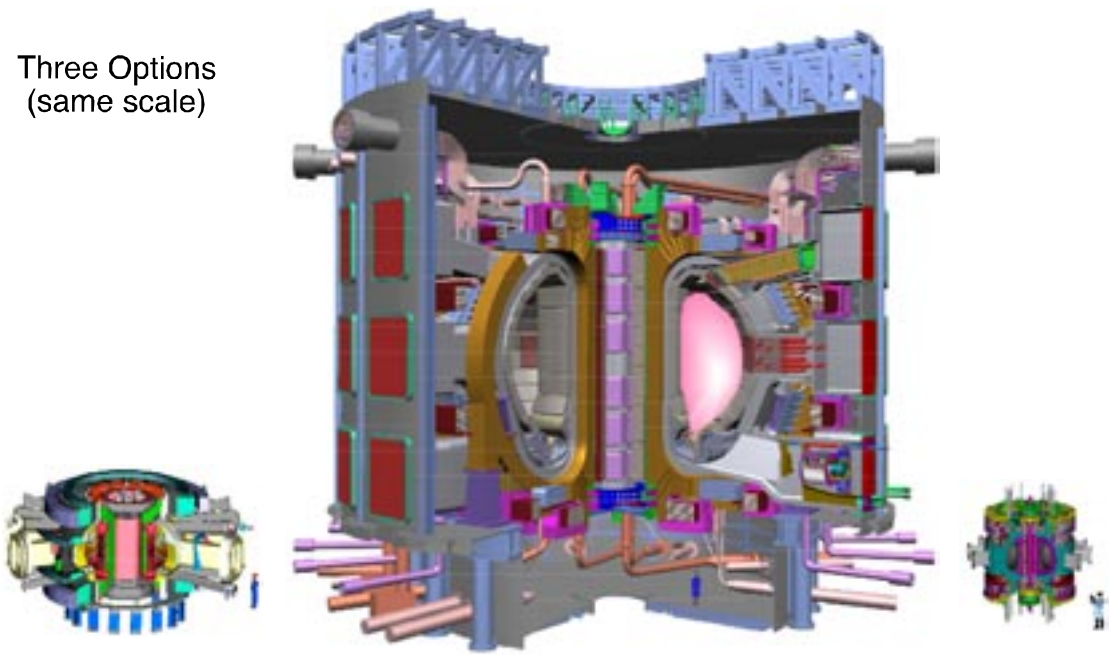
EXECUTIVE SUMMARY–3

3. IGNITOR, FIRE, and ITER would enable studies of the physics of burning plasma, advance fusion technology, and contribute to the development of fusion energy. The contributions of the three approaches would differ considerably.

- **IGNITOR offers an opportunity for the early study of non-stationary burning plasmas aiming at ignition.**
- **FIRE offers an opportunity for the study of burning plasma physics in conventional and advanced tokamak configurations under quasi-stationary conditions and would contribute to plasma technology.**
- **ITER offers an opportunity for the study of burning plasma physics in conventional and advanced tokamak configurations for long durations with steady state as the ultimate goal, and would contribute to the development and integration of plasma and fusion technology.**

The contributions of the three approaches would differ considerably.

For the three candidate burning plasma devices, we will list **key benefits**: i.e., *the capabilities for studies of the physics and technology of burning plasmas* (assuming that each facility will achieve its proposed performance).



FIRE ITER-FEAT IGNITOR

Common benefits from all three candidate devices

PHYSICS

1. Strongly-coupled physics issues of equilibrium, stability, transport, wave-particle interactions, fast ion physics, and boundary physics in the regime of dominant self-heating.

TECHNOLOGY

2. Plasma support technologies (heating, fuel delivery, exhaust, plasma-facing components, and magnets) will benefit most because parameters and plasma conditions will be close to those required for power production.
3. Nuclear technologies (remote handling, vacuum vessel, blankets, safety and materials) will advance as a result of the experience of operating in a nuclear environment. The level of benefit will depend on tritium inventory, pulse length, duty factor, and lifetime fluence.

Key benefits from IGNITOR

PHYSICS

1. Capability to address the science of self-heated plasmas in a reactor-relevant regime of small ρ^* (many Larmor orbits) for globally MHD-stable plasmas at low β_N (normalized plasma pressure).
2. Capability to study sawtooth stability at low beta with isotropic alpha particles and self-consistent pressure profile determined by dominant alpha heating.

TECHNOLOGY

3. Development of high-field copper magnets with advanced structural features, including bucking & wedging and magnetic press.
4. Development of high-frequency RF antennas for wave heating in a burning plasma environment.

Key benefits from FIRE

PHYSICS

1. Capability to address the science of self-heated plasmas in reactor-relevant regimes of small ρ^* (many Larmor orbits) and high β_N (normalized plasma pressure) with a large fraction of non-inductive current sustained for up to a few current relaxation times.
2. Exploration of high self-driven current regimes with strong shaping and active MHD stability control.
3. Study of removal of helium ash and impurities with exhaust pumping.

TECHNOLOGY

4. Development of electrical insulation for high-field pulsed copper magnets in high neutron fluence environment.
5. Development of high heat flux plasma-facing components with steady-state heat removal capability (tungsten/beryllium).

Key benefits from ITER

PHYSICS

1. Capability to address the science of self-heated plasmas in reactor-relevant regimes of small ρ^* (many Larmor orbits) and high β_N (plasma pressure), and with the capability of full non-inductive current drive sustained in near steady state conditions.
2. Exploration of high self-driven current regimes with a flexible array of heating, current drive, and rotational drive systems.
3. Exploration of alpha particle-driven instabilities in a reactor-relevant range of temperatures.
4. Investigation of temperature control and removal of helium ash and impurities with strong exhaust pumping.

TECHNOLOGY

5. Integration of steady-state reactor-relevant fusion technology: large-scale high-field superconducting magnets; long-pulse high-heat-load plasma-facing components; control systems; heating systems.
6. Testing of blanket modules for breeding tritium.