D0 ENGINEERING NOTE

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FIBER TRACKER CYLINDER NESTING

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Approved: _____

DO UPGRADE FIBER TRACKER ASSEMBLY CYLINDER NESTING

The fiber tracker consists of 8 concentric carbon fiber cylinders of varying diameters, from 399mm to 1032.2mm and two different lengths, 1.66 and 2.52 meters (fig. 1). Each completed cylinder is covered over the entire o.d. with scintillating fiber ribbons with a connector on each ribbon. These ribbons are axial(parallel to the beam line) at one end and stereo(at 3 deg. to the beam line) at the other. The ribbon connectors have dowel pins which are used to match with the connectors on the wave guide ribbons. These dowel pins are also used during the nesting operation, locating and positioning measurements.

The nesting operation is the insertion of one cylinder into another, aligning them with one another and fastening them together into a homogeneous assembly. For ease of assembly, the nesting operation is accomplished working from largest diameter to smallest. Although the completed assembly of all 8 cylinders glued and bolted together is very stiff, individual cylinders are relatively flexible. Therefore, during this operation, #8 must be supported in a manner which maintains its integrity and yet allows the insertion of #7. This is accomplished by essentially building a set of dummy end plates which replicate a #9 cylinder. These end plates are mounted on a wheeled cart that becomes the nesting cart (fig. 2). Provisions for a protective cover fastened to these rings has been made and will be incorporated in finished product. These covers can be easily removed for access to #8 and/or the connection of #8 to #9. Another wheeled cart, transfer cart(fig. 3), is used to push a completed cylinder into the cylinder(s) already mounted in the nesting cart.

NESTING CART

The nesting cart contains the tracker assembly as the cylinders are installed, until final completion of all cylinders and the tracker is ready to accept the silicon tracking assembly.

Two large aluminum rings are mounted at each end of the cart base. The top of the rings are held apart by a tubular spacer. At +/- 45 deg. from the bottom are two stub shafts. The #9 end plates are mounted on these stubs and the top spacer with bronze bushings. The #9 end plate at the axial end of the tracker cylinder is fixed to the aluminum ring in Z. The stereo end is also fixed during the assembly of #8, but it is free to move during the insertion of all other cylinders. The reason for this is to allow for changes in cylinder length due to humidity and/or temperature changes. The stub shafts and the top spacer are designed for easy disassembly when the completed tracker assembly is removed from the nesting cart. Mounted to the aluminum rings are alignment devices which provide for the appropriate adjustments to be made. The axial end has X, Y, Z and phi capability and the stereo end has X and Y. The axial end adjusting mechanism is removable from the ring during the insertion of a cylinder. These devices are machine slides with micrometer adjusting screws (fig. 4).

The #9 end plate is made of carbon fiber in order to better match materials for temperature and humidity concerns. As part of all cylinders there is a carbon fiber ring, bottom centering ring (fig. 5), glued to the outer most ribbon array. This ring is thin in radial thickness and wide in axial length. It has two purposes:

- a-provides a surface for the cylinder to cylinder interconnecting washer to be glued to,
- b-distributes the load of the cylinder(s) more uniformly across the fibers

The #8 cylinder is connected to this end plate through two additional pieces. Each piece is segmented, with one bolted to the end plate.(The size and number of segments will be determined through a series of tests confirming removal of these parts without causing any damage to #8). The second connecting piece is wedge shaped on one side which matches the bolted piece and flat on the other which matches the bottom centering ring on #8. After alignment, this piece is inserted and glued to #8 and #9. The glue gap is such that no forces are transmitted to the #8 cylinder during this operation. This connection design was developed with removal of #9 end plates from #8 in a non-destructive manner. First, #9 end plate can be un-bolted from the segmented pieces and then the smaller pieces can be more easily separated from the #8 bottom centering ring.

The dowel pins in the connectors of #8 are used to establish the datum for all further cylinder installations.

TRANSFER CART

The transfer cart (fig. 3) has a twofold purpose. One, it is used to take a completed cylinder from the ribbon laying machine and then, coupled to the nesting cart, transfer the cylinder into the tracker assembly. The cart consists of a welded base frame with two THK-LM system linear bearings and rails mounted to it. A vertical mast is mounted to this bearing/rail arrangement and travels axially along them. The mast carries a horizontal shaft which fits into bearings mounted within every cylinder's end plates. This mast consists of two linear machine slides, which provide vertical and horizontal adjustments. The cart can readily be connected to the ribbon beam moving cart (fig. 7) and the nesting cart for cylinder transfers.

First, the completed cylinder is removed from the ribbon laying machine and supported by the ribbon beam moving cart (already in use for ribbon installation on cylinders). The cylinder is supported in two slings. The transfer cart is aligned and connected to the beam moving cart (fig. 8). The mast is moved forward and the shaft engages the cylinder end plates. The shaft on the transfer cart now carries the cylinder and the ribbon beam moving cart can be de-coupled and moved away. The mast is retracted, pulling the cylinder within the confines of the transfer cart.

Next, the transfer cart is coupled to the nesting cart and the cylinder transfer begins (fig. 9). The machine slides of the mast are used to provide a rough alignment of the cylinder(s) and the mast is carefully moved forward inserting the newest cylinder into the array. The insertion process is done from the axial end of the array. Once the cylinder is positioned roughly into the array, the axial end alignment mechanism is put in place on the nesting cart (fig. 10). The shaft carrying the cylinder is lowered to transfer the cylinder load onto the alignment blocks. At this time the shaft is de-coupled from the mast and the transfer cart is removed from the immediate area. The nesting cart is moved into the CMM and the final alignment process is started. When the alignment is completed the newest cylinder is fixed into the array, i.e. bolted and glued using "L" shaped washers. The array is removed from the CMM area to allow for the removal of the cylinder end plates and transfer cart shaft.

CYLINDER TO CYLINDER CONNECTION

The basic connector used in the tracker nesting of cylinders is an "L" shaped, segmented piece of carbon fiber material, connecting washer. The washer is connected to the smaller cylinder by a glue joint at the bottom centering ring and by fasteners at the recessed portion of the larger cylinder end ring (fig. 11). This arrangement is typical for most of the connections, however there are a few exceptions. The connecting member is always an "L" shaped washer. Because the clearance between #7 and #8 is small and thus there is no room for the fastener style joint at the #8 end ring. Therefore, this washer is a glue joint at both interfaces.

Since cylinder #3 carries the load of #1, #2, and the silicon tracker, an internal support is required to join #3 and #4 together at a point directly above the joint of #2 to #3. The joining of #3 and #4 at this point provides a stiffer connection which in turn maintains the appropriate deflection in the final assembly. In order to accomplish this type of connection, a mounting ring is added to #4 at the appropriate internal position, approximately 17" from the end and a corresponding bottom centering ring is added to #3 at the same axial location. The joint is completed with standard washer/glue/fastener arrangement. This scheme is basically repeated for the #2 to #3 connection, with the mounting ring added to #3, approximately 17" in from the end and the washer connecting to #2 at the end of #2. #1 is connected to #2 in the standard manner.

The connection between #1 and the silicon tracker is yet to be determined.

REV.	DATE	DESCRIPTION AND SIZE	BY
PARTS LIST			
1	1	1. 7.00 FIBER CABLE BUNDLE	1. 7.00 FIBER CABLE BUNDLE
2	2	2. 7.00 FIBER CABLE BUNDLE	2. 7.00 FIBER CABLE BUNDLE
3	3	3. 7.00 FIBER CABLE BUNDLE	3. 7.00 FIBER CABLE BUNDLE
4	4	4. 7.00 FIBER CABLE BUNDLE	4. 7.00 FIBER CABLE BUNDLE
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8	8	8. 7.00 FIBER CABLE BUNDLE	8. 7.00 FIBER CABLE BUNDLE
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96	96	96. 7.00 FIBER CABLE BUNDLE	96. 7.00 FIBER CABLE BUNDLE
97	97	97. 7.00 FIBER CABLE BUNDLE	97. 7.00 FIBER CABLE BUNDLE
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99	99	99. 7.00 FIBER CABLE BUNDLE	99. 7.00 FIBER CABLE BUNDLE
100	100	100. 7.00 FIBER CABLE BUNDLE	100. 7.00 FIBER CABLE BUNDLE

FIG. 2

TRANSFER CART

FIG. 3

FIG. 4

DETAIL A

SCALE: FULL

FIG. 5

FIG. 6

FIG. 7

FIG. 8

FIG. 9

FIG. 10

DETAIL A
SCALE: FULL

DETAIL B
SCALE: FULL

DETAIL C
SCALE: FULL

FIG. 11