SNS Vacuum 02/13/01 Meeting Minutes
L. Smart 02/16/01

A meeting was held on February 13, 2001 at Jefferson Laboratory to discuss

- Suitability of JLAB power supply for the SNS CCL/DTL and Ring/Transport Line subsystems
- SNS gauge controller and ion pump controller specifications
- SNS turbomolecular pump station design.

The meeting participants:

Bill Schneider	757-269-7173	schneide@jlab.org
Ganapati Myneni	757-269-7657	rao@jlab.org
Keith Kishiyama	925-422-8602	kishiyama1@llnl.gov
Isidoro Campisi	757-269-7650	campisi@jlab.org
Dan Weiss	631-344-4463	dweiss@bnl.gov
Loralie Smart	631-344-2425	lsmart@bnl.gov
Johnny Tang	631-344-5175	jtang@bnl.gov
Dick Hseuh	631-344-7505	hseuh@bnl.gov
Kevin Jordan	757-269-7023	jordan@jlab.org
Bob Dalesio	410-557-0297 or 505-667-3414	ldalesio@lanl.gov
Mircea Stirbet	757-269-7659	stirbet@jlab.org

1) JLAB IPPS Overview

An overview of the JLAB Ion pump power supplies was presented by Kevin Jordan. The compact, 70-mA power supply has proven reliability and has sub-millisecond response time for >4 decade pressure rise. Base unit cost is ~$750.

a) The failure rate is low; the power supplies require little maintenance.

b) A self-biasing FET protects the supply from shorts at the output.

c) One potentiometer in the supply is used to adjust the over-current. Supply trips if current is > 10 mA after 15 minutes at 70 mA start current.

d) The interlock trip levels are set in control cards through potentiometers.

e) The power supply remote interface control card has 3 discrete outputs (On/Off/Enable), 2 discrete inputs (Trip/Ready), and one analog input per supply. Each control card handles signals from 2 power supplies. The control cards also have proven reliability.

f) The front panel has LED indicators for power supply Enable and ON, and a BNC for analog current reading. Three switches provide local control of power supply On/Off/Enable.

Discussion included ELBE window breakage and proper CW interlock protection.
The ELBE system uses Varian MidiVac controllers, which require a power-up reset when the units trip off. The MidiVacs die when their gun arcs. The recent ELBE window break was caused by window heating due to sustained arcing and lack of vacuum interlocks.

2) Gauge controller and ion pump controller specifications

Loralie Smart discussed gauge controller and ion pump controller draft specifications. Safety issues were briefly addressed - there are no LOTO concerns with the JLAB supplies. There is also no concern regarding cable-to-connector compatibility. Local displays are not essential to CCL/DTL, but are desired by Ring systems. The use of a modified JLAB power supply precludes the need for Controls to implement remote serial communication software.

a) Large Ion Pump Control

To satisfy the CCL/DTL and RING requirements, the JLAB IPPS would require 200 mA start current and 10 mA continuous duty output. Ring systems would require a high voltage readout.

b) Cold Cathode Control

To be used for the CCL/DTL cold cathode gauge, the power supply would require a lower output voltage, perhaps smaller transformer, capacitors, etc. and a review of the log amplifier specifications. The cold cathode controller must read current down to 1×10^{-10} Torr (~0.1 nA).

c) Response Time

The CCL/DTL cold cathode response time requirement is 13-30 ms (one or two pulses, to be determined). The SNS RF pulse is 1.3 ms @ 60 Hz (300 usec rise time, 1 ms flat-top). The cold cathode response time for the non-CW SNS SRF power couplers could be 13 ms or longer. There is no response time requirement for ion pump controllers for the CCL/DTL or Ring/Transport subsystems.

Kevin raised timing issues - should the RF check the vacuum interlock just prior to turning on?

Balzers gauge controller card specifications state a response time <50 ms. Loralie will acquire a controller and gauge set to test the response time.

d) IPPS Control Interfaces

Should the JLAB power supply modifications be pursued, there are two ways of remote IPPS control. The first is to use the JLAB CAMAC control cards. The second is to replace the functionality of the CAMAC cards with PLC software. The cost per analog input channel, ADC resolution, and ADC response time requires a closer look. Numbers approximated: $50 per channel for a 64-channel, 10 kHz, 12-bit ADC. A fast ADC could cost $1.5k per channel.

3) Tour

Tour of FEL facility, with IPPS in action. Photos courtesy of J. Tang, Appendix A.

4) PLC Programming

PLC programming architecture was briefly discussed. The goal is to structure code and programs similarly for valve control. The scope of the PLC control system (IPPS and/or TMPS control) is not yet fixed, and may impact the program structure. The current CCL/DTL budget includes one PLC per tank.

5) TMPS Design

Dan Weiss presented the evolution of the Turbomolecular pump (TMP) cart design. The design includes local control of station components with station control logic residing in a remote PLC. This configuration requires about 40 conductors.

Bob Dalesio brought up the possibility of using Flex I/O modules, which require twisted pairs rather than multi-conductors, to ship the signals back to the PLC. The SCL would require cables run to 34 locations from 9 racks in the Klystron gallery. Warm LINAC will not use standard TMP cart for windows/NEG locations. SCL may use standard cart for insulating vacuum pump-down only.

Radiation-induced failures were contemplated.

TMP Cart Design Recommendations to facilitate use on SCL systems

a) Add a manual valve on the beam line side of the electro-pneumatic PIV. The PIV will be installed with the TMP cart.

b) Control the PIV through the TMP cart since the valve would never be operated if the station were not present.

c) Add CCG for independent station operation.

d) Investigate the use of Flex I/O to minimize cabling.

The fore pump I/O should include an Auxiliary signal. A revised schematic will be generated for review.

6) RF Conditioning

Mircea Stirbet presented data documenting vacuum response during RF conditioning at LEP. The vacuum readings increased gradually over 40-50 ms. In addition to the critical shutdown interlock, analog input to the RF system was used to attenuate power as the vacuum degraded. See UHV Gauge and Controller Specifications (2 pages, Appendix B).

7) Action Items

a) Verify commercial controller gauge response time (Smart).

b) Determine Ring/CCL/DTL interest in IPPS modifications for large ion pump control (Smart/Kishiyama).

c) Investigate IPPS modifications for 200 mA @ 2500 V start, 10 mA sustained output, and front panel voltage tap for large ion pumps (Jordan). This action item depends upon item b) above.

d) Determine Ring/CCL/DTL interest in IPPS modifications for cold cathode gauge control (Smart/Kishiyama).

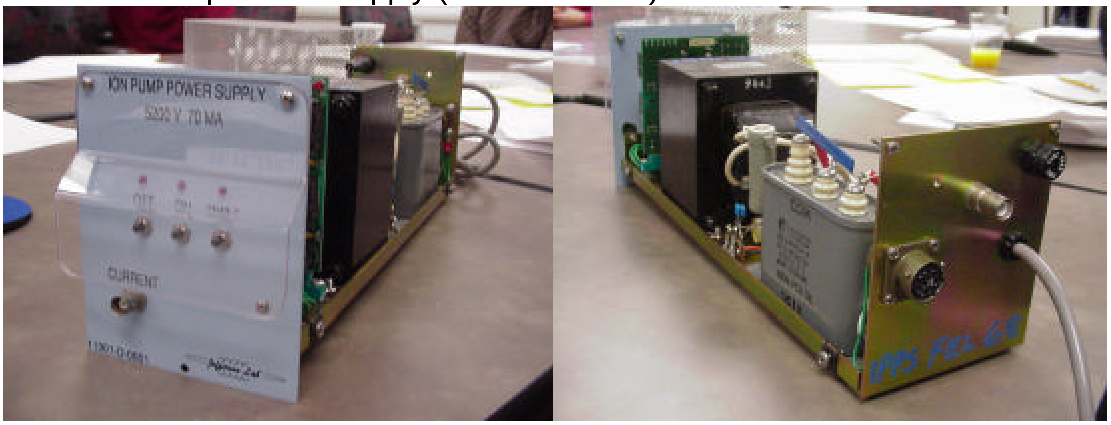
e) Investigate IPPS modifications for cold cathode control at reduced voltage and log amp resolution down to 0.1 nA. Test response time for modified unit at 1e-7 and 1e-9 Torr (Jordan). This action item depends upon commercial controller response time and item d) above.

f) Nail down response time requirements for RF interlocks (SNS Project).

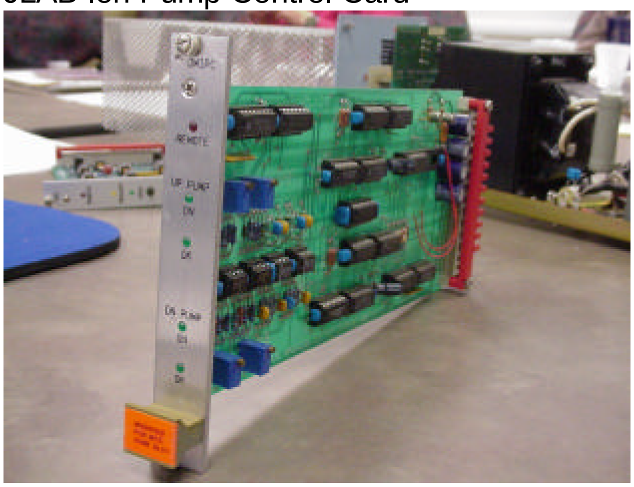
g) Circulate TMP Cart design iterations with recommendations listed in section 5 (Weiss/Kishiyama)

Appendix A.

JLAB Ion Pump Power Supply (5200 V 70 MA)



JLAB Ion Pump Control Card



Live JLAB Ion Pump Controllers for FEL at JLAB

Appendix B

UHV gauge specification:

Measurement Range	1.0 10^{-9} to 1.0 Pa	Observations
Material exposed to vacuum	Stainless steel shell, alumina ceramic feed through	
Reproducibility	5% of reading at constant temperature	
Cables and connectors	Tube side: molded connector with a positive locking bolt or triaxial. Controller side: bayonet connector and threaded coaxial connector	Depending on the controller input
Bakeout temperature	250°C with cable attached to the controller (operational during baking)	
Operating temperature	0 to 70°C	Storage temperature $\pm$50°C
Calibration gas	Air, Nitrogen or Argon	
Installation orientation	Any	
Weight	< 250 g	
Connecting flange	Mini ConFlat® (CF16, CF25, CF34?)	Conform to VDE 0160
Sensor dimensions	Length 60 - 80 mm, ∅ 25 - 35 mm	
Connector	Length 40-50 mm, ∅ 25-35 mm	Bending cable ~∅ 50mm
Materials exposed to vacuum	UHV compatible, resistant to vibrations and radiations (10^7 Gy).	
Easy of maintenance	No need to degas the gauge, when mounted cleaning should be possible with HV discharges.	
The measured signal dependence	The values displayed should be accurate for dry air, N_2, 0_2 & CO.	The measurement signals depending on the gas type
Leak rate	<10^{-10} Pa l/s	
Overpressure	Max 10 bar	
Cleaning	Conform with clean room class 10	
Cable	Length 100 m, ∅12 -16 mm	Cable jacketing CL2 or plenum rated. Radiation resistant
Ignition delay	Less than 5 minutes at 10^{-8} Pa	

I prefer Cold Cathode Gauge Tubes: Cold cathode discharge gauges are pr(economical and durable alternative to hot filament ionization gauges in the high-pre regime. With no active components such as hot filaments, the discharge gauge is destroyed in sudden or prolonged high-pressure gas exposures.

These vacuum gauges should be robust to withstand sudden vacuum burst in process normal RF conditioning of the main power coupler as well as RF and high pressure helium cavity processing.

Appendix B (continued)

Controller for UHV gauge specification:

Measurement Range	1.0 10^{-7} to 1.0 Pa	Observations
Display	Simultaneous digital display of at least two gauges	
Reproducibility	5% of reading at constant temperature	
Set point response	Less than 50 ms	
HV at gauge	3.3 kV	
Cables and Connectors	Tube side: molded connector with a positive locking bolt or triaxial. Controller side: bayonet connector and threaded coaxial connector	Depending on the controller input
Readout (display range)	Direct readout for Air from 1.0 to 1.0 10^{-9} Pa	
Operating temperature	0 to 70°C	Storage temperature ±50°C
ass control	Up to six control set points	
Installation orientation	Any	
Interfaces	RS232, RS485 or IEEE 488	
Protections	Automatic cold cathode gauge ON/OFF	
Output	At least two analog outputs	
Units of measurements	Mbar, torr, Pa, Micron	Selectable
The measured signal dependence	The values displayed should be accurate for dry air, N2, 02 & CO.	The measurement signals depending on the type of gas being measured
Chart recorder output	0 to 10 V, log/lin divisions	
Main connection	50/60 Hz, 110, 230 V	
Memory	Non-volatile parameter Memory	
Cable	Length 100 m, ∅12-16 mm	
Certification	89/336/EEC Directive 73/23/EEC Low Voltage Directive	
Ignition delay	Less than 5 minutes at 10^{-8} Pa	