Detection of HEU Using a Pulsed D-D Fusion Source

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Outline

- HEU detection method
- Inertial Electrostatic Confinement (IEC) Fusion Background
- Pulsed IEC design
- Diagnostics/HEU Detection
- Summary

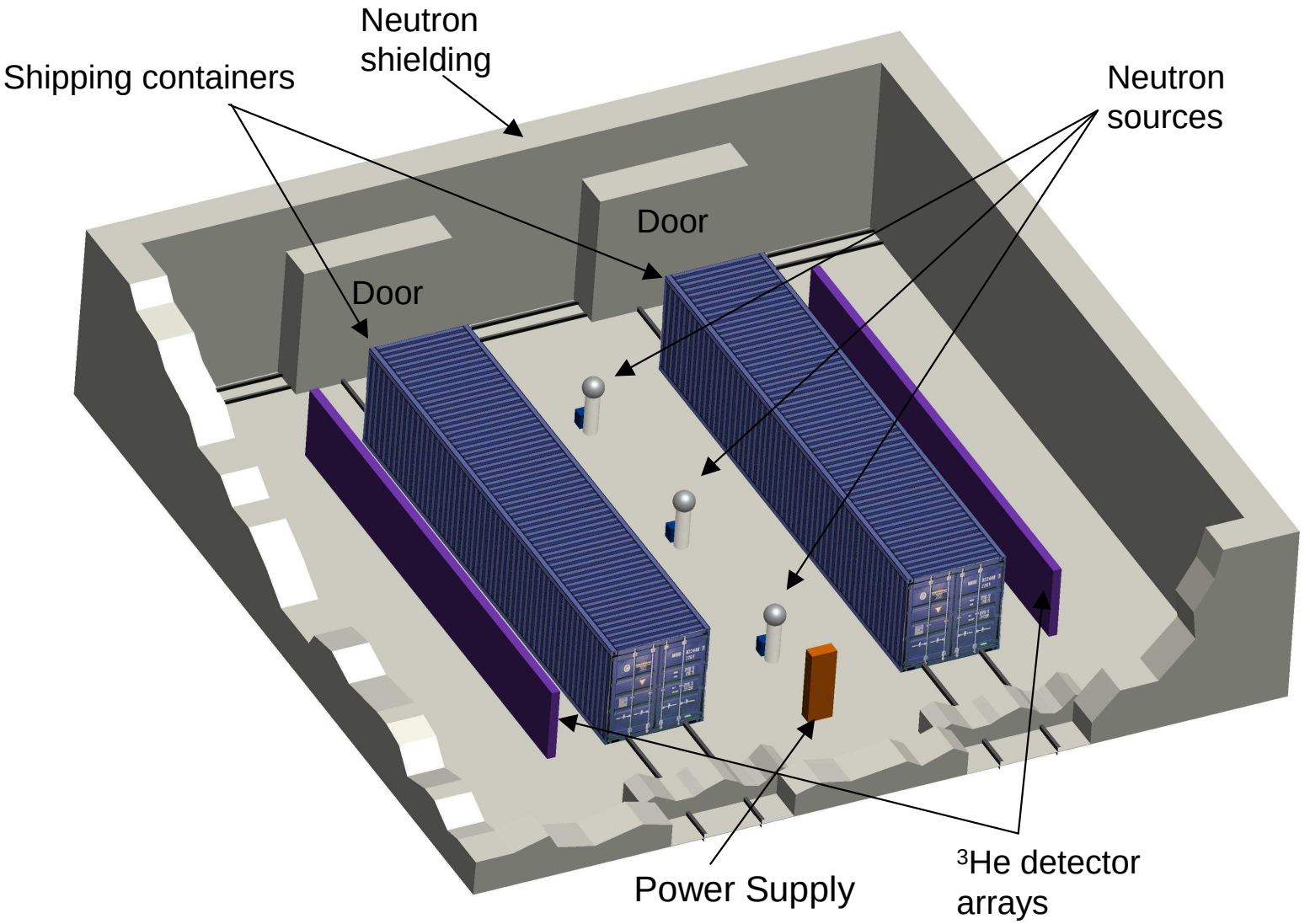
Importance of HEU Detection Research

- There have been at least 150 incidents of nuclear smuggling in past decade (IAEA), half involving special nuclear materials
- As little as 16 kg of HEU or 6 kg of Pu can be used to produce a 20 kiloton weapon, even with low technology levels
- Developing technology for the detection of HEU has become a priority for the US Department of Homeland Security
- IEC technology can provide high fluxes of D-D or D-T neutrons for long lifetimes

There are Two Categories of Non-Destructive Special Nuclear Material Detection

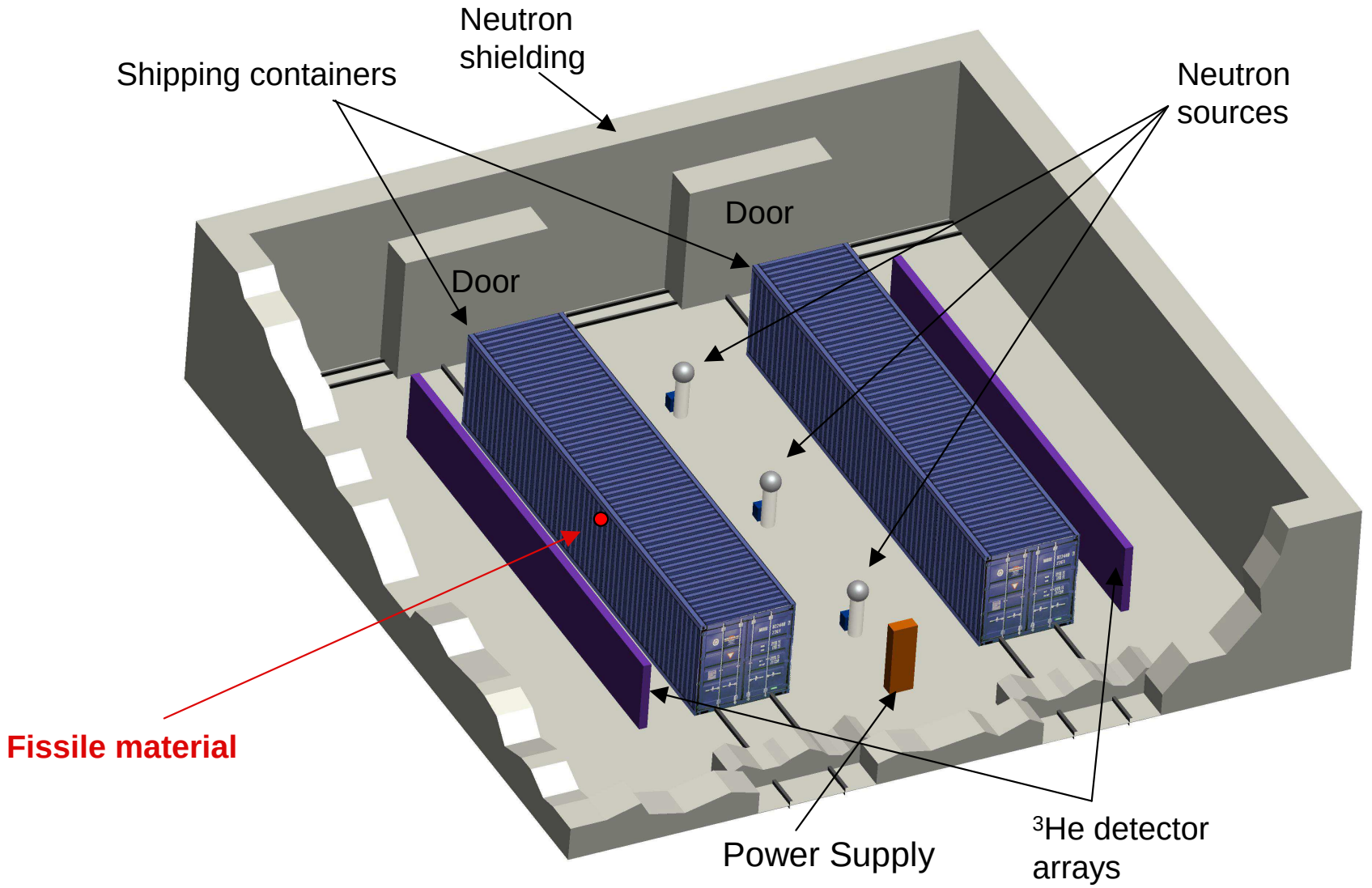
- Passive and active detection
- Passive detection is unreliable for HEU
  - Low count rates
  - Simple to shield
  - Calorimetry easy to deceive
- Active Detection is more applicable
  - Neutrons or photons
  - Neutrons are highly penetrating in high-Z material
  - Large fission cross-sections

IEC Fusion-Based HEU Detection Concept



Source: Greg Sviatoslavsky

IEC Fusion-Based HEU Detection Concept



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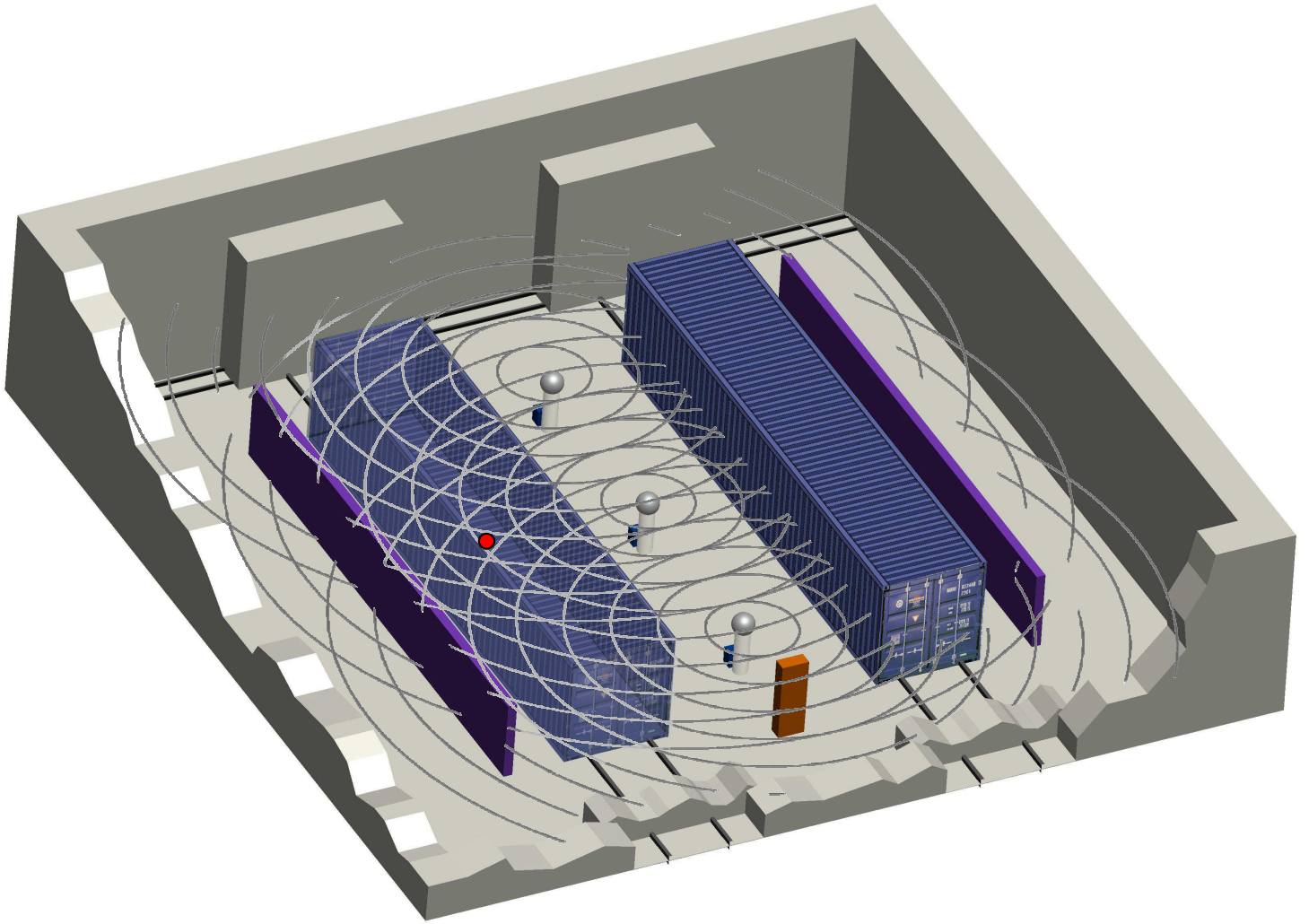
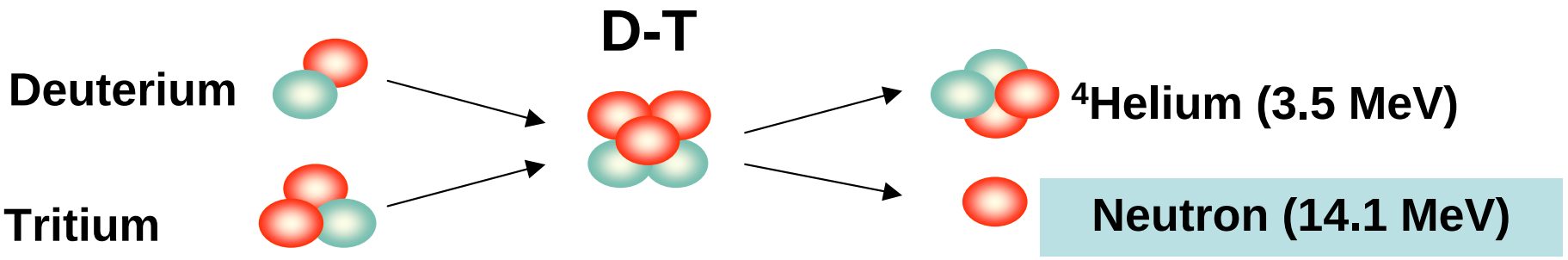
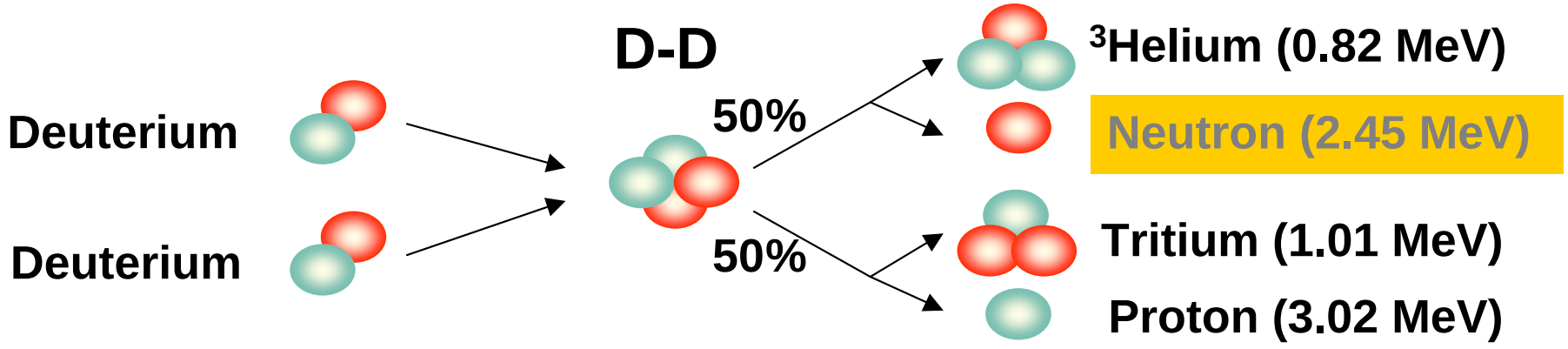
Pulsed Fusion Neutrons Induce Fissions within the Shipping Container



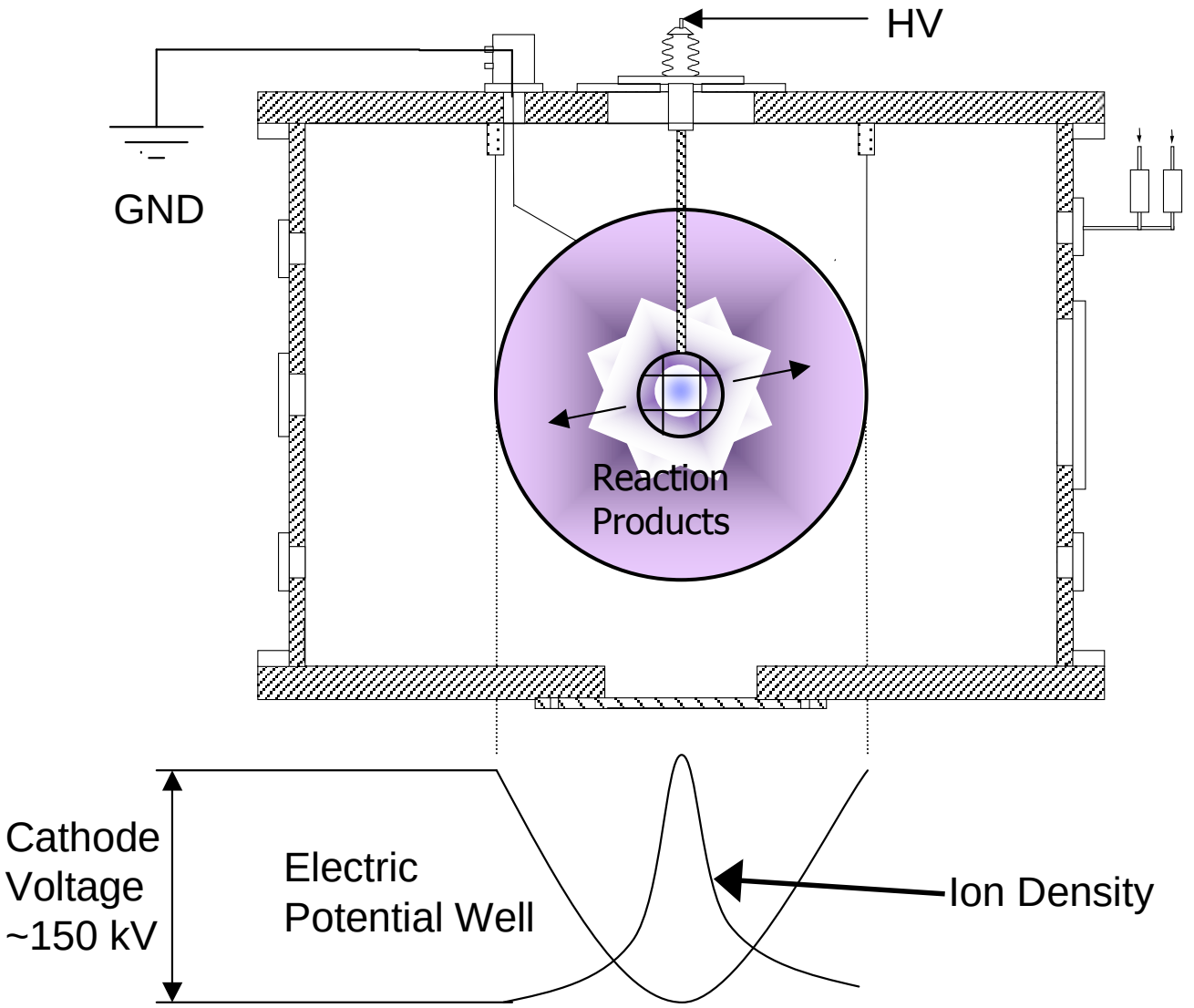
Source: Greg Sviatoslavsky

Fusion Reactions of Interest for HEU Detection

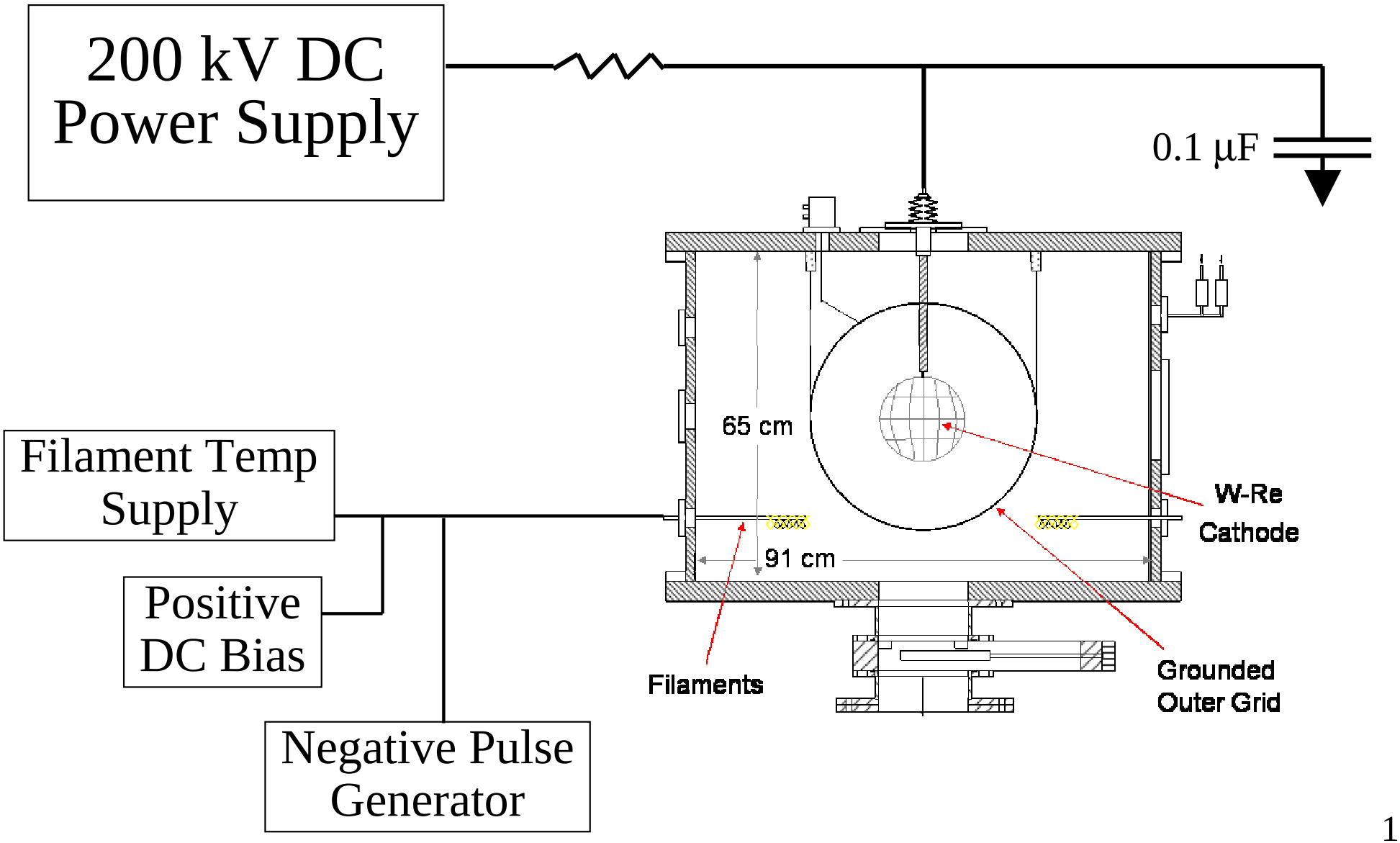




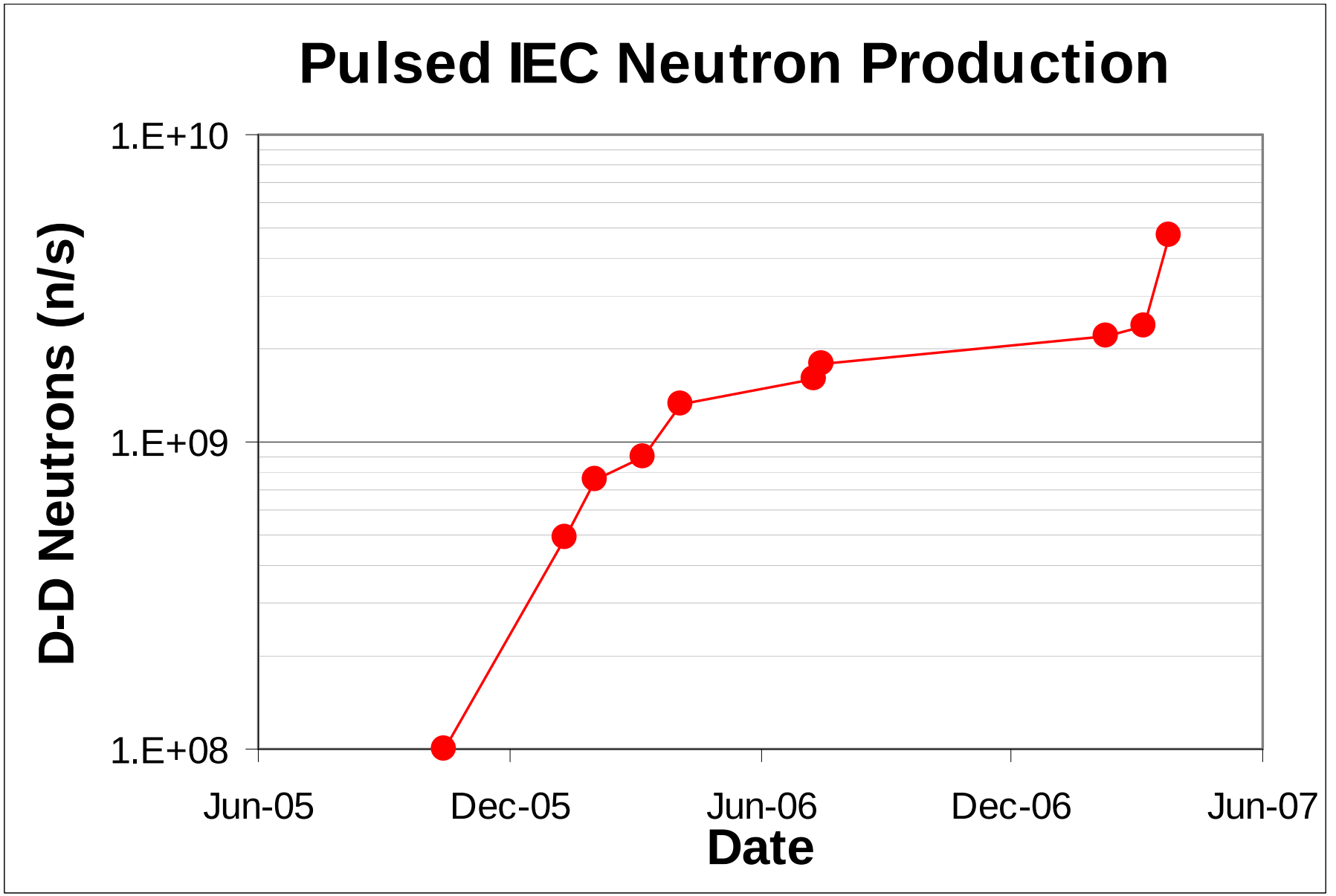
IEC Achieves High Ion Temperatures and Ion Confinement with an Electrostatic Well



Wisconsin Design Uses Ion Source to Generate Pulses

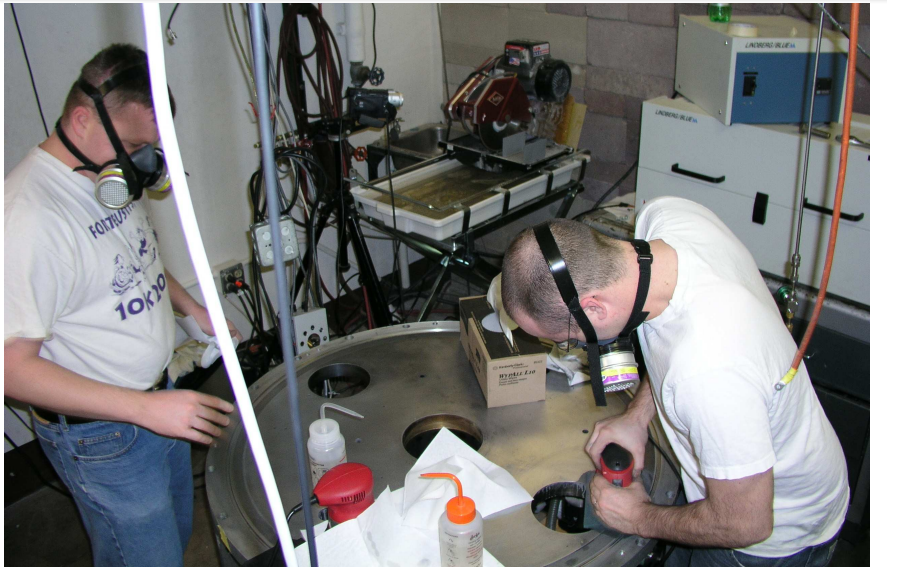


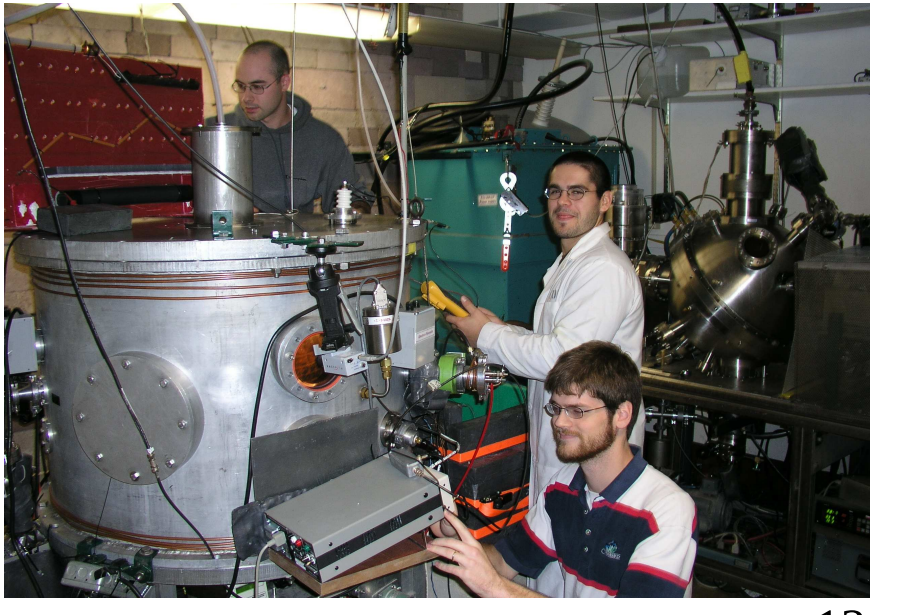
Significant Progress has been Made Over the Past Two Years



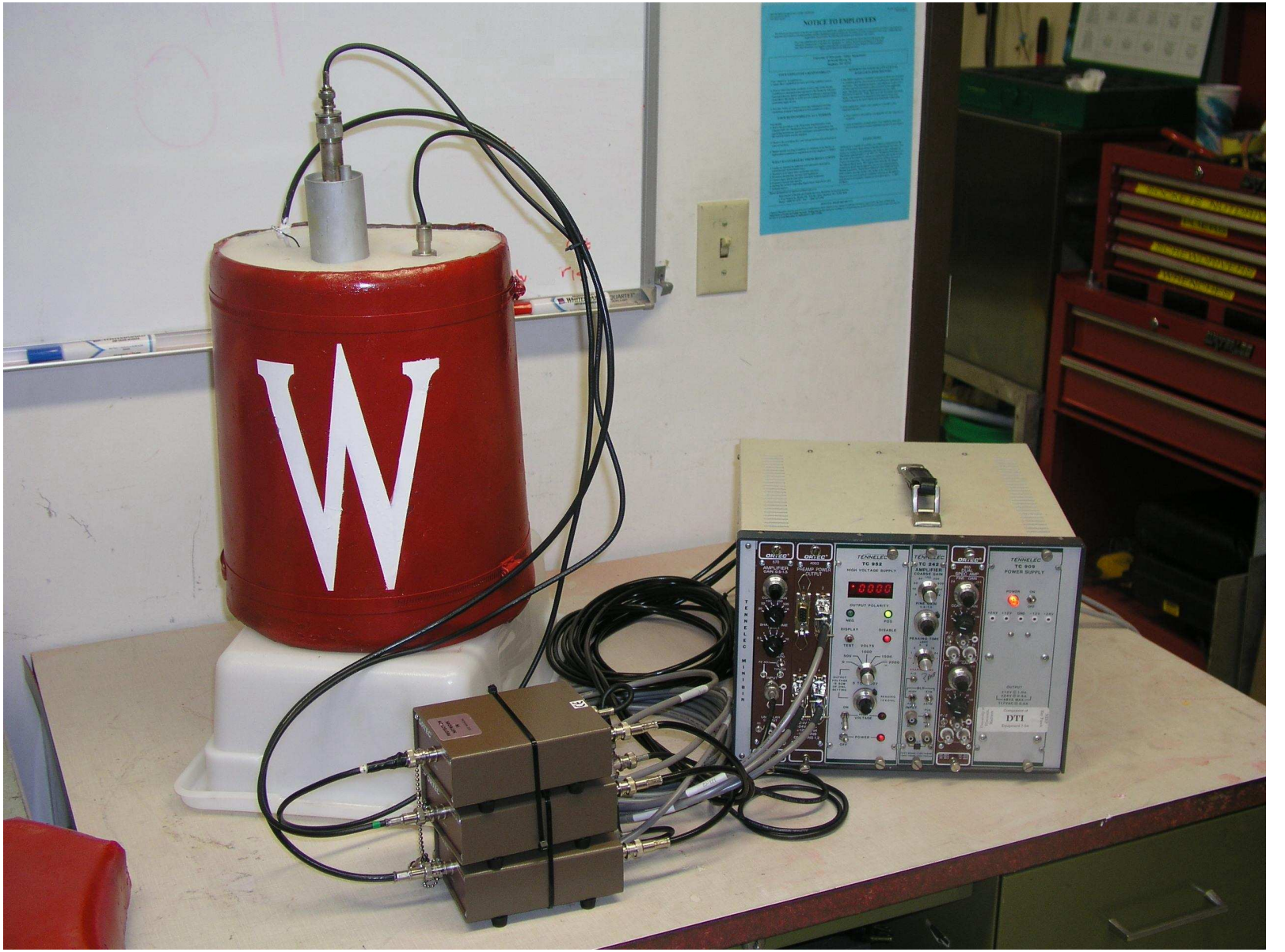
Current Pulsed IEC Status

- Max Voltage: 115 kV
- Max Pulse Current: 6 Amps
- Max Neutron Rate: 4.7×10^9 n/s
  - (96 kV , 5 A, 2.5 mTorr)
  - (110μs pulse width, 5 Hz)

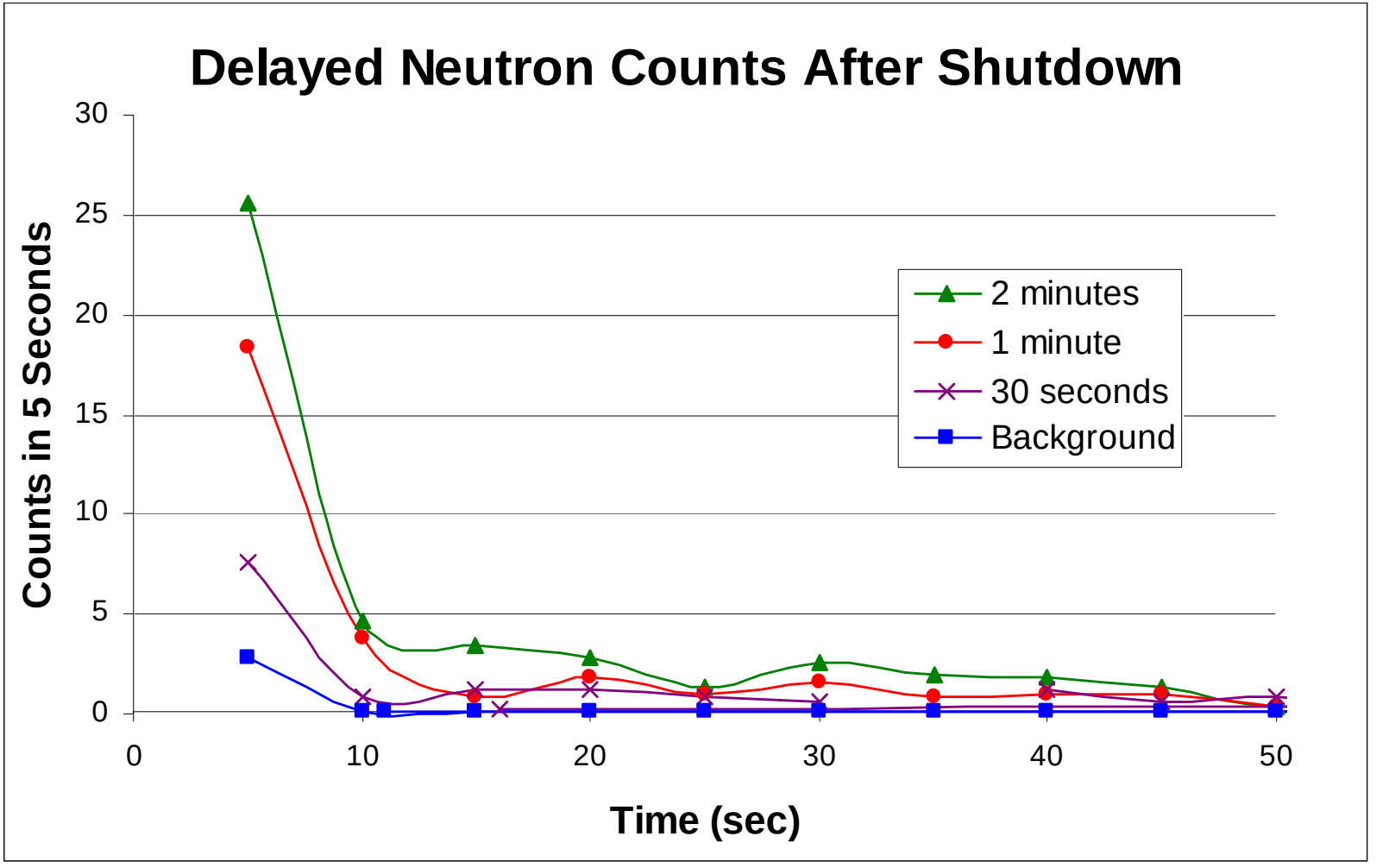




Initial Neutron Detector Construction Optimizes Delayed Neutron Detection

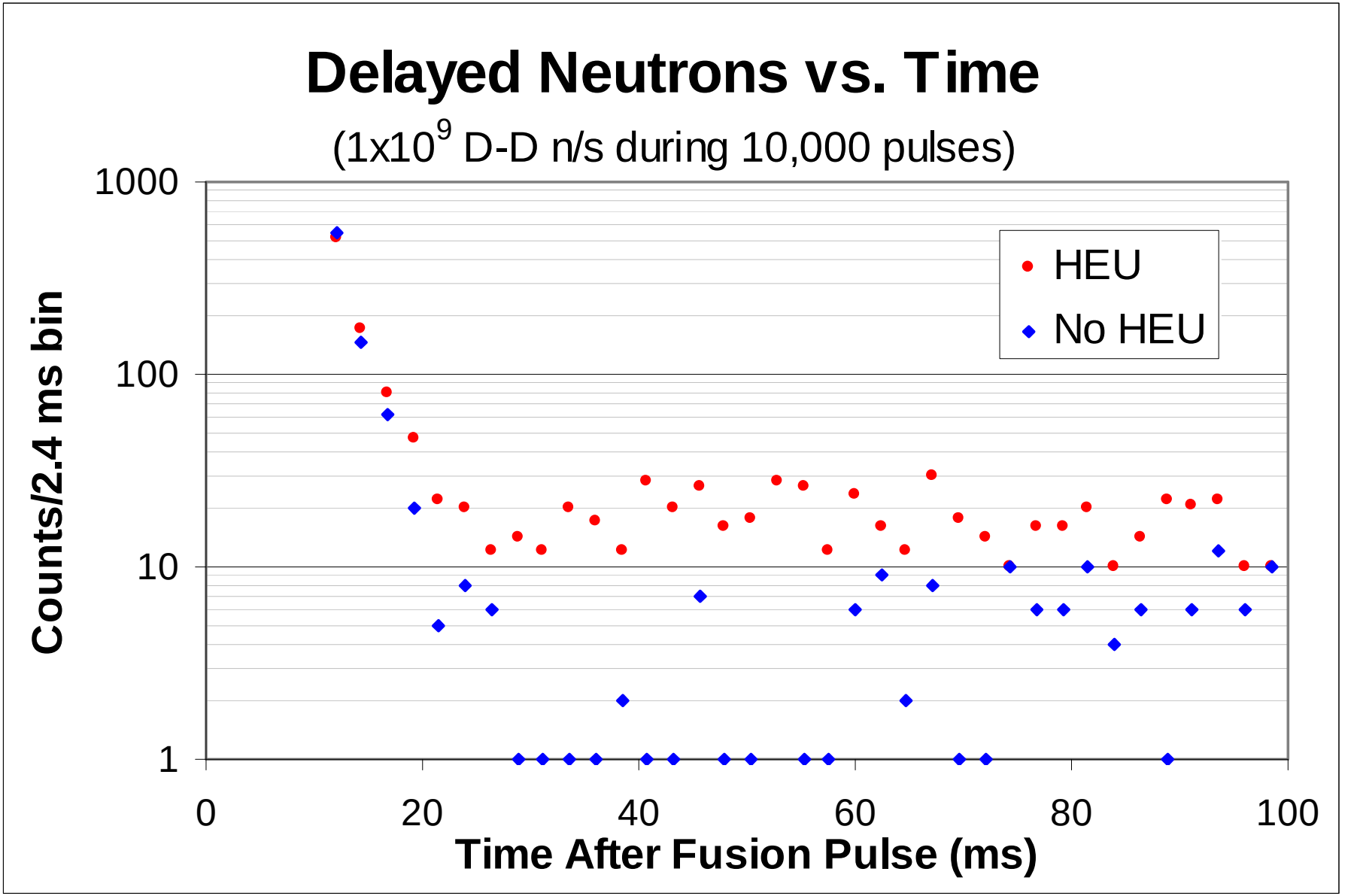


Preliminary HEU Data Yields Promising Results

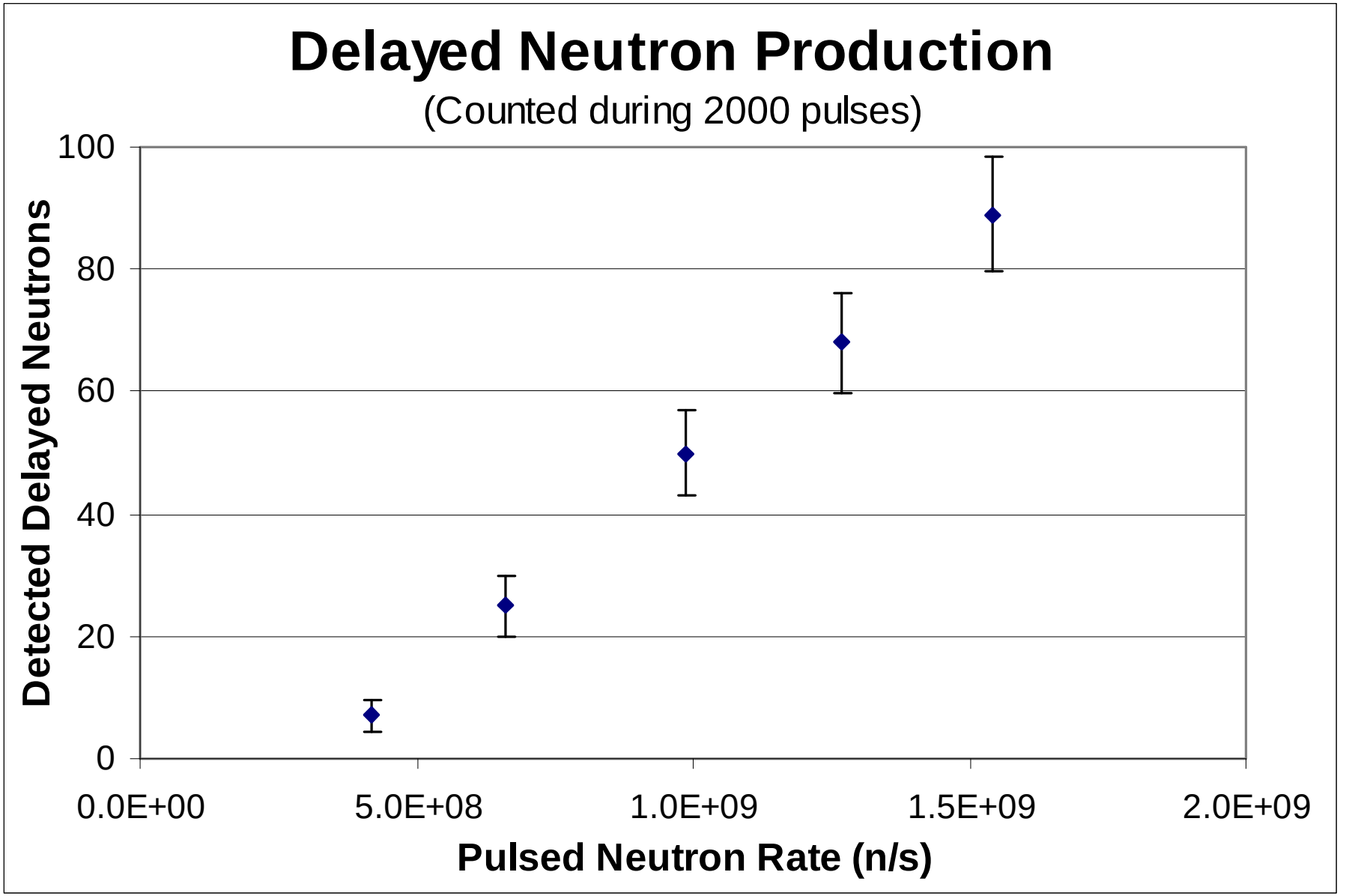


- Steady-state
  - 130 kV, 60 mA, 2.7 mtorr D_2
  - ~1.5×10^8 n/s

IEC Device has Generated Detectable Levels of Delayed Fission Neutrons



Delayed Neutron Production Scaled with Fusion Neutron Rate



Summary

- Pulsed IEC has been developed that is capable of operation at 115 kV, 6 A, 3 mTorr D_2
- Pulsed neutron rates of 4.7×10^9 n/s have been achieved during 110 μs pulses
- Detection circuitry has been tested, and has demonstrated steady-state and pulsed HEU detection capability
- Delayed neutron production has been shown to scale with fusion neutron rates

Questions?

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