EXECUTIVE SUMMARY:

3. ITER, FIRE, and IGNITOR 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.

1. IGNITOR would offer an opportunity for an early study of non-stationary burning plasmas aiming at ignition.
2. FIRE would offer 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.
3. ITER would offer an opportunity for the study of burning plasma physics in conventional and advanced tokamak configurations for long durations aiming at steady-state and would contribute to the development and integration of plasma and fusion technology.

IGNITOR	Key Benefits #	High-level Issues
PHYSICS	IGNITOR baseline operation can address the science of self-heated plasmas in a reactor-relevant regime of small ρ^* and globally MHD stable plasmas at low beta.	The simultaneous sustainment in the baseline operation of limiter radiating edge, low core Z_{eff} and core density peaking, with enhanced confinement over standard L-mode scaling.
	Capability to study sawtooth stability at low β with isotropic alphas and self-consistent pressure profile determined by dominant alpha heating.	
TECHNOLOGY	High-field Cu magnets	Fit up of complex magnet systems
	BPX experience with high-Z PFC's	Precise alignment to B field and plasma control for first wall
	High frequency ICRF	Has no active pumping in base line (Physics issue)
	High-speed pellet injection	
	Remote handling and metrology experience at smaller scale	
EXPERIMENT	IGNITOR allows early demonstration of an important fusion milestone, burning plasmas.	Lack of access for diagnostics is severe
		Lack of provision for burn control and/or AT studies

 # "Capabilities for studies of the physics of burning plasmas if the facility achieves its advertised performance"

FIRE	Key Benefits	High-level Issues
PHYSICS	FIRE can address the science of self heated plasmas in reactor relevant regimes of small ρ^* and high β_N , with a large fraction of non-inductive current sustained for up to a few current relaxation times.	Predicted ELM power loads on FIRE are near the upper boundary of acceptable energy deposition. ELM control and amelioration is needed.
	FIRE can explore high self-driven current regimes with strong shaping and active MHD stability control	NTM control with LHCD in the baseline case is not sufficiently understood or validated
	FIRE possesses a range of flexible tools to explore burning plasma advanced confinement regimes.	
	FIRE can explore removal of helium ash and impurities with exhaust pumping	
TECHNOLOGY	Contributes to high field pulsed Cu magnet technology and insulators	Radiation damage to magnet insulators
	Thermal steady-state PFCs at high heat loads (W/Be)	Reduced PFC, antenna, vacuum vessel margins due to higher heat flux and nuclear heating
	High pressure He cryo-pump	Plasma initiation with large Cu shell
	Integration of control coils with VV	
	Remote handling experience at modest scale	
EXPERIMENT	Ability to study AT well above no-wall limit	Sufficient pulse length for full AT control
	Reduces initial facility investment costs and allows optimization of experiments for separable missions.	Requires high-performance D-D device (as part of international portfolio)

ITER - 1	Key Benefits	High-level Issues
PHYSICS	ITER can address the science of self heated plasmas in reactor relevant regimes of small ρ^*, high β_N and with the capability of full non-inductive current drive sustained in near steady state conditions.	Predicted Type I ELM power loads on ITER are near the upper boundary of acceptable energy deposition. Tritium retention is a major concern for the proposed ITER carbon divertor.
	ITER possesses the flexibility and range of control tools to explore a range of burning plasma advanced confinement regimes.	Active stabilization of RWM, and adequate current drive to achieve near steady state in the AT regime.
	Exploration of alpha particle driven instabilities in a reactor relevant range of temperature, pressure and ρ^* in conventional and advanced regimes.	
	Investigate the stability and dynamic suppression of MHD modes using current, pressure, and rotation control tools	
	Explore temperature control and removal of helium ash and impurities with strong exhaust pumping	

ITER - 2	Key Benefits	High-level Issues
TECHNOLOGY	Contributes to large high field SC technology	Reliability and operation of large scale SC magnet systems
	Contributions to long pulse high heat load PFC technology	Type I ELMs erosion limits divertor life-time
	Wide array of heating technologies (NBI, ICRF, ECH, [LH])	Unmitigated disruption thermal loads
	High throughput in steady state fueling, pumping and fuel reprocessing systems	Tritium retention in carbon
	Reactor relevant vacuum vessel	Continuous tritium processing and control in large throughput system
	Remote handling experience at large scale	
	Power plant relevant inventories and hazards (safety demonstration)	
	Ability to test breeding blanket modules	
	Reactor relevant steady state control system	
	Extended integrated operating experience	
EXPERIMENT	Set of diagnostics needed for a demo-reactor will be achieved and relevant experience obtained in a harsh environment.	Tritium retention
	Long pulse	
	Reactor-relevant operating experience with S/C coils	

GENERIC	Key Benefits	High-level Issues
PHYSICS	Strongly-coupled physics issues of equilibrium, stability, transport, wave-particle interactions, fast ion physics, and boundary physics in the regime of dominant self-heating	Adequate diagnostics (short-λ fluctuations, alpha particles, MHD)
	Error field penetration with low rotation	RF profile control & dynamic accessibility scenarios
		Alpha absorption of RF power
		Particle, electron thermal, and momentum transport models
TECHNOLOGY		
EXPERIMENT	Demonstration of operation of diagnostics in a nuclear environment	Adequate alpha diagnostics
	Study of strongly coupled plasmas	Uncertainty in transport based projections
		impurity accumulation in (density) peaked profiles
		Steady-State and transient power handling for plasma facing components