Methods in Using a Novel ^{3}He Target During GEn-II

Jack Jackson

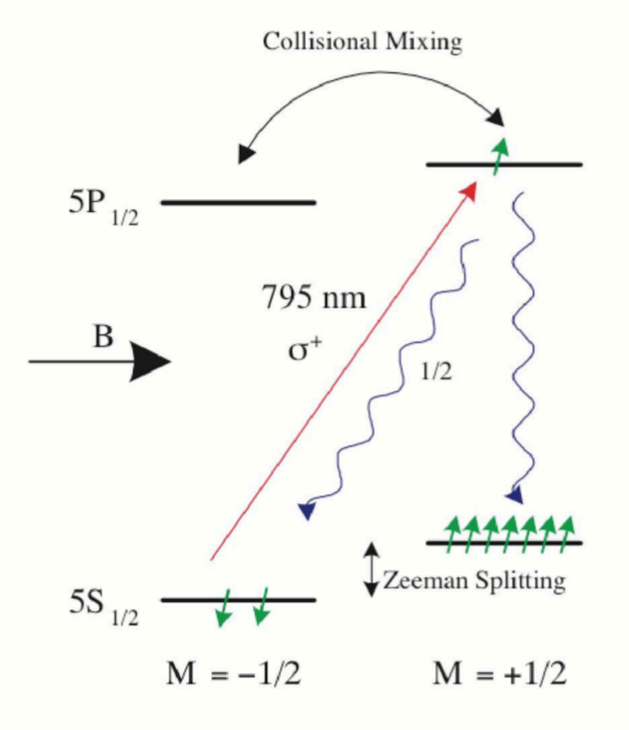
on behalf of the SBS Collaboration
and the 3He Target Group

Outline

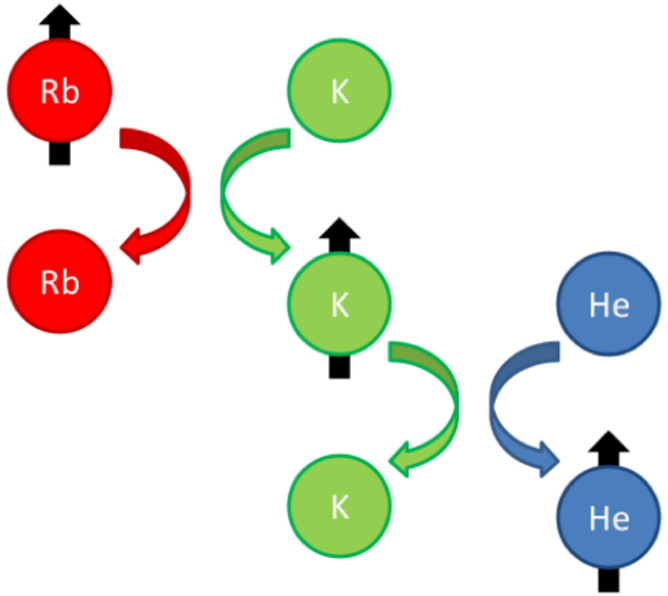
- Quick Overview of GEn-II Neutron Magnetic Form Factor Experiment
- Target Sub-Systems Needed for the Novel Target
- Effects on the ^{3}He Target Performance

SEOP in a Nutshell

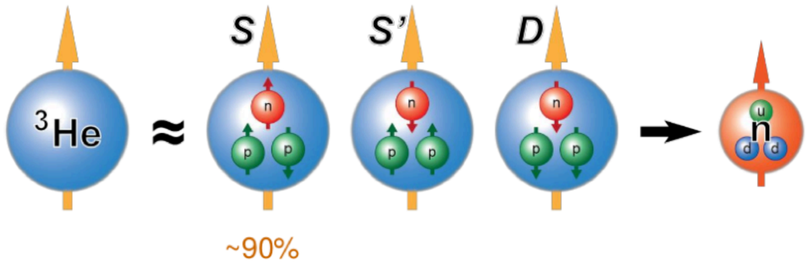
Optical pumping of Rb vapor at 794.7 nm circularly polarized light



Spin exchange optical pumping



Collisional mixing

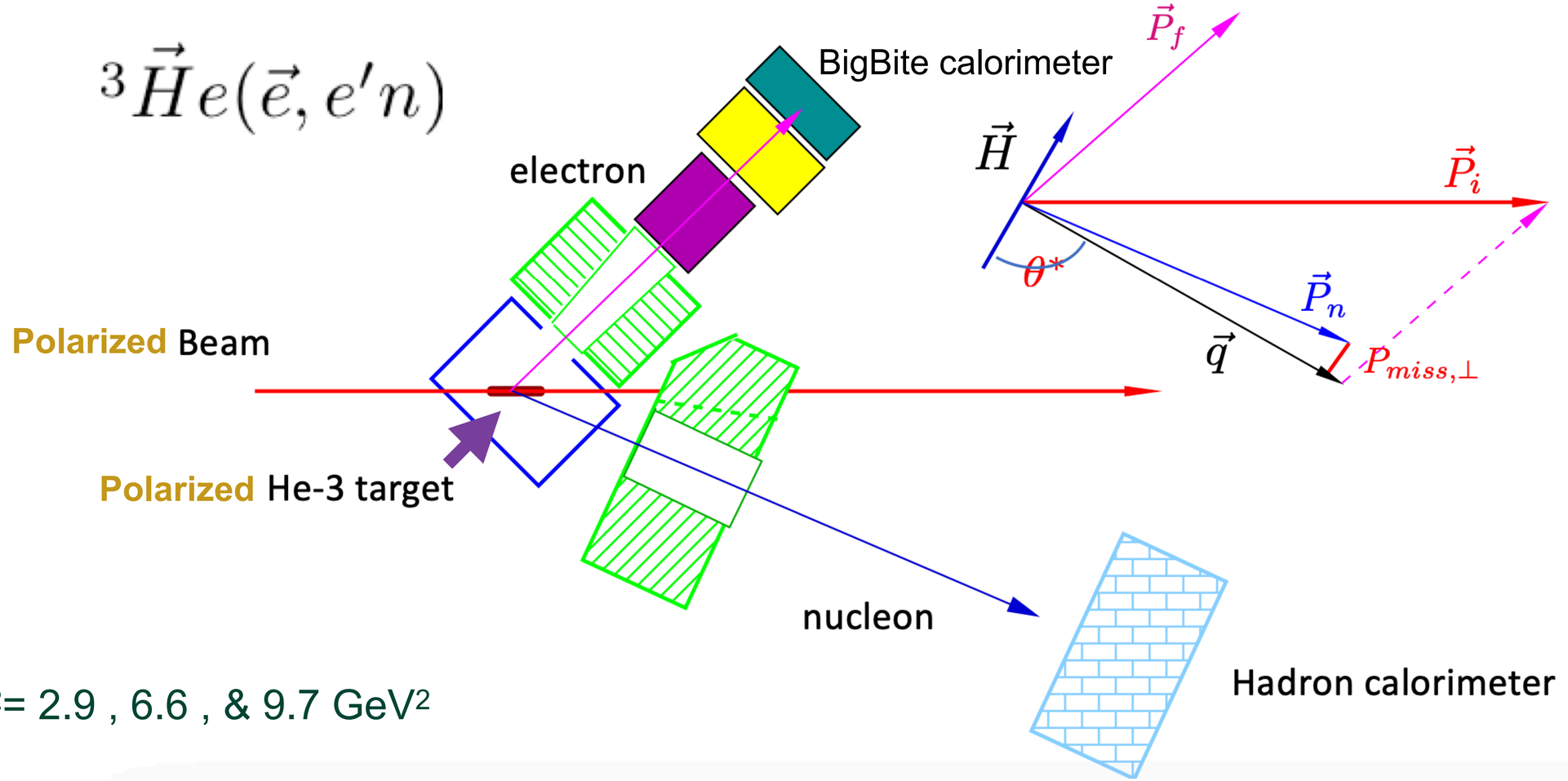


Effective neutron target

A Look at GEn-II

Double Polarization Method

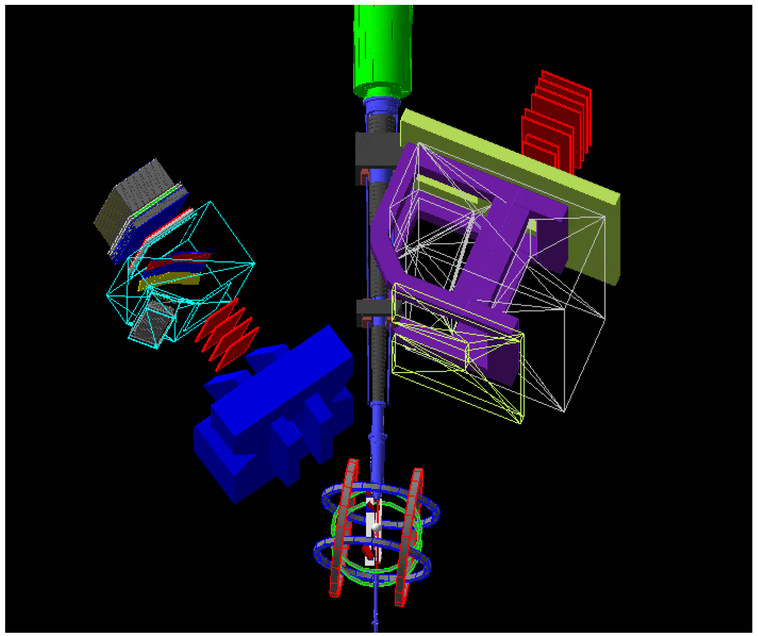
$^3\vec{H}e(\vec{e}, e'n)$

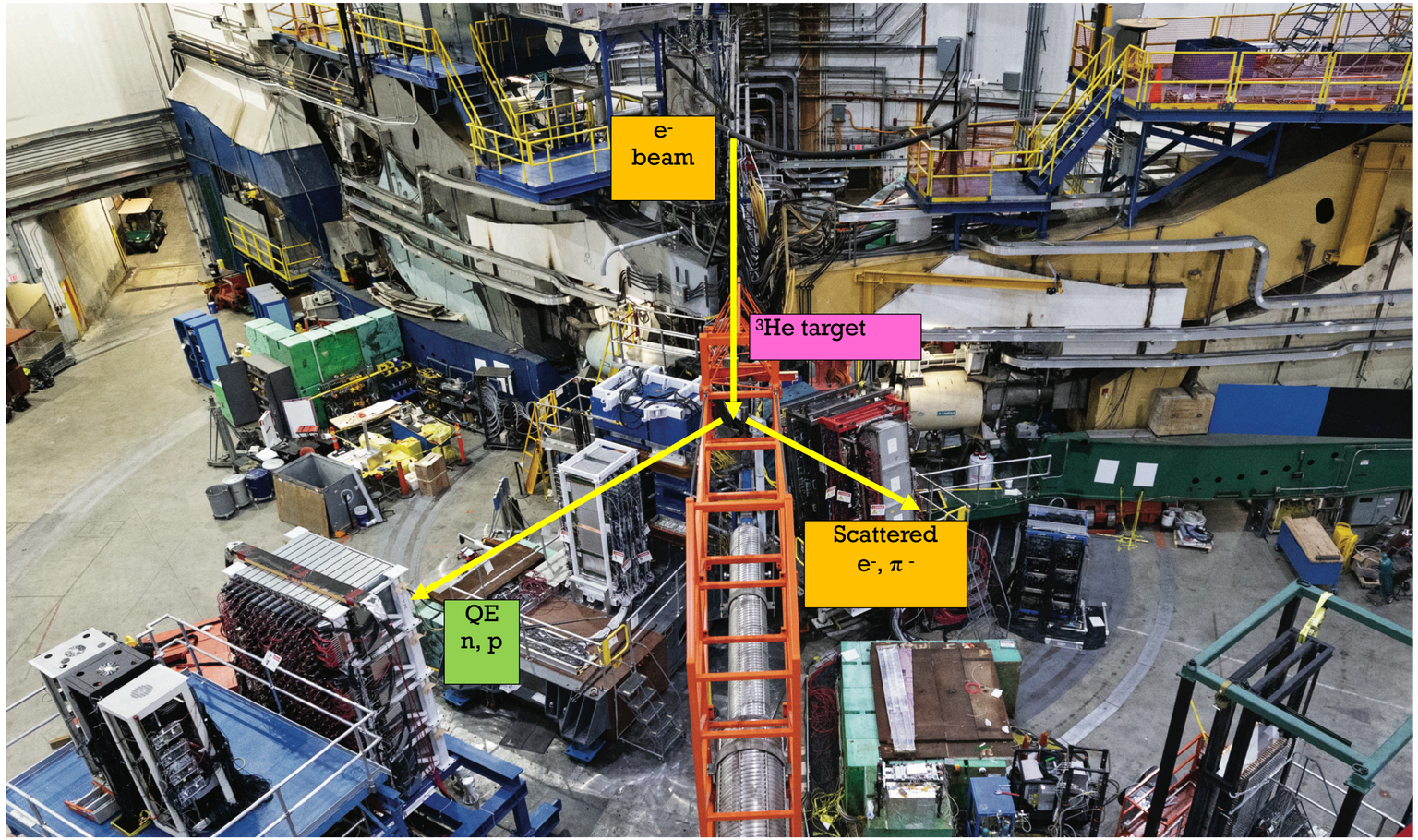


Q^2= 2.9 , 6.6 , & 9.7 GeV^2

Credit B. Wojtsekhowski, 2020 ERR

GEn-II On The Floor





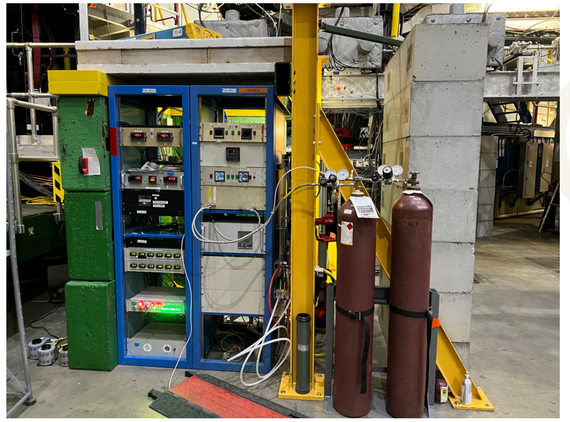
Complicated

Laser Enclosure

Laser Room

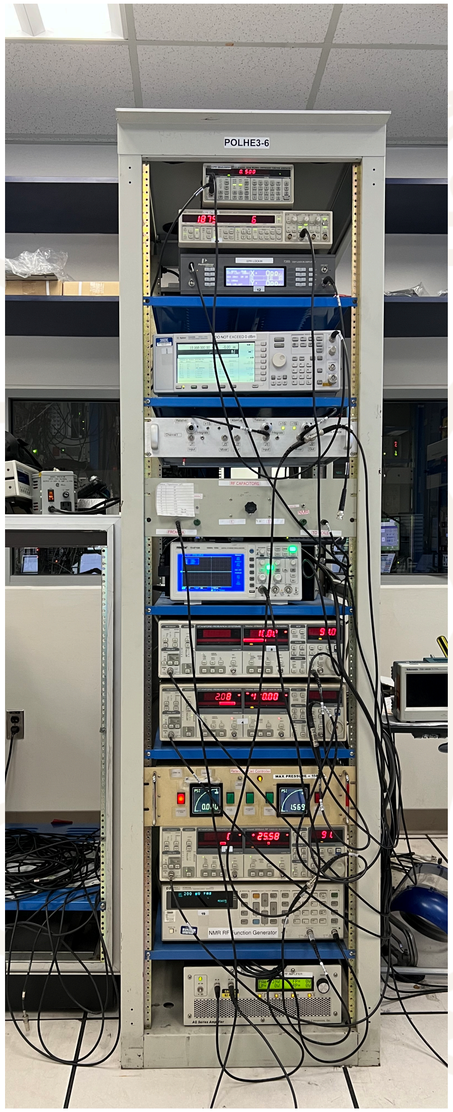
Target enclosure

HH coils electronics



Ref Cell and Oven Controls

Counting house electronics



Target Area

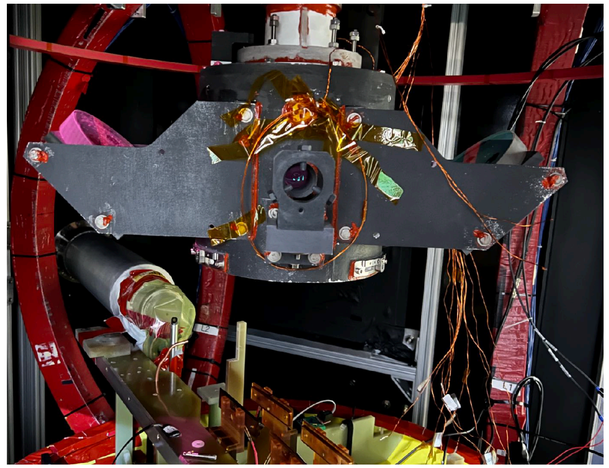
- Laser fibers enter (grey box)
- Upper Periscope Mirrors & Heating system (cyan)
- Helmholtz Coils, Oven, & Targets (rust)
- Beam enters W-SW to E-NE

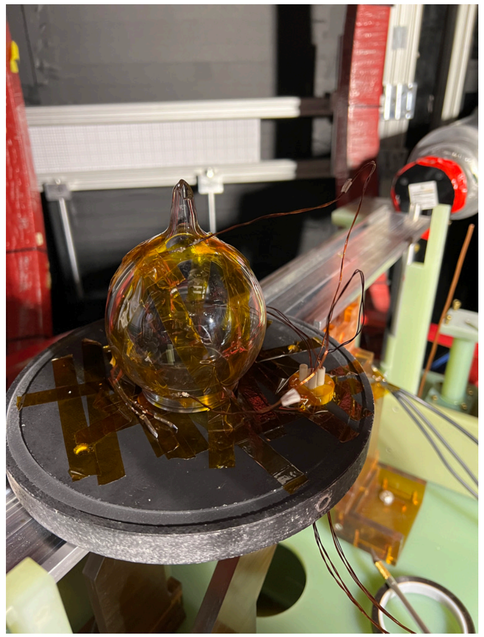
Enclosure

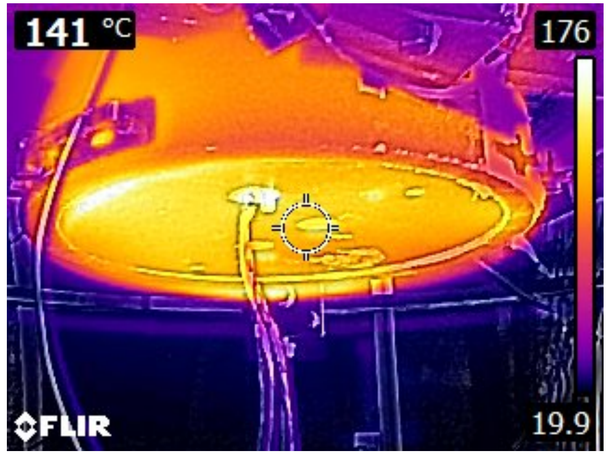
Enclosure

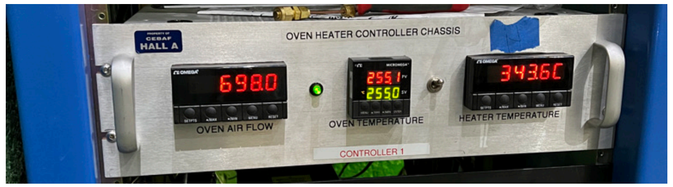
- Helmholtz Coils
  - 25G Net Holding Field
  - RF Field
- Target Ladder
  - Heater Column
  - Oven
  - ^{3}He Target
  - Carbon Foils
  - Reference Cell
- Cooling Jets / Lines
- Beam Pipe
- Tungsten Collimators

Oven Configurations for the GEn-II Kinematics

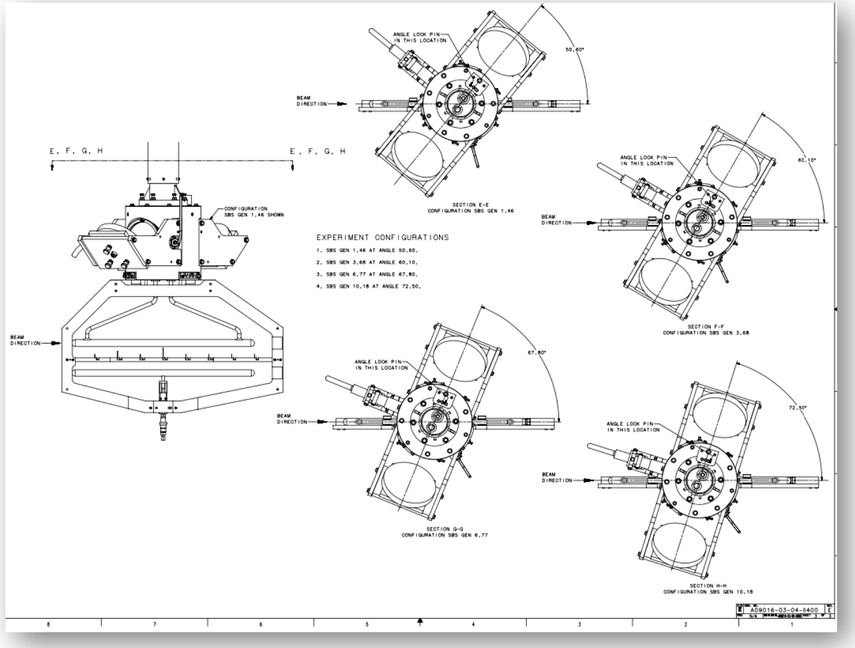




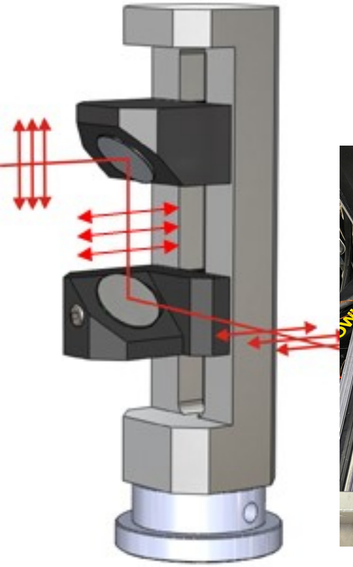


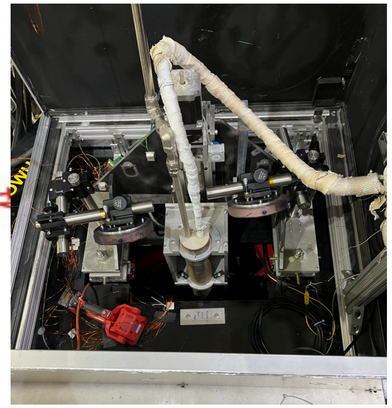


- Target oven rotated for each kinematic setting
- 3/8” spacer included to accommodate cell pull offs inside the oven
- Oven checked for alignment after rotation at each setting and the position was repeatable within noise of the survey and alignment device

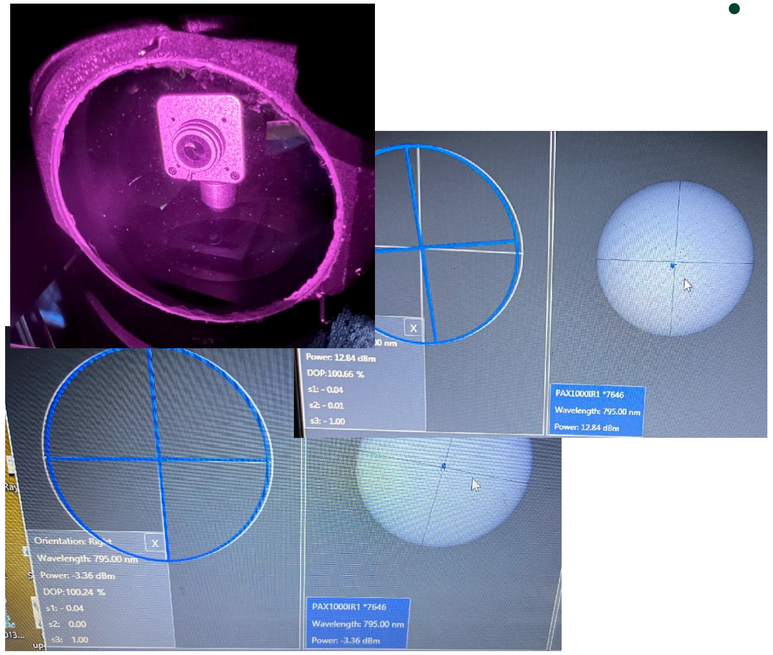


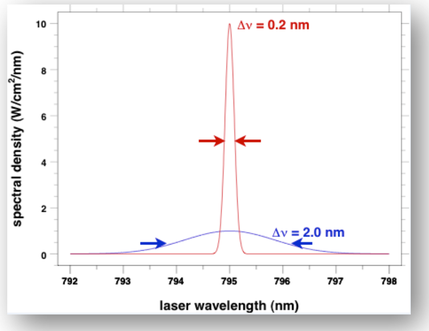
Laser System

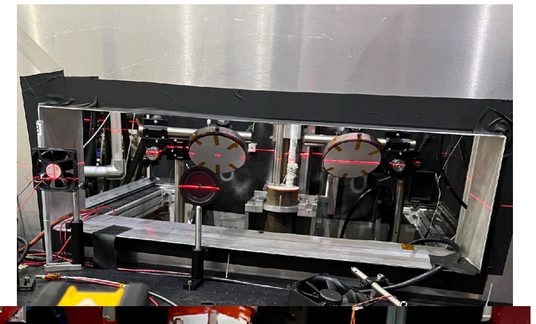


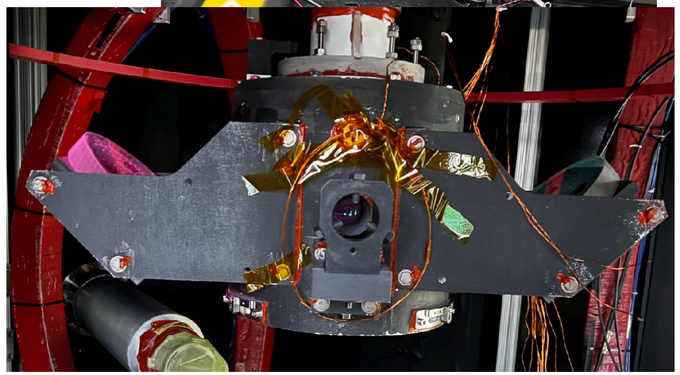


- Needed Circular Polarization >99.5%
- Linewidth Requirement < 0.2nm
- Setup required LHP down one & RHP down opposite periscope
- Allowed for up to 100W per side
  - Limits heating & improves photon absorption through cell



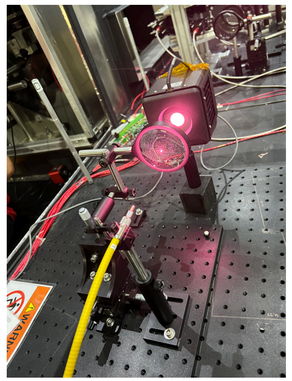




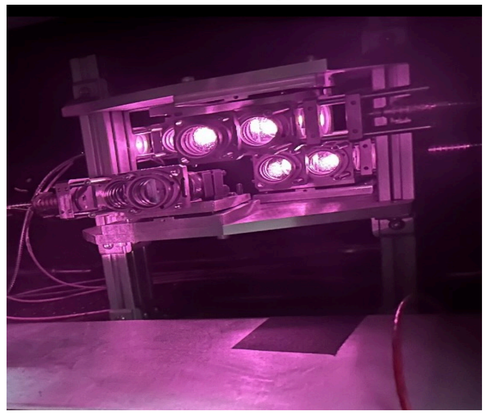


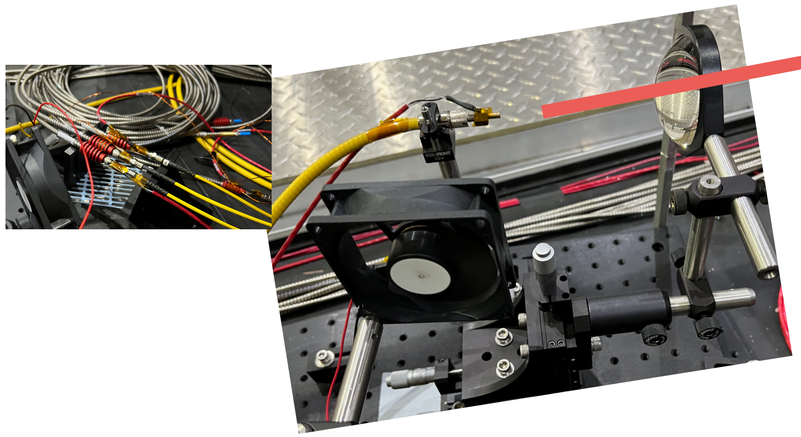
SEOP Laser Optics

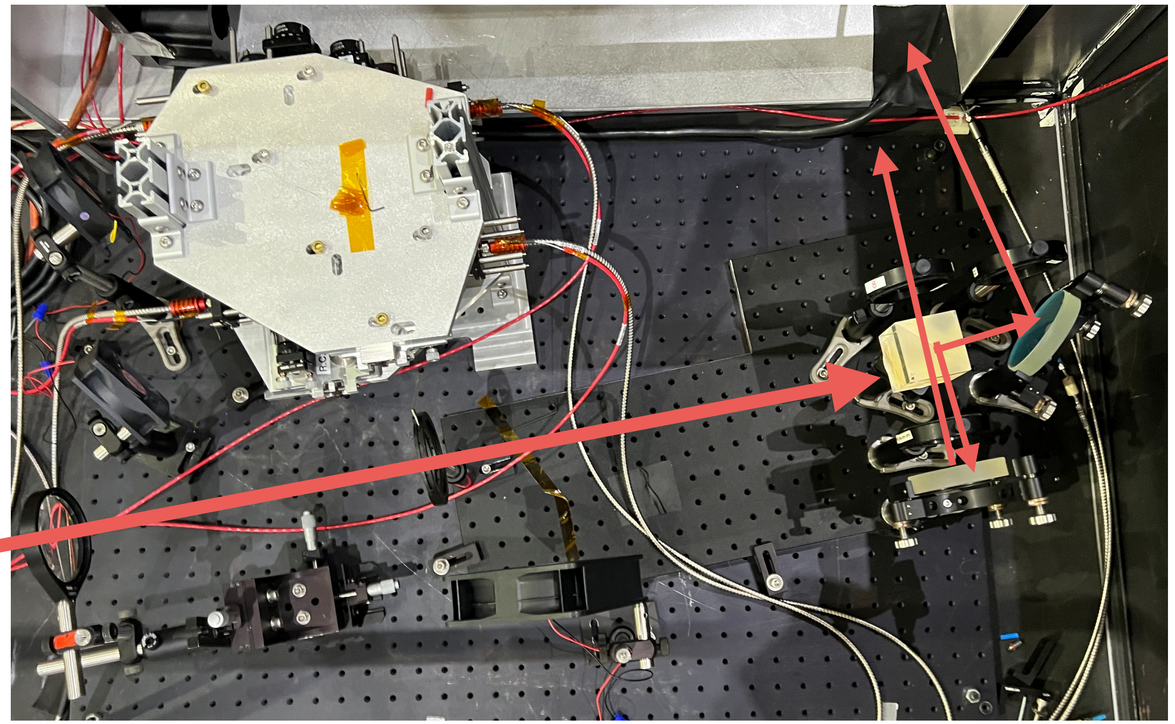
Laser Power Tests



“UVA” Optics

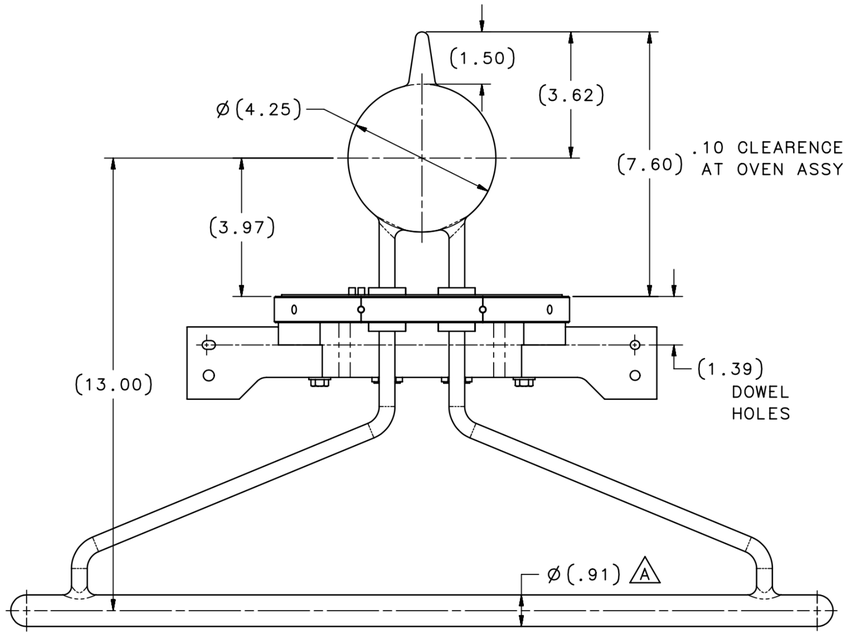


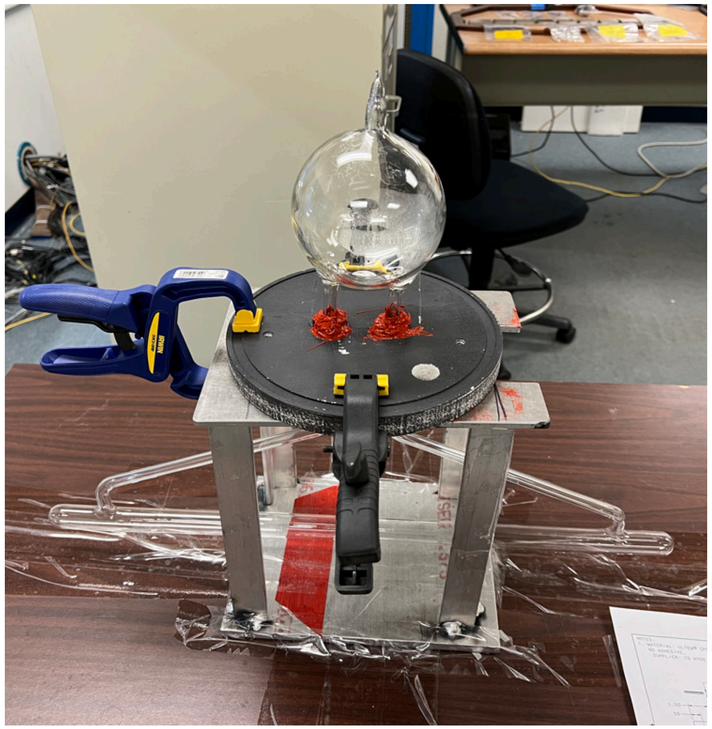




Laser Path Through “JLab” Optics

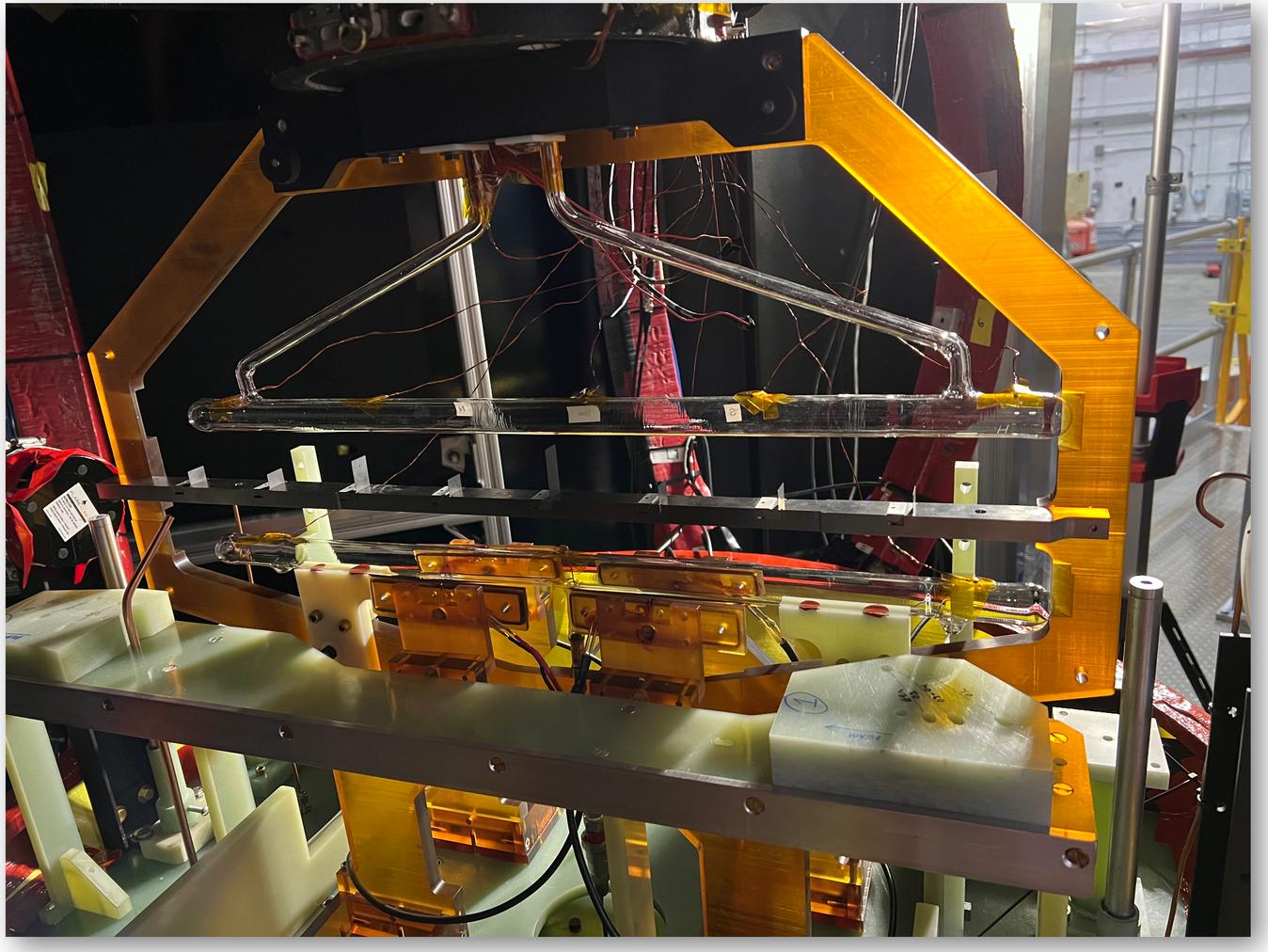
Preparing the Target Cell



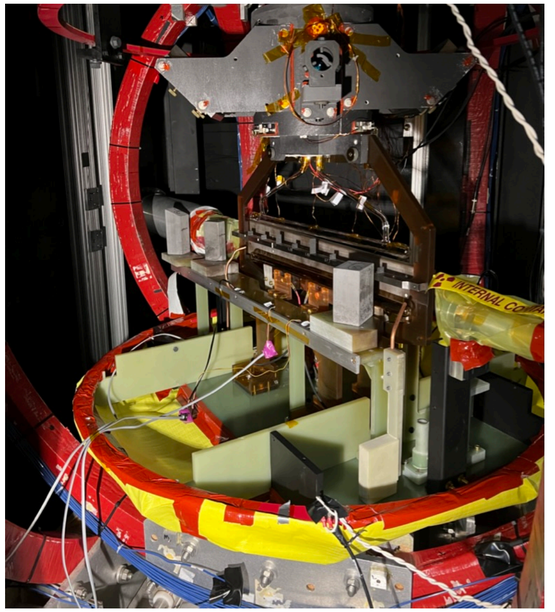


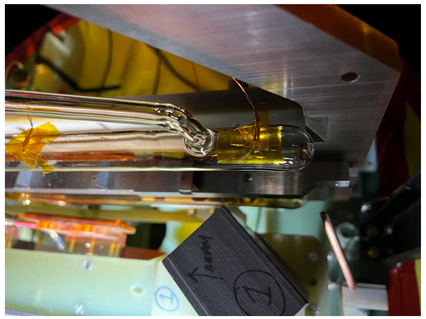
- Cell mounting jig in EEL building used to mount bottom plate onto each cell
- TC chamber aligned carefully in V-shape slots of the mounting jig for alignment with beam axis in the hall

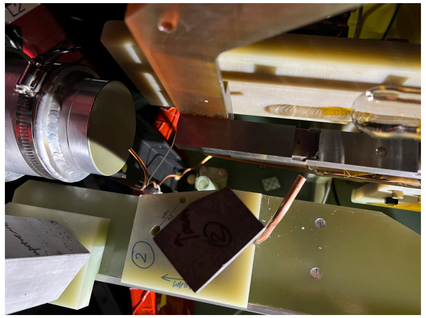
All Targets Installed



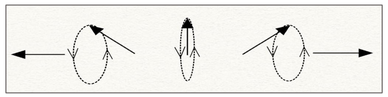
- SEOP ^{3}He Target
  - Heater tape for convection
- Carbon Foils
- Reference Cell
- Target Chamber NMR Coils

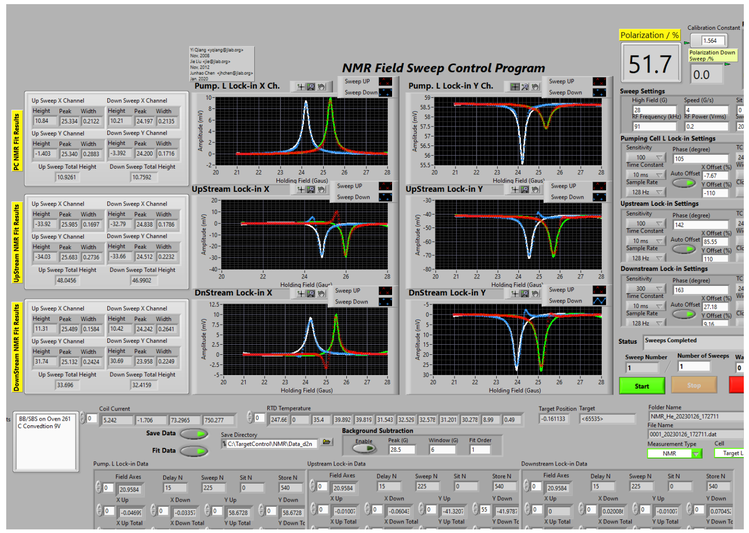


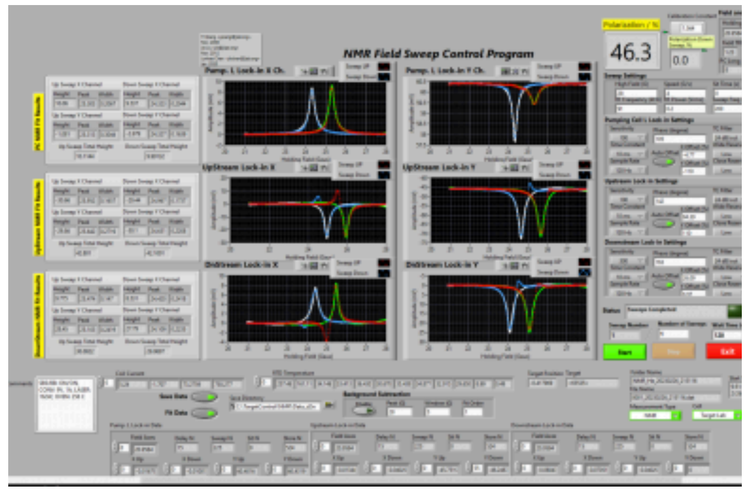




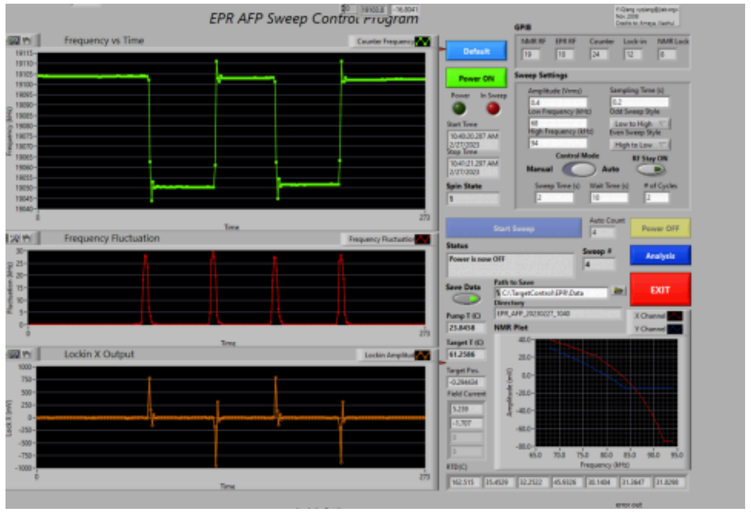
Polarimetry

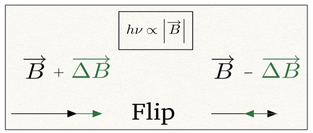




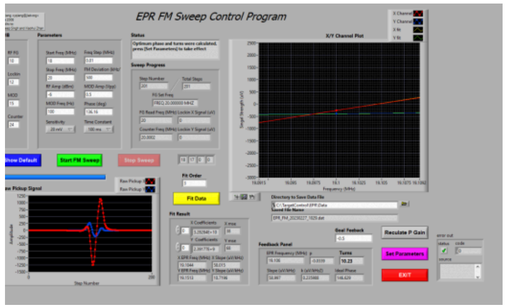


- Completed during production running of each cell opportunistically (~3 Hours)
- Gives a generally accurate % / mV value to apply to NMR data in real time

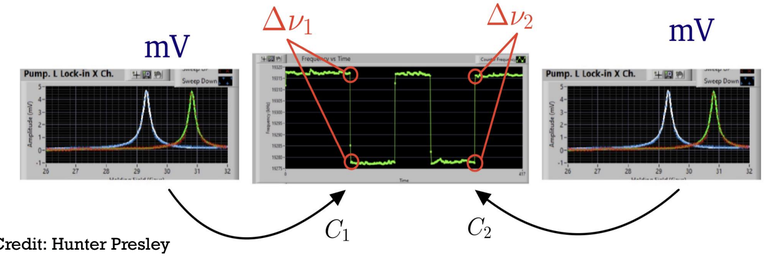




Calibrations



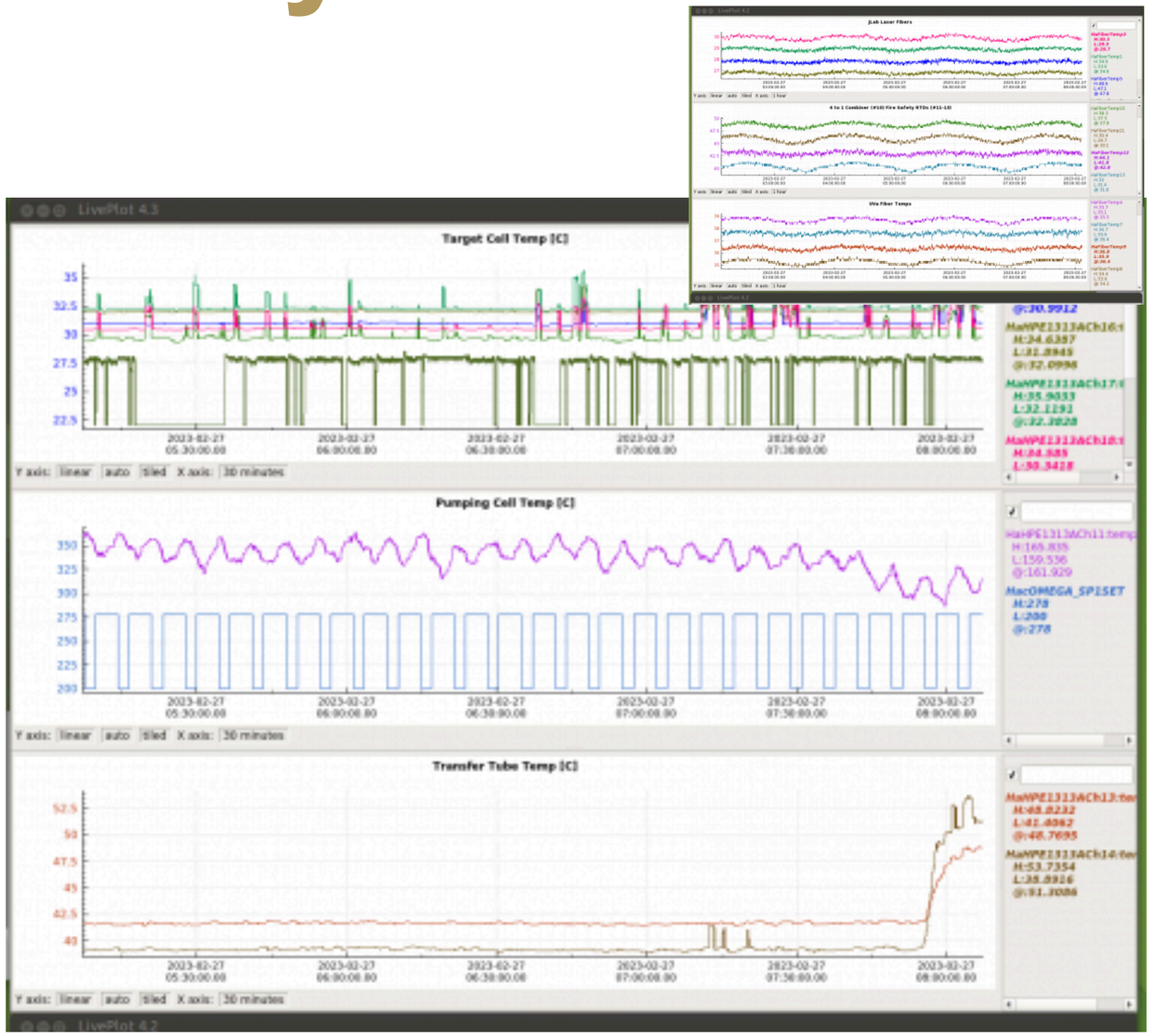
1. Set Convection to 25V
2. Wait 30 minutes for mixing
3. Find EPR frequency through FM sweep
4. NMR -> EPR -> NMR
5. Reset Convection to 9V



Credit: Hunter Presley

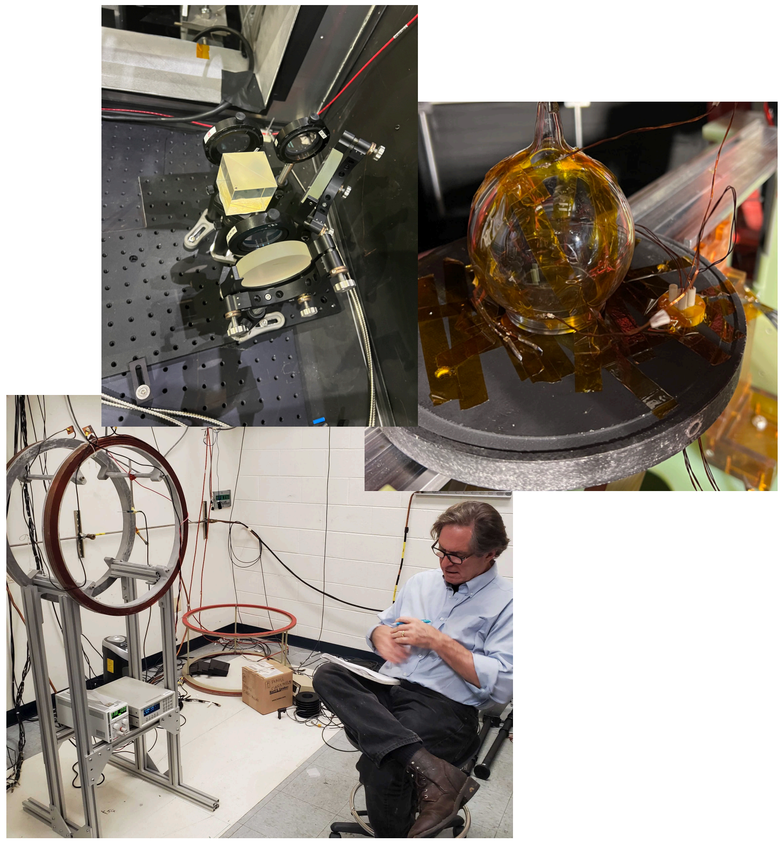
Monitoring the System

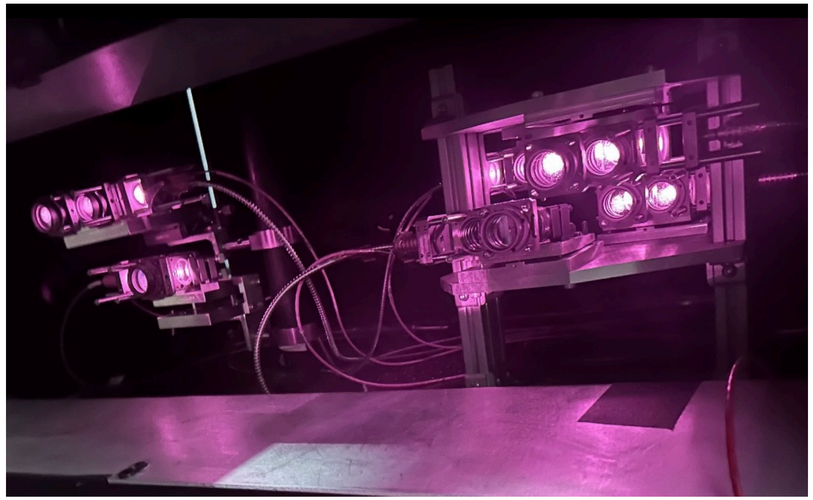
- Laser Fiber Temp. Monitored for equipment / fire safety
- Cell temperatures initially monitored for “Polarization Dance” and density corrections
- Dance between Laser Power & Oven Temp.

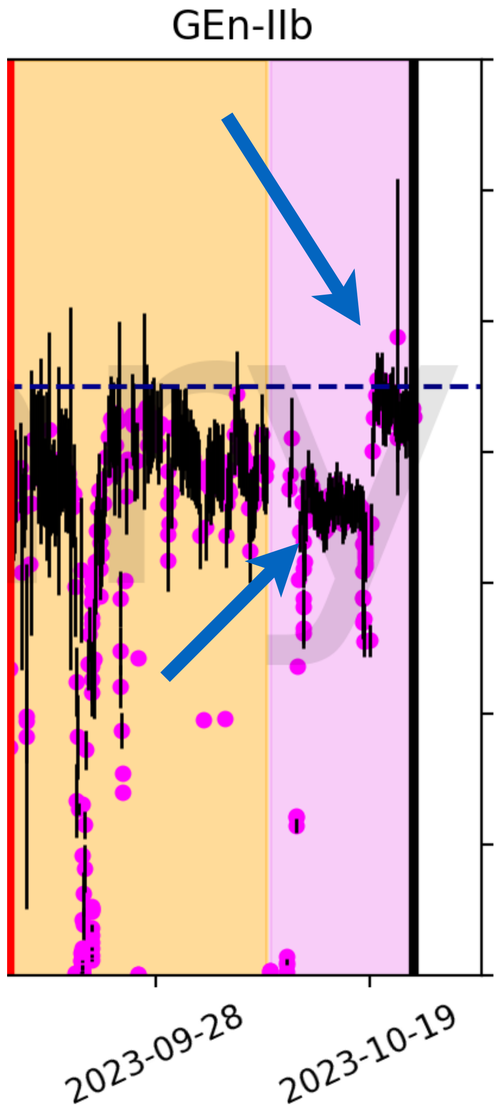


GEN4B Issues

- Low Target Polarization
- Tests for Magnetic field anomalies
- Laser issues (alignment & power losses)
- Nominal increase from 35% to 45% polarization after fix

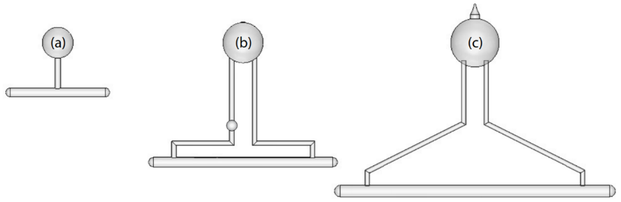


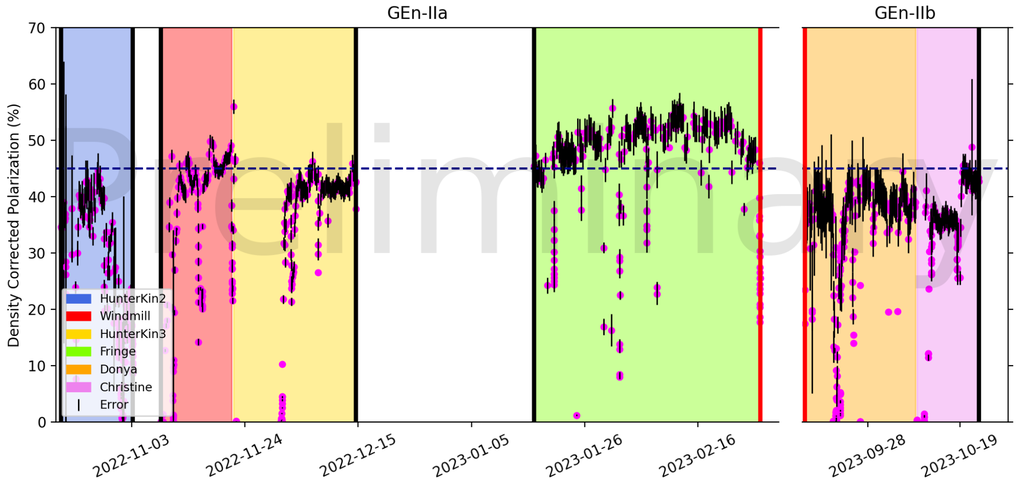


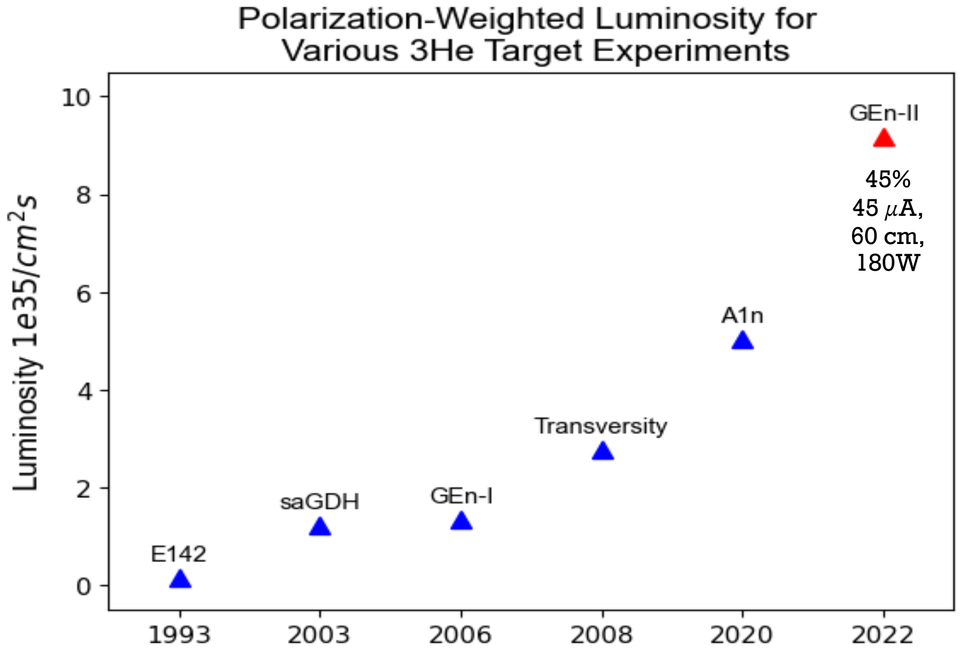


Summary

- Larger Volume Convection Cells
- Very Good Polarization for SEOP Cells
- Record Breaking Luminosity for SEOP ^{3}He Target







	Cell Name	Average Polarization	Max Polarization	Duration Installed
Kinematic 2	Hunter	40%	46.08%	20 days
Kinematic 3	Windmill	45%	49.80%	14 days
	Hunter	42%	46.32	24 days
Kinematic 4	Fringe	53%	55.92%	60 days
	Chicago	n/a	43.60%	12 days
	Donya	40%	44.49%	31 days
	Christin	40%	45.57%	20 days

Credit: Hunter Presley

Thank You.