UNIVERSITY OF LIVERPOOL

Mechanic design for CEPC vertex tracker prototype project

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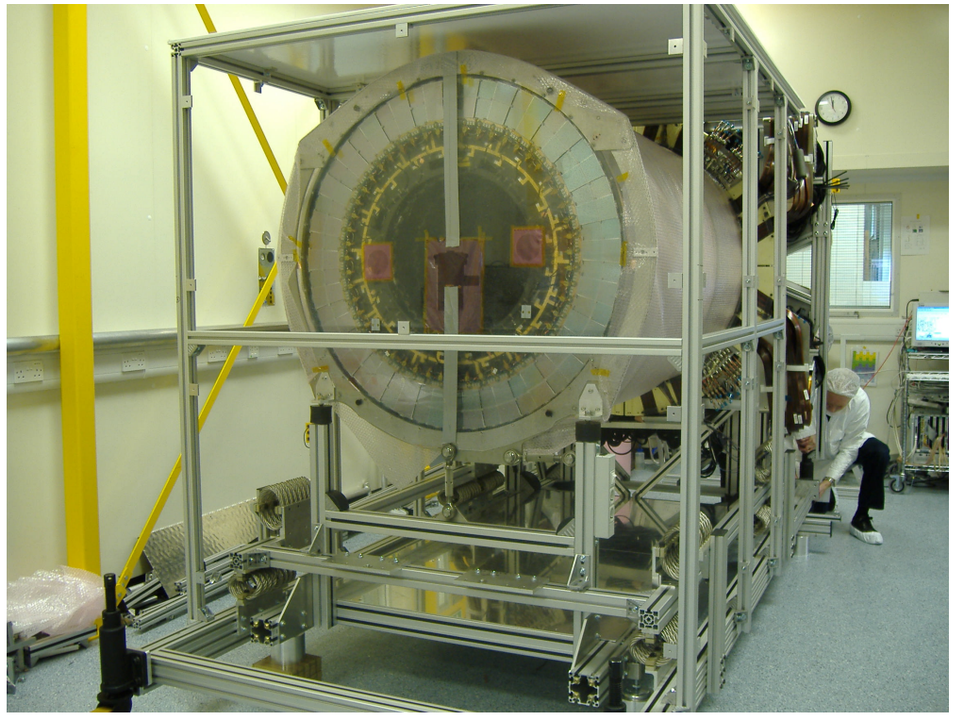
Mini-workshop for CEPC MOST silicon project, 23-Nov-2017

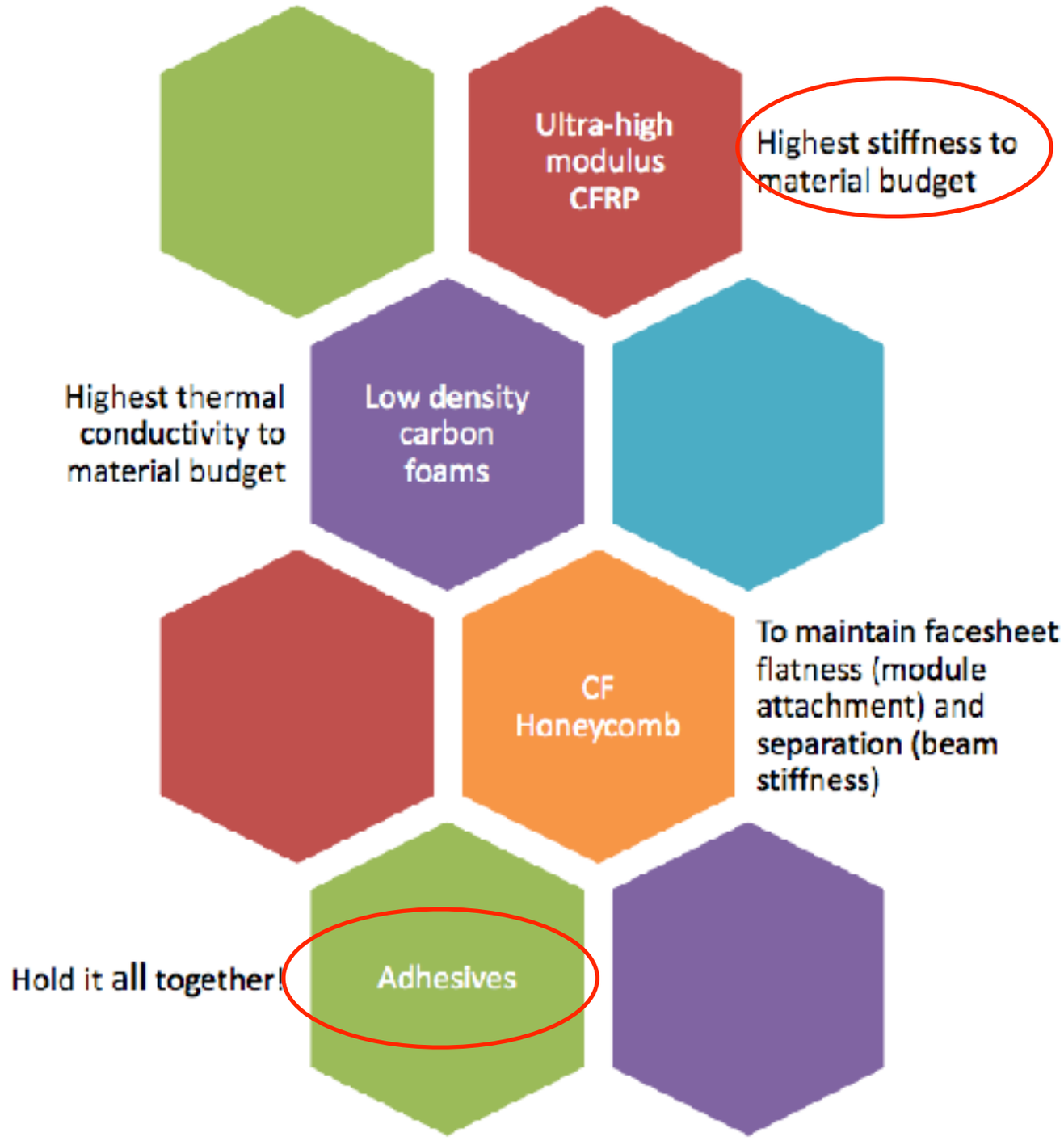
Brief introduction to Liverpool silicon projects

- Major Deliverables:
  - ATLAS SCT: R&D, Module assembly, Module Mounting & Endcap 'C' Integration
  - LHCb VeLo: R&D, Module assembly for VeLo 1 & 2
  - ALPHA: Silicon tracker R&D & assembly
  - R3B: Silicon tracker R&D & assembly
  - Generic R&D: Sensor design & prototyping, radiation hardness (RD50)
- On going projects
  - ITK pixel and strip

ATLAS: SCT Endcap C (14/2/06)



Key considerations in the material



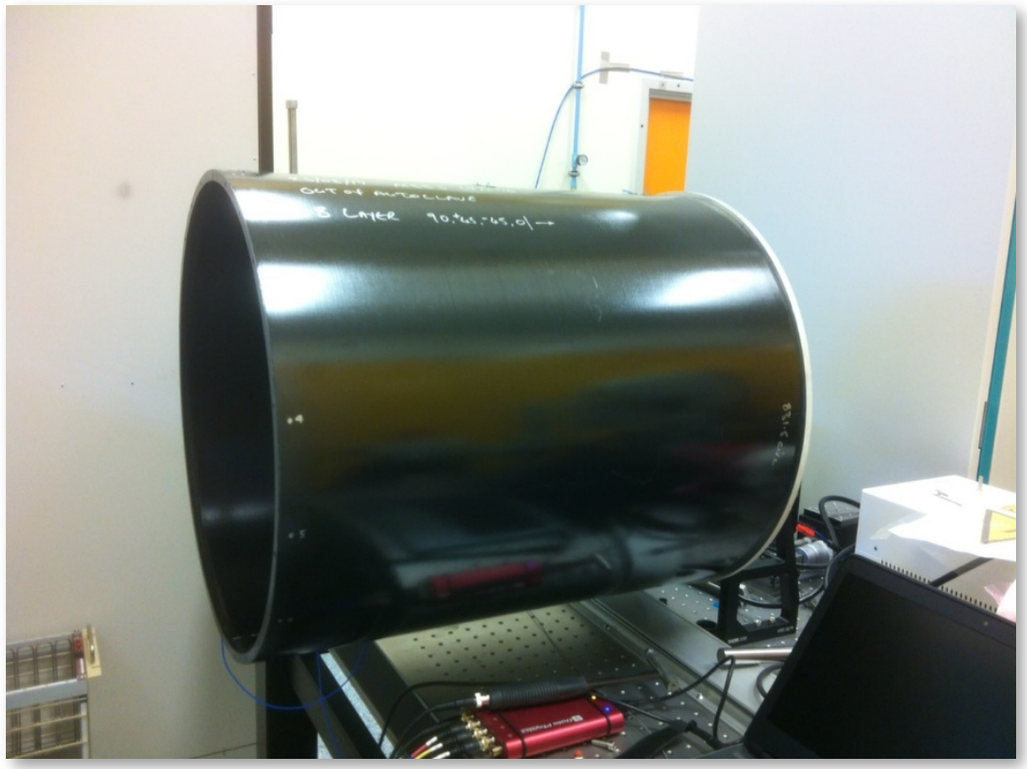
Advanced material lab at Liverpool

- Facilities
  - 50m2 space for CFRP lay-up, 1.7m x 1m Autoclave, Oven, Pattern Cutter.
  - New 30m2 space for large composite curing oven & furnace
- This lab supports low mass structure prototype project
  - Ladder design for the CEPC vertex prototype fits well

Advanced material lab at Liverpool

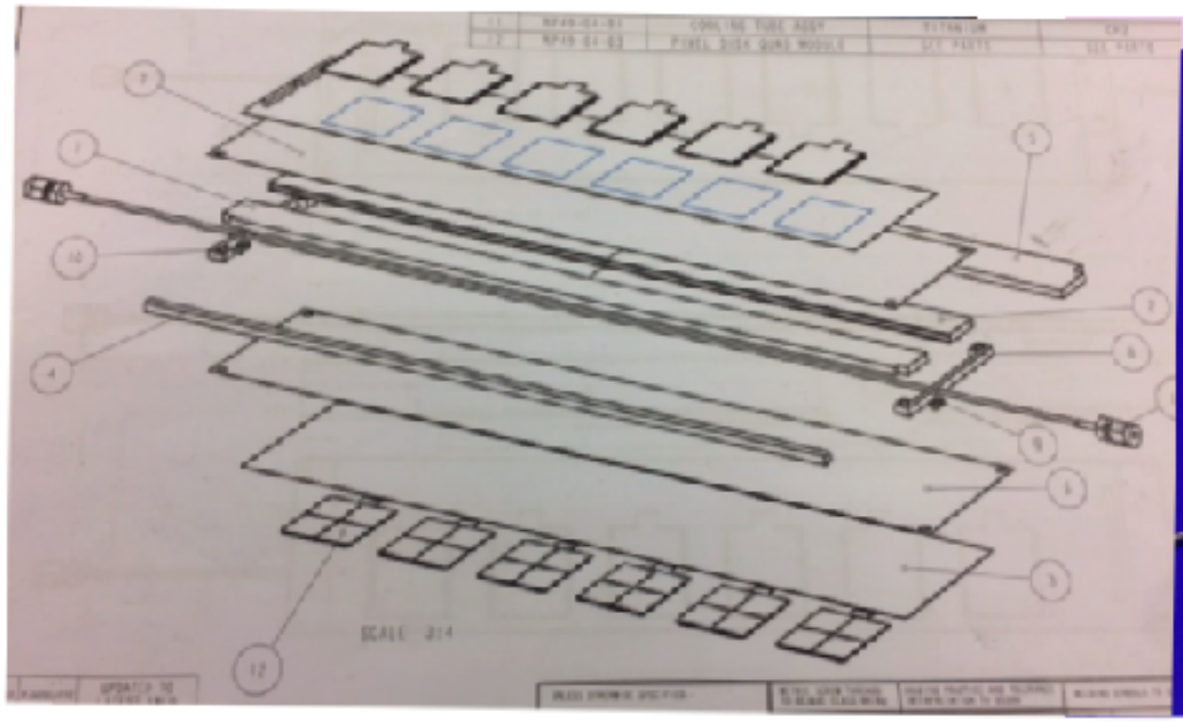
- Current projects

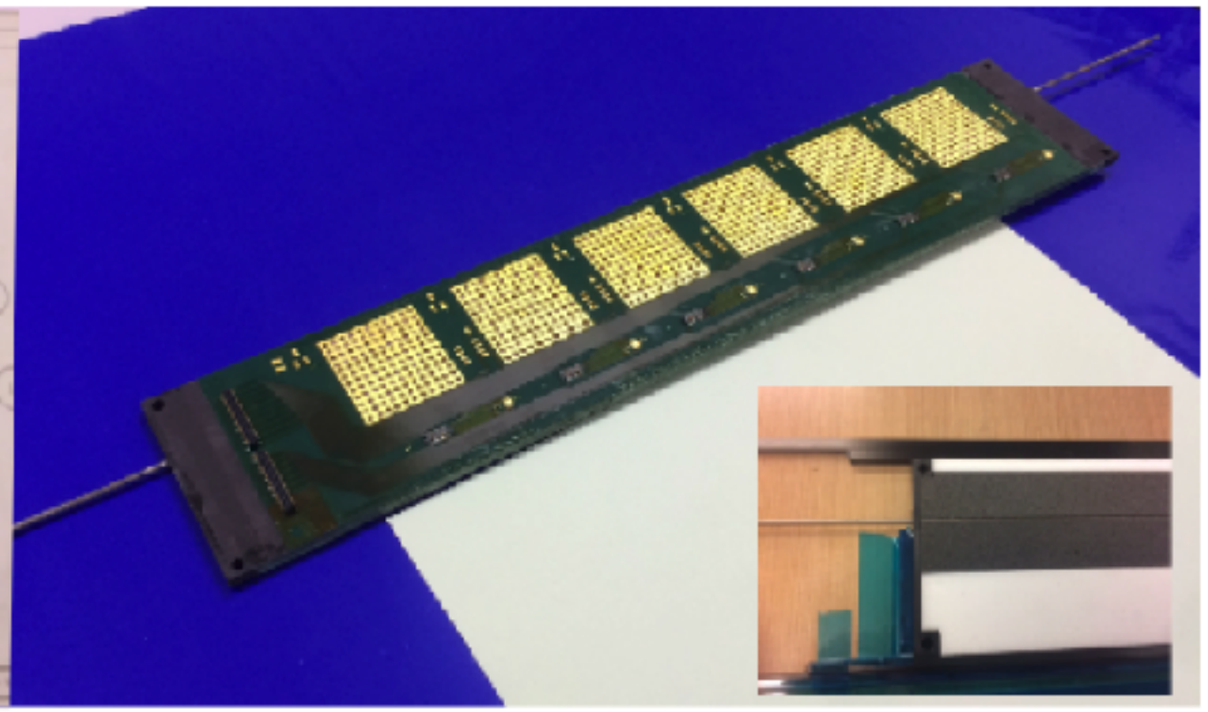
Linear Collider (CLIC)
Designed tooling to produce detector support beams. Ultimately 3 metres long, 300mm prototypes were produced trialling a novel dovetail connection (Oxford)



Vibration analysis of prototype ATLAS ITk Pixel Endcap Support Structure

Building the double-sided CF stave for ATLAS ITK pixel modules





Materials: CFRP (~200um), Rohacell, All comp (carbon foam)

Cooling: titanium pipe (2.275mm diameter, 0.125mm wall thickness)

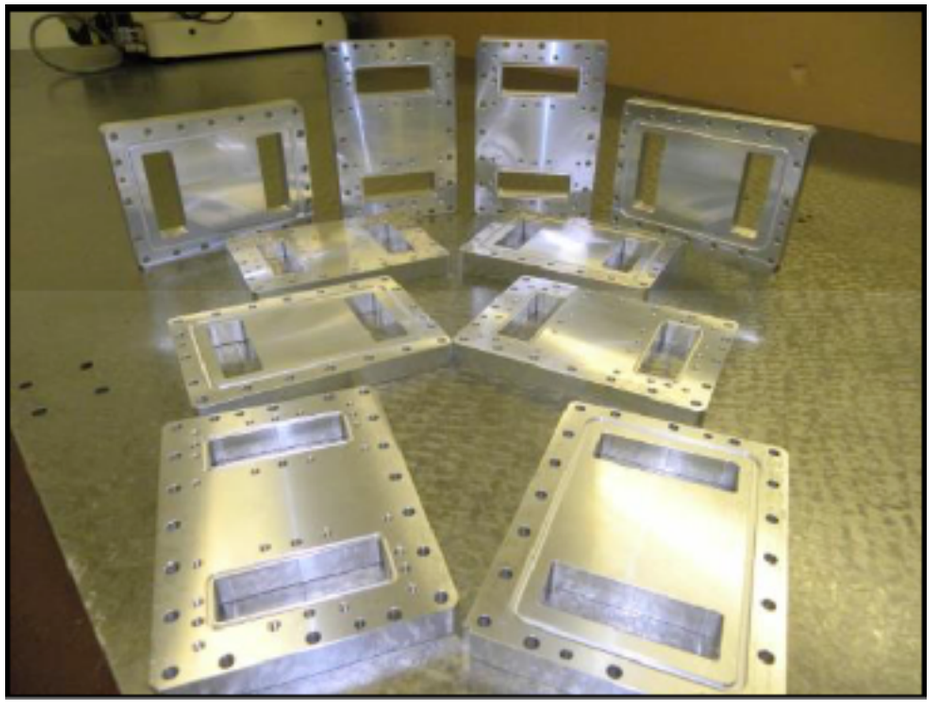
Hysol 9396 loaded with boron nitride used for assembly of carbon foam to carbon fibre skin and without boron for the Rohacell

- Low-mass structure ~100g / 55g (with / without tapes)
- Tapes allow mounting of 6 quads / side
- Will allow cooling tests with / without irradiated quads, cross-talk and noise studies
- Serial powering for up to 12 modules (48 FEs)

From mechanical design to final assembly: all done in-house

Mechanical workshop

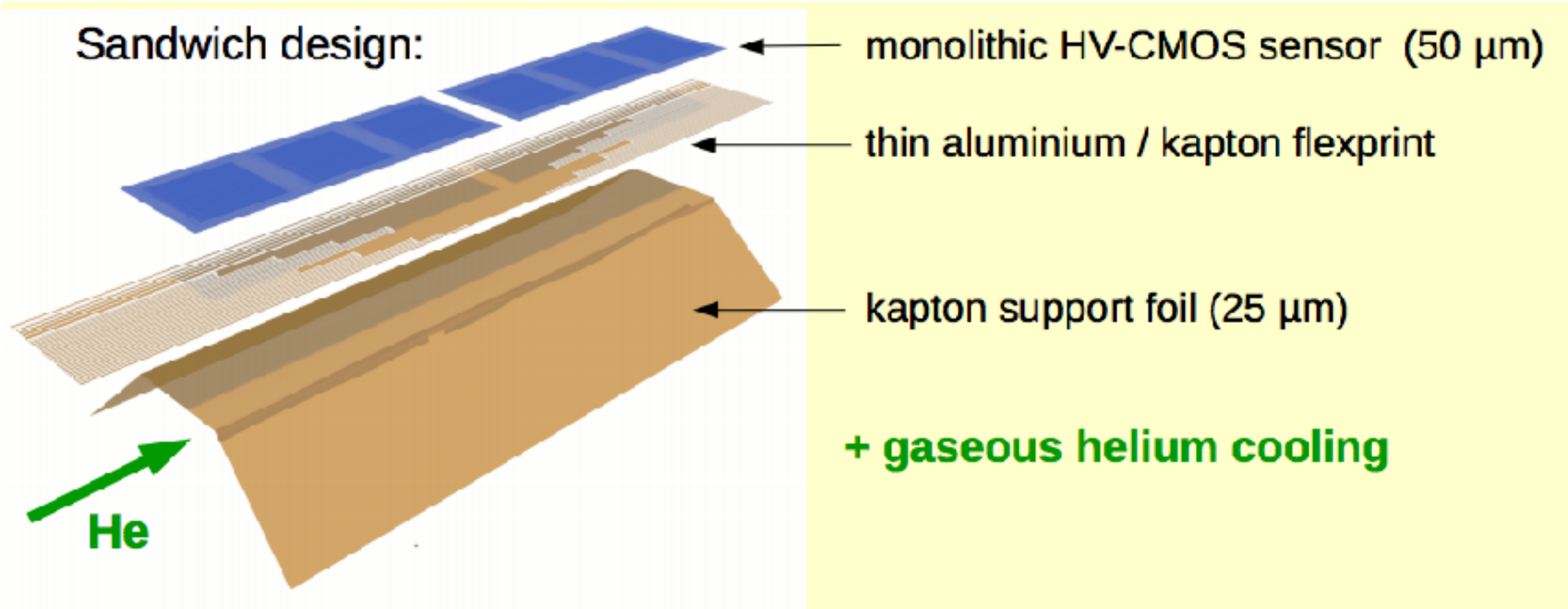
- Facilities
  - High quality manual mills and lathes
  - 3, 4 and 5 axis CNC milling machines
  - CNC lathes (2)
  - Wire EDM
  - Metrology
  - Welding
- Can be used to manufacture tooling needed for the ladder assembly



g-2 straw tracker

Mu3e mechanic design

- Mu3e pixel tracker uses HV-CMOS sensor with similar material budget
  - However the tolerance to vibration in CEPC is much more stringent
    - Kapton support foil may not be suitable for CEPC



Summary

- Liverpool is interested in contributing in the mechanic design and manufacturing of the ladder
  - Mechanic design
    - This depends on the module and readout specification, as well as the scope of prototype (whether we will readout 3 ladders and to connect them mechanically with a realistic support)
  - Materials
    - CF: typically ~50μm thickness each layer that correspond to ~0.025% X_0 (probably too thick)
      - RnD ongoing at Liverpool exploring thinner options (resin infusion)
    - CVD diamond support
  - Manufacturing of the ladder support
  - Thermal and structure property measurements
    - Thermal cameras
    - TIM towers
    - Structural and thermal FEA (ANSYS)
- In all areas we would like to collaborate with local people in China