

NuMI Beamline Vacuum System

Vacuum Requirements

The system will be a high vacuum system, pumped by sputter ion pumps, requiring a pressure maximum of 10^{-5} torr in the beamline, 10^{-6} torr in the instrumentation areas in the beamline and 10^{-7} torr in the ion pumps. To meet these requirements, all materials will be high vacuum compatible. All chambers will be 300 series stainless steel, incorporating welded construction wherever practical. Demountable connections will use standard high vacuum flanges and gaskets. Materials other than these, to be incorporated into the vacuum system, must have prior approval of the system manager.

System Layout

The beamline will be divided into three vacuum sectors, separated by vacuum sector valves. Sector 1 will begin in the Main Injector at the downstream end of Lambertson 61B and end at the upstream end of the RCP Region of the Carrier Tunnel, a distance of about 540 feet. Sector 2 will encompass the 12" vacuum tube installed in the RCP Region of the Carrier Tunnel, a distance of about 220 feet. Sector 3 will begin at the downstream end of the RCP and end with a vacuum window just upstream of the target, a distance of about 400 feet.

Pumps

High Vacuum Pumps

All high vacuum pumps will be standard diode sputter ion pumps. In sectors 1 and 3, 30 liters/second pumps will be spaced on an average of every 24 ft. This size and spacing was chosen, because it is the same as many beamlines and machines similar in component layout and dimensions, operated successfully at Fermilab for many years. Typical pressure at the pumps will be $1-2 \times 10^{-7}$ torr and between pumps $2-3 \times 10^{-7}$ torr. There is a built in redundancy in this layout, in that any one pump can be off and the system will continue to operate normally, with only an increase in pressure of a factor of 2-3 at the adjoining pumps.

Sector 2 will have 2 large pumps installed at each end of the 12" pipe. The pumps will be 400 or 500 liters/second, depending on the physical space available. Pressure at the pumps will be 1×10^{-7} torr and between pumps 4×10^{-7} torr.

Pressure calculations are included in the appendix A.

Roughing Pumps

All sectors will be roughed-down using portable, turbo-molecular/rotary mechanical pump carts. This type of cart has the capability to evacuate these systems to 10^{-5} torr, at which pressure the ion pumps can be started. These carts are commonly used in the accelerators and beamlines and are available for use.

Valves

Sector Valves

The sector valves will be standard, stainless steel gate valves with Viton seals. They will be pneumatic-remote operated with position indicator switches. The system will incorporate 3 sector valves. A 4" valve at the upstream end of Sector 1 and 2-6" valves, one at each end of Sector 2 (the 12" vacuum tube)

Roughing Valves

Two roughing valves will be located in each sector. The valves will be 2 1/2", hand-operated, right angle, stainless steel vacuum valves. These will be used to rough the sectors and for leak testing.

Let-up Valves

One let-up valve will be installed in each sector. The valve will be a 1/2", hand-operated, right angle, stainless steel vacuum valve. The valve will be piped to the common Main Injector nitrogen system, which will be used to let the sectors up to atmospheric pressure when required.

Gauging

Two Pirani gauges will be installed in each sector to monitor pump-down and indicate the status of each sector when the ion pumps are off. High vacuum will be measured by monitoring the ion pump current and converting it to a pressure reading, at each pump.

Inter-locks

Sector valves will be inter-locked with the high vacuum in each adjoining sector for a particular valve. This will be accomplished by monitoring ion pumps. Four ion pumps in each sector will be designated as permit pumps, two of the four pumps must be on and in the normal high vacuum range ($< 10^{-6}$ torr), in order for a permit to open a valve adjoining that sector.

Ion pumps will be inter-locked through each individual pump's power supply. An ion pump must be operating in its normal range in order to remain on.

Vacuum Window

A vacuum window will be installed at the down stream end of sector 3, immediately upstream of the target. Details of the window will be covered in another note to follow at a future date.