# GLAST Tray Radiation Length: Update

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The tray material was updated with the eye on the interconnect ("Kapton") sheet which supplies the bias voltage to the back plane and a shield plane against noise pick-up. The multi-layer sheets have been identified as the single largest contribution to the mass of the tray active area (excluding the silicon detectors and the converters).
We assume that we can reduce the thickness and area coverage of the Cu conductors by a large amount.

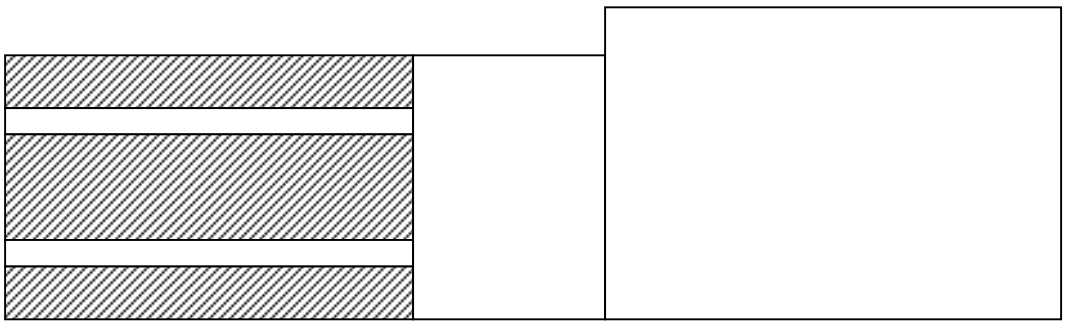
The following assumptions for the interconnect layers were made:

Glue layers were assumed uniformly at ½ mil =12.5um.
The Cu layers were assumed 1/4oz/ft$^2$, i.e. 8.4um thick. The area coverage was assumed to be 5% in the trace layer, 25% in the shield layer.
The silver epoxy was assumed to have 2% area coverage, 80% fill factor.
The glue between detectors and interconnect sheet was assumed to be 100um, with 50% area coverage.
Other glues outside the tray face sheets were assumed to be 40um, the glue thickness between face sheet and core to be 10um.
The face sheet is 250um carbon.
The hexel core aluminum with 0.18% R.L.

Two basic rules were followed in selecting the thickness of the insulator layers in the interconnect:

a) The "Standard" configuration follows the rules of the IPC standards, i.e. use 7mils between the shield and the trace layer (for a total distance of 200um) and 1.5mil otherwise (for a total distance of 50um).
b) The "Aggressive" configuration reduces the insulator between the shield and the trace layer to 3mil (for a total distance of 100um) and the others to 1/2mil (for a total distance of 25um). This means that we would use the 100V standard for ~120V operation and 1mil for no voltage difference. The cartoon in Fig. 1 shows these configurations.

Figure 1: Configuration of the Interconnect Layers



The mass in the active volume of the trays (i.e. excluding closeouts, electronics etc) is shown for each layer of the tray in the spread sheet (Appendix A) and in summary in Table 1 in percentage of radiation length, for the two configuration. Besides the Kapton interconnect, a multi-layer interconnect made out of G-10 is shown, which has a radiation length of 19.4cm, compared to 28.6cm for Kapton. The mass of a single piece of interconnect is shown first, then the one of a tray without SSD's and converter, and finally the mass of a full tray with 3.0% converter.

Table 1 Mass of the Trays and their Components in the active volume, [in % Radiation Length Xo]

*A converter thickness of 3.0% is assumed*

| Material | Kapton | | G-10 | |
|---|---|---|---|---|
| Layout | Standard | Aggressive | Standard | Aggressive |
| Single "Kapton" Layer | 0.12 | 0.07 | 0.16 | 0.09 |
| Tray Only | 0.80 | 0.69 | 0.88 | 0.73 |
| Tray + SSD's + Converter | 4.65 | 4.55 | 4.74 | 4.58 |

Conclusion

Both Kapton and G-10 interconnects are viable. For G-10, the option with thinner insulators looks preferable.

Appendix
Spread Sheet to calculate Mass of Standard G-10 Interconnect

| | Cover | Thickness [cm] | R.L. [cm] | R.L./layer | Fraction | Total[%] | Fraction of tray (no Si, no conv) | |
|---|---|---|---|---|---|---|---|---|
| SSD | 1 | 0.0400 | 9.36 | 4.27E-03 | | 9.02 | | |
| Silver in Glue | 0.01 | 0.0100 | 0.88 | 1.14E-04 | | 0.24 | 1.29 | 2% Area, 80% fill |
| Glue | 0.5 | 0.0100 | 30.00 | 1.67E-04 | | 0.35 | 1.89 | 50% Area |
| Sum Interconnect | | | 1.00 | 0.00E+00 | | 0.00 | 0.00 | 1.63E-03 |
| Insulator | 1 | 0.0038 | 19.40 | 1.93E-04 | | 0.41 | 2.19 | |
| K-Glue | 1 | 0.0013 | 30.00 | 4.17E-05 | | 0.09 | 0.47 | |
| Cu - Traces | 0.05 | 0.0008 | 1.43 | 2.94E-05 | | 0.06 | 0.33 | 1/4 ounce/ft^2, 5% area 8.4um |
| K-Glue | 1 | 0.0013 | 30.00 | 4.17E-05 | | 0.09 | 0.47 | |
| Insulator | 1 | 0.0175 | 19.40 | 9.02E-04 | | 1.90 | 10.23 | |
| K-Glue | 1 | 0.0013 | 30.00 | 4.17E-05 | | 0.09 | 0.47 | |
| Cu - Shield | 0.25 | 0.0008 | 1.43 | 1.47E-04 | | 0.31 | 1.67 | 1/4 ounce/ft^2, 25% area, 8.4um |
| K-Glue | 1 | 0.0013 | 30.00 | 4.17E-05 | | 0.09 | 0.47 | |
| Insulator | 1 | 0.0038 | 19.40 | 1.93E-04 | | 0.41 | 2.19 | |
| Glue | 1 | 0.0040 | 30.00 | 1.33E-04 | | 0.28 | 1.51 | |
| Face Sheet | 1 | 0.0250 | 18.80 | 1.33E-03 | | 2.81 | 15.08 | |
| Glue | 1 | 0.0010 | 30.00 | 3.33E-05 | | 0.07 | 0.38 | |
| Al Core | 1 | 0.0160 | 8.90 | 1.80E-03 | | 3.80 | 20.39 | |
| Glue | 1 | 0.0010 | 30.00 | 3.33E-05 | | 0.07 | 0.38 | |
| Face Sheet | 1 | 0.0250 | 18.80 | 1.33E-03 | | 2.81 | 15.08 | |
| Glue | 1 | 0.0040 | 30.00 | 1.33E-04 | | 0.28 | 1.51 | |
| Converter | 1 | 0.0105 | 0.35 | 3.00E-02 | | 63.34 | | |
| Glue | 1 | 0.0040 | 30.00 | 1.33E-04 | | 0.28 | 1.51 | |
| Insulator | 1 | 0.0038 | 19.40 | 1.93E-04 | | 0.41 | 2.19 | |
| K-Glue | 1 | 0.0013 | 30.00 | 4.17E-05 | | 0.09 | 0.47 | |
| Cu - Shield | 0.25 | 0.0008 | 1.43 | 1.47E-04 | | 0.31 | 1.67 | 1/4 ounce/ft^2, 25% area, 8.4um |
| K-Glue | 1 | 0.0013 | 30.00 | 4.17E-05 | | 0.09 | 0.47 | |
| Insulator | 1 | 0.0175 | 19.40 | 9.02E-04 | | 1.90 | 10.23 | |
| K-Glue | 1 | 0.0013 | 30.00 | 4.17E-05 | | 0.09 | 0.47 | |
| Cu - Traces | 0.05 | 0.0008 | 1.43 | 2.94E-05 | | 0.06 | 0.33 | 1/4 ounce/ft^2, 5% area, 8.4um |
| K-Glue | 1 | 0.0013 | 30.00 | 4.17E-05 | | 0.09 | 0.47 | |
| Insulator | 1 | 0.0038 | 19.40 | 1.93E-04 | | 0.41 | 2.19 | |
| Sum Interconnect | 1 | | 1.00 | 0.00E+00 | | 0.00 | 0.00 | 1.63E-03 |
| Glue | 0.5 | 0.0100 | 30.00 | 1.67E-04 | | 0.35 | 1.89 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Silver in Glue | 0.016 | 0.0100 | 0.88 | 1.82E-04 | 0.38 | 2.06 | 0.02 Area, 80% fill |
| SSD | 1 | 0.0400 | 9.36 | 4.27E-03 | 9.02 | | |
| Sum | | | | 4.74E-02 | | | |
| Tray w/o SSD, Conv | | | | 8.82E-03 | | 100.00 | |