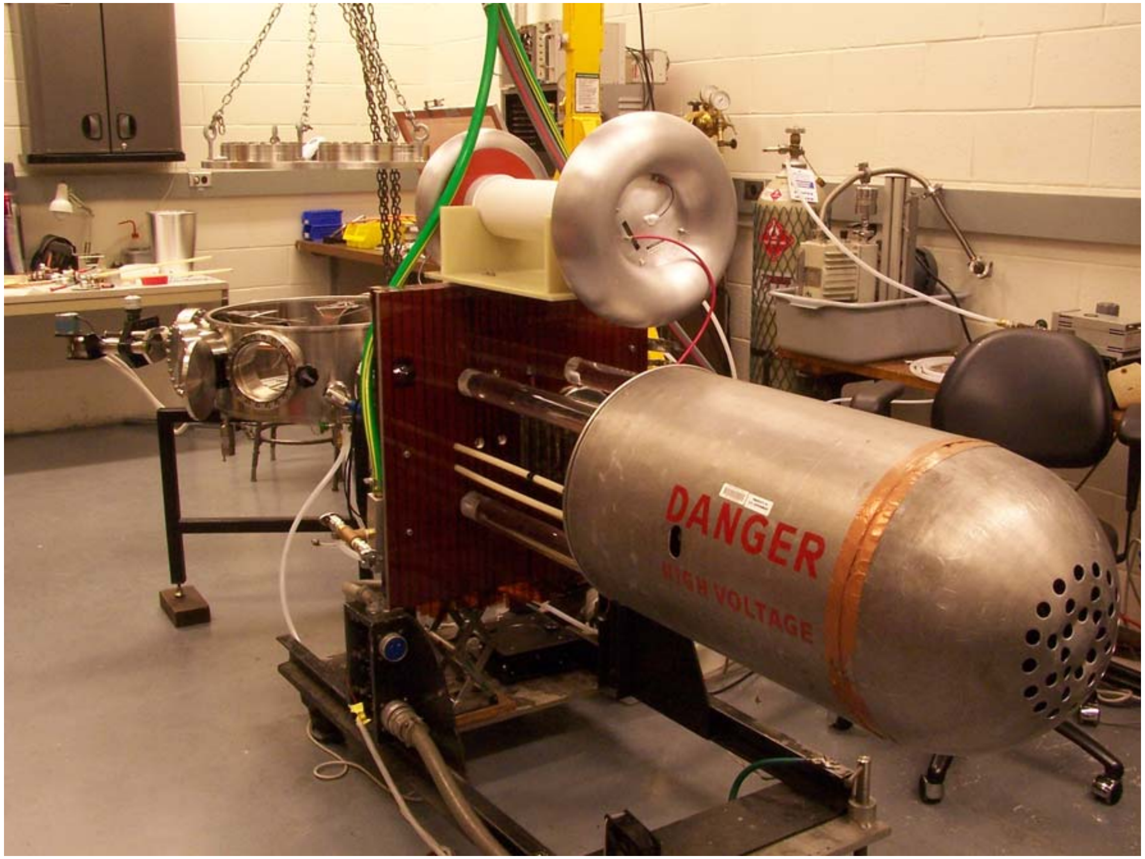
The MIT accelerator: A fusion product source for ICF diagnostics development and education



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MIT - Plasma Science and Fusion Center

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PSFC UR LLE

Collaborators

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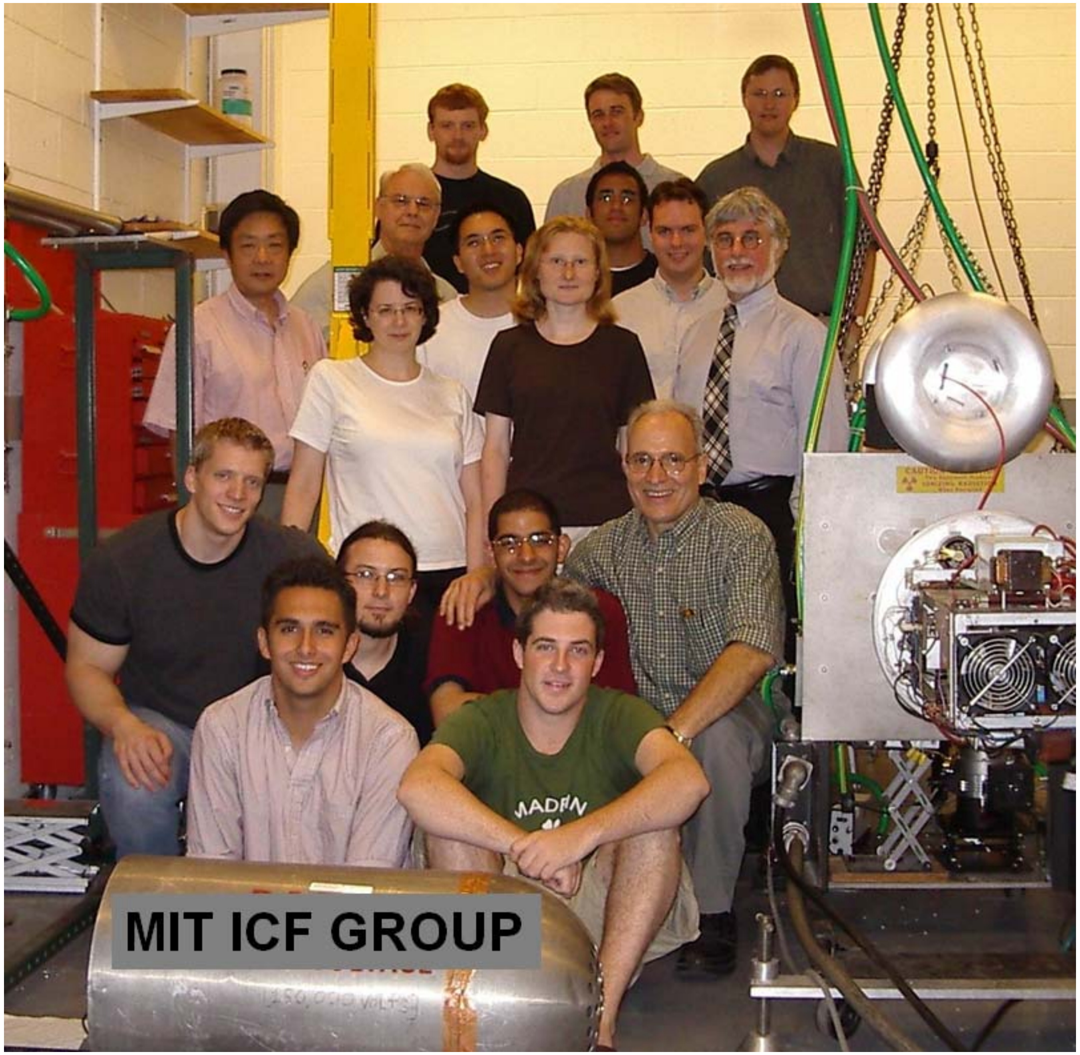
The MIT ICF Group



Abstract

The MIT fusion product source (initially a Cockcroft-Walton accelerator) has been significantly upgraded through experimental and computational work, furthering the usefulness of this tool for many ICF applications. Additional hardware and software upgrades and testing of various components have improved and allowed greater control over yields and energies of several types of emergent fusion products. ICF diagnostics development is currently being done, including testing of different kinds of CR-39 detectors, calibration of charged particle spectrometers[††]. This effort also supports the development of the Magnetic Recoil Spectrometer (MRS) in addition to the current ICF diagnostics.**

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**** J.A. Frenje et al., QO3.00010, J.A. Frenje et al., Rev. Sci Instrum. 72 (2001) 854.**
[††] F.H.Seguin et al., Rev. Sci Instrum. 72 (2001) 854.

Outline

- A Cockroft-Walton accelerator has been significantly upgraded
  - A new flexible target chamber has been designed, built and installed.
  - A remotely controlled target system is currently being installed.
  - Accelerator beam diagnostics have been installed.
  - LabView based control and data acquisition is being installed.

- Accelerator protons will be used to improve/characterize the following ICF diagnostics:
  - CR-39 detectors of various thicknesses.
  - Wedge Range Filter (WRF) spectrometers[††].
  - The Magnetic Recoil Spectrometer (MRS)**.
  - neutron Wedge Range Filter (nWRF) spectrometers.

- Educate students and give them valuable hands-on experience.

** J.A. Frenje et al., QO3.00010, J.A. Frenje et al., Rev. Sci Instrum. 72 (2001) 854.
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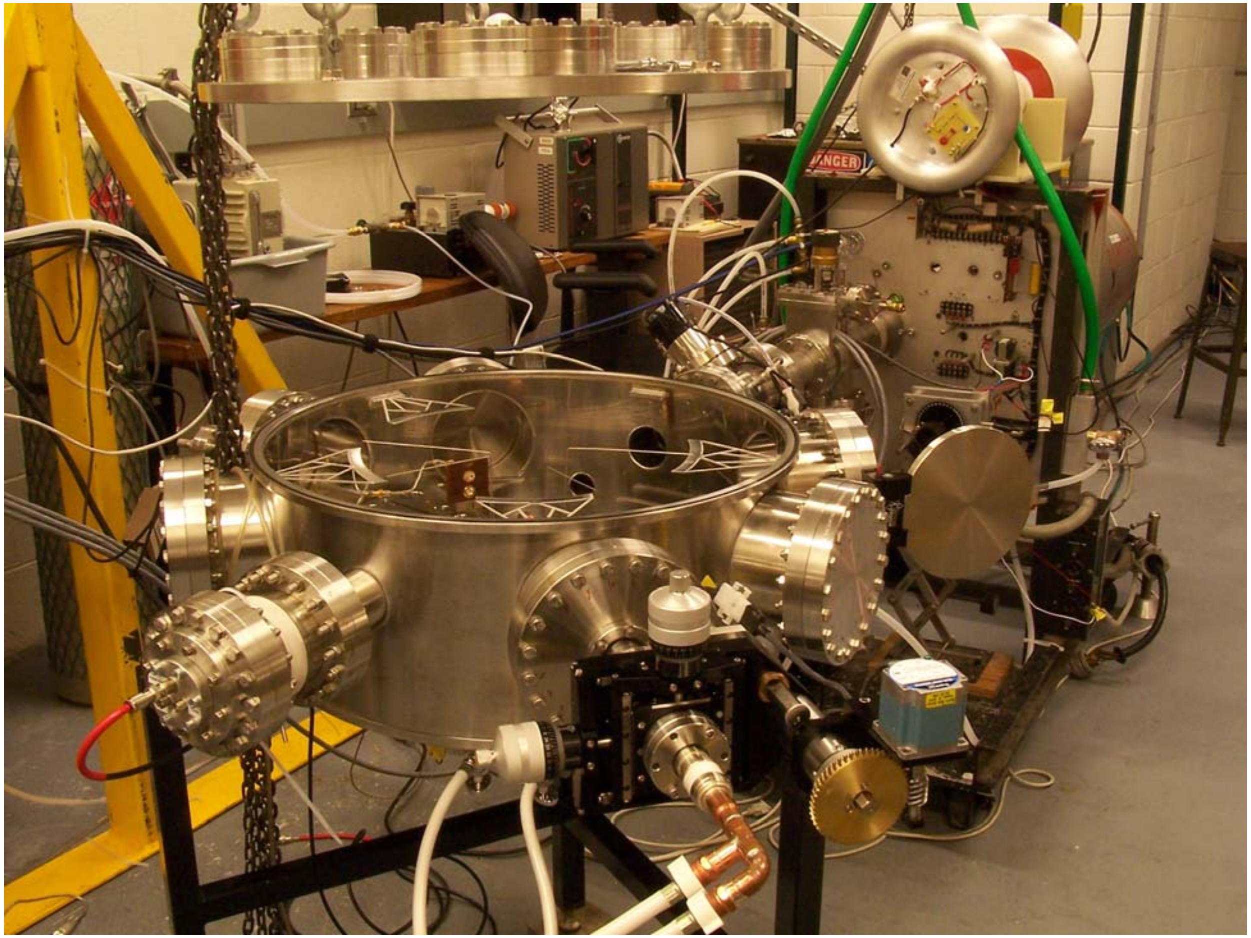
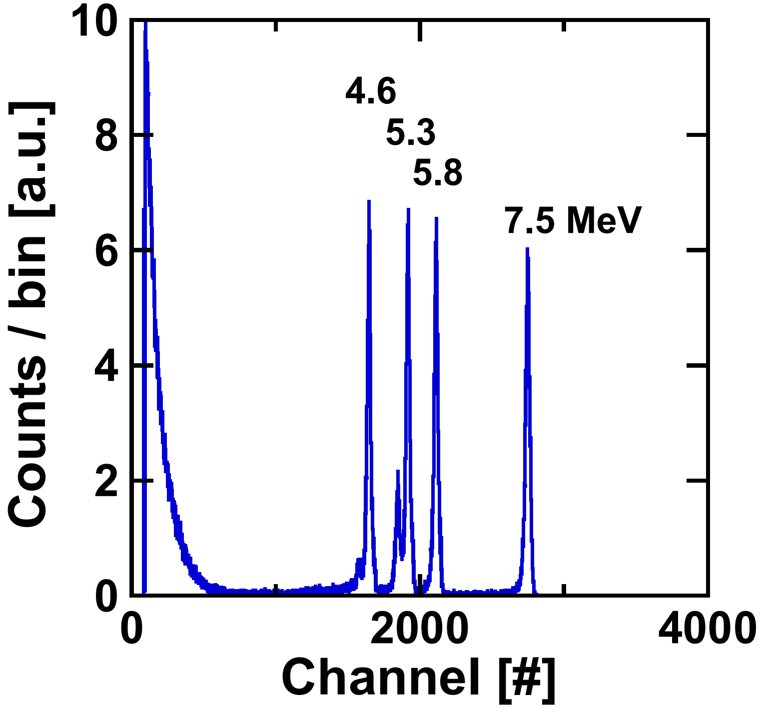
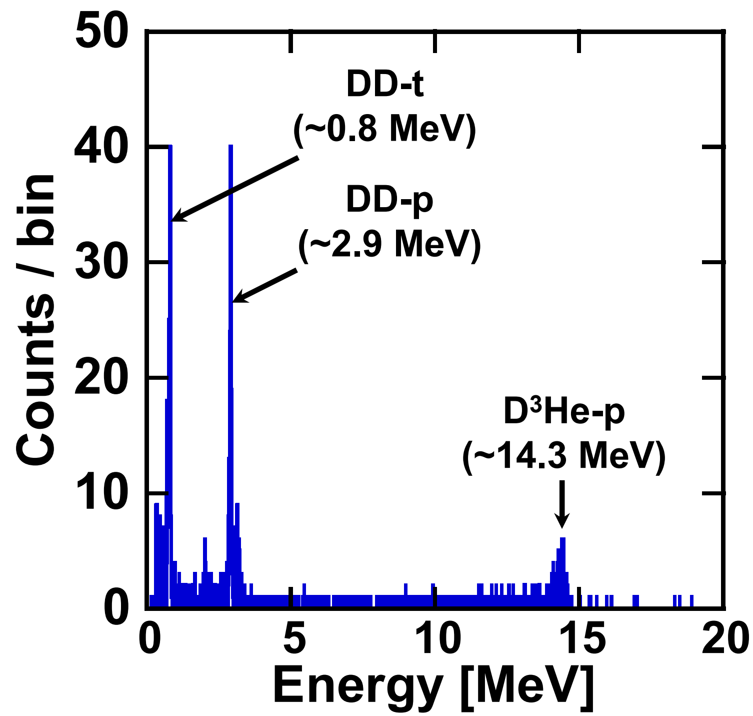
The MIT accelerator has been upgraded for ICF diagnostics development and education



Several well characterized fusion products can be produced with the accelerator

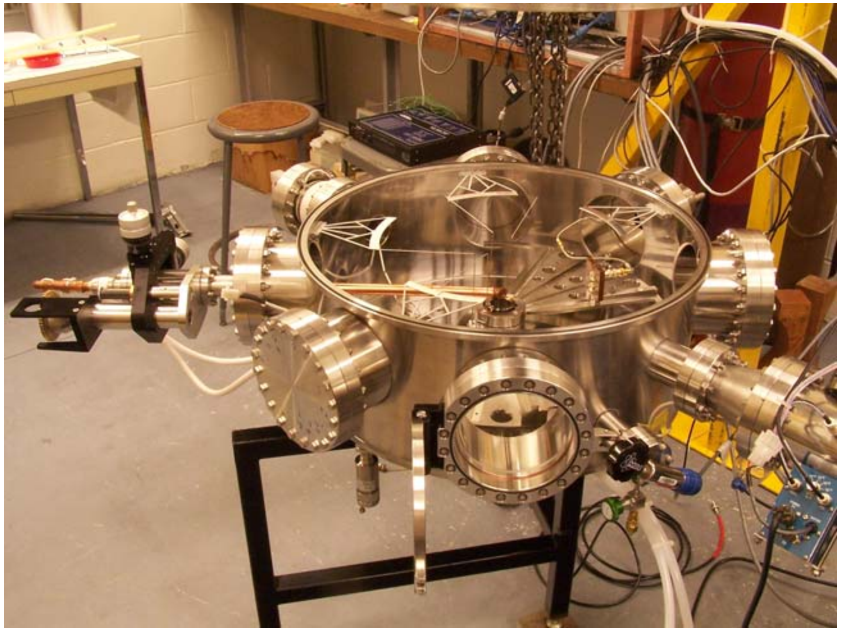
^{226}Ra source (α-source) for DAQ calibration

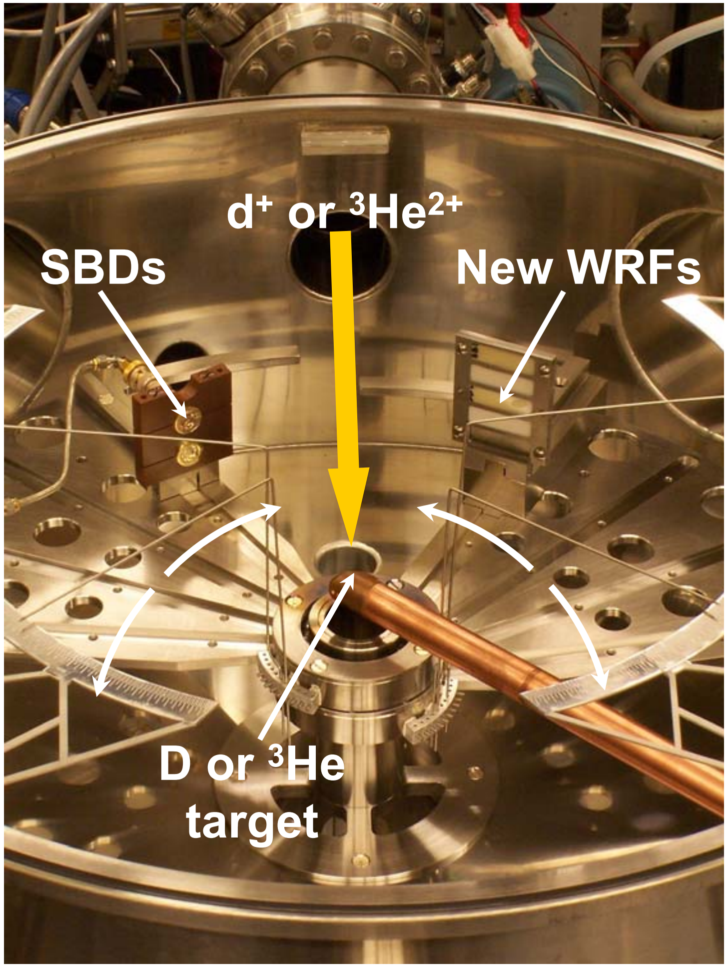




The accelerator also produces DD-neutrons, which will be used for developing and optimizing several types of ICF diagnostics

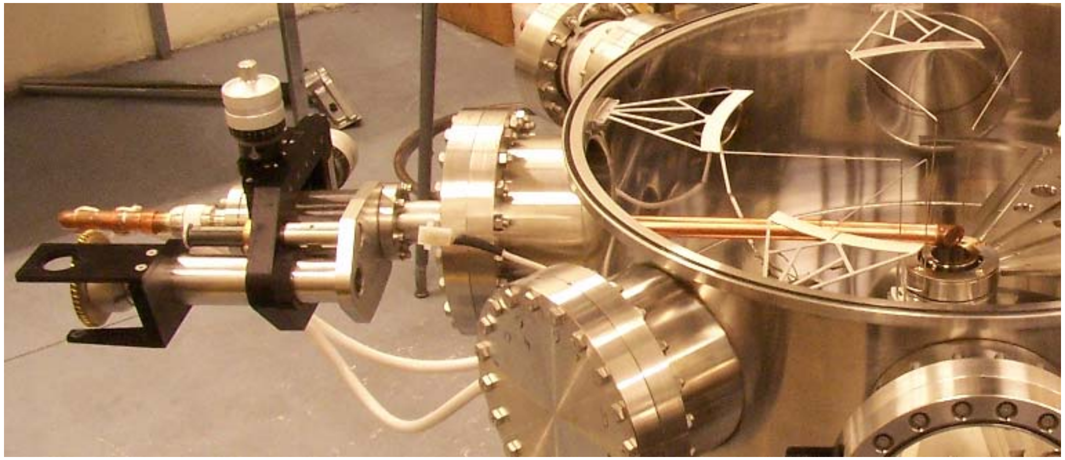
A new flexible target chamber has been designed, built and installed

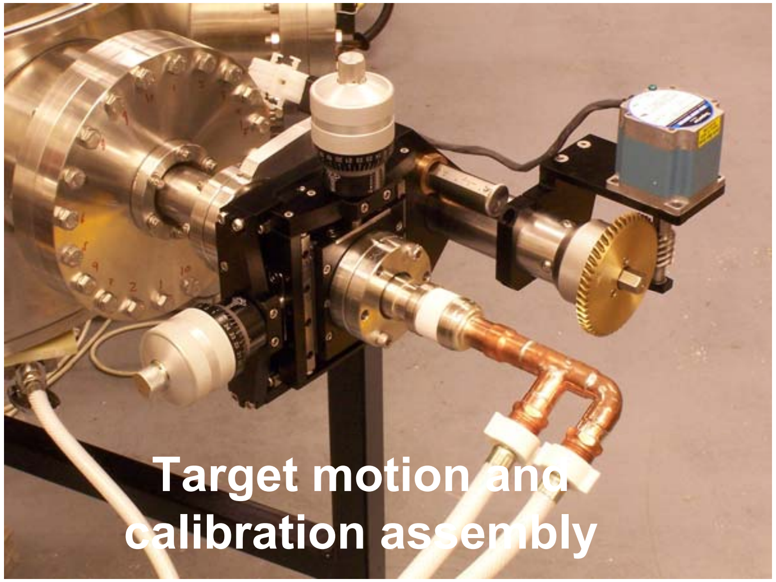


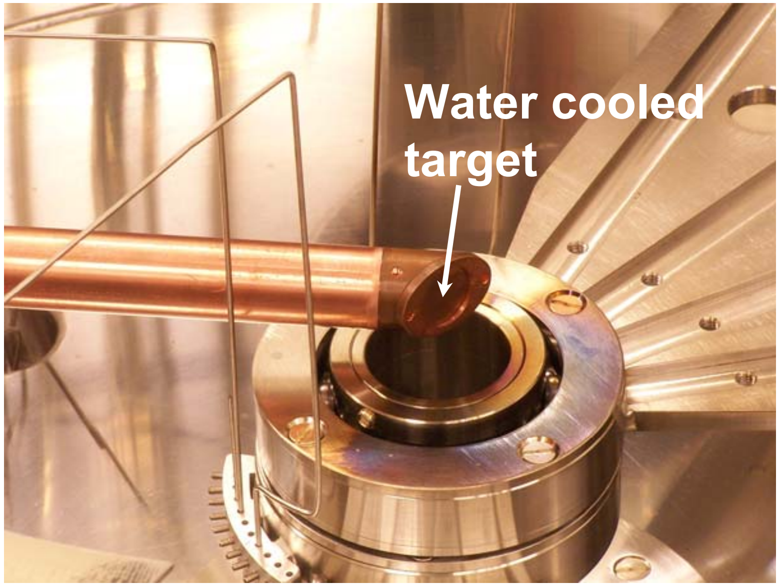


The new target chamber can be quickly and easily configured for different types of experiments.

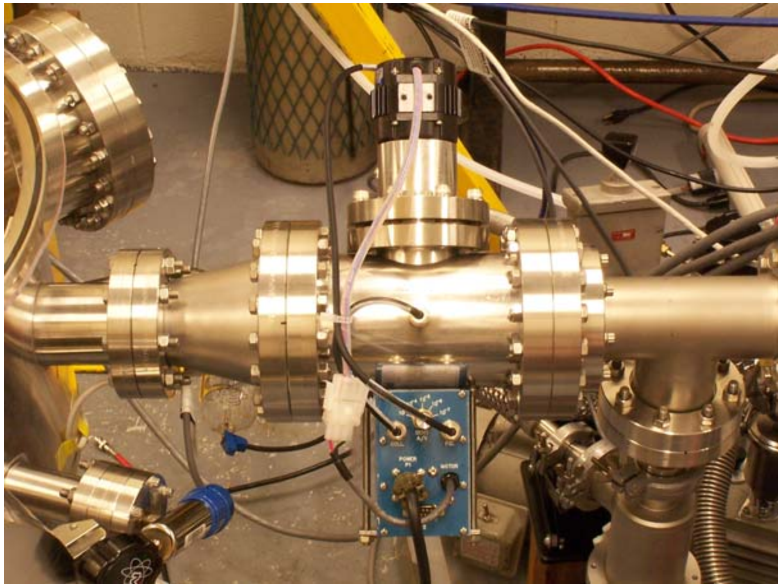
A remotely controlled target system is currently being installed

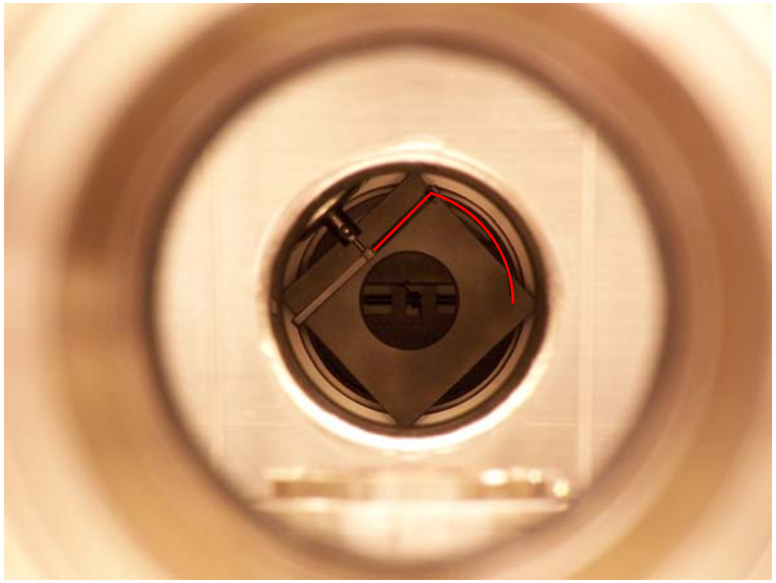






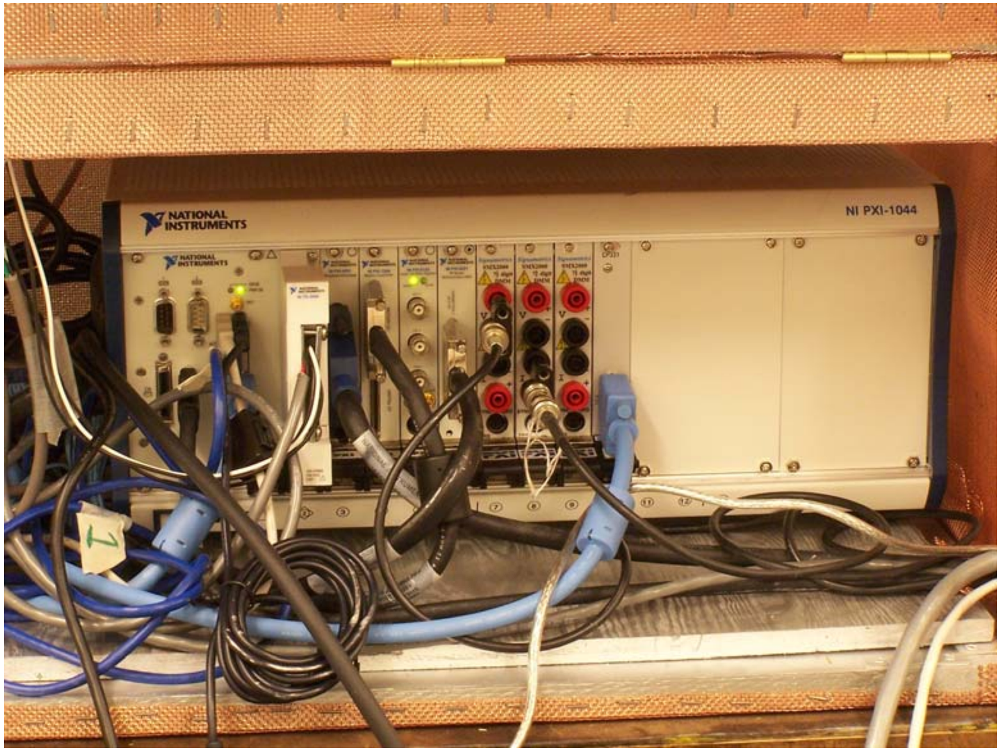
Accelerator-beam diagnostics have been installed





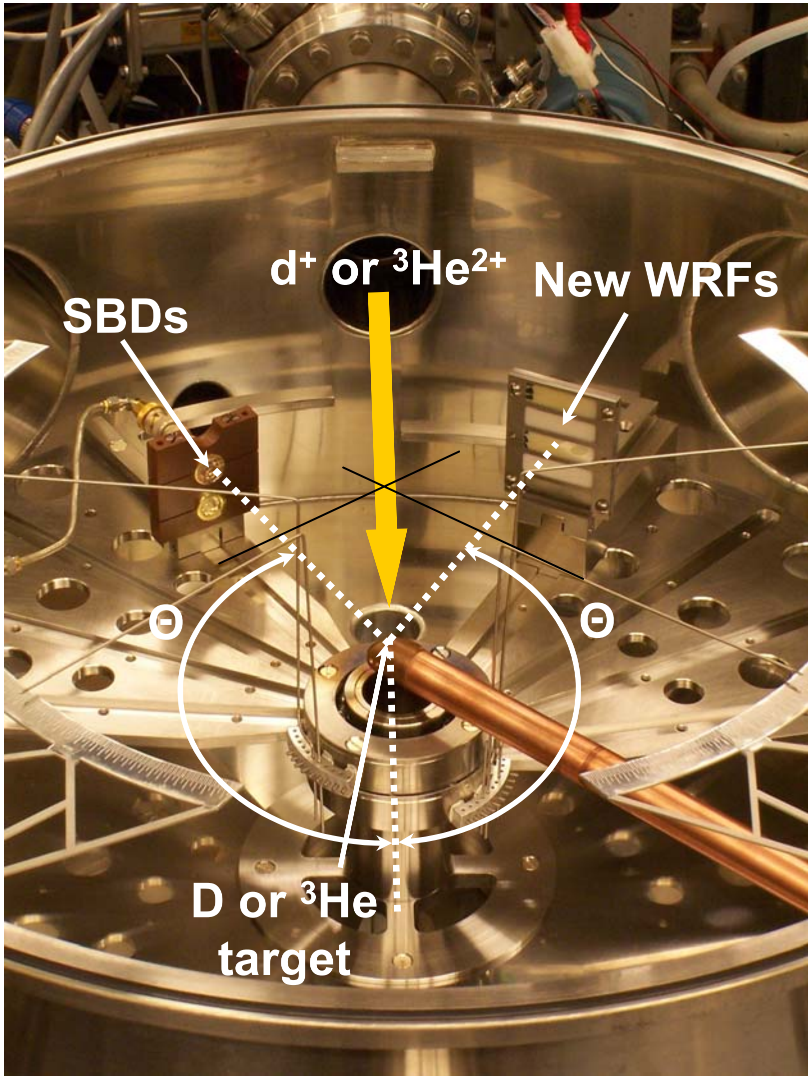
The NEC beam profiler system (left). When a curved wire is passing through the beam (right), secondary electrons are generated and the spatial distribution of the beam can be determined.

LabView based control and data acquisition system is being installed



A National Instruments PXI system is being implemented to replace many of the older control elements, and add new diagnostic functionality and expandability.

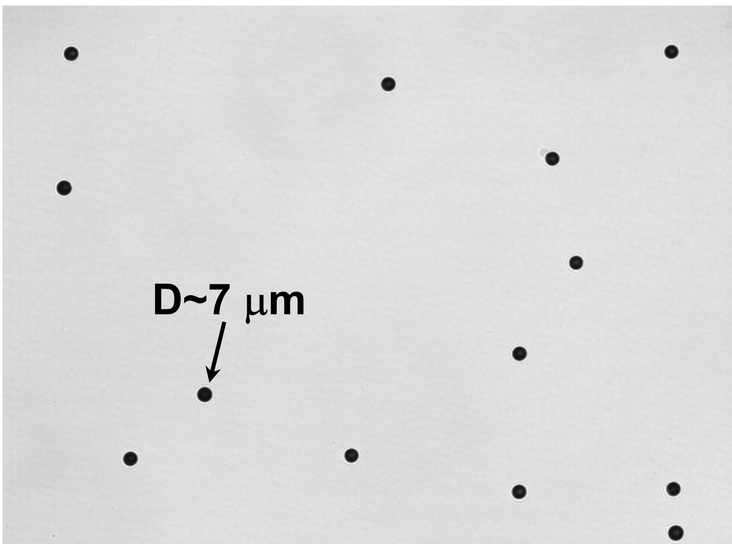
D^3He and DD reactions are mainly being used in the accelerator for the ICF diagnostics development

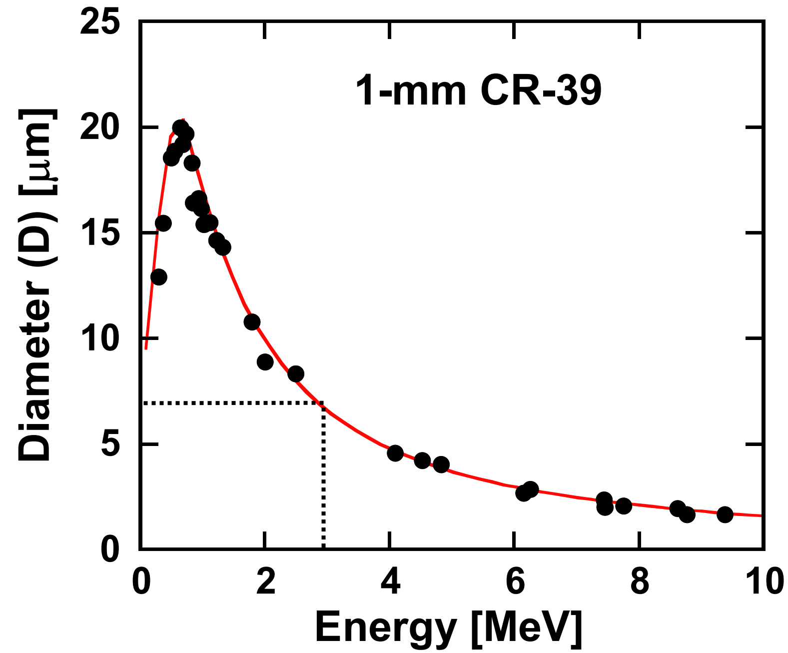


D^3He-protons (or DD-protons) produced at same angle (Θ) have same energy. These fusion products of same energy can be simultaneously monitored by several calibrated SBDs and new ICF diagnostics to be tested or calibrated. In this particular case new WRFs are being calibrated.

D^{3}He-p and DD-p are being used to accurately characterize response of different types of CR-39

~3-MeV DD-p tracks in the CR-39**

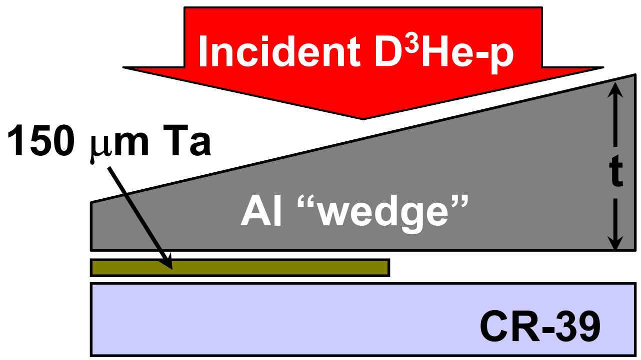


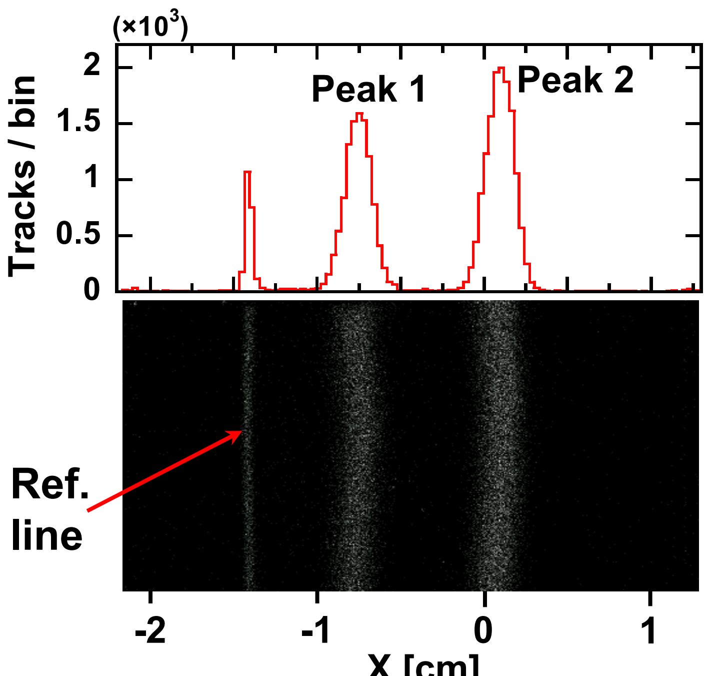


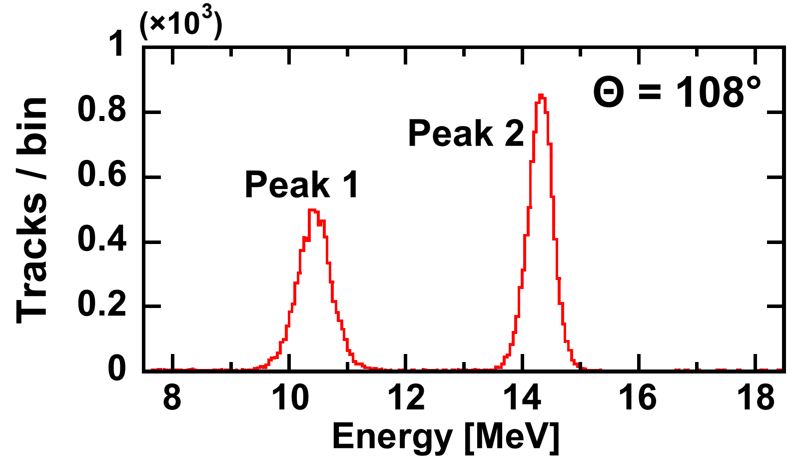
A calibrated mapping between track diameter and proton energy can be obtained, since track diameter is proportional to dE/dx.

** The tracks are made visible through etching in 6M NaOH. In this case, the CR-39 was etched for 6 hours.

Current WRFs are being recalibrated on the accelerator to account for any changes from use at OMEGA



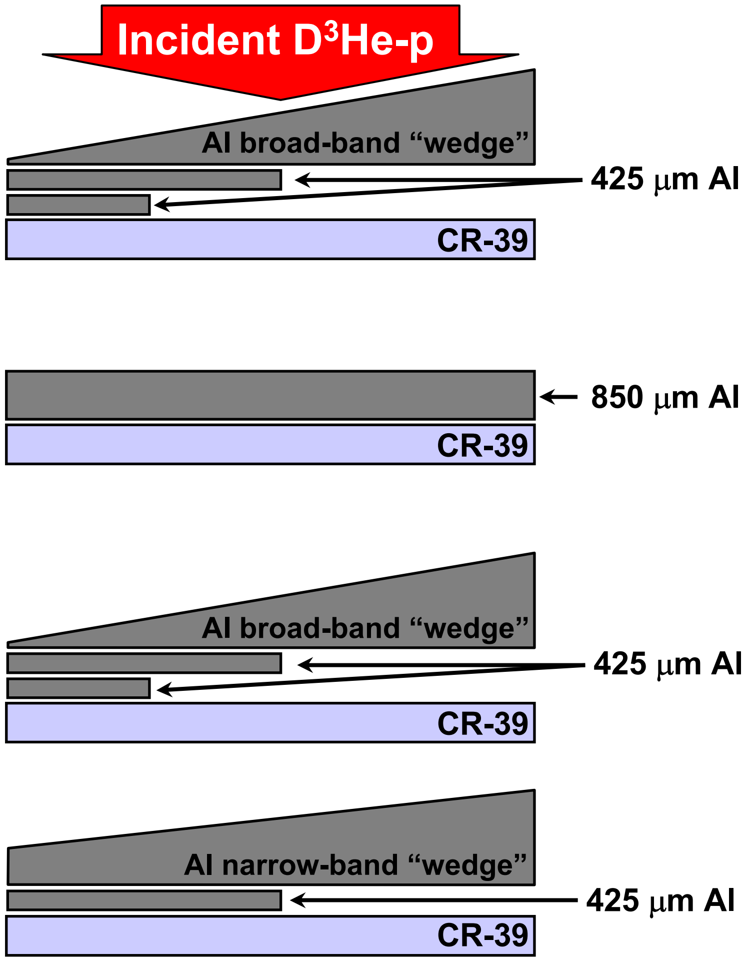


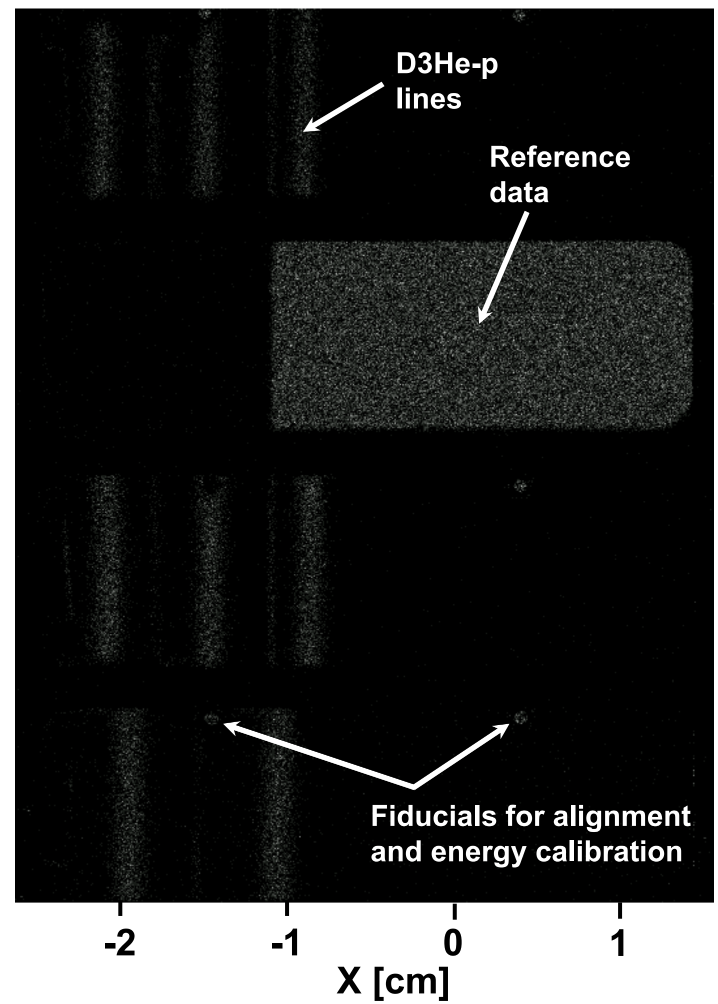


Peak:	1	2
Measured (MeV):	10.32	14.35
Anticipated (MeV):	10.3	14.4

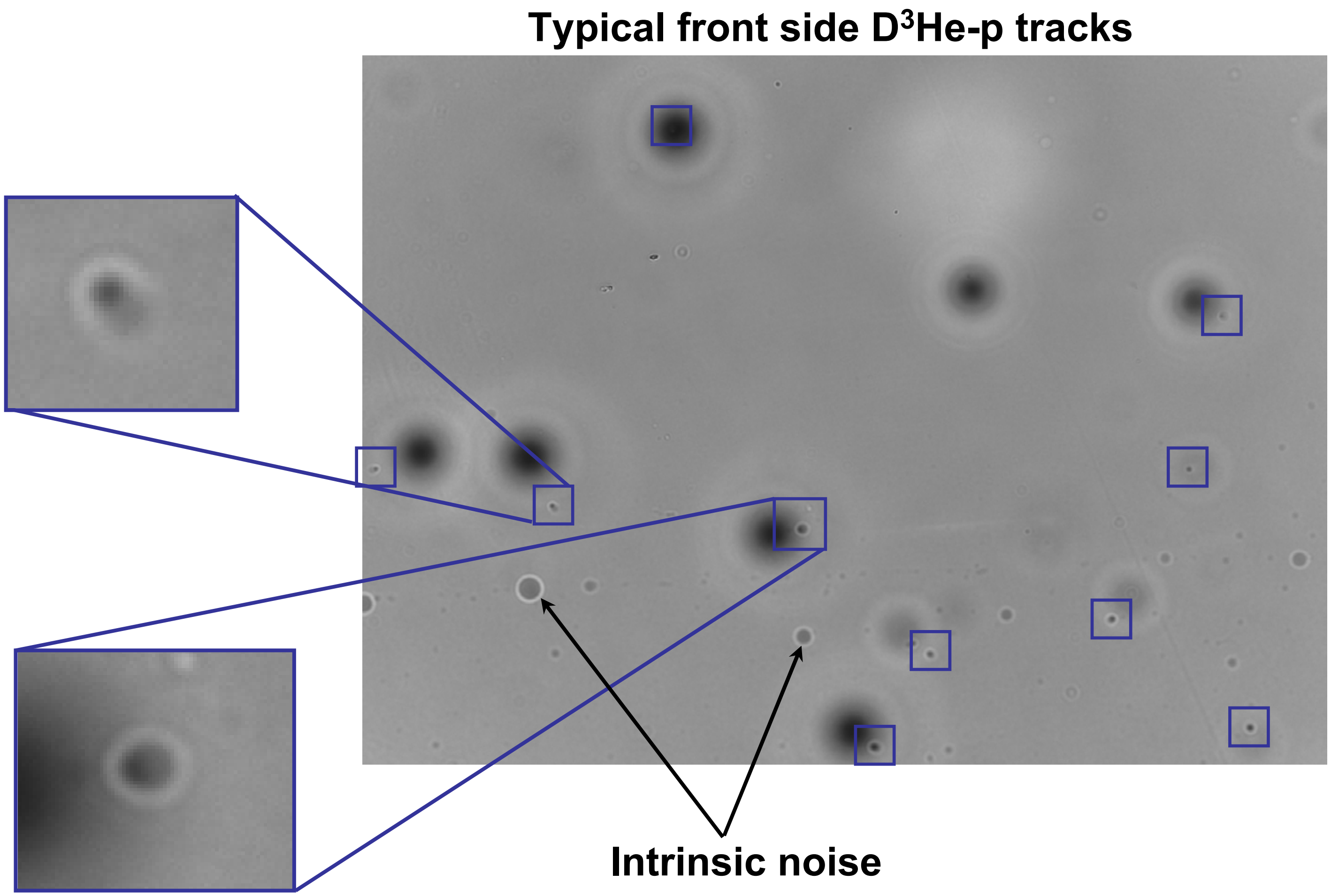
No significant changes have occurred during several years of operation at OMEGA

Absolute energy calibration of new improved WRFs are using D^{3}He-p





Track coincidence-counting technique (CCT)** will be optimized using D^{3}He-p at the accelerator



** Using the CCT will reduce neutron background in the MRS and nWRF data with several orders of magnitude (see S. Volkmer et al., FP1.00007)

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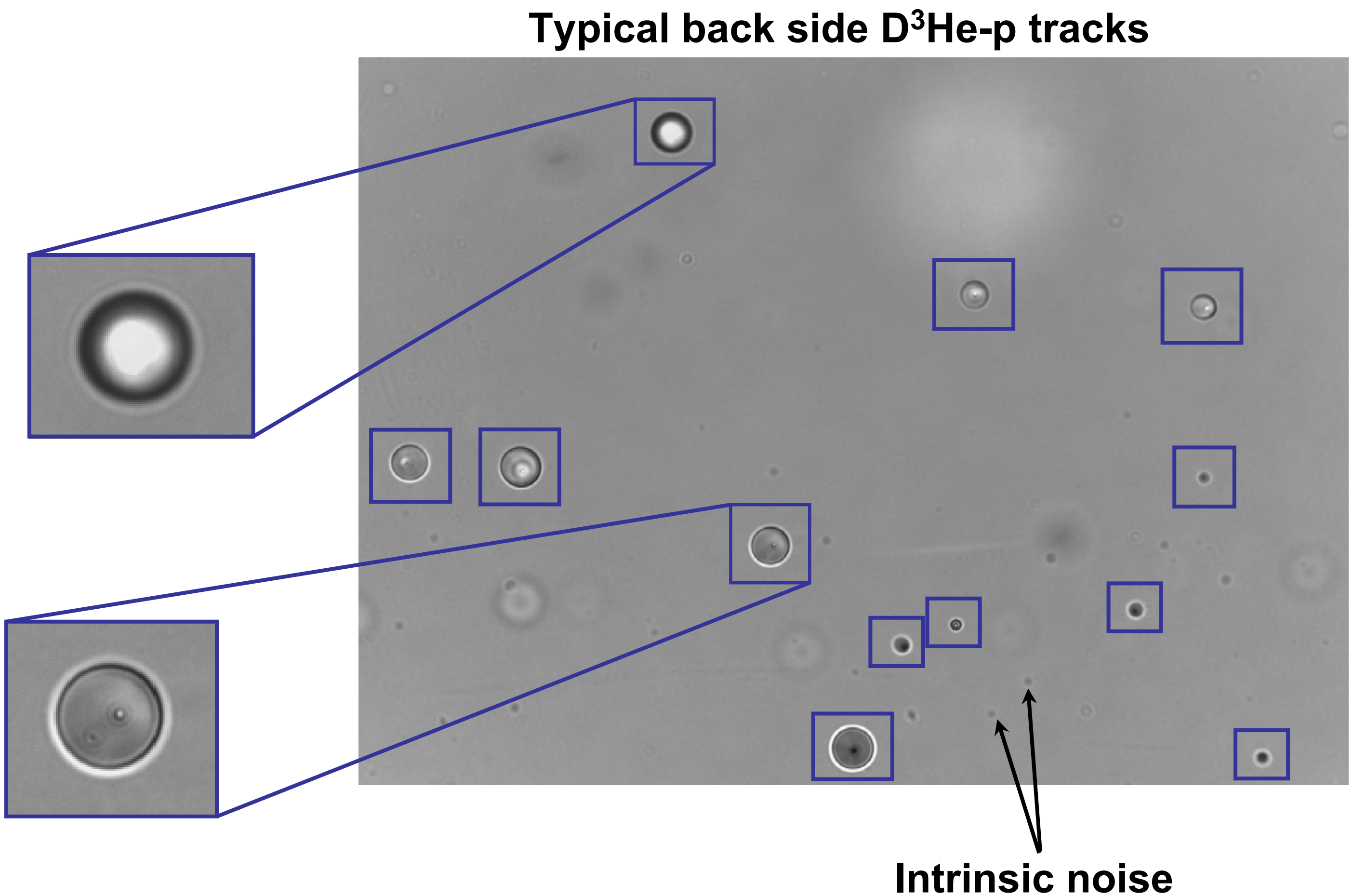
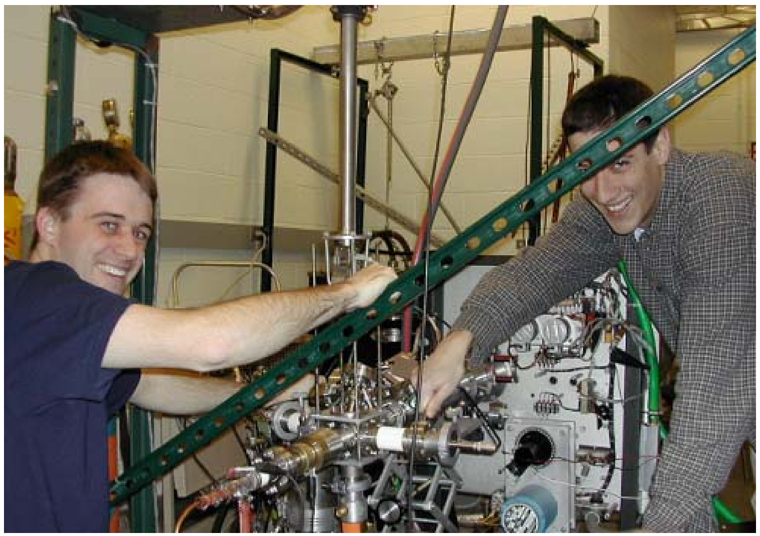


** Using the CCT will reduce neutron background in the MRS and nWRF data with several orders of magnitude (see S. Volkmer et al., FP1.00007)

Students get valuable hands-on experience when working with the accelerator

Graduate students Ryan and Joe working on the old accelerator



Undergraduate students Jeff and Sohrab behind the new target chamber

Future work

Experiments:

- CR-39 coincidence-counting studies.
- Continue calibration of different types of WRFs.
- Characterization of CR-39 with various thicknesses.
- Single event response studies of different types of electronic detectors for ICF applications.

Hardware development and upgrades:

- Implement hi-flux ion beam imaging diagnostics.
- Improve vent/pump cycle time.
- Implement and improve beam shaping and beam energy selection.

Software development and upgrades:

- Improve LabView based data acquisition system.
- Implement data management protocols.