Hall B Drift Chamber Gas System

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June 17, 2015

This note presents the proposed design of the gas system for the Hall B drift chambers.

The Hall B Drift Chamber Gas System will deliver a precise flow of a pure gas mixture to the drift chamber detectors in the hall, a requisite for proper detector operation. Further, the system will maintain constant pressure inside each detector to reduce risk of damage to the detector windows.

The proposed gas system design consists of six sub-systems: argon and carbon dioxide liquid gas bulk supply, argon and carbon dioxide gas mixing and storage, 10% carbon dioxide/90% argon gas delivery to the detectors, drift chamber PID pressure control, active detector over-pressure and under-pressure protection, and passive detector over-pressure and under-pressure protection.

Argon gas will be supplied by a 1500-gallon liquid argon dewar located next to the Hall B gas shed, Bldg 96B; carbon dioxide gas will be supplied by four to six 480-pound liquid carbon dioxide dewars also located alongside the building, Fig. 1. Argon tank level will be maintained by a bulk gas supplier, who monitors tank level by remote telemetry; carbon dioxide dewars will be ordered as needed.

FIG. 1. Outside of the Hall B gas shed, showing argon and carbon dioxide dewars.

There will be two identical gas mixing systems, each with a 300-slm flow capacity. The two gases will be mixed in a ratio of 10% carbon dioxide/90% argon by MKS mass flow controllers (MFCs), whose flow is controlled by MKS 647B multi-gas controllers located in the 96B control room. The carbon dioxide MFC will run in slave mode to the argon MFC to maintain proper ratio.

A Panametrics Thermal Conductivity Unit will continuously measure the thermal conductivity of the gas mixture. The individual MFC flows will be manually adjusted to match the mixed gas thermal conductivity to that of a calibration standard.

The mixed gas will be stored in tanks that have a total capacity of 53,000 liters. These tanks, called buffer tanks, will be maintained at a pressure of 100 psig, at which the buffer volume contains 360,000 liters of gas. The large volume smooths out any small change in the argon/carbon dioxide ratio in the mixed gas supply.

There will be three nearly identical gas delivery systems, one for each of the three drift chamber regions. Mixed gas will be supplied by the storage buffer tanks to each of the three MFCs. The three systems will have capacities of 65 slm, 260 slm, and 260 slm for regions 1–3, respectively. The gas will flow to the detectors in the hall via three 1-inch lines to the supply manifolds near the TORUS magnet. The individual detectors will be connected to their respective manifolds by equal length supply lines to equally divide the gas flow to each detector. The gas will flow into the small end of each detector and exit into the exhaust manifold at the large end.

The drift chambers will use aluminized Mylar windows of 0.001-inch thickness, with a large surface area. An over-pressure event could cause the windows to burst. An under-pressure event could damage the wires inside the detectors.

To maintain constant pressure inside the detector gas volume, a programmable logic controller will be used to control an exhaust valve using a PID loop on the exhaust manifold pressure. Vacuum pumps located in the gas shed will remove gas from the exhaust manifold, according to control valve position, to maintain a pressure of 0.025 ± 0.010 inches of water column above atmosphere.

Due to the potential for damage to the detectors in the case of an under-pressure or an over-pressure event, a set of solenoid valves controlled by an Omega DP25 process controller will be installed so that, in the case of high or low pressure, the detectors are isolated from the gas supply and pressure control systems, preventing damage to the detectors.

A Magnahelic pressure transducer will monitor the pressure in the exhaust manifold and send a 4–20 mA signal to the process controller, which has dual alarm set-points and dual relays. If the pressure signal input from the Magnahelic is out-of-bounds for either the high or low set-points, the relays will open to de-energize the solenoid valves and isolate the detectors from the gas system. In case of a power outage, all solenoid valves will fail to a safe configuration.

In addition to the active pressure protection, a set of bubblers will be installed on each exhaust manifold. In case of over-pressure, gas will be vented out of the exhaust manifold until the differential pressure to atmosphere comes back to a safe value. In case of an under-pressure failure, air will be sucked into the exhaust manifold until the differential pressure to atmosphere reaches a safe value—high flow differential pressure reliefs.

This relief system will consist or three parts: an oil-filled over-pressure bubbler, an oil-filled under-pressure bubbler, and an empty oil trap. The oil trap will be connected directly to the exhaust manifold. Each of the oil-filled under-pressure and over-pressure units will be attached to the oil trap to prevent contamination of the exhaust manifolds with oil. Each of the three units contains oil baffles to remove oil droplets from the gas passing through the unit at high velocity.

Once combined, these subsystems will form the Hall B Drift Chamber Gas System.