



Vertex Detector Mechanics

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Mechanical Challenges

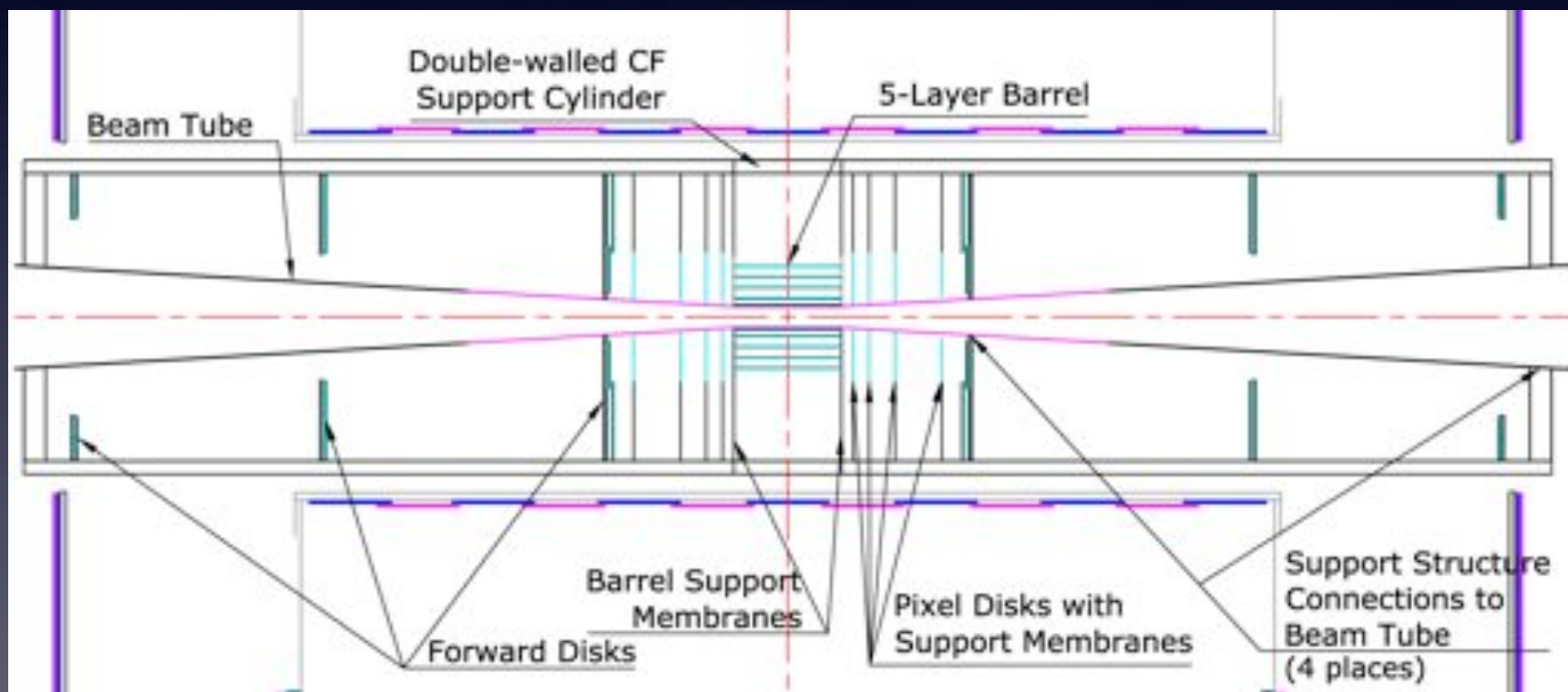


- Measure 3D space points to a few microns
 - ▶ Precise and stable construction
 - ▶ Minimal/predictable thermal behaviour
- Reduce multiple scattering and secondaries
 - ▶ Target 0.1% X_0 per layer
 - ▶ Gas cooling
- Not compromise other subdetectors
 - ▶ Minimal external/forward material
- Buildable, robust...
- Dependent on sensor technology



Baseline

- 5 concentric 12.5 cm barrels
- Pixel & forward disks
- Thinned silicon sensors attached to carbon fibre





Silicon

Material target equivalent to 100 μm silicon

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

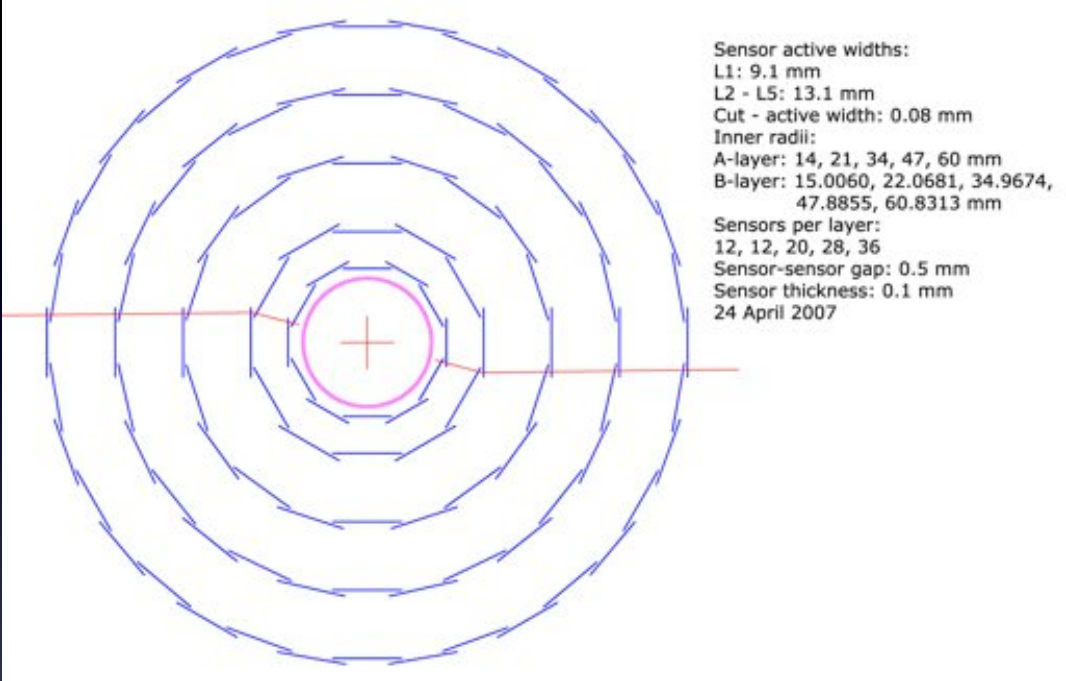


- Need to:

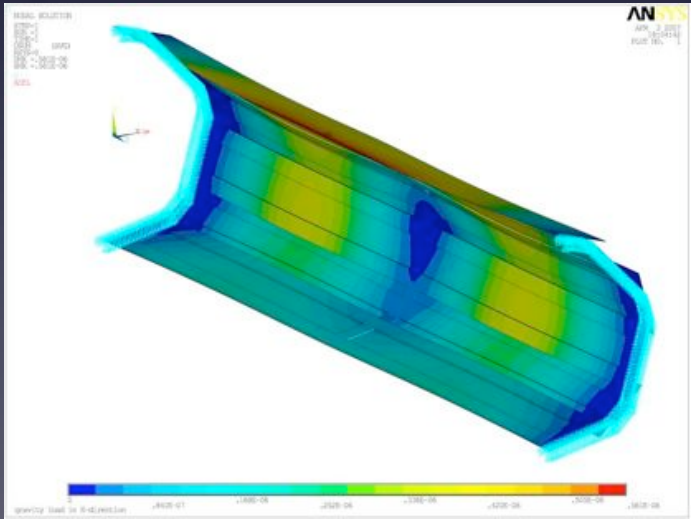
- ▶ Control intrinsic behaviour
- ▶ Minimise differential contraction



Barrel

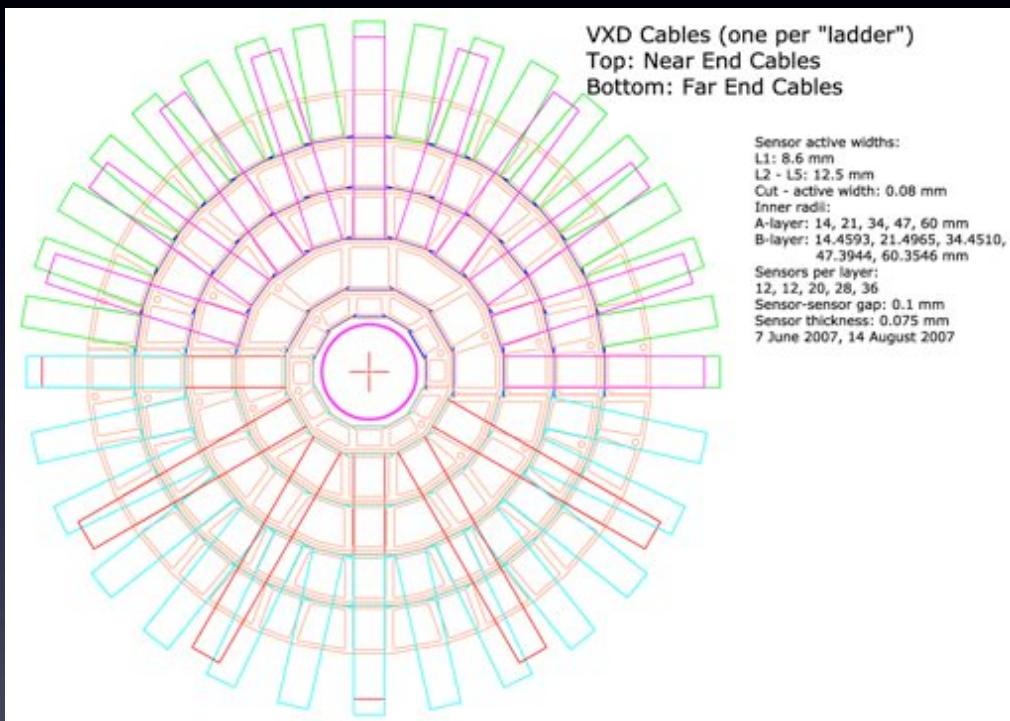


- Substrate built as carbon fibre half shells
- Studied by FEA and prototype





Barrel Cables



- Cables becoming critical
 - ▶ Stress on detector elements
 - ▶ Mass in front of forward disks
 - Need serial power



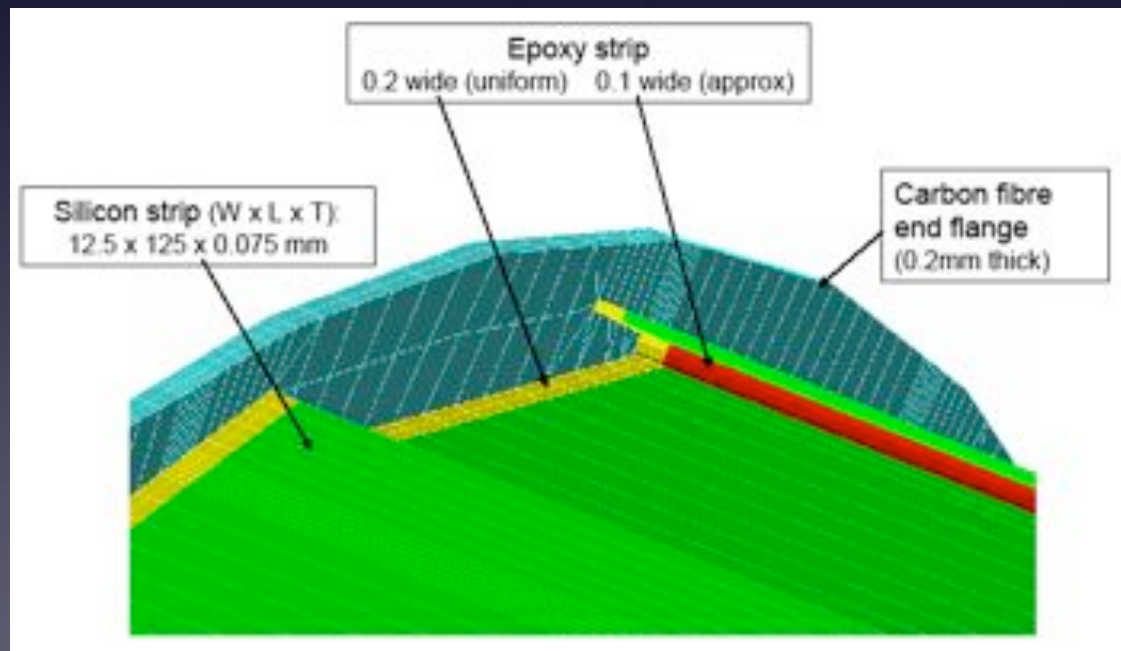
Alternatives

- Several promising alternatives for barrel:
 - ▶ All-silicon shell structure
 - 100 μm thick sensor glued into barrel shape
 - Eliminates sensor/substrate CTE problem
 - ▶ Integral foam structure
 - Promising results with ladder structures
 - Inspired to explore all-SiC vertex detector



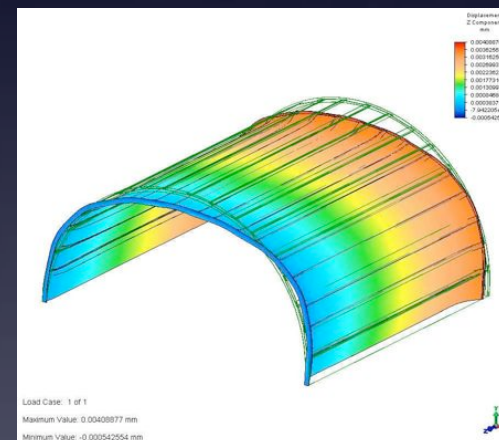
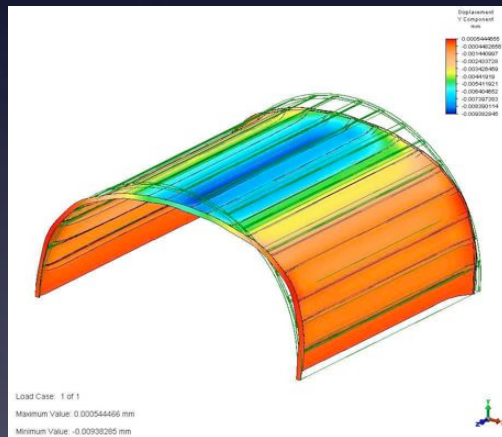
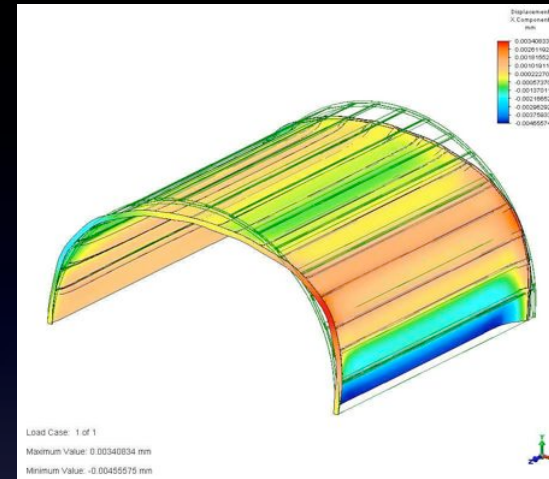
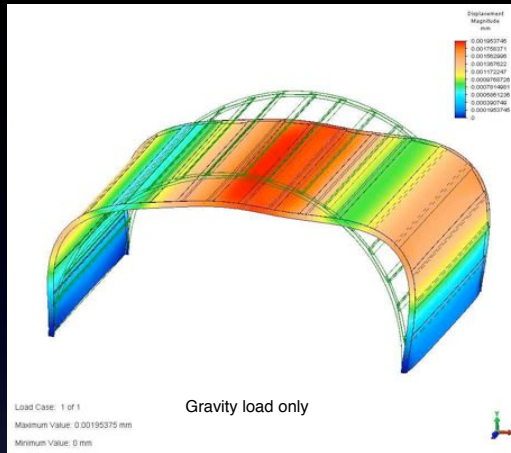
All-Silicon

- Prototyped at FNAL
- FEA work at Washington and Oxford
 - ▶ Thermal effects due to glue/CF flange





All-Silicon FEA



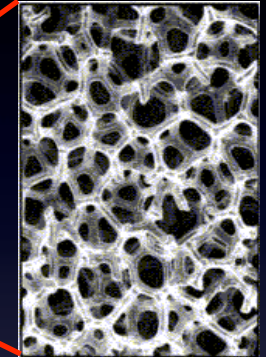
- Thermal deviations $< 10 \mu\text{m}$ for 10°C
- Cable stress will be crucial



Foam Ladders

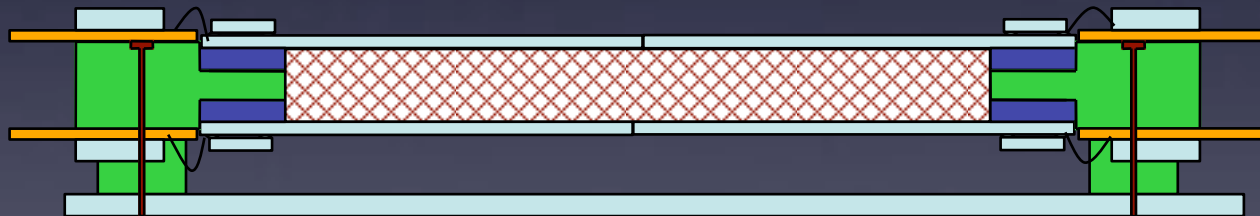
- 25 micron silicon on 1.5mm 8% SiC

- ▶ Very rigid
- ▶ Achieved 0.14% X_0



- 20 micron silicon sandwiching 1.5mm 2% carbon

- ▶ Could be double-sided
- ▶ Achieved 0.07% X_0

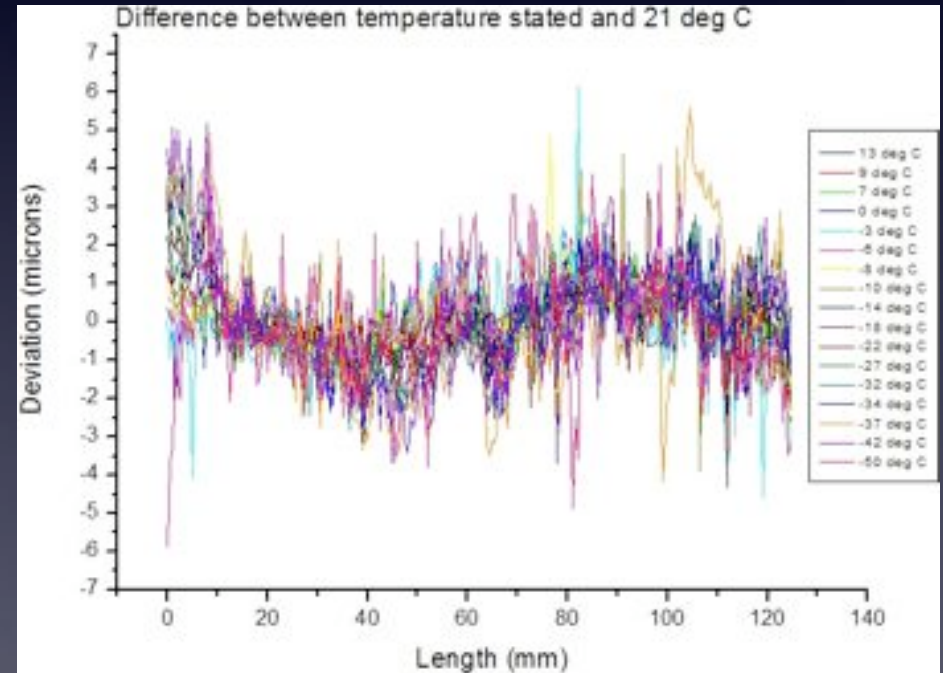
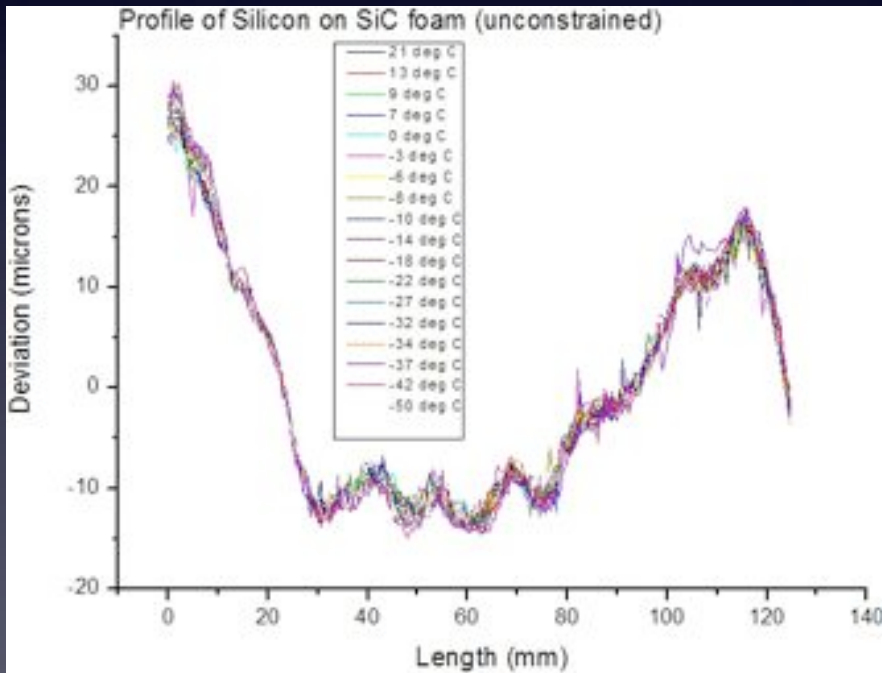




SiC Foam Results



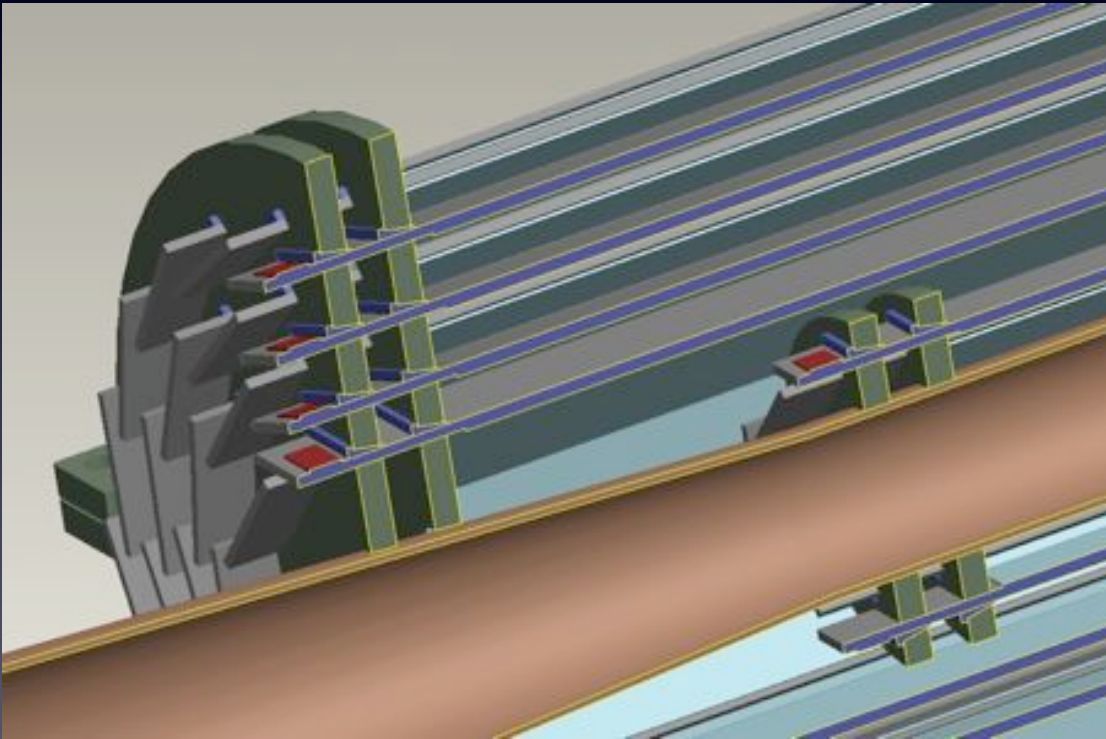
- SiC Foam substrate ladder cooled
- Negligible thermal distortion over 70°C





Integral Foam VXD

- Conceptual design of all-SiC structure
 - ▶ Differential CTE moved to beam-pipe joint



- Need to develop:
 - ▶ SiC foam engineering
 - ▶ Lower density foams



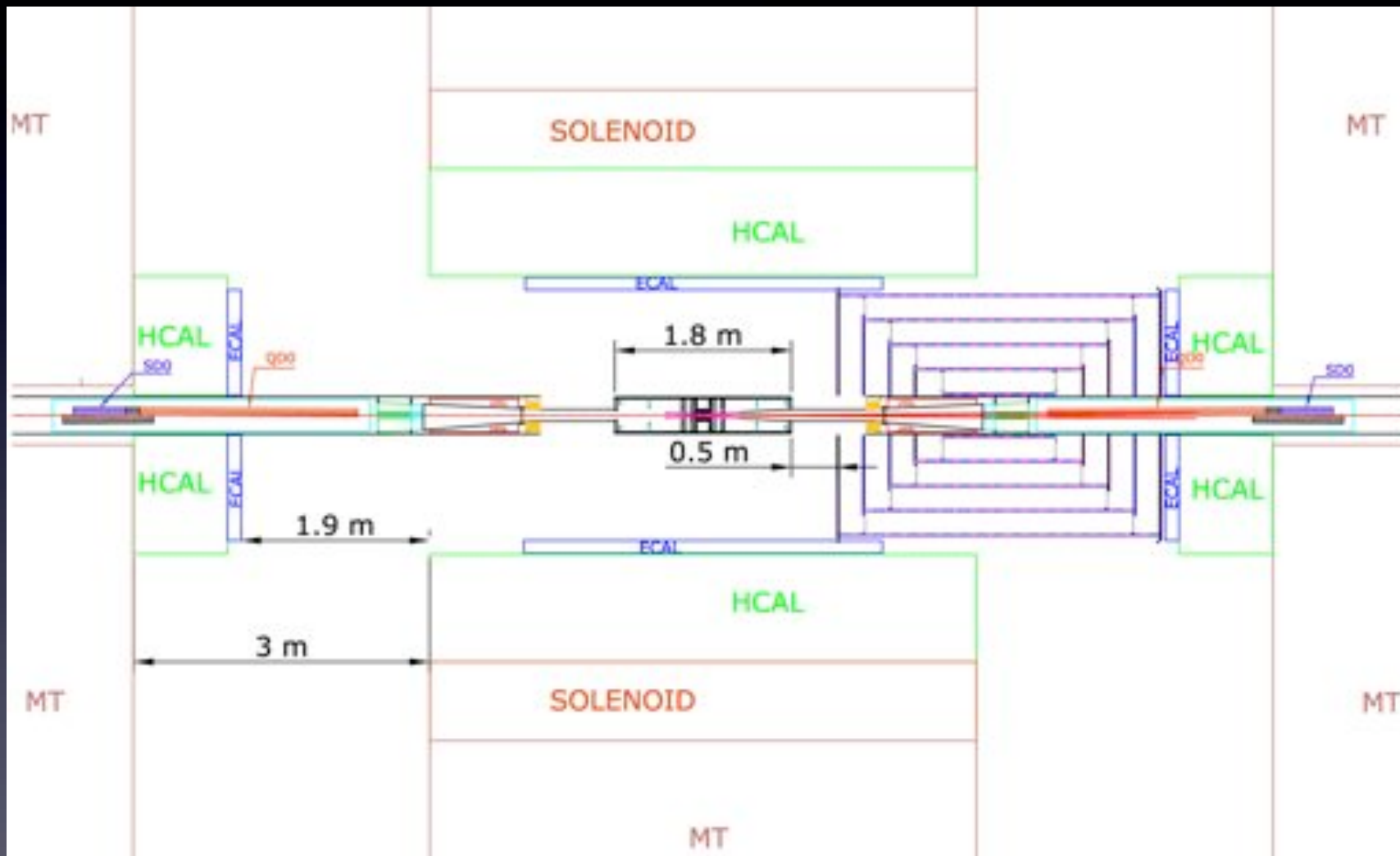
Hot Topics



- Support cylinder
 - ▶ Prototype planned at FNAL
- Endcaps
 - ▶ Sensor design and layout under discussion
- Inner/outer transition
 - ▶ Assumed to be 20 cm; 30 cm suggested



VXD Access





Summary



- Mechanical constraints challenging
- CF shell baseline
 - ▶ New alternatives appearing
- U.S. and U.K. efforts hit by funding crises
- Serious effort still continuing