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SDC
SOLENOIDAL DETECTOR NOTES

STRAW AND MODULE PLACEMENT
(Presented at ORNL on February 11, 1991)

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I will begin by discussing support structure stability. I assume that Abe Seiden's numbers on correlated errors for the tracking layers are a statement of stability requirements for the structure. I will discuss module placement in a second section. In this report the numbers I will quote for errors are sigmas of the assumed gaussian errors. ie. +-sigma = +- 15 microns In order to be conservative we will assume that this should be interpreted as construction tolerances ie. +- 15 microns. (all points on the part within this window), with 1 mil = 25.4 microns.

Support stability:

1) the centroids of the Si and the Straw system must not vary by more than +- 15 microns. This will require monitoring the relative position of the silicon with respect to the outer tracker.

2) The rotational stability of the Si with respect to Straw layers is Δ phi = +_ 10^{-5} radians= +_ 0.00057 degrees. This also should be monitored continuously.

3) Each superlayer must have a circumferential stability (phi rotation with respect to other superlayers) that is about +- 50 microns. (actually the requirement is less strict for the inner layers of the straws, but lets be conservative). This will require a good understanding of the long term stability of support materials, but may not require continuous monitoring.

4) The radial stability is much less stringent. The purely radial stability is +_1.5 mm. However, this assumes that the circumference position (phi) does not change. So, I don't think this really allows us much design flexibility. Abe reduces this to +- 200 microns.

1) Placement of each end of the system with respect to other end. (hard to say, needs more work, probably close to the rotational requirement for each module, ie. +- 50 microns.) Will be fixed at assembly time using optical alignment techniques.

2) Placement of the entire tracking system with respect to the beam is , in part set by the amount of beam movement we expect. (+-1 mm?)
It is also set by the triggering requirements in the Si system., so it should be smaller than a strip size , say +- 100 microns. This may require local (Si) adjustment. This can be done to high accuracy during initial installation, and then monitored each down time, and perhaps adjusted with the kinematic constraints.

3) Assuming that the modules are aligned after the support structure is complete, the construction of the gross support frame need not be more accurate than +- 500 microns. This is an engineering detail of how the support cylinders are made.

Module requirements:

1) Placing modules on the cylinders (module placement)

Assuming that we have monolithic support rings or cylinders for the modules in each superlayer, then the over all angular error requirement should result in a maximum placement error of +_ 50 microns for each module.(this is the total placement error for the mean position of the module, ie placement of fiducial points at say 8 positions on the module.) To be conservative I will assume that each of the 8 module attachment positions has this precision.

2) Module intrinsic straightness.

From our limited tests on a 1 meter, smaller section, carbon composite shell, the bowing should amount to less than +_50 microns between support points (80 cm). I will assume +- 50 conservatively. This is one place where the reduced radial requirement helps us, since the modules are thinner radially, and might have more built-in bowing in this direction.

3) Straw placement within a module

The wire placement error will add in quadrature with the intrinsic wire resolution, assuming that they are random , uncorrelated errors. We have attempted to determine the size of such placement errors by optical measurements of straw center (double vee) positions at the end of a 64 straw rhombus. The x-y positions were measured using a milling machine and an optical telescope. Our estimated reading error was about +- 1 mil. The measurements were done with the endplate inserted in the rhombus shell. These measurements were then fitted to a close packed pattern with arbitrary center, rotation, and straw radius. The individual deviations from a perfect close packed geometry are shown in Fig. 1.This resulted in a 65 micron average sigma. determination of wire centers .(So a good part of this may be our measurement error.) But again, I will take 65 microns as the deviation from true close packing. The best fit straw separation was 3984 +- 7 microns.

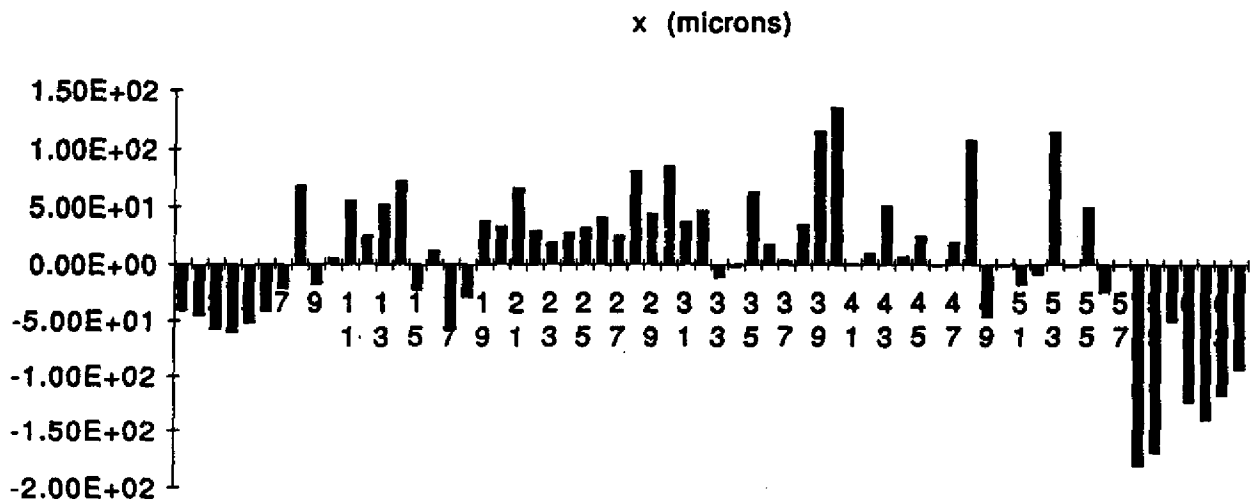

Fig. 1 Wire displacements from best fit of close packed geometry

In order to determine the effects of correlated errors in the straw and wire positions, the difference matrix from the above fit was used to fit vertical tracks. (see Figure 2). Correlation effects would show up as significant deviations from a "Zero "crossing. These were found to be small < 30 microns for all x positions. So we

conclude that correlated displacements are not a problem. We will assume a straw placement error of 65 micron wire placement, however we feel that this can this can be improved considerably in our final module design.

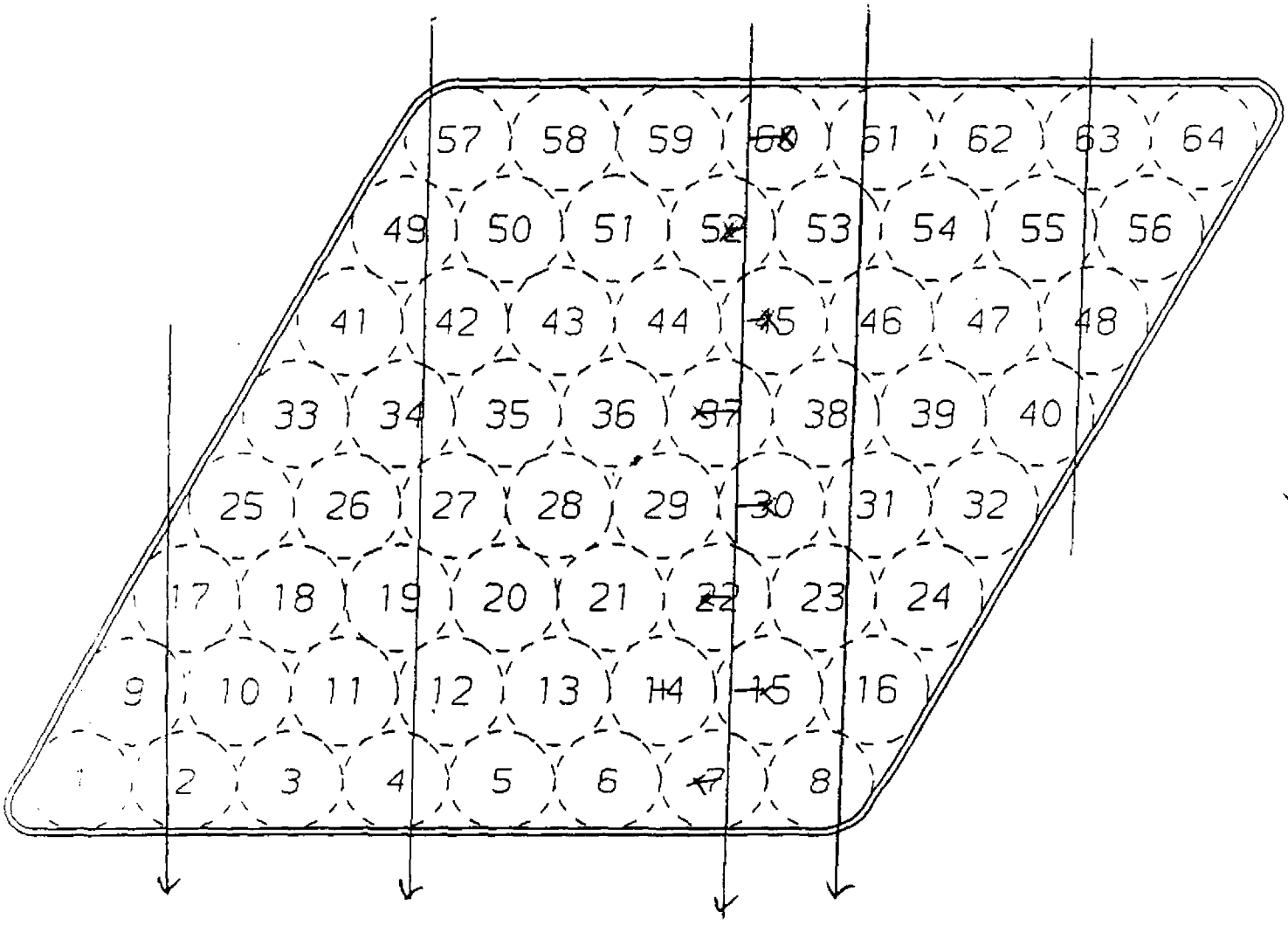

Fig. 2 Fitting wire displacements with vertical tracks

If we use an intrinsic wire resolution of 100 microns, wire placement error of 65 microns, module placement error of 50 microns, and module intrinsic error of 50 microns. then we get get micron total superlayer error of 83 microns. I take this to indicate that we can build and align a modular system that will give us the required momentum resolution.

Notice that unlike Abe, we conclude that the major part of the error in the superlayer measurement comes from alignment not intrinsic error in the straw.