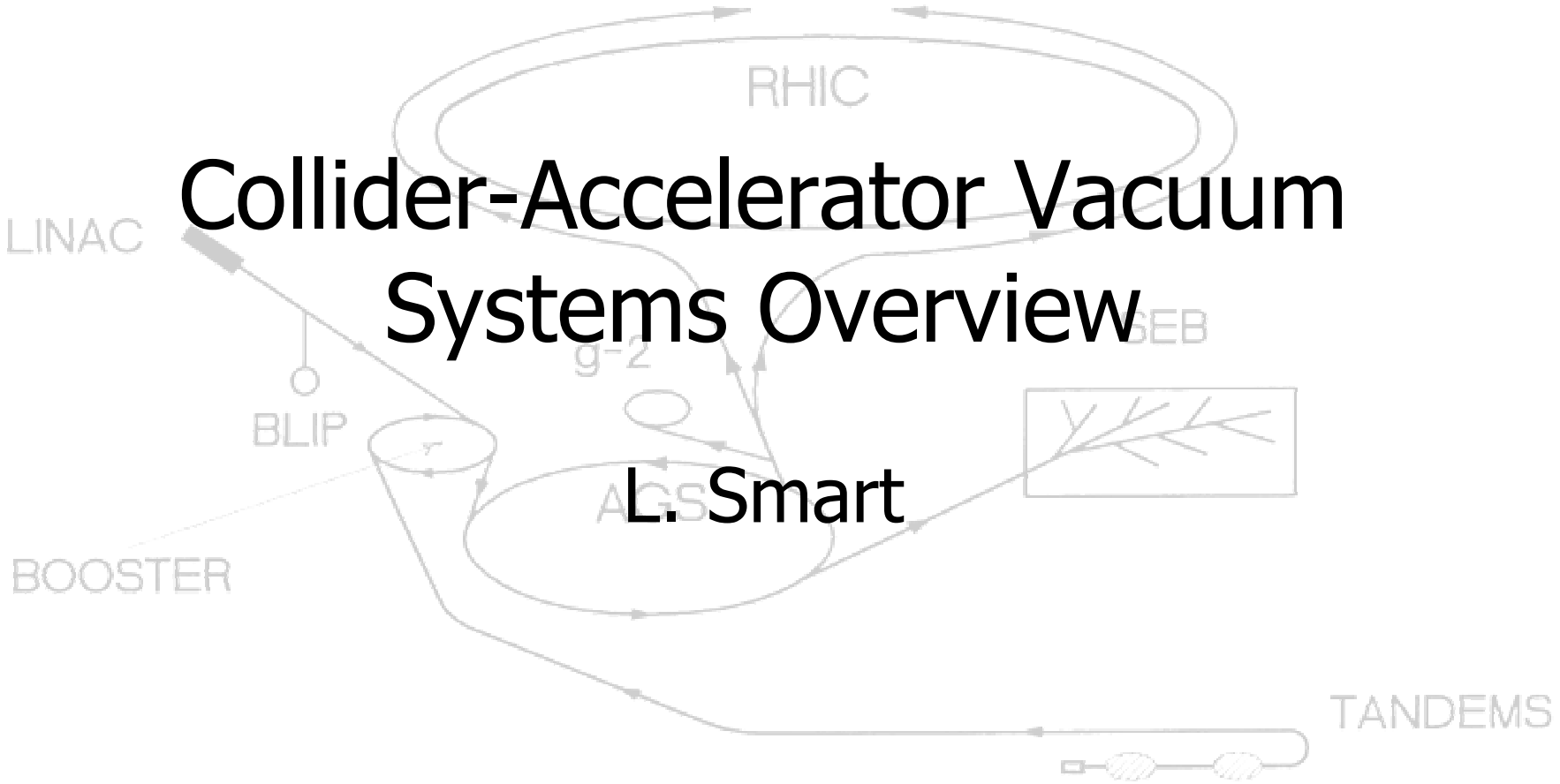


Collider-Accelerator Vacuum Systems Overview

L. Smart

Collider-Accelerator Vacuum Systems

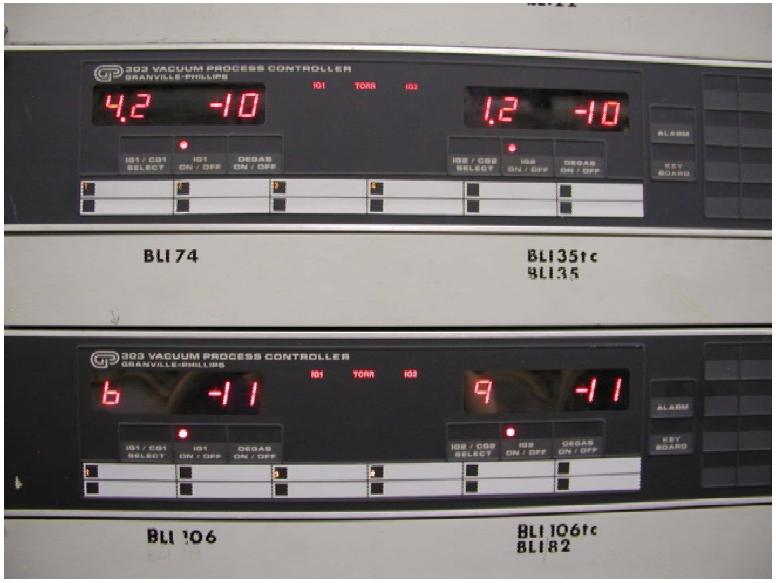
- AGS: A10, H10, E18, 929 (Seimens/RF)
- Booster, TTB, LTB, BTA: 930UEB
- NSRL: 957
- ATR, RHIC: A-Trailer, 1000-P, 1006B, 1008B, 1010A, 1012A, 1002B, 1004B.

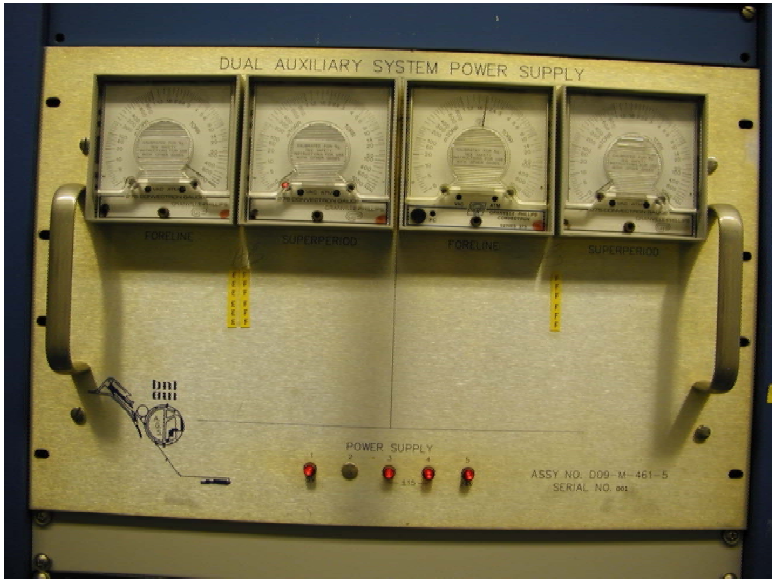
Preinjector vacuum systems are not included in this discussion

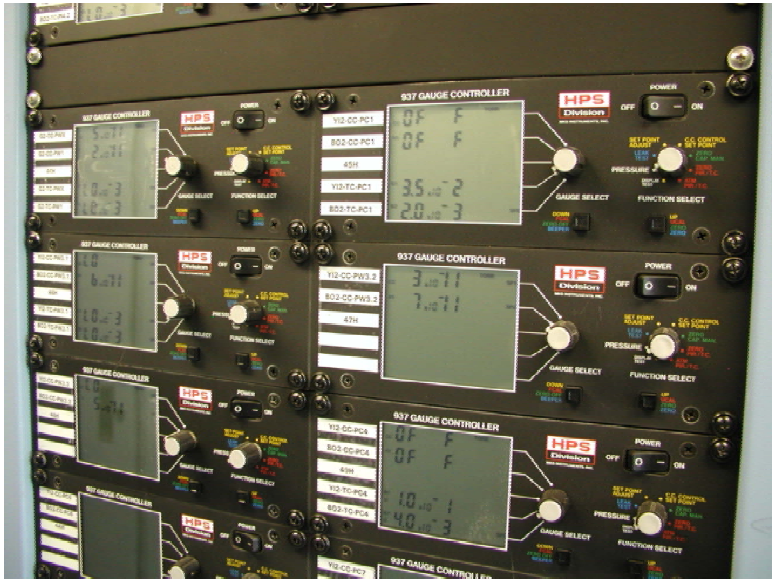
Vacuum Equipment

- Ion pump controllers
  - High voltage output ~ 5 kV; Current up to 400 mA; Range C electrical hazard
- Gauge Controllers
  - Ion Gauges (hot cathode gauges) operate at voltages 180+ V, up to ~500 V for degas (Booster)
  - Cold cathode gauges operate @ 4 kVdc, <150 uA; Range A electrical hazard (AGS, RHIC, NSRL)
  - Thermal conductivity gauges (Convectron, Convection-Pirani) operate at < 30 Vdc, low current; Range A electrical hazard.

Gauge Controllers

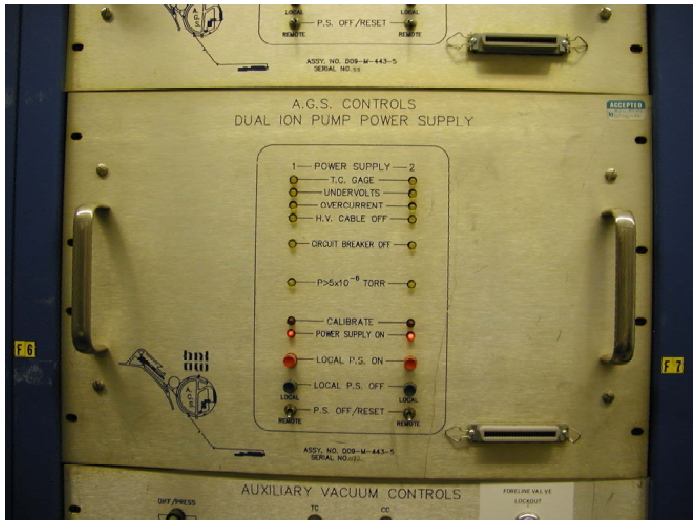


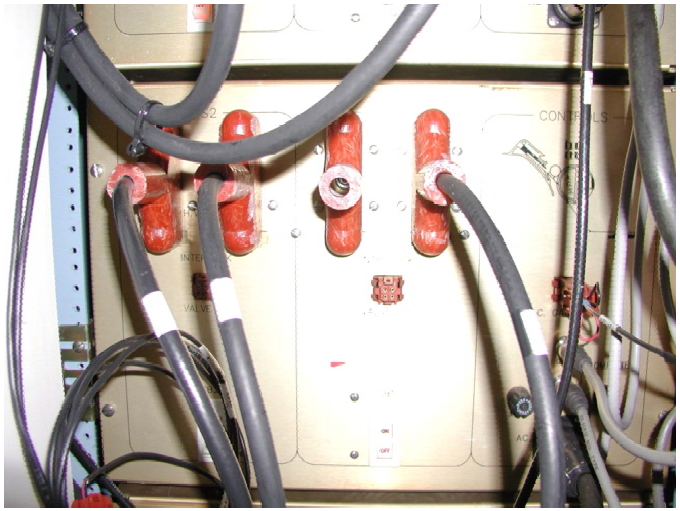




Gauge Controller pet pages

- Booster/Vacuum/Gauges/Line
- Booster/Vacuum/Gauges/Ring
- Booster/Vacuum/NSRL/Gauges
- AGS/Vacuum/Gauge/Ring
- AGS/Vacuum/Gauge/Turbo
- RHIC/Vacuum/BlueGauges/Sector...
- RHIC/Vacuum/YellowGauges/Sector...
- RHIC/Vacuum/CryostatGauges/Blue...
- RHIC/Vacuum/CryostatGauges/Yellow...





Ion Pump Controllers

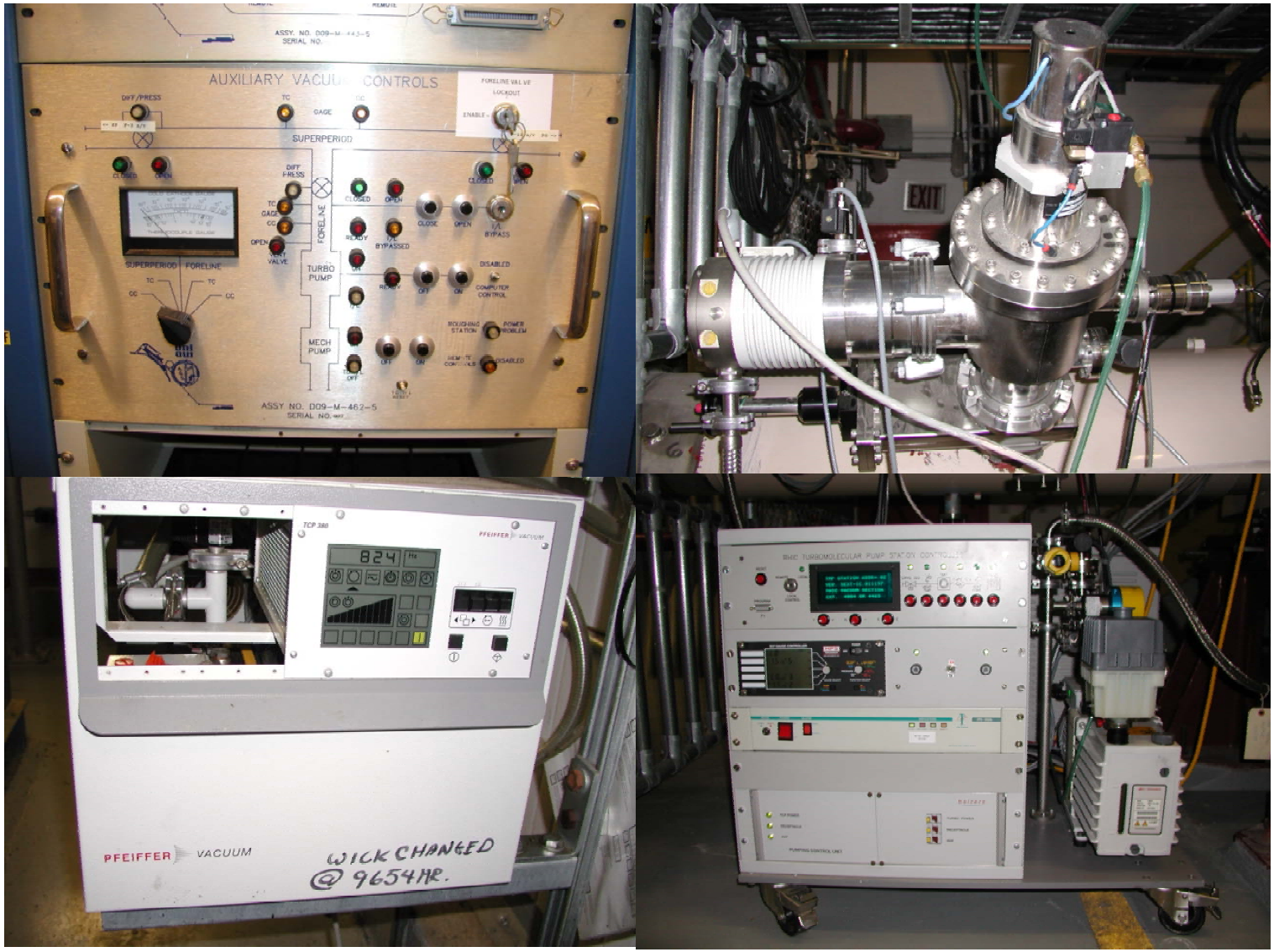
Ion Pump pet pages

- Booster/Vacuum/Pump/Line/Pressure
- Booster/Vacuum/Pump/Line/Voltage
- Booster/Vacuum/Pump/Ring/Pressure
- Booster/Vacuum/Pump/Ring/Voltage
- Booster/Vacuum/NSRL/Pump
- AGS/Vacuum/section_a...section_la
- RHIC/Vacuum/RingIonPumps/Sectors...

Vacuum Equipment, cont'd

- Turbo pump controllers
  - Located in AGS and RHIC tunnels, and at RHIC valve boxes
  - Normally OFF in AGS, ~24 stations (1/sector)
  - Normally ON in RHIC, ~36 stations in tunnel, and 12 @ valve boxes
- Programmable Logic Controllers
  - Control valves using 24 Vdc
  - Bad vacuum in 2 out of 3 nearby gauges/pumps closes valve, and prevents valve from being opened

Turbopumps


AUXILIARY VACUUM CONTROLS
SUPERPERIOD
TURBO PUMP
MECH PUMP
ASSY NO. 009-M-462-5
EXIT
PFEIFFER VACUUM
WICK CHANGED
@ 9654HR.

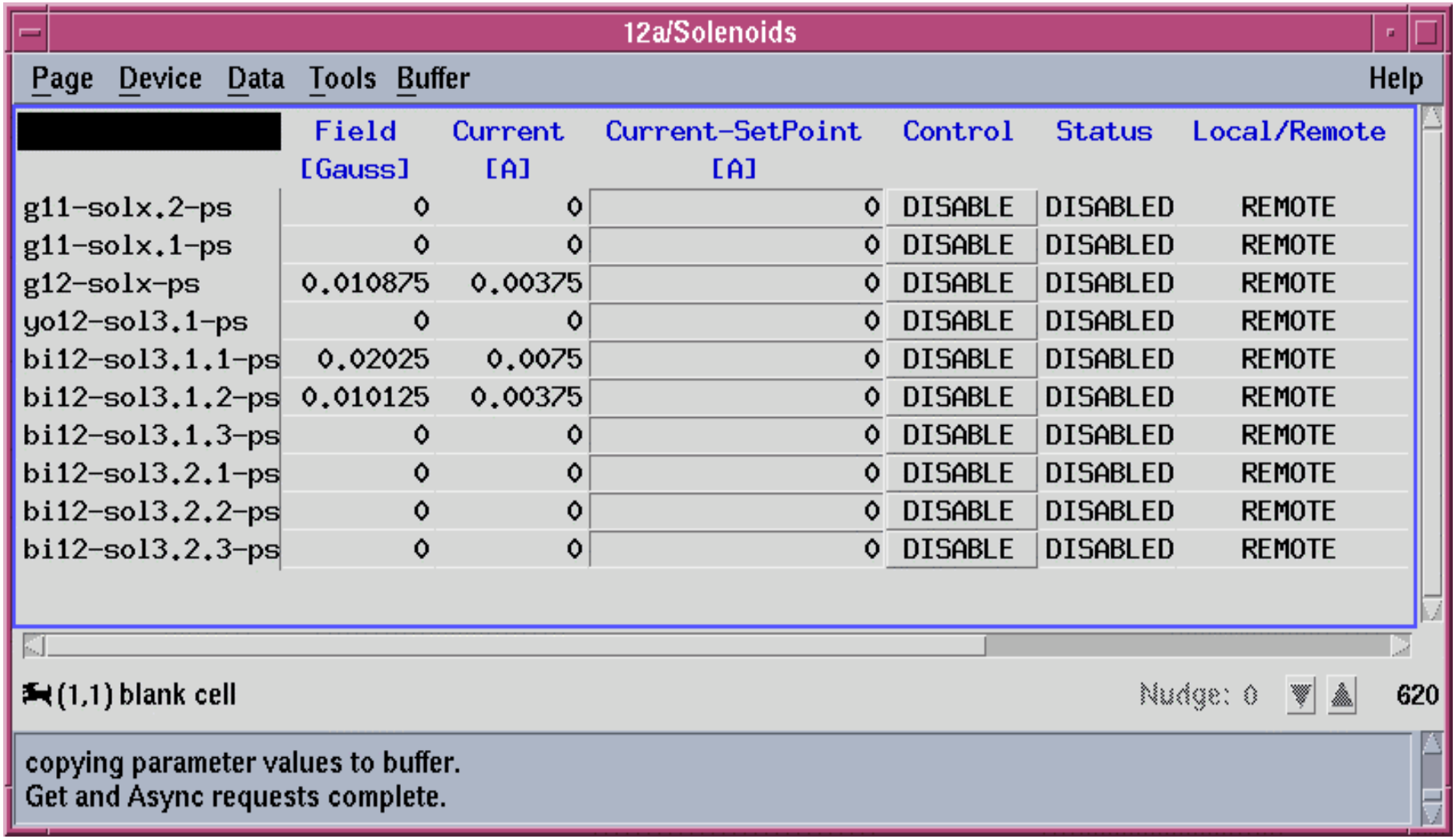
Vacuum Equipment, cont'd

- Titanium Sublimation Pump (TSP) power supplies
  - Only in Booster and RHIC Warm vacuum systems
  - Typically activated at the end of a bakeout
  - Otherwise activated between fills for RHIC high intensity beam operation, or when Booster vacuum creeps up
- Solenoid power supplies
  - Used during beam studies and high intensity RHIC operations for electron cloud mitigation

TSP & Solenoid Supplies

Solenoid Control

FECs/ElectronDetector/12a/Solenoids



AGS Vacuum Systems

- Valve Control: upgraded to PLC this shutdown, with PC GUI and Ethernet controls.
- Ion Pump Controls: BNL-design Dual power supplies with Datacom remote interface.
- Gauge controls: gauge controller cards built into BNL-design chassis, Datacom remote control.
- Turbo station controls: BNL-design chassis with inputs from gauge controls, also with Datacom interface.

AGS Valve Control

- Controls for ~36 valves in 24 sections is distributed among A10, E18, H10 equipment houses and building 929
- A10: sections KL through C
- E18: sections CD through G
- H10: Sections GH through K
- 929: Equipment Interlocks and Beam Stop Interlock

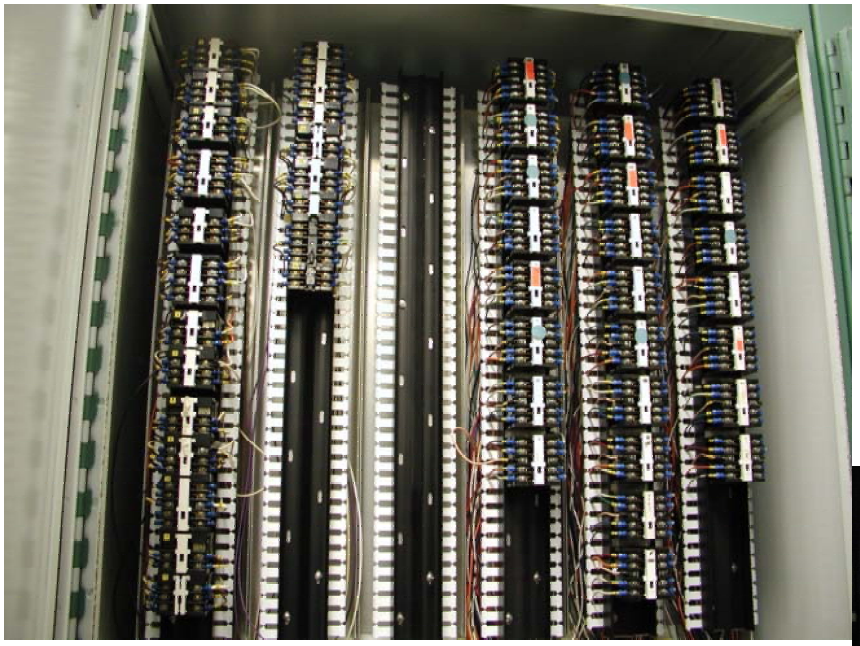
AGS Valve Control

AGS Valve Control

- Ion pump interlocks work the same as they did before
  - Two out of three ion pumps OFF in a sector will close the nearest sector valves.
  - If an ion pump fails, the interlock cable can be moved to another pump in the same rack.

AGS Equipment Interlocks & BSI

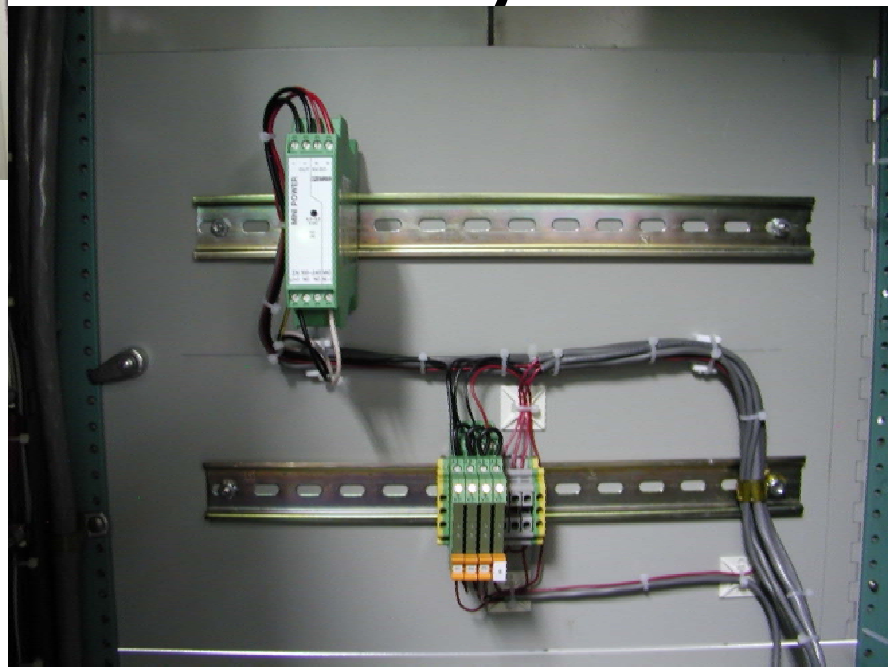
- Located in building 929 (Siemens/RF)
- Equipment interlock: one vacuum status signal for each of the 24 AGS vacuum sectors, used by other subsystems (e.g., RF)
- Equipment interlock wiring remains unchanged
- Beam stop interlock relay chassis replaced by DIN rail relays; same connection to Access Controls



Equipment

Interlocks

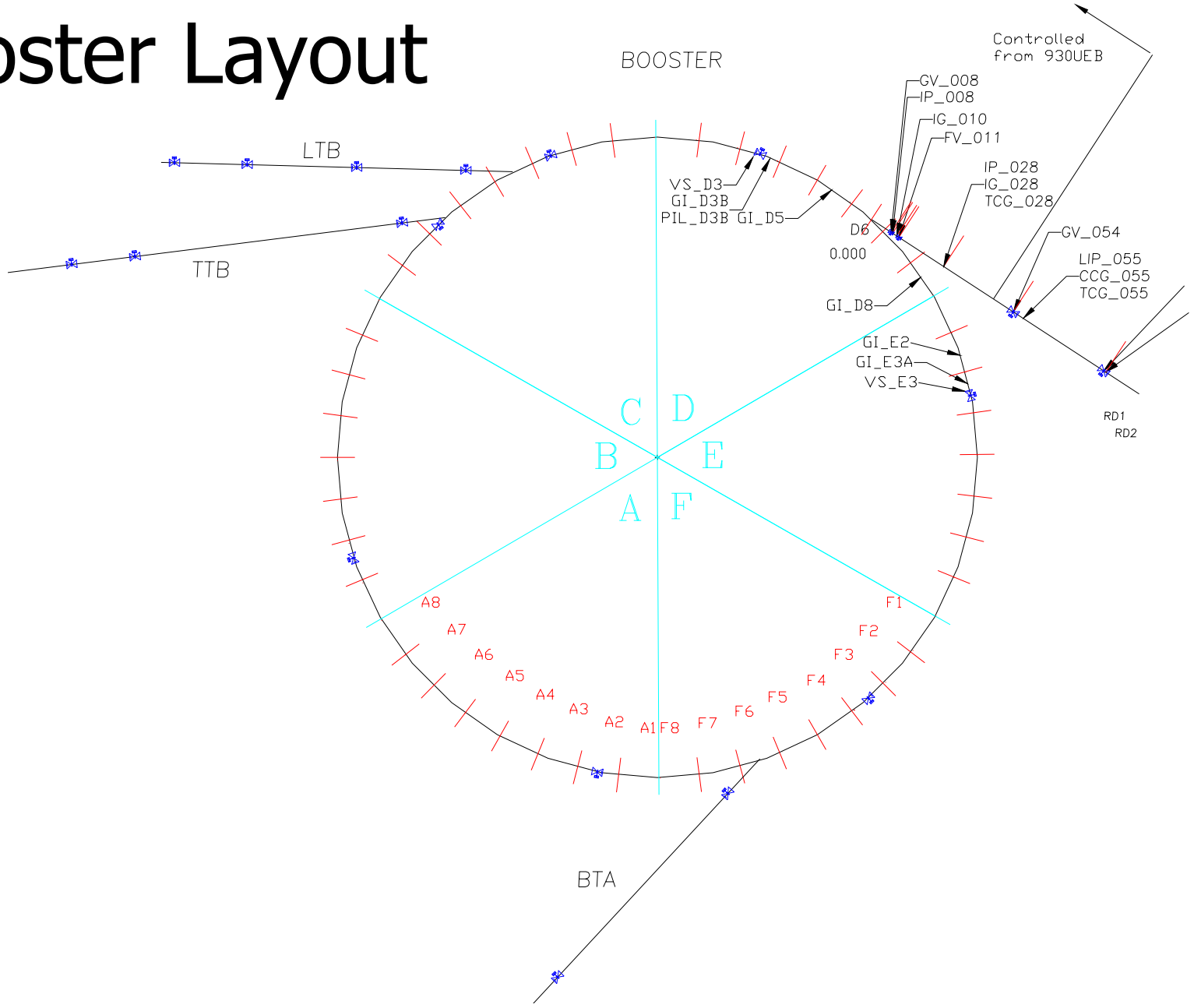
BSI
Relays



AGS Cold Snake Vacuum

- To be housed in A18 house
- Turbo controls
- Gauge controller

Booster Layout

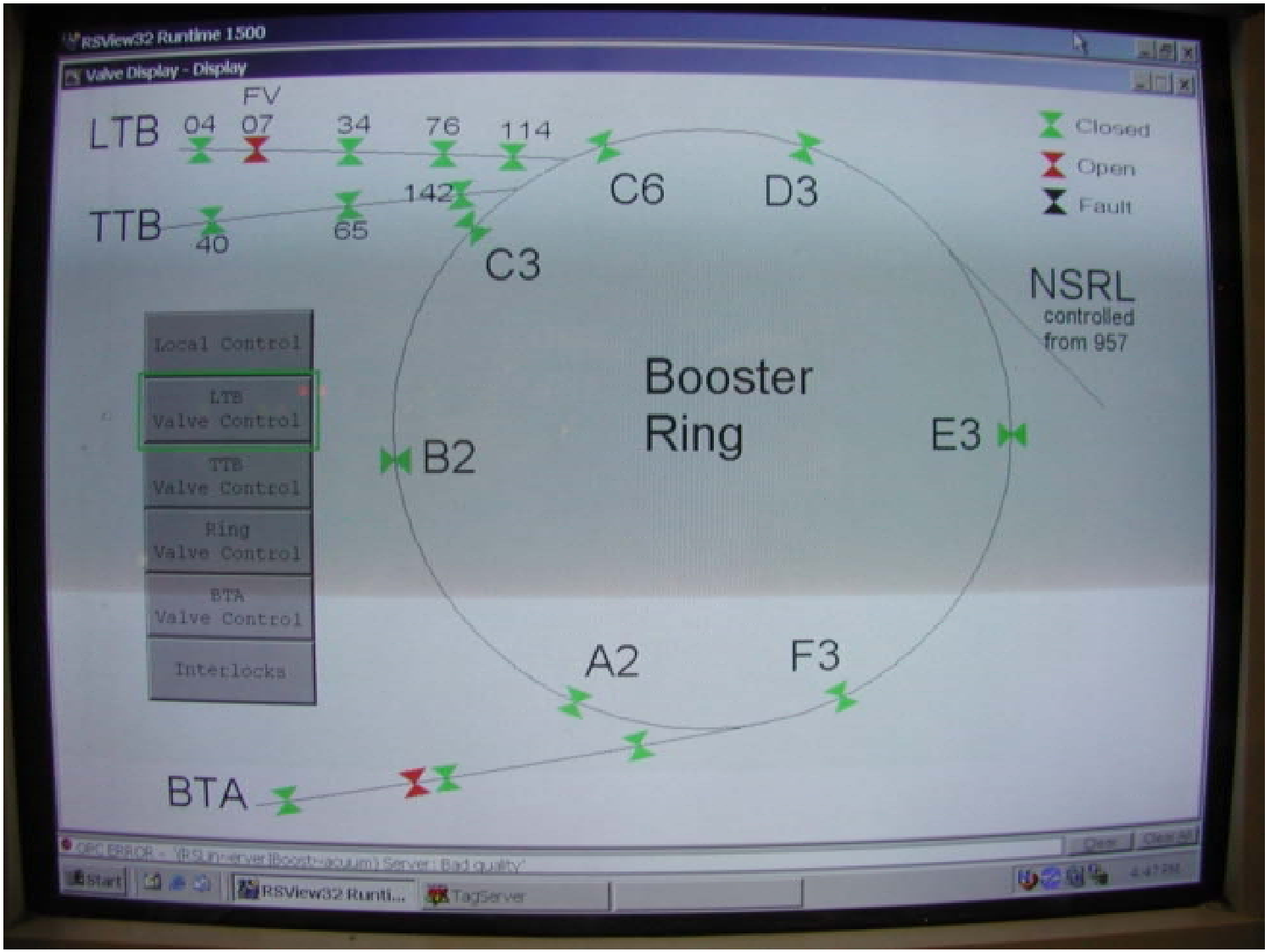


Booster

- Valve control - PLC with GUI in 930UEB (2003)
  - **pet** control of 19 sector valves in the Booster Ring and Transfer Lines
  - Input to LINAC F(ast)B(eam)I(nterrupt): inhibits LINAC if any valve in the Booster ring or LTB line closes
  - Two Fast Valves - valve closes in milliseconds if severe vacuum failure is detected in LTB and BTA lines

Booster

Booster GUI


RSView32 Runtime 1500
Valve Display - Display
FV
LTB
04
07
34
76
114
TTB
40
65
142
C6
D3
C3
Closed
Open
Fault
NSRL
controlled
from 957
Local Control
LTB
Valve Control
TTB
Valve Control
Ring
Valve Control
BTA
Valve Control
Interlocks
Booster
Ring
B2
E3
A2
F3
BTA
Start
RSView32 Runti...
TagServer

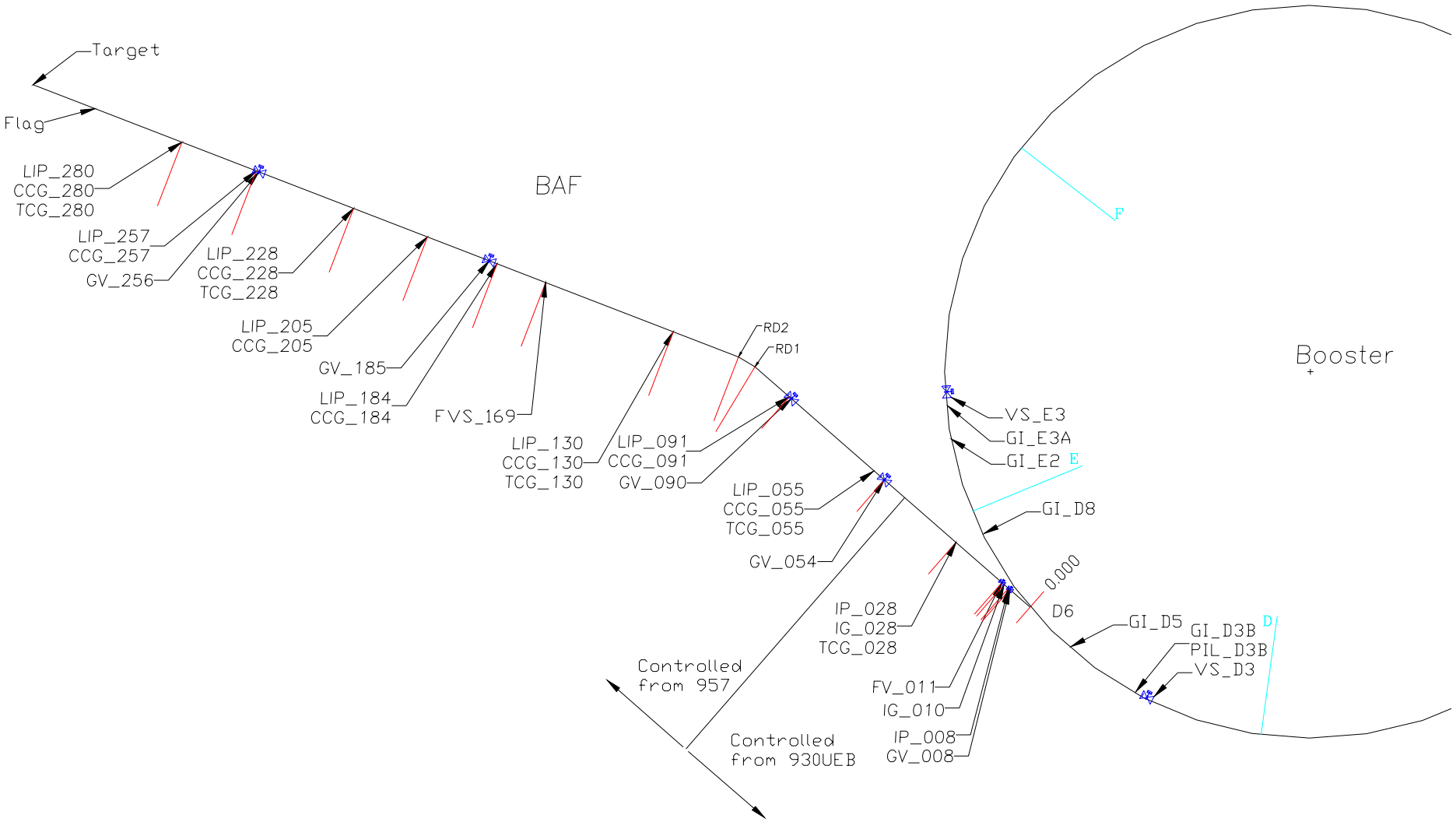
Booster

- Ion Pump Controls: BNL-design Dual power supplies with Datacom remote interface; Booster supplies similar to AGS units, modified to power up to 4 pumps
- Gauge Controls: Granville Phillips controller with RS-232 controls interface
- No Turbo stations in tunnel during Booster operation

Booster Lines

- LTB: LINAC to Booster
- TTB: Tandem to Booster
- BTA: Booster to AGS
- NSRL: Booster extraction to NASA space rad lab; AKA "R-line"
  - Only the pumps/gauges in the first section of the NSRL line is controlled from 930UEB

NSRL Layout


Target
Flag
LIP_280
CCG_280
TCG_280
LIP_257
CCG_257
GV_256
LIP_228
CCG_228
TCG_228
BAF
LIP_205
CCG_205
GV_185
LIP_184
CCG_184
FVS_169
LIP_130
CCG_130
TCG_130
LIP_091
CCG_091
GV_090
RD2
RD1
LIP_055
CCG_055
TCG_055
GV_054
IP_028
IG_028
TCG_028
Controlled
from 957
Controlled
from 930UEB
FV_011
IG_010
IP_008
GV_008
F
Booster
VS_E3
GI_E3A
GI_E2
E
GI_D8
0.000
D6
GI_D5
GI_D3B
PIL_D3B
VS_D3
D

NSRL

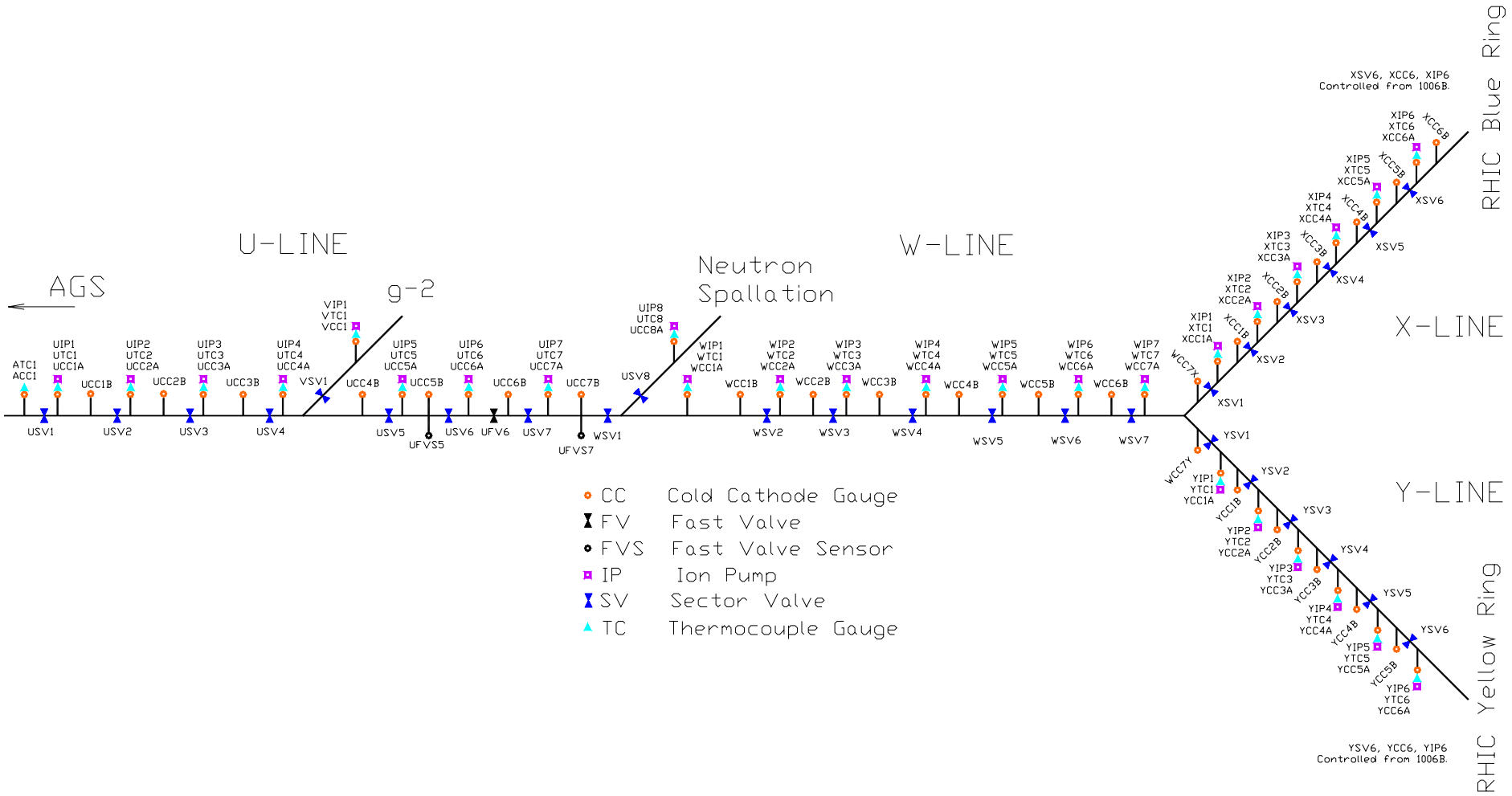
- Valve controls in 957
- Four sector valves, one fast-acting valve
- Physical Electronics ion pump controllers with RS-232 interface
- Balzers Pfeiffer gauge controllers with RS-232 interface

NSRL

RHIC

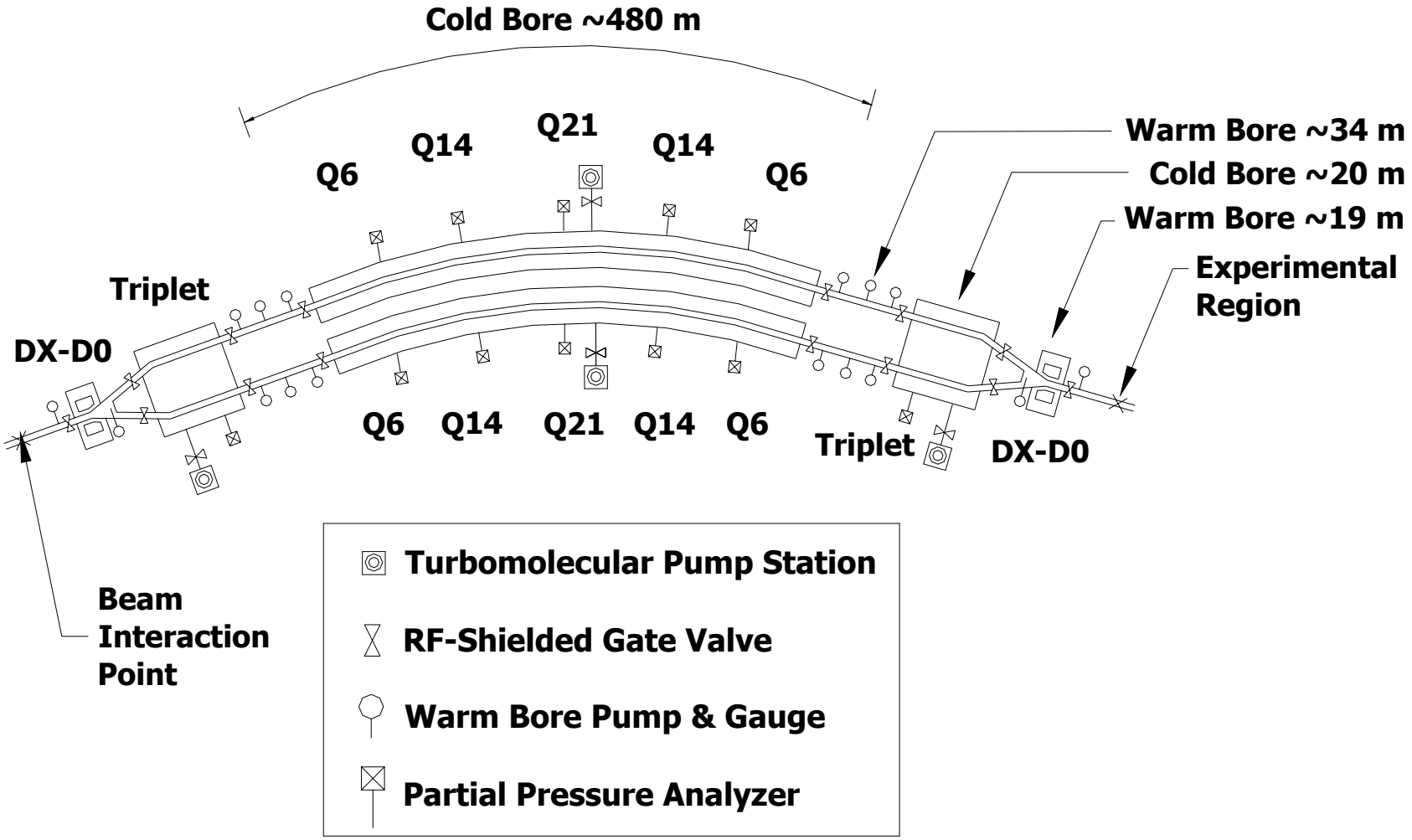
- Beam line vacuum
  - Cold bore: beam tube inside magnets, ~4 K
  - Warm bore: room temperature
- Cryostat vacuum
  - Insulates superconducting lead/magnets from room temperature

AtR Layout

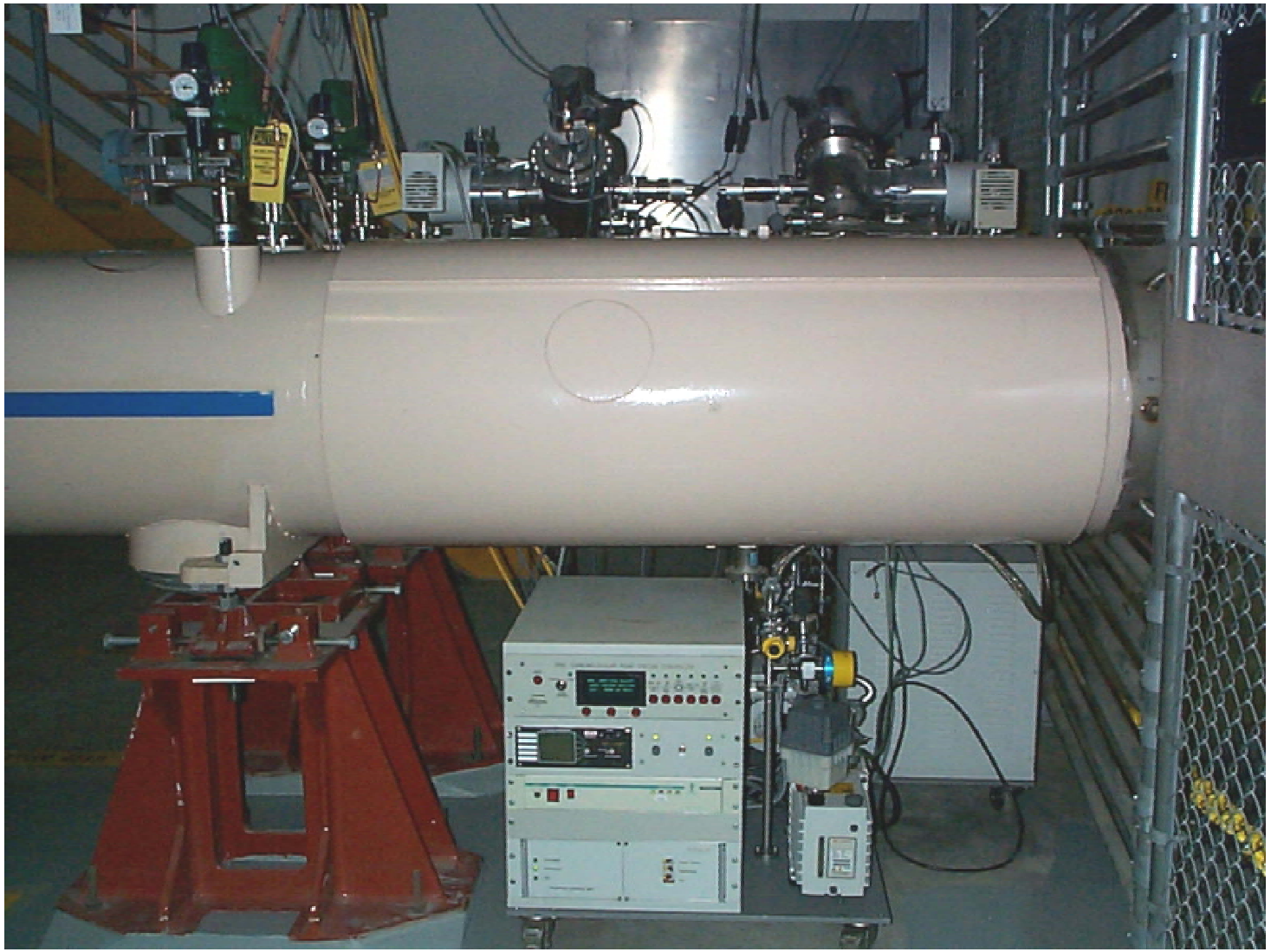

U-LINE
AGS
g-2
Neutron
Spallation
W-LINE
X-LINE
Y-LINE
RHIC Blue Ring
RHIC Yellow Ring
XSV6, XCC6, XIP6
Controlled from 1006B.
YSV6, YCC6, YIP6
Controlled from 1006B.
CC Cold Cathode Gauge
FV Fast Valve
FVS Fast Valve Sensor
IP Ion Pump
SV Sector Valve
TC Thermocouple Gauge

AtR Vacuum Controls 1000-P

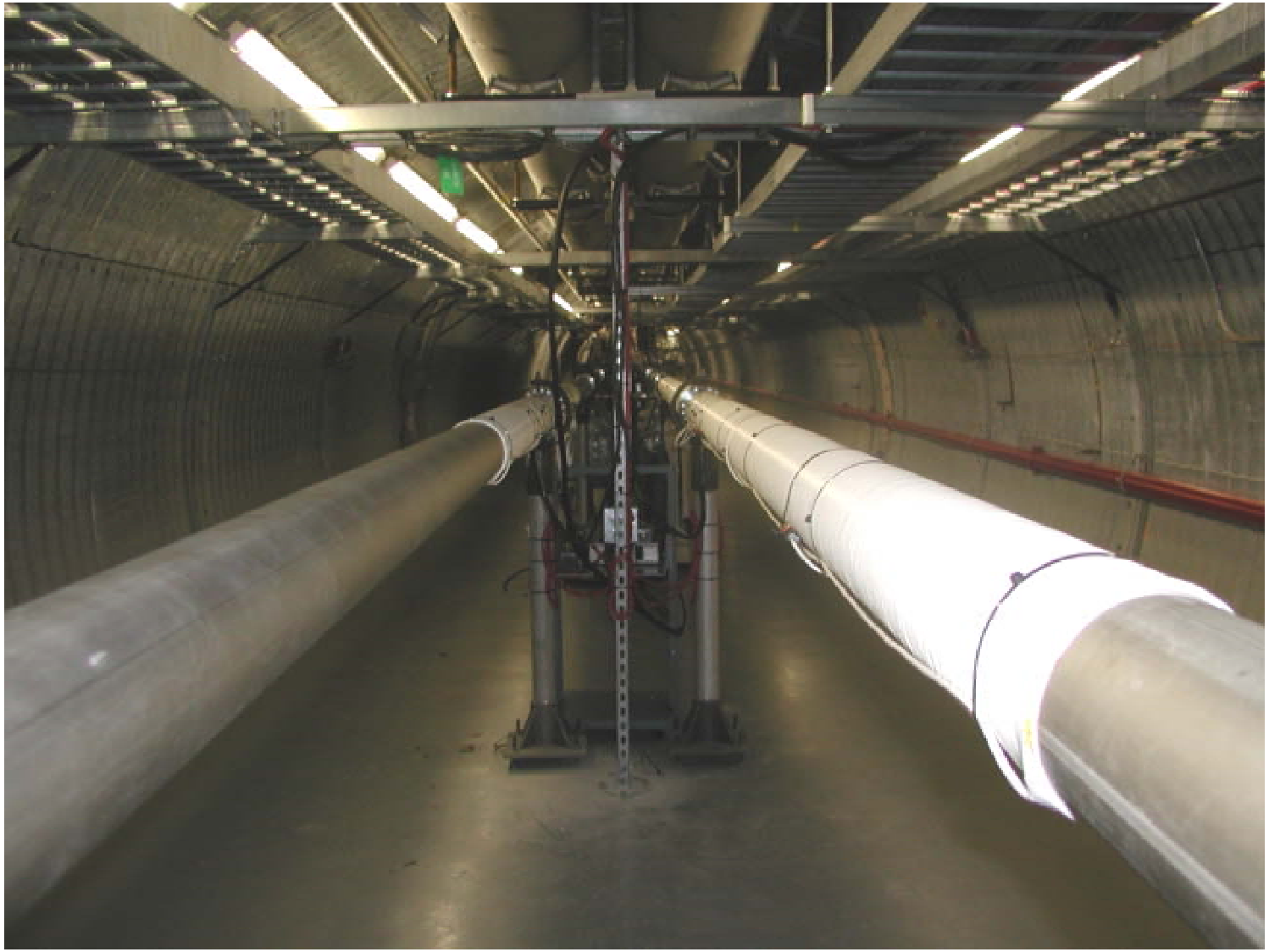
Detail A: One Sixth of the RHIC Ring



RHIC Cryostat



RHIC Warm Bore



RHIC

RHIC

- Beam line = Ultrahigh Vacuum
  - Thermal conductivity (TC) gauges, Cold cathode (CC) gauges, ion pumps (IPs), TSPs
  - Baked out during shutdown/maintenance
- Cryostat = High Vacuum
  - TC gauges, CC gauges, turbo pump stations
- VJR, VJRR lines = High Vacuum
  - TC gauges, stand-alone turbo pumps as needed

RHIC Valve Controls

- Valves close when associated gauges/pumps indicate high pressure
- Valve faults require a RESET before the valve can be re-opened
- PLCs located at A-Trailer, 1000-P, 1002B, 1004B, 1006B, 1008B, 1010A, and 1012A.
- PC GUI interfaces located at 1000-P and 1006B
- **`pet`** control of all sector valves
- Beam permit inputs at each of the 8 service buildings

Valve Control Pet Pages

- AGS/Vacuum/Valves
- Booster/Vacuum/Valves
- Booster/Vacuum/NSRL/Valve
- RHIC/Vacuum/SectorValves/Sectors_1+2, Sectors_3+4, Sectors_5+6, Sectors_7+8, Sectors_9+10, Sectors_11+12

Vacuum Alarms During Operations

- AGS, Booster, TTB, LTB, BTA, NSRL Valves
  - Alarm generated when valve closes
- RHIC Ion Pumps
  - Alarm generated when pumps turn OFF
- RHIC Valve Beam Permit Inputs
  - Various beam permits are pulled when one of 132 valves closes
  - Alarm generated when beam permit is pulled

Beam Permits

- AGS: Any valve closure causes the beam stop interlock relay to open; Access Controls system closes beam stops
- Booster: Any valve closure in the Booster ring or LTB line inhibits LINAC via the F(ast)B(eam)I(nterrupt)
- RHIC: Any valve closure pulls permit; RHIC Beam Permit system inputs in 1000-P, 1002B, 1004B, 1006B, 1008B, 1010A, and 1012A

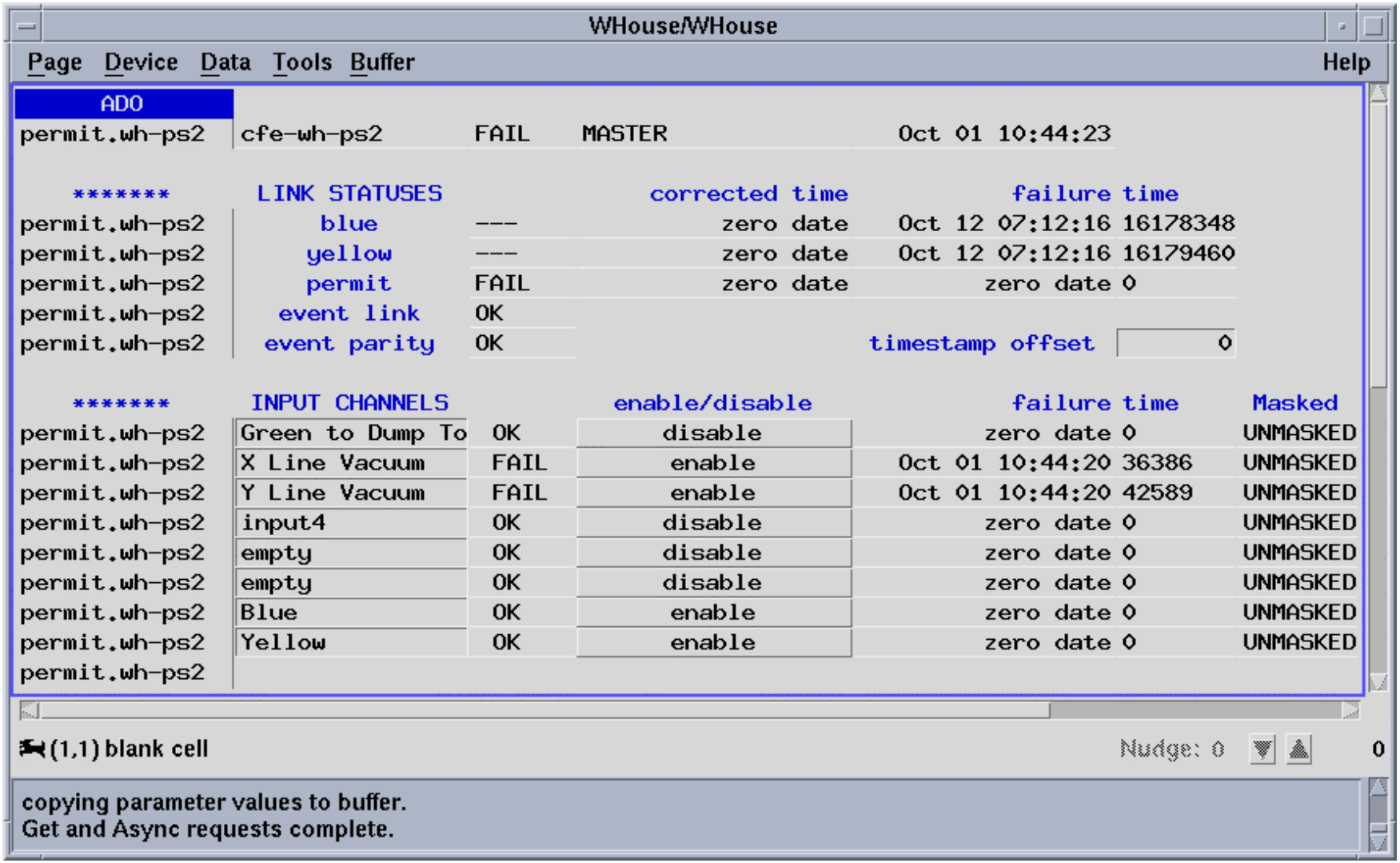
RHIC Vacuum Beam Permits

RHIC Vacuum Beam Permits

Location	BPL Chassis Input	Signal	Vacuum Valves Open
A-Trailer	Atrailer-1	g-2	U1 through U5 and V1
	Atrailer-2	U Line	U1 through U7 and the Fast Valve
1000P	Whouse-2	Z Line	W1 and U8 (for Neutron Spallation)
	Whouse-3	W Line	W1 through W7
	WhouseB-1	X Line	X1 through X6
	WhouseB-2	Y Line	Y1 through Y6
1002B	2b	3	Blue and Green Sectors 1 & 2
	2b	4	Yellow and Green Sectors 1 & 2
1004B	4b	3	Blue and Green Sectors 3 & 4
	4b	4	Yellow and Green Sectors 3 & 4
1006B	6b	3	Blue and Green Sectors 5 & 6
	6b	4	Yellow and Green Sectors 5 & 6
1008B	8b	3	Blue and Green Sectors 7 & 8
	8b	4	Yellow and Green Sectors 7 & 8
1010A	10A	3	Blue and Green Sectors 9 & 10
	10A	4	Yellow and Green Sectors 9 & 10
1012A	12A	3	Blue and Green Sectors 11 & 12
	12A	4	Yellow and Green Sectors 11 & 12

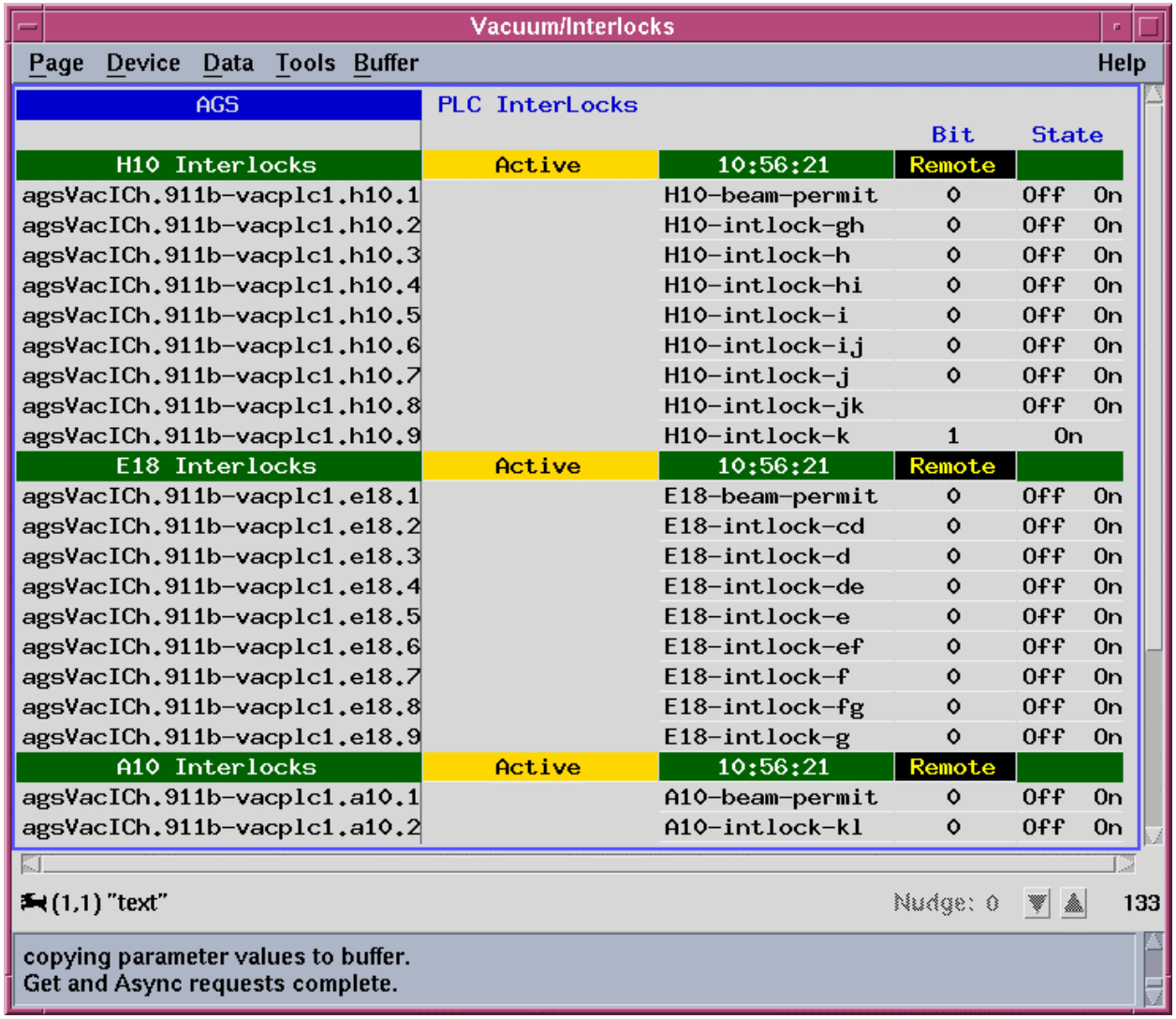
RHIC Permit Status

RHIC/Links/Permit/WHouse/WHouse



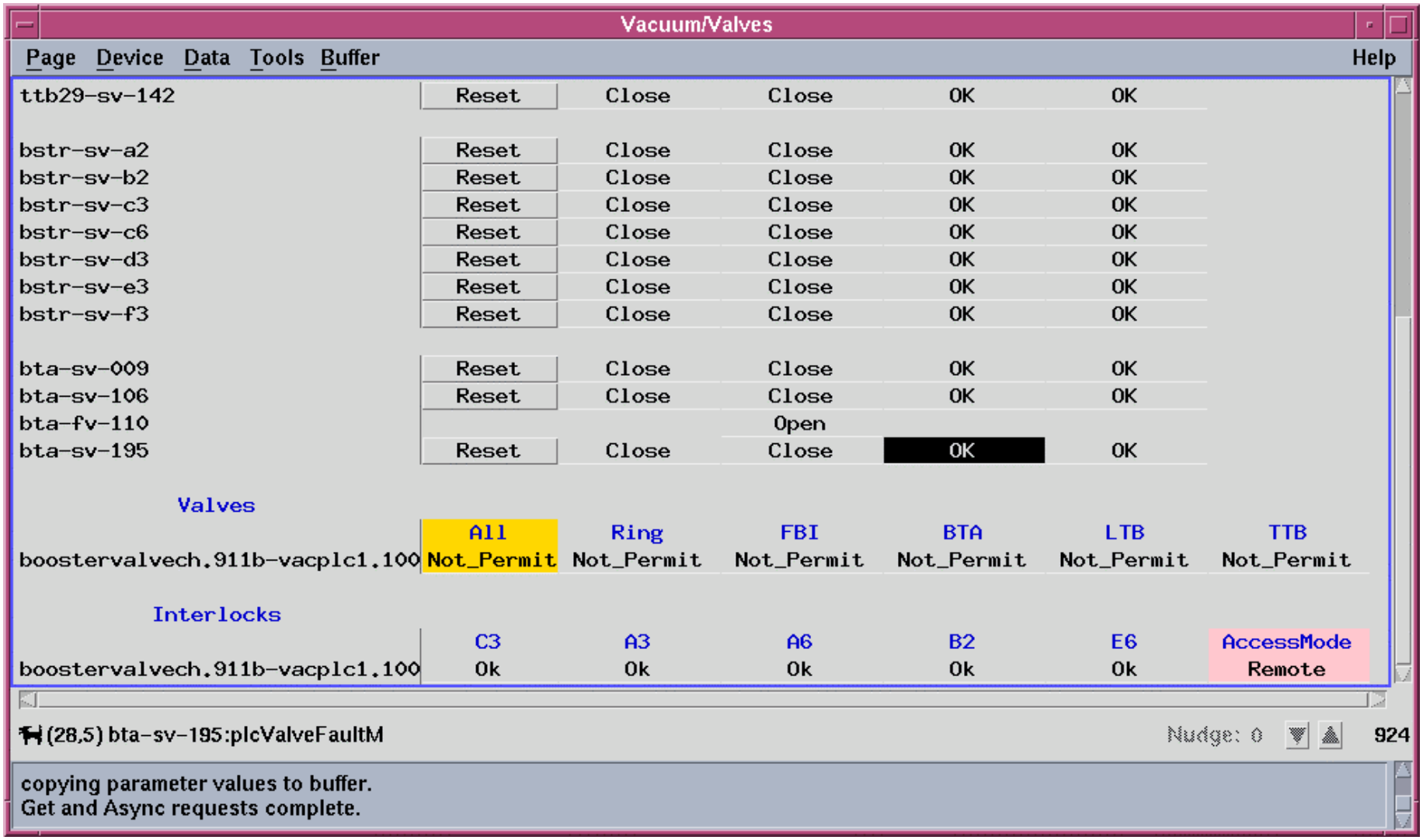
AGS Interlock Status

AGS/Vacuum/Interlocks



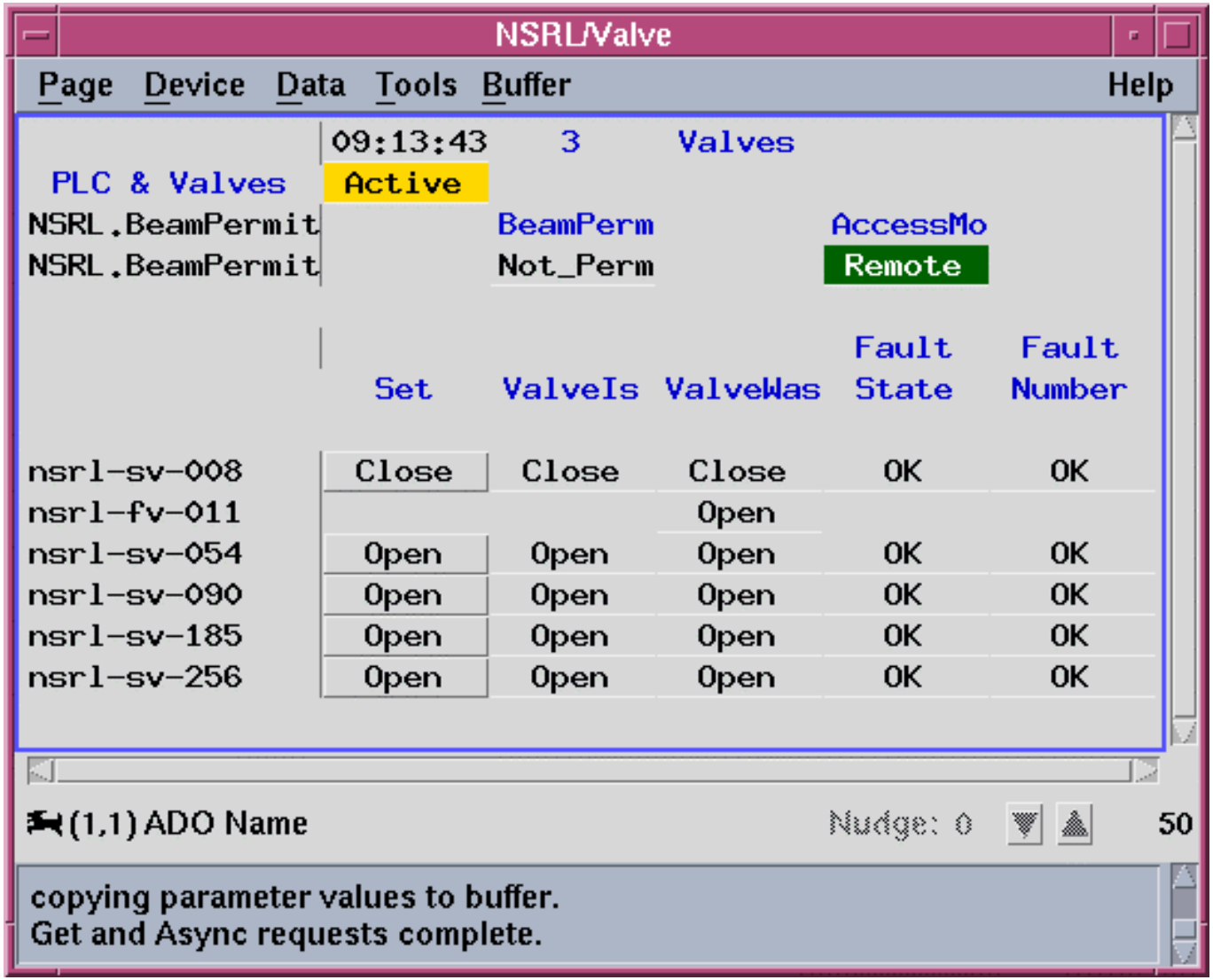
Booster Valve, Interlock Status

Booster/Vacuum/Valves



NSRL Valve, Permit Status

Booster/Vacuum/NSRL/Valve



Vacuum System Status During Shutdown

- All sector valves are normally CLOSED for duration of shutdown
- Most vacuum system ion pumps and gauges are left ON = energized
- Pumps and gauges LOTO by Vacuum personnel for system maintenance
- AGS ion pumps LOTO as required by others (e.g., cable pulling activity)

Vacuum Home Page

- www.cadops.bnl.gov/AGS/Accel/Vacuum