Status of phi-meson signal reconstruction in Xe+CsI collisions in the BM@N experiment

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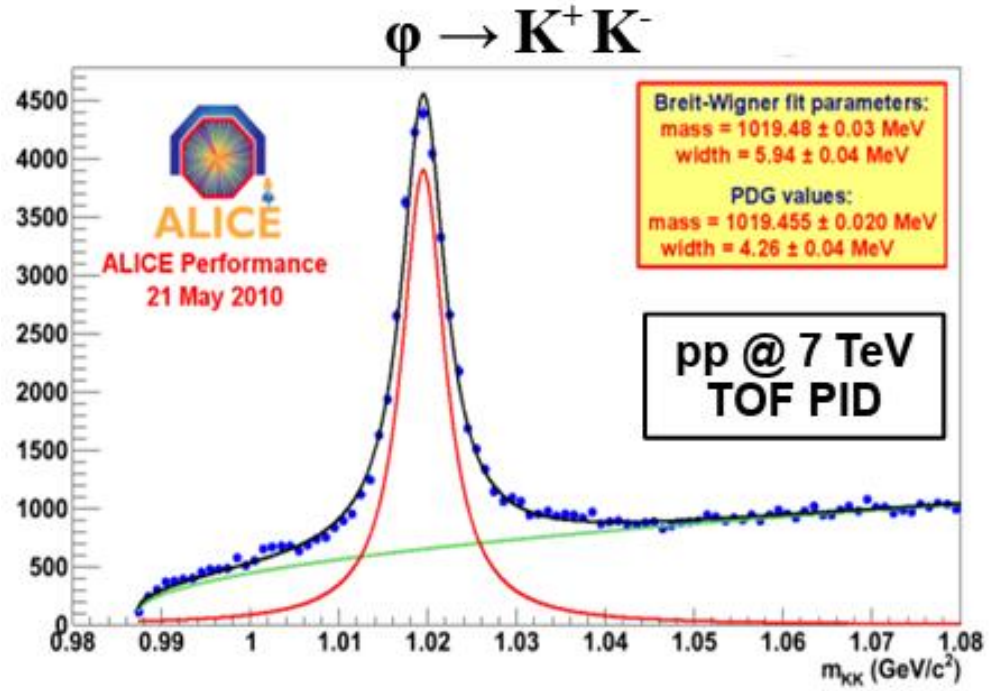
Introduction

Why is φ(1020) 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].



[2]

[1] J. Phys. G: Nucl. Part. Phys. 32, S373-S380 (2006) DOI: 10.1088/0954-3899/32/12/S46.
[2] efaidnbmnnnibpcajpcglclefindmkaj/https://lss.fnal.gov/conf2/C100715/Preghenella.pdf

Goal

- Optimization of the observed signal of φ(1020) in the 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.
- About 450 million experimental events were analyzed.

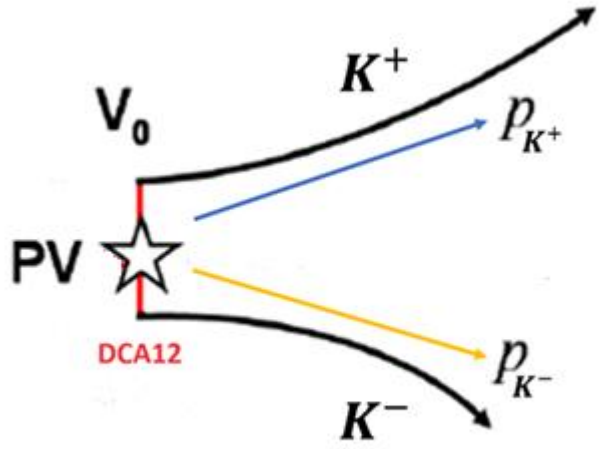
Data processing procedure

- Reconstruction of particle tracks was carried out.
- Mathematical algorithms were developed and implemented to search for the $\varphi(1020) \rightarrow K^+ + K^-$ 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 $\varphi(1020)$.

Other restrictions employed:

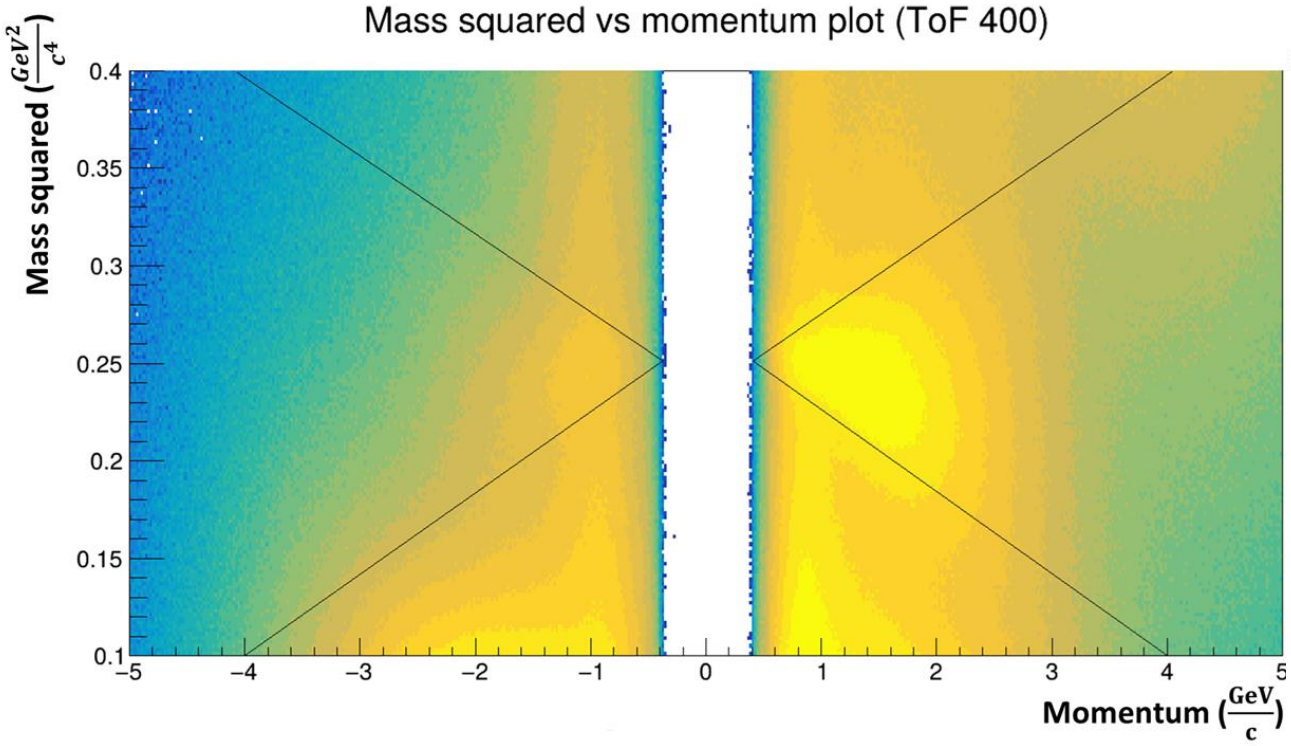
Constraints on the squared masses of the two products of decay (K^+ and K^-).

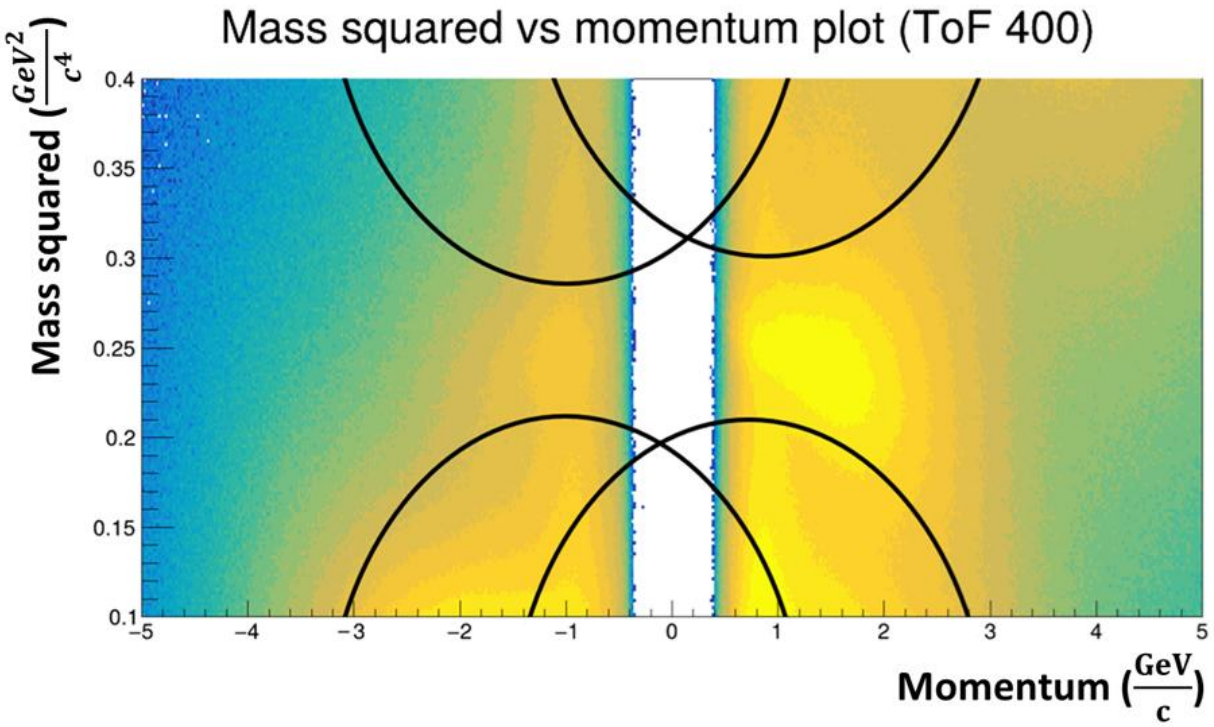


Event topology $\varphi(1020)$

Results

Following two situations with regards to constraints on the squared mass were considered:

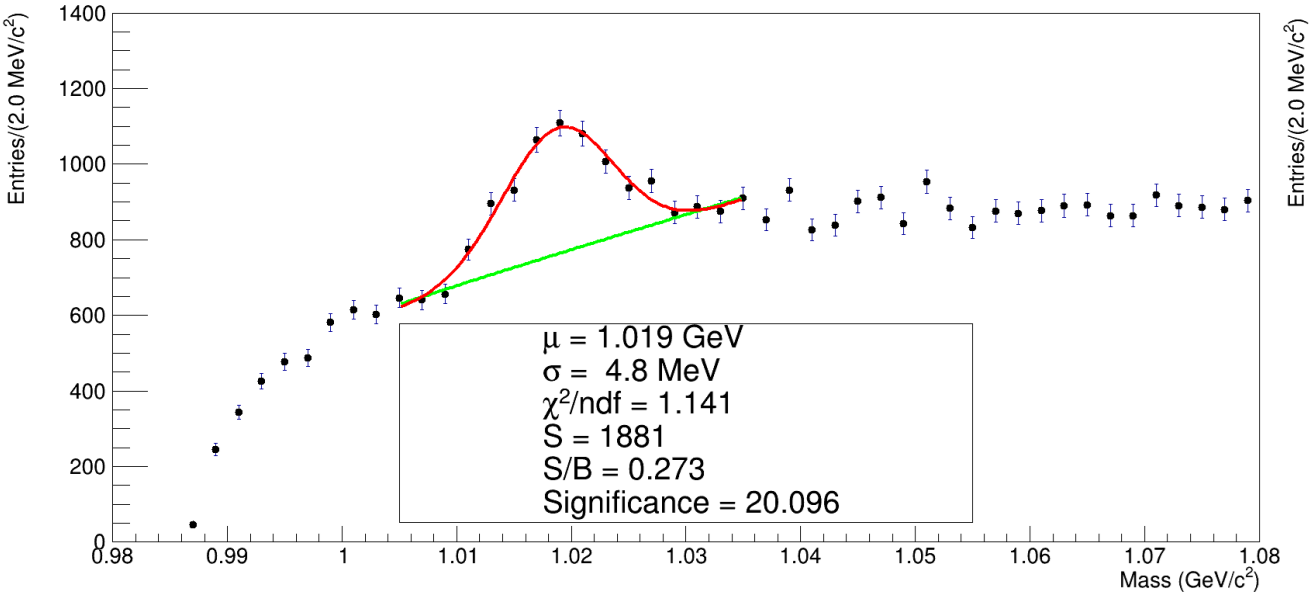


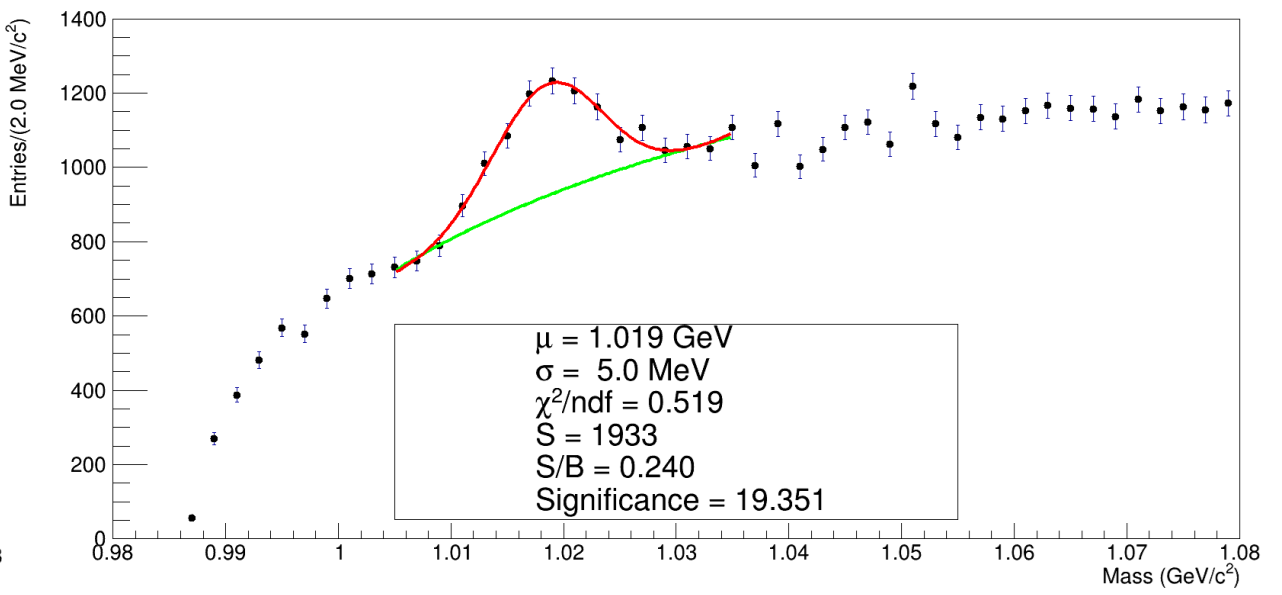


Additional constraint used in both cases:

0.0 cm <= dca12 <= 1.0 cm

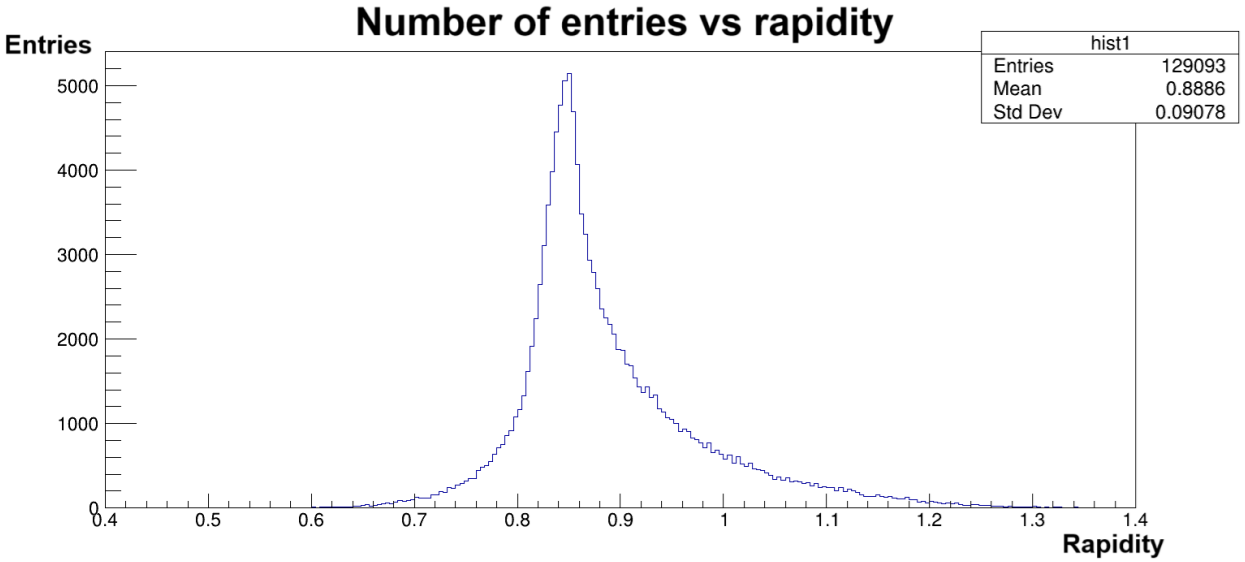
Results

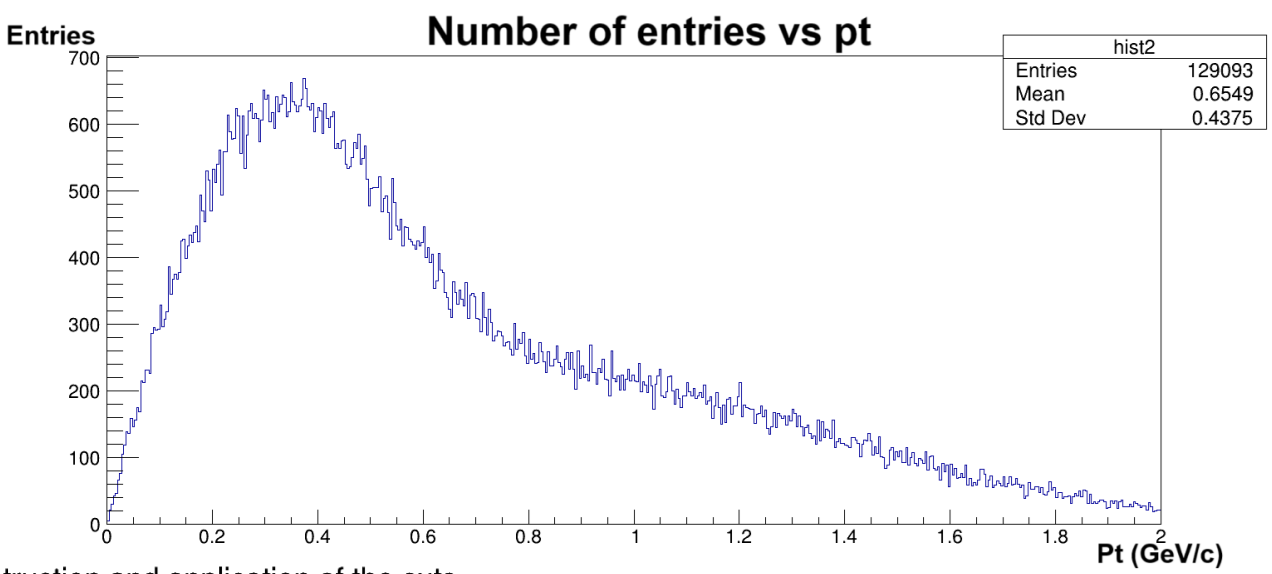

Entries/(2.0 MeV/c²)
Mass (GeV/c²)
μ = 1.019 GeV
σ = 4.8 MeV
χ²/ndf = 1.141
S = 1881
S/B = 0.273
Significance = 20.096

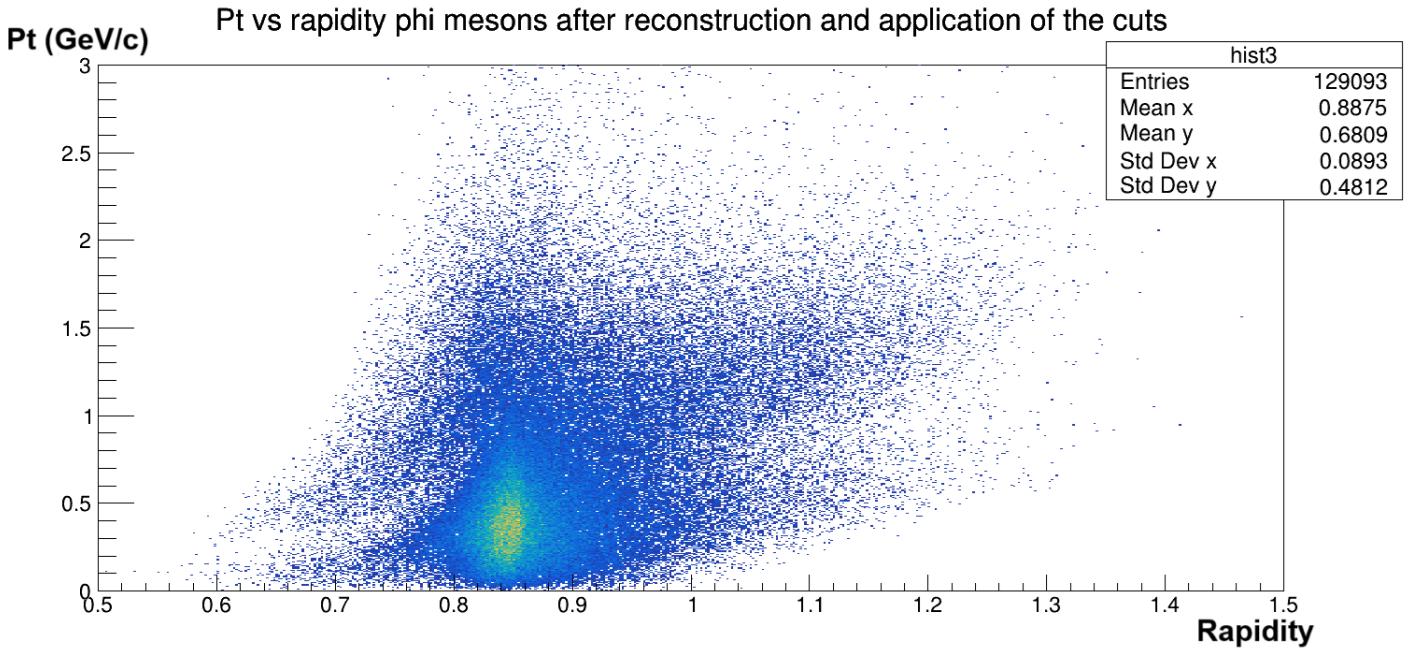

Entries/(2.0 MeV/c²)
Mass (GeV/c²)
μ = 1.019 GeV
σ = 5.0 MeV
χ²/ndf = 0.519
S = 1933
S/B = 0.240
Significance = 19.351

Results

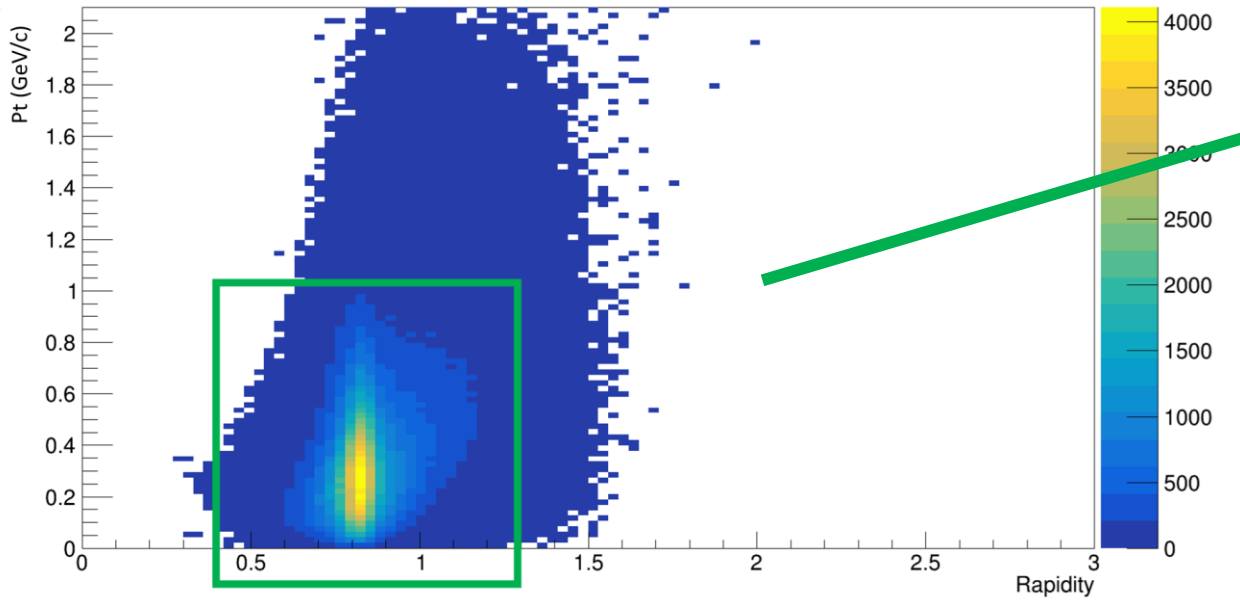
Initial stages of the phase space analysis:





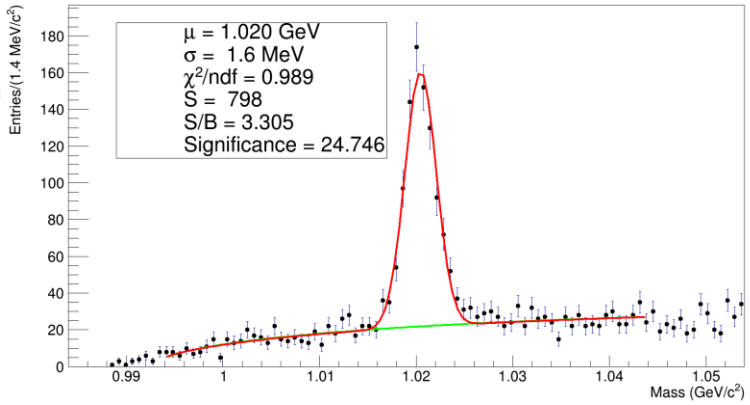


Results

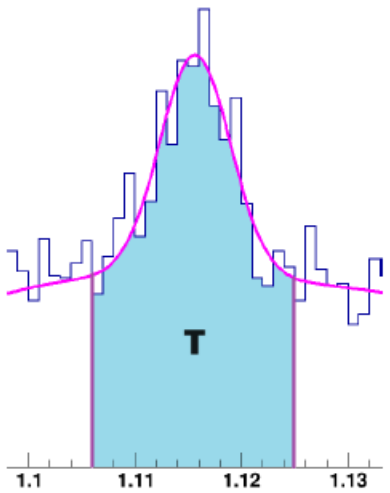


Pt				
4	9	14	19	24
3	8	13	18	23
2	7	12	17	22
1	6	11	16	21
0	5	10	15	20

0 Rapidity



S =



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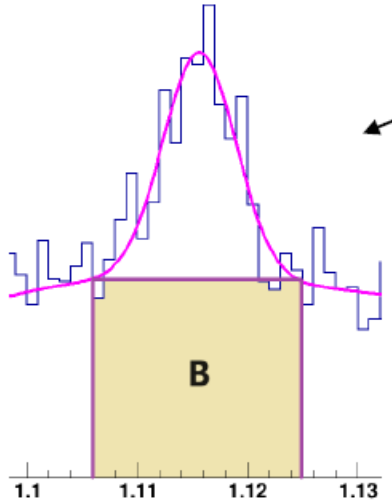
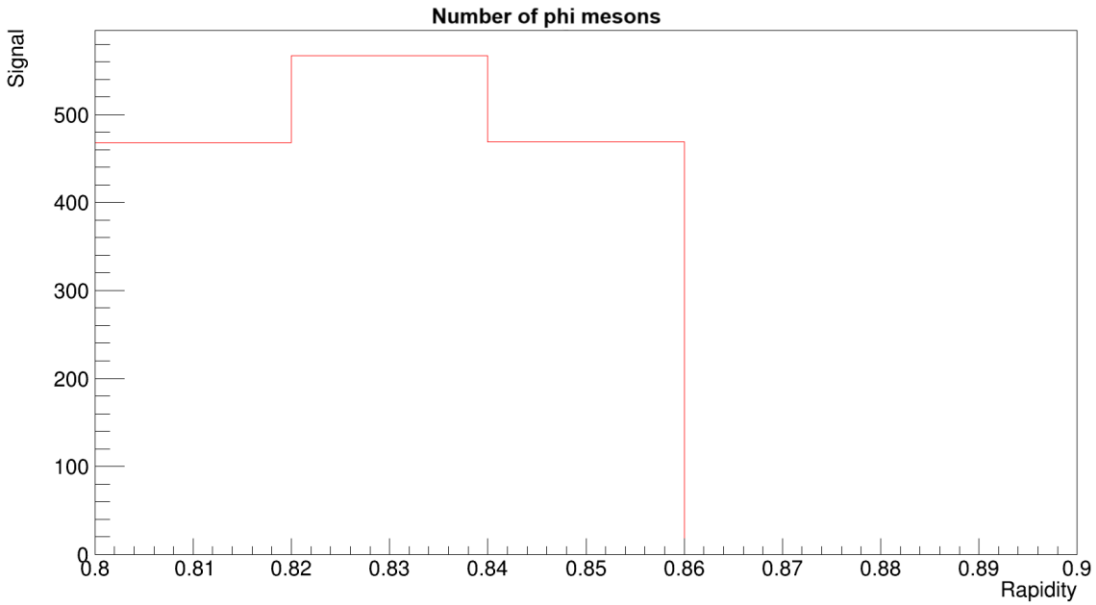
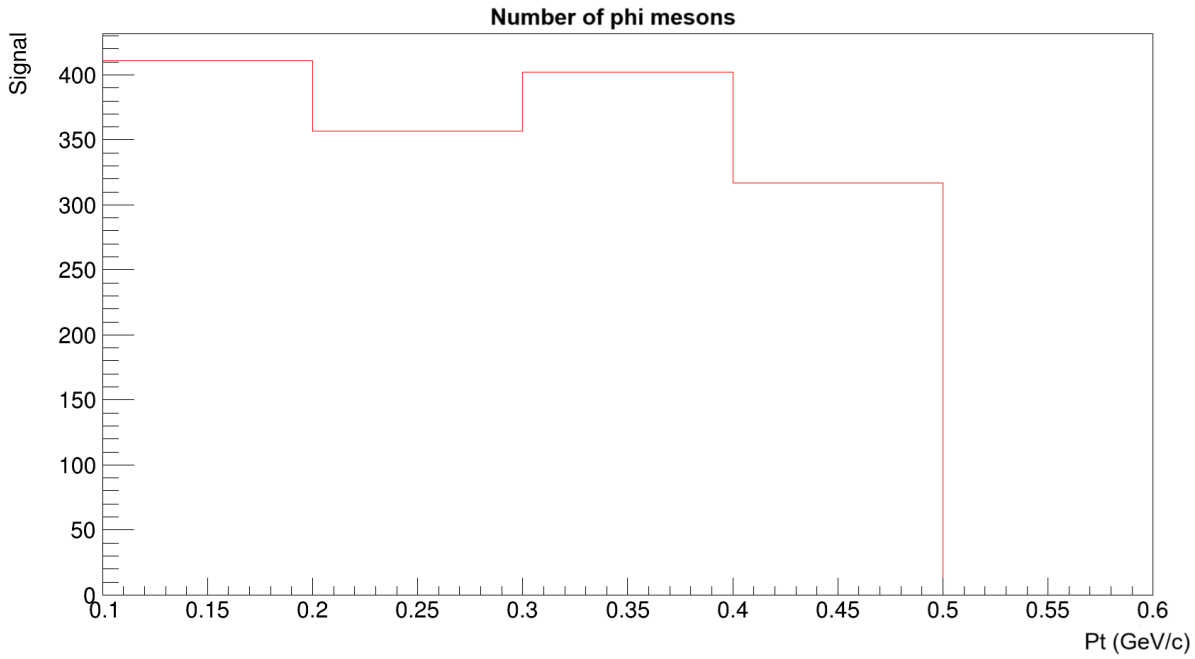


Results


Number of phi mesons
Signal
500
400
300
200
100
0
0.8
0.81
0.82
0.83
0.84
0.85
0.86
0.87
0.88
0.89
0.9
Rapidity

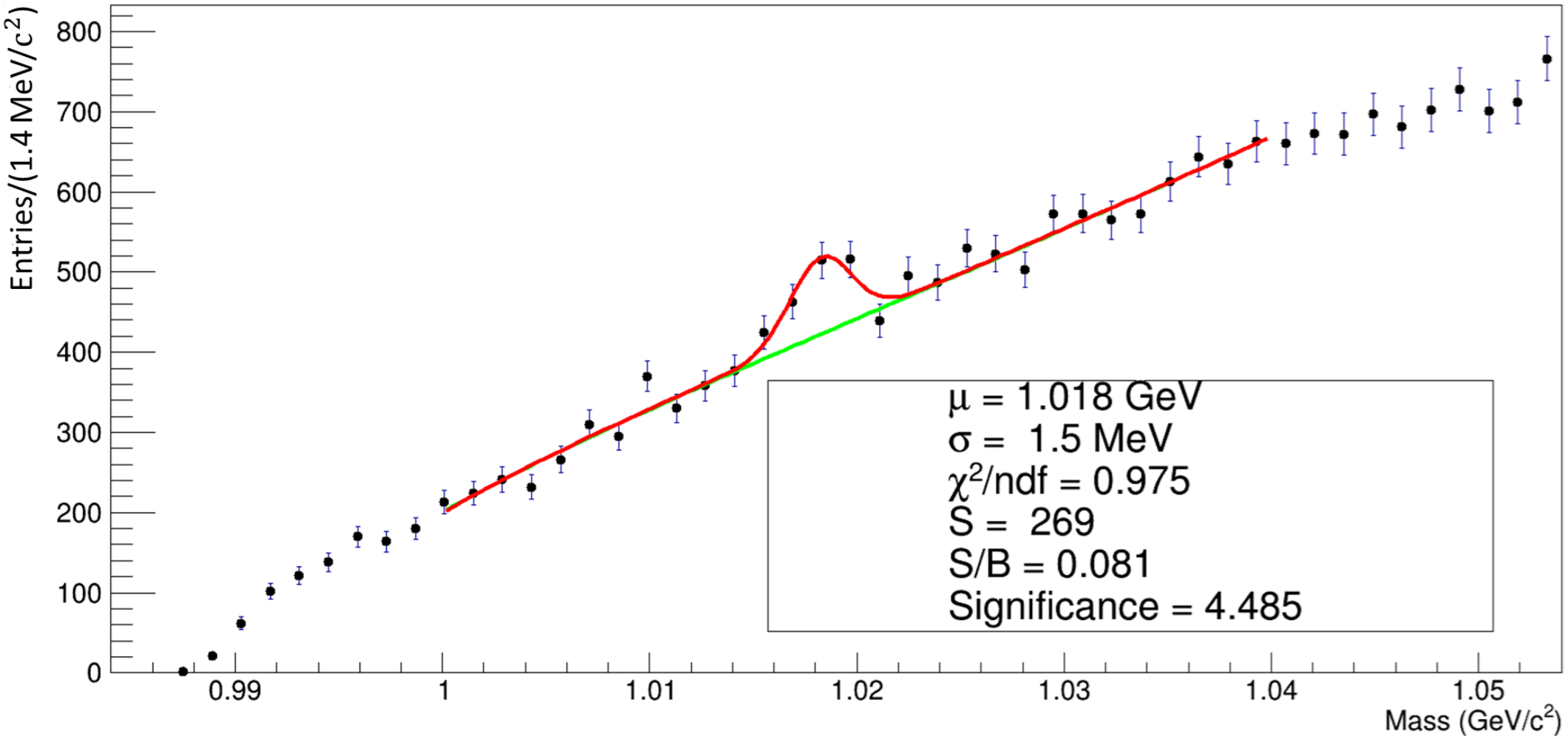

Number of phi mesons
Signal
400
350
300
250
200
150
100
50
0
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
Pt (GeV/c)

Conclusion and future work

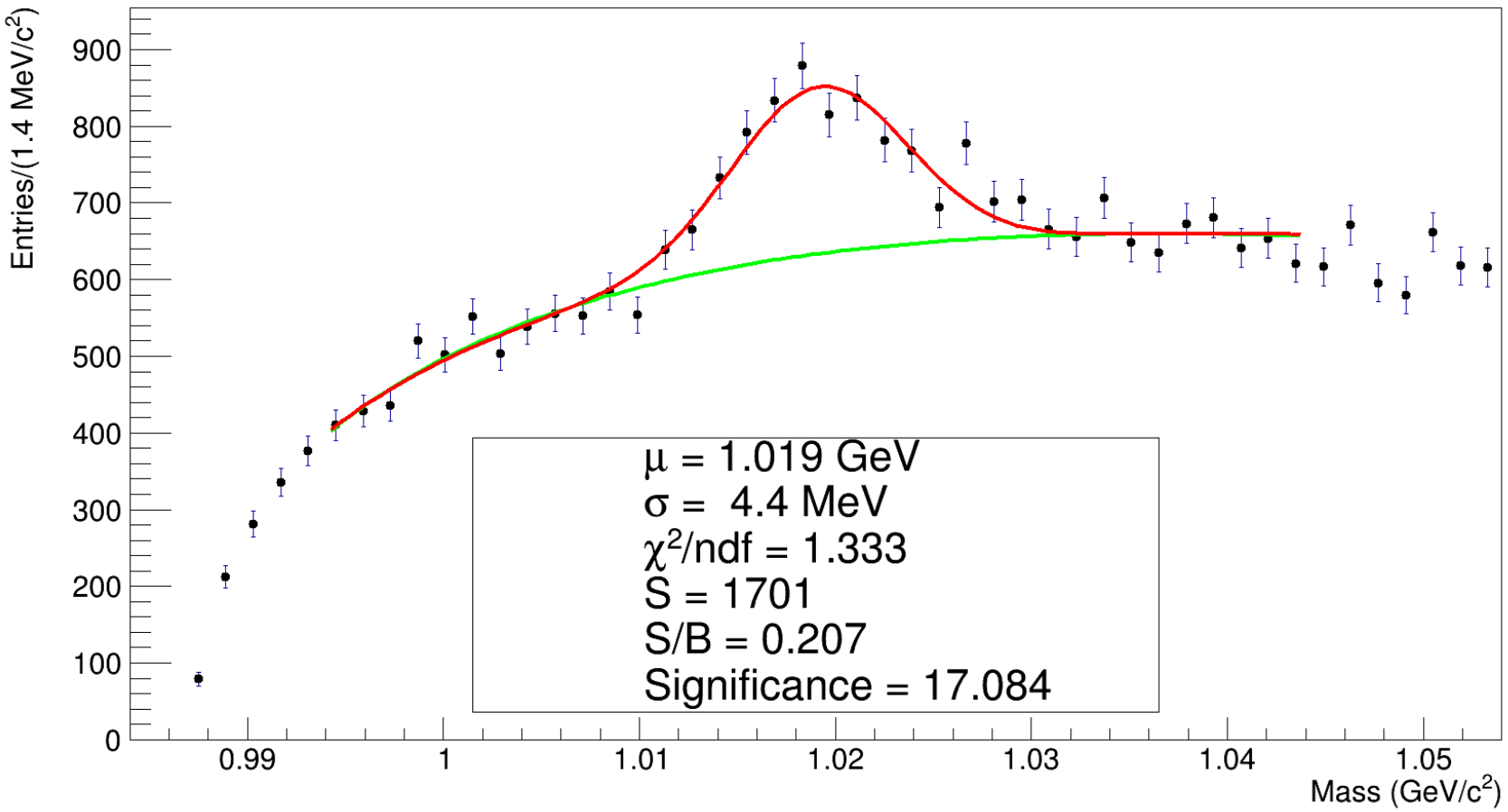
- φ(1020) signal was optimized by assuming constraints based on the ratio between mass squared and momentum.
- Phase space analysis was initiated.

- Further optimization of the φ(1020) signal by improving the matching of ToF 400.
- Continuation of the phase space analysis.
- Estimation of the number of φ(1020) by combining the results from the experimental case and MC case (reconstruction efficiency).

Old Results


Entries/(1.4 MeV/c²)
800
700
600
500
400
300
200
100
0
0.99
1
1.01
1.02
1.03
1.04
1.05
Mass (GeV/c²)
μ = 1.018 GeV
σ = 1.5 MeV
χ²/ndf = 0.975
S = 269
S/B = 0.081
Significance = 4.485

Old Results


Entries/(1.4 MeV/c²)
900
800
700
600
500
400
300
200
100
0
0.99
1
1.01
1.02
1.03
1.04
1.05
Mass (GeV/c²)
μ = 1.019 GeV
σ = 4.4 MeV
χ²/ndf = 1.333
S = 1701
S/B = 0.207
Significance = 17.084