Longitudinal shower profile study

- playing with the longitudinal shower parameterization
  (as Benoit has already shown at the last workshop)
- in order to compare data and Geant4 simulation

Longitudinal shower parameterization

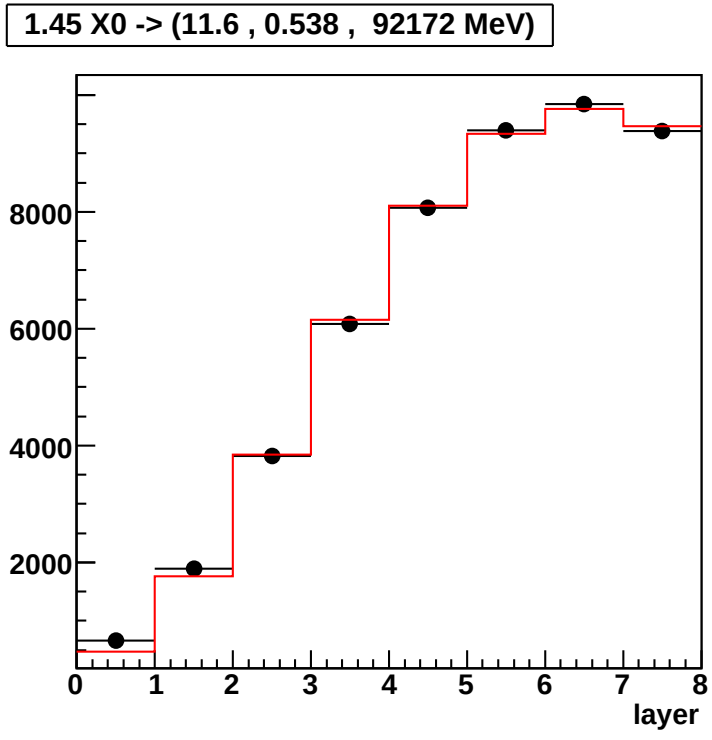
$$\frac{dE}{dt} = Eb\frac{(bt)^{a-1}e^{-bt}}{\Gamma(a)}$$

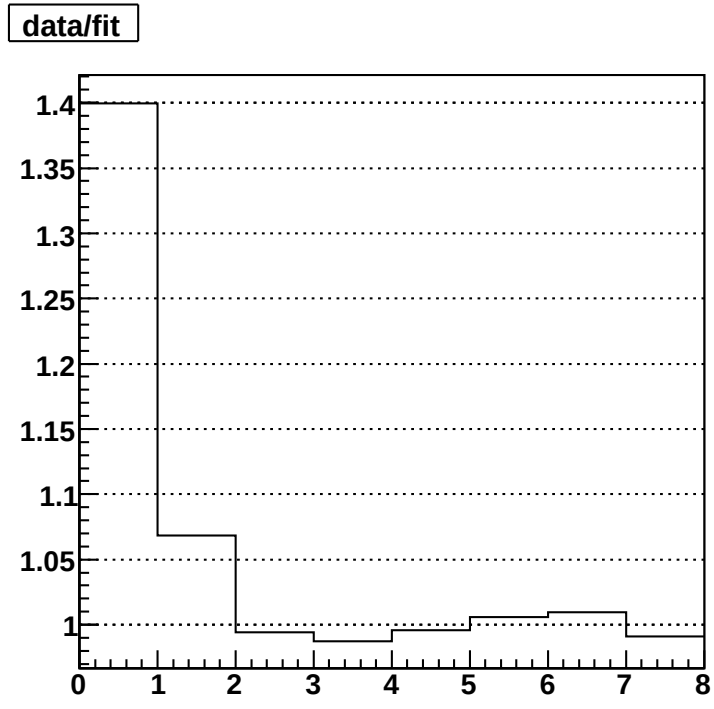
- b : scaling parameter
  - it almost does not depend on energy
  - it should lie between 0.50 and 0.54
- a : shape parameter
  - $t_{max} = (a-1)/b = \ln(E/E_c) - 1$ (Rossi approximation)
  - $\Rightarrow a = 1 + b(\ln(E/E_c) - 1)$
  - with $E_c = 610/(Z + 1.24) = 11.04$ MeV

BT-162 (100 GeV)

1.45 X0 in front of the calorimeter

E, Ec and b completely free

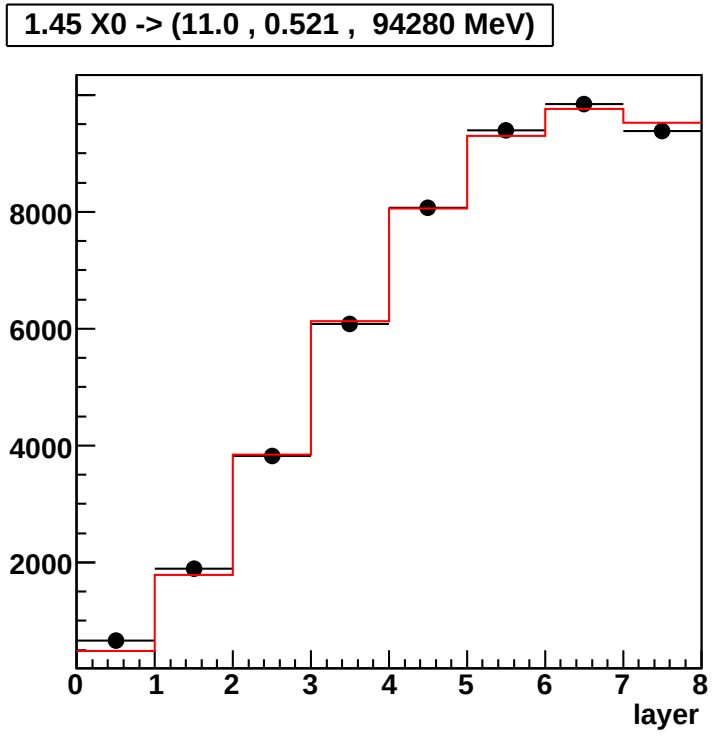


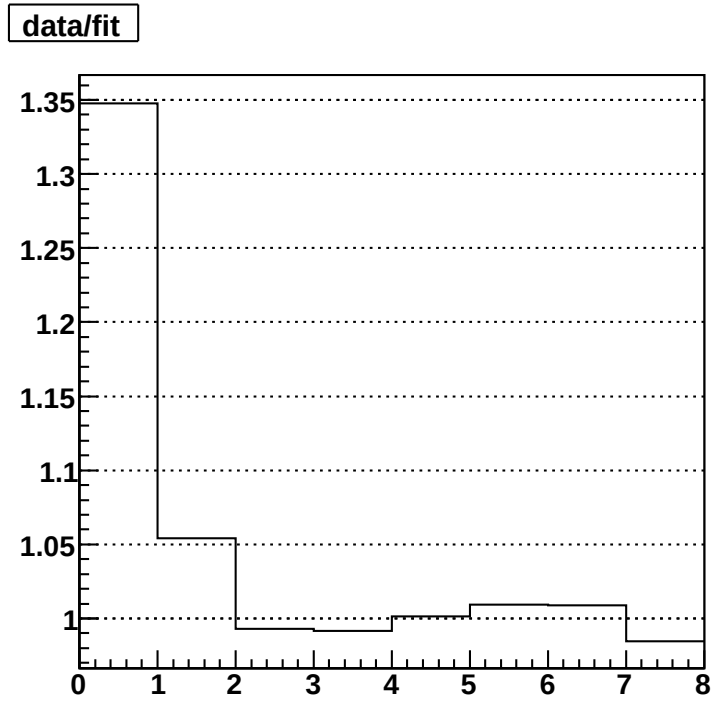


BT-162 (100 GeV)

1.45 X0 in front of the calorimeter

E is free but Ec=11.04 and b=0.52

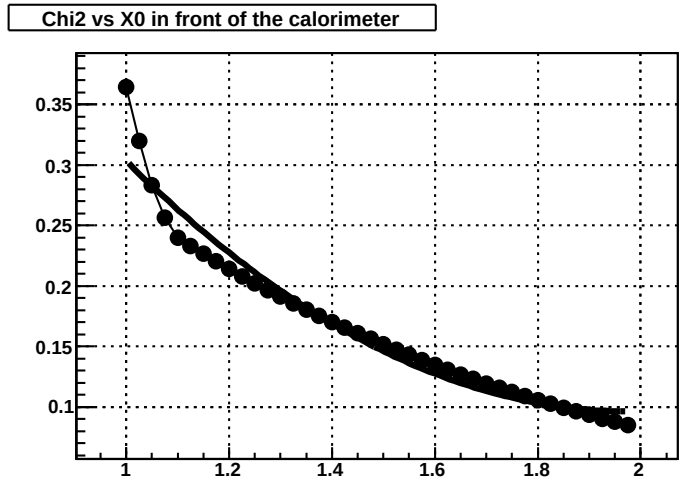


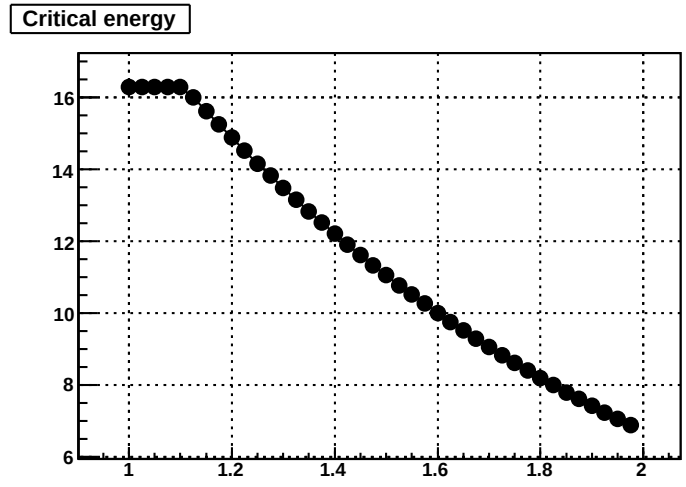


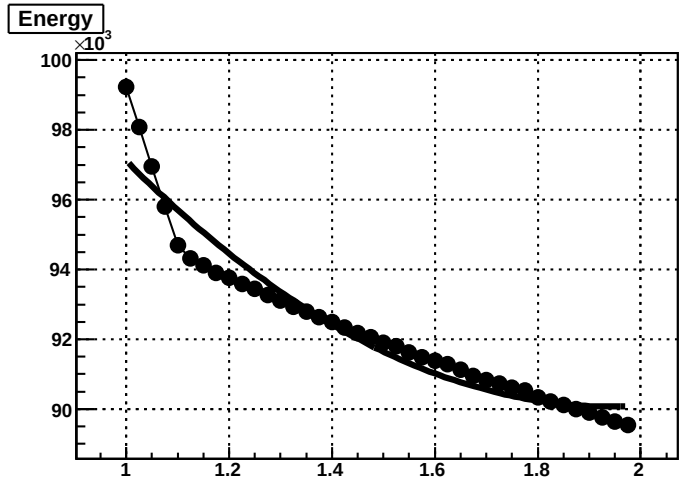
BT-162 (100 GeV)

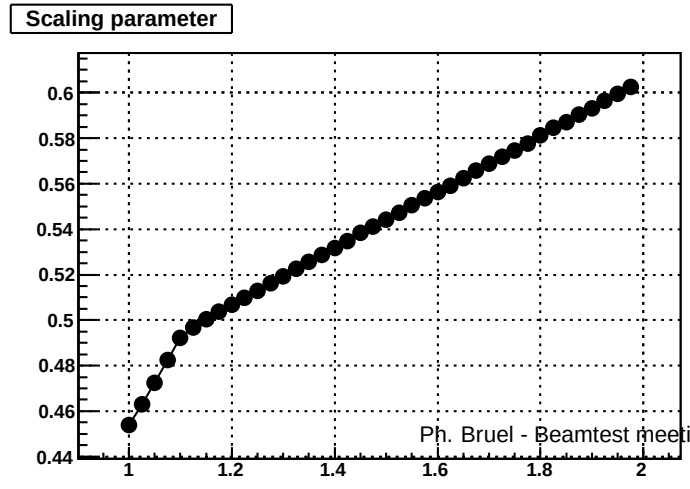
Search the optimal X0

E, Ec and b completely free





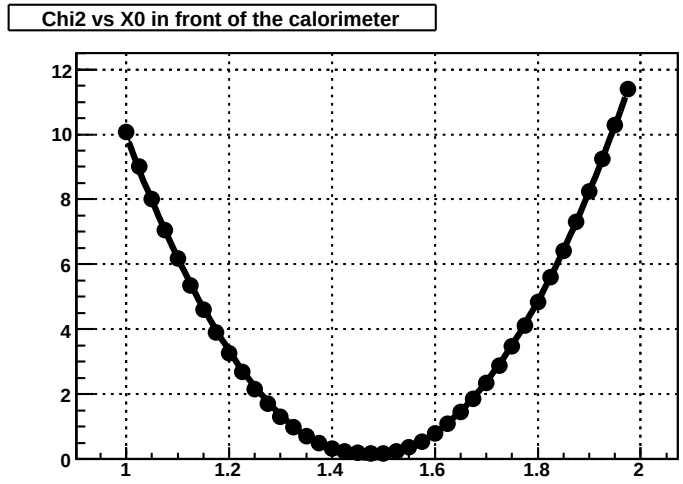


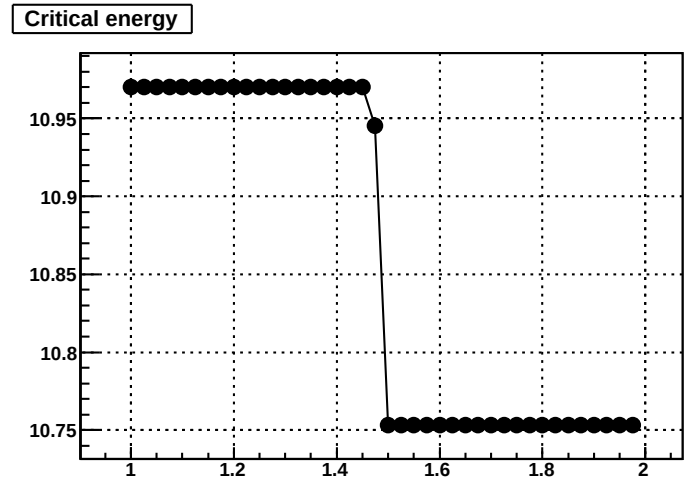


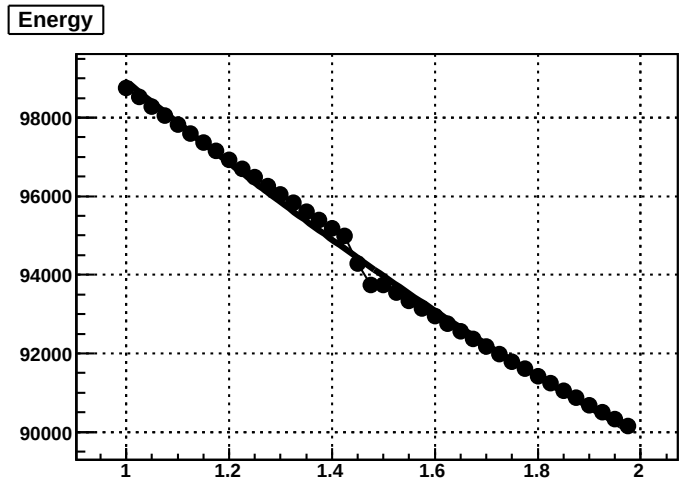
BT-162 (100 GeV)

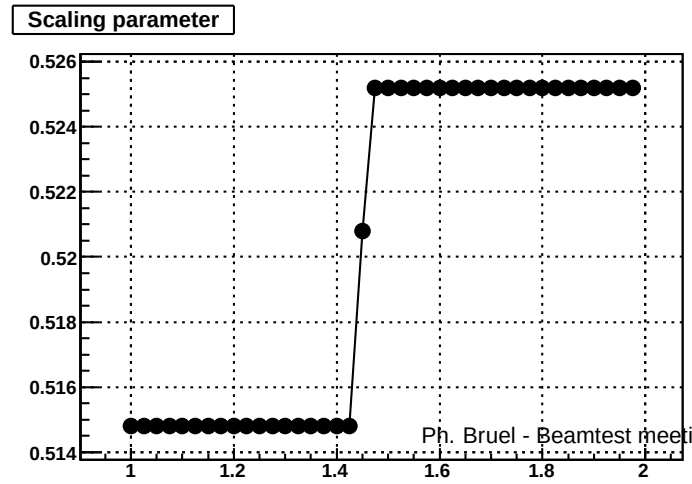
Search the optimal X0

E is free but Ec=11.04 and b=0.52





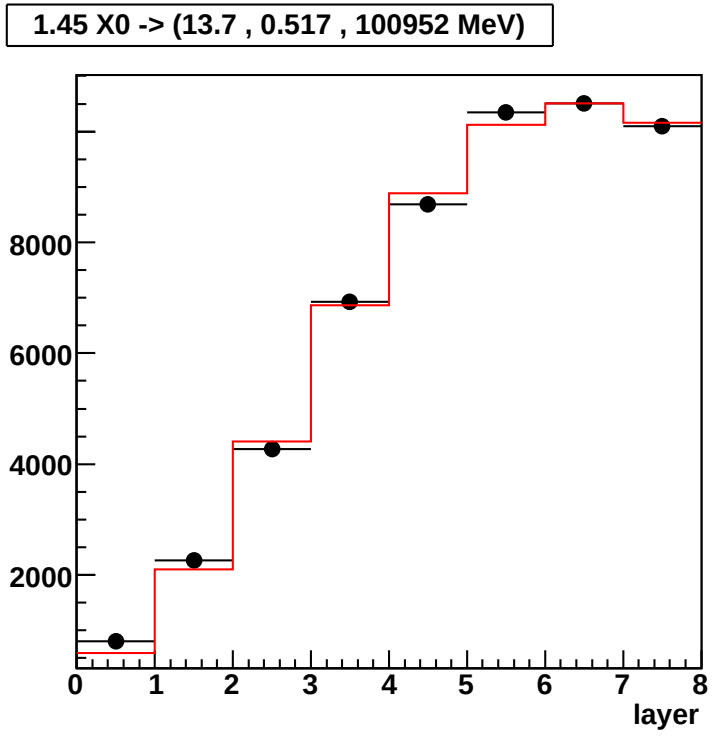


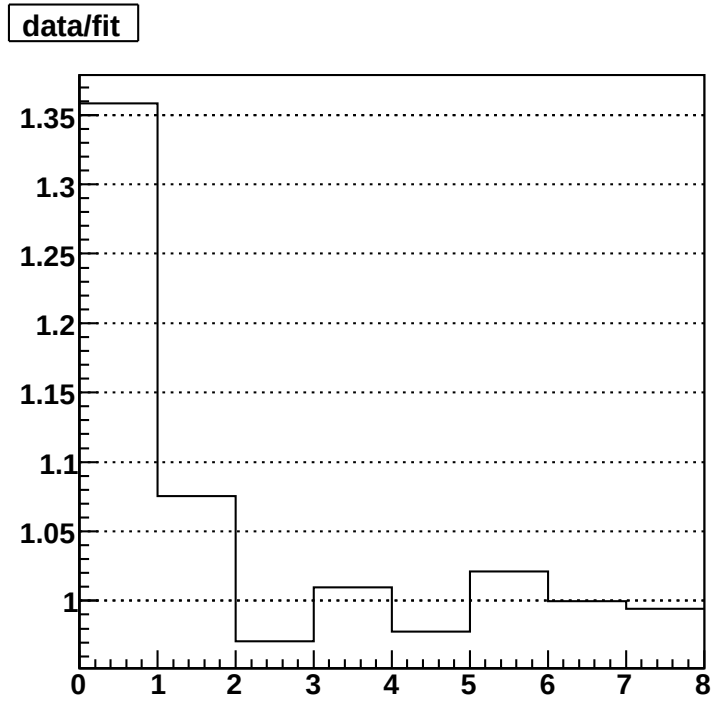


700002024 (100 GeV)

1.45 X0 in front of the calorimeter

E, Ec and b completely free

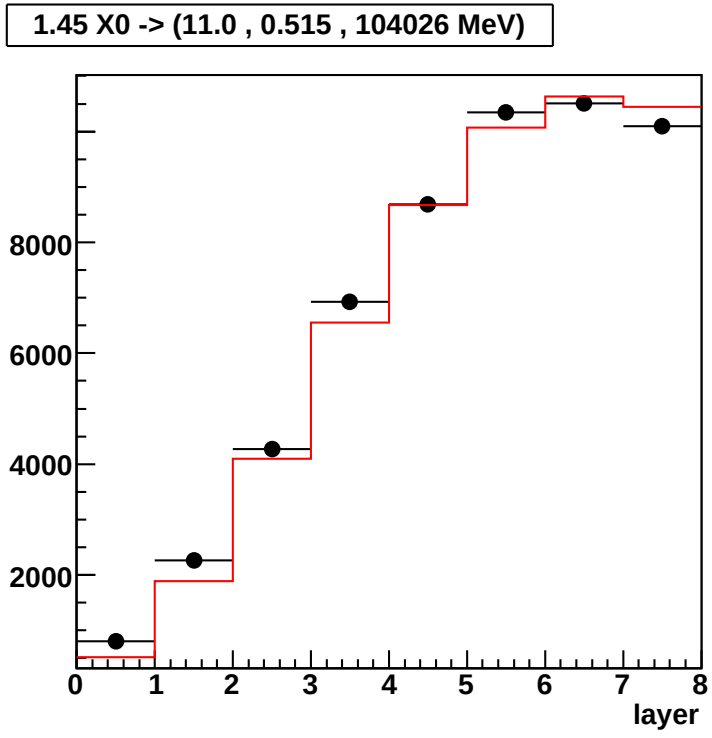


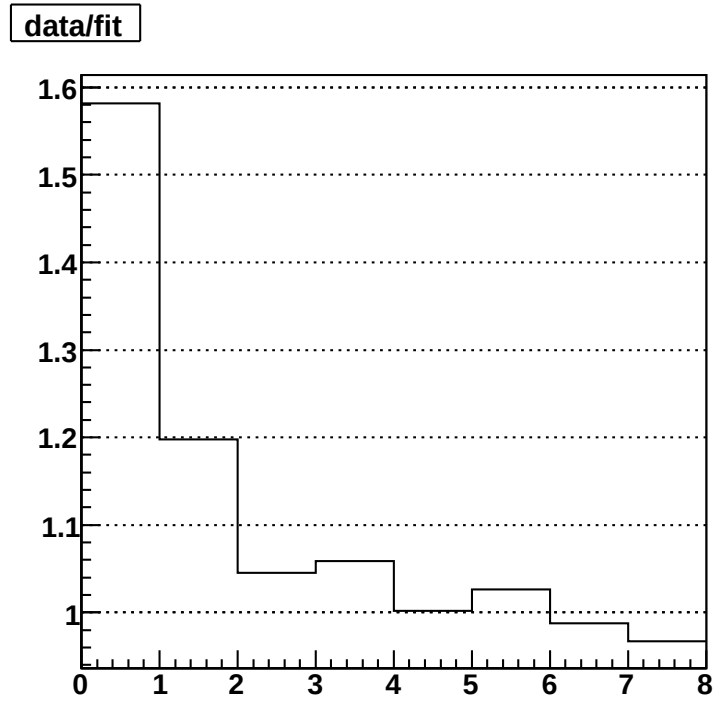


700002024 (100 GeV)

1.45 X0 in front of the calorimeter

E is free but Ec=11.04 and b=0.52

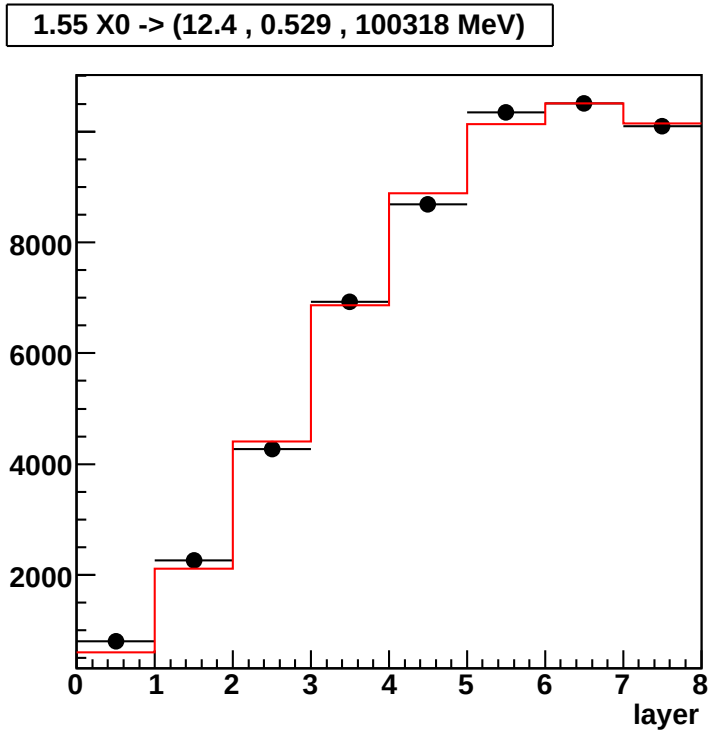


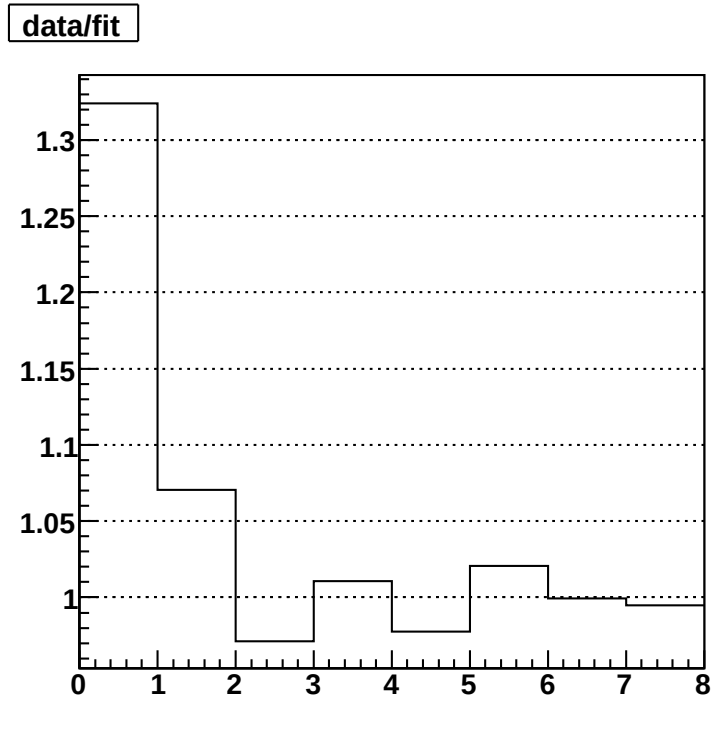


700002024 (100 GeV)

1.55 X0 in front of the calorimeter

E, Ec and b completely free

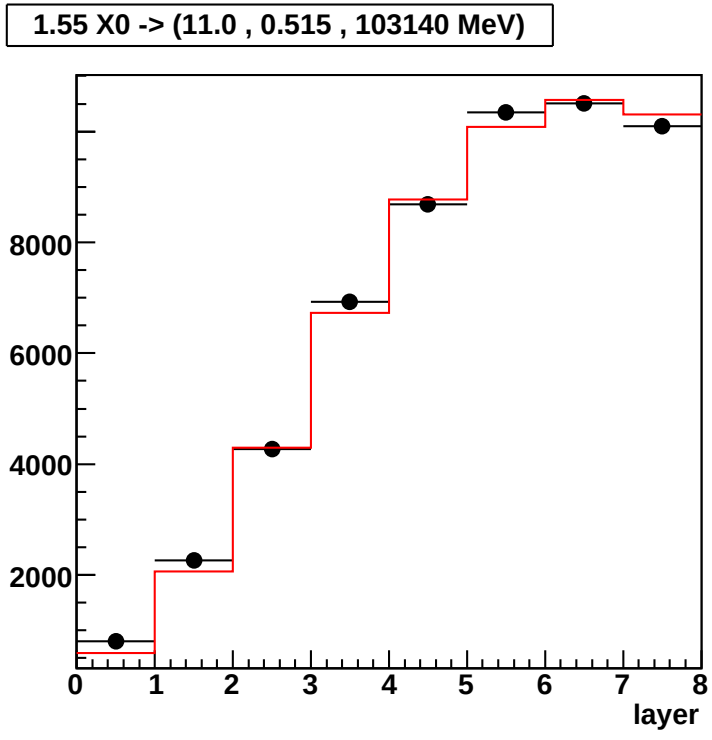


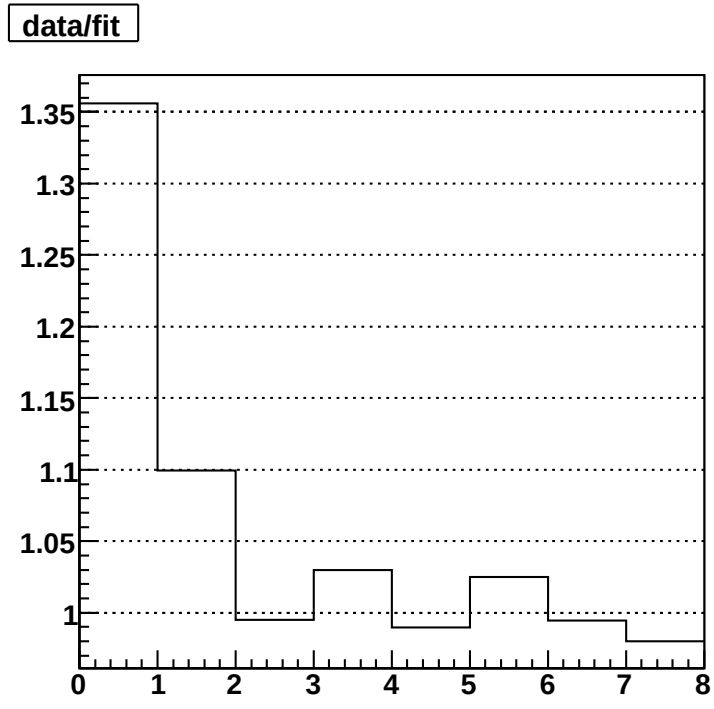


700002024 (100 GeV)

1.55 X0 in front of the calorimeter

E is free but Ec=11.04 and b=0.52

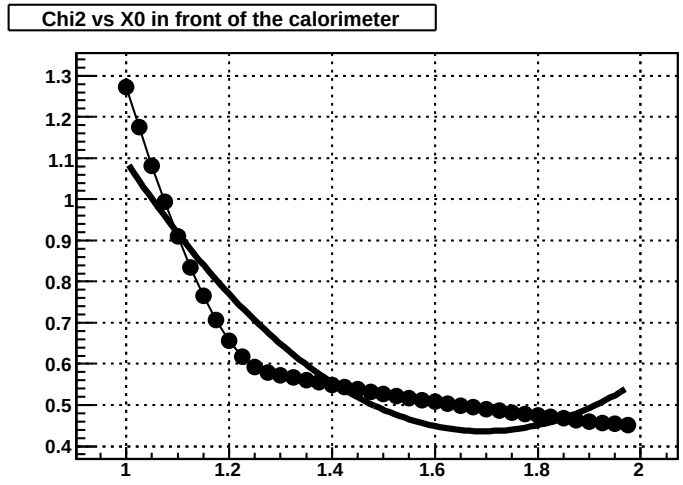


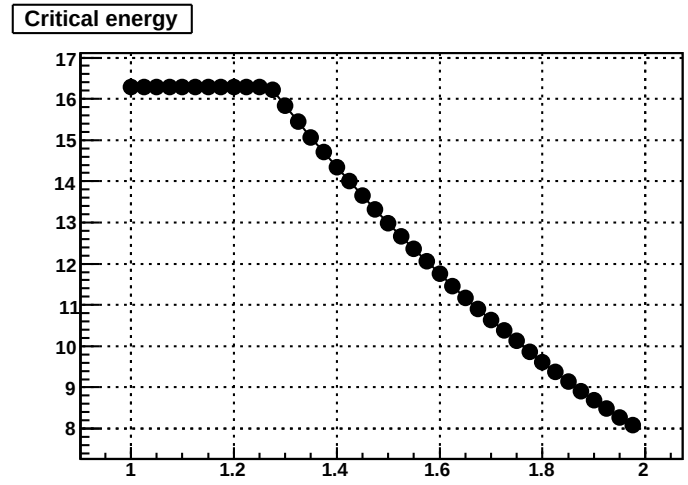


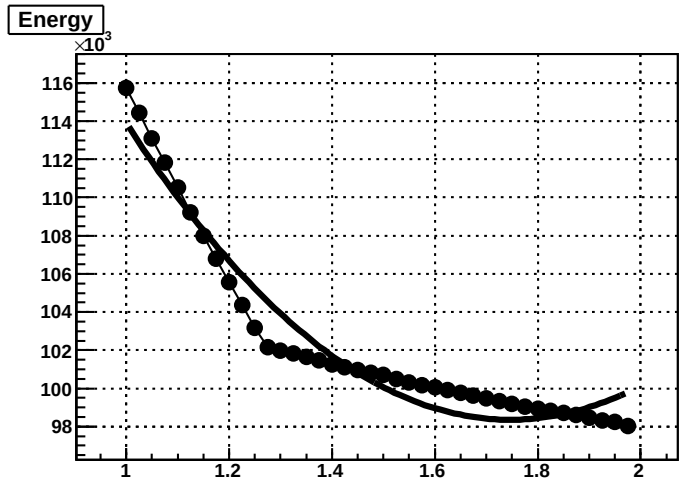
700002024 (100 GeV)

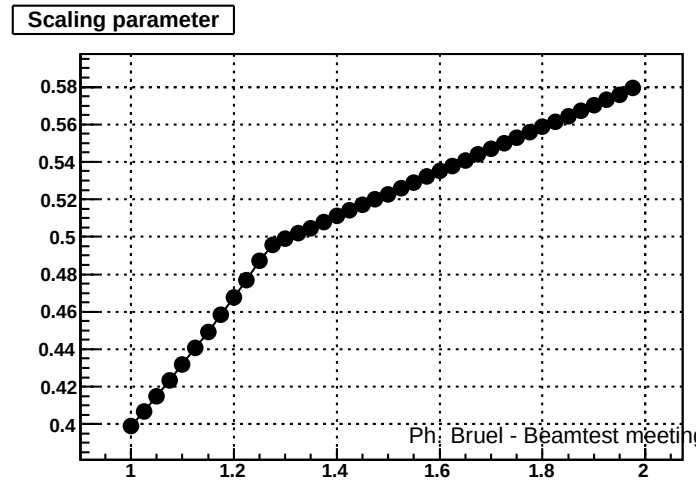
Search the optimal X0

E, Ec and b completely free





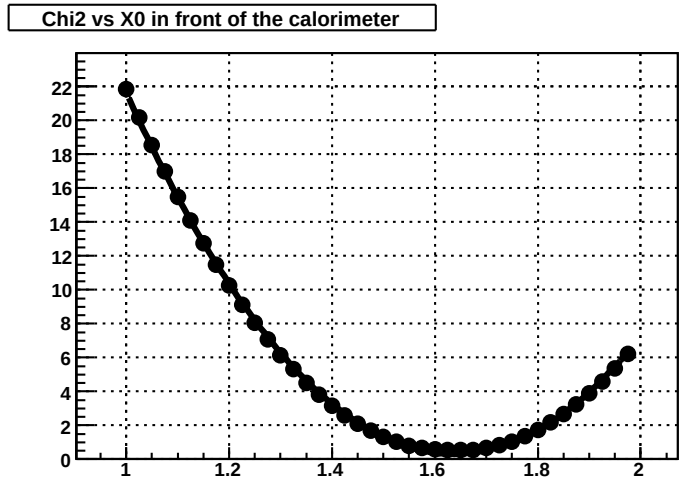


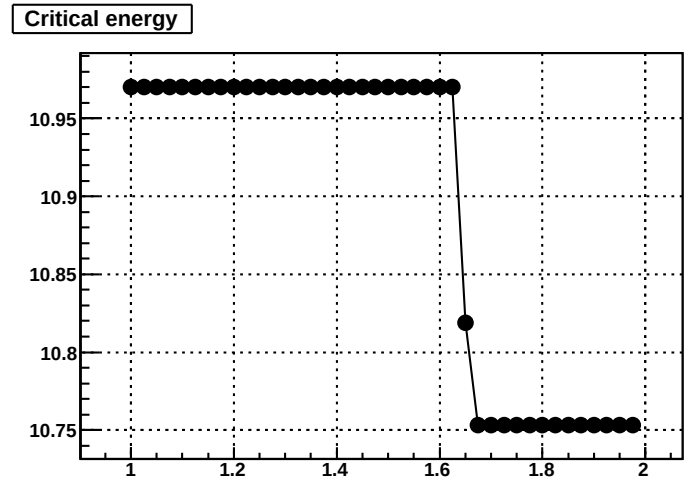


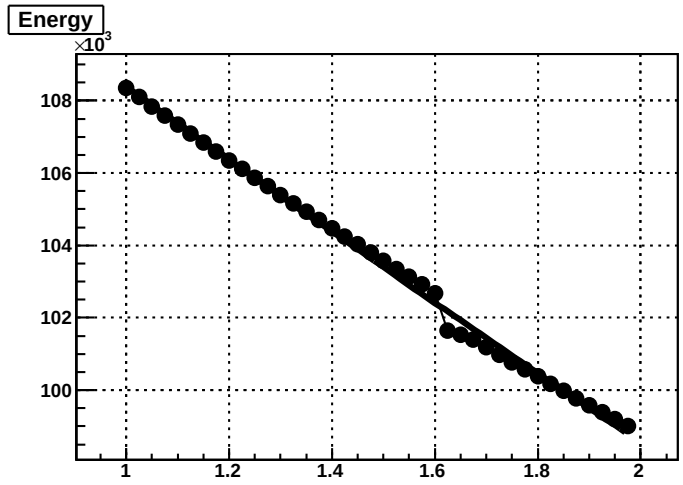
700002024 (100 GeV)

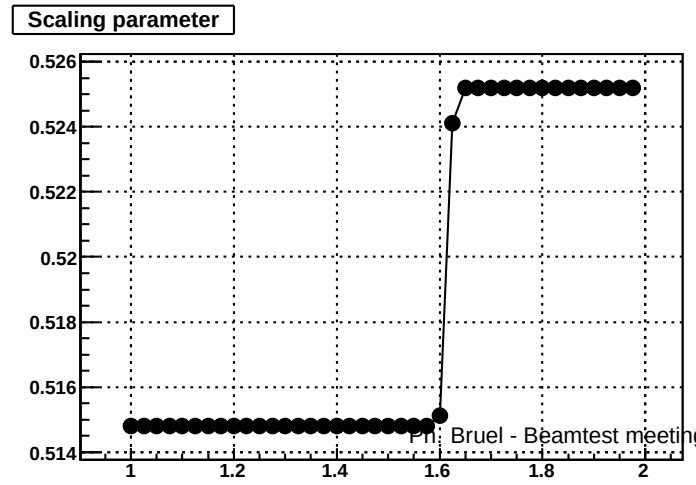
Search the optimal X0

E is free but Ec=11.04 and b=0.52





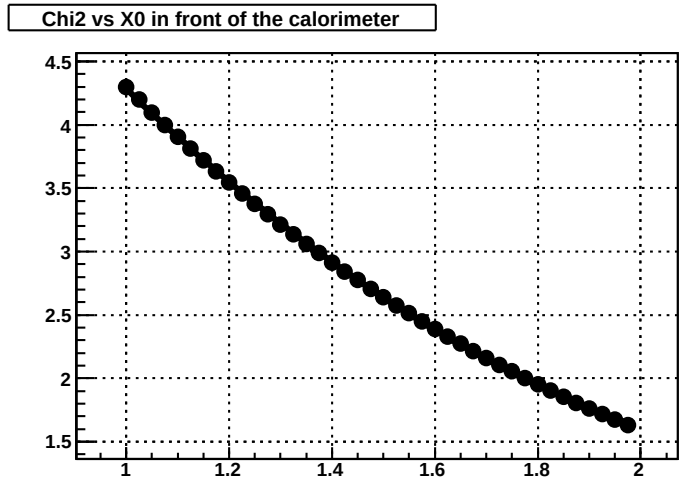


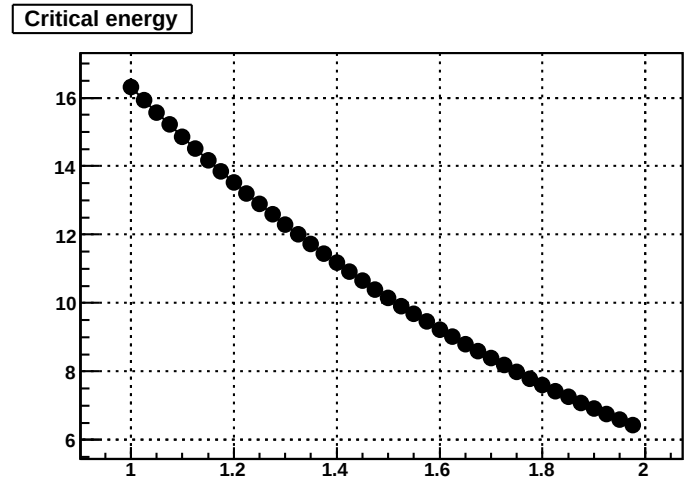


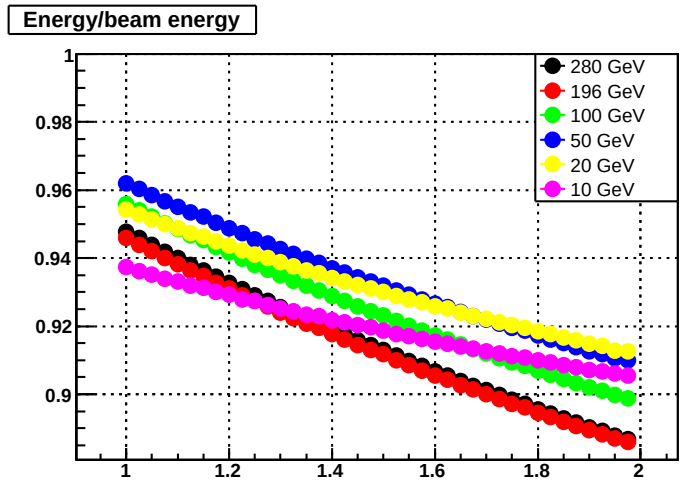
All MC (10 to 280 GeV)

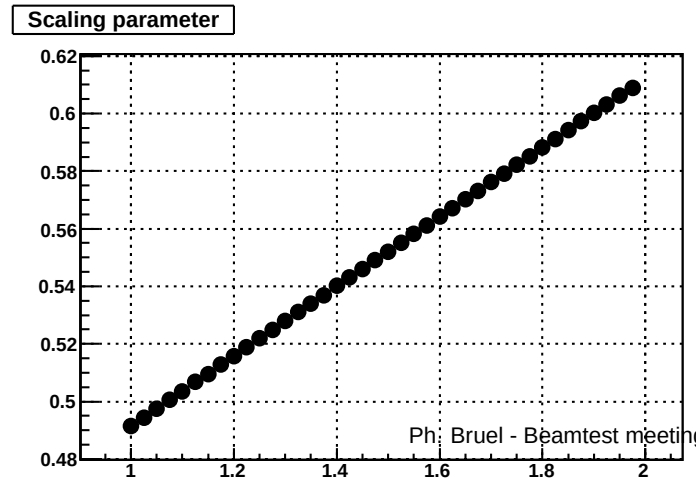
Search the optimal X0

all E, Ec and b completely free





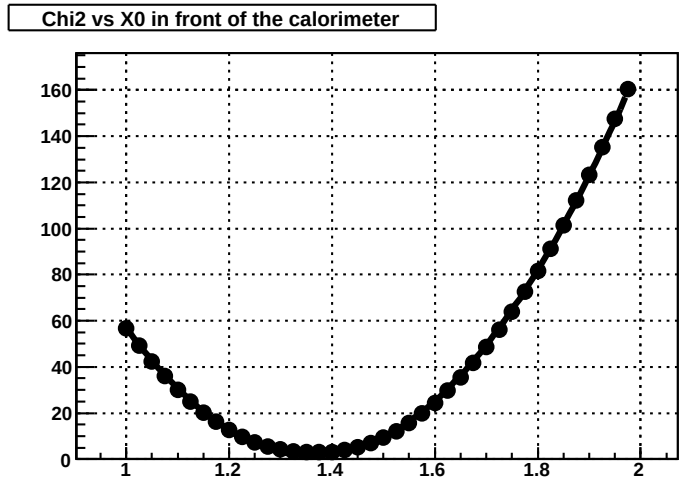


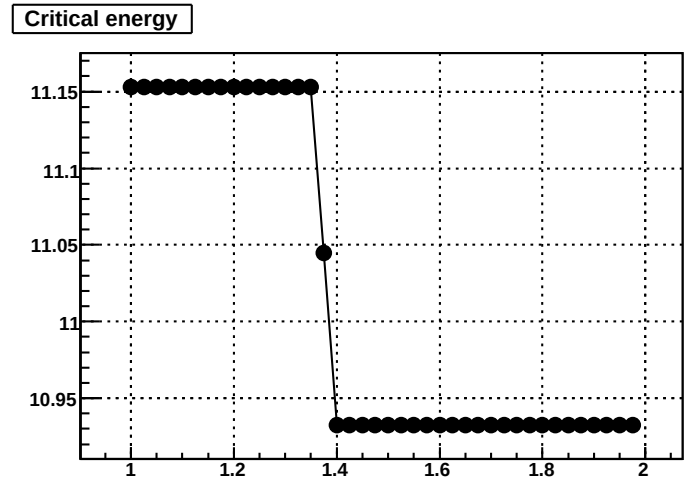


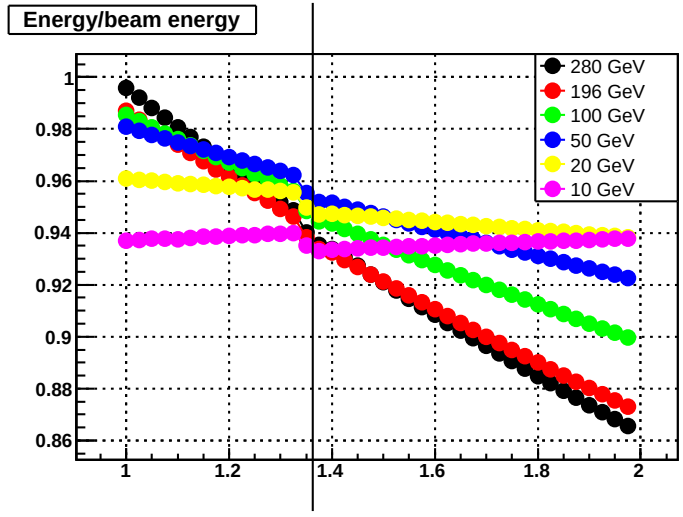
All MC (10 to 280 GeV)

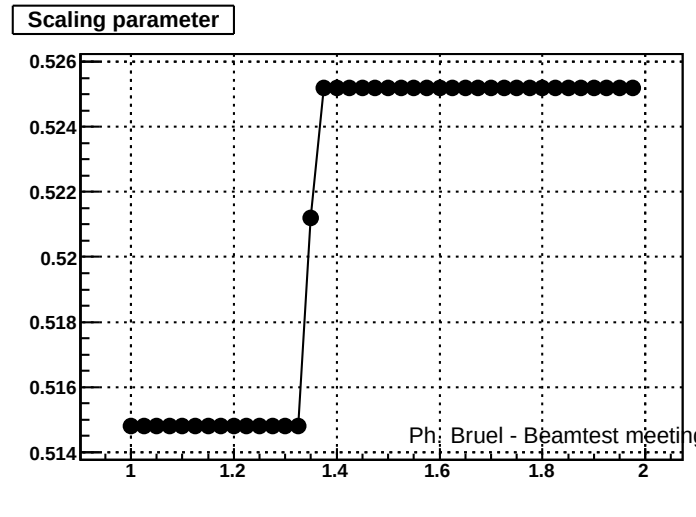
Search the optimal X0

all E are free but Ec=11.04 and b=0.52





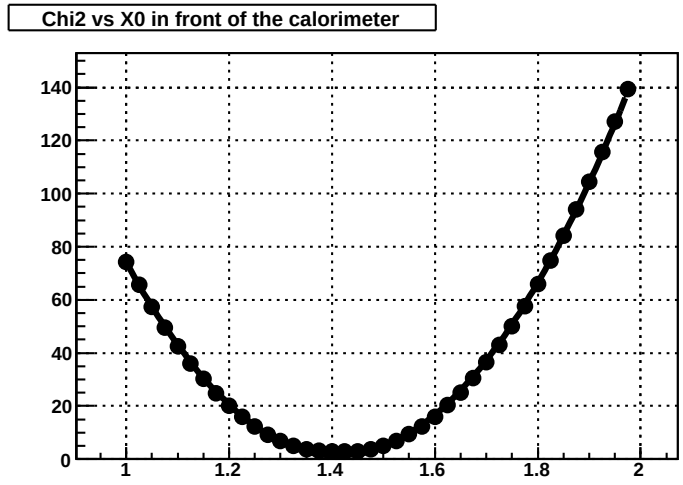


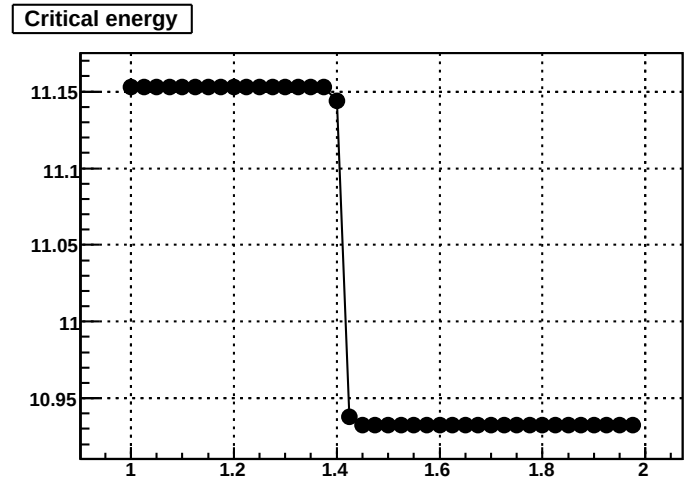


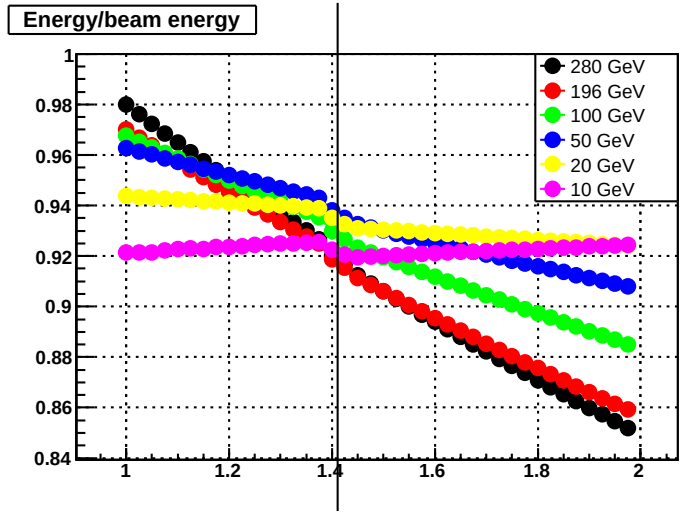
All MC (10 to 280 GeV)

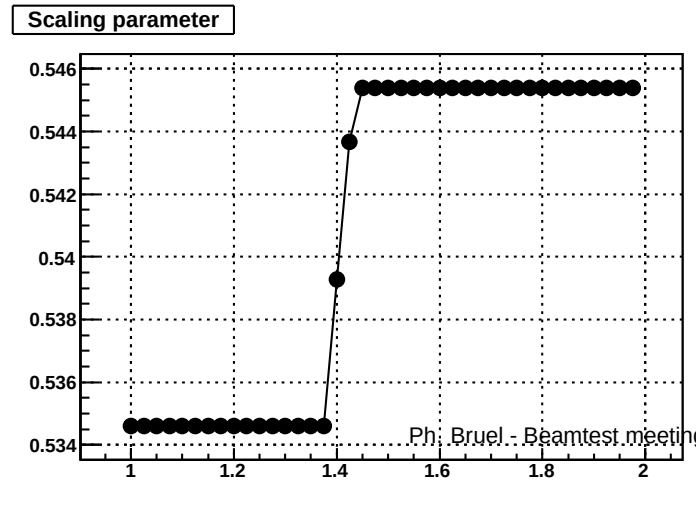
Search the optimal X0

all E are free but Ec=11.04 and b=0.54





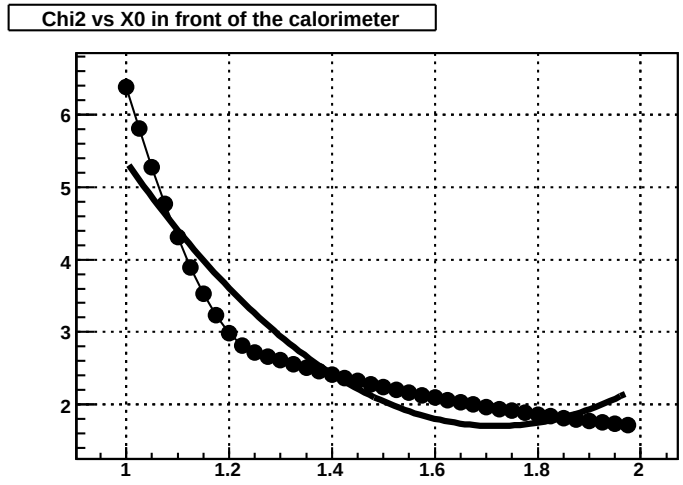


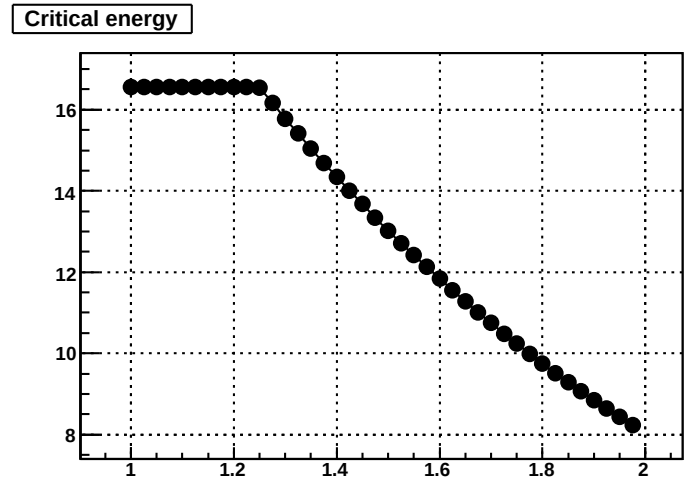


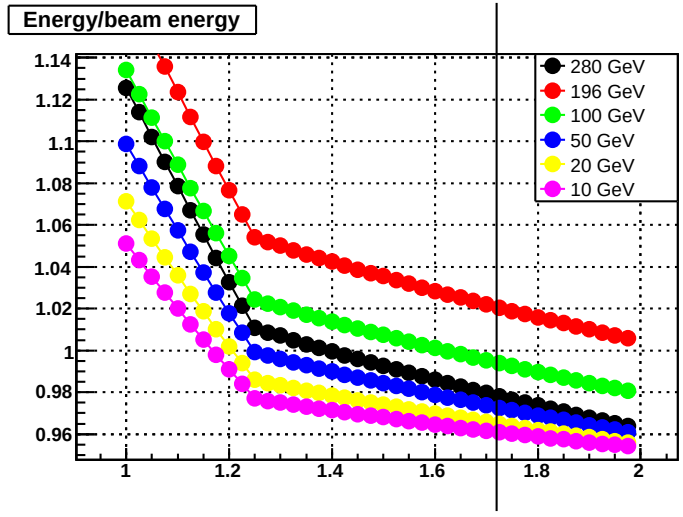
All data (10 to 280 GeV)

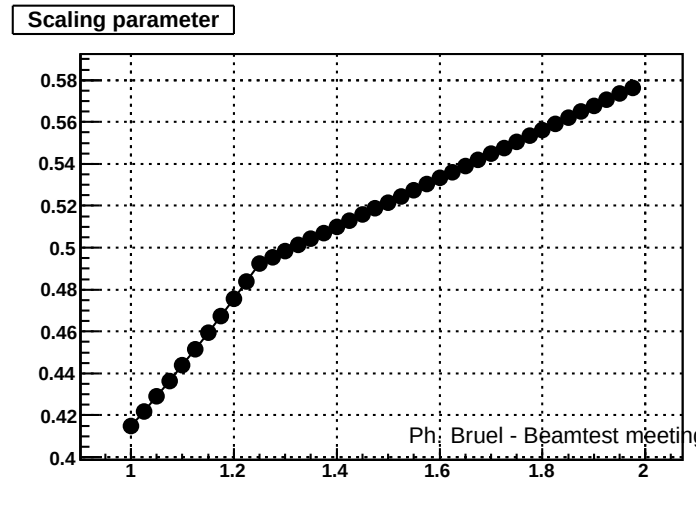
Search the optimal X0

all E, Ec and b completely free





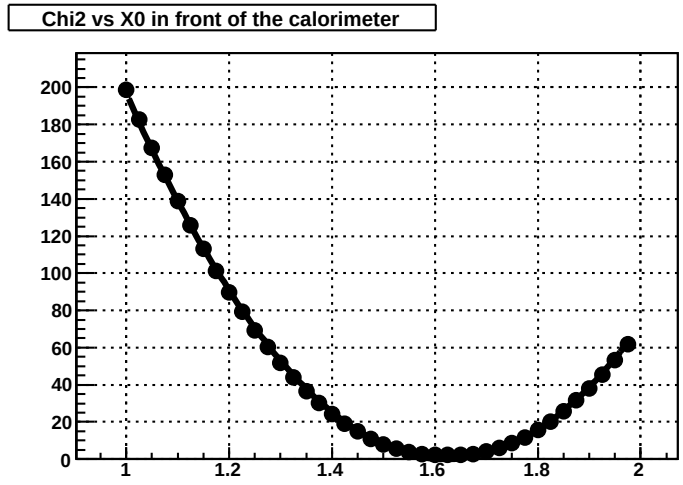


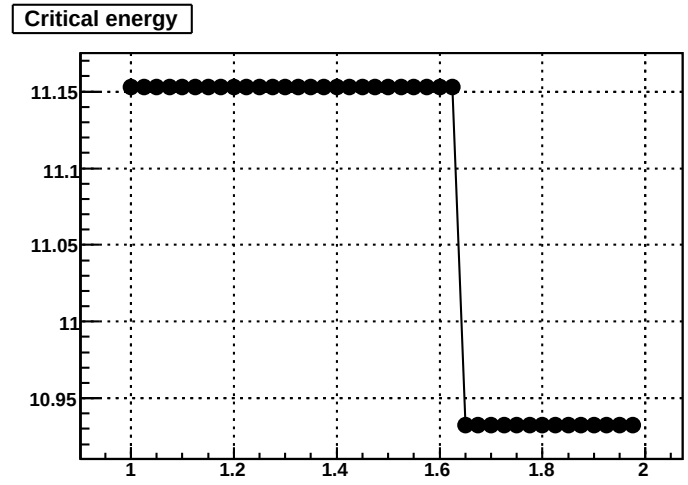


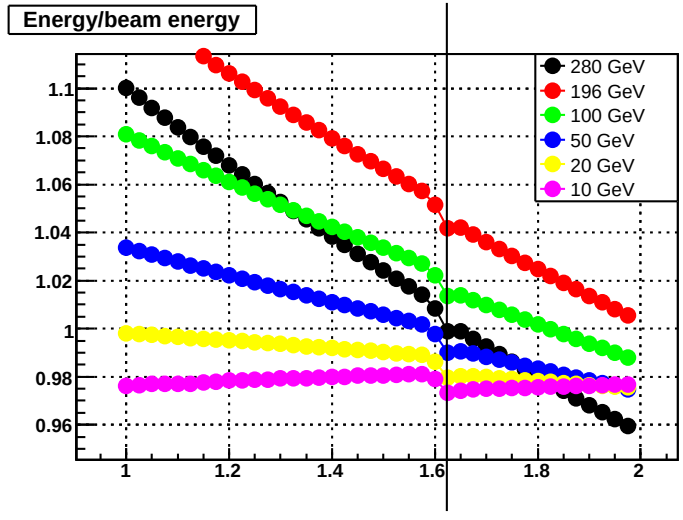
All data (10 to 280 GeV)

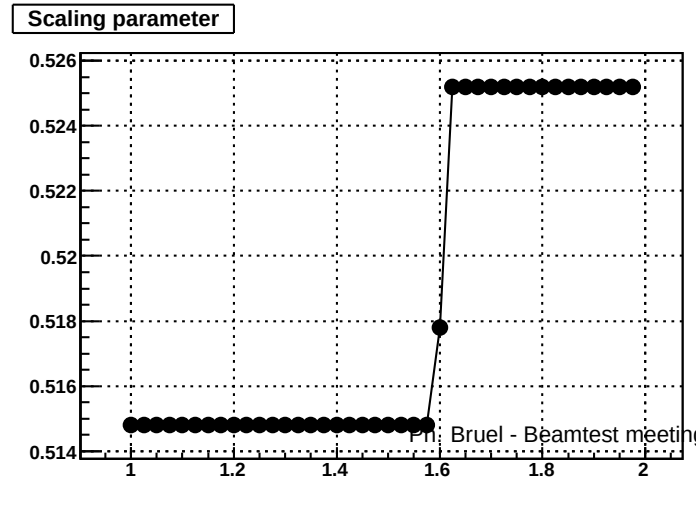
Search the optimal X0

all E are free but Ec=11.04 and b=0.52





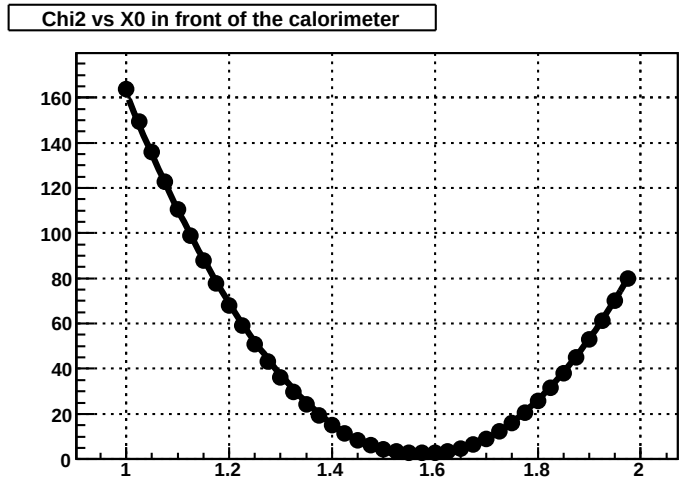


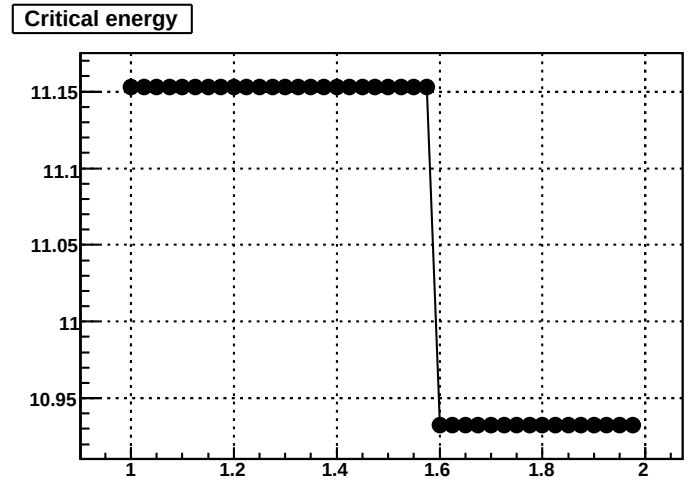


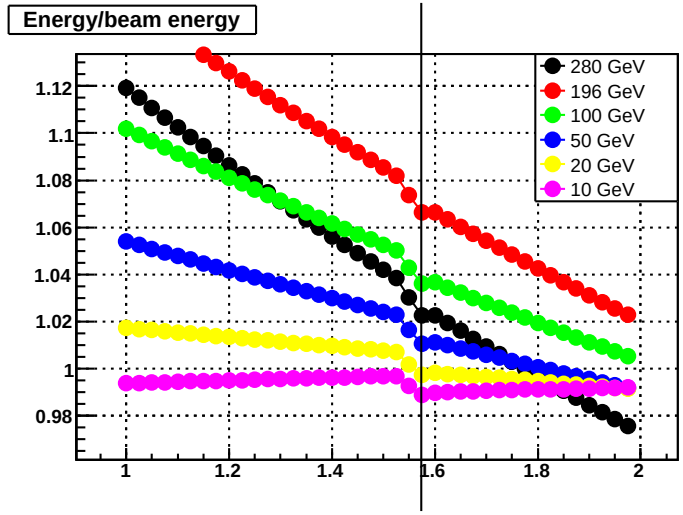
All data (10 to 280 GeV)

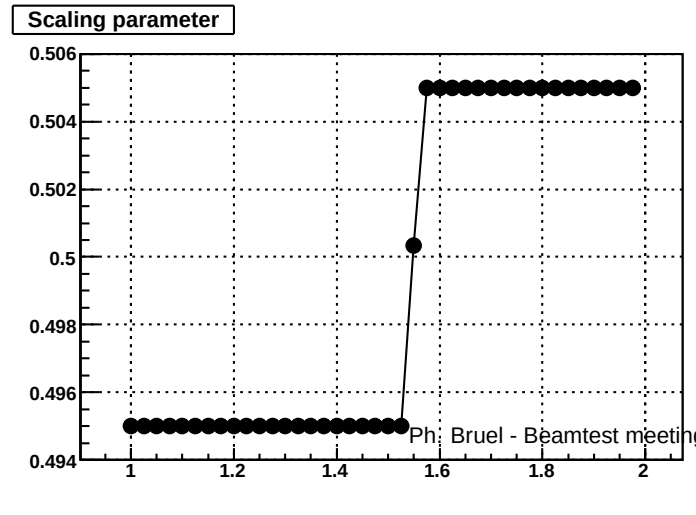
Search the optimal X0

all E are free but Ec=11.04 and b=0.50



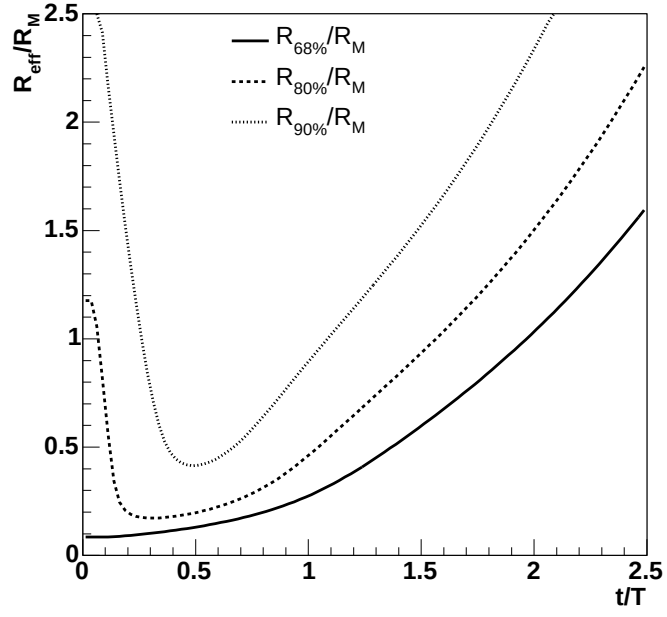






Discussion

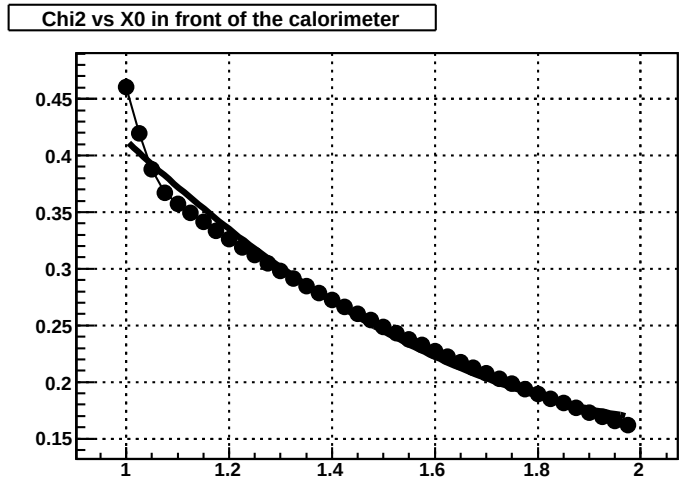
- standard parameterization tends to favor :
  - MC : $\sim$1.4 X0 but $\sim$5% less energy
  - data : $\sim$ right energy but $\sim$1.6 X0
- standard parameterization is for homogeneous material :
  - cal structure between layers
  - cal structure between logs : 26.7mm/27.84mm $\Rightarrow$ -6% but the effect should not be so huge for particles hitting the center of a log

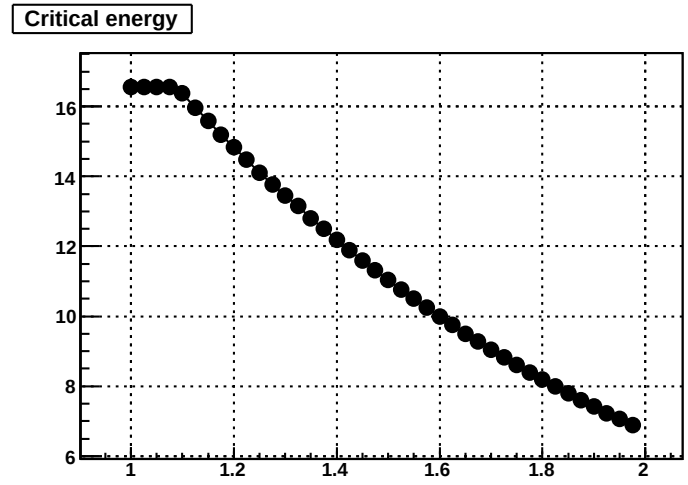


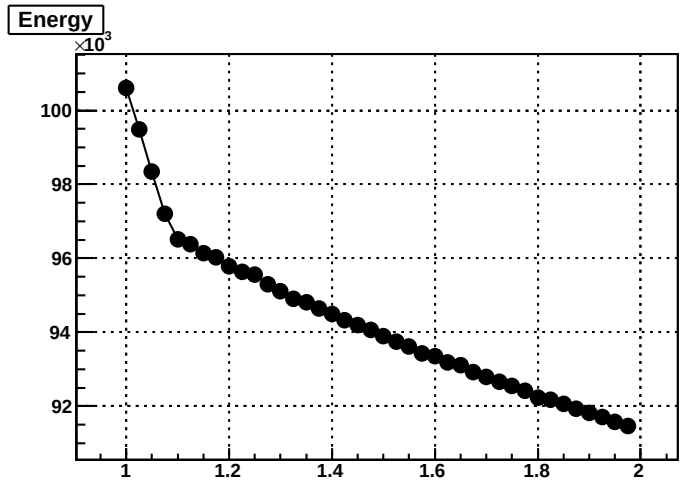
pure CsI with 1.45 X0 (100 GeV)

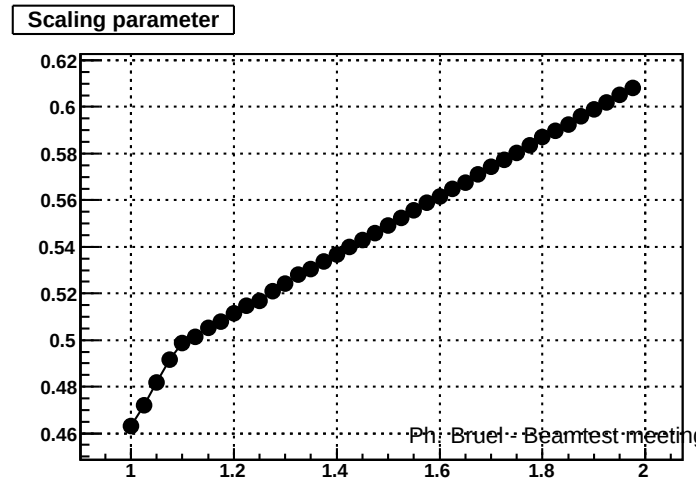
Search the optimal X0

E, Ec and b completely free





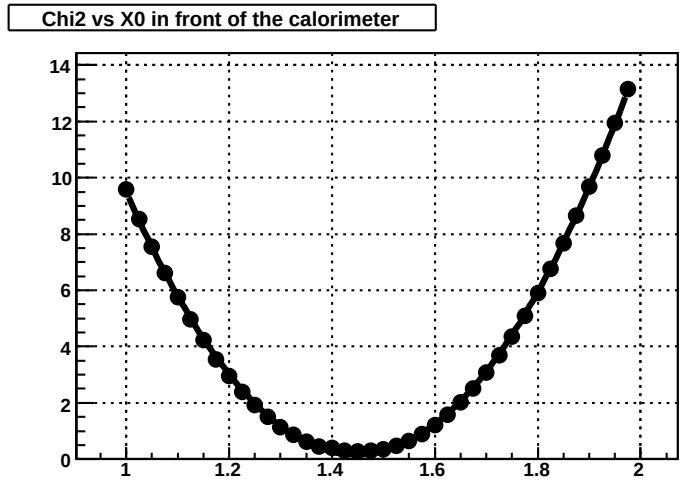


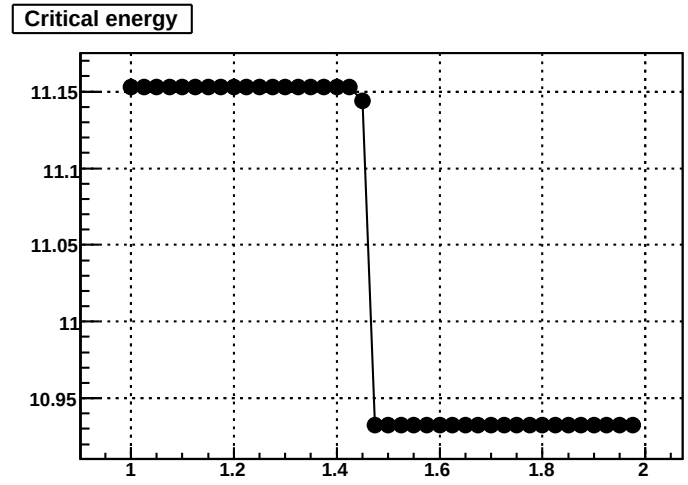


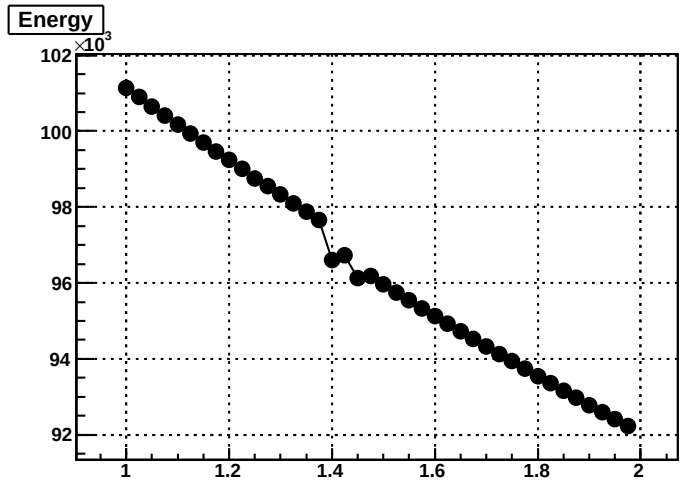
pure CsI with 1.45 X0 (100 GeV)

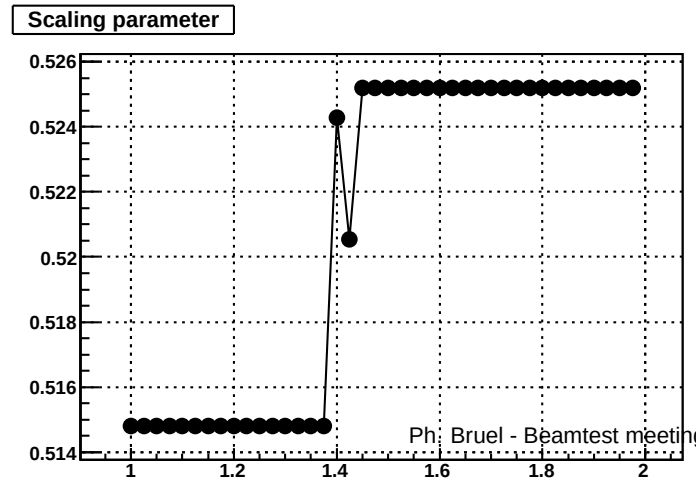
Search the optimal X0

E is free but Ec=11.04 and b=0.52



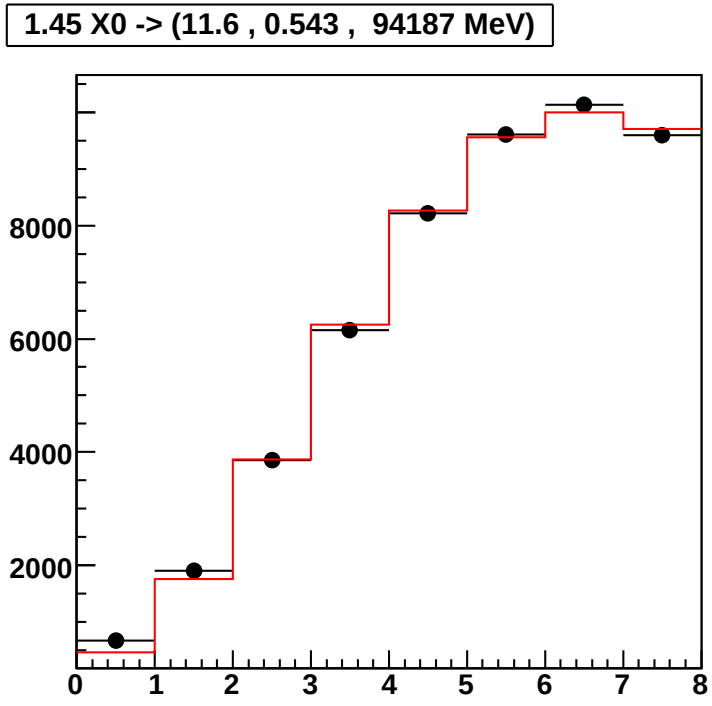


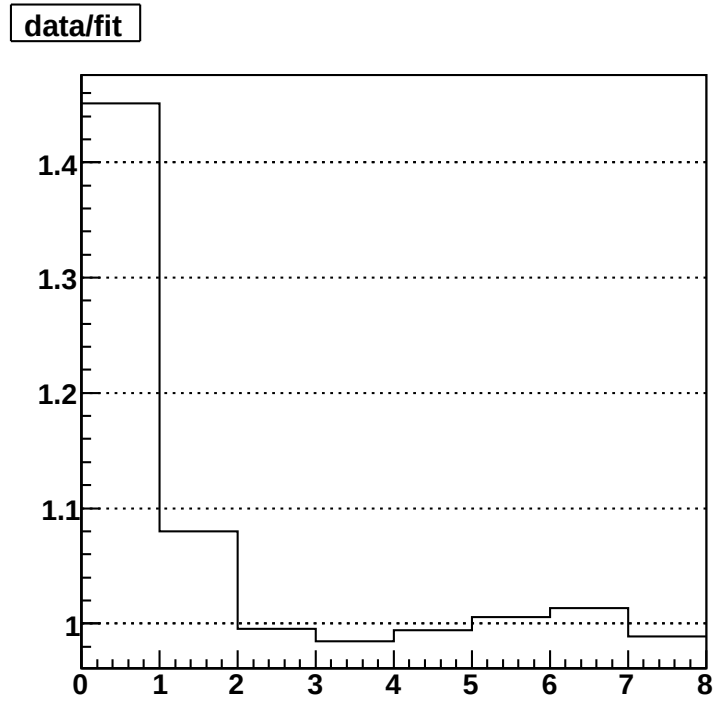




pure CsI with 1.45 X0 (100 GeV)

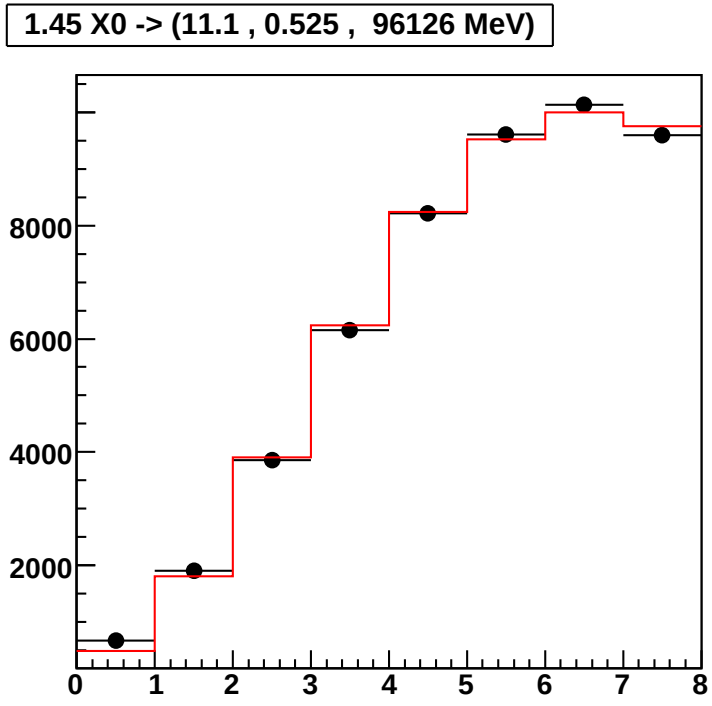
E, Ec and b completely free

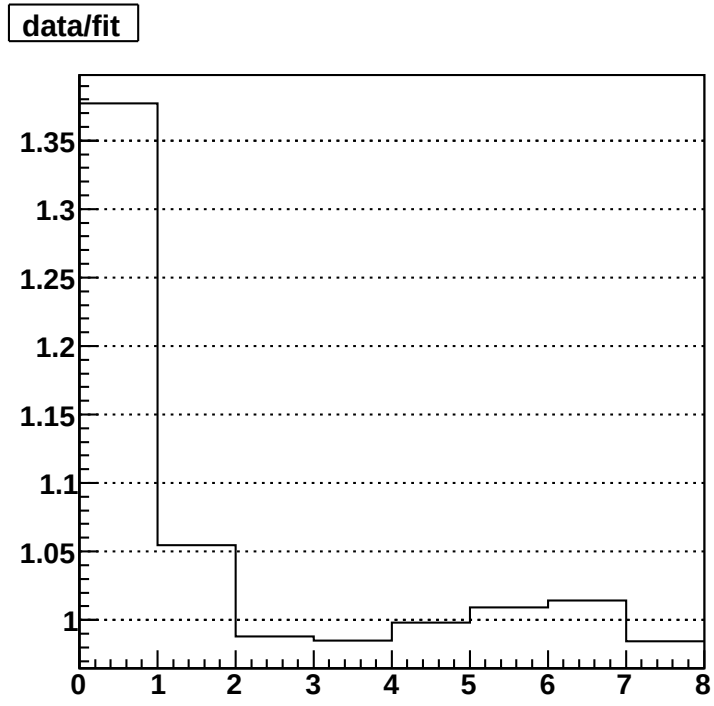




pure CsI with 1.45 X0 (100 GeV)

E is free but Ec=11.04 and b=0.52





Conclusion

- MC
  - no difference between CU simulation and pure CsI simulation
  - why 5% less energy ?
- data
  - we need first to solve our pure calibration problems
  - and then we will be able to estimate the amount of extra material
- other angles : the problem is that for some layers the trajectory crosses two logs and therefore the CU simulation and the pure CsI simulation are no more identical