

SiD Simulation and Reconstruction Status

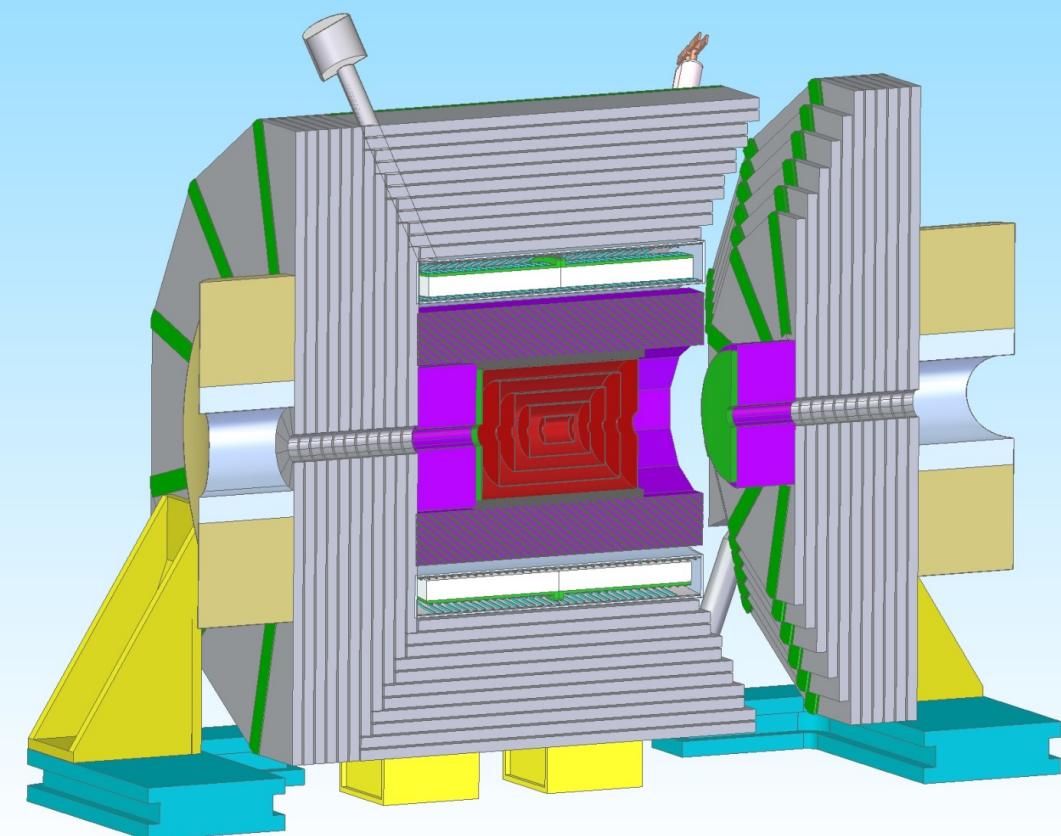
LCUK Meeting, London 19th April 2017

- ◆ DD4HEP simulation model status
- ◆ Reconstruction status
- ◆ Collaboration activities
- ◆ Outlook

Aidan Robson
Dan Protopopescu

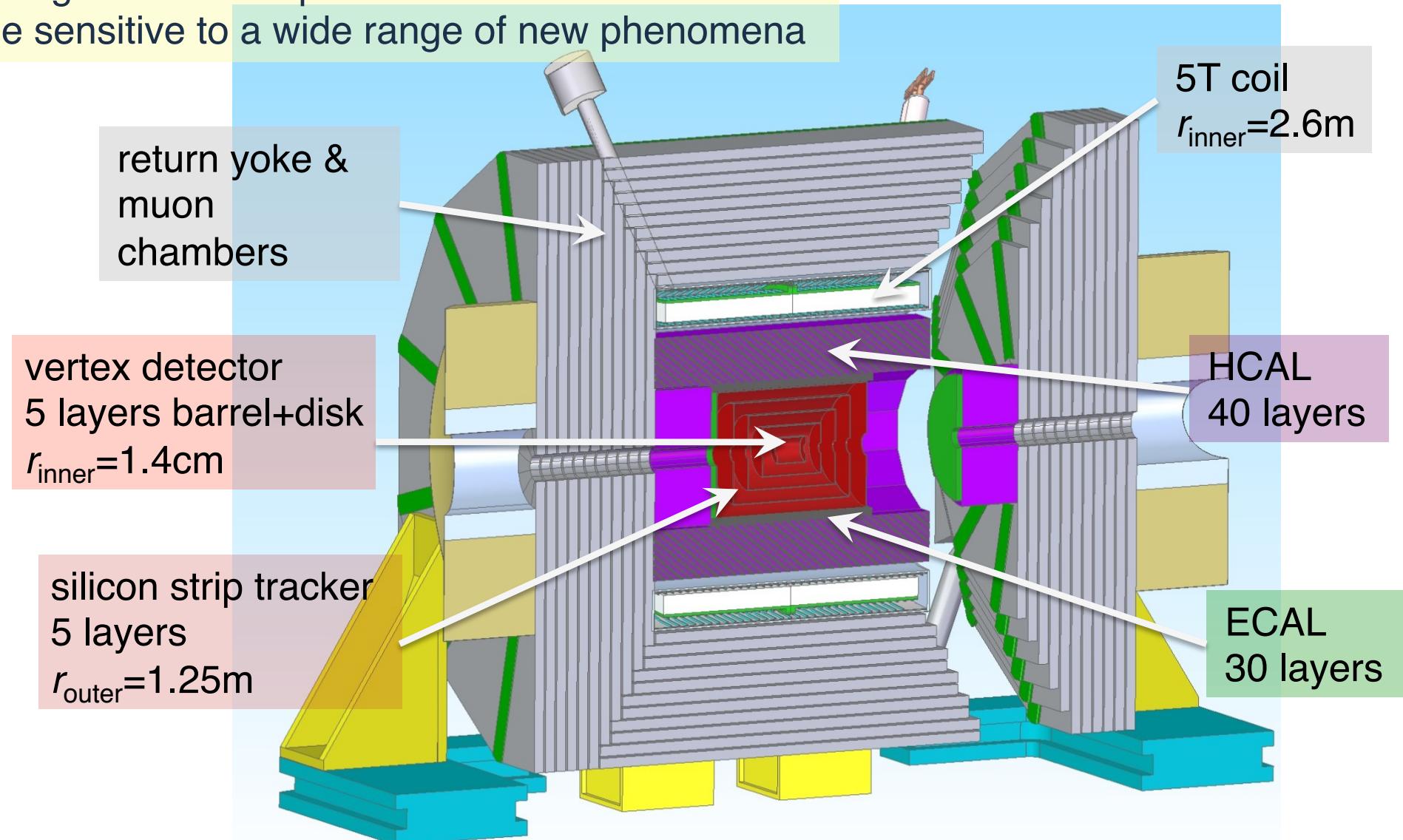


University
of Glasgow | Experimental
Particle Physics



A compact, cost-constrained detector

designed to make precision measurements and
be sensitive to a wide range of new phenomena



SiD context:

New implementation of detector model in DD4hep
incorporating updates since LOI model

sid_o2_v02

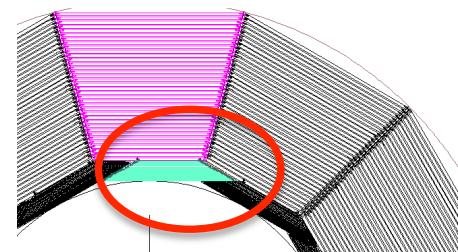
being used in ilcsoft v01-19-01

contains updates on:

ECalBarrel from Oregon (overlap regions)

HCal from UT Arlington
(end plate, air gaps, layer thicknesses)

plus changes from Aidan/Dan (Glasgow) to
accommodate technical issues with low-angle
tracks and PFA



Incremental progress since last LCUK meeting (November 2016)
Focus on reconstruction and benchmarking

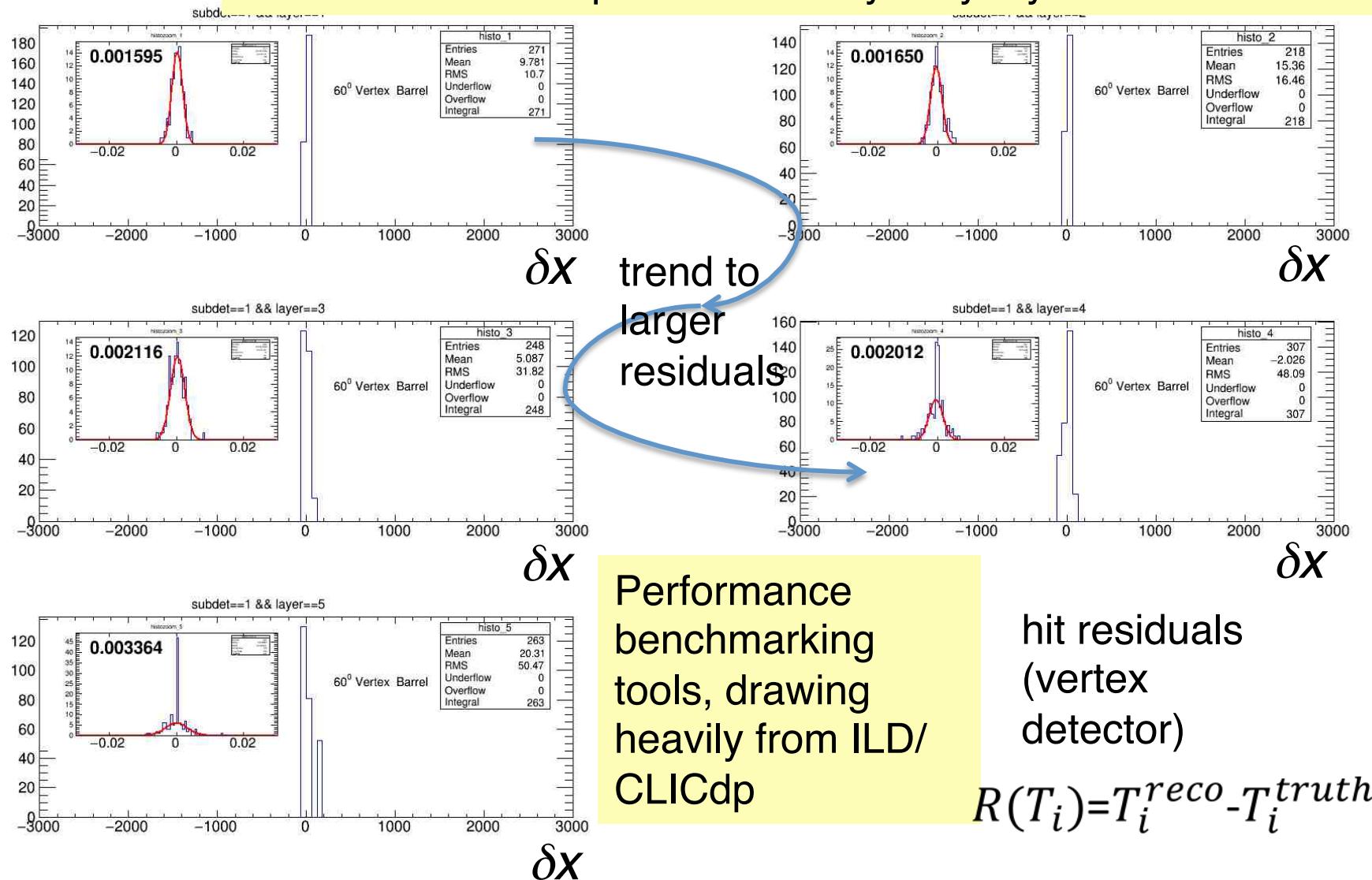
Tracking performance:

studies from Bogdan Mishchenko (Glasgow MSc student)
and Jonathan Jamieson (Glasgow UG student)

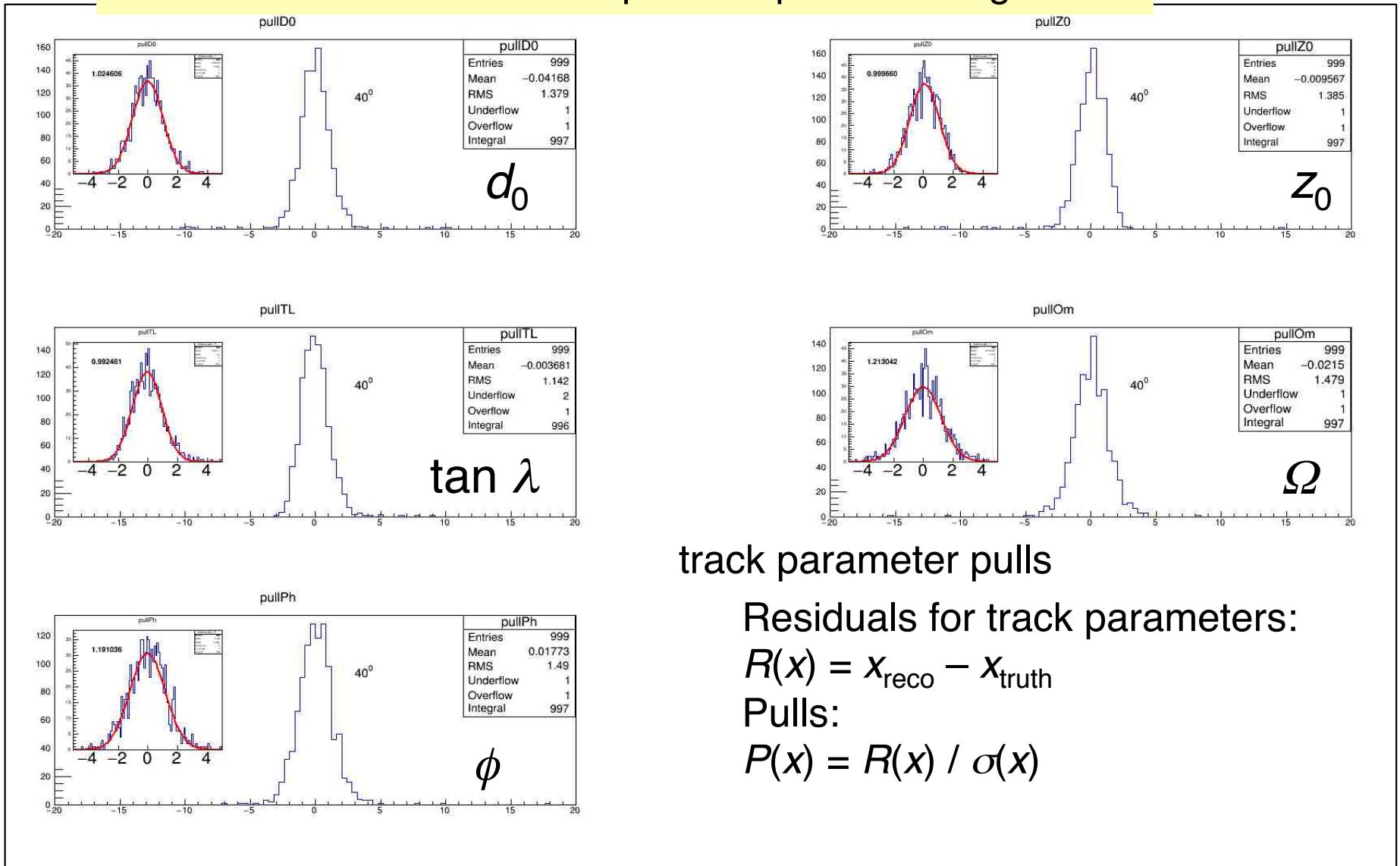
Calorimeter performance:

studies from Lauren Darling (Glasgow UG student)

Simulation performance diagnostics underway
Look at different aspects – here layer-by-layer hit residuals



...and track parameters – here for truth tracking but point is to be able to evaluate/compare full pattern recognition



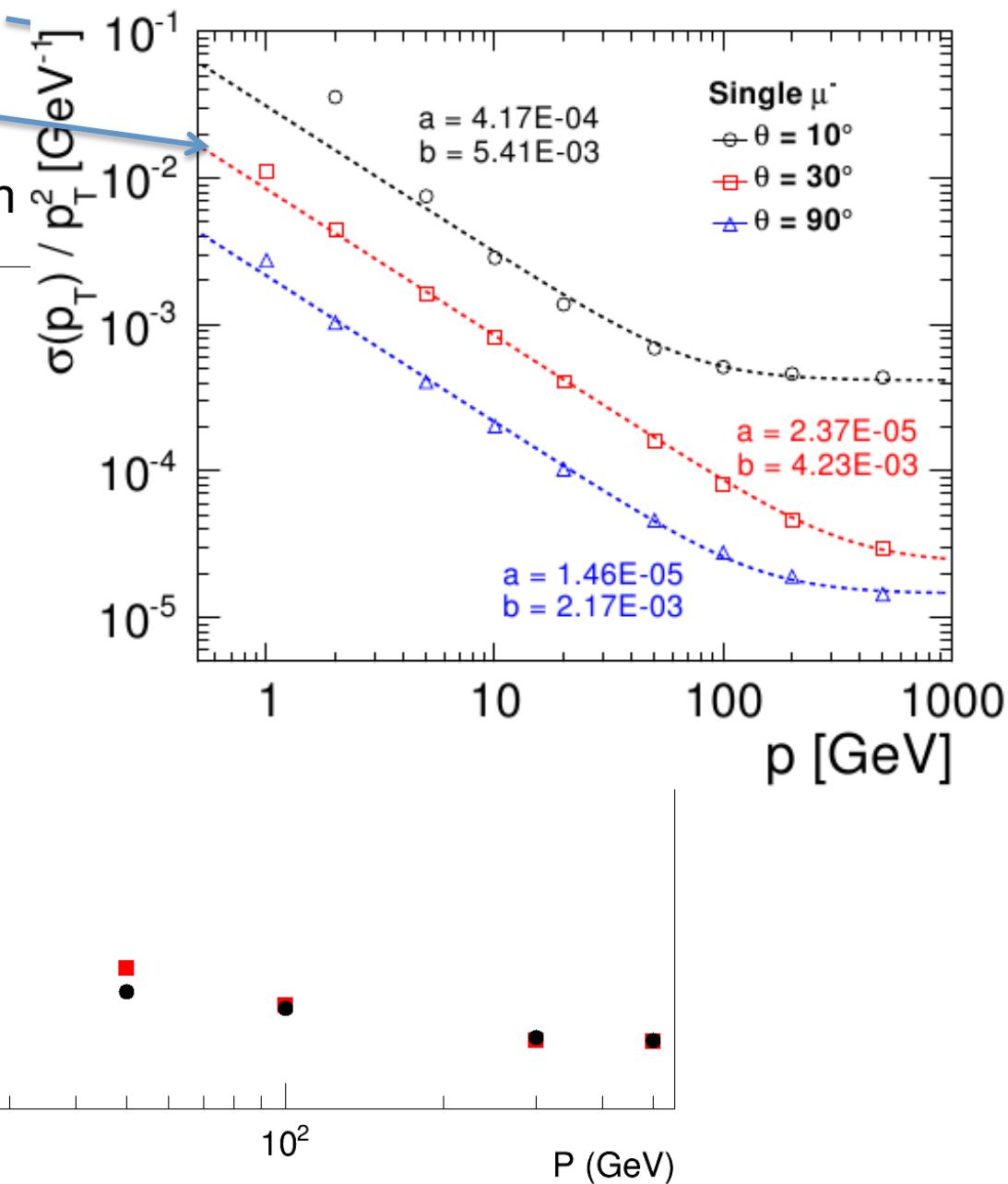
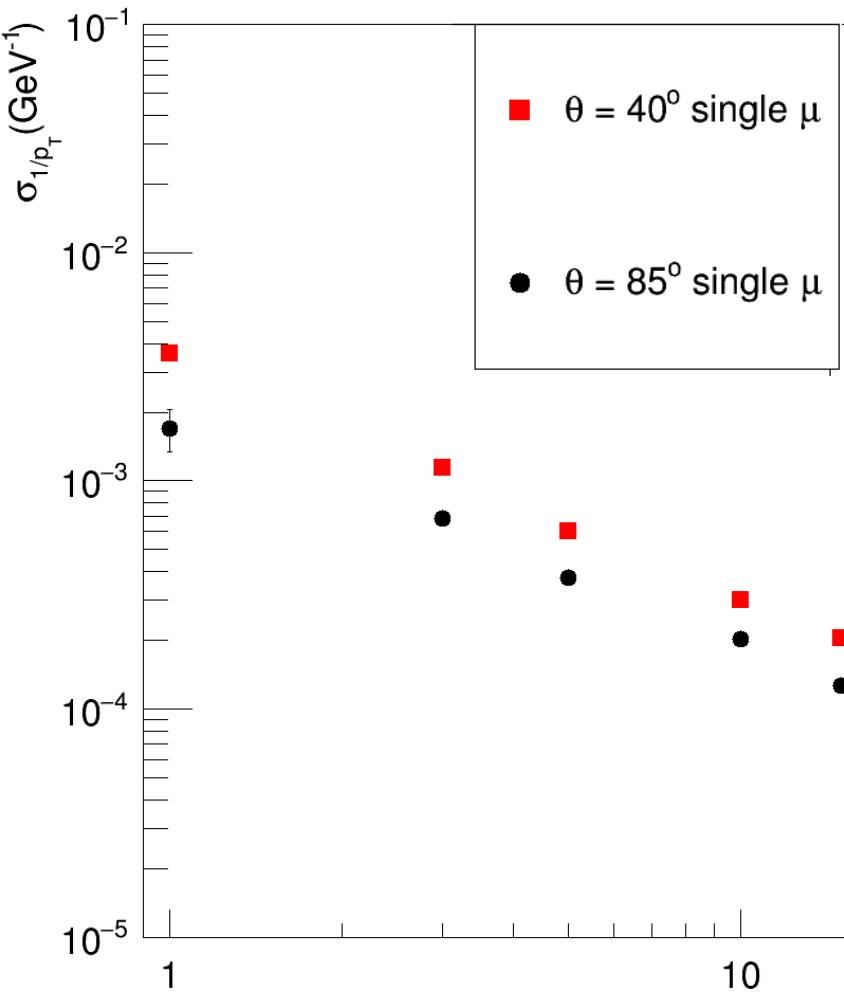


• Simulation/tracking performance •



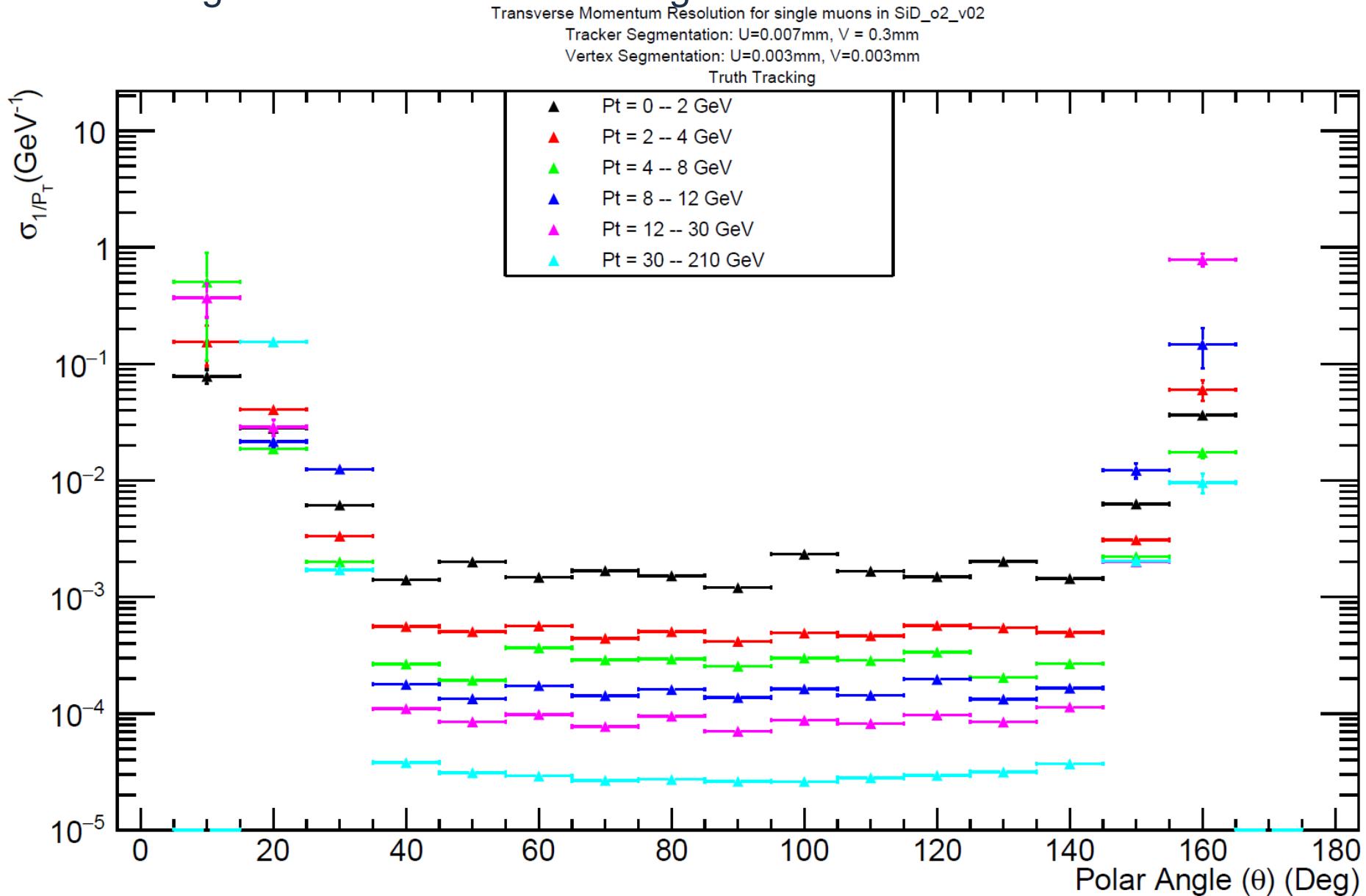
DBD: very similar
low-angle tracks to be added

Momentum Resolution



Tracking

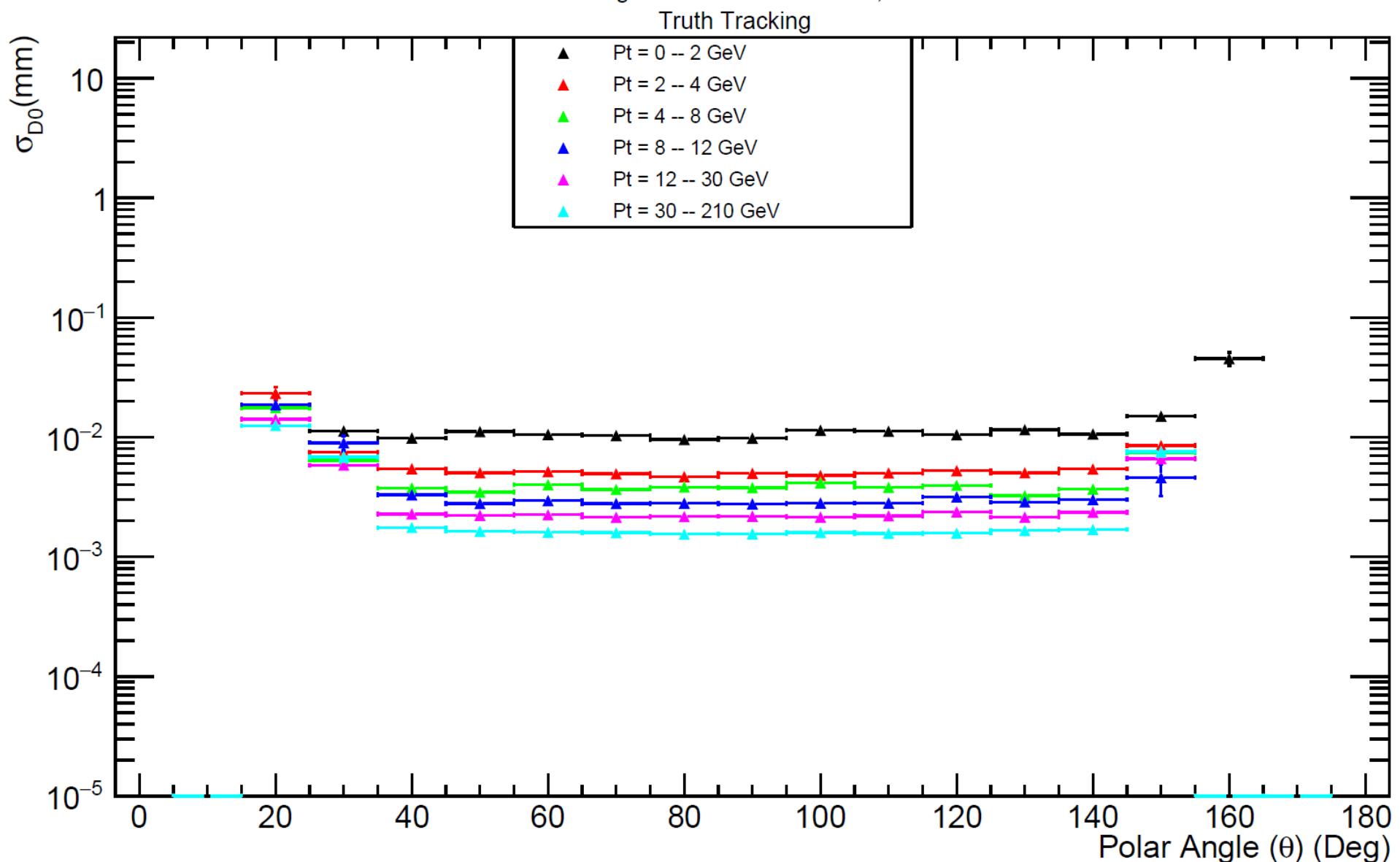
Start with single muons and truth tracking:



Tracking

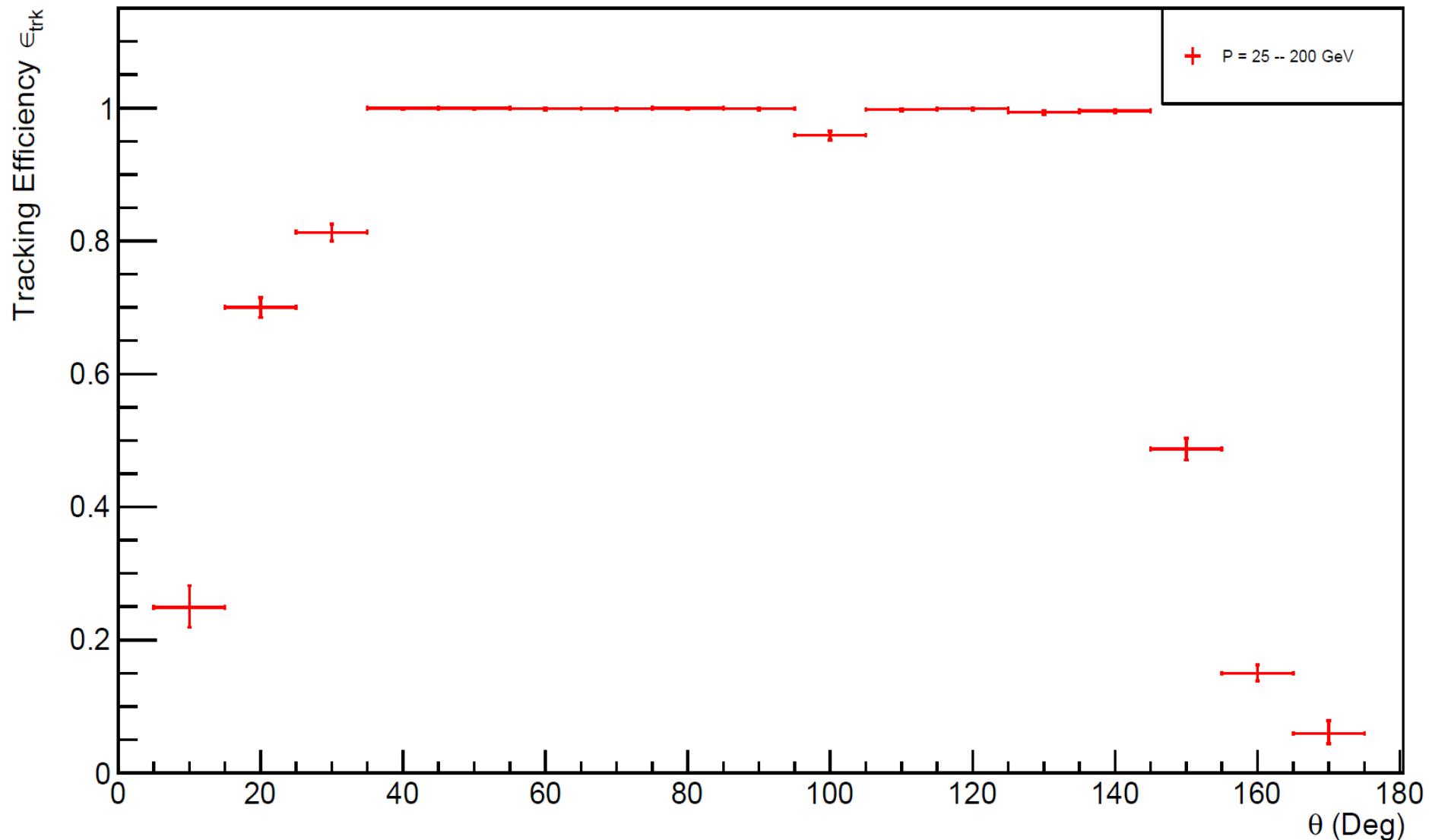
Single muons & truth tracking: D0 Resolution for single muons in SiD_o2_v02

Tracker Segmentation: U=0.007mm, V = 0.3mm



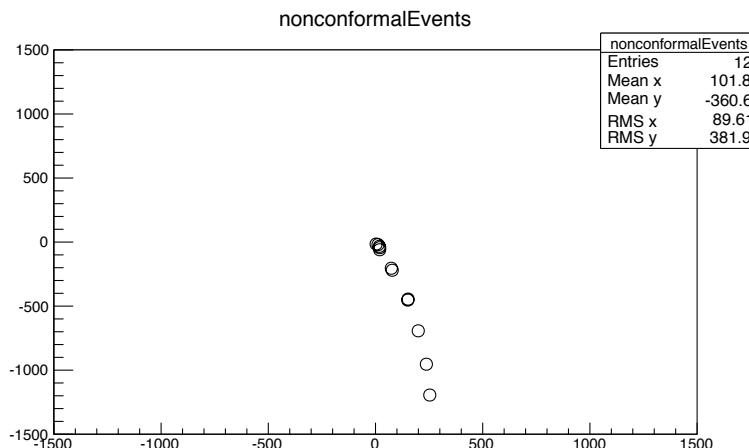
Single muons & truth tracking:

Track Reconstruction Efficiency vs Theta in SiD_o2_V02 Single Muons Truth Tracking

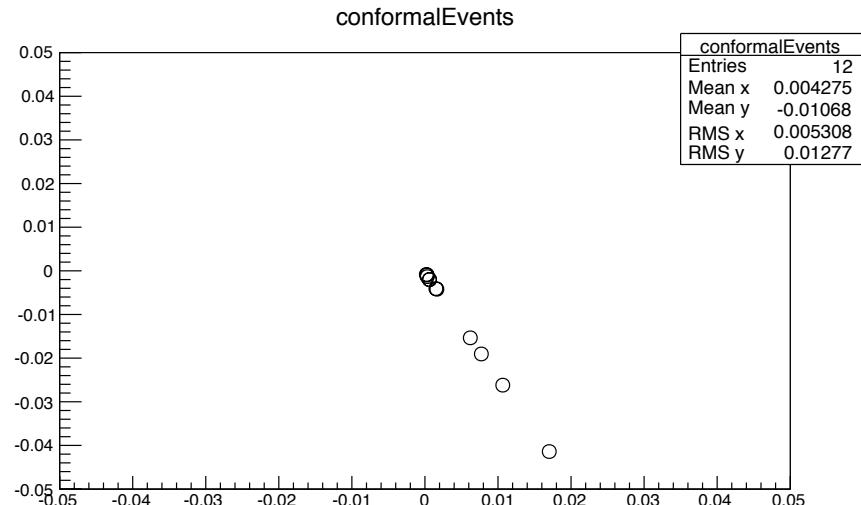


Tracking

Implemented pattern recognition from CLICdp



Transform vertex detector hits
and fit straight lines with cellular automaton
extrapolate to tracker and add hits

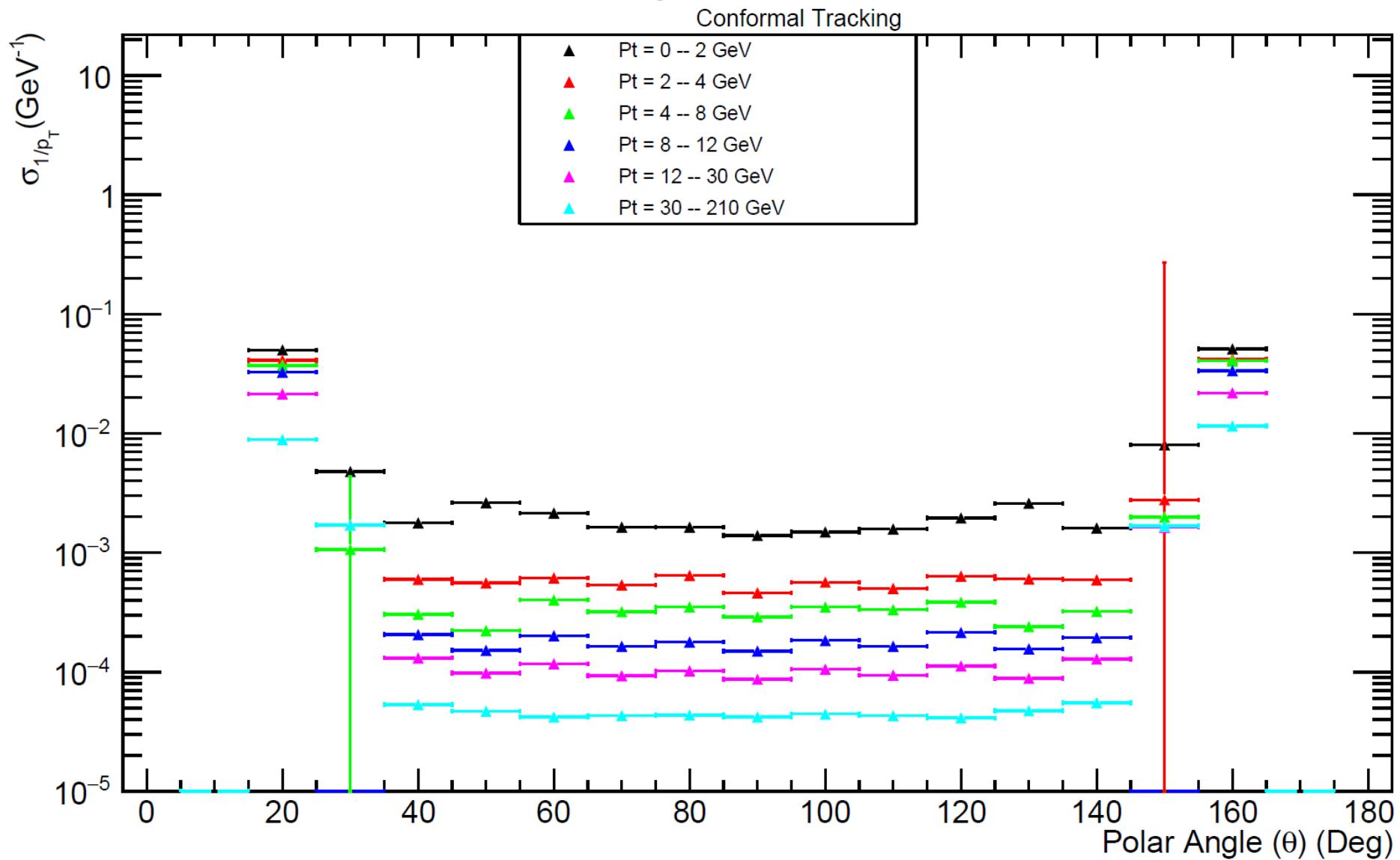


Tracking

with pattern recognition:

Transverse Momentum Resolution for single muons in SiD_o2_v02

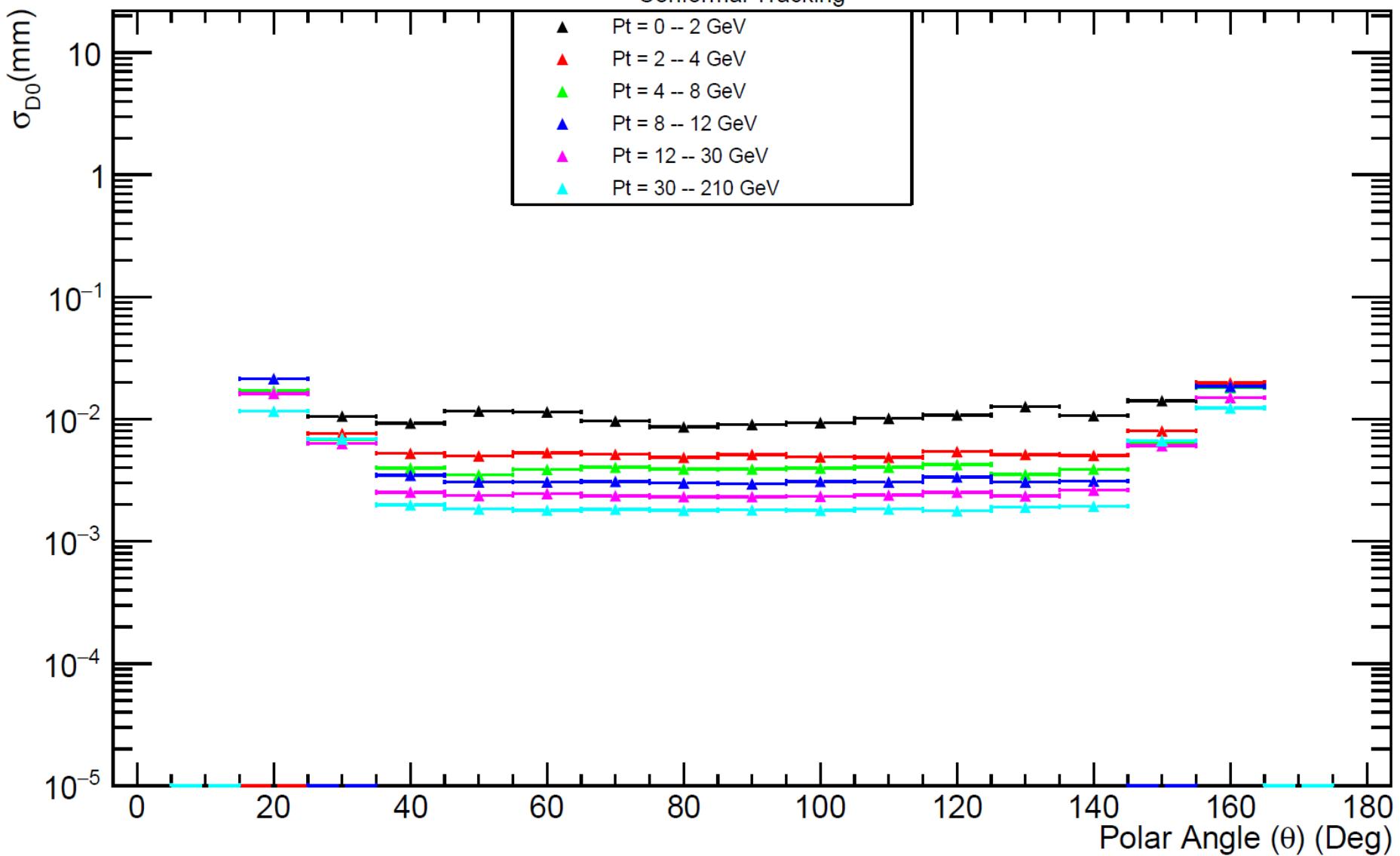
Tracker Segmentation: U=0.007mm, V = 0.3mm



Tracking

with pattern recognition:

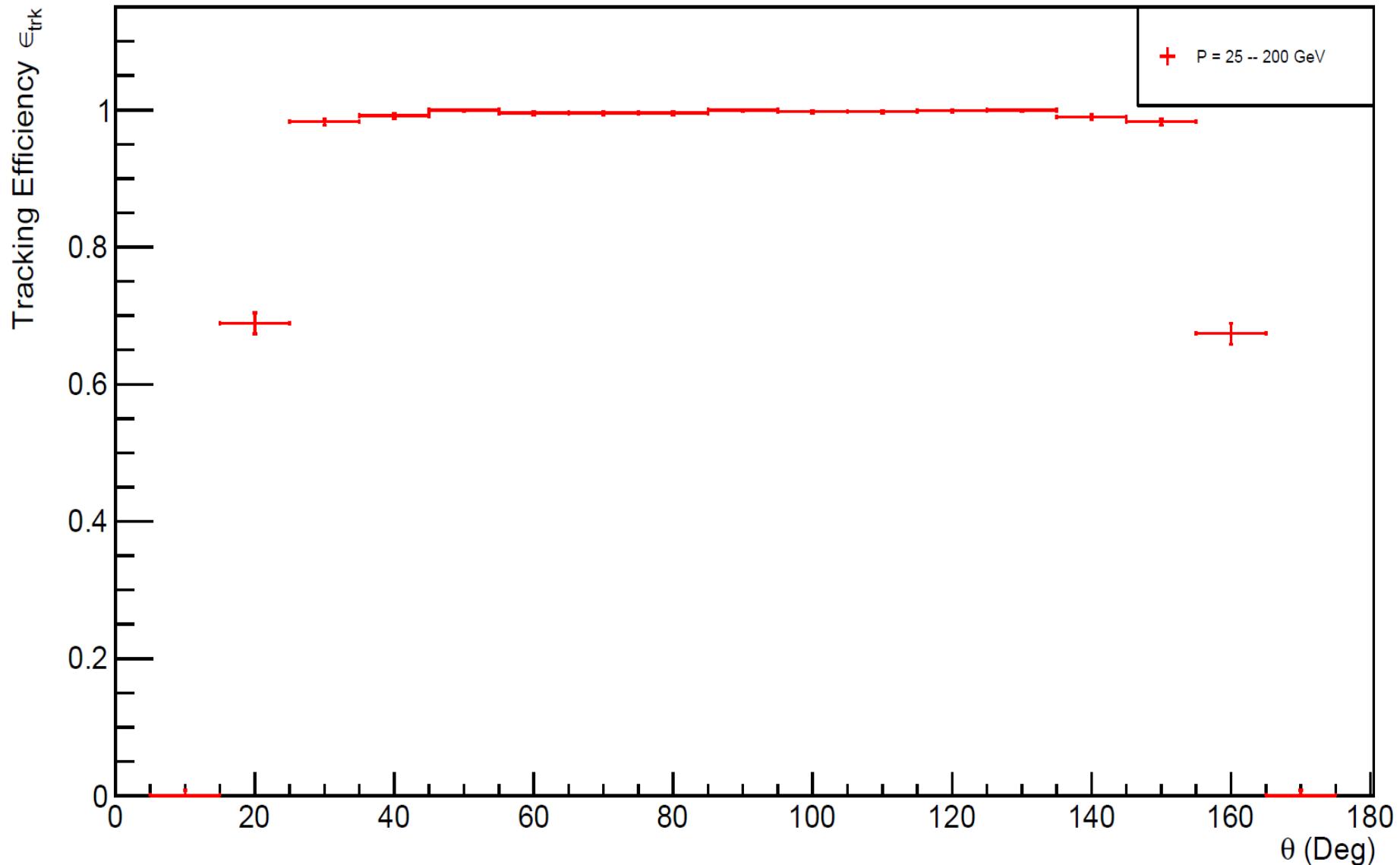
D0 Resolution for single muons in SiD_o2_v02
Tracker Segmentation: U=0.007mm, V = 0.3mm
Conformal Tracking



Tracking

with pattern recognition:

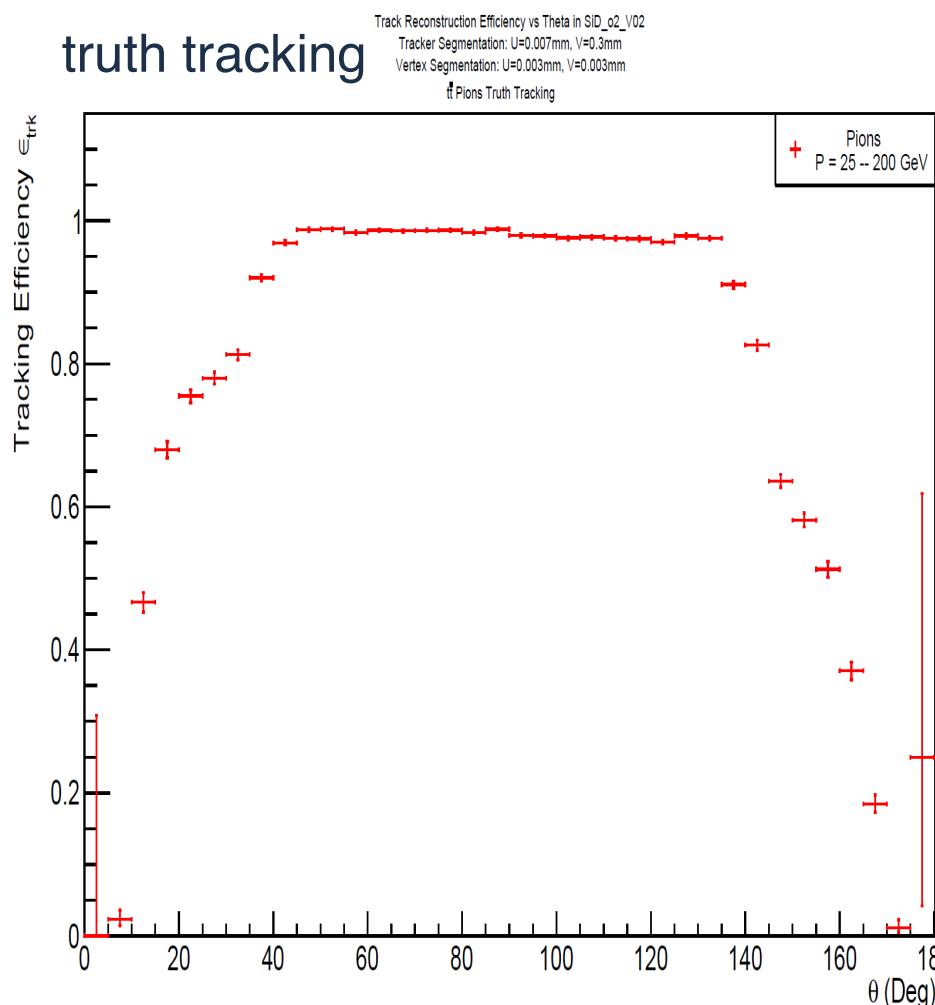
Track Reconstruction Efficiency vs Theta in SiD_o2_V02
Single Muons Conformal Tracking



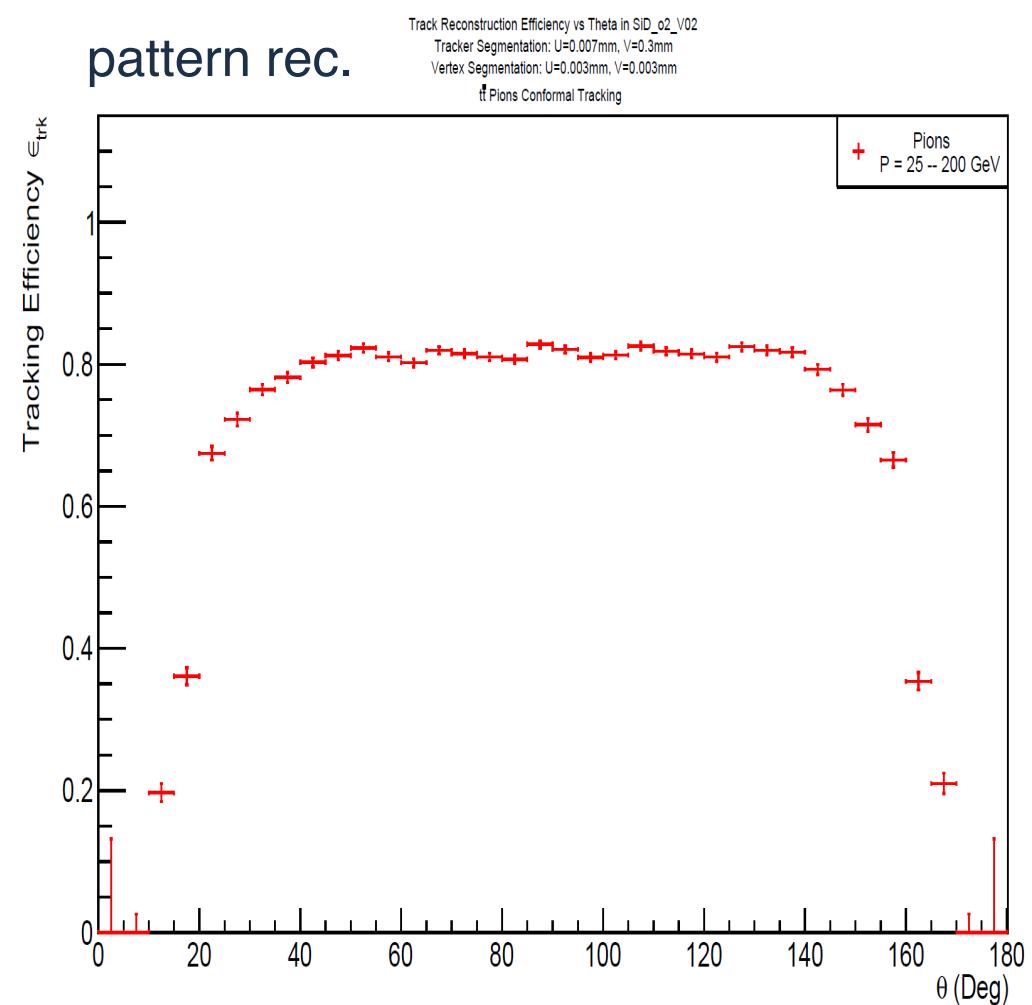
Tracking

Compare tracks in complex environments
– pions in ttbar events

truth tracking

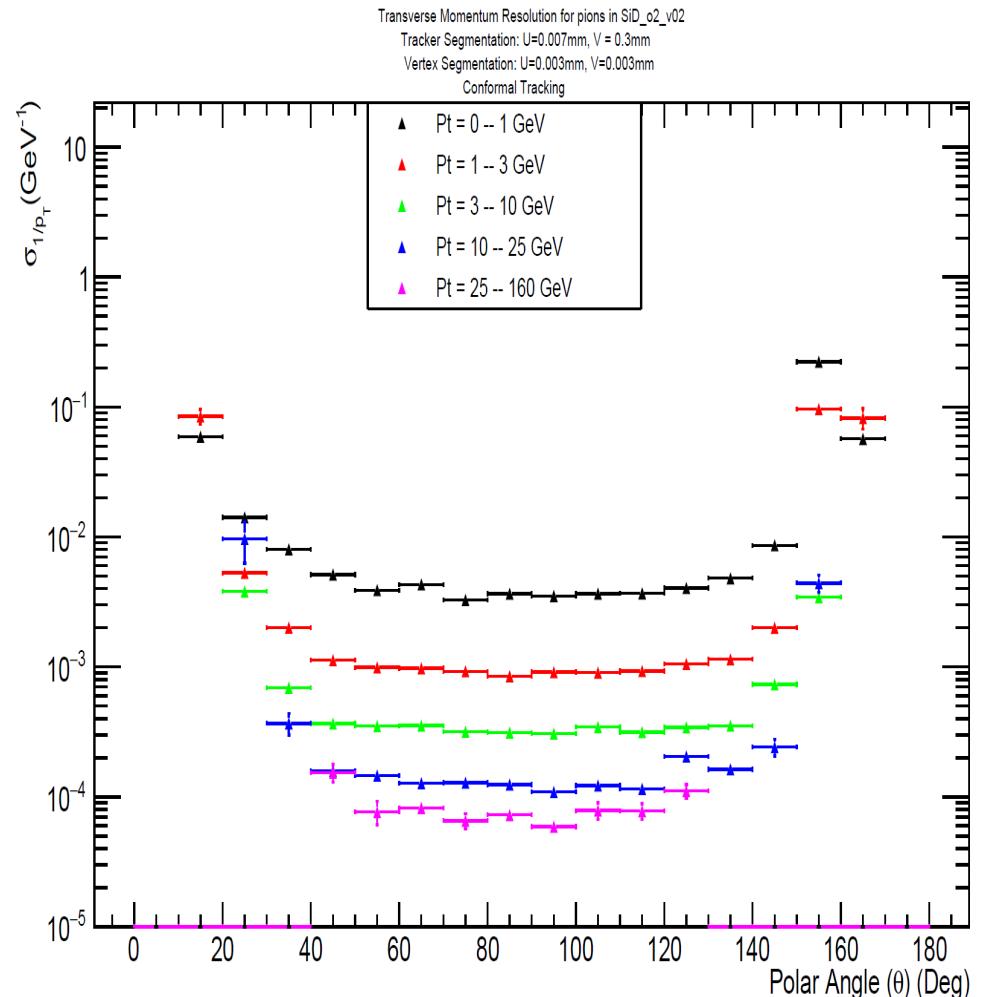
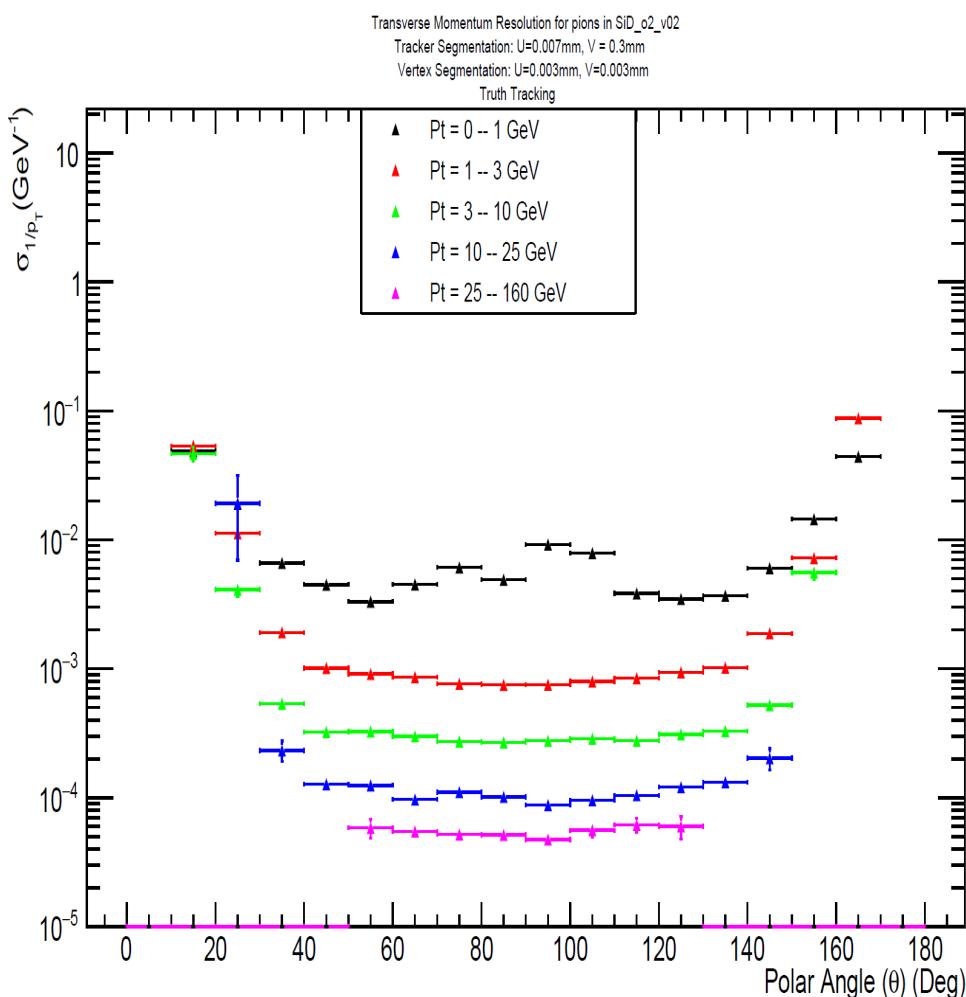


pattern rec.



-> tracker segmentation studies

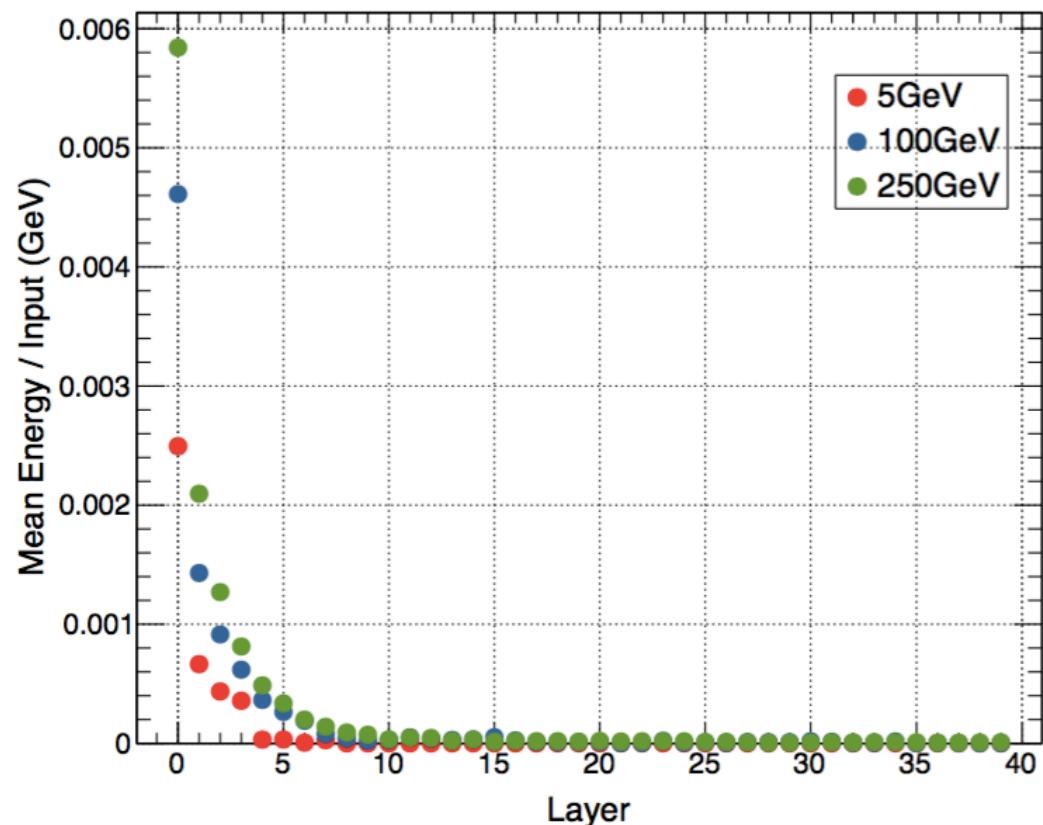
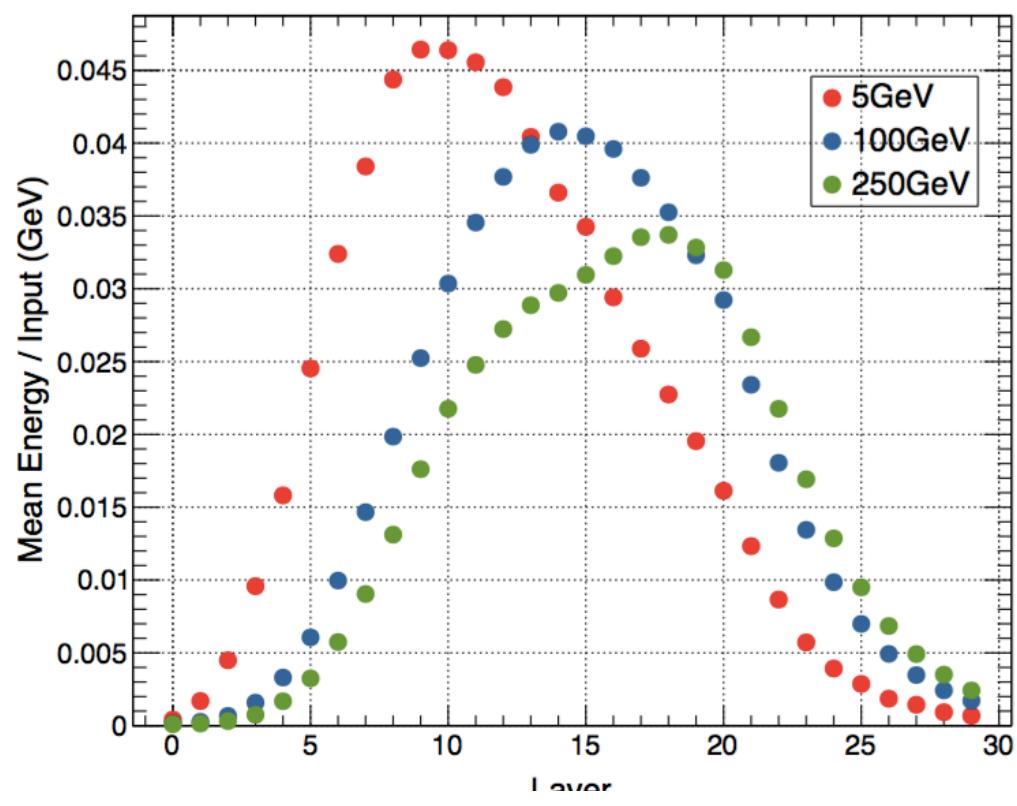
Pions in ttbar events



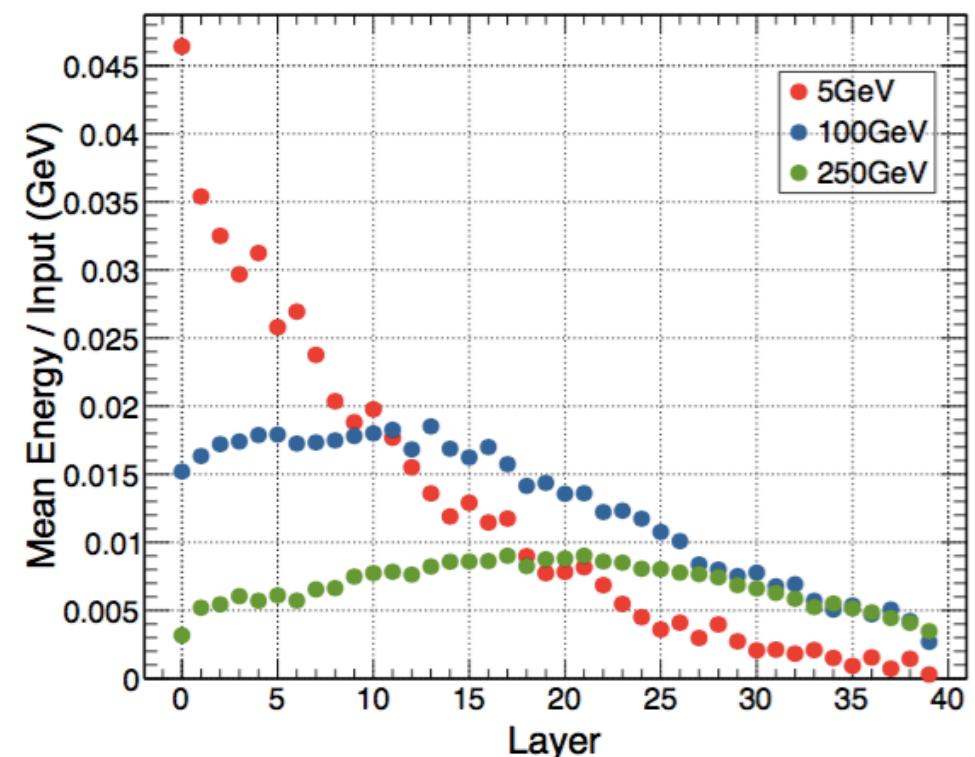
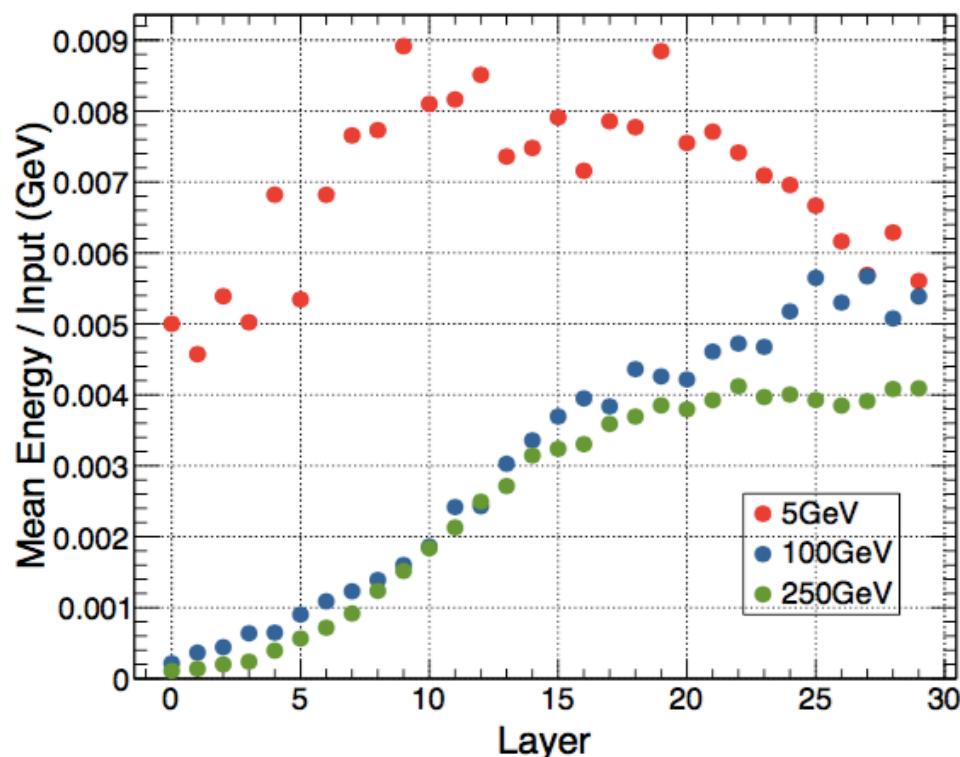
- ◆ All based on CLICPerformance and ILDPerformance
- ◆ We will start populating the SiDPerformance package soon with modules and scripts
(first road-testing just now)

Calorimeter

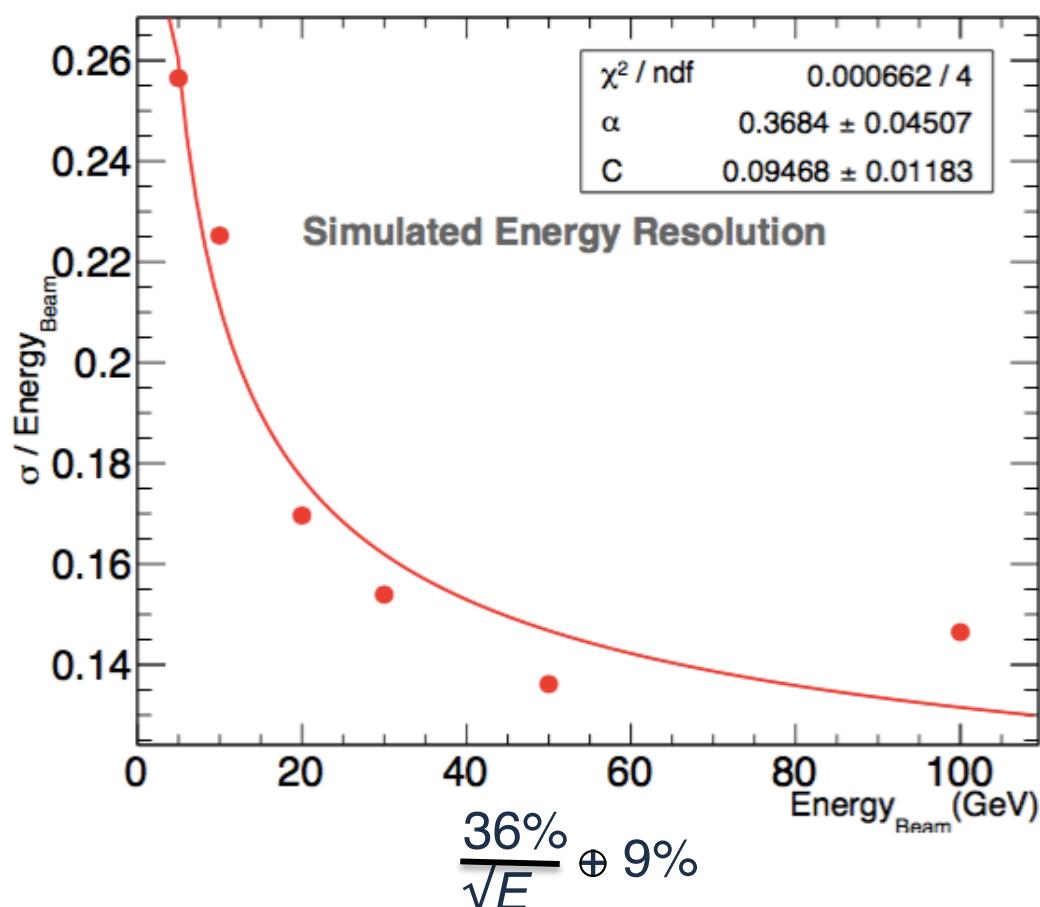
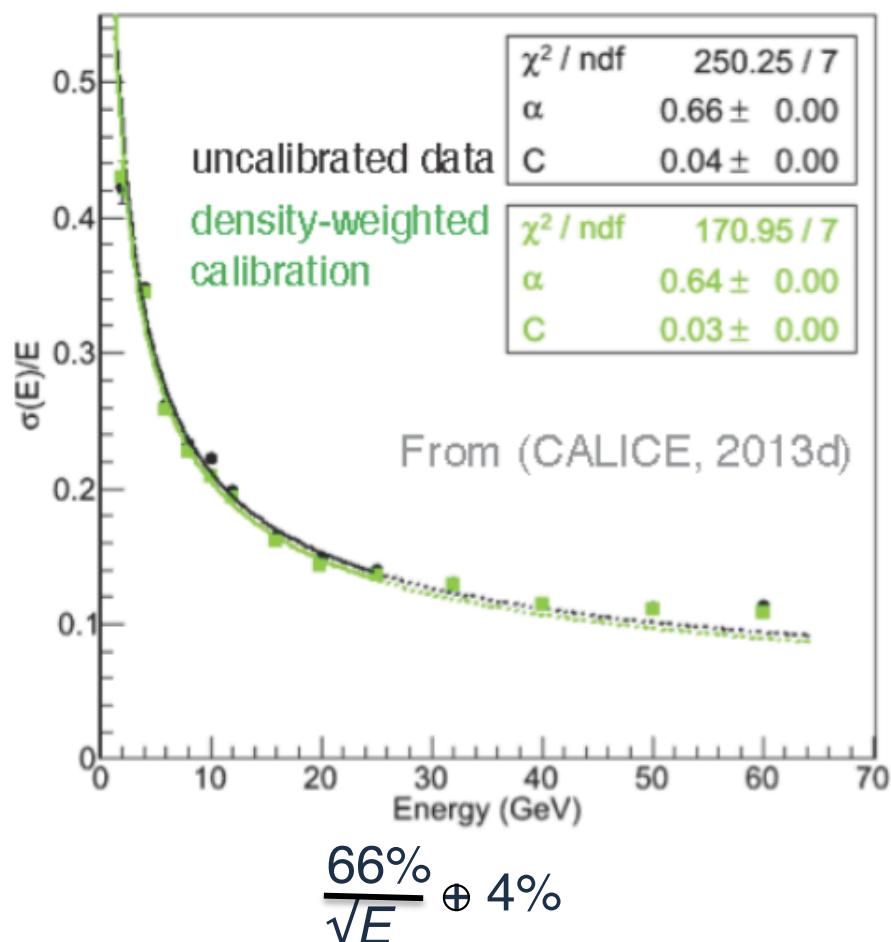
Photons layer deposits



Pions layer deposits



Pions resolution, compared with testbeam



However energy scale not calibrated – work starting now
(Oregon, UTA, Glasgow)

Top priority: (for AR to do)~~Digitization get working CaloDigi, MuonDigi (top)~~ Done~~Particle flow DDTTrackCreator and get working DDMarlinPFAPProcessor (top)~~ Done~~Commit all to repository, update wiki instructions and release (top)~~ Done**Following:****Model**

Tracker detail layout questions (medium)

Look at supports (medium)

~~Switch HCAL to scintillator (high)~~ Done~~Change to 30° barrel/end angle (low)~~ In progress~~ECAL overlapping trapezoids (low)~~ Done (Amanda)**Digitization**~~Check resolution parameters etc (high)~~ In progress~~Use Daniel Jeans new CaloDigi (?high)~~ Done

Implement hexagonal readout (medium/low)

Particle flow~~Do pandora calibration (high)~~ Started looking at**Tracking**~~implement CLIC tracking (high)~~ Done**High-level tool implementation**~~vertex-finding (high)~~ started~~flavour-tagging (high)~~ started

– consider what samples needed

Production

pile-up / overlay

liaise with ILCdirac to run on grid
and use same stdhep files as ILD**→ performance plots a la DBD**

To do / plans

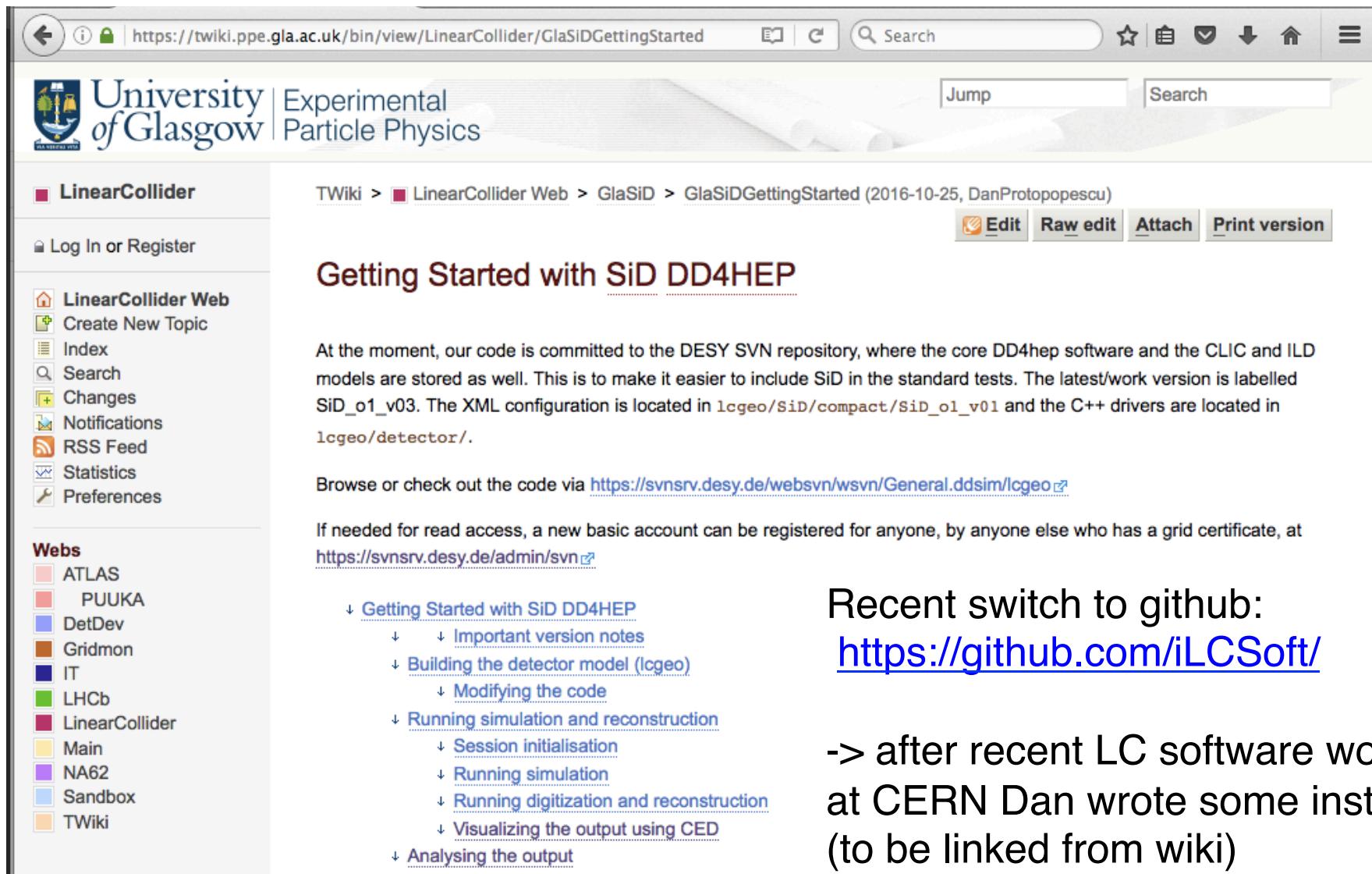
Focus now on
calorimeter simulation calibration
vertexing
flavour tagging (in contact with LCFIPlus authors)

UCSC group started to use overlay

Move towards production

-> physics studies...
(Glasgow: tracking aspects of $H \rightarrow \tau\tau$)

'Getting started' tutorial prepared by Dan
<https://twiki.ppe.gla.ac.uk/bin/view/LinearCollider/GlaSiDGettingStarted>



The screenshot shows a web browser window with the following details:

- Address Bar:** https://twiki.ppe.gla.ac.uk/bin/view/LinearCollider/GlaSiDGettingStarted
- Page Title:** Getting Started with SiD DD4HEP
- Page Content:**
 - At the moment, our code is committed to the DESY SVN repository, where the core DD4hep software and the CLIC and ILD models are stored as well. This is to make it easier to include SiD in the standard tests. The latest/work version is labelled SiD_o1_v03. The XML configuration is located in lcgeo/SiD/compact/SiD_o1_v01 and the C++ drivers are located in lcgeo/detector/.
 - Browse or check out the code via <https://svnsrv.desy.de/websvn/wsvn/General.ddsim/lcgeo>.
 - If needed for read access, a new basic account can be registered for anyone, by anyone else who has a grid certificate, at <https://svnsrv.desy.de/admin/svn>.
- Sidebar (Left):**
 - LinearCollider** (selected)
 - Log In or Register
 - LinearCollider Web**
 - Create New Topic
 - Index
 - Search
 - Changes
 - Notifications
 - RSS Feed
 - Statistics
 - Preferences
- Webs (Bottom Left):**
 - ATLAS
 - PUUKA
 - DetDev
 - Gridmon
 - IT
 - LHCb
 - LinearCollider
 - Main
 - NA62
 - Sandbox
 - TWiki
- Top Right:** Jump, Search, Edit, Raw edit, Attach, Print version

Recent switch to github:
<https://github.com/iLCSoft/>

-> after recent LC software workshop
at CERN Dan wrote some instructions
(to be linked from wiki)



SiD Optimization Group

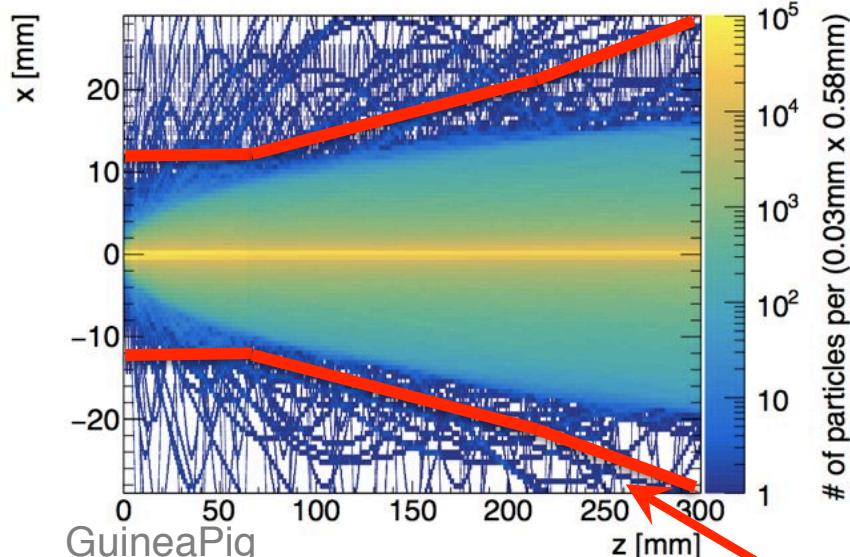


Active Optimization Group, meets weekly (Wednesdays 5pm UK)
Co-conveners Jan Strube and Aidan Robson

Following slides give flavour of recent activities beyond simulation / reconstruction development

Pair background envelope

Pairs spiraling in the magnetic field

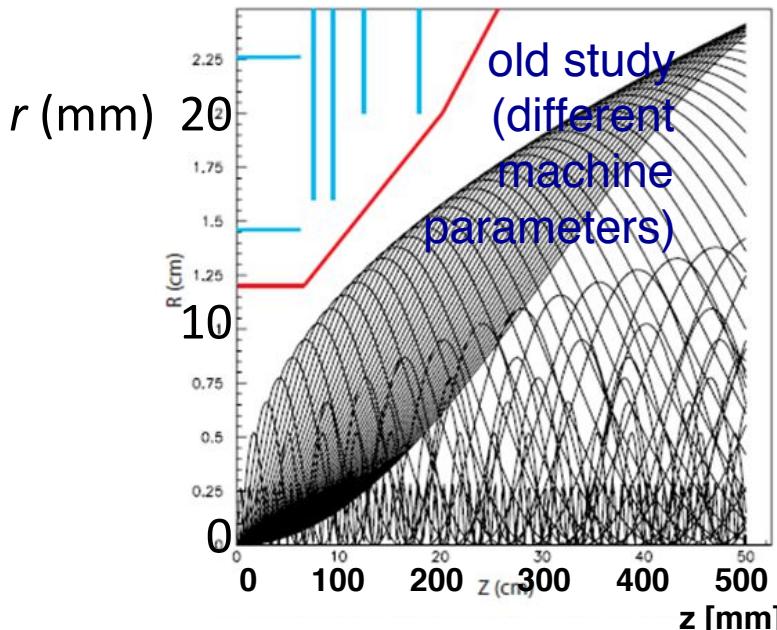


GuineaPig

Re-analysed pair background envelope in beam pipe

New analysis!

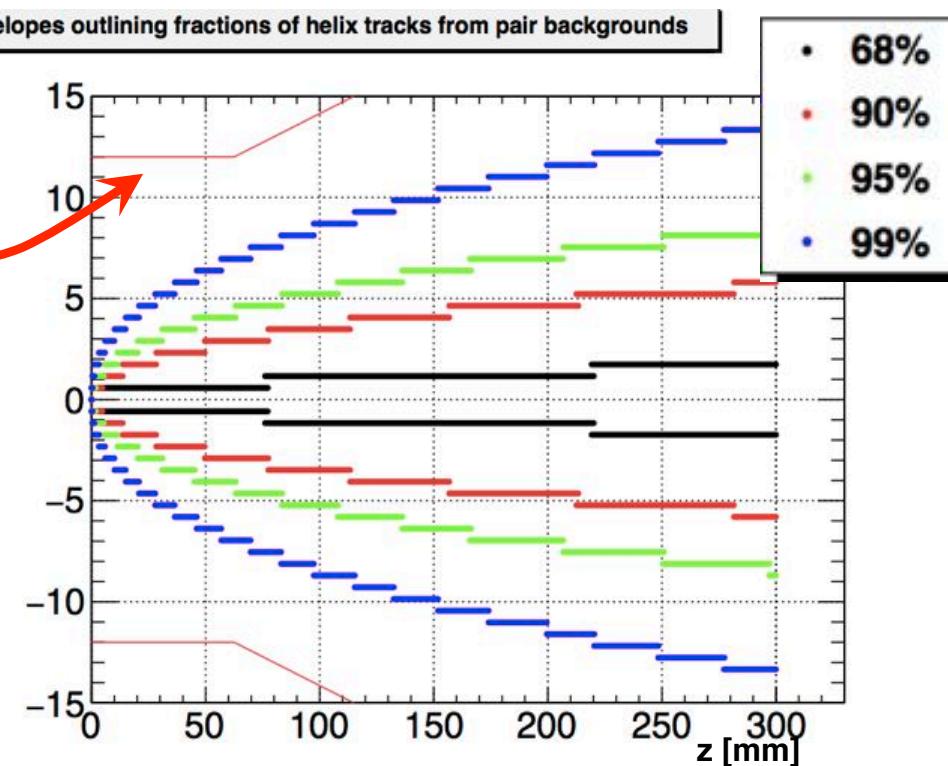
- with current beam pipe design, around 0.45% of all particles leave tracks outside the beam pipe
- could consider reducing beam pipe radius by 2mm
- could consider an additional vertex detector layer for SiD



Aidan Robson

DESY

Envelopes outlining fractions of helix tracks from pair backgrounds

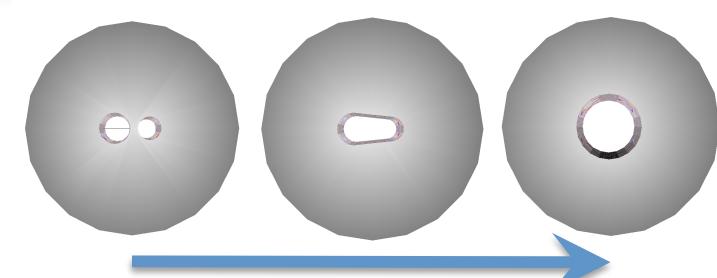
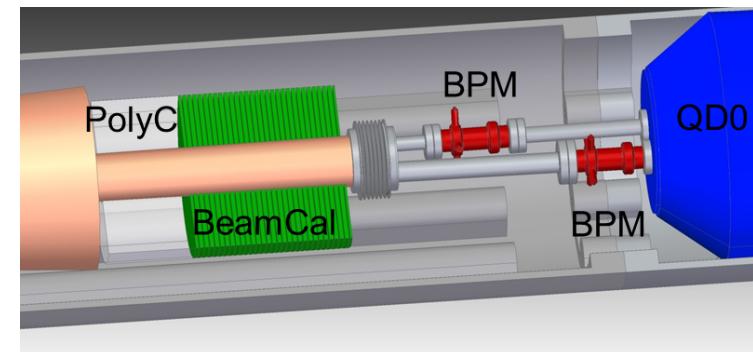
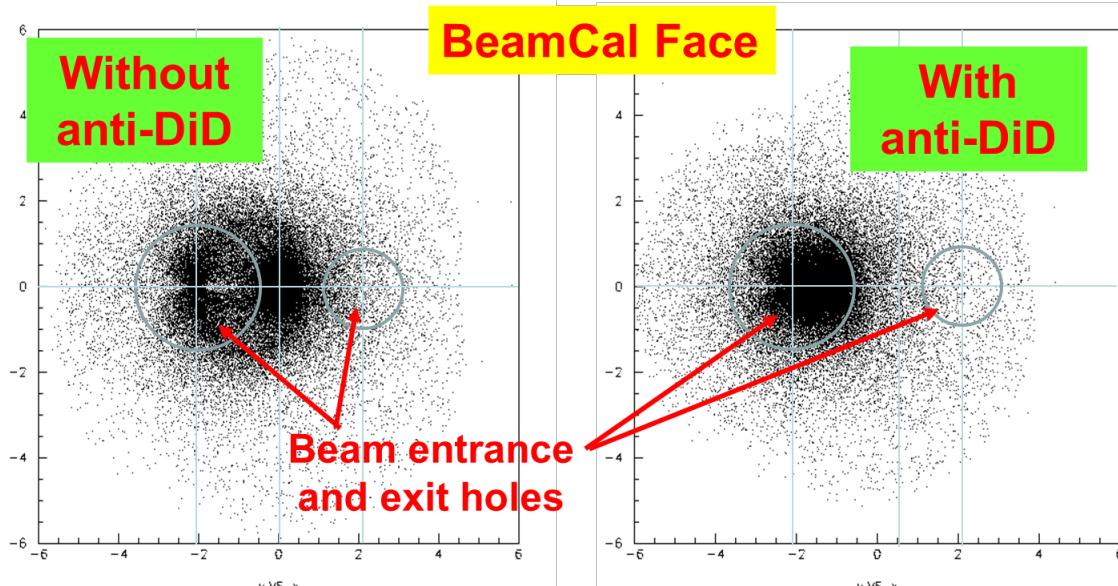


Recent studies have looked at different aspects of the forward region layout

Set of related questions:

- ◆ Is the anti-DID necessary?
- ◆ What is the optimum forward calorimeter (BeamCal) shape?
- ◆ What buffer depth is required for forward/inner detectors?

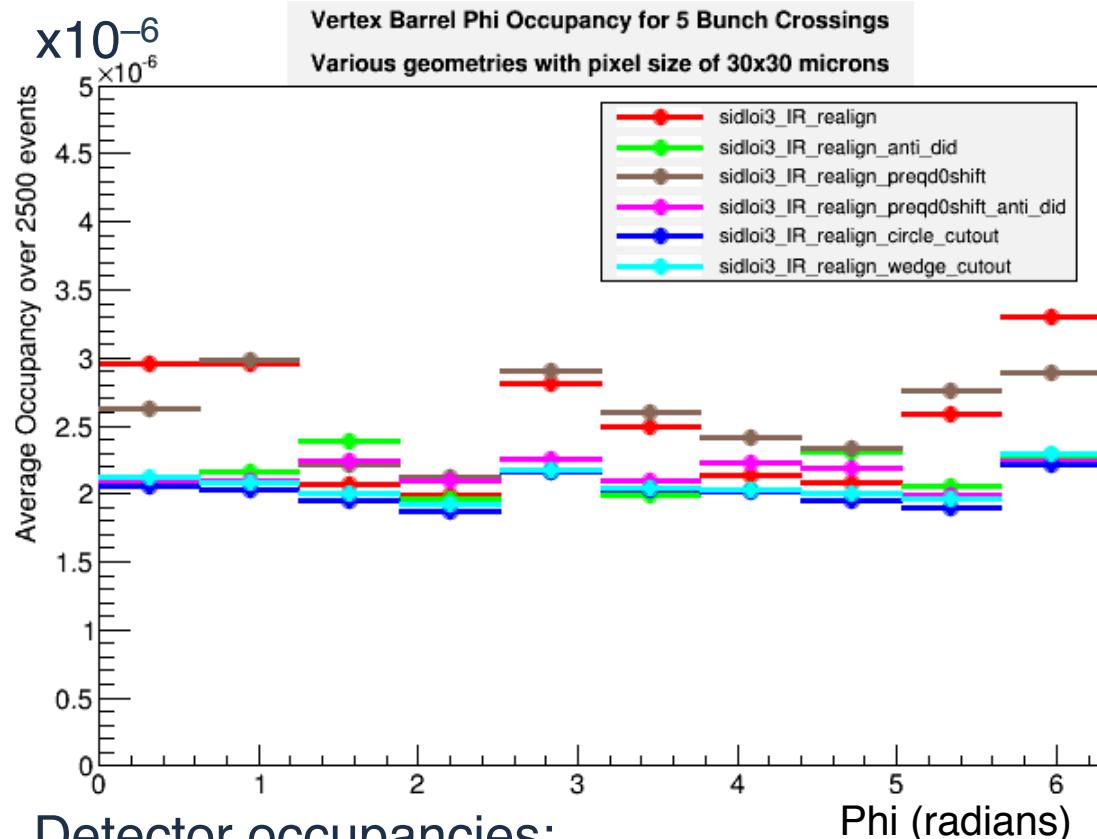
DID: Detector-integrated Dipole



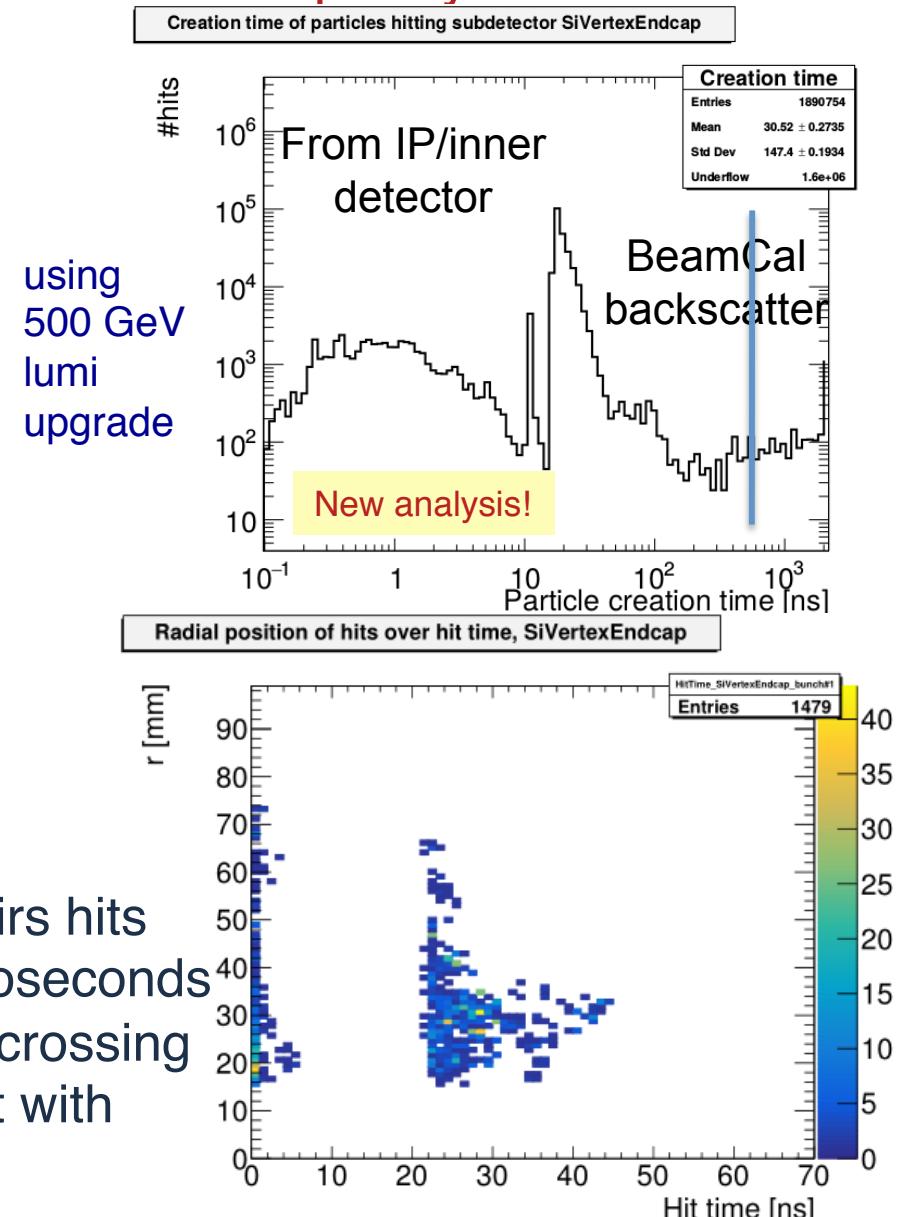
More aggressive approach
to removing material from the
path of backgrounds

Trade-off between BeamCal
reconstruction efficiency and
albedo effect

Forward region design can affect vertex detector occupancy:



Detector occupancies:
with/without anti-DID
different beam holes
-> robust

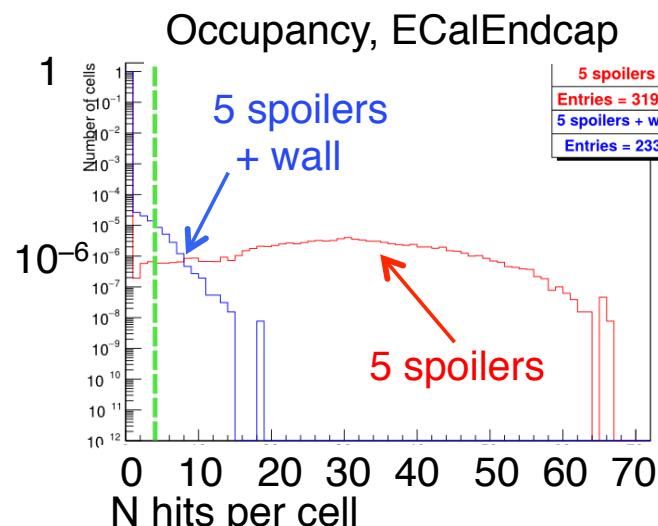
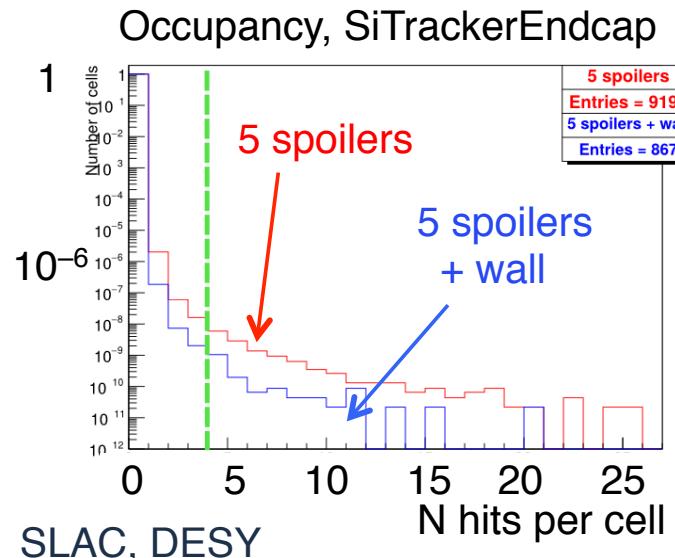
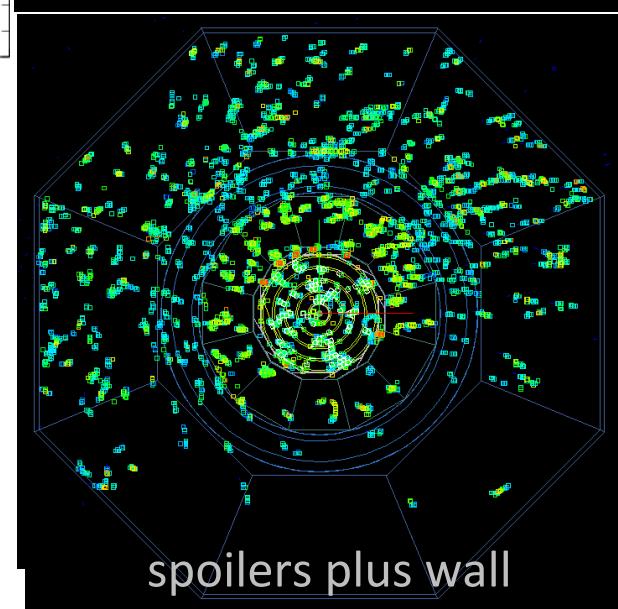
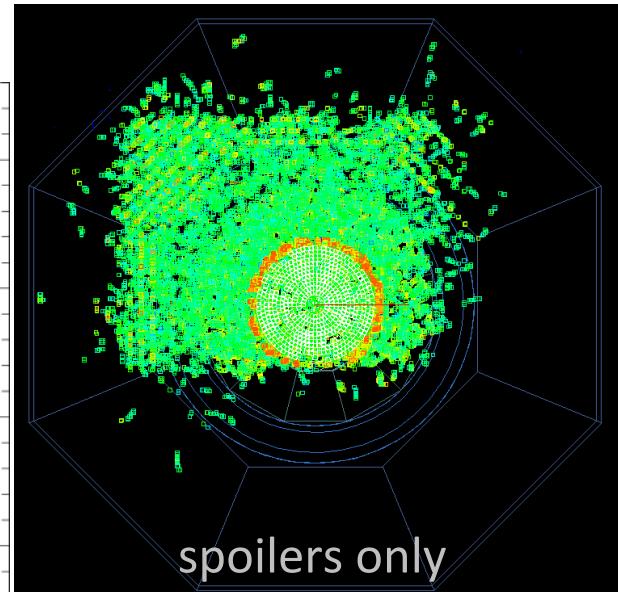
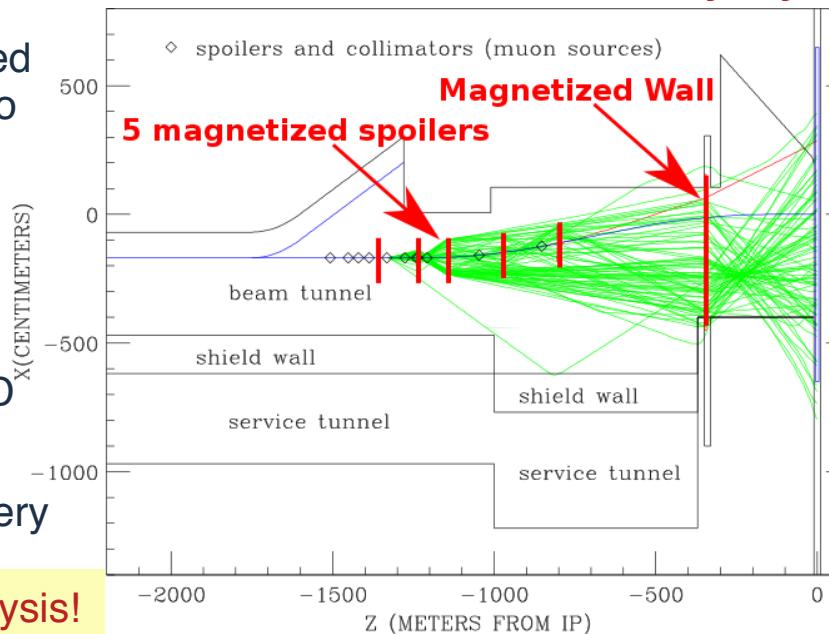


Background pairs hits
can arrive microseconds
after the beam crossing
-> able to reject with
timing cuts

Shield detectors from muons from beam delivery sys

- ◆ Magnetized spoilers intended to sweep muons from BDS into tunnel walls
- ◆ Is magnetized wall also necessary?
- ◆ Simulated with MUCARLO from BDS plus full Geant 4 SiD detector simulation
- ◆ ECcalEndcap occupancy very high without wall

New analysis!

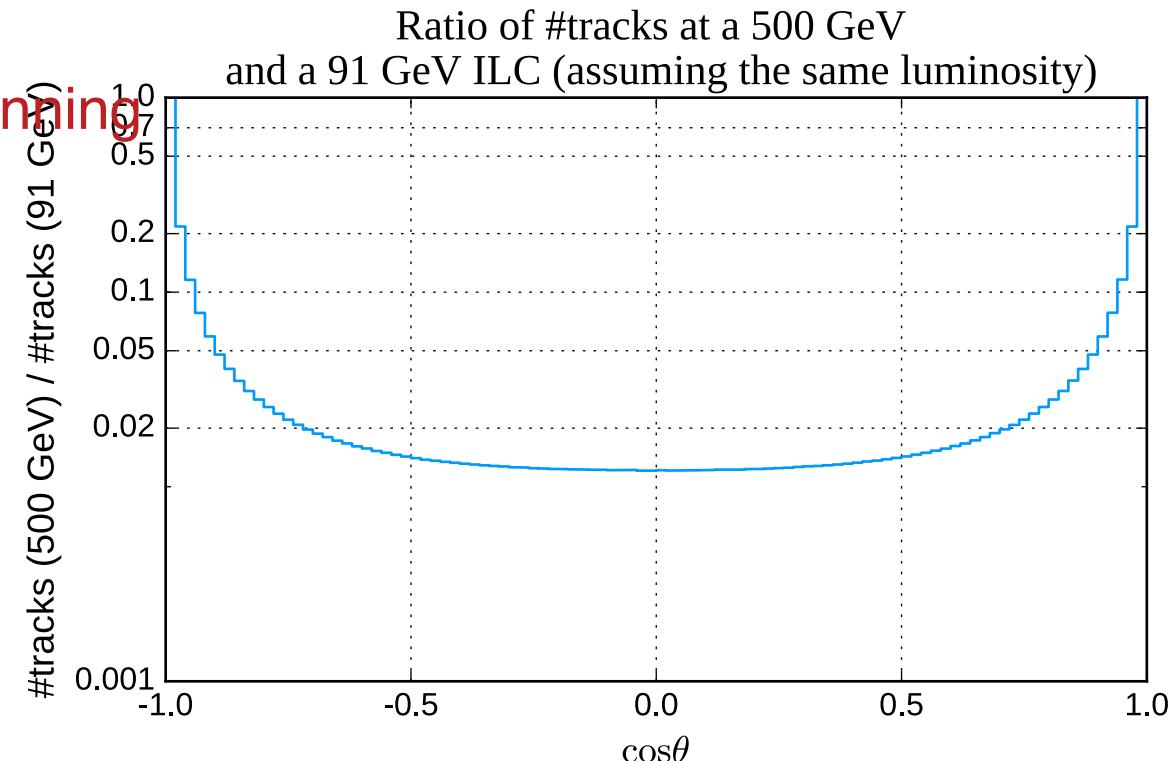


-> A. Schuetz et al.

(Joel)

Considering question of Z-pole running

- ◆ Track-based alignment essential for high-precision tracking
- ◆ Low cross-section of relevant processes => limited high-pT tracks
 - currently, SiD has no reason to believe this will improve by running the machine at the Z pole
- ◆ Rough estimation: 1000 tracks / month / module in outer tracker during ramp-up in the first year
- ◆ SiD has started to look at different strategies to augment alignment
 - ATLAS-like FSI
 - changes to electronics to increase efficiency for cosmics
- ◆ Currently back-of-the-envelope calculations only
- ◆ Discussions in the dedicated session tomorrow



Bristol, PNNL

Active slack channels to continue from PNNL workshop

https://silicondetector.slack.com/messages/detector_geometry/

The screenshot shows a Slack interface. On the left, there's a sidebar with a team icon for 'SiliconDetector' and a list of channels and direct messages. The main area is a channel named '#detector_geometry'. At the top of the channel, a yellow banner prompts for desktop notifications. Below the banner, there's a header with a search bar and some icons. A message from Aidan Robson dated November 2nd is displayed, containing a 3D model of a detector structure and a text about sketch angles and sides. Below this message, there's a reply from Amanda Steinhebel and a response from Dan Protopopescu.

Slack needs your permission to [enable desktop notifications](#).

#detector_geometry

Nov 2nd Sketch Angles and sides Screenshot extrusions to sort out Solved most; remaining must be due to some rounding errors Driver code 3D view Detail (52KB)

Oh, this is easy to fix. To figure out what "Handle_t::child: Element [detector] has no child of type 'parameter'" means, and how to fix it, please have a look at how this is done in the driver that works ... (and compare the associated XMLs)

Amanda Steinhebel 5:51 PM I'll do that today, thanks so much!

Dan Protopopescu 5:52 PM Good luck!

Message #detector_geometry

- ◆ Much progress on SiD model and reconstruction
 - Built from close collaboration with CLICdp and ILD
 - Many more users since PNNL workshop
- ◆ Complete/Ongoing:
 - Tracking pattern recognition commissioning
 - Tracking (/tracker) performance / development
 - Calorimeter calibration / reconstruction performance
 - Particle Flow implementation/commissioning
- ◆ Future:
 - Beam overlay
 - Production
 - Physics studies

Forward tracks – needed ECal endcap to have systemID 29 (defined by UTIL::ILDDetID) in CaloFaceEndcapSurfacePlugIn, for MarlinTrk extrapolation to calo surface to work. Not same as detector ID.

HitEncoder issue – hit location stored in bitword; encoder hard-coded in tracking code as system:5,side:2,layer:9,module:8,sensor:8

Not enough bits for us -> temporarily switched to single-sided forward tracker disks.

This is also a problem for CLICdp, and newly fixed (big intervention!) in a head release — to be tested by SiD

For Pandora:

added det_type correctly for all subdetectors

Need pandora extension for muon system

-> need GenericCalBarrel instead of DD4hep_PolyhedraBarrelCalorimeter2 driver

gives duplicate volumes when two sensitive layers => added 01 versions to muons with single sensitive layer per stack

hack in HCalEndcap to add 'auxiliary hadronic calorimeter' because this was hardcoded in DDCaloHitCreator::CreateMuonCaloHits

Outcome: we get low-angle tracks, plus we get PFA objects!

(but not fully present in performance plots yet)

As we still use lcgeo from head of release, you may find occasional compile problems unrelated to SiD – if so please tell me/Dan!