

Status of Geometry & Silicon Tracking

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Outline

- Status of geometry implementation
- Status of silicon tracking
- Preliminary performance of silicon tracking
- Summary

Geometry of CEPC Detector Released in CEPCSW

■ CEPCv4

- CDR baseline

- ✓ with TPC as main tracker
- ✓ Coil outside Hcal

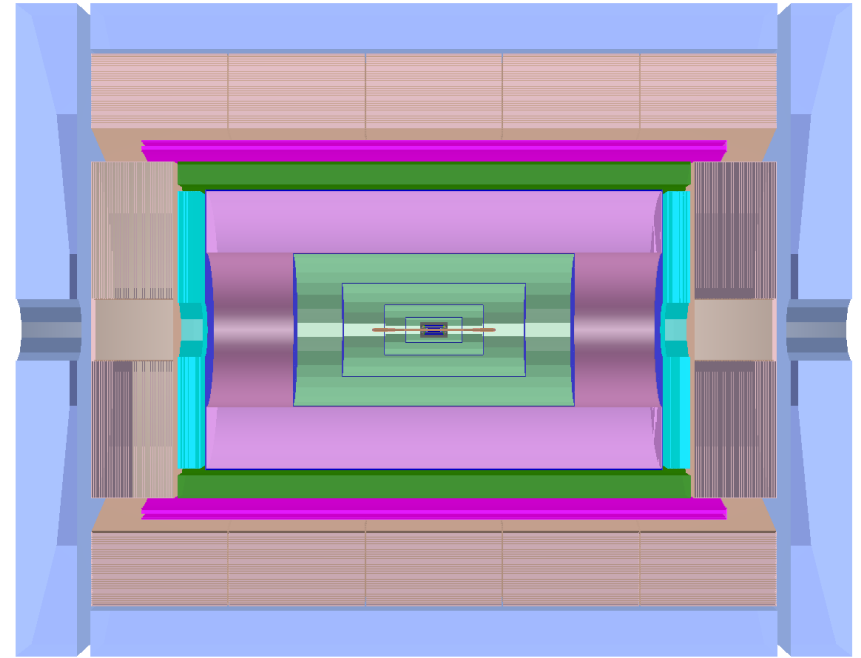
■ CRD (CEPC reference detector)

- 4th conceptual detector

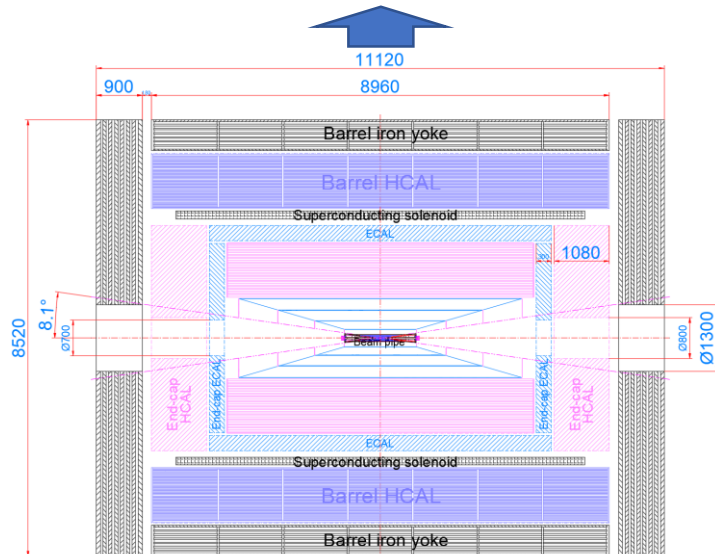
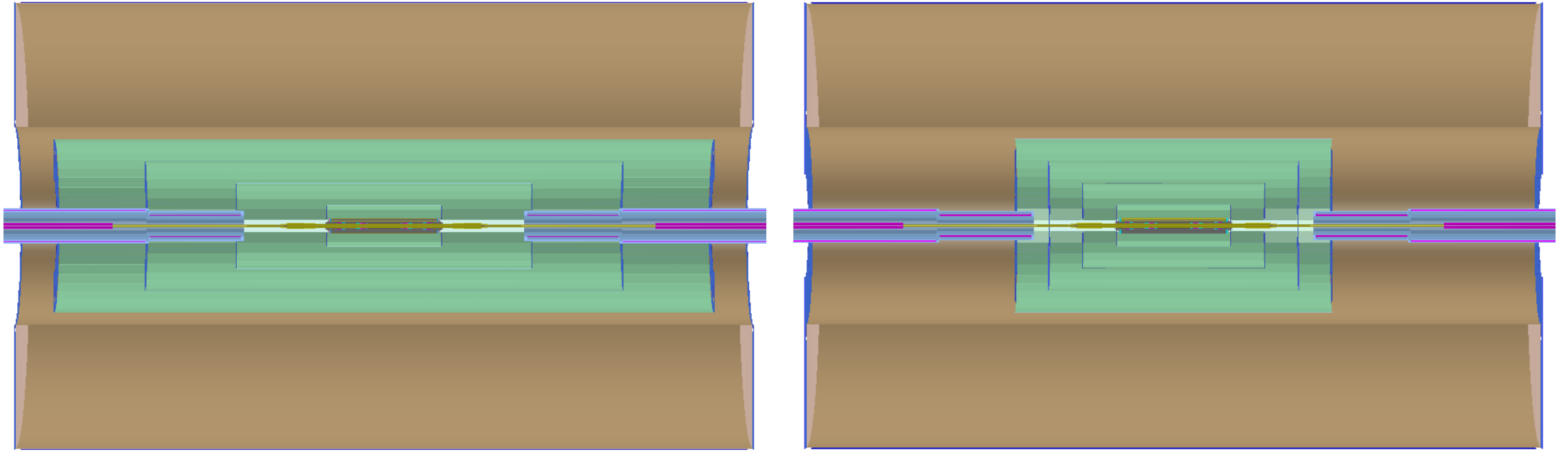
- ✓ with silicon tracker as main tracker and DC as PID
- ✓ Coil inside Hcal

- Branches

- ✓ CRD_o1_v01: silicon pixel detector (SPD) as SET/SOT
- ✓ CRD_o1_v02: silicon strip detector (SSD) as SET/SOT
- ✓ CRD_o1_v03: MOST2 vertex vs CRD_o1_v01
- ✓ CRD_o1_v04: 10mm beam pipe vs CRD_o1_v01



Un-released Geometry

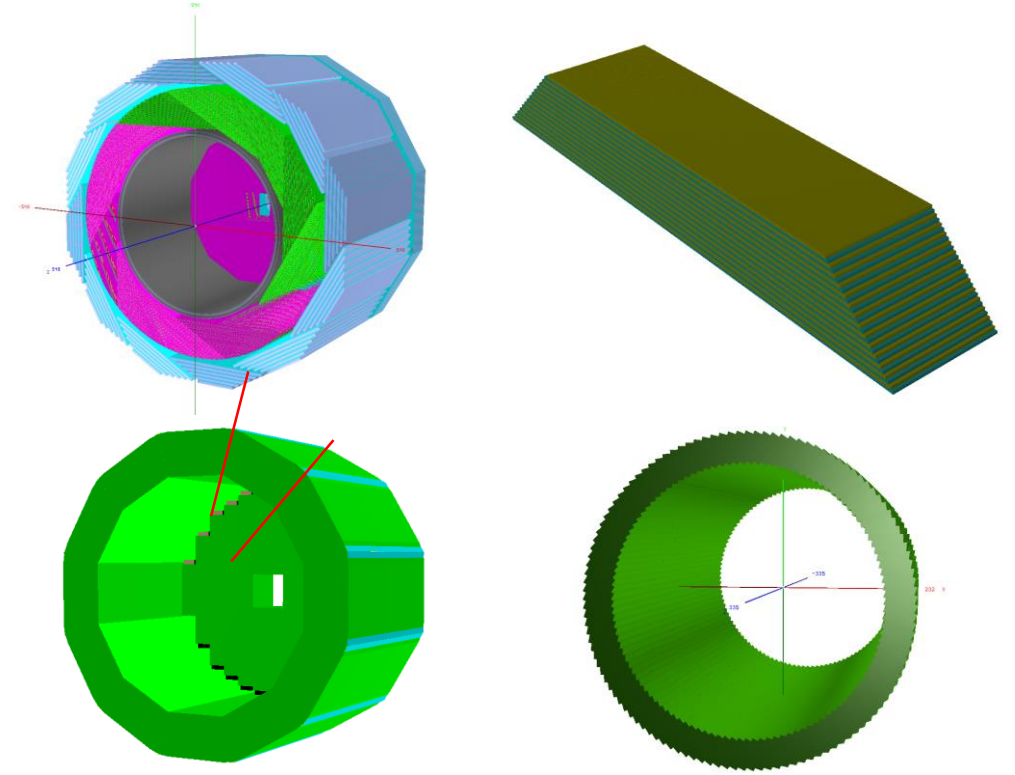


Expandability

- Sub-detector replacement
- Layouts
 - ✓ layer number
 - ✓ layer position
- Material structure

Sub-detector Modules

- MDI: Beampipe
- LumiCal: todo
- Vertex
 - VXD04 (ILD-like)
 - SiTrackerStaggeredLadder (MOST2)
- Silicon tracker
 - SIT_SimplePixel, SIT_SimplePlanar
 - SET_SimplePixel, SET_SimplePlanar
 - FTD_SimpleStaggered, SiTrackerSkewRing (support skew angle)
 - TODO: dead region
- DC
 - DriftChamber
- TPC
- TPC10: to update according TDR
- Ecal, Hcal & Muon
 - SEcal05 (si- W)
 - CRDEcal (4D crystal bar)
 - RotatedCrystalCalorimeter (stereo crystal)
 - SHcalRpc01 (octahedron), SHcalRpc02 (optional side)
 - SHcalSc04
 - Yoke05
 - RotatedPolyhedraBarrelCalorimeter



Four calorimeter configurations implemented, sensitive type is determined by material option of sensitive layer/bar, and will be reflected in digitization.

TODO:

- improve detail
- update for new designs: endcap idea, etc.

Status of Sub-detector study

■ MDI

- cepssoft

■ LumiCal

- standalone
- cepssoft: position optimization

■ Vertex

- fast/full/beam: layouts position close to frozen, length?

■ Silicon tracker

- fast/full

■ DC

- CEPCSW

■ TPC

- cepssoft
- CEPCSW: same stage with cepssoft, easy to modify readout material

■ Ecal/Hcal/Muon

- cepssoft for old modules: optimization and physical study
- CEPCSW for new modules: reconstruction and optimization

Status of Silicon Tracking

job		propose	code	run	validation	application	optimization	
Geometry	Module	[Green]						
	New module	[Blue]	[Red]					
	Tracker implement	[Green]					[Blue]	[Red]
Digitization		[Green]					[Blue]	[Red]
Tracking algorithm	Track finding	[Green]					[Blue]	[Red]
	Track fitter	[Green]					[Blue]	[Red]
Tracking tool	Common API	[Green]				[Blue]	[Red]	
	Kalman filter	[Green]				[Blue]	[Red]	
	Global fit	[Green]				[Blue]	[Red]	
Performance	Single particle	[Green]						
	Multiple particles	[Green]						
	$H \rightarrow \mu\mu$	[Green]				[Blue]	[Red]	
	$\tau \rightarrow 3\text{prong}$	[Green]				[Blue]	[Red]	
	$b\bar{b}H$	[Green]				[Blue]	[Red]	
	Non-uniform field	[Green]				[Blue]	[Red]	
	Random noise	[Green]				[Blue]	[Red]	
	Beam background	[Blue]	[Red]					
Application	Tracker optimization	[Green]				[Blue]	[Red]	
	Beam test	[Green]				[Blue]	[Red]	

Digitization

■ Gaussian smearing on SimTrackerHit at measurement dimension (u,v)

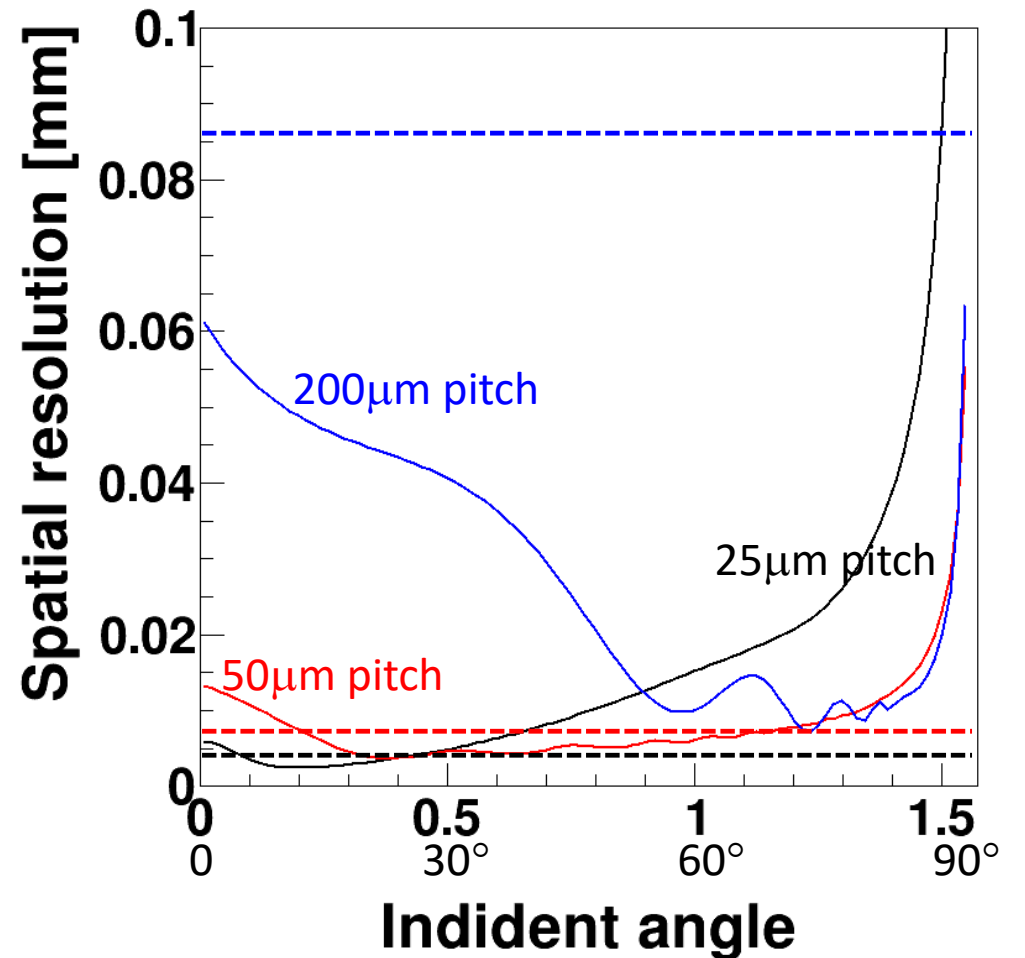
- pixel: 2D (u,v)
- strip: 1D (u,0) or (0, v)

■ Fixed spatial resolution

- VXD
 - ✓ $\sigma_{rphi,z} = 4\mu\text{m}(2.8\mu\text{m}), 4\mu\text{m}(6\mu\text{m}), 4\mu\text{m}, 4\mu\text{m}, 4\mu\text{m}, 4\mu\text{m}$
- SIT
 - ✓ $\sigma_{rphi} = 7.2\mu\text{m}, \sigma_z = 86\mu\text{m}$
- SOT/SET
 - ✓ $\sigma_{rphi} = 7.2\mu\text{m}, \sigma_z = 86\mu\text{m}$
- Endcap tracker
 - ✓ $\sigma_{rphi} = 7.2\mu\text{m}, \sigma_z = 86\mu\text{m}$

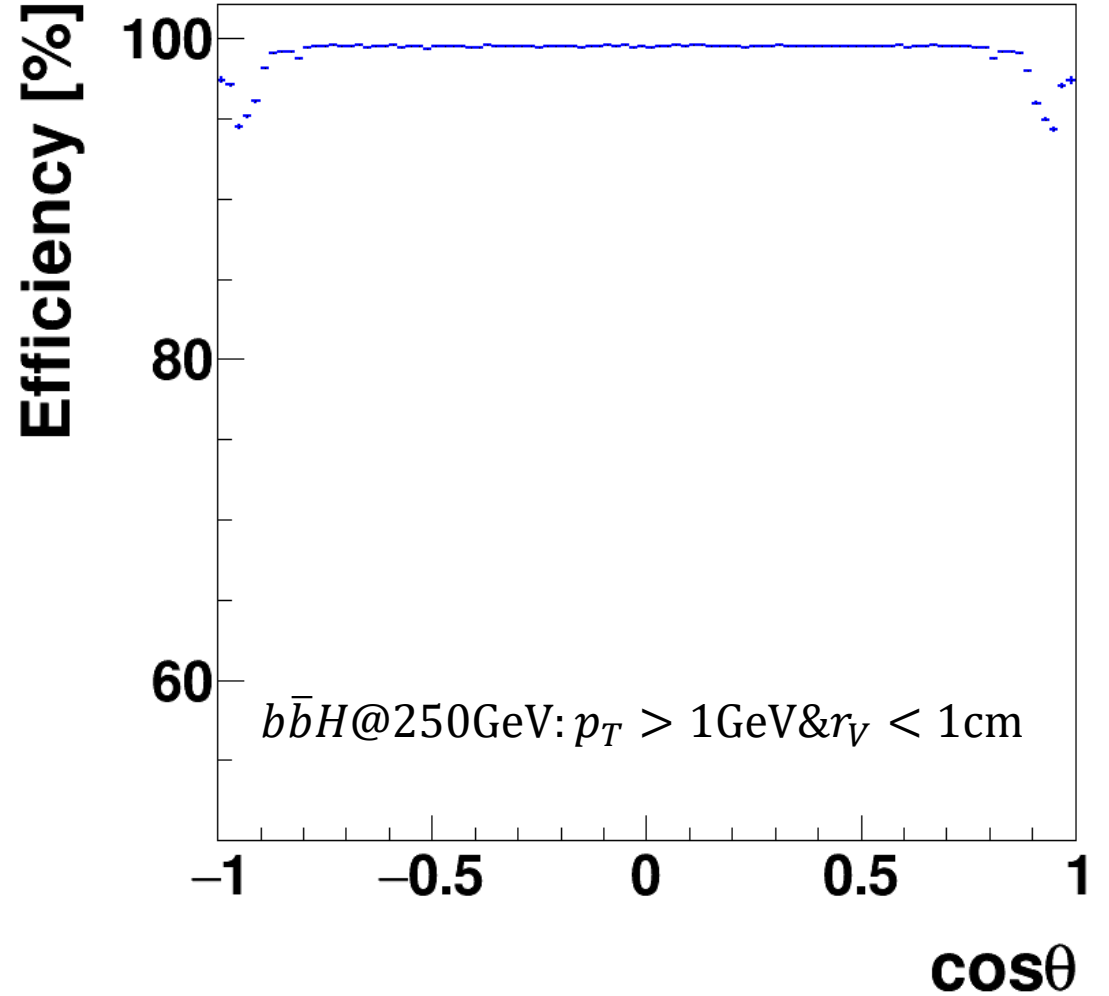
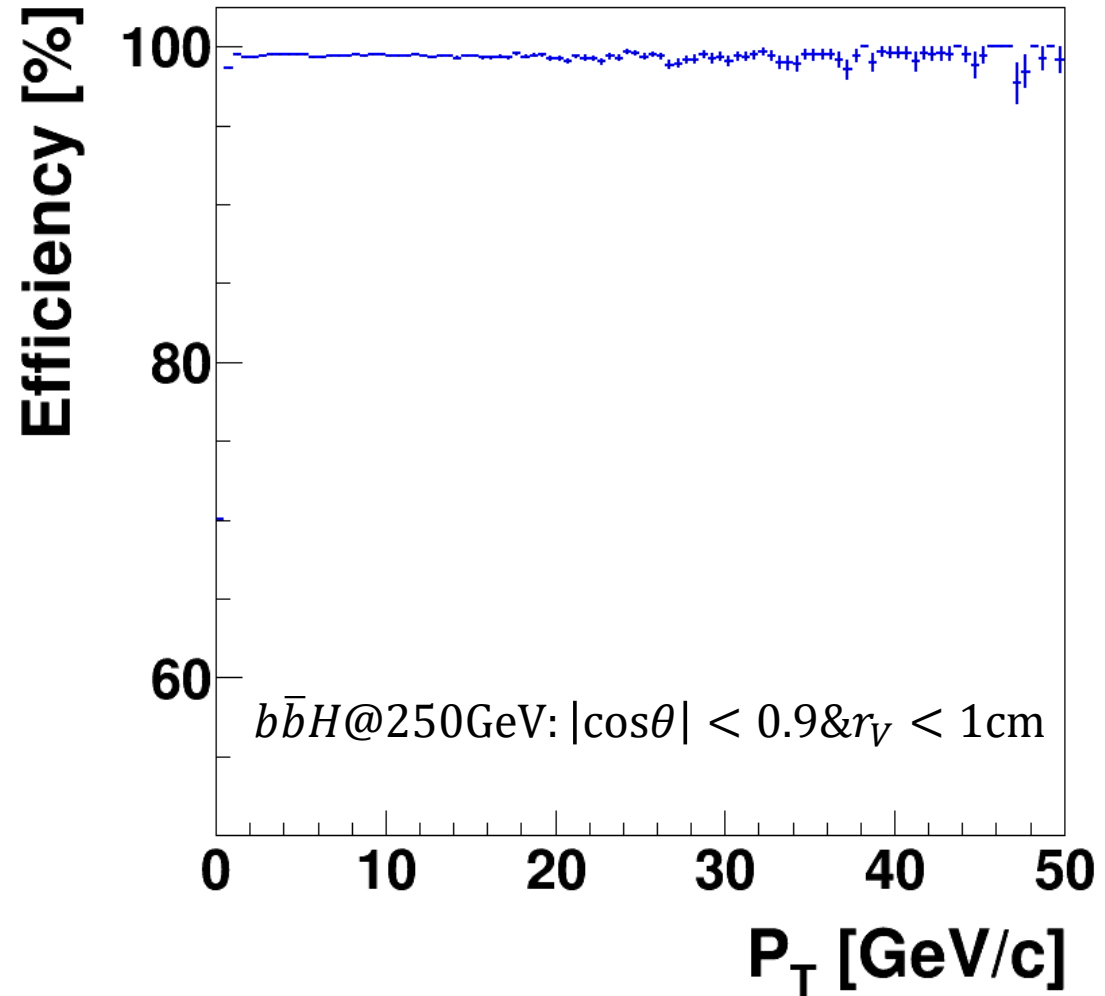
■ Parameterized spatial resolution

- Riccardo del Burgo's parametrization model
 - ✓ $\sigma_{u,v} = p_0 + p_1x + p_2e^{-p_9x} \cos(p_3x + p_4) + p_5e^{-\frac{(x-p_6)^2}{2p_7^2}} + p_8\sqrt{x}$
- parameters are relative to pitch size (for CMS PhaseII)
 - ✓ VXD: $25\mu\text{m} \times 25\mu\text{m}$
 - ✓ others: $50\mu\text{m} \times 200\mu\text{m}$



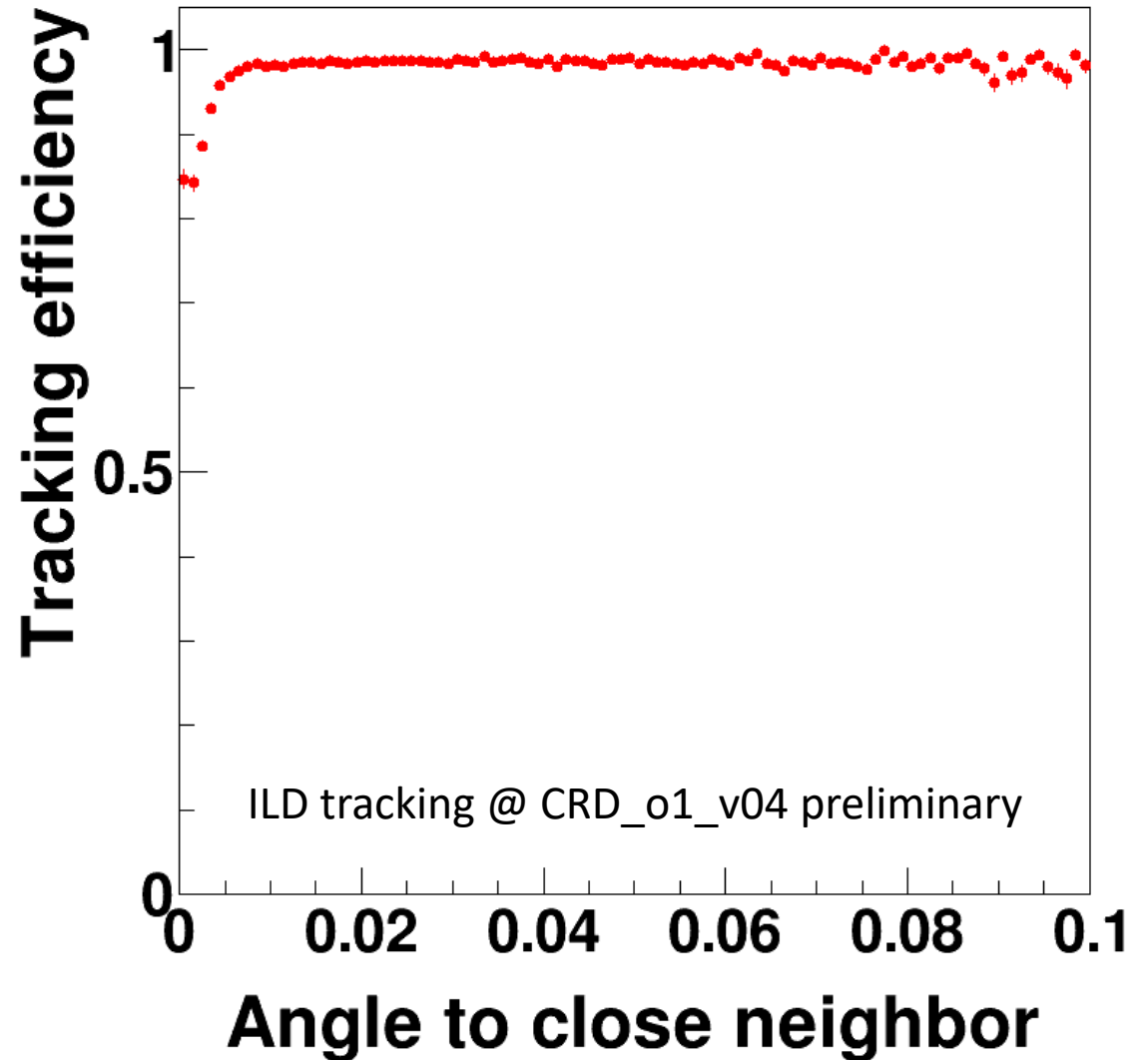
Efficiency in $b\bar{b}H$

■ Observe particle: has ≥ 6 hits in trackers

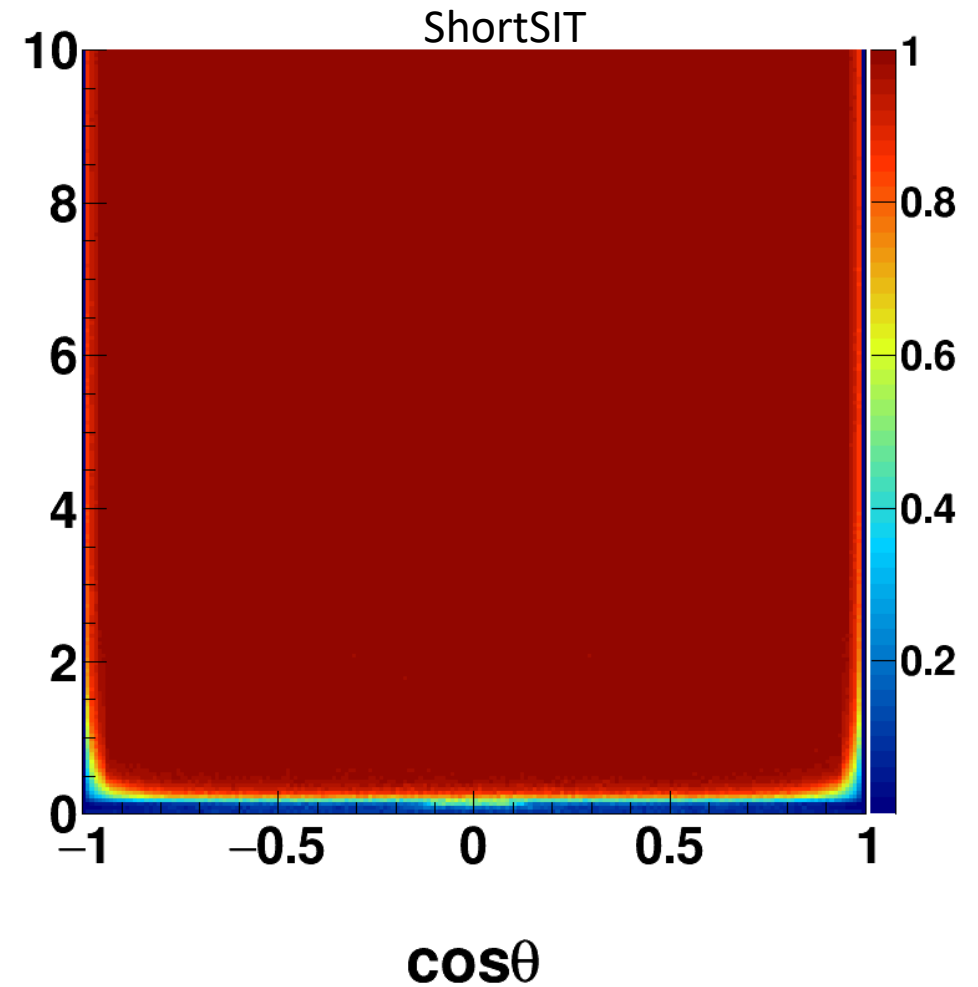
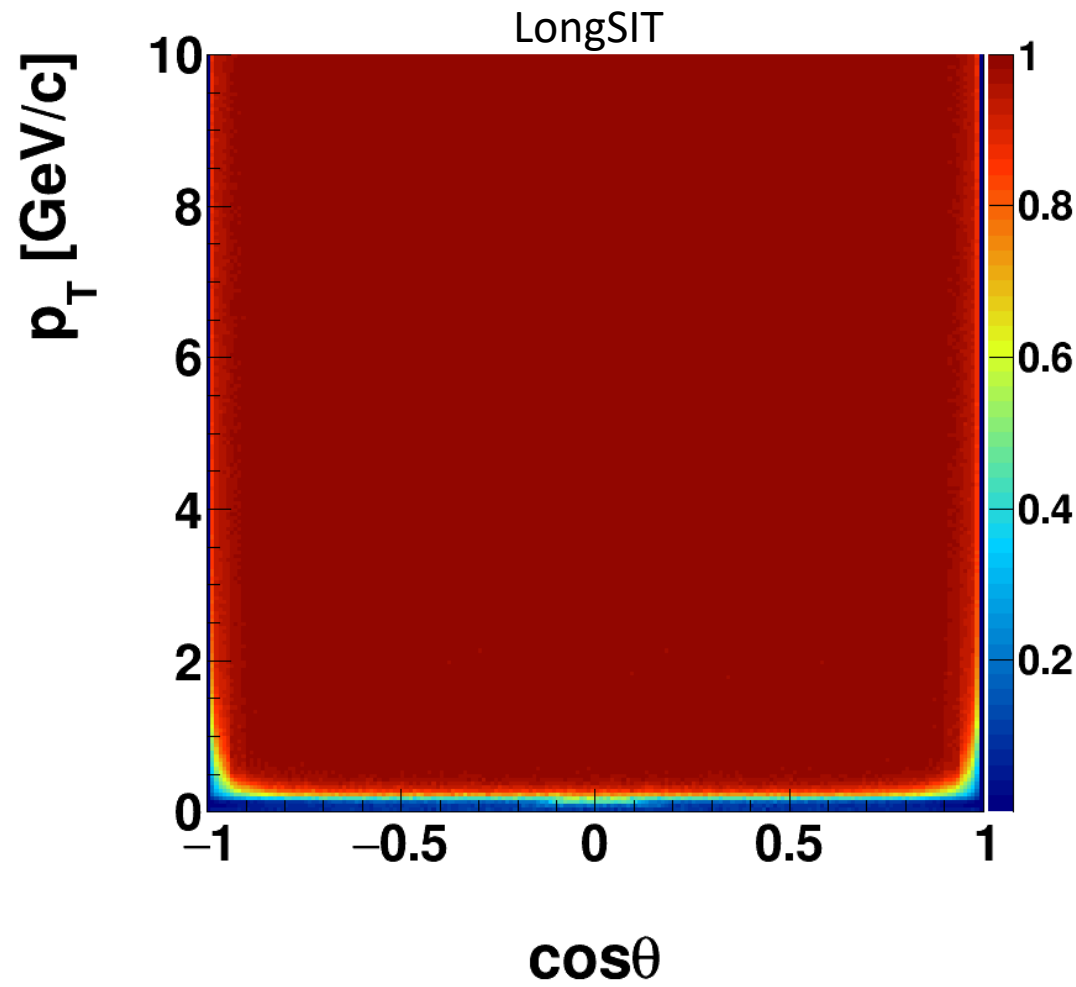


Efficiency in $\tau \rightarrow 3\text{prong}$

- Observed particles (N): has ≥ 6 linked tracker hits
 - Has linked track (Nf)
 - $\varepsilon = Nf/N$
- Search the close neighbor in the final state particles



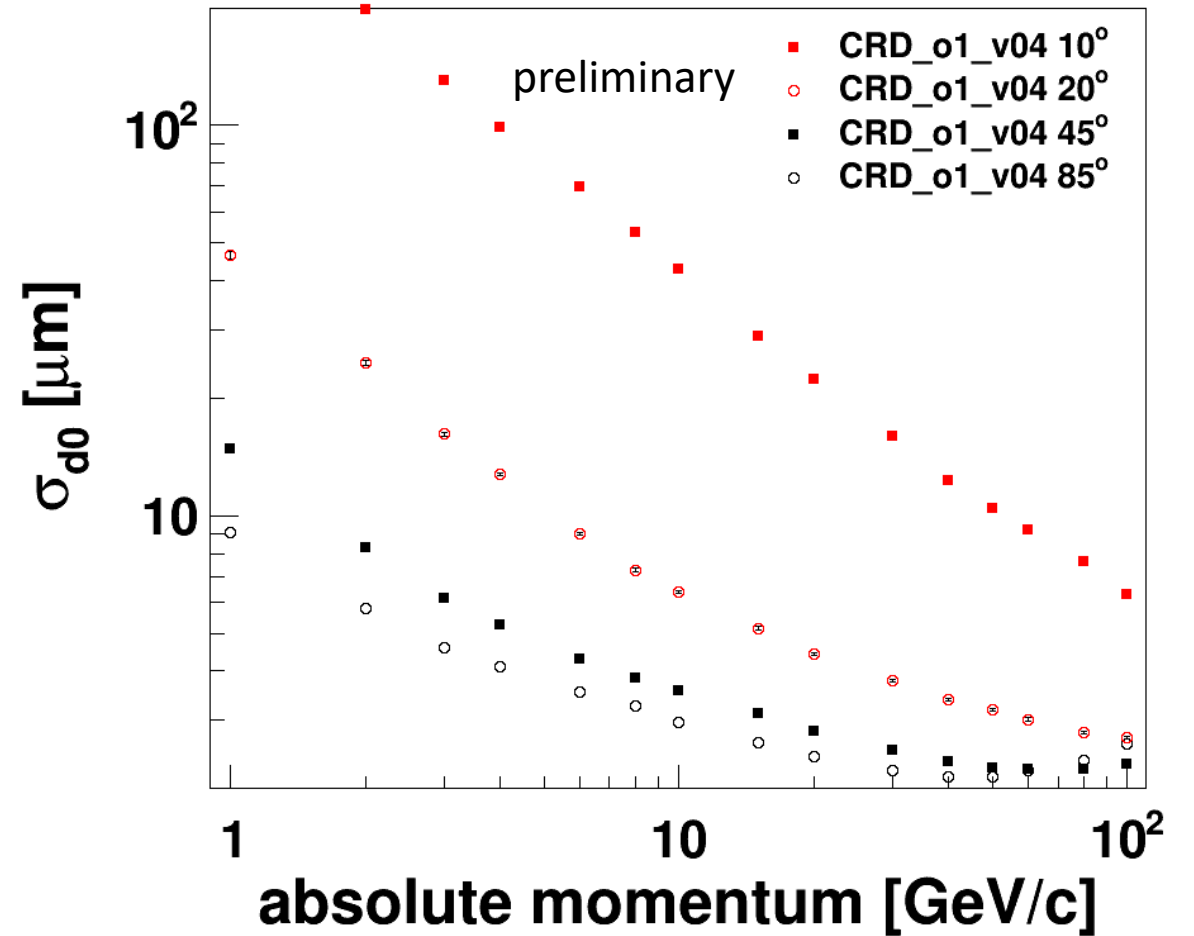
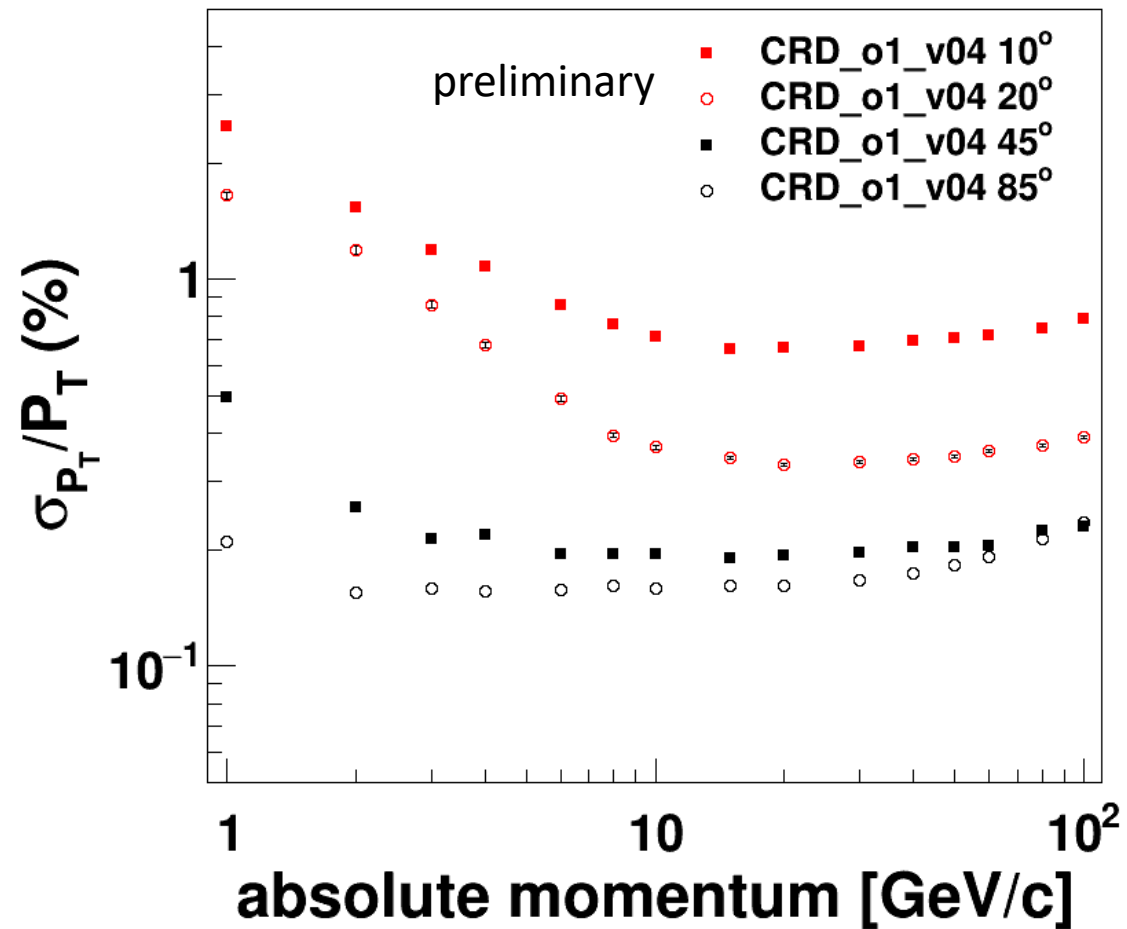
Efficiency



■ ~86% @ $\cos\theta=(0.98-0.99)$

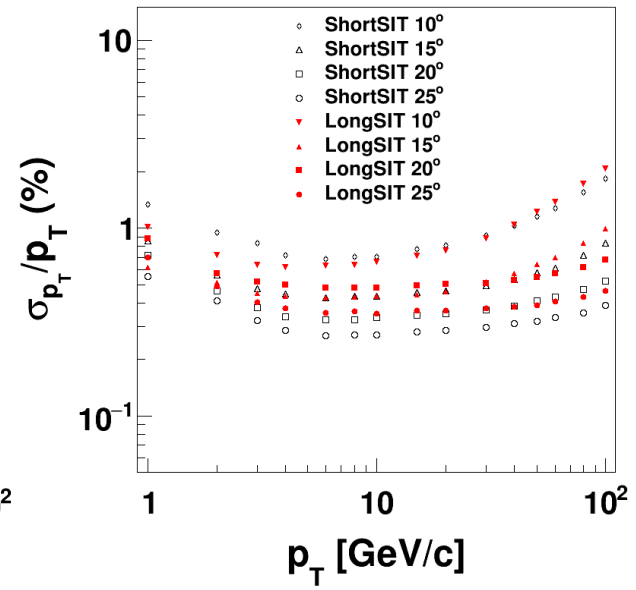
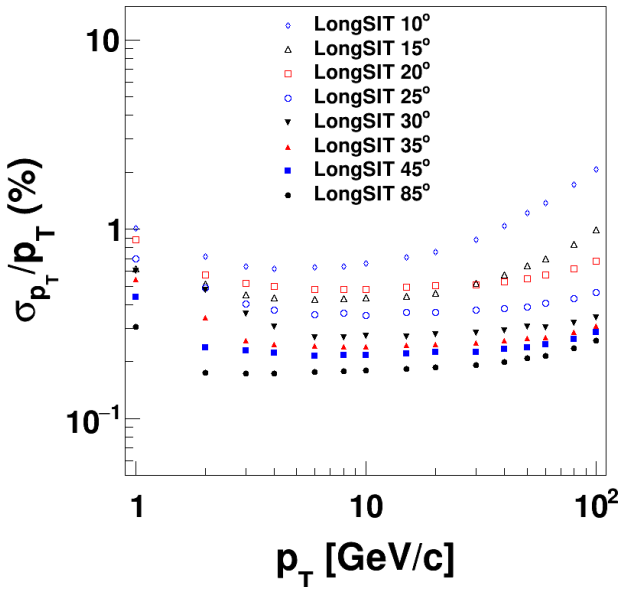
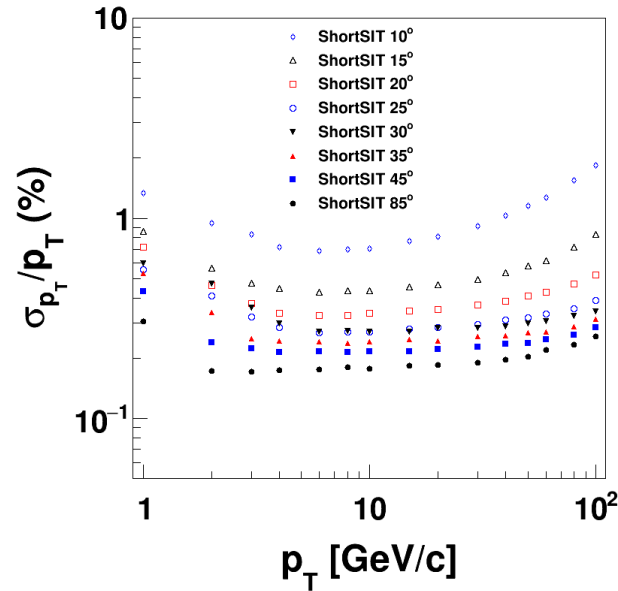
Resolution

■ $\sigma_{IP}=(15\mu\text{m}, 36\text{nm}, 2.8\text{mm})$

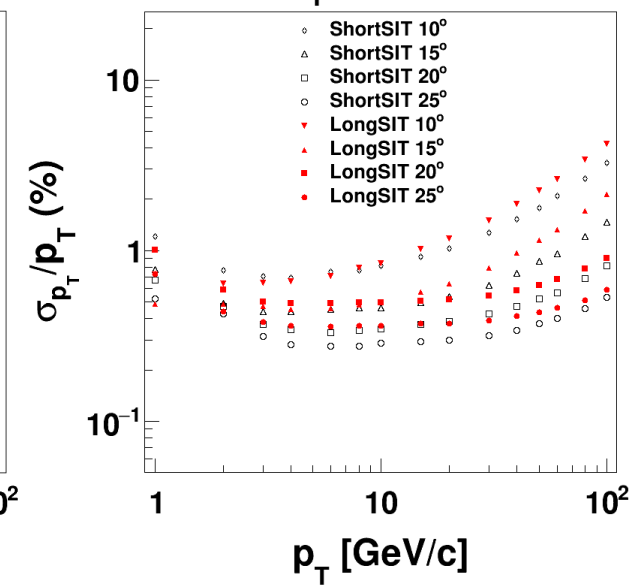
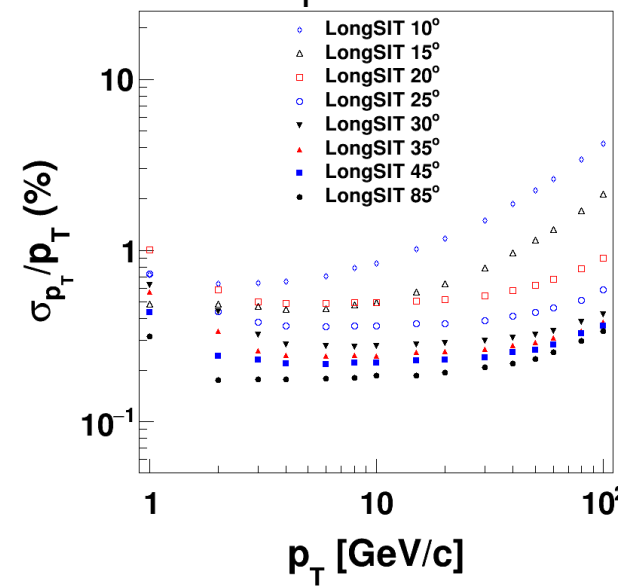
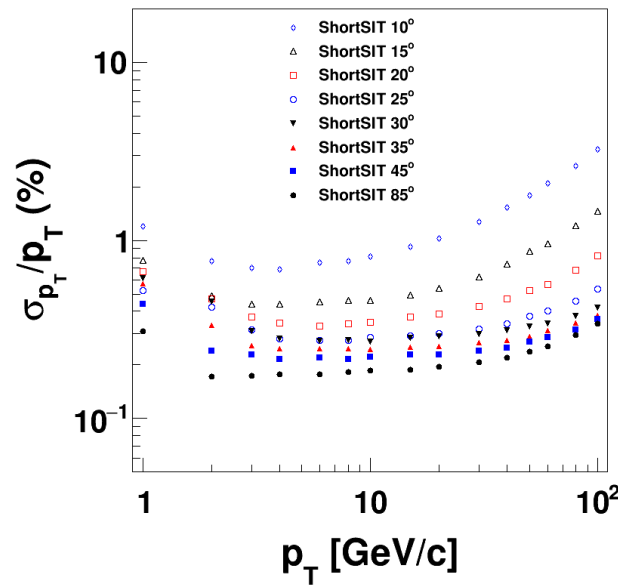


Resolution of p_T

Fixed



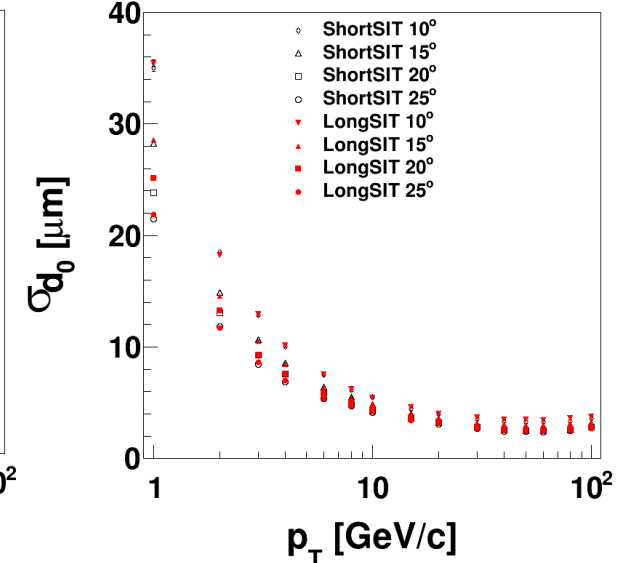
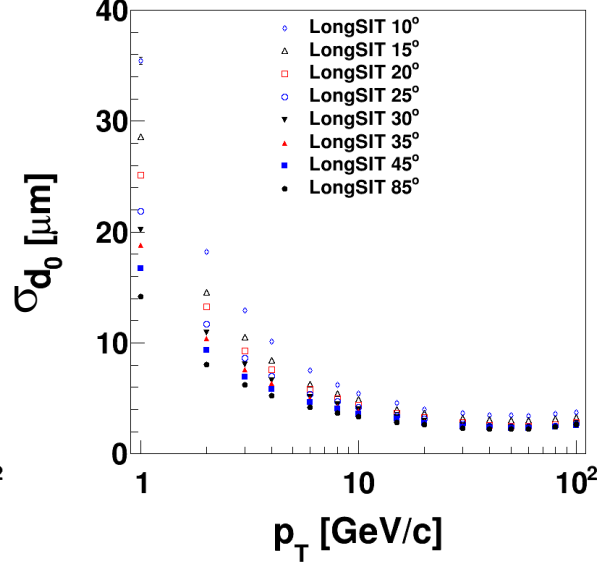
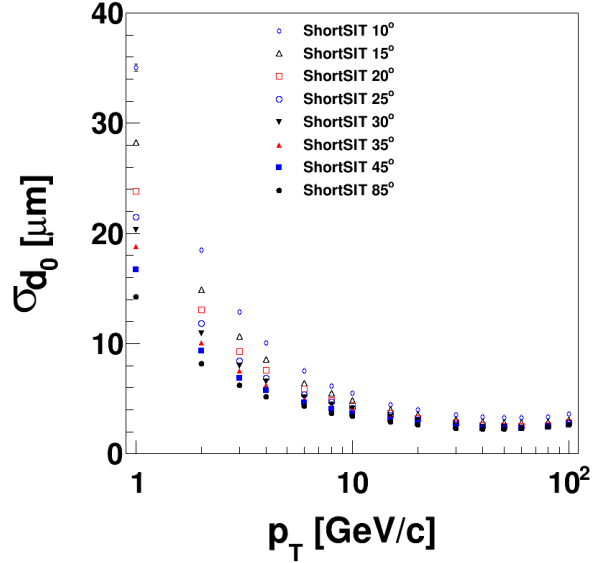
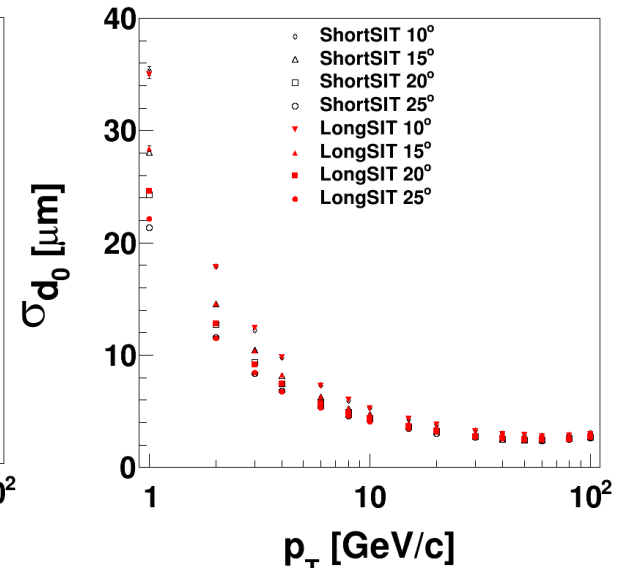
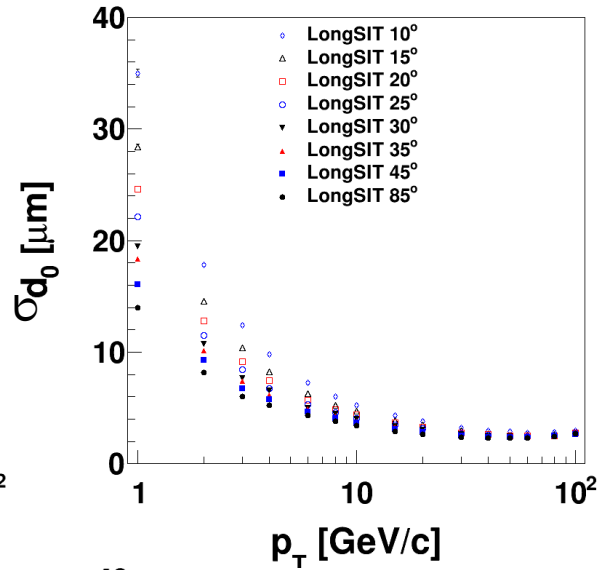
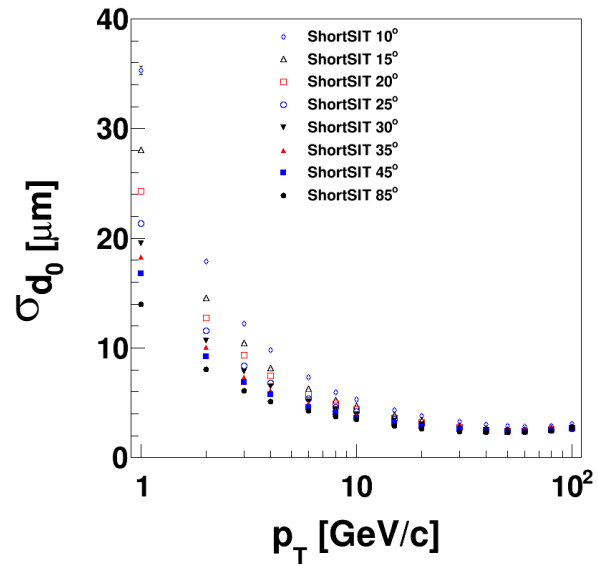
Parametrization



Resolution of d_0

Fixed

Parametrization



Plan

- Provides geometry of detector design to study
- Standard efficiency estimation
- As TDR requirement
- Software improvement