Search for Strangeonia in Photoproduction using CLAS

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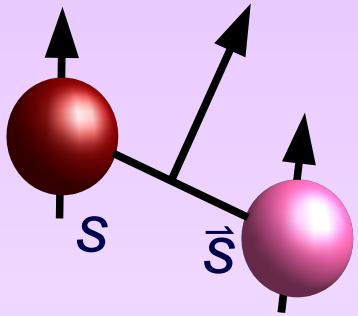
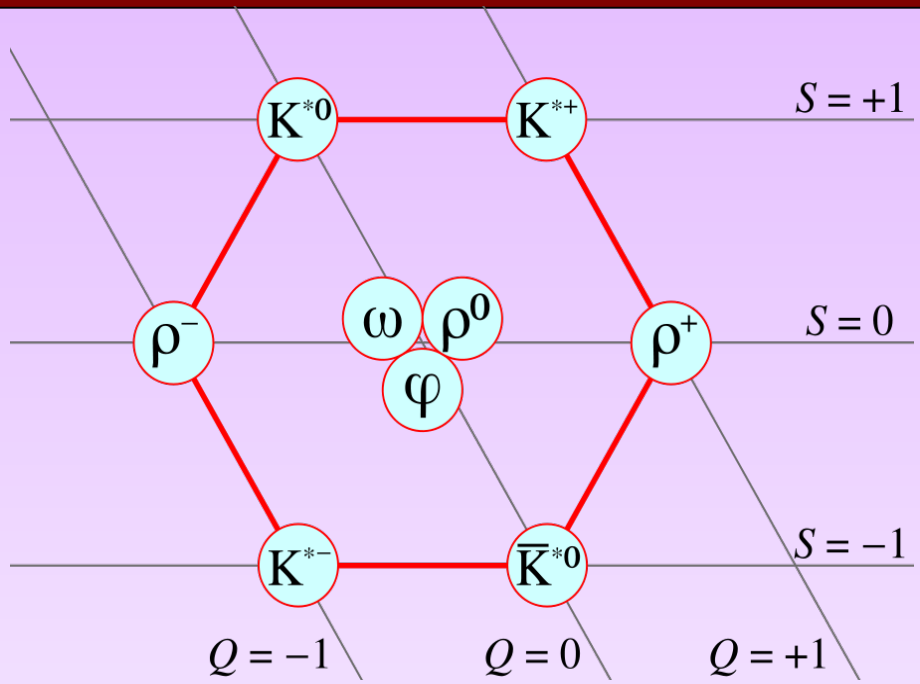
Strangeonia





- Of the **22** expected resonances, only **7** are well identified
  - η-η'
  - ϕ (1020)
  - h_1 (1386)
  - f_1 (1426)
  - f_2' (1525)
  - ϕ (1680)
  - ϕ_3 (1854)

Expected Strangeonia spectrum

			J^{PC}	Name	Mass (MeV)
n=2	L=0	S=0	0^{-+}	η_s	1415
		S=1	1^{--}	ϕ	1680
	L=1	S=0	1^{+-}	h_1	1850
		S=1	0^{++}	f_0	2000
			1^{++}	f_1	1950
			2^{++}	f_2	2000
n=3	L=0	S=0	0^{-+}	η_s	1950
		S=1	1^{--}	ϕ	2050

Radial excitations of (I = 0, $s\bar{s}$) meson.

			J^{PC}	Name	Mass (MeV)
n=1	L=0	S=0	0^{-+}	η,η'	548,958
		S=1	1^{--}	ϕ	1020
	L=1	S=0	1^{+-}	h_1'	1380
		S=1	0^{++}	f_0'	1500
			1^{++}	f_1'	1530
			2^{++}	f_2'	1525
	L=2	S=0	2^{-+}	η_2'	1850
		S=1	1^{--}	ϕ_1	1850
			2^{--}	ϕ_2	1850
			3^{--}	ϕ_3	1854

Orbital excitations of (I = 0, $s\bar{s}$) meson.

Why study Strangeonia?

- QCD is well tested at high mass meson states. Perturbative QCD, quarks essentially free ($\alpha_s << 1$).

  It works reasonably well in the charmonium sector and above.

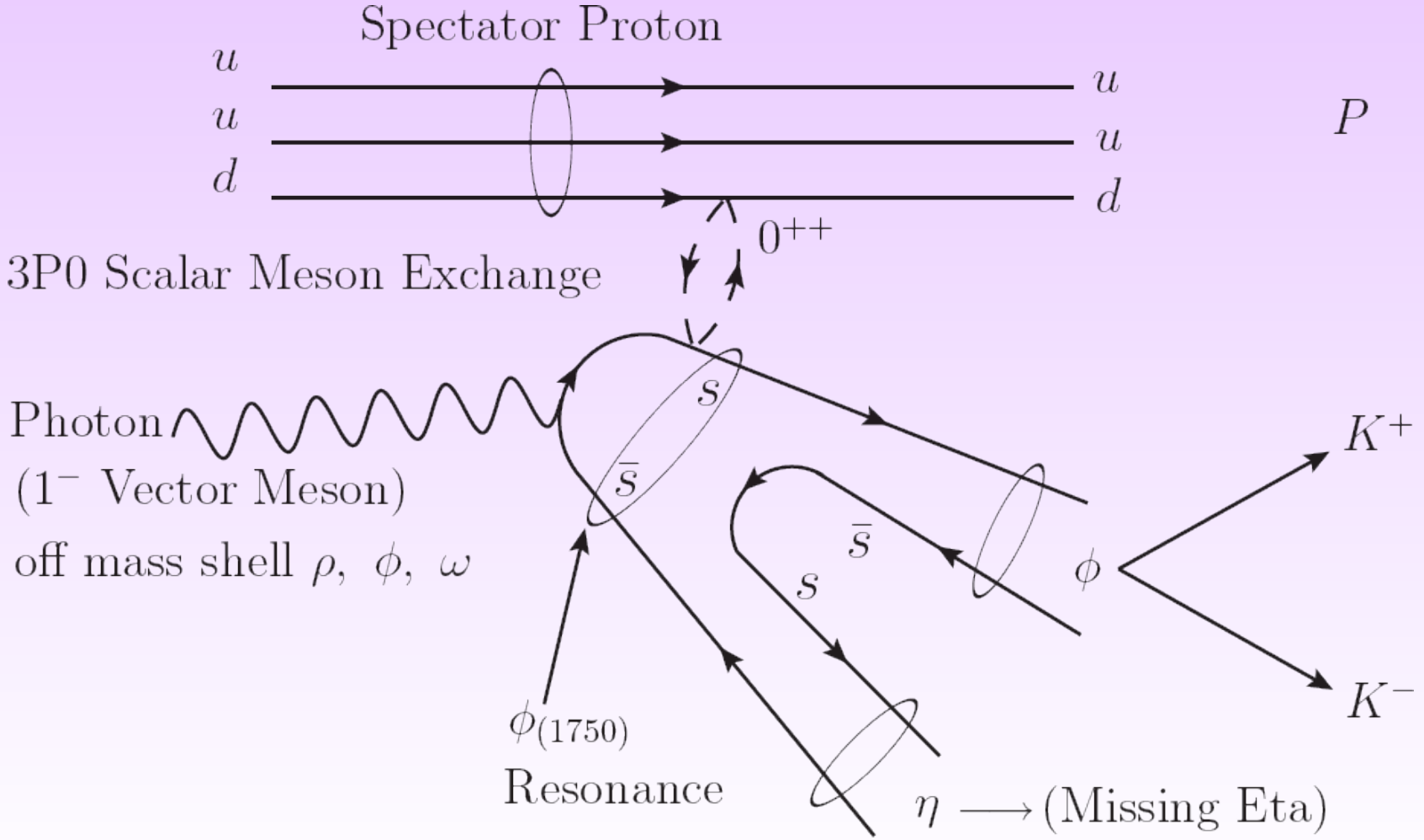
- Perturbative QCD breaks down at the low mass scale. QCD is non-linear in this non-perturbative regime ($\alpha_s \sim 1$). We have to resort to specific hadronic models now.

- Because of the intermediate mass of the strange quarks, study of strangeonium states will serve as a bridge between short and large distance behavior of QCD confinement potential.

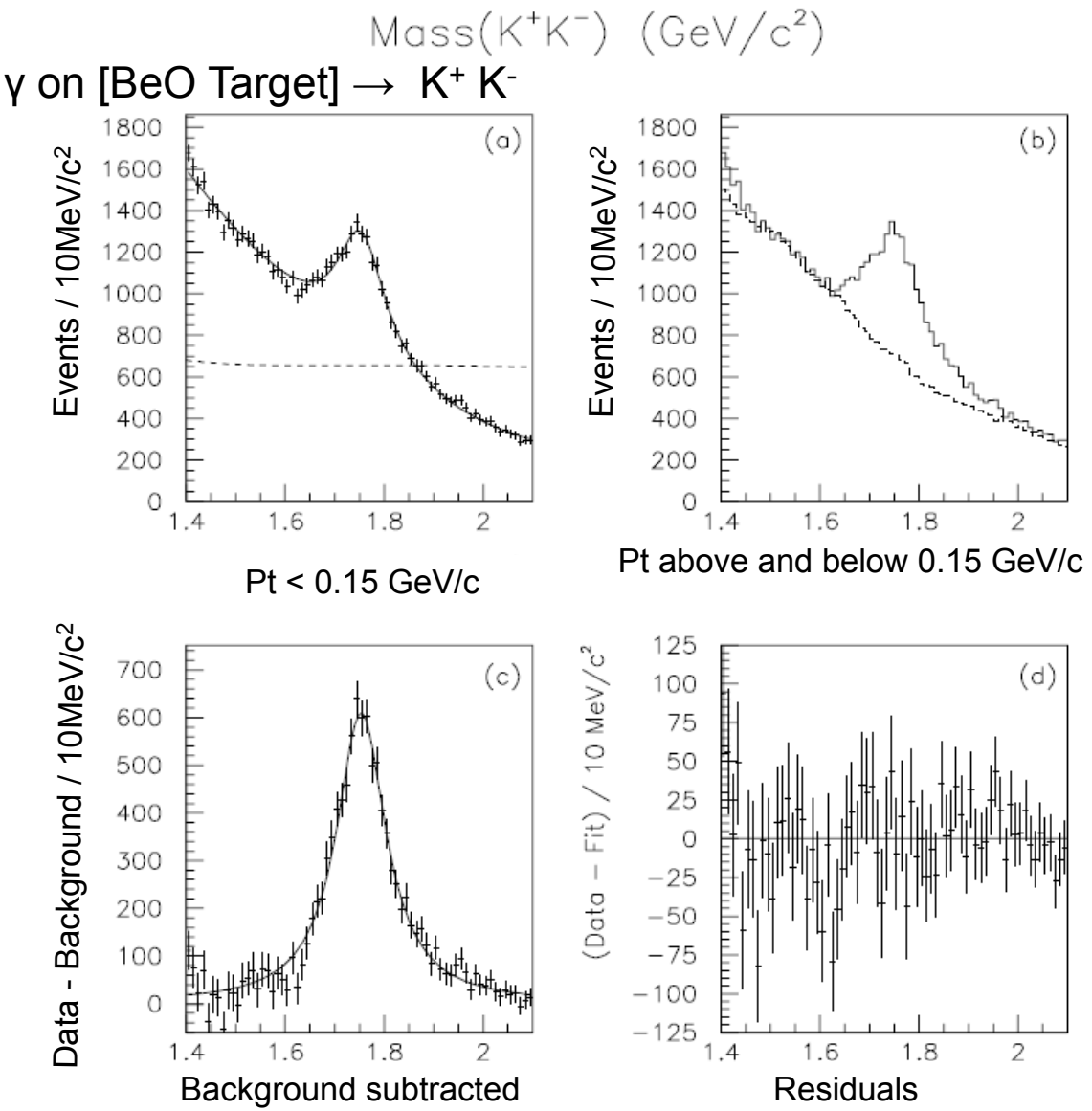
Photoproduction

Vector Meson Dominance

Photon can be regarded as a superposition of vector mesons (ρ, ω, ϕ) with an important $s\bar{s}$ component.



φ(1680)/φ(1750)



- e^+e^- production experiments observe the $\phi(1680)$
- $\phi(1750)$ is cited by PDG under $\phi(1680)$ with a note
- Focus experiment @ Fermilab has ~ 11,700 events for a resonance at $\phi(1750)$
- Exclusive K^+ K^- events
- Cleanest way to look for this resonance is in the $\phi\eta$ decay

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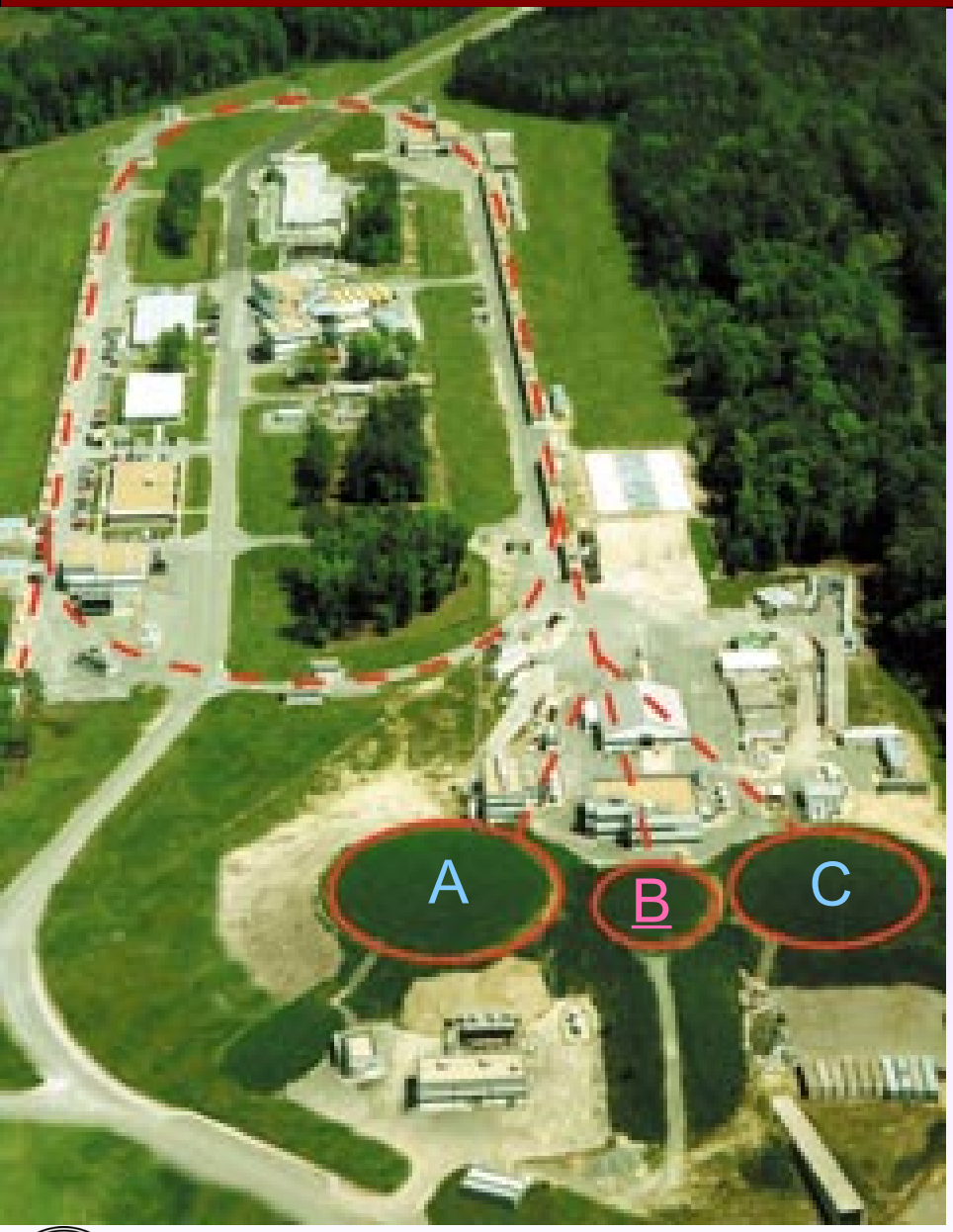
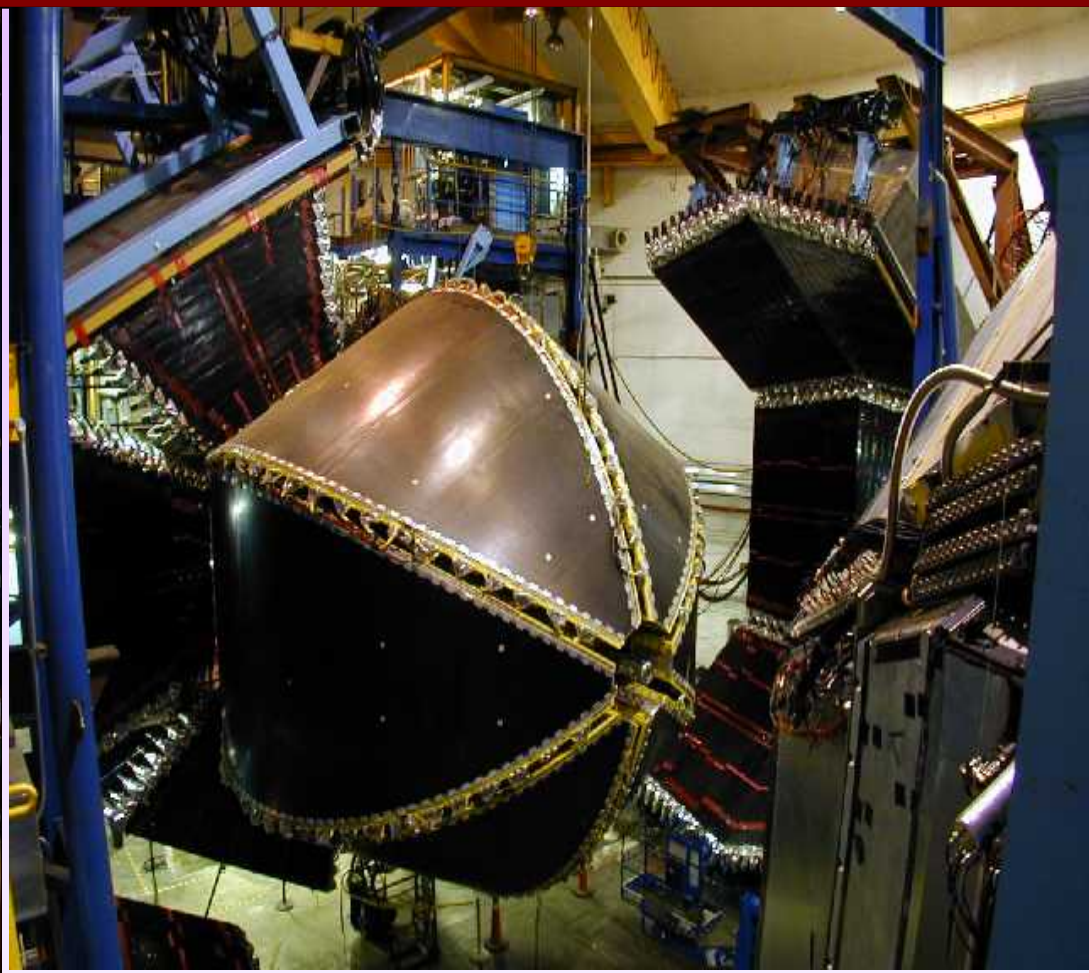


CEBAF: Continuous Electron Beam Accelerator Facility @ Thomas Jefferson National Accelerator Facility, Newport News, Virginia.

- Operated for U.S. DOE by JSA, LLC.
- CEBAF delivers e^- beams to the 3 Halls. Polarised if requested. 5-pass beam. Energies up-to 6 GeV (1.2 x 5).
- Hall-B is the smallest experimental Hall with the largest detector "CLAS".

CLAS



- Skeletal superconducting Toroidal Magnets for CLAS.
- CLAS detector during assembly.

g12 Data Summary

Commissioned : April 1, 2008 Completed : June 9, 2008

- 44.2 Days of beam-time over 70 calendar days
- **Beam current ~ 60-65 *nA***
- **E_e = 5.71 *GeV***, DAQ Rate ~ 8 *KHz*
- 26.2 billion triggers, 68 pb^{-1} of data
  - 2 prong or more, **$E_\gamma \geq 4.4$ *GeV***
  - 3 prong with no MOR, etc.
- **126 *TB*** of raw data on tape

Preliminary plots from ~ 1/3rd of g12 data

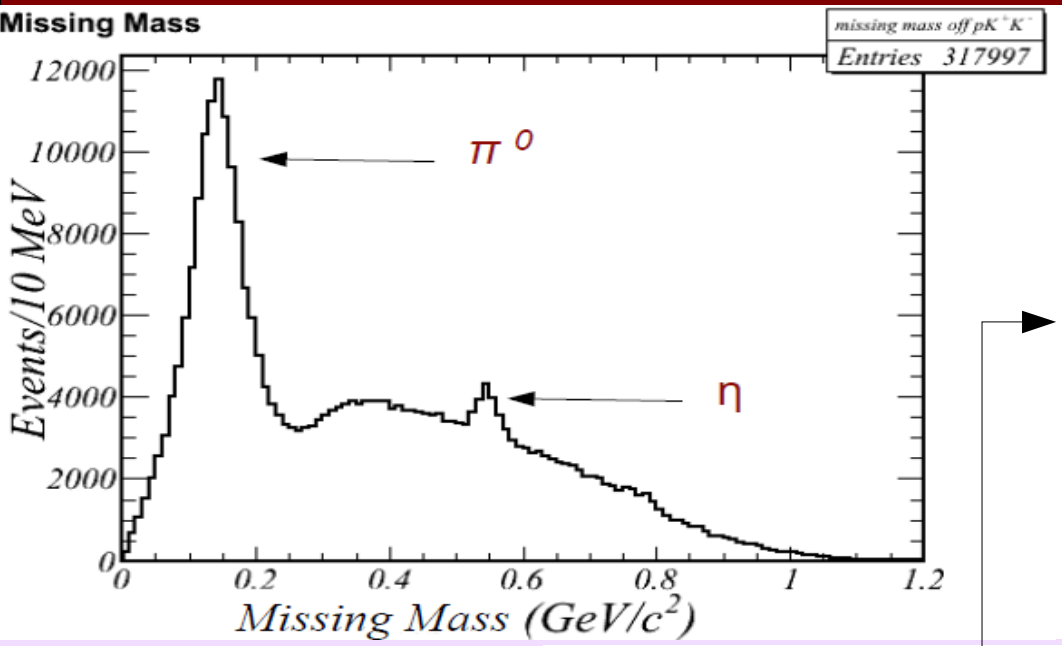
Analysis & Event Selection

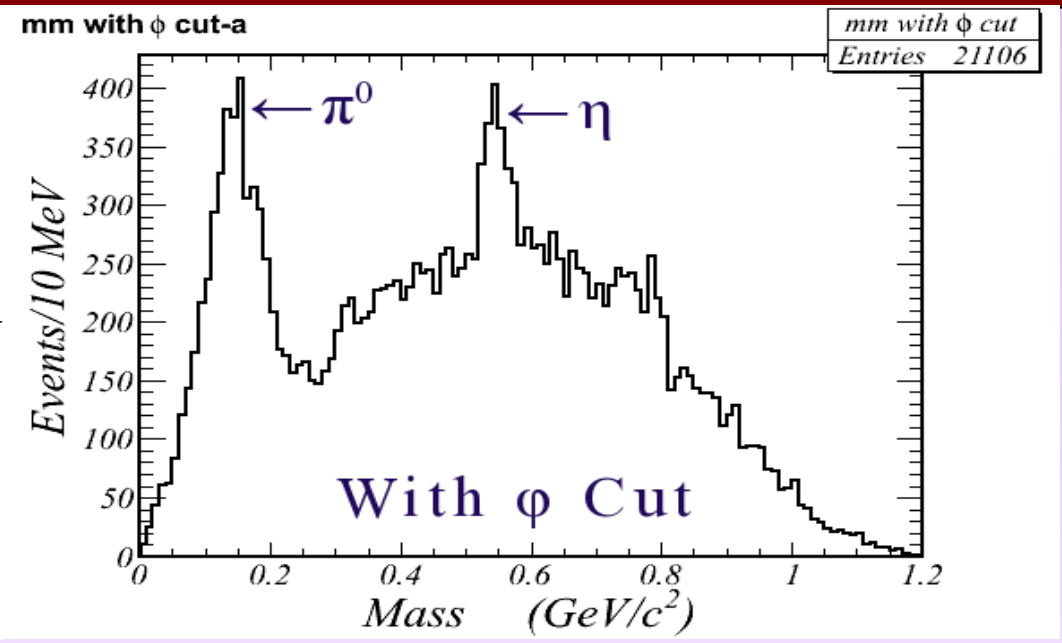
- $\gamma \; p \rightarrow p \; \varphi \; (\eta / \pi^0)$
- $\varphi \rightarrow K^+ K^-$
- η / π^0 *identified by missing mass*

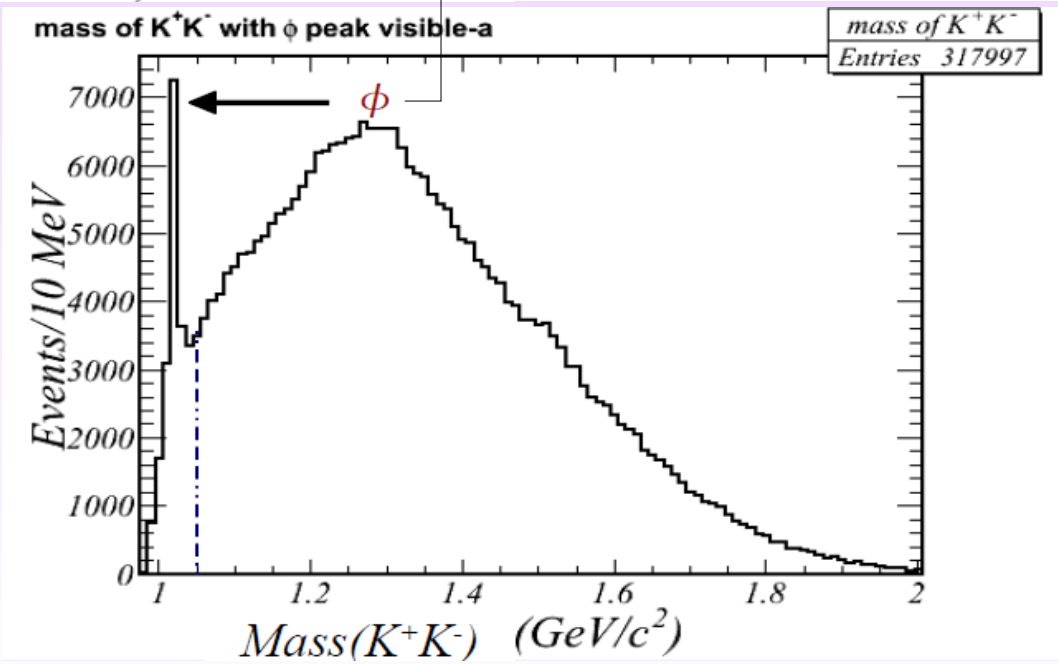
- **Standard Cuts**
  - 3 charged tracks
  - Proton, K^+, K^-
  - Beam Energy > 4.4 GeV
  - Event Vertex (|x| < 1cm, |y| < 1cm, -70cm < z < -110cm)
  - |Photon time – Event vertex time| < 1 ns
- **Beta Cut**
  - | TOF β – Calculated β | < 0.01

Search for Strangeonia in HyCLAS

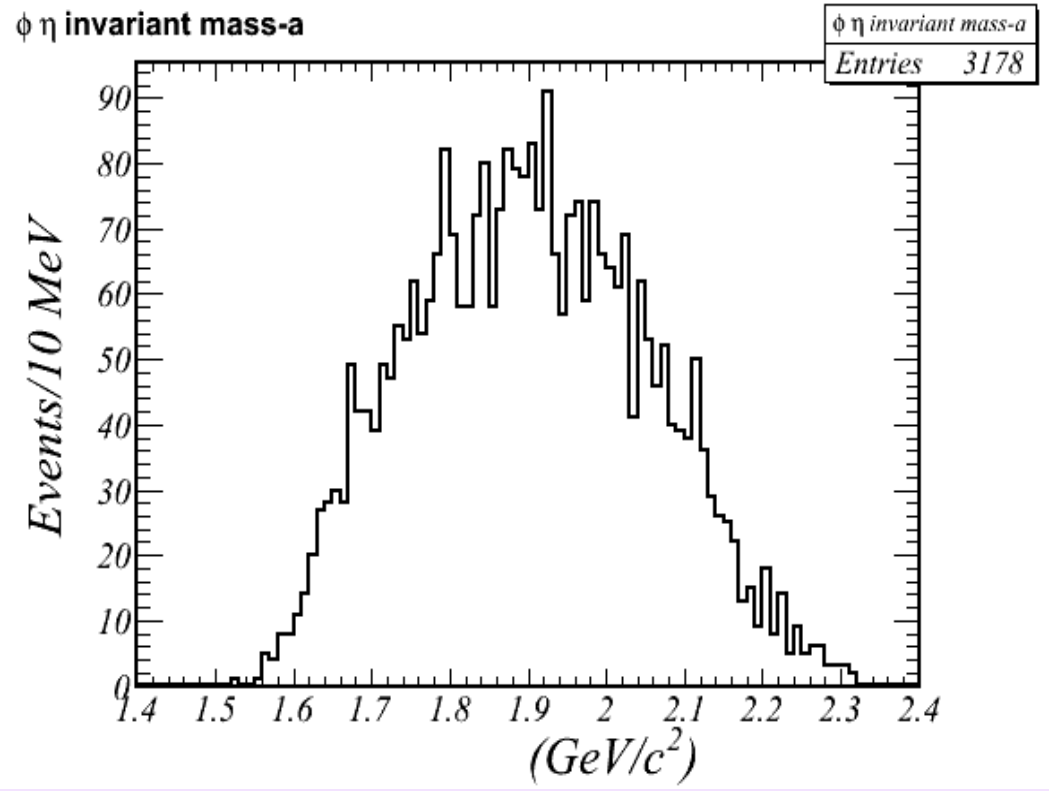
$\gamma\ p \rightarrow p\ K^+\ K^-\ [X]$



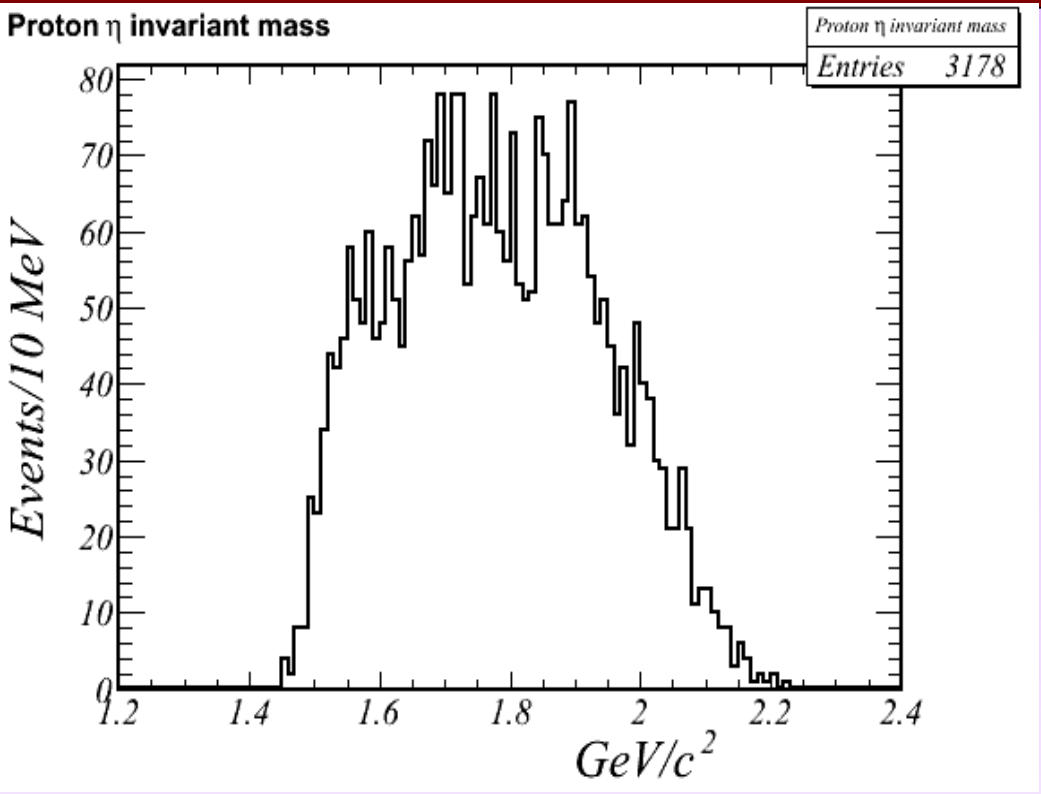




$\gamma\ p \rightarrow p\ \varphi\ [\eta]$



Mass(φ [η])

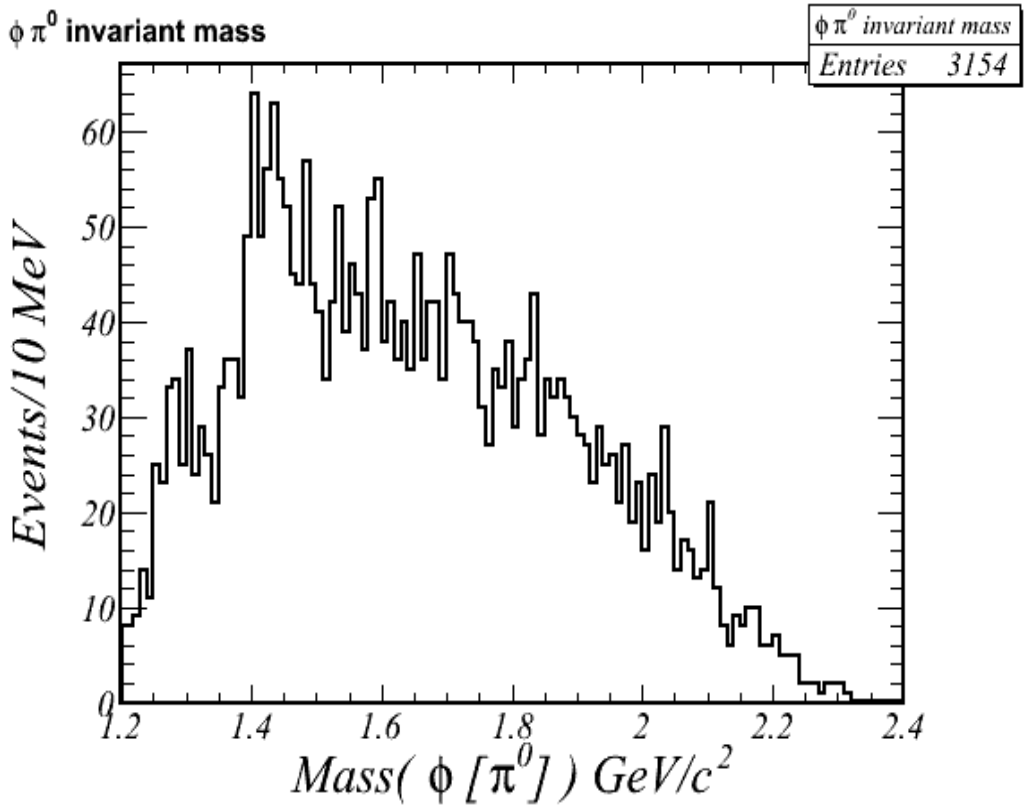


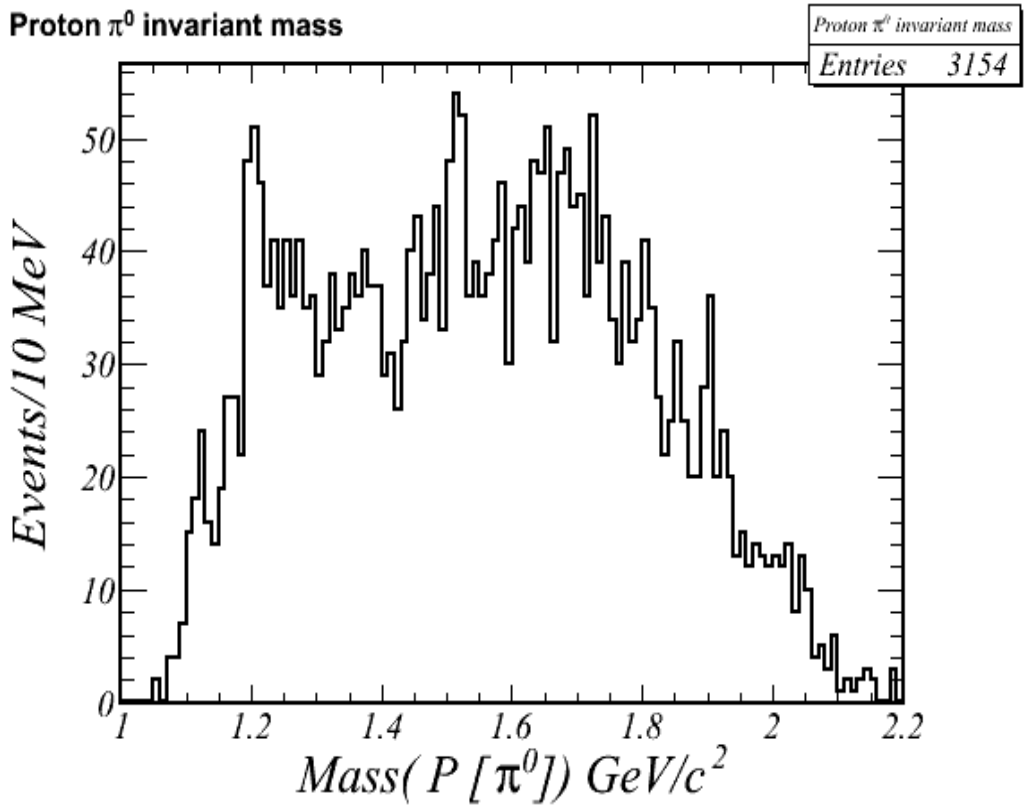
Mass(p [η])

Cuts (φ , η) → Mass ($K^+ K^-$) < 1.050 GeV/c^2 ,
0.500 GeV/c^2 < Missing Mass < 0.600 GeV/c^2

- Invariant mass for events with a φ meson and an eta meson identified through cuts on missing mass

$\gamma\ p \rightarrow p\ \varphi\ [\pi^0]$





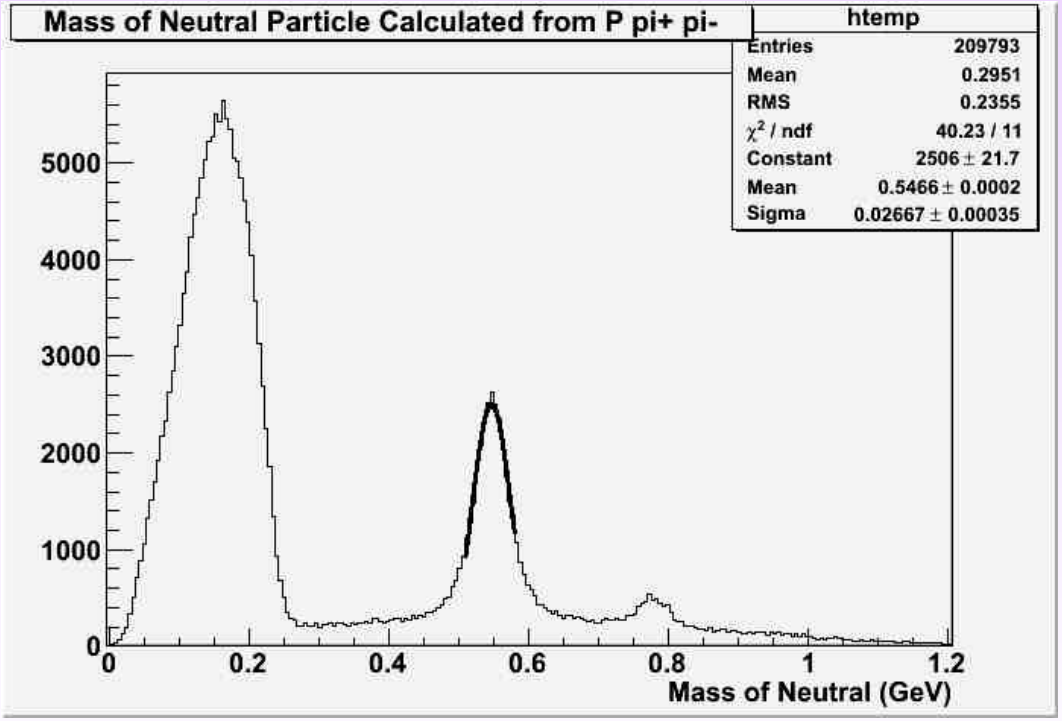
Cuts (φ , π^0) $\rightarrow$ Mass ($K^+ K^-$) < 1.050 GeV/c^2 ,
0.090 GeV/c^2 < Missing Mass < 0.190 GeV/c^2

- Invariant mass for events with a φ meson and a π^0 meson identified through cuts on missing mass

Things to do

- Momentum corrections
- Monte-Carlo simulations
- Tagger energy corrections
- Acceptance corrections
- Use EC to clean up Data

Plot from η-π^0 analysis from g12
by
Diane Schott (FIU)



Summary

- Strangeonia is quite an interesting and important sector to look at. It will give us an insight into Non-perturbative QCD regime.
- g12 has a huge data set that has been calibrated, is being processed and is now available for analysis.
- From preliminary analysis, we observe $\gamma p \rightarrow p \varphi \eta$, which is an ideal channel for observation of strangeonia.