STCC MCC 0911101, APS DPP mtg.
7-10pm, Lenox Room, Hyatt Regency Atlanta

7:00 – 1) Steve Eckstrand – DOE update

7:15 – 2) Mission, attractiveness, plasma conditions for targets

- 2a) PMI
- 2b) BP
- 2c) FNS

8:15 – 3) Research needs, uncertainties, potential benefit/impact toward each target

9:00 – 4) Identify research elements with divergent views

9:45 – 5) Next actions and meeting time

10:00 – Adjourn

2a) Majeski: PMI ST mission, attractiveness, plasma conditions

- Mission

  Qualify candidate wall PFCs and divertors in a long-pulse, DD facility with edge conditions, power loads, and other non-nuclear operating factors approaching those expected in a fusion nuclear device (e.g. a CTF or DEMO), in order to reduce design uncertainties.

- Why attractive?

  1) *A small radius divertor, which provides high power density at reduced input power.*
  2) *A simple geometric form, which eases wall testing and replacement.*
  3) *A small wall area relative to the plasma volume, which provides high wall power density.*
  4) *Small overall size, for reduced construction costs.*

2a) Majeski: PMI ST mission, attractiveness, plasma conditions – cont.

- Plasma conditions

  TBD

2a) Menard: BP ST mission, attractiveness, plasma conditions

- Mission

  The mission of a Burning Plasma Spherical Tokamak (BPST) is to assess the viability of achieving high fusion gain in the compact ST configuration under the unique plasma conditions of high normalized pressure and potentially strong drive for Alfvénic instabilities, with application to increased fusion performance in a nuclear fusion science facility and to provide the physics basis for an ST-based fusion power reactor.

- Why attractive?

  TBD

- Plasma conditions

  TBD

2c) Peng: FNS mission, attractiveness, plasma conditions

- Mission

  to enable the investigation of synergistic effects of interest to plasma material interactions and fusion power extraction in a fusion nuclear environment – encountering four phases of matter, across the nuclear, atomic, nano, meso, and macroscopic scales and for time scales of scientific interest (thousand to million seconds).

- Why attractive?

  1) *Very high stability beta limits to allow disruption-free plasma operations sufficiently far from limits*
  2) *Excellent ion confinement and adequate electron confinement for HIHM with potential for high fusion gain*
  3) *Successful single-turn TFC center and nearly solenoid-free startup $\rightarrow$ compact R_0 ~ 1+m designs*
  4) *Then, simpler modular design including divertors, extensive remote handling, ready component replacement for high duty factor operation in activated conditions (DD & DT)*
  5) *Then, flexible FNS research staging from D-D to D-T, and from JET-level to multiple JET-level performance*

2c) FNS plasma/operation conditions for T16 research elements

Stage	**I**	**II**	**III**
Fuel	D-D	D-T	D-T
Pressure, $\beta_T B^2$ (%T^2)	18	86	133
Outboard fusion neutron W_L (MW/m^2)	0.01	1.0	2.0
Plasma current I_p (MA)	3.4	8.2	10.1
Safety factor q_{Cyl}	9.2	3.7	3.0
Toroidal beta β_T (%)	5	18	28
Normal beta β_N (MA/Tm)	1.9	3.8	5.9
Avg. T_i (keV), Hot-Ion H-Mode	5.4	10.3	13.3
Avg. T_e (keV), Hot-Ion H-Mode	3.1	6.8	8.1
ReNeW Thrust-16 research elements (added in red)			
1a: Startup (formation)	PHI, EBW, PHI+EBW		
1b: Ramp-up	PHI, EBW, NBI, PHI+EBW+NBI		
2a: Divertor Configuration	SXD, SOL thickness uncertain		
2b: Liquid metal surface	Not Yet - high impurity influx; no high heat flux long pulse data		
3a: Confinement	$\tau_{Ei} \sim 0.7\ \tau_{Neo,i}$; $\tau_{Ee} \sim 0.7\ \tau_{ITER\text{-}H}$ Hot-Ion H-Mode, τ_{Ee} improves as $\nu^* \rightarrow 10^{-3}$?		
3b: Stability (energetic particles)	Sub-Alfvenic beam; some super-Alfvenic α		
4a: Active	No ($\beta_N < \beta_{nwl}$)		$\beta_N \sim 1.2\ \beta_{nwl}$
4b: Passive	Yes, for disruption-free plasma operation		
4c: Resonant field error B_{error}/B_T	$<10^{-4}$ to avoid active stability control		
5a: Energetic particle beam (co-E_{NBI}, kV)	100	240	300
5b: Plasma wave	EBW to maintain $q_{min} > 2$ or 3, avoid NTM		
5c: Particle control	SXD, cryo-pump		
5d: Core fueling	High-field side pellet		
5e: Continuous burn time (s)	$10^3 \rightarrow 10^6$		
Other?			

3a) Majeski: PMI ST Research needs, uncertainties, potential benefit/impact

3b) Menard: BP ST Research needs, uncertainties, potential benefit/impact

3c) Peng: FNS Research needs, uncertainties, potential benefit/impact

Stage	I	II	III	Research Need including understanding of physics basis and modeling adequate for projection to FNS conditions	Uncertainties	Benefit/impact
ReNeW Thrust-16 research elements (added in red)						
1: Startup and ramp-up						
1a: Startup (formation)	PHI, EBW, PHI+EBW			• Form ~0.5MA high temperature plasma	M	H
1b: Ramp-up	PHI, EBW, NBI, PHI+EBW+NBI			• Ramp up to ~1MA at high temperature and density	M	H
2: Divertor and PFC						
2a: Configuration	SXD, SOL thickness uncertain			• Produce and test SXD at ~1MA in HIHM • Determine common database and understanding with Tokamak	M	M
2b: Liquid metal surface	Not Yet, high impurity influx; no high heat flux long pulse data			• Develop means to eliminate impurity influx • Develop high heat flux liquid metal PFC test program to determine risk and benefit	H	TBD
3: Confinement stability						
3a: Confinement	$\tau_{Ei} \sim 0.7\ \tau_{Neo,i}$; $\tau_{Ee} \sim 0.7\ \tau_{ITER\text{-}H}$ Hot-Ion H-Mode (HIHM), τ_{Ee} improves as $\nu^* \rightarrow 10^{-3}$?			• Review database on HIHM from Tokamak and ST to establish working τ_{Ee} scaling • Investigate electron turbulence, transport, confinement in ST for $\nu^* \rightarrow 10^{-3}$ in HIHM	L	M
3b: Stability (energetic particles)	Sub-Alfvenic beam; some super-Alfvenic α			• Update ITER database with ST data for HIHM	M	M
4: Stability control						
4a: Active	No ($\beta_N < \beta_{nwl}$)		$\beta_N \sim 1.2\ \beta_{nwl}$	• Complete active stability control research on ST and Tokamak for $\beta_N \leq 1.2\ \beta_{nwl}$ for HIHM	M	M
4b: Passive	Yes, for disruption-free plasma operation			• Update ITER database with ST data on low disruptivity conditions removed from known stability limits	M	H
4c: Resonant field error B_{error}/B_T	$<10^{-4}$ to avoid active stability control			• Review Tokamak and ST database on plasma conditions in the presence of very low resonant error fields ($<10^{-4}$) • Create and study plasma conditions in the presence of very low resonant error fields ($<10^{-4}$)	M	H

3c) Peng: FNS Research needs, uncertainties, potential benefit/impact – cont.

Stage	I	II	III	Research Need including understanding of physics basis and modeling adequate for projection to FNS conditions	Uncertainties	Benefit/impact
ReNeW Thrust-16 research elements (added in red)						
5: Maintain current and profiles						
5a: Energetic particle beam (co-E_{NBI}, kV)	100	240	300	• Develop engineering science basis for steady state positive ion neutral beam for ~100 kV, similar to KSTAR, EAST NBI concepts. • Develop engineering science basis for steady state negative ion neutral beam for ~300 kV, scaled down from ITER prototype.	M	M
5b: Plasma wave	EBW to maintain q_{min} > 2 or 3, avoid NTM			• Test EBW H&CD at ~ MW level in HIHM plasmas	M	M
5c: Particle control	SXD, cryo-pump			• Scale down ITER cryo-pump prototype	L	H
5d: Core fueling	High-field side pellet			• Scale down ITER pellet injector prototype	L	H
5e: Continuous burn time (s)	$10^3 \rightarrow 10^6$			• Apply ITER simulation capabilities such as SWIM, GTLF, TLF23, TSC, etc. to refine estimates of FNS ST plasma projections	L	H
Other?						

4) Next actions and meeting

- Finalize information for FNS ST
- Review and feedback on information for PMI ST and BP ST
- Review and comment on draft report – likely with missing pieces
- Next meeting: in two weeks time (during 11/16-20/09)?