CLAS Update on g12 & a Preliminary Look at Strangeonia

Mukesh Saini

Florida State University, Tallahassee, FL

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g12 Statistical Summary

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

Production Triggers

- 44.2 days of beamtime (over 70 calendar days)
- I $\backsim$ 60-65 nA (DC occupancy $\backsim$ 3%, DAQ rate $\backsim$ 8 kHz)
- 26.2 billion triggers (68 pb^{-1})
  - 2 prong, no L2, $E_\gamma > 4.4$ GeV
  - EC*CC
  - 3 prong w/ no MOR, etc

Single-Sector Trigger

- I = 24 nA
- 2.0 days beamtime
- 1 billion triggers (1.9 pb^{-1})

Calibrators

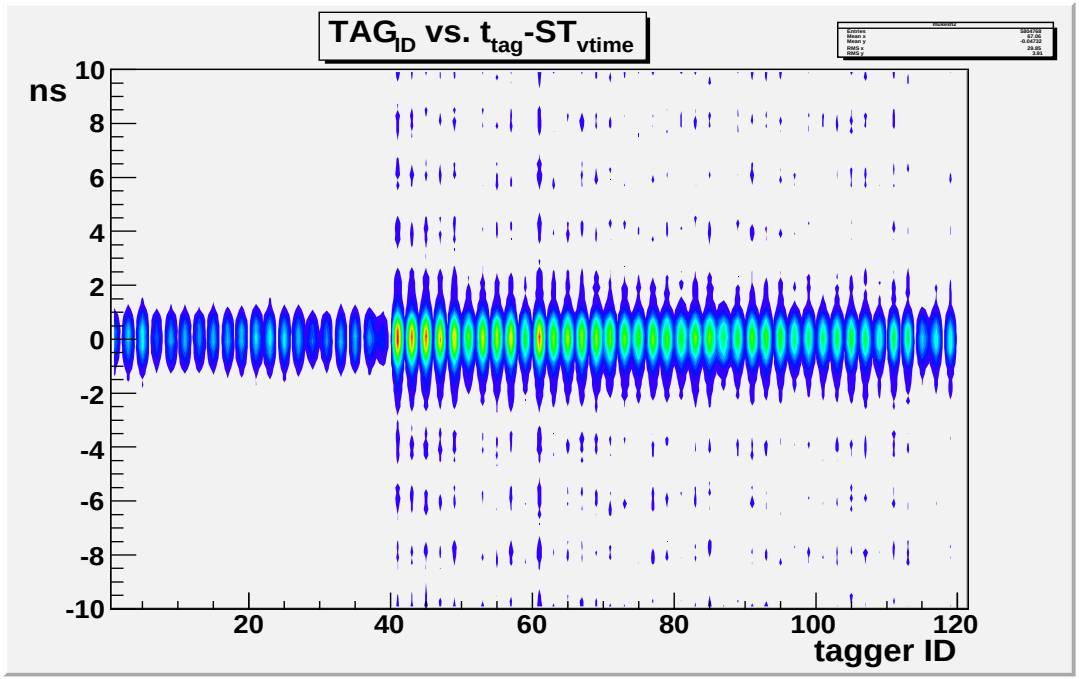
Detector subsystem ⇒ People responsible

- Cherenkov ⇒ Rakhsha Nasseripour & Michael Paolone
- Electromagnetic Calorimeter⇒ Mike Wood & Diane Schott
- Start Counter ⇒ Mukesh Saini
- Tagger ⇒ Mukesh Saini
- Time of Flight ⇒ Craig Bookwalter
- IC Hodoscope ⇒ John Price

Cooking

- Chef ⇒ Johann Goetz
- Troubleshooter/TroubleMaker ⇒ Johann Goetz

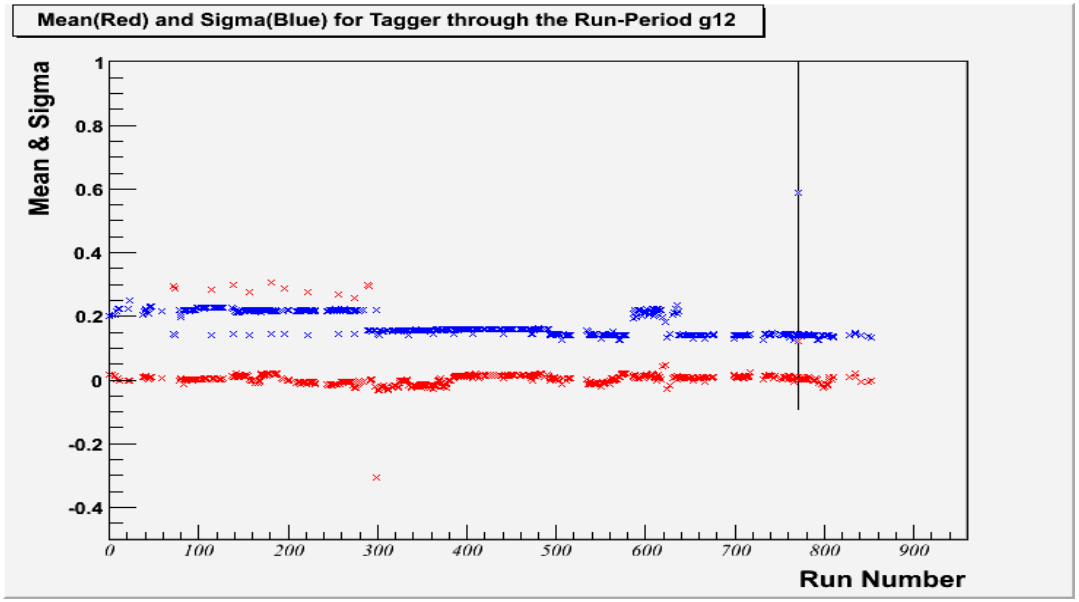
g12 Tagger Calibration Status



Mukesh:

- This plot shows that a hit in the start counter picks the right RF bucket. If one of the T-counter in the tagger is not aligned, it would show up here.

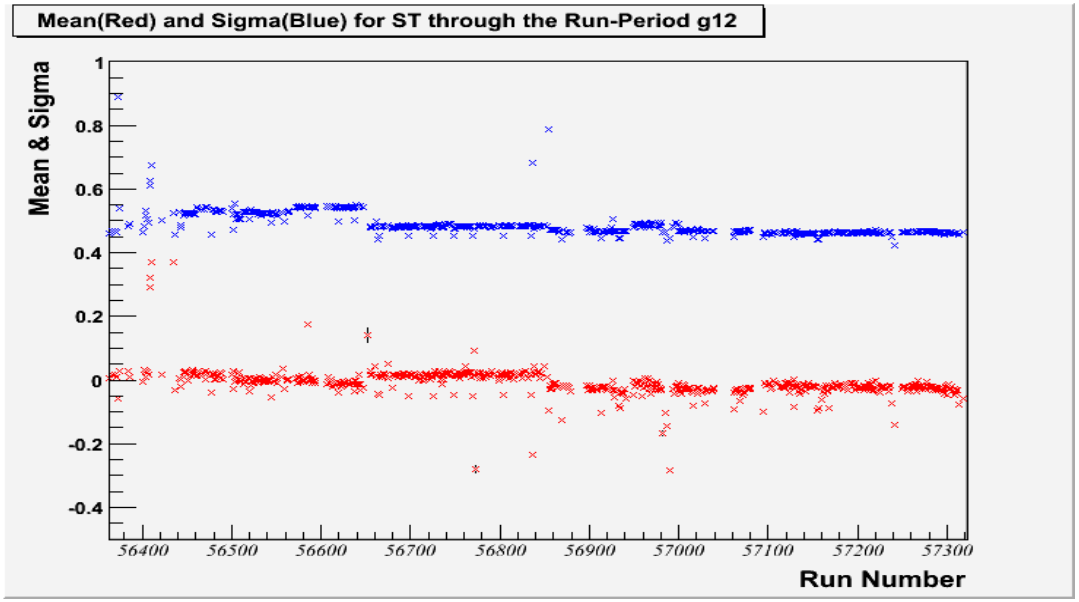
Tagger Run by Run Status



Mukesh:

- This plot is from one of the previous passes.
- E-counters for runs 56941 - 56999 have been adjusted and the offset doesn't show anymore.
- Resolution remains more or less constant except for low current runs and runs after 56653 when we had a trigger change.

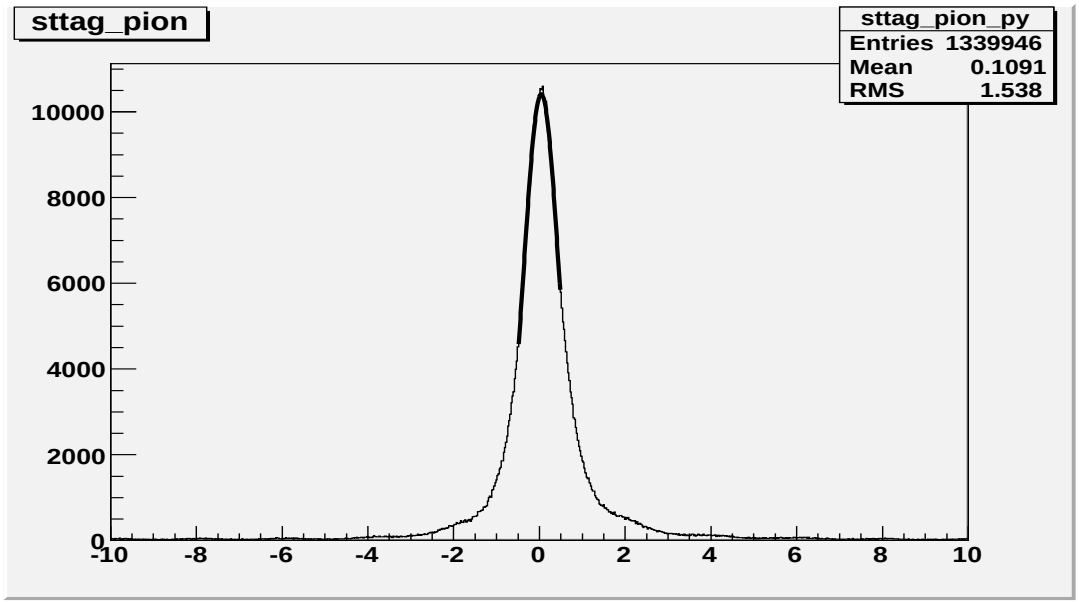
g12 Start Counter Calibration Status



Mukesh:

- This plot is from one of the previous passes.
- The change in resolution for low current runs and runs later than 56553 are more apparent in ST calibrations as shown here. They vary from 480-410 for our runrange.
- Some fine-tuning of time-walk corrections is being undertaken to better resolutions for both pions and protons.

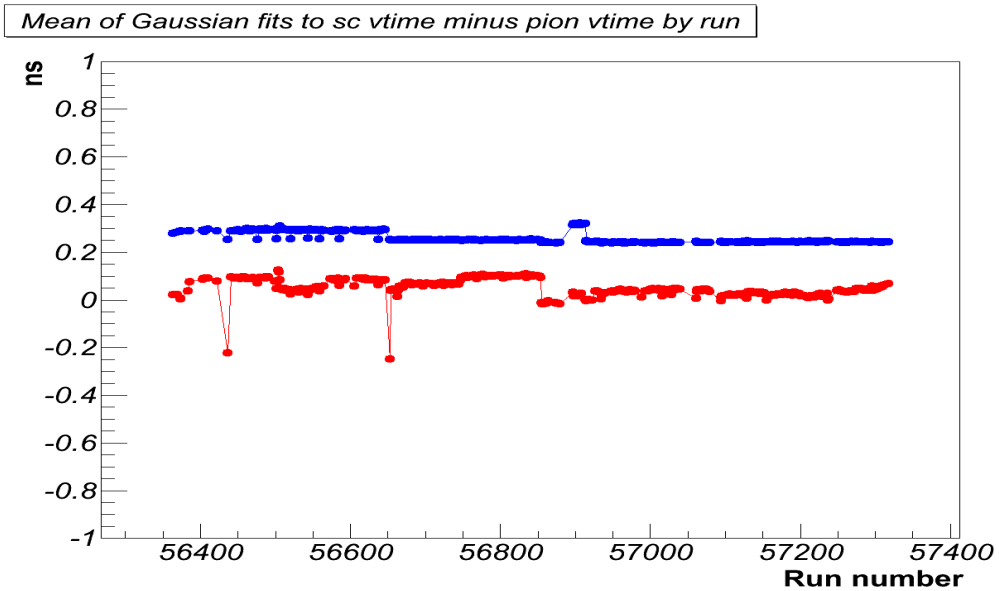
A single run resolution plot for ST



Mukesh:

- This is a plot of RF vertex time - ST vertex time (in the start counter).
- Current run resolution as observed stands at 410 ps from the last pass for Run 56866.
- ST Resolution vary during the run. Its low for low intensity run and after the trigger change around run 56653.

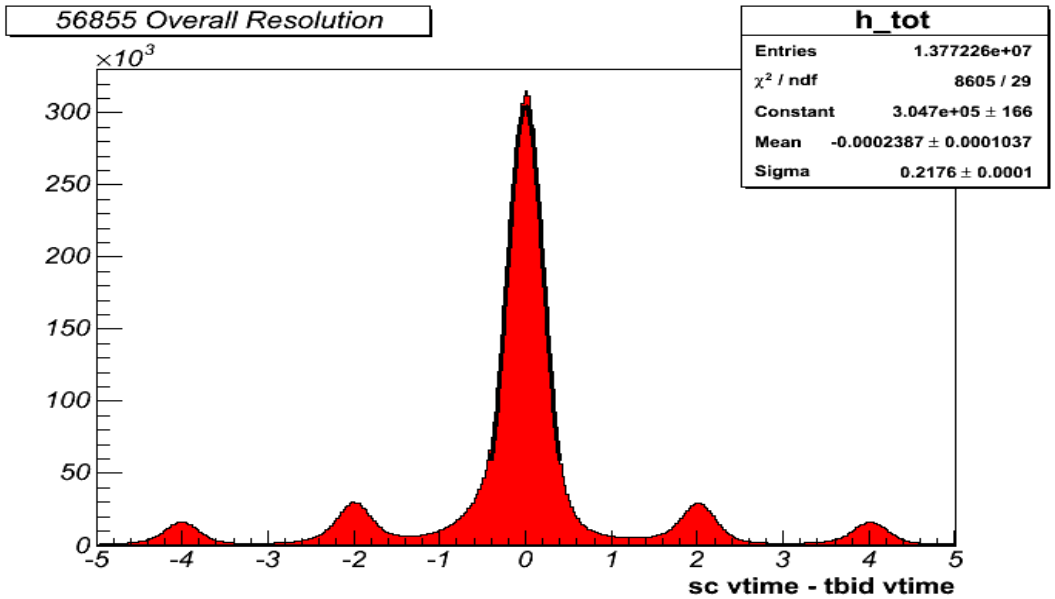
TOF Run by Run Status



Craig:

- Run-by-run stabilization is almost complete.
- Resolution issues have been sorted out. It was discovered that time-walk parameters from 8 years ago give better TOF resolution than current ones obtained from laser data.

A single run resolution plot for TOF



Craig:

- This is a plot of RF vertex time - TOF vertex time.
- Current run resolution as observed stands at 218 ps from the last pass for run 56855.

CC DC EC IC

- CC Status
  - Issues were identified and fixed. Better data & calibrations expected in the next pass.
- DC status
  - Alignment and timing calibrations done. They are satisfactory. Awaiting new pass results. Resolution in last pass was 350-550 μ for superlayers 1-6.
- EC status
  - Energy Calibrations done. Timing calibrations ongoing.
- IC hodoscope status
  - minor progress made.

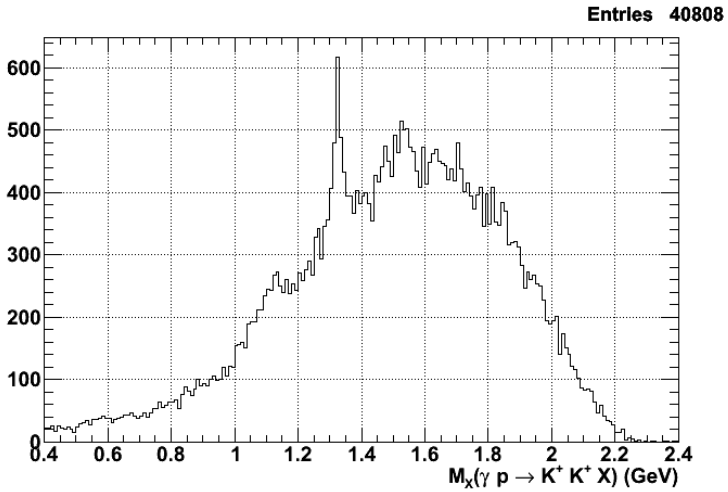
Students working with g12 Analysis

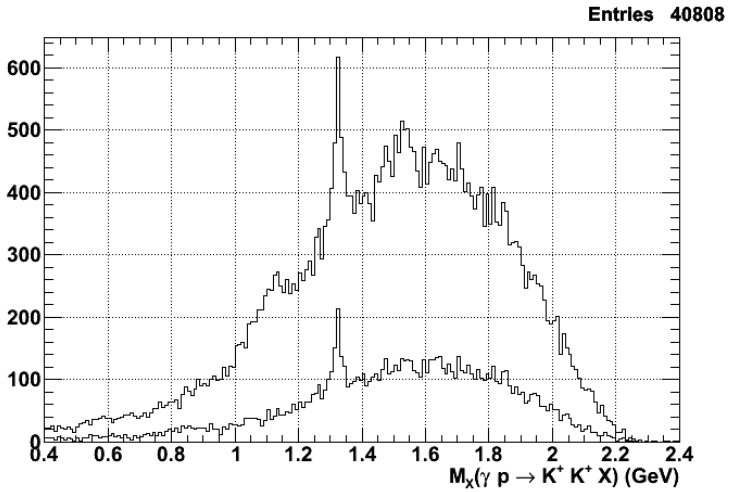
- Craig Bookwalter, FSU
  - $\gamma\ p \rightarrow \pi^+\ \pi^+\ \pi^-\ (n)$
- Johann Goetz, UCLA
  - $\gamma\ p \rightarrow K^+\ K^+\ (\Xi^{*-}_{1530})$
- Mukesh Saini, FSU
  - $\gamma\ p \rightarrow p\ K^+\ K^-\ (\eta/\pi_0)$
- Diane Schott, FIU
  - $\gamma\ p \rightarrow p\ \pi^+\ \pi^-\ (\eta)$
- Jane Spriggs, RPI
  - $\gamma\ p \rightarrow \pi^+\ K^+\ K^-\ (n)$

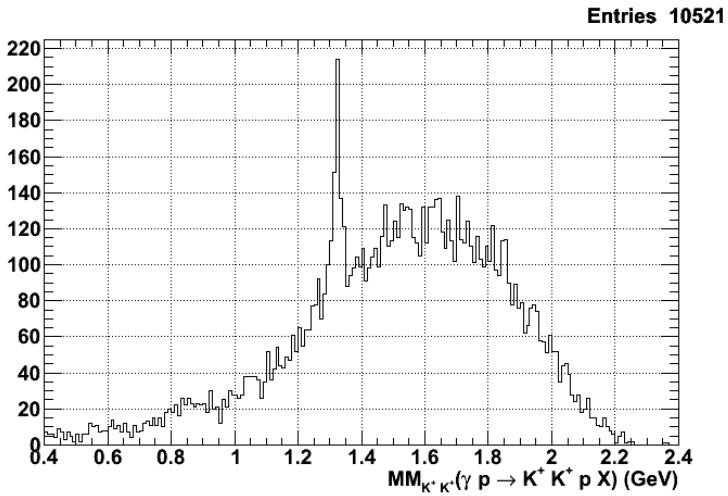
$\gamma p \rightarrow \pi^+\pi^+\pi^-(n)$ (Craig Bookwalter)

Look forward to Craig Bookwalter's talk in a few minutes!!

$\gamma p \rightarrow K^+K^+(\Xi^-)$ (Johann Goetz)

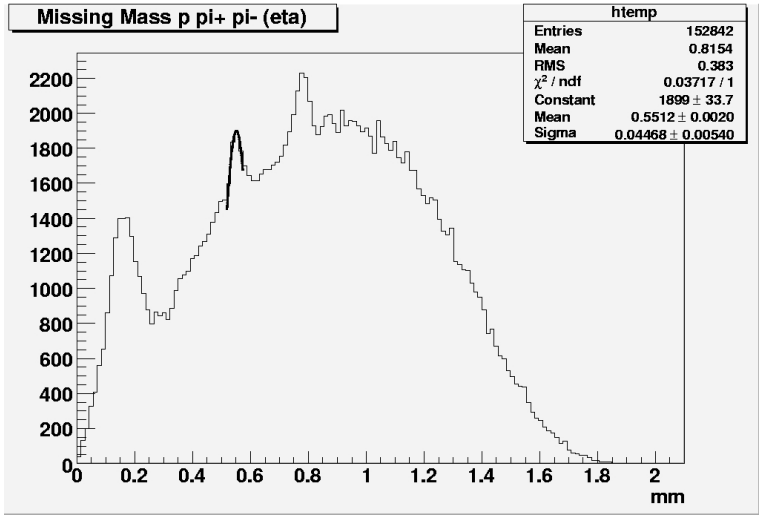


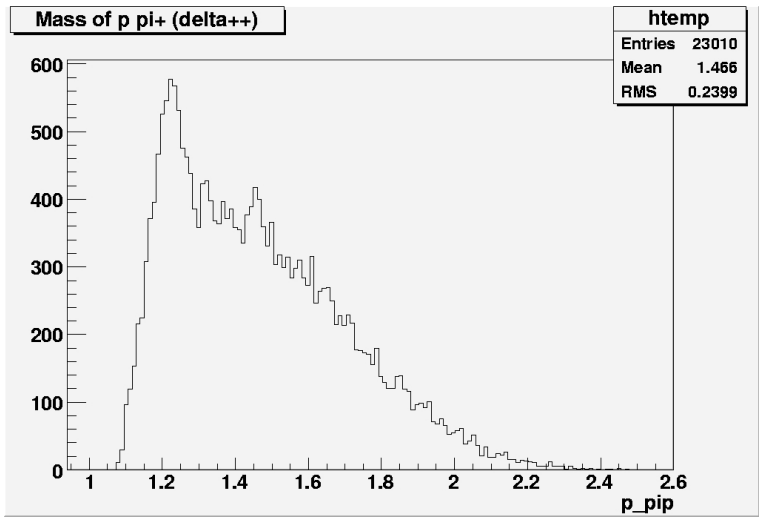


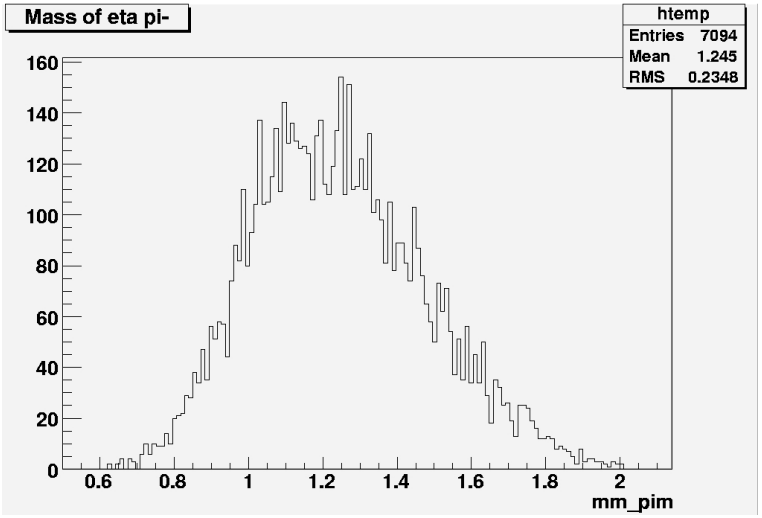


- Ξ^-_{1320} is clearly visible while Ξ^{*-}_{1530} is hinted at but is not statistically significant yet.
- Looking for excited states above 1530 MeV in an effort to confirm existing Ξ states and search for other "missing" states.
- This is about 4% of g12 data.

$\gamma p \rightarrow \Delta^{++}\pi^{-}(\eta) \rightarrow p\pi^{+}\pi^{-}(\eta)$ (Diane Schott)



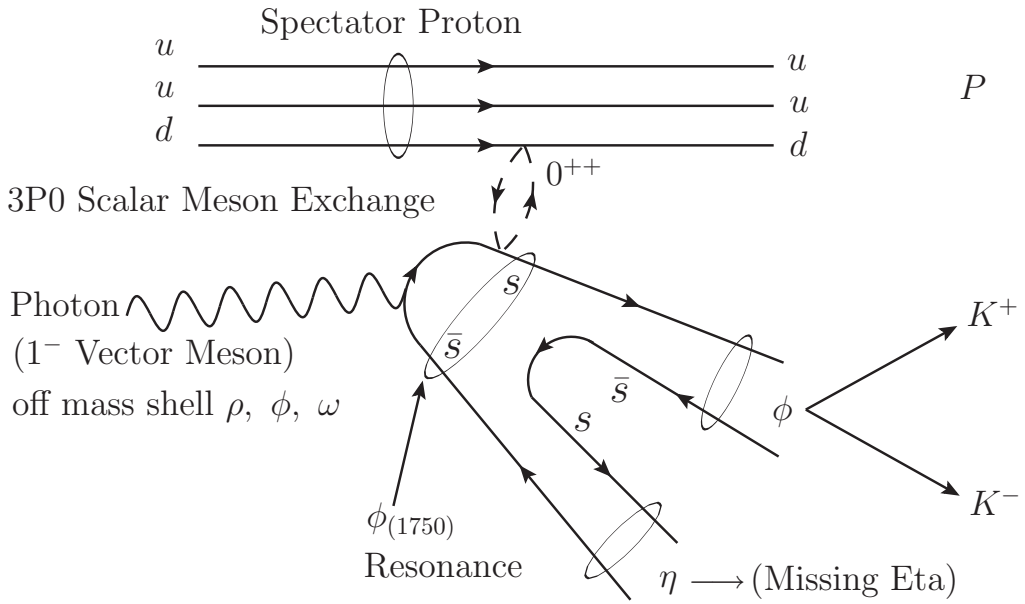




- Looking for the exotic $\pi(1400)$
- Currently hidden beneath background and a_2
- Study asymmetry in the angle distribution
- Do a PWA if possible

$\gamma\ p \rightarrow p\ \phi\ (\eta/\pi^0) \rightarrow p\ K^+\ K^-\ (\eta/\pi^0)$ (Mukesh Saini)

- In Hadronic interactions, A Photon Beam can be regarded as a superposition of vector mesons (ρ, ω, ϕ) with an important $s\bar{s}$ component.
- Study of diffractive photoproduction reaction $\gamma p \rightarrow Xp$, should lead to observation of many C=(-) $s\bar{s}$ states.
- $\phi\eta$ channel is the signature decay mode for initial strangeonium $(s\bar{s})$ states. Interference with non-strange vectors is negligible in this channel.
- $\phi\pi^0$ is an exotic channel due to OZI suppression.



$\gamma\ p \rightarrow p\ \phi\ (\eta/\pi^0) \rightarrow p\ K^+\ K^-\ (\eta/\pi_0)$

- η has a significant $n\bar{n}$ component to it, but $\phi\eta$ and $\phi\eta'$ decay modes can only originate from initial $s\bar{s}$ states.
- "Due to the *OZI* rule, the observation of a state with a large branching fraction to $\eta\phi$, $\eta'\phi$ or $\phi\phi$ and small branches to nonstrange final states can serve as a "smoking gun" for an initial $s\bar{s}$ state." - Barnes, Black & Page (Strong decays of Strange Quarkonia).

Why study Strangeonia?

- 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.

Other Analysis

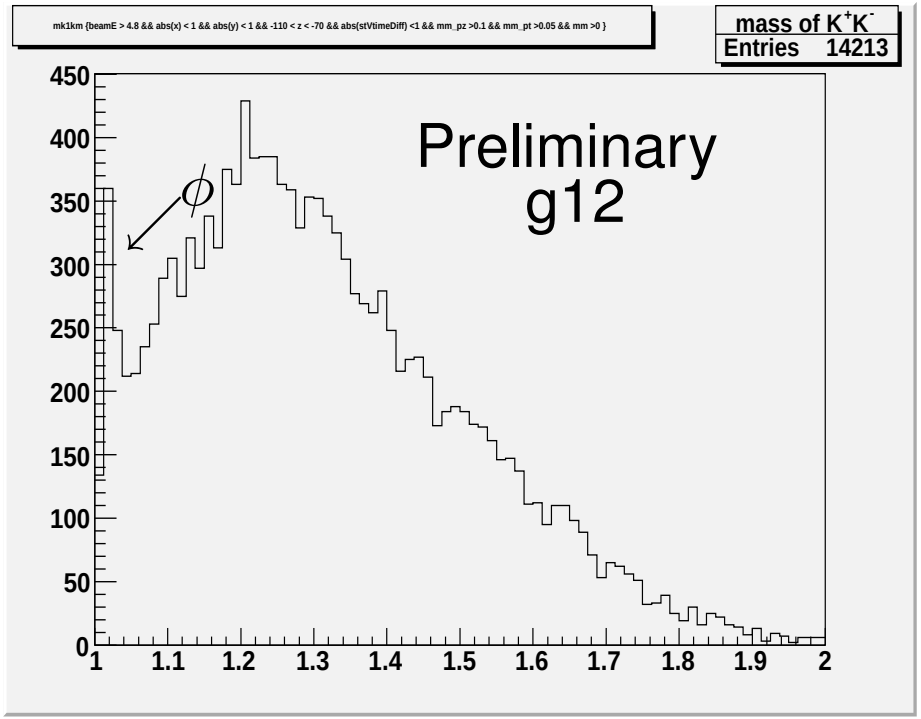
- There has been a short interesting history attached to the ϕ_{1750} resonance.
- Electroproduction data has a resonance at 1680 MeV identified as ϕ_{1680} with its dominant production channel being KK^*
- While in Photoproduction a similar resonance exists at 1750 MeV. This was earlier identified as the ϕ_{1680} but is now disputed to be another resonance altogather, its dominant production channel being K^+K^-.
- FOCUS experiment had about 11,000 events and they concluded the resonances to be different ones, though the interpretation of this signal remains uncertain. This is to be further investigated from the g12 dataset.

Major cuts used in the analysis:

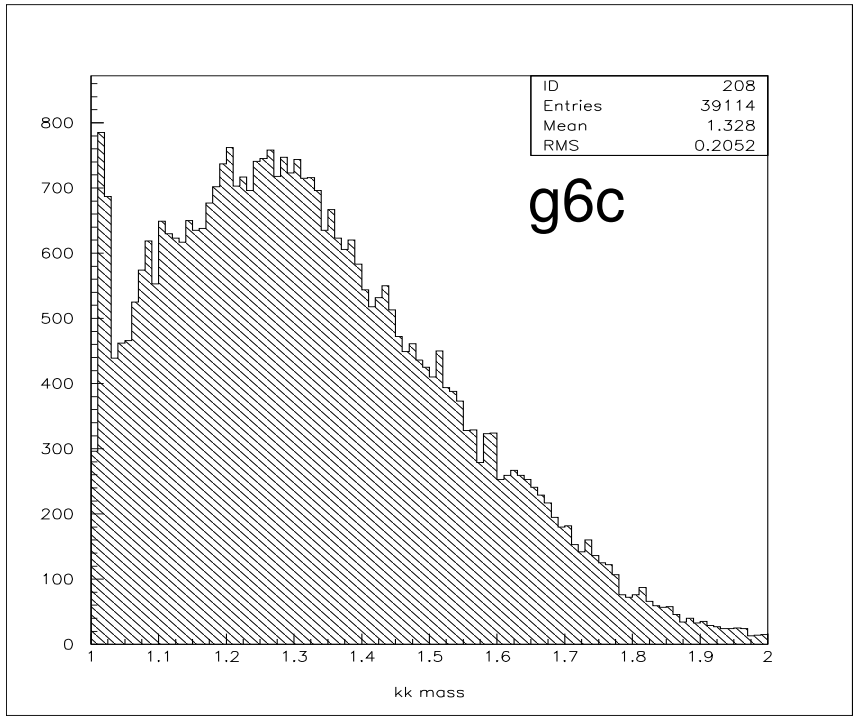
- Number of Charged tracks $\Rightarrow$ 3 $\Rightarrow$ for exclusive pKK events
- Beam Energy Cut $\Rightarrow$ beamE $>$ 4.4 GeV (4.8 GeV in g6c) $\Rightarrow$ To Throw out the Low Energy Events
- Vertex Cut $\Rightarrow$ abs(x,y) < (2,2) & -70 > z > -110 $\Rightarrow$ To make sure that the event originates in the target
- Momentum Beta Cut $\Rightarrow$ $\beta < 1$ $\Rightarrow$ Particles are physical and not just events from the wrong bucket.
- Timing Cuts $\Rightarrow$ abs(stvtime-rfvtime) < 1 $\Rightarrow$ To pick the right bucket and stave off background.
- Missing Momentum (pz , pt) $\Rightarrow$ Range $\leq$ (0.1, 0.05) $\Rightarrow$ To identify peripheral meson production.

$\phi \rightarrow K^+ \ K^-$

- Comparision of plots from g6c and g12 Analysis. This represents about 5 % of g12 dataset.
- Cuts applied on g12 data are the same as those applied on g6c.



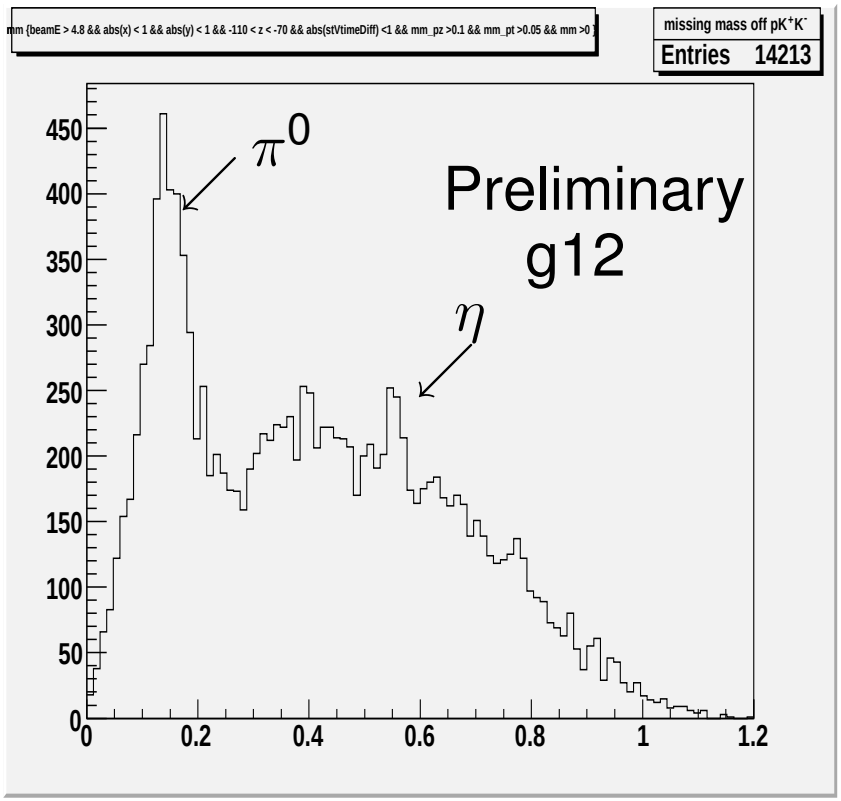
- K^+K^- Mass Plot from g12 Data.



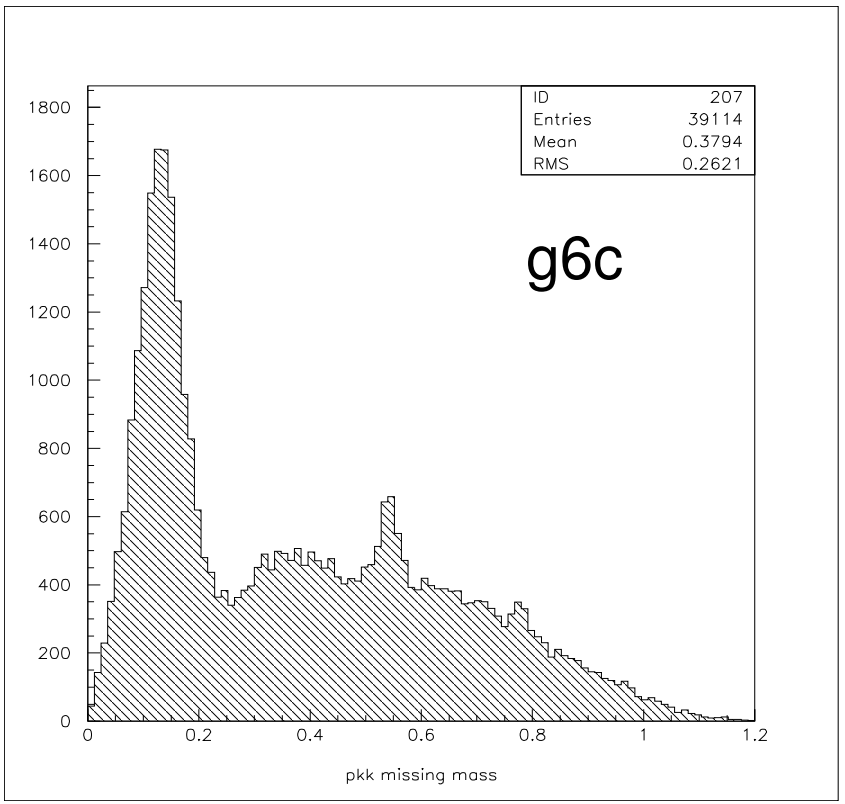
- K^+K^- Mass Plot from g6c Data.

Missing mass (mm > 0) off $p\,K^+\,K^-$

- Identify the missing η/π^0 meson



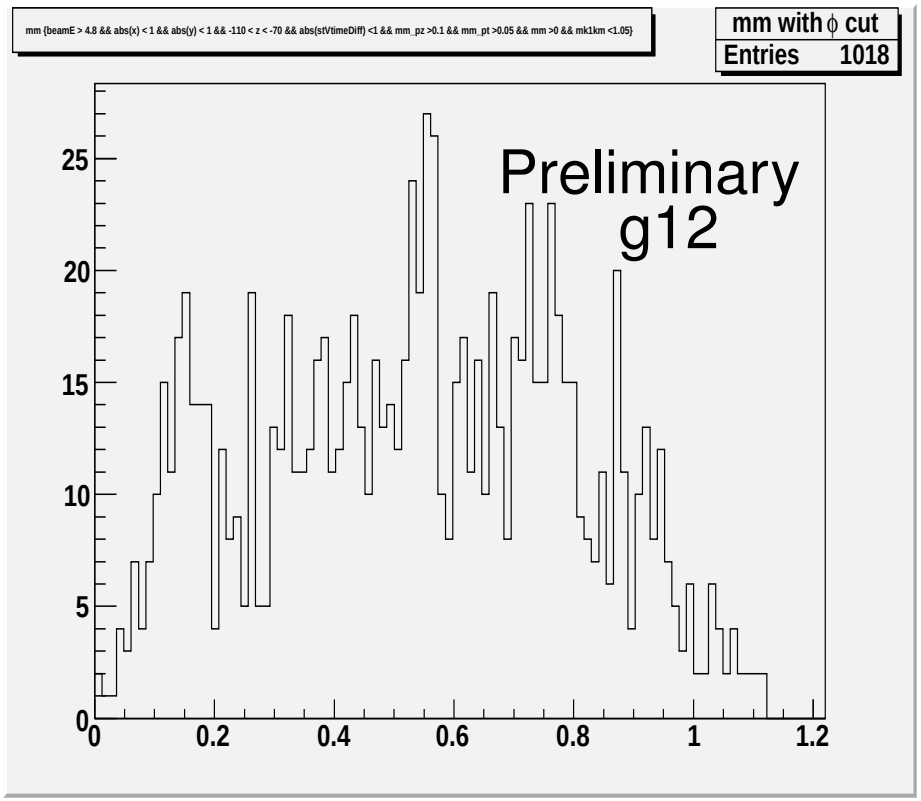
- Missing mass off pK^+K^- from g12 Data.



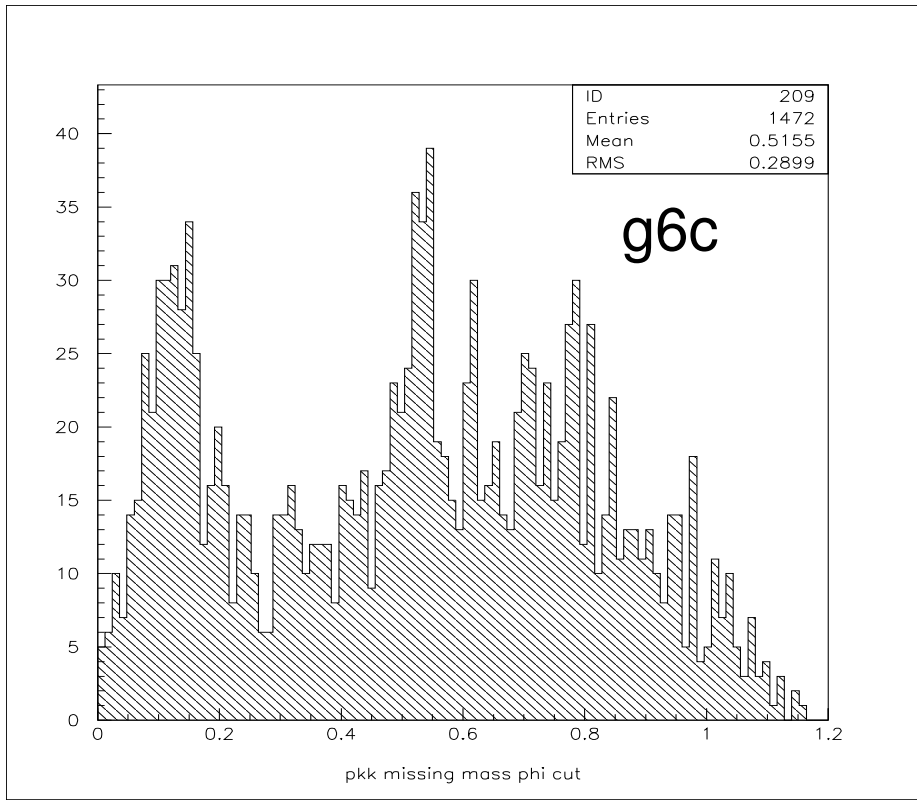
- Missing mass off pK^+K^- from g6c Data.

Missing mass off pK^+K^- with phi cut

- Phi Cut : Sum Mass of K^+K^- < 1050 MeV



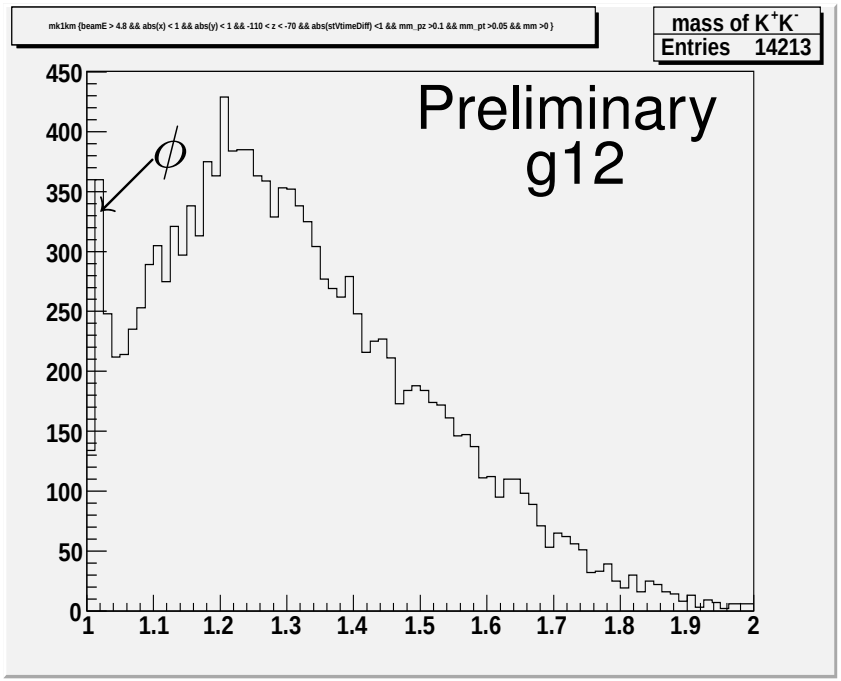
- Missing Mass Plot with phi cut from g12 Data.



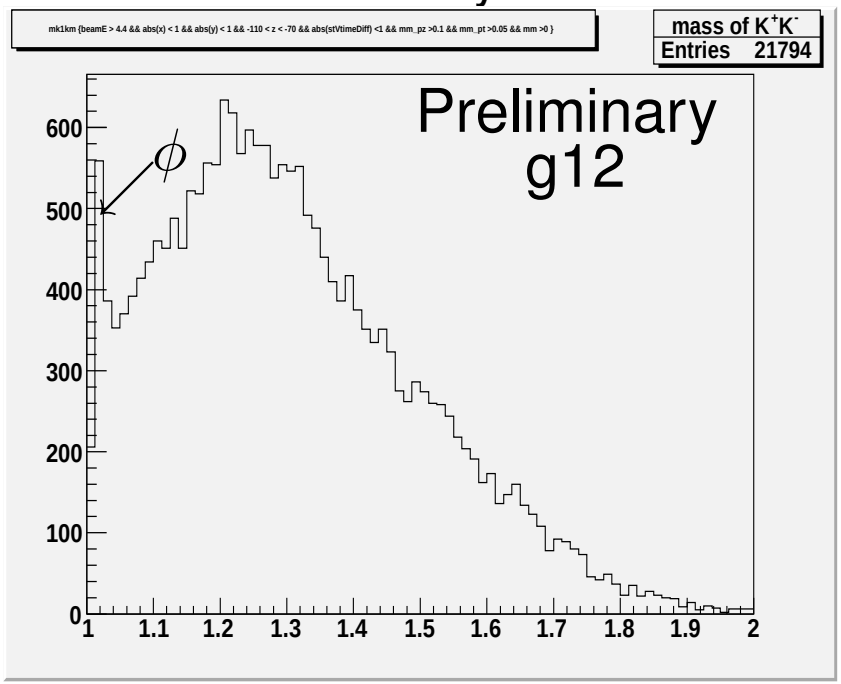
- Missing Mass Plot with phi cut from g6c Data.

Relaxed Cut

- All plots for strangeonia you just saw had a beam energy cut of 4.8 GeV since g6c had tagged photon beam upto 4.8 GeV
- For g12, the tagged photon beam energy in its trigger is upto 4.4 GeV. Effects of these cuts need to be studied more carefully.



- K^+K^- Mass Plot from g12 Data with $E_\gamma < 4.8$.



- K^+K^- Mass Plot from g12 Datawith $E_\gamma < 4.4$.

Summary and Immediate Plans

- Another pass0 (we've done 4 so far) to check the run-by-run stability of calibrations is in progress.
- Tagger Energy loss corrections done.
- Momentum corrections remains.
- Continue TOF & ST resolution studies.
- Pass1 by April!