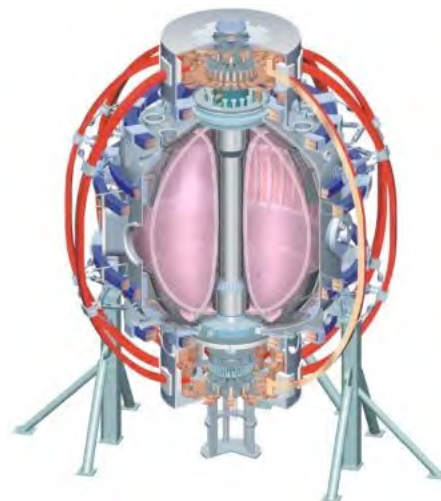


# NSTX NBIU Power System & Controls

**Timothy N. Stevenson**

**NSTX Upgrade Project  
Preliminary Design Review  
LSB B318  
June 23, 2010**



*College W&M  
Colorado Sch Mines  
Columbia U  
CompX  
General Atomics  
INEL  
Johns Hopkins U  
LANL  
LLNL  
Lodestar  
MIT  
Nova Photonics  
New York U  
Old Dominion U  
ORNL  
PPPL  
PSI  
Princeton U  
Purdue U  
SNL  
Think Tank, Inc.  
UC Davis  
UC Irvine  
UCLA  
UCSD  
U Colorado  
U Illinois  
U Maryland  
U Rochester  
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U Wisconsin*

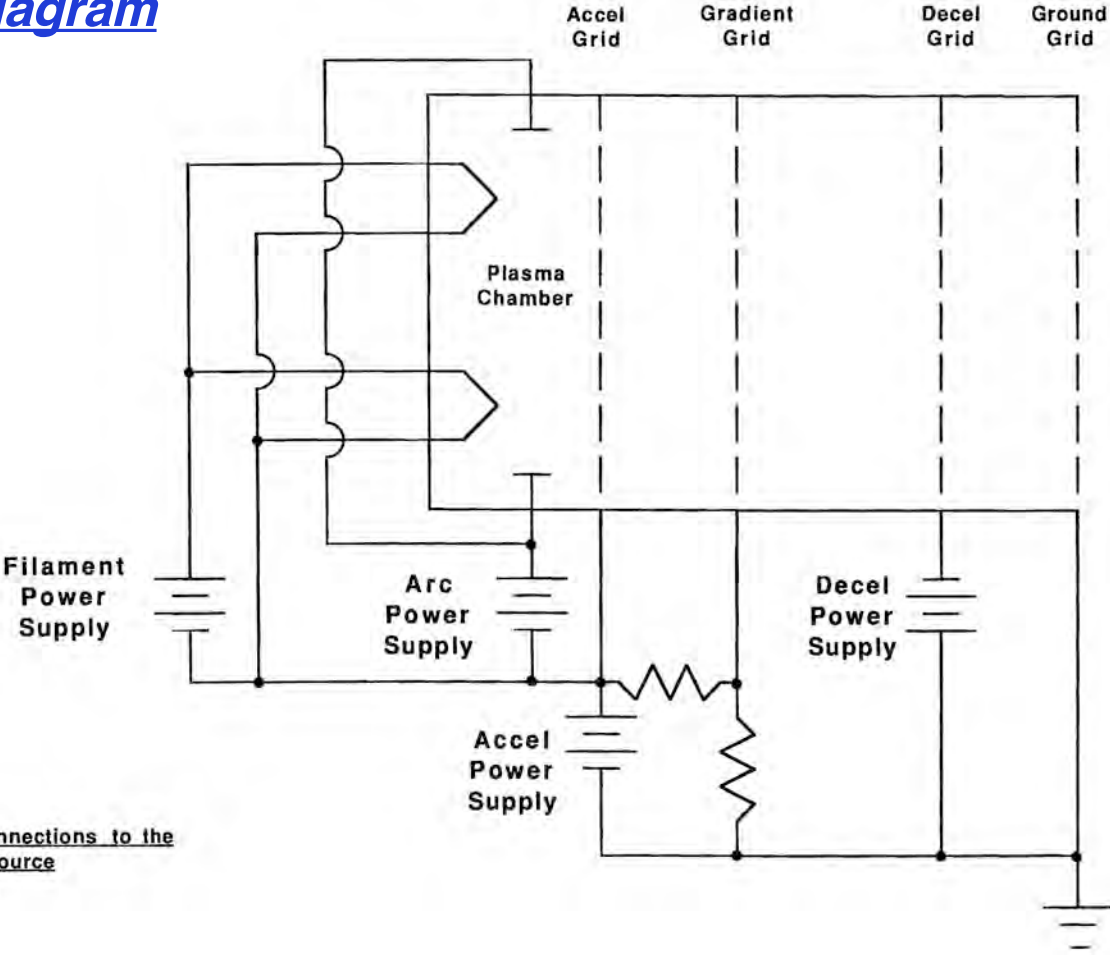
*Culham Sci Ctr  
U St. Andrews  
York U  
Chubu U  
Fukui U  
Hiroshima U  
Hyogo U  
Kyoto U  
Kyushu U  
Kyushu Tokai U  
NIFS  
Niigata U  
U Tokyo  
JAEA  
Hebrew U  
Ioffe Inst  
RRC Kurchatov Inst  
TRINITY  
KBSI  
KAIST  
POSTECH  
ASIPP  
ENEA, Frascati  
CEA, Cadarache  
IPP, Jülich  
IPP, Garching  
ASCR, Czech Rep  
U Quebec*

# NSTX NBIU Power & Controls - Introduction

- *Update on the NBI Power System*
- *Work Scope to connect N4 NBPS ABC to BL2 ion sources*
- *Procurements*
- *Routing and Installation*
- *Grounding*
- *Update on the NBI Controls*
- *Work Scope to control NBI BL2 and inject NBI into NSTX plasma*
- *Conclusion*

# NSTX NBIU Power & Controls - Battery Diagram

## NBI Source Battery Diagram



Power Supply Connections to the Long Pulse Ion Source  
TNS-11/03/88

# NSTX NBIU Power & Controls - NBPS

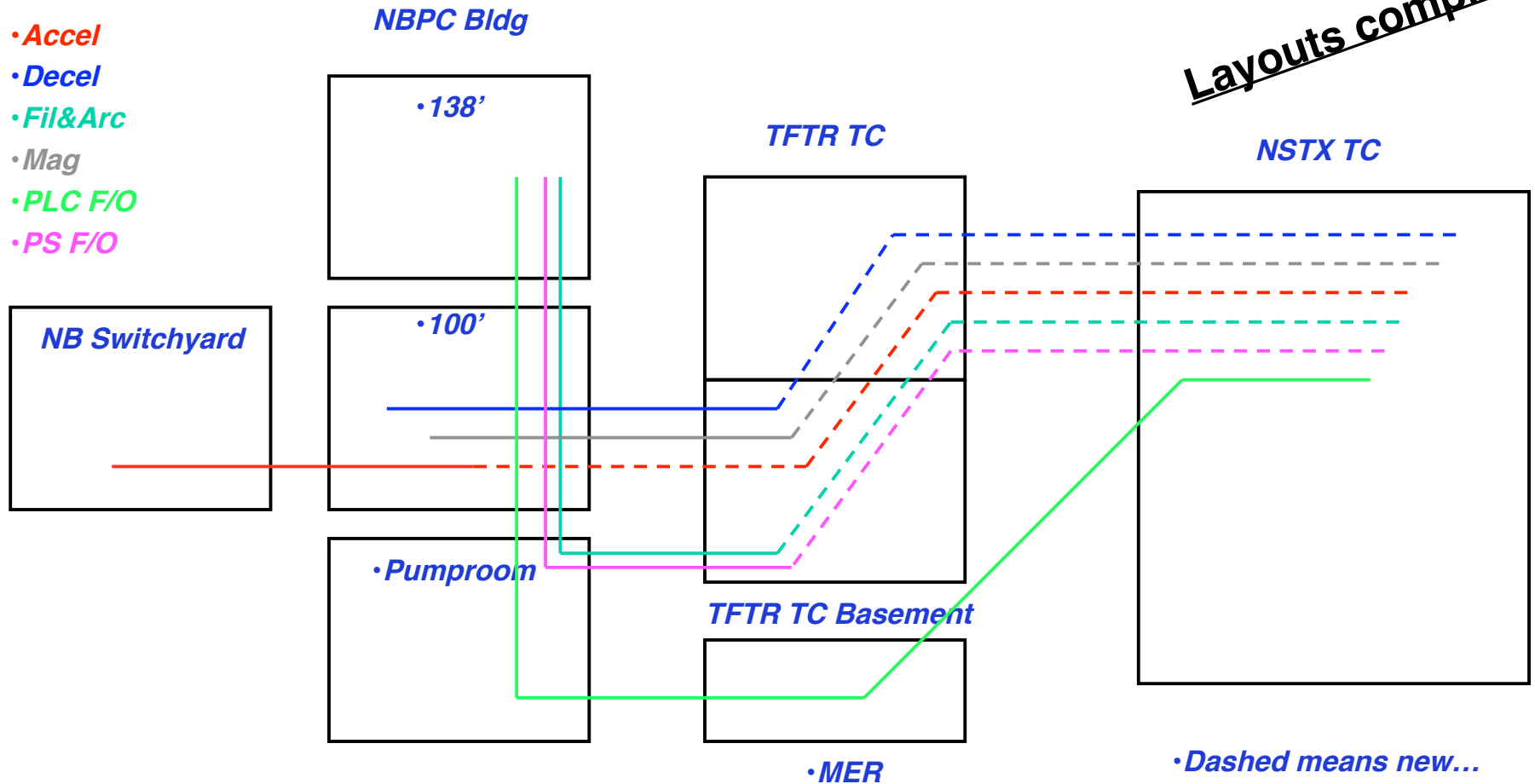
## *Neutral Beam Power System Work Scope*

- Same design as original power systems but updated to present BL1 configuration
- Recommission N4 power systems A,B, & C (all still available):
  - } Accel (with some new electronics in Surge Room & Mod/Reg)
  - } Grad Grid (build new air cooled resistive dividers per BL1 design)
  - } Decel (with new tube control and regulator electronics)
  - } Arc
  - } Filament
  - } Bending Magnet
- Run both beamlines from MG set for 13.8 kV feed (same as we did on TFTR)
  - adding remotely controlled motorized actuation to 13.8 kV switches
- Reuse existing N4 Arc and Filament low voltage cabling to TFTR TC Basement as is
- Add junction boxes and route new cables from TCB through TC to NTC
- Move N4 HVEs from TCB to NTC
- Reuse transmission lines with clamshell arrangement in NTC (like BL1)
- Reuse existing telemetry and fiber optic cables salvaged from TFTR
- Reuse existing NBPS Deionized Water Skids in the pump room (still attached)

# NSTX NBIU Power & Controls - Road Map

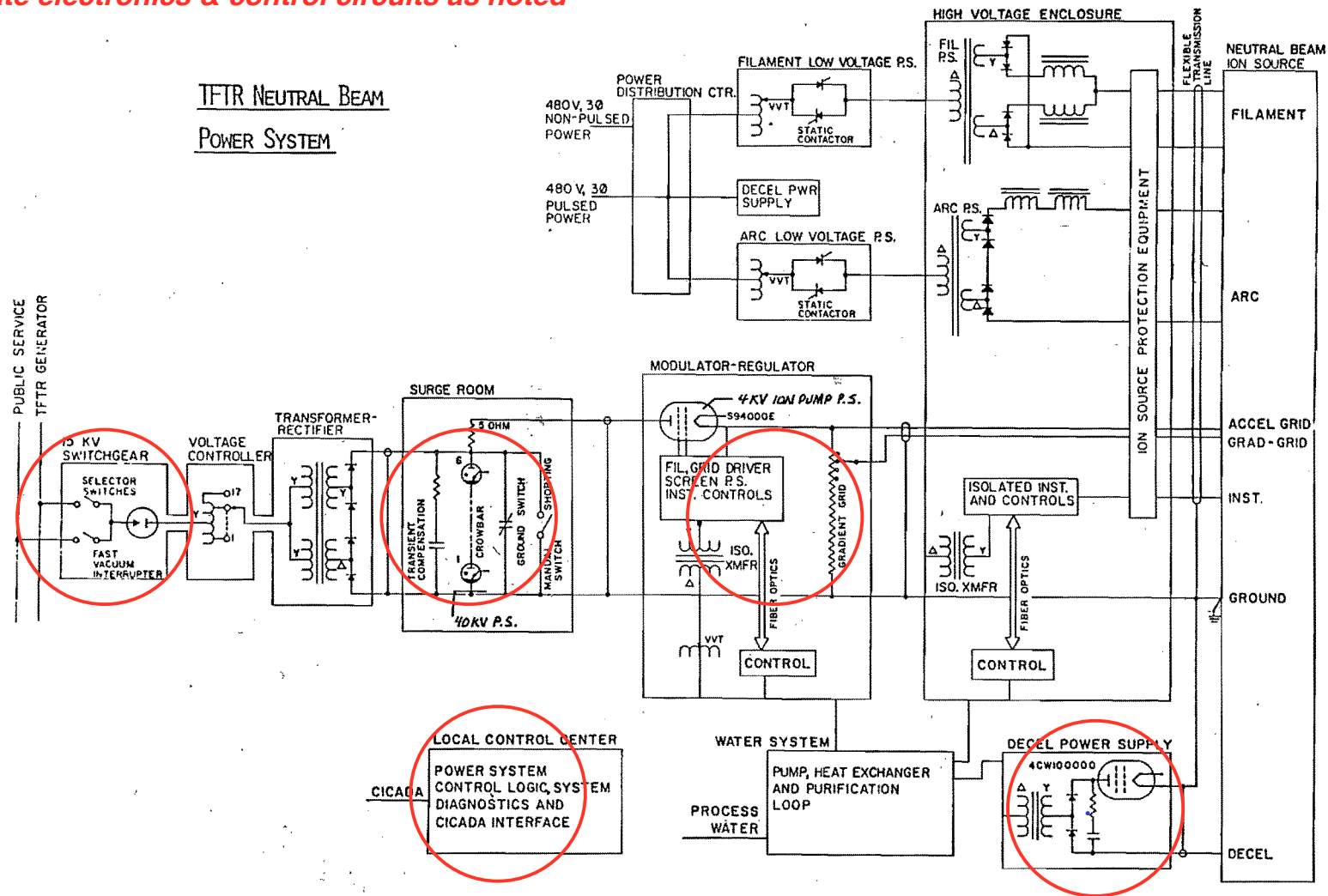
*Routing, Penetrations, draft Installation Procedures done*

**CONFIRMED**  
**&**  
**Layouts completed**



# NSTX NBIU Power & Controls - One Line Diagram

Update electronics & control circuits as noted



NBI NBPS One Line Diagram

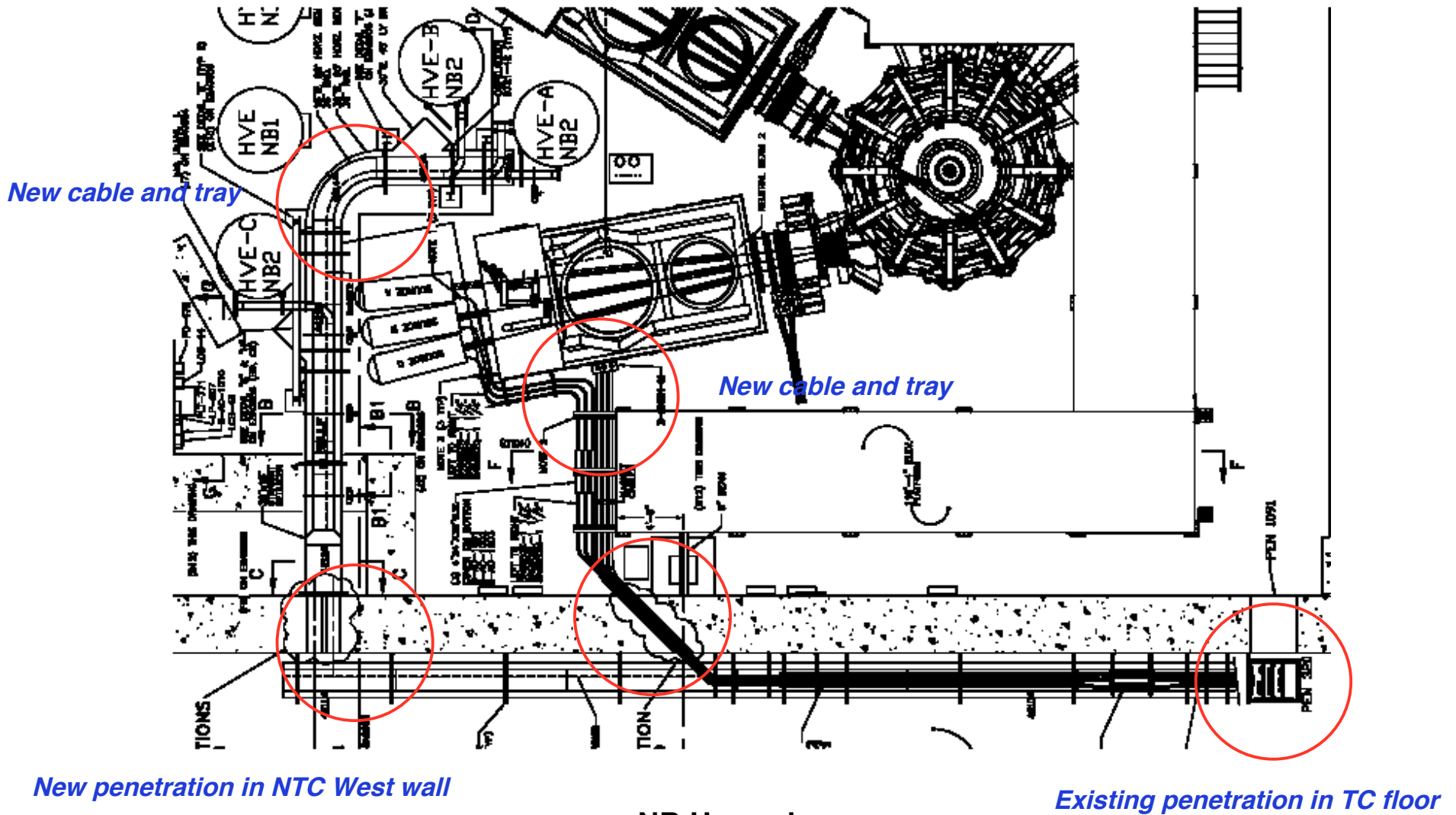
# NSTX NBIU Power & Controls - NBPS N4 available

*N4  
XFMRs*



*NBI NBPS Switchgear and Transformers*

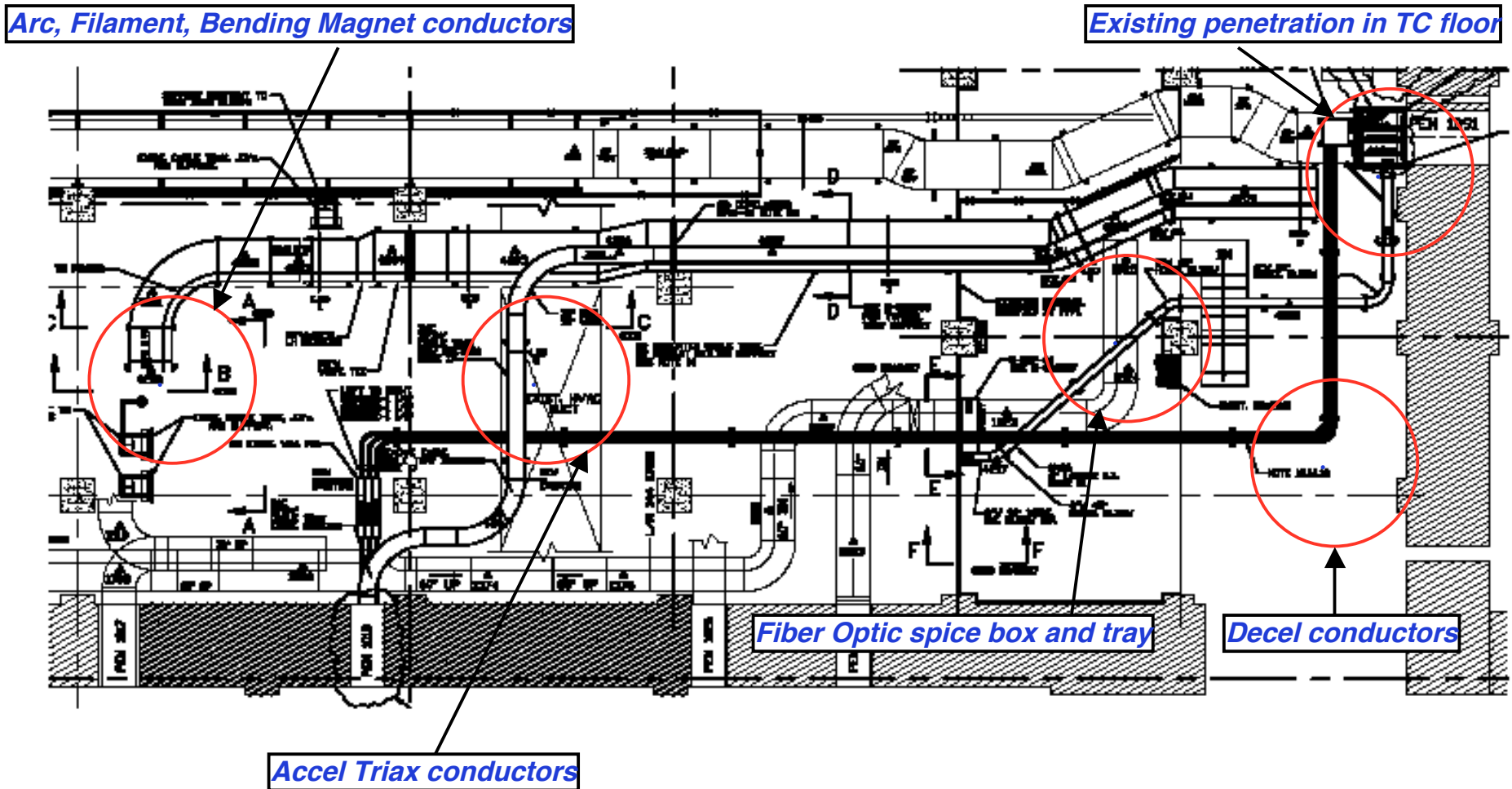
# NSTX NBIU Power & Controls - Layouts complete



**NB Upgrade  
Tray layout in NSTX Test Cell**

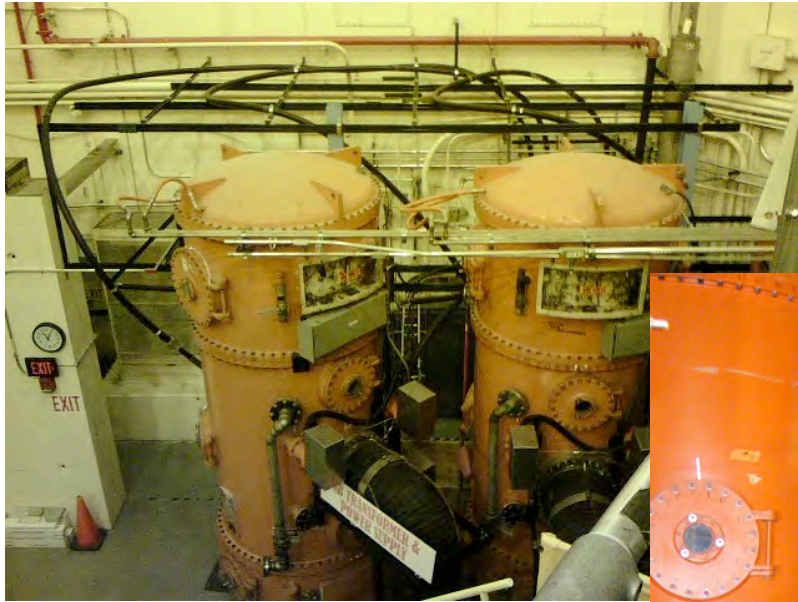


# NSTX NBIU Power & Controls - Layouts complete



NB Upgrade  
Tray Layout TFTR Test Cell Basement

# NSTX NBIU Power & Controls - HVEs & Xmsn Lines



*BL1 HVEs and Triax*



*BL1 Xmsn lines*



*Saving N4 Xmsn line for reuse*

- *HVE internal circuits disconnected.*
- *Ready for removal from TCB and relocation to NTC.*

# NSTX NBIU Power & Controls - New Cable

## Procurements required are standard items for NBPS Operations and Maintenance

- **NEW TRIAX CABLE TO BE PROCURED FOR ACCEL - long lead item**
  - **SOW TO BE ISSUED FOR PROCUREMENT**
    - SUPPLYING THE CABLE
    - TERMINATING AND TESTING THE CABLE
- **NEW 600V 4/C-500 MCM CABLES TO BE PROCURED FOR ARC/FILAMENT/MAGNET**
- **COAXIAL CABLE RG218U FOR DECEL TO BE PROCURED**
- **PARTS FOR GRADIENT GRID RESISTORS & HARDWARE TO BE ORDERED**
- **CABLE TRAY**

*Nothing unusual...*

# NSTX NBIU Power & Controls

- **TOTAL CABLES TO BE INSTALLED**
  - THREE TRIAX CABLES – PROJECTED LENGTHS 300\*3 FEET
  - THREE CABLES 600V 4C/500MCM & GRD WIRE - ARC
  - THREE CABLES 600V 4C/500MCM & GRD WIRE - FILAMENT
  - THREE CABLES 600V 4C/500MCM & GRD WIRE – MAGNET\*
    - \*STANDARDIZE THE CABLES FOR EASE OF PROCUREMENT
  - THREE CABLES 600V 4C/#8 & GRD WIRE – 208V FEED
  - THREE COAXIAL CABLES RG218U FOR DECEL
  - ALL POWER CABLES OF ARMORED CONSTRUCTION
  - FIBER-OPTIC CABLES
    - 6 CABLES WITH 8 FIBERS FOR EACH HVE – TOTAL 18 FOR HVEs
- **ROUTING PROPOSED**
  - ROUTE ALL CABLES VIA TFTR TEST CELL BASEMENT, TFTR TEST CELL AND ON TO NSTX TEST CELL VIA PENETRATIONS
- **INSTALL THE TRANSMISSION LINES**
- **INSTALL AUXILLIARY POWER CIRCUITS**

**SAME**

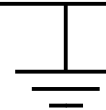
*Routing and Installation well known and ready to go...*

# NSTX NBIU Power & Controls

*NBI Grounding scheme will conform to TFTR and NSTX design and operating experience*

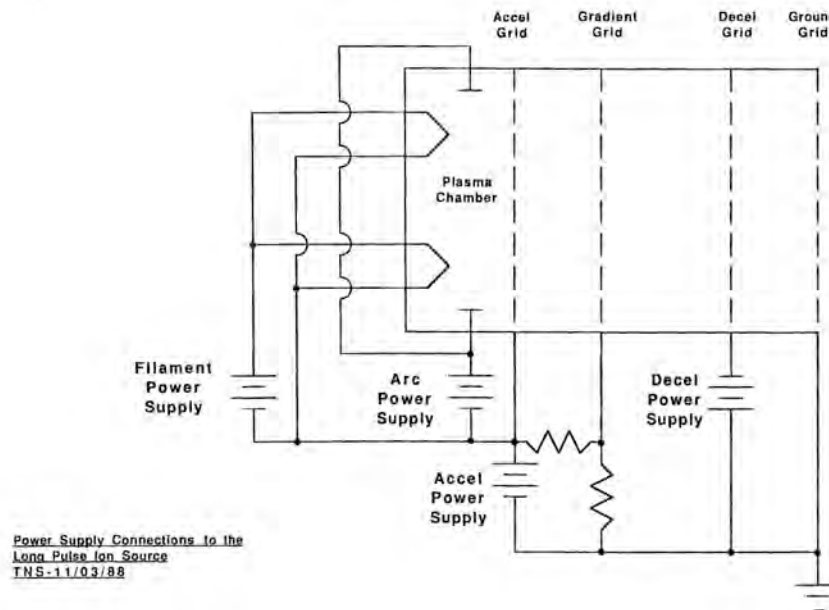
**SAME**

- **GROUNDING BASED ON SINGLE POINT PRINCIPLE**
- **PROVIDE 24"X18"X3/8" CU PLATE ON INSULATORS IN WEST WALL NTC**
- **CONNECT THE 500 KCMIL GROUND WIRES (FROM 2 TRAYS) TO PLATE**
- **CONNECT PLATE TO BUILDING STEEL VIA THE EXISTING TFTR TEST CELL GROUND.**
- **BEAMBOX WITH STAND TO BE INSULATED FROM FLOOR – DOUBLE BREAK**
- **TRIAx RETURN (HVE) TO BE CONNECTED TO THE SOURCE BOX PER EXISTING SCHEME**
- **PROVIDE GROUND WIRE AROUND TRANSMISSION LINE – CONNECT THIS TO THE PLATE**
- **CONNECT SOURCE BOX TO GROUND VIA THE GROUND WIRE AROUND THE TRANSMISSION LINE**
- **RUN GROUND WIRE FROM EACH HVE TO THE GROUND PLATE**
- **CONNECT THE ARMOR OF EACH TRIAX TO THE HVE IN NTC**
- **CONNECT THE ARMOR OF EACH TRIAX TO MODREG GROUND IN NBPC**
- **CONNECT HVE SEGMENTS WITH GROUND JUMPERS**
- **FOR TESTING THE GROUND WIRE CAN BE DISCONNECTED FROM GROUND PLATE AND THEN TESTED**



# NSTX NBIU Power System - Status

- *All electrical design work for installation purposes has been completed*
- *Routing of cables has been optimized to meet the requirements*
- *Penetrations required have been identified and shown in drawings*
- *All installation drawings for raceways and cables have been completed*
- *Draft installation procedures with Bill of Materials have been prepared*



# NSTX NBIU Controls

## *Neutral Beam Injection Control System*

*Work Scope very similar to BL1 with updates to current status*

- Mimic existing NSTX BL1 Control scheme for BL2 but move NTC racks
- Reactivate N4 Local Control Centers, CAMAC, Hardwired Interlock System
- Turn BL2 Plasma Current Interlocks on (chassis still in use for BL1)
- Add additional plasma interlock to prevent long pulse into armor- Ip & IpR
- Expand I/O for PLC control of BL and Services but use existing PLC
- Expand Thermocouple Scanning System to include BL2 & the ARMOR
- Fold BL2 into EPICS & timing pages
- Update NBOS LabView Operator interface so existing staff can run 2 BLs
- Pyrometer not yet feasible... no sight lines so tile upgrade to take the heat.  
(still under consideration.)

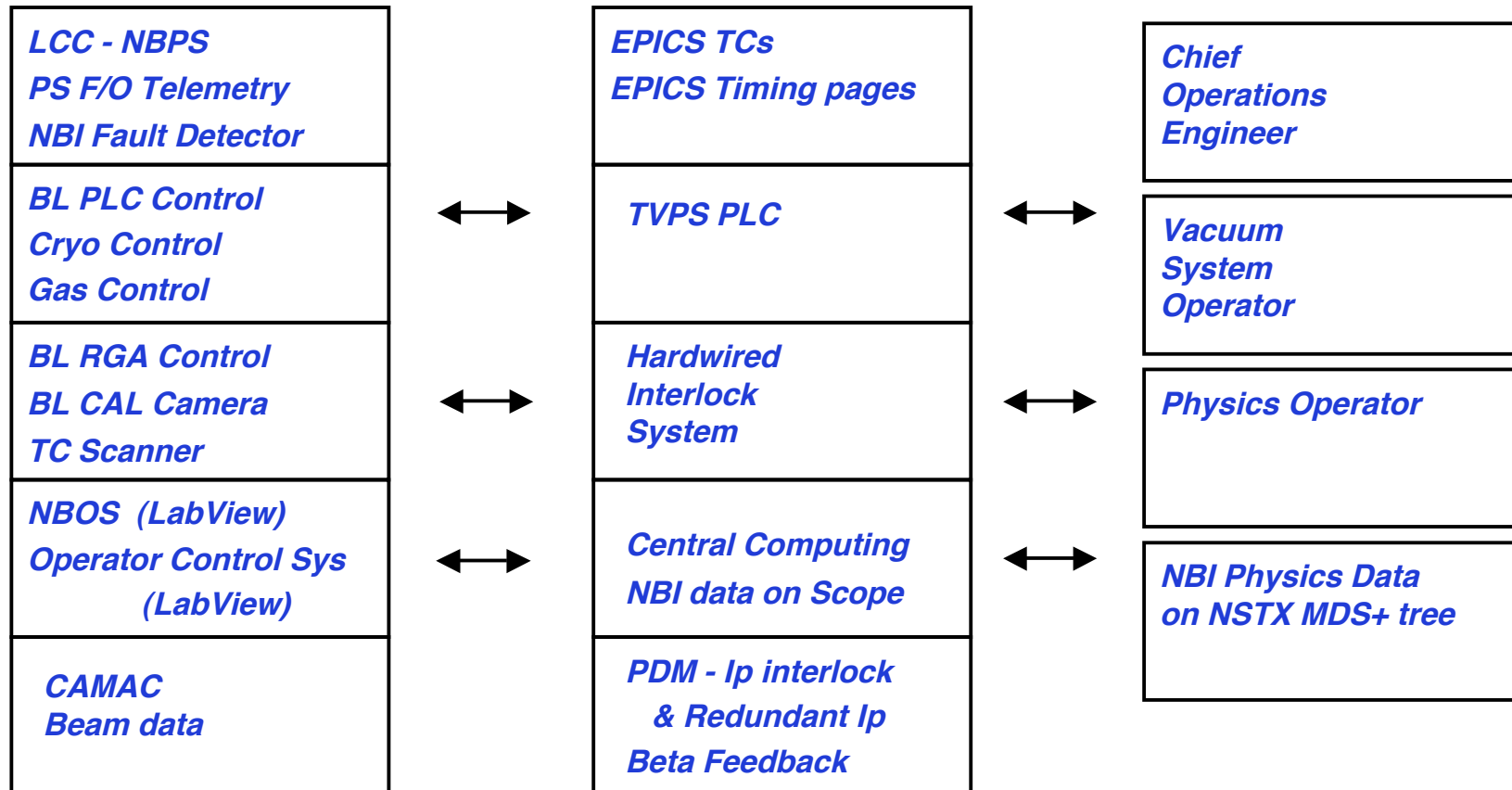
*More sources, more buttons... but not more operators*

# NSTX NBIU Controls - Handshakes

## Neutral Beam Control System & Interfaces to NSTX

*NBI Ops Supervisor & Operators*

*NSTX Ops*



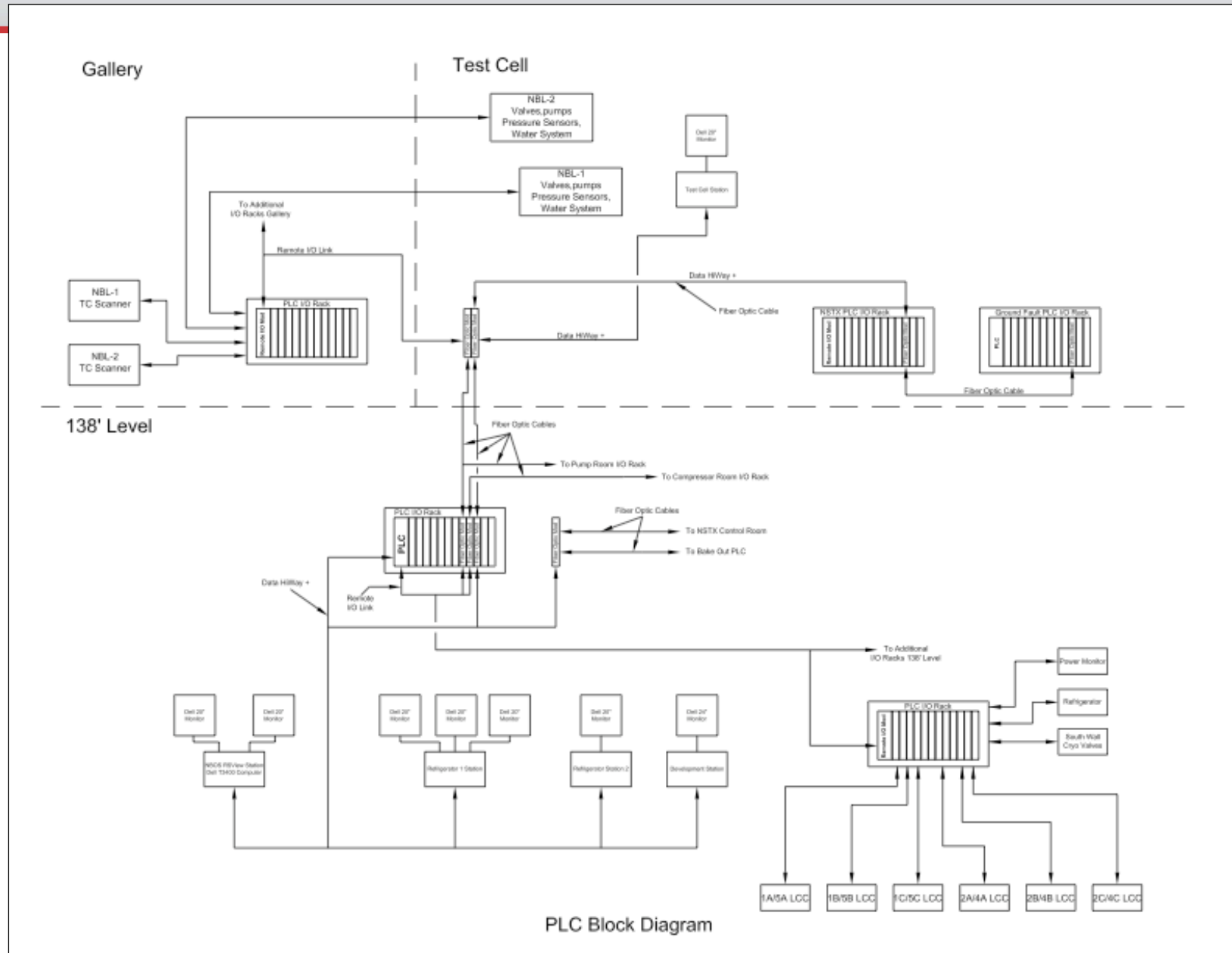


# NSTX NBIU Controls - Progress

- *Block Diagrams of each segment of the control scheme complete*
- *Signal lists have been prepared to determine I/O requirements*
- *Drawing lists have been prepared to determine requirements for new drawings and P&IDs*
- *Rack contents and layouts have been evaluated to determine new space requirements*
- *NBOS LabView Controls will be updated to current technology like BL1*
- *Interfaces are well understood and can be replicated for BL2 control*

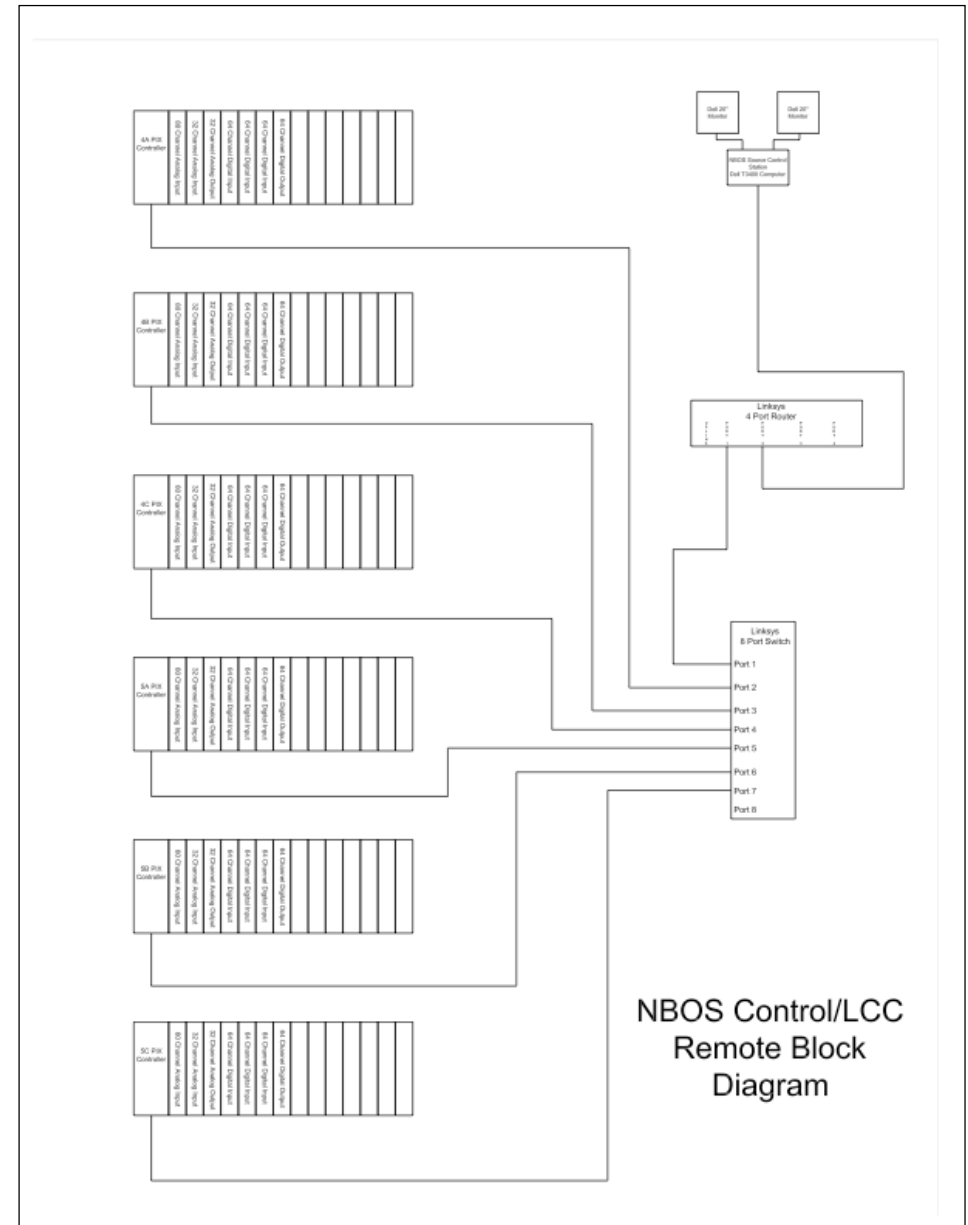
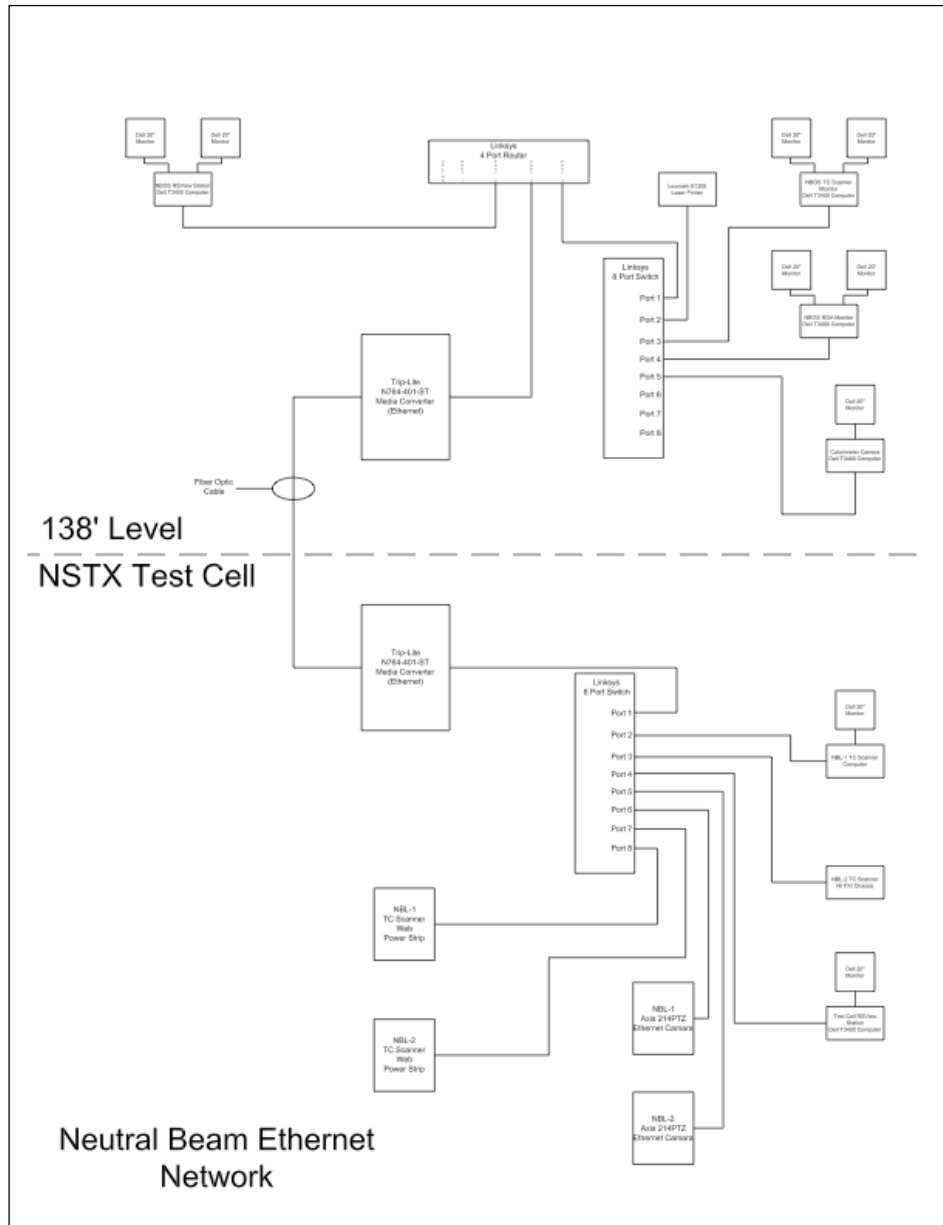
*Controls design is on track...*

# NSTX NBIU Controls - PLC Block Diagram

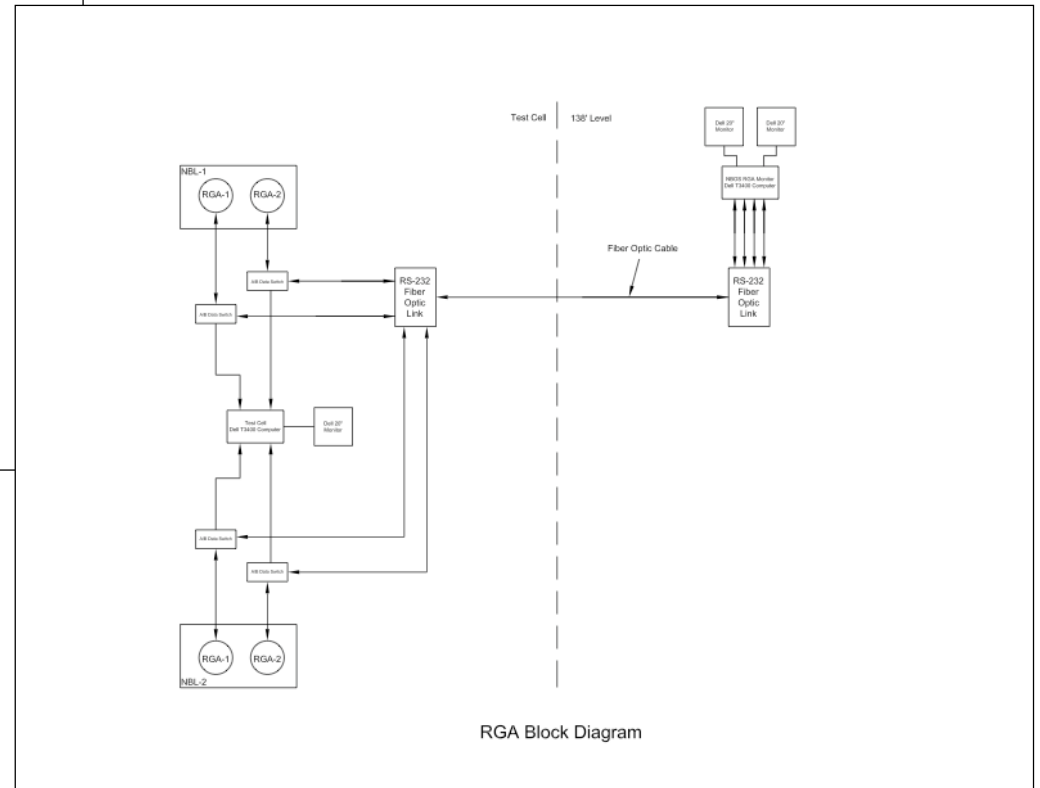
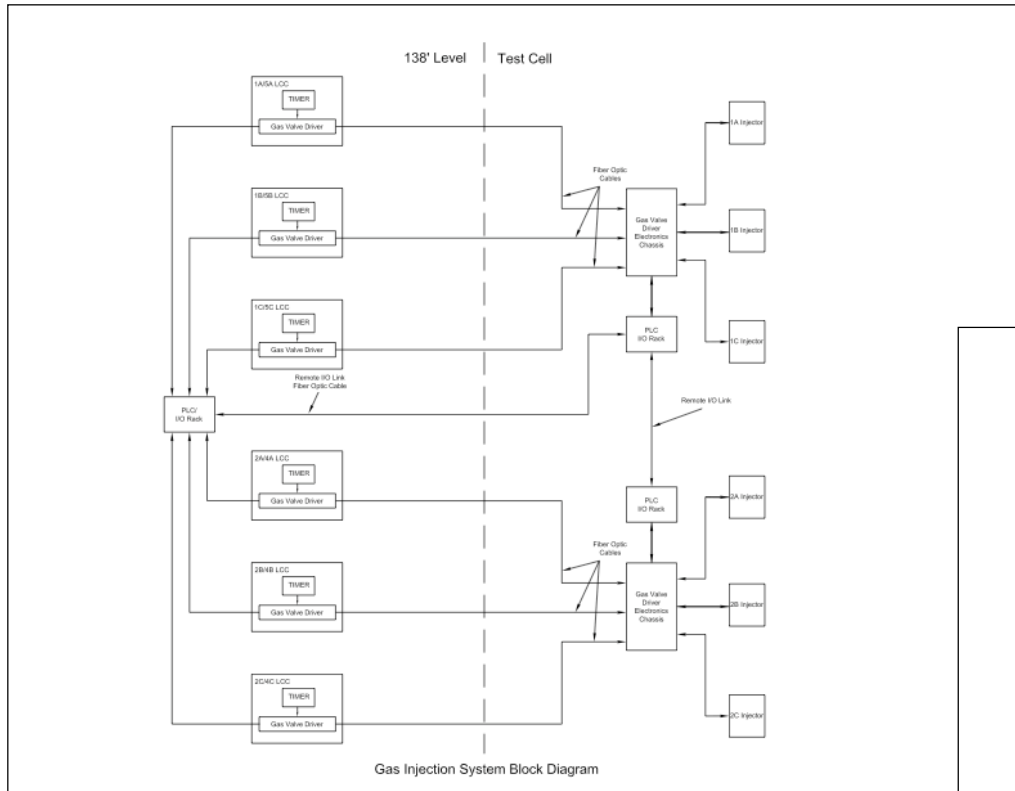


PLC Block Diagram

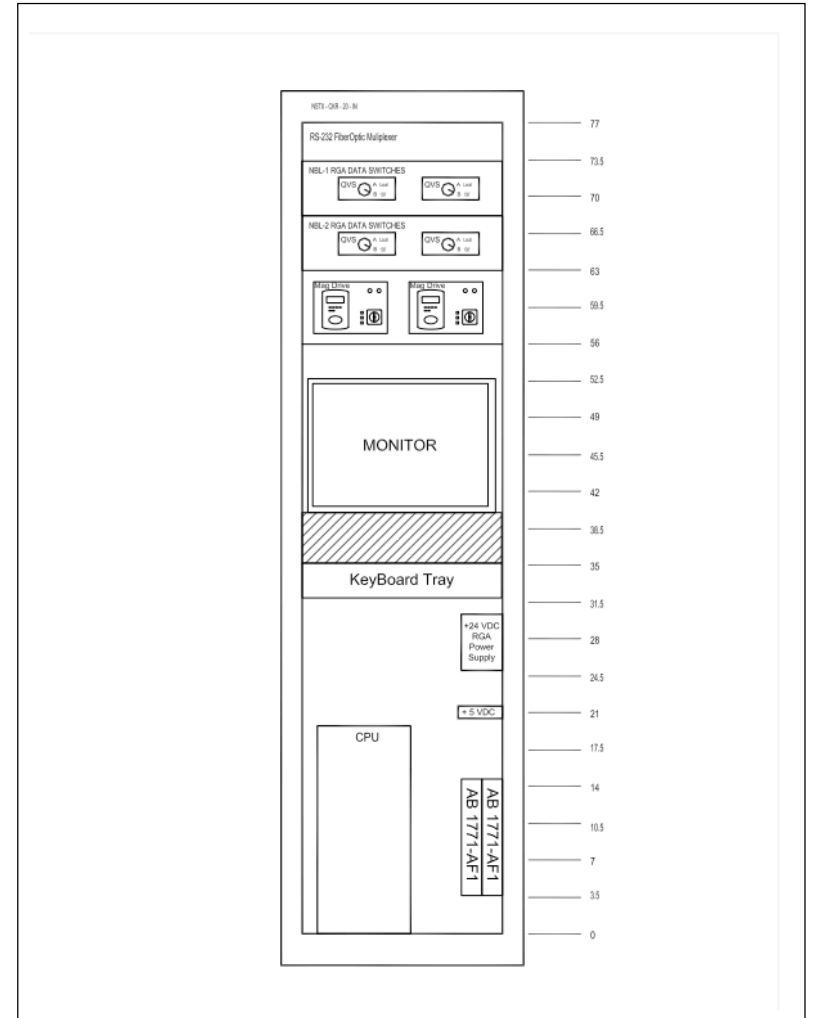
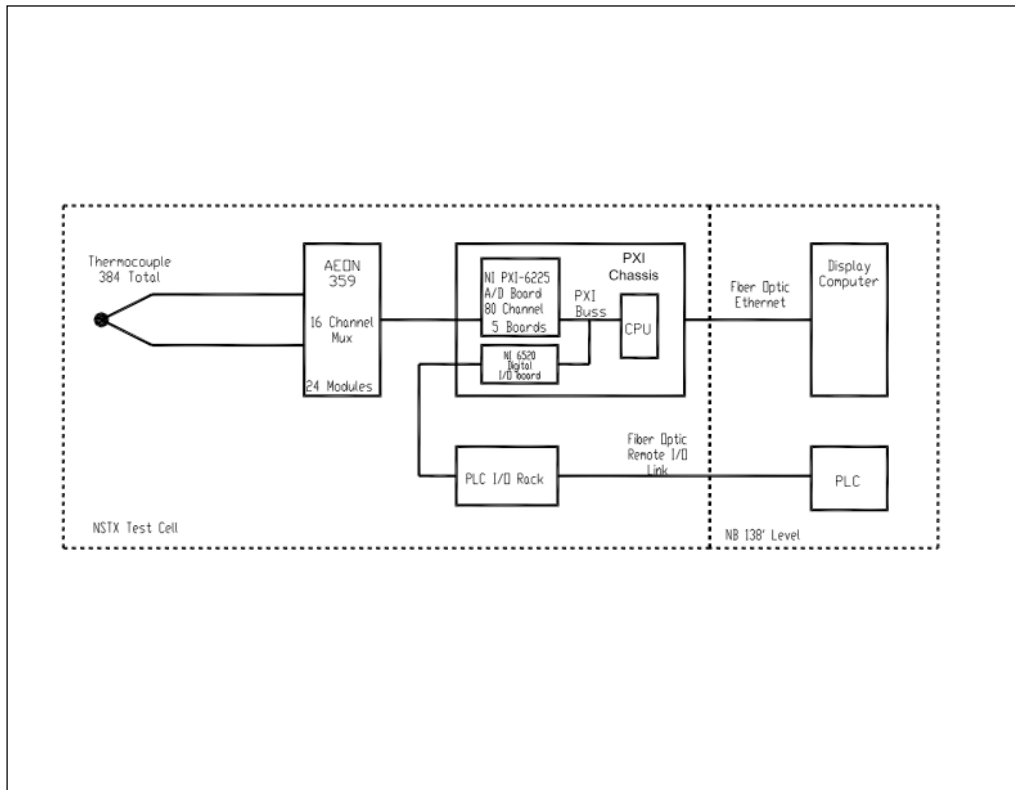
# NSTX NBIU Controls - NB Network, Remote LCC System



# NSTX NBIU Controls - Gas Inj Sys, RGAs



# NSTX NBIU Controls - TC Scanner, NTC Racks



# NSTX NBIU Power & Control - Conclusion

- **NBI Power System -**
  - **Reuse major portions of N4 power supply with updates**
- **Work Scope to connect N4 NBPS ABC to BL2 ion sources - known**
- **Procurements - similar to TFTR and NSTX BL1**
- **Routing and Installation - a clear path forward identified**
- **Grounding - same or similar**
- **NBI Controls - repeat for BL2**
- **Work Scope to control NBI BL2 - known**

**Conclusion - BL2 Power and Control design is well known and tested**

**And ready to run another BL again...**

