CMM Results from the Drift Chamber Endplates

Both the front and rear endplates have been completed at Brenner Tool and Die. All sense wire holes were measured on their coordinate measuring machine (CMM), as well as 320 clearing wire holes and 656 field wire holes from each plate. The results are summarized in the plots below.

The measurements were made with the gas side of the endplates upwards. Each hole was measured at four points at a depth of 5 mm below the upper (gas-side) surface of the endplate.

The location of the holes is excellent. The mean deviation of the measured hole center from the desired is about $25 \mu m$, compared to our spec that all deviations should be less than $75 \mu m$. [Recall that the machinist’s ‘true position tolerance’ is on twice the deviation, and was spec’ed at $150 \mu m$.]

In the first pass of measurements it was noted that about 100 sense wire holes on each plate appeared not to satisfy the true position tolerance. It was then noted that in most cases there was a small amount of material left in the holes from the deburring process. This material would obstruct the CMM probe which measures the holes from their interior, resulting in too small a hole diameter as well as a skewed hole center.

All holes were cleaned again, and sense wire holes with position deviations of greater than 50 $\mu m$ were remeasured on the CMM. They all proved to be within the true position tolerance after the remeasurement.

For holes as small as ours, the CMM can give a measure of the hole diameter subject to a systematic error of a few $\mu m$. Therefore, every hole was tested with two precision X-class gauge pins (go/no-go pins) to verify that all hole diameters exceeded our minimum spec and were less than our maximum spec. The pin diameters were $2.5^{+0.001}_{-0.001}$ and $2.525^{+0.001}_{-0.001}$ mm for the smaller holes and $4.5^{+0.001}_{-0.001}$ and $4.525^{+0.001}_{-0.001}$ mm for the larger.

As can be seen in the following plots, the strong correlation to position deviation is with angle, likely related to a systematic error in the rotary table that supported the endplate during machining. The position deviation grows slowly with radius, likely related to the random error in angle of the rotary table.

The banding seen particularly in the position deviation plots of the rear endplate clearing wires is an artifact of sampling at only four angles combined with the correlation of position deviation with angle.

The hole diameter shows little correlation with any other parameter.

The Appendix discusses the summary-file structure.
1 Front Endplate

Figure 1: Initial measurements of the sense wire holes on the front endplate.
Figure 2: Results including remeasurements of the sense wire holes on the front endplate.
Figure 3: Measurements of the clearing wire holes on the front endplate.
Figure 4: Measurements of the field wire holes on the front endplate.
Figure 5: Results including remeasurements of the sense wire holes on the front endplate.
Figure 6: Measurements of the clearing wire holes on the front endplate.
Figure 7: Measurements of the field wire holes on the front endplate.