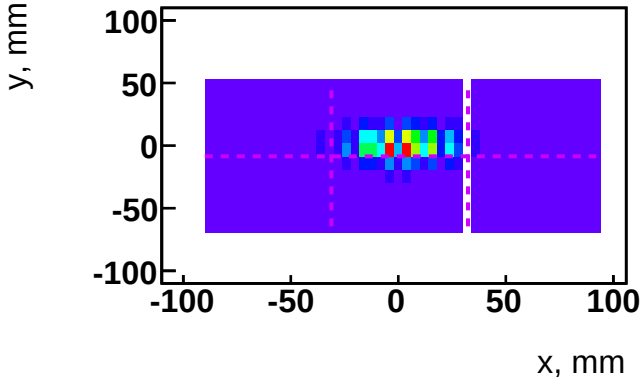
Si-W Resolution /CERN 2006/

Kaloyan Krastev

LPSC

The CALICE Si-W ECAL prototype



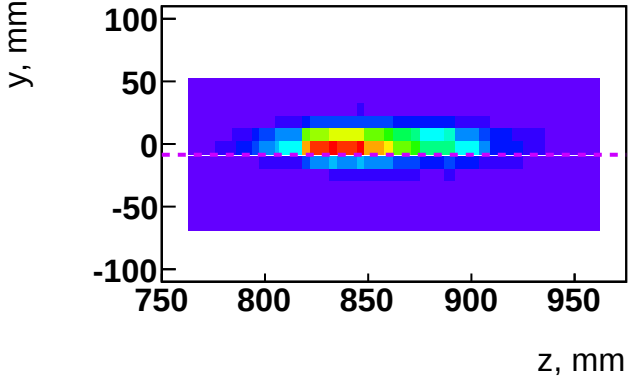
30 layers with 3 x 2 wafers with 6 x 6 pads

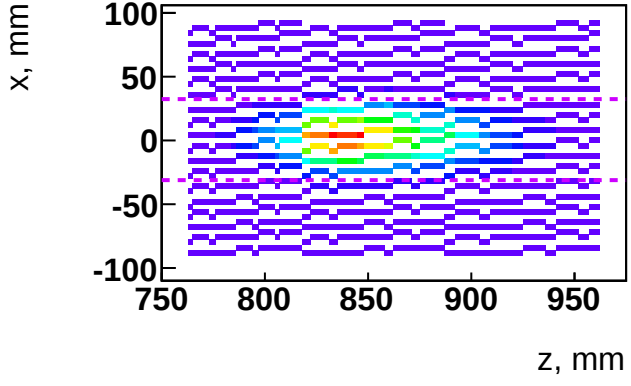
In total: 6480 pads, 10 x 10 mm^2 each

layers aligned in y but shifted in x

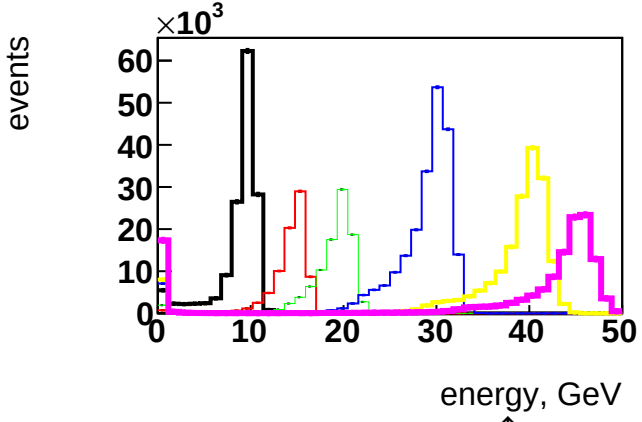
absorber: 1.4 mm (layer 0 - 9), 2.8 mm (layer 10 - 19), 4.2 mm (layer 20 - 19)

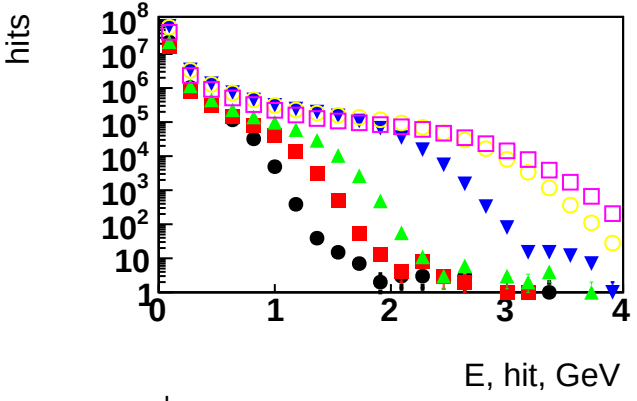
Inter-wafer gaps ~ 1 mm



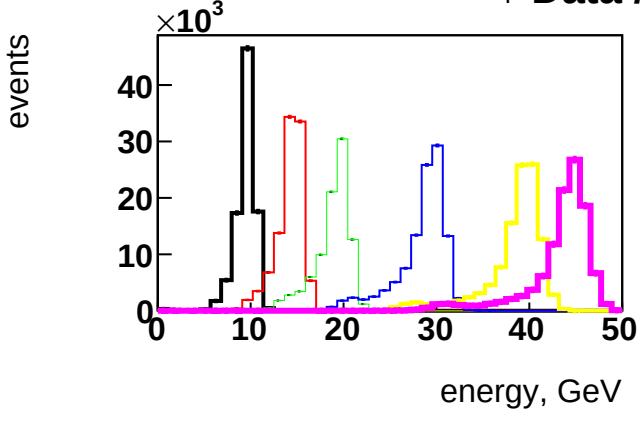


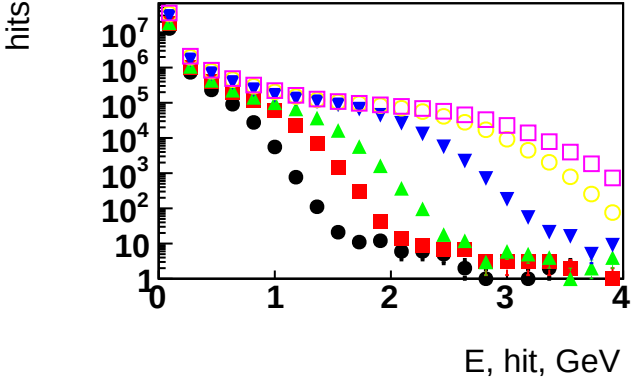
Test beam





↑ **Data / Monte Carlo** ↓





Spatial resolution

1. Calculate energy weighted mean shower position, $\vec{b} = \sum_{hits} \vec{r}_i \, w_i \, / \sum_{hits} w_i$
2. Measure distance ($\vec{b} \rightarrow$ track from drift chambers)
3. Fit distance to Gaus

linear weights: $w_i = E_i / E_{tot}$

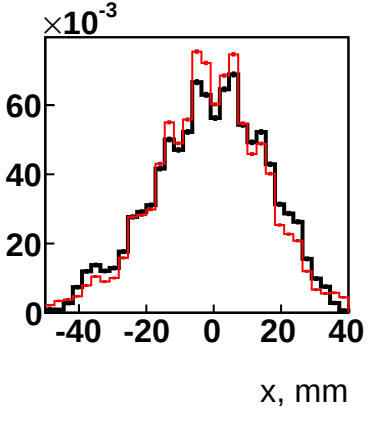
logarithmic weights:

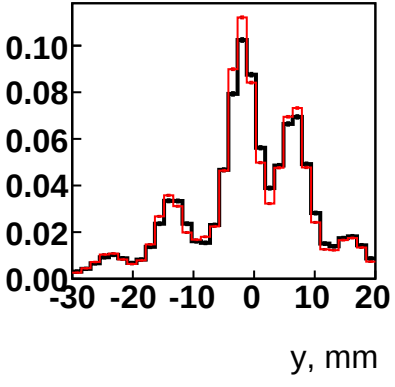
$w_i = \max\{0, w0 + \log(E_i / E_{tot})\}$

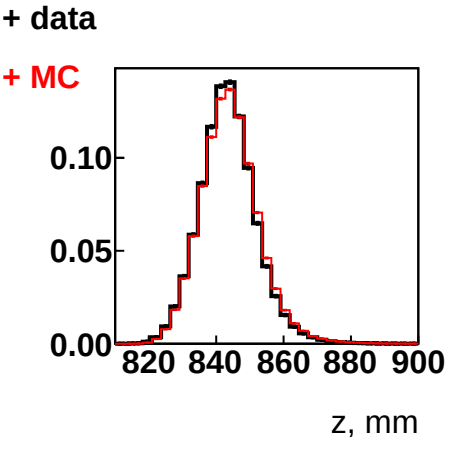
Spatial resolution

1. Calculate energy weighted mean shower position, $\vec{b} = \sum_{hits} \vec{r}_i w_i / \sum_{hits} w_i$
2. Measure distance ($\vec{b} \rightarrow$ track from drift chambers)
3. Fit distance to Gaus

linear weights: $w_i = E_i / E_{tot}$







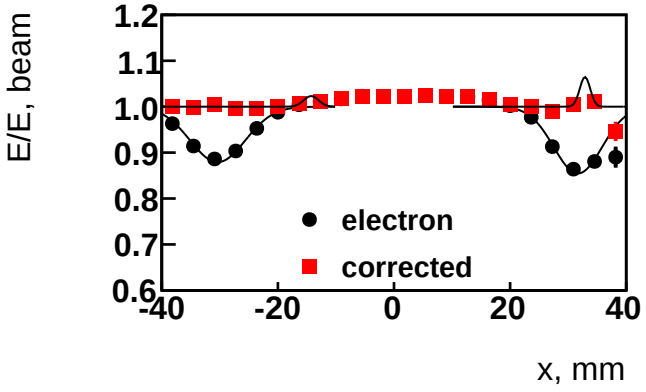
Energy correction

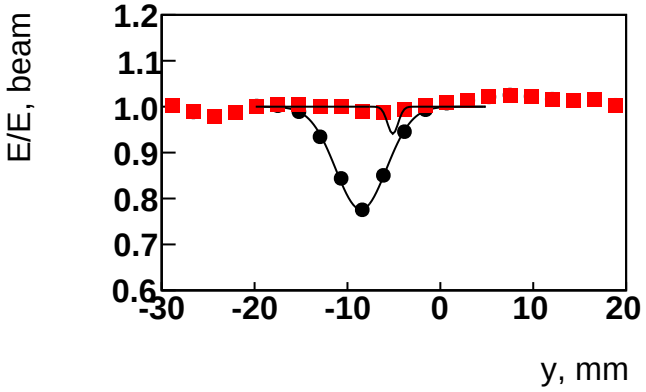
1. Ignore hits with E_i <= 0.6 MIP

2. Account for absorber E_i * 1.1/2/2.7

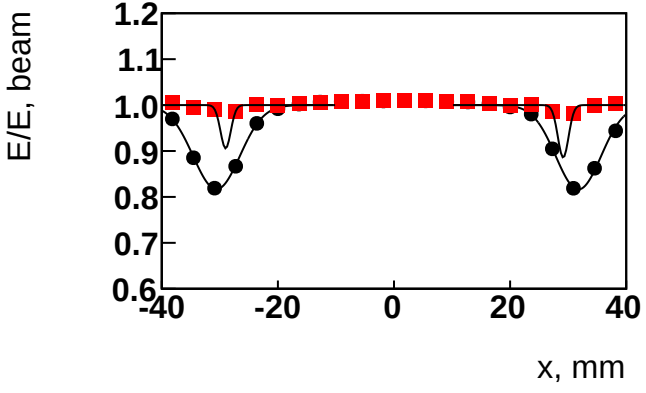
3. Correct event energy

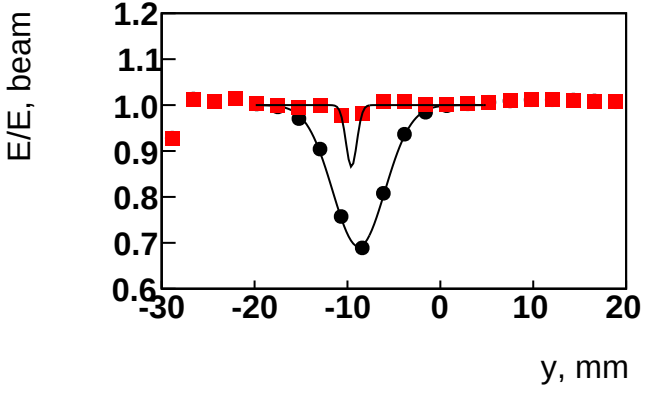
Inter wafer gaps



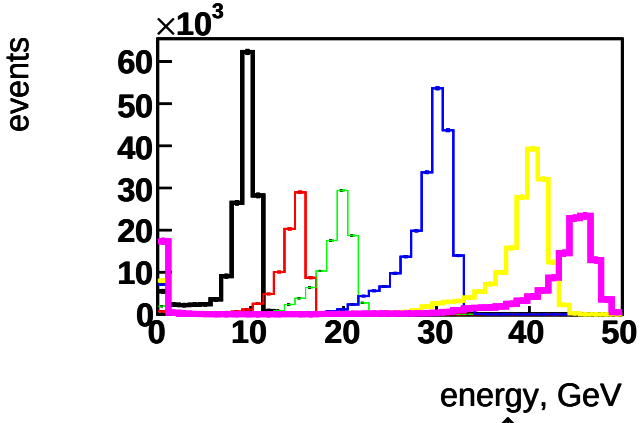


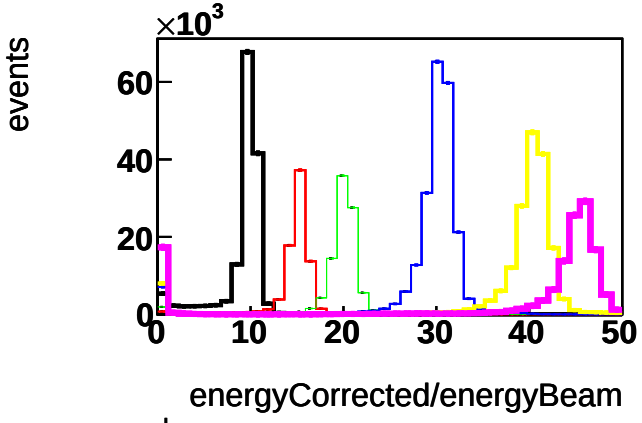
↑ **Data / Monte Carlo** ↓



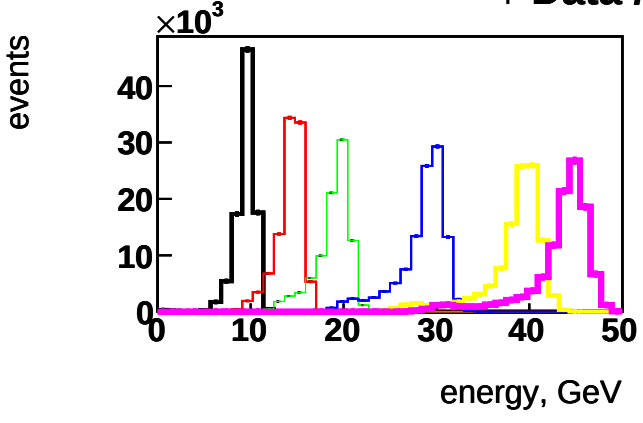


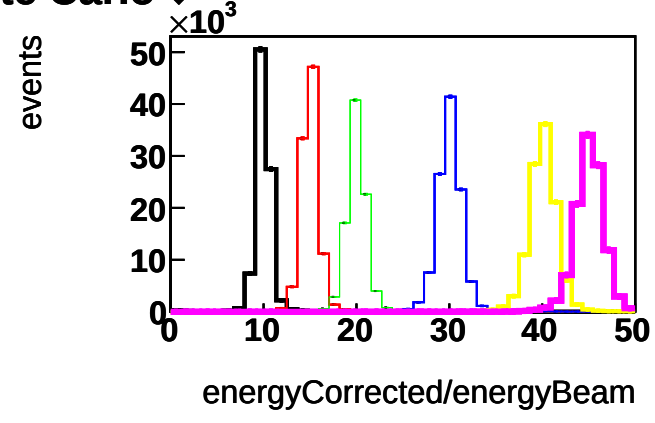
Energy correction



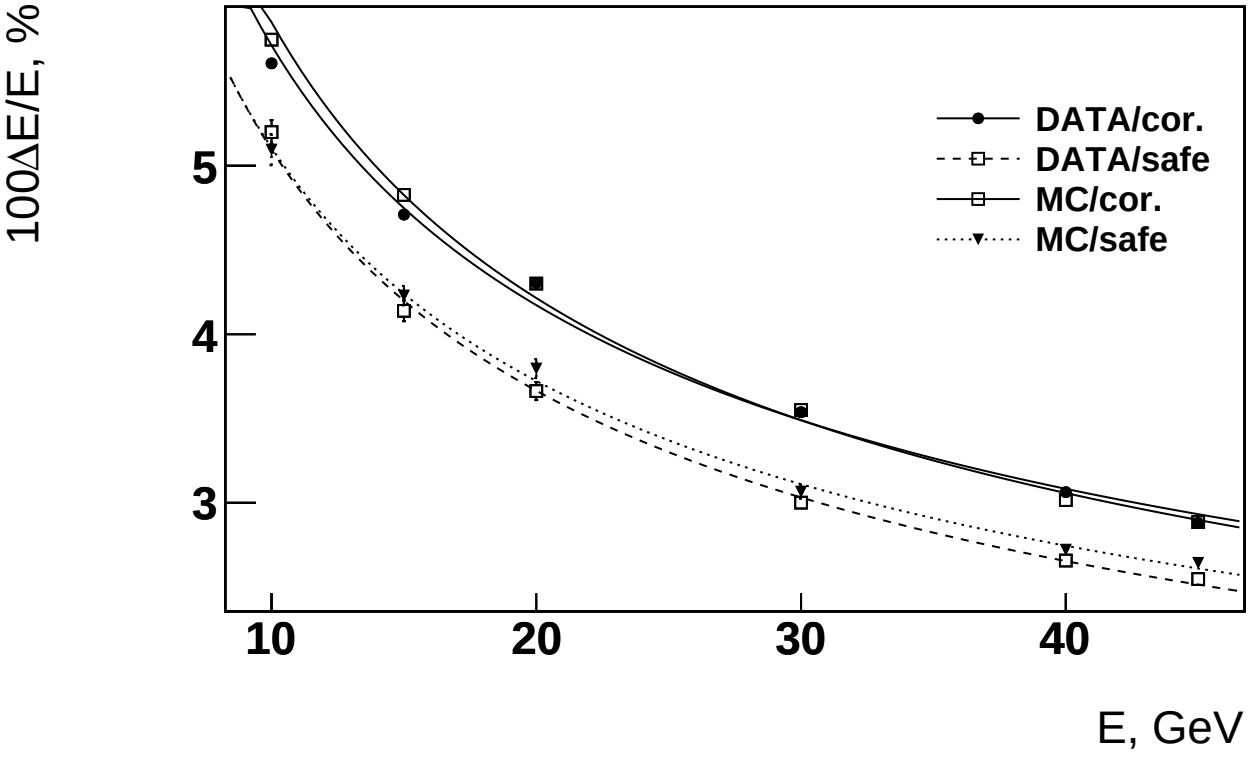


↑ **Data / Monte Carlo** ↓

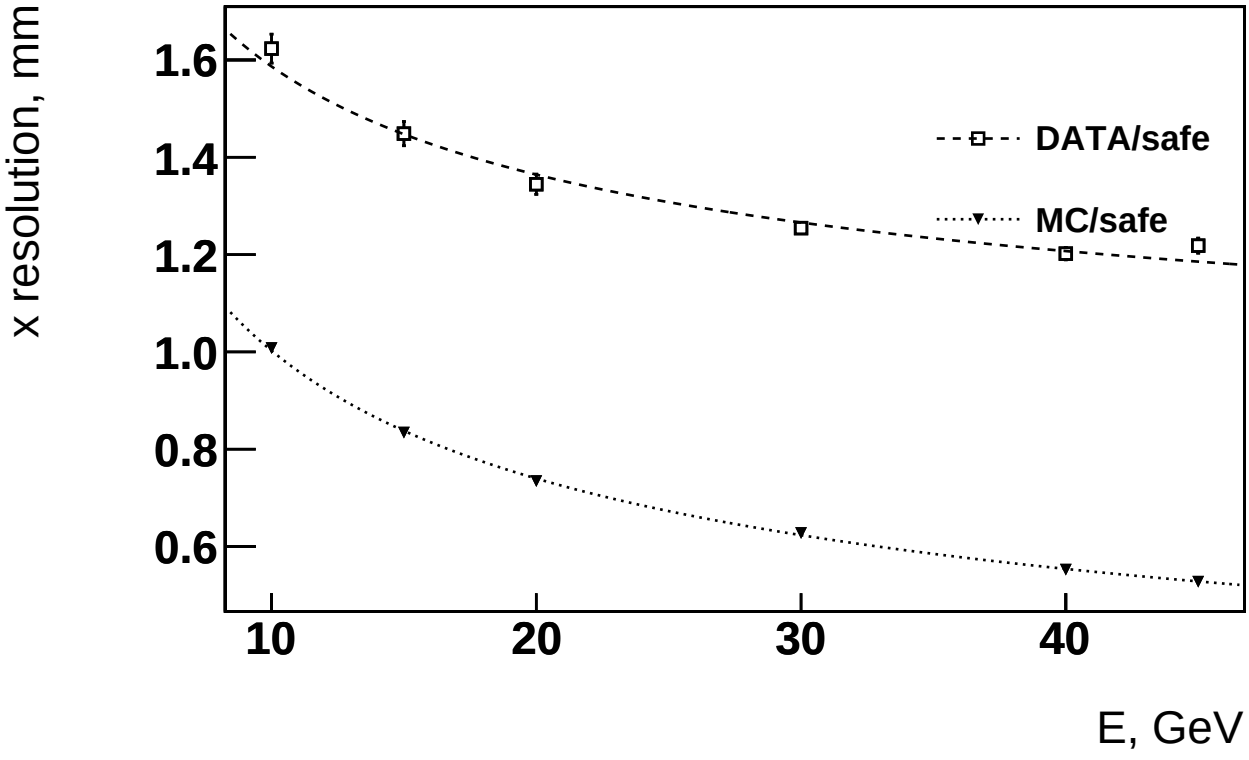




Energy resolution



Spatial resolution



Summary

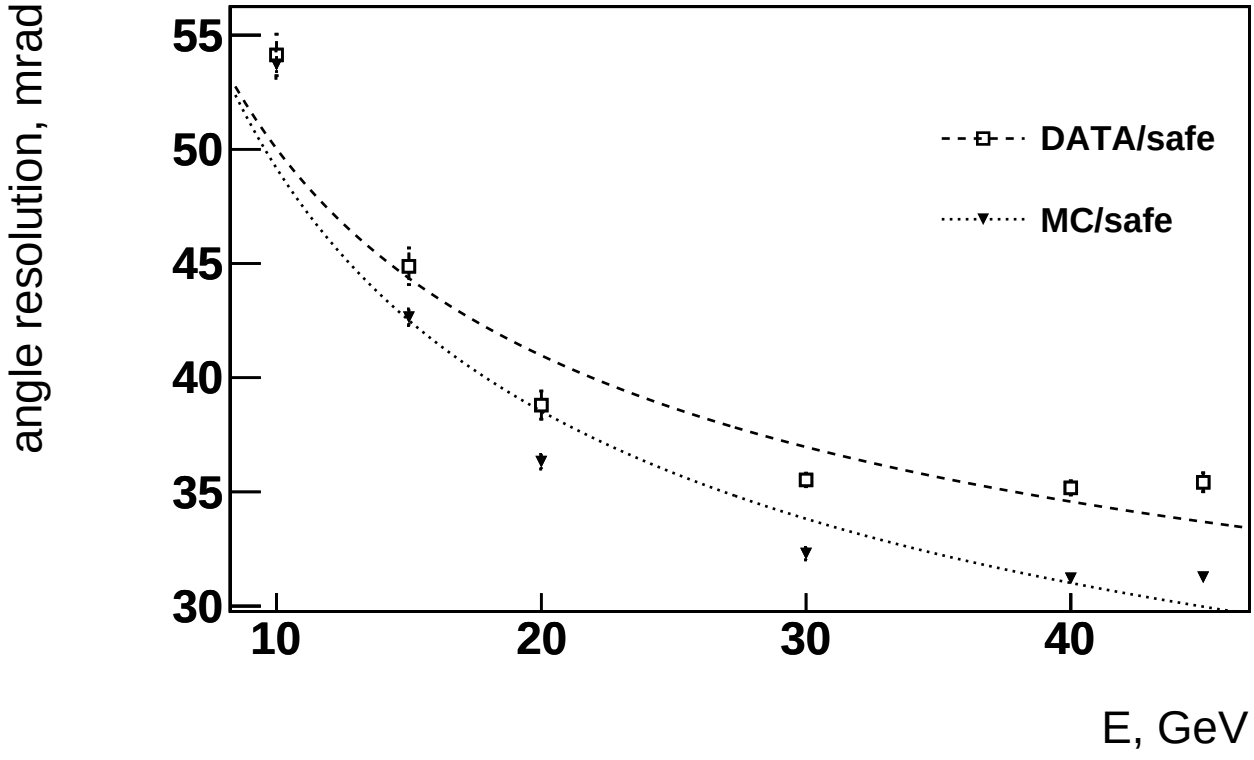
The spatial resolution is not described by Monte Carlo.

The reason for the discrepancy is not known.

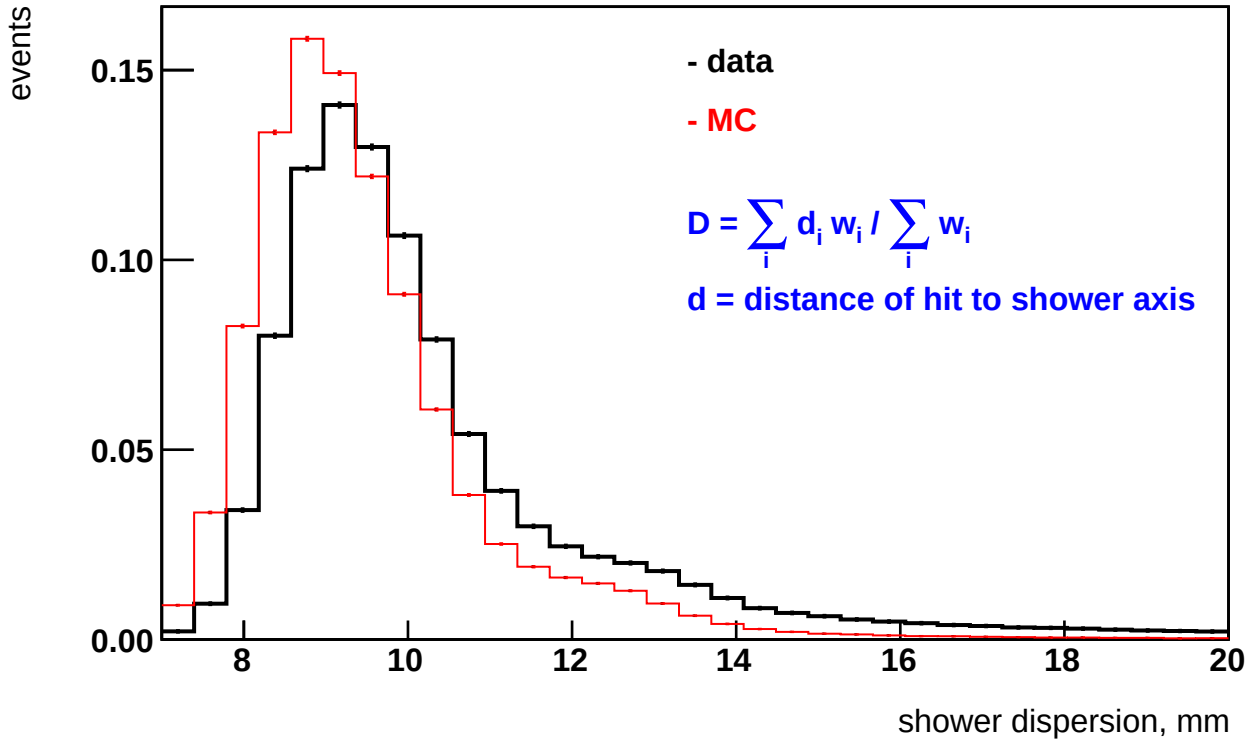
Any suggestions are welcome.

APPENDIX

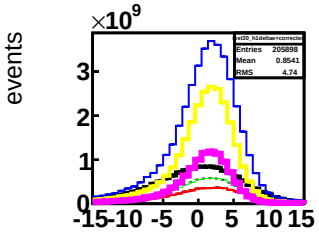
Angle resolution

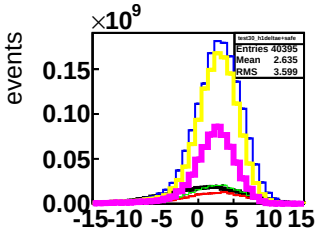


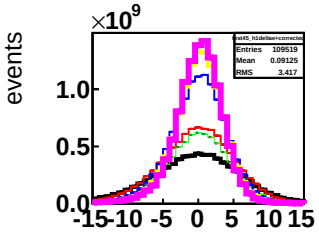
Shower dispersion

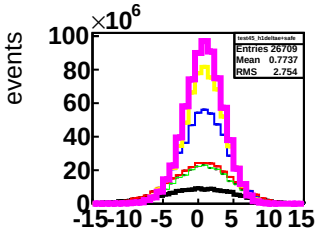


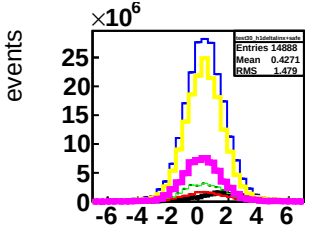
gaus

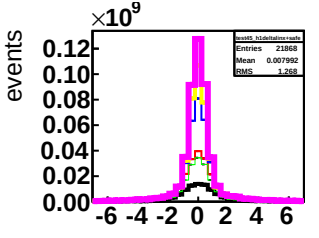

events
×10^9
Entries 205898
Mean 0.8541
RMS 4.74
ΔE, GeV

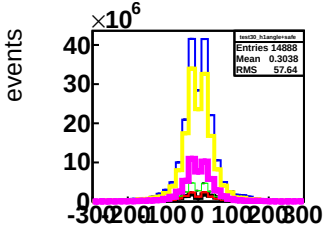

events
×10^9
Entries 40395
Mean 2.635
RMS 3.599
ΔE, GeV

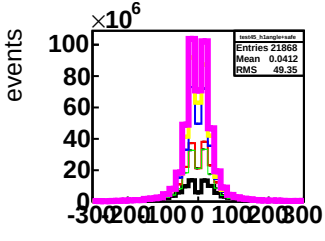

events
×10^9
Entries 109519
Mean 0.09125
RMS 3.417
ΔE, GeV


events
×10^6
Entries 26709
Mean 0.7737
RMS 2.754
ΔE, GeV

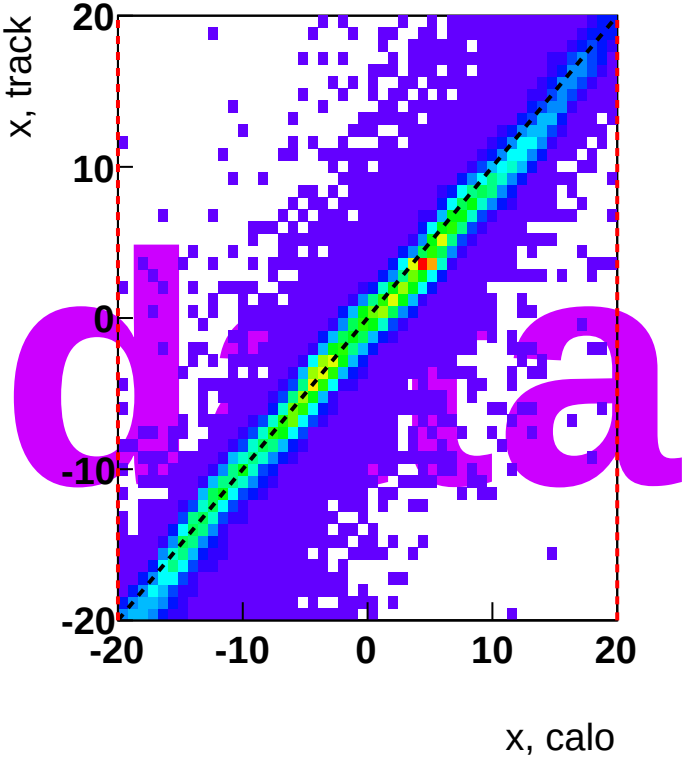

events
×10^6
Entries 14888
Mean 0.4271
RMS 1.479
Δx,lin, mm

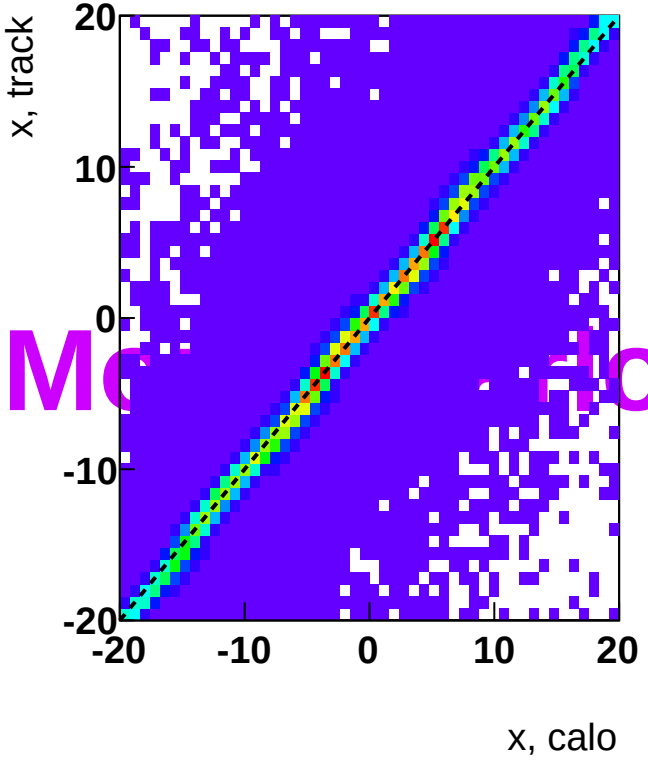

events
×10^9
Entries 21868
Mean 0.007992
RMS 1.268
Δx,lin, mm


events
×10^6
Entries 14888
Mean 0.3038
RMS 57.64
angle, mrad

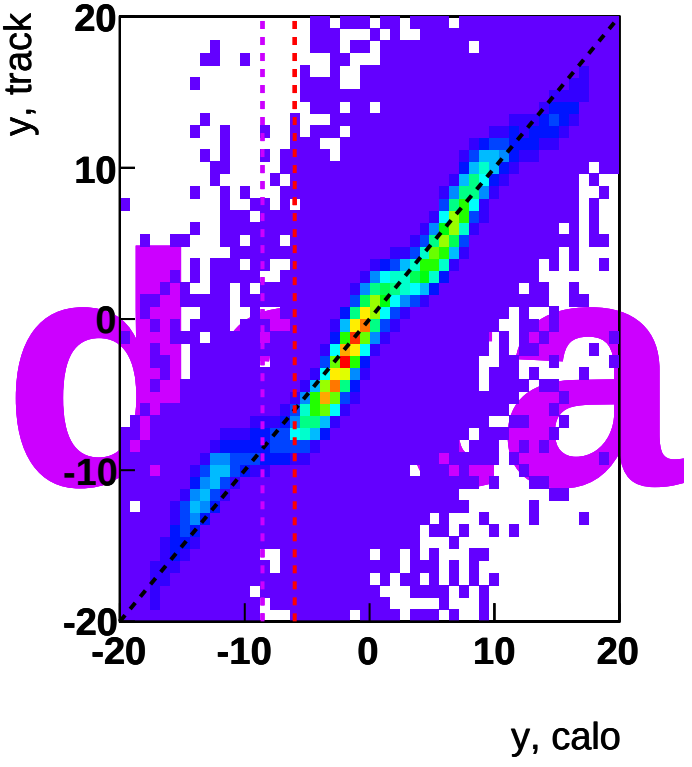

events
×10^6
Entries 21868
Mean 0.0412
RMS 49.35
angle, mrad

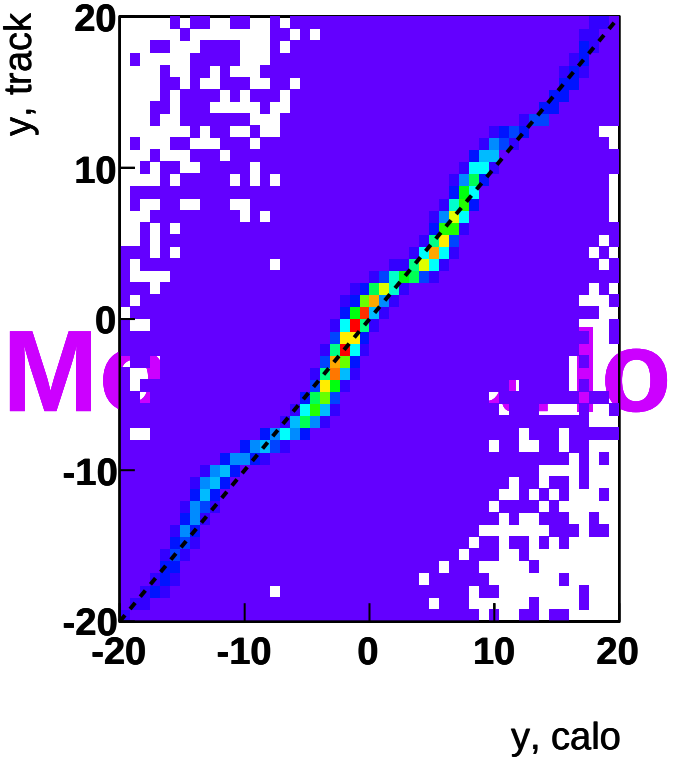
Reference, x


x, track
20
10
0
-10
-20
-20
-10
0
10
20
x, calo

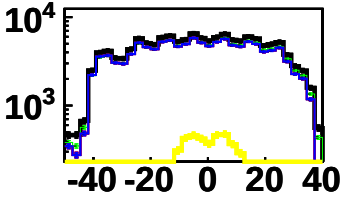

x, track
20
10
0
-10
-20
-20
-10
0
10
20
x, calo

Reference, y

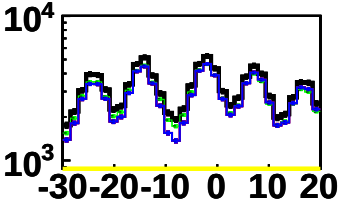

y, track
20
10
0
-10
-20
-20
-10
0
10
20
y, calo


y, track
20
10
0
-10
-20
-20
-10
0
10
20
y, calo

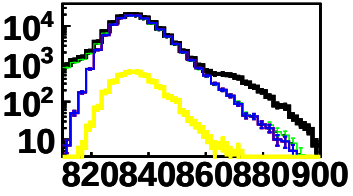
Data at 10 GeV



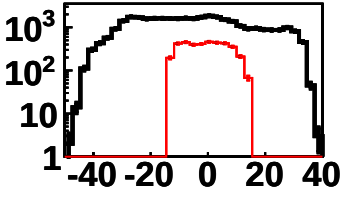
x, mm



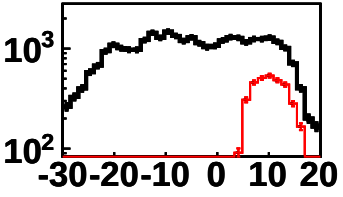
y, mm



z, mm

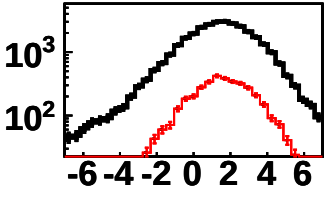


x, mm



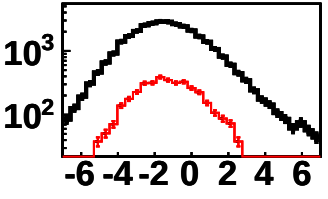
y, mm

events



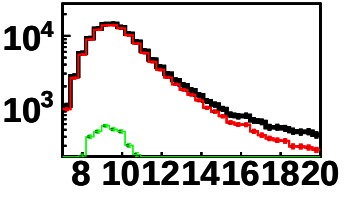
Δx,lin, mm

events



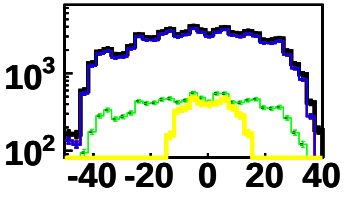
Δy,lin, mm

events

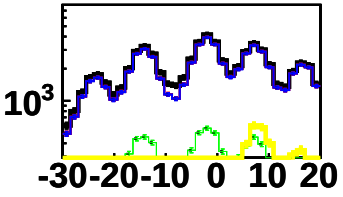


shower dispersion, mm

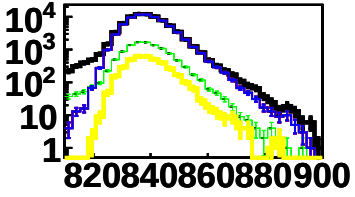
Data at 15 GeV



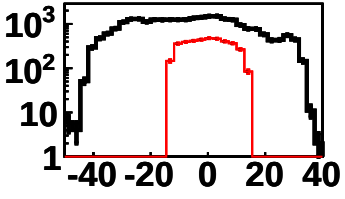
x, mm



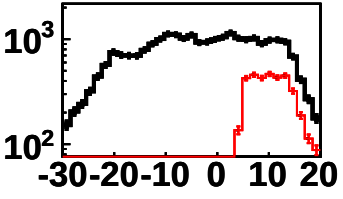
y, mm



z, mm

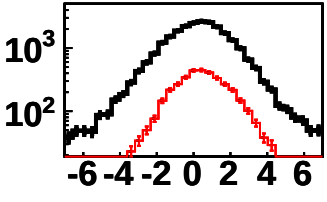


x, mm



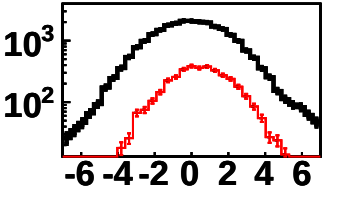
y, mm

events



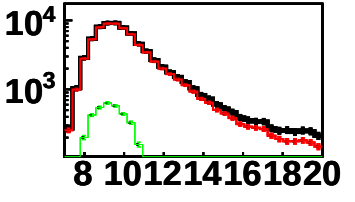
Δx,lin, mm

events



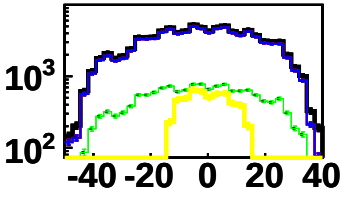
Δy,lin, mm

events

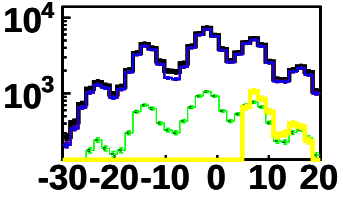


shower dispersion, mm

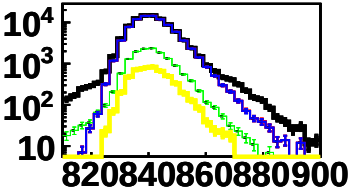
Data at 20 GeV



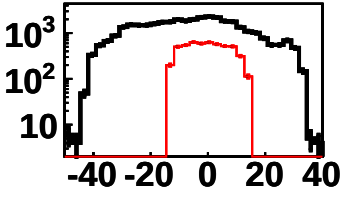
x, mm



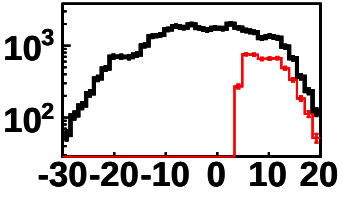
y, mm



z, mm

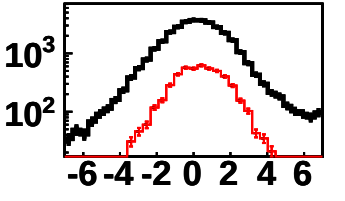


x, mm



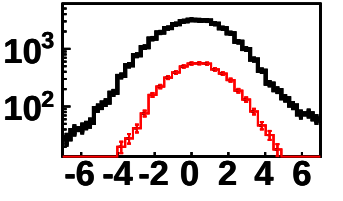
y, mm

events



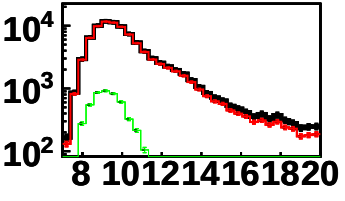
Δx,lin, mm

events



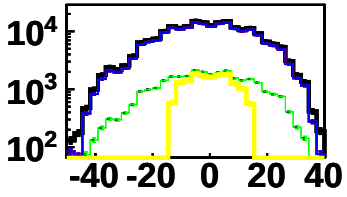
Δy,lin, mm

events

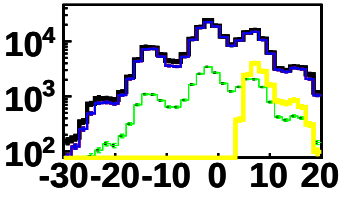


shower dispersion, mm

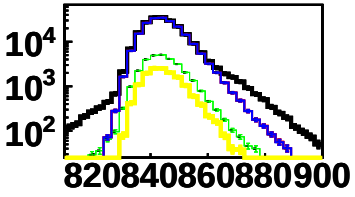
Data at 30 GeV



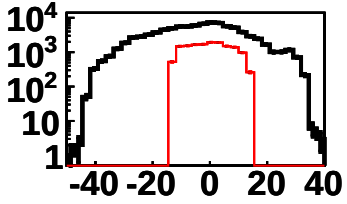
x, mm



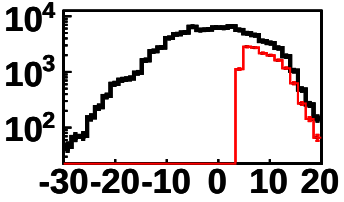
y, mm



z, mm

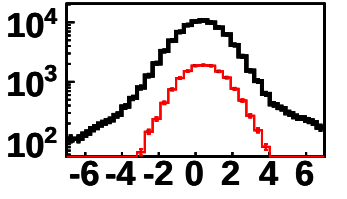


x, mm



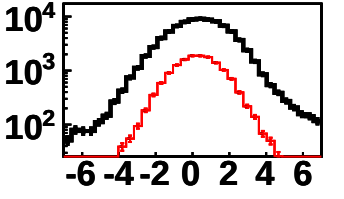
y, mm

events



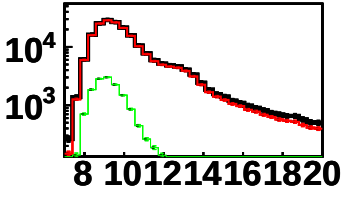
Δx,lin, mm

events



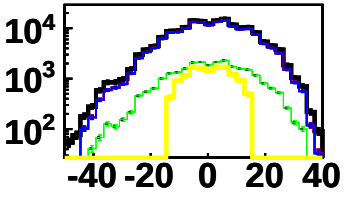
Δy,lin, mm

events

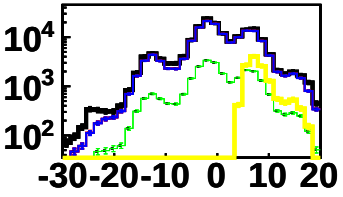


shower dispersion, mm

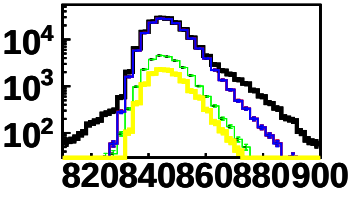
Data at 40 GeV



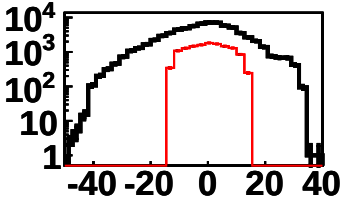
x, mm



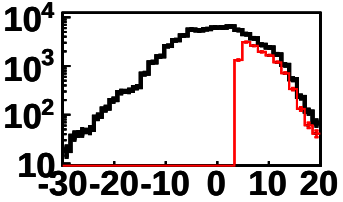
y, mm



z, mm

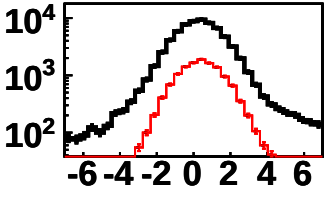


x, mm



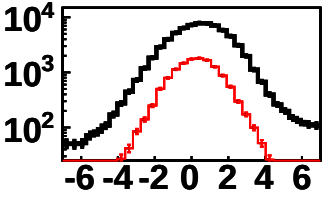
y, mm

events



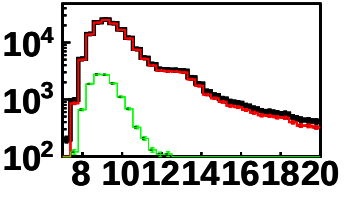
Δx,lin, mm

events



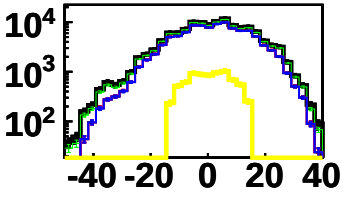
Δy,lin, mm

events

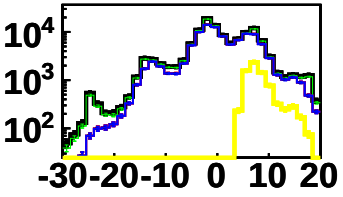


shower dispersion, mm

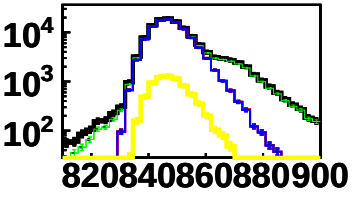
Data at 45 GeV



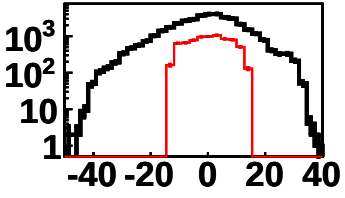
x, mm



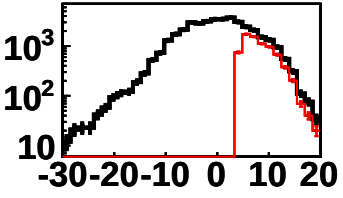
y, mm



z, mm

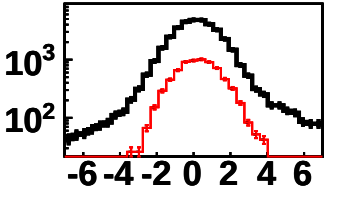


x, mm



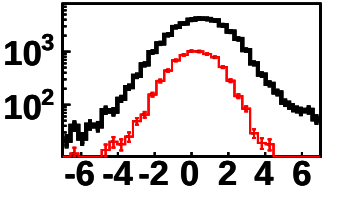
y, mm

events



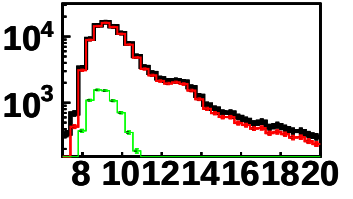
Δx,lin, mm

events



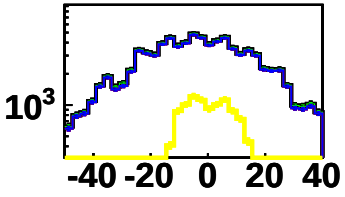
Δy,lin, mm

events

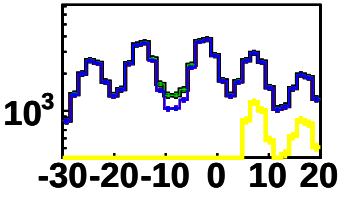


shower dispersion, mm

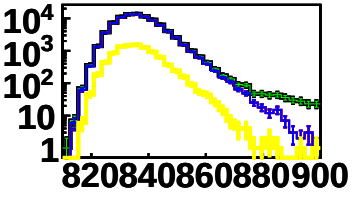
Monte Carlo at 10 GeV



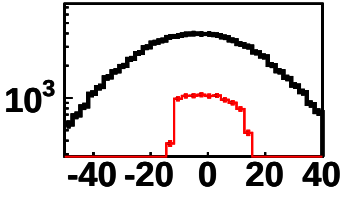
x, mm



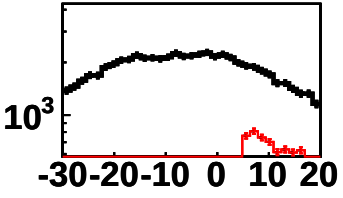
y, mm



z, mm

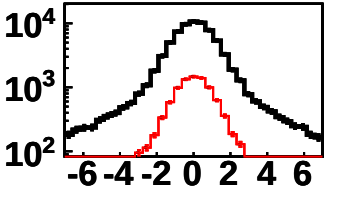


x, mm



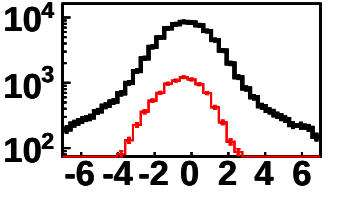
y, mm

events



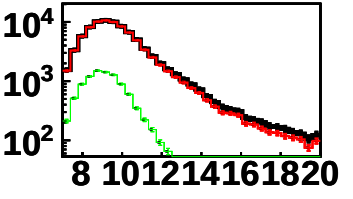
Δx,lin, mm

events



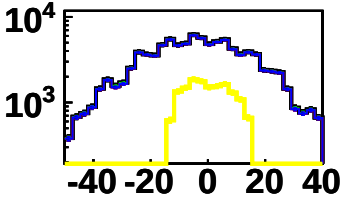
Δy,lin, mm

events

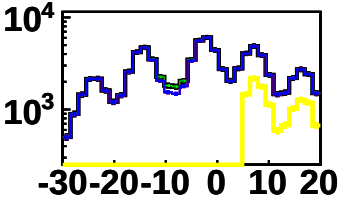


shower dispersion, mm

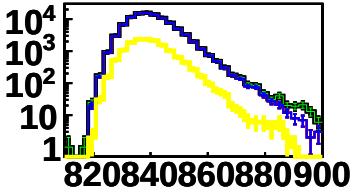
Monte Carlo at 15 GeV



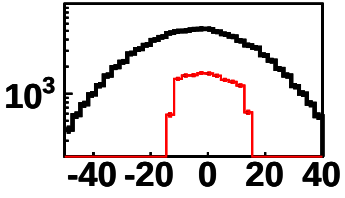
x, mm



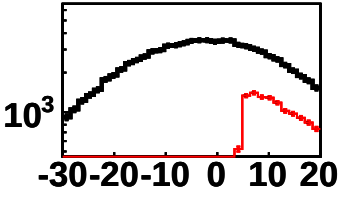
y, mm



z, mm

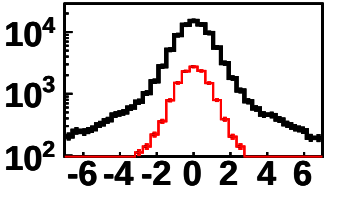


x, mm



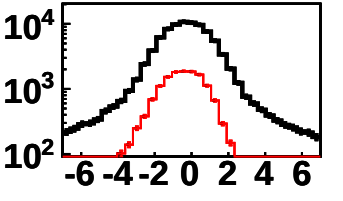
y, mm

events



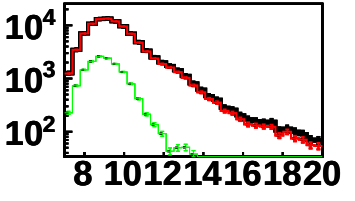
Δx,lin, mm

events



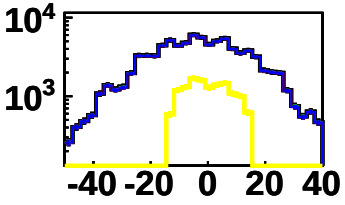
Δy,lin, mm

events

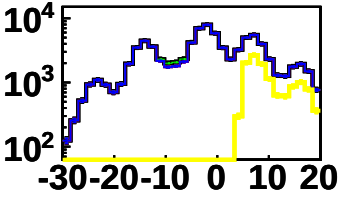


shower dispersion, mm

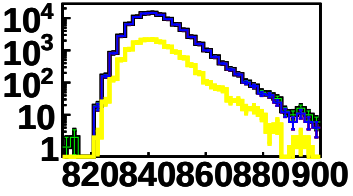
Monte Carlo at 20 GeV



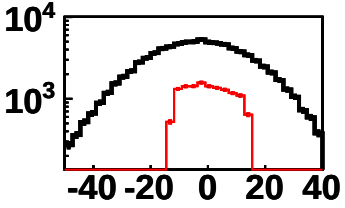
x, mm



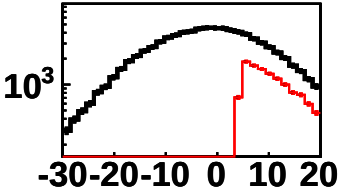
y, mm



z, mm

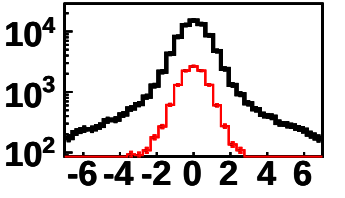


x, mm



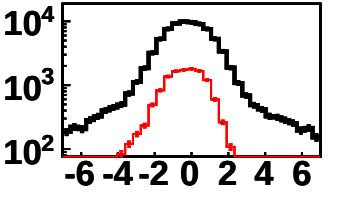
y, mm

events



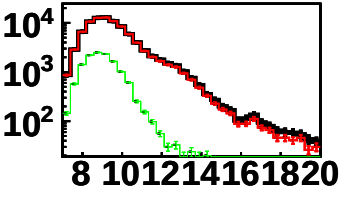
Δx,lin, mm

events



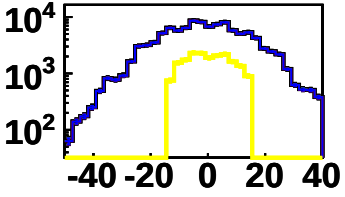
Δy,lin, mm

events

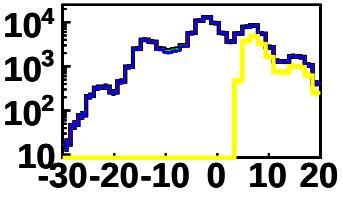


shower dispersion, mm

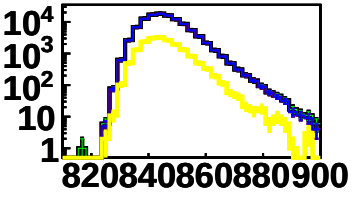
Monte Carlo at 30 GeV



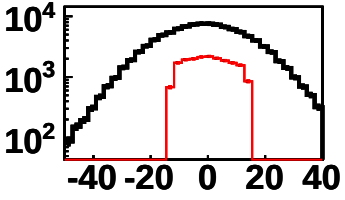
x, mm



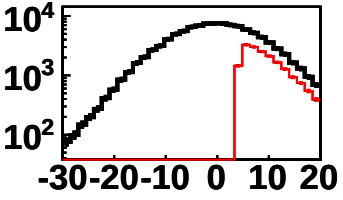
y, mm



z, mm

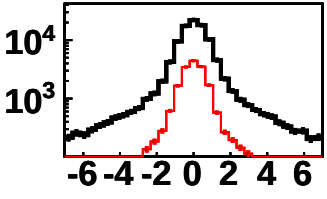


x, mm



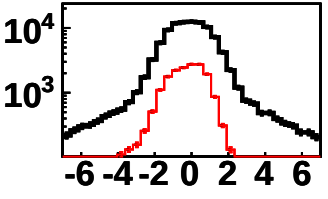
y, mm

events



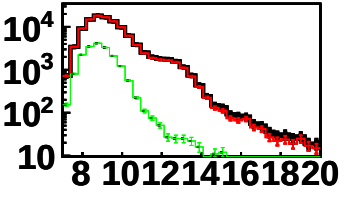
Δx,lin, mm

events



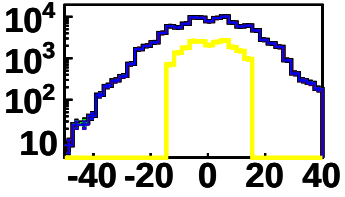
Δy,lin, mm

events

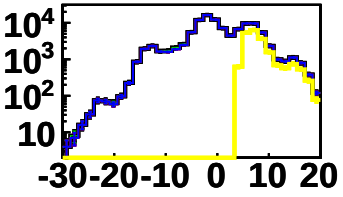


shower dispersion, mm

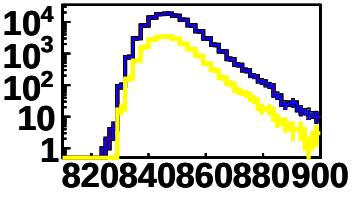
Monte Carlo at 40 GeV



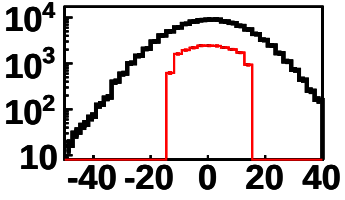
x, mm



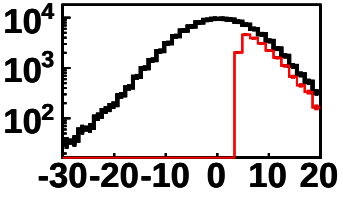
y, mm



z, mm

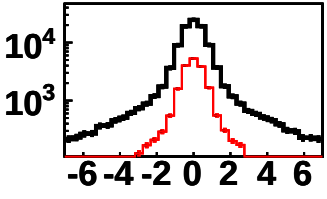


x, mm



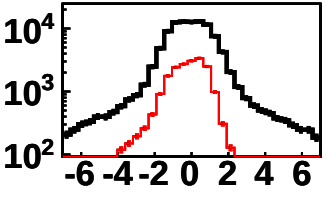
y, mm

events



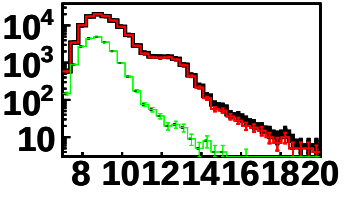
Δx,lin, mm

events



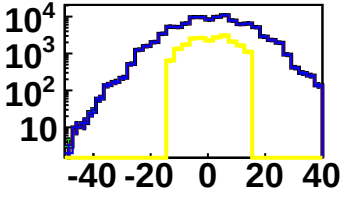
Δy,lin, mm

events

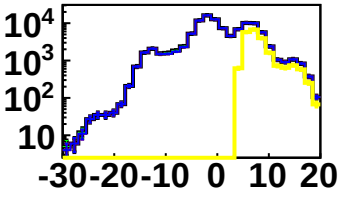


shower dispersion, mm

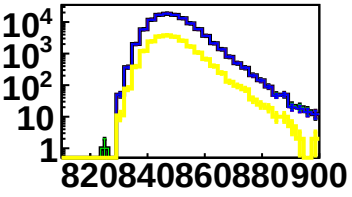
Monte Carlo at 45 GeV



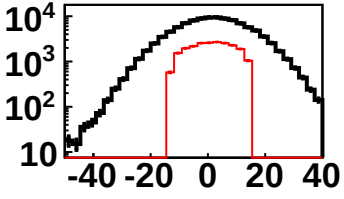
x, mm



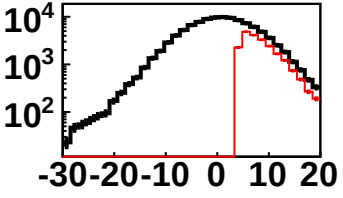
y, mm



z, mm

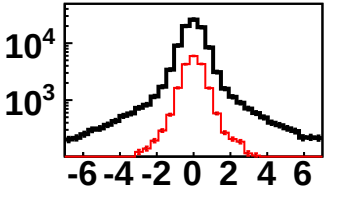


x, mm



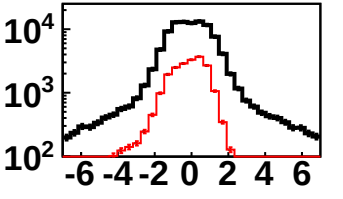
y, mm

events



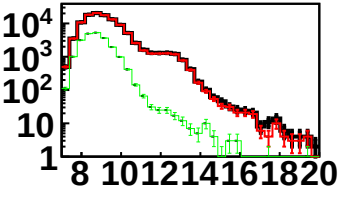
Δx,lin, mm

events



Δy,lin, mm

events



shower dispersion, mm