DVCS Cross Section Extraction for E12-06-114
Kin 48

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DVCS Collaboration Meeting
February 4, 2019

Data Cuts for DVCS:

Leptonic arm cuts (same as for DIS):

- ✅ PID
- ✅ Tracking
- ✅ Vertex
- ✅ RFunction

Calorimeter/photon arm cuts for DVCS…

- ✅ Timing
- ✅ Single photon
- ✅ Photon energy
- ✅ Photon position
- Missing mass

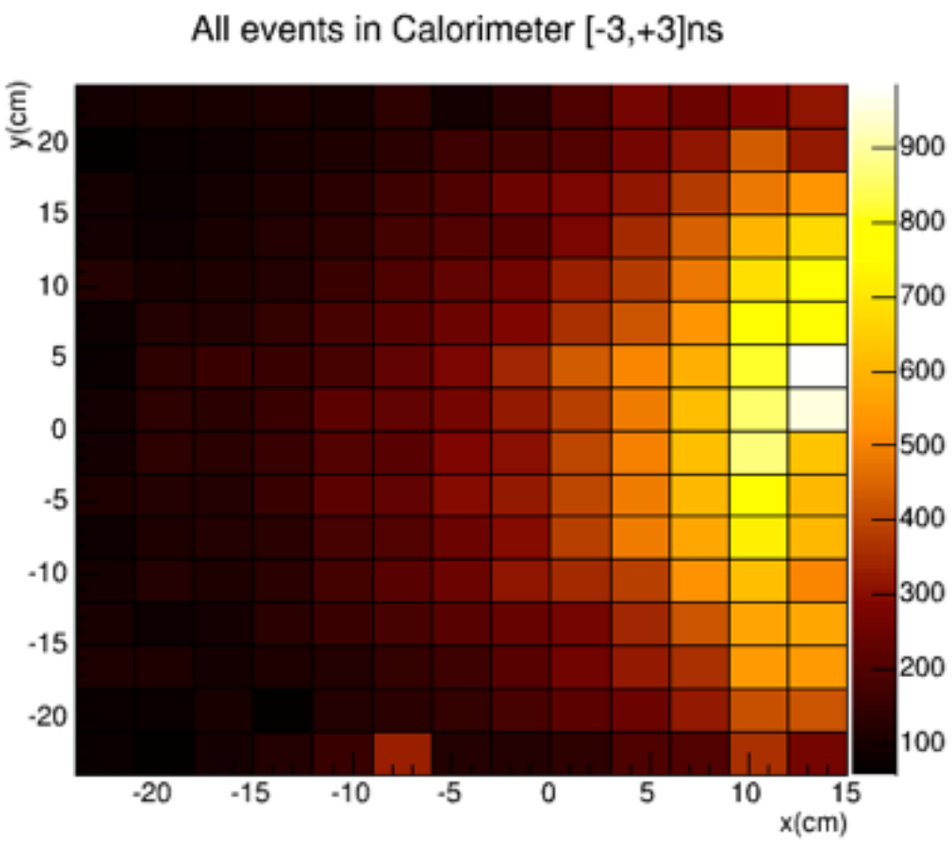
The last cut I need to apply

Timing/Accidental Subtraction:

DVCS window:

N_{All}

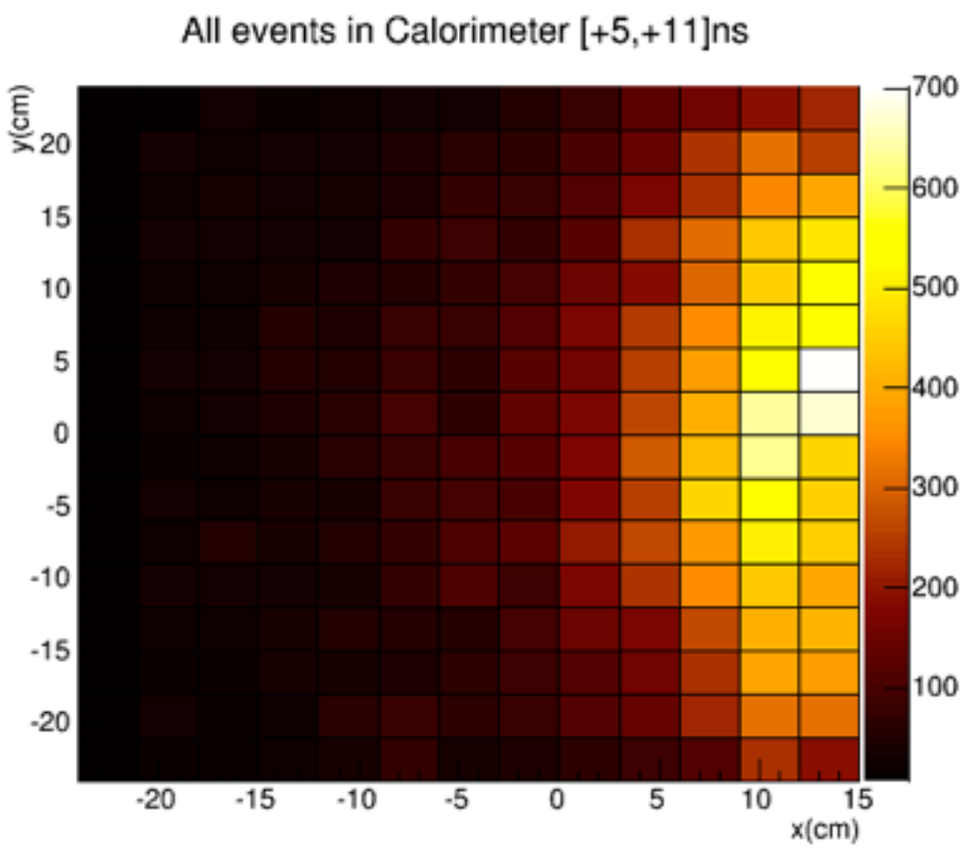
[-3, +3] ns



Accidentals window:

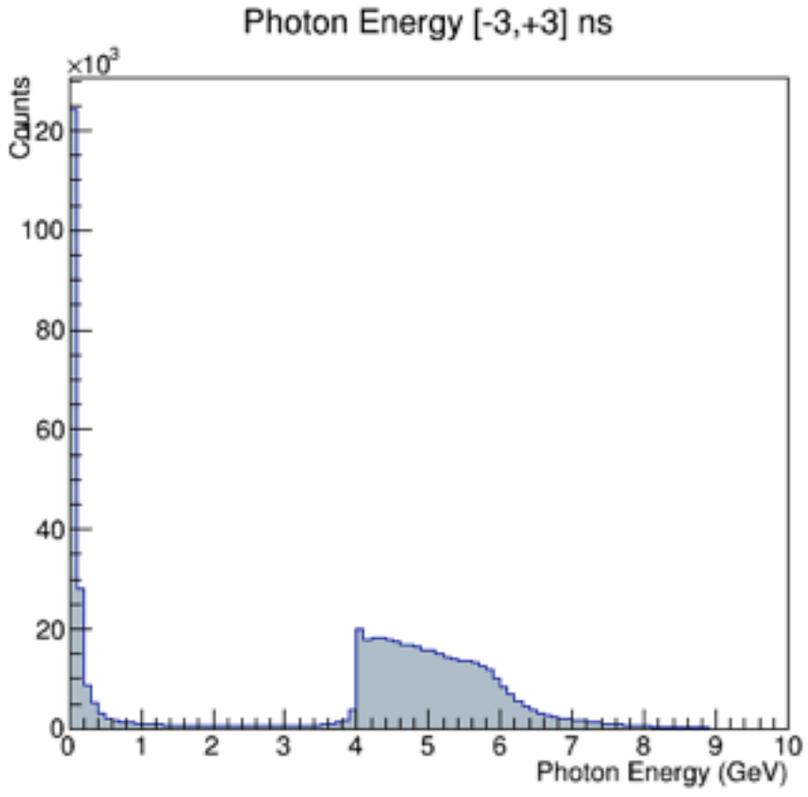
N_{Acc}

[-5, -11] ns, [+5, +11] ns



$N_{DVCS} = N_{All} - N_{Acc}$ ← Take the average of the two windows

Photon Energy Cuts

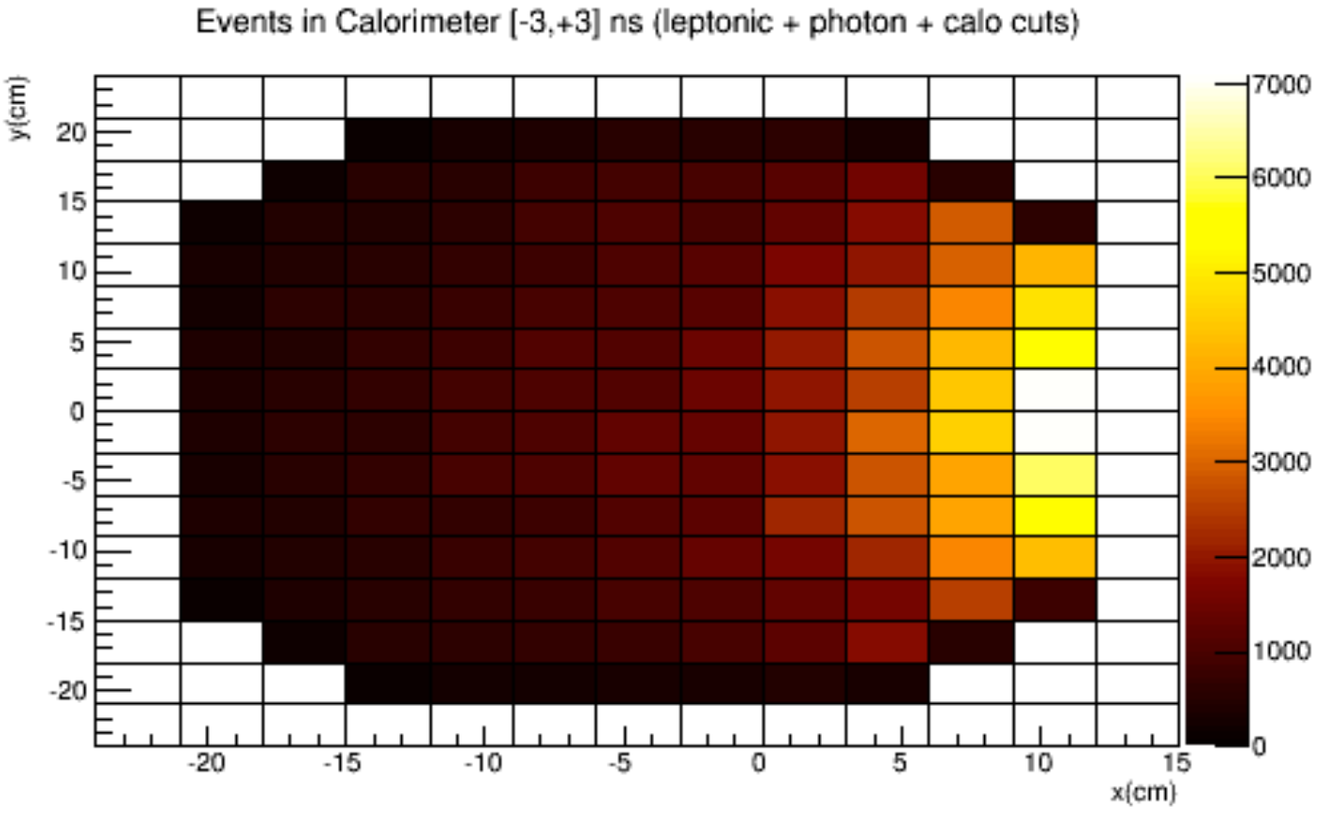


Kin 483 — Cut at 4 GeV

Kinematic	Energy Cut (GeV)
481	2.0
482	3.0
483	4.0
484	5.8

Photon Position Cuts

Cutting on the edges is not good enough for an efficient pi0 subtraction… make octagonal cuts:



Edge Cuts:

$x \leq 11$ cm (7.5 cm for 484)

$x \geq -20$ cm

$y \leq 20$ cm

$y \geq -20$ cm

Corner Cuts:

$y \leq x + 33$ cm

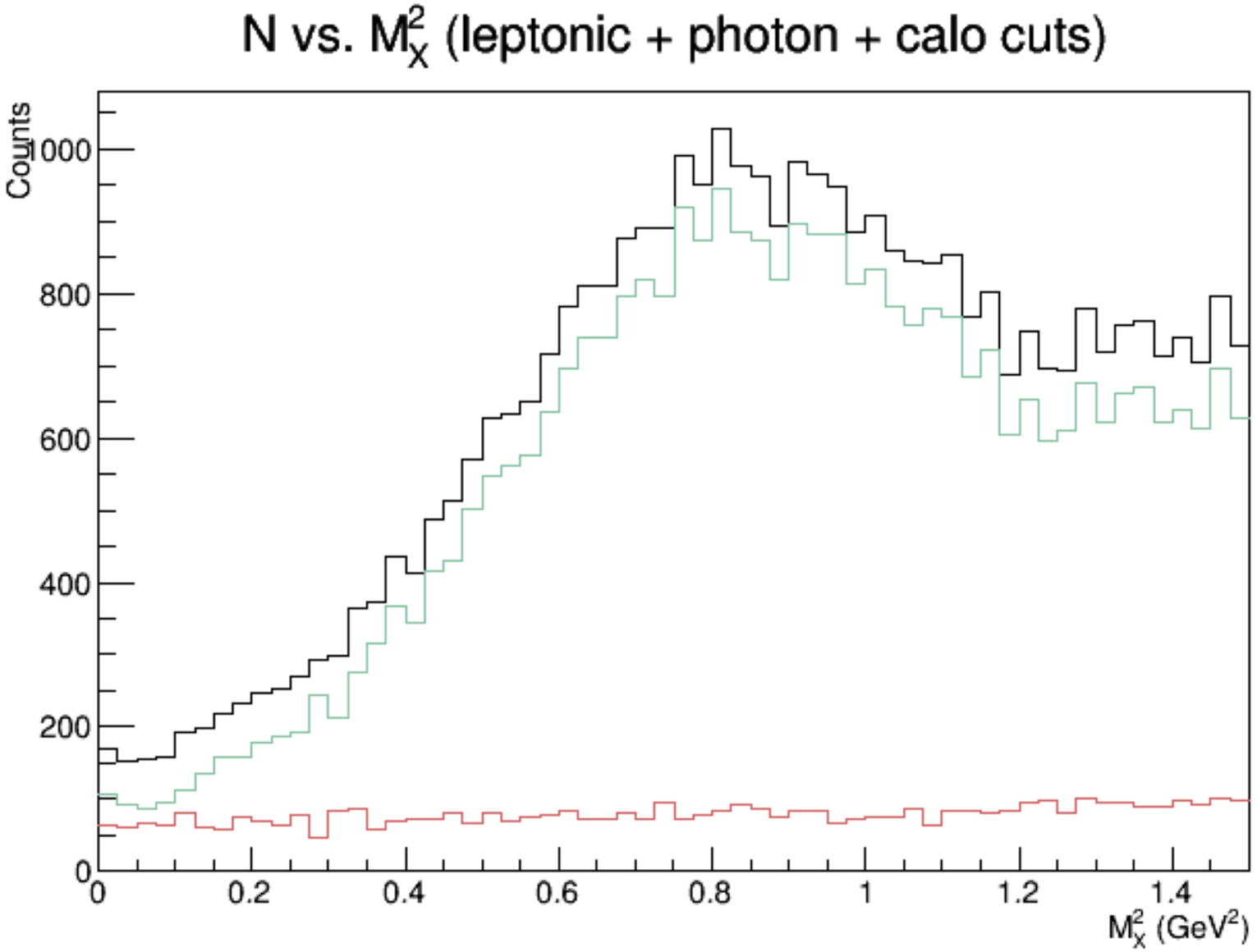
$y \leq -x + 24$ cm

$y \geq -x - 33$ cm

$y \geq x - 24$ cm

Missing Mass Cut

Data includes all leptonic arm cuts, as well as photon energy/position cuts.



All events [-3, +3] ns

Acc events [+5, +11] ns

In progress, Pi0

$N_{DVCS} = N_{All} - N_{Acc} - N_{Pi0}$

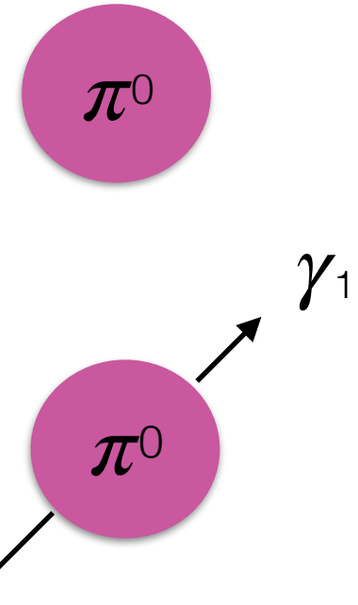
Kin 483

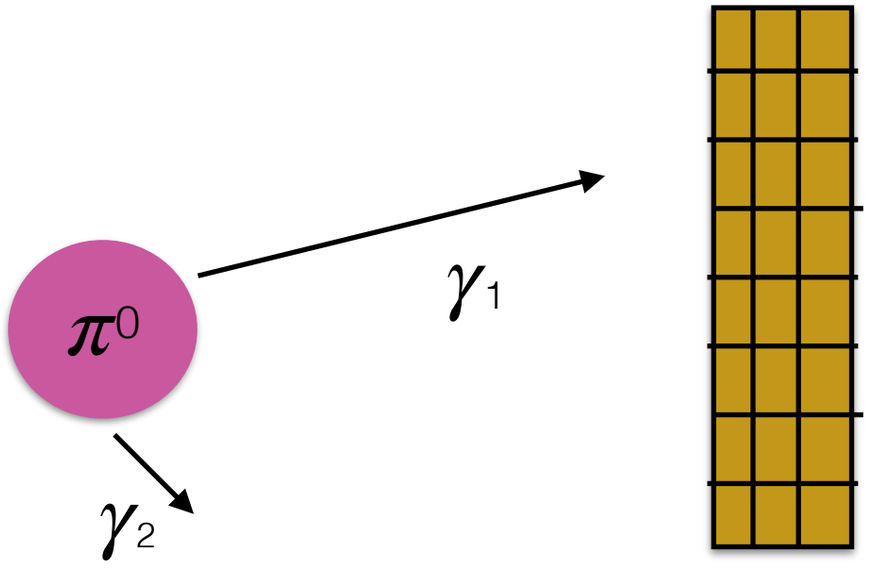
Pi0 Subtraction

$$N_{DVCS} = N_{All} - N_{Acc} - N_{Pi0}$$

Finding this using simple monte carlo

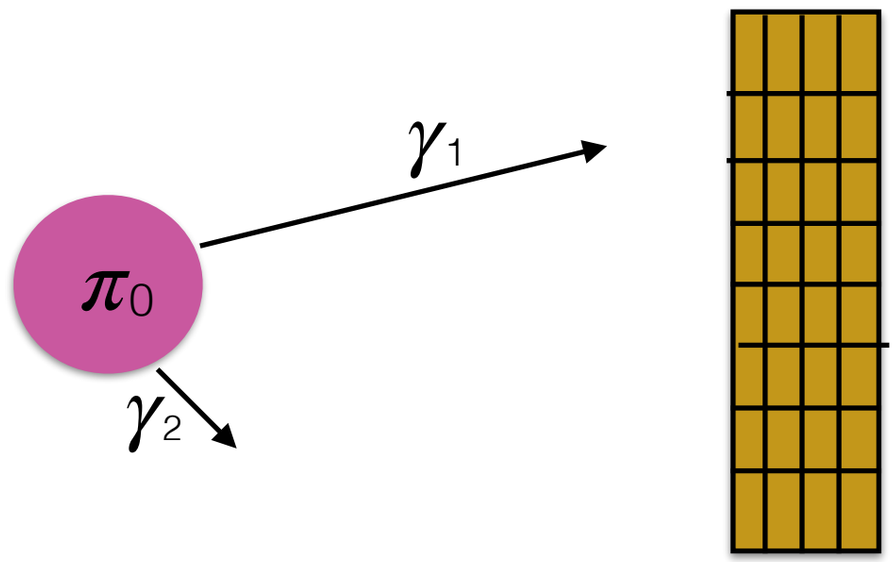
1. Find pi0 in real data for each run
2. For each of those, simulate 5000 decays into 2 photons in the pion rest frame.
3. Boost the two photons back to the lab frame
4. Project to the calorimeter





Pi0 Subtraction

1. Find 4-vector of pi0 in real data for each run
2. For each of those, simulate 5000 decays into 2 photons in the pion rest frame.
3. Boost the two photons back to the lab frame
4. Project to the calorimeter



Count for every Pi0 from the data:

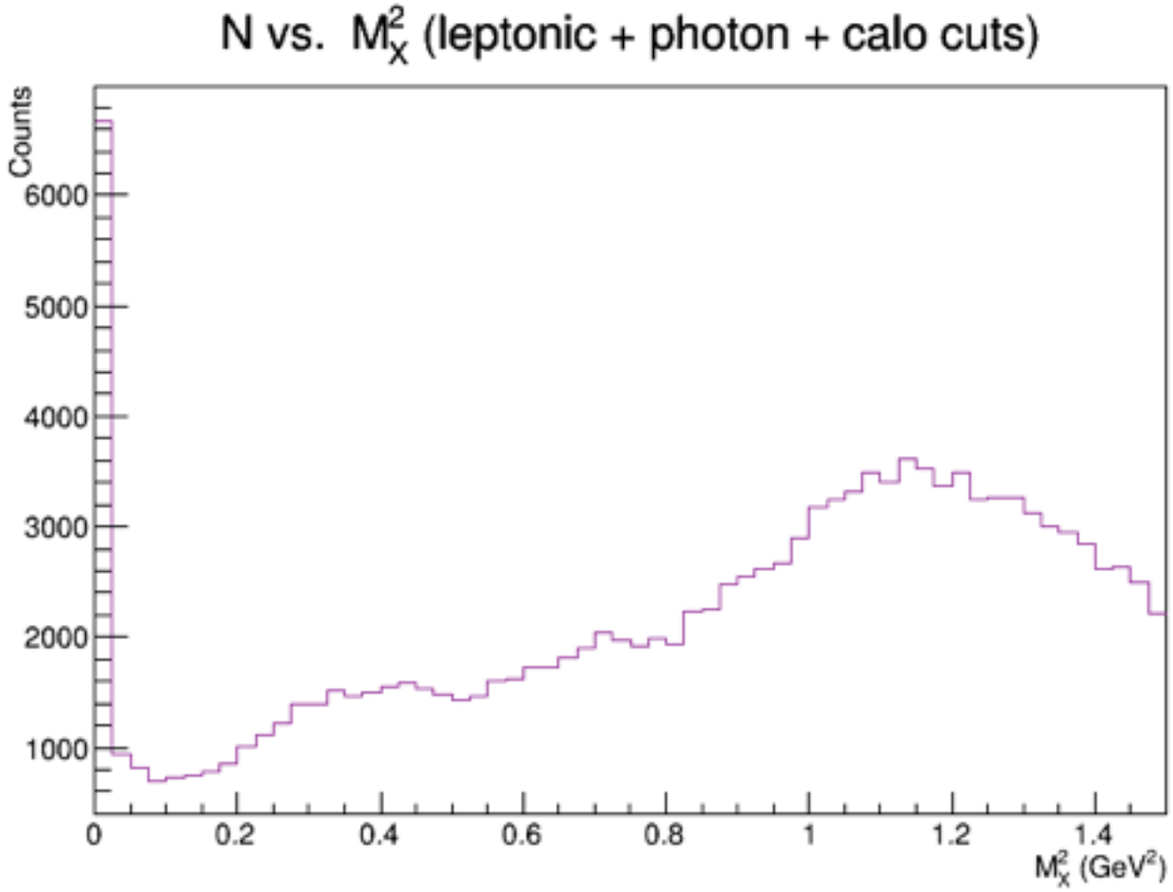
n_0 = 0 photons in calo
n_1 = 1 photon in calo
n_2 = 2 photons in calo

If 1 photon is detected, find all parameters like it was a DVCS event

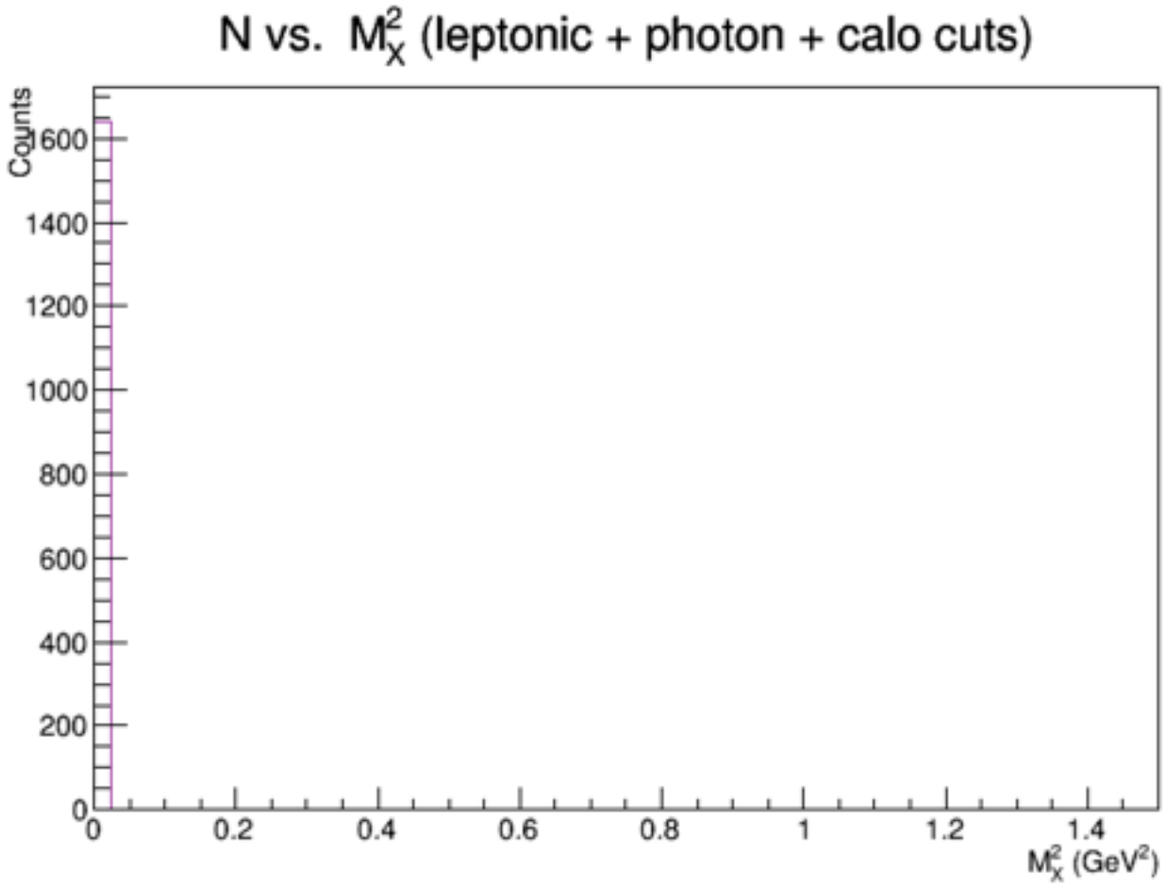
Use this to scale the 1-photon events when subtracting them from the data

Problems with Pi0 Subtraction…

Kin 481 pi0 contamination **before** weighting events by 1/n2



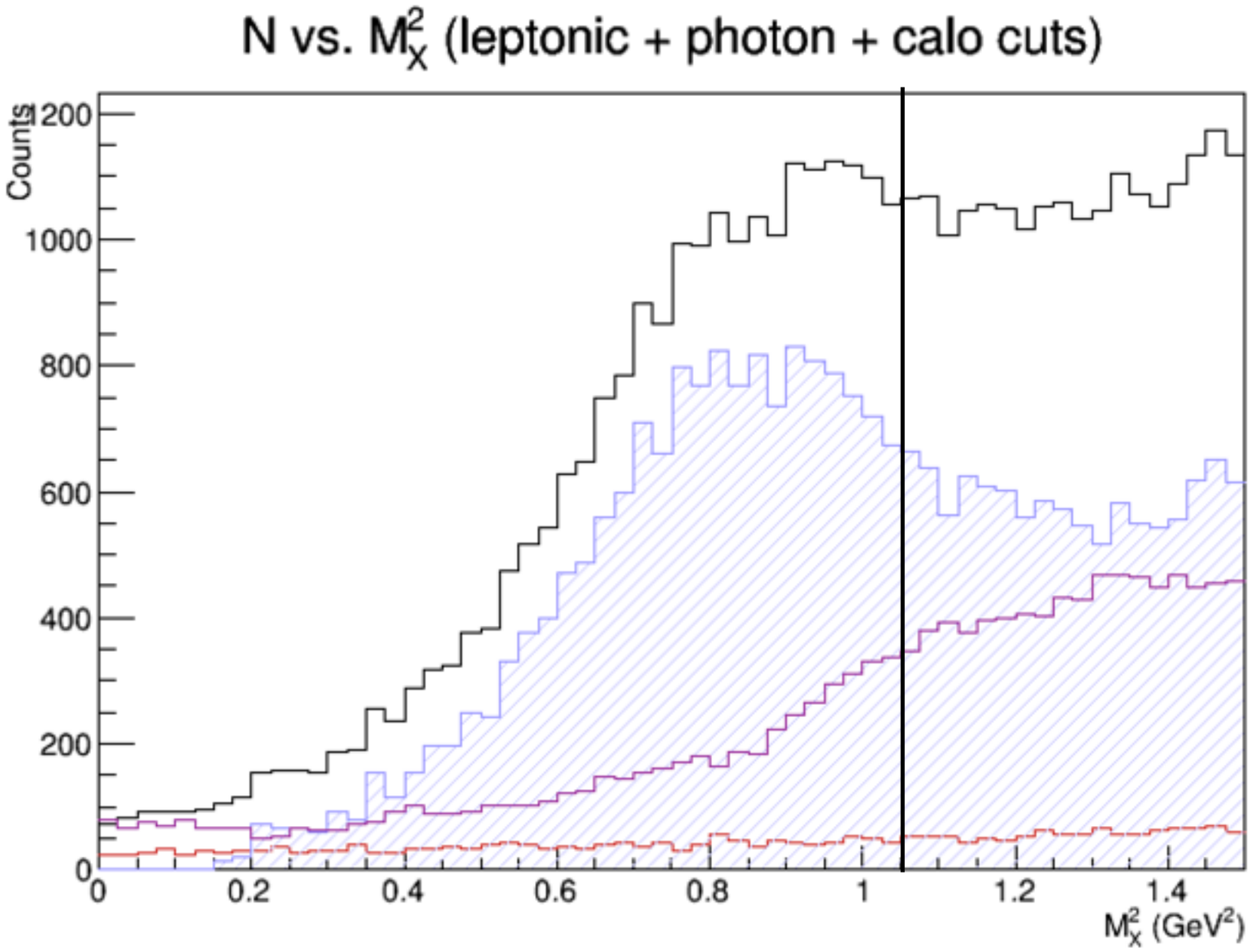
Kin 481 pi0 contamination **after** weighting events by 1/n2



In the following slides, the Pi0 contamination is just weighted by a constant 1/5….

Missing Mass Cut

Data includes all leptonic arm cuts, as well as photon energy/position cuts.



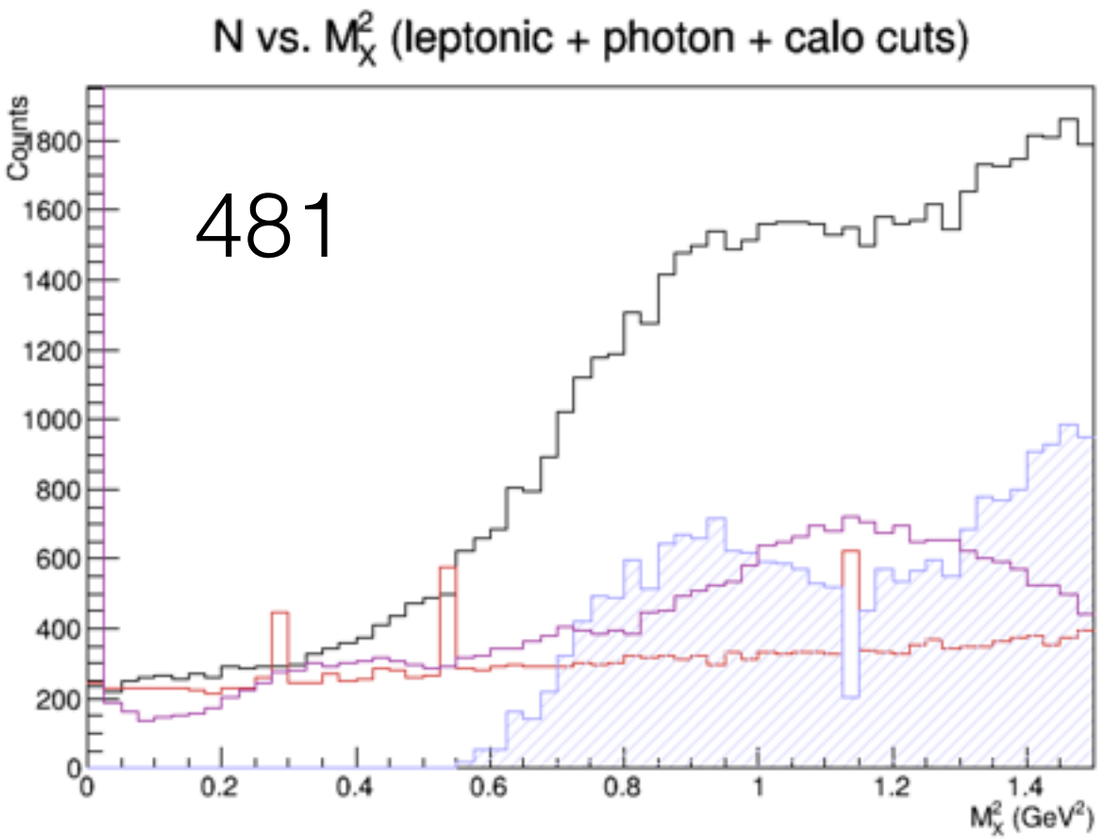
All events [-3, +3] ns

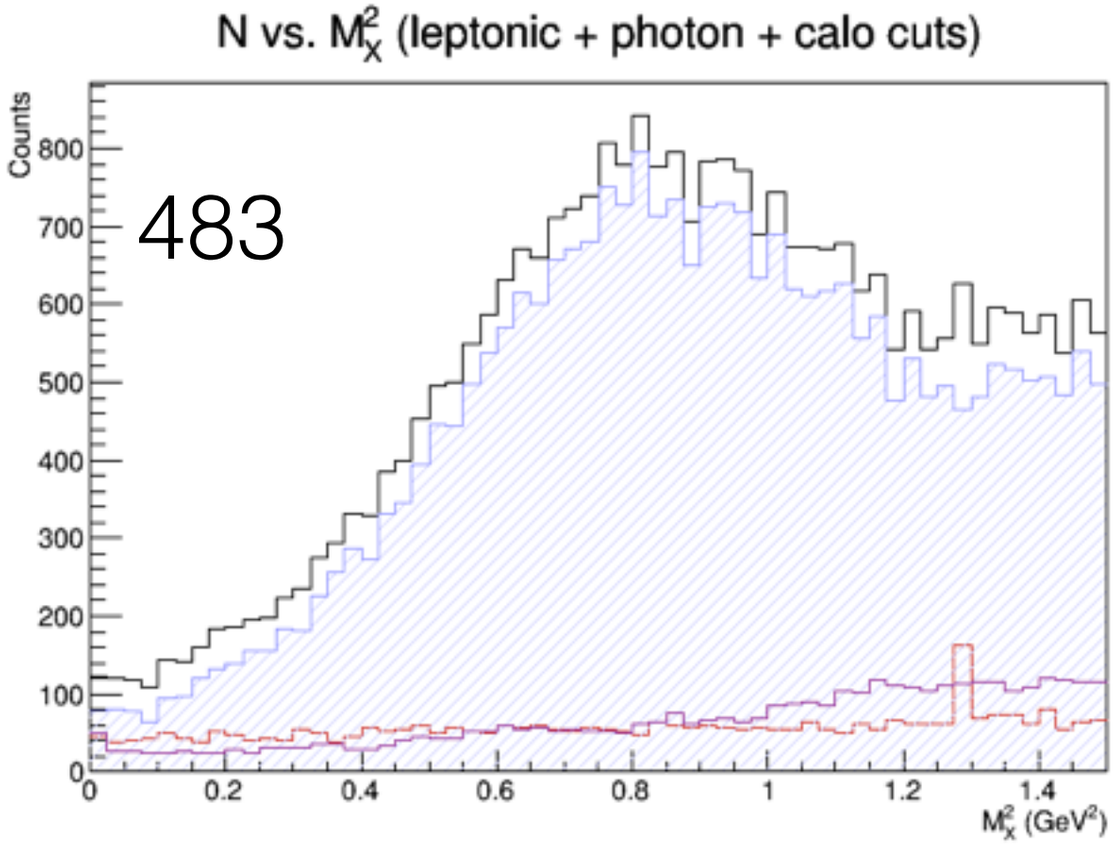
Acc events [+5, +11] ns
[-5,-11] ns averaged

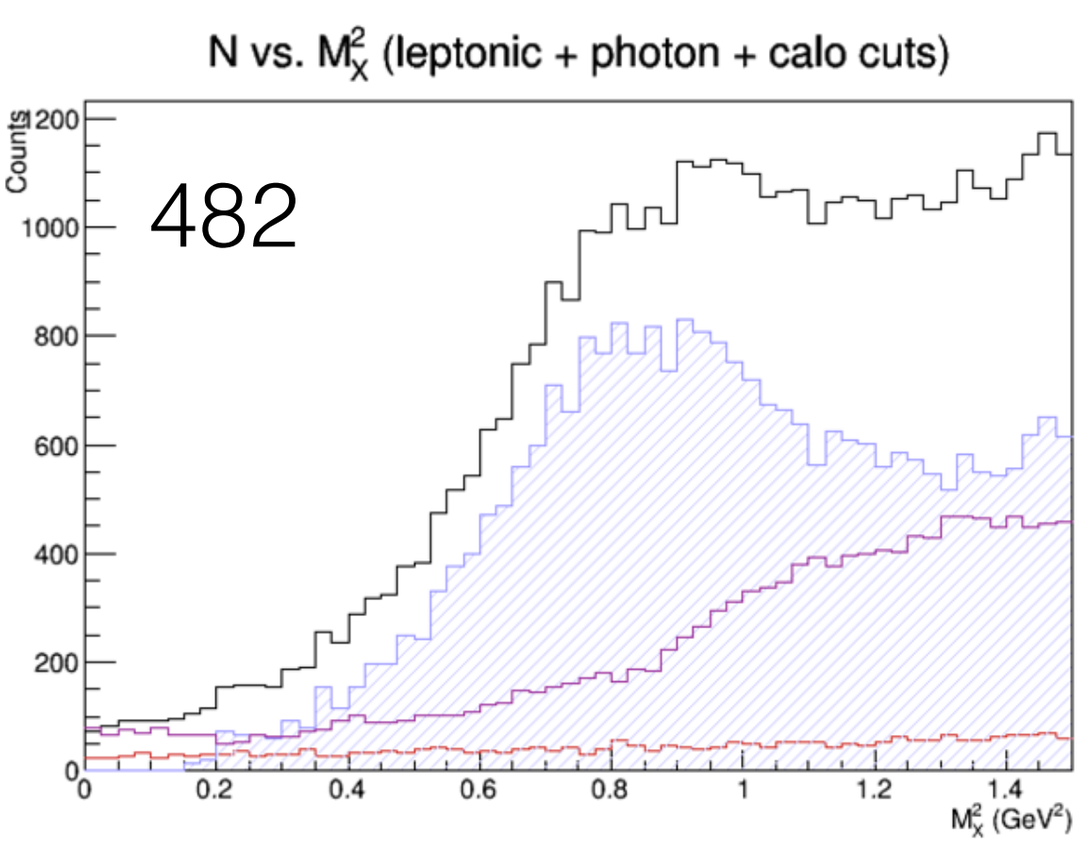
Pi0 contamination (1/5)

$N_{DVCS} = N_{All} - N_{Acc} - N_{Pi0}$

Kin 482


N vs. M_X^2 (leptonic + photon + calo cuts)
481
Counts
M_X^2 (GeV^2)


N vs. M_X^2 (leptonic + photon + calo cuts)
483
Counts
M_X^2 (GeV^2)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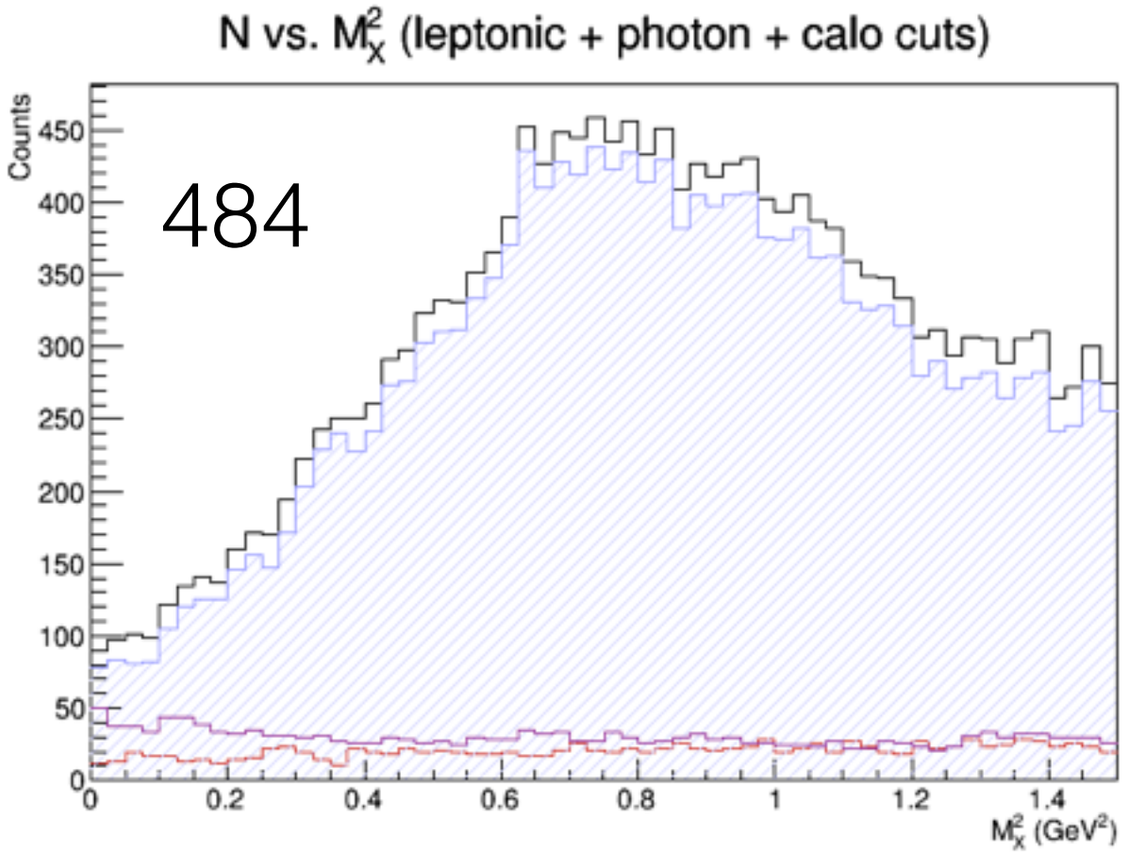
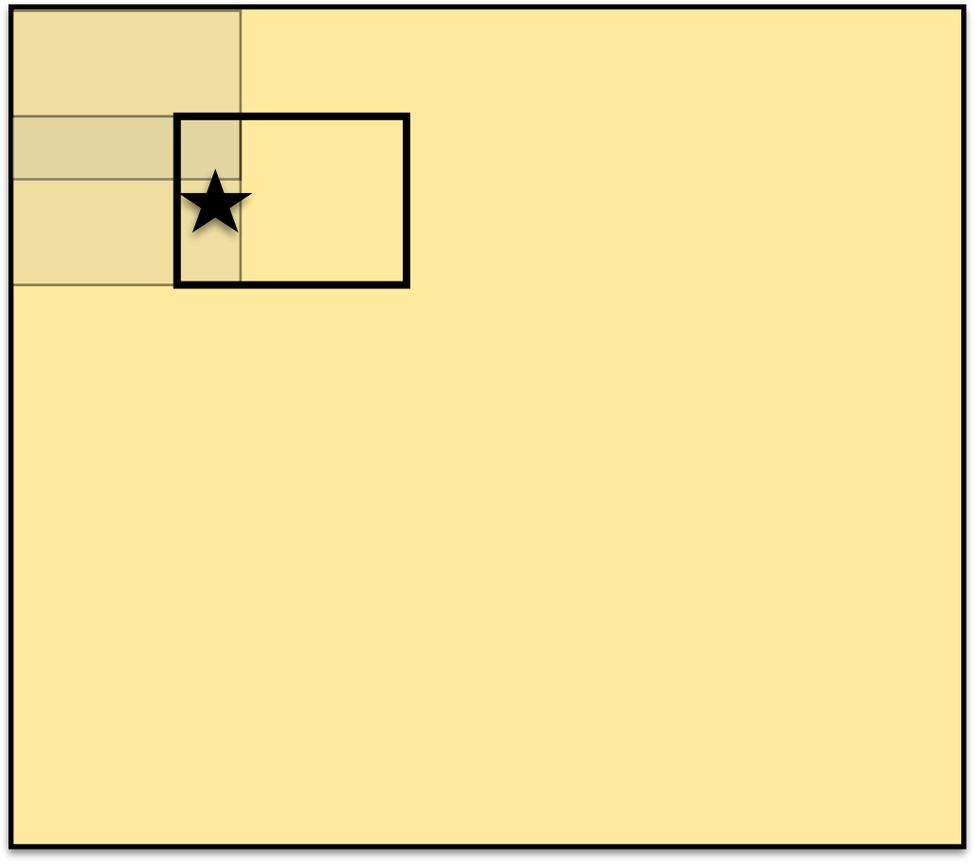
Counts
M_X^2 (GeV^2)


N vs. M_X^2 (leptonic + photon + calo cuts)
484
Counts
M_X^2 (GeV^2)

Calibration/Smearing of the Geant4 Simulation

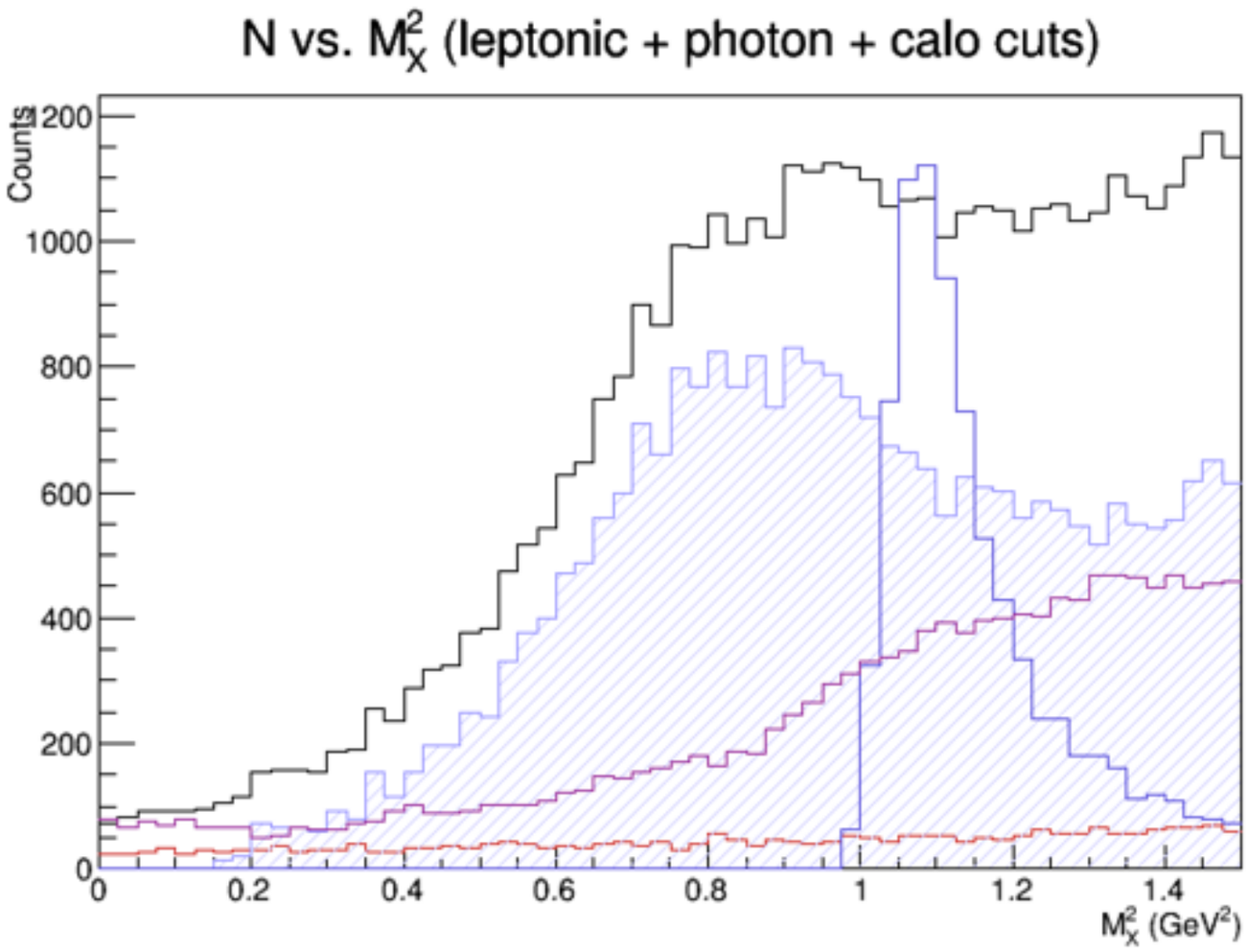
$$\begin{pmatrix} q_x \\ q_y \\ q_z \\ E \end{pmatrix} \longmapsto gaus(\mu, \sigma) \times \begin{pmatrix} q_x \\ q_y \\ q_z \\ E \end{pmatrix} ,$$



- Divide calorimeter into (7x7) 49 overlapping rectangles
- Find σ_i and μ_i for each region
- Find σ and μ for each event by interpolating the σ_i and μ_i values from the different regions

Calibration/Smearing of the Geant4 Simulation

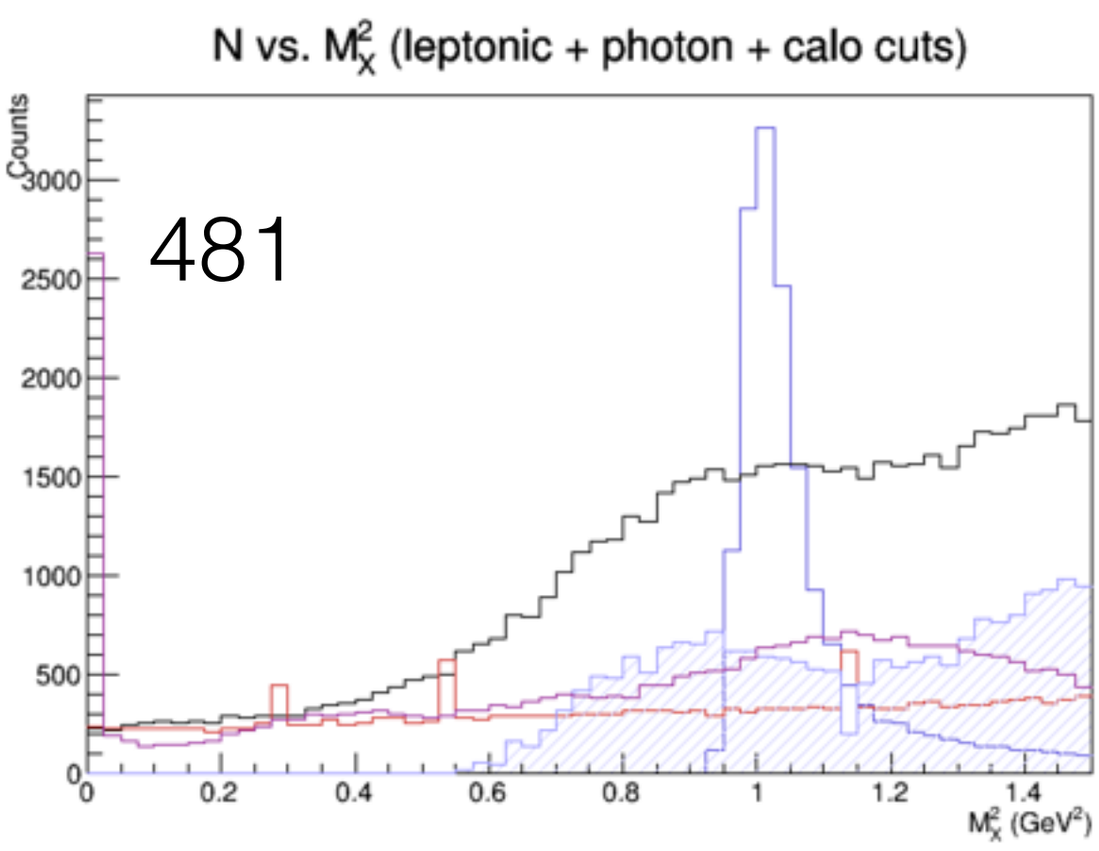
IN PROGRESS— need a correct Pi0 subtraction before I can do this step

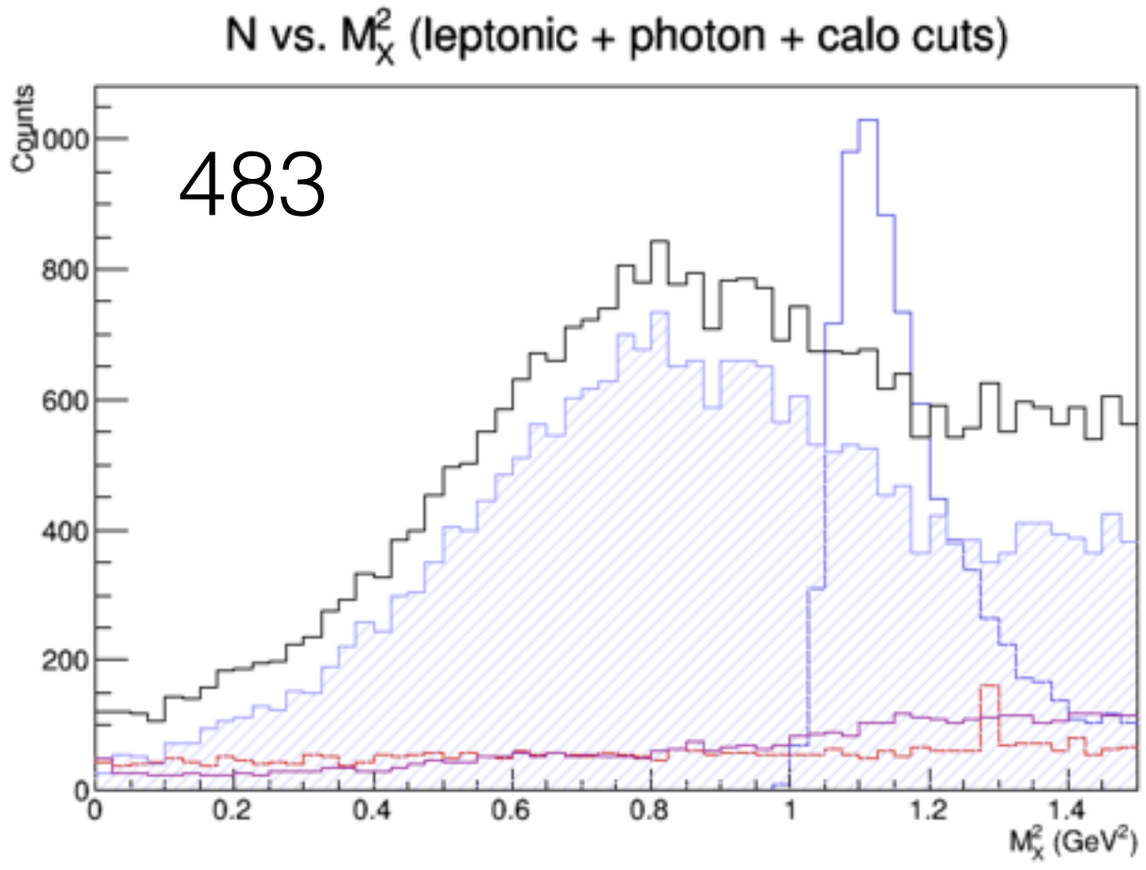


Kin 482

$N_{DVCS} = N_{All} - N_{Acc} - N_{Pi0}$

N_{SIM}


N vs. M_X^2 (leptonic + photon + calo cuts)
481
Counts
M_X^2 (GeV^2)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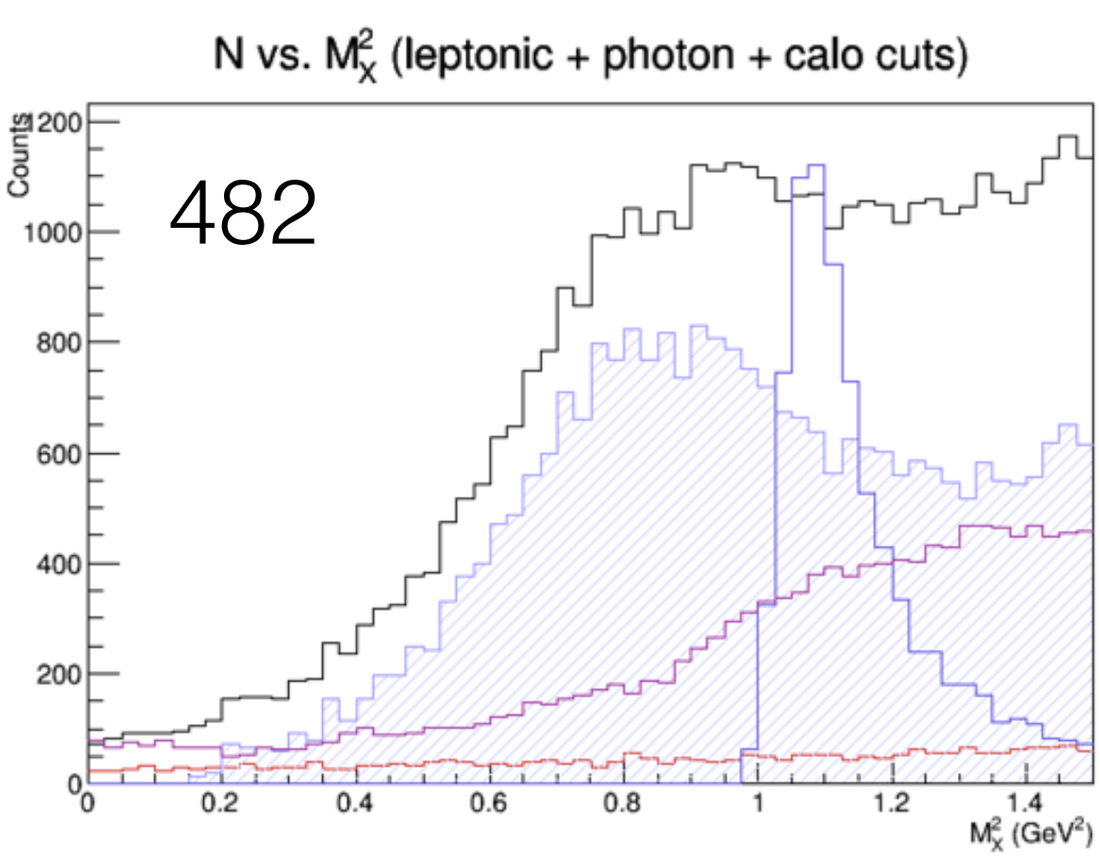
Counts
M_X^2 (GeV^2)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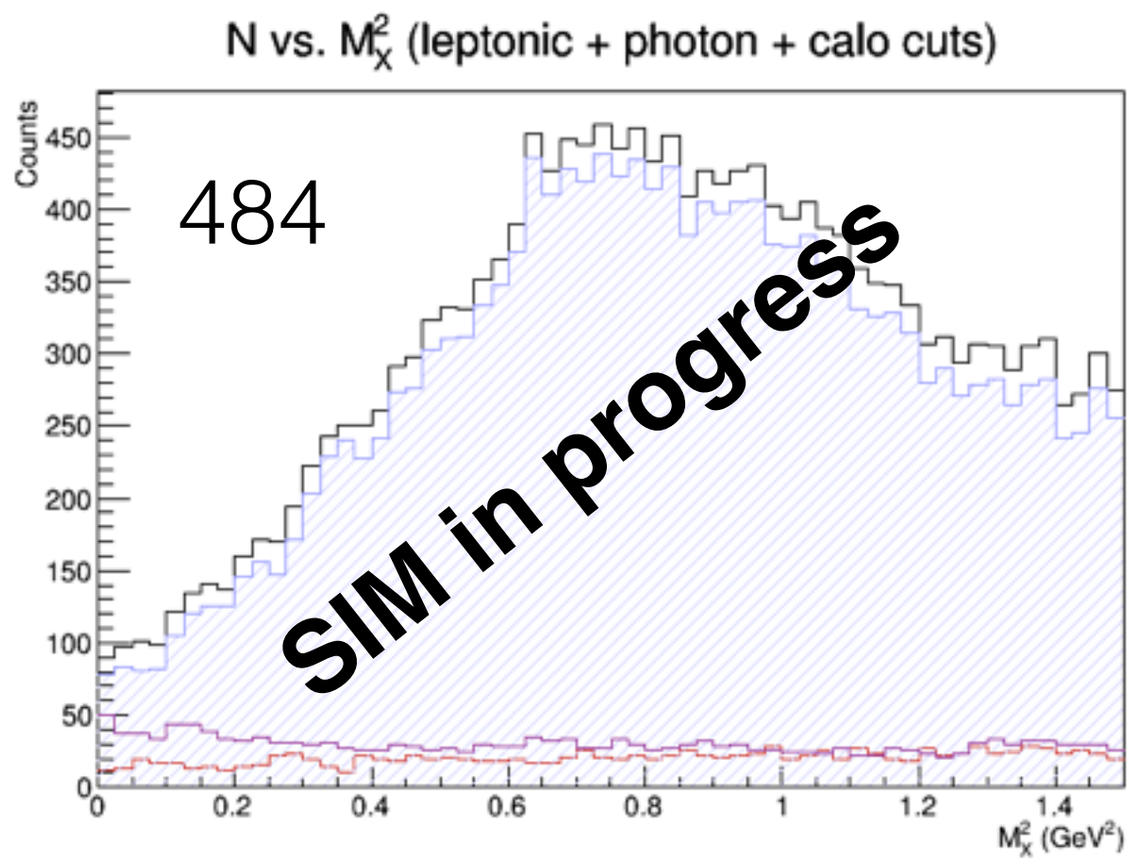
Counts
M_X^2 (GeV^2)


N vs. M_X^2 (leptonic + photon + calo cuts)
484
SIM in progress
Counts
M_X^2 (GeV^2)

Kin Setting	Alexa % diff (DIS)
361	+1
362	-6
363	-6
481	0
482	-6
483	-9
484	-9
601	-6
603	-3

What to do for DVCS???