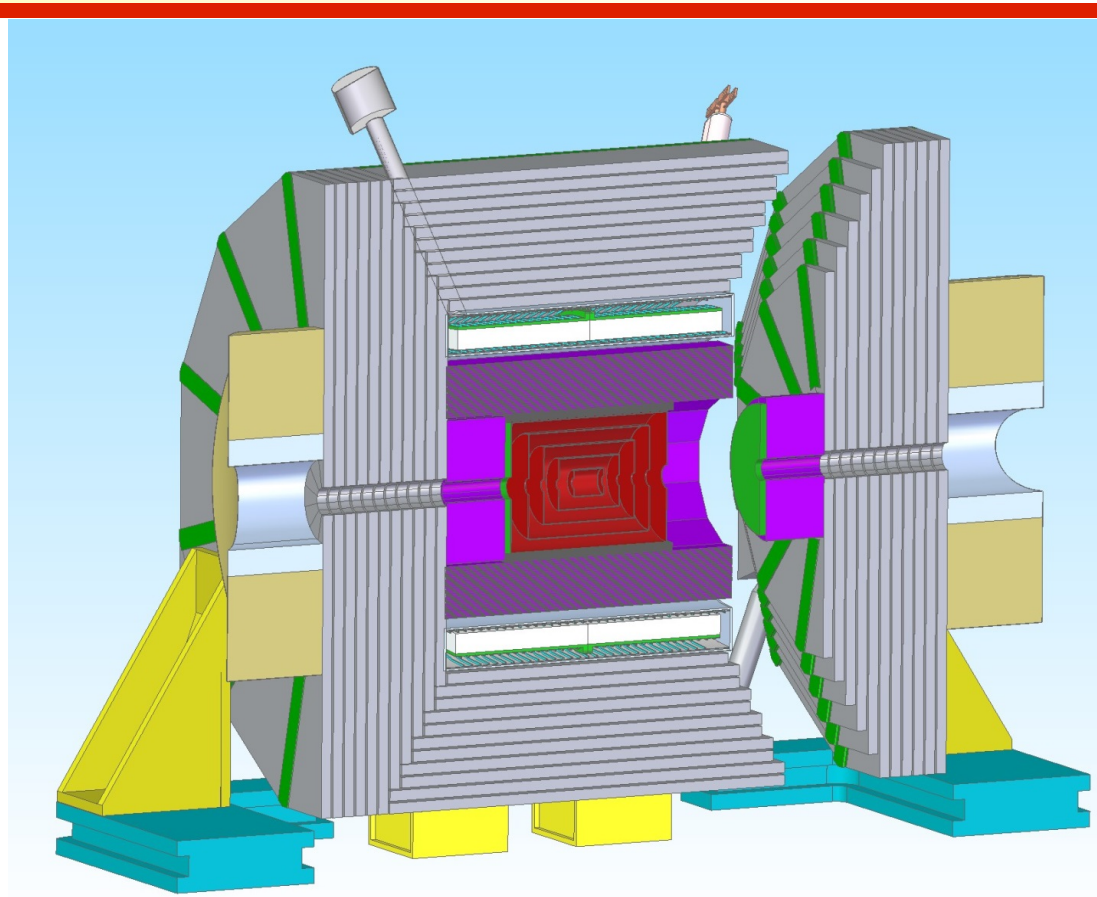
SiD Simulation and Reconstruction

LCWS16

- DD4hep simulation model status.
- Reconstruction status.
- Collaboration activities.
- Outlook.



Bogdan Mishchenko
on behalf of the SiD Consortium

University of Glasgow | Experimental Particle Physics

What we have been doing…

At LCWS15: SiD decided to implement DD4hep simulation to align with ILD/CLICdp and profit from shared effort

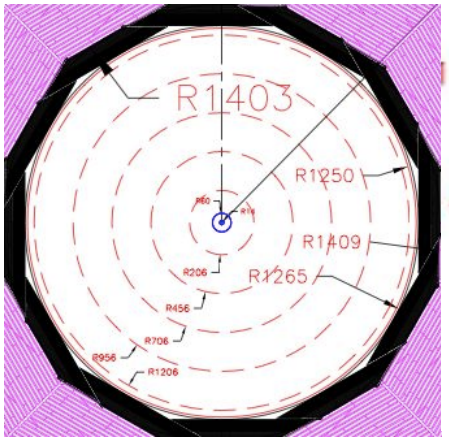
Detector model

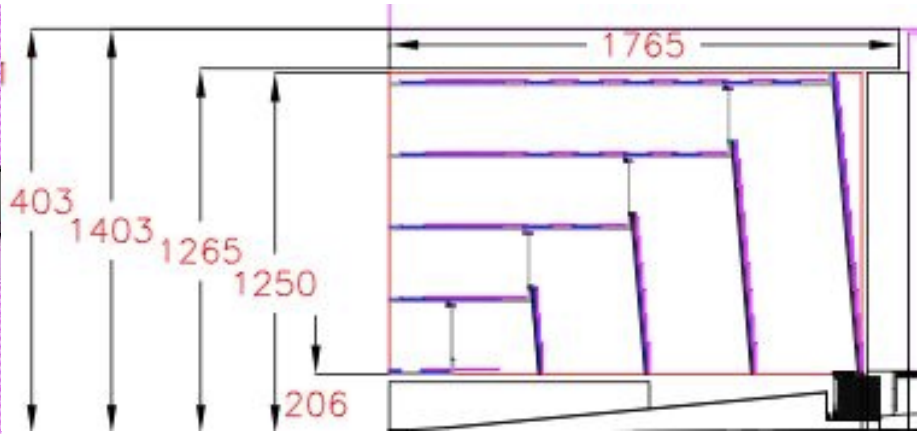
Drivers: C++ code that constructs the detector volumes
XMLs: detector size & arrangement description

- Implementing / updating drivers for the SiD model.
- Updating XMLs to latest naming and structure conventions
  e.g. allows model to be included in automatic tests.
- Updating dimensions to latest engineering drawing (ongoing),
  updates since original SiD concept ('LOI3').
- Moved readouts & plugins to the individual detector descriptions,
- Verified visualizations.
- Checked overlaps

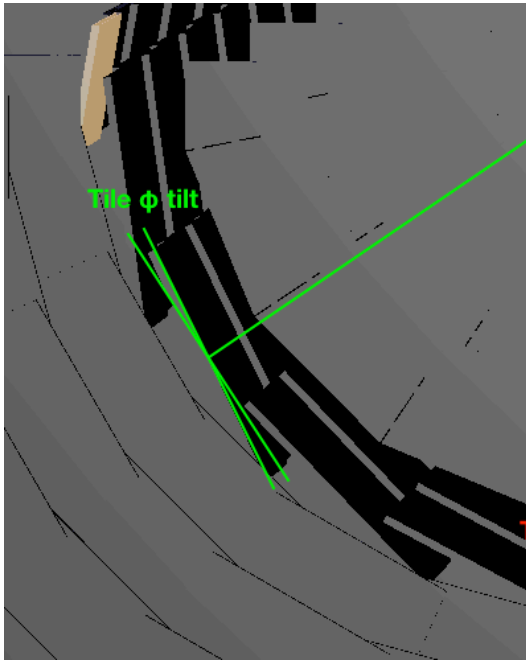
Started with generic DD4hep drivers; a lot of recent effort in implementing detailed/custom drivers.

Tracking

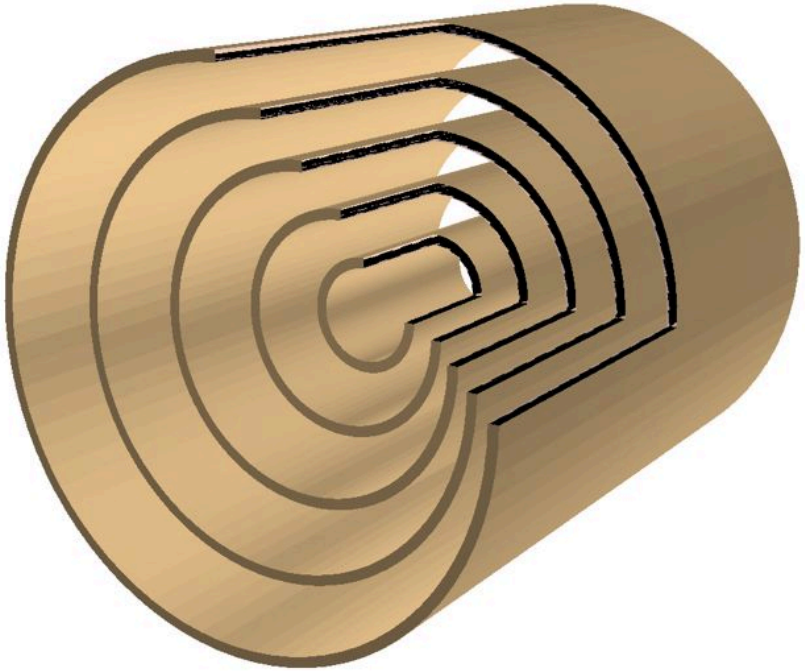




engineering drawings

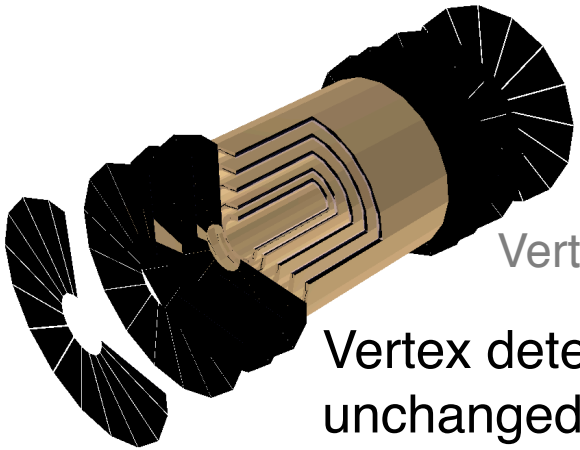


module detail inside envelope



Tracker Barrel

5 barrel layers(Vertex,Tracker); here showing detector envelopes



Vertex detector

Vertex detector so-far unchanged from LOI3 model

Tracker

original ported xml – all dimensions hard-coded

```
<layer module="SiTrackerModule_Layer1" id="1">
  <barrel_envelope inner_r="215.075*mm" outer_r="245.0*mm" z_length="578 * 2*mm"/>
  <rphi_layout phi_tilt="0.17506*rad" nphi="20" phi0="0.*rad" rc="216.355*mm + 5.0*mm" dr="0.0"/>
  <z_layout dr="4.0*mm" z0="512.128*mm" nz="13"/>
</layer>
<layer module="SiTrackerModule_Layer2" id="2">
  <barrel_envelope inner_r="465.075*mm" outer_r="501.0*mm" z_length="749.8 * 2*mm"/>
  <rphi_layout phi_tilt="0.12217*rad" nphi="38" phi0="0.087*rad" rc="466.355*mm + 5.0*mm" dr="0.0"/>
  <z_layout dr="4.0*mm" z0="690.605*mm" nz="17"/>
</layer>
<layer module="SiTrackerModule_Layer3" id="3">
```

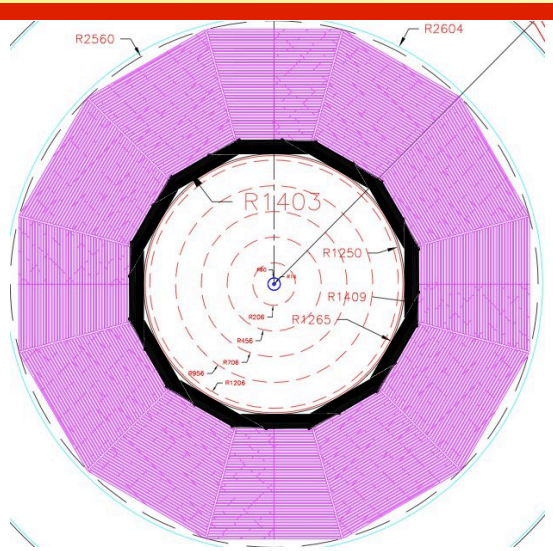
updated xml – as much as possible is computed from a small number of parameters

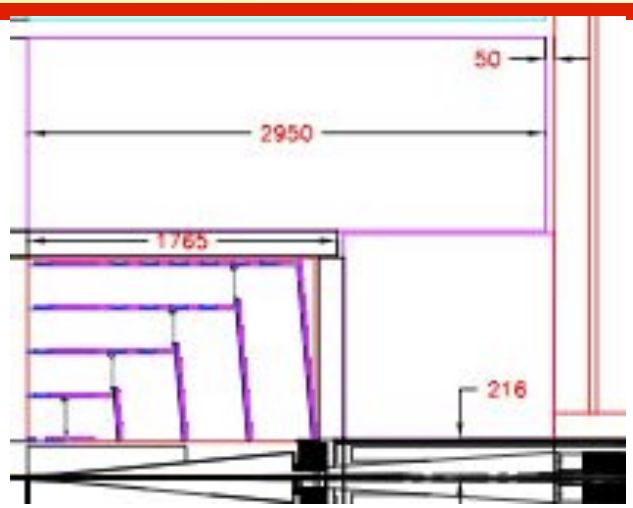
```
<constant name="SiTracker_outer_radius" value="1235.0*mm"/>
<constant name="SiTracker_inner_radius" value="206.00*mm"/>
<constant name="SiTracker_zmax" value="1637.0*mm"/><!-- half-length -->
<constant name="SiTracker_EndcapLayers" value="4"/>
<constant name="SiTracker_BarrelLayers" value="SiTracker_EndcapLayers + 1"/>
```

–> allows studies

```
<layer module="SiTrackerModule_Layer1" id="1">
  <!--barrel_envelope inner_r="215.075*mm" outer_r="245.0*mm" z_length="578 * 2*mm"/-->
  <barrel_envelope inner_r="SiTrackerBarrel_inner_rc - 6.2*mm" outer_r="SiTrackerBarrel_inner_rc + 45.0*mm" z_length="(SiTrackerBarrel_inner_z
+ 60*mm)*2"/>
  <rphi_layout phi_tilt="0.17506*rad" nphi="SiTrackerBarrel_inner_nphi" phi0="0.*rad" rc="SiTrackerBarrel_inner_rc" dr="0.0"/>
  <z_layout dr="4.0*mm" z0="SiTrackerBarrel_inner_z0" nz="SiTrackerBarrel_inner_nz"/>
</layer>
<layer module="SiTrackerModule_Layer2" id="2">
  <!--barrel_envelope inner_r="465.075*mm" outer_r="501.0*mm" z_length="749.8 * 2*mm"/-->
  <barrel_envelope inner_r="SiTrackerBarrel_rc_2 - 6.2*mm" outer_r="SiTrackerBarrel_rc_2 + 45.0*mm" z_length="(SiTrackerBarrel_z0_2 + 60*mm)*
```

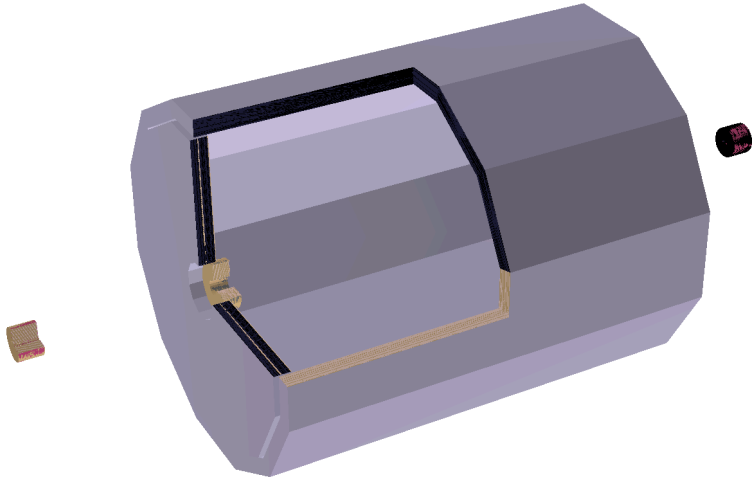
ECAL / HCAL

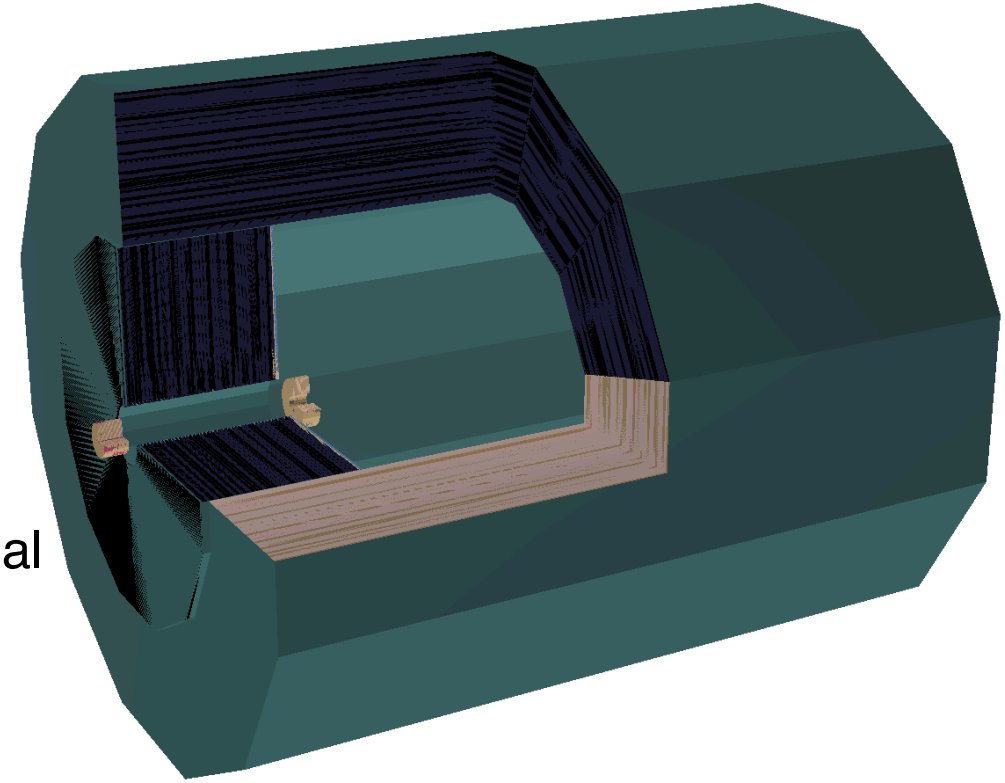


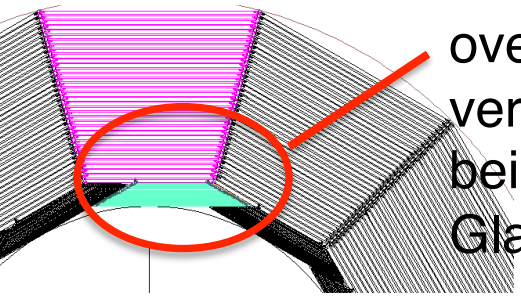


20+10 layer SiW ECAL
40 layer Steel HCAL
recently updated to scintillator

HCAL detailed model being developed at UT Arlington



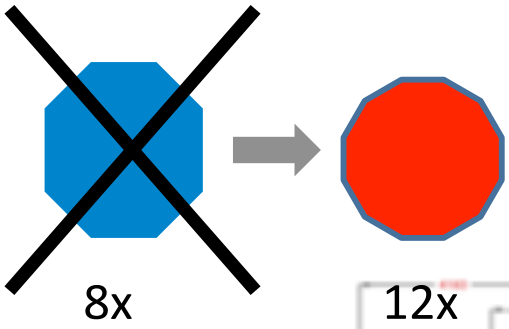


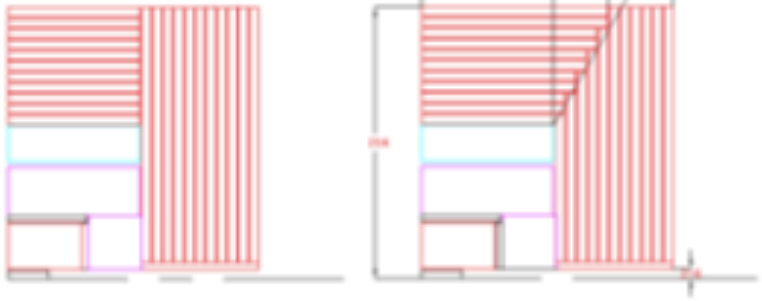


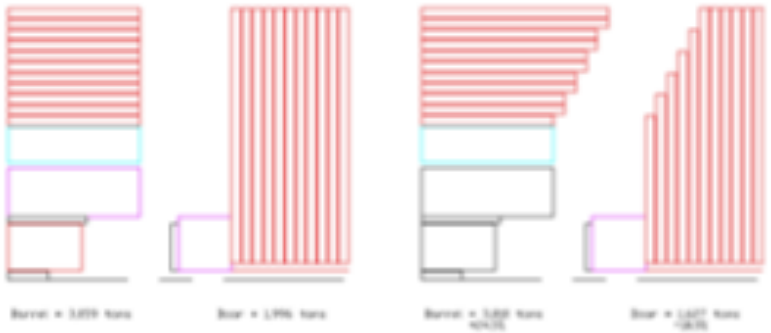
overlap not modeled in initial version – detailed model being developed (Oregon/ Glasgow)

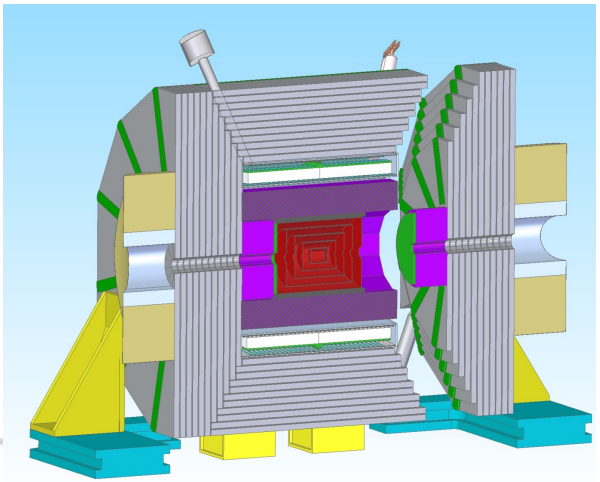
Muon

Yoke/Muon system changes since DBD:

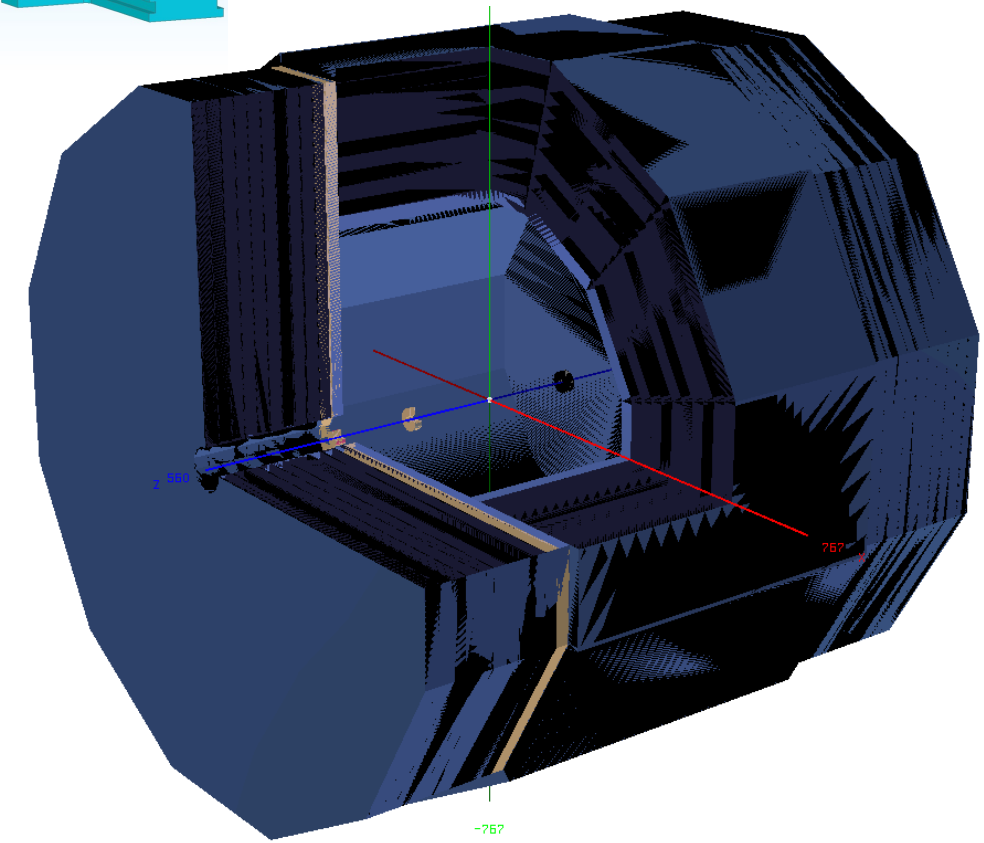








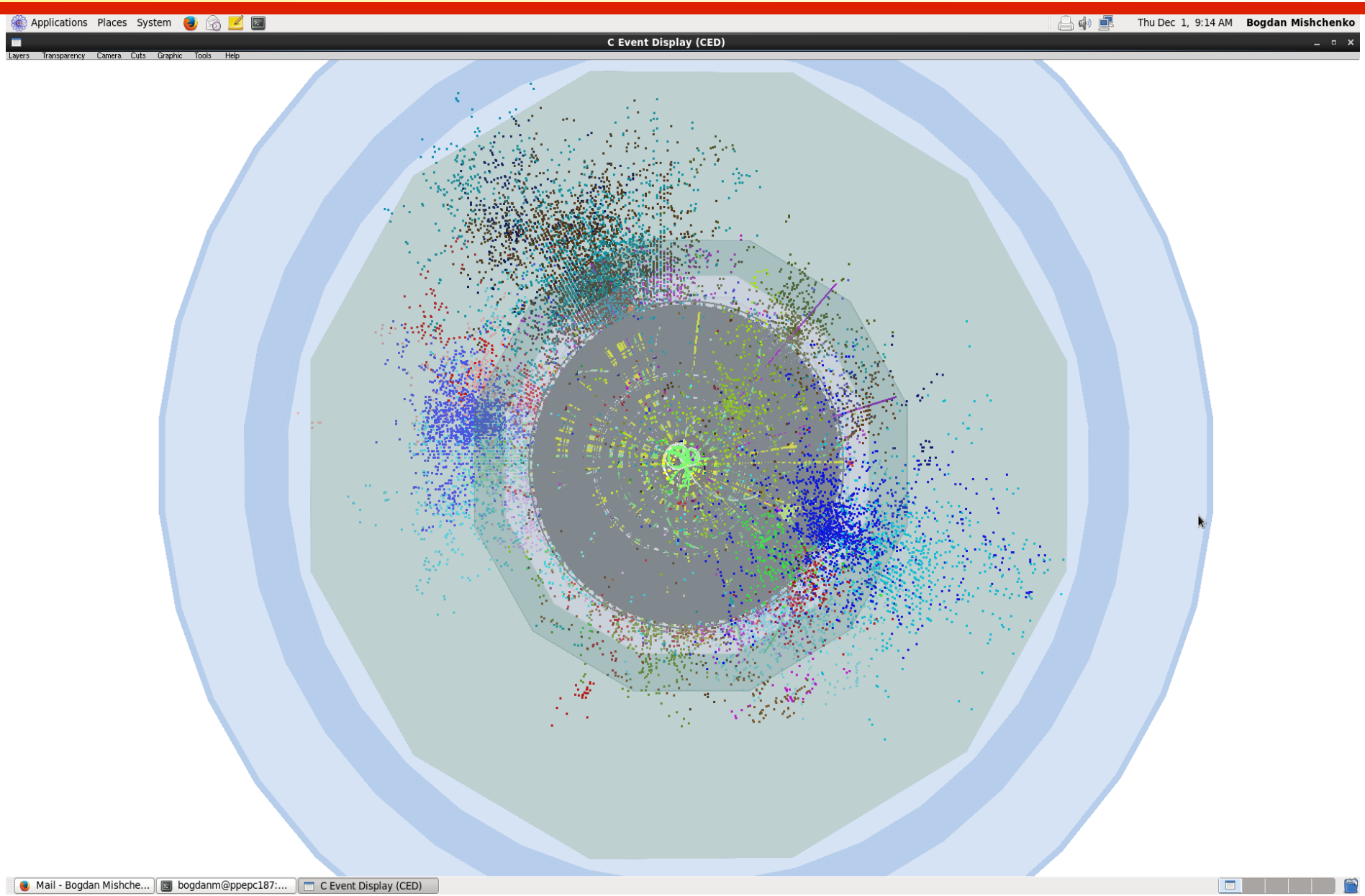
12-sided geometry
implemented
30° barrel/door join
being implemented



Digi/Reco

- Using:
  DDPlanarDigiProcessor
  RealisticCaloDigi
  DDSimpleMuonDigi
  – working
- TruthTrackFinder – working
  full CLIC-style pattern recognition – runs; being commissioned
- DDMarlinPFAProcessor
  – newly working; being commissioned
- Starting on:
  pandora calibration
  vertex-finding
  flavour-tagging
  pileup/overlay
  …

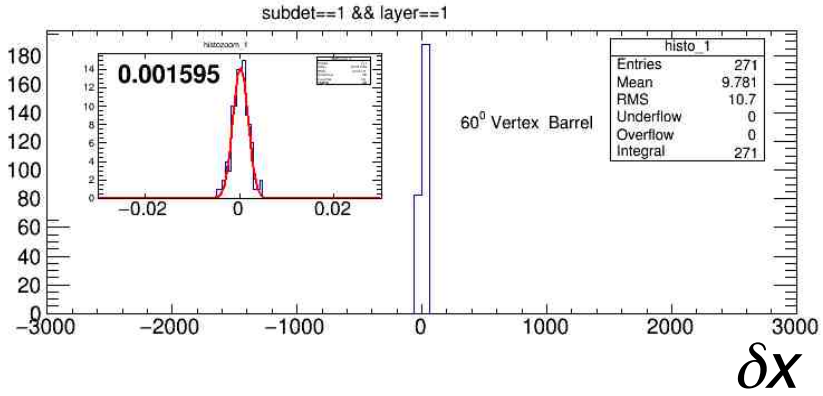
Event display – CED

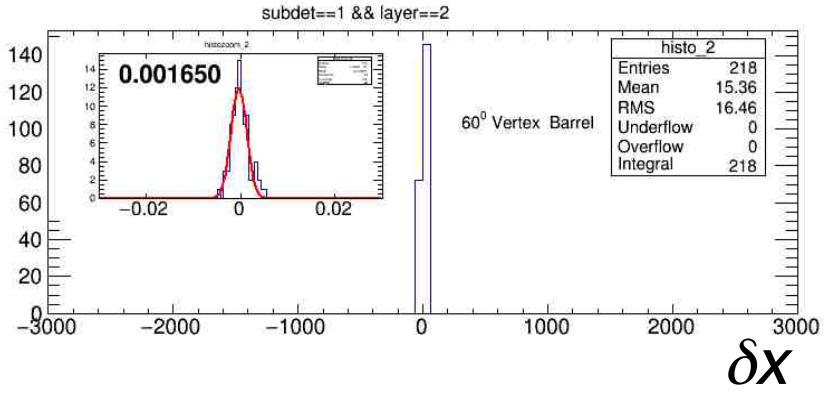


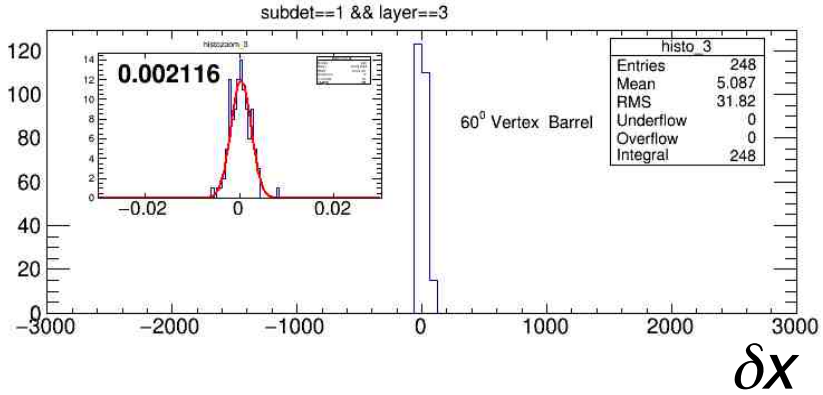
ttbar event displayed

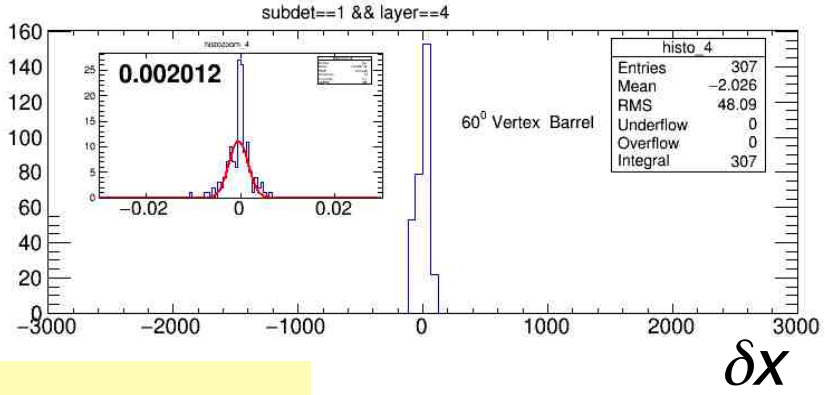
Simulation performance(1)

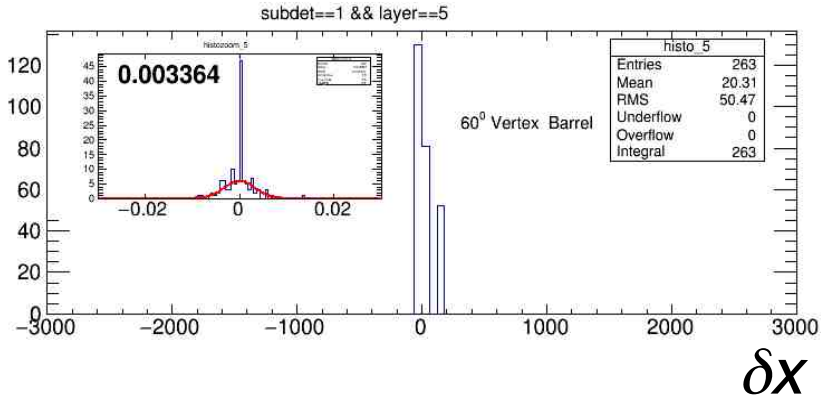
Simulation performance diagnostics underway









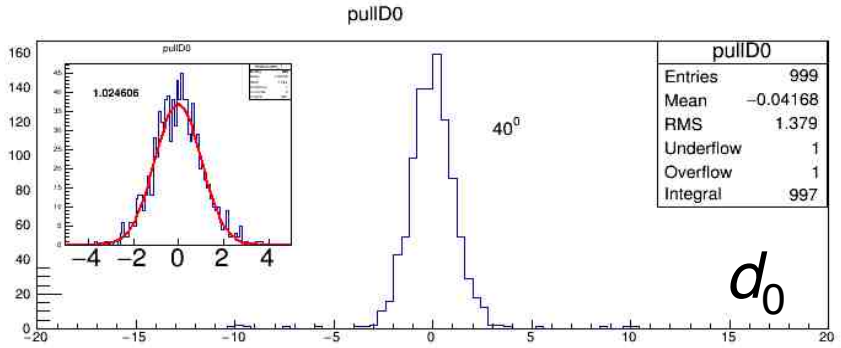


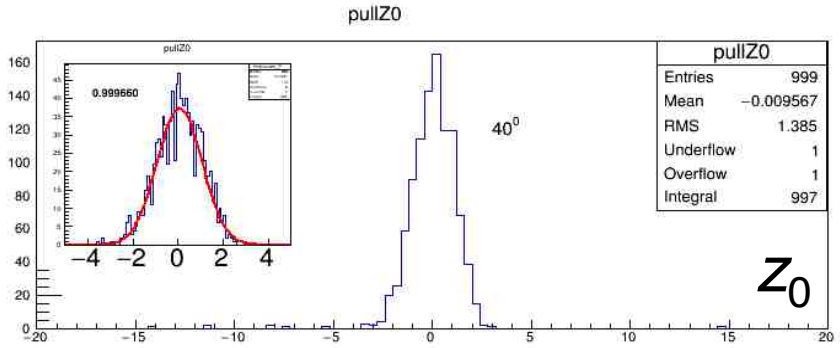
Performance benchmarking tools, drawing heavily from ILD/CLICdp

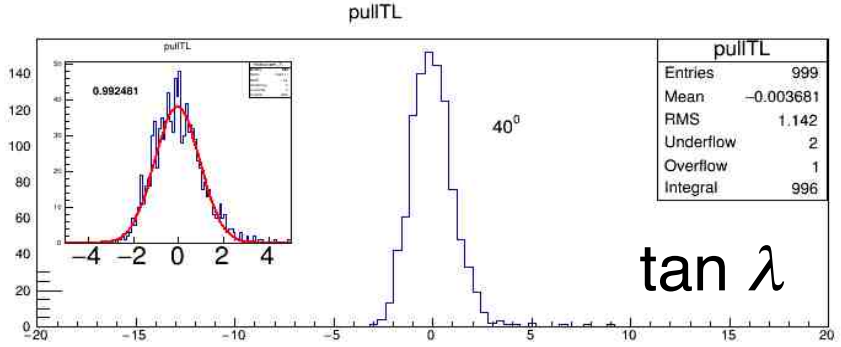
hit residuals (vertex detector)

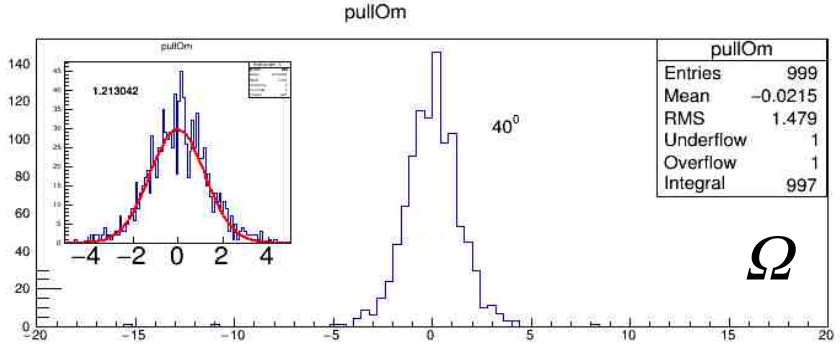
$$R(T_i)=T_i^{reco}-T_i^{truth}$$

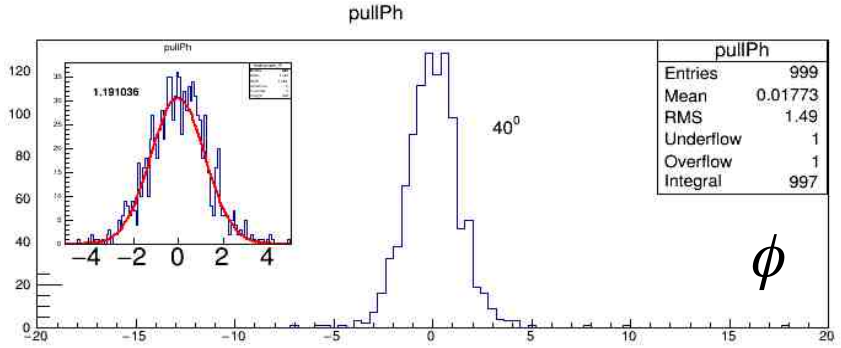
Simulation performance(2)











track parameter pulls

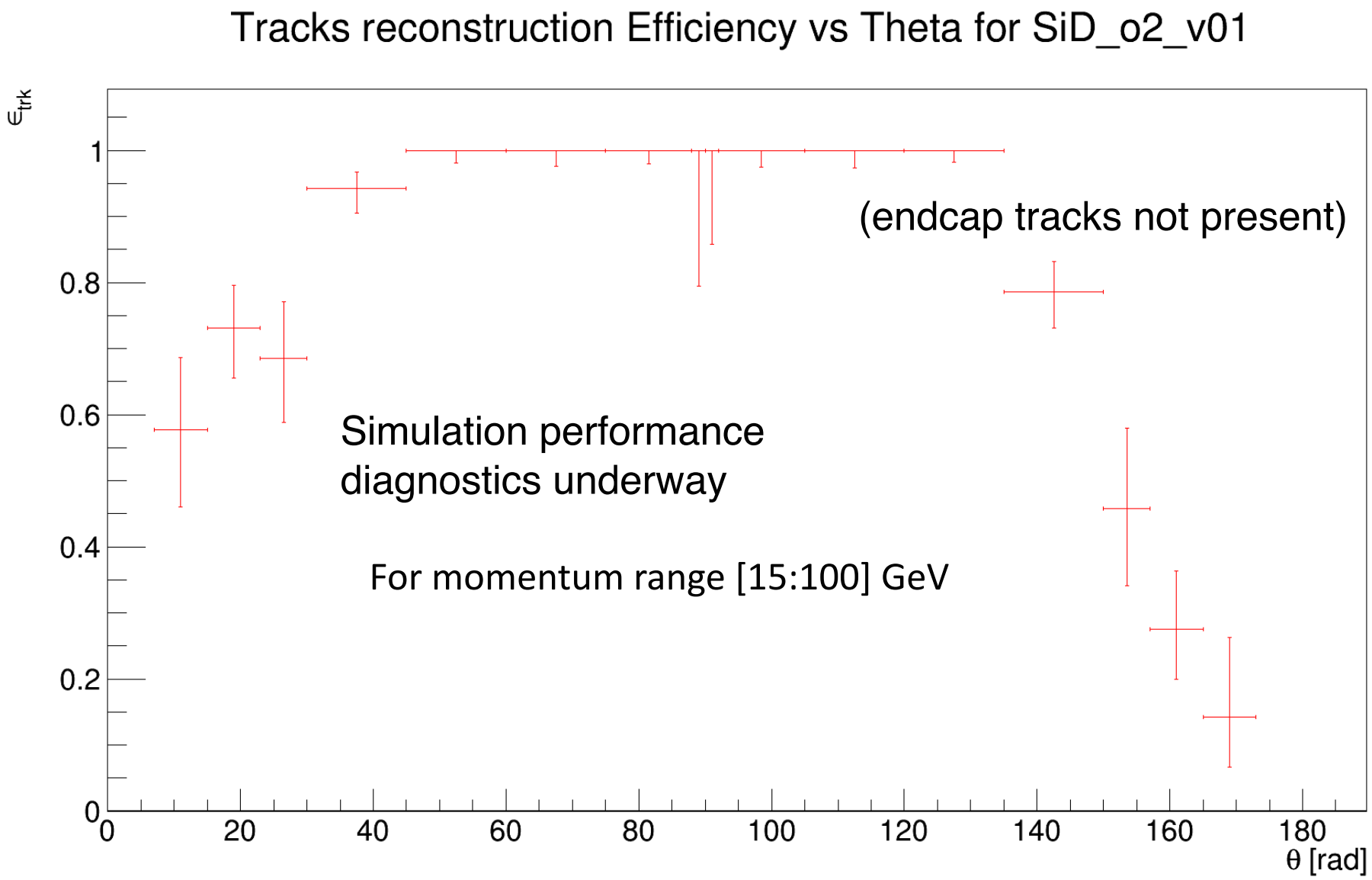
Residuals for track parameters:

$R(T_i)=T_i^{reco}-T_i^{truth}$

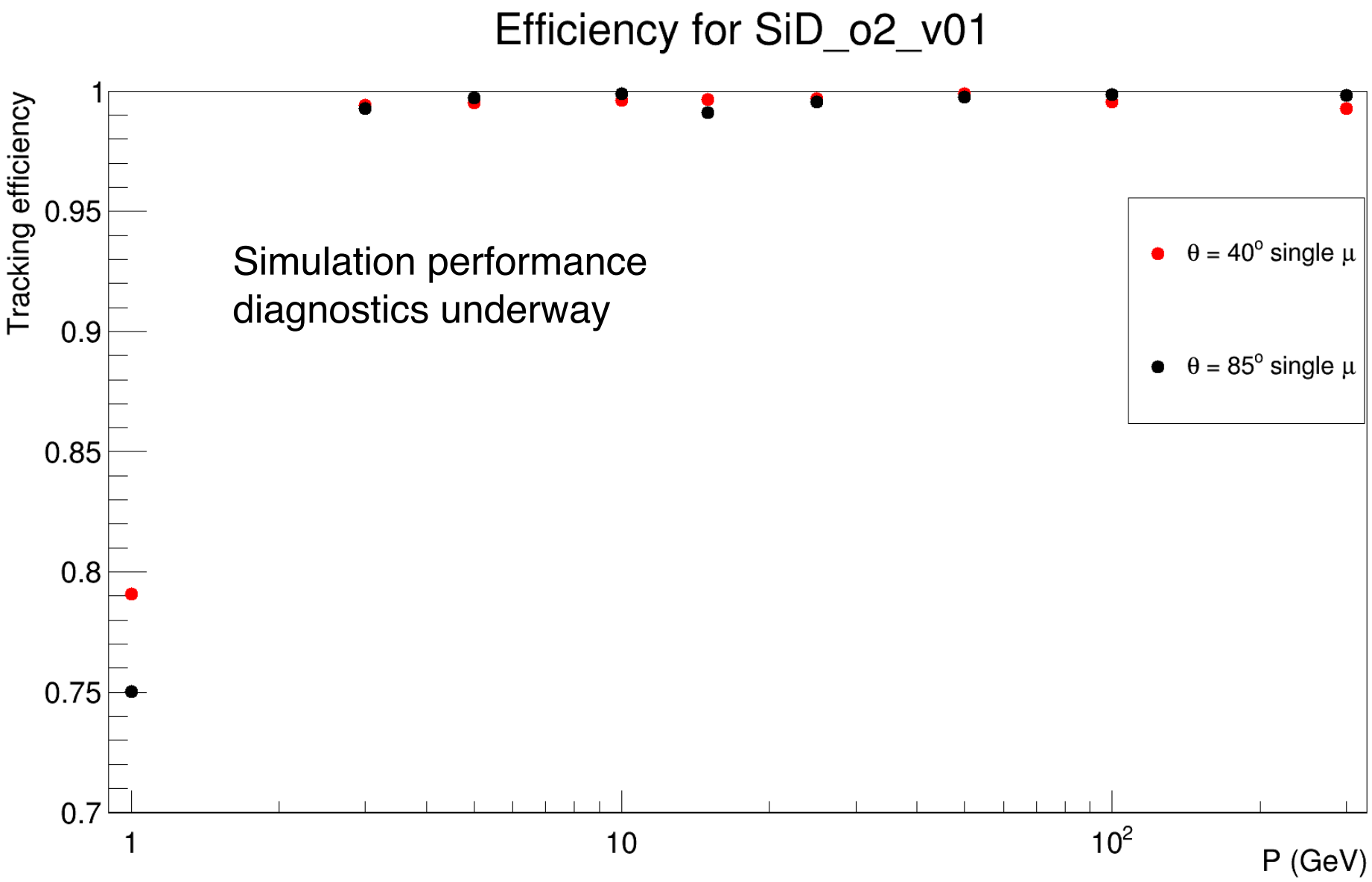
Pulls for residuals:

$$P(T_i)=\frac{R(T_i)}{\sigma T_i}$$

Simulation performance(3)

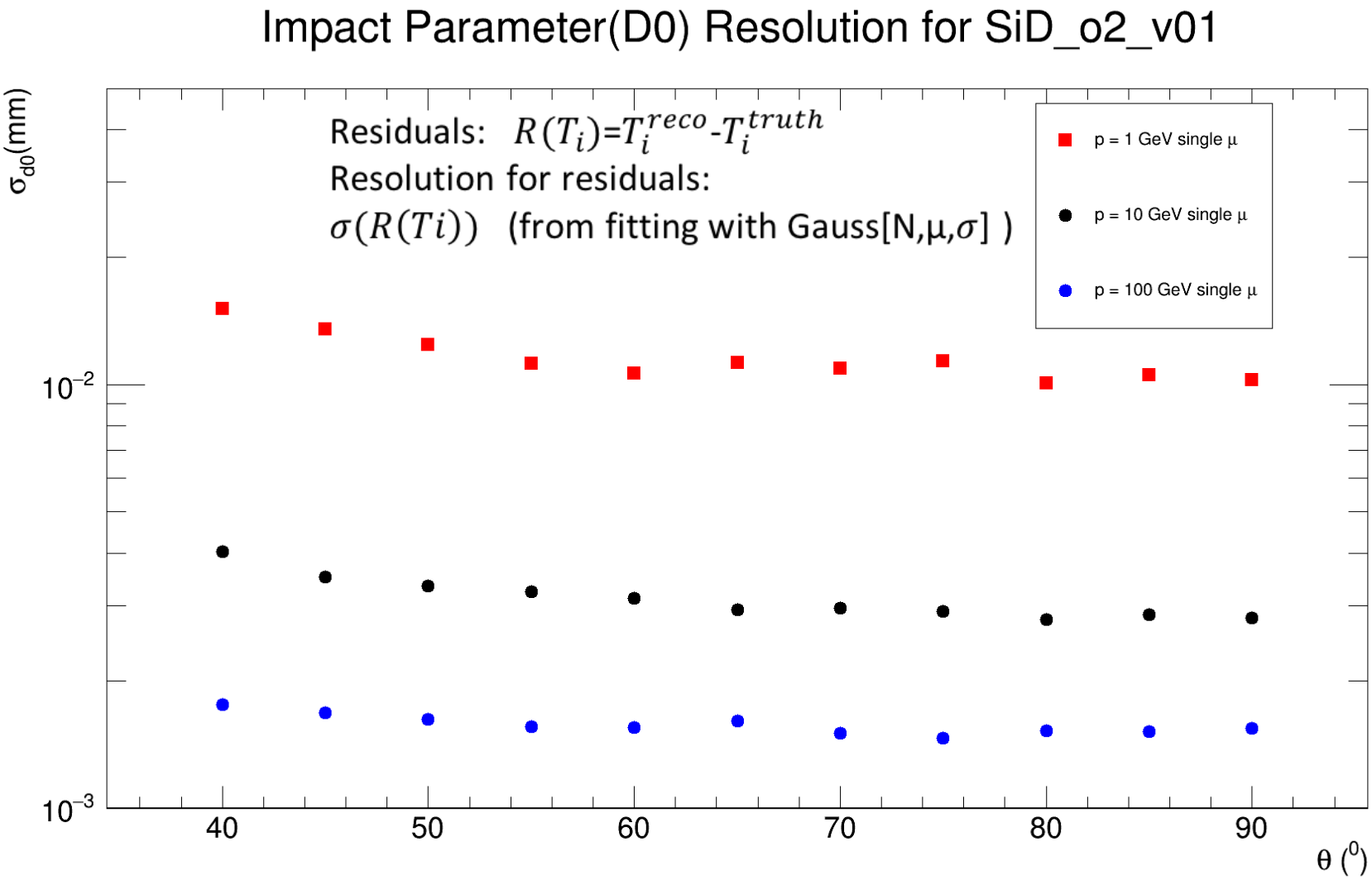


Simulation performance(4)



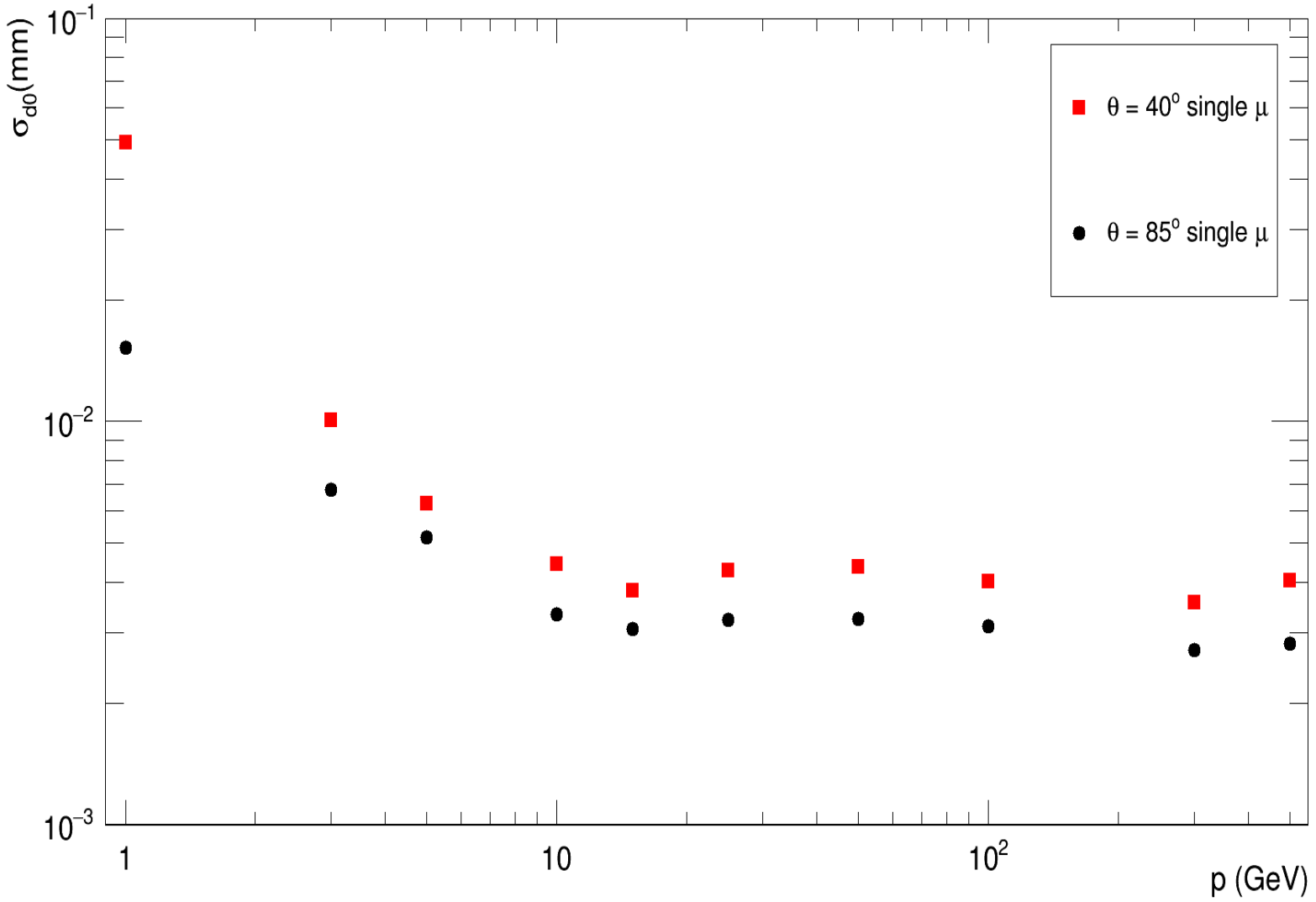
Simulation performance(5)

Simulation performance diagnostics underway:

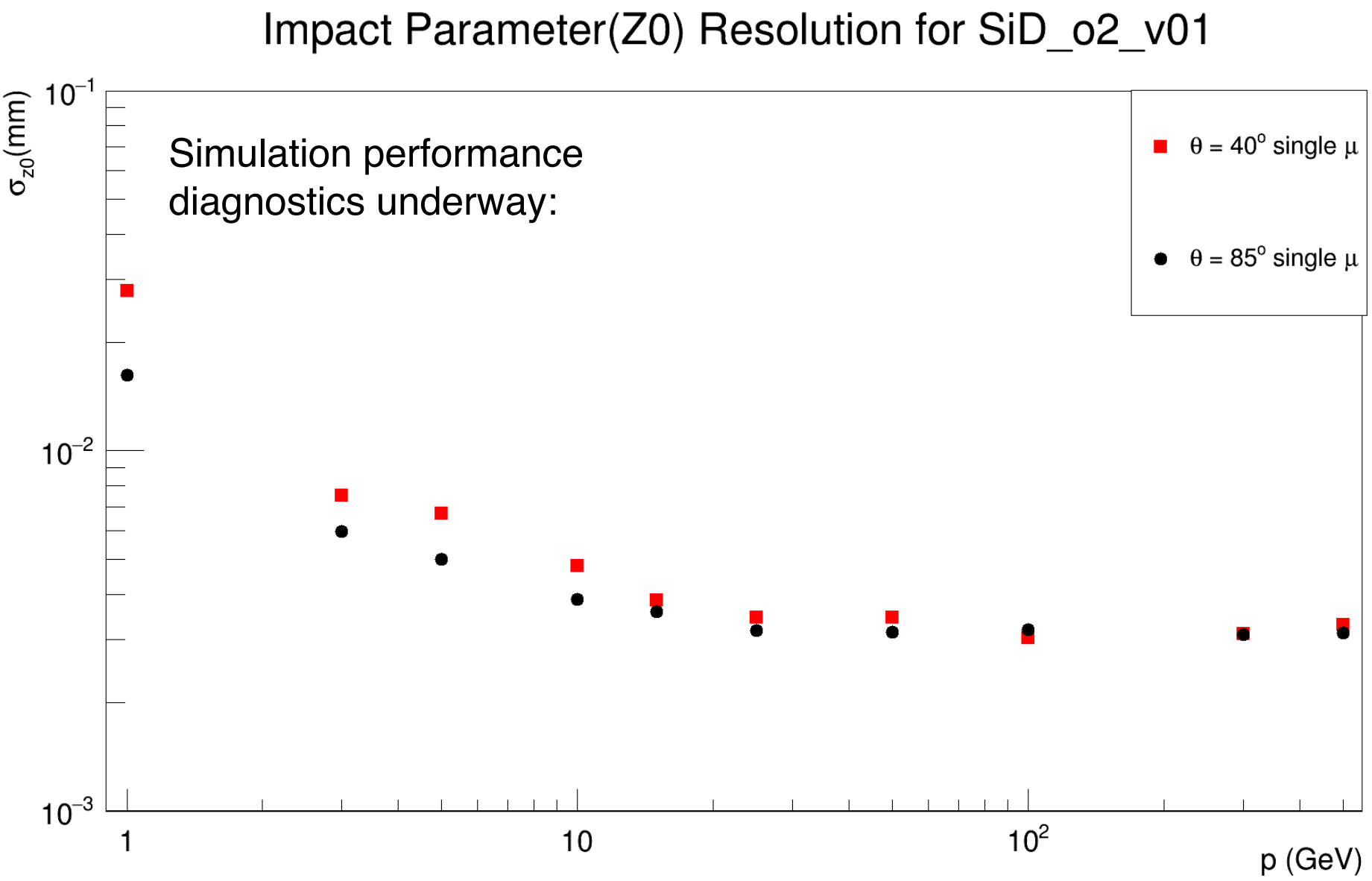


Simulation performance(6)

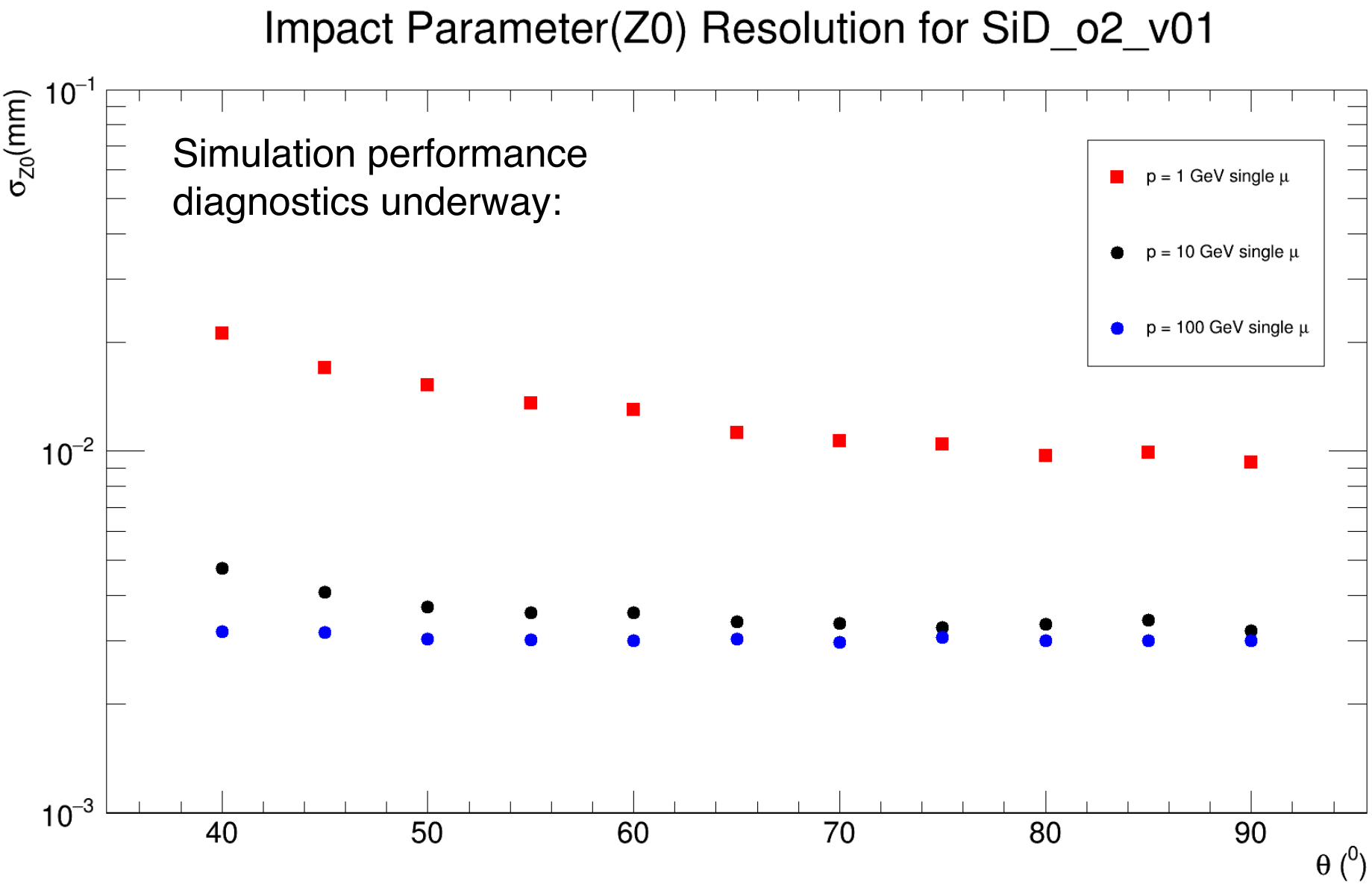
Simulation performance diagnostics underway:



Simulation performance(7)



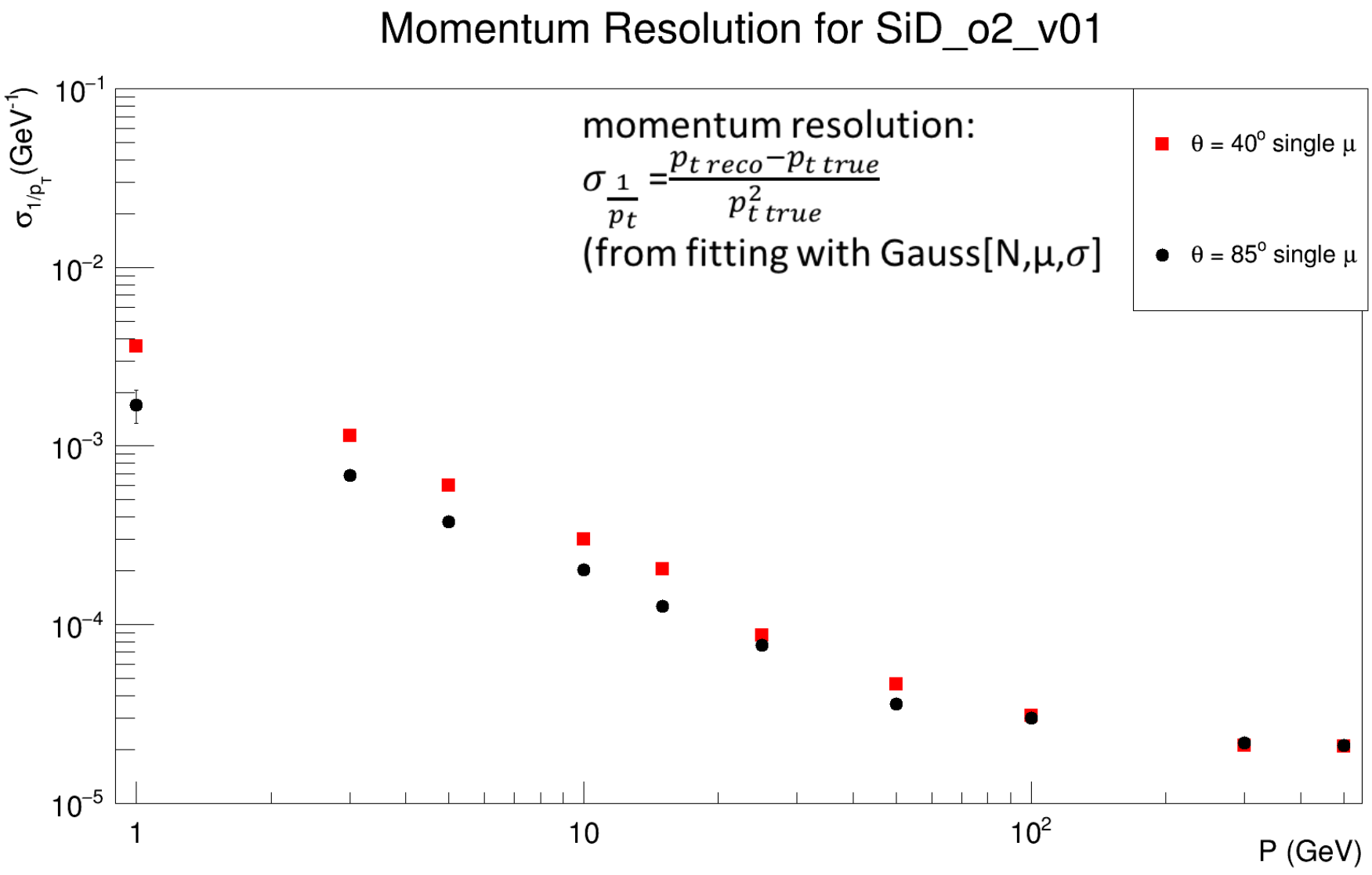
Simulation performance(8)



Simulation performance(9)

Simulation performance diagnostics underway:

(endcap tracks not present)



Collaboration activities

Excellent SiD s/w / optimization workshop at PNNL in September

NEWSLINE
THE NEWSLETTER OF THE LINEAR COLLIDER COMMUNITY

CURRENT ISSUE
3 NOVEMBER 2016

Calorimeter under telescope scrutiny
Strasbourg steers ILC towards ESRFI roadmap
Construction completed: ILC in Roppongi
Download the current issue as a full .pdf

ANNOUNCEMENTS

LCWS2016 early registration deadline extended

The early registration deadline for **LCWS2016** in Morioka, Japan, has been extended to 7 November.

CALENDAR

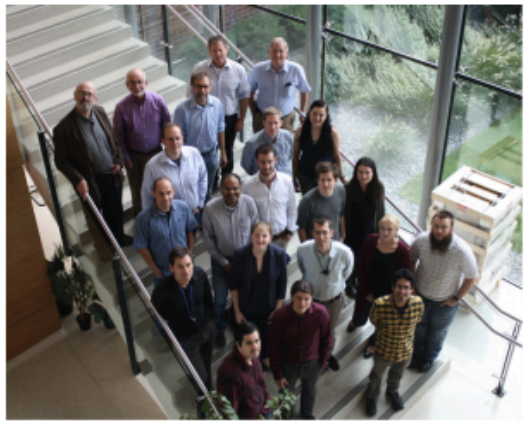
Upcoming Events

International Workshop on Future Linear Colliders

FEATURE

SiD optimisation group moves towards new detector model after PNNL meeting

Jan Strube, PNNL | 20 October 2016



Participants of the 2016 SiD optimisation workshop at PNNL.

With LCWS in Morioka just over eight weeks away, and several new students from the University of Oregon, University of California at Santa Cruz and University of Texas at Arlington joining the optimisation effort, the SiD optimisation group decided that the time was right to hold a workshop dedicated to getting new users up to speed with how to use a different framework. The Pacific Northwest National Laboratory (PNNL) hosted the event, and 20 people from the U.S. and Europe found their way to Richland, WA, about 14 miles away from the LIGO Hanford Observatory.

While the ILC accelerator published their TDR in 2012, the detectors still have a way to go before they can publish their TDRs. The SiD detector consortium decided at the end of 2015 to change their simulation and reconstruction to the new framework developed by ILD and CLIC, which is partially supported by the EU-AIDA2020 project. This change is quite disruptive, as users are moving from tools written in Java to a purely C++-based infrastructure. However, it became mandatory due to the lack of

The be
the old

Active slack channels to continue from PNNL workshop
https://silicondetector.slack.com/messages/detector_geometry/

Summary and to do list

- Huge progress on SiD model and reconstruction
  - –Built from close collaboration with CLICdp and ILD
  - –Many more contributors since PNNL workshop

- Ongoing:

Tracking pattern recognition commissioning

Tracking (/tracker) performance / development
(e.g. working on forward tracks)

Calorimeter calibration / reconstruction performance

Particle Flow implementation/commissioning

Physics sensitivity studies

Thank you

Some useful definitions

Residuals for track parameters:

$R(T_i)=T_i^{reco}-T_i^{truth}$

Pulls for residuals:

$P(T_i)=\frac{R(T_i)}{\sigma T_i}$

Residuals for layers:

$R_i = fit\ coordinate - hit\ coordinate$

Resolution for residuals:

$\sigma(R(Ti))$ (from fitting with Gauss[N,μ,σ])

Resolution for momentum:

$\sigma_{\frac{1}{p_t}}=\frac{p_{t\,reco}-p_{t\,true}}{p_{t\,true}^2}$ (from fitting with Gauss[N,μ,σ]