

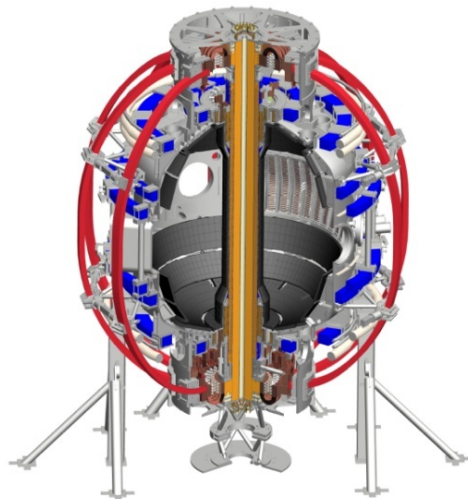
Operations Update for NSTX-U Project

Stefan Gerhardt

Brent Stratton, Bob Kaita, Lane Roquemore

B-318, 1/16/13

Coll of Wm & Mary
Columbia U
CompX
General Atomics
FIU
INL
Johns Hopkins U
LANL
LLNL
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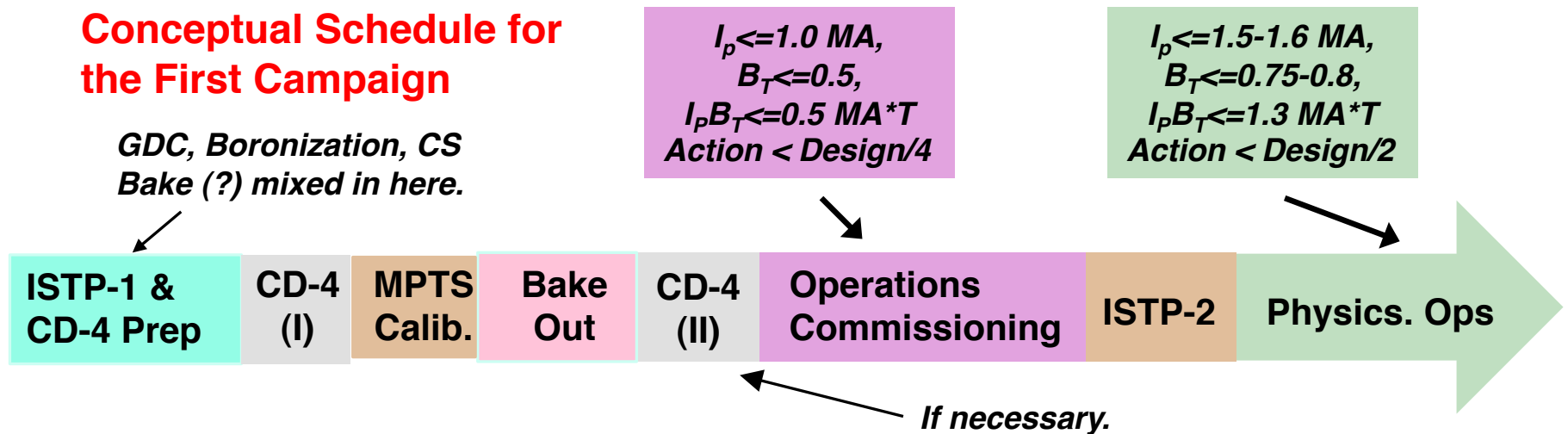


Culham Sci Ctr
York U
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Chonbuk Natl U
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ASIPP
CIEMAT
FOM Inst DIFFER
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep

Goal is to Be Ready for Physics Operations Following CD-4

- Goals for the operations work:
 - Get work done within the existing NSTX-U project schedule.
 - Prepare physics operations following CD-4 plasma.

Conceptual Schedule for the First Campaign



- Will show some ideas, drawings, and we acknowledge that most all still need review.
 - This meeting is not that review.

Contents For Today

- Port map for diagnostics.
 - Proposed Bay-K modifications.
 - Plans for new port covers.
- Gas systems and pressure gauges.
- Needs of two critical diagnostics.
 - MPTS
 - Magnetics
- Installation and calibration schedule information
 - Majority of NSTX diagnostics not captured by 2490 or any other line-item that SPG could identify.
- Other diagnostic needs (time and interest permitting)

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See: http://nstx.pppl.gov/DragNDrop/Operations/Diagnostics_&_Support_Sys/NSTX-U%20Reinstallations/

[illegible]

Diagnostic Needs Met By Penetrations in J/K Cap

Note: View actually doesn't see Beamline #2

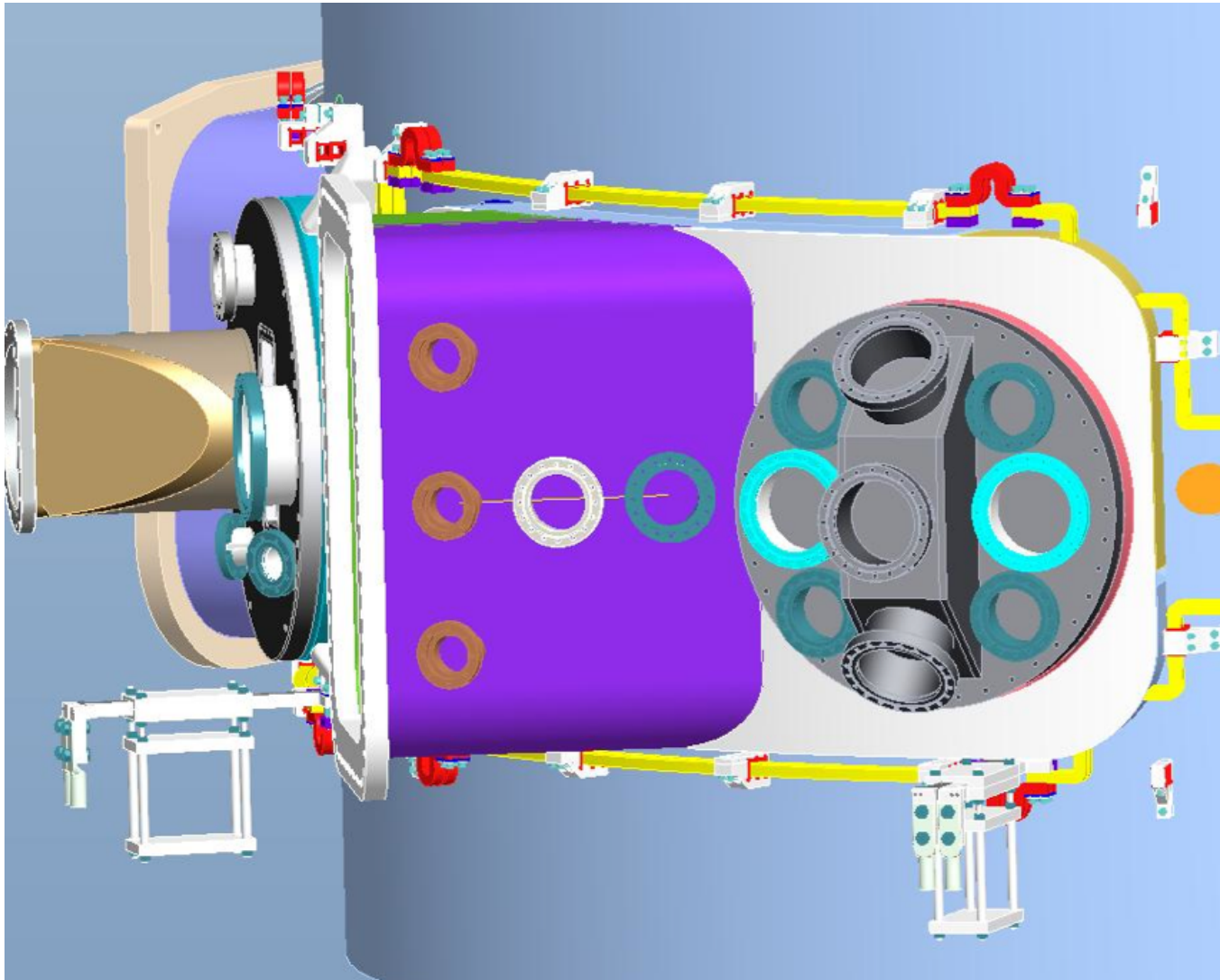
- FIRETIP: Critical for MPTS Calibration, density feedback. Funded Collaborator Diagnostic
 - Beam would enter at Bay K, bounce off of retro-reflector near Bay B.
 - Location is comparatively close to the proposed location of optics table.
 - Bay-L/I sightline has too-large large tangency radius.
- XCS: T_i and V_f to augment CHERS.
 - Excellent toroidal view with space for crystal and detector arms.
 - No other ports with toroidal views and sufficient space for instrument.
- SSNPA and E||B NPA:
 - Only location on NTC floor/platform near vessel where E||B NPA can reside.
 - Chosen sightline looks across the beam to maximize the signal.
 - SSNPA on near identical sightline for complementary information.
- JHU Transmission Grating Spectrometer: Impurity Monitoring from 50 to 700 Angstroms. Funded Collaborator Diagnostic.
 - Should view charge exchange lines from beamline #1 (not 2 beams).
 - Also want to view at location where NB crossed the edge, to maximize signal.

Lane looking for options to install FIRETIP and TGS w/o Bay K work, though options don't look good.
No other solutions for XCS and NPAs

Diagnostic Plan Calls for Installation of Ports on the Side of the Bay K NB Duct

- Motivation: diagnostic ports on the side of the NB duct at Bay K needed early in experimental program.
- Preferable to add them during the Upgrade outage since the NTC is already a major construction area. Would be a significant perturbation on a subsequent outage.
- Holes are nearly normal to surface and would be bored.
- Design is in progress.
 - Some interferences remain to be resolved.
 - Plan to hold a Peer Review later this month, complete detailed design and then hold Final Design Review.

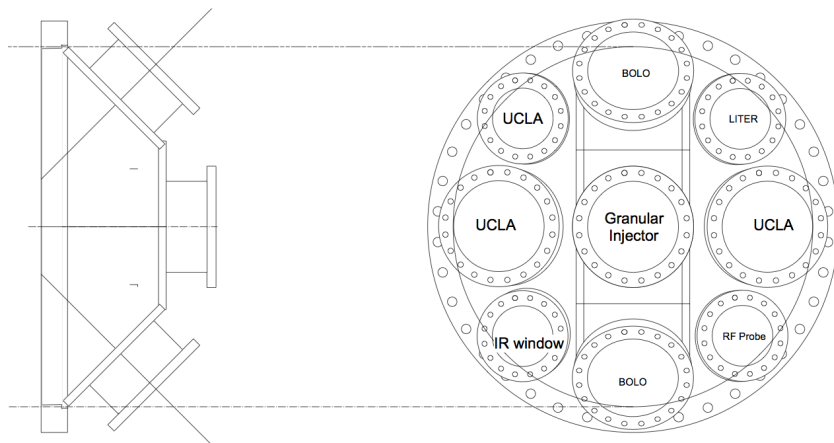
Concepts for Ports on the Side of the Bay K NB Duct & New Bay J Port Cover



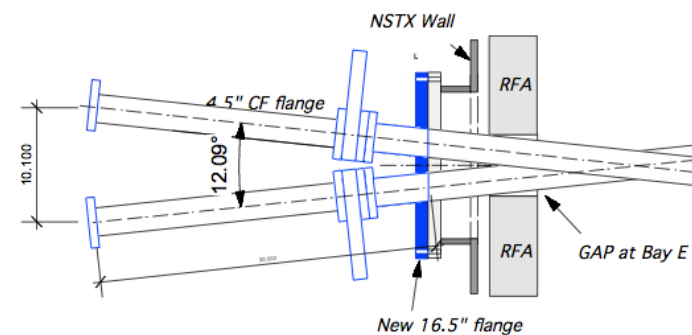
Labor Estimate For Later Table: 6 holes x 3 People x 5 days = 90 man-days

Will Fabricate New Port Covers, or Modify Existing Ones

- Bay E Midplane - have conceptual design
 - Supports LoWEUS, XEUS spectrometers
- Bay I Midplane – design in progress
- Bay J Midplane – design nearly ready for review
- Need to do design for other smaller port covers:
 - Redo Bays J, G, E, D, & C lower dome & Bay G upper dome ports
- Consider utilizing Bay H midplane for feedthroughs and/or a pressure gauge.
 - Discussions between Lane, Brent, Mark, and Tim on this.



Bay J Port Cover Design



Bay E Port Cover Concept

Contents For Today

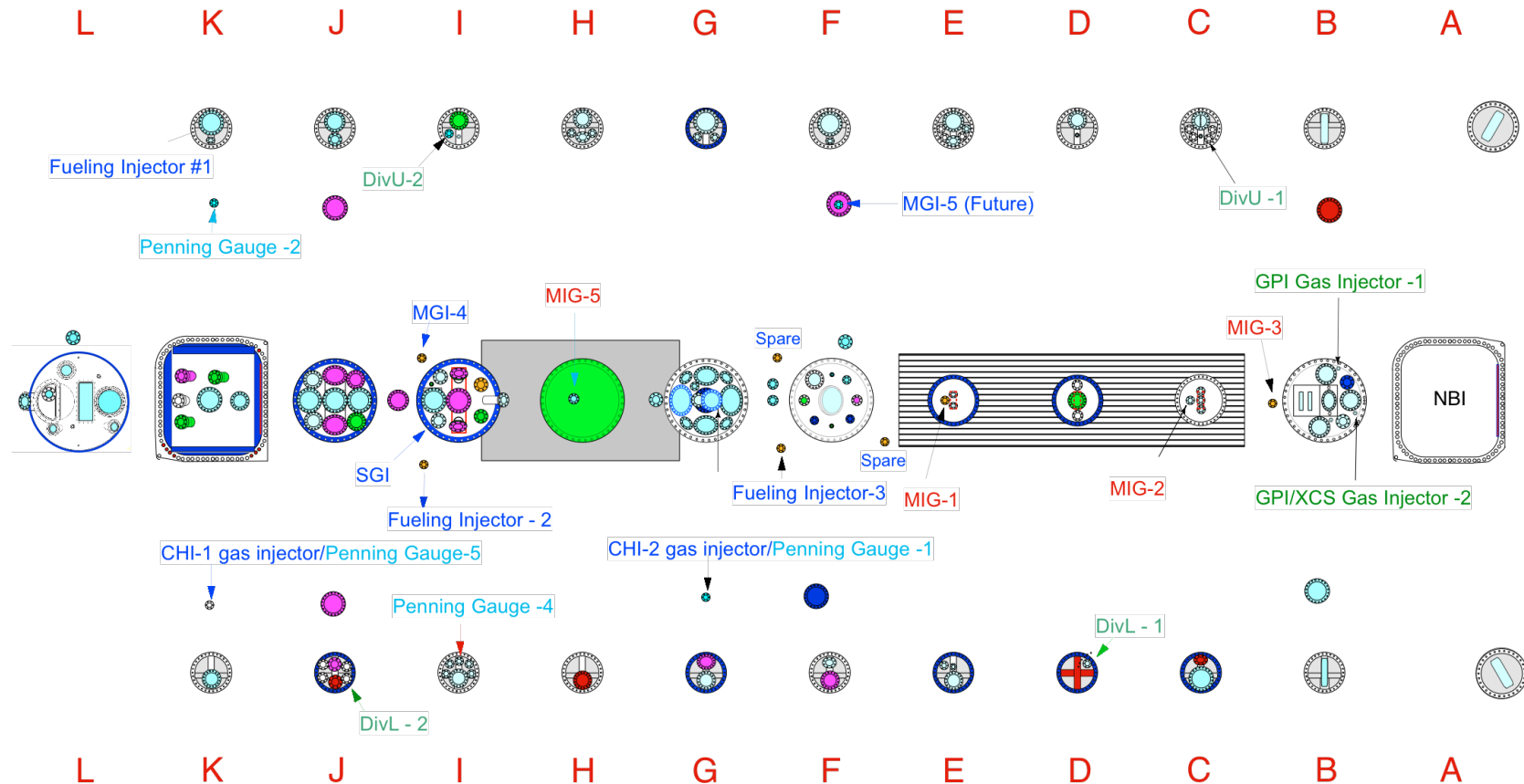
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Gas and Pressure Monitoring Systems On Port Map as Well

(via discussions with L. Roquemoire, R. Raman, B. Blanchard, V. Soukhanovskii, and S. Gerhardt)

See: http://nstx.pppl.gov/DragNDrop/Operations/Diagnostics_&_Support_Sys/NSTX-U%20Reinstallations/

Port assignment for FY 2015 (Pressure measurement and Gas Delivery Systems)



NOTE 1: Indicated gauges and injectors are outer vessel locations only.

Additional gauges and injectors are on inner vessel and not shown

NOTE 2: TVPS Pumping Duct location :

Ion Gauge -1
Ion Gauge-2
Capacitance Manometer 1 (1 Torr)
Capacitance Manometer 2 (10 Torr)
Capacitance Manometer 3 (1000 Torr)
MIG-4

MIG - Massive Gas Injector
MIG - Micro Ion Gauge
DivU - Upper Divertor injector
DivL - Lower Divertor injector

Fueling Injector
GPI - Gas Puff Imaging
CHI - Co-axial Helicity Injection
SGI - Super Sonic Gas Injector
Penning Gauge

Roquemoire
1-08-2013

Gas Injection System Progress

- B. Blanchard, R. Raman, L. Roquemoire, V. Soukhanovsii, & P. Sichta now working off of a common google docs spreadsheet describing the gas system.
 - Both pressure gauges and gas injection systems.
 - Is consistent with port map.
 - Can be used to define further engineering-level requirements.
- Roger Raman lead gas system review in late August of 2012.
 - Identified the need for additional ports on the NSTX vessel.
 - Design is finished, in Erik's hands.
 - Identified the need to review the NSTX-U boronization system before implementation.
 - Critical to make progress here, as it drives expectations for the LITERs
 - If no boronization, then LITERs need to be available immediately after CD-4.
 - Will be needing support for at least one of LITERs or Boronization during this outage
 - Identified the need to finish design for divertor gas injectors.
 - Tubes that run from dome ports to outer divertor bull-nose tiles (see EA-3007).
 - 2 tubes in upper, and 2 tubes in lower.
 - Dome ports for gas inlets preliminarily identified on port maps.
 - Need design/procedure for in-vessel tube runs.
 - Estimate labor at 2 days per tube (J. Desandro), based on NSTX experience.
 - Identified the desire for a 5th gas delivery system.
 - No design work yet that I am aware of.

Installation of Tubes for Divertor Gas Injection

Edge of lower outer divertor tile

Bent tube attached to a drilled in the bullnose tile

See Note 1

See Note 5

③

④

See Note 2

Vacuum

Air Side

Vacuum side

Air side

①

NOTES:

- 1) 1/4" TUBING
- 2) 1/4" TUBING
- 3) TUBING FIELD LOCATED AT
- 4) .156" TUBING
- 5) 1/4" TUBING AT 3 PLACES

5
4
3
2
1
.03
.02
.01

COMPUTER GENERATED DRAWING
MANUAL CHANGES NOT PERMITTED

DO NOT VERIFY INFORMATION BY SCALING DRAWING

SCALE= NONE

NEXT ASSEMBLY

B-EA3008

DATE	1/16/2013	BY	CU	SUB	ASSEMBLY	DATE
CHK	1/16	SUPV	JS	SHEET	1 of 1	REV

Typically field fit-ups by J. Desandro

Moly. shields from previous design likely not necessary with new bull nose tiles.

Labor Estimate For Later Table: 2 upper tubes x 2 lower tubes x 2 days = 16 man-days

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MPTS Ex-vessel Work Scope to be Completed During the Outage

- MPTS ex-vessel work on Rollover Schedule
- Major installation tasks:
 - Optics box on south wall
 - Laser input beam line and calibration probe
 - Light collection optics box
 - Laser output flight tube, turning mirrors, and beam dump
- Will require significant effort from diagnostic physicists and diagnostic and machine techs.
 - G. Labik estimates 600 hrs. for machine techs and 600 hrs. for diagnostic techs between March 15 and October 30th (from WAF).
 - Significant welding time as well (250 hrs).
- Alignment time required following installations:
 - 12 days before CS installation
 - 10 days after CS installation
 - Included in calibration time estimates
 - Will require evacuated NTC part of time; can be done on 2nd shift

Progress on Magnetics Since Review Last Spring

- Cat. 3 racks have been moved to the 118' level.
 - 4th Cat. 3 rack added
 - low-inductance ground connection.
- WAFs have been approved for the SAD-II and new integrator designs with Ed Lawson as the cognizant engineer, and these items are in the rollover schedule.
- Don McBride is working on procedure for reinstalling Cat. 4 ex-vessel flux loops
 - procedure also includes ex-vessel thermocouples.
- Desired Cat. 3 and 4 rack layouts have been presented to P. Sichta's group for comment and implementation (with my help).

Magnetics Work For Preparation for CD-4 and Initial Operations

- Prepare procedures for the items below.
- Do work in the racks.
 - Rearrange/reinstall a lot of electronics.
 - Install small signal cables from the cross-connects to those electronics.
 - Check out existing integrators for functionality.
 - Does not appear in time estimates, because it is mostly P. Sichta's group and myself, should have minimal interferences w/ other work.
- Install FO Tx/Rx between Cat.3 and Cat. 4 racks, for integrator calibrations.
 - Ed Lawson would likely do this.
- Sensor checks for isolation/continuity/mapping.
 - Includes time to put “high-n” array sensors back.
 - 14 days during calibration periods for this task.
 - Need port covers installed, field cables connected, for this job
- All this work has been given to S. Langish/T. Egebo for tracking in the rollover.

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At Least Five Discreet Sets of Diagnostics Scope Needs Design & Engineering Activity

- Mechanical Structure Diagnostics (as defined by Pete Titus).
 - No attempt to account for these in time estimates (probably are Upgrade scope).
 - Warning: potential request for additional vessel penetration.
- Alfvén Eigenmode Diagnostics
 - High-f magnetic field sensor array:
 - Assumed 15 days for installation, all in vessel.
 - TAE Antennas:
 - Assume a set of 4 antennas, for 8 days in vessel
- Lower outer divertor tile diagnostics:
 - Outer Divertor Fast (Eroding) Thermocouples:
 - 2 machine tech days in the vessel.
 - Outer Divertor Langmuir Probes:
 - Assumed 10 days in the vessel, including 4 machine tech days.
 - Shunt tiles in the outer divertor
 - Six presently sitting in the lower divertor, and 4 ready for installation.
 - Assume 2 machine tech days in vessel.
 - Magnetic sensor tiles.
 - RF sensors and potentially a prototype divertor “monolithic” sensor: 2 machine tech days.
- S-FLIP: Assumed 8 days in vessel, 2 day dedicated machine tech/tech shop labor.
- FReTip: Assumed 10 days, 2 of which in vessel

Have slides for all these at the end of this presentation.

Some Time For Installation and Calibration Has Been Placed on the Rollover Schedule

- Calibration Periods
 - Calibration Period #1: Calibrations with CS not in machine (most of the calibration).
 - Calibration Period #2: Calibrations with CS in machine.
- Installation Periods
 - Installation Period #1: Diagnostics for Calibration Period #1
 - Installation Period #2: Diagnostics For Calibration Period #2
 - Installation Period #3: Diagnostics without calibration needs
- Spreadsheet is organized into these three installation periods

Needs Updating!

Activity ID	Activity Name	Start	Finish	Original Duration	Resp	2013												2014											
						S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	
von Halle																													
1151-****-X450 NSTX Diag Ops Support																													
Diagnostic Installation & Calibration																													
2000	Installation Period #1	19-Jul-13	19-Sep-13	45	STRATTON																								
2010	Installation Period #2	20-Sep-13	03-Oct-13	10	STRATTON																								
2020	Calibration Period #1	04-Oct-13	12-Dec-13	50	STRATTON																								
2030	Installation Period #3	13-Dec-13	16-Jan-14	25	STRATTON																								
2040	CENTER STACK INSTALLATION (Lift in New Center Stack ID-1230)	17-Jan-14*	17-Jan-14	0	Strykowski																								
2050	Calibration Period #2	17-Jan-14	20-Feb-14	25	STRATTON																								
2060	Begin Machine Pumpdown (ID-1300)	25-Mar-14*	25-Mar-14	0	Strykowski																								

Process Notes

- Created a spreadsheet listing all diagnostics
 - Includes separate sheets for installations and calibrations.
 - Continually updating it to be consistent with the port map.
 - Diagnosticians have had the opportunity to view and comment on it.
- Installations
 - Expect that most diagnostics will be fairly straight-forward reinstallations.
 - Installation template agreed to between operations and Upgrade project.
 - For the most part, work to be done by physicists and diagnostic techs.
 - Diagnostics with outstanding issues discussed previously.
 - And more details available in subsequent slides.
- Calibrations
 - Mostly physicists + diagnostic techs.
 - Machine techs provide safety watch and assist with setup.
 - Exception: ~14 days of magnetic checking/repairs best done with Scott Gifford or Mike Anderson (with SPG)

Installations and Calibrations Based on Publically Available Diagnostic Spreadsheet.

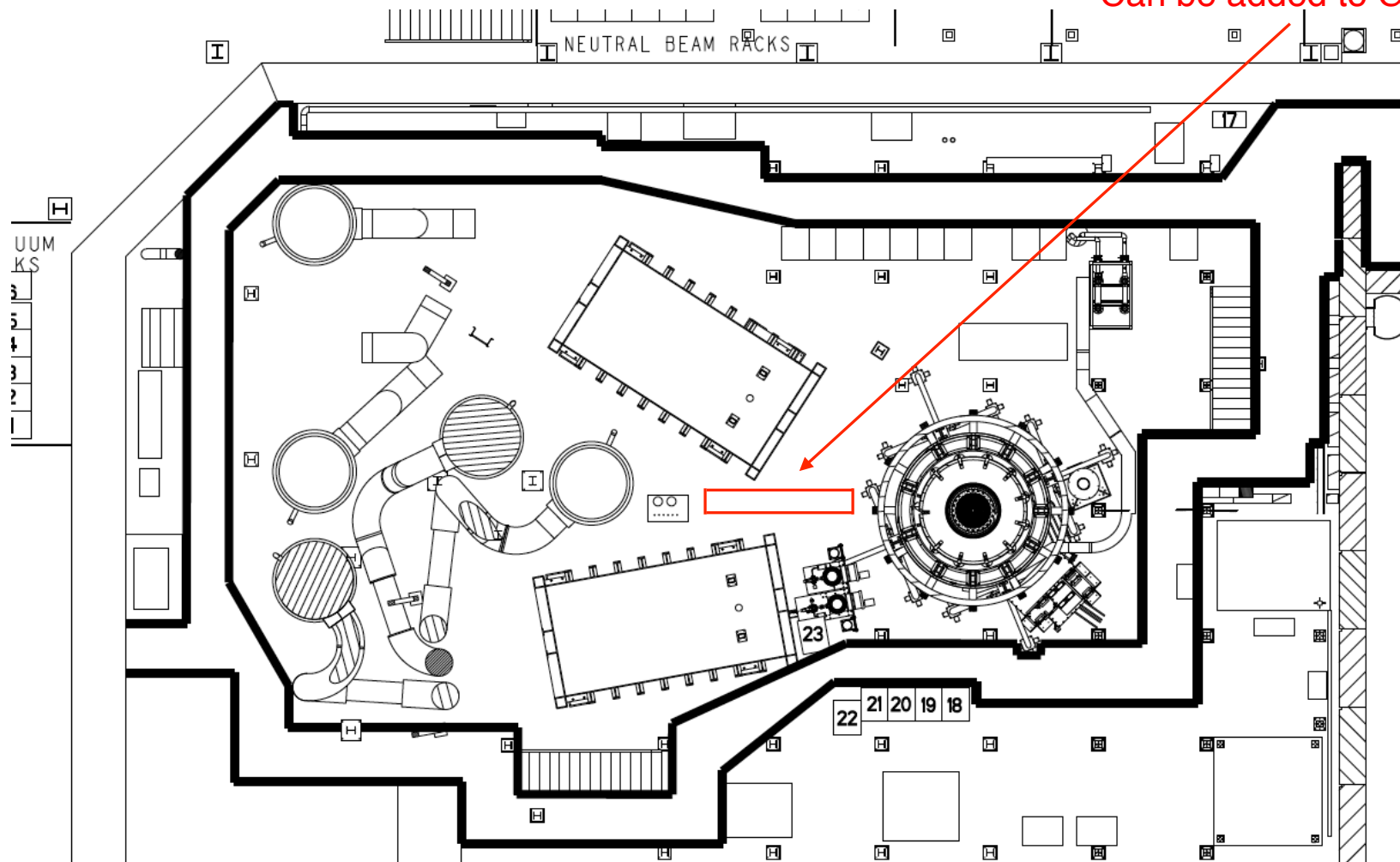
- Includes all known likely non-Upgrade scope at/near the vessel or requiring machine techs.
 - Physicist and diagnostic tech labor at the racks not included.
 - Prep. time outside of NTC not included.
- Machine techs are always capable of doing the “diagnostic tech” work.
- Lots of ways to parse this data, here is the simplest cut (1 day = 8 hrs):

Period	# of diagnostic Tech Days (typically with physicist help)	# of Machine Tech or Tech Shop Days (includes vacuum seals during installations)	In-Vessel Days (i.e. safety watch needs)
Diverter Gas Injection Tubes	0	8	8
Boronization or LITER Support	0	30 (unsubstantiated guess)	0
Bay K Modifications	0	6 holes x 3 People x 5 days = 90	<- included
MPTS Installation (from WAF)	75	107	?
Installation Period #1 (see spreadsheet)	93	28	30
Installation Period #2 (see spreadsheet)	10	3	2
Installation Period #3 (see spreadsheet)	48	13	6
Calibration Period #1 (includes magnetics and MPTS)	56	Support Tasks	Almost all In Vessel
Calibration Period #2 (includes magnetics and MPTS)	25	Support Tasks	Almost all in Vessel

FIReTip/High-k Table Needs to Find a Home on the NTC Floor

Requesting space 2' by 12' on floor, 6' tall. 2 pumps under table
“Dielectric Towers” from the structure to the VV

Proposed Location
Would this work
Can be added to GAD?



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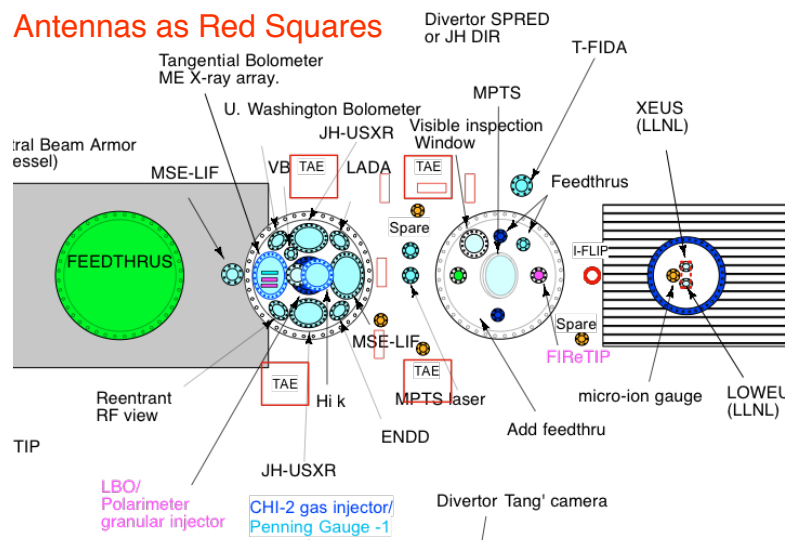
Structural Model Analysis Benchmarking

- Pete Titus has prepared a list of suggested measurements to validate the structural models used in DCPS.
 - These measurements will be important for determining the rate at which the field & current capability of NSTX-U are increased.
- Relevant items:
 - Vessel displacements in the vicinity of the J-K cap.
 - Displacements on the spoke lids.
 - Strain gauges on the TF tie-bars.
 - Strain gauges on the TF outer legs.
 - Preload on the Belleville washer stack that compresses the OH coil.
 - Accelerometer on the passive plates for force due to disruptions and sloppy plate supports.
 - Load cells in the shims at the top of the CS.
 - Views of the PF-1C casing.

TAE-Antennas

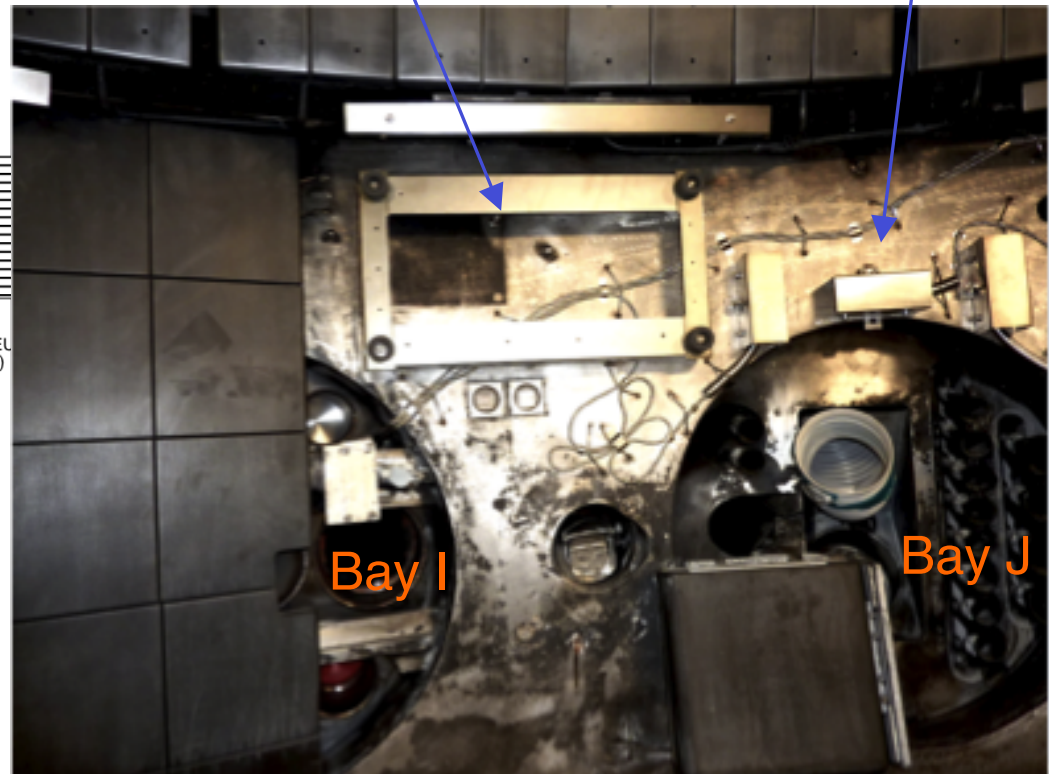
- 5 turns of ~16 gauge polyamide coated wire, behind segmented Moly shield.
- Port map shows between 4 of these loops, though a reduced # may be acceptable.

Antennas as Red Squares



Installed TAE Antenna
Previously at Bay I/J

Triplet of High-f
Coils above Bay J



- Attempt to take wires out of Bay H.
 - There are fall-back ideas.

Scope of High-f Array Reinstallation

- Two 3-coil arrays and one 8 coil array.
- Desire all the three coil sets to be at same R,Z, but separated by 90 and 180 degrees.
- Old 8-coil array disrupted by the larger bay L, vessel supports.
- Critical for energetic particle research program.

Proposed Solution

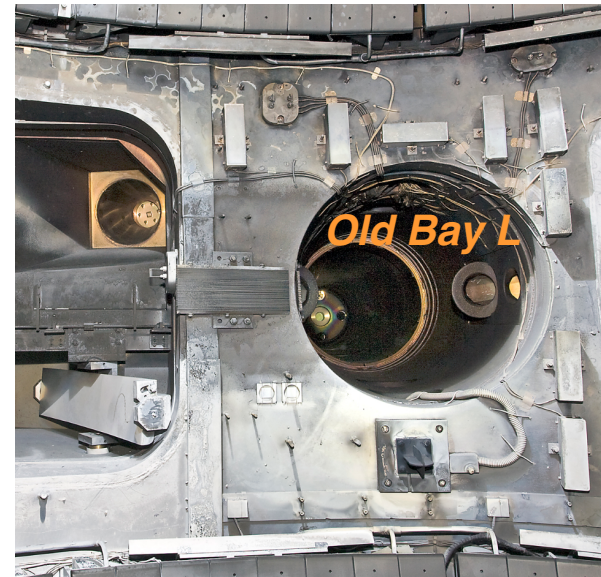
1: Propose to move 8-coil array to Bay F, wires out of Bay F

2: Hang one 3 coil array off of Bay J

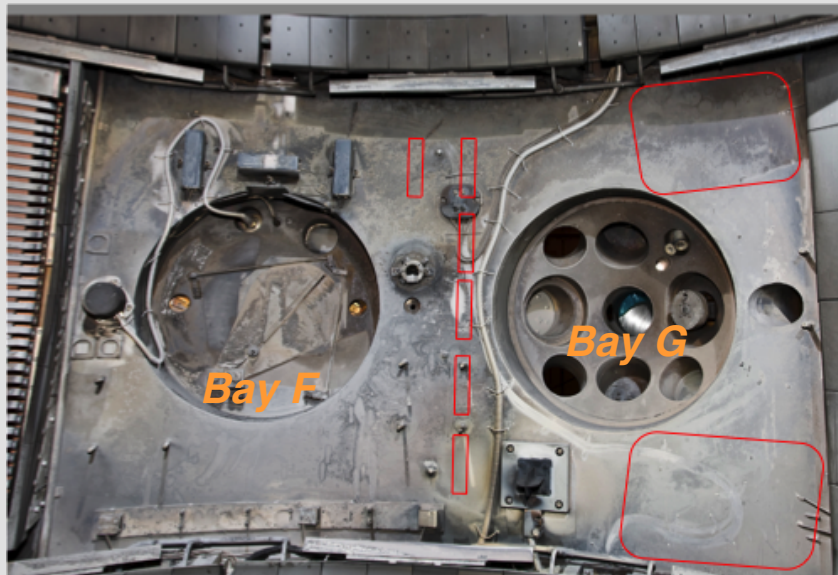
- Weld a plate to the vessel
- Mount the sensors to the plate

3: Hang other 3-coil array above Bay L

- Similar plate scheme used.

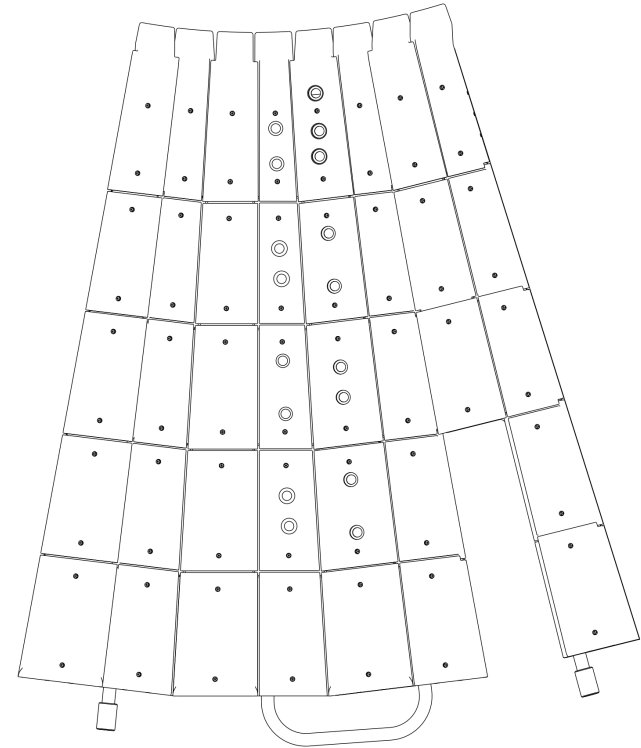


Old 8
Coil
Array



Scope of Outer Vessel Langmuir Probe Array And Eroding Thermocouples

- Preliminary design work done by Ankita.
- 17 probes langmuir probes, distributed among 8 tiles in the lower outer divertor.
 - Duplicate as best possible the inner vessel probe head design.
- Ankita to resume design under ops. funding when she returns.
- Desire from ORNL collaborators to install special “eroding” thermocouples in divertor
 - Request was for 2 in upper and 2 in lower divertor
 - Ankita did some initial design, but feasibility still uncertain.

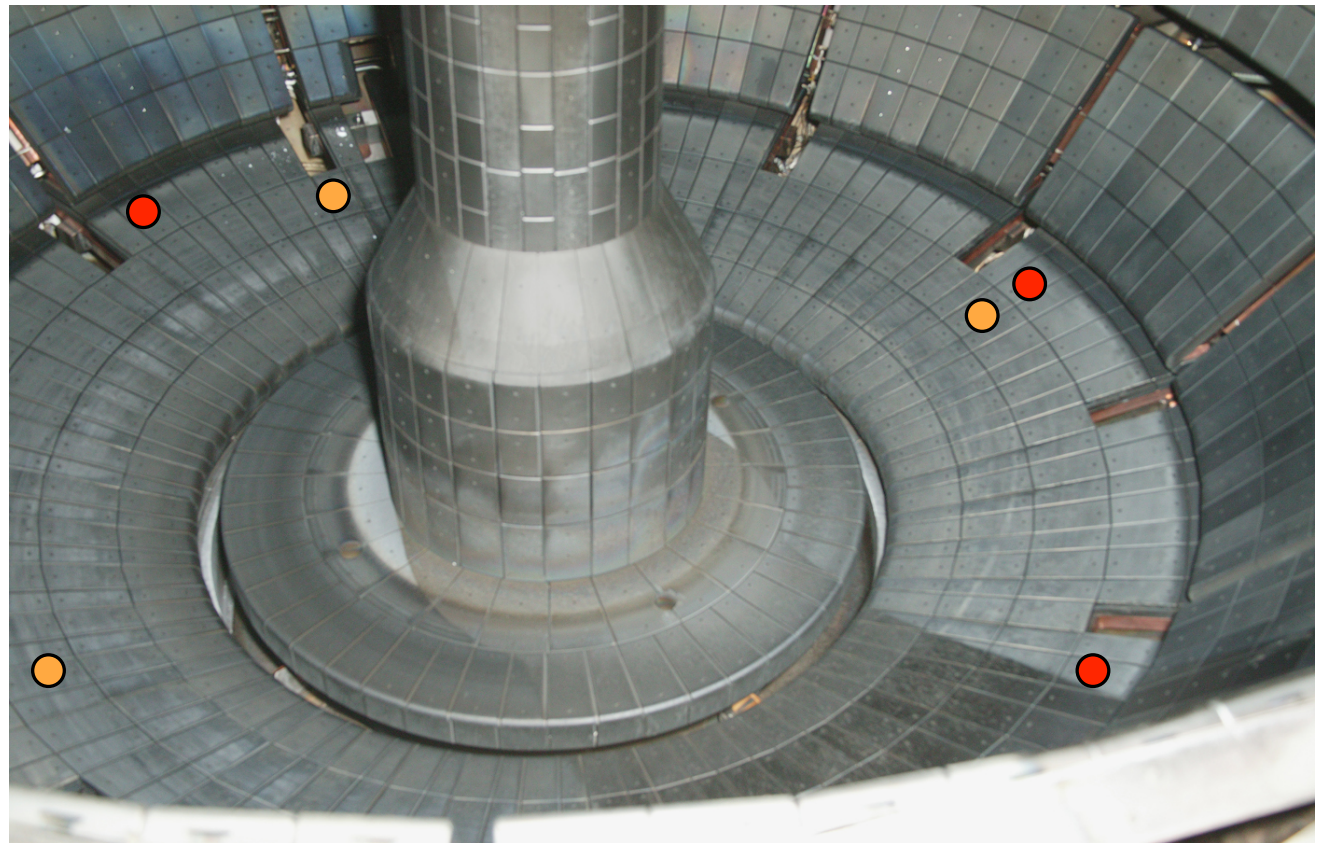


Needs:

1. Finish all drawings & define feedthrough configurations (CWDs)
2. Peer review of entire system
3. Installation procedures

Shunt Tile Diagnostics are in an Uncertain State at the Moment.

- Wires for these exited the old LLD-trees.
 - Need to find a way to get these wires out now.
 - All signal processing electronics already exist, would reside in Rack 418 at 100' level.
- Six row-4 tiles inside NSTX right now are instrumented, but have no means of getting wires out.
 - Four row-3 tiles prepared for installation are in the possession of the machine techs.

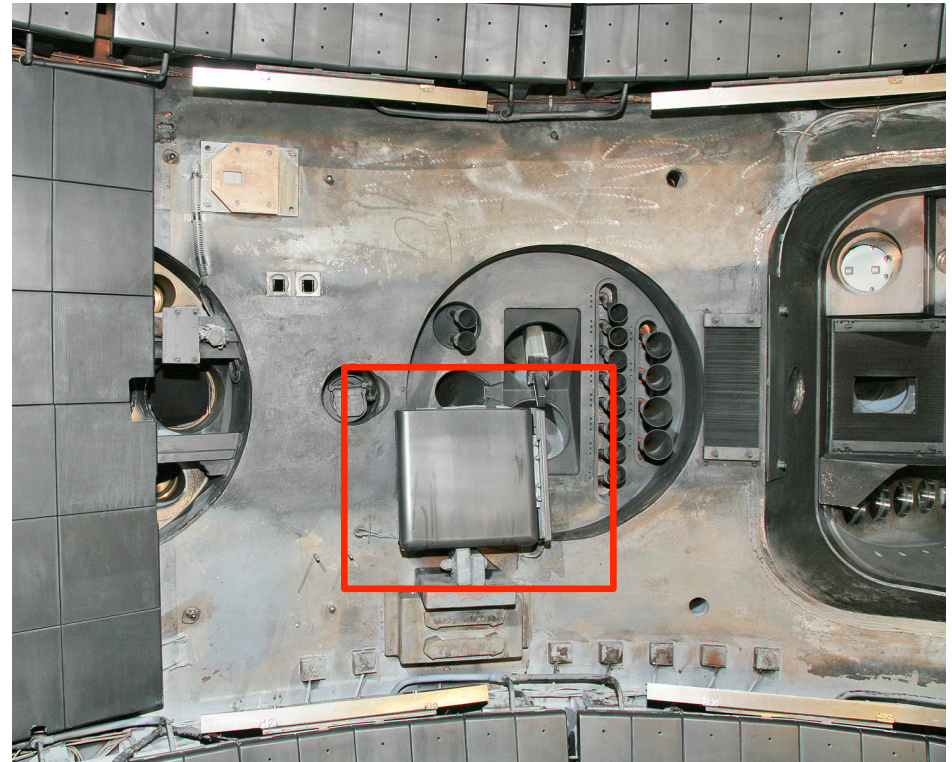


All Divertor Diagnostic Upgrades Should Be Packaged in a Common Review Process.

- Should probably handle all wiring in a common set of CWDs.
 - Thermocouples: 4 Wires
 - LPs: 34 wires
 - Shunt Tiles: 20 Wires
 - Total: $20+34+4=58$.
 - But, would not all go to the same place!
- Propose R. Kaita to oversee process (for now), with help from SPG, MJ, TG.
- What is the target schedule for accomplishing this work?

S-FLIP Diagnostic Needs Modification

- In-vessel tasks:
 - Add heaters (with redundancy) to be able to bake out graphite tile, or fabricate tile from a different material.
 - Design and install support base and fixture to hold probe at optimal angle to field lines.



- G. Labik can do engineering starting in ~2 months.
- Some ex-vessel work to be done by Diag Techs and Cog Physicist.