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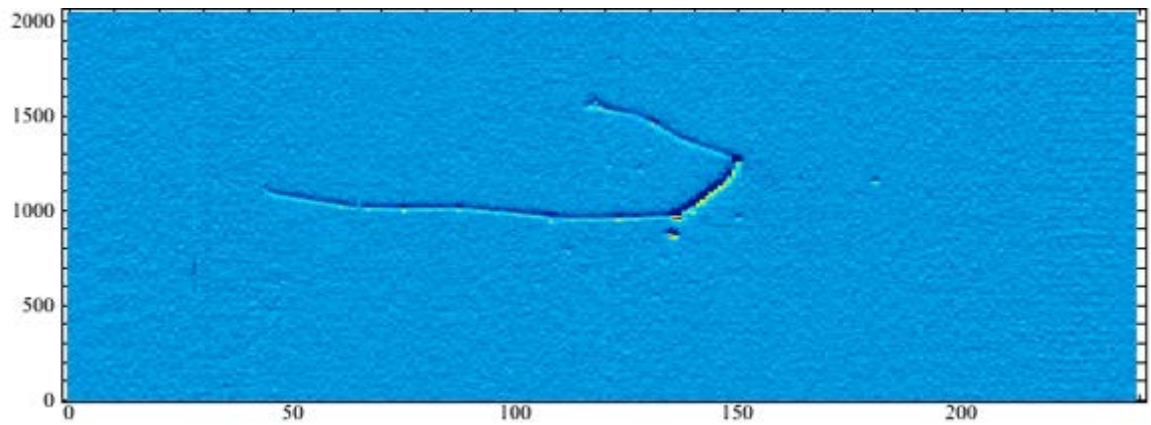
December 23, 2014

System Equipment and Operation Description – LArIAT

The MC7 beam line enclosure has been recently re-purposed for test beam use. The LArIAT experiment is a cryogenic liquid argon time projection chamber (TPC) that will be installed in MC7. LArIAT stands for **L**iquid **Ar**gon **I**n **A** **T**estbeam. The purpose of LArIAT is to study the TPC detector response and calibration using a beam of charged particles of known momentum.

When a high energy charged particle passes through a medium, the particle leaves a path of ionization electrons which can be detected, tagging the path of the incoming particle. In a LAr TPC, the medium is liquid argon (LAr) and the paths of ionization electrons are detected by drifting the electrons in an electric field toward sensing wire planes. The charge from the electrons is collected and digitized. There are several wire planes at stereo angles such that the position of the charge is known and the path of the particle can be reconstructed. See picture 1.



Picture 1. Argoneut data showing a reconstructed track. The color corresponds to the energy deposited. The vertical axis is time and the horizontal axis is location/wire.

The primary element in terms of cryogenics is the Cryostat containing 550 liters of liquid argon and the TPC. See picture 2. The cryogenic system is a simple one pass system where a liquid argon supply from a vendor dewar (located outside of MC7) keeps the cryostat full. A control valve, LCV-105-A, on the supply line opens when the level in the Cryostat is low, and closes when it is full. After the control valve, the liquid passes through a filter that removes oxygen and water before passing on to the cryostat. A tee at the cryostat separates gas phase from liquid phase. The liquid phase drops by gravity into the cryostat. The gas phase flows through the vent piping and is vented outside.

The liquid argon supply dewar is planned to be regulated at a pressure of 40 psig. The cryostat is planned to be regulated at 3 psig by a control valve on the vent line. The liquid argon transfer lines are primarily foam insulated 1" sch. 10 pipe. The cryostat and filters are vacuum jacketed. The expected heat load of the system is 200 watts to 350 watts. This means that the steady state flow rate of liquid argon will be 3.2 to 5.6 liters/hr, a rather low flow rate for the 1" line. The liquid argon dewar is 500 gallon (1893 liters) capacity. A weekly fill of 550 liters to 940 liters is expected from the vendor. The initial cool down is expected to use 185 gallons (700 liters).

Picture 2. Time projection chamber inside the cryostat and the cryostat.

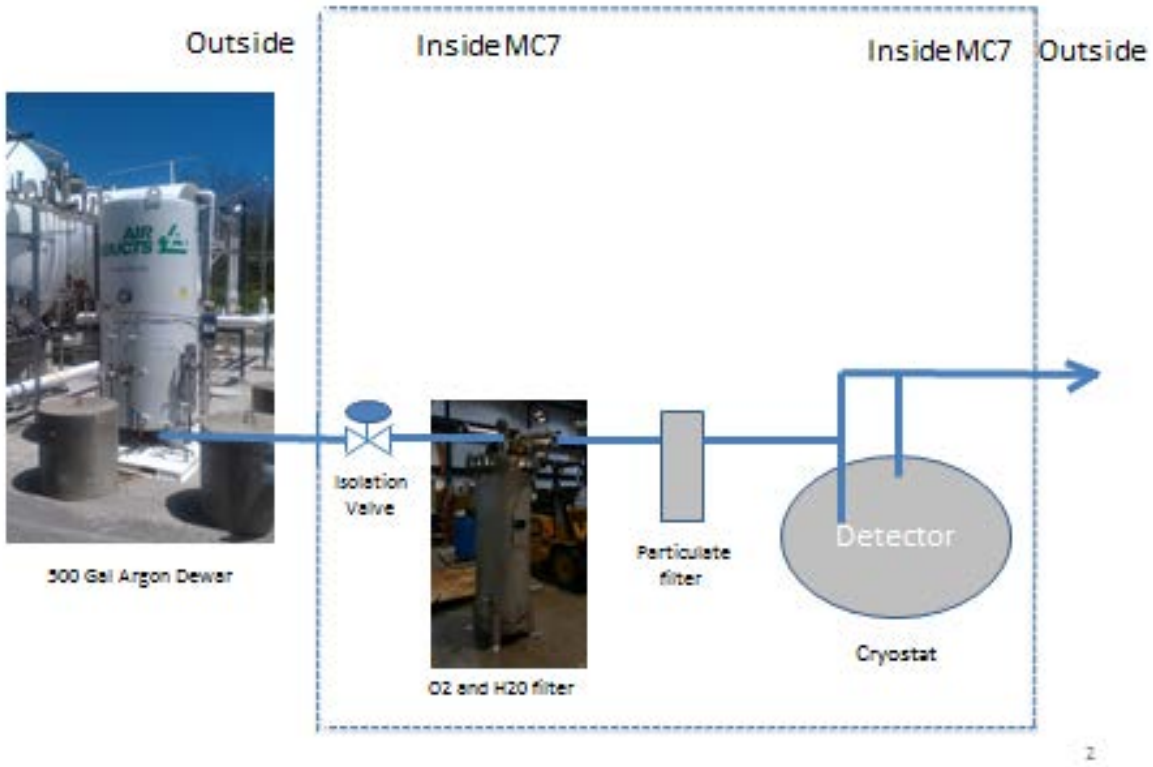


Figure 1. Simplified block diagram of the one-pass cryogenic system.

It is expected that the system will run with very little interaction needed from the cryogenic operators/engineers. The MC7 enclosure that houses the cryostat and filter will be interlocked during beam operations. The control system will be I-FIX so remote monitoring of the system will be the primary means of operation. The following variables will primarily inform the operator of the status:

- LAr storage dewar level and pressure
- LAr supply pressure at the filter
- Cryostat liquid level and pressure
- Vacuum jacket pressures

Alarms will be established and the control system can be utilized to send e-mail as necessary.

The MC7 system has an Oxygen Deficiency Hazard (ODH) monitoring system that includes four ODH heads and an exhaust fan. When an ODH condition (set at 19.5%) is signaled by any of the ODH detectors the following automated responses occur:

A. Activation of ODH alarm horns and lights
B. Activation of the ODH exhaust blower
C. Liquid argon supply valve, LCV-105-A, upstream of filter closes
D. Regeneration gas supply valves close

An e-mail will be sent and a message will be sent to the FIRUS system. The ODH assessment of MC7 is ODH class 0.

The oxygen and water filter will need to be regenerated at the start of operations. This is accomplished by flowing heated argon 97.5%, hydrogen 2.5% mix through the filter bed. This type of filter is the same used on LAPD/LBNE 35t and MicroBooNE. The establishment of regeneration flow will be attended. Once steady state is established, a flow controller controls flow and heater controls control temperature. There are temperature interlocks that will shut off the heater on over temperature. Once the filters are clean, the filter capacity is such that regeneration should not be required for several months.