

Thin ladder development in the LCFI group

Erik Johnson, RAL

Targets

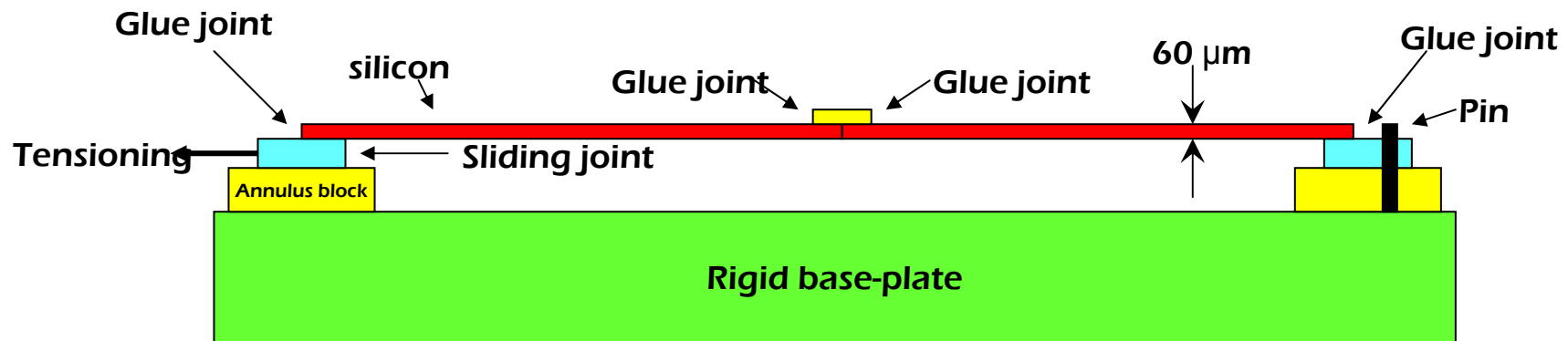
- **Aiming for 0.1 % X_0**
- **Uniformity over full length of ladder**
- **Compatibility with wire and bump bonding**
- **Provision for optical survey**
- **Robust**

The story so far...

- **Have followed up three different approaches so far**
 - **All involving individual long ladders**
 - **Unsupported**, ladder made purely from thinned silicon and tensioned.
 - **Thin Support**, ladder placed on a thin supporting substrate.
 - **Thick Support**, ladder placed on a thick supporting substrate.

Unsupported silicon

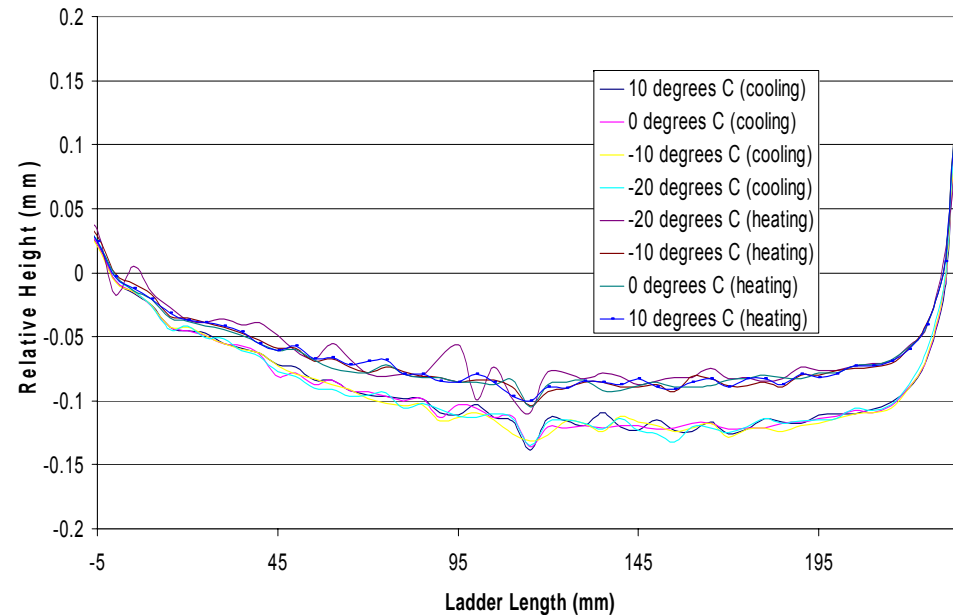
- Made ladder from two pieces of silicon butt-joined together.
 - Silicon dimensions: 125 x 25 x 0.06 mm
- One end fixed the other able to slide
- $\sim 0.07\% X_0$



Unsupported Ladder

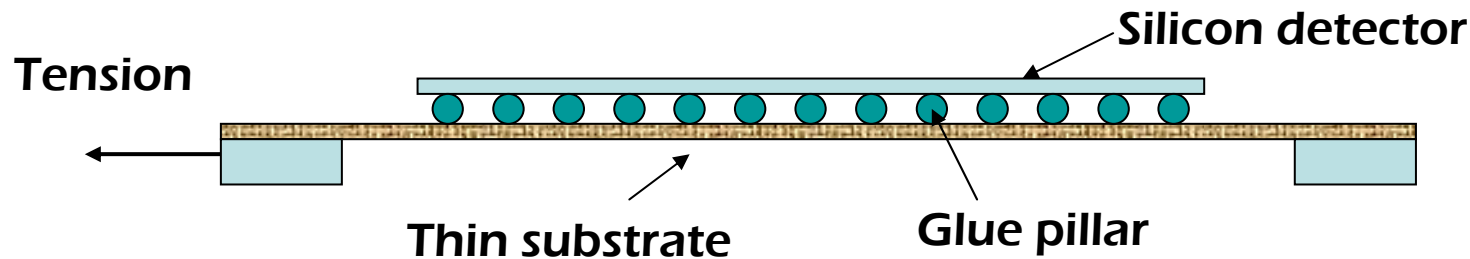
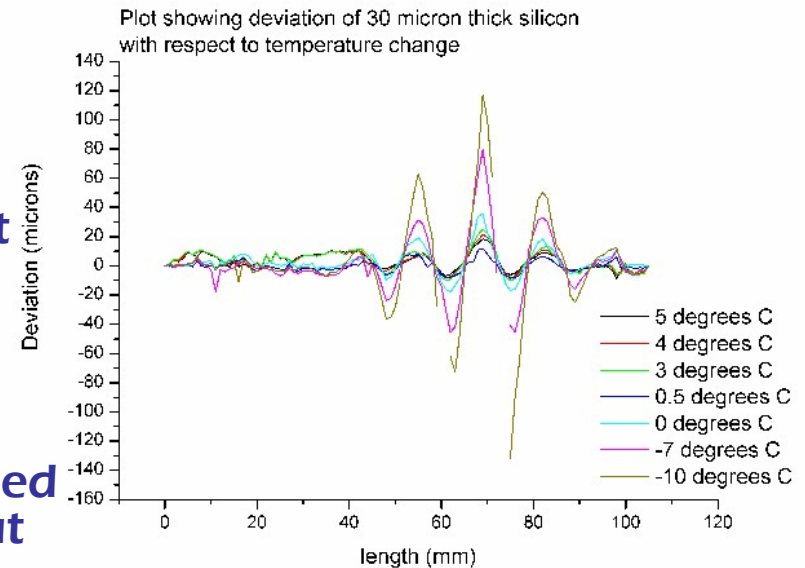
- **Stability found to be good along the length.**
 - Concerns arising are the there is no strength across the width
 - Studies by Glenn Christian at E2V confirmed fears

Profile of Ladder during heating and cooling of the ladder



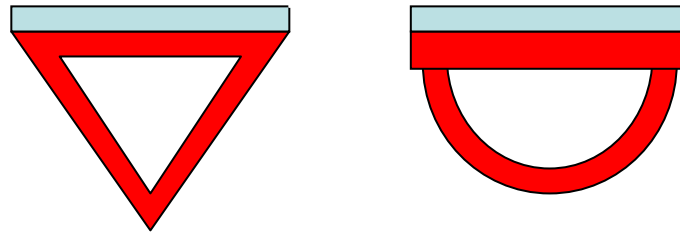
Thin Support Ladders

- Tensioned unsupported ladders have good stability along length
 - Require a lightweight substrate to reinforce width.
- Tensioned substrate ladders
 - Uses a gluing pattern similar to that used in SLD experience
 - A stiff substrate is used such as beryllium or carbon fibre
 - The substrate is strong enough to resist curling across the ladder caused by imbalances from the detector but not strong enough that it is self supporting along the length, hence requires tension.



Thick Support Ladders

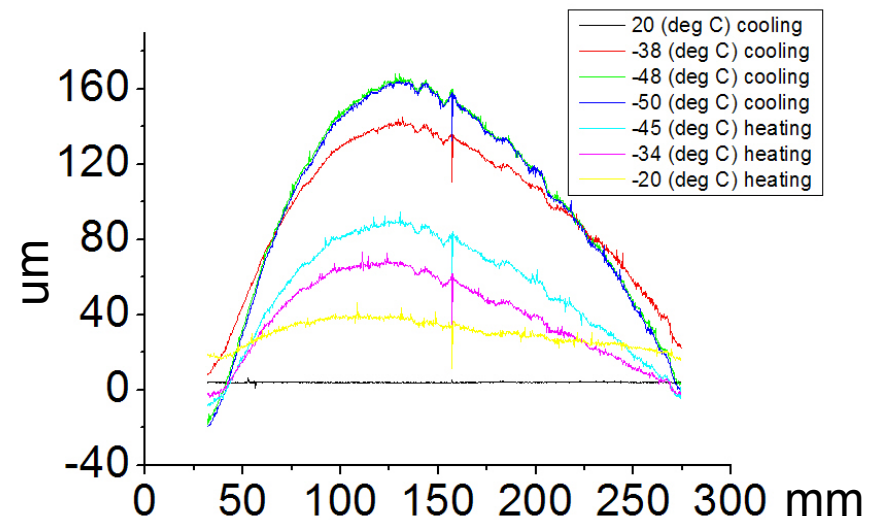
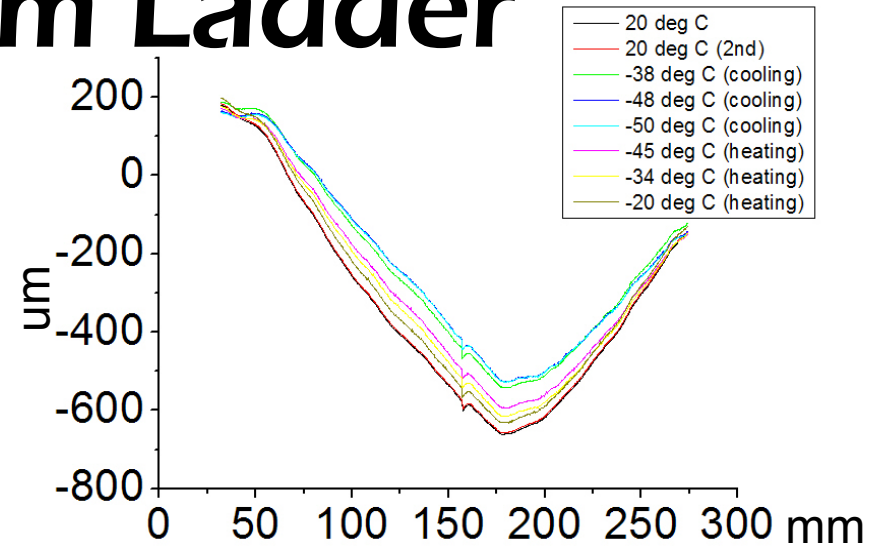
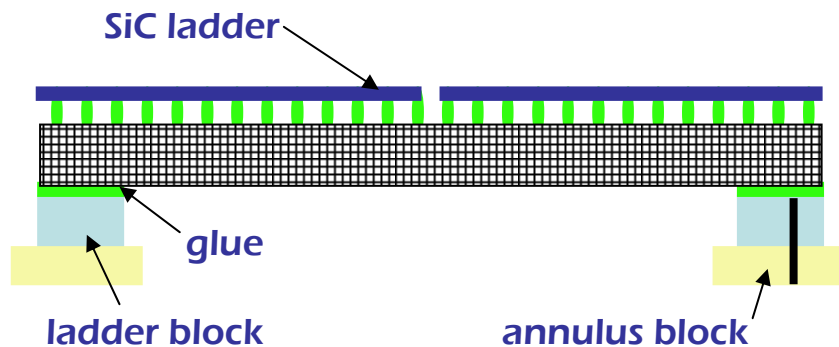
- Idea to fix thin silicon (20 microns thick) to a thick support (>1 mm)
 - Different support structures may be used
 - Support substrate could be hollowed out to make it light weight, ie using a V or Ω beam
 - Shape of substrate would make it fairly non-uniform, at some angles particles would have to pass through a large amount of material



- Sandwiched ladders
 - Makes the detector into a composite material made from a core surrounded by thin silicon.
 - Core can be made from either a foam or a microstructure.
 - Structure strong enough along width, but may require tensioning.

SiC Foam Ladder

- 20 μm thick silicon
- 1.5 mm thick SiC foam
 - 8% relative density
- Silicone adhesive pads
 - 1 mm diameter 200 microns high on ~5mm pitch
- $\sim 0.14\% X_0$



RVC Foam/Silicon Sandwich Ladder

- 20 micron thick silicon
- 1.5 mm thick RVC foam
 - 3% relative density
- Silicone adhesive pads
 - on ~5mm pitch
- Tension ~ 1.5 N
- ~0.08% X_0

