NSTX-U Program - FY2015 Q4 Report*

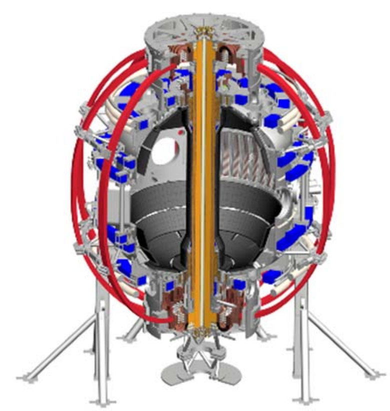
Jon Menard, Stan Kaye, Masa Ono (PPPL)

For the NSTX-U Team

PPPL and FES

October 26, 2015

*This work supported by the US DOE Contract No. DE-AC02-09CH11466



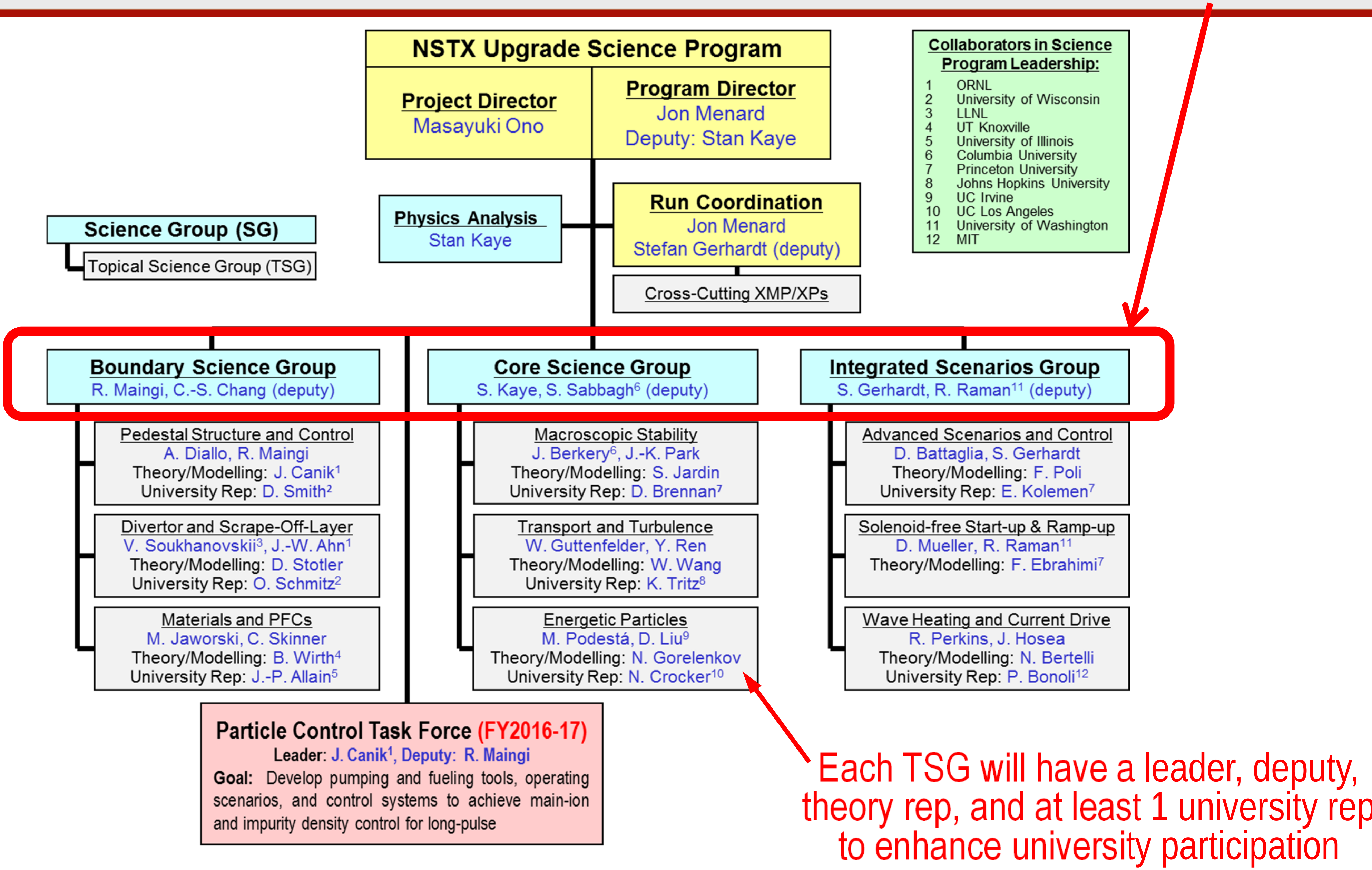
Outline

- Notable Outcomes
- Research Milestones
- FY2015 Research Highlights
- Upcoming events
- Summary

Notable outcome overview

- Objective 1.2 *"Perform experimental research on NSTX-U to resolve key spherical torus issues at magnetic field, plasma current, and pulse length beyond that achieved in NSTX, after completion of CD-4 for the project"*
  - Did not have experimental campaign in FY2015, but generated many new analysis and simulation results, reorganized science groups, planned run
- Objective 1.2 *"Provide leadership, coordination, and support to the FES joint research target with the goal of quantifying the impact of broadened current and pressure profiles on tokamak plasma confinement and stability"*
  - Led by M. Podesta with emphasis on energetic particle physics w/ DIII-D
- Outcome 3.2 *"Develop a plan to continue the NSTX-U/PPPL Theory partnership within projected funding levels"*
  - FY15 budget favorable → maintained/expanded partnership
  - Several / many partnership result examples shown in research highlights

Developed new NSTX-U Science Program organizational structure with 3 Science Groups



NSTX-U Scientific Organization – August 2015

Very strong interest in NSTX-U research

Requested research time exceeds available time by 4-5×

Requested / Available Run Time:

Total: 273 / 80 = 3.4×

Research: 248 / 55 = 4.5×

84 unique lead author names

~85% of requested time

#	Institution	Run Days Requested	Fraction
1	Princeton Plasma Physics Laboratory	112.1	41.1%
2	Oak Ridge National Laboratory	28.5	10.5%
3	Princeton University	20.5	7.5%
4	Lawrence Livermore National Laboratory	18	6.6%
5	General Atomics	17	6.2%
6	ITER (France)	12	4.4%
7	University of Washington	11.5	4.2%
8	Columbia University	10.5	3.9%
9	University of Wisconsin	9	3.3%
10	University of California - Irvine	7.5	2.8%
11	Nova Photonics	6	2.2%
12	University of Illinois	4	1.5%
13	Massachusetts Institute of Technology	4	1.5%
14	University of California - San Diego	3	1.1%
15	Johns Hopkins University	3	1.1%
16	University of Tennessee	2	0.7%
17	Lehigh University	1	0.4%
18	Florida International University	1	0.4%
19	University of California - Los Angeles	1	0.4%
20	University of York (United Kingdom)	1	0.4%
		272.6	100%

Areas of highest interest / need

Topical Science Group or Task Force	Run Days Requested	Fraction
Macroscopic Stability (MS)	40.75	14.9%
Cross-cutting and Enabling (CC)	34.85	12.8%
Divertor and Scrape-off-layer (DS)	33.5	12.3%
Advanced Scenarios and Control (ASC)	33	12.1%
Pedestal Structure and Control (PS)	25	9.2%
Particle Control Task Force (PC)	23	8.4%
Energetic Particles (EP)	22.5	8.3%
Turbulence and Transport (TT)	21	7.7%
Materials and PFCs (MP)	15.5	5.7%
Solenoid-free Start-up and Ramp-up (SR)	14.5	5.3%
Wave Heating and Current Drive (RF)	9	3.3%
	272.6	100%

Review of first 30 high priority experimental proposals (XPs) nearly complete

- **Only 2 of 30 high-priority XPs remain to be reviewed**

Expectation of when XP will run

XP number	XP title	Responsible Group	XP author first name	XP author last name	XP author e-mail	Priority	Run Weeks 1-4	Run Weeks 5-8	Run Weeks 9-12	Run Weeks 13-16
1501	Optimization of vertical control algorithm	ASC-TSG	Dan	Boyer	mboyer@pppl.gov	P1a	1			
▶ 1502	Tuning of the Automated Rampdown Software	ASC-TSG	Stefan	Gerhardt	sgerhard@pppl.gov	P1c	1			
1503	X-point control integration with shape control	ASC-TSG	Egemen	Kolemen	ekolemen@princeton.edu	P1a	1			
1504	Beam power and beta-N control	ASC-TSG	Dan	Boyer	mboyer@pppl.gov	P1b	0.5	0.5		
1505	Optimizing Boronization XMP	MP-TSG	Charles	Skinner	cskinner@pppl.gov	P1a	0.5	0.5		
1506	Low-beta, low-density locked mode studies	MS-TSG	Clayton	Myers	cmyers@pppl.gov	P1a	0.25	0.75		
1507	Maximizing the non-inductive current fraction in NSTX-U H-modes	ASC-TSG	Stefan	Gerhardt	sgerhard@pppl.gov	P1a		0.5	0.25	0.25
1508	Controlled Snowflake Studies	ASC-TSG	Egemen	Kolemen	ekolemen@pppl.gov	P1b		0.25	0.5	0.25
1509	Combined betaN and li feedback control	ASC-TSG	Dan	Boyer	mboyer@pppl.gov	P1b		0.25	0.25	0.5
1510	Characterizing the SOL Losses of HHFW Power in H-Mode Plasmas	RF-TSG	Rory	Perkins	rperkins@pppl.gov	P1a		0.5	0.25	0.25
1511	Multi-machine studies of the L-H power threshold dependence on aspect ratio	PS-TSG	Michael	Bongard	mbongard@wisc.edu	P1b		1		
1512	Characterization of the Pedestal Structure as function Ip, BT, and Pnbi	PS-TSG	Ahmed	Diallo	adiallo@pppl.gov	P1a		0.5	0.5	
1513	Effects of B-> Li transition on the pedestal structure	PS-TSG	Rajesh	Maingi	rmaingi@pppl.gov	P1a		0.5	0.5	
▶ 1514	Heat flux and SOL width Scaling in NSTX-U	DS-TSG	Travis	Gray	tkgray@pppl.gov	P1a		0.25	0.5	0.25
1515	High-beta n=1,2,3 feed-forward error field correction	MS-TSG	Clayton	Myers	cmyers@pppl.gov	P1a		0.5	0.5	
1516	Optimization of PID dynamic error field correction	MS-TSG	Clayton	Myers	cmyers@pppl.gov	P1a		0.5	0.5	
1517	Neoclassical toroidal viscosity at reduced collisionality (independent coil control)	MS-TSG	S.A.	Sabbagh	sabbagh@pppl.gov	P1a		0.25	0.5	0.25
1518	RWM PID control optimization based on theory and experiment	MS-TSG	S.A.	Sabbagh	sabbagh@pppl.gov	P1a		0.25	0.5	0.25
1519	Massive Gas Injection Studies on NSTX-U	MS-TSG	Roger	Raman	raman@aa.washington.edu	P1a			0.5	0.5
1520	Ip/Bt scaling	TT-TSG	Stan	Kaye	kaye@pppl.gov	P1a		0.5	0.25	0.25
1521	Validation of gyrokinetic codes in NSTX-U NBI-heated L-mode plasmas	TT-TSG	Yang	Ren	yren@pppl.gov	P1a		0.5	0.25	0.25
1522	Beam ion confinement of 2nd NBI	EP-TSG	Deyong	Liu	deyongl@uci.edu	P1a		0.75	0.25	
1523	Characterization of 2nd NBI line	EP-TSG	Mario	Podesta	mpodesta@pppl.gov	P1a		0.25	0.5	0.25
1524	AE Critical Gradient	EP-TSG	Bill	Heidbrink	wwheidbr@uci.edu	P1a		0	0.25	0.75
1525	Rotation effects on CAEs and GAEs	EP-TSG	Neal	Crocker	ncrocker@physics.ucla.edu	P1a				1
1526	Establish heat transmission pathways in high-Z reference shape	MP-TSG	Michael	Jaworski	mjaworsk@pppl.gov	P1a		0.25	0.25	0.5
1527	ELM pacing via multi-species granule injection and 3D field application for main ion c	PC-TF	Robert	Lunsford	rlunsfor@pppl.gov	P1a		0.75	0.25	
1528	Characterize plasma near planned plenum entrance position	PC-TF	John	Canik	canikjm@ornl.gov	P1a		0.75	0.25	
1529	Controlled introduction of Lithium into NSTX-U	PC-TF	Rajesh	Maingi	rmaingi@pppl.gov	P1a		0.5	0.5	
1530	Triggering ELMs with LGI and 3-D fields in lithiated discharges	PC-TF	Robert	Lunsford	rlunsfor@pppl.gov	P1a			0.75	0.25

Latest run plan schedule for 2016

Goal is to operate 14-16 run weeks as per research forum

- ➢ If FY16 budgets are favorable enough, may run more run weeks
- ➢ Want as much data as possible for IAEA synopses/meeting, APS-2016

- November: ~ ISTP/Commissioning (XMP)
  - May want to slow/pause for ST workshop, APS, Thanksgiving
- December: 2-3 run weeks (XMP → XP)
- January: ~2 run weeks (XP)
  - PAC-37
- February: ~ 3 run weeks
  - Mid-run assessment (if applicable)
- March – May 7-8 run weeks, complete FY16 run
- May/June: Start outage: install high-k, high-Z tiles, …
- Resume operations fall/winter 2016 for FY17

FY2015 Research Milestones

- JRT-2015: *Conduct experiments and analysis to quantify the impact of broadened current and pressure profiles on tokamak plasma confinement and stability.*
- R(15-1): *Assess H-mode energy confinement, pedestal, and scrape-off-layer characteristics with higher B_T, I_P and NBI heating power*
- R(15-2): *Assess the effects of neutral beam injection parameters on the fast ion distribution function and neutral beam driven current profile*
- R(15-3): *Develop the physics and operational tools for obtaining high-performance discharges in NSTX-U*

  - **No XPs in FY2015 → emphasize analysis/modelling, research prep**
  - **FY2015 Research Milestones shifted to FY2016 largely unchanged**

NSTX-U Milestone Schedule for FY2016-18

	FY2016	FY2017	FY2018
Run Weeks: Incremental	14 / 16	16 / 18	12 / 16
Boundary Science + Particle Control	R16-1: Assess H-mode confinement, pedestal, SOL characteristics at higher B_T, I_P, P_{NBI}	R17-1: Assess scaling, mitigation of steady-state, transient heat-fluxes w/ advanced divertor operation at high power density R17-2: Assess high-Z divertor PFC performance and impact on operating scenarios	R18-1: Assess impurity sources and edge and core impurity transport IR18-1: Investigation of power and momentum balance for high density and impurity fraction divertor operation
Core Science	R16-2: Assess effects of NBI injection on fast-ion f(v) and NBI-CD profile	R17-3: Assess τ_E and local transport and turbulence at low ν^* with full confinement and diagnostic capabilities	IR18-2: Assess role of fast-ion driven instabilities versus micro-turbulence in plasma thermal energy transport Begin ~1 year outage for major facility enhancement(s) sometime during FY2018
Integrated Scenarios	R16-3: Develop physics + operational tools for high-performance: κ, δ, β, EF/RWM	IR17-1: Assess fast-wave SOL losses, core thermal and fast ion interactions at increased field and current R17-4: Develop high-non-inductive fraction NBI H-modes for sustainment and ramp-up	R18-2: Control of current and rotation profiles to improve global stability limits and extend high performance operation R18-3: Assess transient CHI current start-up potential in NSTX-U
FES 3 Facility Joint Research Target (JRT)	C-Mod leads JRT: Assess disruption mitigation, initial tests of real-time warning, prediction	DIII-D leads JRT: Examine effect of configuration on operating space for dissipative divertors	NSTX-U leads JRT: TBD

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NSTX-U Research Team Has Been Scientifically Productive

Very Active in Scientific Conferences, Publications, and Collaborations

- Strong APS meeting participation in 2014: 1 ST review talk, 5 invited talks, 44 additional presentations.
- Collaboration research contributions made in range of topics directly relevant to NSTX-U program
  - DIII-D: Pedestal saturation, fast-ions, RWM, RFA, QH TEM
  - KSTAR: NTV rotation damping, error fields, RMP
  - C-Mod: ELM cycle, high-Z spectroscopy
  - Halo current data/studies: DIII-D, AUG, C-Mod
- Strong technical NSTX-U / next-step presentations at 2015 SOFE, Li Symposium, IAEA-TM on divertors
- 45 refereed publications for FY2015

Topical Science Group Research Highlights

- Boundary Science
  - Pedestal Structure and Control
  - Divertor and Scrape-off Layer
  - Materials and Plasma Facing Components
- Core Science
  - Macroscopic Stability
  - Transport and Turbulence
  - Energetic Particles
- Scenario Integration
  - Advanced Scenarios and Control
  - Solenoid-Free Start-up and Ramp-up
  - Wave Heating and Current Drive

Emphasis on PPPL Theory / NSTX-U Partnership

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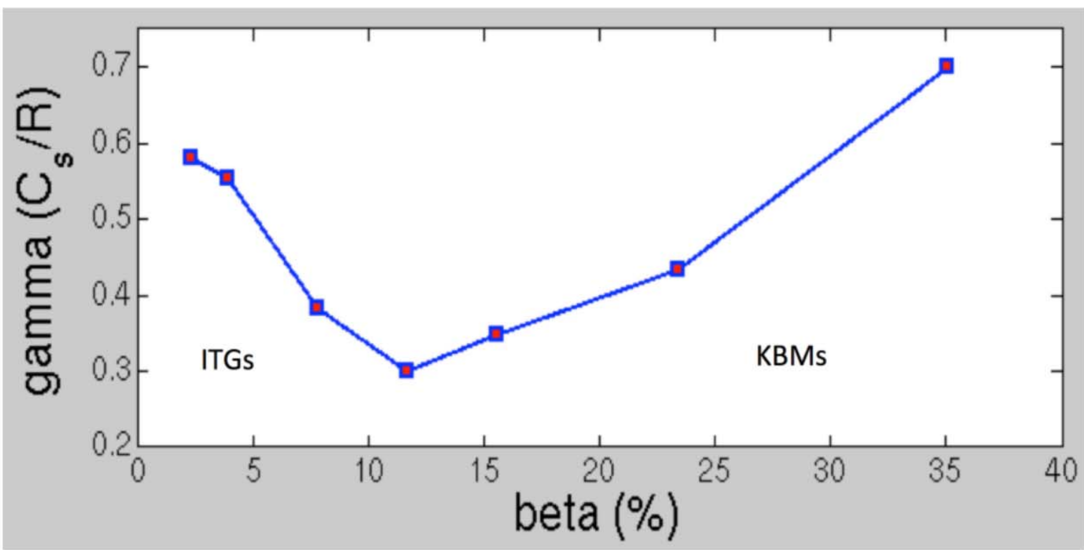
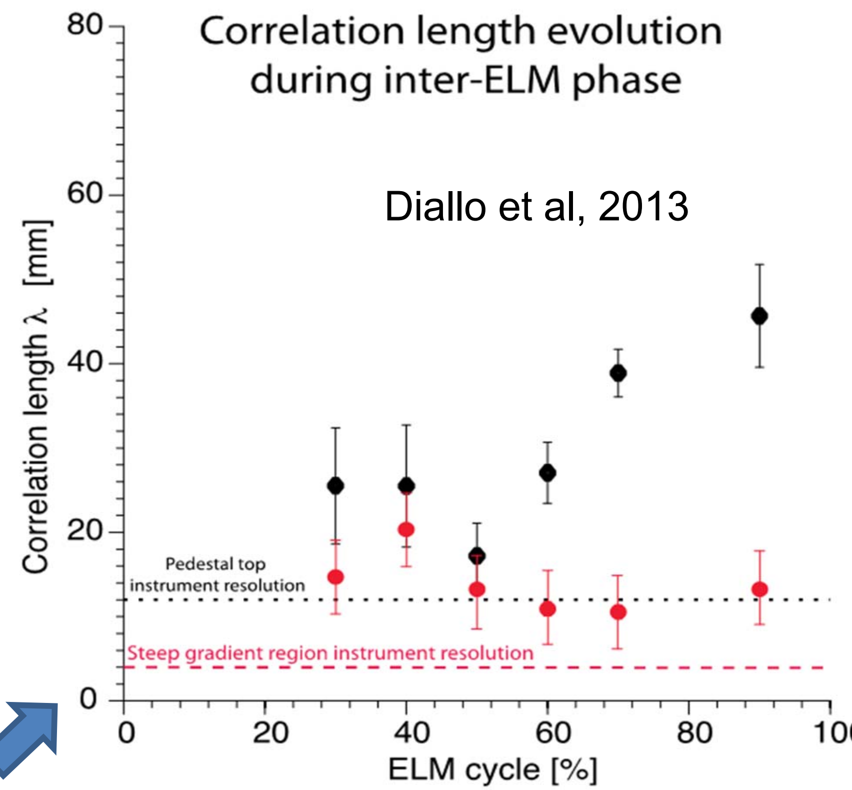
Electromagnetic (EM) effects critical for understanding transport in the pedestal and core of NSTX/NSTX-U

- XGC-1 (full-f, global PIC) recently implemented hybrid EM effects *(kinetic ions, fluid electrons - kinetic electrons under development)*
- Used to study pedestal turbulence in NSTX H-modes

- Linear simulations → transition from ITG to KBM at pedestal top for β_e~12%
- Expt → abrupt change in turbulence at ped. top at 50% of ELM cycle (β_e~8%)





Theory 2015 Notable Outcome

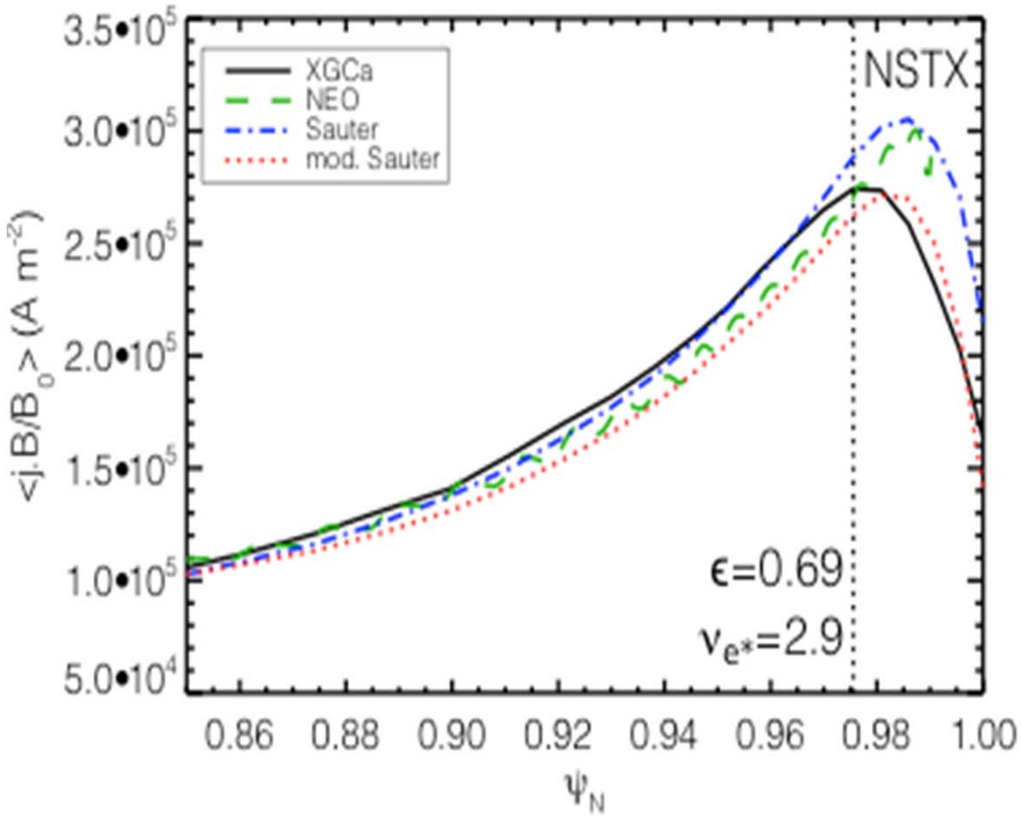
R15/16-1, 17-3, 18-1

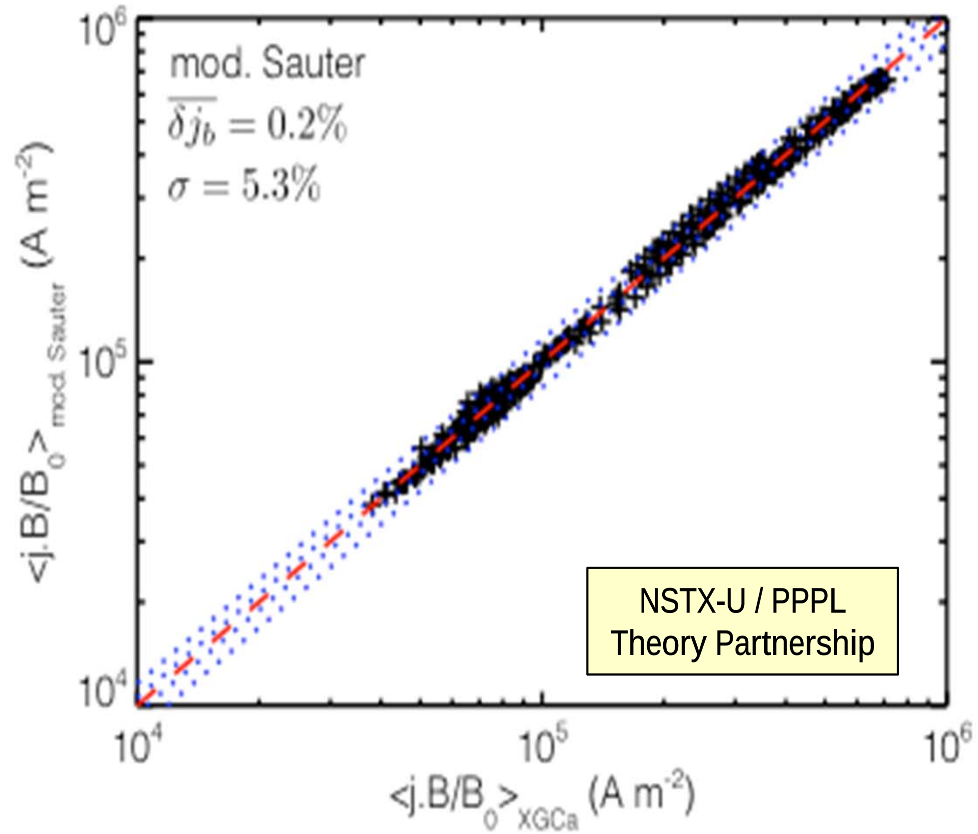
NSTX-U / PPPL Theory Partnership

XP1512 (Diallo): Characterization of pedestal structure

Non-local effects can reduce bootstrap current in NSTX edge/pedestal region at high collisionality

- Model: Global gyrokinetic neoclassical code XGCa
  - Fully non-linear Fokker-Planck-Landau collision operator
  - Includes effects of banana and gyro-orbits >> pedestal width
- Also developed modified analytic Sauter formula





NSTX-U / PPPL Theory Partnership

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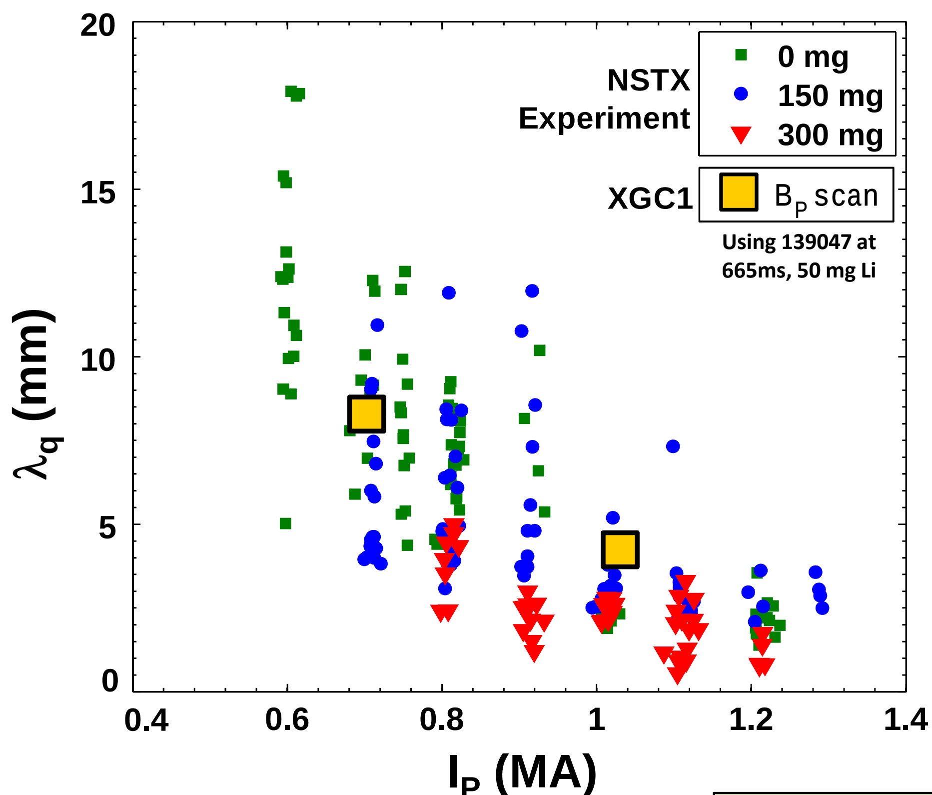
XGC1 simulations aiding in understanding of SOL heat flux width trends in NSTX

- Expt shows contraction of SOL heat flux width at midplane with I_p as well as influence of Li conditioning

XGC1 w/ collisions → similar trends



Heat flux width determined primarily by neoclassical processes

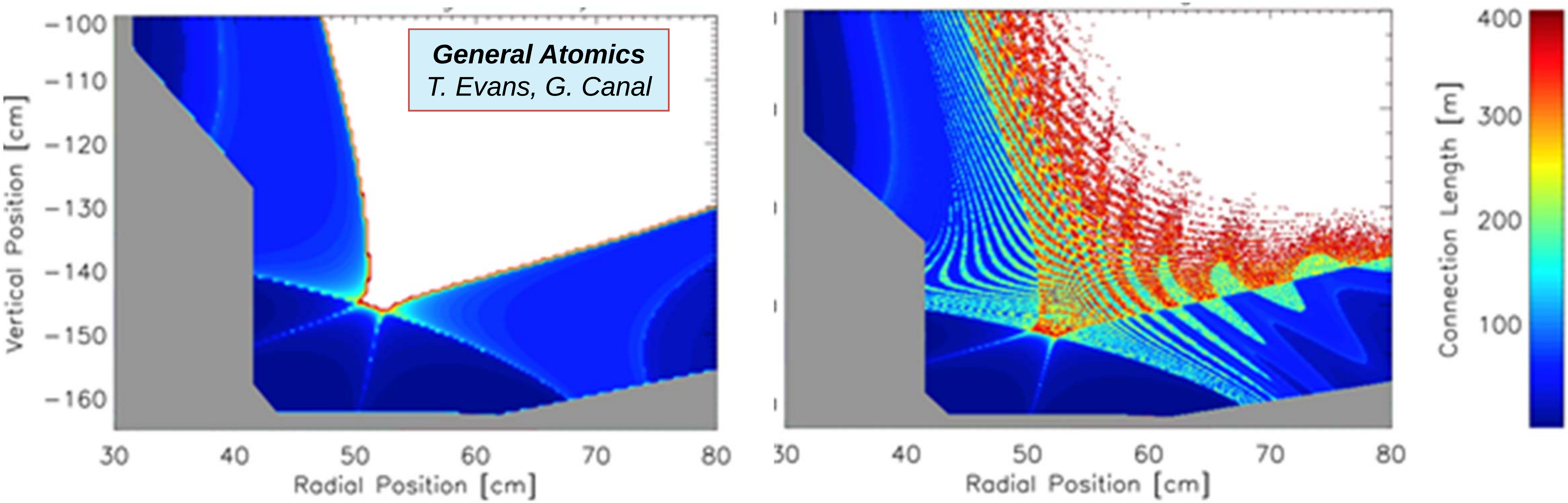
NSTX-U / PPPL Theory Partnership

XPs:

- (Gray) – Heat flux width scaling in NSTX-U; extend range of I_p, shape, Li dep
- (Gray) – Is interchange drive responsible for SOL contraction with Li (in collaboration with LODESTAR)

R15/16-1, 17-1

Initiated investigation of interactions of 3D magnetic perturbations with snowflake divertor



- Short L_c fine-scale field line bundles (green, light green) extend well into the confined plasma region
  - These magnetic field line bundles represent open field line bundles with 3-5 times the characteristic SOL length
  - Second null generates strong lobes on HFS
  - Potential for substantial parallel losses to the target

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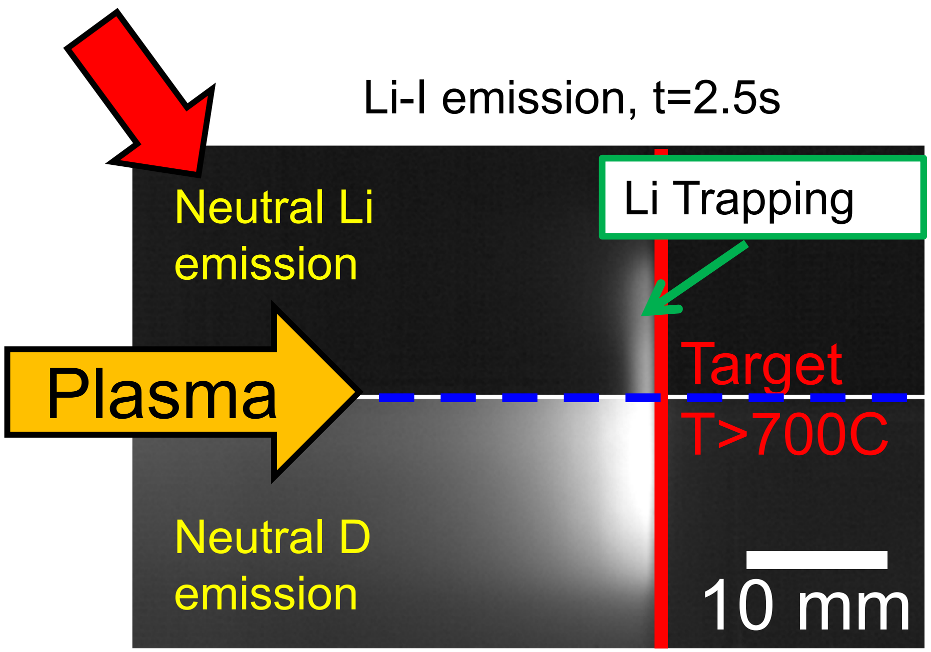
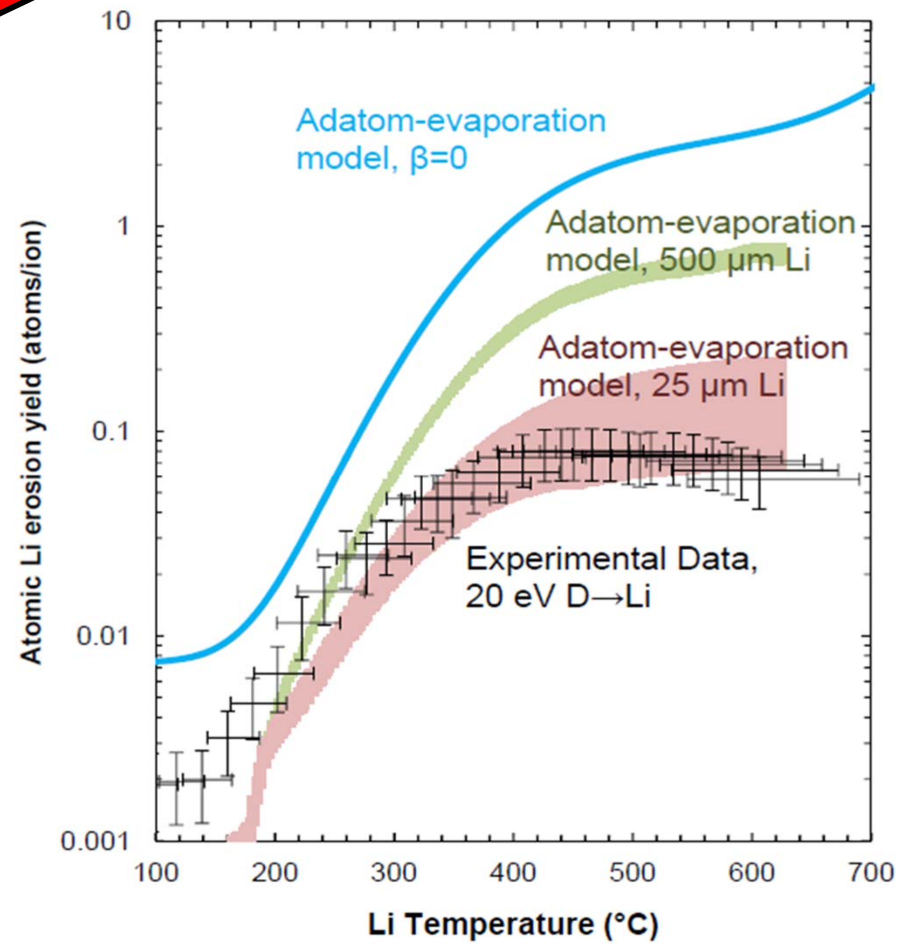
Reminder: Suppressed Li erosion and trapping at target observed in MAGNUM-PSI linear plasma device

- Mixed-material effect reduces erosion due to LiD formation
- Plasma pre-sheath potential well large enough to retain eroded Li
- Significant implications for evaporative cooling concepts

T. Abrams 2014 PhD Princeton U.,
T. Abrams 2015 Nucl. Fusion submitted,
M. Chen 2015 Nucl. Fusion submitted.

Li-I emission, t=2.5s





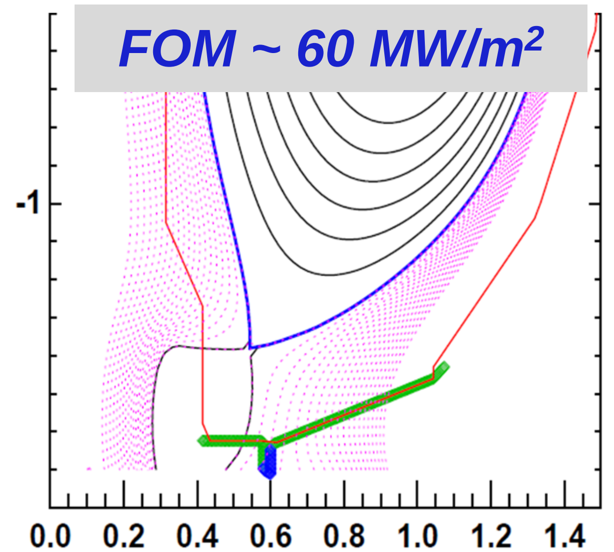
Jaworski, 3rd ISLA, 2013

FY15 modelling → outboard row of high-Z tiles can access high heat-flux, maintain operational flexibility

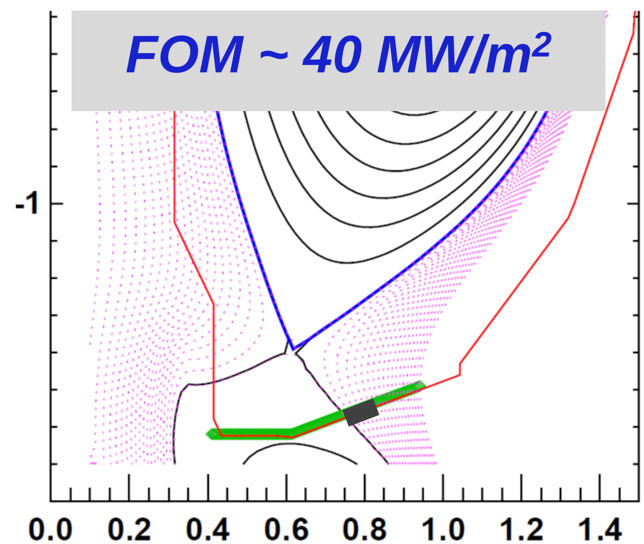
- Shape developed to perform dedicated tests on outboard PFCs
  - ISOLVER free-boundary solver utilized with specified β_N
  - 0D-analysis obtains heating power for assumed confinement multiplier H_{98y2}

- Zero-radiation power exhaust provides heat flux figure-of-merit (FOM)
  - FOM calculates incident power accounting for magnetic shaping only
  - High-Z shape FOM is 66% of similar full-power, high-triangularity scenario

High-performance discharge



High-Z reference discharge

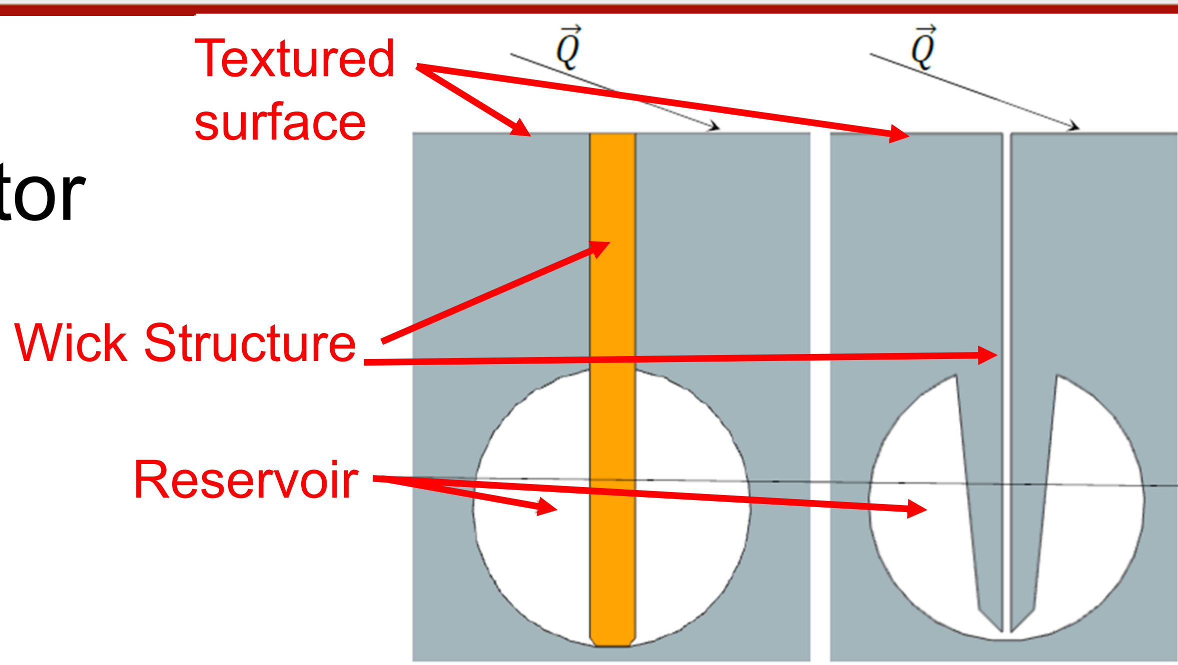


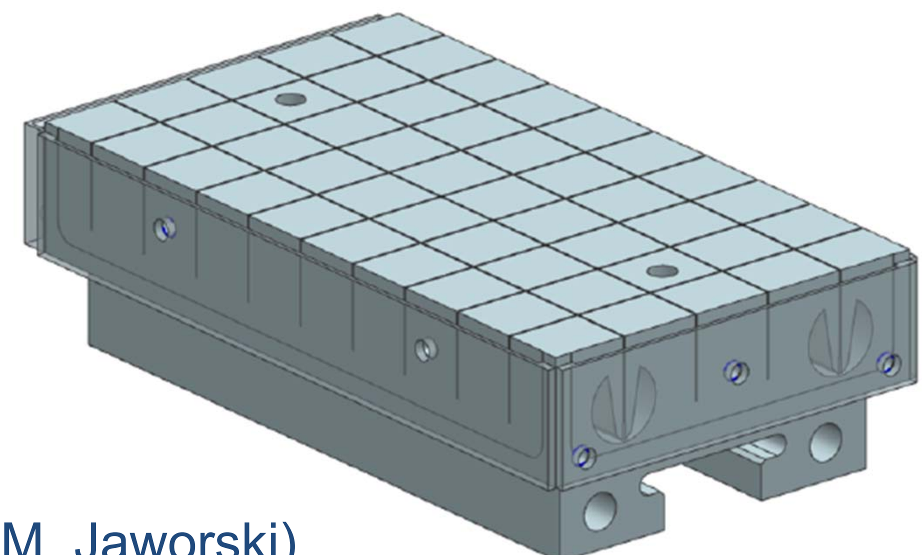
Developing pre-filled target concept integrating Li reservoir with high-Z tile scheme

- Similar to CPS device but applicable as divertor PFC

- Utilizes wire-EDM fabrication to obtain complex geometry

- Emphasizes passive replenishment via capillary action





P. Rindt, TU/Eindhoven Thesis Project (advisor: M. Jaworski)

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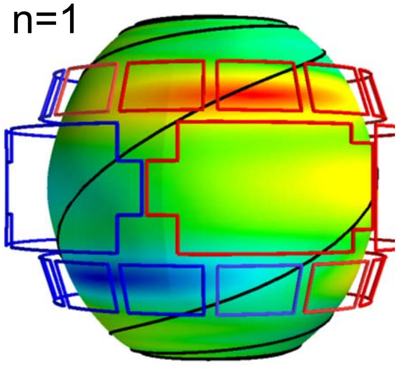
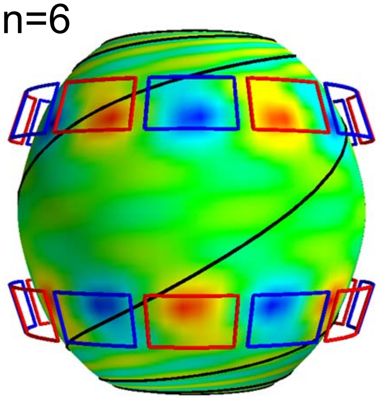
NCC physics design completed: Optimization for NTV braking performed with IPEC coupling matrix

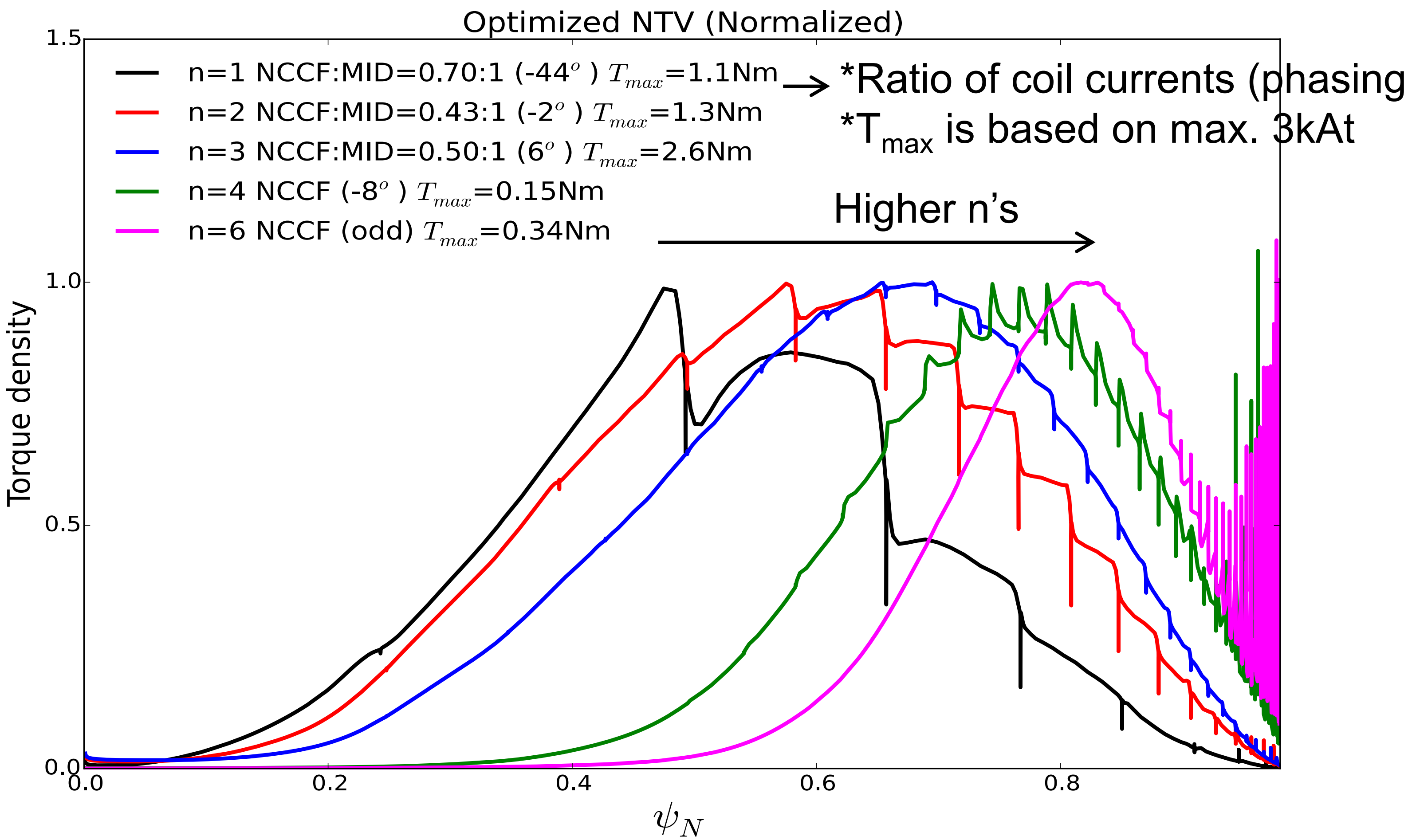
- NCC and midplane coils can be combined to remove the dominant resonant modes up to the second, giving the optimized NTV for core
  - NCC 2x12 provides n=1,2,3,4,6 optimized NTV, and 2x6 provides n=1,2,6
  - Optimized NTV can be used to control local torque with minimized resonance

n=1

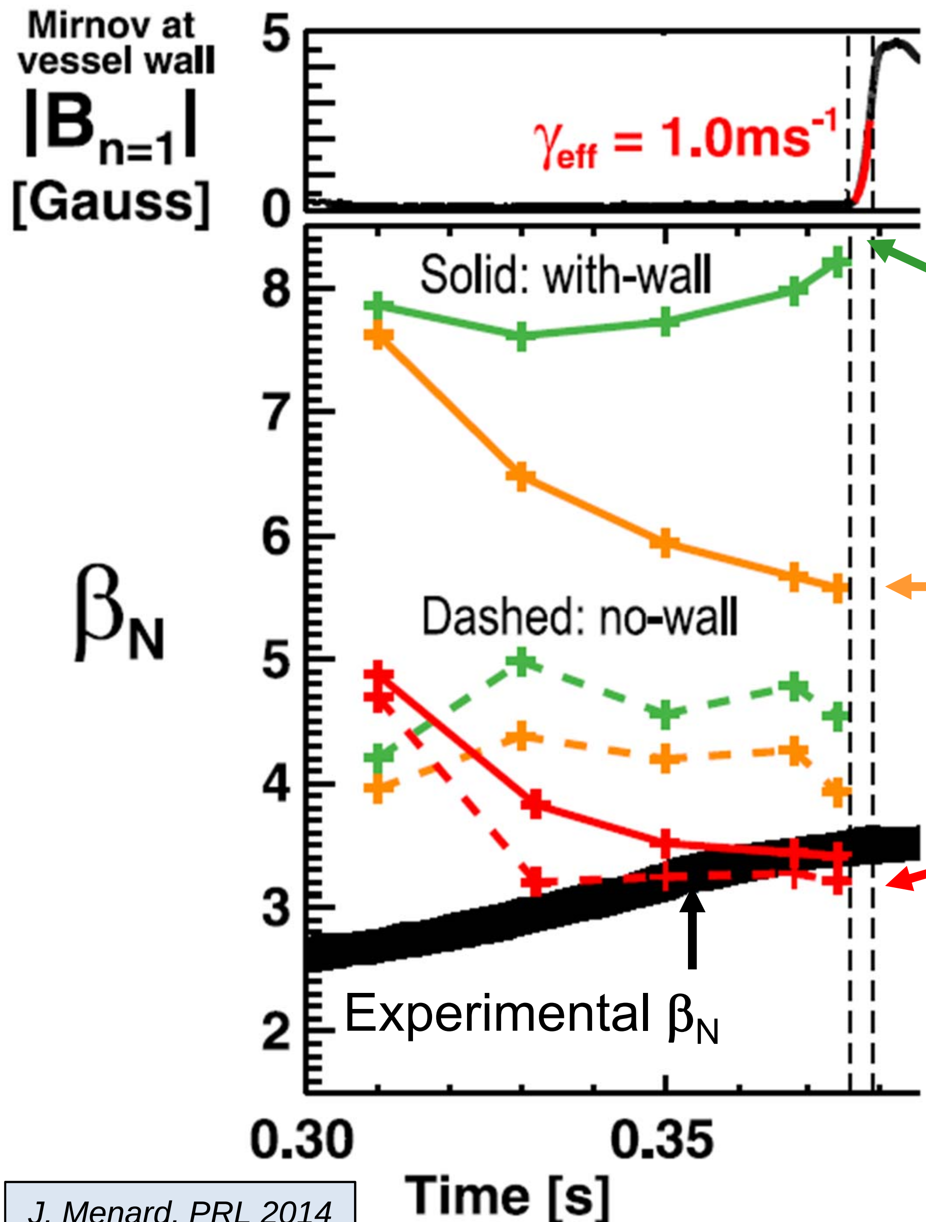


n=6





Rotation shear and fast-ion population both reduce "with-wall" β limit set by Ideal Wall Mode (IWM)



J. Menard, PRL 2014

- Hybrid MHD-drift-kinetic MARS-K consistent with NSTX Ideal Wall Mode onset at high rotation, β_{fast}

Low-rotation fluid with-wall limit is very high → marginal β_N ~ 7-8

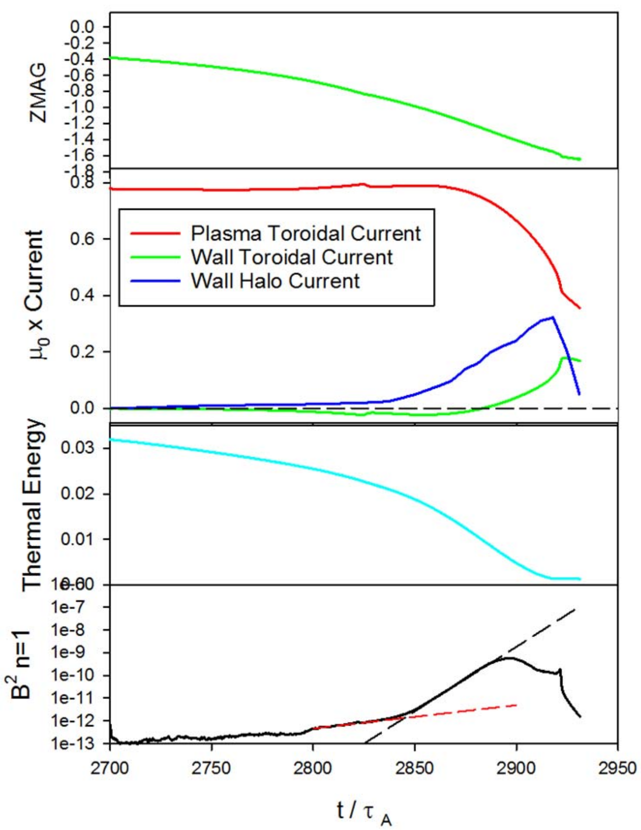
Increasing rotation lowers max β_N to ~5.5 at mode onset time

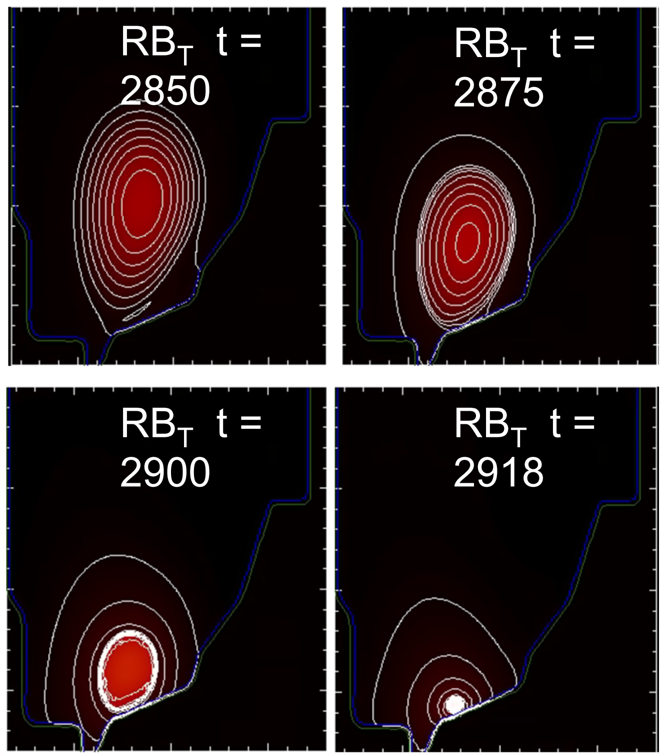
Full kinetic treatment including fast-ions → marginal β_N ~3.5 → most consistent with experiment

NTV + 2nd NBI will be used to optimize rotation shear, fast-ion profiles to maximize β limits

M3D-C1 modeling of Vertical Displacement Events (VDEs) has been extended to 3D

- Implemented arbitrary thickness resistive wall, giving 3 region computational space (vacuum, RW, plasma)
- 3D modeling of NSTX VDE with realistic wall resistivity (Jardin, Ferraro)
  - n=1 growth slow during drift (RWM?), growth then accelerates (external kink?)
  - Halo currents begin to form when plasma makes contact with vessel





NSTX Discharge 132859

- Disruption phase 2700 < t < 2950
- **Contours of RB_T show halo currents**

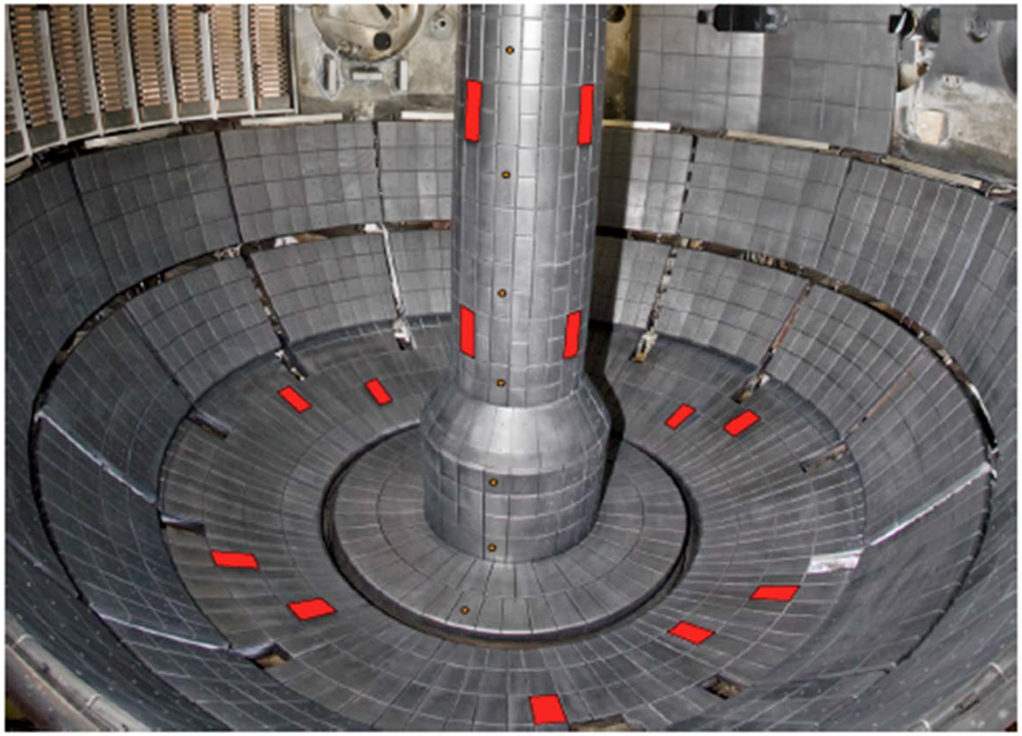
NSTX-U / PPPL Theory Partnership

M3D-C1 with resistive wall capability will be used to determine optimal placement of new halo sensors

- Dynamics of halo currents and forces critical for ITER: particular concern are halo current asymmetries and rotation
- New sensors will measure halo currents, B-fields and JxB forces in NSTX-U
- Critical theoretical issues: (i) role of boundary conditions (ii) halo current distributions in 3D conducting structures (new post-doc D. Pfefferle)

Planned NSTX-U Base Configuration

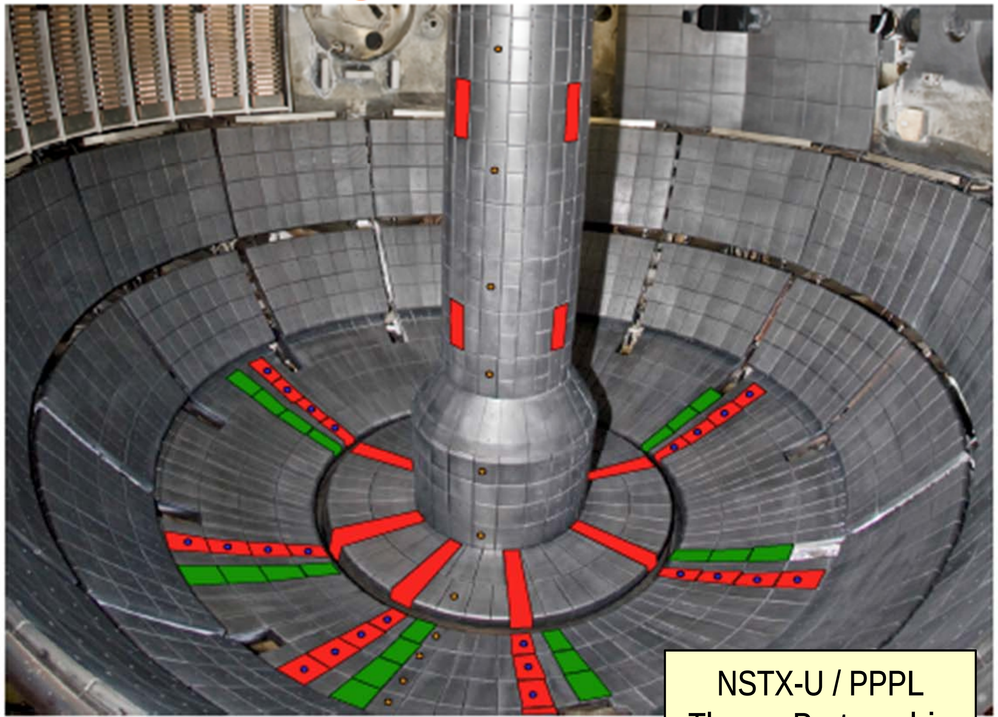
Normal Current Tiles   Single Axis B Sensors



R15/16-3, 17-2, 18-2, 2016 JRT

Potential NSTX-U Expanded Configuration

Normal Current Tiles   Single Axis B Sensors   Tangent Current Tiles   Multi-Axis B sensors



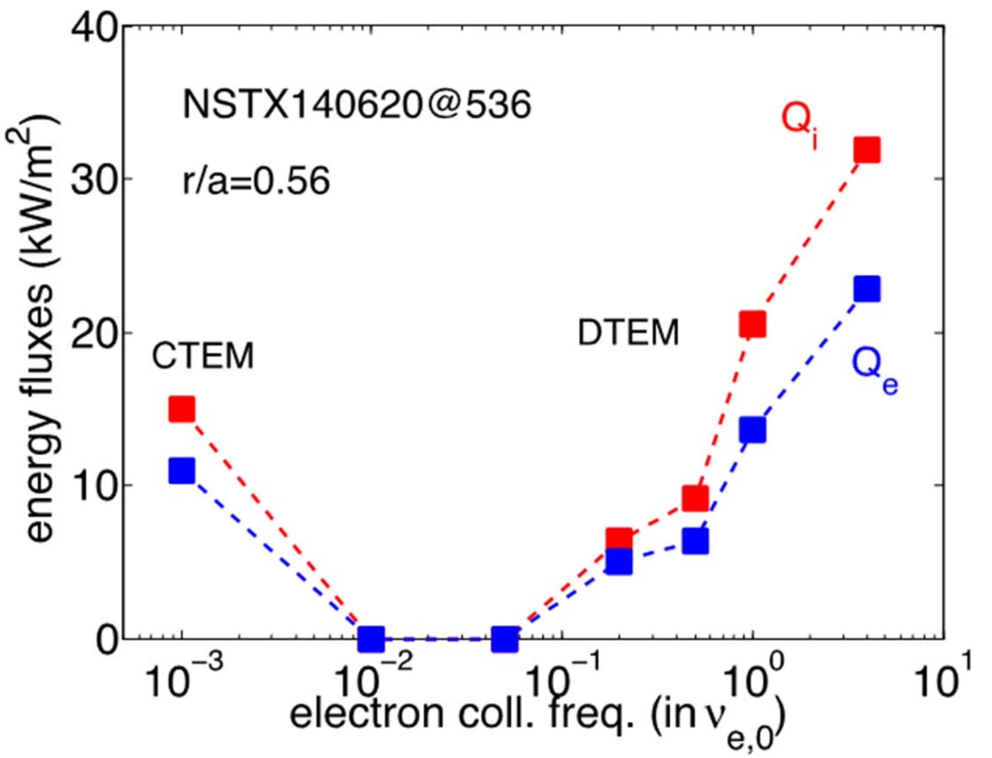
NSTX-U / PPPL Theory Partnership

Topical Science Group Research Highlights

- Boundary Science
  - Pedestal Structure and Control
  - Divertor and Scrape-off Layer
  - Materials and Plasma Facing Components
- Core Science
  - Macroscopic Stability
  - Transport and Turbulence
  - Energetic Particles
- Scenario Integration
  - Advanced Scenarios and Control
  - Solenoid-Free Start-up and Ramp-up
  - Wave Heating and Current Drive

Global, non-linear GTS simulations giving insight into causes of thermal electron and ion transport

- New simulations have shown possible role of Dissipative TEM in contributing to observed favorable collisionality scaling ($B\tau_{th} \sim \nu_{*e}^{-0.8}$)
  - In addition to microtearing



- E-M capability presently being implemented (Startsev, Wang)
  - Benchmarked for cylindrical geometry up to β=5%
  - Extend to toroidal geometry, higher β by end of CY15
  - Theory Notable Outcome
- XP1520 (Kaye): I_p/B_T scaling
  - Extend to lower ν_{*e}
  - Impact of microtearing, DTEM
- XP1521 (Ren): validation of g-k codes in L-mode plasmas

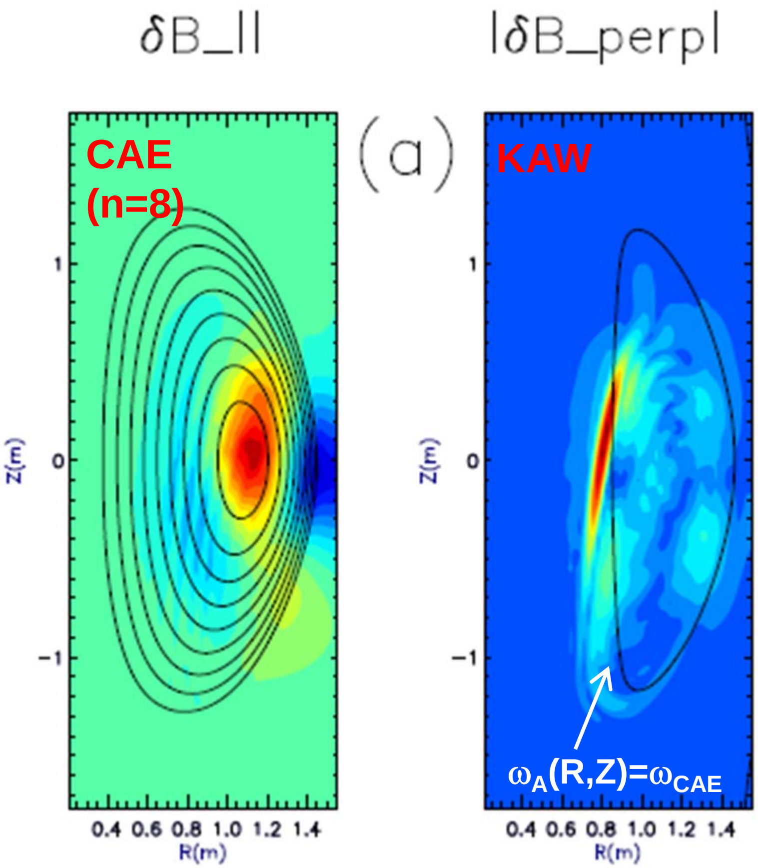
NSTX-U / PPPL
Theory Partnership

R15/16-1, 17-3, 18-1

W. Wang et al., accepted for pub. in NF Letters

CAE mode-conversion to kinetic Alfvén waves (KAW) predicted to transfer core NBI power to mid-ρ electrons

- CAEs also couple to KAW - Poynting flux redistributes fast ion energy near mid-radius, $E_{||}$ resistively dissipates energy to thermal electrons
  - $P_{CAE \rightarrow KAW}$ ~ **0.4 MW** from QL estimate + experimental mode amplitudes
  - $P_{e,NBI}$ ~ **1.7 MW** for ρ <0.3, NBI power deposited on core electrons



Up to 25% of electron heating power transferred to KAW off-axis

HYM code
E. Belova, PRL 2015

NSTX-U / PPPL Theory Partnership

- XP1525 (Crocker): Rotation effects on CAE/GAEs
- XP1520 (Kaye), 1523 (Podesta): Effects of collisionality, power on transport

R15/16-1,2, 17-3, 18-2 IR18-2

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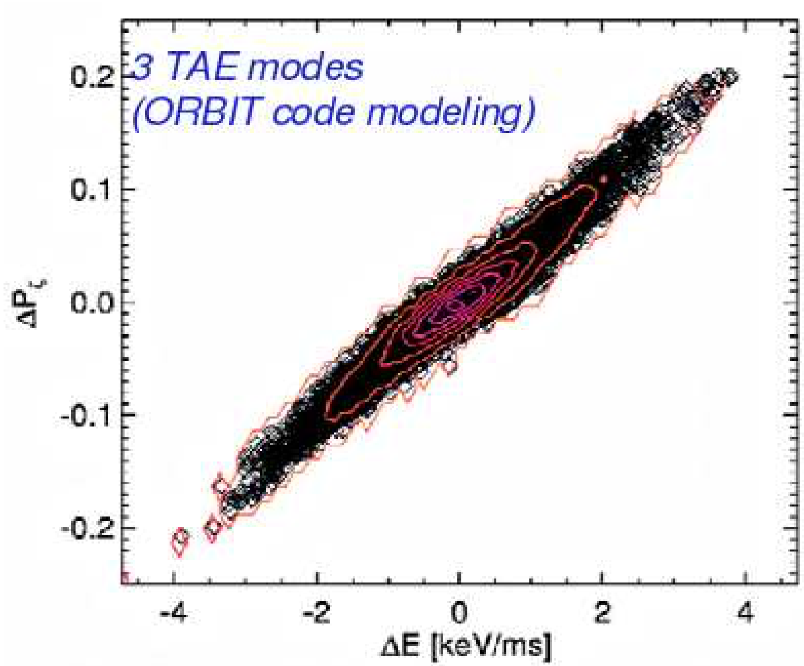
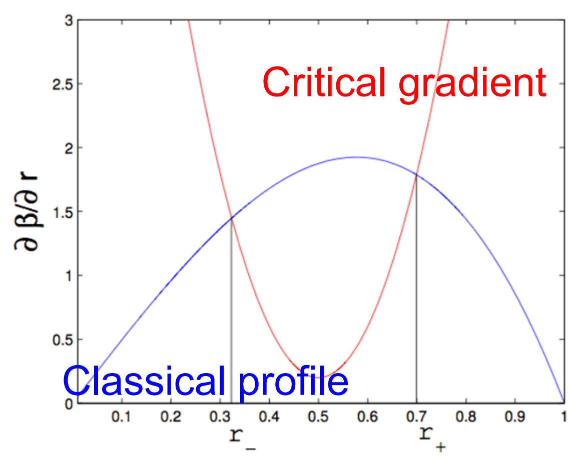
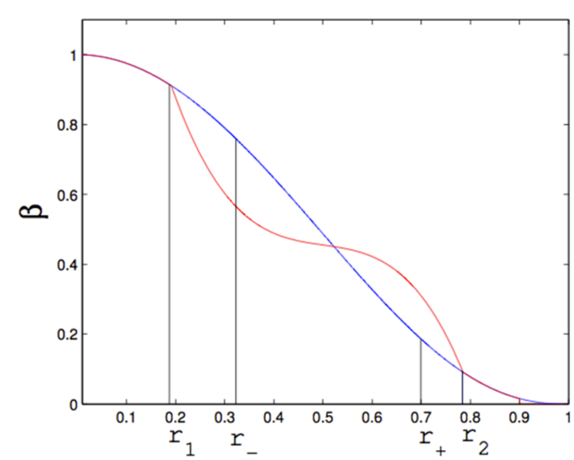
Beam ion confinement: predictive models for fast ion profile relaxation in presence of *AEs

- "Kick" model (Podesta)
  - PDF computed by ORBIT (White) in presence of TAEs
  - Mode structures computed by NOVA (Gorelenkov)
  - Kicks ~ mode amplitude

- Critical Gradient Model (Gorelenkov)
  - Compute critical $\partial\beta_{EP}/\partial r$ due to AE
  - Mode growth/damping computed by NOVA-K (Fu, Gorelenkov)
  - Include ion Landau, collisional electron, radiative damping of modes





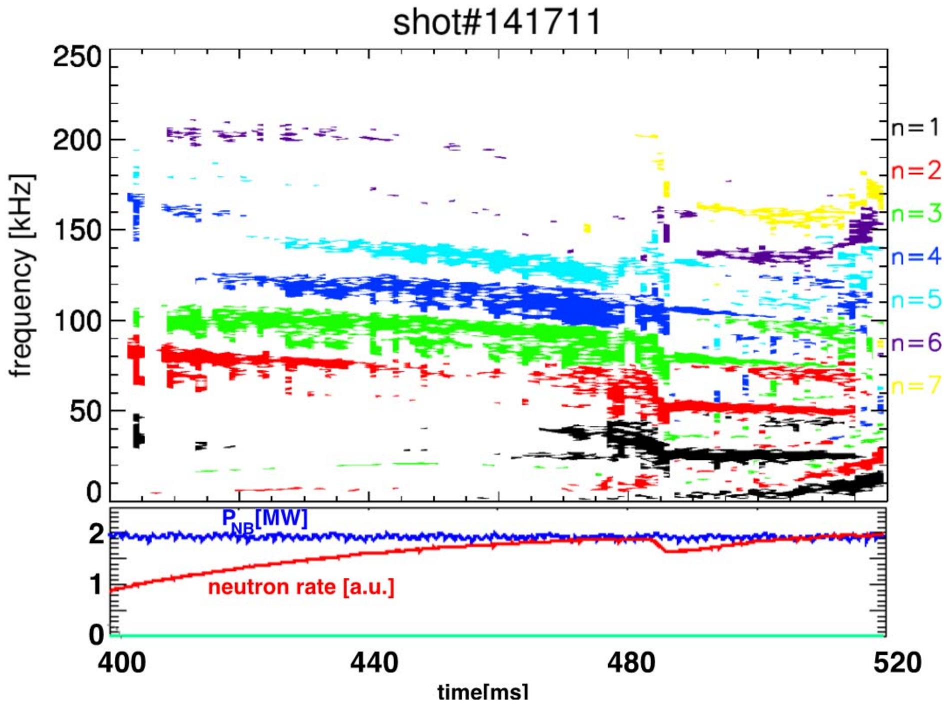


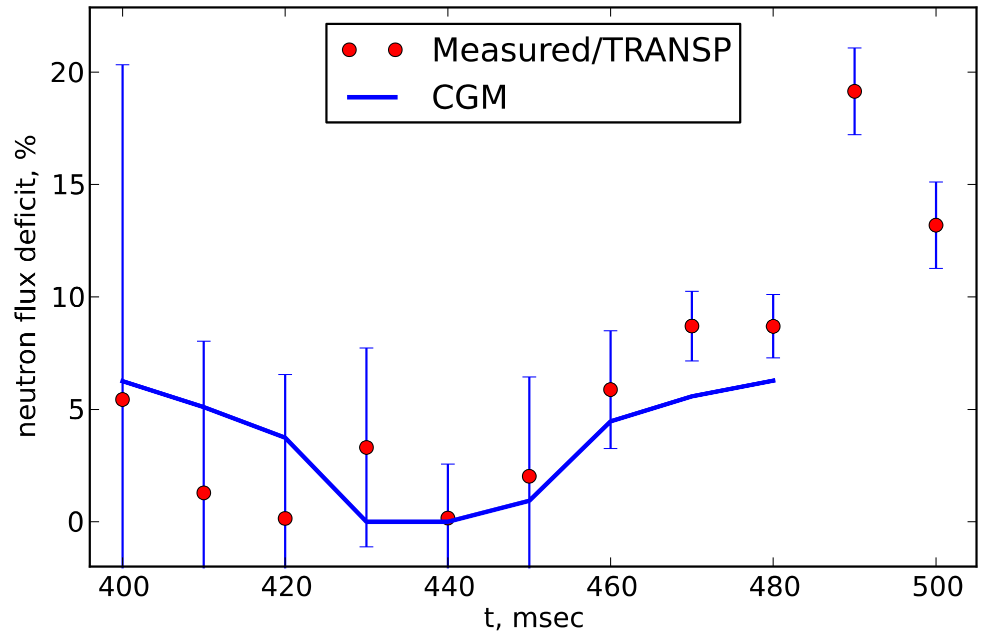
Originally benchmarked against DIII-D data

JRT-15, R15/16-2, R18-2, IR18-2

CGM recently validated for NSTX, will be much more extensively tested on NSTX-U

- Multiple TAE unstable discharge chosen for validation





- XP1524 (Heidbrink) directly tests CGM
  - Fashioned after successful DIII-D expt.
  - Different AE activity on NSTX(-U) crucial test for validating theory

Other related XPs include XP1522, 1523 (characterize 2nd beam, beam confinement)

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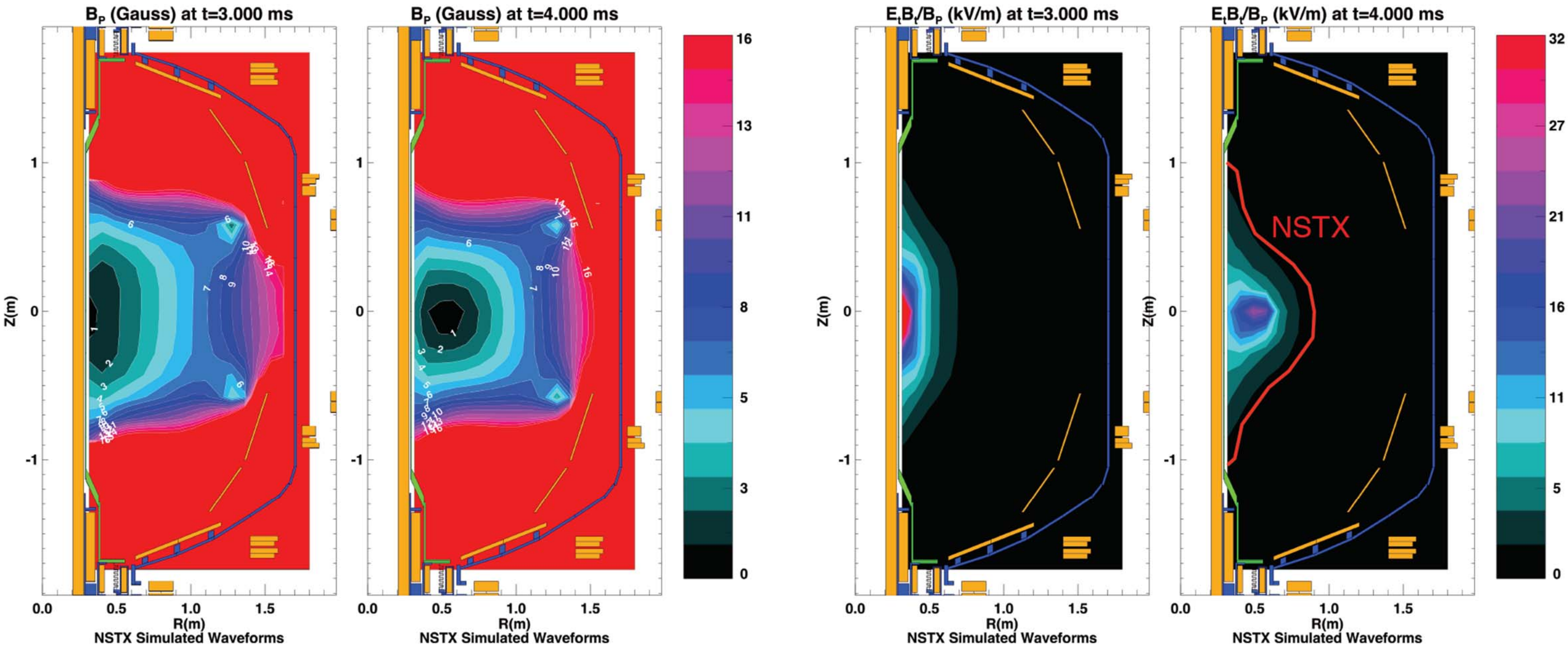
Advanced Scenarios TSG led efforts to generate good field null, breakdown, ramp-up to 140kA first test plasma

Only CS was baked → high impurities → high loop voltage → modelling very important

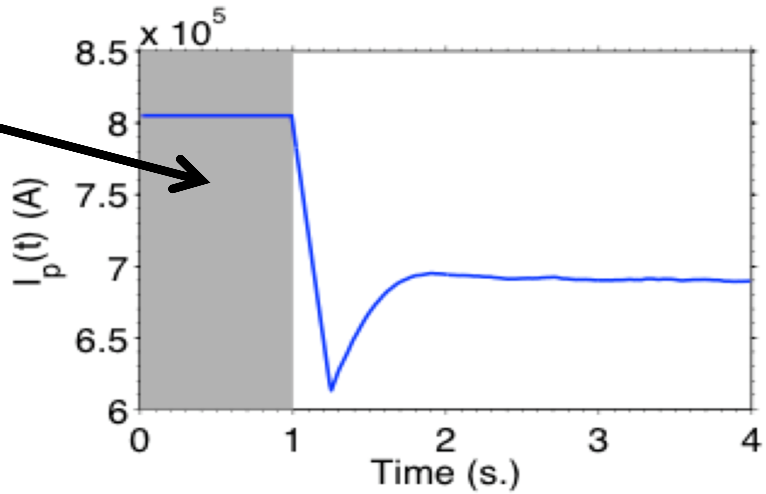


+3 ms   +4 ms   +3 ms   +4 ms

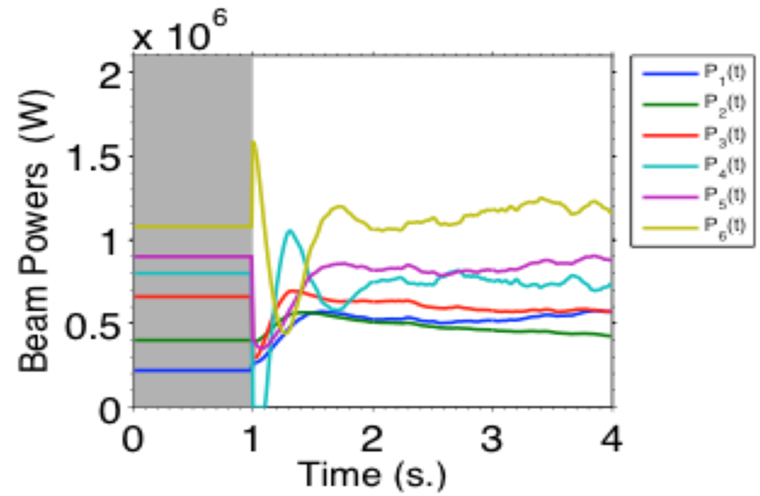
Using TRANSP to develop current (iota) profile control algorithm using 6 NBI sources

Controller off during gray phase

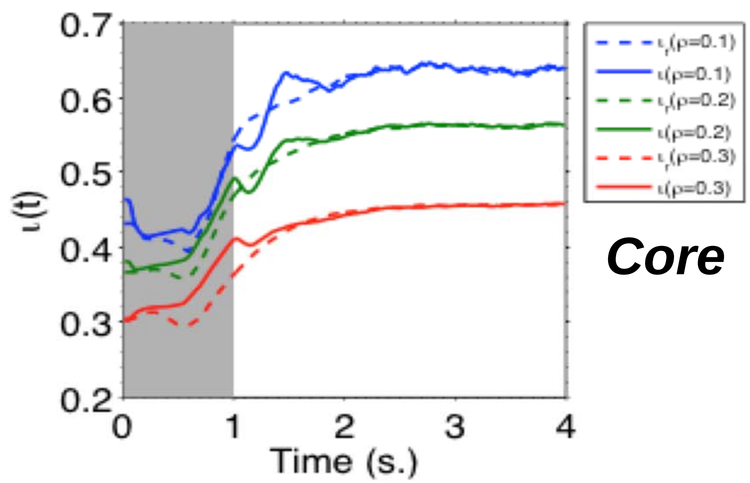
Target (dashed), actual/TRANSP (solid)



(a)

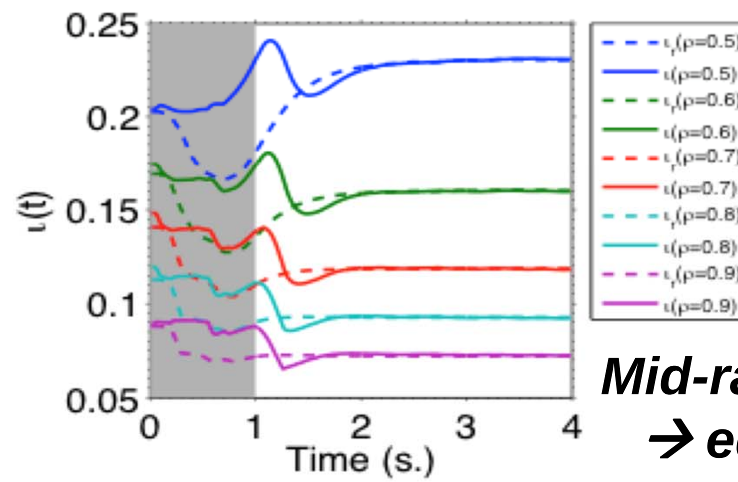


(b)



(c)

Core



(d)

Mid-radius → edge

Several ASC XPs ready to test and utilize l_i control, prep for q(r) control

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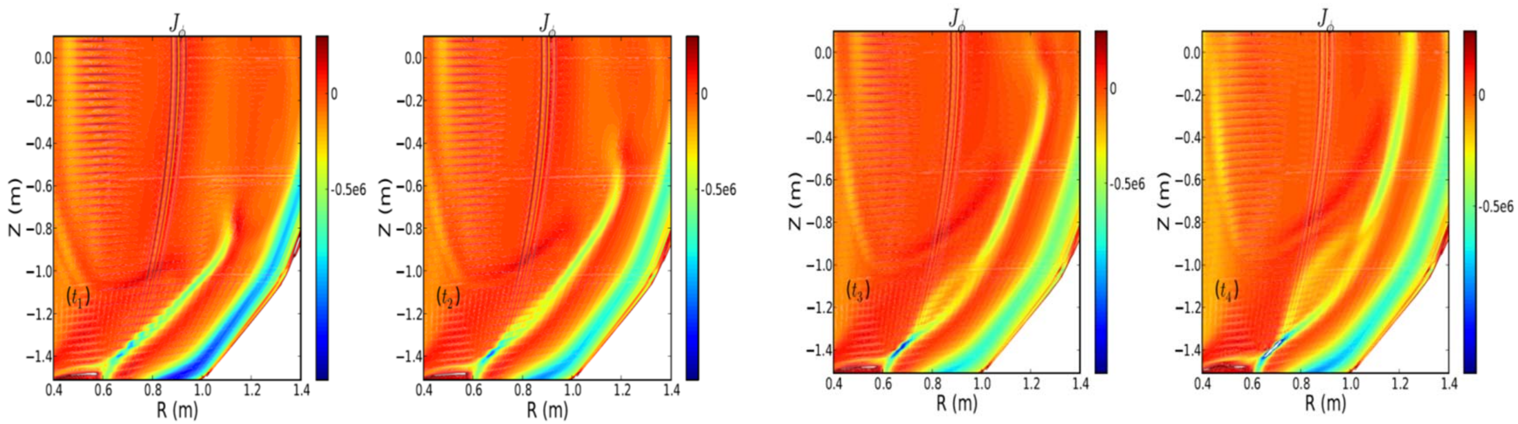
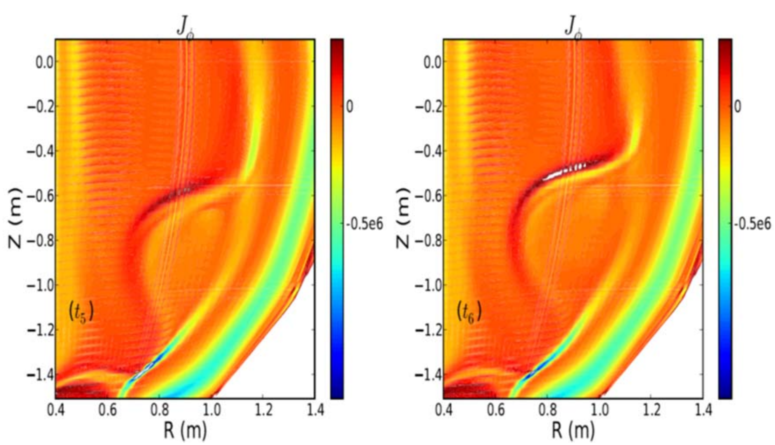
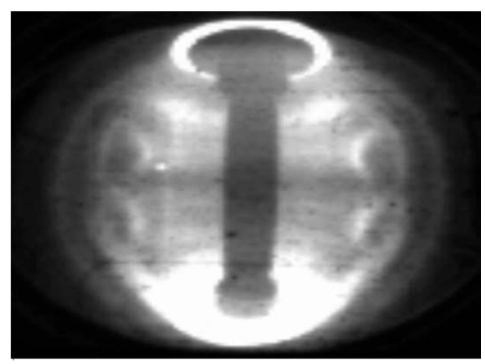
Formation of "Plasmoids" found in NIMROD simulations of Coaxial Helicity Injection (CHI) start-up

- Sweet-Parker reconnection basis for CHI flux closure
  - Break-up of S-P thin current layer leads to formation of plasmoids, which are inferred in expt
- NIMROD simulations (Ebrahimi et al., PoP 2013, PRL 2015) shown below:

Current sheet shown in the lower half of the device.







NSTX

XP on Transient CHI in NSTX-U (Raman et al.)

R17-4, 18-3

- Need to assess if plasmoids impact CHI start-up extrapolation to FNSF/Pilot

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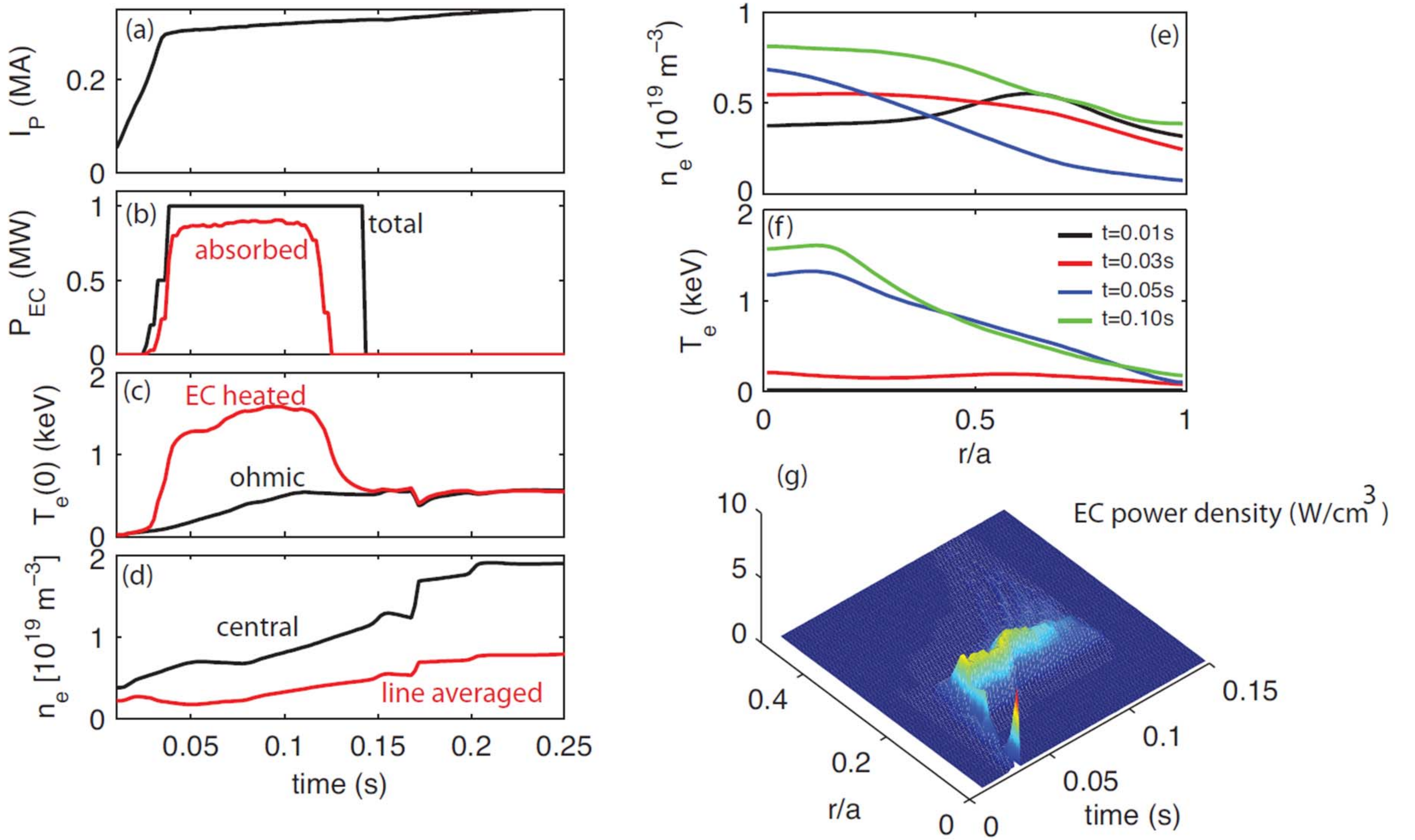
TRANSP modelling: ECH is game-changer for non-inductive ramp-up

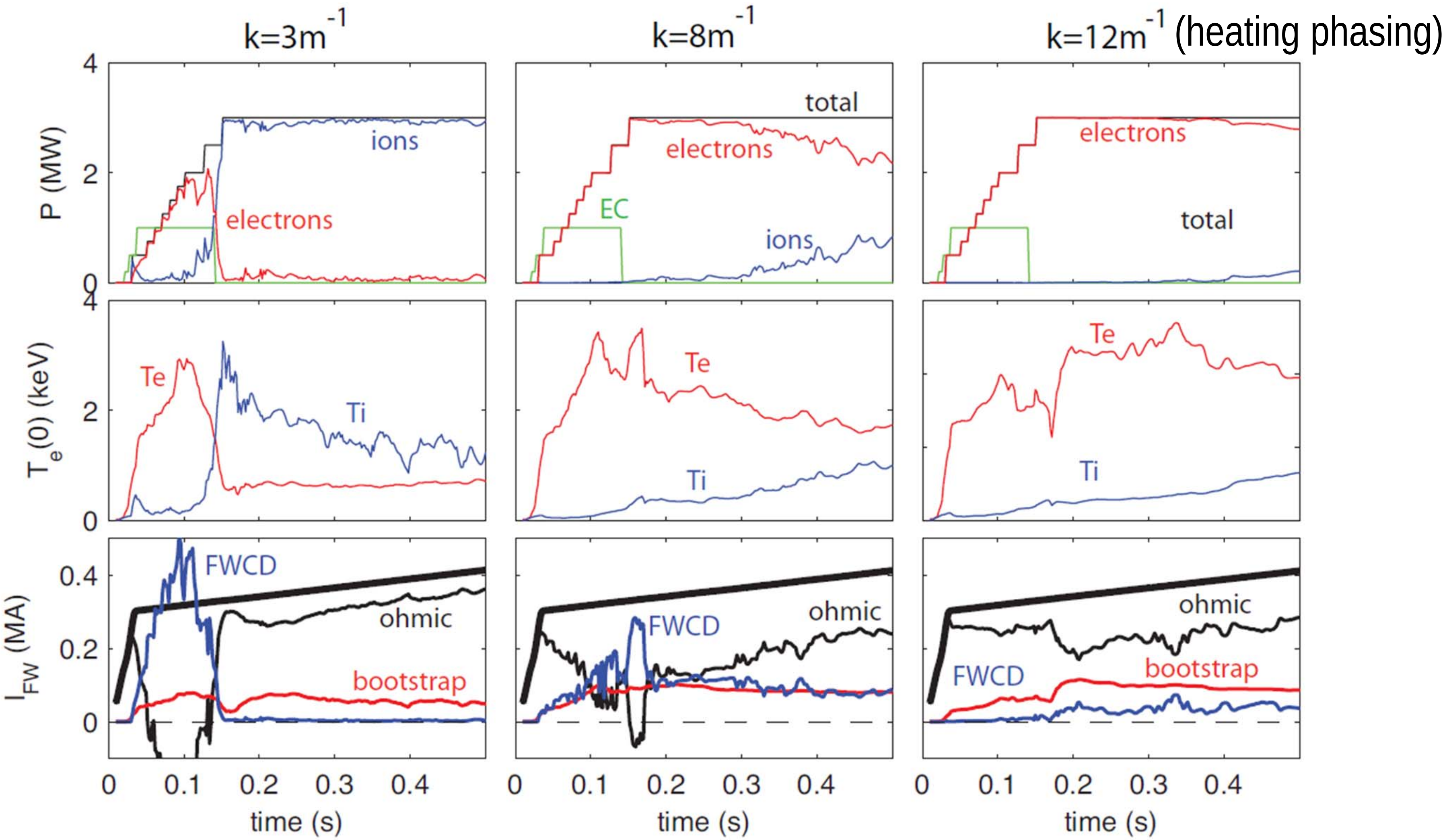
Heats low temperature plasma to 1-1.5keV in ~30ms



ECH accessibility limited to low density, but compatible with CHI

EC + FWCD synergistic for lowest FW phasing $k_\phi = 3m^{-1}$
Half power needed to drive 400kA compared to no EC

- ECH enables sustained T_e conditions for higher FW k_ϕ
- Need to optimize FW phasing during shot to sustain H&CD



Outline

- Notable Outcomes
- Research Milestones
- FY2015 Research Highlights
- Upcoming events
- Summary

PPPL hosting 18th International ST Workshop November 3-6 on Princeton University campus

ISTW-2015

Search this site

ISTW 2015 Web Pages:

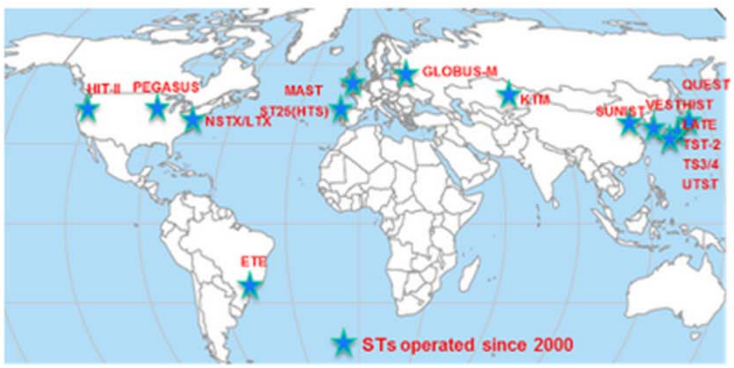
- Home
- Upload Presentation
- Agenda and Presentations
- Conference Venue
- Accommodations / Hotel
- Important Dates
- Local Organizing Committee
- Meeting Format
- Objectives and Topics
- Program Committee
- Reception and Banquet
- Abstract Submission (CLOSED)
- Registration and Payment Forms
- Travel to Princeton
- Visa Information
- Sitemap

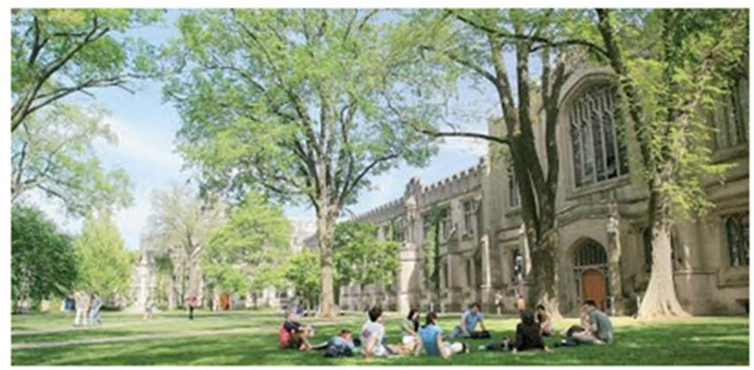
Other Useful Links:

18th International Spherical Torus Workshop (ISTW 2015)

and 2015 US-Japan Workshop on ST Plasmas

Princeton University, 3-6 November 2015





Introduction

The joint 18th International Spherical Torus Workshop (ISTW 2015) and 2015 US-Japan Workshop on ST Plasmas will be held during November 3-6, 2015 at Princeton University, Princeton, New Jersey, USA.

Previous ISTWs were held in Oak Ridge (1994), Princeton (1995), Culham (1996), St. Petersburg (1997), Tokyo (1998), Seattle (1999), Sao Jose dos Campos (2001), Princeton (2002), Culham (2003), Kyoto (2004), St. Petersburg (2005), Chengdu (2006), Fukuoka (2007), Frascati (2008), Madison (2009), Toki (2011), and York (2013).

~100 registrants, 10 Overviews, 28 orals, 40 posters

~50% international covering CTs, start-up, EP, core/edge transport, MHD, boundary, RF

Program for 18th International ST Workshop - November 3-6, 2015

Tuesday, November 3

8AM - 8:30AM - Registration

8:30 - 8:50AM - S. Prager - Welcome
J. Menard - Agenda, logistics, local info

8:50AM - Session O1 - Chair: Rajesh Maingi

Extended Oral	S. Gerhardt	Abstract	Presentation
Oral	P. Micozzi	Abstract	Presentation
Oral	S. Cohen	Abstract	Presentation
Oral	M. Gryaznevich	Abstract	Presentation
10:25 - 10:45AM - Coffee Break			
Extended Oral	A. Kirk	Abstract	Presentation
Oral	E. Fredrickson	Abstract	Presentation
Oral	Z. Gao	Abstract	Presentation

12 - 1:15PM - LUNCH at Frist Campus Center

1:15PM - Session O2 - Chair: Andrew Kirk

Extended Oral	J. Menard	Abstract	Presentation
Oral	F. Alladio	Abstract	Presentation
Oral	D. Battaglia	Abstract	Presentation
Oral	M. Bongard	Abstract	Presentation
Oral	R. Maingi	Abstract	Presentation
3:10 - 3:30PM - Coffee Break			

3:30 - 5:30PM - Poster Session 1 (P1)

Abstract	*Poster*	*Abstract*	*Poster*
P1-1	J. Yang	P1-11	W. Guttenfelder
P1-2	H. Furui	P1-12	E. Evans
P1-3	C. Swanson	P1-13	M. Podesta
P1-4	G. Hao	P1-14	D. Liu
P1-5	J. Berkery	P1-15	F. Wang
P1-6	G. Canal	P1-16	S. Medley
P1-7	I. Waters	P1-17	T. Bigelow
P1-8	P. Jandovitz	P1-18	J. Jo
P1-9	W. Wang	P1-19	Y. Nozawa
P1-10	J. Ruiz-Ruiz	P1-20	N. Tsujii

Catered wine reception at Princeton Art Museum

6-8PM

Wednesday, November 4

8AM - 8:30AM - Registration

8:30 - 8:40AM - J. Menard: Updates, logistics

8:40AM - Session O3 - Chair: Richard Majeski

Extended Oral	K. Hanada	Abstract	Presentation
Oral	H. Tanabe	Abstract	Presentation
Oral	H. Tanaka	Abstract	Presentation
Oral	F. Poli	Abstract	Presentation
10:15 - 10:45AM - Coffee Break			
Extended Oral	Y. Ono	Abstract	Presentation
Oral	S. Jardin	Abstract	Presentation
Oral	S. Sabbagh	Abstract	Presentation

12PM - Group photo in McDonnell Hall courtyard

12:15 - 1:45PM - LUNCH at Frist Campus Center or Nassau Street

1:45PM - Session O4 - Chair: Steven Sabbagh

Extended Oral	R. Majeski	Abstract	Presentation
Oral	Y. Ren	Abstract	Presentation
Oral	A. Thornton	Abstract	Presentation
Oral	J.-W. Ahn	Abstract	Presentation
Oral	H. Frerichs	Abstract	Presentation
3:40 - 4:00PM - Coffee Break			

4:00 - 6:00PM - Poster Session 2 (P2)

Abstract	*Poster*	*Abstract*	*Poster*
P2-1	S. Banerjee	P2-11	C. Ribeiro
P2-2	K. Gan	P2-12	P. Titus
P2-3	R. Lunsford	P2-13	L. El-Guebaly
P2-4	H. Lee	P2-14	B. Colling
P2-5	J. Park	P2-15	Y. Jung
P2-6	K. Yamasaki	P2-16	H. Togashi
P2-7	M. Boyer	P2-17	M. Lee
P2-8	Z. Ilhan	P2-18	S.-K. Kim
P2-9	R. Yoneda	P2-19	J. Matteucci
P2-10	S. McNamara	P2-20	Z. Wang

Thursday, November 5

8AM - 8:30AM - Registration

8:30 - 8:45AM - J. Menard: Updates, logistics

8:45AM - Session O5 - Chair: Roger Raman

Extended Oral	Y. Takase	Abstract	Presentation
Oral	M. Nagata	Abstract	Presentation
Oral	F. Ebrahimi	Abstract	Presentation
10 - 10:25AM - Coffee Break			
Extended Oral	Y. Tan	Abstract	Presentation
Oral	R. Minami	Abstract	Presentation
Oral	R. Perkins	Abstract	Presentation
Oral	N. Bertelli	Abstract	Presentation

Gather all belongings, board bus by 12:10PM
12:15PM - Bus leaves for PPPL

12:30 – 1:50 PM - LUNCH in PPPL Cafeteria

1:30PM - PPPL cafeteria food service ends

2:00 PM	Tour group meets in LSB lobby to begin tour			
Group:	Group 1	Group 2	Group 3	Group 4
Guide:	J. Menard	S. Kaye	R. Maingi	R. Kaita
2:10 PM	NSTX-U Control Rm	QUASAR	Hall Thruster	LTX
2:30 PM	NSTX-U Test Cell	Hall Thruster	QUASAR	PFRC-2
2:50 PM	QUASAR	NSTX-U Control Rm	PFRC-2	MRX
3:10 PM	Hall Thruster	NSTX-U Test Cell	LTX	QUASAR
3:30 PM	MRX	LTX	NSTX-U Control Rm	Hall Thruster
3:50 PM	PFRC-2	MRX	NSTX-U Test Cell	NSTX-U Control Rm
4:10 PM	LTX	PFRC-2	MRX	NSTX-U Test Cell
4:30 PM	Tour ends in PPPL Lobby near Plasma Hutch			
4:45 PM	Bus leaves for main campus / Nassau Inn			

Banquet at Prospect House

6PM - 8PM

Friday, November 6

8:30 - 8:40AM - J. Menard: Final updates, logistics

8:40AM - Session O6 - Chair: Yuichi Takase

Extended Oral	Y. Hwang	Abstract	Presentation
Oral	J. Lee	Abstract	Presentation
Oral	M. Inomoto	Abstract	Presentation
Oral	R. Raman	Abstract	Presentation
10:15 - 10:45AM - Coffee Break			
Extended Oral	D. Sutherland	Abstract	Presentation
Oral	J. Reusch	Abstract	Presentation
Oral	J. Menard	Abstract	Presentation

12 - 12:30PM - Discussion and Closing Remarks

12:30PM - Official End of Workshop

1:30-3:00PM - US-Japan Collaboration Discussion

Takase, Menard, all others who are interested

- 3 events during workshop:
  - Reception at Art Museum
  - NSTX-U / PPPL tour
  - Banquet at Prospect House

NSTX-U PAC-37

- Dates: January 26-28, 2016
- Aiming to have 3-5 run weeks complete before PAC
- Possible PAC charge topics:
  - Progress, next-steps in NSTX-U / PPPL theory partnership
  - Missing elements, new opportunities for FY2015 experiments
  - Prioritization / strategy on facility enhancements, high-Z walls
  - Ideas for further enhancing University, collaborator roles in NSTX-U research and program
- We welcome (request) FES input / comment on possible PAC charge questions
  - Any pressing / urgent NSTX-U issues from FES perspective?

Summary

- NSTX-U research team remained very scientifically productive during FY2015
- High priority experimental proposals already reviewed for first ~50-75% of FY15 run-time
- Very excited and ready to get new data!

Backup

Overview of FY2016-18 NSTX-U research milestones

- **FY2016**
  - Obtain first data at 60% higher field/current, 2-3× longer pulse:
    - Re-establish sustained low l_i / high-κ operation above no-wall limit
    - Study thermal confinement, pedestal structure, SOL widths
    - Assess current-drive, fast-ion instabilities from new 2nd NBI
- **FY2017**
  - Extend NSTX-U performance to full field, current (1T, 2MA)
    - Assess divertor heat flux mitigation, confinement at full parameters
  - Access full non-inductive, test small current over-drive
  - First data with 2D high-k scattering, prototype high-Z tiles
- **FY2018**
  - Study low-Z and high-Z impurity transport
  - Assess causes of core electron thermal transport
  - Test advanced q profile and rotation profile control
  - Assess CHI plasma current start-up performance

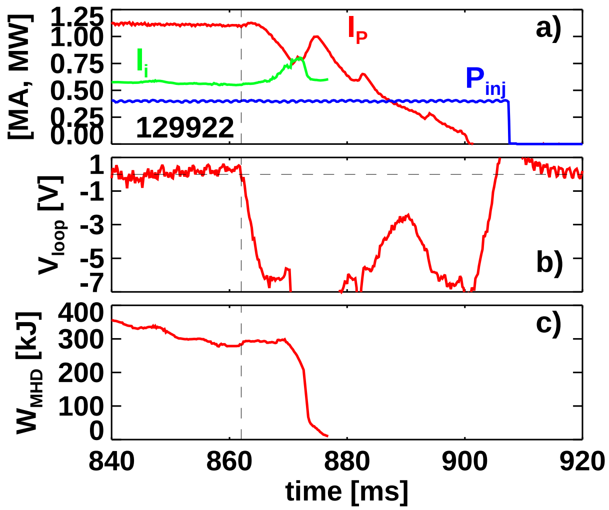
See backup for detailed Research Milestone timeline

NSTX-U/Theory Partnership is focusing on issues central to achieving NSTX-U goals

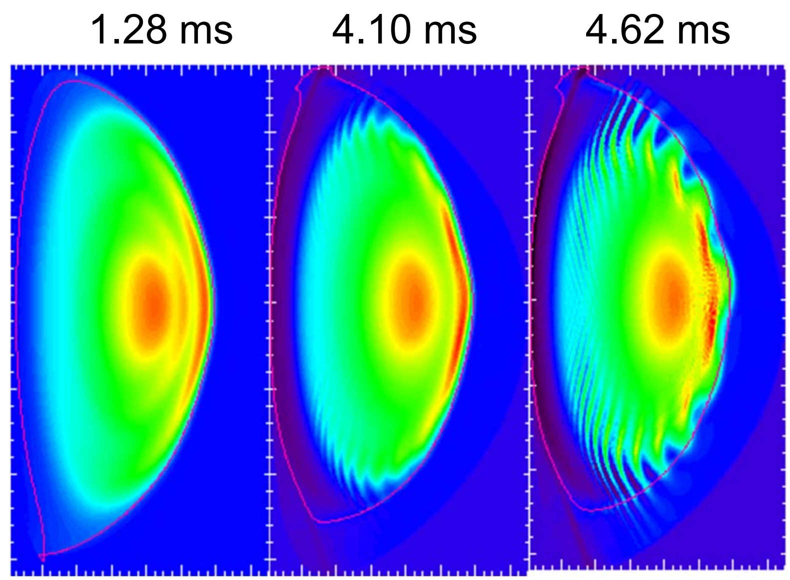
- Both over-arching goals and specific yearly Research Milestones
  - Matched personnel to topical choices
  - Attempted to provide mapping to Goals, Milestones
- Partnership funding now integrated into the NSTX-U budget
  - No longer incremental
- Theory work not limited to PPPL Theory Dept.
  - Augmented by project theorists, collaborations, SCIDAD, direct Theory coverage of personnel
- Significant synergy with work on DIII-D by same theory personnel – aspect ratio, β, ν_*, ρ_* leverage on theory validation
  - Fast ion confinement/effects of AE modes on fast-ion distribution
  - RMP/NTV/RWM physics, RF heating and current drive, pedestal/SOL characteristics, core transport

Developing M3D-C^1 simulations of NSTX disruption induced by rapid current ramp down

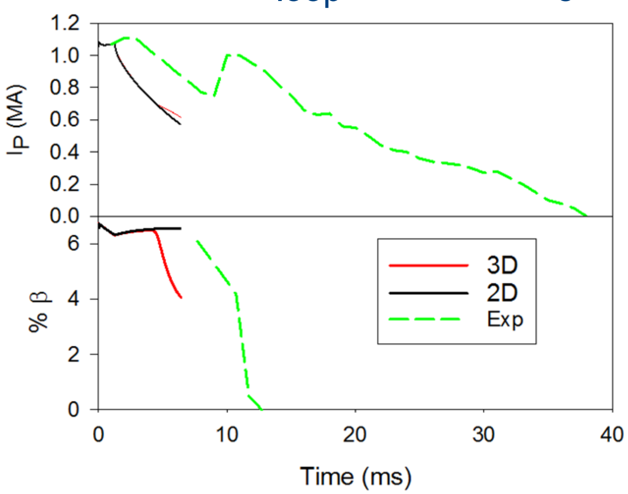
- High W_{MHD} disruption in NSTX: Large negative V_{loop} to drive OH current to zero



- M3D-C^1 simulation
  - Large # toroidal modes unstable both linearly and non-linearly
  - Instability starts at edge, moves inward



- Comparison with expt needs improvement (realistic vessel, V_{loop}, match T_e)



NSTX-U / PPPL Theory Partnership

- XPs for validation: Jardin (MS), Poli (ASC) – current ramp down studies

R15/16-3, 17-1, JRT 2016