NP Isotope Program, Facilities and the SBIR/STTR Program

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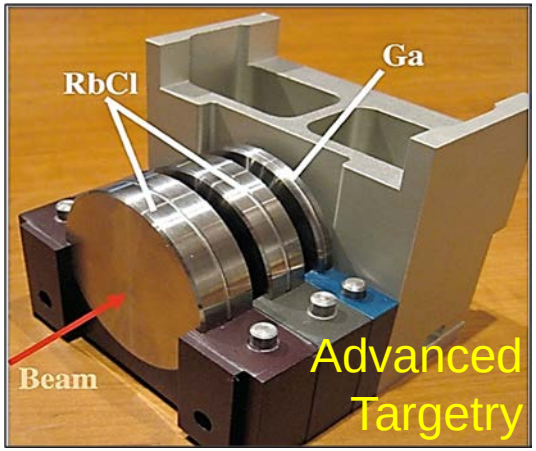
Isotope Program Mission

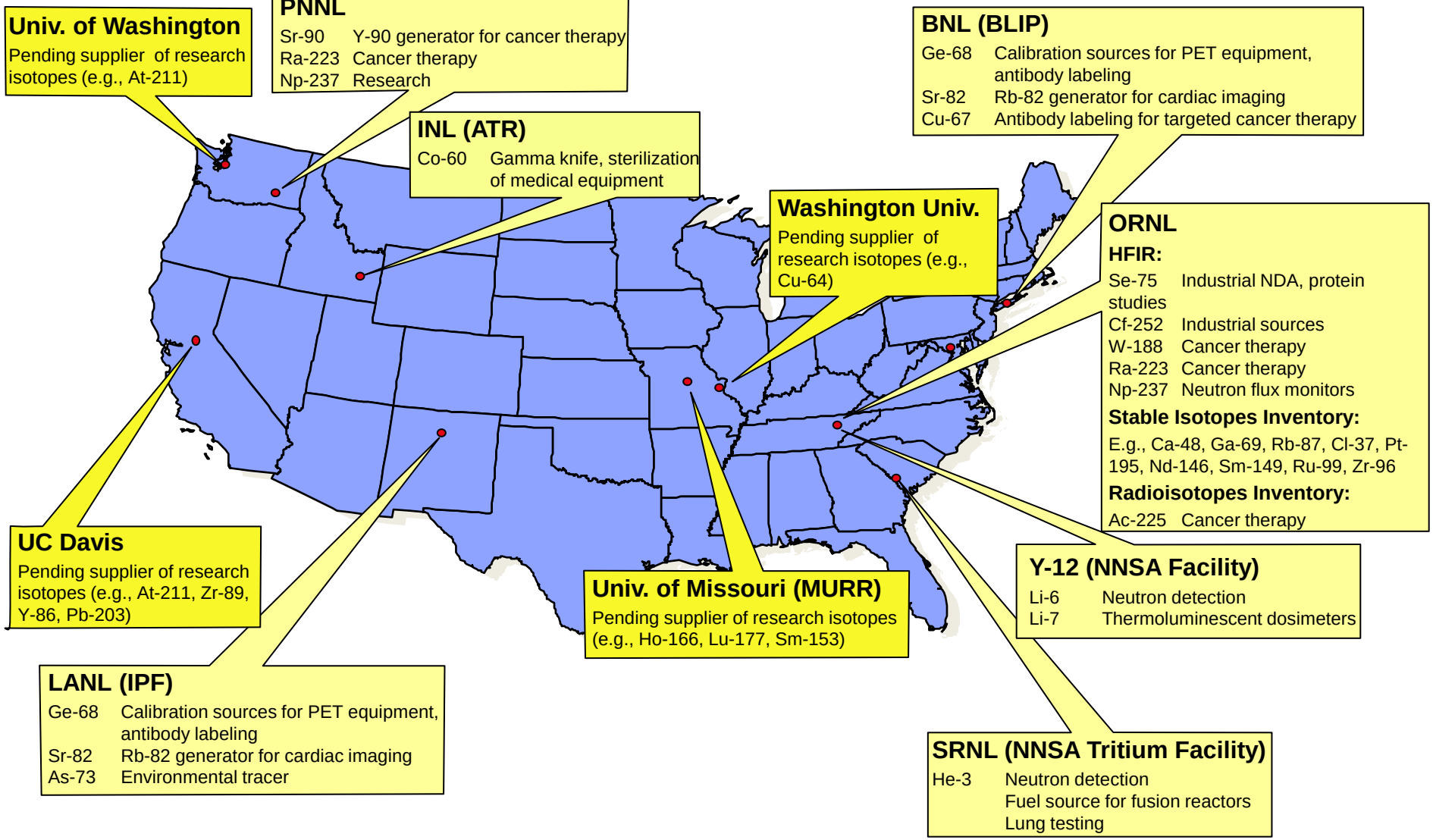
- Produce and/or distribute radioactive and enriched stable isotopes that are in short supply, including valuable by-products, surplus materials and related isotope services.
- Maintain the infrastructure required to produce and supply isotope products and related services.
- Conduct R&D on new and improved isotope production and processing techniques which can make available new isotopes for research and applications.
  - **Core R&D at Key Laboratories where there are Programmatically stewarded activities**
  - **Competitive R&D**
  - **SBIR/STTR, Early Career Award Program**


Workforce Development


Ac-225 – Cancer Therapy



Production Sites Integrated in the DOE Isotope Program

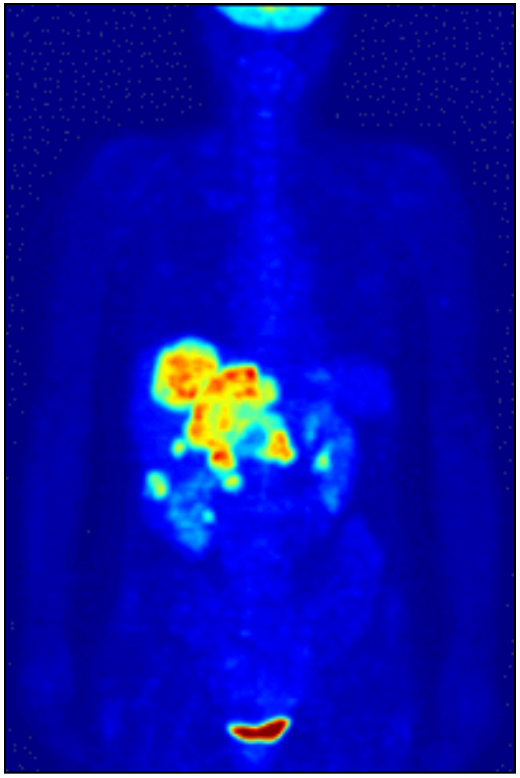


For more details on products, see NIDC site - http://www.isotopes.gov/

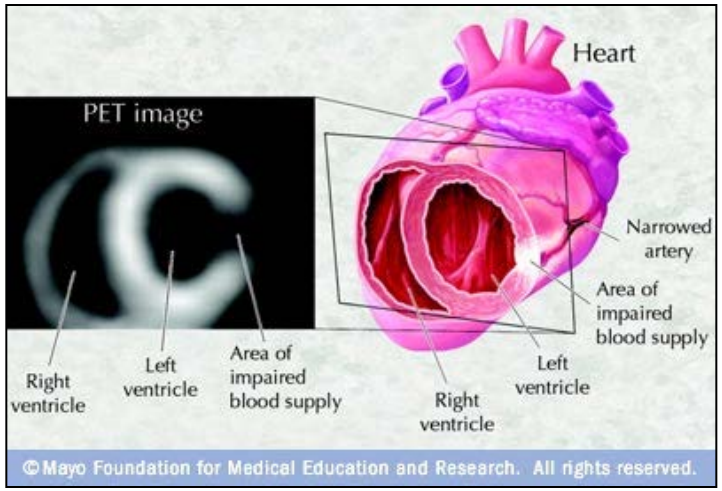
Applications – Accelerator Isotopes

Si-32: Environmental applications

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



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



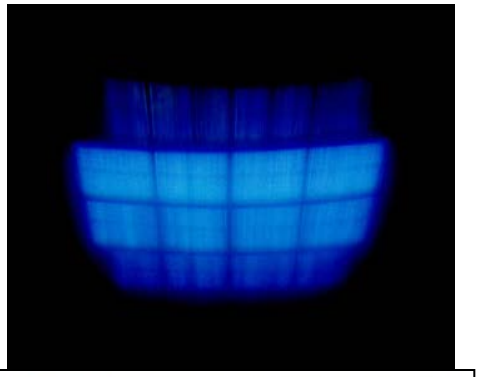
Ac-225/Bi-213: Generator-cancer therapy – R&D Stage

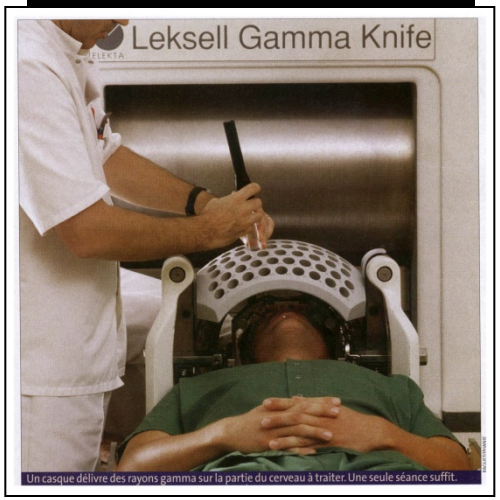
α-Immunotherapy

Applications – Reactor Isotopes

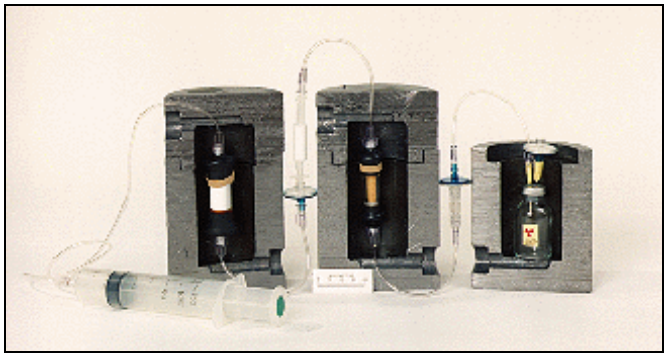
Cf-252: Source – Oil Well Logging

Co-60: Source – gamma sterilization, Gamma-Knife

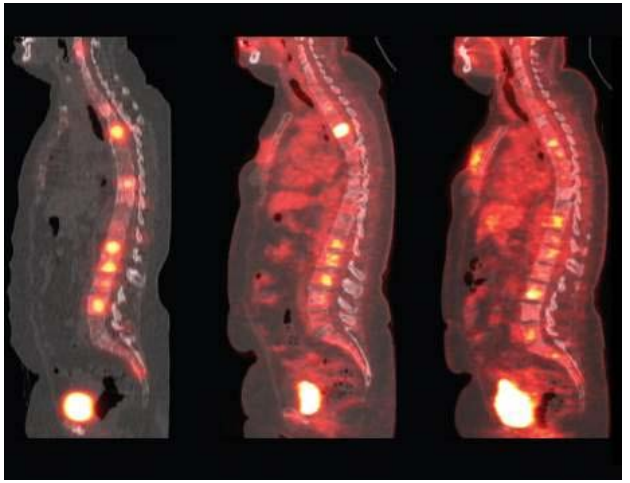




Se-75: Source – medium energy gamma applications; non-destructive testing

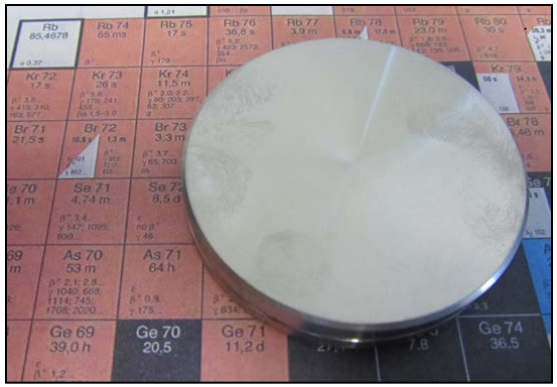


W-188/Re-188: Generator – Cancer therapy applications



Ra-223: Cancer therapy applications

Applications – Stable Isotopes



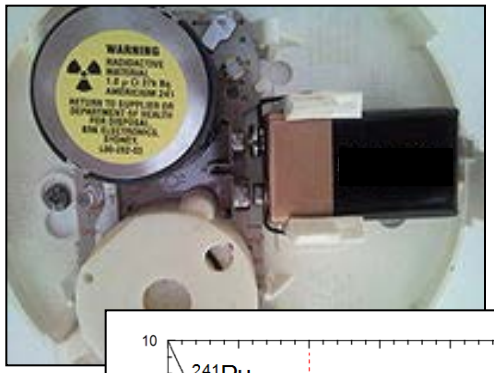
W-186: Target Material- permits production of high specific activity Re-186 (cancer therapy)

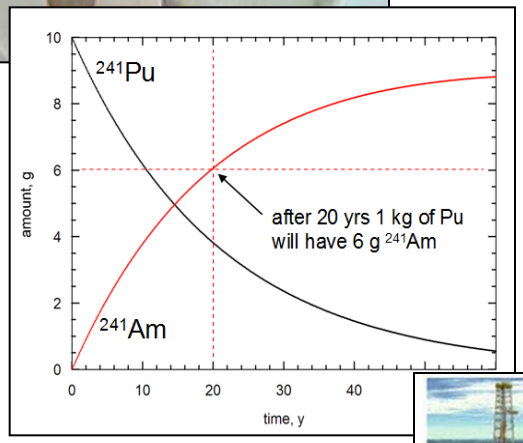
K-40: Human Cardiovascular System research, and calibration sources

Li-6: Neutron Detection (scintillating glass fiber)

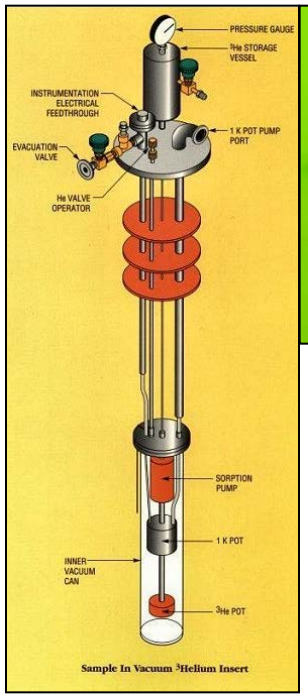
Fe-57: Geological research of mineral compositions

Isotopes From DOE's Nuclear Defense Mission

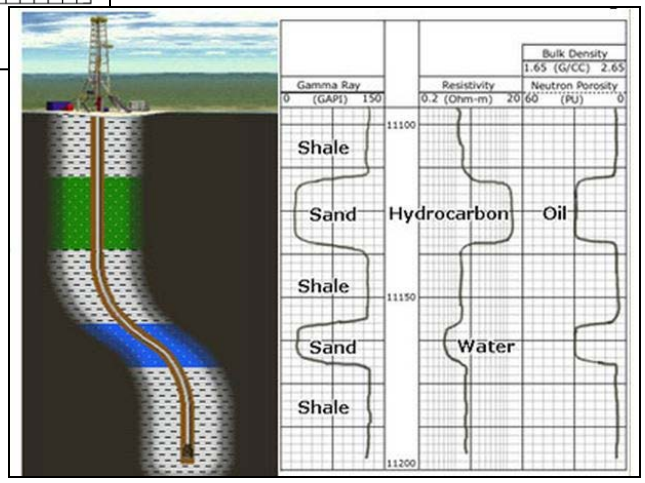




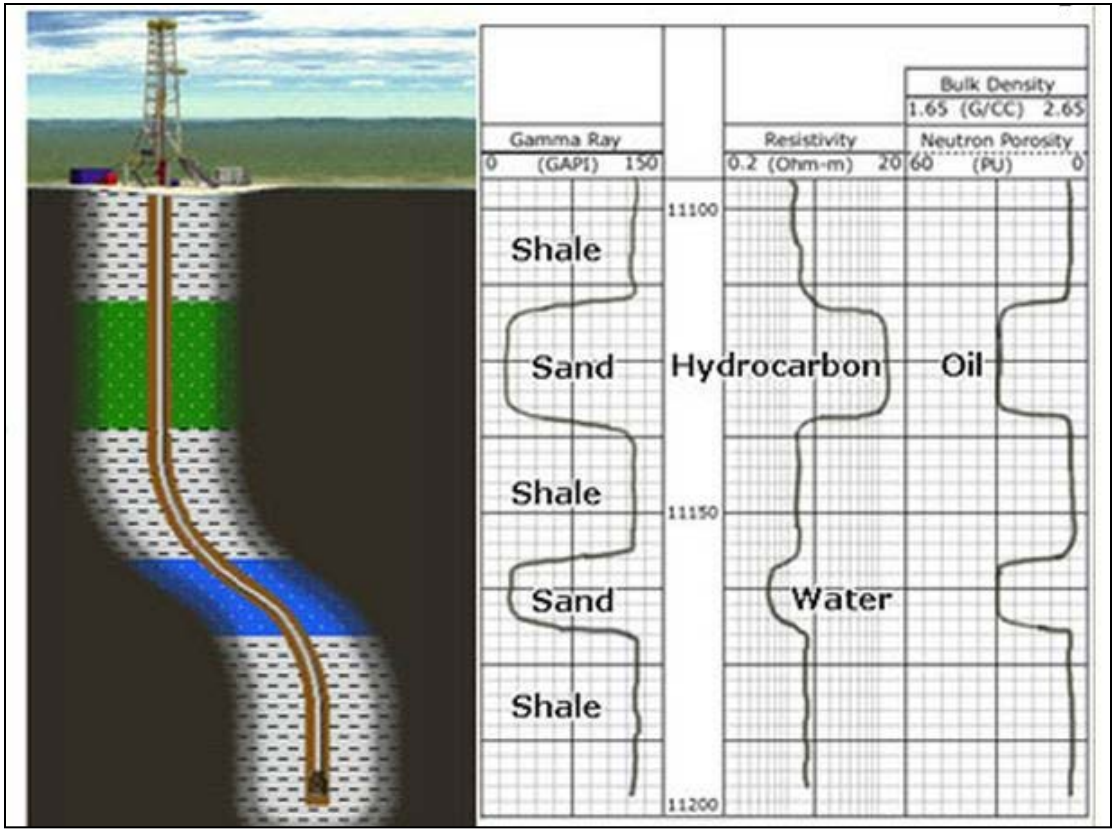
Am-241 (from Pu-241): Oil well logging, smoke detectors, moisture gauge in use for highway construction QC



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

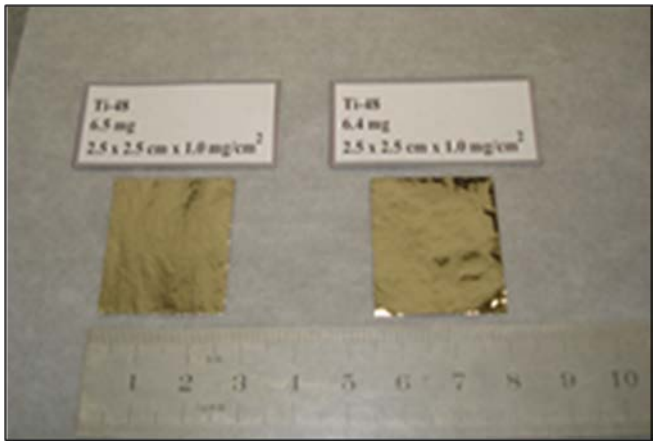


Li-7 (co-product from enriching Li-6): Pressurized water reactor


Bulk Density
1.65 (G/CC) 2.65
Gamma Ray
0 (GAPI) 150
Resistivity
0.2 (Ohm-m) 20
Neutron Porosity
60 (PU) 0
11100
11150
11200
Shale
Sand
Shale
Sand
Shale
Hydrocarbon
Oil
Water

Service Activities

Sr-82/Rb-82 Generator Refurbishment (LANL):
Receipt of generators after clinical use, compliant disposal of residual radioactive components, return of precision-machined lead

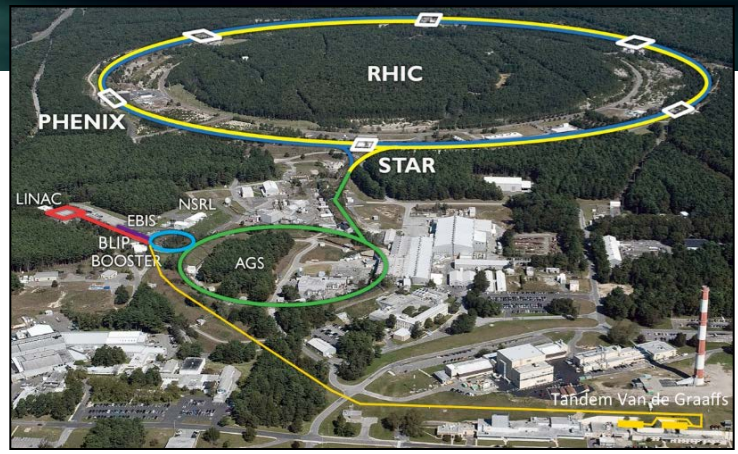


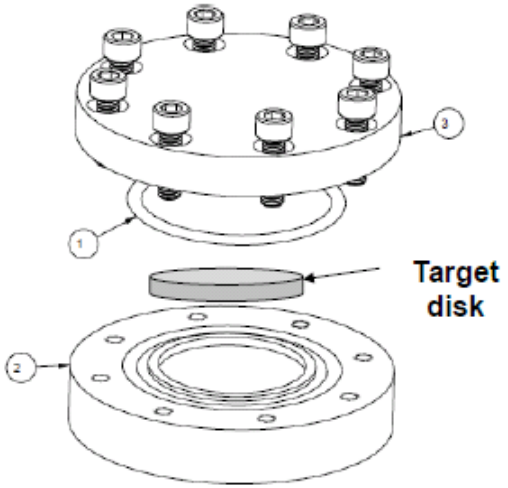
Laboratories at ORNL are available to provide unique services and dispense over 200 different isotopes in a wide variety of chemical and physical forms:

- Metallurgical, ceramic, and high vacuum processing methods
- Pyrochemical Conversion: oxide to high-purity metal
- Arc-melting and alloying
- Hot and cold rolling
- Preparation of cold-rolled foils from air-reactive metals
- Drop casting
- Wire rolling/swaging (hot or cold)

Brookhaven LINAC Isotope Producer

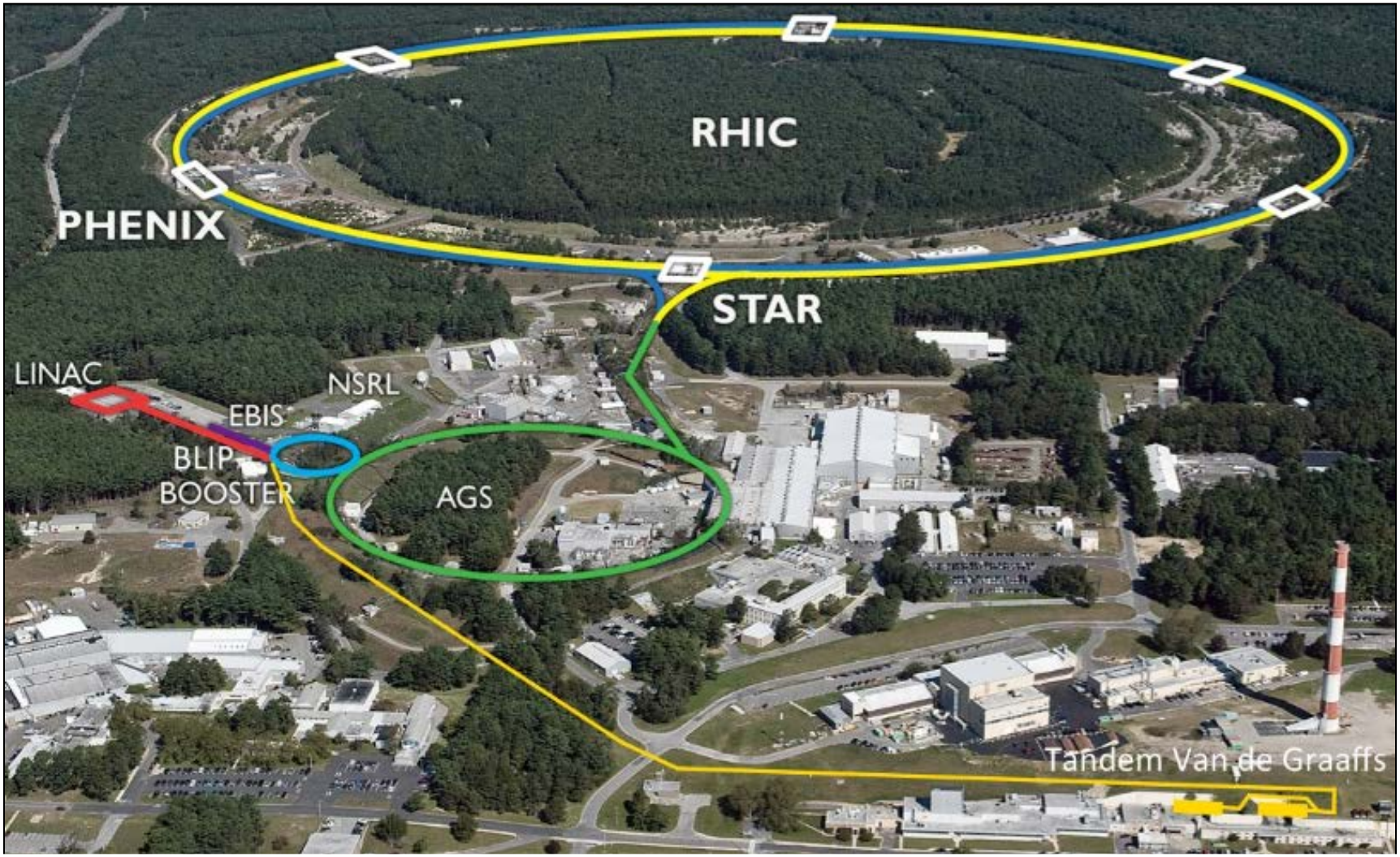
- BLIP utilizes the beam from the proton Linac injector for the Booster, AGS, and RHIC accelerator (nuclear physics)
- Excess pulses (~85%) are diverted to BLIP. Energy is incrementally variable from 66-202 MeV.
- The BLIP beam line directs protons up to 105µA intensity to targets; parasitic operation with nuclear physics programs for more cost effective isotope production.





BROOKHAVEN NATIONAL LABORATORY

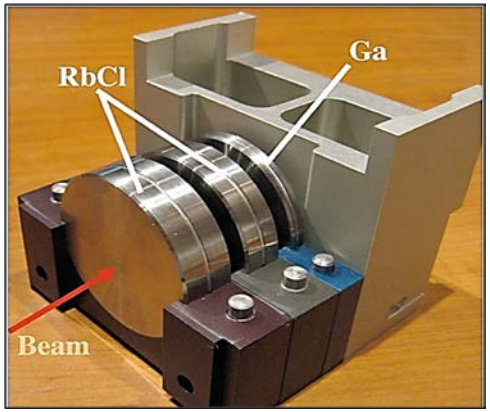
http://www.bnl.gov/cad/Isotope_Distribution/Isodistoff.asp



RHIC intersecting storage ring accelerator – approx. 2.4 mile

LANL Isotope Production Facilities

- IPF receives beam from the LANSCE accelerator at 100 MeV incident energy up to 250 μA for routine production.
- IPF targets are subjected to extreme conditions with up to 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 Cells Facilities possess unique inert process capabilities as well as FDA-compliant infrastructure



Los Alamos NATIONAL LABORATORY EST. 1943

http://isotopes.lanl.gov/

DOE Reactor Sites: HFIR and ATR

High Flux Isotope Reactor (HFIR) at ORNL:

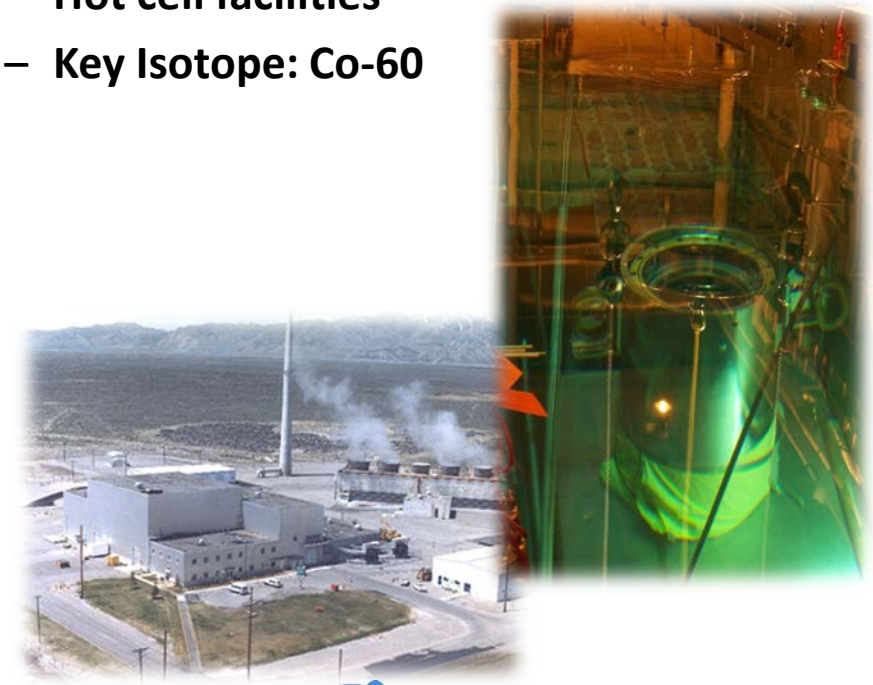
http://neutrons.ornl.gov/facilities/HFIR/

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

Advanced Test Reactor (ATR) at INL:

http://www.inl.gov/research/advanced-test-reactor-research/

- **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

PNNL Radiochemical Processing Capabilities

DOE hazard category 2 facility for work with mg to kg of fissionable and non-fissionable radioactive materials (40,000 ft^2 of laboratory and more than 8,500 ft^2 of hot cell space (16 hot cells).

Radiological facilities for work with trace quantities supporting work in detection.

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

PNNL's radiochemistry capability includes staff with extensive experience in radiochemistry, separations, and actinide science that support clients in environmental management, nuclear energy, national security, homeland security and science.


Modular Hot Cell


Actinide Chemistry


Automated Radiochemistry

Pacific Northwest
NATIONAL LABORATORY

Re-establish Production of Enriched Stable Isotopes

- Calutrons have not operated for over a decade.
- Isotope Program manages inventory – depleted/short for many isotopes in demand.
- Developing concepts for modern stable isotope separation technology: electromagnetic separation coupled with small configurable gas centrifuges.
- Smaller scale enrichment of specific isotopes for research
- ORNL 10 mA EMIS commissioned December 15, 2011; now developing 100mA ion source
- Successful peer review in August 2013
- Construction of Pilot Production facility approved December 2013 (FY2016 Finish)

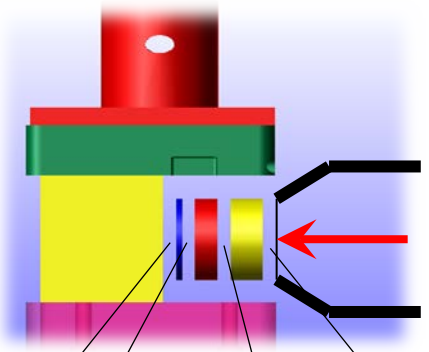
Stable Isotope Inventory at ORNL

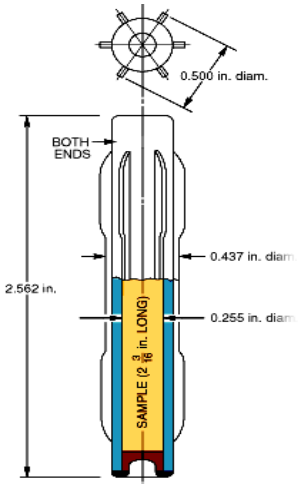
10 mA EMIS at ORNL

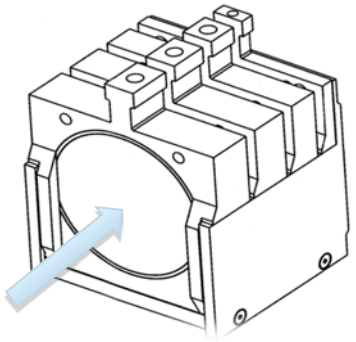
OAK RIDGE National Laboratory

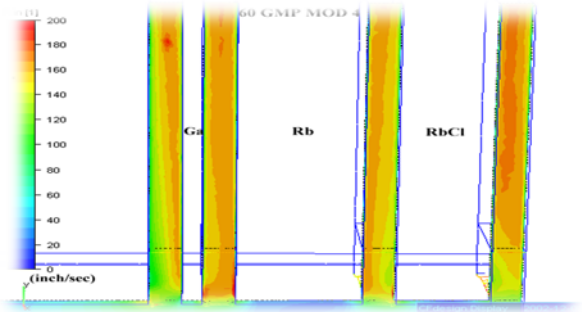
Programmatic Interests

- Stable Isotope Enrichment
  - **High enrichment**
  - **High volume**
  - **Safe, secure operations**
- Accelerator and Reactor Radioisotope Production
  - **Targetry design and modeling**
  - **Accelerator/Reactor Technologies**
  - **Separations and purification**
  - **Automation and remote handling**
  - **Safe compliant transportation of radioactive products**
  - **Waste management**



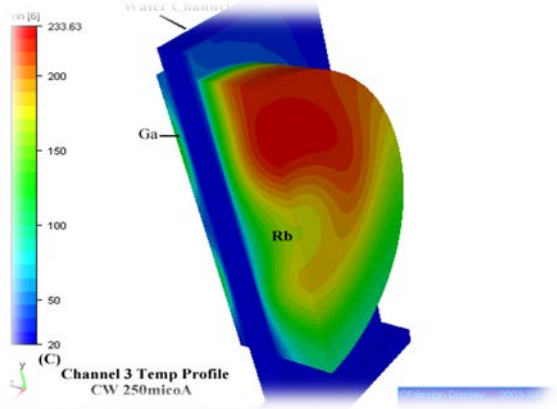






SBIR and the Isotope Program

- **SBIR/STTR**
  - Support R&D toward commercialization of isotope products or services
  - Encourage collaboration between Labs and Industrial Partners
  - 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



Summary

Strong synergy with US Private Sector (Medical and Industrial Applications)

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

Potential areas of opportunity with SBIR/STTR:

SBIR/STTR Topic Areas

A

- **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 stable isotope separation: general diagnostics**

B

- **Process Optimization – automation of process and associated activities (product dispensing) would be of great benefit to overall program**