UE/MinBias with Calorimeters

- Motivations
  - Large acceptances
  - Detects neutral and charged particles
  - Precise direction and energy reconstruction
- Challenges
  - No direct single particle reconstruction hadronic final state
    - Except for high energy isolated particles
  - Particle energy is spread
    - Especially laterally
  - Poor quality response to low energetic particles
    - Large signal fluctuations
    - Acceptance and calibration highly intertwined

Solutions

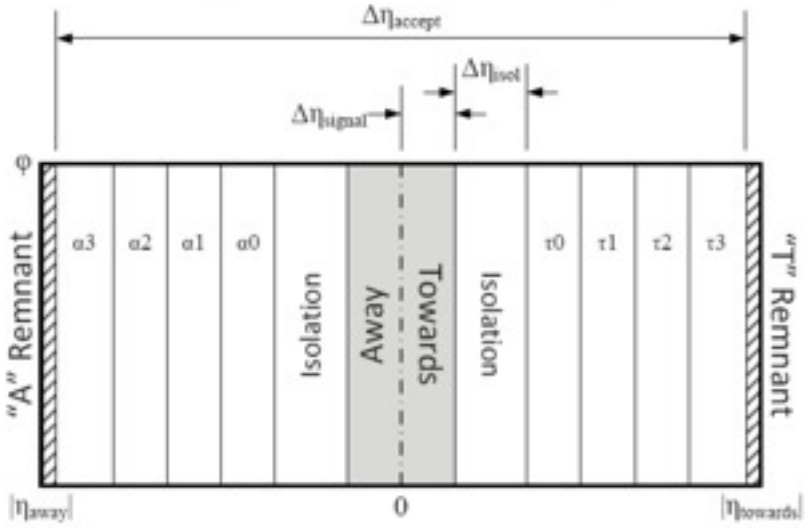
- Topological cell clusters
  - Collect cell signals into energy blobs
    - Suppresses noise
    - Follows particle shower development – especially for isolated particles
  - Apply local calibrations depending on cluster shapes
    - Calibrate “photon/electron-like” clusters differently than hadronic clusters
    - Provides calibrated input to jet finding
  - Reasonable “picture” of original event Et flow
    - Allows to reconstruct event (and jet!) shapes
- Use observables least affected by calorimeter ineffciencies
  - Focus for the rest of this

Longitudinal Et Flow

- Original idea developed August 2009
  - FNAL visit with P.Skands
  - Major motivation: can we learn something about color flow/connections between (hard) scattered partons and the rest of the event
    - Radiation, even MPIs?
- Interesting topologies
  - Di-jets
    - E.g., expect soft Et flow between leading and sub-leading jet and remnant ~ similar
  - Photon + jet(s)
    - Lack of color connections in the photon

Jet-Jet and Photon-Jet final states

- We require the two leading hard objects to be reconstructed in different η hemispheres (one in the positive η and one in the negative η hemisphere). The hemisphere with the leading jet will be called the "towards" region, while the one with the sub-leading jet or the leading photon the "away" region.



- Isolation cut: hard objects are required to be reconstructed in the central region, while we look at the E_T deposited in η strips closer to the beam remnants.

Event Selections (P8

- Prompt Photon

TOPOLOGY CUTS: both jet and photon pt > 20 GeV
jet is good
$\Delta\Phi > 2.9$
opposite η hemispheres
$|\eta| < 0.8$ for both jet and photon

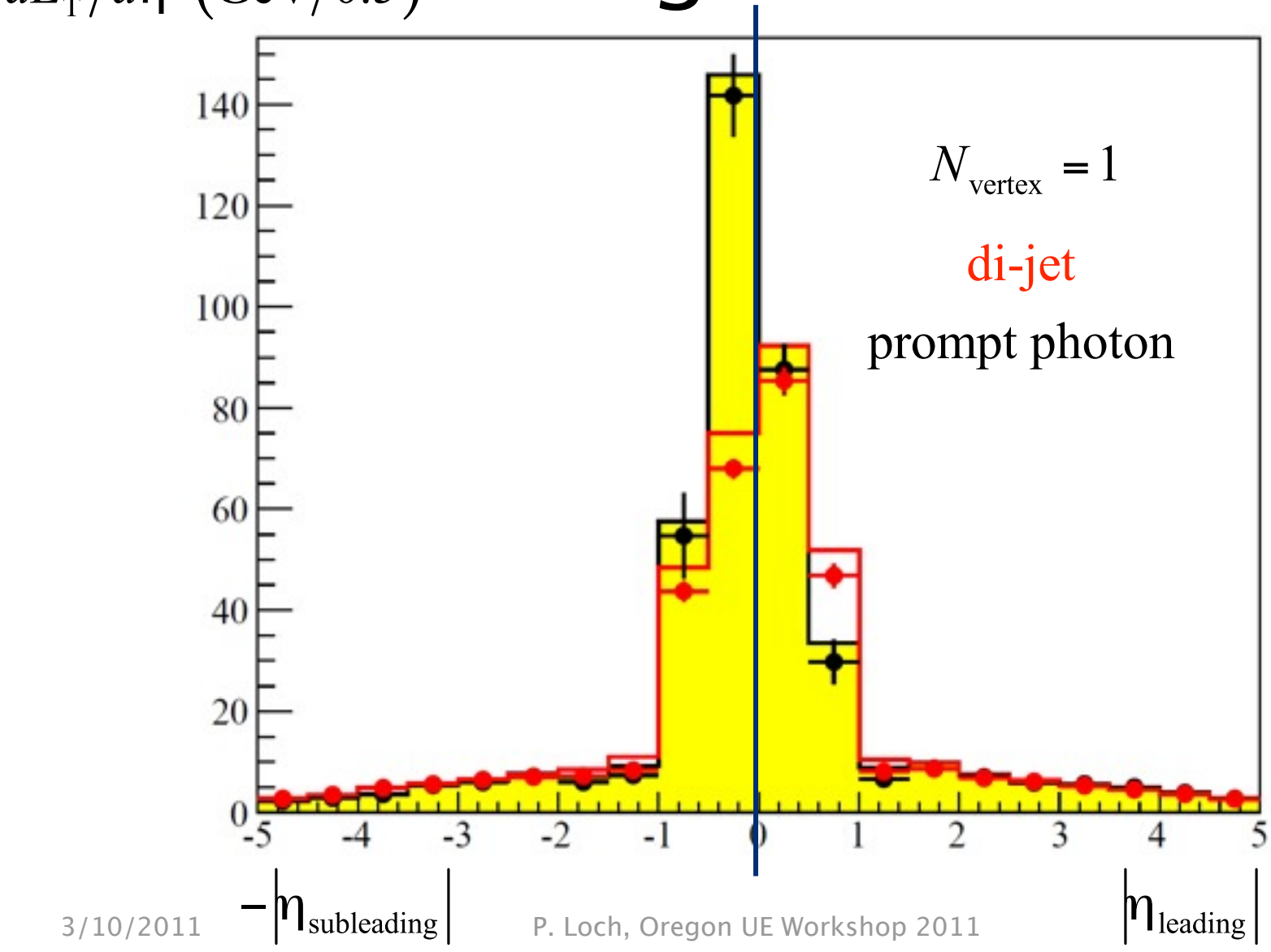
- Di-jets

TOPOLOGY CUTS: both jets with pt > 20 GeV
both jets are good
$\Delta\Phi > 2.9$
opposite η hemispheres
$|\eta| < 0.8$ for both jets.

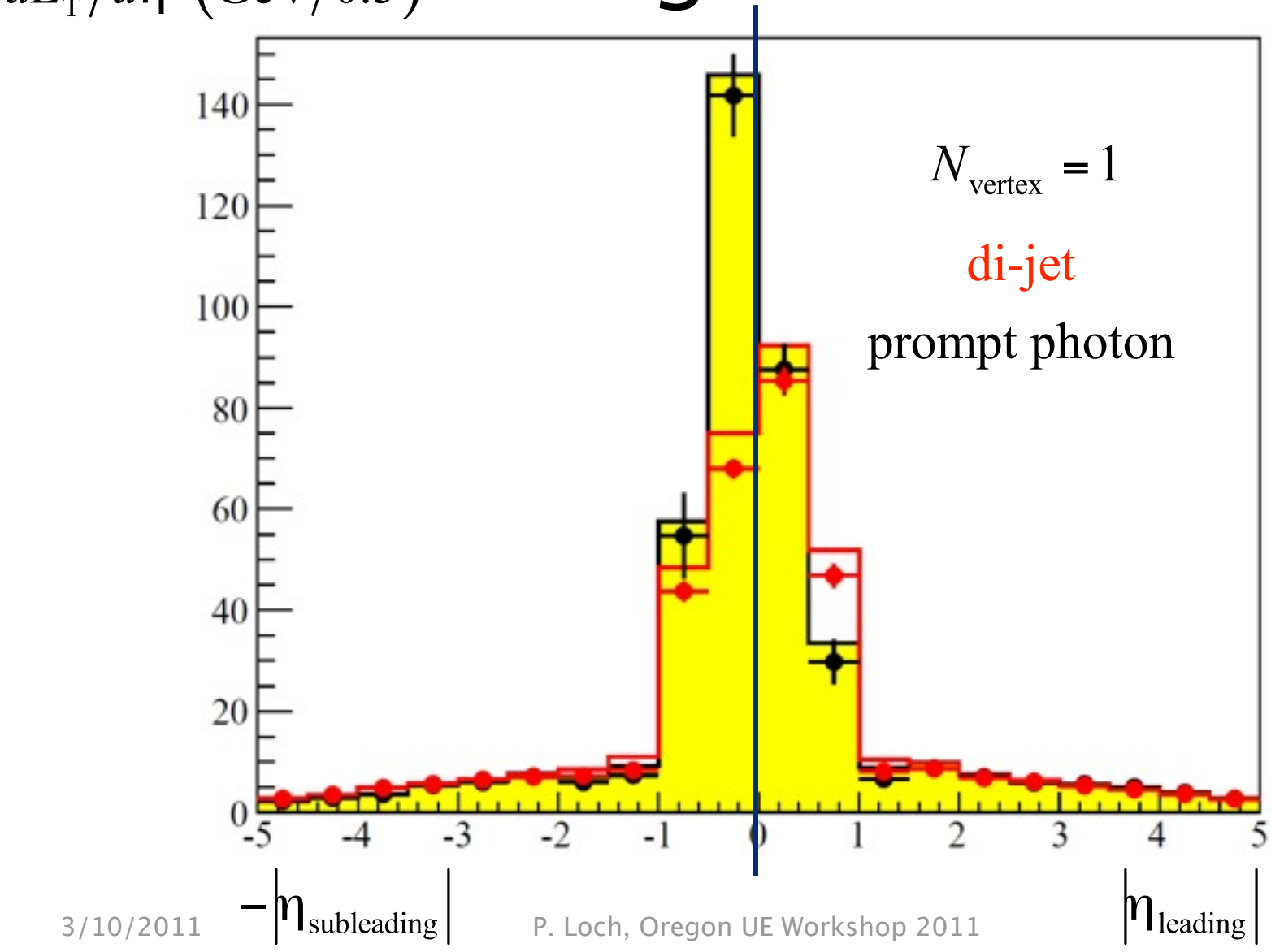
- Detector effects
  - Acceptance
    $E > 1\ \mathrm{GeV}$
  - Gaussian Fluctuations

$$\sigma = \sqrt{a^2 E + c^2}$$

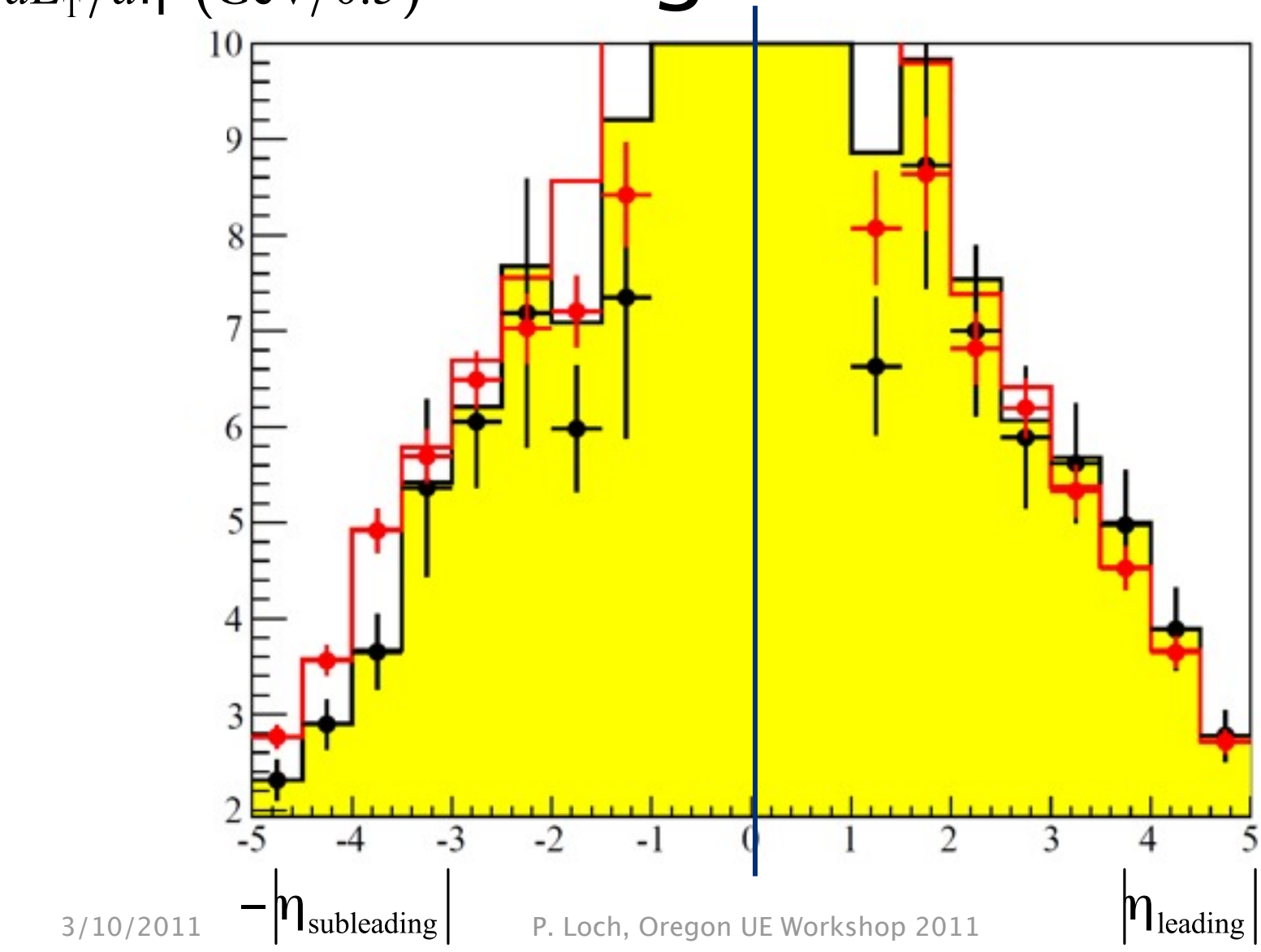
Average Et Flow



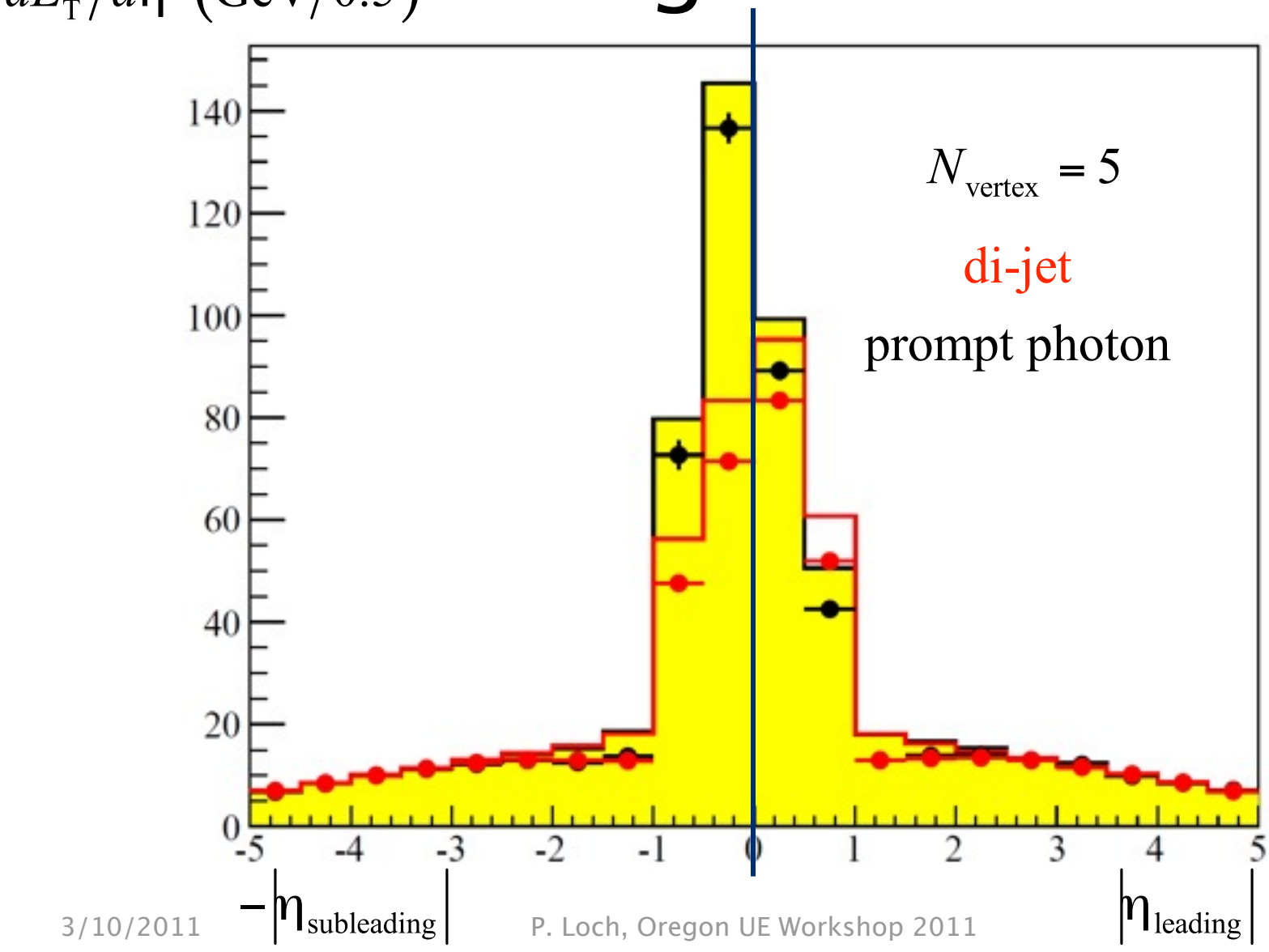
Average Et Flow



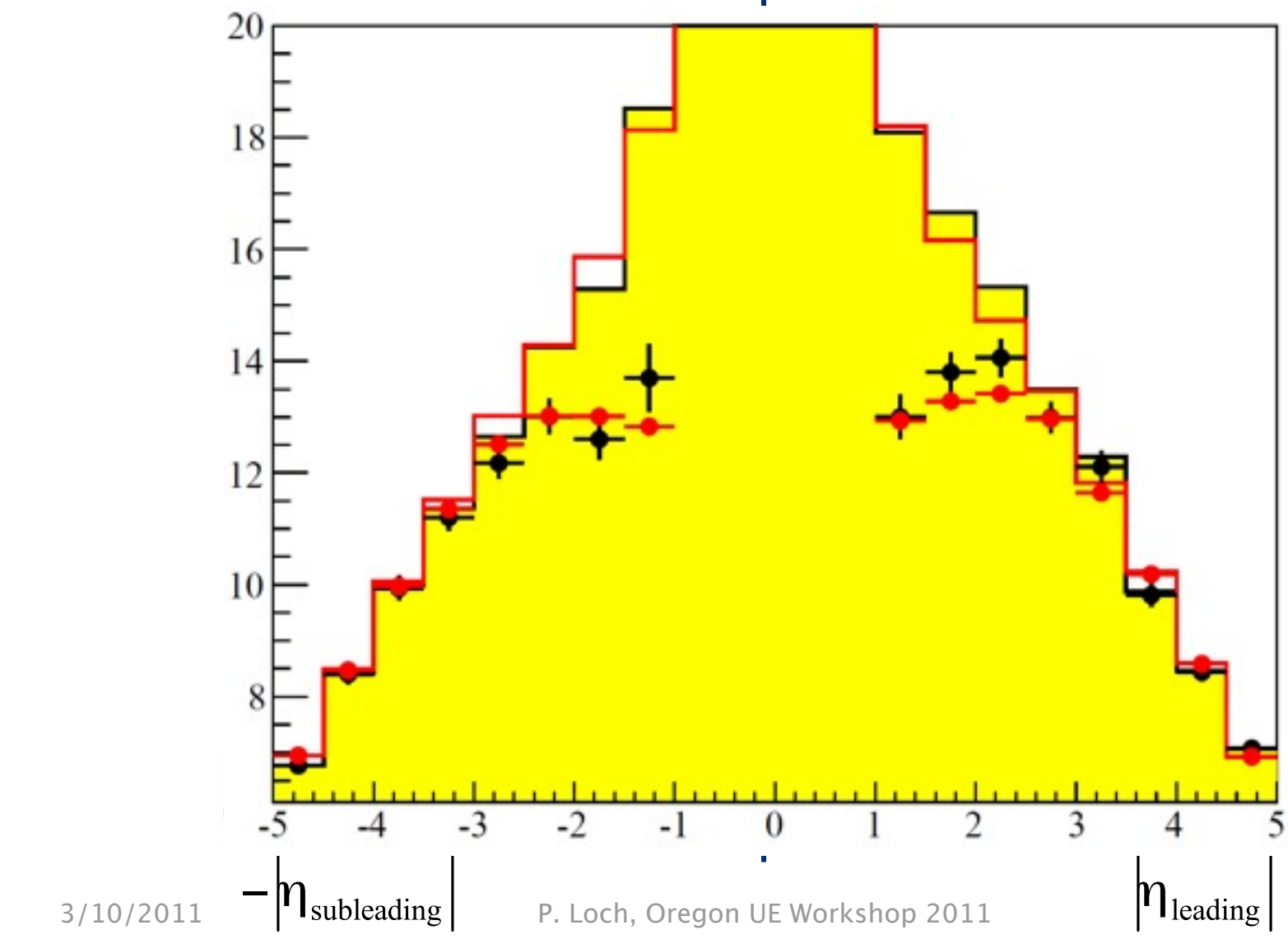
Average Et Flow



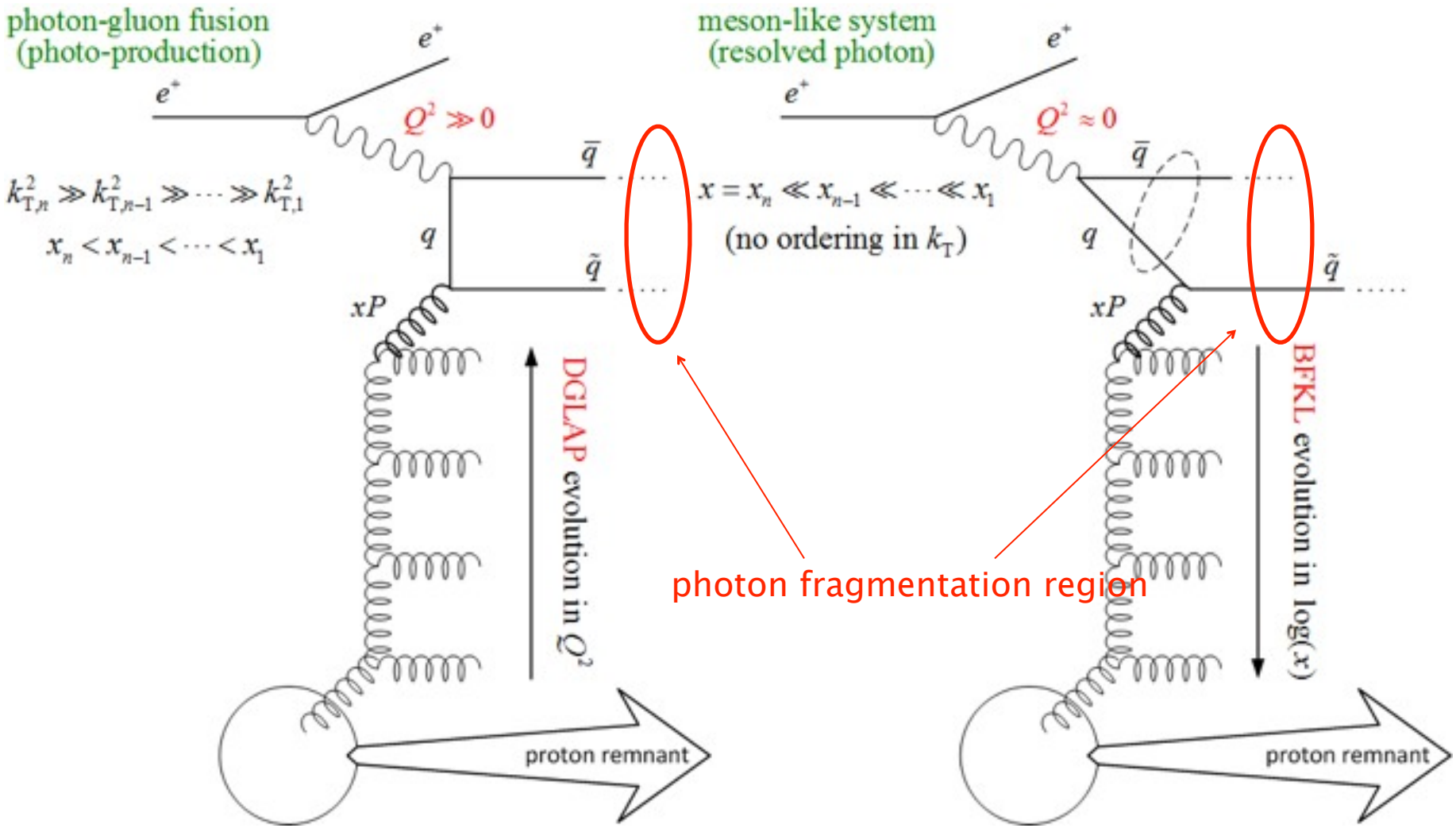
Average Et Flow



Average Et Flow

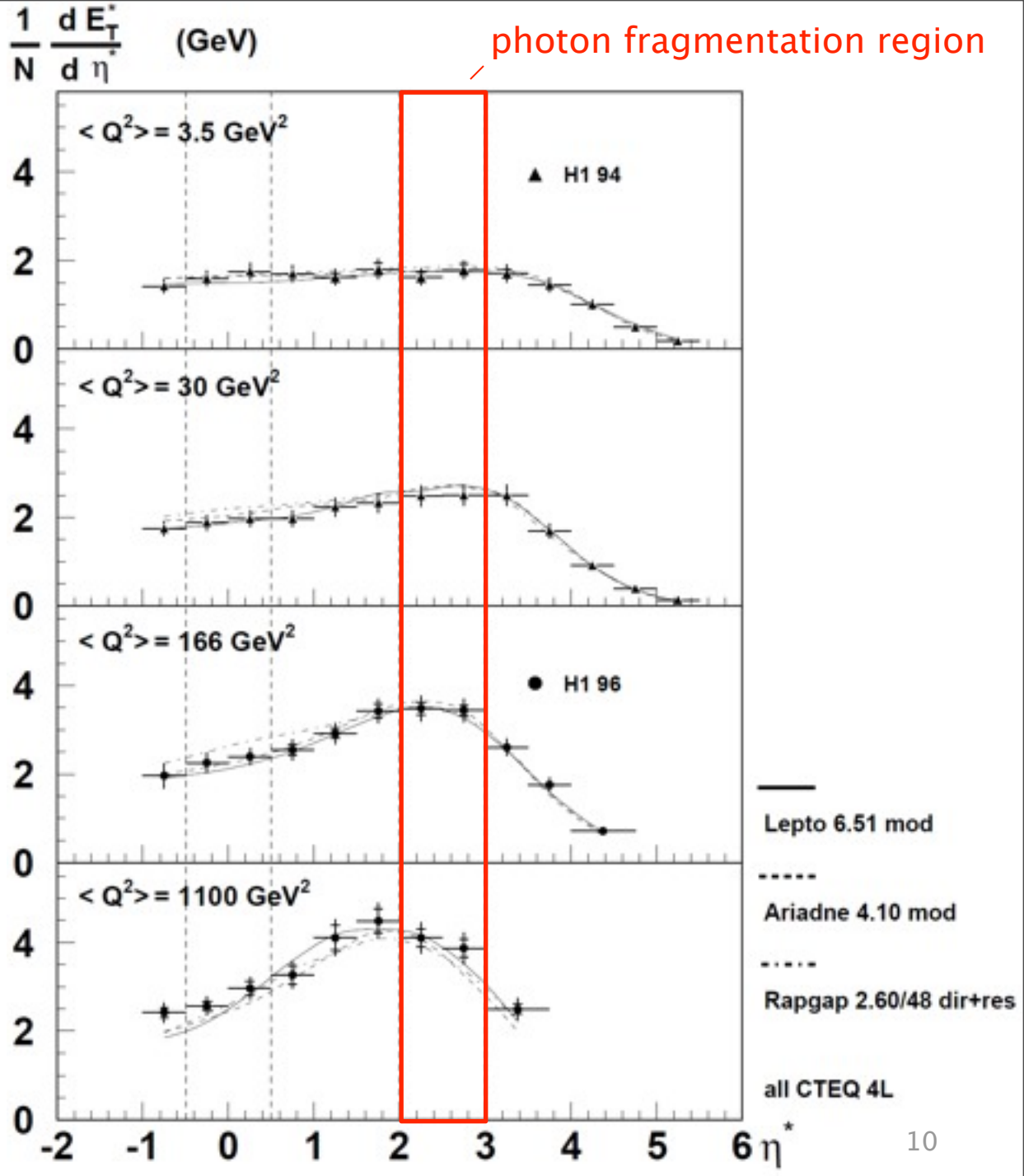


Deep Inelastic Scattering (1)

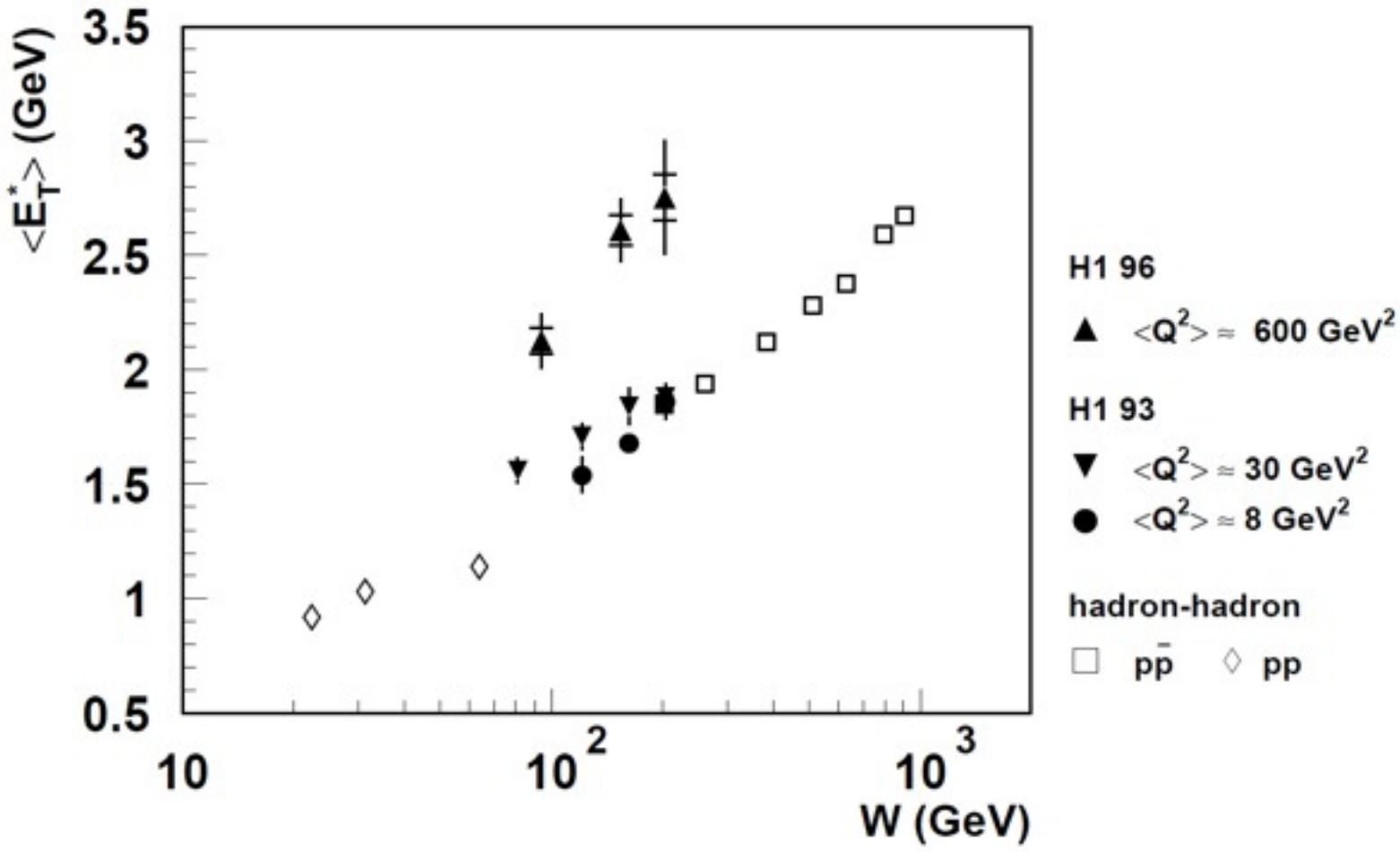


Deep Inelastic Scattering

Hadronic center-of-mass in DIS at HERA



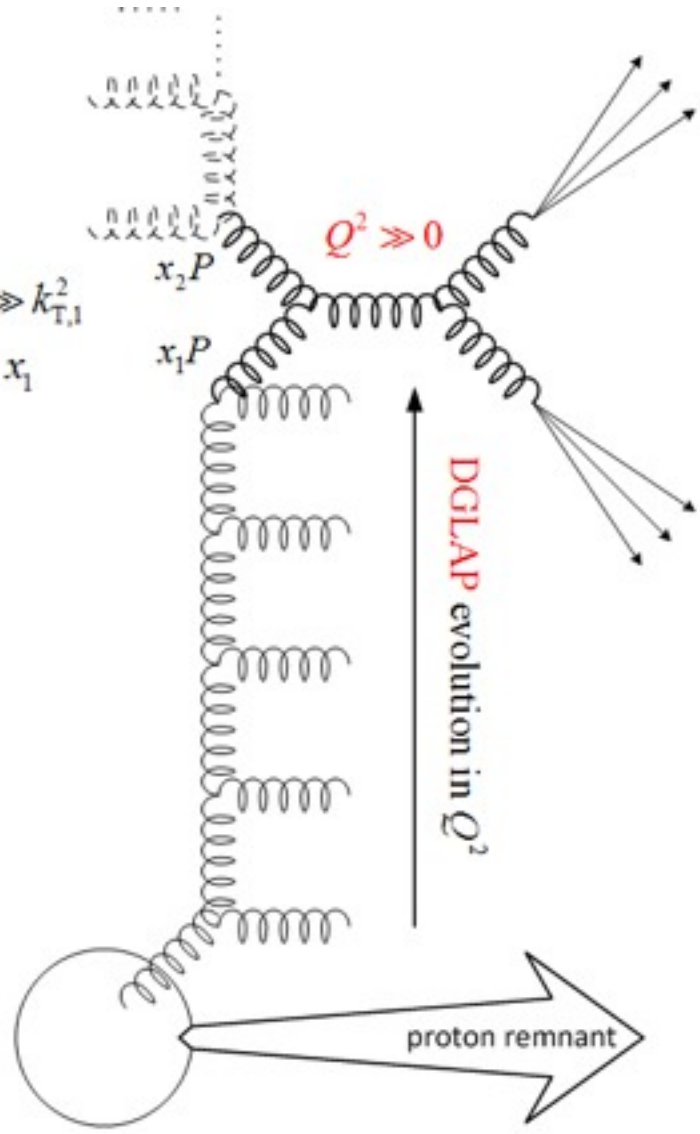
Deep Inelastic Scattering (3)

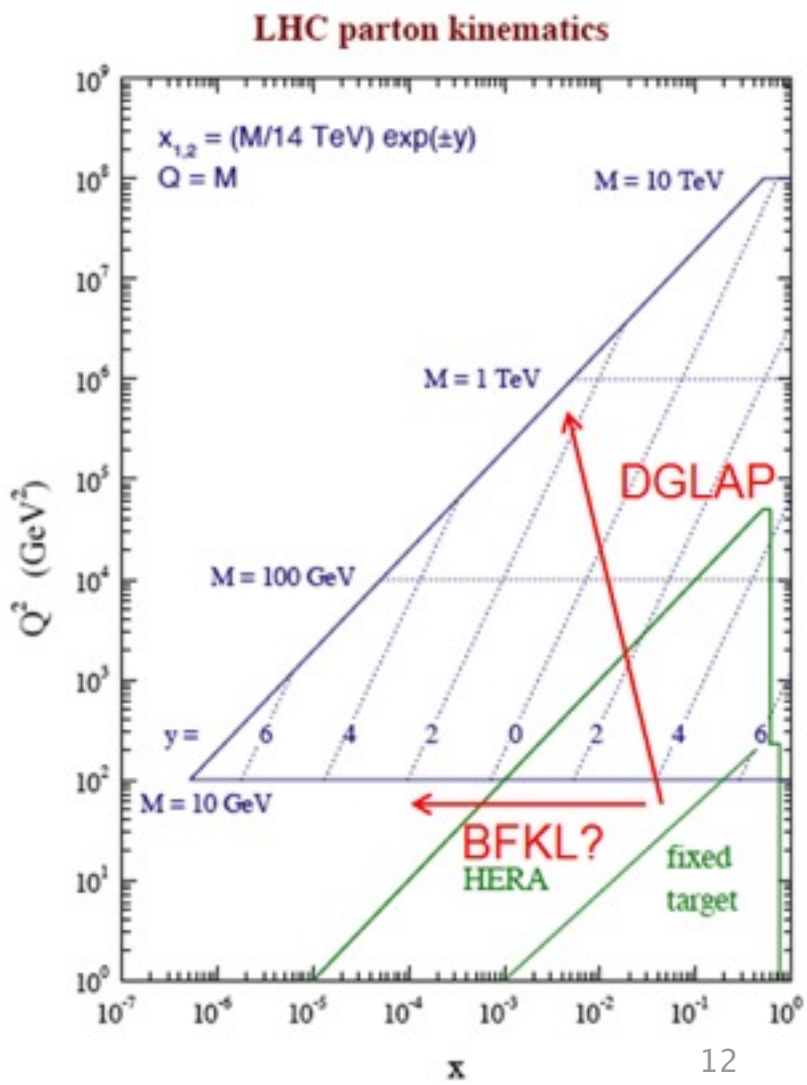


pp at LHC: QCD 2→2

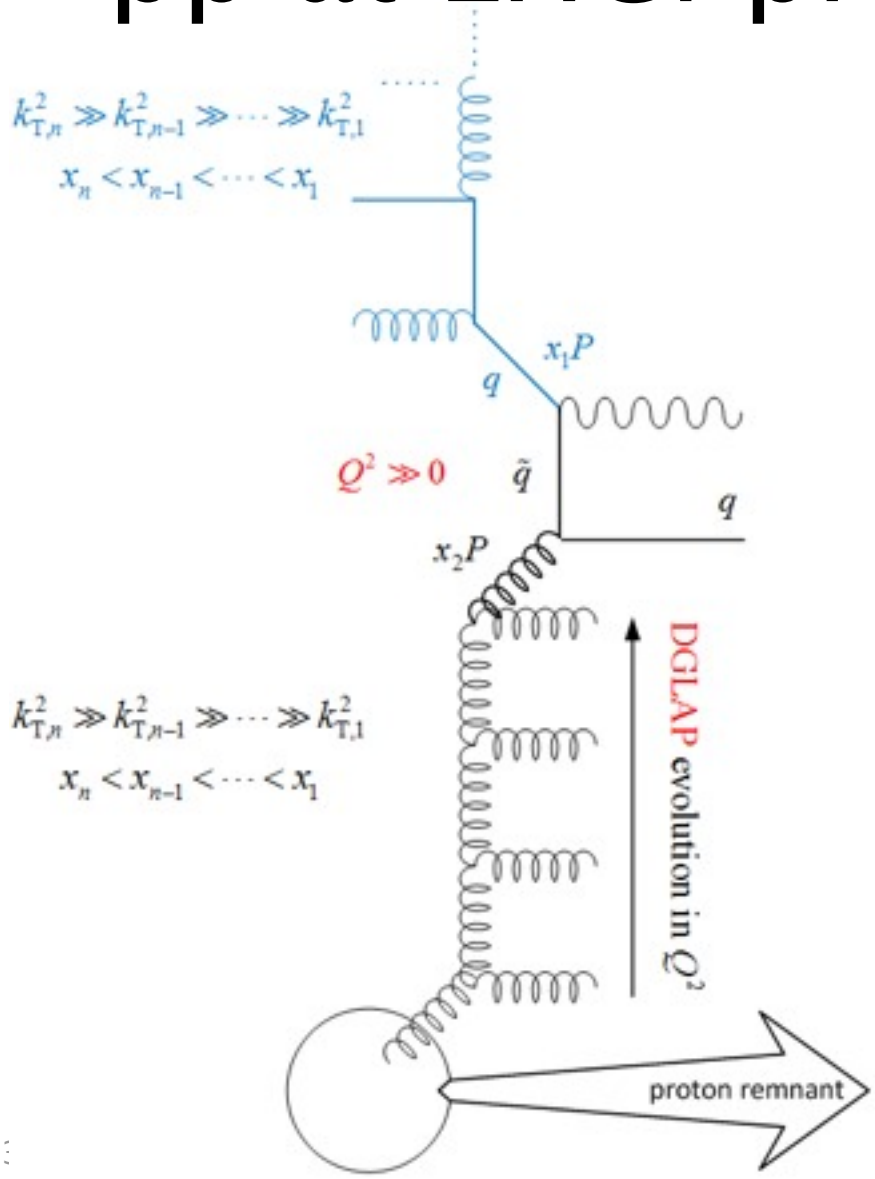
$$k_{T,n}^2 \gg k_{T,n-1}^2 \gg \cdots \gg k_{T,1}^2$$

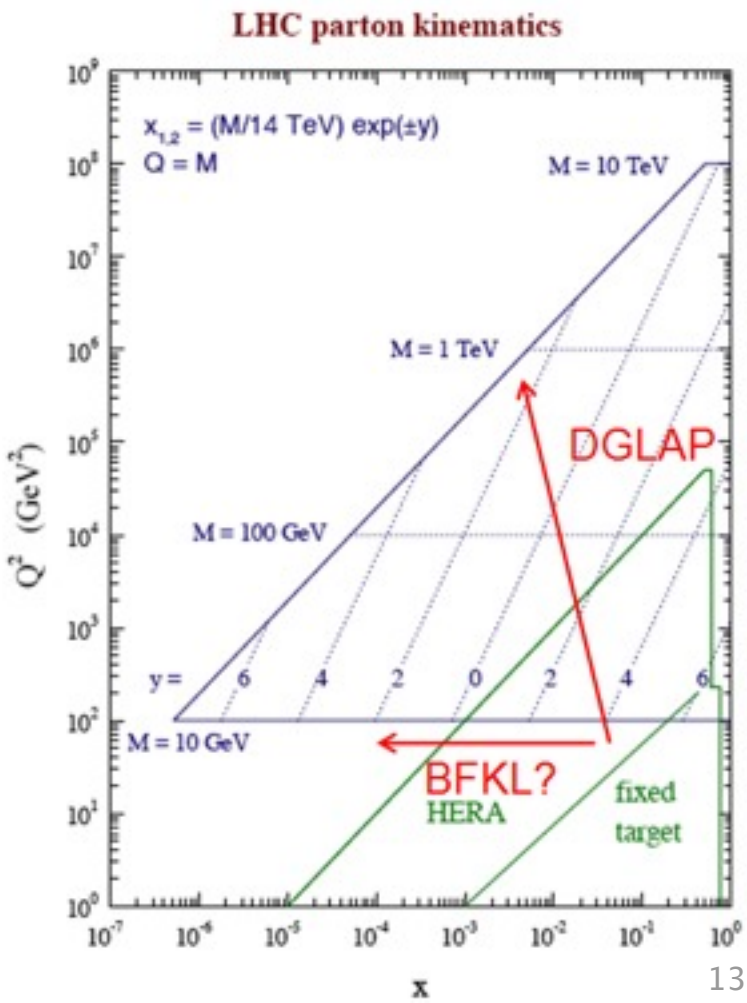
$$x_n < x_{n-1} < \cdots < x_1$$





pp at LHC: prompt photon





pp at LHC: soft QCD (UE,