HPS Cooling System
Design aspects and Pressure Tests

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The cooling manifold of HPS can be functionally subdivided in three zones:

Zone 1: Distribution manifold inside the vacuum chamber
Zone 2: Distribution manifold outside the vacuum chamber
Zone 3: Single Supply & Return Hoses between the chiller and the HPS

The design of the cooling system has been done by SLAC in close collaboration with JLAB. The fabrication of the manifold in the Zone 1 & 2 has been done at SLAC and delivered with the detector. The Chiller, the supply-return hoses, as well as the flow meter, the check valve and the solenoid valve have been procured and installed by JLAB.

The manifold in Zone 1, being inside the beamline vacuum, is the most delicate part where status of art design has been adopted. This part comprises two separate circuits, one or the Top and one the Bottom Plates of HPS, which are electrically and mechanically independent subassemblies mounted on a common support structure. Each loop has five cold plates with 1/8" copper tubing connected in parallel with dismountable Stainless Steel Swagelok micro-fittings, welded to the internal distribution manifold. The two supply-return manifolds are identical and, to minimize the location of potential leaks, they are fully welded with exception of ten (per circuit) micro-fittings on the cold plates and two (per circuit) dielectric fittings just before the feed-through on the vacuum box. The manifold included stainless steel, not braided bellows between the cold plate to accommodate the thermal dilation; stainless steel flexible lines to accommodate the required kinematic movement for the support plates between the garage and data taking position; Dielectric Swagelok fitting to break the electrical continuity and avoid Ground Loops. The liquids feed-through on the vacuum chamber have been done at SLAC and follow standard design rules identical to those commercially available.

The distribution manifold in Zone 2 is outside the vacuum chamber but close the many of the beamline instrumentation. A full stainless steel design has been adopted made of all commercial components by Swagelok. The main function of this manifolds is to connect the HPS detector with supply-return lines from the chiller, switch the flow in two spate branches, provide isolation valves to exclude one of the two circuit in case of leak, as well as provide purge lines and pressure reliefs valves. The pressure relive valves have been set to 65 psig.

Test procedure

The maximum operative pressure of the chiller is 60 psig (from the vendor specs) and the tests have been extended to 70 pisg, with a margin in excess of 20%.

Test 1: The first test of the Zone 1 manifold has been done at SLAC on a mechanical dry fit assembly of HPS with all the mechanical part, including the cold plates, the vacuum box and the feed-through, with the exception of the silicon sensors. Each circuit has been tested separately, connecting gas Helium at room temperature and a calibrated pressure gauge, on the "in-air" side of the feed-through. The pressure has been increased from 0 to 72 psig by steps of 15 psig followed by plateau of 3 minutes each, the final step being held for 15 minutes. No leaks have been detected.

Test 2: The two individual manifolds have been reassembled in the clean room at SLAC, this time including the detectors and electronics for the final assembly. A pressure test protocol identical the Test 1 has been applied, the only difference being the absence of the vacuum box, therefore of the feed-through. The helium and the gauge have been connected directly of the locations of the dielectric fitting inside vacuum. No leaks have been detected up to 70 psig.
Test 3: The full detector has been assembled in the Hall B and installed at its nominal position, inside the vacuum chamber of the spectrometer magnet. The vacuum box with feed-through has been installed, the two cooling circuit have been connected and a pressure test in-situ with helium at room temperature as been done. The same protocol used for Test 1 has been adopted; this time the maximum pressure has been extended to 80 psig. No leaks have been detected.

Test 4: Once completed the test 3, the Zone 2 external distribution manifold has been connected and pressure tested together with the Zone 1 manifold. The pressure has been increased from 0 to 60 psig in steps of 15 psig followed by plateau of 3 minutes. Finally the pressure has been increased to 80 psig to check the opening of the pressure release valves. No leaks have been detected; all the pressure valves work properly.

Test 5: A final test has been done on the Zone 3, the chiller with the supply return lines separated from the HPS experiment. The loop of the supply and return lines has been closed over a flow meter and a pressure gauge. The pressure drop measured for each line is ~15 psig with a flow of ~1.5 gpm.

Test 6: The full system Zone 1-2-3 has been closed. The output pressure at the chiller has been set at 50 psig; the inlet pressure at the HPS-Zone 2 is 38 psig, while the outlet pressure at HPS-Zone 2 is ~28 psig. The measured flow is ~0.8gpm, the temperature setting point is 15C.