φ_0 signal observation in the BM@N experiment

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Introduction

- Collisions of heavy relativistic ions allow us to study nuclear matter at extreme density and temperature.
- At sufficiently high temperature and energy density, the so-called Quark-Gluon Plasma (QGP) is formed [1]:
  - Formation of strange particles.
- Theoretical models offer different descriptions [2],[3]:
  - New experimental data is needed for clarification.

[1] Kapishin.M, “Studies of baryonic matter at the BM@N experiment (JINR).” Nuclear Physics A 982 (2019) 967–970.
[2] J. A. et al Nucl. Phys., vol. A 757, pp. 102–183, 2005.

[3] K. A. et al Nucl. Phys., vol. A 757, pp. 184–283, 2005.

Goal

- Observation of φ_0 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 22 million experimental events were analyzed.

Data processing procedure

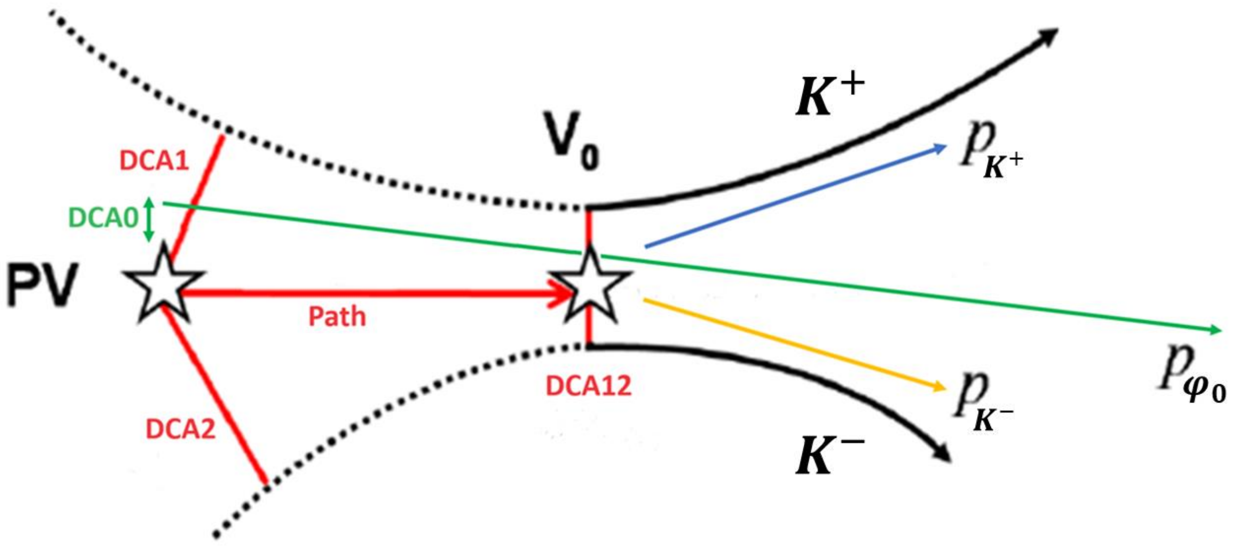
- Reconstruction of particle tracks was carried out.
- Mathematical algorithms were developed and implemented to search for the $\varphi_0 \rightarrow K^+ + K^-$ decay:
  - shuffling pairs of particles with different signs
  - calculation of invariant mass
  - imposing a number of geometric restrictions (4) on the parameters of each pair

PV – primary vertex.
Path – the distance traveled by φ_0 from the primary vertex to the point of its decay.
DCA0 – the distance between the primary vertex and the projection of momentum of φ_0.

DCA1 – the shortest distance from K^+ to the vertex.

DCA2 – the shortest distance from K^- to the vertex.

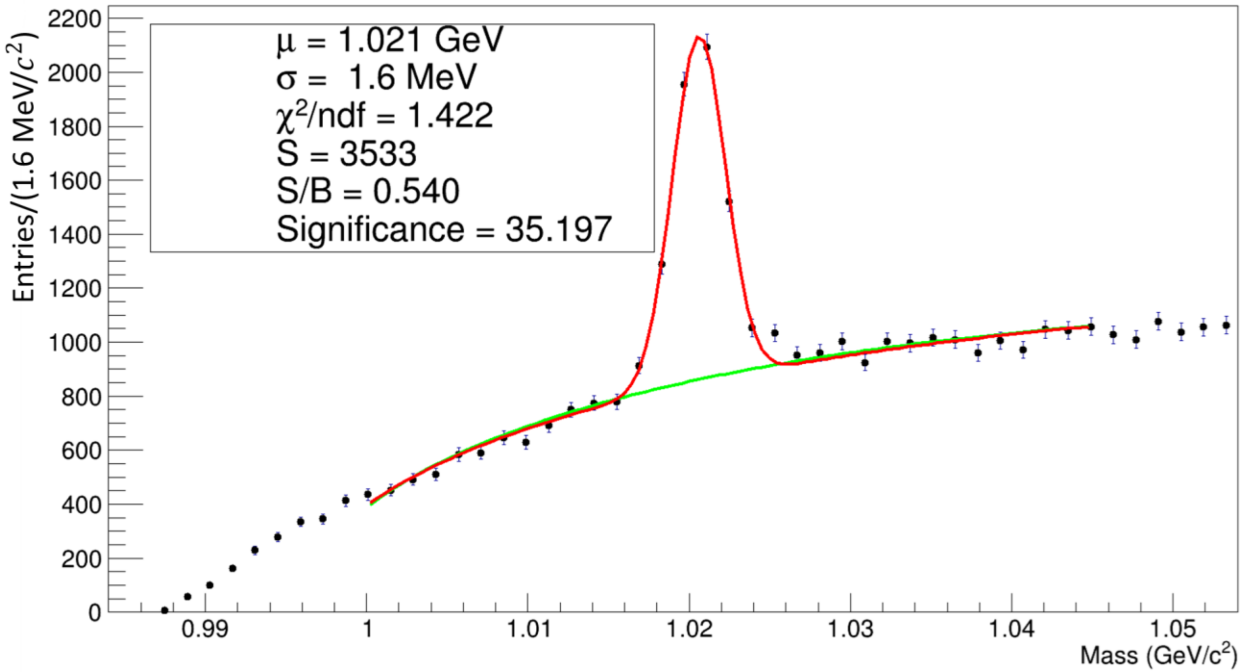
DCA12 – the distance between K^+ and K^- at the decay point of φ_0.



Event topology

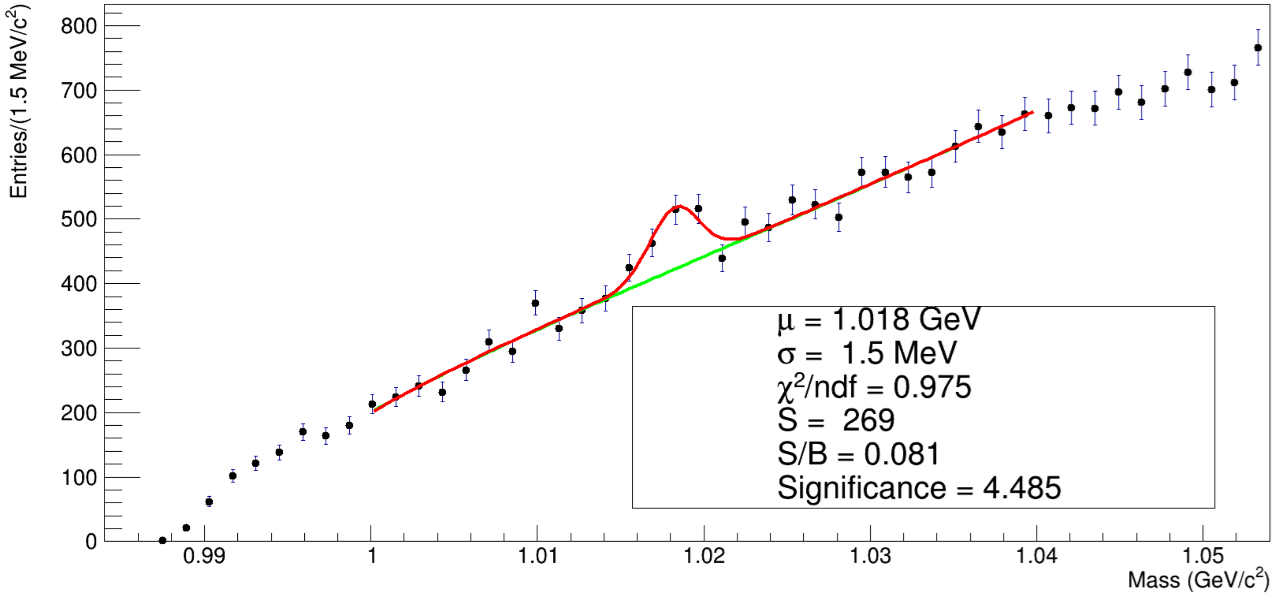
Results

MC



Efficiency = 0.44 %

EXP



Conclusion and future work

- Phi meson signal was observed in both MC and experimental cases.

- Put more stringent constraints on certain cuts and more lenient ones on others.
- Increase the number of analyzed events in order to improve the results regarding experimental data.
- Derive more realistic values for kinematic parameters by means of other MC generators (UrQMD, PYTHIA).
- Compare MC results with experimental ones.
- Perform phase space analysis.

Backup

Cuts

MC:

0.0 cm <= path <= 5.0 cm

0.0 cm <= dca12 <= 2.0 cm

0.0 cm <= dca0 <= 1.0 cm

0.15 $\frac{GeV^2}{c^4}$ <= mass_squared_К+<= 0.35 $\frac{GeV^2}{c^4}$

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

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

EXP:

0.0 cm <= path <= 1.0 cm

0.0 cm <= dca12 <= 1.0 cm

0.0 cm <= dca0 <= 0.05 cm

0.0 $\frac{GeV^2}{c^4}$ <= mass_squared_К+<= 0.75 $\frac{GeV^2}{c^4}$

0.0 $\frac{GeV^2}{c^4}$ <= mass_squared_K-<= 0.75 $\frac{GeV^2}{c^4}$