ILD Vertex Detector

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Outline

- Performance goal
- Baseline design
  - Design parameters
  - Pixel technology options
  - Ladders
  - Support structure
  - Cooling system
  - Installation and alignment
- Future prospects
  - Detector upgrade with beam energy
  - R&D needed

Performance goal

- Excellent impact parameter resolution

  $\sigma_{IP} < 5 \oplus 10/p\sin^{3/2}\theta$ [μm]

- Large acceptance

  max $|\cos\theta| \cong 0.96$ (L1–L3)

  $\cong 0.9$ (outermost layer)

- Low pixel occupancy: $\lesssim$few%

Design parameters

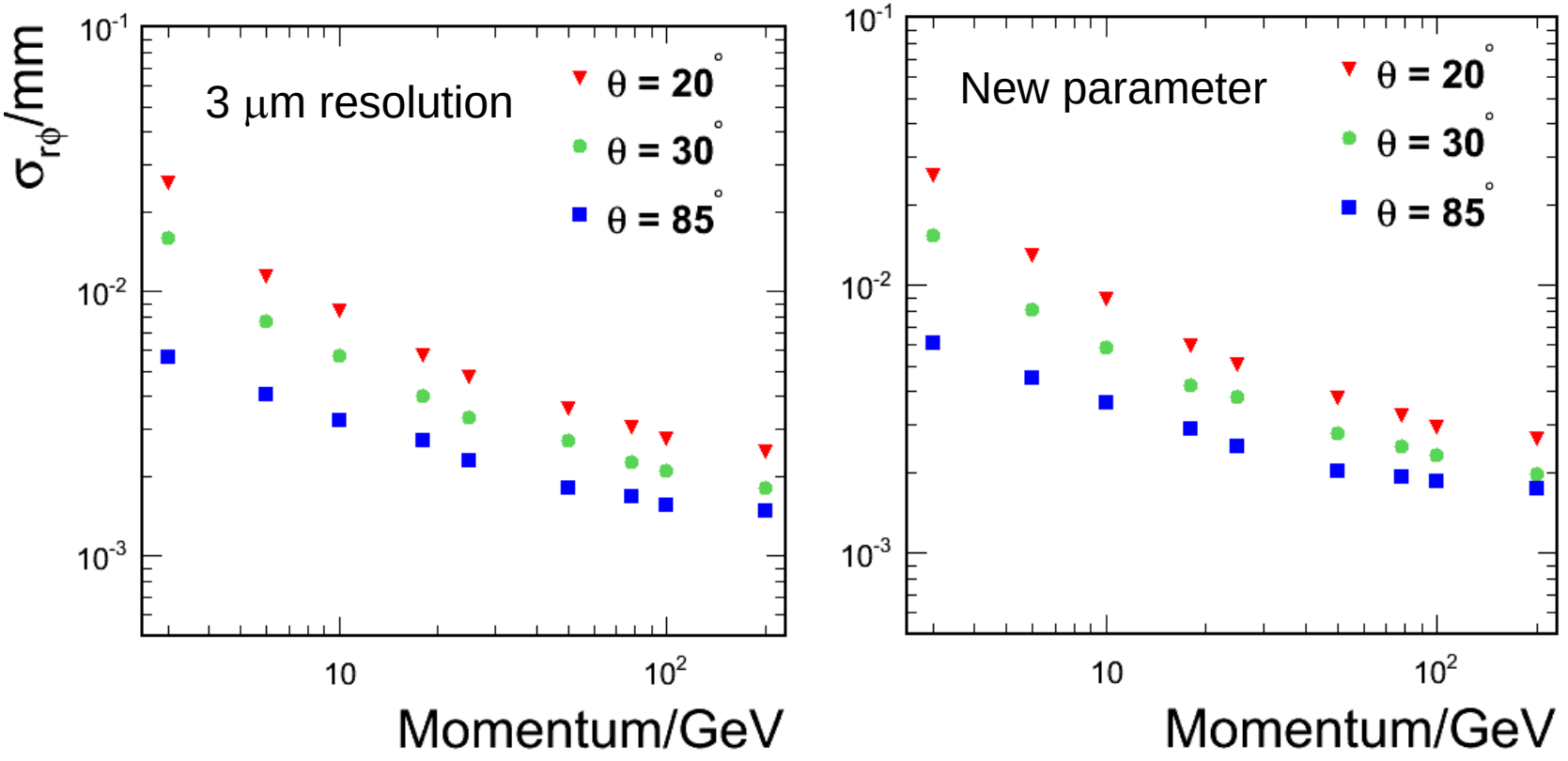
- Overall design
  - Each ladder has sensors on both sides ~2 mm apart
  - Three layers of the double-sided ladders make the vertex detector
  - Rin = 16 mm, Rout = 60 mm
  - Material budget ~ 0.3%X_0/ladder = 0.15%X_0/layer
- Software baseline parameters
  - Conservative parameters which have been demonstrated or seem within our reach will be used
  - It should be noted that the MOKKA simulation model is independent of sensor technology option
  - Difference in sensor technologies (point resolution, etc.) matters only in digitization and reconstruction phase, or in the background study

Design parameters

	R (mm)	|Z| (mm)	|cosθ|	σ (μm)	Readout time (μs) (for CMOS)
Layer 1	16	62.5	0.97	2.8	50
Layer 2	18	62.5	0.96	6	10
Layer 3	37	125	0.96	4	100
Layer 4	39	125	0.95	4	100
Layer 5	58	125	0.91	4	100
Layer 6	60	125	0.90	4	100

Design parameters

- Impact parameter resolution
  - Difference is very small



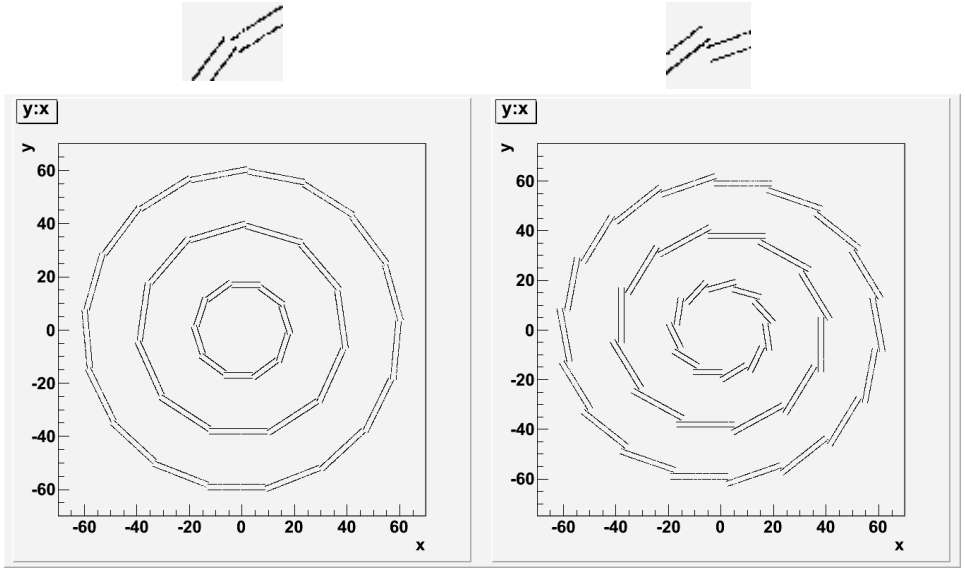
Pixel technology options

- Three sensor technology options seem to satisfy the requirements and are studied actively
  - CMOS
  - FPCCD
  - DEPFET
- Details of each sensor technologies will be presented in different talks later
- Each technology has pros and cons
  - Hybrid design using different sensor options in one vertex detector is not excluded
- Alternative technology options for future upgrade
  - ISIS
  - 3D sensors

Ladders

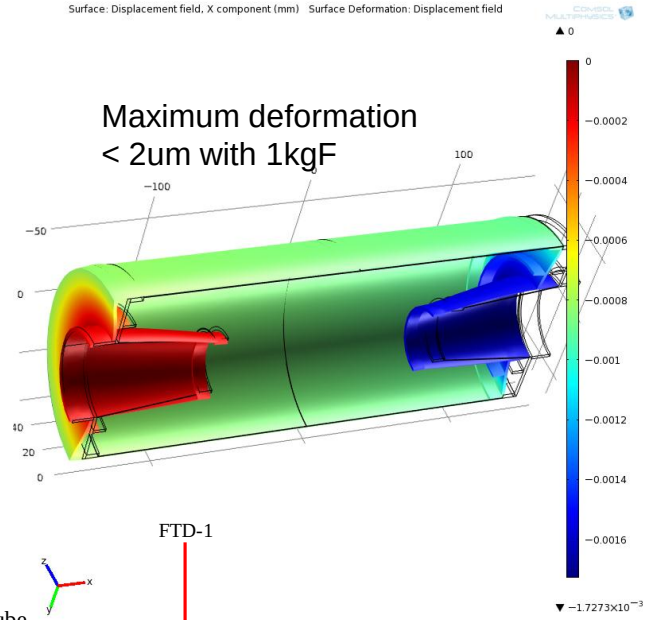
- Baseline design
  - Rigid foam (SiC or C) core sandwiched by thin (50μm) Si sensors
  - SiC core option is actively studied by PLUME collaboration
  - Carbon core option is proposed by FPCCD group
- Alternative design
  - Single sided ladders (5 layers) with or without (DEPFET) support
- Ladder overlapping in the baseline design
  - Two possible ways: layer by layer or ladder by ladder
  - Layer by layer overlapping will be used in the simulation

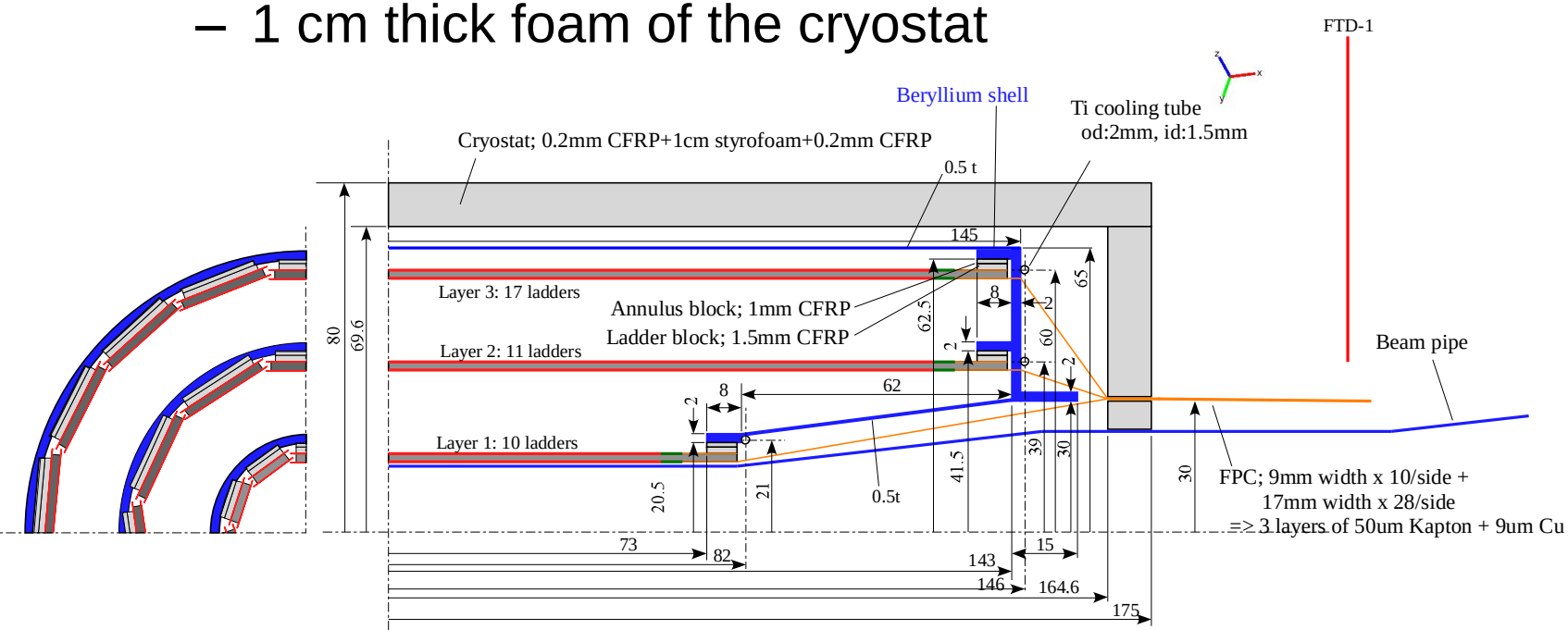
	Width (mm)	# of ladders
Layer 1,2	11	10
Layer 3,4	22	11
Layer 5,6	22	17



Support structure

- Design in ILD simulation model
  - Similar to SLD vertex detector
  - 2 mm thick Be end plate, 0.5 mm thick Be support shell
  - Kapton+Cu flexible cables
  - Ladders
  - 1 cm thick foam of the cryostat





Cooling system

- Two-phase CO2 cooling system
  - Cooling power of ~300J/g
  - Thin (OD~2mm) cooling tube on the end plate
  - Studied by FPCCD group (P>50W inside the cryostat): target temperature = −40℃
- Gas cooling system
  - Applicable for low power consumption sensors

Installation and alignment

- Installation
  - ILD vertex detector is supported by the beam pipe, and the beam pipe is supported by the inner support tube
  - Integrated to ILD detector as a part of the “inner Si trackers” inside the inner support tube
- Alignment
  - Pre-alignment by optical survey during assembly
  - Precise alignment is achieved by beam-base alignment

Detector upgrade with energy

- Vertex detector is relatively easy to replace
- Detector upgrade with energy upgrade is reasonable
- Particularly at 1TeV where beam background is expected to increase by factor 5, new sensor technologies with much shorter readout time could be used
  ➔ R&D should be continued

R&D needed

- R&D towards the baseline design
- R&D for better performance
- What R&D should be put in the common chapter?

- Detail will be discussed in each option talk