



U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science



# Operations Update

Stefan Gerhardt

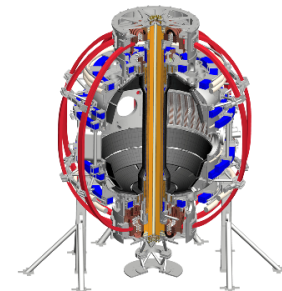
(with a lot of help from physics operations team, diagnostics team)

Monday Physics Meeting

B-318

1/11/2016

Place your institutional logo(s) here:



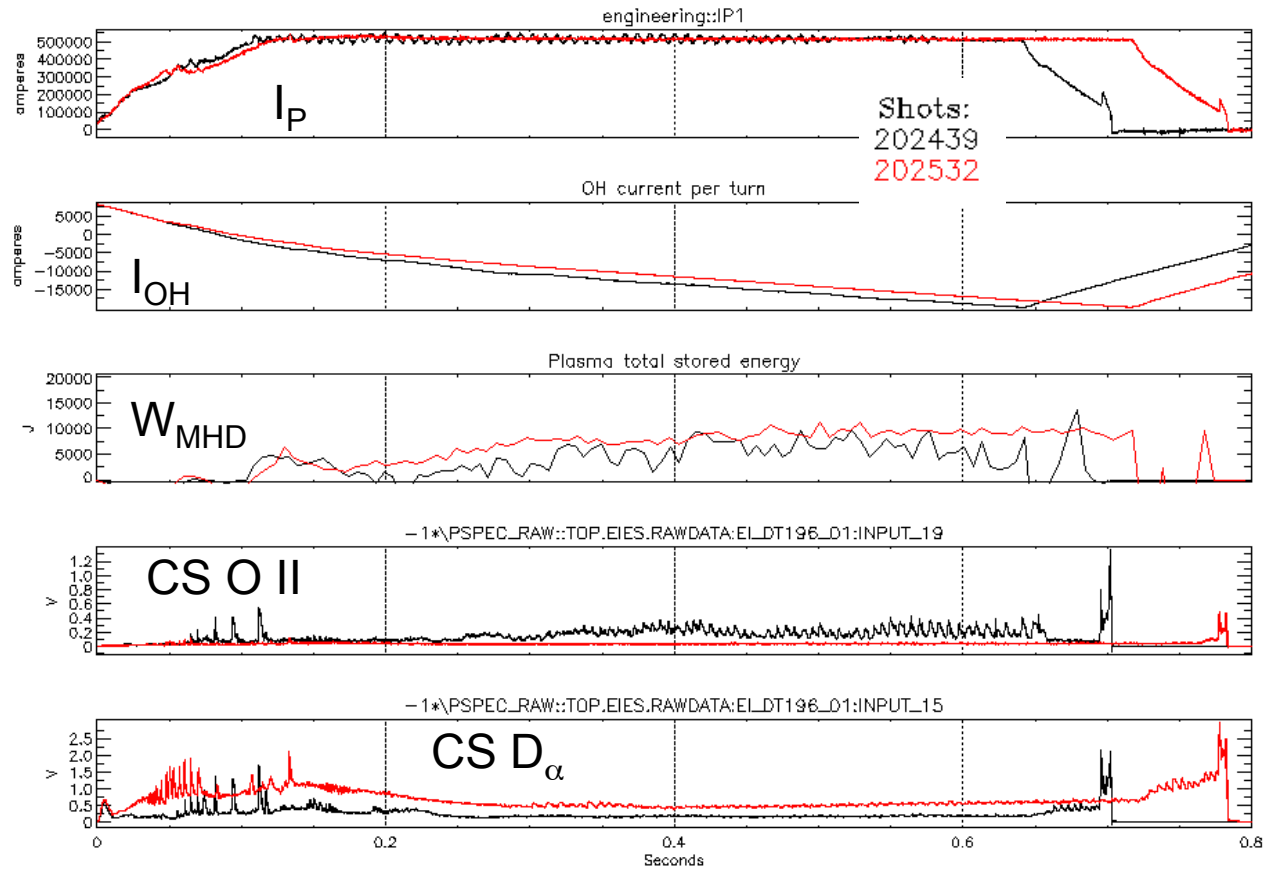
# About 6-8 Total Calendar Days of Running So Far

12/19/2015 +

Date	5/21/2015	5/22/2015	5/23/2015	5/24/2015	5/25/2015
Day	Monday	Tuesday	Wednesday	Thursday	Friday
First Shot	202368	202414			
Last Shot	202402	202444			
	XMP-106 (12)	XMP-101 & 126 (14)	No Operations	Lab Closed	
	XNP-101 (13)	XMP-101 & 105 (13)			
	XMP-126 (4)				
Date	1/4/2016	1/5/2016	1/6/2016	1/7/2016	1/8/2016
Day	Monday	Tuesday	Wednesday	Thursday	Friday
First Shot		202514	202539	202570	202601
Last Shot		202535	202567		202632
	Boronization #1, 1 Bottle, XMP-118 (Skinner)	Fire in RF Building, Other Troubleshooting	XMP-101, 126, 105, 132 (11)	XMP-127 (9)	XMP-105 & -125 (22)
			OP-NSTX-22	XMP-107 (7)	
		XMP-101 & -126 (8)	XMP-101 & -126 (5)	XMP-105 & XMP-126 (11)	

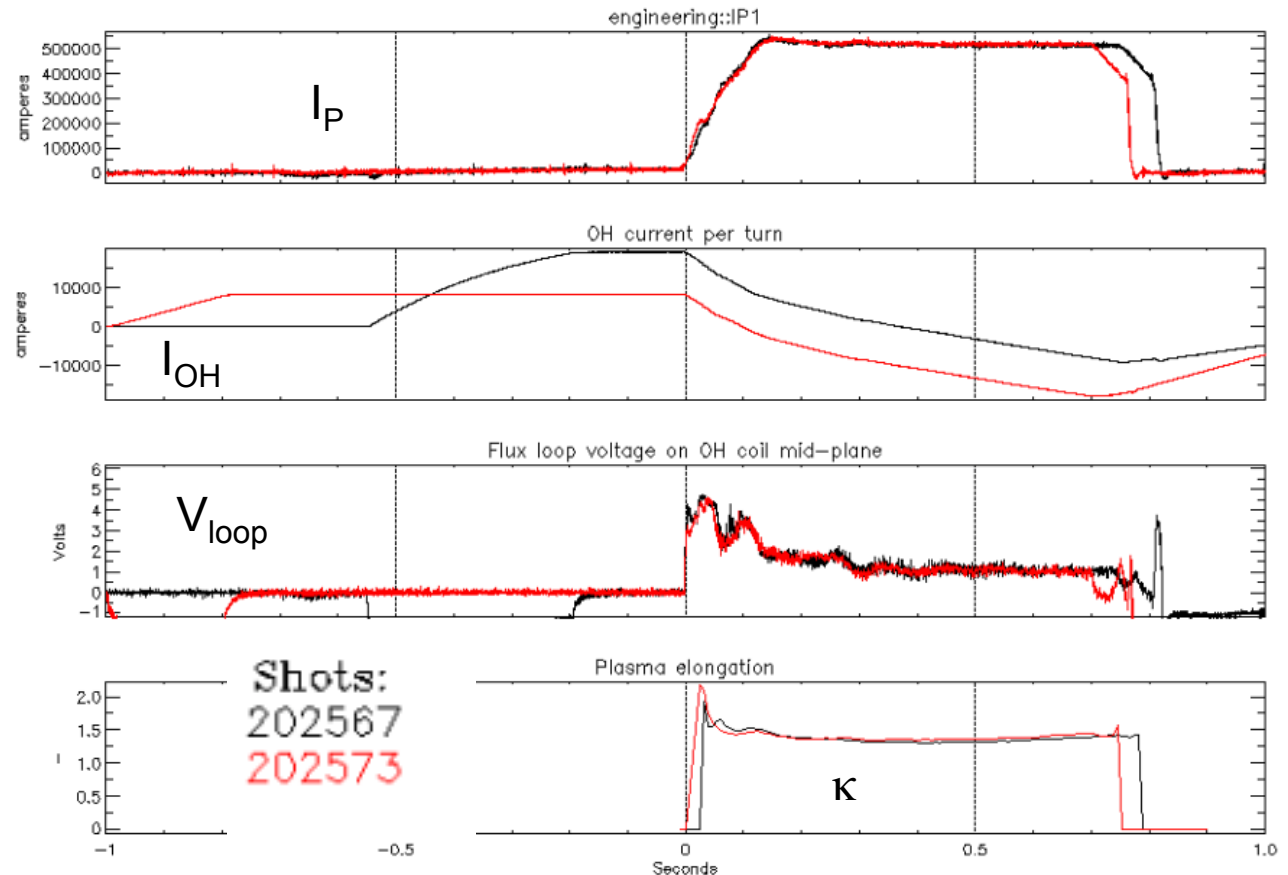
# Boronization Was Successful In Decreasing Oxygen Levels

- Shots are:
  - 202439, from 1/23/2015
  - 202532, from 1/5/2016.
- Clear benefits:
  - Reduced flux consumption
  - Higher stored energy
  - Reduced CS O II
- Intend to repeat boronization tonight (1/11/2016)



# Higher Pre-Charge Scenarios Have Been Developed

- 8 kA pre-charge chosen to match NSTX, but 20 kA provides more total flux for driving current.
- 20 kA case has smaller null, and requires more loop voltage initially.
- Both He shots.
- PCS shuts down both shots after detecting a VDE.
- All further operations in this talk used 8 kA pre-charge; will revisit this topic.

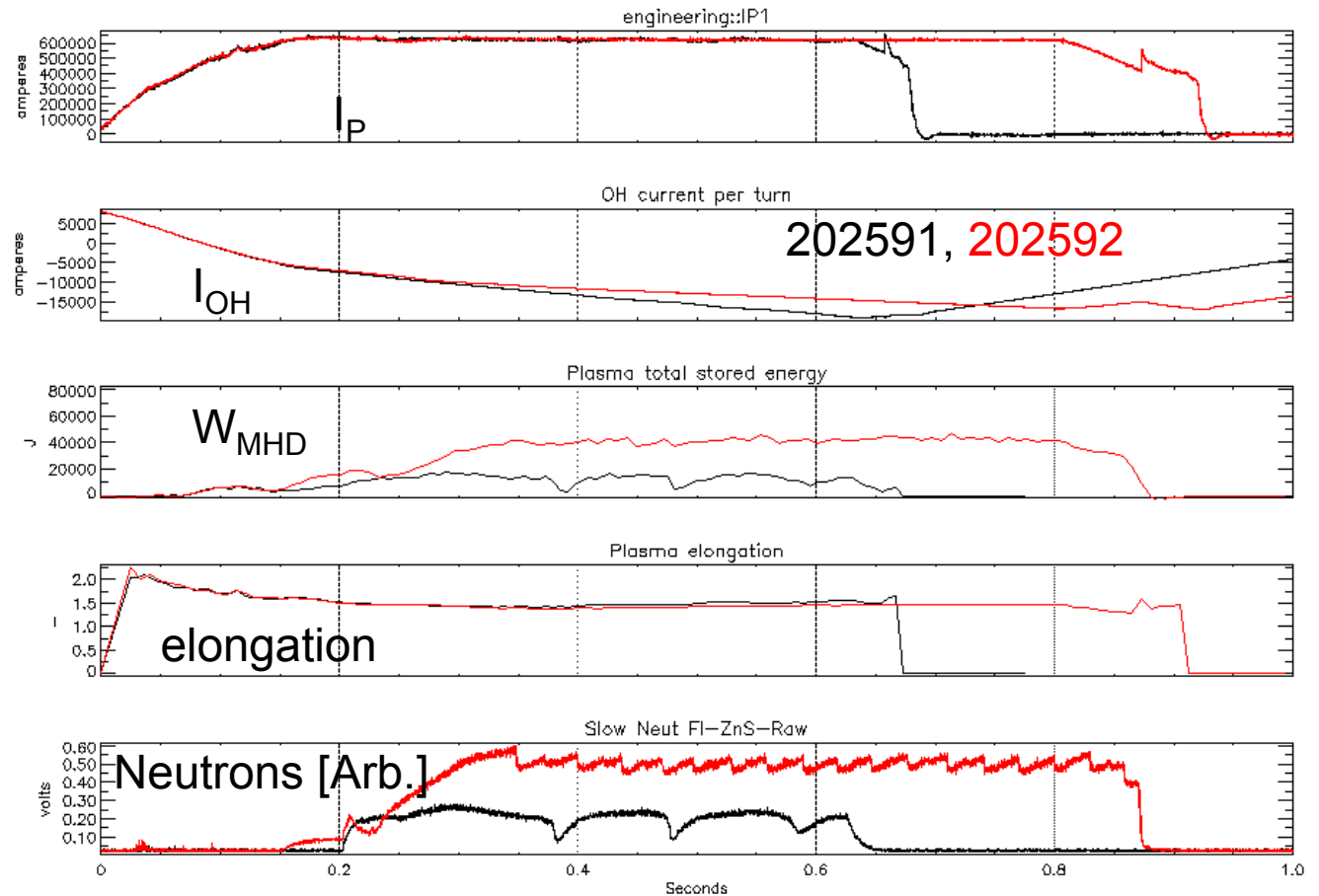


## Each Beam Was Put Into a Helium Plasma in XMP-127

- Source 1A: 202577
  - From TS: Had run in the high 50s [kV], but ran at about 40 kV on 1/8/2016 because we had some M/R and arc problems
- Source 1B: 202578
  - From TS: 1B has been working in the 40s. It needs conditioning time.
- Source 1C: 202576
  - From TS: 1C has been up to 65 kV and ran reliably at 60 kV.
- Source 2C: 202580
  - From TS: 2C has been steady at 60 kV but we have not raised it due to questions about the transmission line.
- These sources are now available for operations.
- Sources 2A and 2B will be commissioned once their trunk-line issues are resolved.

# Collected Data for Neutron Calibration

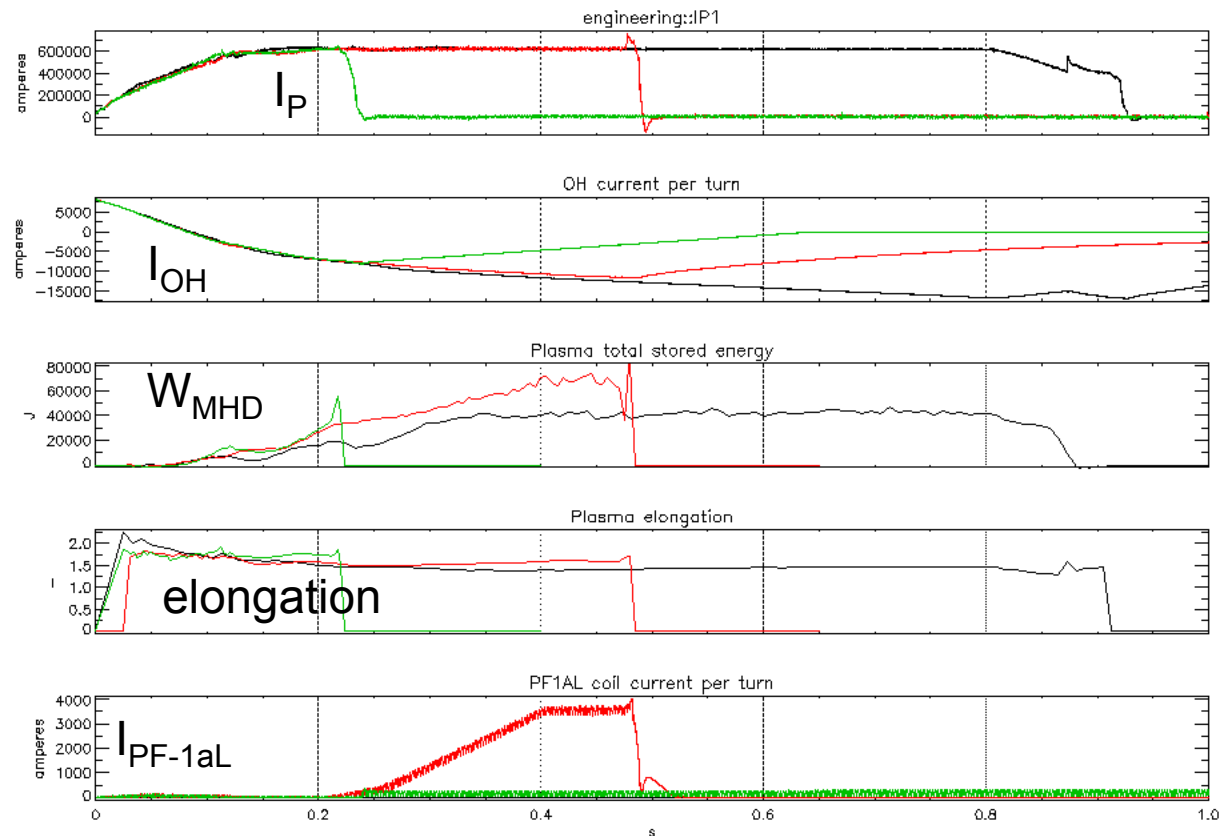
- Neutron transfer important because the model train calibration is done using 'count mode', but big plasma shots use 'current mode'
  - Need shots where both modes have good signals.
- These were the first D<sub>2</sub> shots ever for NSTX-U.
- Shot **202592** is the highest neutron emission, largest  $Q = \int I$ , for NSTX-U



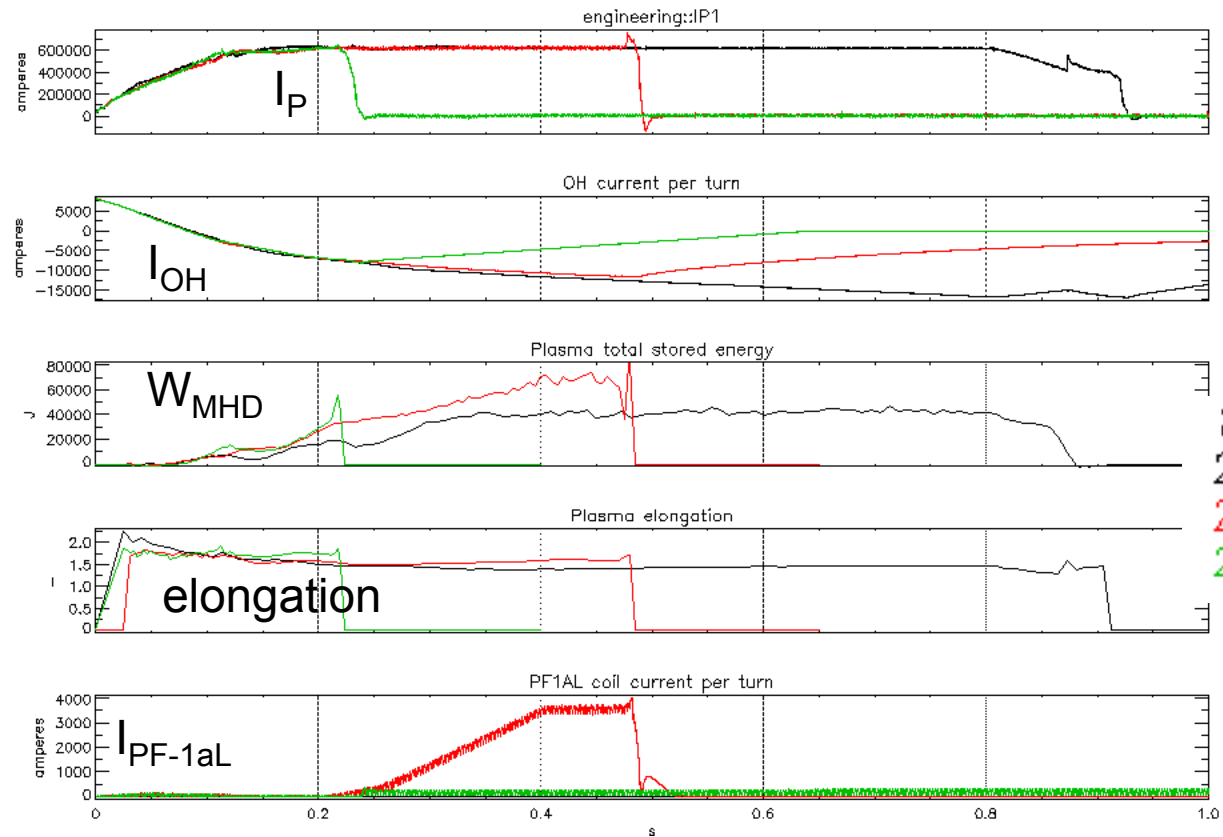
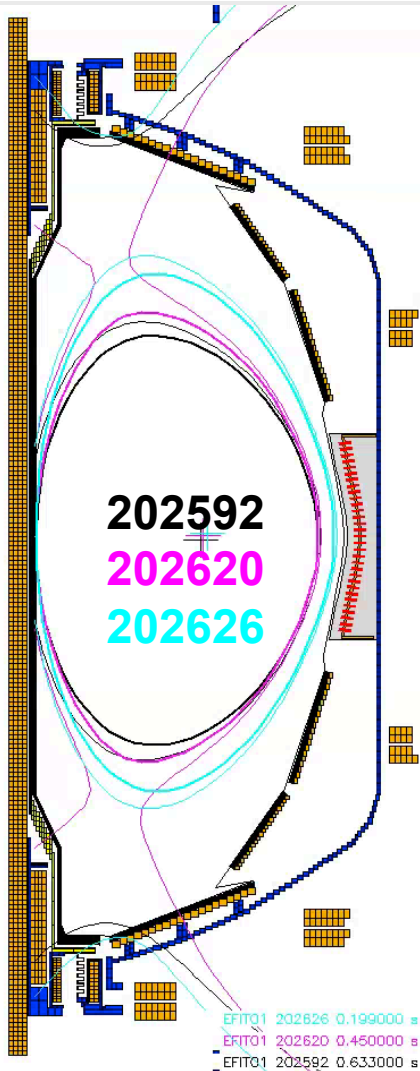
# Recent Efforts Have Looked at Increasing the Elongation

- Increase the elongation by both lowering the PF-3 current and raising the divertor current.
- Stored energies of ~70 kJ achieved with NB heating in larger elongation shots.

Shots:  
202592  
202620  
202626



# Physics Have Looked at Increasing the Elongation

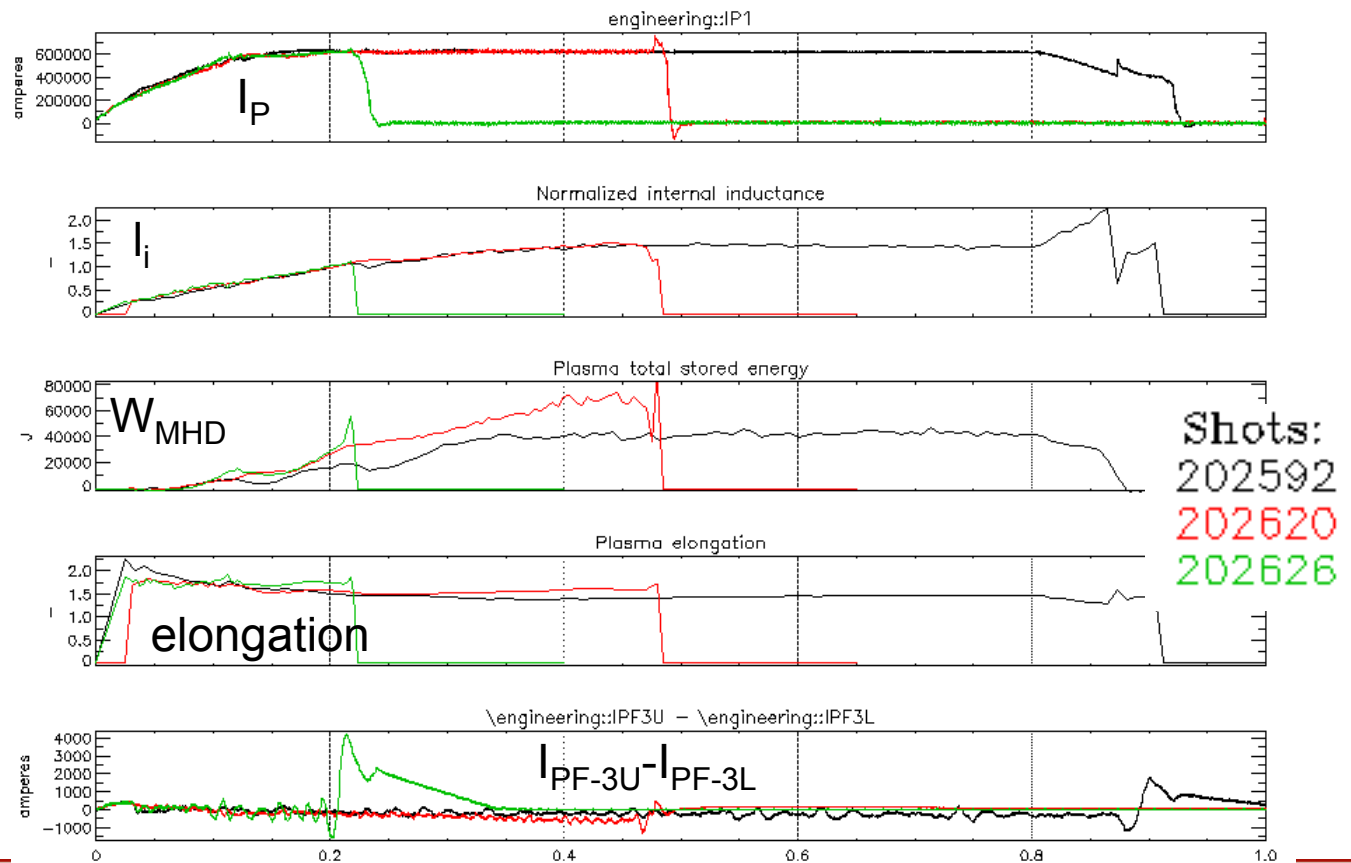


Shots:  
202592  
202620  
202626



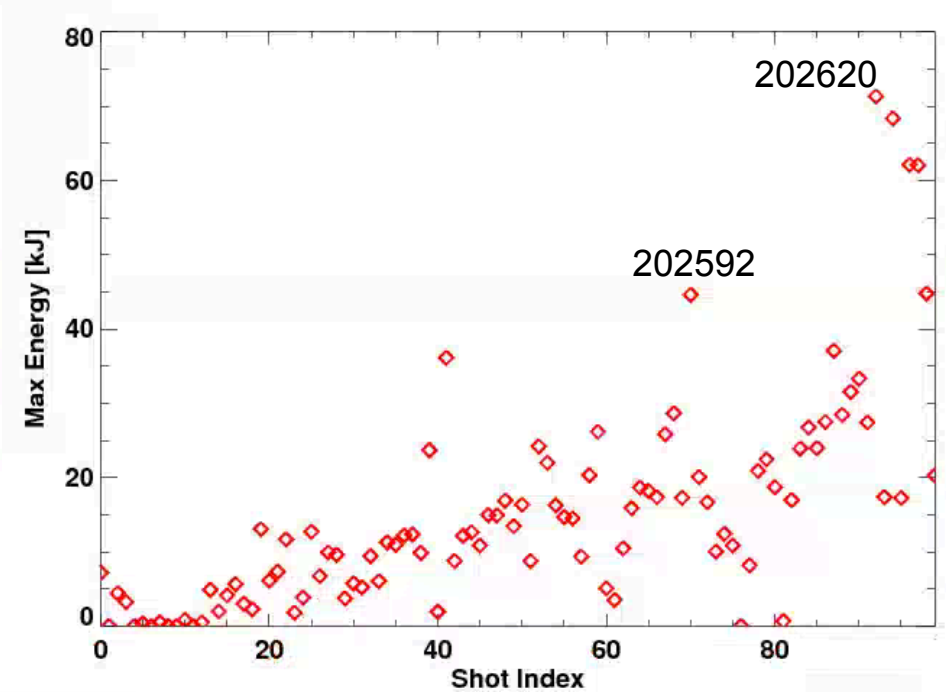
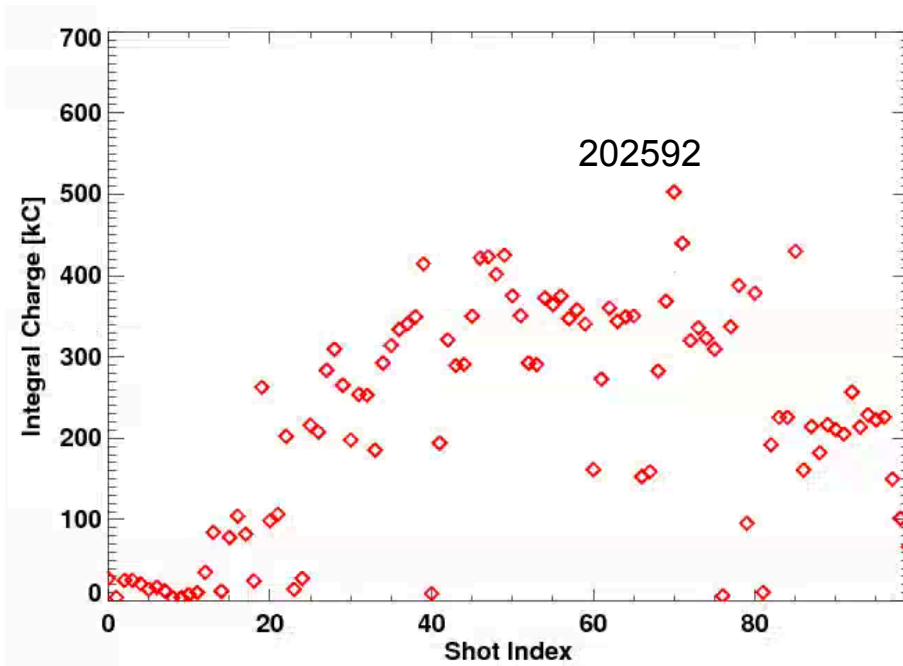
# Vertical Control Has Been Problematic When Increasing Elongation

- Internal inductance is ramping up.
- Vertical oscillations and LoC are common when the elongation is increased.
- Now looking at ways to lower  $I_i$ .



# Consistent Improvements in Duration and Stored Energy

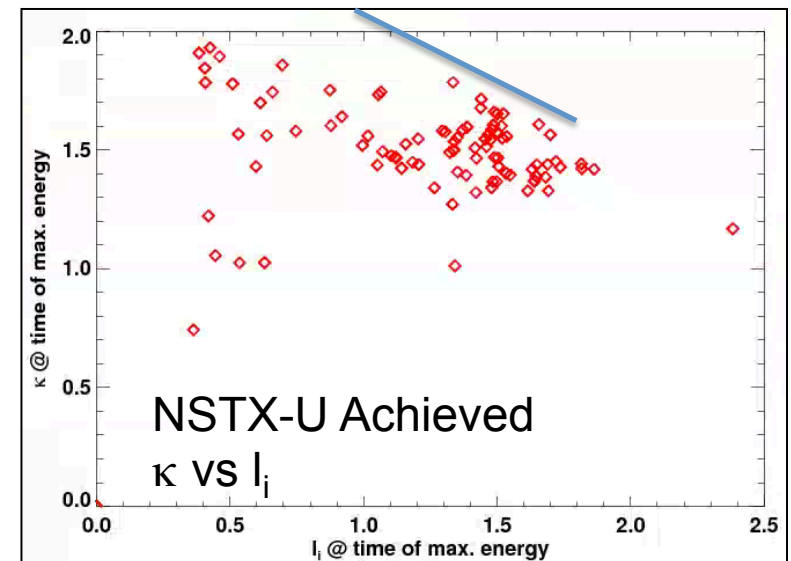
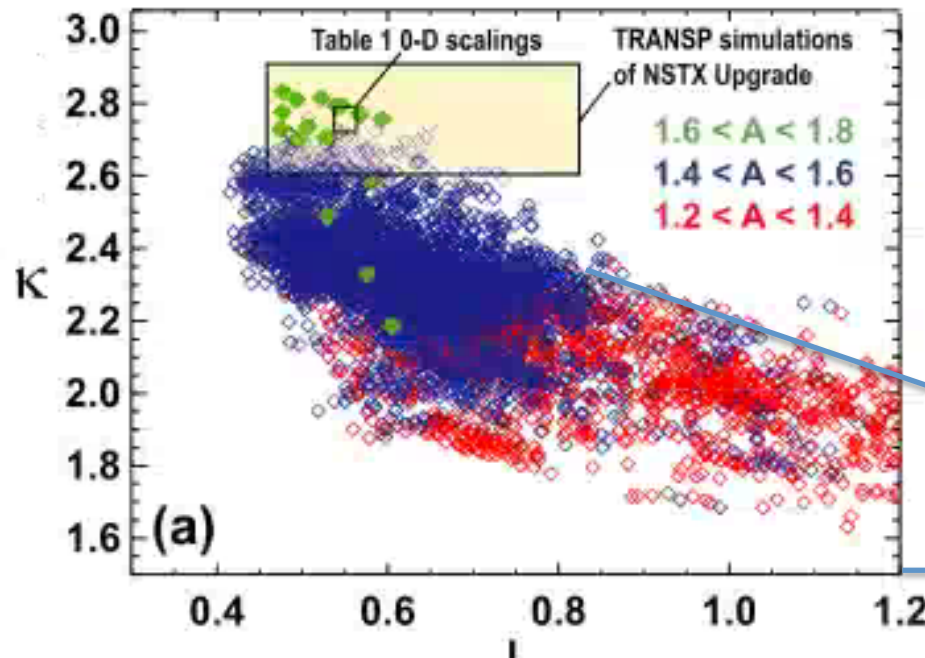
- Database excluding 'fizzles'



# But Need to Reduce The Internal Inductance

From Menard, et al, Nuclear Fusion 2012

NSTX experimental  $\kappa$  vs.  $I_i$  operating space



Extrapolation of the NSTX database implies there is not a lot of room for improvement at this  $I_i$

# Many Upgrades to PCS Compared to NSTX

- Demonstrated
  - Control of multiple plasma wall gaps from simple shape control algorithm.
    - (SP gaps in PCC algorithm)
  - Use of multiple sensors for vertical control.
  - Sloped baseline subtraction for magnetics.
  - Automatic plasma shutdown when a disruption is deemed imminent.
    - $I_p$  rampdown, beams & gas off, shaping reduction, automatically when VDE or  $I_p$  transient is detected.
- Being rolled out now
  - Loop voltage compensations on the RWM sensors.
  - Reduced noise processing for vertical position detecting sensors.

# Some Diagnostic Status Notes (I)

- Magnetics:
  - Equilibrium flux and field measurements in good shape, support EFIT and PCS operations.
  - New diamagnetics loops appear to be working out well.
  - RWM sensors writing data to tree, but need better plasmas to complete calibration.
  - High-n and high-f arrays both producing data.
- CHERS
  - CHERS, pCHERS, ERD, RTV systems are up & running. Acquisition software is working OK for all systems.
  - So far, we confirm light from CHERS, RTV & top views of pCHERS
    - bottom shutters were kept closed during shots, so no pCHERS bottom views have seen light).
  - Analysis software is still under development to account for new hardware & software configurations.
- MPTS
  - The MPTS system has started data acquisition in its upgraded 42-channel configuration.
  - The analysis  $T_e$ ,  $n_e$  and  $p_e$  profiles are not ready for dissemination as they reflect alignment and hardware problems.

# Some Diagnostic Status Notes (II)

- BES [Dave Smith]
  - Not ready yet. A few hardware tasks to complete, and the computer group is still configuring the BES digitizer.
- Irvine EP diagnostics [Deyong Liu]
  - v-FIDA and t-FIDA: work reasonably well, in the process of fine tuning and data validity check.
  - ssNPA: pick up huge noise during plasma operations, currently troubleshooting noise problem.
- Survey spectroscopy [Vlad Soukhanovskii]
  - EIES (aka filterscopes) operational, 7 channels viewing lower divertor, 5 channels viewing inner wall, 5 channels viewing upper divertor with common filters for edge intensities of D-alpha, C II, O II, B II, Li I
  - Survey UV-VIS spectrometer VIPS 2 operational with 4 simultaneous views
- Plasma TV [Mike J.]
  - Bay B Plasma-TV: operating. Unexpected vignetting is making it appear like the current lens is not fish-eye. I'll be changing it out when schedules permit.
  - Bay I Plasma-TV: waiting on some installations in the test cell.

# Some Diagnostic Status Notes (III)

- IR Cameras [Travis Gray]
  - Lower Divertor Fast IR Camera: Revised Work Package submitted. Waiting approval
  - Lower Divertor wide-angle IR Camera: Revised Work Package submitted. Waiting approval
  - Upper Divertor Fast IR Camera: Plan to install during first maintenance break
  - Testing and debugging of automated data acquisition software is in progress.
- Physics Cameras [Scotti]
  - Three wide angle divertor fast cameras (two lower, one upper) installed and running, equipped with filter wheels.
  - New LLNL filtered fast camera with lower divertor view installed and running.
  - Two new radiation-hardened CID cameras equipped with custom two-wavelengths optics (TWICE-1, -2) installed. TWICE-1 has been running routinely. Working on acquisition for TWICE-2.
  - Overall 2D imaging of lower divertor available at 7 different wavelengths simultaneously.
  - The new ENDD installed and running. Mirror alignment being improved.

# Some Diagnostic Status Notes (IV)

- Core AXUV Bolometry System [Luis D.-G.]
  - Core diode arrays, electronics and DAQs for AXUV-bolometer are installed.
  - New fiber optic and ethernet cables will be installed during the two-week maintenance period.
- JHU Spectroscopy [Kevin T.]
  - Poloidal USXR is mounted and waiting for ethernet in the rack and mounting of the stepper motors.
  - MESXR systems are mounted and ready, but working on the noise issues.
  - TGIS is ready to be installed, blue folder work packet has been generated.
- MSE-CIF [Howard Yuh]
  - MSE-CIF is ready to go. We should be ready to take data when it is available.
- Langmuir Probes [Mike J.]
  - delayed due to schedule and priority constraints. 90% fabricated but some remaining design work needed.



# Near Term Schedule

- Presently repairing a leaky fitting on the TF coil.
  - Plan to boronize tonight, run tomorrow (1/12/2016).
- Run weeks of 1/11/2016, 1/18/2016
- PAC is week of 1/25/2016
- Maintenance weeks on 1/25/2016, 2/1/2016. Key items:
  - Repairs of NB 2a and 2b trunk lines.
  - LITER electrical and mechanical.
  - Argon purge system piping
  - You can work on any of your systems with approved work permit or work package.
  - LoWEUS/XEUS/MONALISA electrical/mechanical.
- Run again starting 2/8/2016