Near term

Long Term

Advancement of Measurement Technology Needed for the Burning Plasma Era

Opportunities (Issues & Gaps)	Work Description	Benefit to Fusion	Overlap with other Themes
Develop innovative diagnostics suitable for a neutron environment	Develop reliable and verified models for predicting particle, heat, and neutron fluxes on passive components in realistic geometry in both normal and off-normal operating conditions.		
	Develop reliable and verified models for improved predictive capability to reduce the measurement requirements		
	Develop/extrapolate/innovate new concepts, which qualify structural, shield and coating material with which to construct internal Diagnostic components (e.g. mirrors, sensors, tec.), including joining/bonding technologies.		
	Test coating techniques and advanced refractory alloys and metal doping		
	Validate techniques for predicting particle, heat, and neutron fluxes on passive components (e.g. mirrors, sensors, tec.) in realistic geometry in both normal and off normal operating conditions using test stands		
	In-situ testing of material surface dynamic response		
Validate diagnostic performance on non-nuclear confinement devices	Develop and employ diagnostics for low-neutron facilities		
	Upgrade the diagnostics for ITER		
	Test nuclear-capable diagnostics on ITER		
	Use long-pulse facilities to develop and test in-situ approaches and procedures for calibration		
	Test nuclear-capable diagnostics on non-nuclear facilities		
	Design/develop/innovate instrumentation to monitor the front end of diagnostics in-situ		
RAMI Documentation	Test diagnostics components in a nuclear environment		
	Employ diagnostics on CTF		
	Integrated long pulse tests of innovative approaches		

Advancement of ICRF&LH Antenna Technology Needed for the Burning Plasma Era			
Opportunities (Issues & Gaps)	Work Description	Benefit to Fusion	Overlap with other Themes
Improve RF Sheath & near field modeling, including long pulse and high power effects	Develop reliable and verified techniques for computing self-consistent heat and particle fluxes to high-power, energized components which interact with and alter the edge plasma		
	Develop improved models of RF wave propagation from antenna through the plasma edge		
	Develop computation methods of all wave processes that can lead to edge losses in SOL		
	Develop/extrapolate/innovate diagnostics to measure the SOL, in particular the ability to track power and particles (non-Maxwellian)		
Increase antenna power density, (present antennas are voltage limited)	Develop improved models of the physical properties that cause arcing. Use these models to develop higher power density RF antennas		
Effects of heat load, neutrons & T retention on antenna materials	Develop/extrapolate/innovate new concepts		
	Modeling and development of new materials		
	Qualify structural, shield and coating material with which to construct RF Antennas, including joining/bonding technologies		
	Test coating techniques and advanced refractory alloys and metal doping		
	Develop designs that incorporate active cooling necessary to address the thermal management needs for long pulse		
	Evaluate the anticipated contribution to dust formation from the materials selected for ICRF & LH antenna front ends.		
Use magnetized plasma long pulse based RF test	Validate techniques for computing heating performance and self-consistent heat and particle fluxes to high-power, energized RF		

stands to validate antenna concepts and performance	Antenna, which interact with and alter the edge plasma.		
	In-situ tests of material surface dynamic response using test stands		
	Validate edge loss processes in existing devices and determine power flow in the SOL		
Perform integrated antenna testing on non-nuclear confinement devices	Test nuclear-capable RF Antennas on non-nuclear facilities		
	Develop antenna/launcher/mirror concepts using nuclear grade materials in a high heat environment		
Perform integrated engineering validation (RAMI) on a CTF device	Test RF Antennas in a nuclear environment		
	Validate nuclear capable RF Antennas on CTF		
	Integrated long pulse tests of innovative approaches		

Advancement of Microwave Launcher Technology Needed for the Burning Plasma Era

Opportunities (Issues & Gaps)	Work Description	Benefit to Fusion	Overlap with other Themes
Effects of erosion, neutrons & T retention on launcher materials	Reliable and verified techniques for computing self-consistent heat and particle fluxes to high-power, energized components.		
	Modeling and development of new materials		
	Develop/extrapolate/innovate new concepts, which qualify structural, shield and coating material with which to construct microwave launchers, including joining/bonding technologies.		
	Tests of coating techniques and advanced refractory alloys and metal doping		
Use microwave test stands to validate launcher concepts and performance	Validate techniques for computing heating performance and self-consistent heat and particle fluxes to high-power, energized microwave launchers.		
	In-situ tests of material surface dynamic response		
	Validate innovative concepts for performance and completeness		
Perform integrated launcher testing on non-nuclear confinement devices	Test nuclear-capable microwave launchers on non-nuclear facilities		
Perform integrated engineering validation (RAMI) on a CTF device	Test Microwave launchers in a nuclear environment		
	Validate nuclear capable Microwave Launchers on CTF		
	Integrated long pulse tests of innovative approaches		

Advancement of Control Coil Technology Needed for the Burning Plasma Era			
Opportunities (Issues & Gaps)	Work Description	Benefit to Fusion	Overlap with other Themes
Develop innovative control coils suitable for a neutron environment	Develop reliable and verified techniques for predicting heat, and neutron fluxes on passive components in realistic geometry in both normal and off-normal operating conditions.		
	Modeling and development of new materials		
	Develop/extrapolate/innovate new concepts, and qualify structural and/or conductive material with which to construct internal Control Coils, including joining/bonding technologies		
	Explore the effect of various blanket structures and their impact on the control coil system being able to achieve its mission requirements		
Use test stands to validate control coil concepts and performance	Test new solid materials in neutron irradiation facilities. The study of conducting and insulating materials overlap other themes and should be a collaborative effort.		
Perform integrated control coil testing on non-nuclear confinement devices	Test nuclear-capable Control Coils on non-nuclear facilities		
Perform integrated engineering validation (RAMI) on a CTF device	Validate nuclear capable Control Coils on CTF		
	Integrated long pulse tests of innovative approaches		