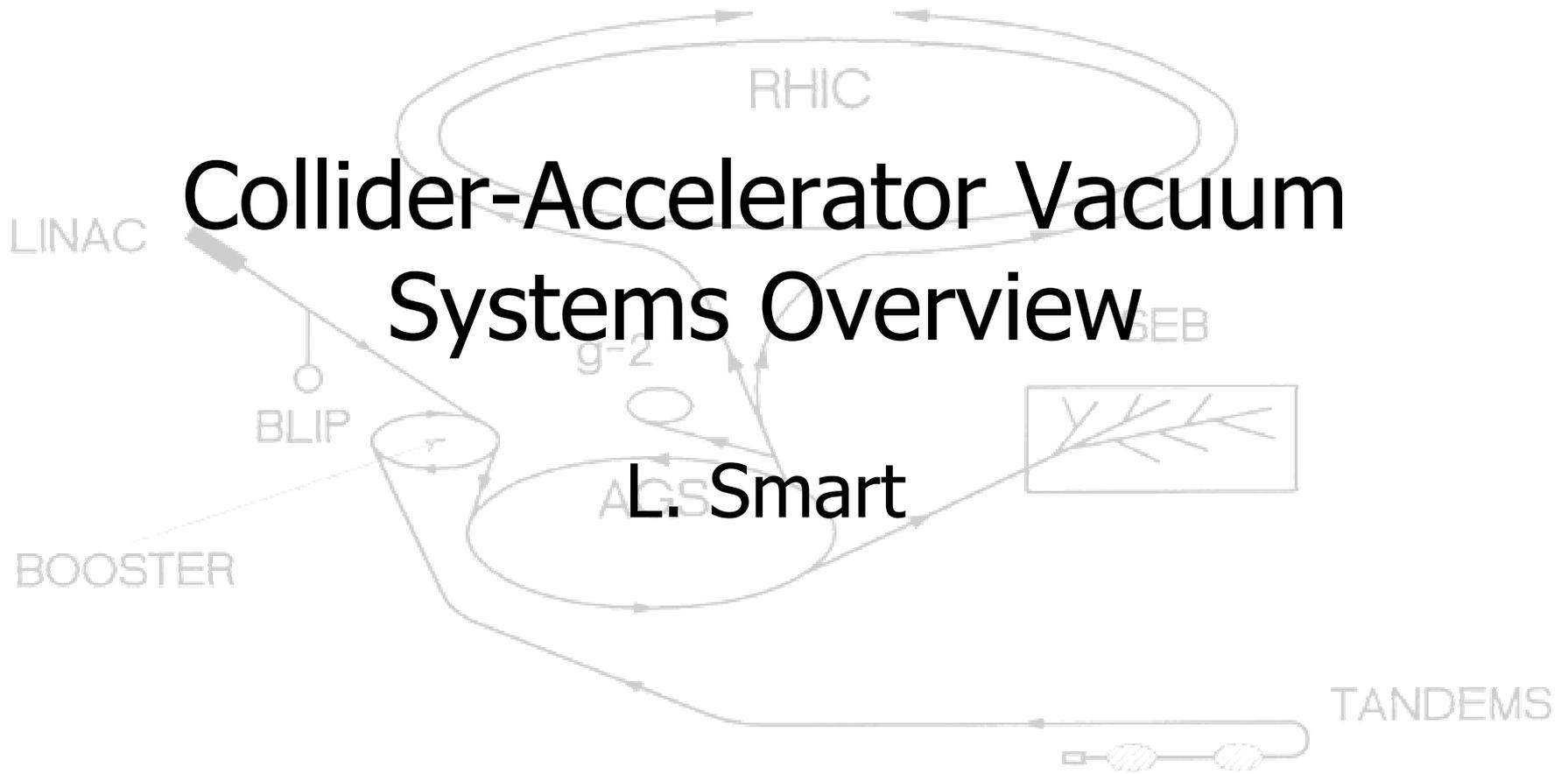


Collider-Accelerator Vacuum Systems Overview



Collider-Accelerator Vacuum Systems

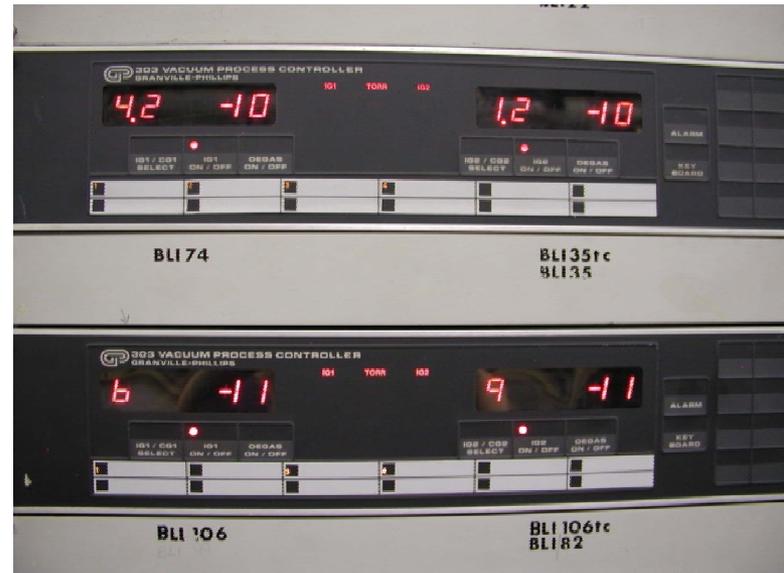
- AGS: A10, H10, E18, 929 (Seimens/RF)
- Booster, TTB, LTB, BTA: 930UEB
- NSRL: 957
- ATR, RHIC: A-Trailer, 1000-P, 1006B, 1008B, 1010A, 1012A, 1002B, 1004B.

Preinjector vacuum systems are not included in this discussion

Vacuum Equipment

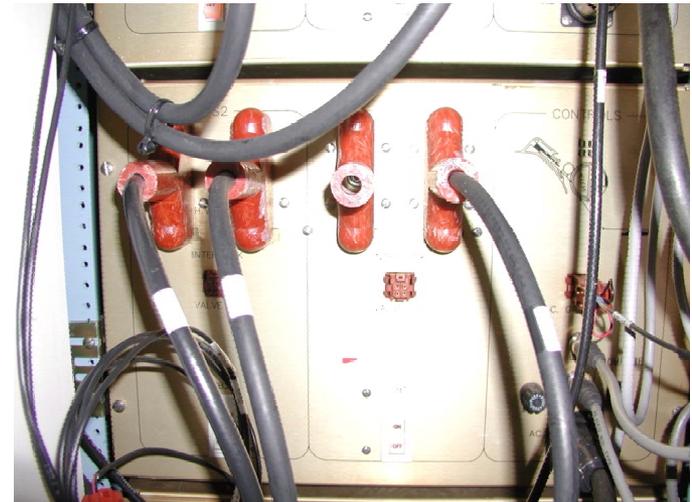
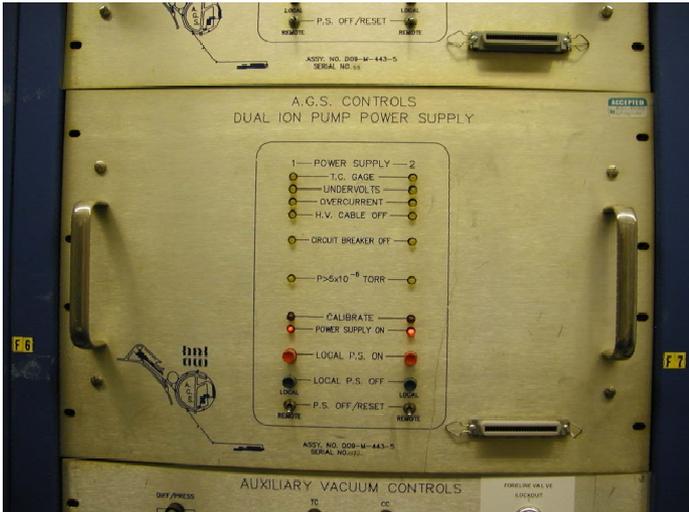
- Ion pump controllers
 - High voltage output ~ 5 kV; Current up to 400 mA; Range C electrical hazard
- Gauge Controllers
 - Ion Gauges (hot cathode gauges) operate at voltages 180+ V, up to ~ 500 V for degas (Booster)
 - Cold cathode gauges operate @ 4 kVdc, < 150 μ A; Range A electrical hazard (AGS, 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



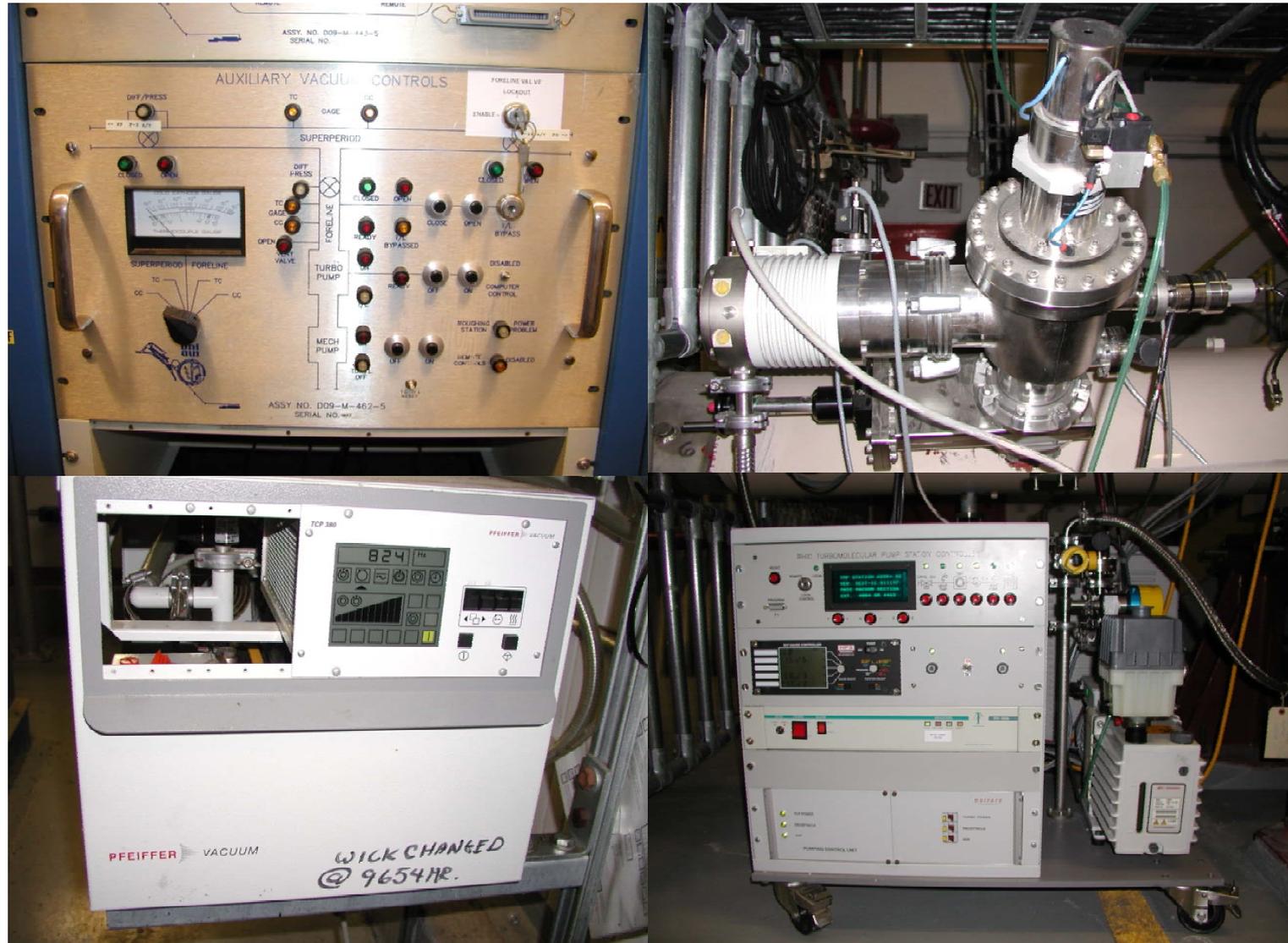
Ion Pump pet pages

- [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



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L. Smart - C-AD Vacuum System Overview

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

12a/Solenoids

Page Device Data Tools Buffer Help

	Field [Gauss]	Current [A]	Current-SetPoint [A]	Control	Status	Local/Remote
g11-solx.2-ps	0	0	0	DISABLE	DISABLED	REMOTE
g11-solx.1-ps	0	0	0	DISABLE	DISABLED	REMOTE
g12-solx-ps	0.010875	0.00375	0	DISABLE	DISABLED	REMOTE
yo12-sol3.1-ps	0	0	0	DISABLE	DISABLED	REMOTE
bi12-sol3.1.1-ps	0.02025	0.0075	0	DISABLE	DISABLED	REMOTE
bi12-sol3.1.2-ps	0.010125	0.00375	0	DISABLE	DISABLED	REMOTE
bi12-sol3.1.3-ps	0	0	0	DISABLE	DISABLED	REMOTE
bi12-sol3.2.1-ps	0	0	0	DISABLE	DISABLED	REMOTE
bi12-sol3.2.2-ps	0	0	0	DISABLE	DISABLED	REMOTE
bi12-sol3.2.3-ps	0	0	0	DISABLE	DISABLED	REMOTE

(1,1) blank cell

Nudge: 0 620

copying parameter values to buffer.
Get and Async requests complete.

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



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L. Smart - C-AD Vacuum System Overview

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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.

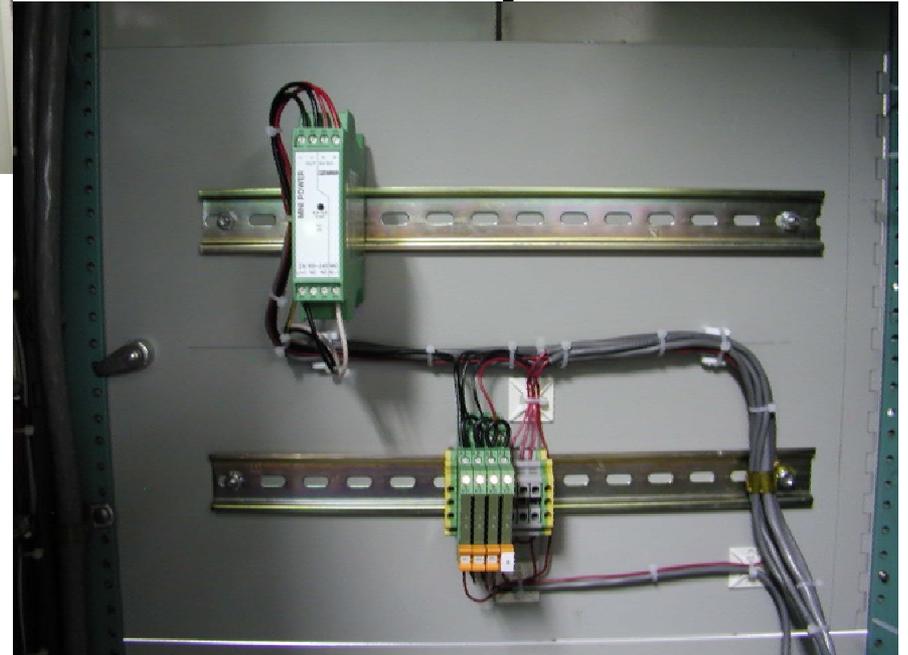
AGS Equipment Interlocks & BSI

- 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



BSI Relays

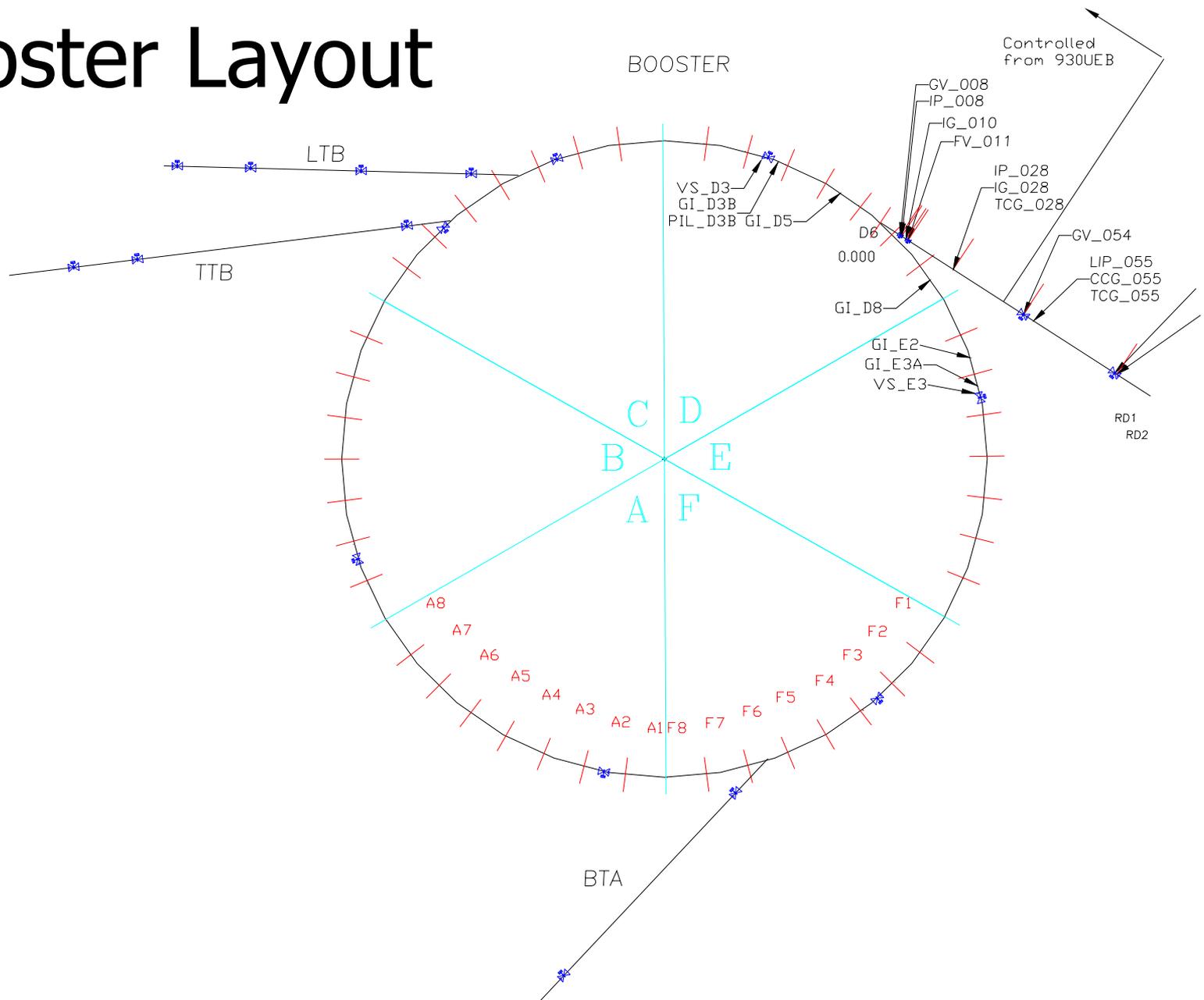
Equipment
Interlocks



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

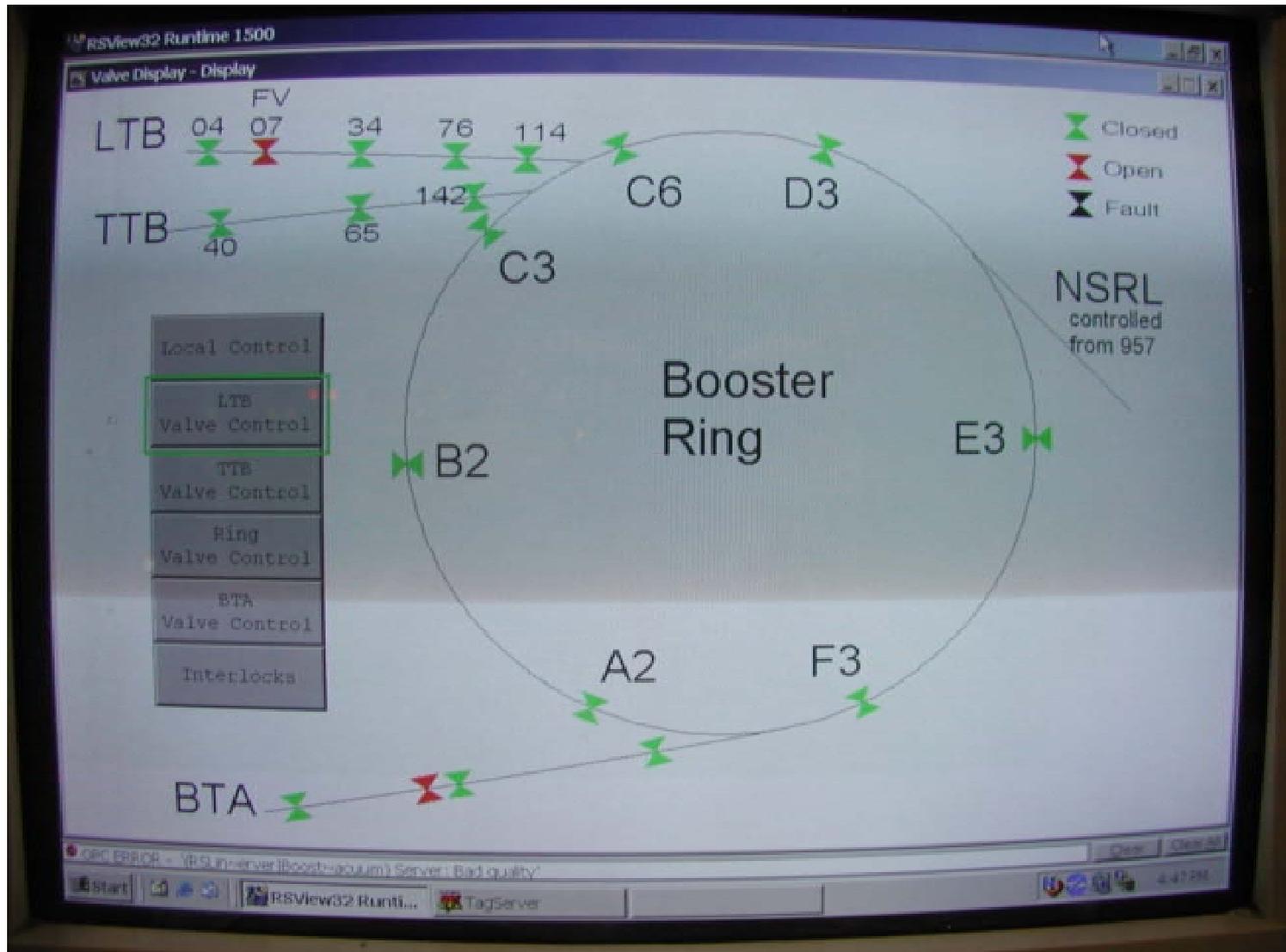


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L. Smart - C-AD Vacuum System Overview

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Booster GUI



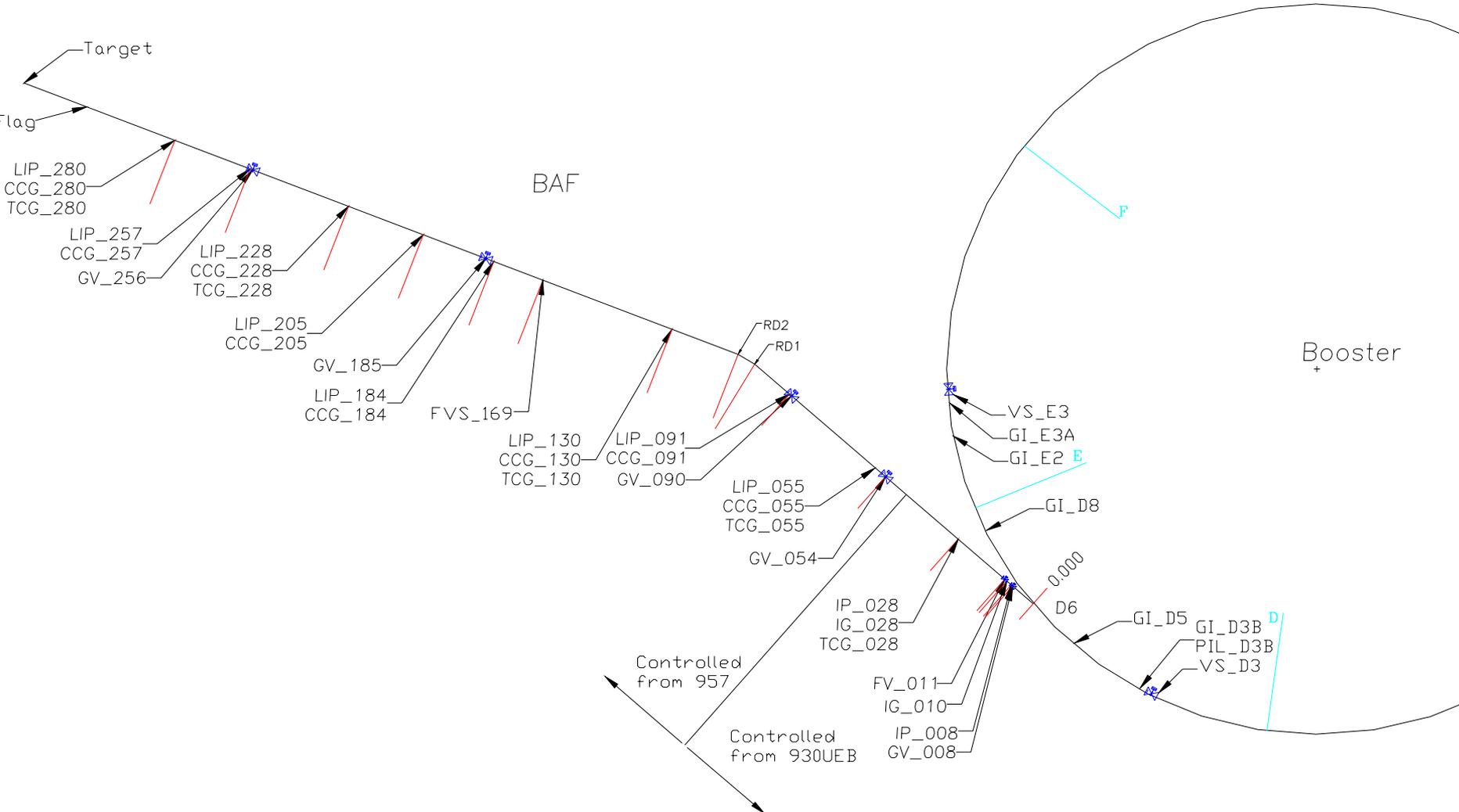
Booster

- 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



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

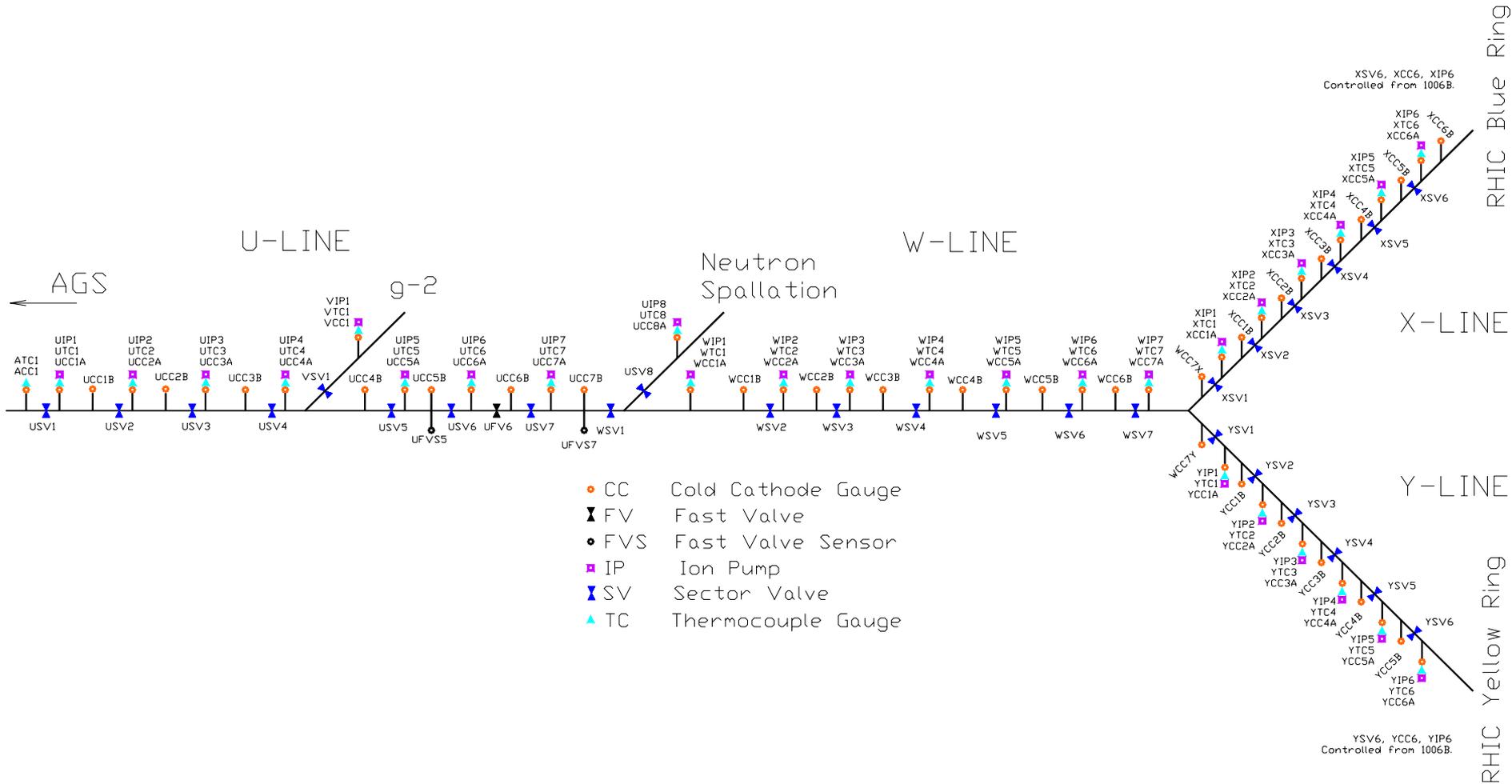
NSRL



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

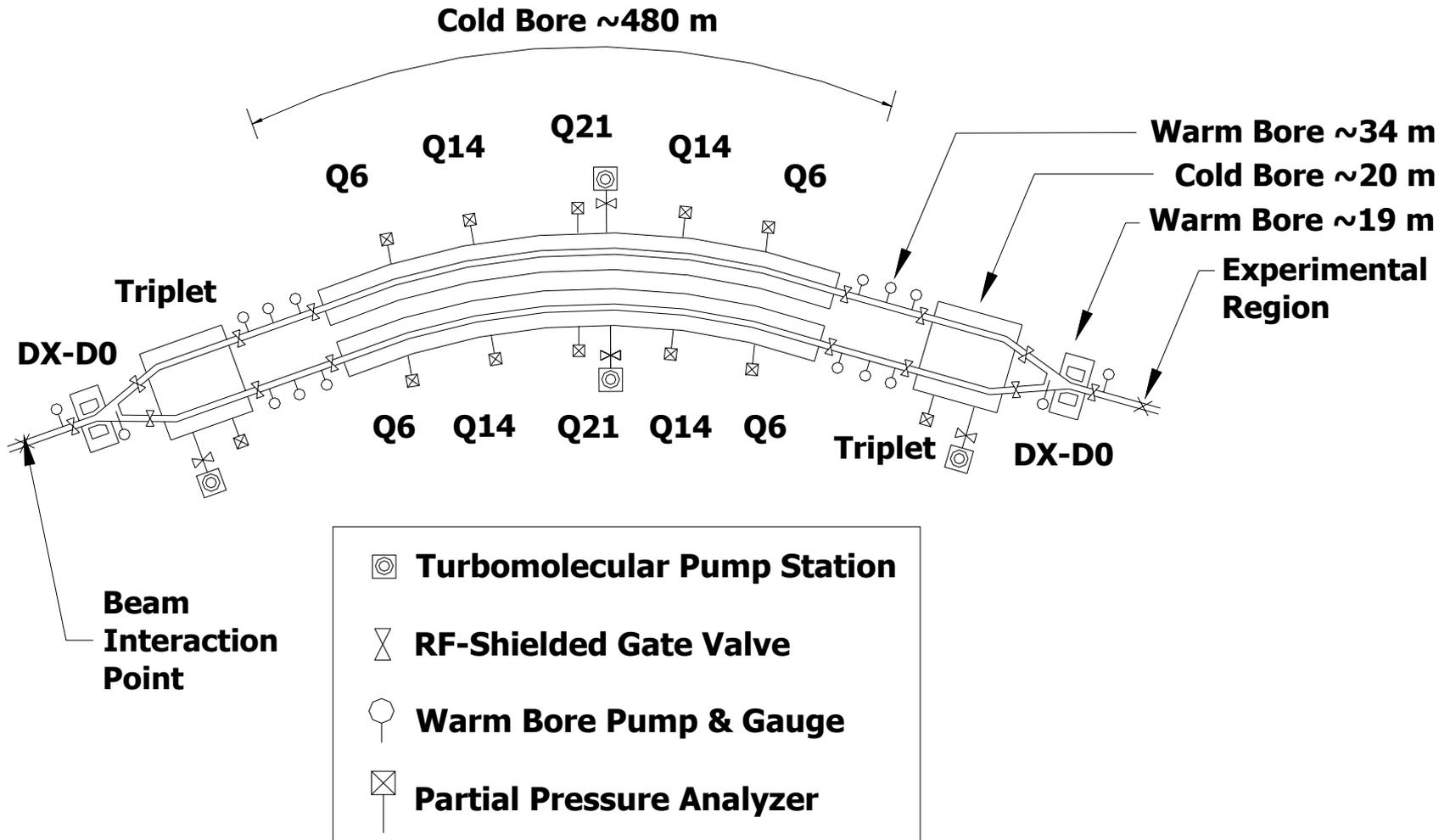
AtR Layout



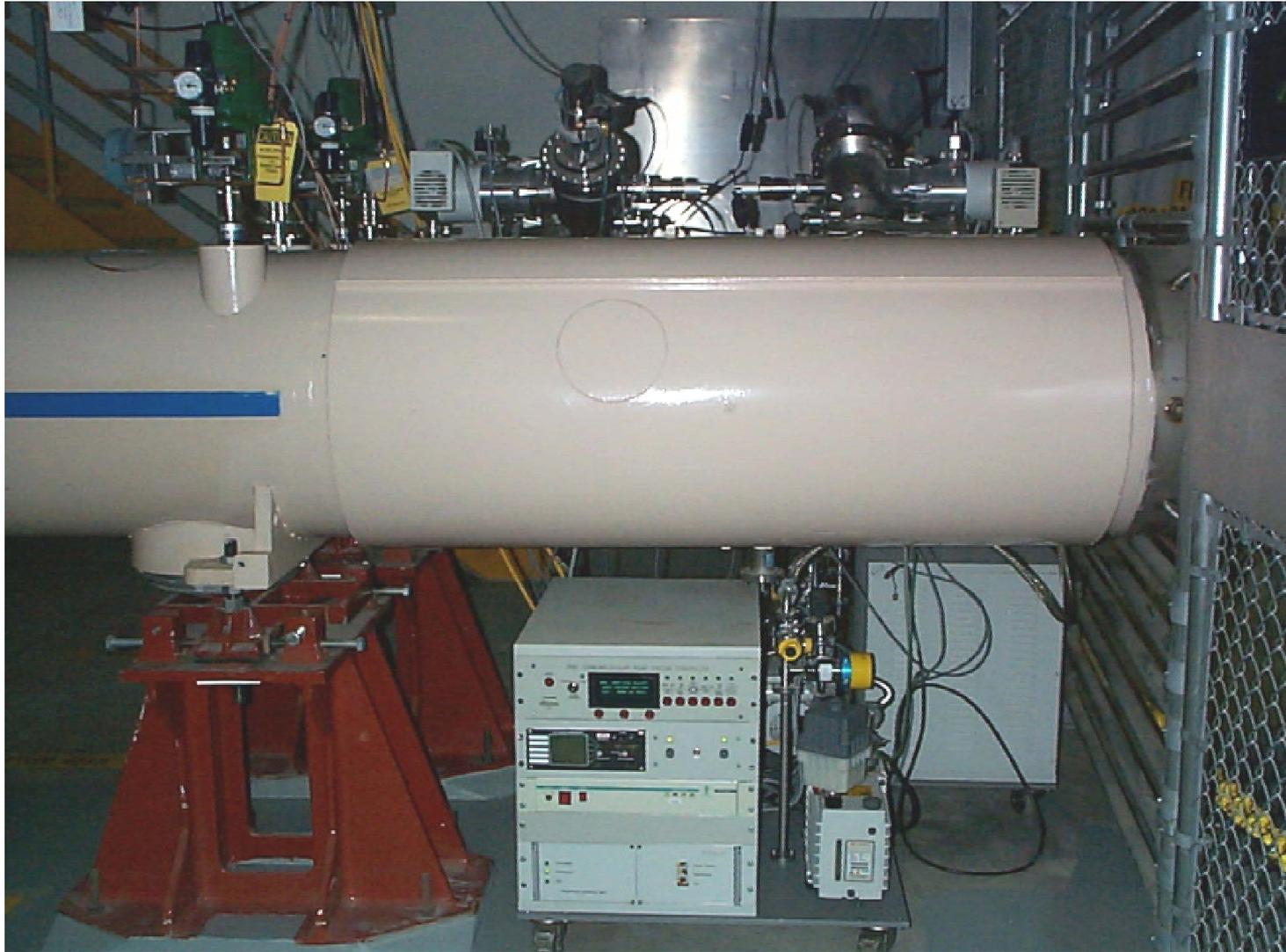


AtR Vacuum Controls 1000-P

Detail A: One Sixth of the RHIC Ring



RHIC Cryostat

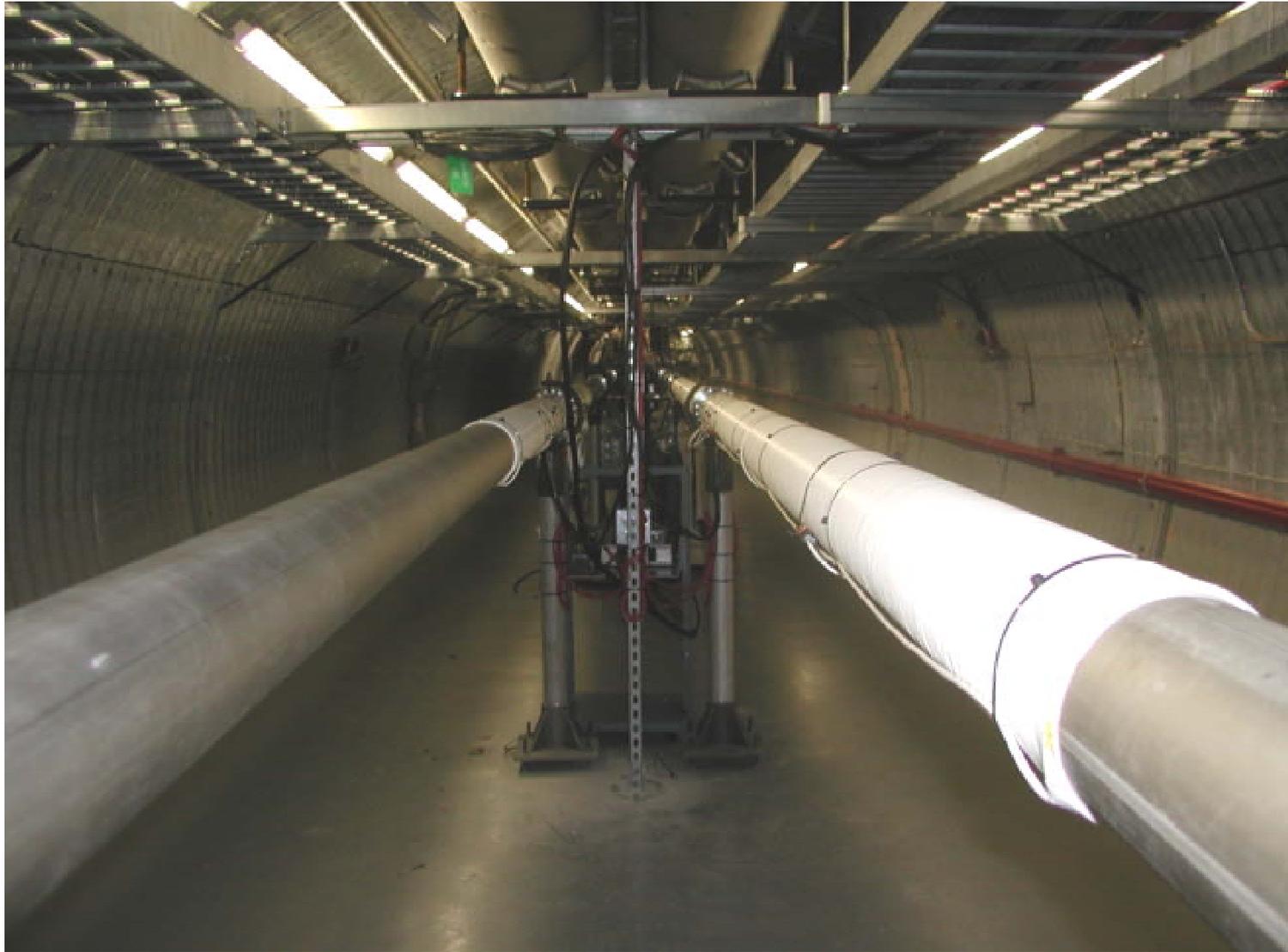


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RHIC Warm Bore



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RHIC



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L. Smart - C-AD Vacuum System Overview

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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

WHouse/WHouse

Page Device Data Tools Buffer Help

ADO

permit.wh-ps2 cfe-wh-ps2 FAIL MASTER Oct 01 10:44:23

***** LINK STATUSES

			corrected time	failure time
permit.wh-ps2	blue	---	zero date	Oct 12 07:12:16 16178348
permit.wh-ps2	yellow	---	zero date	Oct 12 07:12:16 16179460
permit.wh-ps2	permit	FAIL	zero date	zero date 0
permit.wh-ps2	event link	OK		
permit.wh-ps2	event parity	OK		

timestamp offset

***** INPUT CHANNELS

			enable/disable	failure time	Masked
permit.wh-ps2	Green to Dump To	OK	disable	zero date 0	UNMASKED
permit.wh-ps2	X Line Vacuum	FAIL	enable	Oct 01 10:44:20 36386	UNMASKED
permit.wh-ps2	Y Line Vacuum	FAIL	enable	Oct 01 10:44:20 42589	UNMASKED
permit.wh-ps2	input4	OK	disable	zero date 0	UNMASKED
permit.wh-ps2	empty	OK	disable	zero date 0	UNMASKED
permit.wh-ps2	empty	OK	disable	zero date 0	UNMASKED
permit.wh-ps2	Blue	OK	enable	zero date 0	UNMASKED
permit.wh-ps2	Yellow	OK	enable	zero date 0	UNMASKED

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copying parameter values to buffer.
Get and Async requests complete.

AGS Interlock Status

AGS/Vacuum/Interlocks

Vacuum/Interlocks					
Page	Device	Data	Tools	Buffer	Help
AGS		PLC InterLocks			
			Bit	State	
H10 Interlocks		Active	10:56:21	Remote	
agsVacICH.911b-vacplc1.h10.1		H10-beam-permit	0	Off	On
agsVacICH.911b-vacplc1.h10.2		H10-intlock-gh	0	Off	On
agsVacICH.911b-vacplc1.h10.3		H10-intlock-h	0	Off	On
agsVacICH.911b-vacplc1.h10.4		H10-intlock-hi	0	Off	On
agsVacICH.911b-vacplc1.h10.5		H10-intlock-i	0	Off	On
agsVacICH.911b-vacplc1.h10.6		H10-intlock-ij	0	Off	On
agsVacICH.911b-vacplc1.h10.7		H10-intlock-j	0	Off	On
agsVacICH.911b-vacplc1.h10.8		H10-intlock-jk		Off	On
agsVacICH.911b-vacplc1.h10.9		H10-intlock-k	1		On
E18 Interlocks		Active	10:56:21	Remote	
agsVacICH.911b-vacplc1.e18.1		E18-beam-permit	0	Off	On
agsVacICH.911b-vacplc1.e18.2		E18-intlock-cd	0	Off	On
agsVacICH.911b-vacplc1.e18.3		E18-intlock-d	0	Off	On
agsVacICH.911b-vacplc1.e18.4		E18-intlock-de	0	Off	On
agsVacICH.911b-vacplc1.e18.5		E18-intlock-e	0	Off	On
agsVacICH.911b-vacplc1.e18.6		E18-intlock-ef	0	Off	On
agsVacICH.911b-vacplc1.e18.7		E18-intlock-f	0	Off	On
agsVacICH.911b-vacplc1.e18.8		E18-intlock-fg	0	Off	On
agsVacICH.911b-vacplc1.e18.9		E18-intlock-g	0	Off	On
A10 Interlocks		Active	10:56:21	Remote	
agsVacICH.911b-vacplc1.a10.1		A10-beam-permit	0	Off	On
agsVacICH.911b-vacplc1.a10.2		A10-intlock-kl	0	Off	On

(1.1) "text" Nudge: 0 133

copying parameter values to buffer.
Get and Async requests complete.

Booster Valve, Interlock Status

Booster/Vacuum/Valves

Vacuum/Valves

Page Device Data Tools Buffer Help

ttb29-sv-142	Reset	Close	Close	OK	OK
bstr-sv-a2	Reset	Close	Close	OK	OK
bstr-sv-b2	Reset	Close	Close	OK	OK
bstr-sv-c3	Reset	Close	Close	OK	OK
bstr-sv-c6	Reset	Close	Close	OK	OK
bstr-sv-d3	Reset	Close	Close	OK	OK
bstr-sv-e3	Reset	Close	Close	OK	OK
bstr-sv-f3	Reset	Close	Close	OK	OK
bta-sv-009	Reset	Close	Close	OK	OK
bta-sv-106	Reset	Close	Close	OK	OK
bta-fv-110			Open		
bta-sv-195	Reset	Close	Close	OK	OK

Valves

	All	Ring	FBI	BTA	LTB	TTB
boostervalvech.911b-vacplc1.100	Not_Permit	Not_Permit	Not_Permit	Not_Permit	Not_Permit	Not_Permit

Interlocks

boostervalvech.911b-vacplc1.100	C3 Ok	A3 Ok	A6 Ok	B2 Ok	E6 Ok	AccessMode Remote
---------------------------------	----------	----------	----------	----------	----------	----------------------

(28,5) bta-sv-195:plcValveFaultM Nudge: 0 924

copying parameter values to buffer.
Get and Async requests complete.

NSRL Valve, Permit Status

Booster/Vacuum/NSRL/Valve

The screenshot shows the NSRLValve software interface. At the top, there is a menu bar with 'Page', 'Device', 'Data', 'Tools', 'Buffer', and 'Help'. Below the menu bar, the main display area shows the following information:

- Time: 09:13:43
- Count: 3
- Section: Valves
- Status: **Active** (highlighted in yellow)
- Permit: BeamPerm
- Access Mode: AccessMo
- Remote: **Remote** (highlighted in green)

Below this information is a table with the following columns: Set, ValveIs, ValveWas, Fault State, and Fault Number. The rows represent different valves:

	Set	ValveIs	ValveWas	Fault State	Fault Number
nsrl-sv-008	Close	Close	Close	OK	OK
nsrl-fv-011			Open		
nsrl-sv-054	Open	Open	Open	OK	OK
nsrl-sv-090	Open	Open	Open	OK	OK
nsrl-sv-185	Open	Open	Open	OK	OK
nsrl-sv-256	Open	Open	Open	OK	OK

At the bottom of the interface, there is a status bar showing '(1,1) ADO Name' and 'Nudge: 0'. Below the status bar, a message box displays the text: 'copying parameter values to buffer. Get and Async requests complete.'

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