

Theme II – High Performance Steady State Plasmas

Plasma Modification by Auxiliary Systems

J.R. Wilson

Theme V Workshop
Princeton, NJ
March 16, 2009

Establish the physics and engineering science of auxiliary systems that can provide power, particles, current and rotation at the appropriate locations in the plasma at the appropriate intensity

Applies to Alternates just as well as Tokamaks

Looking at Heating and Fueling Systems

- NBI, ECH, ICRF, LHCD
- Gas, Pellets, SSGI, CT injection

Exploit Existing Devices, Test Stands and ITER to Develop Physics and Technology Required

Combine with Validated integrated codes to develop predictive capability

Alternates expand the envelop of understanding

Issues Peculiar to non-Tokamak DEMO

- Current start-up ramp-up and sustainment can be more severe
- NBI may require low energy high current beams
- RF heating of over-dense plasmas $\omega_{pe}/\omega_{ce} > 1$ eliminates use of conventional ECH, LH requiring development of EBW
 - Some tokamak DEMOs may also have this and could be best addressed presently in alternates
- Use of ICRF may require high harmonic if B-field low

STs have the Potential for Timely Contributions for the Development of New Fuelling Systems for ITER and a Demo

- The standard operating conditions for a reactor based on the ST concept relies on operation at very high values of the bootstrap current fraction (>90%).
 - The balance of the required current drive (CD) needs to be provided from RF based CD systems.
- In order to benefit from these high-levels of bootstrap current, *it is essential that the optimized density and pressure profiles be maintained during the steady-state phase.*
- This operating regime has many similarities with the ITER Steady-State (and to some extent, the ITER Hybrid) Modes.
- Fuelling these modes requires advancement in fuelling technology that first requires a test on present machines (Greenwald Panel Recommendation)
- To this extent, tokamaks should develop operating scenarios for sustaining Hybrid and AT modes using pellet injection.
 - Pellet injection is being tested in MAST
 - Supersonic gas injection is being tested in NSTX
- Because of the steep-gradient in the toroidal field, STs are in a unique position to significantly contribute to toroidal science by testing a new generation of fuelling systems based on Compact Toroids.

Present STs Should Test Other Potential Benefits of Advanced Fuelling Systems

- Timely, ITER relevant, disruption-mitigation studies,
- Timely, ITER relevant, momentum injection during RF heated discharge studies,
- Greenwald panel recommended, advanced scenario profile control studies,
- ITPA SSO recommended, advanced fueling studies for ITER
- Innovative particle confinement measurements by measuring the decay of an isotope tailored CT induced density change.

Alternate Concept Experiments Provide Opportunities for Physics and Technology Progress

- Force Innovative Thinking
- Push Envelope of Physics and Modeling Parameters