

Measurement of the Ar/CO₂ Gas Mixture Composition for the CLAS12 Drift Chambers

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This note presents the procedure and results of the measurement of the Ar/CO₂ gas mixture composition with a thermal conductivity unit (TCU).

To measure the percentage composition by volume of the Ar/CO₂ gas mixture supplied to the CLAS12 drift chambers, first the dynamic range of the TCU's output voltage is set by adjusting the TCU's output voltage to 0 V for 100% Ar/0% CO₂ and to 10 V for 0% Ar/100% CO₂. Then, the TCU's output voltage for the standard (calibrated by manufacturer) gas mixture (89.8% Ar/10.2% CO₂ ± 2%, i.e. 89.6% Ar/10.4% CO₂ — 90.0% Ar/10.0% CO₂) is recorded. Finally, the input gas line of the TCU is switched to receive the mixed gas produced by two mass flow controllers (MFCs), one for Ar, the other for CO₂. The MFCs are adjusted so that the TCU's output voltage for the mixed gas is equal to the previously measured output voltage of the standard gas.

To check the variation of the mixed gas composition, compared to the standard gas composition, output voltages were acquired over a period of two weeks—first week for the standard gas, the subsequent for mixed gas—at a rate of 575 ms/voltage reading. For both standard and mixed gases, ~3.5×10⁵ voltages as a function of time were acquired.

Both histograms of the acquired data, Fig. 1, have a small shoulder centered at ~2.755 V, perhaps due to changes in the ambient temperature, which influences the MFC and thereby the output voltage of the TCU.

Table I lists the mean values, standard deviations, number of data points, and the standard errors for the standard and the mixed gases.

	Standard gas	Mixed gas
Mean value [V]	2.723	2.722
Standard deviation [mV]	8	11
Number of data points	~3.5×10 ⁵	~3.5×10 ⁵
Standard error [nV]	23	31

TABLE I. Computed statistics for standard and mixed gas.

The mean voltage of the mixed gas is lower than that of the standard gas by 1 mV, ~0.037%, indicating that the composition of the mixed gas, compared to the composition of the standard gas, has changed by 0.037%.

Given the above observation, calibration is performed on a weekly basis to ensure that the variation of the composition of the mixed gas is less than the recommended 0.5%.

In the near future, the discussed procedure will be automatized so that calibration is easily performed, and if warranted, could be performed even on an hourly basis. Any change in the composition of the mixed gas as compared to the standard gas could be corrected immediately by adjusting the MFCs.

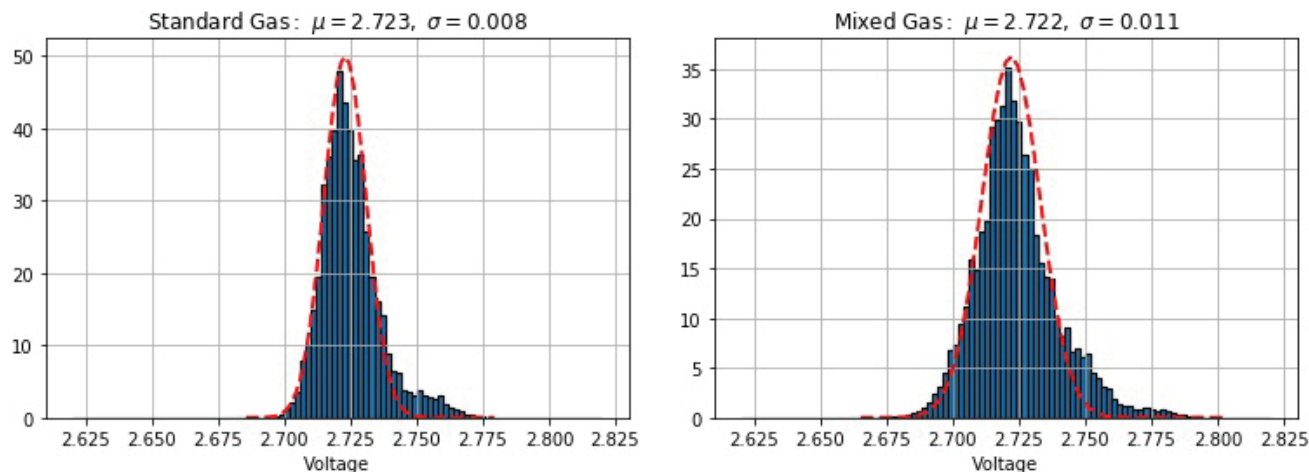


FIG. 1. TCU voltages V for standard gas and mixed gas taken over a week (~3.5×10⁵ voltage values for each type of gas).