CMS Phase 2 Tracker
PS4 Module Mechanical Assembly Outline Concept

Greg Derylo[1]
Fermilab
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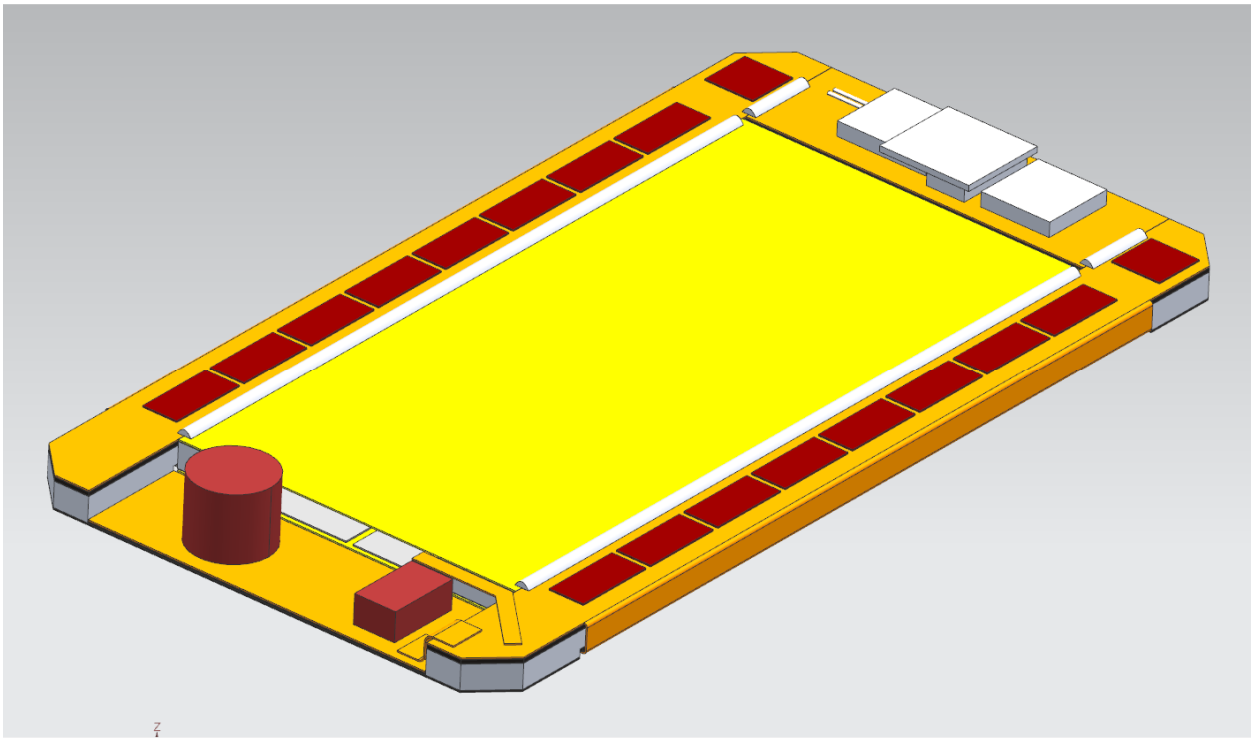
INTRODUCTION

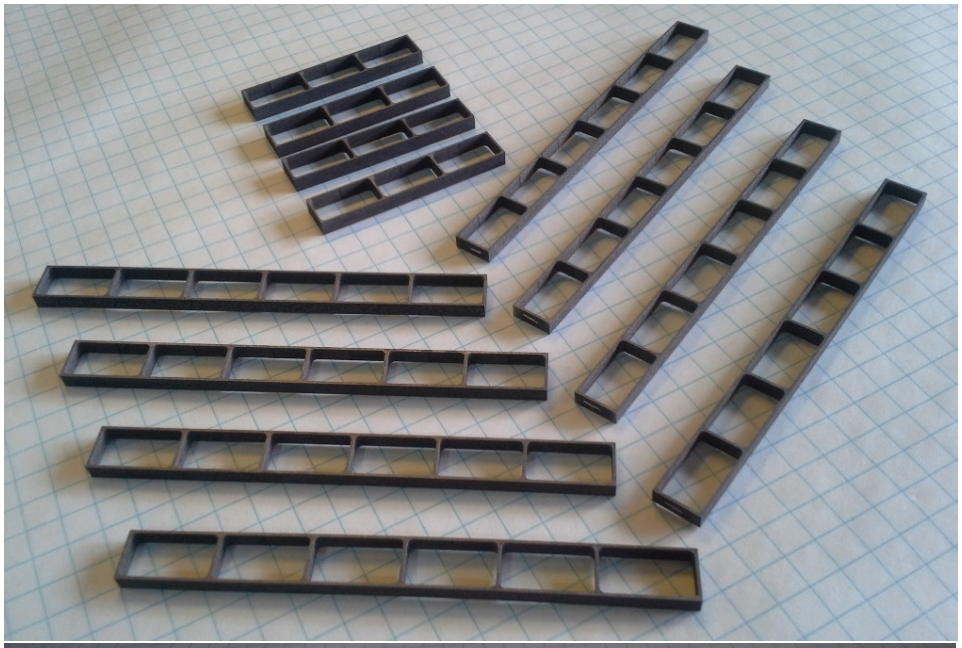
The purpose of this document is to roughly outline the steps needed to assemble a S4 module and are presented as a concept for the basic assembly flow. Issues unknown to the author may exist that would require an alternative scheme and the outline presented here is put forward primarily to spur discussion on this topic.

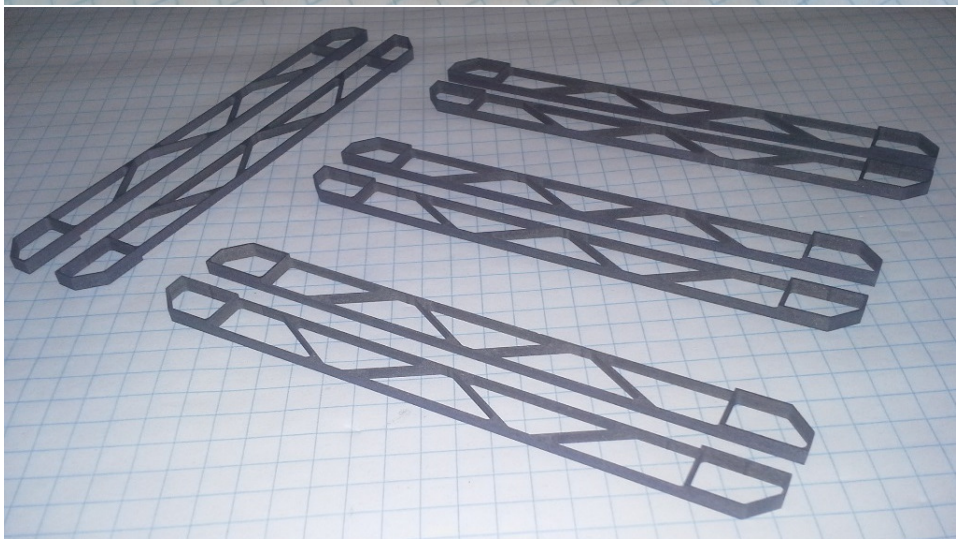


[1] derylo@fnal.gov

ASSEMBLY STEP OUTLINE CONCEPT

1. Machine the Al-Gr spacers

a. 



b. Machine sensor, flex, and optical spacers

   i. Spacers made last year done by machining a block to thickness and then cutting out the profile & cells with wire EDM. The machinist neglected to machine the step in the flex spacers, so this was added last using the wire EDM machine. Also, the lip for the flex spacer pixel wirebonds was ignored for this initial trial since it does not impact the thermal R&D.

   ii. A new batch of spacers is being machined at the Lab 4 shop as we speak. Considering attempting the step on the flex spacers, but I haven't officially asked them for this yet. *This requires some R&D.*

c. Parylene coating of spacers

d. Inspect sensor, flex, and optical spacers *(note that several of the 2014 prototype parts did not meet the 100micron flatness tolerance)*

LHC CMS Detector Upgrade Project

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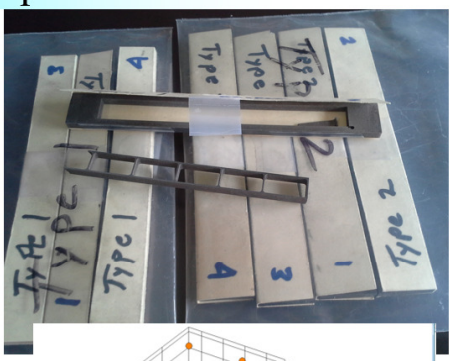
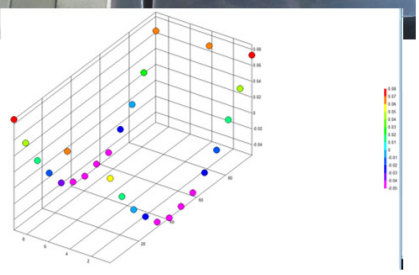
Module Prototype Parts: Sensor Spacer

- Lab 4 shop produced 8 parts (4 x two material orientation types)
- One "type 1" part broken when it was knocked off the CMM onto a soft floor mat – material is very brittle (and it also sheds)
- Inspected 4 parts (50%) on optical CMM at Sidet
  - Flatness: all parts are out of spec (147, 193, 131, and 114 um vs. 100 um limit). Parts are bowed, with some minor twist.
  - Profile: 32 points measured around the edge. Max deviations are 73, 57, 33, and 30 um
- Micrometer thickness measurement deviations for 4 parts:
  - Max thickness: +12 +12 +13 +12 um
  - Min thickness: -8 -7 -13 -2 um

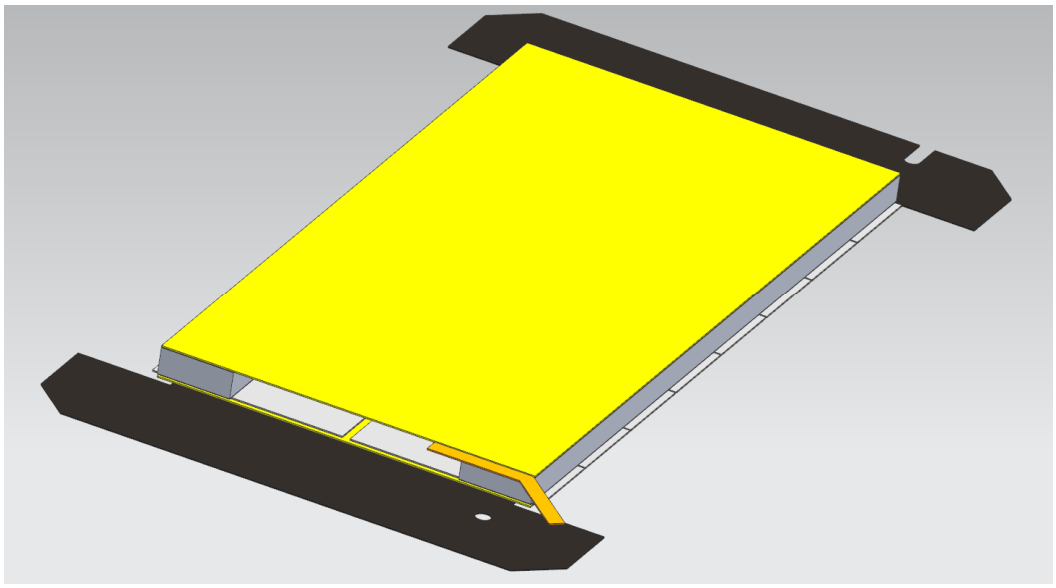




Greg Derylo, 13 Nov 2014 CMS Phase 2 4

2. Laminate & machine carbon fiber
    a. 
    b. Laminate & cure carbon fiber sheets
        i. *Is there any electrical grounding concern with these parts that would require a co-cured grounding mesh?*
    c. CNC routing of individual part profiles
    d. Parylene coating?

3. Assemble sensor subassembly

a. 

b. I have never heard any requirements for sensor-to-sensor alignment requirements (or module-to-module requirements either). The following is therefore assumed:

i. sensor-to-sensor Phi & Z alignment requirements are such that the sensor edges can be used to set their position

ii. sensor-to-sensor R requirements are not restrictive

iii. Deviations from either of these assumptions requires R&D

c. Pixel sensor:

i. Position the base carbon fiber sheet on the fixture

ii. Adhere the pixel sensor assembly to the base carbon fiber

1. Fixturing uses sensor edges to register position

2. Film adhesives and epoxies are being evaluated for this task. *This is R&D.*

iii. Cure the bonding adhesive

d. Strip sensor:

i. Using a fixture, epoxy the Al-Gr spacers to the strip sensor

ii. Attach bias voltage flex strip to underside of strip sensor with silver epoxy

iii. Allow adhesives to cure

e. Sensor mating:

i. Remove the strip sensor subassembly from its fixture

ii. Blot epoxy onto the bottom of the sensor spacers

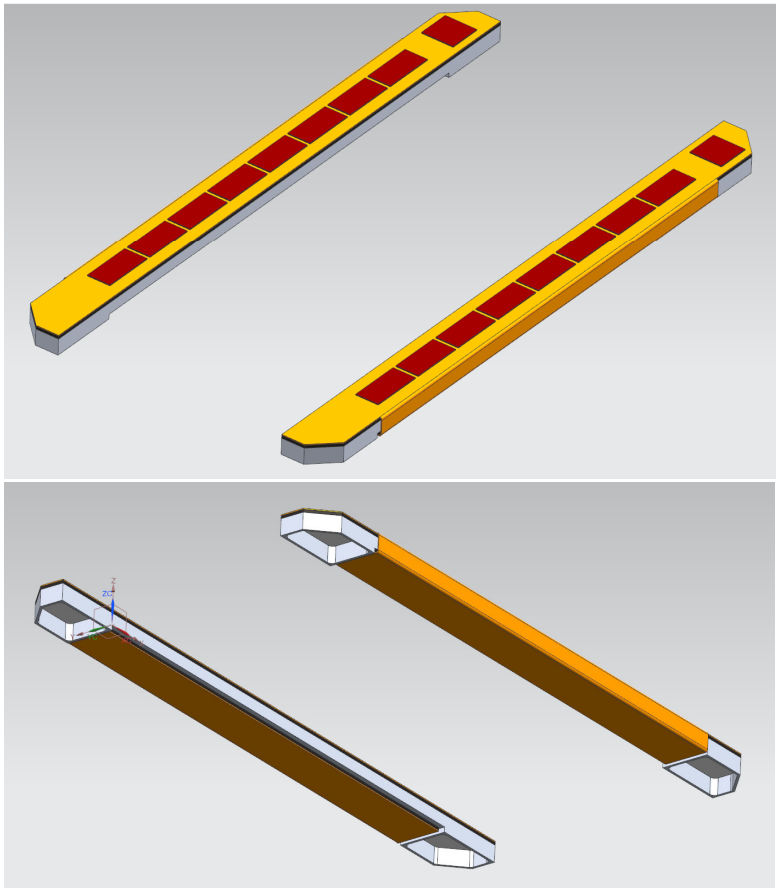
iii. Install the strip sensor on the pixel sensor assembly using the pixel tooling to register its position

iv. Due to variations in part thicknesses and flatnesses, use a weight used to maintain parts in contact rather than a fixed gap height set by the fixturing

v. Allow the epoxy to cure

f. Sensor subassy ready for final module assembly

4. Assemble L&R flex circuit subassemblies

a. 

b. It is assumed here that the circuits will have small tabs with alignment pin holes in them that can be used for assembly on a fixture and then they can be cut off with snips when no longer needed

c. Laminate flex circuit in flat form to its two carbon fiber substrates

d. Using an assembly fixture, epoxy the pixel-side of circuit to the spacer, using tabs on the strip-side circuit to set the flex's position on a fixture. Allow epoxy to cure.

e. Using an assembly fixture, wrap the top side around the spacer, epoxy into place, and allow to cure.

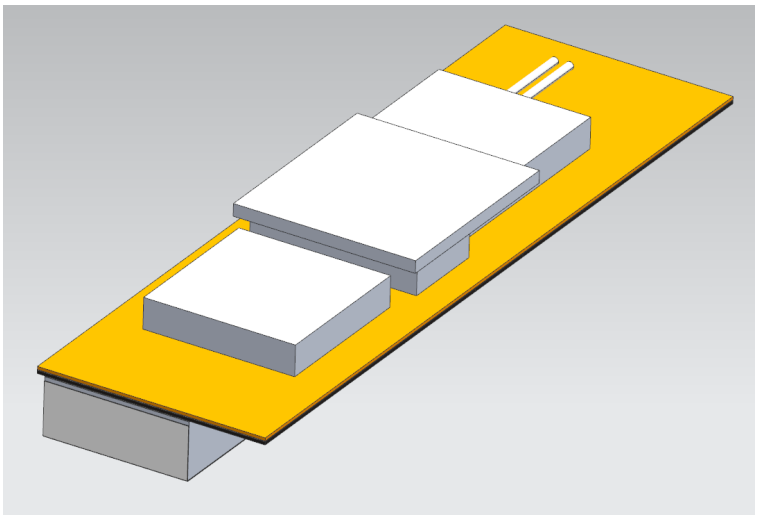
f. Trim off temporary tabs

g. Mount readout electronics to flex circuit

h. Electrical test *(only tested parts get committed to a production module)*

i. Flex subassemblies ready for final module assembly

5. Assemble optical subassembly

a. 

b. *Recommend that the circuits have small tabs with alignment pin holes in them that can be used for assembly on a fixture and then they can be cut off with snips when no longer needed*

c. Laminate flex circuit to carbon fiber substrate

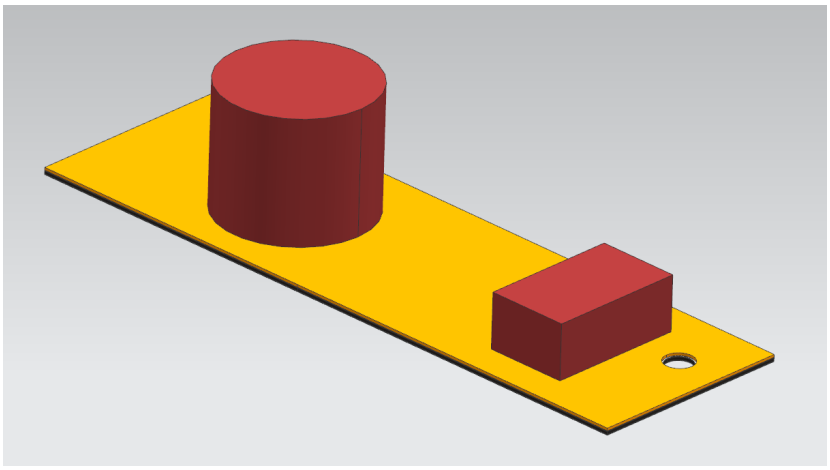
d. Epoxy spacer to carbon fiber substrate

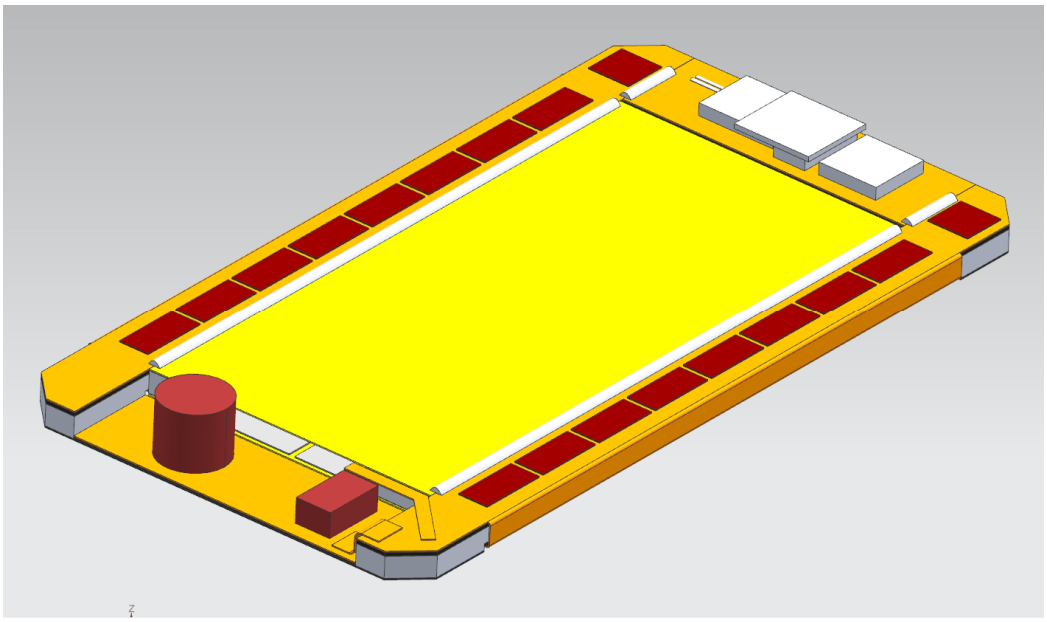
e. Trim off temporary tabs

f. Mount electronics to flex circuit

g. Electrical test *(only tested parts get committed to a production module)*

h. Optical subassembly ready for final module assembly

6. Assemble power circuit subassembly
   a. 
   b. *Recommend that the circuits have small tabs with alignment pin holes in them that can be used for assembly on a fixture and then they can be cut off with snips when no longer needed*
   c. Laminate flex circuit to carbon fiber substrate
   d. Trim off temporary tabs
   e. Mount electronics to flex circuit
   f. Electrical test *(only tested parts get committed to a production module)*
   g. Power subassembly ready for final module assembly

7. Full module assembly
    a. 
    b. *This process is assumed to start off the sensor subassy above still on its assembly fixture, which is designed for use with the following steps as well*
    c. Install power circuit subassembly into place using fixture to set position
        i. *Use film adhesive here to prevent any epoxy runout issues*
    d. Epoxy optical subassembly into place using fixture to set position
        i. *May need to allow this step to cure before proceeding, depending on the fixture design*
    e. Epoxy L&R flex circuit subassemblies into place using fixture to set position
    f. Allow all adhesives to cure
    g. Connect strip sensor bias voltage cable
    h. Connect cable between power subassy and RH flex subassy
    i. Wirebond strip sensor to R&L flex subassemblies
    j. Wirebond optical subassy to R&L flex subassemblies
    k. Optical CMM inspection of strip sensor fiducials relative to module mounting features *(but mounting features not all visible? May need to use reference monuments on the tool instead)*
    l. Transfer module off fixture onto separate tooling plate that allows flipping
    m. Optical CMM inspection of pixel sensor fiducials relative to module mounting features
    n. Wirebond pixel ROCs to L&R flex subassemblies

    o. The module mechanical assembly is now complete
8. Transfer module into storage box
9. Deliver module in storage box for electrical testing
10. After initial testing to verify functionality, encapsulate wirebonds