^{13}N Production Via D-^{3}He Fusion using a Water-Cooled IEC Cathode

Ben Cipiti

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THE UNIVERSITY of WISCONSIN MADISON

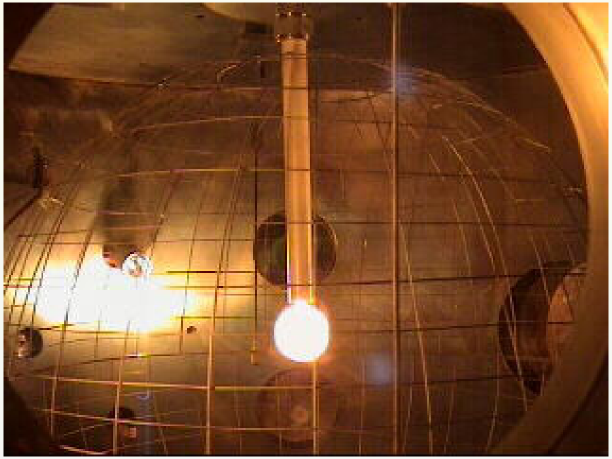
Overview

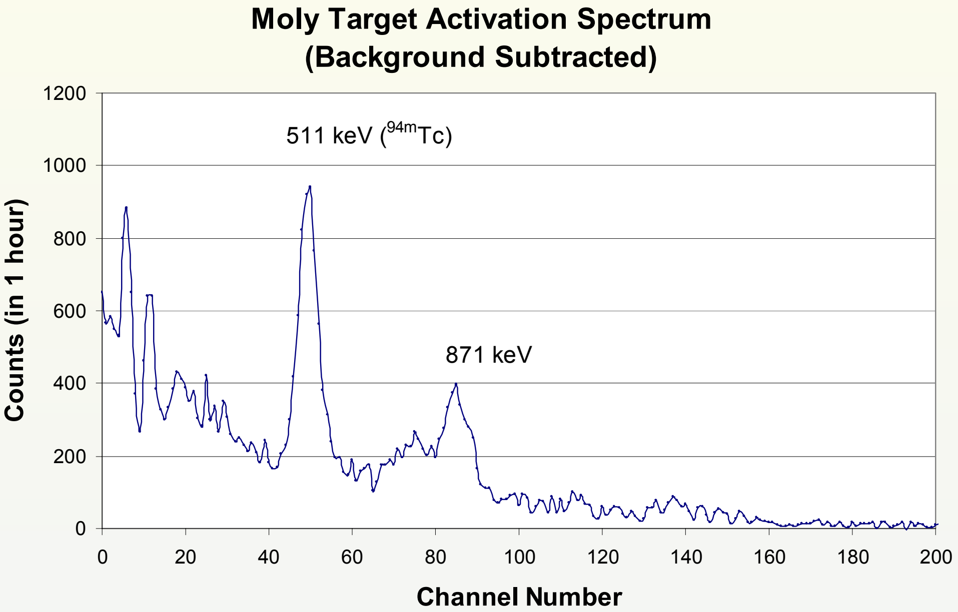
- Experimental Objective

  To use beam-target D-^{3}He reactions in the IEC device to produce medical isotopes

- Outline
  - Previous Work (^{94m}Tc Production)
  - Isotope Production System Goals
  - Water Target Experimental Setup
  - Production Yield
  - Discussion
  - Future Work

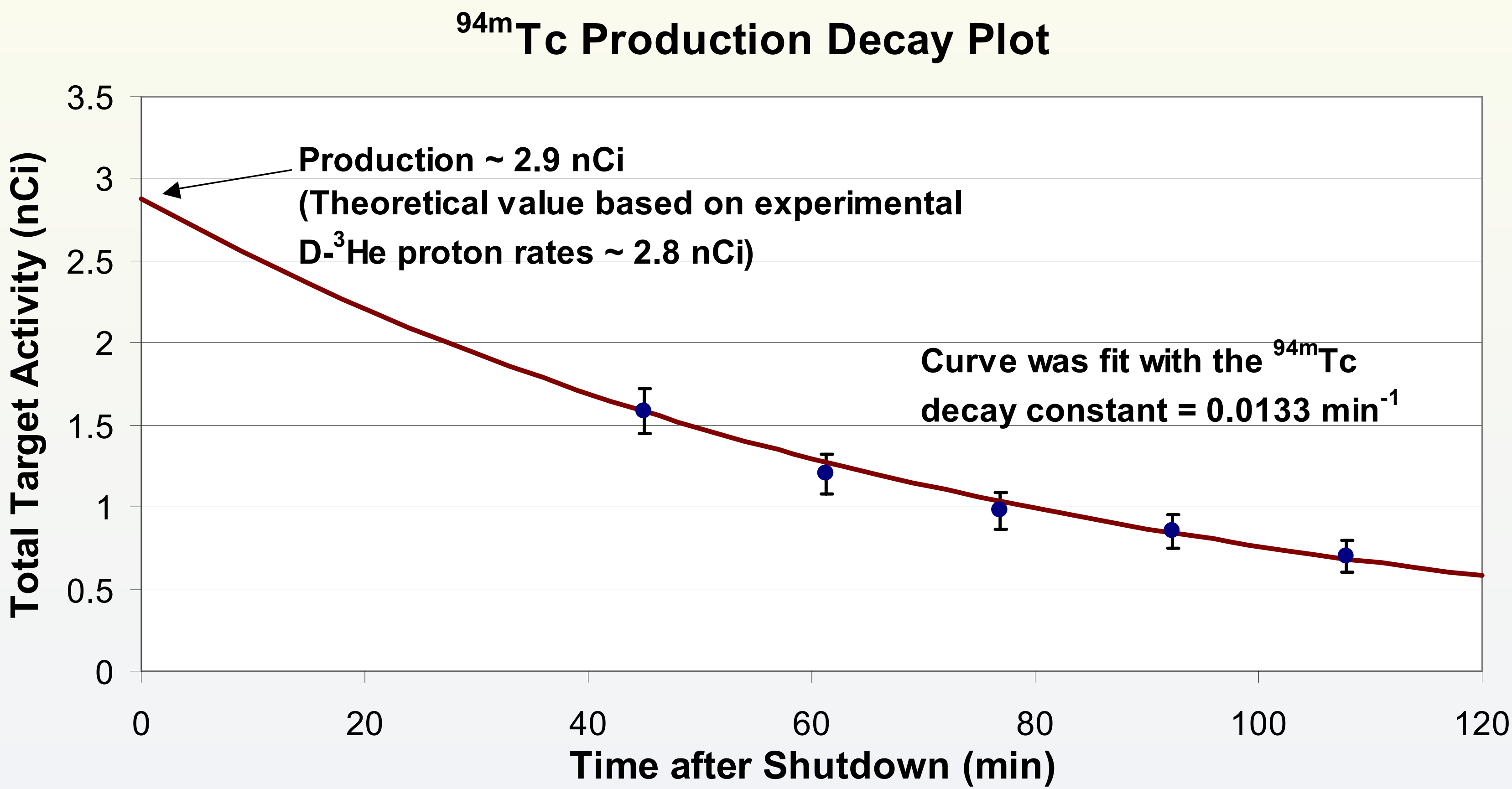
Molybdenum Target Produced 1 nCi ^{94m}Tc (as Reported US-Japan 5)





- Embedded D-^{3}He reactions at the cathode surface
- 14.7 MeV protons traveled into the molybdenum target
- ^{94m}Tc produced from a (p,n) reaction on ^{94}Mo

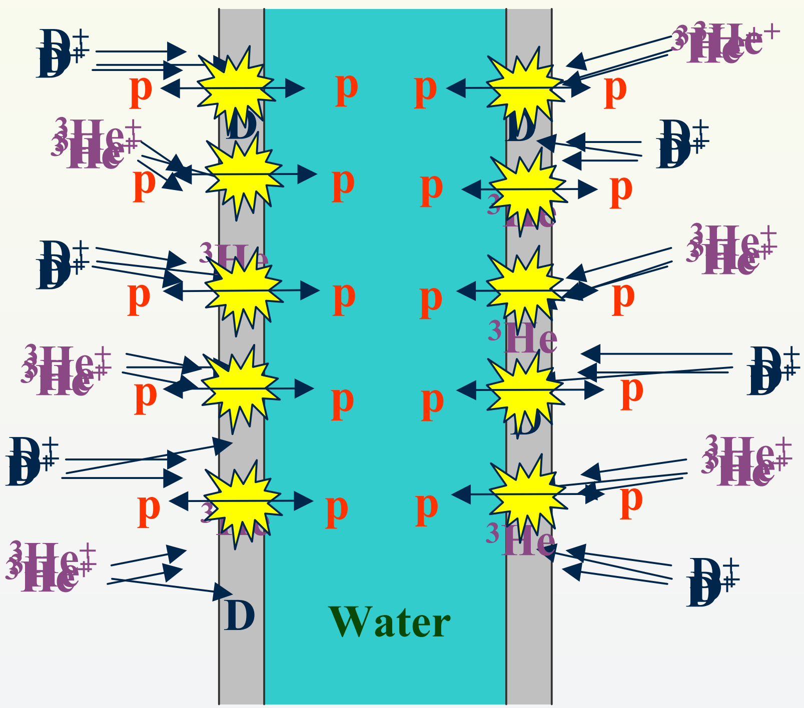
Follow-up Runs Produced 2.8 nCi & Verified the 52-minute Half Life



Isotope Production System Goals

- Target must be robust to handle many runs
- The activated isotope should be able to be removed from the device quickly
- Target must withstand the high power input
- Rates must be maximized

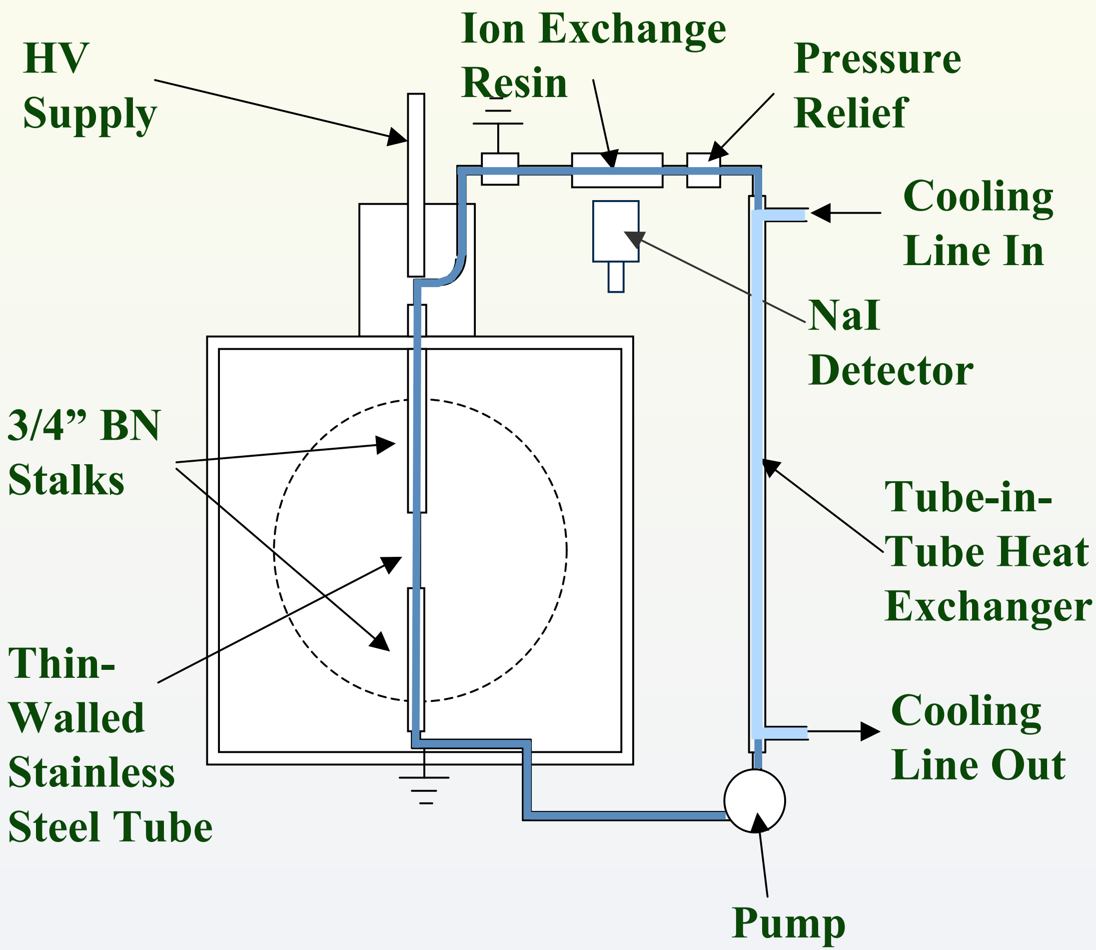
Embedded Fusion Can Be Used To Produce ^{13}N From A Water Target



Thin-Walled Stainless Steel Tube

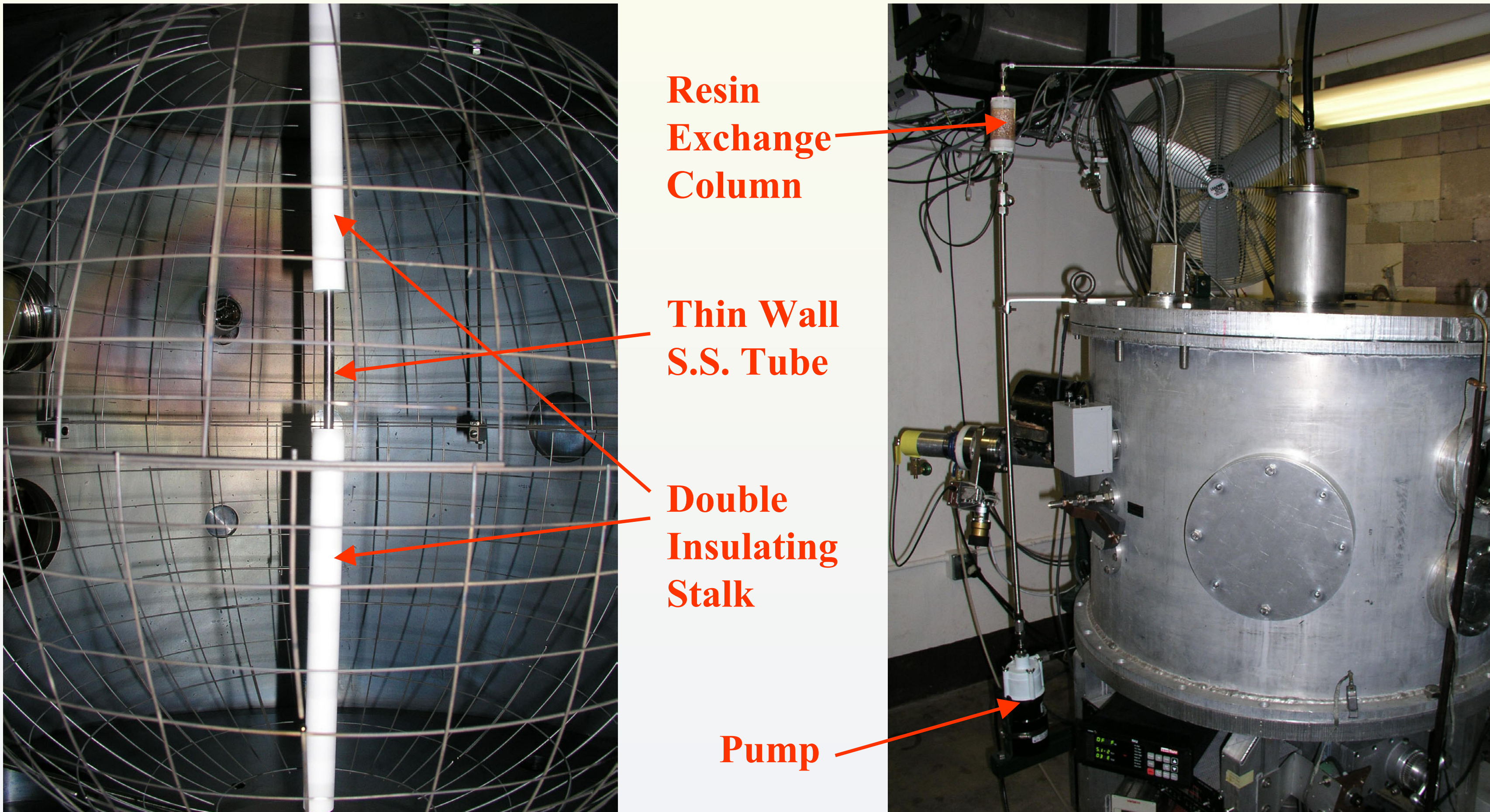
- Replace the cathode with a thin-walled stainless steel tube
- Embedded fusion occurs in the tube wall
- Half of the 14.7 MeV protons travel into the water: $^{16}O(p,\alpha)^{13}N$

Water Target Setup

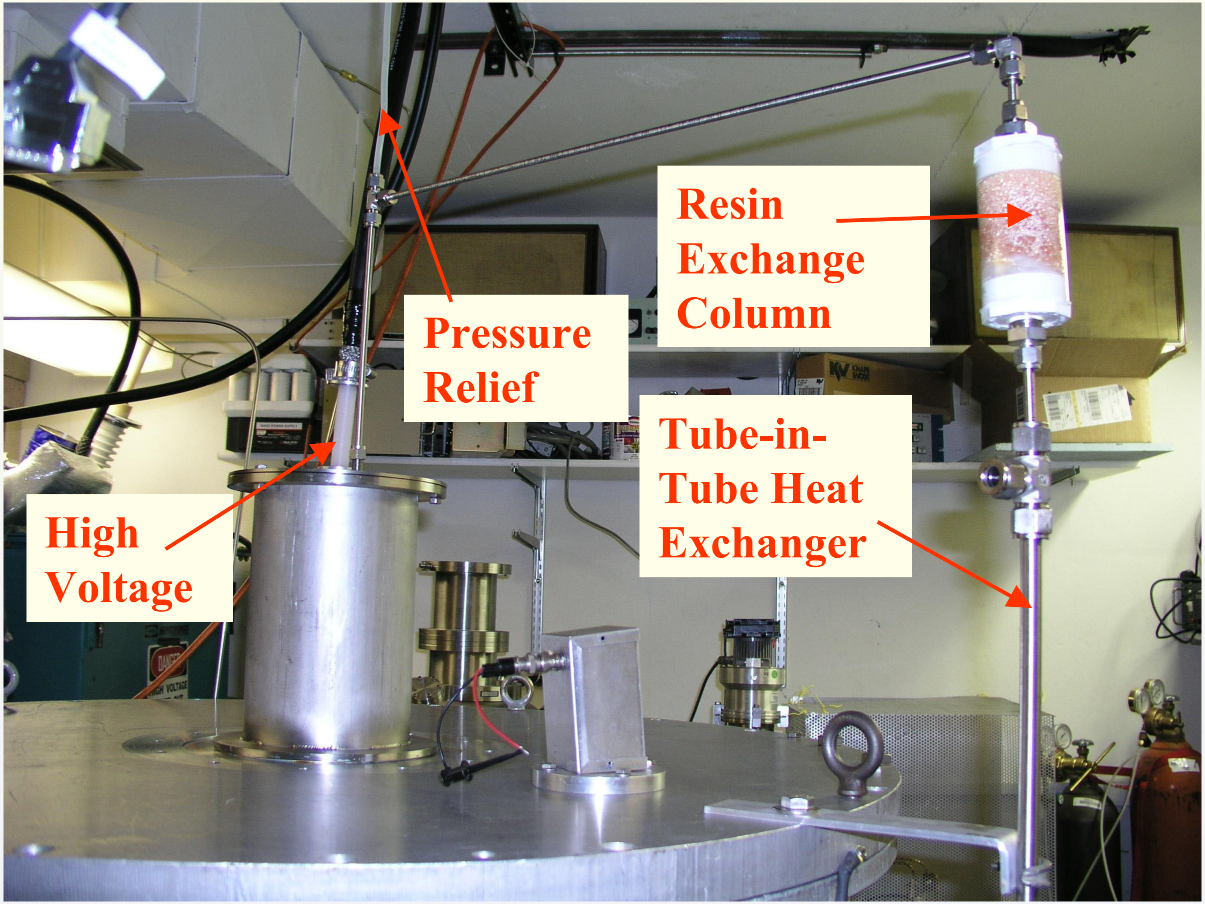


- Water target must be cooled
- Water serves as both the cooling system and the material to be activated
- Primary water loop must be kept pure and ion free
- Ion exchange resin removes the ^{13}N ions

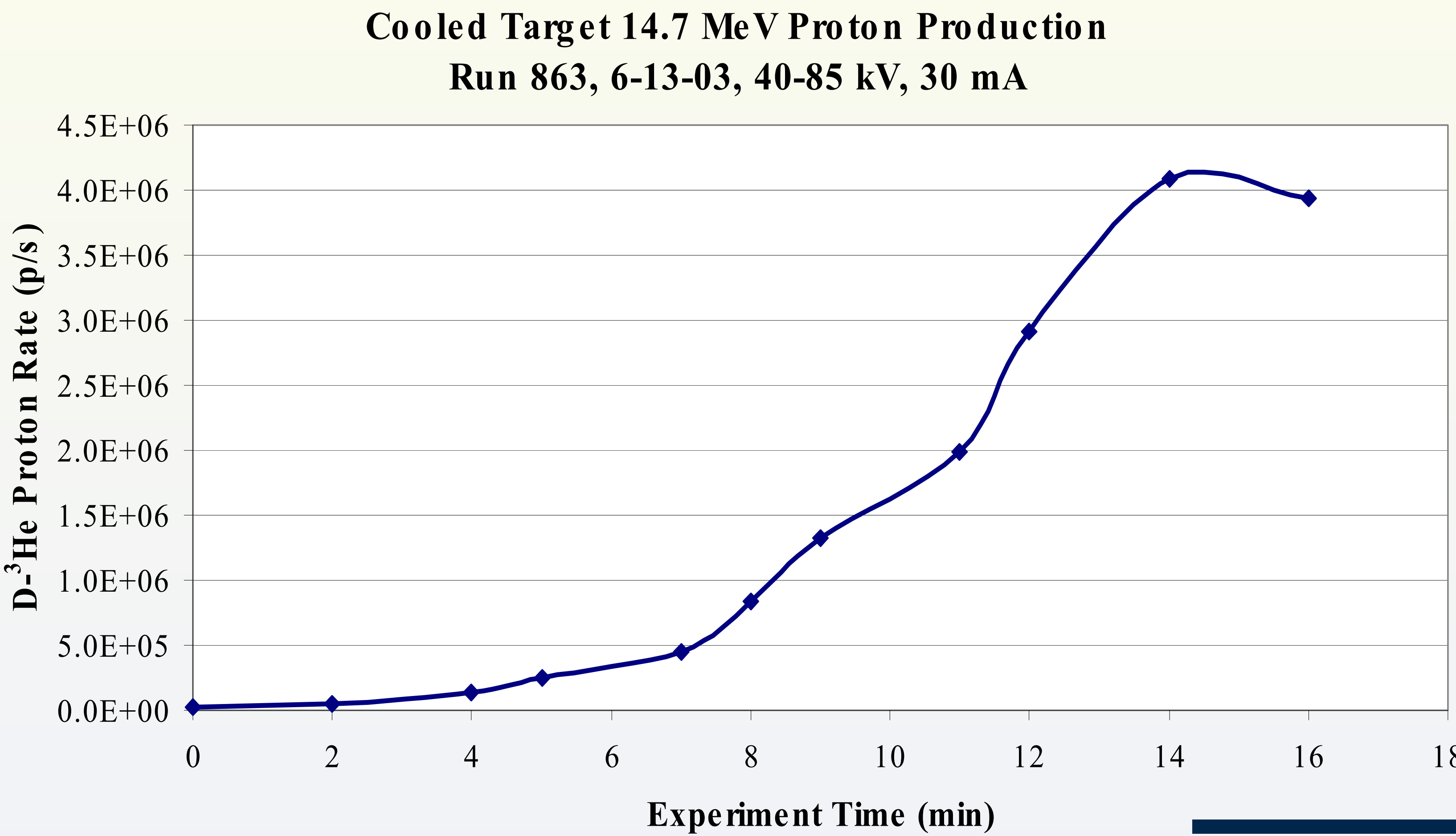
Water Target System



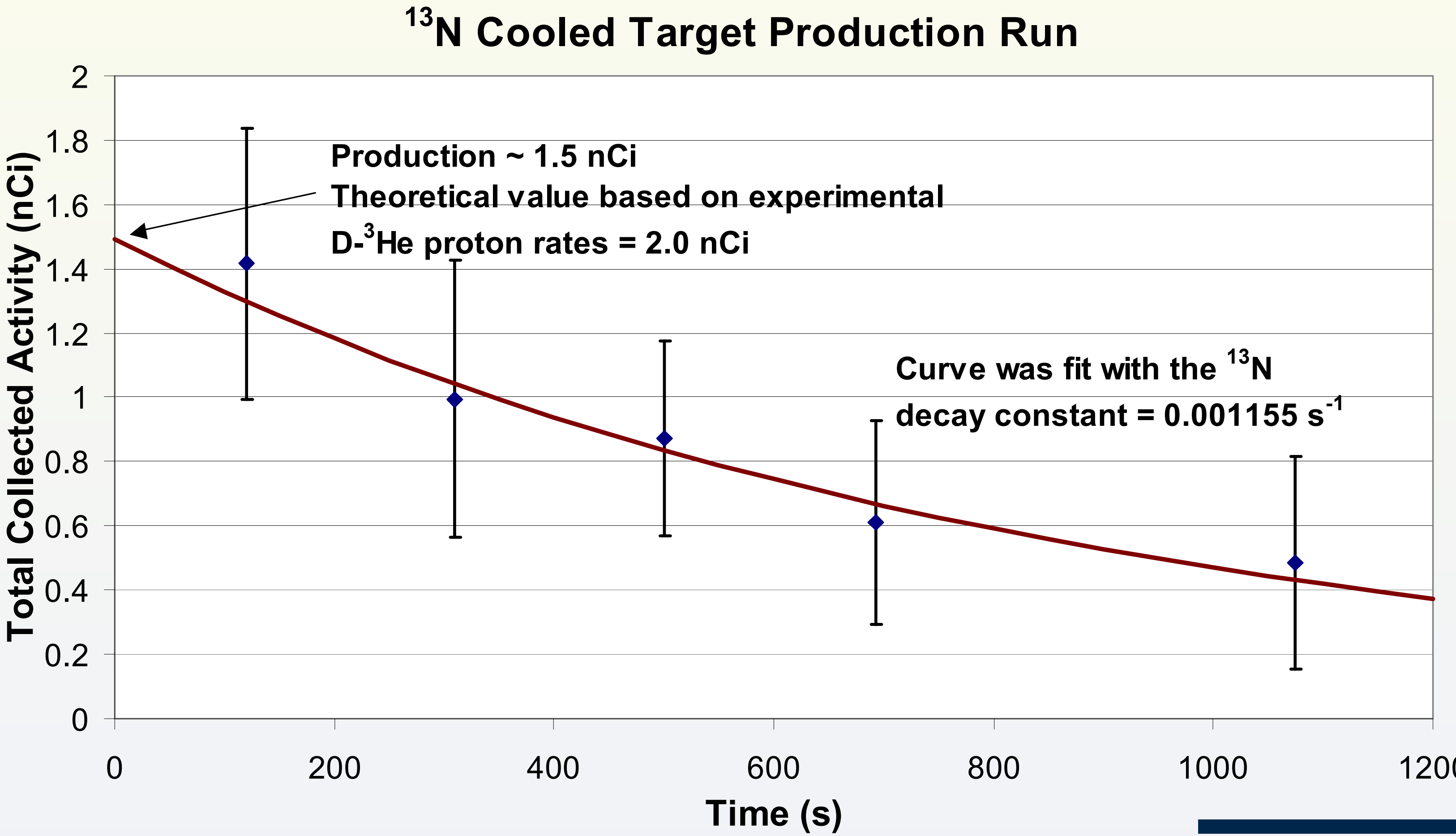
Water Processing System



Current Configuration Achieved $4x10^6$ p/s 85 kV, 30 mA



Cooled Target Run Produced 1.5 nCi ^{13}N at End of Bombardment



Methods to Increase the ^{13}N Yield

- Increase the run voltage
  - *At 150 kV, the proton fluence should be a factor of 15 greater than rates at 85 kV*
- Increase the current
  - *Current is directly proportional to yield*
- Increase the run time
  - *Up to 2-3 half-lives*
- Increase the embedded number density
  - *Change tube material*

Conclusion and Future Work

- Running the cooled water target at 85 kV for a short time produced 1.5 nCi ^{13}N
- The cooled target setup satisfies the initial goals for a production system
- The next step is to improve the design for higher, sustained voltages
- In the future continuous counting of the rates during a run will be implemented