

EM shower study with GEANT 3

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Introduction

- The longitudinal development produced in CsI calorimeter by high energy electrons (1-200 GeV) has been simulated with GEANT3 code.
- The average longitudinal profile has been fitted with the gamma distribution (p_0 , a and b are the fitted parameters)

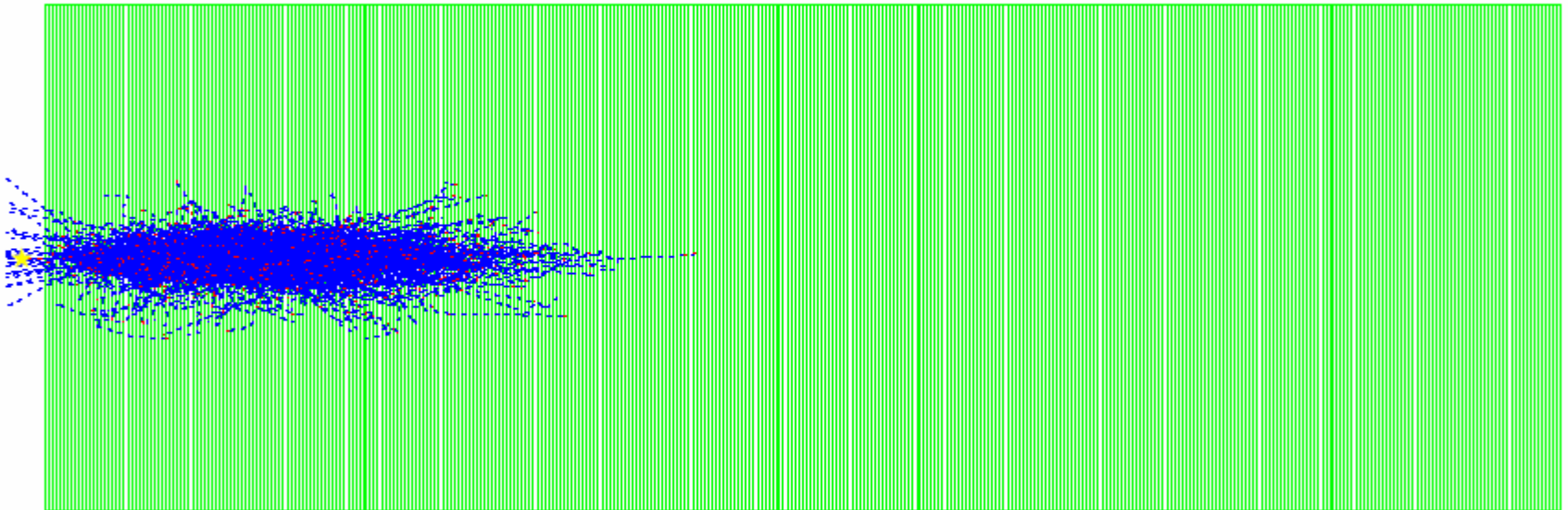
$$f(t) = p_0 t^{a-1} \exp(-bt)$$

- The maximum of the shower t_{\max} and the critical energy E_c have been evaluated

Geometry

- 400 layers 200cm x 200cm and 0.5 cm thick have been simulated

ELECTRON 50.00 GeV Event 1



Csl definition

The GSMIXT routine has been used to define the Csl

Input :

```
WMIX(1) = 1.
WMIX(2) = 1.
AMIX(1) = 132.90545
AMIX(2) = 126.90447
ZMIX(1) = 55.
ZMIX(2) = 53.
DCSI = 4.51
CALL GSMIXT(33, 'CSI$', AMIX, ZMIX, DCSI, -2, WMIX)
```

Output :

```
===== MATERIALS =====
MATERIAL          A          Z  DENSITY  RADIAT L  ABSORP L  NMIX
33 CSI            129.974    54.023    4.510  0.186E+01  0.419E+02    2    A    Z    W
                                     132.91  55.00  0.512
                                     126.90  53.00  0.488
===== TRACKING MEDIA =====
TMED          MATERIAL ISVOL IFIELD  FIELDM  TMAXFD  STEMAX  DEEMAX  EPSIL  STMIN
23 CsI            33          1      0      0.00    1.00  0.100E+11  0.147  0.000  0.074
```

$X_0 = 1.86$ cm, the radiation length is computed according the EGS manual slac-210 uc-32 June-78, formula 2-6-8 (37)

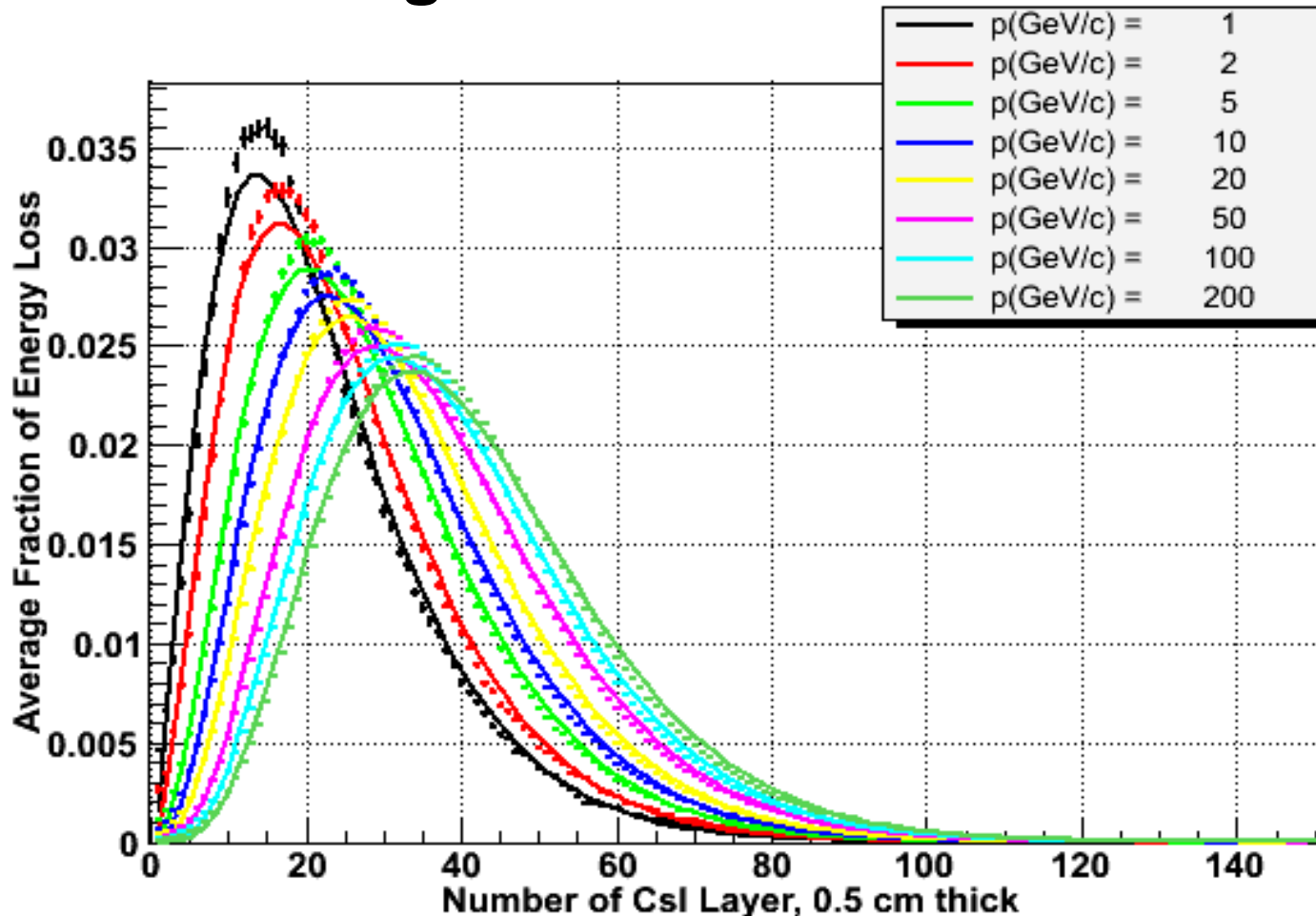
G3 cuts and physical processes

```
*****
*
*   G E A N T   Version 3.2114       DATE/TIME 061228/1048  *
*
*           R U N       1
*
*****

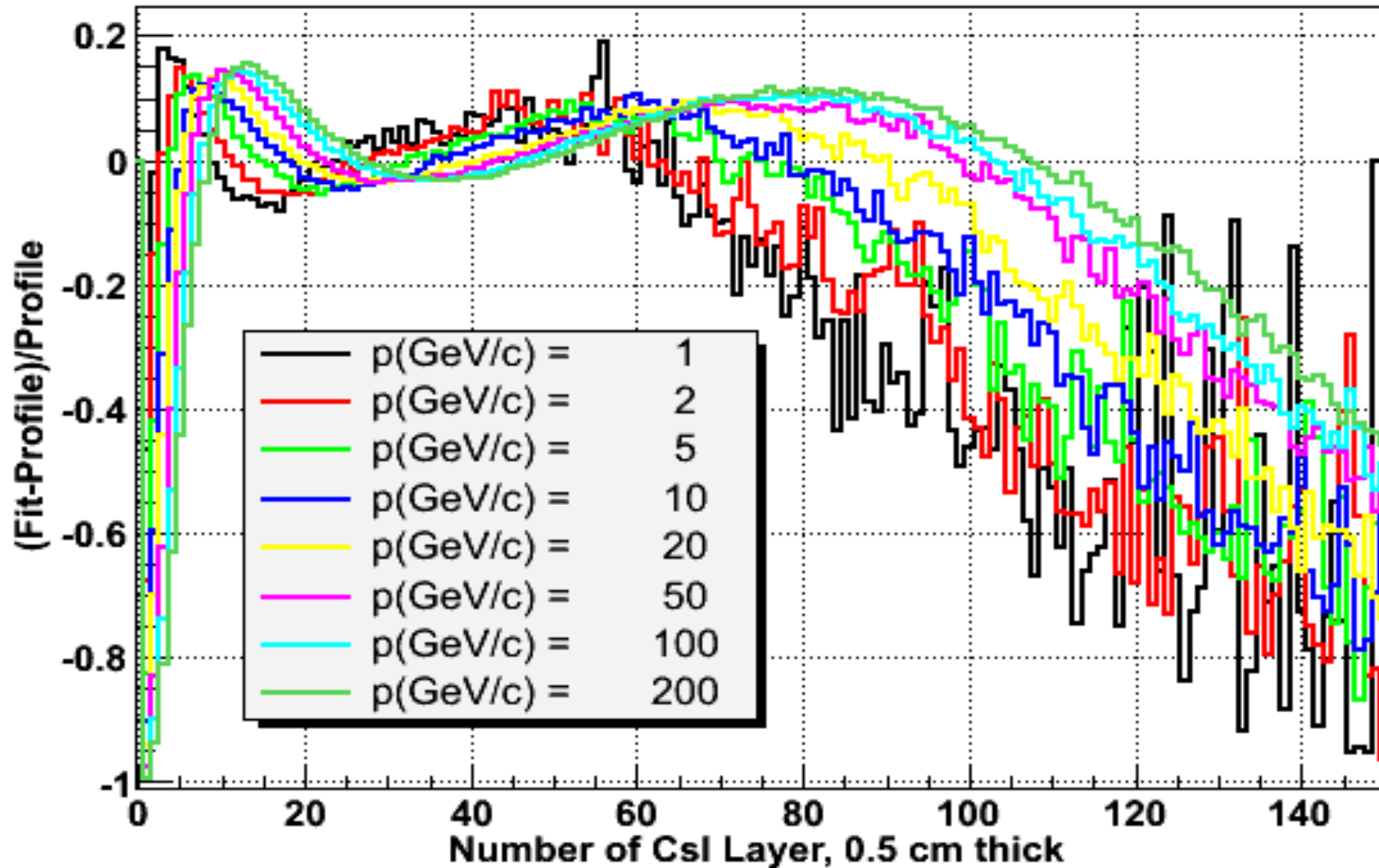
*-----*
*
*           Standard TPAR for this run are
*           -----
*
*           Special TPAR for TMED  23   CsI
*           -----
*   CUTGAM=100.00 keV  CUTELE=100.00 keV  CUTNEU= 10.00 MeV *
*   CUTHAD= 10.00 MeV  CUTMUO= 10.00 MeV
*   BCUTE =100.00 keV  BCUTM =  1.00 MeV
*   DCUTE = 10.00 TeV  DCUTM = 10.00 TeV  PPCUTM= 10.00 MeV *
*   IPAIR =          1.  ICOMP =          1.  IPHOT =          1. *
*   IPFIS =          1.  IDRAY =          0.  IANNI =          1. *
*   IBREM =          1.  IHADR =          1.  IMUNU =          1. *
*   IDCAY =          1.  ILOSS =          2.  IMULS =          1. *
*   IRAYL =          0.  ILABS =          0.  ISYNC =          0. *
*   ISTRA =          0.
*
*
*****
```

Longitudinal Shower Profile

- Profile: average energy deposited in each layers/Initial kinetic energy
- Line: fitted gamma function

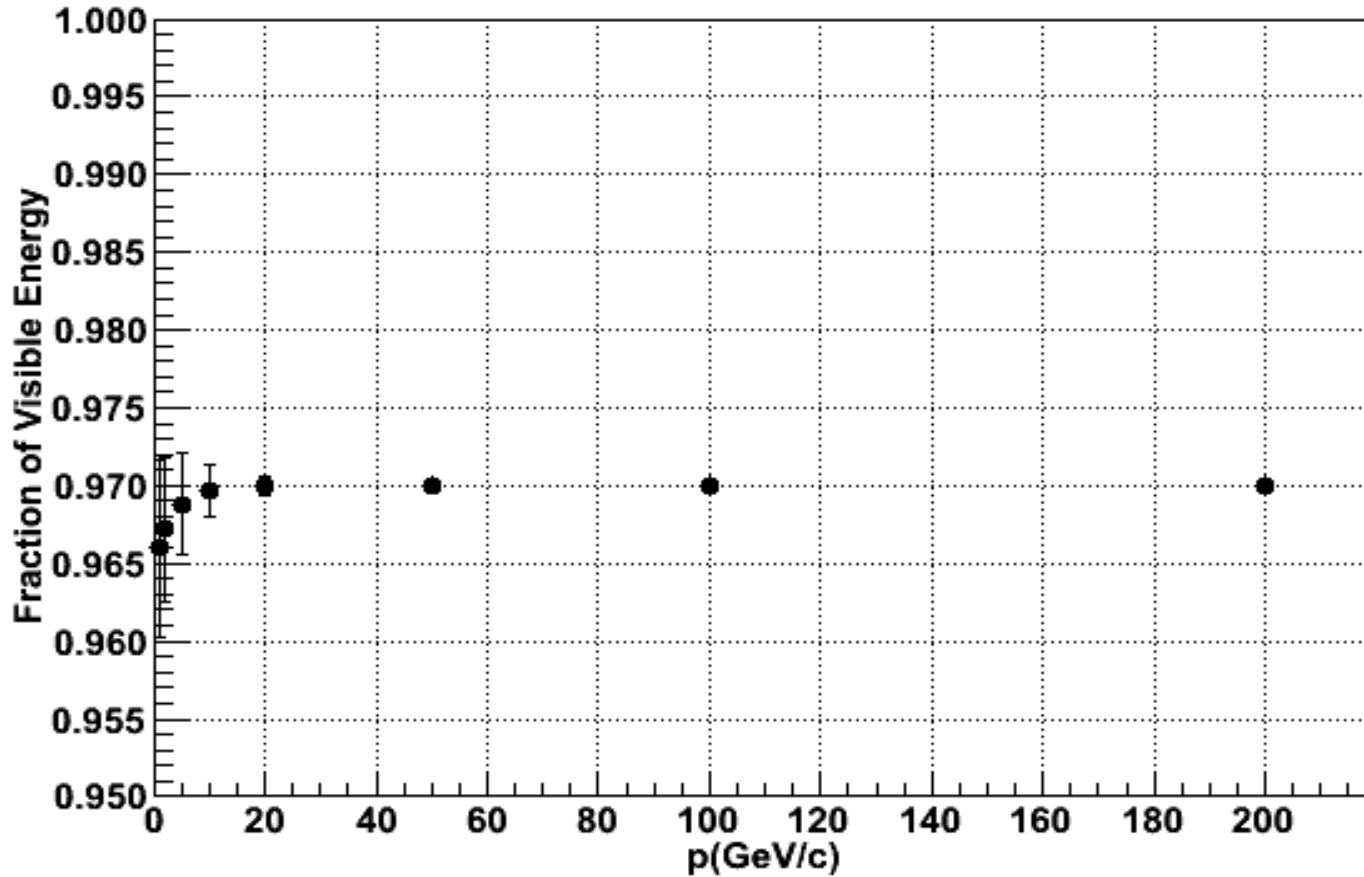


Fit – Profile/Profile

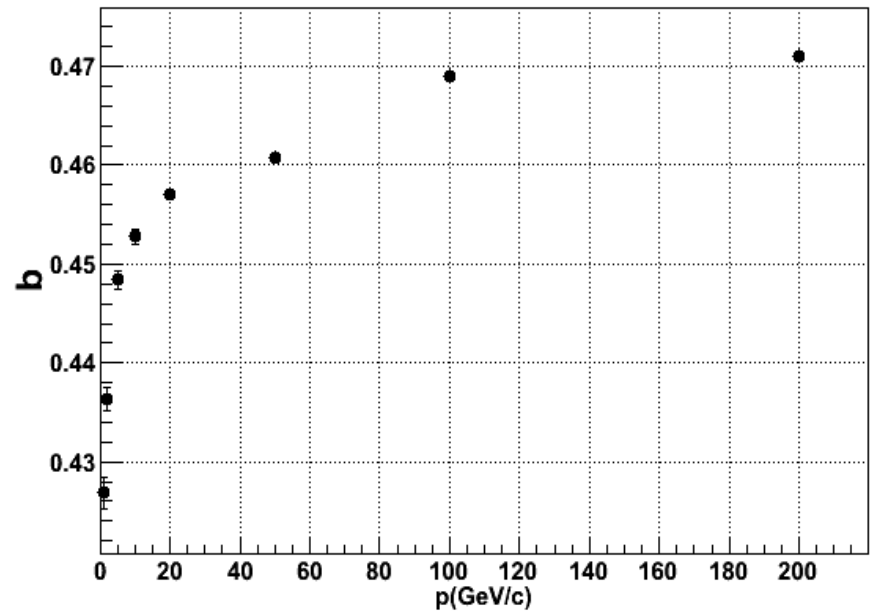
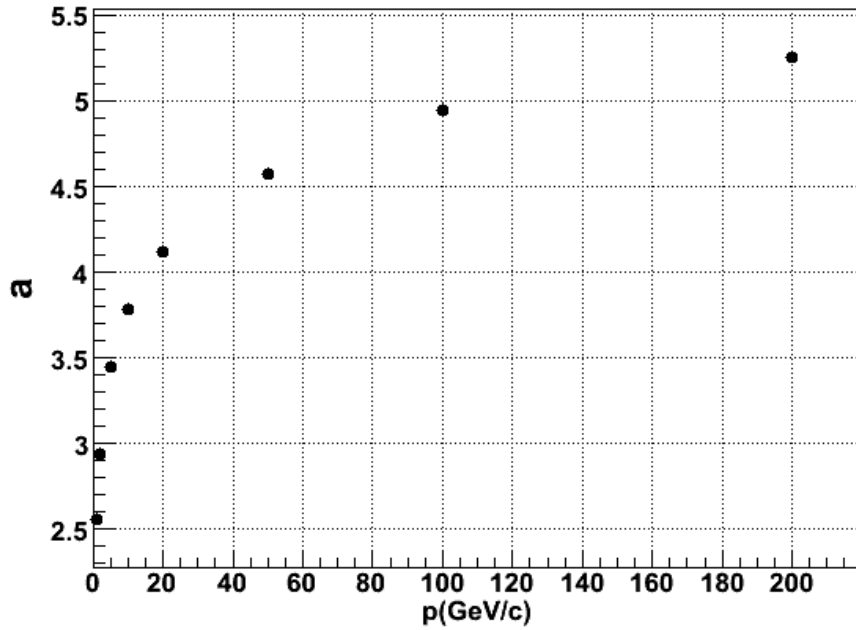


Visible Energy

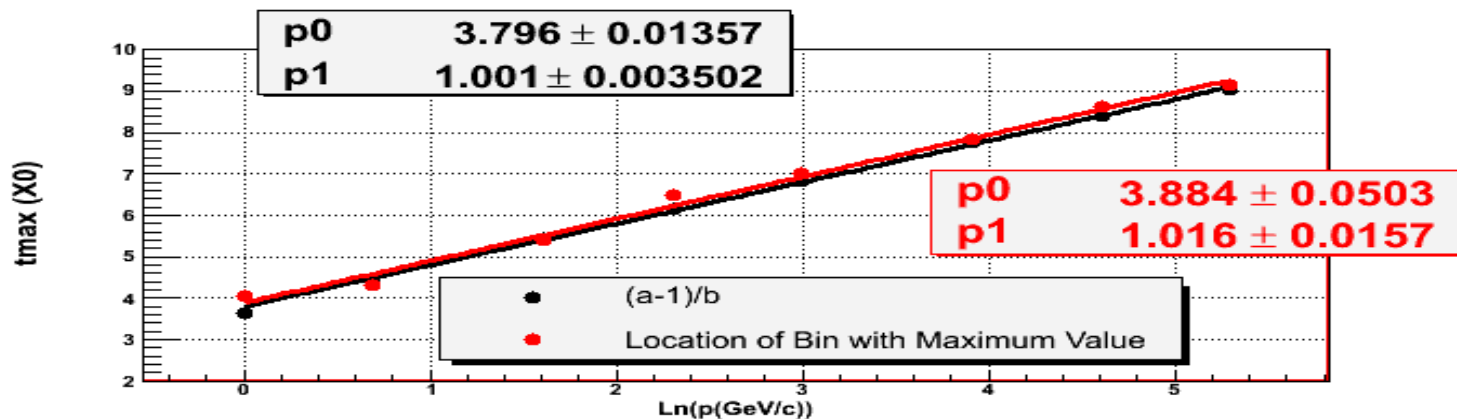
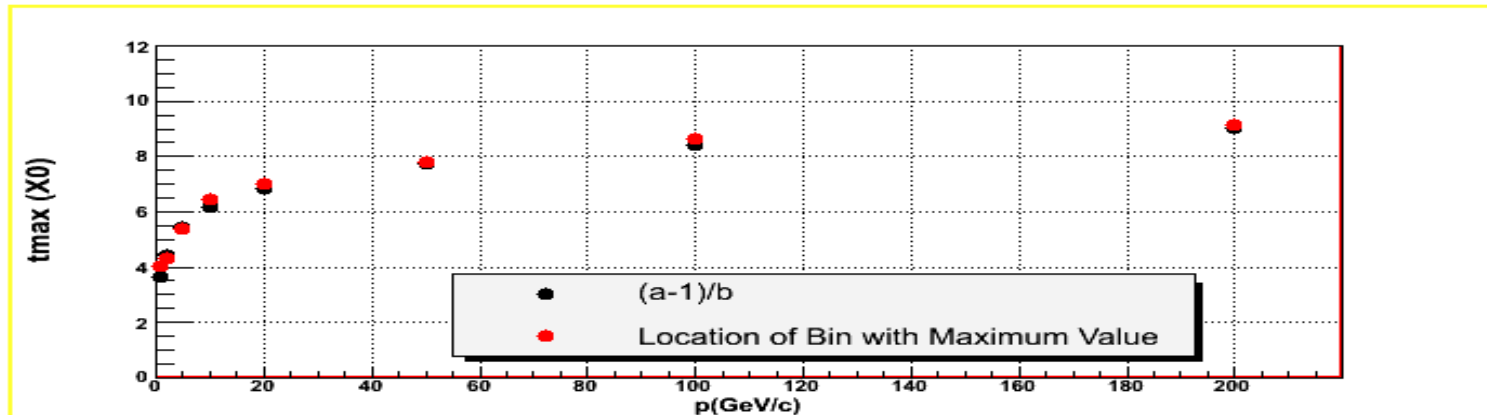
Total energy deposited/Initial kinetic energy



a and b value from best-fit



T max

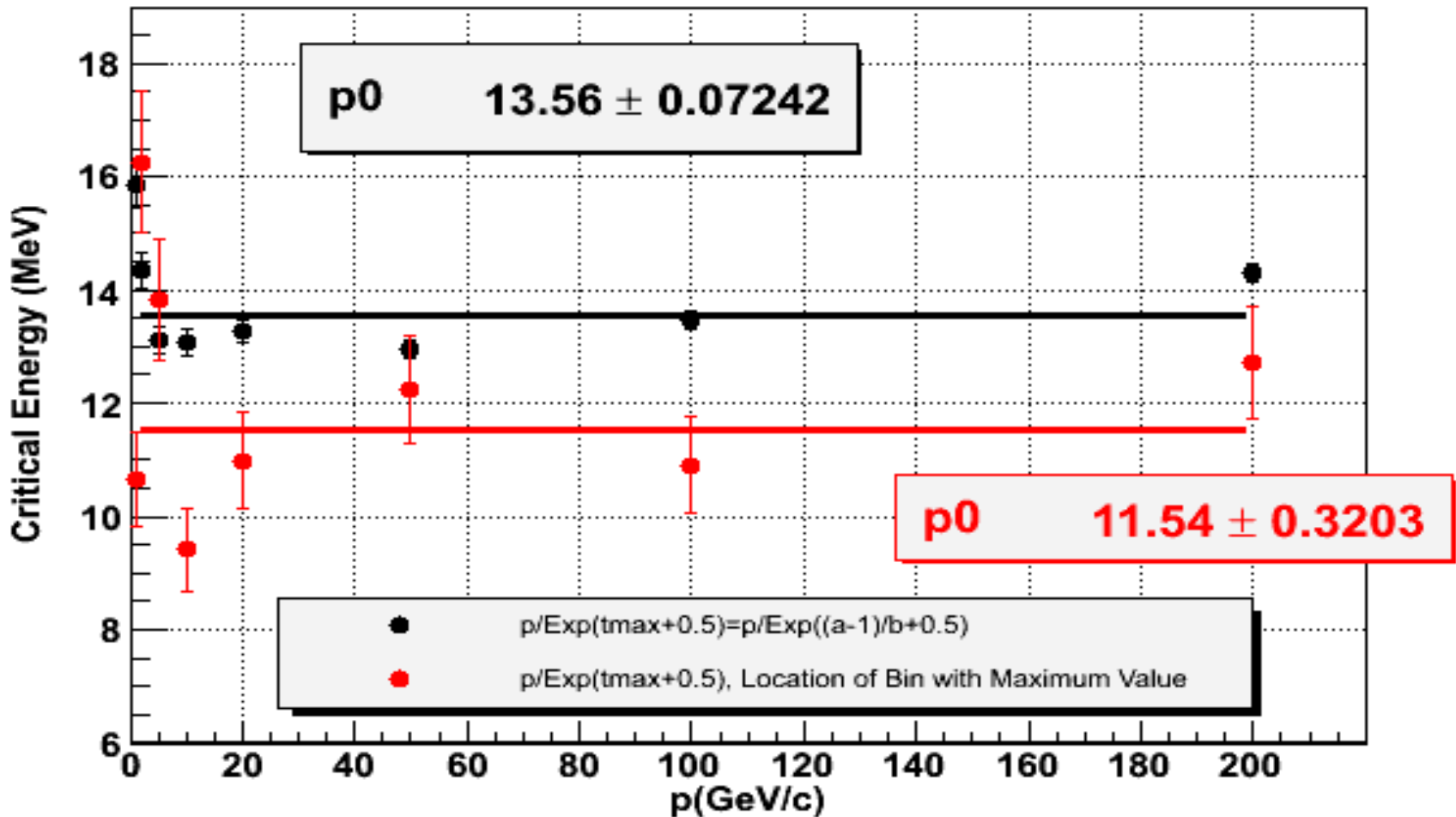


T_{max} increases with $\ln(E)$, $t_{max} = p_0 + p_1 \cdot \ln(E)$

$T_{max} = \ln(E/E_c) + C_e$, where $C_e = -0.5$

$E_c = \exp(C_e - p_0) \rightarrow E_c = 13.62 \text{ MeV}$ (12.47 MeV)

Critical energy



Conclusions

- **The shower profile of the energy deposition EM cascade could be described by a gamma function**
 - **The discrepancies around the maximum are within 10-20%**
 - **The gamma function fails in the first and in the last radiation lengths**
- **The position of the maximum increases with the initial electron energy**
- **The critical energy evaluated by means of t_{\max} ranges from 11.5 MeV to 13.6 MeV**