LCLS Engineering Specifications Document # 1.2-204 | Vacuum - Mechanical | Revision 1

LCLS Photon Systems Vacuum Pump Cart Specification

C.E Rago
Author (Modified)

John Arthur
Photon System Manager

Phil Cutino
SLAC Manufacturing Department, Department Head

Darren Marsh
LCLS Quality Assurance Manager

Brief Summary:

This ESD contains the specification for a vacuum leak detector/residual gas analyzer/roughing pump cart for the LCLS Injector and Linac

Change History Log:

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SCOPE

This ESD describes the technical requirements for a combined, stand-alone, portable Helium vacuum leak detector/residual gas analyzer/pump-down cart, hereinafter described as Pump Cart.

1.0 APPLICABLE DOCUMENTS

- SLAC-I-007-12004-001-R1, SLAC Vacuum Specification
- FP-202-831-14-R5, Fabrication of UHV Components

2.0 TECHNICAL REQUIREMENTS

2.1 GENERAL

2.1.1 The block-diagram found under “4.0 SKETCH OF LCLS INJECTOR PUMP CART” in this document, shall be used to describe the principles of operation and gross construction of the Pump Cart. It is the responsibility of the selected vendor to interpret the block-diagram, this specification and prepare and provide the necessary documentation for the actual Pump Cart.

2.1.2 The selected vendor shall provide SLAC with fabrication drawings, electrical schematics, component specifications and any other documentation that defines the Pump Cart, no later than three months after SLAC has taken ownership of the Pump Cart.

2.1.3 Standard-size fasteners, vacuum flanges and other hardware components shall be used as much as possible.

2.1.4 The user interface to the Pump Cart shall be along the long side of the Pump Cart.

2.2 PHYSICAL AND PERFORMANCE CHARACTERISTICS

2.2.1 General

2.2.1.1 The total gross weight of the Pump Cart shall not exceed 200 lb.

2.2.1.2 The total foot print of the Pump Cart shall not exceed 26” x 34”.

2.2.1.3 The total height of the Pump Cart shall not exceed 57”.

2.2.1.4 The Pump Cart assembly shall have a low center-of-gravity and provide a stable operating platform.
2.2.1.5 The sound signature of the *Pump Cart* shall not exceed sixty-five (65) dbA, measured one meter from the source.

2.2.1.6 All vacuum components and vacuum chambers shall be built from 304 stainless steel. Flanges of 304 ESR stainless steel are preferred.

2.2.2 **Cart Frame**

2.2.2.1 The cart frame shall use pneumatic tires of sufficient size to bridge ½" floor gaps without significant resistance or overturning.

2.2.2.2 Two of the wheels on the shorter side of the *Pump Cart* shall be of the fixed axle type, with built-in brakes. See sketch for clarification.

2.2.2.3 The wheels on the other short side shall be swivel-type with built-in brakes. See sketch for clarification.

![Cart Frame Diagram](image)

Max. 34”

Max. 26”

2.2.2.4 The cart frame shall be an all-metal construction.

2.2.3 **Turbo Pump**

2.2.3.1 The turbo pump shall have a pumping speed of no less than 200 liter/second for nitrogen.

2.2.3.2 The turbo pump shall not show any residuals of hydrocarbons when measured with a Residual Gas Analyzer (RGA). Vacuum assemblies suspected of hydrocarbon contamination may be tested with a quadrupole-type residual gas analyzer (RGA). *(The RGA used must be sensitive to a partial pressure of 1E-14 Torr or 0.1 ppm,*

Check the LCLS Project website to verify that this is the correct version prior to use.
whichver is greater, and be capable of scanning in the 1 to 100 AMU range. The RGA probe shall demonstrate a measured background, before exposure to the test system, of not more than 5E-12 Torr for the sum of all partial pressures above atomic mass 44. Both the RGA probe and the test chamber shall be maintained at the same temperature, which shall be in the range of 80°C. In the test system, the sum of all partial pressures between atomic mass 44 and 100 shall not exceed the measured background of the RGA probe by more than 1E-11 Torr. Test systems that exhibit the presence of atomic masses above 100 are unacceptable.) [Source: SLAC-I-007-12004-001-R1, SLAC Vacuum Specification]

2.2.3.3 The turbo pump shall have an appropriately-sized stainless steel wire mesh screen on the inlet flange to stop fragments larger than 1 mm from entering the turbo pump.

2.2.3.4 The turbo pump shall be air-cooled and have an appropriately-sized cooling fan attached to it.

2.2.3.5 The turbo pump shall have an ultimate pressure equal-to or lower-than 5E-10 Torr with its mated fore pump described in 3.2.4.

2.2.3.6 The turbo shall have a Conflat inlet flange.

2.2.3.7 The turbo shall have a DN 25 ISO-KF outlet flange.

2.2.3.8 The turbo pump shall be bakeable to a temperature no less than 100 degrees C at the inlet flange.

2.2.4 Fore Pump

2.2.4.1 The fore pump shall have a pumping speed for air equal to or greater than 260 ft³/hr.

2.2.4.2 The fore pump shall have an ultimate pressure equal-to or less-than 5E-2 Torr at room temperature (20°C).

2.2.4.3 The fore pump shall be “dry” and be free from hydrocarbon-based lubricants.

2.2.4.4 The fore pump shall be air-cooled.

2.2.4.5 The fore pump shall have a DN 25 ISO-KF inlet flange.
2.2.4.6 The fore pump and the turbo pump shall be connected via an appropriately-sized stainless steel flexible hose.

2.2.5 Valves

2.2.5.1 The Pump Cart shall have an electro-magnetic valve between the turbo and the fore pump, hereinafter called the Turbo Shut-off Valve. The main-seal leak-rate of this valve shall equal-to or less-than 1E-9 std. cc/sec He. The body leak-rate shall equal-to or less-than 1E-10 std. cc/sec He.

2.2.5.2 The Turbo Shut-off Valve shall have a minimum bore of 0.75".

2.2.5.3 The Pump Cart shall have an electro-magnetic by-pass valve, hereinafter called the By-pass Valve, which permits connection of the fore pump directly to the pumped beam line volume, see sketch. The main-seal leak-rate of this valve shall be equal-to or less-than 1E-9 std. cc/sec He. The body leak-rate shall be equal-to or less-than 1E-10 std. cc/sec He.

2.2.5.4 The By-pass Valve shall have a minimum bore of 0.75".

2.2.5.5 The Turbo Shut-off Valve and the By-pass Valve shall have visual status indicators for valve OPEN and CLOSED.

2.2.5.6 The Turbo Shut-off Valve and the By-pass Valve shall have micro-switches indicating valve OPEN and CLOSED.

2.2.5.7 In their CLOSED positions the Turbo Shut-off Valve and the By-pass Valve shall be bakeable to a temperature no less than 100 degrees C.

2.2.5.8 The Pump Cart shall have one 4 1/2" CF VAT series 54 manual valve. See sketch for location.

2.2.5.9 The Pump Cart shall have two 2 3/4" CF VAT series 54 manual valves. See sketch for location.

2.2.5.10 The Turbo Shut-off Valve and the By-pass Valve shall have DN 25 ISO-KF flanges.

2.2.5.11 All valves, except the Turbo Shut-off Valve and the By-pass Valve, shall be all-metal, stainless steel and manual.
2.2.5.12 All Pump Cart valves, except the Turbo Shut-off Valve and the Bypass Valve, shall be bakeable to a temperature no less than 100 degrees C.

2.2.6 Gauges

2.2.6.1 The Pump Cart shall be equipped with an MKS Enhanced Convection Pirani gauge, type 317, part number 103170024SH and a MKS Cold Cathode gauge, type 422, part number 104220006. See sketch for locations.

2.2.6.2 The combination of the Pirani and the Cold Cathode gauge shall function over the entire pressure range between 760 Torr and 1E-10 Torr.

2.2.7 Residual Gas Analyzer

2.2.7.1 The Pump Cart shall be equipped with a Residual Gas Analyzer (RGA).

2.2.7.2 The RGA shall be equipped with an electron multiplier.

2.2.7.3 The RGA shall have a range between 1 amu and 100 amu.

2.2.7.4 The RGA shall have a detection limit <5E-14 Torr with the electron multiplier.

2.2.7.5 The RGA head shall be bakeable to a temperature not to exceed 200 degrees C.

2.2.8 Laptop

2.2.8.1 The laptop is intended for data accumulation and as a display device for the RGA.

2.2.8.2 The RGA laptop shall have a processor speed of no-less-than 1 GHz.

2.2.8.3 The RGA laptop shall have no-less-than 512 MB RAM.

2.2.8.4 The RGA laptop shall have hard drive space of no-less-than 80 GB.

2.2.8.5 The RGA laptop shall have a DVD +/- RW.
2.2.8.6 The RGA laptop shall have a screen size of no-less-than 13” measured diagonally over the screen.

2.2.8.7 The RGA laptop shall have an Ethernet port.

2.2.8.8 The RGA laptop shall have a built-in wireless card that is compatible with IEEE 802.11 a/b/g.

2.2.8.9 The RGA laptop shall have at least 3 USB ports plus connections for external keyboard and monitor.

2.2.8.10 The RGA laptop shall be preloaded with Microsoft Windows XP professional version and Microsoft Windows Office - professional version.

2.2.8.11 The RGA laptop shall be regarded as a permanent part of the Pump Cart and have its own designated storage space.

2.2.9 Controls and Electrical System

2.2.9.1 General

2.2.9.1.1 The Pump Cart shall operate at 120 VAC, 60 Hz.

2.2.9.1.2 The current draw of the Pump Cart shall not exceed 15 A during any phase of operation of the Pump Cart.

2.2.9.1.3 The Pump Cart shall be equipped with a 50 foot power cord.

2.2.9.1.4 The power cord shall be regarded as a permanent part of the Pump Cart and have its own designated storage space.

2.2.9.1.5 In case of power loss, the Pump Cart shall be prevented from re-starting on its own. Re-starting after power loss shall be operator controlled.

2.2.9.2 Control Panel

2.2.9.2.1 The Pump Cart shall have a control panel with the following functions:

2.2.9.2.1.1 Main ON/OFF
2.2.9.2.1.2 Emergency OFF

2.2.9.2.1.3 Fore pump ON/OFF

2.2.9.2.1.4 Mode selector BYPASS/TURBO

2.2.9.2.1.5 By-pass Valve OPEN/CLOSED

2.2.9.2.1.6 Turbo Shut-off Valve OPEN/CLOSED

2.2.9.2.2 The Control panel shall have status lights showing status of By-pass Valve and Turbo Shut-off valve. Green light shall indicate OPEN valve. Red light shall indicate CLOSED valve.

2.2.9.2.3 The control panel shall have a status light for Main ON.

2.2.9.2.4 When the Pump Cart is energized (Main ON), the emergency OFF switch shall be illuminated.

2.2.9.2.5 The fore pump ON/OFF function shall be indicated with status lights. Green light shall indicate fore pump ON. Red light shall indicate fore pump OFF.

2.2.9.2.6 The By-pass Valve OPEN/CLOSED status shall be indicated with status lights. Green light indicates valve OPEN. Red light indicates valve closed.

2.2.9.2.7 The Turbo Shut-off Valve OPEN/CLOSED status shall be indicated with status lights. Green light indicates valve OPEN. Red light indicates valve CLOSED.

2.2.9.2.8 When the By-pass Valve is OPEN, the Turbo Shut-off Valve shall be CLOSED and not allowed to open as long as the mode selector is in BY-PASS mode.

2.2.9.2.9 When the Turbo Shut-off Valve is OPEN, the By-pass Valve shall be CLOSED and not allowed to open as long as the mode selector is in TURBO mode.

2.2.9.2.10 The turbo, the vacuum gauges and the RGA shall be controlled from their respective controllers

2.2.9.3 Turbo Controller
2.2.9.3.1 The selected turbo pump shall be controlled and operated with an appropriately-matched turbo pump controller.

2.2.9.3.2 The turbo controller shall be a permanent part of the Pump Cart.

2.2.9.3.3 The fore pump shall be turned on by the turbo controller, as well as independently, when in By-Pass mode.

2.2.9.4 Gauge controller

2.2.9.4.1 The turbo cart shall have a gauge controller that can display information from no-fewer-than three Pirani and one Cold Cathode gauge.

2.2.9.4.2 The gauge controller shall have a set-point card.

2.2.9.4.3 The gauge controller shall have an RS 232 communication card.

2.2.9.5 Valve Controller

2.2.9.5.1 The Pump Cart shall have a valve controller that controls the Turbo Shut-off Valve and the By-pass Valve.

2.2.9.5.2 The Turbo Shut-off Valve and the By-pass Valve shall be individually controlled.

2.2.9.5.3 The Turbo Shut-off Valve and the By-pass Valve shall be interlocked with the gauge controller set-point card and close, or be prevented from opening, at a specific pressure determined by LCLS.

2.2.9.5.4 The Turbo Shut-off Valve and the By-pass Valve shall close in the case of a power loss.

2.2.9.5.5 The Turbo Shut-off Valve and the By-pass Valve shall remain closed when the power returns. The operation of these valves after a power loss shall be operator controlled.

2.2.9.6 RGA Controller

2.2.9.6.1 The Residual Gas Analyzer (RGA) shall have a separate controller.
2.2.9.6.2 The RGA controller shall be able to be controlled via the Pump Cart laptop. The RGA controller shall be able to transfer data files to the Pump Cart laptop. Display RGA scans in Partial Pressure units of Torr. Display Helium Background and Helium Leak Rates in a dedicated Helium Leak Check Mode. Have "Easy Access" icon on PC desktop screen for RGA operations including "Helium Leak Check Mode" and "RGA Scan Mode".

4.0 SKETCH OF LCLS INJECTOR PUMP CART