Vertex Detector Mechanics

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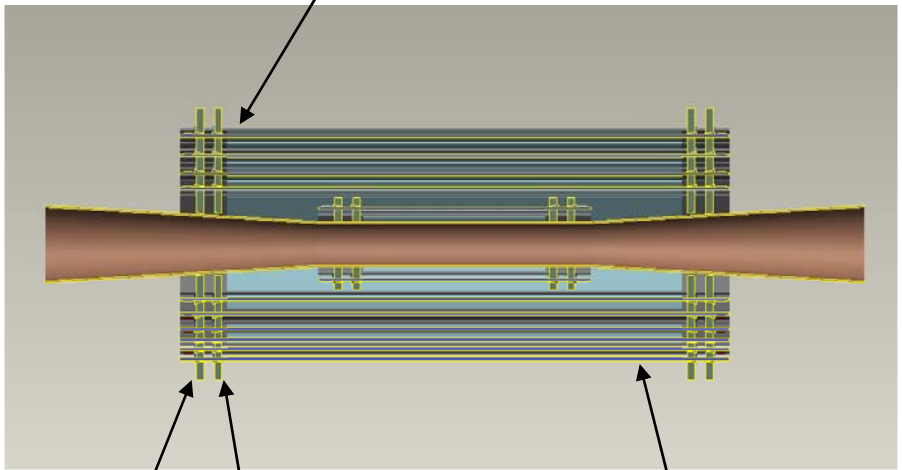
Introduction

- Vertex detector mechanical efforts have been in process for several years in the UK, continental Europe, Asia, and the United States.
- Prior to funding reductions at the end of 2007, Joel Goldstein and I led meetings to develop designs for a low-mass, highly-stable vertex detector support system.
  - The meetings included contributions from each of the three major ILC regions (Europe, Asia, the United States).
  - Since then, efforts have been directed towards generic designs.
  - Though progress has continued, it has been slower.
- R&D results have been presented at a variety of conferences, workshops, and reviews.
- The goals are a material budget not to exceed 0.1% of a radiation length per layer at normal incidence and a sensor location stability in each coordinate ~ 1 μm.
- Sensor operating temperature depends upon the sensor technology that will be used in the end.
  - Initial studies assumed -10^{o}C.
  - More recent studies have sought stability to -80^{o}C.
  - A reasonable compromise may be -40^{o}C.

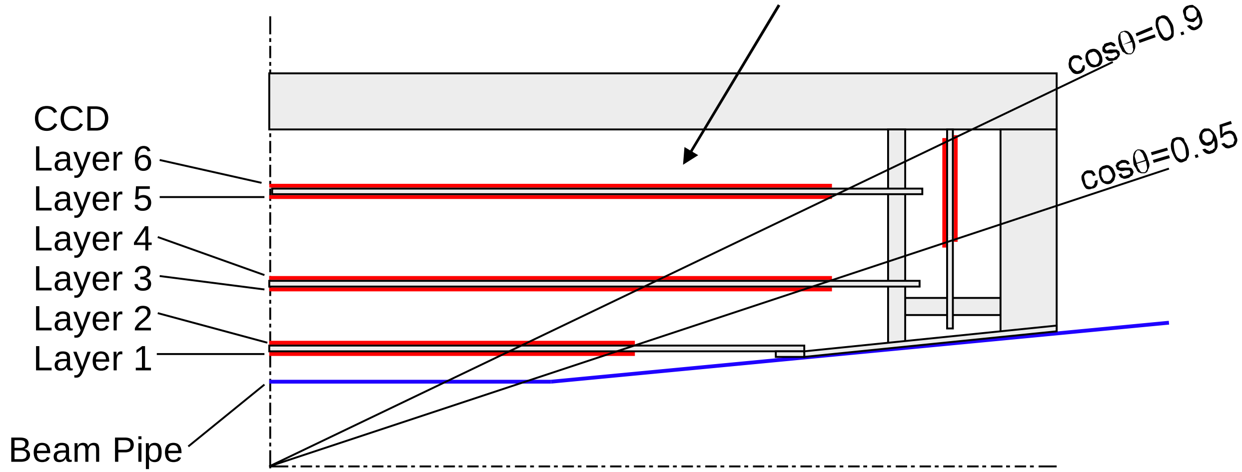
Design Varieties with Long Ladders

- LCFI



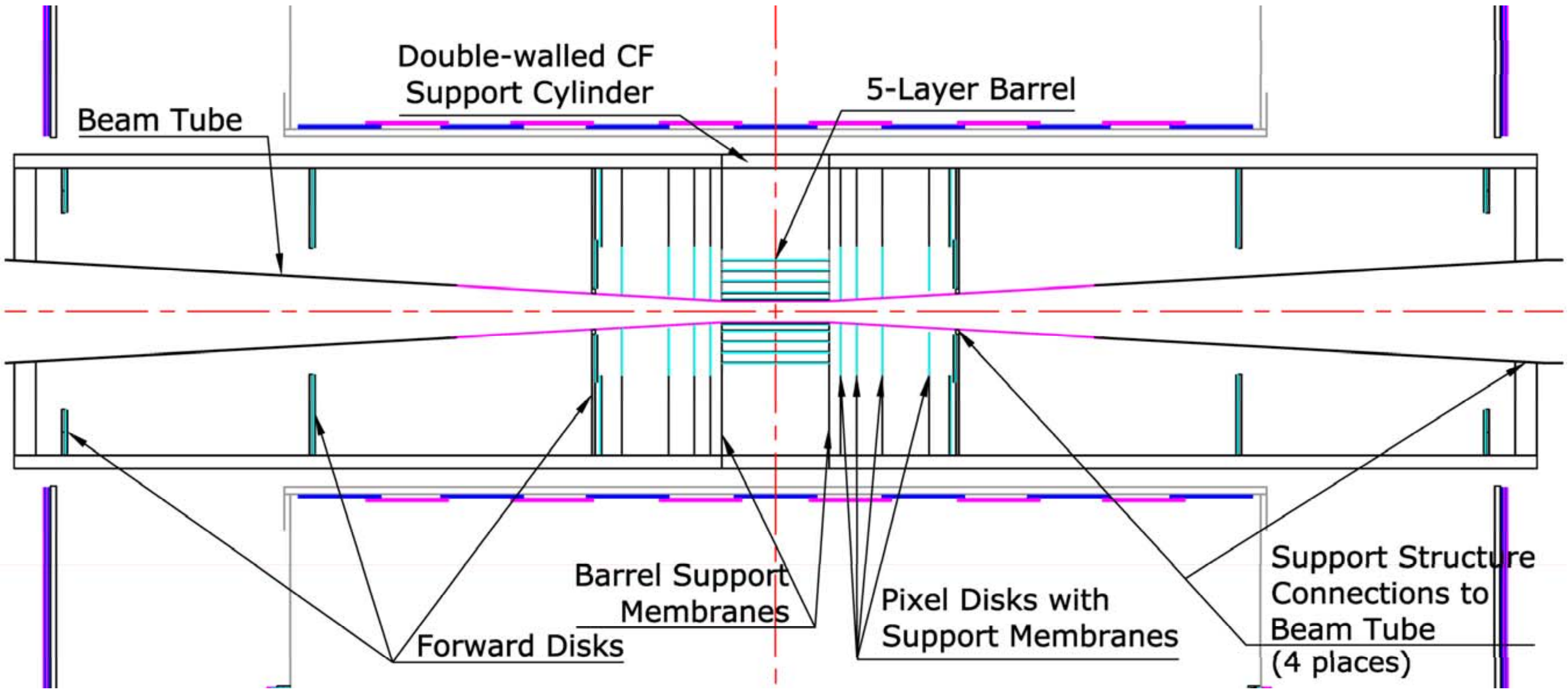
- Both approaches include interesting ladder features and assume foam is used as a structural element.
- Length of longest ladders ~ 240 to 250 mm

- KEK



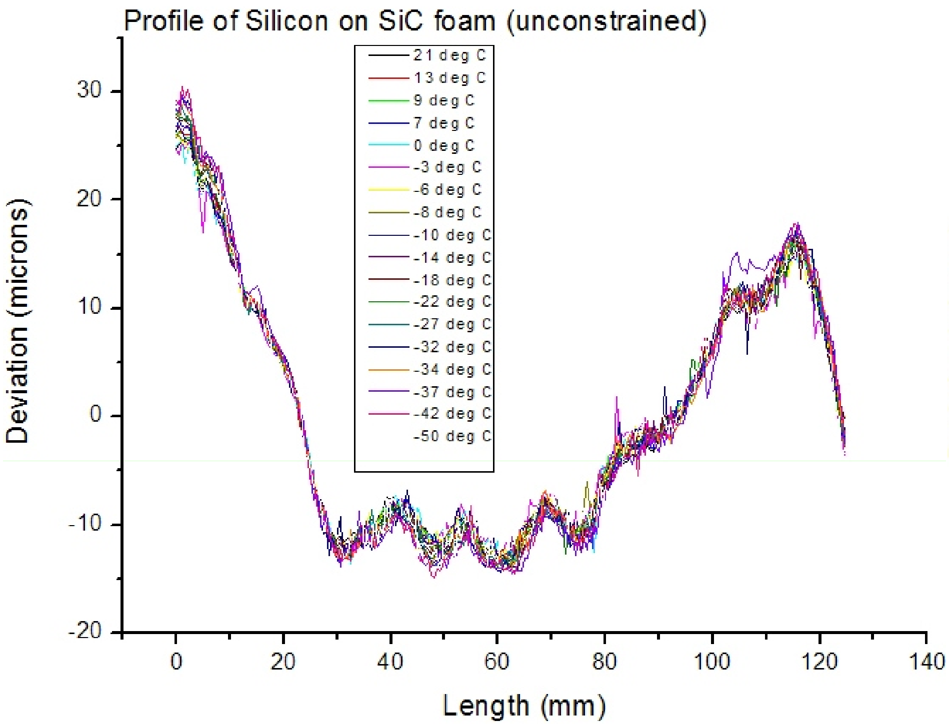
Design with short Ladders plus Disks (SiD)

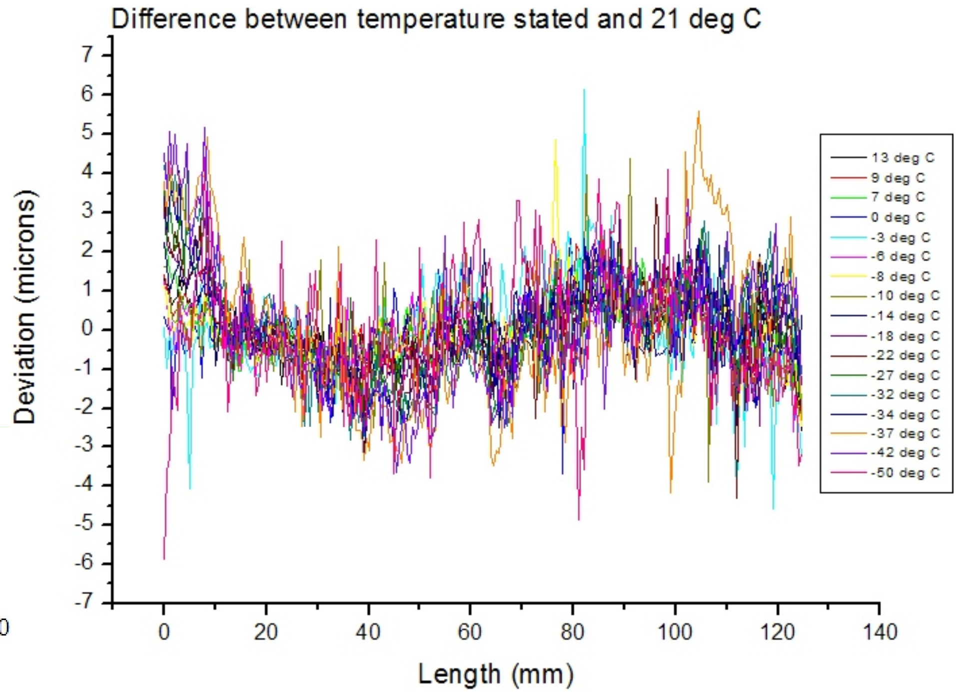
- Barrel length ~ 125 mm
- Innermost silicon at a radius of 14 mm



CTE Mismatch

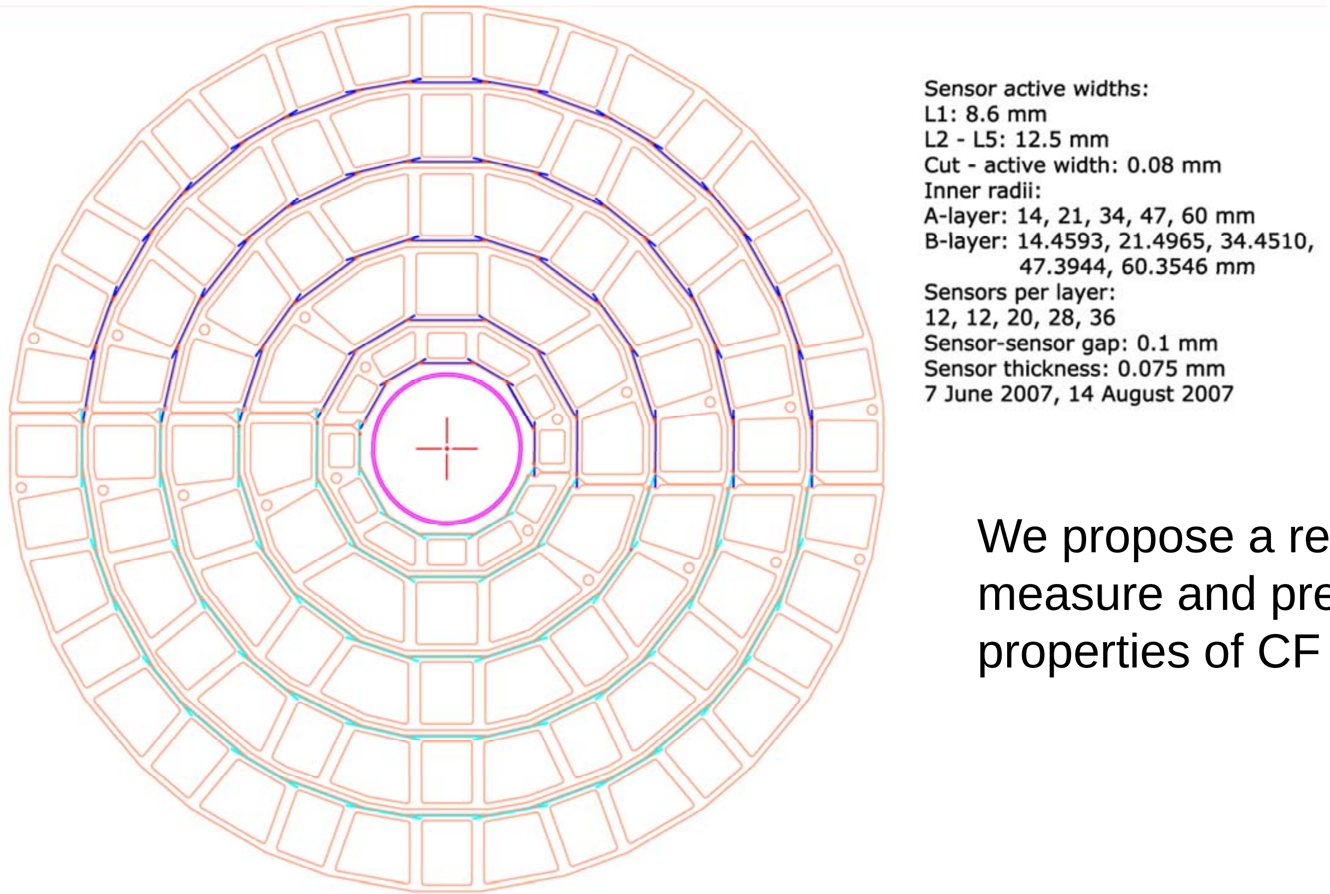
- Two general approaches offer promise of stability to low temperatures.
- Support from silicon-based foam structures with CTE close to that of silicon.
  - Good progress within LCFI
  - Initial studies at LBNL have been slowed by reduced funding.





CTE Mismatch

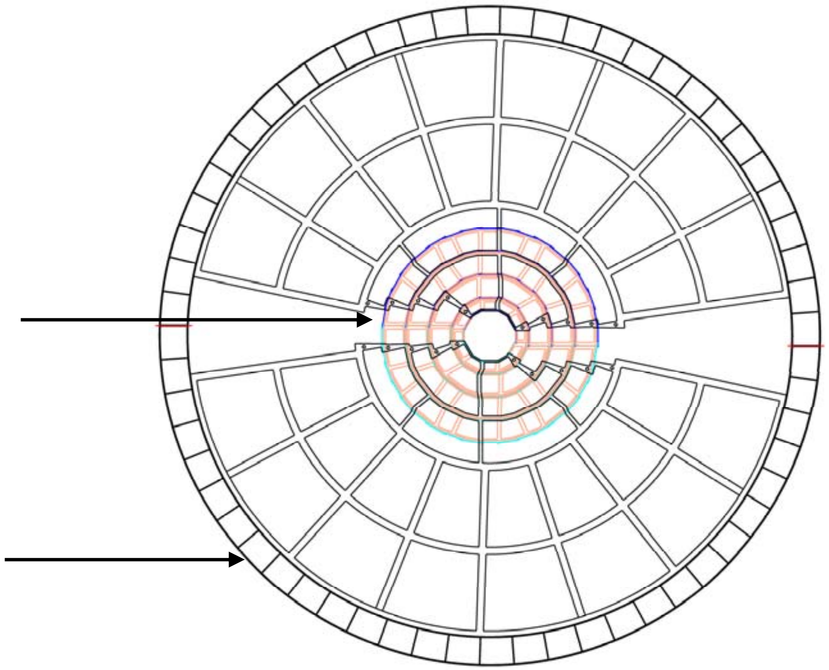
- "All-silicon" barrel of length 125 mm
  - Acceptable results from FEA by LCFI and by U. Washington for $10^{o}C$ temperature change (smaller change than desired)
  - End rings were assumed to be CF laminate.



We propose a renewed effort to measure and predict the properties of CF laminate.

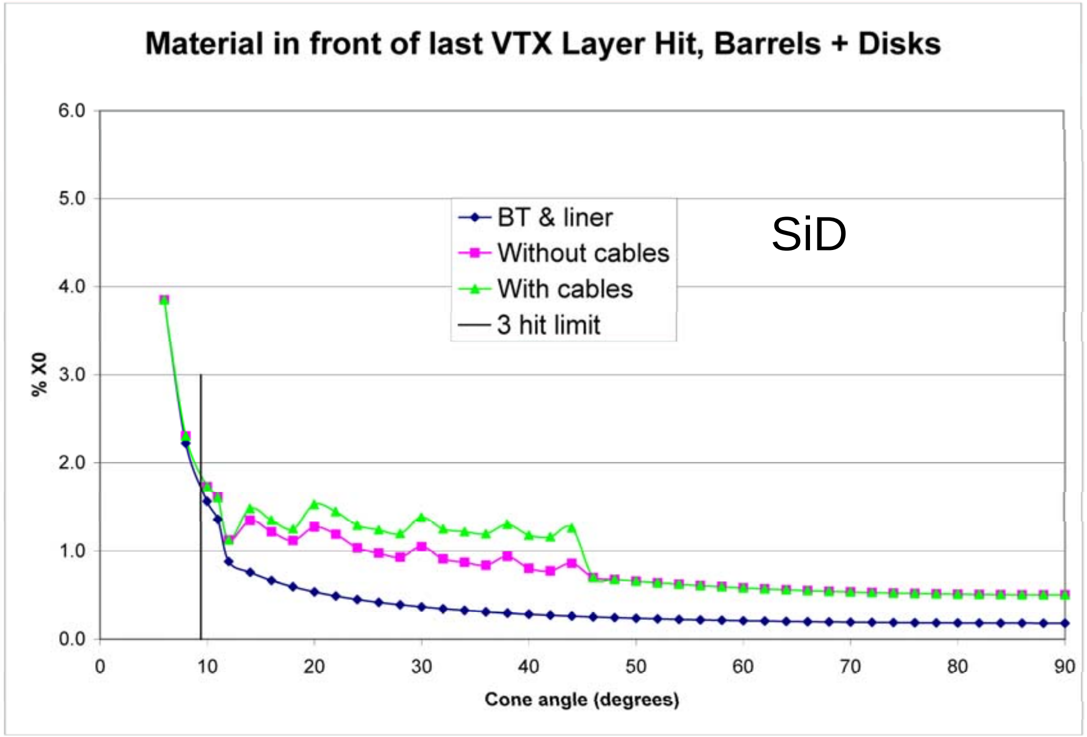
CTE Issues

- Silicon-based foams of sufficiently low density have been difficult to obtain.
  - They have also been difficult to machine without fracture.
- CF laminates have shown more thermal distortion than we would like.
- Even with perfectly matched CTE’s within a barrel, support is likely to be necessary from a more robust external structure with a different CTE.
  - Properly oriented leaf springs or equivalent should help.



Cabling, Power Distribution, Vibration

- All of these are serious issues.
- Cabling contributes significantly to the material budget.
  - Part of that arises from the power requirements of sensors and the need to limit IR losses in cables.
  - Either DC-DC conversion or serial powering are likely to be necessary to obtain an acceptable conductor thickness.
- Hence the interest in power distribution.
- Pulsed power in ILC designs, coupled with forces and moments from the solenoidal field, may lead to vibration.
  - To address that, power cables with three conductor layers (return – supply – return or equivalent) have been suggested.



In Conclusion

- We understand a variety of mechanical R&D topics that should be pursued.
- Areas of interest include:
  - CTE matching and accommodation
  - Cabling and power distribution
  - Minimization of material
  - Prototyping and tooling to demonstrate precise fabrication
  - Heat removal
  - Hermeticity and acceptance
  - Integration with outer tracker and forward detectors
  - Beam pipe design and support
- Thank you!