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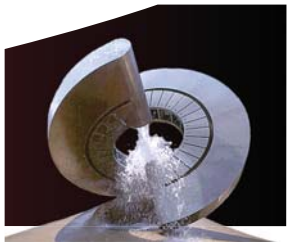
UNIVERSITY OF WISCONSIN-MADISON

RECENT ADVANCES IN IEC PHYSICS AND TECHNOLOGY AT THE UNIVERSITY OF WISCONSIN

G. L. Kulcinski, J. F. Santarius, G. A. Emmert, R. L. Bonomo, E. C. Alderson, G. E. Becerra, L. M. Garrison, K. B. Hall, A. M. McEvoy, M. K. Michalak, and C. M. Schuff

October 15, 2012



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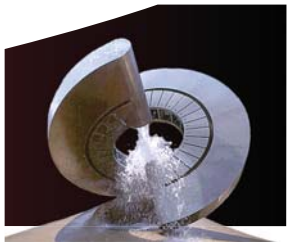
Outline of Presentation

- Brief History of IEC Program.
- New Insight and Results at the Univ. of Wisconsin
  - Advances on Helios (Becerra) Session 2.
  - Upgrade to VICTER code-Added negative Ions and He^{++} (Emmert) Session 3 .
  - Efficiency of neutron production in 6-gun device (Michalak) Session 5.
  - 300 kV Power Supply (Bonomo) Session 5.
  - Exploration of Core Physics (Santarius) Session 6.
  - Time of Flight measurements and spatial distribution of fusion reactions (McEvoy) Session 6.
  - Analysis of negative ions in jets of gridded IEC devices (Alderson).
  - New data on interaction of high energy He and W at high temperature (Garrison, Hall).



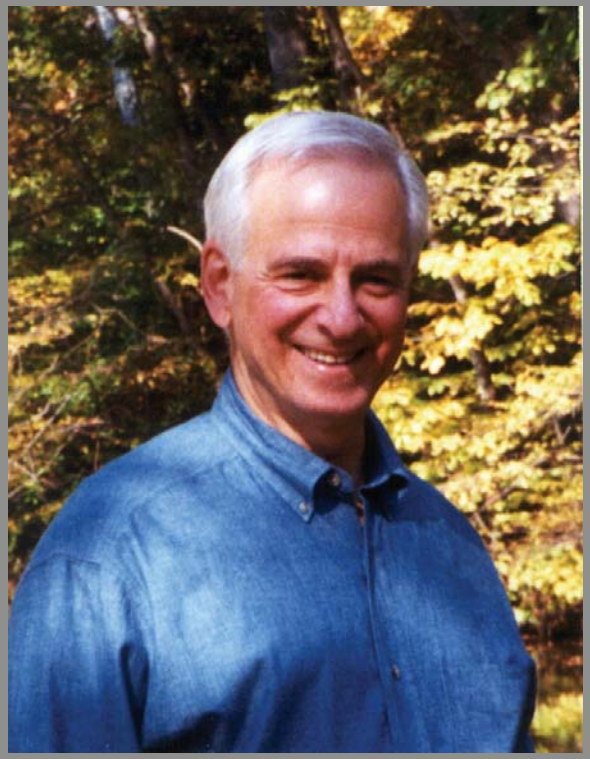
Inertial Electrostatic Confinement Devices First Introduced by Lavrentyev and Farnsworth in the Late 1950's

Lavrentyev

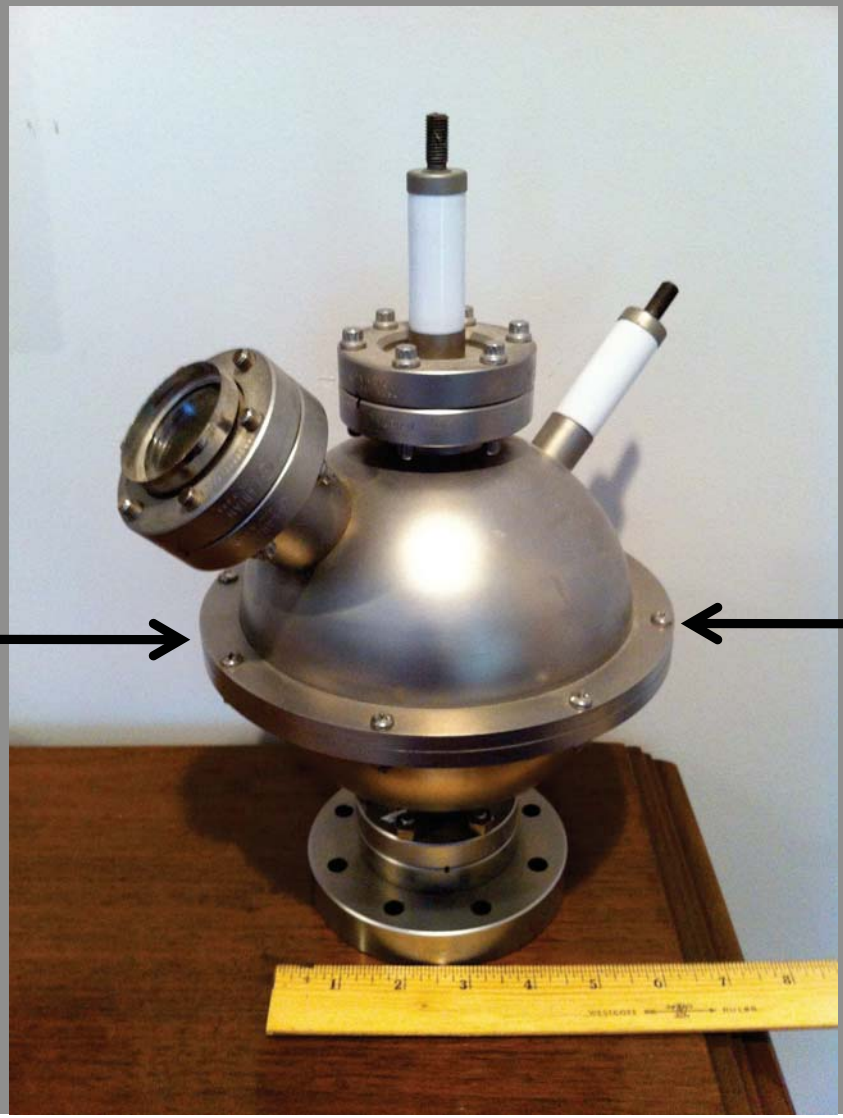
Farnsworth

After T. Dolan

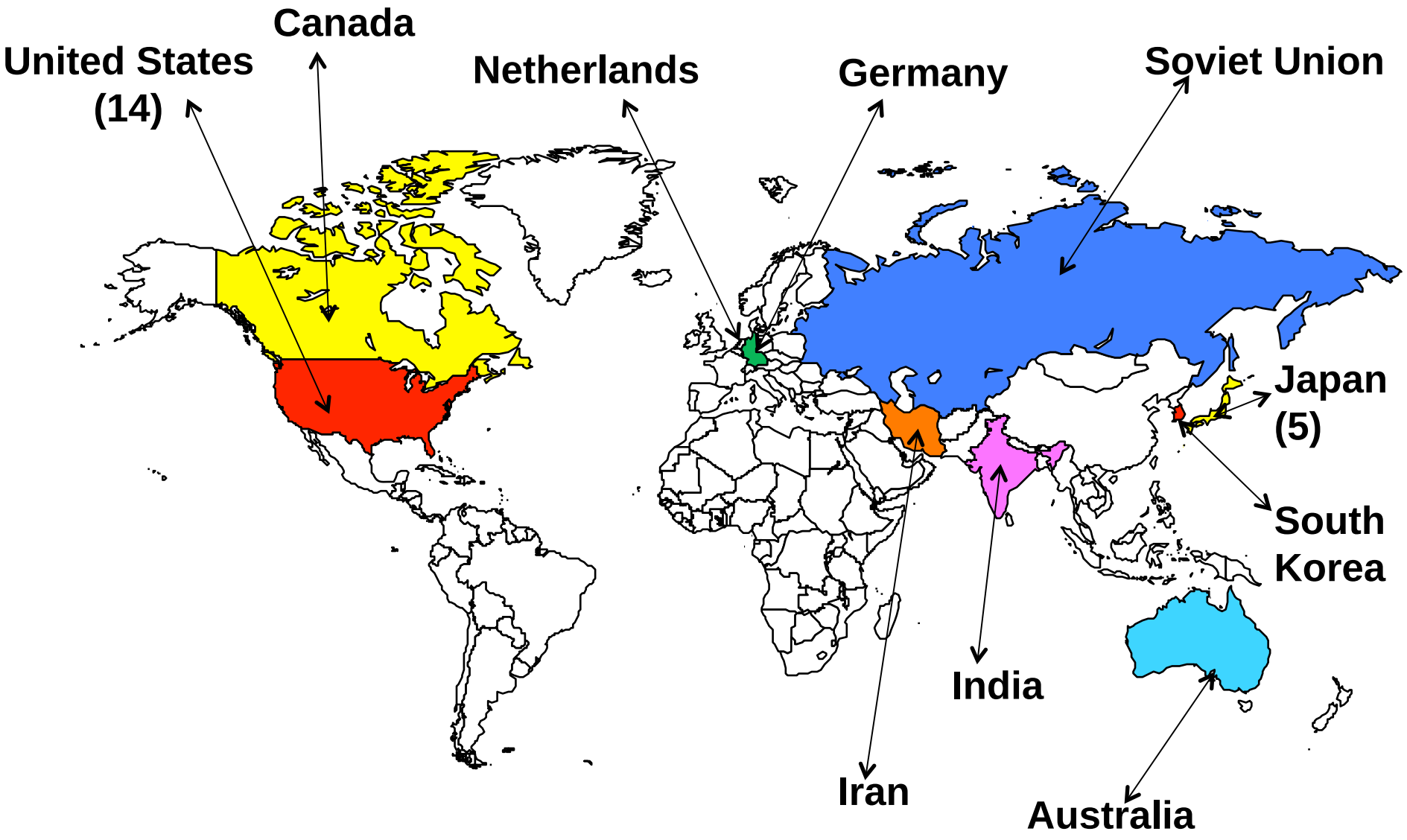
Robert Hirsch Reported High Neutron Production Rates in the First Ion IEC Device in 1968 at ITT-Farnsworth in Fort Wayne, IN



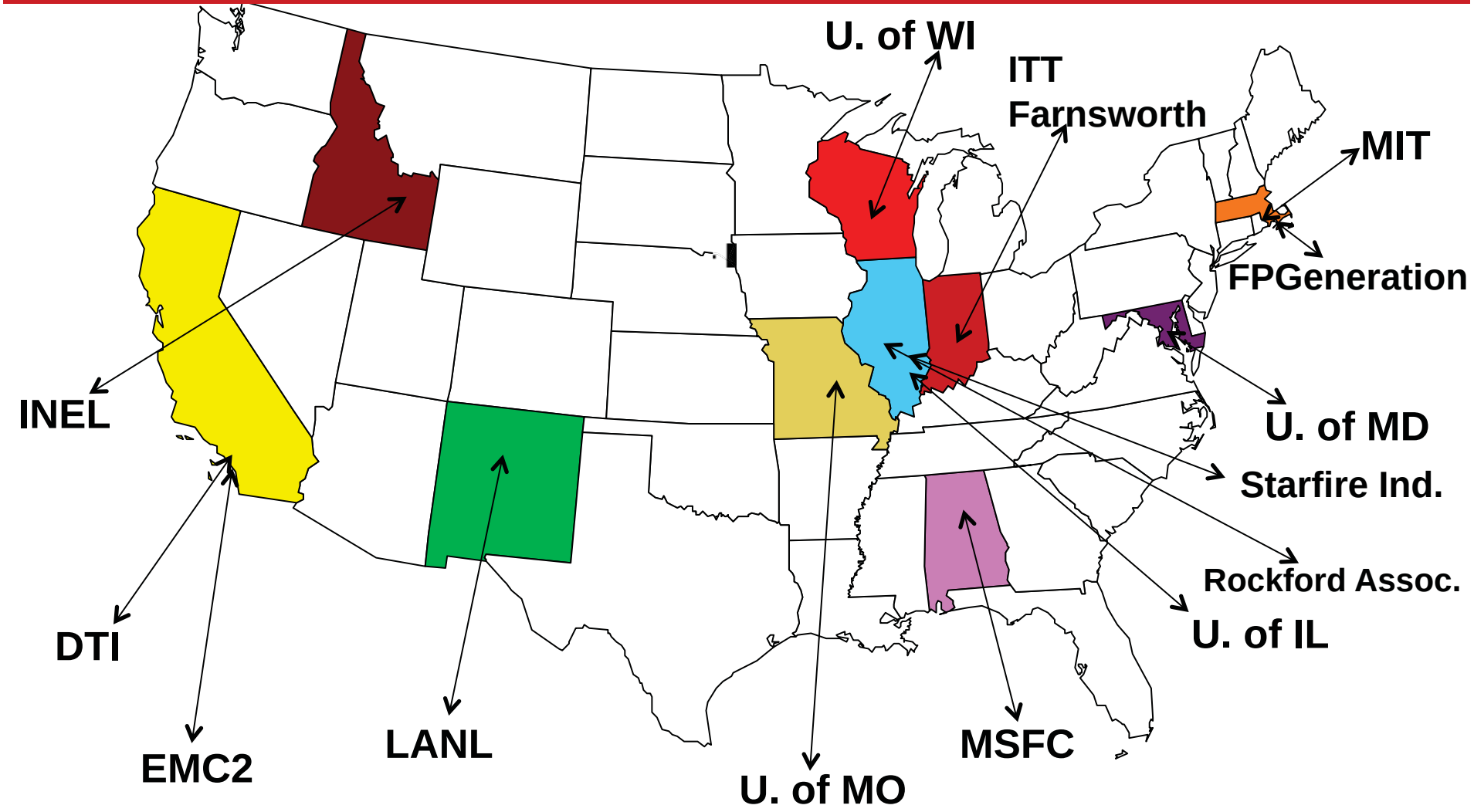
20 cm



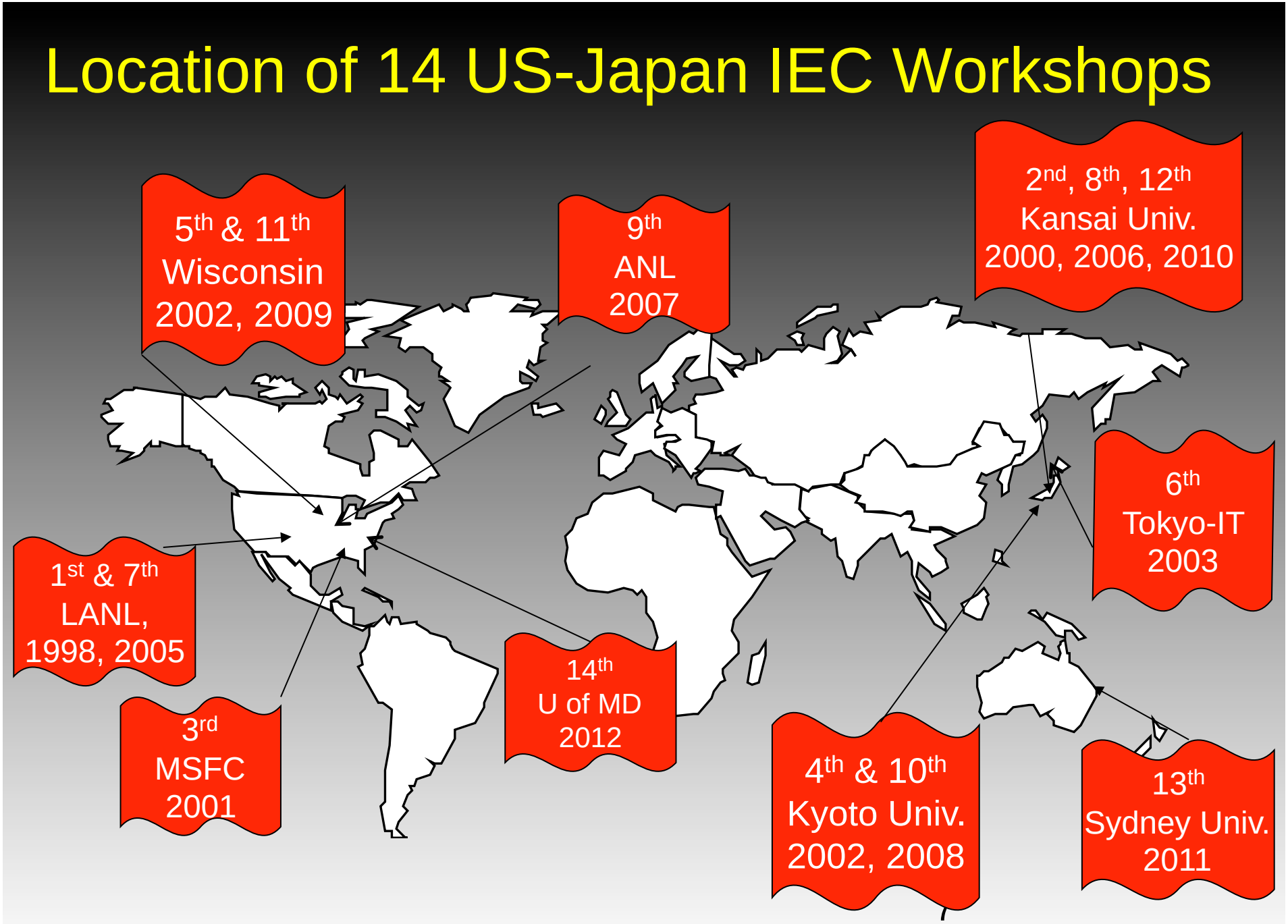
There Have Been at Least 27 IEC Research Programs in 10 Countries Around the World in the Last 55 Years



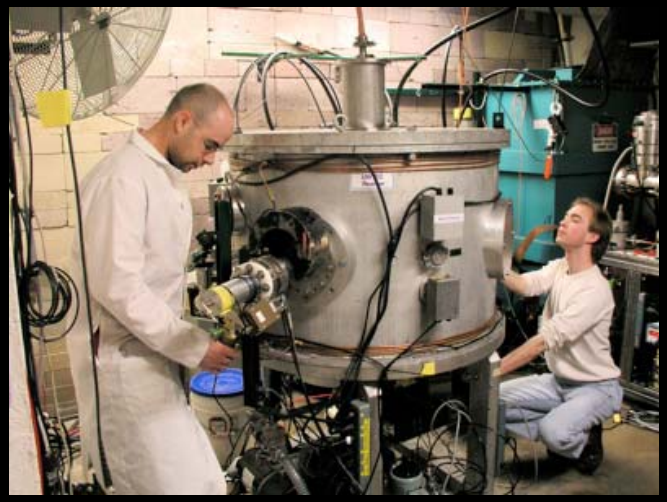
There Have Been 14 IEC Research Programs in the U. S. in the Last 45 Years



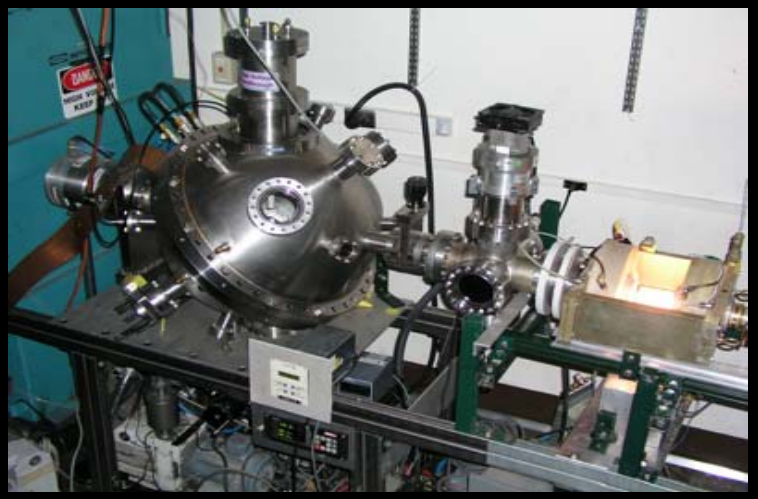
Location of 14 US-Japan IEC Workshops



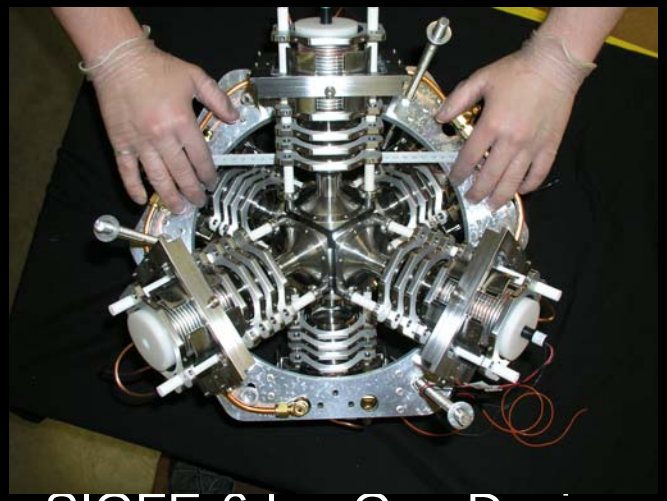
There are Currently Four Different IEC Chambers in Operation at the University of Wisconsin



HOMER-Gridded Device



HELIOS-Ion Injected Gridded Device



SIGFE-6 Ion Gun Device

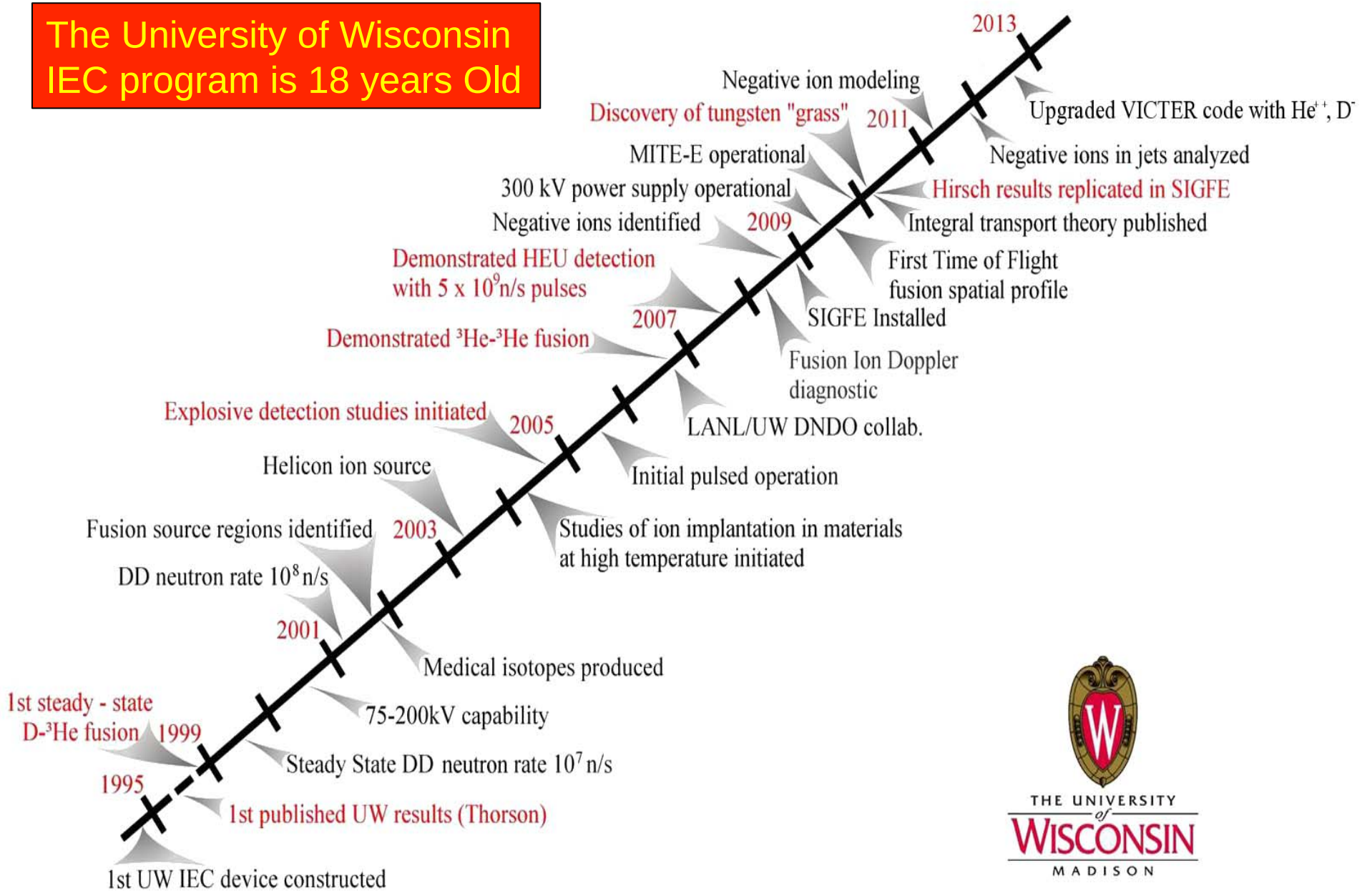
MITE-E Ion Gun Device

Two New Pulsed Neutron Sources Under Development

- The STOROID

- The PING

The University of Wisconsin IEC program is 18 years Old



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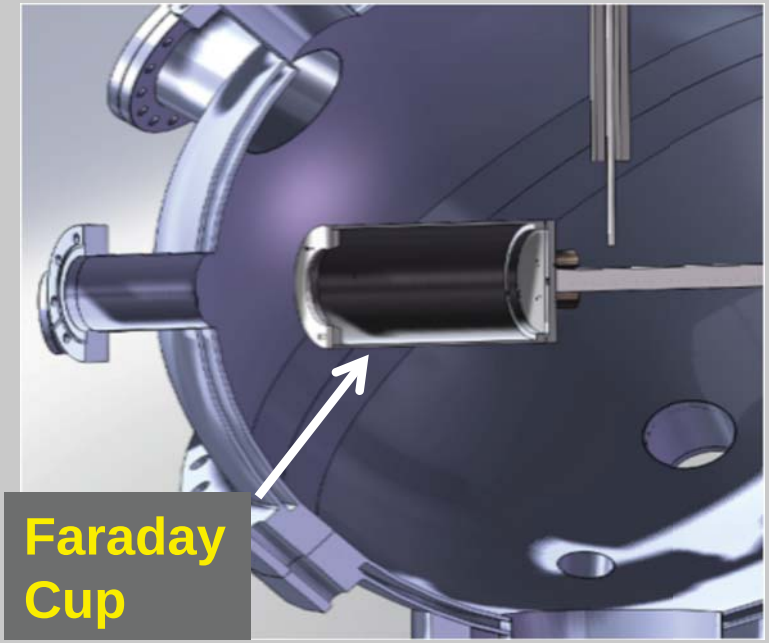
Becerra Studying the Discrepancy Between Predicted and Measured Helium Ion Current from Helicon Sources (session 2)



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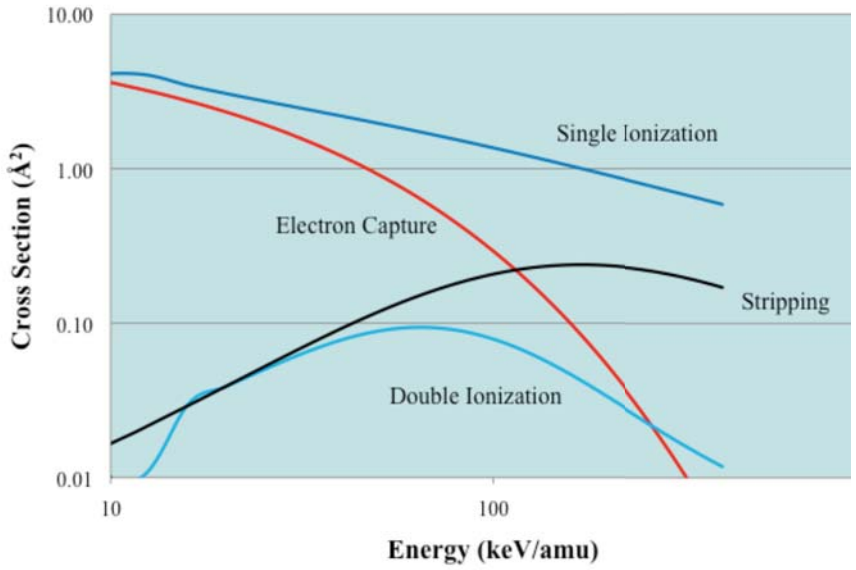
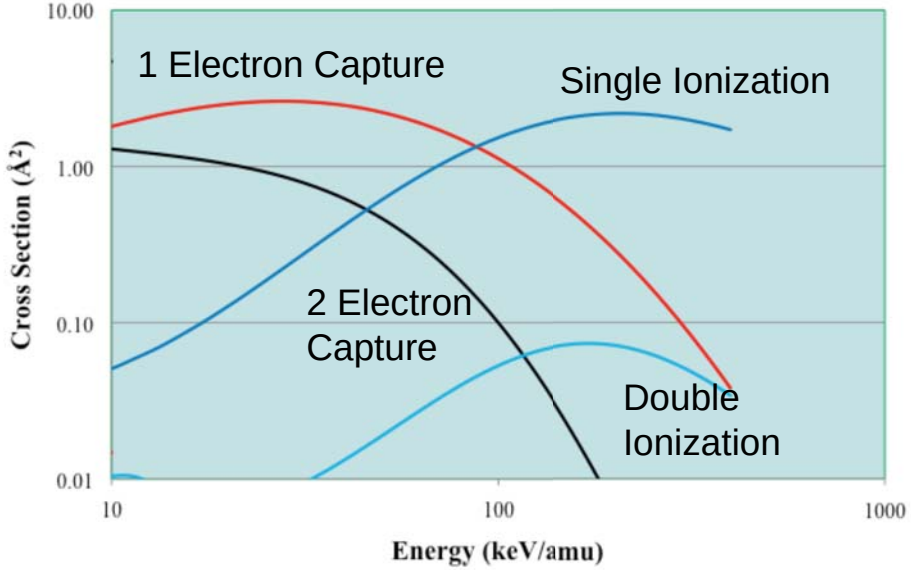
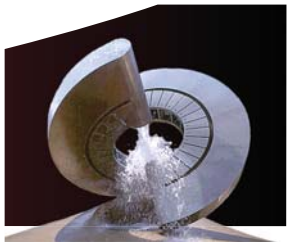
Emmert is Modifying the VICTER Code to Include He^{+} and He^{++}-Session 3

Production Cross Section He^{+}

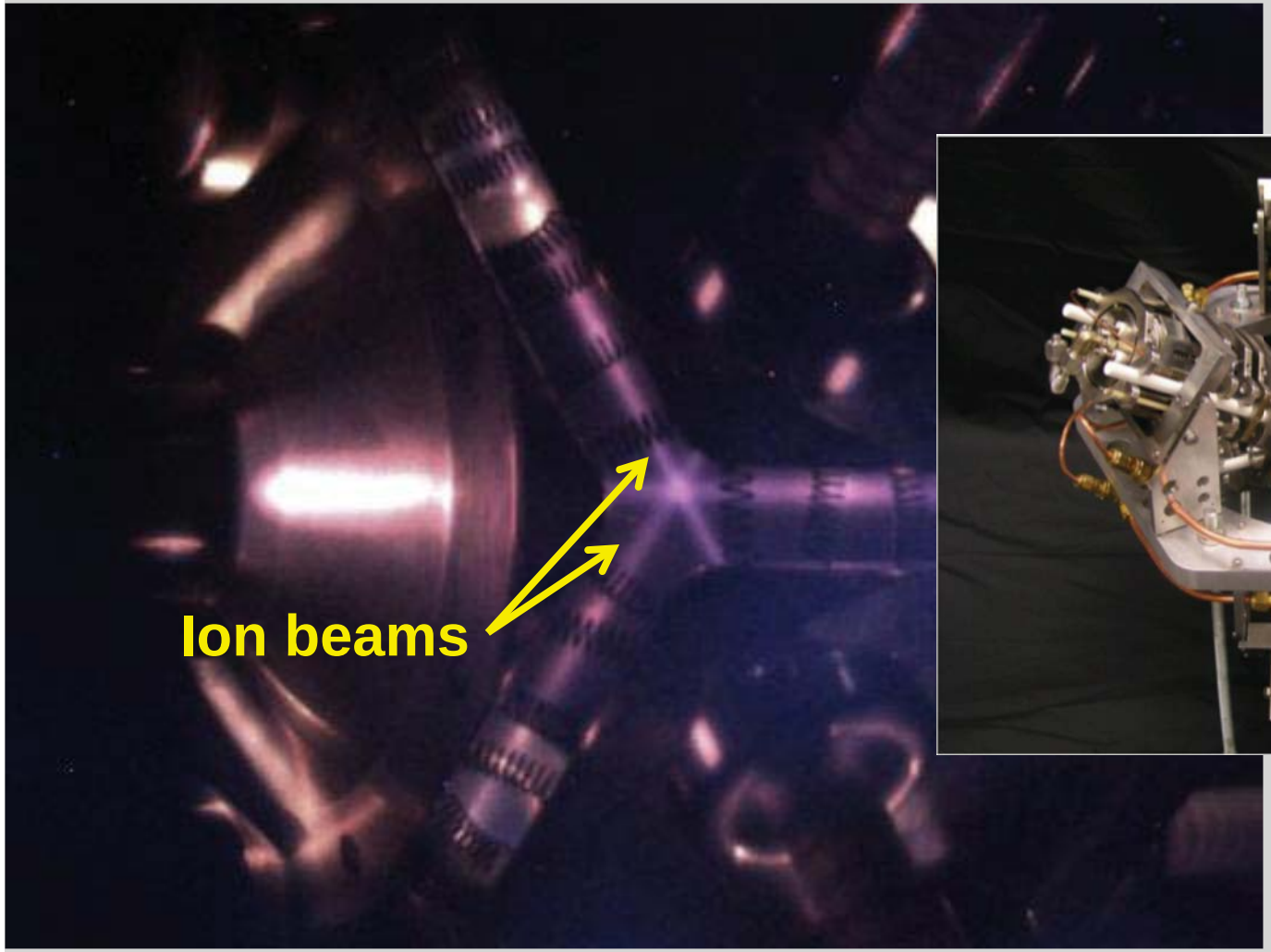


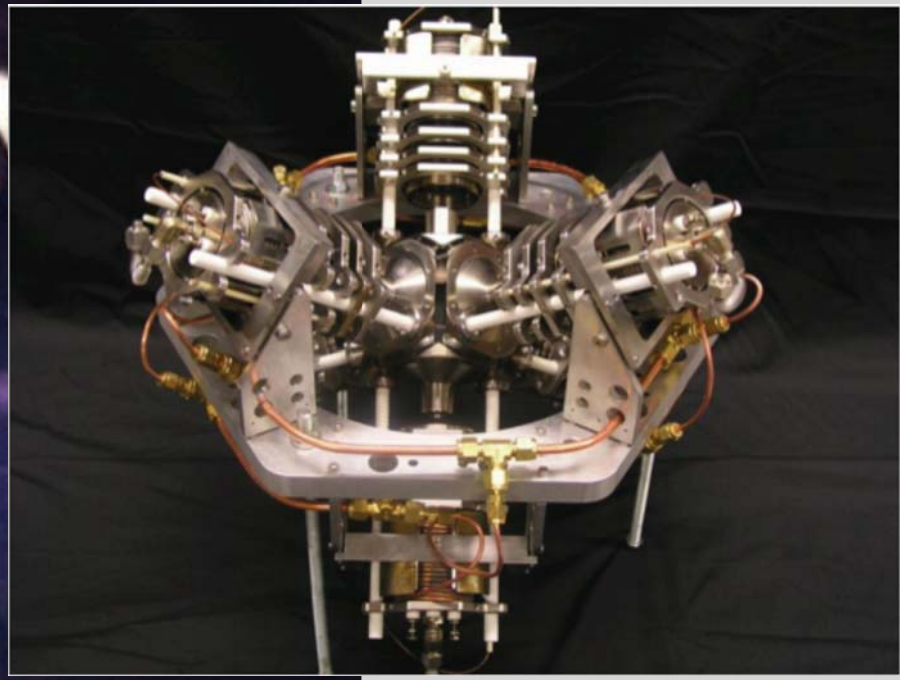
Production Cross Section He^{++}





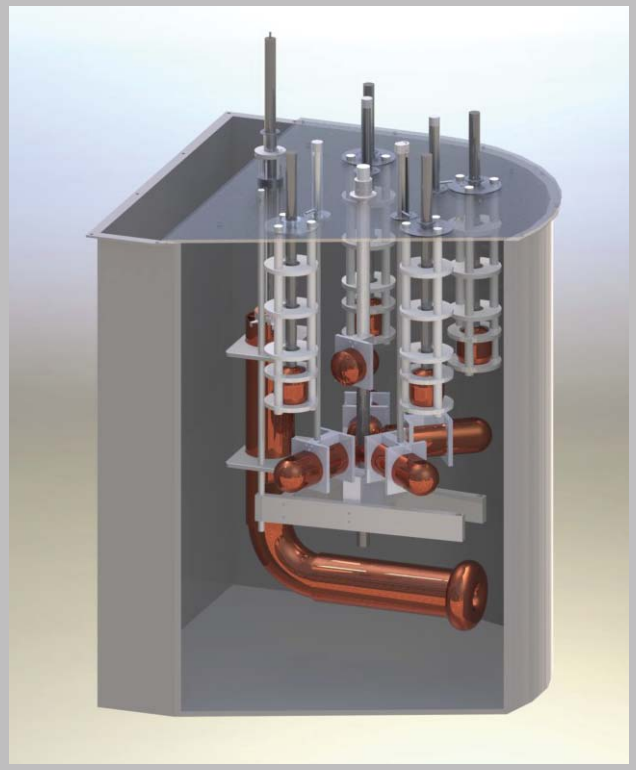
Michalak is Upgrading the 6-Gun SIGFE to Balance Individual Gun Output-Session 5





Bonomo is Addressing the Issues Associated With Coupling to a 300 kV Power Supply-Session 5

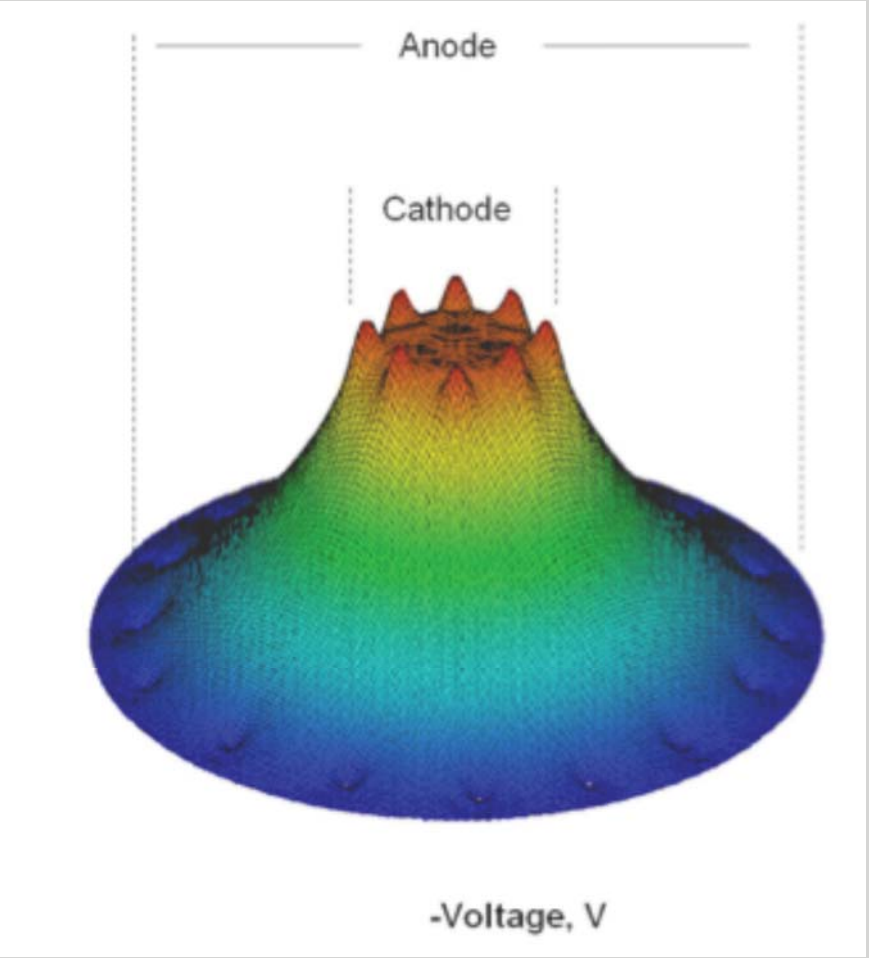
CAD Drawing of 300 kV Switch



Installation of Final Assembly

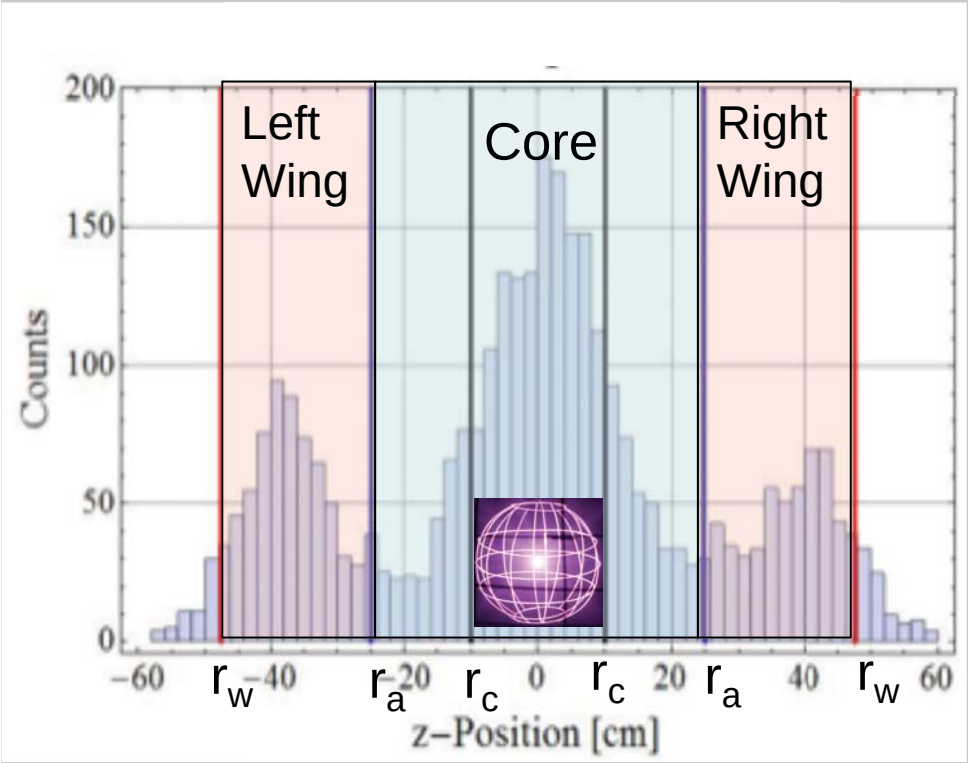
Santarius is Investigating IEC Core Physics-Session 6

- Electrostatic potential created by discrete wires in cylindrical geometry
  - Channels formed between grid wires, and
  - potential peak near origin due to converging ion space charge.

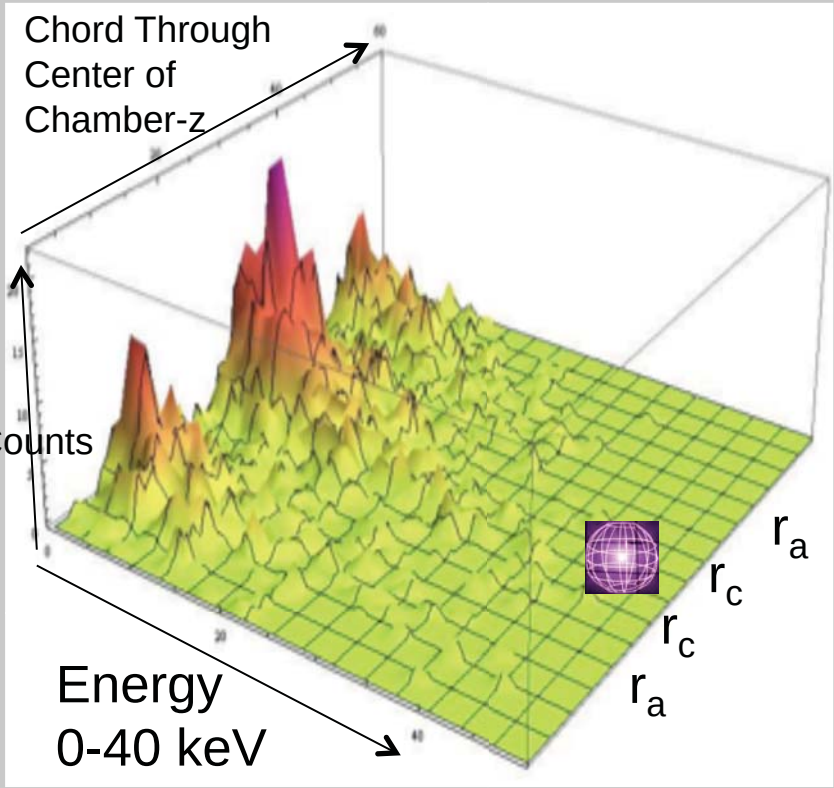


McEvoy is Reassessing the Spatial Distribution of Fusion Events in a Gridded IEC-Session 6

- Raw DD Fusion Spatial Profile

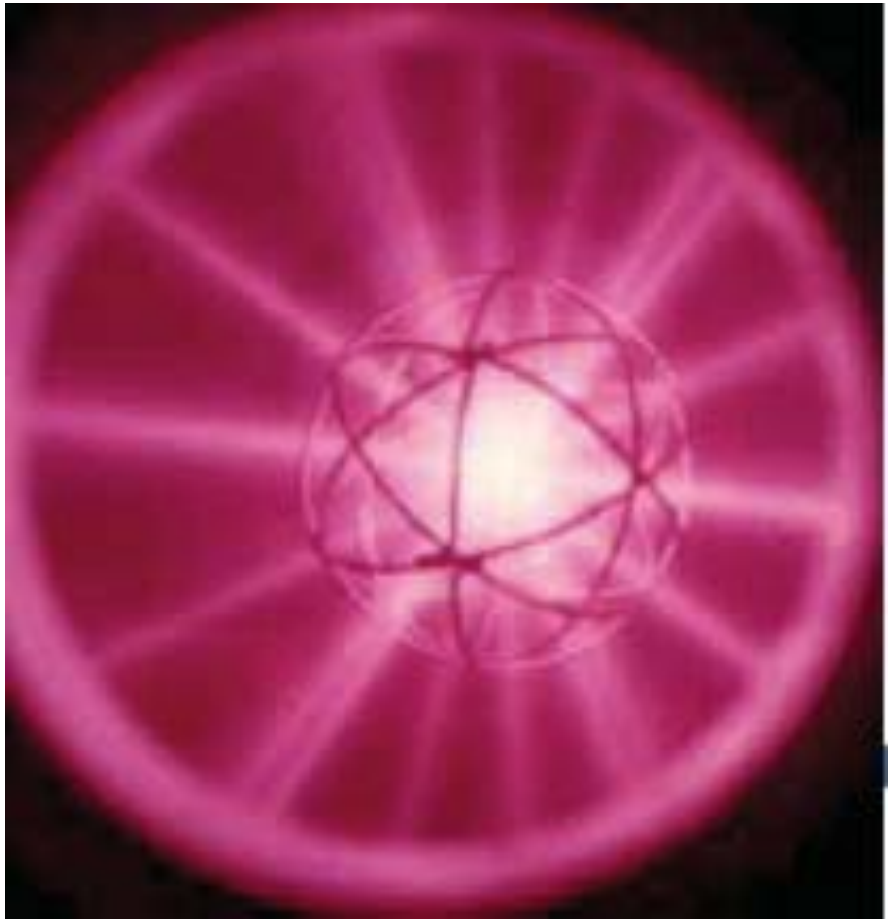


Additional Information on Energy of Reactants



Jets are a fundamental phenomenon in the IEC device

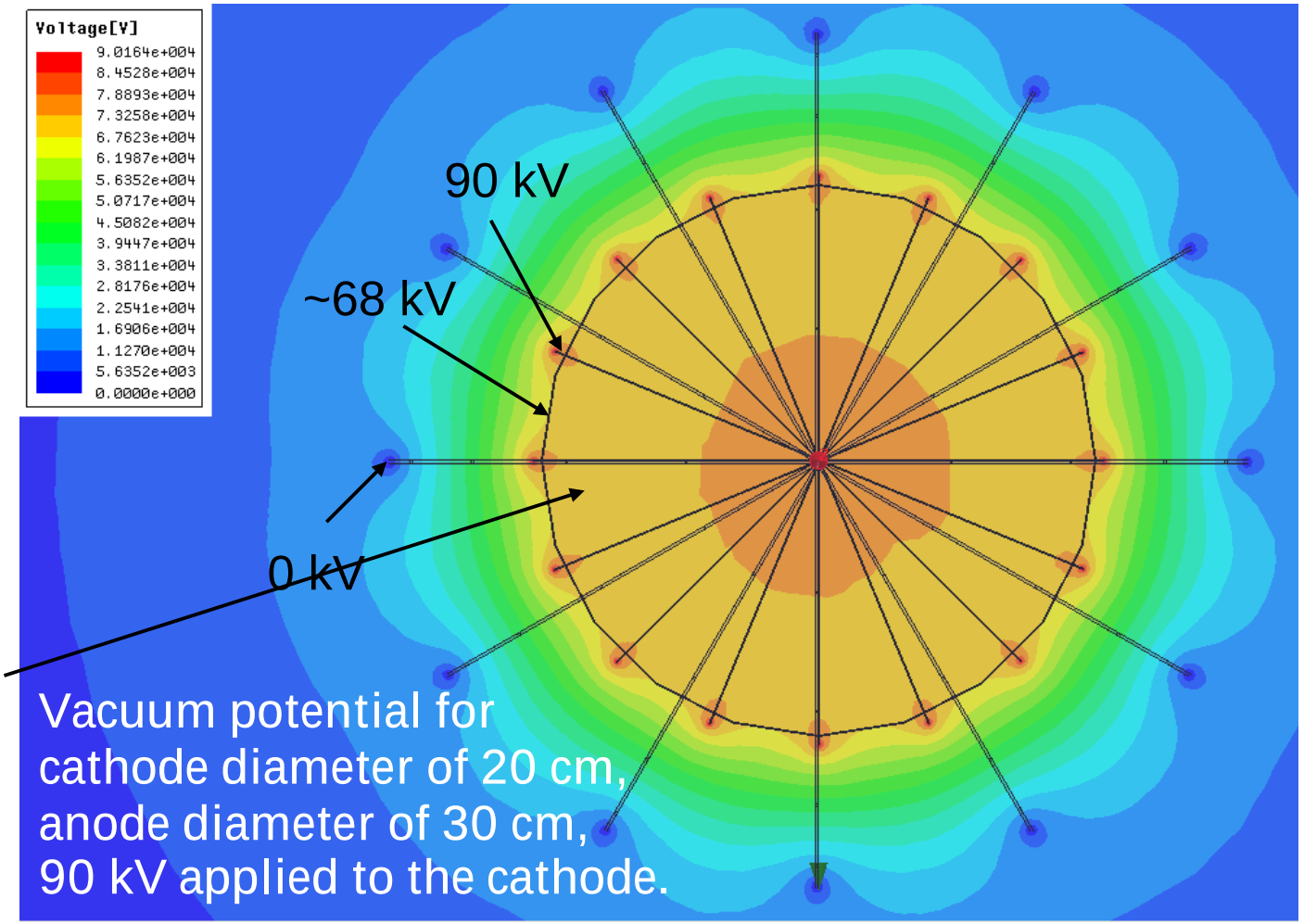
Univ of Wisconsin



Courtesy of G.H. Miley

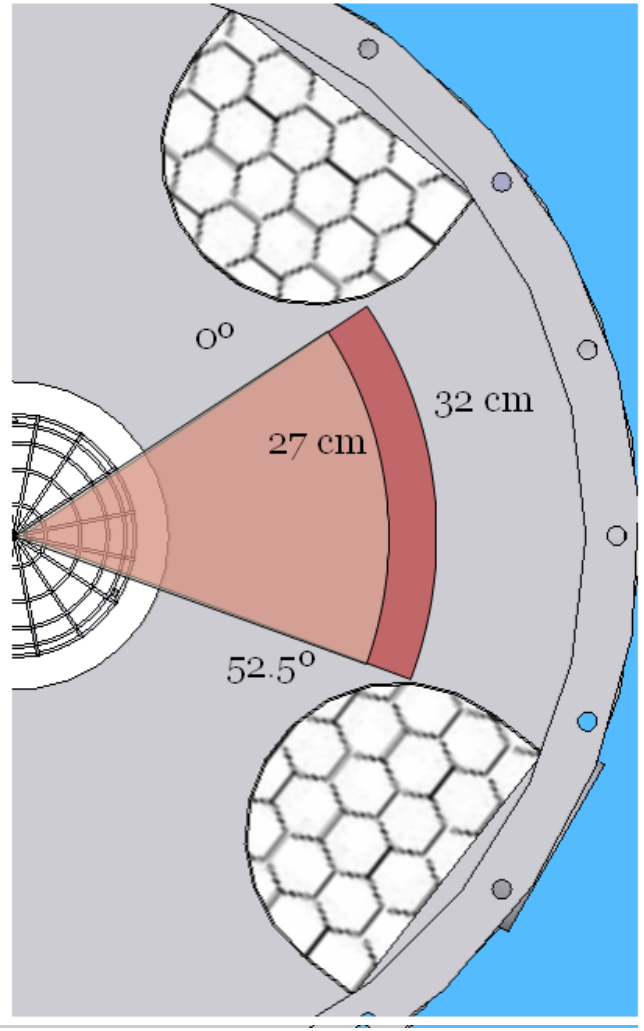
Alderson Analyzed the Negative Ion Current in IEC Jets

- The IEC device cathode produces a rippled potential near the cathode, more negative at the wires, less negative in the spaces between the wires.
- These dips in potential produce jets that negatively charged particles preferentially pass through.

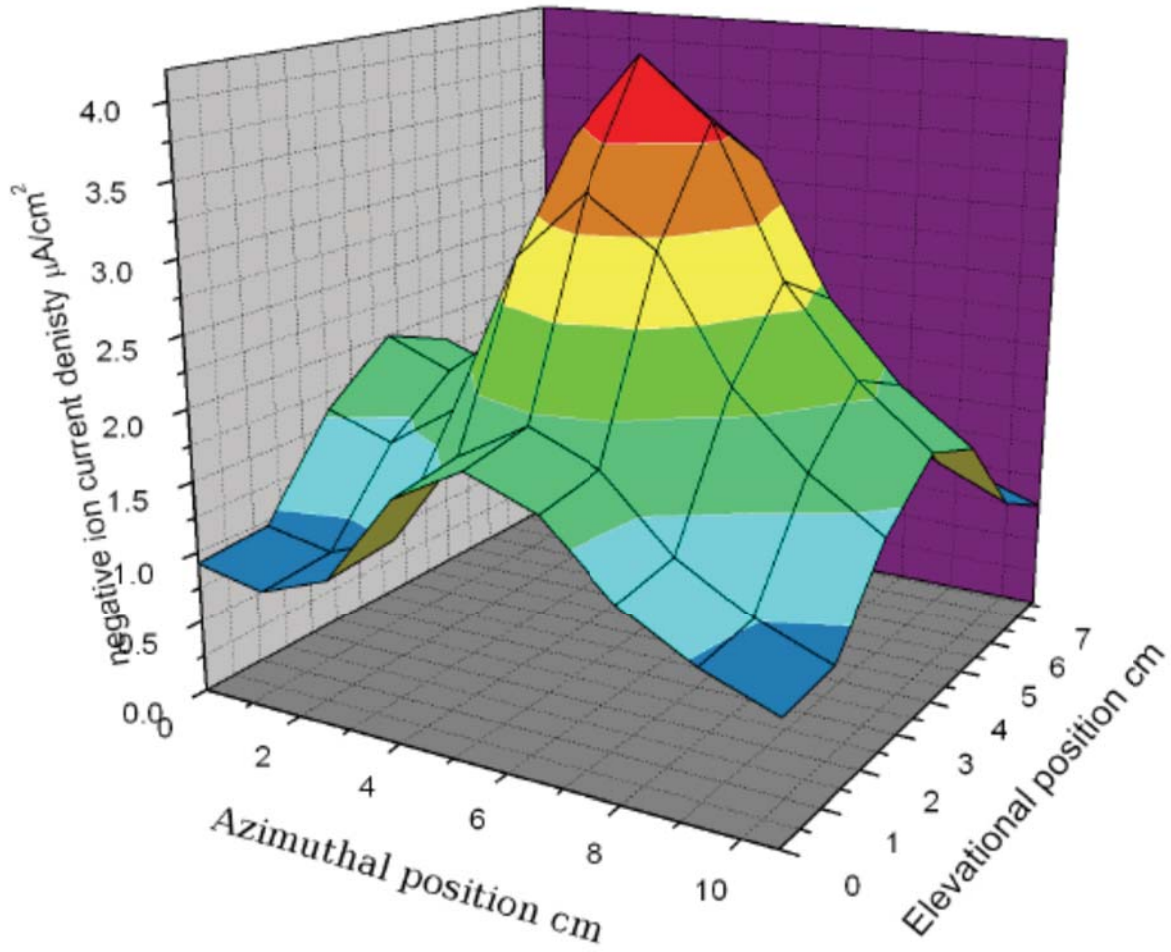


The enclosed electrodes and small size allow the Faraday cup to be used to produce spatial profiles-Alderson 2012.

- Azimuthal positioning

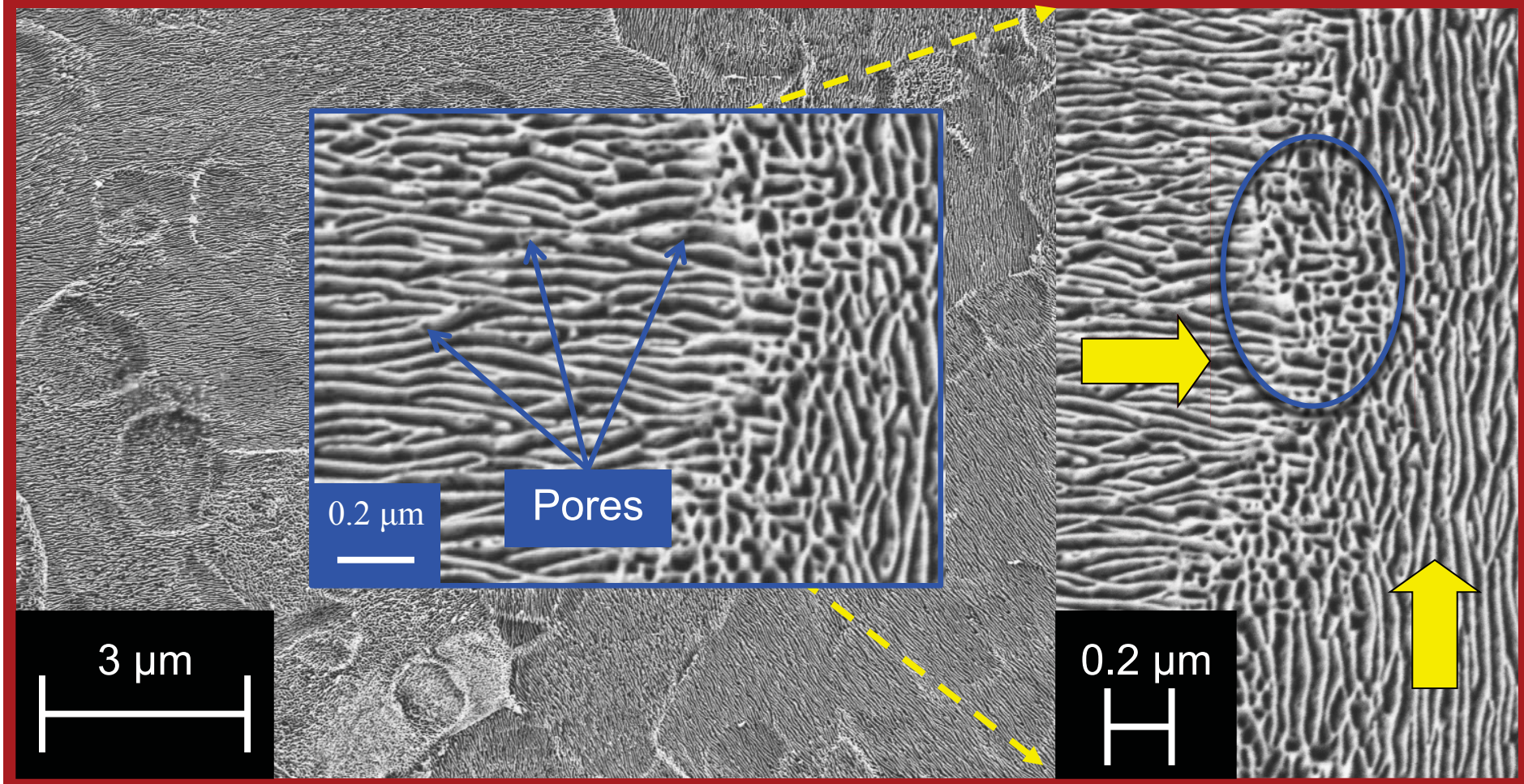


The jet produced by a 20 cm dia. cathode at -60 kV and 30 mA with a 30 cm dia. anode produces a jet, which extrapolations suggest contains ~100 μA of negative ions



Eric Alderson-PhD Thesis, University of Wisconsin, 2012

“Grass” Morphology in W is Highly Dependent on the Orientation of the Grains to the Ion Beam-Garrison and Zenobia



φ_L – 3.6x10^{18} He^+/cm^2 ,T – 900°C

SHINE
Medical Technologies

The Wisconsin IEC Team

Questions?