Track Segments and Shower Substructure

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Overview

1. "Follow Your Nose"
   - principle
   - λ estimation
   - MC Particle endpoint / Track endpoint comparison
2. Monte Carlo - Data comparison
   - track length
   - track multiplicity
   - track angle
   - track gap percentage
3. Impact of new Mokka model
   - the new mokka model
   - track gap percentage
   - track multiplicity
   - track length
   - track angle

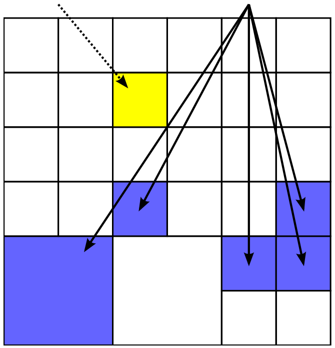
Tracking in hadronic showers

We are using the analog HCal only, for more information see CAN-013.

2nd algorithm based on Hough Transformation also developed.

Algorithm

1. Find all isolated hits / layer



Tracking in hadronic showers

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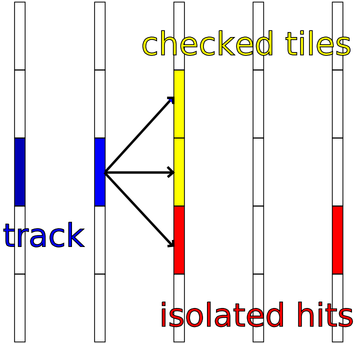
Algorithm

1. Find all isolated hits / layer
2. Start at innermost layer, connect hits at roughly same position in adjacent layers



Tracking in hadronic showers

We are using the analog HCal only, for more information see CAN-013.
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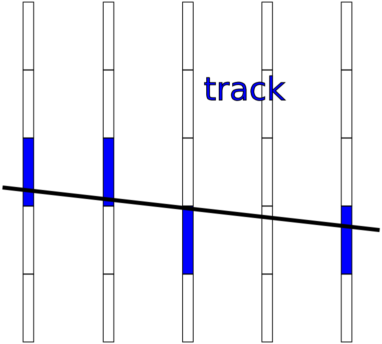
Algorithm

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



Estimation of interaction length λ

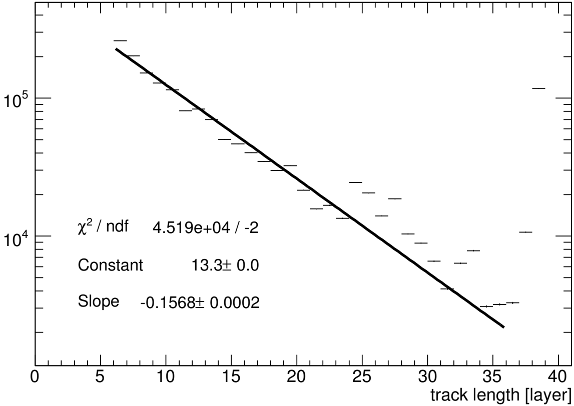
Definition

Probability P that no hadronic interaction takes place after distance x:

$$P(x) = e^{-\frac{x}{\lambda}} \quad (1)$$

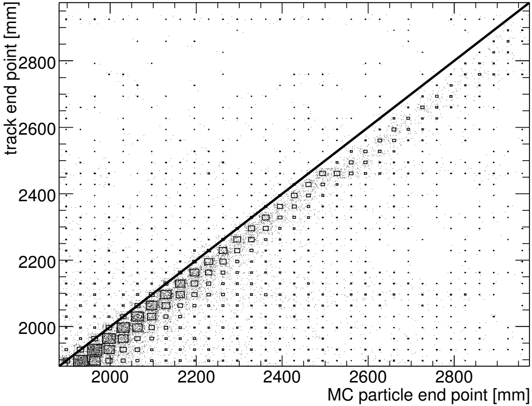
$\Rightarrow$ Tracklength of tracks starting in 1st layer = # particles still active in layer x.

Estimation of interaction length λ



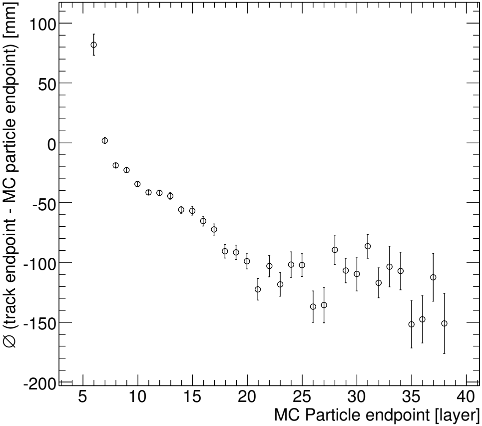
$\lambda = \frac{\mathrm{layer}}{0.1568} \approx 6.38\,\mathrm{layers}$ - too low!

MC Particle endpoint / Track endpoint comparison



found tracks too short

MC Particle endpoint / Track endpoint comparison



systematic offset between track and MCParticle endpoints!

$\Rightarrow$ reconstruction of λ too small

Monte Carlo - data comparison

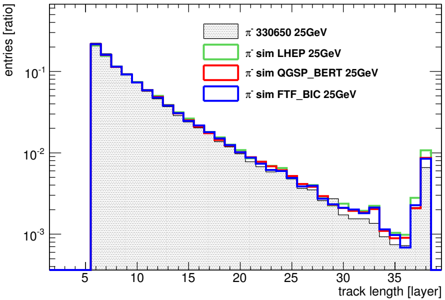
using tracking algorithm for Monte Carlo - Data comparison

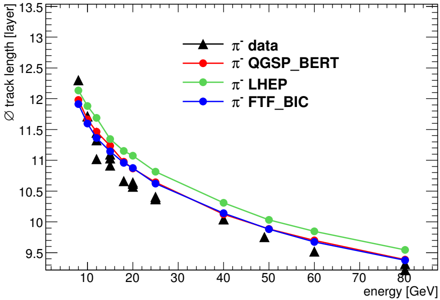
- good possibility to compare different shower models (physics lists)
- but: tracks found not within shower core!
- still better than comparing rough shower profiles

used parameters

- FYN algorithm with default settings (min length: 6 layers)
- Mokka version 0608-p01
- Mokka model TBCern0707_p0709

Monte Carlo - Data comparison: track length

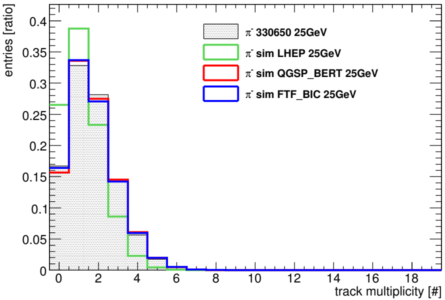


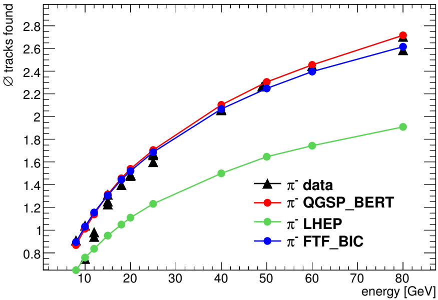


conclusion

- all to long
- QGSP_BERT and FTF_BIC almost identical
- LHEP even further away

Monte Carlo - Data comparison: track multiplicity

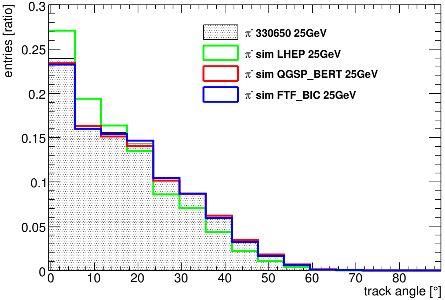


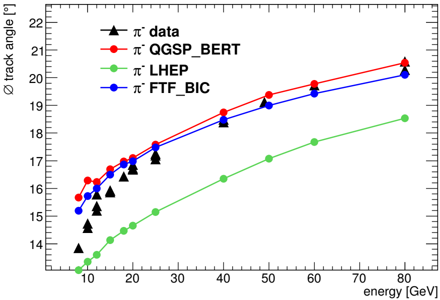


conclusion

- QGSP_BERT and FTF_BIC very close to data, LHEP has too few tracks
- QGSP_BERT and FTF_BIC almost identical

Monte Carlo - Data comparison: track angle

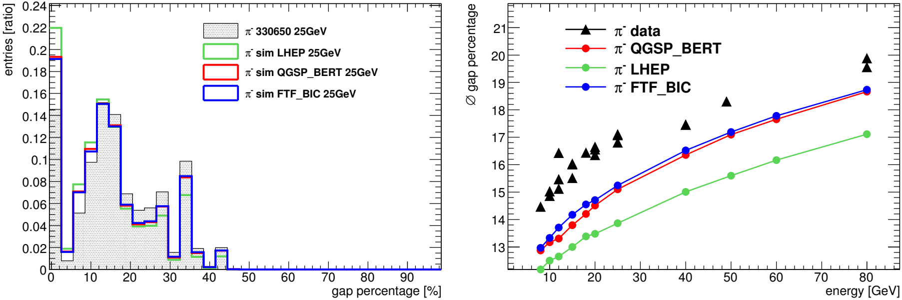




conclusion

- for energies $> 10\,\mathrm{GeV}$ QGSP_BERT and FTF_BIC very good
- LHEP close to data for $\approx 10\,\mathrm{GeV}$, too short for higher energies

Monte Carlo - Data comparison: track gap percentage



conclusion

- very sensitive to right amount of noise - digitization test
- in all cases too few gaps ⇒ missing effect in digi?
- LHEP still worse than QGSP_BERT and FTF_BIC

Monte Carlo - Data comparison: conclusion

conclusions

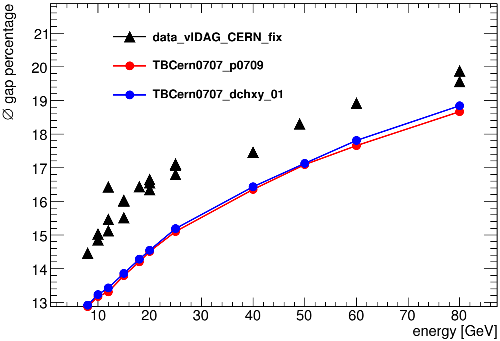
- QGSP_BERT and FTF_BIC almost identical
- LHEP's tracks are too few and too long with too low angles
- QGSP_BERT and FTF_BIC compare well to data, except gap percentage
- gap percentage too low in simulation. Maybe missing effect in digitization?

Impact of the new Mokka Model

the new Mokka model

- until now: 16 mm steel absorber plates
- measurements: most absorber plates with $\approx 17.5\,\mathrm{mm}$
- $\Rightarrow$ change in Mokka (new version mokka-06-08-p01) and new models
- here: comparison of model TBCern0707_dchxy_01 (old absorber thickness) with TBCern0707_p0709 (new absorber thickness)
- physics list: QGSP_BERT

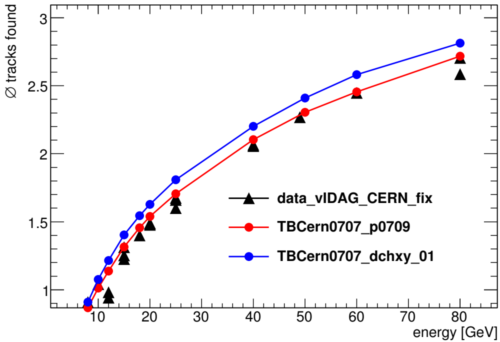
new Mokka model: track gap percentage



comparison

- no change expected (noise not affected by absorber)
- no change seen

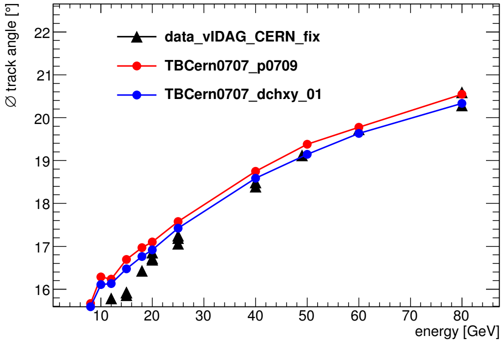
new Mokka model: track multiplicity



comparison

- more absorber ⇒ shorter tracks ⇒ less tracks above threshold of 6 layers

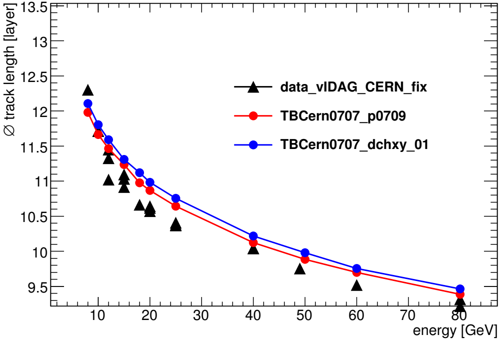
new Mokka model: track angle



comparison

geometry change ⇒ more scattering ⇒ angles get bigger

new Mokka model: track length



comparison

- more absorber ($4 + 16\,\mathrm{mm} \rightarrow 4 + 17.5\,\mathrm{mm}$) $\Rightarrow$ expecting $\approx 7\%$ shorter tracks
- only $1 - 2\%$ effect seen!?

new Mokka model: conclusion

conclusion

- gap percentage / track multiplicity / track angle changes as expected
- but: track length decrease is too low

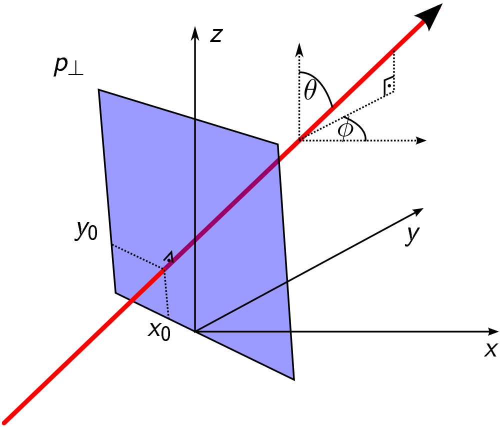
$\Rightarrow$ Needs to be studied further.

Conclusion

Conclusion

- FYN tracking can find tracks within hadronic showers
- Estimation of interaction length λ not yet possible, efficiencies needed
- Still: comparision between Monte Carlo and real data possible:
  - QGSP_BERT and FTF_BIC provide results that are almost identical
  - QGSP_BERT and FTF_BIC close to real data
  - LHEP has too long tracks with too less particles
  - possible missing effect in digitzation
- new Mokka model: results from comparison not yet fully understood

Hough algorithm: tracking parameters



removal of 35 GeV runs from MC comparison