

LOW-MASS
VERTEX DETECTOR
R&D

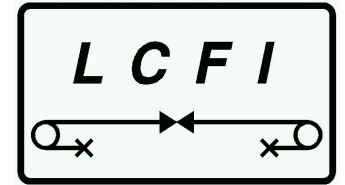
Joel Goldstein
The University of Bristol
6th May 2010

Projects



1. LCFI
2. Low-Mass
3. PLUME

Concepts

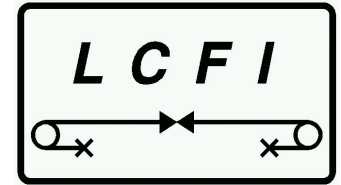


- * **ILC material target equivalent to 100 μm silicon**
- * Thinning silicon to 50-100 μm becoming routine
- * Thinning to epitaxial possible
- * **Possible $\Delta T \sim 70^\circ\text{C}$**

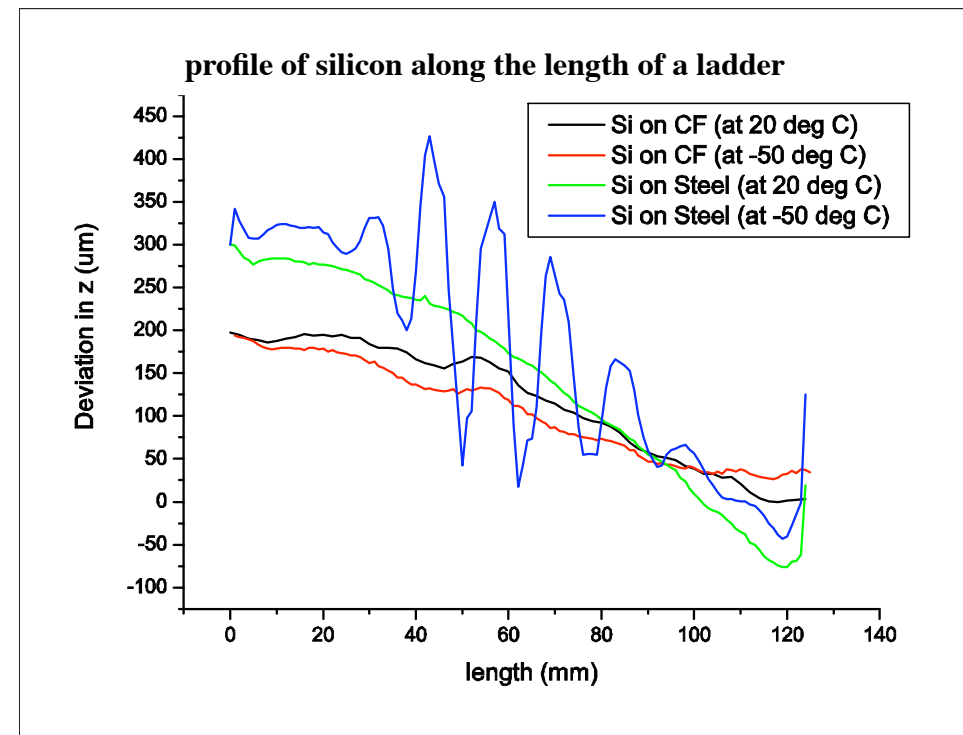
1. Unsupported silicon
 - *can't control lateral curl*
2. Laterally stiffened silicon
3. Rigid structures



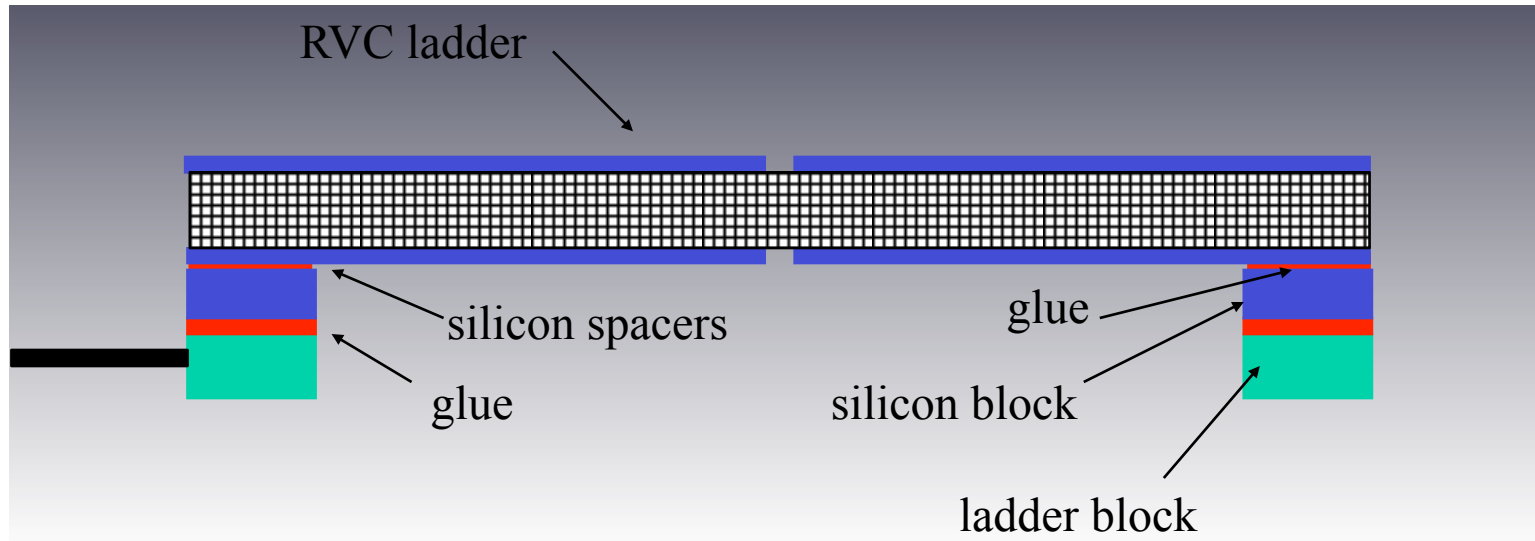
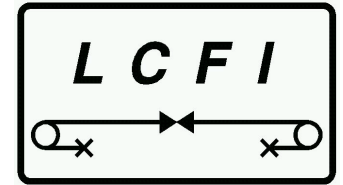
Thin Substrates



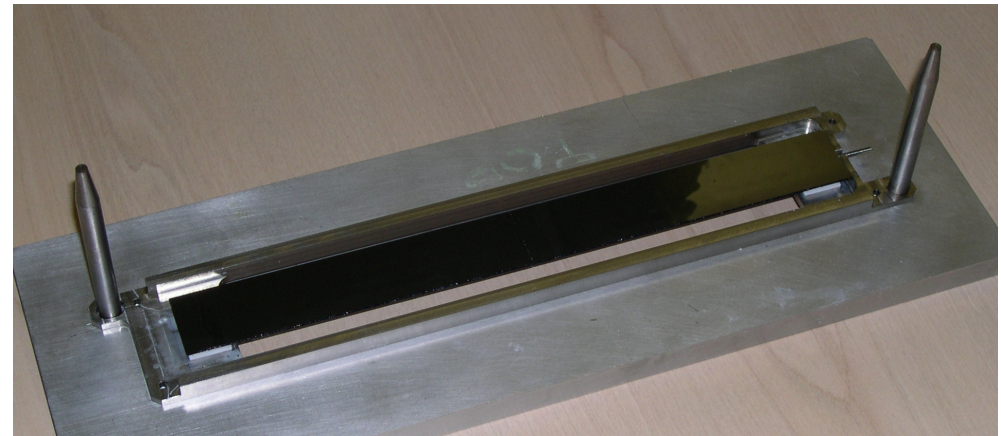
- * Longitudinal stiffness from tensioning
- * Lateral stiffness from thin substrate
- * Beryllium: good specific stiffness but bad CTE
- * Carbon fibre good candidate
 - * 0.09% X_0 test model
 - * poor laterally stability



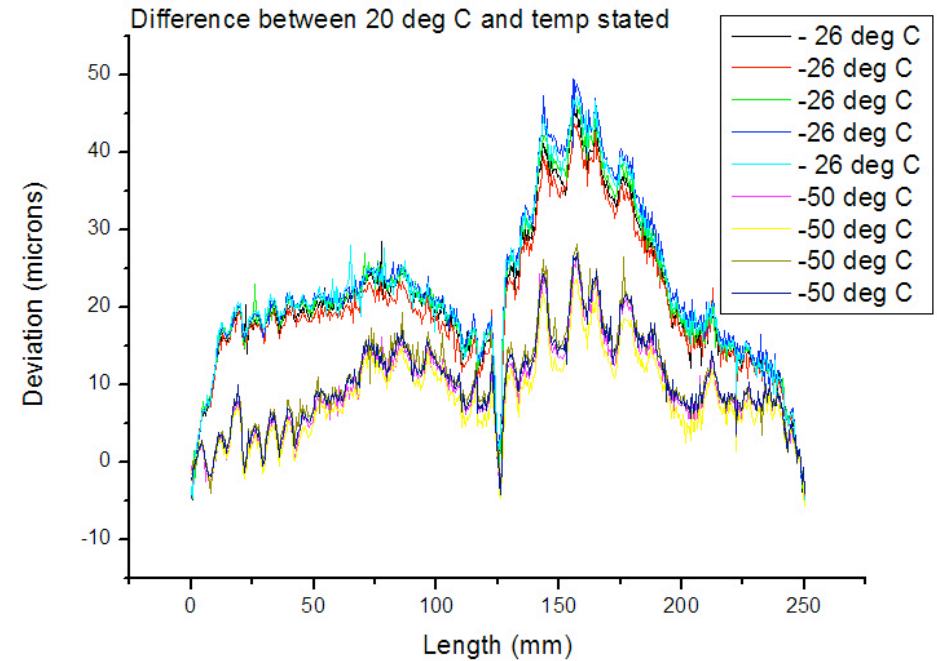
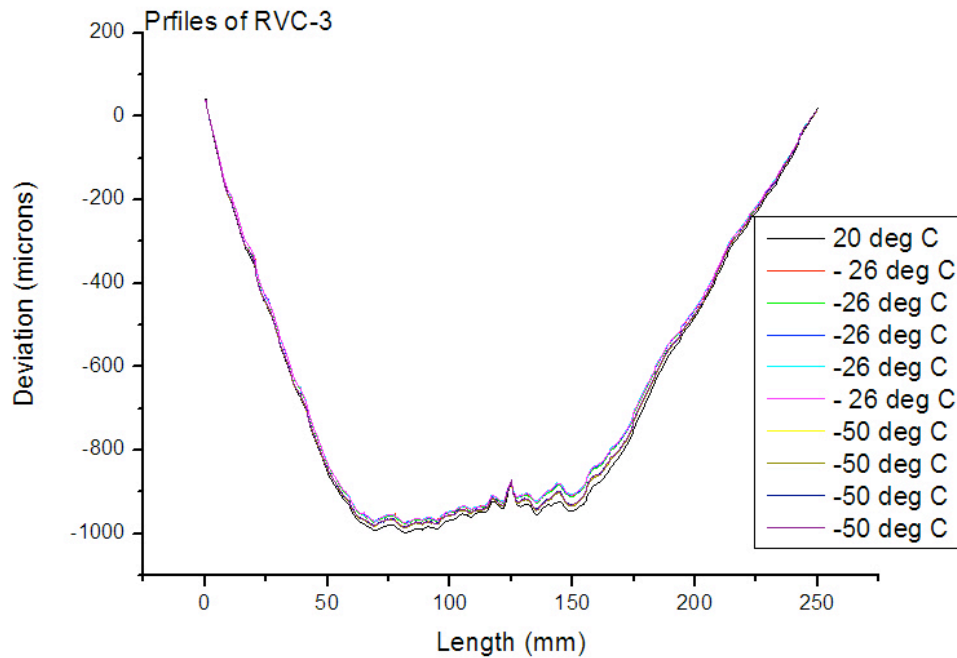
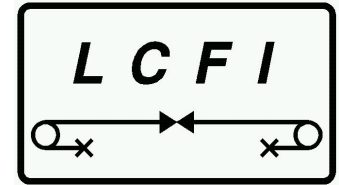
RVC Foam



- * Reticulated Vitreous Carbon
- * 2-3% relative density
- * Not stiff enough for single-sided



RVC Results

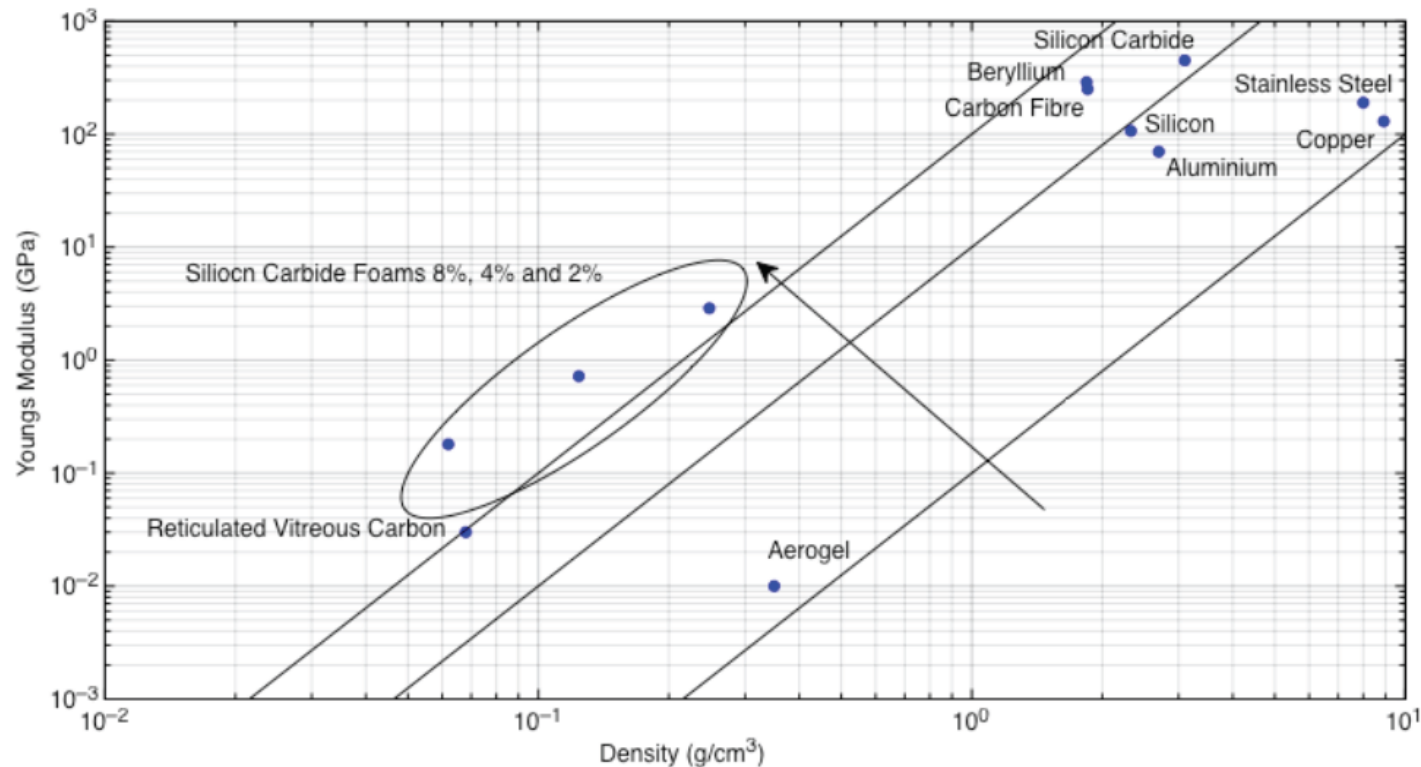


* Difficult to control shape & behaviour

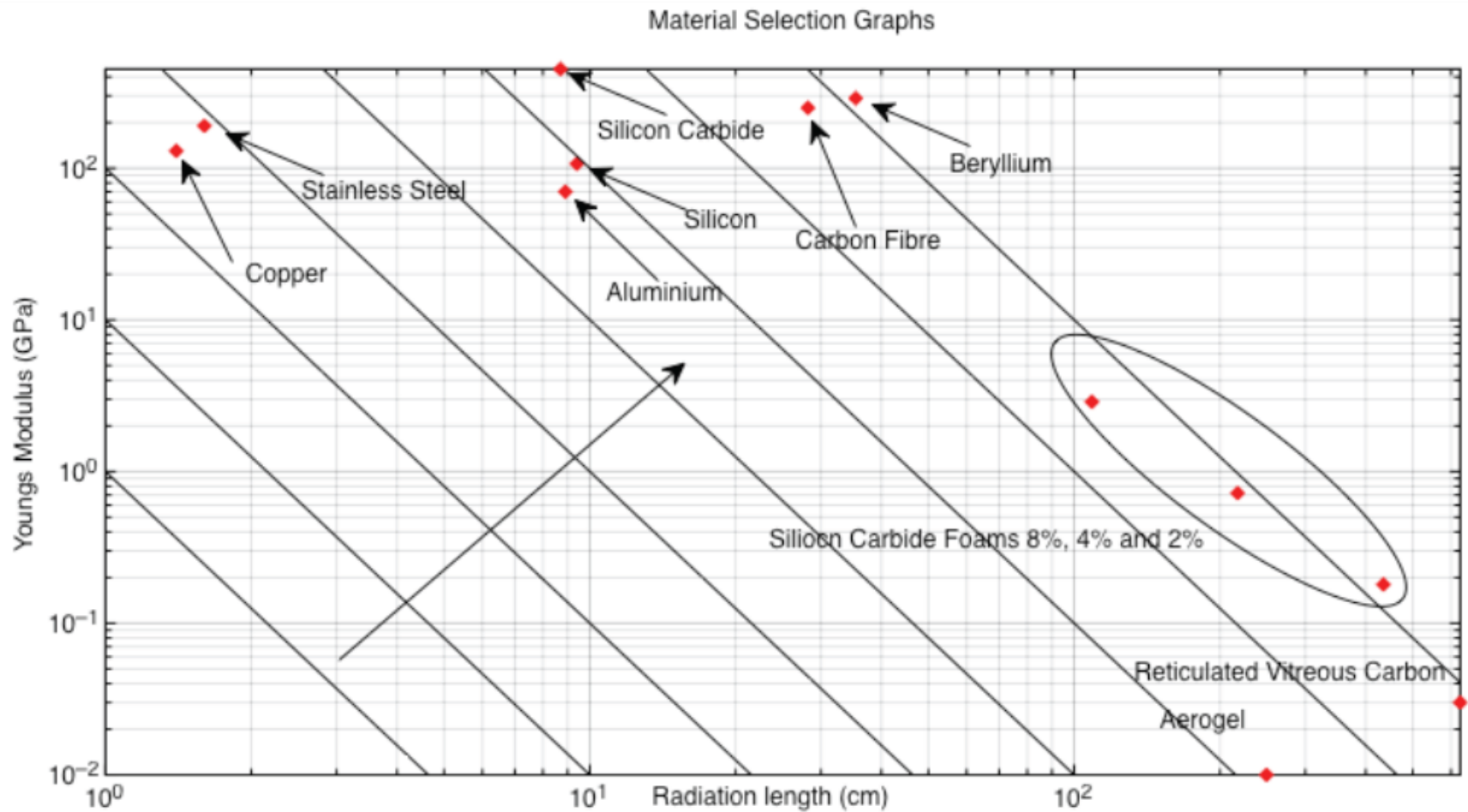


- * Want structural material with best specific stiffness:

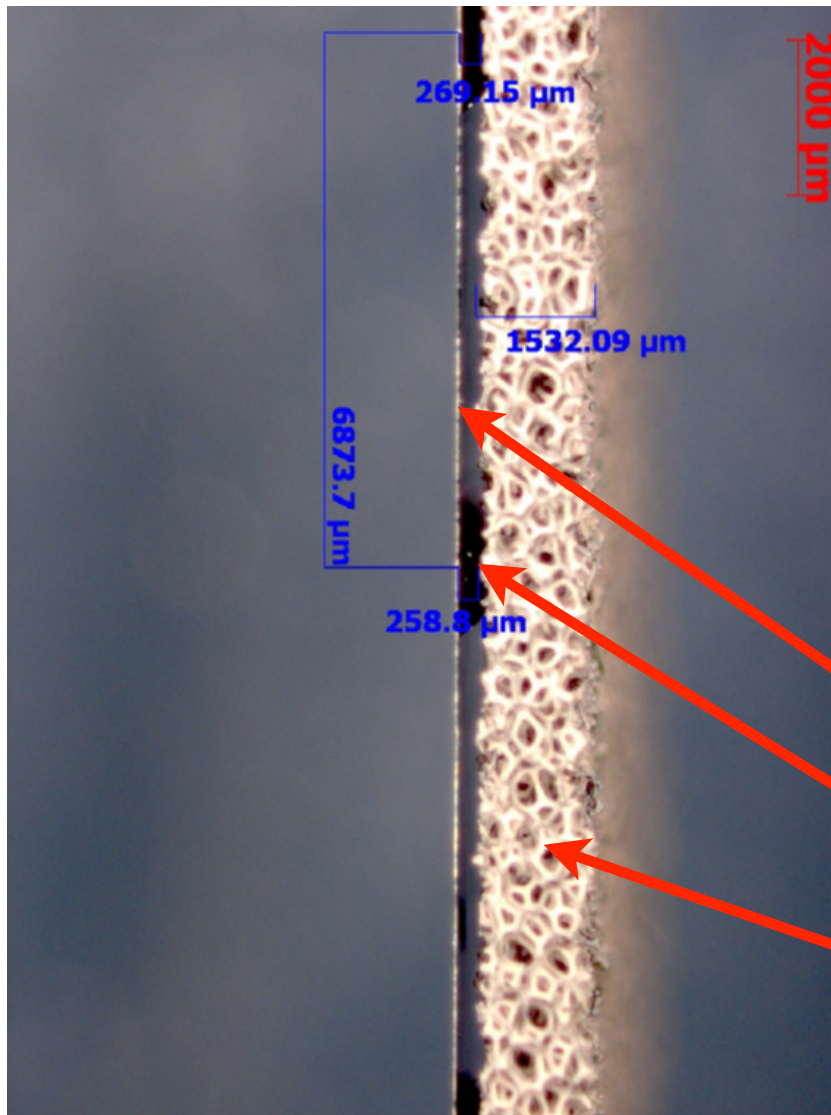
$$\frac{\text{Young's Modulus}}{\text{Density}}$$



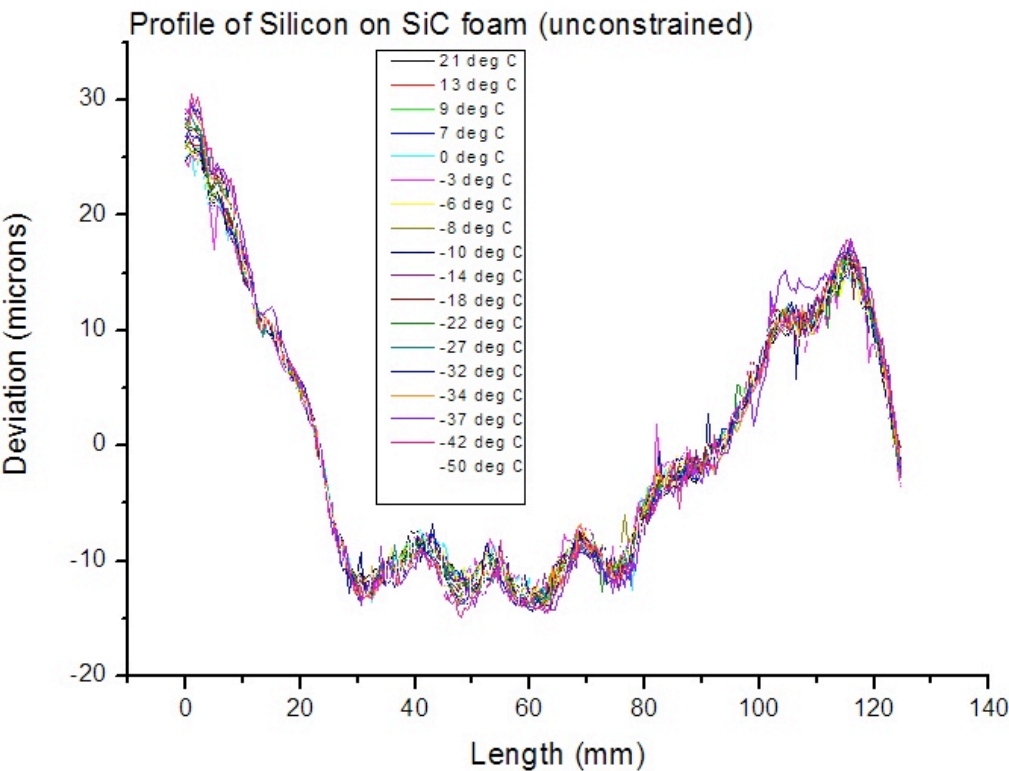
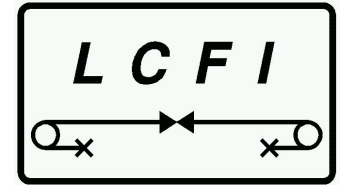
* In terms of Radiation Length:



SiC Foam

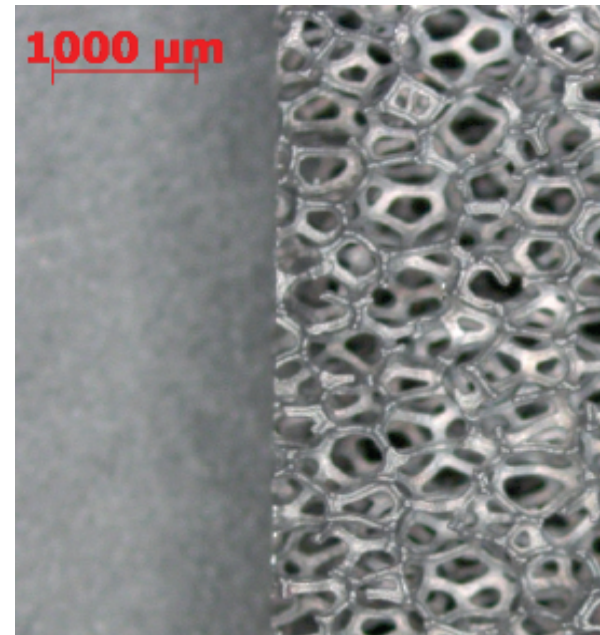
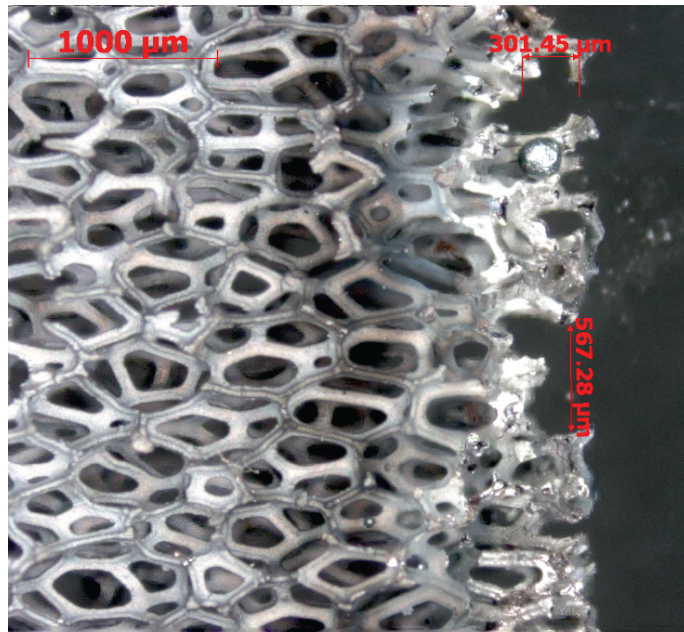


- * Open-cell foam
- * Commercially available at 8%
- * Can get 2-3%
- * Much stiffer than RVC
- * Baseline ladder:
 - * 20μm silicon sensor
 - * Silicone glue/gap
 - * 1.5 mm foam

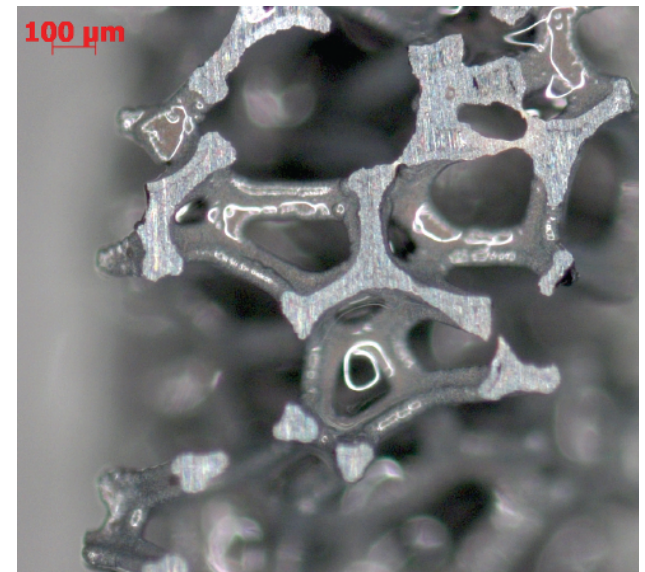


- * Processed 8% SiC Foam
- * A fraction of initial shape left
- * 30% over material budget
- * Now have 3-4% foams
- * Minimally constrained
- * Stiction in mountings

Negligible deformation over 70 degrees!



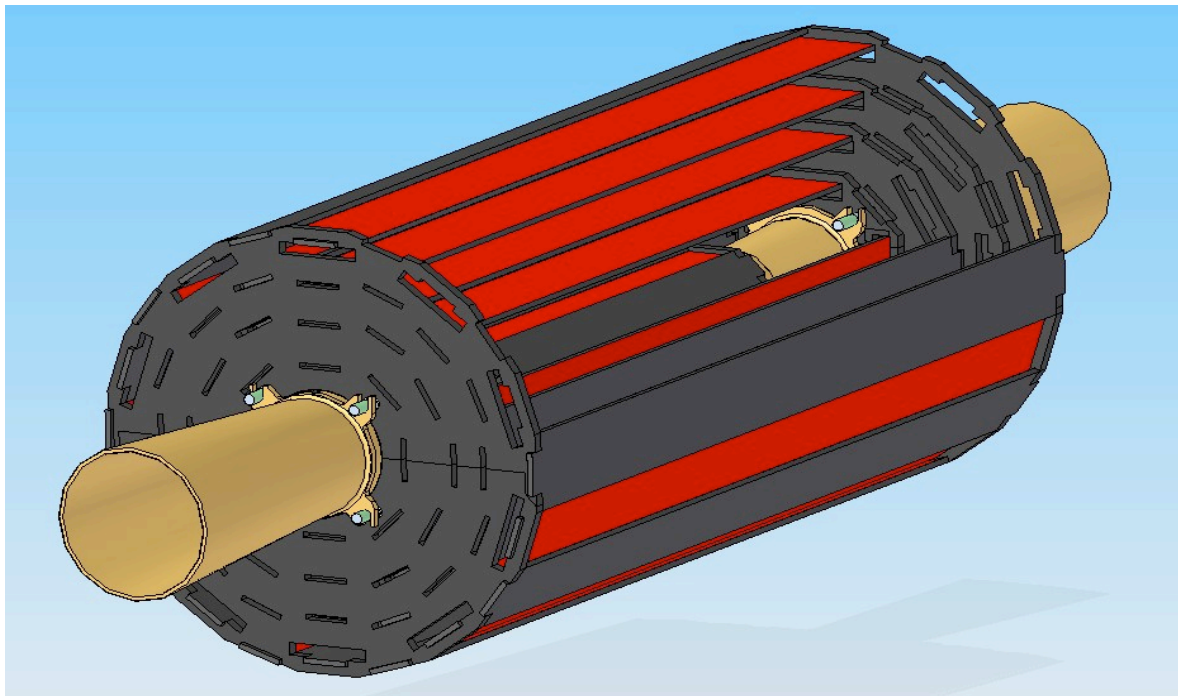
- * Measuring material properties
- * Developing processing techniques
 - * Grinding/machining
 - * Cutting: laser/milling
 - * Adhesives etc.



ILC VXD



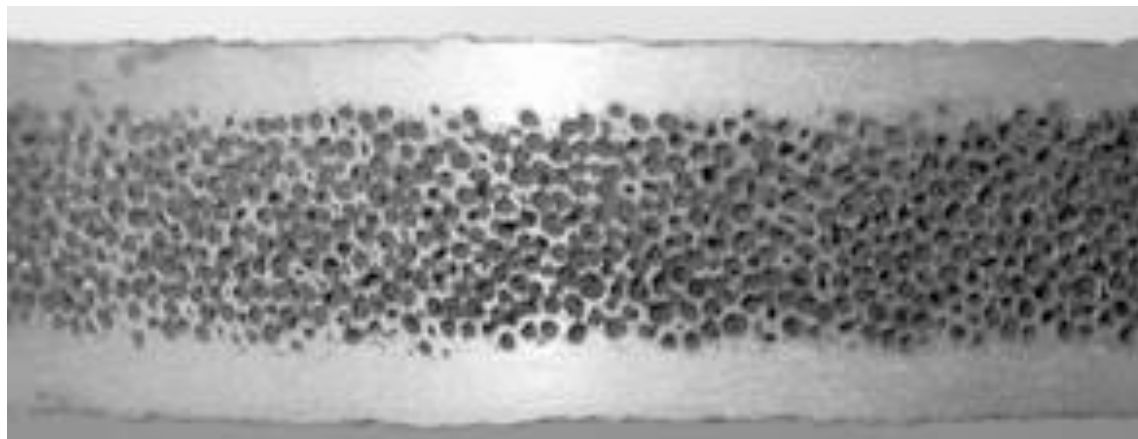
- * Demonstrate ILC VXD mechanics
- * All SiC structure
- * Eliminate differential contraction
- * Prototype components in production



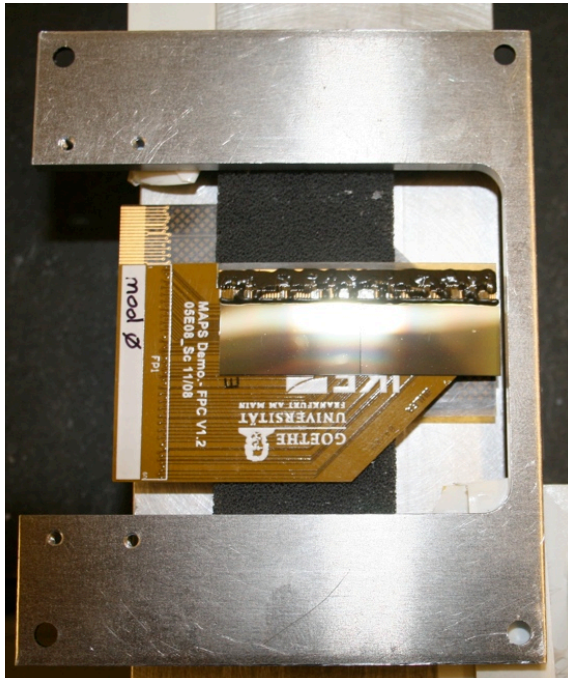
Cooling



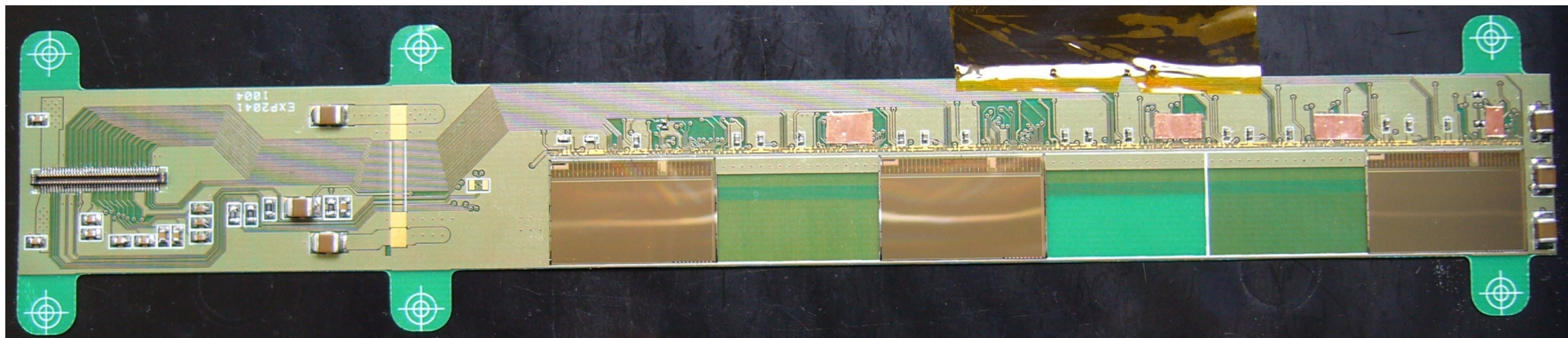
- * Many applications will require liquid/evaporative cooling
- * Cooling pipes add significant material
- * Flow coolant through foam
- * Add skins of SiC/epoxy/CF/....
- * Thermal conductivity higher than expected
- * Similar to pocof foam - *carbon core*



PLUME



- * European R&D for ILC VXD ladders
- * *Strasbourg, DESY, Oxford, Bristol*
- * Mimosa (MAPS) chips on SiC Foam
- * **Material not optimised**
- * Prototypes in test beams
- * 15cm-long ladders this summer



Summary



- * Silicon carbide foam promising for low-mass structures
 - * High specific stiffness
 - * No thermomechanical issues
 - * Can tailor thermal and electrical conductivity
- * R&D continuing in the UK (*Low-Mass*)
- * SiC foam ladders demonstrated in test beams (*PLUME*)