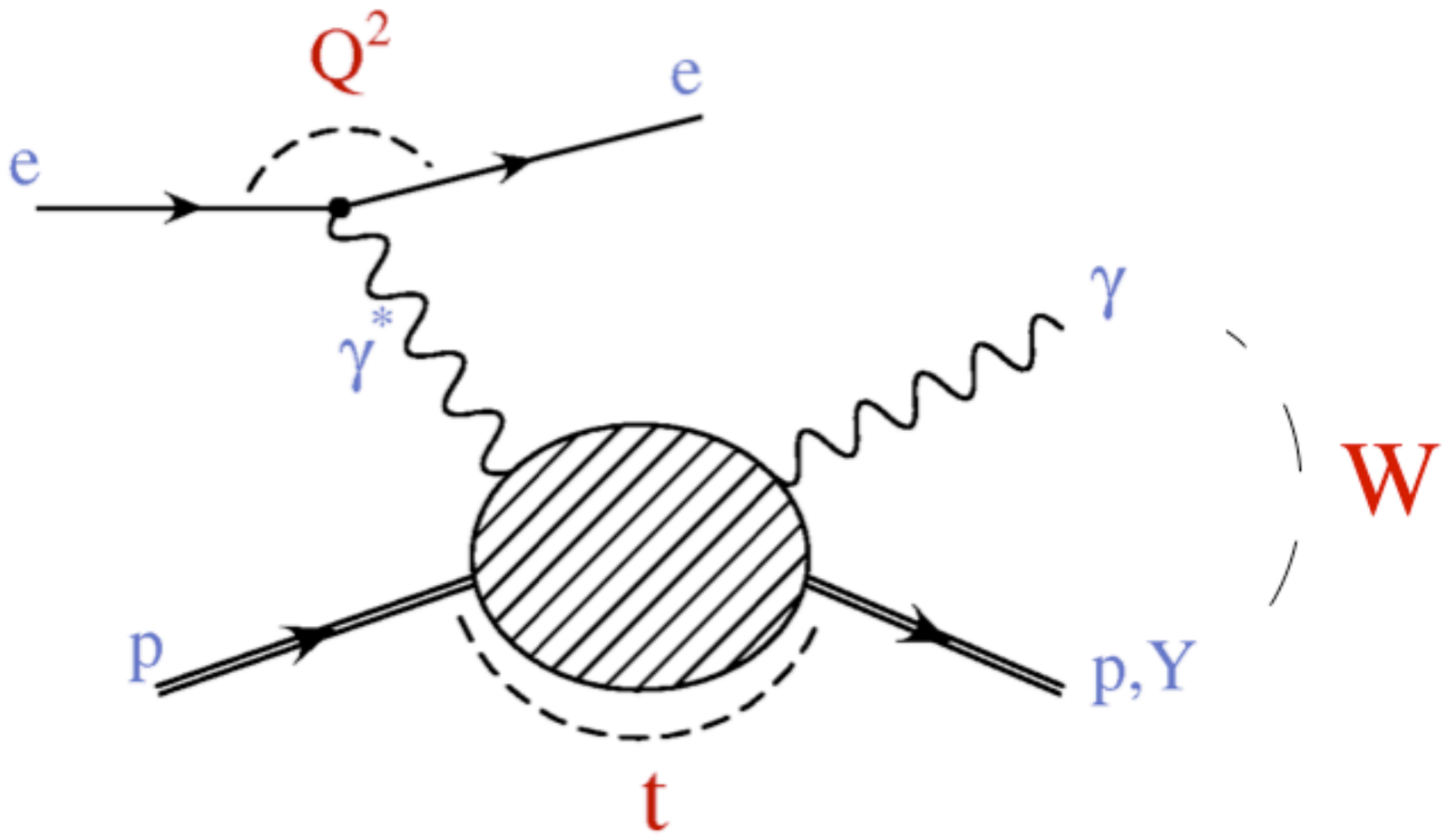
Proton tagging in DVCS



2/24/11

JH Lee

Deeply Virtual Compton Scattering

- ep → eγp: Simplest exclusive diffractive process
- Offers access to the spatial distribution of partons in the transverse plane: GPD (polarized, unpolarized)
- Kinematics overlaps with Hera and compass but
  - more precise measurement in wide kinematics (QCD evolution)
  - access to complex DVCS amplitude with e^-,e^+ and transverse and longitudinal polarization

Exclusive diffractive process

- Identifying diffractive process: Rapidity gap tagging, forward proton tagging
- Complete kinematic constraint including identifying and reconstructing the proton in diffraction needed for minimizing systematic uncertainties:
  - exclusiveness
  - t-resolution
  - angular resolution

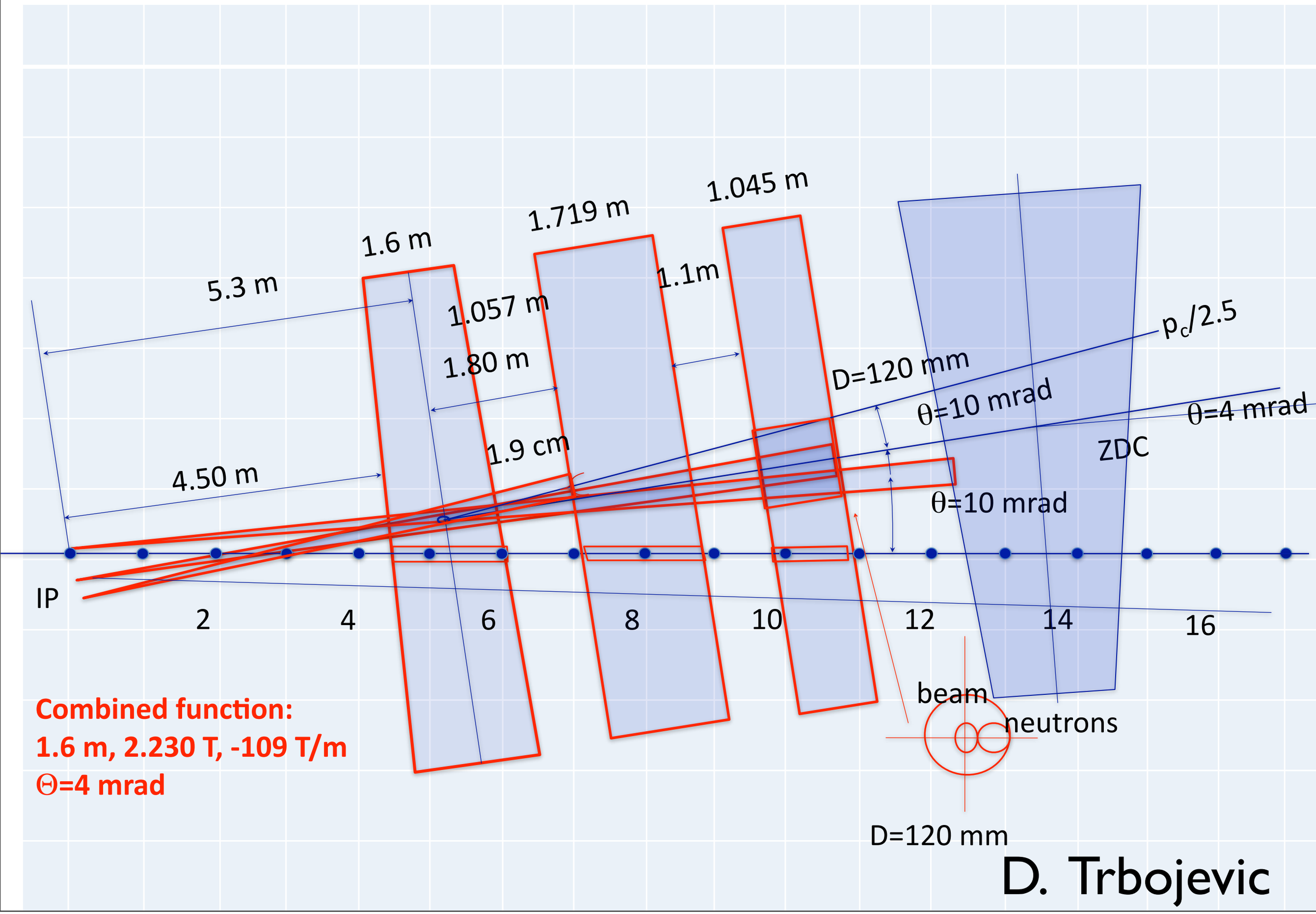
Forward proton

- Scattered with ~O(mrad): Need Roman Pot
- high-t acceptance mainly limited by magnet aperture
- low-t acceptance limited by beam envelop (~10σ)
- t-resolution limited by
  - beam angular divergence (~O(100μrad)) for mainly small t
  - uncertainties in vertex (x,y,z) and transport
  - ~<5-10% resolution in t (RP at STAR)

DVCS Events

- 5(e)x50(p) and 25x250 GeV +(5x100,5x250)
- Using MILOU (arXiv:hep-ph/0411389)
  - –GPD based (NLO) by Freund and McDermott
  - –Measurements will be mostly limited by systematic uncertainties
- Kinematic cuts
  - $1<Q^2<100\ \mathrm{GeV}^2$, $10^{-5}< x <0.7$, $0<t < 2\ (\mathrm{GeV}/c)^2$
- QED processes with the same final state (Bethe-Heitler) are also considered for 25x250

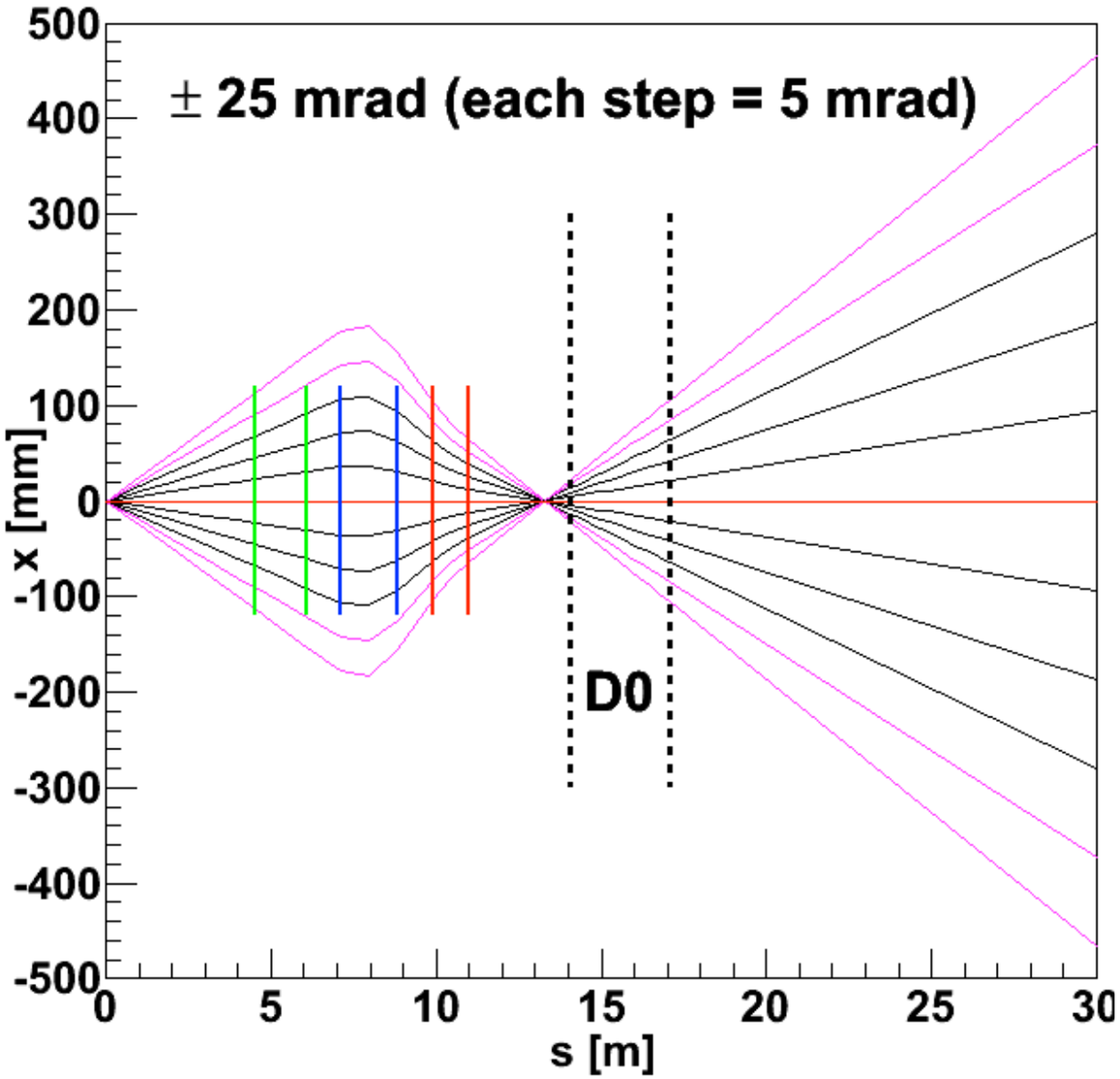
January 25, 2010, IP configuration for eRHIC

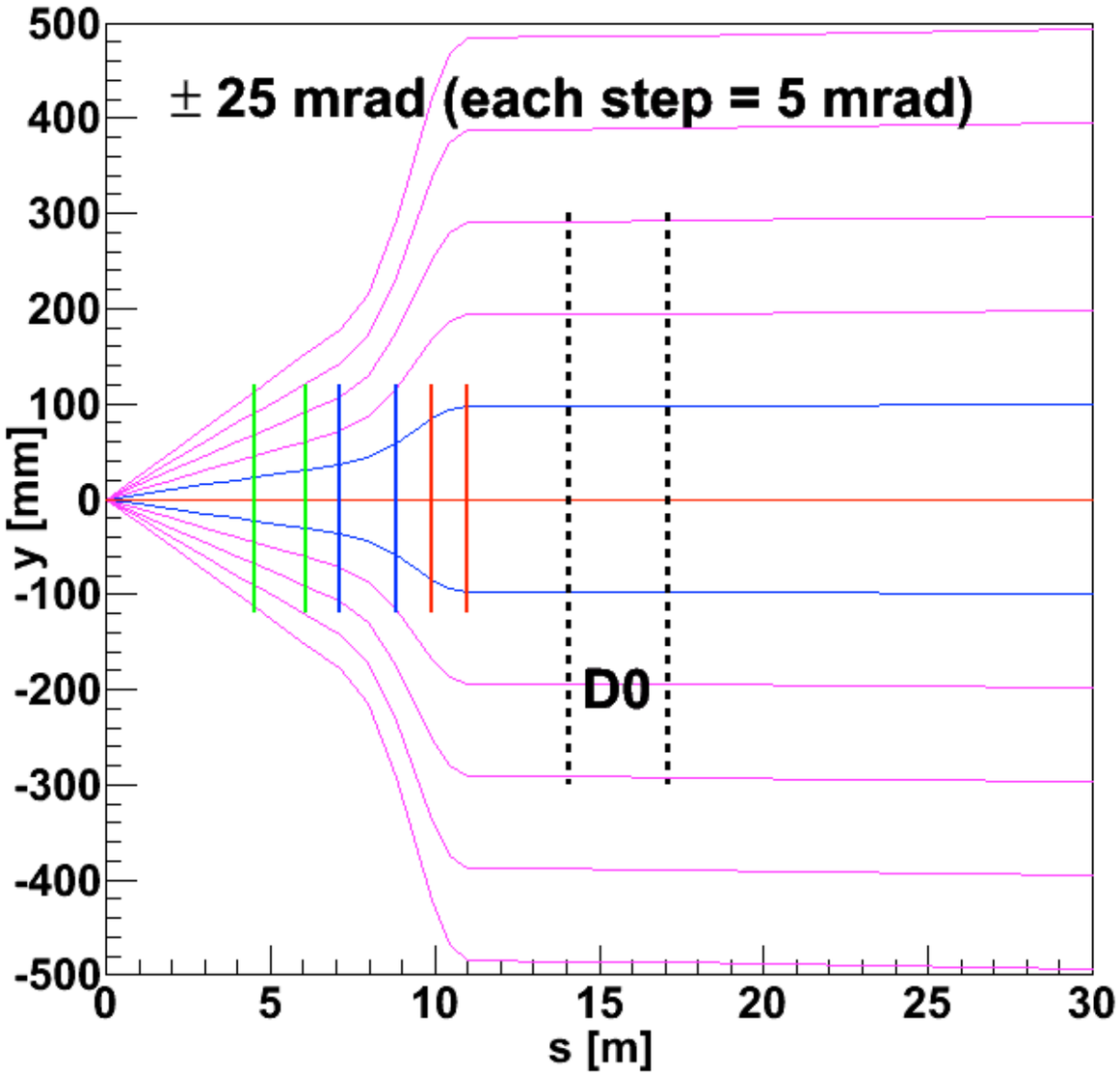


Combined function:
1.6 m, 2.230 T, -109 T/m
Θ=4 mrad

D. Trbojevic

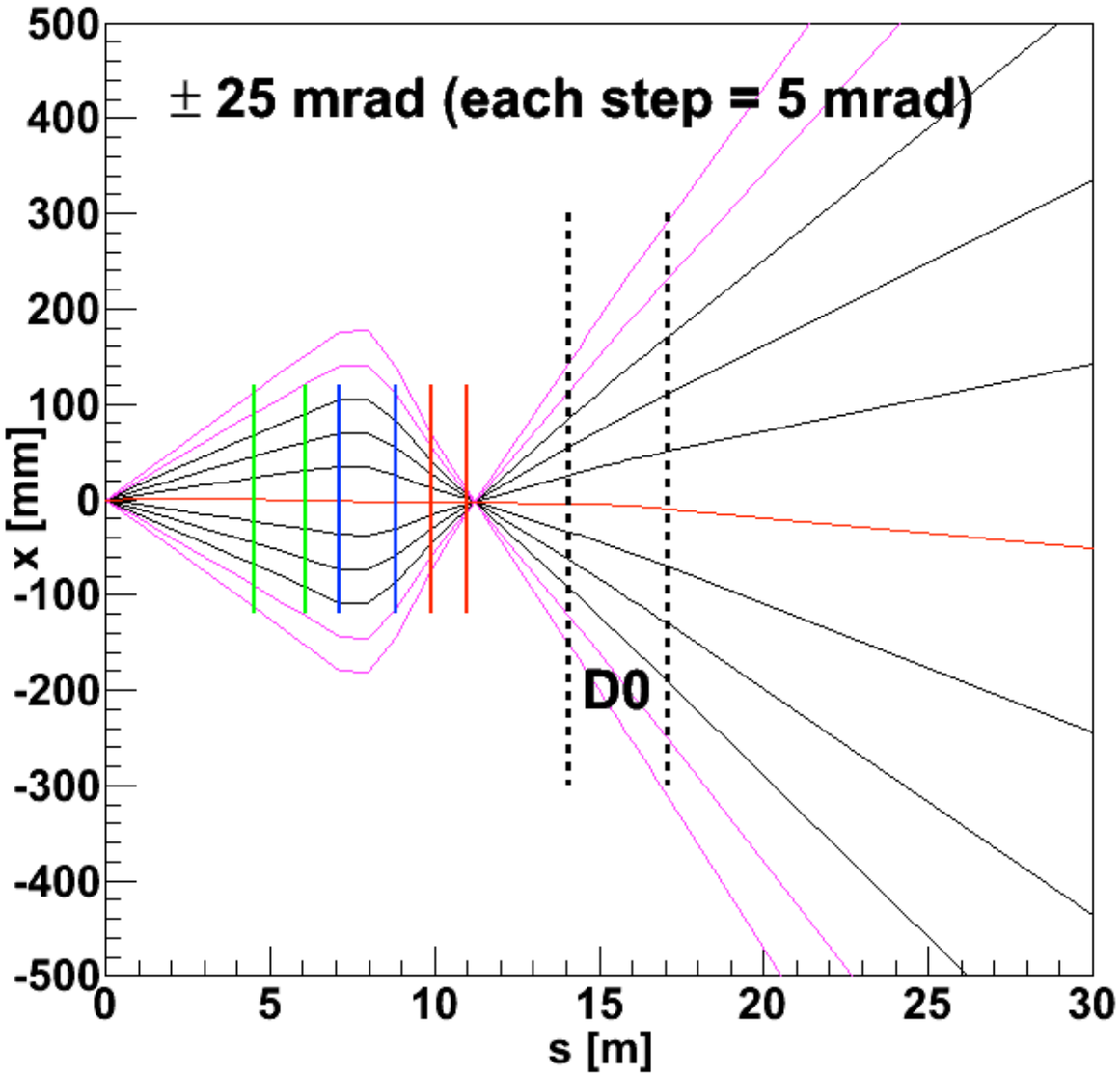
Latest beam optics for outgoing nominal protons

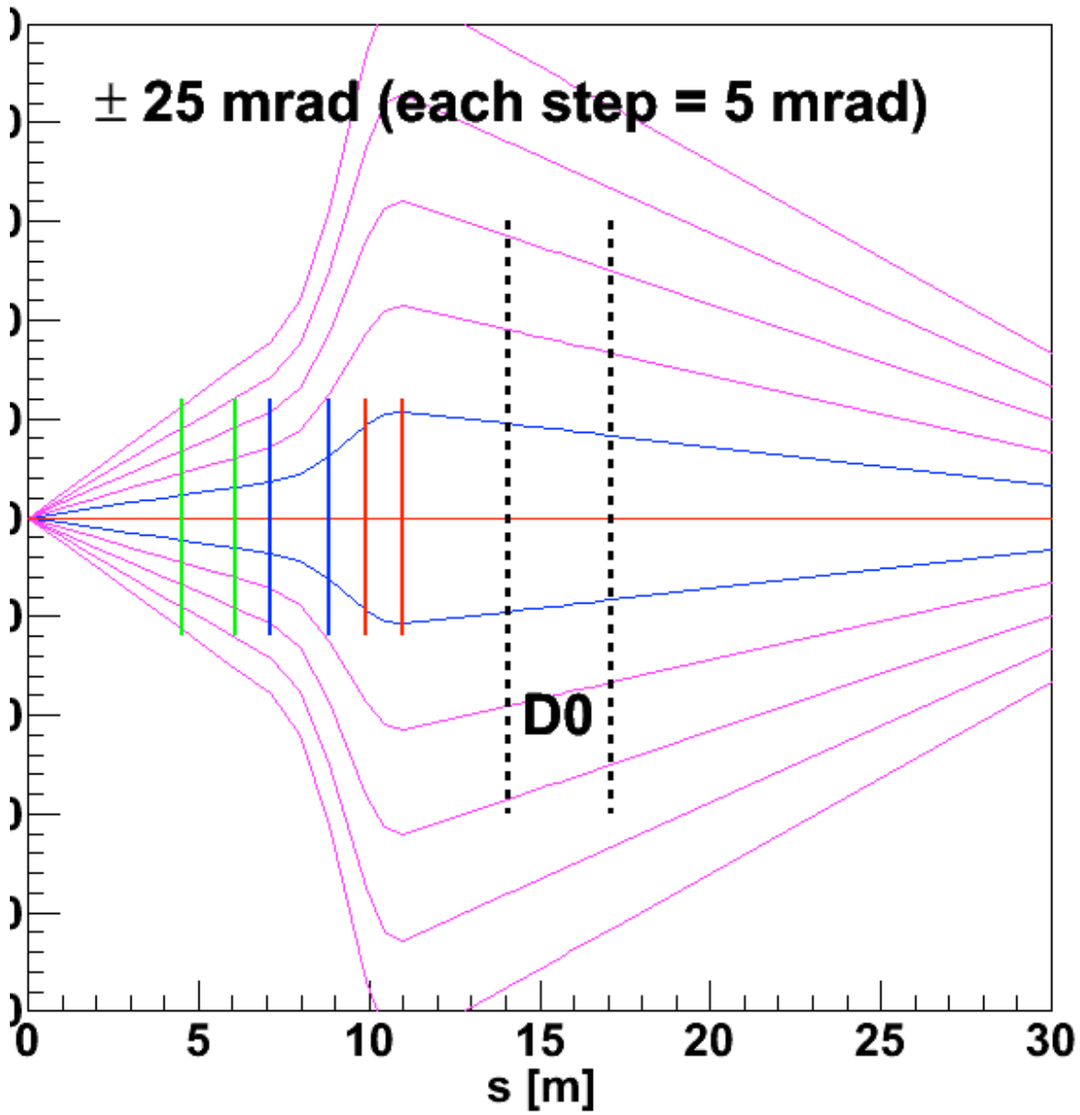




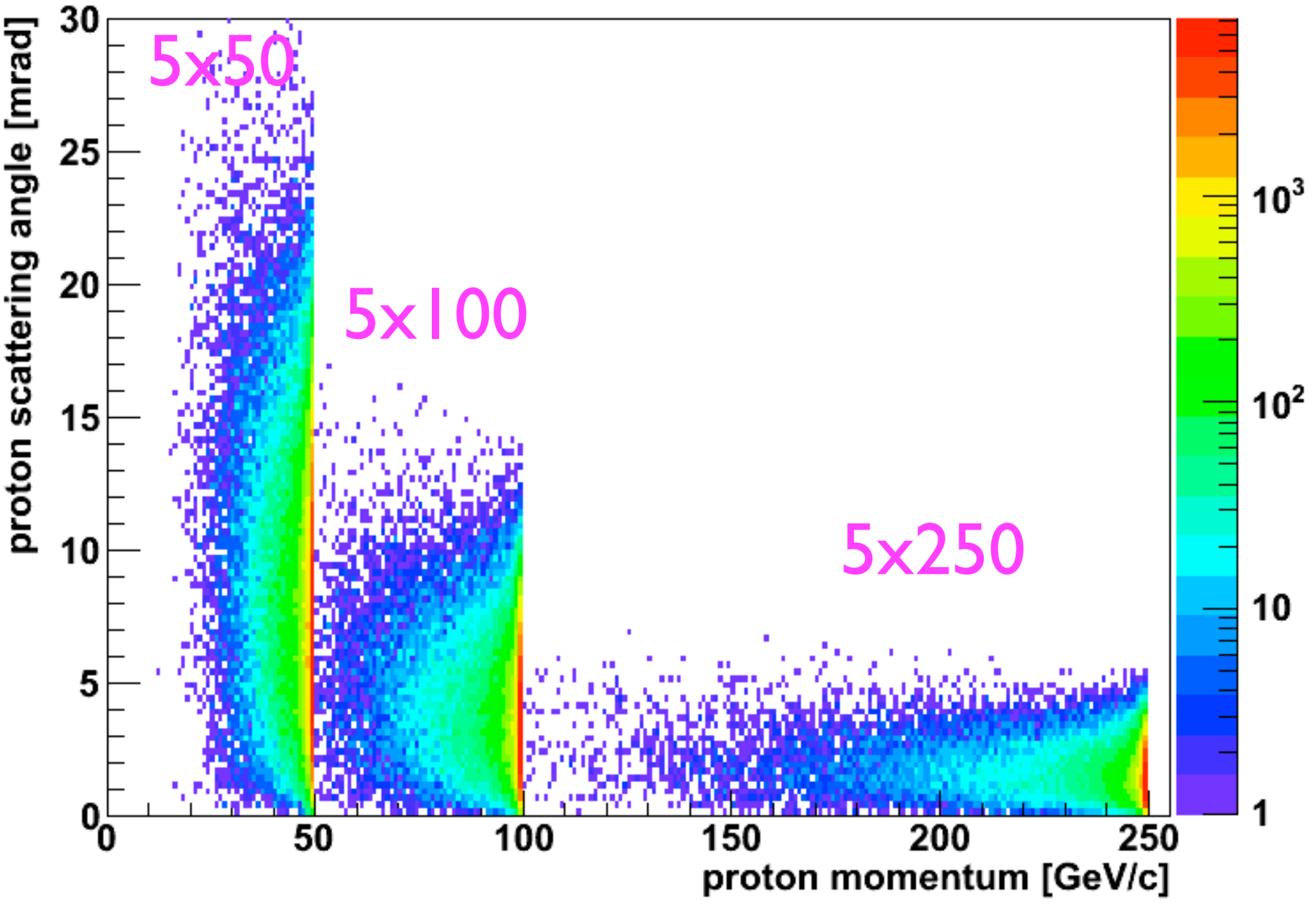
Beam transport using Hector

Latest beam optics for outgoing protons with 20% momentum loss

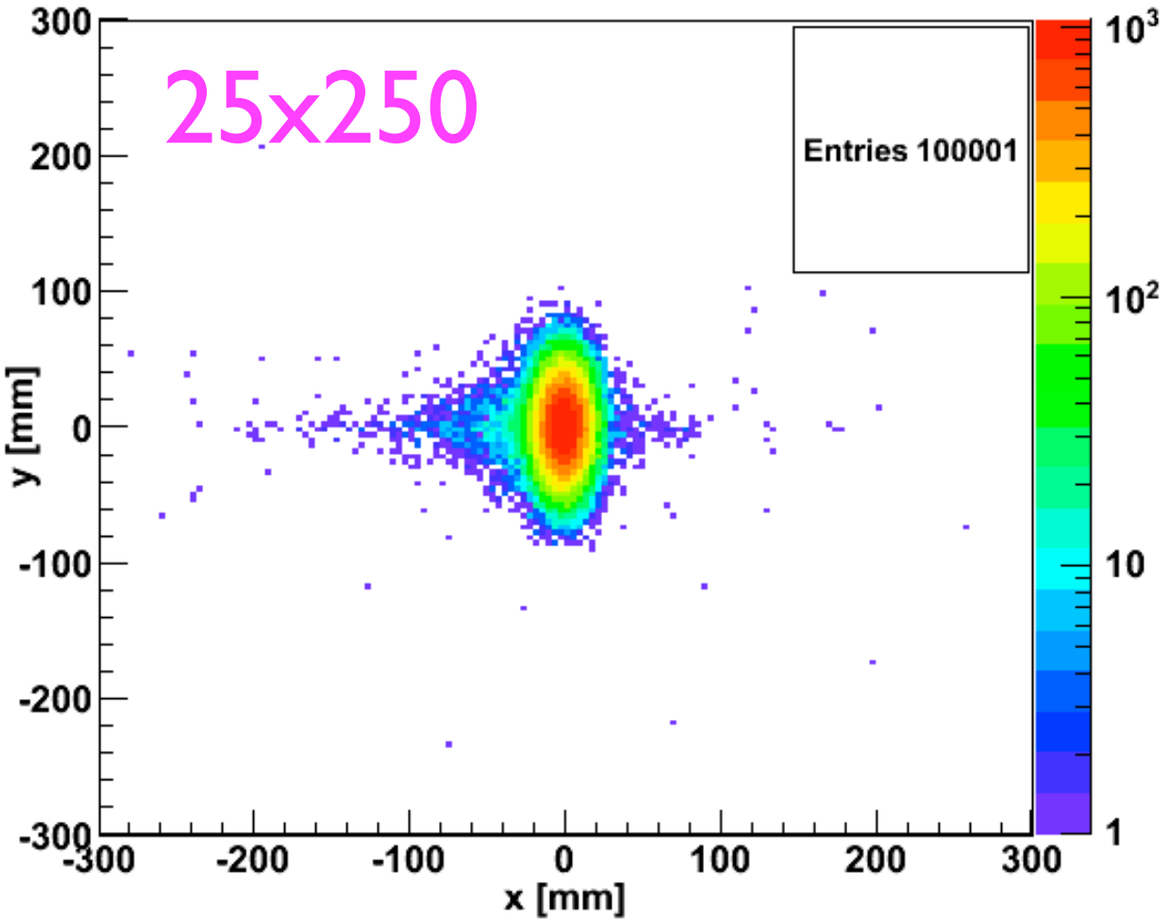


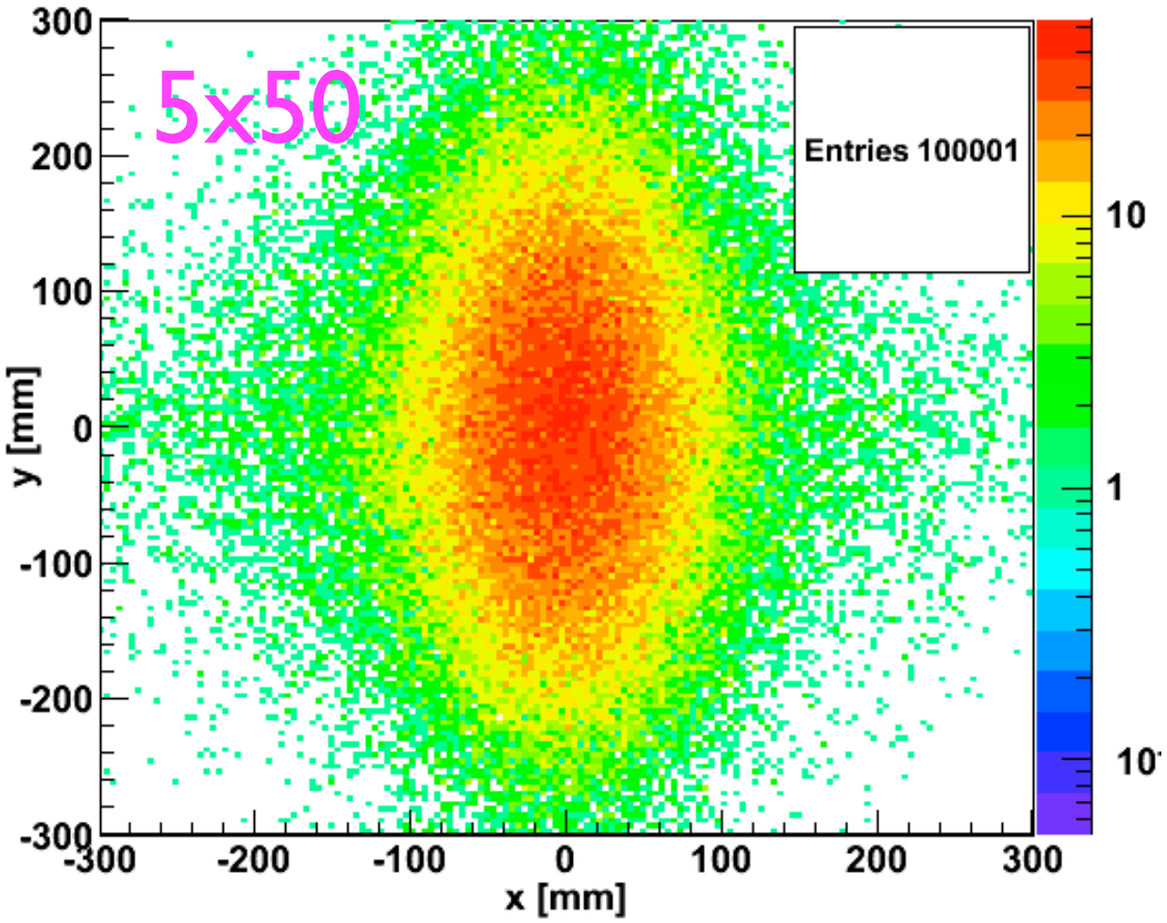


proton scattering angle vs momentum

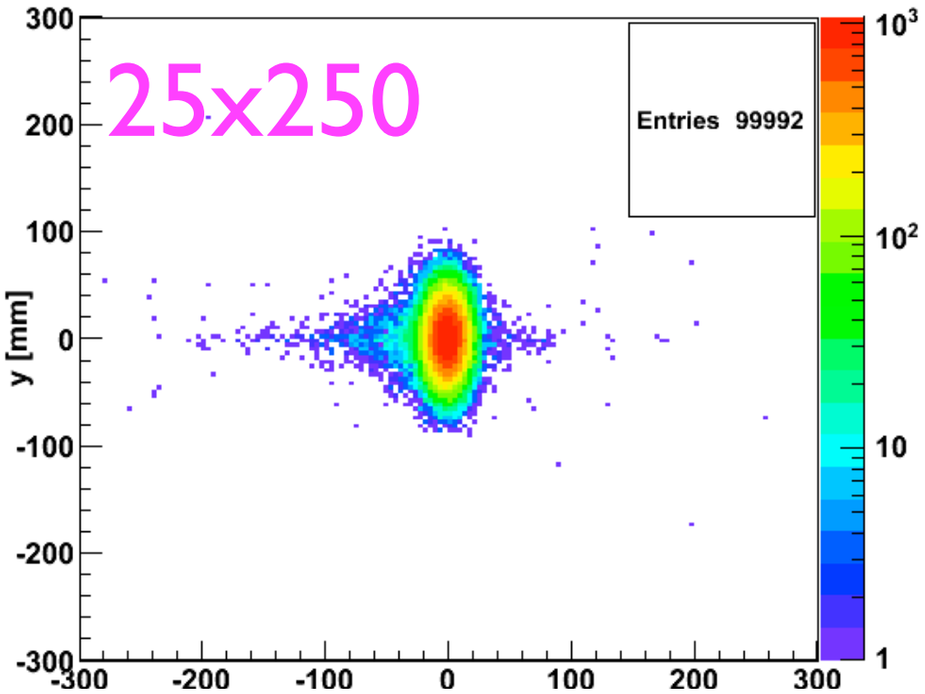


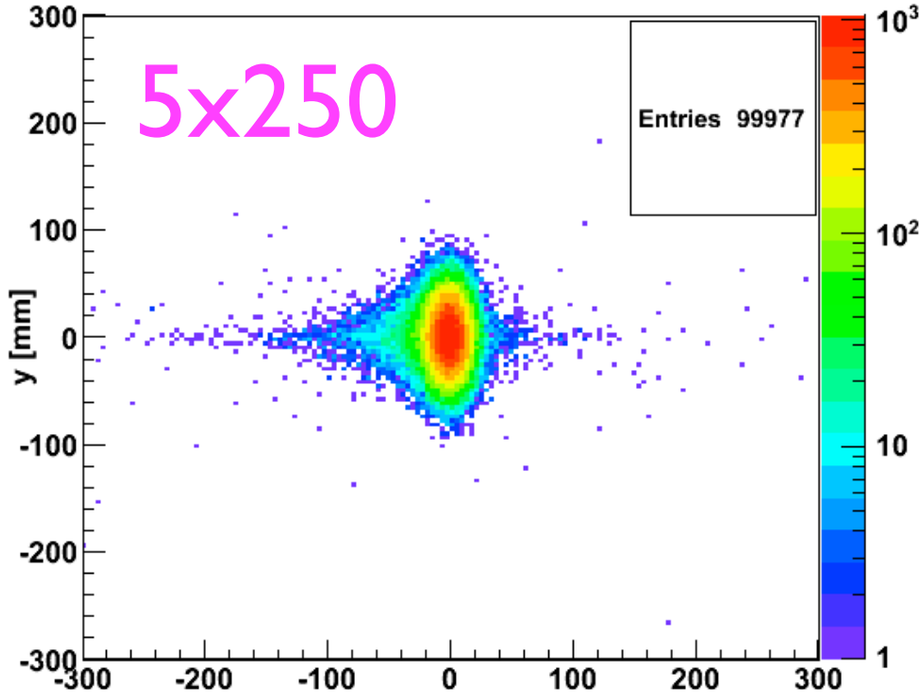
proton distribution in y vs x at s=20m (without quadrupole aperture limit)

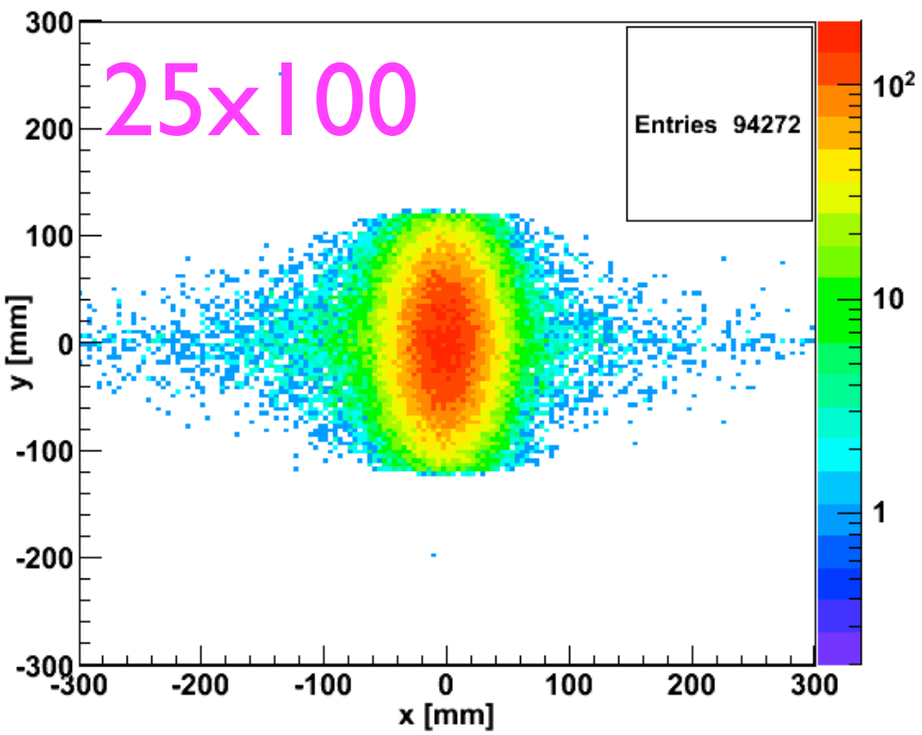


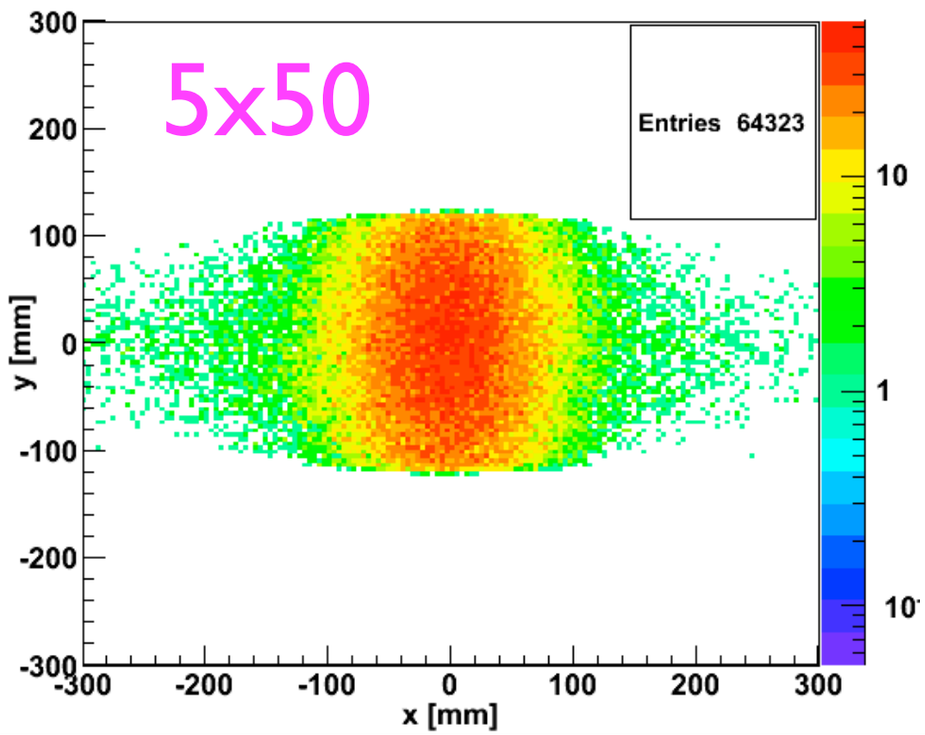


Quadrupole aperture limits (mostly for lower energy set-ups)

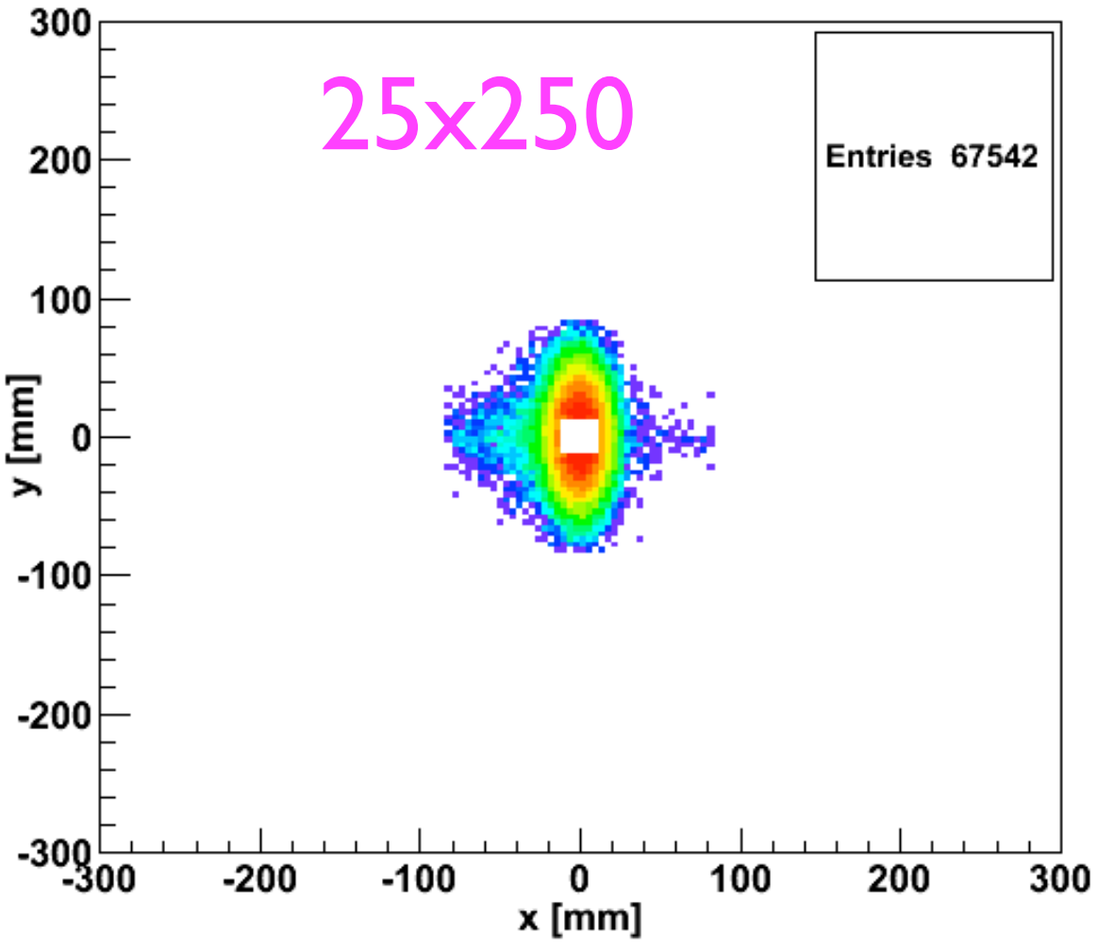


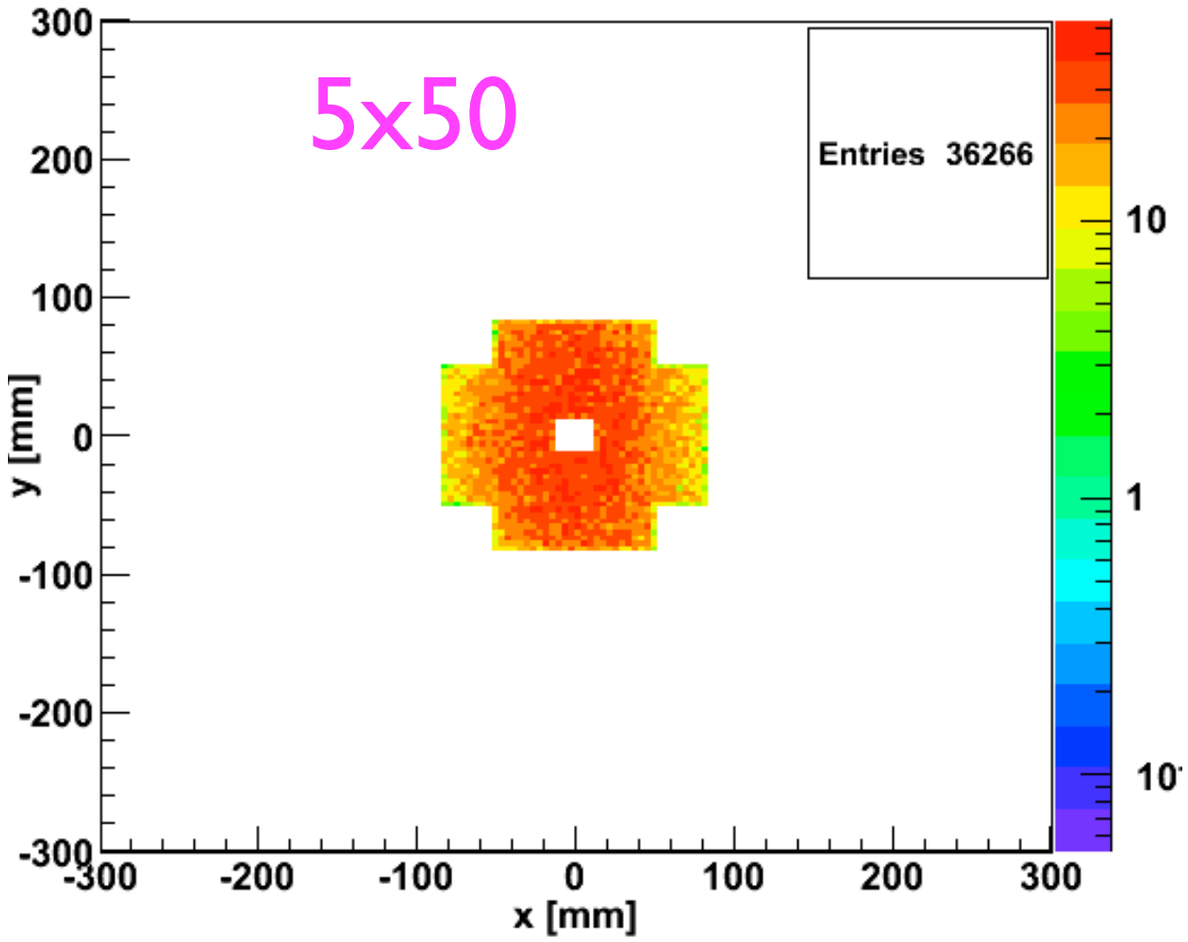




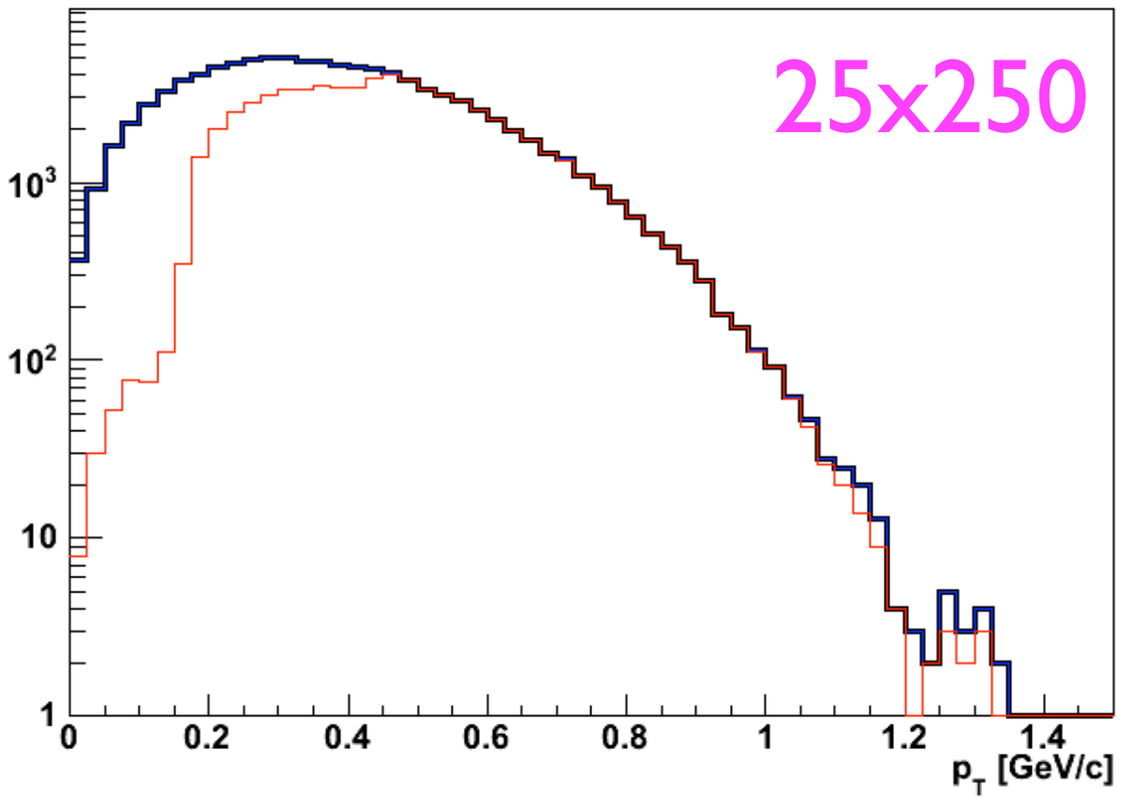


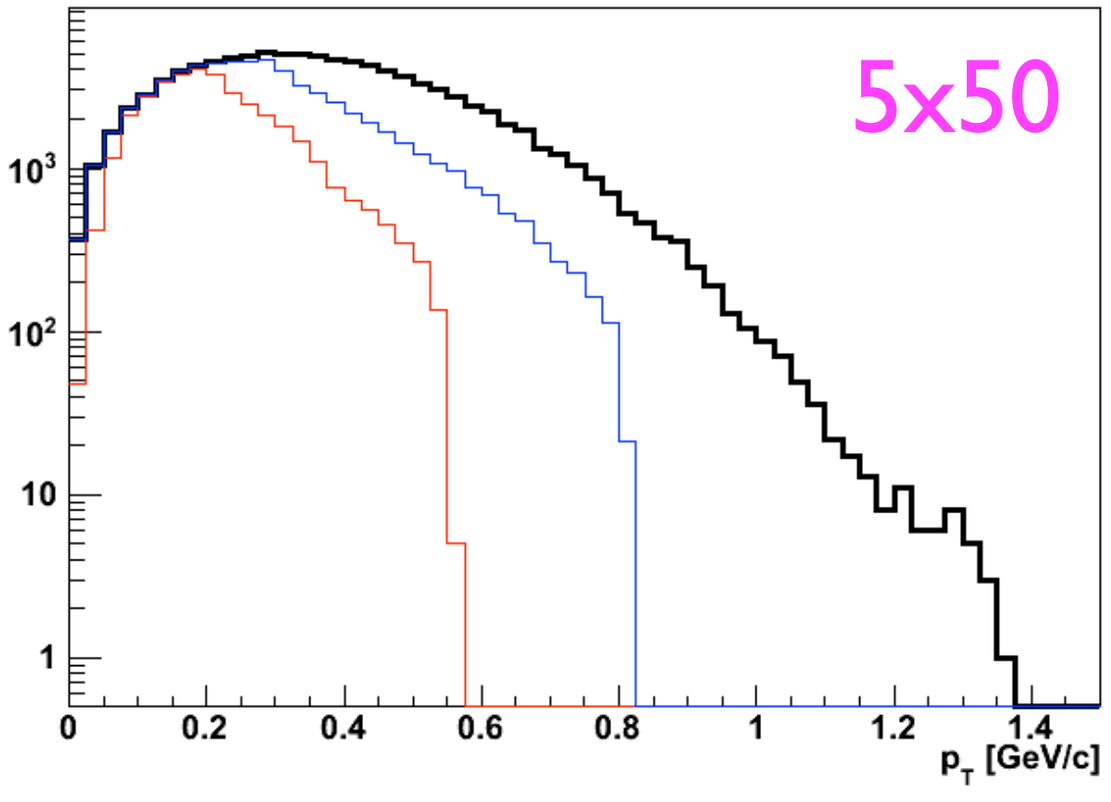
Accepted in“Roman Pot”(example) at s=20m





pT-acceptance of scattered proton





— Generated

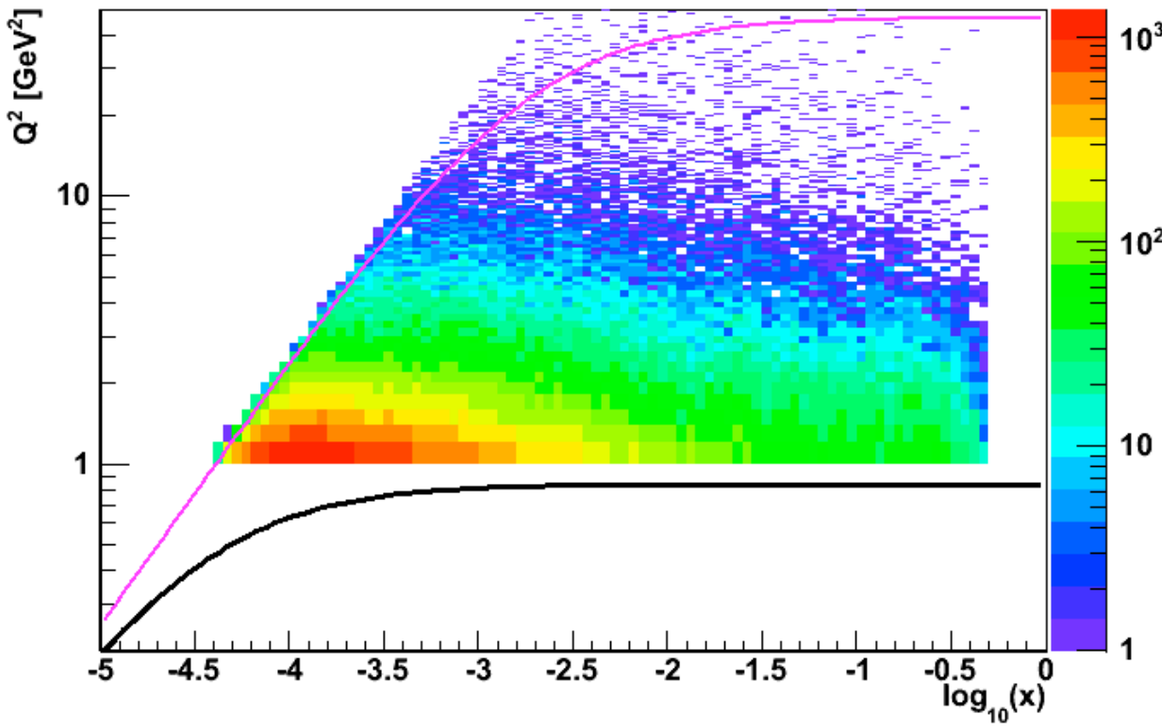
— Quad aperture limited

— RP (at 20m) accepted

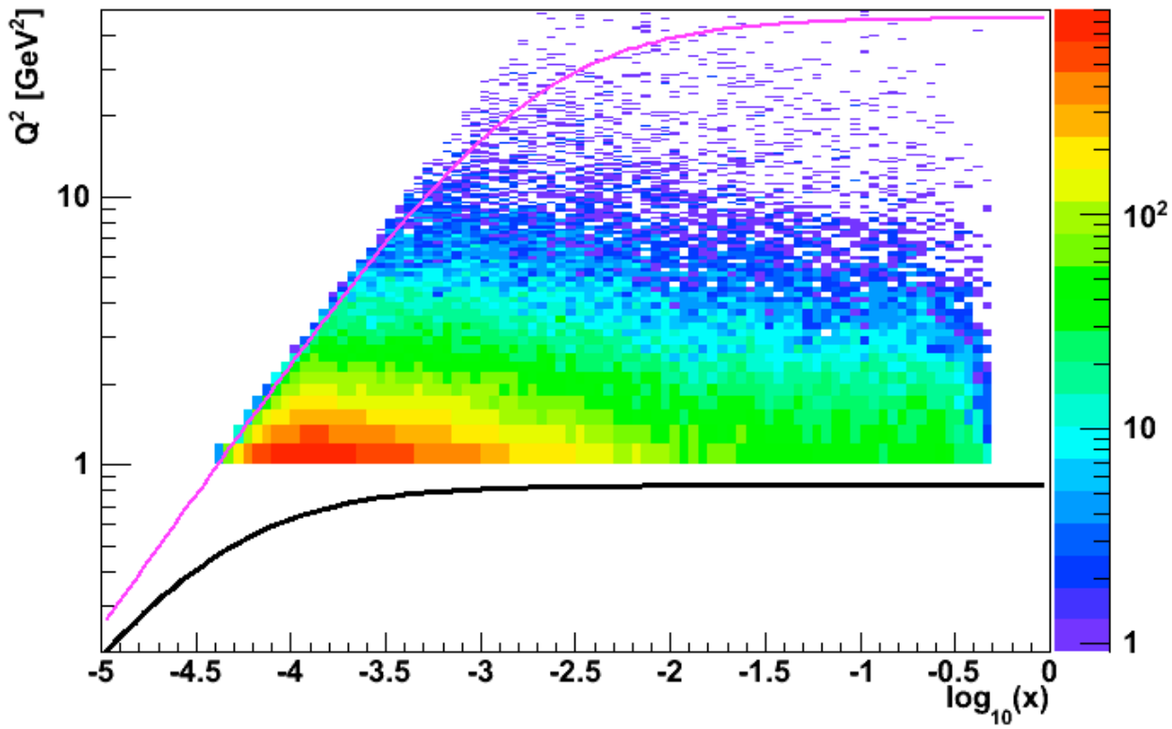
Q^2 vs x

25x250

generated



"RP" accepted



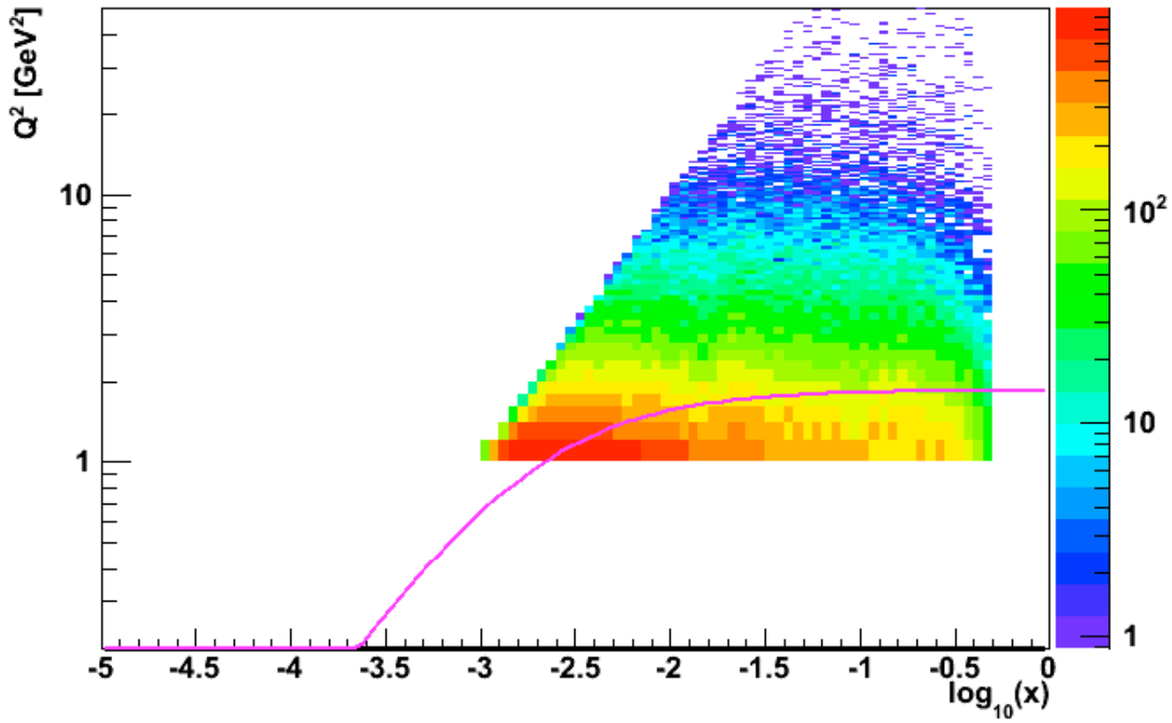
—— η = 4 (~2.1 degree)

—— η = 2 (~15.5 degree)

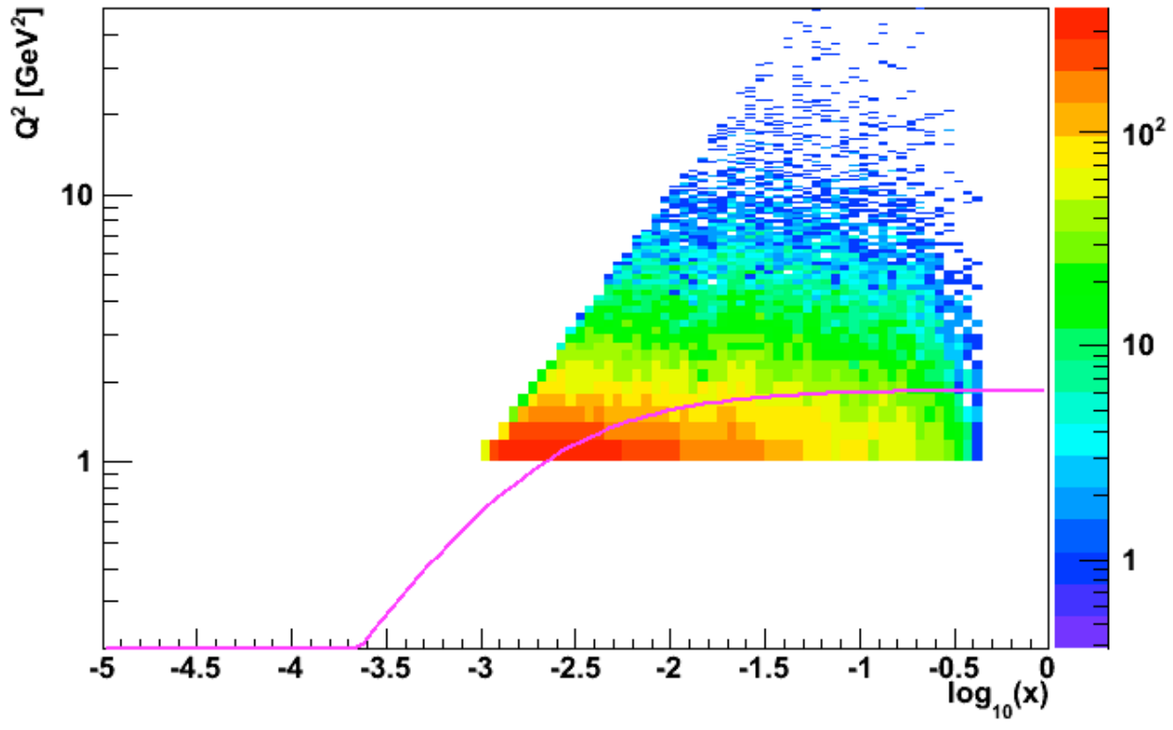
Q^2 vs x

5x50

generated

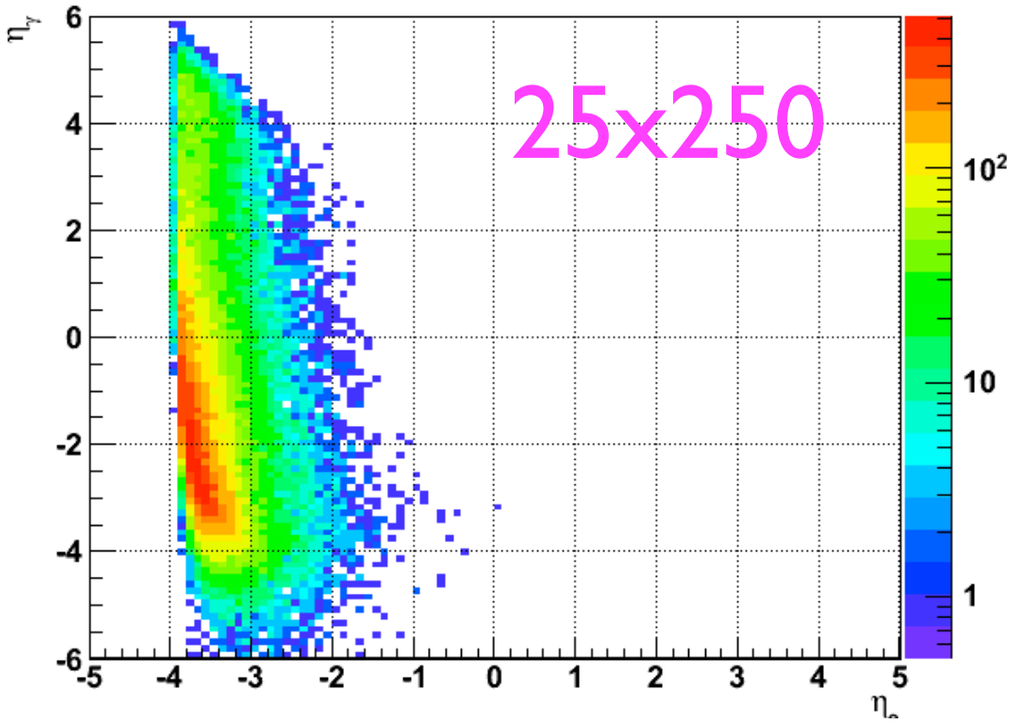


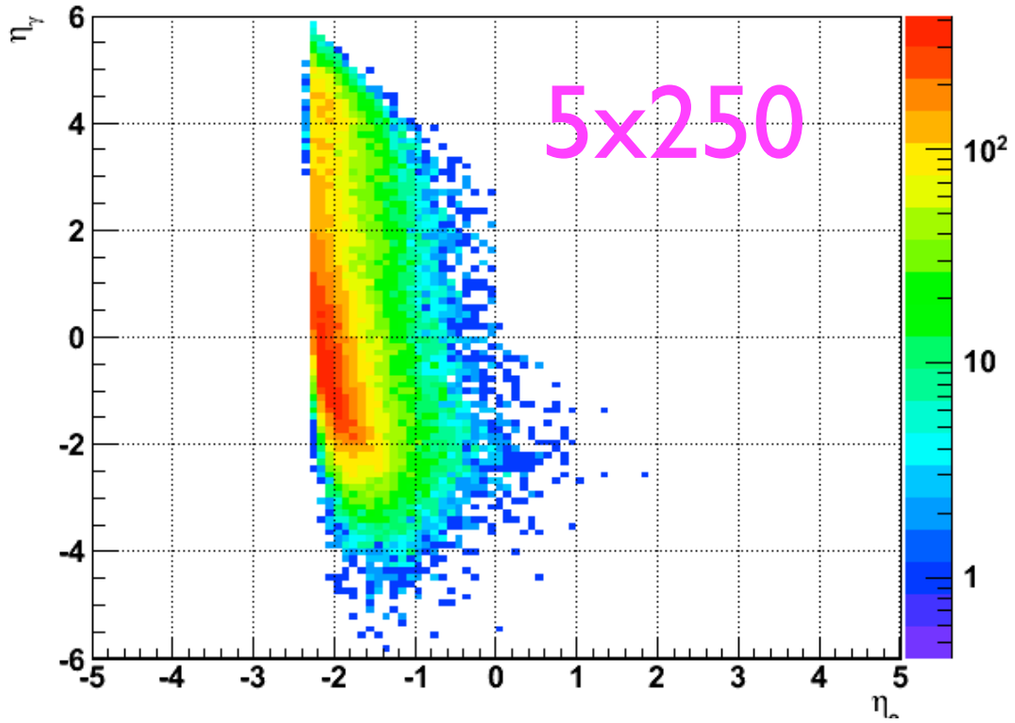
"RP" accepted

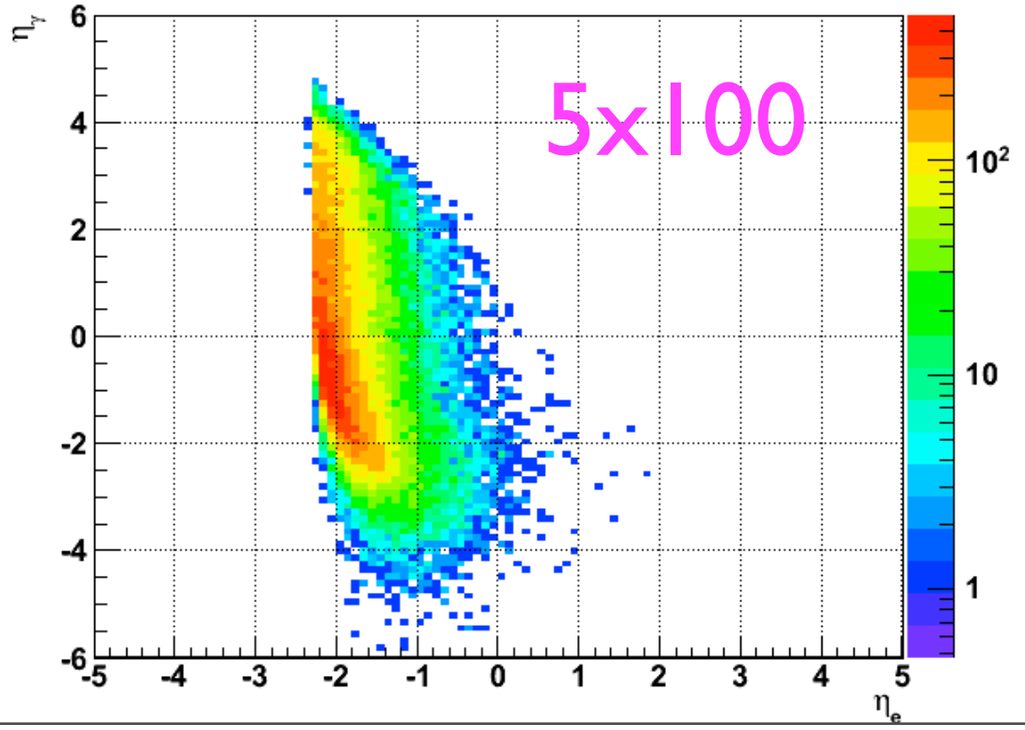


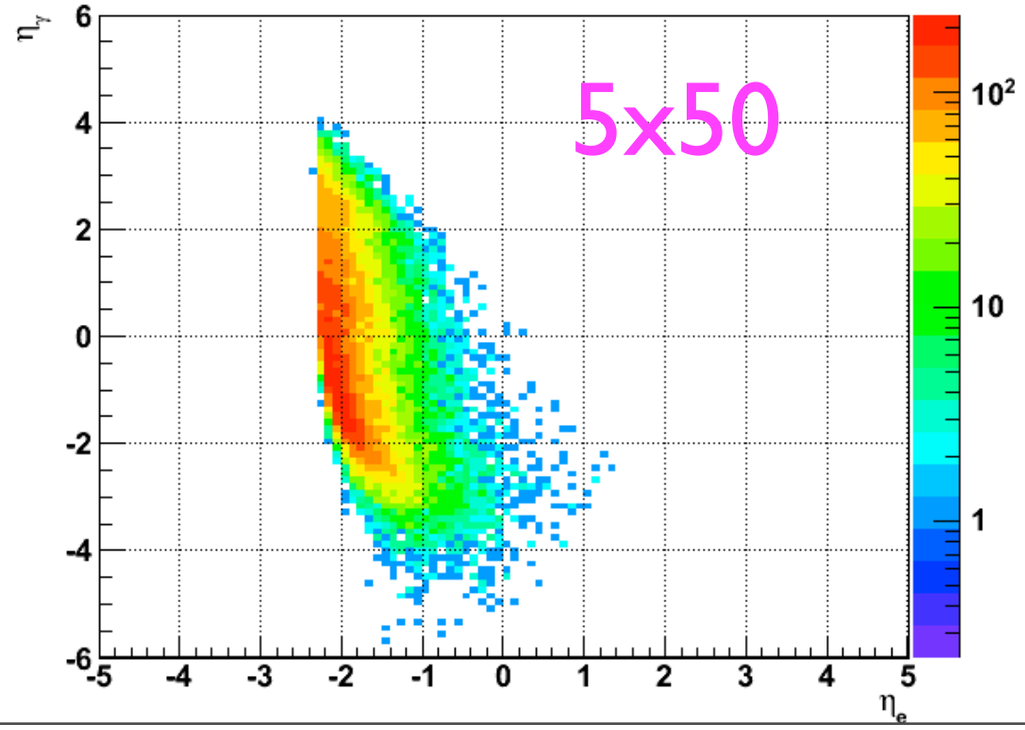
—— η = 2 (~15.5 degree)

η_γ vs η_e with "RP" accepted events





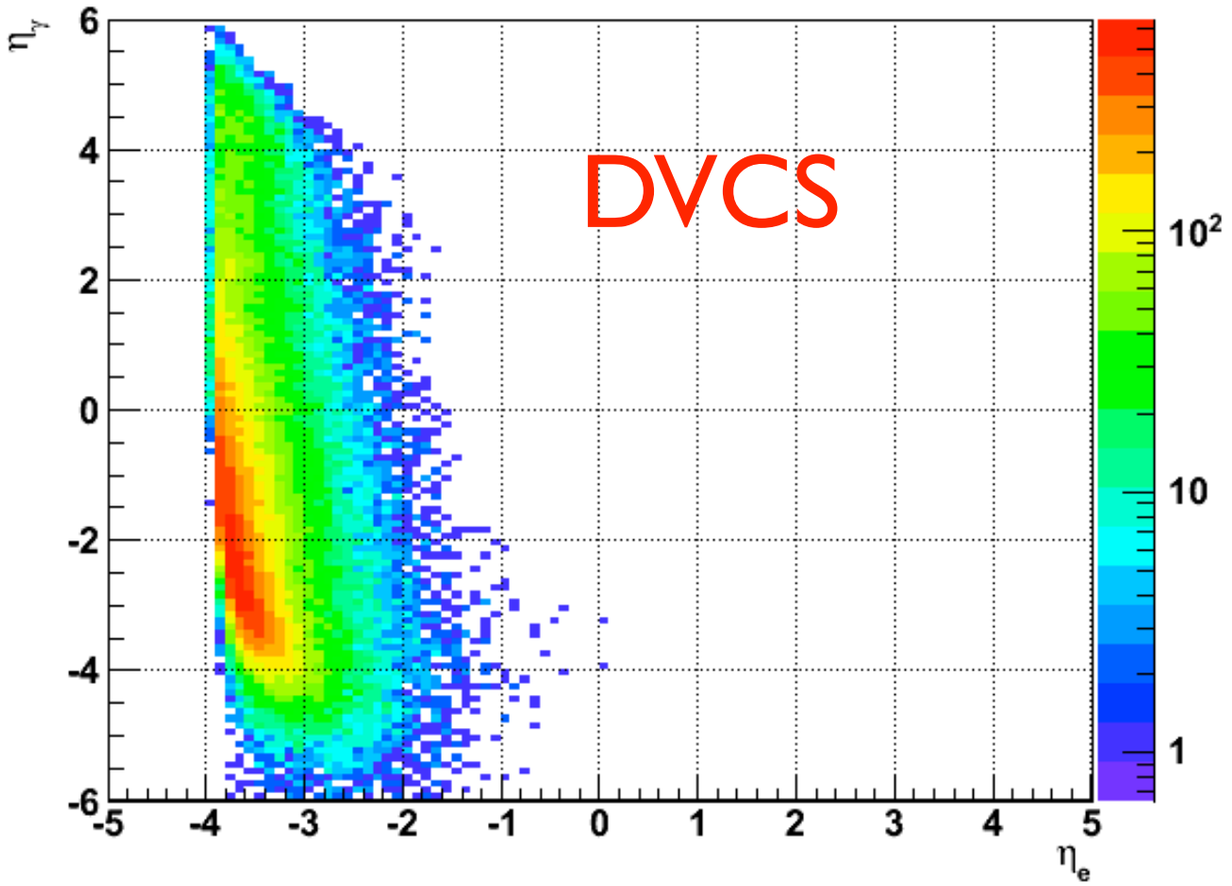


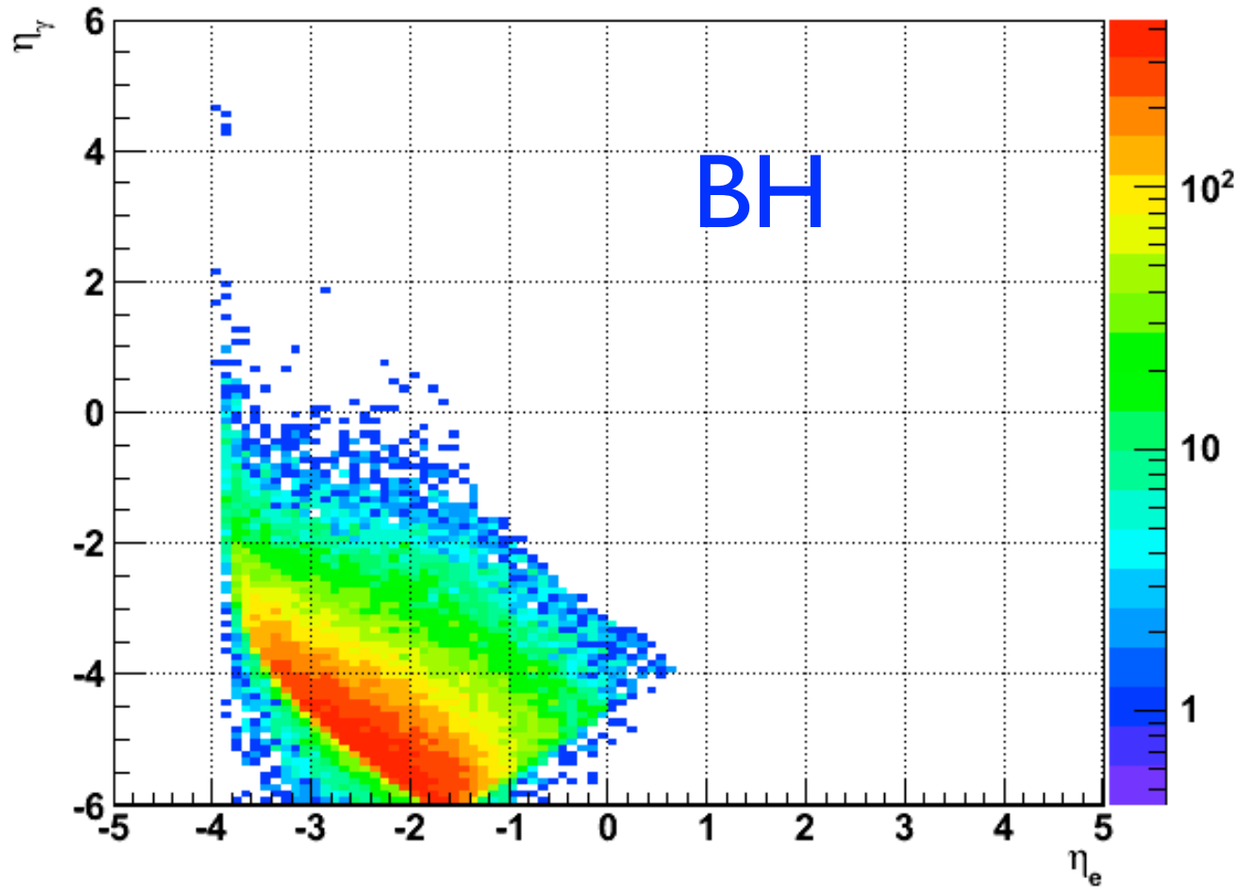


DVCS vs Bethe-Heitler

η_γ vs η_e

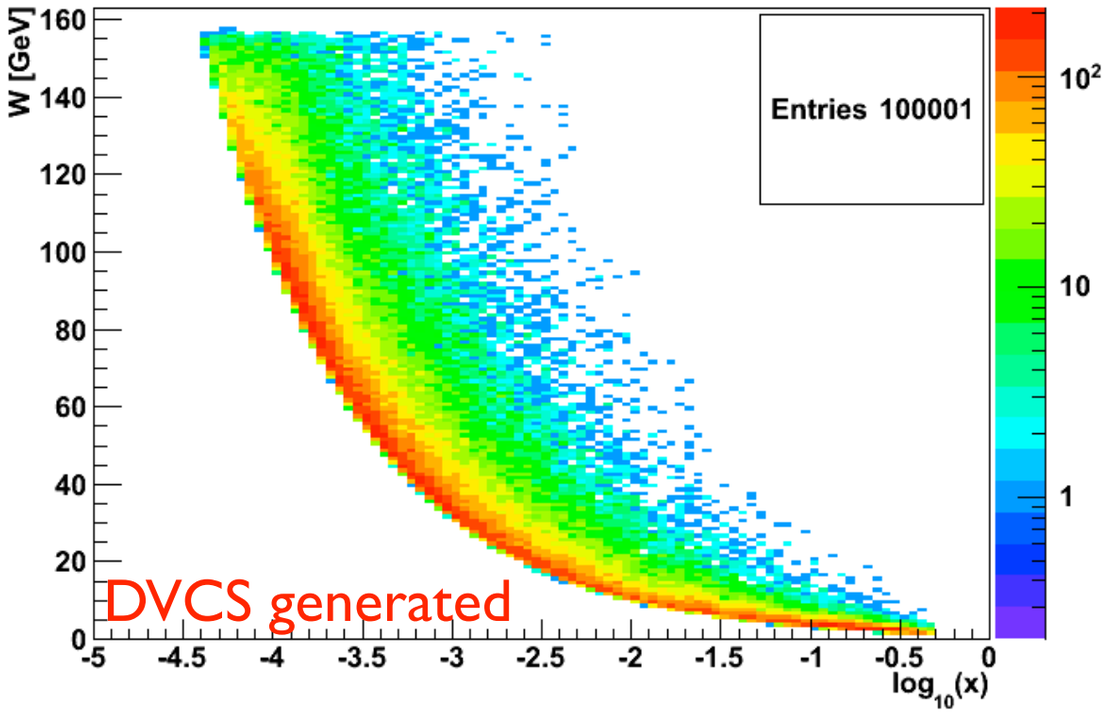
25x250

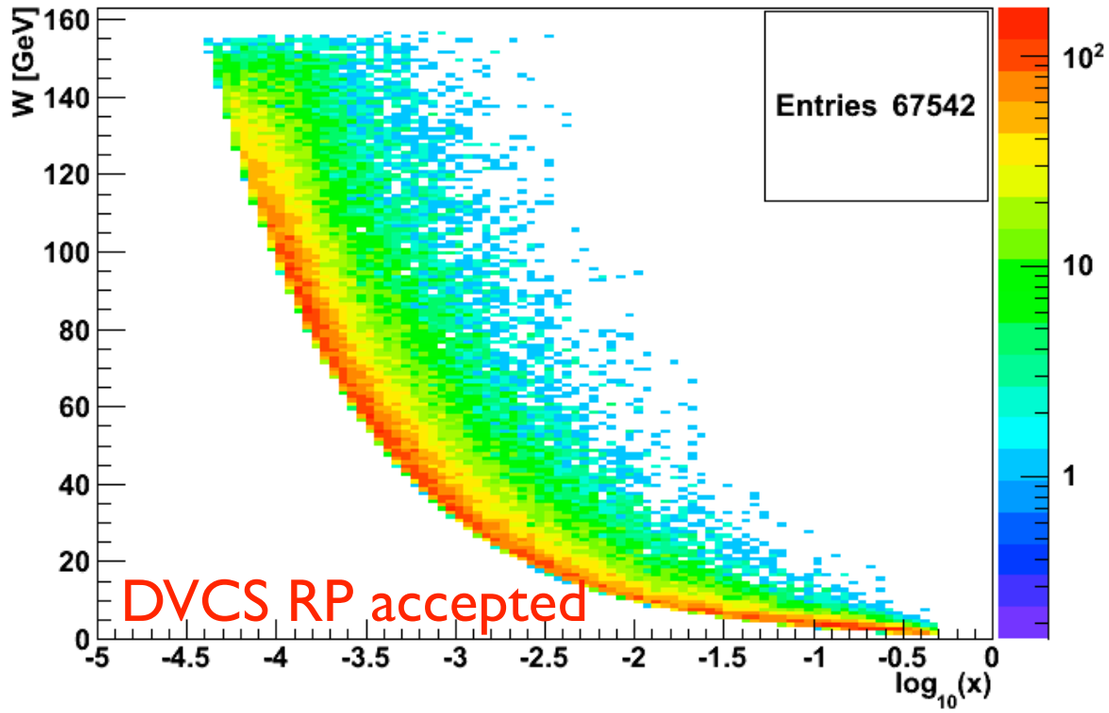


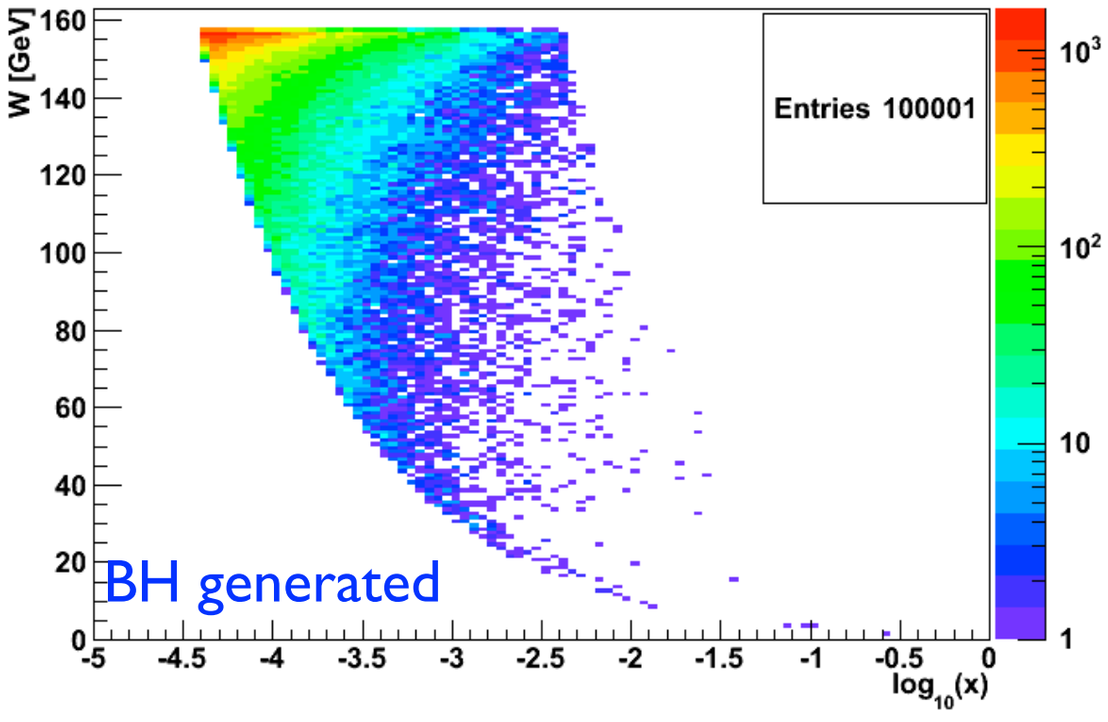


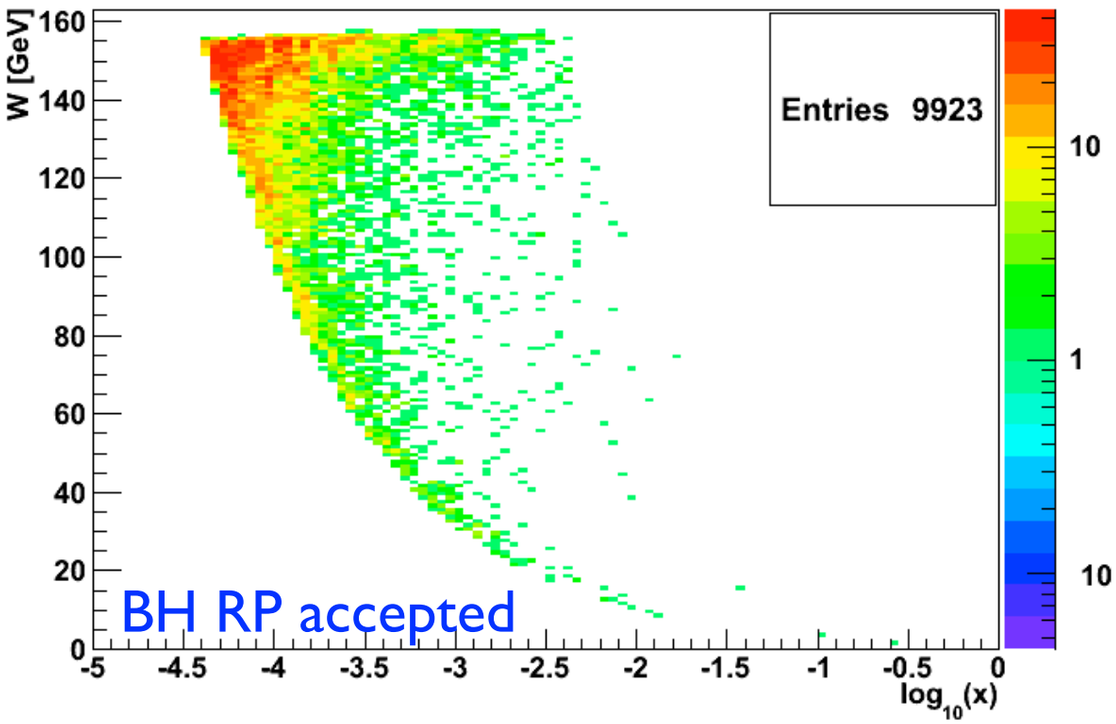
DVCS vs Bethe-Heitler

25x250









Proton tagging in DVCS and more

- Forward proton tagging necessary for DVCS and other diffractive processes. Needs
  - multiple RPs required for angle and momentum reconstruction
  - Beam optics optimization for lower proton energy (~<100 GeV)
- More realistic simulation needed with more realistic detector coverage and resolution
  - design consideration for optimal coverage and resolution
- More diffractions consider: Exclusive VM, nuclear DVCS, other large rapidity gap events (photon+Pomeron fusion...)