# First results from the new study of ECAL-P simulation results

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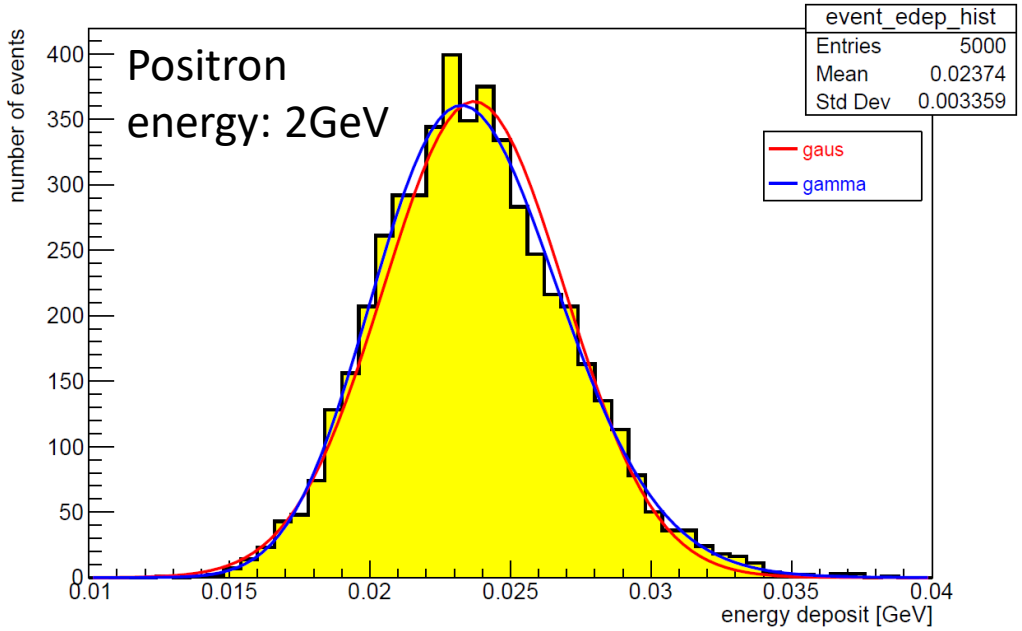
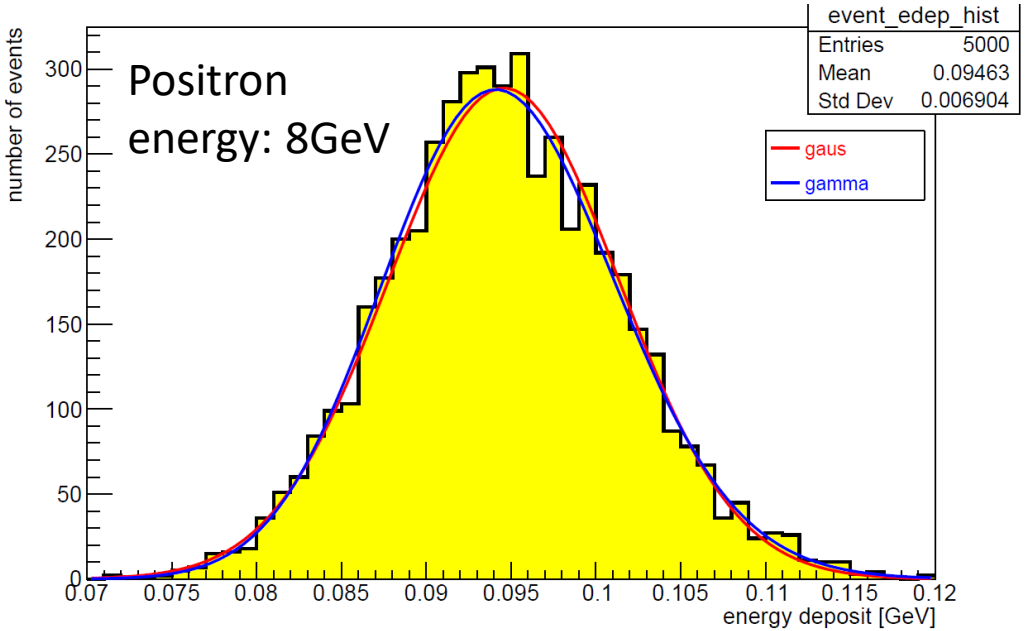
# Introduction

- Results have been obtained from analysis of mc21.singlePositron_xxGeV.G4gun.SIM.se0002.root files from naf-luxe
- Files contain interaction of single positron with given energy (from 2 to 15 GeV) with detector geometry, 5000 events for each sample
- Only interactions with ECAL was taken into account
- Counting energy deposits from hits recorded in active medium of ECAL (detid==2000 cut)
- 20 layers of ECAL taken into account (21st layer is present in files due to simulation details, but it won't be the part of the ECAL)



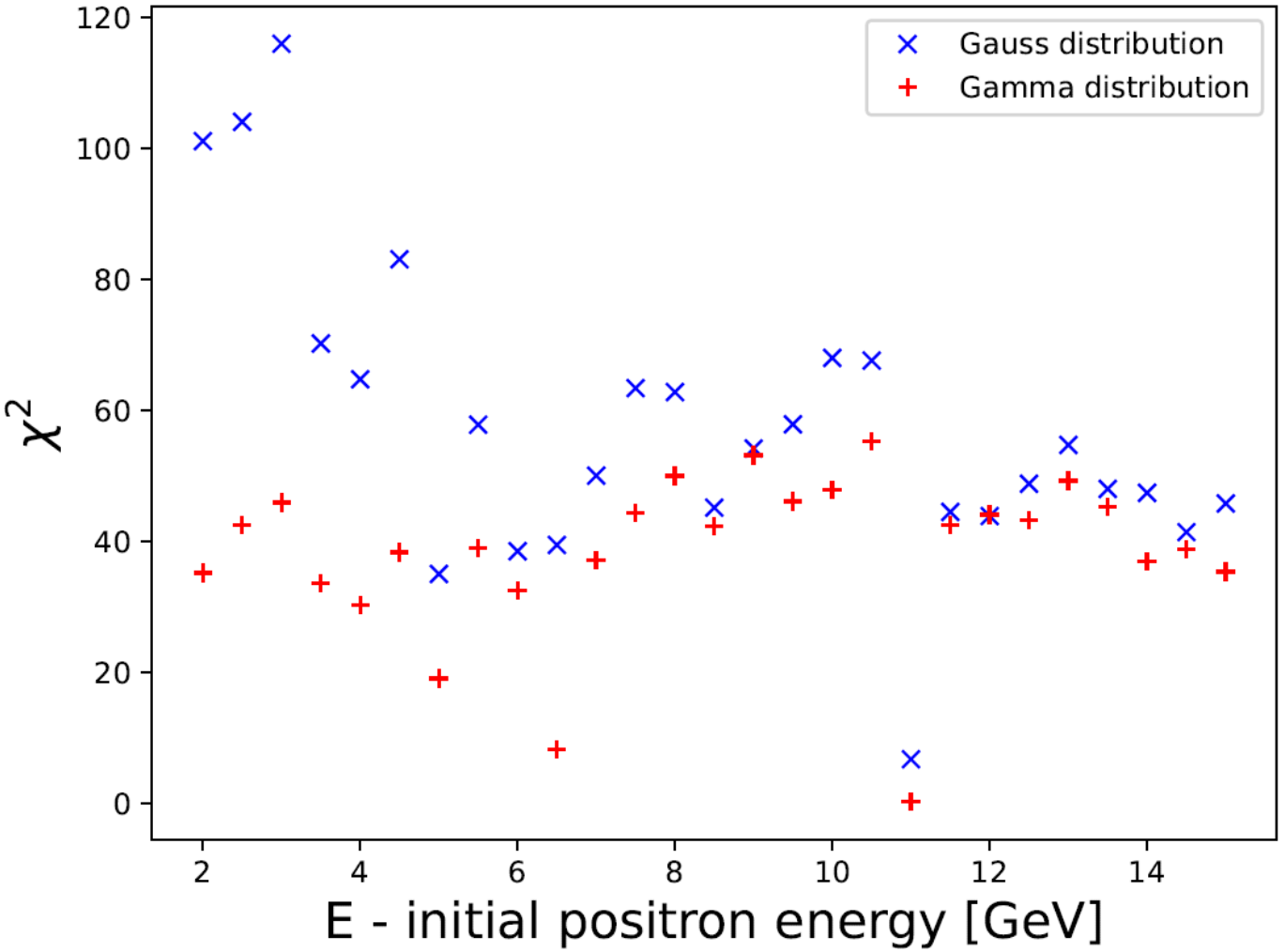

# Gauss and gamma function

- Distributions of deposited energy in calorimeter aren't symmetrical, especially for low positron energy → comparison between Gaussian and gamma function fit

- $\gamma(x, A, x_0, \sigma_0) = A \exp(-\left(\frac{x_0}{\sigma_0}\right)^2 \left(\frac{x-x_0}{x_0} - \ln\left(\frac{x}{x_0}\right)\right))$

- $\mu_x = x_0 + \frac{\sigma_0^2}{x_0}, \sigma_x = \sigma_0\sqrt{1 + \frac{\sigma_0^2}{x_0^2}}$

- $g(x, \mu_x, \sigma_x) = \frac{A}{\sigma_x} \exp(-\frac{1}{2}\frac{(x-\mu_x)^2}{\sigma_x^2})$




Values of $\chi^2$ test from fitting Gaussian and gamma function

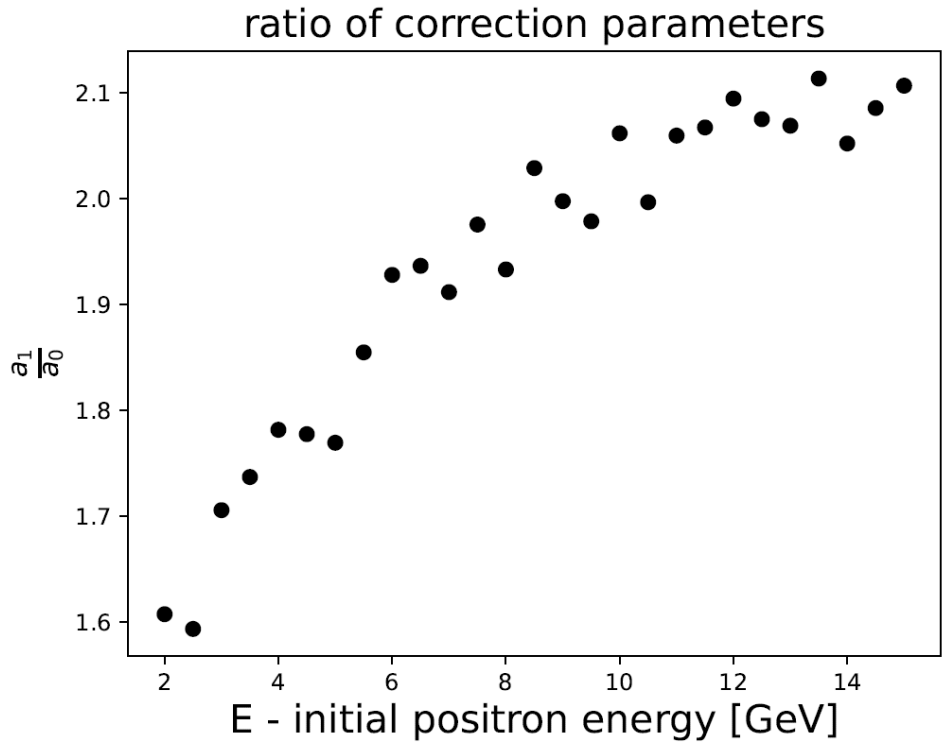
# $\chi^2$ test results

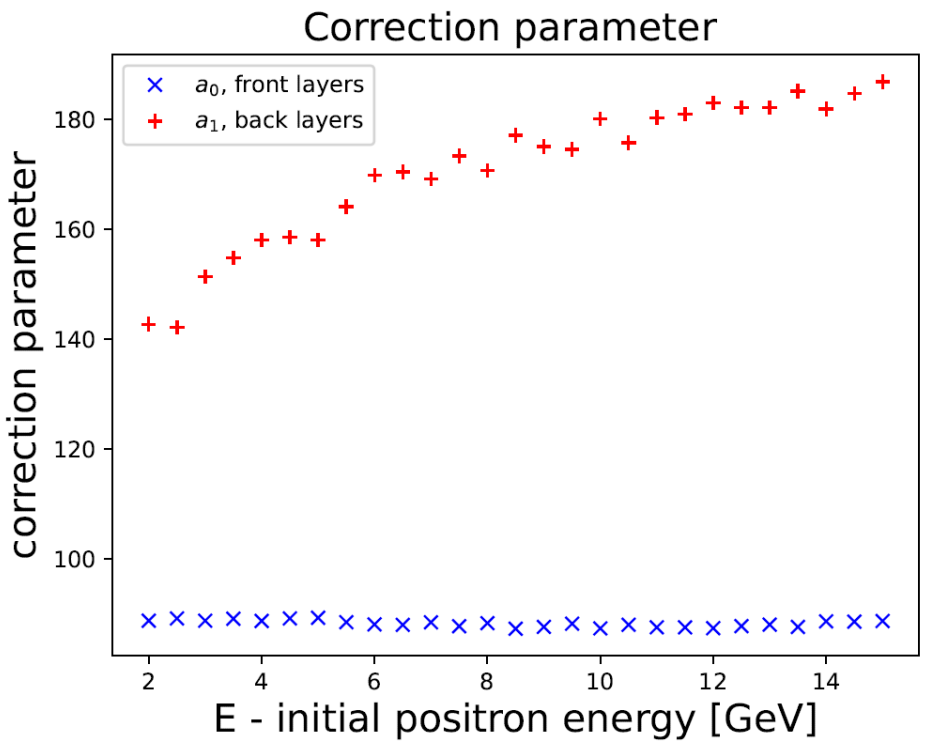
Number of degrees of freedom is equal to number of bins in the histogram, which is equal to 50.

# ECAL performance for reduced number of layers

- Changing granularity from 20 ($20 \cdot X_0$) to 15 ($10 \cdot X_0 + 5 \cdot 2X_0$) layers,
- Even layers starting from 10th layer were removed
- Since the detector is now divided into two parts correction procedure is needed: deposits from front and back layers will have different weights $a_0$ and $a_1$ respectively, taken from minimizing the function:

$$f(a_0, a_1, \lambda) = \sum_{j=1}^{5000} \left(E_0 - a_0 s_0^j - a_1 s_1^j\right)^2 - 2\lambda(E_0 - a_0 s_0^j - a_1 s_1^j)$$

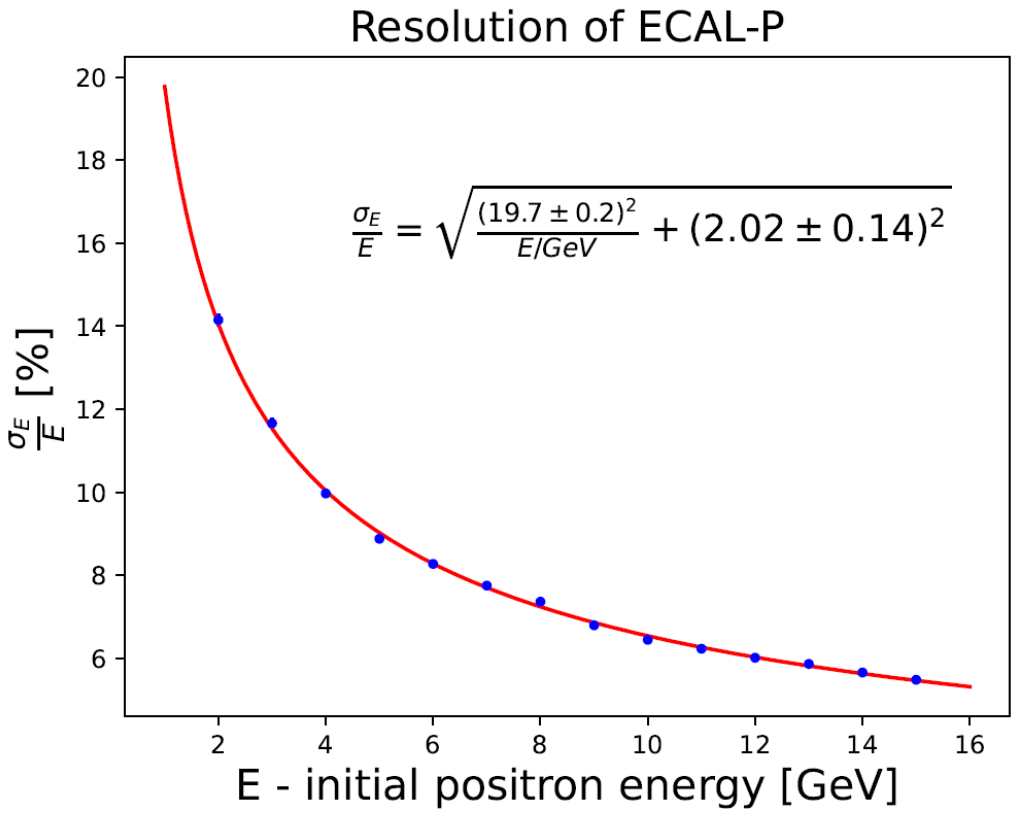


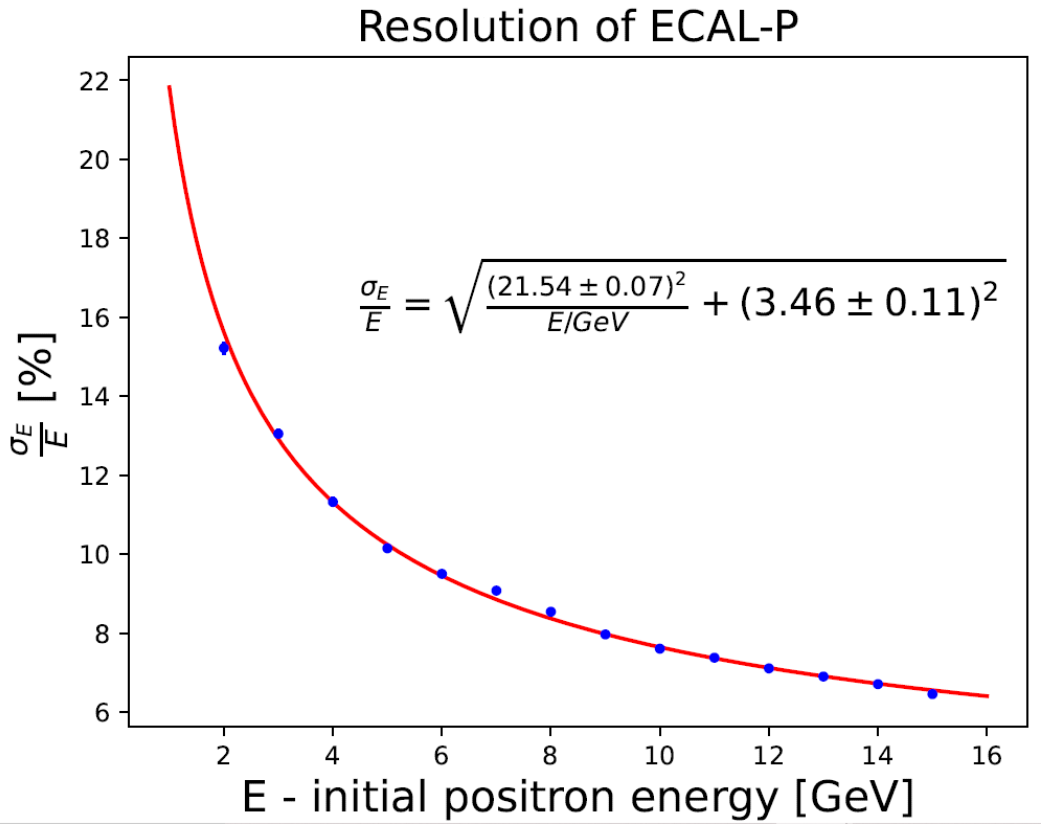

# Correction parameters

- From naive perspective $a_1$ should be about two times larger than $a_0$.
- Energy dependence corrects for possible nonlinearity of ECAL response.

# ECAL performance for reduced number of layers




Energy resolution for 20 layers




Energy resolution for 15 layers

In TN:

$$\frac{\sigma_E}{E} = \frac{a}{\sqrt{E}}$$

# Next steps

- Study nonlinearity of the ECAL response in more detail
- Ratio of average energy deposits in events and nominal positron energy decreases with positron energy → estimate impact of the longitudinal energy leakage
- Fitting correction parameter independent of positron energy
- Energy of positron hitting ECAL is smaller than nominal energy → determine the effects of energy losses on secondary particles generation