Silicon Vertex Tracker

Table I lists design values of the CLAS12 SVT.

Parameter	Design value
Number of regions	4 (Labelled: R1, R2, R3, R4)
Number of modules/Region (R1, R2, R3, R4)	10, 14, 18, 24
Number of silicon layers/module	2 (Labelled: *U*, *V*)
Module dimensions	41.8 cm x 4.2 cm x 0.39 cm
Strip layout	(0^o— 3^o) Graded angle
Sensor size	111.62 mm x 42.00 mm x 0.320 mm
Pitch (Readout, Intermediate)	(156 µm, 78 µm)
Number of readout channels/module	512
Angular coverage (θ, Φ)by R1—R3	(32.8°–138.7°, ~2π)
Angular coverage (θ, Φ)by R1—R4	(33.4°–116.7°, ~2π)
Gap between sensors of adjacent sectors (R1, R2, R3, R4)	0.353 mm, 0.359 mm, 0.391 mm, 0.427 mm
Radii (beam line to backing structure) (R1, R2, R3, R4)	65.588 mm, 93.198 mm, 120.608 mm, 161.533 mm
Resolution (spatial, momentum)	(~50 µm, ~5% [for 1GeV pions @ θ = π/2])
Angular resolution (θ, φ)	(10–20 mrad, ~5 mrad)
Design luminosity	10^{35} $cm^{-2}s^{-1}$

Table I. SVT design values.

Each module, Fig. 1, is made by gluing to the backing structure silicon sensors, pitch adapters, and the hybrids of the hybrid flex circuit boards (HFCB) and wire bonding them together. Three types of sensors, Hybrid, Intermediate, and Far, two of each type (one for the top side—*V*, the other for the bottom side—*U*, side closer to the beam), are used on a module.

Clearances between components are: 110 ± 10 µm between silicon sensors, $500\mu m^{+110\ \mu m}_{-\ \ 90\ \mu m}$ between Hybrid sensors and pitch adapters, and $300\mu m^{+150\ \mu m}_{-\ \ 50\ \mu m}$ between pitch adapters and hybrids.

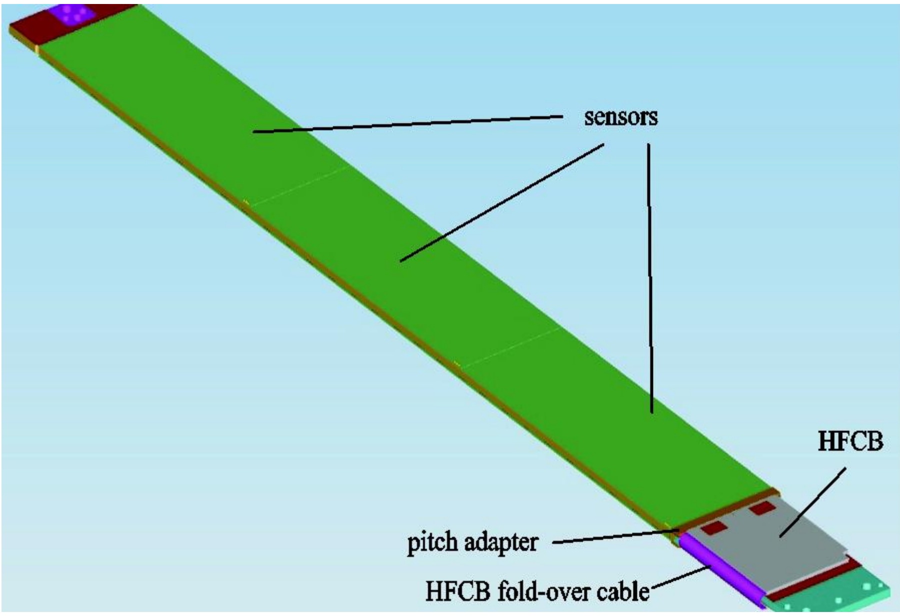


FIG. 1: Top side of module.

Fig. 2 shows dimensional details of the module.

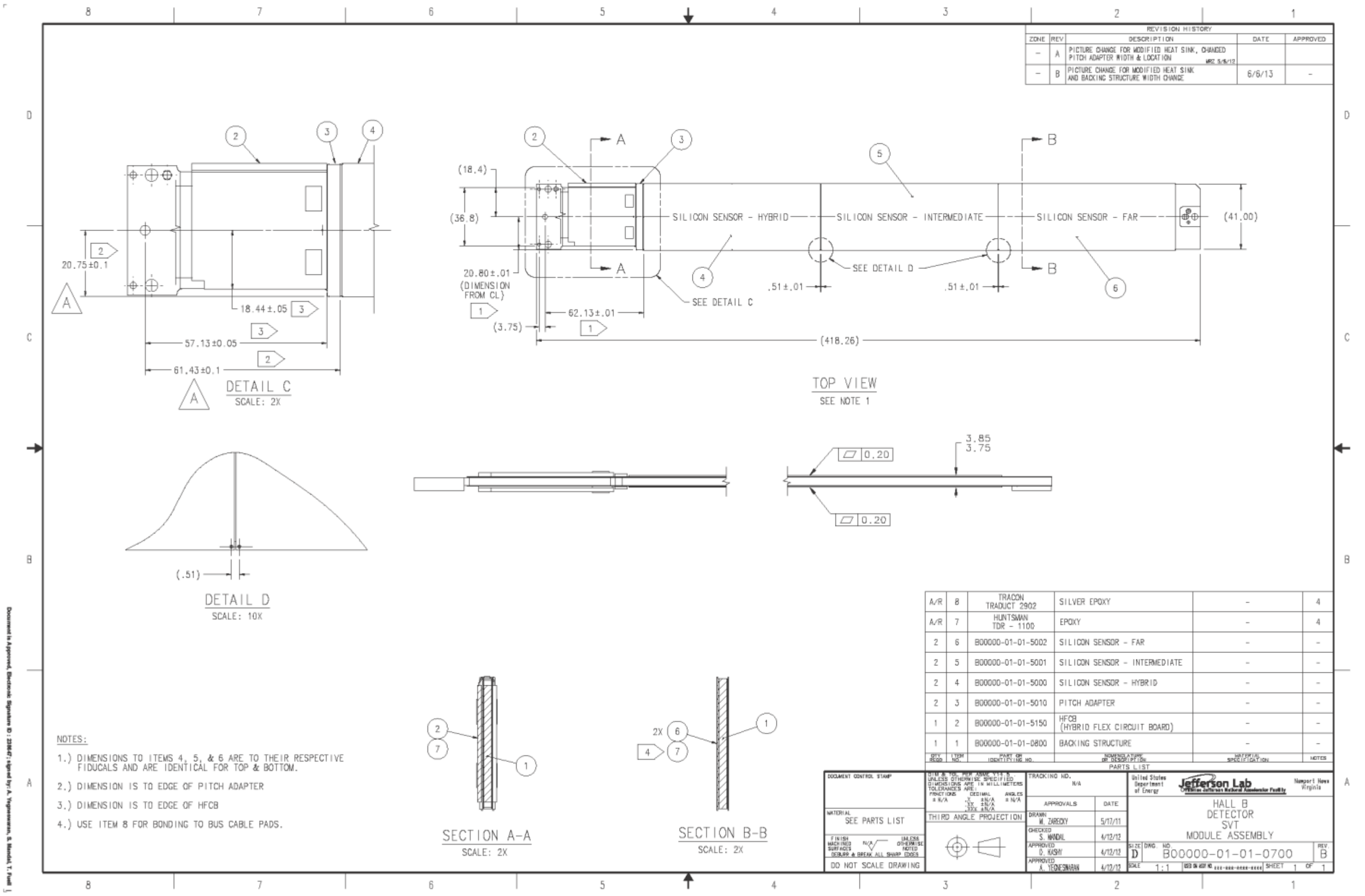


FIG. 2. Module fabrication drawing.

Module's sensors are diced from 6-inch wafers, two sensors (111.62 mm x 42.00 mm x 0.320 mm) per wafer. The sensor's 26-µm wide readout and intermediate strips are AC-coupled by a ~1.2 µm thick SiO_2 layer to the 20 µm-wide p_+ implant strips.

Readout strip layout is such that the n_{th} readout strip's angle, $(\alpha_n)_o$, with respect to the z-axis is given by:

$$(\alpha_n)_o = (n-1)/85,\ n \in [1, 256].$$

Consequences of this layout are: readout strip lengths range from ~2 cm to ~33 cm; readout pitch ranges from 156 µm at the beginning of the Hybrid sensor to 202 µm at the end of the Far sensor, Fig. 3.

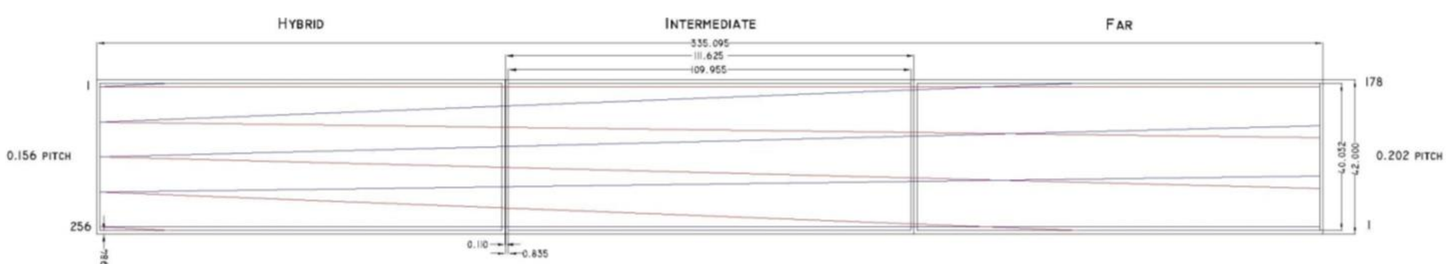


FIG. 3. *V* and *U* strips are shown in red and blue. Active length and width of a sensor is 109.955 mm x 42.032 mm. The total length of the three sensors including the two clearances of 0.11 mm is 335.095 mm. Unit for linear dimension numbers is mm.

Figures 4—6 show the side and the beam's eye view of the layout. Radii are measured from the beam line to the backing structure's *U*-surface. Three and four regions θ-coverage are measured from target center to the end of active area on the *V*-layer Far sensor and to the beginning of the active area on *V*-layer Hybrid sensor.

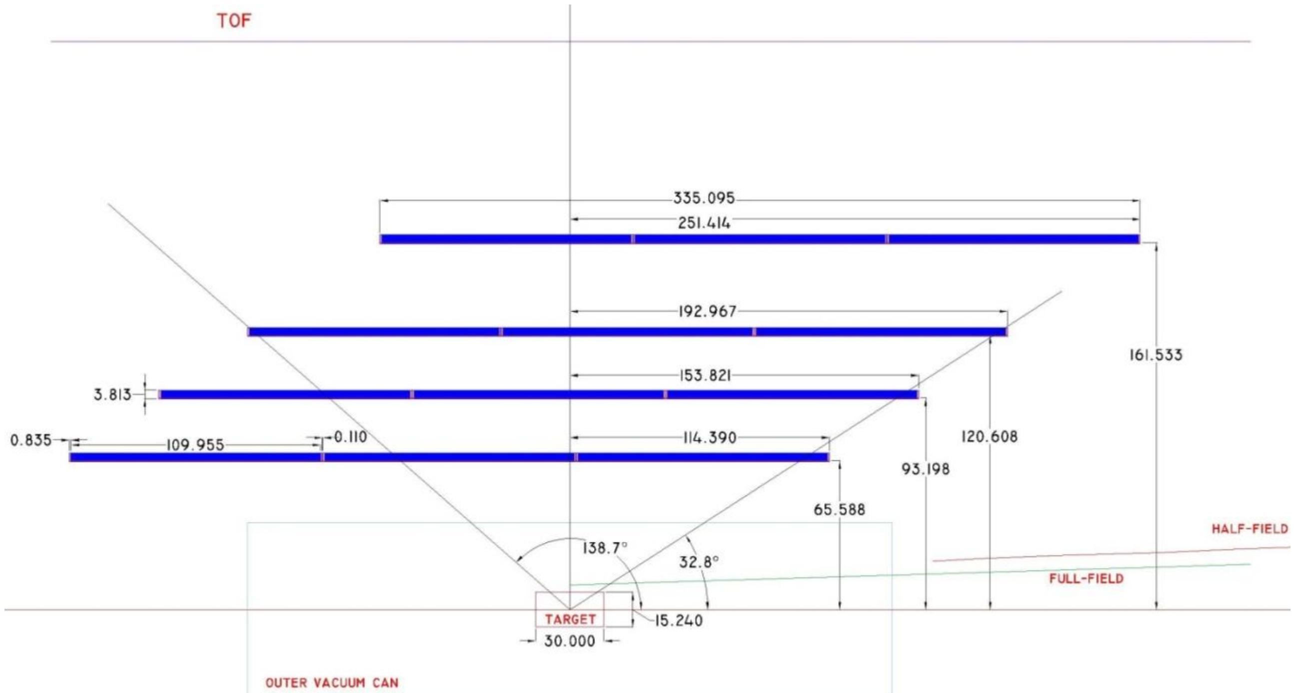


FIG. 4. Three region θ-coverage. Unit for linear dimension numbers is mm.

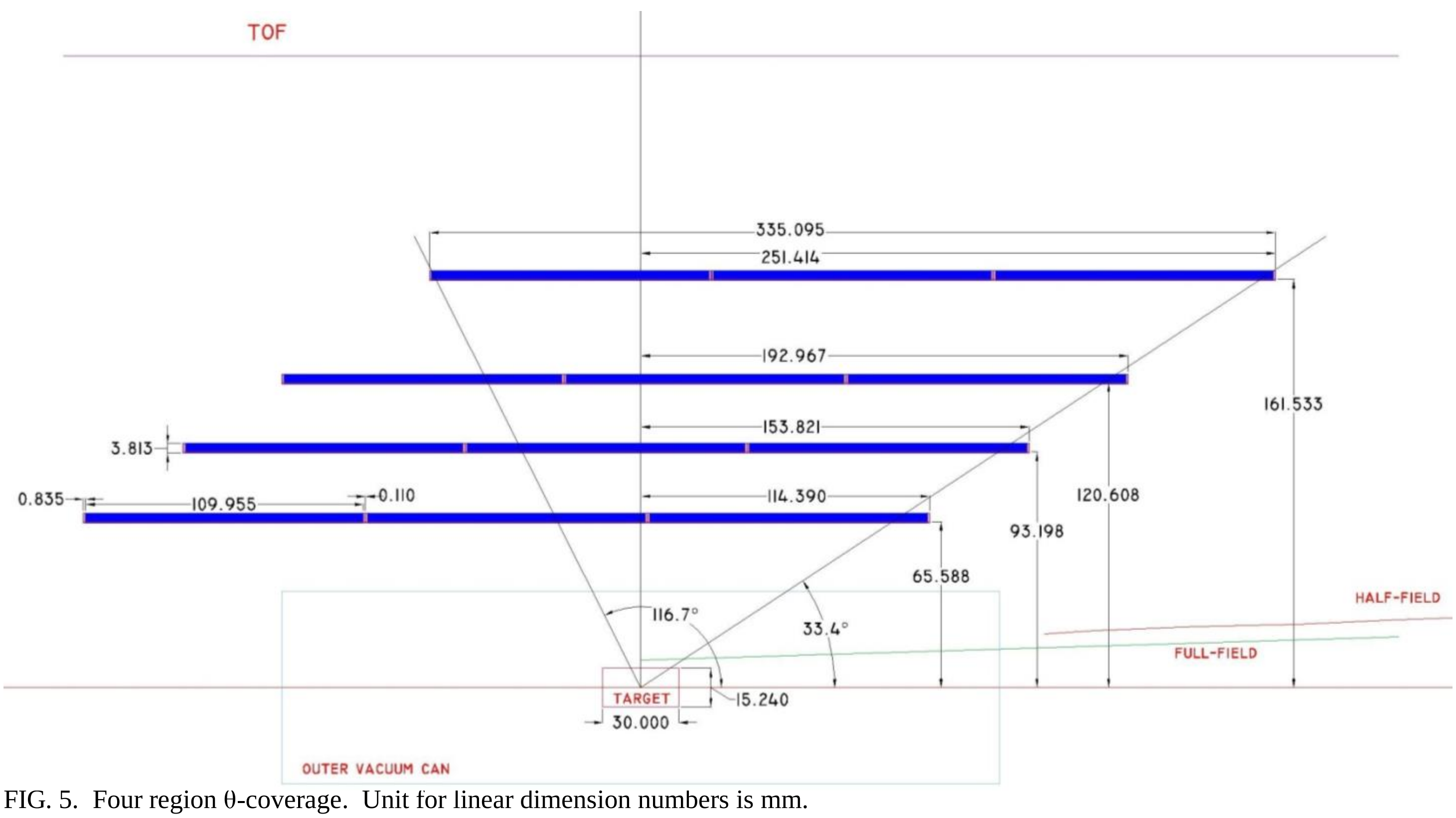


FIG. 5. Four region θ-coverage. Unit for linear dimension numbers is mm.

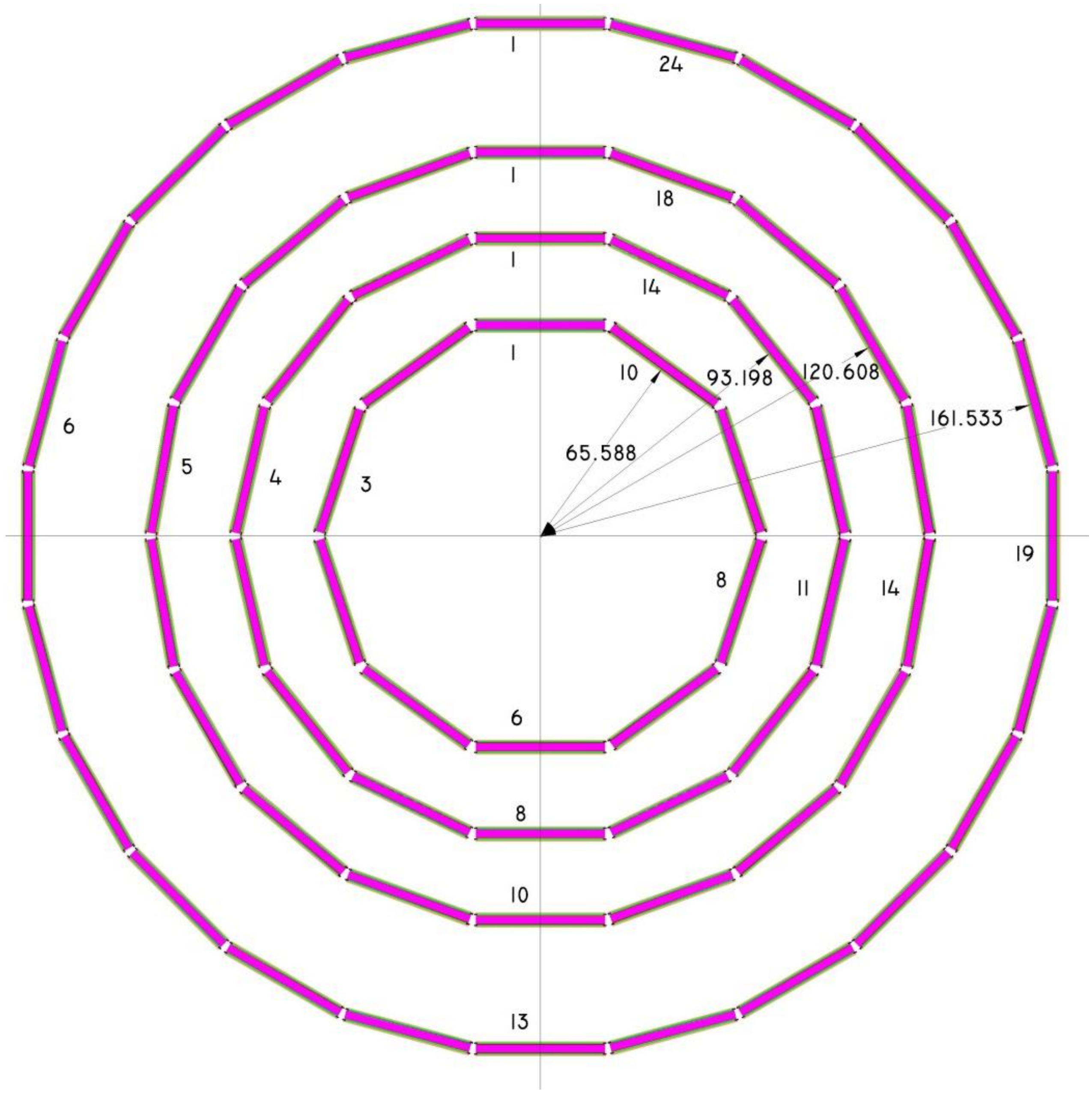


FIG. 6. Beam's eye view, showing radii and the module numbering scheme. Unit for numbers showing radii is mm.

The widths and the thicknesses of the module components are shown in Fig. 7.

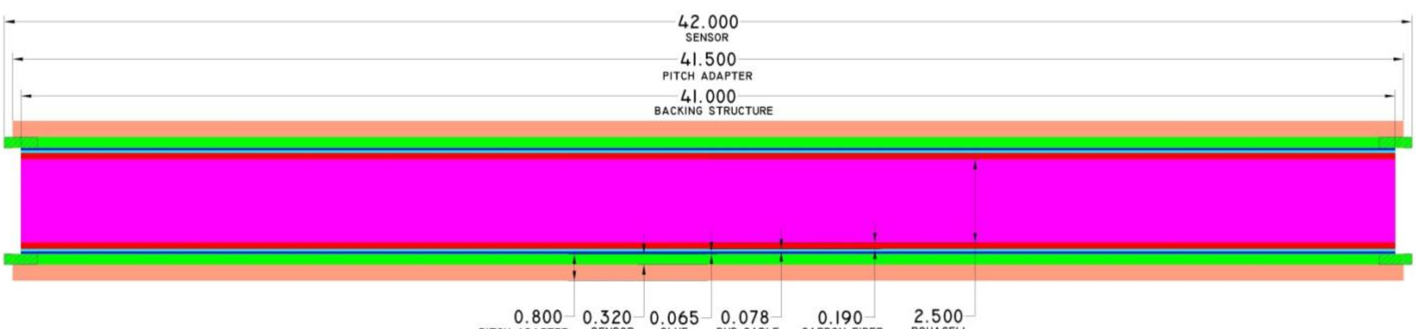
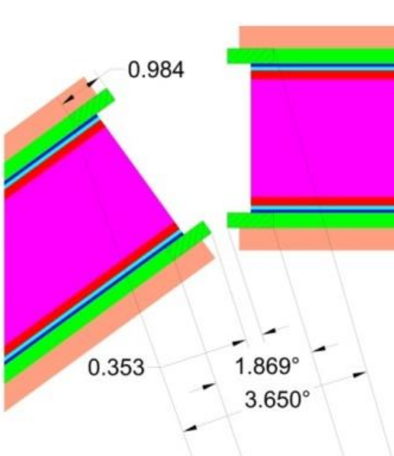
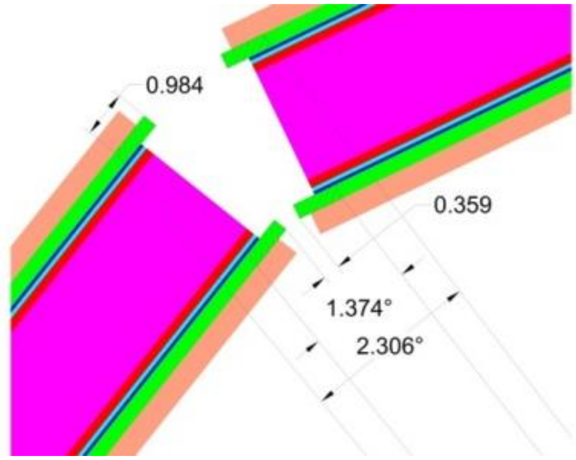


FIG. 7. Widths and thicknesses of module components. Unit for all numbers is mm.

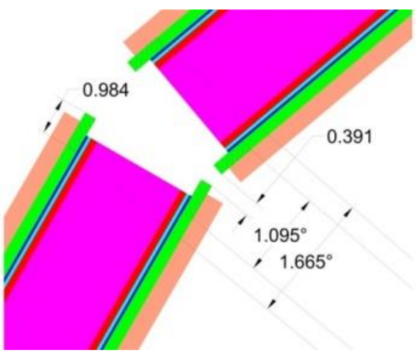
Figure 8 shows for adjacent modules of R1—R4: inactive regions, smallest clearance between silicon sensors, and angles subtended at the beam line by the inactive regions of the *U* and *V* layers.



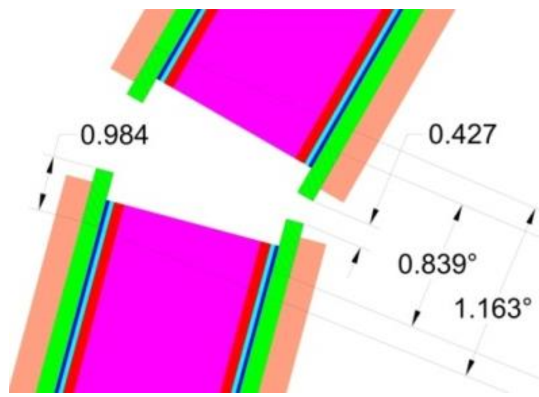
Region 1



Region 2



Region 3



Region 4

FIG. 8. Clearances between adjacent modules. Unit for linear dimension numbers is mm.

Module sag due to gravity was calculated using ANSYS v11. For horizontal modules, the maximum sag of~15 μm is roughly in the middle of the module, Fig. 9.

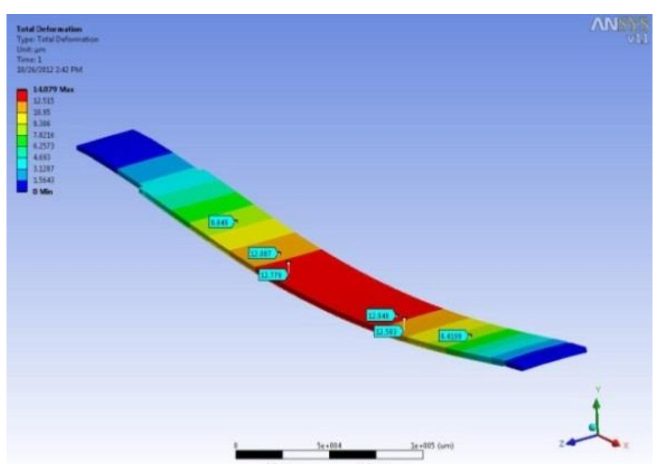


FIG. 9. Sag of an individual module, due to gravity.

Figures 10—14 show the side and the upstream (-*z* axis) view of the fabrications drawings of R1—R4.

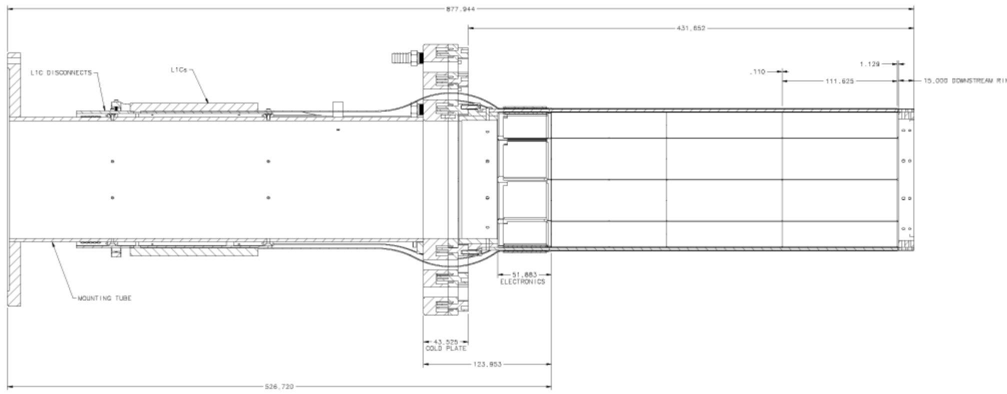


FIG. 10. Region 1.

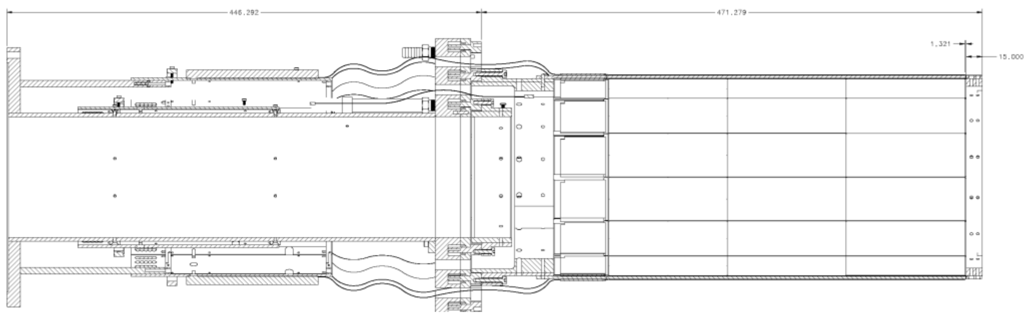


FIG. 11. Region 2.

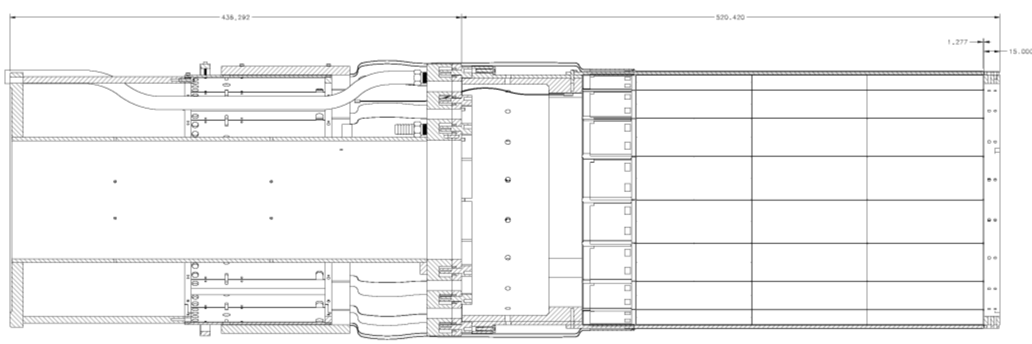


FIG. 12. Region 3.

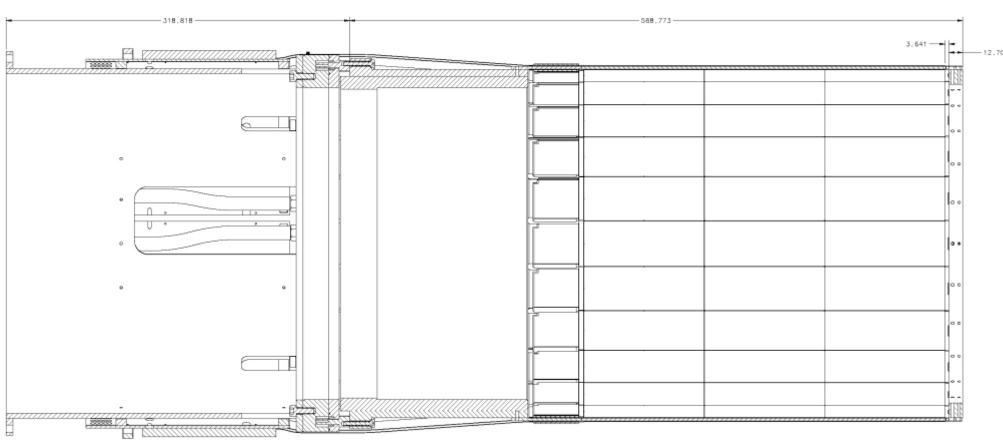


FIG. 13. Region 4.

When a module is considered as part of a region instead of as an independent entity, the maximum sag of a module between the upstream support structure and the downstream ring is as before; the deflection of the downstream ring is ~7 μm, Fig. 14.

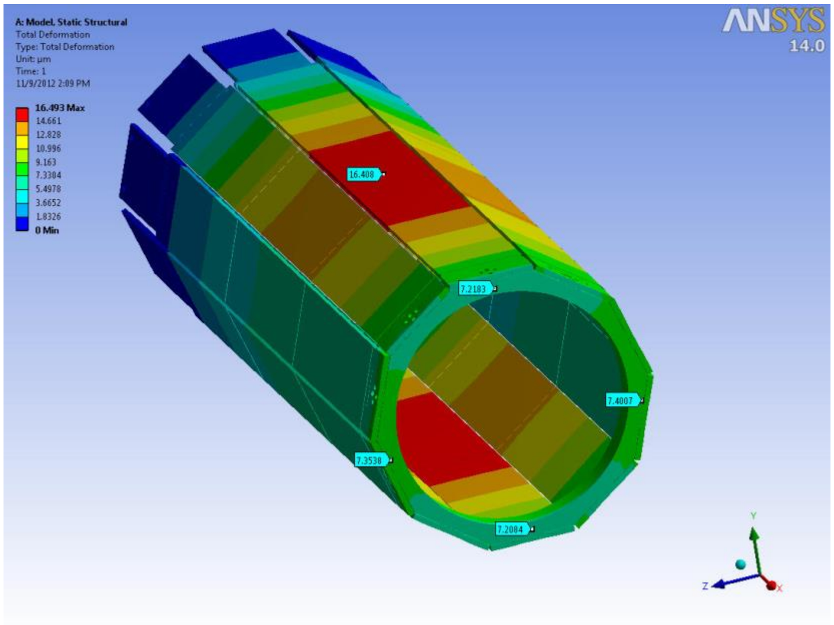


FIG. 14. Deflections of assembled R1.