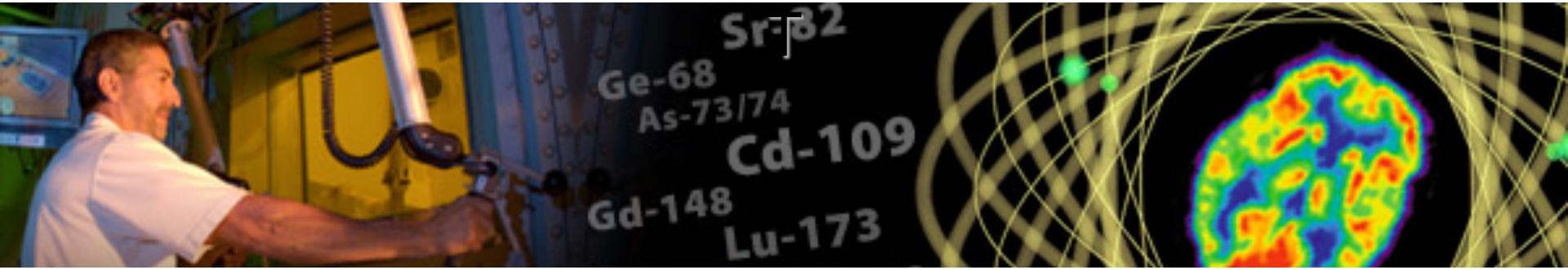
U.S. DEPARTMENT OF ENERGY

OFFICE OF SCIENCE

Office of Nuclear Physics SBIR/STTR Exchange Meeting



The DOE Isotope Program and Facilities and the SBIR/STTR Program
August 14, 2019

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Isotope Program Manager, Los Alamos National Laboratory

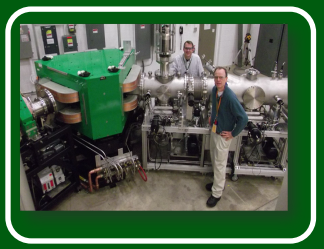
LA-UR-19-27923

Outline

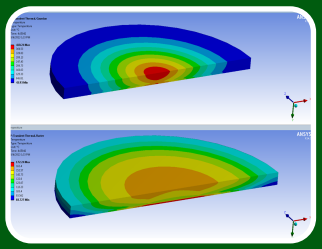
- Background
- Applications, Products, and Services
- Facilities and Capabilities
- Isotope Program Development and Areas of Overlap with SBIR/STTR

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 services



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

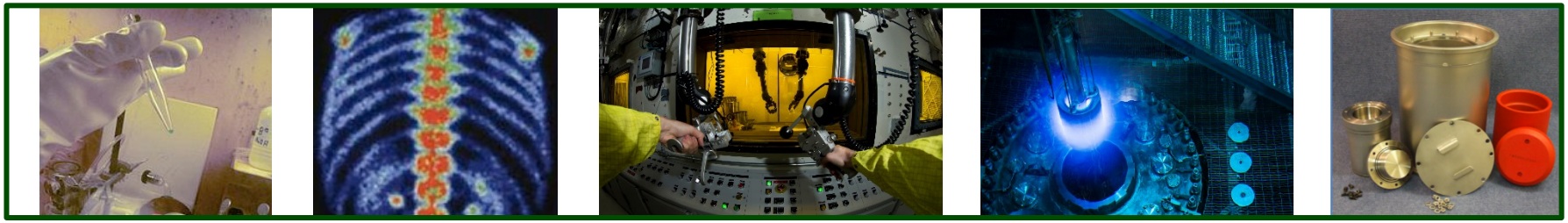
Isotope Program Authority, Resources, Goals

- 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 **allows 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 the R&D program
  - Revenue supports production and distribution of isotopes

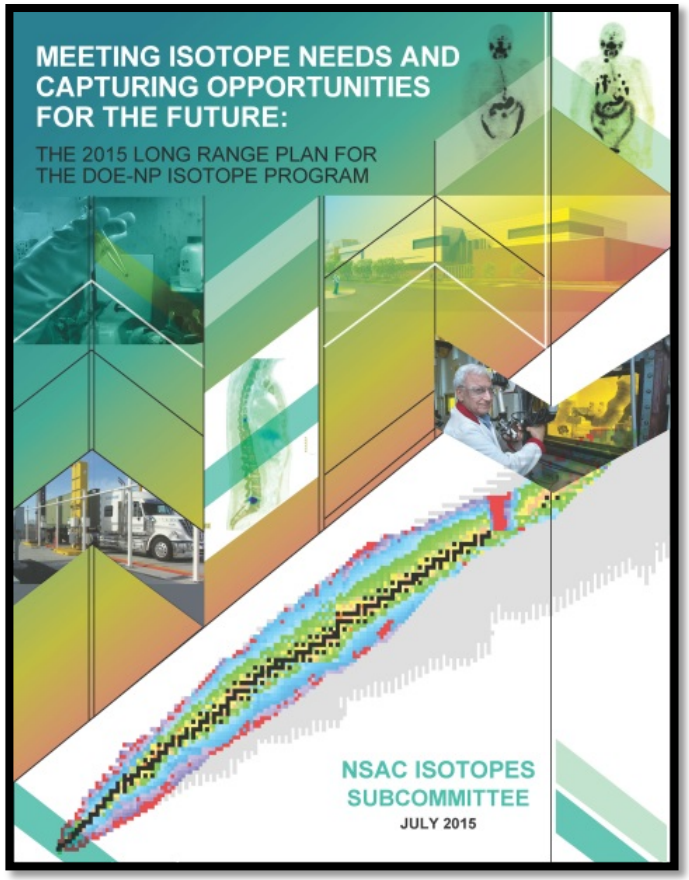
- We try to understand and anticipate isotope demand for federal missions, research and U.S. industry
  - **Increase availability of isotopes in short supply**
  - **Mitigate potential shortages**
  - **Develop new production and processing techniques of isotopes currently unavailable**
  - **Reduce 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**



Guided by NSAC Report released July 20, 2015

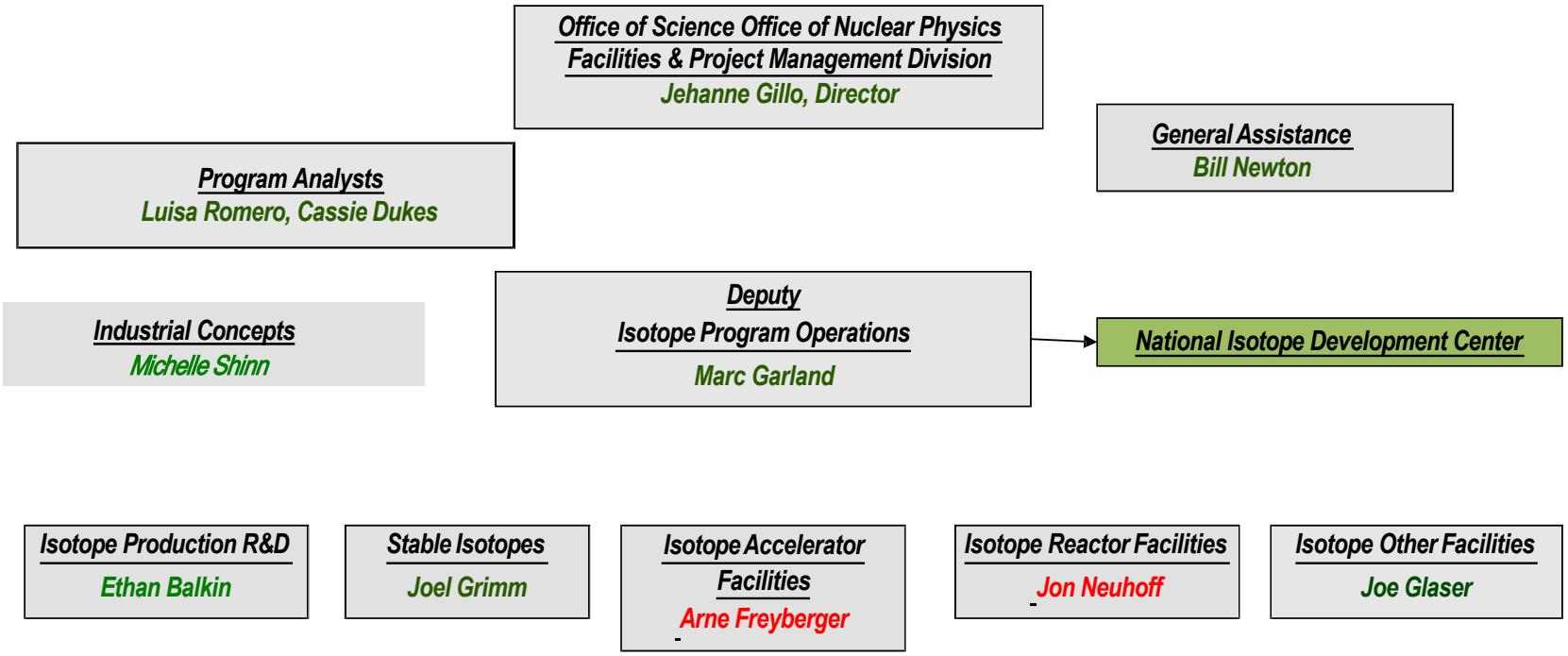
Recommendations: *All in Progress*

- 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

DOE Isotope Program Organization



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National Isotope Development Center
www.isotopes.gov

- The DOE NIDC coordinates the distribution of all DOE isotope products and services for the DOE Isotope Program.
- Responsible for all contractual discussions with customers.
- Responsibilities in transportation, quality & regulatory issues, public relations (website, newsletter, booth), cross-cutting technical topics, marketing strategy.
- Contact point for requesting quotes for products and more detailed technical information.

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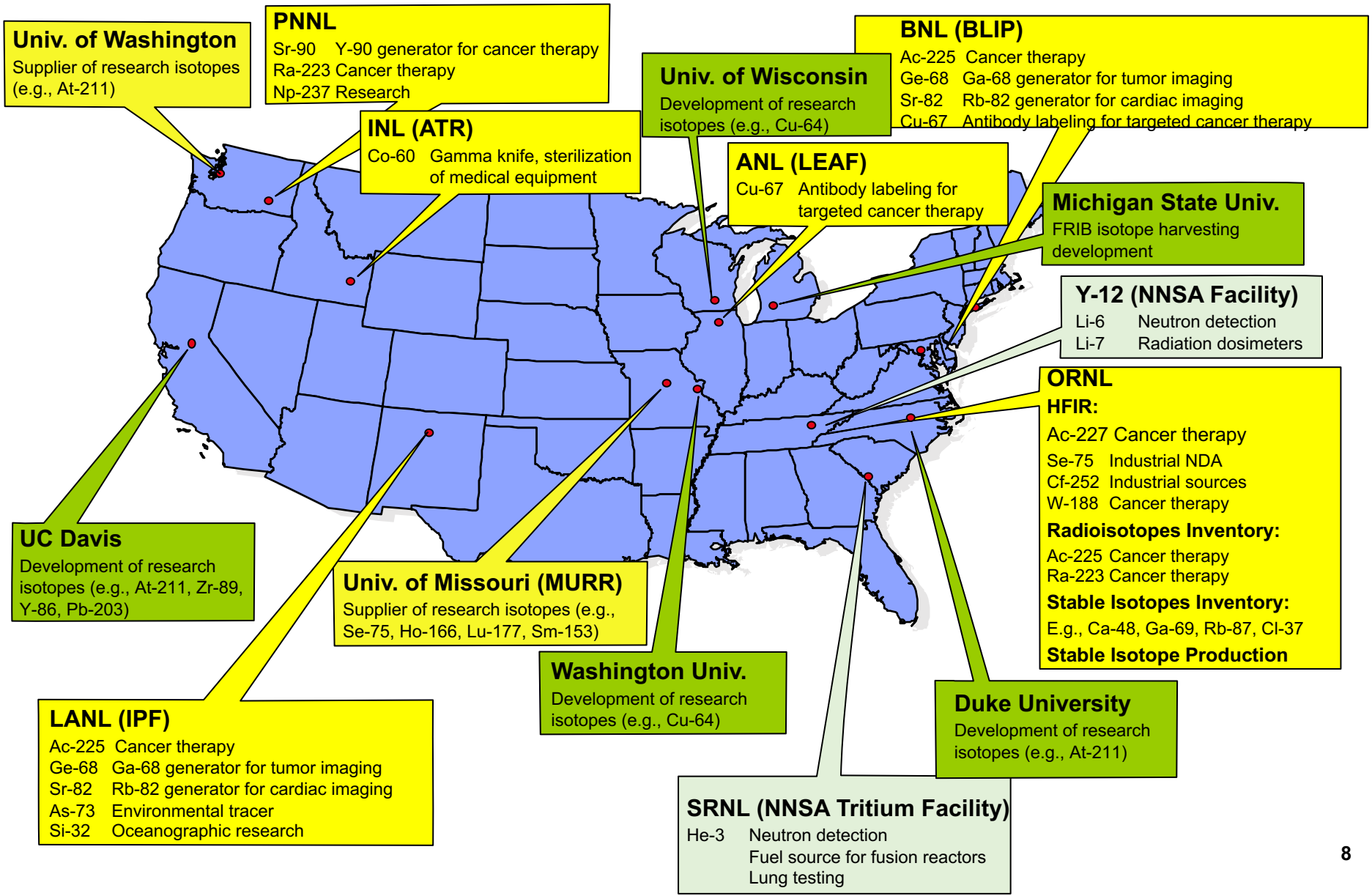
DOE Isotope Program Production and/or Development Sites -2018



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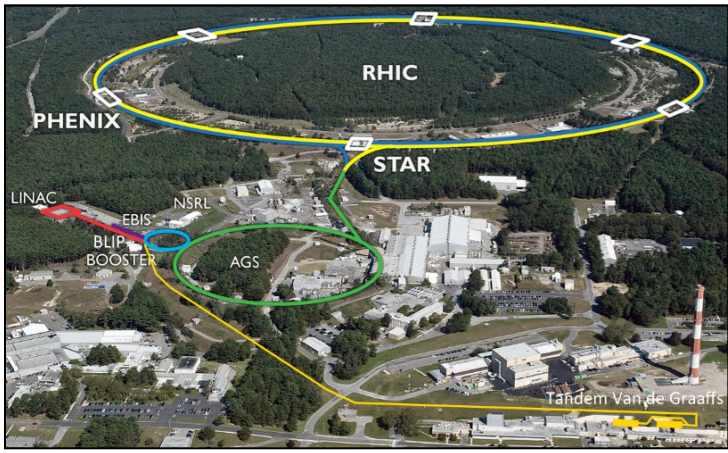
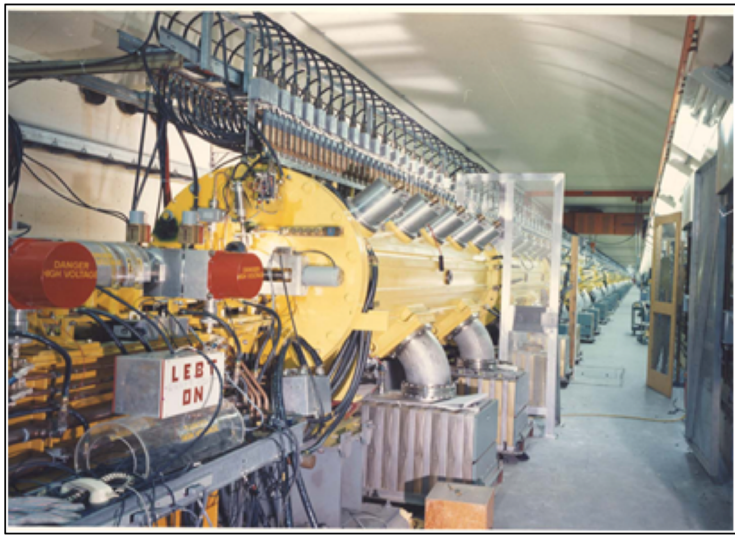
Brookhaven LINAC Isotope Producer (Cathy Cutler)

- BLIP utilizes the beam from the proton Linac injector for the Booster, AGS, and RHIC accelerator (nuclear physics)
- Excess pulses (~85%) are diverted to BLIP. Energy is incrementally variable from 66-202 MeV.
- The BLIP beam line directs protons up to 165µA intensity to targets; parasitic operation with nuclear physics programs for more cost effective isotope production.
- Hot cell processing capability for isotope separation

https://www.c-ad.bnl.gov/esfd/BLIP Group/

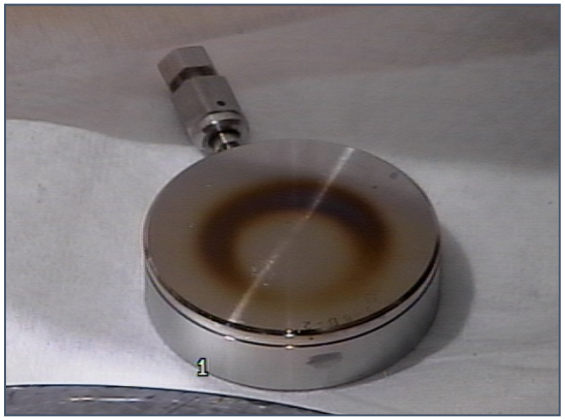




BROOKHAVEN NATIONAL LABORATORY

LANL Isotope Production Facility (Eva Birnbaum)

- IPF receives protons from the LANSCE accelerator at 100 MeV incident energy up to 265 μA for routine production.
- IPF targets are subjected to extreme conditions with ~ 5-7 kW of power deposited in each target.
- IPF is the sole user of H^+ beam at LANSCE – overall parasitic operation with other NNSA programs at LANSCE.
- Hot Cell Facility (13 hot cells) with unique inert process capabilities as well as FDA-compliant infrastructure.

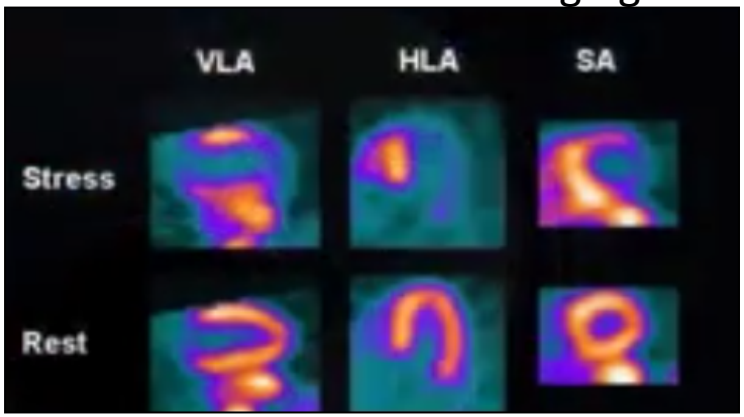


http://isotopes.lanl.gov/

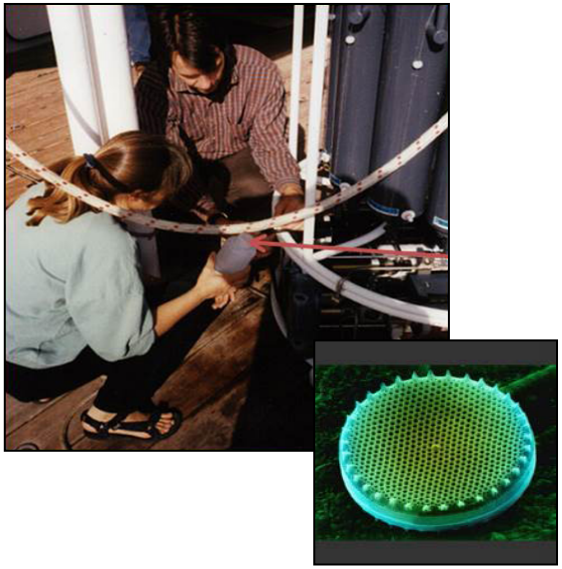
Los Alamos NATIONAL LABORATORY EST. 1943

Products – Accelerator Isotopes

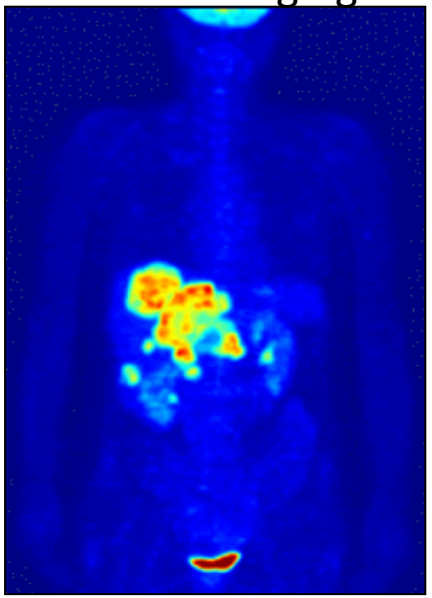
Sr-82/Rb-82:
Generator- cardiac imaging



Si-32: Environmental applications



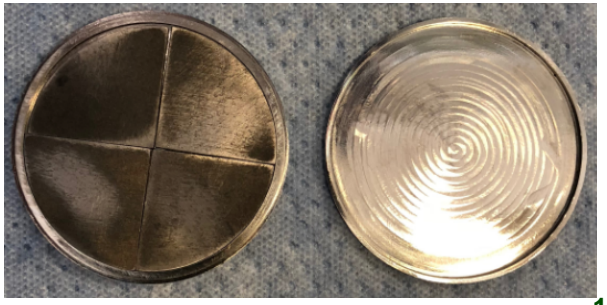
Ge-68/Ga-68:
Generator-
cancer imaging



Na-22: Source for PET imaging

Cd-109: X-ray fluorescence

Ac-225: Cancer therapy

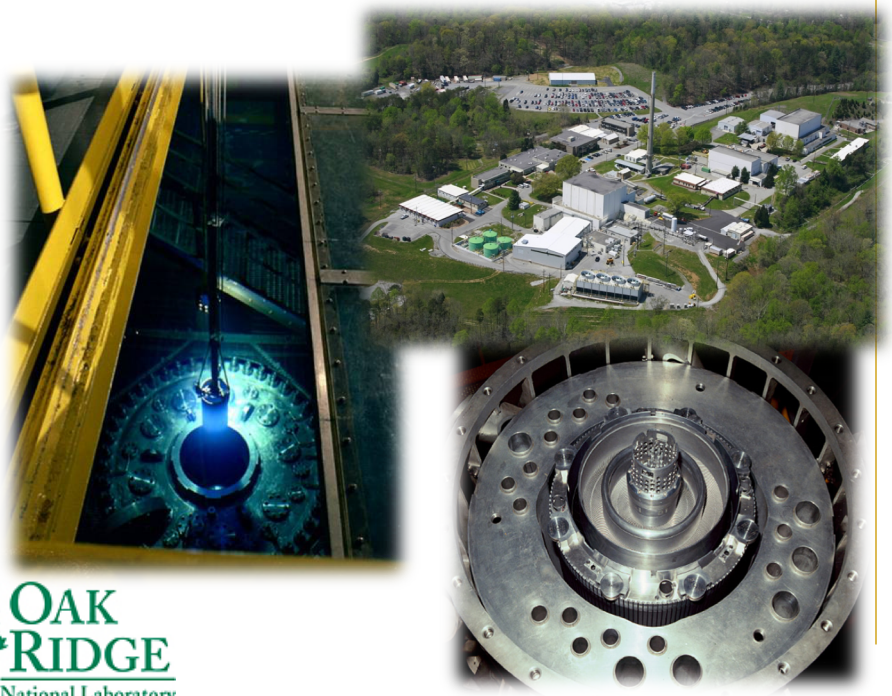


DOE Reactor Sites: HFIR (Ben Lewis) and ATR (Stephen Johnson)

High Flux Isotope Reactor (HFIR) at ORNL:

http://neutrons.ornl.gov/facilities/HFIR/

- *High thermal neutron flux*
- *($2x10^{15}$ n/cm^2 s)*
- *Multiple hydraulic tubes*
- *Several hot cell facilities*
- *Key Isotopes: Cf-252, Ac-227, W-188, Ni-63, Se-75*



Advanced Test Reactor (ATR) at INL:

https://factsheets.inl.gov/FactSheets/AdvancedTestReactorSafety.pdf

- ***Moderately high thermal neutron flux ($4x10^{14}$ n/cm^2 s)***
- ***Hot cell facilities***
- ***Key Isotope: Co-60***

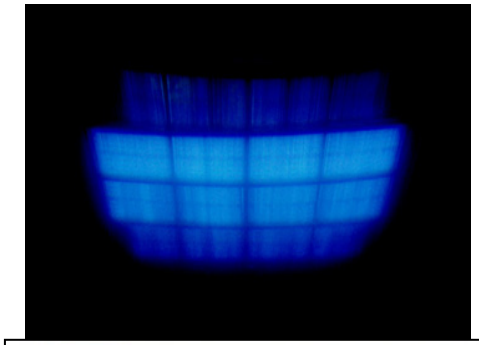
OAK RIDGE National Laboratory

INL Idaho National Laboratory

Products – Reactor Isotopes

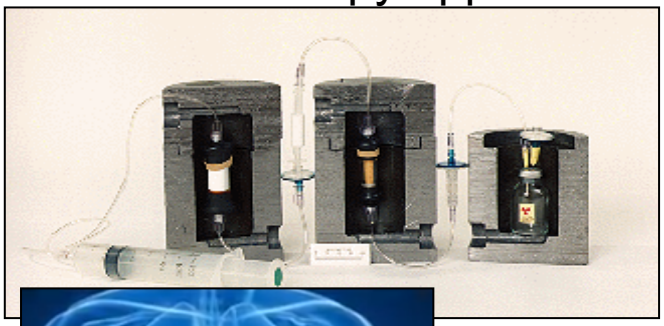
Cf-252: Source – Oil Well Logging

Co-60:
Source – gamma sterilization
Gamma-Knife

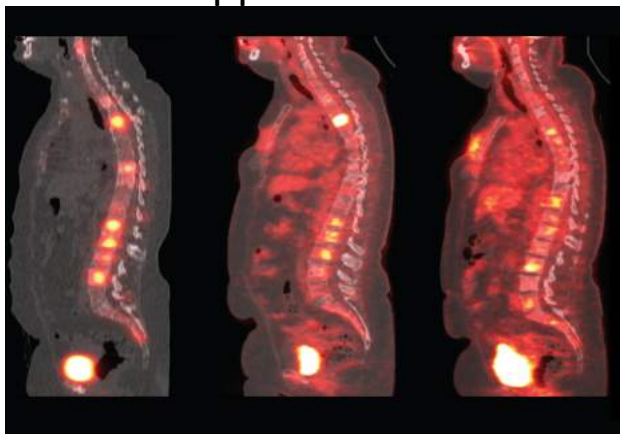


Se-75:
Source – medium energy gamma applications; non-destructive testing

W-188/Re-188: Generator – Cancer therapy applications



Ra-223: Cancer therapy applications



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Processing Capabilities (Gert Patello) and Electron LINAC (Jerry Nolan)

PNNL: *DOE hazard category 2 facility for work with mg to kg of radioactive materials (16 hot cells).*

Extensive wet laboratories, shielded glove boxes, radiochemistry fume hoods, and a modern analytical lab.

PNNL's radiochemistry capability includes staff with extensive experience in radiochemistry, separations, and actinide science.

Pacific Northwest NATIONAL LABORATORY

http://radioisotopes.pnnl.gov/

ANL: Low Energy Accelerator Facility (LEAF) *A 50 MeV/25 kW electron linear accelerator producing a wide range of radioisotopes for medical and industrial use via photonuclear reactions.*

Radiochemistry capabilities and recycling of enriched target materials.

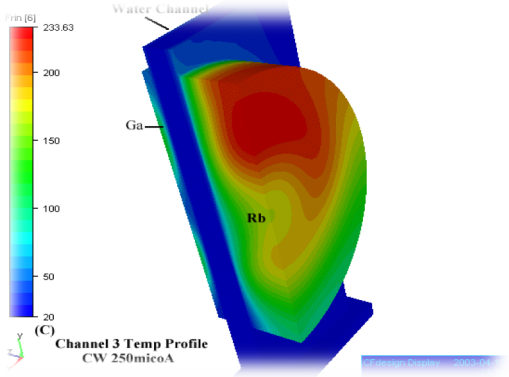
Argonne NATIONAL LABORATORY

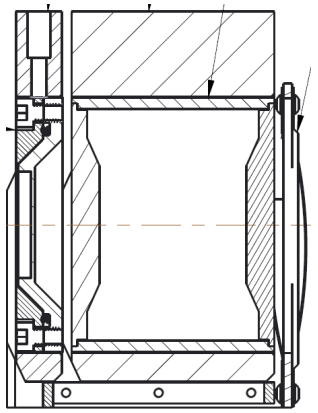
https://www.anl.gov/cfc/reference/radioisotope-research-and-production-program

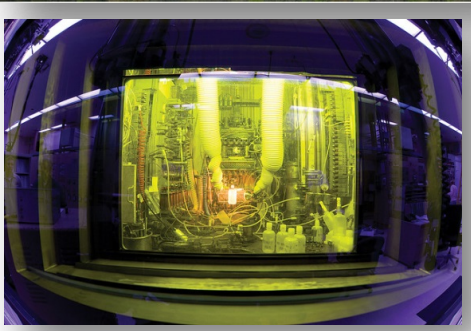
Isotope Program Development and Areas of Overlap with SBIR/STTR

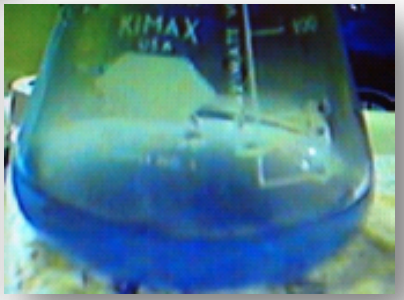
SBIR and the Isotope Program

- **SBIR/STTR**
  - Support R&D toward commercialization of isotope 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
  - Recognize the moral and legal obligations to comply with export controls and policies that relate to the transfer of knowledge that has relevance to the production of special nuclear materials (SNM)









SBIR and the Isotope Program

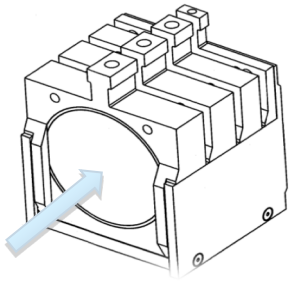
- **Exceptions/ Areas outside scope**
  - Applications related to Mo-99 and SNM where NNSA has responsibility
  - Duplication of R&D previously funded by DOE Office of Nuclear Physics
    - See https://science.energy.gov/sbir/awards/ (Release 1, DOE Funding Program: Nuclear Physics).
  - Proposals utilizing government facilities for commercial production or duplicating IP efforts

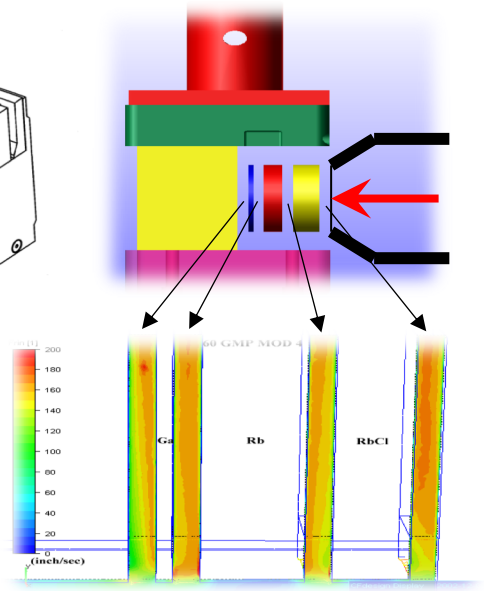
Questions – Contact: Michelle Shinn, Michelle.Shinn@science.doe.gov or the NP SBIR/STTR Topic Associate for Isotope Science and Technology: Ethan Balkin, Ethan.Balkin@science.doe.gov.

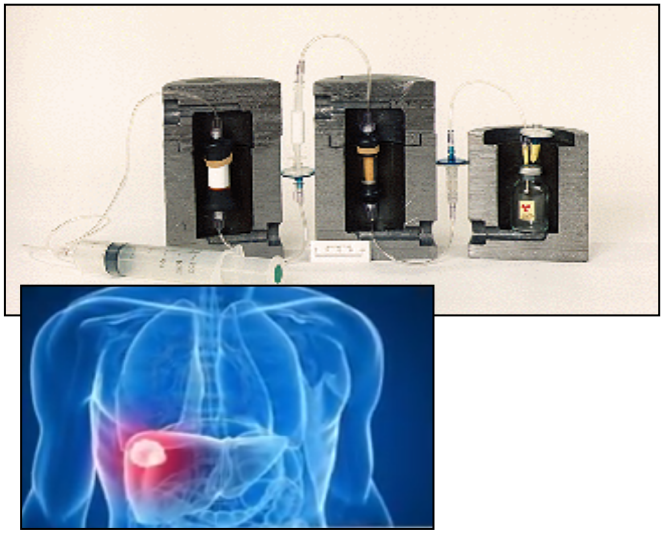
Programmatic Interests

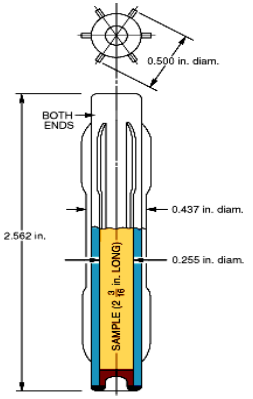
Novel or Improved Isotope Production and Radiochemical Separation Techniques

- Production of theranositc, alpha, and auger emitters
- Targetry design, fabrication and thermal modeling
- Separations and purification
- Automation and remote handling
- Safe compliant transportation of radioactive products
- Waste management
- In situ target monitoring
- Radiation resistant IX resins, sorbents and extractants
- Novel self-healing materials with extreme radiation resistance

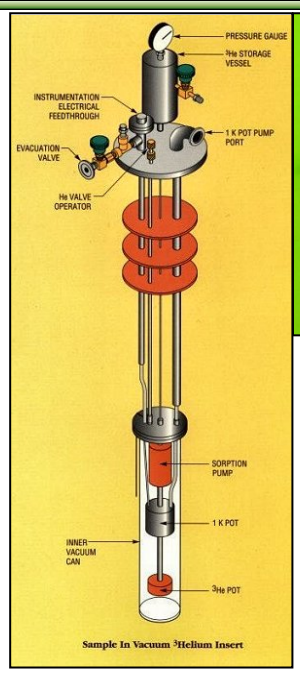








Isotopes From DOE's Nuclear Defense Mission



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 µCi/Kg.

Summary

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

Variety of production capabilities (accelerator and reactor) and associated hot cell processing infrastructure for partnering

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 process and associated activities (product dispensing) would be of great benefit to overall program; focus on developing transportation needs

Goal to have working prototype or method by end of Phase II


Thank You!