U.S. DEPARTMENT OF ENERGY | Office of Science

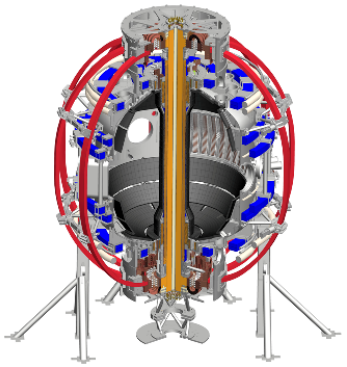
NSTX-U

NSTX-U Run Assessment Overview of Run

S.P. Gerhardt

NSTX-U Run Assessment
PPPL B-318
9/28/2016, 10:00 AM

PPPL



Comprehensive Run Summary is Posted

National Spherical Torus eXperiment Upgrade

Home | Meetings | Drag & Drop | Calendars | Phone Book | Sitemap

NSTX-U Web Pages:

- Home
- Overview
- Mission
- Accomplishments
- Collaboration Info
- Data Management Plan
- Diagnostics
- Five Year Plans
- Group Links / Files / Email
- Joint Research Targets
- Milestones
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- Organization
- Outreach Seminars
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- Publications & Presentations
- Reports
- Remote Connection Info - Zoom
- Research Forum - 2015
- Roles and Responsibilities
- **Run Coordination**
- Run Schedule Calendar
- Science Groups
- Scientific Conferences
- Software
- Surface Science
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- User Information Form
- Working Groups
- NSTX Upgrade Overview
- NSTX Upgrade Project

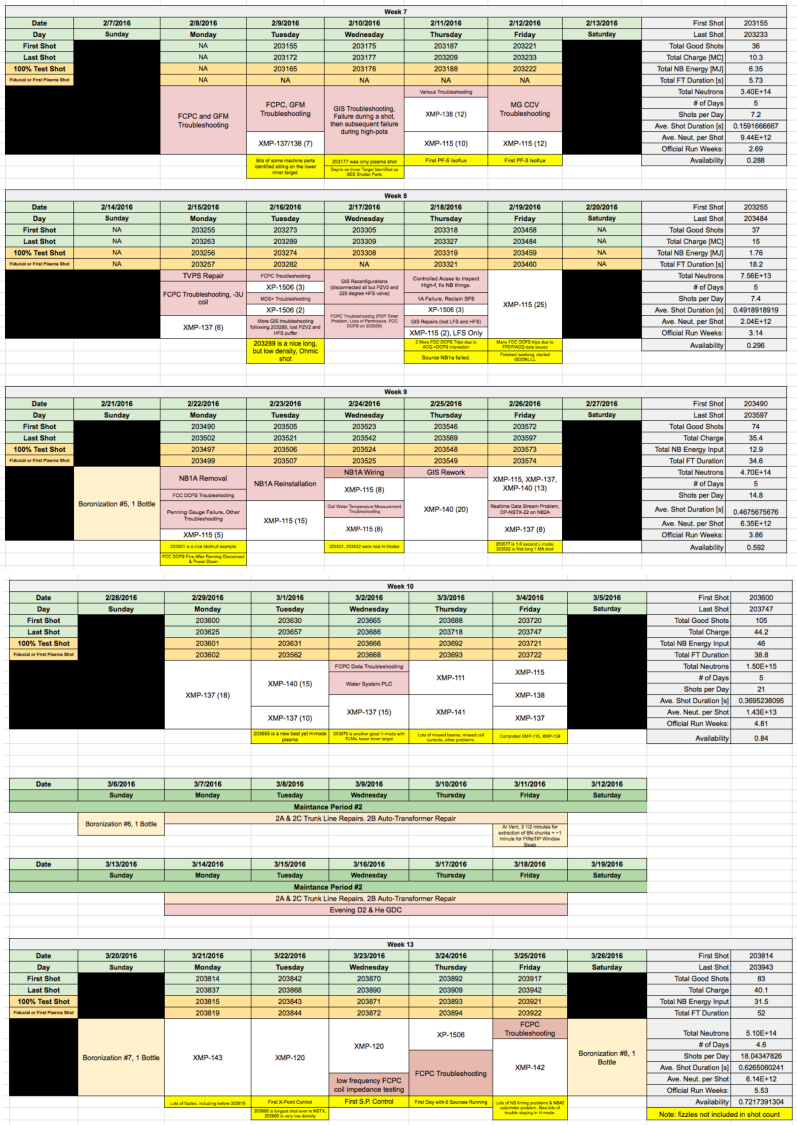
Program >

Run Coordination

Send Email to Run Coordinators

Leader	Jon Menard
Deputy	Stefan Gerhardt

- **NSTX-U Status**
- **Run Schedule Calendar**
- **Operations Chronology and Run Statistics**
  - FY2016
- **Approved XPs**
  - **Controlled copies: XPs and XMPs**
- **Master Spreadsheet of XMPs and XPs**
- **XP Review Meetings:**
  - Final Review Meeting Files
  - Online Chit Submission Form (preferred way to submit XP review chits)
    - Download Chit Form
  - View chits submitted from XP reviews
- **XP (eXperimental Proposal) Procedures and Forms:**
  - Procedures for XP approval
  - XP Template (blank form)
- **XMP (eXperimental Machine Proposal) Forms and Folders:**
  - XMP Template (blank form)
  - Approved XMPs



Week 7

Date	2/7/2016	2/8/2016	2/9/2016	2/10/2016	2/11/2016	2/12/2016	2/13/2016
Day	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
First Shot		NA	203155	203175	203187	203221	
Last Shot		NA	203172	203177	203209	203233	
100% Test Shot		NA	203165	203176	203188	203222	
Fiducial or First Plasma Shot		NA	NA	NA	NA	NA	
		FCPC and GFM Troubleshooting	FCPC, GFM Troubleshooting	GIS Troubleshooting. Failure during a shot then subsequent failure during high-pots	Various Troubleshooting XMP-138 (12)	MG CCV Troubleshooting	
			XMP-137/138 (7)		XMP-115 (10)	XMP-115 (12)	
			9hs of some machine parts identified acting on the lower inner target.	203177 was only plasma shot Signs on lower Target identified as SAS Shutter Parts	First PF-5 lasflux	First PF-3 lasflux	

First Shot	203155
Last Shot	203233
Total Good Shots	36
Total Charge [MC]	10.3
Total NB Energy [MJ]	6.35
Total FT Duration [s]	5.73
Total Neutrons	3.40E+14
# of Days	5
Shots per Day	7.2
Ave. Shot Duration [s]	0.1591666667
Ave. Neut. per Shot	9.44E+12
Official Run Weeks:	2.69
Availability	0.288

Week 8

Date	2/14/2016	2/15/2016	2/16/2016	2/17/2016	2/18/2016	2/19/2016	2/20/2016
Day	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
First Shot	NA	203255	203273	203305	203318	203458	NA
Last Shot	NA	203263	203289	203309	203327	203484	NA
100% Test Shot	NA	203256	203274	203308	203319	203459	NA
Fiducial or First Plasma Shot	NA	203257	203282	NA	203321	203460	NA
		TVPS Repair FCPC Troubleshooting, -3U coil	FCPC Troubleshooting XP-1506 (3) MDS+ Troubleshooting XP-1506 (2)	GIS Reconfigurations (disconnected all but FZV2 and 225 degree HFS valve)	Controlled Access to Inspect High-f, fix NB things. 1A Failure, Reclain SP6 XP-1506 (3) GIS Repairs (lost LFS and HFS) XMP-115 (2), LFS Only	XMP-115 (25)	
		XMP-137 (6)	More GIS troubleshooting following 203289, lost FZV2 and HFS puffer 203289 is a nice long, but low density, Ohmic shot	FCPC Troubleshooting (FCP Toser Problem, Loss of Permissive, FCC DCPS on 203306)	2 More FCC DCPS Trips due to ACQ / DCPS interaction Source NB1a failed.	More FCC DCPS trips due to FPGP/ACQ code issues Finished cleaning, started GDC/BLLD	

First Shot	203255
Last Shot	203484
Total Good Shots	37
Total Charge [MC]	15
Total NB Energy [MJ]	1.76
Total FT Duration [s]	18.2
Total Neutrons	7.56E+13
# of Days	5
Shots per Day	7.4
Ave. Shot Duration [s]	0.4918918919
Ave. Neut. per Shot	2.04E+12
Official Run Weeks:	3.14
Availability	0.296

Week 9

Date	2/21/2016	2/22/2016	2/23/2016	2/24/2016	2/25/2016	2/26/2016	2/27/2016
Day	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
First Shot		203490	203505	203523	203546	203572	
Last Shot		203502	203521	203542	203569	203597	
100% Test Shot		203497	203506	203524	203548	203573	
Fiducial or First Plasma Shot		203499	203507	203525	203549	203574	
	Boronization #5, 1 Bottle	NB1A Removal FCC DCPS Troubleshooting Penning Gauge Failure, Other Troubleshooting XMP-115 (5) 203501 is a nice 500mJ/2 example FCC DCPS Fire After Penning Disconnect & Power Down	NB1A Reinstallation XMP-115 (15)	NB1A Wiring XMP-115 (8) Gal Water Temperature Measurement Troubleshooting 203501, 203502 were nice H-Modes	GIS Rework XMP-140 (20)	XMP-115, XMP-137, XMP-140 (13) Realtime Data Stream Problem, OP-NSTX-2 on NB2A XMP-137 (8) 203577 is 1.6 second I-mode, 203582 is first long 1 MA shot	

First Shot	203490
Last Shot	203597
Total Good Shots	74
Total Charge	35.4
Total NB Energy Input	12.9
Total FT Duration	34.6
Total Neutrons	4.70E+14
# of Days	5
Shots per Day	14.8
Ave. Shot Duration [s]	0.4675675676
Ave. Neut. per Shot	6.35E+12
Official Run Weeks:	3.86
Availability	0.592

Week 10

Date	2/28/2016	2/29/2016	3/1/2016	3/2/2016	3/3/2016	3/4/2016	3/5/2016
Day	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
First Shot		203600	203630	203665	203688	203720	
Last Shot		203625	203657	203686	203718	203747	
100% Test Shot		203601	203631	203666	203692	203721	
Fiducial or First Plasma Shot		203602	203562	203668	203693	203722	
		XMP-137 (18)	XMP-140 (15) XMP-137 (10)	FCPC Data Troubleshooting Water System PLC XMP-137 (15)	XMP-111 XMP-141	XMP-115 XMP-138 XMP-137	
			203659 is a new best yet H-mode plasma	203670 is another good H-mode with ELMs, lower inner target	Lots of missed beams, missed coil currents, other problems.	Complete: XMP-115, XMP-138	

First Shot	203600
Last Shot	203747
Total Good Shots	105
Total Charge	44.2
Total NB Energy Input	46
Total FT Duration	38.8
Total Neutrons	1.50E+15
# of Days	5
Shots per Day	21
Ave. Shot Duration [s]	0.3695238095
Ave. Neut. per Shot	1.43E+13
Official Run Weeks:	4.81
Availability	0.84

Date	3/6/2016	3/7/2016	3/8/2016	3/9/2016	3/10/2016	3/11/2016	3/12/2016
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				Maintance Period #2			
	Boronization #6, 1 Bottle			2A & 2C Trunk Line Repairs. 2B Auto-Transformer Repair			
						Al Vent, 3 1/2 minutes for extraction of BN chunks + ~1 minute for FPM/TF Window Swap	

Date	3/13/2016	3/14/2016	3/15/2016	3/16/2016	3/17/2016	3/18/2016	3/19/2016
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				Maintance Period #2			
				2A & 2C Trunk Line Repairs. 2B Auto-Transformer Repair Evening D2 & He GDC			

Week 13

Date	3/20/2016	3/21/2016	3/22/2016	3/23/2016	3/24/2016	3/25/2016	3/26/2016
Day	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
First Shot		203814	203842	203870	203892	203917	
Last Shot		203837	203868	203890	203909	203942	
100% Test Shot		203815	203843	203871	203893	203921	
Fiducial or First Plasma Shot		203819	203844	203872	203894	203922	
	Boronization #7, 1 Bottle	XMP-143	XMP-120	XMP-120 low frequency FCPC coil impedance testing	XP-1506 FCPC Troubleshooting	FCPC Troubleshooting XMP-142	Boronization #8, 1 Bottle
		Lots of fizzles, including before 203816	First X-Point Control 203868 is longest shot ever in NSTX, 203865 is very low density	First S.P. Control	First Day with 6 Sources Running	Lots of NB timing problems & NBAH calibration problem. Also lots of trouble staying in H-mode.	

First Shot	203814
Last Shot	203943
Total Good Shots	83
Total Charge	40.1
Total NB Energy Input	31.5
Total FT Duration	52
Total Neutrons	5.10E+14
# of Days	4.6
Shots per Day	18.04347826
Ave. Shot Duration [s]	0.8265060241
Ave. Neut. per Shot	6.14E+12
Official Run Weeks:	5.53
Availability	0.7217391304
Note: fizzles not included in shot count	

Highest Level Overview

- Refrigerator Cooled: 12/2/2014
- ISTP: Started on ~11/11/2015
- First Plasma: 12/21/2015
- Last Plasma: 6/28/2016
- End of Operations Phase: 8/10/2016

27 Weeks

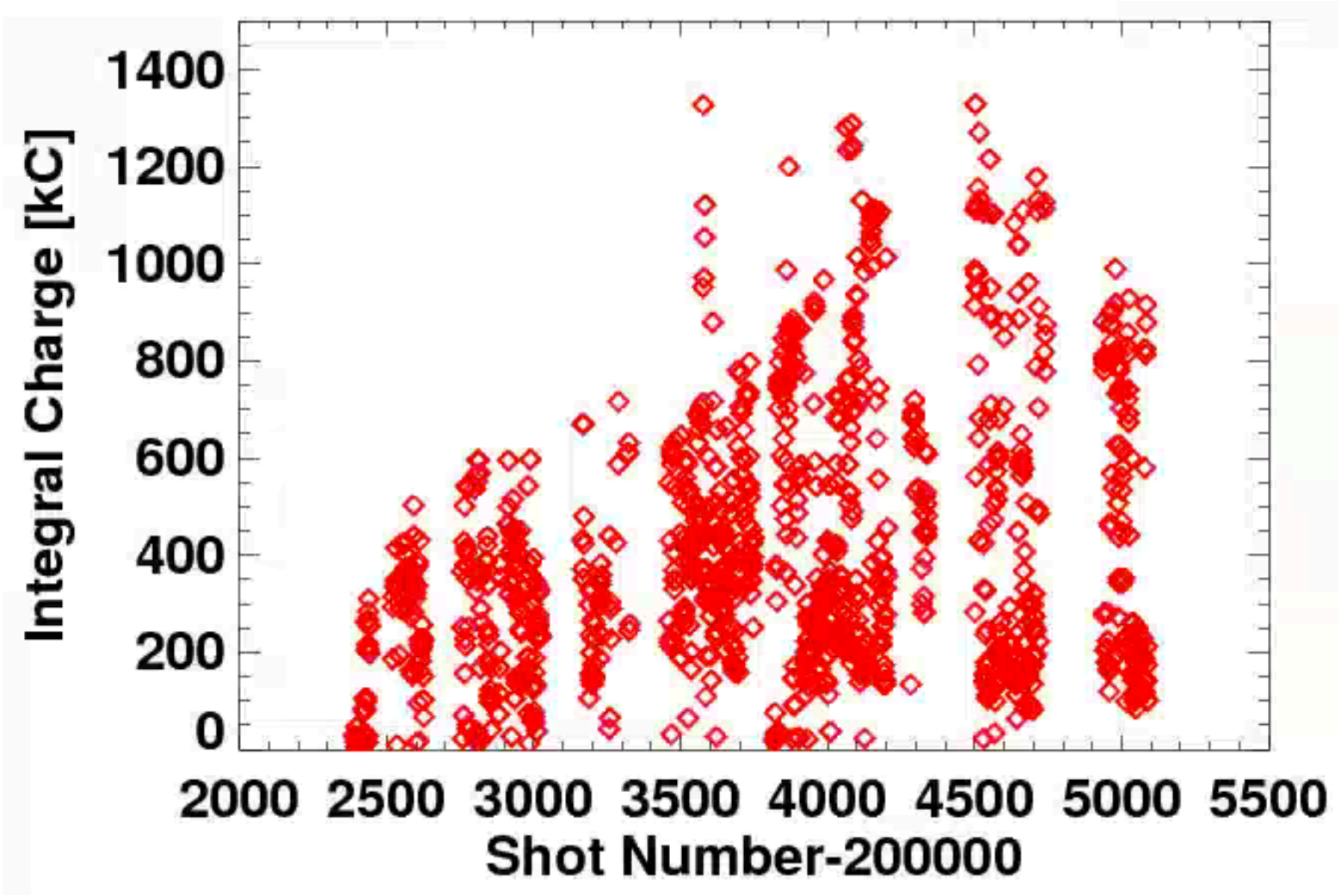
39 Weeks

1 ¾ Years

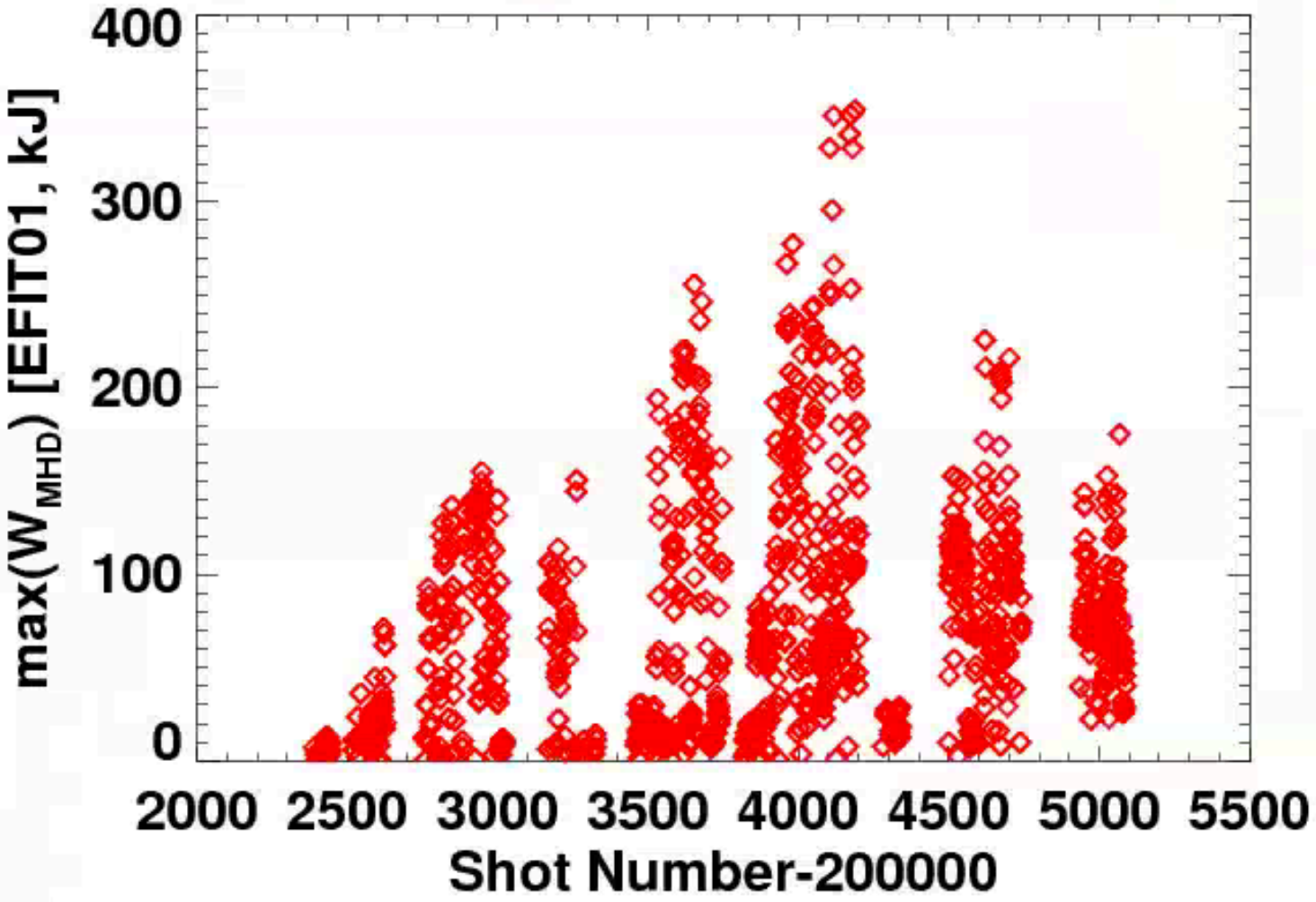
- 11 declared maintenance weeks in the 27 weeks
  - And ~16 weeks where we tried to run.

- 10 full bottle boronizations and 12 mini-boronizations

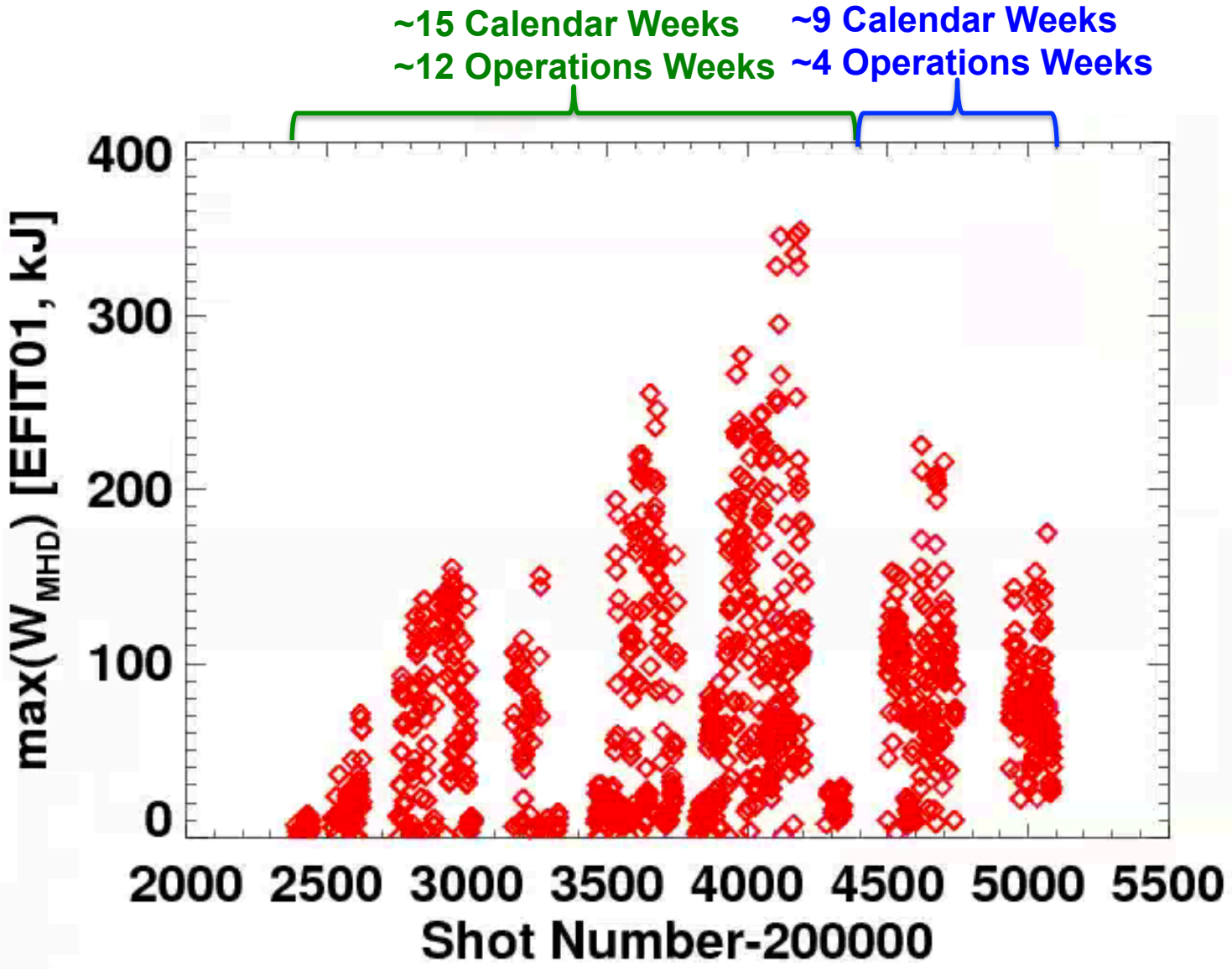
Much Progress Made During the Run
Charge



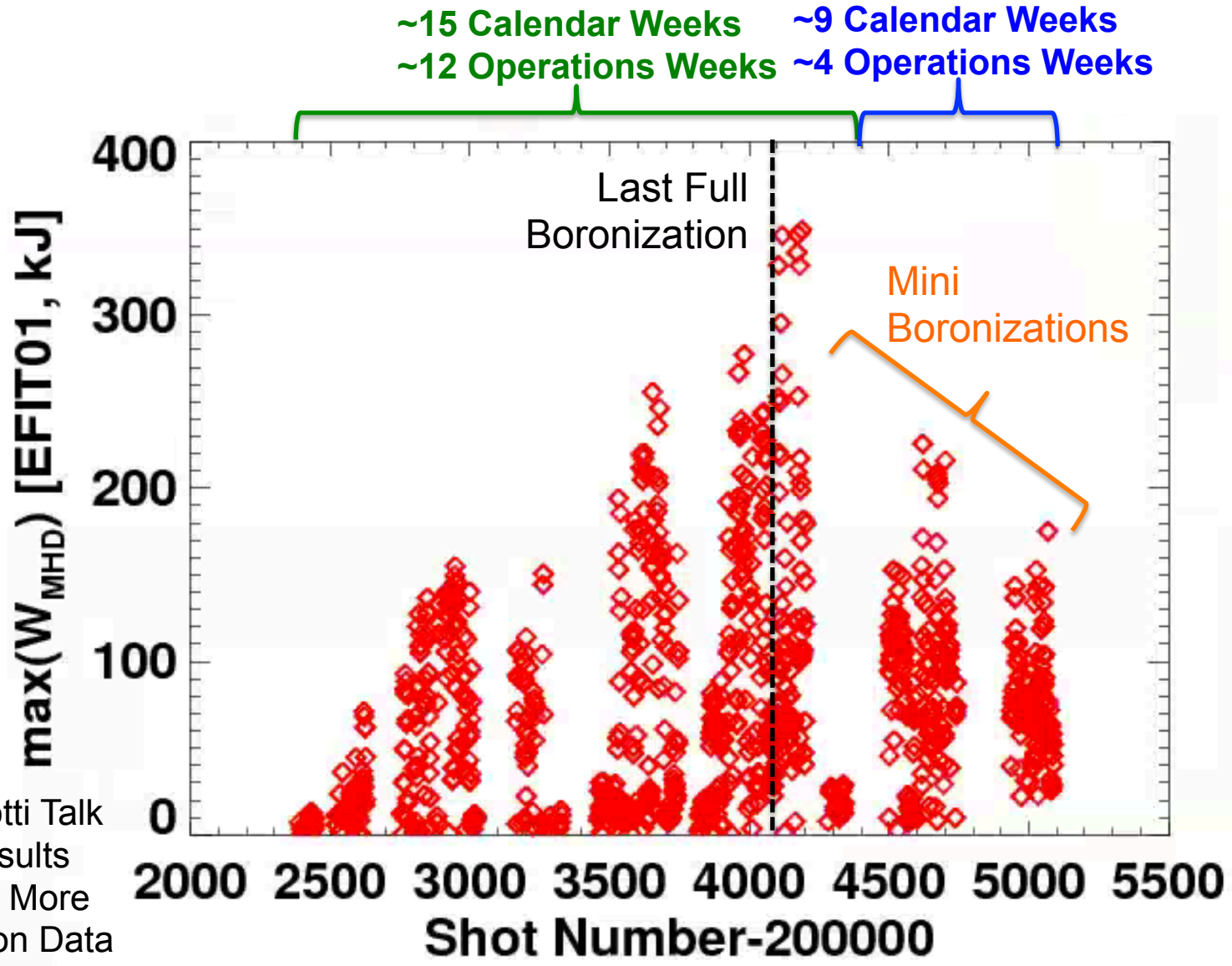
Much Progress Made During the Run
Stored Energy



Much Progress Made During the Run
Stored Energy

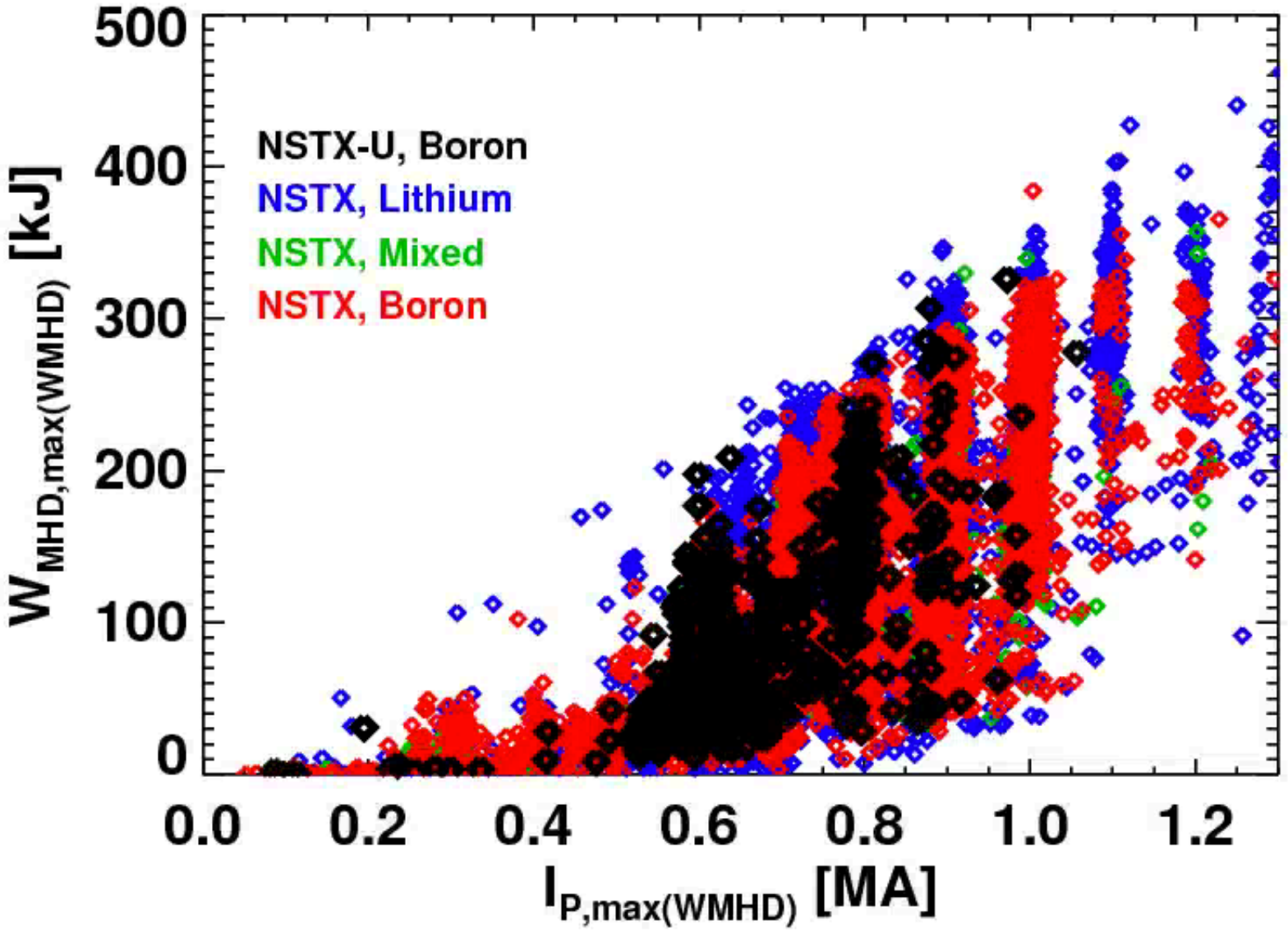


Much Progress Made During the Run
Stored Energy

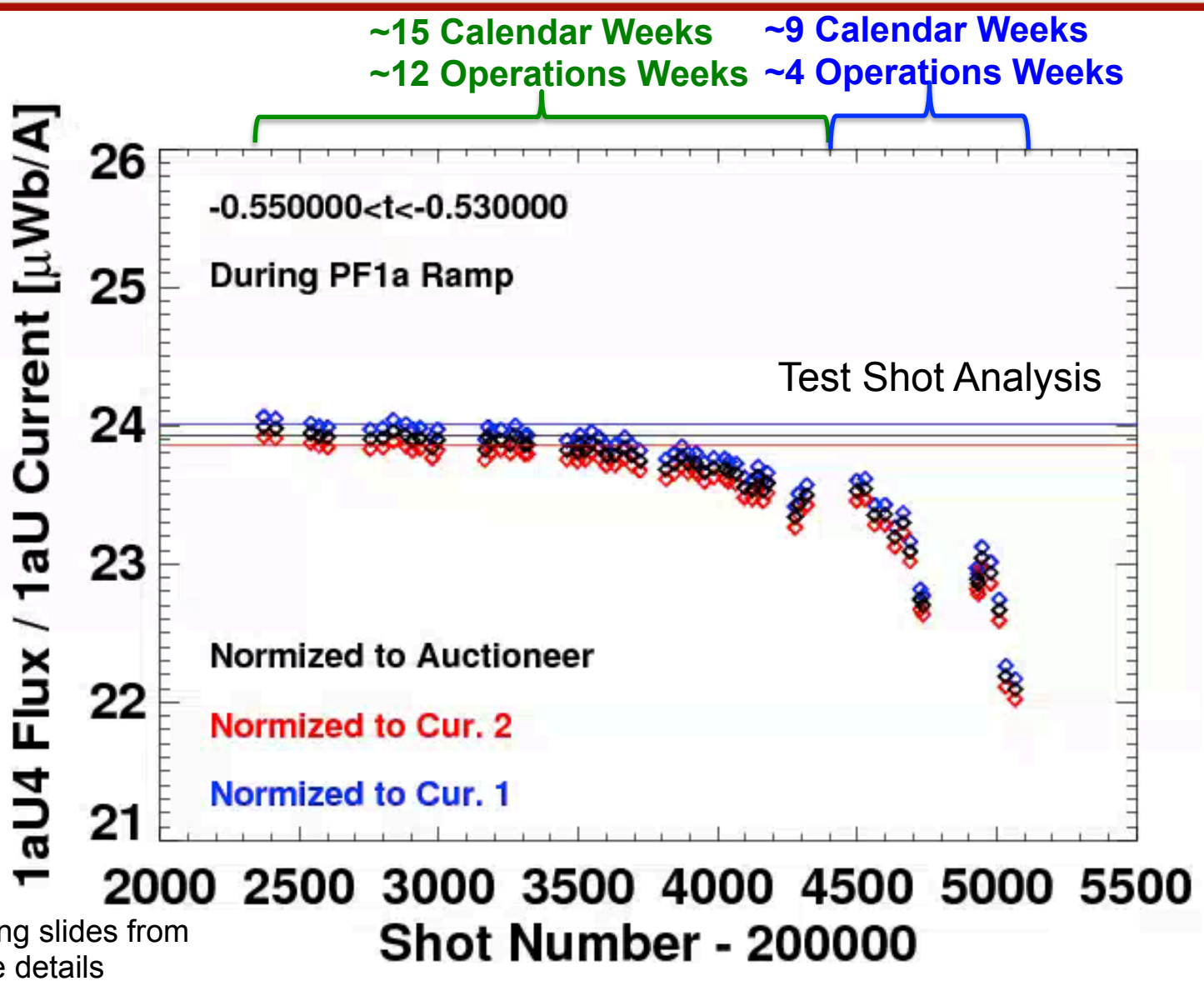


See F. Scotti Talk at from Results Review for More Boronization Data

Stored Energy of the Best H-Modes in NSTX-U Matched those in NSTX w/ Lithium

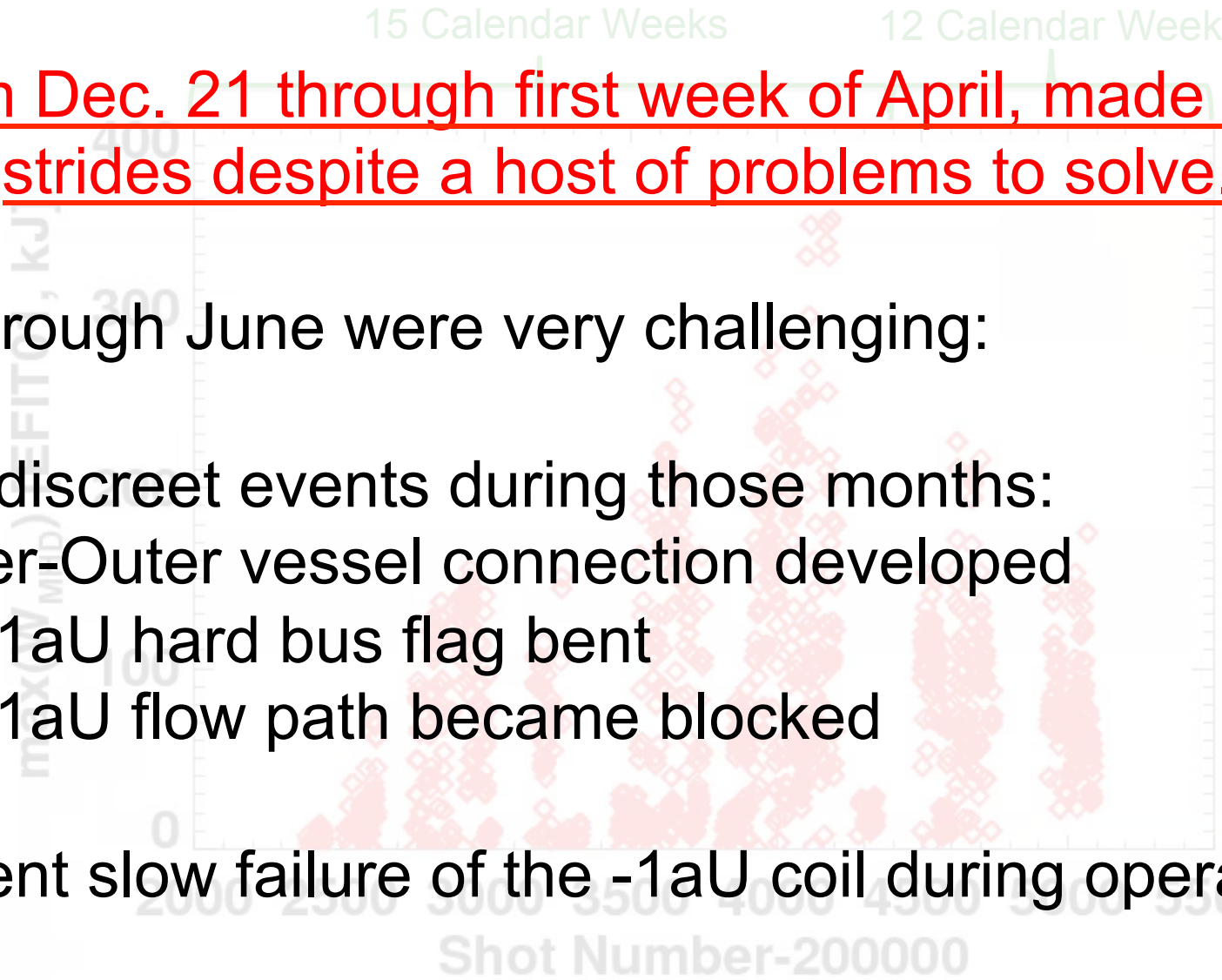


The -1aU Coil Was Slowly Failing Through the Run



See team meeting slides from 7/29/16 for more details

Key Message:
We Really Did Make a Lot of Progress



From Dec. 21 through first week of April, made great strides despite a host of problems to solve.

May through June were very challenging:

Three discreet events during those months:

- Inner-Outer vessel connection developed
- PF-1aU hard bus flag bent
- PF-1aU flow path became blocked

Apparent slow failure of the -1aU coil during operations

Ran All or Part of 35 Commissioning XPs and XMPs

XMP #	Author	Title	Started	Finished
101	Battaglia	Breakdown Optimization	Yes	Yes
105	Boyer	Software Test for n=0 Control	Yes	Yes
106	Myers	Magnetics calibrations	Yes	Yes
110	Liu	ssNPA and FIDA Checkout	Yes	No
114	Podesta	CHERS NB Modulation Study	Yes	No
115	Boyer	ISOFLUX Commissioning	Yes	Yes
116	Battaglia	Initial H-Mode Development	Yes	Yes
120	Boyer	Strikepoint Control	Yes	Yes
121	Gerhardt	RWM Control Checkout	Yes	No
126	Mueller	Ip and R Control	Yes	Yes
127	Boyer	Neutral Beam Commissioning	Yes	Yes
128	Battaglia	Increase L-Mode Elongation	Yes	Yes
130	Lunsford	LGI Commissioning	No	No
132	Gerhardt	Fast Rampdown Sequence Commissioning	Yes	Yes
134	Bell	Ne GDC for Spectroscopy	Yes	Yes
136	Raman	MGI Commissioning	No	No
137	Battaglia	Increase Ip and Kappa in L- and H- Mode	Yes	Yes
138	Boyer	Vertical Control Checkout	Yes	Yes
140	Gerhardt	PF-5 Proportional EFC Test	Yes	Yes
141	Myers	More PF-5 Proportional EFC	Yes	No
142	Battaglia	Reduced MHD H-mode Development	Yes	Yes
143	Gerhardt	Assess Vessel Conditions	Yes	Ongoing
144	Gerhardt	NSTX-U Morning Fiducial	Yes	Ongoing
145	Gerhardt	Flat-Top H-mode Transition Scenarios	Yes	No
146	Myers	Higher Order Feed Forward EFC in L-Mode	Yes	No
147	Boyer	Improve L-Mode Fiducial	Yes	Yes
148	Kaye	BEAST Validation	Yes	Yes
149	Seachrest	MSE-LIF Diagnostic Neutrol Beam Testing	Yes	Yes
150	Skinner	He Density Scan for Zeff Calibration	Yes	Yes
151	Guttenfelder	L-Mode Development in Support of Core and Boundary XPs.	Yes	No
152	Boyer	Improved rtEFIT and drSEP	Yes	Yes
153	Battaglia	H-mode access and control development in boronized wall conditions	Yes	No
154	Boyer	Inner Gap Control Checkout	Yes	Yes
156	Gerhardt	Use PF-2 and PF-3 to Apply Loop Voltage to PF-1aU	No	Yes

XP #	Author	Title	Started	Finished
1506	Myers	L-Mode Error Field Correction	Yes	No

Key Accomplishments During the Run: Engineering Operations

- DCPS, PCS, EPICS, MDS+ provided excellent service.
- Excellent MG and FCPC availability.
- Up to 12 MW of beams simultaneously firing at the end of run.
- FISO sensors deployed on the TF
- Control of all GIS valves from PCS
- CHI Handiscope installed and used
- Things that were ready to go when we stopped:
  - LITERs and APS
  - HHFW (after breaker failure recovery)
  - IGI
  - MGI

Key Accomplishments During the Run: Diagnostics

Core Profile Diagnostics
BES
AXUV Core Bolometer
Poloidal CHERS
Toroidal CHERS
ERD
MPTS
MSE-CIF
MSE-LIF
USXR Poloidal Arrays (2)
rtVPhi
ME-SXR

Fast Ion Diagnostics
T-FIDA
V-FIDA
SNPAs (3)
Neutron Detectors
S-FLIP
I-FLIP
Fixed-f Reflectometer

Magnetics
Operations Magnetics
Diamagnetic Loop
RWM sensors
High-f and high-n arrays

Divertor
Divertor AXUV Bolometer (LADA)
Divertor Fast Cameras
Divertor Intensified Cameras
Infrared Video Bolometer
Divertor Langmuir Probes
U. Of Tennessee Spectrocospy
1D CCDs
MAPP
Divertor Tangential Imaging
Wide Angle Infrared Camera
Fast Infrared Cameras
Divertor SPRED

Spectroscopy
ENDD
XEUS
LOWEUS
MonaLISA
VIPS
DIMS
VB
EIES (Filterscopes)
DIBS

Other
Plasma TV (2)
Shunt Tiles
GPI
Penning Gauges

Operational
In Progress

Key Accomplishments During the Run: Research Operations

- Breakdown and current ramp scenarios in the challenging high pre-charge scenario.
- H-Modes on 8th (!) operations day.
  - And recovered (briefly) NSTX like H-mode performance at 900 kA.
  - And did it in about ~10 calendar weeks!
- Developed L-mode scenarios for physics studies.
- Enormous amount of control development, including many capabilities not available on NSTX.
- Error field assessment and initial corrections.
- Physics results coming out…see Results Review
  - 2nd Neutral Beam Physics: Blip experiments, GAE modes
  - L-mode core turbulence and divertor filaments
  - Error fields

It was a Pleasure Working With The Team During This Operations Phase

The End

Major Challenges For Run Coordination (I)

- Evolving Facility
  - Beams were on an strong upward trajectory through the full run, but there were daily changes of status.
  - Unknown to us, the PF-1aU coil inductance and Cu cooling tube state.
- Boronization Schedule
  - Each full boronization is a full day activity!
  - We moved to mini-boronization scheme on 4/4/16 after 10 full boronizations
    - This appeared to be supported by the diverter OII light.
  - This may or may not have been the right choice.
    - P_{LH} regression indicates threshold doesn't scale simply with this quantity.
    - We were going to go back to a full boronization when the -1aU broke.

Major Challenges For Run Coordination (II)

- H-mode Development vs. L-mode XPs
  - We had a bias towards H-mode development…milestones…
  - We could have done more L-mode XPs.
    - Though the lack of MSE made some of these XPs less attractive.
- Communications
  - Was very difficult to plan more than a few days in advance.
  - Tried to keep the google run schedule calendar up to date.
  - Was on occasion hesitant to send status emails to anonymous groups.
  - But needed to get information to the control-room physicists.
  - Defaulted to my own email list