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The generator of photons in the reaction $p + Ni \rightarrow \gamma + X$ at 24 GeV/c.

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1 Preface

The aim of this work was to prepare the software generator of γ which are created in the reaction $p + Ni \rightarrow \gamma + X$ at 24 GeV/c. Such generator is needed to study, for example, the electron-positron pairs produced by photons in the DIRAC setup.

To get the momentum, angular and spatial distributions of photons in the DIRAC setup the FRITIOF generator was used. The photons were separated into two sets. The first set is the photons produced from short-lived sources, which decay in the target with photon(s) in final state. The second set is the photons produced from long-lived sources, which decay beyond the target(fully or partly) with photon(s) in final state. The first set is the photons which come from the decays of $\pi^0, \omega, \rho^{\pm}, \Phi, D^{*0}, D^{*\pm}, K^{*\pm}, K^{*0}, \Delta^0, \Delta^+, \Sigma^0, \Sigma^{*0}$ and $\Sigma^{*\pm}$(directly or indirectly).

The second set is the the photons which come from the decays of $\Lambda, \Sigma^+, K^{\pm}, K^0_S, K^0_L, D^{\pm}$ and D^0(directly or indirectly).

To prepare the generator of photons we need to describe their momentum and angular distributions which photons have when they enter DIRAC channel and for photons from long-lived sources we need to know how the photons are produced along the channel.

2 The momentum,angular and spatial distributions of photons.

In the FRITIOF based program we selected all the photons which are emitted in the angle of $1.5 \cdot 10^-4sr$ (the square of 12x12 cm^2 at 310 cm distance from the target) along the channel with momentum higher 2 GeV/c. For the photons which were created far from the target some additional spatial cuts were applied to simulate somewhere the DIRAC collimator.

The photon beam intensity in the channel depends on the vertical coordinate(Y). This dependence is a bit different for these two gamma sets and they are shown on Fig.1(top distribution - for short-lived sources and bottom one - for long-lived ones decaying beyond the target). These distributions are fitted by polynomial of second degree and these polynomials are used in the gamma generator. The contributions of these two sets are equal 97.8% and 2.2% correspondingly.

The momentum distribution of photons in the channel is fitted well by exponent(Fig.2). We accepted the photons with momentum higher than 2 GeV/c as only such photons can produce electron-positron pairs which are detected both in the DIRAC setup.

Really the shape of photon momentum distribution depends on Y-coordinate - for high values of Y the momentum is softer. To find the dependence of photon momentum distribution shape on Y-coordinate the last one was divided into 12 bins of 1 cm width and the momentum distribution for each bin was fitted by exponent too and the slope of this exponent for each bin is shown on Fig.3. The top picture is for photons which come from short-lived sources and bottom one - for long-lived ones decaying beyond the target. These distributions were fitted by polynomials, for top one it's well the linear function and the bottom one is fitted by quadratic function.

The last problem was the spatial description of photons which come from the long-lived sources which decay in the channel - the distribution of sources of photons on Z-,X- and Y-coordinates. For the Z-coordinate we obtained the following distribution (Fig.4), it is fitted well by Gaussian function. On Fig.5 the dependencies of σ_X and σ_Y on Z-coordinate are shown(X- and Y-distributions for each Z-distribution histogram bin were fitted by Gaussian function). They were fitted by polynomial of fourth degree.

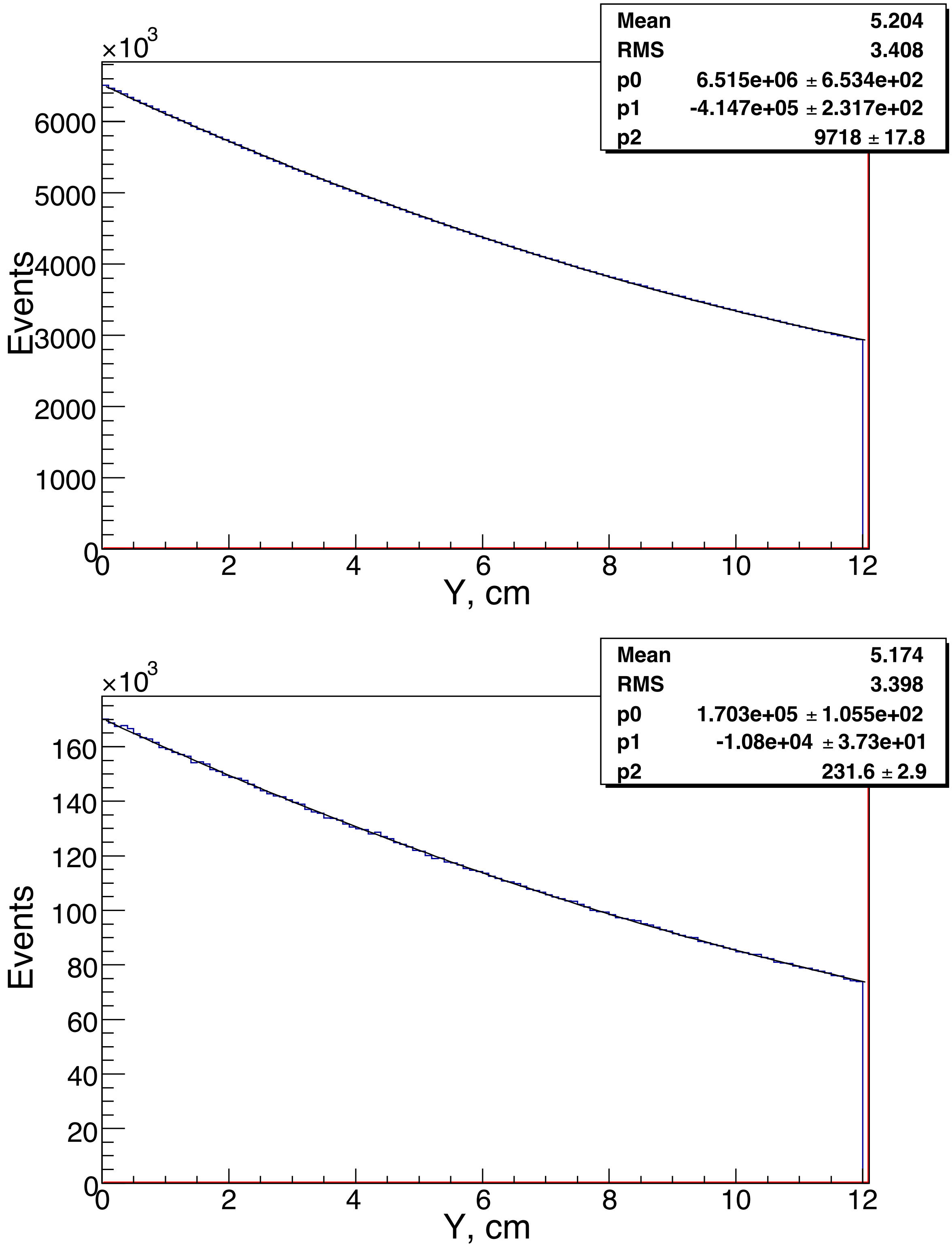


Figure 1: *The dependence of photon intensity in the DIRAC channel at distance of 310 cm from the target on Y-coordinate. The top picture is for photons which come from short-lived sources and bottom one - for long-lived ones decaying beyond the target. The distributions are fitted by polynomial of second degree.*

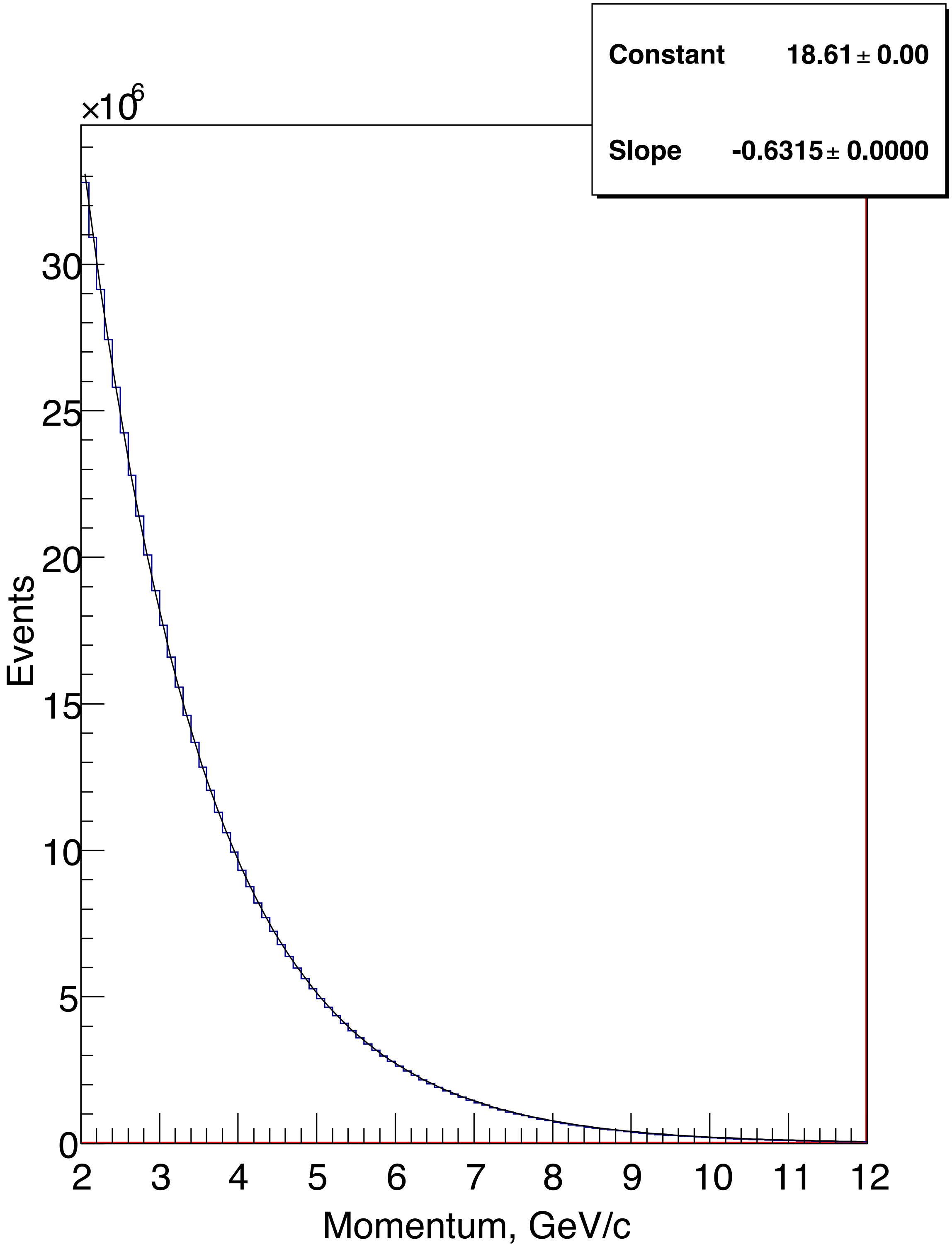


Figure 2: *The momentum distribution of photons in the DIRAC channel. The distribution is fitted by exponent.*

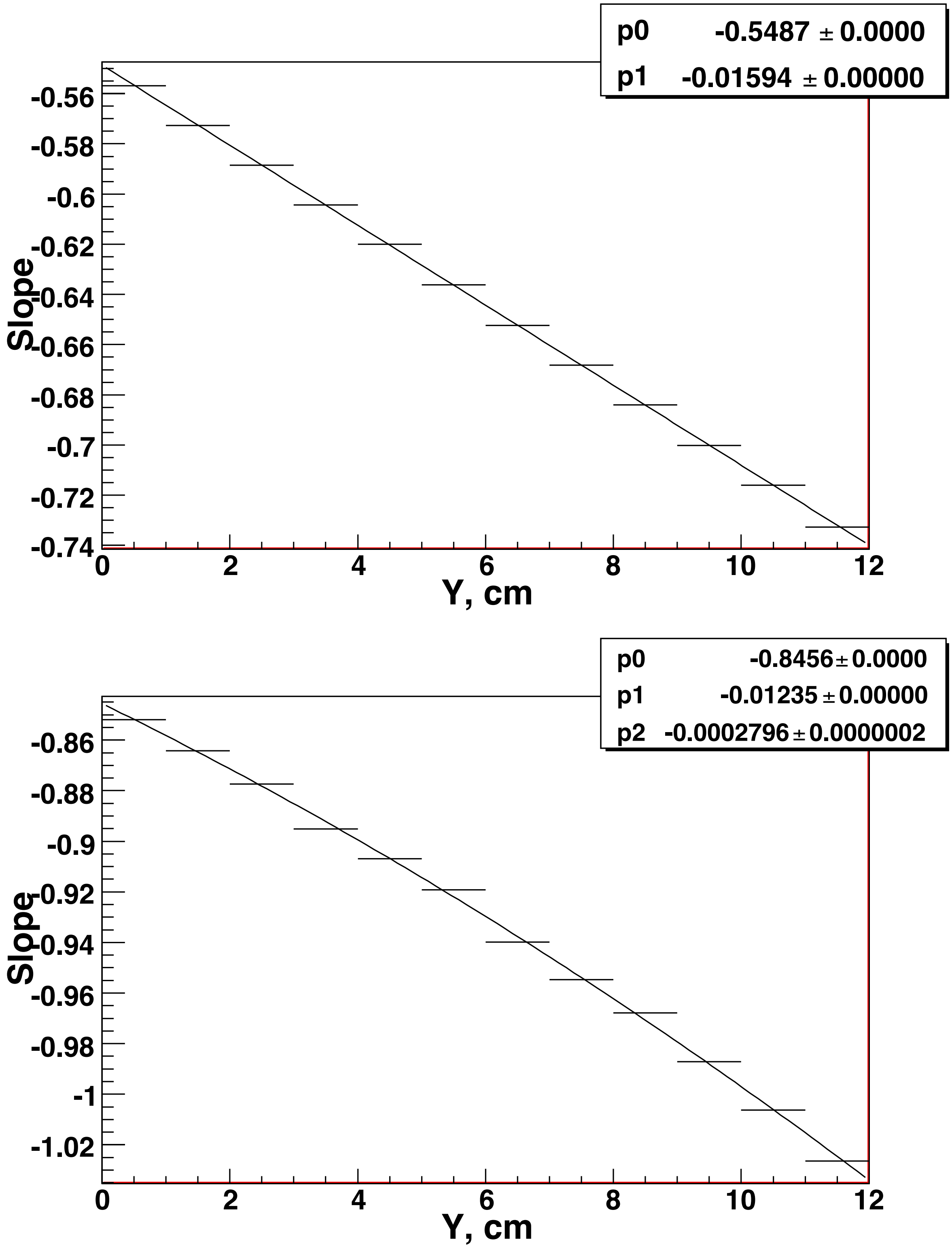


Figure 3: *The dependence of exponent slope which describes the photon momentum shape on Y-coordinate in the channel. The top picture is for photons which come from short-lived sources and bottom one - for long-lived ones decaying beyond the target. These distributions were fitted by polynomials, the top one is fitted by linear function and the bottom one is fitted by quadratic function.*

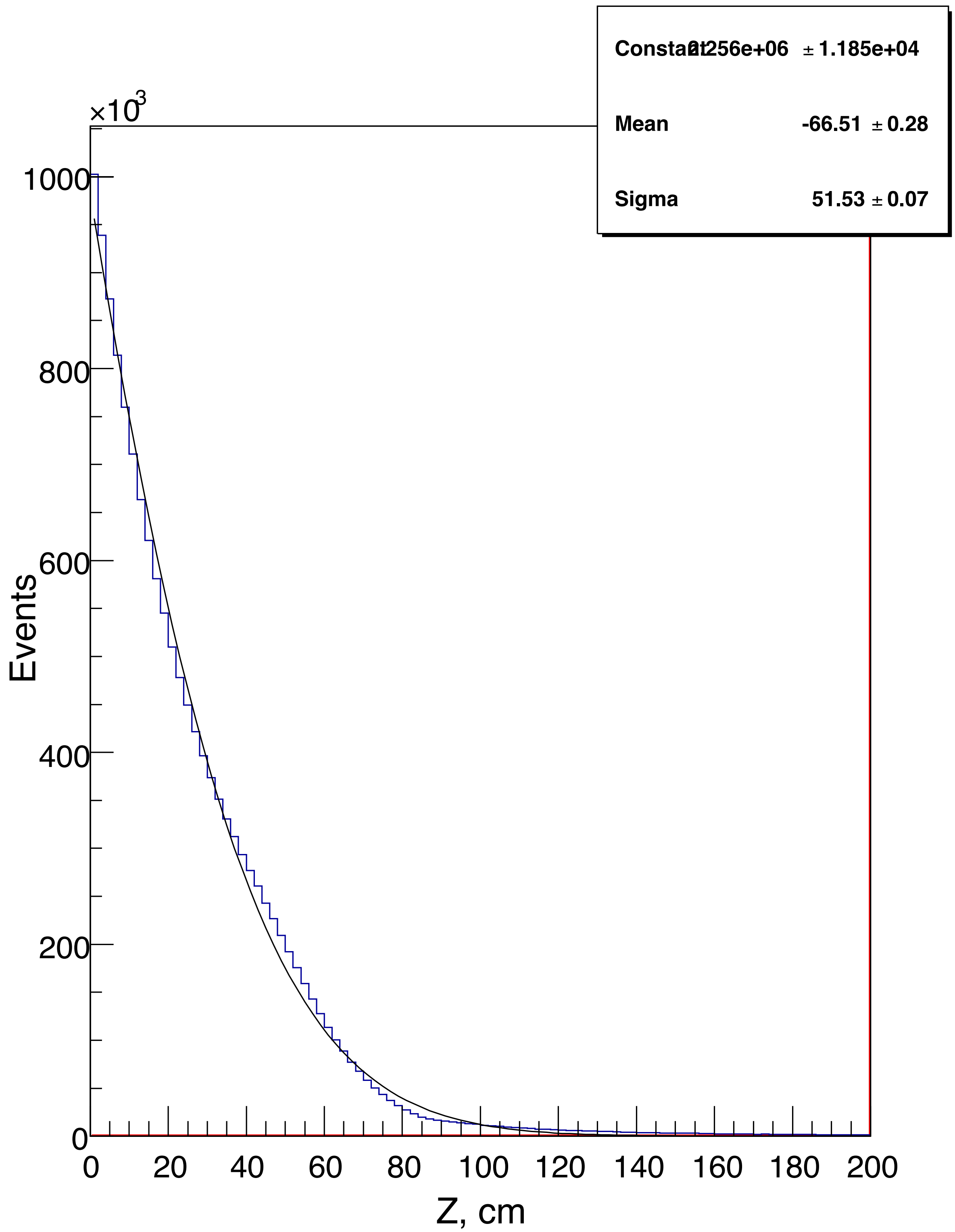
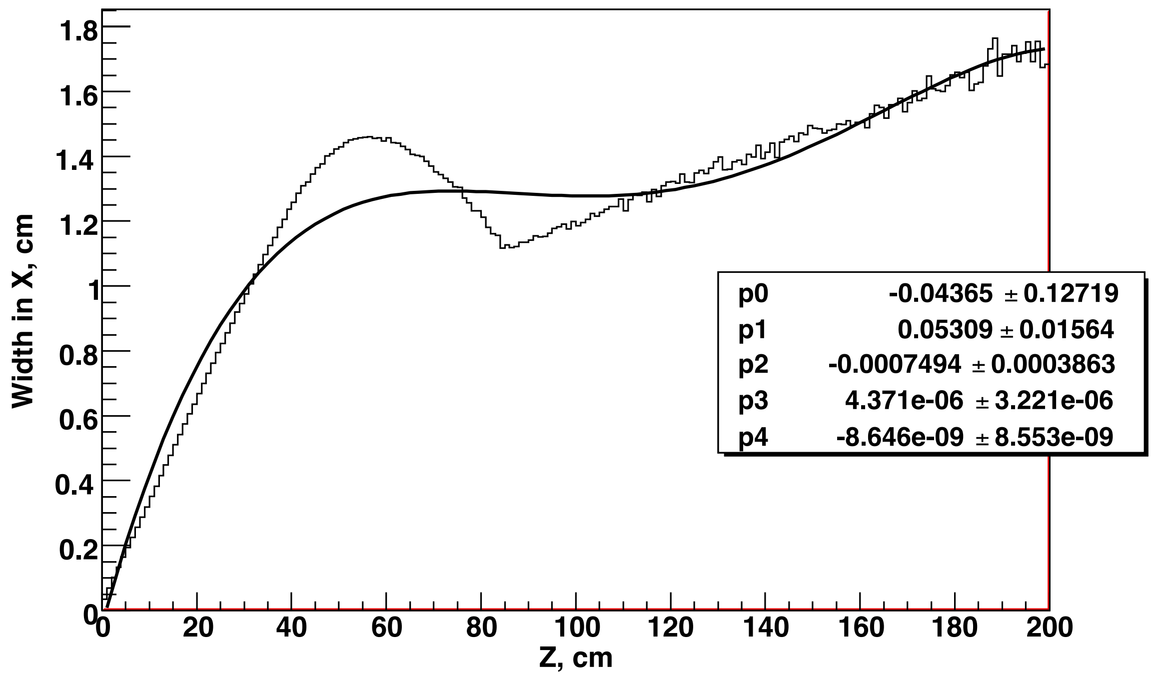


Figure 4: *The distribution of photons which come from long-lived sources along Z-axis. The fit is done by Gaussian function.*



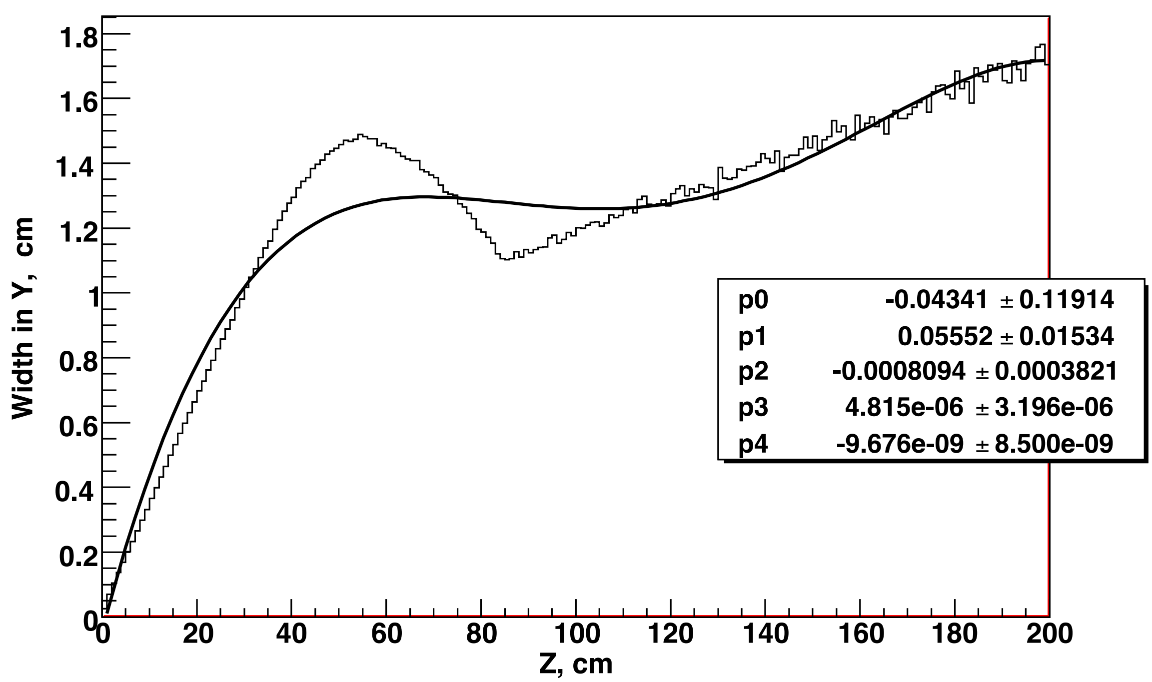


Figure 5: *The dependencies of σ_X and σ_Y on Z-coordinate for photons from long-lived sources. The fit is done by polynomial of fourth degree.*