

Kaleidos

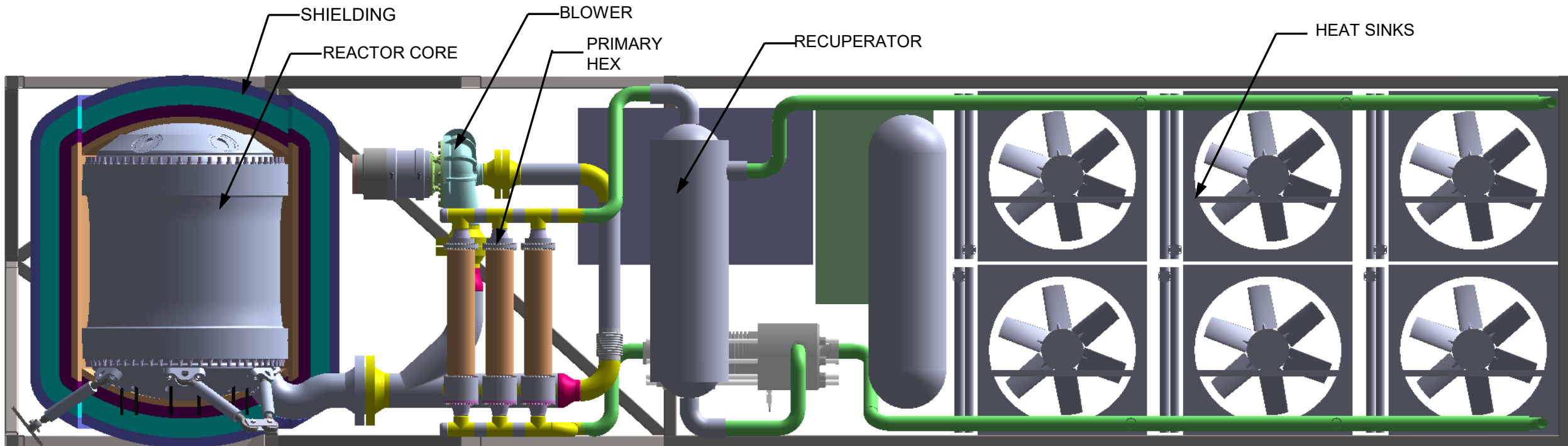


Overview of a Portable, High
Temperature Gas-Cooled Microreactor
Demonstration Unit Design

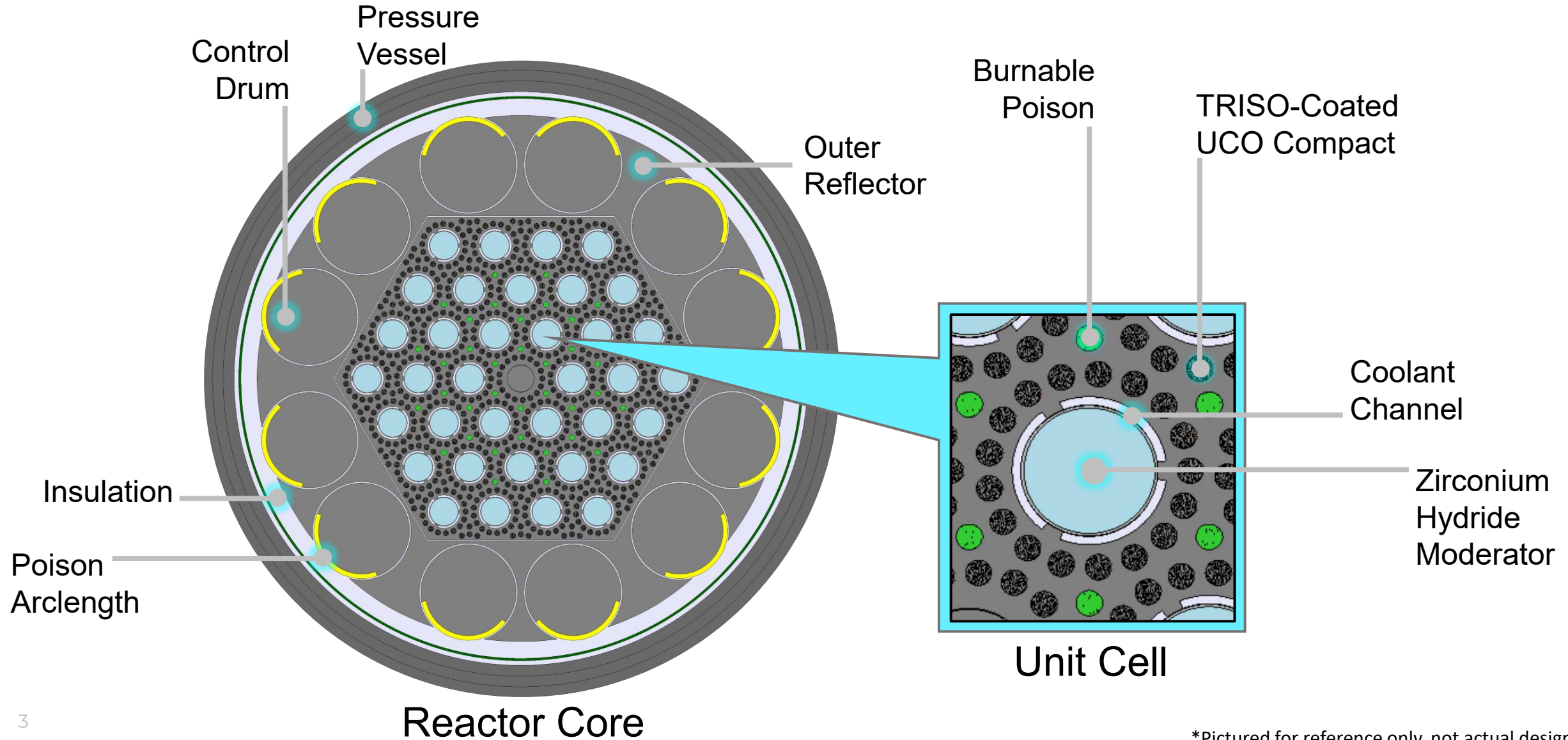
June 20th, 2023

Kaleidos Overview

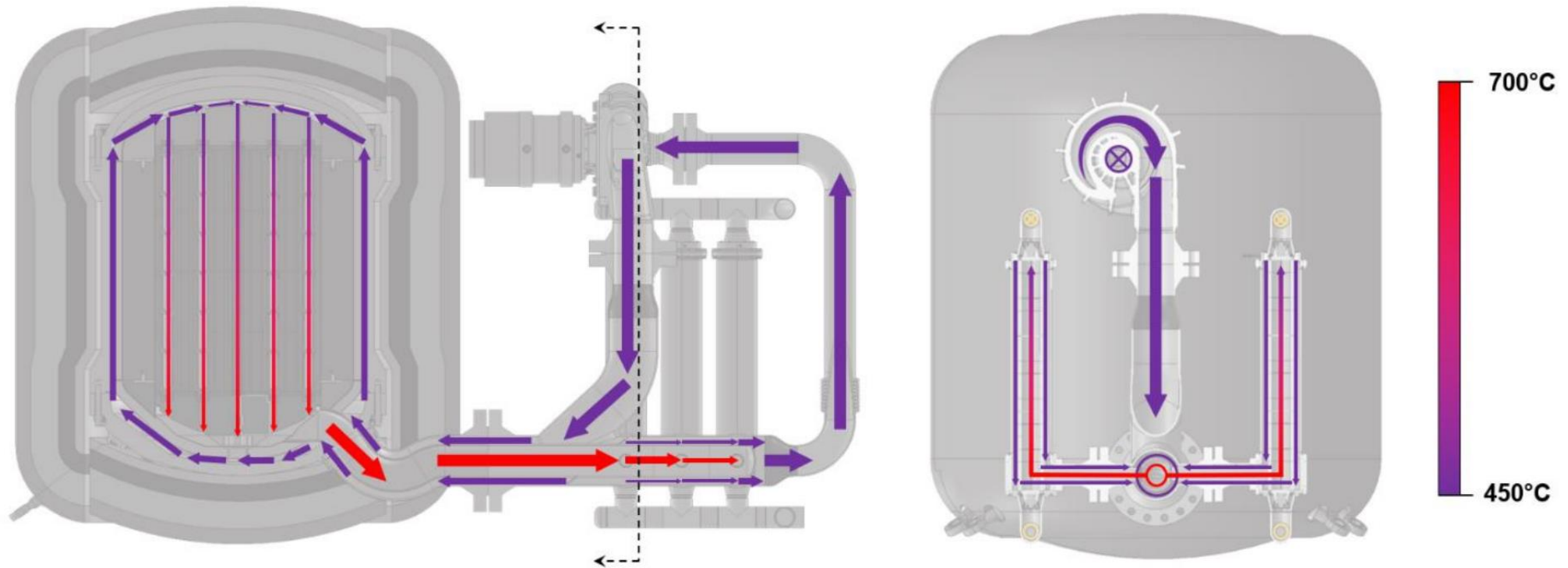
- Power output of 3.5 MWt, 1 MWe
- Factory refueled, no waste left on-site
- 5-year energy source equivalent to 5,500 tons of diesel fuel per core
- TRISO-coated UCO fuel
- Helium primary loop coolant
- Passive cooling air jacket



Core Design



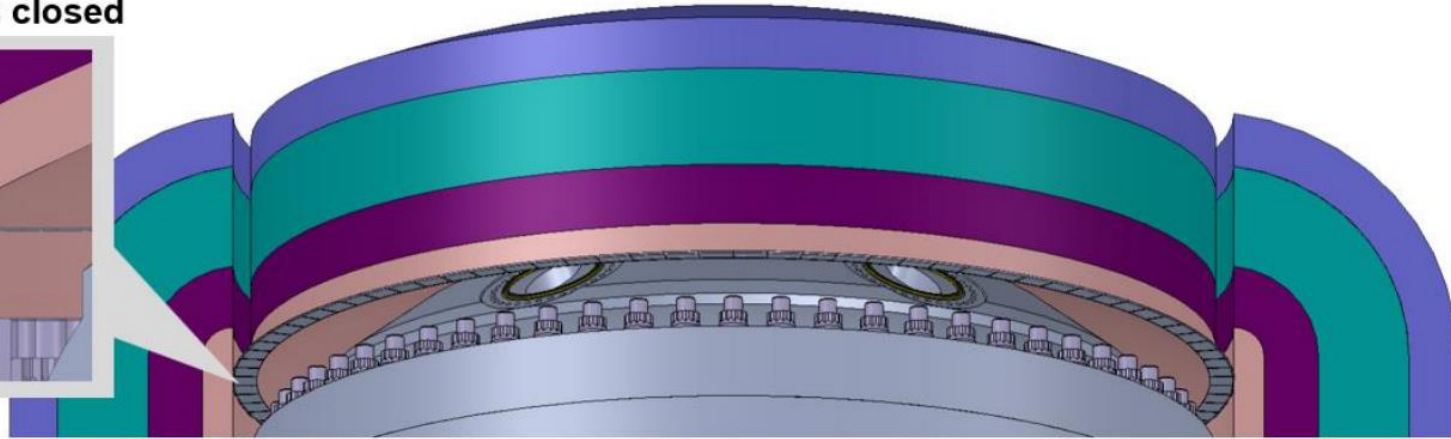
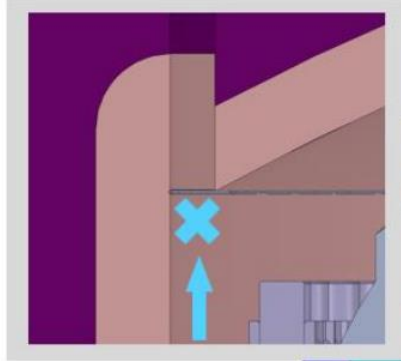
Primary Loop Design



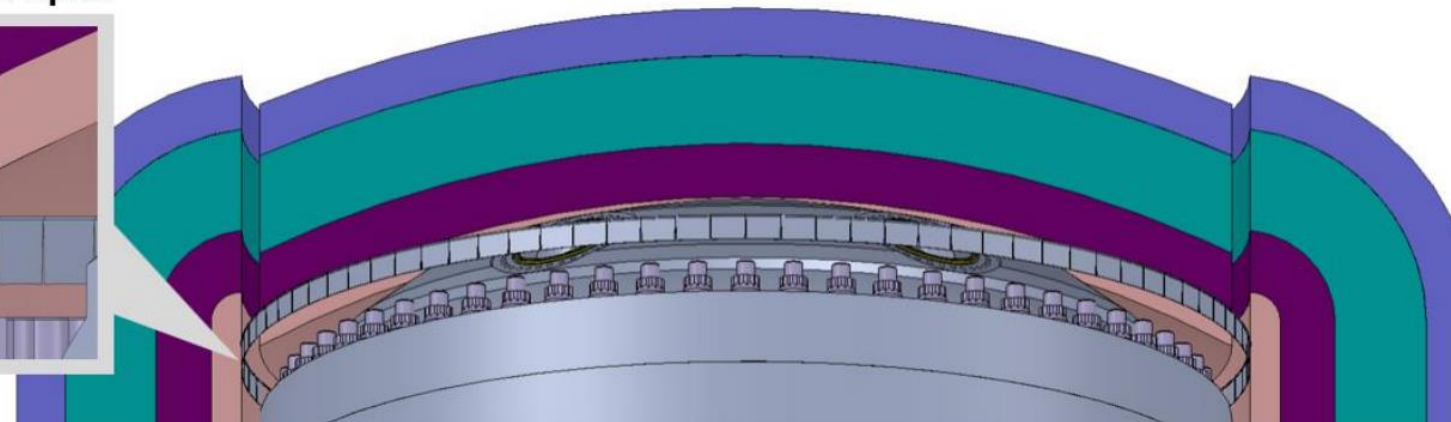
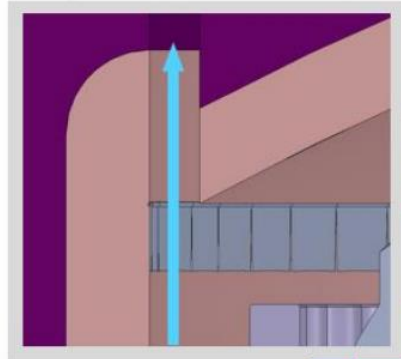
Primary Loop Helium Flow Path

Air Jacket Design

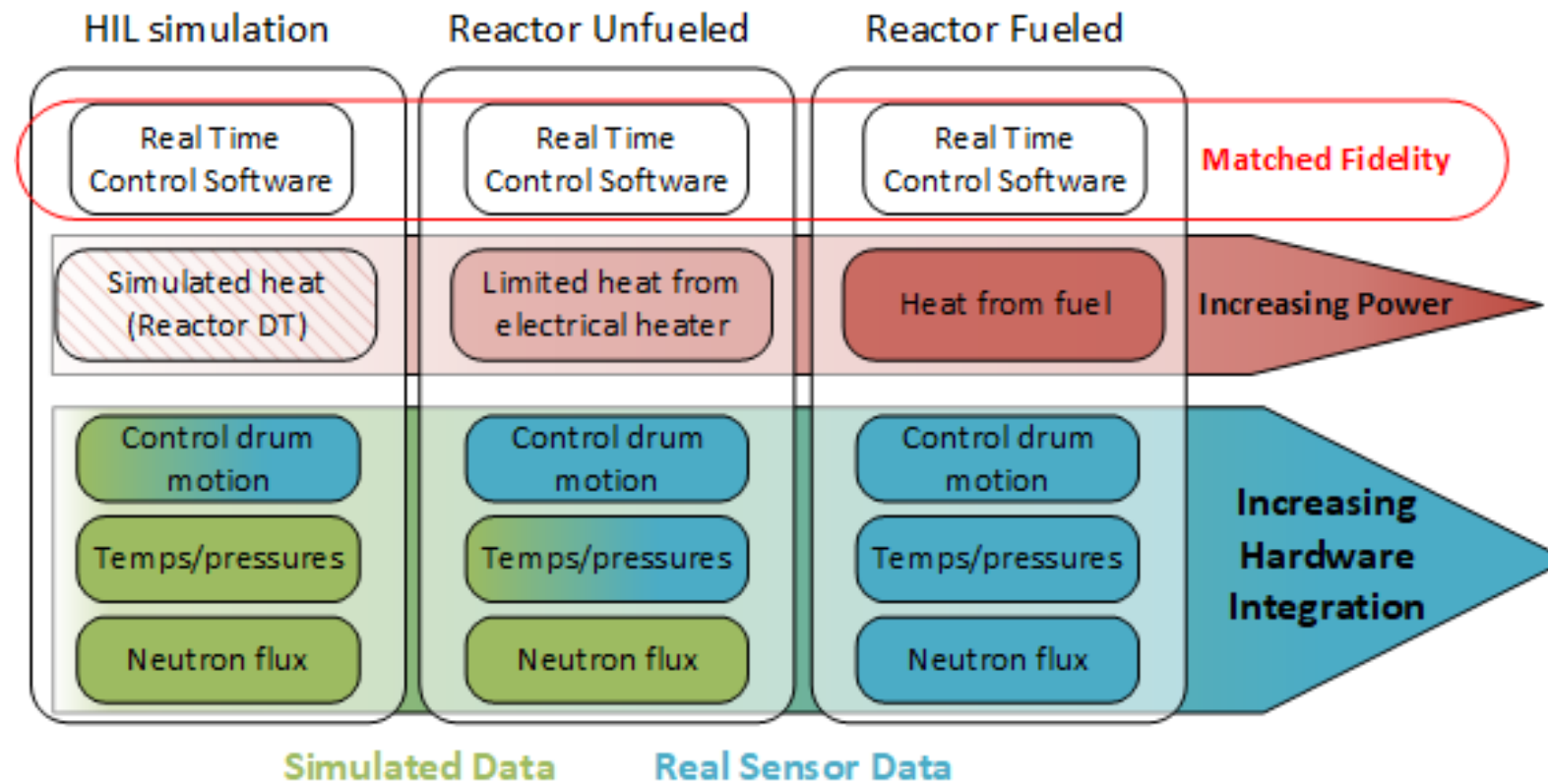
Air jacket louvers closed



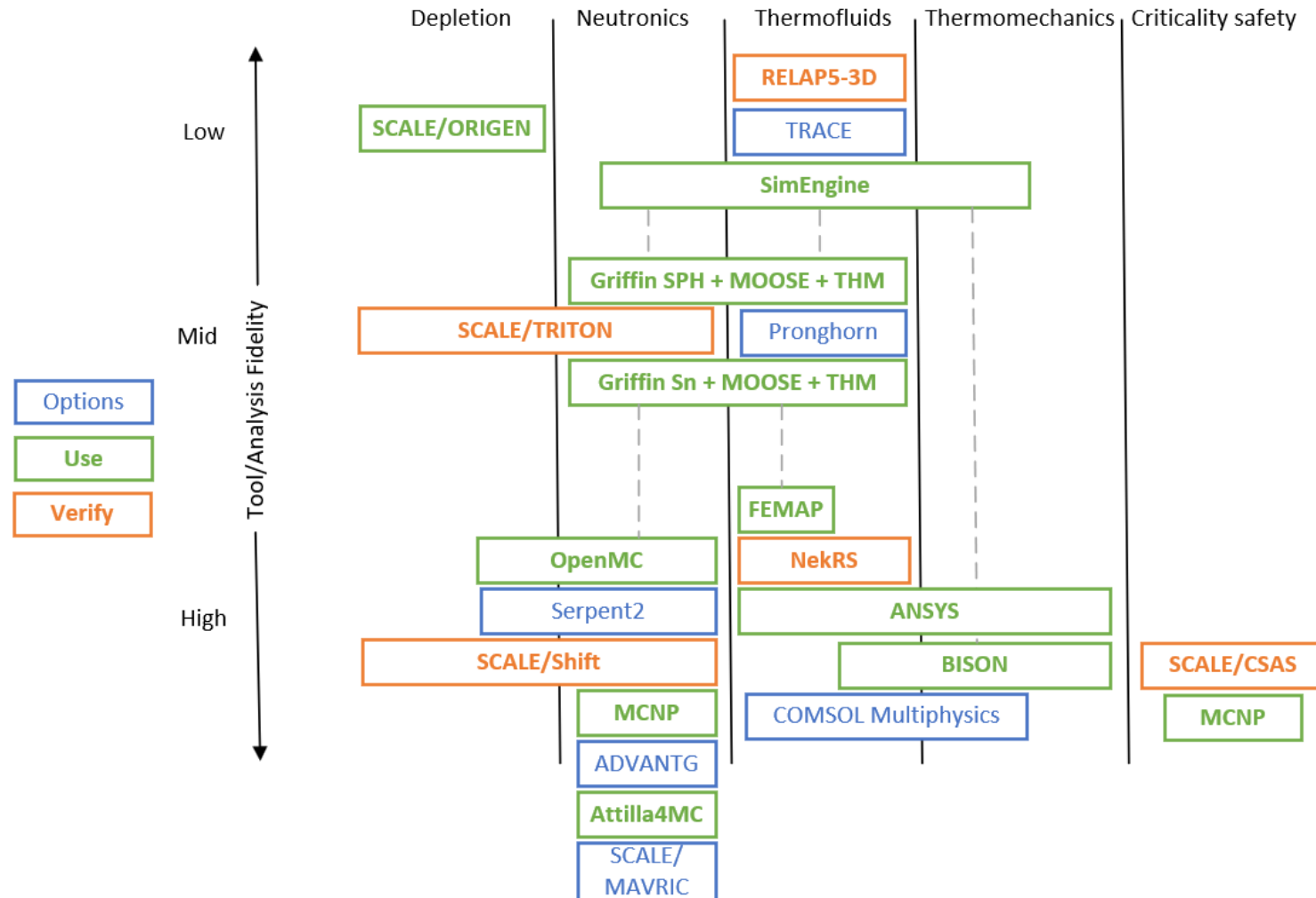
Air jacket louvers open



Modeling and Simulation Methodology

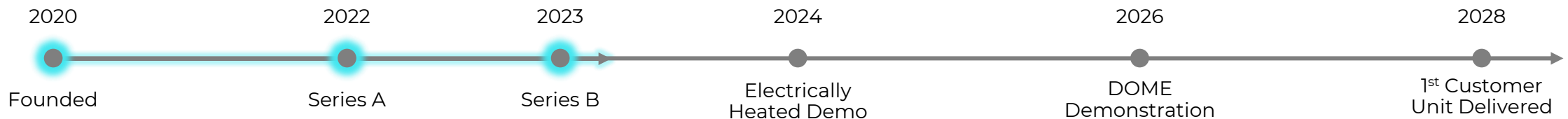


Modeling Methods and Tools



Kaleidos Demonstration Project

- Operate Kaleidos at 3.5 MWt for at least 1 week
- Tests reactor and primary loop in existing containment structure, only generates heat
- Qualification through demonstration: Unlocks commercialization

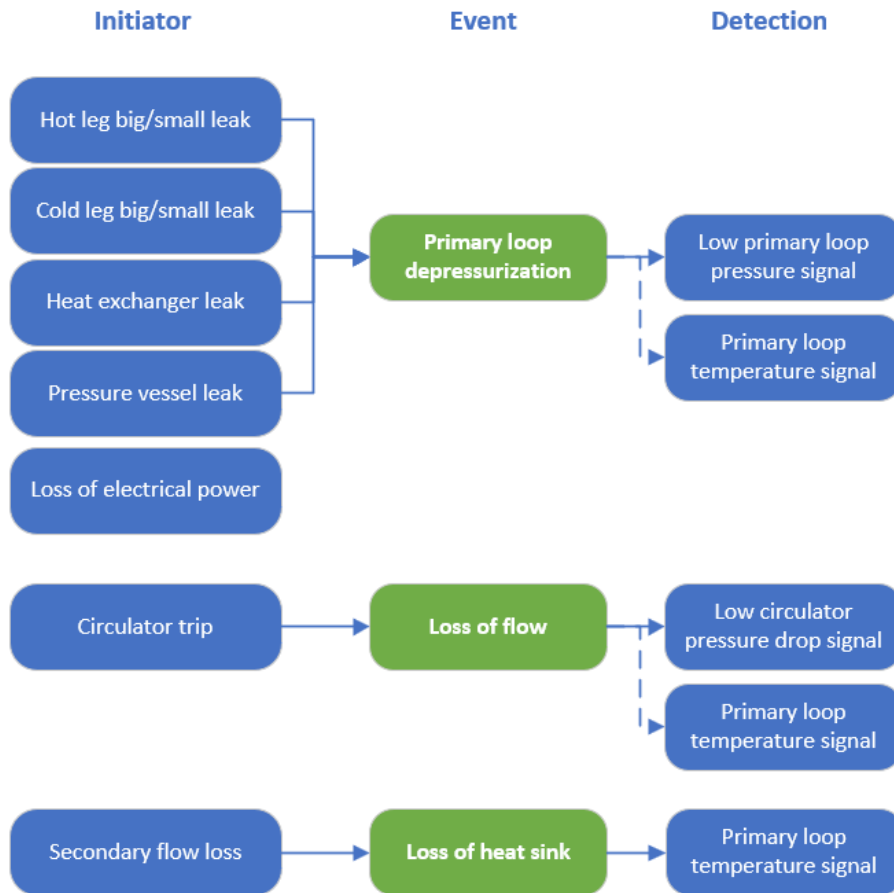




Q & A

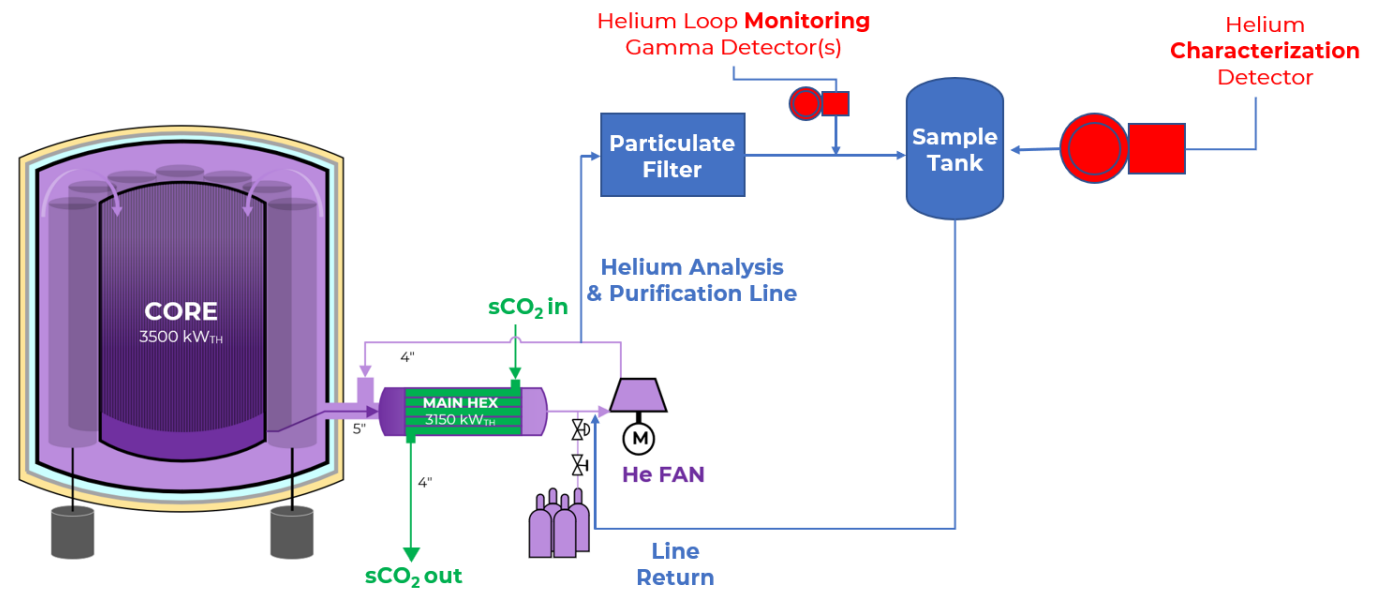
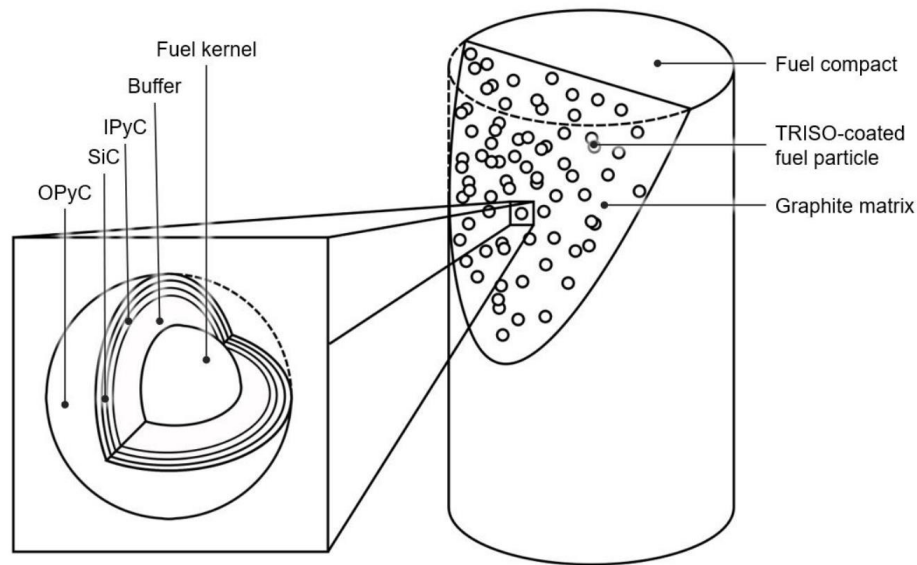
Supplemental Slides

Analysis



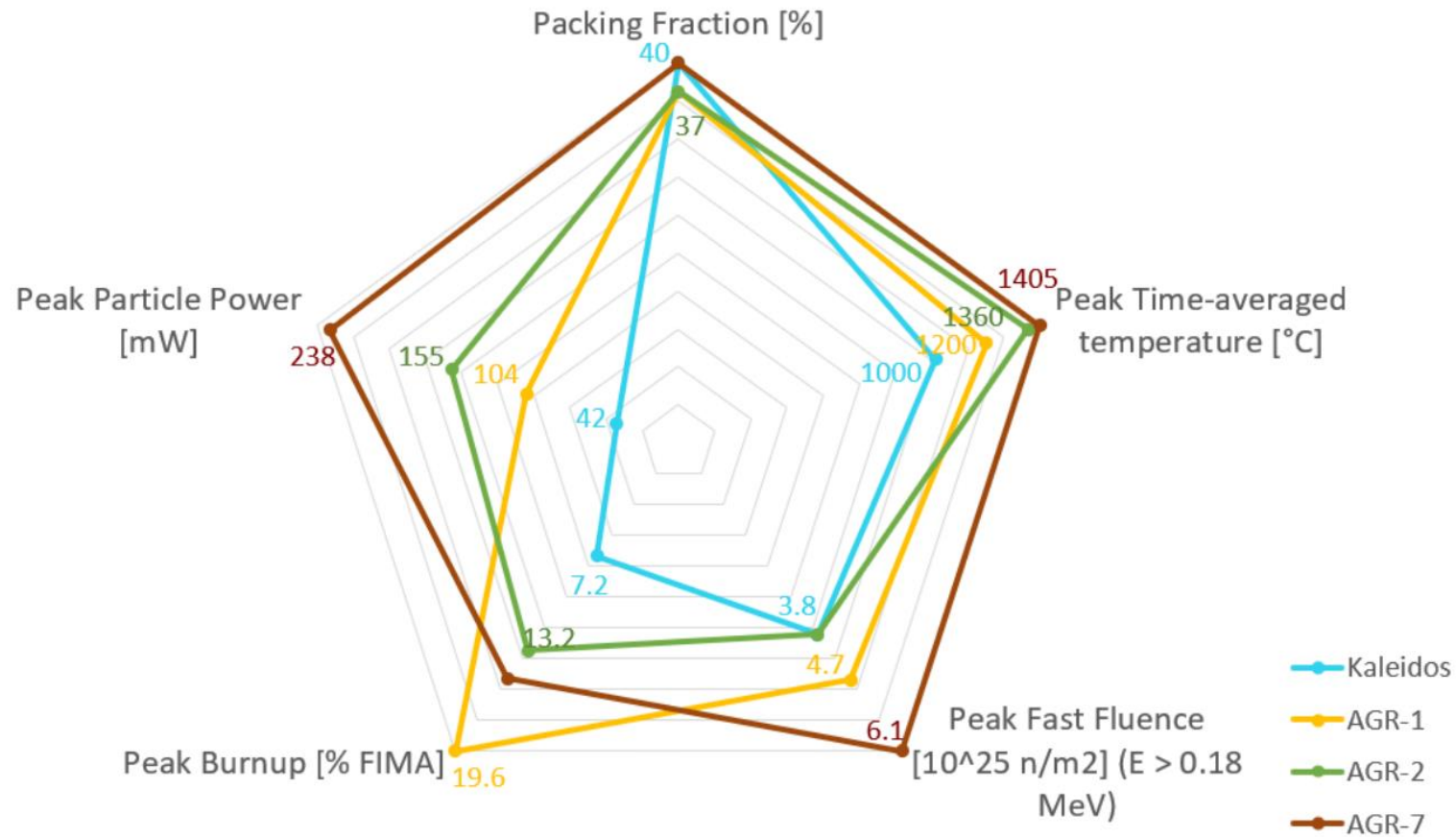
Quantity of Interest	Method(s)	Purpose
Configuration criticality	MCNP	Initial critical configurations, reactivity worth
Excess reactivity & shutdown margin	OpenMC & MCNP	Condition reactivity worth measurements
Time-dependent decay heat	OpenMC & SCALE	Heat source for postulated scenarios
Time-dependent source term	OpenMC & SCALE	Radiological source for mechanistic source term evaluation
Power distribution	OpenMC	Power peaking factors
Control drum worth	OpenMC & MCNP	Safety margins, reactivity insertion rates, conditions for postulated scenarios
Temperature and other reactivity coefficients	OpenMC	For transient simulations
Steady-state coolant temperatures	SimEngine	Initial conditions for postulated scenarios
Time-dependent core temperature during loss of coolant/flow	SimEngine & ANSYS	Margin to fuel, moderator, and steel limits
Fuel thermomechanical performance	BISON	Failure probability/margin

Kaleidos Fuel



Helium loop radionuclide monitoring and characterization components in flow loop.

Kaleidos Fuel Performance Envelope

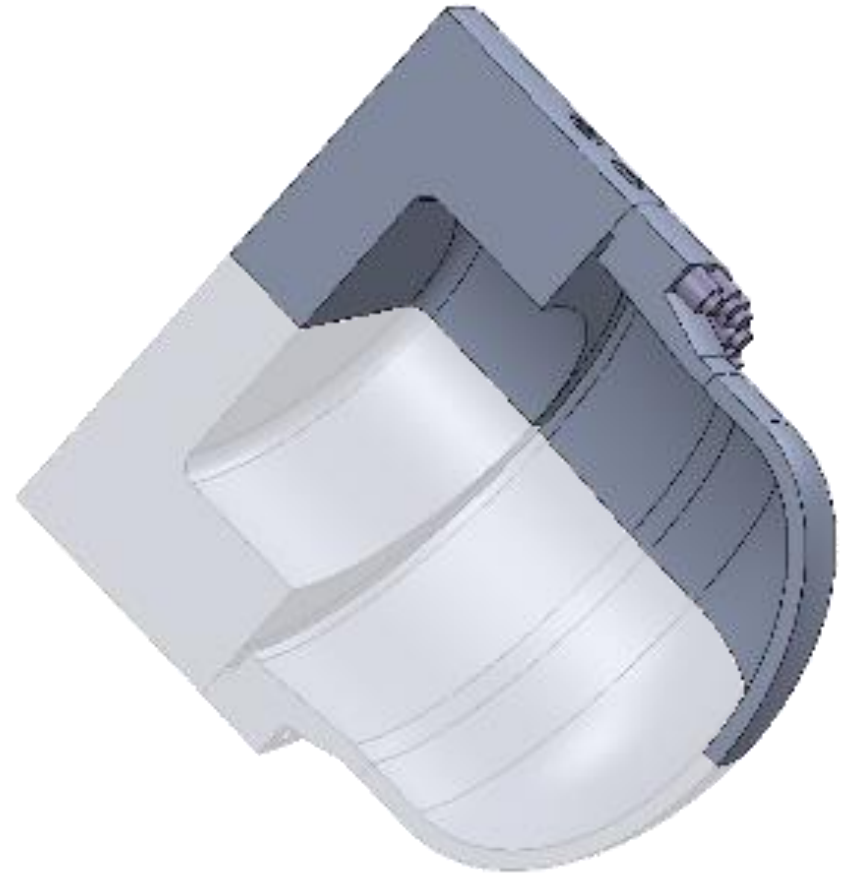


Pressure Vessel Milestones

- SS-316H ingot produced
- Completed custom tooling for forging
- Designed seal test unit to validate high temperature seal leak rates and bolted joint performance



Our SS-316H ingot.



High temperature seal test unit.

Structural Graphite Milestones

- 4.5 tons of PCEA billets
- Ordered consumer grade graphite for the electrically heated demonstration build
- Fabricated test units with multiple vendors to assess as-built tolerances



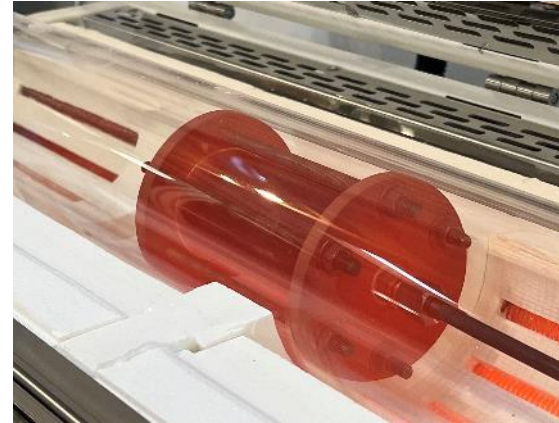
PCEA graphite from AGM



Graphite machining tests.

Zirconium Hydride Production Milestones

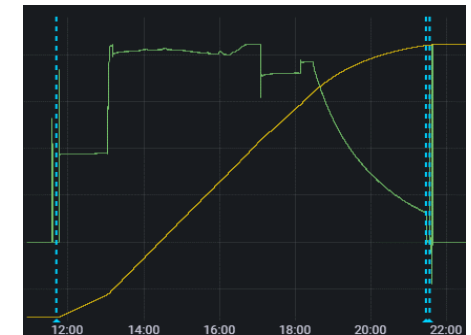
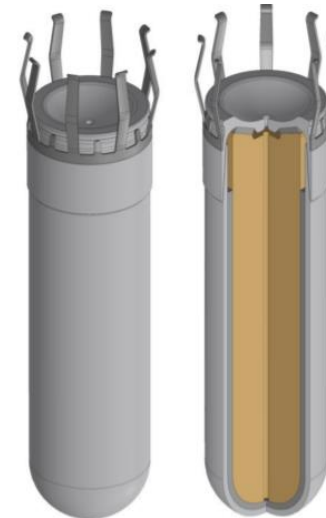
- Multiple successful runs to saturated beta phase, verifying setup and absorption rate
- Target H/Zr atomic ratio of 1.0, achieved atomic ratio of 0.992
- Identified max hydriding speed by increasing flow until diffusion rate was limited by zirconium



Red-hot hydriding chamber (zirconium slug sits inside of this).



Zirconium post-hydriding.

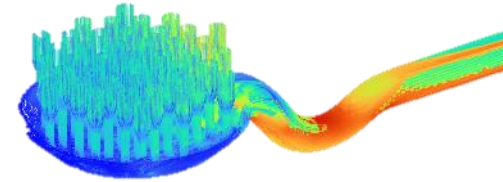
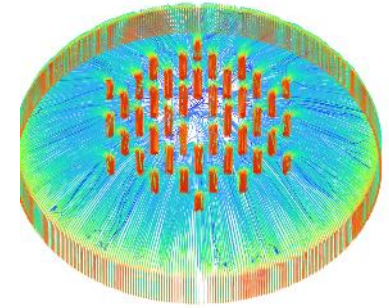
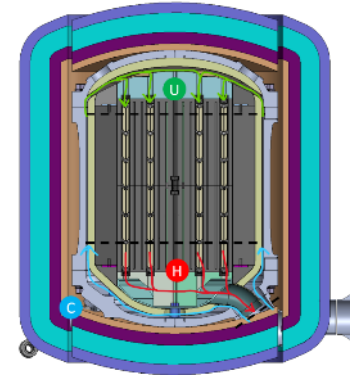


Diffusion Rate Limited



Primary Loop Milestones

- Computational Fluid Dynamics
 - Used to refine internal reactor geometry
 - Methods for performing Multiphysics analysis of reactor core graphite are in development
- Helium Circulator In Fabrication



Impeller



Motor Housing



Motor Shaft Before Magnets



Motor Shaft with Magnets



Volute Casting