Overview of University of the Wisconsin IEC Research Program-2011

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December 7-8, 2011

13th U.S.-Japan IEC Workshop

THE UNIVERSITY of WISCONSIN MADISON

Overview

- Progress since the 12th Meeting in Osaka, 2010.
- Specific Highlights on Selected Projects.
- Conclusions & Future Work

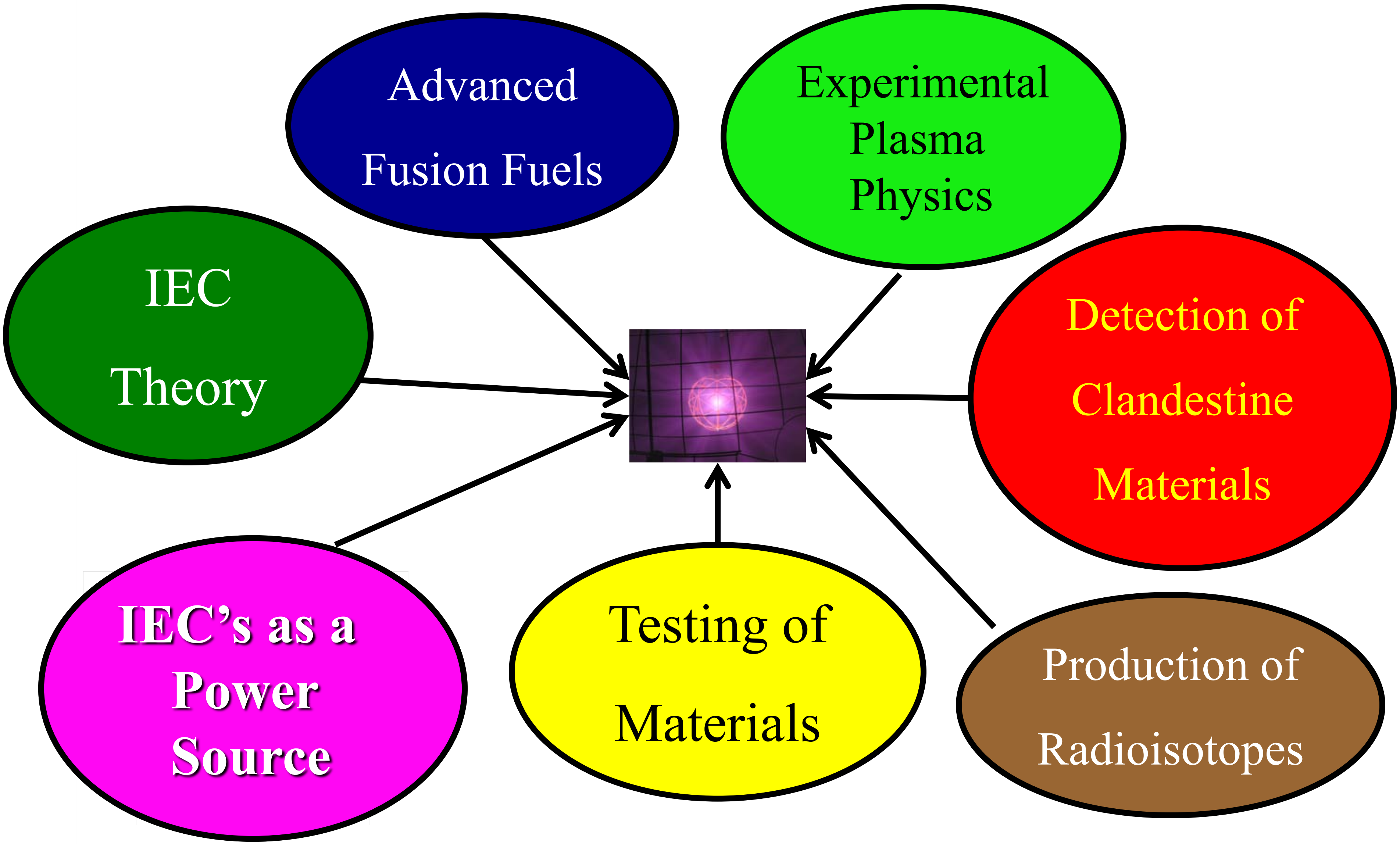
The Wisconsin IEC Team

Other UW-IEC Papers at the 2011 U. S./Japan Workshop

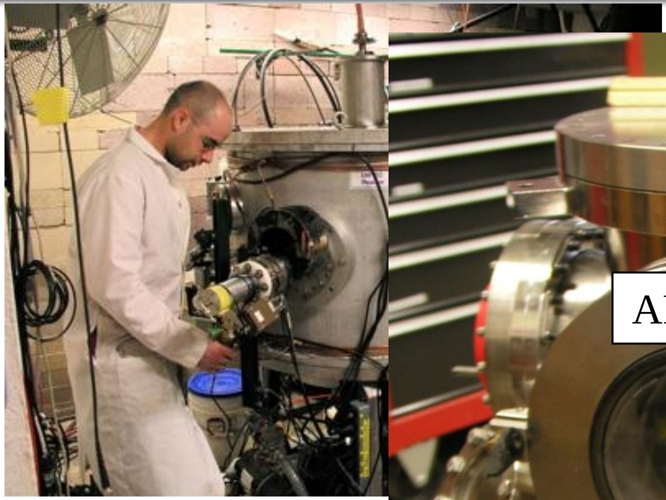
(Presenting Author/Title/Time)

- Matt Michalak, **“Six Ion Gun Fusion Experiment Findings and Future Work”** Wed. 2:00 PM.
- Gabriel Becerra, **“Enhancement of an Inertial Electrostatic Confinement Device with a Helicon Ion Source for Helium-3 Fusion**”, Wed. 2:30 PM.
- Rich Bonomo, **“UW IEC Group 2011: Continuing Preparations for 300 kV Operation – Device Switching”,** Wed. 3:00 PM.
- Gil Emmert**, “Update on the VICTER Code for Modeling Gridded, Spherically Symmetric IEC Devices”,** Thurs. 9:00 AM.
- Eric Alderson, **“Negative Ion Studies in an IEC Fusion Device”,** Thurs 9:30 AM.
- John Santarius, **“Theoretical Exploration of UW IEC Device Operation at Moderate Pressure”,** Thurs. 10:00 AM.

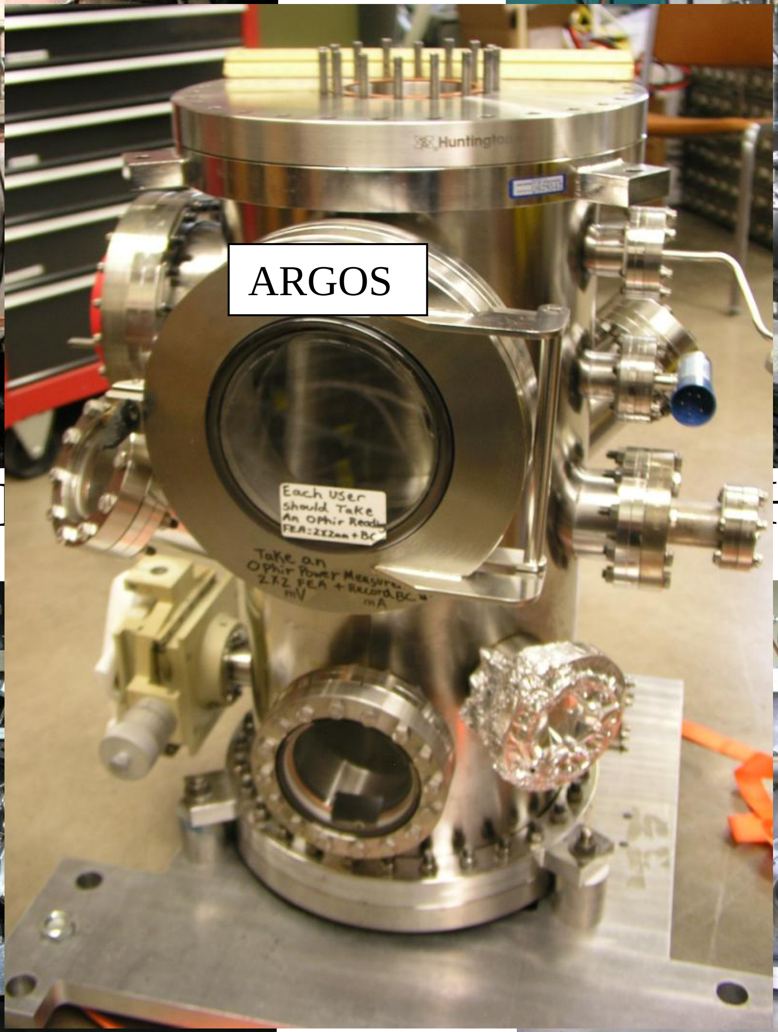
Current IEC Research Projects at the University of Wisconsin

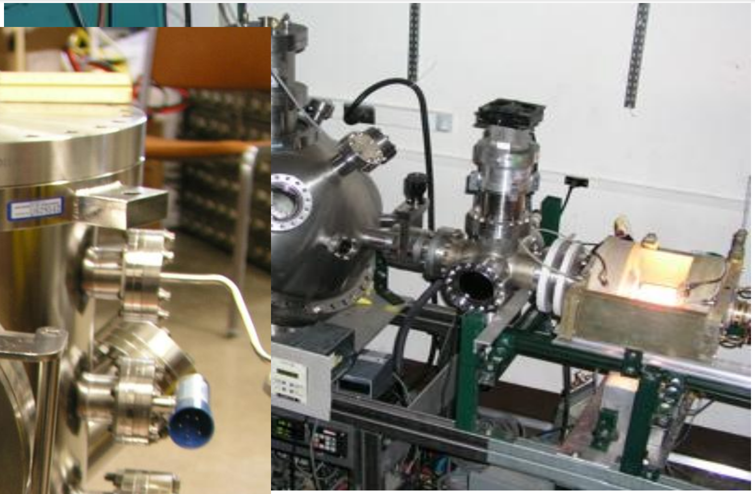


There are Currently Four Different "IEC" Chambers in Operation and One Under Construction at the University of Wisconsin

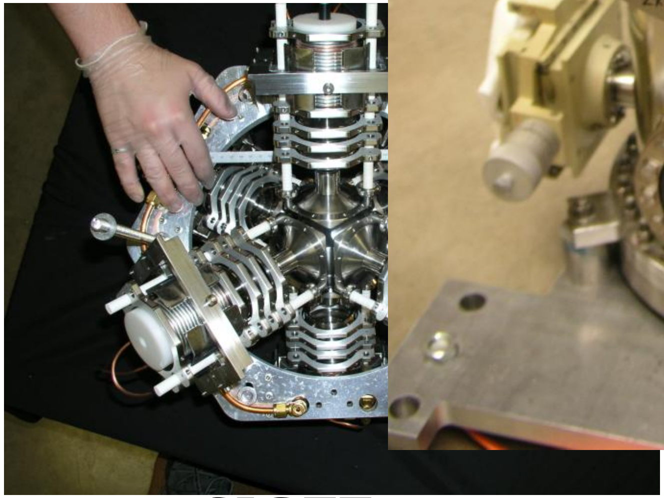


HOM

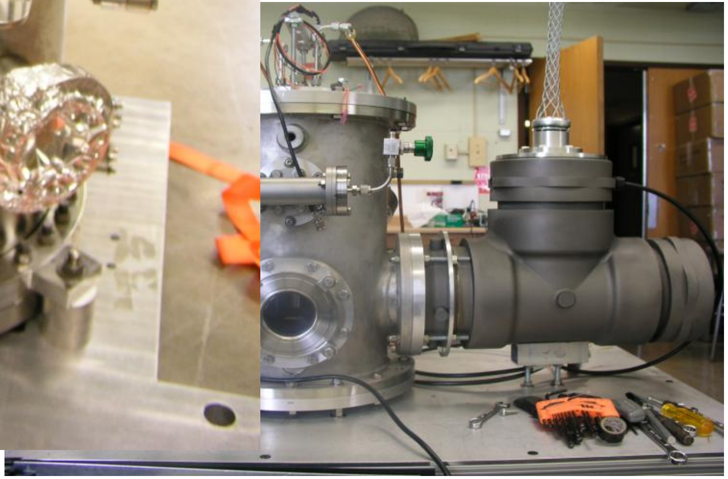




HELIOS

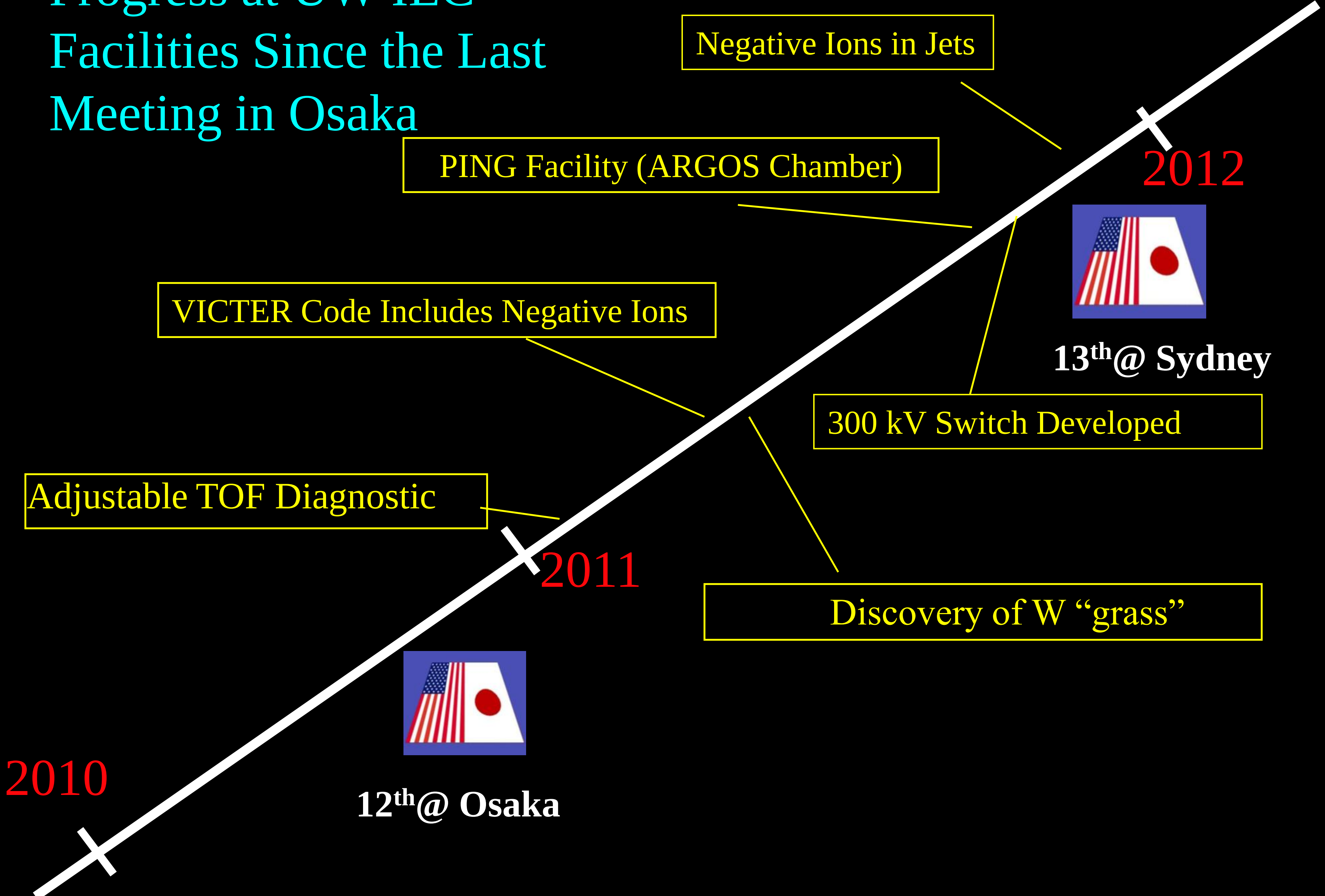


SIGFE



MITE-E

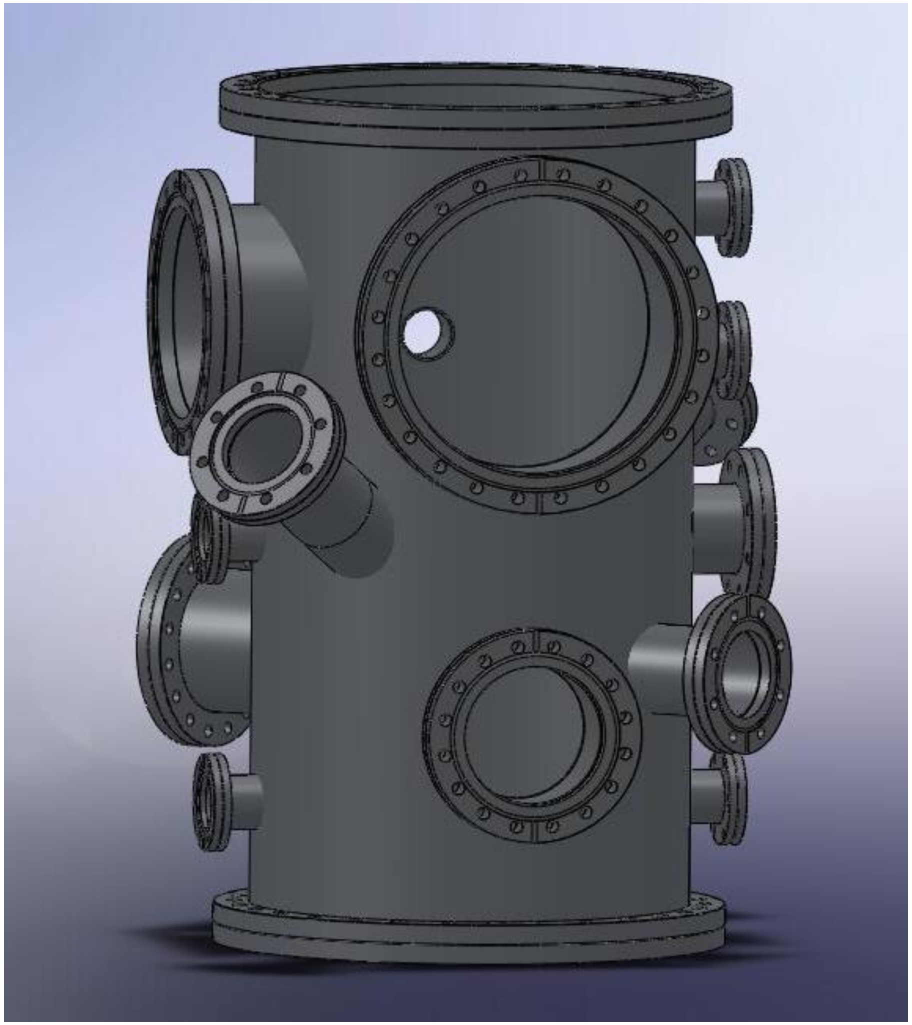
Progress at UW IEC Facilities Since the Last Meeting in Osaka



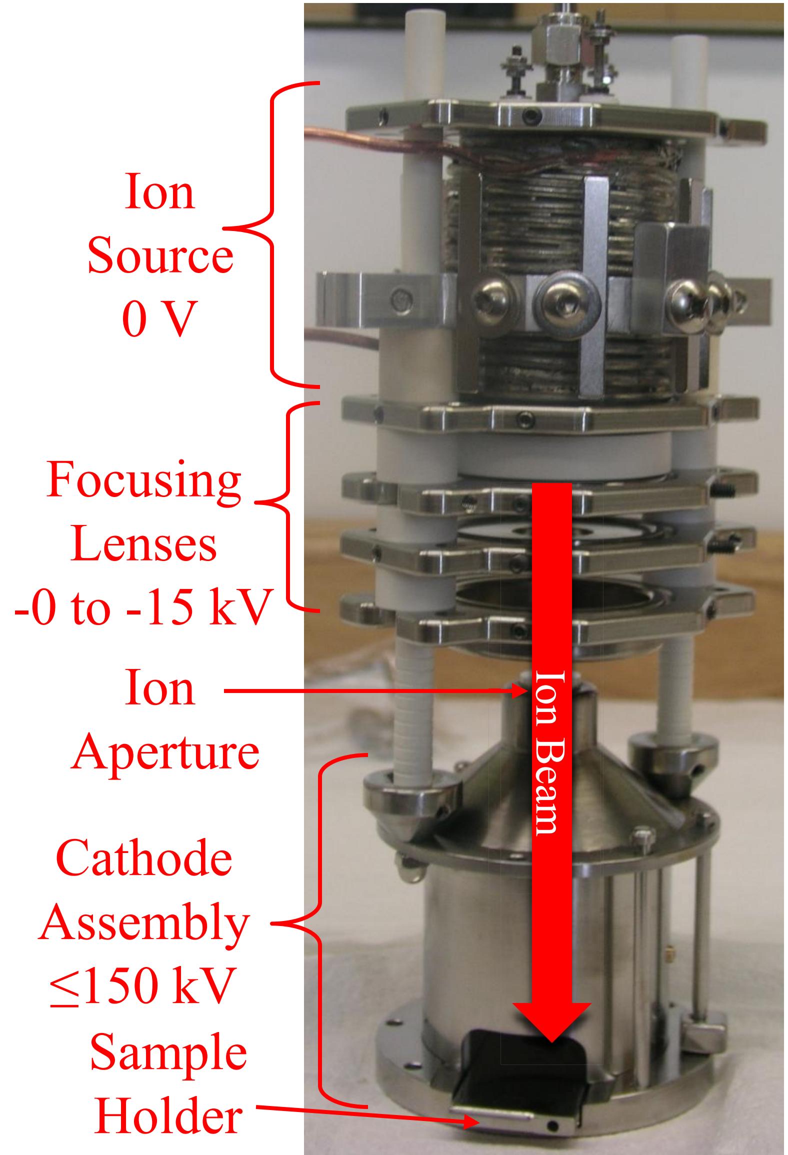
Development of Improved Pulsed Neutron Sources is Progressing

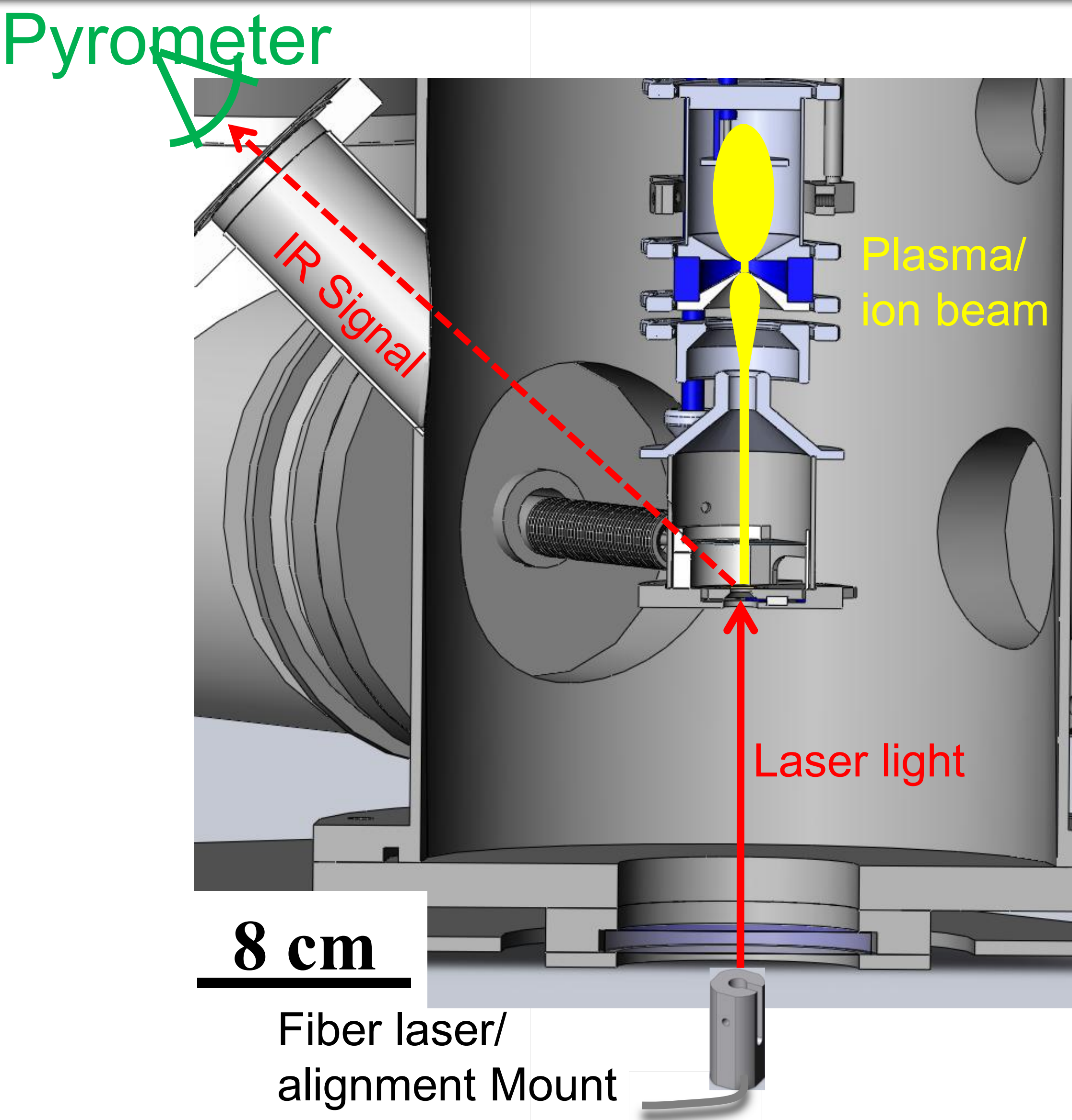
- <u>Storoid Facility:</u>
  - –patent application
  - –results next Workshop
- <u>PING Facility</u>
  - –Concept developed-2010
  - –ARGOS chamber constructed-2011
  - –Tests in 2012

The ARGOS Chamber

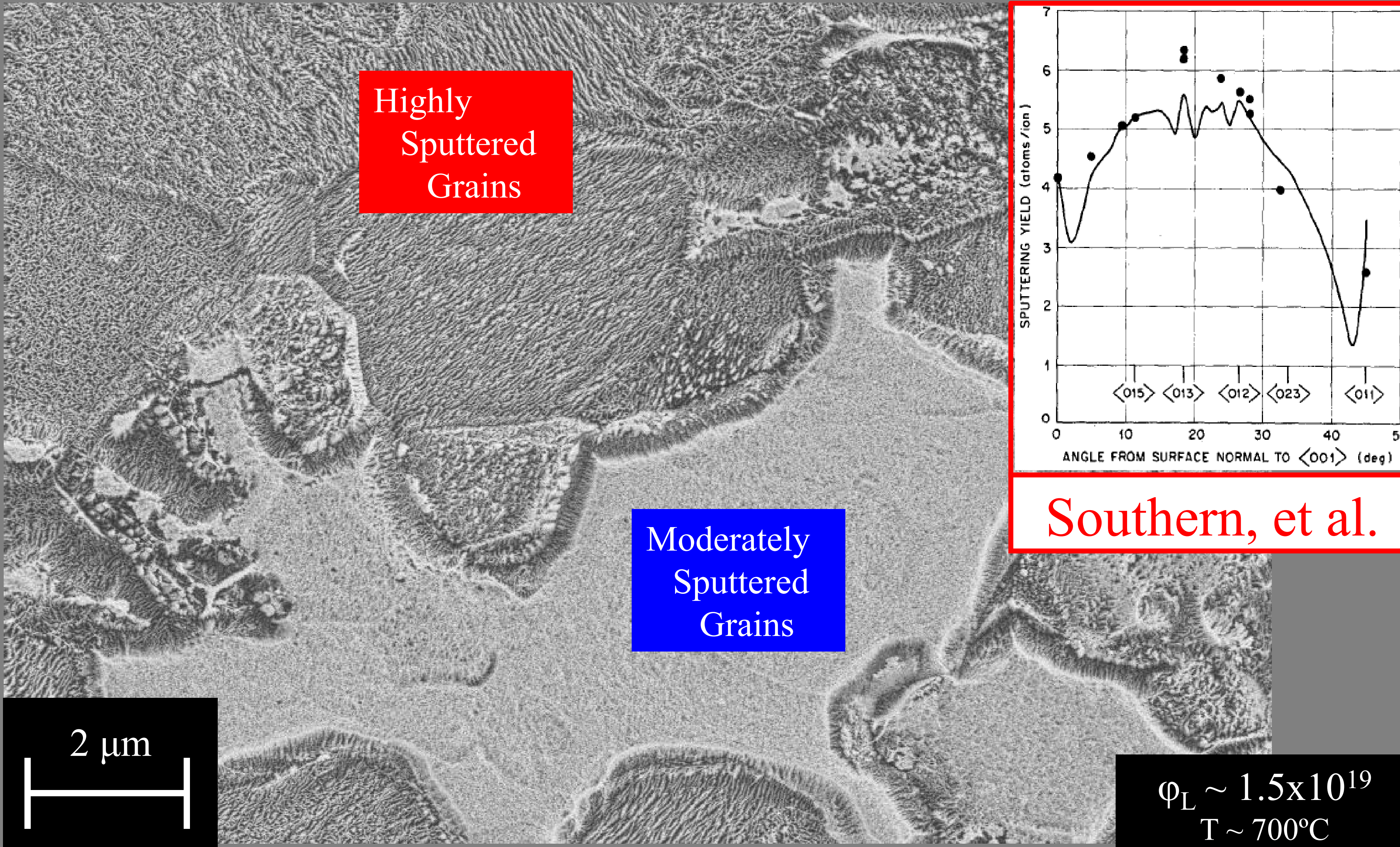


The *MITE-E's* Ion Gun Module



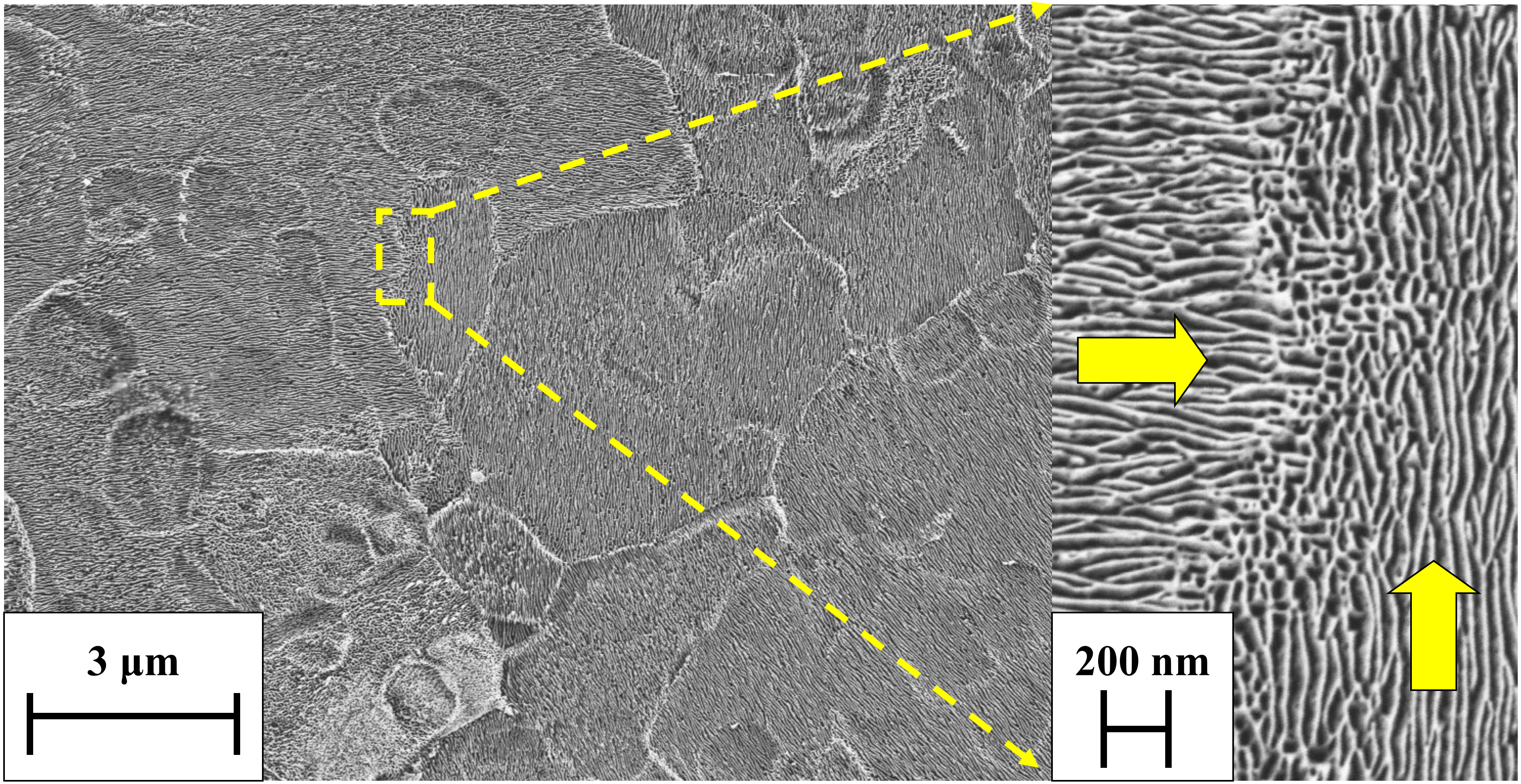


In the *MITE-E*, Surface Morphology Changes for W are Highly Dependent on Crystal Orientation



Southern, et al.

“Grass” Morphology Dependent on the Orientation of the Grains

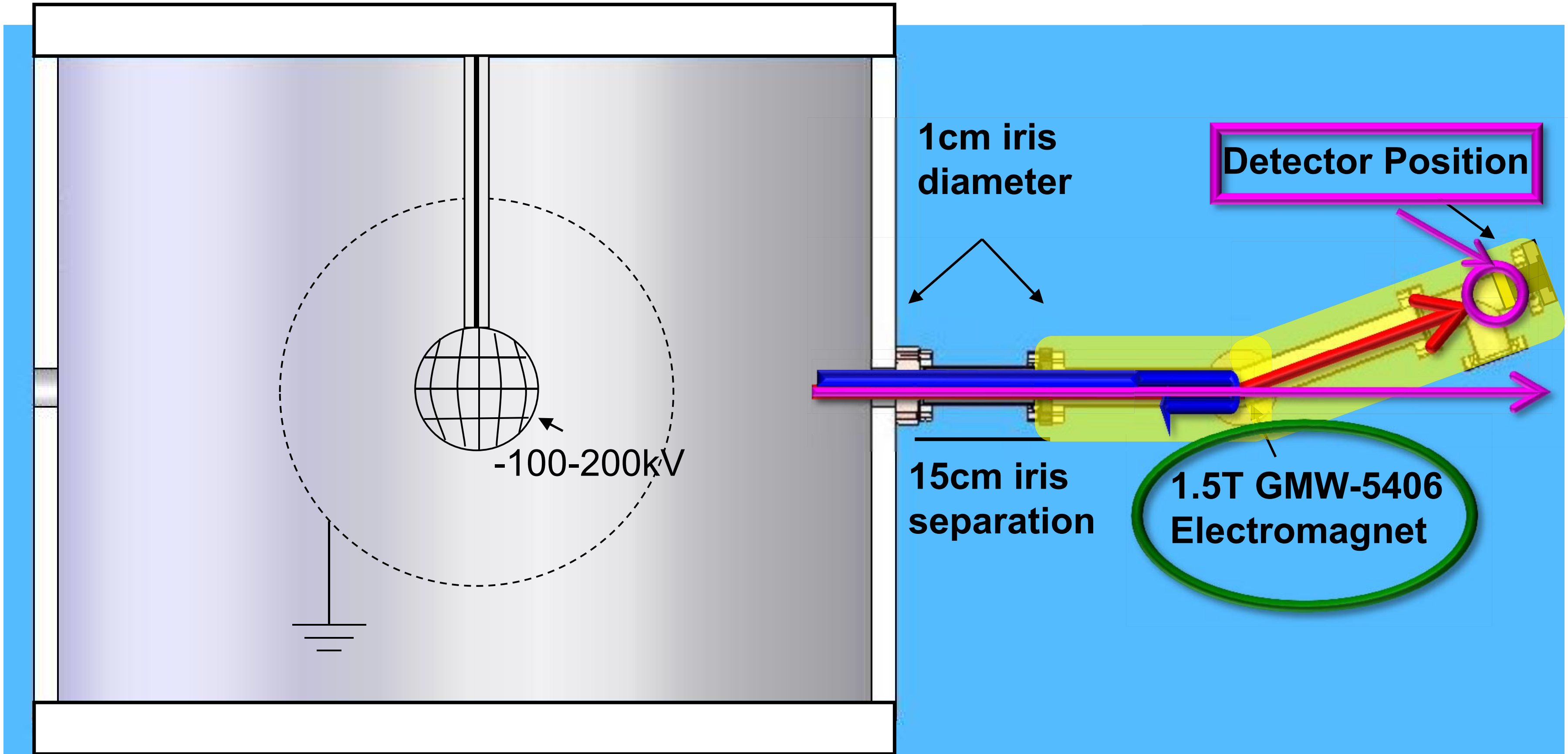


φ_L – 1.3x10^{18} He$^+$/cm^2 ,T – 900° C

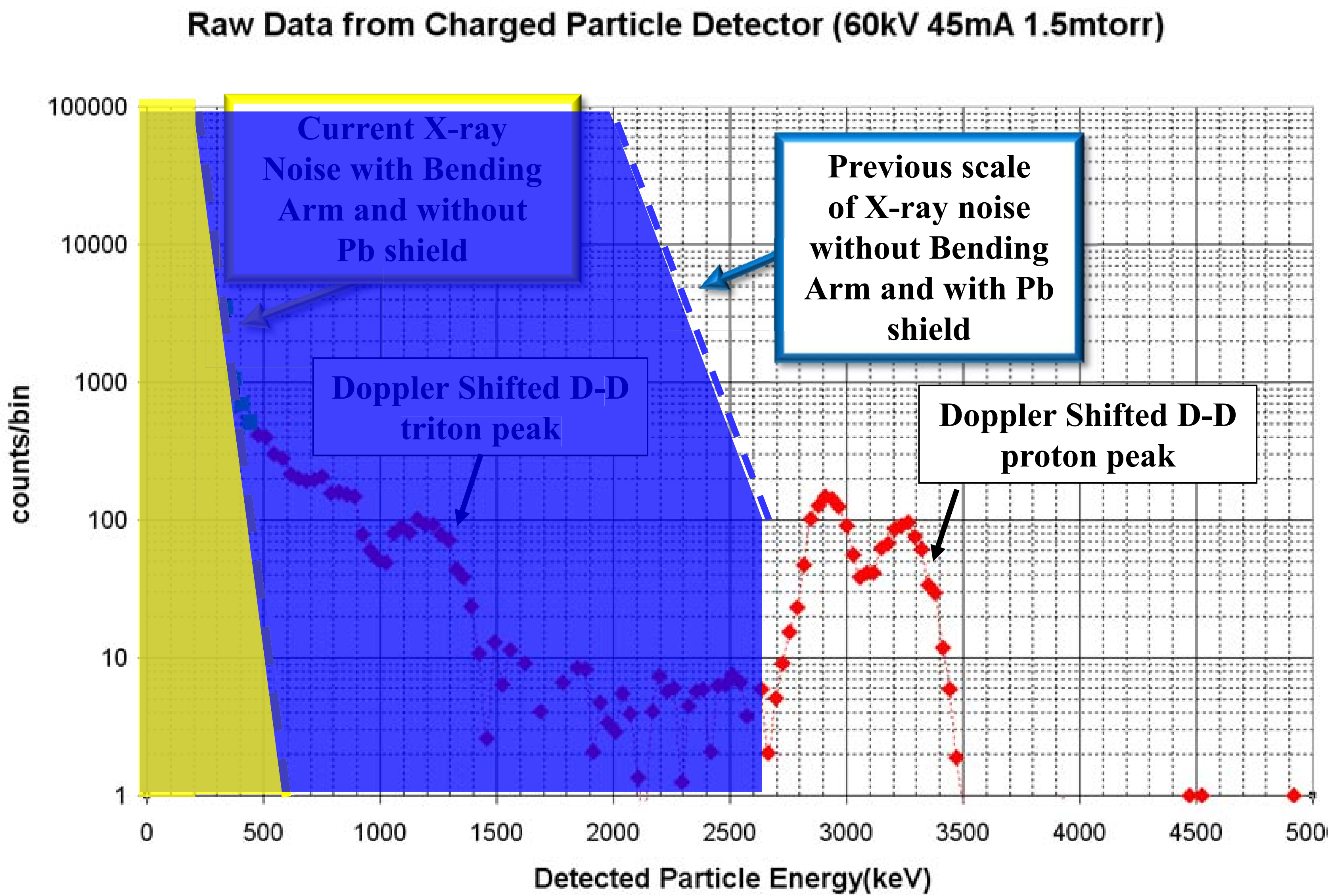
Fusion Ion Doppler (FIDO) Diagnostic Was Developed by Boris to Reduce Background Noise During D-D Proton Collection

- Detector face moved out of line of sight of chamber
- Magnetic Deflection
  - Fusion products (MeV)
  - Secondary electrons (Hundreds of keV)

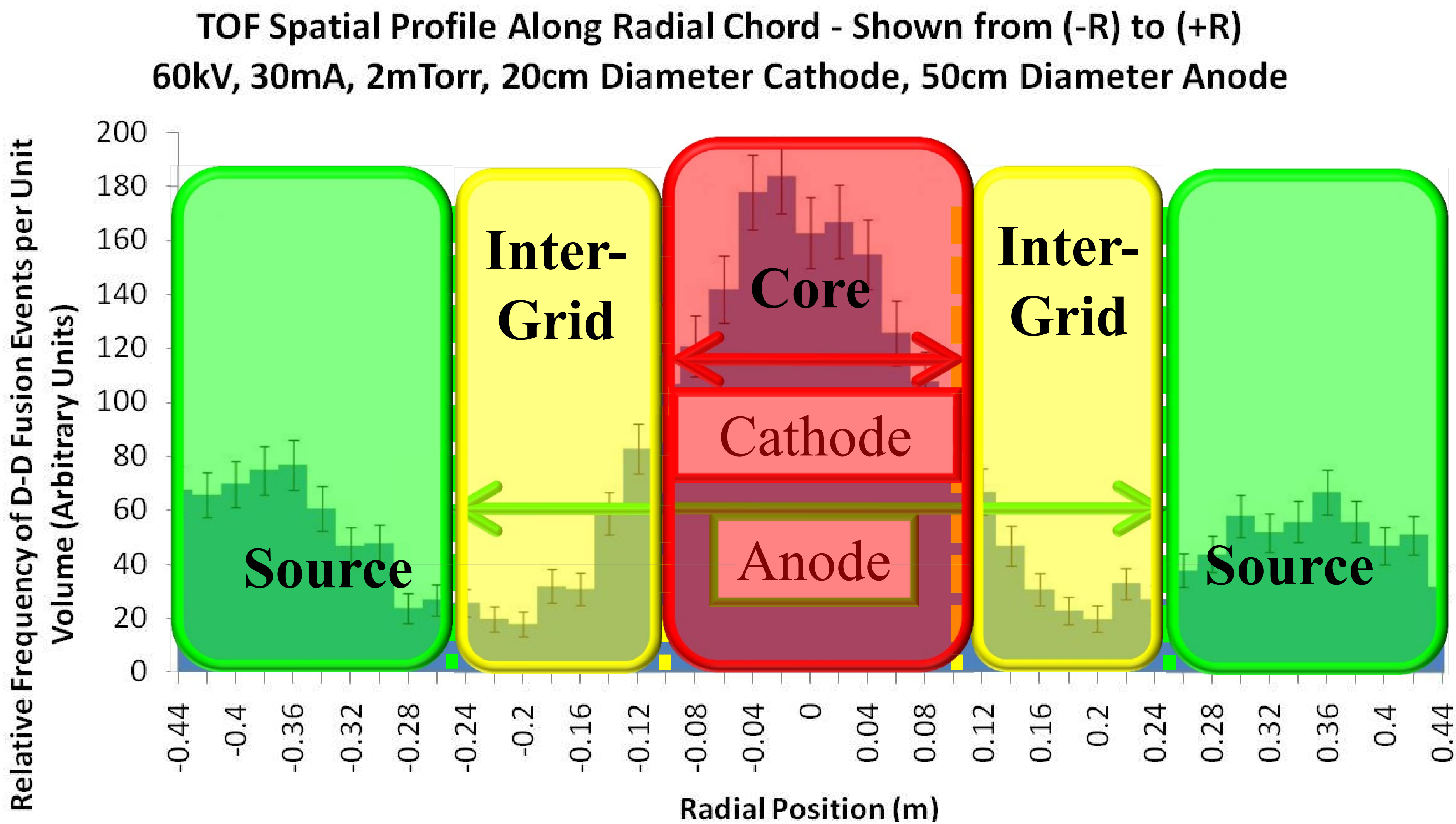
- Pb shielding around collimator channel and detector mount



Bending Arm Allows Both Protons and Tritons to be Detected Along with Doppler Shifts

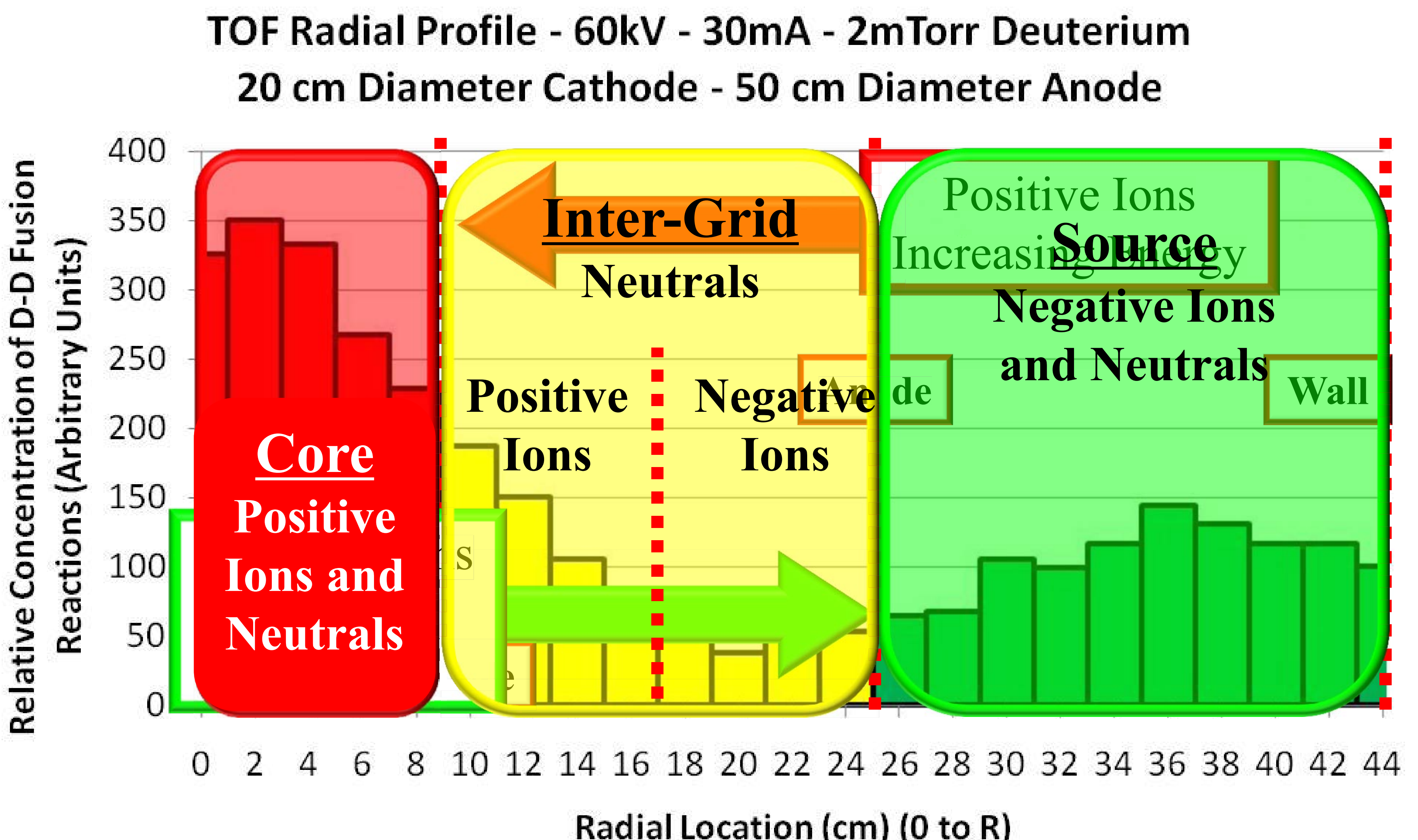


Spatial Profile of Fusion Reactions per Unit Volume Along Radial Line Through IEC (Donovan)

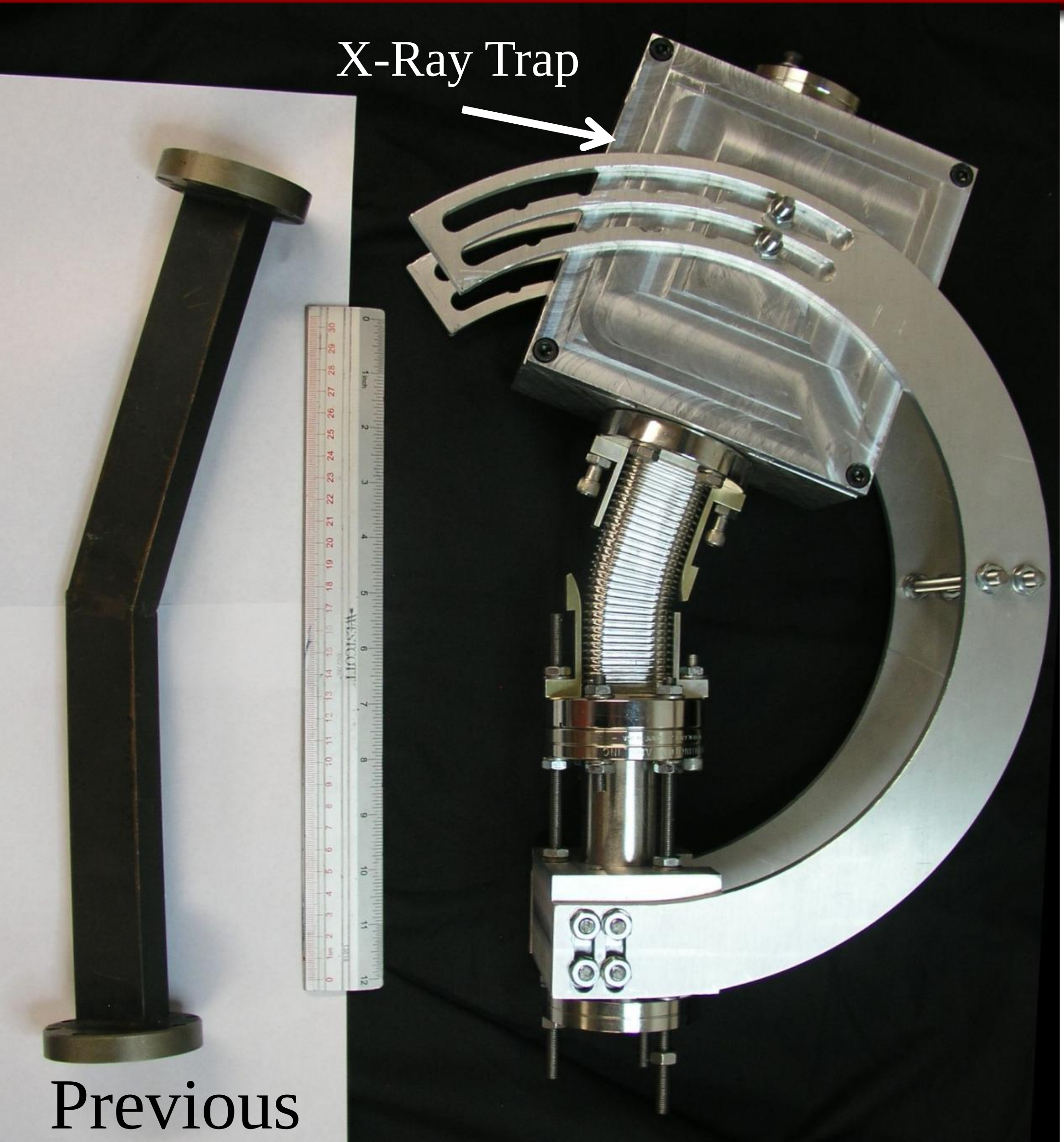


- Plot extends from chamber wall (-*R*) to chamber wall (+*R*)

TOF Radial Profile Shows a Rise in Fusion Event Concentration in the Source Region (Donovan)



An Adjustable Diagnostic Arm Has Been Successfully Constructed and Tested



- Capable of reaching at least 1 μTorr
- Able to study:
  - D-D Fusion (20°)
  - D-He^3 Fusion (15°)
  - Negative Ions (-20°)
- Adjustable rectangular 316 SS bellows arm allows 66 times greater D-D proton capture ability at higher power due to noise reduction
  - X-ray trap and corrugated elbow offer factor of 5 increase in proton collection
  - Increasing angle from 20 to 30 degrees further increases proton capture by factor of 13

Conclusions

- Considerable progress has been made in experimental facilities
  - Adjustable Arm for FIDO and TOF measurements
  - Argos chamber for pulsed neutron generation
  - 300 kV switch for rapid changeover of 4 IEC devices
  - New design for 300 kV feed-through to avoid insulating stalk failures
- IEC Technology spinoff has been used for a materials irradiation facility

Conclusions (cont.)

- Negative ion azimuthal scans reveal structure in “jets”.
- Negative ions seem to be playing an unexpected role in promoting DD fusion in IEC devices.
- Helicon optimization studies improve performance
- VICTER code now has the ability to include negative ions and their transport in IEC devices.
- Six gun ion experiments reveal more about plasma physics of Hirsch device.

Future Goals of UW IEC Program

- Understand the role of negative ions in the spatial distribution of DD fusion events.
- Apply the TOF adjustable arm diagnostic to D^3He fusion.
- Test plasma facing component materials at higher temperatures and a wider range of fluences.
- Investigate D^3He fusion in 6-Gun SIGFE device.
- Analyze test results from STOROID and PING pulsed neutron facilities.

Future Goals of UW IEC Program (cont.)

- Compare VICTER theoretical predictions with experimental data from HOMER.
- Increase the He^{+} source strength of HELIOS.
- Test pulsing effects on SIGFE.

Questions?