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Barrel TRT HV plate dimension measurements

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This report describes the results of the measurements of the Barrel TRT HV plates. These plates are measured during the fabrication process prior to the lamination of kapton HV circuit.

1. Description of measuring equipment and technique.

The HV plates are measured using a non-contact measuring machine. The Optical Gauge Products (OGP) Avant-600 is shown in figure 1. This machine has a measurement accuracy of ± 0.005mm as determined by a 100mm x 300mm glass calibration standard. This machine as a measurement area of 18" x 24" (457 x 610mm). The OGP machine is has three modes of illuminating the part under measurement: backlighting (best for measuring the straw holes and fixation hole), through the lens lighting and off-axis lighting. Due difficulty in measuring the alignment slot using the available light sources on the Avant-600, an external fiber optic light was used direct light down the slot. Figure 2 shows the images of the fixation hole A and fixation slot B as seen by the OGP machine.

Figure 1 Photograph of the OGP Avant-600 non-contact optical measuring machine used to measure the Barrel TRT HV plates prior lamination of the kapton HV distribution circuit. It has measurement area of 18"x24" and measurement accuracy of ± 0.005mm

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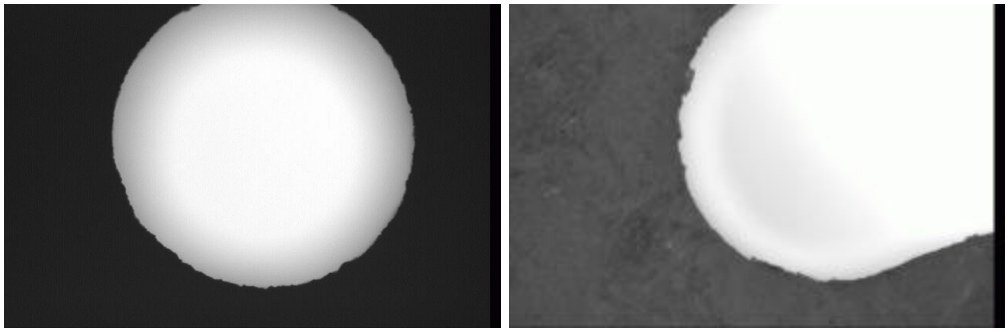

Figure 2 Images of the fixation hole A and the alignment slot B of a typical HV plate. The fixation hole A was backlit and the alignment slot B was lit with an external light. The OGP used the fixation A as the original and the radius of the alignment slot B was used to align the X axis.

The features measured are the fixation hole A, alignment slot B, gas hole A, gas hole B, twelve straw holes (3 in each of the corners of the parts) and several points along each of the four sides. The origin of the part is determined from fixation hole A and positive x-axis was aligned to the line between the fixation hole A and radius of alignment slot B. Figure 3 shows a drawing of the type XX plate with the features that are measured noted on the drawing. The straw holes (311, 310, 320, 313, 294, 293, 16, 17, 1, 14, 30 and 31) are measured for type 1 plates. Type 2 plates have the straw holes (474, 475, 498, 519, 496, 497, 39, 38, 19, 2, 21 and 20) measured and for type 3 plates the straw holes (765, 764, 793, 767, 738, 737, 24, 25, 1, 22, 46 and 47) are measured.

Figure 3 - drawing of features measured on HV plate by OGP machine

The straw hole position data has been interpreted using two coordinate systems. The first system uses the fixation hole A as the origin and the positive x-axis is along the line between fixation hole A and the semicircle at the end of alignment slot B (In most of the HV plates, there is a hole at the end of the alignment slot that is used instead of the semicircle). The OGP machine measures the fixation hole A and hole in alignment slot B initially to setup the coordinate system. All subsequent measurements are reported in this coordinate system. The second coordinate system is constructed from the straw hole data. The origin is determined from the average straw hole position. This system is just a simple translation of the origin from the fixation hole to the average straw hole position.

Before presenting the data it is instructive to explain how the plates are measured. Each plate is placed on the OGP stage with the straw hole recess facing upward. The fixation hole A and semicircle (or hole) in alignment slot B are measured. The coordinate system origin and x axis orientation are determined from these measurements. As many points as possible are used to measure each hole (circle). The position, roundness and a form factor are reported. The fixation hole A and alignment slot B are measured again along with the cooling holes A and B and the twelve straw holes. After the holes are measured, then several points along the outer perimeter of each part are measured. The perimeter measurements are not being reported here because of problems with using the first coordinate system.

We decided to look at the parts using the second coordinate system because of problems with the fixation hole. The fixation hole has diameter of 2.000 mm and is very long (??.??mm). The

fixation hole is not very cylindrical. Touch probe measurements measuring the fixation hole near the bottom, middle and top relieved that the center of the fixation hole at the top was different from the center of the fixation hole at the bottom by ~0.030 mm. Subsequent measurements with the OGP show similar results, though these measurement were hard to make because the relied on focusing at the bottom of the hole and focusing at the top. Table 3 provides further evidence of the random location of the fixation hole in each of the three types of plates measured.

2. Analysis of straw position data

In this section we will present straw position data for the HV plates that have been measured to date. The data will be presented in an ensemble manner with the individual measurements included in a HV plate passport uploaded into the production database. An example of such a passport can be found in appendix A. Additionally an excel file with the data in tabular form will also be stored in the database. Table one lists the numbers of plates measured by each module type.

	MIRRORED HV PLATE	NON-MIRRORED	TOTAL
Type 1	30	27	57
Type 2	34	40	74
Type 3	22	23	45

Table 1 Number of HV plates measured

Figure 4,5 and 6 show the distribution of the deviation of the straw holes from their nominal positions when fixation hole A is used as the origin and when the average straw hole position is used as the origin for type 1, type 2 and type 3 TRT modules respectively. The fact that the distributions are narrower when average straw hole position is used as the origin is further evidence that there is significant uncertainty in the position of the fixation hole. This fact should be noted because it means that the TRT modules will be randomly place in the space frame. The exact position of the straws will have to be determined by tracks.

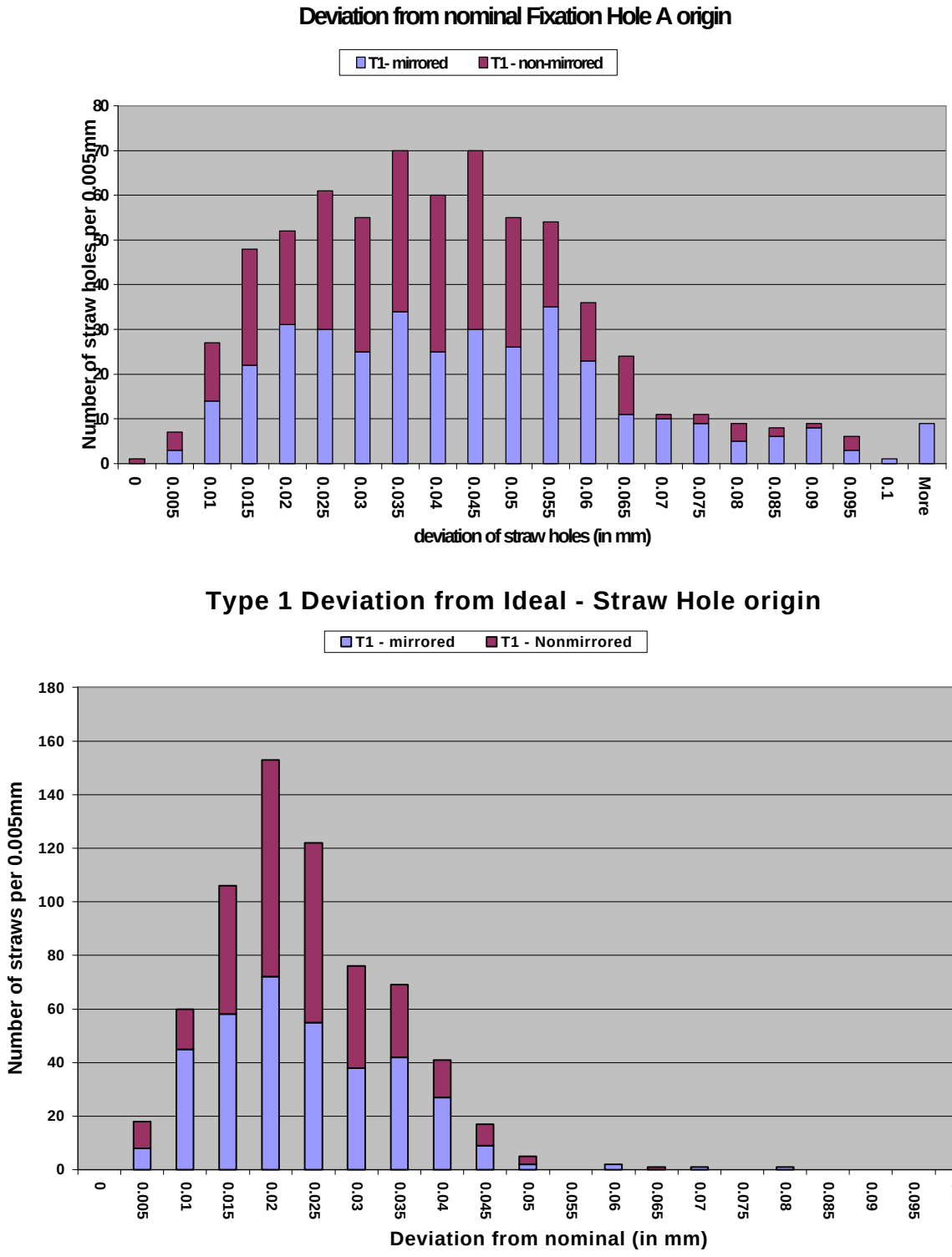

Figure 4 Deviation of straw hole positions for Type 1 modules using fixation hole A as origin (top) average straw hole position as origin (bottom). The mean of the top plot is 0.039 mm with sigma = 0.021. For the bottom plot the numbers are mean= 0.021 mm and sigma = 0.010.

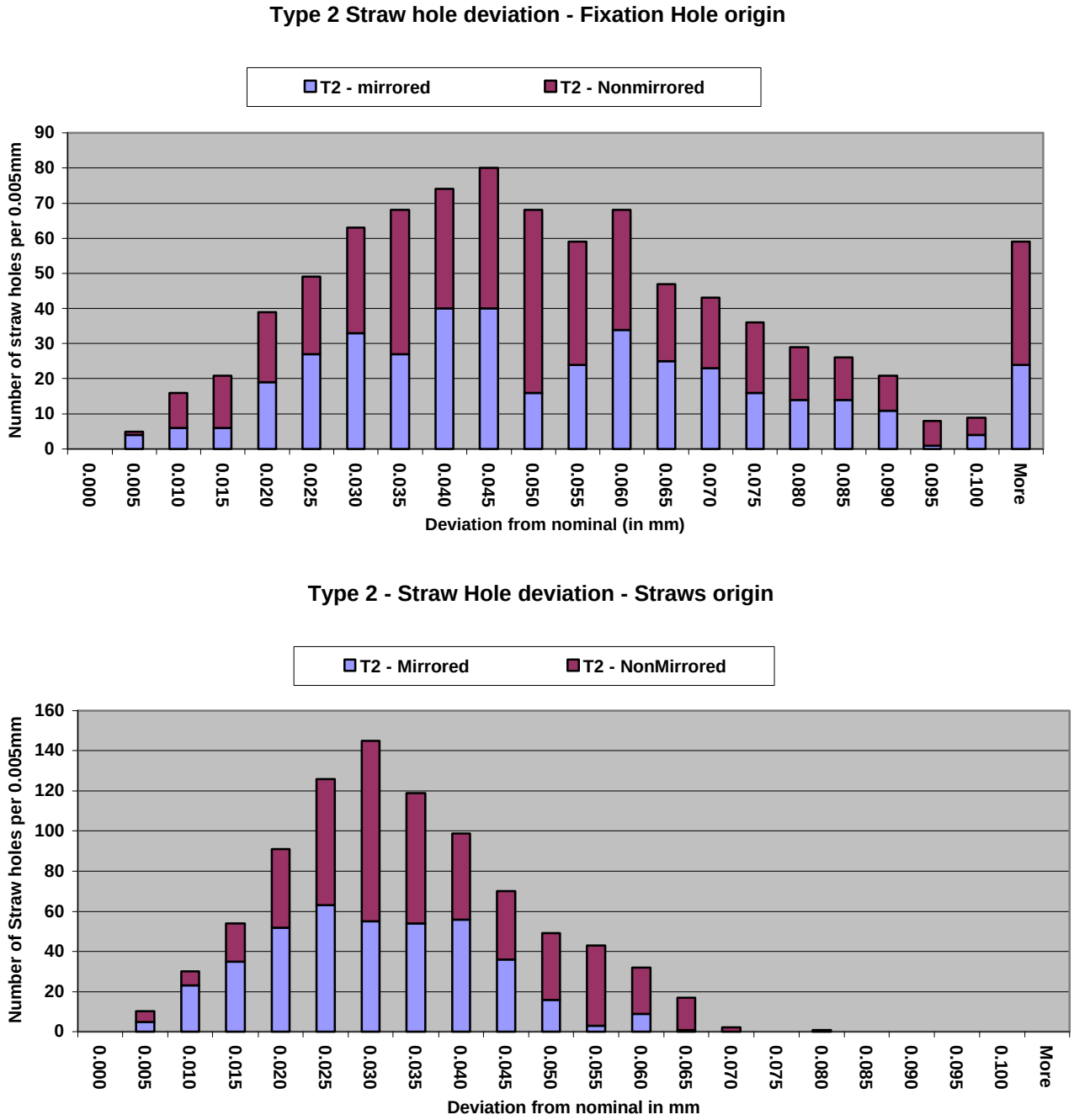

Figure 5 Deviation of straw hole positions for Type 2 modules using fixation hole A as origin (top) average straw hole position as origin (bottom). The mean of the top plot is 0.051 mm with sigma = 0.026. For the bottom plot the numbers are mean= 0.031 mm and sigma = 0.013.

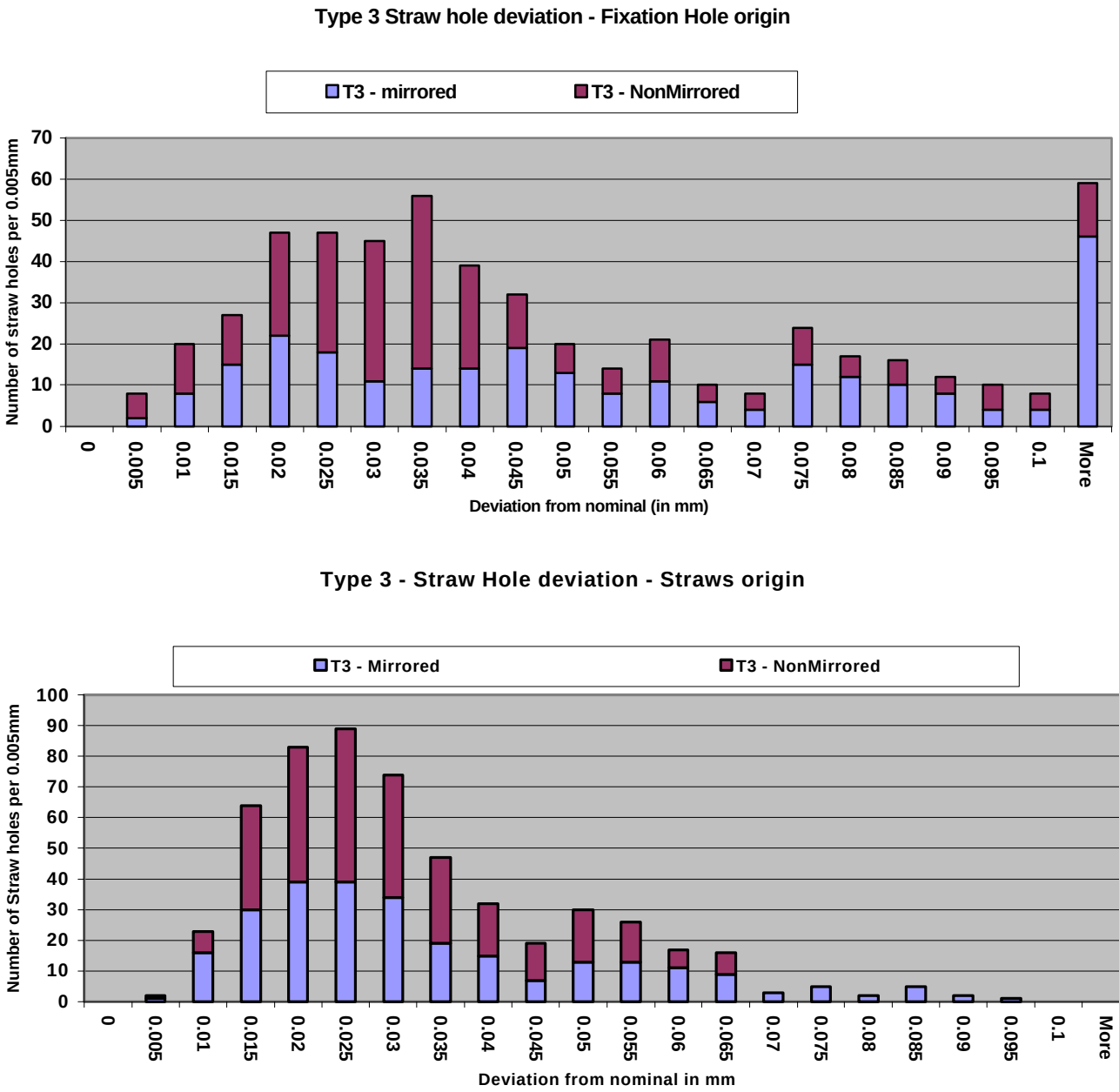

Figure 6 Deviation of straw hole positions for Type 2 modules using fixation hole A as origin (top) average straw hole position as origin (bottom). The mean of the top plot is 0.050 mm with sigma = 0.038. For the bottom plot the numbers are mean= 0.030 mm and sigma = 0.017.

Table 2 summaries the mean deviation and the r.m.s. for the straw holes of modules of each type. The results using fixation hole A as the origin and the average straw hole position origin are listed in the table.

		Mean (in mm)	Rms (in mm)
Type 1	Fixation hole origin	0.039	0.021
	Avg. straw position origin	0.021	0.010
Type 2	Fixation hole origin	0.051	0.026
	Avg. straw position origin	0.031	0.013
Type 3	Fixation hole origin	0.050	0.038
	Avg. straw position origin	0.030	0.017

Table 2 Summary of the average deviation and the rms for the straw holes from their nominal positions for all three module types in both coordinate systems.

Origin = Avg straw hole position	mean (in mm)	rms(in mm)
Type 1	0.030	0.030
Type 2	0.040	0.023
Type 3	0.042	0.032

Table 3 Summary of average deviation and the rms for the fixation hole A from its nominal position in the coordinate system which uses the average position of the straws as the origin.

3. Conclusions:

If one uses the coordinate system whose origin is defined by the average straw hole position, then almost all of the HV plates pass the specification that each straw hole must be within 0.075 mm of its nominal position. Only one straw holes of the type 1 and one for a type 2 modules fail the specification. The numbers are higher for the type 3 modules (13 straw holes mostly localized to 2 plates). The fixation holes are more problematic. Ten plates (2- type 1, 4 type 2 and 4 type 3) have fixation holes that are more than 0.075 mm away from their nominal positions. In addition the spread on the deviation is larger for fixation holes than it is for the straw holes. This will present problems when it is time to pin the modules into the space frame.