GlueX Document 1243
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1 Gas Flow in The CDC

We start by estimating the volume of the CDC. The chamber is roughly 1.5 m long plus another 0.15 m in the gas plenums. The radial shape is annular with an inner radius of 10 cm and and outer radius of 58 cm. Putting this all together, we arrive at a total volume as follows:

$$\begin{aligned} V_{cdc} &= (1.5\,m)\cdot\pi\left((0.58\,m)^2-(0.10\,m)^2\right) \\ V_{cdc} &\approx 1.7\,\mathrm{m}^3\,. \end{aligned}$$

We will then assume that the maximum gas flow is three gas changes per day. This leads to a total volume of about 5.1 m^3 per day. This then leads to a flow rate of

$$\begin{aligned} \frac{dV}{dt} &= 3.2\,\mathrm{liter/min} \\ \frac{dV}{dt} &= 53\,\mathrm{cm}^3/\mathrm{s} \end{aligned}$$

If this gas needs to flow through a $\frac{1}{4}$" ID gas tube, then we estimate that the cross sectional area of the tube is $0.3\,\mathrm{cm}^2$, which yields a gas flow speed of about 150 cm/s. Assuming that the gas is coming in through four such tubes, we get a flow rate of 37.5 cm/s.

2 Other Drift Chambers

Each of the six sector of the CLAS region 1 chamber is fed with two 0.25 inch OD stainless steel tubes. Taken together, they have about the same cross

sectional area as the tubes above. The volume of one of the region one chamber is

$$\begin{aligned} V_{RI} &\approx (2\,m) \times (1\,m) \times (0.3\,m) \\ V_{RI} &\approx 0.67\,m^3 \end{aligned}$$

or about 40% of the volume of the CDC. Nominally, we would then want four times the gas flow through the CDC that we have through region I. This would lead one to assume that four tubes should be OK for filling the chamber. However, we would also note that there is likely more resistance to the gas flow in the CDC than in region I.

Similarly, we obtained information from one of the other halls at Jefferson Lab. They are running gas at 80 cm/s .

Based on this, it would seem that it is safe to run gas at $\sim$ 40 cm/s in the GlueX CDC. For convenience, we will choose this to be 42 cm/s.

3 Flow Rates

There are two procedure in discussion for getting gas into and out of the CDC. The first involves using some fraction of the 12 support rods to handle the gas. The second involves using 0.25 inch ID polyflow tubes for the gas.

In the case of the support rods, we estimate that the constriction point will be in the flow through the endplates where we have a bored out threaded insert. We estimate that the maximum ID of such a bore-out would be $\frac{3}{16}$". For $\frac{1}{4}$" ID polyflow, we will nominally take the ID, but we note that most fittings will also introduce a reduction in available area.

Table 1 shows the gas flow through various sized openings and the number of such openings that would be required to have the gas flow at or below 42 cm/s. In the case of using the support rods, we would be required to feed gas in through six of the rods. For $\frac{1}{4}$" ID polyflow tube, we would need at least four such tubes, and possible more if the ID is constricted.

4 Gas flow through the CDC

In order to minimize the risk of contamination from leaks in the chamber, gas will be fed into the down-stream gas plenum of the chamber. The gas then then flow through the straw tubes to the up-stream plenum. Here, we

Tube ID	Tube Radius	Area	Gas Speed	No. Tubes
$\frac{3}{16}$"	0.238 cm	0.18 cm^2	253 cm/s	6
$\frac{1}{4}$"	0.318 cm	0.3 cm^2	150 cm/s	4
$\frac{1}{2}$"	0.635 cm	1.3 cm^2	42 cm/s	1
1"	1.270 cm	5.1 cm^2	10 cm/s	1

Table 1: A table showing the cross sectional area and flow speed at three gas changes per day for various sized tubes. The last column is the number of such tubes needed to have a flow speed no larger than 42 cm/s.

anticipate allowing the gas to flow back through holes in the end plate into the volume around the straws. These holes will be placed along the lower half of the CDC endplate at the radius of the support rods. The gas will then be taken out near the top of this volume and discharged.

There are two possible exit schemes. In the case of polyflow tube, the there will need to be additional holes through the up-stream endplate that allow tubes to pass through the up-stream plenum. In the case of the support rods, the remaining six rods can be used to exhaust the gas by provides collection holes along the length of the rods inside the CDC.