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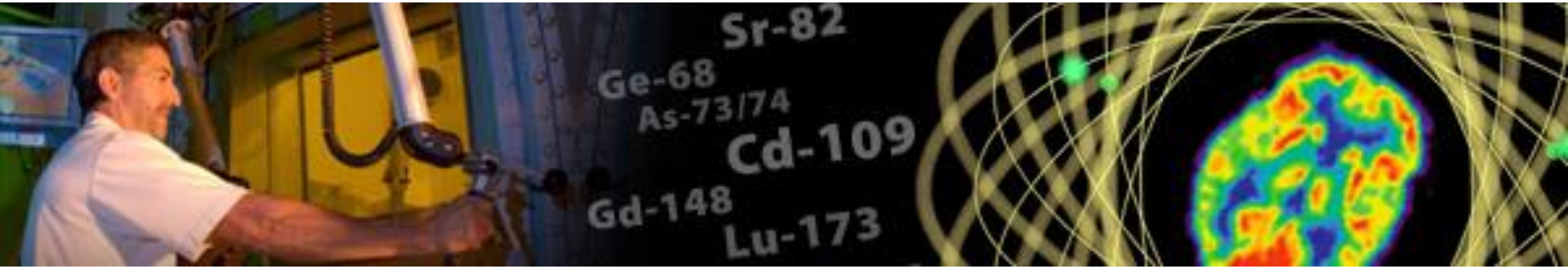
Enriched Stable Isotope Production



DOE Isotope Program -- Federal Workshop

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Stable Isotopes
DOE Isotope Program
Office of Science, U.S. Department of Energy

November 2018

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Introduction

- Stable Isotopes Uses and History
- Enrichment Technology Developments
- Enriched Stable Isotope Prototype Plant
- Accomplishments – Electromagnetic Separator
- Status – Gas Centrifuge Separator
- Stable Isotope Production Plant
- Radioactive Isotope Separator

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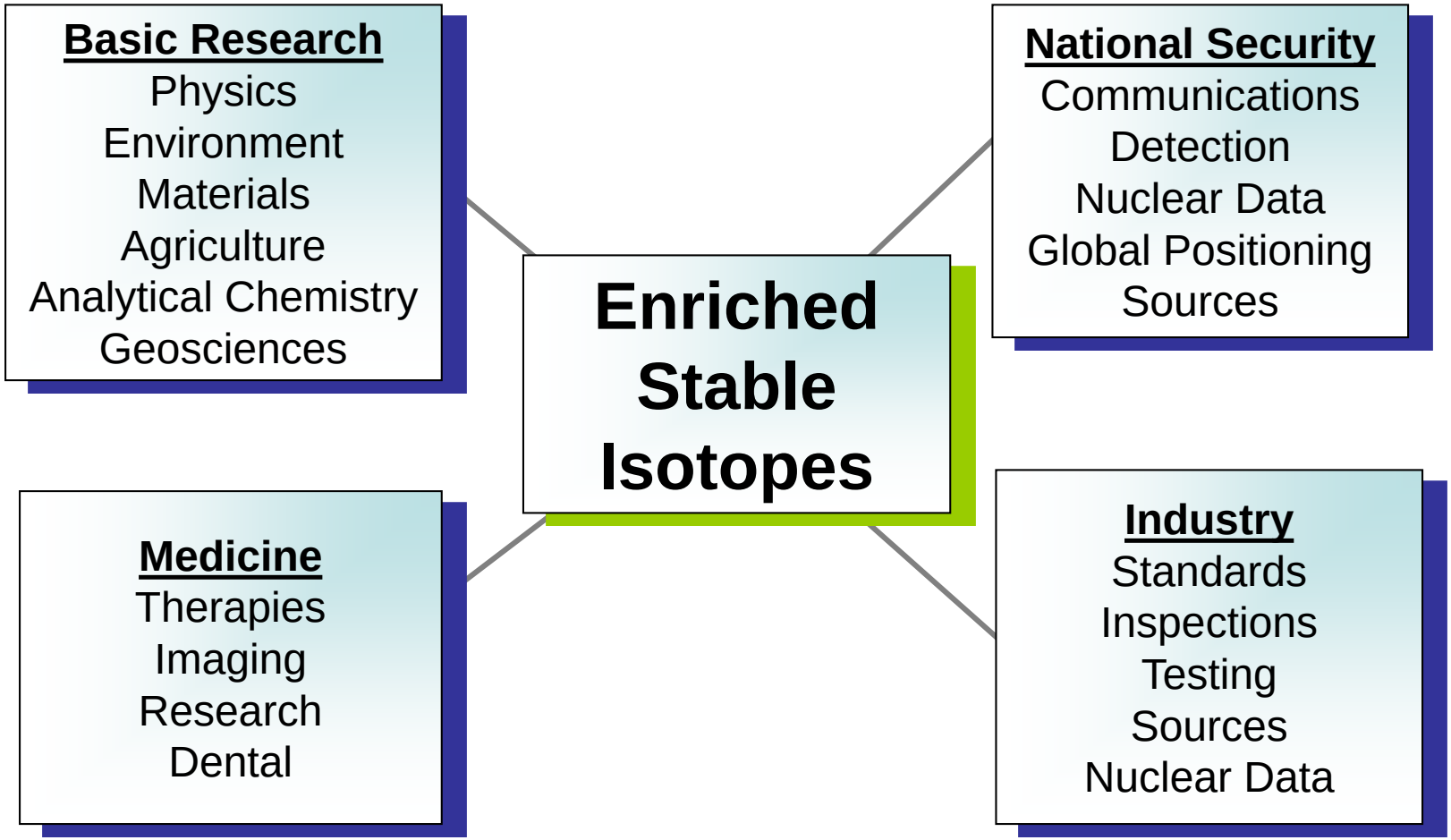
Stable Isotopes Uses



Stable Isotopes Inventory

Stable Isotope Operations at ORNL

- Enriched >230 stable Isotopes 1945 - 1998
- Unique materials with few other suppliers
- No existing domestic broad-scope enrichment
- U.S. dependent on foreign sources for new production
- Isotope Program manages national inventory
- Inventory of 11 has been exhausted
- Answered 643 isotope quote requests
- Dispensed more than 216 items in 109 shipments

  – www.isotopes.gov

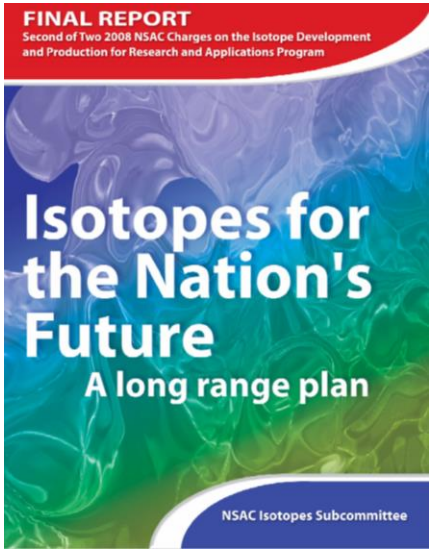
NSAC Recommendations

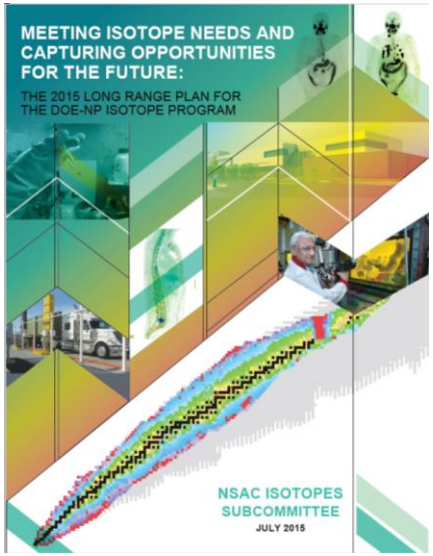
Strategic Planning for Isotopes Opportunities

- **The 220 stable non-gaseous isotopes are not currently produced domestically**
- **Most require separation and enrichment by either electromagnetic or gas centrifuge separators**

NSAC Recommendations:

- **Reestablish a domestic source of mass-separated stable research isotopes.**
- **Develop a strategy to re-establish a separator for radioactive isotopes to support research**





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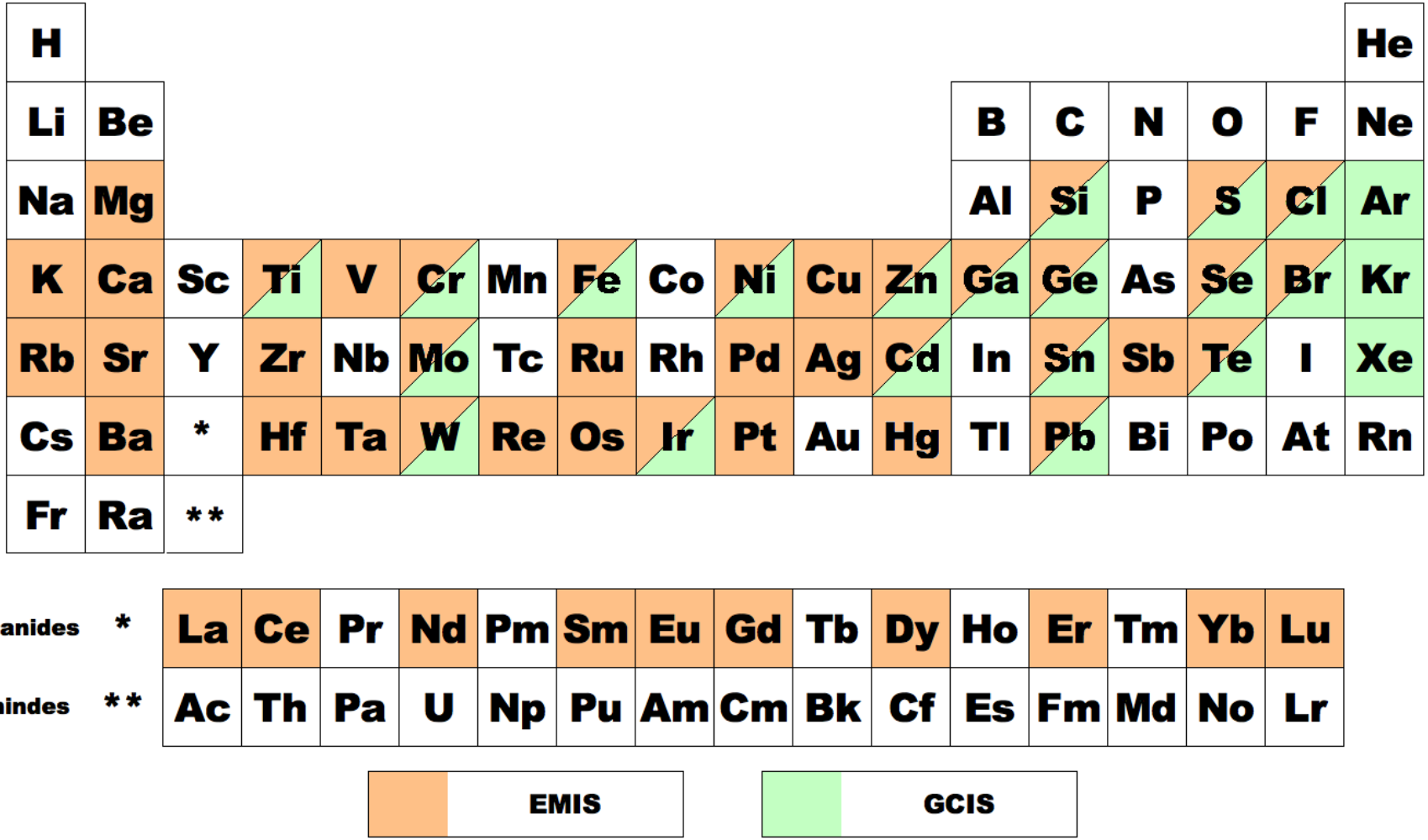
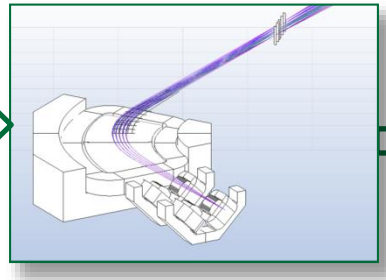
Enrichment Technology



Pathways to Enrichment

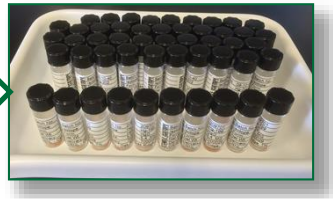
Natural Material

Electromagnetic Separator

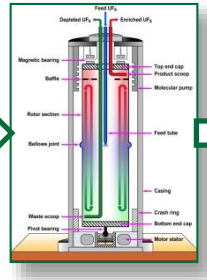


all elements, all isotopes
x10s enrichment
mg to 100s g/yr,

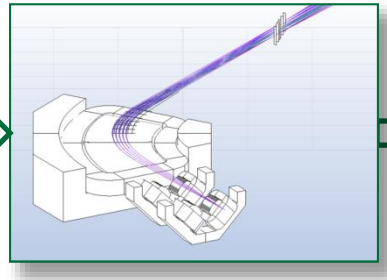
Isotopically Enriched Product



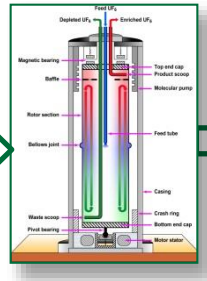
Gas Centrifuge



Electromagnetic Separator



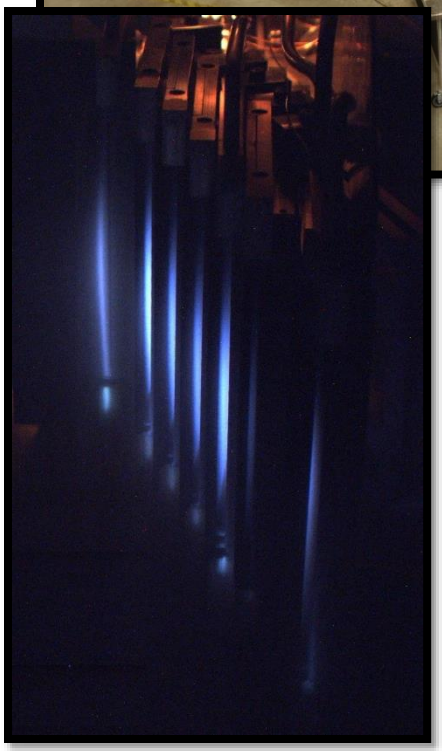
Gas Centrifuge



select elements, one isotope
x2 to x5 enrichment
100s g to kg/yr

Enriched Stable Isotope Prototype Plant (ESIPP)

- Commissioned 2017
- Investment of $11M by DOE Isotope Program
- Capability established for the Federal research community
- Small-scale production (research quantities)
- First EMIS product!
  - Ruthenium-96
  - Brookhaven National Lab Quark-Gluon Plasma research
  - Delivered January 2018.
- Pre-production under way for Ytterbium-176 enrichment



Separated ruthenium ion beams entering EMIS collector pockets.

Enriched Stable Isotope Prototype

Transition to Operations FY 2017 - 2018

Production Priorities -- EMIS

- Ruthenium-96; for physics research
- Ytterbium-176; target for cancer-therapy radioisotope

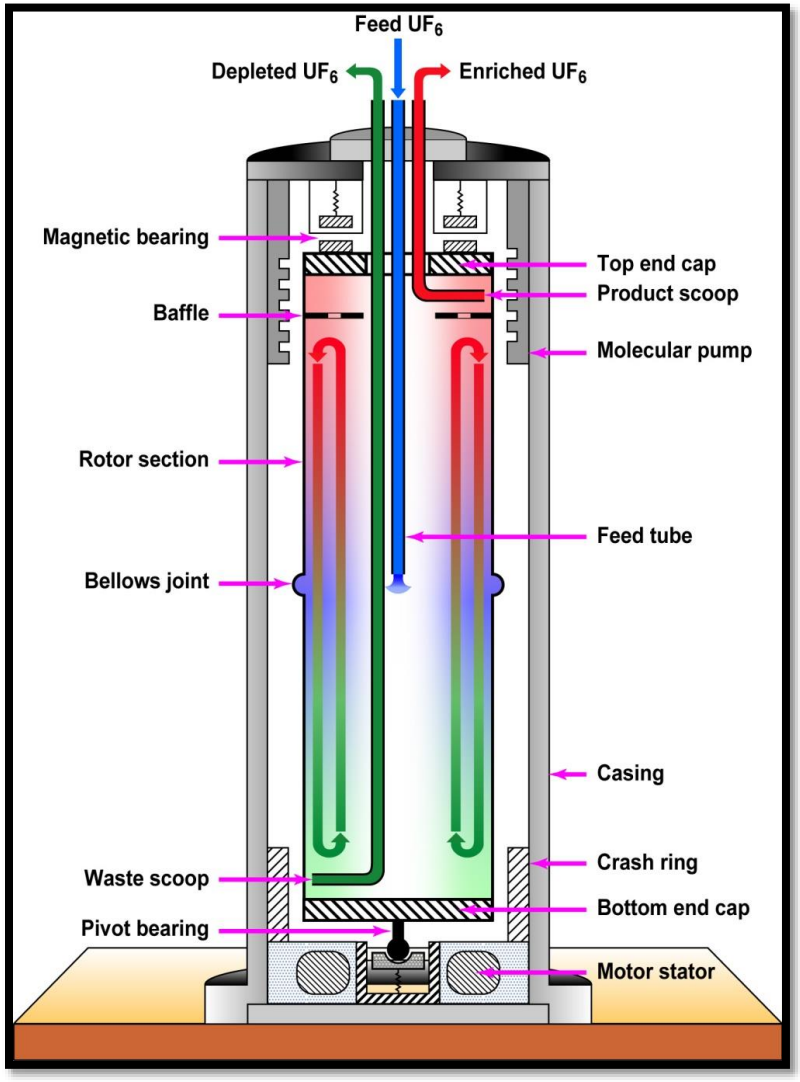
Production Priorities -- GCIS

- Molybdenum-98 and -100; targets for diagnostic radioisotope
- Xenon-129 and -136; for polarized lung imaging and physics
- Silicon-28 for semiconductors

99-percent enriched ruthenium-96

This capability is for you – let us know what you need.

Gas Centrifuge Isotope Separation



- **Higher throughput**
- **Some isotopes can be fully enriched (e.g. Ge, Mo)**
- **Provide pre-enriched feedstock material for EMIS**
  - ✓ **Multiplies EMIS performance to help achieve g/year production**
  - ✓ **Reduces the number of EMIS machines needed**

Stable Isotope Production Facility

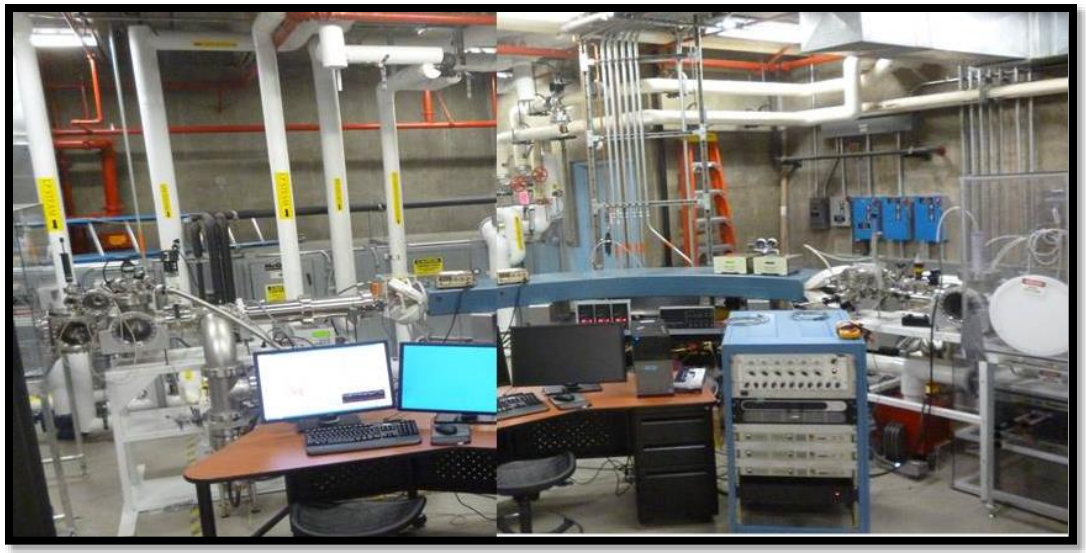
Expand from prototype to nominal kilogram annual production

- **Mission Need (CD-0) – Approved**
- **Alternatives Analysis (CD-1) for Expansion -- Approved**

- **Kilogram goal requires focus on expanding GCIS for throughput capacity**
- **CD-2 will establish baseline and final centrifuge design**
- **Early candidates include**
  - **Xenon**
  - **Silicon**
  - **Germanium**
  - **Molybdenum**

Radioactive Isotope EMIS?

- NSACi 2015 Recommendation
- Other programs are conducting development work
- Federal Information gathering 2017 - 2018:
  - ^{225}Ac, ^{153}Gd, ^{177}Lu, ^{153}Sm, and ^{166}Ho for medicine
  - Add ^{74}Se and thorium isotopes for commercial applications
  - beryllium and californium for physics research
- INL and MURR EMIS machines are candidates
- Further Mission Need is not clear. Further input is welcome.



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Conclusion

- Addressed NSAC Recommendations
- Transitioned ESIPP to Operations for the Stable Isotope Community
- Input from the Community will Affect Priorities
- Next Steps?
  - FY 2019 ^{100}Mo, ^{96}Ru, ^{129}Xe, ^{176}Yb Gram-scale Production
  - Stable Isotope Production Facility
  - Maximizes Use of ESIPP Footprint
  - Kilogram-scale production achievable for selected isotopes
  - Radioactive Isotope Separator Development