# Simulation with tracks in hadronic showers

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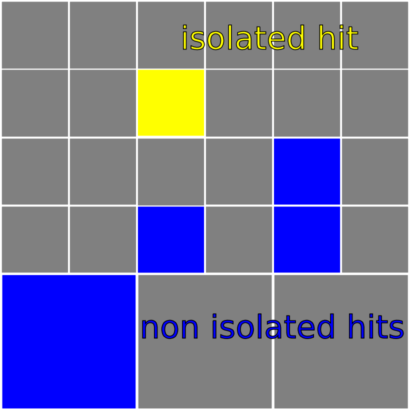
# Tracking in hadronic showers

We are using the analog HCal only
For more information see CAN-013

## Algorithm

1. Find all isolated hits / layer



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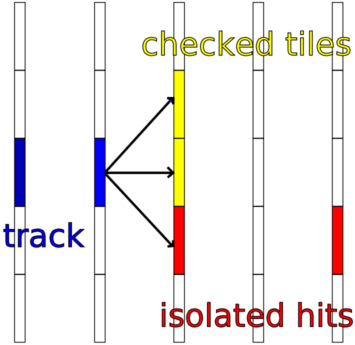
2. Start at innermost layer, connect hits at rougly same position in adjacent layers



# Tracking in hadronic showers

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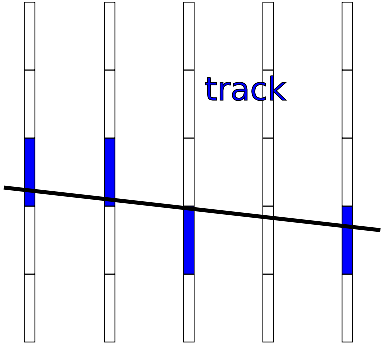
## Algorithm

1. Find all isolated hits / layer
2. Start at innermost layer, connect hits at rougly same position in adjacent layers
3. Use the finished track



# known problems

## known problems

- sensitive to isolation criteria
  $\longrightarrow$ noise reduces length and number of tracks
- not possible directly within a shower (too many adjacent hits)
- can only find tracks to a max angle of 63° $(3 \times 3\mathrm{cm}^2)$

# Simulation parameters

## w/o noise

- Geant 4.9.1 32Bit
- Mokka 06-07 32Bit

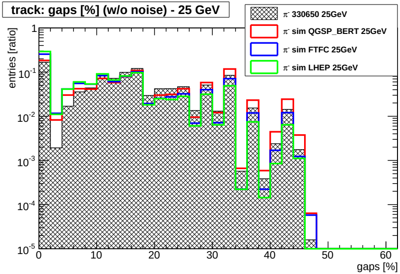
## with noise

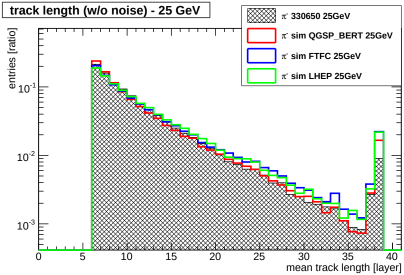
- Geant 4.9.2 64Bit
- Mokka 06-07-p03-calice 64Bit
  - ⇒ timecut
  - ⇒ Birk's Law

## common parameters

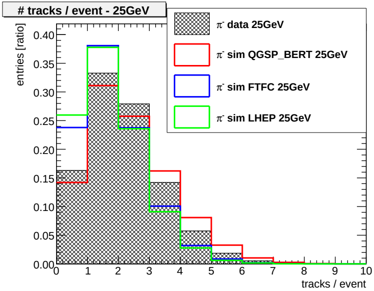
- Marlin 32Bit, Calice Soft 01-03-04 (devel branch 7.1.2009)
- detector model: TBcern0707_dchxy_01
- run: 330650
- full detector simulation, but only HCal reconstructed
- g10 density should have the new value of 2.64 g/ccm

# $\pi^-$ w/o noise @ 25GeV

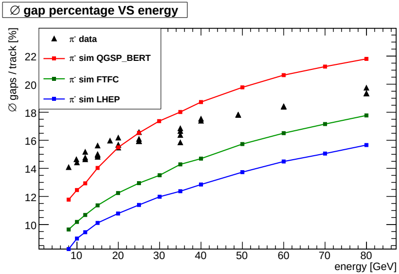


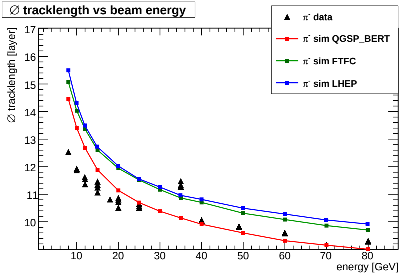




- No Birk's law, no timecut
- comparison data $\leftrightarrow$ simulation: looks good
- QGSP_BERT seems to be best choice

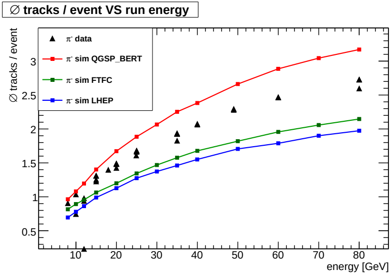


# $\pi^-$ w/o noise - all energies

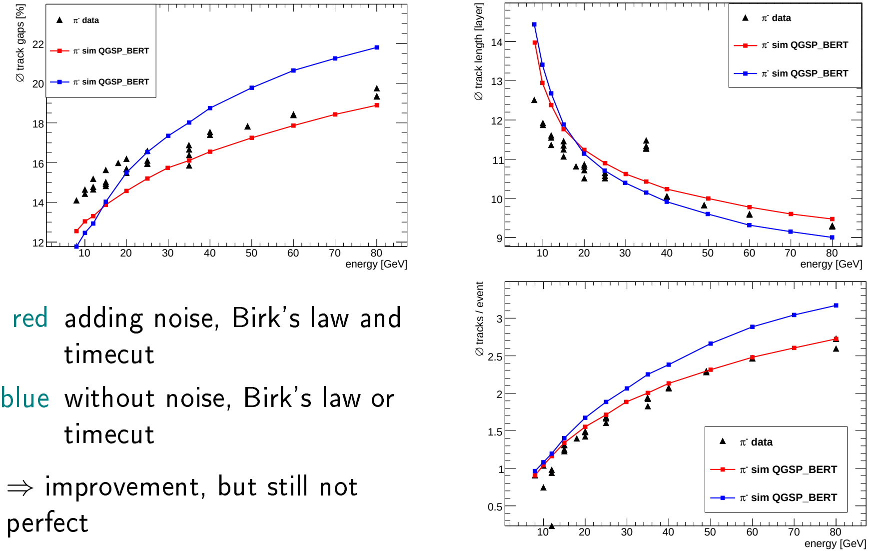



- high $\mu$ component @ 35GeV
- no noise $\Rightarrow$ only tendencies
- data and MC have same trend
- QGSP_BERT seems best



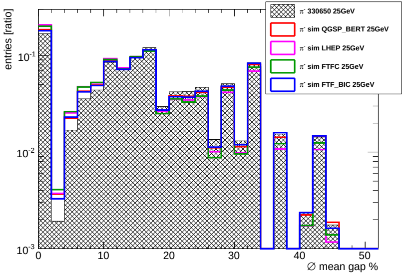
# Improvement with Birk's law and timecut

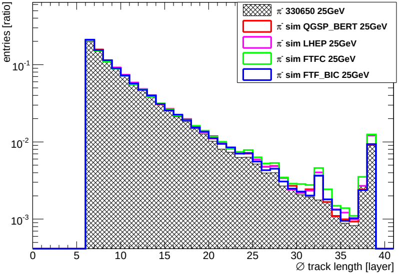



- **red** adding noise, Birk's law and timecut
- **blue** without noise, Birk's law or timecut

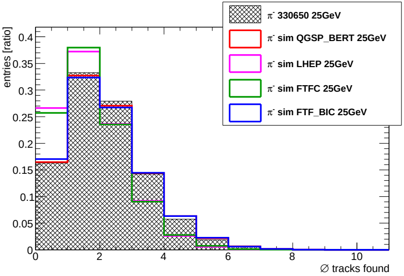
⇒ improvement, but still not perfect

# $\pi^-$ w/ noise @ 25GeV

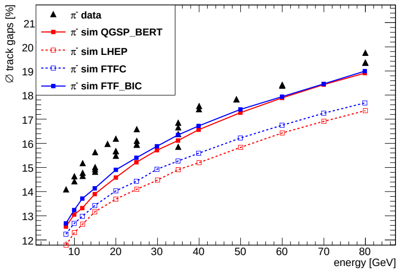


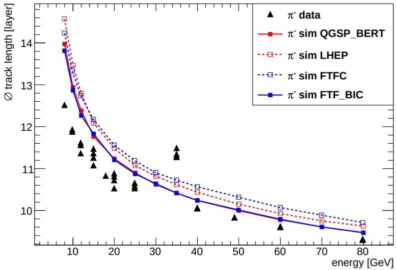




- QGSP_BERT and FTF_BIC look almost identical
- comparison data ↔ QGSP_BERT / FTF_BIC: looks good



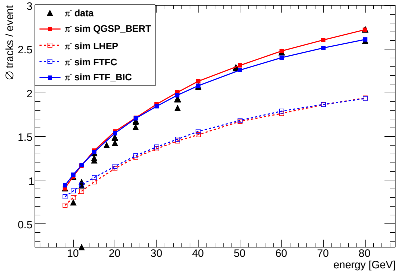
# $\pi^-$ w/ noise - all energies



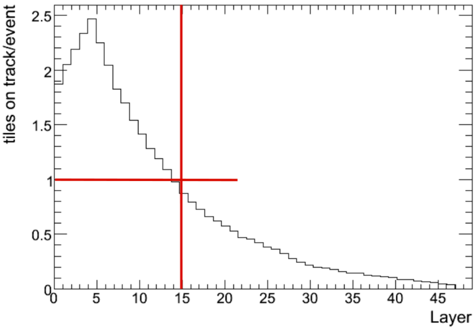

same over all energies:

- QGSP_BERT and FTF_BIC are similar
- QGSP_BERT and FTF_BIC are closer to real data than LHEP and FTFC



# Calibration for ILD

full ILD detector: $Z^0 \rightarrow q\overline{q}$ @ 91.2GeV




$> 1 \frac{\textbf{track}}{\textbf{layer}}$ out to layer 14

Figure: tiles on track/event VS layer

- high statistics in first layers, then fast drop
- average over i and j

# Calibration for ILD

plots are from Shaojun Lu for TILC conference

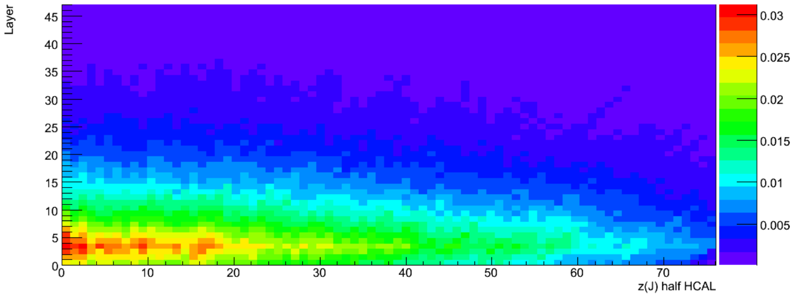



Figure: tiles on track/event

- picture shows only half of the detector barrel in z
- number of tiles on a track drops fast to outer regions

# Calibration for ILD: How much luminosity is needed?

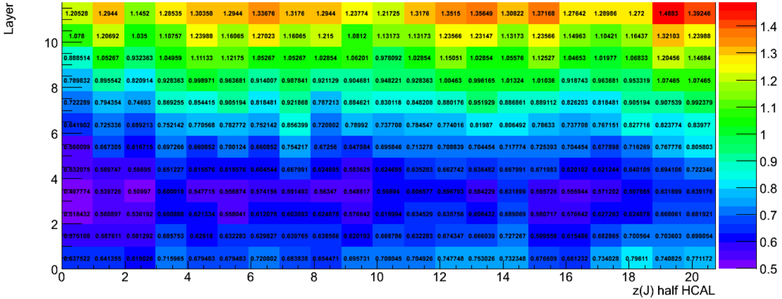



Figure: integrated luminosity needed for having >1000 hits per tile

- zoomed out inner area of detector barrel
- up to layer 12 one needs $1.5\mathrm{pb}^{-1}$ for calibration
- endcaps will be done next

## Conclusion

- MC and data have same trends
- noise, timecut and Birk's law improve MC
- QGSP_BERT and FTF_BIC seem to fit best while still not being ideal

## Outlook

- improve tracking algorithm
- check luminosity needed for calibration of endcaps