

Precise measurement of $e^+e^- \rightarrow K^+K^-$ at SND

(in energy range from 1.05 to 2.0 GeV, preliminary results)

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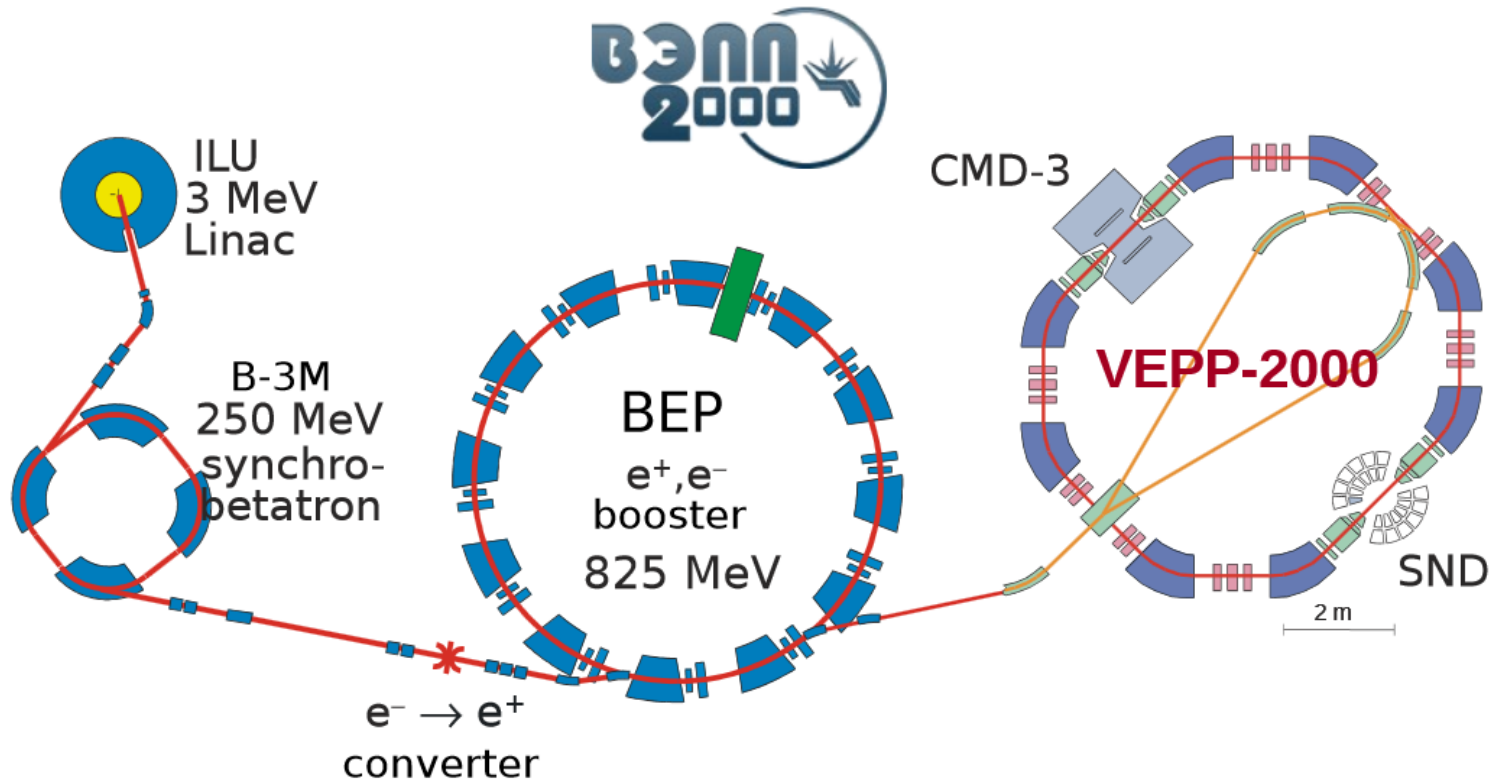
Novosibirsk State University

Budker Institute of Nuclear Physics

International Workshop on e^+e^- collisions from Φ to Ψ 2015

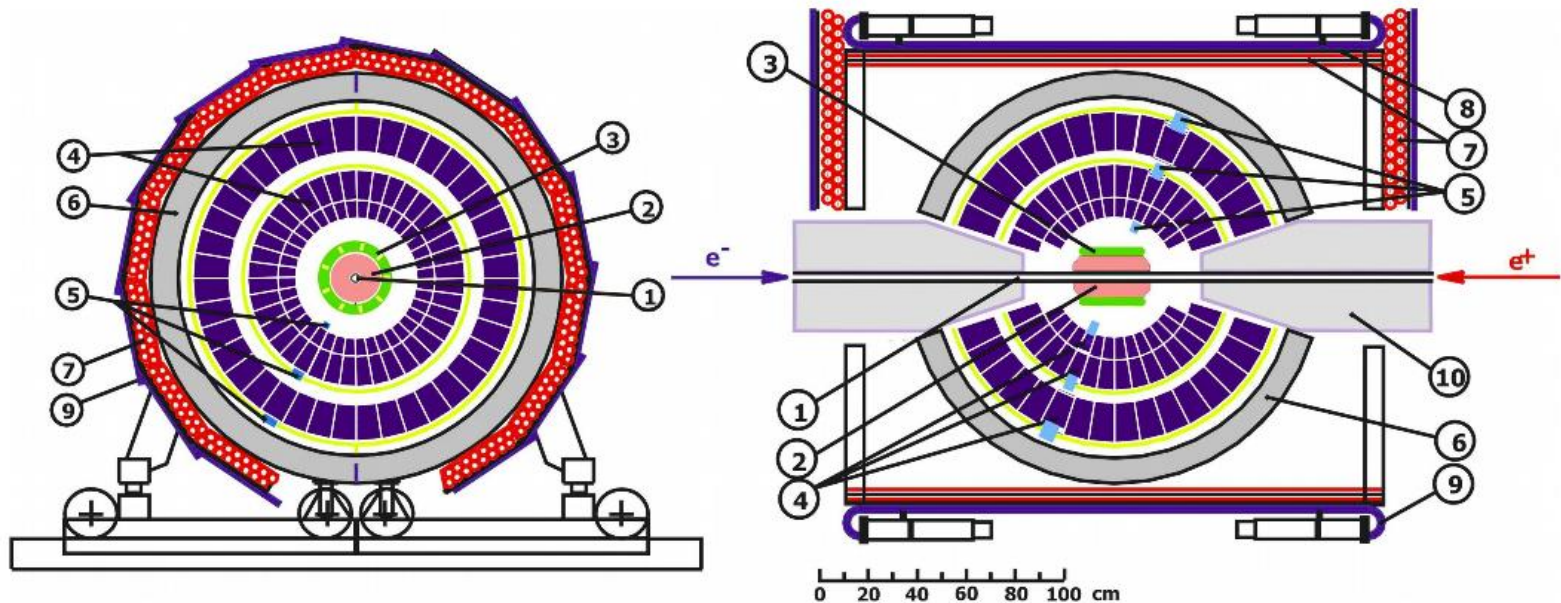
September 23-26, 2015

VEPP-2000 complex



Maximum c.m. energy is 2 GeV, achieved luminosity is $L = 2 \cdot 10^{31} \text{ 1/cm}^2\text{s}$ at $\sqrt{s} = 2 \text{ GeV}$
Unique optics, “round beams”, allows to reach high luminosity
Experiments with two detectors, CMD-3 and SND, started by the end of 2010

Spherical Neutral Detector (SND)

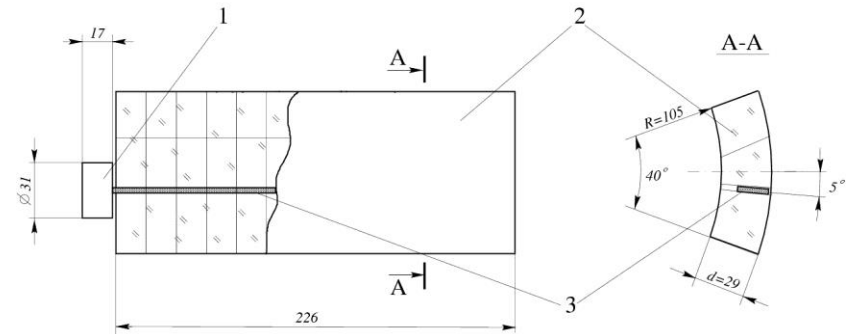
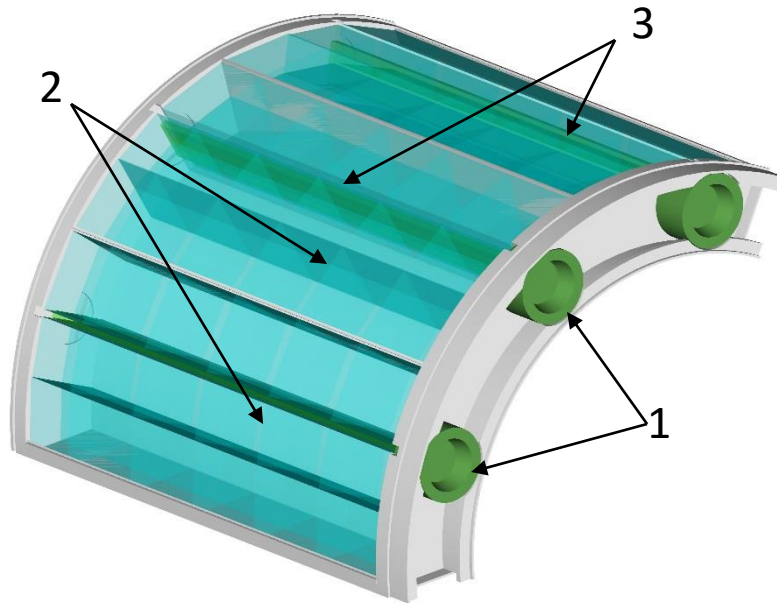


- 1 – beam pipe
- 2 – tracking system
- 3 – aerogel
- 4 – NaI(Tl) crystals
- 5 – phototriodes
- 6 – muon absorber
- 7–9 – muon detector
- 10 – focusing solenoid

Advantages compared to previous SND:

- new system - Cherenkov counter ($n=1.05, 1.13$)
 e/π separation $E < 450$ MeV
 π/K separation $E < 1$ GeV
- new drift chamber
 better tracking

Aerogel counters: design



1 - PMT, 2 – aerogel with $n=1.05/1.13$, 3 - WLS

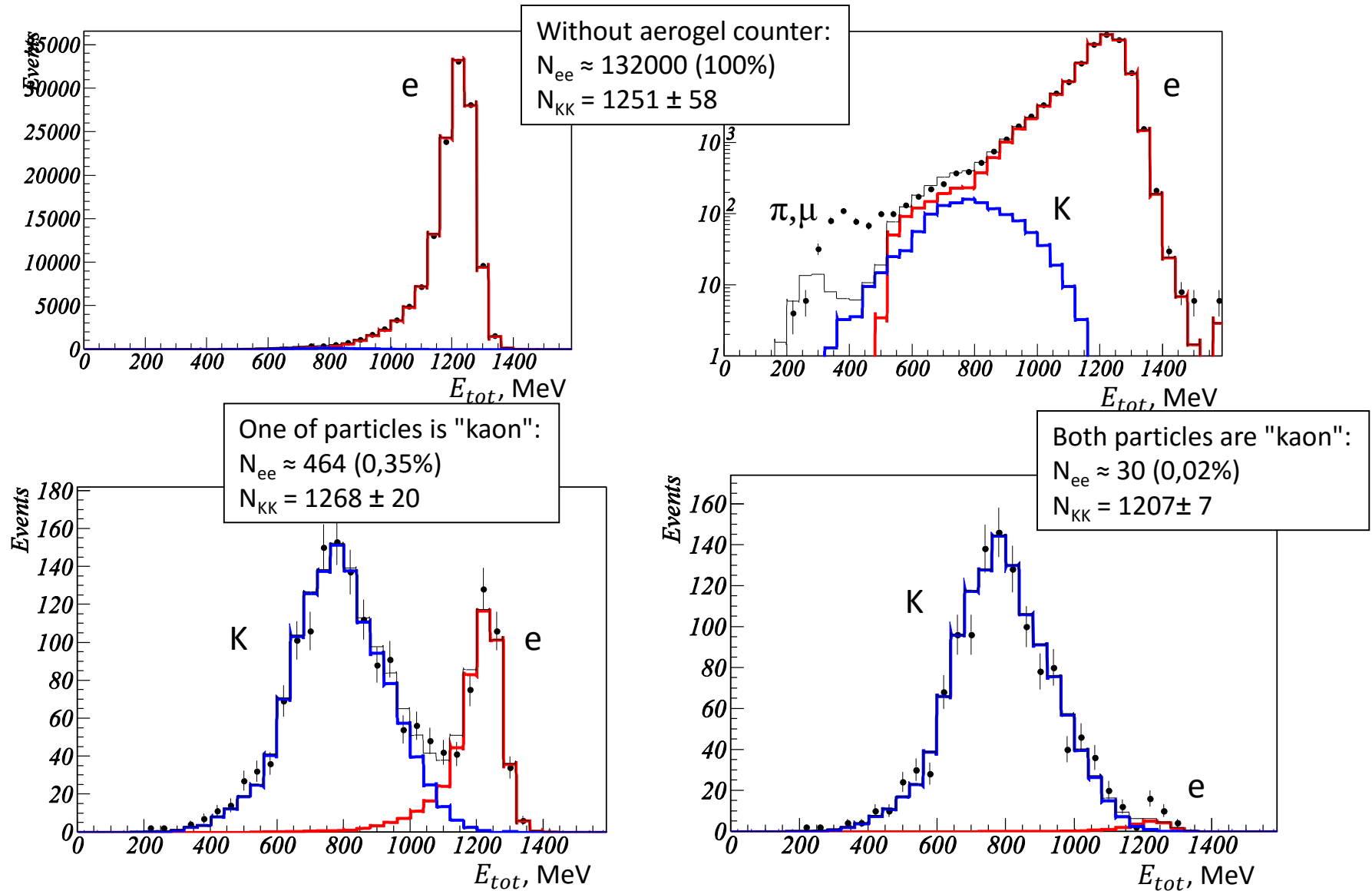
Aerogel System Design

- Cylindrical shape: $R=105 \div 141$ mm
- Walls material: Al, 1 mm thickness
- Consists of 3 segments with 3 separate counters in each
- Solid angle: $\sim 60\%$ of 4π
- Thickness: $0.09 X_0$

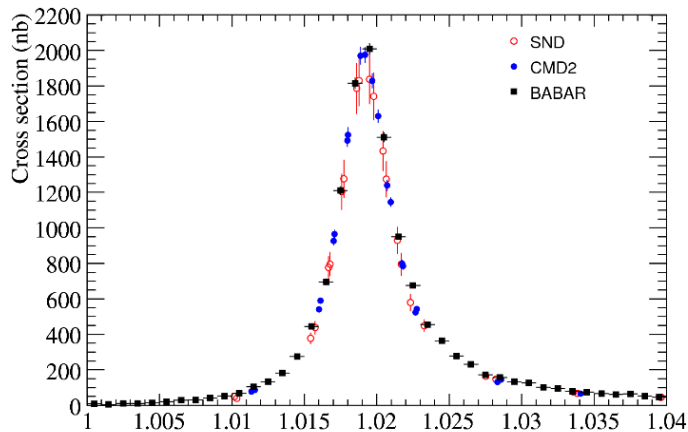
Aerogel counter Design

- Scheme: Aerogel + Wavelength shifter (WLS) + PMT
(**Nucl.Instrum.Meth.A315:517-520,1992**)
- WLS position: displaced by $\sim 5^\circ$ from counter center
- Aerogel cover: Teflon with a refractivity of $R \sim 98\%$
- Aerogel thickness: ~ 31 mm

Tests with aerogel counter (n=1.13) on experimental events

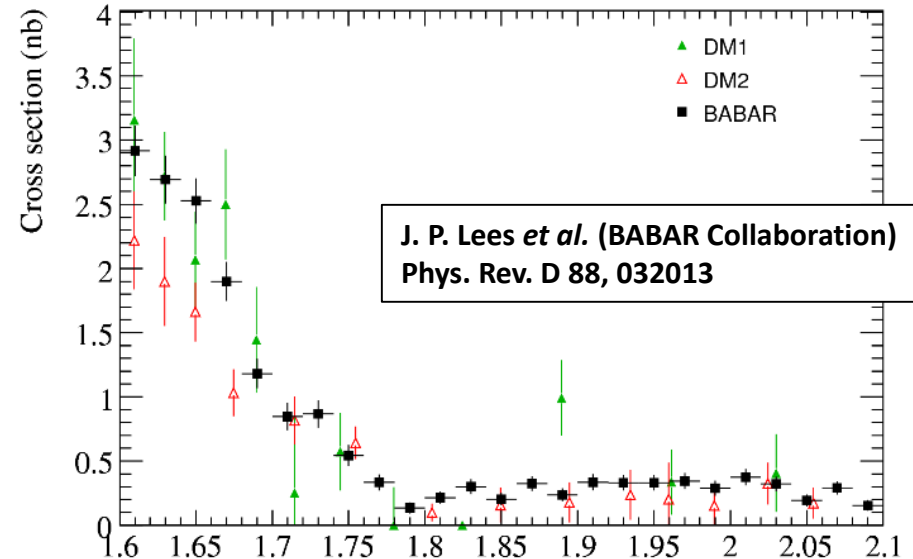
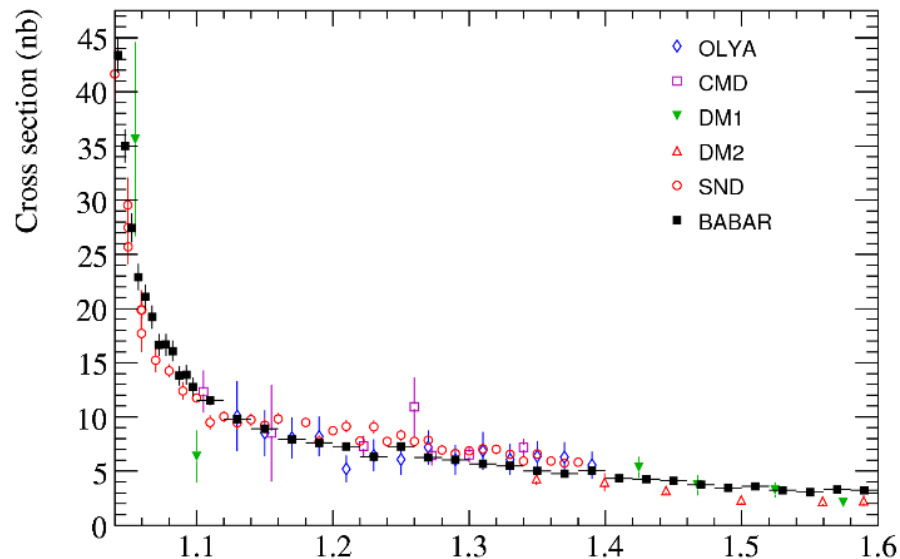


$e^+e^- \rightarrow K^+K^-$ in previous experiments



Our reasons to study the $e^+e^- \rightarrow K^+K^-$:

- Precise measurement of cross section of the process
 - Study of excited states of ρ, ω and ϕ
 - Contribution to R
 - CVC tests
- Test new aerogel counter with charge kaons
 - Study other processes with charge kaons



This work energy range

PhiPsi2015

Selection cuts

- number of charge particles:

$$n_c \geq 2$$

- tracks from interaction point:

$$|\Delta z_{12}| < 1 \text{ cm}, |z_i| < 7 \text{ cm}, |\rho_i| < 0.25 \text{ cm}$$

- collinearity:

$$|\Delta\phi| < 3^\circ, |\Delta\theta| < 7^\circ$$

Kinematic cuts

- One of the particles is a «kaon»

- Energy deposition in the drift chamber ($2E_0 > 1.9 \text{ GeV}$) :

$dE/dx_i < 1.5 dE/dx_i$ (for electrons) –
for one of the two charged particle

Identification cuts

Background sources

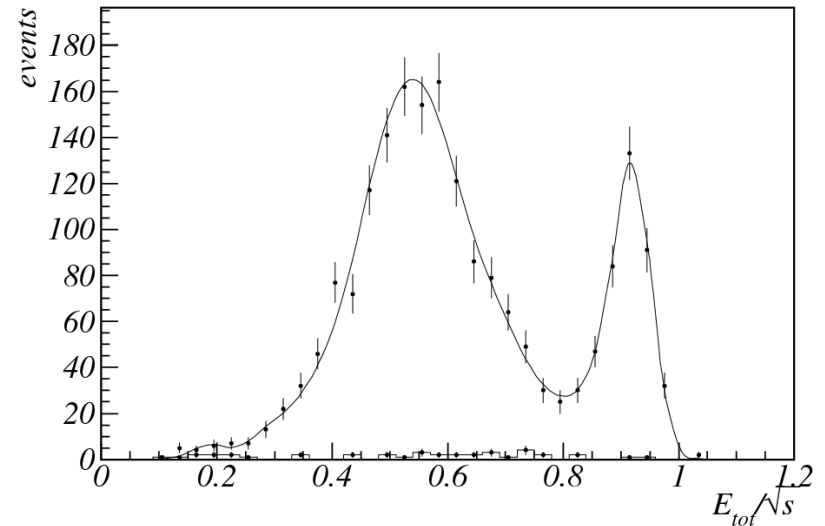
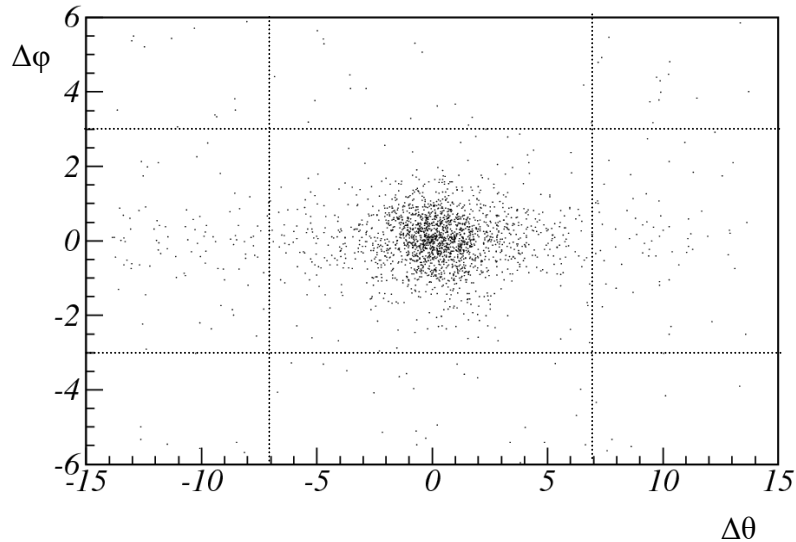
1. Collinear tracks background:

- Cosmic events
- Charged two-body processes (e^+e^- , $\mu^+\mu^-$, $\pi^+\pi^-$, p^+p^-)

2. Non-Collinear tracks background:

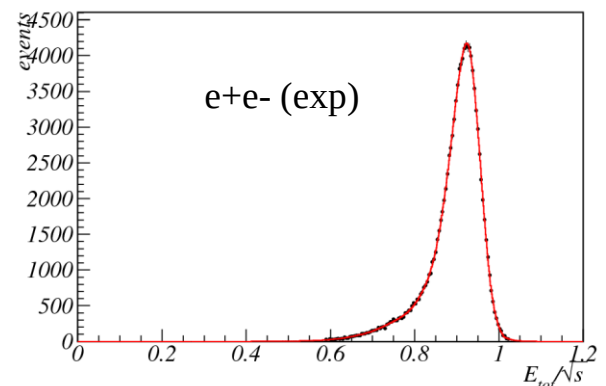
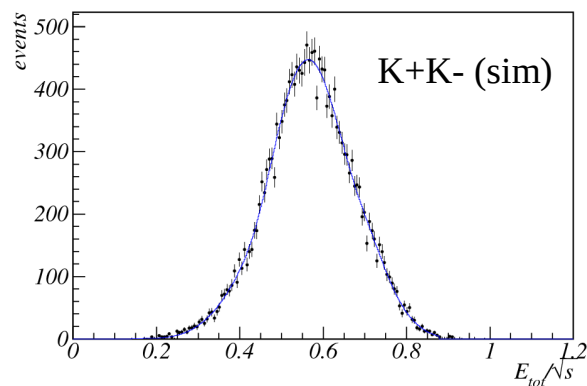
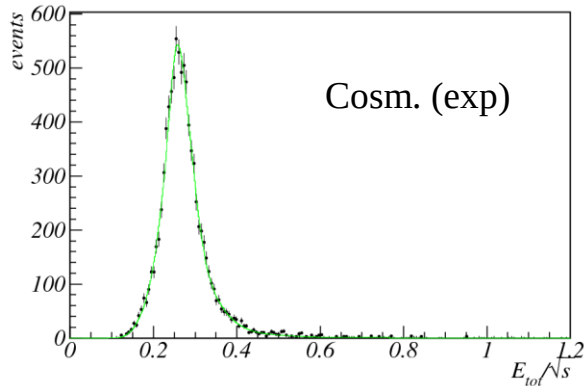
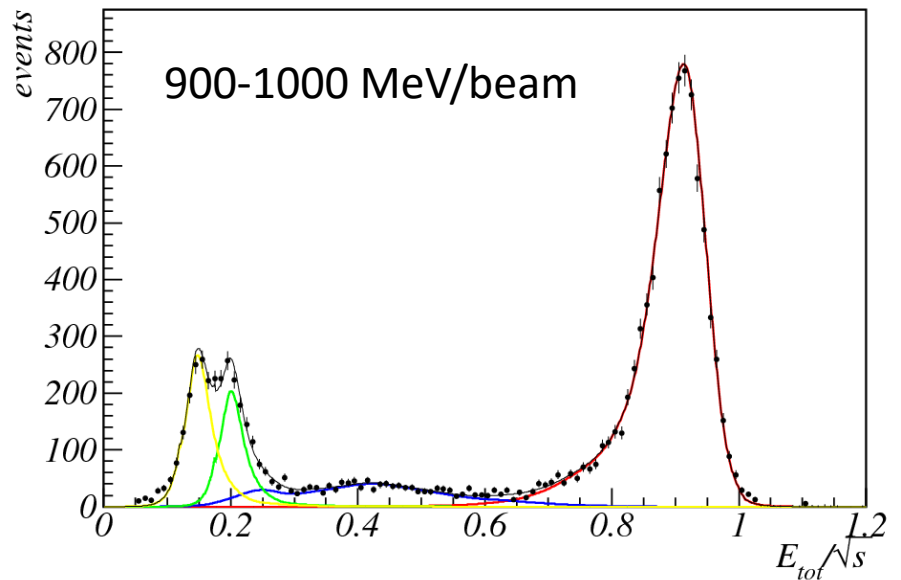
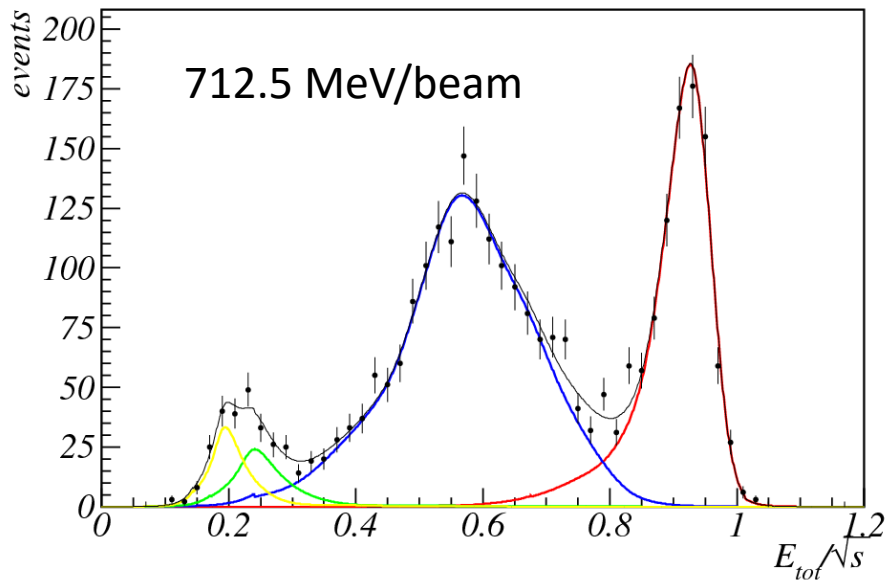
- Charged multi-body processes ($\pi^+\pi^-\pi^0$, $\pi^+\pi^-\pi^0\pi^0$, $KK\pi$ etc.)
- Two-photon processes (e^+e^- , $\mu^+\mu^-$, $\pi^+\pi^-$)

Subtraction of non-collinear backgrounds

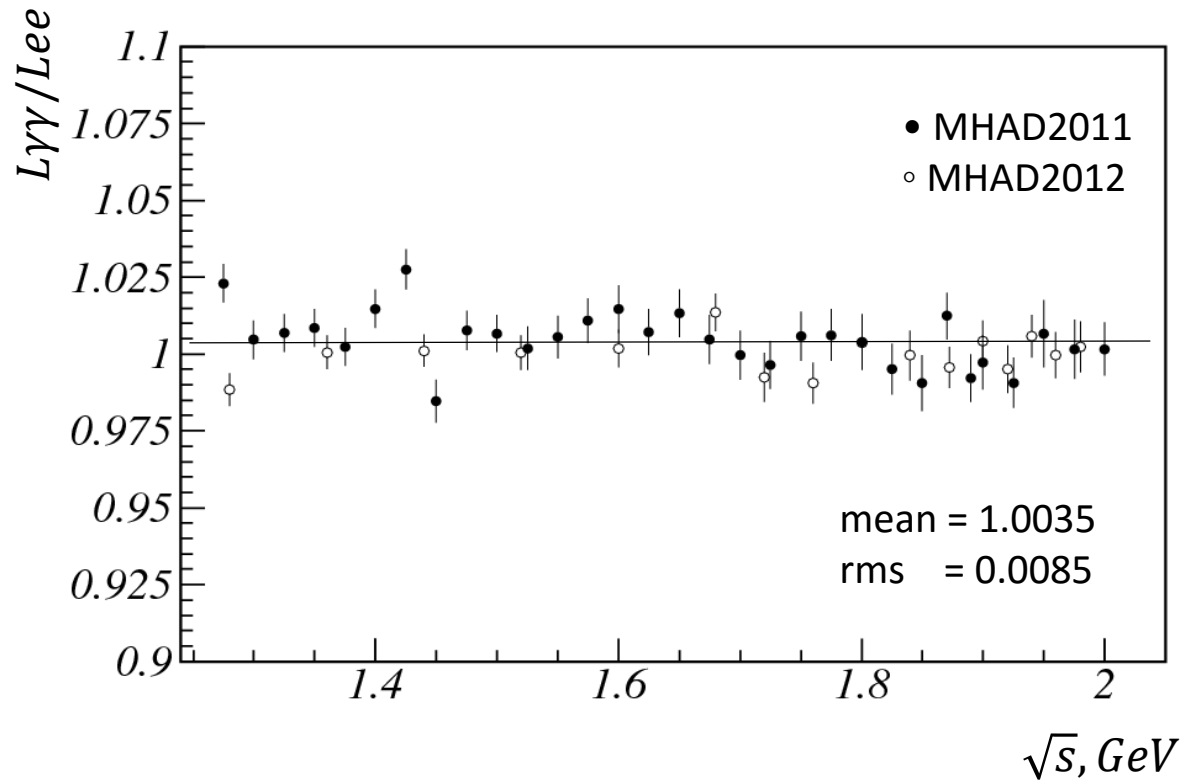


Number of events of non-collinear backgrounds
is estimated using the corner regions,
Scaled and subtracted from number
of events of central region.

Subtraction of collinear backgrounds



Luminosity



Luminosity was measured
in two processes:

$$e^+e^- \rightarrow e^+e^-$$

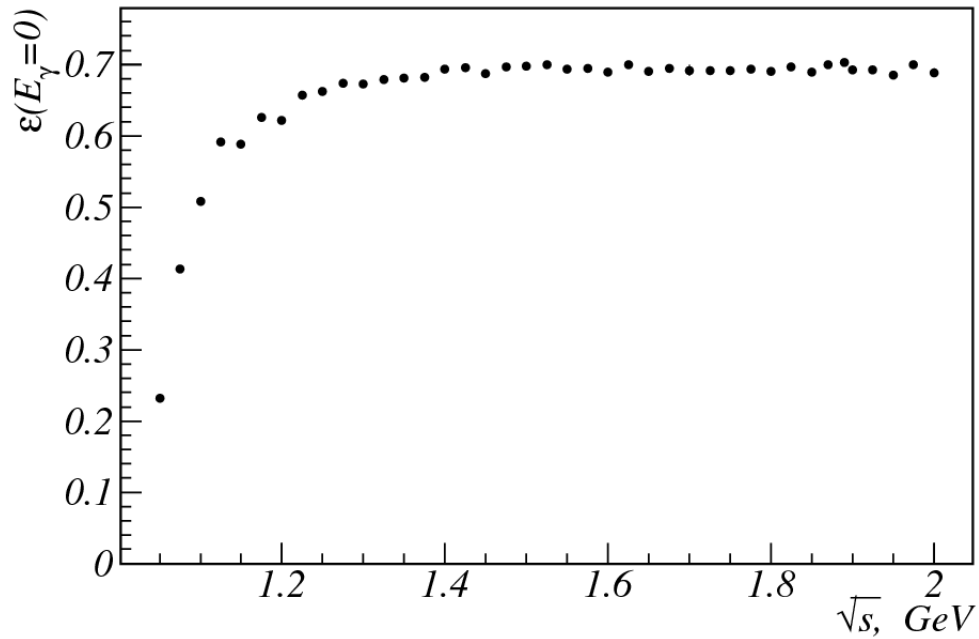
$$e^+e^- \rightarrow \gamma\gamma$$

Ratio is very close to 1

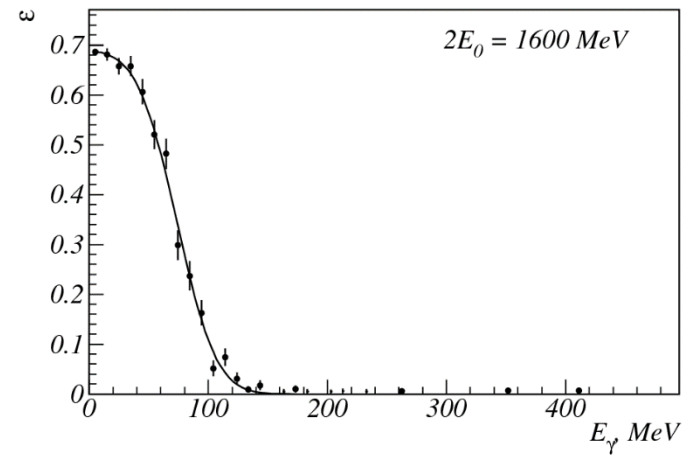
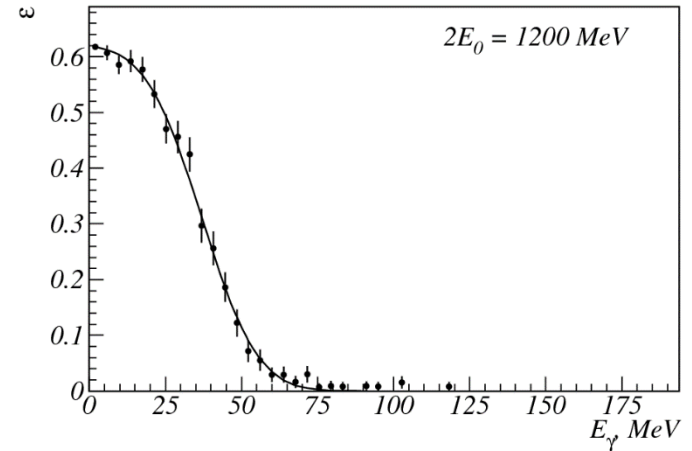
Visible cross section:

$$\sigma_{vis,i} = N_i/L_i$$

Detection efficiency

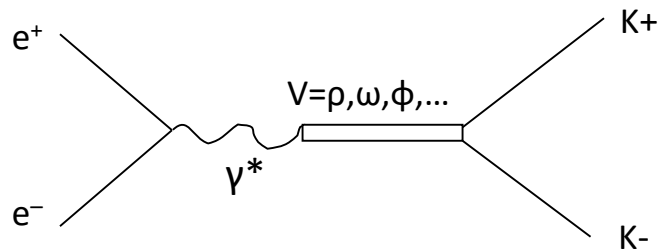


$$\sigma_{\text{vis}}(E) = \int_0^1 dz \sigma_0(E(1-z)) F(E, z) \varepsilon(E, zE)$$



Data approximation: model

Vector Meson Dominance Model

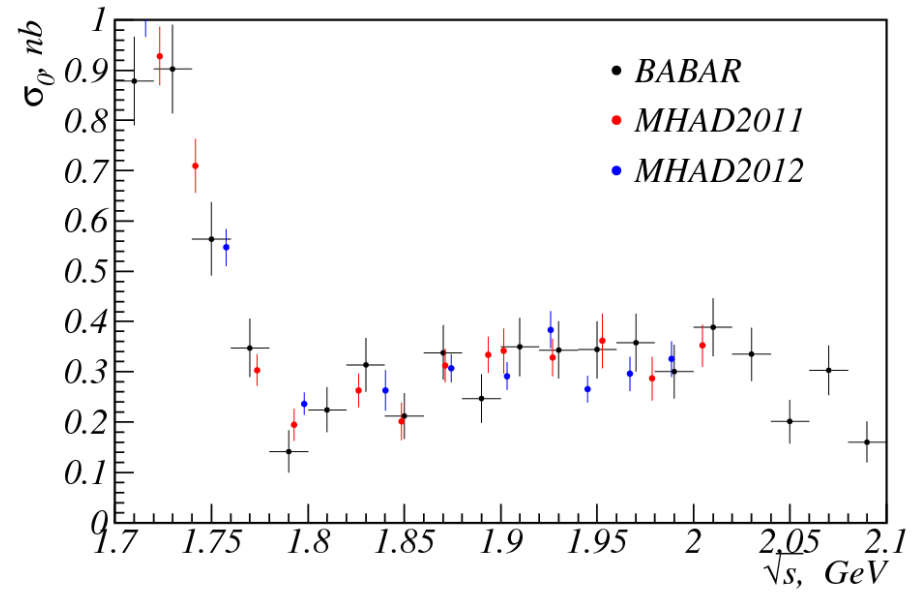
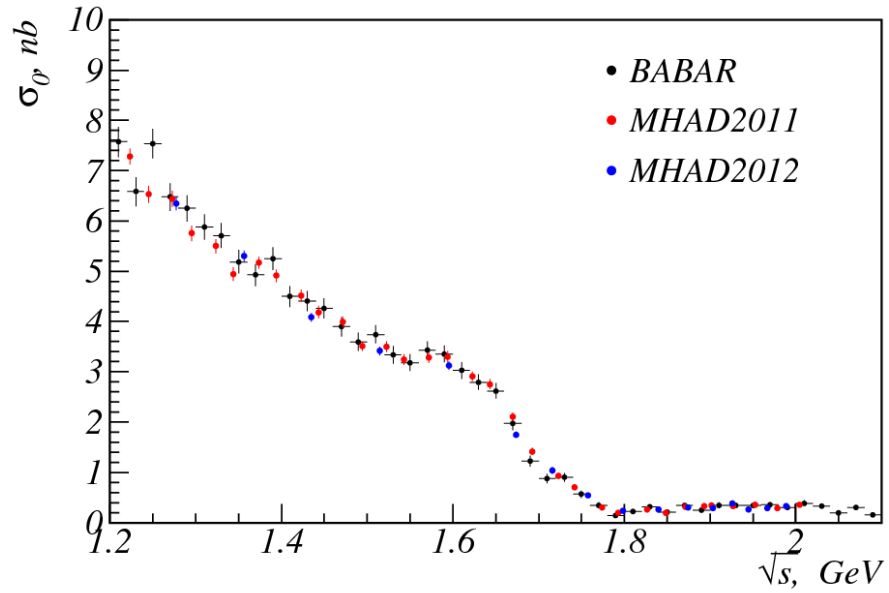


$$\sigma_{K^+K^-}(s) = \frac{\pi \alpha^2 \beta^3}{3s} |F_K|^2$$

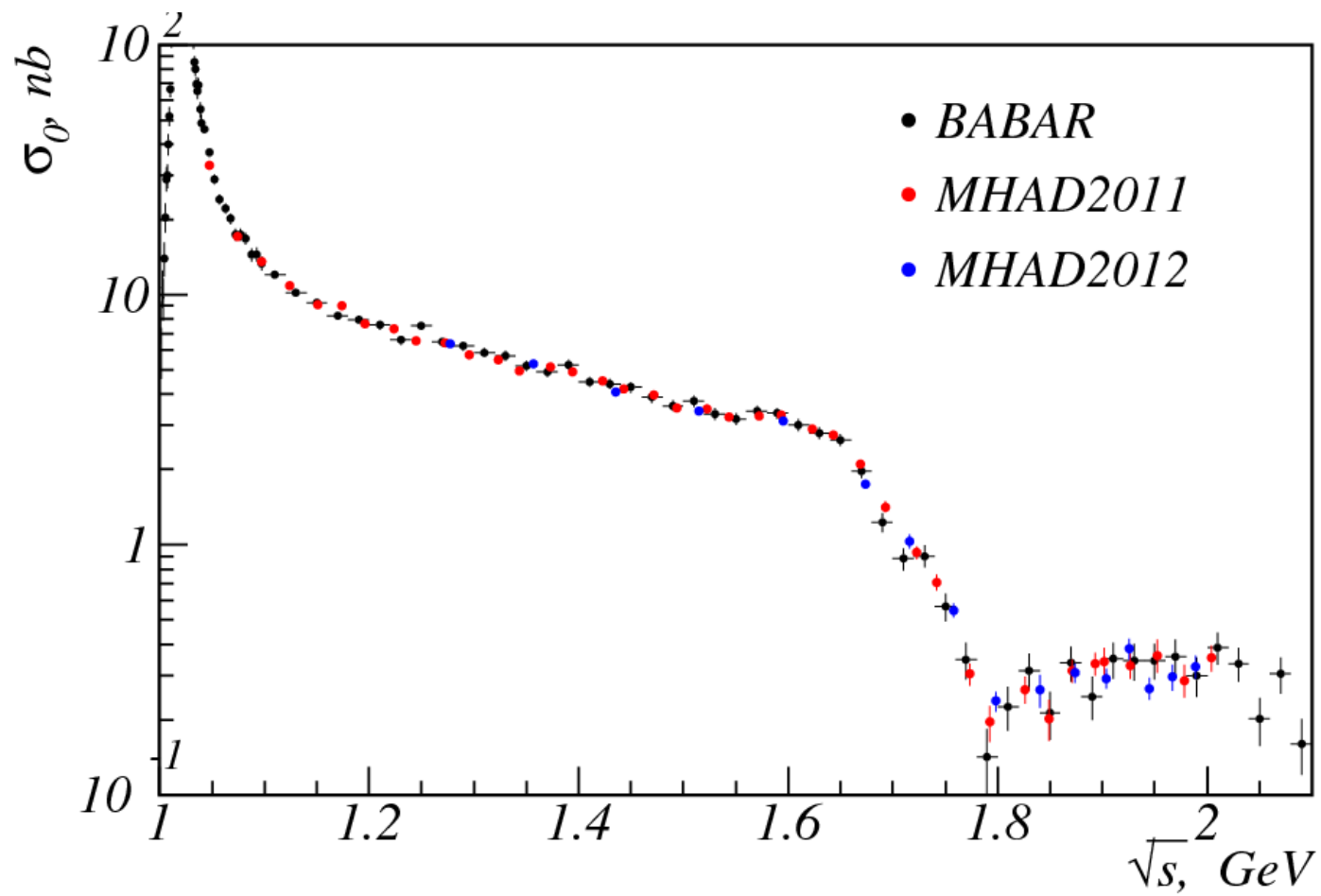
$$J^{PC}=1^{--}$$

$n^{2S+1}l_J$	I=1	I=0	I=0
1^3S_1	$\rho(770)$	$\phi(1020)$	$\omega(783)$
1^3D_1	$\rho(1700)$	—	$\omega(1650)$
2^3S_1	$\rho(1450)$	$\phi(1680)$	$\omega(1420)$

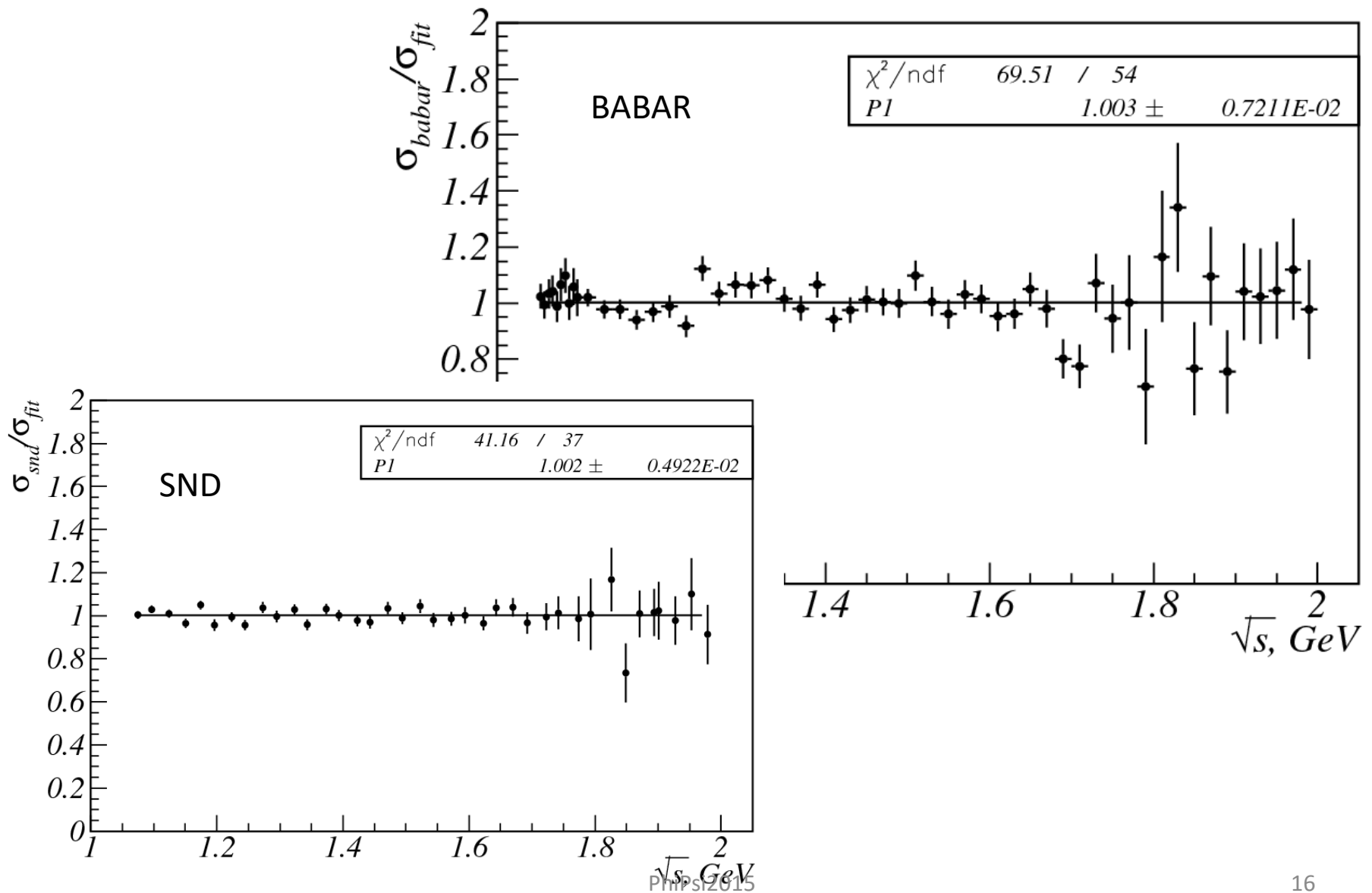
Cross section



Cross section



Ratio of the BABAR cross section to the SND fit



Systematic uncertainties (preliminary)

Source	1.2 GeV < 2E0 < 1.75 GeV	2E0 > 1.75 GeV
Luminosity	0.9 %	0.9 %
Selection cuts	2.1 %	2.1 %
Background subtraction	1 %	<10 %
Total	2.5 %	10 %

Conclusion

- ✓ The $e^+e^- \rightarrow K^+K^-$ cross section has been measured
- ✓ Aerogel identification system is ready for measurements of processes with kaons
- ✓ The cross section
 - is used as contribution to R
 - is used for excited states parameters measurements
 - is not contradict to previous precise results of BABAR