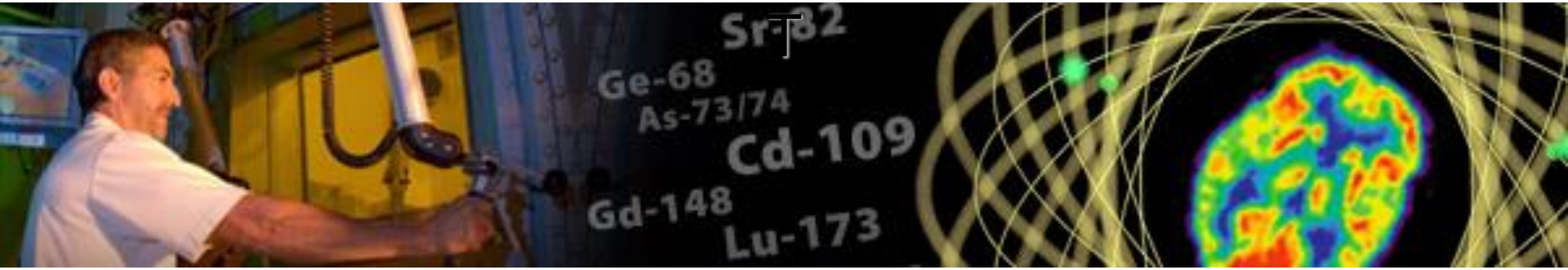
U.S. DEPARTMENT OF ENERGY

OFFICE OF SCIENCE

Office of Nuclear Physics SBIR/STTR Exchange Meeting



The DOE Isotope Program and Facilities and the SBIR/STTR Program
August 9, 2017

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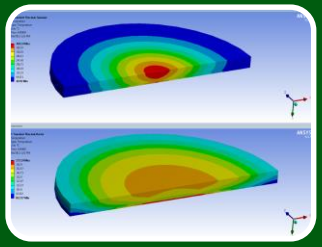
Office of Nuclear Physics, Office of Science, U.S. Department of Energy

DOE Isotope Program Mission

Produce and/or distribute radioactive and stable isotopes that are in short supply; includes by-products, surplus materials and related isotope services

Maintain the infrastructure required to produce and supply priority isotope products and related service



Conduct R&D on new and improved isotope production and processing techniques which can make available priority isotopes for research and application. Develop workforce.

Produce isotopes that are in short supply only – we do not compete with industry
Mitigation of U.S. reliance on foreign supplies of isotopes is a priority

Isotope Program Authority, Resources, Goals

- Public Law 101-101 (1990), as modified by Public Law 103-316 (1995) created the Isotope Production and Distribution Program Fund (called a revolving fund) and **allow prices charged to be based on costs of production, market value, U.S. research needs and other factors**.

- **Isotope Program in DOE has sole governmental authority to produce isotopes for sale and distribution** – labs may not embark on isotope production on their own.

- Program costs are financed by two resources: appropriation and revenue.
  - Appropriation supports mission readiness and R&D program
  - Revenue supports production and distribution of isotope

- We try to understand and anticipate isotope demand for federal missions, research and U.S. industry
  - **Increase availability of isotopes in short supply**
  - **Mitigate potential shortages**
  - **Develop new production and processing techniques of isotopes currently unavailable**
  - **Reduce U.S. dependencies on foreign supply**
  - **We are prepared to make investments on behalf of research, medicine, & industry**
    - **Annual Federal Isotope Needs Surveys and interacting with POC's**

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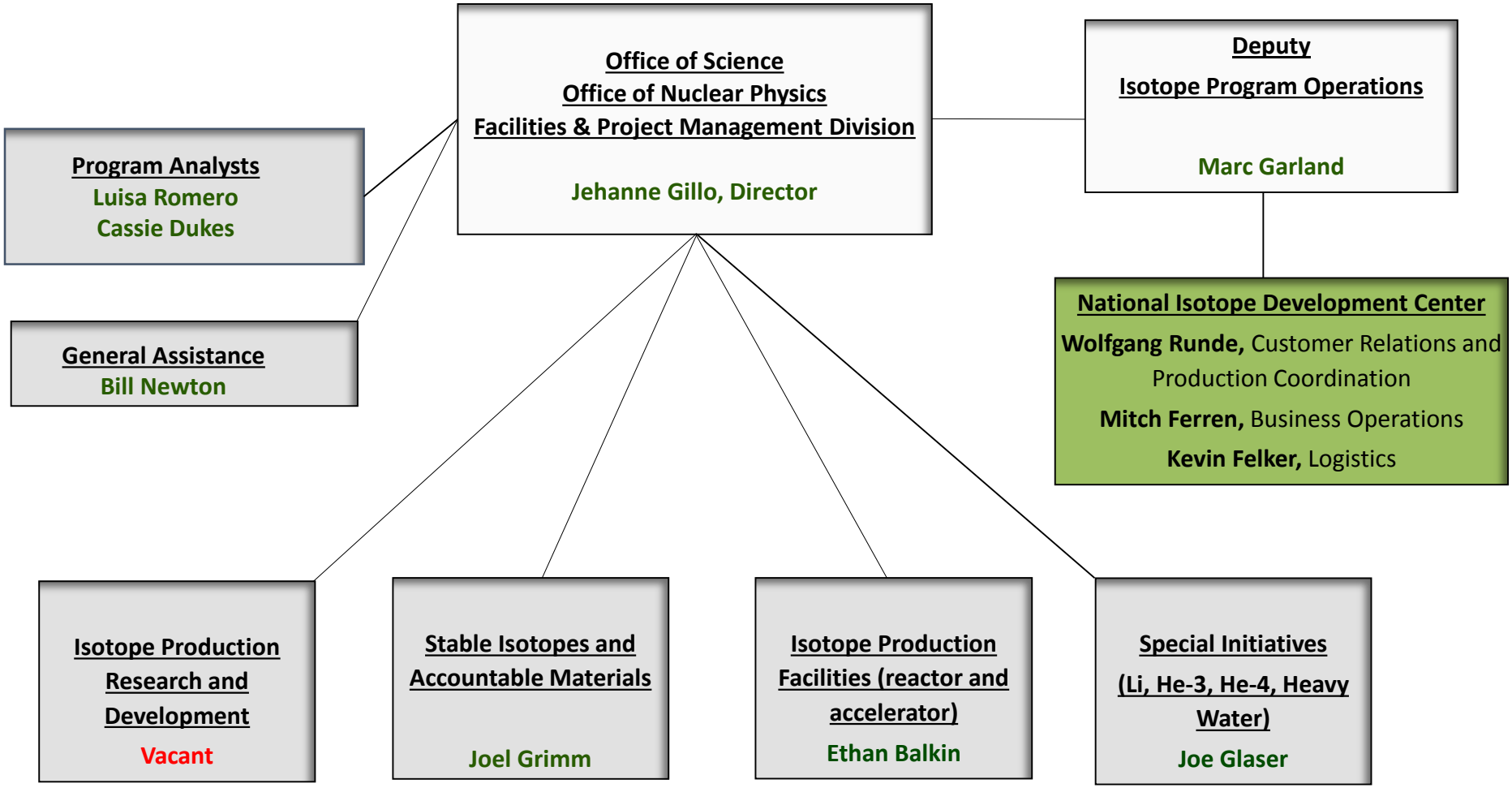
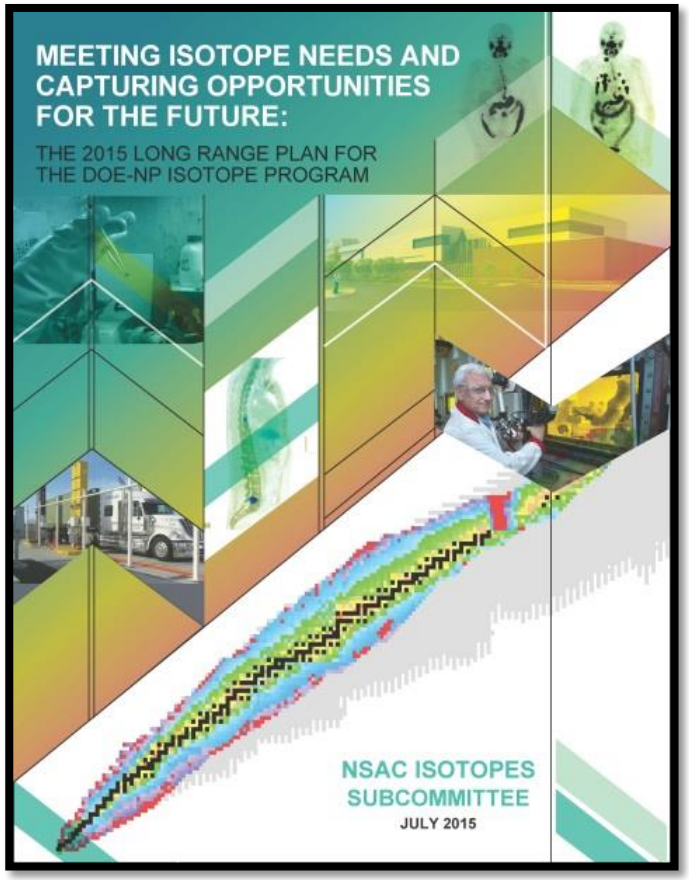
DOE Isotope Program Organization



Guided by NSAC Report released July 20, 2015

Recommendations: *All in Progress*

- Significant increase in R&D funding
  - Continue R&D on alpha-emitters (Ac-225, At-211)
  - High specific activity theranostic isotopes
  - Electron accelerators for isotope production
  - Irradiation materials for targets
- Complete stable isotope capability
- Increase in infrastructure investments and operating base
  - Isotope harvesting at FRIB
  - Separator for radioactive isotopes
    - DOE to host meetings in the new year; focus on additional mission needs
    - Several programs looking at actinide EMIS
    - Potential needs for medical and research isotopes
  - BLIP intensity upgrade and second target station
  - IPF intensity, stability and energy upgrades
- Continue integration of university facilities



https://science.energy.gov/~/media/np/nsac/pdf/docs/2015/2015_NSACI_Report_to_NSAC_Final.pdf

National Isotope Development Center
www.isotopes.gov

- The DOE NIDC coordinates the distribution of all DOE isotope products and services for the DOE IP.
- All contractual discussions with customers.
- Responsibilities in transportation, Q&A, public relations (website, newsletter, booth), cross-cutting technical topics, marketing strategy and
- Receive updates and request quotes for products.

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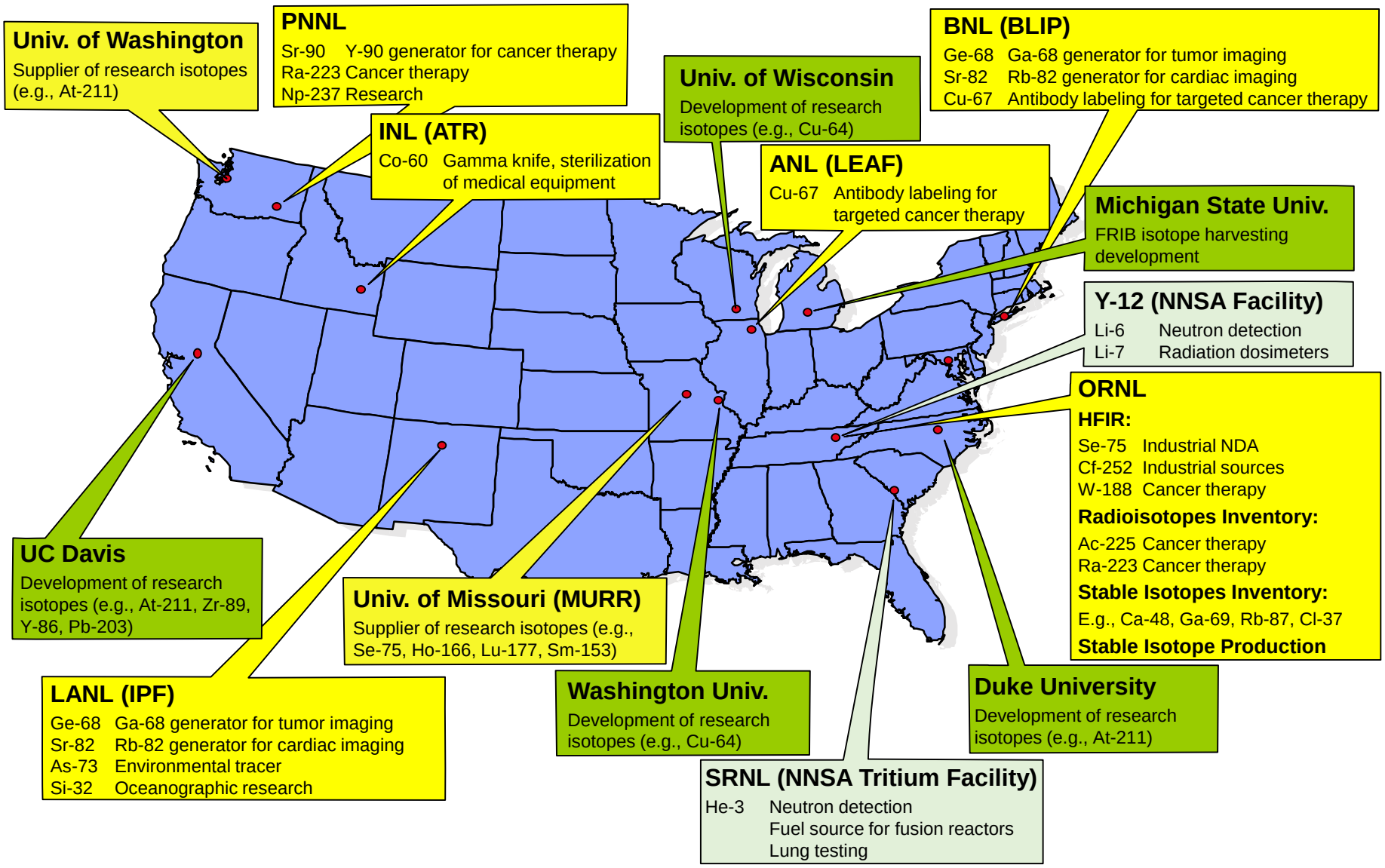
DOE Isotope Program Production and/or Development Sites



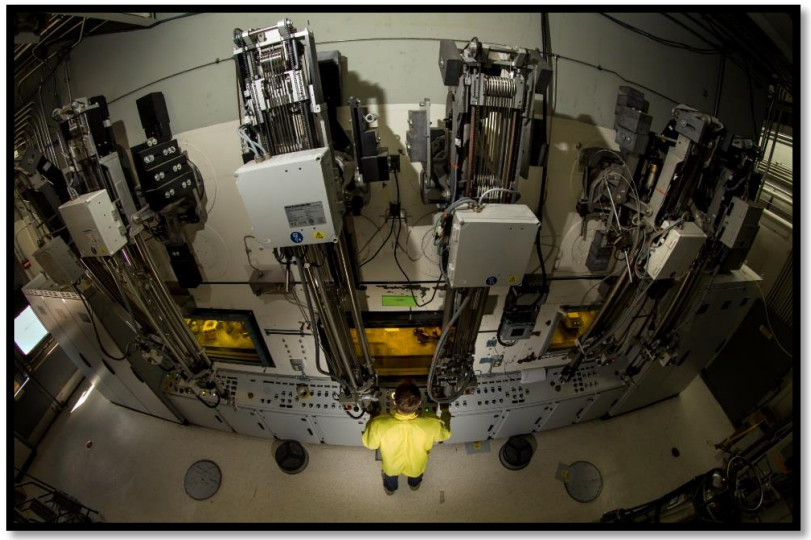
Accelerator Facilities

Brookhaven National Laboratory Brookhaven Linac Isotope Producer (BLIP)

- The BLIP beam line directs protons up to 105µA intensity to targets; parasitic operation with nuclear physics programs for more cost effective isotope production.
- Accelerator improvement project completed in 2016
  - Beam rastering increased isotope yield and decrease target fatigue.

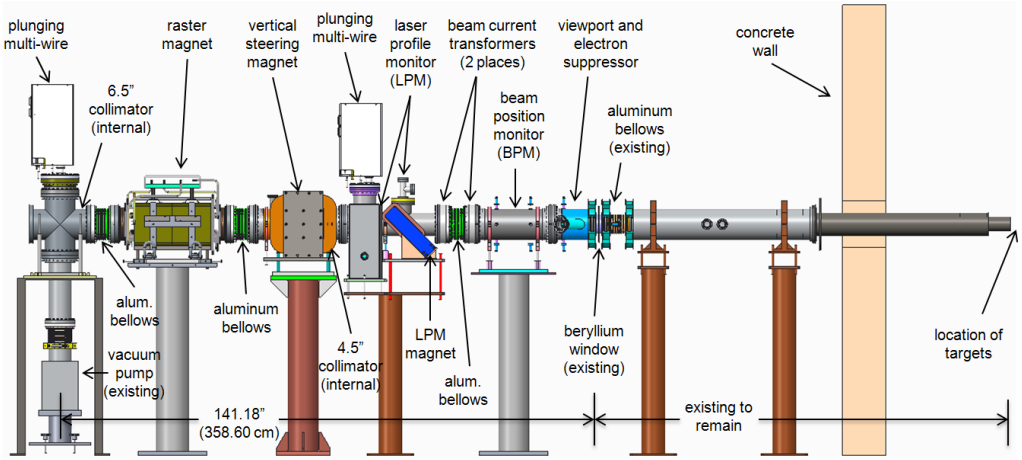
Los Alamos National Laboratory Isotope Production Facility (IPF)

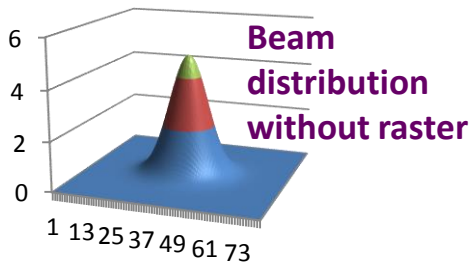
- Diversion of 100 MeV proton beam to target station.
- Irradiates targets while LANSCE operates for NNSA.
- Accelerator improvement project recently completed
  - IPF beam transport system upgraded to increase isotope yields and enhance R&D capabilities.
  - Final review to occur in September.

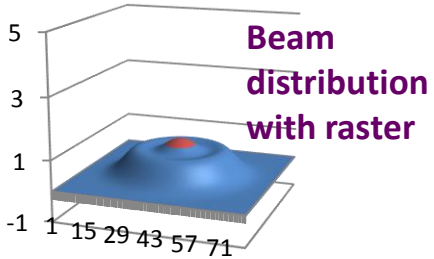


Major Initiatives to Increase Isotope Production Capabilities

- Brookhaven Linac Isotope Producer (BLIP) Beam Raster System
  - Added equipment to
    - Raster the proton beam
    - Provide enhanced beam diagnostics
  - Enabled increase in beam current on target (greater isotope yields)
    - Max. design current increased from 125 to 140 μA due to project to modify proton pulses
    - Actually achieved >160 μA
    - Current had been limited to <100 μA to prevent target failure
  - Lowered possibility of target failures



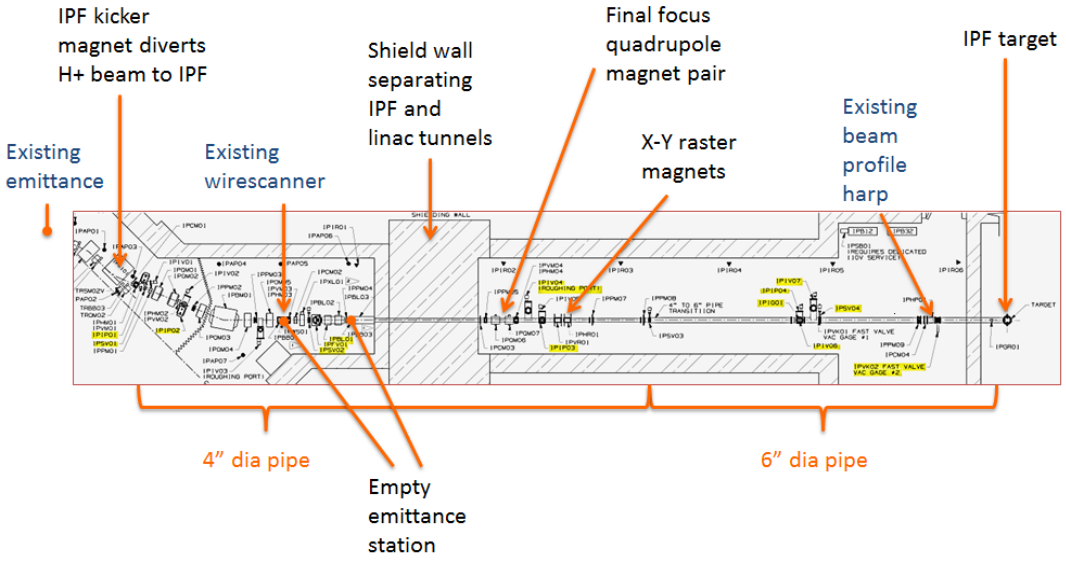


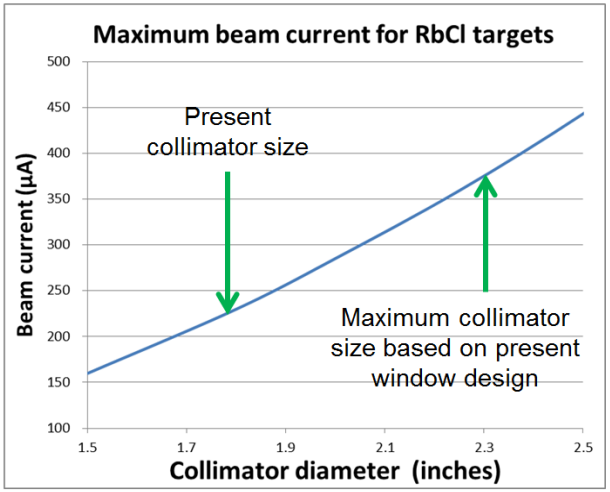


Integral of beam distribution is the same for both plots

Major Initiatives to Increase Isotope Production Capabilities

- LANL Isotope Production Facility (IPF) Beam Transport Upgrade
  - Project completed on time - prior to IPF operating cycle in summer 2017
  - Enables increase in beam current from 230 μA to 380 μA
    - Anticipated 65% increase in production yields
  - Improves R&D capabilities and enhances facility reliability
    - Beam energy, current, profile, and emittance measurements





Reactor Facilities

Idaho National Laboratory Advanced Test Reactor (ATR)

- Co-60 target design in collaboration with ORNL
- High Specific Activity Co-60 for medical applications

Oak Ridge National Laboratory High Flux Isotope Reactor (HFIR)

- Radiochemical Engineering Development Center (REDC)

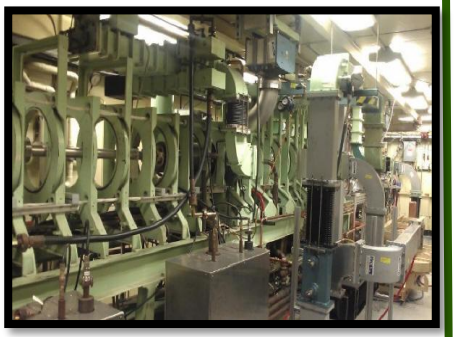
Other Isotope Program Sites

Y-12

- Li-6
- Li-7
- Establishing reserve of Li-7 for nuclear power industry

Argonne National Laboratory

- Low Energy Accelerator Facility (LEAF)
  - e^- accelerator
  - Theranostic production by phototransmutation for cancer therapy



Pacific Northwest National Laboratory

- Radiochemical Processing Laboratory
  - Automated target processing and separations

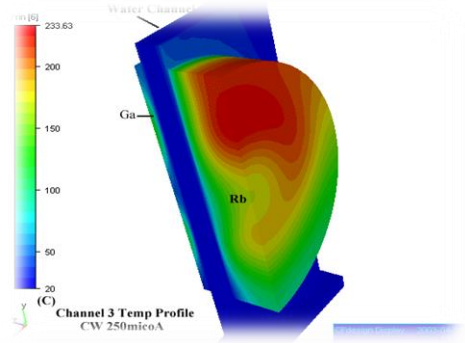
SRS

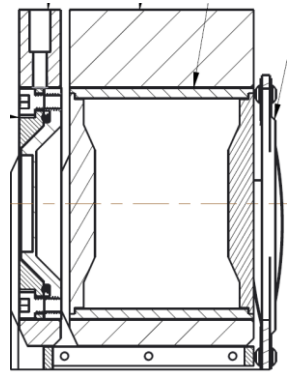
- He-3 extraction from NNSA tritium

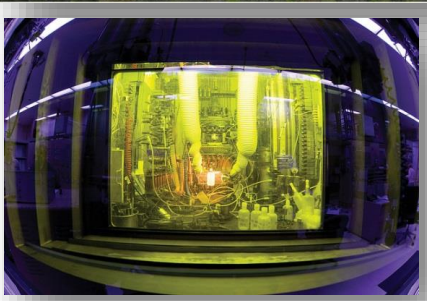
Isotope Program Development and Areas of Overlap with SBIR/STTR

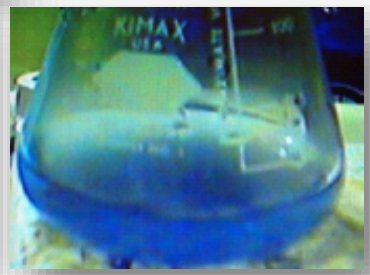
SBIR and the Isotope Program

- **SBIR/STTR**
  - Support R&D toward products or services and process improvements with broad impact
  - Encourage collaboration between Labs and Industrial Partners
  - SPP (Strategic Partnership Project; replaces WFO), CRADA, IBO Contract
- **Expectations**
  - No adverse impacts on programmatic mission (facilities, personnel resources)
  - Development to commercialization primarily responsibility of the industrial partner
  - Private industry may not use Government facilities for commercial production of proprietary end products.



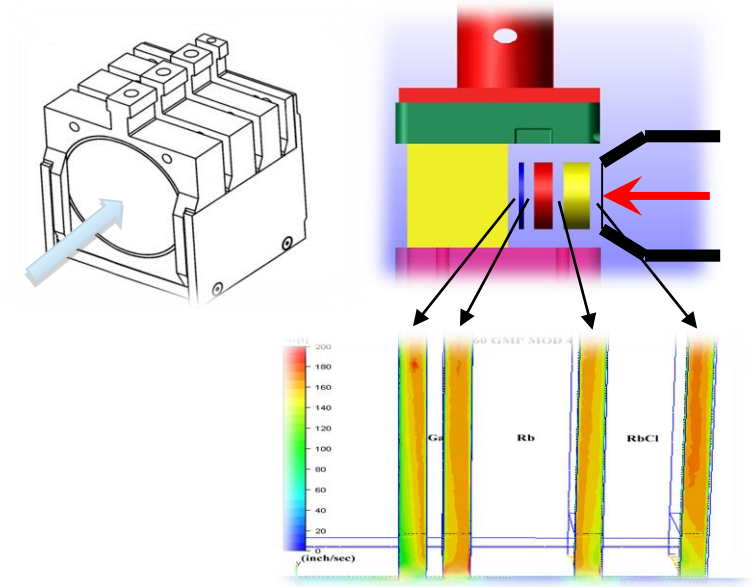




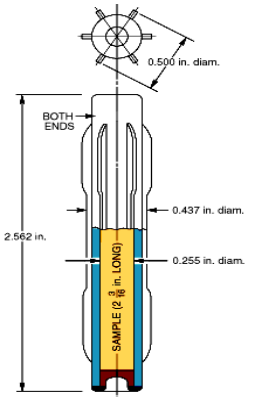


Subtopic A: Novel or Improved Isotope Production Techniques

- Targetry design, fabrication and thermal modeling
  - Withstand higher-current and power densities from commercial accelerators
  - In situ target monitoring
  - Novel self-healing materials
  - Extreme radiation resistance
  - In-hot cell techniques



- Advanced Accelerator or Reactor Technologies
  - High-gradient particle accelerating structures
  - High-energy/high-current cyclotrons
  - Compact sources

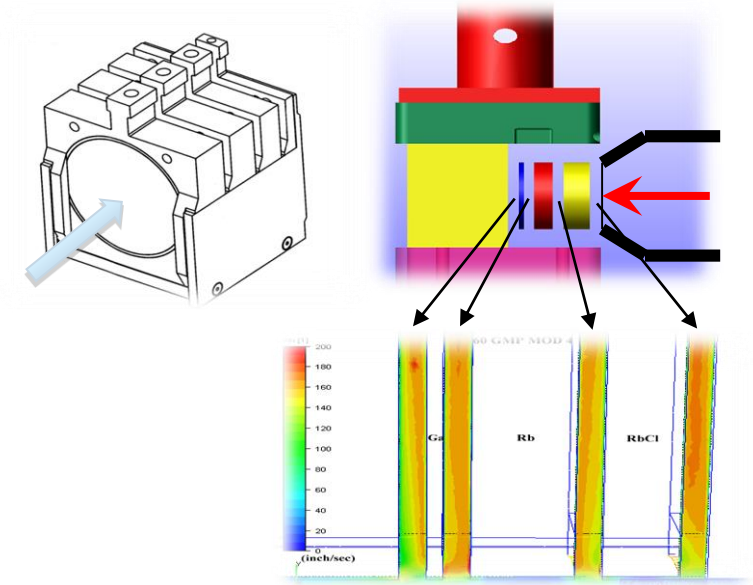


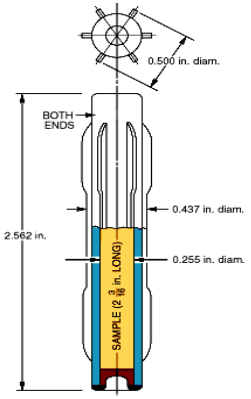
- Automation or robotics to handle and process large mass, highly radioactive thick targets

A. Subtopic A *(continued)*

- Isotopic decay by high Linear Energy Transfer particulate emission for targeted therapy
  - Alpha-particle emitters
  - Auger-electron emitters

- Isotopes capable of functioning as diagnostic/therapeutic (theranostic) pairs or single isotopes combining both traits

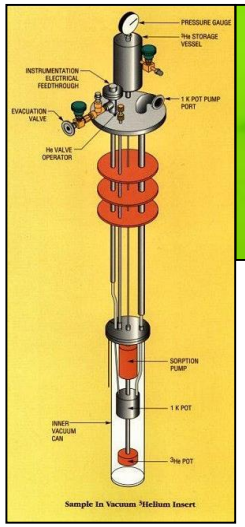




Subtopic B: Improved Radiochemical Separation Methods for Preparing High-Purity Radioisotopes

- Particular interest in lanthanide and actinide separations
- Developments in automation and remote handling using radiation hardened modular systems
  - Separation, purification, elution, radiolabeling, and dispensing
  - Reduced worker dose and labor hours
  - Easily adaptable to multiple processes and hot-cell configurations
  - Ease of compliance with cGMP practices for clinically relevant isotopes
- Developments of separation technologies to improve binding capacity, separation efficiencies, resin selectivities, void volume decreases, and minimize waste streams
  - High-radiation field resistant ion exchange resins, sorbents and extractants
  - Lanthanide and actinide separations
  - Scale up of separation techniques

Subtopic B: *(continued)*



He-3 (beta decay tritium, SRNL): *Neutron Detection (proportional counter tube), cryogenic systems (below 300 mK)*

New Production:

- *We anticipate longer term He-3 demand growth in areas including:*
  - *Cryogenics*
  - *Oil/gas exploration*
  - *Medical diagnostics*
- *Proposals are sought for efforts leading to terrestrial production of He-3*
  - *Potential methodologies might include natural gas, reactors, or other means of production not listed*

D_2O (Heavy Water) Remediation and Tritium Capture:

- Current need to process contaminated D_2O (Heavy Water)
- Proposals are sought for novel processes that:
  1. remove head-gas He-3
  2. remove and capture residual tritium from U.S. Government (USG)-owned heavy water
- After purification, the residual tritium levels in the heavy water must be below the established EPA limit of 2 uCi/Kg.

Summary

Strong synergy with US Private Sector (Medical and Industrial Applications) – would like to see growth fostered by SBIR/STTR interactions

Potential areas of opportunity with SBIR/STTR:

- Target Optimization – new modeling capabilities, new materials and designs can be considered, novel fabrication techniques
- General Equipment – areas related to improved accelerator and reactor technologies as well as general diagnostics
- Process Optimization – automation of processing and associated activities (product dispensing)
- Production of alpha-emitters, auger-electron emitters, and theranostics


Thank You!