PWI Gaps *vs.* Tools: General Requirements on the Tools

Theme 3 PWI Panel

	Theory & Modeling	**Existing/Upgraded/New Test Stands**	**Existing/Upgraded Confinement Facilities**	**New Confinement Facility**
SOL and Divertor Plasma **Turbulent heat and particle transport** **SOL particle flows** **Impurity transport** **Radiation transport** **He pumping**	*Increase focus on edge, SOL and divertor, integrated with PMI effects. First-principles simulation of edge transport, critical gradients and intermittency. Non-Maxwellian f. Improved neutral and photon modeling.*	*Measurements of f. Measurements of turbulent transport, impurity flows.*	*Development of SOL width scaling. Detailed tests of advanced SOL and divertor models including first-principles turbulence simulations. Development of new diagnostics. Identification of missing edge physics.*	*Detailed long pulse, Demo-relevant power, hot walls tests of advanced SOL and Divertor model, including first-principles turbulence simulations. Extensive diagnostics for long-pulse, high-power, hot walls.*
Erosion & Redeposition **Impurity generation** **RF sheaths** **Dust production** **Morphology changes** **Component lifetime** **Energetic α effects**	*Improved PMI models including dust production and stability of deposited layers. Linkage to improved SOL models. Coupled RF antenna and SOL sheath models. Mixed material characterization. Neutron and alpha effects.*	*Tests of PMI models for erosion, including stability of redeposited layers and dust production under Demo conditions. In-situ tests of material surface dynamic response. Tests of techniques for dust removal. Tests on neutron irradiated materials.*	*Tests of integrated PWI/PMI models. RF sheath effects, redeposition. Development of new diagnostics. Tests of techniques for dust removal. Identification of missing edge physics.*	*Long pulse, Demo-relevant power, hot wall tests of integrated PWI/PMI model, erosion, redeposition, RF effects, including fast ions. Neutron-irradiated coupons. Extensive diagnostics. Tests of techniques for dust removal.*
ELMs & Disruptions **Off-normal heat flux** **Energetic electrons** **Dust production** **Impurity injection**	*3-D MHD, two-fluid, & kinetic models including runaways. Control techniques such as edge ergodicity, stimulated edge transport and small ELMs*	*Tests of impacts of Demo-relevant off-normal events. Tests on neutron-irradiated materials.*	*Tests of advanced models and control techniques. Scenario development with focus on stability.*	*Demonstration of high accumulated run time without large off-normal events. Test of effects of many small off-normal events.*
Tritium Retention **Safety**	*Improved theory for tritium trapping in materials.*	*Tests of tritium diffusion/permeation and trapping on neutron irradiated materials at high temperature.*	*Tests of deuterium retention in high-temperature refractory metals.*	*Deuterium, trace tritium retention with long pulse, Demo-relevant power & hot walls. Tests on neutron irradiated coupons.*
Innovations **High radiation frac'n** **Flux expansion** **Stellarator edge** **Material development** **Liquid surfaces** **Active coating**	*Modeling and design of new divertor concepts.* *Multi-scale materials modeling and development of new materials.* *Modeling of liquid surfaces and flows.* *Modeling of techniques for coating and removal.*	*Tests of new solid materials and of liquid surfaces under plasma bombardment.* *Tests of coating techniques, advanced refractory alloys and metal doping.*	*Tests of innovative approaches to power and particle handling, including self-consistency of He pumping.*	*Integrated long pulse, Demo-relevant power, hot-wall tests of innovative approaches to power and particle handling, including self-consistency of He pumping.*