NSTX-U Supported by U.S. DEPARTMENT OF ENERGY Office of Science

Wave Heating and Current Drive TSG: XMP/XPs for the 2015 NSXT-U Campaign

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X Science LLC

RF-TSG
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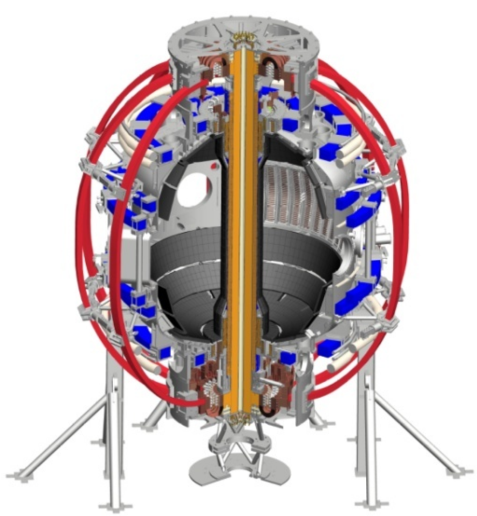
January 22, 2015



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RF research: first year goals

- Establish reliable coupling in L- and H-mode (w/ and w/o NBI)
  - Evaluate antenna performance in broad range on conditions
    - Assess recent change in antenna grounding
  - Characterize RF power losses in the SOL
    - Higher B_T should help
  - Contributes to R(16-3)
- Characterize HHFW absorption in NBI-heated plasma
  - Collaboration with EP TSG
  - Contributes to R(16-3)
- Generate non-inductive $I_p \sim 300$ kA H-mode with HHFW alone
  - Collaboration with SFSU TSG
  - Attempt FW ramp of I_p from 250 to 400 kA
- Measure O-X-B coupling with synthetic aperture microwave imaging (SAMI):
  - Collaboration with York U. & CCFE

RF XMP/XPs in first 2 months (weeks 1-8)

- XMP for commissioning the HHFW System
  - Vacuum conditioning after boronization/lithium
    - Does not require run time
  - IDEALLY: plasma conditioning after boron/lithium
    - Needed for full characterization of antenna performance
    - Requires several run days
  - RF conditioning into plasma w & w/o NBI
    - Determine plasma-antenna gap acceptable for outer NB operation

- RF XPs
  - RF heating in core vs. SOL both w/ & w/o NBI
  - HHFW absorption by ions in NBI-heated plasmas

XMP: Bring HHFW System online and operate into plasma

- Evaluate performance and condition antenna to maximum voltage:
  - Verify HHFW system controls (phase, amplitude, arcing, ect.)
  - Compare voltage limits across multiple plasma configurations
    - Determines maximum power level
  - Monitor heating performance
    - Requires magnetics and Thomson Scattering
- Evaluate heat load of 2nd NB on HHFW limiter:
  - Both with and without applied HHFW power
  - Determine minimum acceptable plasma-limiter gap
- Evaluate voltage standoff before and after lithium/boron conditioning
- Expect XMP will require 4-5 days during weeks 1-8

XPs for weeks 5-8: RF heating in the core vs. SOL and HHFW absorption by ions

- RF heating in the core vs. SOL w/ & w/o NBI:
  - Depends on available diagnostics (incl. IR cameras, probes, edge reflectometer, etc.)
  - Requires ~ 1 day, some data maybe acquired during HHFW XMP

- HHFW ion absorption in NBI-heated plasma:
  - w/ and w/o 2nd NBI
  - Requires ~ 1 day (in combination with EP TSG XP)

Preliminary list of XPs requiring HHFW, some in collaboration with other TSGs/SGs (weeks 5 - 18)

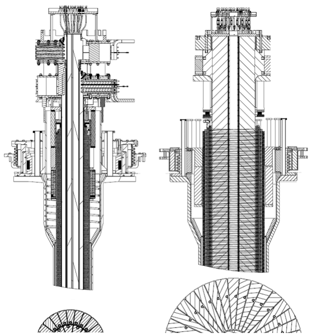
Lead Author(s)	Title	Collaborating TSG(s)
G. Taylor	HHFW Ramp Up of Inductively Initiated Plasma from 250 to 400 kA	Solenoid-Free Start-Up + RF TSGs
J. Hosea, R. Perkins	Study HHFW Power Coupling Versus ELM activity	
G. Taylor	Low Plasma Current Fully Non-Inductive HHFW H-Mode	Solenoid-Free Start-Up + RF TSGs
G. Taylor	HHFW Heating of CHI-initiated Plasma	Solenoid-Free Start-Up + RF TSGs
J. Hosea	Turbulence Characteristics for HHFW Saturated Stored Energy versus RF power	Transport and Turbulence + RF TSGs
N. Bertelli, M. Podestà, B. LeBlanc	HHFW absorption in NBI-Heated plasmas	Energetic Particles + RF TSGs
Energetic particles & RF TSGs	Effects of HHFW on toroidal rotation (core and edge)	Energetic particles + RF TSGs
Pedestal & RF TSGs	Impact of HHFW of edge/pedestal turbulence	Pedestal structure and control + RF TSGs
Energetic particles & RF TSGs	Suppression of energetic particle driven instabilities with HHFW heating	Energetic particles + RF TSGs
RF TSG + others	FWCD for core q profile control and MHD avoidance	RF TSG + others
Particle control TF + RF TSG	Impact of HHFW on impurity	Particle control TF + RF TSG
N. Bertelli	HHFW CD measurements by MSE and code validation	

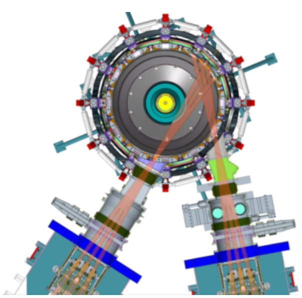
FY2015-16 research milestones target exploitation of new capabilities, exploration of new regimes

Incremental (full ops)

Expt. Run Weeks:

Previous center-stack | New center-stack





Present NBI | New 2[nd] NBI

	FY2015	FY2016
Expt. Run Weeks:	12 / 14	16 / 20
Boundary Science	R15-1: Assess H-mode confinement, pedestal, SOL characteristics at higher B_T, I_P, P_{NBI}	R16-1: Assess scaling, mitigation of steady-state, transient heat-fluxes w/ advanced divertor operation at high power density
	Develop snowflake configuration, study edge and divertor properties (IR15-1)	R16-2: Assess high-Z divertor PFC performance and impact on operating scenarios
Core Science	R15-2: Assess effects of NBI injection on fast-ion f(v) and NBI-CD profile	IR16-1: Assess confinement and local transport and turbulence at low ν^* with full range of B_T, I_P, and NBI power
Integrated Scenarios	R15-3: Develop physics + operational tools for high-performance discharges (κ, δ, β, EF/RWM)	R16-3: Assess fast-wave SOL losses, core thermal and fast ion interactions at increased B_T, I_P
		R16-4: Develop high-non-inductive fraction NBI H-modes for ramp-up & sustainment
FES 3 Facility Joint Research Target (JRT)	NSTX-U leads JRT: Quantify impact of broadened J(r) and p(r) on tokamak confinement and stability	C-Mod leads JRT: Assess disruption mitigation, initial tests of real-time warning and prediction techniques