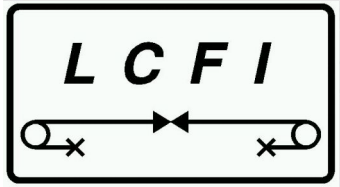


LCFI Mechanical Studies

A Vertex Detector for the ILC

Ringberg, 2006

Joel Goldstein

CCLRC Rutherford Appleton Laboratory

For the LCFI Collaboration

Outline

1. **Thin Ladders ~ *0.1% X_0***
   - **Materials and designs for ΔT ≈ 70K**
   - **Uniform material in tracking volume**
   - ***CCDs routinely thinned to epitaxial layer***
2. **Cooling**
   - **Check gas cooling capability**
3. **Status and Plans**

Mechanical Options

Target of ~0.1% X_0 per layer

(100μm silicon equivalent)

1. Unsupported Silicon

- Longitudinal tensioning provides stiffness
- No lateral stability
- Not believed to be promising

2. Thin Substrates

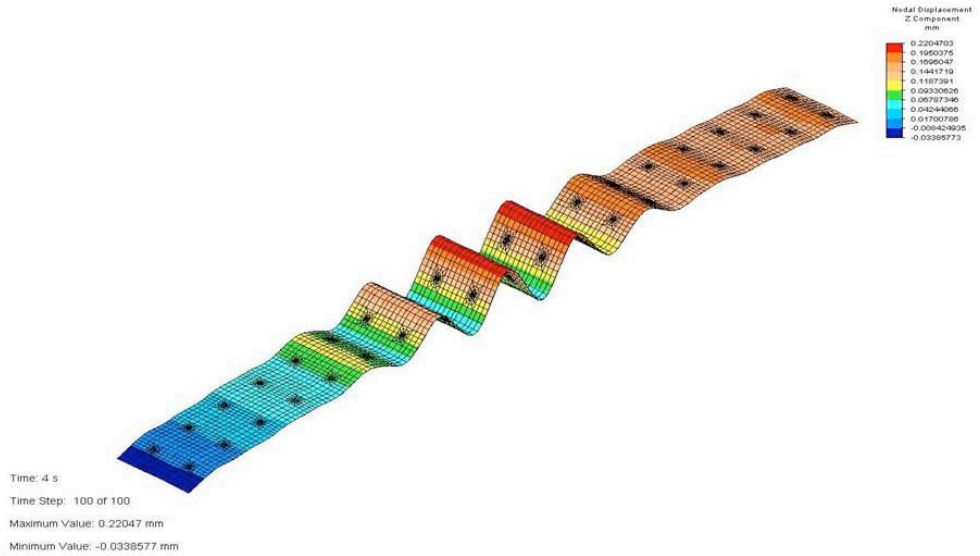
- Detector thinned to epitaxial layer (20μm)
- Silicon glued to low mass substrate for lateral stability
- Longitudinal stiffness still from tension

3. Rigid Structures

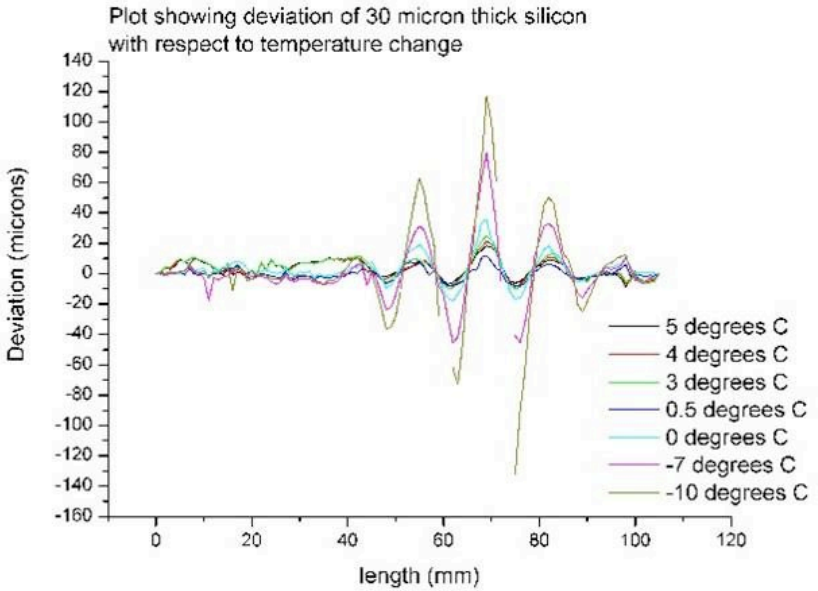
- No tensioning required

Mechanical Methods

FEA Simulations



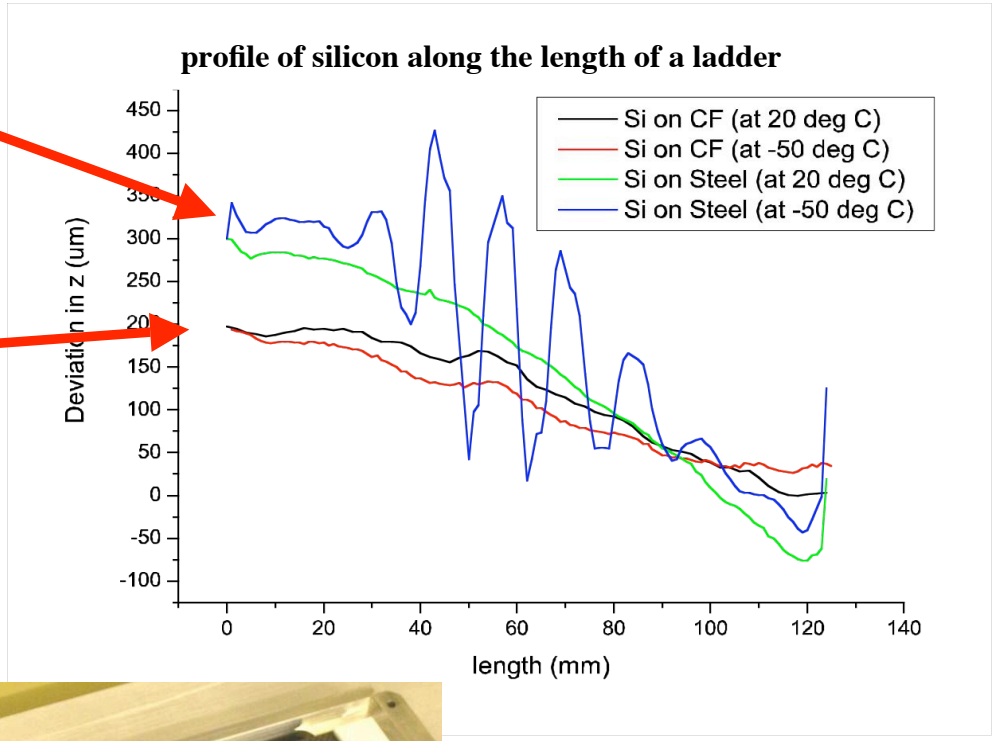
Physical Prototyping



- Laser survey system

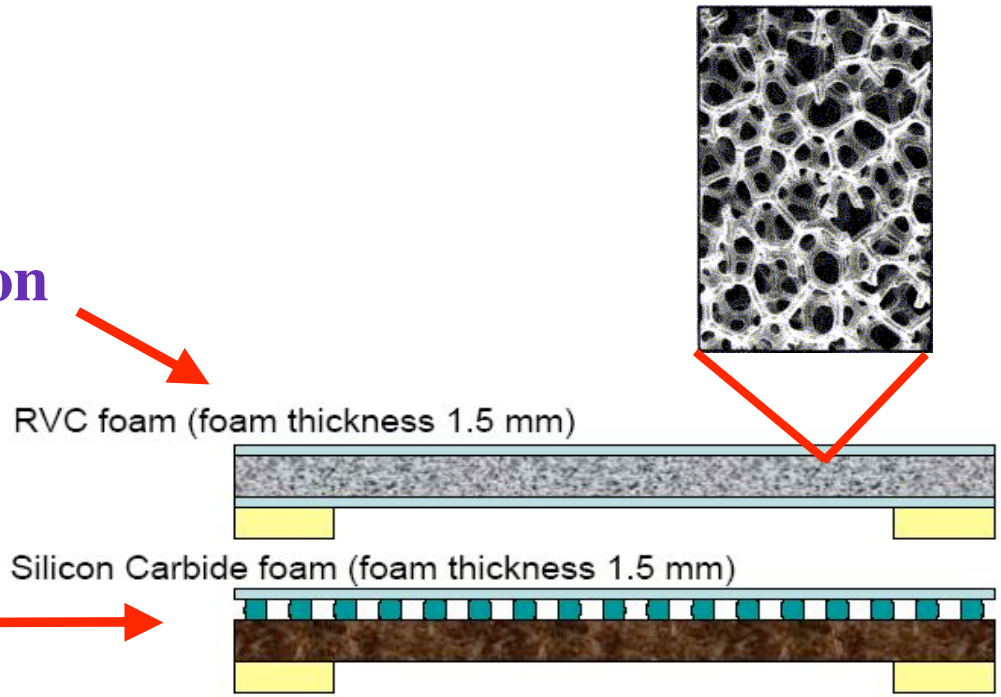
Thin Substrates

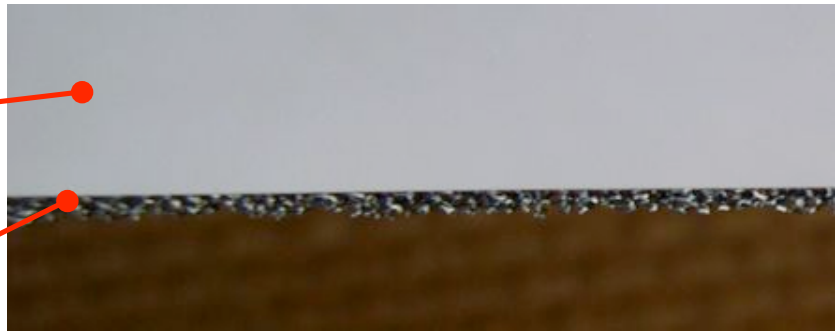
- **Beryllium**
  - CTE mismatch too large
- **Carbon fibre**
  - 0.09% X_0 prototype
- **Ceramics**
  - Fragile



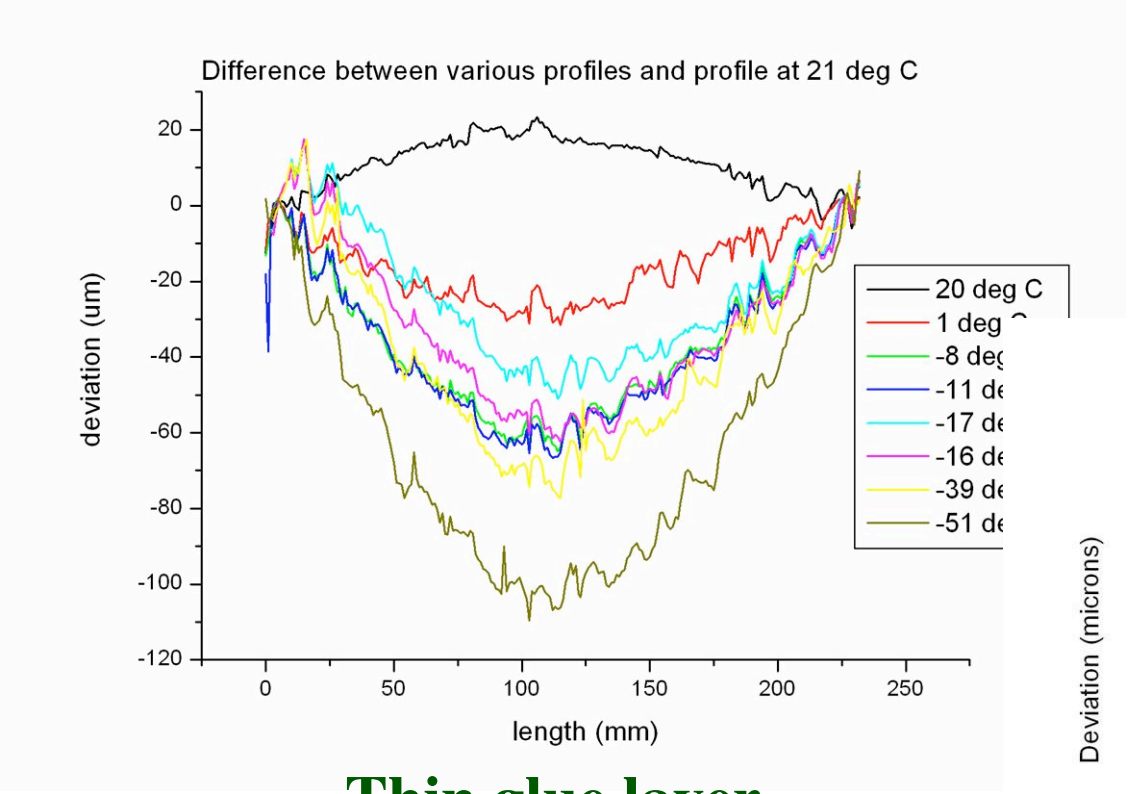
Rigid Structures: Foams

- 3% RVC Sandwich
  - 0.09% X_0
  - Working on glue application
- 8% Silicon Carbide
  - 0.14% X0
  - 3-4% believed possible



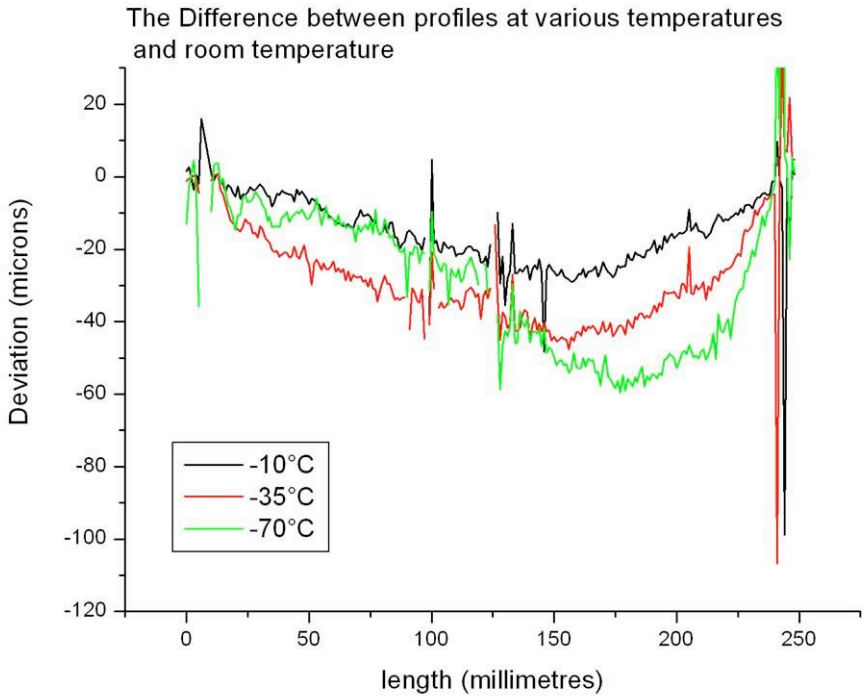


SiC Foam Results



Thin glue layer

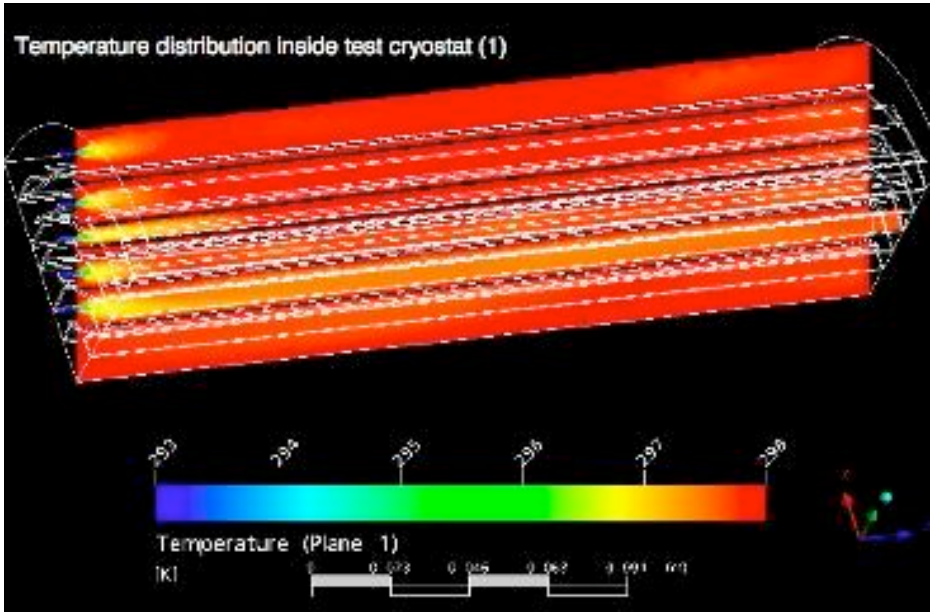
Glue "pillars"

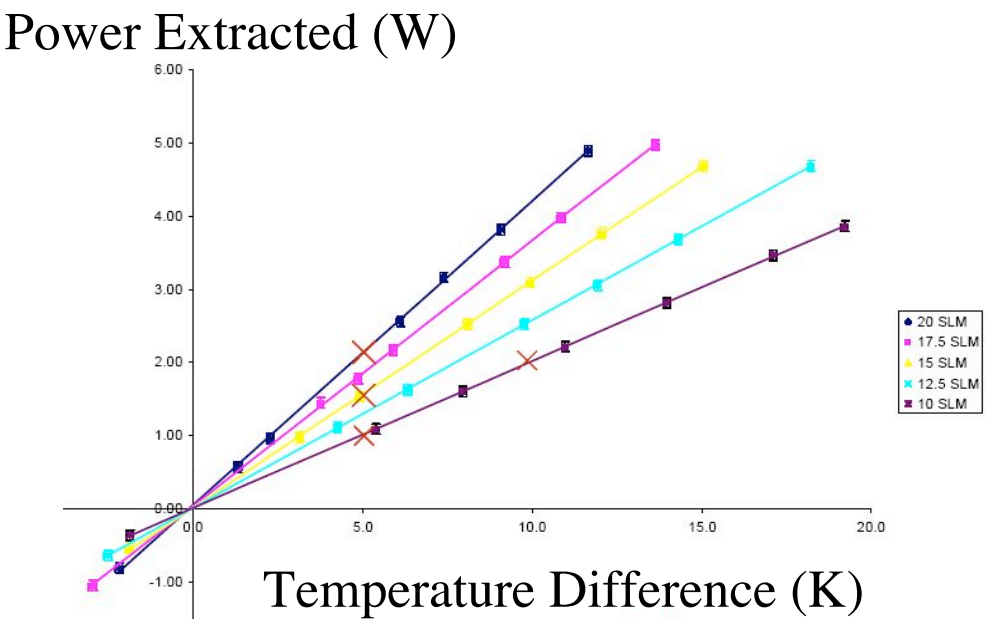


Cooling Studies

Test model of 1/4 Barrel

- Cold nitrogen cooling
- Heaters at ladder ends
- Parallel CFD simulations



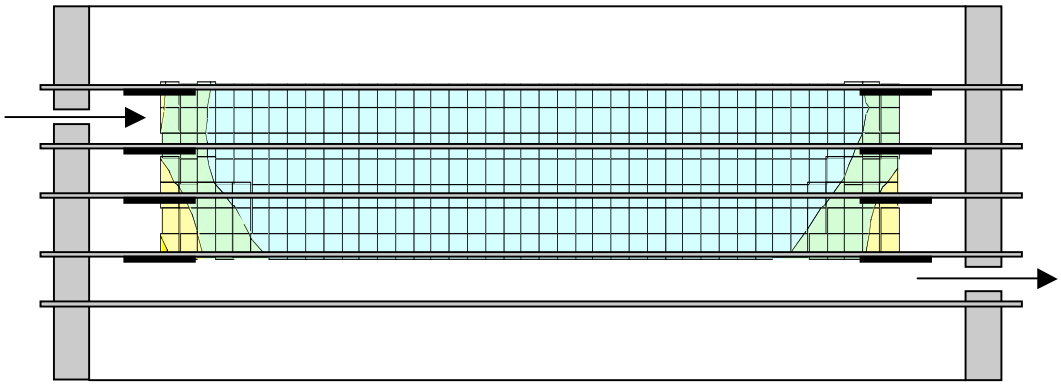


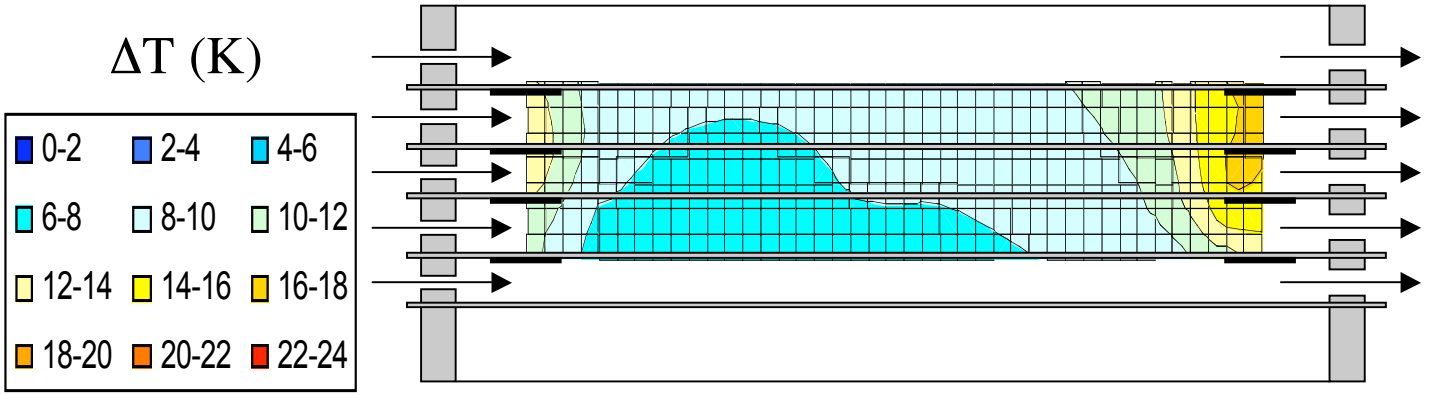
- Flow 5-20 SLM
  - *0.5–2 g/s whole detector*

Temperature Distributions

20 SLM / 8 W

- **Bulk ~ 8 K above inlet**
- **"Chips" 5-10 K hotter**
- **Layouts similar**

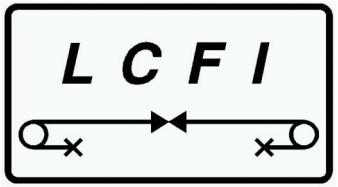




Caveat: conduction through ladders/endplates

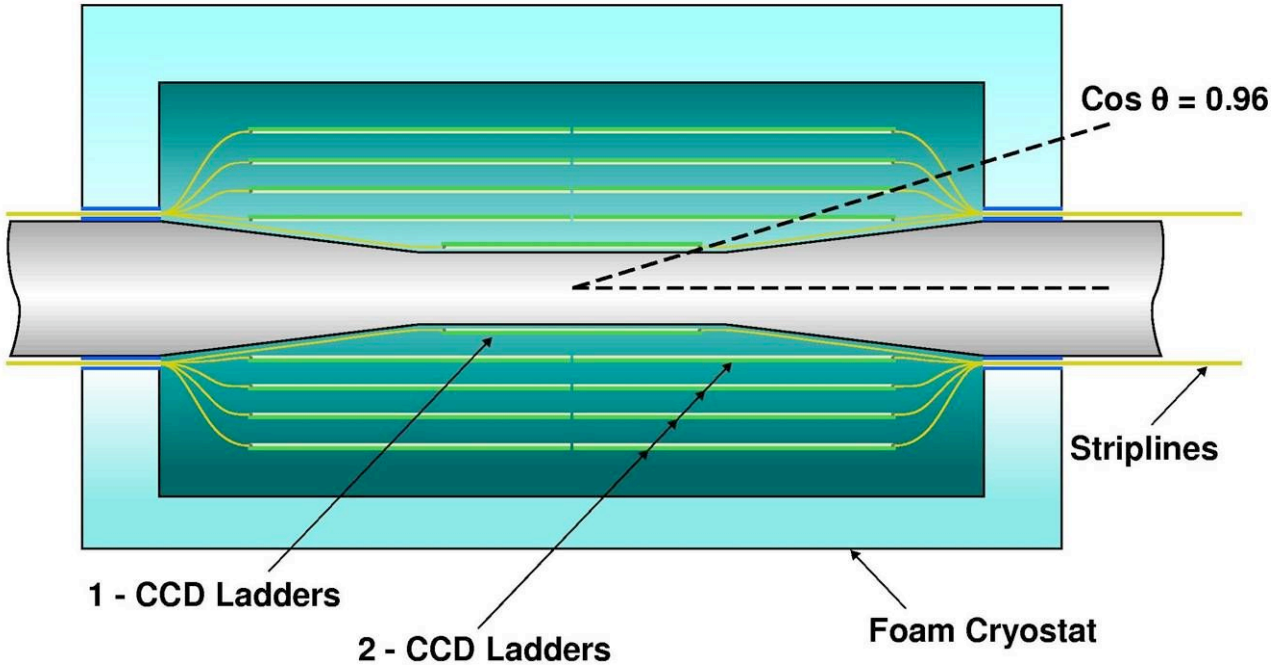
Status & Plans

- **Ladder designs**
  - **Upgrading fabrication, surveying facilities**
  - **Foams, CF looking promising**
  - **Start looking at production/aging issues**
- **Cooling studies**
  - **Non-conductive material**
  - **Match simulations**
  - **30 W at low flow rates**



Backup Slides

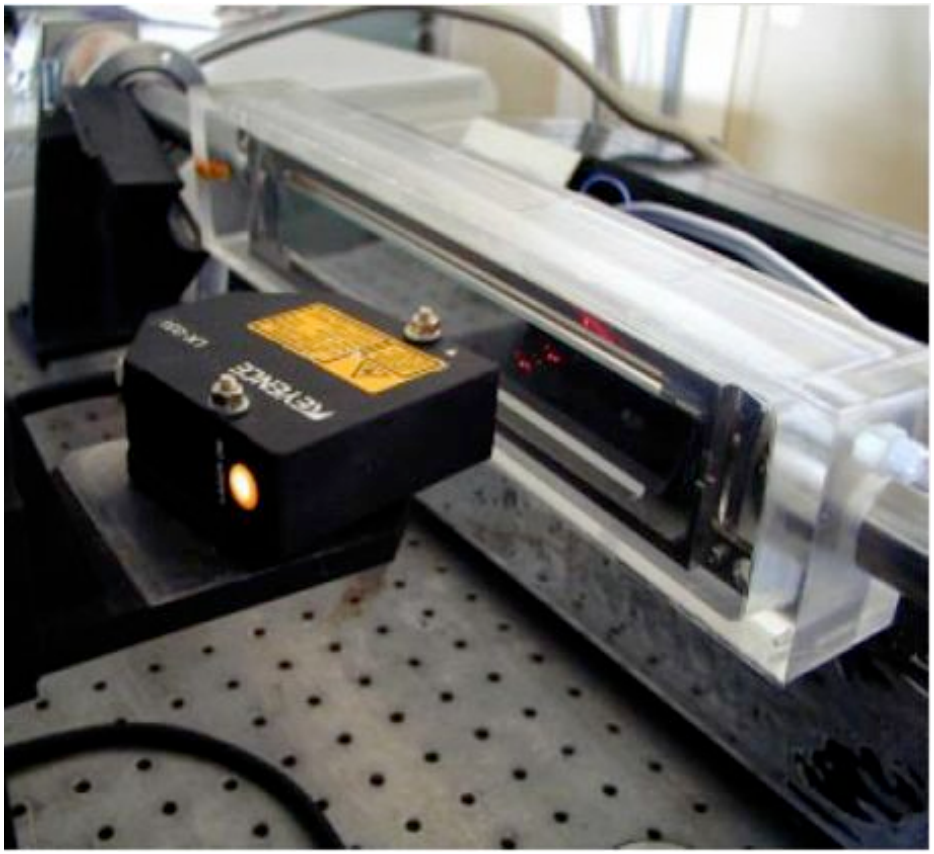
Baseline Vertex Detector



- 800 Mchannels of 20×20 μm pixels in 5 layers
- Optimisation:
  - Inner radius (1.5 cm?)
  - Readout time (50 μs?)
  - Ladder thickness (0.1% X_0?)

Laser Survey System

- **Laser displacement meter**
  - Z precision ~ 1 μm
- **2D motorised stage**
  - X-Y precision < 1 μm
- **Ladder in cryostat:**
  - ΔT ~ 100°C
- **Fast:**
  - 1D scan < 1 minute
  - Scan during cooling



Laser Calibrations