Recirculating gas system for GEM-TRD large-prototype: Vanderbilt Univ. proposal

The main purpose of the system is to recirculate the expensive Xe gas. At the same time it should provide the correct mixture, monitor the gas composition, measure the unavoidable contaminants (Oxygen, water, Nitrogen) and purify the gas to keep them bellow specified values. This is critical especially with respect to the electronegative atoms due to the relatively long drift distances.

Another important task of the system is to control the pressure in the gas volumes within specified precisions. The most critical is the differential pressure between the gas volume of the detector and the radiator volume. To reduce the absorption of the TR photons with the lowest energies (few keV) that are most numerous, the thickness of the entrance window (the TRD cathode) should be minimized. At the same time, the deformation of the window should not exceed a specified limit as it will affect the uniformity of the drift volume. Therefore, the radiator volume will be filled with CO2 and the pressure difference between the two volumes should be regulated within some specified tolerance.

To optimize the detector performance, simulations will be done that include the input TR spectrum and its absorption in the cathode, deformation of the cathode depending on its thickness and pressure difference, the corresponding variations of the drift time, and the recombinations of the electrons in the drift volume. Such simulations should provide optimized values for the cathode thickness, pressure tolerance, and acceptable contaminant percentage.

The main elements of the recirculation gas system are shown in Fig. {TRD_gas_diagram.pdf}. The mixing stage has input from both, Xe supply bottle and the cleaning unit. During normal operation most of the Xe gas should come from the cleaning unit, still some Xe is needed from the supply bottle, as loosing gas in the system is unavoidable. The CO2 bottle supplies both, the detector volume through the mixing stage and the radiator volume. The flow and pressure of both volumes with respect to the atmospheric and between them is regulated using pressure transducers, flow controllers, and vacuum pumps. The cleaning unit removes the contaminants and some fraction of CO2 so that it can be restored to the correct proportion by the mixing stage. The inner Xe loop includes the mixing unit, pressure and flow regulators, the gas volume of the detector, the cleaning unit, and gas analyzers at the input and output of the detector volume. Additional safety elements will be included to avoid damage of the detector in case of abnormal operation like power outage or improper operation of the gas system.

The successful realization of this project requires first of all formulation of the specifications for the recirculating gas system that will supply gas to the large-scale prototype. JLab team will specify the parameters for the gas system based on the many-years' experience of operating and testing small-scale prototypes. This step requires also some measurements, like contamination rates, that will also be done at JLab using there the existing gas equipment and some large-volume gas detectors. Note that the JLab team already started consultations with experts from the ATLAS experiment that operate the TRT gas system. The simulations of the detector

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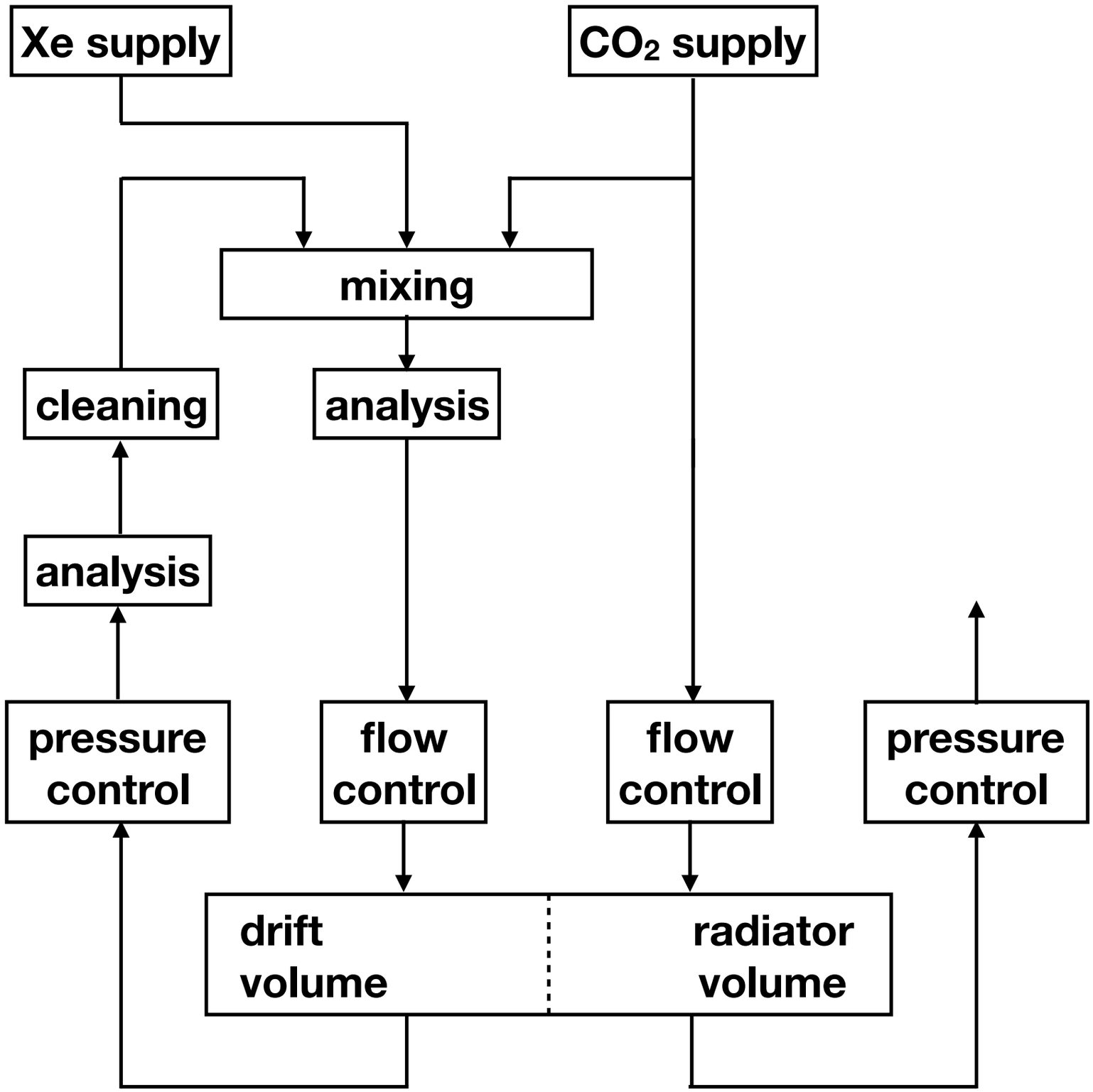
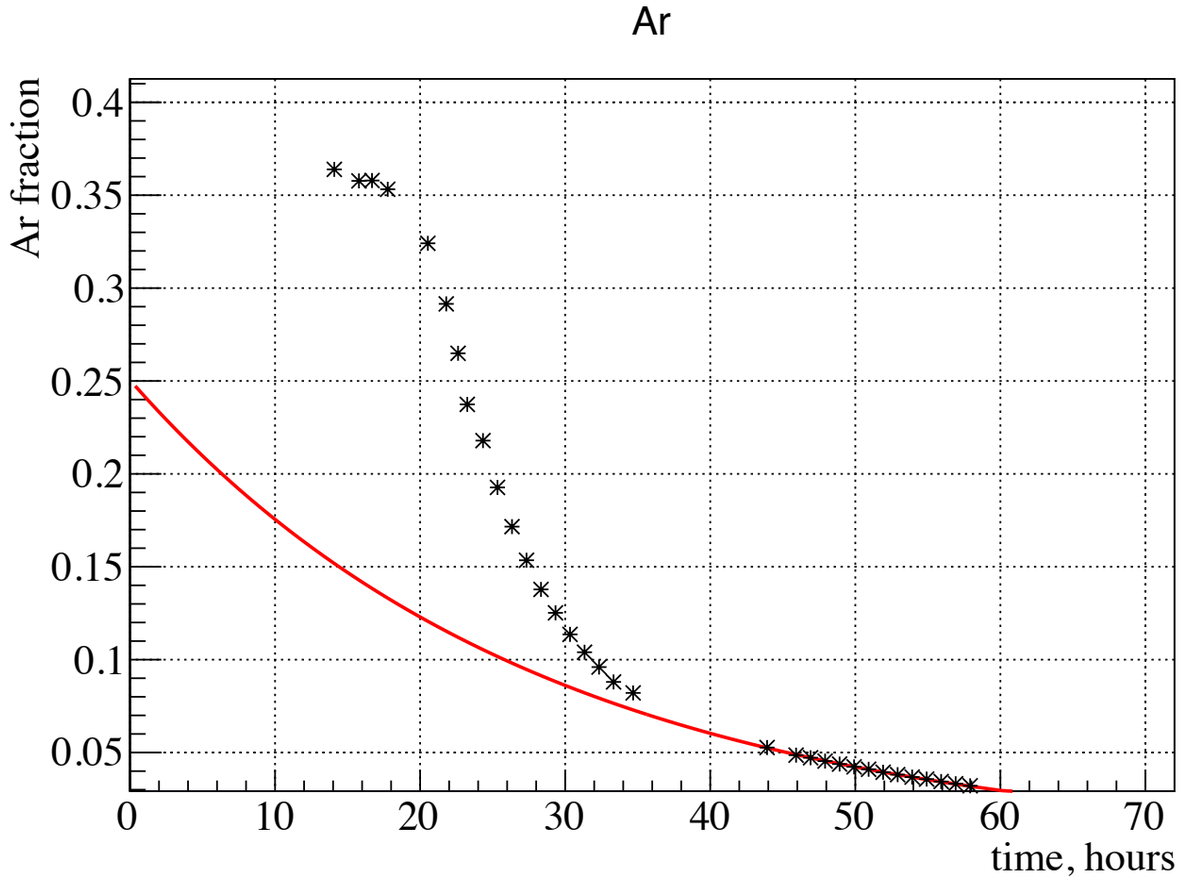
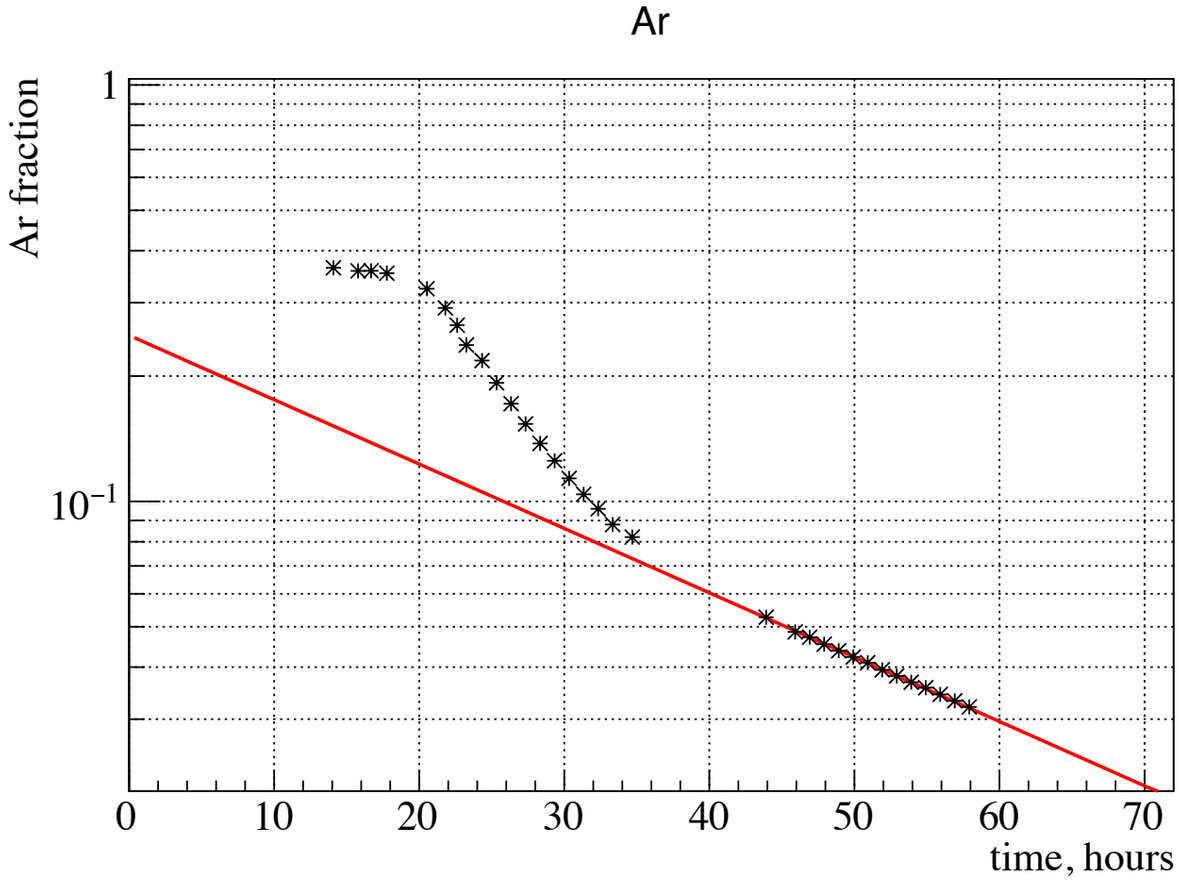


CDC gas tests





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