Status of vector mesons reconstruction in Xe run

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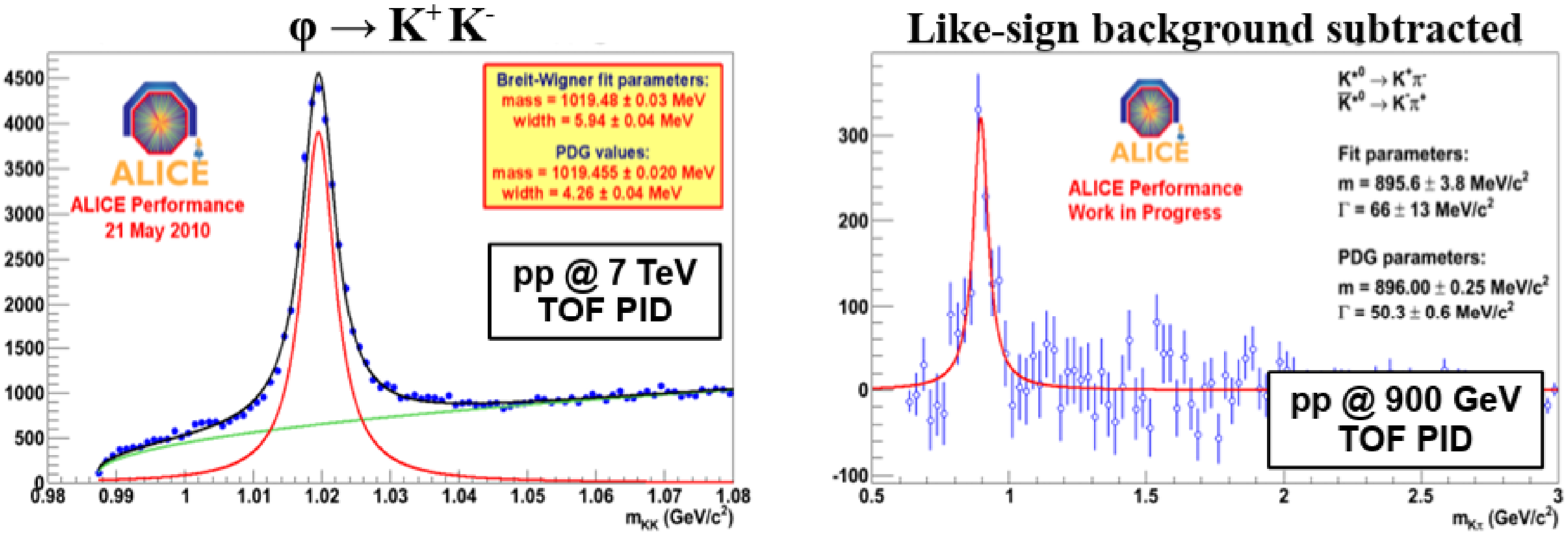
Introduction

Why φ(1020) and K*(892) are interesting to study?

φ(1020) is expected to have a small cross-section for interactions with other non-strange particles, and its life time is relatively long (~41 fm/c), it may keep information of the early stage of the system’s evolution [1]. Neutral K*(892) mesons provide information about the properties of the late hadronic phase due to the presence of rescattering and regeneration effects that can modify resonance yields because of their short lifetimes (~4 fm/c) [2].



[3]

[1] J. Phys. G: Nucl. Part. Phys. 32, S373-S380 (2006) DOI: 10.1088/0954-3899/32/12/S46.
[2] https://doi.org/10.1051/epjconf/201922202005

[3] efaidnbmnnnibpcajpcglclefindmkaj/https://lss.fnal.gov/conf2/C100715/Preghenella.pdf

Goal

- Observation of φ(1020) and K*(892) signal in the MC and experimental data.

Data

- Experimental data obtained in the physical session at the beginning of 2023 with a beam energy of 3.8 AGeV, a CsI target and Xe beam.
- Dubna Cascade Model - Statistical Multifragmentation Model (DCM-SMM) and BOX Monte Carlo generators were used to model the data.
- About 0.8 million Monte Carlo and 450 million experimental events were analyzed.

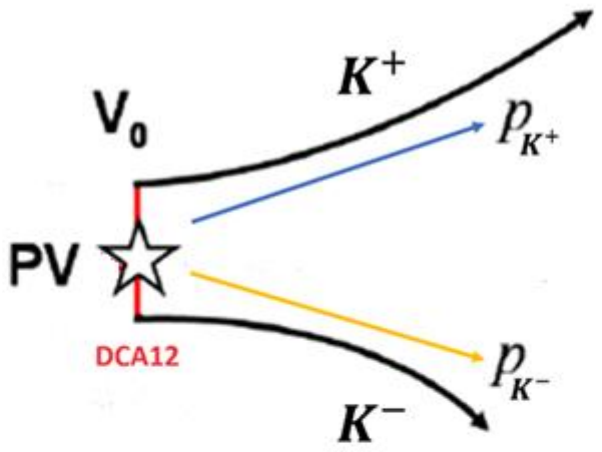
Data processing procedure

- Reconstruction of particle tracks was carried out.
- Mathematical algorithms were developed and implemented to search for the φ(1020) → $K^+ + K^-$ (K*(892) → $K^+ + \pi^-$) decay:
  - shuffling pairs of particles with different signs
  - calculation of invariant mass
  - imposing a number of geometric restrictions on the parameters of each pair

DCA12 – the distance between K^+ and K^- at the decay point of φ(1020).

Other restrictions employed:

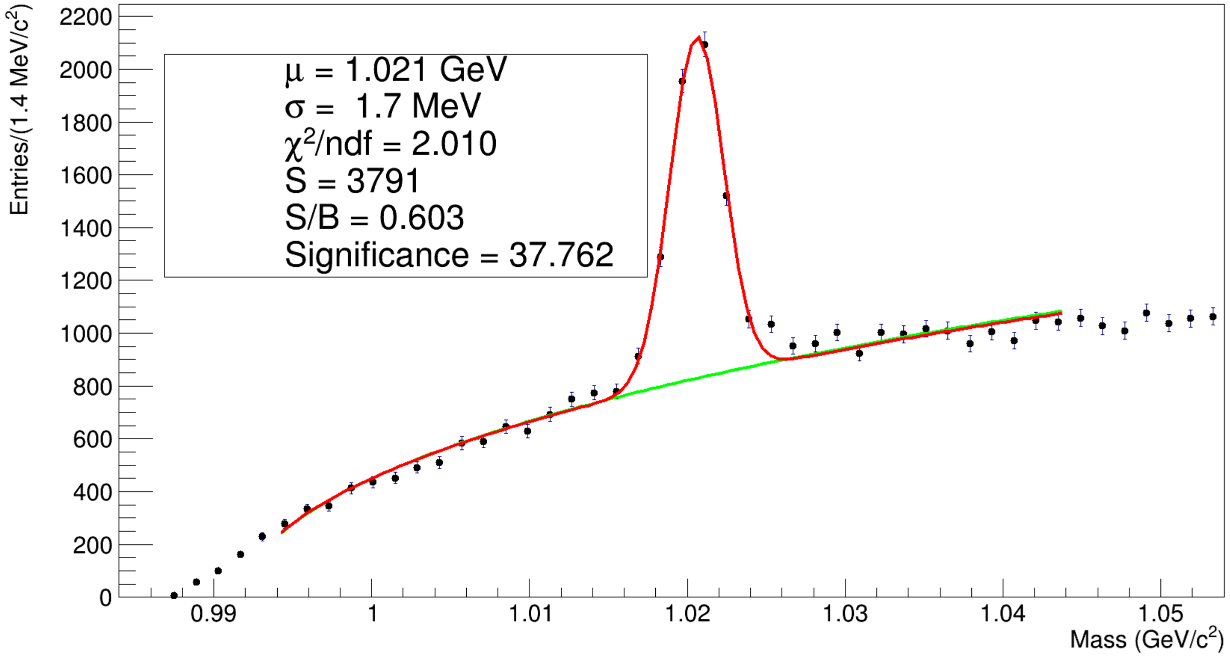
Constraints on the squared masses of the two products of decay (K^+ and K^-).



Event topology φ(1020)

Results

MC



Efficiency = 0.47 %.

CUTS:

0.0 cm <= dca12 <= 2.0 cm

0.0 cm <= dca0 <= 1.0 cm

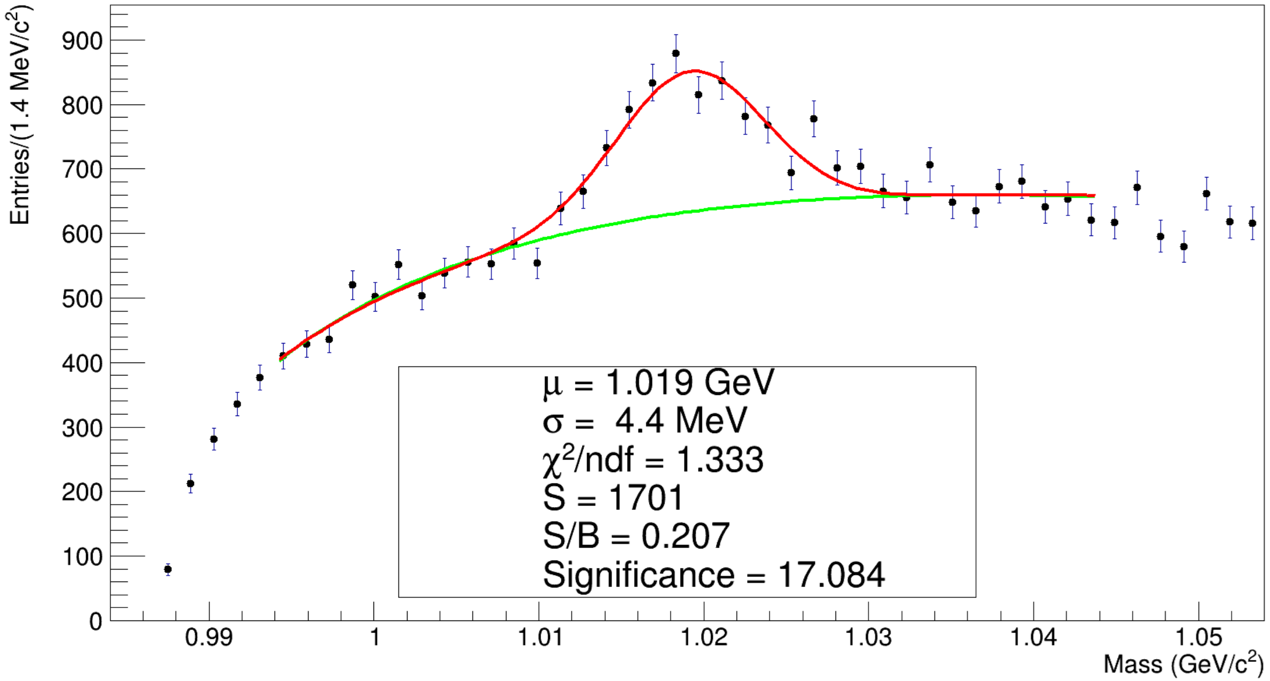
0.15 $\frac{GeV^2}{c^4}$ <= mass_squared_K+<= 0.30 $\frac{GeV^2}{c^4}$

0.1 $\frac{GeV^2}{c^4}$ <= mass_squared_K-<= 0.30 $\frac{GeV^2}{c^4}$

0.7 $\frac{GeV}{c}$ <= momentum_K+<= 2.5 $\frac{GeV}{c}$

-2.5 $\frac{GeV}{c}$ <= momentum_K-<= -0.7 $\frac{GeV}{c}$

EXP



CUTS:

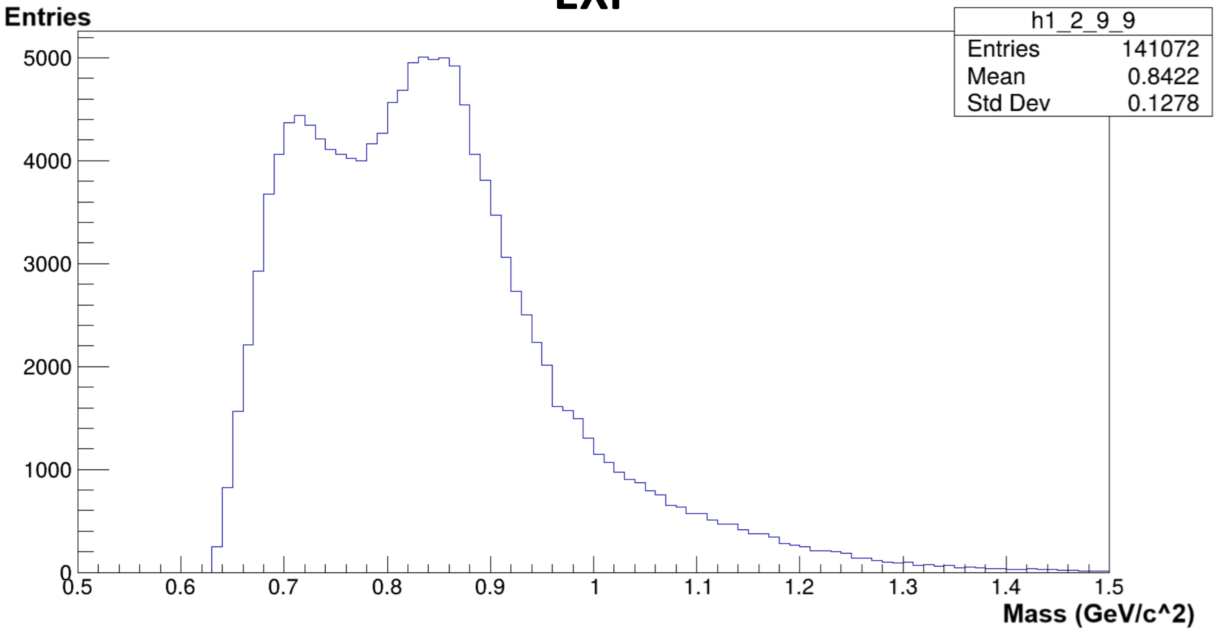
0.0 cm <= dca12 <= 1.0 cm

0.15 $\frac{GeV^2}{c^4}$ <= mass_squared_K+<= 0.30 $\frac{GeV^2}{c^4}$

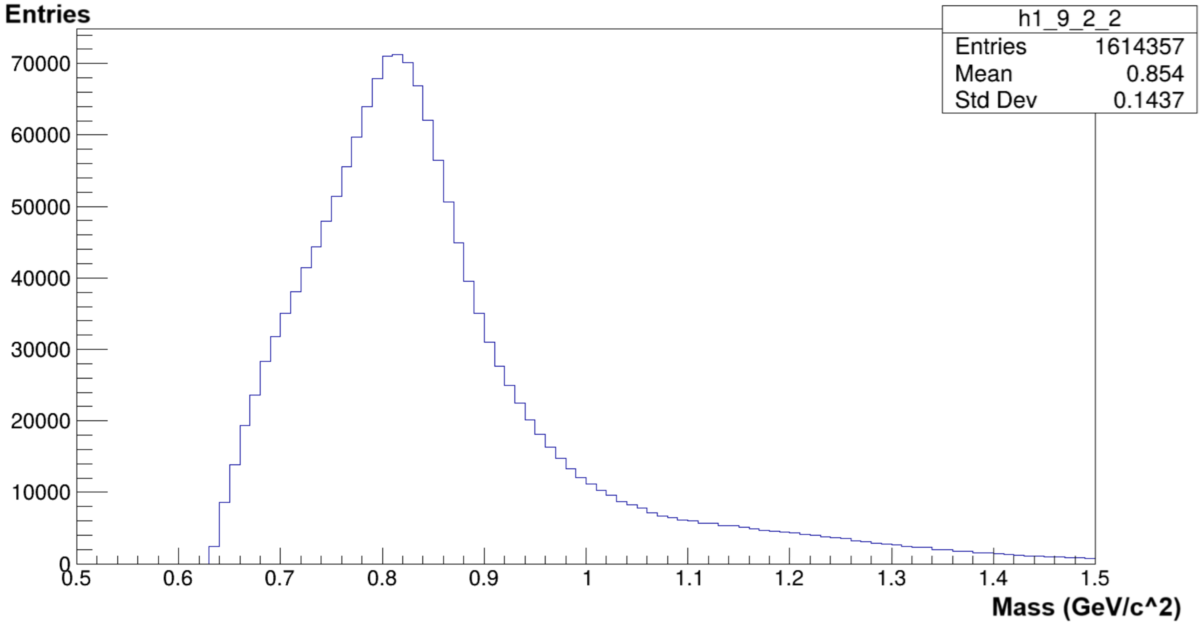
0.1 $\frac{GeV^2}{c^4}$ <= mass_squared_K-<= 0.30 $\frac{GeV^2}{c^4}$

Results

EXP



EXP



K*(892)

Cuts:

0.0 cm <= dca12 <= 0.03 cm

$$0.0\ \frac{GeV^2}{c^4} <= \text{mass\_squared\_K+} <= 0.3\ \frac{GeV^2}{c^4}$$

$$0.0\ \frac{GeV^2}{c^4} <= \text{mass\_squared\_Pi-} <= 0.3\ \frac{GeV^2}{c^4}$$

$\overline{\textbf{K*(892)}}$

Cuts:

0.0 cm <= dca12 <= 0.09 cm

$$0.0\ \frac{GeV^2}{c^4} <= \text{mass\_squared\_K-} <= 0.3\ \frac{GeV^2}{c^4}$$

$$0.0\frac{GeV^2}{c^4} <= \text{mass\_squared\_Pi+} <= 0.3\ \frac{GeV^2}{c^4}$$

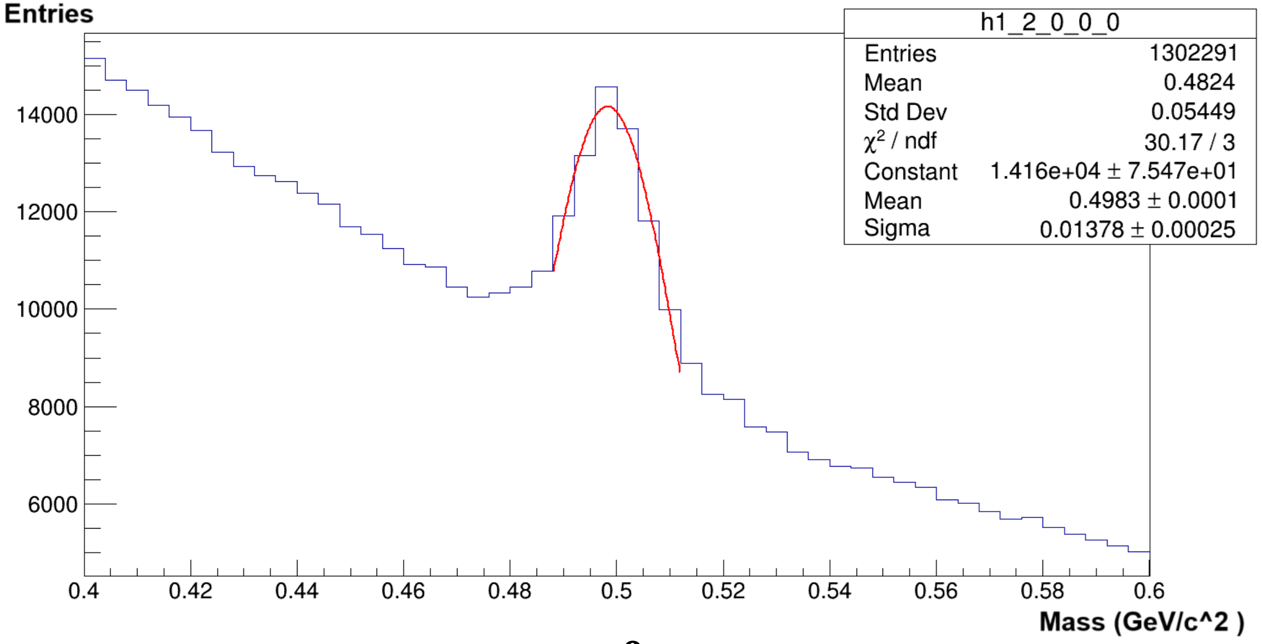
A peak at about 850 MeV, instead of 895.55 MeV, as is to be expected. A clear shift to the left of ~50 MeV.

Possible reasons:

1) Influence of acceptance of the experimental setup, which can be verified by means of MC simulations.
2) Influence of the magnetic field, which can be verified by considering other particles.

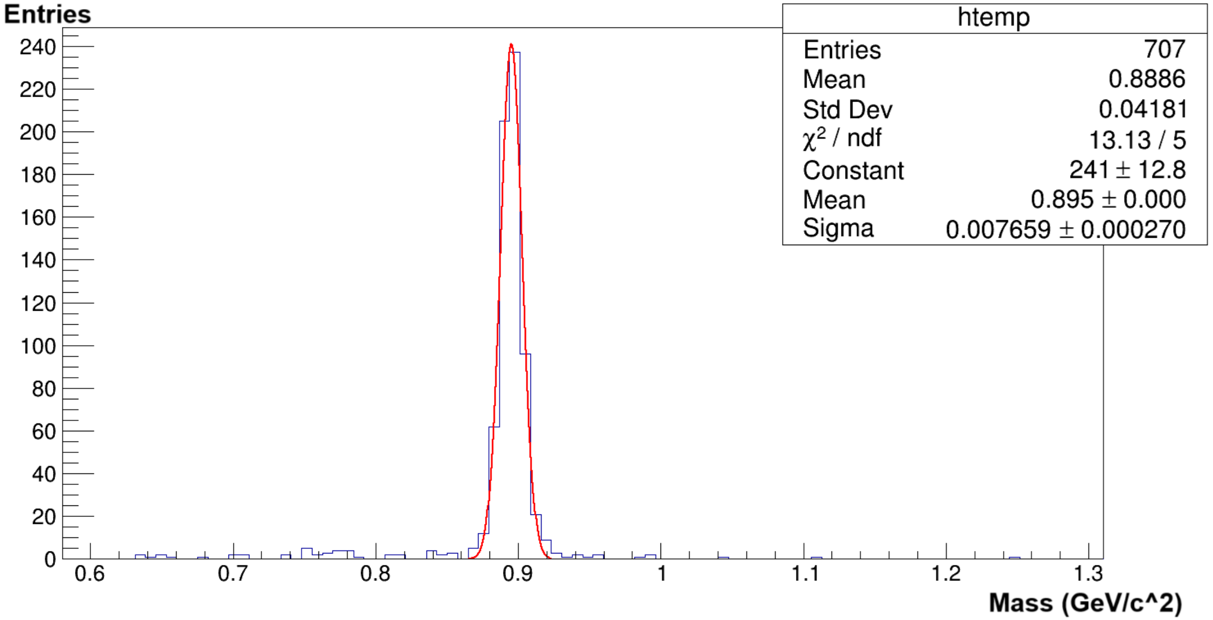
Results

EXP



$\mathbf{K_S^0}$

MC



K*(892)

Masses of both K_S^0 and K*(892) (in the (ideal) MC case) correspond to the expected values.
Hence both hypotheses posed in the previous slide have been disproven.

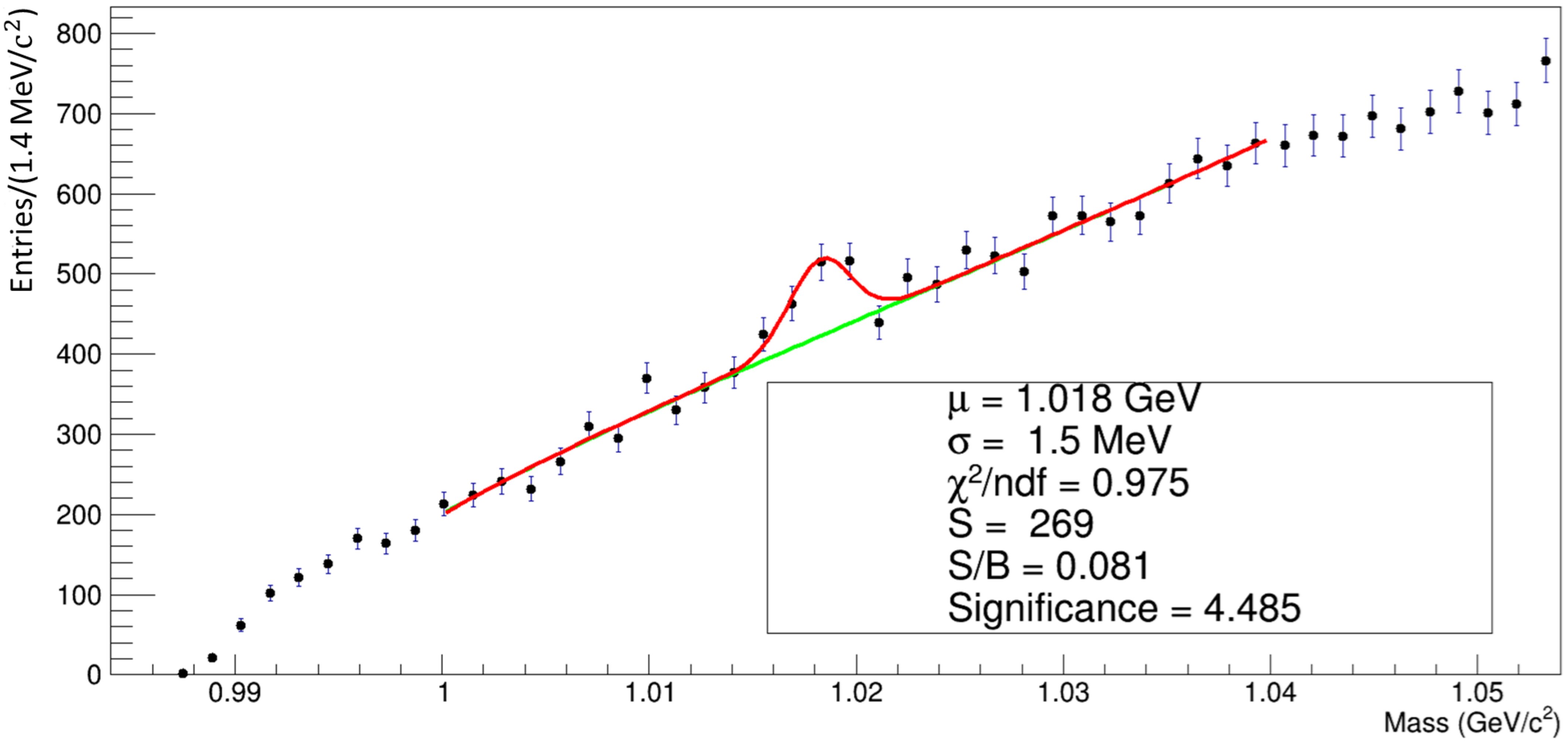
Conclusion and future work

- φ(1020) signal was observed in both MC and experimental cases. Signal was increased by almost a factor of 7 in the experimental case.
- K*(892) signal was observed in the MC case. A signal with a shift of ~50 MeV to the left from the expected value was observed in the experimental case.
- Mass of K_S^0 observed in the experimental data corresponds to expected value.
- Mass of K*(892) observed in MC data corresponds to expected value.

- Continuation analysis K*(892) regarding the shift to the left of the expected mass value.

Backup

Old Results



Entries/(1.4 MeV/c^2)
800
700
600
500
400
300
200
100
0
0.99
1
1.01
1.02
1.03
1.04
1.05
Mass (GeV/c^2)
μ = 1.018 GeV
σ = 1.5 MeV
χ^2/ndf = 0.975
S = 269
S/B = 0.081
Significance = 4.485