INL/CON-19-56670-Revision-0

# Production of More Pure Xe-135

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**Matthew G Watrous, Troy A Robinson**

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**Idaho National Laboratory**
**Idaho Falls, Idaho 83415**

**http://www.inl.gov**

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# Production of More Pure Xenon-135

Matthew Watrous, Idaho National Laboratory, USA matthew.watrous@inl.gov
Troy Robinson, Idaho National Laboratory, USA troy.robinson@inl.gov
Coral Kazoroff, Georgia Tech University, USA

- **Challenge:** Over time the shorter half-life of $^{135}Xe$ relative to $^{133}Xe$ and $^{133m}Xe$ (14x and 6x, respectively) leads to the impact of the $^{133}Xe$ and $^{133m}Xe$ contaminants becoming greater in activity than the desired $^{135}Xe$ activity.
- **Benefit:** Reduced $^{133}Xe$ and $^{133m}Xe$ allows for more transit time to reach multiple destinations around the globe.
- **Solution:** Reduce the production of the $^{133}Xe$ and $^{133m}Xe$ by adjusting neutron environment where $^{134}Xe$ is activated to $^{135}Xe$.

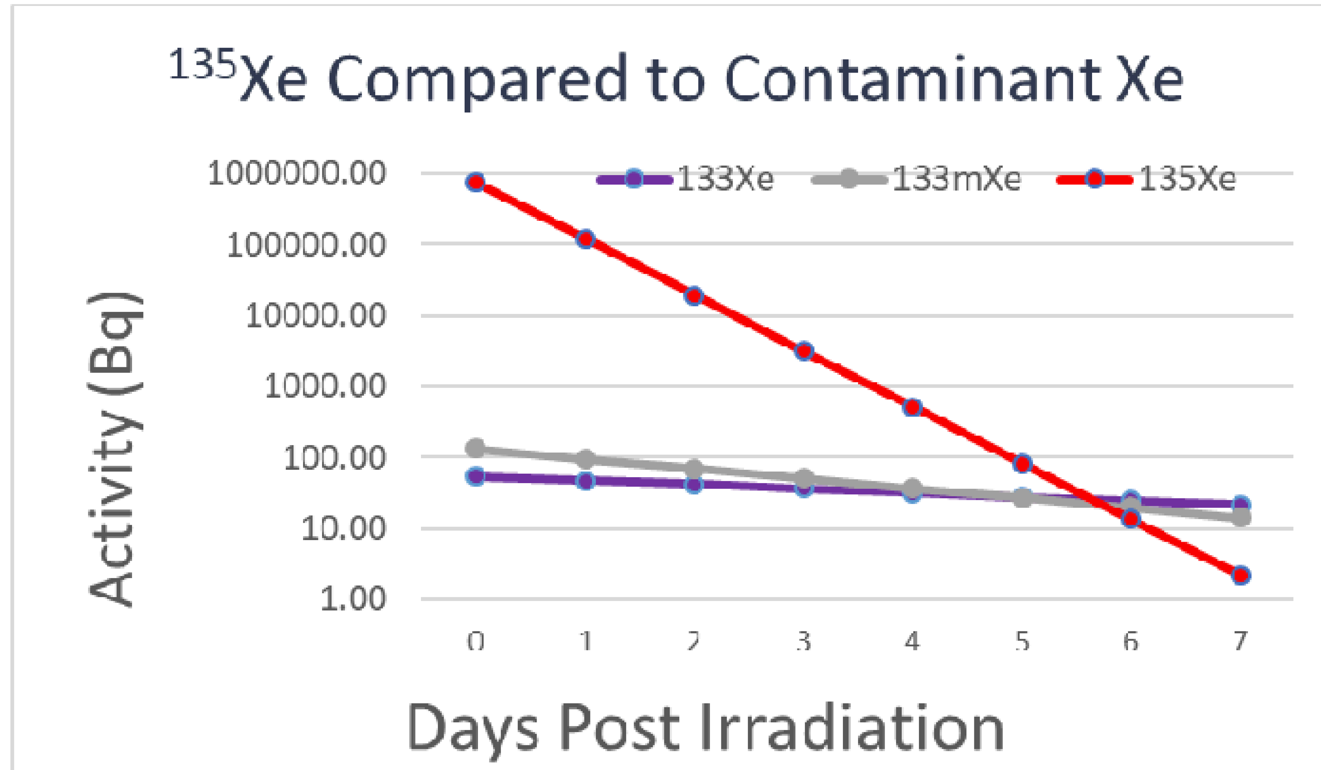
$^{135}Xe$ currently produced by neutron activation of $^{134}Xe$

Product $^{135}Xe$ contains $^{133}Xe$ and $^{133m}Xe$

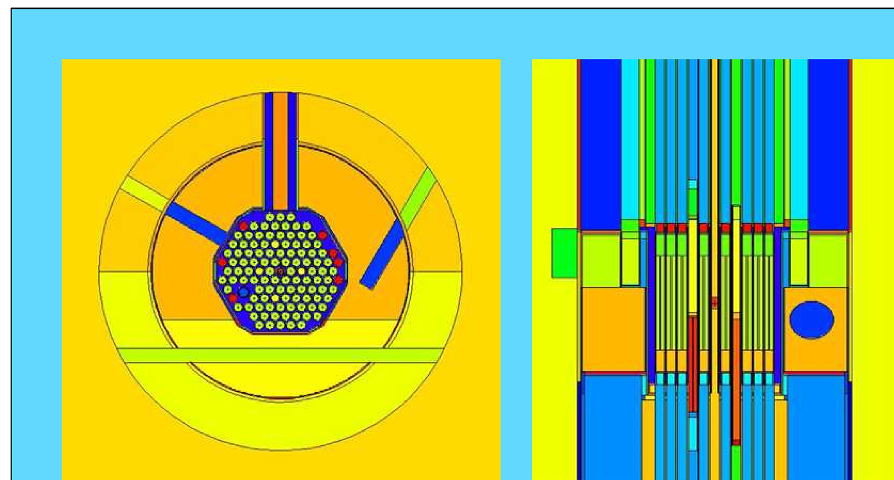
Two sources of contaminant

$^{132}Xe$ impurity in $^{134}Xe$ target material neutron activates

**( η,2η ) reaction of $^{134}Xe$**




## Neutron Activation Modeling



MCNP modelling of TRIGA reactor used in irradiation of $^{134}Xe$ targets for the production of $^{135}Xe$.

Modeled effect of added moderator on $^{133}Xe$ and $^{133m}Xe$ production versus $^{135}Xe$ production via neutron activation.

| Added Moderator | $^{133}Xe$:$^{135}Xe$ | $^{133m}Xe$:$^{135}Xe$ |
|---|---|---|
| NONE | 1.00 | 1.00 |
| BERYLLIUM | 1.57 | 1.60 |
| GRAPHITE | 0.94 | 0.94 |
| WATER | 0.27 | 0.72 |
| HEAVY WATER | 0.22 | 0.22 |

*Water and Heavy Water Minimize $^{133m}Xe$ and $^{133}Xe$ production*

## Neutron Activation Experiment

*Two different lots of $^{134}Xe$ target material were irradiated in the Washington State University Reactor at positions: D8, C9, E9 and F9. D8 is the typical irradiation position used. The amounts of $^{133}Xe$:$^{135}Xe$ and $^{133m}Xe$:$^{135}Xe$ produced relative to the typical D8 irradiation are shown in the table below*

| 0.003% $^{132}Xe$ in $^{134}Xe$ Target | | |
|---|---|---|
| Irradiation Position | $^{133}Xe$:$^{135}Xe$ | $^{133m}Xe$:$^{135}Xe$ |
| c:d | 95% | 92% |
| e:d | 100% | 99% |
| f:d | 109% | 96% |
| | | |
| 0.150% $^{132}Xe$ in 134Xe Target | | |
| Irradiation Position | $^{133}Xe$:$^{135}Xe$ | $^{133m}Xe$:$^{135}Xe$ |
| c:d | 96% | 94% |
| e:d | 98% | 96% |
| f:d | 104% | 98% |

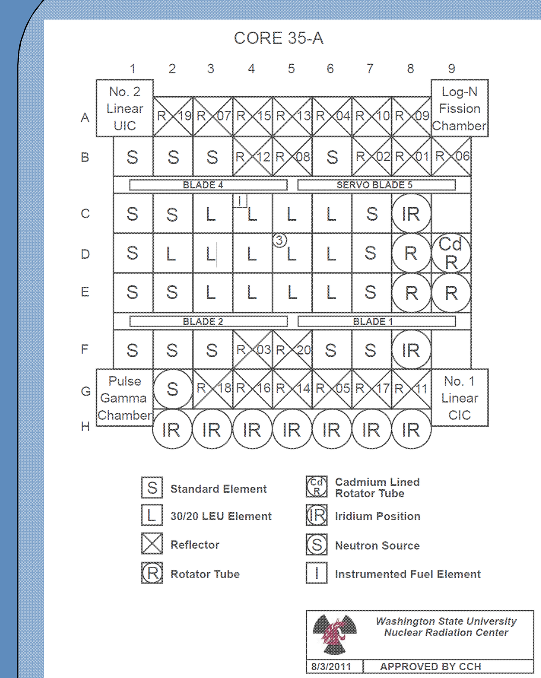



Diagram of WSU Reactor irradiation positions

*Position C9 Minimizes the Production of $^{133}Xe$ and $^{133m}Xe$*

**Modeling shows $^{133m}Xe$ and $^{133}Xe$ production can be minimized by moderating the neutron environment for the irradiation**

**Experiment demonstrates that the $^{133m}Xe$ and $^{133}Xe$ Production can be minimized at different reactor irradiation positions.**

***Path forward is to rework the modeling and the experiments to refine the improvements in minimizing $^{133m}Xe$ and $^{133}Xe$ Production***

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