Progress in IEC Research at the University of Wisconsin Since the 8th US-Japan Workshop

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9th US-Japan Workshop
Argonne National Laboratory
May 22nd, 2007

THE UNIVERSITY of WISCONSIN MADISON

Outline

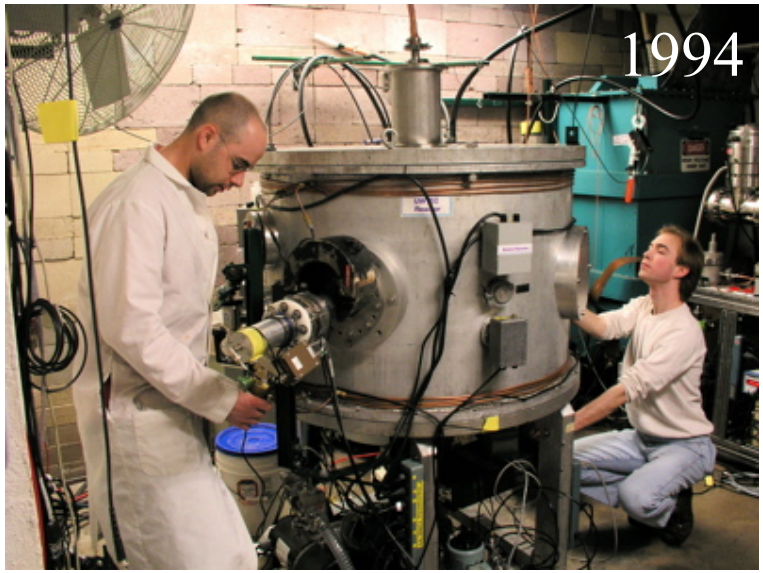
- **Historical Perspective**
- **Overall Progress Since the 8th US-Japan Workshop-2006**

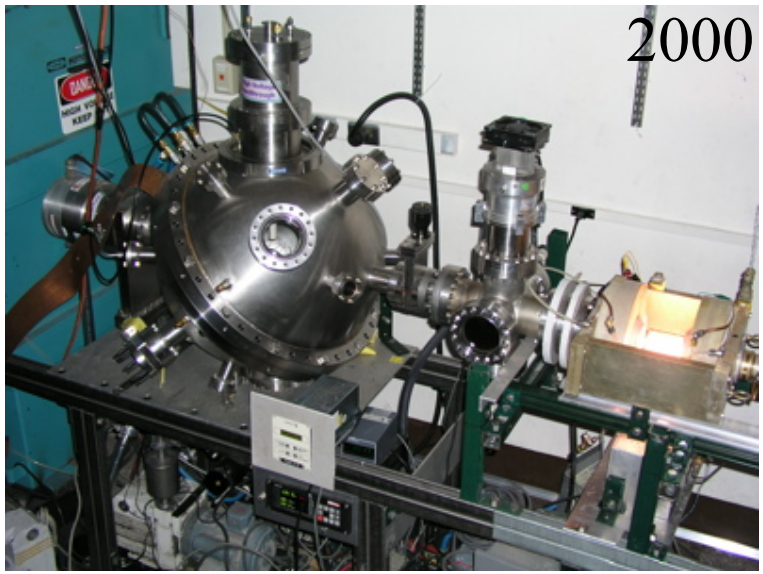
The UW IEC Group Now Numbers 15

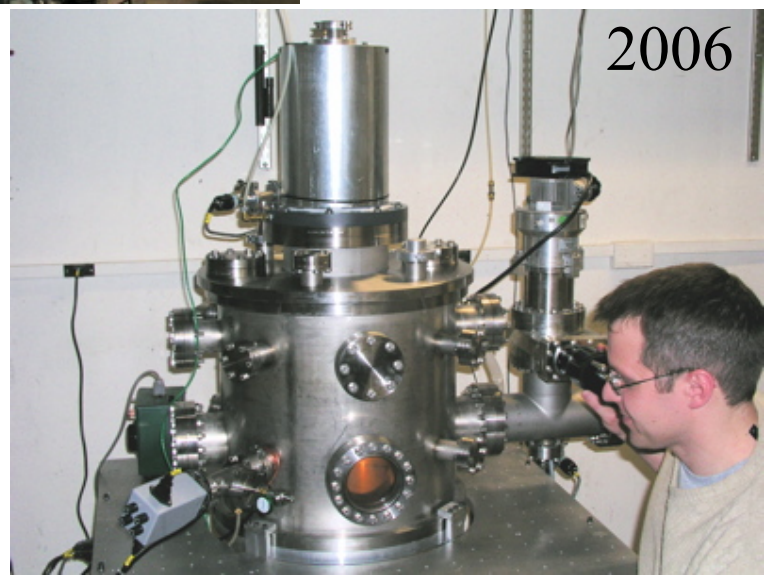
History of Major Events in UW IEC Program

- IEC device first constructed-1994
- First D-^{3}He fusion-1998
- Steady state DD neutron production, 10^{7}/s-1999
- Installed 200 kV power supply-2000
- Steady state DD neutron production, 10^{8}/s-2001
- Medical isotopes first produced-2002
- Helicon ^{3}He source first operated-2003
- High temperature materials studies begun-2003
- Explosive (C-4) detection demonstrated-2004
- First repeatable detection of ^{3}He^{3}He reactions-2006
- Source & Core Plasmas Characterized by Theory & Expts.-2007
- Detection of HEU (10g) with n pulse of 5 x 10^{9}/s-2007

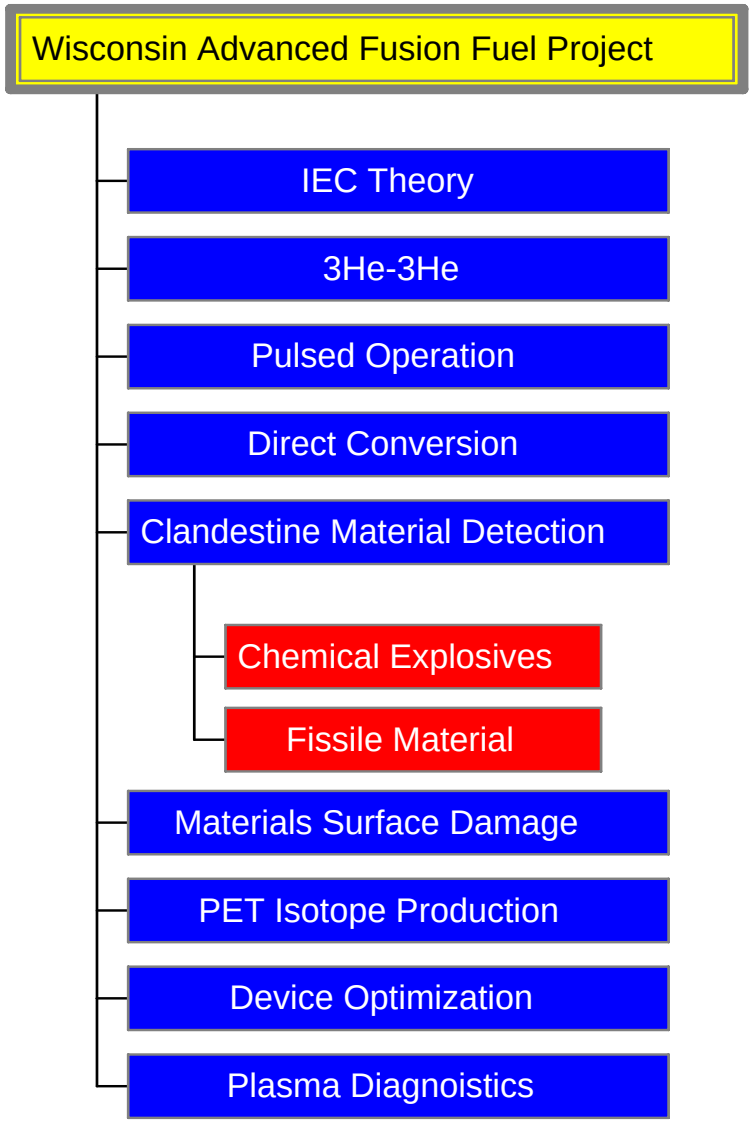
Three IEC Chambers Are Now in Operation at the University of Wisconsin







IEC Activities at the University of Wisconsin-2007



Lead Investigator(s)

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R. F. Radel, R. P. Ashley, J. H. Sorebo

D. R. Boris

D.C. Donovan, (Giar, Wehmeyer)
R. F. Radel, J. H. Sorebo

S. J. Zenobia. R. F Radel, (Cipiti)

B. J. Egle, (Weidner, Cipiti)

R. P. Ashley, P. E. Rusch, (Seyfert, Murali)

E. R. Alderson, D. R. Boris

Recent UW IEC History Timeline

Detection of HEU with 5 x 10^9 n/s pulses

2007

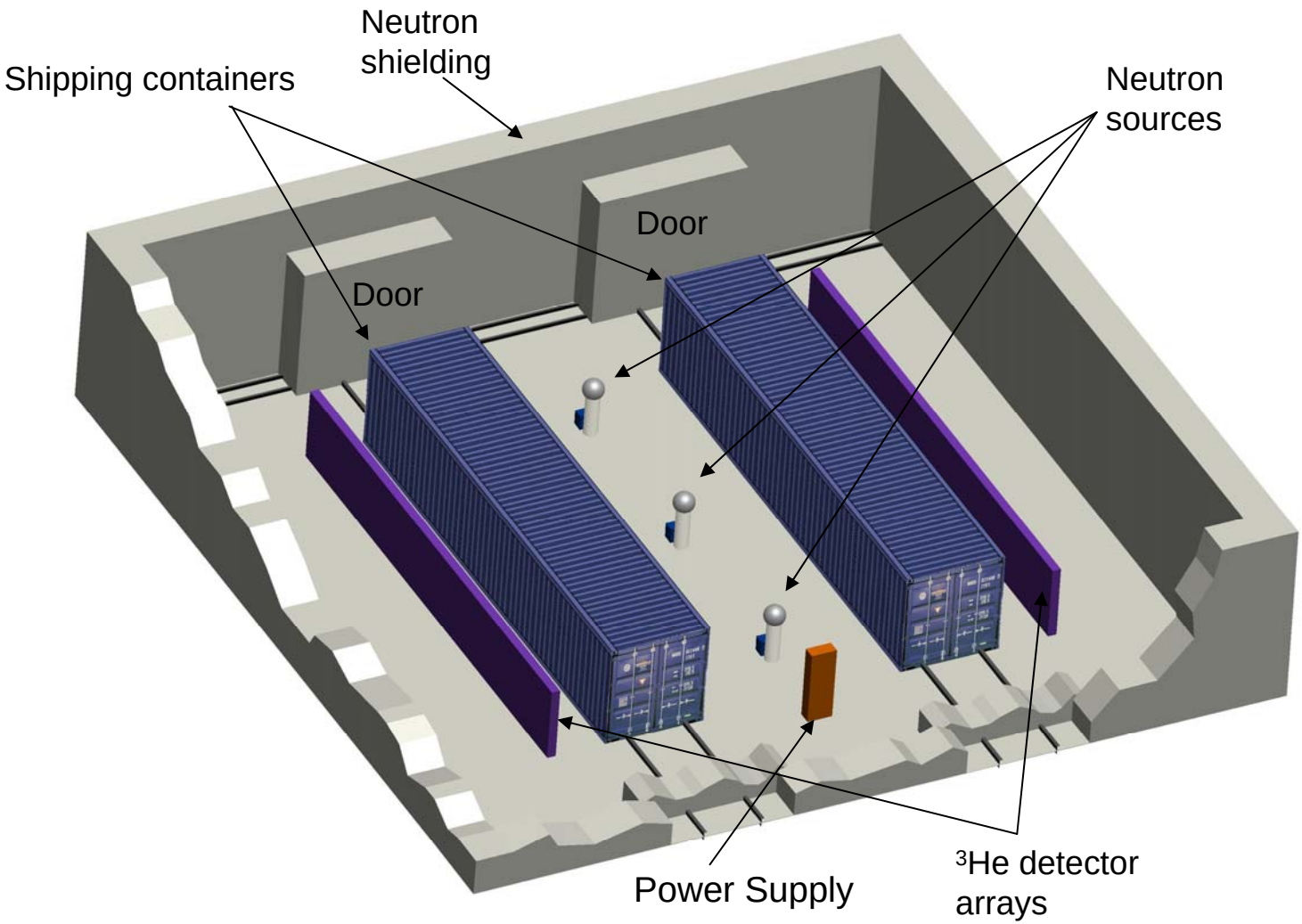
9th@ANL

Homeland Security/LANL HEU Detection Project

2006

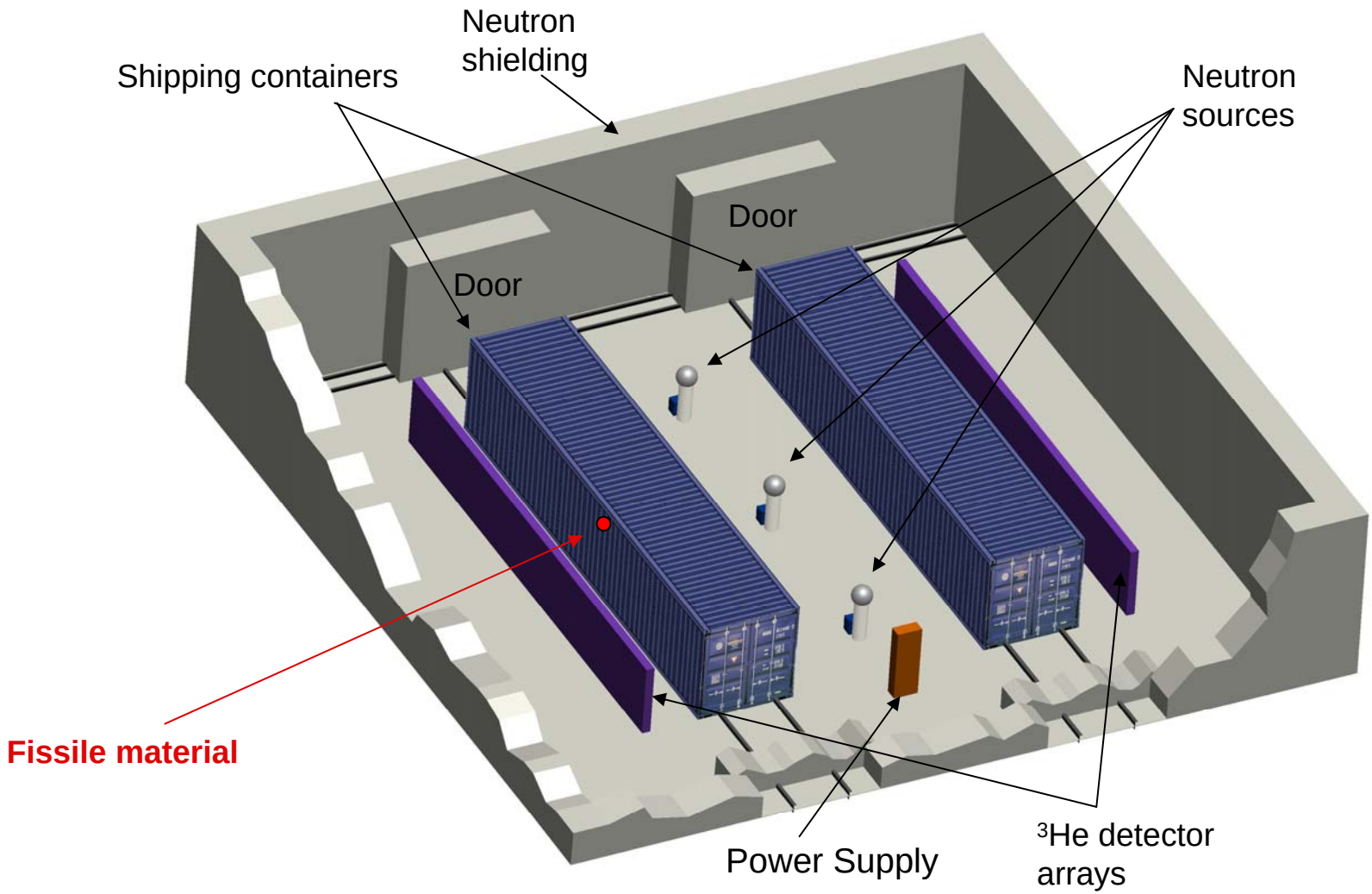
8th@Kansai

IEC Fusion-Based HEU Detection Concept



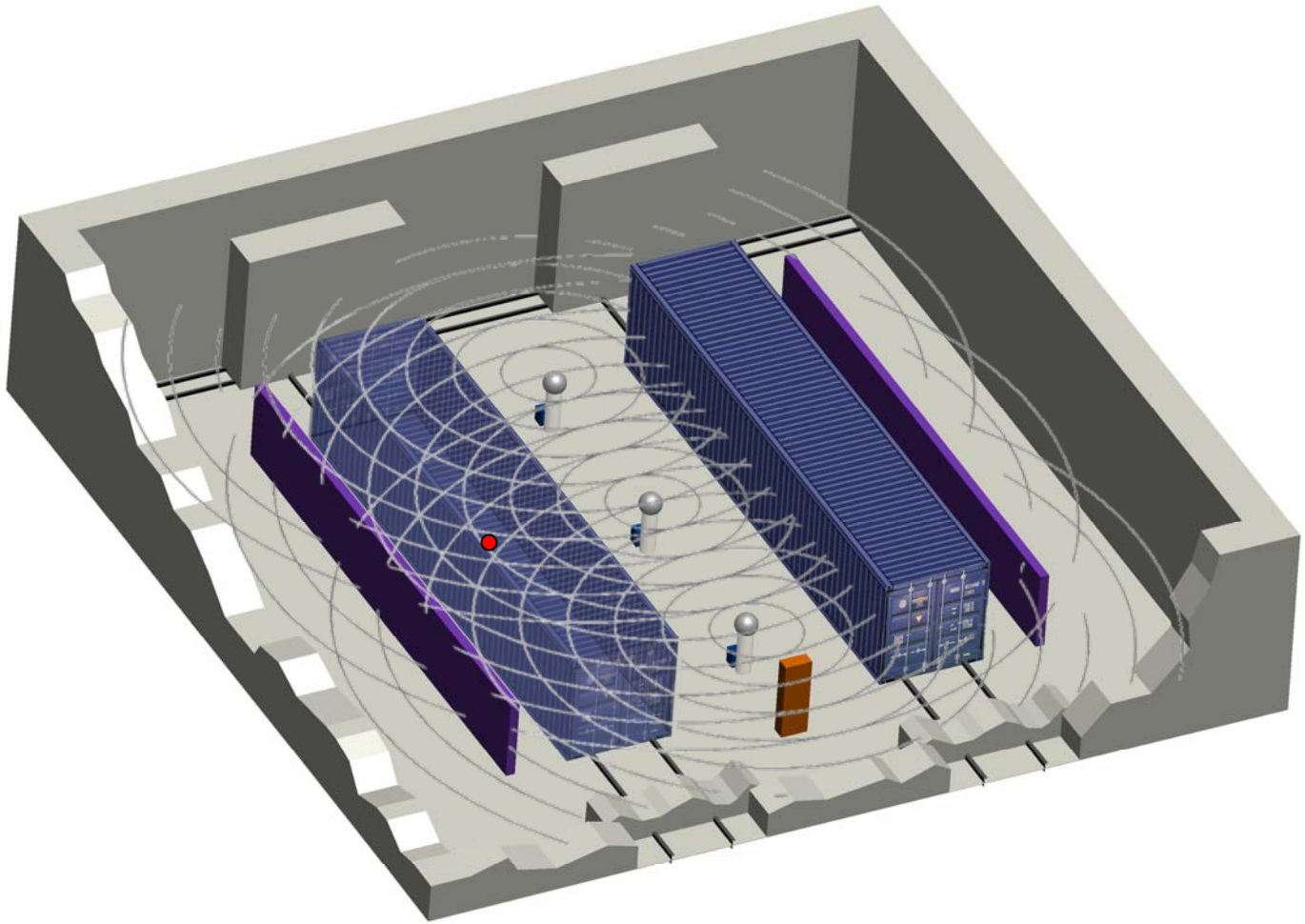
Source: Greg Sviatoslavsky

IEC Fusion-Based HEU Detection Concept



Source: Greg Sviatoslavsky

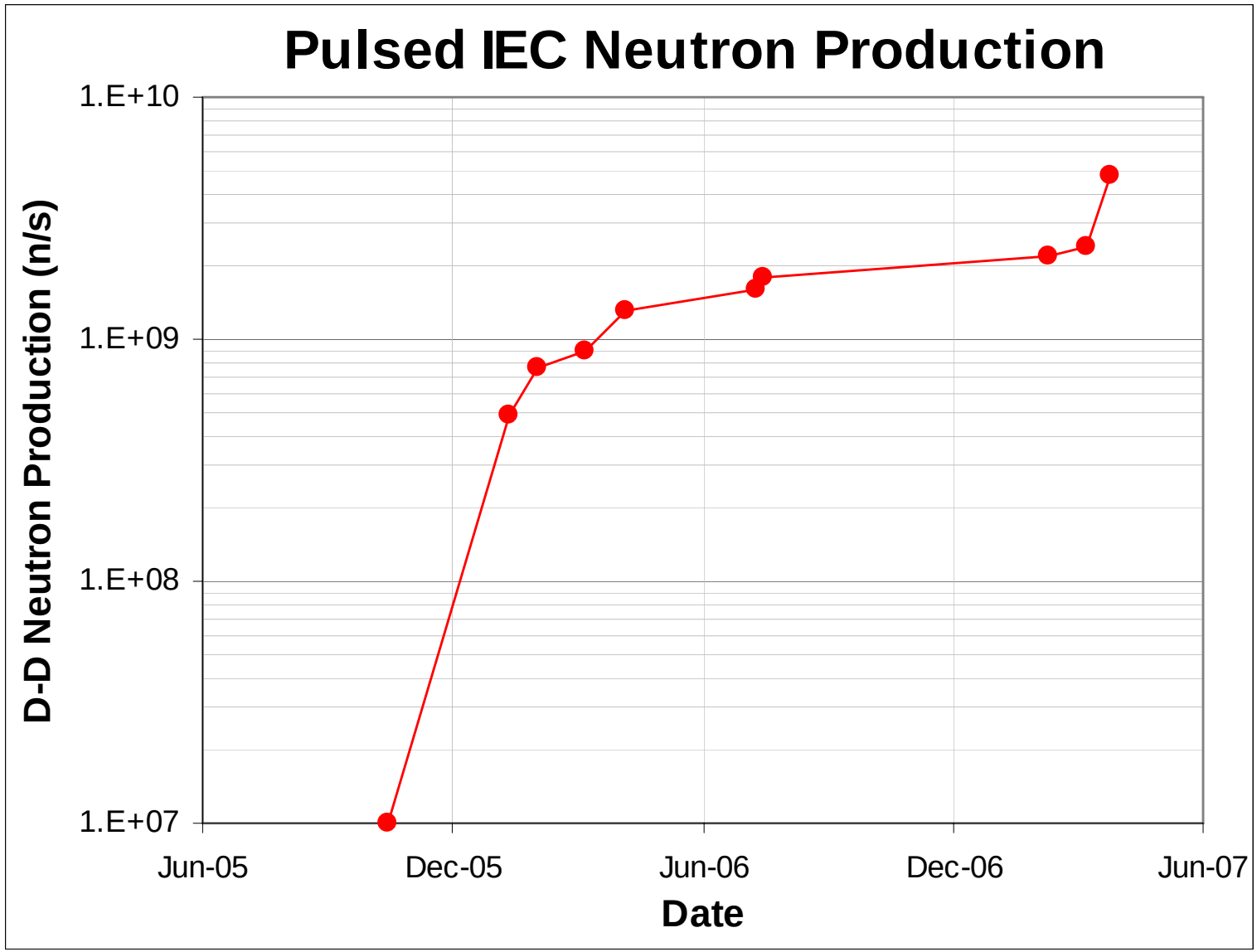
Pulsed Fusion Neutrons Induce Fissions within the Shipping Container



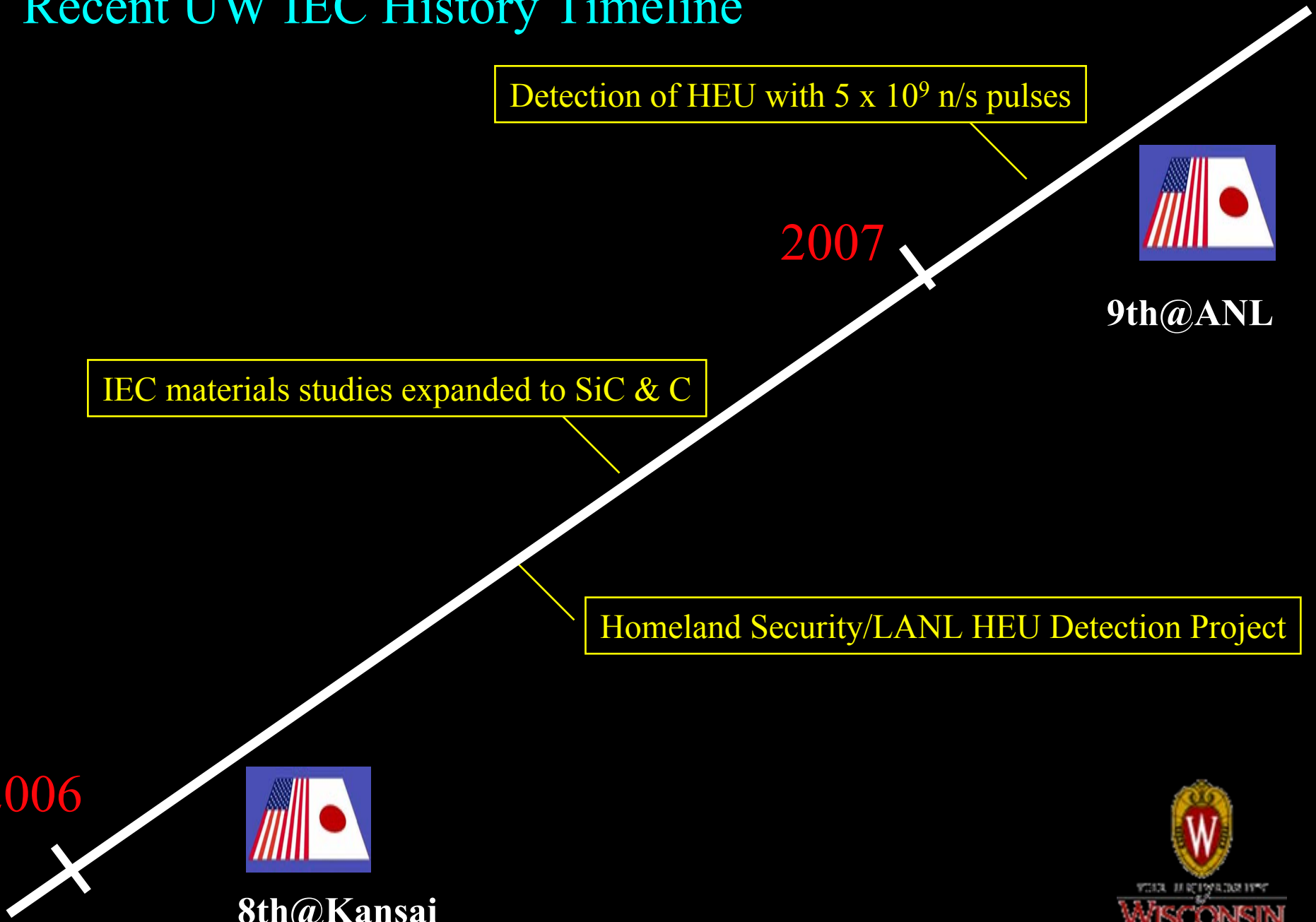
Source: Greg Sviatoslavsky

Activities are Now Focusing on Testing at Sea

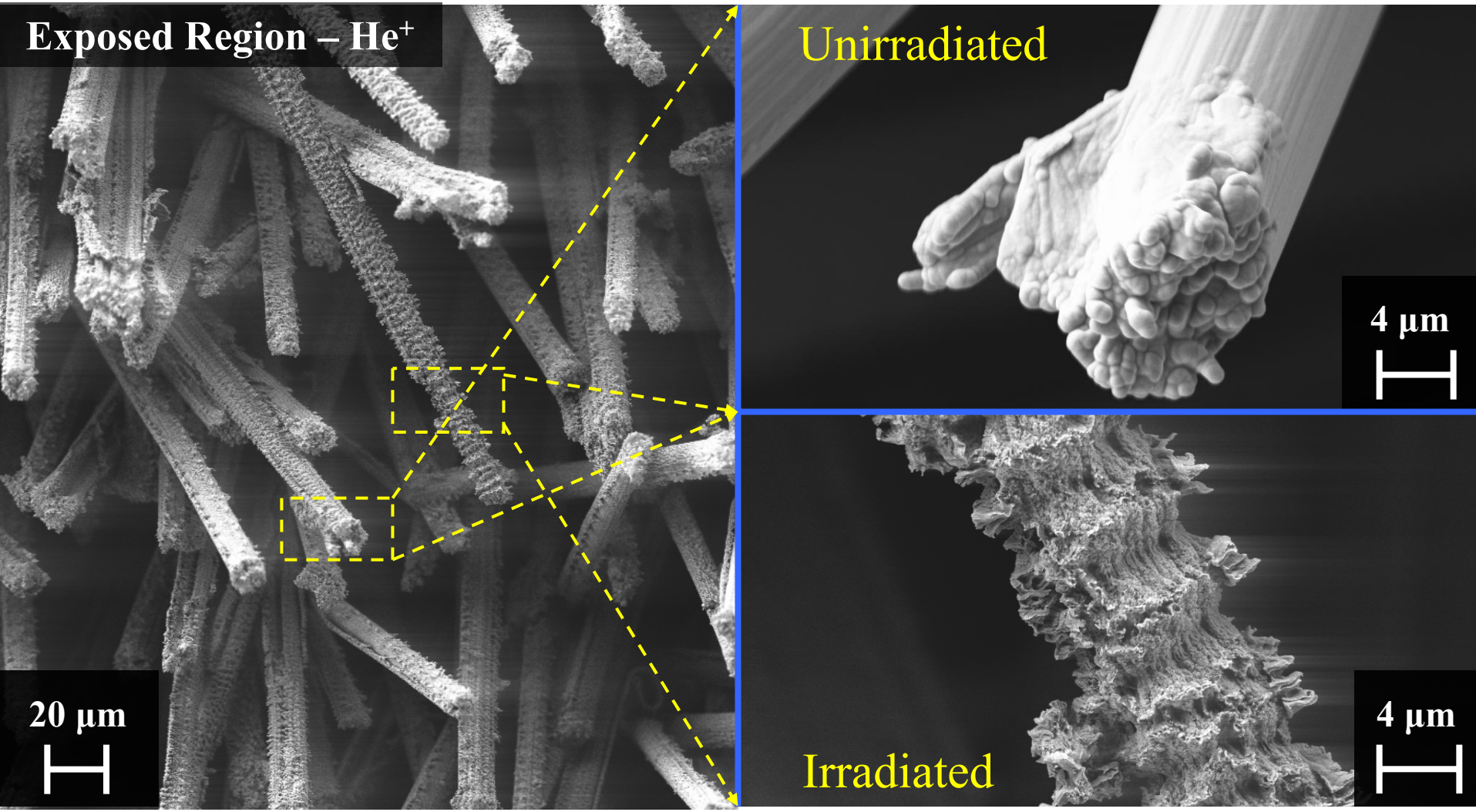
Significant Progress in Pulsed Neutron Flux Has Been Made Over the Past Two Years



Recent UW IEC History Timeline

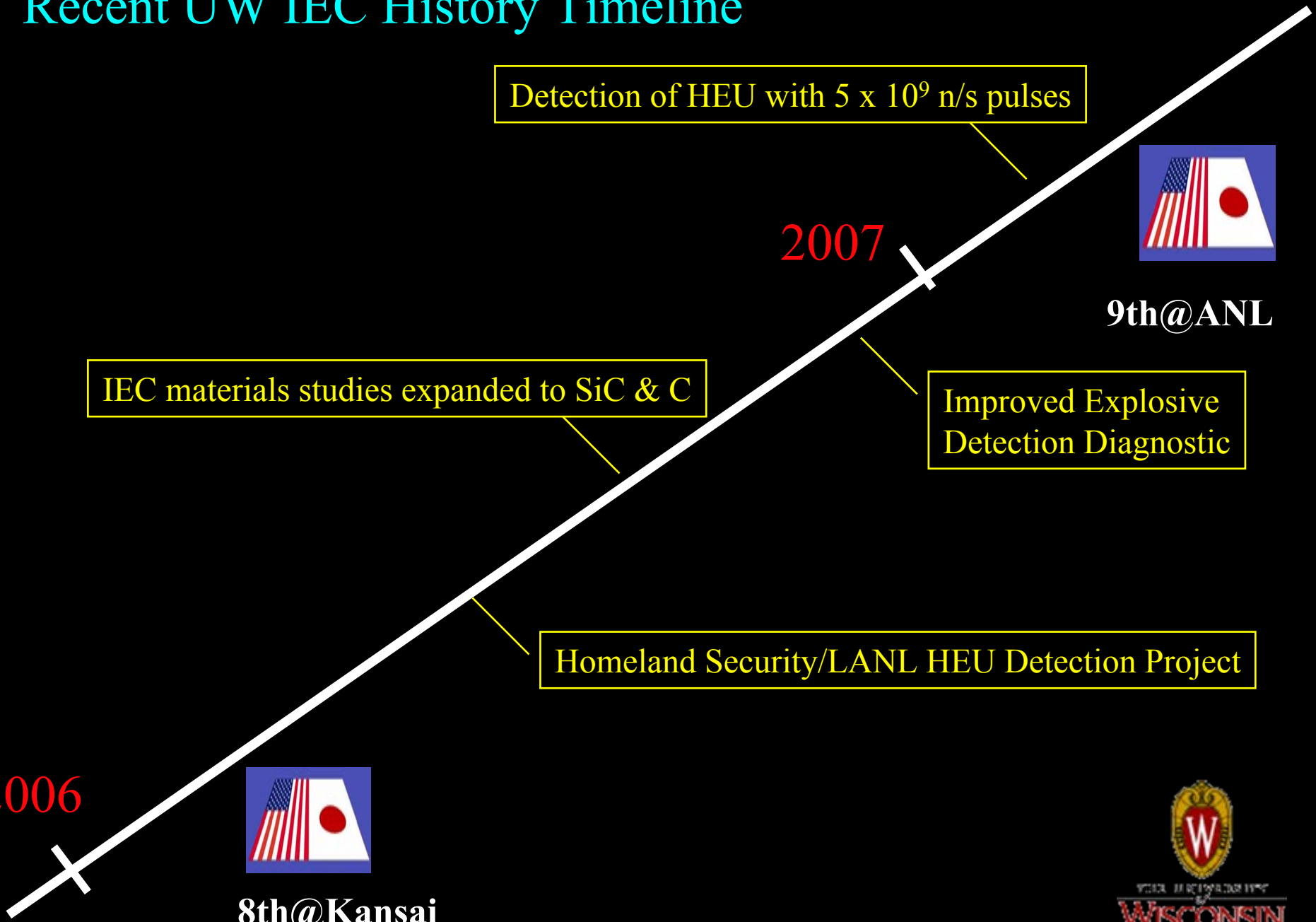


Irradiation of Carbon Coated Velvet to 10^{19} He^+/cm^2 Results in Surface Roughness and Shaft Corrugation

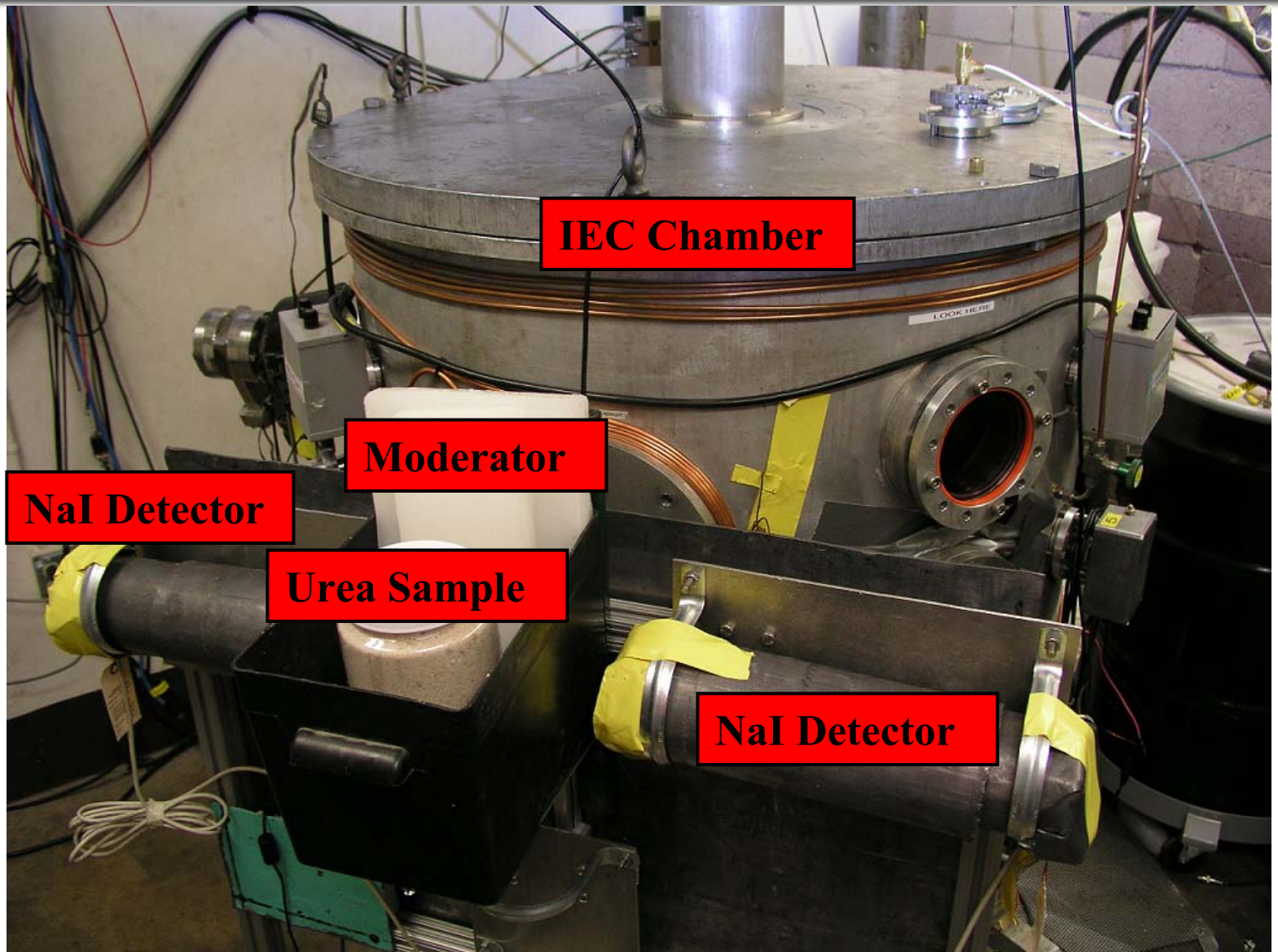


T ~ 1150 °C, φ ~ 10^{19} He^+/cm^2, V ~ 30 kV

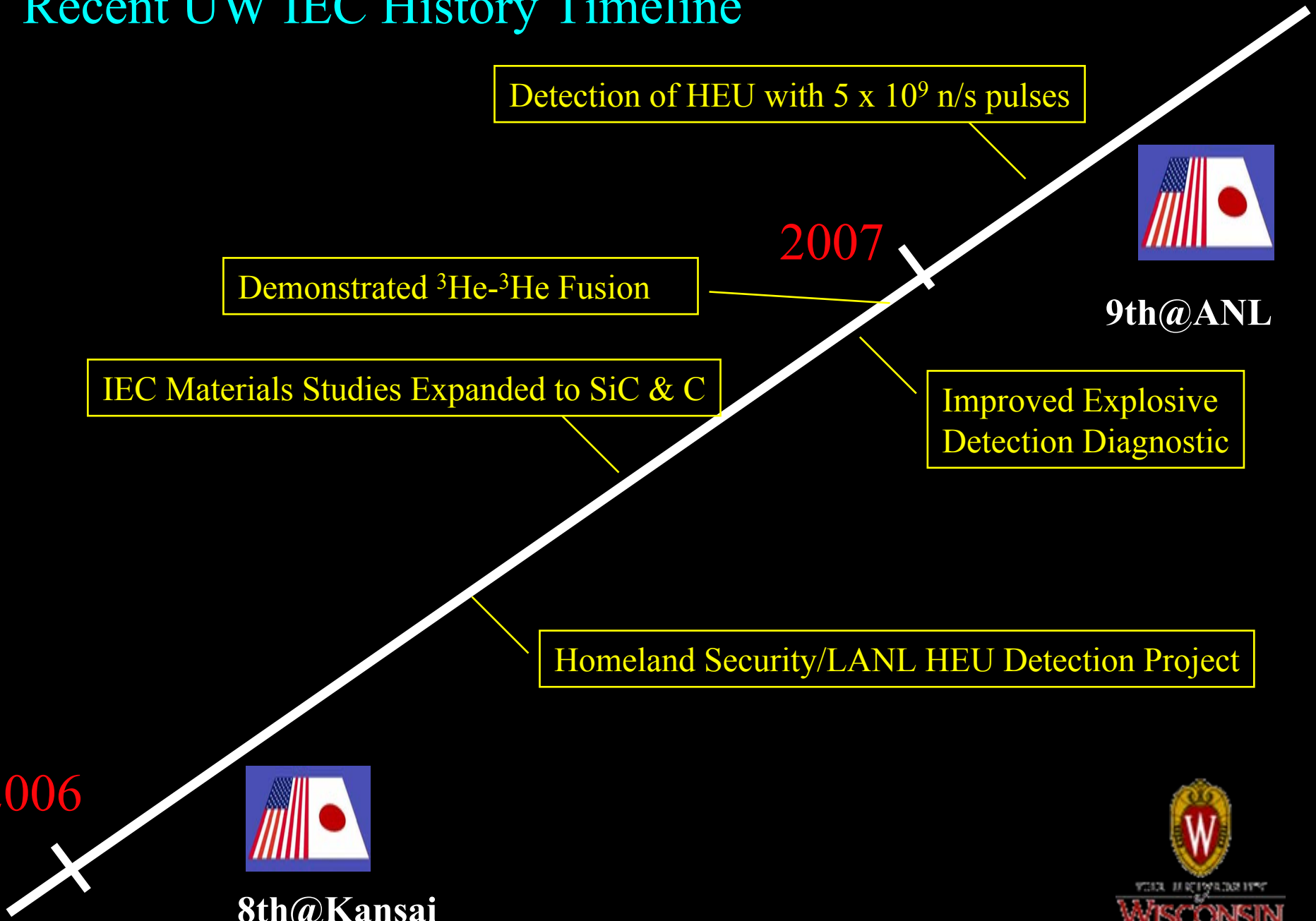
Recent UW IEC History Timeline

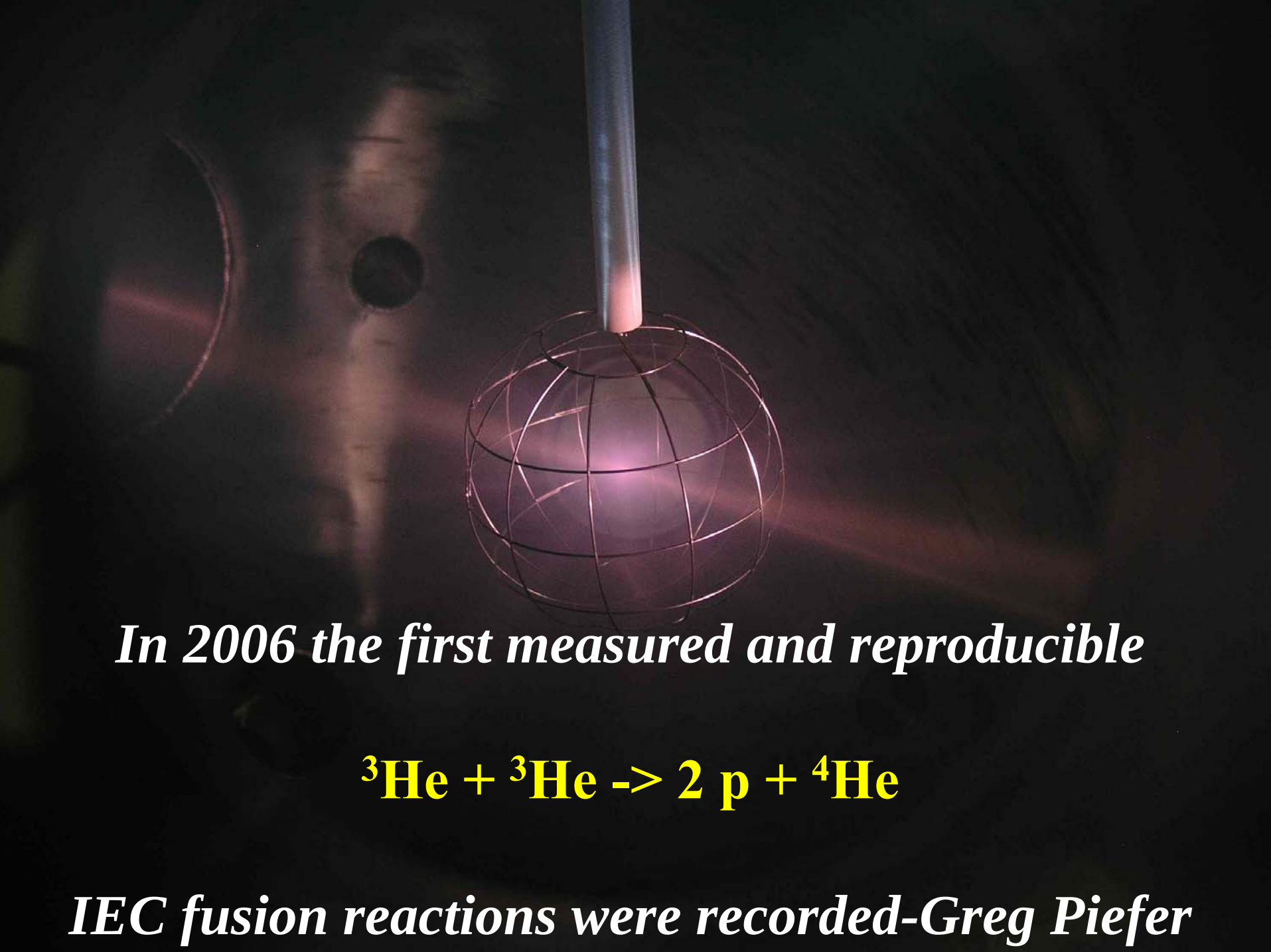


Experimental Configuration for Urea Calibration of UXO Detection Apparatus



Recent UW IEC History Timeline



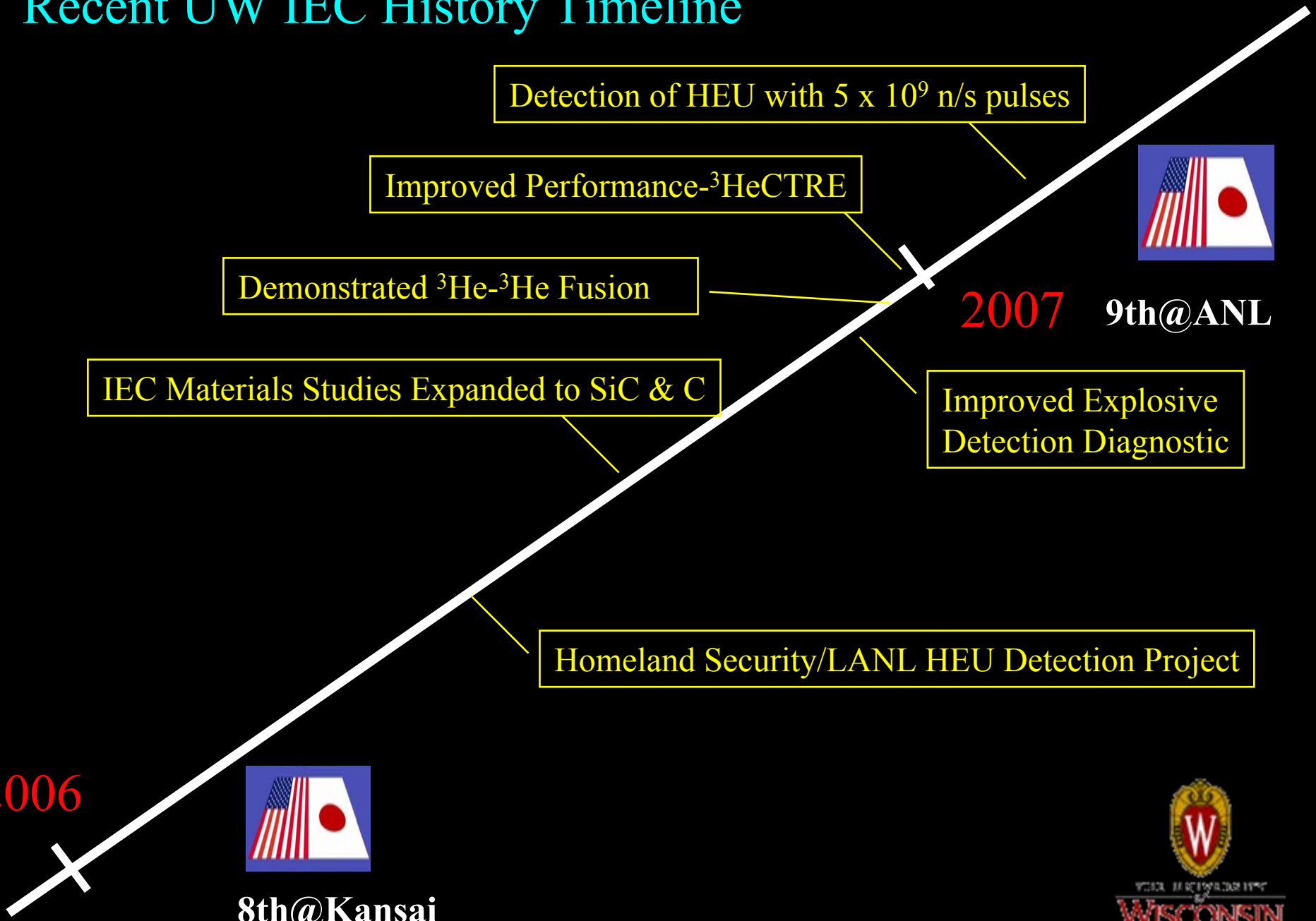


In 2006 the first measured and reproducible

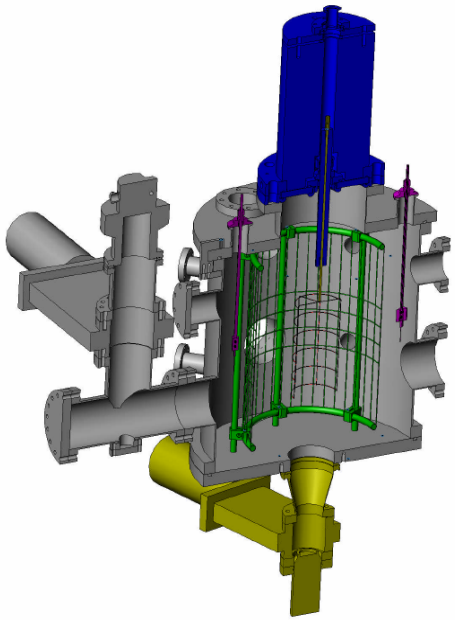
$^{3}He + ^{3}He \rightarrow 2\ p + ^{4}He$

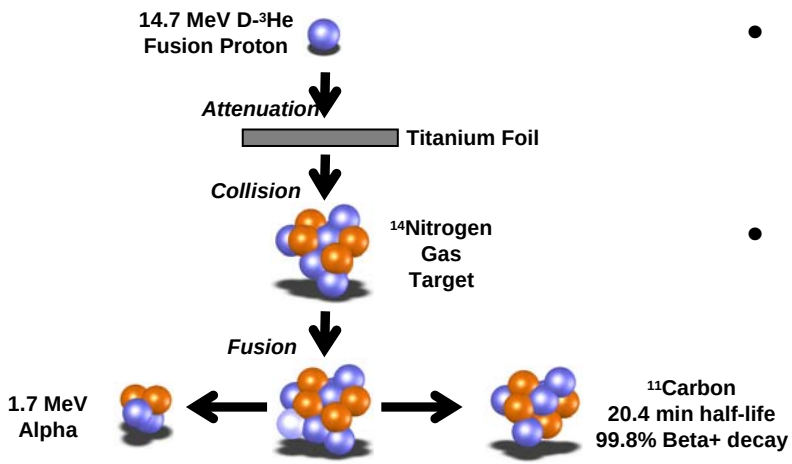
IEC fusion reactions were recorded-Greg Piefer

Recent UW IEC History Timeline



^{3}HeCTRE is a Proof of Principle Device for Radioisotope Production





New Chamber Milestones:

- Began construction July 2005
- First D-D reactions April 2006
- Best steady state neutron rate **2.7x10^{7} neutrons/sec** at 145 kV, 35 mA, and 0.3 Pa (2 mTorr)
- First D-^{3}He reactions Oct 18, 2006
- Best steady state proton rate at this point is **2.0x10^{7} protons/sec** at 130 kV, 30 mA and 0.3 Pa (2 mTorr)
- MCNPX simulation predicts 10 nCi of ^{11}C at current proton rates

Recent UW IEC History Timeline

Source & Core Plasmas Characterized by Theory & Expts.

Detection of HEU with 5 x 10^9 n/s pulses

Improved Performance-HECTOR

Demonstrated Repeatable ^{3}He-^{3}He Fusion Rates

IEC Materials Studies Expanded to SiC & C

Improved Explosive Detection Diagnostic

Homeland Security/LANL HEU Detection Project

2006

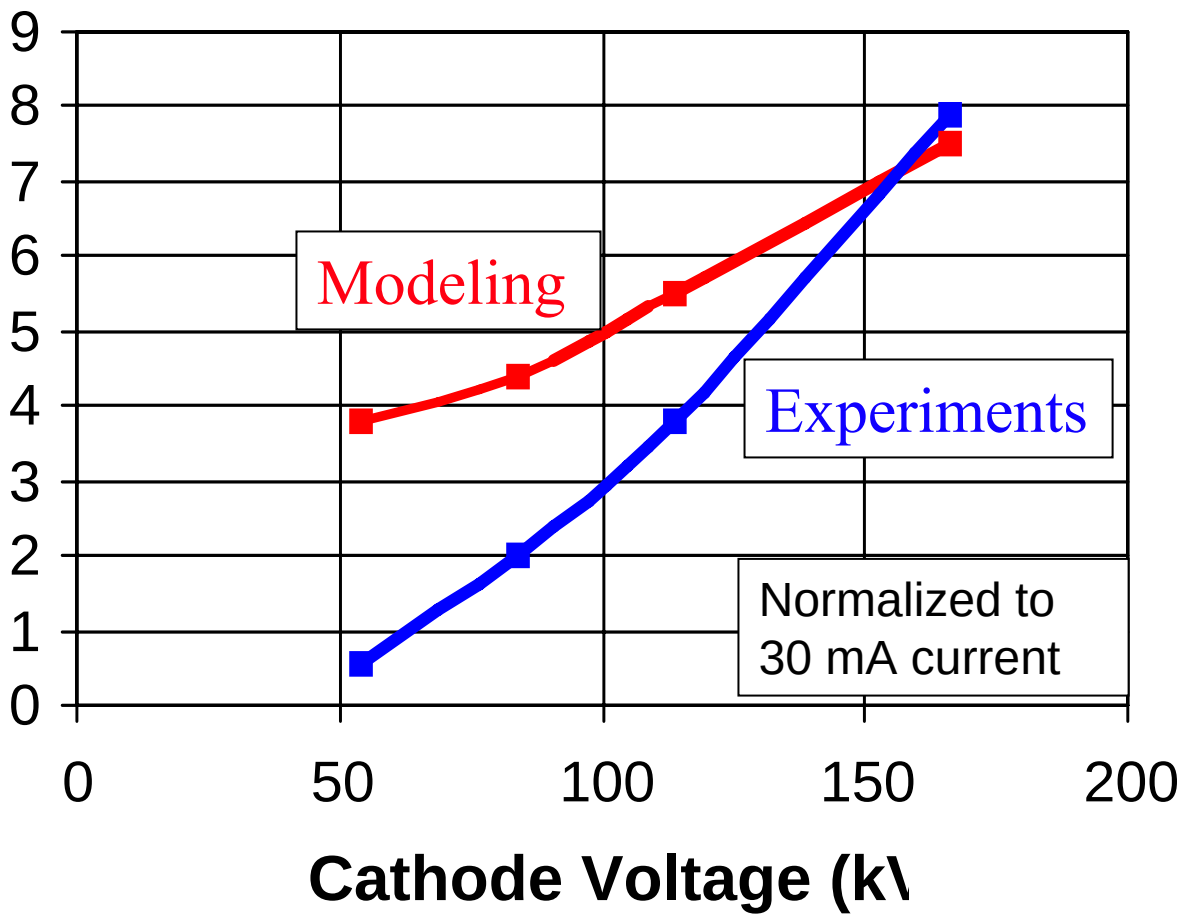
8th@Kansai

2007

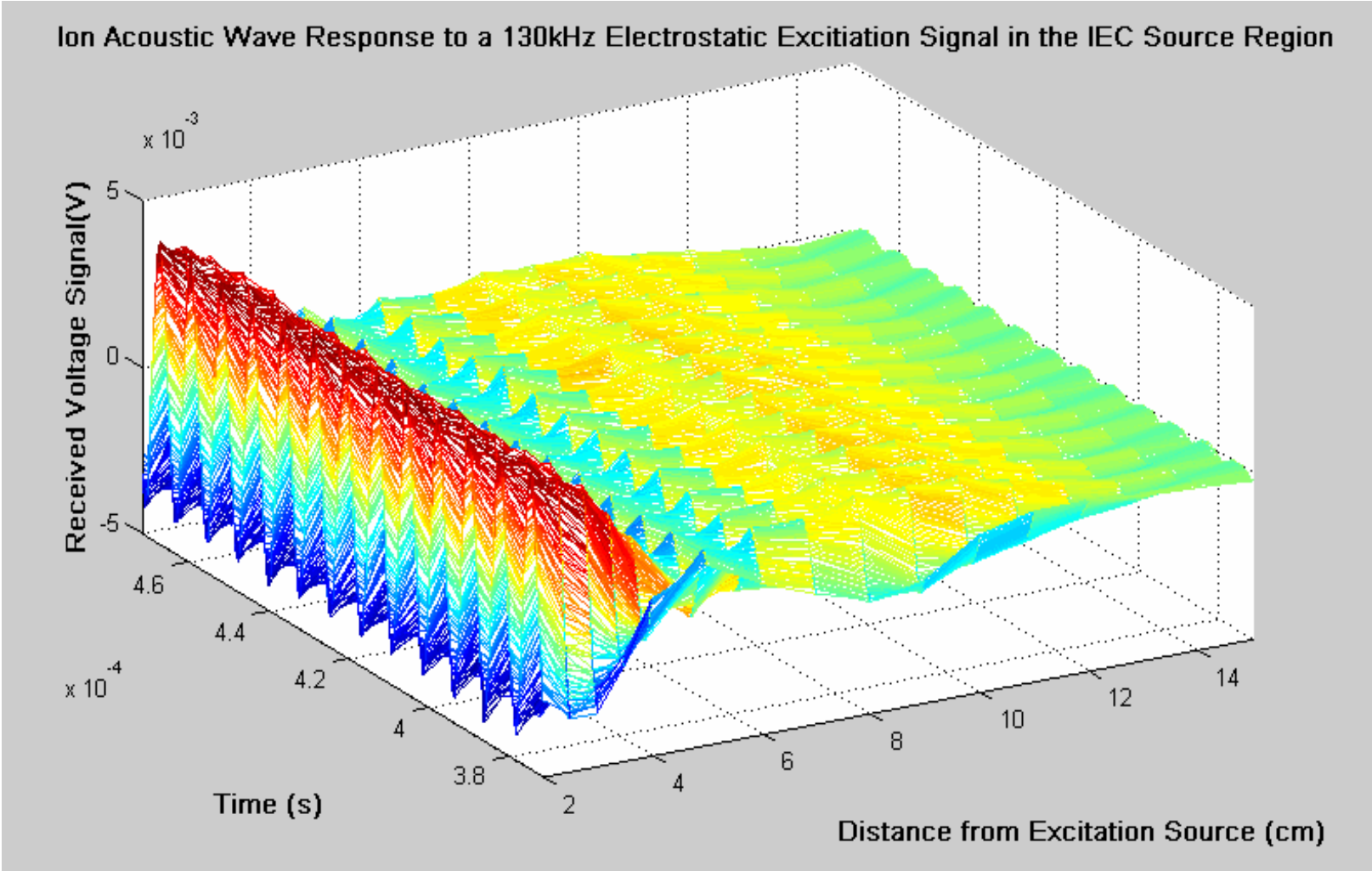
9th@ANL

WISCONSIN

The Integral Equation Molecular Code Agrees with Experiment Well at High Voltage, but Less So at Lower Voltage



Ion Acoustic Wave Measurements Have Confirmed Theoretical Predictions of Deuterium Source Region Characteristics



D_3^+ fraction = 0.8 +/- 0.1

Talks and Posters Given by the UW Group at This Workshop

- Tuesday, May 22
  - 10:30-Overview-Kulcinski
  - 1:30-Molecular Ions Source-Emmert
  - 3:30-IEC Theory-Sanrtrius
  - Posters
    - Cylindrical IEC-Egle
    - IEC Spectroscopy-Alderson
    - IEC materials Studies-Zenobia
    - Increasing DD Rates in an IEC-Rusch
    - Progress in IEC Pulsed Operation-Ashley
- Wednesday, May 23
  - 9:00-Detection of HEU-Radel
  - 11:30-IEC Plasma Measurements-Boris
  - 1:30-Detection of N Based Explosives-Donovan
  - 3:30-Measurements of ^{3}He-^{3}He in an IEC-Piefer

UW IEC History Timeline