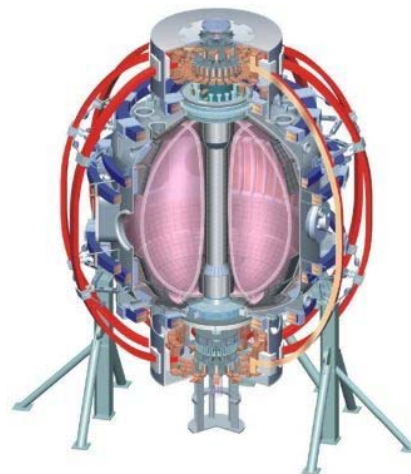


# NSTX NBIU Power System & Controls

**J. Edwards/ M. Cropper**  
**S. Ramakrishnan/ Timothy N. Stevenson**

**NSTX Upgrade Project**  
**Final Design Review**  
**LSB B318**  
**June 23, 2011**



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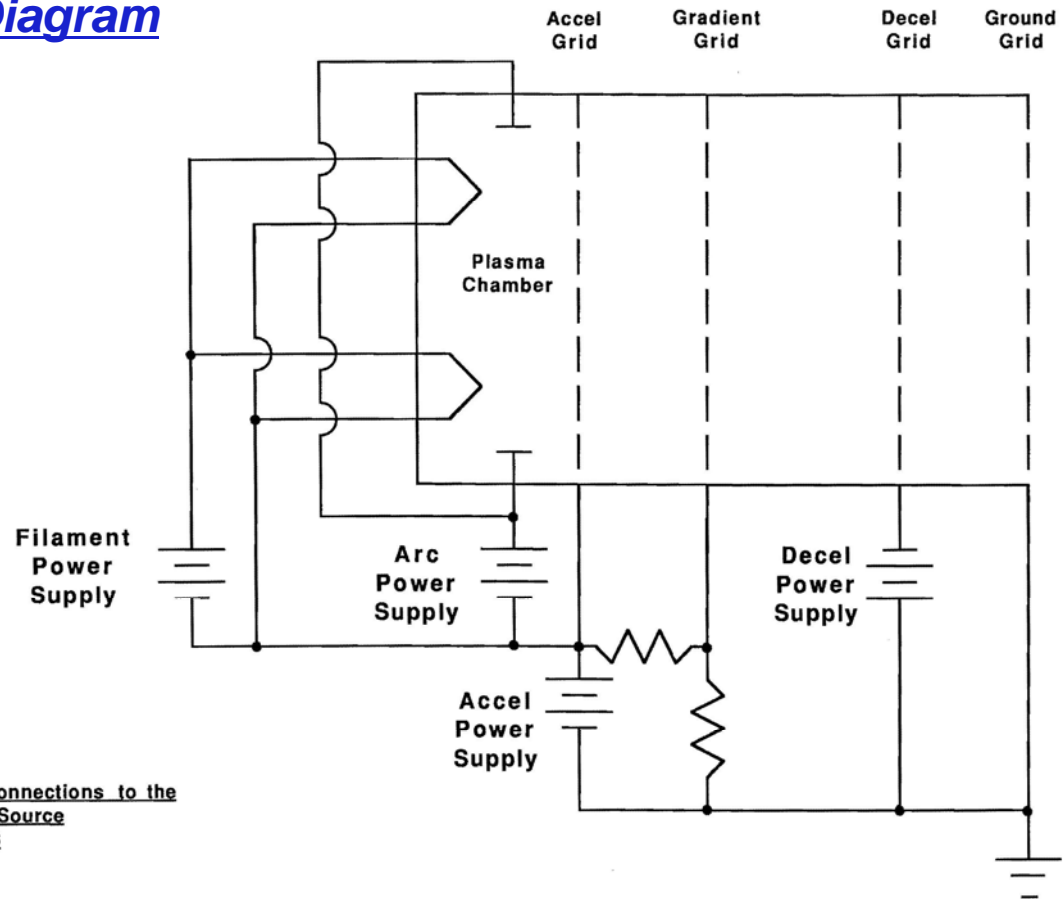
Culham Sci Ctr  
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KBSI  
KAIST  
POSTECH  
ASIPP  
ENEA, Frascati  
CEA, Cadarache  
IPP, Jülich  
IPP, Garching  
ASCR, Czech Rep  
U Quebec

# 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

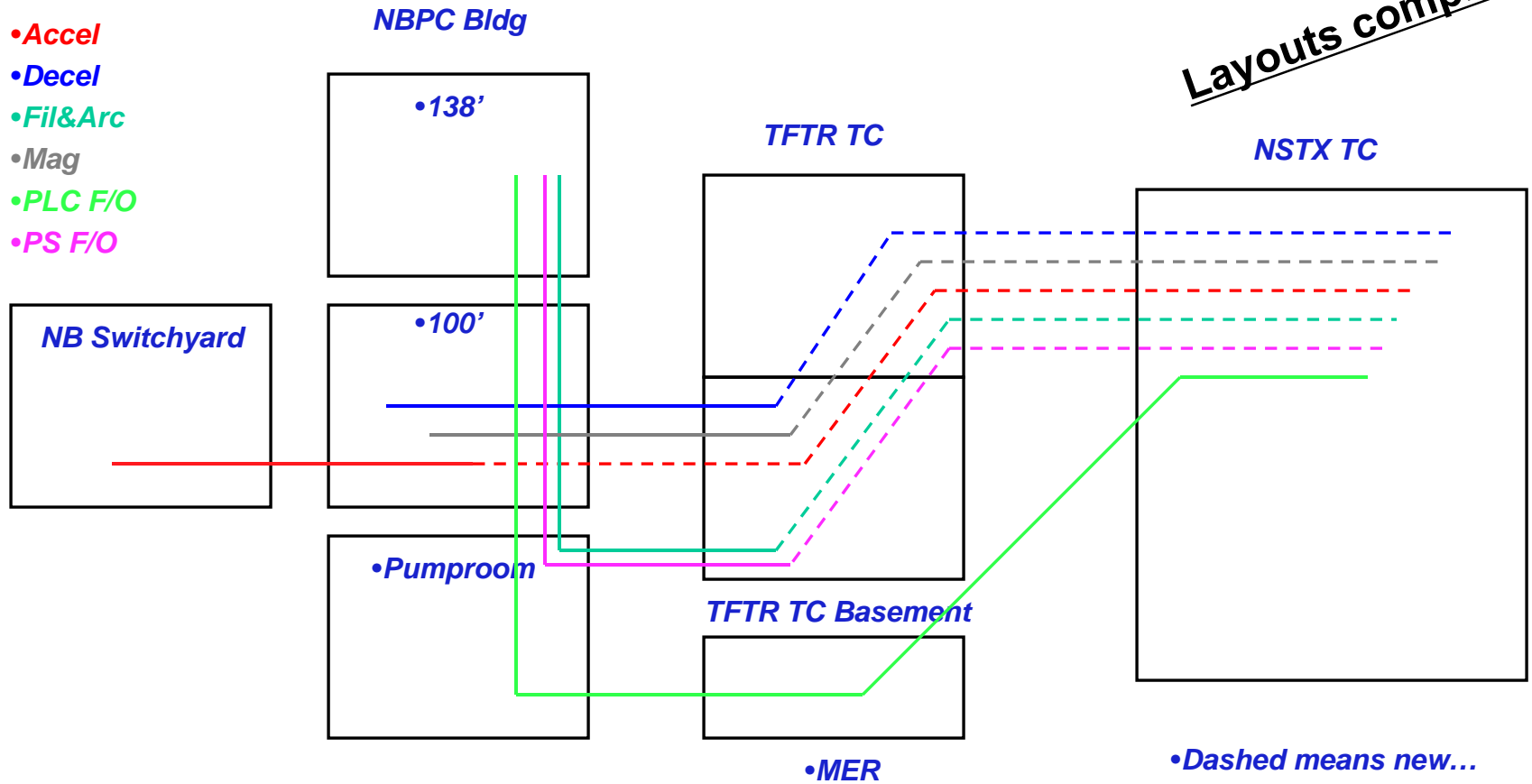
# NSTX NBIU Power & Controls - NBPS

## *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)

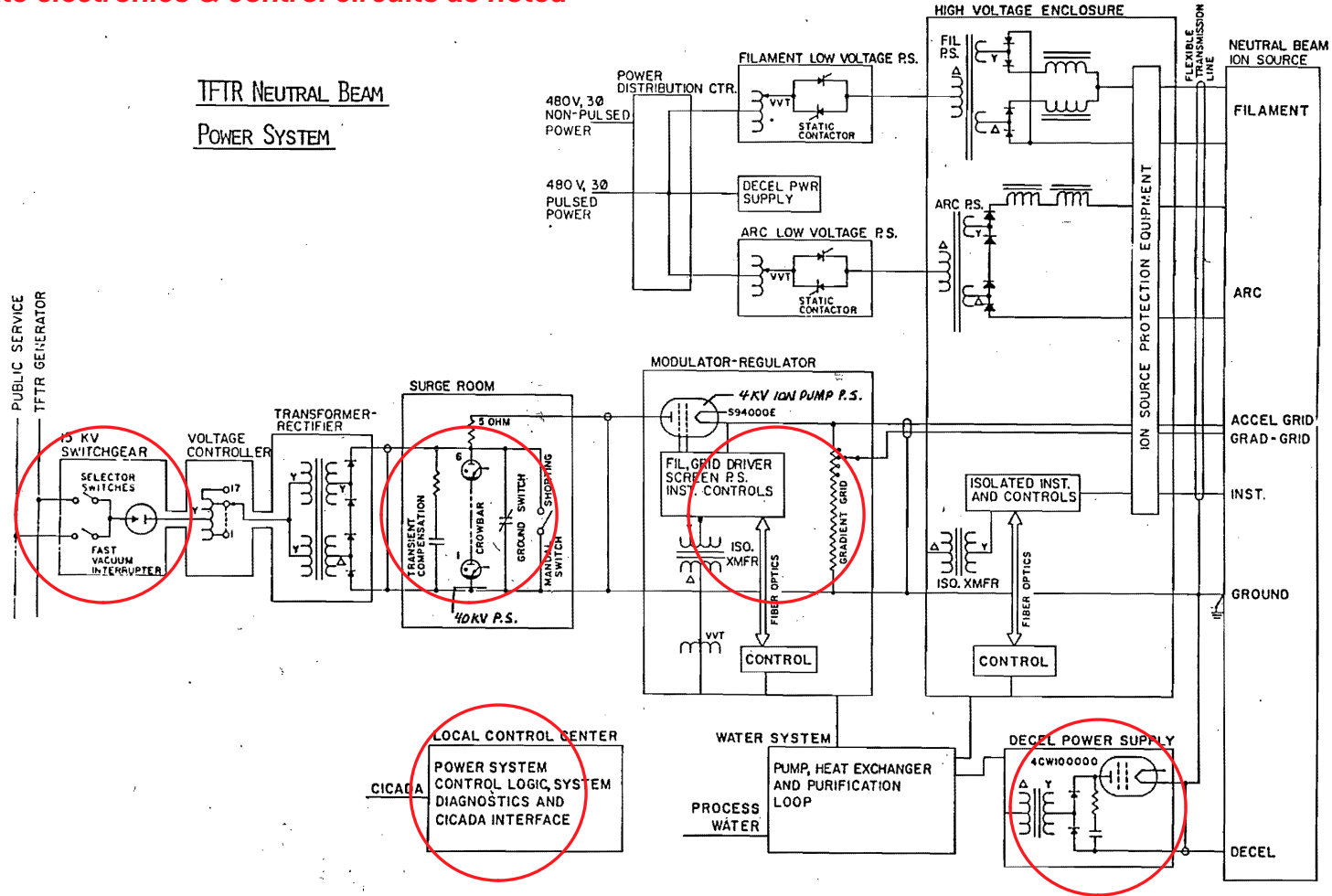
# NSTX NBIU Power & Controls - Road Map

*Routing, Penetrations, draft Installation Procedures done*



# NSTX NBIU Power & Controls - One Line Diagram

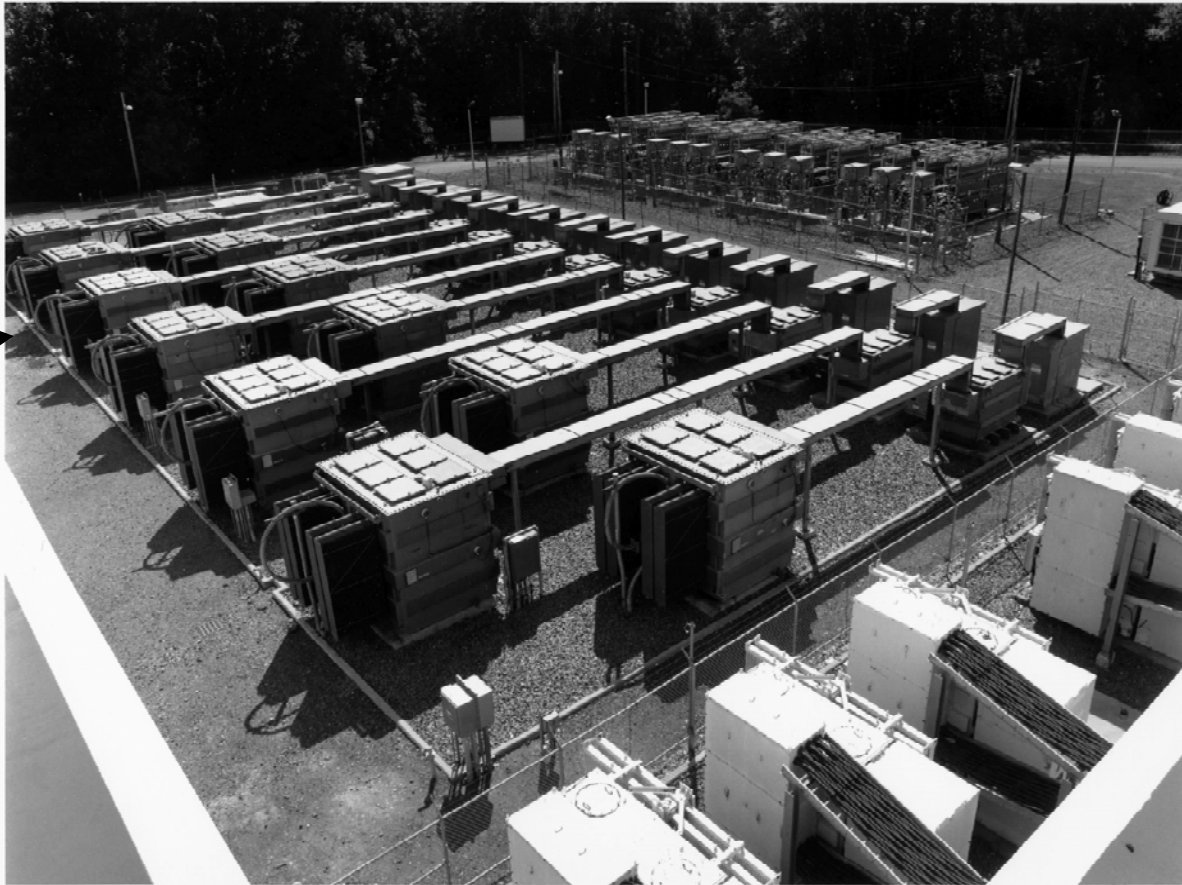
Update electronics & control circuits as noted



NBI NBPS One Line Diagram

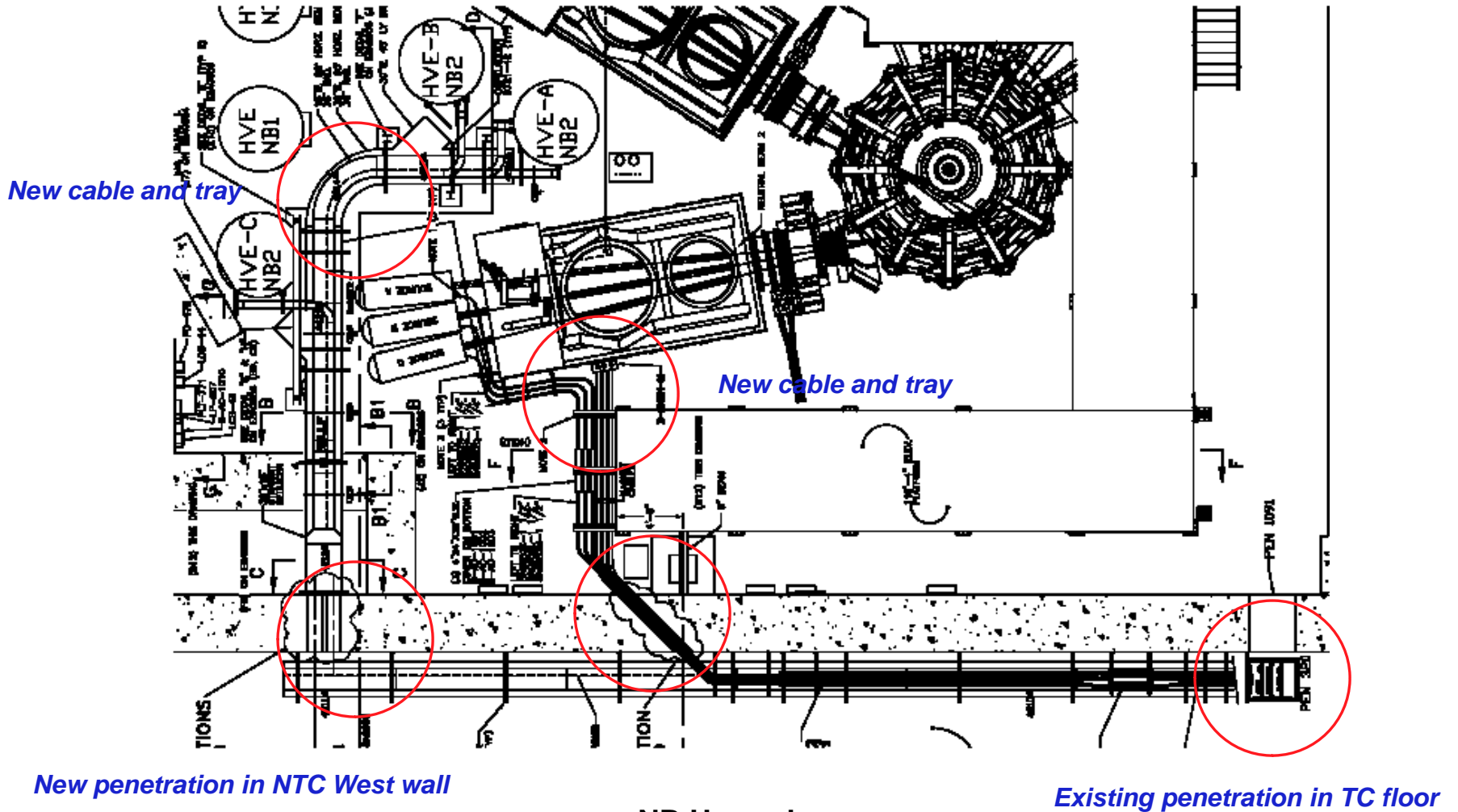
# NSTX NBIU Power & Controls - NBPS N4 available

*N4  
XFMRs*



*NBI NBPS Switchgear and Transformers*

# NSTX NBIU Power & Controls - Layouts complete



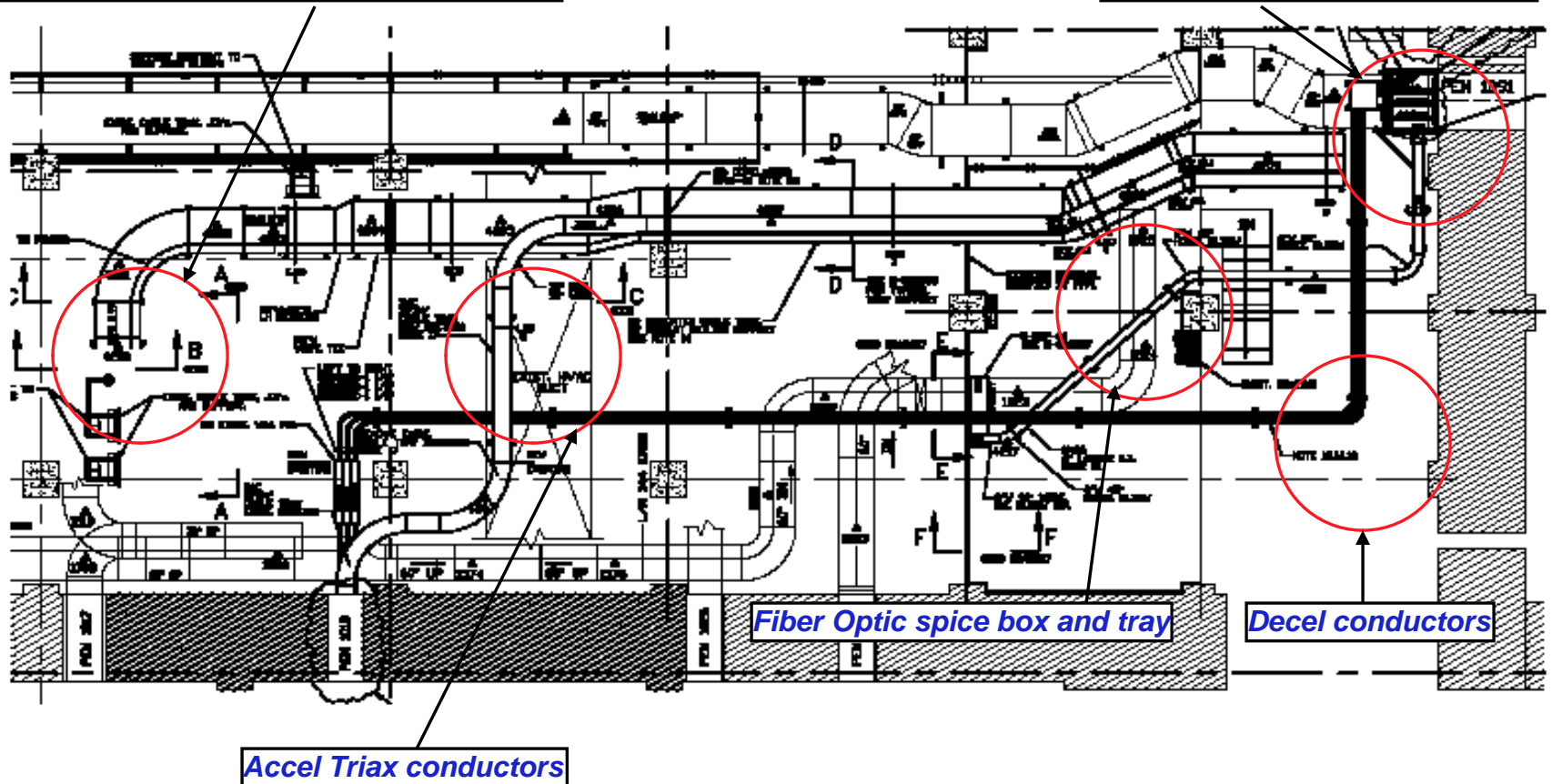
**NB Upgrade  
Tray layout in NSTX Test Cell**



# NSTX NBIU Power & Controls - Layouts complete

Arc, Filament, Bending Magnet conductors

Existing penetration in TC floor



NB Upgrade

Tray Layout TFTR Test Cell Basement

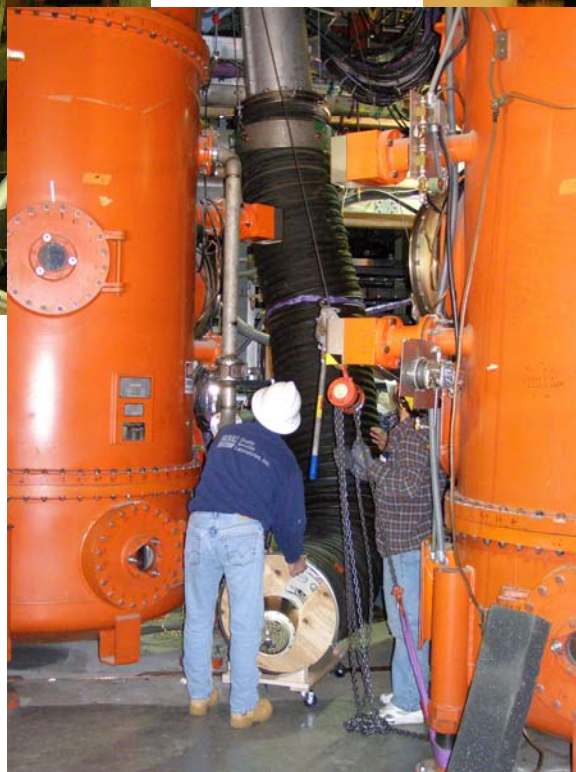
# NSTX NBIU Power & Controls - HVEs & Xmsn Lines



*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 - *20-26 weeks ARO*
  - 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
  - *Cost has nearly doubled since last estimate due to Cu price increase*
- 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**

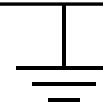
***Routing and Installation well known and ready to go...***

# NSTX NBIU Power & Controls

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

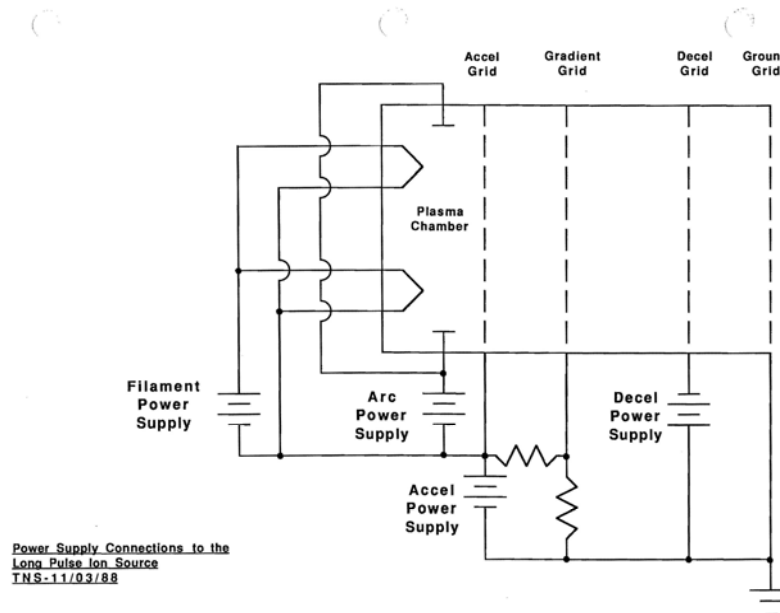
**SAME AS  
FOR NB1**

- **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.)

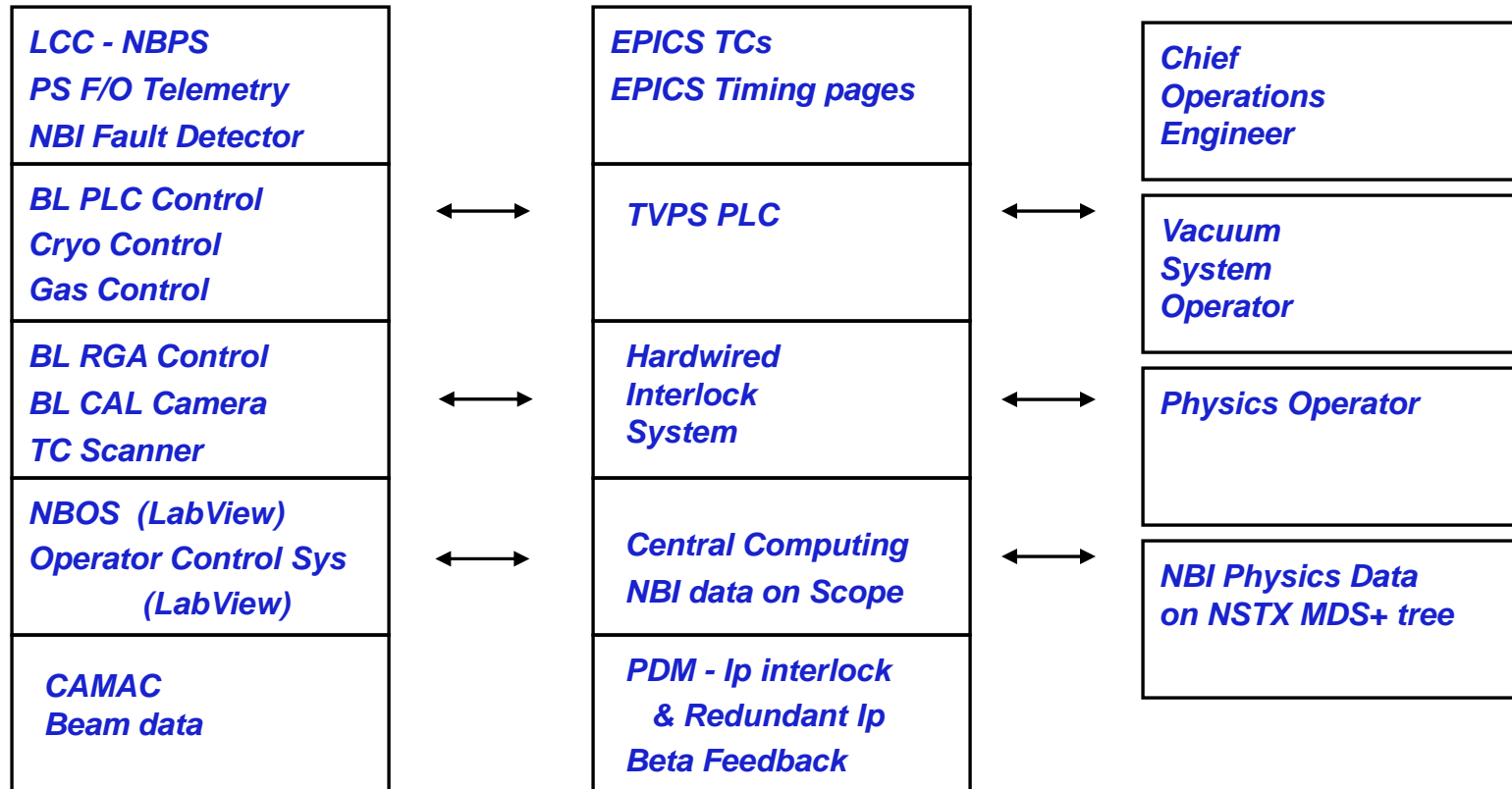
*More sources, more buttons... but not more operators*

# NSTX NBIU Controls - Handshakes

## Neutral Beam Control System & Interfaces to NSTX

*NBI Ops Supervisor & Operators*

*NSTX Ops*

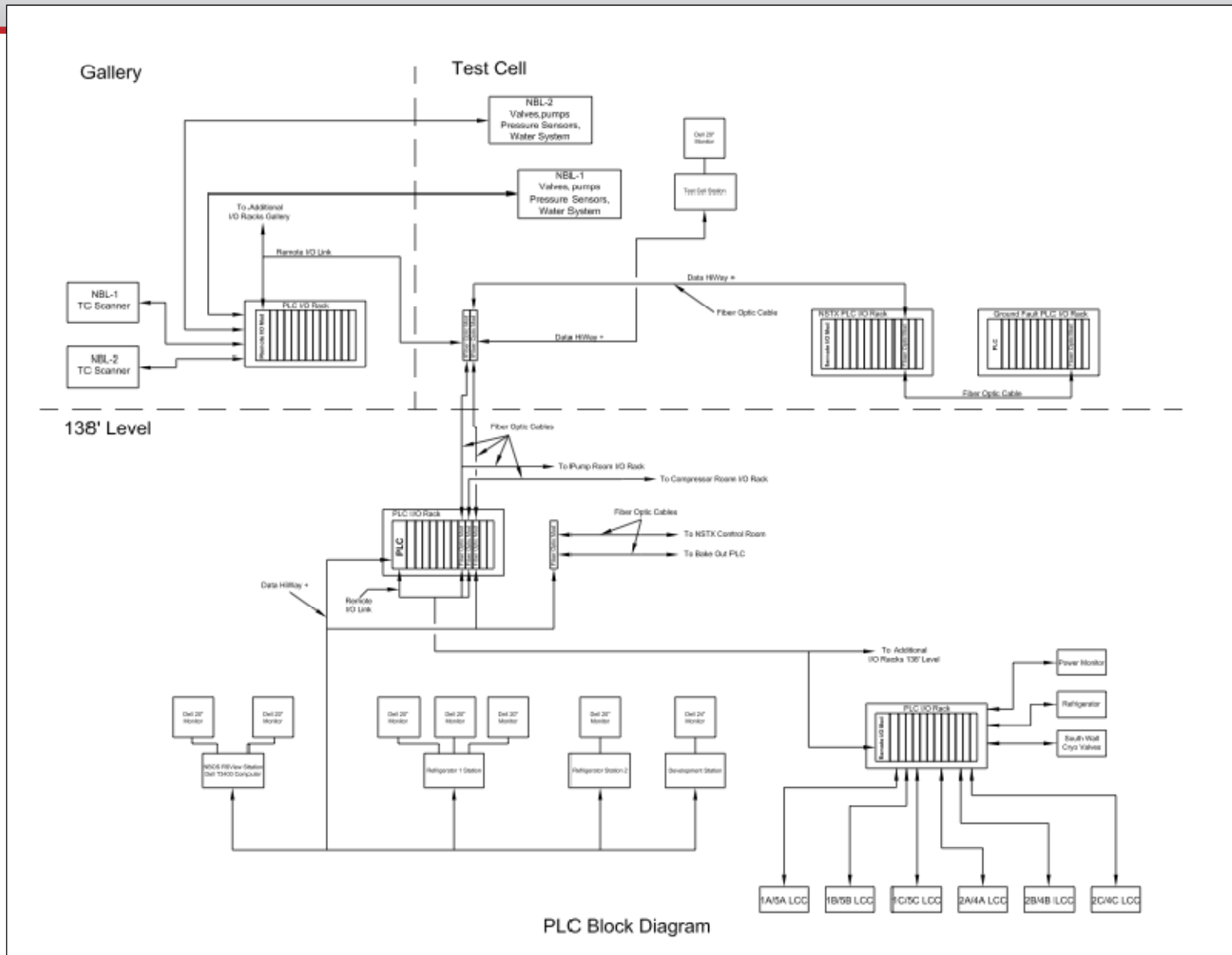




# NSTX NBIU Controls - Progress

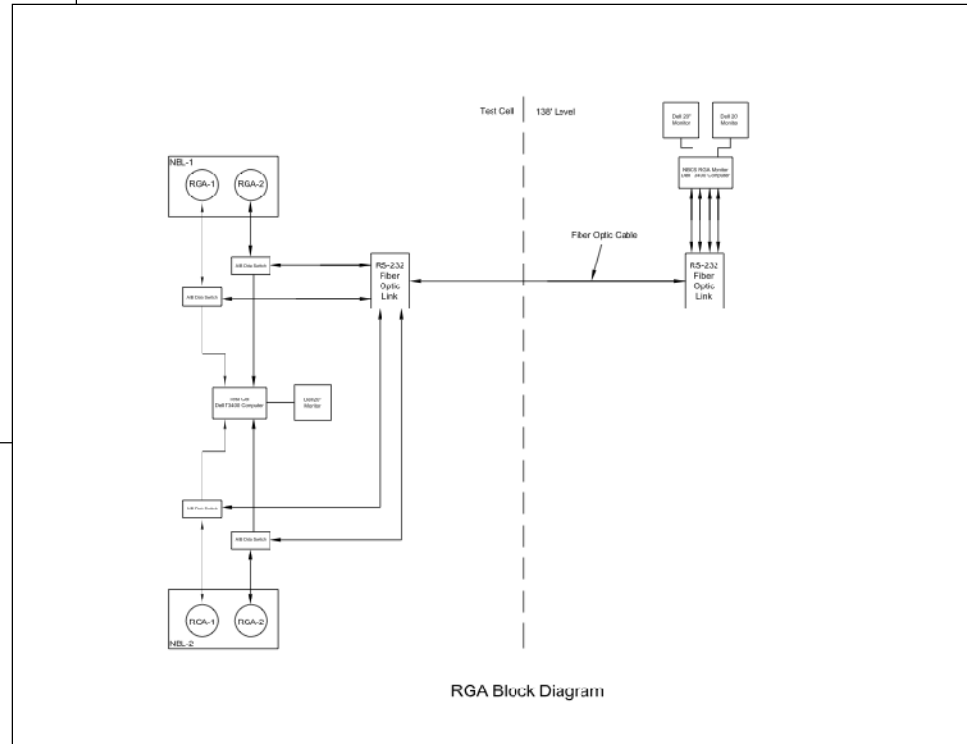
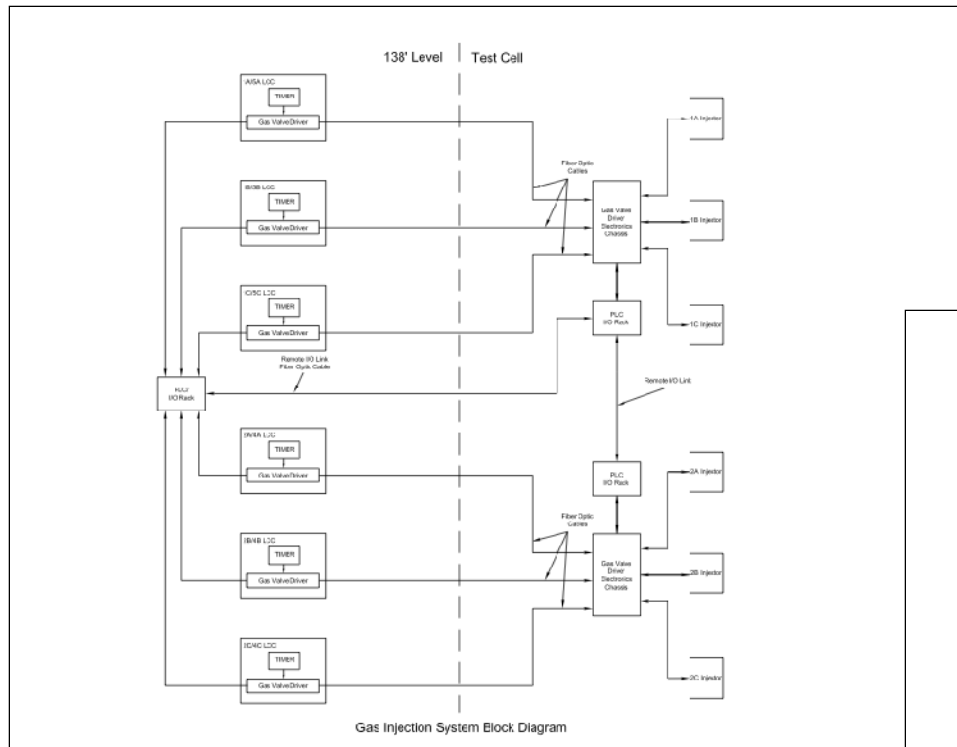
- *Block Diagrams of each segment of the control scheme complete*
  - *Signal lists have been prepared to determine I/O requirements*
  - *Drawing lists have been prepared to determine requirements for new drawings and P&IDs*
    - *53 Drawings identified 52 completed.*
    - *608 CWD's identified 75 of them are commercial cables and do not need drawings generated, 470 require new drawings, 460 completed.*
    - *Test Cell/Gallery portion complete , 138' level not started.*
  - *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*
  - *Test Cell cable trays lay out has not been started – last major effort for controls*
- Controls design is on track...*

# NSTX NBIU Controls - PLC Block Diagram

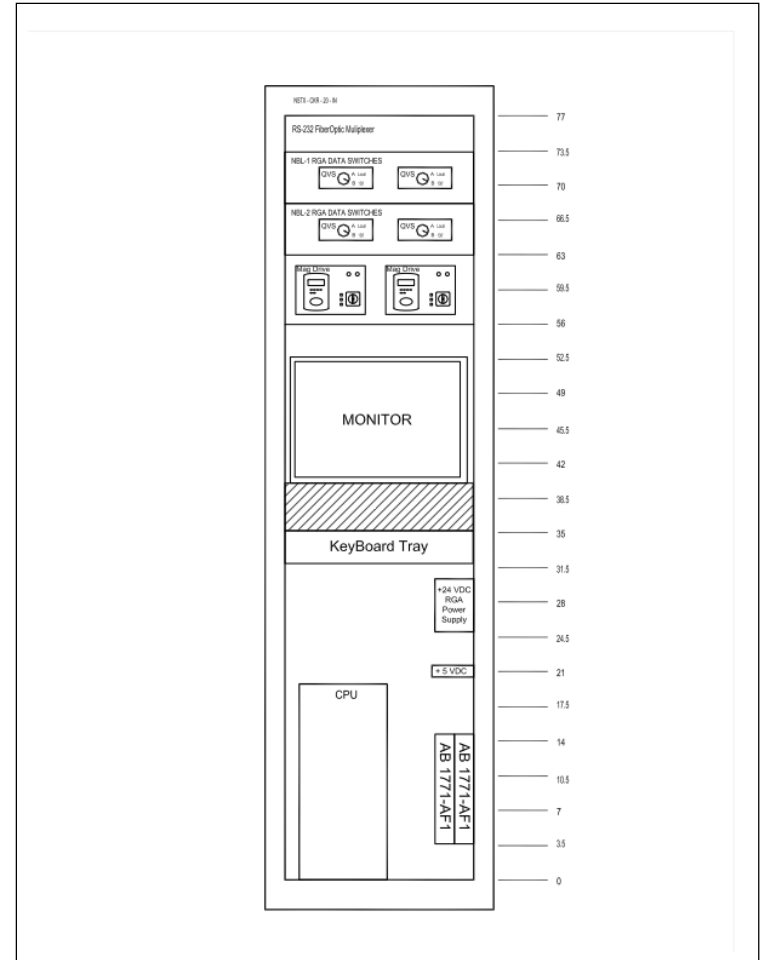
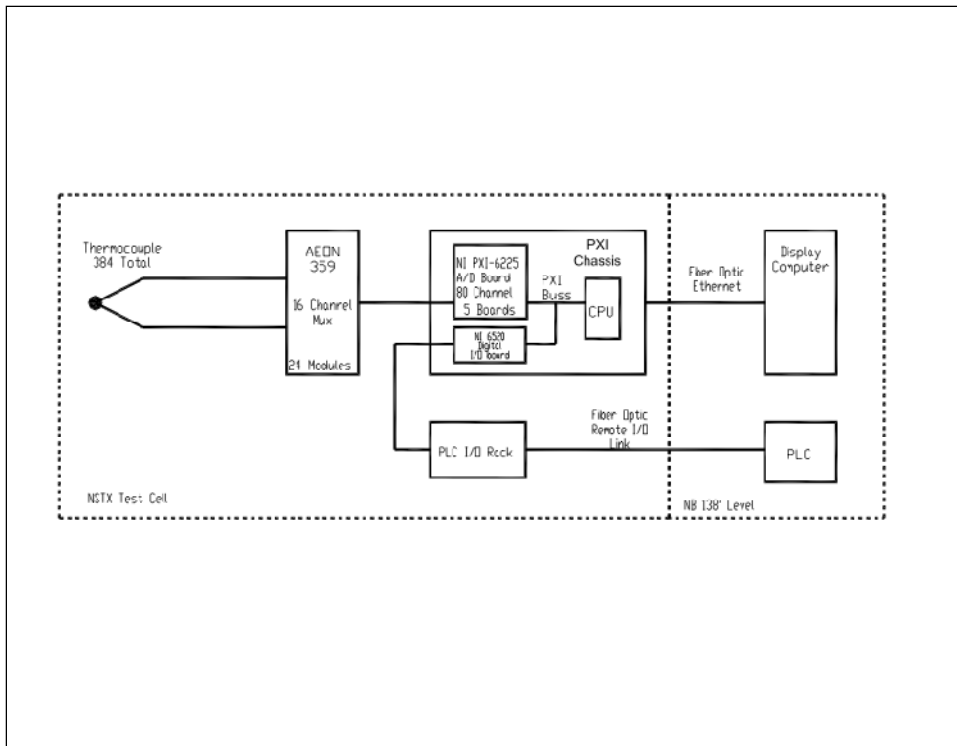




# NSTX NBIU Controls - Gas Inj Sys, RGAs



# 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...**

