

SLArchetto Operation Procedure

Yun-Tse Tsai

May 11, 2022

Notes:

- All the doors of the LNTF hut have to be open, the intake fan has to be turned on, and oxygen deficiency sensor and monitor (ODM) have to be checked.
- V3, V5, V6, V9, V18 isolate the LAr filter. During the LAr filling, V5, V9, and V18 should be always closed.
- V12, V13, V14 (V15, V16, V17) isolate the SLArchetto vessel. V13 and V16 should be always closed, while V14 should be always open until the very end of the LAr filling.
- After connecting a new LAr supply dewar, purge the air in the tube from V2.
- At the beginning of LAr filling, LAr evaporates in the LAr filter. Purge the gas Ar from V10 because the LAr filter doesn't filter gas Ar, and this gas Ar will contaminate the LAr in SLArchetto in the end.
- When starting filling LAr in SLArchetto (at the room temperature), all the LAr will evaporate. This is the time that pressure will build up in the system. Carefully control V15 to release the pressure.
- Keep the pressure in the SLArchetto vessel at 2 – 4 psig (16.5 – 18.5 psia).
- The torque for V3 and V17 is 25 foot-pound.
- RTD2 (the bottom one) is not available in this run, but it is repetitive to RTD1.
- RTD3 in this run is connected to Cryocon channel B.
- Take LArPix data during filling (but after the vessel is at \geq atmospheric pressure).
- Turn off the LArPix tile before ramping up the high voltage.

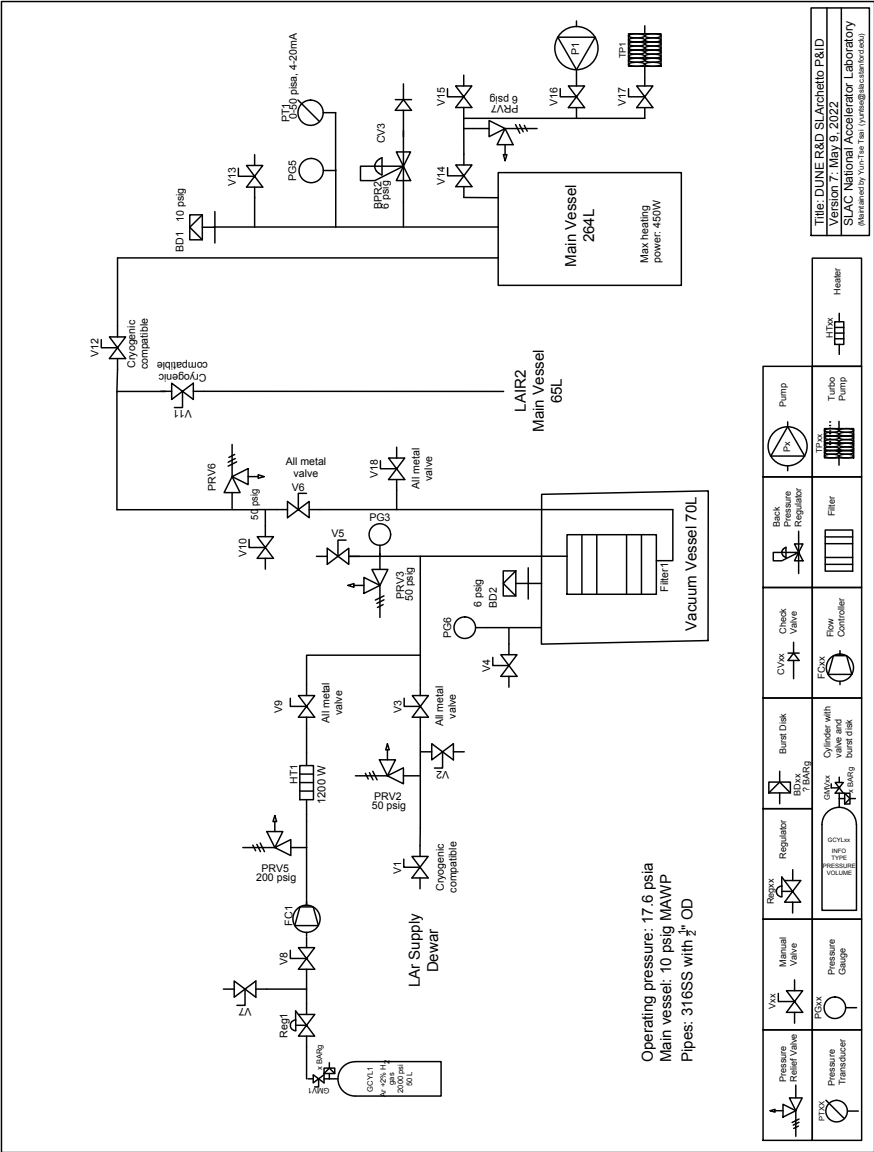


Figure 1: P&ID

Checklist	What to Do and Detailed Description
24 hours before LAr filling	
Vessel closed and tightened	
Leak check	
All valves are closed	
V14, V16 are open	For pumping the vessel
P1 (scroll pump) on	Need to use the scroll pump first
P1 on for 30 minutes, PG5 (pressure gauge) way below 0 psig, PT1 (pressure transducer) at absolutely 0 for more than 10 minutes	Read PT1 from Pressure in the Ignition detector monitor
V16 closed	
P1 off	
V17 open	Prepare to start the turbo pump
TP1 (turbo pump) on	
V19 and the valve on the Hicube pump open	The Hicube pump is located behind the computer monitor. V19 is connected on the thermosyphon evaporator, and is not shown in the current version of P&ID
The HiCube pump on	Pump the thermosyphon vacuum jacket
LAr filter regenerated	See the procedure for LAr filter regeneration
V6, V11, V12 closed, V10 connected to a turbo pump and opened	Evacuate the tube between V6 and V11/V12 with a turbo pump
P1 connected to V4. V4 opened and P1 on	Evacuate the vacuum vessel insulating the LAr filter
Prepare LAr filling	
TP1 (turbo pump) pumped for 24 hours, PT1 (pressure transducer) at absolutely 0 for at least 24 hours, ion gauge at 10^{-3} mbar	Read PT1 from Pressure in the Ignition detector monitor
The vacuum in the thermosyphon line jacket is at 10^{-3} hPa level or below	Read the display at the Hicube pump
Purge the thermosyphon line	Open the Tree (botton near home at the top left corner) → subsystems → services → Thermosyphons (we are TSL11). Click the number and a side panel will open, click purge . Purge will take about 3 minutes
HEPAs speed high	HEPA control is in the back of the fans (outside the clean tent), and there are five HEPAs
Ventilation light on	Red light at the east wall of the LNTF

Ventilation of the clean room on
Emergency exhaust fan button is yellow

Feel the wind blowing
Press the red button on the east wall of the LN₂TF to turn the exhaust fan to high speed. Note: Button turns “yellow” when the fan is on high speed

The front and back doors of LN₂TF are open and stay open

Cool down the LAr filter

V10 closed, the turbo pump off
LAr supply dewar has < 230 psi

If it is higher, vent the argon to lower pressure ~230 psi.
If it is too low (such as 30 psi), open the pressure builder to build the pressure to > 100 psi

PPE (cryo gloves, safety glasses) on
LAr supply dewar connected to the transfer line

V1, V2 open
LAr supply dewar opened
When seeing LAr, LAr supply dewar, V1, V2 closed
V1, V3, V6 opened
LAr supply dewar opened, carefully opened V10 according to PG3
When seeing LAr from V10, LAr supply dewar, V10 closed

Purge the air in the tube

Stop purging

PG3 should be at 5 – 10 psig

Fill the main vessel

V17 closed
TP1 (turbo pump) off
LArPix fan on

V17 is a torque valve
Prepare for filling the main vessel
Plug the cable into the extension cord used for the turbo pump

V6, V12 open
Double check the closed valves: V2, V5, V9, V10, V11, V13, V15, V16, V17
LAr dewar closed
Double check the open valves: V1, V3, V6, V12, **V14 (IMPORTANT)**

V14 is on the top lid, connecting to the hose. If closed, the burst disk will crack when LAr just fills in.

Two people ready: One adjusting the LAr flow, the other adjusting V15 (venting)

One opens the LAr dewar slightly, and the other monitors PG5 (pressure gauge) or PT1. When the pressure reaches 2.5 psig at PG5 (17.1 psia at PT1), open V15 slightly to prevent the pressure from building up.

We want to keep the pressure at about 2 psig at PG5 (16.6 psia at PT1) and not to exceed 4 psig at PG5 (18.6 psia at PT1) all the time. We also don't want the vessel pressure to go below 0 psig at PG5 (14.6 psia at PT1), in which condition the air would come in and contaminate the LAr purity.

Fill with 10L at 10 slpm, and the pressure is less than 5 bar (better less than 3 bar)

Fill the numbers 10L at 10 slpm, and click Add LN₂. Click on the pressure graph below the value of liters to check the pressure

LArPix power supply on. Voltage at 24 V, current limit at 1 A

LArPix starts taking data when the pressure reaches ~14.6 psia

Ask Patrick

Equilibrium reached and ~3 bar at PG3 (pressure gauge on top of the LAr filter)

Pressure in TSL11 stable and < 3 bar, add 5 L at 5 slpm. Totally 15 L

Pressure in TSL11 stable and < 3 bar, add 5 L at 5 slpm. Totally 20 L

Pressure in TSL11 stable and < 3 bar, add 5 L at 5 slpm. Totally 25 L

Pressure in TSL11 stable and < 3 bar, add 5 L at 5 slpm. Totally 30 L

Pressure in TSL11 stable and < 3 bar, add 5 L at 5 slpm. Totally 35 L

Pressure in TSL11 stable and < 3 bar, add 5 L at 5 slpm. Totally 40 L

Pressure in TSL11 stable and < 3 bar, add 5 L at 5 slpm. Totally 45 L

Pressure in TSL11 stable and < 3 bar, add 5 L at 5 slpm. Totally 50 L

Pressure in TSL11 stable and < 3 bar, add 5 L at 5 slpm. Totally 55 L

Pressure in TSL11 stable and < 3 bar, add 5 L at 5 slpm. Totally 60 L

LAr dewar transition

When the LAr dewar is almost empty, start to close the LAr dewar

1 – 3 psig at PG5 (pressure gauge) or 15.6 – 17.6 psia at PT1 (pressure transducer) during the LAr dewar transition

V1, V3 closed

The first LAr dewar disconnected, the second one connected

V1 opened

LAr dewar, V2 open

When seeing LAr from V2, LAr dewar, V2 closed

V3 open

Double check V6, V12 opened

Two people ready: One adjusting the LAr flow, the other adjusting V15 (venting)

Pressure at PG3 (pressure gauge) will start dropping when the LAr dewar is almost empty

Adjust V15 to control the pressure. May need to completely close it. Read PT1 from **Pressure** in the Ignition detector monitor

Purge the air in the tube

One opens the LAr dewar slightly, and the other monitors PG5 or PT1. When the pressure reaches 2.5 psig at PG5 (17.1 psia at PT1), open V15 slightly to prevent the pressure from building up. We want to keep the pressure at about 2 psig at PG5 (16.6 psia at PT1) and not to exceed 4 psig at PG5 (18.6 psia at PT1) all the time. We also don't want the vessel pressure to go below 0 psig at PG5 (14.6 psia at PT1), in which condition the air would come in and contaminate the LAr purity.

Stop LAr filling

Cryocon D (RTD 4) reaches ~90 K at ~16.1 psia, or drops significantly

Liquid seen through the viewport

When Cryocon E (RTD 5) shows the beginning of the significant temperature drop, two people ready to close the valves

LAr dewar, V15 closed

V1, V3, V6, V12 closed

All valves closed

This means the LAr reaches the desired liquid level. Read RTD values at the Ignition detector monitor or the Cryocon device

Turn on the flash light and place it on top of the viewport shield

Stop filling LAr from now. When the pressure starts to drop, slightly close V15. Adjust V15 according to the pressure – we don't want the pressure to go below 2 psig at PG5 (pressure gauge) or 16.6 psia at PT1 (pressure transducer) nor above 3 psig at PG5 (17.6 psia at PT1). The working pressure should be ~3 psig at PG5 (17.6 psia at PT1)

Electrical box plugged and switched on	Toggle up, switch on in case we need heaters
Set the threshold of LArPix channels	Need to set the threshold with HV off. Call Patrick at this moment
Enable the warning, alert, and alarm for the pressure	Click the alarm button. Warning range: 14 – 17.7 psia; Alert range: 14 – 18.7 psia; Alarm range: 14 – 19.7 psia
Enable the warning, alert, and alarm for RTD 1, 3, and 4	Click the alarm button. Warning range: 87 – 91 K; Alert range: 85 – 92 K; Alarm range: 83 – 93 K
Enable the warning, alert, and alarm for RTD 5	Click the alarm button. Warning range: 87 – 130 K; Alert range: 85 – 130 K; Alarm range: 83 – 130 K
Enable the warning and alert for RTD 6	Click the alarm button. Warning range: 150 – 163 K; Alert range: 145 – 170 K
20-40 minutes for equilibrium	Check for example, if temperature at RTD 4 is rising, if the pressure is stable
Cryoncon A, B, C, D (RTD 1, 2, 3, 4) show < 90K at ~16 psia	
LAr filter vented through V5	
All valves closed	The valves likely were not closed because of the ice on them. Check them again and completely close them
Emergency exhaust fan button is red	Press the yellow button on the east wall of the LNTF to turn the exhaust fan to low speed. Note: Button turns “red” when the fan is on low speed

Ramp up high voltage

LArPix data taking stopped	At this moment, ask Patrick. Will have instructions later
LArPix tile powered off	At this moment, ask Patrick. Will have instructions later
High voltage power supply on	
PicoAmmeter on, set to the ‘zcheck’ mode	
PicoAmmter DAQ script running and field shell current updating	Log in <code>neutrino@nu-daq01-ir2.slac.stanford.edu</code> run <code>cd ~/kapton_daq</code> <code>source setup.sh</code> <code>nohup python3 daq.py --config config/config_keithley6485.yaml &</code> Check the Current in the HV Control panel in the main page, or PicoAm Current in the SLArchetto High Voltage Control page

HV status on and HV current set to 1mA	Go to the HV Control panel, and then go to HV ramping. Click PS initialization. Then the button HV Status On/Off should be On and green.
High voltage ramped up to 15 kV	Set Target voltage to 15 kV, and click HV ramping Interlock ON, disabling the interlock. Click Start. More details in RampingHighVoltage.pdf.
High voltage (Cathode voltage) at 15 kV, field shell current (PicoAm Current) at $\sim 9000 - 10000$ nA	Check Cathode Voltage and PicoAm Current in the SLArchetto High Voltage Control page, or Voltage and Current in the main monitor
Enable the alert and alarm for high voltage	Click the alarm button. Warning range: 14.95 – 15.05 kV; Alert range: 14.9 – 15.1 kV; Alarm range: 14.8 – 15.2 kV
Enable the warning, alert, and alarm for the current	Click the alarm button. Warning range: -20,000 – 0 nA; Alert range: -25,000 – 0 nA; Alarm range: -30,000 – 0 nA
HV ramping Interlock OFF	
<hr/>	
Start data taking	
LArPix tile powered on	At this moment, ask Patrick. Will have instructions later
LArPix data taking	At this moment, ask Patrick. Will have instructions later
<hr/>	
Stop operation	
Stop data taking	At this moment, ask Patrick. Will have instructions later
LArPix tile powered off	At this moment, ask Patrick. Will have instructions later
HV and current alarms disabled	Click the alarm button and disable the alarms
HV ramped down	Go to the HV Control panel, and then go to HV ramping. Set Target voltage to 0 kV, and click HV ramping Interlock ON, disabling the interlock. Click Start. More details in RampingHighVoltage.pdf.
High voltage (Cathode voltage) at 0 kV, field shell current (PicoAm Current) at 0 nA	Check Cathode Voltage and PicoAm Current in the SLArchetto High Voltage Control page, or Voltage and Current in the main monitor
HV Status off	Click Switch On, and the button will become grey and HV Status Off will show
V14 and V15 open	Prepare for boiling LAr

Removed liquid nitrogen in the thermosyphon line

Heater interlock off

Go to SLArchetto main page, turn off the **Heater**
ITLK ON

Set up the heater range: 91 – 95 K

Go to LAr evaporator, set **Heater OFF**
temperature to 95 K while **Heater ON**
temperature to 91 K

Heater on

Click **Start**

Heat for 24 hours, and heater off

Go to LAr evaporator, click **Stop**

Heater interlock on

Go to the main page and turn on the heater in-
terlock
