LCFI Mechanical Studies

Joel Goldstein
University of Bristol

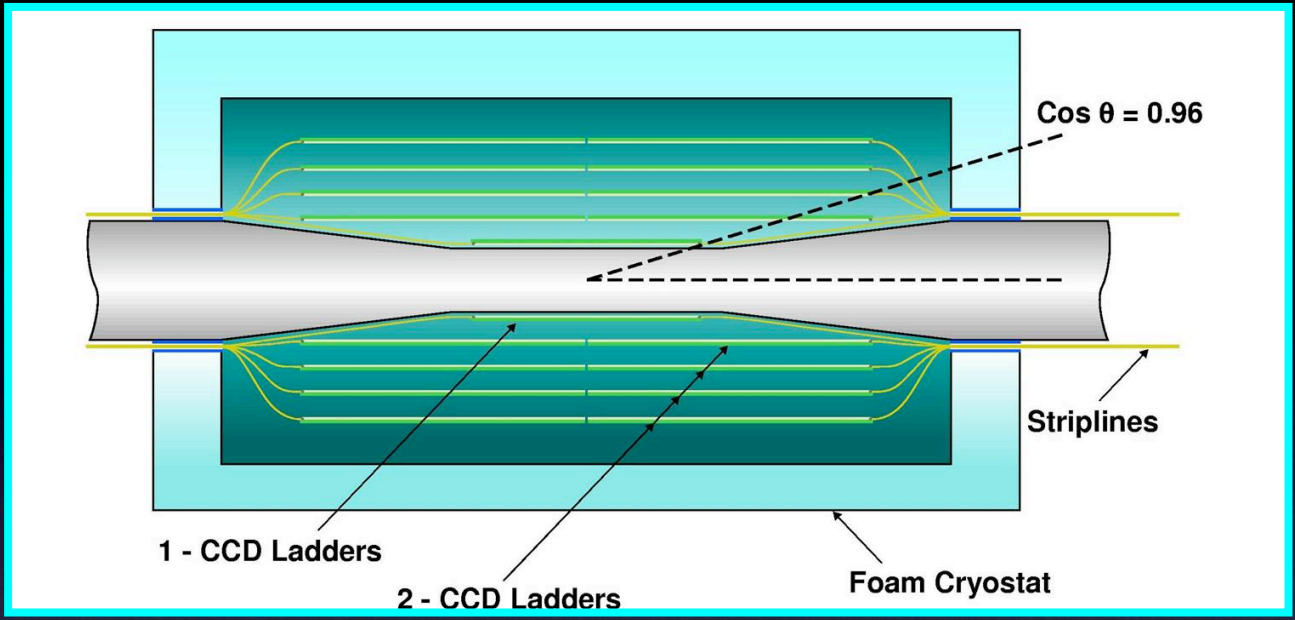
LCFI Collaboration

ILC Vertex Detector Review, FNAL 25/10/07

LCFI Mechanical Work

1. Support Prototyping
   - RVC and SiC Foams
   - Carbon Fibre
   - Shells
2. Conceptual Design
   - Check Compatibility
3. Cooling studies
   - Test Rig and Simulations

Conceptual Design



- 5 layers, inner radius ~ 1.5 cm
- Gas cooling
  - 0.1% X_0 per layer
  - Uniform material distribution

Optimisation

- Layout - barrel vs endcaps
- Material in active volume
- Material outside
  - May depend on sensors, electronics etc.
    - material, temperature. . .
  - Needs input from simulations and studies
    - tools becoming available

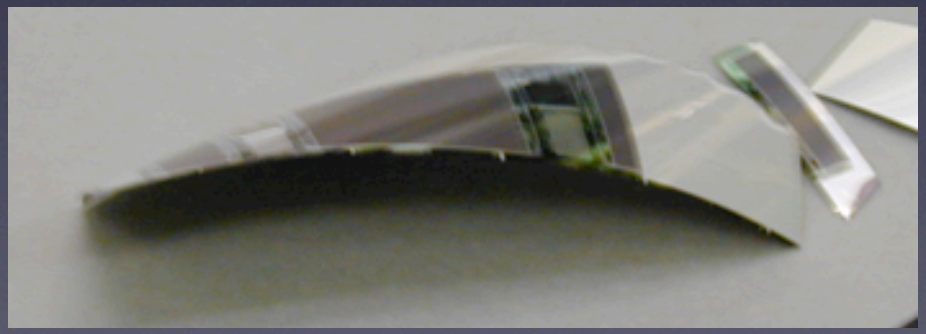
Support Options

Material target equivalent to 100 µm silicon

- Thinning silicon to 50-100 µm becoming routine
- Thinning to epitaxial possible

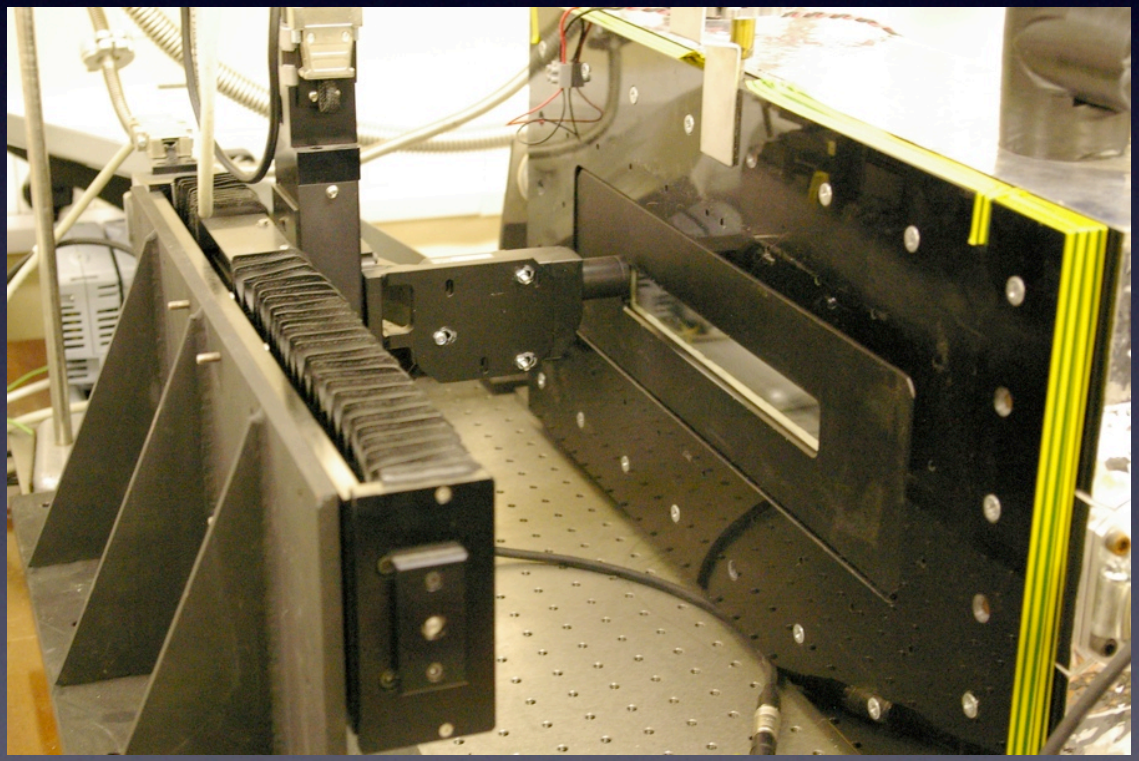
- *Ladders with bulkheads*

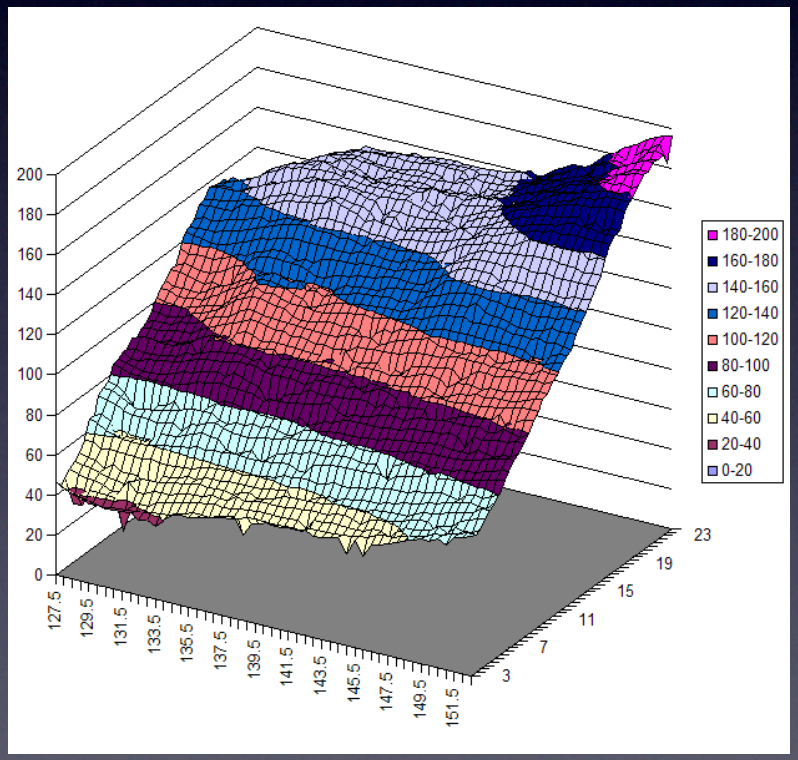
1. Unsupported silicon
   - can't control lateral curl
2. Laterally stiffened silicon
3. Rigid structures



Metrology

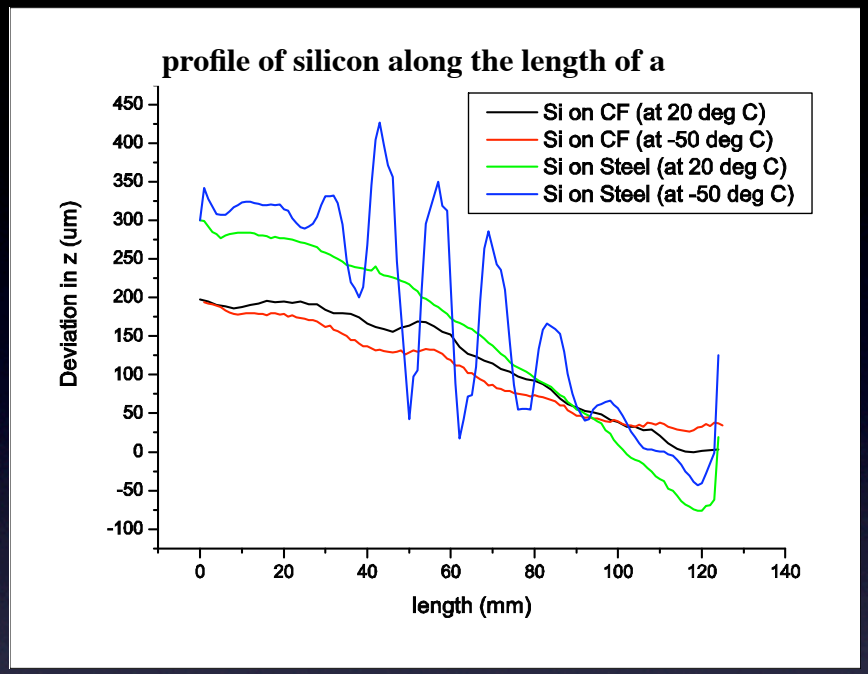
- 2D scanning system based on Keyence LK-3010M
- Gas-cooled cryostat capable of ~180K

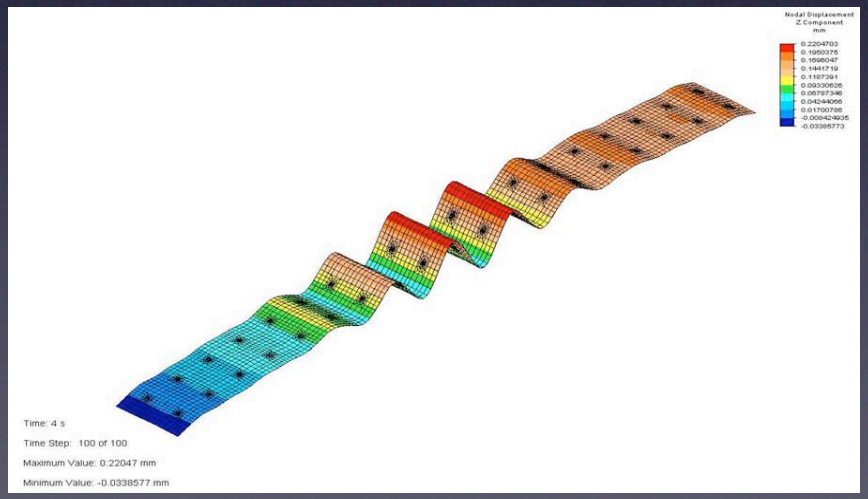




Thin Substrates

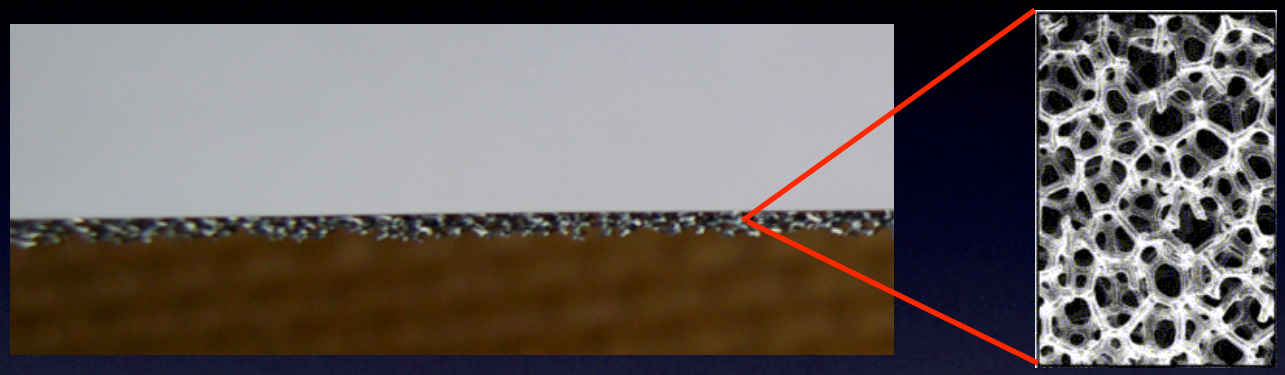
- Tensioned along length
- Lateral stiffness from substrate
  - Beryllium: stiff, but bad CTE
  - Diamond, SiC, etc....
  - Carbon fibre most promising
    - 0.09% X_0 test model
    - laterally stability insufficient



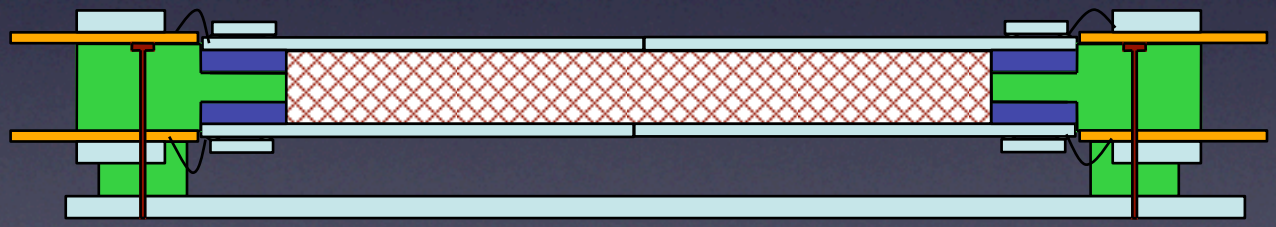


Foam Ladders

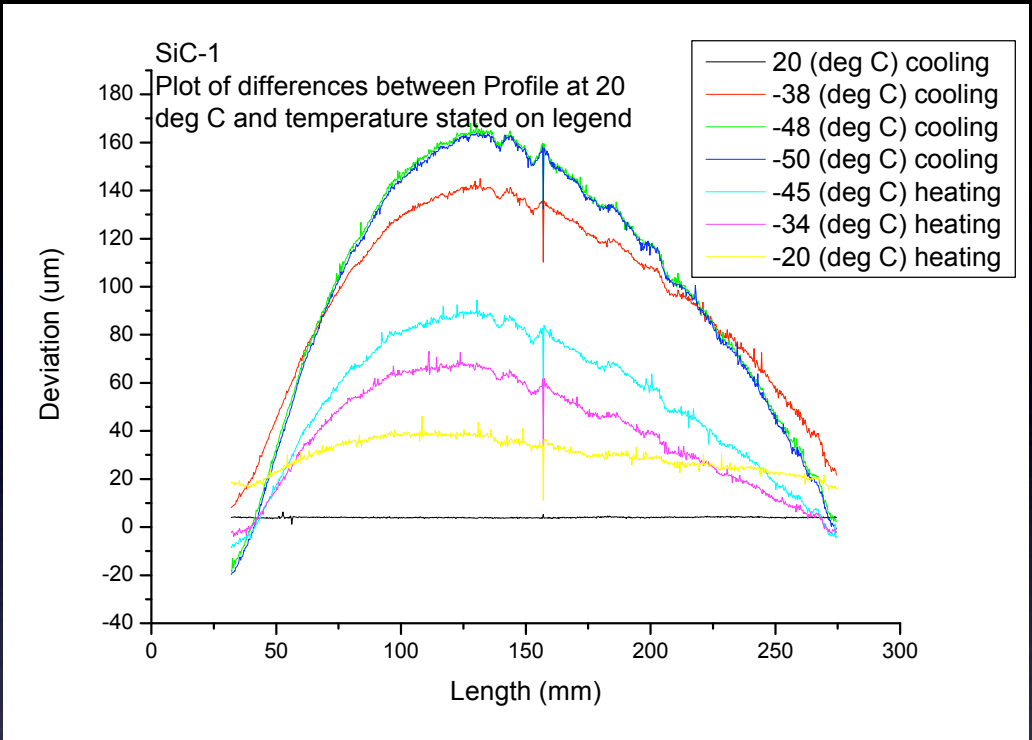
- 25 micron silicon on 1.5mm 8% SiC
  - Very rigid
  - Achieved 0.14% X_0



- 20 micron silicon sandwiching 1.5mm 2% carbon
  - Could be double-sided
  - Achieved 0.07% X_0

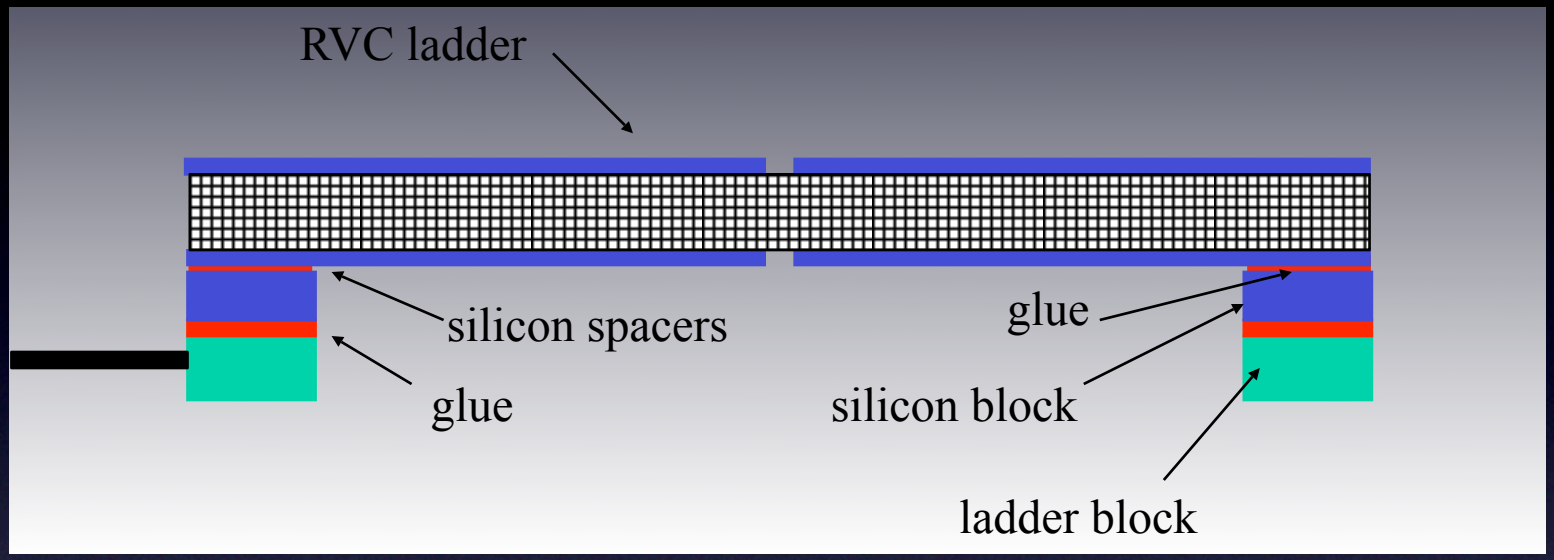


Silicon Carbide

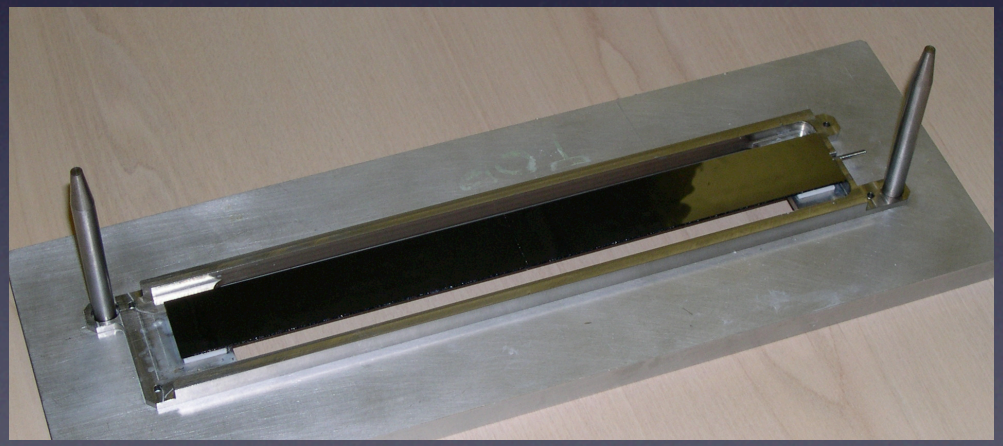


- Samples of 8% and 6% relative density obtained
  - Lower density believed possible
  - Processing and measuring techniques being investigated

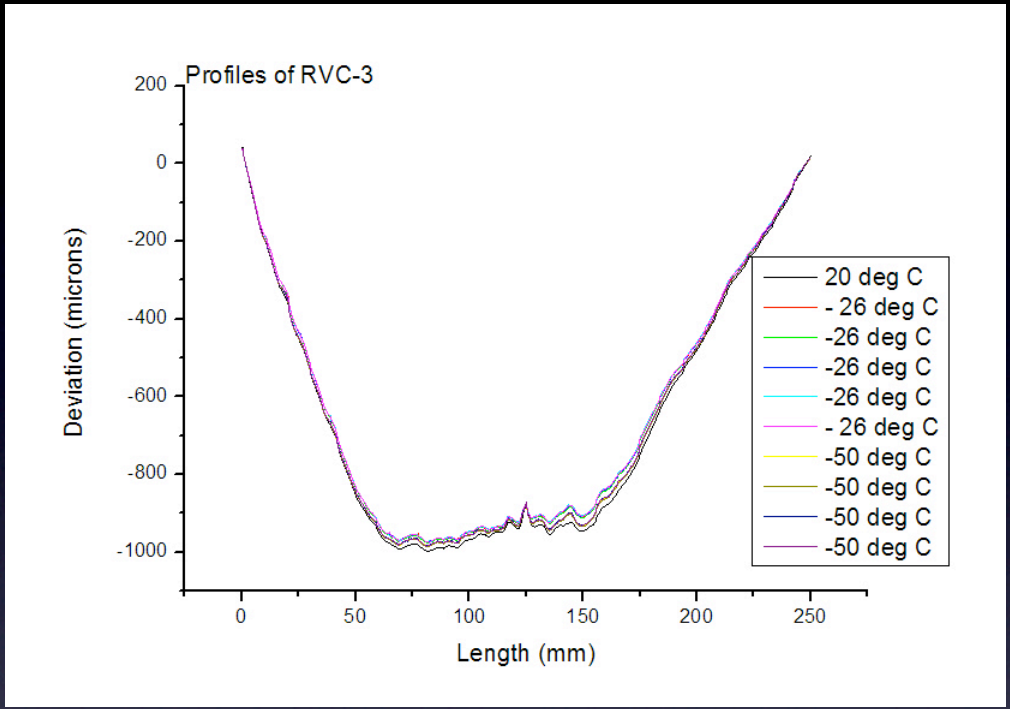
RVC Foam

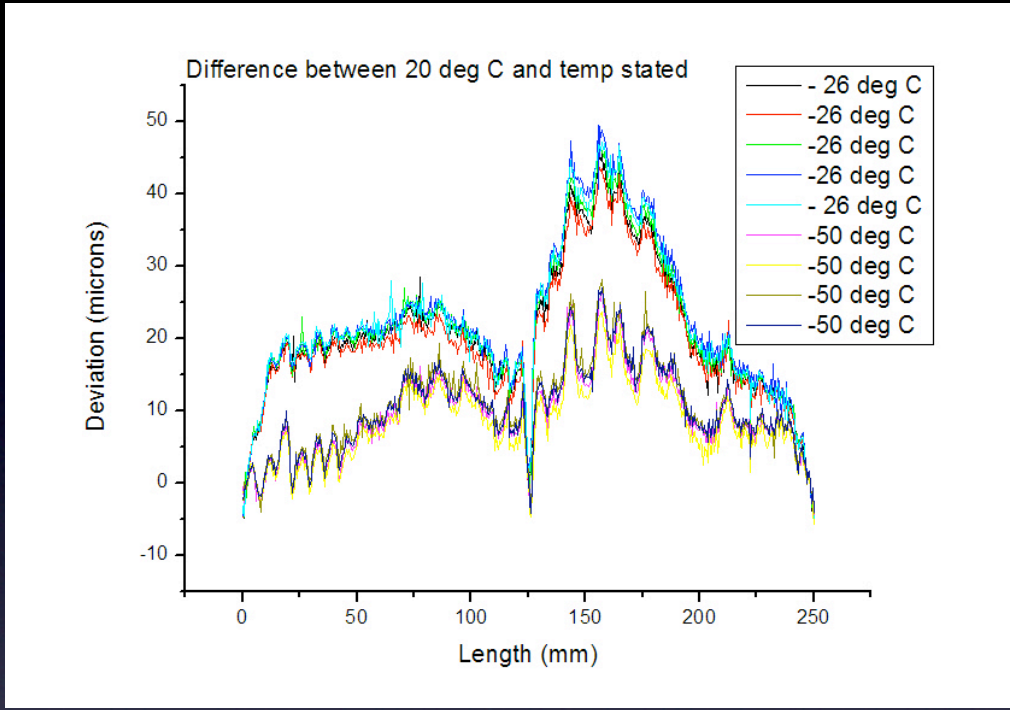


- Reticulated Vitreous Carbon
  - 2-3% relative density
  - Not stiff enough for one-sided



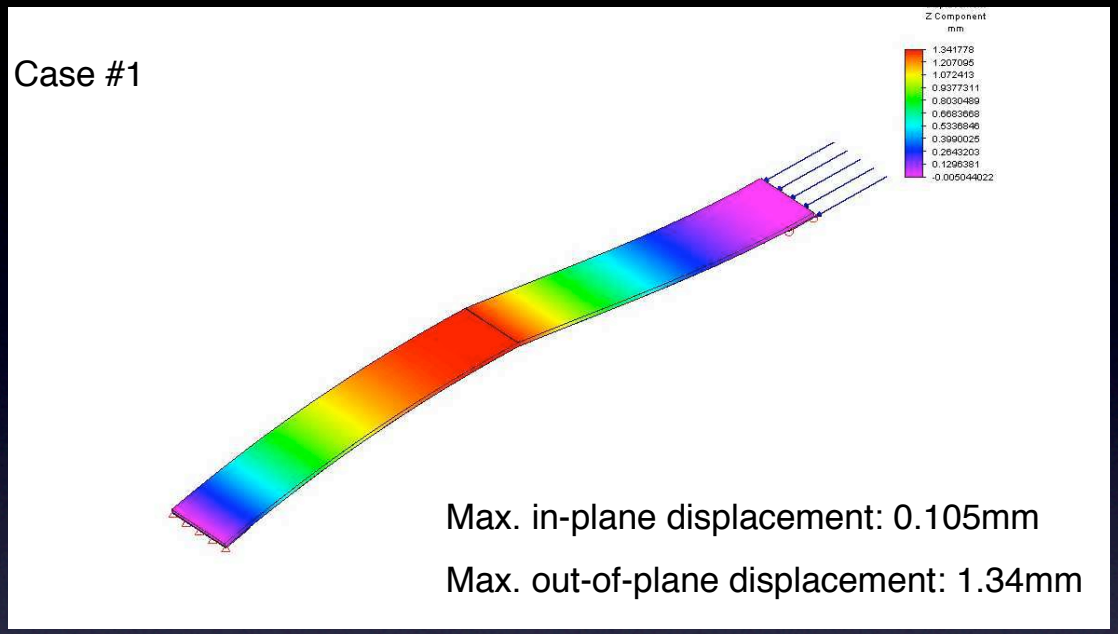
RVC Results



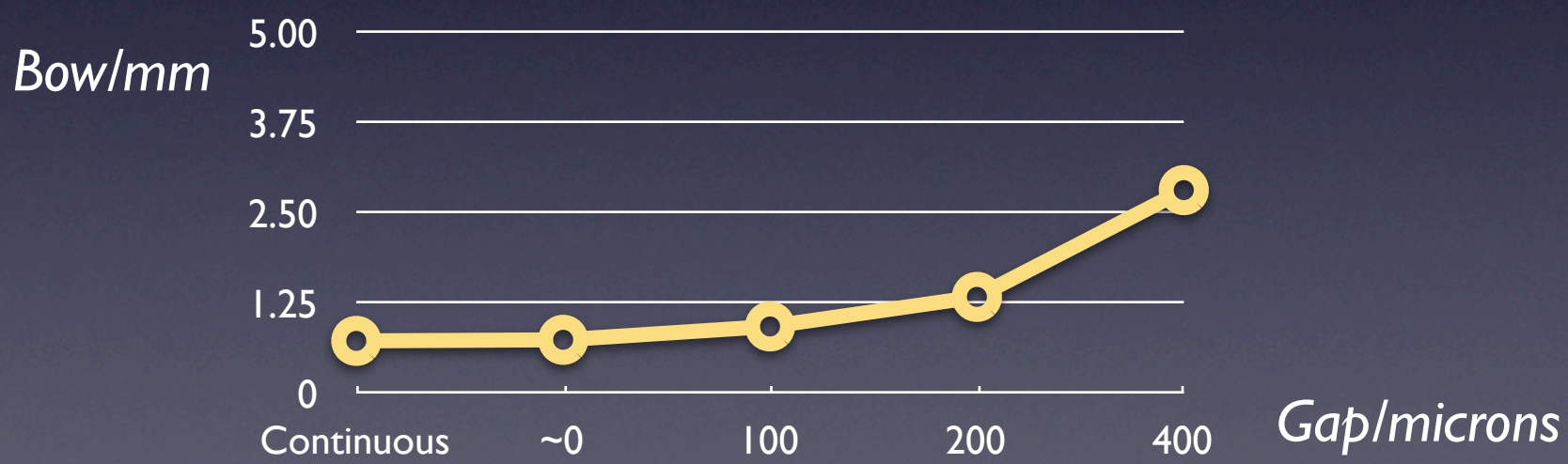


- Overall shape due to asymmetry in production
  - New fixturing being made
- "Rippling" believed to be an artefact

FEA Study of RVC

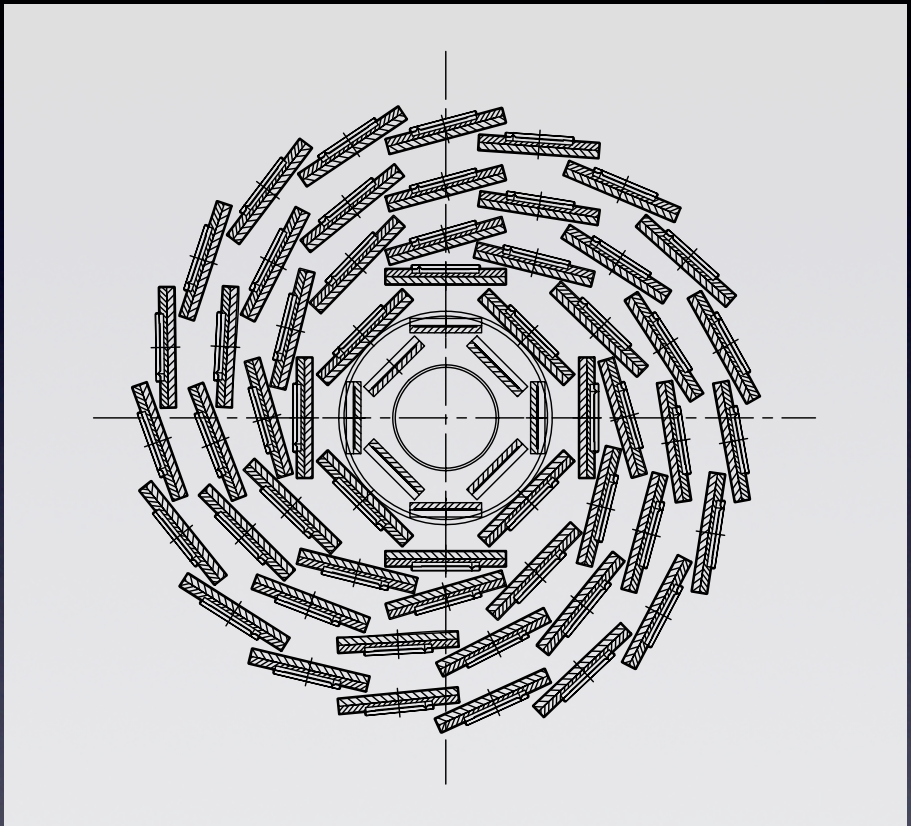


- Effect of gap size
  - 7.5N compression
  - 70 degree cooling



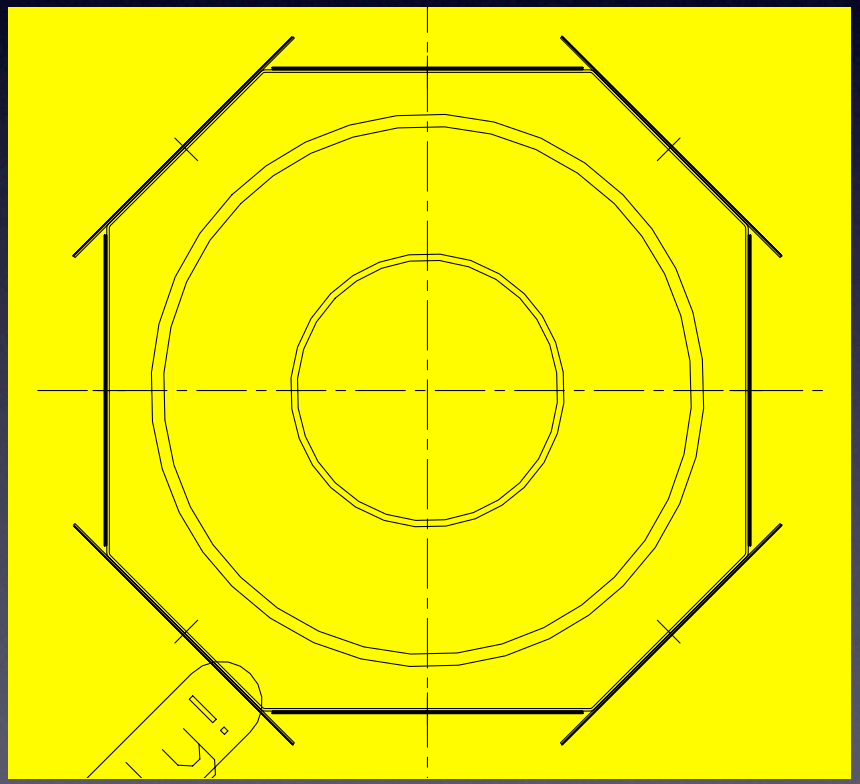
Conceptual Design

- Checking feasibility
- Thick foams not easy
  - Layers 1&2 crowded
  - Some sensors at large radii
    - Double-sided layers...?
    - CF shells...?
    - …



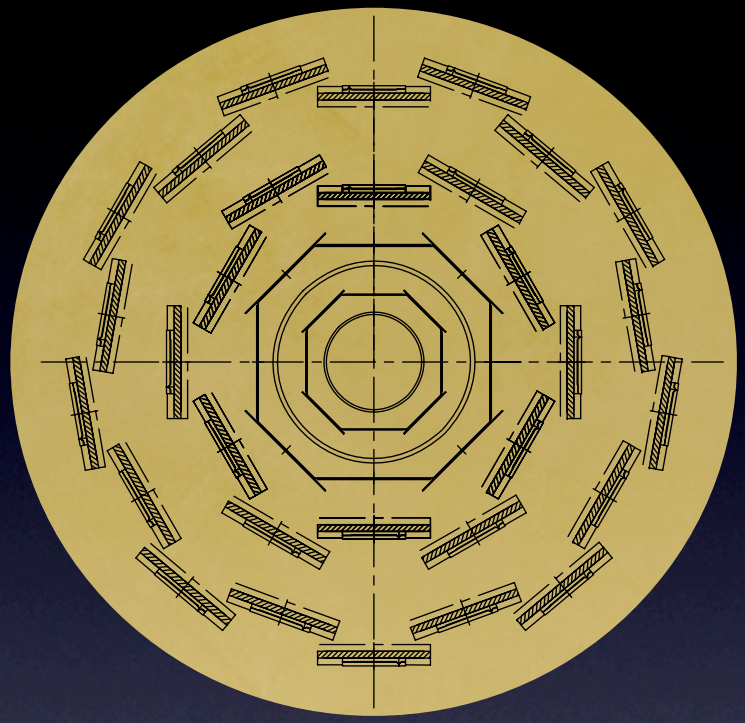
CF Shells

- CDF and DZero innermost silicon layers
- Prototyping 25cm long ILC structure



- 90°/10° uniaxial layup did not hold shape on release
- Trying 2D weave

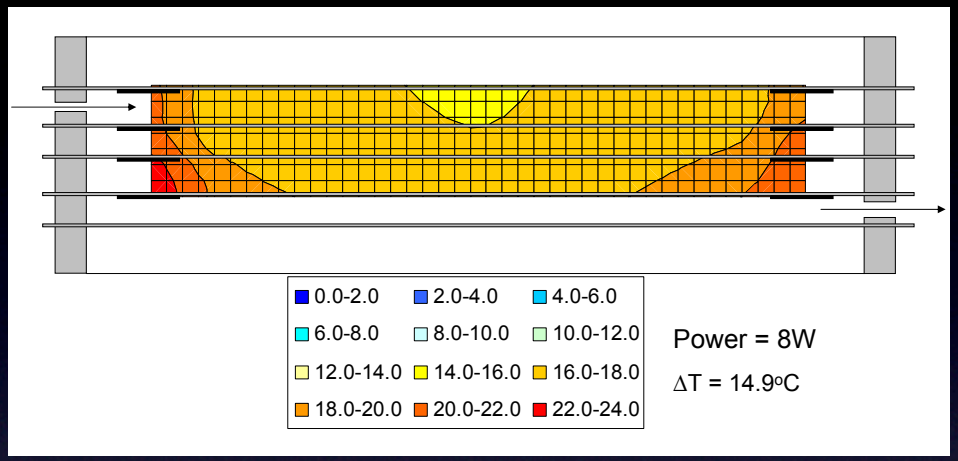
Other Concepts

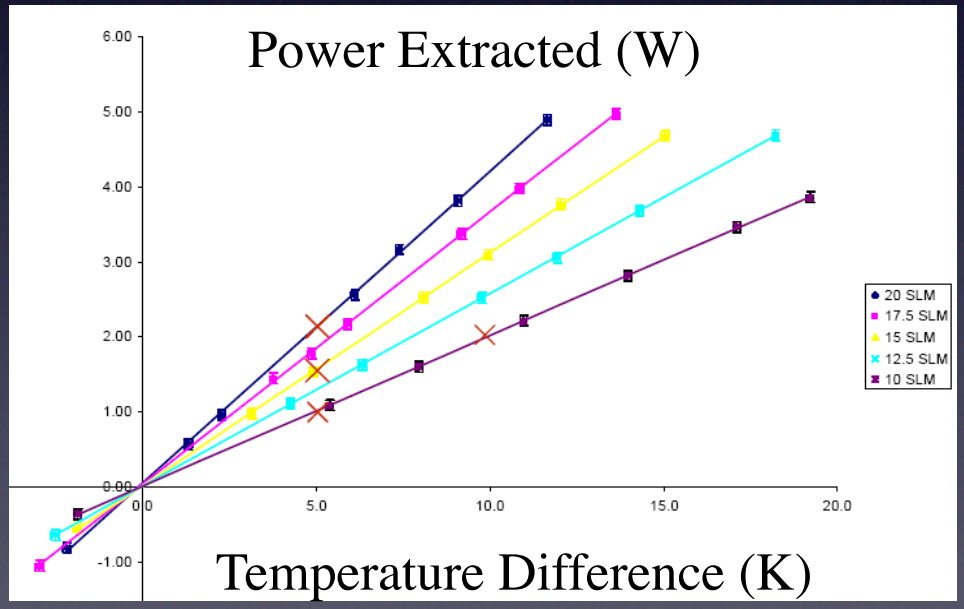


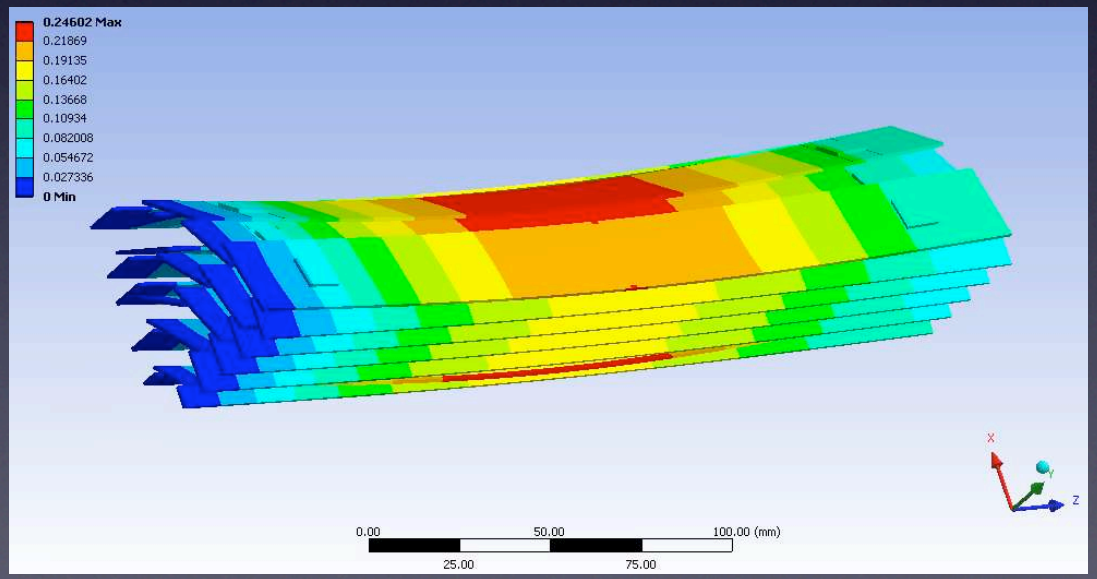
- Combine technology
  - e.g. 2 layers CF shell, 2 double-sided foam
- Complete foam structure
- …

Cooling Studies

- Model of 1/4 barrel
  - 30W equivalent
  - ~0.2 m/s average flow
- Calibrating CFD and FSI tools







The Next Steps

- Prototypes of RVC, SiC Ladders
  - Closer to real ladders
  - Detailed tests of production, robustness...
- Evaluate shells and other alternates
  - Collaboration with other groups
- Begin to explore I&I issues
  - Metrology/alignment/monitoring/...
- Build for the future
  - ***Full engineering designs***
  - ***Realistic ladders in test beams***

LCFI Summary

- Strong involvement in algorithms and physics studies
  - ✓ *State of the art vertexing package released*
- Column Parallel CCDs perform well at 20 MHz with custom clock driver CPD1
  - ✓ *Run at 45 MHz with transformer drive*
- CPCCD readout chip CPR2 runs at 9 MHz
  - ✓ *Improved version CPR2A ready soon*
- Have proof of principle for ISIS and actively looking for vendors for next generation ISIS2
- Actively exploring various mechanical solutions based on foams and thin silicon
- Ready to demonstrate a full scale ladder prototype in the next funding cycle