Observation of e+e- → KKJ/ψ at sqrt(s) Between 4189 and 4600 MeV

Preliminary results

BESIII Collaboration

Data Samples

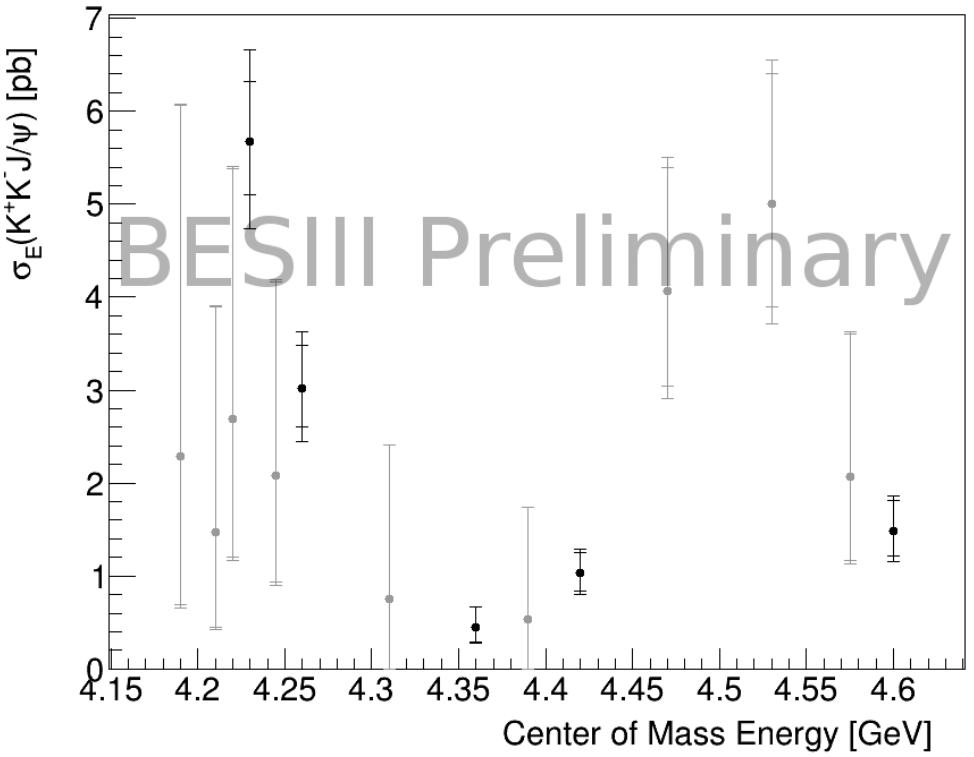
Energy [MeV]	Int. Lumin. [pb^{-1}]
4189	43.1
4208	54.6
4217	54.1
4226	1091.6
4241	55.6
4258	825.7
4308	44.9
4358	539.8
4387	55.2
4416	1073.6
4467	109.9
4527	110.0
4575	47.7
4600	566.9
TOTAL	4672.8

Event Selection

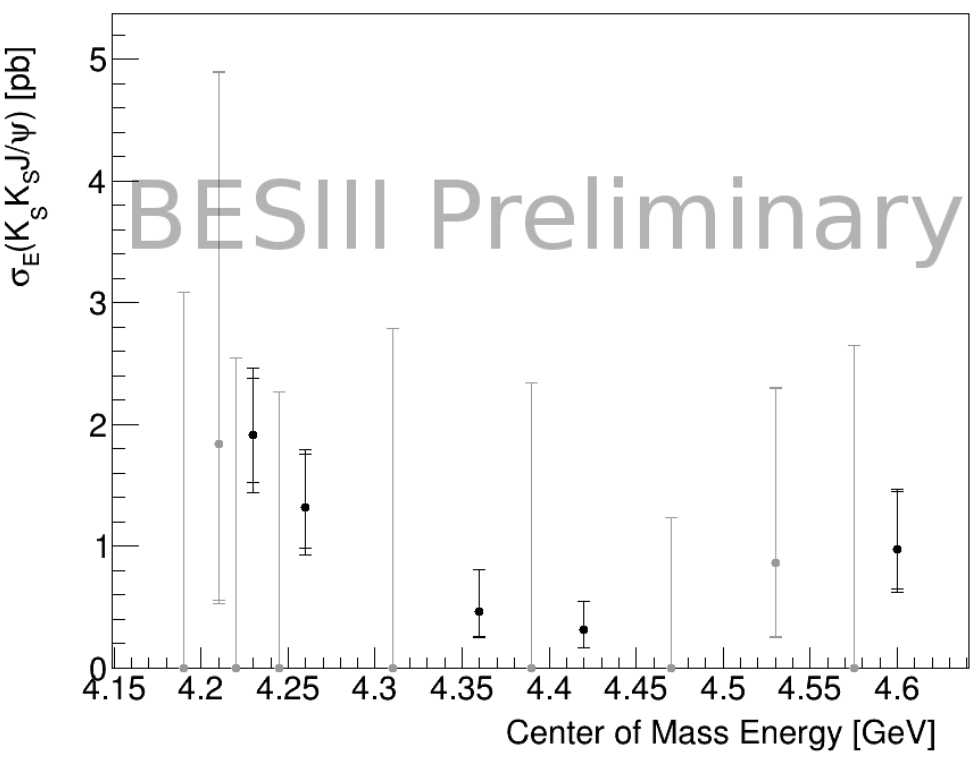
- At least 2(3) positive and 2(3) negative tracks for K^+K^-J/ψ (KsKsJ/ψ)
- "Good" Tracks
  - Angles within $|\cos(\theta)| < 0.93$
  - Tracks $|z| < 10$cm, $|r| < 1$cm from IP
- 4C (6C) fit for K^+K^-J/ψ (KsKsJ/ψ)
  - $\chi^2 < 10$
- For K+/-, Prob(K) PID hypothesis > Prob(π) PID hypothesis
- Opening Angle of Tracks $\cos(\theta) < 0.98$
- E/p < 0.25 for both muons

Results: KKJ/ψ

e+e- → K+K- J/ψ



e+e- → K_S K_S J/ψ

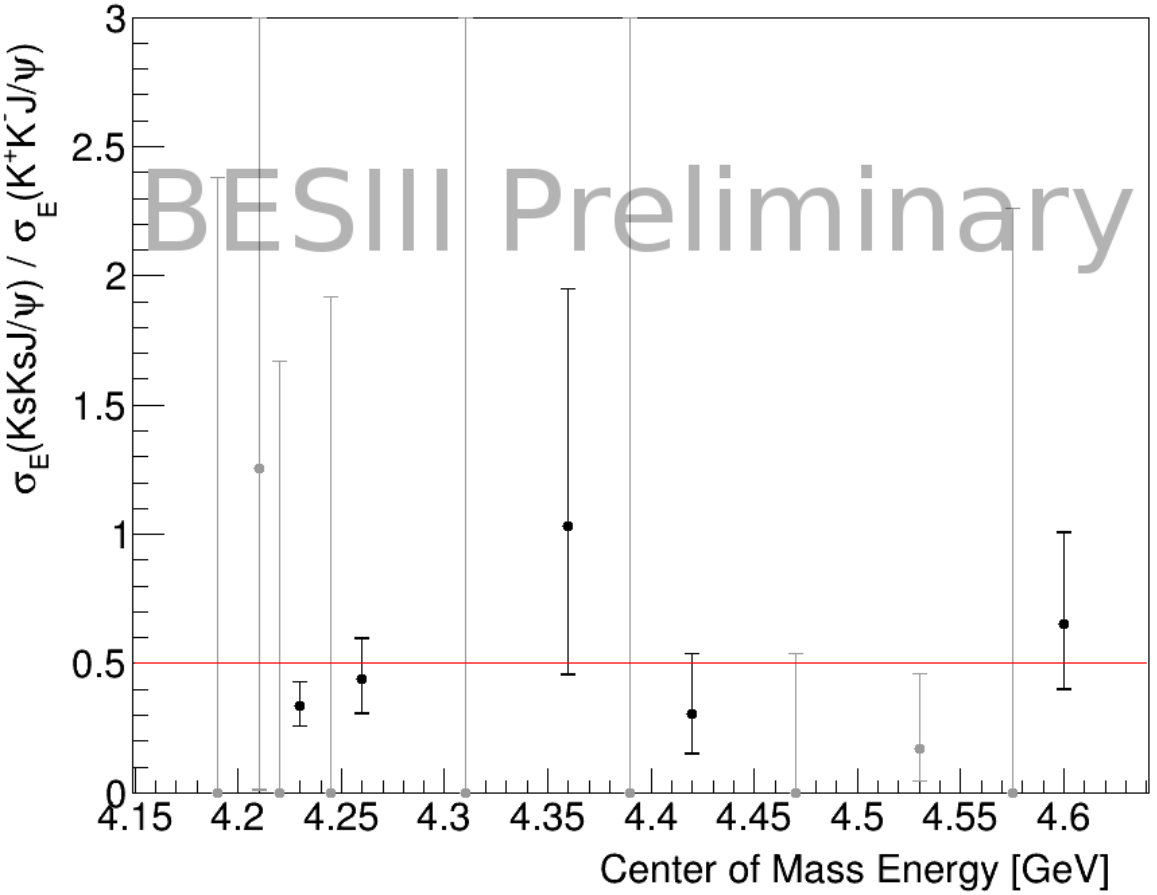


Black Lines: Higher Luminosity Energy Points
Grey Lines: Lower Luminosity Energy Points

The small errorbars are statistical errors, while the larger errorbars are combined statistical and systematic.

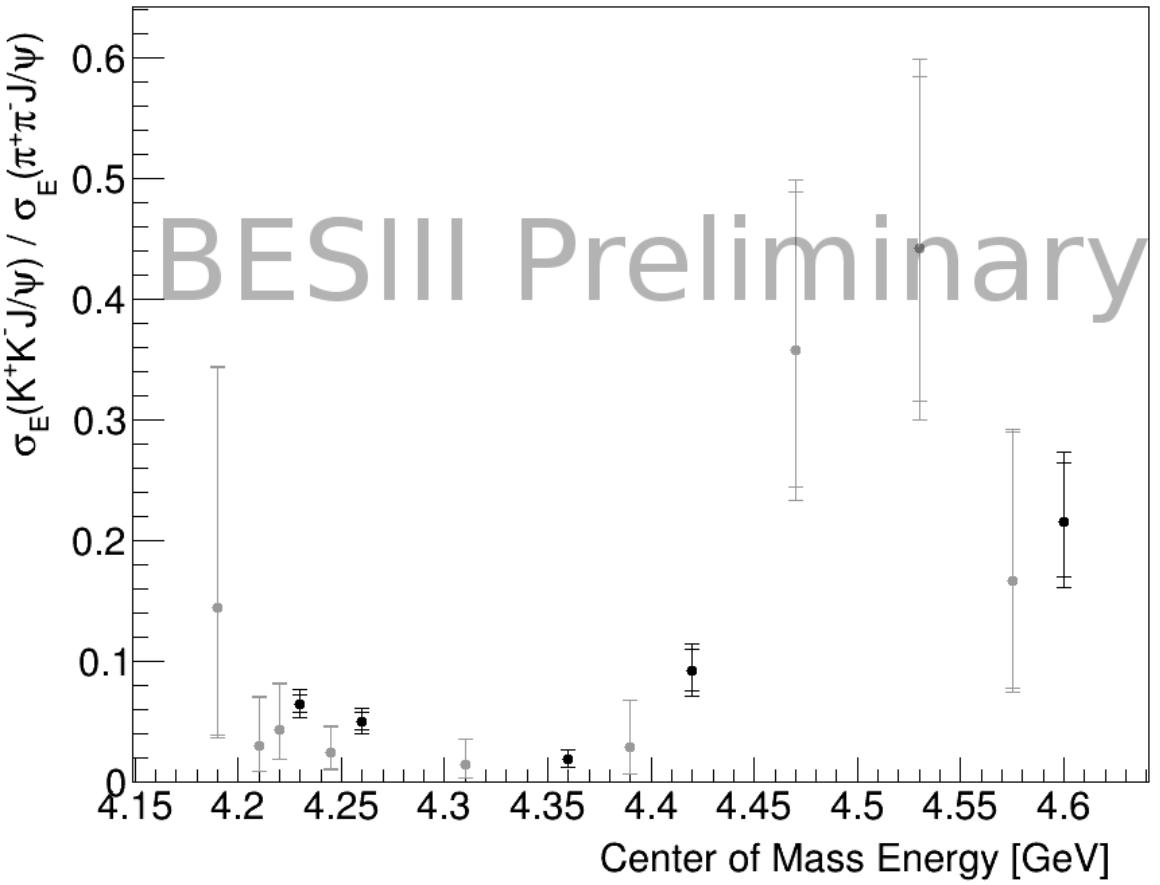
$\sigma_E()$ are the Born Cross-sections for that energy

Results: KsKsJ/ψ to K^+K^-J/ψ Ratio



Red Line:
$\sigma(KsKsJ/\psi) / \sigma(K^+K^-J/\psi) = 0.5$, as predicted by isospin symmetry.

Results: K^+K^-J/ψ to $\pi^+\pi^-J/\psi$ Ratio



Numerical Results

Energy [GeV]	$\sigma_{\text{E}}(K^+K^-J/\psi)$ [pb]	$\sigma_{\text{E}}(K_SK_SJ/\psi)$ [pb]	$\frac{\sigma_{\text{E}}(K_SK_SJ/\psi)}{\sigma_{\text{E}}(K^+K^-J/\psi)}$	$\frac{\sigma_{\text{E}}(K^+K^-J/\psi)}{\sigma_{\text{E}}(\pi^+\pi^-J/\psi)}$
4.189	$2.3^{+3.8}_{-1.6} \pm 0.3$	< 5.1	< 2.4	$0.14^{+0.20}_{-0.11} \pm 0.02$
4.208	$1.5^{+2.4}_{-1.0} \pm 0.2$	$1.8^{+3.0}_{-1.3} \pm 0.3$	$1.3^{+2.9}_{-1.2} \pm 0.1$	$0.030^{+0.040}_{-0.021} \pm 0.004$
4.217	$2.7^{+2.7}_{-1.5} \pm 0.4$	< 4.2	< 1.7	$0.043^{+0.038}_{-0.024} \pm 0.006$
4.226	$5.64^{+0.63}_{-0.57} \pm 0.75$	$1.9^{+0.5}_{-0.4} \pm 0.3$	$0.306^{+0.087}_{-0.072} \pm 0.024$	$0.0644^{+0.0072}_{-0.0067} \pm 0.0094$
4.241	$2.1^{+2.1}_{-1.1} \pm 0.3$	< 3.8	< 1.9	$0.024^{+0.022}_{-0.014} \pm 0.004$
4.258	$2.99^{+0.47}_{-0.41} \pm 0.40$	$1.3^{+0.4}_{-0.3} \pm 0.2$	$0.47^{+0.17}_{-0.14} \pm 0.04$	$0.0499^{+0.0076}_{-0.0070} \pm 0.0073$
4.308	$0.7^{+1.7}_{-0.7} \pm 0.1$	< 4.7	< 6.6	$0.015^{+0.020}_{-0.011} \pm 0.002$
4.358	$0.44^{+0.22}_{-0.15} \pm 0.06$	$0.46^{+0.34}_{-0.20} \pm 0.07$	$1.03^{+0.92}_{-0.57} \pm 0.08$	$0.0185^{+0.0080}_{-0.0063} \pm 0.0027$
4.387	$0.5^{+1.2}_{-0.5} \pm 0.1$	< 3.9	< 5.7	$0.028^{+0.039}_{-0.022} \pm 0.004$
4.416	$1.14^{+0.22}_{-0.19} \pm 0.14$	$0.32^{+0.23}_{-0.15} \pm 0.05$	$0.31^{+0.23}_{-0.15} \pm 0.02$	$0.091^{+0.018}_{-0.016} \pm 0.013$
4.467	$4.0^{+1.3}_{-1.0} \pm 0.5$	< 2.1	< 0.5	$0.36^{+0.13}_{-0.11} \pm 0.05$
4.527	$4.3^{+1.4}_{-1.1} \pm 0.7$	$0.86^{+1.43}_{-0.60} \pm 0.13$	$0.17^{+0.29}_{-0.13} \pm 0.01$	$0.44^{+0.14}_{-0.13} \pm 0.06$
4.575	$2.1^{+1.5}_{-0.9} \pm 0.3$	< 4.4	< 2.3	$0.17^{+0.12}_{-0.09} \pm 0.02$
4.600	$1.53^{+0.33}_{-0.27} \pm 0.20$	$1.12^{+0.50}_{-0.35} \pm 0.14$	$0.65^{+0.35}_{-0.25} \pm 0.05$	$0.215^{+0.049}_{-0.045} \pm 0.031$

Systematic Uncertainties

	$\pi^+\pi^- J/\psi$	$K^+K^- J/\psi$	$K_S K_S J/\psi$
Luminosity	1.0%	1.0%	1.0%
Tracking and PID	4.0%	7.0%	6.0%
Branching Ratios	0.39%	0.39%	0.40%
K_S Reconstruction	-	-	6.0%
J/ψ Resolution	1.0%	1.0%	1.0%
Kinematic Fit	2.6%	3.8%	5.9%
Vacuum Polarization	0.5%	0.5%	0.5%
ISR Correction	4.0%	6.0%	
Z_c Substructure	4.0%	-	
KK Substructure	-	10.0%	
Total	7.5%	14.1%	14.5%

Conclusions

- $\sigma_E(K^+K^-J/\psi)/\sigma_E(\pi^+\pi^-J/\psi)$ inconsistent with flat ratio at 4.226 GeV, 4.258 GeV, and 4.358 GeV

  χ^2 = 16.9 with 2 d.o.f. (3.5σ difference)

  Y(4260) as defined by $\pi^+\pi^-J/\psi$ inconsistent with K^+K^-J/ψ at these energies

- $\sigma_E(K^+K^-J/\psi)/\sigma_E(\pi^+\pi^-J/\psi)$ inconsistent with flat ratio at 4.416 to 4.600 GeV

  χ^2 = 17.6 with 4 d.o.f. (3.0σ difference)

  More complex structure in K^+K^-J/ψ at these energies

- $\sigma_E(KsKsJ/\psi)/\sigma_E(K^+K^-J/\psi)$ combined ratio i$0.370^{+0.064}_{-0.058} \pm 0.018$ which is slightly inconsistent with the isospin symmetry prediction of 0.50 (first err stat, second err sys)

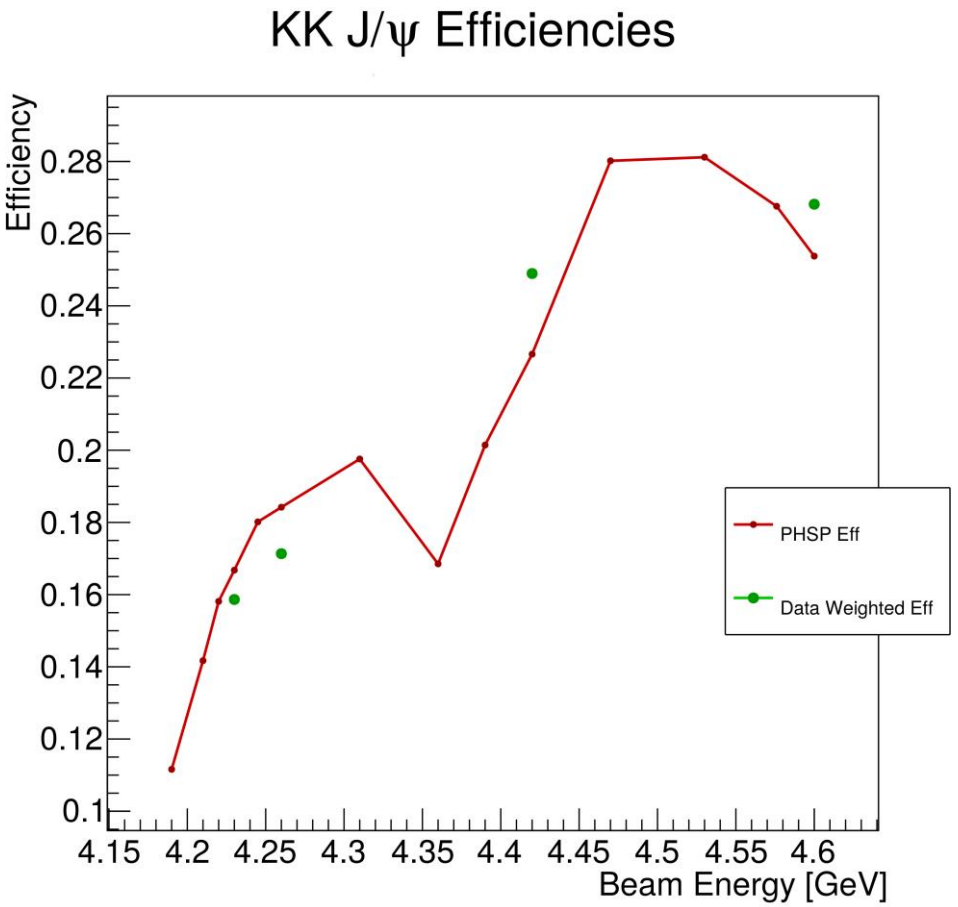
Backups

Systematic Error: KK Substructure (1)

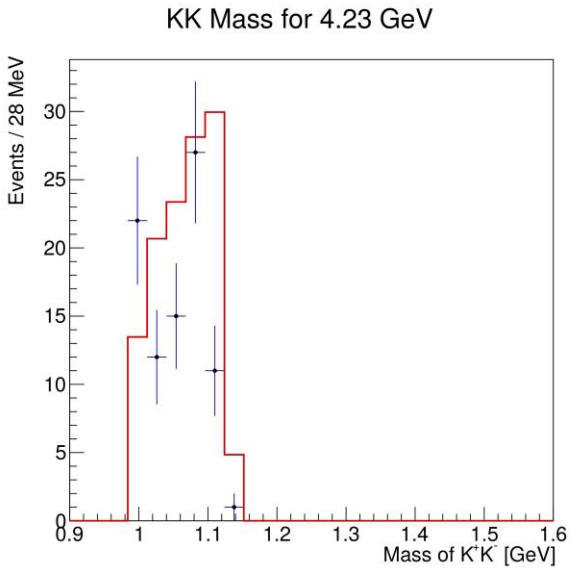
- Largest systematic error for K+K-J/ψ and KsKsJ/ψ at 10%
- Based on difference in efficiency when assuming a Phase Space substructure for KK from Monte Carlo (RED), and the efficiency weighted to the KK substructure seen in the data (GREEN)
- Difference at high-luminosity energy points is about 10%, used as conservative error.

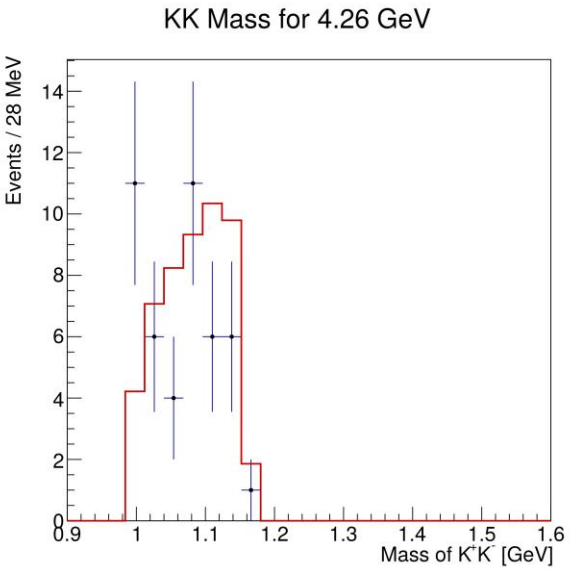
[4230 MeV, 4260 MeV, 4420 MeV, 4600 MeV]

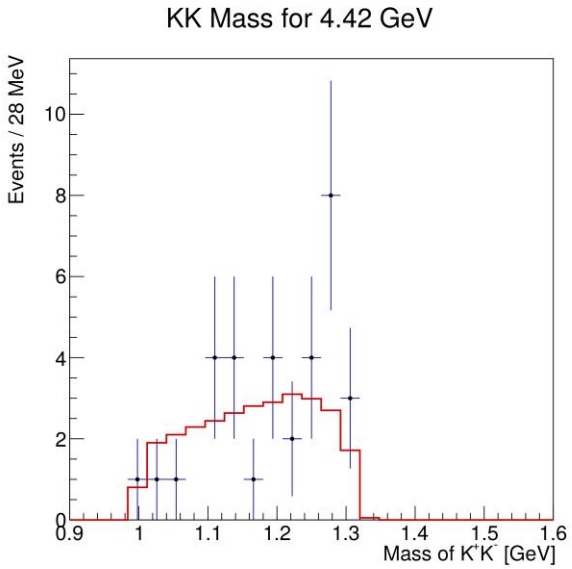
- KK Mass for Phase Space vs KK Mass seen in Data shown on next page.

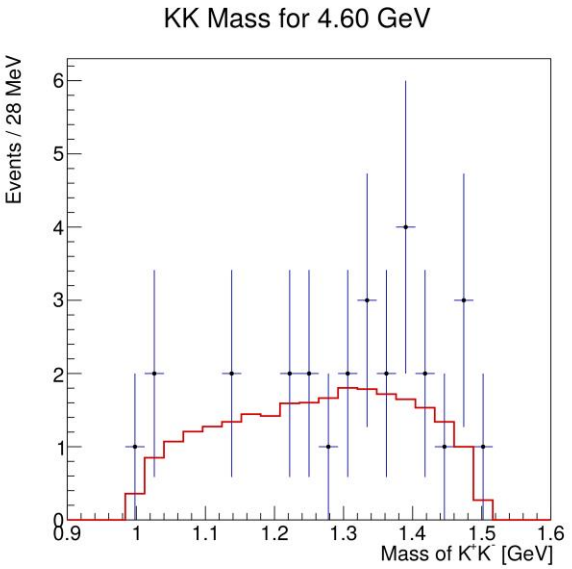


Systematic Error: KK Substructure (2)









Red Histogram:
PHSP Monte Carlo
Points + Errors:
Data