Status of R&D on New Isotope Production Approaches

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Research Program Components

- **Isotope Program Appropriated Funding**
  - Core R&D
    - Directly stewarded activities at Labs and Universities
    - Support R&D using unique capabilities and expertise to support IP mission
    - Facilitates responsiveness to requests for isotopes
    - Important to recruiting and retention of workforce at our key facilities
  - Competitive R&D
    - Gives opportunities to Labs and Universities that have facilities and expertise in isotope production (all labs and academic institutions are eligible to submit proposals)
    - Helps us identify interests and needs in the broader community
    - Helps enable development of future workforce
  - SBIR/STTR for small businesses.

- **Workforce Development**
  - Support travel bursaries for post docs and students to attend conferences/symposia
  - Collaboratively support Nuclear Chemistry and Radiochemistry Summer Schools
  - Participation in SC Early Career Award Program
  - Participation in SC Graduate Student Research Program
Key Areas of Research

- **Transmutation** (neutrons, charged particles, high energy gamma photons)
- **Targetry** (thermal hydraulics, materials, nuclear data, particle transport modeling)
- Mass-separation for enriched stable isotopes and HSA radioactive isotopes
- Processes for recovery and purification of radioisotopes; remote handling/automation
- **Other?**
  - Application research NOT directly supported by Isotope Program
Funding Opportunity Announcements ($30.2 to date)
- Held biannually for academic and national laboratories
- Support research to provide the scientific and technical foundation to enable availability of critical isotopes for research and applications for the nation
- Evaluation of proposals done under rigorous peer review; funding decisions strongly guided by community needs

Next FOA will issue early spring for FY17/18 appropriation
- Posting in March 2016
- Proposals Due May 2016
- Review July-August 2016
- Selection by August-September 2016
- FY17 funded University efforts would start January, 2017; Labs start October-November, 2017
- [http://science.energy.gov/np/funding-opportunities/](http://science.energy.gov/np/funding-opportunities/)
- Alpha emitters for targeted therapy
  - Ac-225/Bi-213, At-211, Rn-211, Ac-227/Th-227/Ra-223, Ra-224/Pb-212, U-230/Th-226
- Beta and Auger electron emitters
  - Sc-47, Cu-67, As-77, Re-186, W-188/Re-188, HSA Sm-153, Rh-105, Ru-106, Lu-177, Ho-166, Pm-149, and other radiolanthanides, Te-119/Sb-119, Pt-193m, Pt-195m
- PET isotopes
  - Sr-82, Se-72/As-72, Ti-44/Sc-44, Cu-64, Zr-89, Mn-52, Nb-90
- SPECT and planar gamma imaging
  - Direct Tc-99m production, Cu-67
- Theranostic isotopes
  - Y-86/Y-90, As-72/As-76 or As-77, Cu-64/Cu-67, Cu-67, Sc-44/Sc-47, Sn-117m, Pt-193m
- Bimodal imaging
  - PET/CT (Ga-68)
  - PET/MRI (Mn-52)
Other Isotopes for Research and Applications

- **Np-236/Pu-236**
  - Mass spectroscopy isotope dilution standards
  - Collaborative effort between LANL and U. Washington
  - Accelerator production on uranium targets

- **Actinides for Heavy Element Chemistry and Super Heavy Element Discovery**
  - Am-243, Pu-244, Cm-248, Cf-249/Cf-251, Bk-249
  - Es-253/Es-254, Fm-257
  - U-238, Np-237, Pu-239/Pu-240/Pu-242
  - Harvested from legacy materials and/or co-produced in production of Cf-252
  - “Experimental Validation of the Optimization of Transcurium Isotope Production Model”

- **Environmental Tracers**
  - Si-32 for oceanographic research
  - As-73 for environmental toxicology

- **Isotopes for Nuclear Physics Research**
  - Ho-163 and Al-26 for astrophysics
  - Ge-76 for neutrino research

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Enriched Stable Isotopes

- Technologies currently under development
  - New electromagnetic and gas centrifuge technologies
  - Microchannel distillation for Ge-76 enrichment
  - Environmentally friendly Li-7 production based upon crown-ether solvent extraction and/or chromatography
Broad Scope Developments

- New technologies for chemical separations of lanthanides and actinides for isotope production
- Automation of isotope recovery and purification technologies
- Radioisotope production using photo-transmutation reactions in electron accelerators
- Production of radioisotopes using high energy neutrons
- Selective gaseous extraction of valuable fission isotopes from low-enriched uranium targets
- Harvesting isotopes from the Facility for Rare Isotope Beams
- Development of 100 mA ion source for electromagnetic stable isotope enrichment
Workforce Development

- Core research funding at Laboratories may support students and post-docs
- Funded several grants with significant training components (training emphasis will continue)
  - MURR/LANL/BNL
  - Penn State University
  - University of Washington/PNNL
  - Hope College/Washington University
  - Texas A&M University
- Provided FY15/16 funding to support Summer Schools in Nuclear Chemistry and Radiochemistry
- Workforce Development for Teachers and Scientists, http://science.energy.gov/wdts/  
  - DOE Office of Science Graduate Student Research (SCGSR) Program
  - SULI Program (Science Undergraduate Laboratory Internships)
- OSC Early Career Research Program
  - http://science.energy.gov/early-career/
The R&D program has been successful!

- Significant publishable advances that may lead to new or improved production capability
- Numerous students and postdocs have been engaged in the work supported by the program
- The existence of the R&D program increases the ability to recruit and retain a skilled and vibrant workforce

R&D must remain a priority for the Isotope Program

- NSACI LRP Recommendations
  - We recommend a significant increase of funding for Research and Development