UNIVERSITY OF LIVERPOOL

Expression of interest in the CEPC vertex prototype project

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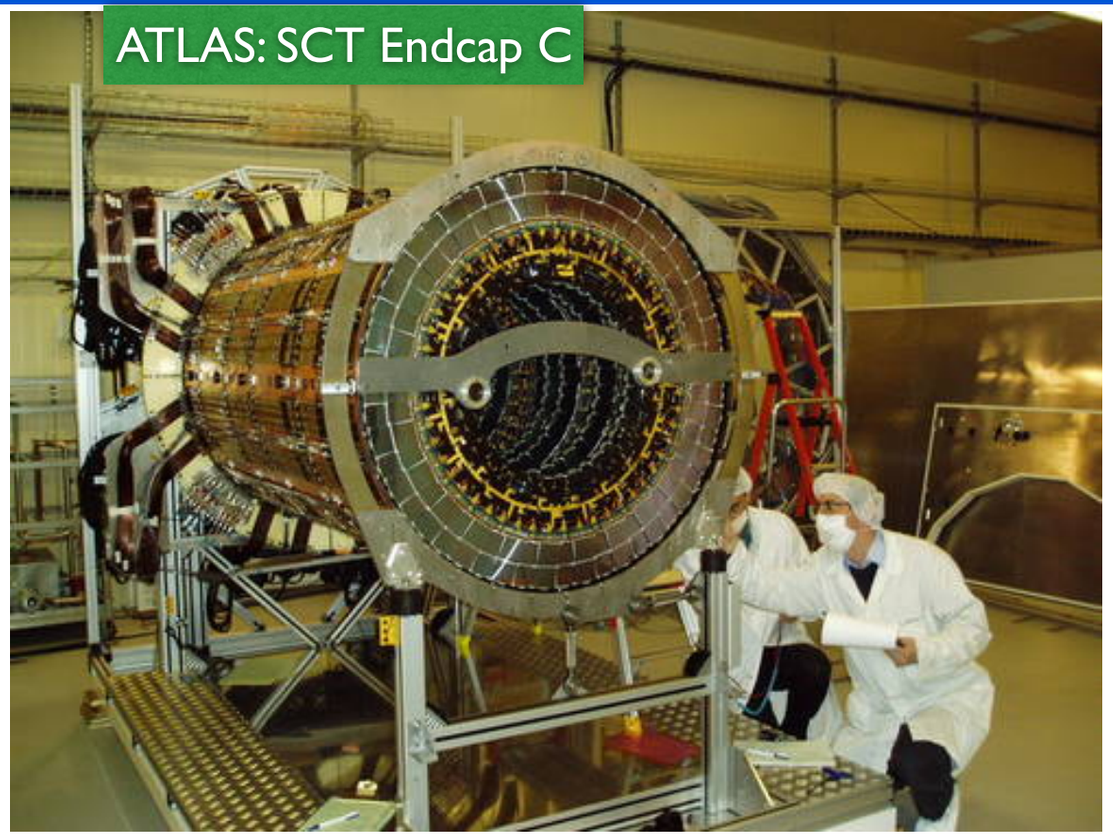
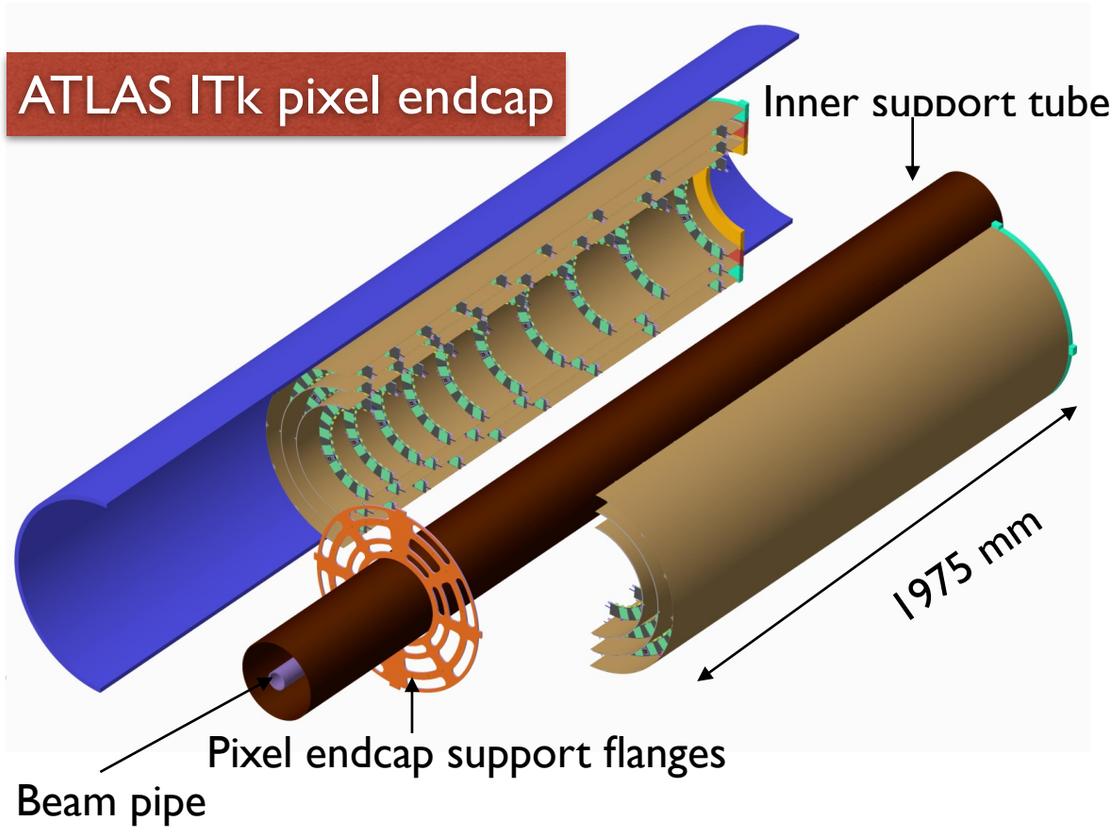
Overview

- Liverpool silicon related projects
- Liverpool detector design and fabrication facilities
- Interests in the CEPC vertex prototype project

Highlights of Liverpool silicon detector projects

- Liverpool has been heavily involved in many silicon strip and pixel projects
  - Sensor, electronic circuits and local support
  - Module assembly
  - System integration
- Highlights of previous projects
  - ATLAS SCT
  - LHCb VeLo
  - g-2 straw tracker
- On-going projects
  - ATLAS ITk upgrade (modules and mechanics)
  - LHCb velo upgrade (hybrid and mechanics)
  - ALICE ITS module assembly (production)
  - μ3e outer barrel tracker(mechanics and production)
  - HV-CMOS (R&D)





Liverpool Semiconductor Detector Centre

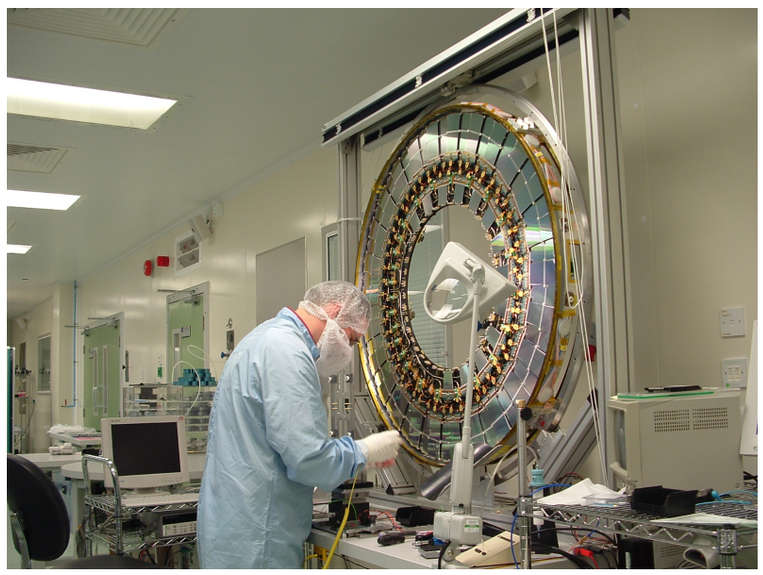
350 m² clean room
100 m² class 5
250 m² class 7

Highlights of hybrid and flex circuit designs

- Specialise in low mass, high band-width and analogue/digital outputs

LHCb velo

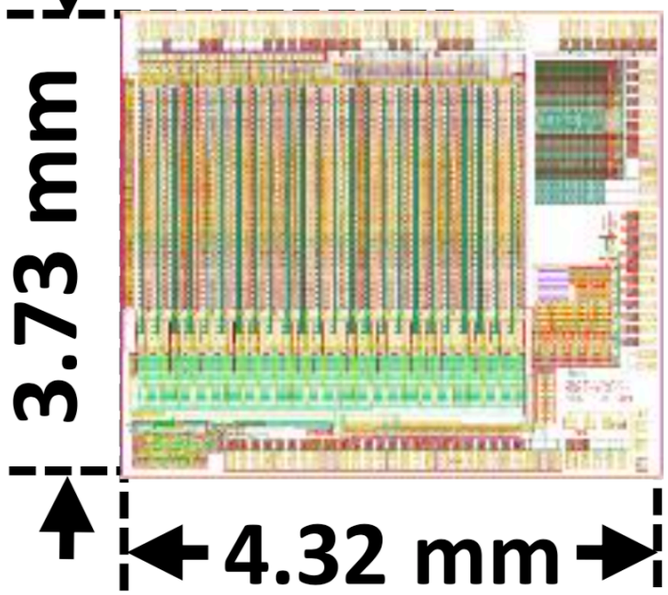
ATLAS SCT



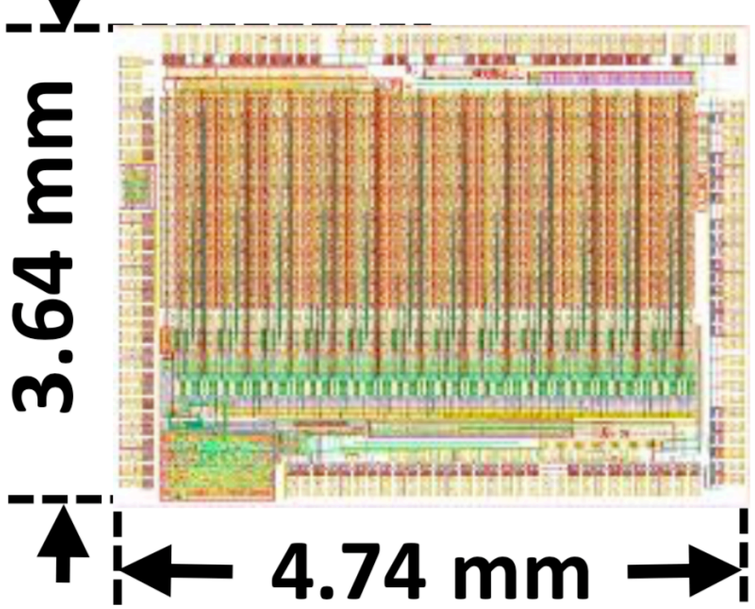
ATLAS ITk pixel straight stave prototype

HV-CMOS R&D

- We are active in the sensor design, performance studies a HV-MAPS detectors
  - Professors Gianluigi Casse and Joost Vossebeld, Engineer Eva Vilella
  - Strong links with LFoundry

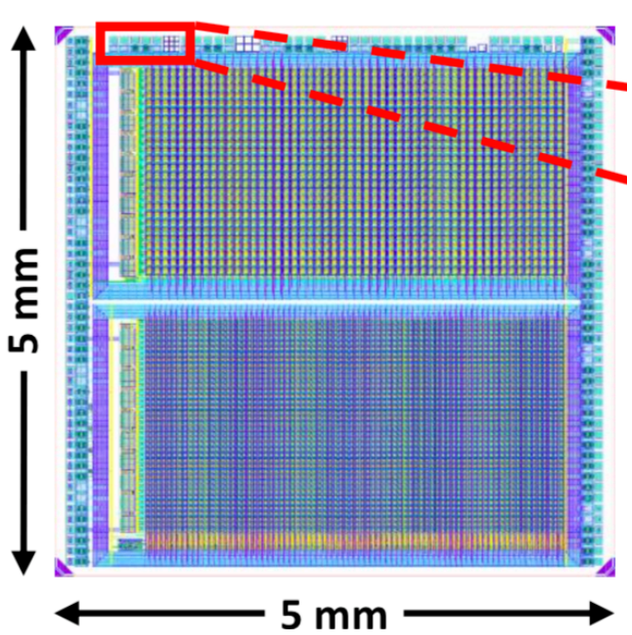


ATLASPix-2 180nm AMS



Mu3ePix9-180nm

We will build CMOS ladders and modules for the Mu3e experiment

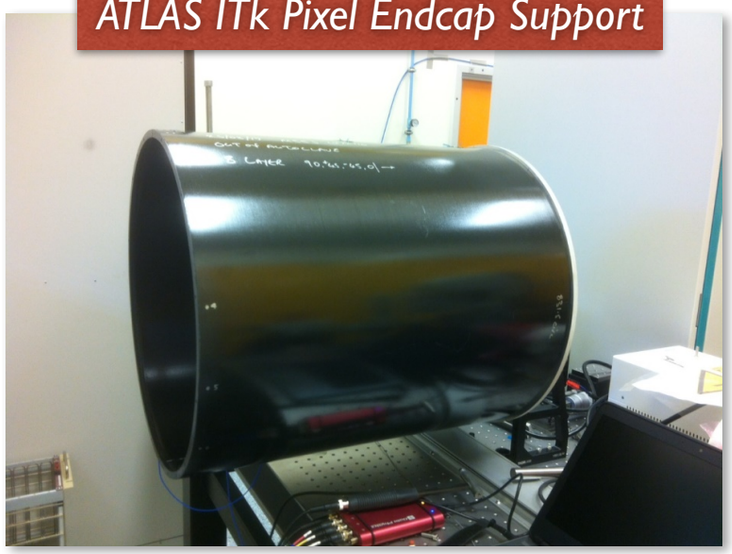


LF-HVMAPS-FEI3

Gianluigi is the RD50 spokesperson

Advanced material lab at Liverpool

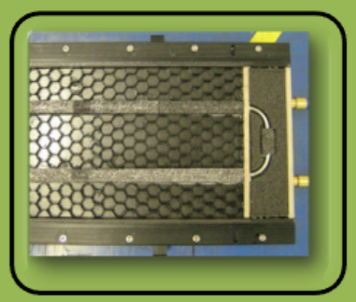
- Main facilities
  - 50m2 space for CFRP lay-up, 1.7m x 1m Autoclave, Oven, Pattern Cutter.
  - New 30m2 space for large composite curing oven & furnace



ATLAS ITk Pixel Endcap Support

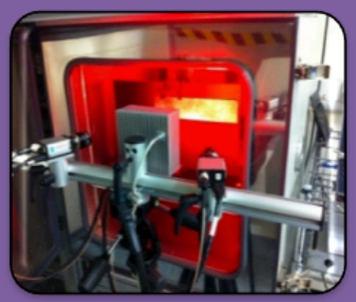
Materials & Processing Technology

- Carbon fibre, resin systems, nano-particles
- CFRP pre-preg, resin infusion
- Spread-tow pre-preg



Structures

- High-performance, low-mass support structures for tracking detectors
- Composite components for CTA, Formula Student, etc..

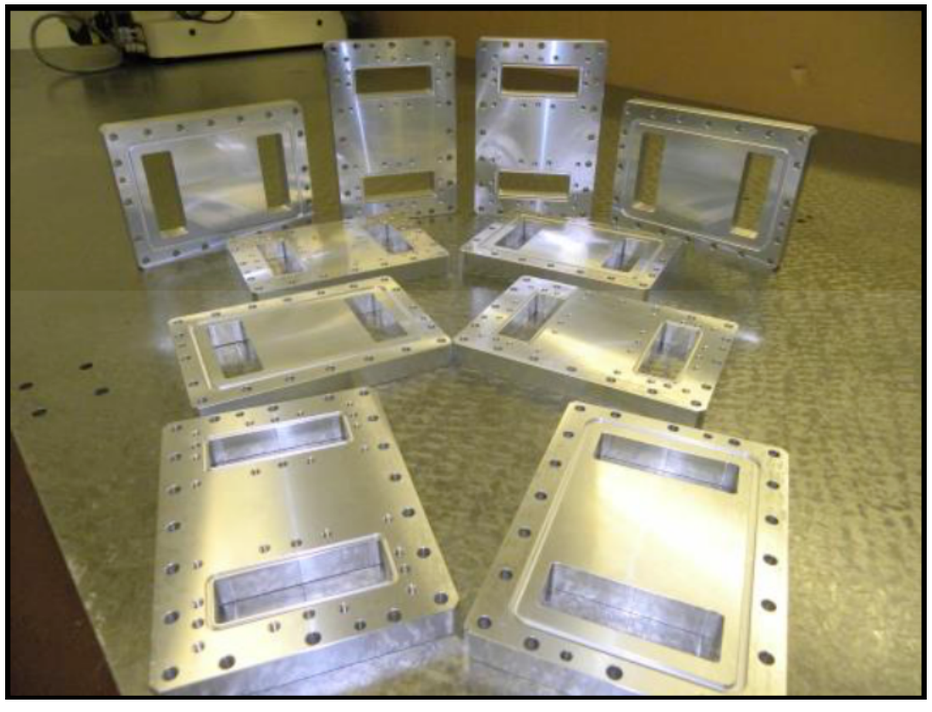


Performance Verification

- Component geometry
- Mechanical properties of CFRP laminates
- Deformation of structures

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



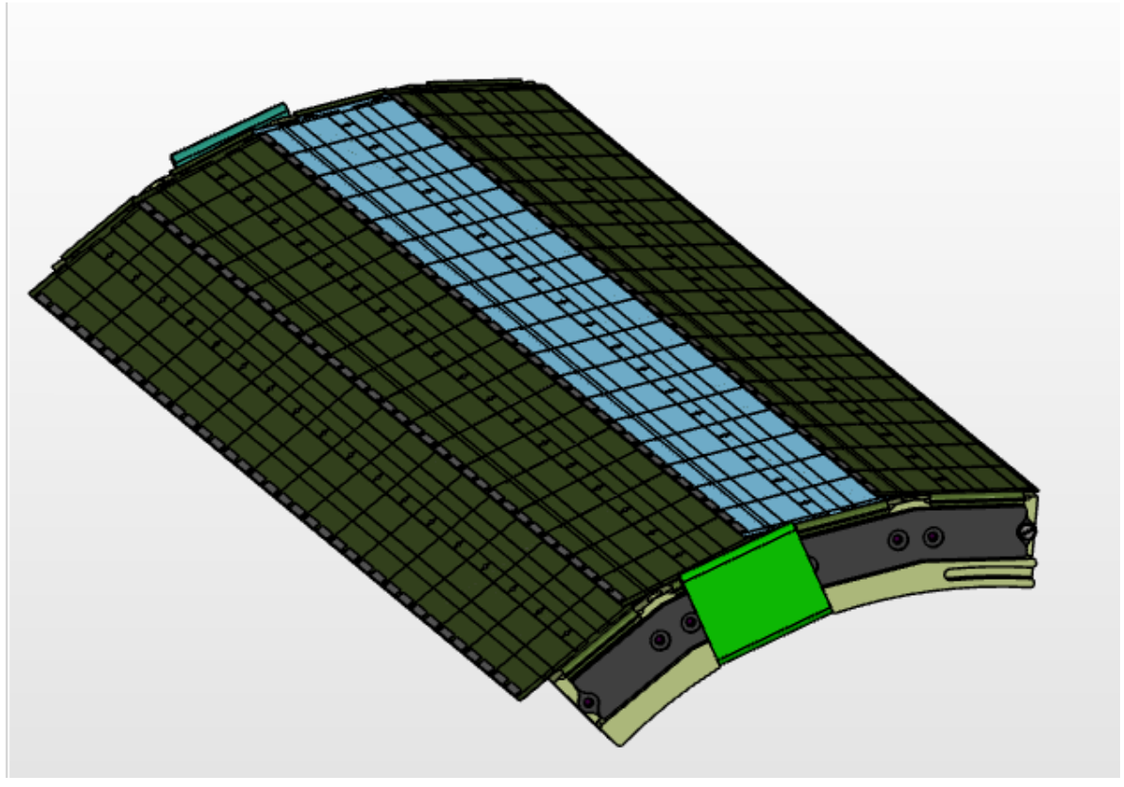
g-2 straw tracker

Mu3e module assembly

- Mu3e pixel tracker uses HV-CMOS sensor with similar material budget
  - However the tolerance to vibration in CEPC is much more stringent

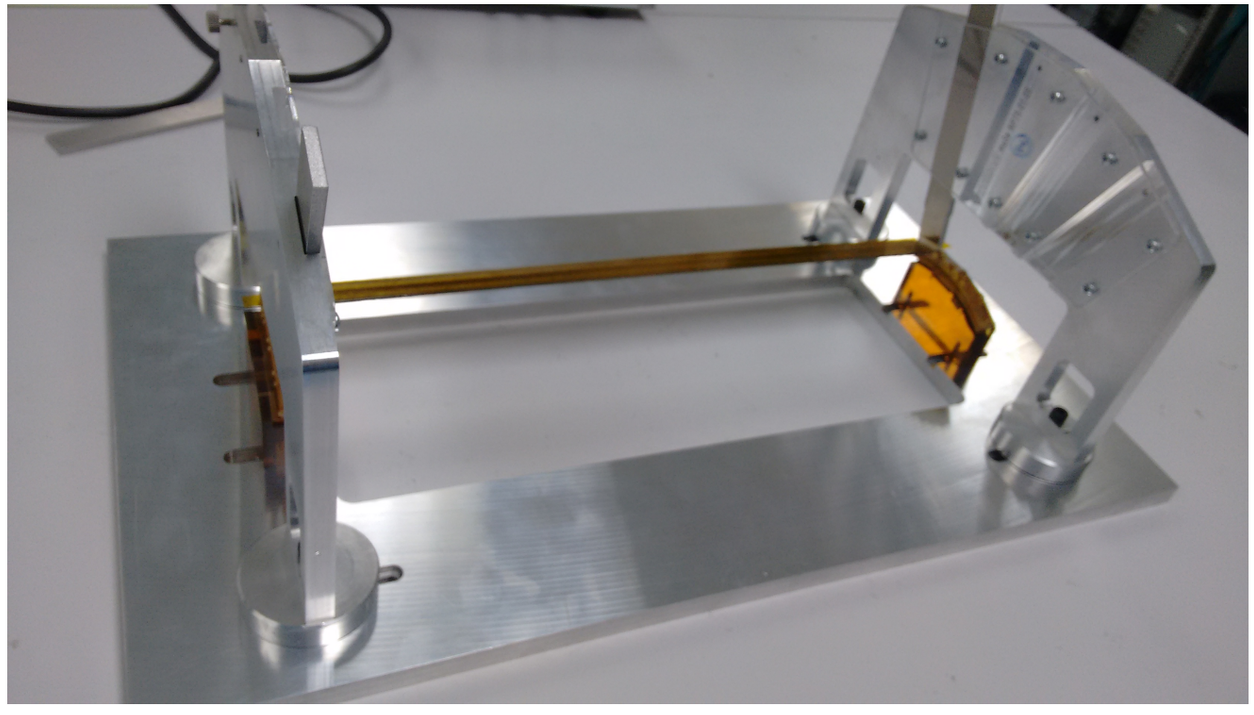
Mu3e pixel module with 72 HV-CMOS chips

0.1% X_0 material budget per sensing layer



Gaseous helium cooling

Prototype of assembly jig



ALICE ITS module production

- Liverpool responsibility: 25% of the modules of the Outer Layers of the Outer Barrel

Interests in the CEPC vertex prototype

- Low-mass mechanic design, cooling and manufacturing
  - 2 lead engineers for the mechanical design of ATLAS ITk pixel endcap and LHCb velo upgrade
  - Extensive manufacturing capabilities in low mass CF structures (e.g. CDF layer 00, LHCb/ATLAS)
    - Recent work on very low mass support structure: Link to Tim Jones' talk at Rome workshop
- Flex circuit design
  - 3 experienced electronic engineers (responsible for ATLAS/LHCb hybrids)
    - Specialise in low mass, high band-width and analogue/digital outputs
- CMOS sensor
  - 1 experienced ASIC designer
  - Extensive experience in simulation and characterisation studies of the sensor