SOFT **and** ***HARD*** **INTERACTIONS in** $\bar{p}p$ **COLLISIONS at** $\sqrt{s}$**= 1800 and 630 GeV**

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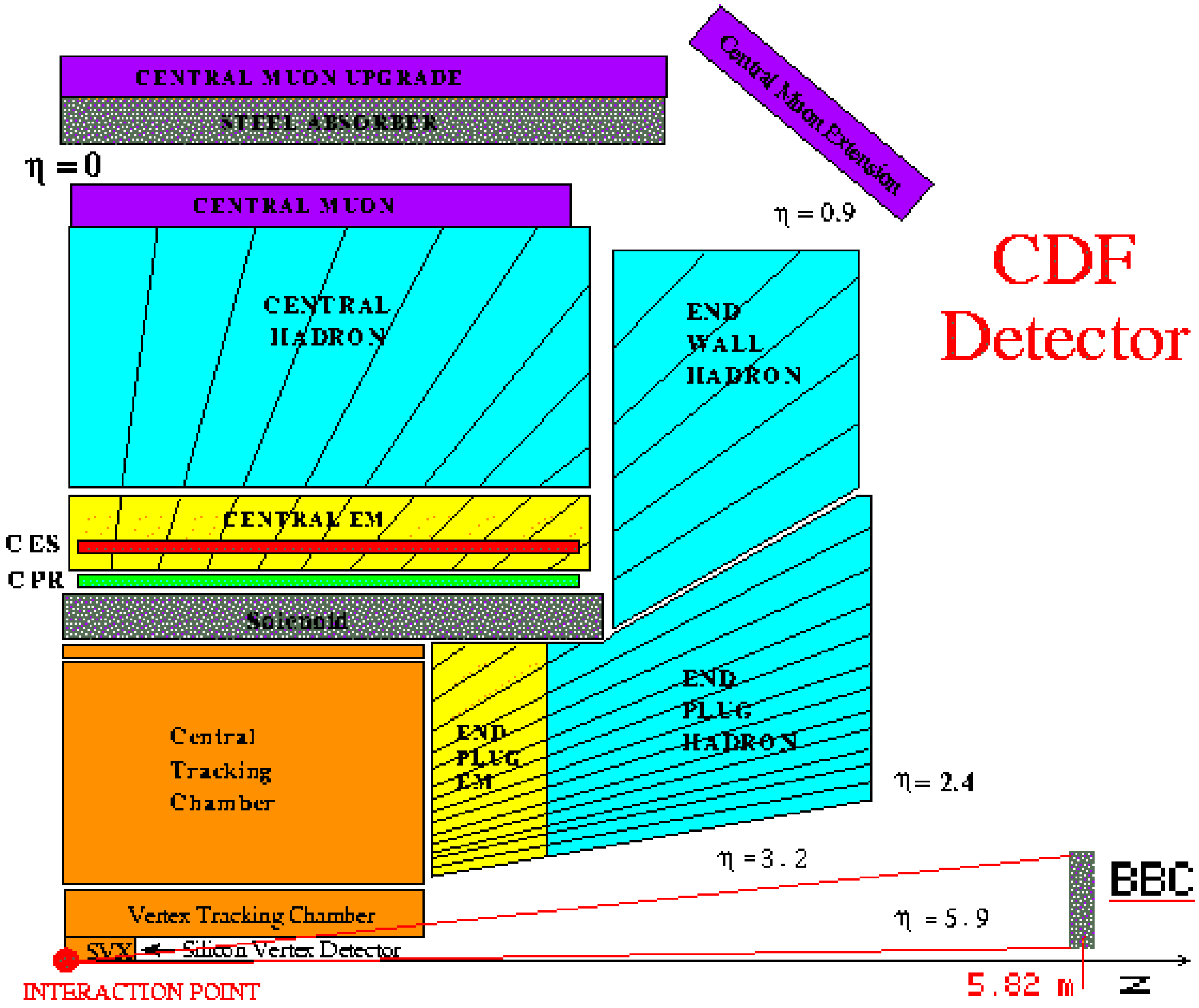
CDF Collaboration

Events collected with a minimum-bias trigger by the CDF detector are splitted into two sub-samples:

Soft sample - Events with no cluster of transverse energy greater than 1.1 GeV in $\mid \eta \mid \leq 2.4$

Hard sample - Events with at least one cluster of transverse energy equal to or greater than 1.1 GeV in $\mid \eta \mid \leq 2.4$

Multiplicity and p_t inclusive distributions, average p_t versus multiplicity dependence and p_t dispersions as a function of the multiplicity are compared for the two samples at the two center of mass energies



CENTRAL MUON UPGRADE
STEEL ABSORBER
Central Muon Extension
$\eta = 0$
CENTRAL MUON
$\eta = 0.9$
CDF
Detector
CENTRAL
HADRON
END
WALL
HADRON
CENTRAL EM
CES
CPR
Solenoid
Central
Tracking
Chamber
END
PLUG
EM
END
PLUG
HADRON
$\eta = 2.4$
$\eta = 3.2$
BBC
Vertex Tracking Chamber
$\eta = 5.9$
SVX
Silicon Vertex Detector
INTERACTION POINT
5.82 m
Z

Minimum Bias Trigger: coincidence hits in BBC located at 5.8m from the nominal vertex position and covering 5.4 units in η.

Event collected in runs 1A, 1B and 1C.
3,300,000 triggers at $\sqrt{s}=$ 1800 GeV
2,600,000 triggers at $\sqrt{s}=$ 630 GeV

Event selection:

- Standard CDF offline event selection;
- Event vertex in ± 60 cm from the nominal vertex position;
- One single primary vertex (rejection of multi-interaction events).

After selection:
2,068,999 triggers at $\sqrt{s}=$ 1800 GeV
1,966,645 triggers at $\sqrt{s}=$ 630 GeV

Track Selection

Besides standard offline track selection:

- impact parameter d $\leq$ 0.5 cm;
- $\mid Z_o - Z_{vertex} \mid \leq 5$ cm;

To ensure full CTC efficiency only tracks with $p_t \geq 0.4$ GeV/c and $\mid \eta \mid \leq 1.0$ are accepted.

With these selections:

Multiplicity $\Rightarrow$ Number of CTC selected tracks

Average $\mathbf{p}_t$ $\Rightarrow$

$$\bar{p}_t = \frac{1}{N} \sum_i^N p_{t_i}$$

Efficiencies

Pythia MB events generated and simulated through QFL.

Efficiencies include corrections for:

- secondary interactions
- γ conversion
- neutral particle decays

- $\mathcal{E}(\eta) \simeq$ constant $\simeq$ 98 %
- $\mathcal{E}(\mathrm{p}_t) \simeq$ constant $\simeq$ 1 up to p $\simeq$3.5 GeV/c
- $\mathcal{E}(\mathrm{mult}) \simeq$ 1 up to mult $\simeq$ 20 then dropping to 80 % from mult $\simeq$ 20 to mult $\simeq$ 40

All plots corrected for efficiencies

Soft **and** ***Hard*** **Interactions**

Cluster finder algorithm identifies energy clusters of a minimum transverse energy of 1.1 GeV in a cone radius of 0.7

Correction applied for energy loss in the calorimeter cracks
($|\eta| \leq 0.1$, $0.92 \leq |\eta| \leq 1.2$)
with a track cluster algorithm

Minimum Bias sample splitted into two subsamples:

- events with no cluster in $|\eta| \leq 2.4$
- events with at least one cluster in $|\eta| \leq 2.4$

Cluster Definition

A seed calorimeter tower with at least 1 GeV transverse energy

+

at least a contiguous tower with $E_t \geq 0.1$ GeV

Two different measurement of the average p_t at each multiplicity

- Mean p_t of the "observed" tracks

$$\langle p_t \rangle = \frac{1}{N} \sum_i^N p_{t_i}$$

- True value of the average p_t obtained fitting the p_t distribution at each multiplicity to the form

$$f(p_t) = A \left(\frac{p_0}{p_t + p_0} \right)^n$$

with A, p_0 and n free parameters

$$\langle p_t \rangle = \frac{2p_0}{n-3}$$

$\boxed{\langle p_t \rangle_{ev}\ \textbf{Dispersion}}$

Dispersion of the mean event p_t at fixed multiplicity m

$$D_m\left(\bar{p}_t\right) = \frac{\langle \bar{p}_t^2 \rangle_m - \langle \bar{p}_t \rangle_m^2}{\langle p_t \rangle_{sample}}$$

where

$$\langle \bar{p}_t \rangle_m = \frac{1}{N_{ev}} \sum_{N_{ev}} \bar{p}_{t_{ev}}$$

(N_{ev} = all events of multiplicity = m)

$$\bar{p}_{t_{ev}} = \frac{1}{m} \sum_i^m p_{t_i}$$

Conclusions

- Multiplicity and transverse momentum distributions in *soft* and *hard* interactions are significantly different. Differences similar at both energies

  In *soft* interactions multiplicity distributions follow KNO scaling

- Transverse momentum distributions **at fixed multiplicity** scale with energy in ***soft* interactions**

  This is visible in single inclusive distributions as well as in $\langle p_t \rangle$ vs multiplicity correlations

  $\Longrightarrow$Independently from c.m.s. energy the $\mathbf{p}_t$ distribution is determined from the event multiplicity

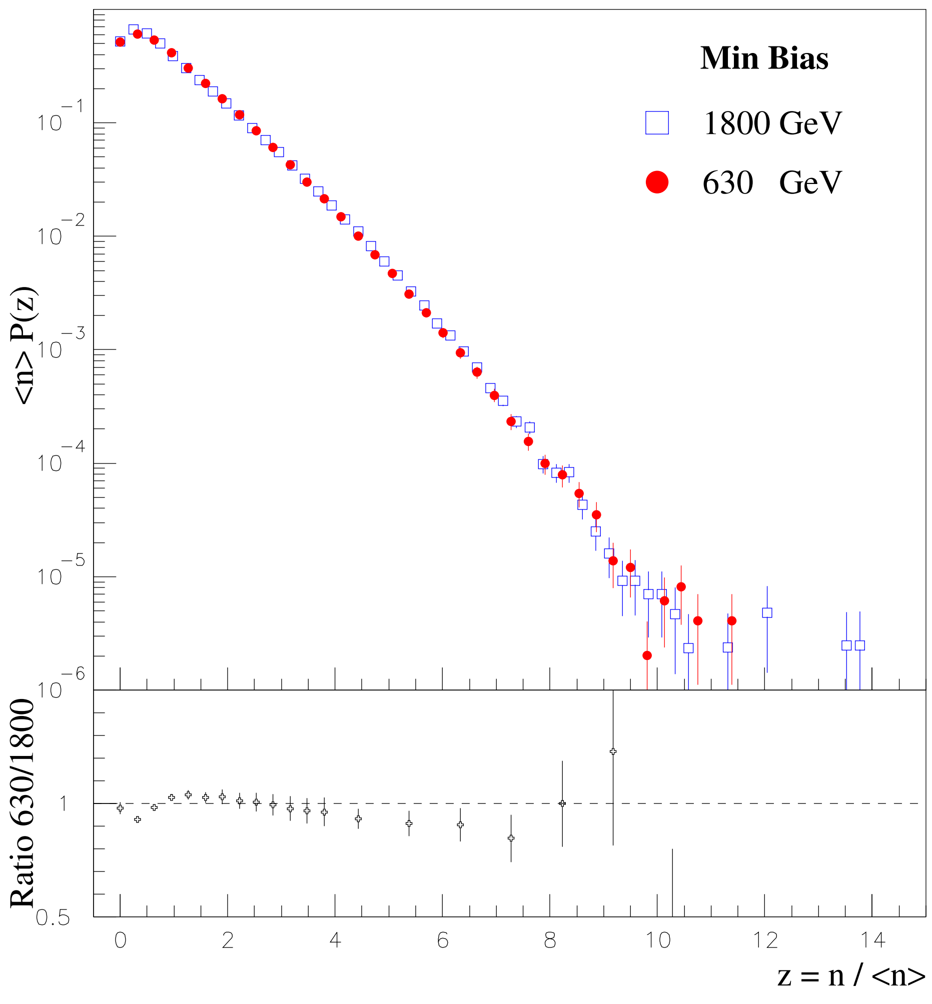
%

- Dispersion of the $\langle p_t \rangle_{ev}$ vs inverse multiplicity for the full MB sample is not linear as it would be expected from Poisson statistics

  Rise at multiplicity ~ 10 due to the *hard* interactions

  In *soft* interactions the slope of the dispersion is consistent with a zero extrapolation at infinite multiplicity

CDF Preliminary



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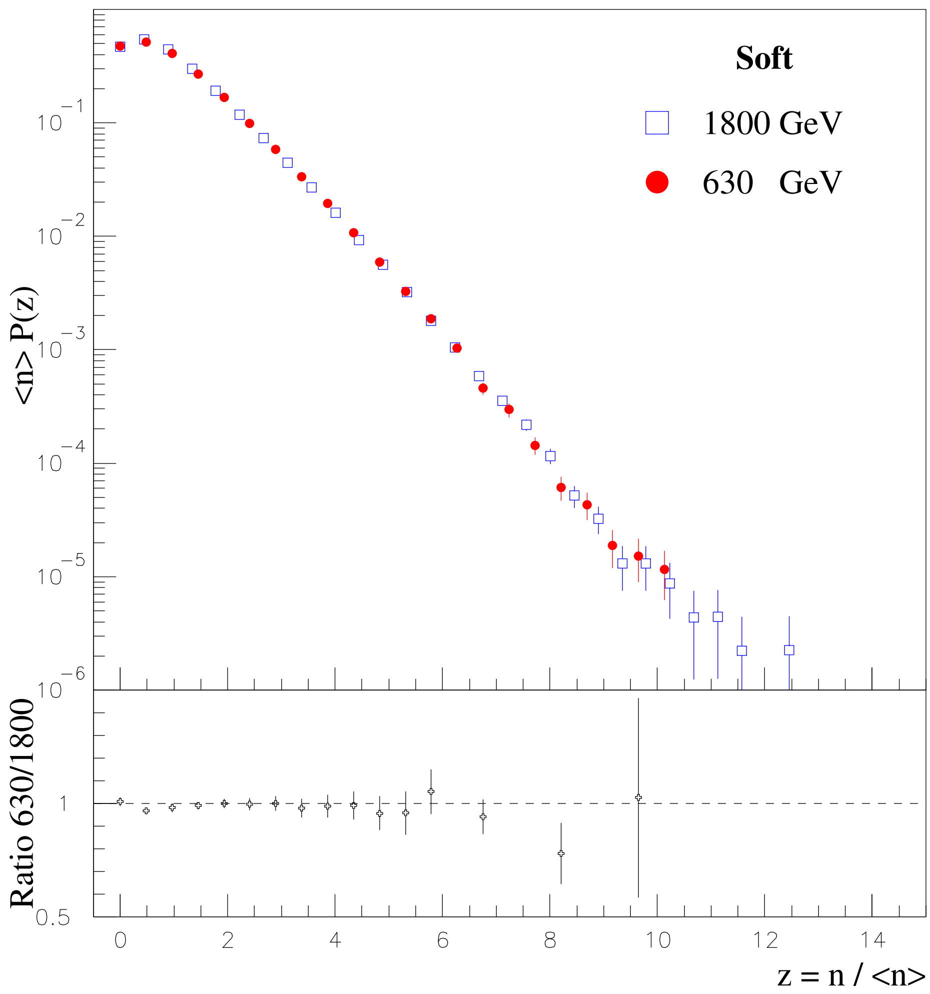

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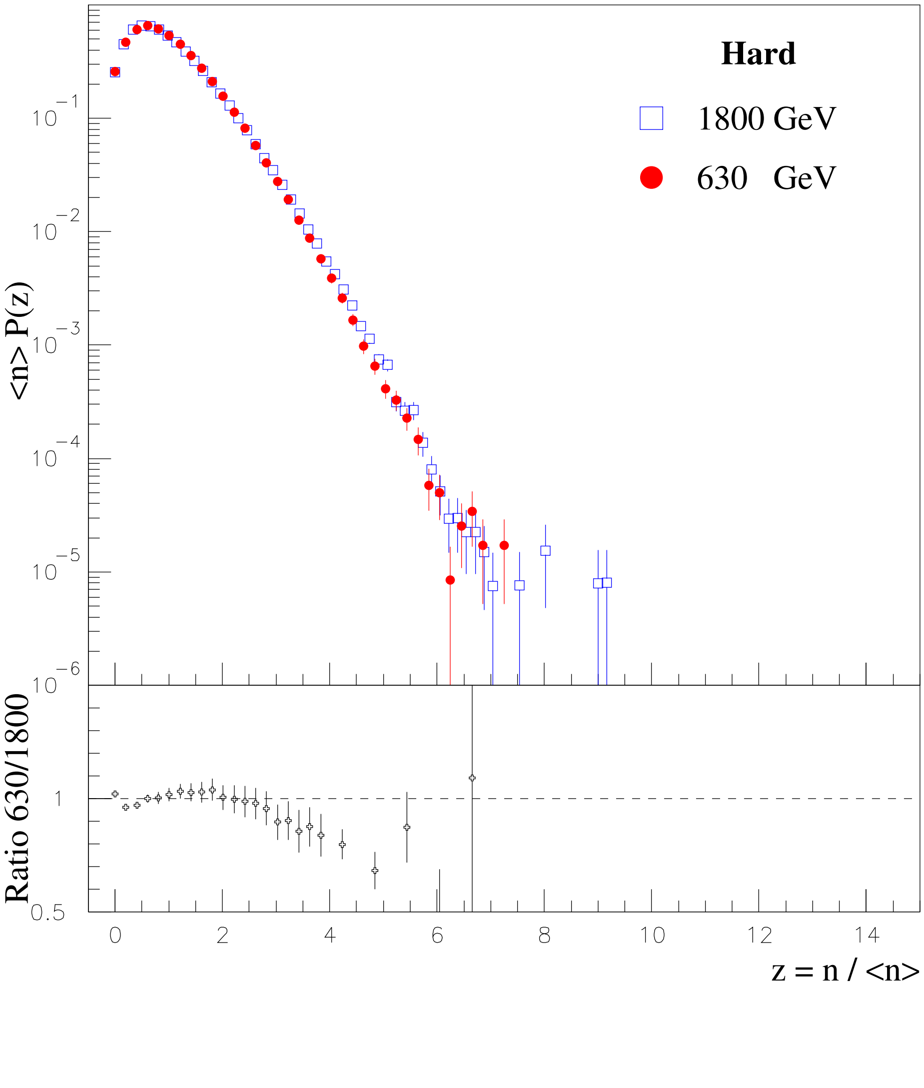

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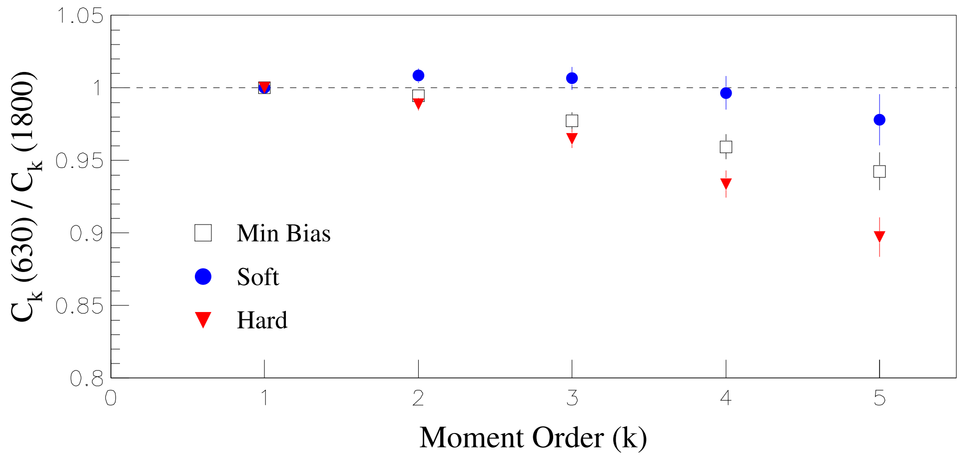

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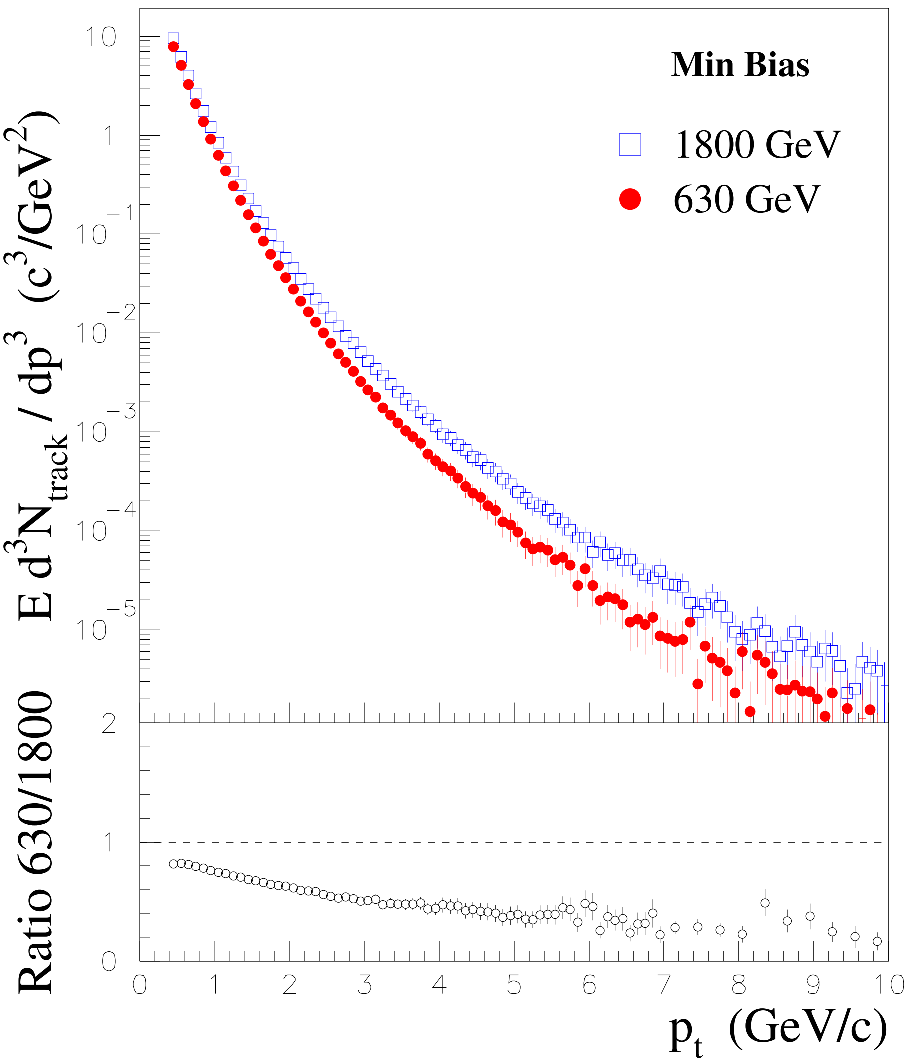

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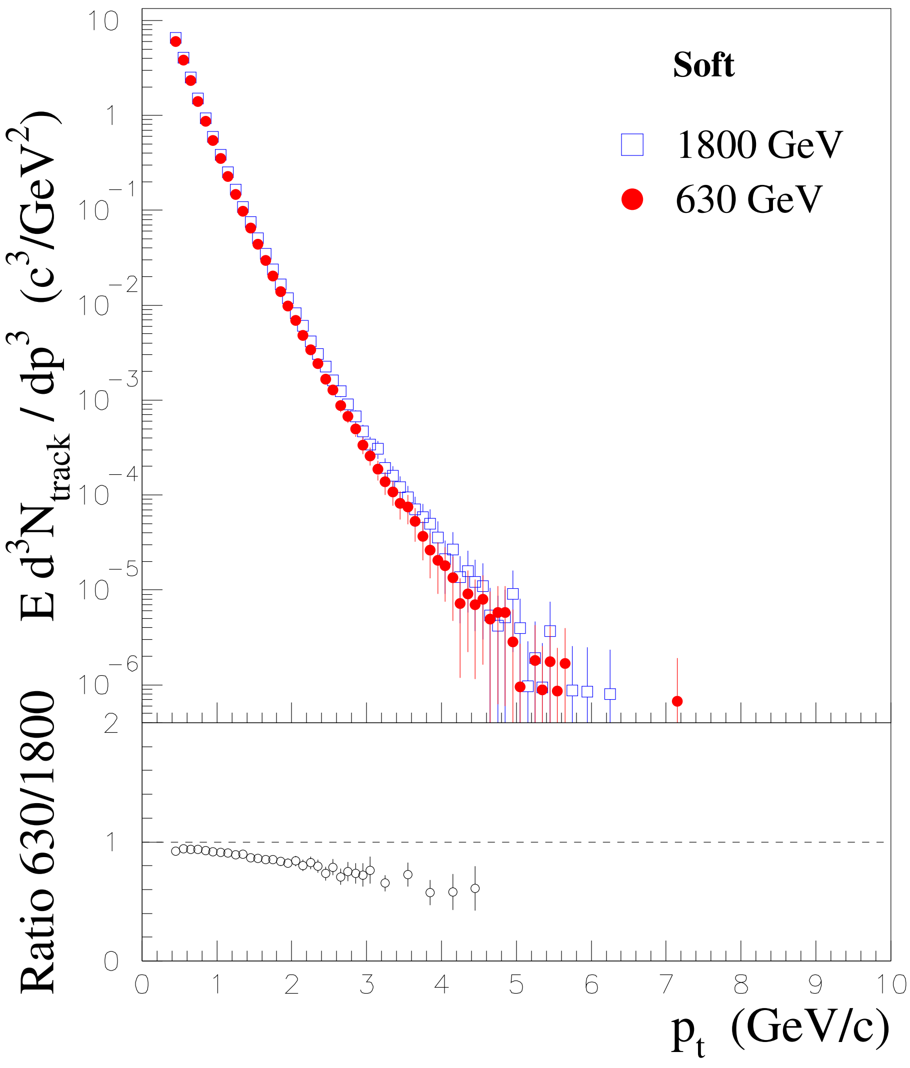

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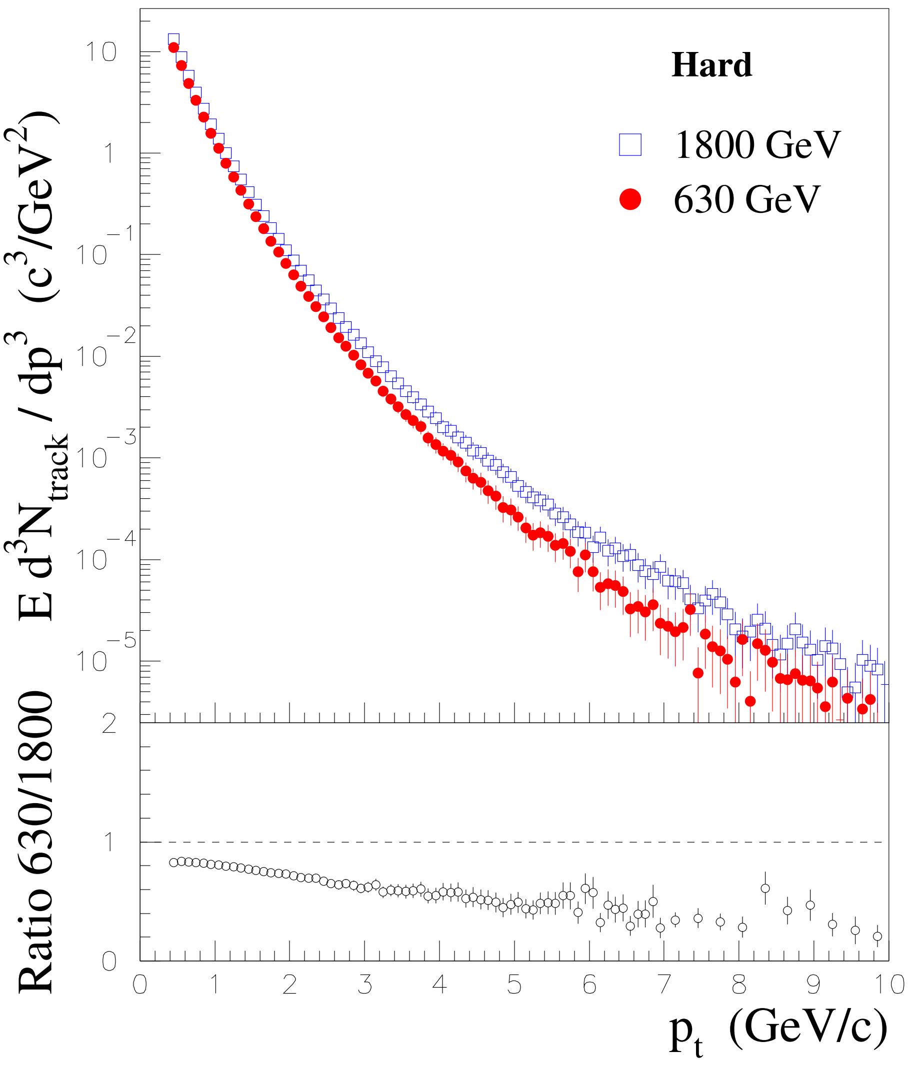

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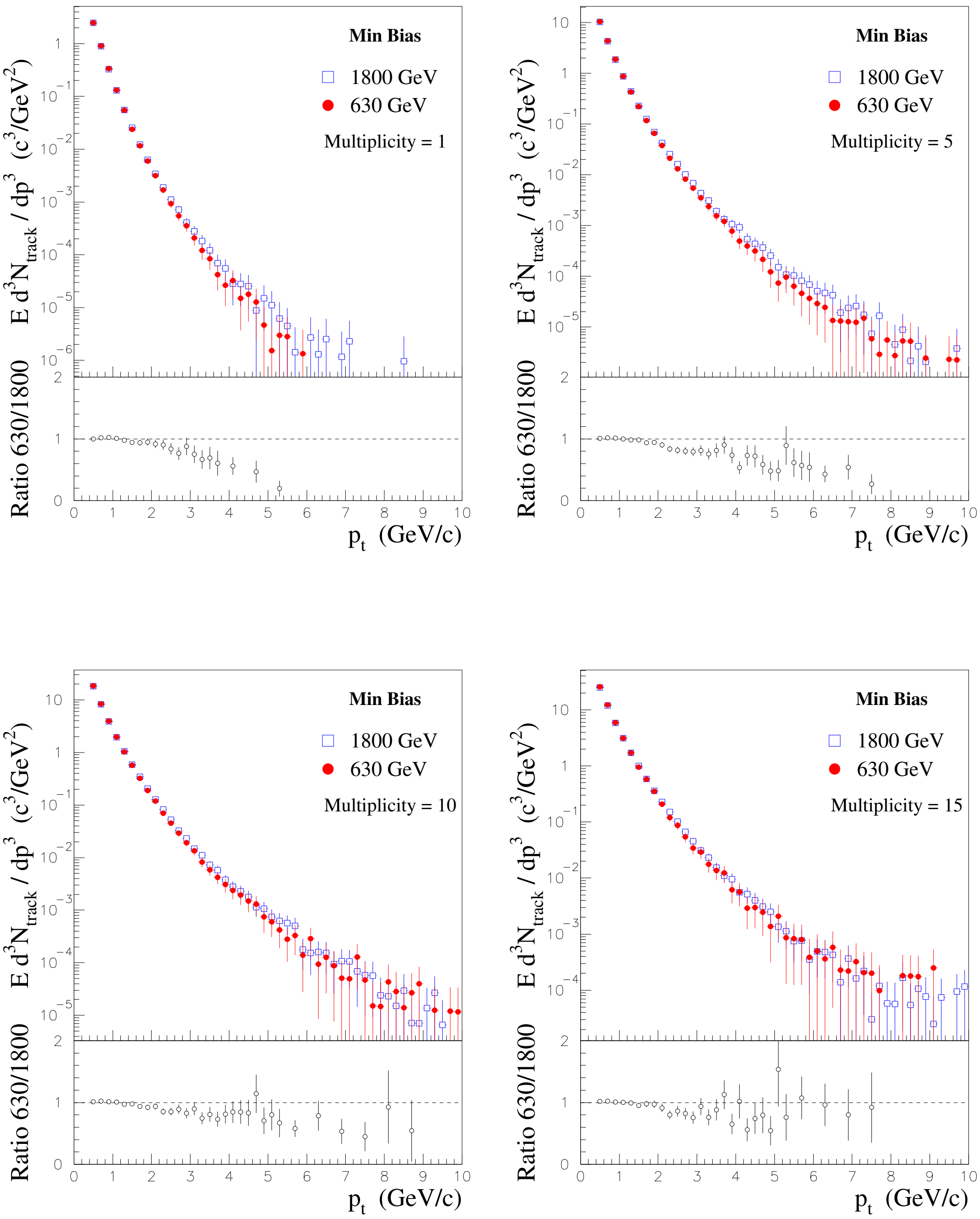

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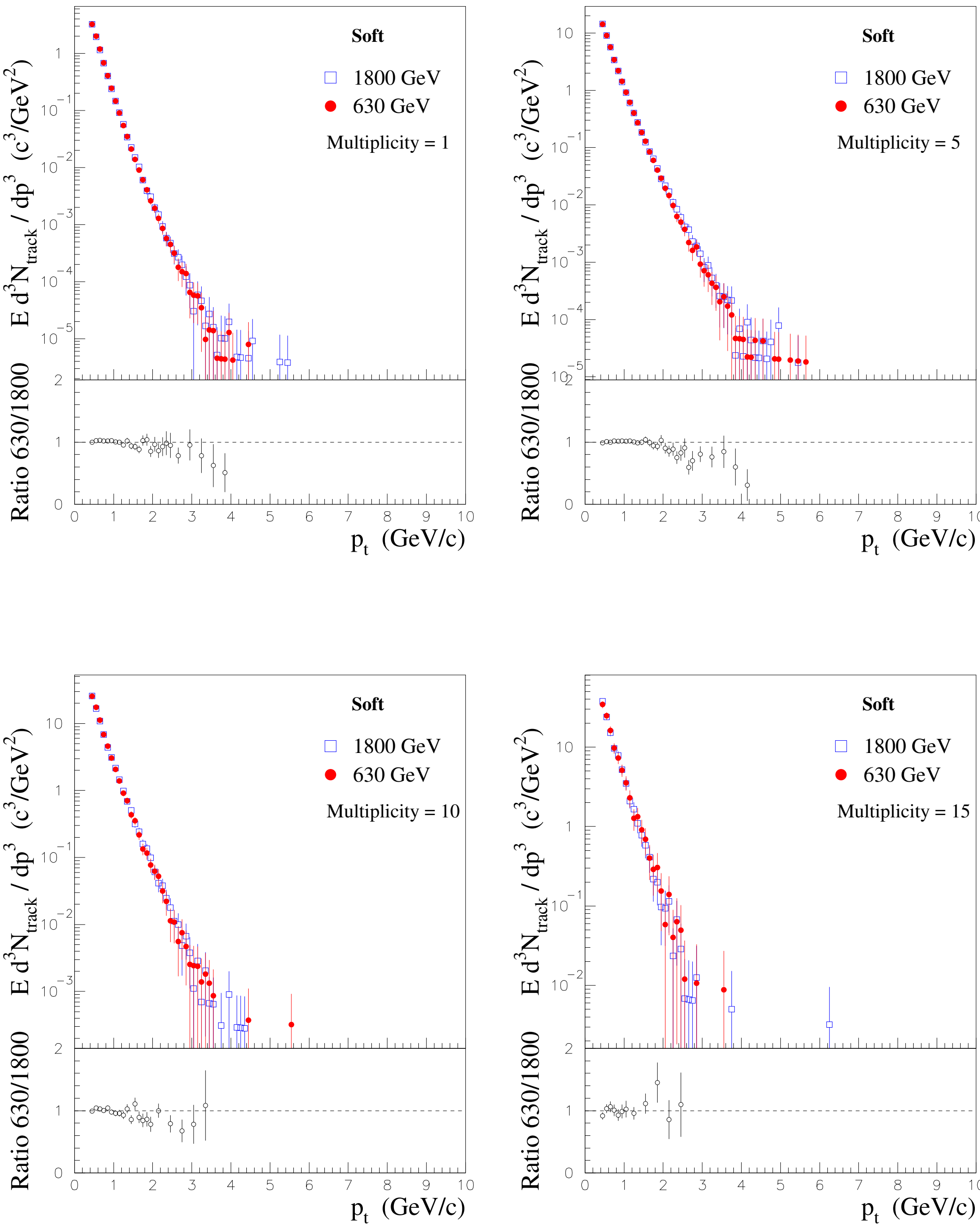

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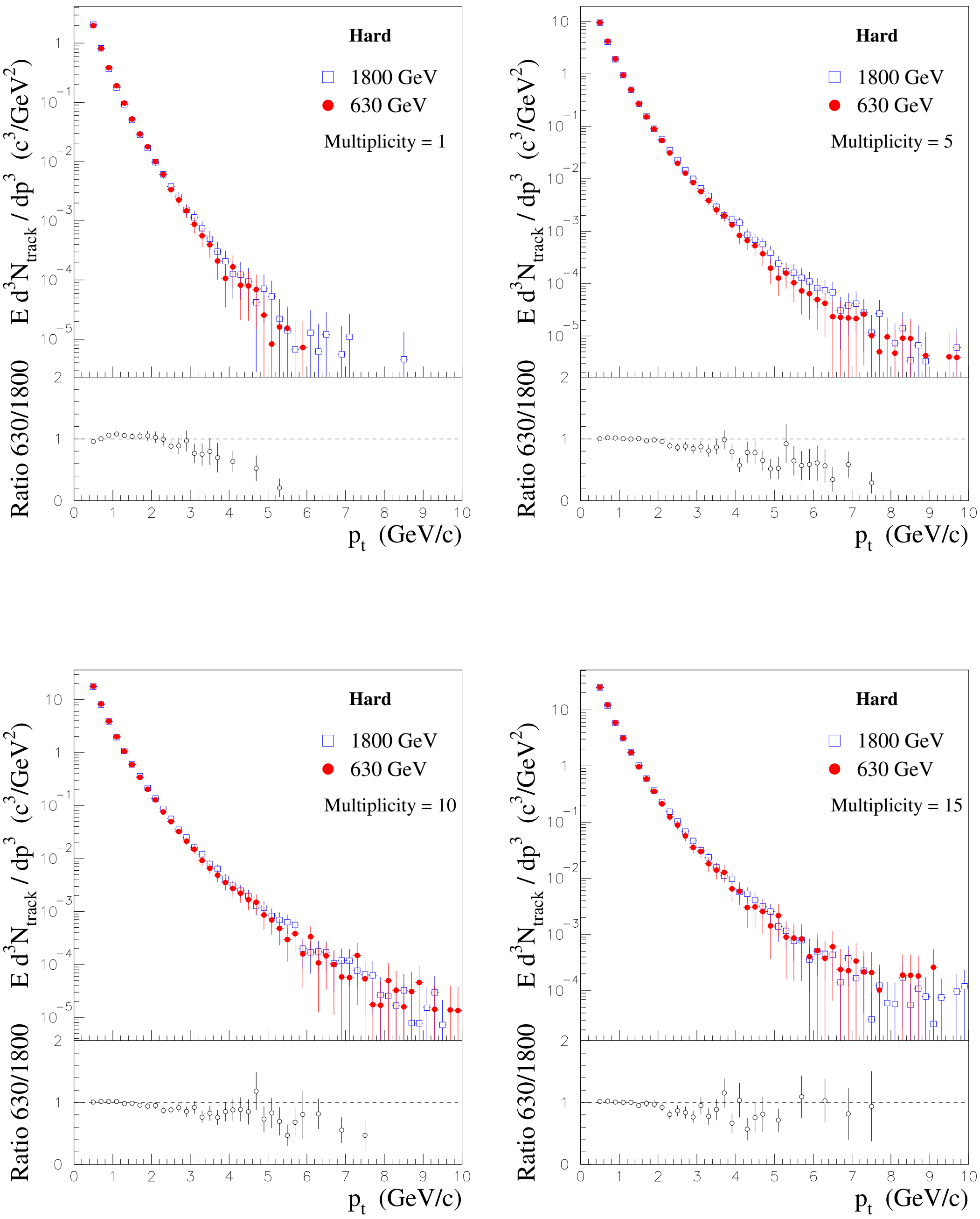

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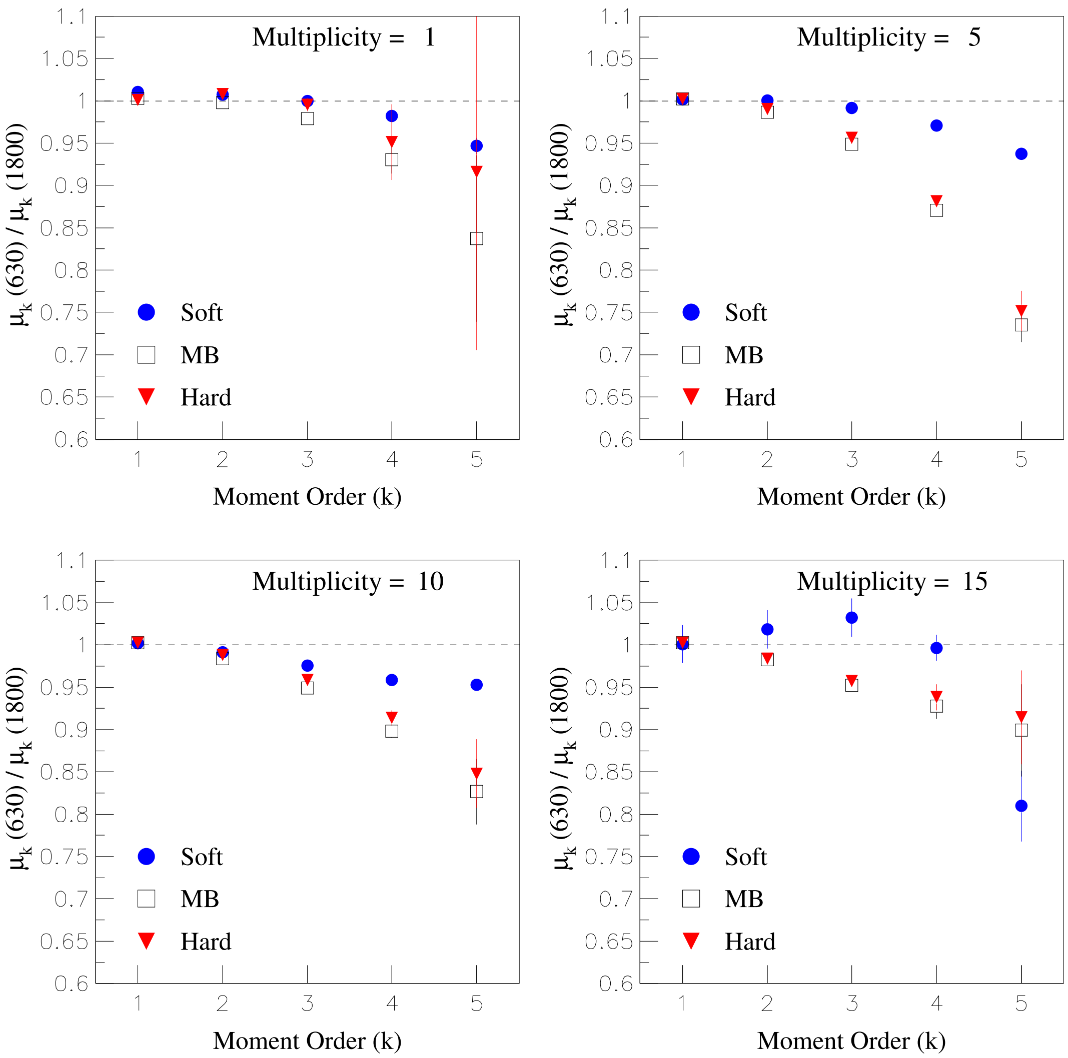

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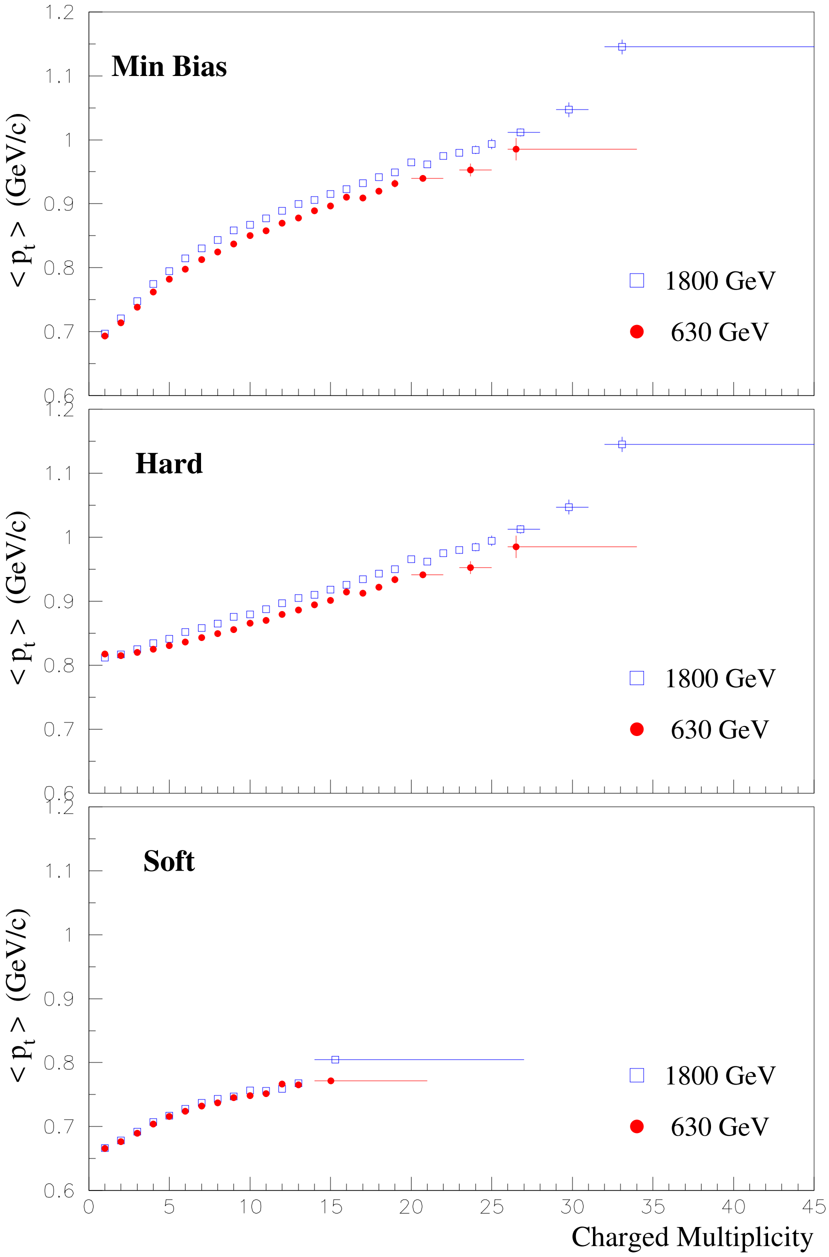
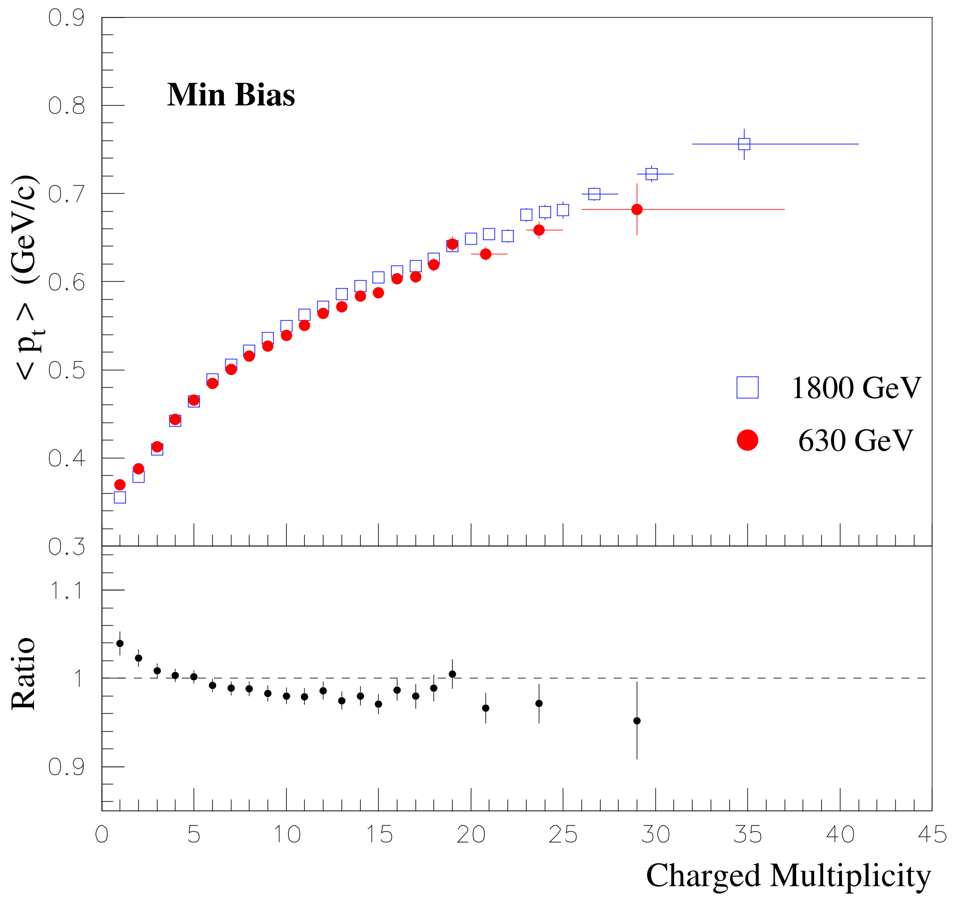


CDF Preliminary

$\langle p_t \rangle$ from fit



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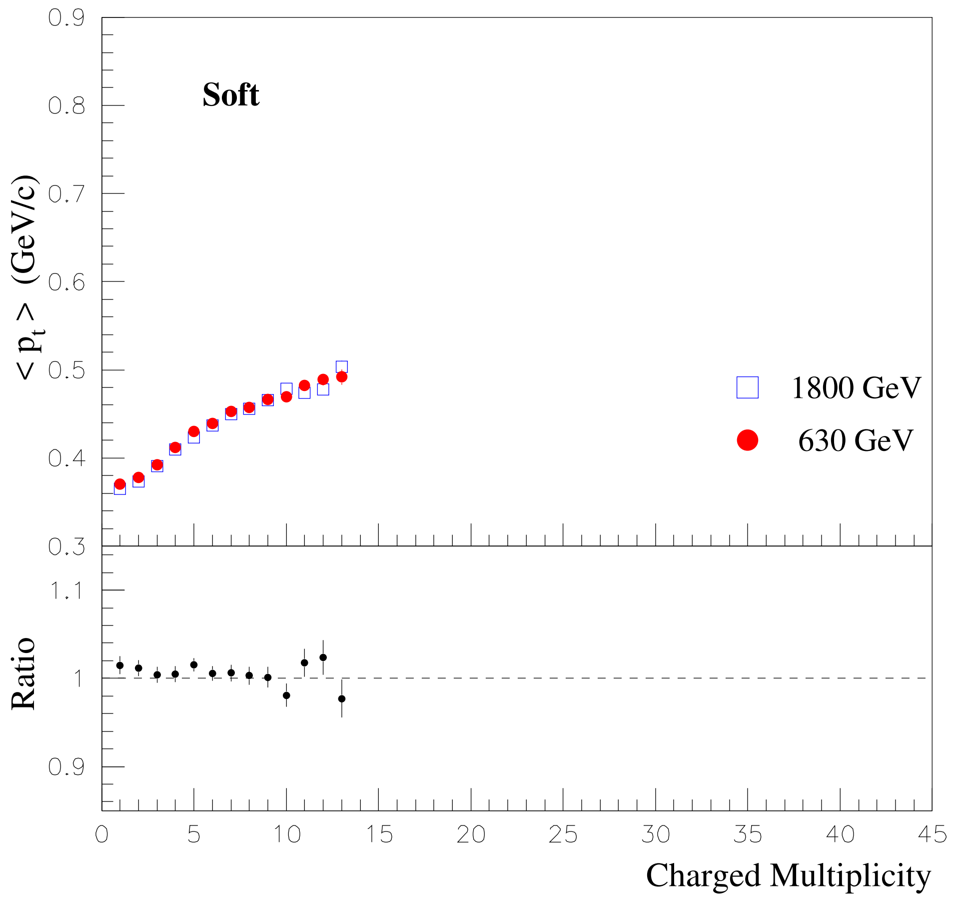

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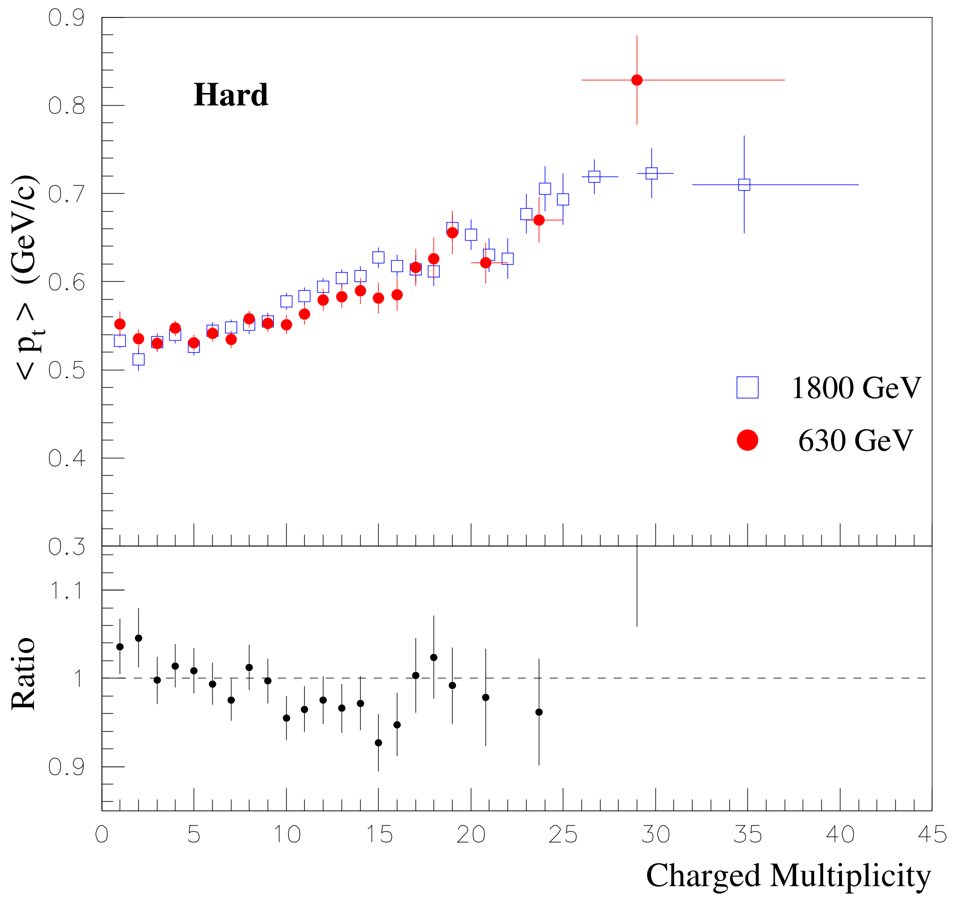

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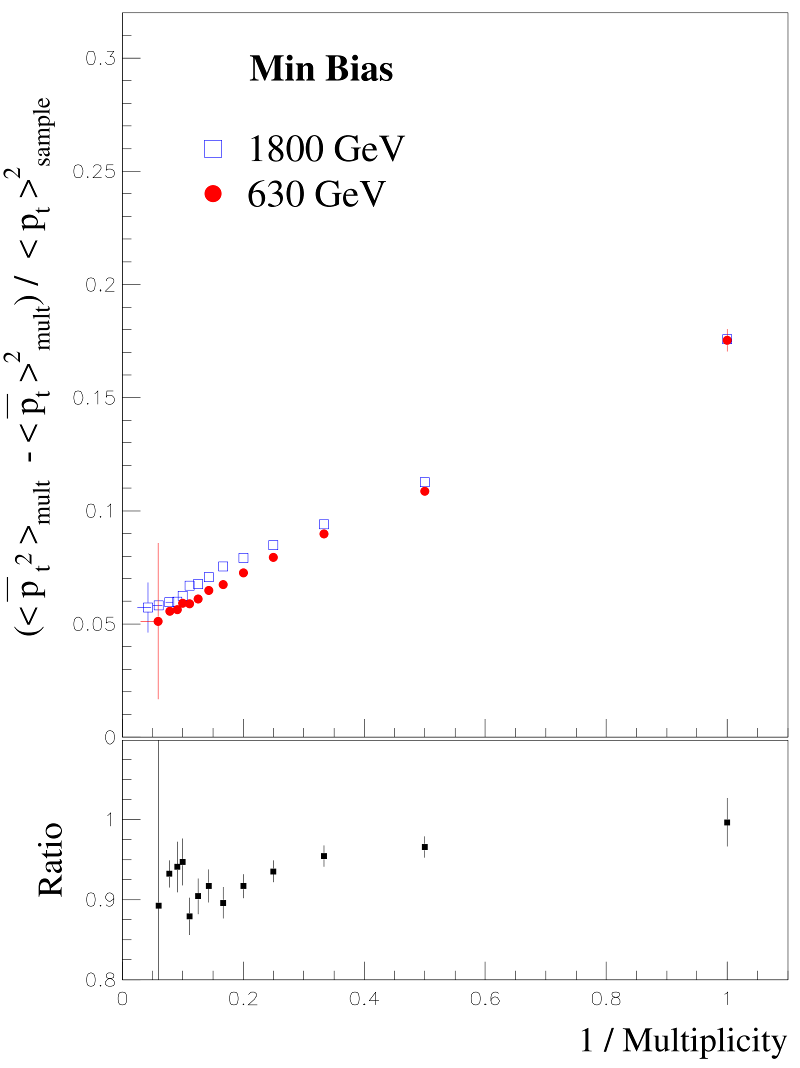

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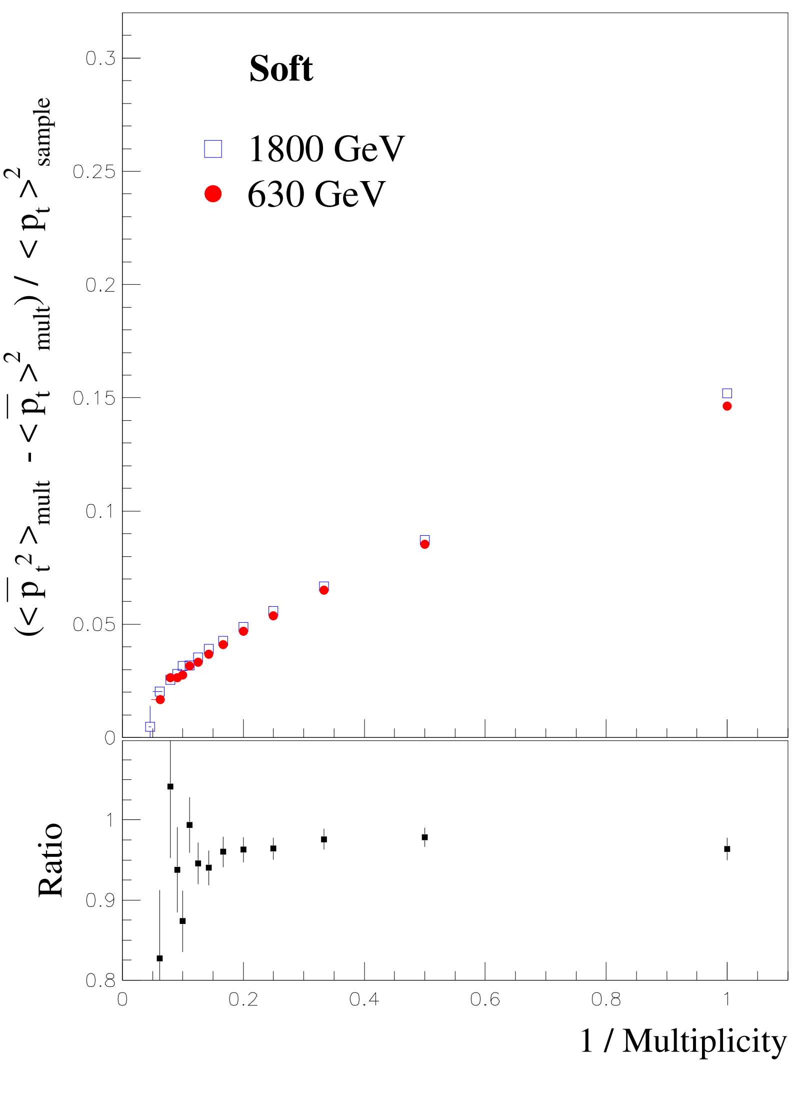

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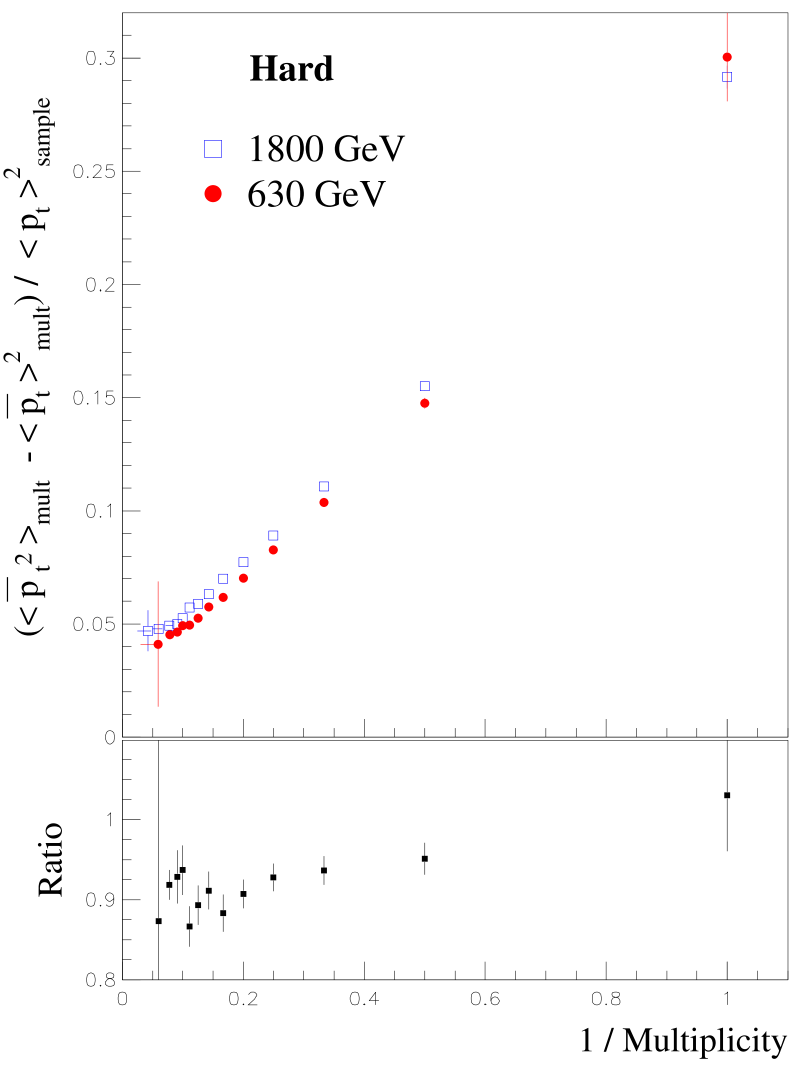

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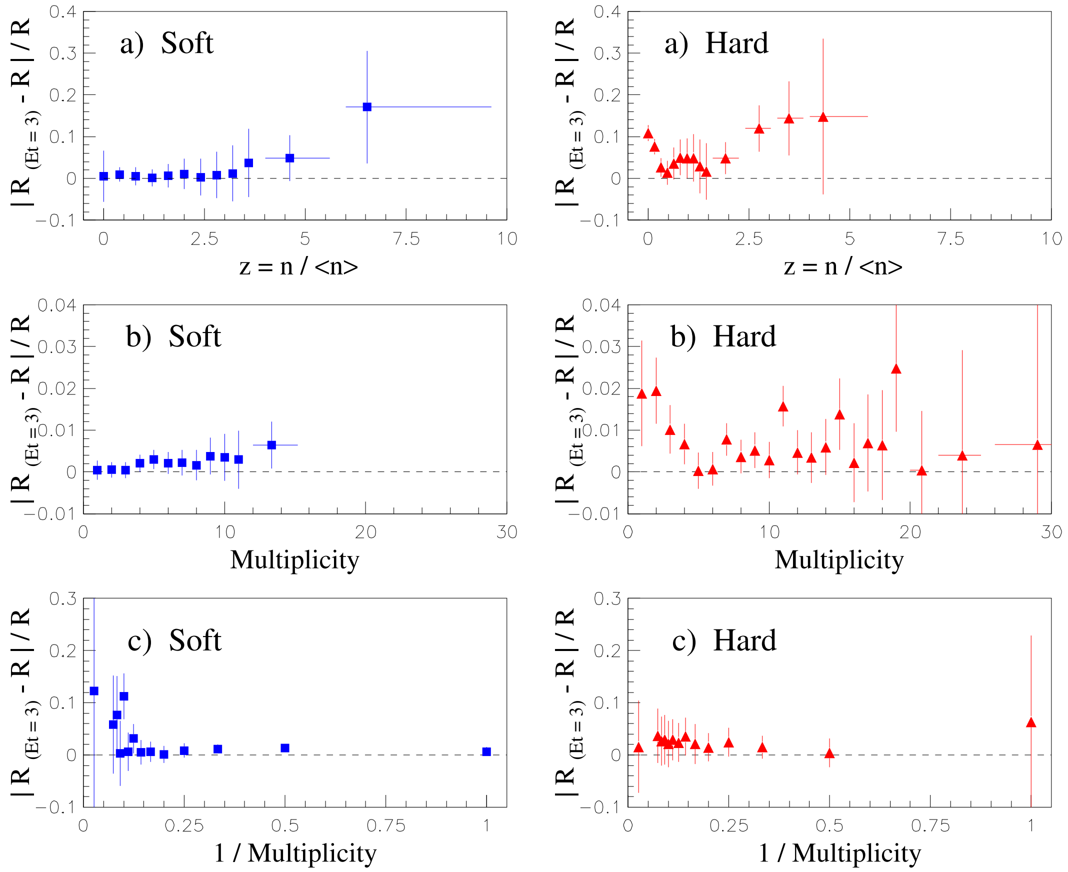

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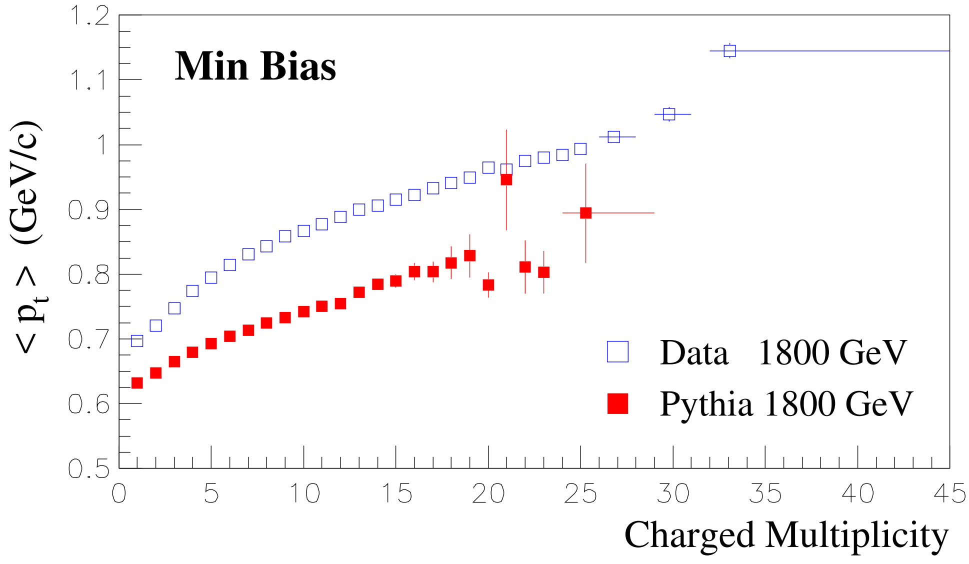

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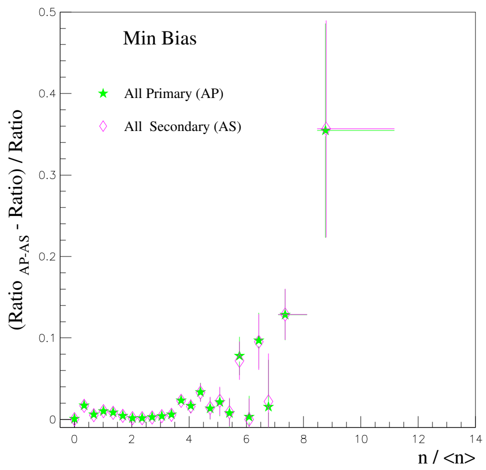

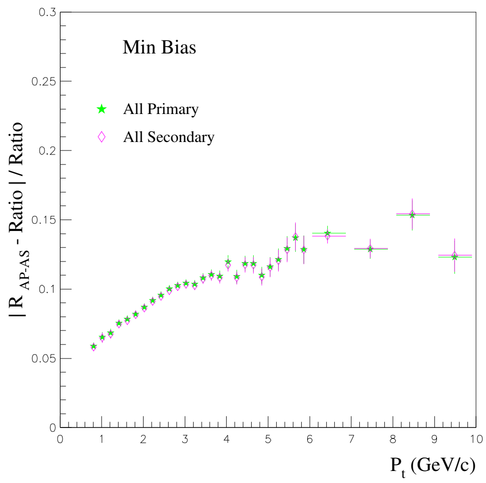

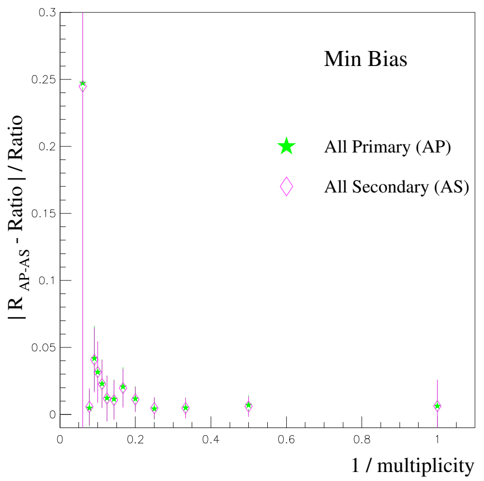

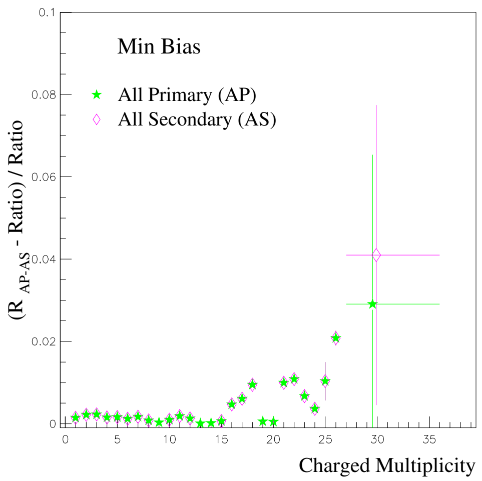

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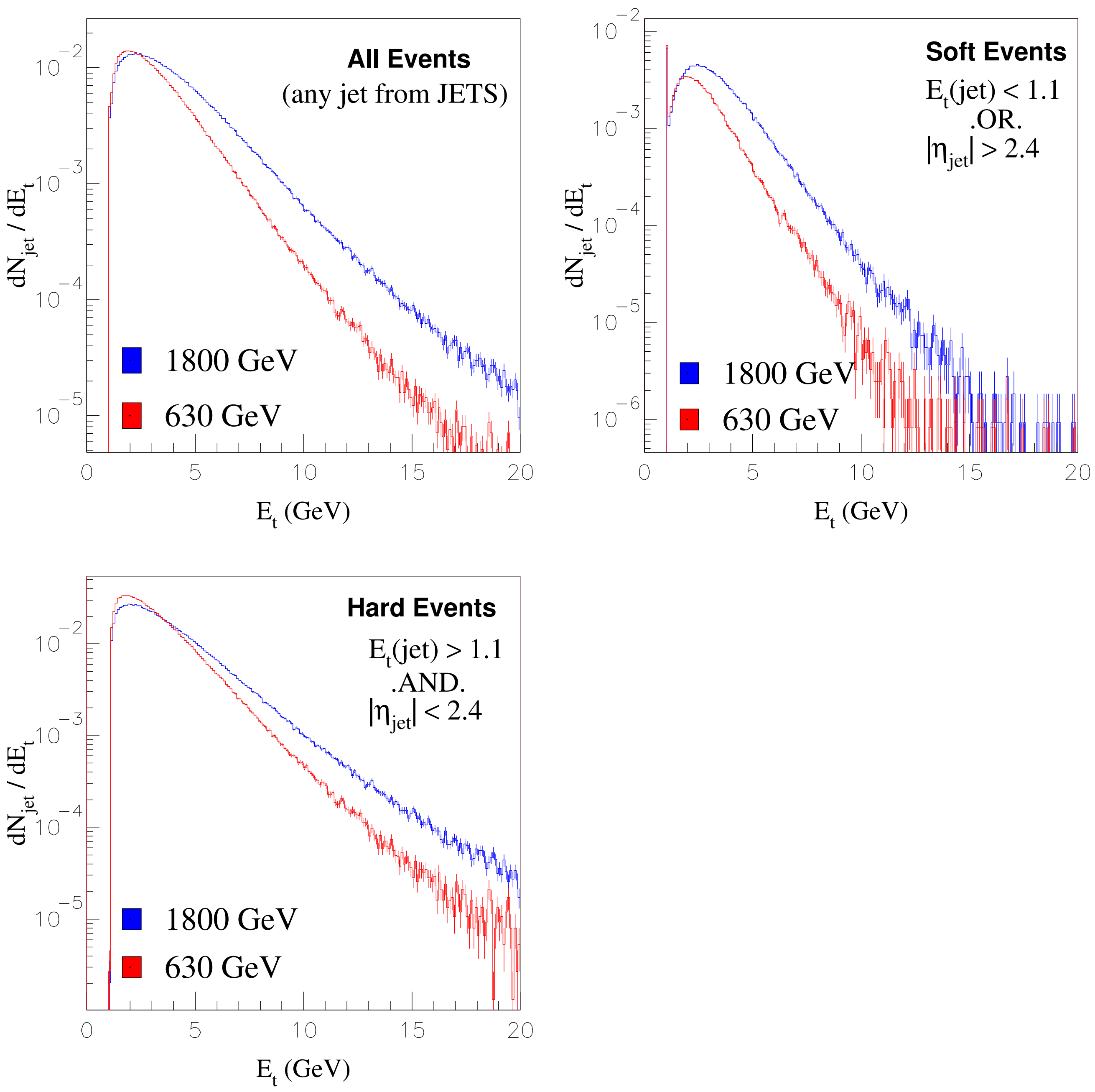

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