Status update Mupix outer layers
Mu3e Integration Meeting
19-20 June 2018, University of Geneva

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- Status of preparation for module assembly

  production steps, tooling solutions, etc

Project steps

I. Manufacture of layer 3 and layer 4 flex-heater modules
   - assembly has now started

II. Manufacture of Silicon heater modules
   - flex design progressing,
   - assembly will start with availability LTU and SwissPCB flexes.

III. Manufacture of MuPix modules
   - Mostly using tooling of step II.

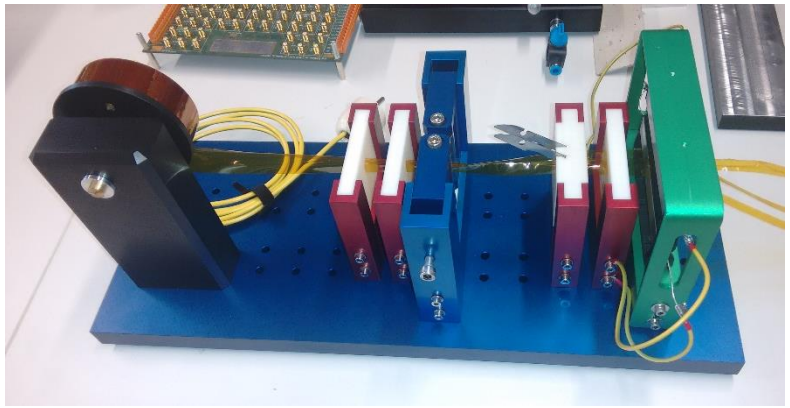
L4 (L3) Flex-heater ladders

Components:

- Tape heaters ✓ *(L4 - produced on laser cutter)*
- Kapton V-folds ✓ *(produced on v-fold tooling)*
- Spacers in lieu of interposer flex ✓ *(laser cutter)*
- Glue ✓ *(Araldite2011)*

Tooling:

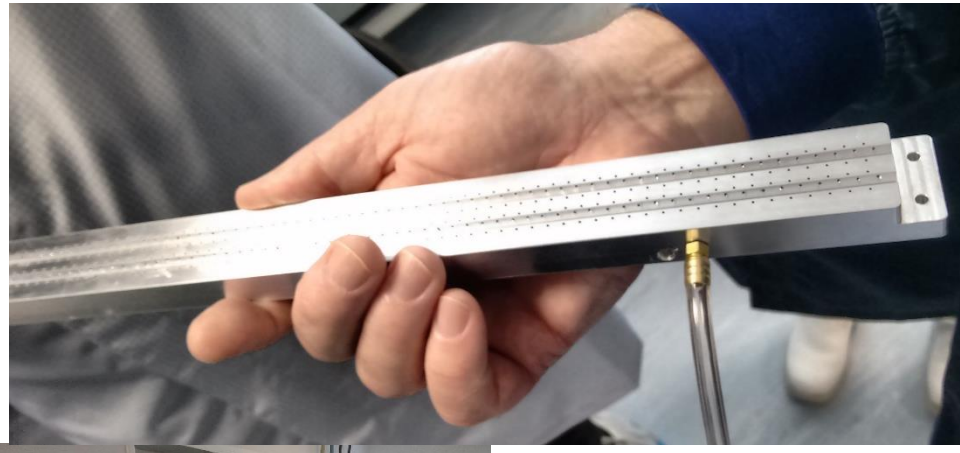
1. V-fold manufacture tool



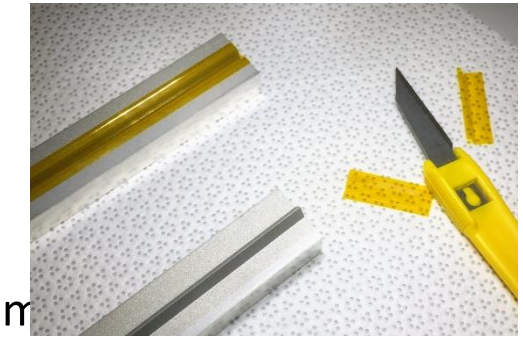
To be resolved:

Flex circuit slightly short compared to drawings – doesn't stop assembly

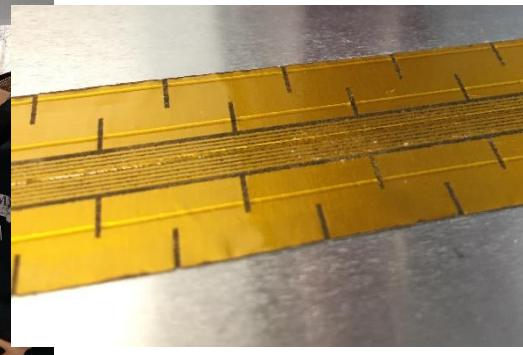
L4 Flex-heater ladder assembly in Oxford



Step:
1. V-fold cut to length and placed on vacuum chuck
2. Flex placed on vacuum plate and moved onto glue dispenser
3. Both vacuum tools mounted on ladder assembly stand
4. Glue cured on the stand and subsequently with curing weight



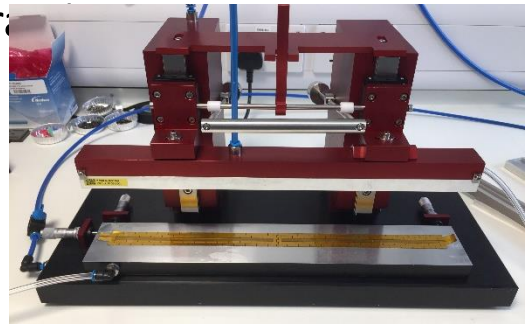
Tooling:
1. V-fold cutting: 2 counter moulds + scalpel
2. Double-V-fold vacuum chuck
3. HDI vacuum chuck
4. Glue dispenser
5. Ladder assembly stand



Process for flex heaters now rehearsed several tim
- double-v-fold chuck hold v-fold in shape well
- Manage continuous glue beads over full length of the ladder

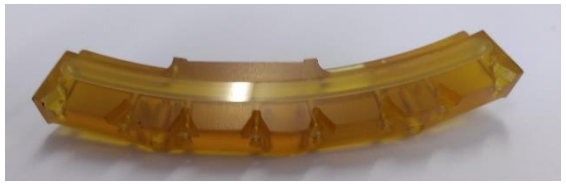
6 good ladders produced (shipped to L'pool this week)
- Some variations in v-fold placement (most extreme ~500 µm)

NOTE on tolerances: see back up the tolerances in the current design dr

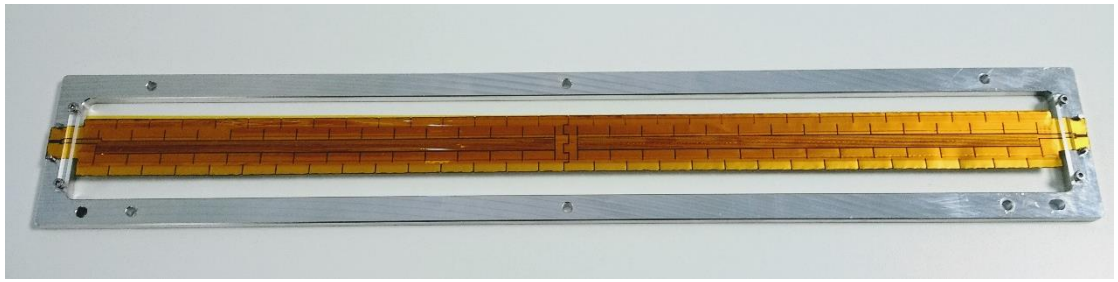


L4 Flex-heater module assembly in Liverpool

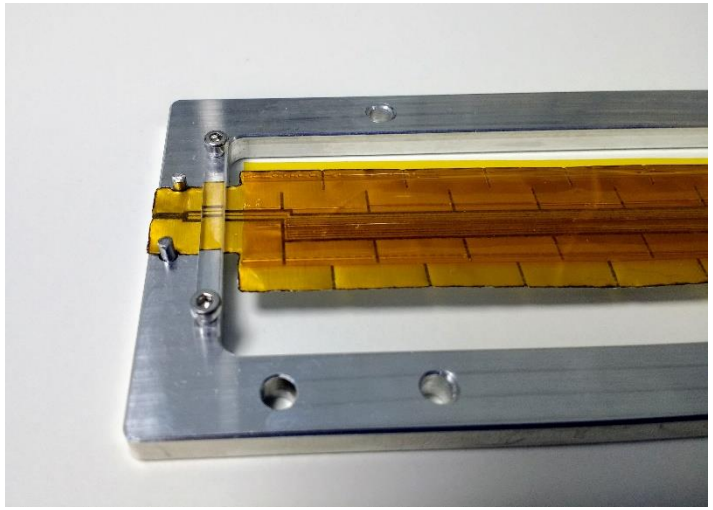
Components:
- module endpieces, Helium volume lid, interposers, spacers, clamp plate, etc (all in place)



- 4 ladders (in handling/shipping frames),



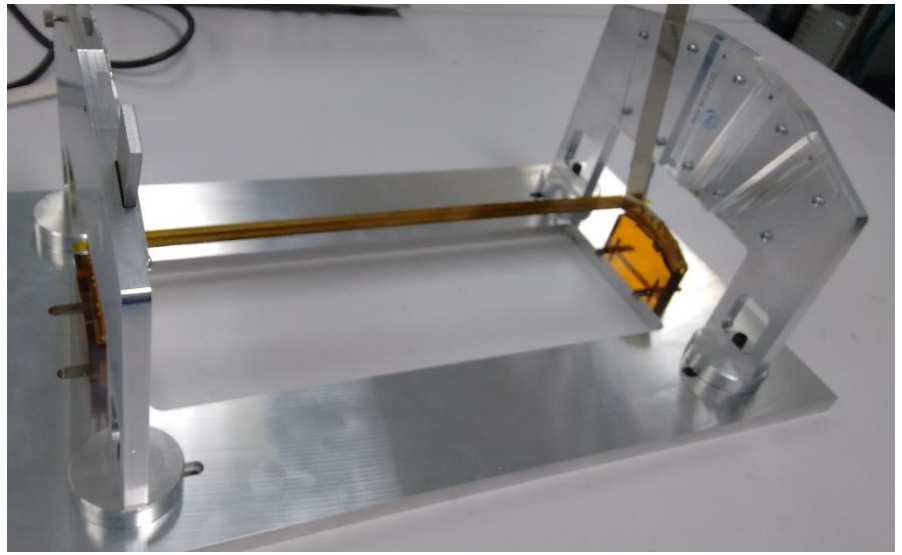
Oxford ladder frame for: QA/handling/shipping frame



First batch of 6 silicon heaters to arrive in Liverpool this week.
First opportunity to trial assembly steps.

L4 Flex-heater module assembly in Liverpool

Where we can use tooling we would also use for final ladders (if needed, for flex heater modules, many steps could be done by a steady hand)



Assembly steps:

1. mount module endpieces to tooling
2. align the tooling stand (smartscope or rigid aluminium jig)
   - for trials used a rigid dummy ladder
3. transfer ladder from Oxford frame to handling chuck (slide 7)
4. glue deposition
5. align module to dowel pins (see slide 8)
6. apply glue curing weights

Once all four ladders are mounted, connect pickup tool to transfer module to transport frame/box or separate QA test stand.

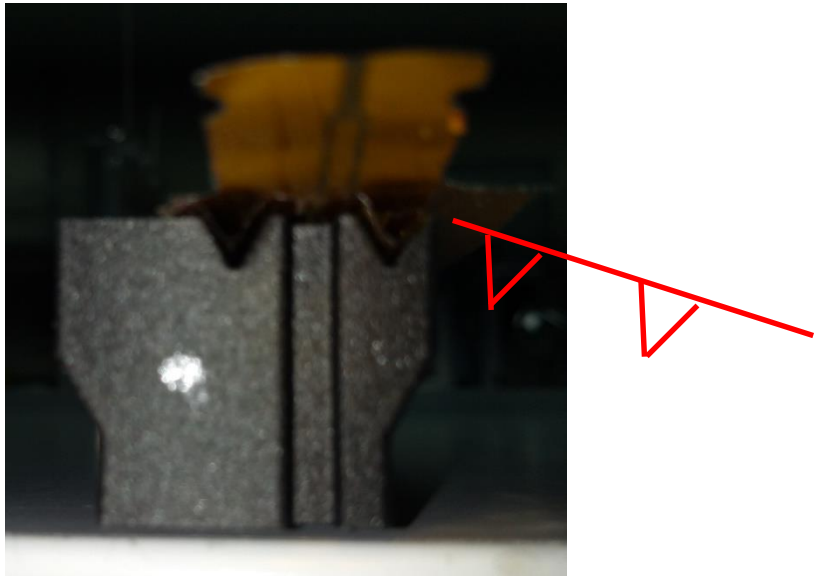
Tooling

1. Ladder mounting stand, with bridge holding the curing weights, endpiece mounting blocks
2. tooling alignment jig with suitable alignment notches/dowels.
3. Ladder handling tool double-V-fold vacuum chuck
4. Ladder alignment jig
5. Module pickup and handling tool, transport frame/box

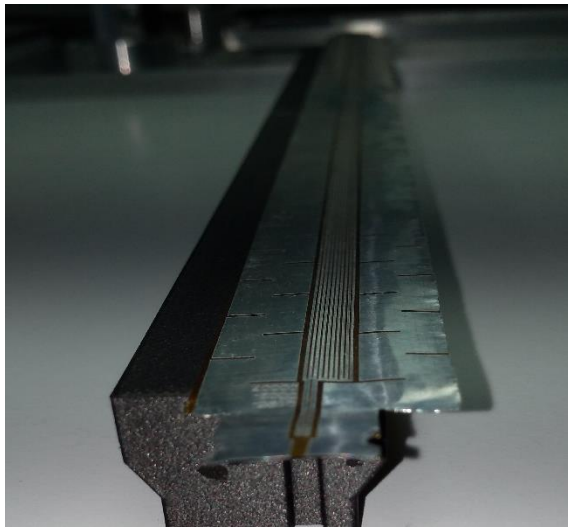
Ladder handling and mounting vacuum chuck

Prototype made out of 3d printed CF composite

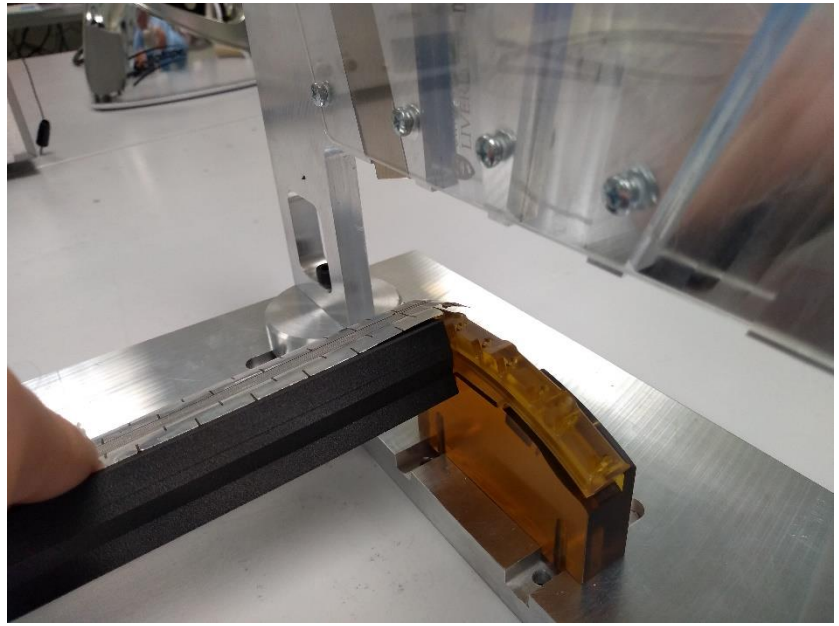
- So far only a prototype lid
- Ultimately will be a vacuum pick-up tool out of aluminium



Ladder mounted asymmetrically so tool doesn't hit previously mounted ladder neighbouring ladder



Notch to fit alignment dowels or rail. Only works if v-fold can be used as the reference for placement (probably not)



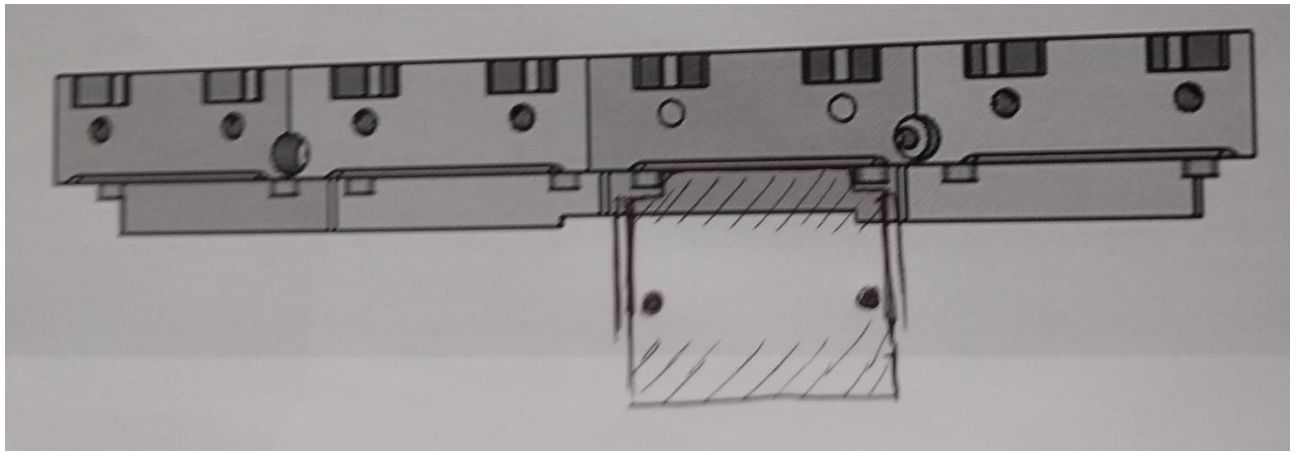
Vacuum chuck is used to lower the module in to place.

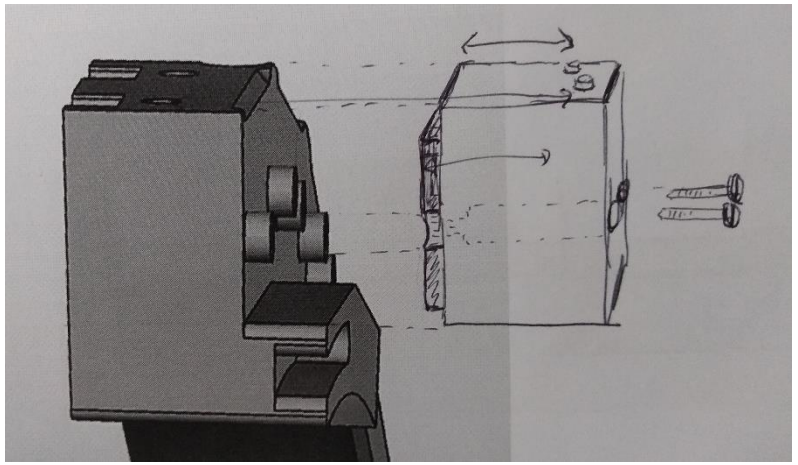
Alignment of ladder to module endpieces

Key to the correct operation of a module is the correct alignment of the flex where it connects to the interposer.

(Tolerance for flex heaters is quite large but aim to achieve alignment need for real modules)

Will machine a small block to fit the endpiece with dowels to fit the notches in the flex ladder can





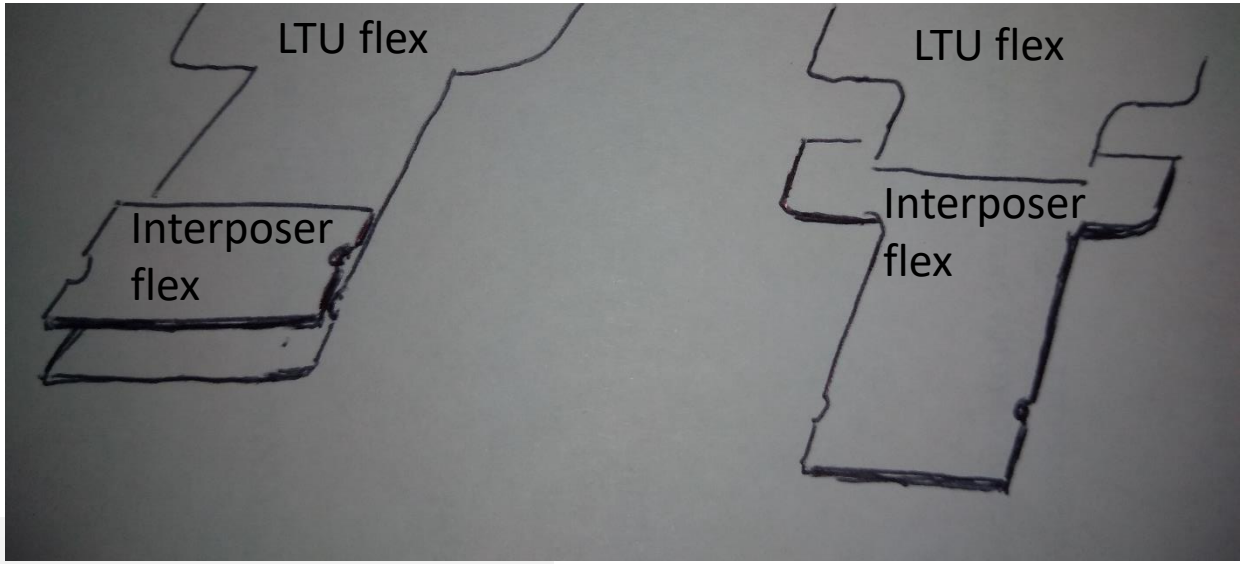
- To be decided whether the vacuum chuck holding the ladder needs full xyz adjustments to position the ladder to match the dowels.

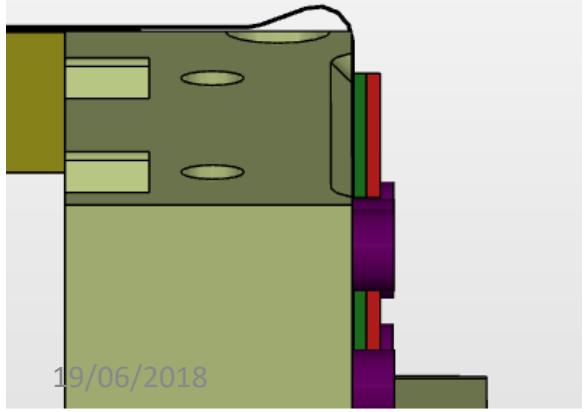
Beyond the flex heater modules

Proposed modifications to the Silicon heater flex (and final MuPix flex)

To work around space limitation now pursuing extended interposer flex.

This means the bend is made with in the copper-kapton flex (more rigid) flex.





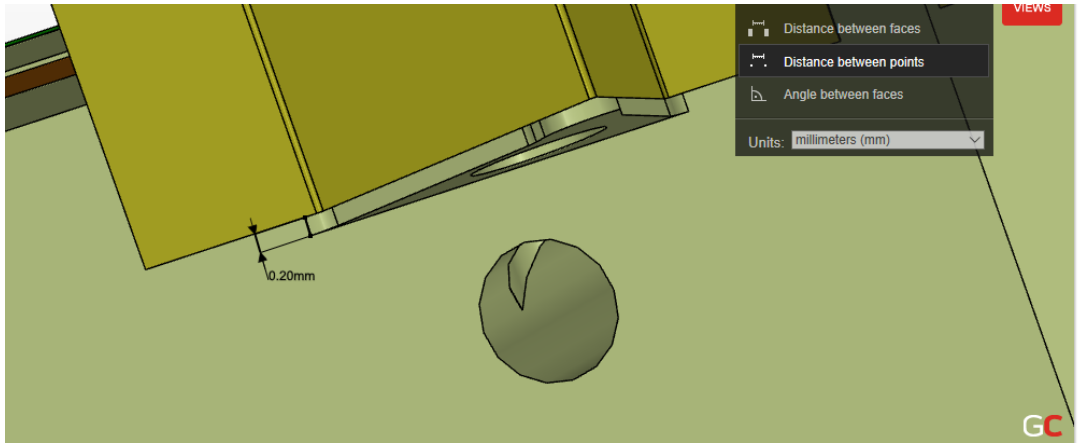
May now need a 90° bend with less ability to take up length variations and possible requirement to pre-bend the flex

- modifications to ladder and module assembly tooling
- changes to the alignment procedure

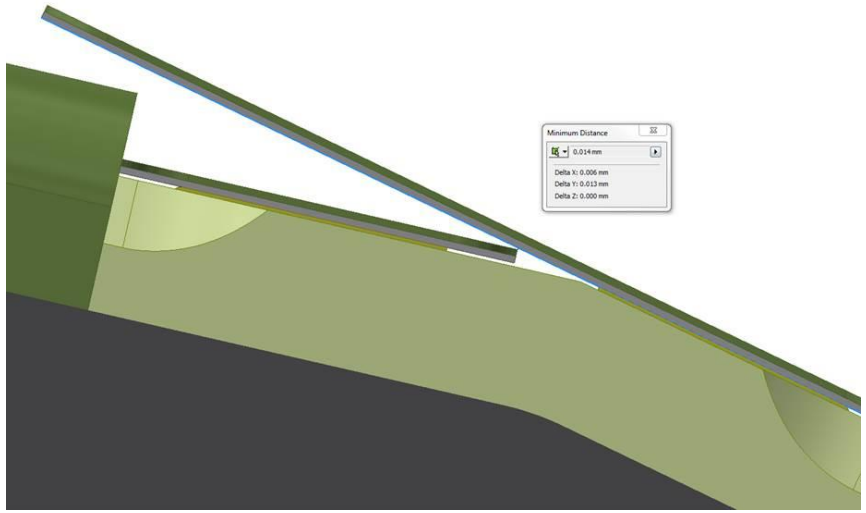
Tolerances

With first ladder production and module production and associated metrology, come a good moment to review whether tolerances in current design can be achieved (or need to be achieved).

Some are particularly tight.



Clearance end of v-fold to end-wall of v-shaped notch in the endpiece is 20 um. This would require control of length v-folds and placement to better than 10 um.
Most likely need ~200 um clearance, but should confirm this number once we have done metrology on several ladders.



Clearance of one ladder to the next is 14 um. Small lateral misalignment would mean they touch. Would we risk damaging edge of lower chip during mounting?

QA procedures

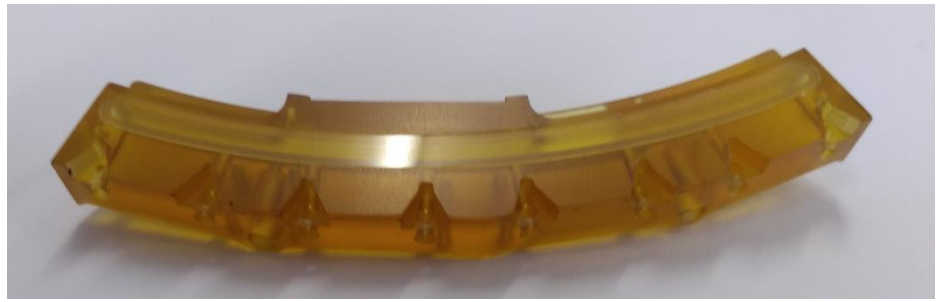
- Electrical testing
- metrology on components before and after assembly
- Leak tightness of helium volume and v-channels (slide)

Assessment Helium tightness endpiece seals

Machining of endpiece leaves helium volume open in 2 places.

1. C-shaped slot to be closed by seal-plate
2. 8 holes on top of endpiece sealed by glued-on flex

Failure of either seal would interfere with Helium flow.

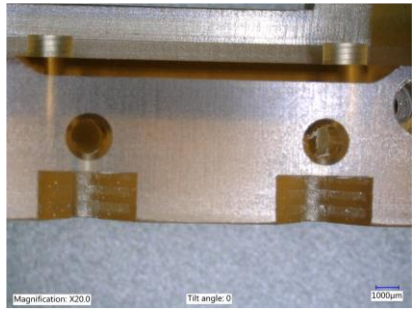


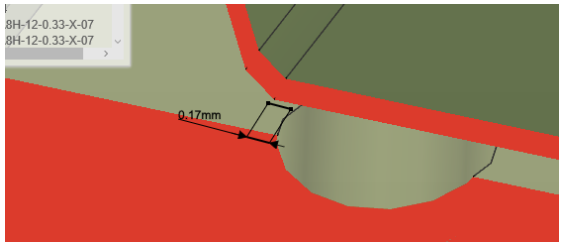
To do: test glue joint for stability under thermal cycling

- Machine dummy PEI endpiece with slots and glued-in seal-plates.
- Thermal cycling under under pressure.

Done: pressure test on dummy piece

- On drawing distance hole to edge of glue is ~200 um!
- Test was done with groove at 500 um
- Kept 1 hour at +100 mbar (some pressure drop but no failure
- Need way to convince ourselves this is robust
  for a few hundred such glue-joints in the detector





BACKUP

Notes

- Both tooling alignment tool and module pick-up tool will probably use

Two angle holes on top of module end piece