SFPS – 5YR Plan Status Report

8. Research Goals and Plans for Plasma Formation and Current Ramp-up

Raman, Mueller, Nelson, Gerhardt, Kessel, Poli, Jarboe, Jardin – CHI
Redd, Raman, Mueller – Gun plasma start-up
Taylor, Raman, Mueller - ECH (closely coupled to Wave Particles TSG)

Raman and Mueller will write sections that do not have identifying authors

PROGRESS WITH FIRST DRAFT

RED: First draft essentially completed
BLUE: First draft to be completed by next week
BLACK: First draft to be completed before Oct. 5

8.1 Overview of goals and plans
- 8.1.1 Establish predictive capability for the performance of FNSF

- 8.1.2 Thrusts and goals
  - 8.1.2.1 Demonstrate and understand solenoid-free current start-up
  - 8.1.2.2 Use CHI and point helicity injection as initial current seed for subsequent non-inductive current ramp-up

8.2 Research Plans

- 8.2.1 **Years 1-2:**
  - 8.2.1.1 Establish initial transient CHI discharges
  - 8.2.1.2 Use graphite divertor plates
  - 8.2.1.3 Use full Li coverage to reduce low-Z impurities
  - 8.2.1.4 Test benefits of (partial) upper metal divertor and Lithium during absorber arcs
  - 8.2.1.5 Initially couple to induction, then assess coupling to NBI
  - 8.2.1.6 Assess ramp-up of a 400kA inductive target with NBI (Raman, Kessel, Gerhardt)
  - 8.2.1.7 Establish plasma gun start-up in NSTX-U (Redd, Raman, Mueller)

- 8.2.2 **Years 3-5:**
  - 8.2.2.1 Establish CHI discharges using metal divertor plate electrodes
  - 8.2.2.2 Assess benefits and compare to QUEST results (if available)
  - 8.2.2.3 Assess benefits of cryo pumping in the absorber region
  - 8.2.2.4 Maximize current start-up

  - 8.2.2.5 Ramp a 400 kA inductive target using NBI (Raman,Kessel,Gerhardt)

8.2.2.6 Ramp CHI target using 1 MW ECH, then HHFW for coupling to NBI (Raman, Kessel, Gerhardt)
8.2.2.7 Couple plasma gun started plasma to induction and NBI (Redd, Raman,Mueller)

8.3 Summary timeline for tool development to achieve research goals

8.3.1 Theory and simulation capabilities

8.3.1.1 2D resistive MHD simulations – TSC (Raman, Kessel, Poli)
8.3.1.2 3D Resistive MHD simulations – NIMROD, M3D
8.3.1.3 GENRAY for ECH/EBW (Taylor)
8.3.1.4 PTRANSP for NBI coupling to low-Ip CHI plasma (Raman, Kaye, Gerhardt)

8.3.2 Diagnostics

8.3.2.1 New additional fast voltage monitors for upper divertor
8.3.2.2 Additional dedicated current monitors near injector
8.3.2.3 Special set of EMI shielded inner vessel magnetics (Raman, Gerhardt)
8.3.2.4 Additional flux loops and Mirnov coils on lower and upper divertor (Raman, Gerhardt)
8.3.2.5 Langmuir probe array on lower divertor (Raman, Jaworski)
8.3.2.6 Multipoint Thomson scattering, Filter scopes, multi chord bolometers and SXR arrays (Raman, Ahmed, Vlad, Tritz)

8.3.3 Other facility capabilities including plasma control

8.3.3.1 2nd NBI for coupling to low-Ip CHI plasma

8.3.3.2 Baseline capacitor bank power supply
8.3.3.2.1 Voltage increased to ~2 kV & improve voltage snubbing systems
8.3.3.2.2 NSTX-U to support 4kV Ops including transients
8.3.3.2.3 Design study of next generation power supply system

8.3.3.3 Upgraded capacitor bank power supply
8.3.3.3.1 Voltage increased to ~3 kV, bank energy increased to 200 kJ
8.3.3.3.2 Additional modules for improved voltage control

8.3.3.4 1MW → 2MW ECH for heating low-Ip CHI plasma

8.3.3.5 Point helicity sources/plasma guns

Other supporting work beyond First Draft (to be completed soon after APS)

Next week: First draft of Red & Blue sections to be circulated to supporting authors

- TSC: Start-up with CHI, with PF5, PF3 control and current ramp-up now working (to be summarized in IAEA paper & in first draft)
  - Next steps (FY13/14): Couple to TRANSP and RF codes [Kessel, Poli to improve these sections]
  - Gerhardt to revise sections related to PTRANSP
  - Taylor to improve sections related to RF modeling
- Improve plan for plasma gun start-up [Redd, Mueller to improve these sections]