Embedded Fusion & Isotope Production in the UW IEC Device

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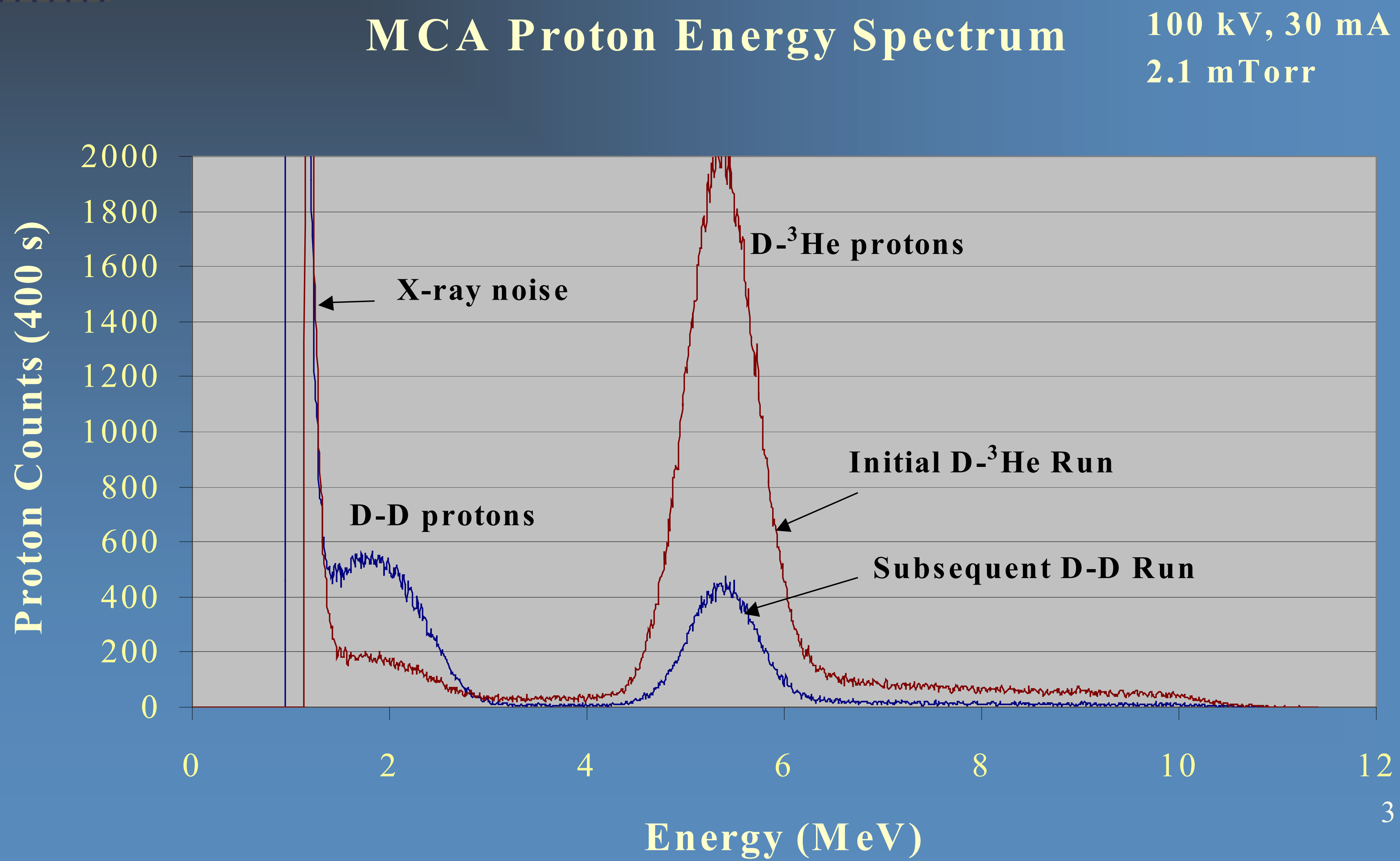
Outline

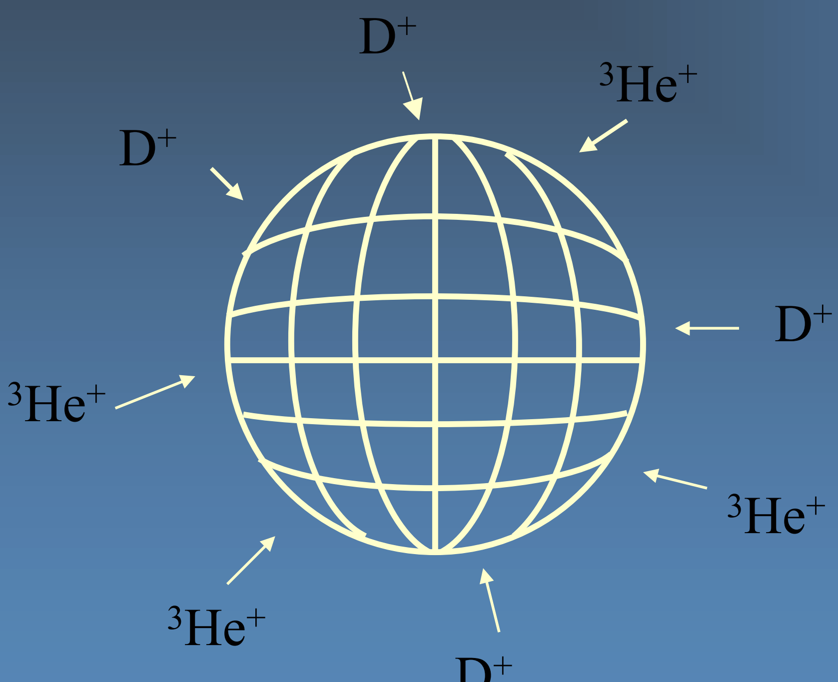
- Evidence of Embedding
- D^+ vs. $^3He^+$ Embedding
- Non-Transparent Cathode Experiments
- Isotope Production
- Summary

D-^{3}He Proton Peak Evident In D-D Runs Following D-^{3}He Runs

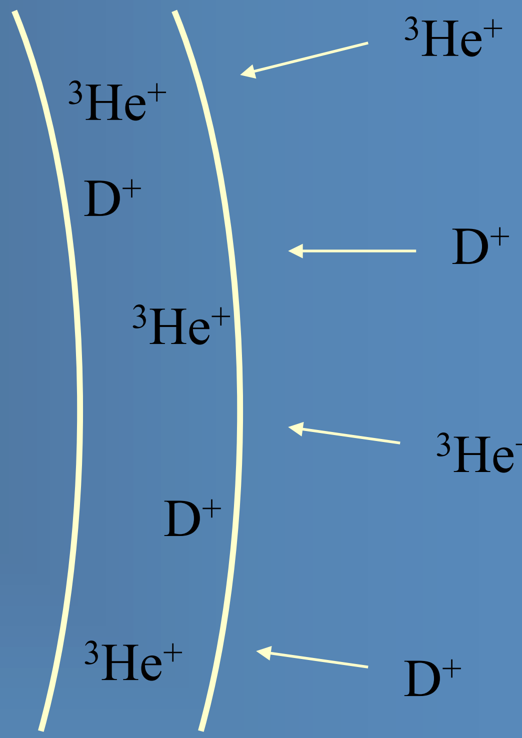


Embedded Regime

(100 keV $^{3}He^{+}$ ions penetrate 0.3 μm in tungsten)

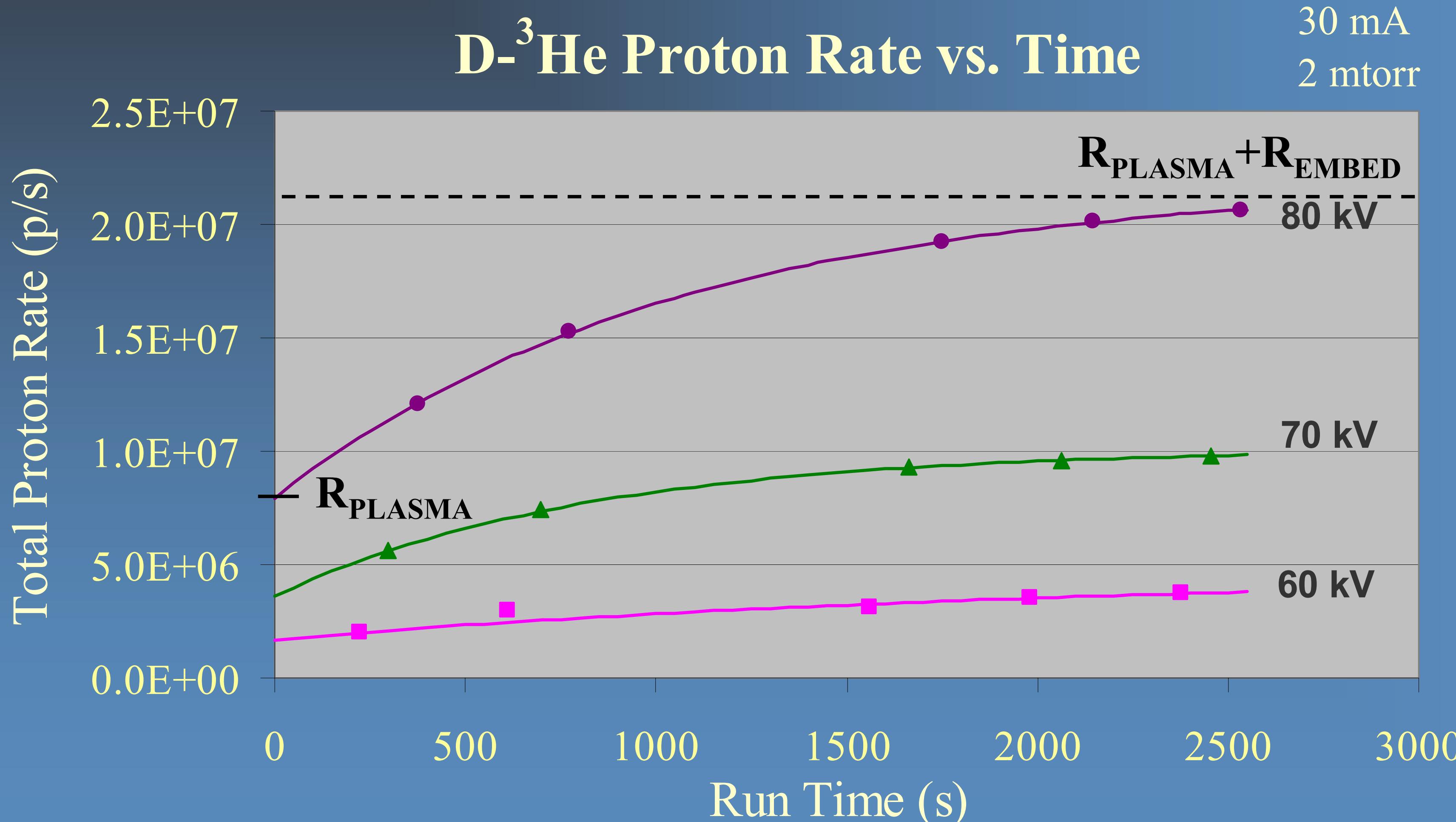


Cathode



Grid Wire

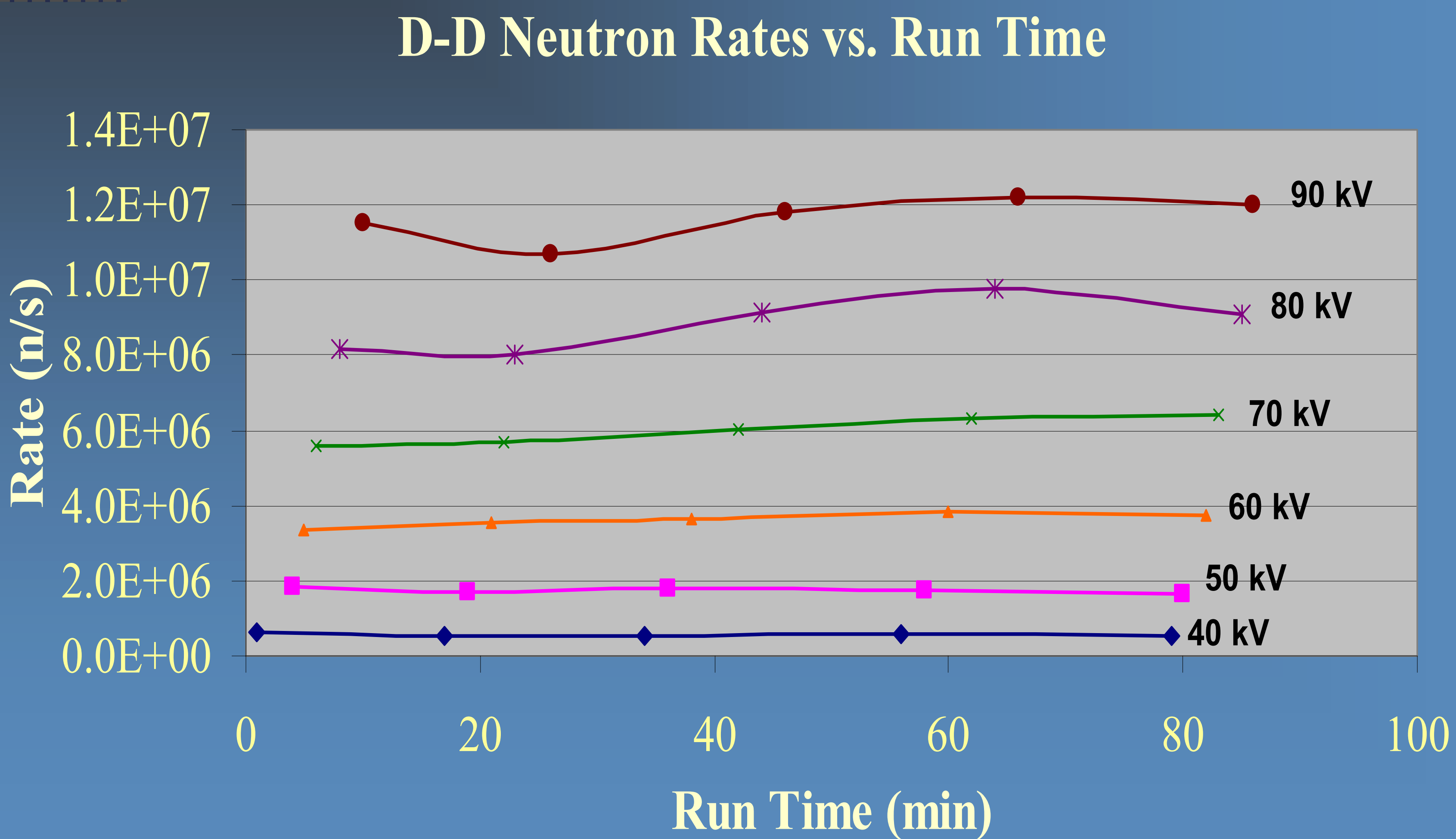
D-^{3}He Fusion Rates Increase With Run Time After Installing Virgin Grid



D-^{3}He Fusion Rates Appear To Saturate

- Exponential saturation equations were fit to the curves
- $R_{TOTAL}=R_{PLASMA}+R_{EMBED}(1-e^{-\lambda t})$
- For the three voltages, ~2/3 of the maximum rate was due to embedded reactions.

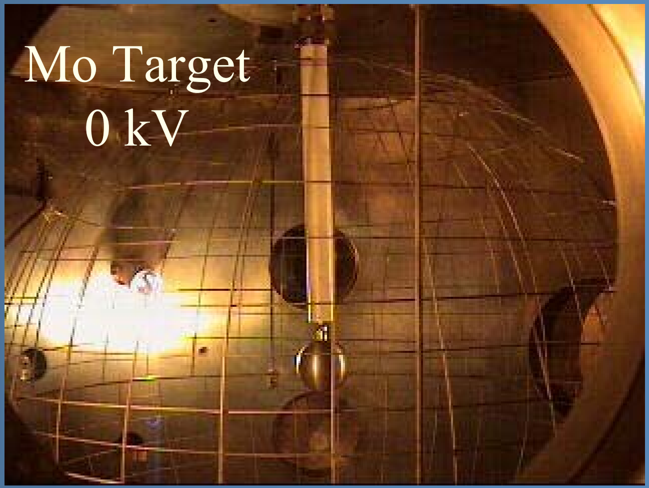
D-D Fusion Rates Are Generally Constant With Run Time



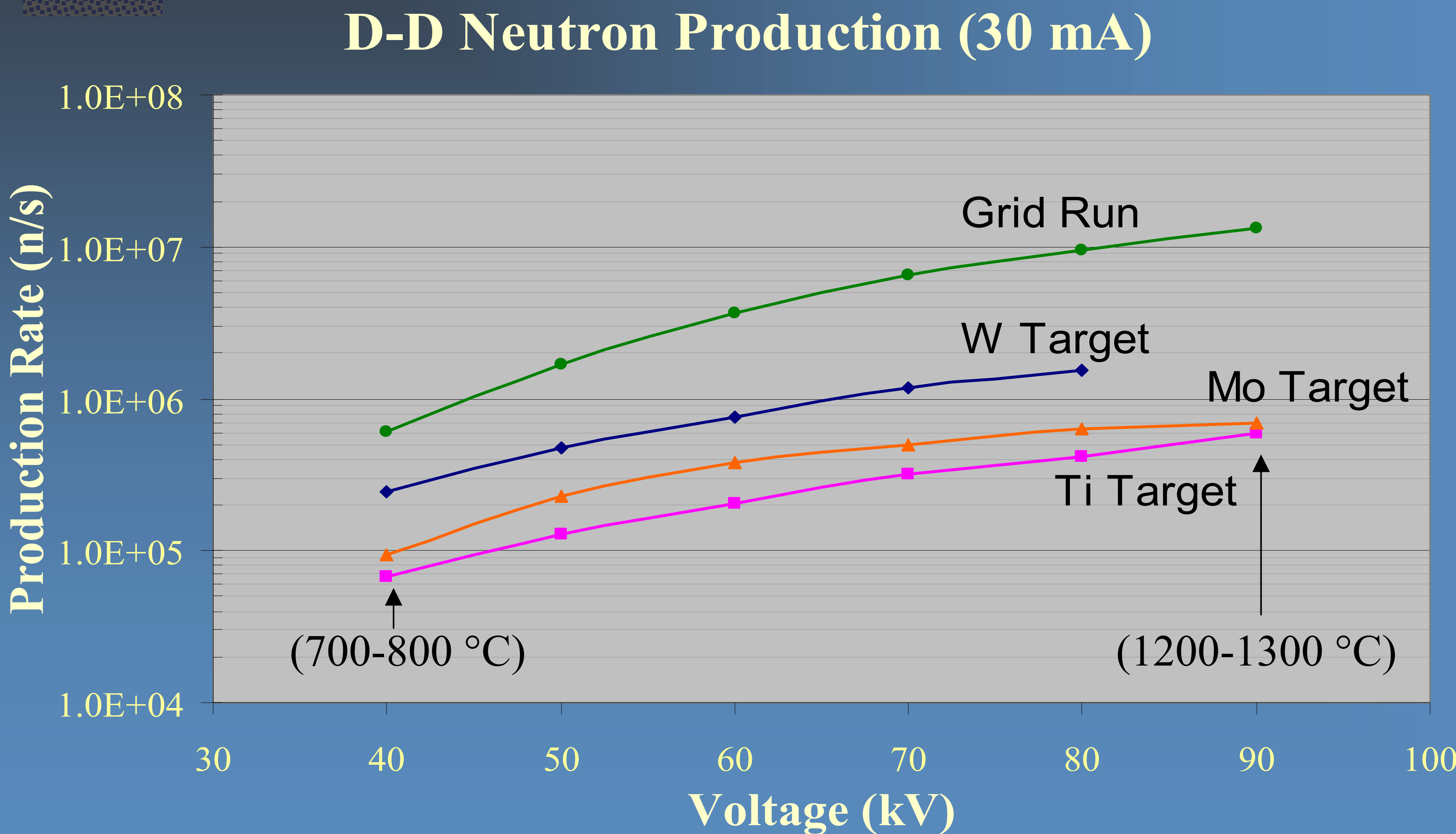
Non-Transparent Cathode Experiments

- A large fraction of D-^{3}He reactions occur at the cathode
- The 14.7 MeV proton flux is higher at that location
- A non-transparent cathode forces only embedded reactions to occur

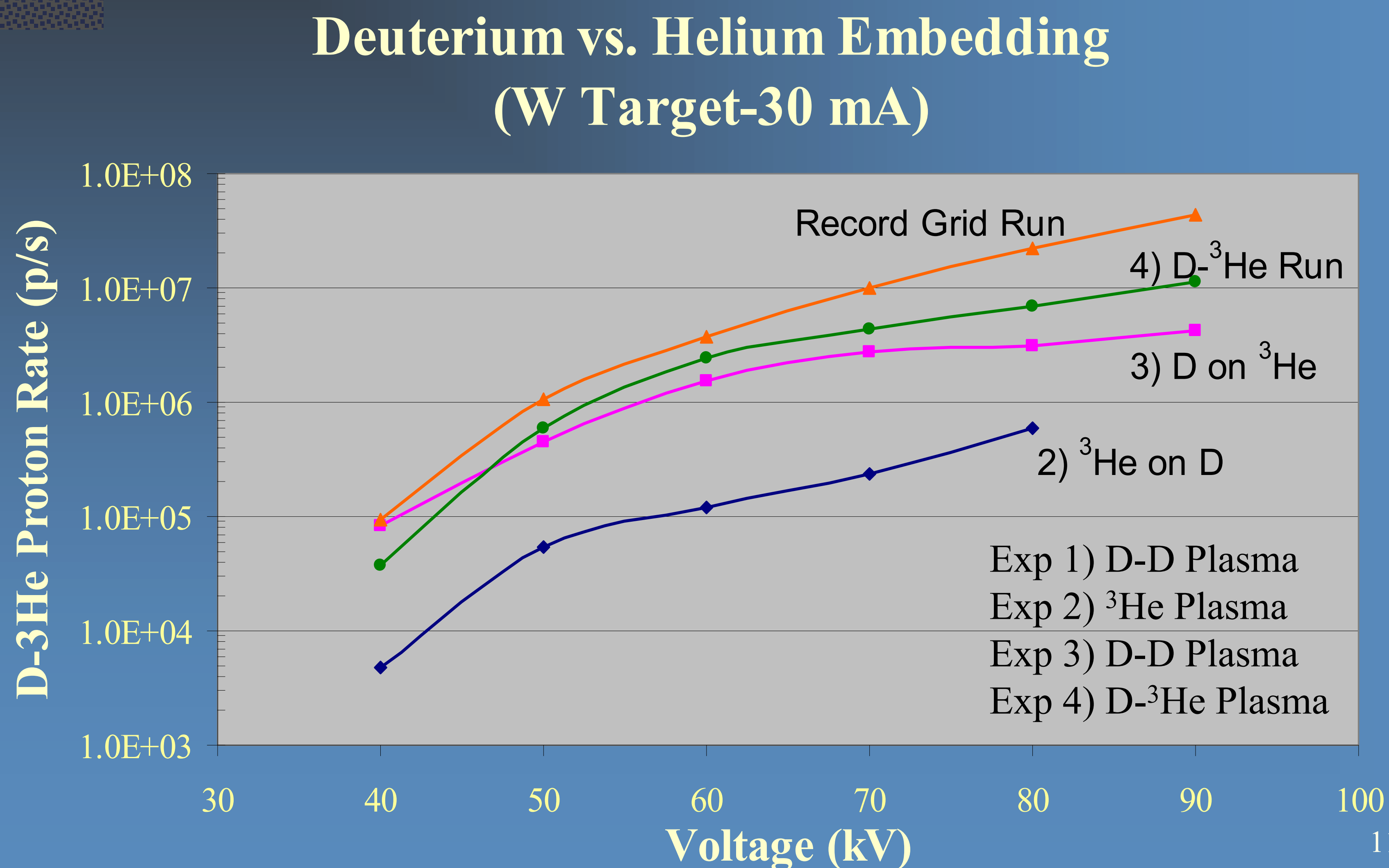
Tungsten, Titanium, & Molybdenum Targets Were Fabricated



D-D Neutron Rates With Targets Are Low Compared to Grid Runs



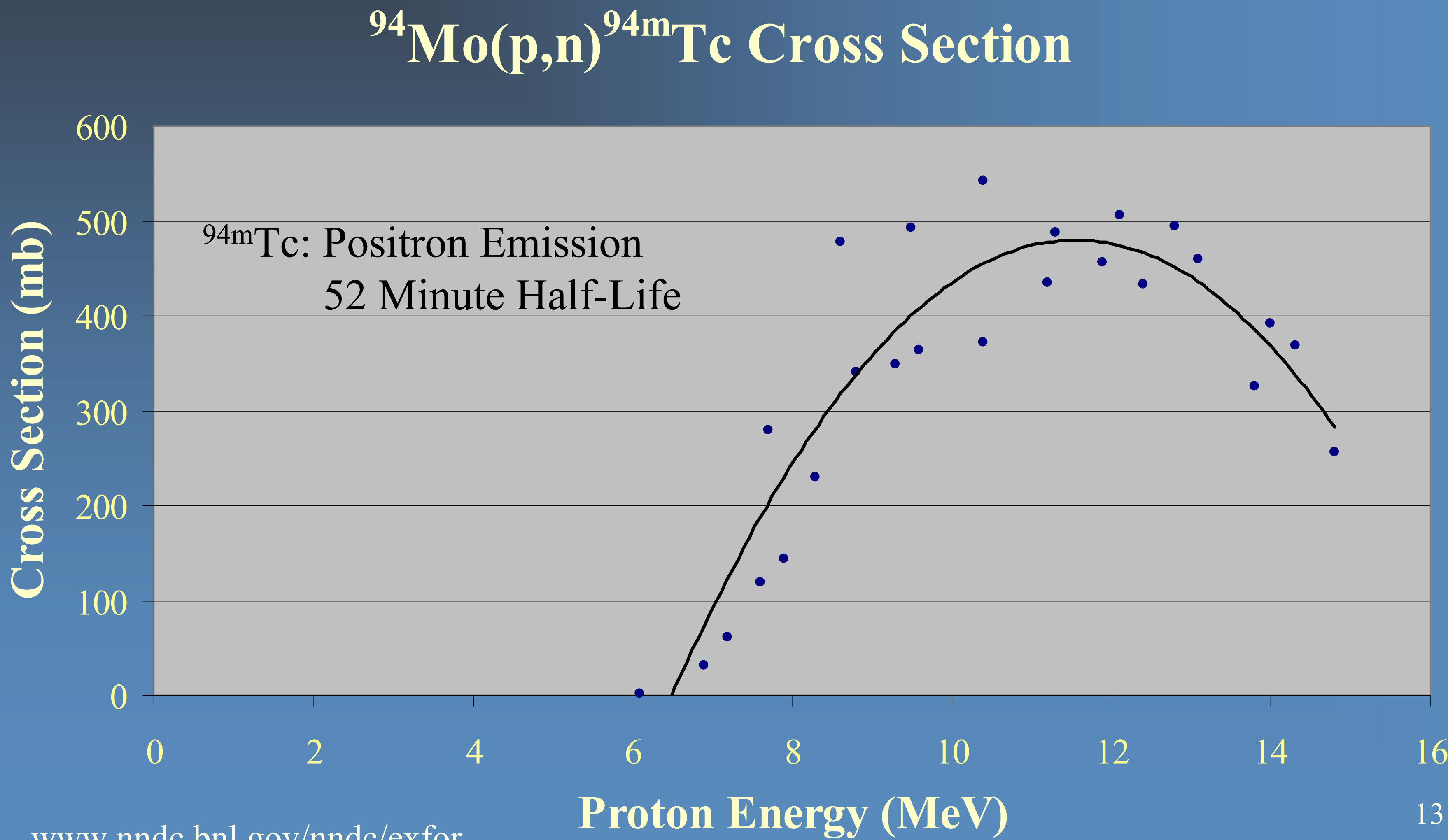
D-^{3}He Fusion Rates Depend on D^+ and $^3He^+$ Implantation



Isotope Production

- Can a solid cathode be used to produce isotopes?
- Reactions occur in the outer layer of the target, protons created isotropically
- Protons activate the target material below the surface
- Initial studies concentrated on $^{94}Mo(p,n)^{94m}Tc$ reaction

^{94}Mo Has A Significant Cross-Section For 14.7 MeV Protons



www.nndc.bnl.gov/nndc/exfor

Molybdenum Irradiation Experiment

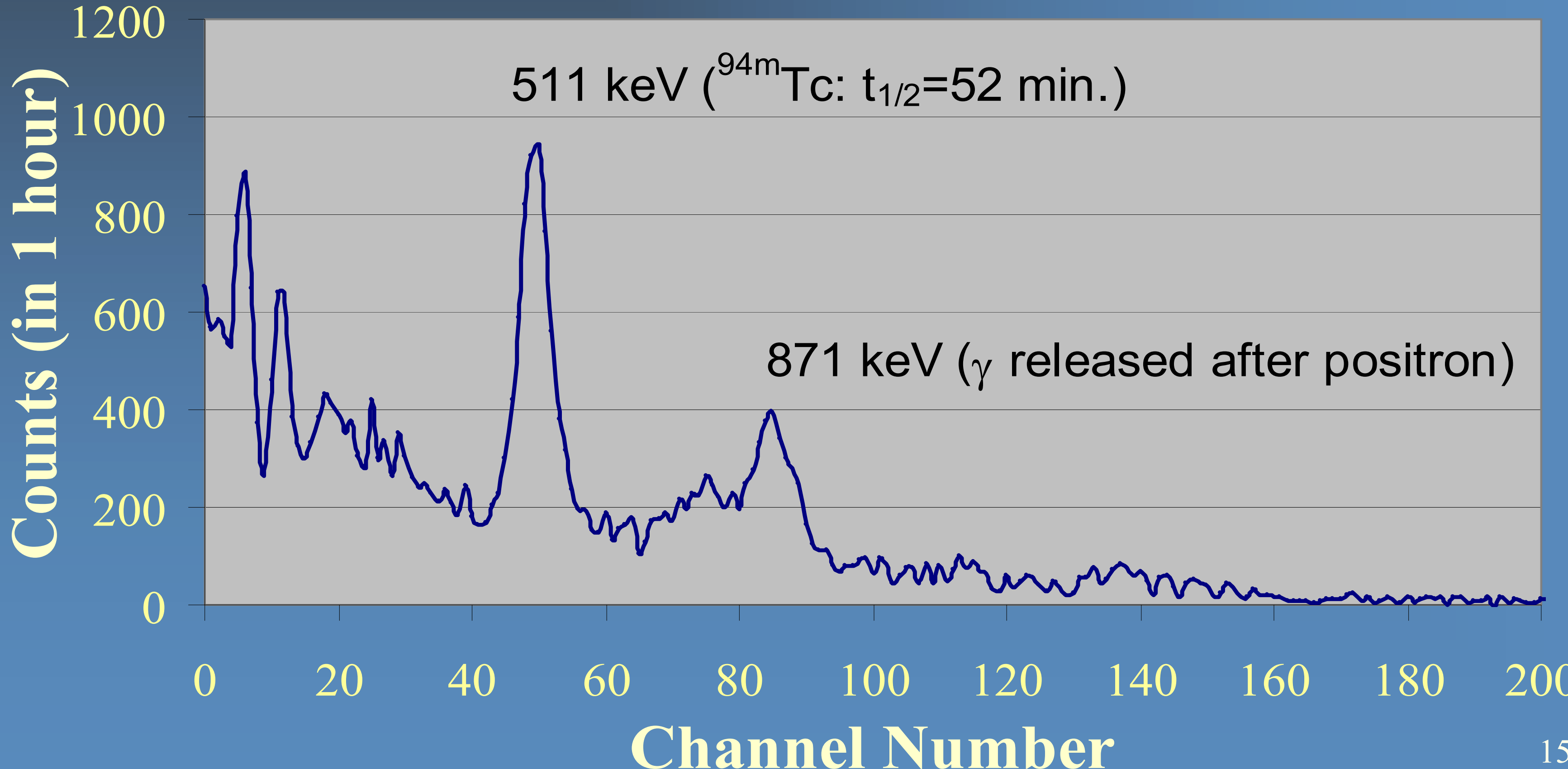
- Both deuterium and helium-3 were run in the chamber
- Voltage was increased from 40 to 110 kV, keeping current constant at 30 mA
- Voltage was held at 110 kV for 15 minutes
- On average, about 5×10^6 p/s were created at the cathode surface for 20 minutes
- Then, chamber was vented, target was removed and counted (NaI detector)

About 1 nCi of ^{94m}Tc Was Created

Run 684
9-16-02

Moly Target Activation Spectrum (Background Subtracted)

40 min
after run



Summary

- Retention of $^{3}He^{+}$ seems to be higher than D^{+} in W, Ti, Mo
- Metals with low hydrogen diffusivities seem to hold more implanted ions (W>Mo>Ti)
- Embedded reactions can be used to produce isotopes in an IEC beam-target setup