



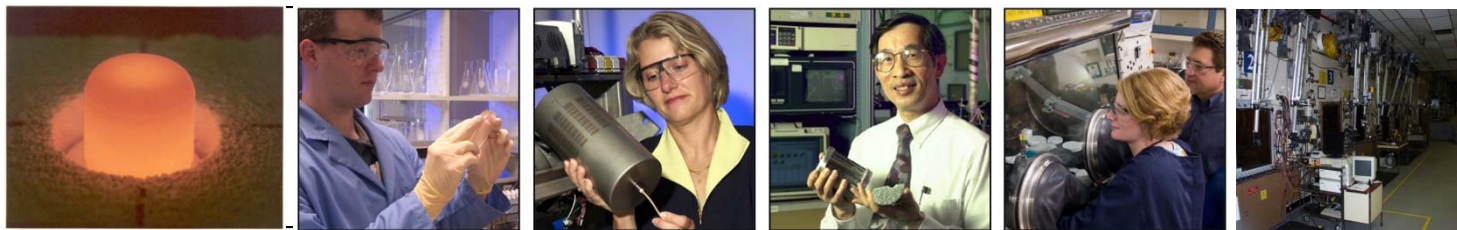
Savannah River National Laboratory[™]
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SRNL-STI-2016-00604

(U) SRTE Science Experiment Support at TJNAF

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Tritium Focus Group (LANL)
Nov 3-5, 2015



Savannah River Tritium Enterprise – Thomas Jefferson National Accelerator Facility

SRTE - TJNAF

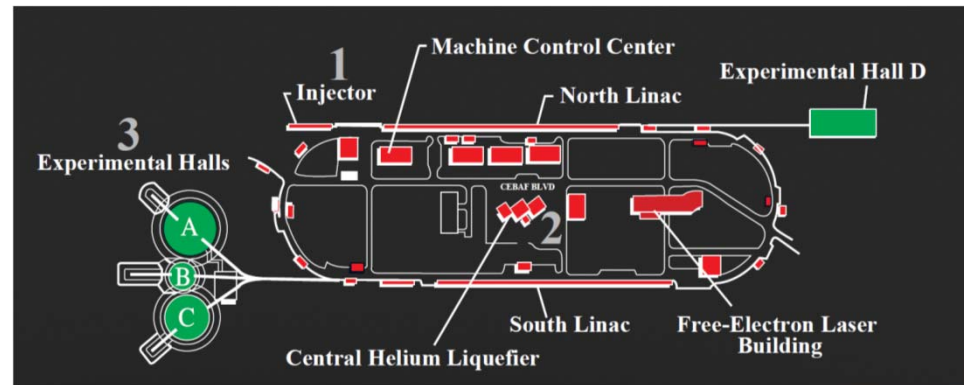
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SRTE

- SRNL and Tritium Programs Partnership
Nuclear Weapon Gas Boosting Systems
R&D – Production - Tritium Supply

TJNAF (also called Jefferson Lab or JLab)

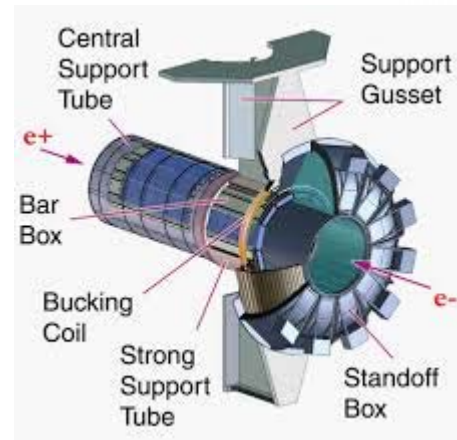
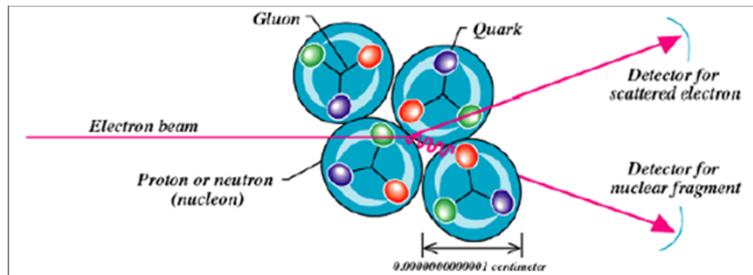
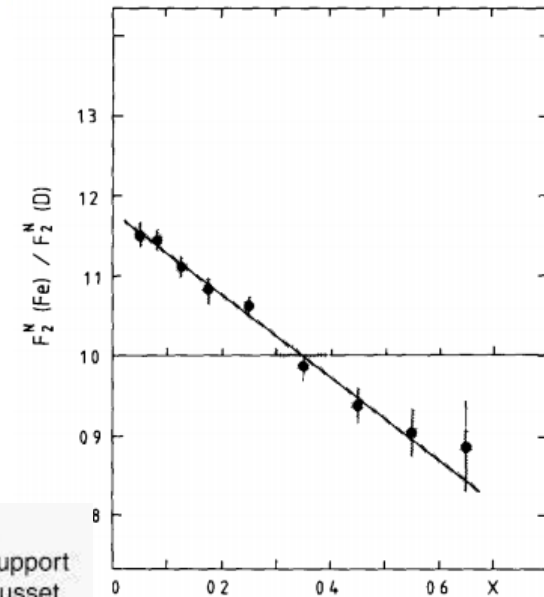
- DOE Office of Science – Fundamental Physics Experiments
Continuous Electron Beam Accelerator
6 GeV (12 GeV upgrade) - User Community - 4 Halls



JLab Experiment

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- JLab Experiment:
Deep Inelastic Scattering – protium, deuterium, tritium, helium-3
- ratio of neutron to proton inelastic structure functions
 - ratio of down to up quark distributions
 - medium and large Bjorken x
 - contribution to the EMC effect



Purpose: high energy hadron collider and neutrino oscillation data interpretation

Basic Experiment Layout

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Five Target Cells Total:

- dummy
- protium, deuterium, tritium
- helium-3

Stacked Under Cryo System

Cells: Aluminum 7075-T651

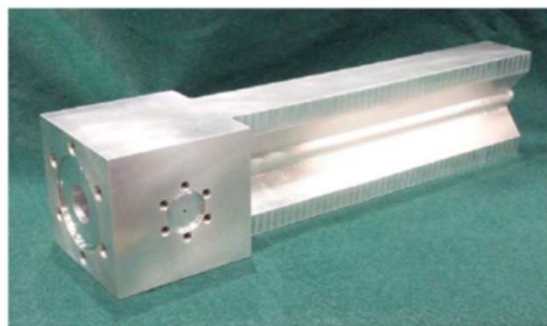
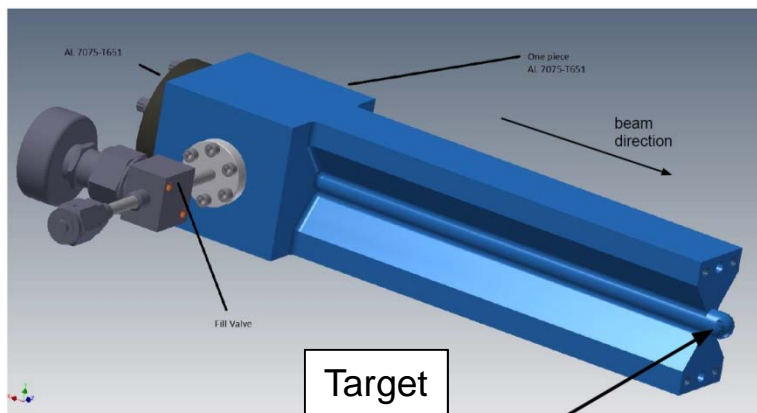
Machined from Casting

Cu Conflat

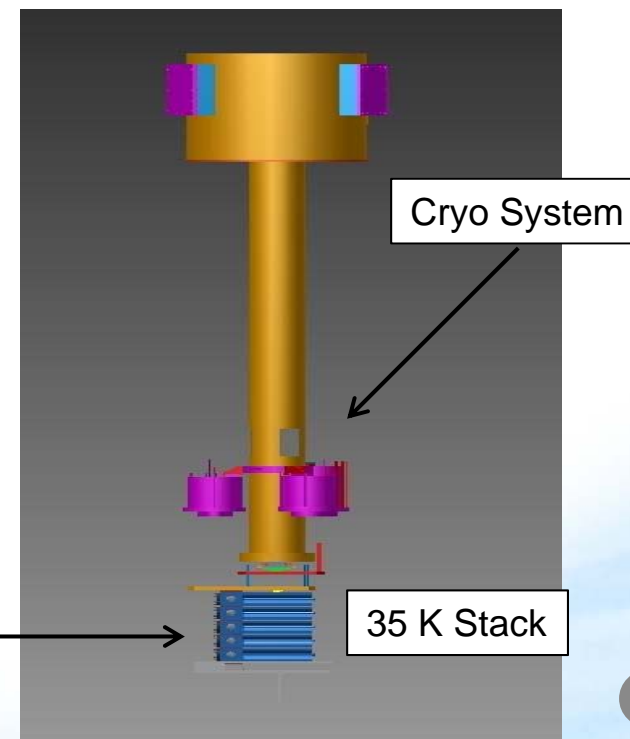
Swagelok valve

Entrance Window 0.01" thin

Exit ~0.016" (curve), 0.011" (tip)



electron beam



Experiment/Target Operation

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Key Parameters:

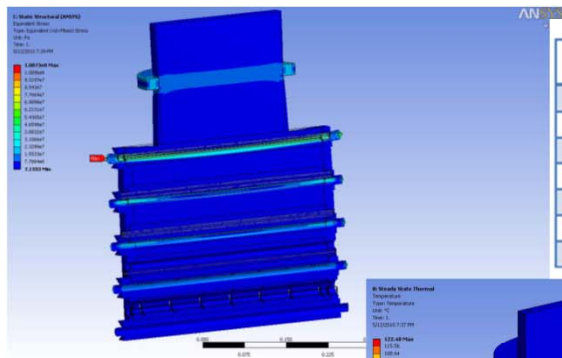
- 15 microA electron beam
- 42 days
- 200 psia (tritium)
- ~1099 Ci
- 99.5%+ purity
- 35 K pre-beam

burst test – 3000 psi

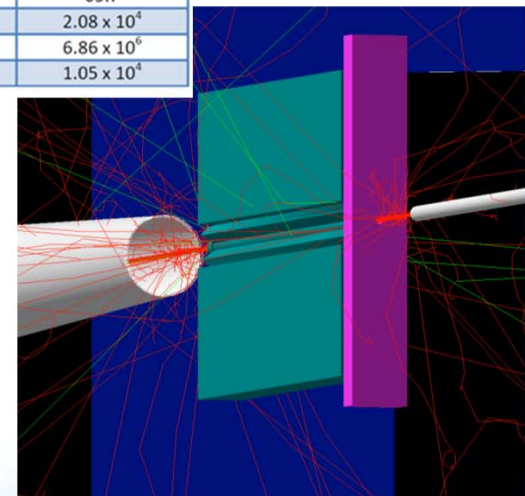
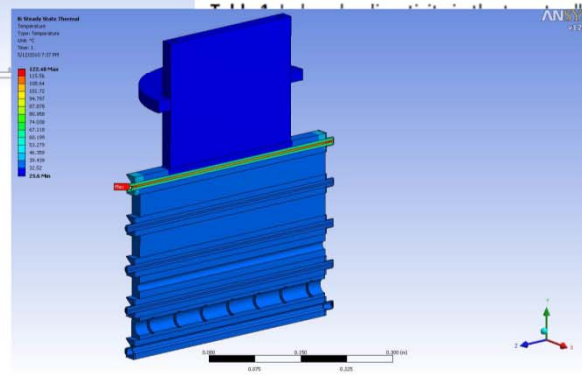


Modeling/Testing:

- temperature
- pressure
- hydrogen embrittlement
- permeation
- activation products
- beam/particle mapping



Radionuclide	T _{1/2} (days)	A _{1day} (Bq)	A _{1month} (Bq)	A _{1year} (Bq)
²² Na	950	6.02 x 10 ⁵	5.89 x 10 ⁵	4.61 x 10 ⁵
²⁴ Na	0.625	2.15 x 10 ⁶	N/A	N/A
⁶⁵ Zn	244.3	1.01 x 10 ⁶	9.32 x 10 ⁵	3.6 x 10 ⁵
⁵¹ Cr	27.7	6 x 10 ⁵	2.9 x 10 ⁵	65.7
⁷ Be	53.1	2.38 x 10 ⁶	1.62 x 10 ⁶	2.08 x 10 ⁴
⁵⁷ Co	271.8	1.73 x 10 ⁵	1.61 x 10 ⁶	6.86 x 10 ⁶
⁵⁸ Co	70.9	3.7 x 10 ⁵	2.78 x 10 ⁵	1.05 x 10 ⁴

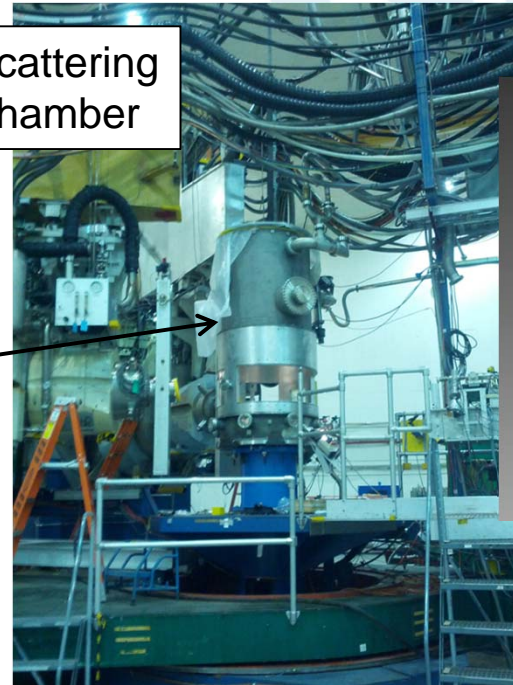


Experiment Configuration

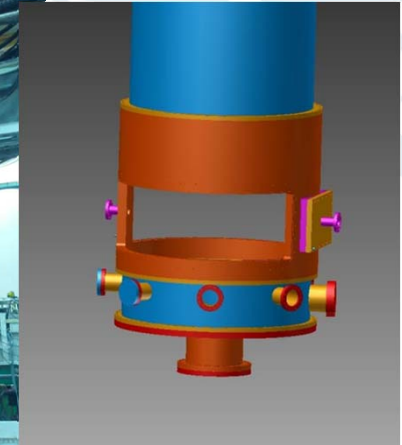
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stack assembly



scattering chamber

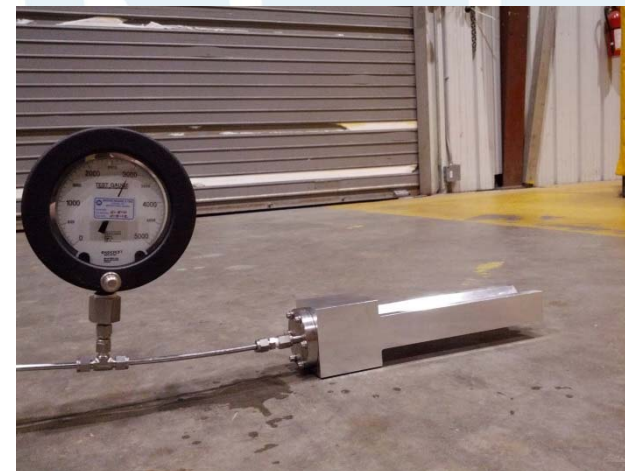


Cherenkov Detector

Tritium Collaboration

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- Tritium Target Cell
 - 1) Production
 - 2) Material Compatibility
- Tritium Safety Analysis, Protocols and Reviews



Hall A

100 ft diameter

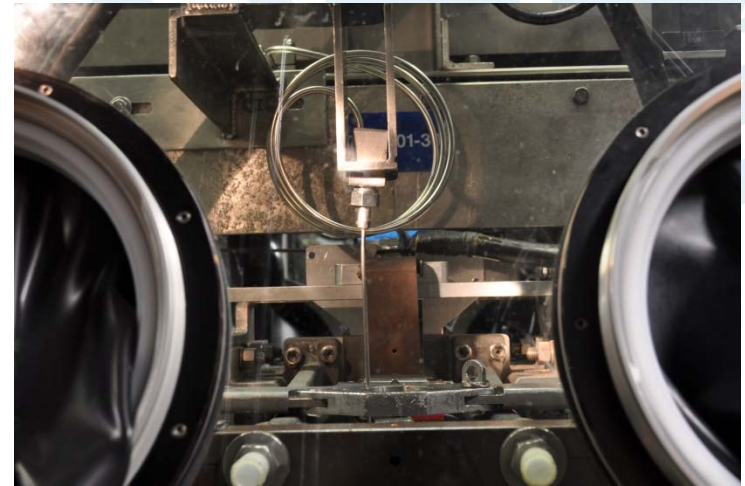
3 stories high



Tritium Target Cell – 1) Production

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- A) load 99.5%+ T2
 - 200 psia
 - 1099 Ci (Type A Shipping Package)
 - verification:
 - NFW and PVT
 - HRMS
- B) burst test data review and approval
- C) valve type review and approval
- D) activation product consideration (Na-22)



Loaded and Shipped September 2016

Collaborative Installation October 2016

Beam Operation Over 10-12 Months

Decay for ~ 2 Months

Returned for Unload

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Tritium Target Cell – 2) Material Compatibility

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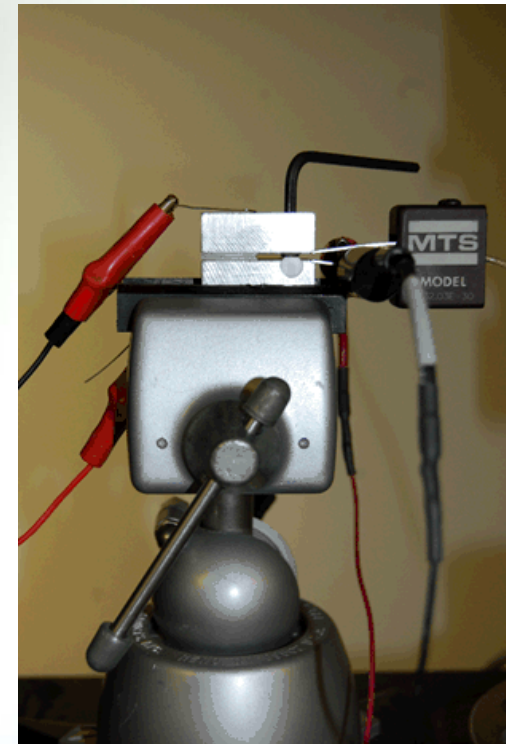
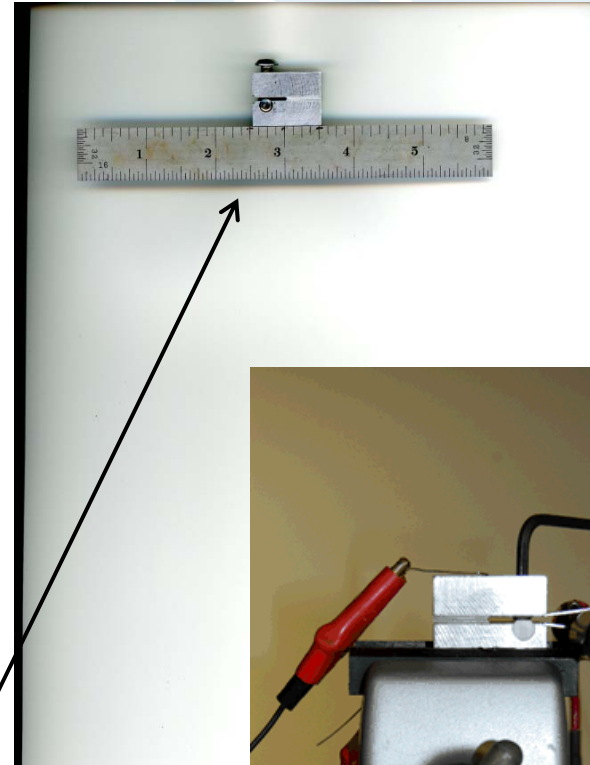
Uncertainty:

- although low permeability in Al(O)
- and low solubility in Al
- and low temperature (< 100 K)
 - beam produces reactive environment
 - tritium exposure for 6 months

INTEGRITY – SAFETY

Al-T Study Implementation

- 28 x Al7075 coupons
- bolt open load (0.5” crack induction)
- exposed to 1850 psi tritium (t=0@RT) up to 1 year
- periodic removal and evaluation of crack propagation with clip gauge



- Multiple Reviews Supported
 - 1) Detection Recommendations
 - Kanne
 - Tyne Engineering
 - RGA
 - 2) Handling Support
 - Hut Provision
 - 3) Package Receipt
 - approvals (DOE/DOT)
 - 4) Leak Scenarios
 - scattering chamber
 - Hall A
 - 5) Clean-Up Methods
 - U getter
 - dilute/wait

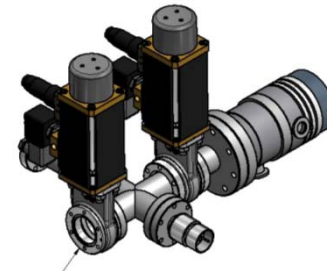


Tritium Leaks

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- Scattering Chamber
 - continuously pumped to $<1 \times 10^{-3}$ torr
 - RGA detection activates bypass to getter bed
 - pumped by CapaciTorr D400-2
- Hall A
 - vented to stack
 - Kanne monitor
 - air turnover and wait
 - possible humidity trapping

scattering chamber getter bed



Summary and Future

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- First Time Tritium Use in TJNAF Experiment
- Necessary to Complete Picture of Nucleon Energetics
- According to PI, One of Top 10 Physics Experiments
- SRTE Handling Target Production and Safe Operation
 - loading, unloading
 - safety reviews, recommendations, equipment
 - material compatibility/effects
- SRNL on Final Paper
- Three More Tritium-Based Experiment Proposals
- Dr. Dave Meekins (PI) 757-269-5434