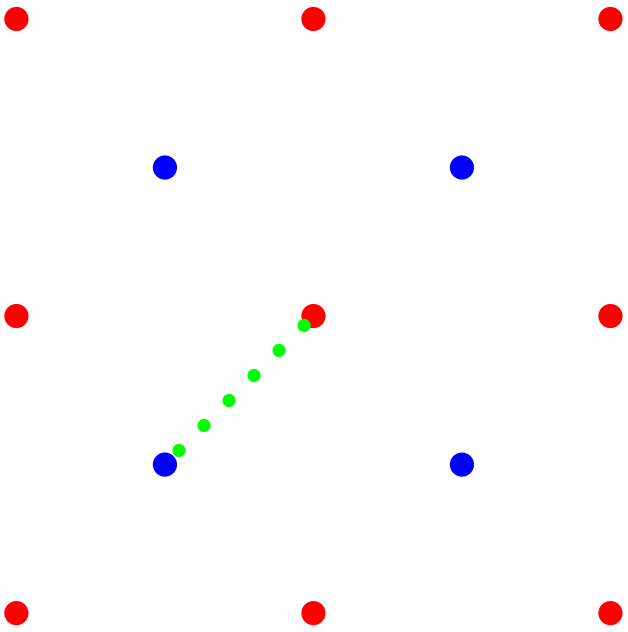
Geometry - Gmsh



Fields - Elmer FEM

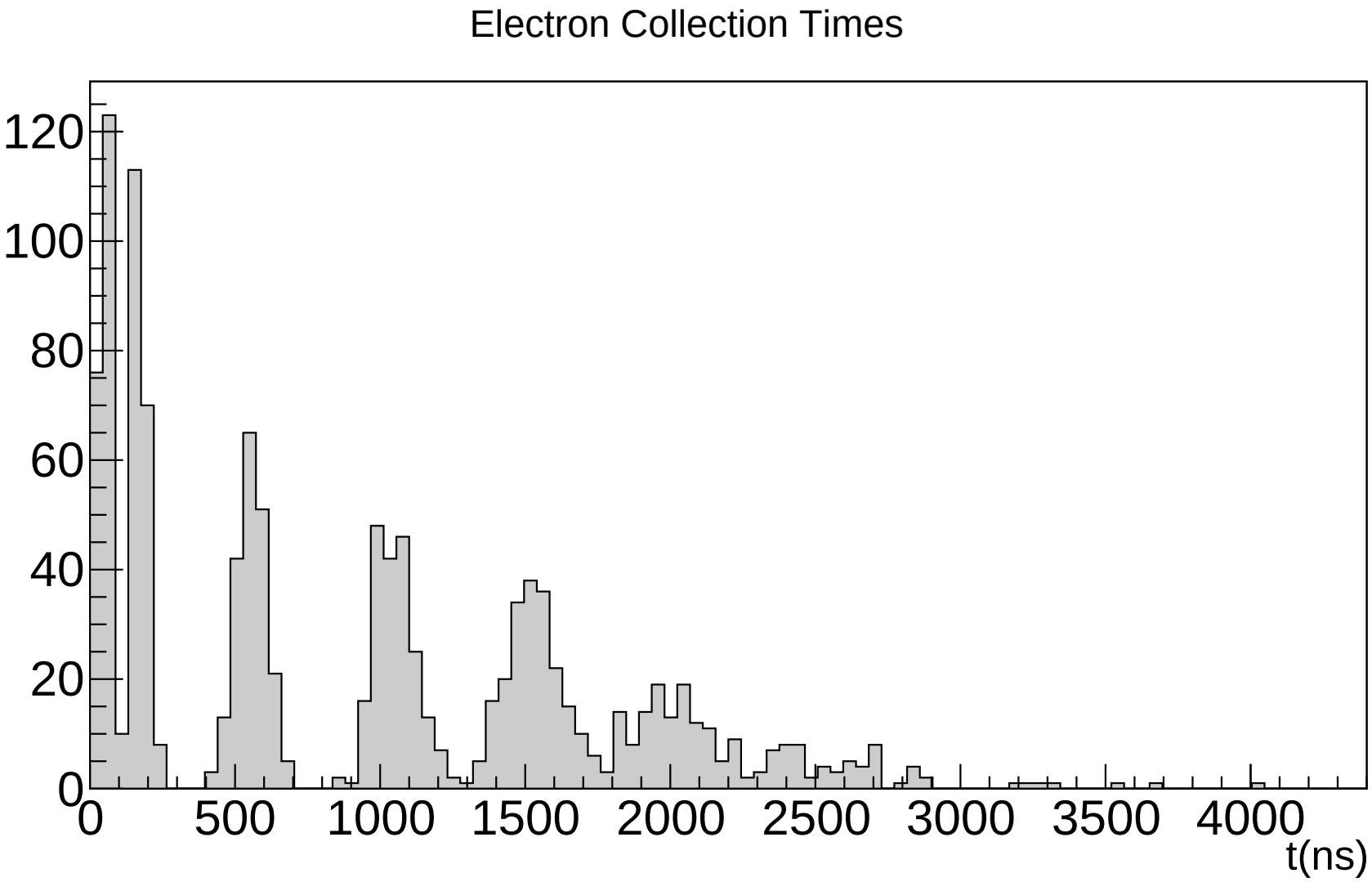


Initial Simulation Details



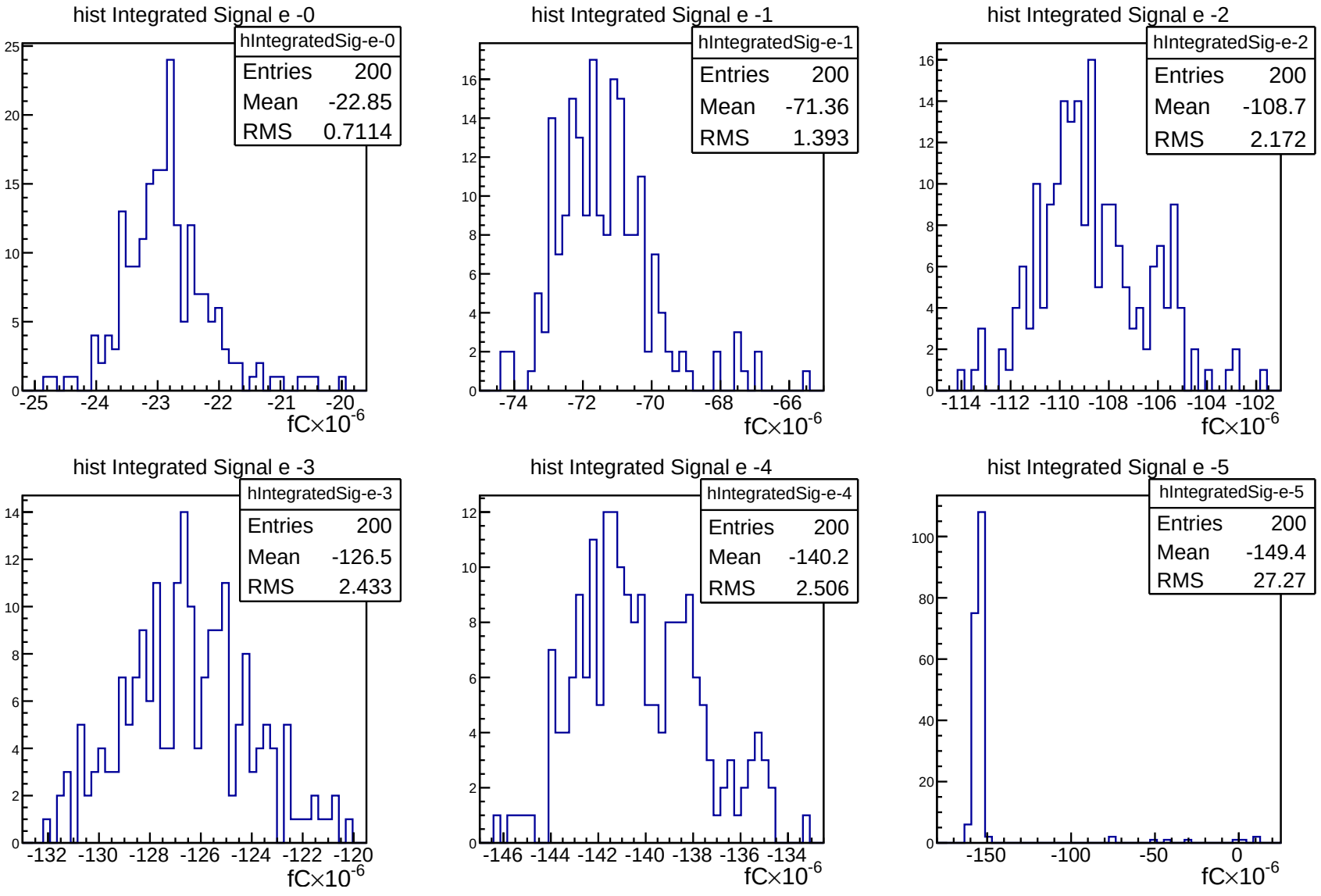
- 200 events at 6 locations spaced evenly between HV and Signal wire
- ion and electron propagated from each point
- collection time to be compared with measured values

Collection Times



- Six equally spaced starting positions gave 6 peaks.
- 200 electrons per positions

Integrated Signal - electron



Ion/Electron pair signals measure from 6 positions

Summary

- Target chamber assembled and tested November 2014
- Target chamber installed December 2014
- First Data from Chamber January 2015
- Data taking to continue until end of 2015
- Charge collection simulations are progressing

n3He Collaboration

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