Λ*(1520) Photoproduction off *Proton* and *Neutron*

from eg3 data set

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Hadron 2009/06/12

- Physics motivation
- Data analysis
- Preliminary results
- Summary and outlook

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Physics Motivation

$\Lambda(1520)\ D_{03}$ $I(J^P) = 0(3/2^-)$

Mass m = 1519.5 ± 1.0 MeV[a] Full width Γ = 15.6 ± 1.0 MeV[a]

• Λ^*(1520) production mechanism is still poorly understood due to the lack of experimental data.

1. a few photoproduction measurements on the ***Proton***

no published data on the ***Neutron***

2. a few electroproduction measurements on the ***Proton***

• Existing Data suggest dominance of t-channel processes and K* or K exchange.

• Several model predictions for total and differential cross sections are available. J. M. Laget, V. Yu. Grishina et al. , L. Roca et al. , S. Nam et al.

• Measurement of cross section and decay angular distribution can provide constraints on model prediction and insights into the production mechanism.

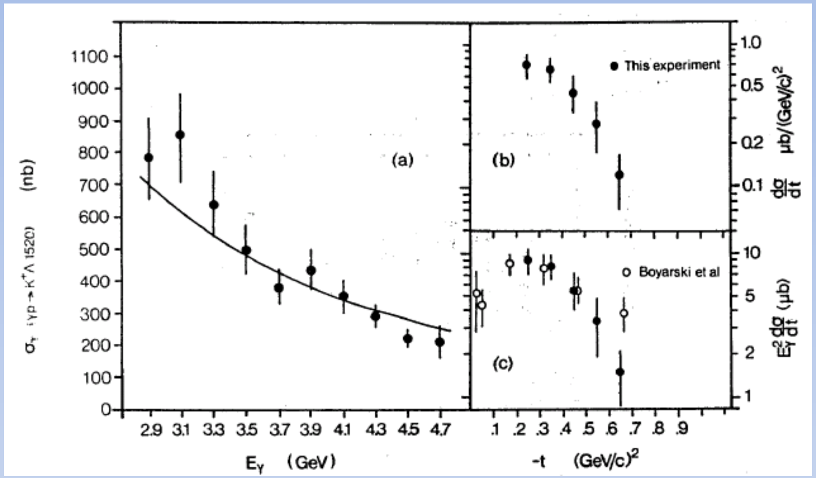
• Possible missing N* resonances decaying through strange channels.

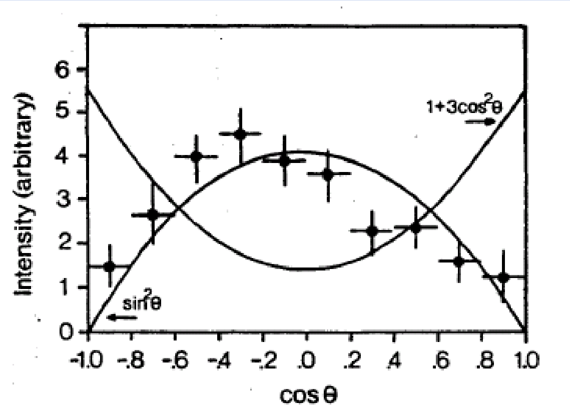
Existing data Photoproduction

- Photoproduction measurements on the ***Proton*** were performed at SLAC and Daresbury

- Daresbury measured differential and total cross section as well as decay angular distribution in the energy range of 2.8-4.8 GeV
  - First look at the decay angular distribution showed dominance of $m_z=\pm3/2$ spin projection
  - Limited statistics

- ***No data on Neutron yet***





Theoretical result Photoproduction

Reactions	$\gamma p \to K^+ \Lambda^*$		$\gamma n \to K^0 \Lambda^*$
σ	$\sim 900\ nb$	>>	$\sim 30\ nb$

?

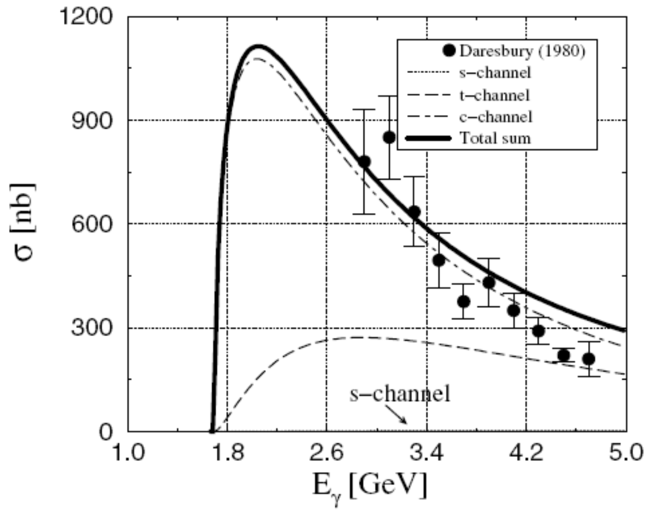


FIG. 3. The total cross sections for the proton target with the form factor F_1. The s-, t- and c-channel contributions are drawn separately. The experimental data are taken from Ref. [4]

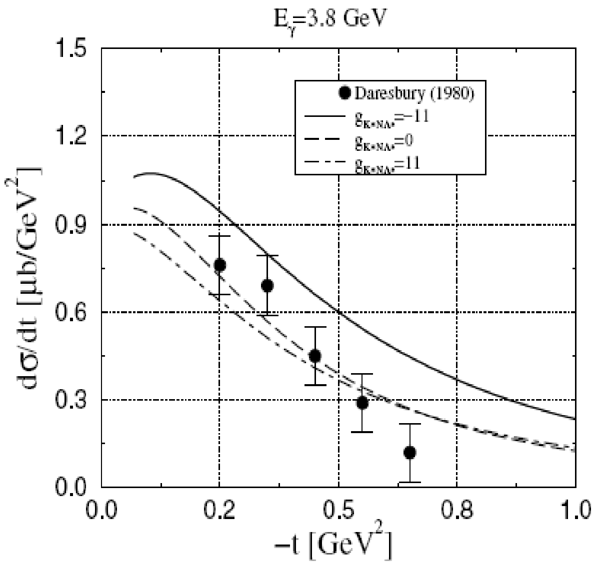


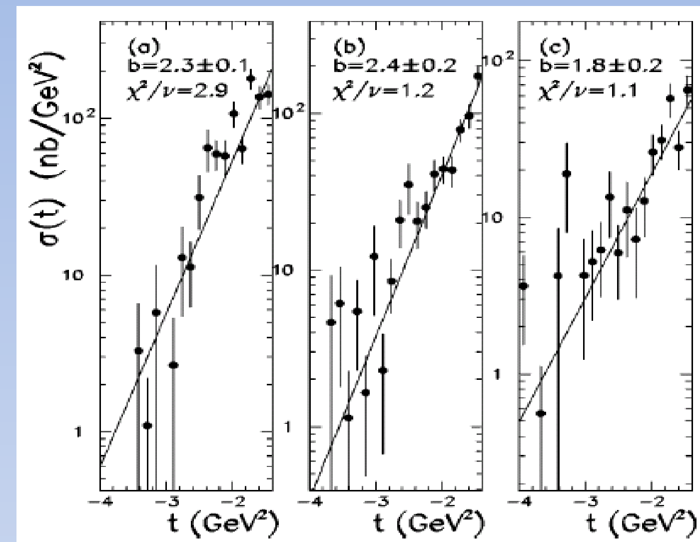
FIG. 5. The t-dependence for the proton target at $E_\gamma = 3.8$ GeV. We choose $(\kappa_{\Lambda^*}, X) = (0, 0)$. The experimental data are taken from Ref. [4]

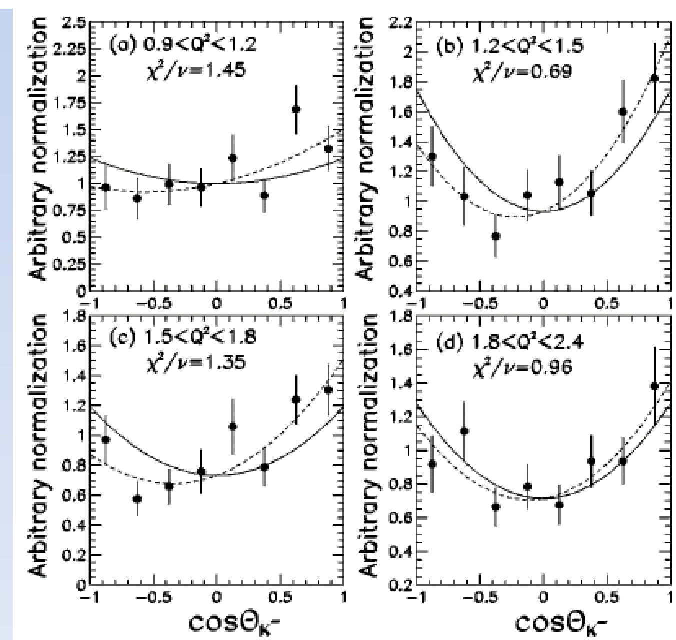
Comparing between data and theory (*Proton*)

S. Nam et al. Phy.Rev.D 71,114012 (2005)

Existing data electroproduction

- Electroproduction of Λ* off ***Proton*** has been studied at DESY and CLAS
- CLAS data (S. Barrow, e1c) showed
  - Dominance of t-channel process confirmed
  - Decay angular distribution showed significant contribution from $m_z=\pm 1/2$ spin projection





Reaction Channels

two exclusive

$\gamma p(n) \rightarrow K^+ \Lambda^* (n)$ *Proton*

$\gamma n(p) \rightarrow K^0 \Lambda^* (p)$ *Neutron*

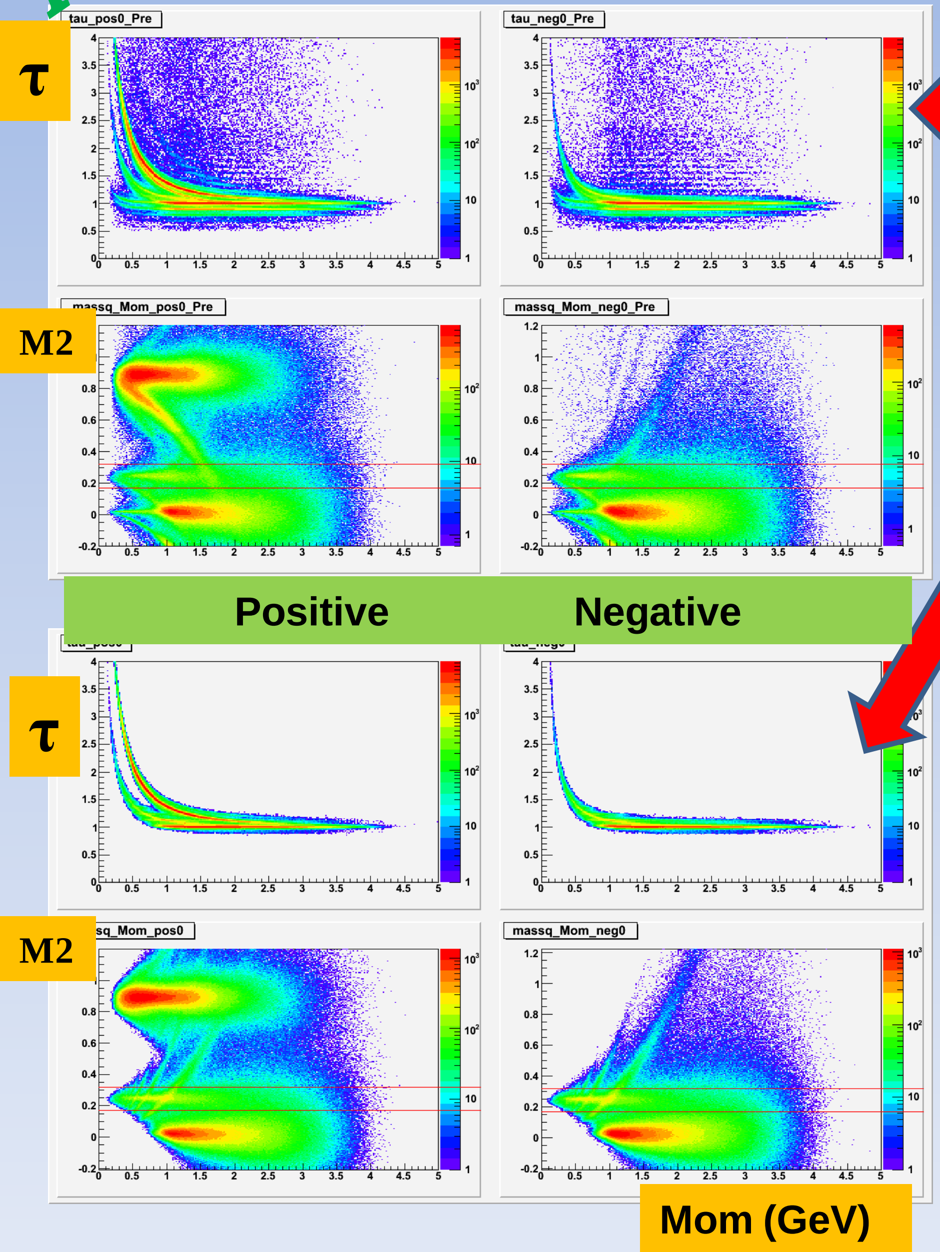
$(\Lambda^* \rightarrow p K^- , K^0 \rightarrow K^s \rightarrow \pi^+ \pi^-)$

eg3 run

- **Photon beam** electron beam 5.77 GeV, photon energy Tagger 4.5 < E < 5.5 GeV, 30 nA
- **Target** 40 cm upstream, LD2
- **Trigger** Tagger 4.5 < E < 5.5, STxTOF (mainly 3 sectors and prescaled 2 sectors)
- **Torus field** optimized to -1980 A, negative outbending
- **Run Period** 12/06/2004 – 01/31/2005, 29 days of production on LD2 target
- **Data** 4.2 billion physics events, 32 TB raw data, average 2.7 tracks/event

Particle Identification

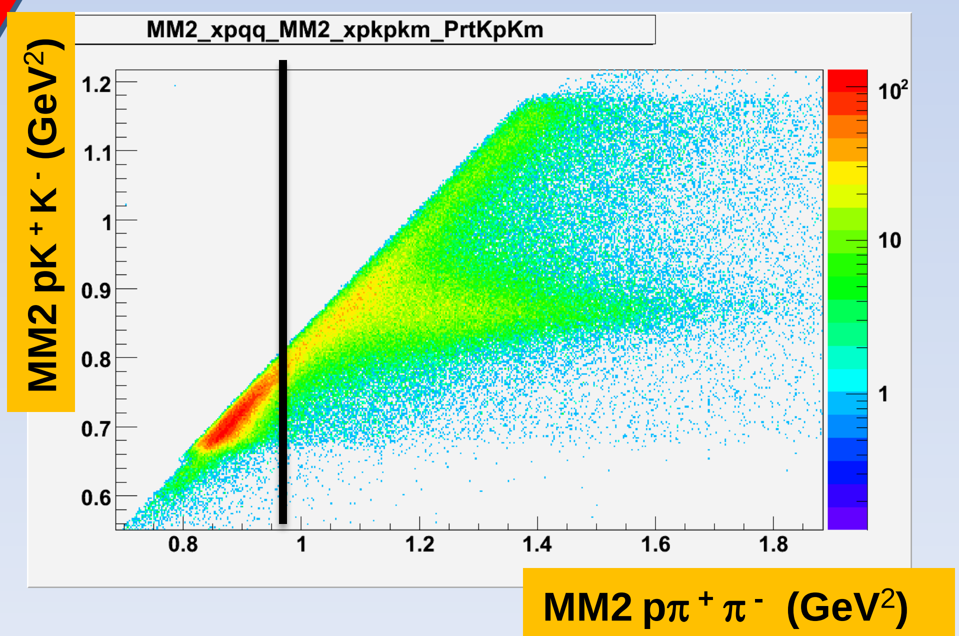
Proton



starttime by cooking code

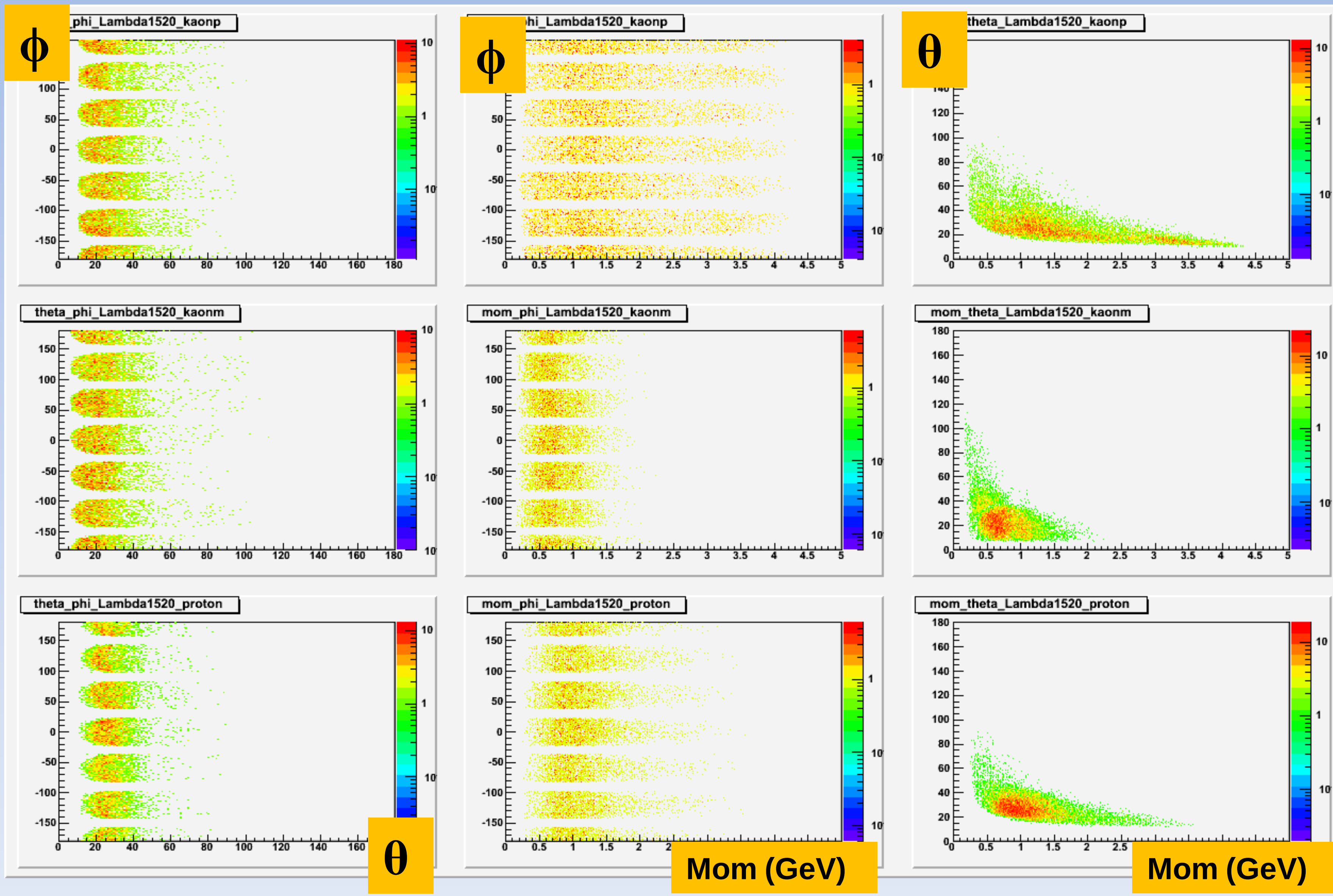
starttime after photon selected with particle vertex timing

Cut Missidentified Pions



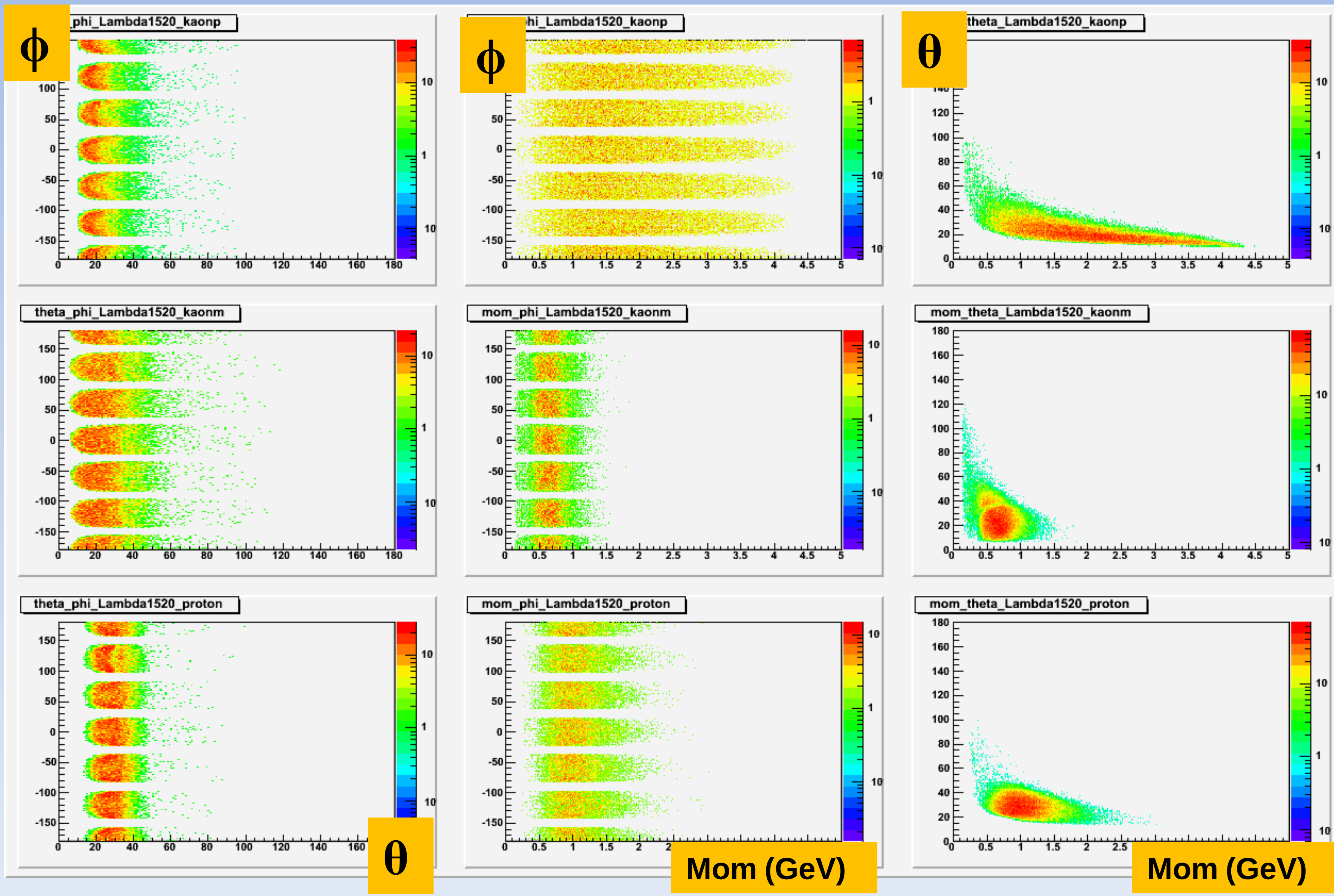
Proton Particle Distribution

data



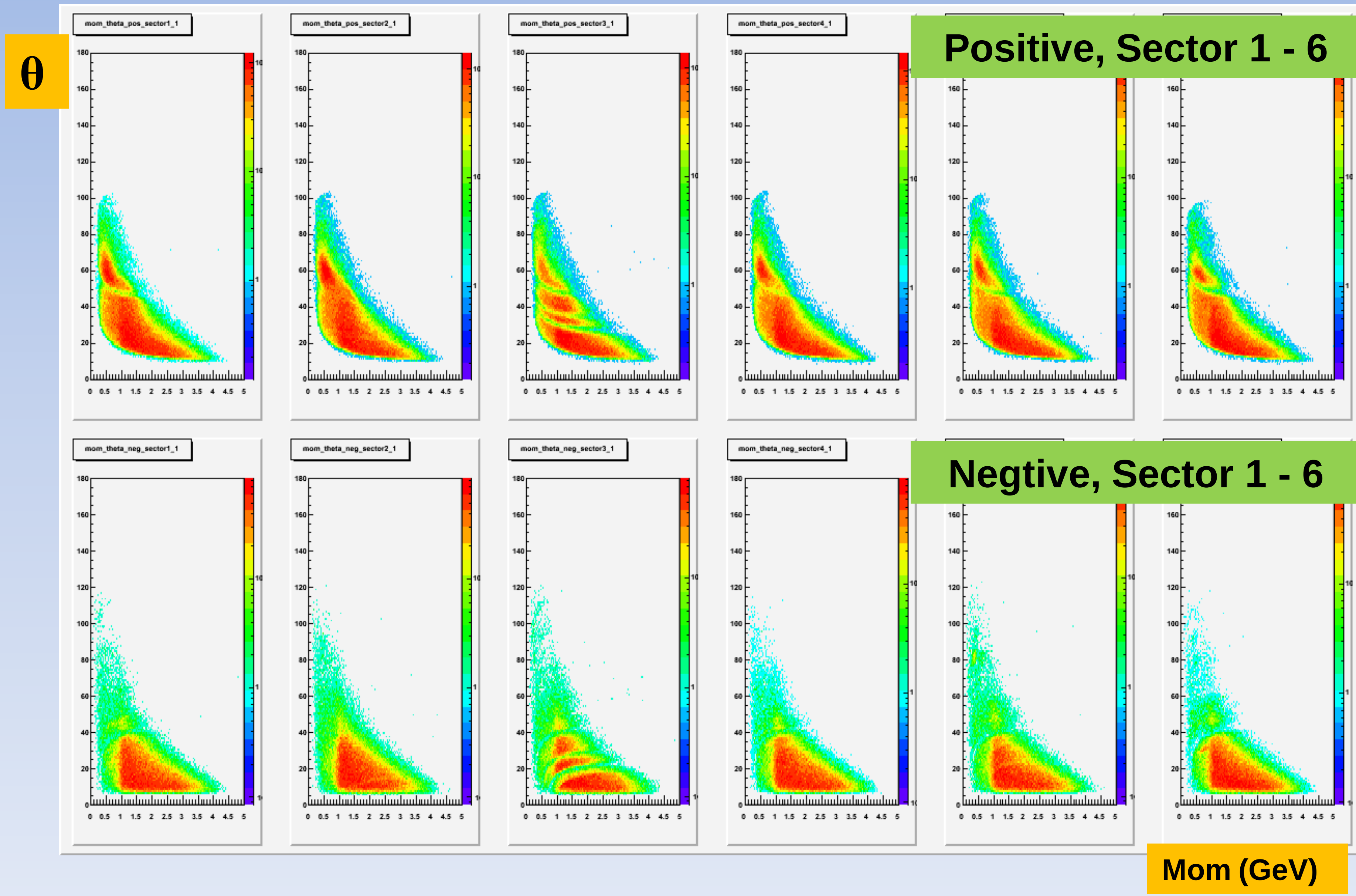
Proton Particle Distribution

sim



Proton Particle Distribution

data

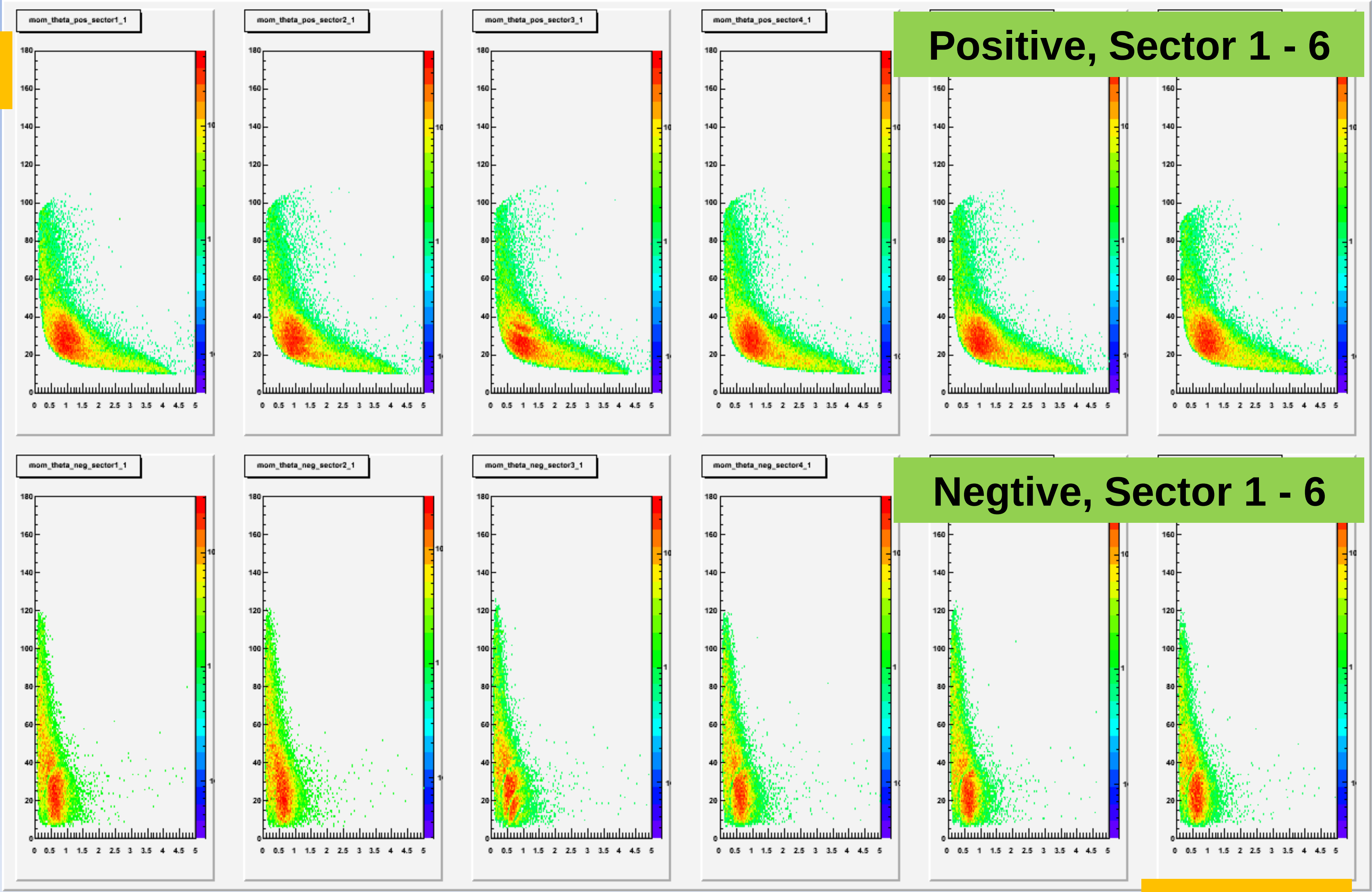


Proton

Particle Distribution

sim

θ



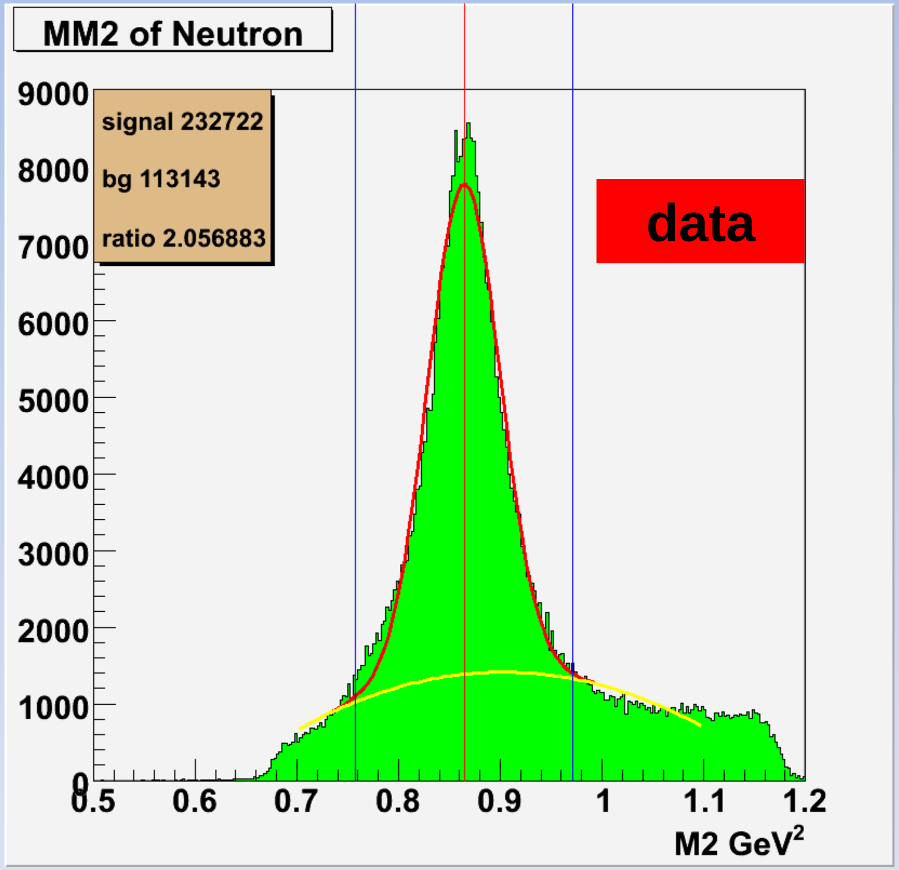
Positive, Sector 1 - 6

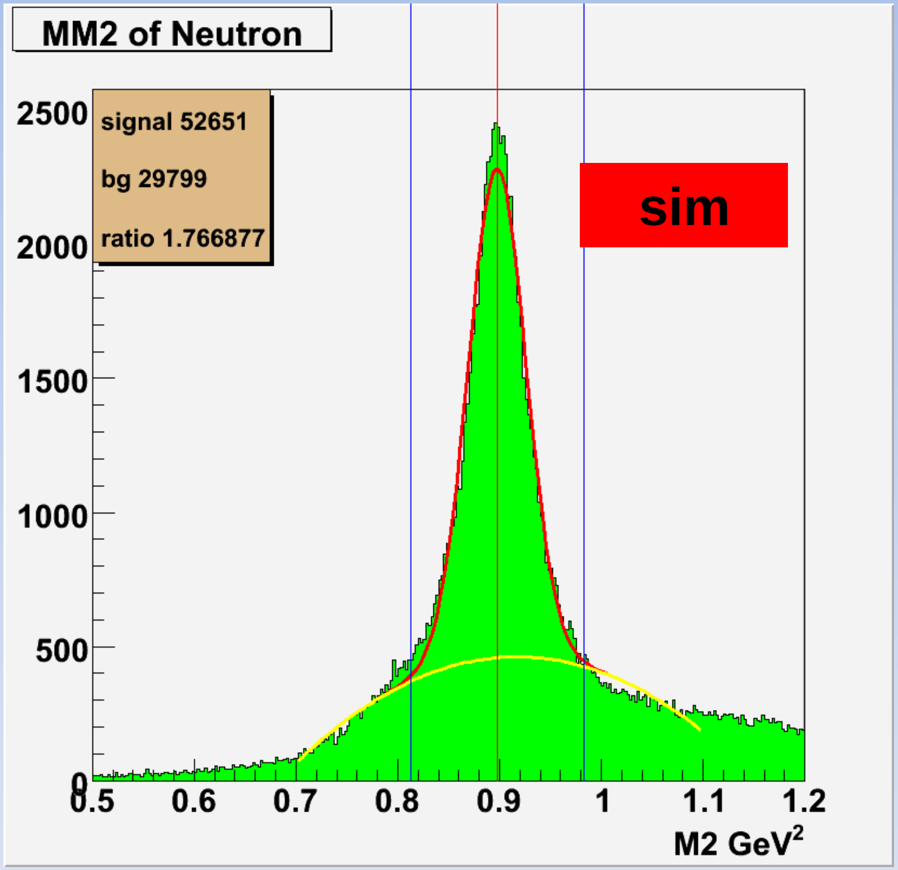
Negtive, Sector 1 - 6

Mom (GeV)

Proton

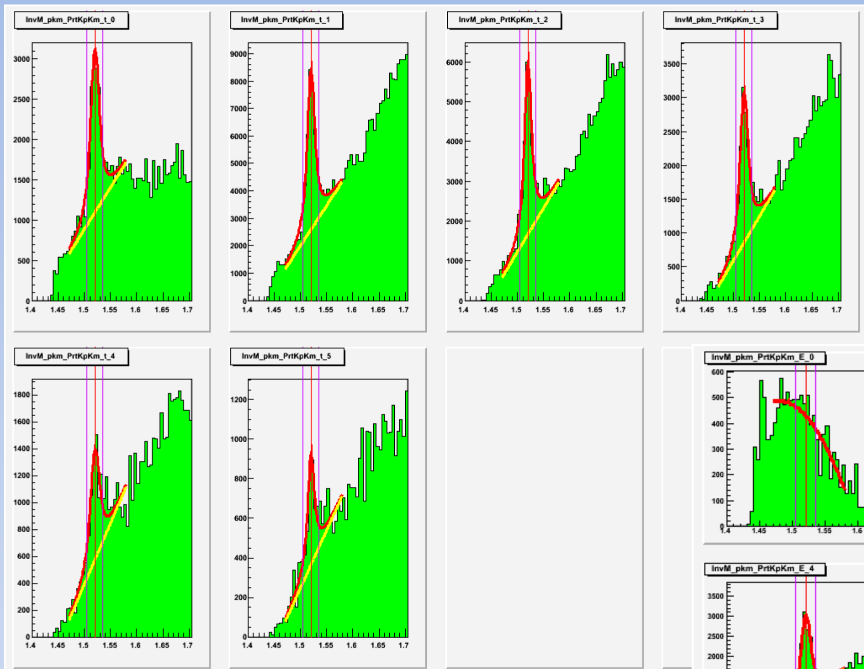
Neutron Missing Mass





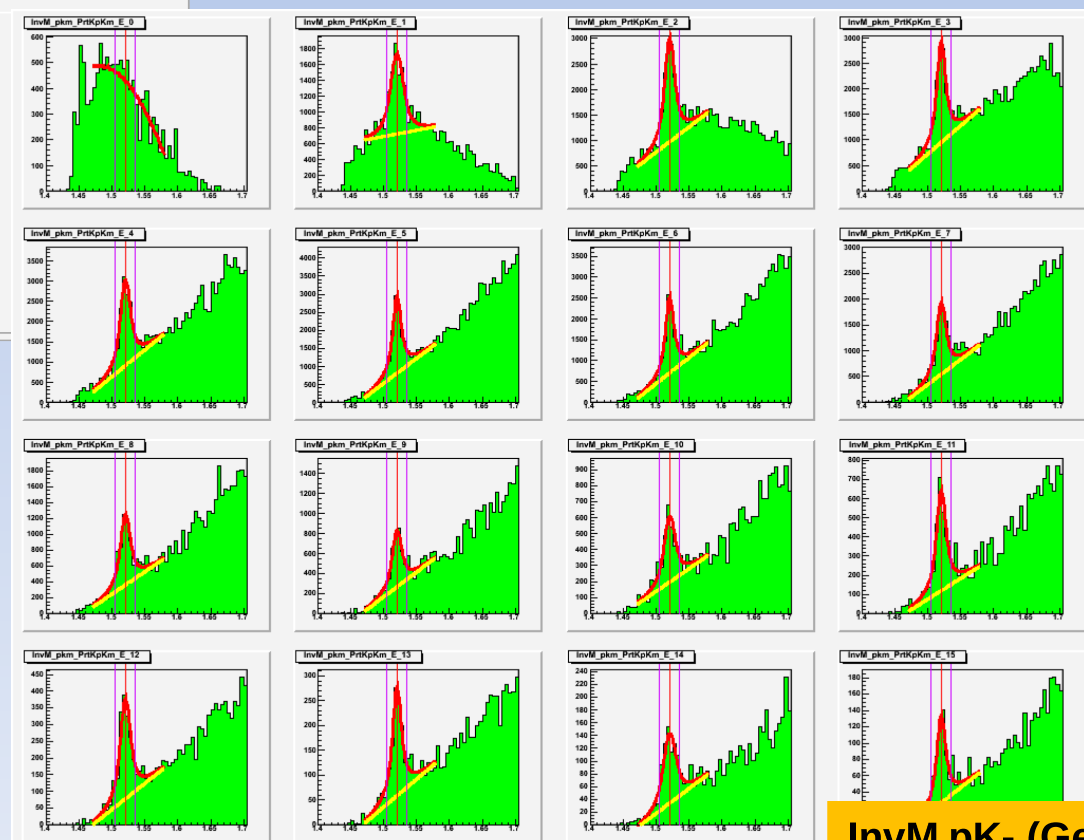
Proton

Yield Extraction (data)



- Data are binned by E_γ and $t^* = -(t-t0)$
- The Λ^* yield is extracted as fitting the P K^- invariant mass spectrum with BW function convoluted with a Gaussian + polynomial
- The width and peak of the BW are fixed to Λ^* PDG value. the sigma of the Gaussian is a fitting parameter

$0 < t^* < 2$ GeV^2
6 bins, binwidth = 0.33 GeV^2



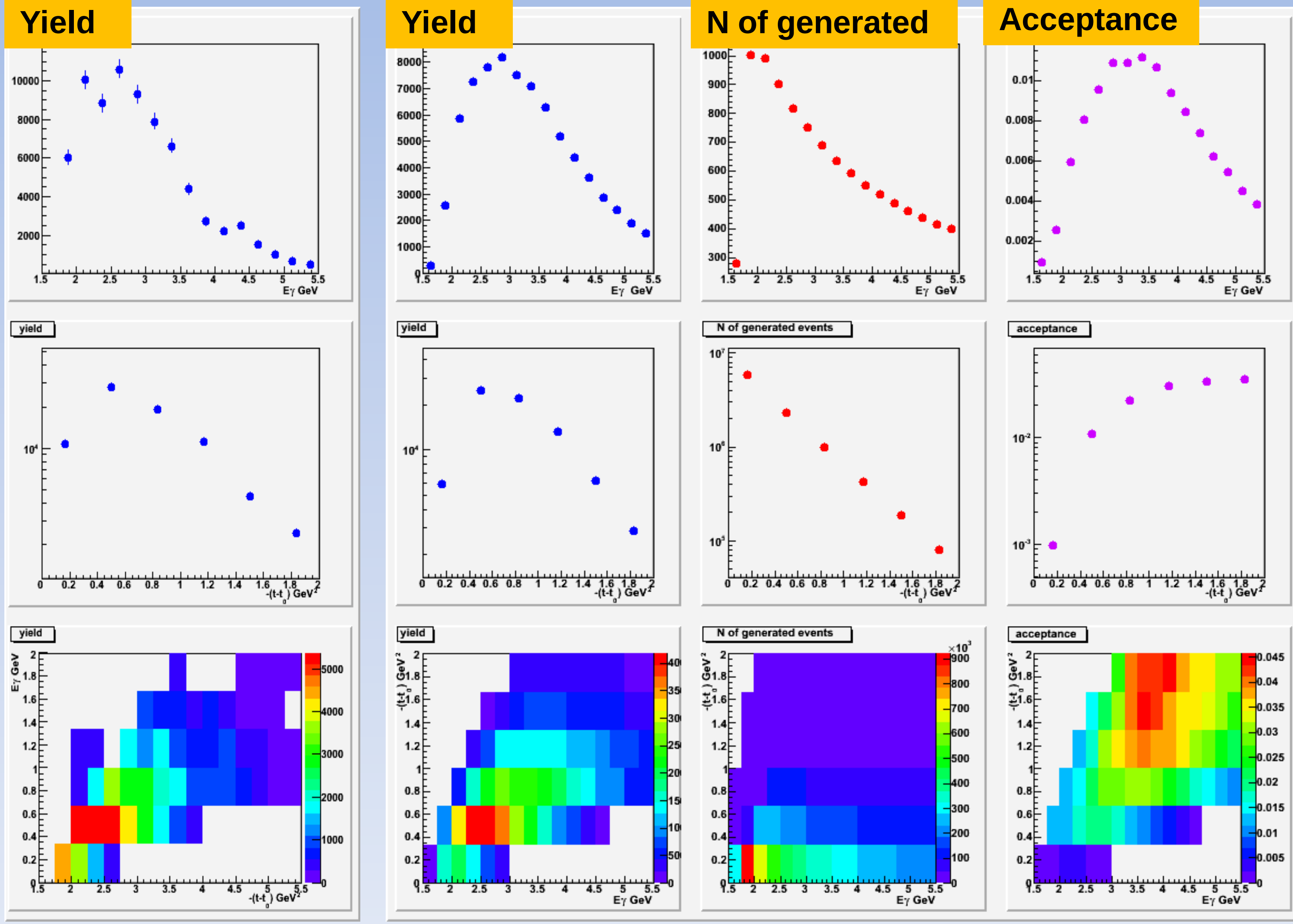
$1.5 < E_\gamma < 5.5$ GeV
16 bins, binwidth=250MeV

InvM pK- (GeV)

Yield and Acceptance

Proton

	Data	**Simulation**		
	Yield	**Yield**	**N of generated**	**Acceptance**
Eγ bin				
t* bin				
Eγ, t* bin				

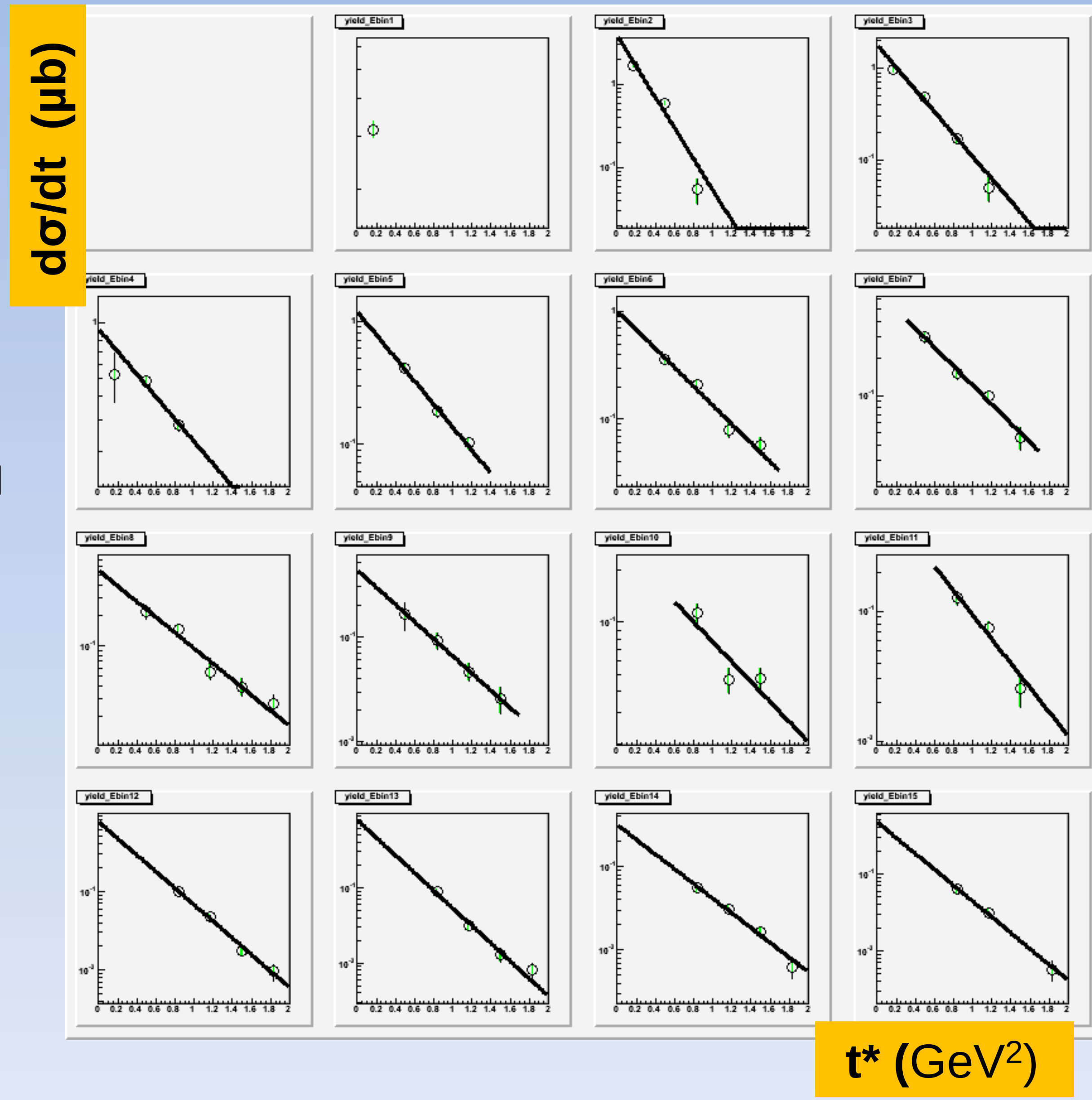


Proton Differential Cross Section

- 1.5 < E_γ < 5.5 GeV
16 bins, binwidth=250MeV

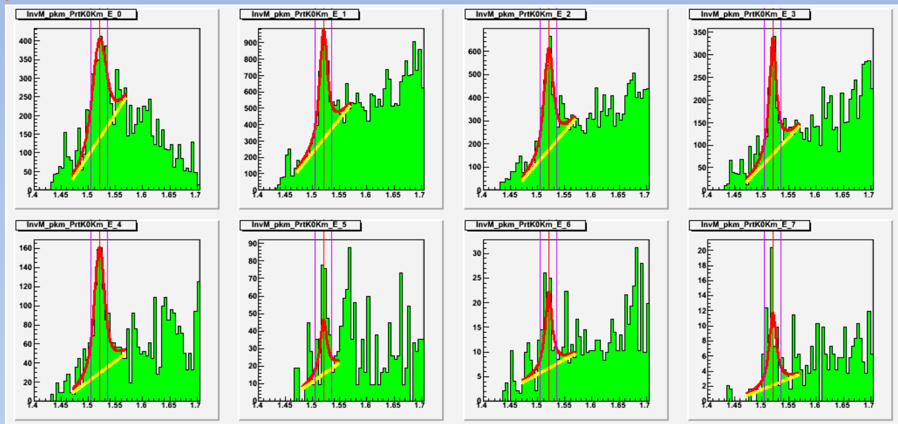
- Extrapolating to low t* with an exponential function

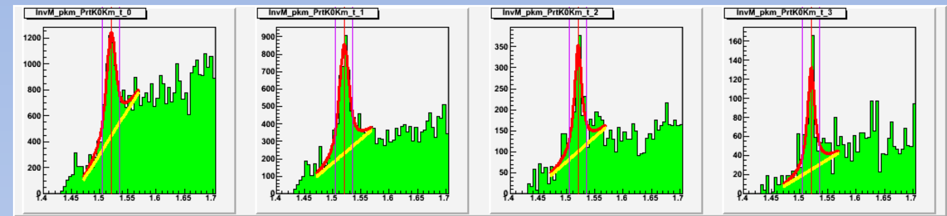
- Integrating over t* to get total cross section.



Neutron

Yield and Acceptance





$1.5 < E_\gamma < 5.5$ GeV
8 bins, binwidth = 500MeV

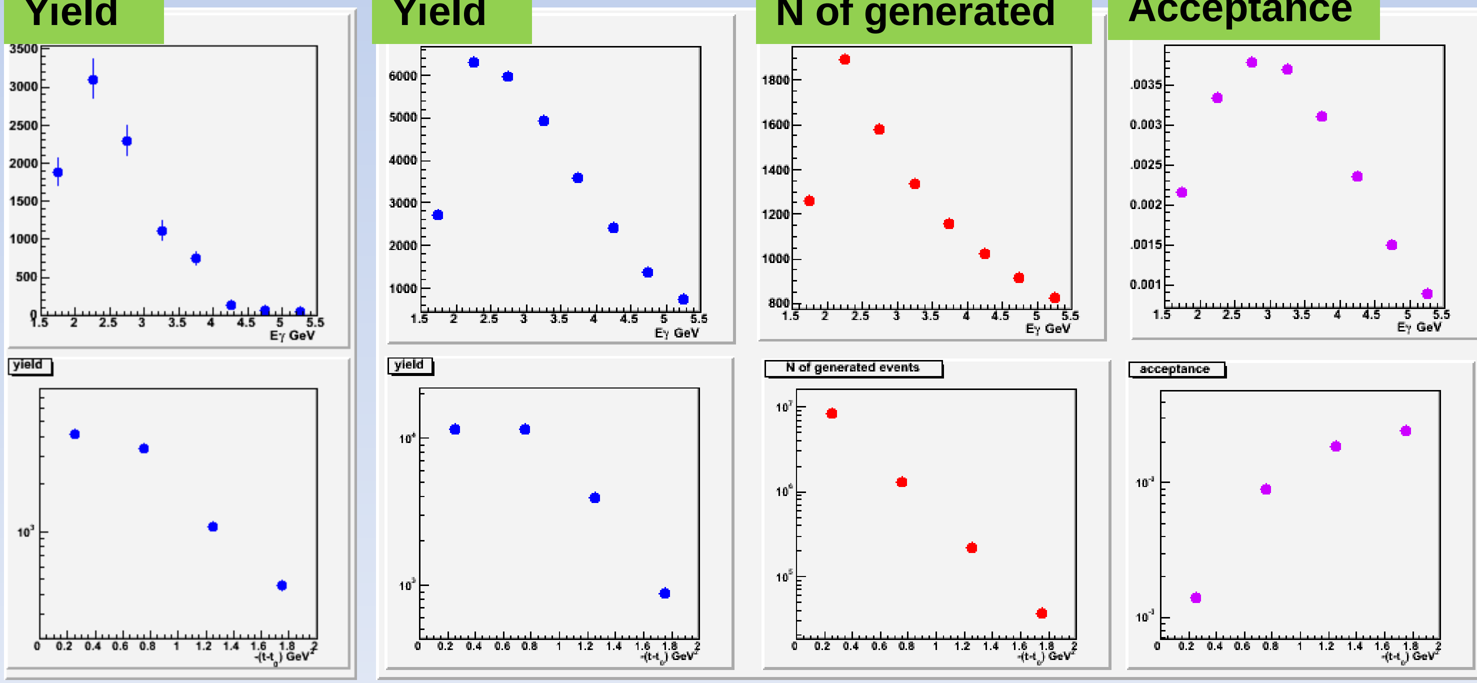
$0 < t^* < 2$ GeV^2
4 bins,
binwidth =
0.5 GeV^2

Data **Simulation**

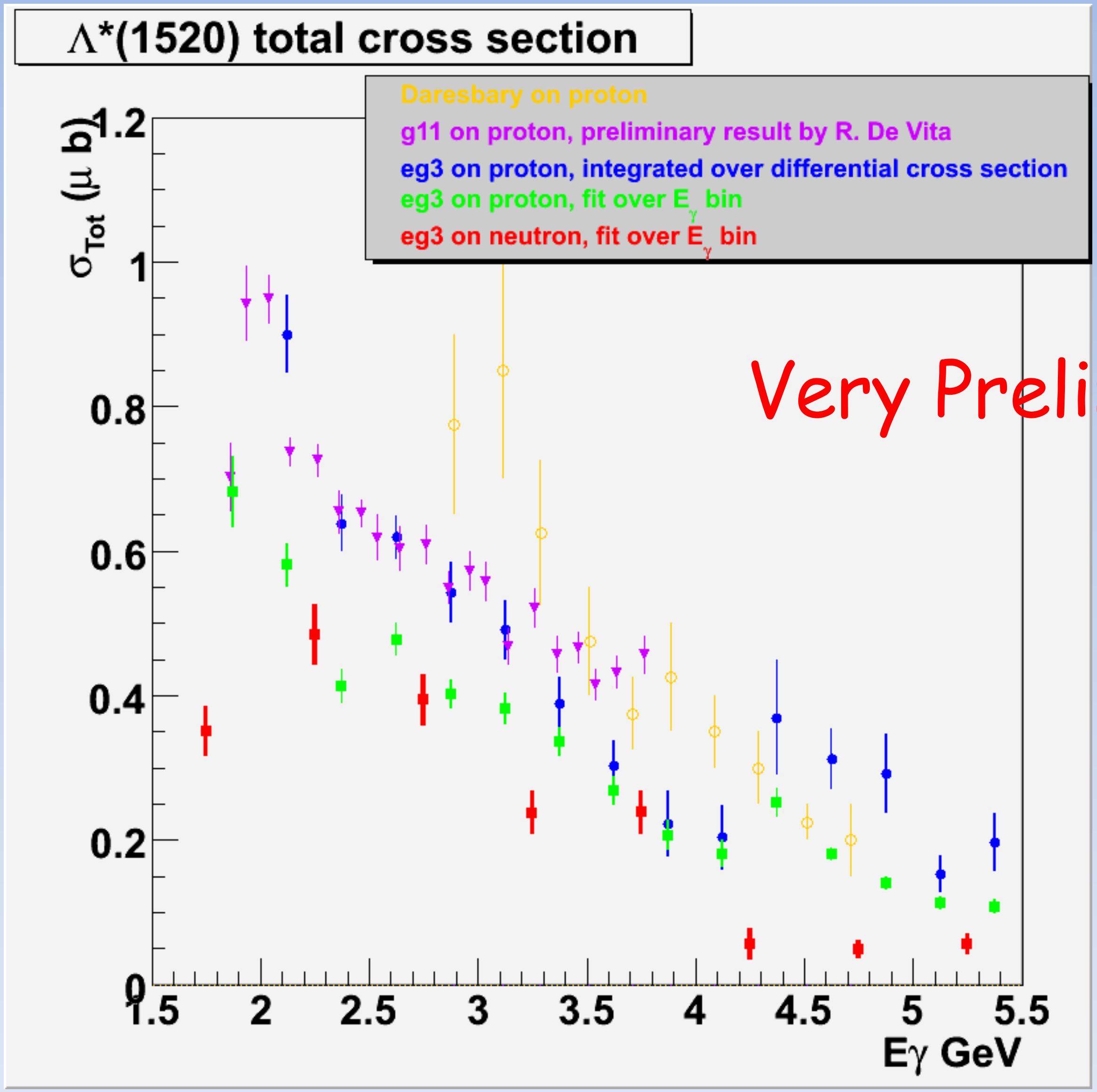
Yield **Yield** **N of generated** **Acceptance**

Eγ bin

t* bin

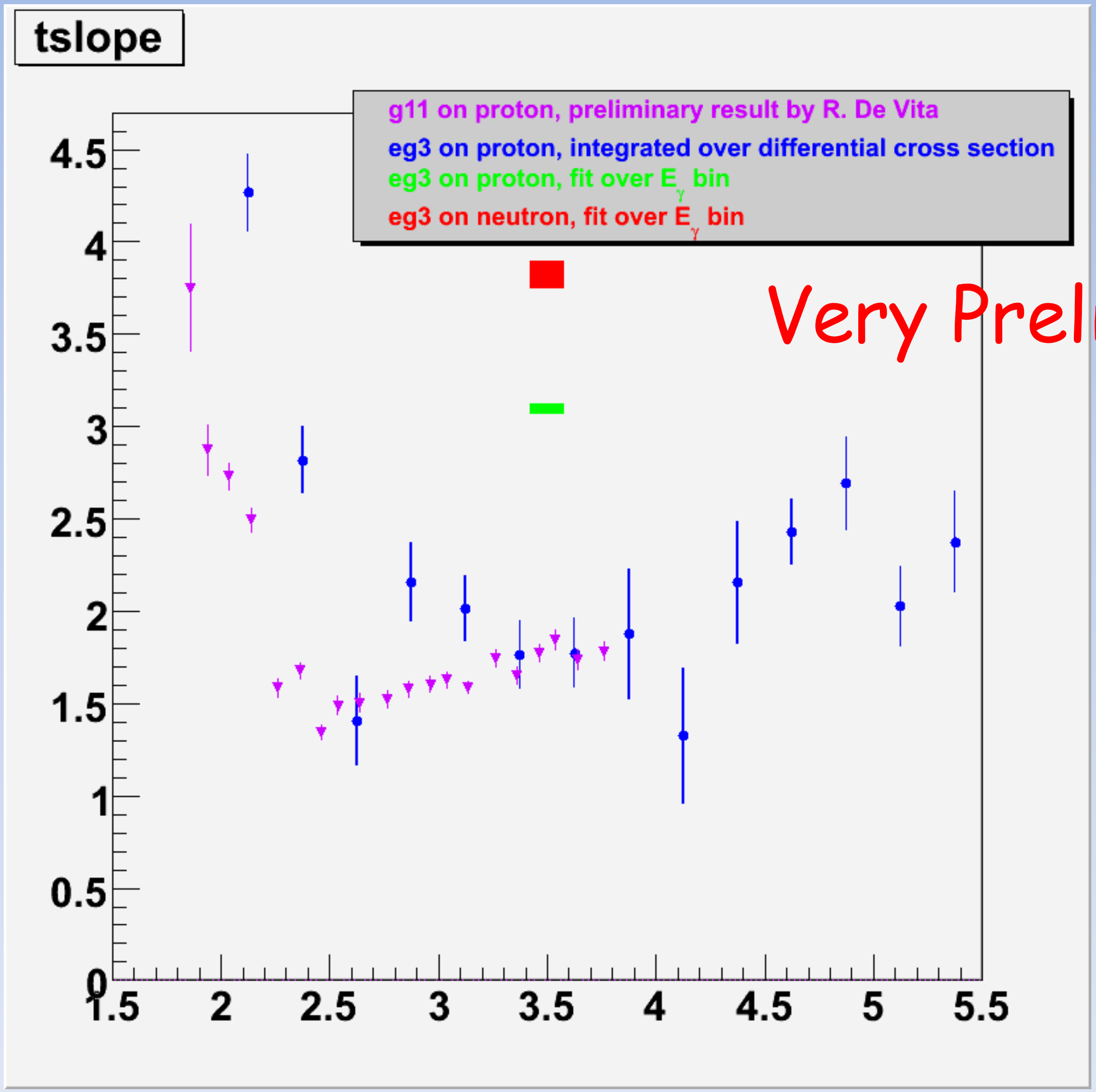


Total Cross Section



Very Preliminary

t slope



Very Preliminary

Summary

- The Λ*(1520) total cross section on the *Proton* extracted by integrating over differential cross sections agrees with the result from the g11 run group and extends to higher energies up to 5.5 GeV.
- The Λ*(1520) total cross section on the *Proton,* extracted by fitting yields in E_γ bins, depends on the **t** slope input in the simulation. It can be tuned closer to the more accurate result based on differential cross sections.
- The total cross section on the *Neutron* is obtained by fitting yields in E_γ bins and it's much larger than what the theory expected.

Outlook

- Study other inclusive channels (eg. K^- not detected) with higher statistics to obtain differential cross section on the *Neutron*.
- Look for possible missing N* resonances.