Dry Air Requirements for MOLLER

M. Gericke, K. Isaak, D. McNulty, L. Mohammad, M. Pitt
January 2, 2024 (Rev. 1)

Main and Auxiliary Detector Dry Air Requirements:

The main and auxiliary detectors will require a continuous flow of dry air to provide cooling for the front-end electronics in the PMT base housings and to prevent reflective surface degradation and minimize background event light yield for detectors that employ air light guides. Airflow cooling tests and COMSOL 6.1 simulations have determined that the minimum needed volumetric flow rate per detector is 3933 cm^3/min (see page 125 of MOLLER Technical Design Report). This corresponds to 8.33 CFH (cubic feet per hour) per module. The module counts and locations are, from upstream to downstream:

- LAM: Large Angle Monitors: 7 detectors x 2 PMT/detector = 14 located in the barite concrete wall
- Upstream scanner detector: 2 detectors x 1 PMT/detector = 2 located upstream of the main detector support
- DBM: Diffuse Beam Monitors: 14 detectors x 2 PMT/box = 28 located on the front face of the main detector support
- Main thin quartz detectors: 224 detectors with one PMT each located in the main detector support
- Shower-max detectors: 28 detectors with one PMT each located on the downstream end of the main detector support
- Pion detectors: 28 detectors with one PMT each located in the pion donut structure
- Downstream scanner detectors: 4 detectors with one PMT each located on the SAM beampipe
- SAM: Small Angle Monitors: 8 detectors with one PMT each located on the SAM beampipe.

This is a total of 336 detectors that need dry air flow, resulting in a minimum total volumetric flow rate of 2800 CFH. **Allowing for 10% overhead for possible leakage, we recommend the capability to provide a total volumetric flow of 3100 CFH to the main and auxiliary detectors.**

Ring 5 HVMAPS Dry Air Requirements:

The Ring 5 HVMAPS auxiliary detectors will require a continuous flow of compressed, filtered, dried, temperature-controlled air during their operations for the purposes of cooling the HVMAPS chips and flushing the enclosures of dust.

There will be 84 identical HVMAPS modules/enclosures. Each module will require 22.5 CFH of chilled air to achieve the required cooling performance. The combined flow required for all HVMAPS enclosures is 2280 CFH, however, additional flow is needed to account for the hot-side-

venting of the vortex-chiller components of the temperature control system as will be described below.

Temperature control will be achieved using a combination of an upstream, powered, temperature controller at the compressor-side of the system and 28 vortex chillers. Each vortex chiller will be mounted on a segment plate and will chill sufficient air for three HVMAPS enclosures. The temperature controller will supply air at a steady inlet temperature to the vortex chillers (roughly 35°C), which will then split the air into a hot and cold stream. The hot stream will be vented, while the cold stream will be delivered to the HVMAPS modules to chill the HVMAPS chips.

Because the vortex chillers split air into a hot and a cold stream, and only the cold stream is needed for chilling the HVMAPS enclosures, the system will vent a certain percentage of air into the Hall. The 'cold flow %' of the vortex chillers is required to be approximately 73% as per thermodynamic and head-loss calculations. Therefore, to deliver 2280CFH to the HVMAPS enclosures, a total flow of 3120 CFH is required.

We recommend allowing an additional 20% headroom above the minimum value to accommodate leakage, purge air for a reflow desiccant dryer, and to provide room to adjust flow if required to optimize cooling. **Therefore, we recommend the capability of providing 3750CFH of air to the Ring 5 HVMAPS enclosures mounted on the Main Detector.** This flow is planned to be delivered by a new, dedicated compressor for the HVMAPS gas system.