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Proposal for the gas distribution in the outer tracking system

Abstract

A scheme for the distribution of the counting gas for the straw tube detectors in the outer tracking system is presented.

The outer tracking system is made of three stations as shown in figure 1. Every station consists of 4 layers (X1/U/V/X2). A layer is divided between modules S2/S3 to allow opening of the outer tracking system for maintenance. One half of the X1-layer (V-layer) and one half of the U-layer (X2-layer) build a quarter station. Every quarter station is built as independent system. In total 12 quarter stations exist.
Four different types of detector modules exist: F, S1, S2, and S3. The number of modules of every type and their volume is given in table 1. The total volume of the outer tracker adds up to 3.74 m^3. One exchange of the detector volume every two hours is envisaged, therefore the total gas flow should be approximately 2 m^3/h.
The gas is circulated in a close loop, the regeneration per exchange is expected to be 90%. There will be a single gas line from the mixing and purifying system, located at the gas building at the surface, to the gas distribution behind the radiation wall. In the distribution system the gas line is split in 24 parallel lines. The gas flow through every individual line is controlled by means of a mass flow controller [1].
The natural way to distribute the gas in the outer tracking system is a common gas supply for every quarter station, as they build individual subsystems. This leads to two gas lines available for the supply of one quarter station. Two lines are necessary, as every detector module is split into the

module type	length [mm]	width [mm]	volume per module [l]	number per quarter station	volume per quarter station [l]
F	4826	340	18.0	14	252.0
S1	2314	340	8.7	4	34.8
S2	2215	340	8.3	2	16.6
S3	2215	172	4.2	2	8.4
Σ				**22**	**311.8**

module type	total number of modules	total volume [l]
F	168	3024
S1	48	418
S2	24	199
S3	24	101
Σ	**264**	**3742**

Table 1: *Different types of detector modules for the outer tracking system. For all module types the inner height of the module is 11 mm.*

straw tube gas volume and the envelope gas volume as shown in figure 2 [2]. The separation of these two gas volumes blocks the counting gas from impurities entering the modules by leaks.
The gas runs through the detector modules, either by crossing one F-module, two S1-modules, or one S2- and one S3-modules. It should be noted that the impedance is determined by the inlet and output line of the modules. These are in total approximately 30cm of pipe with an inner diameter of 3 mm. Some of the lines pass only one module (F-modules) while other lines pass two modules (S-Modules). Without compensation this leads to a higher gas flow through the S-modules compared to the gas flow through the F-modules. A simple compensation is to adapt the length of the input pipes for the F-modules to a length resulting in the same impedance as for the S-Modules.
The lines rejoin behind the radiation shield to a single line and return to the surface by means of a pump. The resulting supply scheme for the gas distribution system including the gas flow in every individual line is shown in figure 3.

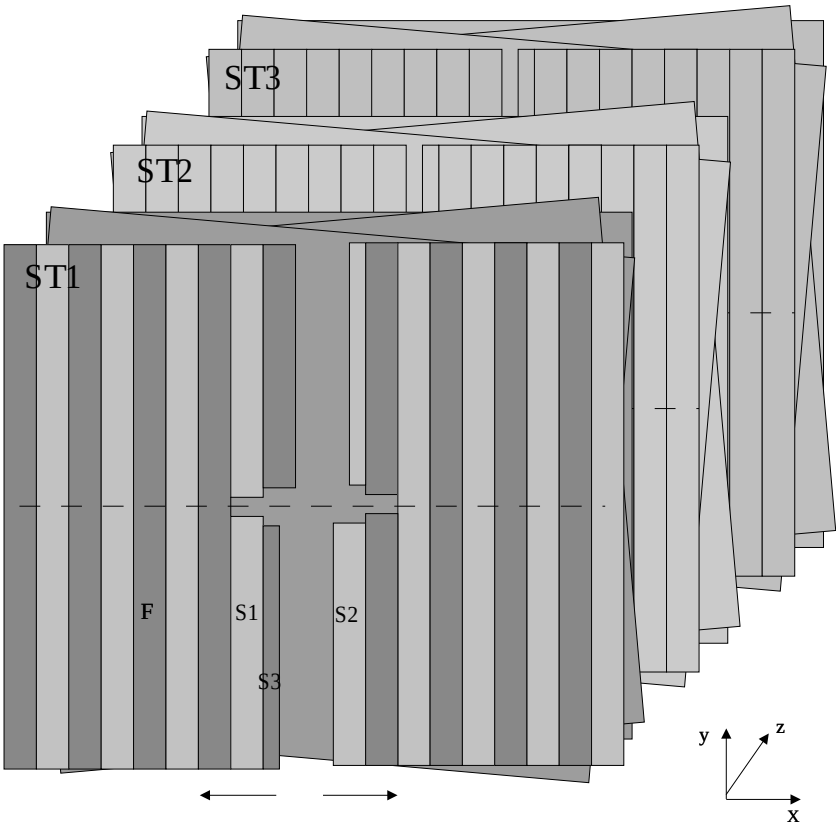

Figure 1: *Arrangement of detector modules in the outer tracking system.*

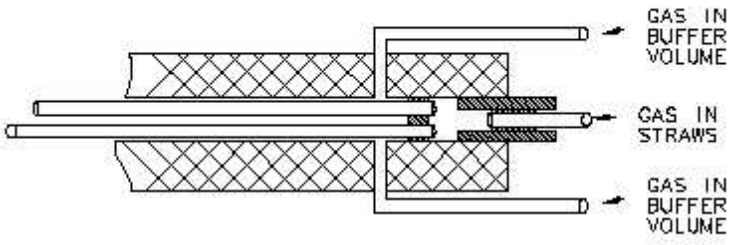

Figure 2: *Gas flow through detector modules*

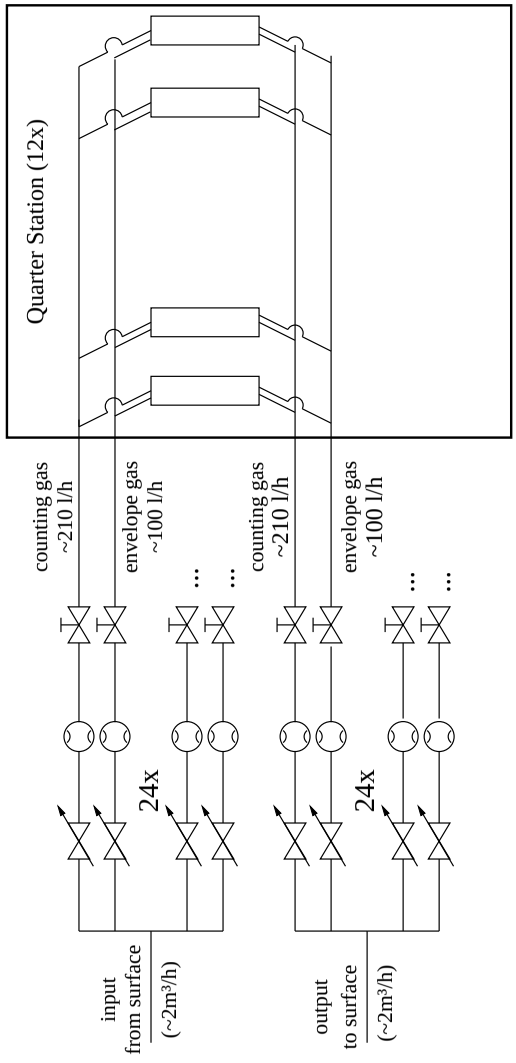

Figure 3: *Gas distribution for the outer tracking system. The gas flow is given for all supply lines.*

References

[1] LHCB Outer Tracker Gas System Proposal, F.Hahn et.al., LHCB-IG-EN-0004

[2] LHCb outer tracker, Technical Design Report 6 CERN/LHCC 2001-024