

Alternatives for ^3He

1st *Workshop on Isotope Federal Supply and Demand*

Hosted by the
Department of Energy Isotope Program (DOEIP)
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Doubletree Hotel, Bethesda, MD
Ballroom B & C

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Department of Homeland Security/Domestic Nuclear Detection Office (DHS/DNDO)
Product Acquisition and Deployment Directorate (PADD)



Neutron Detection is Crucial

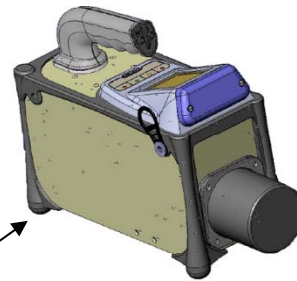
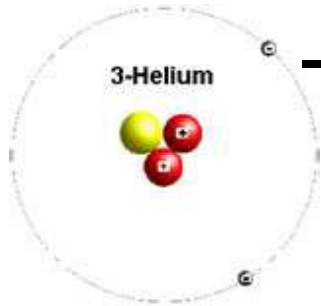
- ^3He shortage jeopardized neutron detection in many applications critical to national security
 - Example: Scanning commerce entering for fissile material (e.g., HEU and Pu) and unlicensed (e.g., ^{252}Cf) neutron emitters
- Mission too critical to be interrupted so many USG agencies took the mission on immediately: DOE, DOD, NIST, and DHS
 - Currently about 40 projects funded across USG to investigate alternative technologies



Radiation Detection Devices

Supply (A)

Demand (B)



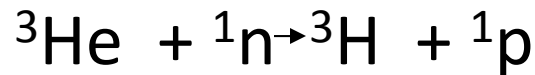
Neutron Detection is a Critical Component in many systems

Neutron Capture Reactions

Neutron Detection can be achieved with several materials

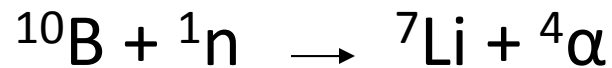
Q-Value

${}^3\text{He} (n,p):$



0.764 MeV

${}^{10}\text{B}(n,\alpha):$

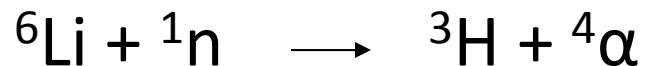


2.792 MeV



2.310 MeV

${}^6\text{Li}(n,\alpha):$



4.780 MeV



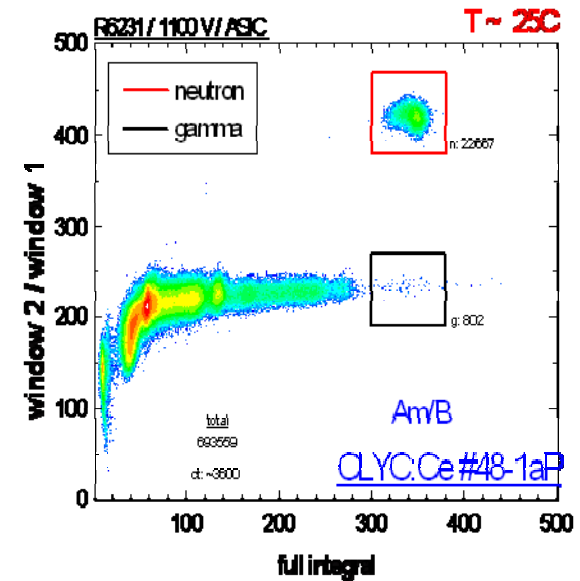
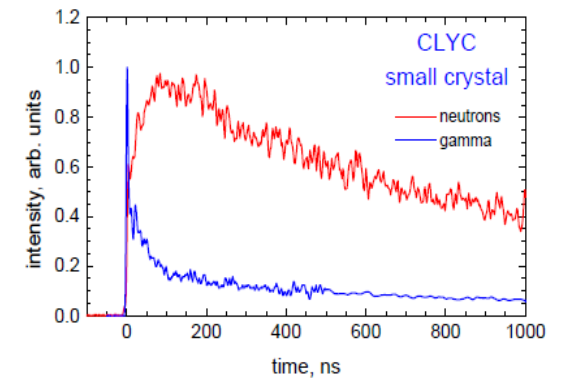
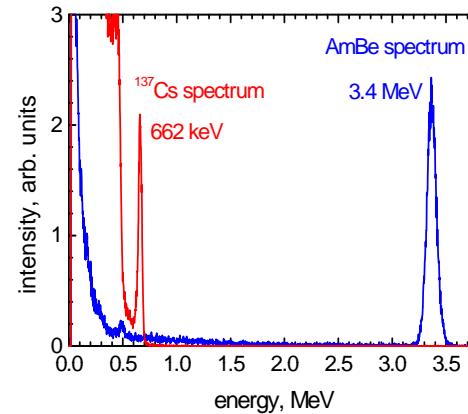
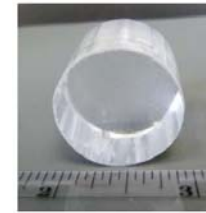
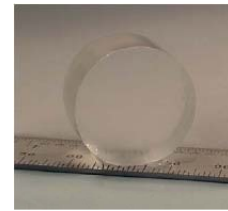
NDRP Completion

- Two years ago there were no alternative technology options. DNDO worked to find a replacement technology along with other ^3He IPT members
- The DNDO Neutron Detector Replacement Program (NDRP) and Radiation Portal Monitor Program (RPMP) produced four portal monitor alternative technologies that met RPM8 technical specifications. Test campaigns concluded in Aug 2011
 - Boron-10 lined tubes (2 systems)
 - $^6\text{LiF:ZnS(Ag)}$ with wave length shifting fibers (1)
 - BF_3 based detectors (1 systems)
- DNDO's initial efforts designed to encouraged commercial sector to develop portal monitor alternative technologies
- For FY12 DNDO working on alternative technologies for backpacks, handhelds, and vehicle mounted mobile systems
 - Several of the alternative technologies found for RPMs will be applicable to other systems
 - Test campaign scheduled for March – May 2012 at NNSS



CLYC

- Capable of detecting gammas and neutrons
 - pulse shape
 - pulse height discrimination
 - High gamma/neutron discrimination
- 1 cm 95% enriched ${}^6\text{Li}$ provides $\sim 80\%$ efficiency
- High energy resolution for gammas
 - High proportionality
- Easy growth:
 - Cubic crystal structure
 - Melting point of 640 C
 - allows for vertical Bridgeman growth



^3He Alternative Isotopes

- ^{10}B : appears commercial sector can supply a sufficient quantity of this isotope
 - Estimate of need is: ~20 kg/year
- ^6Li : DOE is main supplier of isotope
 - March 2010 agreement signed to reserve 8,000 kg by NNSA (assumed ~40 year supply)
 - About 1.2 kg/portal, 0.8 kg/backpack, 2.5 gm/CLYC crystal 1" OD x 1" long
 - Estimate of need is: ~200 kg/year
- Chlorine – 35 (^{35}Cl) – quantities needed for a promising n-gamma reaction technology under investigation



Summary

- Several alternative technologies have been found to replace ^3He based neutron detection in RPMs
 - Some characteristics are superior to He3 based detectors
 - Other detector systems (backpacks, handhelds, and vehicle mobile systems) are under investigation in FY12
- ^3He IPT requested NNSA to reserve 8,000 kg of ^6Li in March 2010 to avoid having a shortage event
- DHS estimates a need for about:
 - 200 kg/yr for ^6Li
 - 20 kg/yr for ^{10}B
 - TBD/yr for ^{35}Cl



^3He Alternative Technology

Questions

