U.S. DEPARTMENT OF ENERGY | Office of Science

NSTX-U

Overview of Initial NSTX-U Experimental Operations

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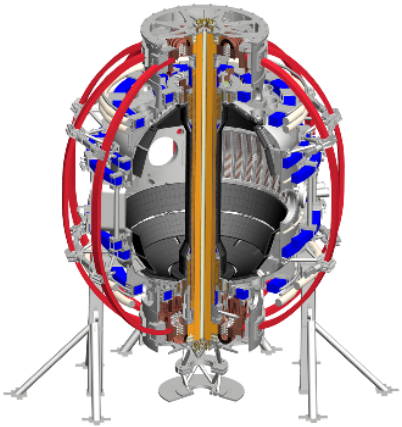
On behalf of the NSTX-U Team

58th Annual APS DPP Meeting
San Jose, CA
October 31 – November 4, 2016



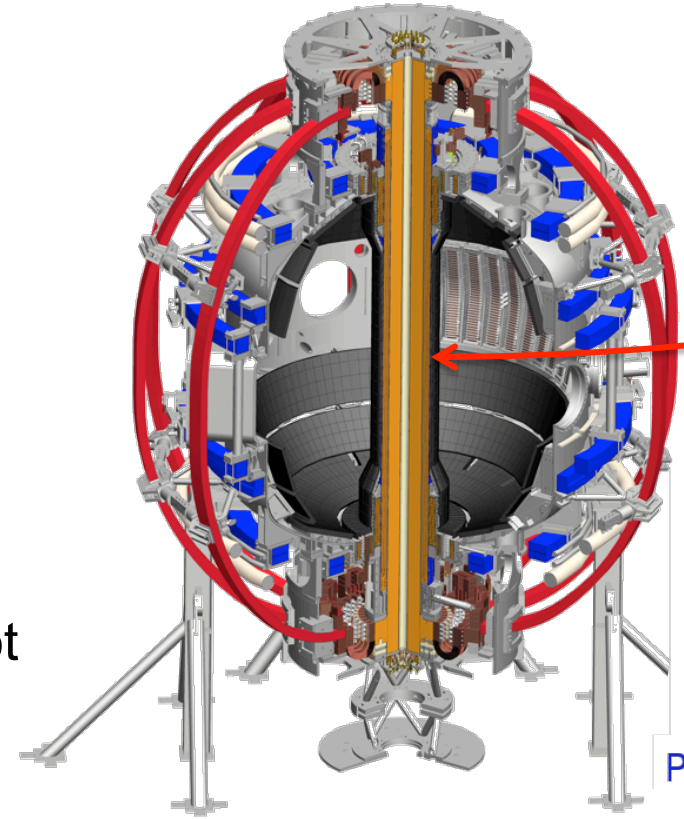
PPPL

NSTX-Upgrade will advance predictive understanding and enable critical R & D for future burning plasma devices

Mission Elements

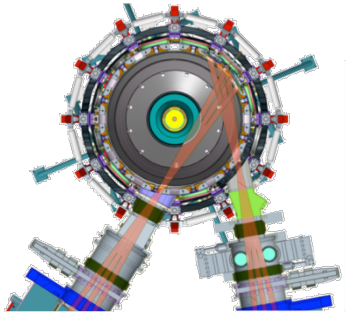
- Extend performance in the low-A regime to advance predictive understanding
- Develop solutions for the plasma-material interface
- Evaluate aspect ratio optimization of FNSF and Pilot Plant concepts

TI3.4 J. Menard, Thursday AM



Major upgrade components:

New center column



Present NBI

New 2nd NBI

NSTX-U operated for ten productive run weeks in FY16

- First operation with many new systems
  - Updated plasma control and device protection

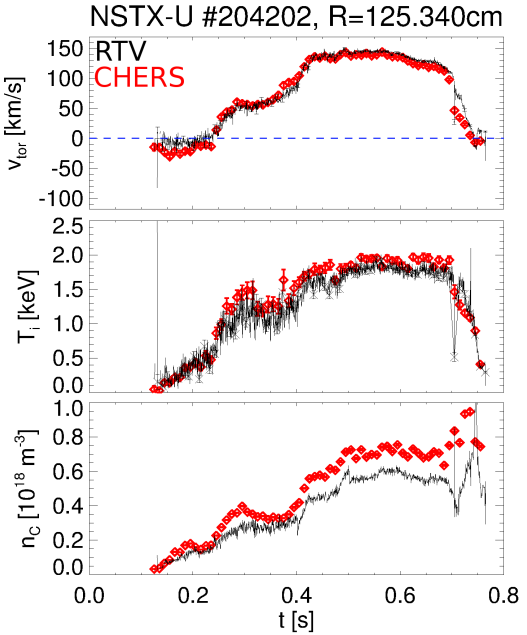
NP10.1 M. Ono

- 90% of commissioning activities completed
  - Developed stationary L-mode discharges
  - Matched NSTX H-mode performance for I_p < 1 MA
  - Many magnetic and kinetic profile diagnostics commissioned
    - Real-time CHERS → rotation control

BI2.5 I. Goumiri, Monday AM

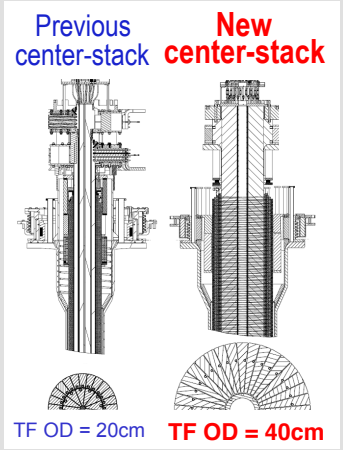
- Run ended prematurely due to PF coil failure

Comparison of real-time CHERS system to standard CHERs

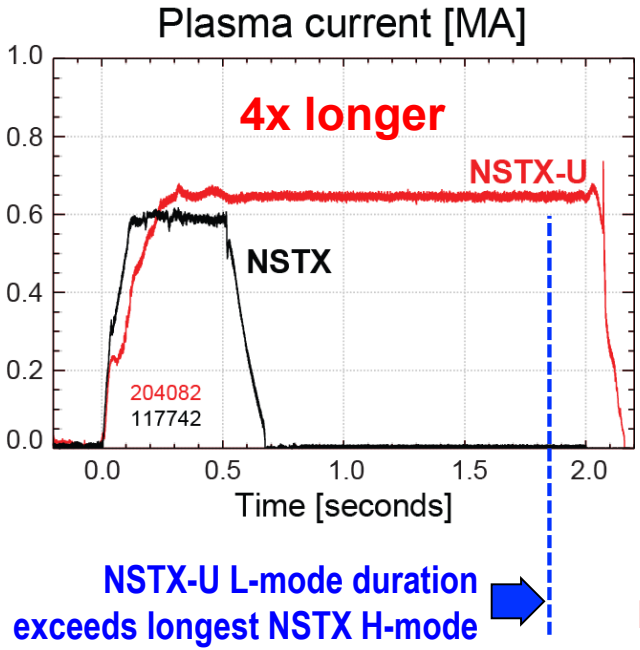


NP10.9 M. Podesta

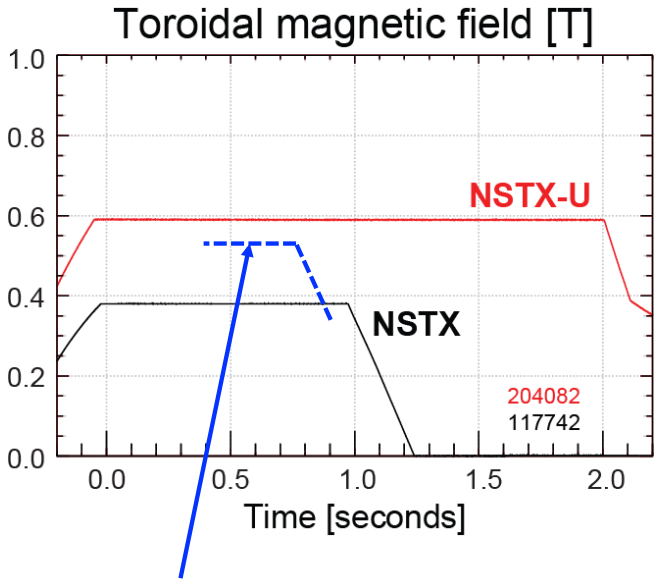
L-mode discharges simultaneously exceeded the pulse length and toroidal magnetic field strength on NSTX



	NSTX (typical)	NSTX-U (target)
B_T	0.5 T	1.0 T
I_p	1.0 MA	2.0 MA
T_{pulse}	1 s	5 s
A	1.4	1.7



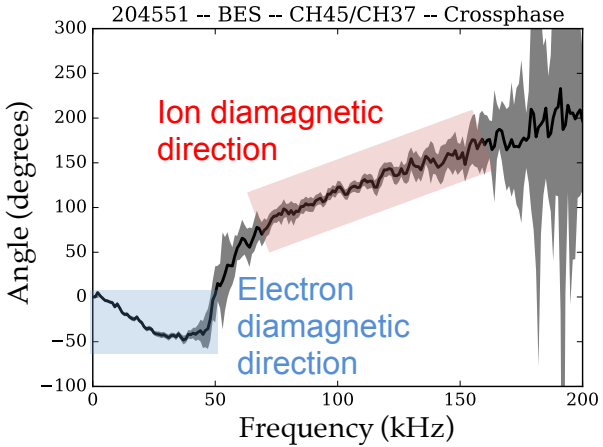
NSTX-U L-mode duration exceeds longest NSTX H-mode



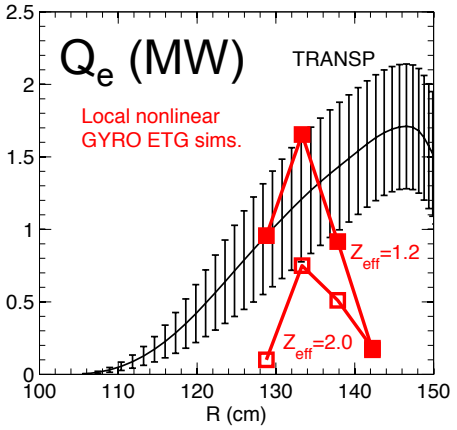
NSTX-U B_T > highest NSTX B_T

Stationary L-mode discharges support detailed turbulence and transport measurements and calculations

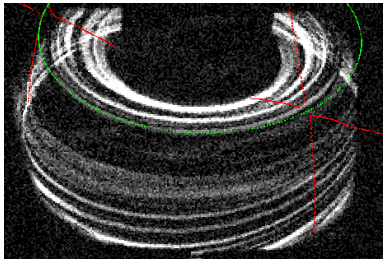
- ST extends range of β, R/a and ρ_* for turbulence theory and simulation
  - Initial local, non-linear GYRO calculations: ETG may account for Q_e at mid-radius
  - Bi-modal ion-scale turbulence measured by BES
- ST geometry supports complete imaging of divertor with fast cameras
  - Divertor filaments observed to propagate toward X-point on both inner and outer divertor legs



NP10.14 M. Kriete

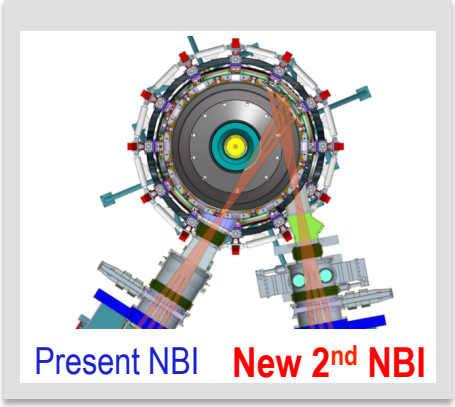


GO6.4 W. Guttenfelder

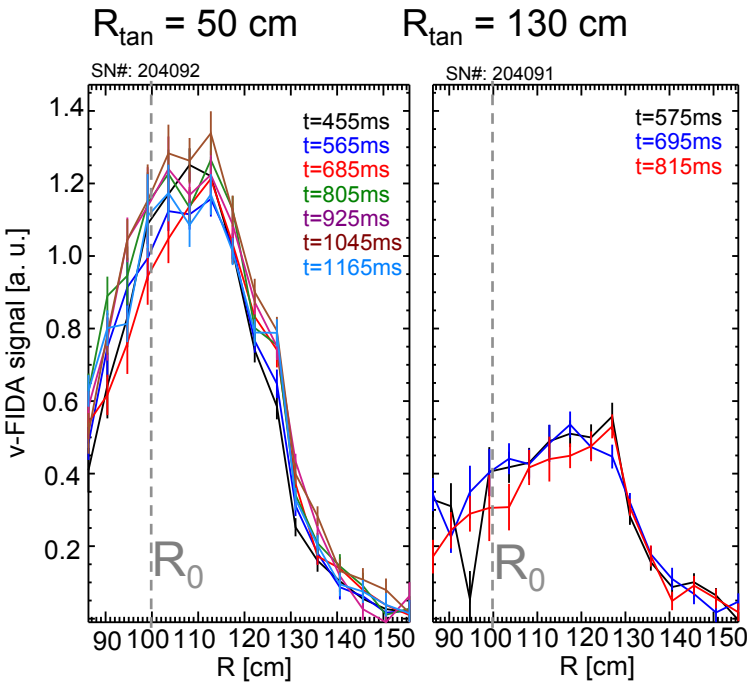


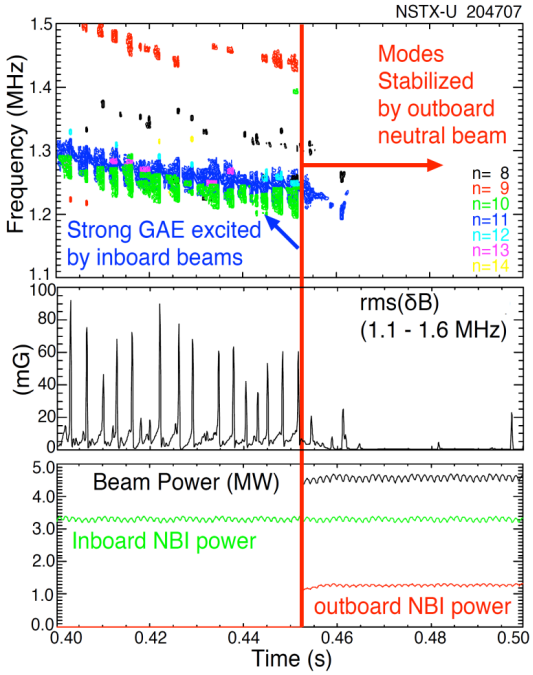
NP10.28 F. Scotti

New tangential NBI increases flexibility in tailoring heating, rotation, current drive and fast-ion profiles



Off-axis beam injection produces broader fast-ion profiles and stabilizes GAE activity



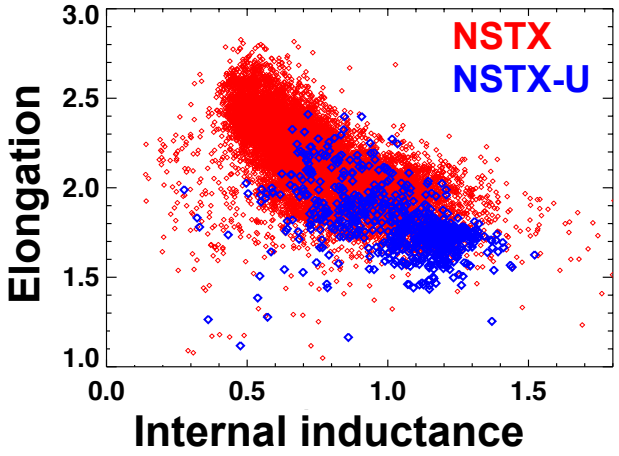


GO6.5 D. Liu

GO6.6 E. Fredrickson

Steady progress in error field correction, plasma control and NBI heating improved H-mode performance

Improved Z position measurement enables stable operation at κ similar to NSTX despite higher aspect ratio



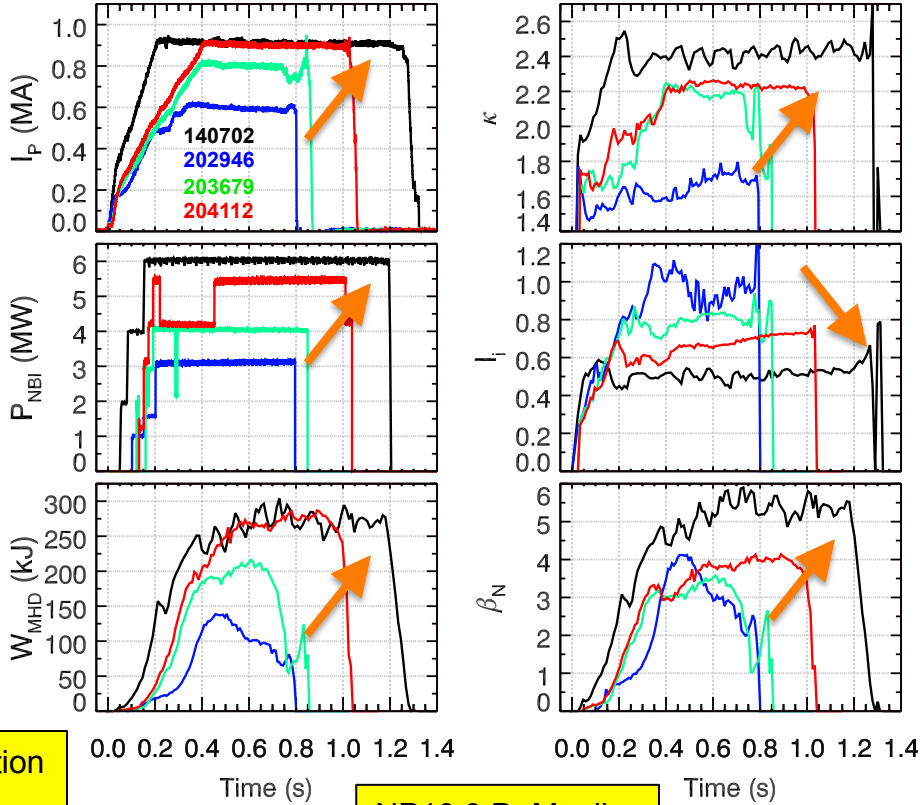
GO6.3 M. D. Boyer

NSTX
0.44 T
H-mode

NSTX-U
0.62 T
Week 3
No EFC

Week 5
EFC v1

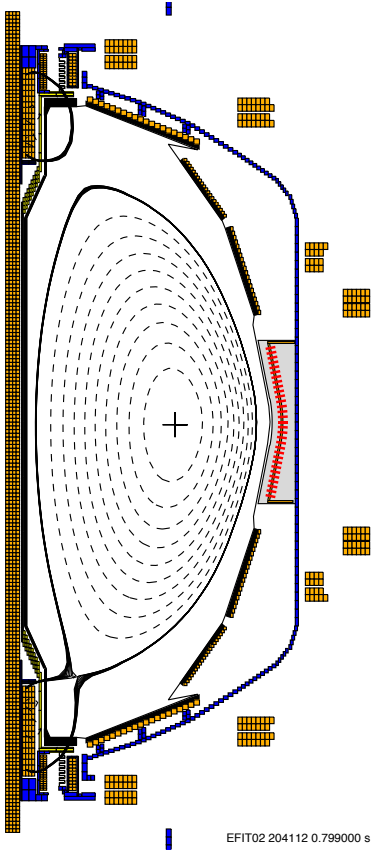
Week 7
EFC v2

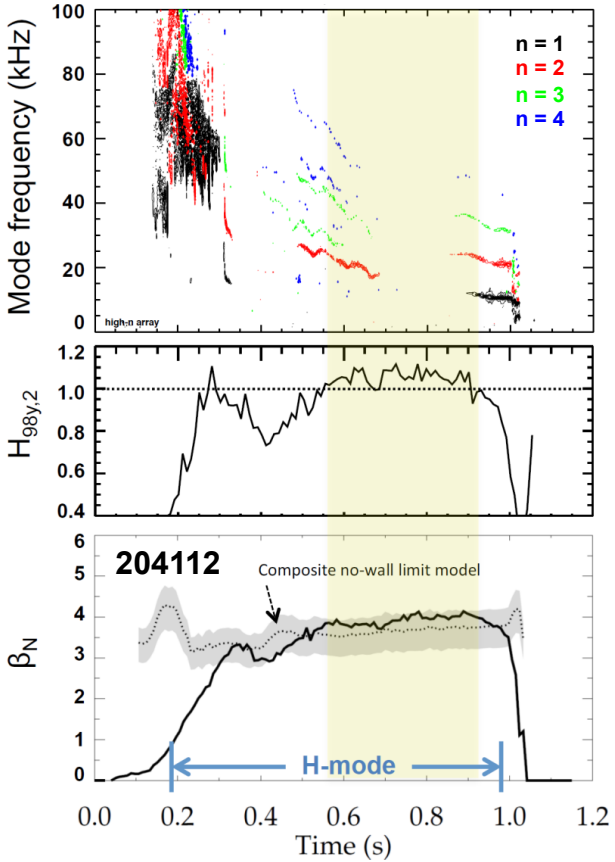


Error field correction
GO6.2 C. Myers

NP10.3 D. Mueller

MHD-quiescent H-mode discharges sustained with $H_{98y,2}$ and $\beta_N/\beta_{no\text{-}wall} \geq 1$





Minimal core MHD

$H_{98y,2} \geq 1$

$\beta_N/\beta_{no\text{-}wall} \geq 1$

NP10.10 S. Kaye

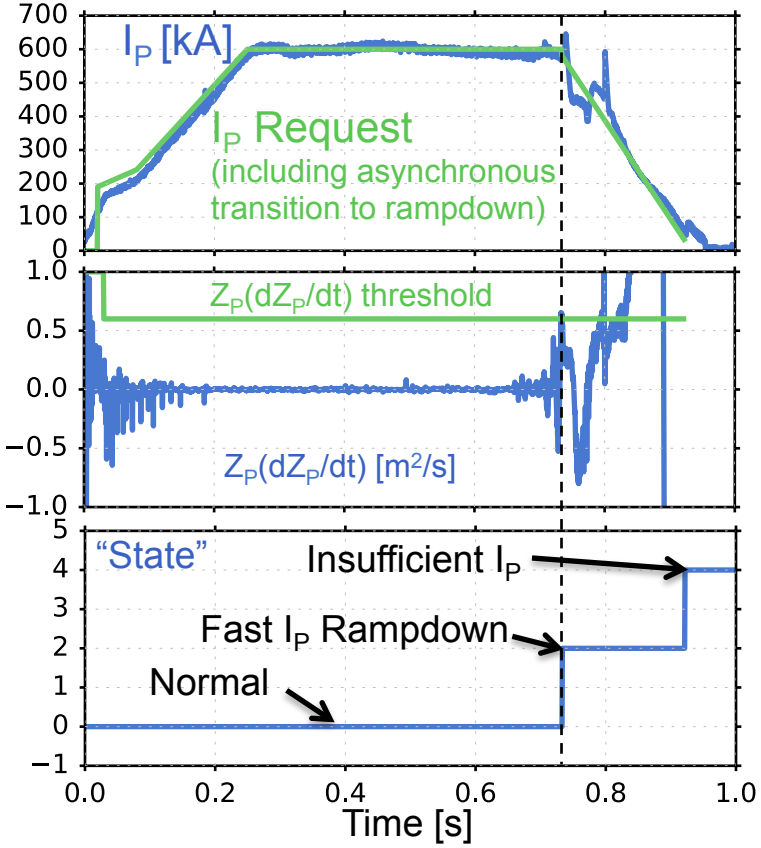
Plasma shutdown scheme routinely used to initiate controlled rampdown of NSTX-U discharges

- Plasma control system detects loss of control, initiates controlled ramp down
  - Figure at right: loss of vertical stability triggers I_p ramp down

GO6.3 M. D. Boyer | NP10.5 S. Gerhardt

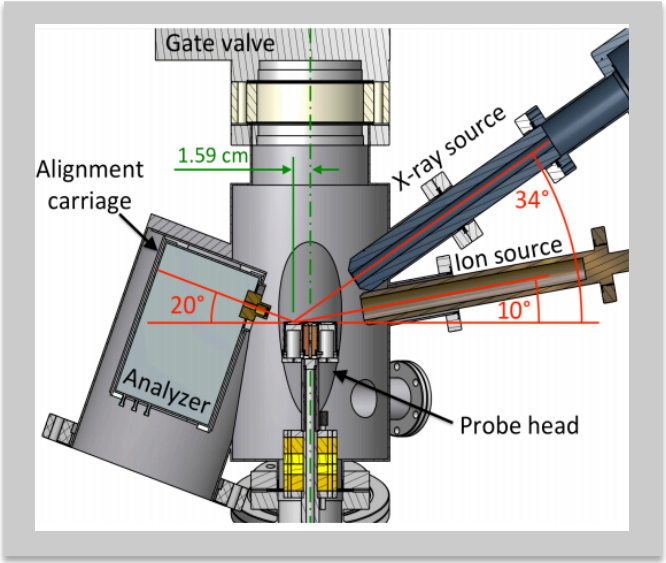
- Disruption Characterization and Forecasting (DECAF) framework in development
  - Classify event chains and test warning thresholds
  - Example: Reduced kinetic RWM model developed for real-time warning of RWM instability onset

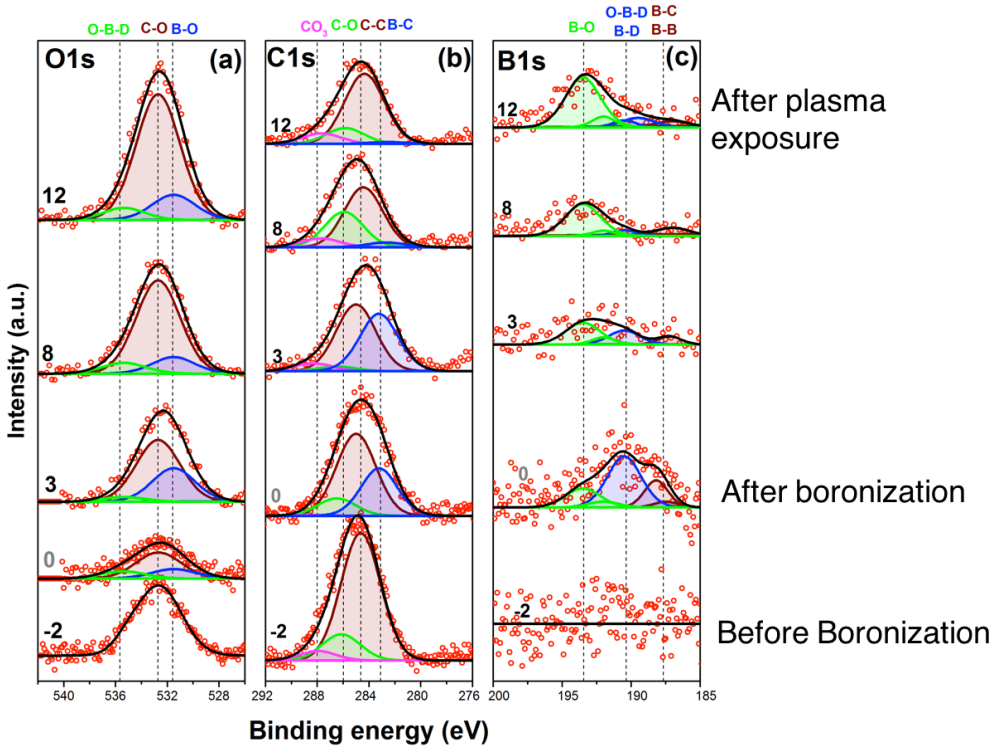
GO6.7 S. Sabbagh | YI2.5 J. Berkery, Friday AM



Novel surface analysis tools on NSTX-U quantify evolution of first wall composition during plasma operations

Materials Analysis Particle Probe (MAPP) performs surface analysis of exposed samples in chamber attached to NSTX-U





GO6.9 C. Bedoya

GO6.8 C. Skinner

NSTX-U had a productive first year, now poised to address key scientific issues by leveraging the unique low-A regime

- Exceeded NSTX pulse length and B_T in L-mode discharges
  - Error field correction, transport and fast-ion physics studies benefited from stationary discharges
  - New fast-ion physics with 2nd NBI, such as GAE stabilization
- Matched best NSTX H-mode performance at $I_p \leq 0.9$ MA
  - Steady progress supported by excellent diagnostic availability and advances in plasma control
- Many new systems commissioned and are ready to support the scientific program
  - New diagnostics enable future science: Real-time CHERS, MAPP

Please attend the NSTX / NSTX-U Posters on Wednesday Morning!