INL/MIS-23-71001-Revision-0

Xenon Quality Control Materials Production

April 2023

Troy A Robinson, Matthew G Watrous, Tracy P Houghton, Alonzo Martinez

Changing the World's Energy Future

Idaho National Laboratory

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Gas Standards Team Lead

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Battelle Energy Alliance manages INL for the
U.S. Department of Energy's Office of Nuclear Energy

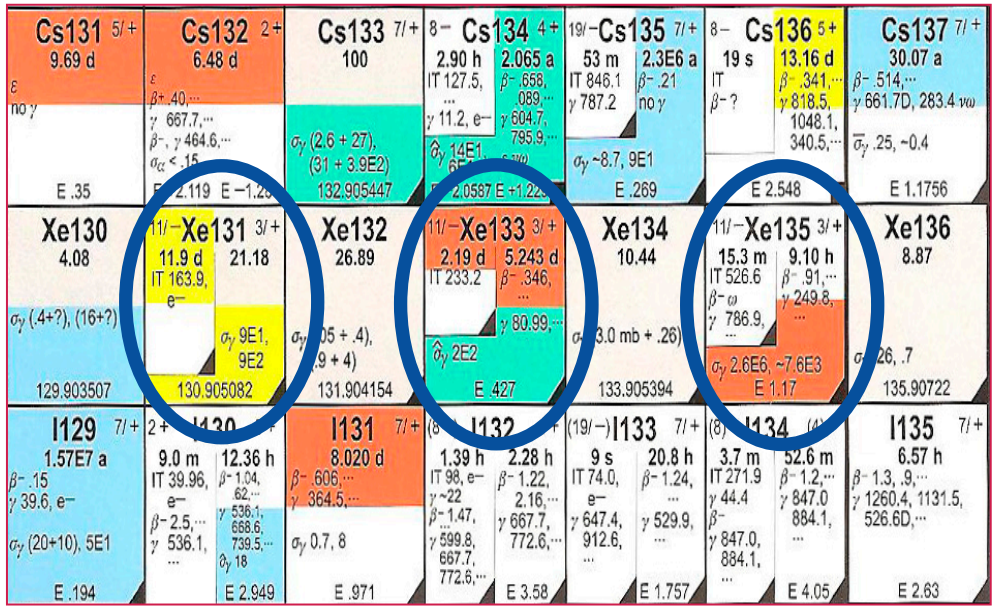
Idaho National Laboratory

Xenon Quality Control Materials Production

- Isolate Isotope of Interest
- Quantify the Activity
- Mix to Desired Specific Activity
- Fill Individual Lab Containers
- Conduct Internal Quality Control
- Ship
- Report

Routine Xenon Isotope Isolation and Mixing

- Individual Isotopes
- Mixed Isotopes



Two Dimensions of “Purity” for Isotopes

Radioactively Pure – *Only one radioactive isotope / isomer present in a gas population*

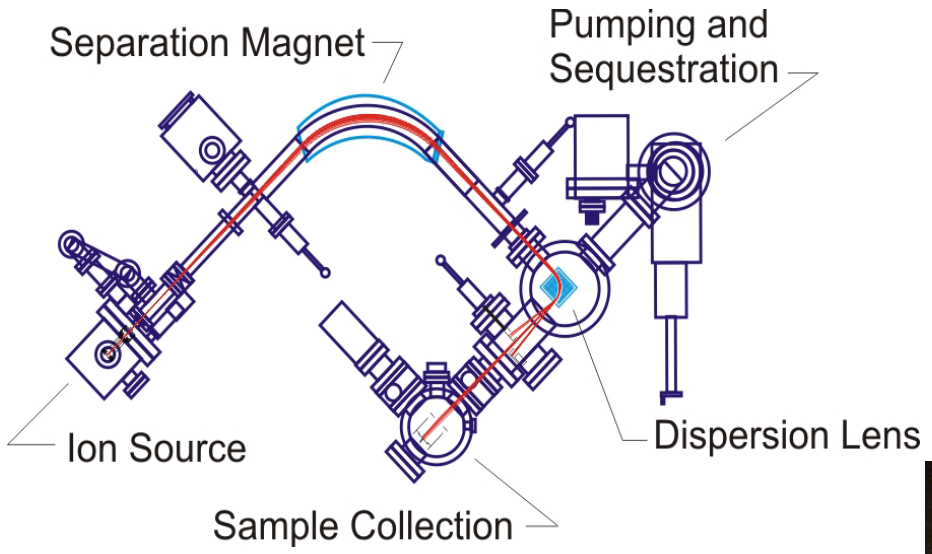
Carrier Free – *Radioactive isotope not in the presence of stable xenon many orders of magnitude more abundant.*

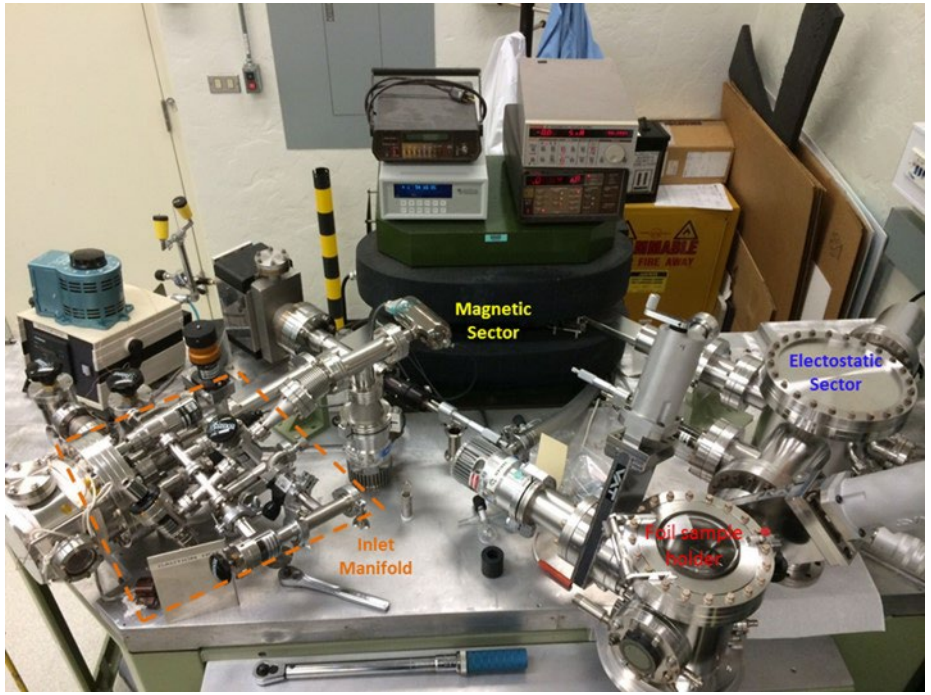
The Goal of INL Noble Gas Laboratory is to have available Radioactively and Isotopically Pure Xenon for use in supplying quality control and test samples.

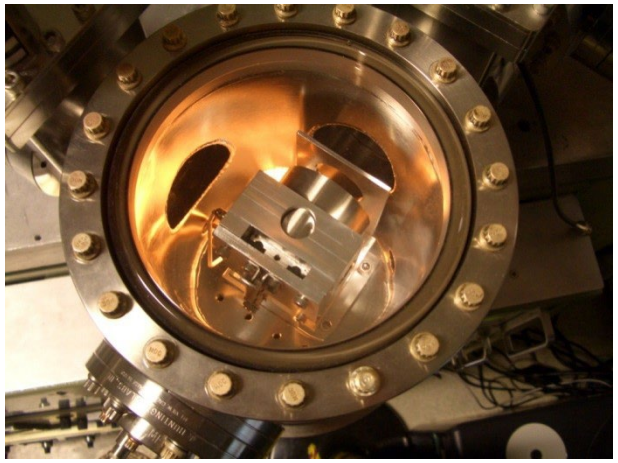
Two Dimensions of Purity - Status

		Isotopic Purity	
		No Carrier Xenon	Carrier Xenon
Radioactive Isotopes / Isomers	Single	^{131m}Xe ^{133}Xe	^{131m}Xe ^{133}Xe $[^{127}Xe]$
	Multiple		^{135}Xe ^{133m}Xe

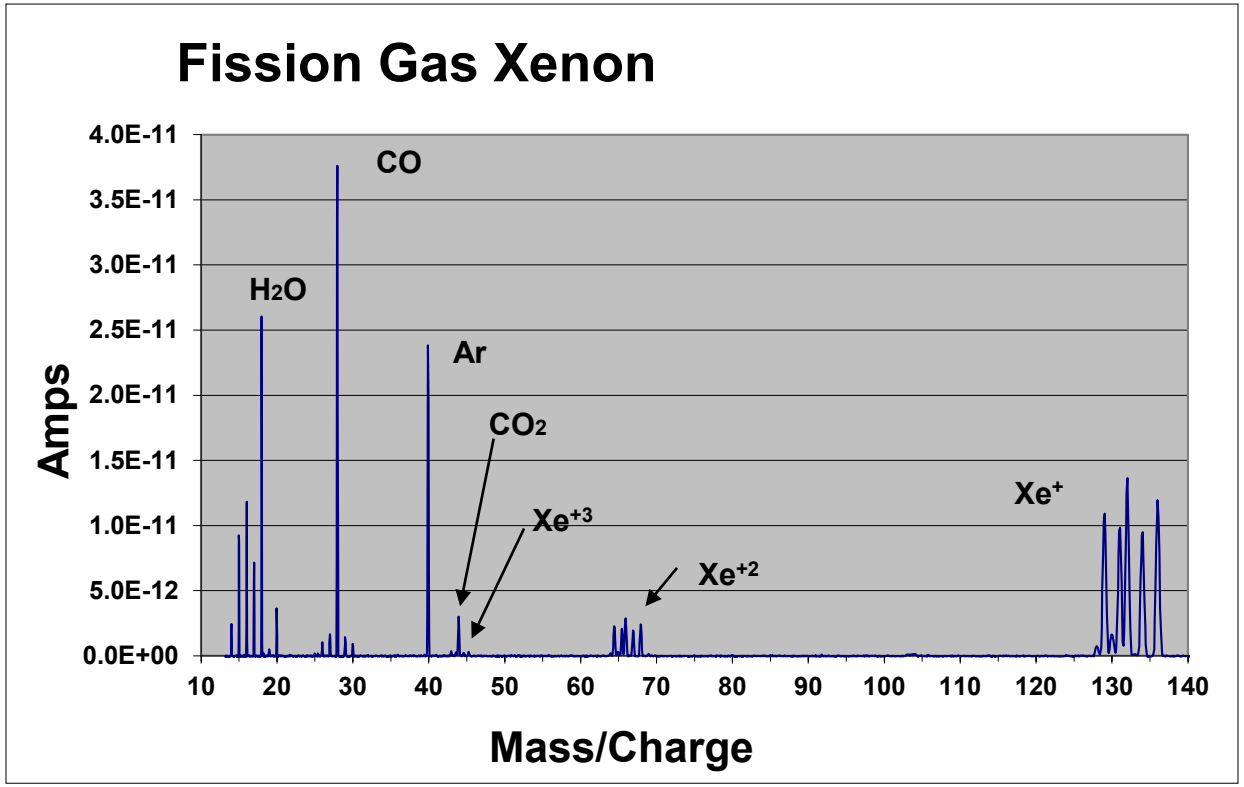
Isolate ^{133}Xe from Fission Gas
-- Xenon separator designed and built at INL

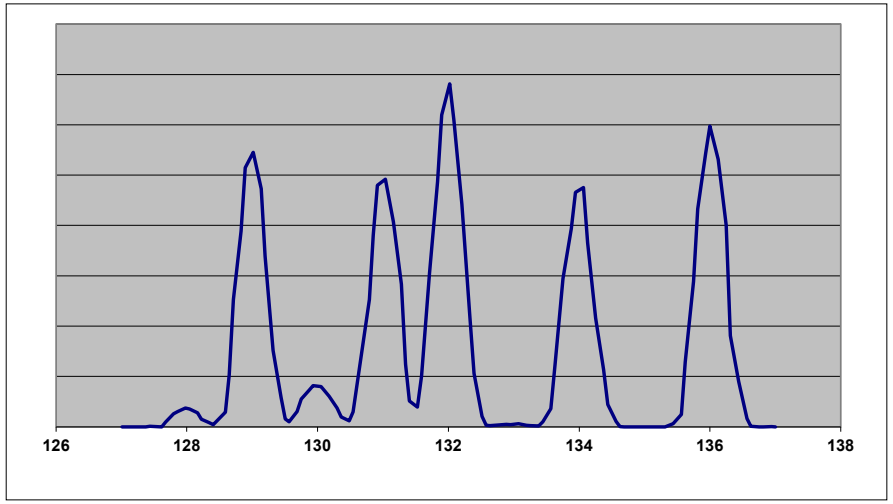


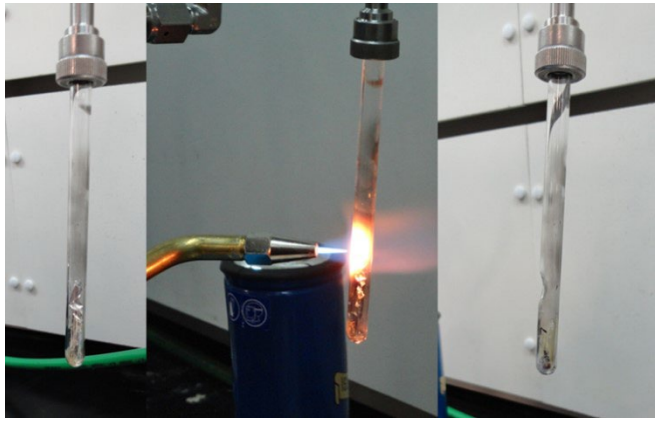




Starting material for ^{133}Xe standard is fission product xenon

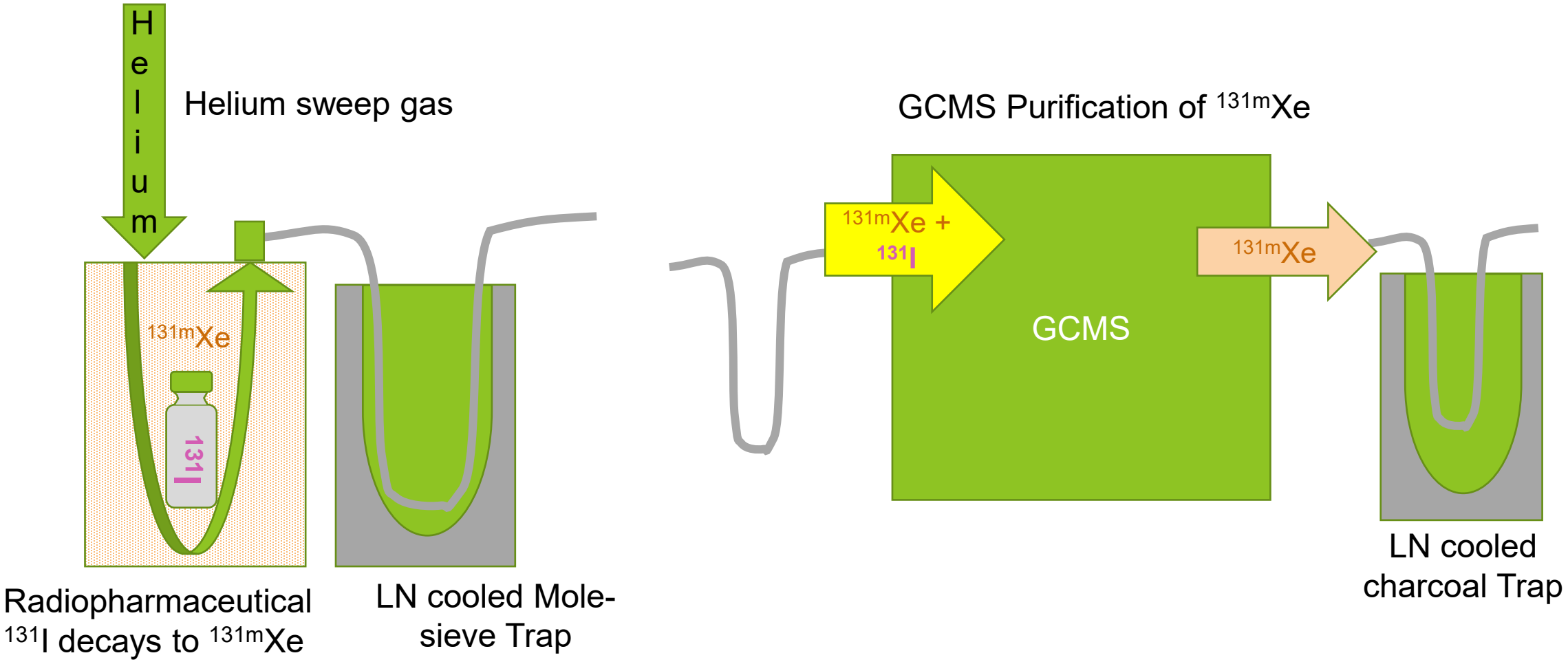




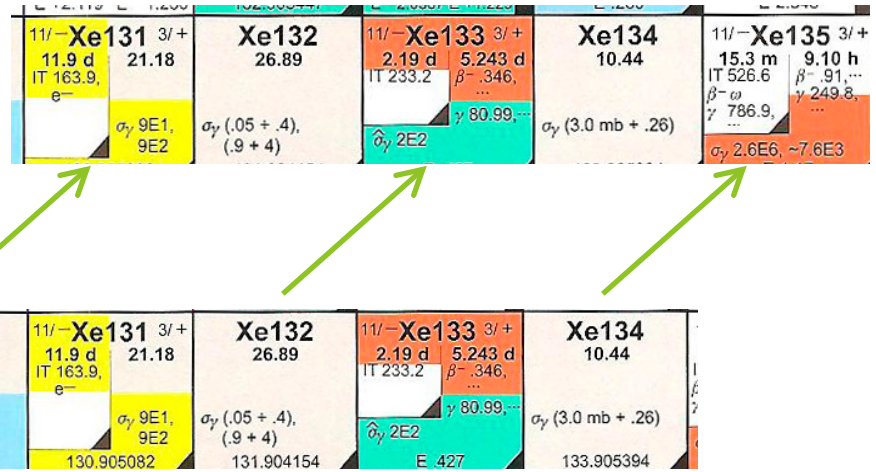


Starting Material:	20.0	mCi ^{133}Xe
Product Material:	0.02	mCi ^{133}Xe

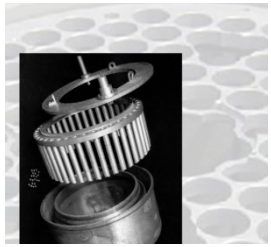
Preparation of Carrier Free ^{131m}Xe



[127], 131m, 133, 133m, 135 Xenon by Neutron Activation



NEUTRONS

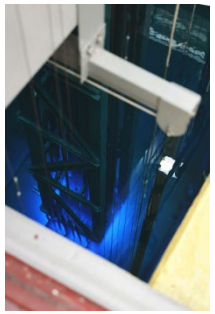


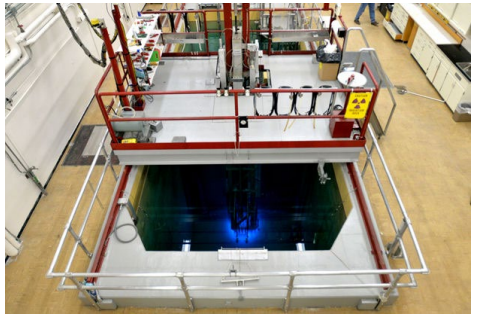
Nuclear Engineering Teaching Laboratory

at the University of Texas in Austin
Pickle Research Campus

WASHINGTON STATE UNIVERSITY

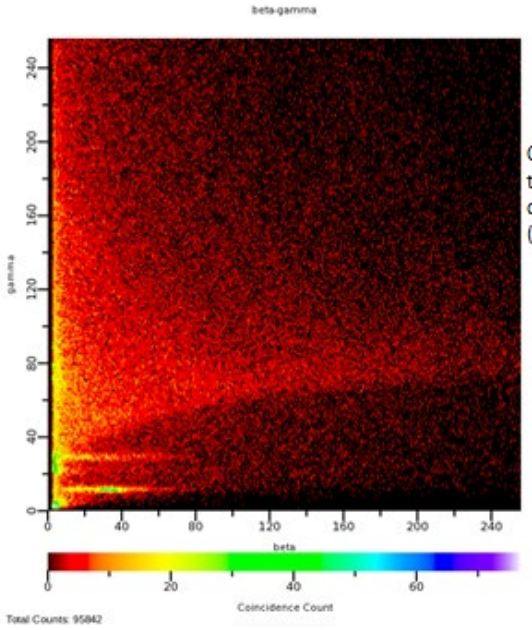
Nuclear Science Center





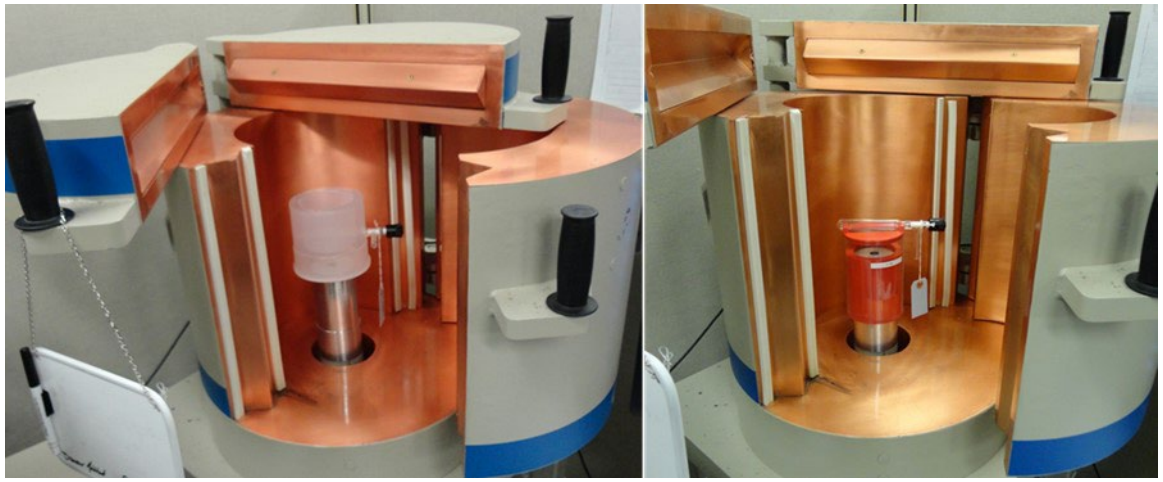
Detection Capabilities

- Germanium Detectors
- Beta-Gamma Coincident



Cell "3" was started on the day after the t-zero day. The spectrum contains less 135Xe, 133Xe (133mXe, and 131mXe?).

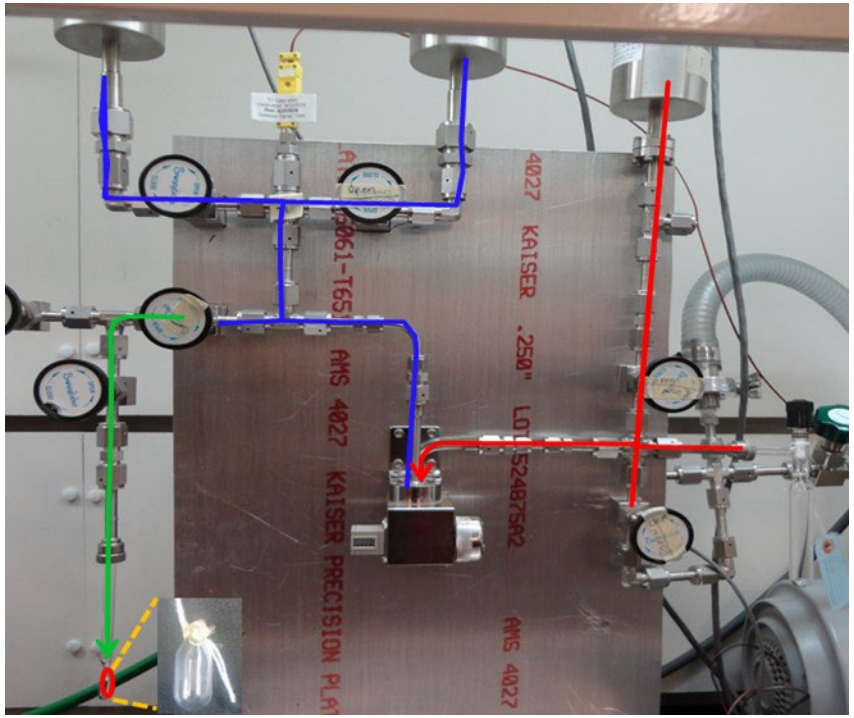
Count start	12/18/2015 14:48
Count end	1/4/2016 12:51

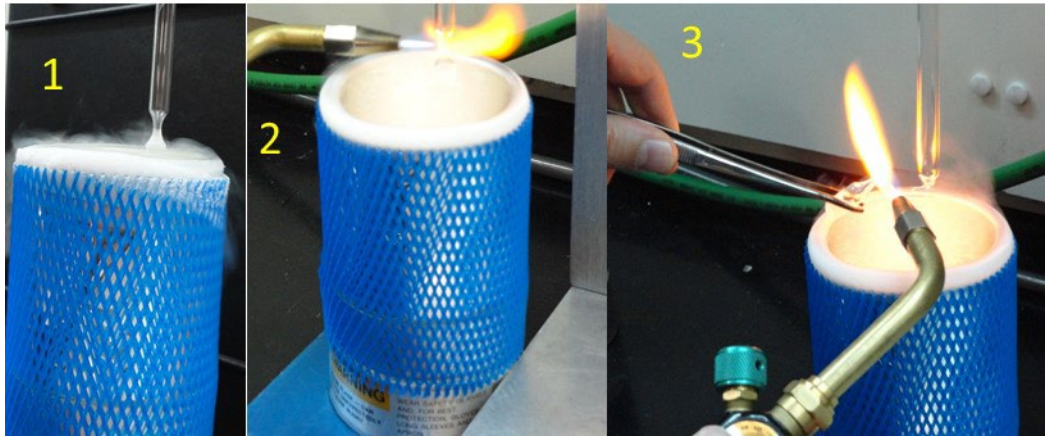


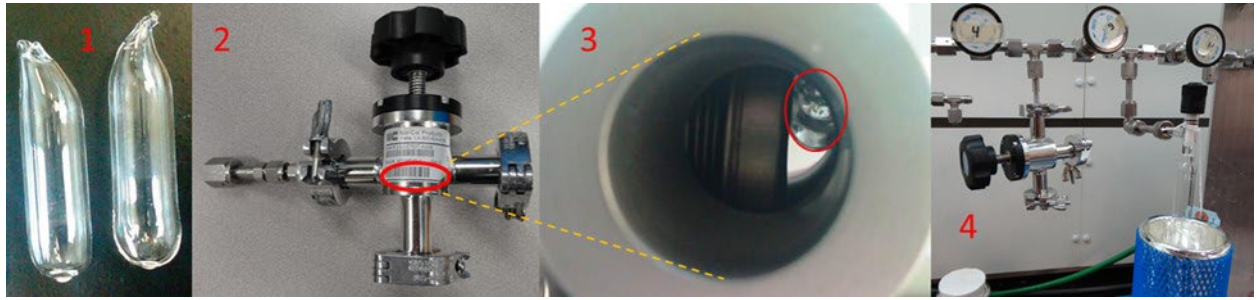
Mixing in Various Matrices

- Air
- Xenon
- Helium/Xenon
- Nitrogen/Xenon

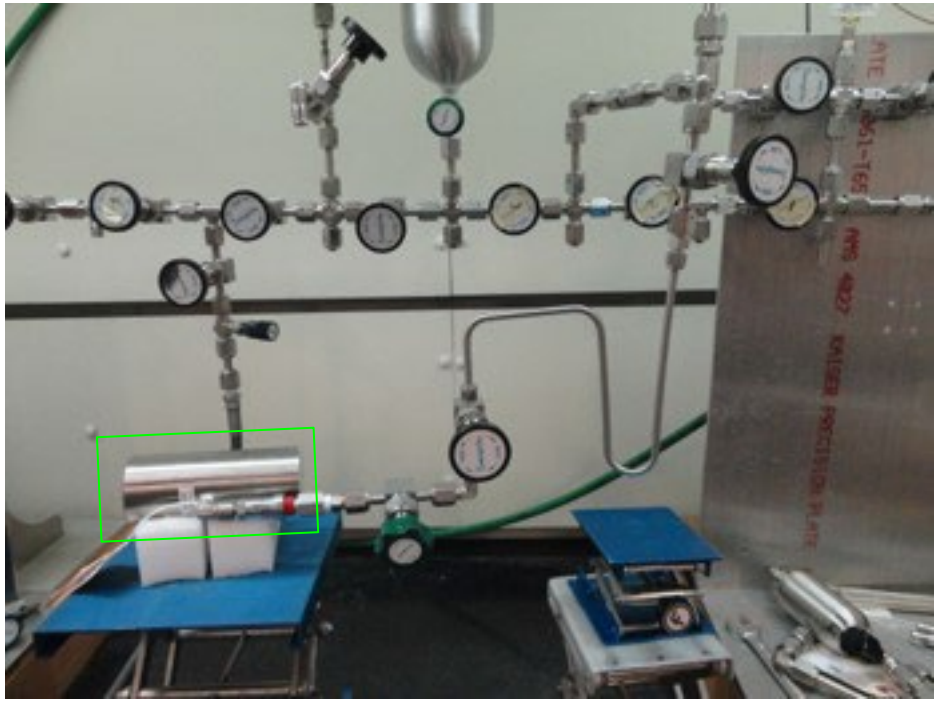
Small Volume Mixing & Dilution



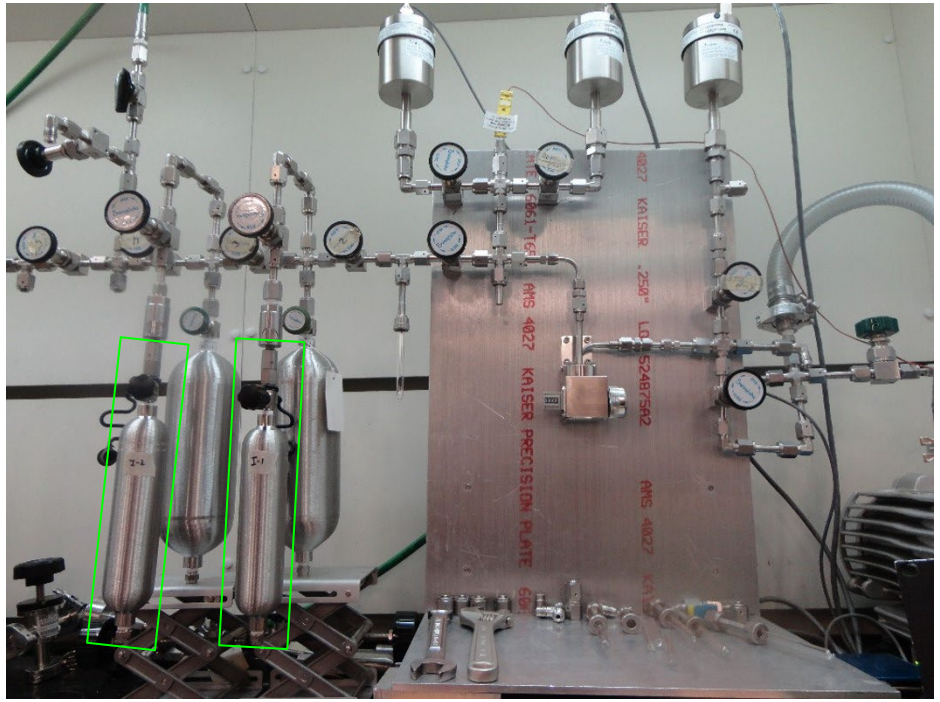




Filling Exercise Bottles



New filling procedure does not include freezing the SAUNA bottle



Filling procedure does include freezing the SPALAX bottle

SAUNA Bottle Configuration Change

Old SAUNA bottle

Manual valve Added

SPALAX already has manual valve

New Packaging Protocol to Discourage Tampering with Sample in Transit

- Measurement lab in PTE reported odd sample properties
  - Air impurity
  - Moisture content
- After analyzing filling procedures and consulting with other labs, it was theorized that samples were tampered with in transit
- New packaging and bottle design implemented to discourage tampering
  - Shrink-wrap to discourage removal of stem protectors, operating manual valves
  - Stem protectors in place to prevent operation of quick-disconnect valves

Shipment

- Rugged case shipments were initially performed in the hope of reusing shipping materials would reduce waste
  - Smaller shipments not efficient use of large case capacity
  - Cardboard boxes adopted for smaller shipments to save weight and size in shipping
- New shrink-wrap packaging is incompatible with custom foam insulation
  - Cardboard boxes are used for shipments with shrink-wrapped samples

Conclusion

- Isolate Isotope of Interest
- Quantify the Activity
- Mix to Desired Specific Activity
- Fill Individual Lab Containers
- Conduct Internal Quality Control
- Ship
- Report

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Battelle Energy Alliance manages INL for the U.S. Department of Energy's Office of Nuclear Energy. INL is the nation's center for nuclear energy research and development, and also performs research in each of DOE's strategic goal areas: energy, national security, science and the environment.