Experimental Progress in 2003 of the UW IEC Facility

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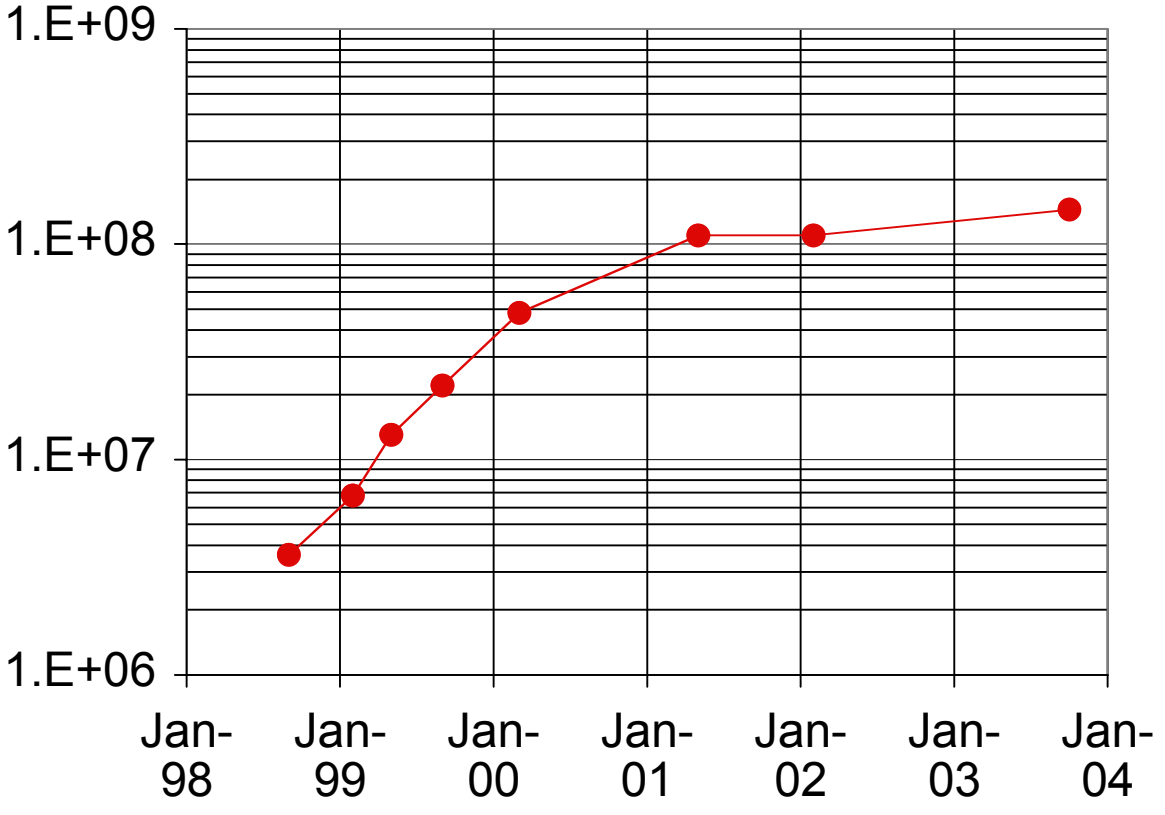
Overview of Activities

- Operation to 180 kV
- Produced 180 million neutrons per second steady state
- Fabricated internal and external activation systems
- Studied ^{3}He ion damage of tungsten grid wire
- Upgraded diagnostics with the addition of a pyrometer, spectrometer, and off axis proton detector
- Designed a standardized cathode grid fabrication system
- Conducted thermionic electron emission studies
- Developed and constructed a helicon source ion gun

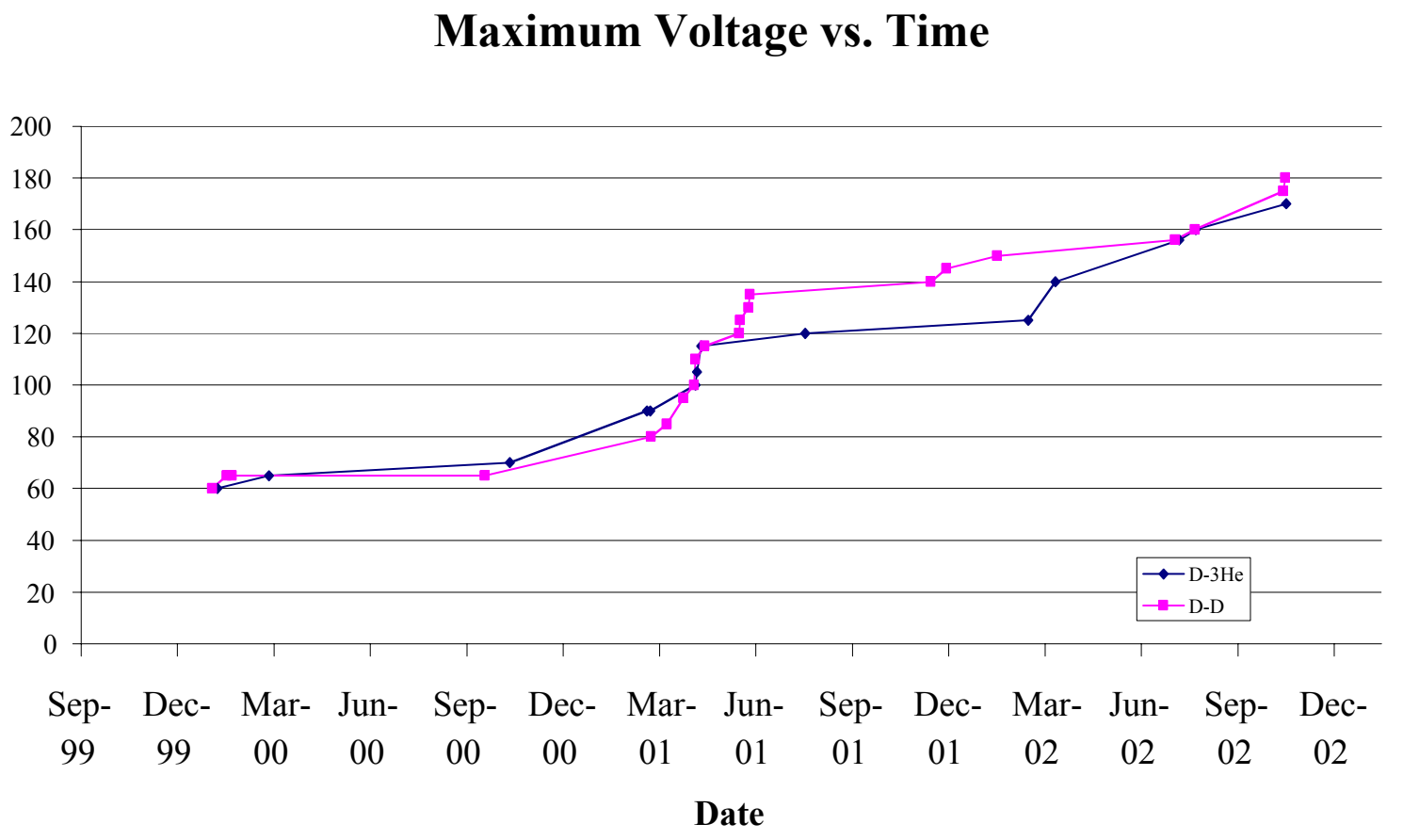
We Have Produced a UW IEC Record of 1.8 x 10^8 D-D Neutrons /s



Date Experiments Conducted in Wisconsin IEC Device

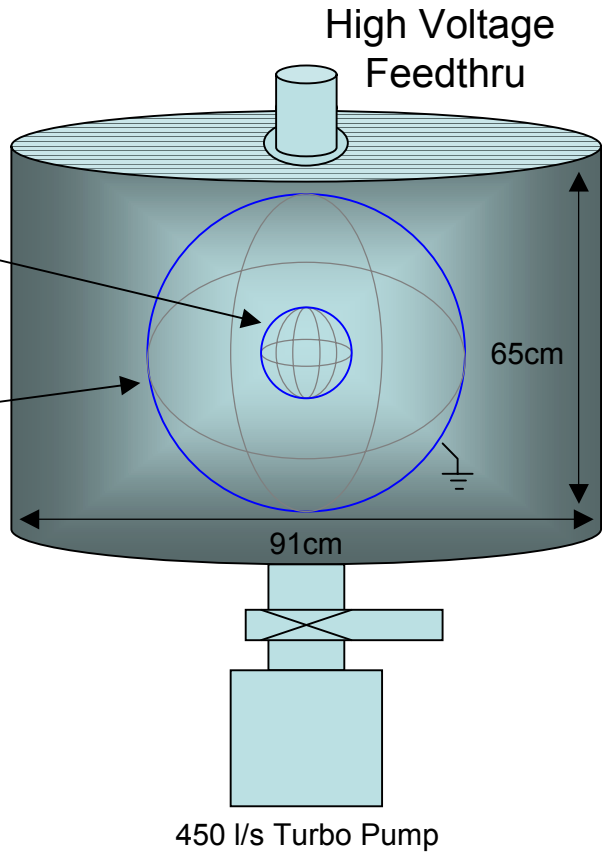
RPA

We Have Operated at a Maximum of 180 kV D-D



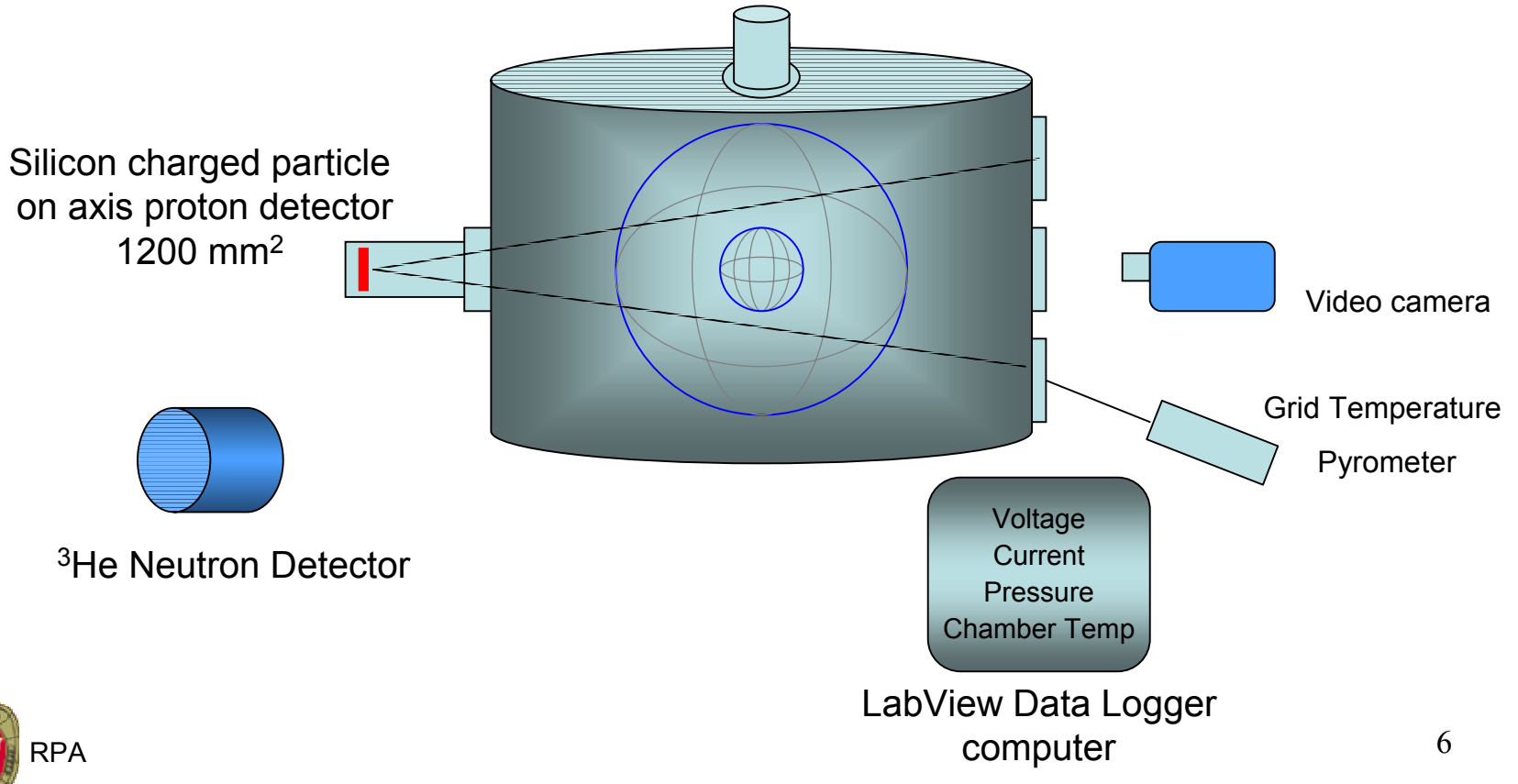
RPA

University of Wisconsin IEC Facility



Typical operating conditions
Cathode voltage:40-150 kV
Cathode current: 30-60 mA
Pressure:1.5-2.5 mTorr

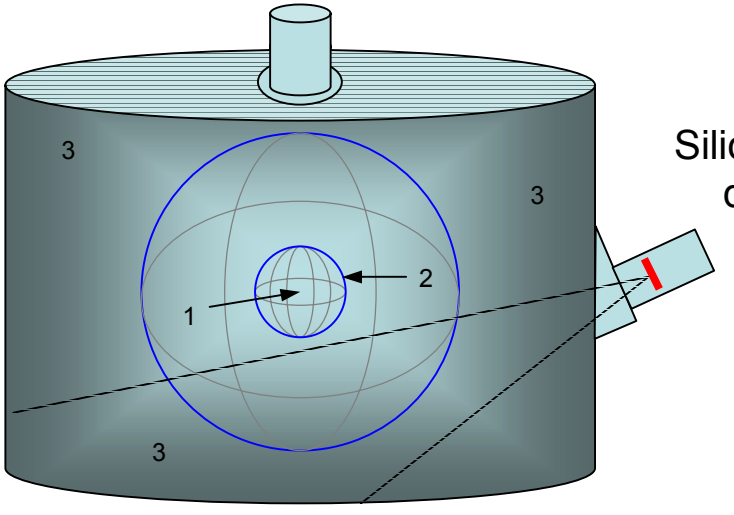
Primary Diagnostics



Off Axis Detector Confirms Significant Volume Source of D-D Protons

There are three main regions of fusion reactions in the UW IEC reactor

1. converged core region
2. ^{3}He embedded fusion
3. volume source region

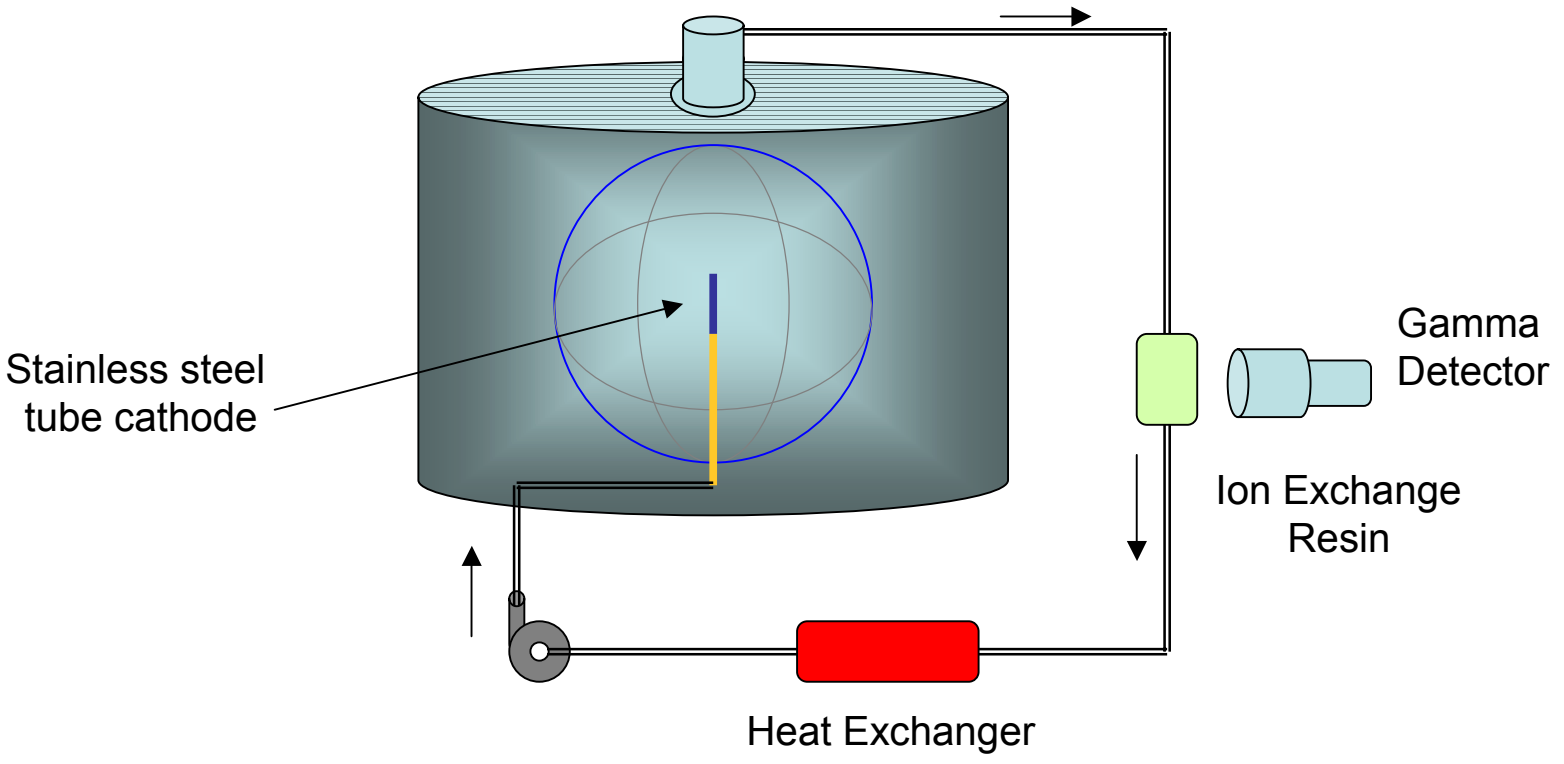


Silicon charged particle detector 450 mm^2

- **Off axis detector shows similar D-D proton rates per unit volume as the on axis detector, confirming a volume source of D-D protons**
- **Off axis detector shows negligible D-^{3}He proton rates per unit volume confirming embedded D-^{3}He fusion**

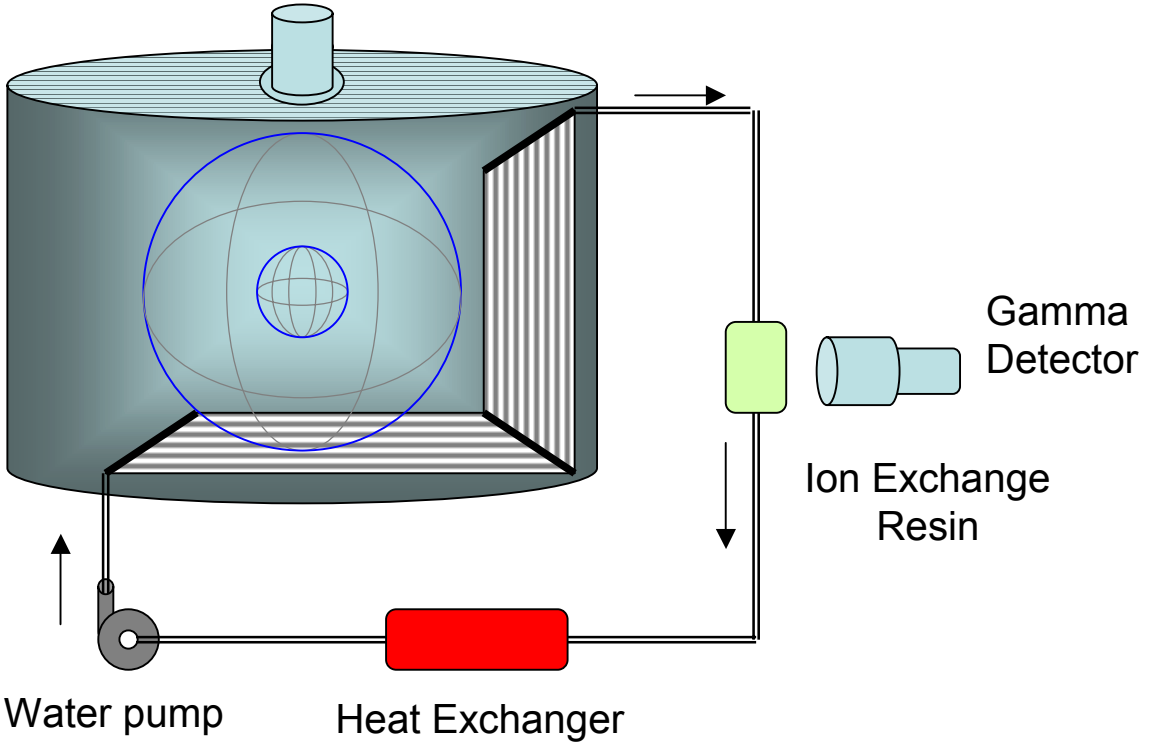
^{13}N Production Has Been Accomplished with Water Cooled Cathode Target

1. **Embedded 3He fusion occurs in the stainless steel tube cathode**
2. **^{13}N is produced in the cathode tube cooling water**

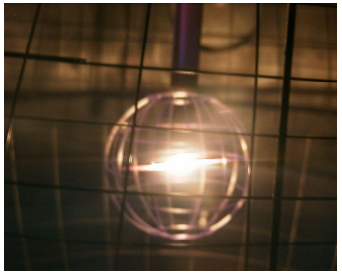


^{13}N Production Also Accomplished with Internal Water Circulator

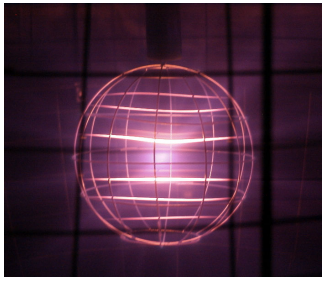
1. **Stainless steel tube assembly is exposed to D-^{3}He fusion proton flux**
2. **14 MeV protons penetrate the tubes and activate the oxygen in H_2O**
3. **^{13}N is captured in the ion exchange resin**



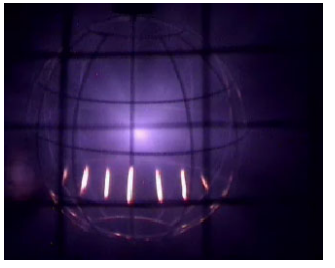
Diagwire experiments help determine ion flow characteristics *



- Wire power balance helps diagnose ion flux patterns



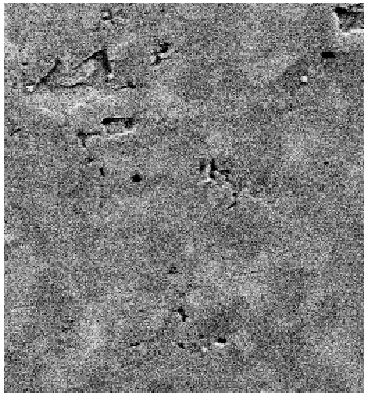
- Thermionic emission reduces the overall fusion rate at fixed meter current



*details will be reported at next workshop

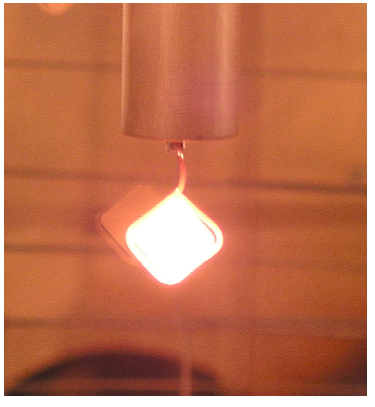
Fast He Ions Can Produce Significant Damage in Tungsten

Wire grid cathode was replaced by a
1 cm square tungsten sample target



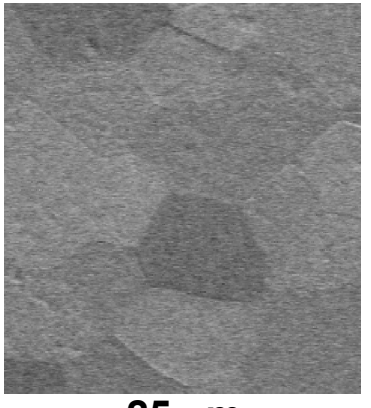
5 μm

SEM picture of sample before operation



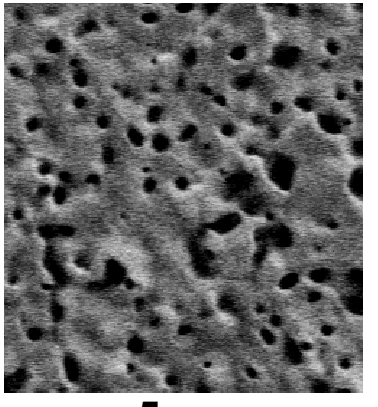
1 CM

D^+, 20 kV, 5 mA
2 mtorr, 1100 ° C



25 μm

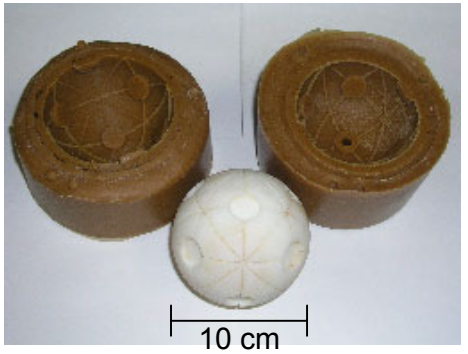
sample after
2×10^{19}
deuterium ions /cm^2



5 μm

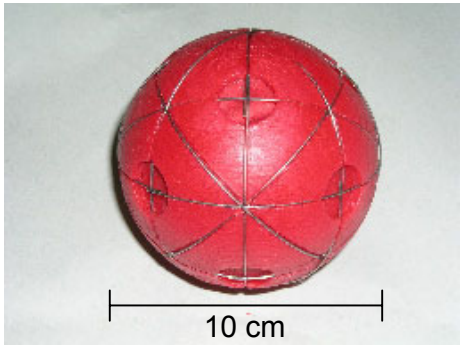
sample after
6×10^{18}
helium ions /cm^2

Fabrication System for Standardized Grid



1. Mold produced from rapid prototype model

2. Wax poured into mold



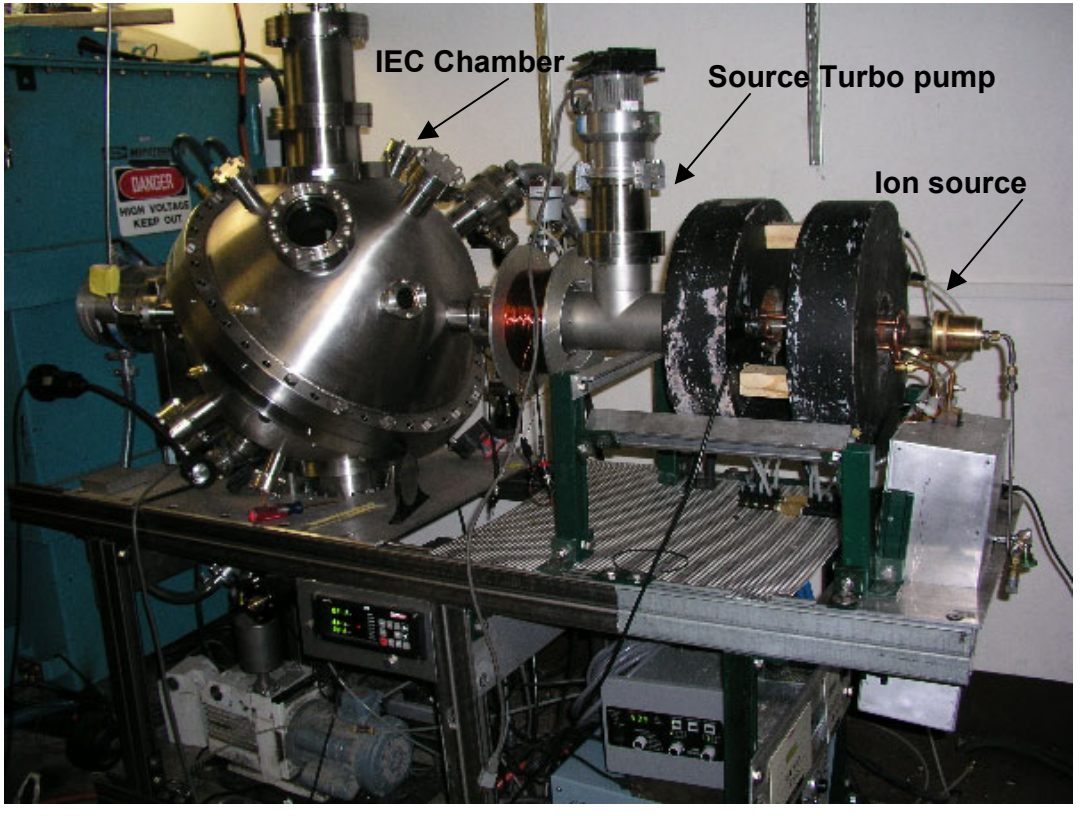
3. Wires wound around wax form

4. Wires spot welded at junctions

5. Wax form melted away @100C

6. Finished grid cathode

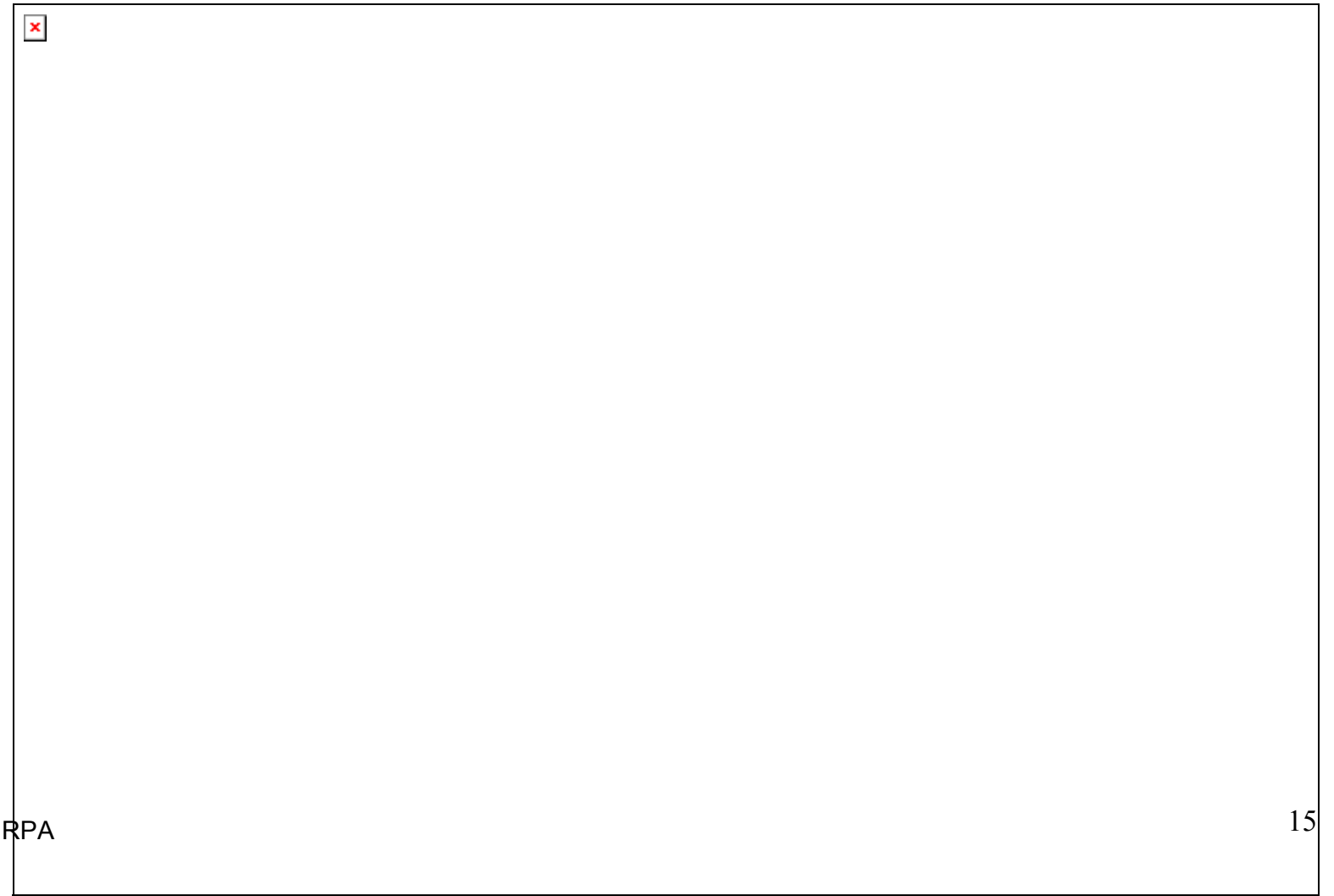
Ion Gun on New Chamber
(see talk by Piefer)



Future Plans

- Improve proton rates for medical isotope production
- Study converged core formation with new ion source
- Understand grid wire damage caused by helium ions
- Characterize ion and impurity population densities with spectroscopy studies
- Simulate ion flow to better understand the source regions and reaction rates

At 100 kV, We Have Seen Lower Rates of D-D Neutrons at Lower Pressures



Gamma detector is all-in-one instrument for ease of use