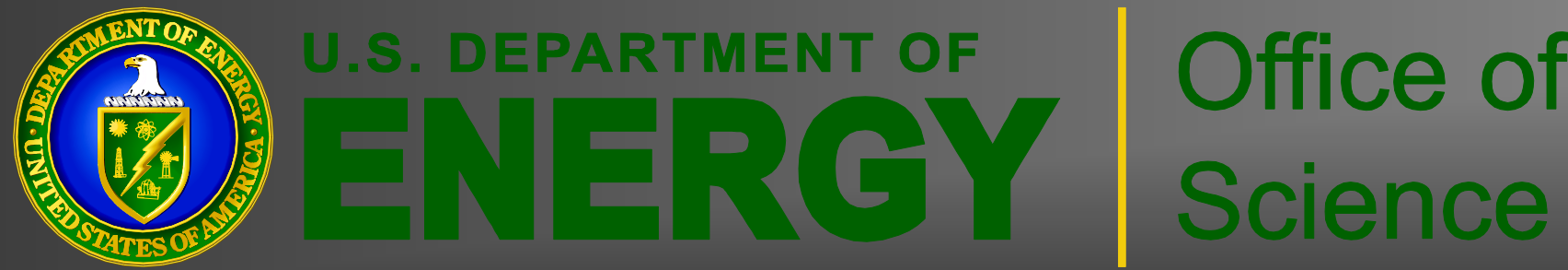
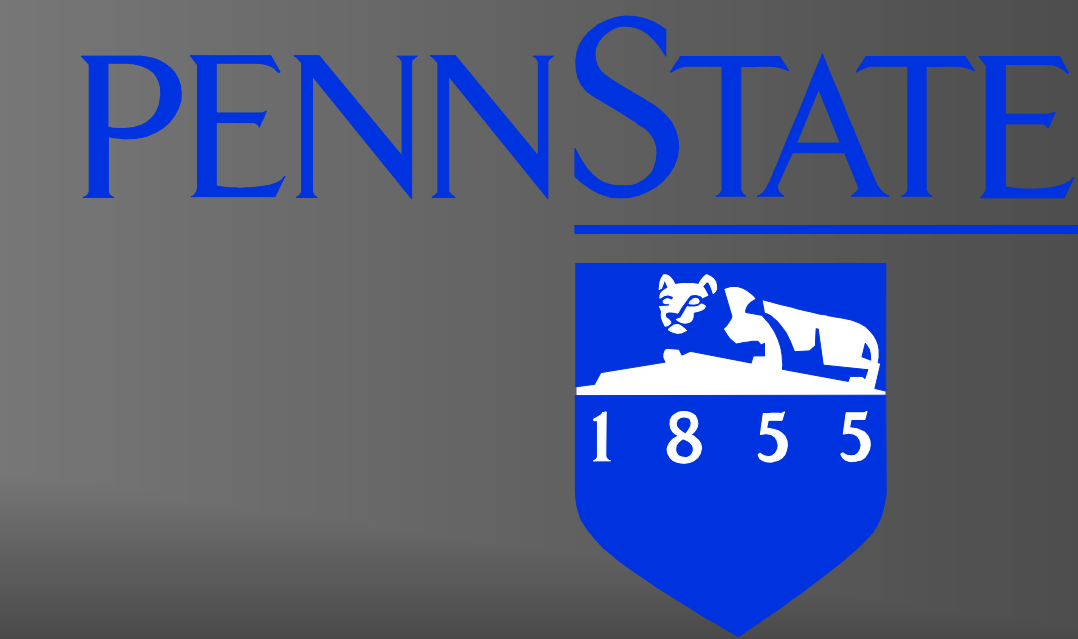


Pulsed-NMR Apparatus for ^3He Target System

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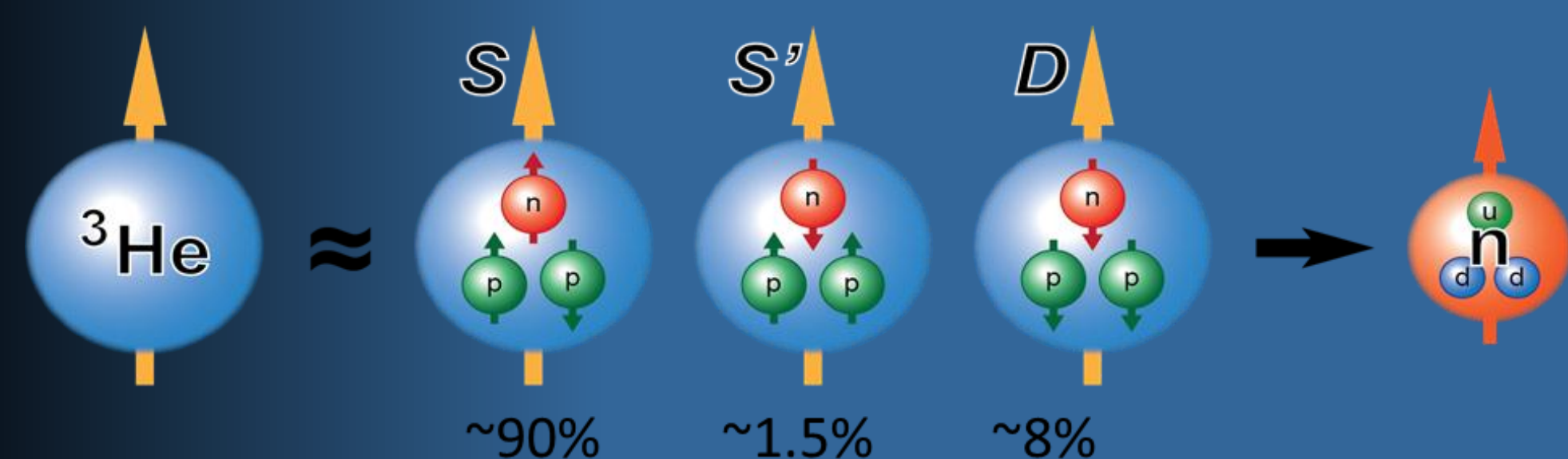


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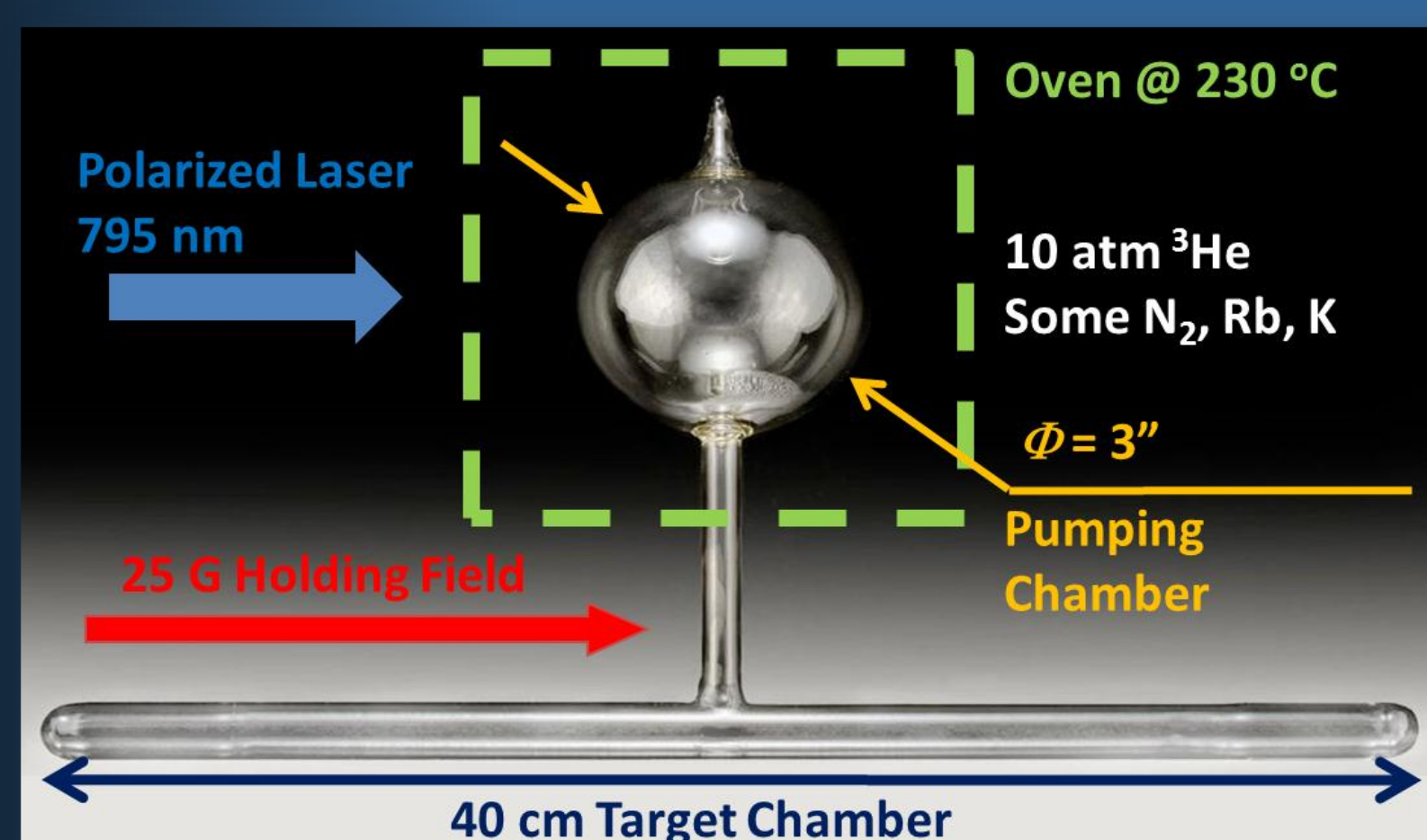
Polarized helium-3 (^3He) has proven to be an extremely effective neutron target for use in high-energy nuclear physics experiments. The unique quantum properties of ^3He cause the spins of the majority of its protons to pair up, allowing the neutron to carry the majority of the nucleus spin. Through spin-exchange optical pumping (SEOP), it is possible to achieve higher polarization for the nucleus, which can then be measured using pulsed nuclear magnetic resonance (NMR). The focus of this study is to maximize the polarization of the ^3He target cell and implement pulsed-NMR in order for it to be used for experimentation in Jefferson Lab's 12 GeV Upgrade.

Why Use ^3He ?

- Neutron carries the majority of ^3He 's spin, making ^3He an excellent neutron target
- ^3He can be polarized through spin-exchange optical pumping (SEOP)

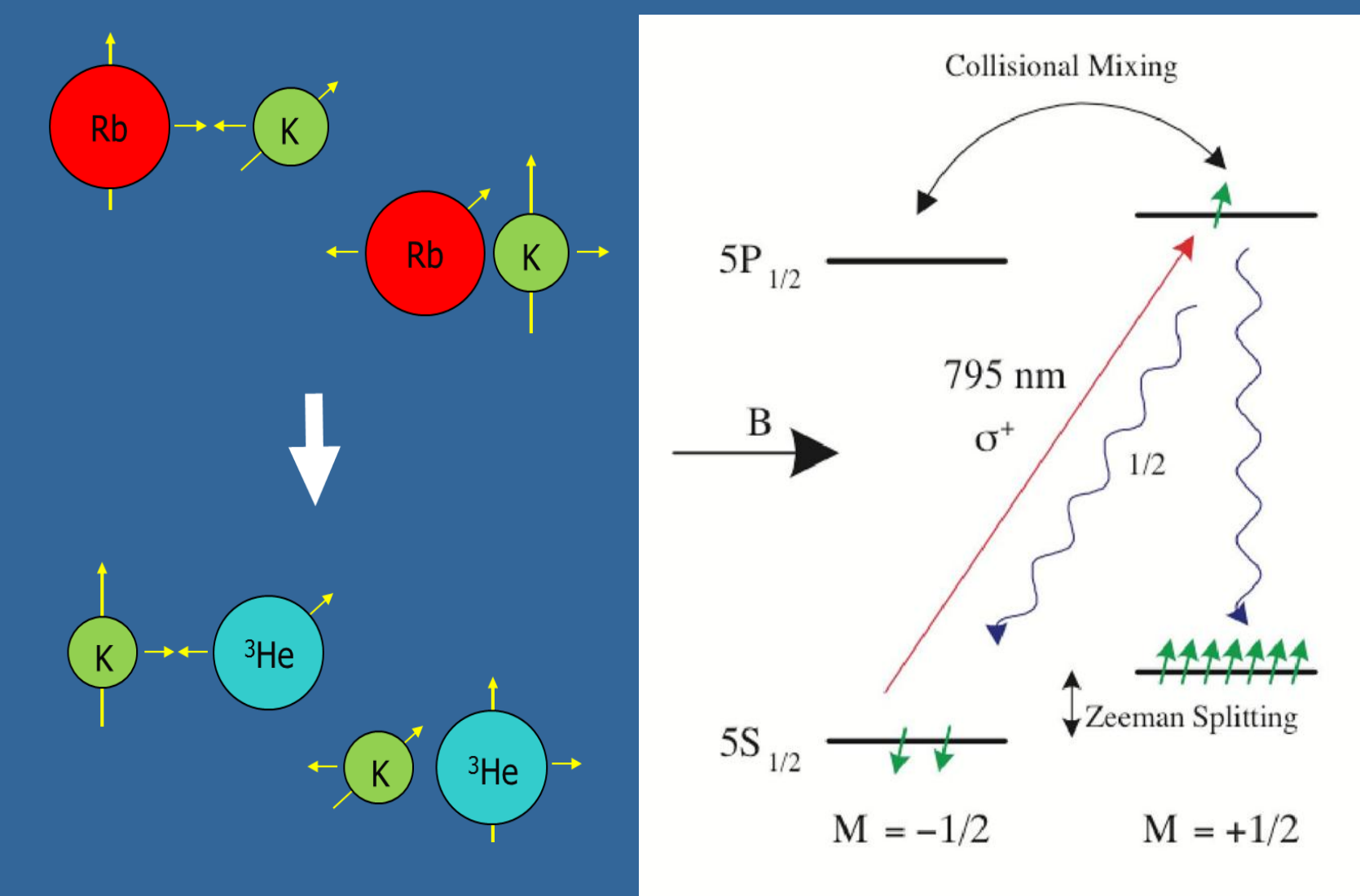


Polarization Method



- Pumping chamber contains mixture of Rb, K, and ^3He
- Cell is kept in high temperature oven to allow for vaporization of alkali metals
- Circularly polarized laser light is used to polarize Rb atoms
- Through this process, spin can be successfully transferred from Rb to ^3He via K through collisions

Polarization Method (cont.)

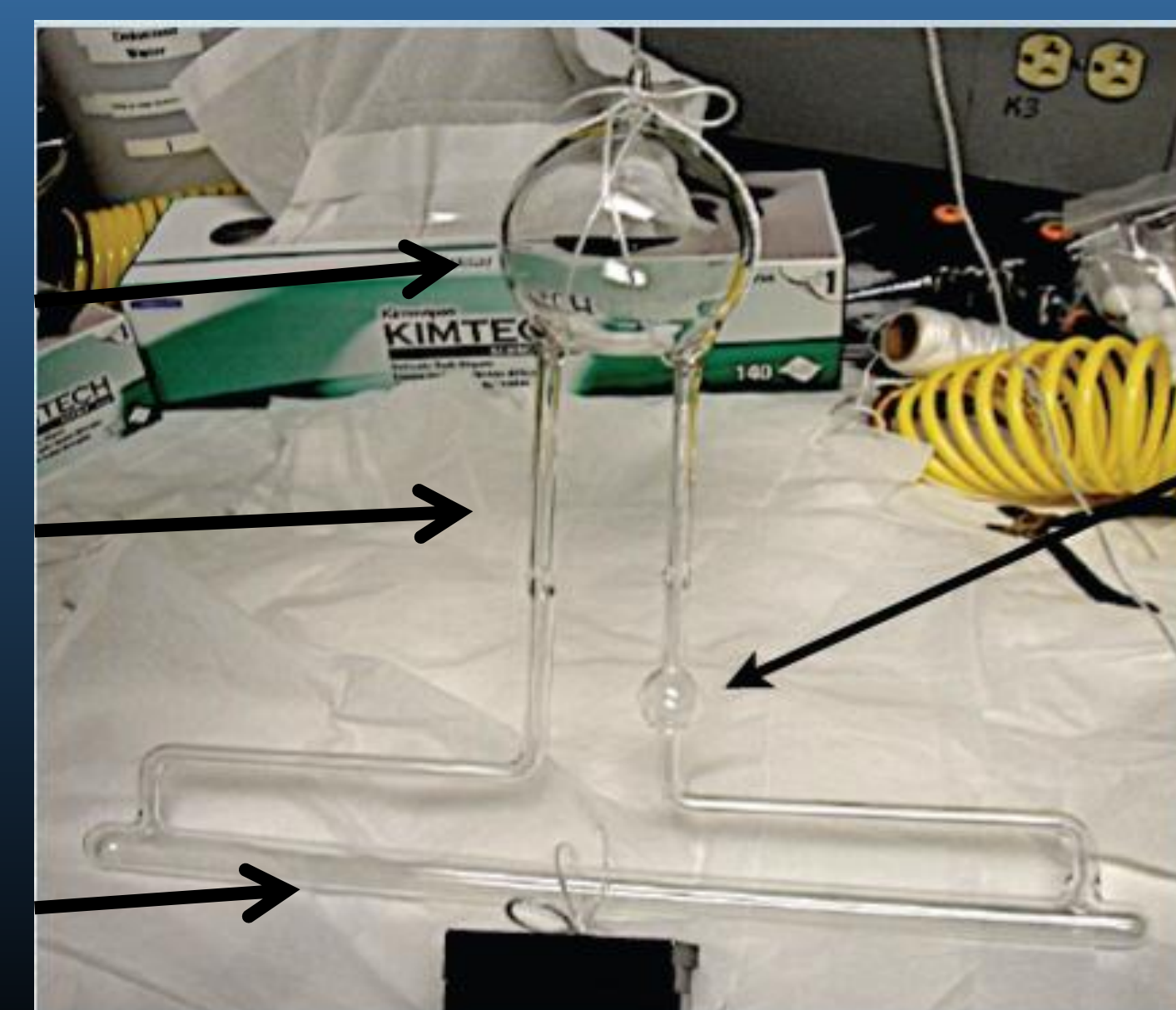


Example of spin-exchange optical pumping (SEOP) process

Convection Target Cell

- Current target system uses diffusion as method for transferring ^3He from pumping chamber to target chamber
- New target cell will pump ^3He into target chamber via convection rather than diffusion, thus creating higher polarization of ^3He within target chamber
- High beam current may require target chamber to be made out of metal, making pulsed-NMR a more effective method for determining polarization of ^3He

Pumping Chamber
Transfer Tubes
Target Chamber



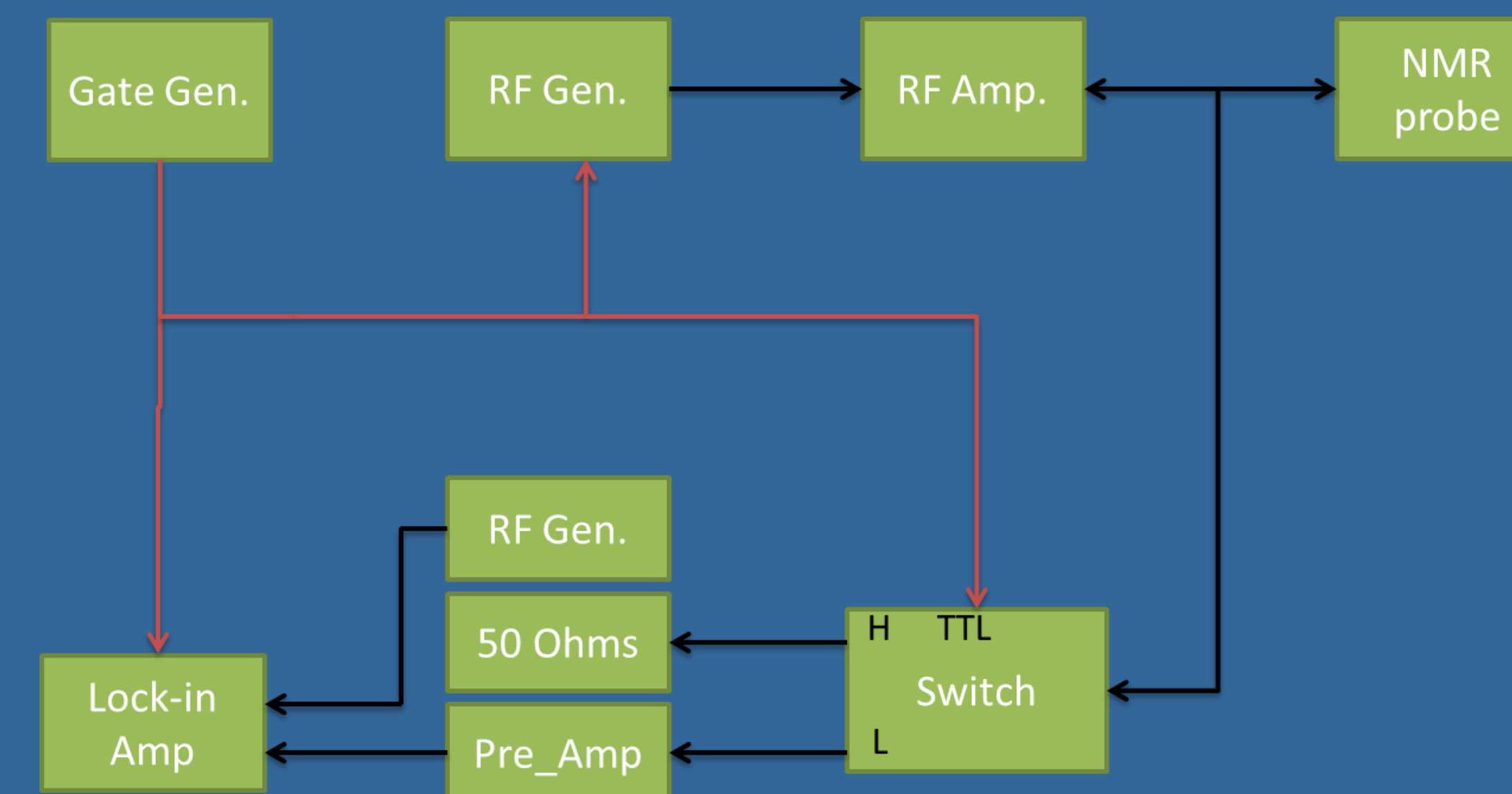
Picture of new convection cell

Chamber for pulse-NMR

Pulsed-NMR

$$P_{He}(t) = P_0 e^{-(\gamma_{se} + \Gamma)t} + P_A \frac{\gamma_{se}}{\gamma_{se} + \Gamma} [1 - e^{-(\gamma_{se} + \Gamma)t}]$$

P_0 : initial polarization, γ_{se} : polarization rate due to spin-exchange, Γ : spin-relaxation rate, P_A : polarization of alkali vapor



- Measure polarization of ^3He in a local area
- Sends out short burst radio frequency (RF) signals
- Polarization can be determined from pulsed-NMR signal

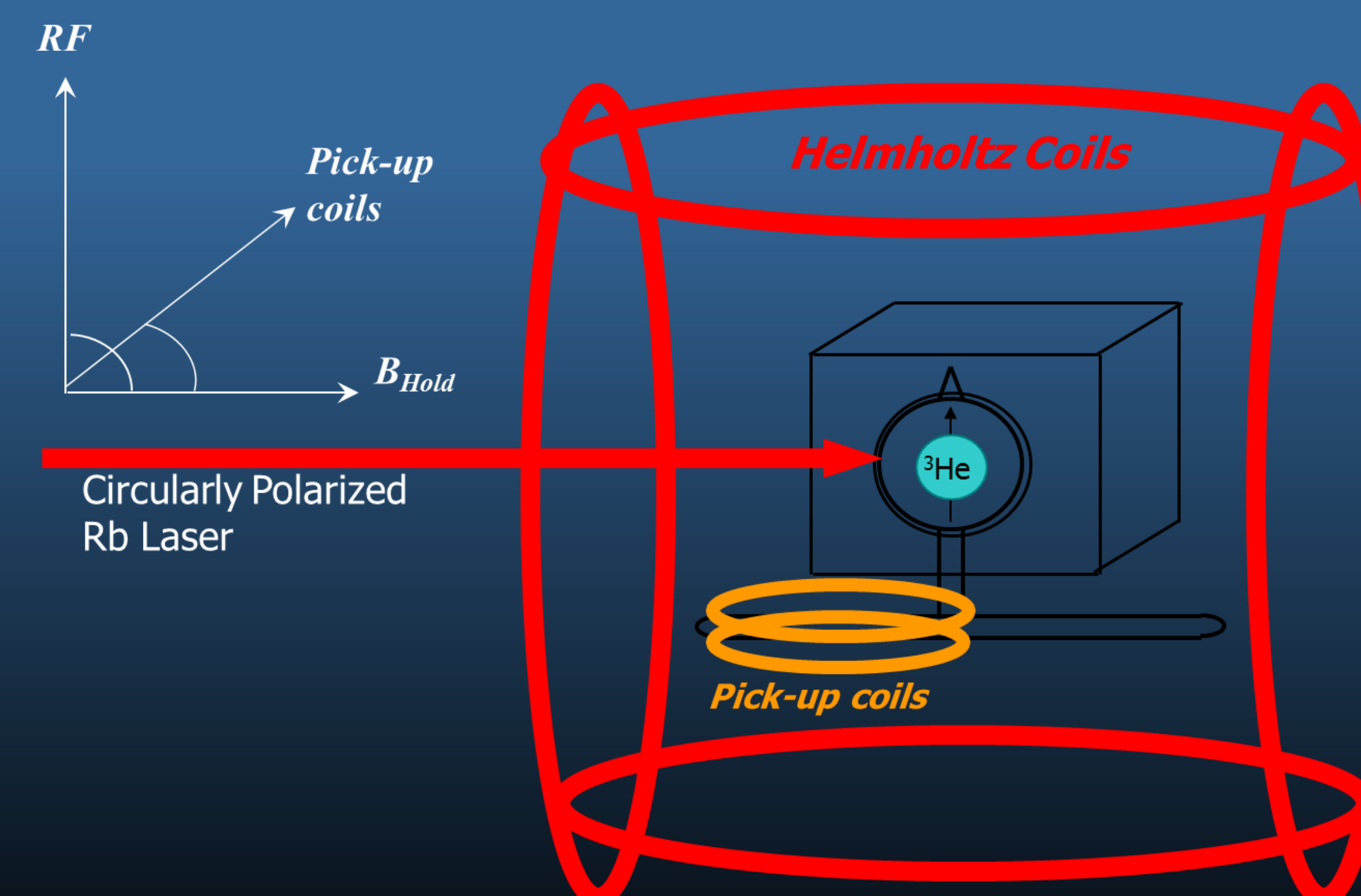
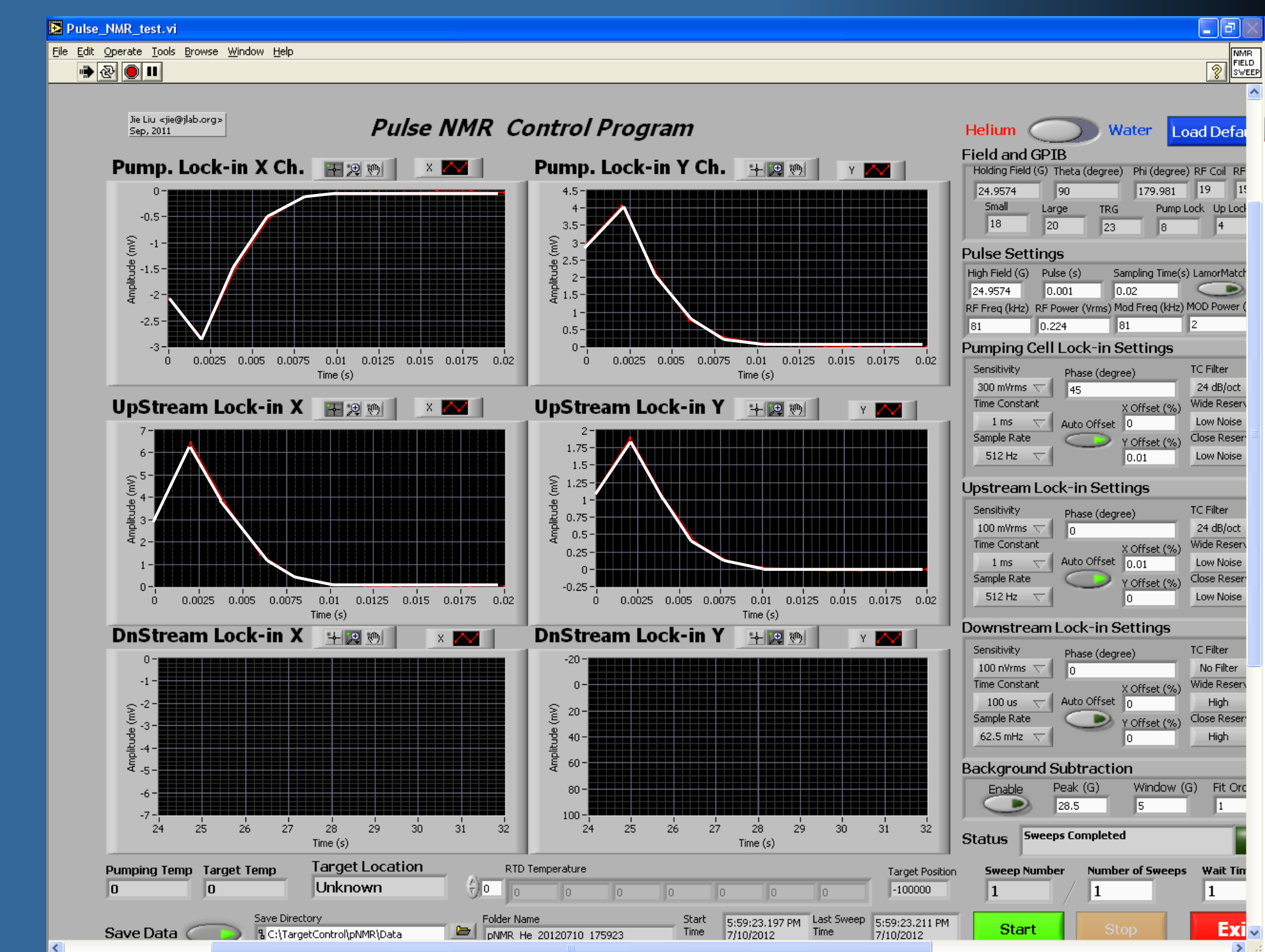


Diagram of target cell apparatus

Results

- Preliminary results suggests that we are, in fact, getting a signal using the pulsed-NMR apparatus
- At this time we are still unsure what is causing initial spike in signal
- Further testing with pulsed-NMR needs to be done to confirm that the signal is real



Conclusion

Preliminary results show that pulsed-NMR signal is observed for the first time at JLab. These results are encouraging, however, further testing must be performed to understand the initial spike in the signal. If this signal is confirmed and accurate, the pulsed-NMR setup can be used with the new convection target system, which is being developed for 12 GeV experiments.