1. CSC Timing

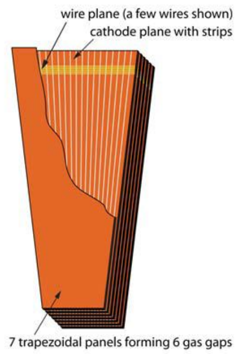

Figure 1. Layout of CSC chambers showing anode wires and cathode strips

The Cathode Strip Chambers (CSC) measure the position of hits using a nearly orthogonal layout of anode wires and cathode strips as can be seen in Fig. **??**. The cathode strips run radially away from the beam pipe and are used to measure the phi position of the hits whereas the anode wires determine the radial position. The signal produced in both the strips and the wires can be used to determine the timing of a hit with similar resolution.

When the gas in a CSC chamber is ionized electrons drift towards the anode wires which are kept at a high voltage. The charge collected on the anode wire is input into a constant fraction discriminator in the Anode Front End Board (AFEB). If the charge is above the detection threshold, a 35 ns pulse is output to the chamber's ALCT-board. As the pulse is digitized every 25 ns, the start time of the pulse will determine if the anode hit is in one or two BXs. Using these digitized values the time from the anode wires is determined with a quantization of 12.5 ns.

The ionized electrons induce a charge on the cathode strips which is amplified, shaped, and then sampled every 50 ns. Eight 50 ns samples are saved with the first two bins serving as dynamic pedestals The sample with the largest charge along with the sample before and two after are used to determine the time of the hit. The peak time of the pulse is found with a 5-pole fit to these four samples.

An important task during 2010 running was to calibrate the timing from the CSC system so that the average time of all hits from collision muons would be zero. Both the anode wire and cathode strip times are corrected for time of flight from the IP assuming straight line speed of light travel. Additionally a propagation delay correction is applied to the cathode strip time based on the location of the hit along the strip. Finally chamber level offsets were derived separately for the cathode strip and anode wire times using hits associated with high pt, high quality muons.

The distribution for the anode wire and cathode strip times can be seen in Figures **??** and **??** respectively. It can be seen that the anode wires have a long positive tail. A pruning procedure is used when creating the global inverse beta of the track to deal with

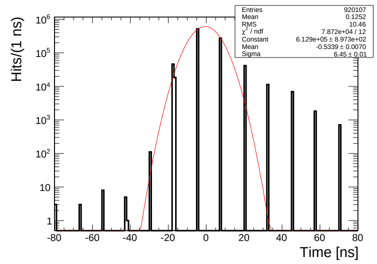

FIGURE 2. Time distribution from Anode Wires

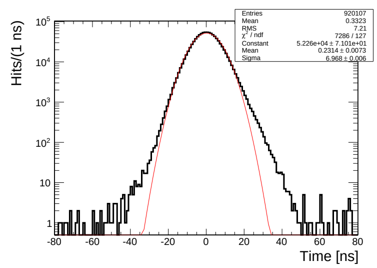

FIGURE 3. Time distribution from Cathode Strips

this effect. The two measurements are expected to have some correlation due to the drift delay of the ionized electrons to the anode wires which averages 60 ns. The correlation coefficient between the two values is 0.28.

Assuming the particle left the IP at time t=0, an inverse beta measurement can be made for a time measurement at distance d using the formula

$$\beta_{Hit}^{-1} = 1 + \frac{t * c}{d}$$

The global inverse beta is calculated as the weight average of the inverse beta of each time measurement along the track. The weight for each measurement is determined as the distance from IP squared divided by the time variance of the hit. To deal with the large tail of the anode wire measurement any CSC measurement which is more than three sigma from the global mean is removed from the fit.

A particle transversing the CSC system will normally cross three or four chambers and each chamber has six layers. This means that particles in the CSC system will normally have 18-24 hits and 36-48 time measurements.