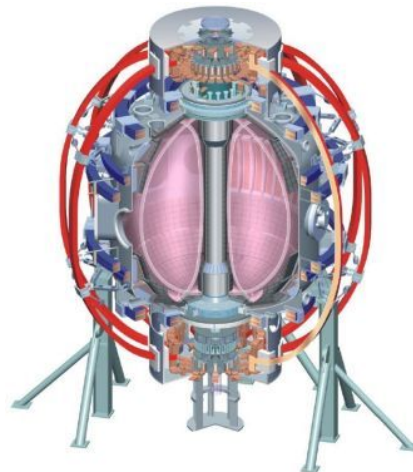


NSTX NBIU Decon Peer Review

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**Princeton Plasma Physics Laboratory
NSTX Upgrade Project
LSB DCR
April 21, 2010**



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NSTX NBIU Decon - Intro to Decon

- Introduction
- Requirements - Tritium Work
- BL Recon & Decon
- Decon Overview
- Goals & Approach
- Decon Ops in full swing
- To Do List
- Lessons Learned
- Conclusions

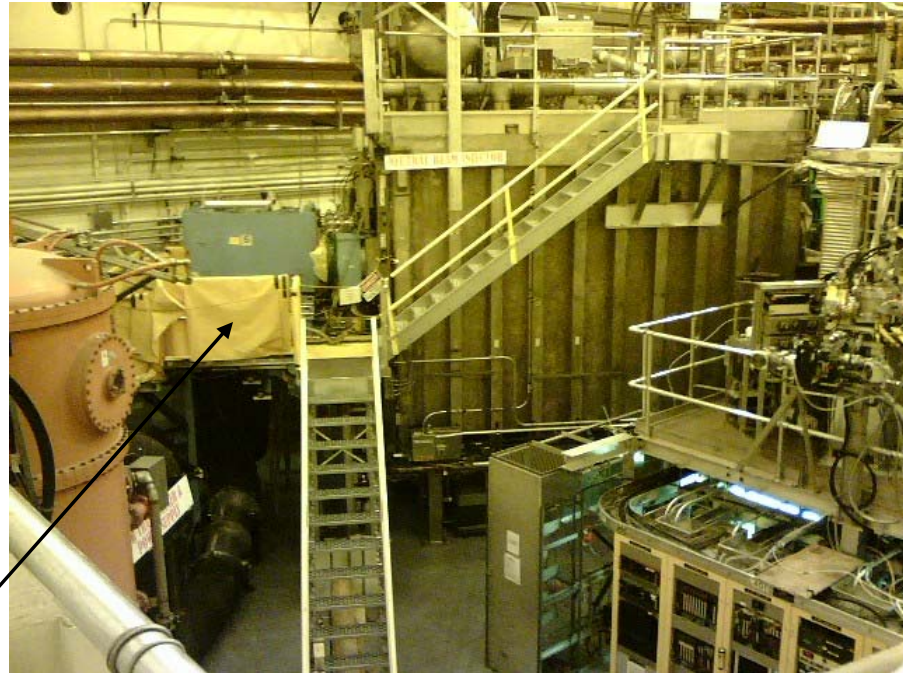
1 Curie = 3.7×10^{10} decays/sec
= 2.22×10^{12} decays/min

PPPL dose limit = 1000 mR/yr
NJ background dose = 365 mR/yr

Contamination in units of:
Decays per minute per 100 square cm.

NSTX NBIU - Tritium Work Required

- *Disassemble & evaluate a TFTR BL*
- *Decon a TFTR DT BL*
- *Refurbish BL for reuse*
- *Lift BL over wall & assemble*
- *Add second NBI & Services in NTC*
- *Connect Power & Controls*
- *Aim wider*
- *Rearrange NTC to fit*
- *Capability to run either or both*
- *NBI Power x 2 for NSTX!*



Note tritium work on BL1 from source linebreak

NSTX Beamline 1 operating since 2000

...and assess impact on future NSTX Operations.

NSTX NBIU BL Recon and Decon

Evaluation, Decontamination, & Refurbishment of TFTR BL4

- BL operating on TFTR DT campaign and shut down in 1997
- BL operated in deuterium to heat surfaces and remove tritium
- Air purged to stack for 12 years **& NOW OPEN TO AIR FOR 1 YEAR.**
- Sampled in 1997 and 1998 to determine feasibility of decon - **airborne and surface levels OK**
- Pump and purge BL - **done**
- Remove calorimeter, dump, magnet, and 90 inch flange - **done**
- Remove lid and panels and place in stand - **done**
- Evaluate for reuse - **BL and components are in very good shape - done.**
- Decon calorimeter, dump, magnet, 90 inch flange, lid, box **<=== 90% done.**
- Replace full energy ion dump copper plate **<=== disassembly started.**
- Upgrade Calorimeter - **new double bellows design in the works.**
- Refurbish seals and TCs
- Leakcheck
- Move each piece to NTC South High Bay and into NTC
- Reassemble BL

Note: HP & ERWM required for duration of project and into future NSTX operations just as they are now...

Decon Overview

- *Tritium Decon a function of:*
 - *contamination levels (high)*
 - *imbedded tritium from beam (some)*
 - *contaminated carbon from TFTR tiles*
 - *surface area (huge)*
 - *surface type (various)*
 - *accessibility (good to terrible)*
 - *techniques (several)*
 - *dose (zero is good)*
 - *ERWM issues*
 - *Other...*



Decon Sprayer in use...

$$F(d) = \{ T, \text{NBI } T, T_c, SA, \text{Matl, Access, Tech, mR, ERWM, ...} \}$$

NSTX NBIU Decon

Decon Goals and Approach

- **Goals - tear it down and clean it**
 - **evaluate BL & components**
 - **prepare for refurbishment**
 - **minimize dose**
 - **minimize rad waste**
 - **reduce levels as low as reasonably achievable**
- **Approach - hands on work**
 - **boots, PC suits, gloves, hoods**
 - **rags, swiffer poles, sprayers**
 - **H2O2, Windex, swiffer pads, DI water**
 - **repeated comprehensive HP surveys to control areas and assess progress**
 - **extensive support by ERWM to provide supplies and manage rad waste**



“Jack, you missed a spot...”

NBI Decon in progress...

- *BL has been fully disassembled*
- *HP Surveys done regularly*
- *Levels in range of PPPL experience*
- *Progress has been steady - levels decreasing*
- *Uptakes have been detectable but very low*
- *Goal: minimize impact on NSTX maintenance*
- *All still true after one full year of Decon Ops...*



Lid and cryo panels sitting in new stand



BL4 Magnet and 90 inch flange



Calorimeter decon in progress...

Decon Ops

RWP postings

Dehumidifier and HVAC

Stack

PC Suits & PPE

The Beam Team

TC Crane

*Rigging
Equipment*



*Breathable
air hoods*

*Rags and
cleaning
supplies*

Ladders

*Daily area
maintenance*

Rad Waste & Laundry

HP supplies

Decon crews, HP, HVAC, & ERWM worked as a team to perform daily decontamination

Decon Ops - a typical Decon day

- a.m.
- *TC survey - open for business, dehumidifier ON, stack OK, TC cool!*
 - *Area maintenance if required. Load up on supplies.*
 - *Bioassays performed and analyzed*
 - *Crews suit up for Decon Ops*
 - *Breathable Air systems ON*
 - *Hoods ON*
 - *High contamination entry*
 - *Decon Ops (1-2 hours)*
 - *Crews exit High contamination areas*
 - *HP and crews collect and package trash and laundry as necessary*
 - *HP surveys of crews upon exit*
 - *Crews cleared to leave TC*
- p.m.
- *Low level decon, processing of trash & laundry, area maintenance*
 - *Surveys of beam equipment, TC floor and areas, water, air, etc...*
 - *HP regulatory compliance paperwork*
 - *ERWM pickup of rad waste, laundry, parts for storage or shipment*
 - *Solidification of DI effluent water in drums and drum removal for shipment*

& Saturdays...

Like clockwork...

NSTX NBIU Decon - *Decon Ops in full swing*



Multiple stations & crews... and a lot to survey afterwards!

NSTX NBIU Decon - *Decon Ops in full swing*



We make this look good...



...and we make this look good too!

NSTX NBIU Decon - *Decon Ops in full swing*



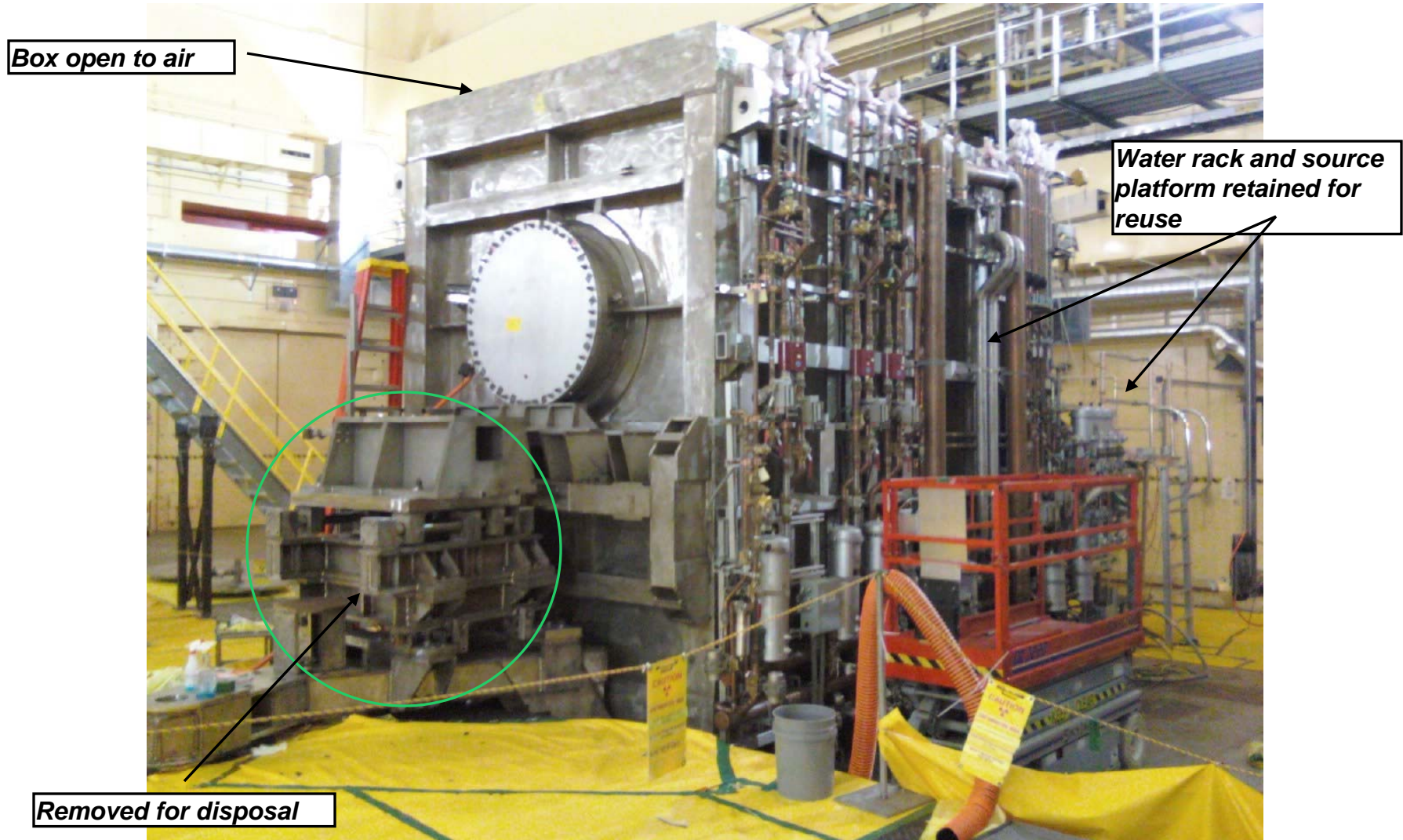
Double suits, triple boots and gloves, hoods, and lots of duct tape...

NSTX NBIU Decon - *Decon Ops in full swing*



Hoods work well - cooler & cleaner while permitting work in close quarters...

NSTX NBIU Decon - *Decon Ops in full swing*



NSTX NBIU Decon - *Decon Ops in full swing*



*Decon of BL Exit Flange
Internal Surfaces!*



NSTX NBIU Decon - *Decon Ops in full swing*



*Large DI water sprayer very effective for large surface areas.
Decon used about 25 gallons per day collecting on floor of BL.
DI water drained off with pump to drums for HP survey and ERWM solidification.*

NSTX NBIU Decon - *Decon Ops in full swing*



Rechargeable sprayer rig with 25 gallon DI water tank

NSTX NBIU Decon - *Decon Ops in full swing*



Hoods made BL entry possible and safe for decon wipedowns after use of sprayer

NSTX NBIU Decon - *Decon Ops in full swing*



Just another decon day at the office... with a million dpm all around.

NSTX NBIU Decon - *Decon Ops in full swing*



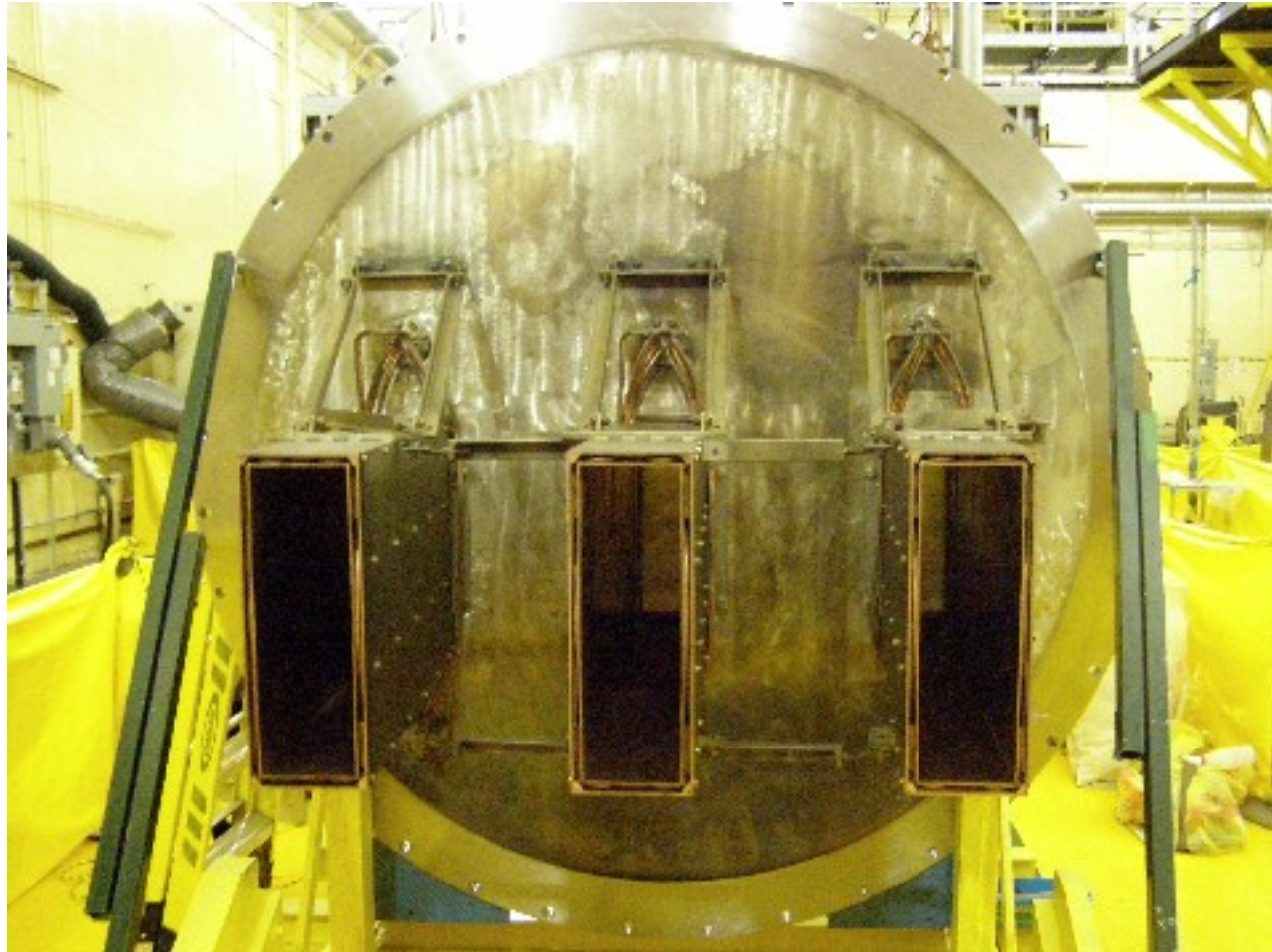
“Are you sure John turned on my air supply?”

NSTX NBIU Decon - *Decon Ops in full swing*



90 inch flange with OMA and SIVs, Magnet shield yoke, and Bending Magnet...

NSTX NBIU Decon - *Decon Ops in full swing*



Neutralizers

NBI BL2 Upgrade Refurbishment - Ion Dump



• *Full energy ion dump*

• *Half energy ion dump*

• *Third energy ion dump*

NSTX NBIU Decon - *Decon Ops in full swing*



Ion Dump - louvers removed for decon in fume hoods

NSTX NBIU Decon - *Decon Ops in full swing*



Ion dump with back shields removed for better access

NSTX NBIU Decon - *Decon Ops in full swing*



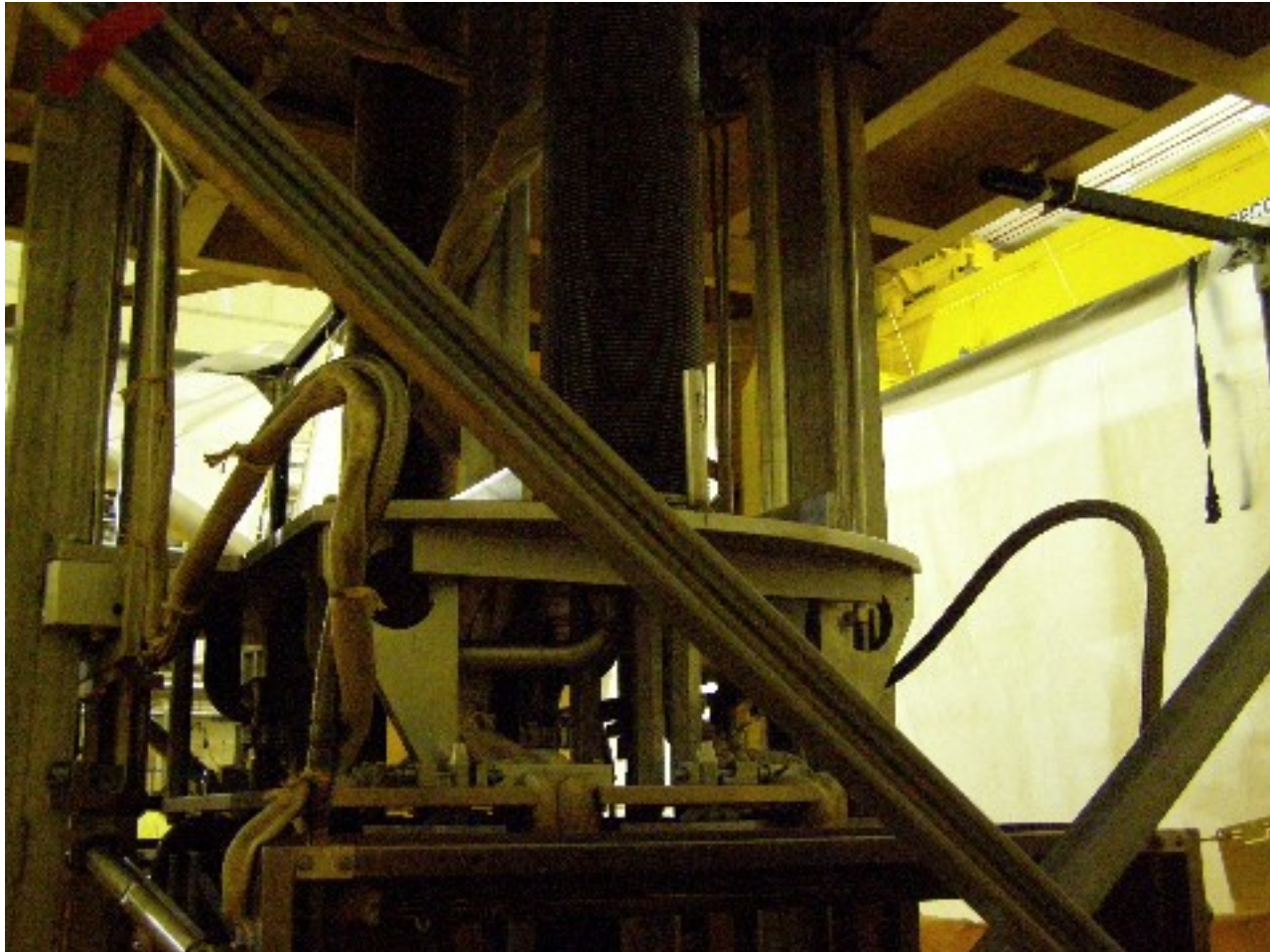
“Seriously, you did want us to take it apart, didn’t you John?”

NSTX NBIU Decon - *Decon Ops in full swing*



Calorimeter with shields removed for better access...

NSTX NBIU Decon - *Decon Ops in full swing*



Upper calorimeter view - bellows will need to be replaced or upgraded to double bellows design

NSTX NBIU Decon - *Decon To Do List*

- *BL Lid LN chevrons - exit end could use some additional sprayer decon*
- *Box floor and exit end still coming down*
- *Ion Dump louvers in fume hoods for decon detailing*
- *Calorimeter Vee decon w/ sprayers could remove some hidden carbon*
- *Area maintenance - ongoing*
- *Trash and laundry removals*
- *DI water ERWM processing*
- *Weekly surveys of TC*

Time to move on to BL refurbishment tasks...

NSTX NBIU Decon - *Results...*

Survey Results

Collected by: R. Hitchner

Analysis by: C. Gentile

NSTX NBIU Decon - *Decon Ops Lessons Learned*

- *Well coordinated HP and ERWM support is vital to make progress (THANKS EVERYONE!)*
- *PC suits and supplies are consumed rapidly and could hold up the job... but didn't!*
- *With double suits it was critical for HVAC to hold TC @ 65 degrees (dose goes up with sweat)*
- *Hoods were cooler so dehydration reduced*
- *Hoods increased efficiency with use of sprayers*
- *Hoods allowed more access under lid and inside box*
- *If breathing air came from outside the TC the hoods reduced our already miniscule dose*
- *ERWM involvement during all phases of job avoided waste disposal problems*
- *The HVAC Dehumidifier was critical in maintaining areas at low levels*

- *Well integrated HP support:*
 - ✓ *posted RWP areas and requirements*
 - ✓ *protected workers*
 - ✓ *avoided regulatory problems*
 - ✓ *increased productivity*
 - ✓ *improved efficiency*
 - ✓ *produced data to assess progress...*



NSTX NBIU Decon - *Decon Ops Conclusions*

- *Assessment of results and extrapolation to NSTXU Operations in the future:*

$$F(d) = \{ T, \text{NBI } T, T_c, SA, \text{Matl, Access, Tech, mR, ERWM, ...} \}$$

- *Initial contamination was 10 million to 100 million dpm / 100 cm²*
- *Current levels have been greatly reduced. Most of the carbon dust is gone... except maybe calorimeter vees*
- *Full energy dump can be removed and replaced to eliminate a possible NBI T source term*
- *Contamination has been reduced one to two order of magnitude on average*
- *Approximately 90-95% of SA has received some form of decon and 100% has been air purged for > 13 years*
- *NSTXU will install BL in three years - more decay and air decon until then*
- *NSTXU daily operations will pump and purge the vessel every shot during a run period*
- *The NBI is the VV pump so T will be pumped by BL and regened away to stack*
- *The NBI will not inject T into NSTXU (TFTR NB OMA data supports this.)*

- *At present, NSTX NBI data after a run suggests a significant drop off from NBI to VV.*
- *Any survey over 1000 dpm/ 100 cm² will require RWP, and suits and gloves*
- *Some contamination after a run very likely but amelioration possible prior to VV entry*

- *NJ background 365 mR per year so about 1 mR per day.*
- *Decon highest total dose per individual is less 18 mR for the year or .05 mR per day*
- *Decon average total is 9 mR for the year and average individual is .025 mR/day.*

Down low...

NSTX NBIU Decon - *Decon Ops Conclusions*

- *Assessment of results and extrapolation to NSTXU Operations in the future: good to go*
- *Given 1000 dpm to 100k dpm / 100 cm² levels, RWP, PCs, and gloves likely but almost no impact*
- *Higher levels are possible, our proven decon techniques in use now will work for NSTXU maintenance*
- *VV entry may require additional air purge time in addition to that required to passivate Lithium*
- *VV may require floor drains if sprayers are used to wash down surfaces prior to entry*
- *VV entry may require PC suits and gloves instead of Tyvec coveralls used now*
- *VV entry may need additional HP coverage*
- *NSTXU will need more coverage to survey items leaving the VV and NTC*
- *NSTXU Ops will need additional HP coverage from that of today due to Tritium NBI*
- *NSTXU NBI Calorimeter and TIV maintenance will require PCs*
- *The NB Decon Facility will need more fumehoods to handle diagnostics and other items for reuse*
- *Activation from neutrons may have a significant effect on operations and maintenance anyway...*
- *Some additional cost to the project for NBI and perhaps VV maintenance (approx. 500k)*
- *Some additional schedule required for outages (on order 1 week extra)*

We can do this... and do it safely and well.

NSTX NBIU 2013

EXIT

Schedule

Decon done	2010
Refurbishment	2011-12
Relocation	2013
Reassembly	2014
Resume NBI Ops	Yes

