SiD performance for the DBD

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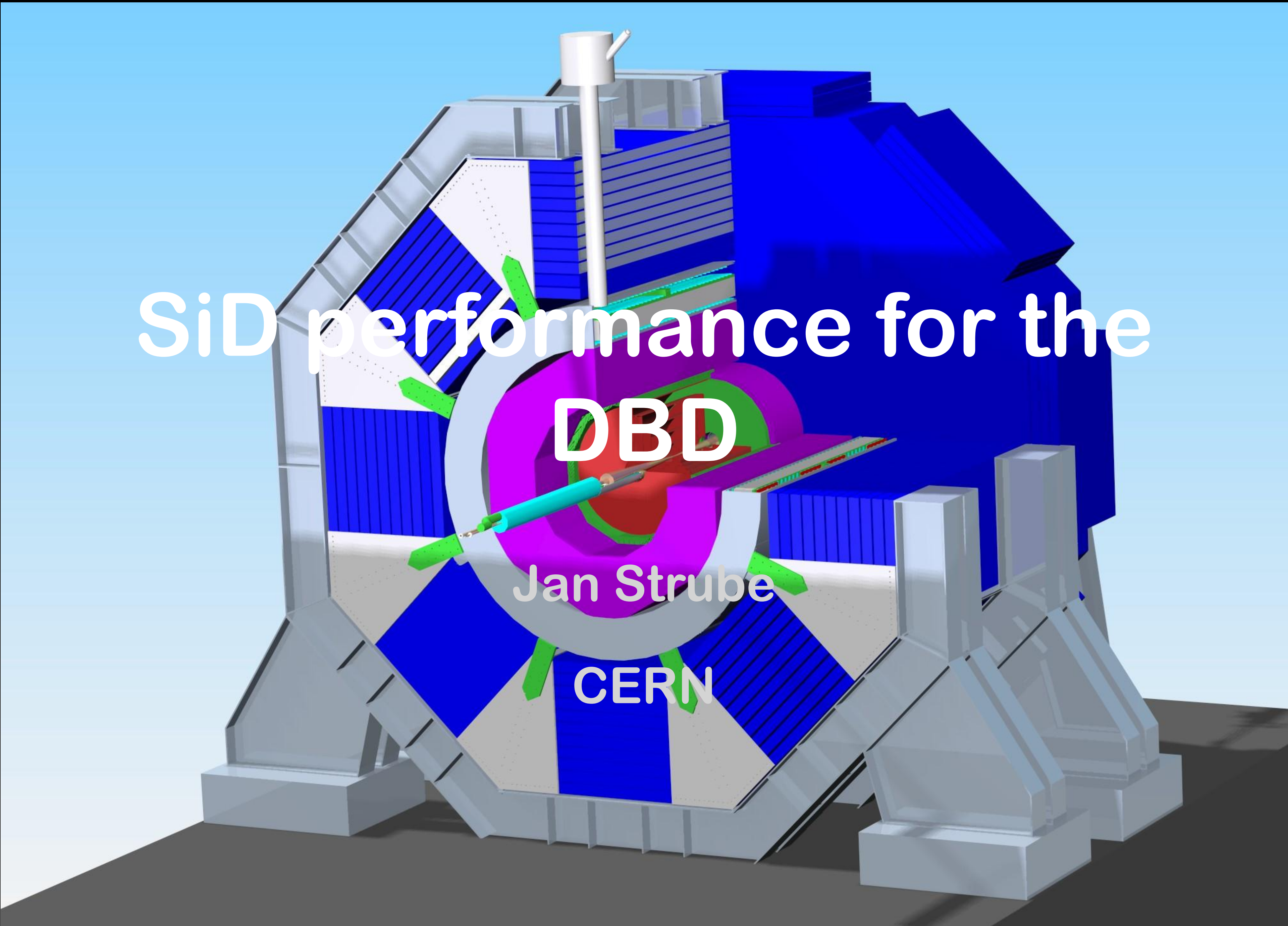
CERN



Overview

- Software Preparation (CERN, SLAC)
- Machine Environment (CERN, SLAC)
- Tracking Performance (C. Grefe)
- Jet Energy Resolution
- Single Particle ID (with C. Grefe, Zhou Zhou)
- Calorimeter-Assisted Tracking (with C. Grefe, J. Niehues)
- Production Status (with S. Poss, C. Grefe, J. McCormick)

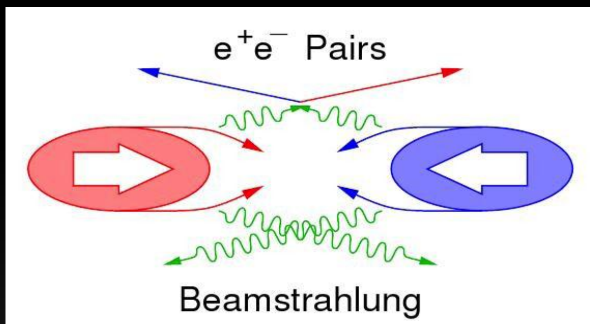
Introduction

- Goal: To evaluate physics performance of the SiD detector in a realistic simulation
- Major changes since LOI:
  - PandoraPFA with a DHCAL?
  - LCFIVertexPlus and SiD?
  - ILCDIRAC for grid submission instead of SLAC queues

Software Used

- stdhep
- lcio x 3
- SLIC, Geant4 9.5
- org.lcsim, tracking, background mixing of pairs and aa_lowpt events, DST maker
- slicPandora/PandoraPFA, calorimetric reconstruction
- MarlinReco, LCFIVertexPlus, FastJet
- ROOT
- ILCDIRAC

Beam-induced Background

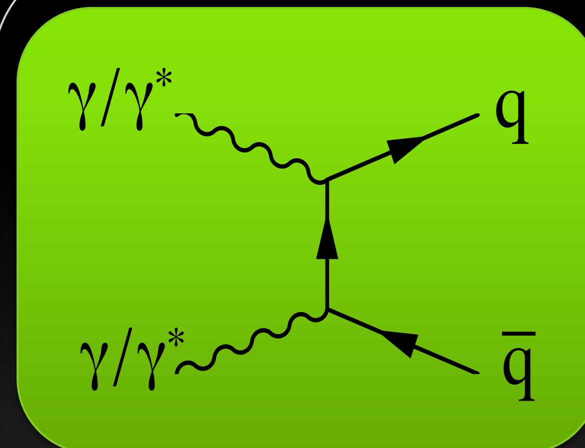


Pair background
1 event per BX
450k particles

Generated by GuineaPig
ascii → hepevt → stdhep

Merged with every "physics" event

MCParticles that don't make hits will be dropped



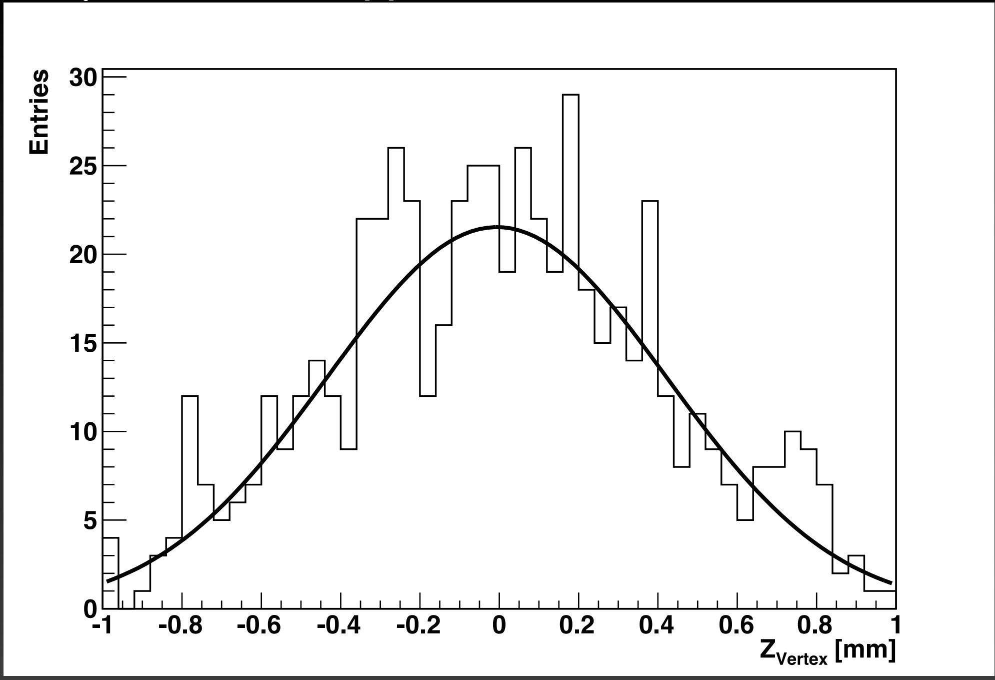
γγ interactions
4.1 events per BX

Generated by Whizard

Luminous Region

- Beam size: σ_z = 225 μm
- Luminous region: σ_z = 318.2 μm
- Events from beam-beam interactions (γγ→ hadrons, incoherent pairs) are distributed over the luminous region
- Physics events are always at z = 0

Reconstructed primary vertex position for γγ→ hadrons



Smearing with: σ_z = 450μm
Fitted width: 428 ±17μm

Reduction of Beam Background

- Excellent Vertex detector resolution is a fraction of size of luminous region

  → Find the primary vertices in the event to get rid of most of the background

- See tth talk (Philipp Roloff) for primary vertex resolution performance plots

Single Particle ID

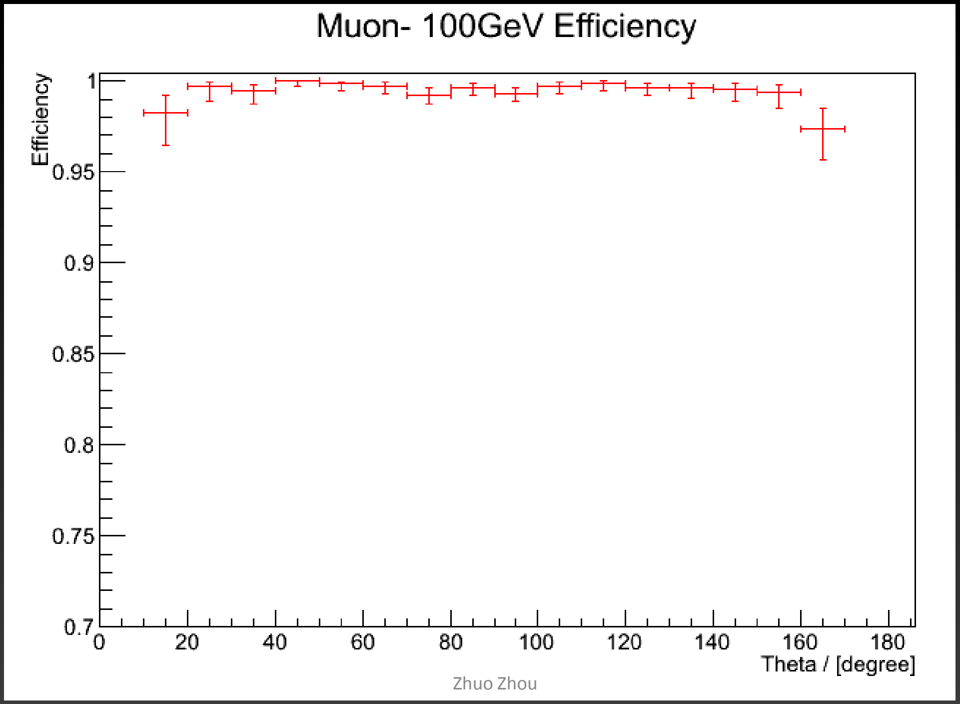
Why?

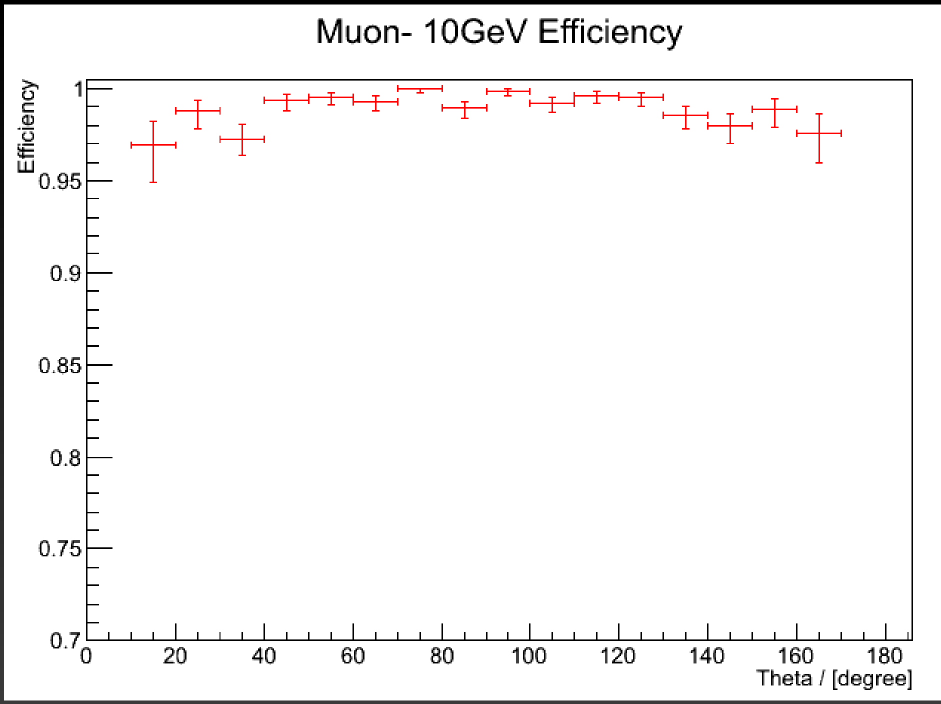
- Several analyses depend on excellent PID
  - WW, tth (semi-)leptonic, hmumu
- Currently, PID comes from PandoraPFA
  - Performance must not be perfect, but must be well-known and understood
- Digital HCAL: remove muons before clustering

How?

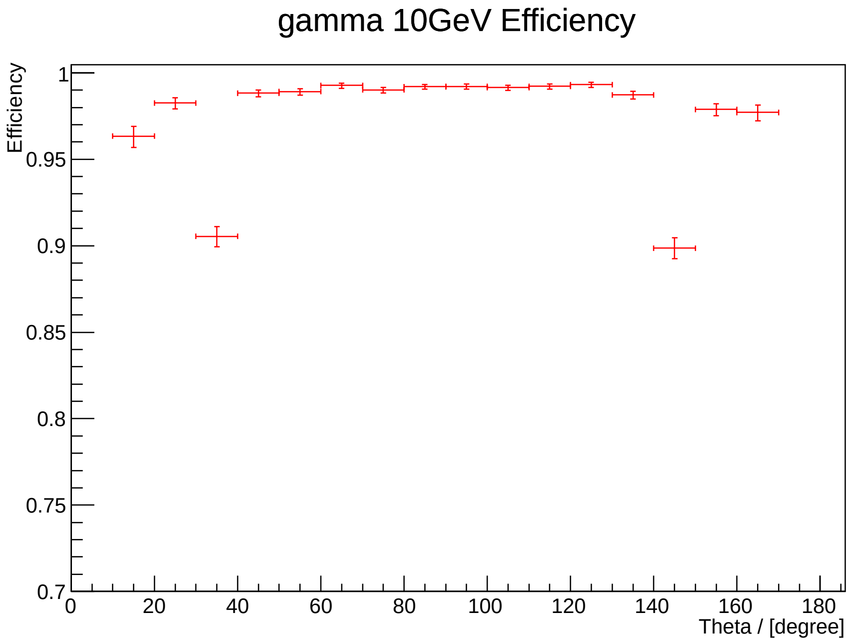
- Generate single particle of given type
- Full detector simulation
- org.lcsim tracking
- PandoraPFA reconstruction Plot ratio of reconstructed / generated particles of given type
- Mis-ID: What id are the mis-identified particles?

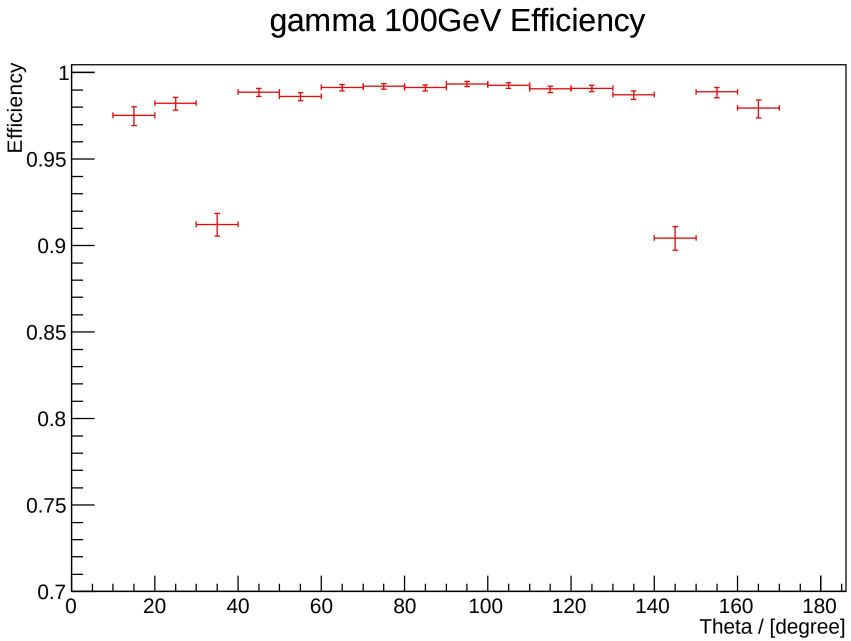
Single Muons





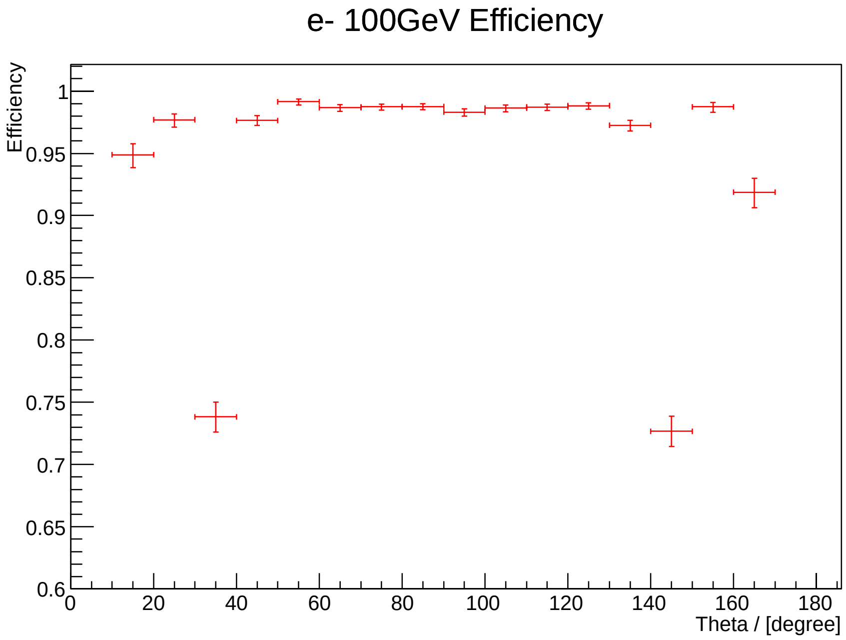
Single Photons

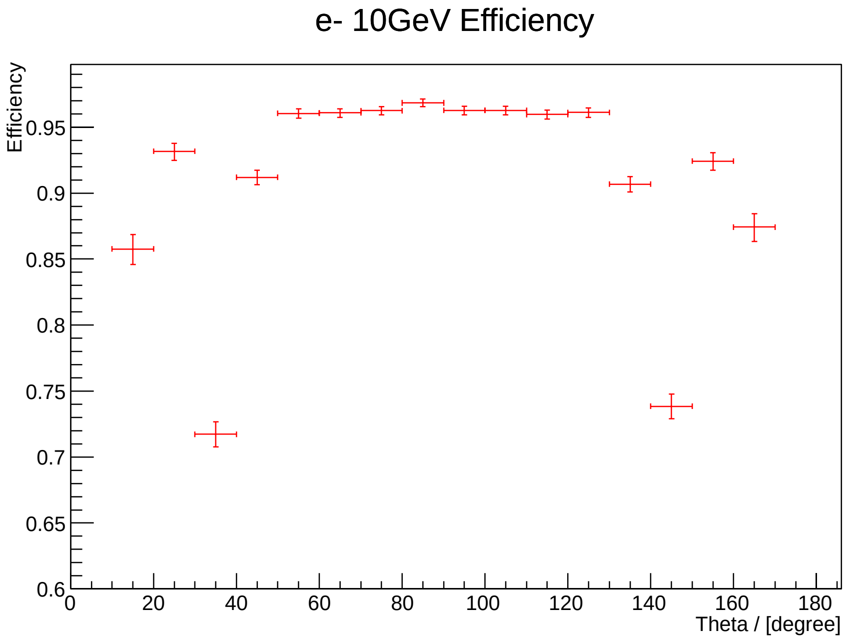




Photon identification efficiency:
98% @ 100 GeV, but > 40% of the events have a neutron
99% @ 10 GeV, high purity

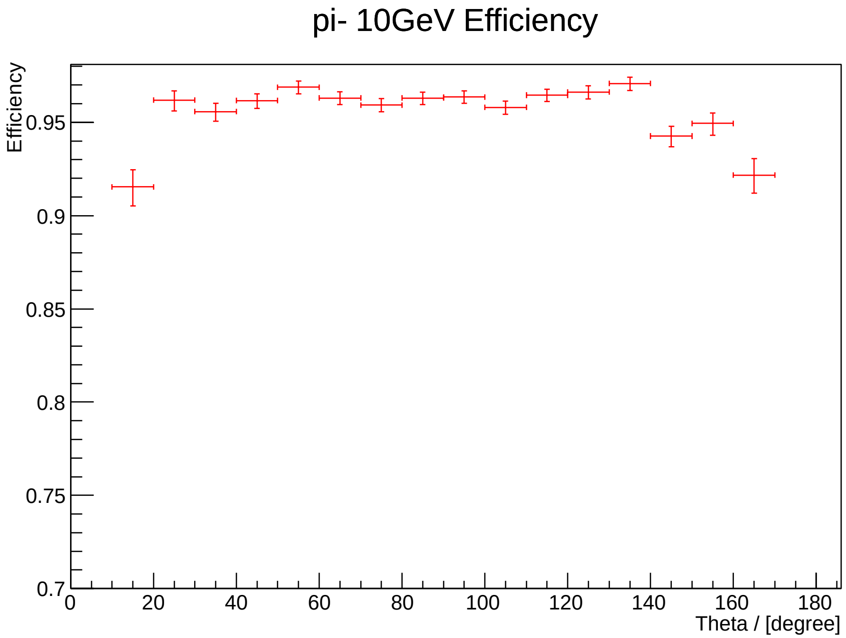
Single Electrons

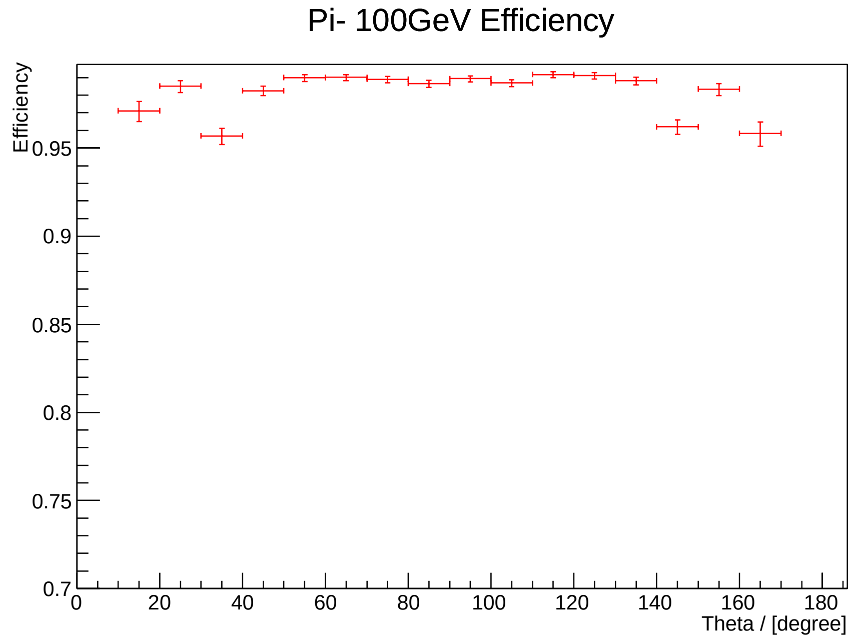




Energy	Muons	Pions	Electrons
10 GeV	/	4.4%	93%
100 GeV	/	3.3%	96%

Single Pions





Energy	Muons	Pions	Electrons
10 GeV	1%	96%	2%
100 GeV	0.3%	98.4%	0.4%

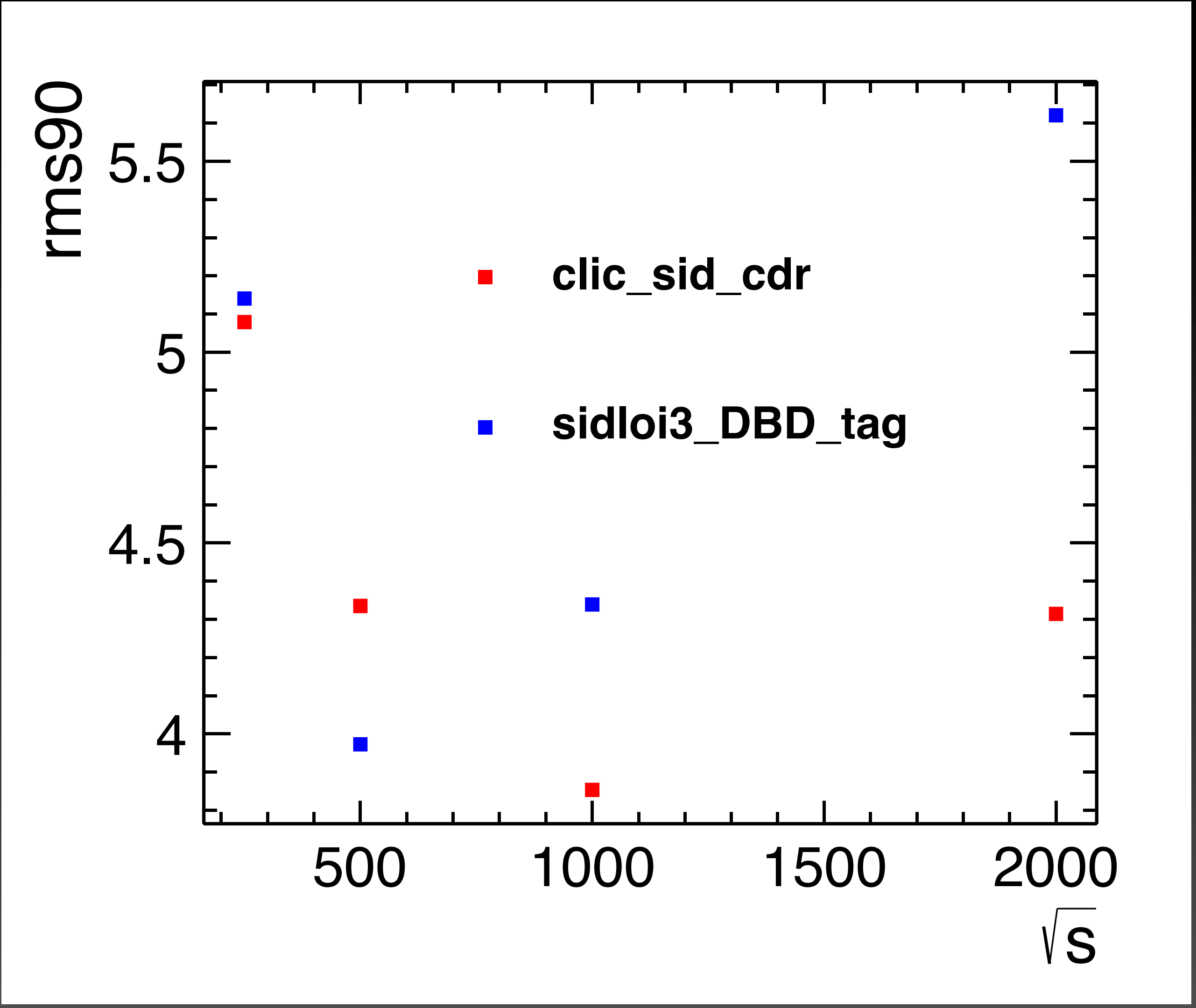
Jet Energy Resolution

- The key benchmark in a detector designed for Particle Flow

Method:

- Generate ZZ events at different energies
  - Z(→ invisible) Z(→qq)
- Simulation / reconstruction
- Jet finding
- Plotted is rms_{90}, not Gaussian width

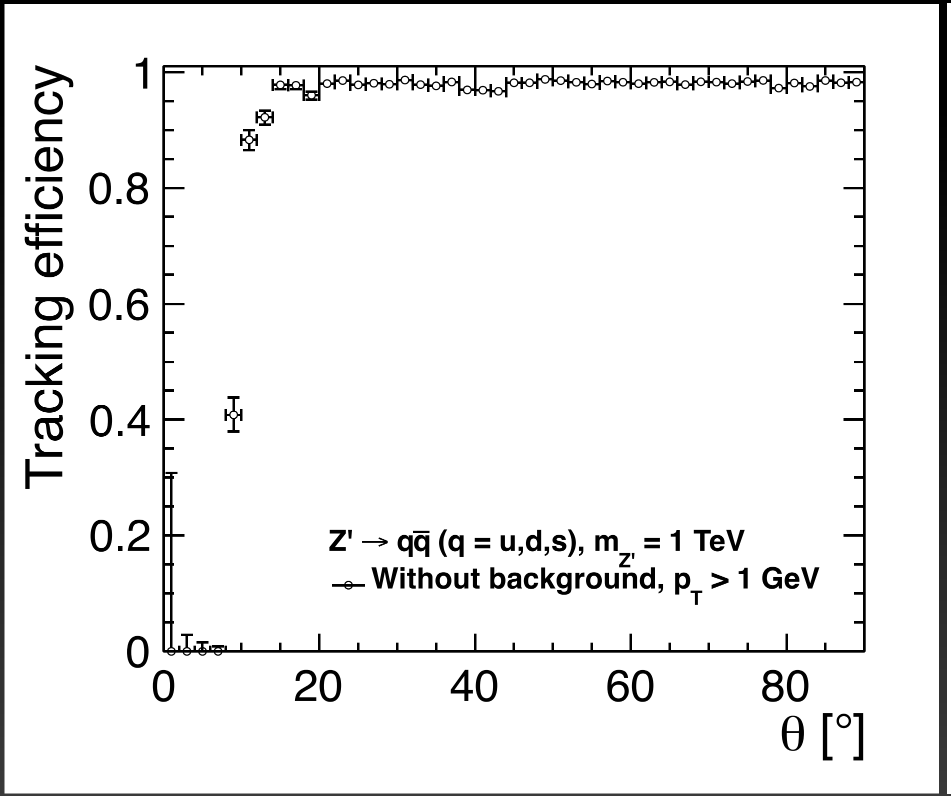
RMS$_{90}$ versus energy

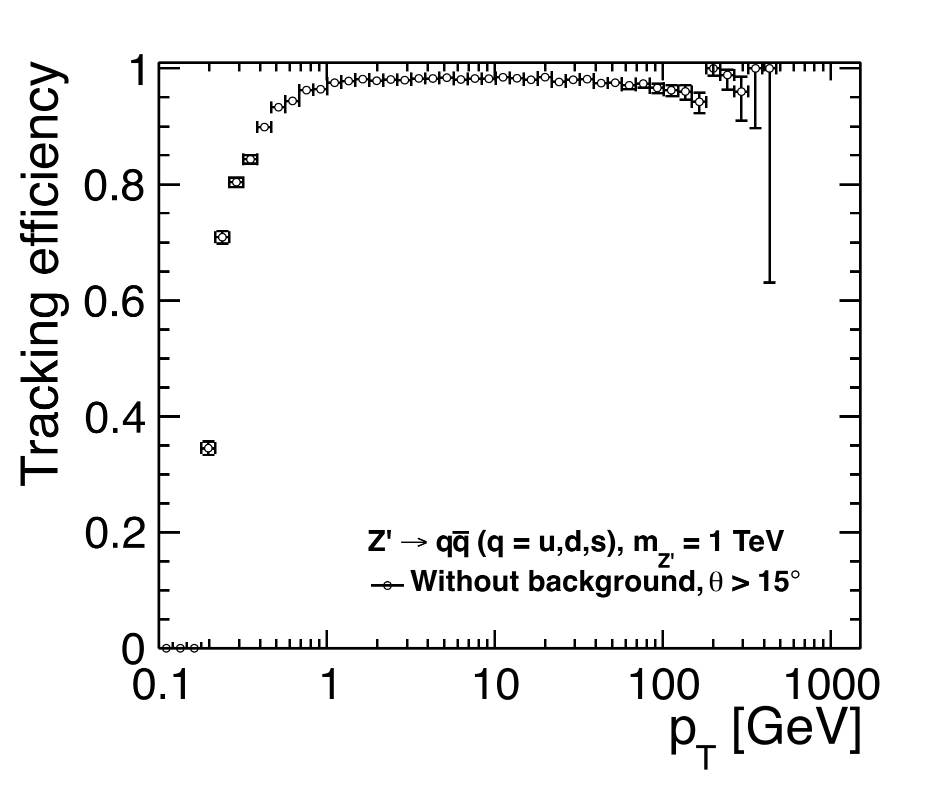


Tracking Performance

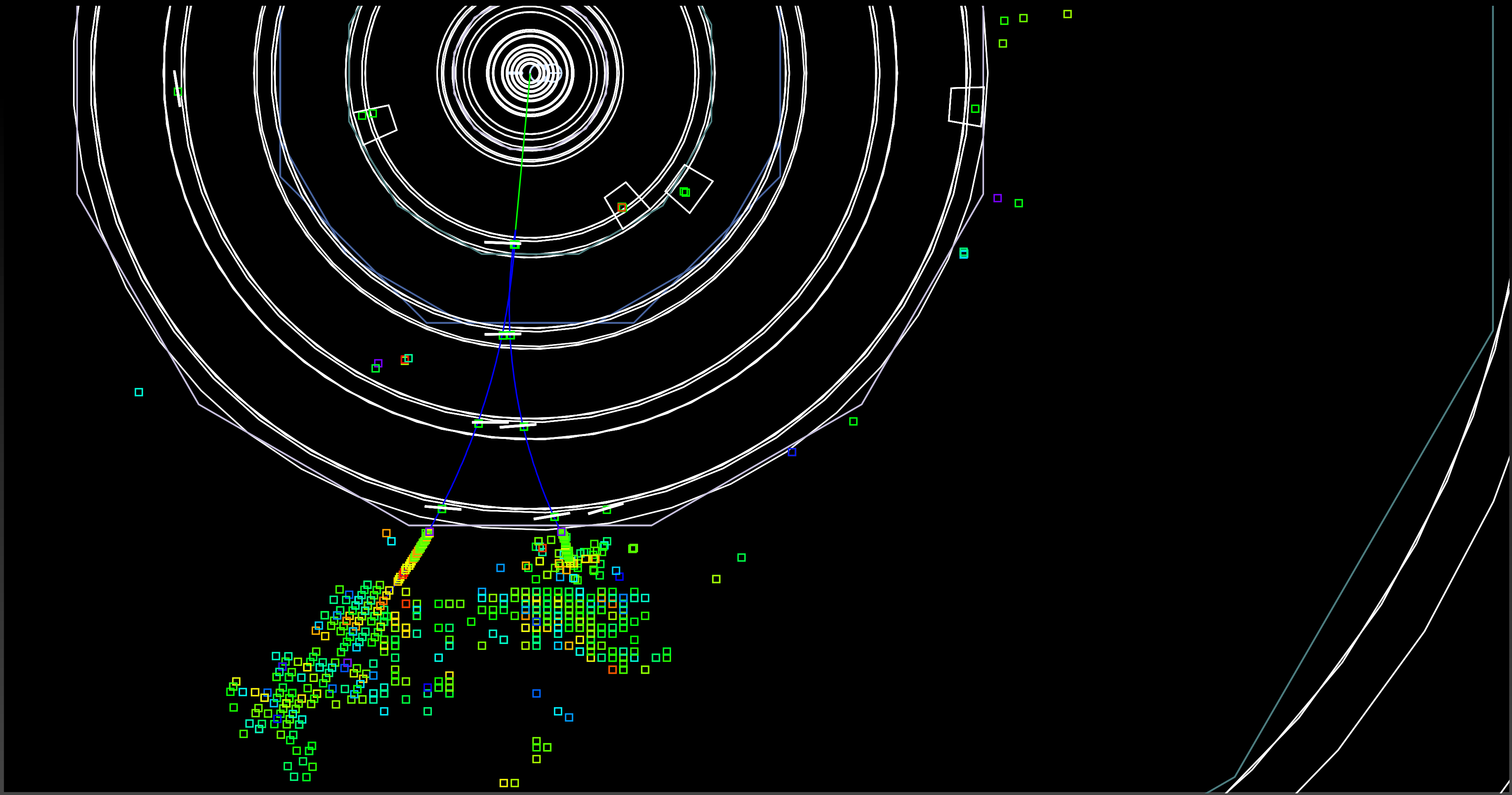
- Studied with Z’ → uds events @ 1TeV.
- Using existing strategies for sidloi3, modified chi2 cut
- Tracking strategies will be re-trained at CERN (C. Grefe) to optimize for background

Tracking Efficiency





Calorimeter-assisted tracking



Garfield Algorithm

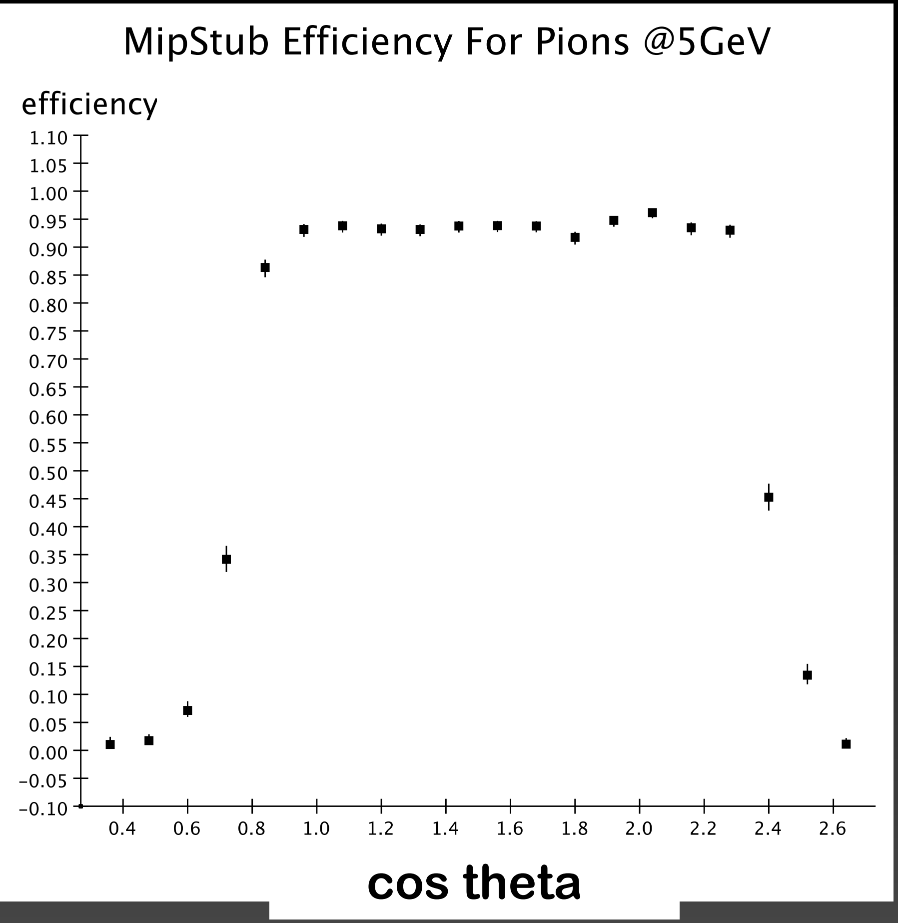
- Long-lived particles difficult to track in ~ 10 active layers
- We can use excellent ECAL resolution to recover decays like $K^0_s \rightarrow \pi^+ \pi^-$
- Strategy:
  - Identify MIP stub from π in ECAL
  - Add unused tracker hits going inward to find a new π track
  - Fit two tracks to make a K^0_s

Reviving Garfield

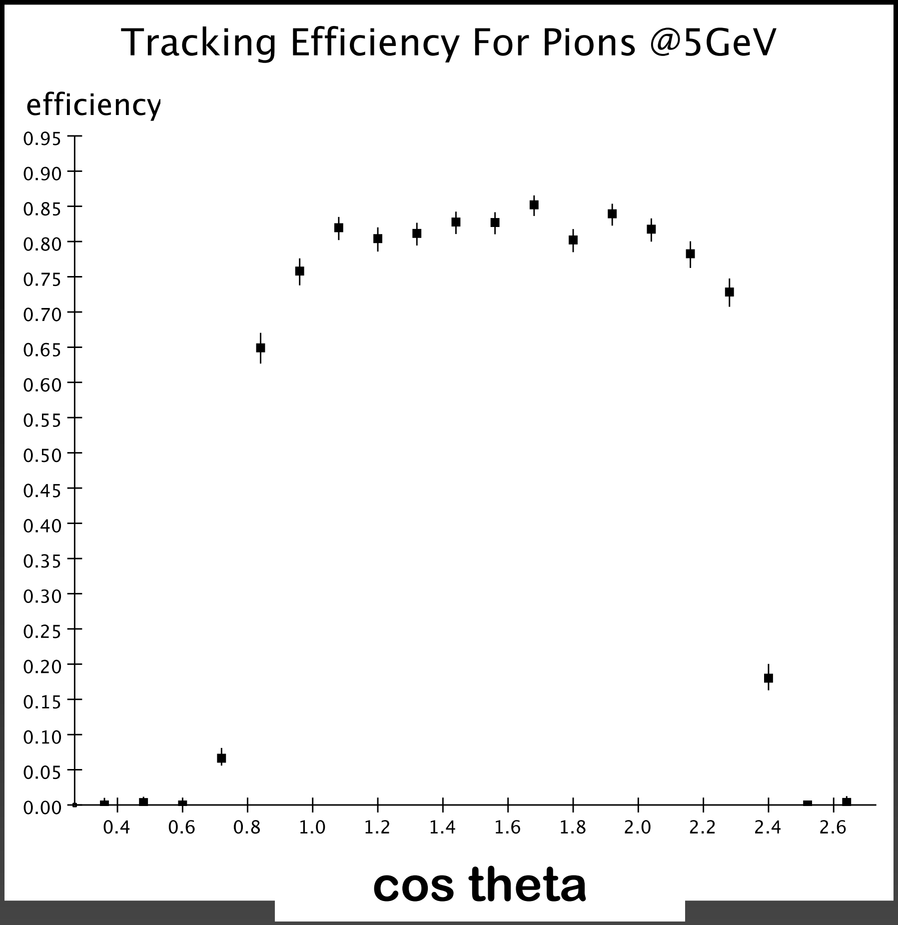
- Developed in pre-lcio times by Dima Onoprienko, Ekhard von Toerne
- Separate package, did not keep up with Tracking developments, not used in LOI
- Revival project at CERN:
  - Kick out the old classes and integrate into the current EDM, while retaining functionality

Example: Finding 5 GeV pions

MIP stub finder



Track finder



Plans for Garfield

- Get the whole chain back into working shape
- Get an idea of physics performance improvements in realistic samples
- Further code clean-up / documentation depending on budget

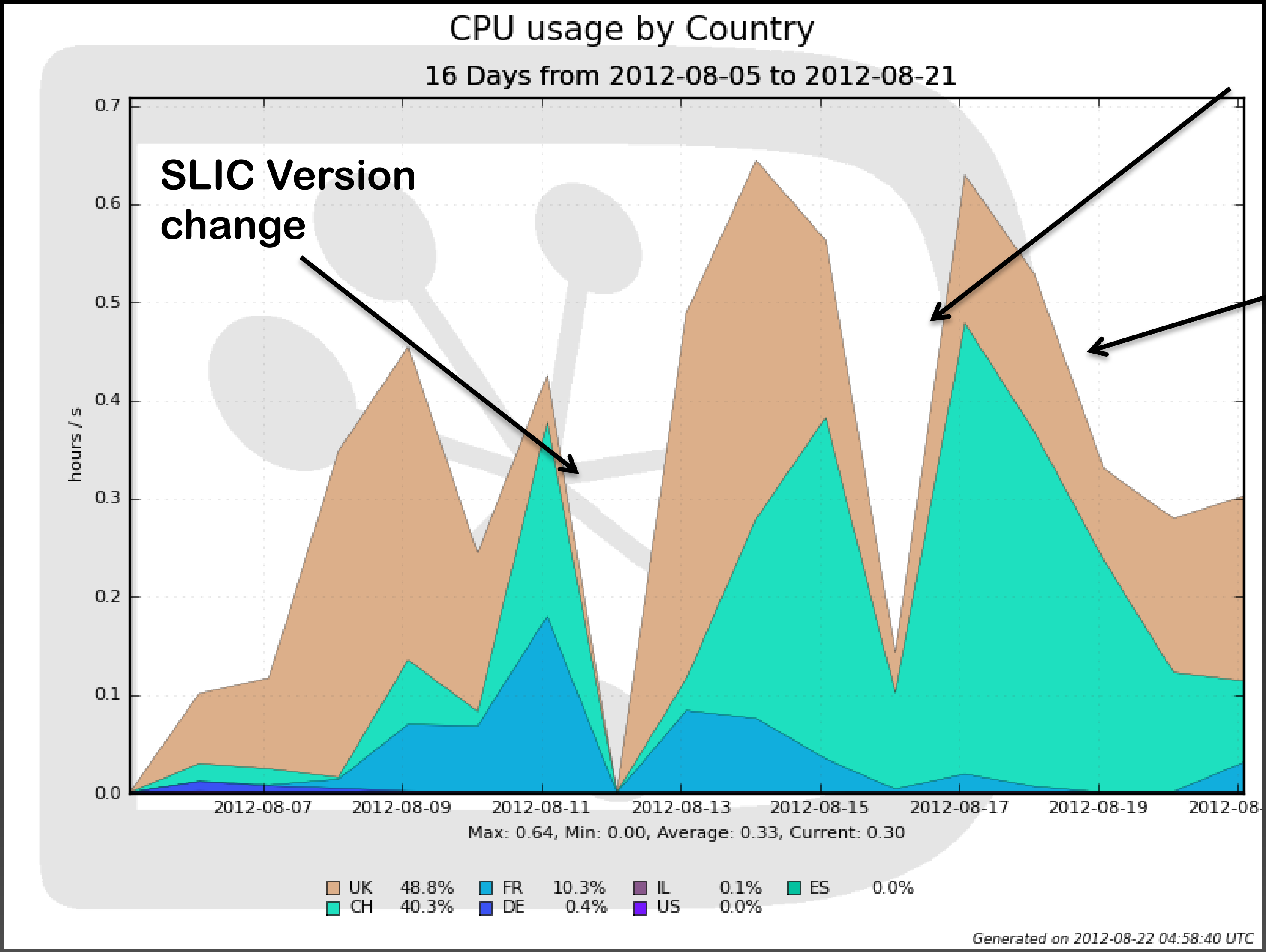
Production Framework

- US ILC and DESY ILC VOs merged
  - Samples can be produced on both, the LCG and the OSG grids
- Bookkeeping most time-consuming aspect of the production
- ILCDIRAC framework to automate submission, monitoring and bookkeeping

SiD DBD Simulation Budget Aug 21, 2012

Process	Ecm(GeV)	# Events	Lumi (ab^{-1})	Mixed File Creation Date
ttH	1000	0.4e6	52	07Aug2012 Mh=125 GeV
$ttZ, ttbb$	1000	0.4e6	15	10Jun2012
tt	1000	1.0e6	2.0	24Jul2012
$ffH\ H \to bb, cc, WW^*, gg$	1000	3.1e6	7.4	26Jul2012 Mh=125 GeV
$ffH, H \to \propto\propto$	1000	0.5e6	6400	
$e\nu W, eeZ, \nu\nu Z \to e\nu qq, eeqq, \nu\nu qq$	1000	4.0e6	0.034	24Jul2012
$eeZ, \nu\nu Z, WW \to ee\propto\propto, \nu\nu\propto\propto$	1000	1.0e6	0.004	16Aug2012
WW	1000	6.0e6	2.0	16Aug2012
other SM processes	1000	6.0e6	varies between 1.e-5 and 1.0	21Aug2012
tt	500	2.0e6	2.0 (1.0 each for two top masses)	
tt background SM processes	500	2.0e6	varies	
$TOTAL$		26e6		

Production Status



SLAC production starting

DIRAC version change

18 million events done

CPU time used in this plot: 53 years

Data Produced: 7.7 TB

Outlook

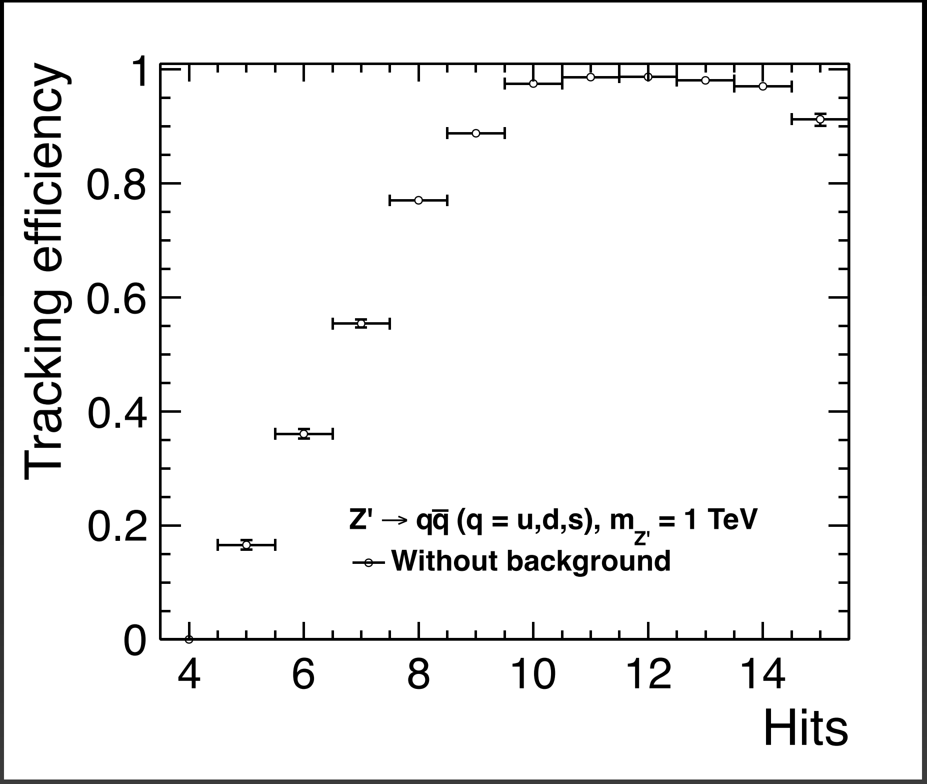
- Performance studies with background currently in progress
  - Tracking
  - Vertexing
  - Jet clustering
  - Flavor tagging
- So far, no showstoppers, but some more work needed
- Reconstruction software validation ongoing, deadline: first week of September

Summary

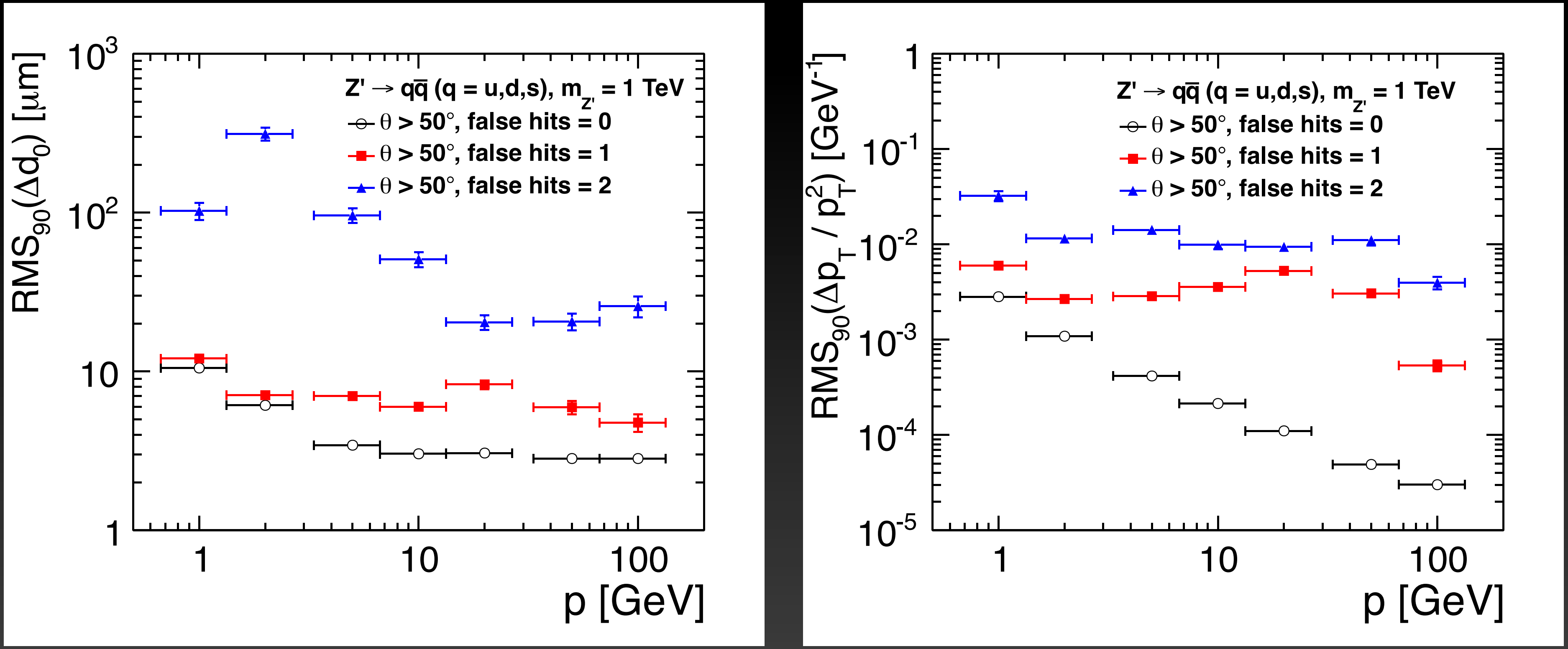
- We have a comprehensive program to evaluate the performance of the detector in a realistic environment
- Most of the polarization states of the physics events have been mixed and are being uploaded to the grid
- The simulation of the events is in full swing
- Analysts have been set up with necessary tools

BACKUP

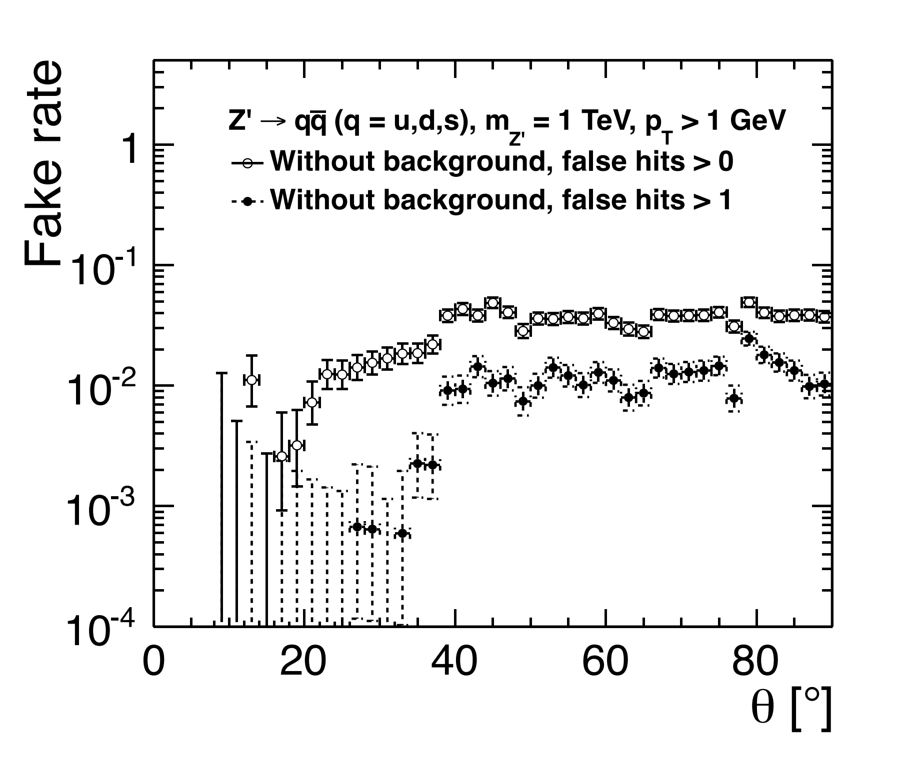
Tracking efficiency vs. #hits

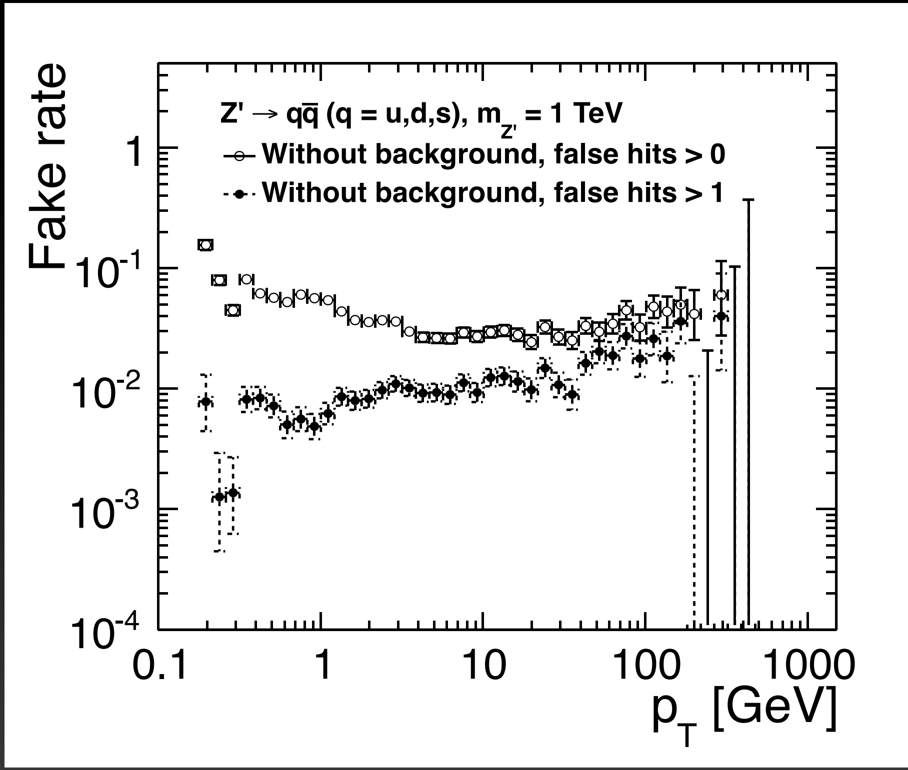


Tracking Resolution



Tracking Fake Rate





Tracking Purity