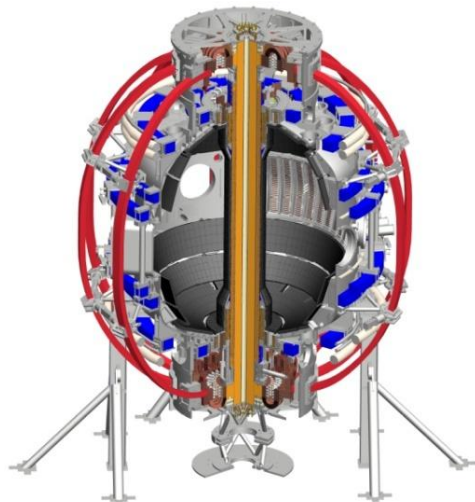


NSTX-U Program Update

J. Menard

**NSTX-U Team Meeting
B318
January 3, 2013**

*Coll of Wm & Mary
Columbia U
CompX
General Atomics
FIU
INL
Johns Hopkins U
LANL
LLNL
Lodestar
MIT
Lehigh U
Nova Photonics
Old Dominion
ORNL
PPPL
Princeton U
Purdue U
SNL
Think Tank, Inc.
UC Davis
UC Irvine
UCLA
UCSD
U Colorado
U Illinois
U Maryland
U Rochester
U Tennessee
U Tulsa
U Washington
U Wisconsin
X Science LLC*



*Culham Sci Ctr
York U
Chubu U
Fukui U
Hiroshima U
Hyogo U
Kyoto U
Kyushu U
Kyushu Tokai U
NIFS
Niigata U
U Tokyo
JAEA
Inst for Nucl Res, Kiev
Ioffe Inst
TRINITI
Chonbuk Natl U
NFRI
KAIST
POSTECH
Seoul Natl U
ASIPP
CIEMAT
FOM Inst DIFFER
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep*

Team actively engaged in writing 5 year plan for 2014-2018

The screenshot shows the NSTX-U website with the following content:

- Navigation: Home, Meetings, Drag & Drop, Calendars, Phone Book, Sitemap
- Page Title: National Spherical Torus Experiment Upgrade
- Breadcrumbs: [Five Year Plan](#) > [Five Year Plan \(2014-18\)](#) >
- Section: **Chapter Text**
- Text: Chapter text and other documents for the 5 year plan are archived on this page
- Text: Chapter writing progress meeting information is archived [here](#)
- Text: Background material (outlines, timelines, and operational staging) is located [here](#)
- List of chapters with responsible persons:
 - Chapter 01 - Overview** Responsible person: Jon Menard (jmenard@pppl.gov)
 - Chapter 02 - Macroscopic Stability** Responsible person: Jong-Kyu Park (ipark@pppl.gov)
 - Chapter 03 - Transport and Turbulence** Responsible person: Yang Ren (yren@pppl.gov)
 - Chapter 04 - Boundary Physics** Responsible person: Vlad Soukhanovskii (vlad@pppl.gov)
 - Chapter 05 - Materials and PFCs** Responsible person: Mike Jaworski (mjaworski@pppl.gov)
 - Chapter 06 - Energetic Particles** Responsible person: Mario Podesta (mpodesta@pppl.gov)
 - Chapter 07 - Wave Heating and Current Drive** Responsible person: Gary Taylor (gtaylor@pppl.gov)
 - Chapter 08 - Plasma Formation and Ramp-up** Responsible person: Roger Raman (rraman@pppl.gov)
 - Chapter 09 - Plasma Sustainment and Control** Responsible person: Stefan Gerhardt (sgerhardt@pppl.gov)
 - Chapter 10 - Facility Upgrades** Responsible person: Masa Ono (mono@pppl.gov)
 - Chapter 11 - Collaborator Plans** Responsible person: Jon Menard (jmenard@pppl.gov)

Additional Links: Home, Overview, Mission, Accomplishments, Collaboration Info, Diagnostics, Five Year Plan, Operations, Organization, Program, Project, Publications, Scientific Conferences, Software, Topical Science Groups, NSTX Upgrade Overview, NSTX Upgrade Project

Logos: PPPL, ITER, USBPO, ITPA

Footer: [Sign in](#) | [Report Abuse](#) | [Print Page](#) | [Remove Access](#) | Powered By [Google Sites](#)

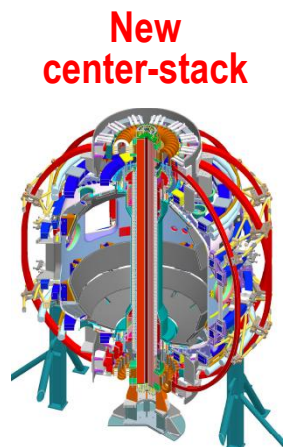
- Plan text to be due to FES approx. April 1, and review in May 2013
- Drafts of each chapter in-hand
 - Many are largely complete
- Complete drafts due mid-January
- Plan and text will be assessed at NSTX-U PAC-33
- Emphasizing support of FNSF, ITER, predictive capability
 - Role of reduced collisionality
 - Non-inductive start-up, sustainment
 - 3D field effects

Your comments on the plan are welcome!

FY2014-18 5 year base plan aims to access new ST regimes with Upgrade + additional staged high priority upgrades

2014	2015	2016	2017	2018
------	------	------	------	------

Upgrade Outage 1.5 → 2 MA, 1s → 5s



New center-stack

Start-up and Ramp-up

● Upgraded CHI for ~0.5MA

ECH/EBW ● 1MW

Boundary Physics

● Divertor cryo-pump

Materials and PFCs

● U or L Mo/W divertor

Liquid metals / lithium

● Li granule injector

● Upward LiTER

MHD

● MGI disruption mitigation

● Enhanced MHD/RWM sensors

Transport & Turbulence

● High k_θ

● δB polarimetry

● DBS

Waves and Energetic Particles

● HHFW limiter UG or EHO/AE straps

Scenarios and Control

Establish control of:

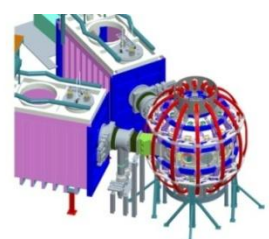
● Rotation

● Snowflake

● Divertor

● P_{rad}

● q_{min}



2nd NBI



- NSTX Upgrade research goals in support of PMI, FNS, ITER**
- Low collisionality plasma regimes
 - 100% non-inductive operation
 - Long-pulse, high power divertor
 - Advanced high- β scenarios

Draft PAC-33 agenda and speakers

PAC dates: February 19-21, 2013

PAC meeting will effectively be dry-run for 5 year plan review

- Program overview Jon Menard
- Upgrade progress, facility and diagnostic prep, budget Masa Ono
- Initial Operations Plan, Scenarios and Control Stefan Gerhardt
- Macroscopic Stability Jack Berkery
- Non-axisymmetric control coil (NCC) applications Jong-Kyu Park
- Transport and Turbulence Yang Ren

- Energetic Particles Mario Podesta
- HHFW and ECH / EBW Gary Taylor
- Solenoid Free Start-up and Ramp-up Roger Raman
- Long-term issues and strategy for boundary and PMI Rajesh Maingi
- Pedestal, SOL, Divertor Vlad Soukhanovskii
- Cryo-pumping and particle control John Canik
- Materials and Flowing liquid Li module development Mike Jaworski

NSTX-U researchers will be playing active role in MAST 2013 run campaign

- Thanks to MAST team for strong outreach/accomodation to NSTX team
- And to Gary Taylor for helping coordinate NSTX collaboration on MAST

Number	Title	Person in charge
FPP-001	Time-resolved measurements of DD fusion products using proton detector & neutron camera/fission chamber during short timescale MHD activity & NBI blips	D. Darrow M. Cecconello
FPP-006	Identification & study of TAE avalanches	E. Fredrickson
MHD-011	Effect of I_p and β_p on pedestal	A. Diallo
TC-014	Measure perturbative particle transport in MAST	Y. Ren
TC-011	Momentum transport	W. Guttenfelder

Experiments to start Feb/Mar - will benefit MAST/MAST-U and NSTX-U

Backup

10 year plan goals with ~10-15% incremental funding

2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
------	------	------	------	------	------	------	------	------	------

Upgrade Outage

Establish ST physics, scenarios

Integrate long-pulse + PMI solutions

Start-up and Ramp-up

Increase CHI closed-flux current

Understand plasma gun start-up at increased device size / major radius

Increase/extend ramp-up heating and off-axis current-drive for advanced scenarios

Develop/understand ECH/EBW H&CD for ST

Boundary Physics

Establish main-ion density and v^* control

Understand snowflake divertor performance

Investigate high-Z first-wall erosion, migration, particle sources & sinks

Materials and PFCs

Assess high-Z divertor PFC impact and performance

Assess high-Z first-wall

Assess impact of high-temperature first-wall

Liquid metals / lithium

Establish low impurities / Z_{eff} , assess increased Li coverage, replenishment

Test flowing liquid metal for heat-flux mitigation, surface replenishment

Assess flowing LM PFC with full toroidal coverage

MHD

Extend disruption and RWM detection, develop disruption mitigation techniques

Enhance non-axisymmetric field spectrum and capabilities for control of: RWM, EF, RMP, rotation, NTM, EP

Transport & Turbulence

Understand ES and EM turbulence at high β , low v^* , emphasizing e-transport

Extend wave-number coverage of turbulence measurements

Waves and Energetic Particles

Support plasma start-up, assess effectiveness of fast-wave in NBI H-modes

Prototype driving edge-harmonic oscillations (EHOs) and/or *AE

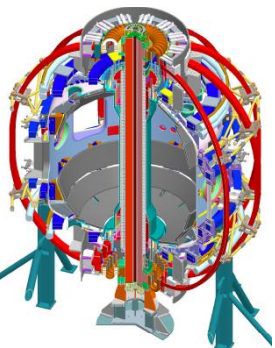
Drive and control EHO and/or *AE modes

Scenarios and Control

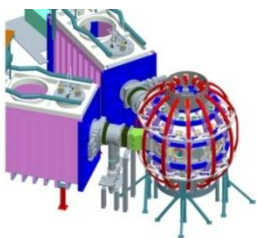
Demonstrate full non-inductive, high I_p & P_{AUX} operation
Control: boundary, β , divertor heat flux, Ω & q profiles

Assess integrated control of long-pulse / high-performance

New center-stack



U.S. FNSF conceptual design including aspect ratio and divertor optimization



2nd NBI

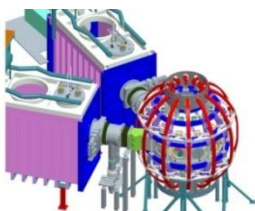
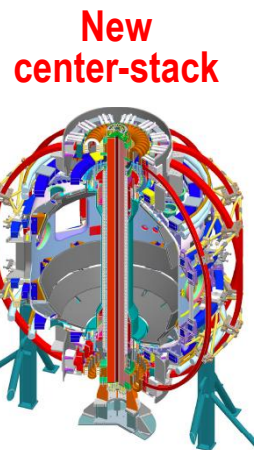
10 year plan tools with ~10-15% incremental funding

2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
------	------	------	------	------	------	------	------	------	------

Upgrade Outage

1.5 → 2 MA, 1s → 5s

Metallic PFCs, 5s → 10-20s



Category	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Start-up and Ramp-up		0.3-0.5 MA CHI ●		0.5-1 MA CHI ●		up to 1 MA plasma gun ●				Extend NBI duration or implement 2-4 MW off-axis EBW H&CD ●
		0.2-0.4 MA plasma gun ●		1MW ●	→	2 MW ●				
Boundary Physics		Divertor cryo-pump ●			Divertor Thomson ●					Diagnostics for high-Z wall studies ●
Materials and PFCs		U or L Mo/W divertor ●		U + L Mo/W divertor ●		All High-Z PFCs ●				Hot high-Z FW PFCs using bake-out system ●
Liquid metals / lithium		Li granule injector ●		Upward LITER ●		Flowing Li divertor or limiter module ●				Full toroidal flowing Li divertor ●
MHD		MGI disruption mitigation ●		Enhanced MHD/RWM sensors ●		NCC coils ●				NCC SPA upgrade ●
Transport & Turbulence		High k_0 ●		δB polarimetry ●		DBS ●				PCI or other intermediate-k ●
Waves and Energetic Particles				HHFW limiter upgrade ●		HHFW straps for EHO, *AE ●				Dedicated EHO or *AE antenna ●
Scenarios and Control				Establish control of:						Control integration, optimization ●
		Rotation ●	Snowflake ●	Divertor ●	P_{rad} ●	q_{min} ●				

U.S. FNSF conceptual design including aspect ratio and divertor optimization