Discrepancies in Photoproduction Reactions

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Introduction and Motivation

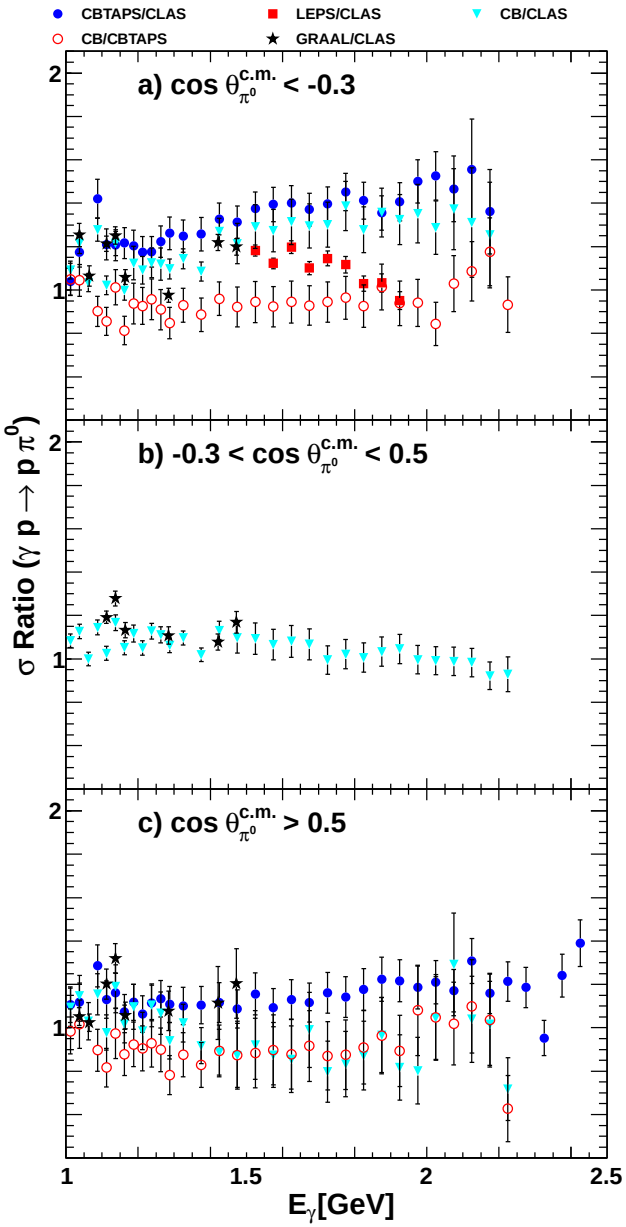
Low-energy N^* program at JLab is slowly coming to an end in terms of its experimental data-taking component:

- GRAAL, CLAS, and SAPHIR programs are essentially over.
- Crystal Barrel (in particular, $\gamma n \to p X$ & study of two-meson reactions, etc.), MAMI, and LEPS programs will continue, though.

For complete experiments, results will come from different experiments and/or facilities. Cross checks of results are also important:

- Now is probably a good time in order to identify the most severe and important discrepancies among observables.
- Some reactions/observables could be (re-)analyzed with existing data (and we still know how to run codes and what we did for the previous analyses).

Outline



Reaction $\gamma p \rightarrow p\,\pi^0$

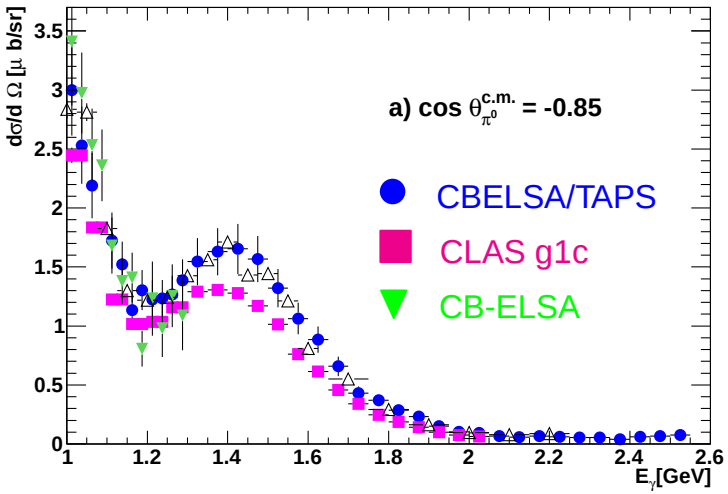
Comparison with CLAS g1c results in three different angular ranges:

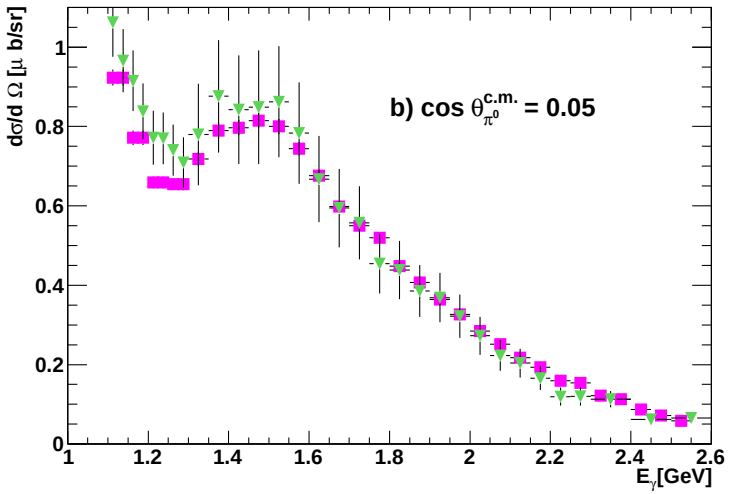
- ▼ CB-ELSA / CLAS
- ● CBTAPS / CLAS
- ○ CB-ELSA / CBTAPS
- ■ LEPS / CLAS

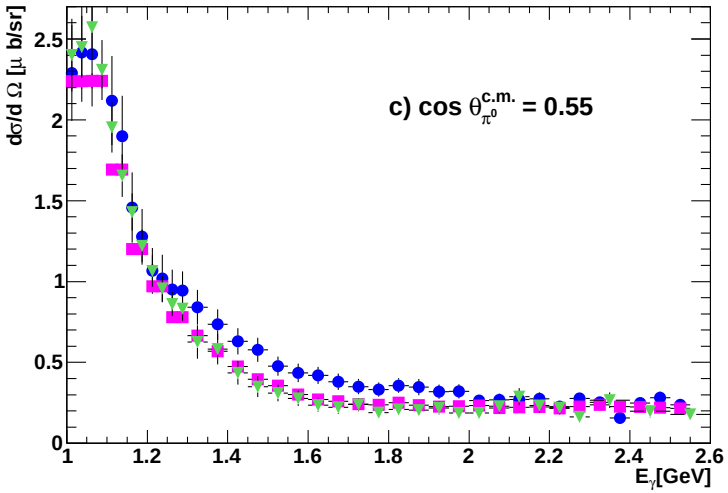
We observe fair agreement among datasets.

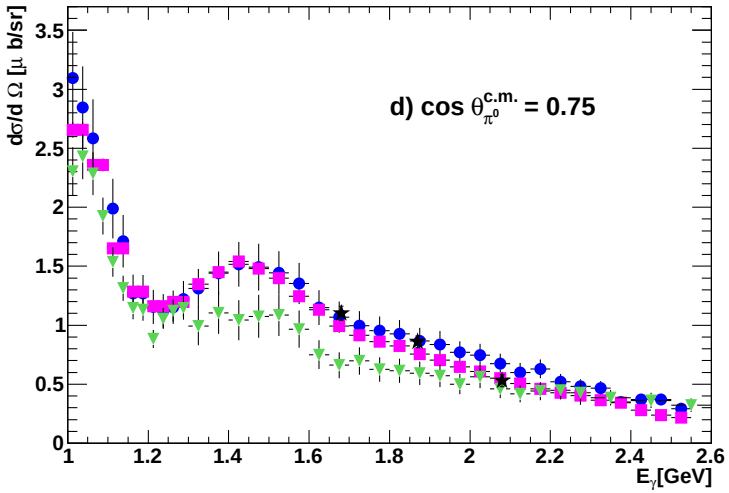
- No obvious normalization issue. (CB-ELSA not absolutely normalized)
- Some “important” acceptance problems need to be resolved, though.

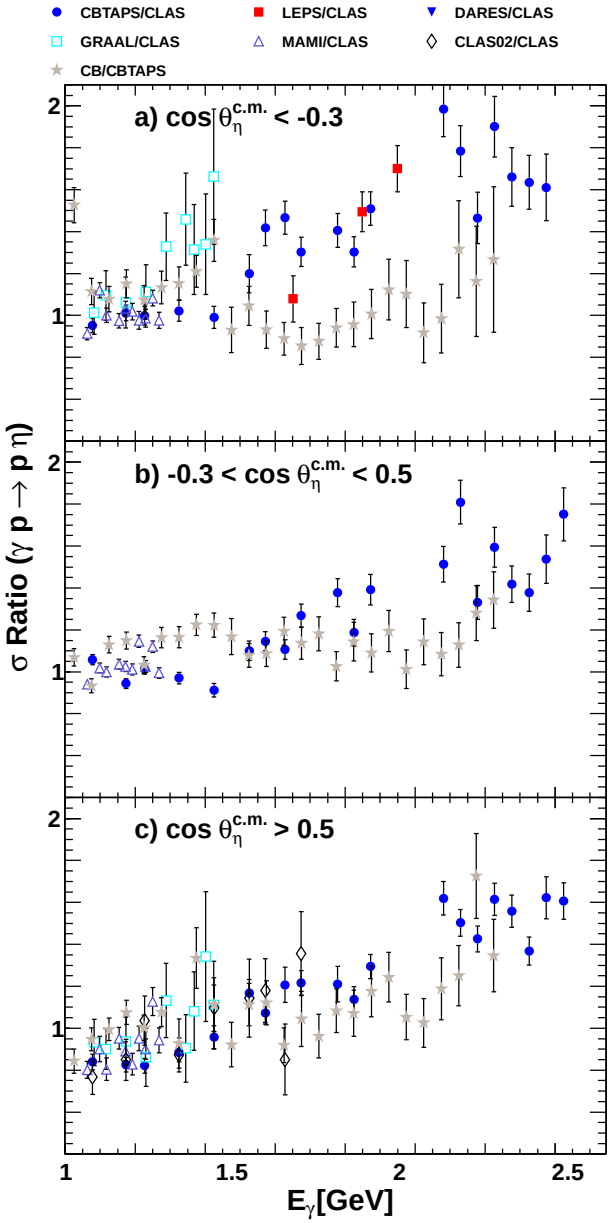
Important Reference Reaction $\gamma p \rightarrow p\,\pi^0$









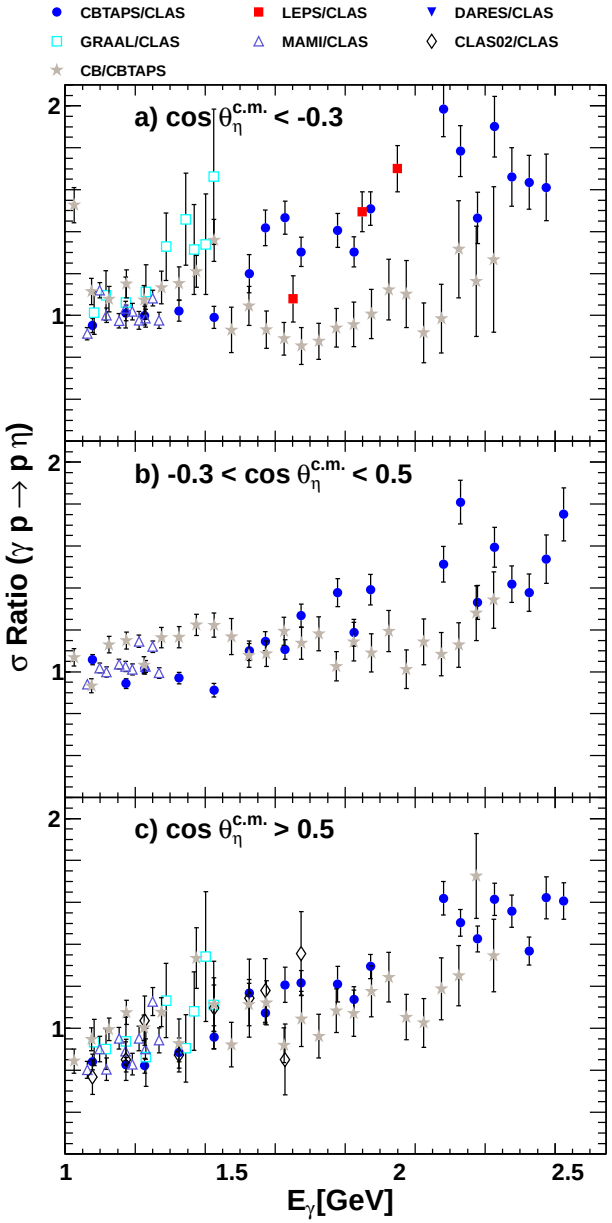


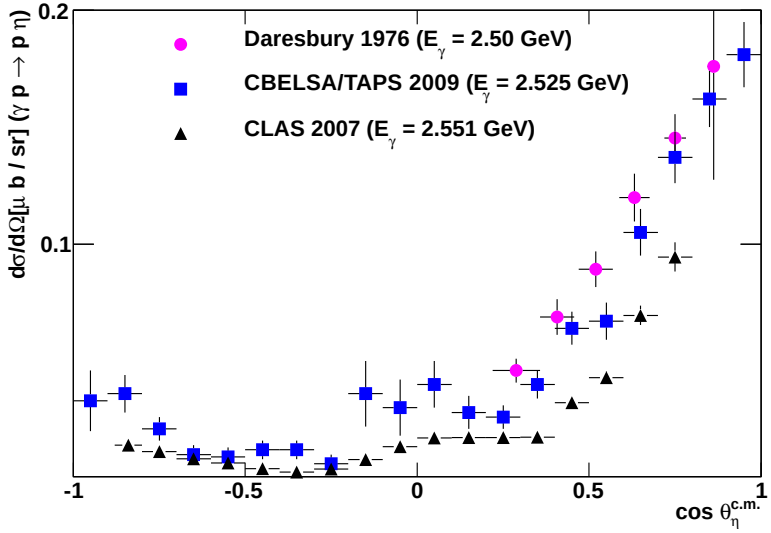
Reaction $\gamma p \rightarrow p\,\eta$

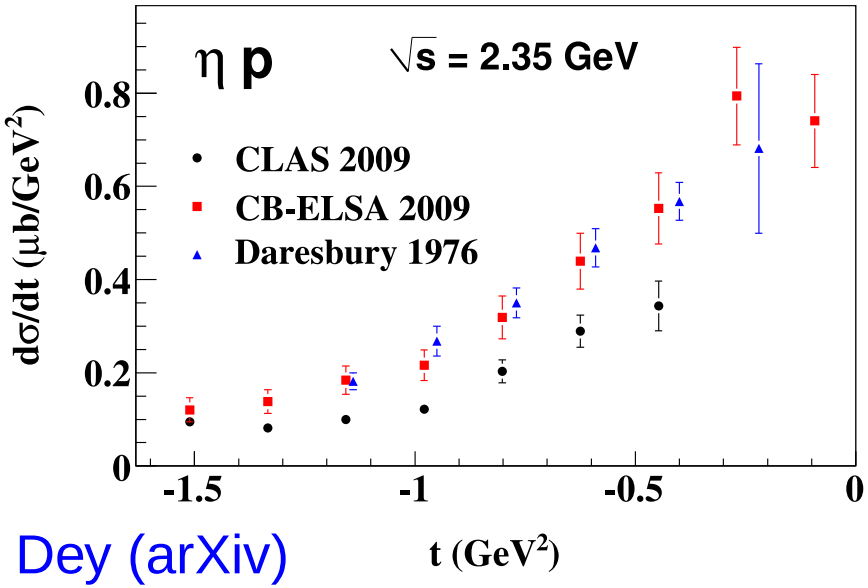
Comparison with CLAS g11a results in three different angular ranges:

- ★ CB-ELSA / CBTAPS
- ● CBTAPS / CLAS
- △ MAMI / CLAS
- ■ LEPS / CLAS
- □ GRAAL / CLAS

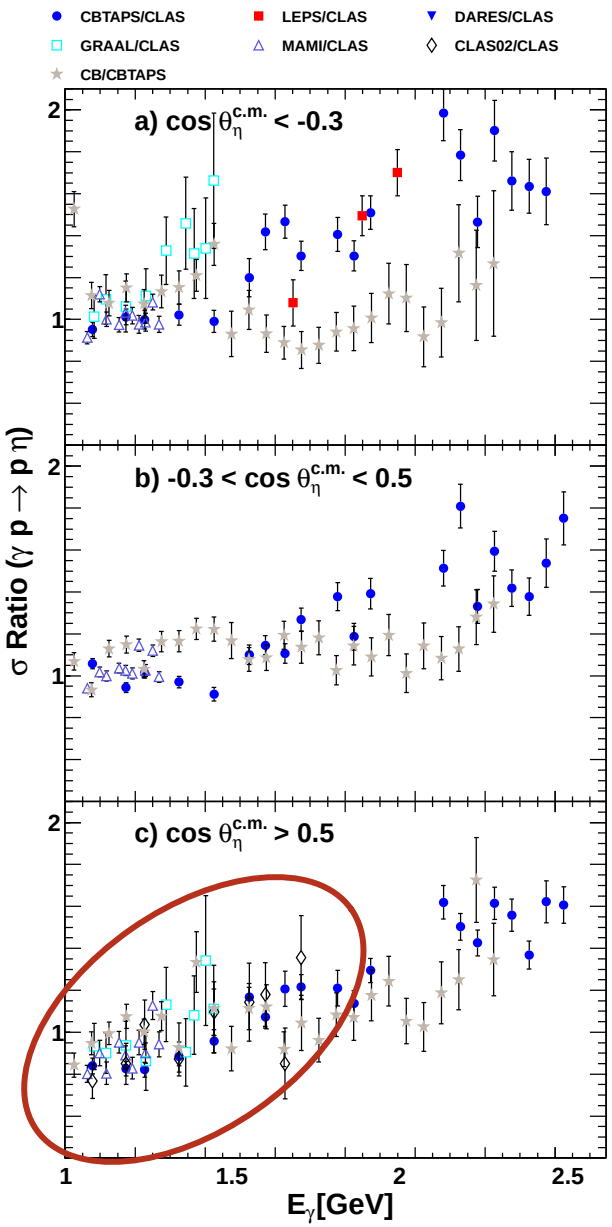
- CB-ELSA data not absolutely normalized.
- Normalization discrepancy relative to g11a?

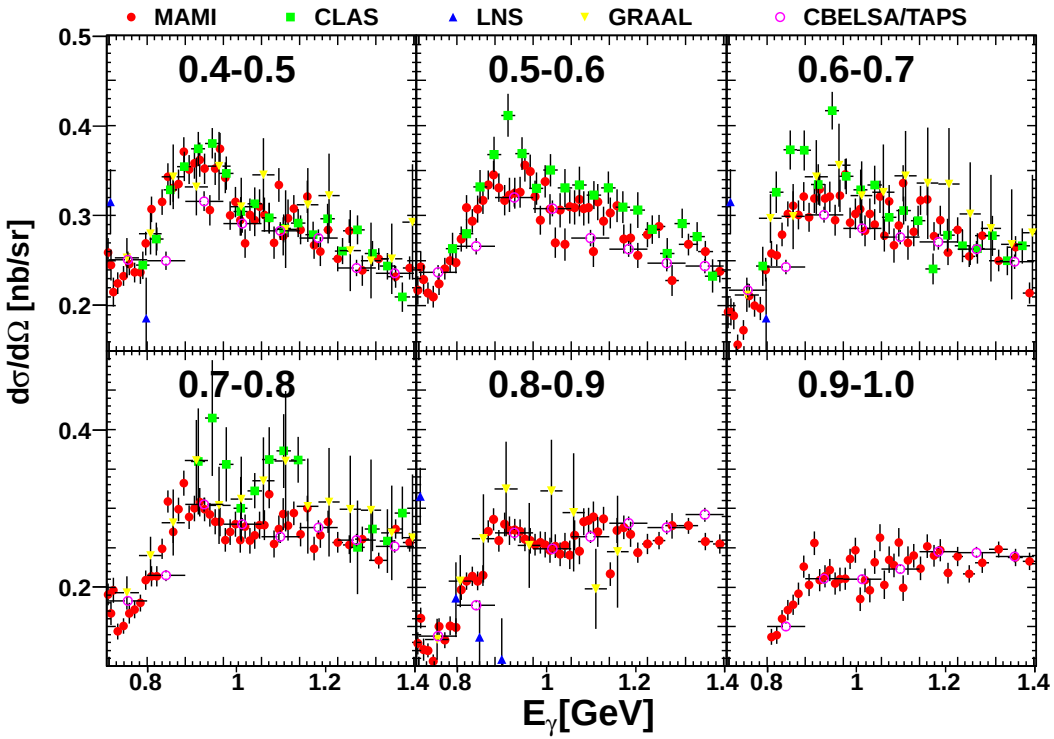

CBTAPS/CLAS
LEPS/CLAS
DARES/CLAS
GRAAL/CLAS
MAMI/CLAS
CLAS02/CLAS
CB/CBTAPS
a) cos θη c.m. < -0.3
b) -0.3 < cos θη c.m. < 0.5
c) cos θη c.m. > 0.5
σ Ratio (γ p → p η)
Eγ[GeV]


Daresbury 1976 (Eγ = 2.50 GeV)
CBELSA/TAPS 2009 (Eγ = 2.525 GeV)
CLAS 2007 (Eγ = 2.551 GeV)
dσ/dΩ[μ b / sr] (γ p → p η)
cos θη c.m.

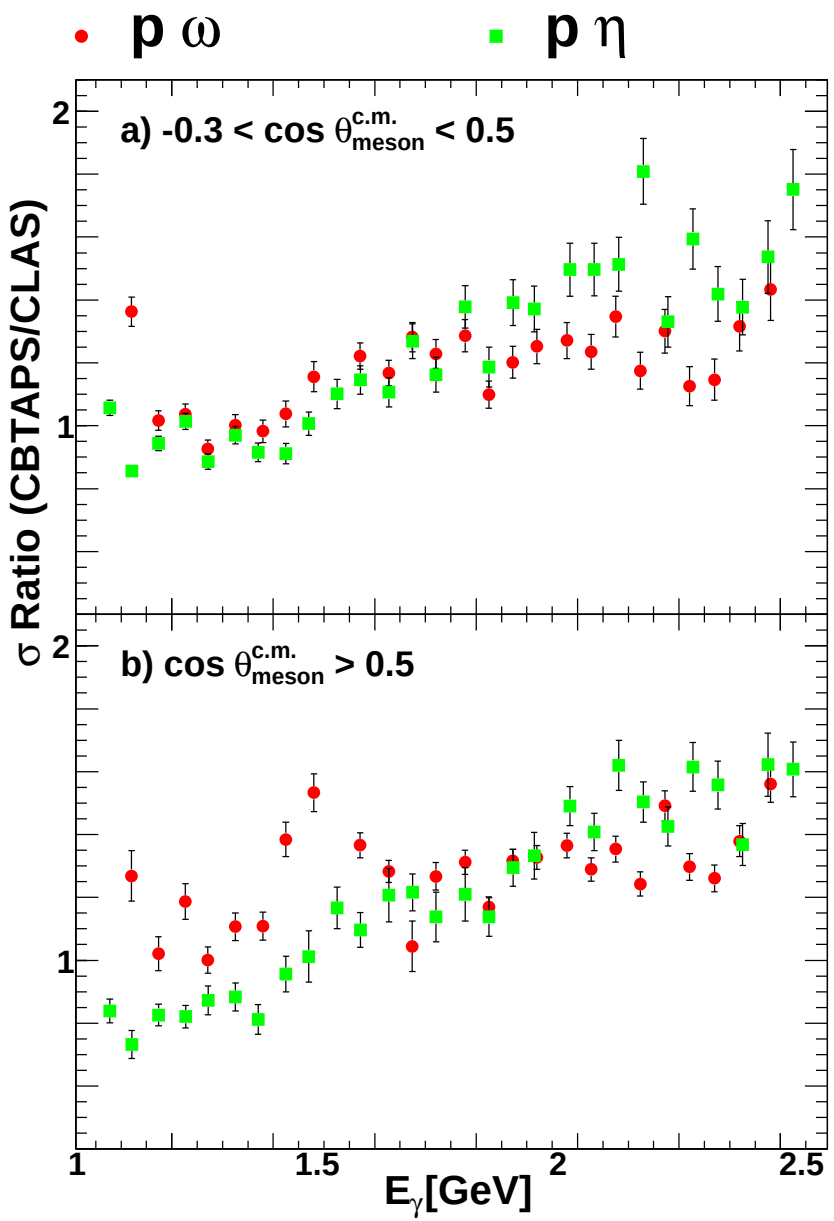

η p
√s = 2.35 GeV
CLAS 2009
CB-ELSA 2009
Daresbury 1976
dσ/dt (μb/GeV²)
t (GeV²)

B. Dey (arXiv)





In the forward region, GRAAL and CLAS g11a results appear systematically higher than higher-statistics datasets with better acceptance.



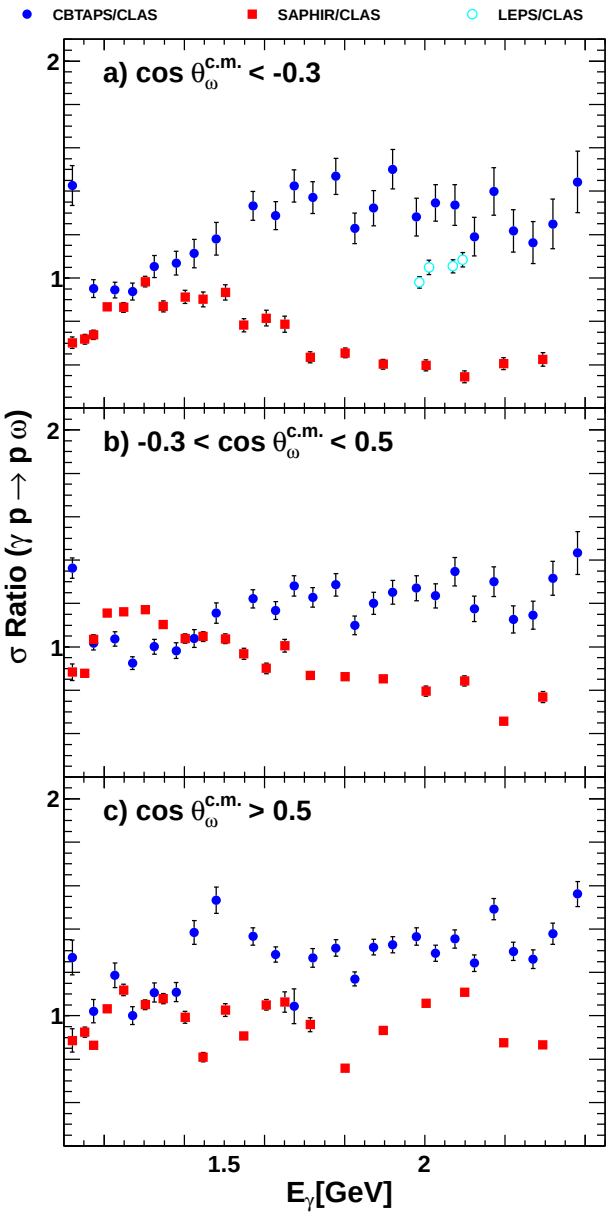
Reactions $\gamma p \rightarrow p\,\eta$ & $\gamma p \rightarrow p\,\omega$

Comparison between CLAS g11a and CBELSA/TAPS results:

- CBTAPS / CLAS for $p\,\omega$
- CBTAPS / CLAS for $p\,\eta$

The comparison shows a very similar behavior between CBELSA/TAPS and CLAS g11a for the two reactions and hints at a normalization issue.

Explains CLAS / CB self-consistency.

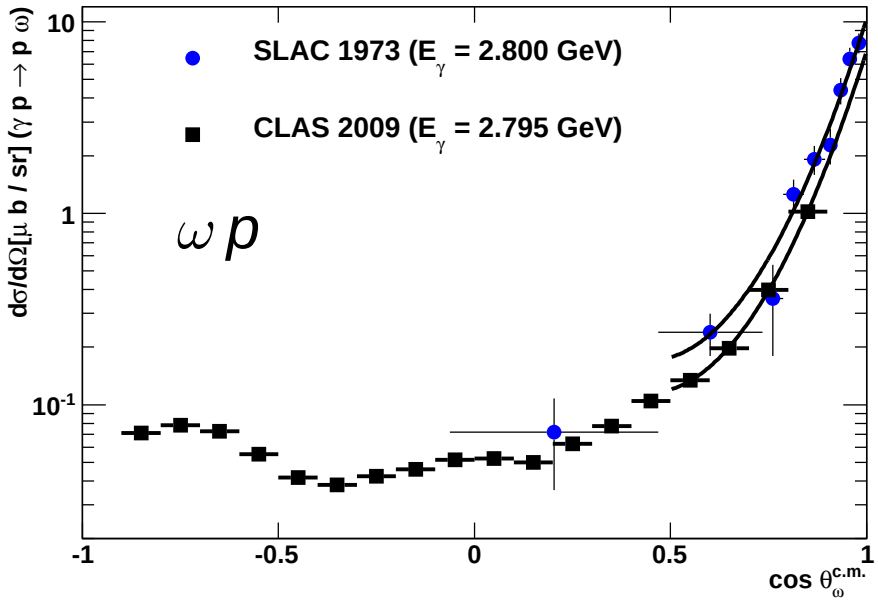


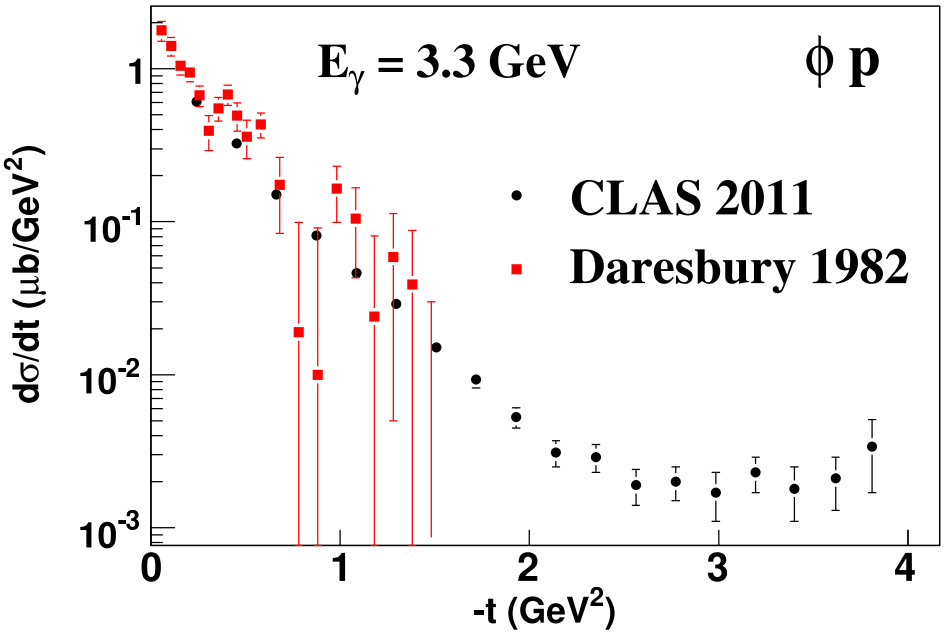
Reaction $\gamma p \longrightarrow p\,\omega$

Comparison with CLAS g11a results in three different angular ranges:

- CBTAPS / CLAS
- SAPHIR / CLAS
- LEPS / CLAS

- Good agreement between CLAS and SAPHIR only (!) in the forward direction.
- (Dis-) Agreement between CLAS / SAPHIR and CLAS / CBTAPS of same magnitude, but in opposite directions. No further ex. evidence supporting SAPHIR normalization.



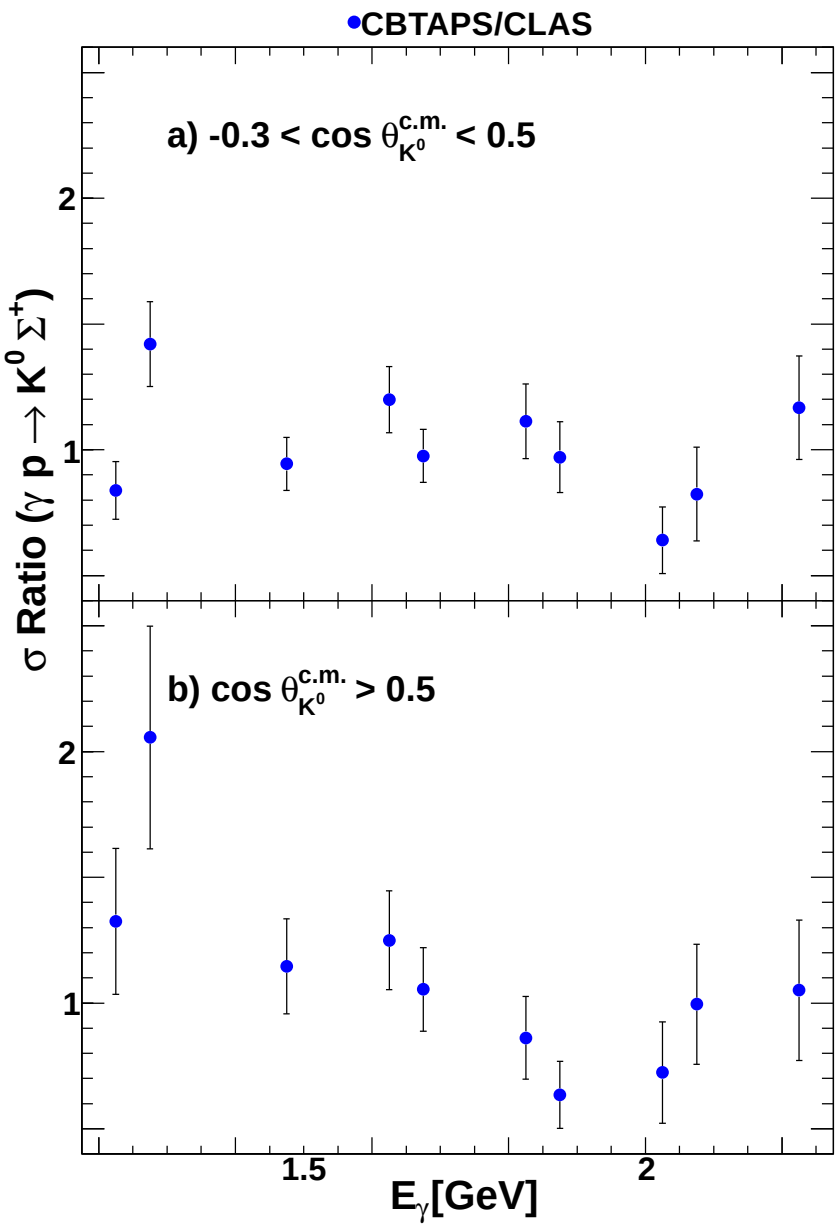


- At $E_\gamma = 2.8$ GeV, old SLAC ω results show disgreement relative to CLAS consistent with CBTAPS / CLAS disagreement. Assuming an exponential behavior in the forward region, ω distribution fitted to $a + bx + cx^2$:

$$a_{\mathrm{SLAC}} / a_{\mathrm{CLAS}} = 1.47 \pm 0.09$$

- We disagree with Biplab who claims good agreement.

Outline



Reaction $\gamma p \rightarrow K^0 \Sigma^+$

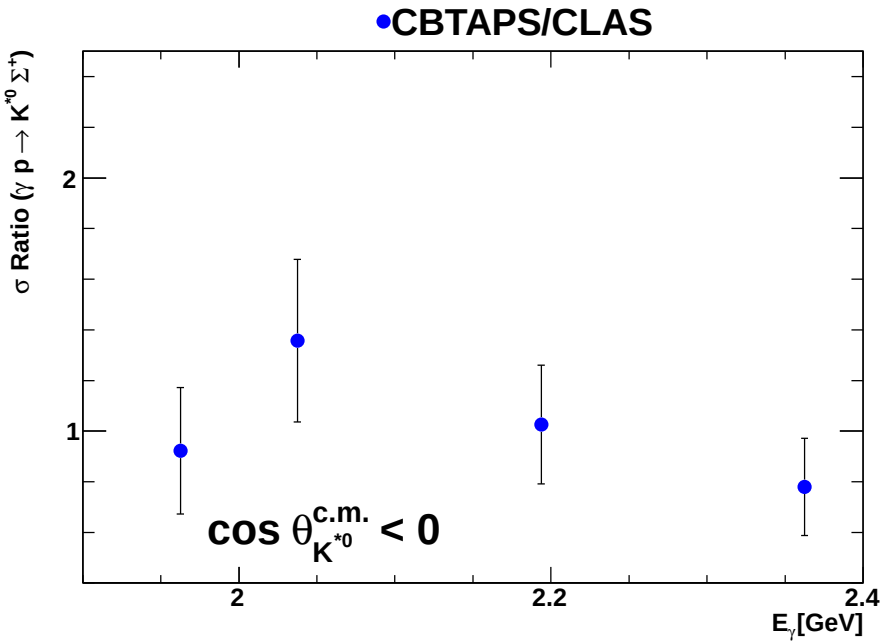
Comparison between CLAS g1c and CBELSA/TAPS results:

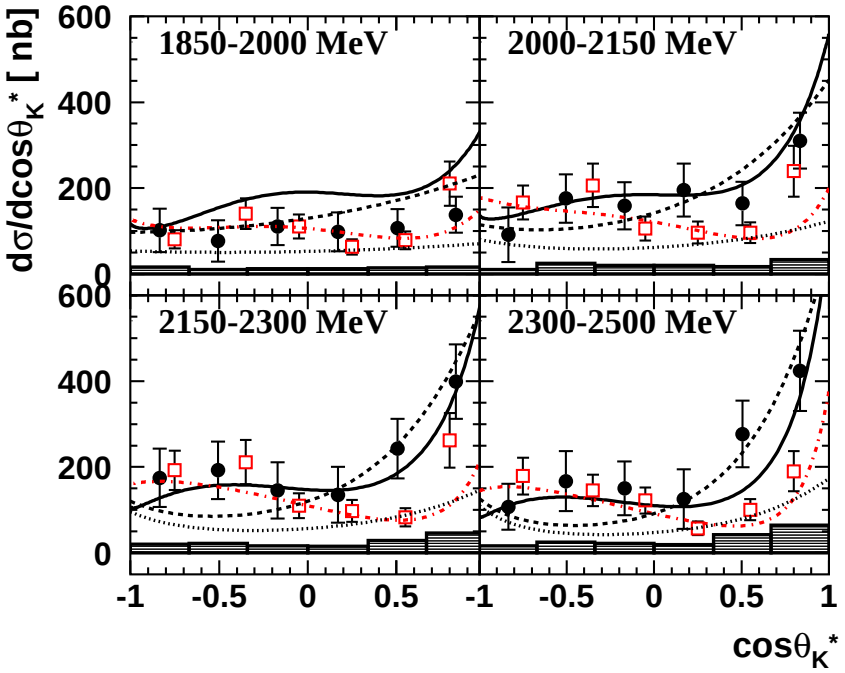
- CBTAPS / CLAS

We do not observe a normalization problem similar to $p\,\eta$ and $p\,\omega$:

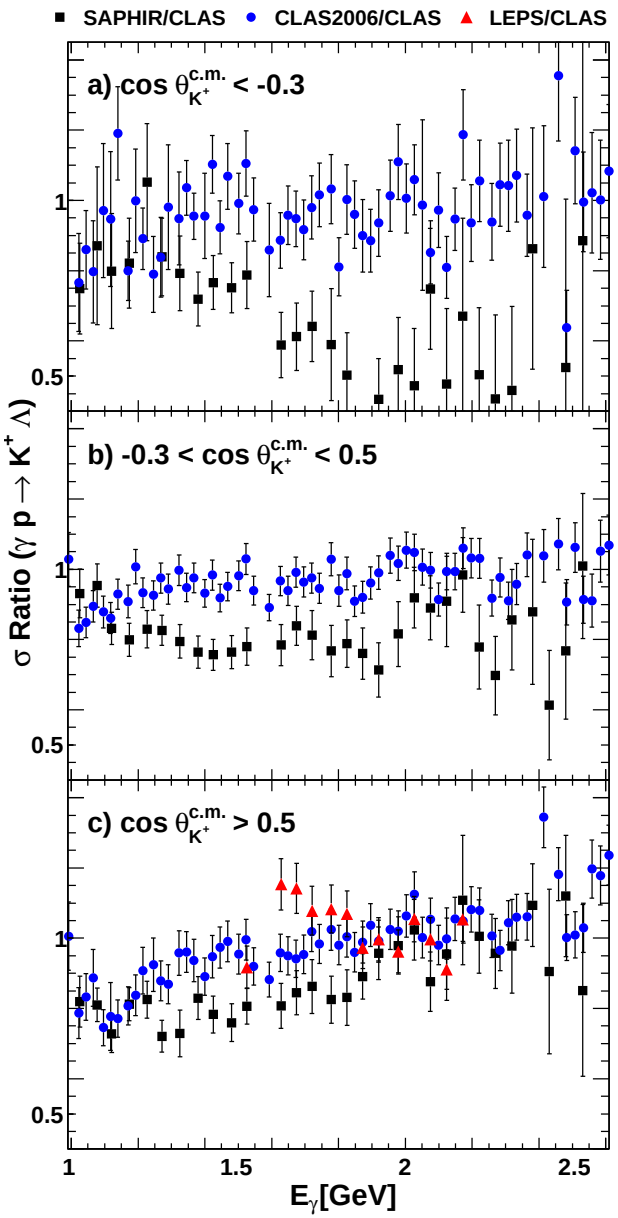
- CLAS data not (yet) published.
- Flux fluctuation around 1.9 GeV?

Reaction $\gamma p \rightarrow K^{*0} \Sigma^{+}$





➜ Comparison between CLAS g1c and CBELSA/TAPS results shows no obvious normalization problem, but a huge unresolved acceptance issue in the forward region.

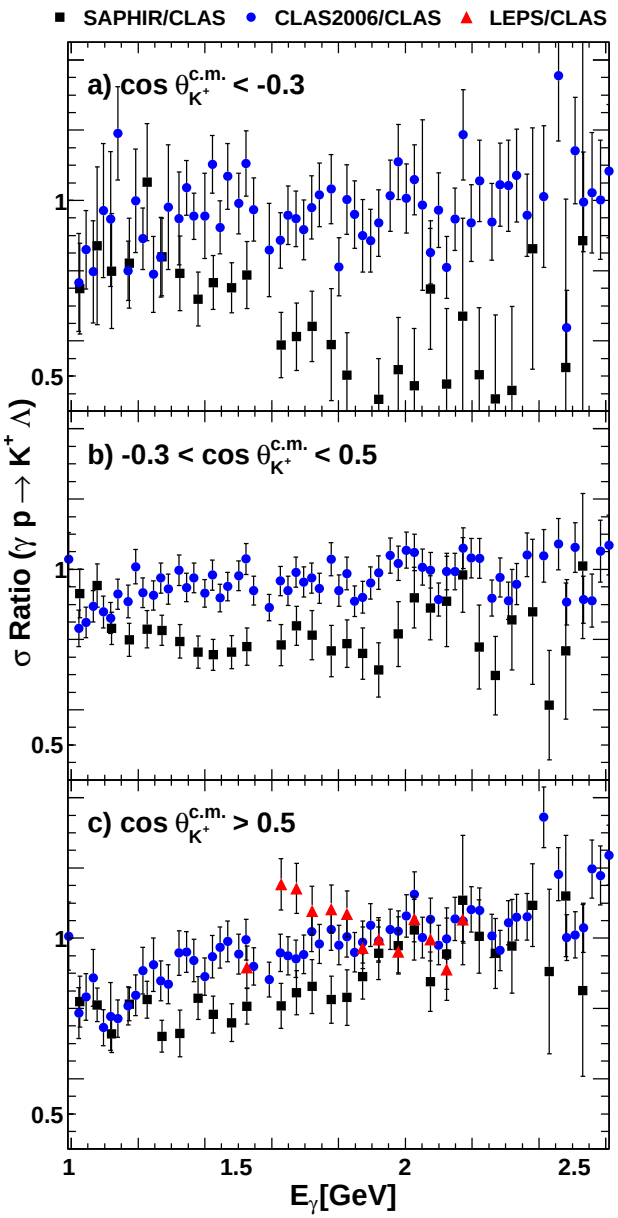


Reaction $\gamma p \rightarrow K^+ \Lambda$

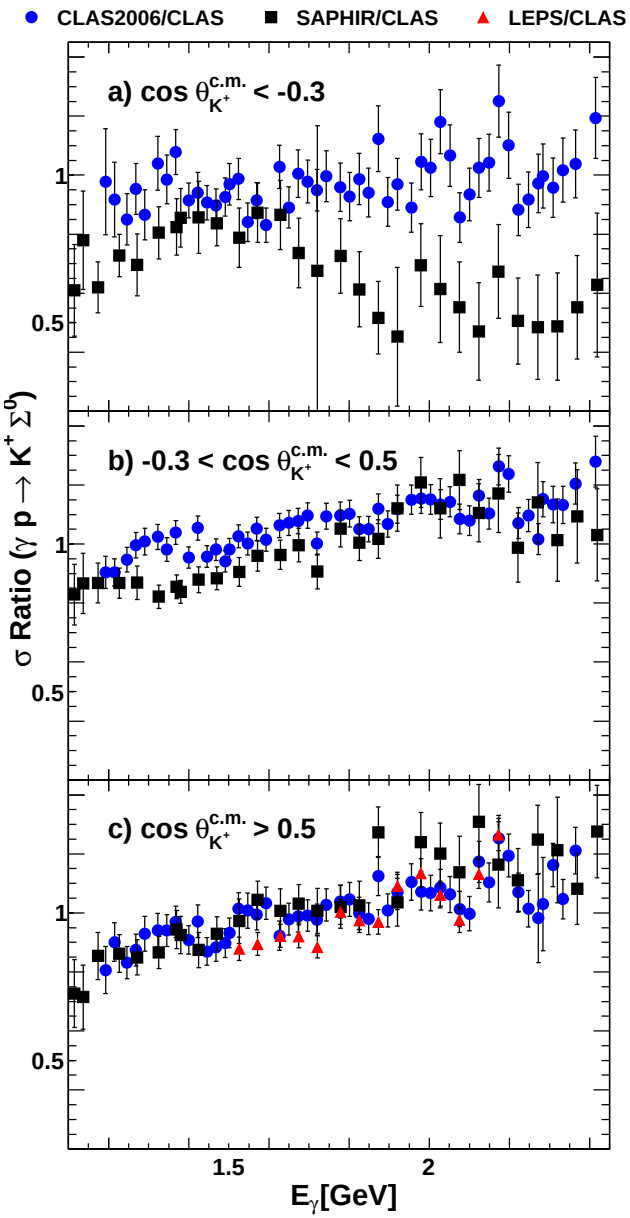
Comparison with CLAS g11a results in three different angular ranges:

- CLAS g1c / CLAS g11a
- SAPHIR / CLAS g11a
- LEPS / CLAS g11a

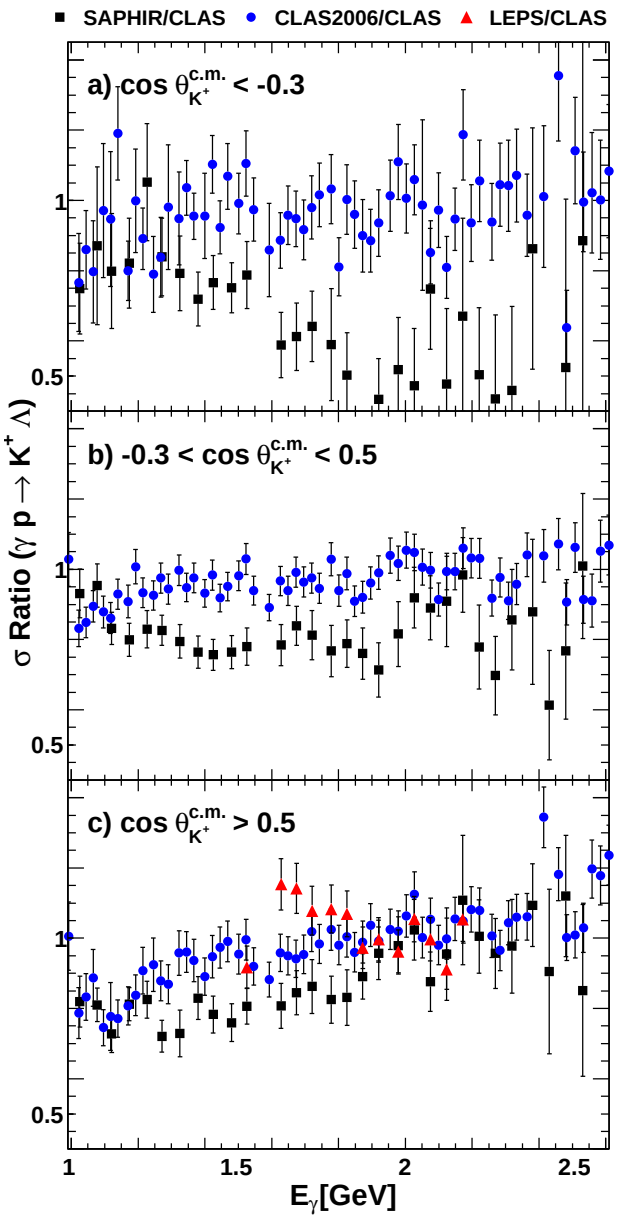
- SAPHIR has an acceptance problem in the backward region.
- Comparison between CLAS g1c and g11a suggestive of a linear behavior.
- LEPS results somewhat inconclusive.



$K^+\Lambda$

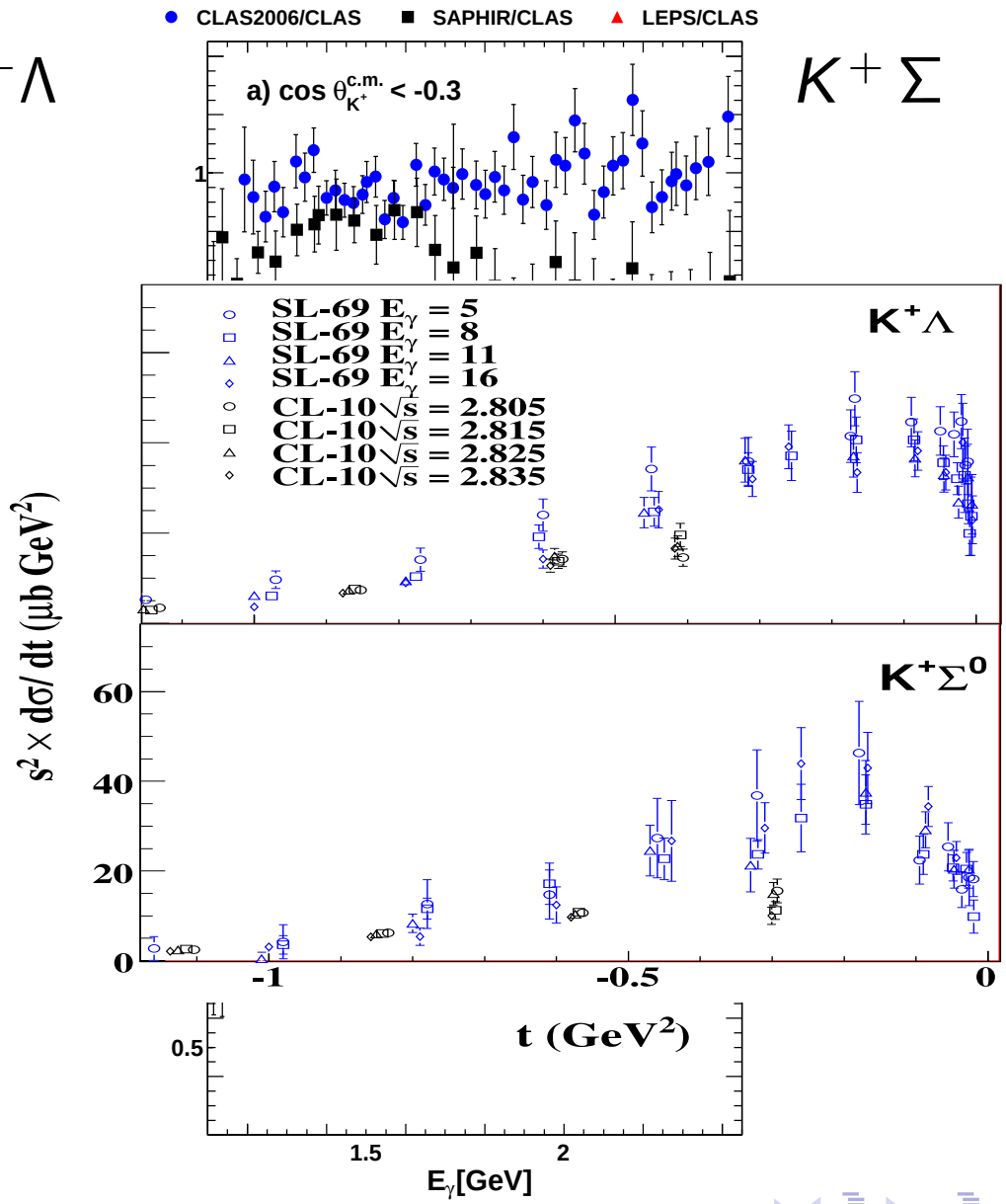


$K^+\Sigma$



$K^+\Lambda$

$K^+\Sigma$



Summary and Conclusion

Photoproduction industry produced results in the 60's and 70's:

- These results are amazingly consistent:
  - ➜ We believe that these results cannot be ignored just because statistics was (partially) poor and energy bins large.
- Cross sections were absolutely normalized (using quantameter).
- We could not find a "serious" problem with the old "untagged" photon beams (Biblap's explanation).

➜ Unknown issue with g11a photon flux?

Probably people from CB, GRAAL, LEPS, and CLAS in this room:

- Do we need a systematic identification of the most severe discrepancies and possible reasons?