### Objective

Develop a methodology to calculate tritium production through the FHR lifetime and examine impacts of design choices (fuel enrichment, Lithium enrichment, and FLiBe inventory).

- Due to FLiBe salt coolant, tritium generation in FHRs increases with higher thermal cross section.
- The resulting tritium is transported throughout the primary loop where it may be released through heat exchangers and other components such as the vessel.
- In order to design systems to control and prevent the release of tritium, the source and generation should be understood in detail.

### FHR Reference Design (preconceptual AHTR from ORNL)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Power</td>
<td>340MW</td>
</tr>
<tr>
<td>Thermal Efficiency</td>
<td>45%</td>
</tr>
<tr>
<td>Fuel Type</td>
<td>Uranium (UCO)</td>
</tr>
<tr>
<td>Uranium-Enrichment</td>
<td>96.9 Li-235</td>
</tr>
<tr>
<td>Fuel Form</td>
<td>TRISO particles</td>
</tr>
<tr>
<td>Number of Assemblies</td>
<td>252</td>
</tr>
<tr>
<td>Moderator / reflector</td>
<td>Graphite</td>
</tr>
<tr>
<td>Primary Coolant</td>
<td>FLiBe Salt (Li$_7$O, Li$_4$F)</td>
</tr>
<tr>
<td>Lithium Purify</td>
<td>99.9% Li$_4$F</td>
</tr>
<tr>
<td>Indet Temperature</td>
<td>650°C</td>
</tr>
<tr>
<td>Outlet Temperature</td>
<td>700°C</td>
</tr>
</tbody>
</table>

### Metrics for Tritium Production

- **Pathways of Tritium Production in FLiBe**
  - Tritium is mainly generated in Li, so the FLiBe salt has lithium with a purity of 99.995% Li. An equilibrium concentration of Li is reached over time.
  - FLiBe Inventory in Primary Loop
  - Flibe Inventory in Primary Loop
  - Tractability of tritium production in FLiBe and important cross sections.

### TRISO Fuel Enrichment

- The reference AHTR design has 2 enrichment options
  - 9% (softer spectrum)
  - 10% Li-6 + 1/3 Li-7 with a high thermal cross section
  - 19.7% (harder spectrum)

### MCNP6.1

1. MCNP6.1 reactor transport with detailed full core model
   - Use continuous energy ENDF/B-V.0 nuclear data library
   - Tally flux magnitude and spectrum in all important regions
   - tally multiply groups spectrum using the 253-group library used in SCALE-6.2
   - Tally important reaction rates in FLiBe

### References


### Conclusions

- FLiBe inventory is significant for tritium reactivity
- Developed a methodology and post-processing interface to study tritium production rates using MCNP and SCALE.
- Optimal balance between lithium enrichment cost and overall tritium production.
- Optimal balance between lithium enrichment cost and overall tritium production.
- Initial AHTR design had 3 enrichments:
  - 10% Li-6 + 1/3 Li-7 with a high thermal cross section
  - 19.7% (harder spectrum)
  - 9% (softer spectrum)

### References