A Study of properties of Light q and g jets.

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SLD collaboration meeting

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Outline:

- Motivation and results from other labs.
- Jet tagging for g and q jets.
  → MC 98(R16) and data 97~98(R17).
- Multiplicity comparison of uds q and g jets.
- Plans.

❑ Motivation:

To search for differences between q and g jets.

1. Inclusive properties.

1) parton level :

Differences are expected from pQCD.

→ $r = \frac{Ng}{Nq} = \frac{9}{4}$ at infinite energy

→ softer energy spectrum and wider jet width for g jets.

2) hadron level :

Differences can be observed in finite energy with higher order calculation.

→ r ~ 1.3 (30 Gev)

→ r ~ 1 (6 Gev)

: strongly depend on jet energy.

well advanced. cf)DELPHI

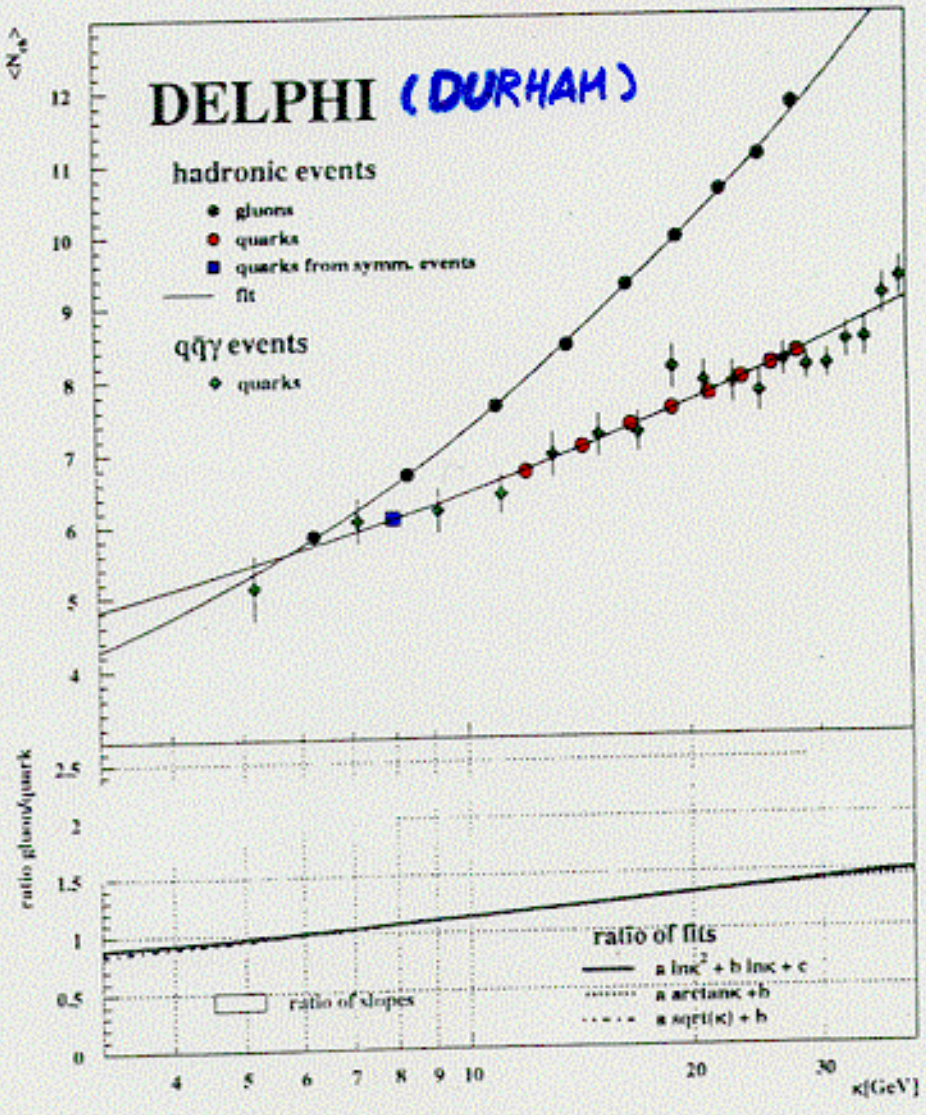
2. Particle production.

1) Differences between q and g for all particle types are expected to be the same.
2) Kinematics can affect heavier particles.
   → Can we verify the differences?
   → Can we observe fundamental differences?
3) More studies must be done cf)DELPHI.

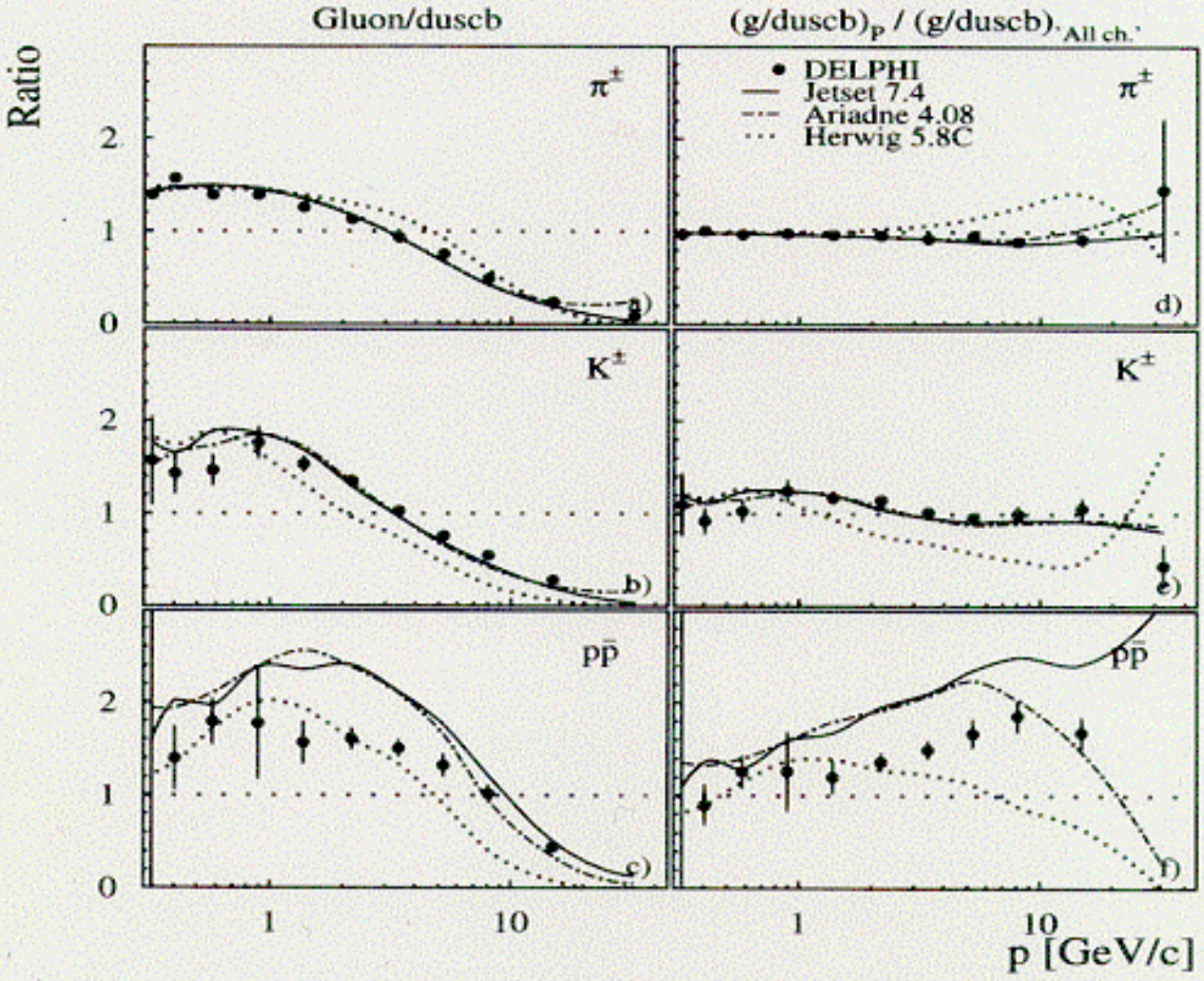
New DELPHI measurement.

E_{jet} vs $\langle N_{ch} \rangle$

Note $\langle N_{ch} \rangle_g \approx \langle N_{ch} \rangle_z$ at 6 GeV.



➔A recent result from DELPHI



➔ A hint that proton production differs in quark and gluon jets(kinematics effect??).

➔ Errors are large.

➔ Further improvement is necessary.

· I will get $(g/uds)_p / (g/uds)_{all\ ch.}$

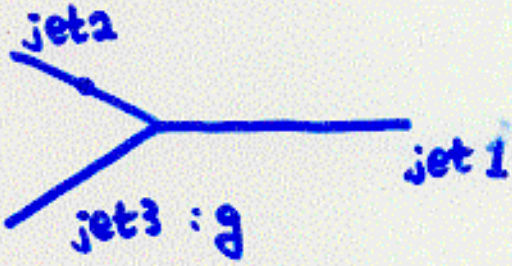
❑ Jet tagging with vertex finding and Nsig

❑ To do this, select 3 jet events using Durham algorithm with $Y_{cut} = 0.005$.

→ Rescale jet energies using angles and energy order.

: E1 > E2 > E3.

1. Gluon tag :



→ E1 jet is assumed to be a quark(antiquark) jet.

→ If jet 2(jet 3) is b or c

→ jet 3(jet 2) is g.

1) Find vertex in a jet. If the vertex is mvt > 0.75Gev and Pvt > 3 Gev, the other is tagged as gluon.
2) Only one of two lower jets must have a vertex.
3) An angle between two lower jets is > 18 degree.
4) Using Nsig tagging :

Investigated no vertex either in jet 2 or in jet 3.

: to get more statistics but didn't help.

To purify the gluon jet sample.

: 10 or 20% background reduction but 6 or 15% signal loss.

→ Decided not to put Nsig cuts for the summer.

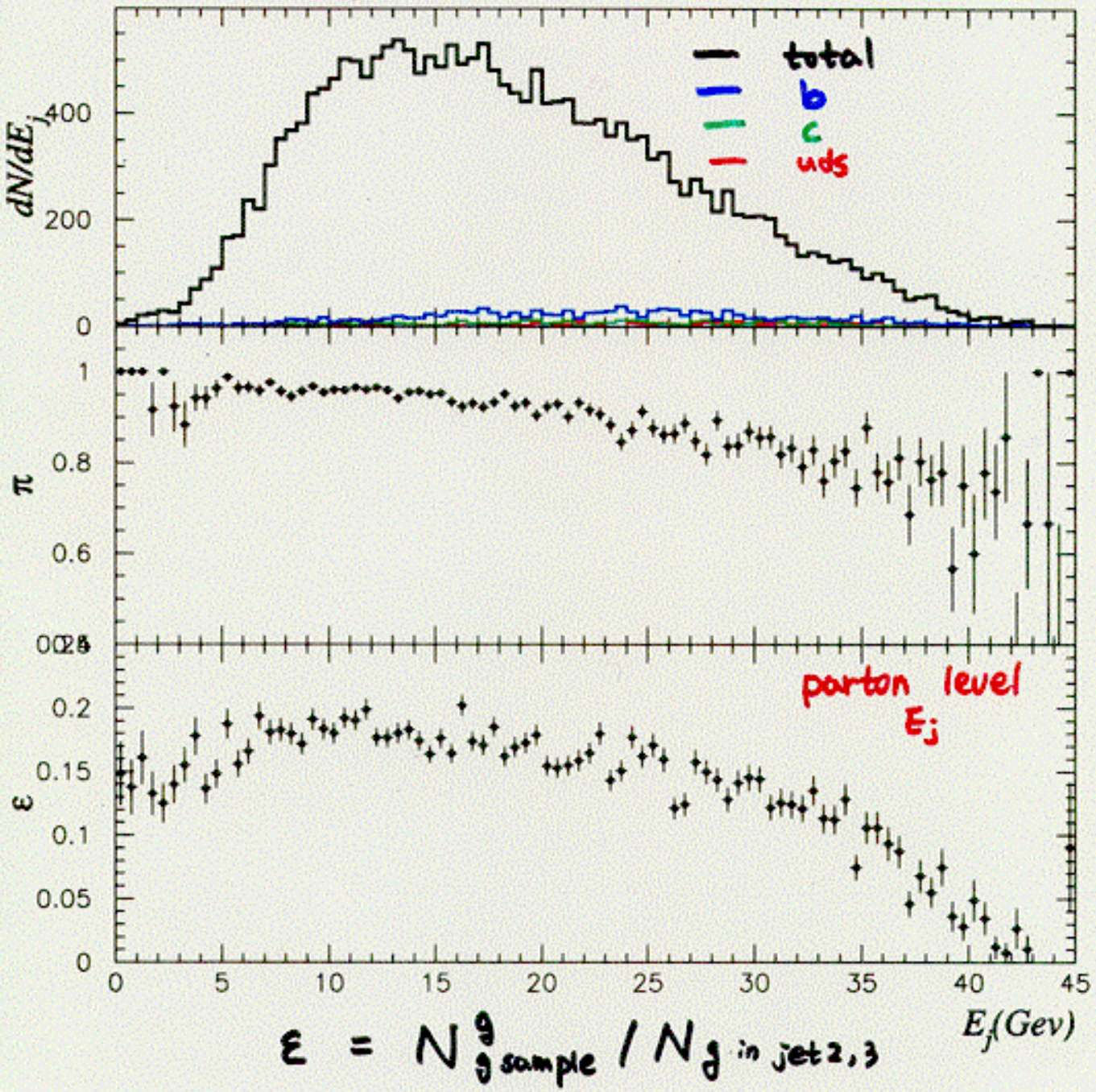
→ g : purity = 91.5% efficiency = 17.6%

where efficiency = Ng g sample / N3 jet events

cf) DELPHI purity = 82%

OPAL purity = 80%

Tagged gluon sample.



$$\varepsilon = N^{g}_{g\ \text{sample}} / N_{g\ \text{in jet 2,3}}$$

2. Light mixture tagging:

Tag as uds events when there is no vertex in any of 3 jets and Nsig = 0 for the event.
→ jet 2 and jet 3 are tagged.
best we can get is 50% of uds q and 50% of g.
→ uds mixture : purity = 96% efficiency = 47.8%
where the efficiency is

$$N^{\text{tagged uds events}}_{\text{uds mixture}} / N_{\text{3 jet events}}$$

cf) OPAL purity = 80.9%

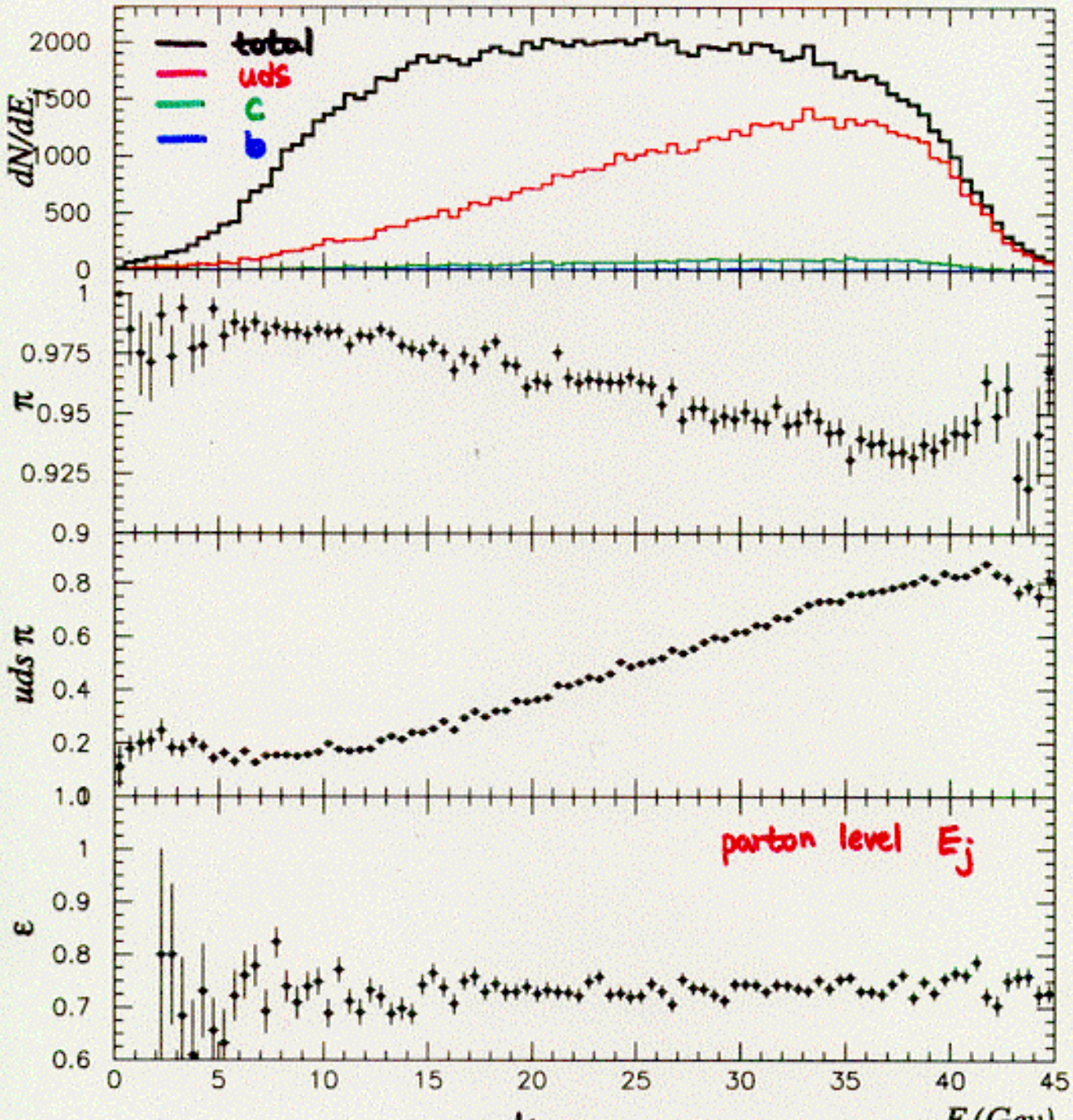
3. B mixture tagging (excluding gluon tagged events)
: To improve background in gluon and uds jets.

If b vertex is found in jet 1 → jet 2 and jet 3 are tagged.
: want to have 50% of b q and 50% of g.
→ Currentley use Tom's routine to find a vertex in jet 1 to tag b($\bar{b}$) with $m_{vt} > 2$ Gev.
→ b mixture : purity = 97.4% efficiency = 25.6%.
→ Investigated Nsig to improve purity and efficiency but little help : vertex finding finds most of high Nsig and some of no Nsig jets.

4. C mixture tagging (excluding gluon tagged events):

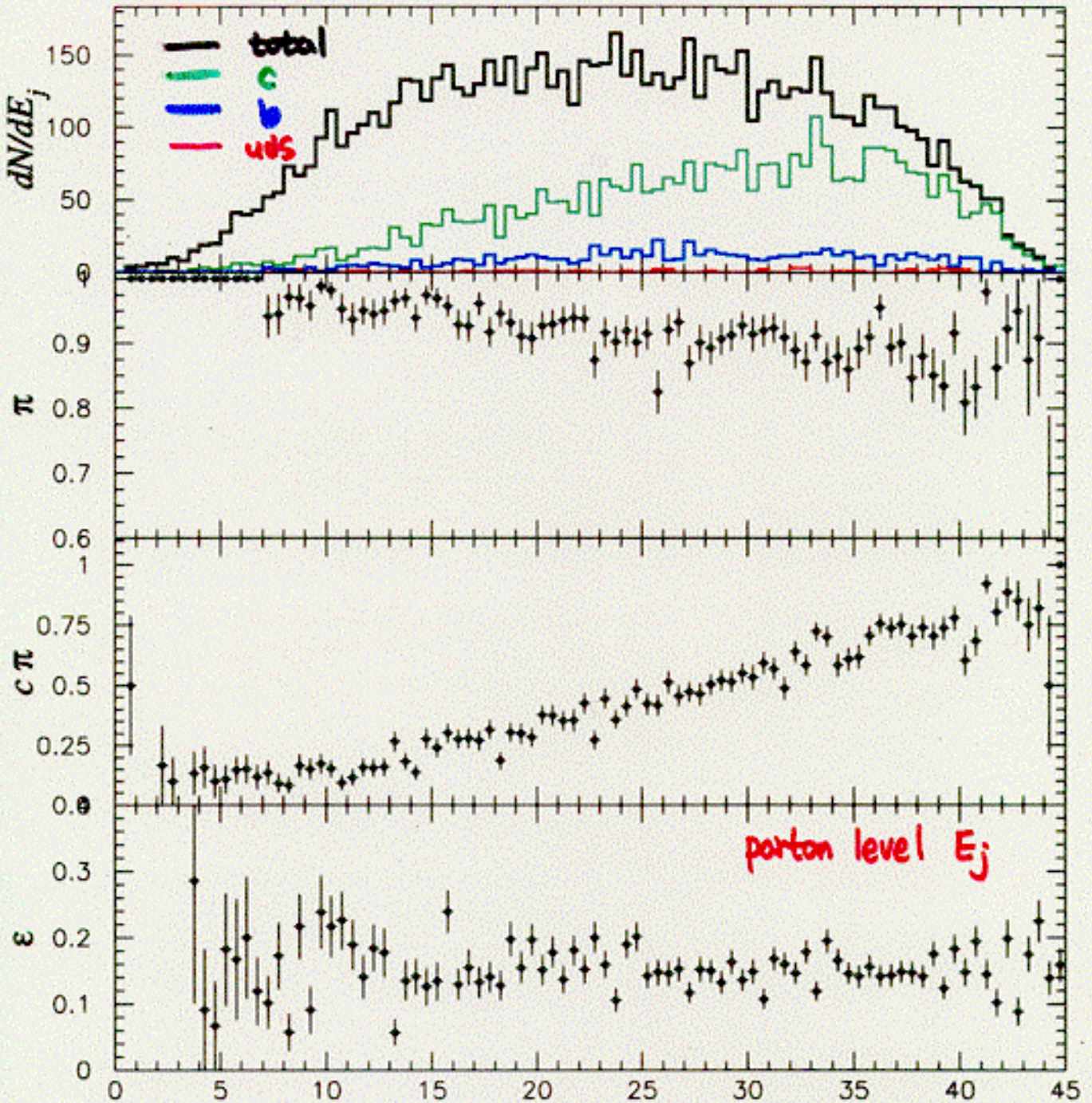
If c vertex is found in jet 1 → jet 2 and jet 3 are tagged.
→ Tag jet 1 as c($\bar{c}$) with finding standard c vertex.
→ the vertex cuts : 1) $0.5 < m_{vt} < 2$ Gev
2) $P_{vt} > 5$ Gev
3) $P_{vt} - 15 * m_{vt} > -10$
→ c mixture : purity = 92% efficiency = 18.7%.

Light mixture



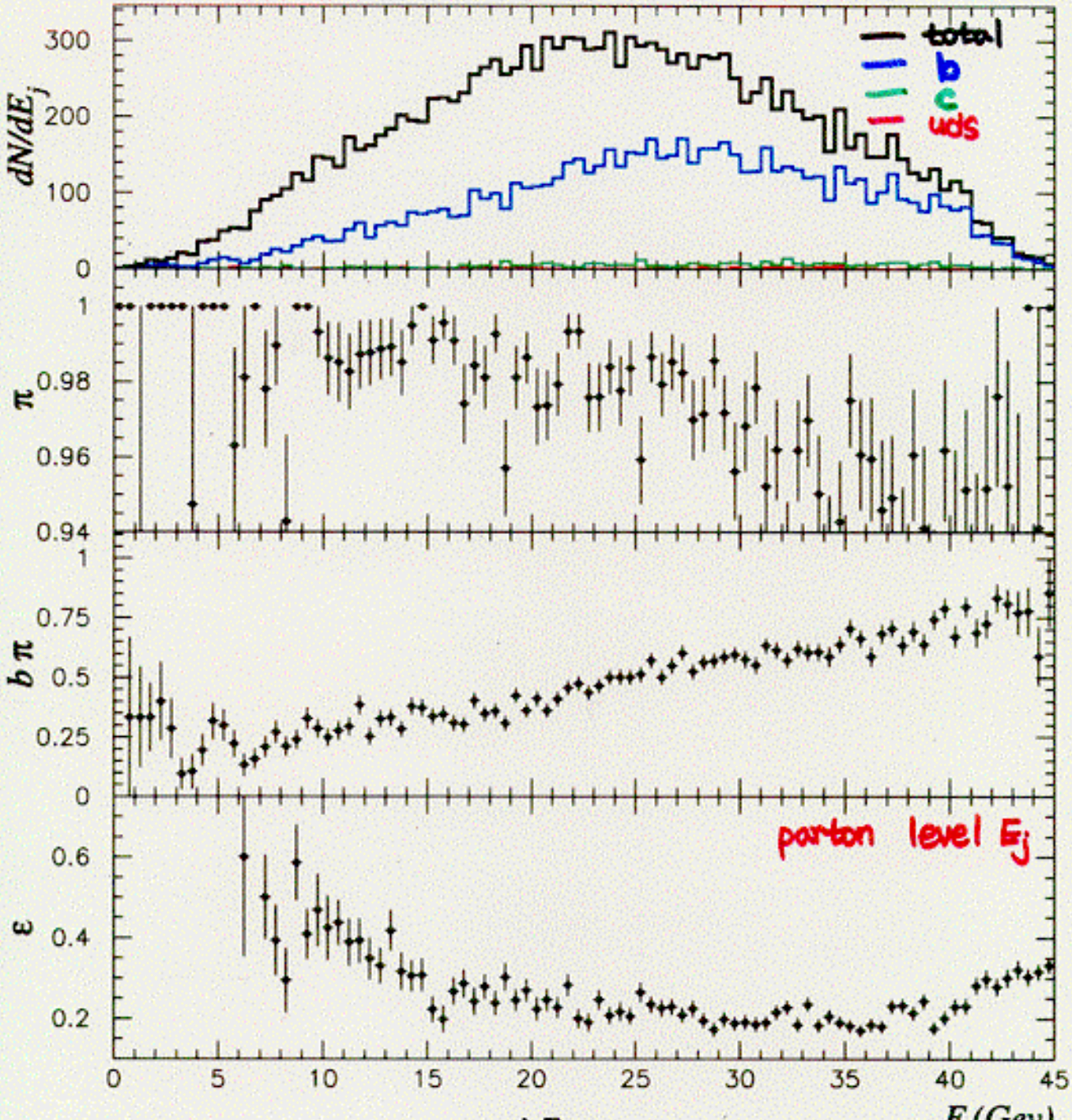
$$\varepsilon = N^{uds}_{uds\ mixture} / N_{uds\ in\ jet2,3}$$

C mixture



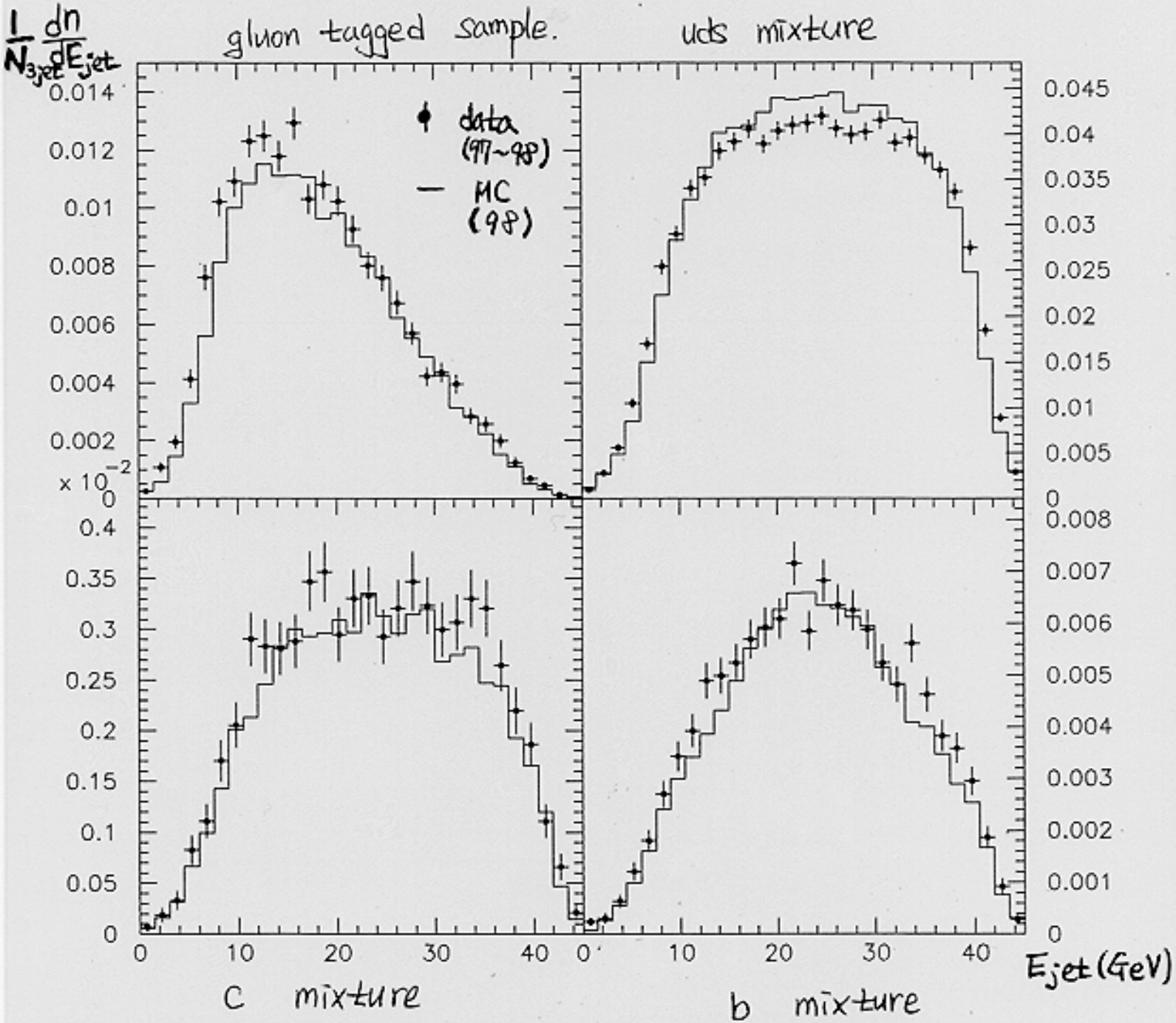
$$\varepsilon = N^{c\bar{c}}_{\text{c mixture}} / N_{\text{c in jet 2,3}}$$

B mixture



$$\varepsilon = N^{b\bar{b}}_{\text{in b mixture}} / N_{\text{b in jet 2, 3}}$$

Jet energy distributions.



❑ Inclusive multiplicity studies of q and g jets.

1. Study of uncorrected $\langle N_{ch} \rangle$ in uds mixture and g tagged samples.: data(R17 97' ~98')

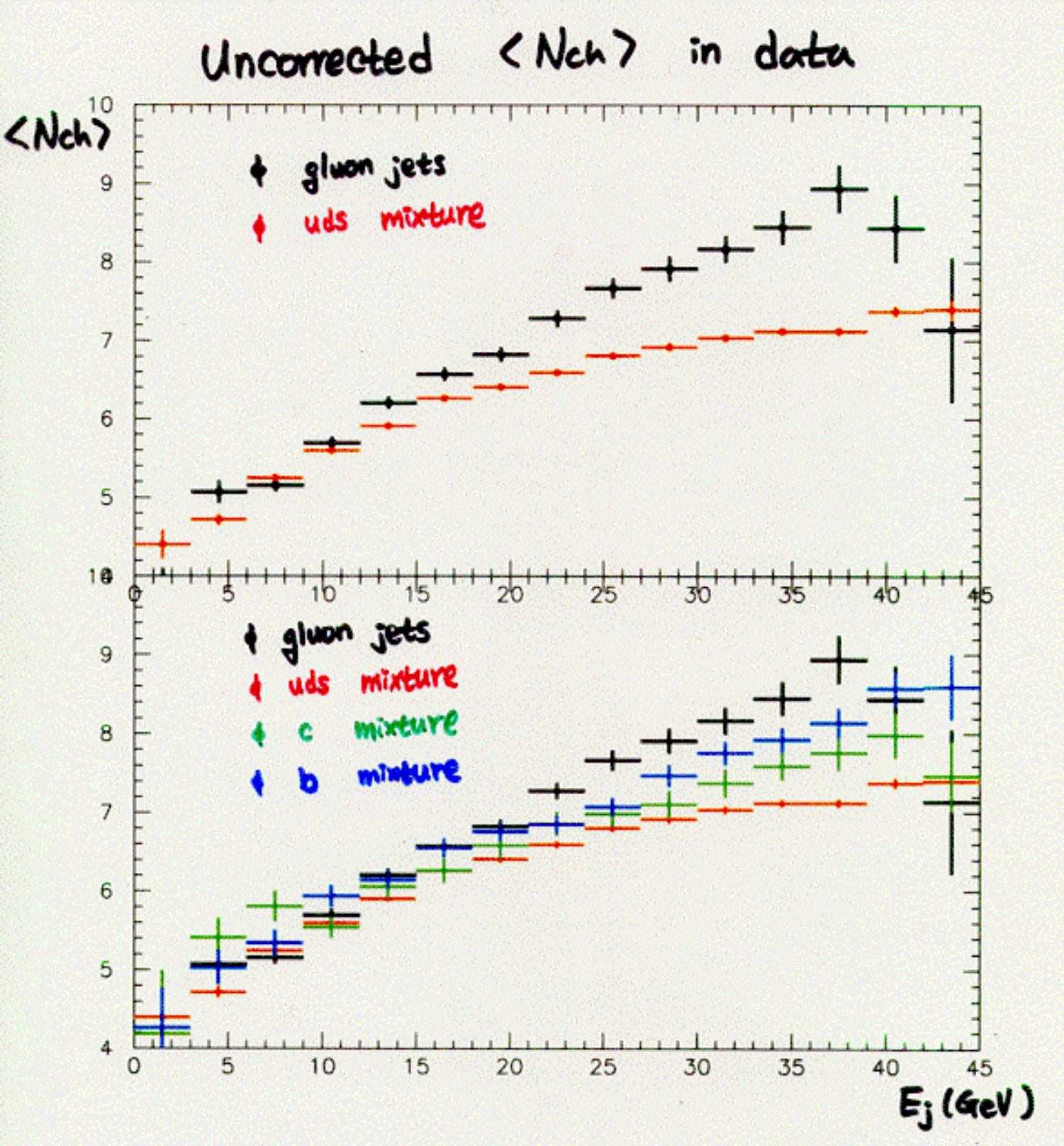
2. Studies of Xp distributions for different Ej. ($x_p = \frac{P_{trk}}{E_{jet}}$)
   → get correction terms from various comparisons for the inclusive study.
   → in progress.

❑ Plans

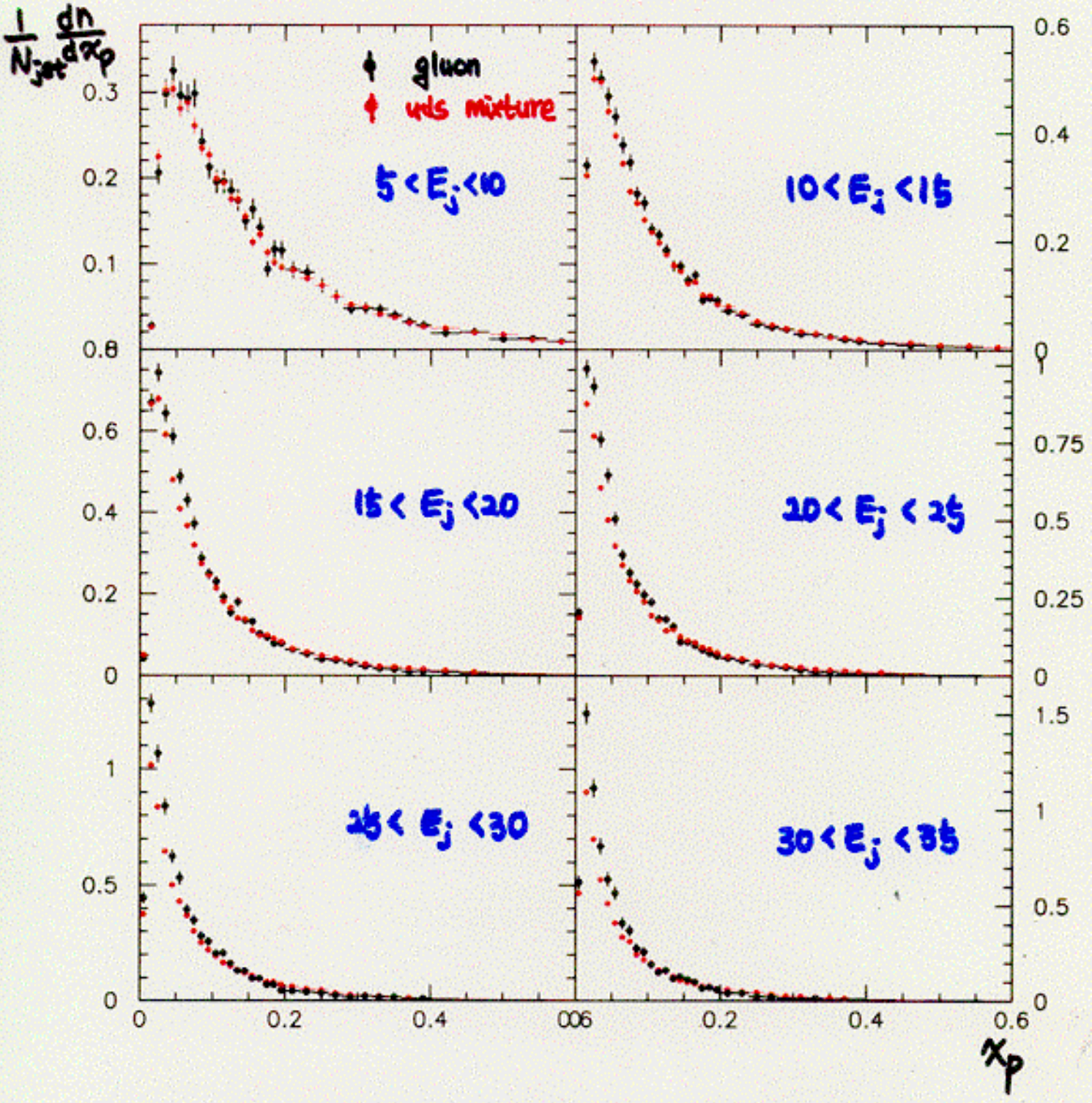
1. Studies of bias from jet tagging. ✓

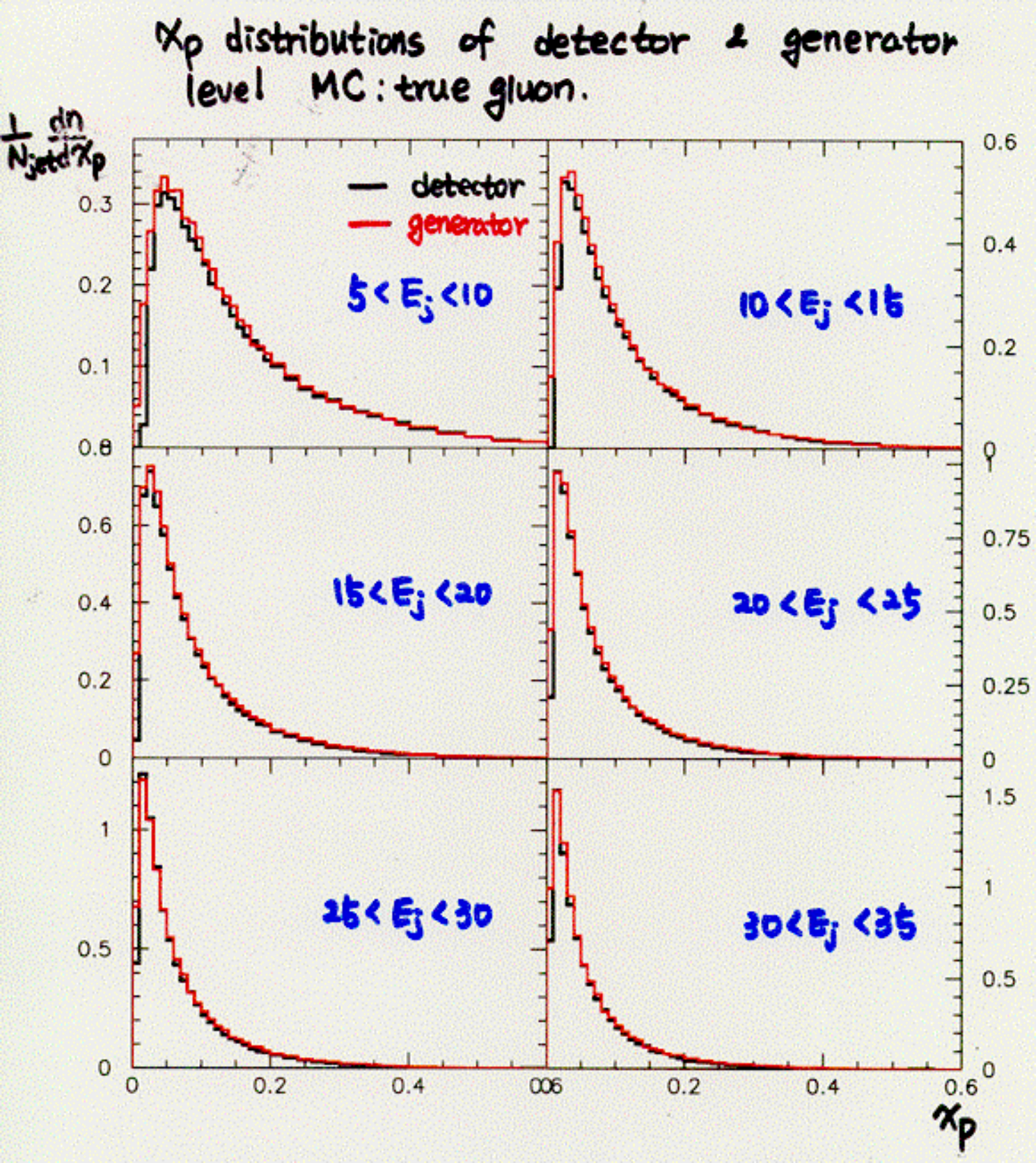
2. Correct <Nch> in g and uds mixture. ✓

3. Apply the particle identification to
   π, K, p production rates in q and g jets.
   → presnt a preliminary result at SLD week meeting in July and DPF.
   → get final results for winter conferences.


Uncorrected <Nch> in data
<Nch>
gluon jets
uds mixture
gluon jets
uds mixture
c mixture
b mixture
E_j (GeV)

x_p distributions of g and light mixture : data




x_p distributions of detector & generator level MC : true gluon.
$\frac{1}{N_{jet}} \frac{dn}{dx_p}$
detector
generator
$5 < E_j < 10$
$10 < E_j < 15$
$15 < E_j < 20$
$20 < E_j < 25$
$25 < E_j < 30$
$30 < E_j < 35$
x_p