Surveying GlueX Final States with a `ReactionFilter` Plugin

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GlueX Analysis Meeting

November 21, 2016

Including:

I. Description of the `ReactionFilter` *plugin*

II. Sanity checks for a few simple channels

III. Reference plots for many channels

`ReactionFilter` Plugin

(1) Specify reactions in a configuration file:

```
ReactionFilter:FS1  EXC_100_110              // exclusive gamma p --> p pi+ pi-
ReactionFilter:FS2  EXC_100_111              // exclusvie gamma p --> p pi+ pi- pi0
ReactionFilter:FS3  EXC_100_110000           // exclusvie gamma p --> p K+ K-
ReactionFilter:FS4  EXC_100000000_100000     // exclusive gamma p --> Lambda K+
ReactionFilter:FS5  EXC_100000000_100001     // exclusive gamma p --> Lambda K+ pi0
ReactionFilter:FS6  EXC_100000000_1100       // exclusive gamma p --> Lambda Ks pi+

ReactionFilter:FS20  EXC_NIMF_100_111              // exclusvie gamma p --> p pi+ pi- pi0
ReactionFilter:FS40  EXC_NIMF_100000000_100000     // exclusive gamma p --> Lambda K+
ReactionFilter:FS50  EXC_NIMF_100000000_100001     // exclusive gamma p --> Lambda K+ pi0
ReactionFilter:FS60  EXC_NIMF_100000000_1100       // exclusive gamma p --> Lambda Ks pi+
```

EXC: exclusive; NIMF: no intermediate mass fits

This uses the Analysis library to make "standard" cuts, do kinematic fitting
(event four-momentum, event vertex, intermediate masses, detached vertices),
and output the standard ROOT TTree.
These decays are used: $\pi^0 \to \gamma\gamma$; $\eta \to \gamma\gamma$; $K_S \to \pi^+\pi^-$; $\Lambda \to \pi^-p$.

(2) Run ReactionFilter as a plugin *(run over data on the karst machines at IU)*.

```
hd_root -PPLUGINS=ReactionFilter --config=RF.txt dana_rest_TESTDATA.hddm
```

(3) Use a ROOT script to convert the output ROOT TTree to a flat format *(my preference)*.

`ReactionFilter` Plugin

Cuts:

```
locReaction->Set_MaxPhotonRFDeltaT(0.5*dBeamBunchPeriod);

if (!fsInfo->inclusive())
locReaction->Set_MaxExtraGoodTracks(2);

locReaction->Set_InvariantMassCut(Pi0,    0.080, 0.180);
locReaction->Set_InvariantMassCut(Eta,    0.500, 0.600);
locReaction->Set_InvariantMassCut(Lambda, 1.000, 1.200);
locReaction->Set_InvariantMassCut(KShort, 0.400, 0.600);

if (fsInfo->exclusive())
locReaction->Add_ComboPreSelectionAction(new DCutAction_MissingMassSquared(locReaction, false, -0.1, 0.1));
```

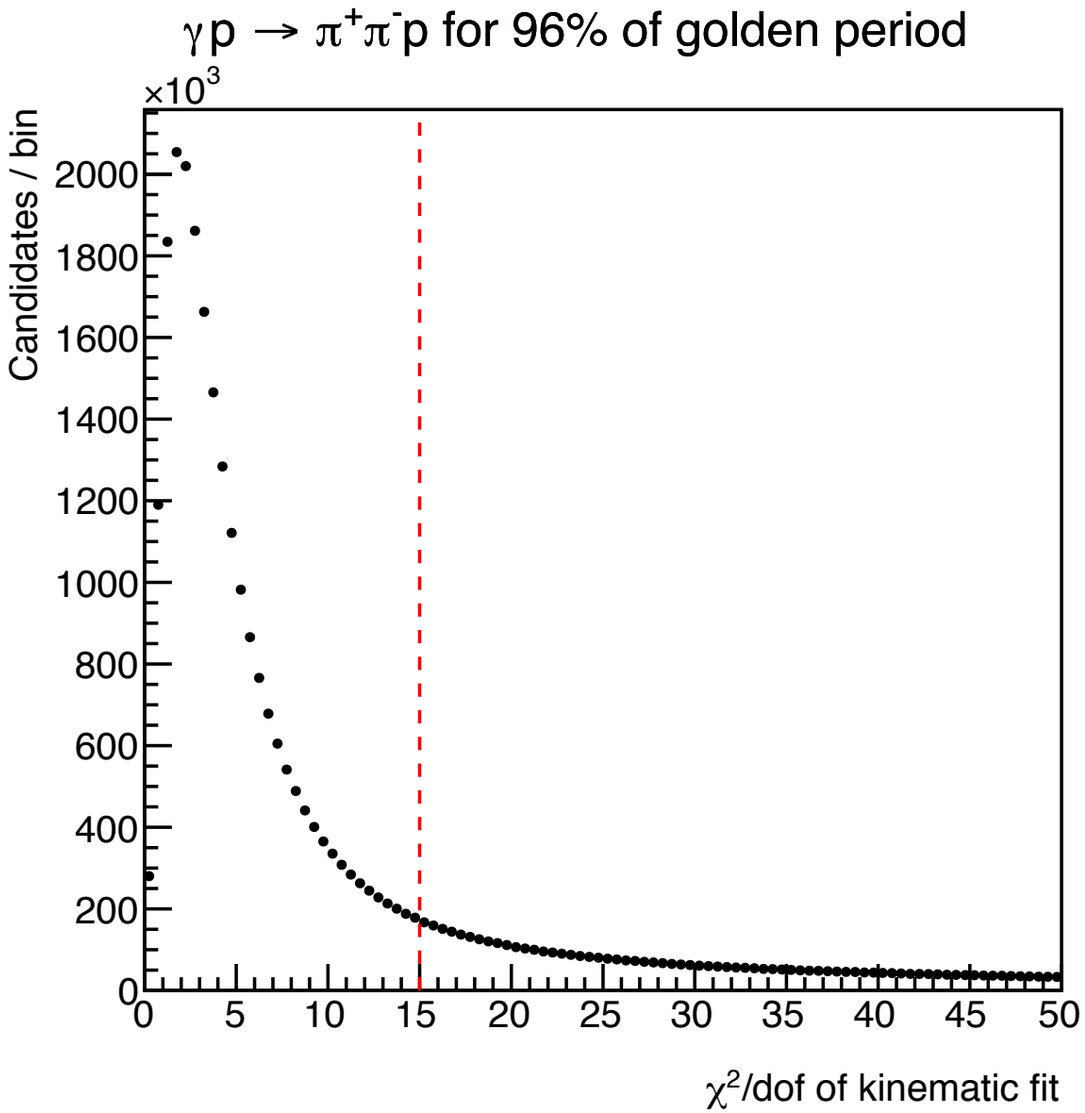
+ PID timing cuts from the wiki

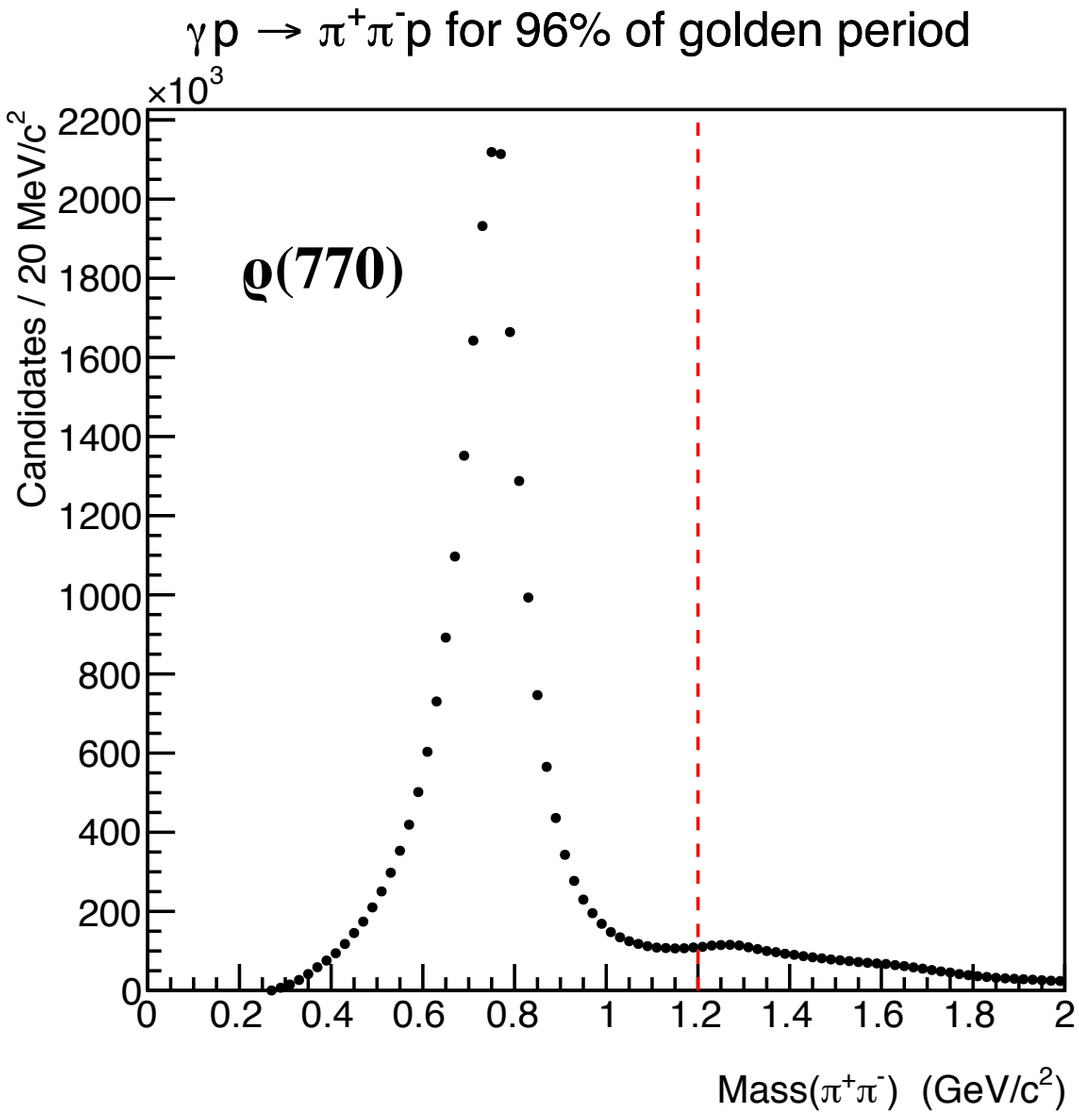
```
// should be tuned
if (fsInfo->exclusive())
      locReaction->Add_AnalysisAction(new DCutAction_MissingMassSquared(locReaction, false, -0.005, 0.005));

// should be tuned
locReaction->Add_AnalysisAction(new DCutAction_KinFitFOM(locReaction, -1.0));
```

Notes:

* running over 27 exclusive channels (shown in reference plots), used ~8GB of memory.
* resulting root files were >1TB, which were reduced to 25GB after flattening, keeping only select information, and skimming using the kinematic fit χ^2/dof.
* jobs crash in two runs in the “golden period”… still investigating.

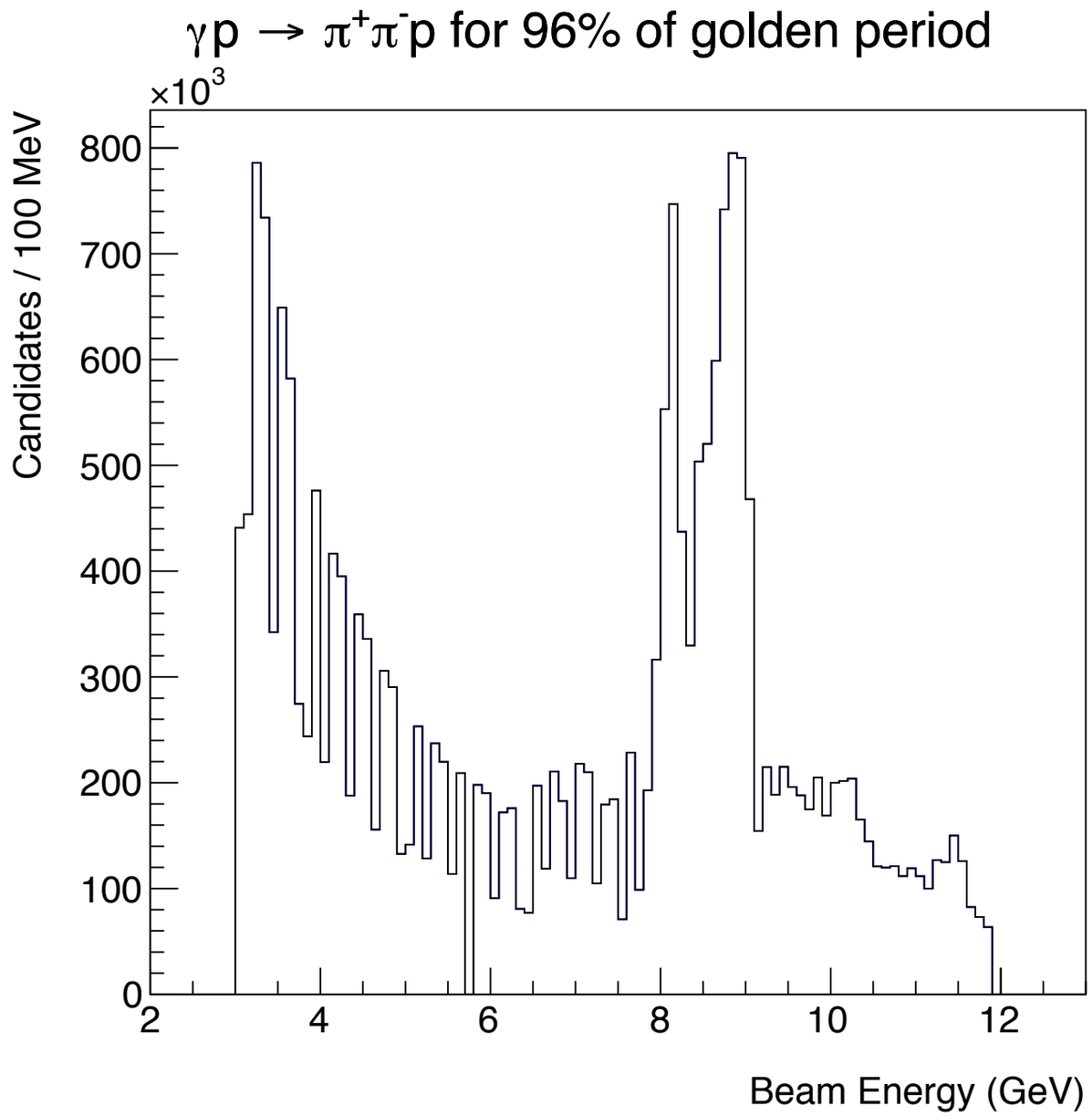
Sanity Checks: $\gamma p \rightarrow \pi^+\pi^- p$



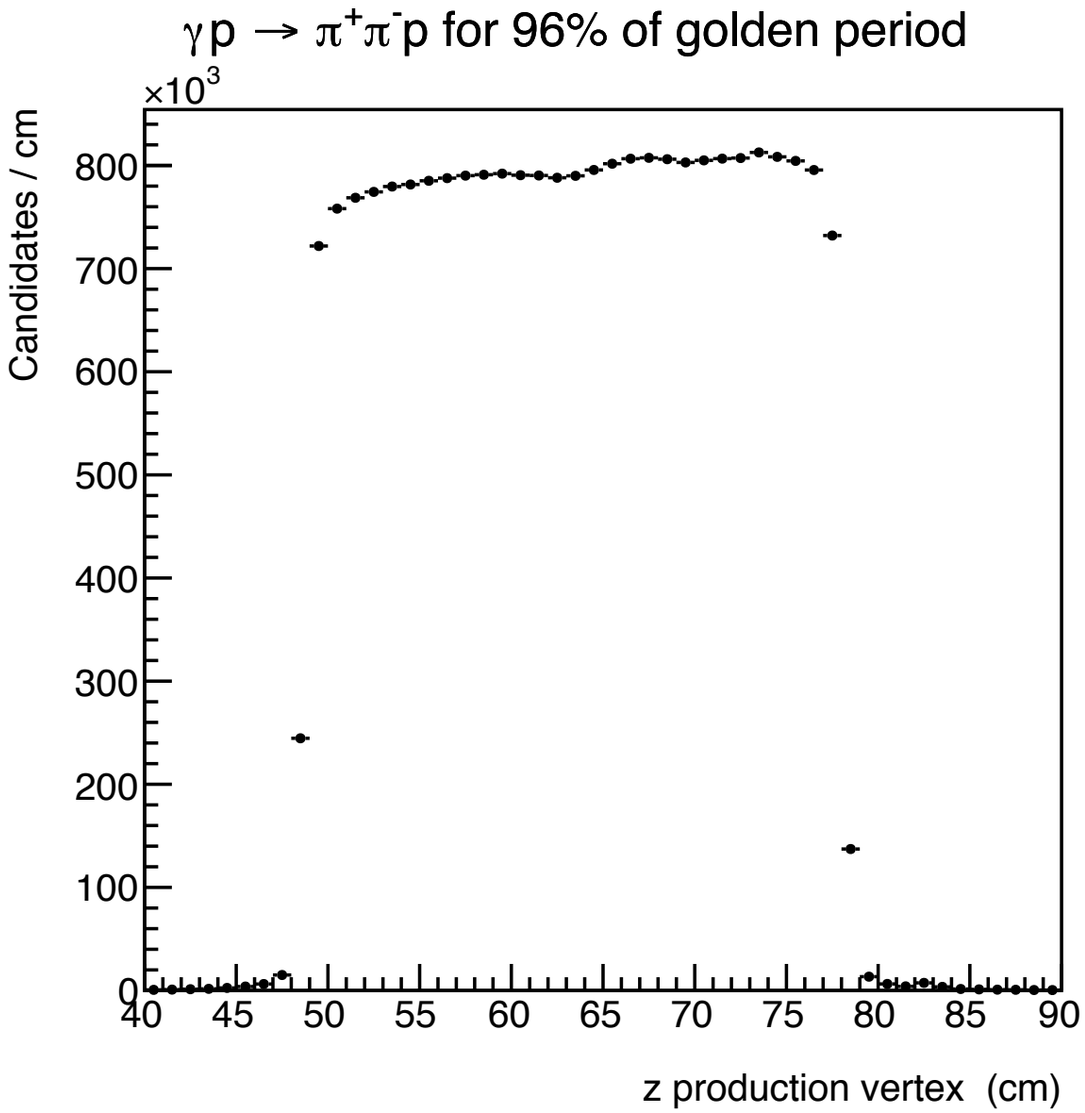


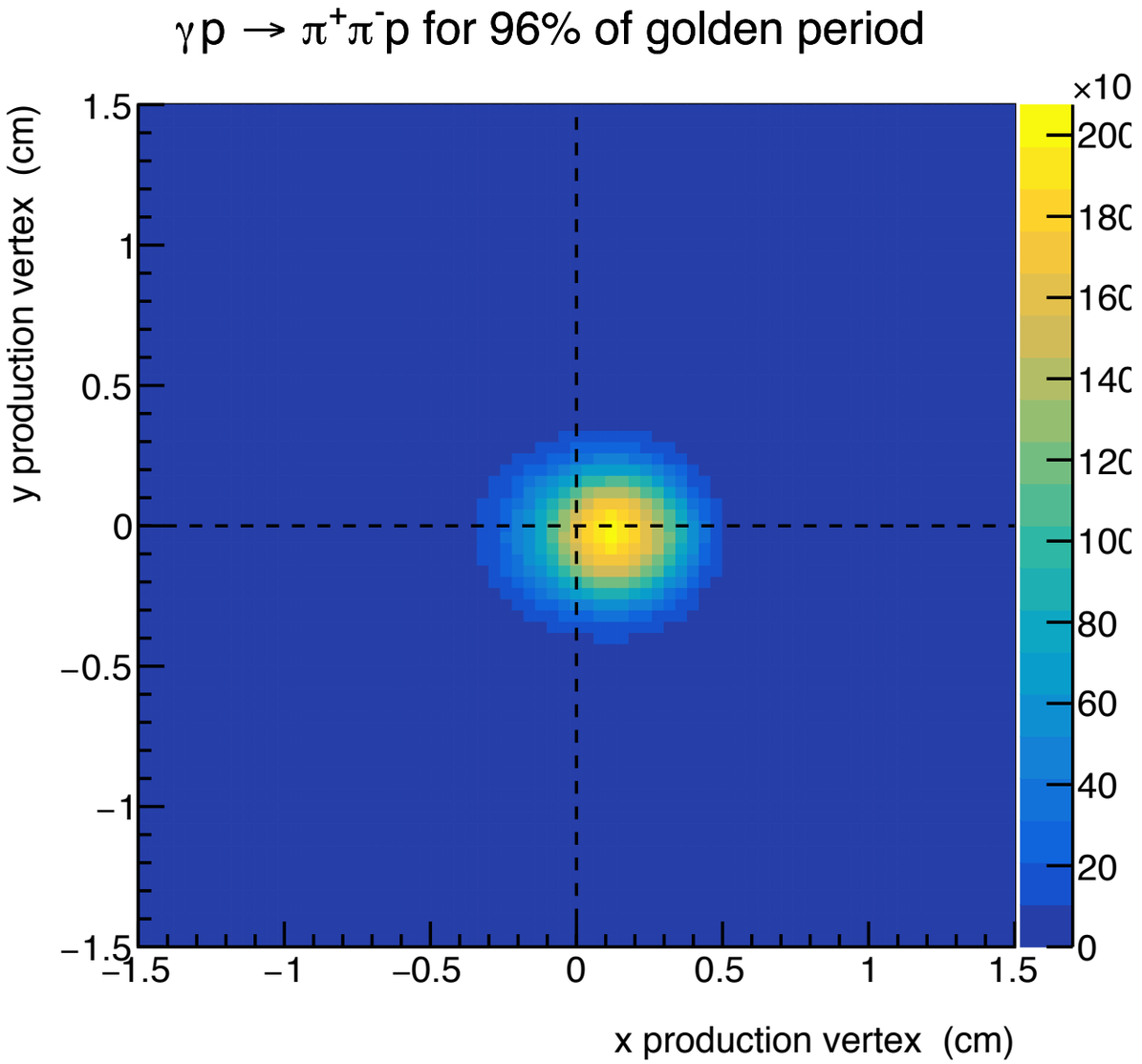
(cuts shown with red lines are applied in all plots for a given channel)

Sanity Checks: $\gamma p \rightarrow \pi^+\pi^- p$

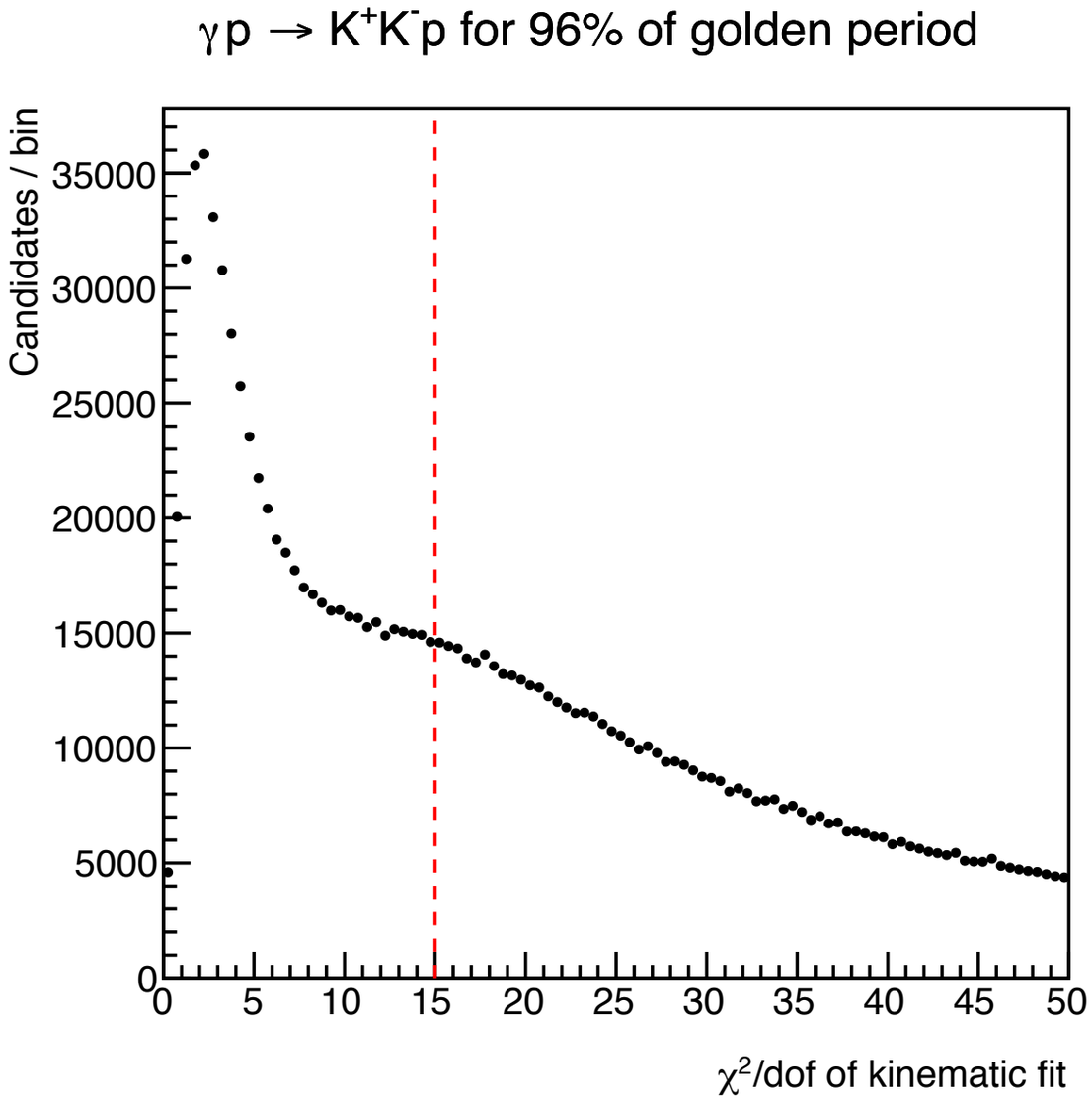


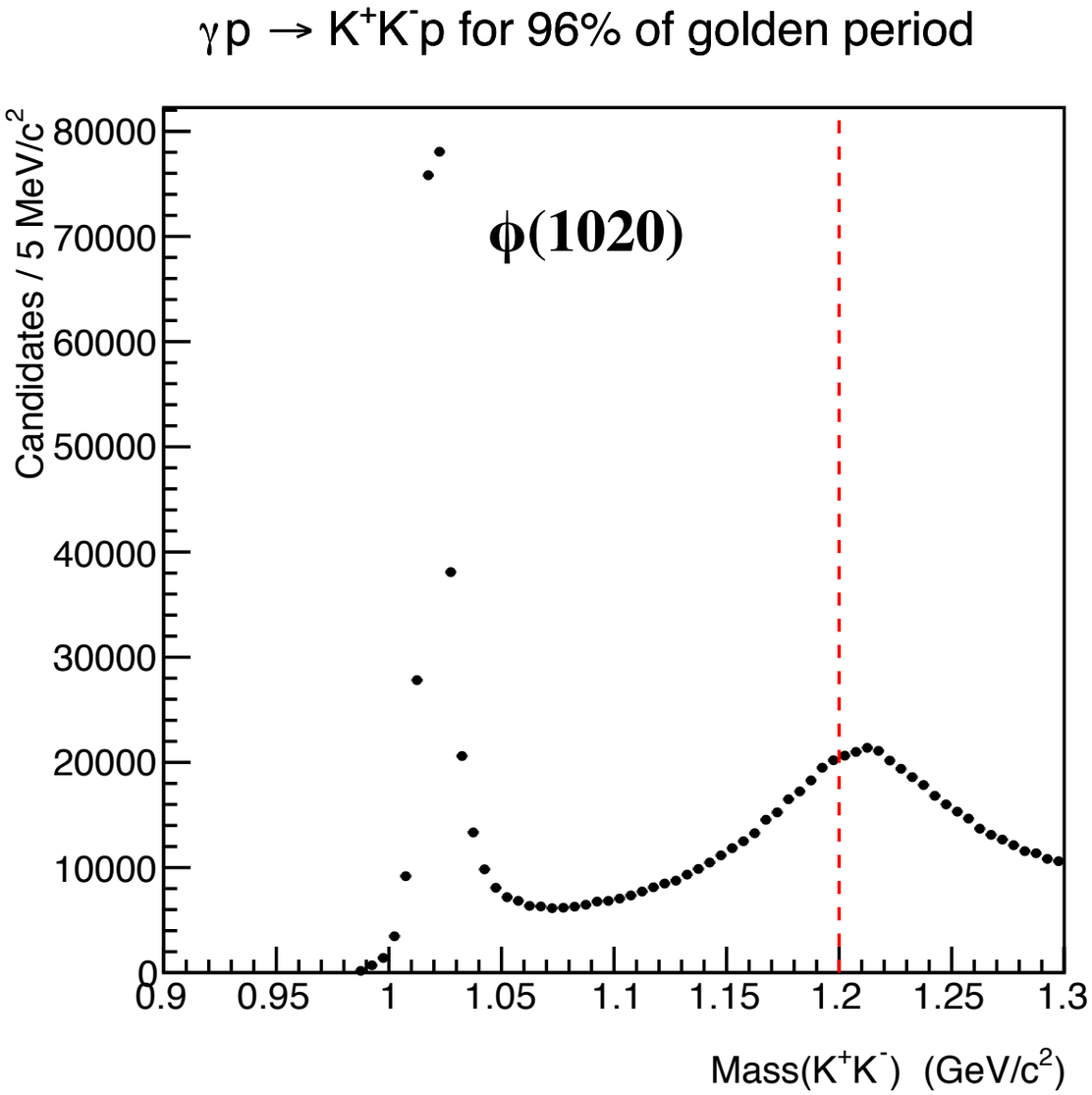
Sanity Checks: $\gamma p \rightarrow \pi^+\pi^- p$





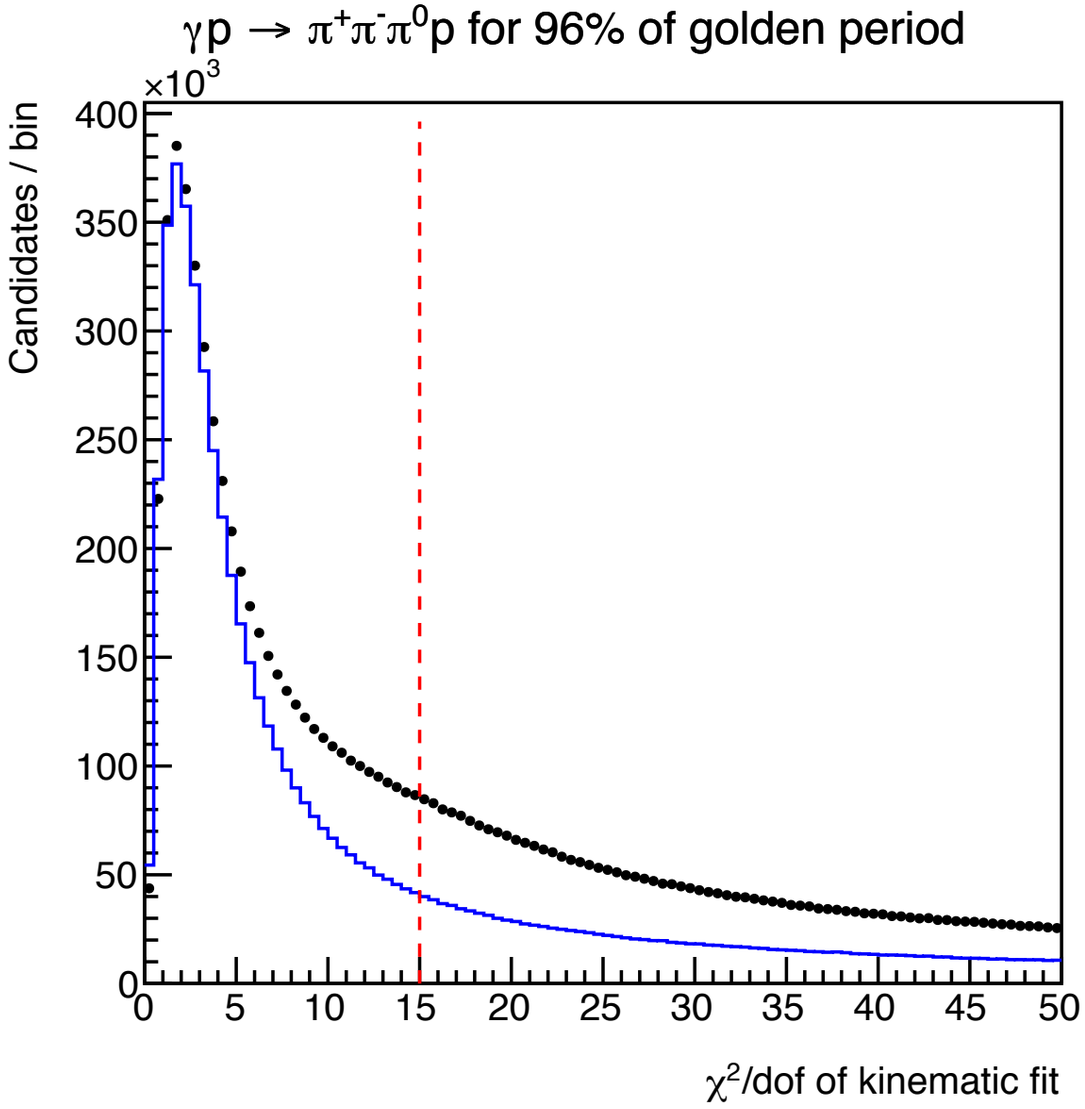
Sanity Checks: $\gamma p \rightarrow K^+K^-p$

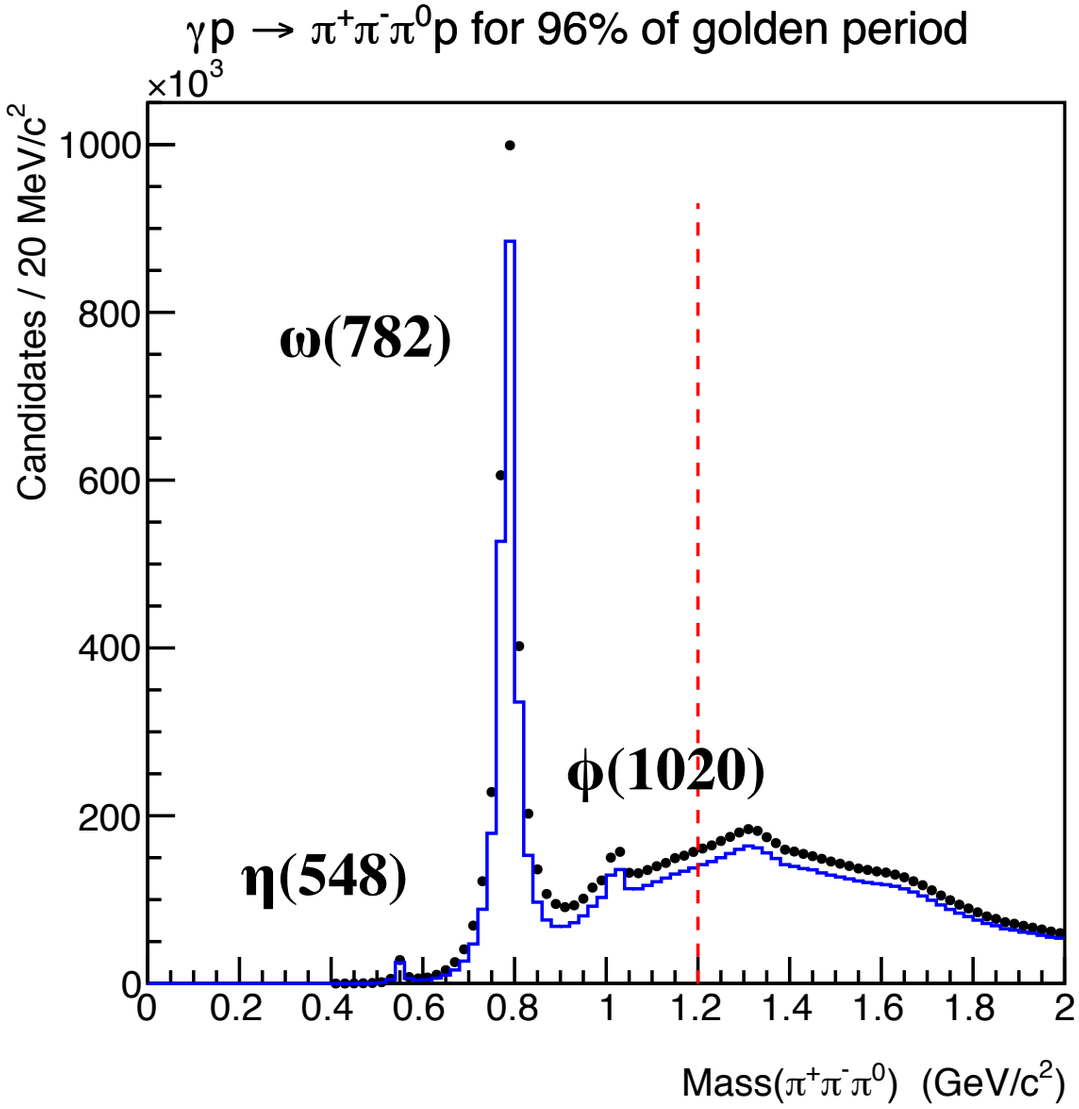




(cuts shown with red lines are applied in all plots for a given channel)

Sanity Checks: $\gamma p \rightarrow \pi^+\pi^-\pi^0 p$



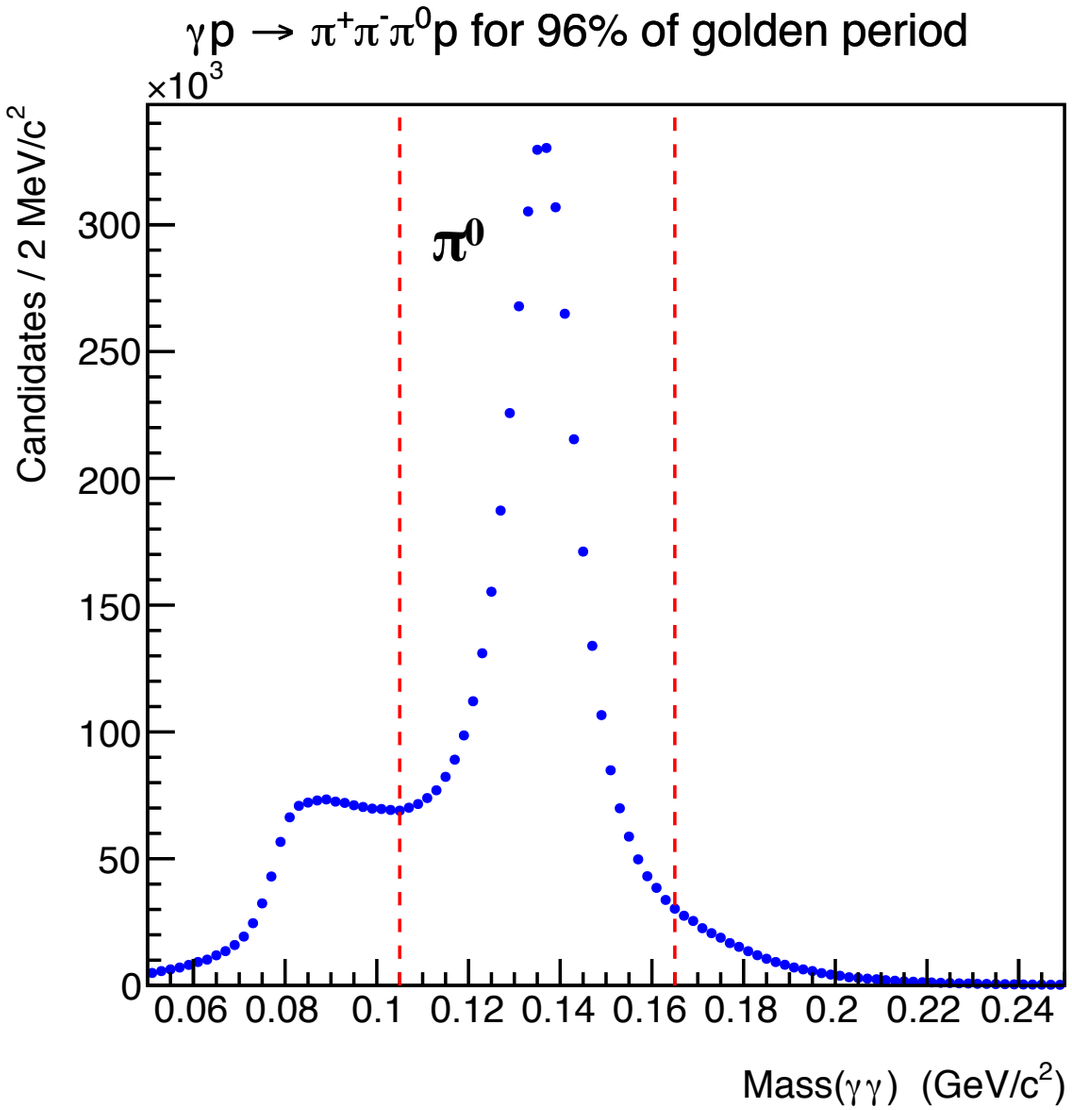


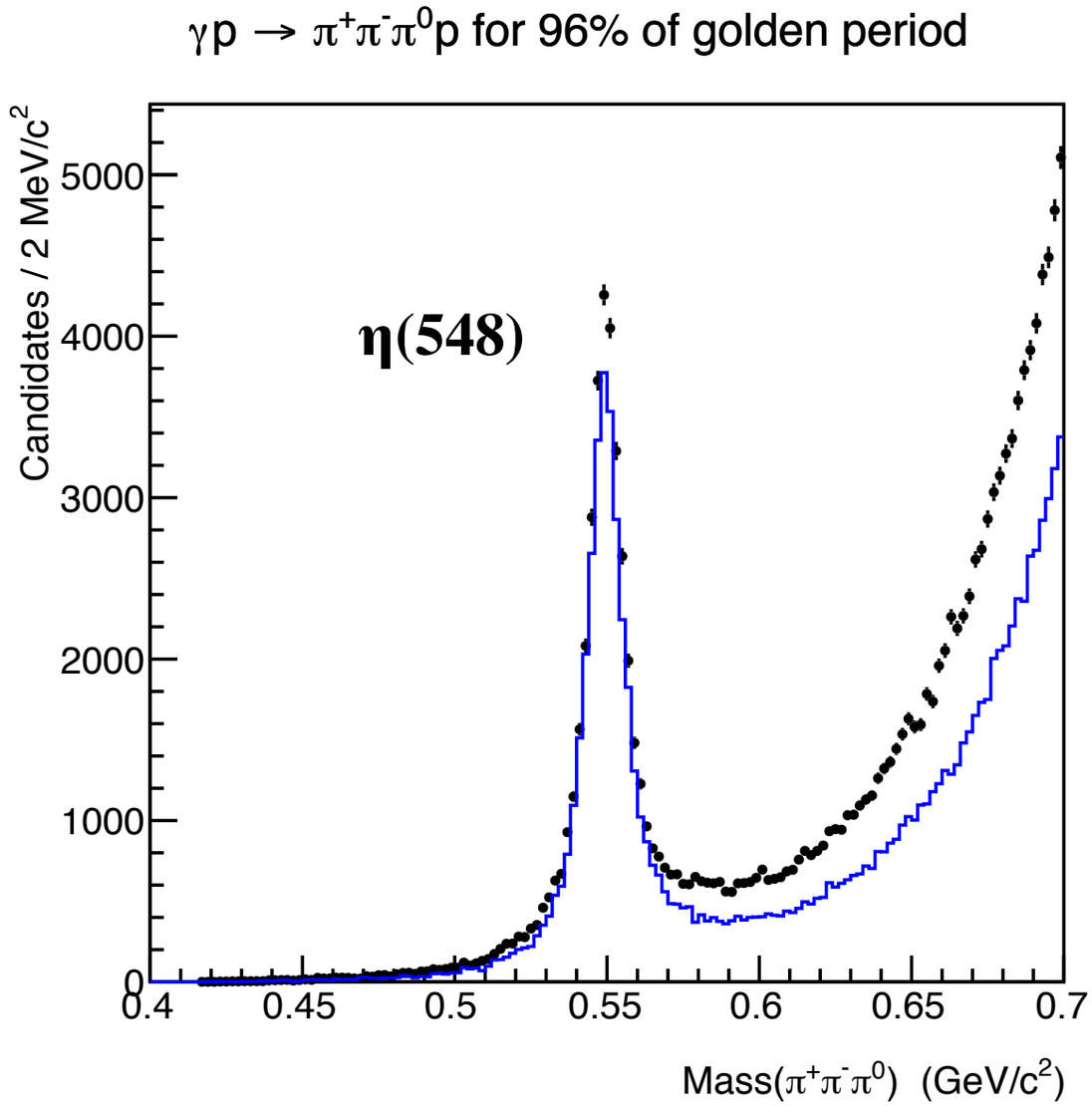
with π^0 mass constraint

without π^0 mass constraint

(π^0 mass cut on next slide)

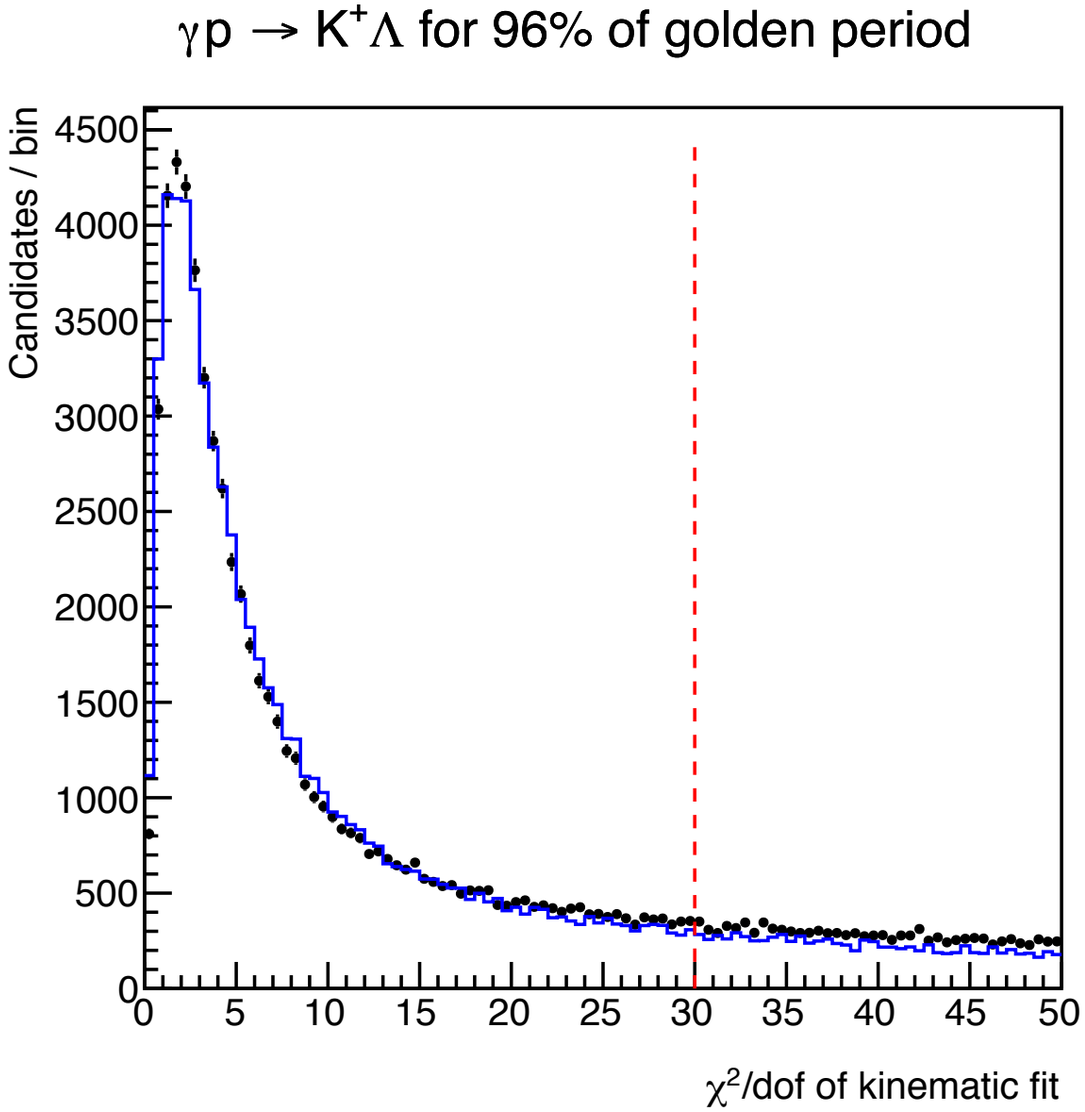
Sanity Checks: $\gamma p \rightarrow \pi^+\pi^-\pi^0 p$





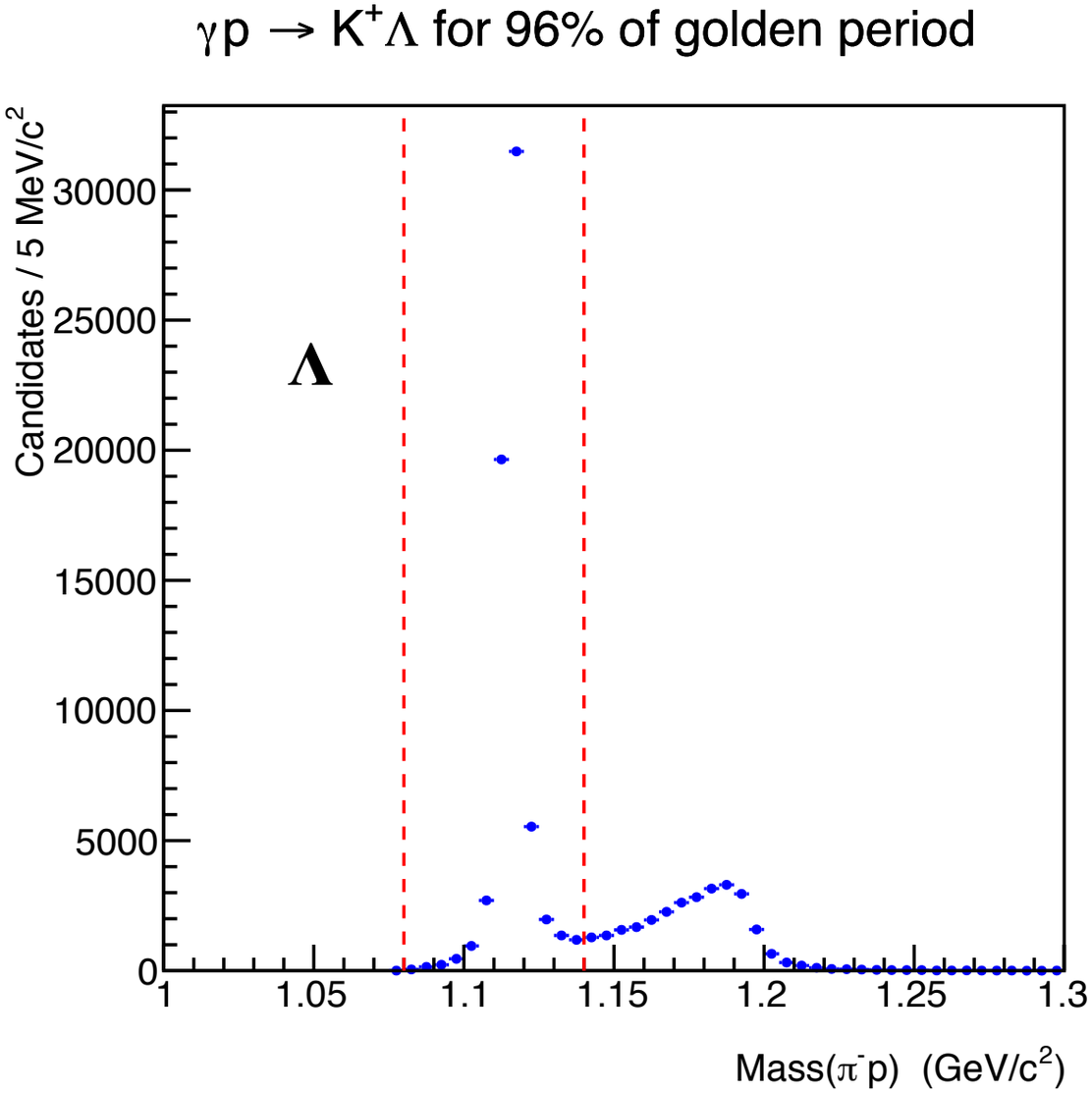
(pre-kinematic fit cuts cause the edges)

Sanity Checks: $\gamma p \rightarrow K^+\Lambda$



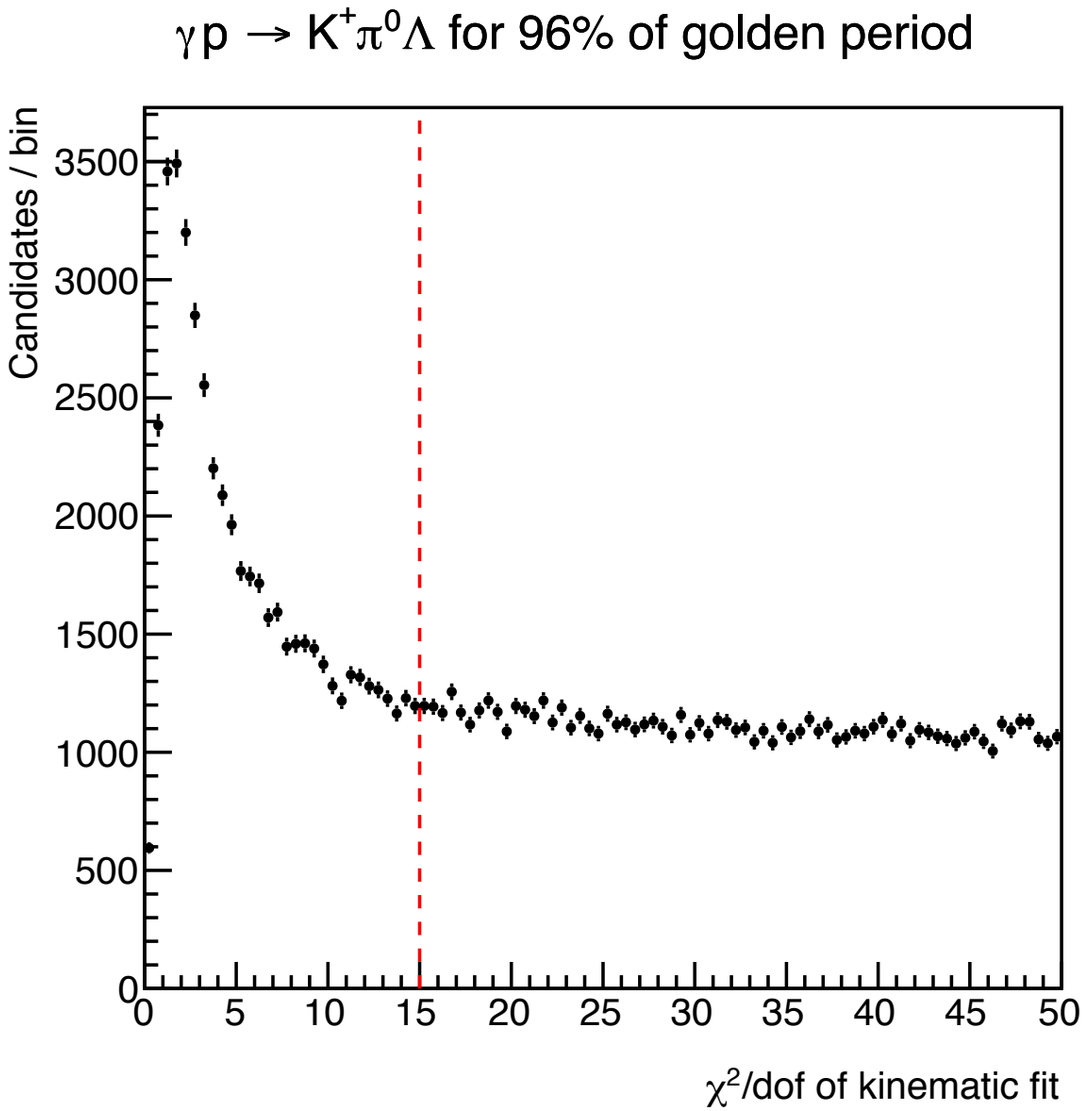
with Λ mass constraint

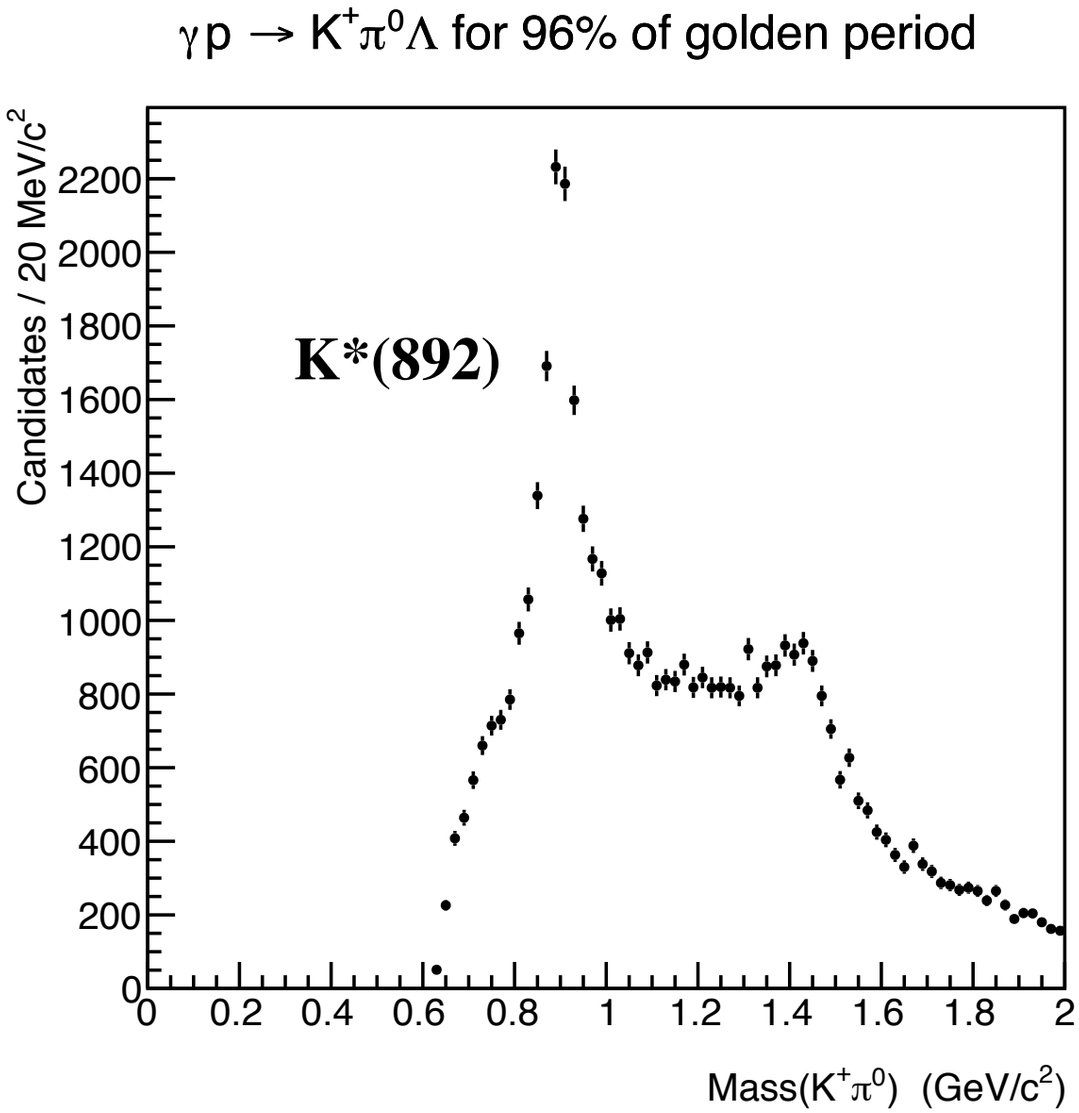
without Λ mass constraint



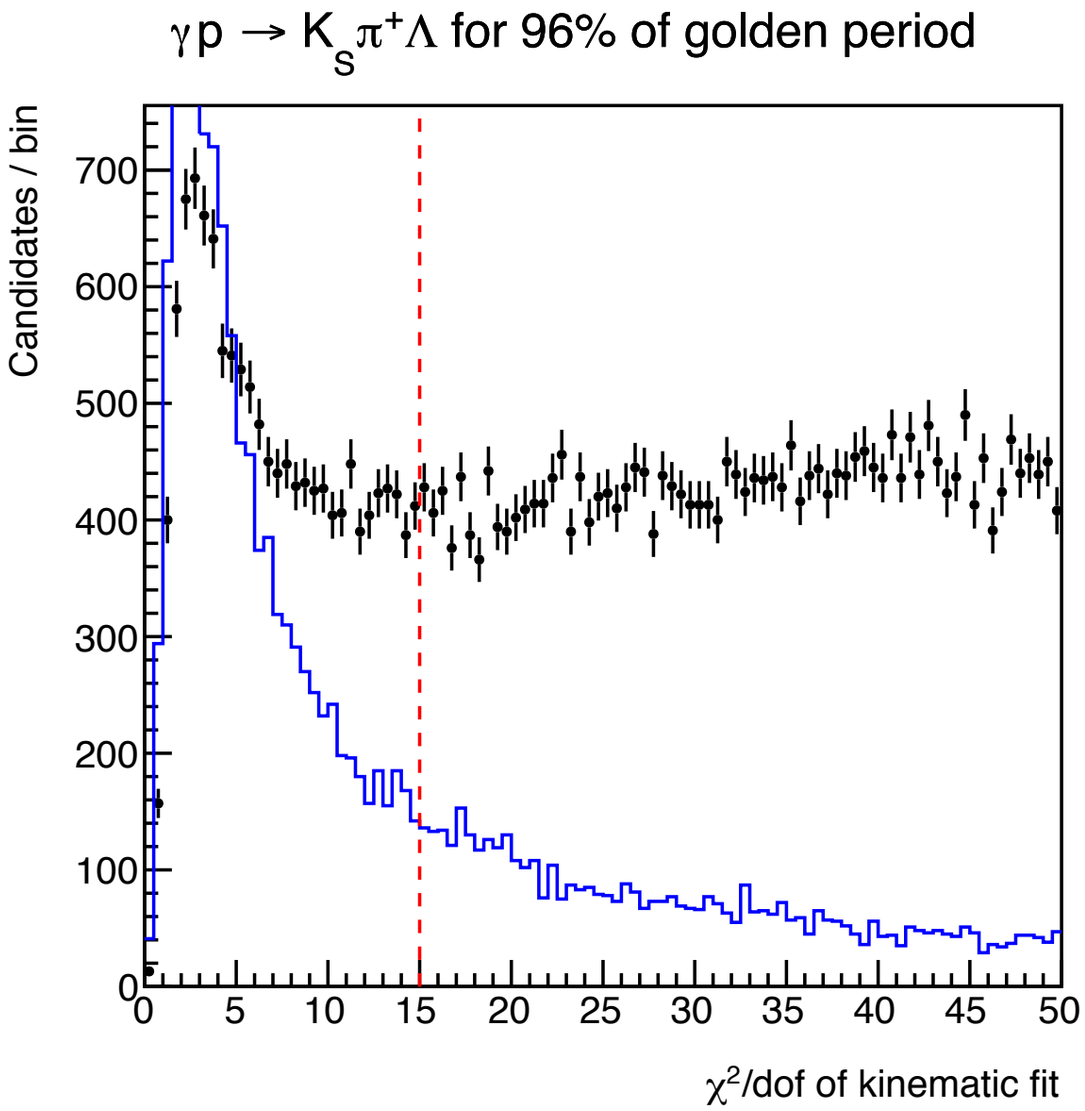
(pre-kinematic fit cuts cause the edges)

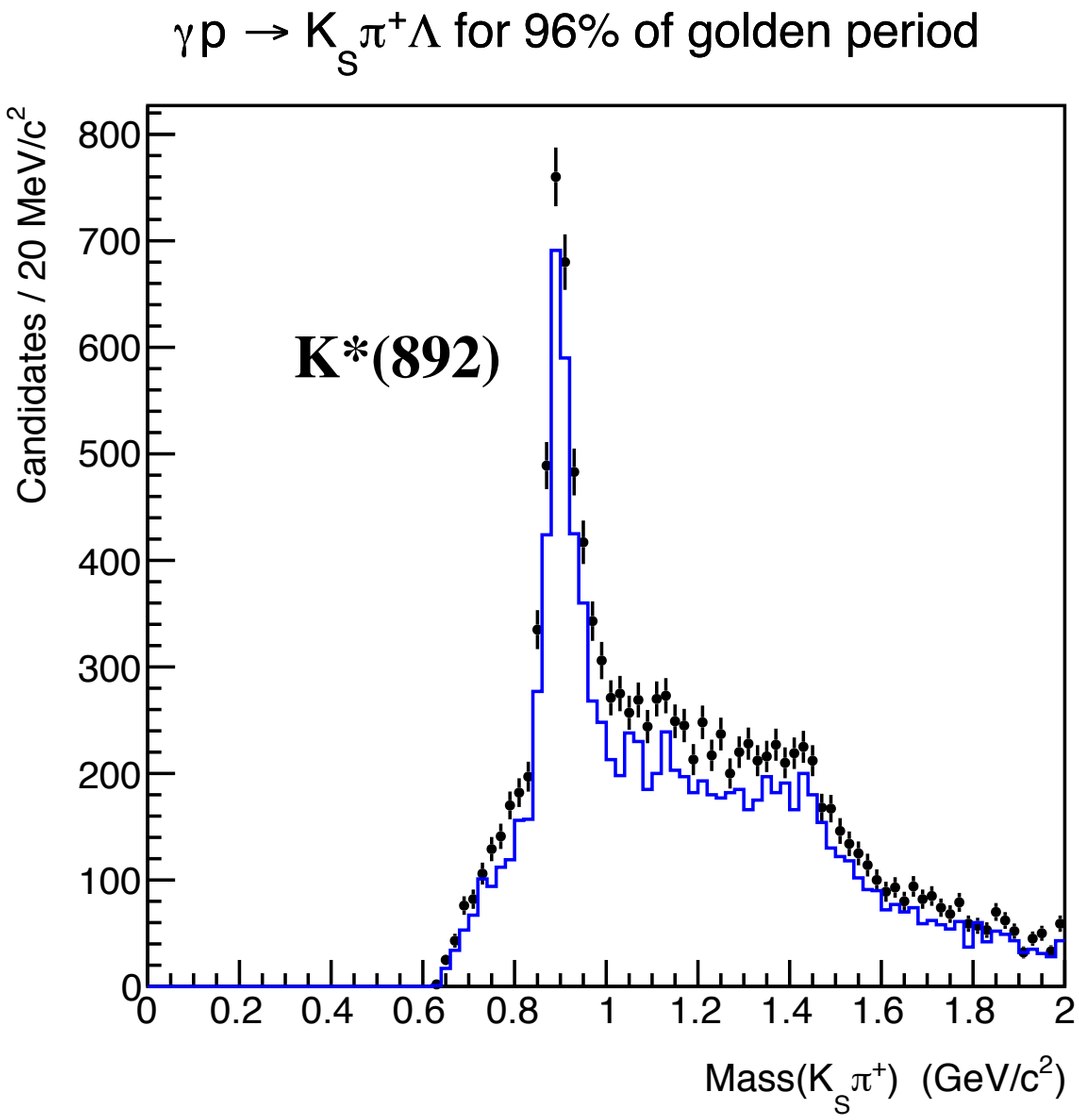
Sanity Checks: $\gamma p \rightarrow K^+\pi^0\Lambda$





Sanity Checks: $\gamma p \rightarrow K_S \pi^+ \Lambda$



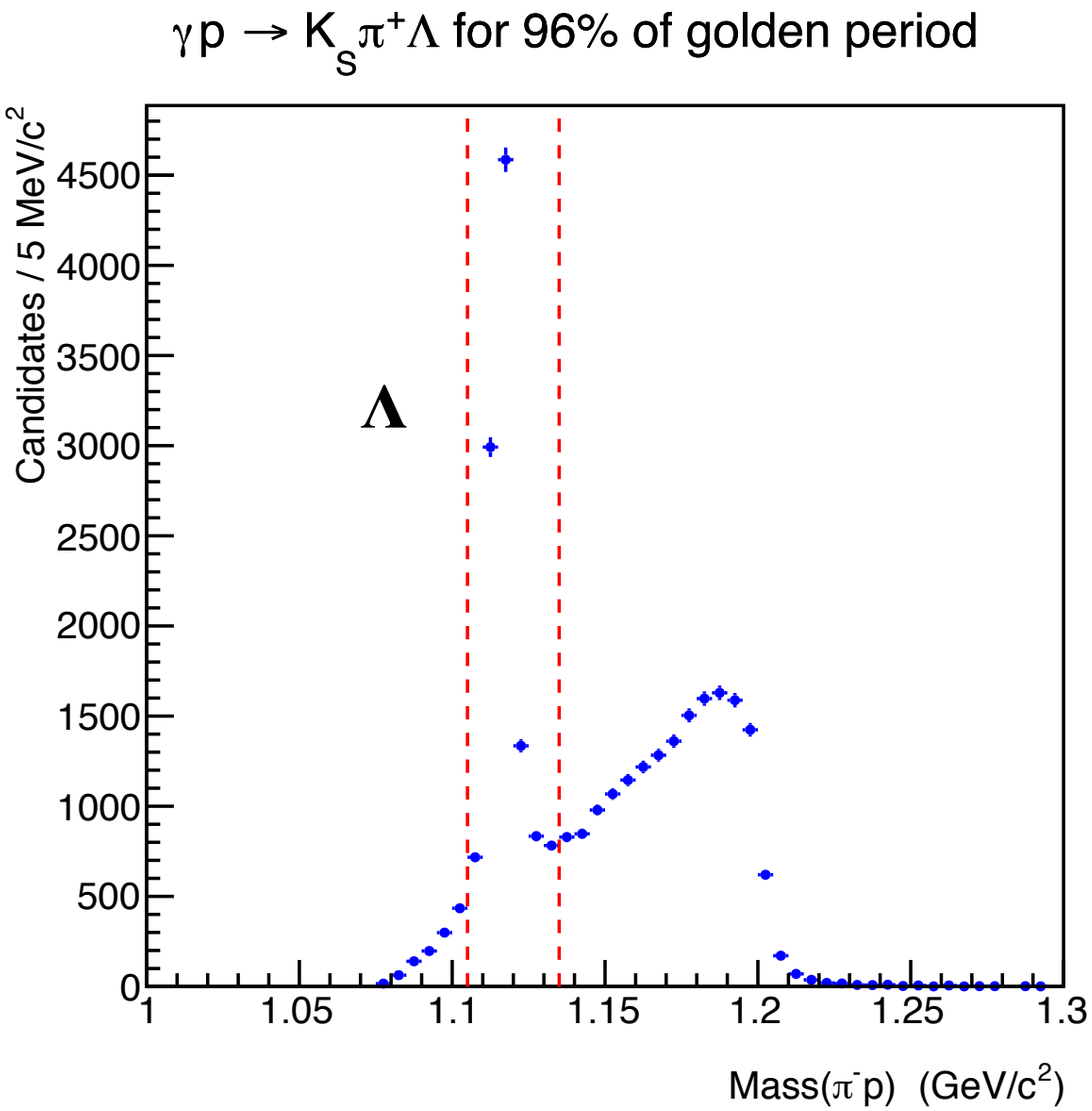


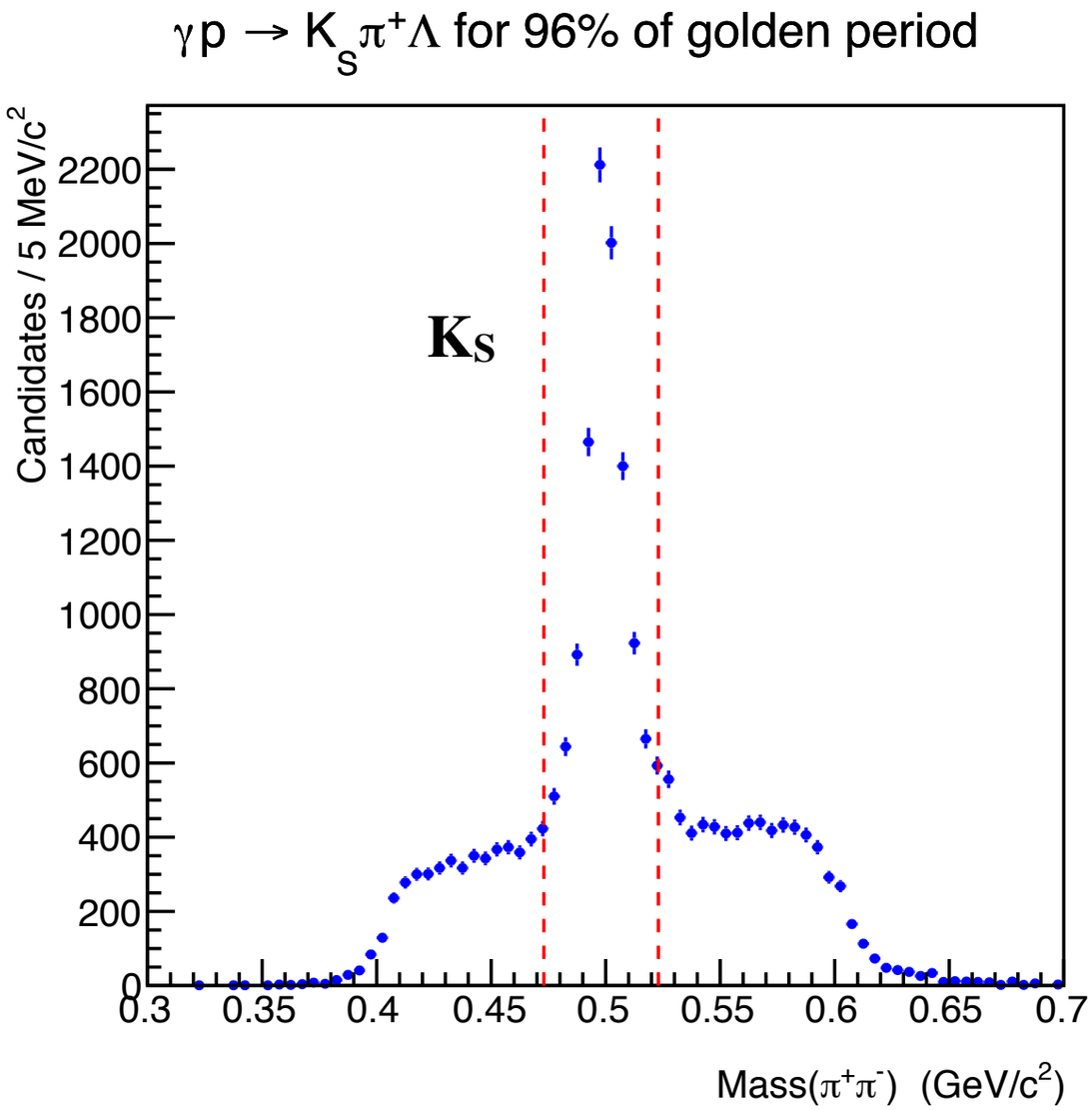
with Λ, K_S mass constraints

without Λ, K_S mass constraints

(mass cuts on next slide)

Sanity Checks: $\gamma p \rightarrow K_S \pi^+ \Lambda$





(pre-kinematic fit cuts cause the edges)

Reference Plots

Run over 27 exclusive channels with p, $\pi^{\pm}$, π^0, $K^{\pm}$, K_S.

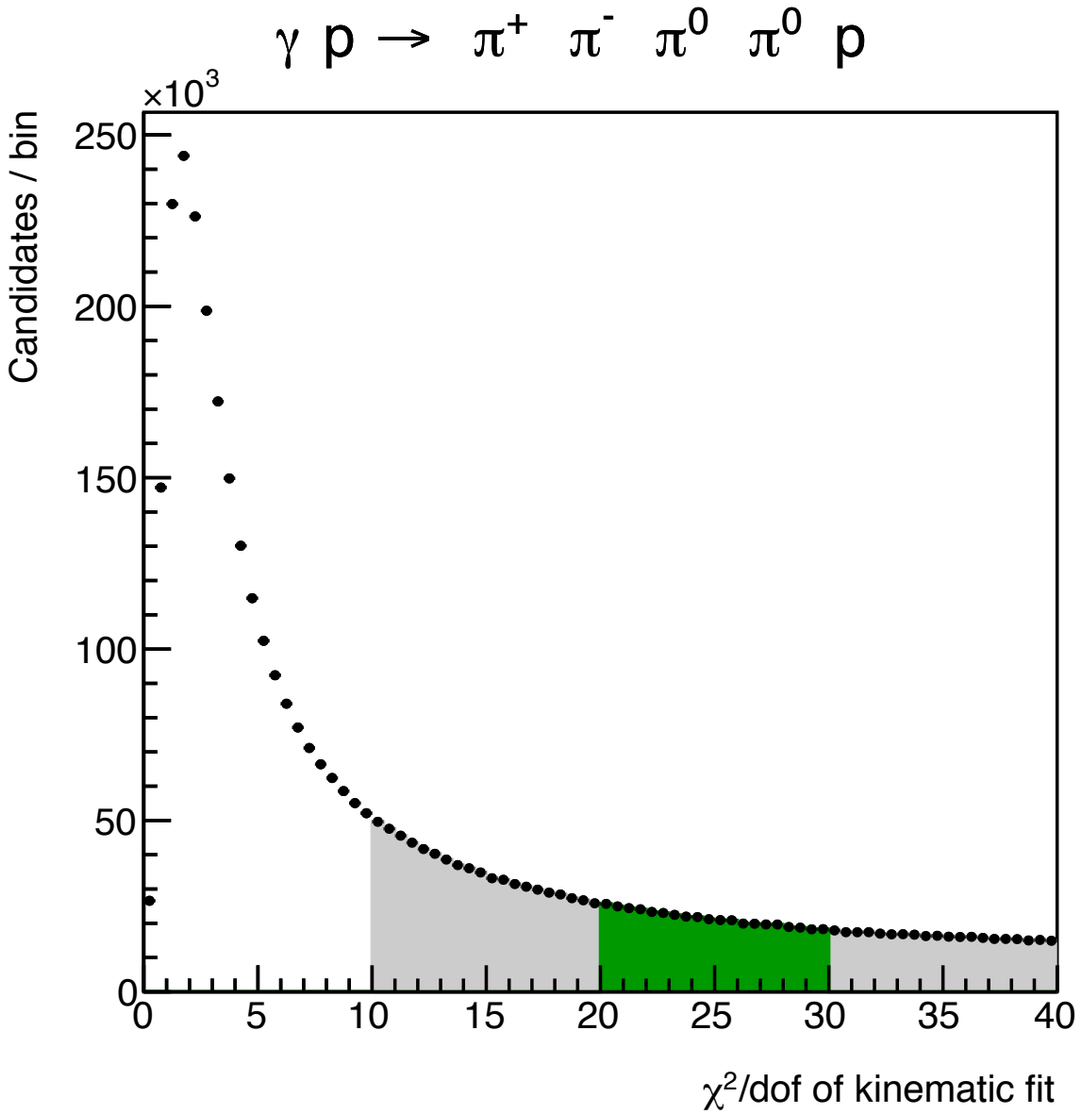
```
ReactionFilter:FS1   EXC_100_2
ReactionFilter:FS2   EXC_100_110
ReactionFilter:FS3   EXC_100_111
ReactionFilter:FS4   EXC_100_112
ReactionFilter:FS5   EXC_100_220
ReactionFilter:FS6   EXC_100_221
ReactionFilter:FS7   EXC_100_222
ReactionFilter:FS8   EXC_100_330
ReactionFilter:FS9   EXC_100_2000
ReactionFilter:FS10   EXC_100_2001
ReactionFilter:FS11   EXC_100_2002
ReactionFilter:FS12   EXC_100_2110
ReactionFilter:FS13   EXC_100_11100
ReactionFilter:FS14   EXC_100_11101
ReactionFilter:FS15   EXC_100_11102
ReactionFilter:FS16   EXC_100_11210
ReactionFilter:FS17   EXC_100_101010
ReactionFilter:FS18   EXC_100_101011
ReactionFilter:FS19   EXC_100_101012
ReactionFilter:FS20   EXC_100_101120
ReactionFilter:FS21   EXC_100_110000
ReactionFilter:FS22   EXC_100_110001
ReactionFilter:FS23   EXC_100_110002
ReactionFilter:FS24   EXC_100_110110
ReactionFilter:FS25   EXC_100_110111
ReactionFilter:FS26   EXC_100_110112
ReactionFilter:FS27   EXC_100_110220
```

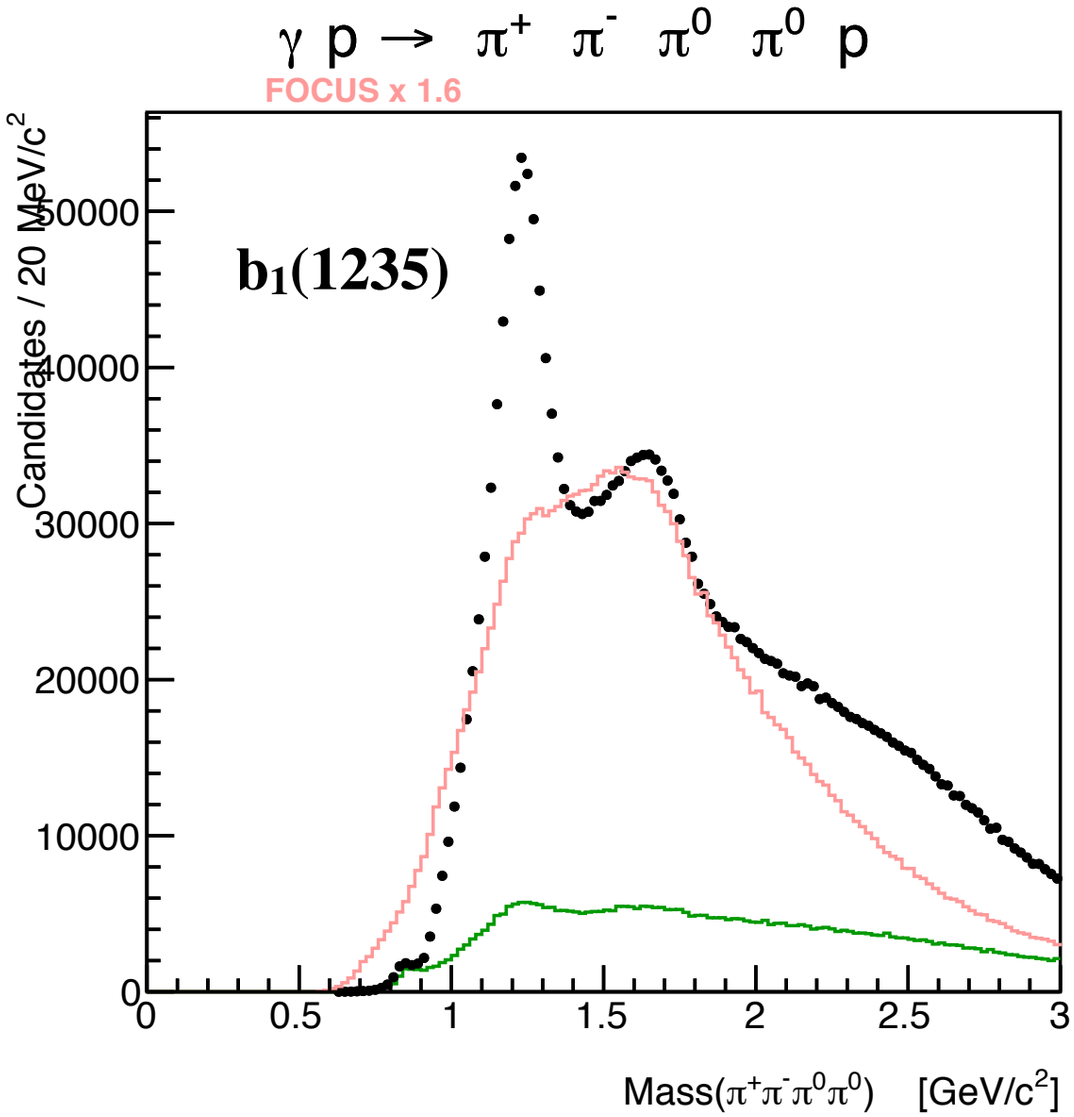
Use the same cuts as before, but add:

Beam energy > 8 GeV.

Use only the combination with the best χ^2/dof across *all channels* *(needs study, maybe introduces a few strange features)*.

Reference Plots (Example Channel)

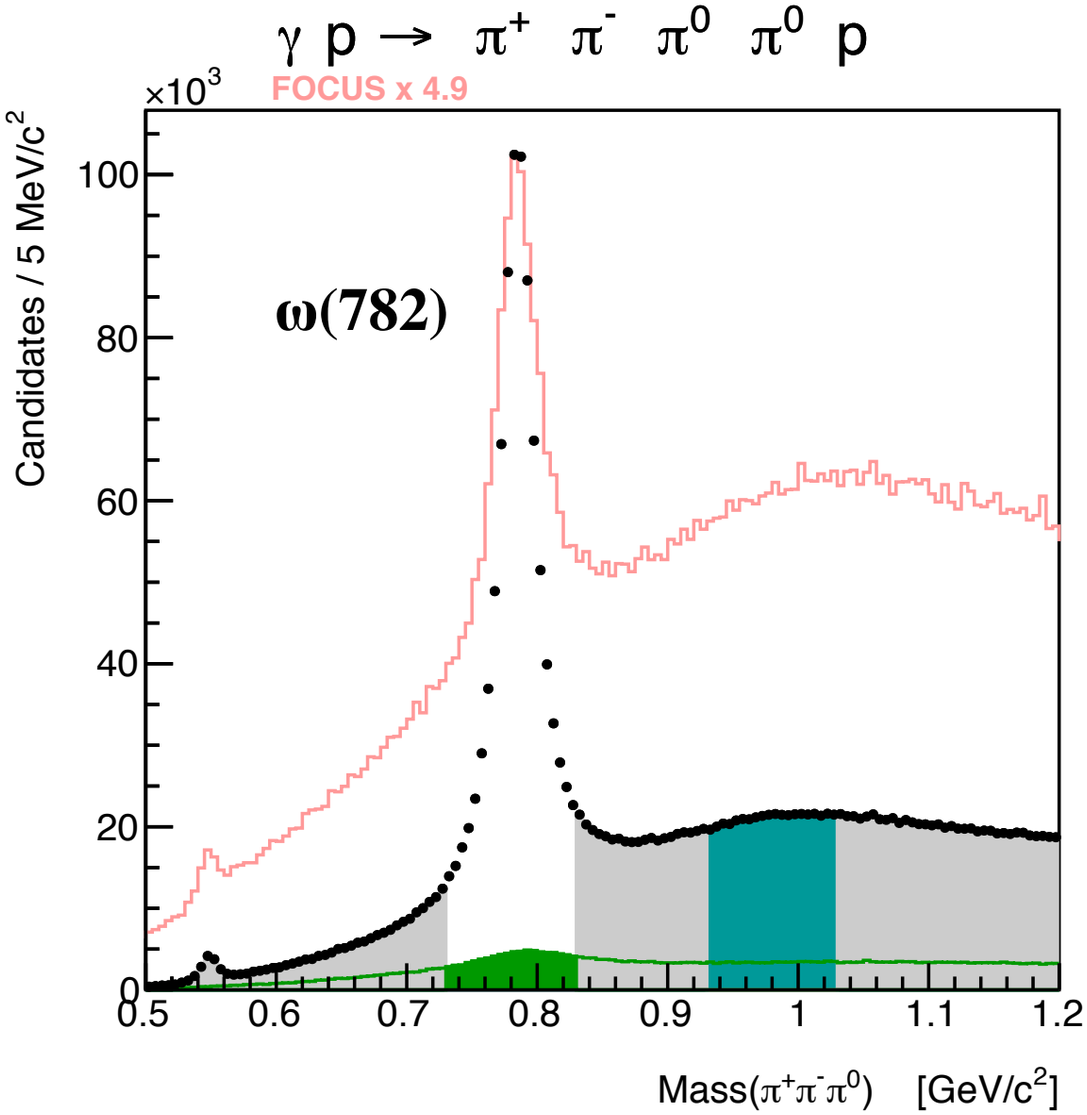


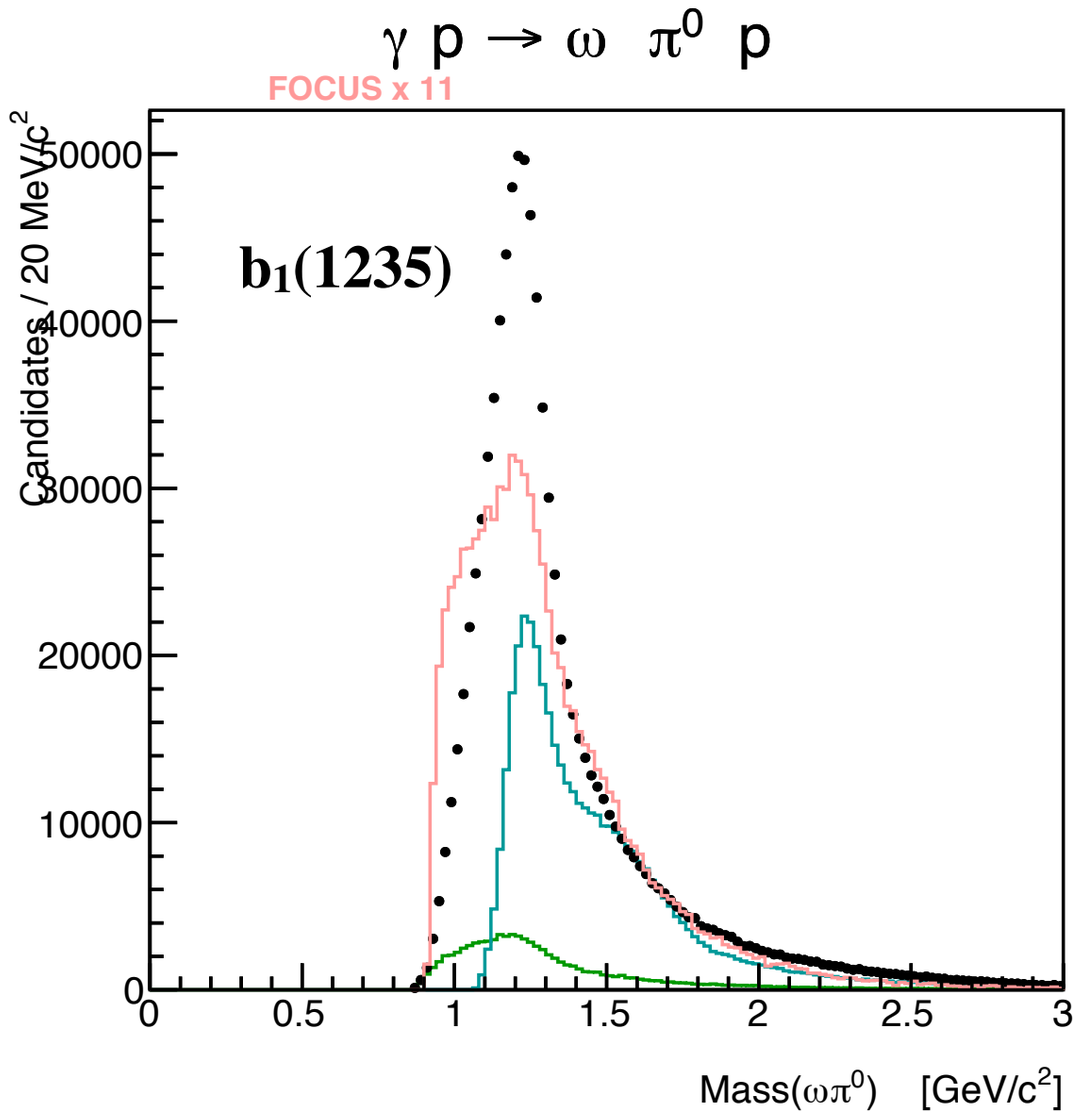


Select **signal** and **sideband** regions using the χ^2/dof of the kinematic fit.

Show mass plots for χ^2/dof **signal** and **sideband**. Compare with old FOCUS plots *(scaled arbitrarily and not to be taken too seriously)*.

Reference Plots (Example Channel)





Also show substructure for $\omega \to \pi^+\pi^-\pi^0$, $\eta \to \pi^+\pi^-\pi^0$, and $\phi \to K^+K^-$.

Colors: GlueX data
χ^2/dof sideband
resonance sideband
FOCUS data

GlueX Reference Plots

Ryan Mitchell

November 19, 2016

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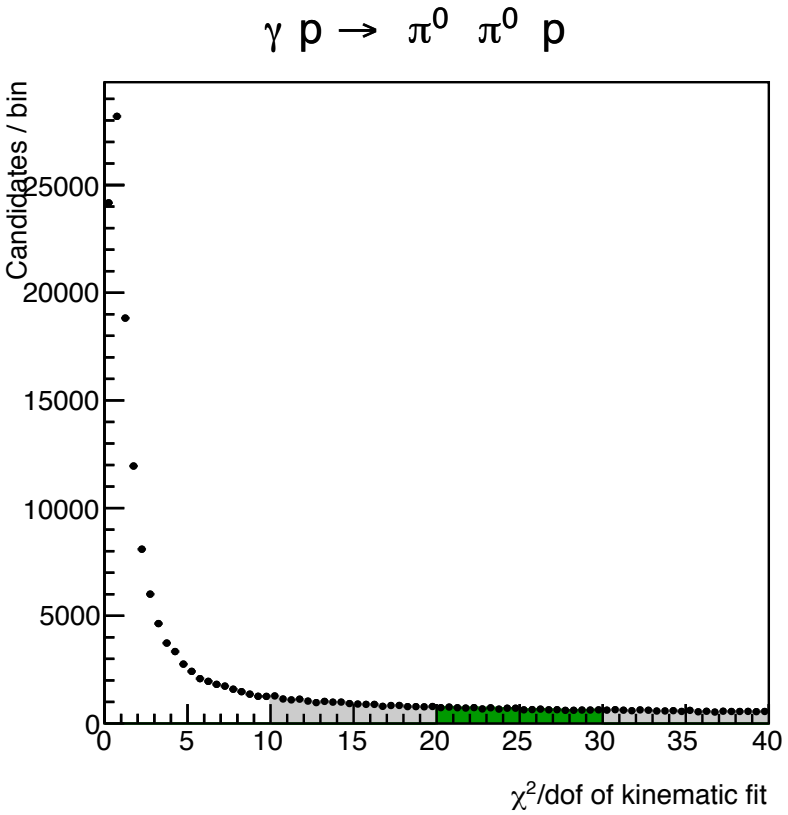
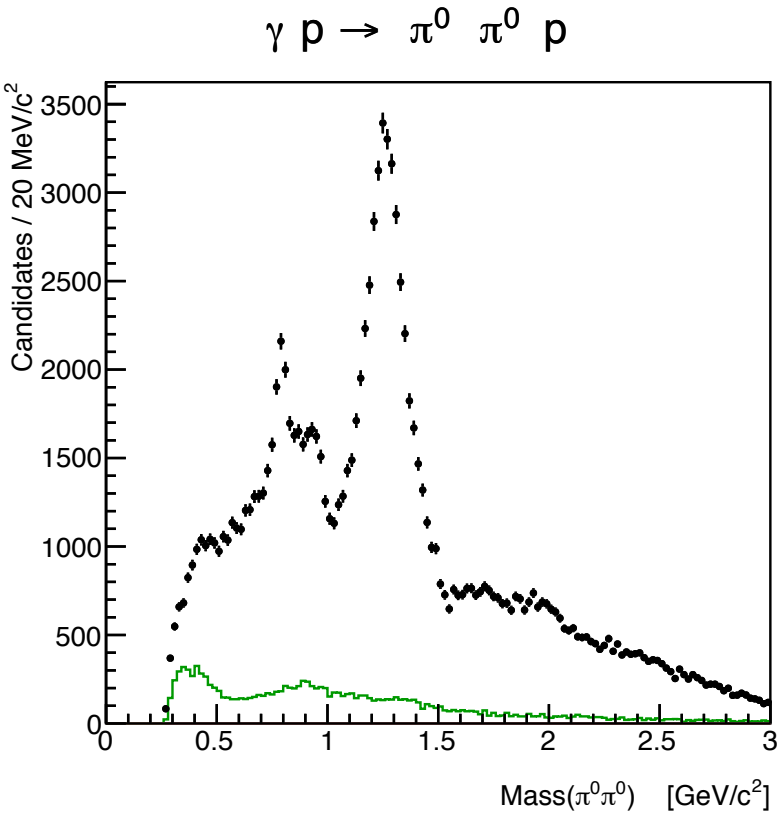
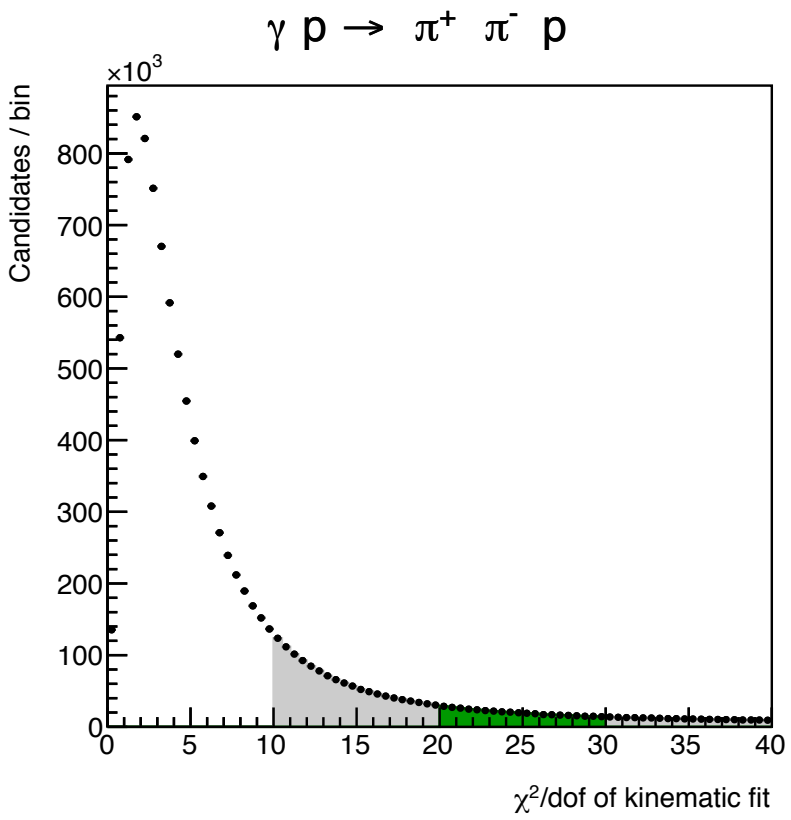
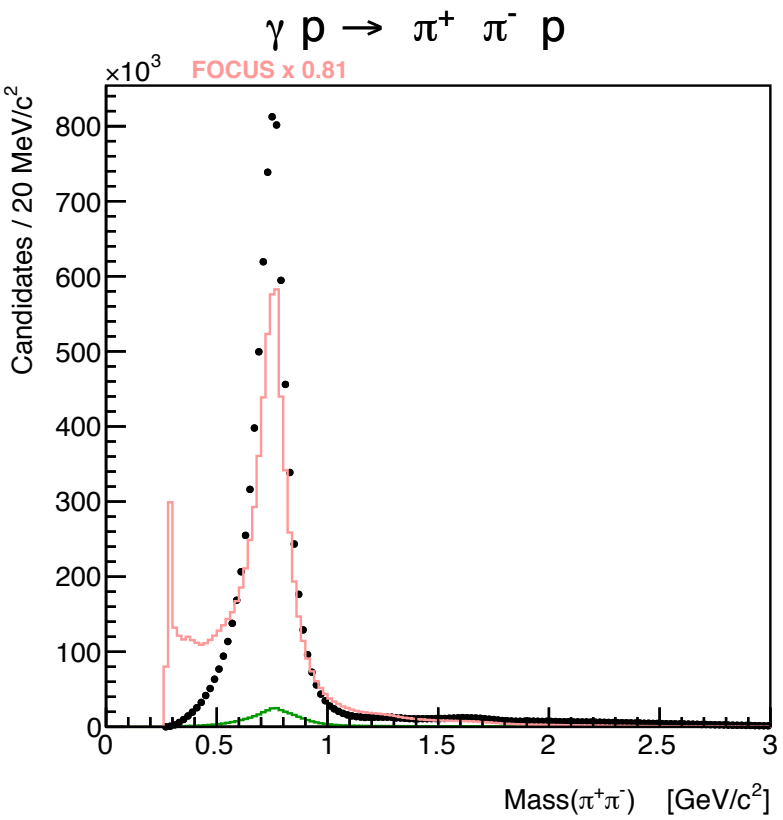
1 $\gamma p \to \pi^0\pi^0 p$



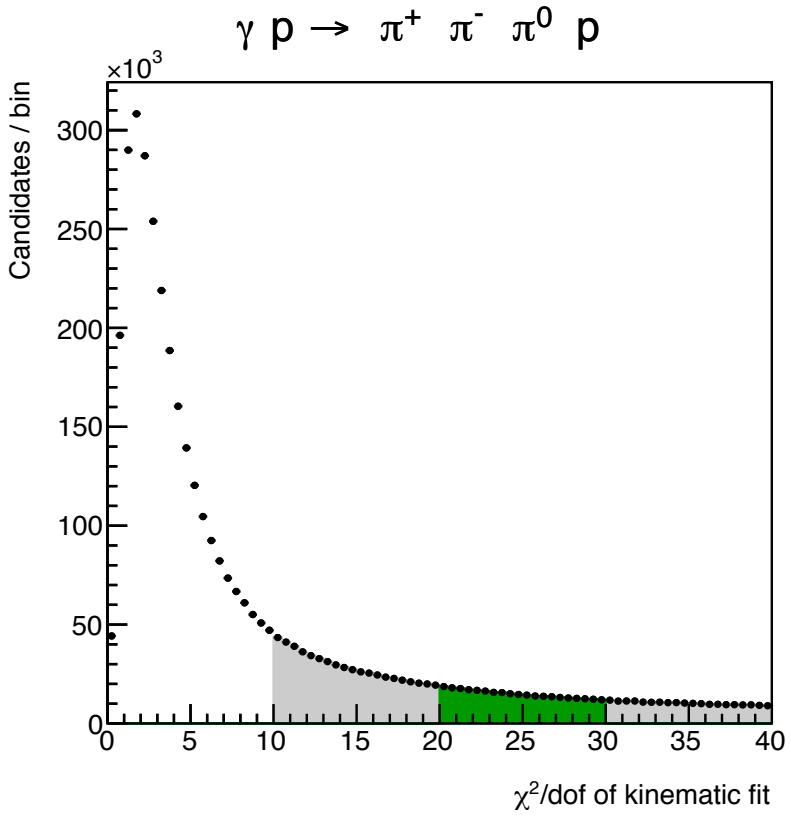


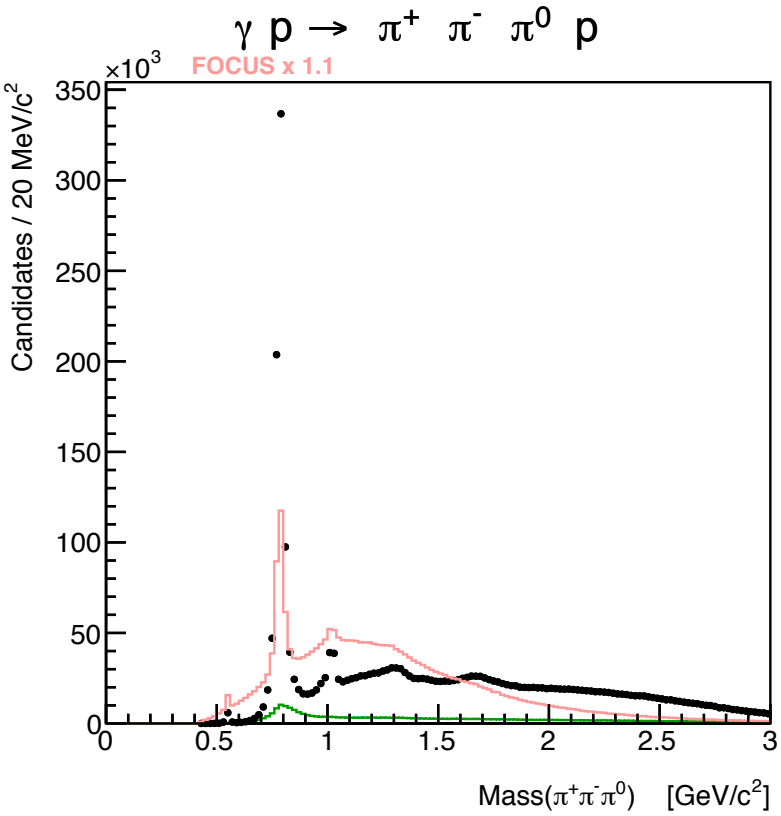
2 $\gamma p \to \pi^+\pi^- p$



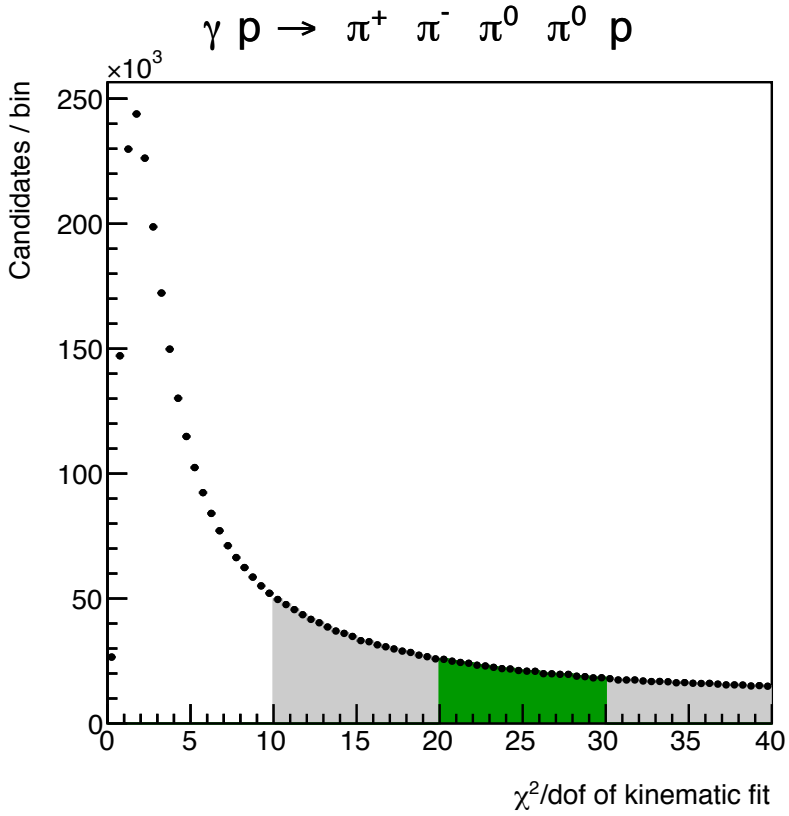


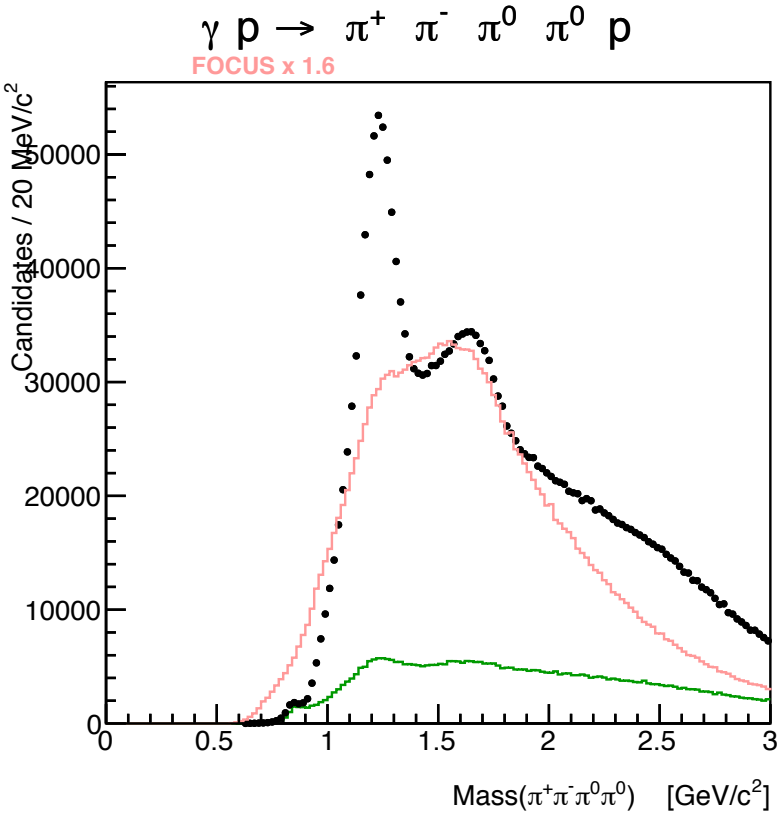
3 $\gamma p \to \pi^+\pi^-\pi^0 p$



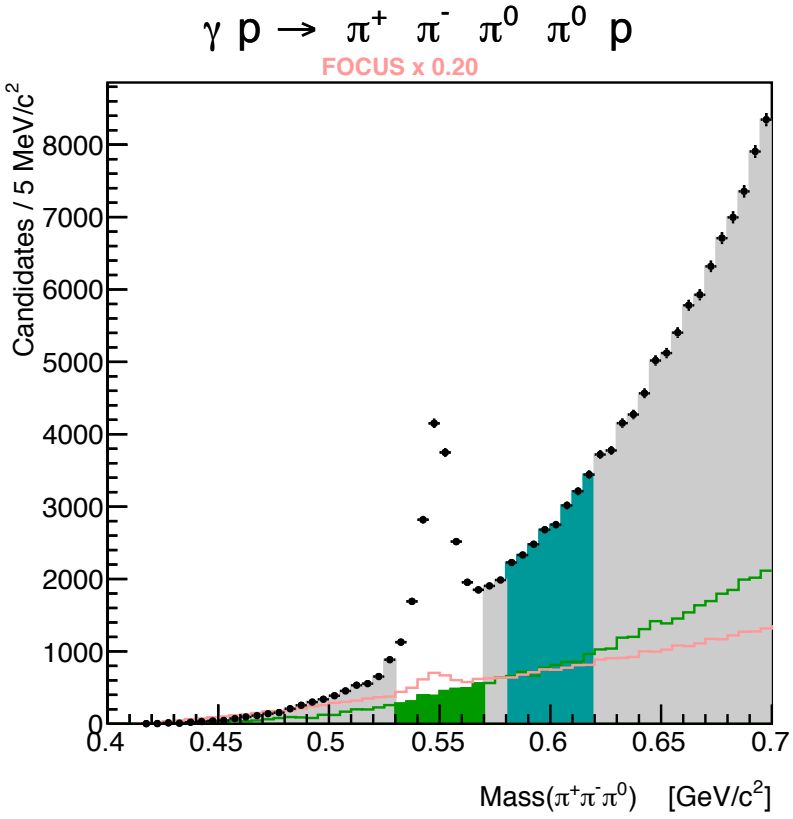


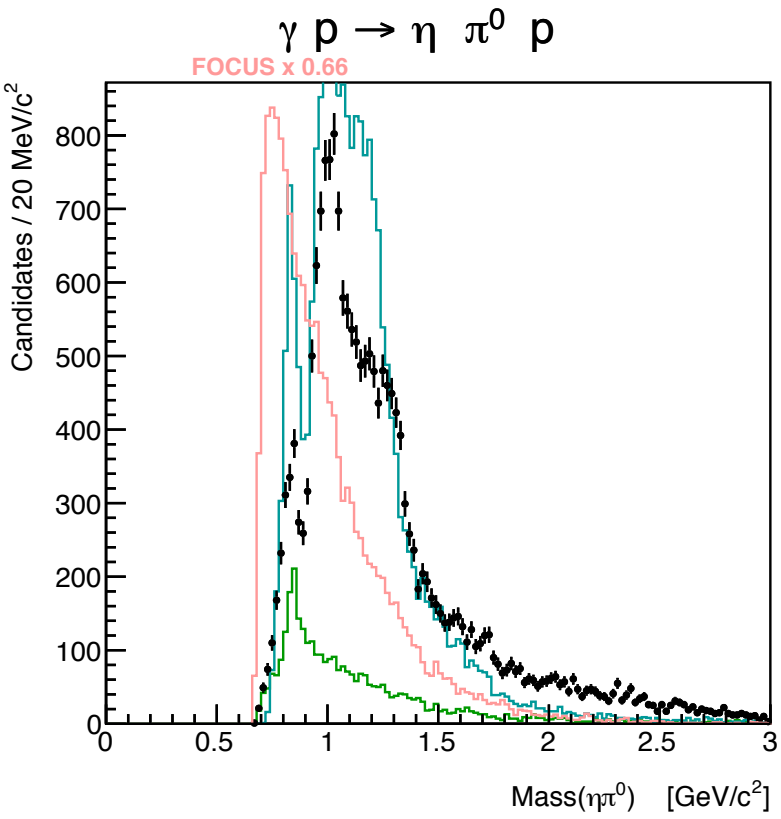
4 $\gamma p \to \pi^+\pi^-\pi^0\pi^0 p$



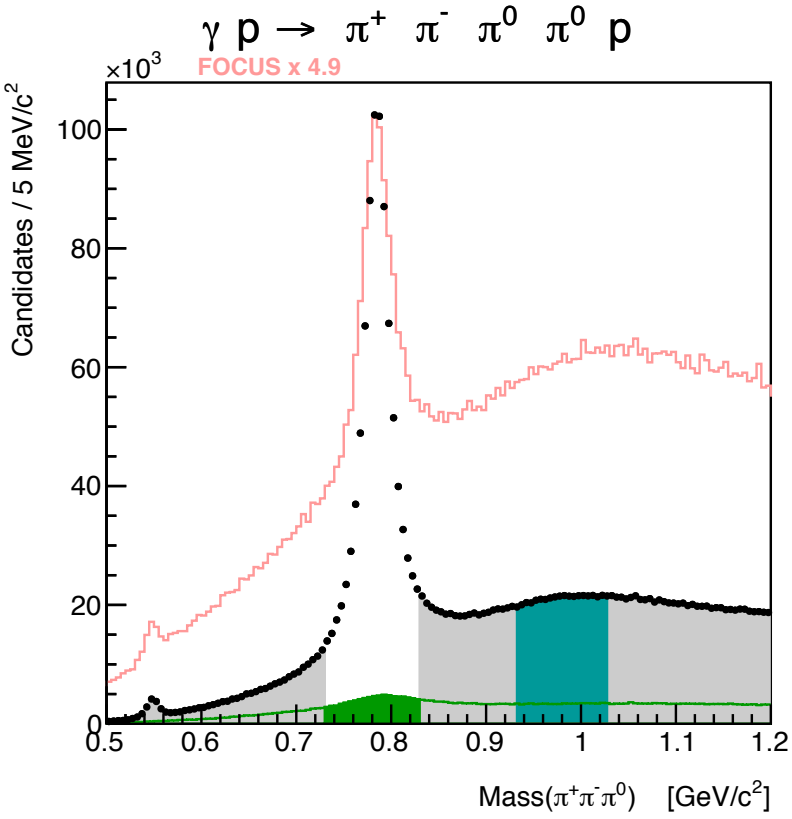


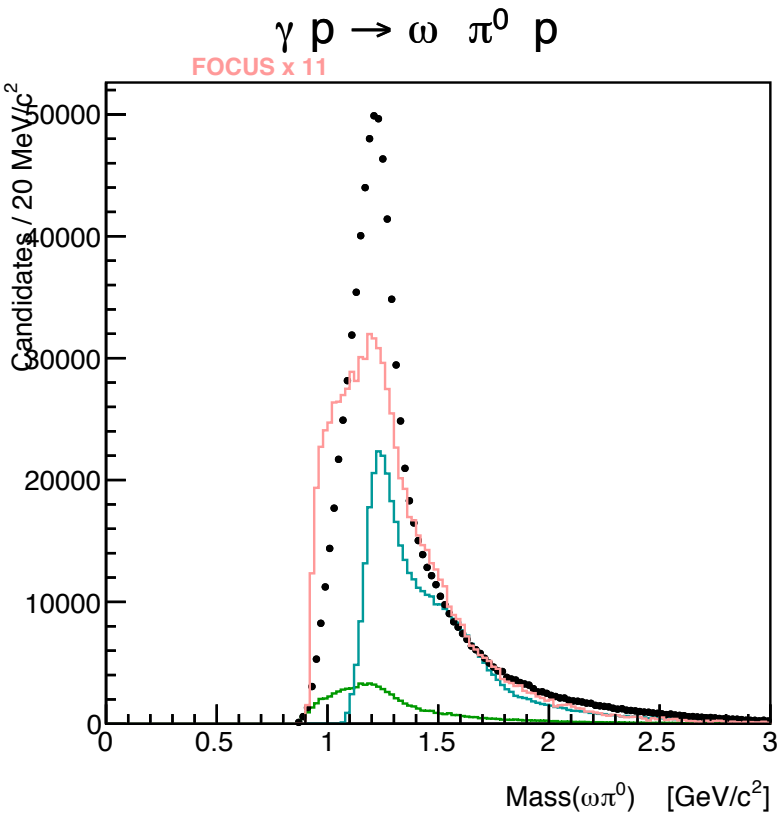
4.1 $\gamma p \to \eta\pi^0 p$



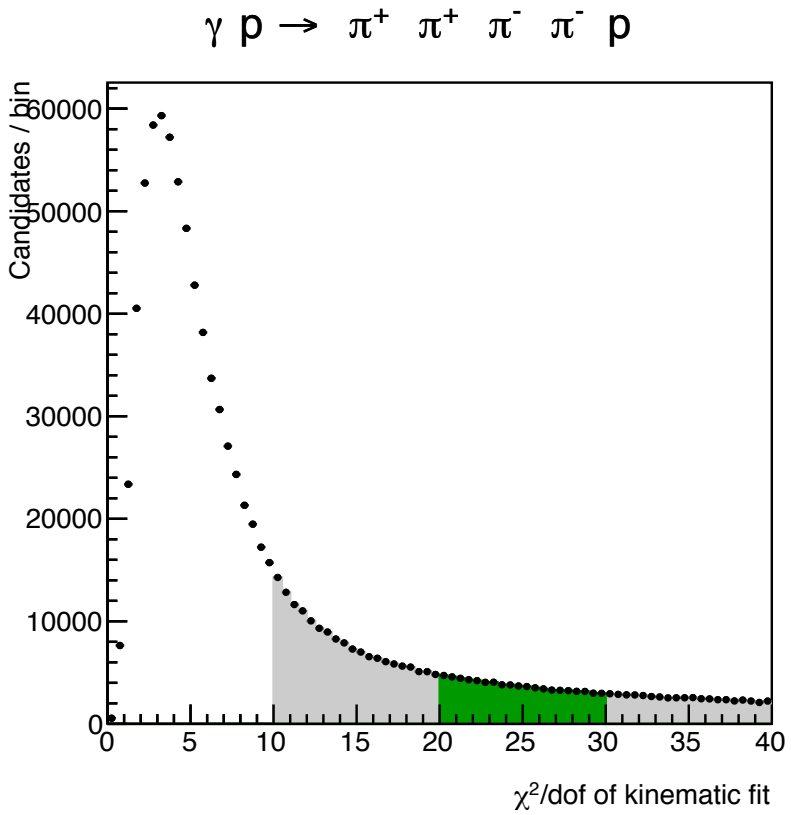


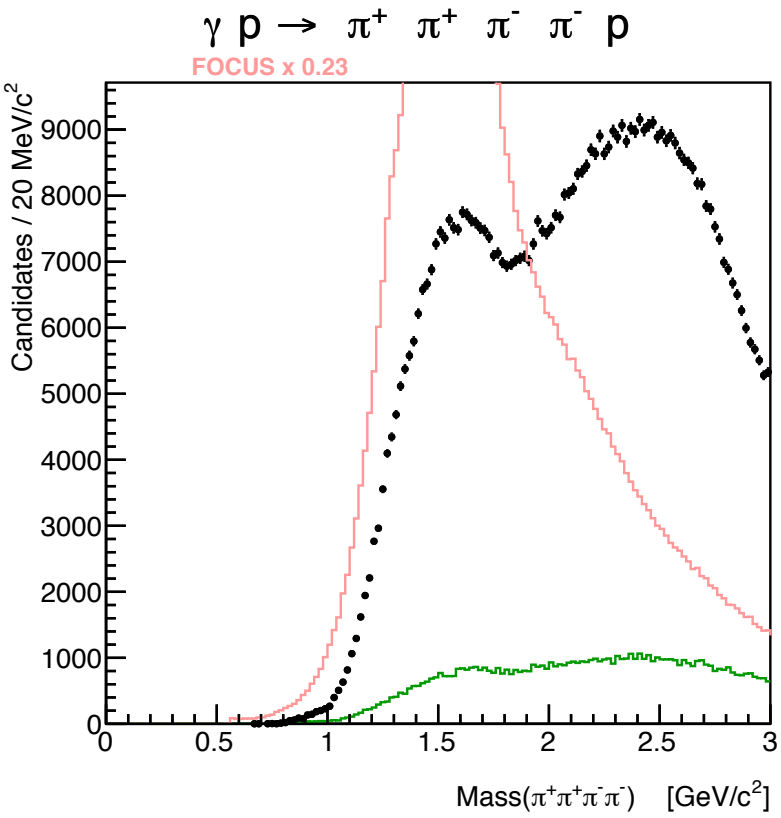
4.2 $\gamma p \to \omega\pi^0 p$



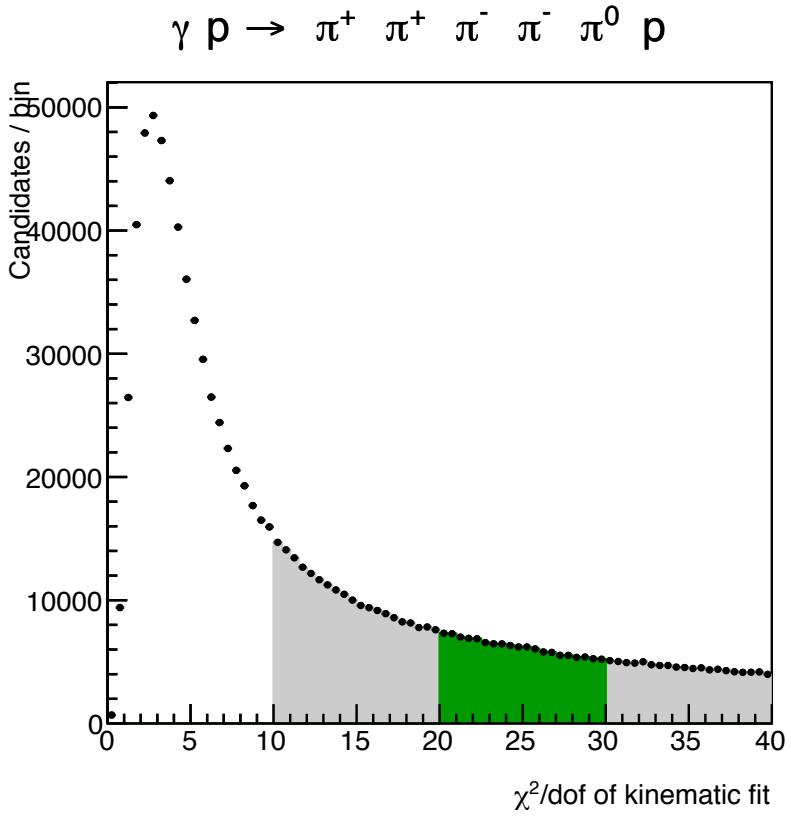


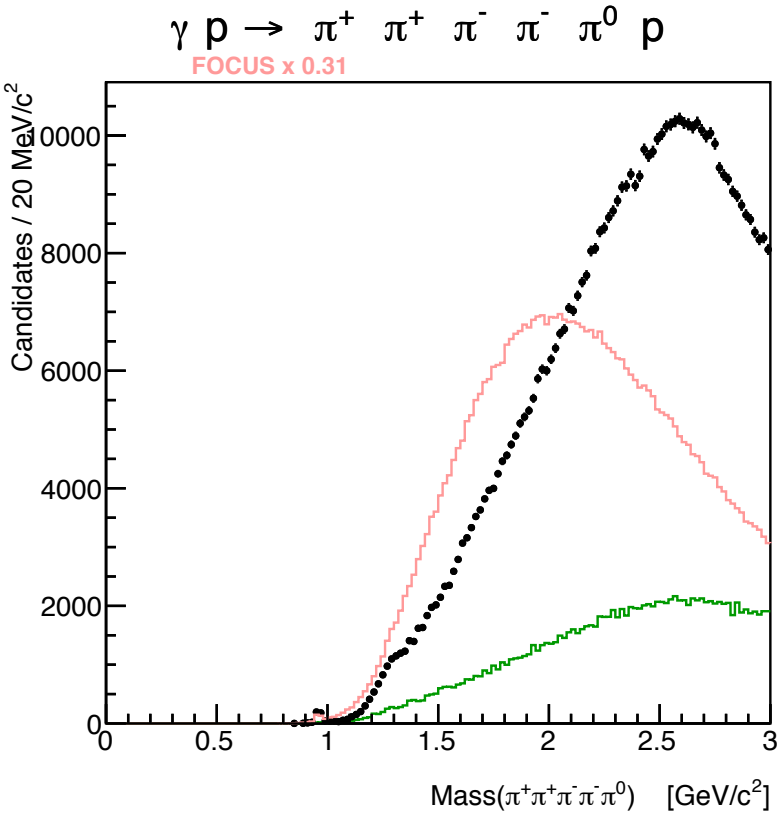
5 $\gamma p \to \pi^+\pi^+\pi^-\pi^- p$



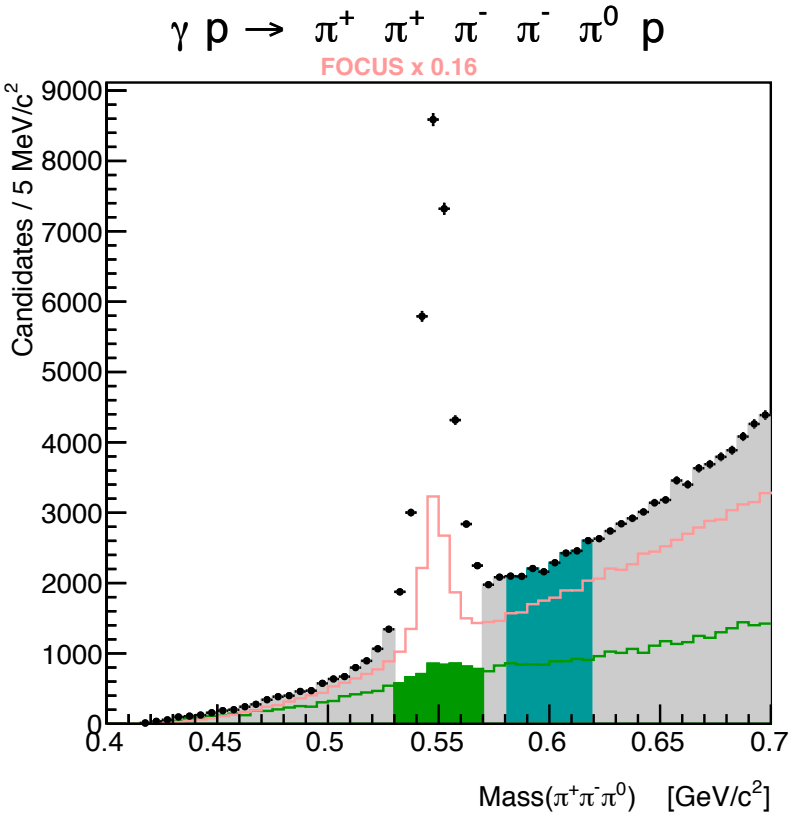


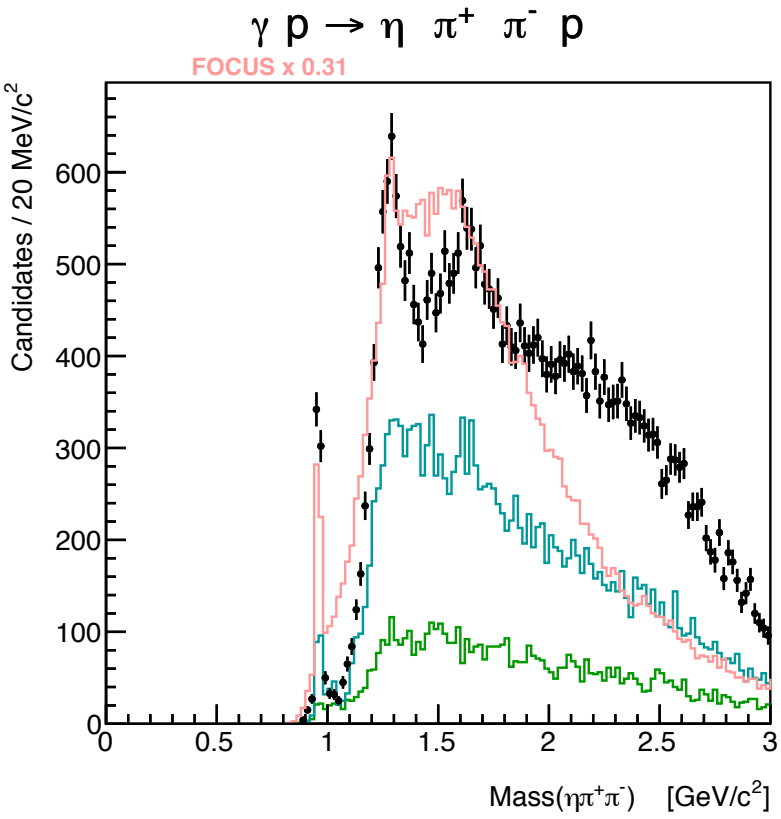
6 $\gamma p \to \pi^+\pi^+\pi^-\pi^-\pi^0 p$



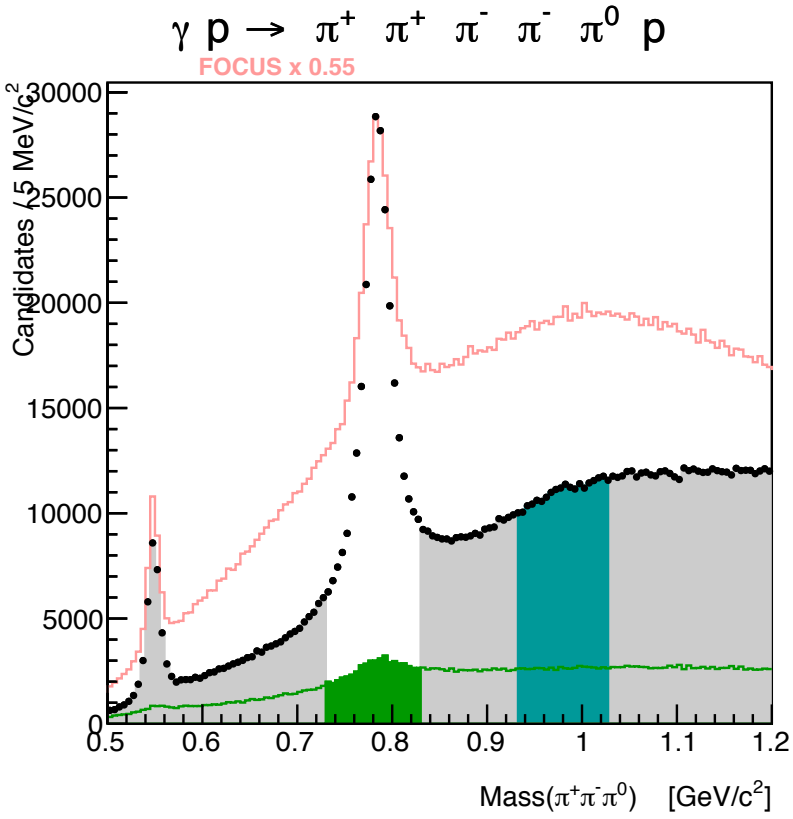


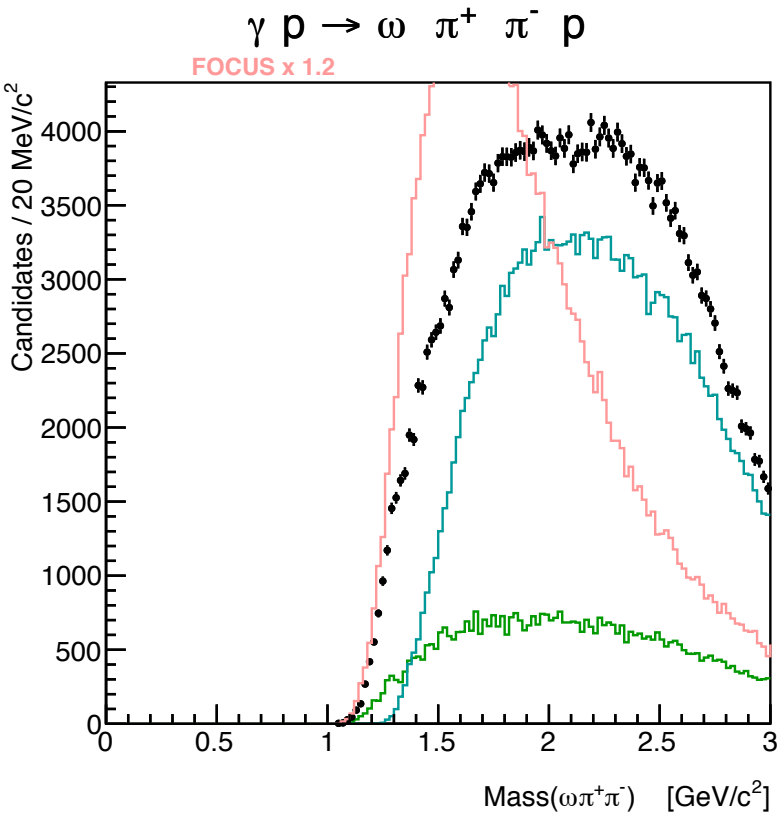
6.1 $\gamma p \to \eta\pi^+\pi^- p$



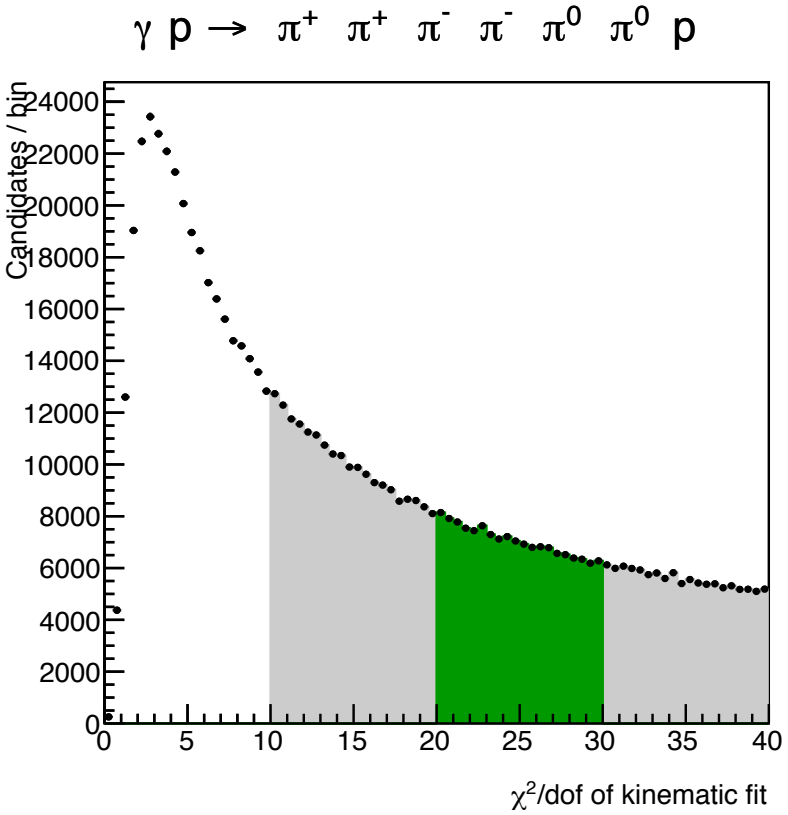


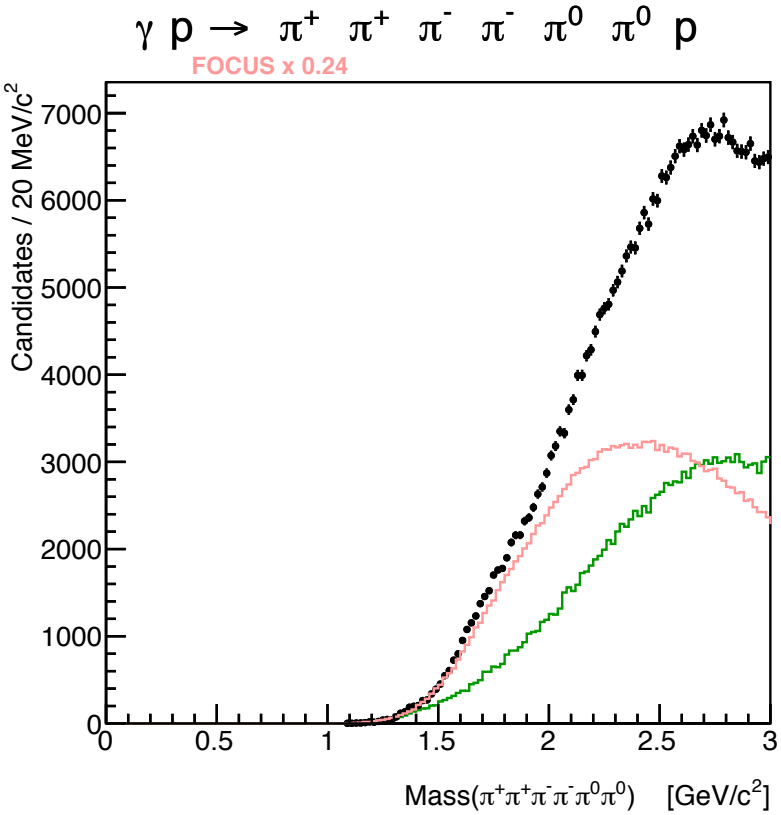
6.2 $\gamma p \to \omega\pi^+\pi^- p$



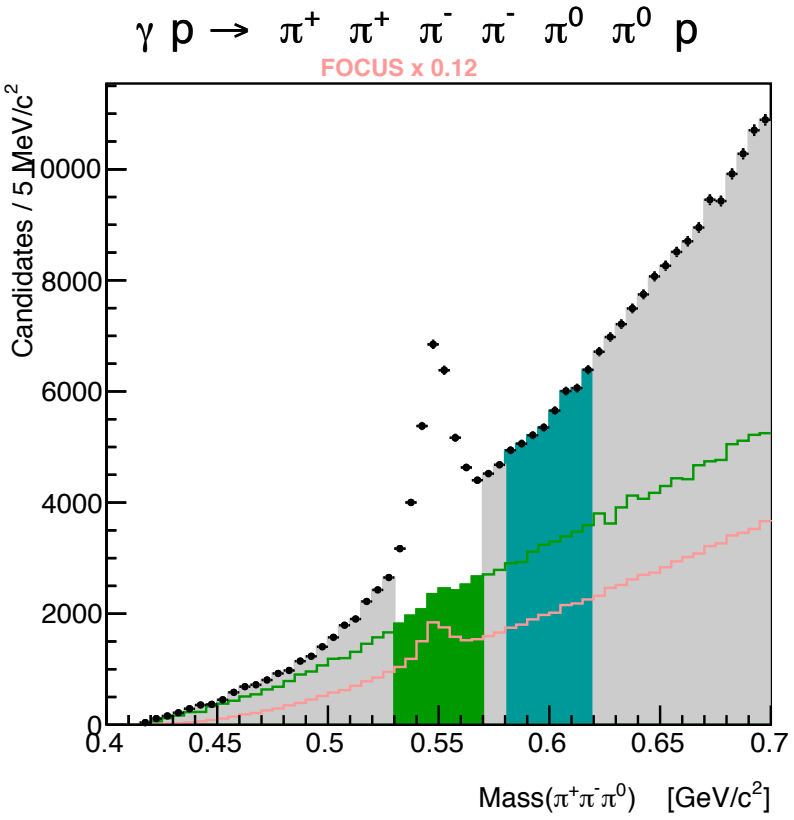


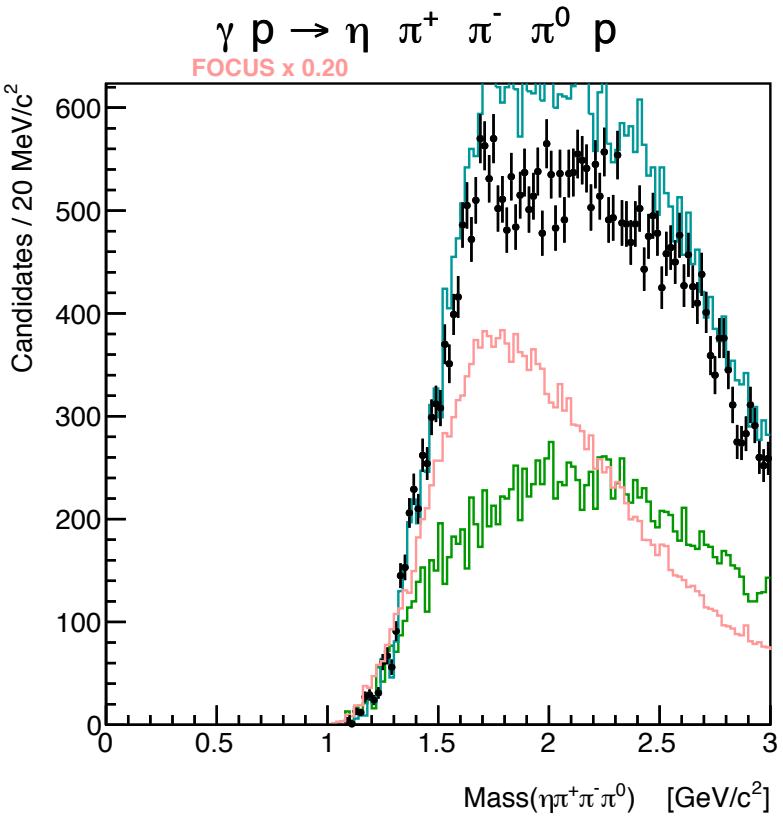
7 $\gamma p \to \pi^+\pi^+\pi^-\pi^-\pi^0\pi^0 p$



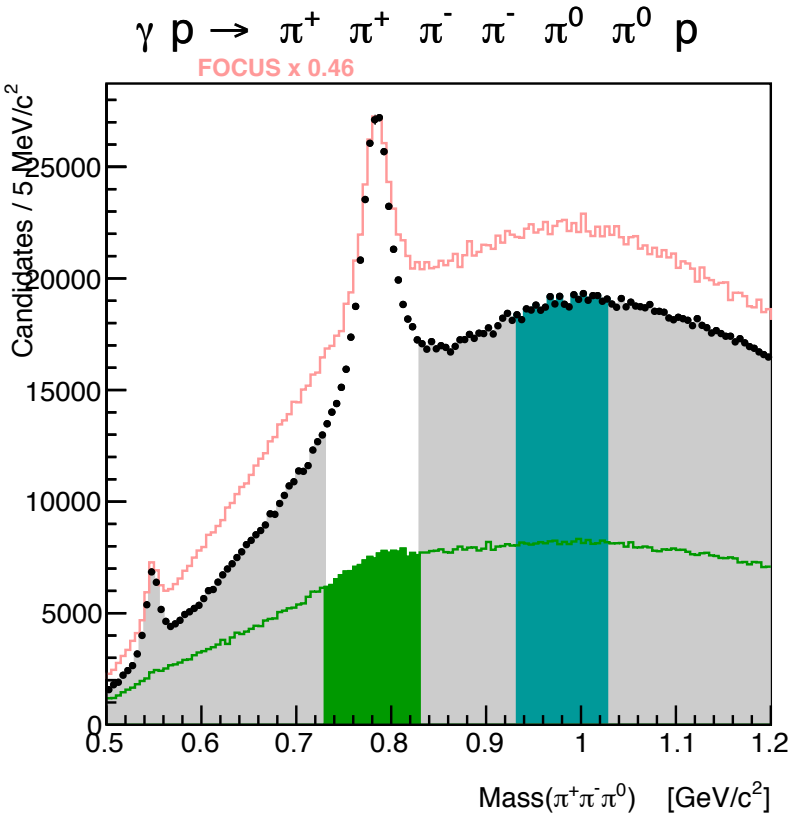


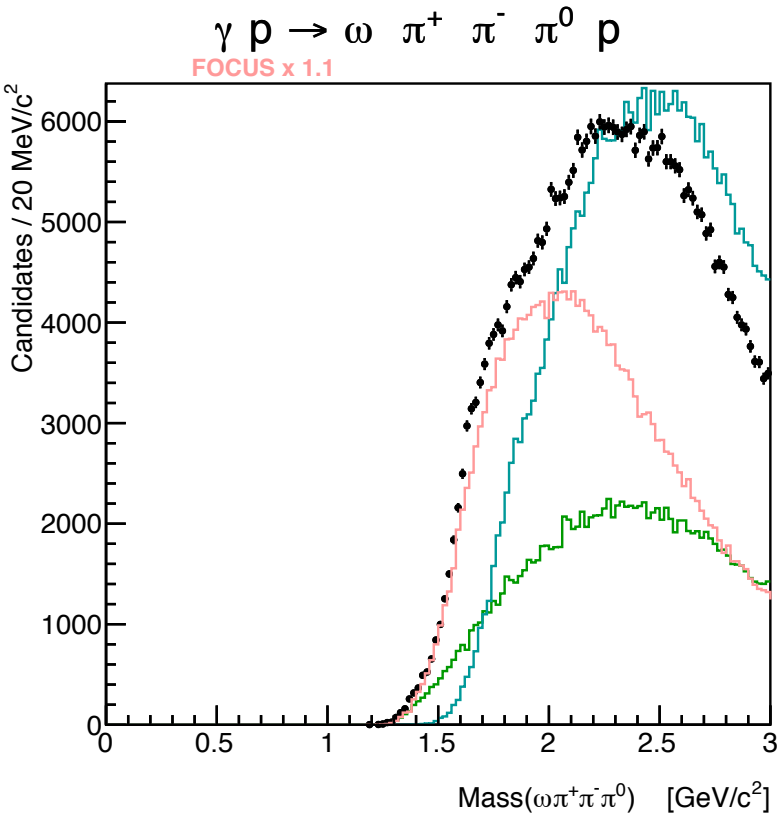
7.1 $\gamma p \to \eta\pi^+\pi^-\pi^0 p$



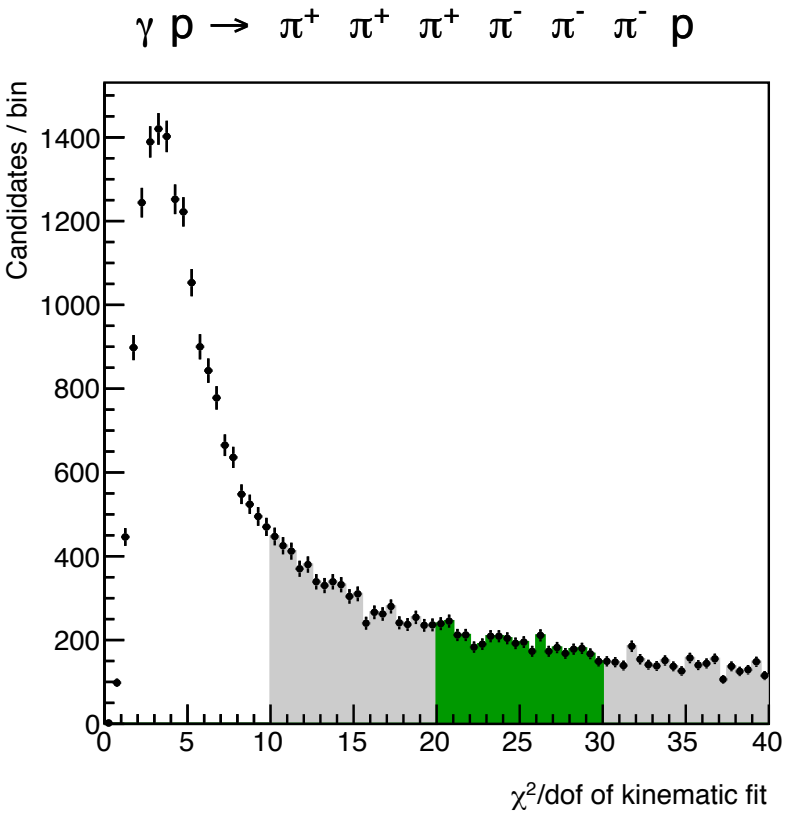


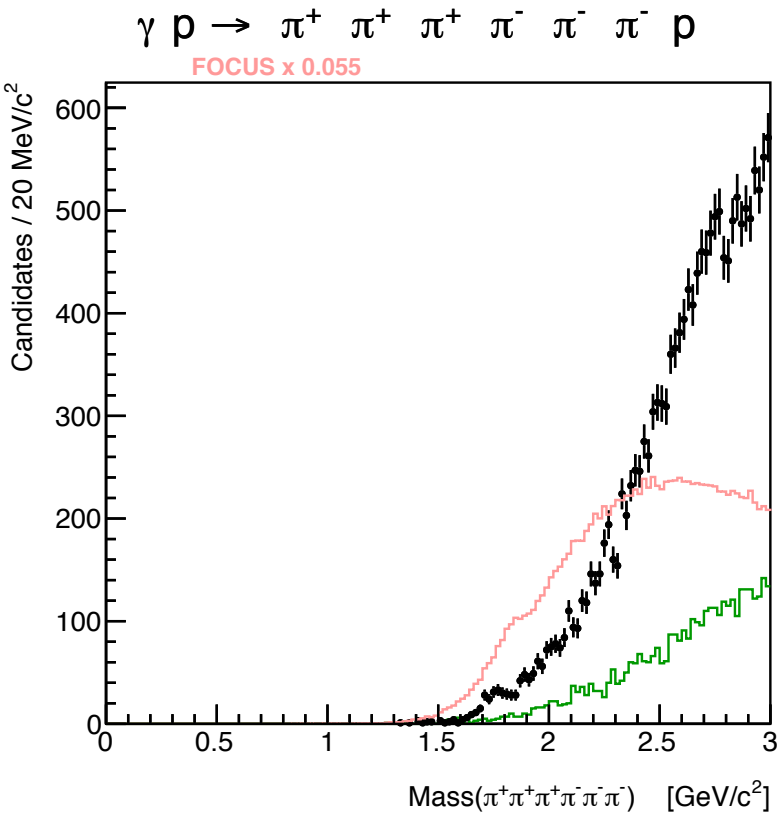
7.2 $\gamma p \to \omega\pi^+\pi^-\pi^0 p$



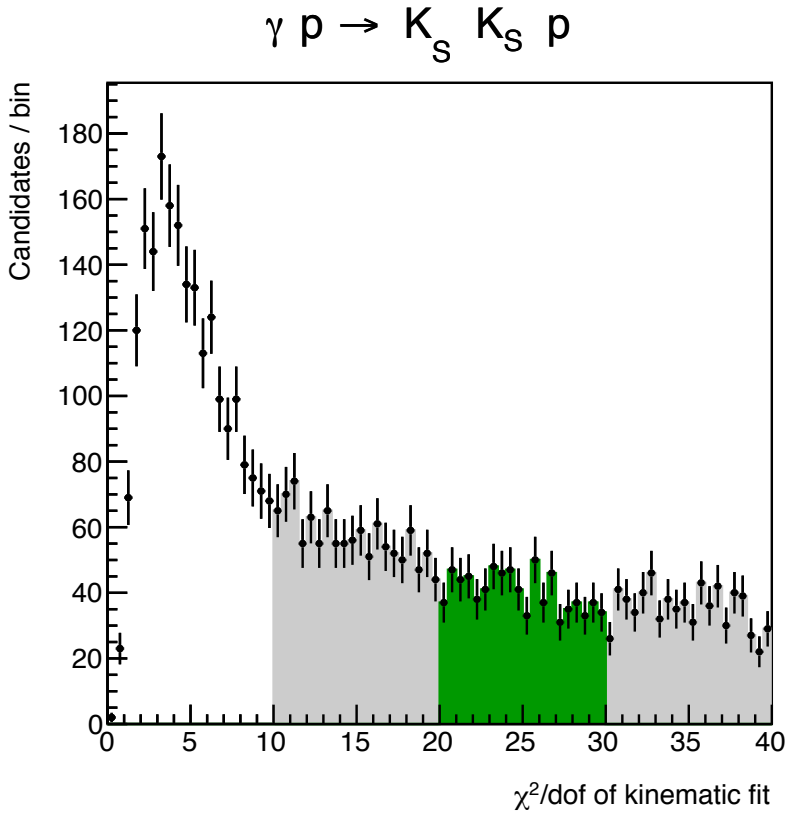


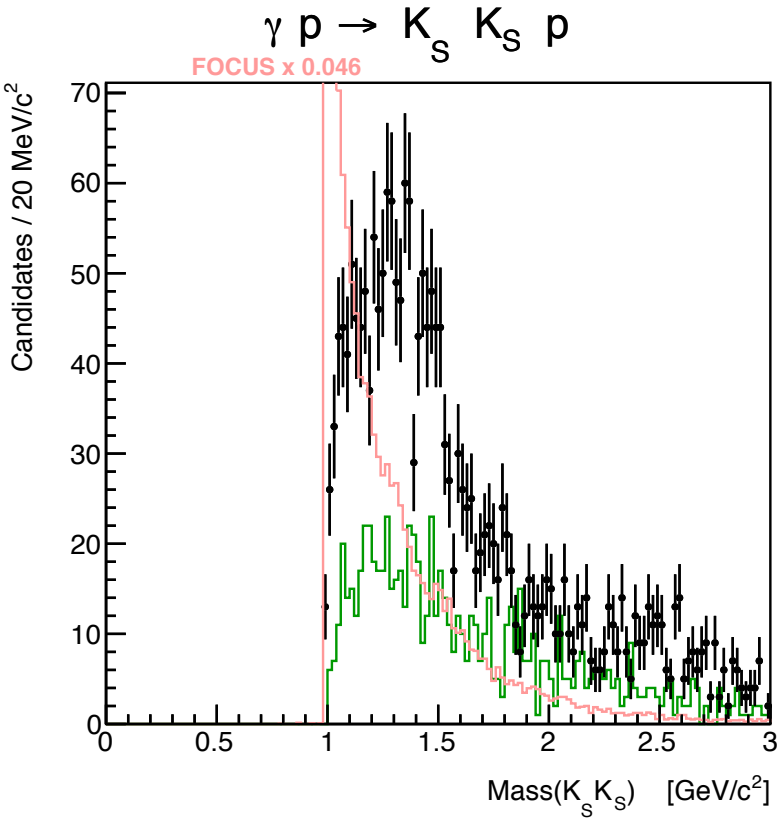
8 $\gamma p \to \pi^+\pi^+\pi^+\pi^-\pi^-\pi^- p$



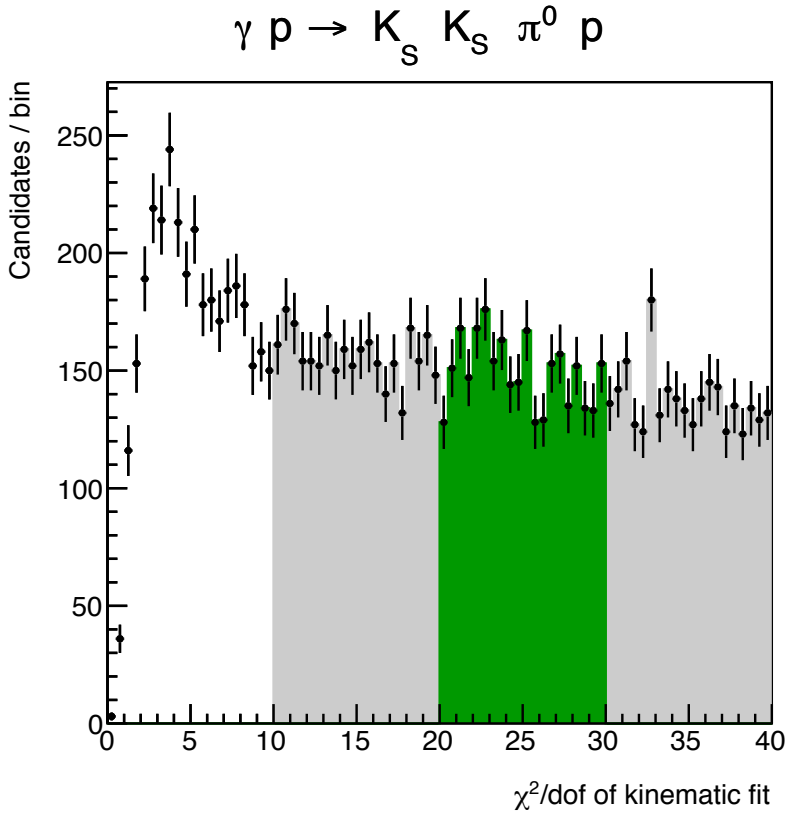


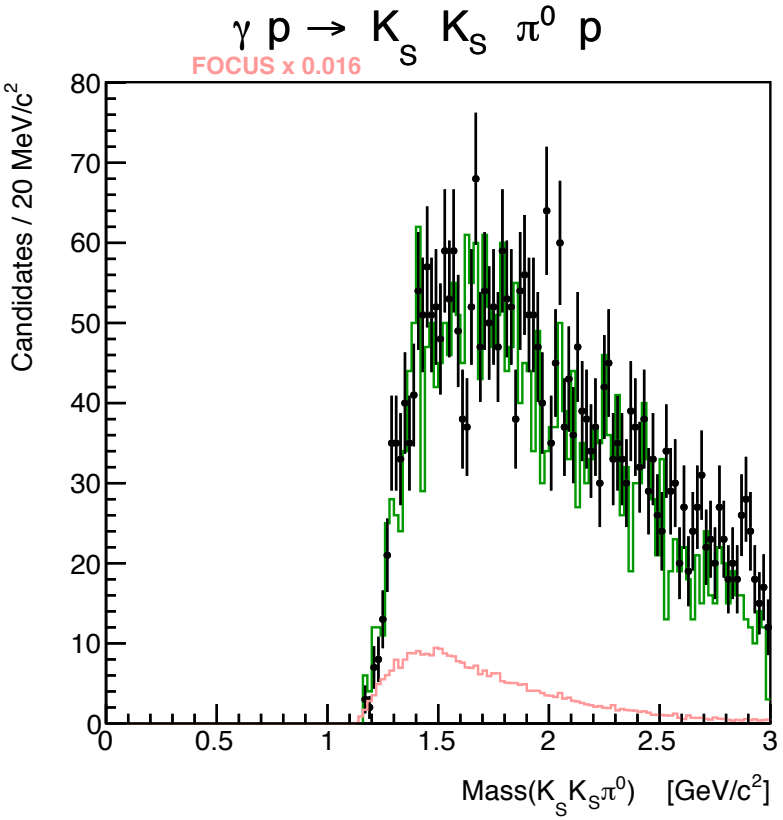
9 $\gamma p \to K_S K_S p$



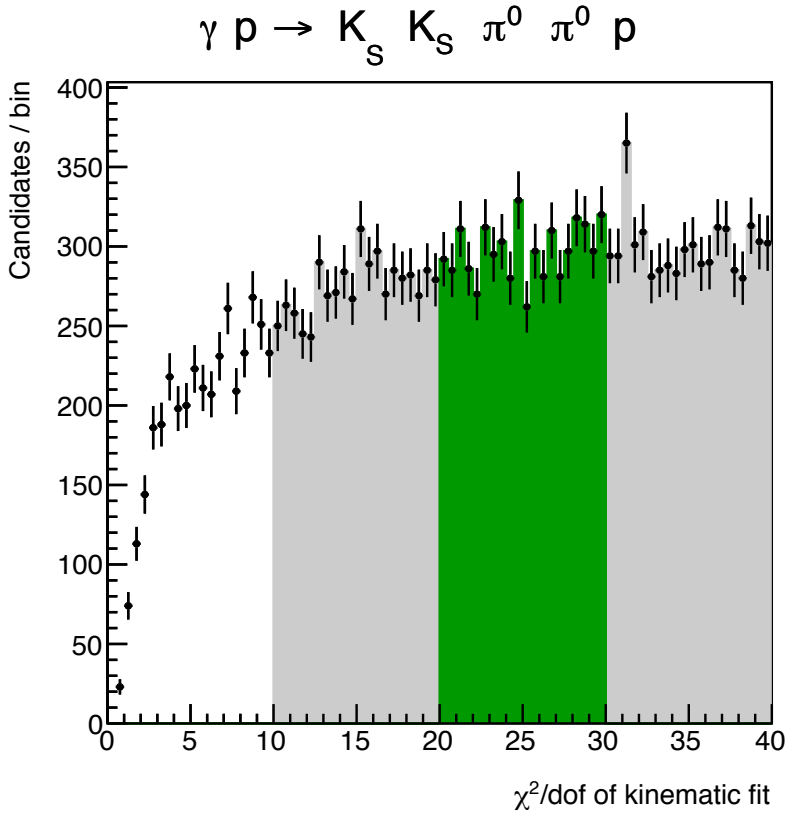


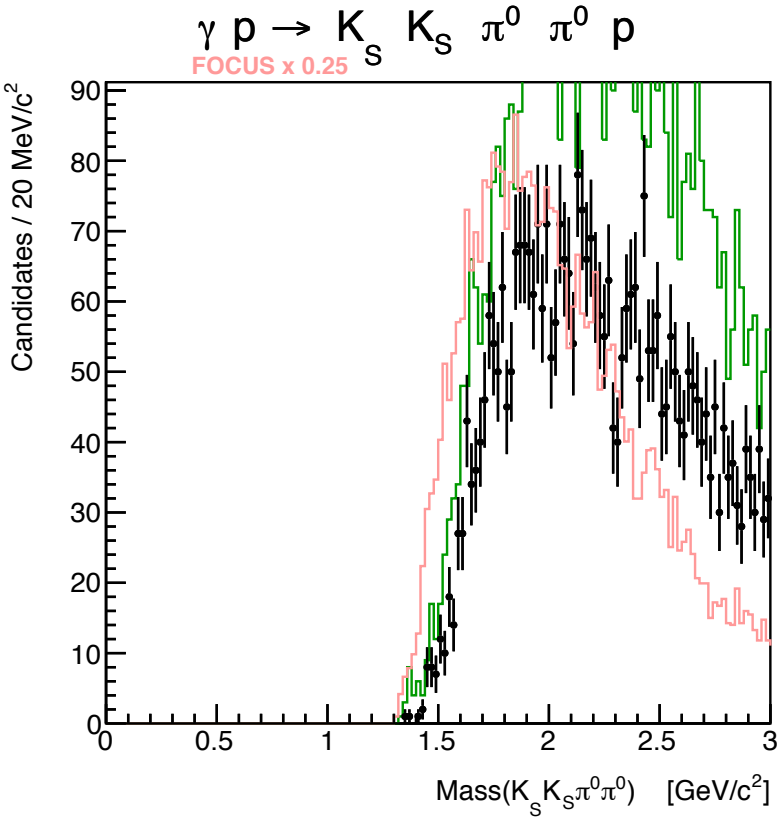
10 $\gamma p \to K_S K_S \pi^0 p$



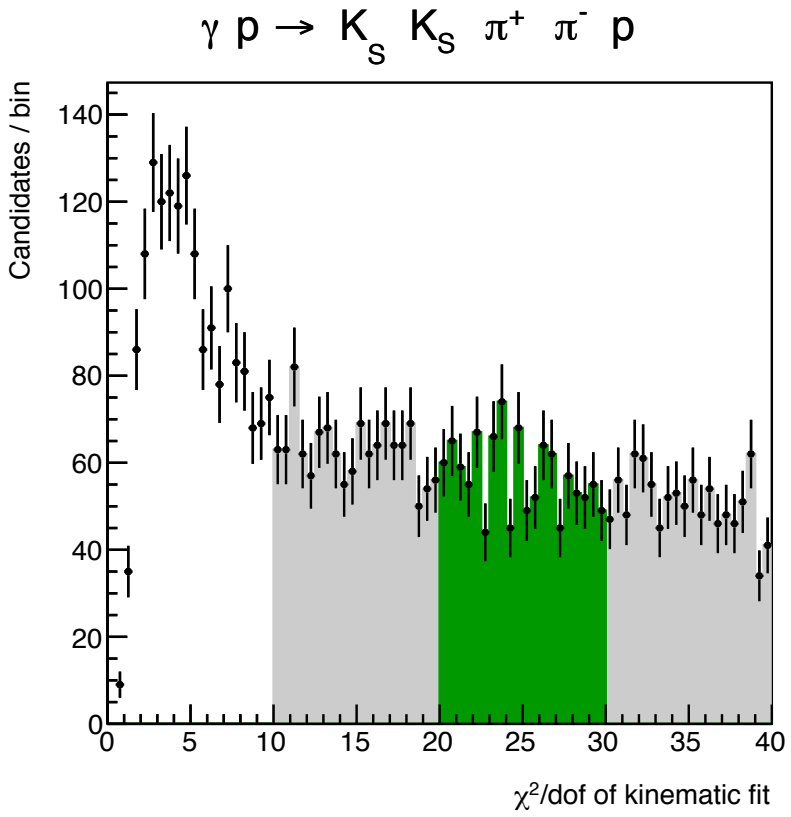


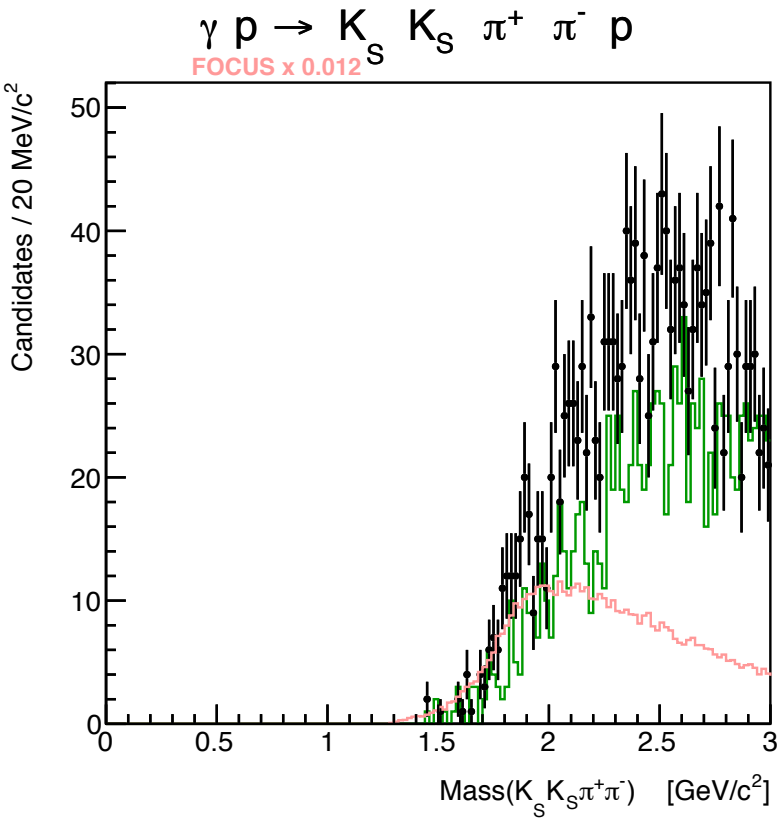
11 $\gamma p \to K_S K_S \pi^0 \pi^0 p$



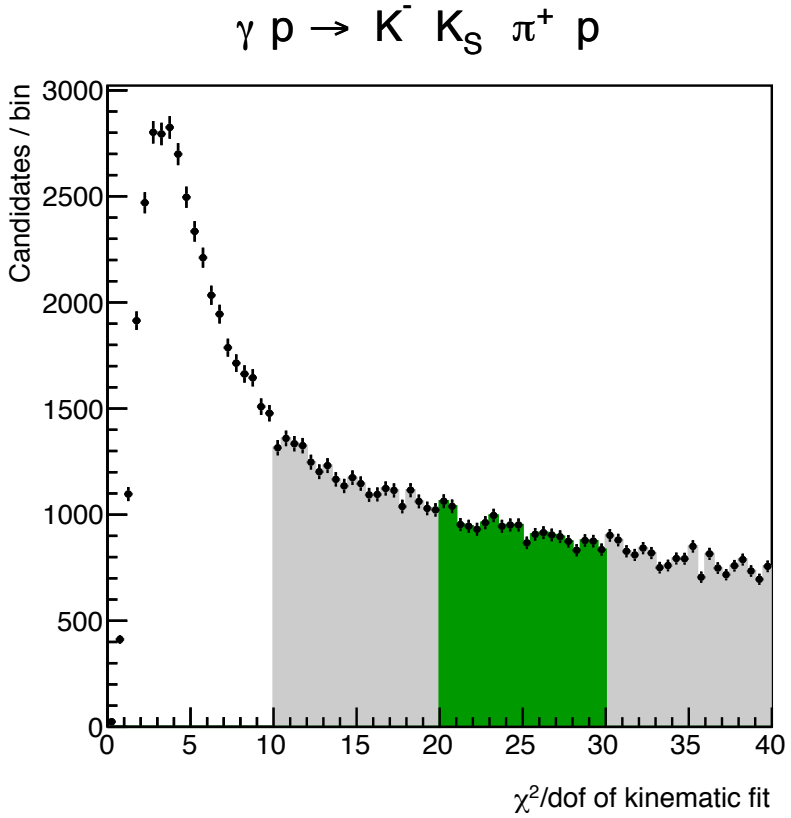


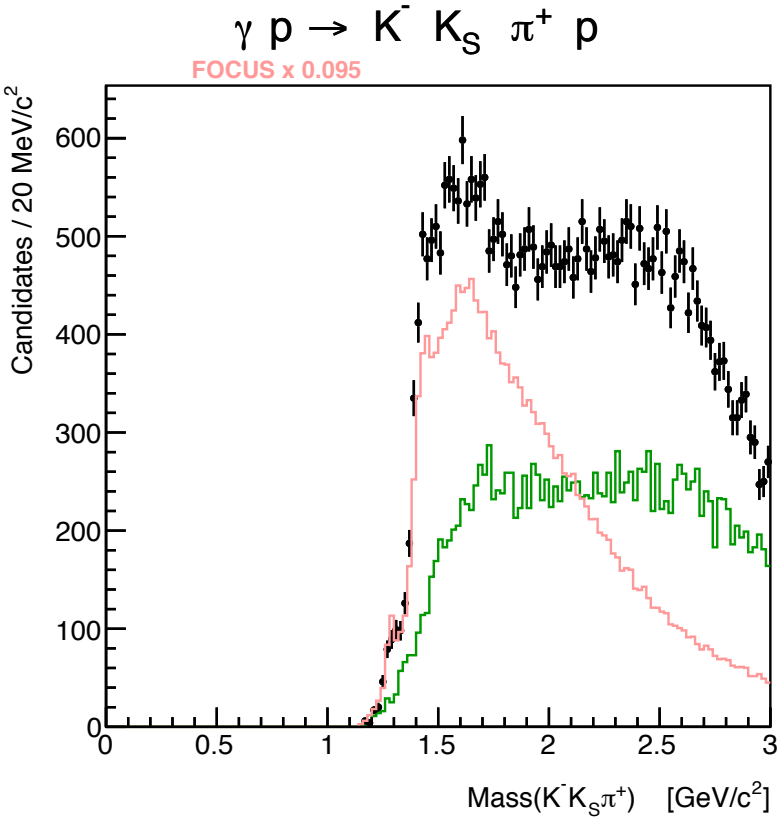
12 $\gamma p \to K_S K_S \pi^+ \pi^- p$



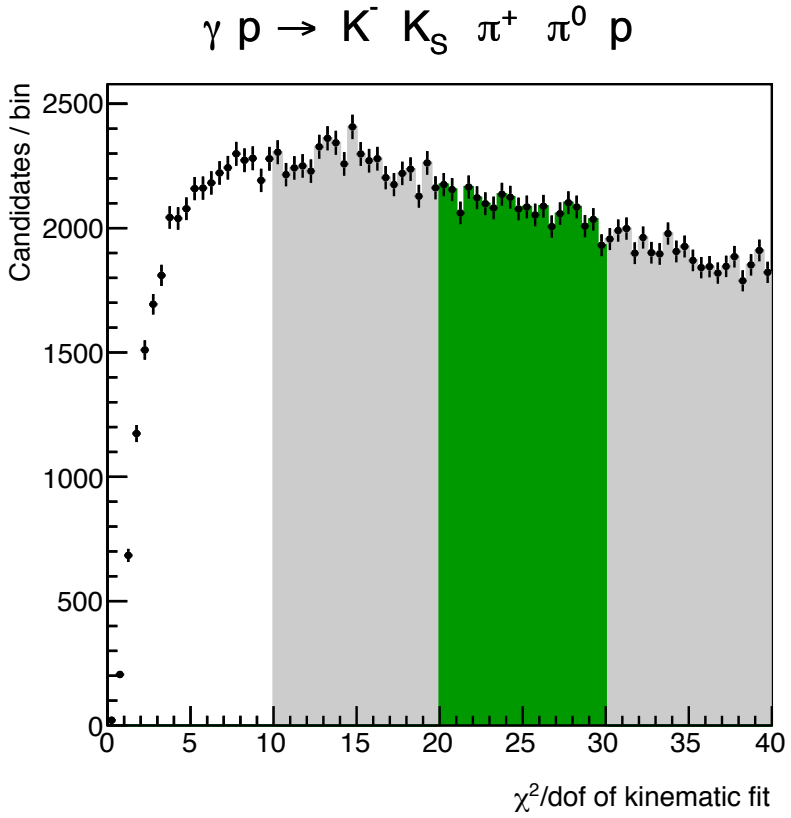


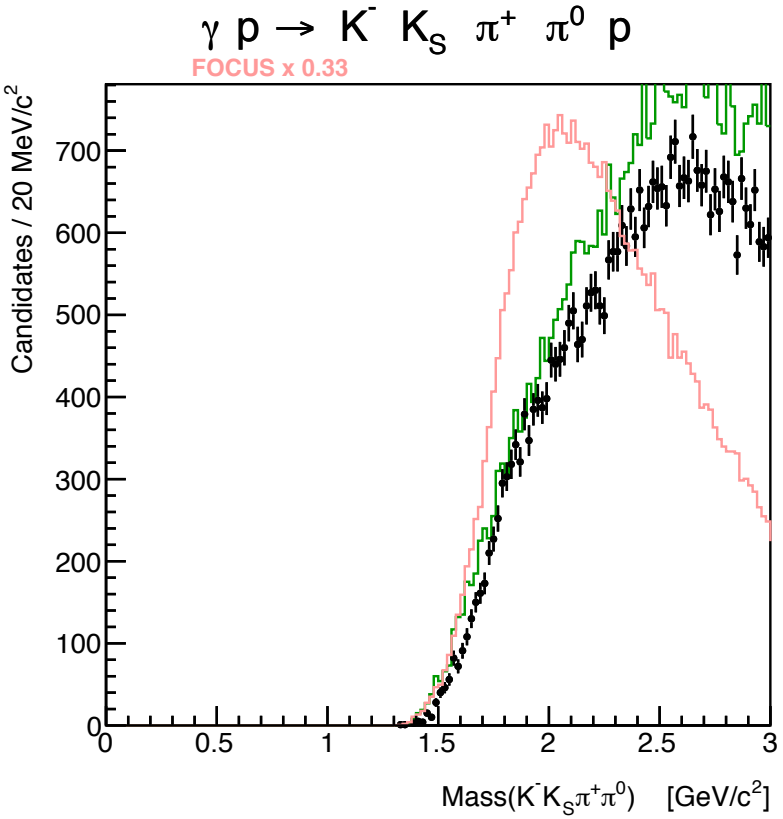
13 $\gamma p \to K^- K_S \pi^+ p$



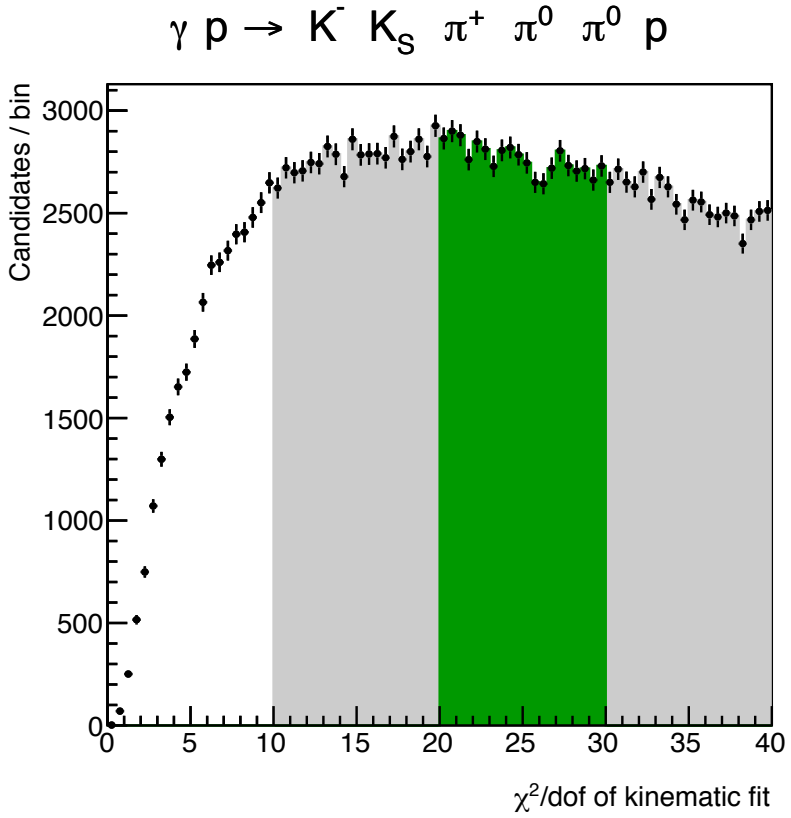


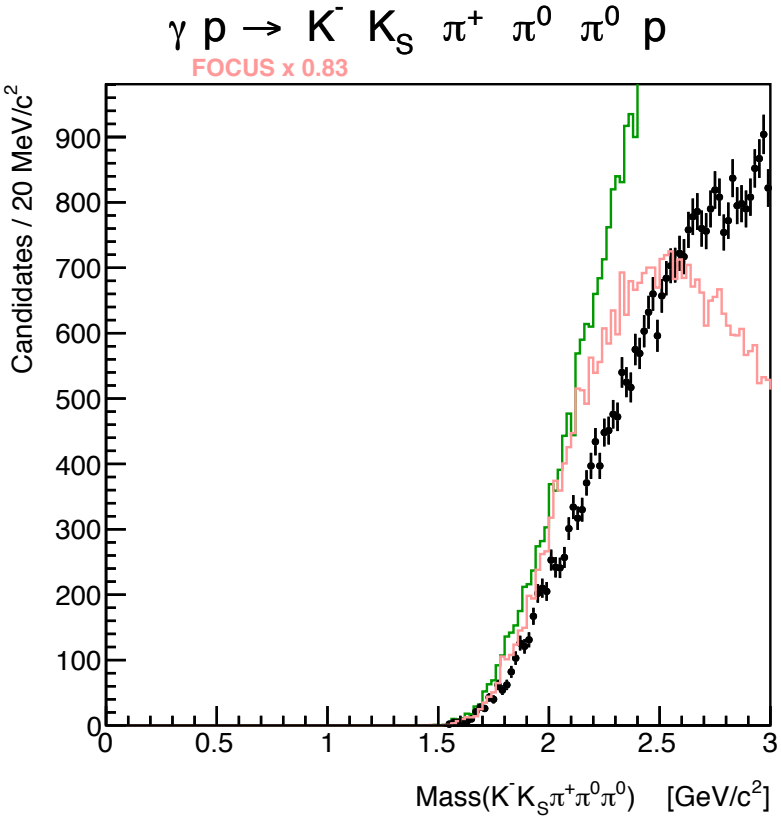
14 $\gamma p \to K^- K_S \pi^+ \pi^0 p$



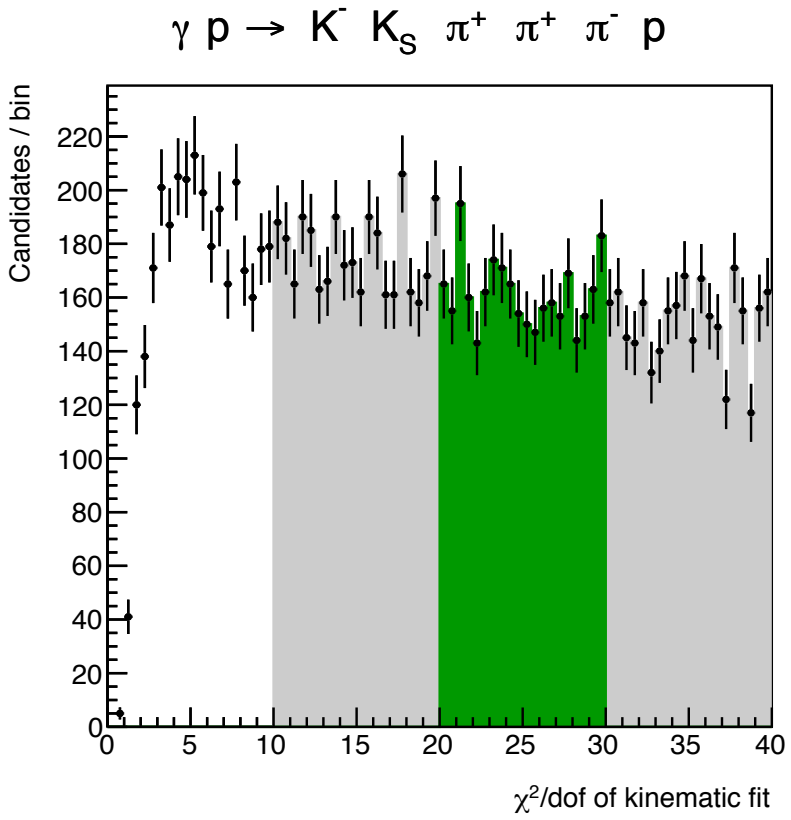


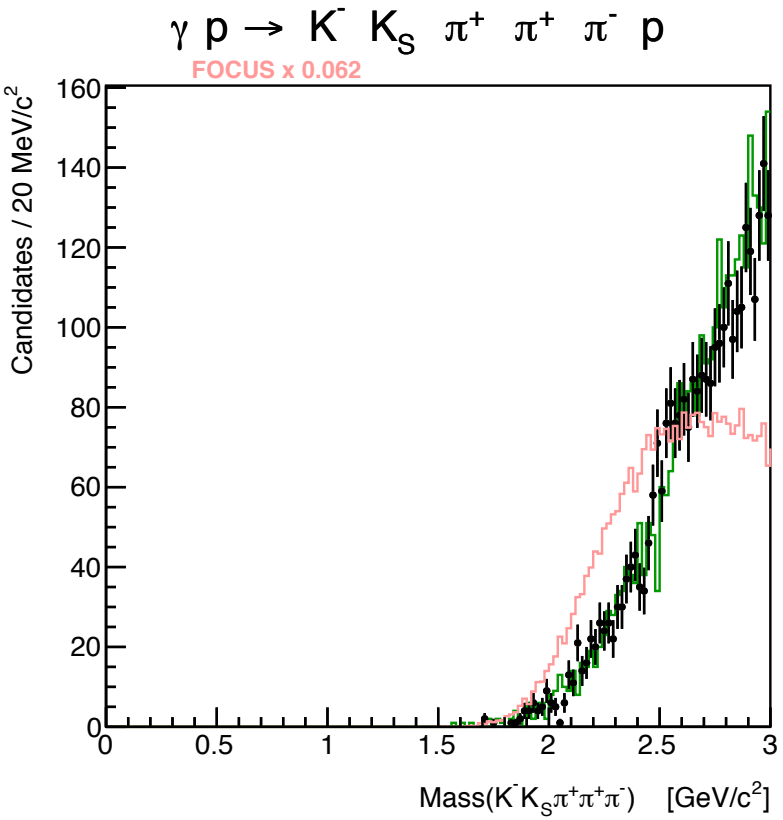
15 $\gamma p \to K^- K_S \pi^+ \pi^0 \pi^0 p$



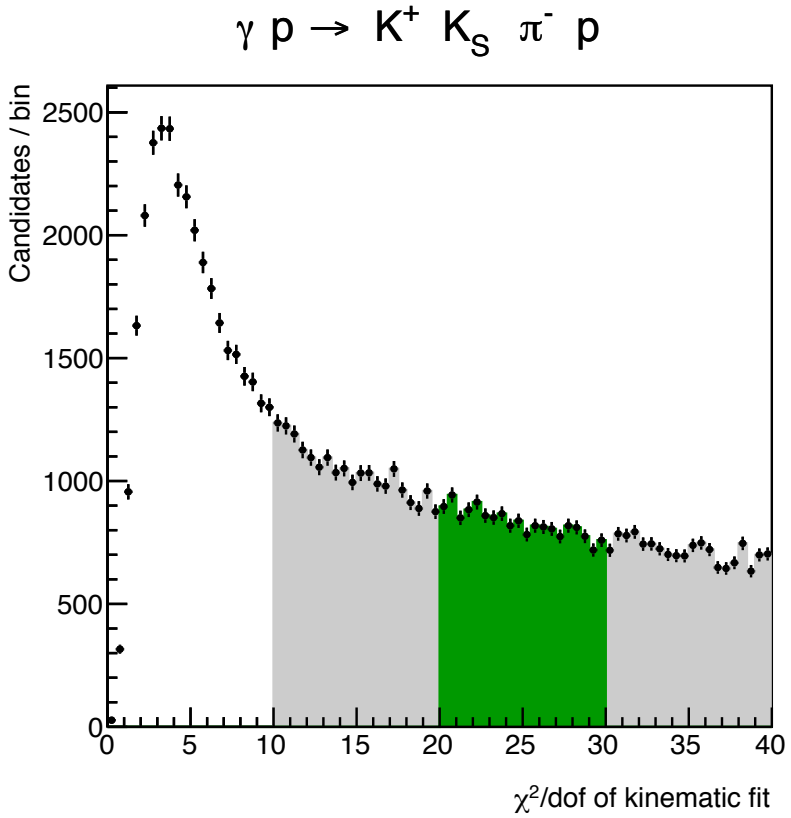


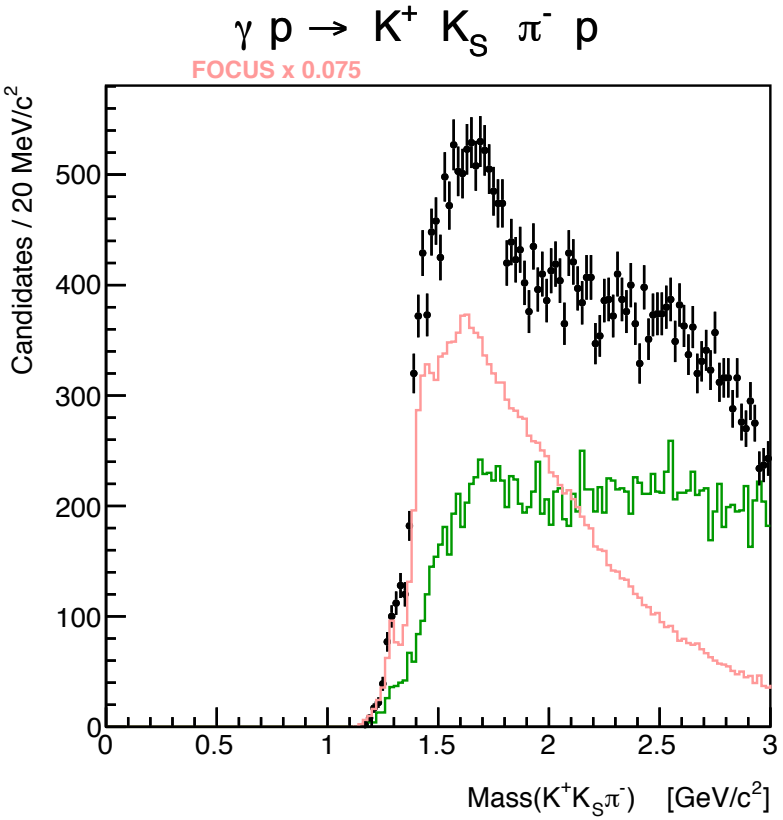
16 $\gamma p \to K^- K_S \pi^+ \pi^+ \pi^- p$



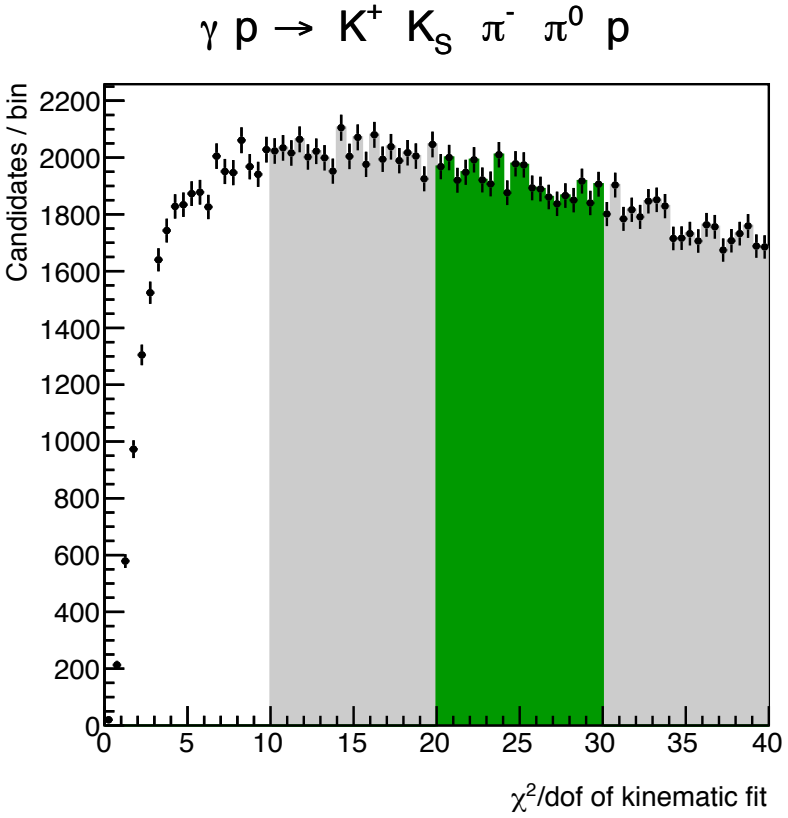


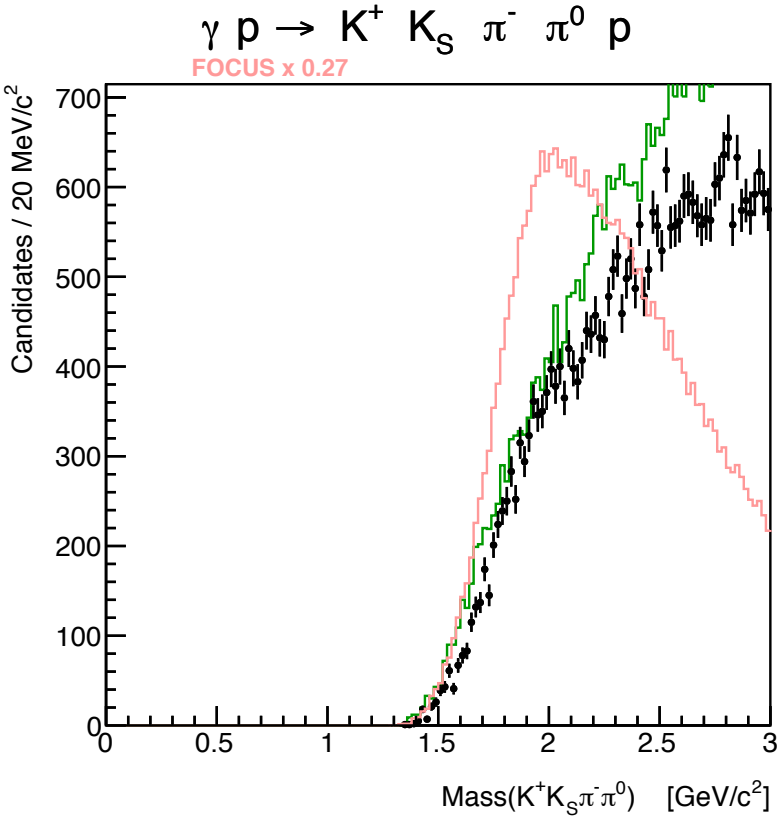
17 $\gamma p \to K^+ K_S \pi^- p$



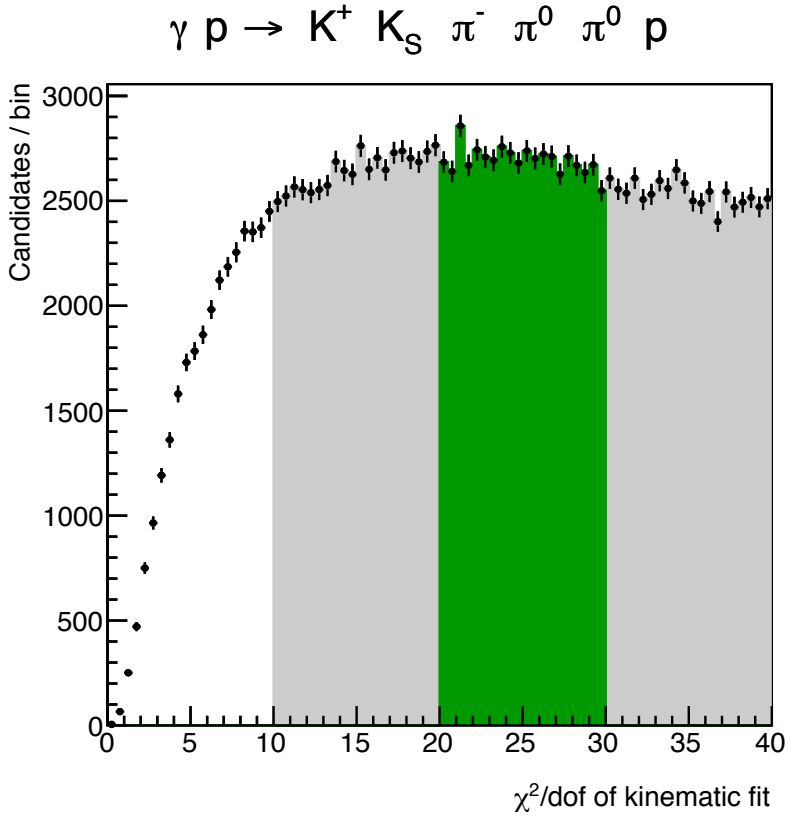


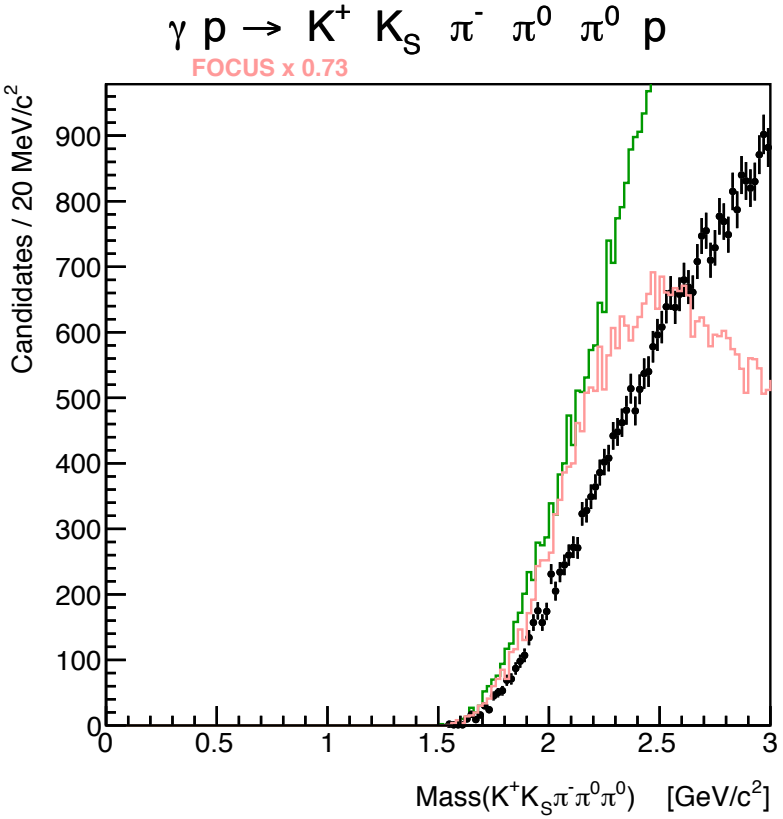
18 $\gamma p \to K^+ K_S \pi^- \pi^0 p$



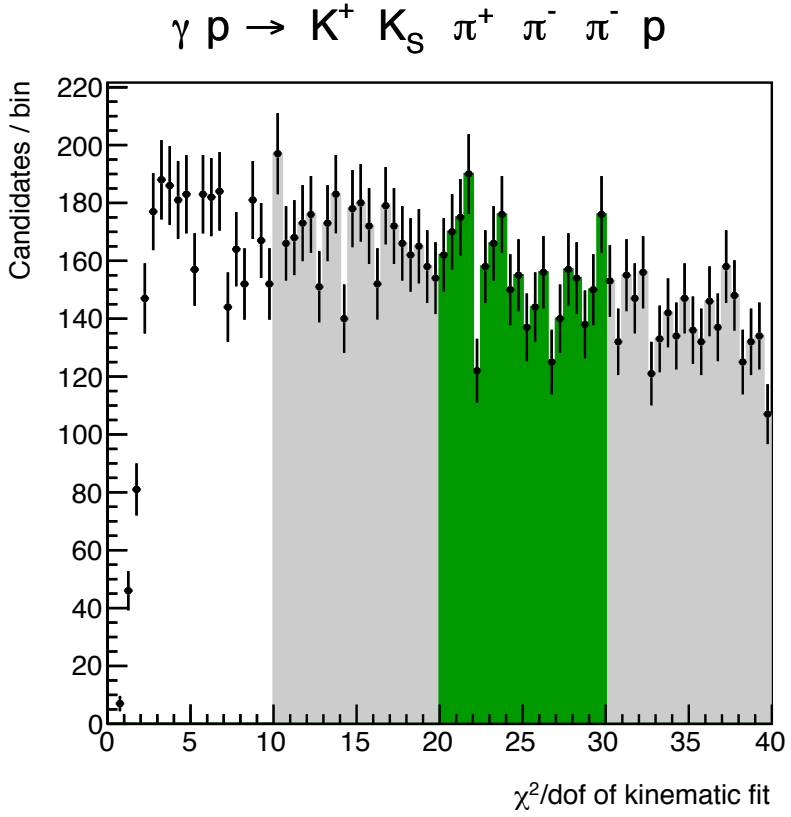


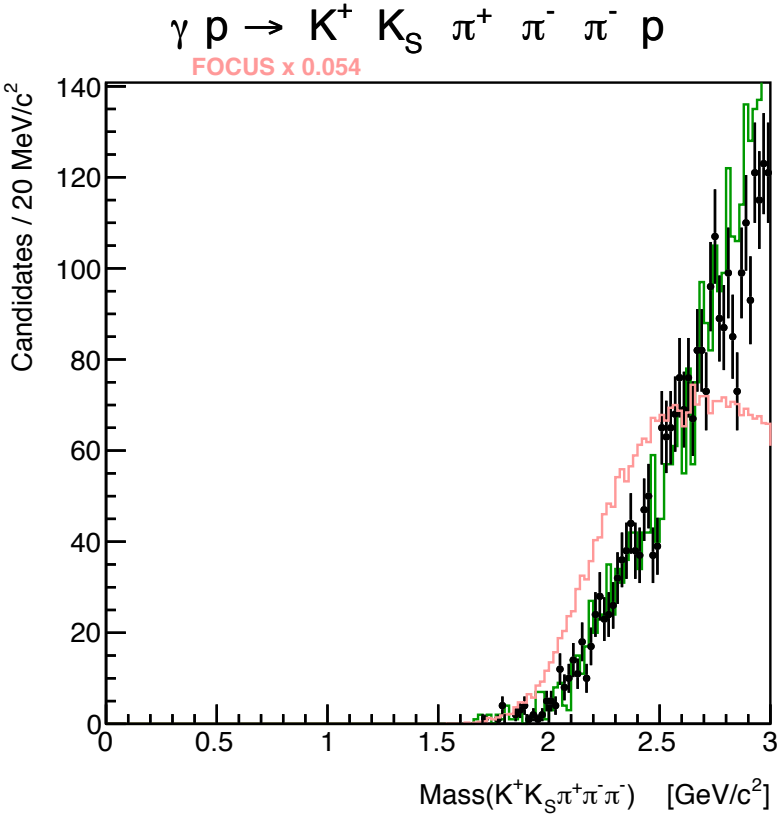
19 $\gamma p \to K^+ K_S \pi^- \pi^0 \pi^0 p$



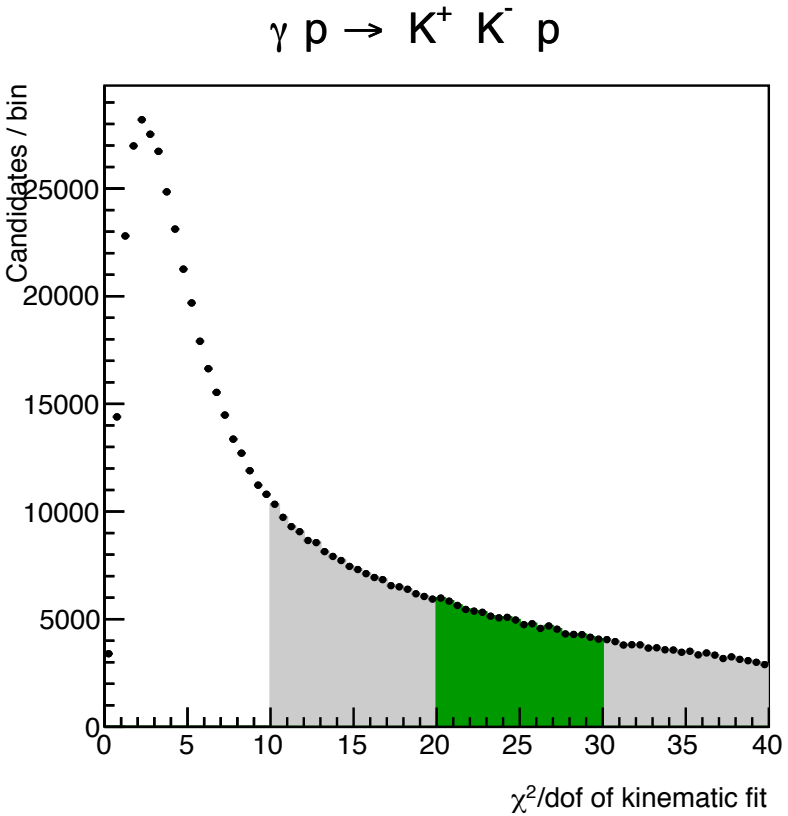


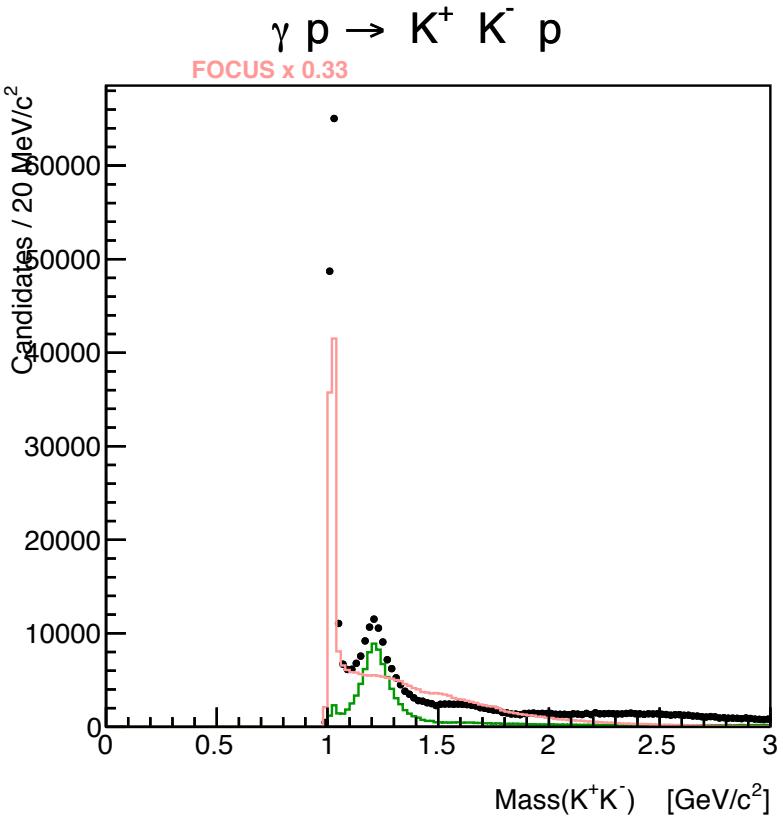
20 $\gamma p \to K^+ K_S \pi^+ \pi^- \pi^- p$



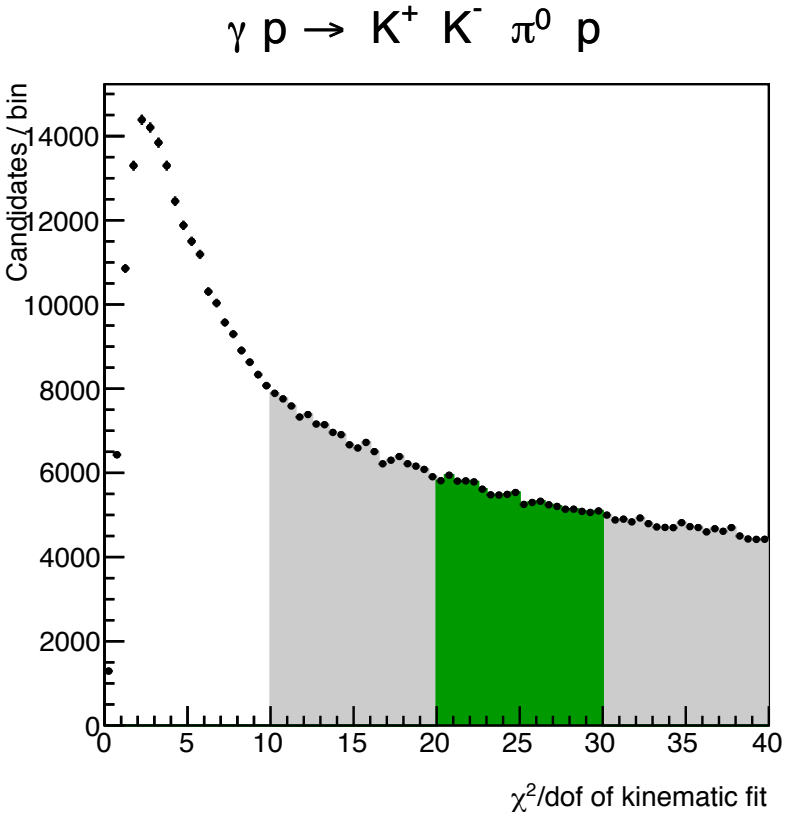


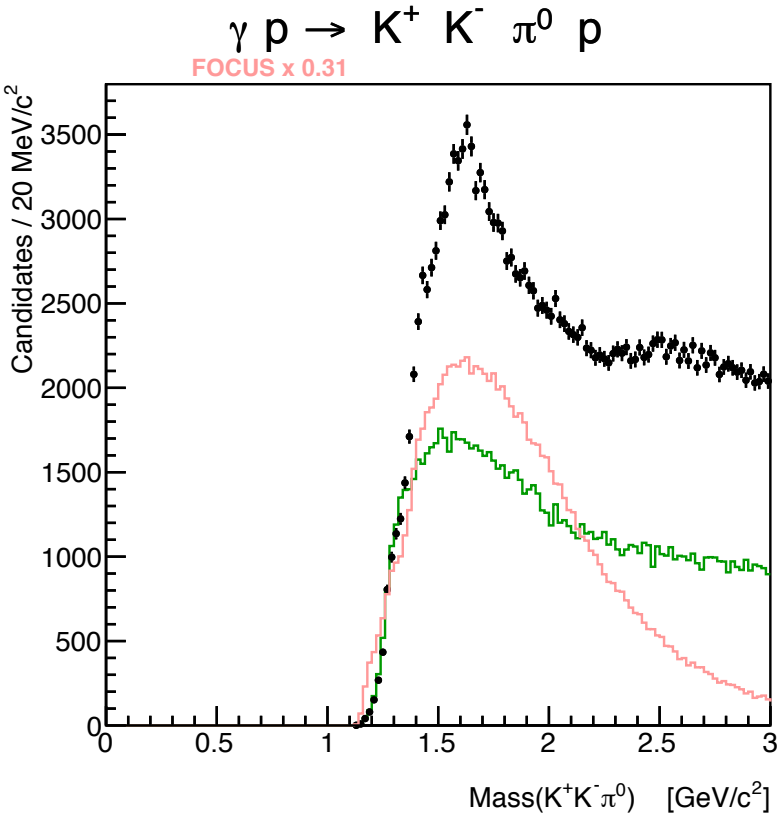
21 $\gamma p \to K^+K^-p$



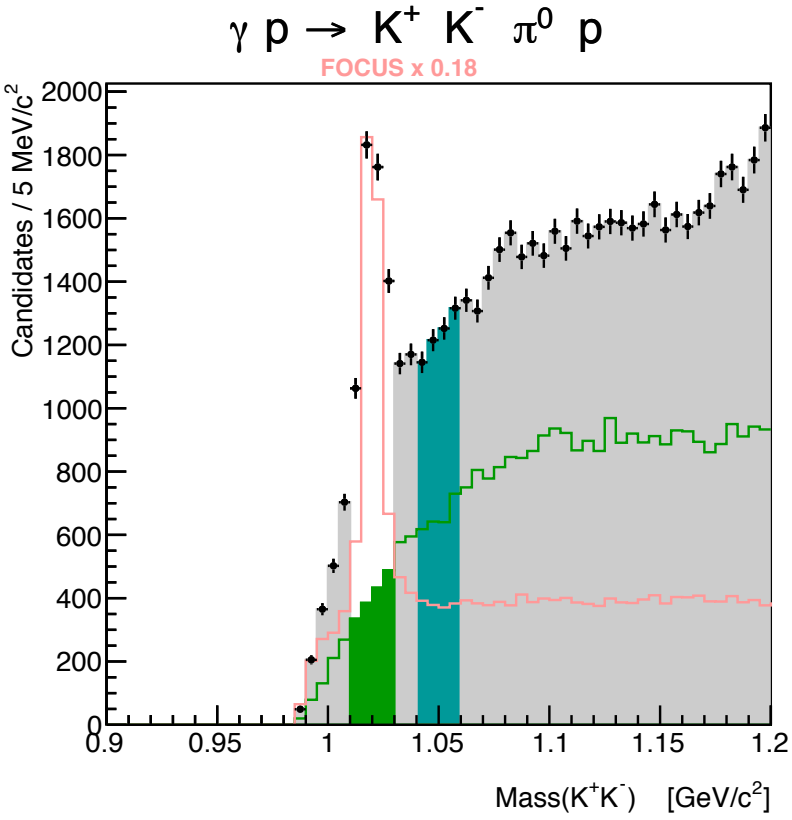


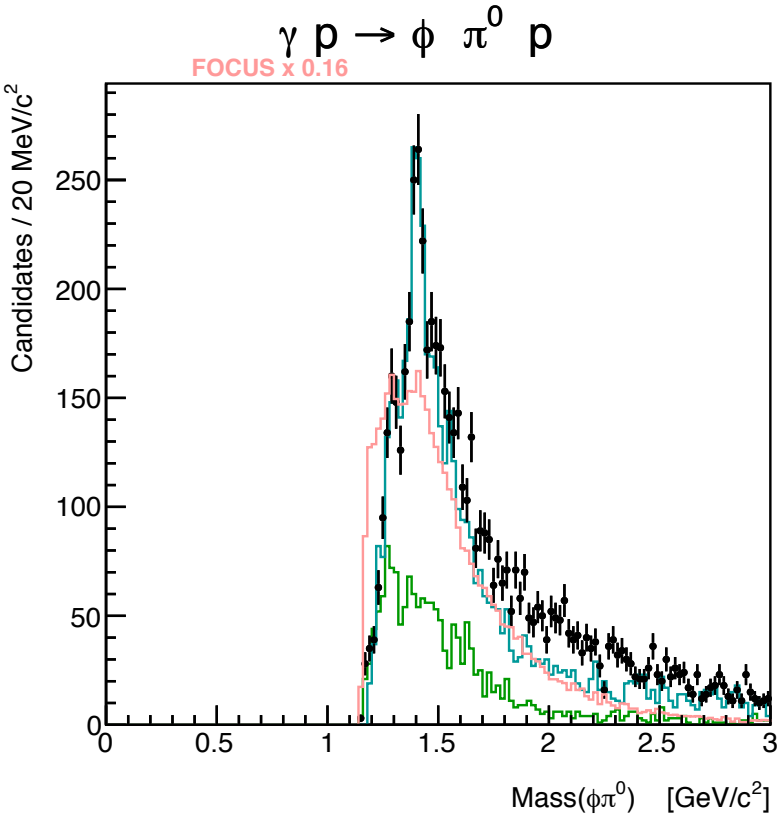
22 $\gamma p \to K^+K^-\pi^0 p$



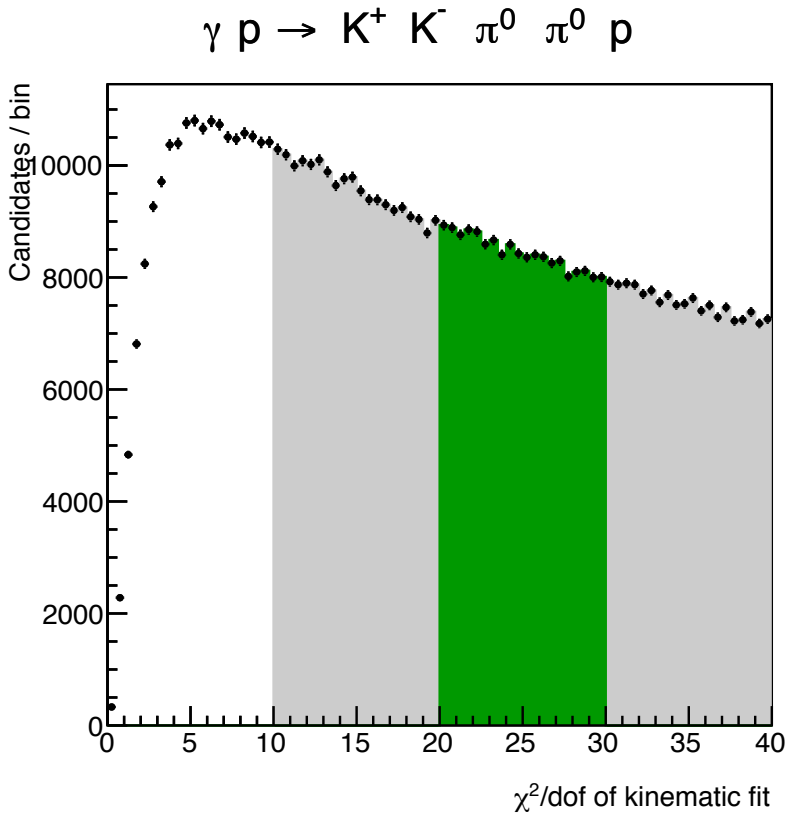


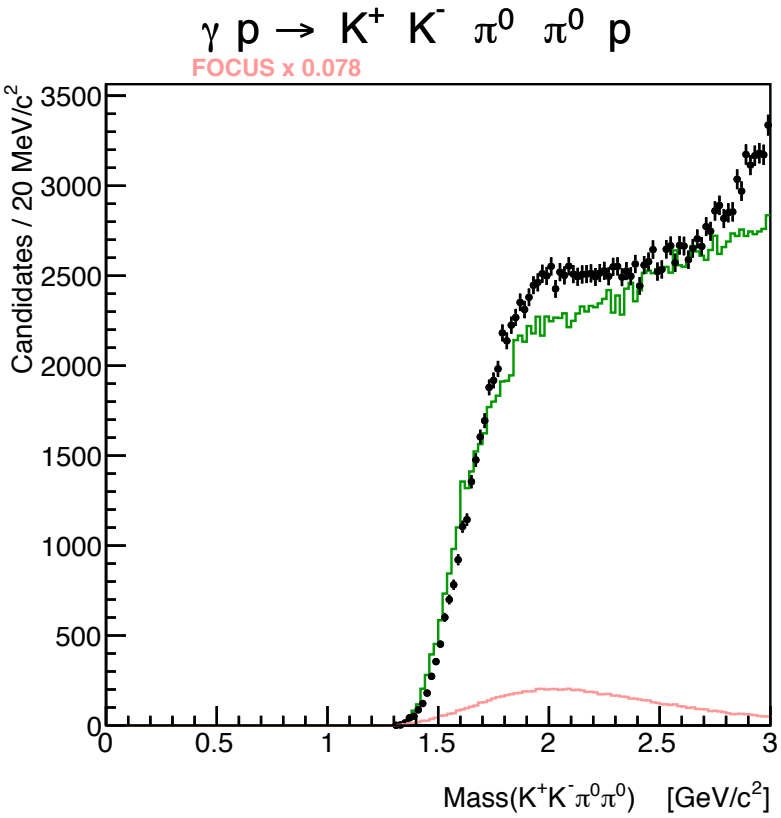
22.1 $\gamma p \to \phi \pi^0 p$



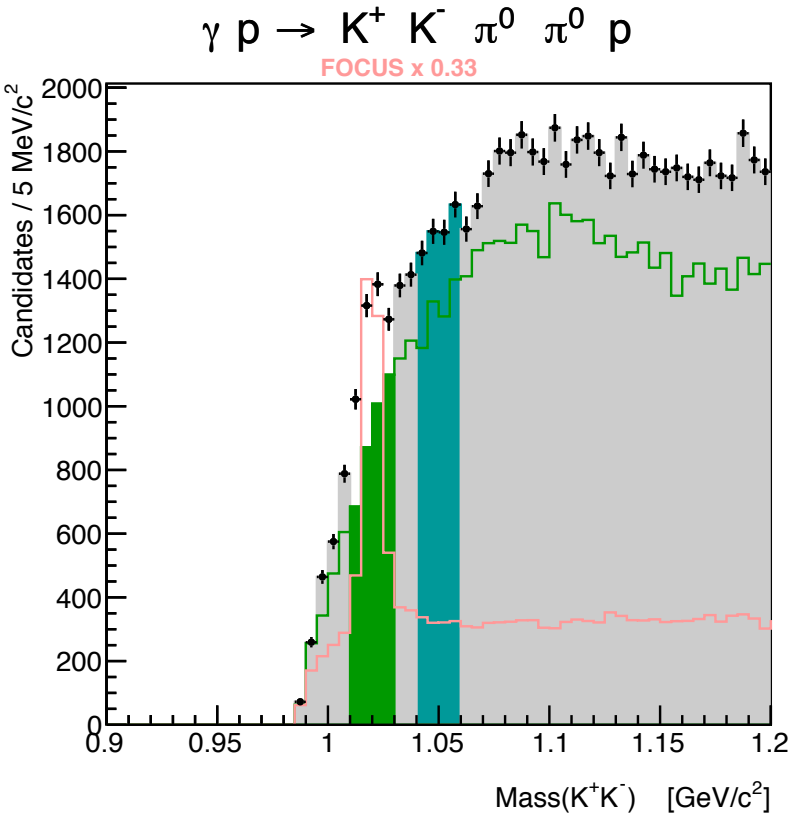


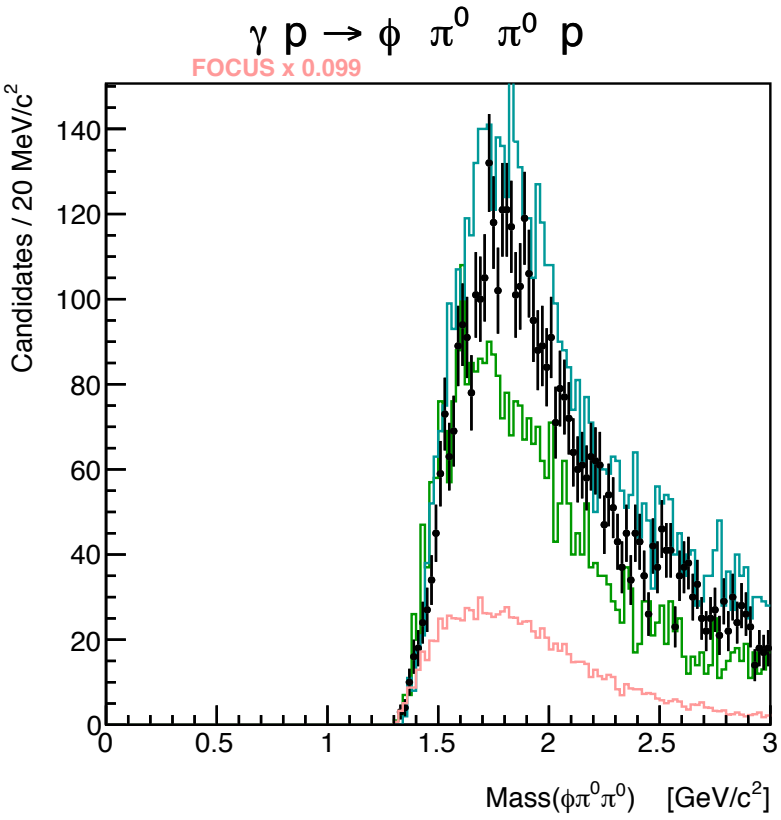
23 $\gamma p \to K^+K^-\pi^0\pi^0 p$



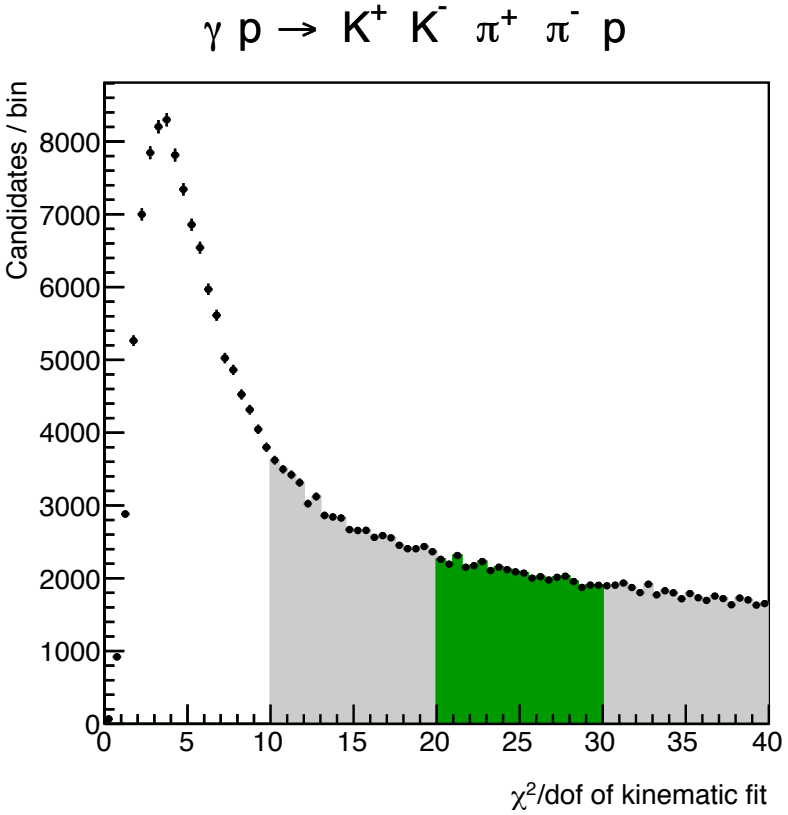


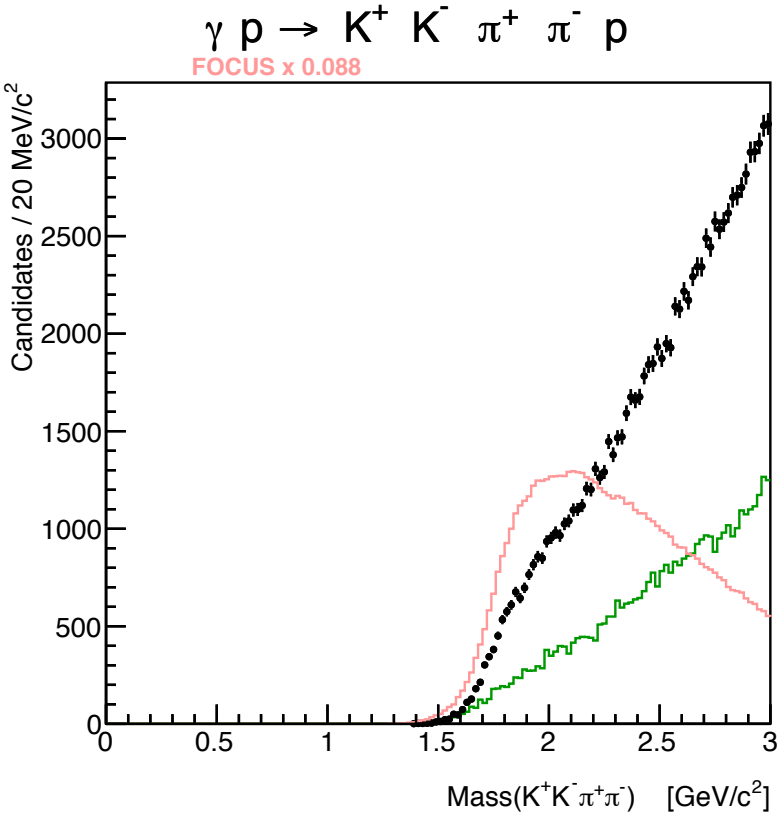
23.1 $\gamma p \to \phi\pi^0\pi^0 p$



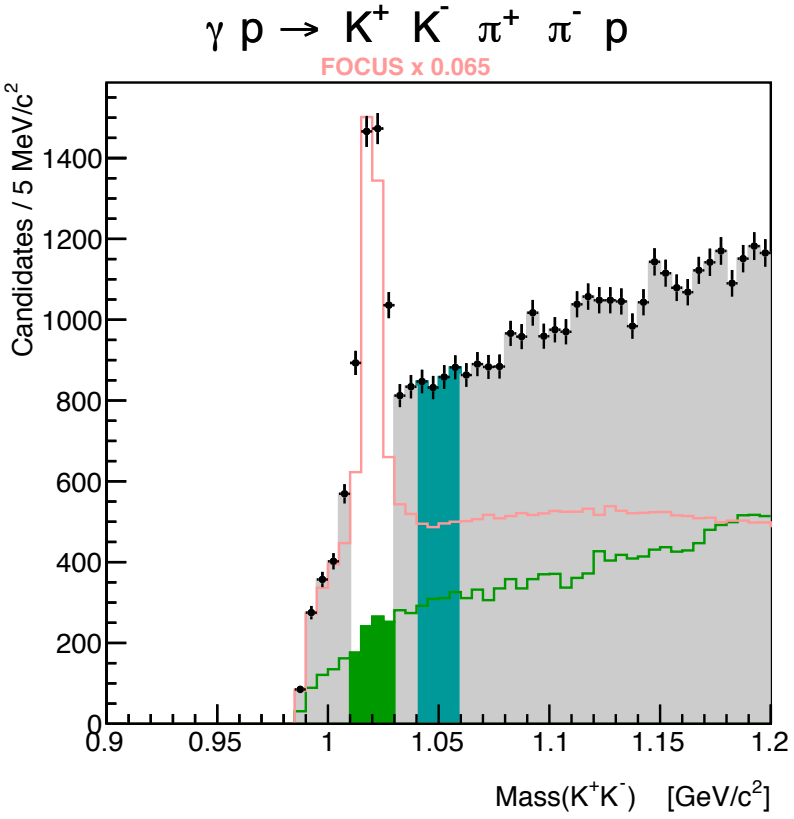


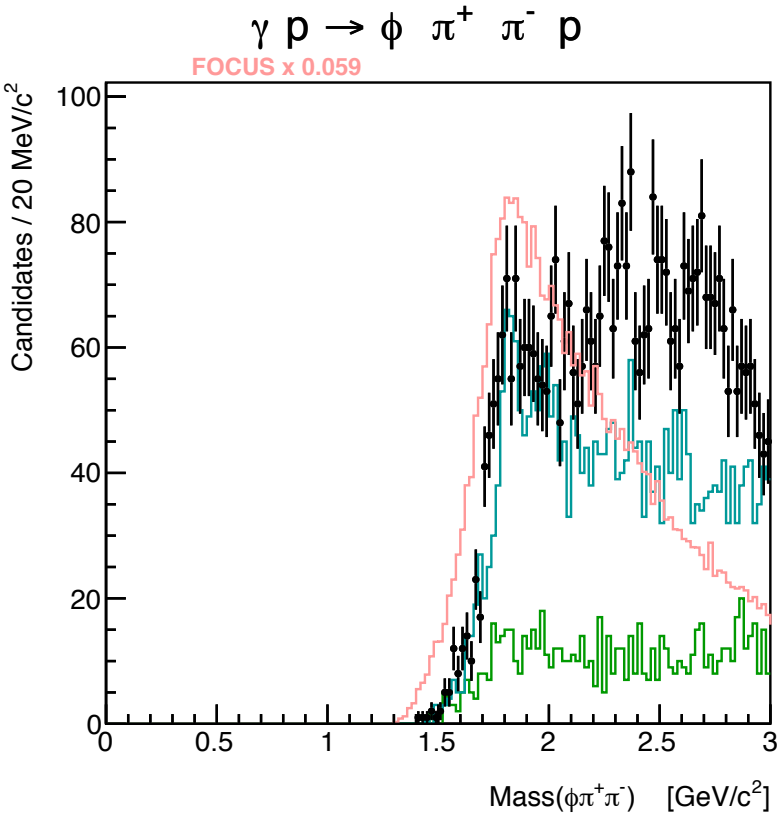
24 $\gamma p \to K^+K^-\pi^+\pi^-p$



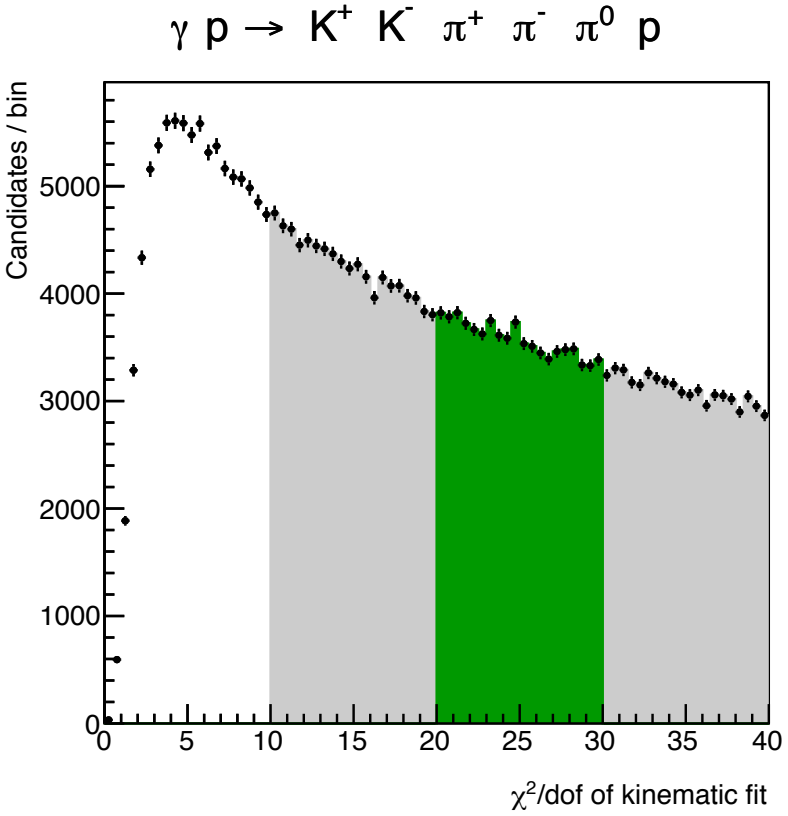


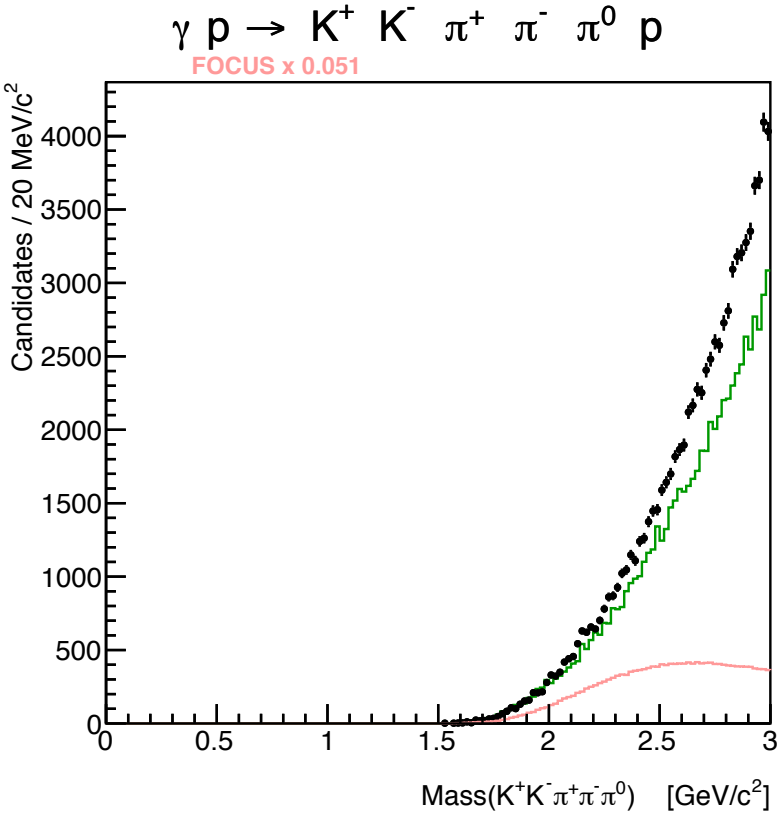
24.1 $\gamma p \to \phi\pi^+\pi^- p$



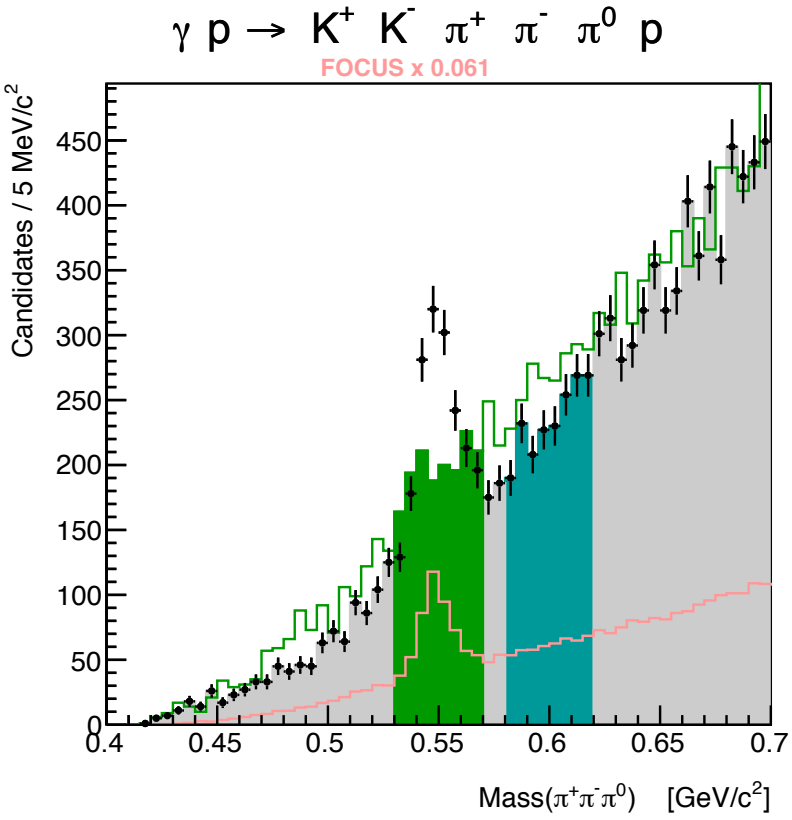


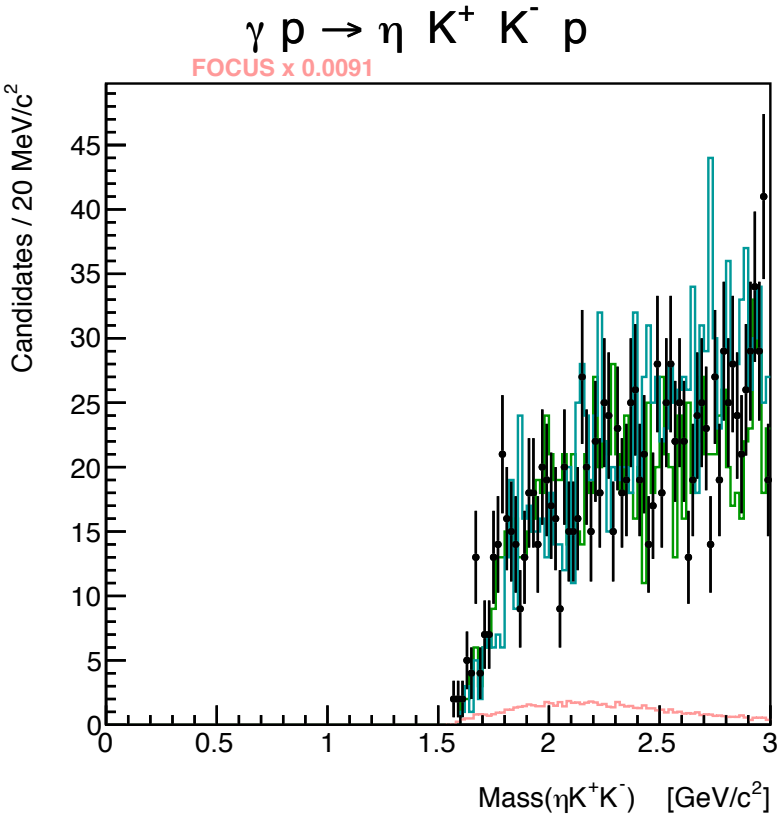
25 $\gamma p \to K^+K^-\pi^+\pi^-\pi^0 p$



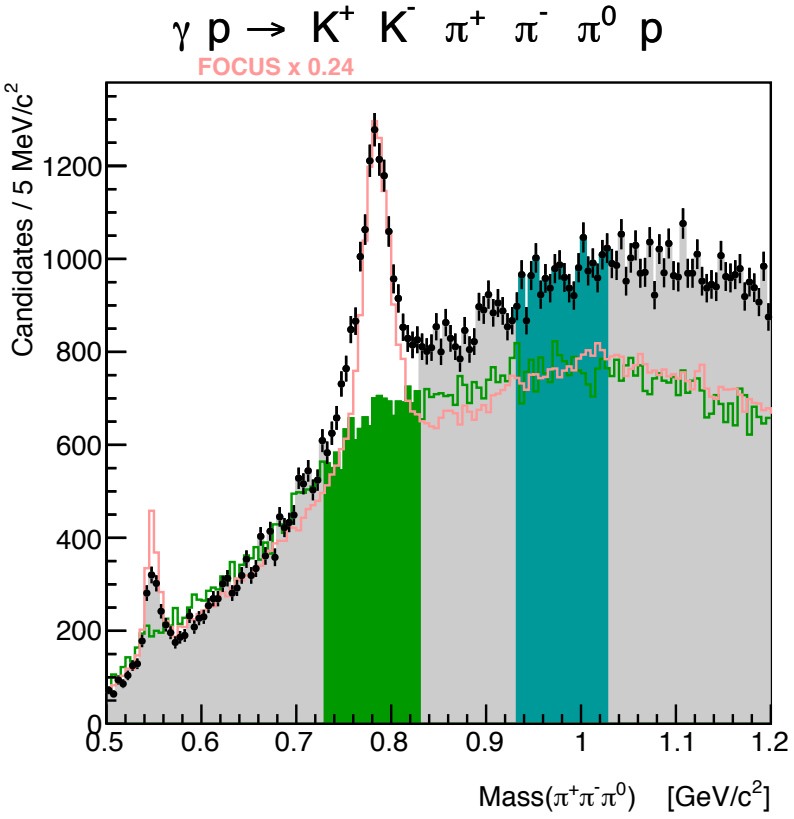


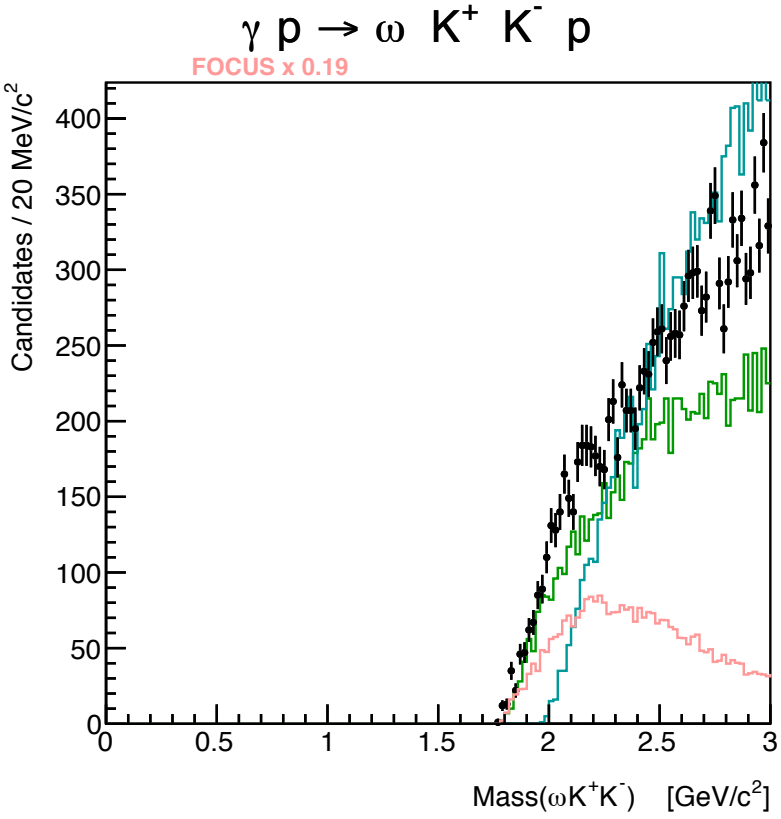
25.1 $\gamma p \to \eta K^+ K^- p$



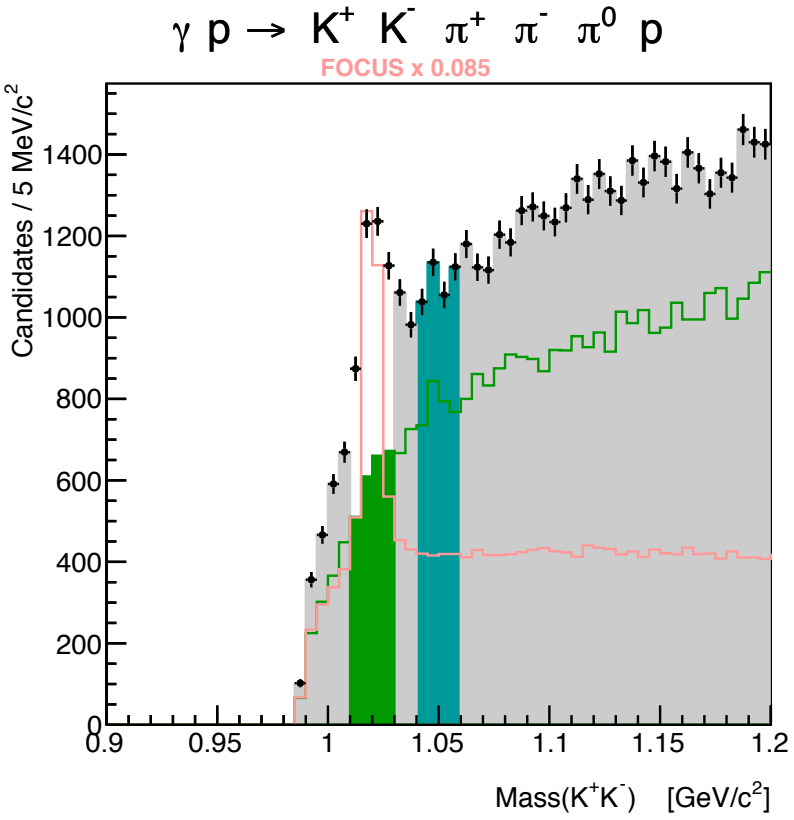


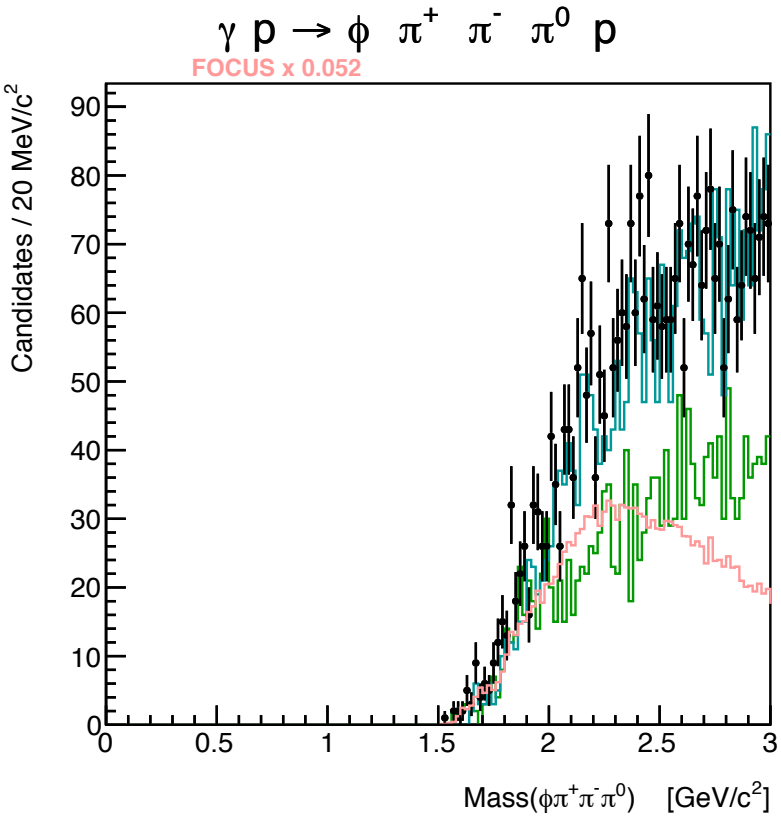
25.2 $\gamma p \to \omega K^+ K^- p$



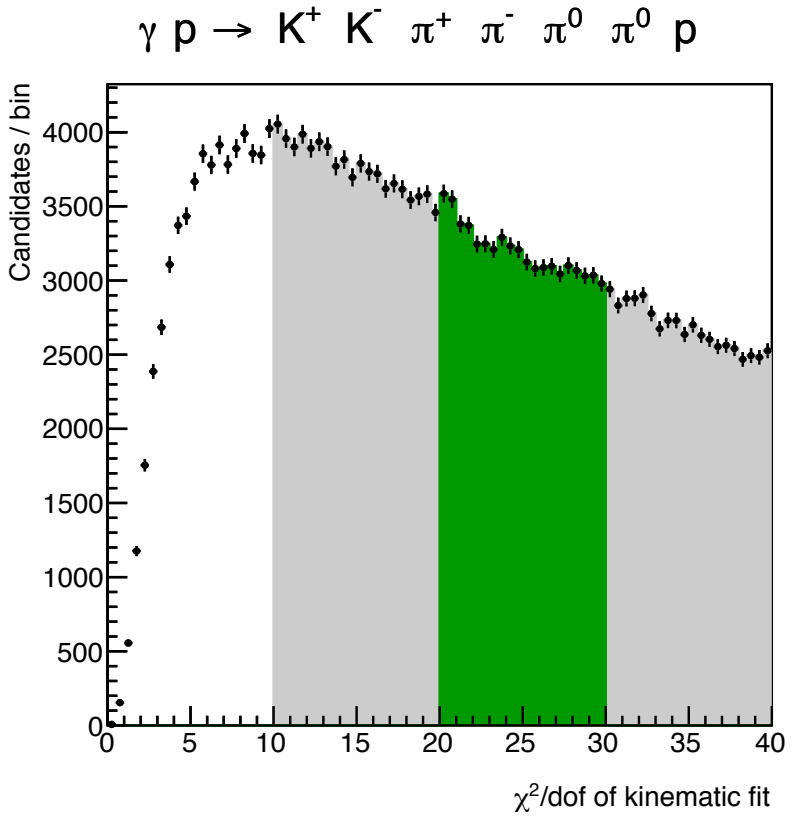


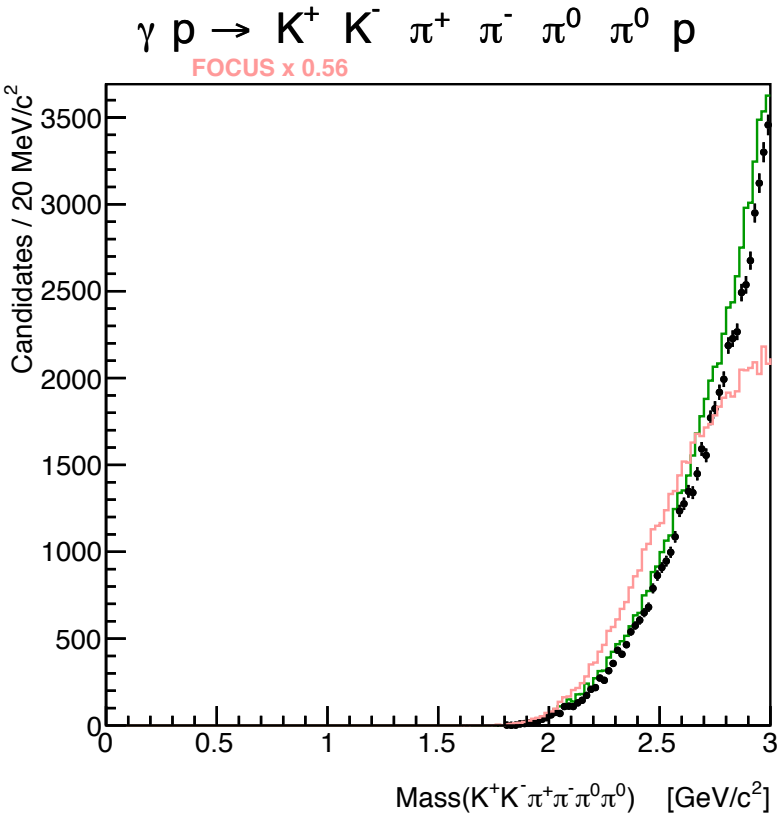
25.3 $\gamma p \to \phi\pi^+\pi^-\pi^0 p$



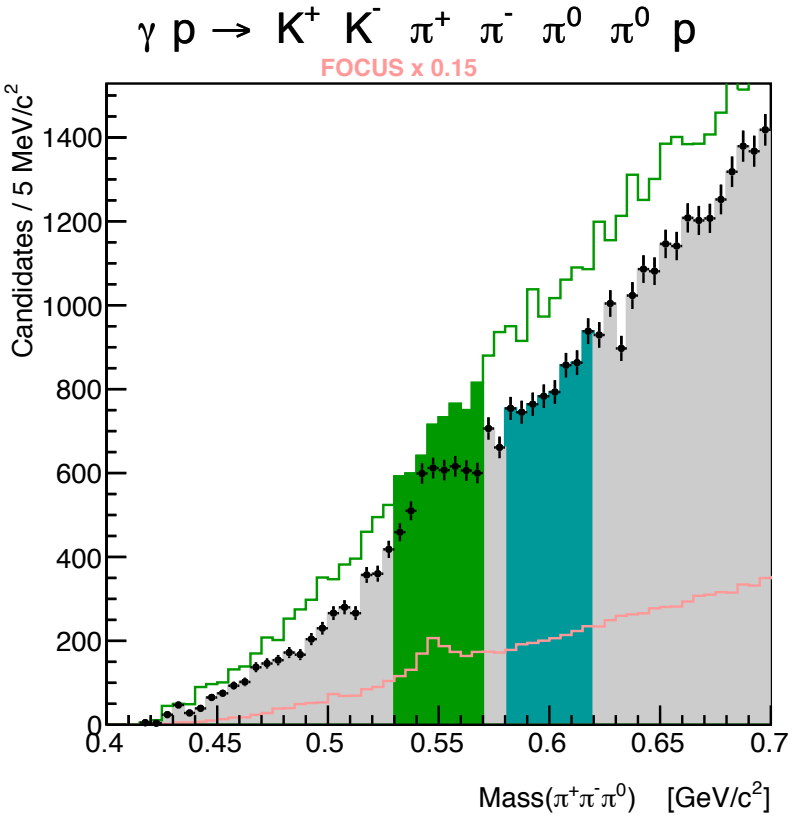


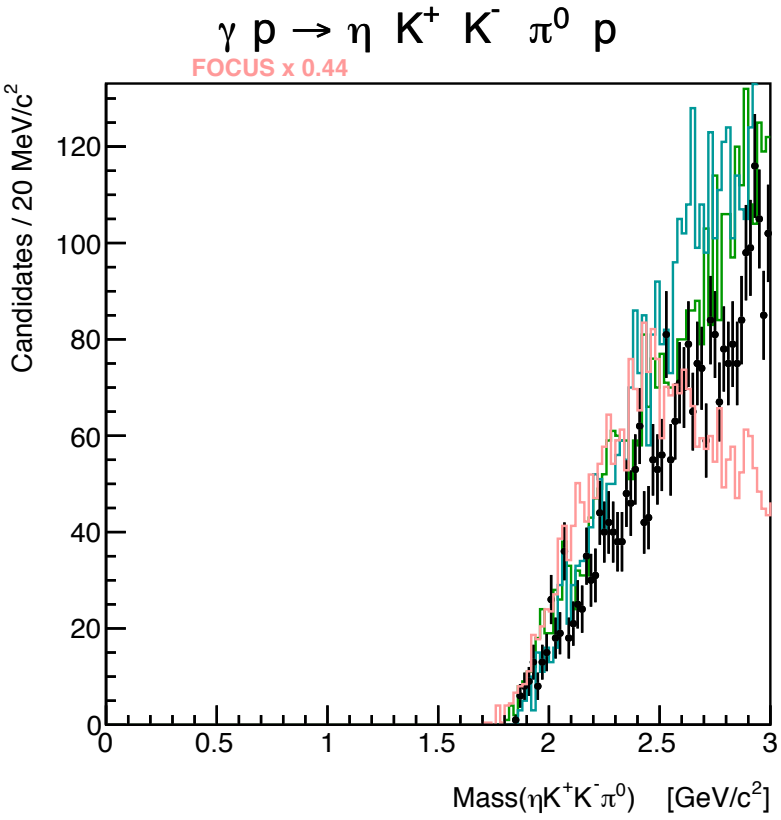
26 $\gamma p \to K^+K^-\pi^+\pi^-\pi^0\pi^0 p$



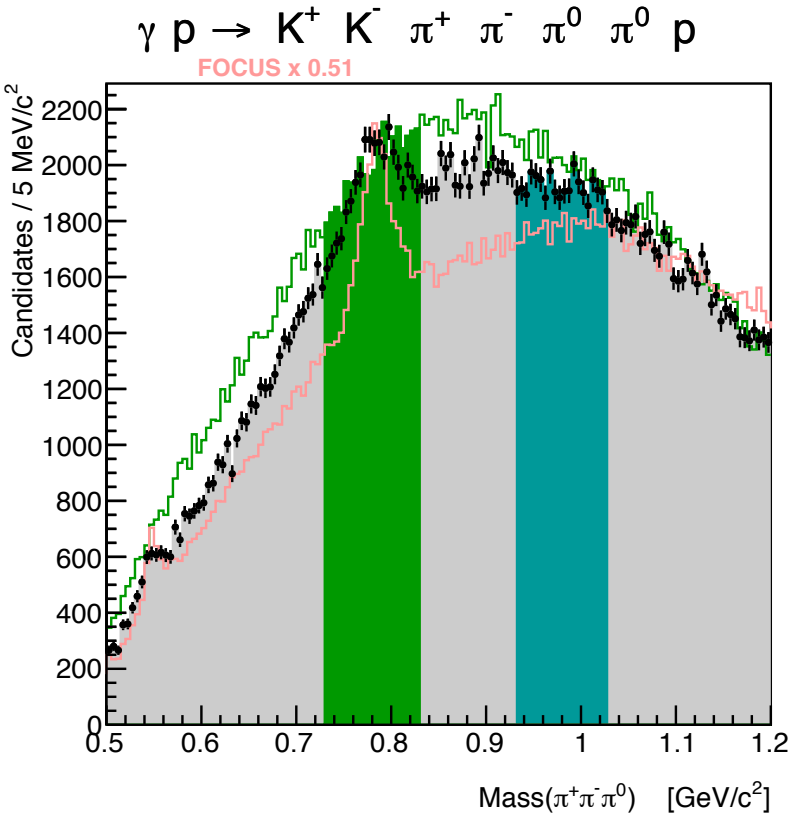


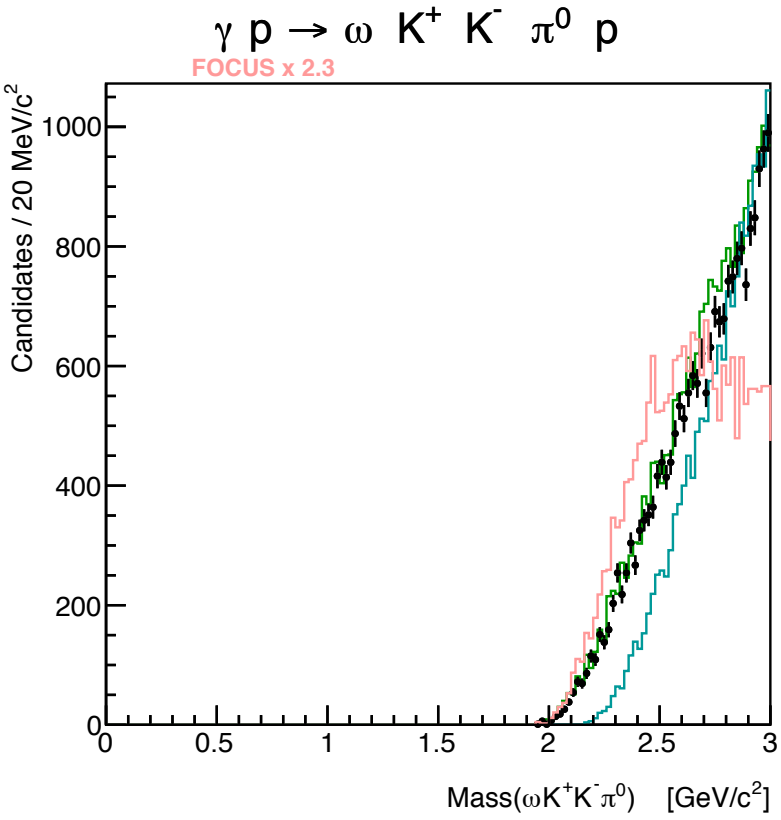
26.1 $\gamma p \to \eta K^+ K^- \pi^0 p$



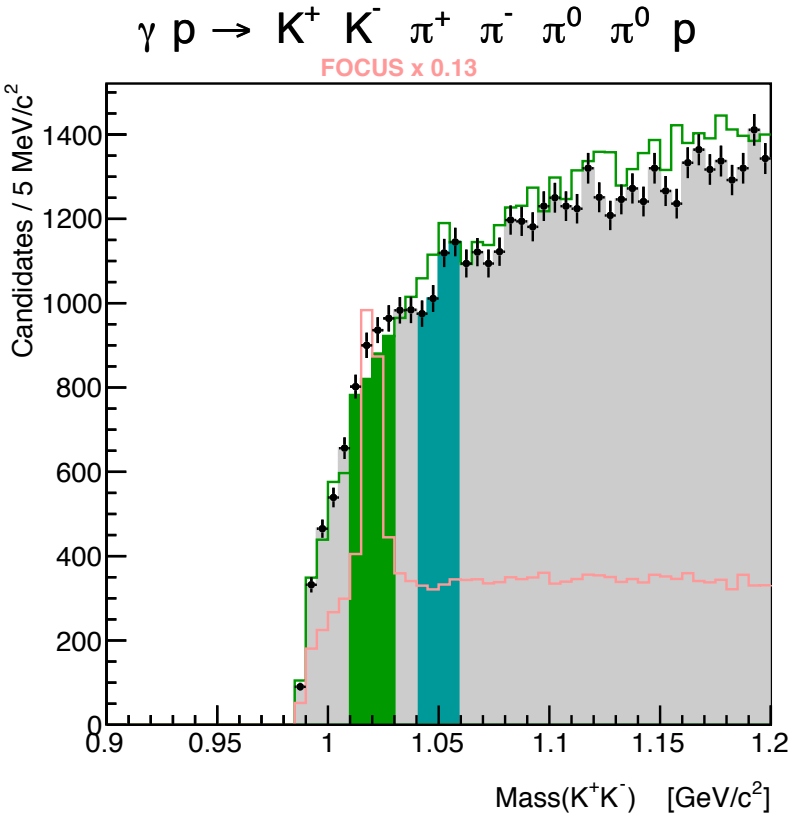


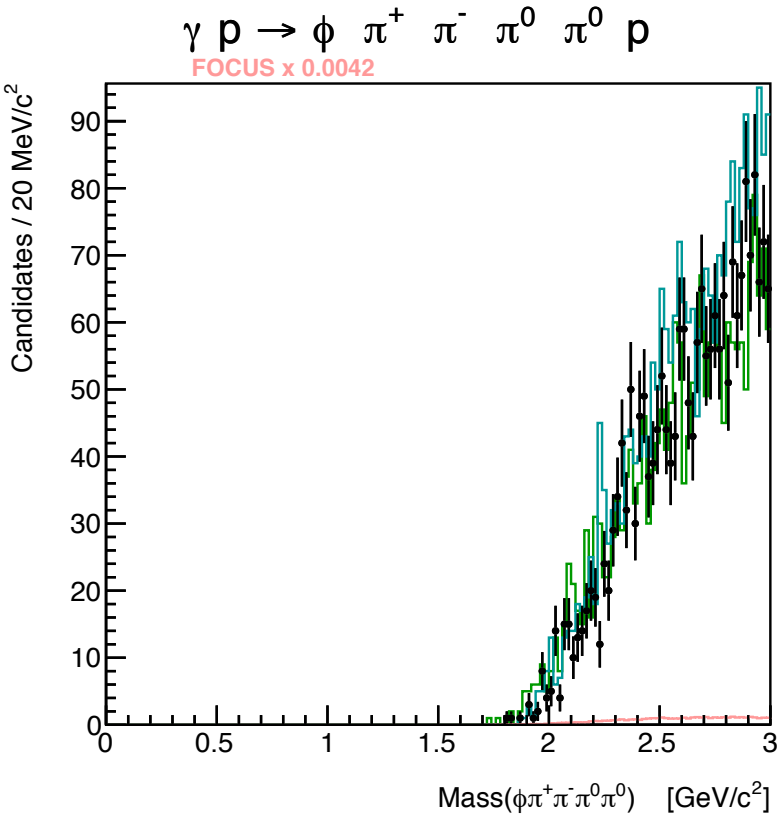
26.2 $\gamma p \to \omega K^+ K^- \pi^0 p$





26.3 $\gamma p \to \phi\pi^+\pi^-\pi^0\pi^0 p$





27 $\gamma p \to K^+K^-\pi^+\pi^+\pi^-\pi^-p$