# Detector Maps from Inclusive Reactions Group

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| Measurement | Main Detector Requirements | Anticipated Plot | Physics Topic/goal |
| --- | --- | --- | --- |
| inclusive $A_{\|\|}$ / $A_{\perp}$ | Standard inclusive | $g_1(x)$ vs $Q^2$<br>$\Delta g(Q^2)$ vs x | Gluon Helicity<br>$\Delta g(x,Q^2)$ |
| inclusive $A_{PV}$ | Standard inclusive | $g^W{}_5(x)$ vs $Q^2$ or<br>$A_{PV}$ vs x for $W^{+/-}$<br>$\Delta s(Q^2)$ vs x | Strange Helicity<br>$\Delta s(x,Q^2)$ |
| $\boldsymbol{\sigma}_{red}(x,Q^2)$, $\boldsymbol{\sigma}^{c/b}{}_{red}(x,Q^2)$ $\rightarrow$ $F_2$, $F_L$, $F_2{}^{c/b}$ | Standard inclusive + heavy quark tag | $\boldsymbol{\sigma}_{red}(x)$ vs $Q^2$<br>$\boldsymbol{\sigma}^{c/b}{}_{red}(x)$ vs $Q^2$<br>$g(Q^2)$ vs x | Proton PDFs<br>$q(x,Q^2)$ , $g(x, Q^2)$ |
| $\boldsymbol{\sigma}_{red}(x,Q^2)$, $\boldsymbol{\sigma}^{c/b}{}_{red}(x,Q^2)$ $\rightarrow$ $F_2$, $F_L$, $F_2{}^{c/b}$ | Standard inclusive + heavy quark tag | $\boldsymbol{\sigma}_{red}(x)$ vs $Q^2$<br>$\boldsymbol{\sigma}^{c/b}{}_{red}(x)$ vs $Q^2$<br>$F_L(Q^2)$ vs x<br>$F^{c/b}{}_L(Q^2)$ vs x | Nuclear PDFs<br>$q(x,Q^2)$ , $g(x, Q^2)$ |
| $\boldsymbol{\sigma}_{red}(x,Q^2)$, $\boldsymbol{\sigma}^{c/b}{}_{red}(x,Q^2)$ $\rightarrow$ $F_2$, $F_L$, $F_2{}^{c/b}$ | Standard inclusive + heavy quark tag | $\boldsymbol{\sigma}_{red}(x)$ vs $Q^2$<br>$\boldsymbol{\sigma}^{c/b}{}_{red}(x)$ vs $Q^2$<br>$\Delta F_L/F_L$ vs x, $Q^2$ | Non-linear QCD dynamics |
| inclusive $A_{PV}$ | Standard inclusive | $A_{PV}(y)$ vs $Q^2$<br>$\sin^2\boldsymbol{\theta}_W$ vs $Q^2$ | BSM & Precision EW ($\sin^2\boldsymbol{\theta}_W$ ) |
| $\frac{d\sigma^{NC}}{dxdyd\phi}$ Triply differential NC X-sec | Standard inclusive | Updated Fig.6 in ***PhysRevD.98.115018*** for CM energies smearing. | Lorentz and CP Violating Effects |

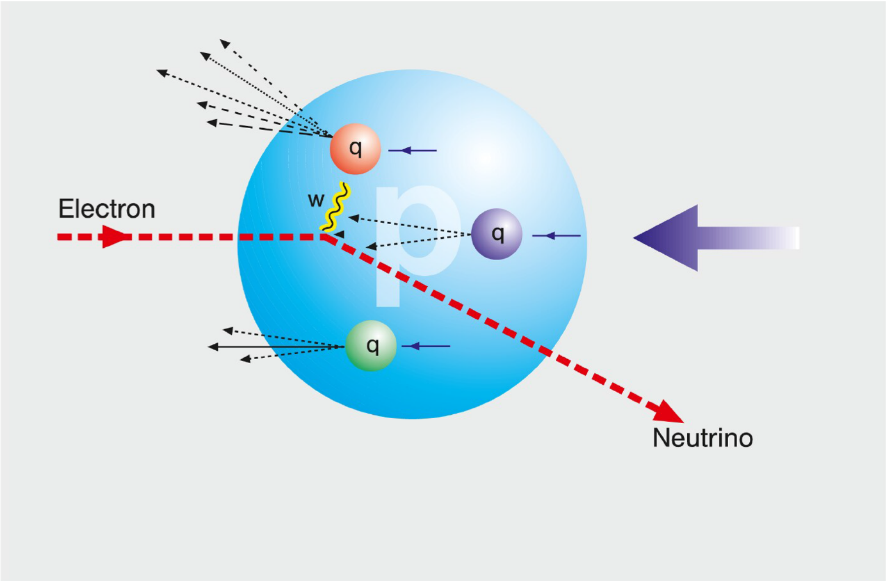
# Critical Channels for Detector Development

- The inclusive group covers a large set of physics interests, ranging from gluon helicity to nuclear PDFs and non-linear dynamics.

- Parity violating ($A_{PV}$) and charged current (CC) channels were singled out, both for high scientific interest and stringent detector requirements.

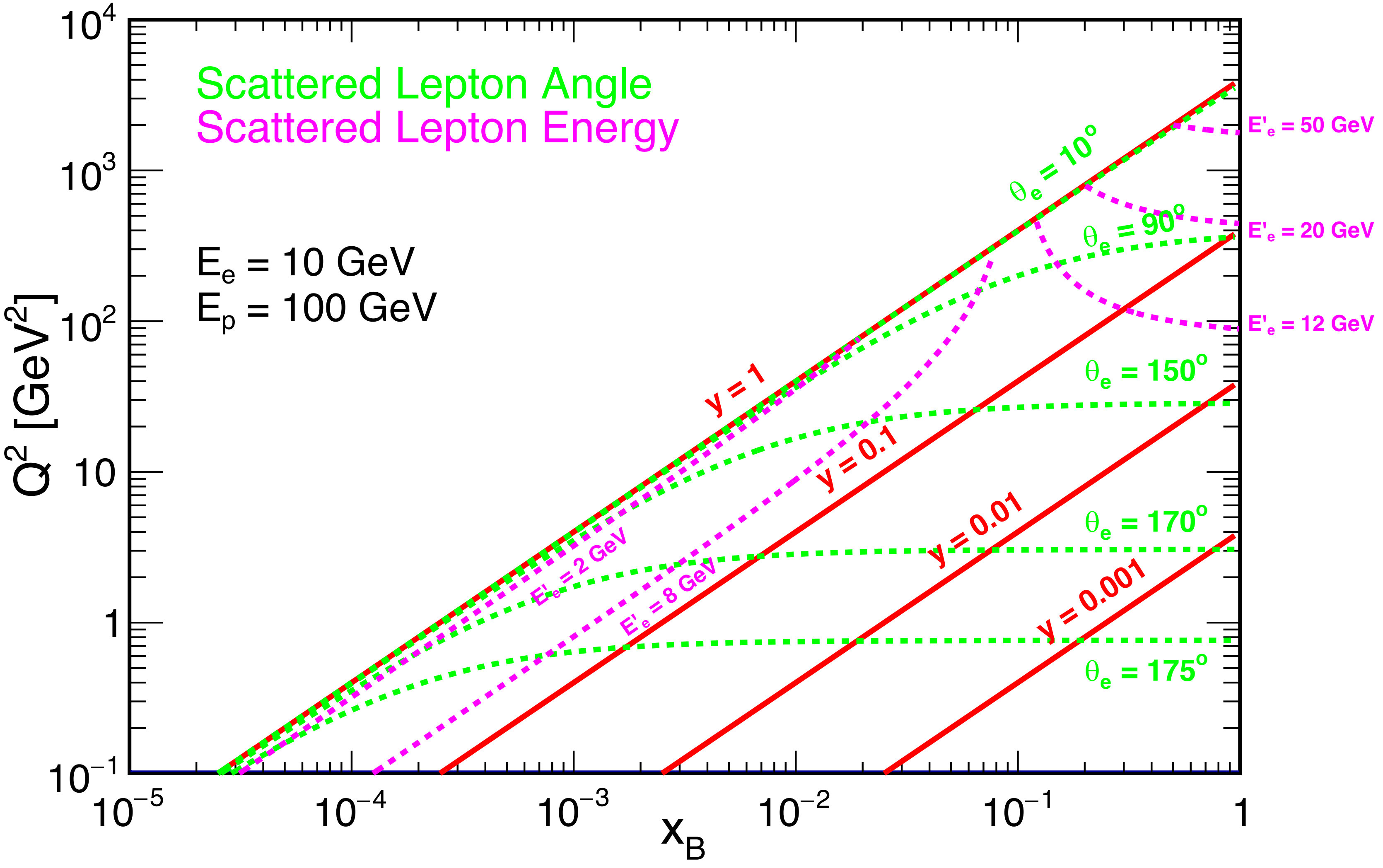
  I. Inclusive $A_{PV}$ - Small signal requires high precision measurement. Electron PID will be critical.

  II. $\sigma^{CC}_{r}$ - Reduced cross-section requires reconstruction of $Q^2$, x from hadronic recoil. Pushing down thresholds for ECAL/HCAL will be critical.



# Inclusive $e^-$ maps

- Work of Barak Schmookler
- $\theta_e$ defined WRT +z
- Yields represent 1 $fb^{-1}$



# Inclusive e⁻ maps

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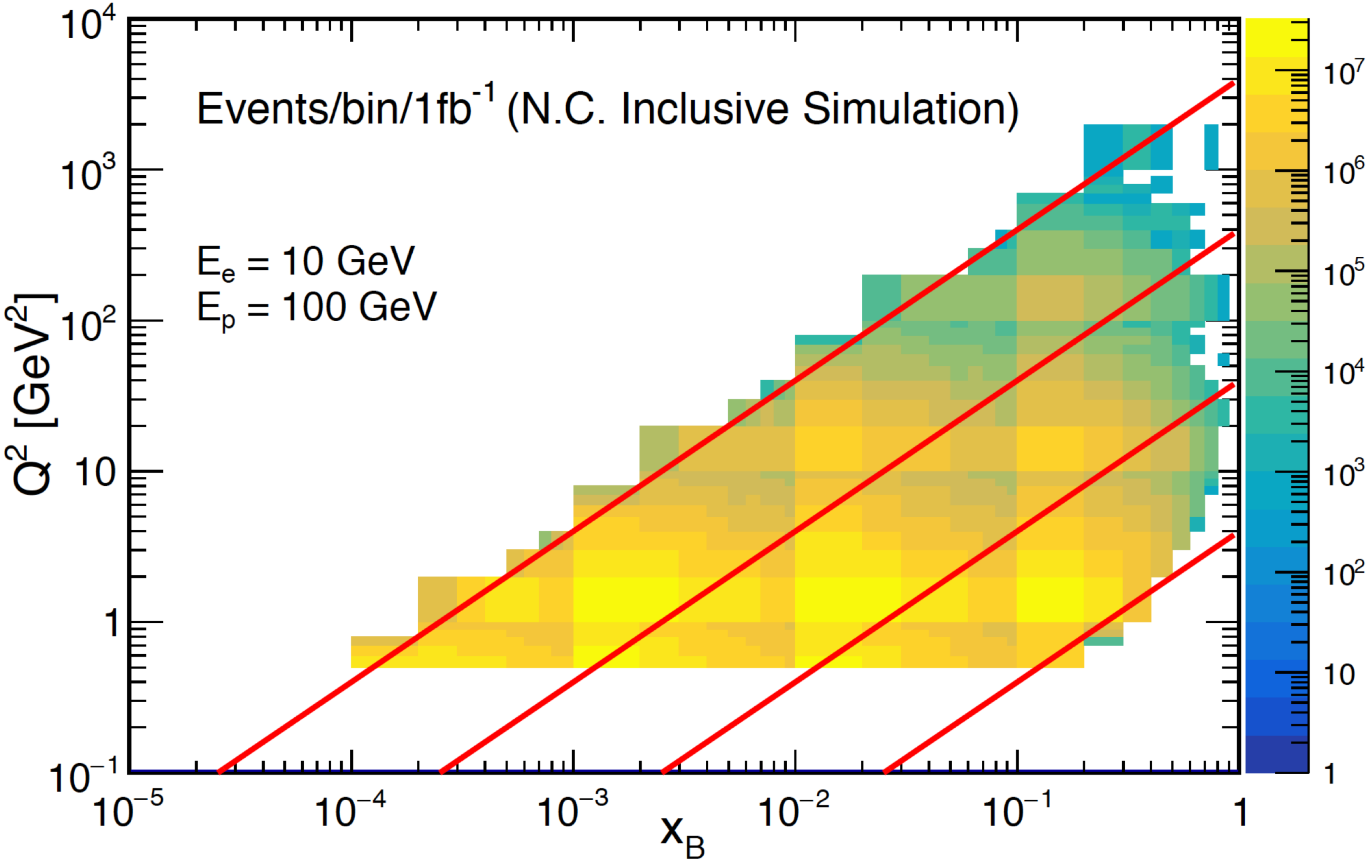
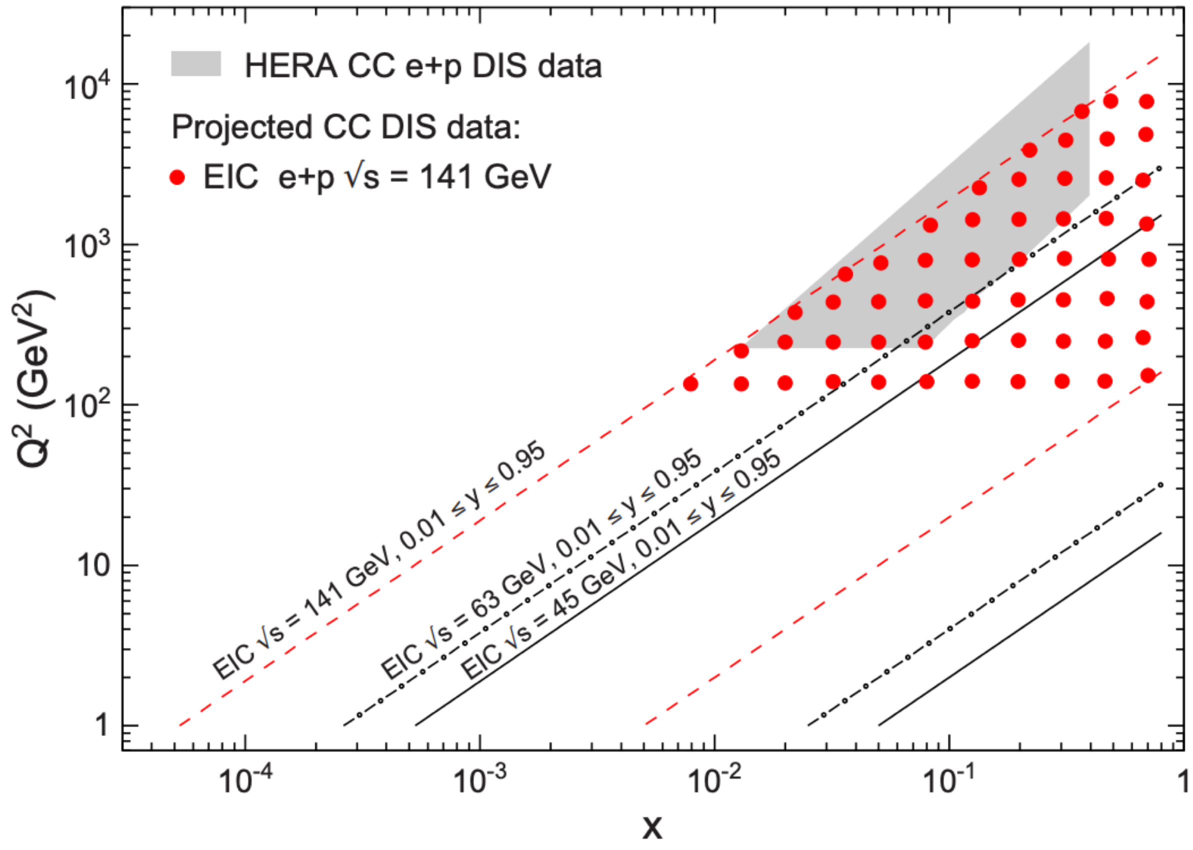


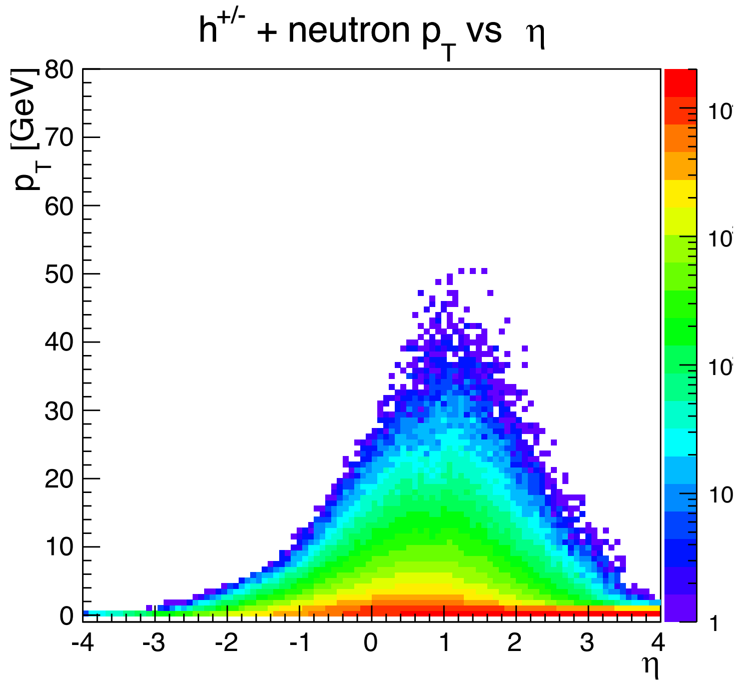
# Hadronic Recoil Maps

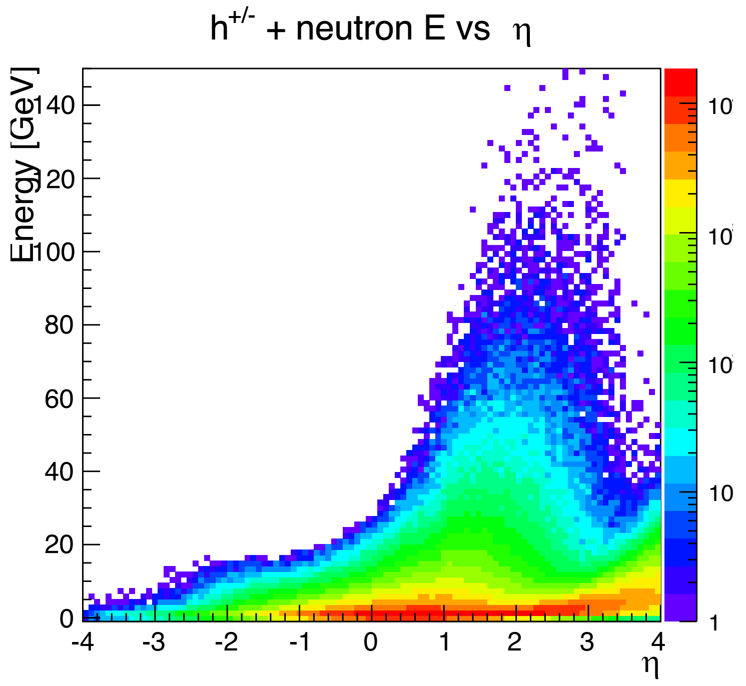
- This is the work of Xiaoxuan Chu. The full details are presented here [https://indico.bnl.gov/event/8389/](https://indico.bnl.gov/event/8389/)
- Use Django, e- beam = 18 GeV, p beam = 275 GeV e-p, $\sqrt{s}$ = 141 GeV. Radiative corrections turned on. L = 10 fb-1 , 0.01< y<0.95 and 100 <$Q^2$ < $10^5$ $GeV^2$.
- Reduced cross-section is extracted using Jacquet-Blondel kinematic reconstruction

$$x_{JB} = \frac{Q^2_{JB}}{s y_{JB}}; \quad y_{JB} = \frac{(E - p_z)_h}{2E_e}; \quad Q^2_{JB} = \frac{p^2_{t,h}}{1 - y_{JB}}$$

- Perfect detector is implemented






------------ Charged Current Charged Hadron + neutron ----------------------------

eta = -3.960 theta = 0.038 pT = 0.215+/-0.000 E = 0.762+/-0.291

eta = -3.880 theta = 0.041 pT = 0.215+/-0.000 E = 0.963+/-0.348

...

eta = -2.040 theta = 0.259 pT = 0.546+/-0.017 E = 2.021+/-0.069

eta = -1.960 theta = 0.280 pT = 0.590+/-0.018 E = 2.113+/-0.065

...

eta = -1.000 theta = 0.705 pT = 1.259+/-0.015 E = 1.971+/-0.023

eta = -0.920 theta = 0.758 pT = 1.350+/-0.015 E = 1.993+/-0.022

...

eta = -0.040 theta = 1.531 pT = 2.257+/-0.016 E = 2.285+/-0.016

eta = 0.040 theta = 1.611 pT = 2.350+/-0.016 E = 2.379+/-0.016

...

eta = 1.000 theta = 2.437 pT = 2.688+/-0.018 E = 4.194+/-0.028

eta = 1.080 theta = 2.487 pT = 2.683+/-0.019 E = 4.462+/-0.031

...

eta = 2.040 theta = 2.883 pT = 1.190+/-0.013 E = 4.823+/-0.050

eta = 2.120 theta = 2.903 pT = 1.081+/-0.012 E = 4.730+/-0.051

...

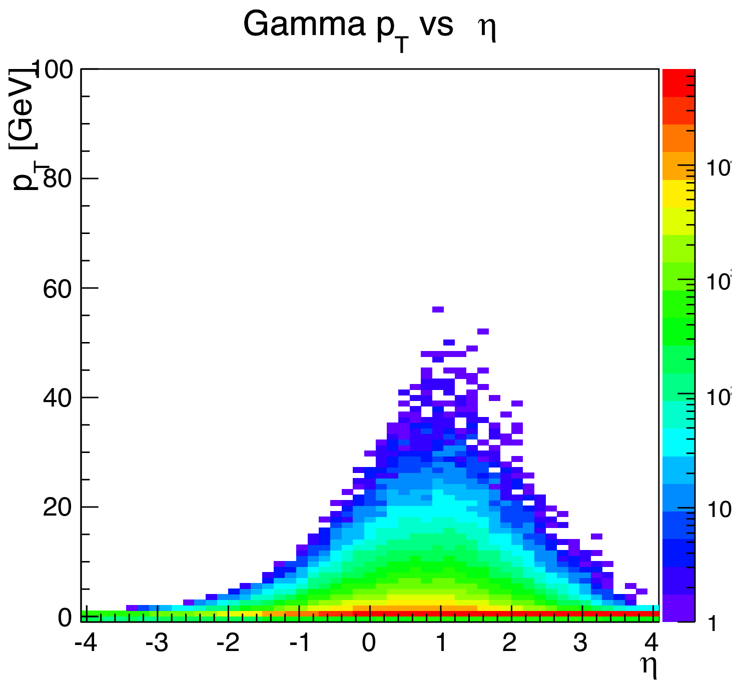
eta = 3.000 theta = 3.042 pT = 0.407+/-0.004 E = 4.523+/-0.040

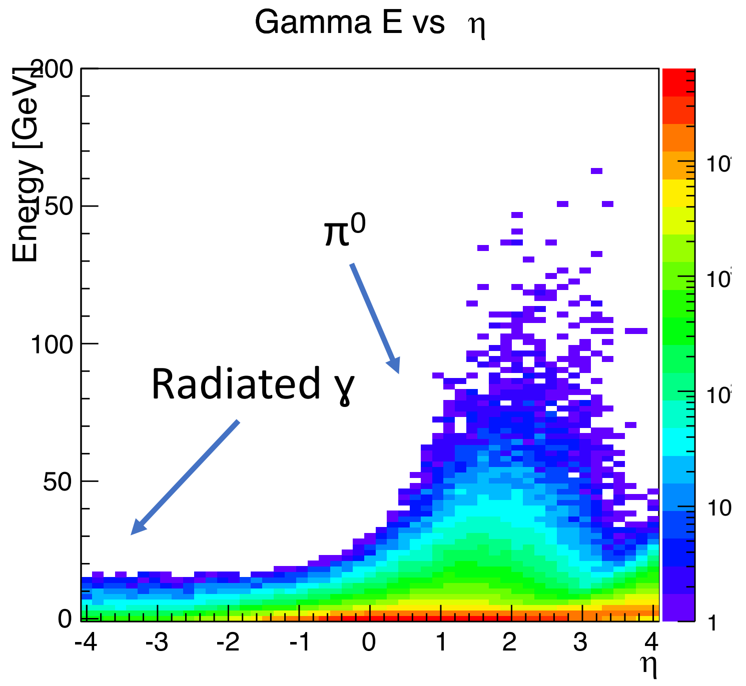
eta = 3.080 theta = 3.050 pT = 0.373+/-0.003 E = 4.525+/-0.034

....

eta = 3.880 theta = 3.100 pT = 0.301+/-0.002 E = 8.314+/-0.035

eta = 3.960 theta = 3.103 pT = 0.304+/-0.002 E = 9.035+/-0.038




------------ Charged Current Photon ---------------------------

eta = -4.000 theta = 0.037 pT = 0.254+/-0.016 E = 1.578+/-0.098
eta = -3.840 theta = 0.043 pT = 0.263+/-0.016 E = 1.598+/-0.098
...
eta = -2.080 theta = 0.249 pT = 0.525+/-0.008 E = 0.939+/-0.035
eta = -1.920 theta = 0.291 pT = 0.551+/-0.007 E = 0.864+/-0.029
...
eta = -0.000 theta = 1.571 pT = 1.176+/-0.007 E = 0.856+/-0.007
eta = 0.160 theta = 1.730 pT = 1.247+/-0.007 E = 0.948+/-0.008
...
eta = 0.960 theta = 2.410 pT = 1.342+/-0.008 E = 1.614+/-0.012
eta = 1.120 theta = 2.511 pT = 1.367+/-0.008 E = 1.879+/-0.014
...
eta = 1.920 theta = 2.850 pT = 0.884+/-0.006 E = 2.075+/-0.021
eta = 2.080 theta = 2.893 pT = 0.797+/-0.005 E = 2.045+/-0.023
...
eta = 3.040 theta = 3.046 pT = 0.526+/-0.001 E = 2.086+/-0.017
eta = 3.200 theta = 3.060 pT = 0.516+/-0.001 E = 2.280+/-0.016
...
eta = 4.000 theta = 3.105 pT = 0.507+/-0.000 E = 4.660+/-0.021
eta = 4.160 theta = 3.110 pT = 0.508+/-0.000 E = 5.462+/-0.024

# Ongoing Work

- Physics Object Maps (Experimentalists)
  1. Barak - inclusive electron channels
  2. Xiaoxuan – hadronic recoil channels
  3. Not currently pursuing heavy flavor tagged channels

- Detector Constraints (Experimentalists)
  1. Electron PID as a function of $\eta$ in e+p - Hanjie
  2. Determine minimum thresholds and resolutions for ECAL/HCAL – Xiaoxuan

- Cross-section/Asymmetry correction and reconstruction (Experimentalists)
  1. Hanjie - $\boldsymbol{\sigma}^{NC}$
  2. Matt – $g_2$ and higher twist
  3. Xiaoxuan - $\boldsymbol{\sigma}^{CC}$ and $\boldsymbol{\sigma}^{NC}$

- Impact Studies (Theorists)
  1. Statistical indicators T-test, KS test for preliminary impact (fast global fit replacement)
  2. Global Fits, including possible reweighting if necessary