EM^2 Gaps and Critical Needs

by
Dr. Christina Back
Division Director
Inertial Fusion and Advanced Fission

Presented to
NRC-DOE Workshop on
Advanced Non-LWRs

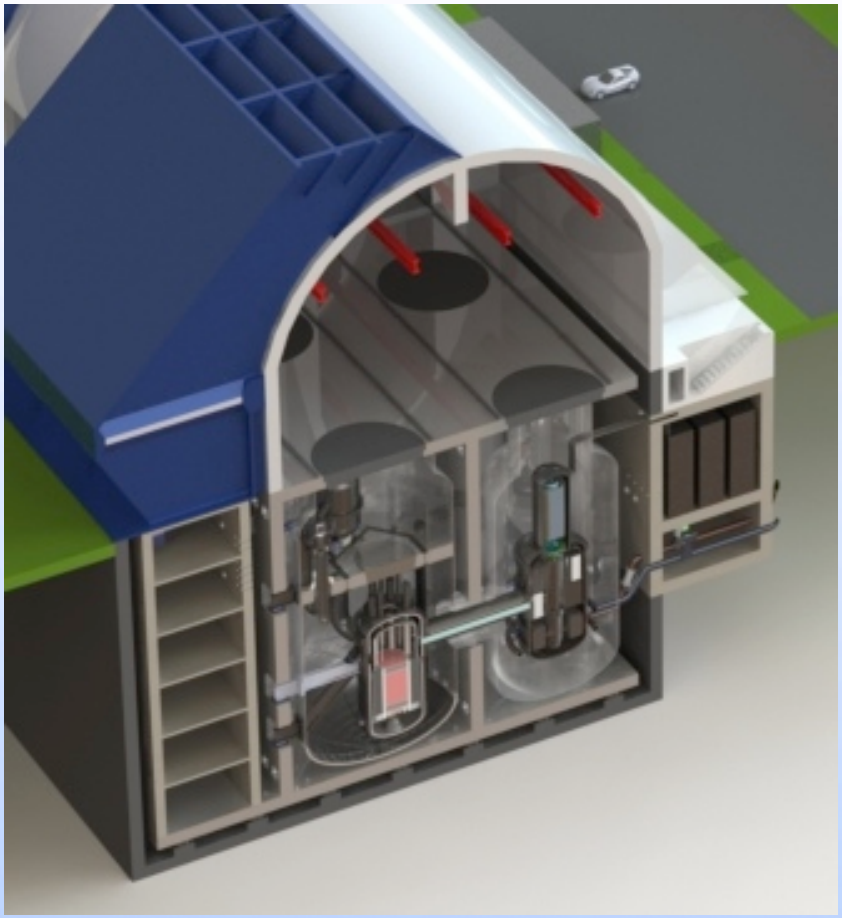
September 2, 2015

Nuclear Plants Have Long Design Life – Envision Desirable Characteristics of a 21st Century Plant

Low financing cost	Modular incremental construction to reduce exposure and control schedule
Competitive power cost	High power density and high efficiency
Load following	Flexibility to capture high-price peak electricity and remain online during demand fluctuations
High fuel utilization	High burnup – transition to fuel recycle
Fuel flexibility	^{235}U, ^{238}U, transuranics, thorium, LWR waste
Siting flexibility	Water cooling not required – road transport
High safety	Total passive design
Proliferation resistant	No heavy element separation (e.g. plutonium)

Energy Multiplier Module (EM^2)
Compact Fast Gas Reactor Producing 265 MWe

Below-ground construction negates many physical threats and improves security



- 30-year fuel life, no shuffling
- Burns depleted uranium, spent fuel, plutonium and thorium
- 53% efficient with evaporative cooling and 48% dry cooling
- Flexible siting, no need for water cooling
- Factory built, truck transportable
- Waste stream reduced 80% for single pass through
- Rapid load following

GENERAL ATOMICS CB&I

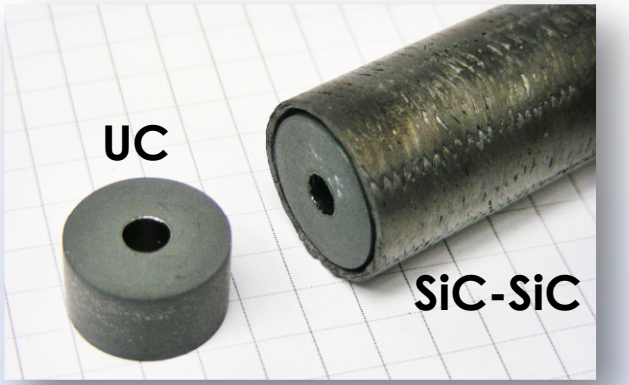
Four Gaps / Critical Needs Identified

- **Fuel Qualification**
- **High Temperature Ceramics Qualification**
- **Prototype Licensing**
- **Methods Validation**

High cost of licensing new fuels, materials and plant designs seriously inhibits innovation in the nuclear industry

Qualification of New Fuel Type

- Challenges related to 30-yr core life, vented fuel design, fast spectrum, UC and SiC-SiC cladding
- Regulatory steps leading to fuel qualification are not clearly defined



- Irradiation to full neutron fluence and burnup would take a very long time
- No US facilities exist to perform irradiation under prototypical operating conditions
- New fuel performance codes equivalent to FRAPCON are needed

High Temperature Ceramics Qualification

- High temp structural ceramics are key to high performance advanced reactors with long core life
- State of the art moving quickly in terms of size, complexity and quality of composite ceramic structures
- Need codes and standards for high temp ceramics design equivalent to ASTM and ASME for wrought metals
- Irradiation to full fluence takes a very long time – need qualified predictive material models including failure models
- No US facilities exist to perform irradiation under prototypical operating conditions

Prototype Licensing -Prototypes Are Generally Required for Advanced Reactors

- Regulatory steps for prototype licensing not clearly defined
- Ownership, siting and cost are challenging
- Additional instrumentation and testing requirements for the prototype
- Prototype should be basis for fuel/material qualification, methods validation, and design certification
- Prototype should resolve many licensing issues to pave way commercial deployment

Methods Validation

- Unique challenge due to long-term convert-and-burn core physics with heterogeneous fuel loading both axially and radially
- High temp critical facilities to benchmark core design codes may not be available
- Fuel performance codes have unique behavior and failure modes that require validation.
- Prototype will provide data on shutdown margin, cold and hot startup, and core and fuel performance at high burnup and high temperature for methods validation