ECAL-P leakage study

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January 2022

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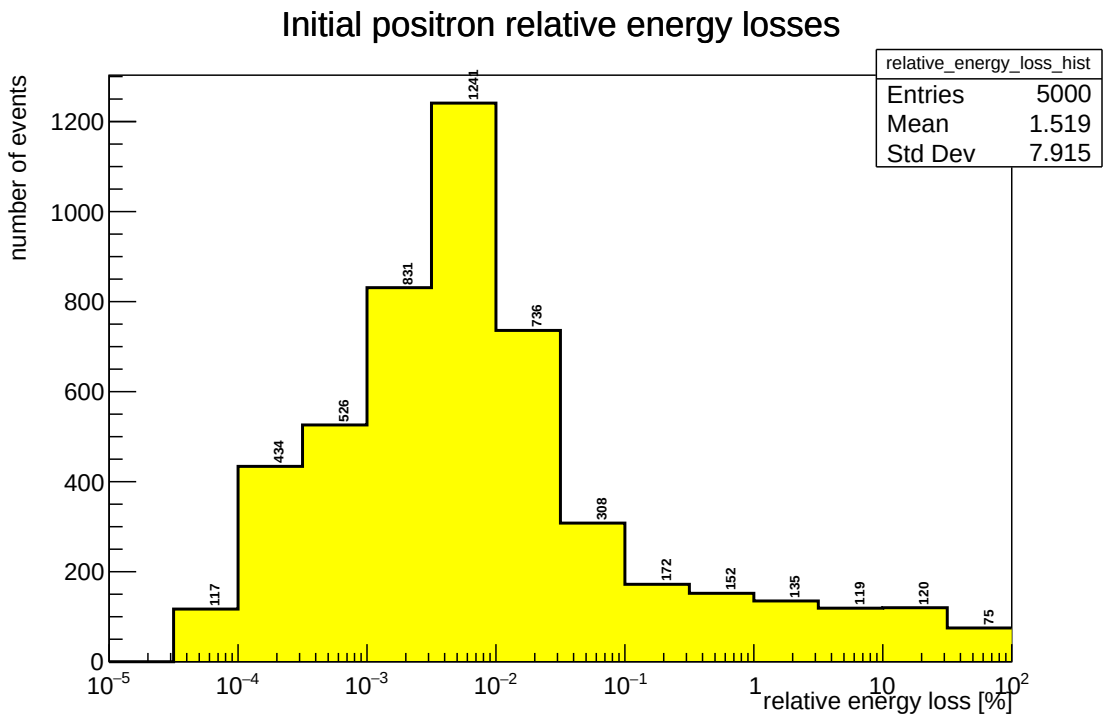

Figure: Relative positron's energy loss, 3GeV

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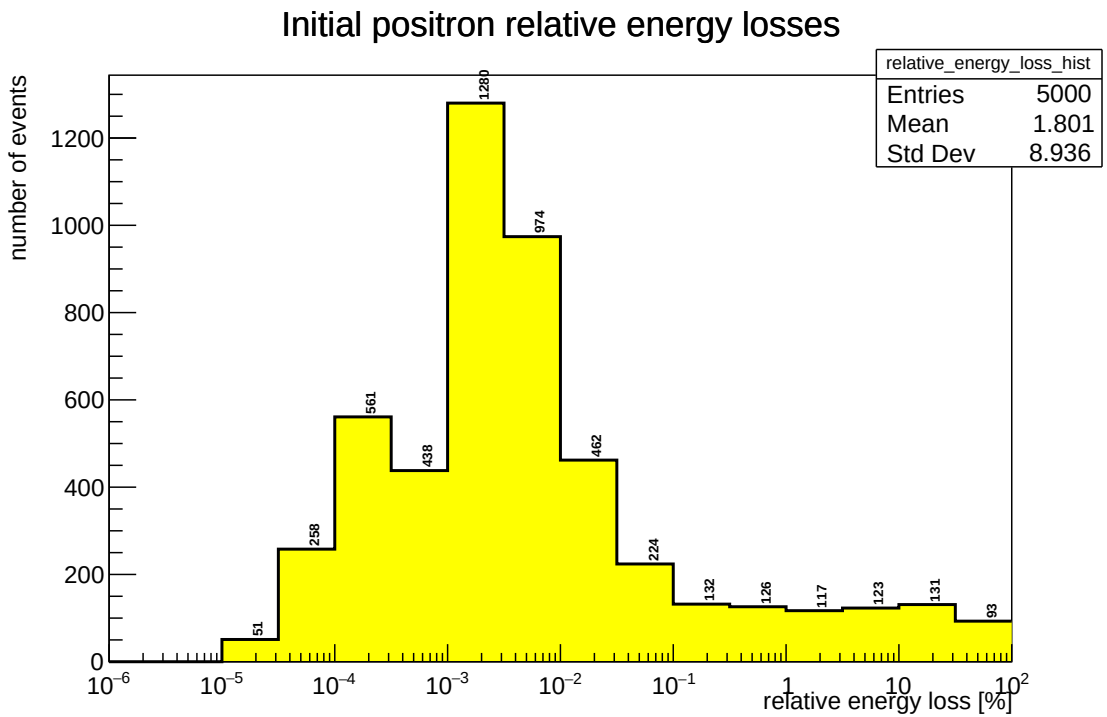

Figure: Relative positron's energy loss, 6GeV

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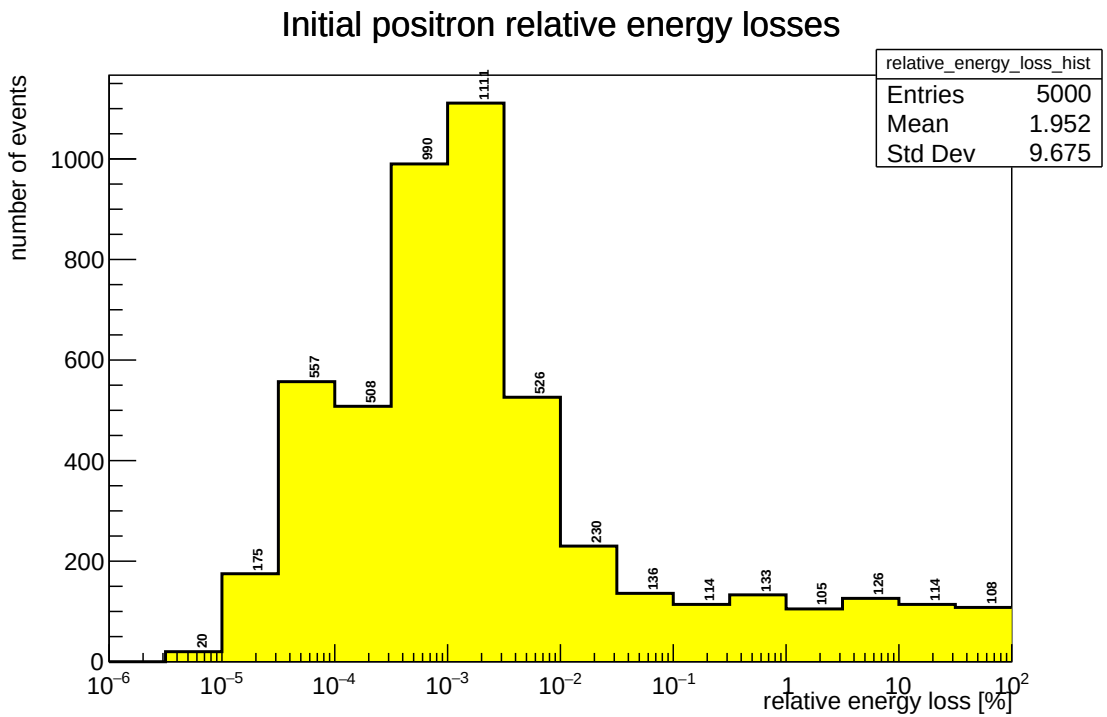

Figure: Relative positron's energy loss, 12GeV

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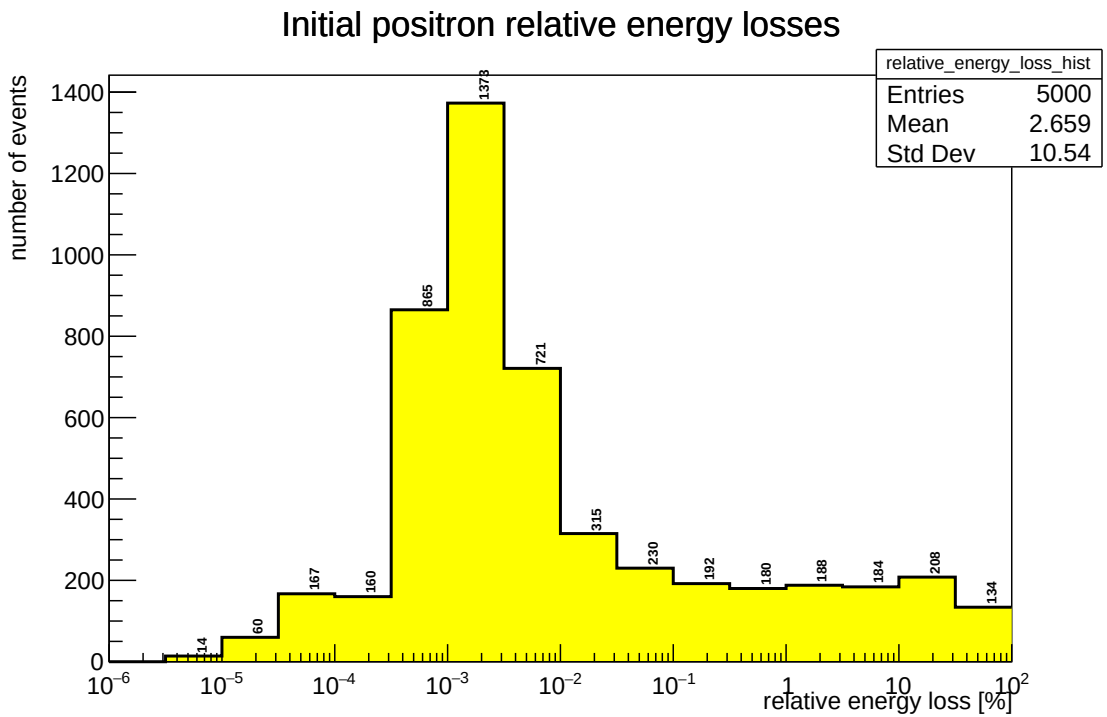

Figure: Relative positron's energy loss, 15GeV

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- New files have lower statistics, drop from 5000 to 1000 events
- Following study is oriented on understanding the impact of the leakages on ECAL-P linearity and resolution

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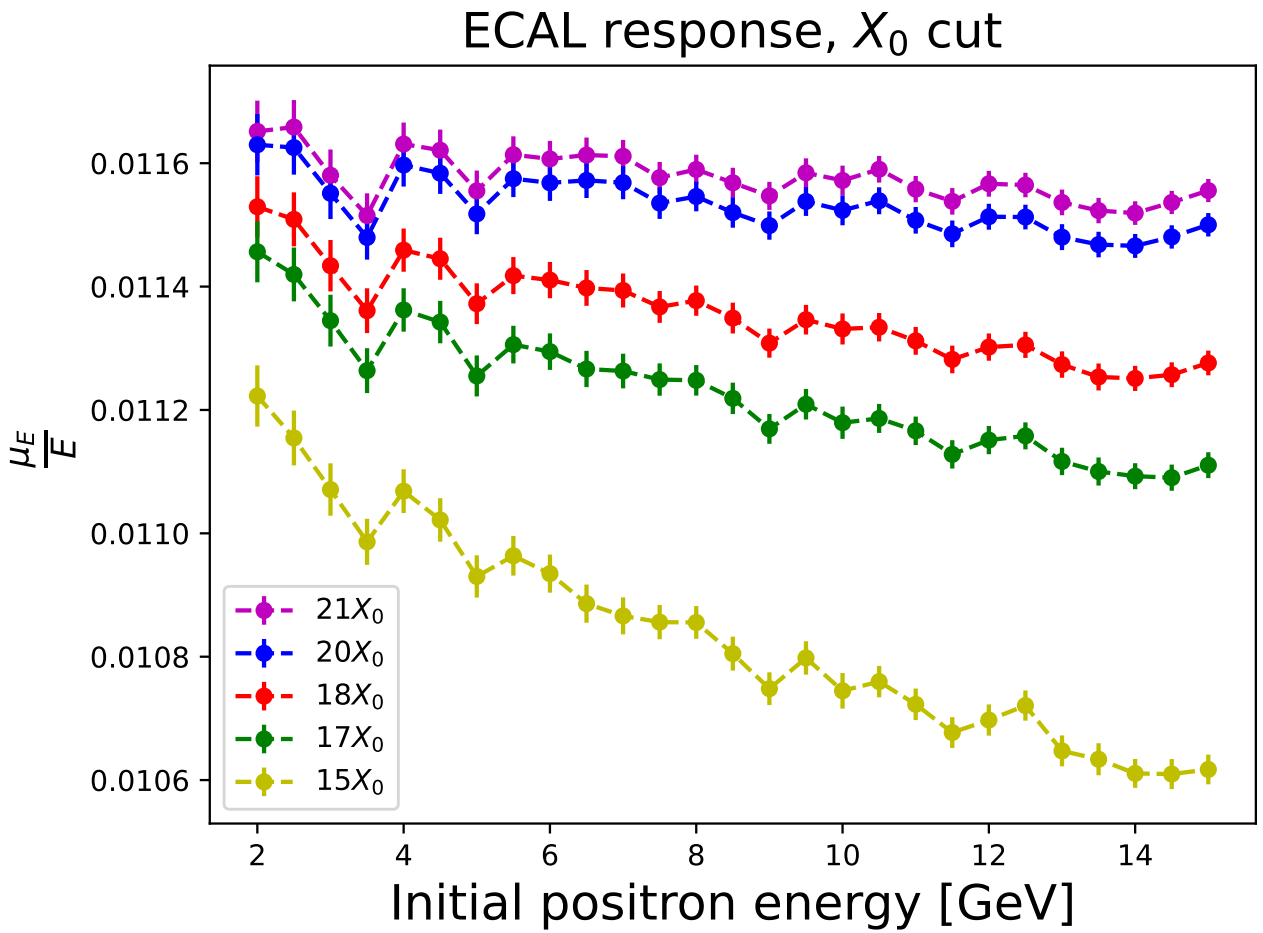
- Last layer is added due to some simulation details and is not included in ECAL-P project
- However, its presence can be used to study linearity of ECAL-P response and the impact of leakages

ECAL-P response with reduced number of X_0

In order to check how the thickness of ECAL-P impacts the linearity of its response, sum of deposits from different number of layers were used. μ_E is an average of energies deposited in each event.



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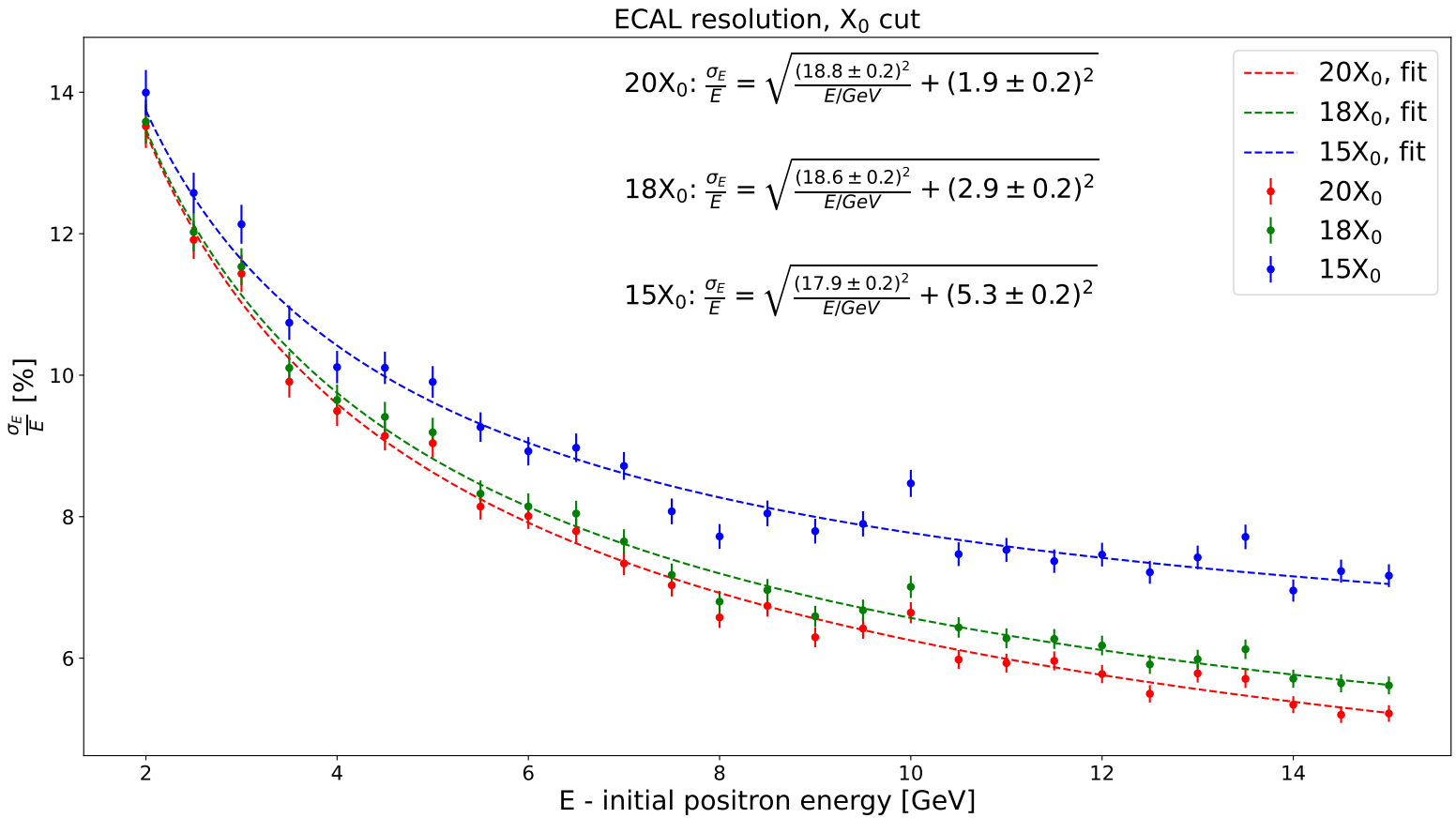

Correlation between energy deposit in 21st layer and sum of deposits in ECAL-P

To check a correlation between sum of deposits in $20X_0$ and deposit in 21st layer of ECAL-P 2D histograms were prepared, where ρ is correlation parameter

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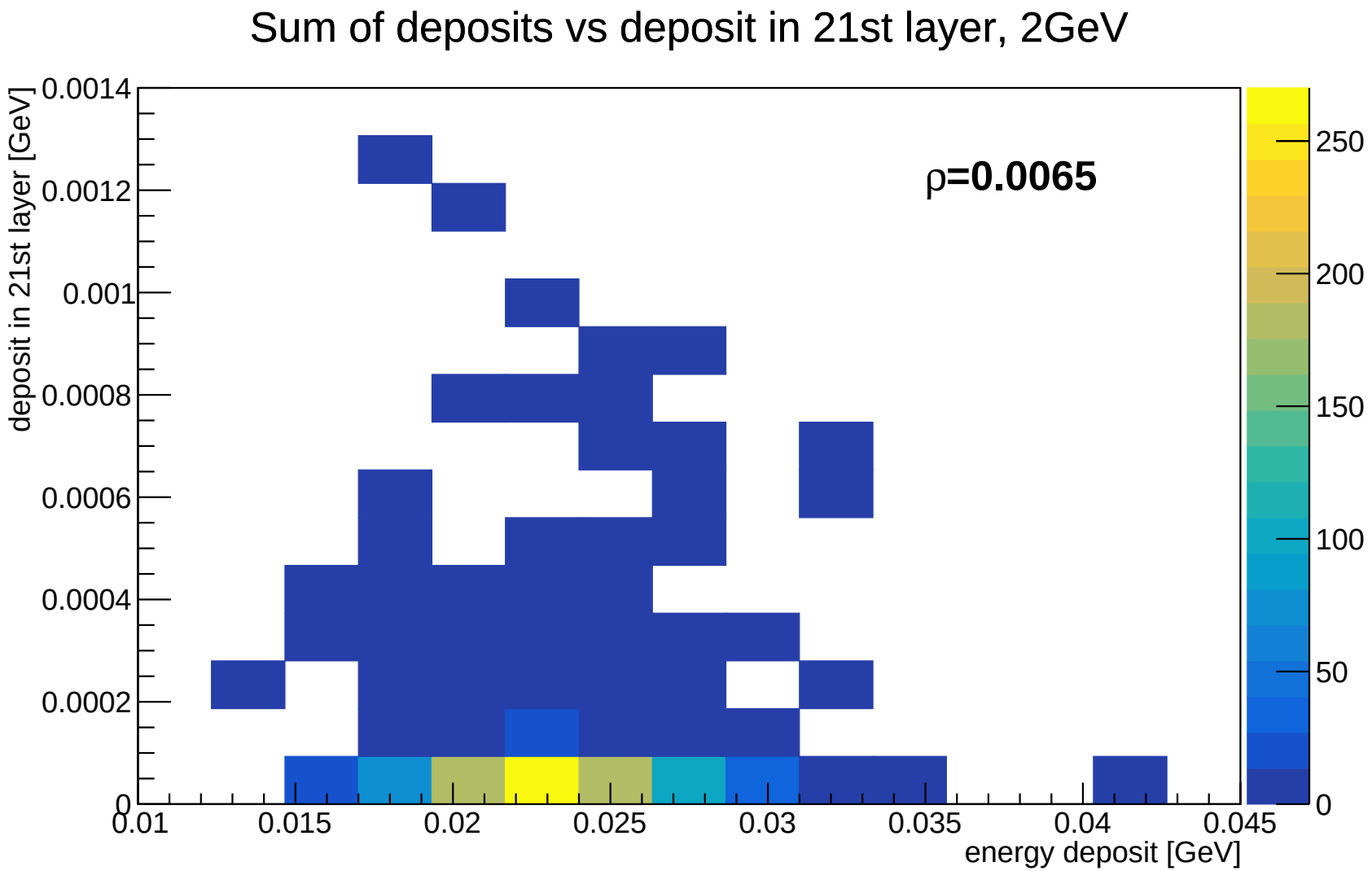

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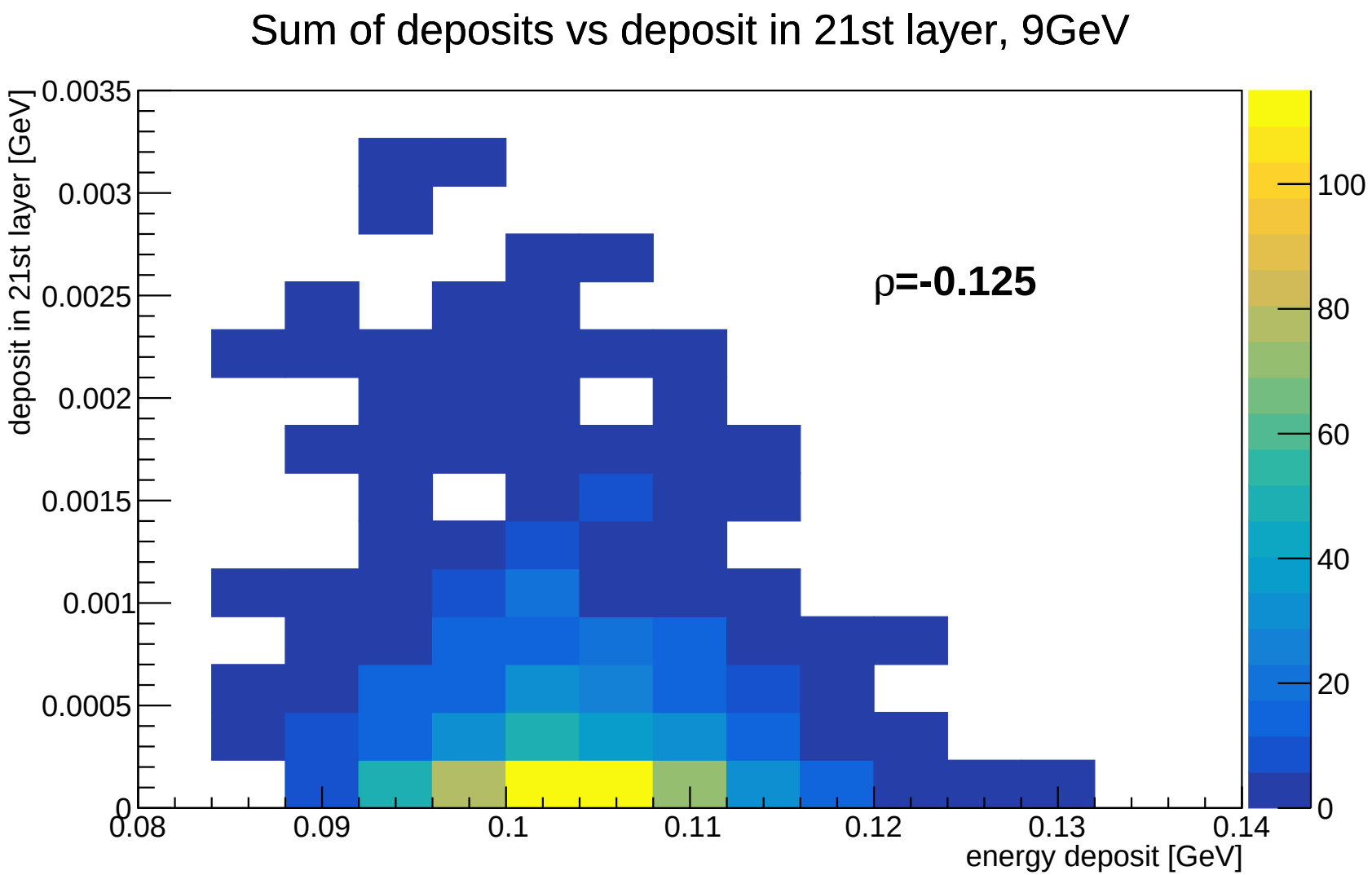

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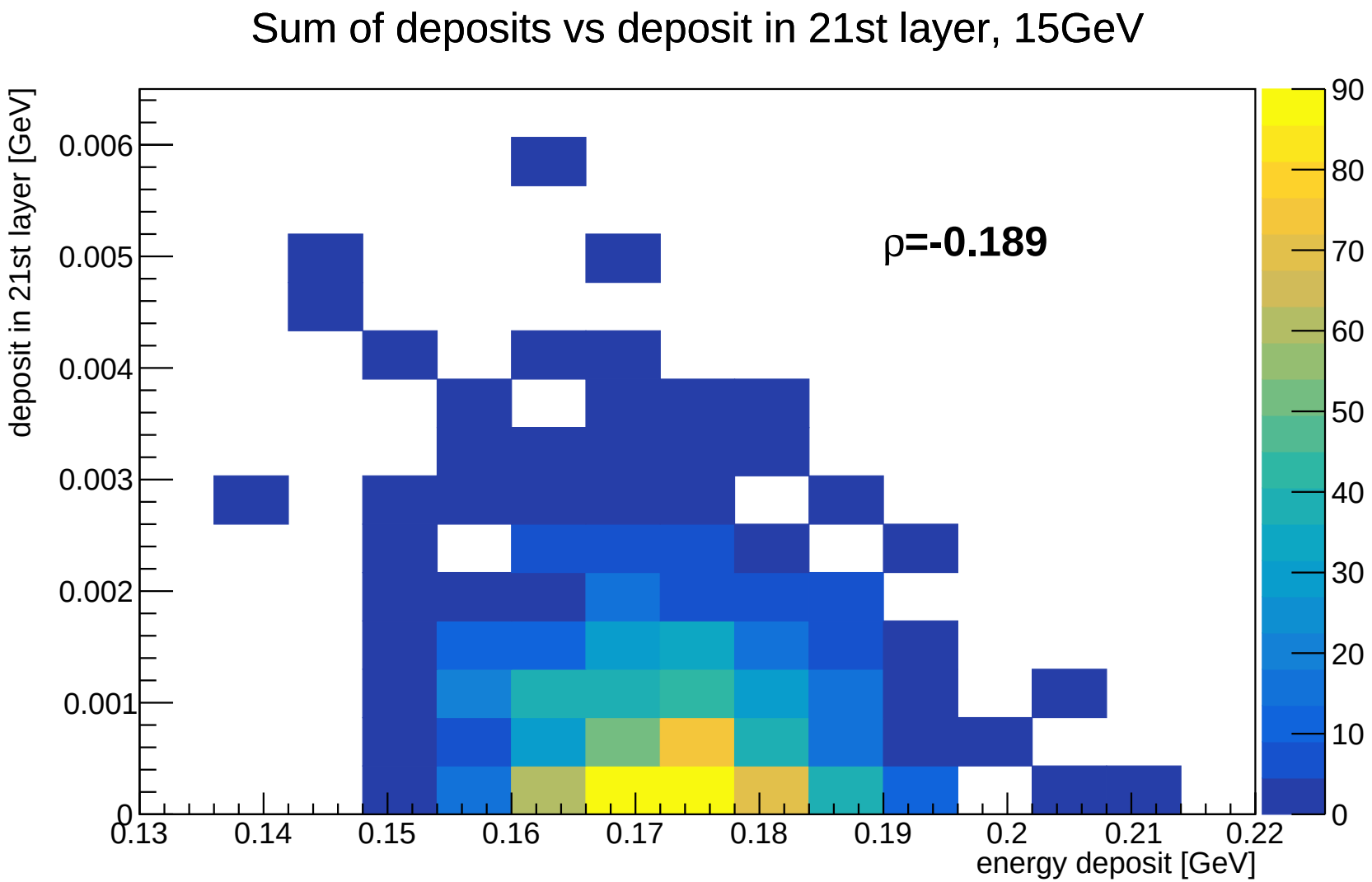

Distribution of ratio of energy deposited in 21st layer to sum of energy deposited in ECAL-P

To check how much energy is leaking from ECAL-P distribution of the ratio of energy deposited in 21st layer to sum of deposited energy in ECAL-P was prepared.

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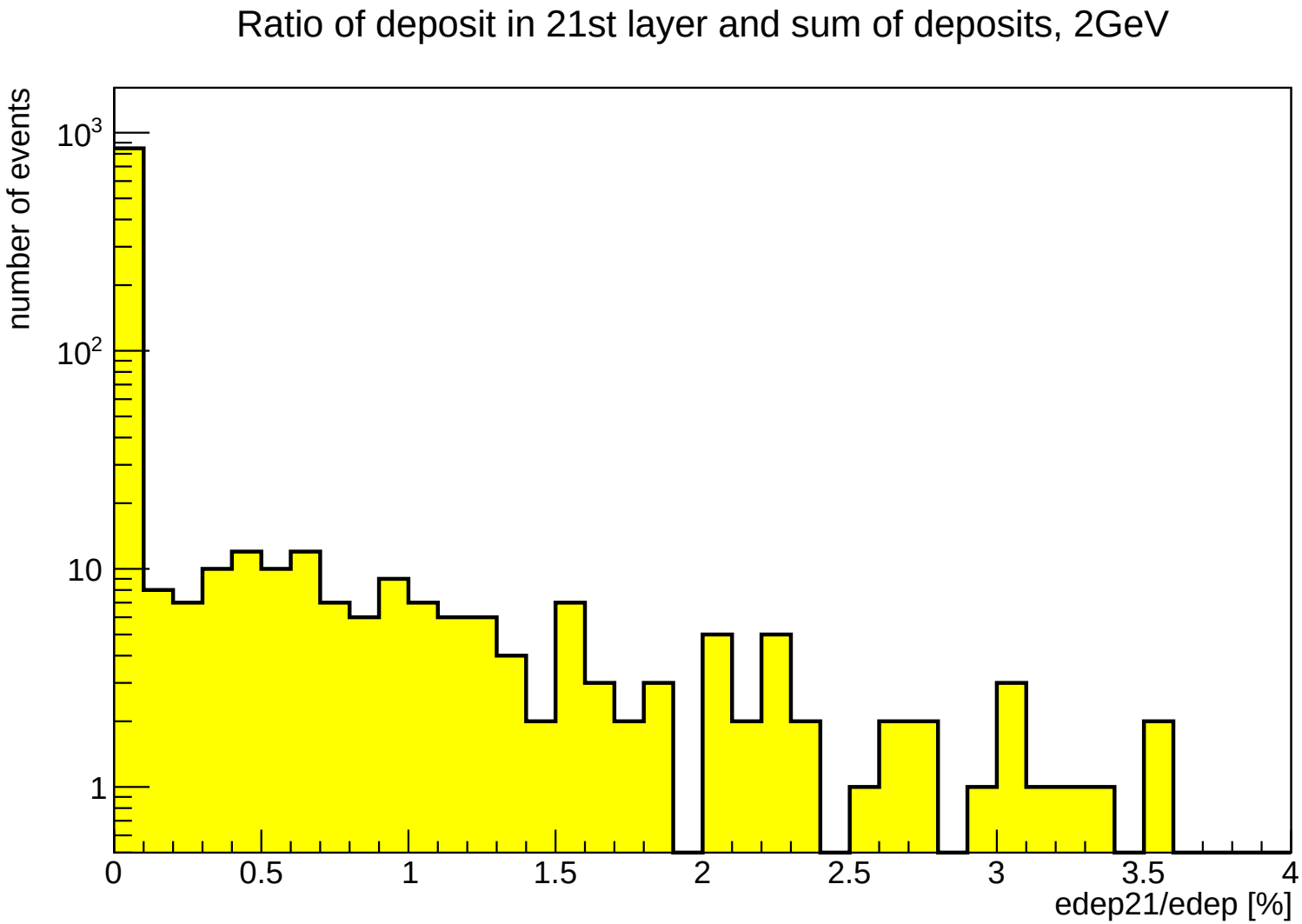

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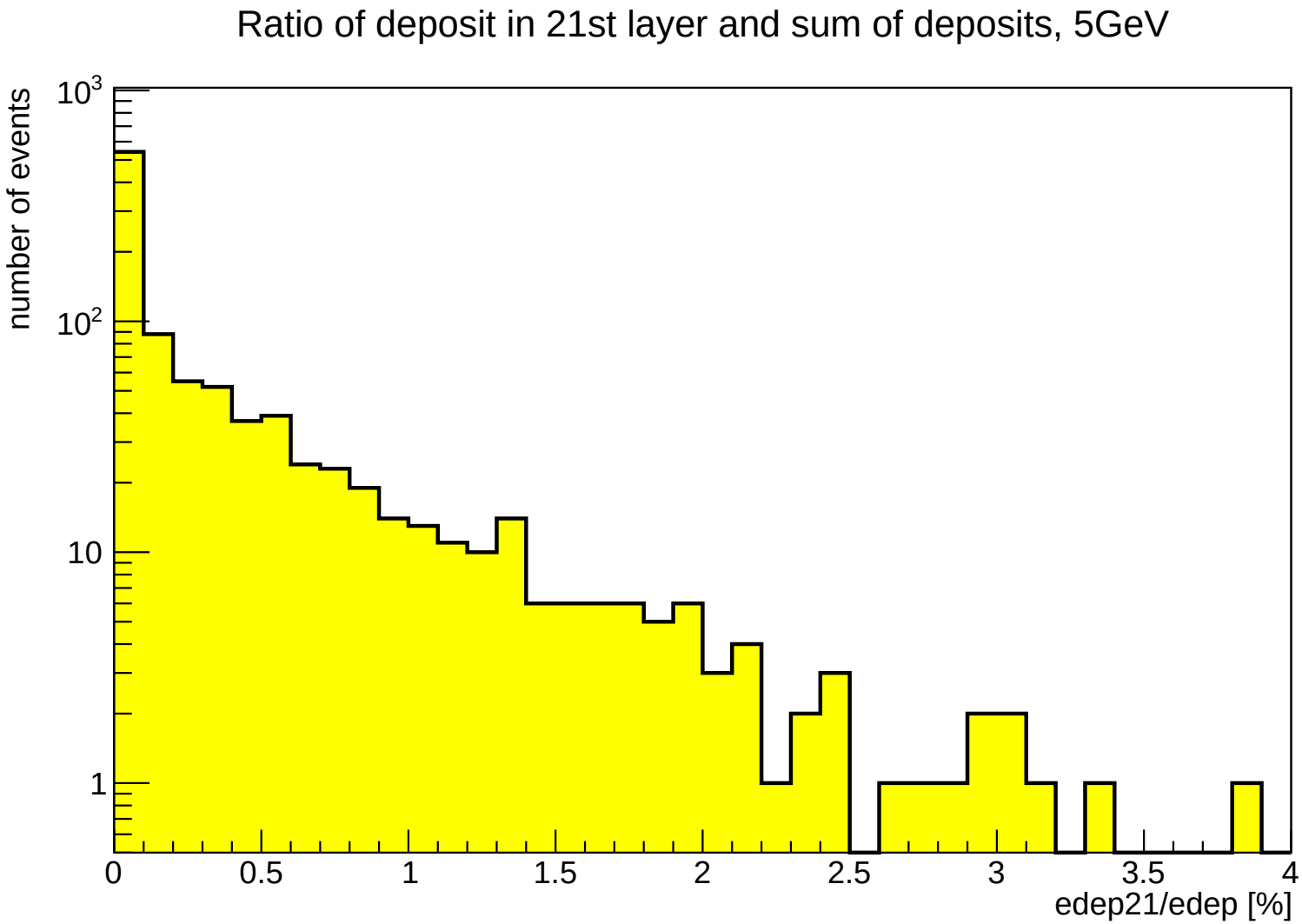

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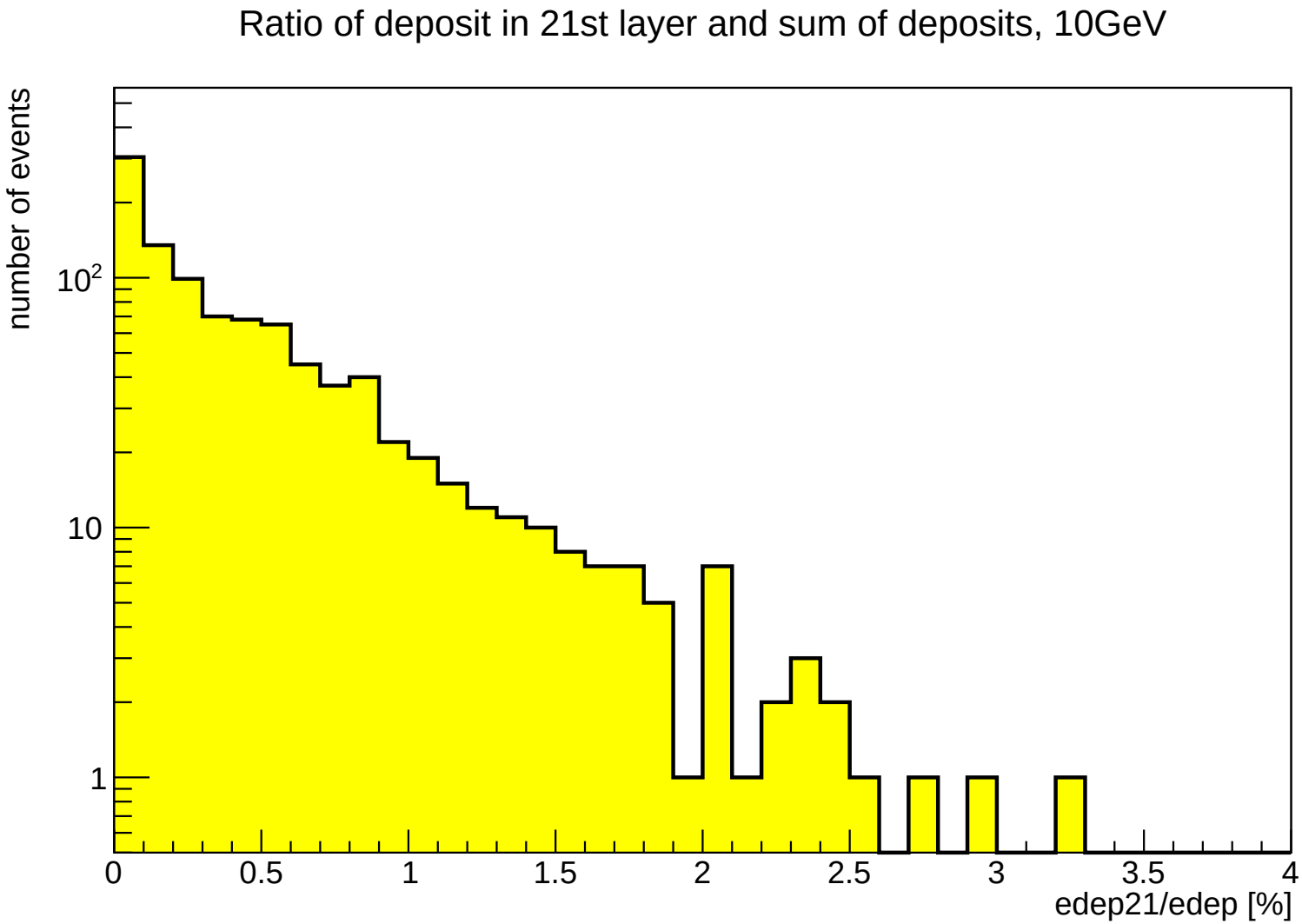

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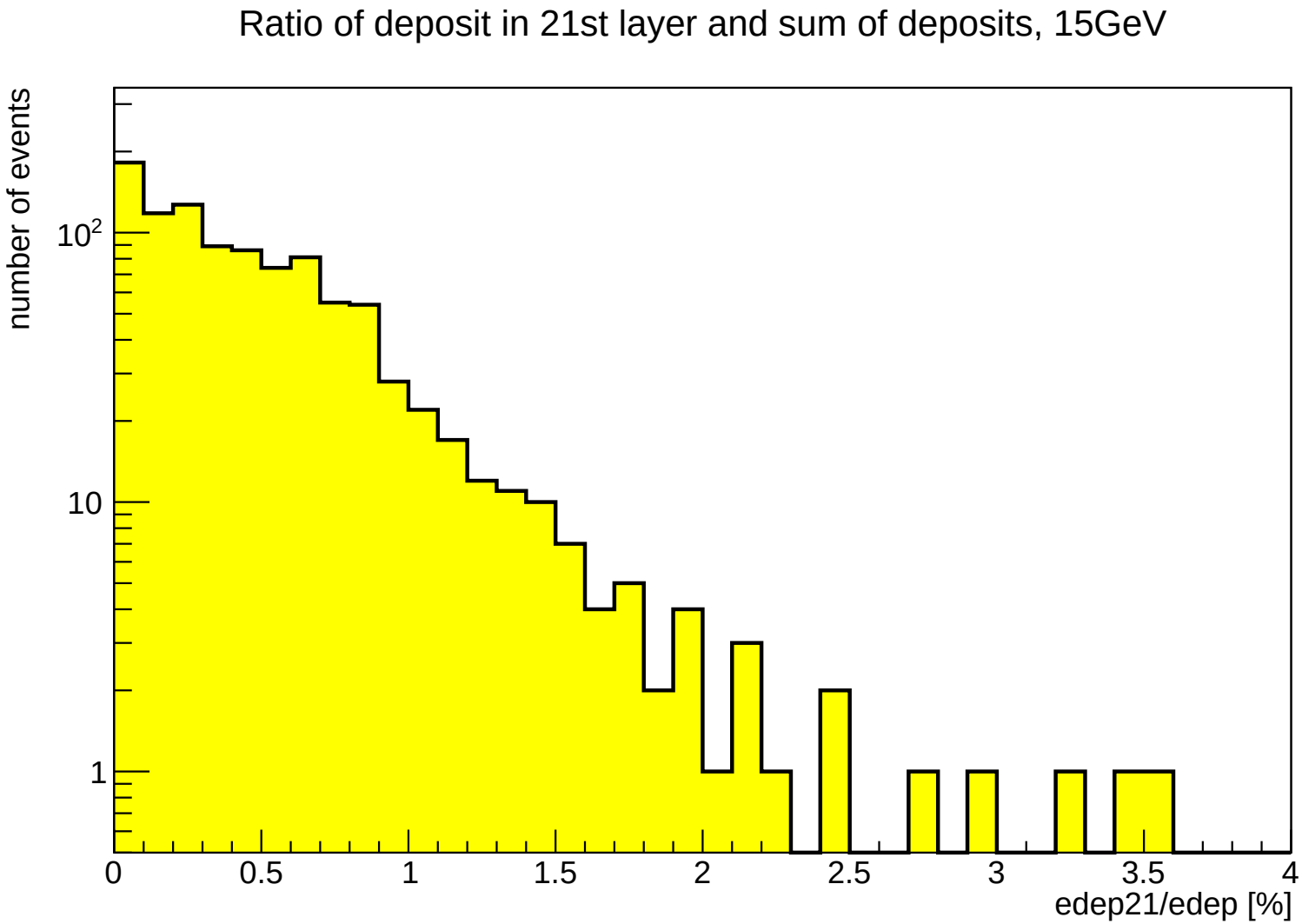

Applying cut on deposit in 21st layer

- To check if the drop in linearity from the previous figure is caused by the leakage, cut on the deposit in 21st layer was applied.

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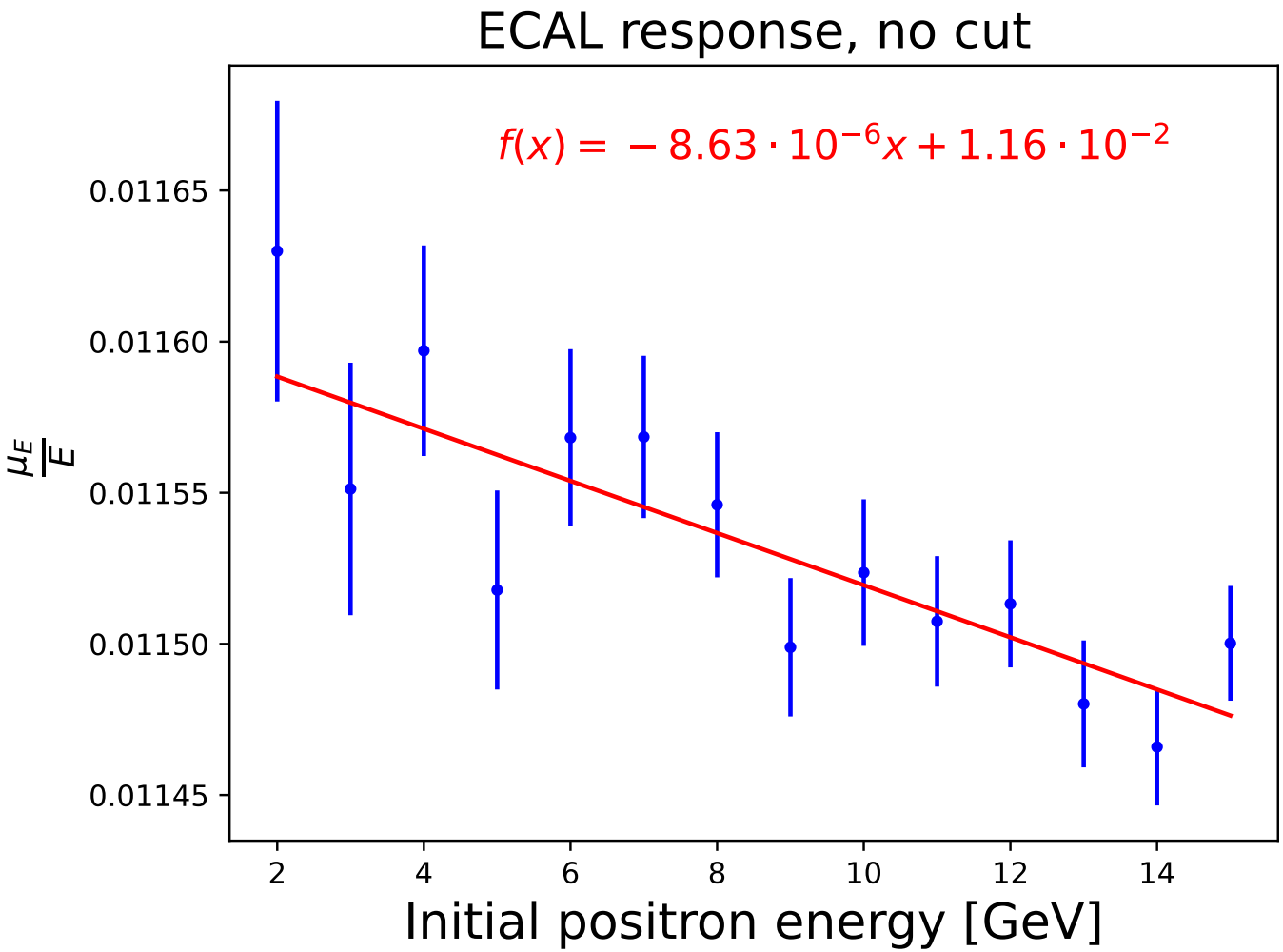

Figure: ECAL-P response with no cut on deposit in 21st layer

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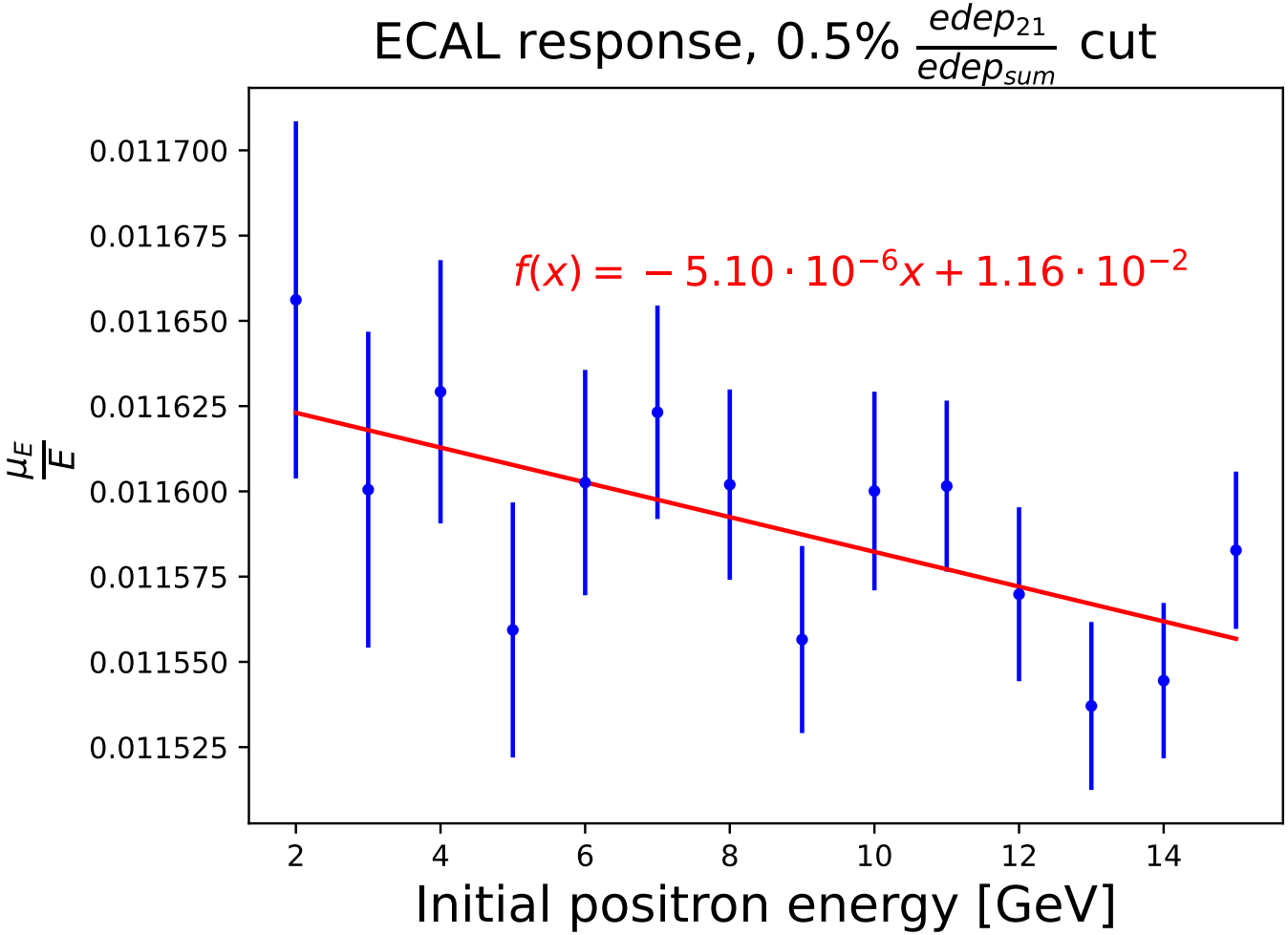

Figure: ECAL-P response with 0.5% cut on deposit in 21st layer

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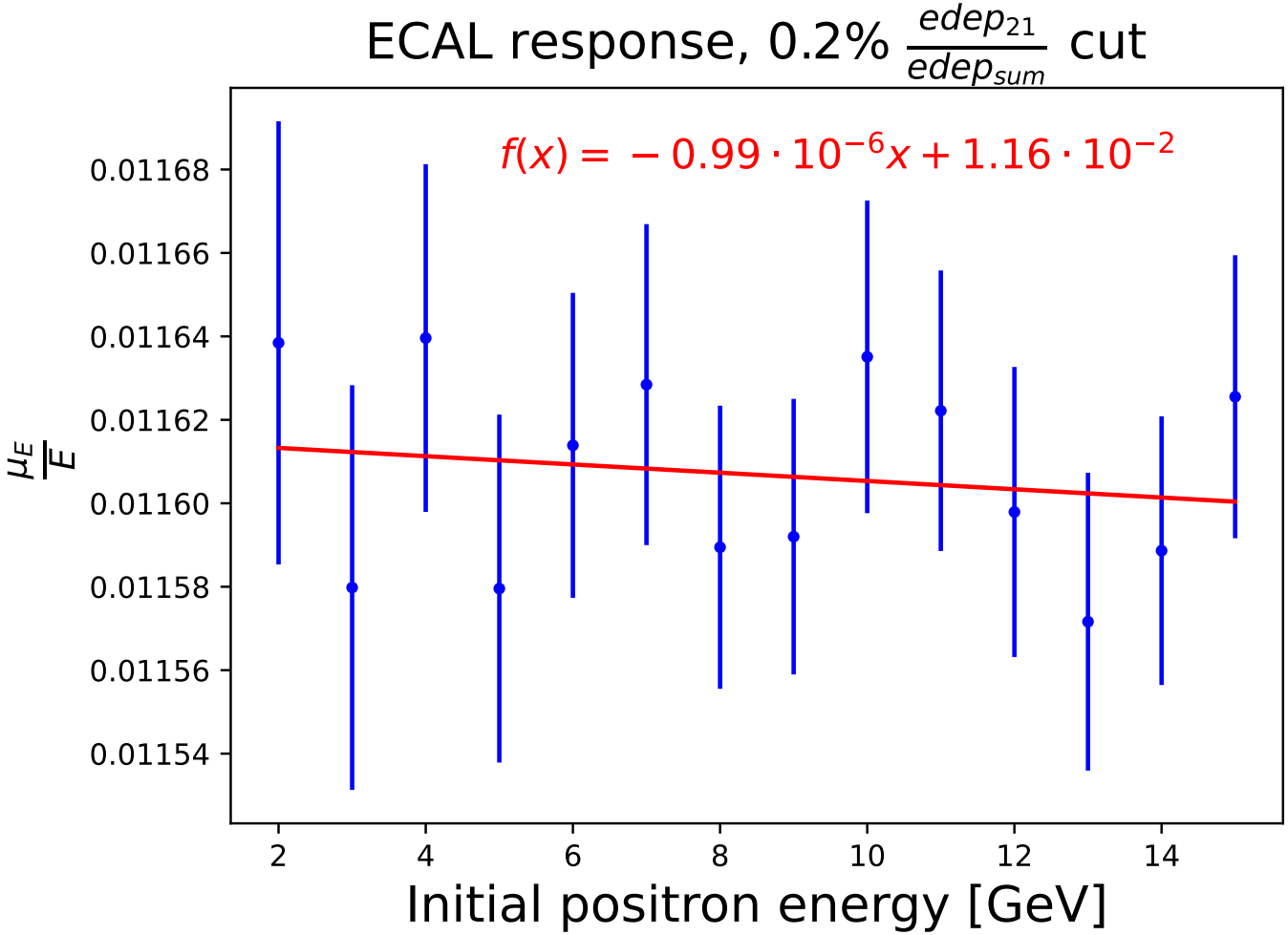

Figure: ECAL-P response with 0.2% on deposit in 21st layer

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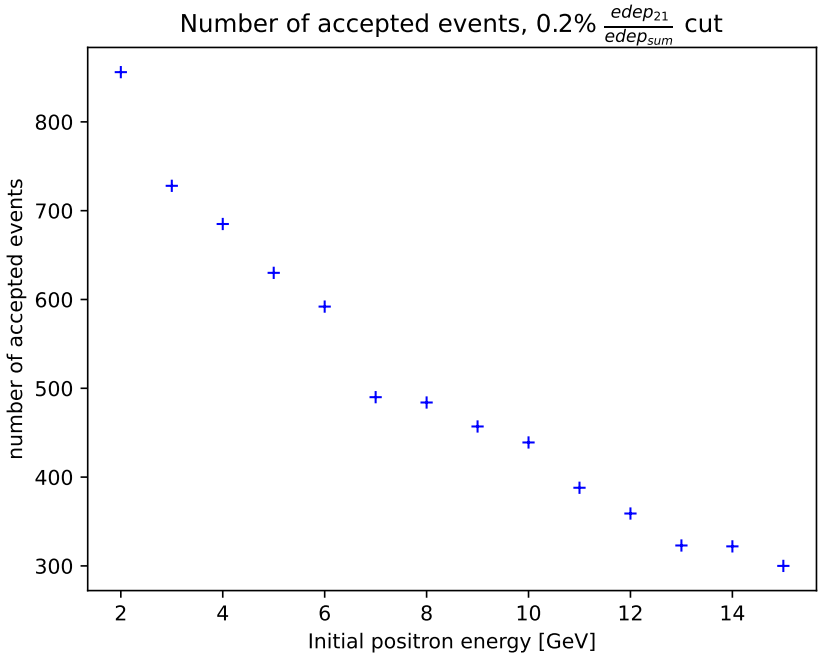

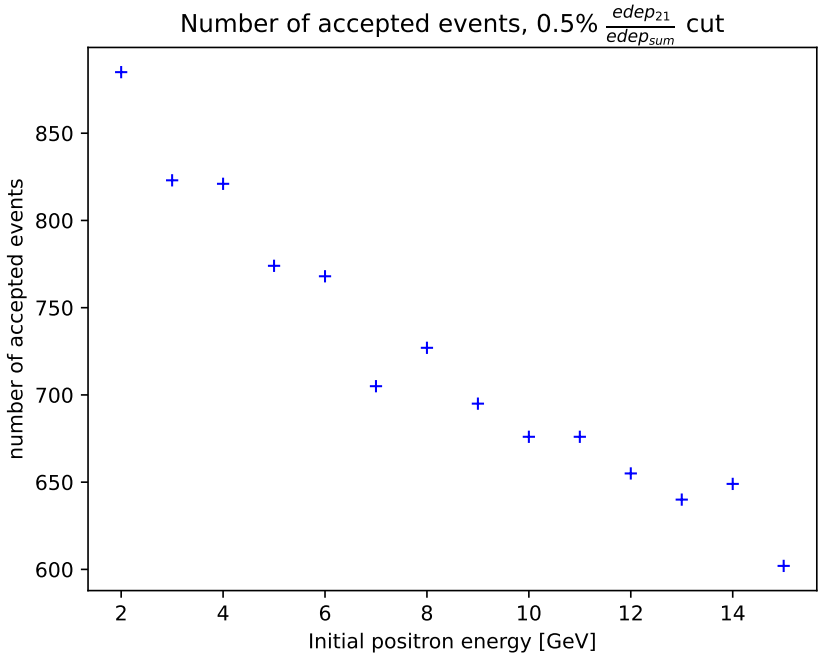

Figure: Accepted events after cut is applied

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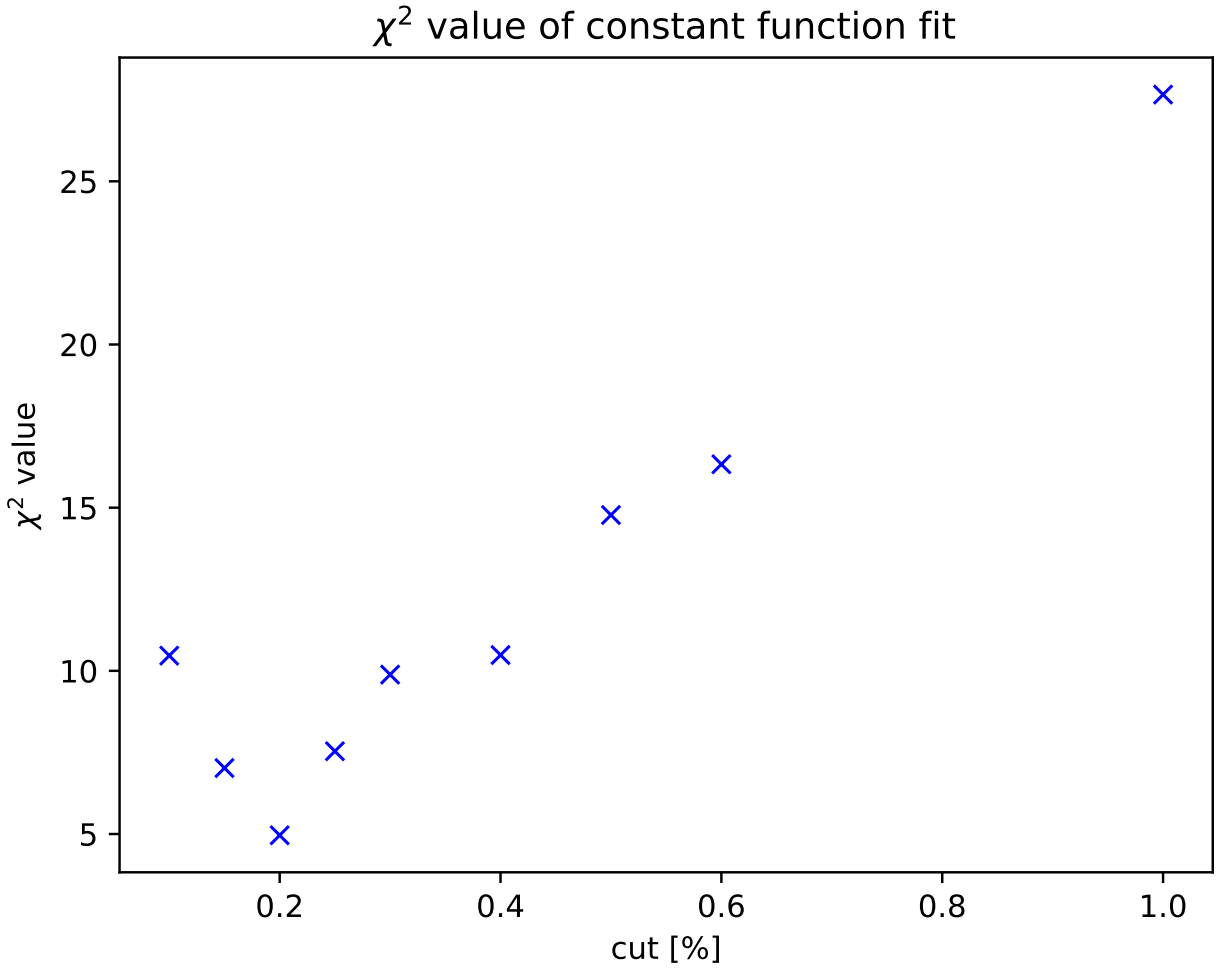

Figure: χ^2 test value of fitting constant function in the function of the cut, number of degrees of freedom is 13

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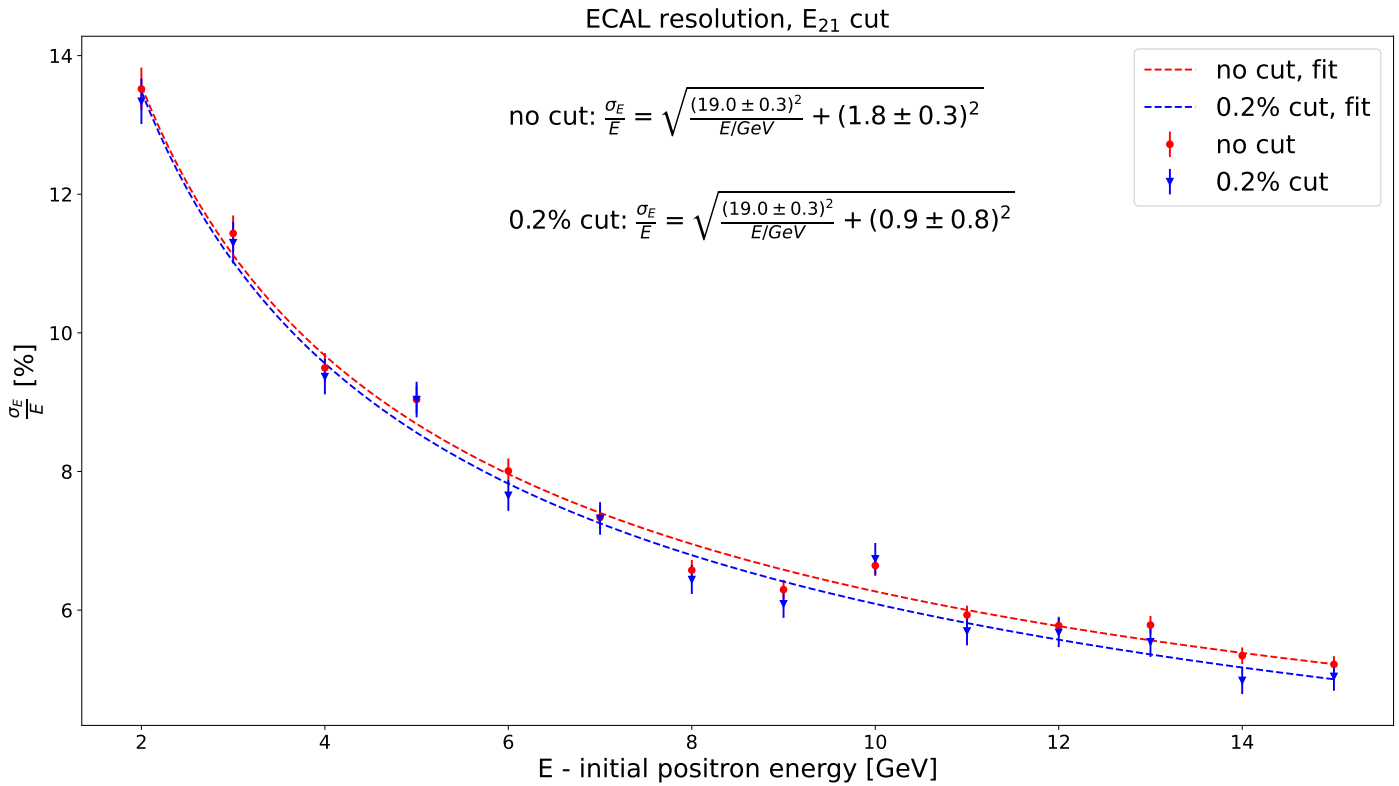

Figure: ECAL-P resolution with applied cut on the deposit in 21^{st} layer

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- However, number of accepted events drops rapidly, which results in growth of uncertainties for high energies and stricter cuts
- Applying cut does not affect the resolution of the ECAL-P, but the uncertainties of the constant term are larger due to smaller statistics
- However 21st layer of ECAL-P is not present in technical design of the detector $\rightarrow$ procedure of correcting for leakages is needed

Leakage correction procedure

- According to PDG mean longitudinal electromagnetic cascade profile can be parameterized using gamma function, where $t = \frac{x}{X_0}$:

$$\frac{dE}{dt} = E_0 \beta^{\alpha} \frac{t^{\alpha-1} e^{-\beta t}}{\Gamma(\alpha)} = E_0 \gamma(t, \alpha, \beta) \tag{1}$$

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- Mean cascade profile is wider than individual cascade profiles due to the fact that distribution of the beginning of the cascade is exponential

Correction for leakage - procedure

- Mean and maximum position of cascade is smaller for individual cascades approximately by X_0 so:

$$t^{ind}_{mean} = \frac{\alpha_1}{\beta_1} = \frac{\alpha}{\beta} - 1, t^{ind}_{max} = \frac{\alpha_1 - 1}{\beta_1} = \frac{\alpha - 1}{\beta} - 1$$

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- Then the gamma distribution was fitted to each cascade individually with α and β fixed to effective values
- For each fit the following value has interpretation of deposited energy in each event:

$$E_{dep} = E_0 \tag{2}$$

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Average cascade profile - fit results

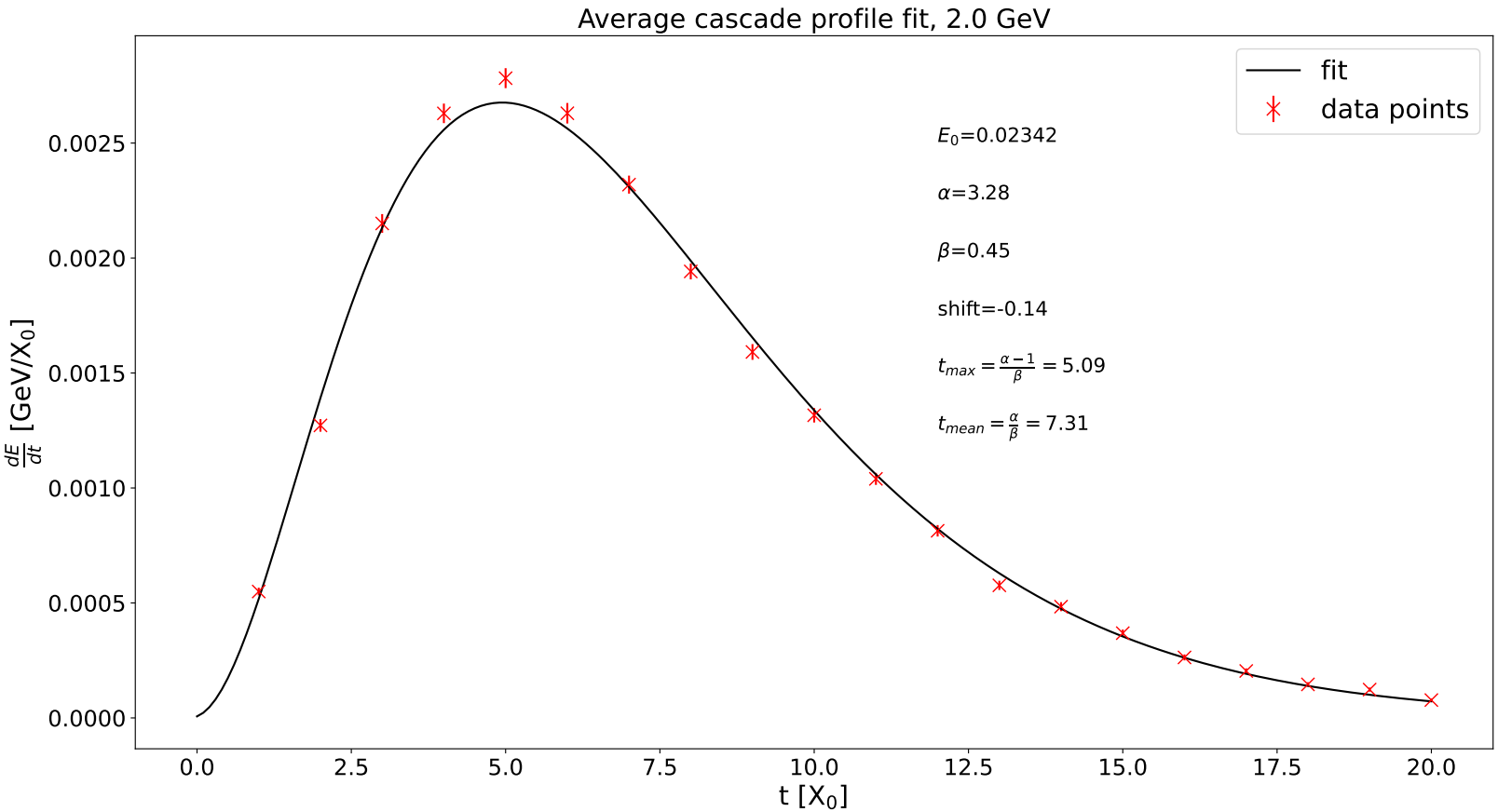

Figure: Gamma distribution fit to average cascade profile, 2GeV

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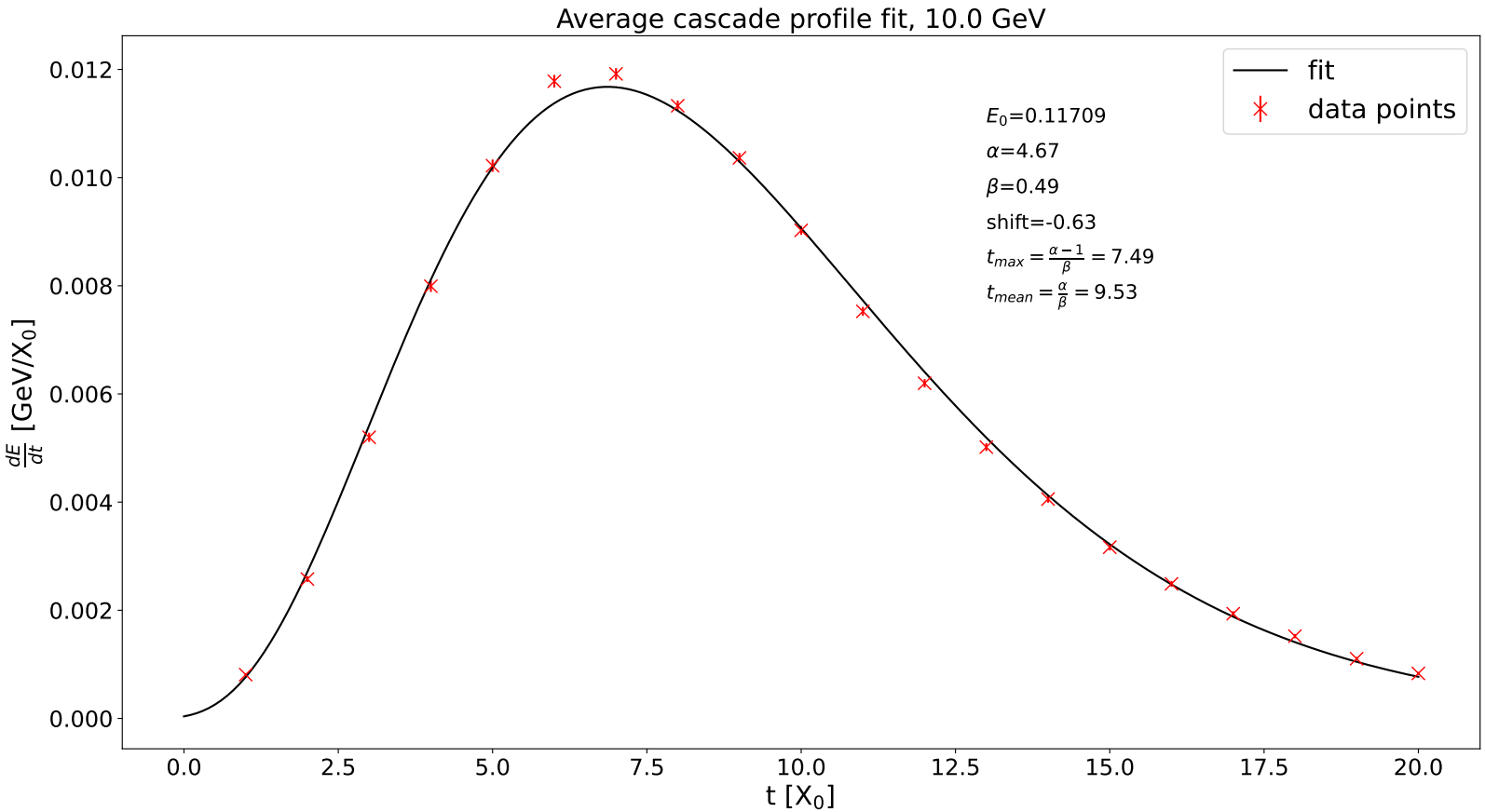

Figure: Gamma distribution fit to average cascade profile, 10GeV

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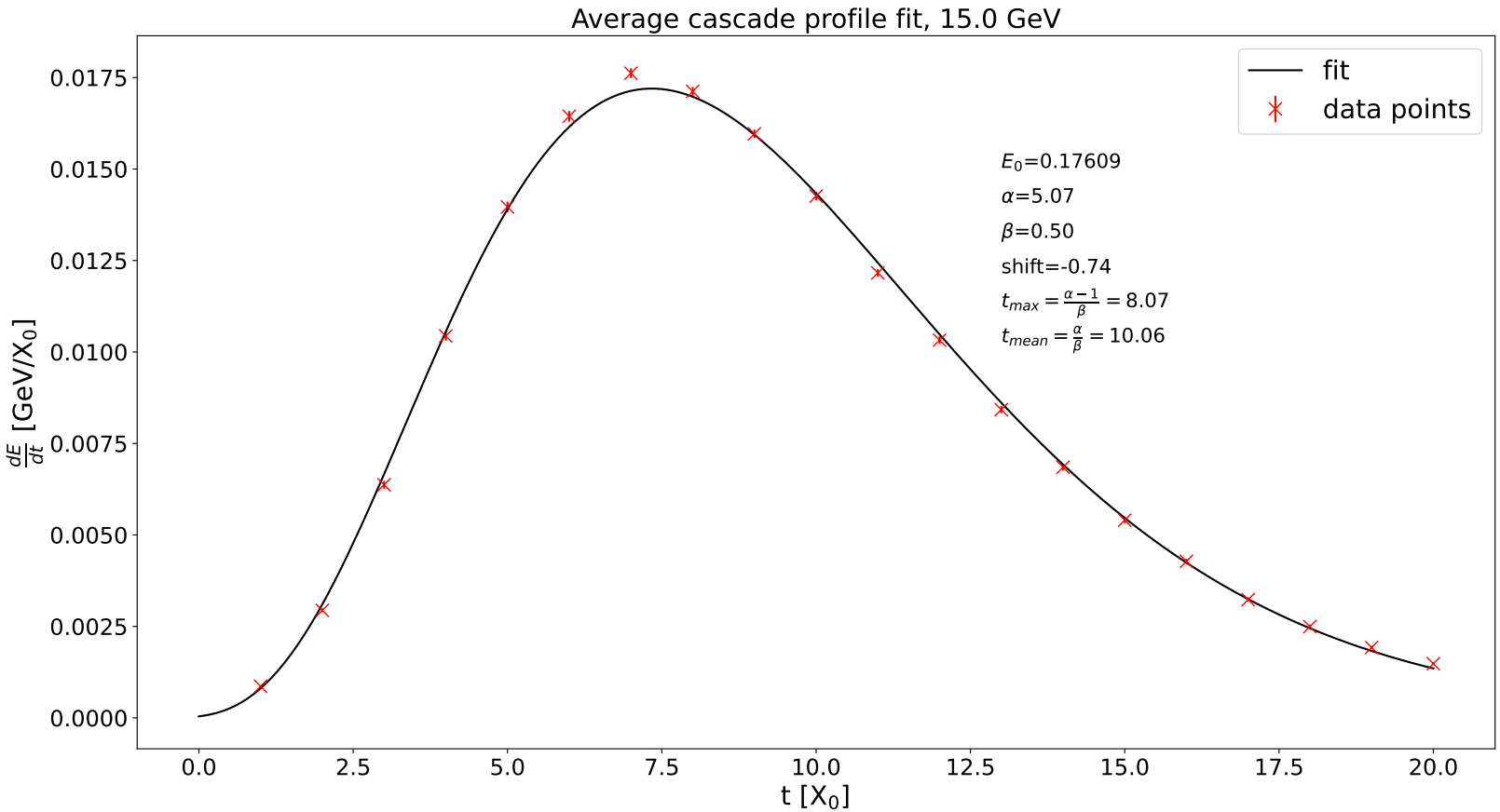

Figure: Gamma distribution fit to average cascade profile, 15GeV

Results of correction for leakage

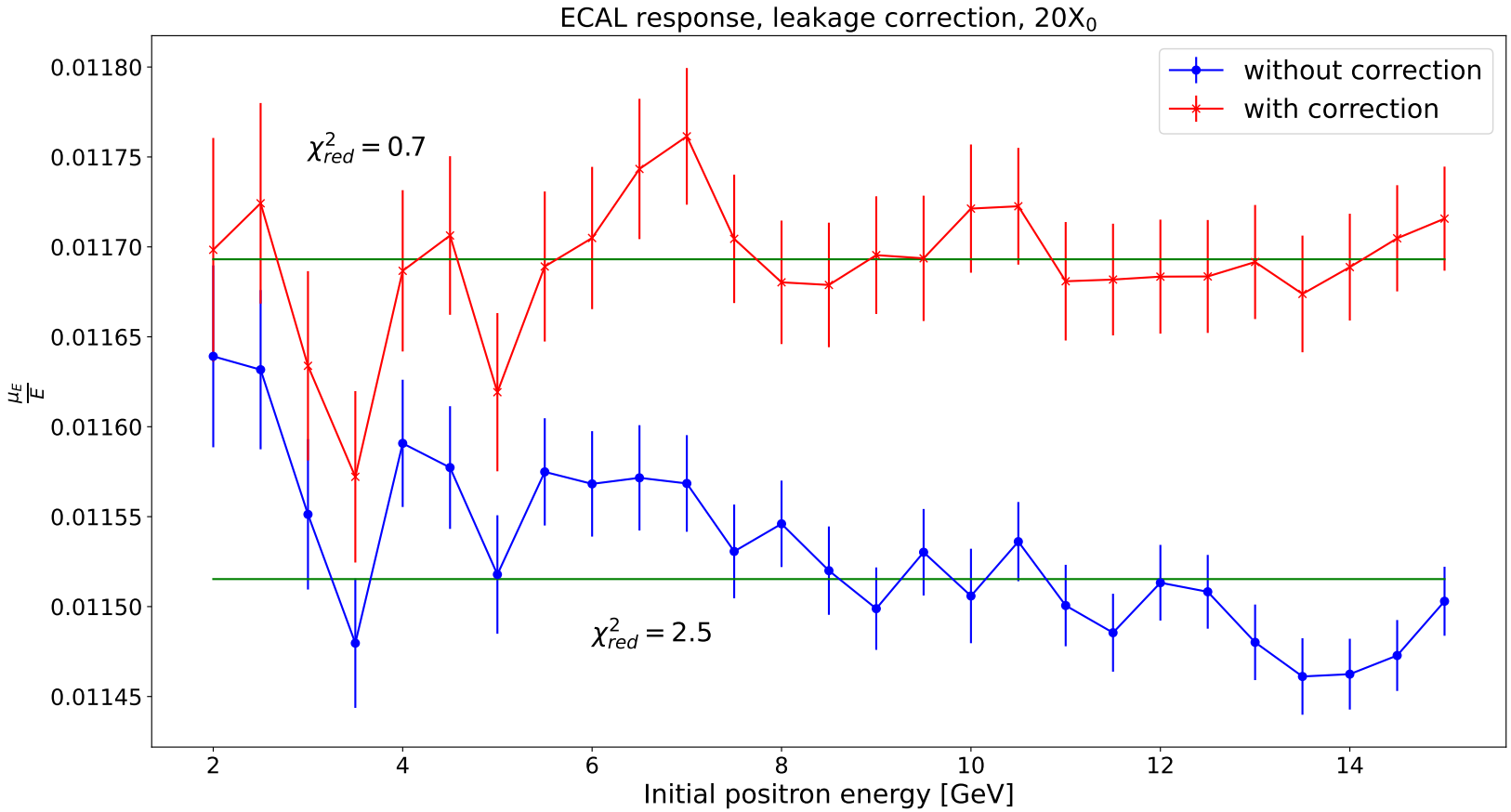

Figure: Leakage correction results for $20X_0$, ECAL-P response plot

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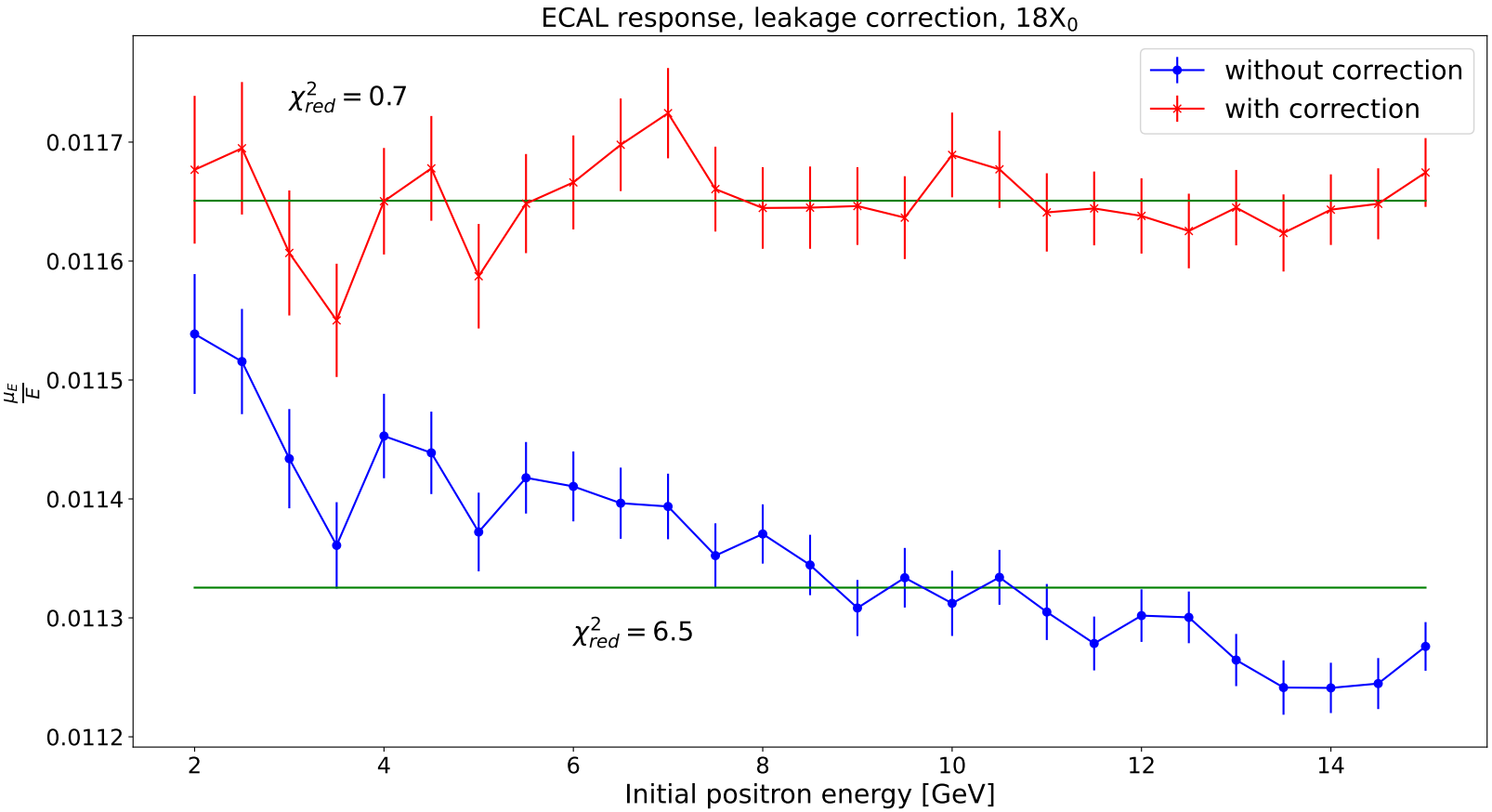

Figure: Leakage correction results for $18X_0$, ECAL-P response plot

Results of correction for leakage

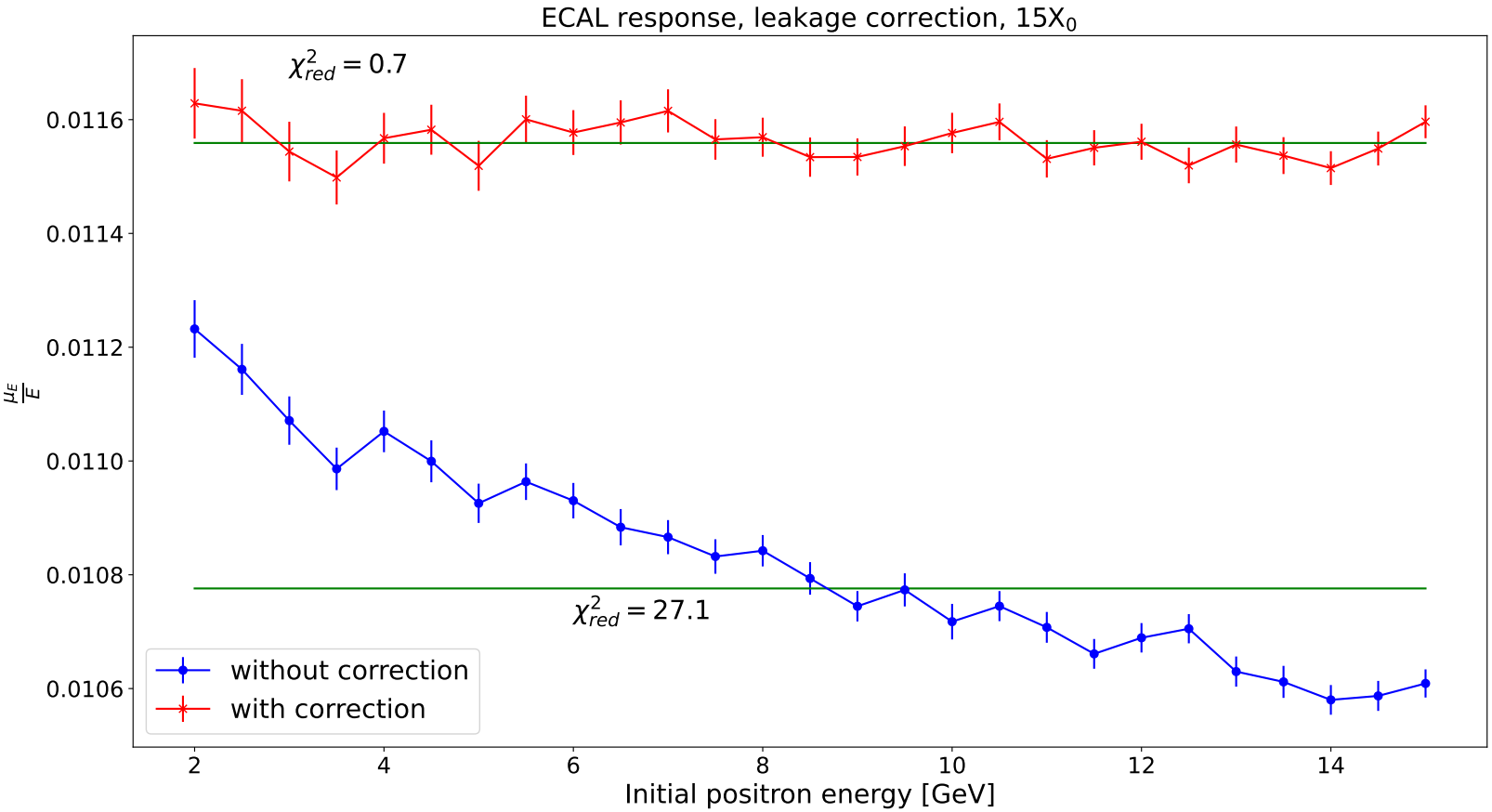

Figure: Leakage correction results for $15X_0$, ECAL-P response plot

Results of leakage correction

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- Procedure described before enable to correct for leakage for higher energies of initial positron making the ECAL-P response linear
- How the correction impacts on the resolution of ECAL-P? (work in progress)