Queen Mary University of London

The Alan Turing Institute

Zero support Mass Detectors (ZMD)

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MICRON SEMICONDUCTOR LIMITED

UKRI Science and Technology Facilities Council

Work Funded by STFC, QMUL and Micron Semiconductor Ltd..

The idea

- Q1) What happens if we take thin film of silicon, stress it and use the strength of the material as mechanical support?

- Q2) What then happens if we try and use the silicon as a radiation detector.

- e.g. can we build a new type of low mass cylindrical silicon tracker, that could be of interest to industry as well as STFC science.

Start of a cross-disciplinary collaboration between condensed matter and particle physicists.

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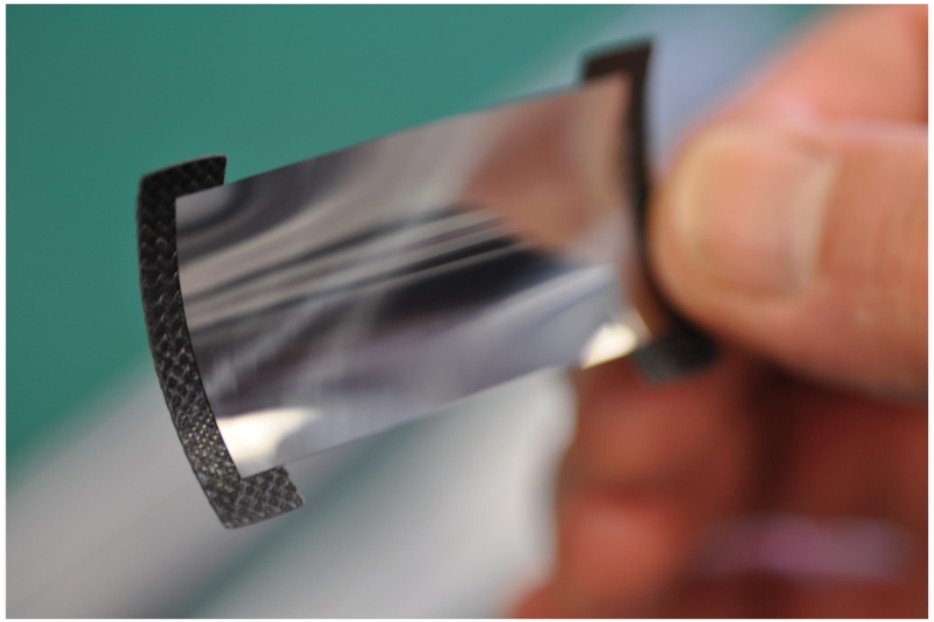
The journey so far

2012

- Constructed some mechanical mock ups to put to one side for a few years to see if they remained stable or not.



CRFP support at each end sufficient to make a rigid structure.

STFC infrastructure for the LHC programme used to measure the shape of the surface of these kinds of bent silicon prototypes.

7 years later this model is still intact.

Start of a cross-disciplinary collaboration between condensed matter and particle physicists.

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The journey so far

2017

- IAA funding (20k) used to start work with Micron Semiconductor Ltd.
- Leveraged 100k of in-kind support from Micron.
- Using TTT10 (10x10cm strip detector designed by Caltech for a space application).

- **50µm thick silicon sensors**
- **Need testing**
- **Need to be assembled into modules for further evaluation.**

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The journey so far

2017

- Investigation into spherical deformation of thin silicon: undergraduate group project: adapt silicon shape to match focal plane of optical systems (e.g. cameras and telescopes).
- Demonstrated spherical curvature suitable for telescope design.

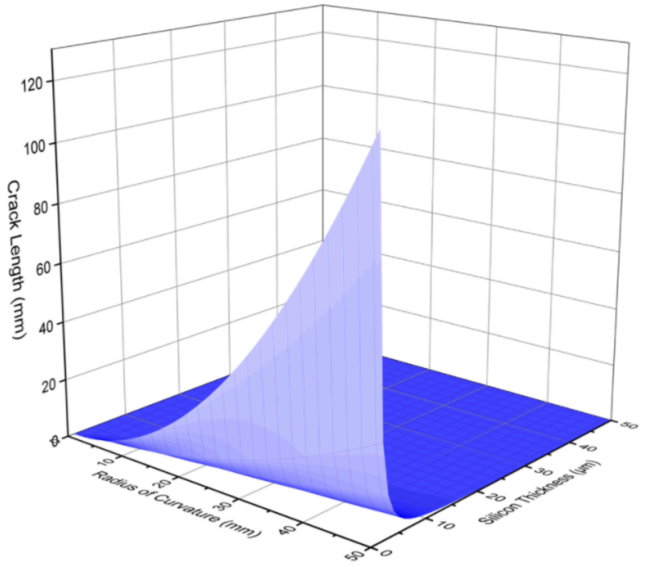
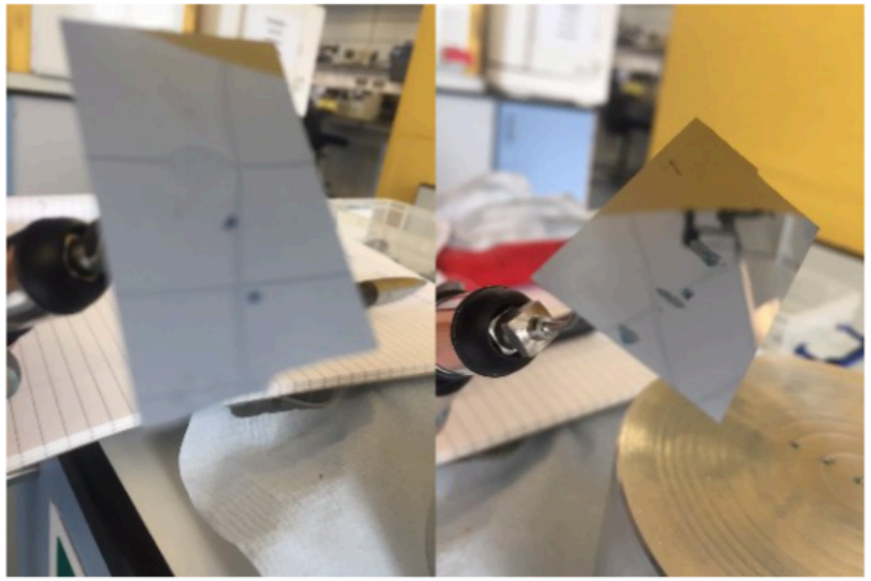


Figure 3: The relationship between the Crack length vs Radius of curvature vs Silicon thickness.



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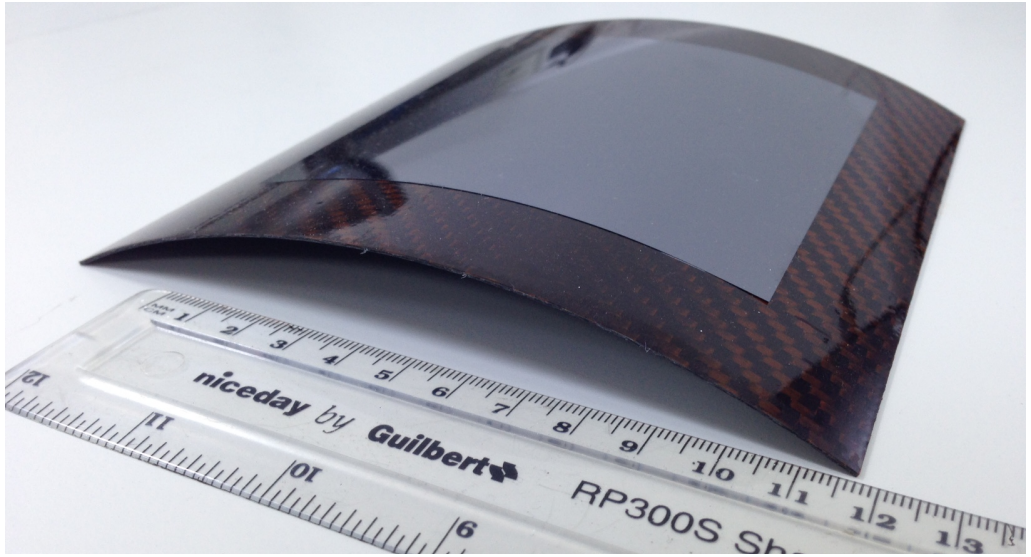
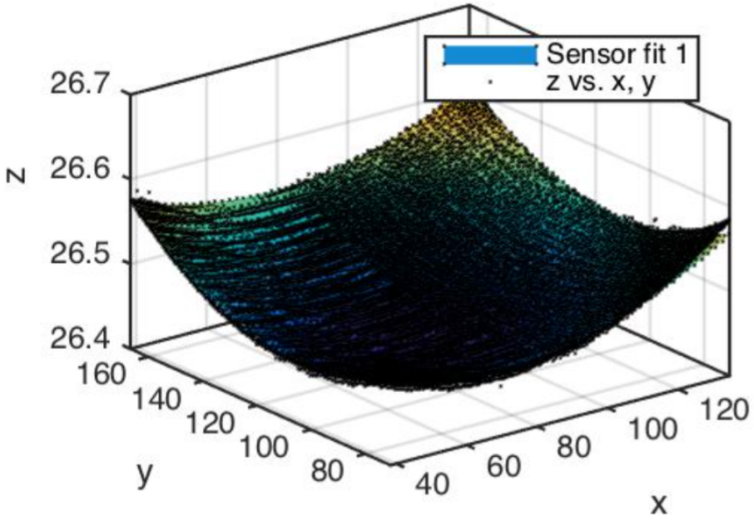
The journey so far

2018

- Undergraduate project student systematically worked through making prototype modules.
- Allowed us to evolve vacuum jig technology for assembly.



10x10cm structure



Metrology for a 10x10 sensor
Spherical deformation, following Stony's theory

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The journey so far

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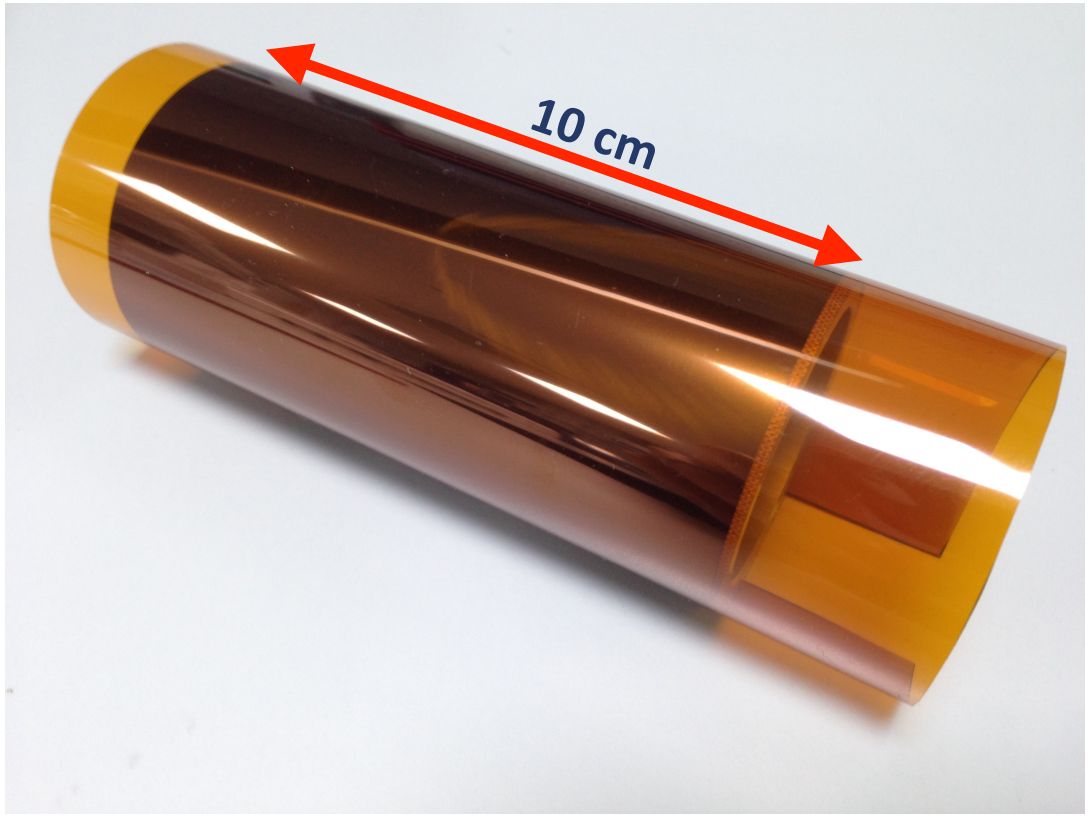
- Allowed us to evolve vacuum jig technology for assembly.

Cylindrical deformation of a 10x10cm ultra-thin silicon sample also demonstrated.

R = 2.5cm



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The journey so far

- Opportunities Call funding: ~178k over 18 months to build and characterise modules.
  - Funding to develop and evaluate a proof of concept for low mass tracking and future product design.
  - Data generated from a R=15cm model will allow us to target product design with MSL for cylindrical wrap-around detectors.
  - PDRA starts 1st Feb 2021.

- Will open the door for us to work with Specialised Imaging on spherically deformed sensors (more challenging: the Kirana CMOS MAPS sensor designed by RAL-TD), and to work with RAL PPD on developing future tracker technologies based on their CMOS chips.