Study of Interaction of Heavy Quarks with Nuclear Matter in CuCu at $\sqrt{s_{NN}}$ = 200 GeV

Miroslav Krůs for STAR collaboration

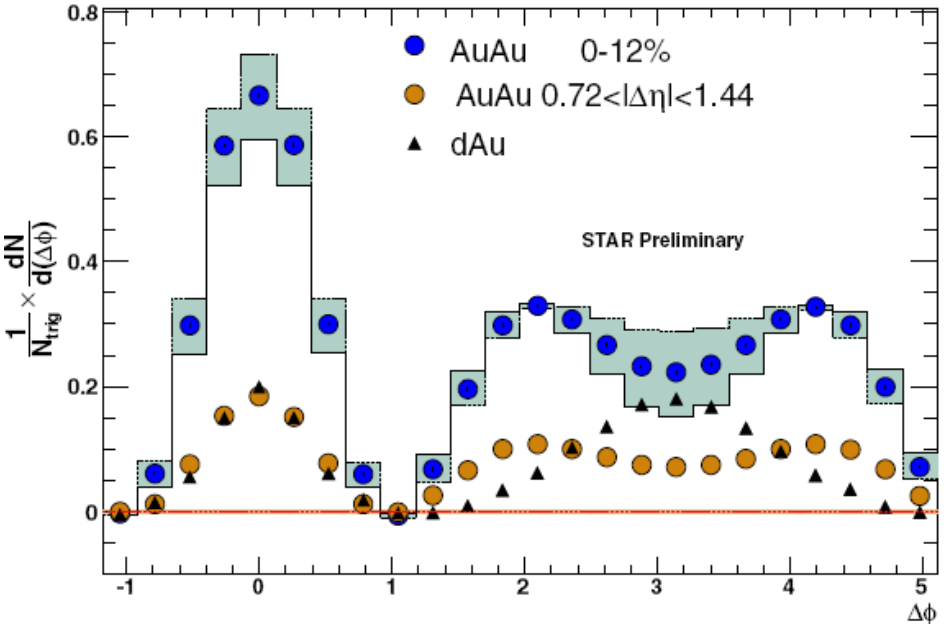
FNSPE CTU, Prague

NPI AS CR Řež

Motivation

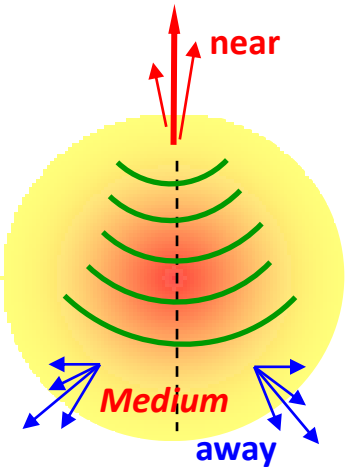
➔ conical pattern in hadron – hadron correlations in Au+Au collisions at 200 GeV

p_T^{trig} = 2.5-4.0 GeV/c & p_T^{assoc} = 1.0-2.5 GeV/c



Mark Horner (for STAR Collaboration):

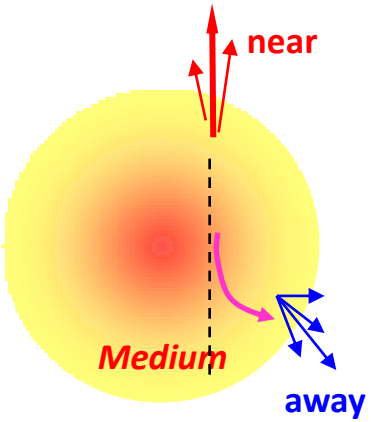
J. Phys. G: Nucl. Part. Phys. 34 (2007) S995



Conical Emission

(Mach cone,

Cherenkov radiation)



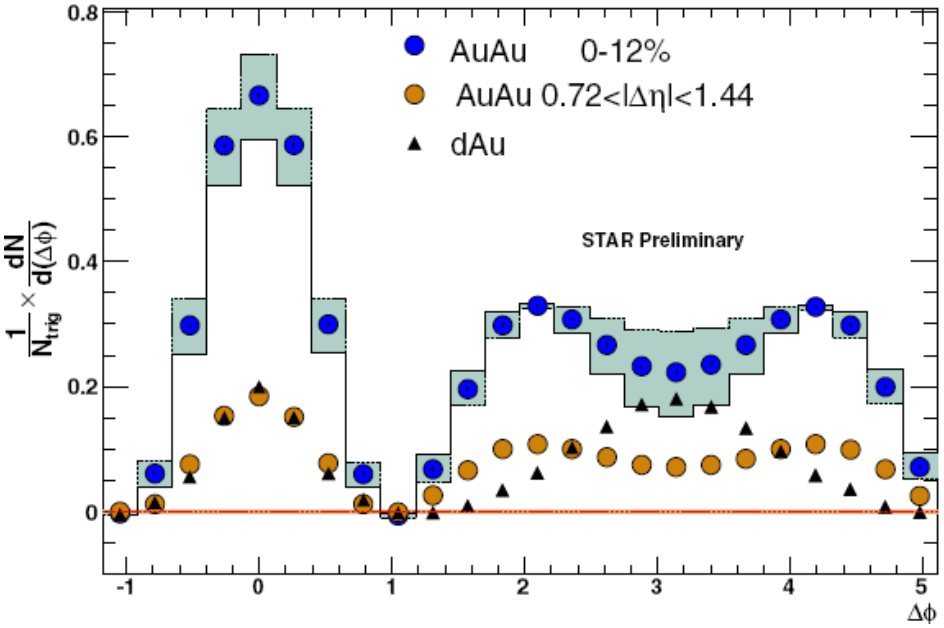
deflected jets

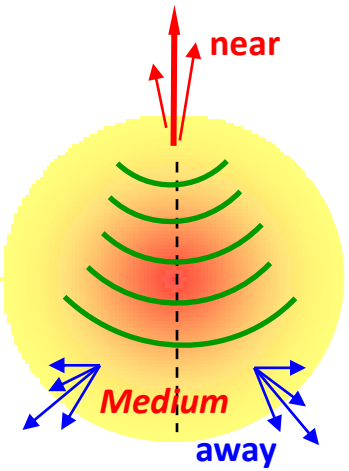
B. Abelev (STAR collaboration): arXiv:0805.0622v1

Motivation

➔ conical pattern in hadron – hadron correlations in Au+Au collisions at 200 GeV

p_T^{trig} = 2.5-4.0 GeV/c & p_T^{assoc} = 1.0-2.5 GeV/c

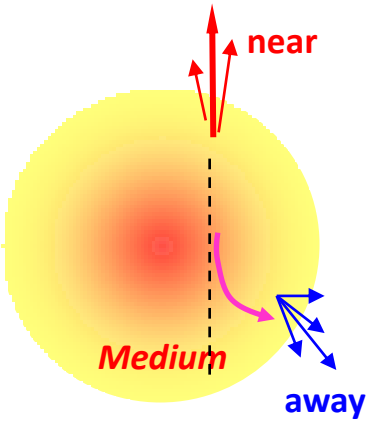




Conical Emission

(Mach cone,

Cherenkov radiation)



deflected jets

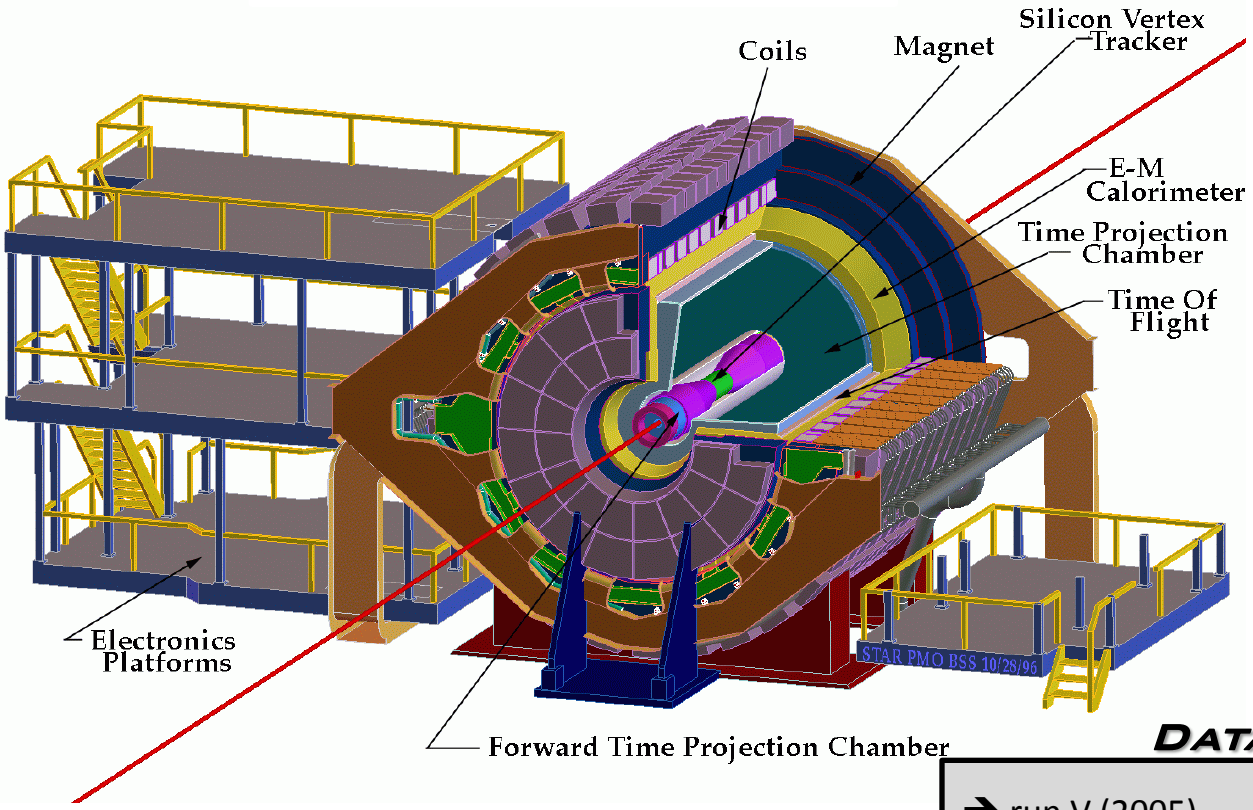
Mark Horner (for STAR Collaboration):

J. Phys. G: Nucl. Part. Phys. 34 (2007) S995

B. Abelev (STAR collaboration): arXiv:0805.0622v1

***Question:** Does heavy quark induce similar effect?*

Detector overview



- ➔ Time Projection Chamber (TPC ➔ tracking, momentum, dE/dx)
- ➔ Barrel Electro-Magnetic Calorimeter (BEMC ➔ deposited energy)
- ➔ Barrel Shower Maximum Detector (BSMD ➔ e-m shower area)

Data sample

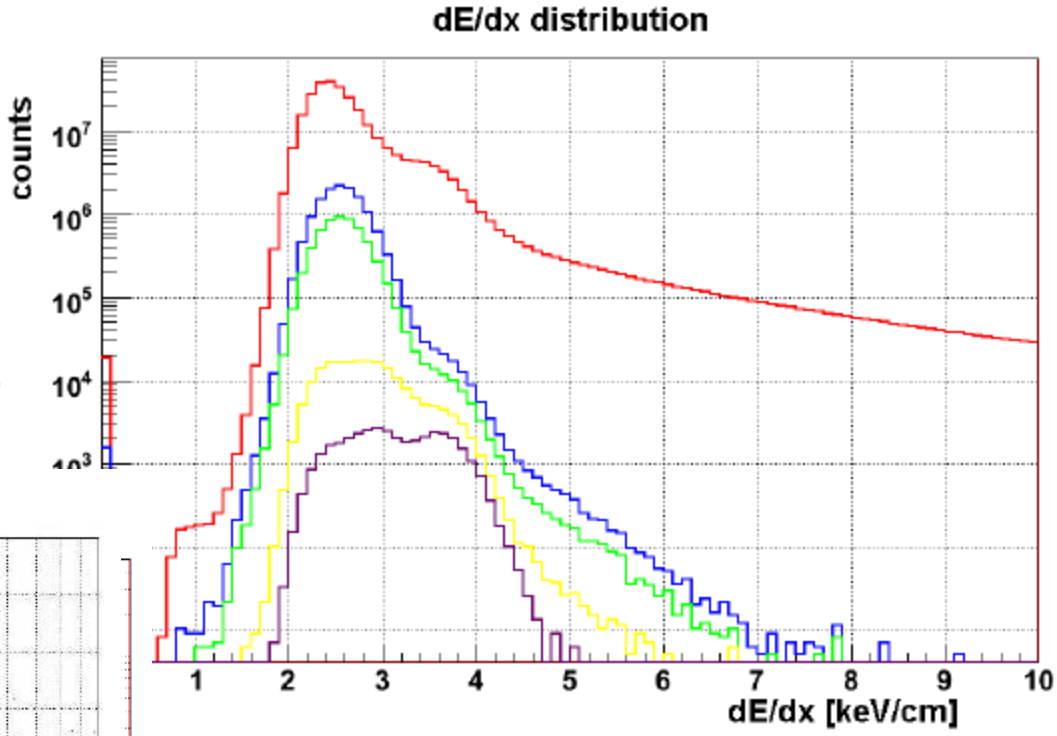
- ➔ run V (2005)
- ➔ Cu+Cu $\sqrt{s_{NN}}$ = 200 GeV
- ➔ centrality selection: 0 – 20%
- ➔ ***HighTower*** triggered (E_T> 3,75 GeV)
  - ➔ 2,2M events
    (after QA selection)

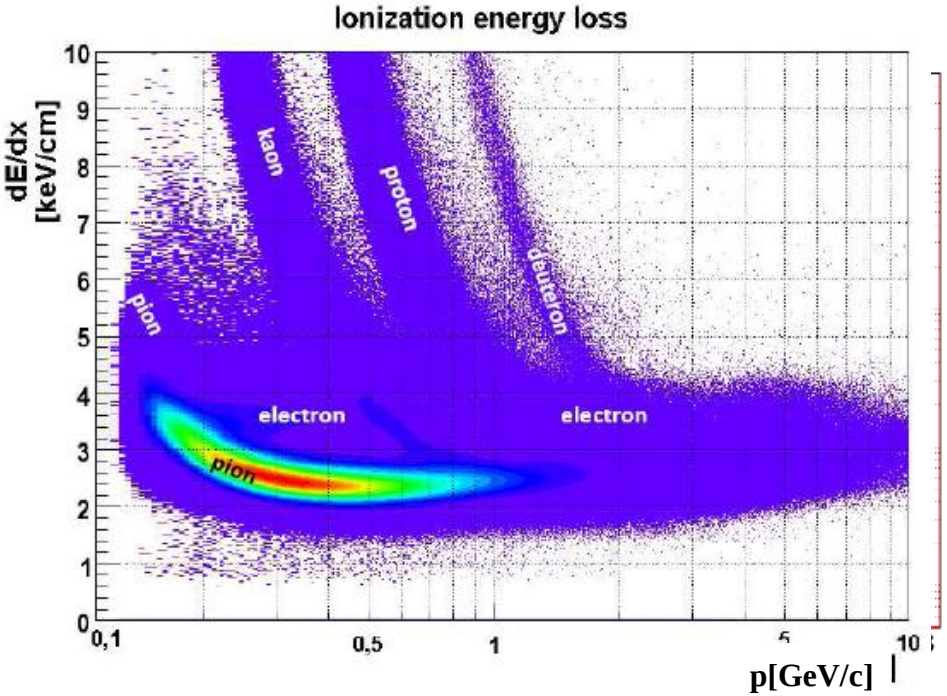
Electron identification

TPC: all tracks
$p > 1.5$ GeV/c

BEMC: good track projection
p/E_{TOW} : 0 – 2

BSMD: electron/hadron shower shape (cluster size $\geq$ 2)





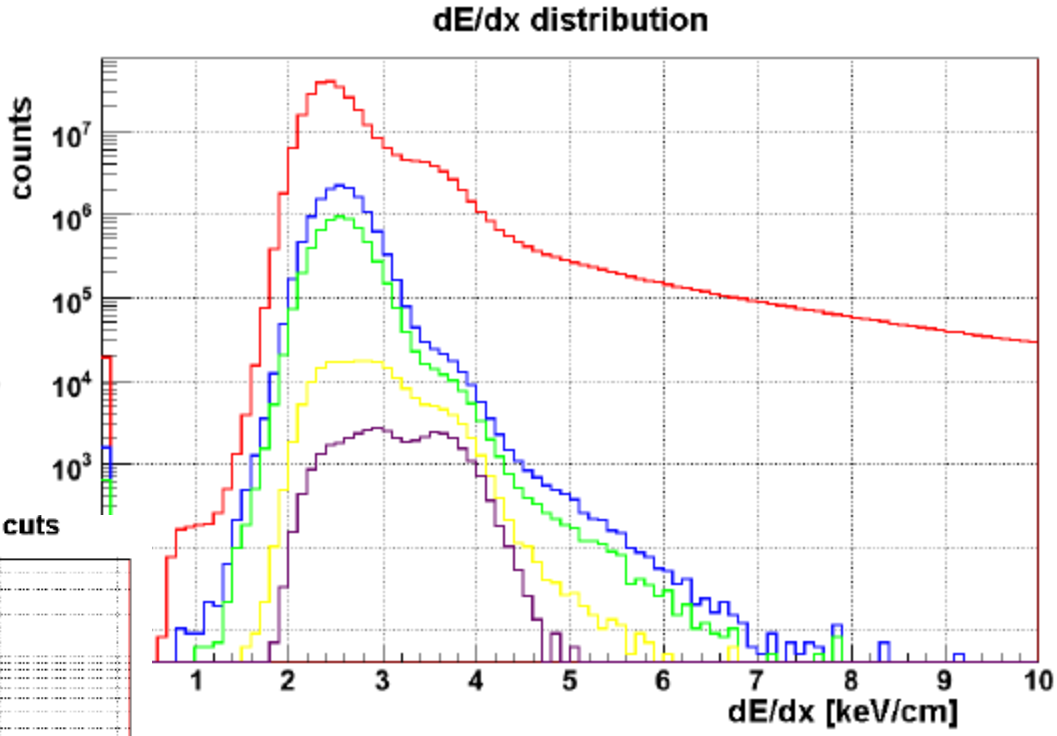
➔95% purity of electron sample
➔ dE/dx: 3.31 – 4.64 keV/cm

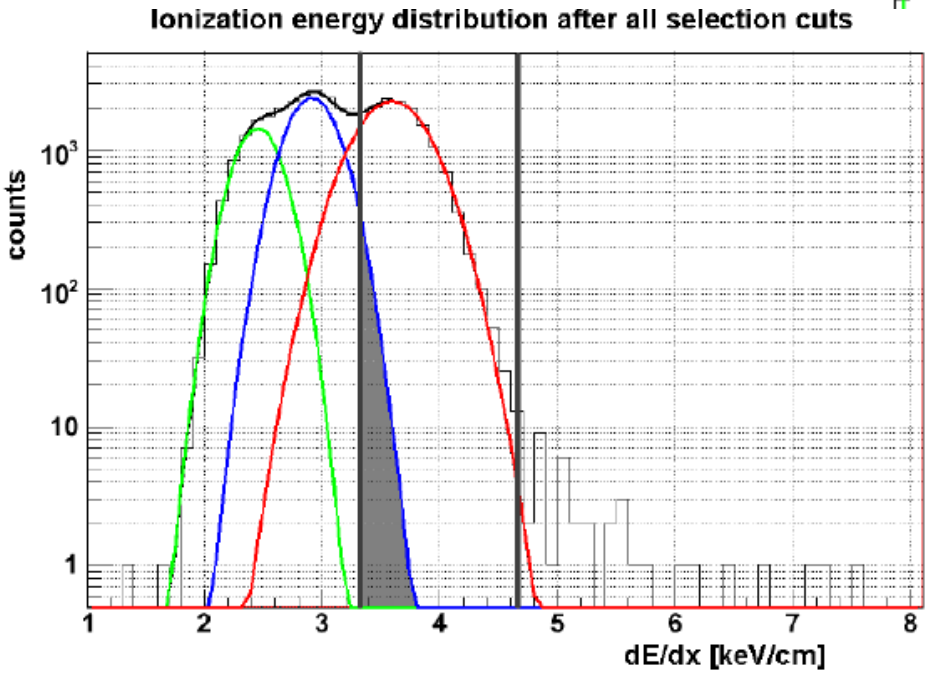
Electron identification

TPC: all tracks
$p > 1.5$ GeV/c

BEMC: good track projection
p/E_{TOW} : 0 – 2

BSMD: electron/hadron shower shape (cluster size $\geq$ 2)





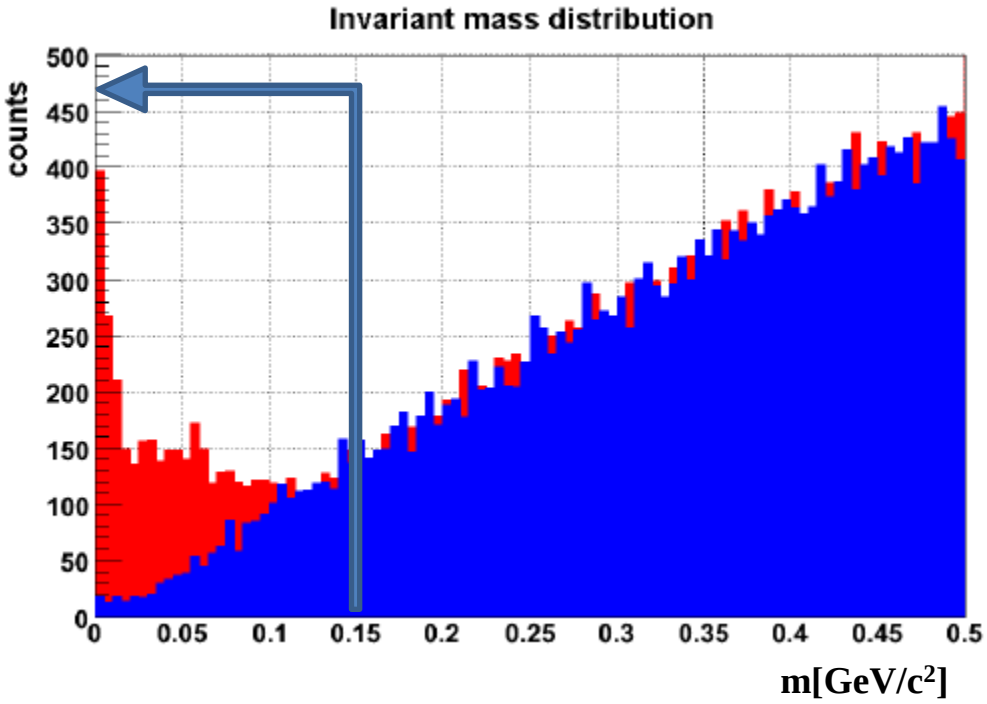
➔95% purity of electron sample
➔ dE/dx: 3.31 – 4.64 keV/cm

Photonic electron background

need to be subtracted

- ➔ photon conversion $\gamma \longrightarrow e^+e^-$
- ➔ π^0 Dalitz decay $\pi^0 \longrightarrow \gamma e^+e^-$
- ➔ η Dalitz decay $\eta \longrightarrow \gamma e^+e^-$
- ➔ kaon decay $K \longrightarrow \pi^0 \nu e$
- ➔ vector meson decays $\rho^0, \omega, \phi \longrightarrow e^+e^-$

- ➔ photonic reconstruction efficiency: 65%
  - ➔ determined from embedded π^0 in real data

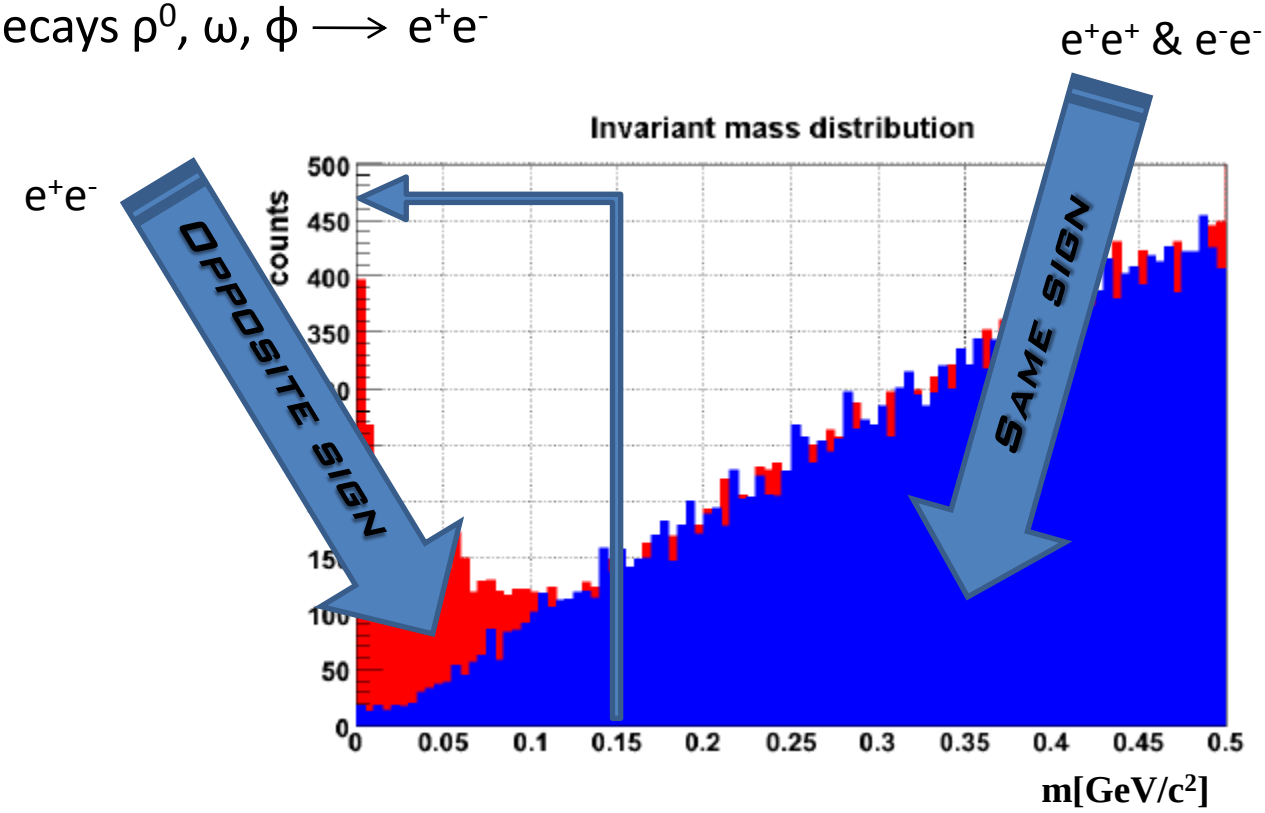


Photonic electron background

need to be subtracted

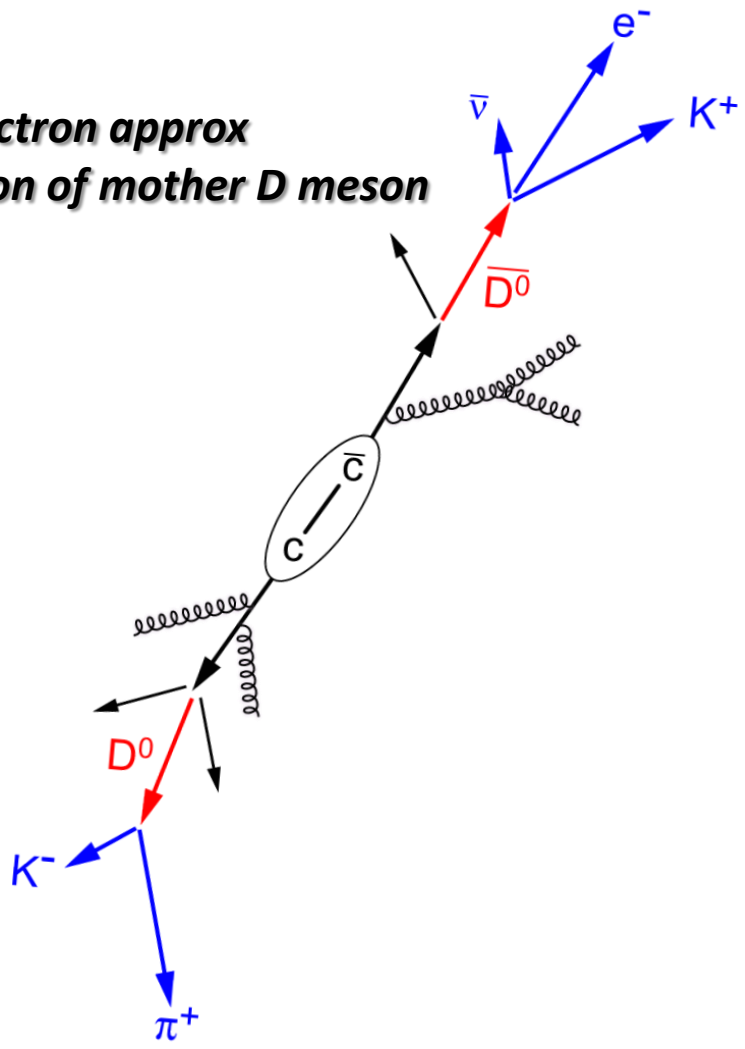
- ➔ photon conversion $\gamma \longrightarrow e^+e^-$
- ➔ π^0 Dalitz decay $\pi^0 \longrightarrow \gamma e^+e^-$
- ➔ η Dalitz decay $\eta \longrightarrow \gamma e^+e^-$
- ➔ kaon decay $K \longrightarrow \pi^0 ve$
- ➔ vector meson decays $\rho^0, \omega, \phi \longrightarrow e^+e^-$

- ➔ photonic reconstruction efficiency ε: 65%
  - ➔ detemined from embedded π^0 in real data



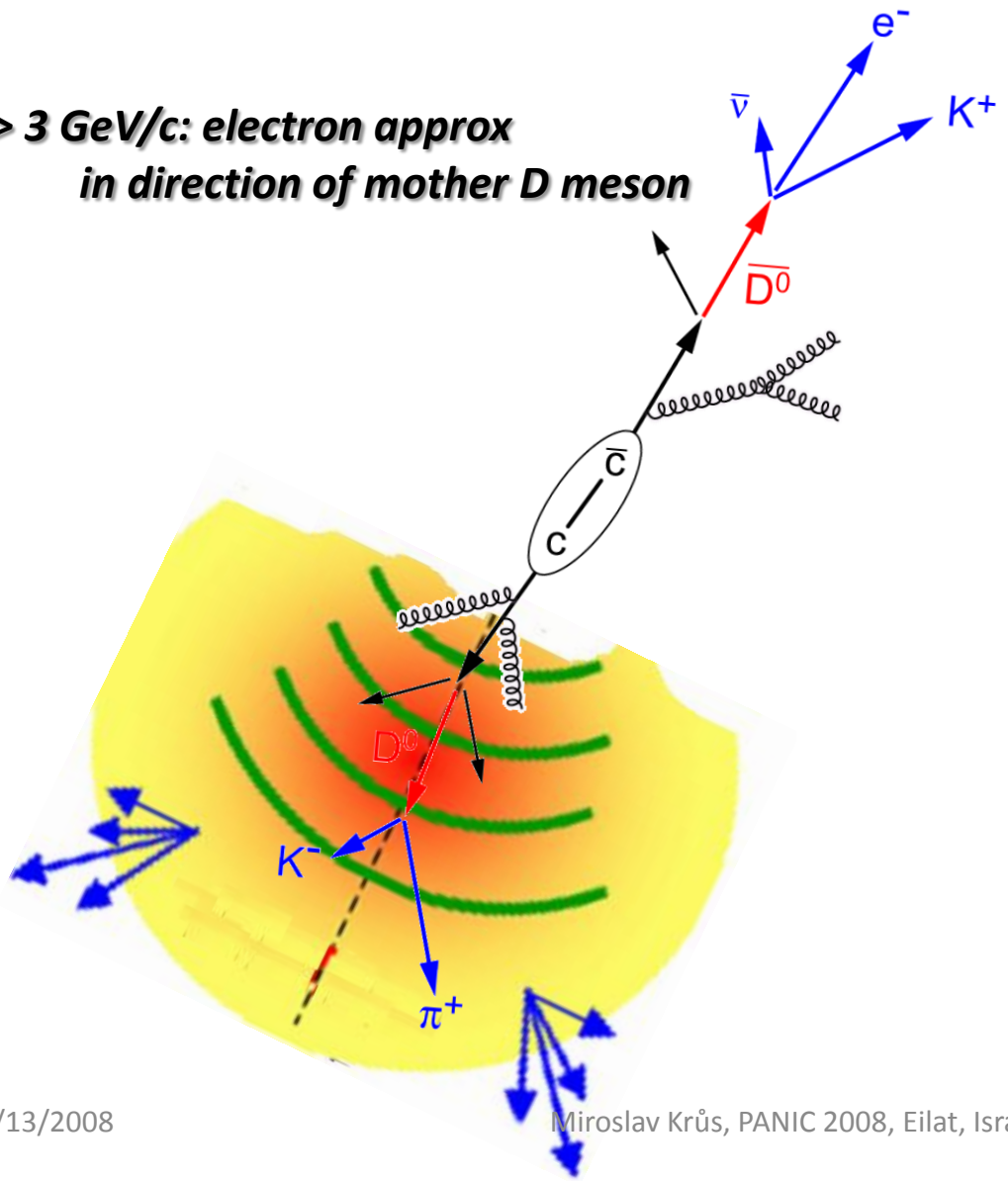
Nonphotonic electron-hadron Azimuthal correlations

p_T > 3 GeV/c: electron approx in direction of mother D meson



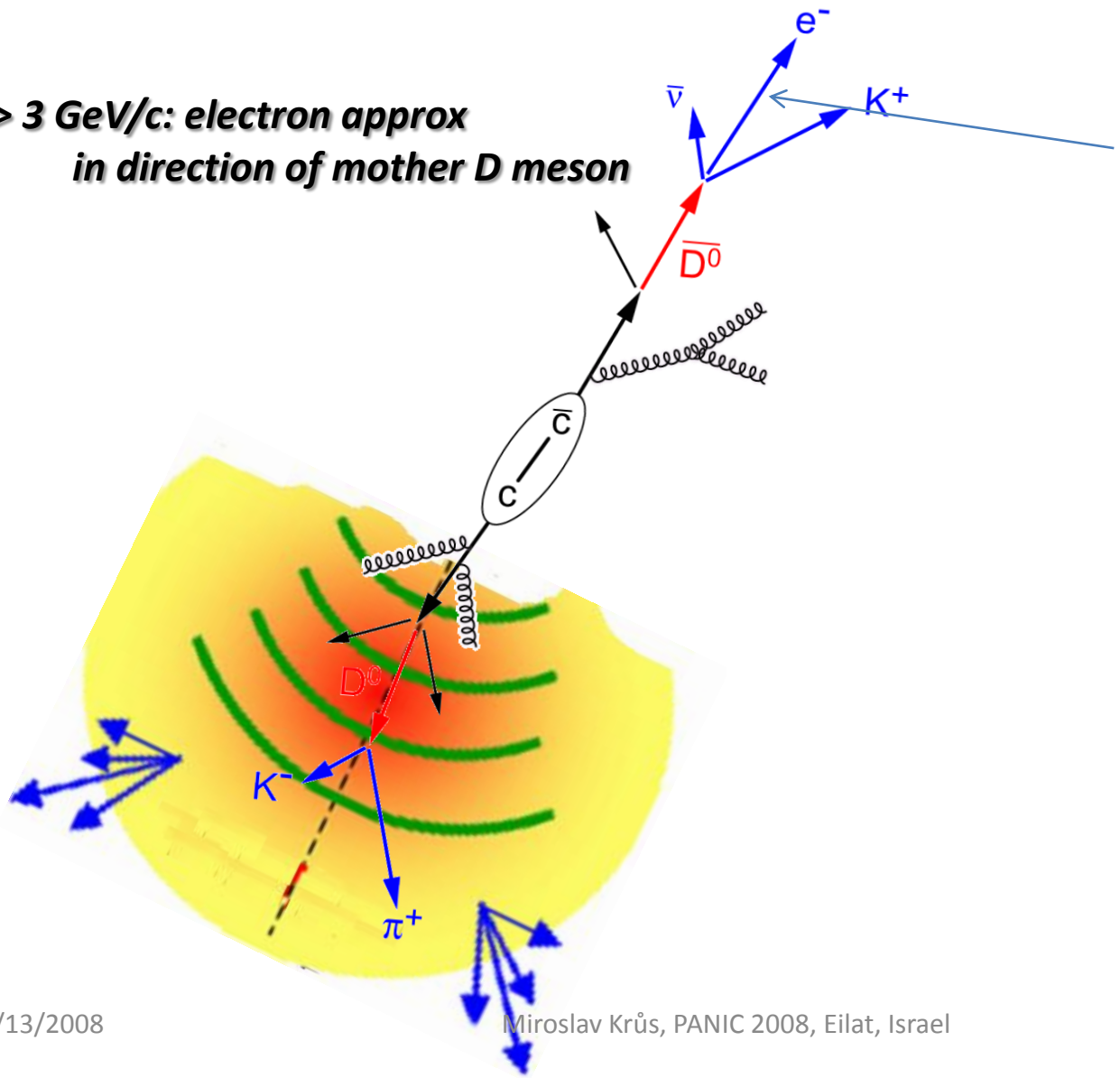
Nonphotonic electron-hadron Azimuthal correlations

p_T > 3 GeV/c: electron approx in direction of mother D meson



Nonphotonic electron-hadron Azimuthal correlations

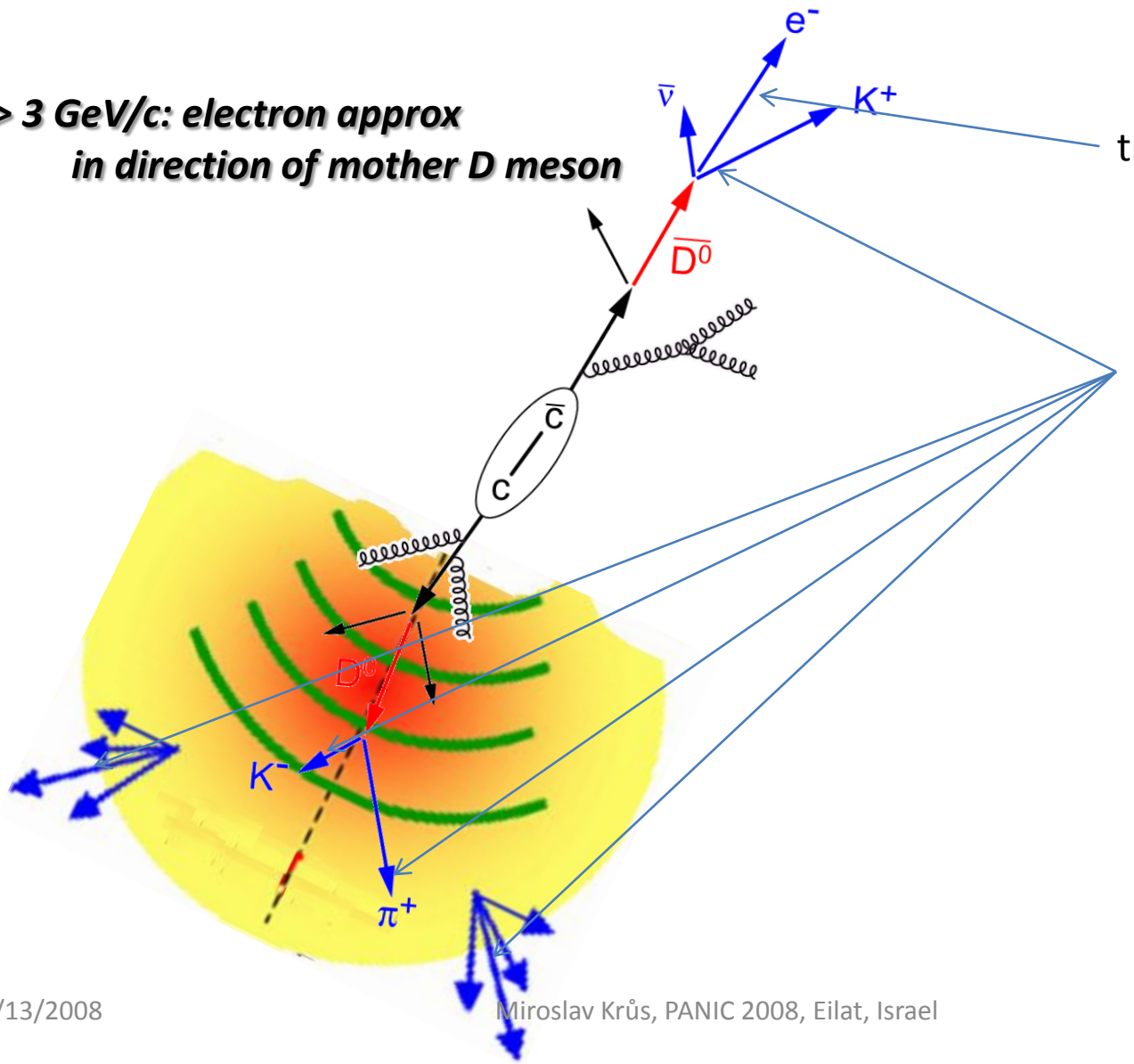
p_T > 3 GeV/c: electron approx in direction of mother D meson



trigger (p_T: 3 – 6 GeV/c)

Nonphotonic electron-hadron Azimuthal correlations

p_T > 3 GeV/c: electron approx in direction of mother D meson

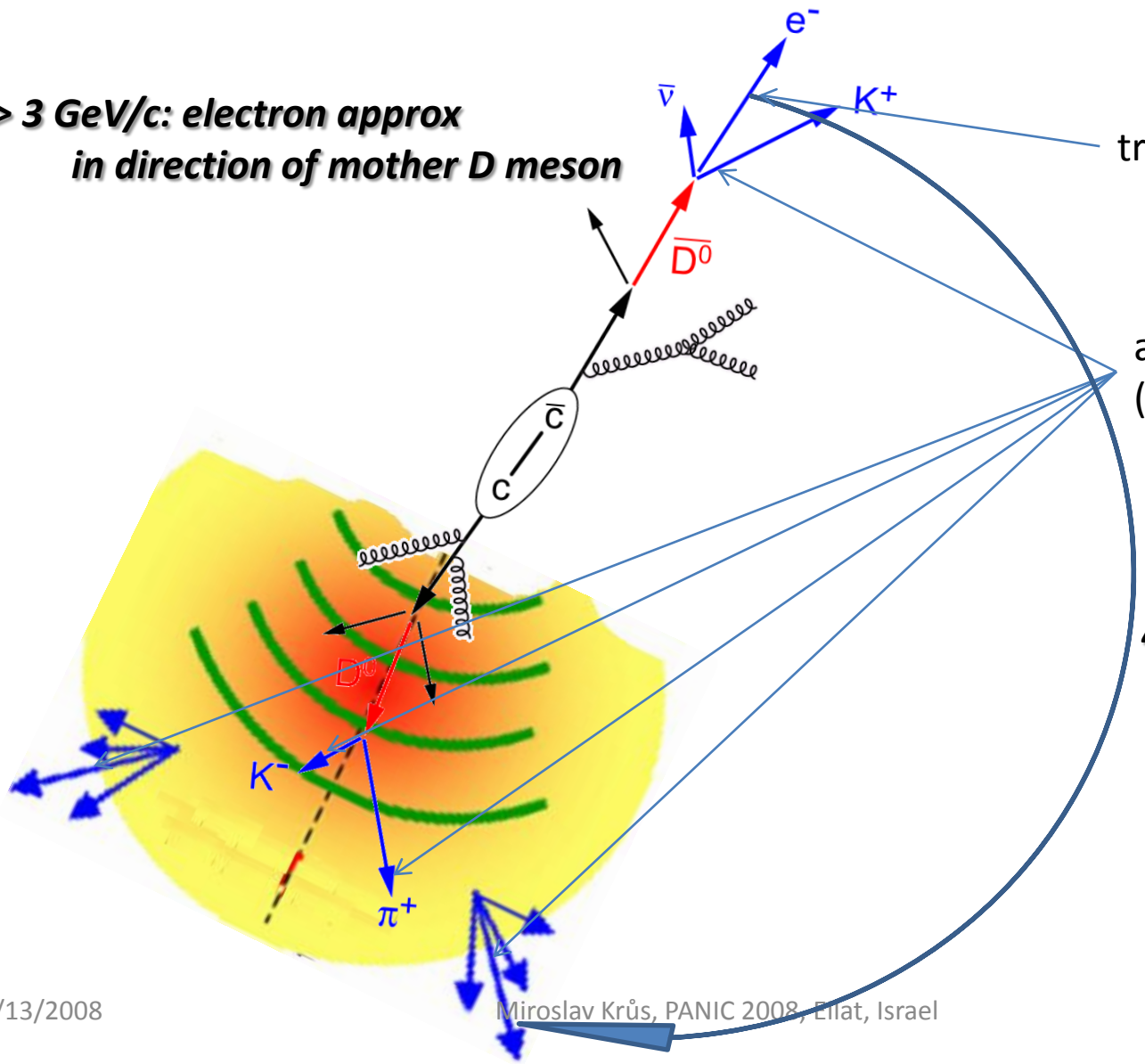


trigger (p_T: 3 – 6 GeV/c)

associated particles (p_T: 0,15 – 1,00 GeV/c)

Nonphotonic electron-hadron Azimuthal correlations

p_T > 3 GeV/c: electron approx in direction of mother D meson



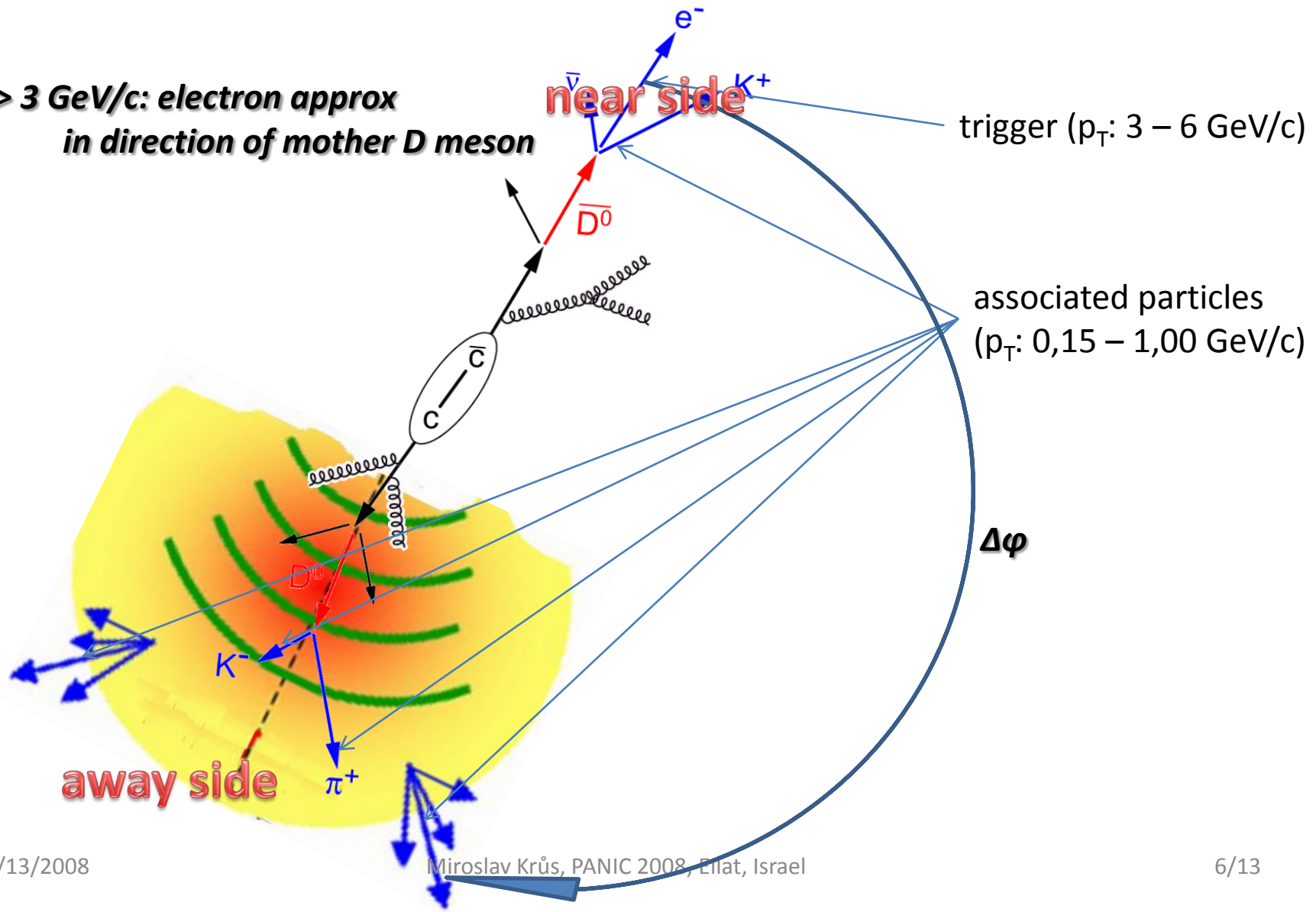
trigger (p_T: 3 – 6 GeV/c)

associated particles (p_T: 0,15 – 1,00 GeV/c)

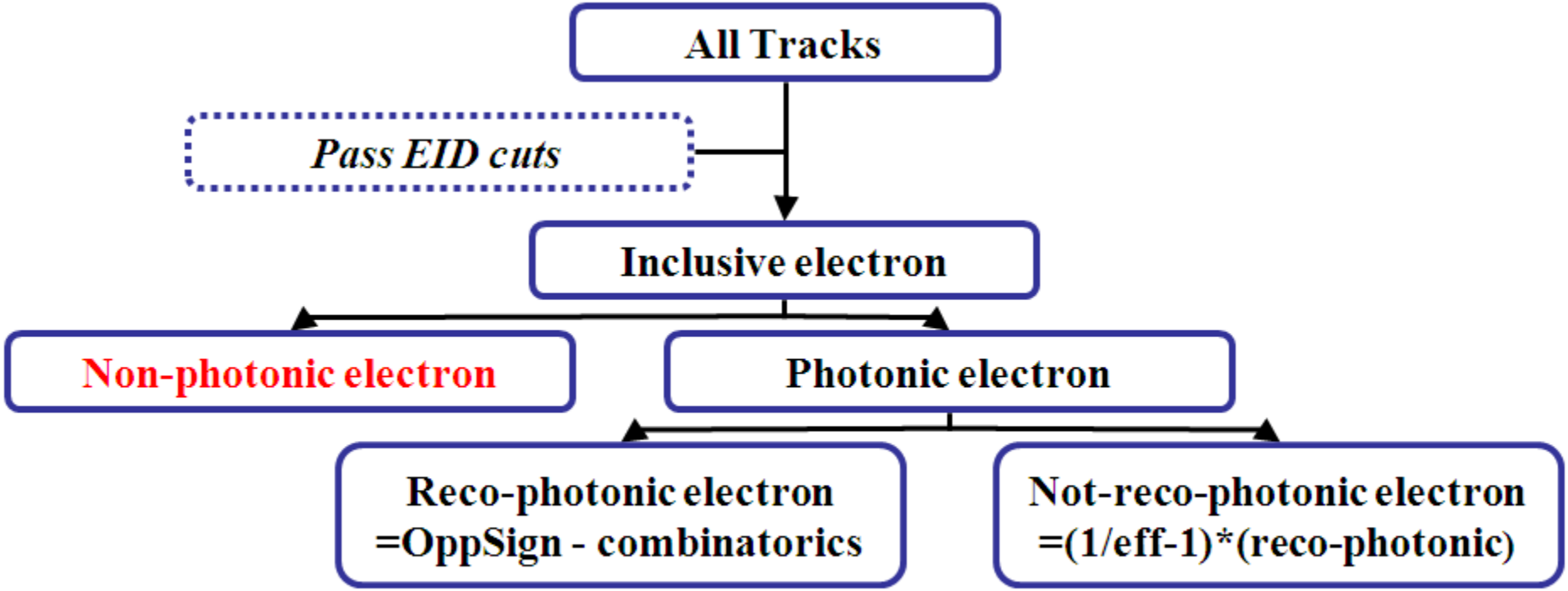
Δφ

Nonphotonic electron-hadron Azimuthal correlations

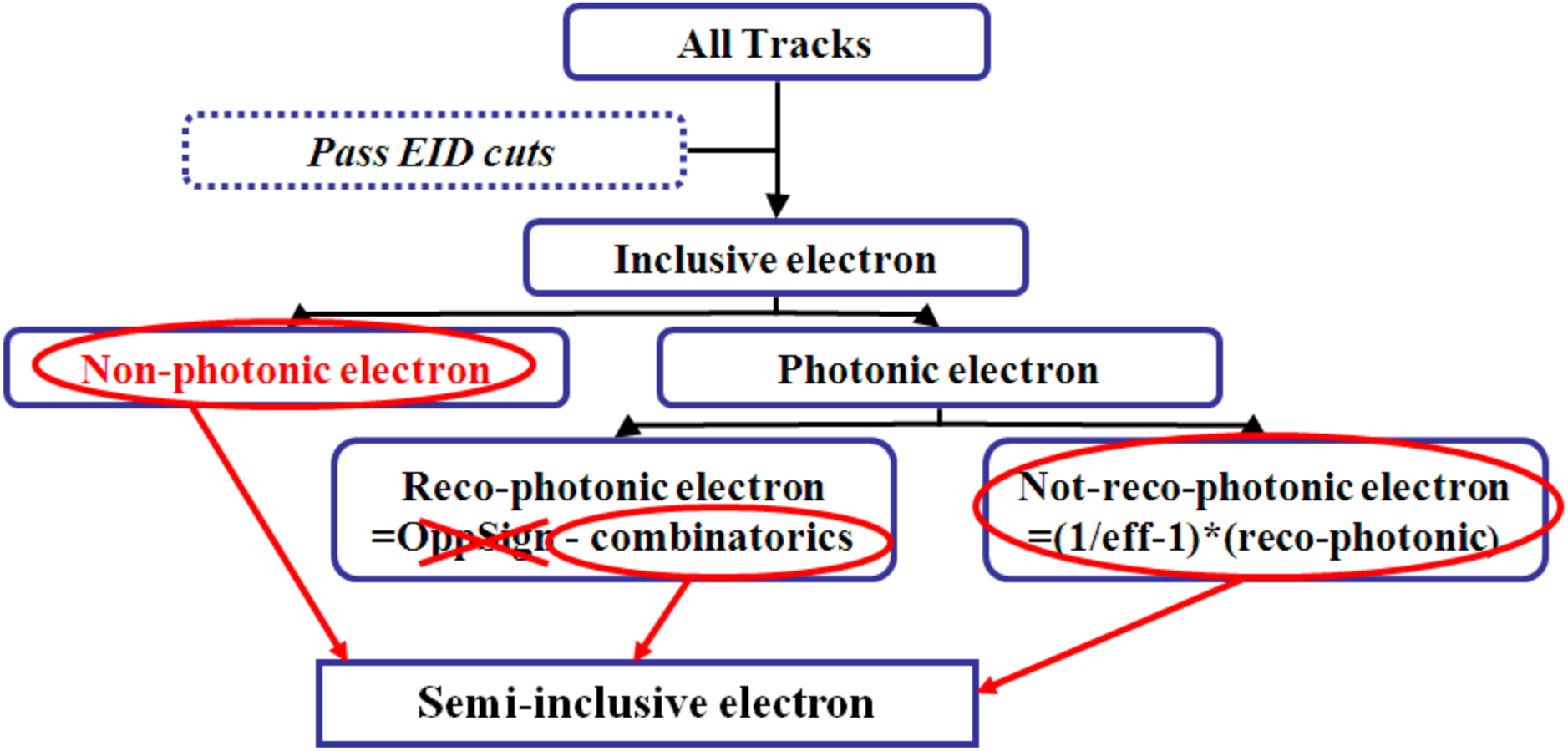
p_T > 3 GeV/c: electron approx in direction of mother D meson



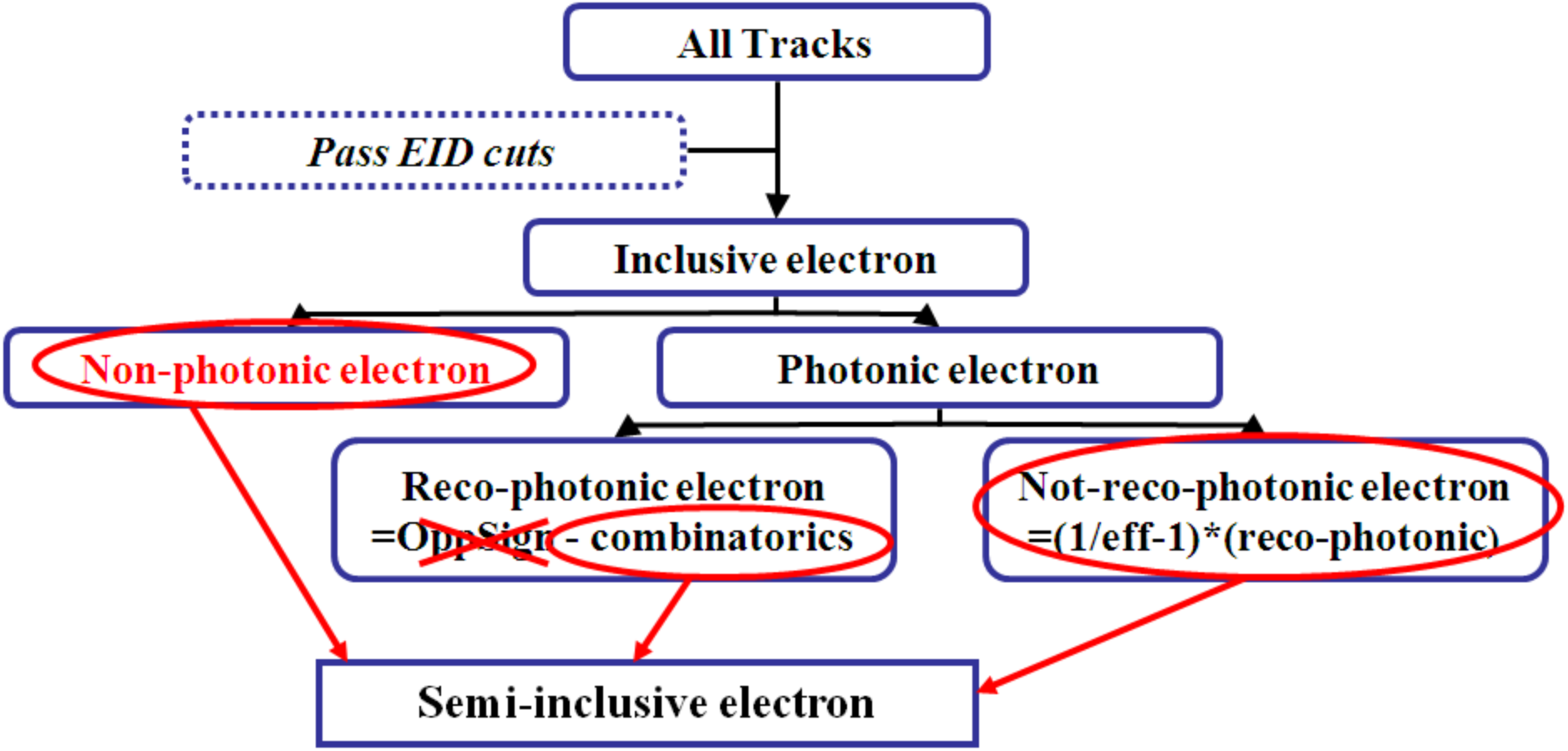
Nonphotonic electron-hadron correlations Extraction procedure



Nonphotonic electron-hadron correlations Extraction procedure

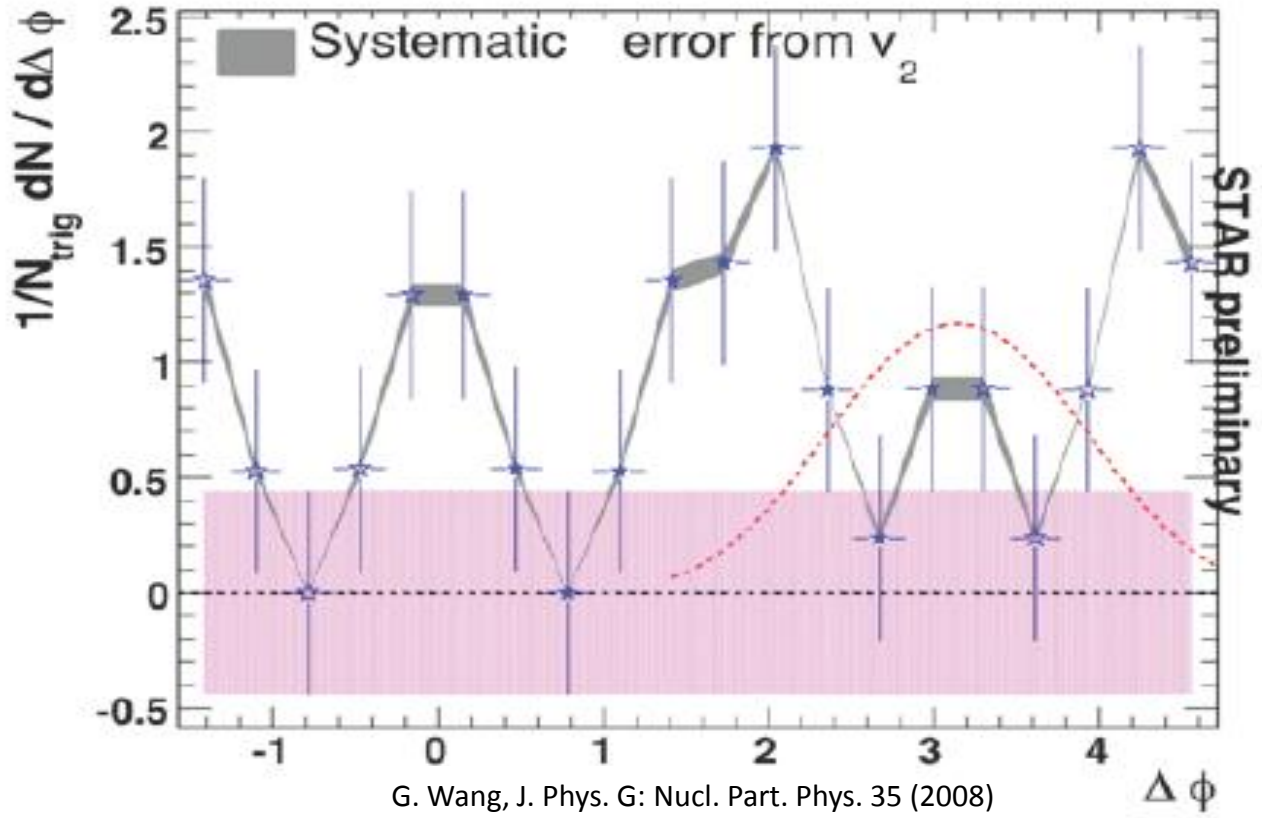


Nonphotonic electron-hadron correlations Extraction procedure



$$\Delta\Phi_{\text{non-photo}} = \Delta\Phi_{\text{semi-incl}} + \Delta\Phi_{\text{Same Sign}} - (1/\varepsilon - 1)\times(\Delta\Phi_{\text{Opp Sign}} - \Delta\Phi_{\text{Same Sign}})$$

Nonphotonic electron – hadron correlations in CuCu collisions at $\sqrt{s_{NN}}$ =200 GeV

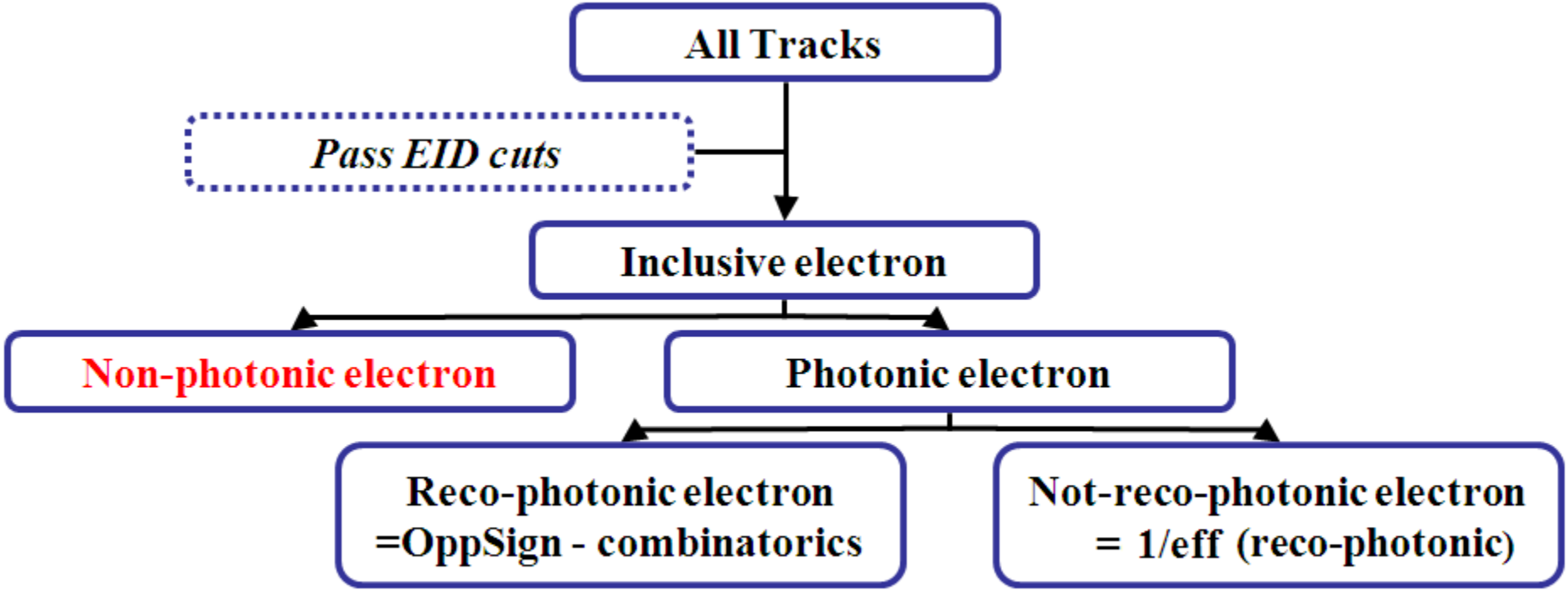


G. Wang, J. Phys. G: Nucl. Part. Phys. 35 (2008)

0-20%, $3 < p_T^{trig} < 6$ GeV/c

$0.15 < p_T^{asso} < 0.5$ GeV/c

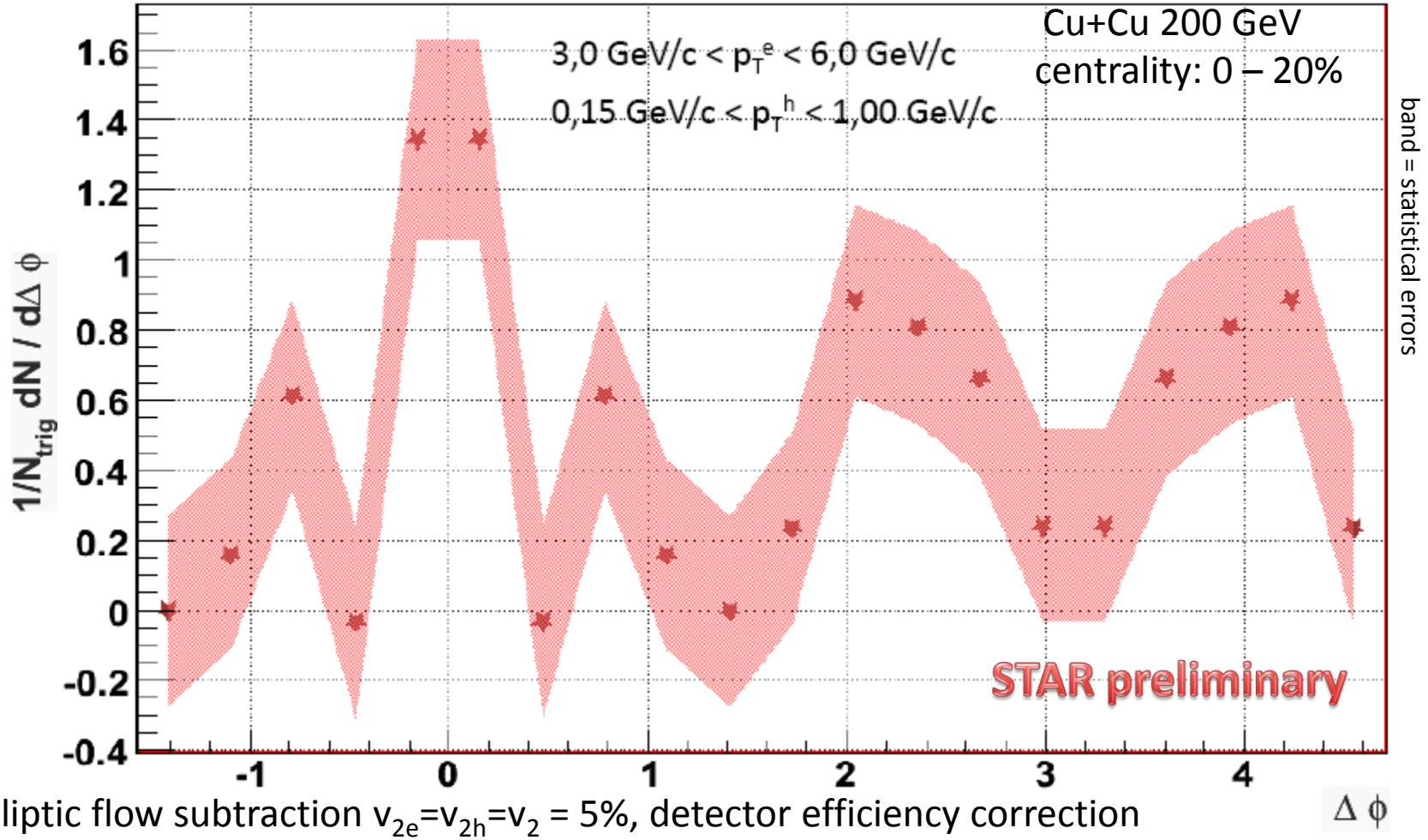
Nonphotonic electron-hadron correlations Extraction procedure II



$$\Delta\Phi_{\text{non-photo}} = \Delta\Phi_{\text{incl}} - 1/\varepsilon \times (\Delta\Phi_{\text{Opp Sign}} - \Delta\Phi_{\text{Same Sign}})$$

➔Photonic sample included in Inclusive sample ➔ correlated quantities and errors

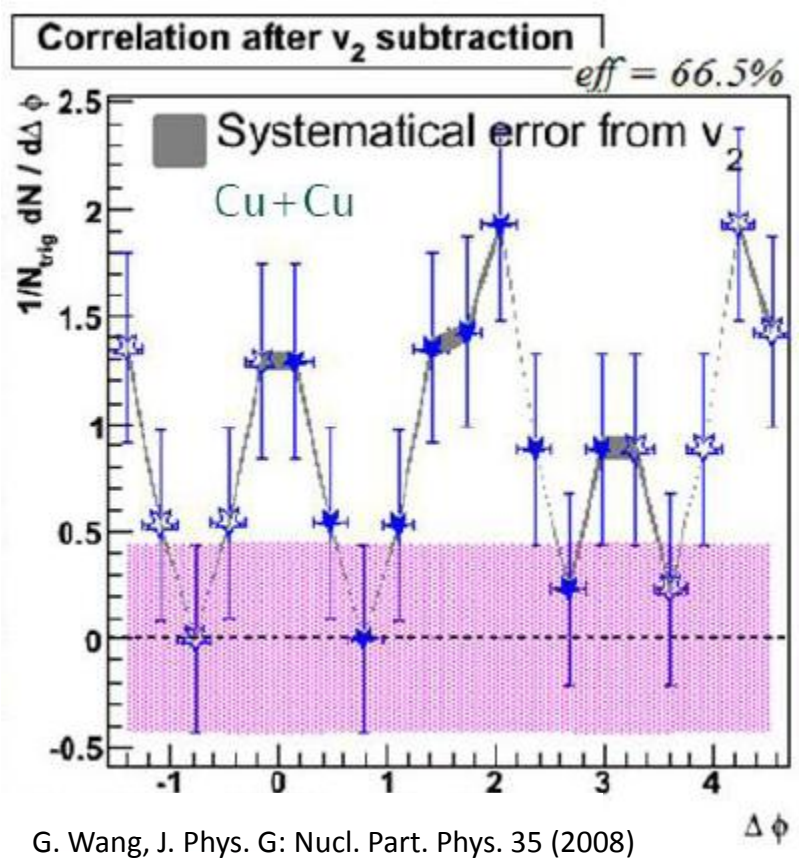
Nonphotonic electron – hadron correlations in CuCu collisions at $\sqrt{s_{NN}}$ =200 GeV



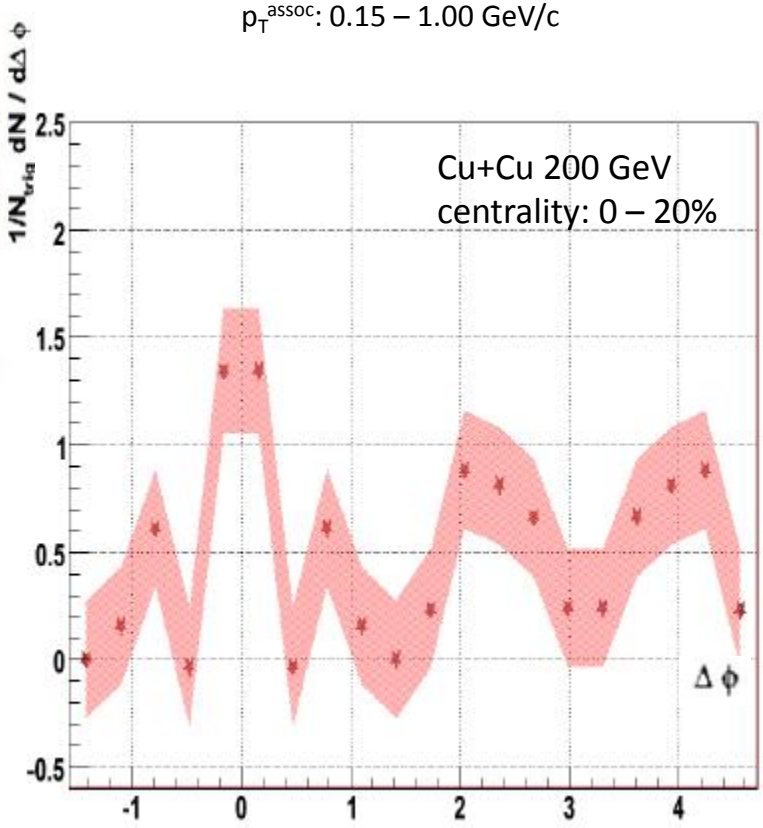
elliptic flow subtraction $v_{2e}=v_{2h}=v_2$ = 5%, detector efficiency correction

Nonphotonic electron – hadron correlations

p_T^{trig}: 3 – 6 GeV/c
p_T^{assoc}: 0.15 – 0.50 GeV/c

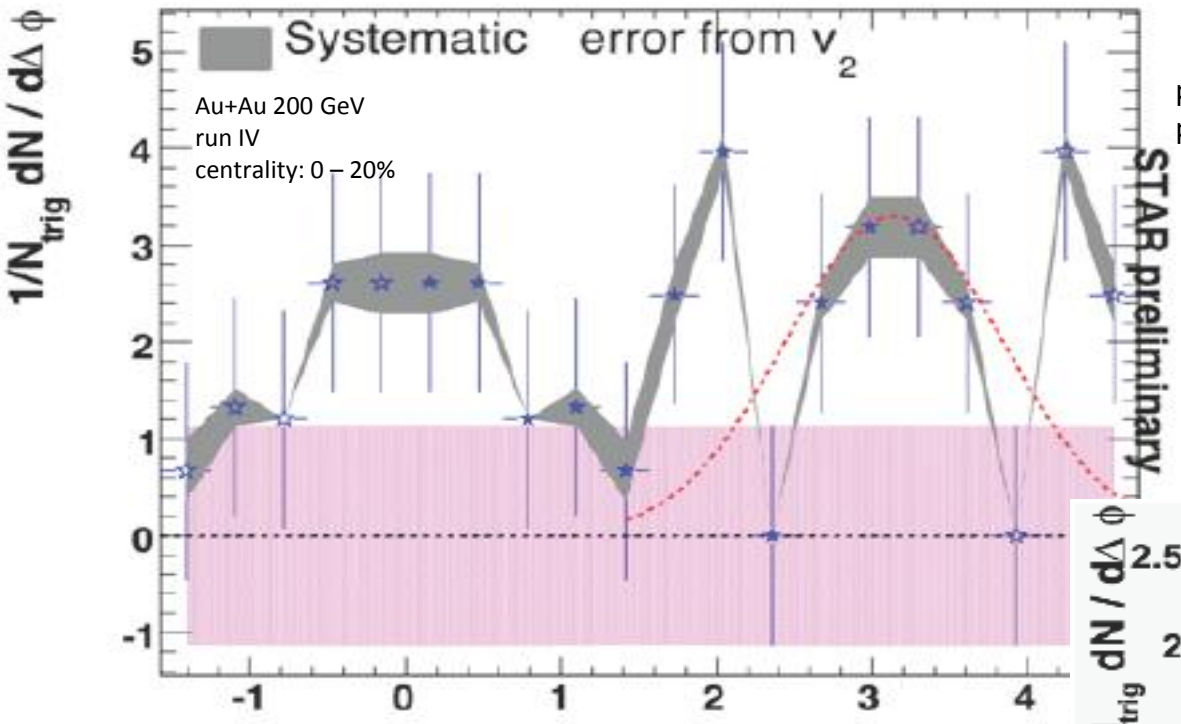


p_T^{trig}: 3 – 6 GeV/c
p_T^{assoc}: 0.15 – 1.00 GeV/c



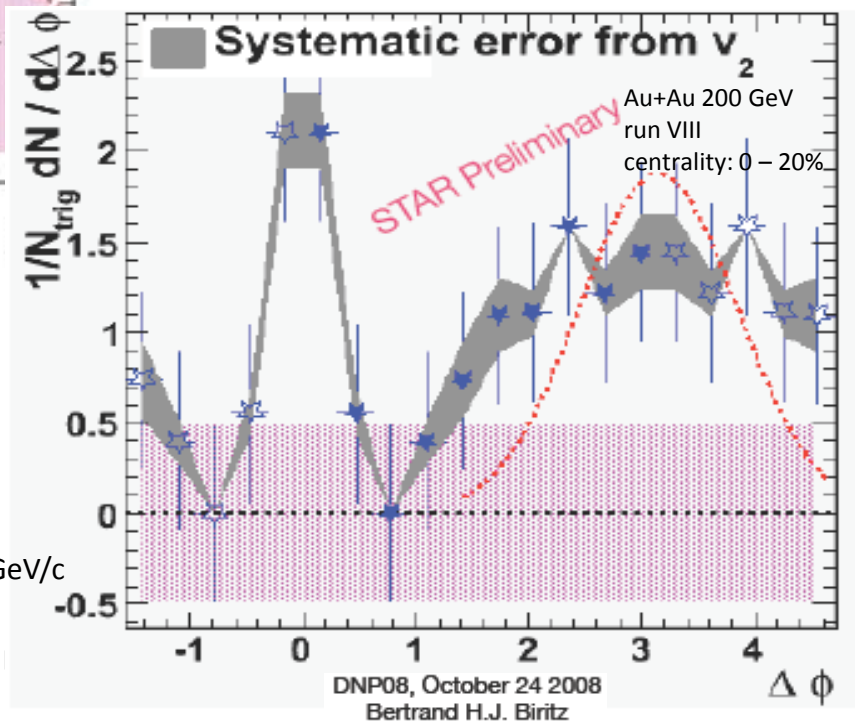
G. Wang, J. Phys. G: Nucl. Part. Phys. 35 (2008)

Nonphotonic electron – hadron correlations in AuAu collisions at $\sqrt{s_{NN}}$ =200 GeV



p_T^{trig}: 3 – 6 GeV/c
p_T^{assoc}: 0.15 – 1.00 GeV/c

G. Wang, J. Phys. G: Nucl. Part. Phys. 35 (2008)



p_T^{trig}: 3 – 6 GeV/c
p_T^{assoc}: 0.15 – 1.00 GeV/c

Summary & conclusion

➔ *nonphotonic electron – hadron correlations in Cu+Cu 200 GeV extracted*

➔ *two independent analysis performed*

➔ *within large statistical uncertainties results suggest possible modification of away- side peak similar to hadron – hadron correlations & electron – hadron correlations in Au+Au*

Summary & conclusion

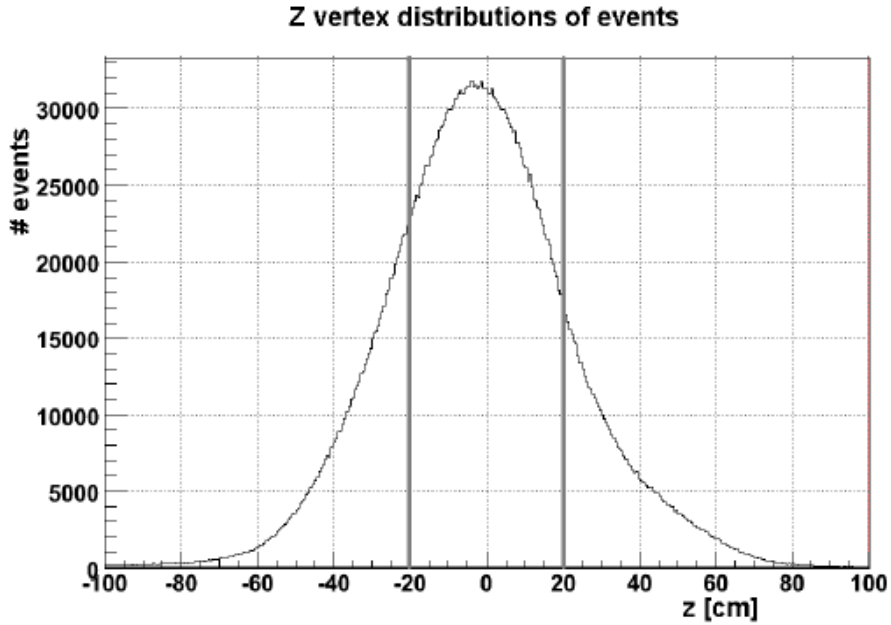
➔ *nonphotonic electron – hadron correlations in Cu+Cu 200 GeV extracted*

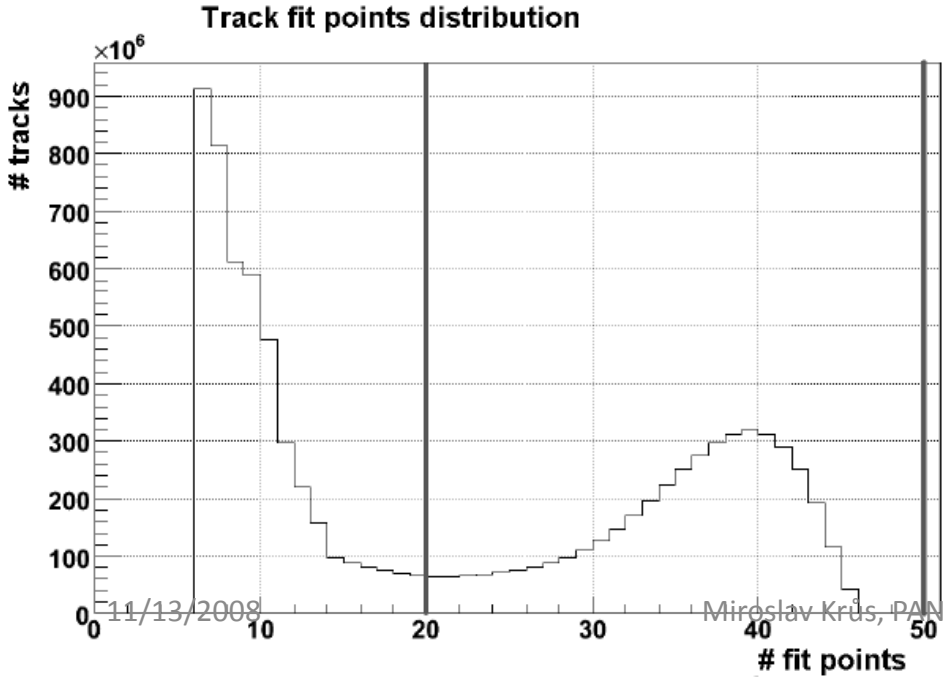
➔ *two independent analysis performed*

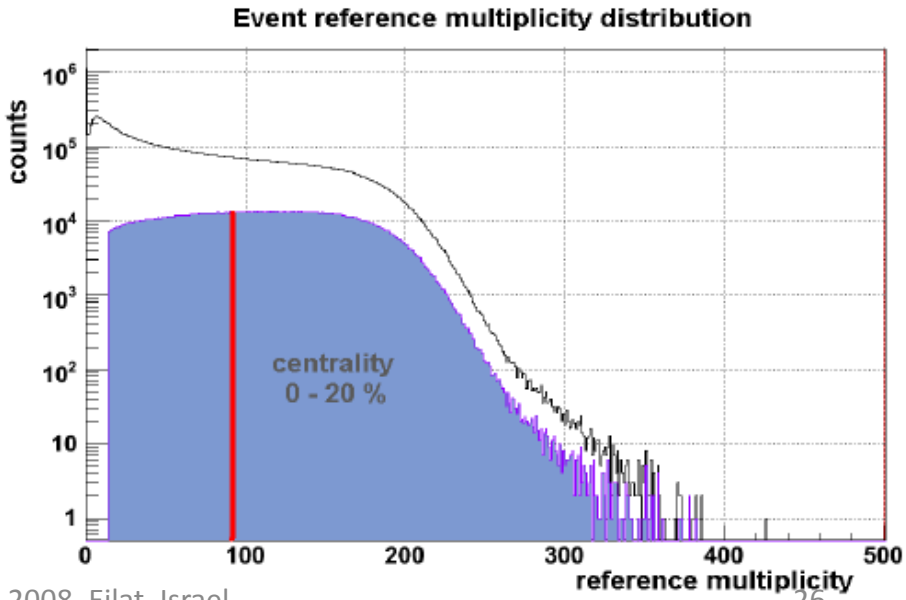
➔ *within large statistical uncertainties results suggest possible modification of away- side peak similar to hadron – hadron correlations & electron – hadron correlations in Au+Au*

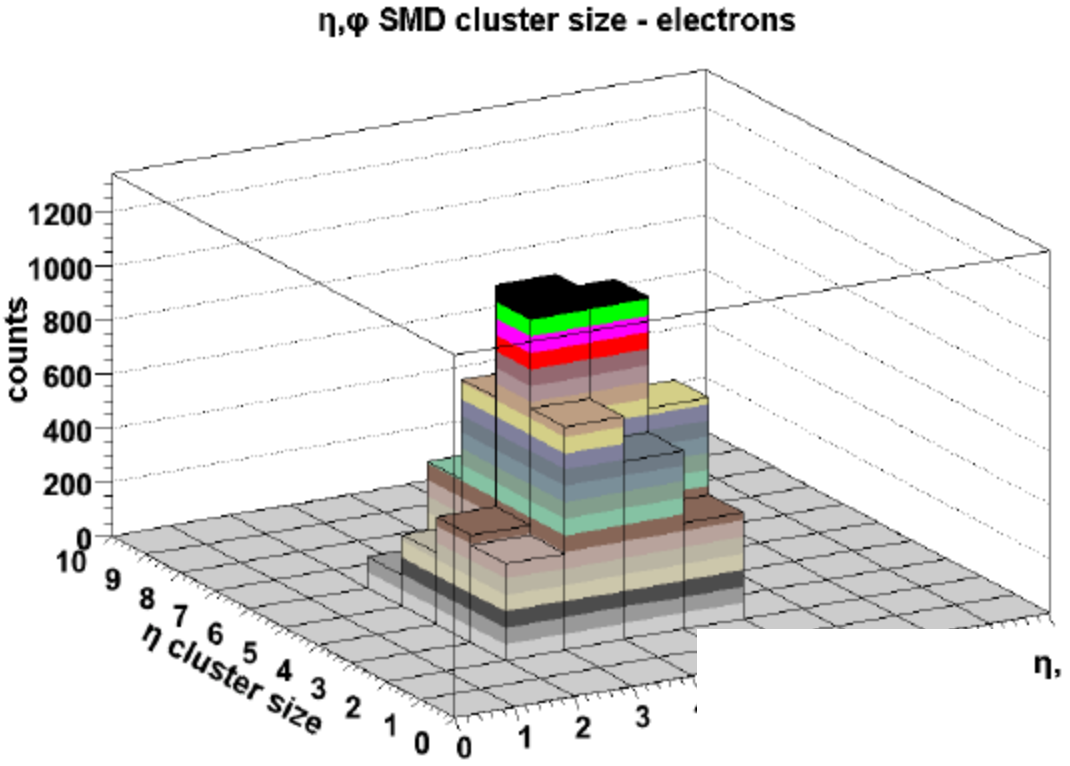
THANK YOU FOR YOUR ATTENTION

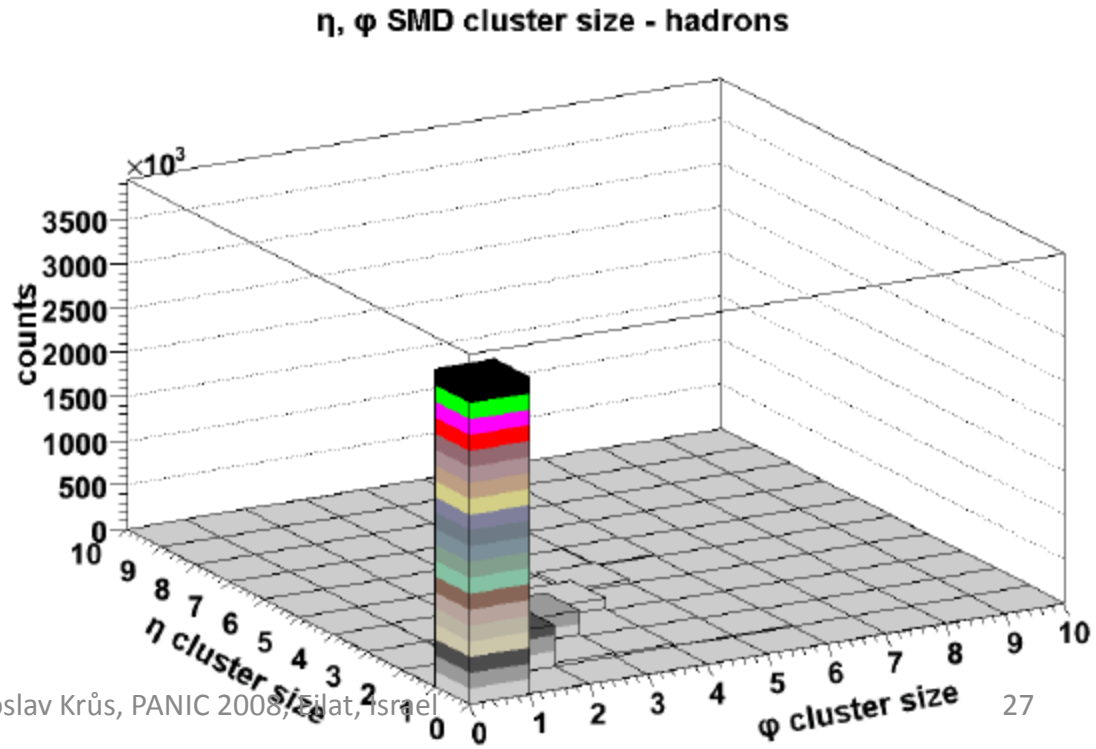
backup

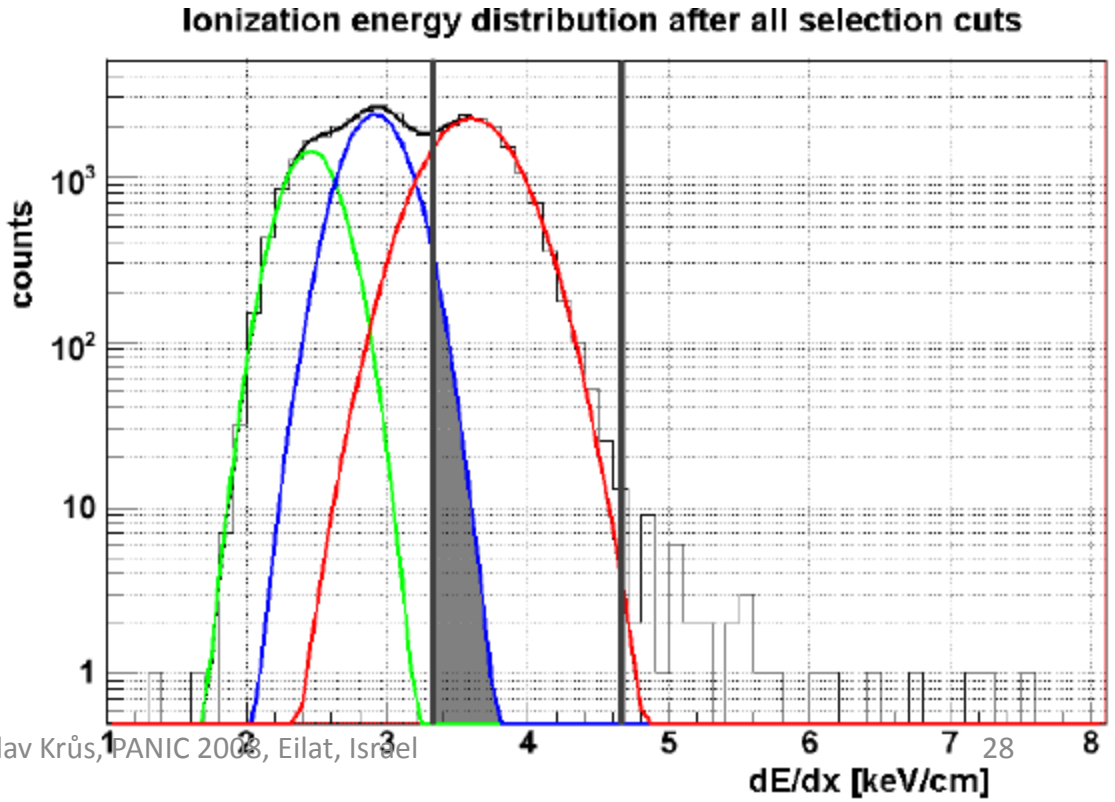

Z vertex distributions of events
events
z [cm]

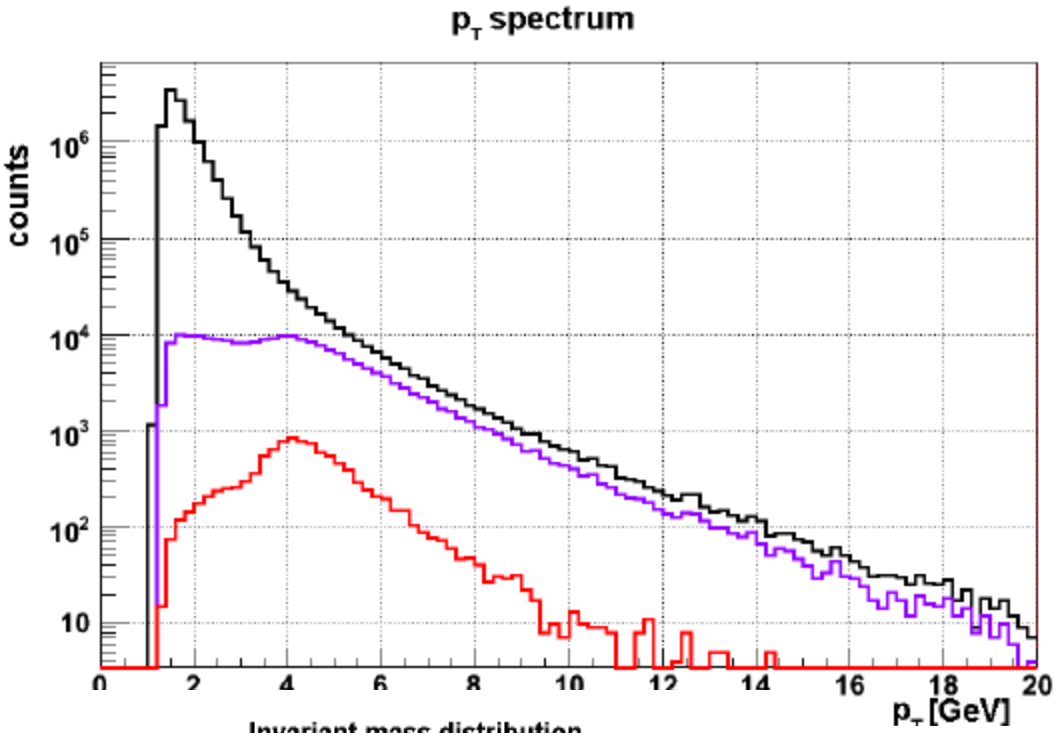

Track fit points distribution
tracks
fit points

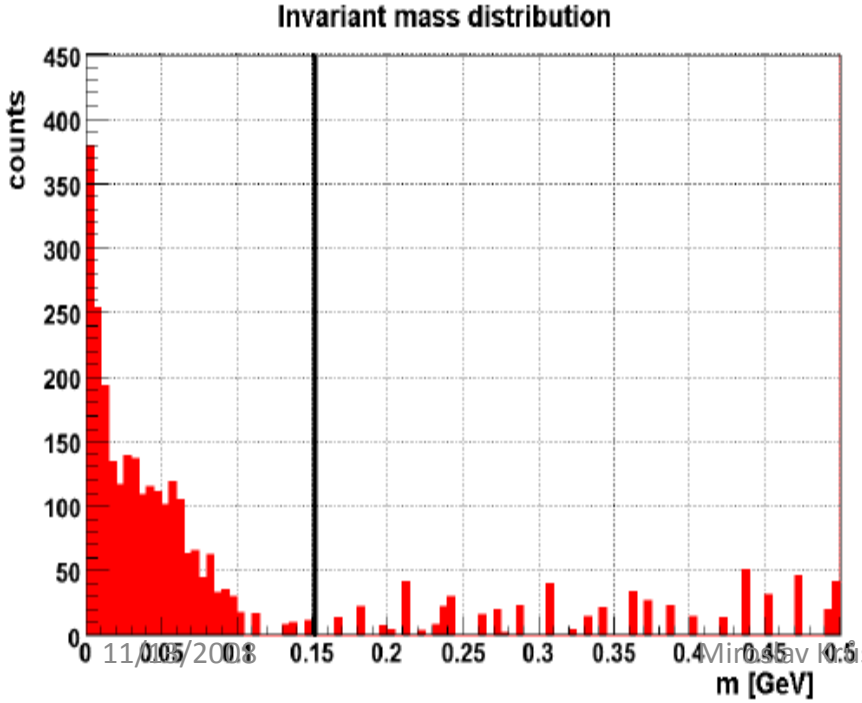

Event reference multiplicity distribution
counts
centrality
0 - 20 %
reference multiplicity

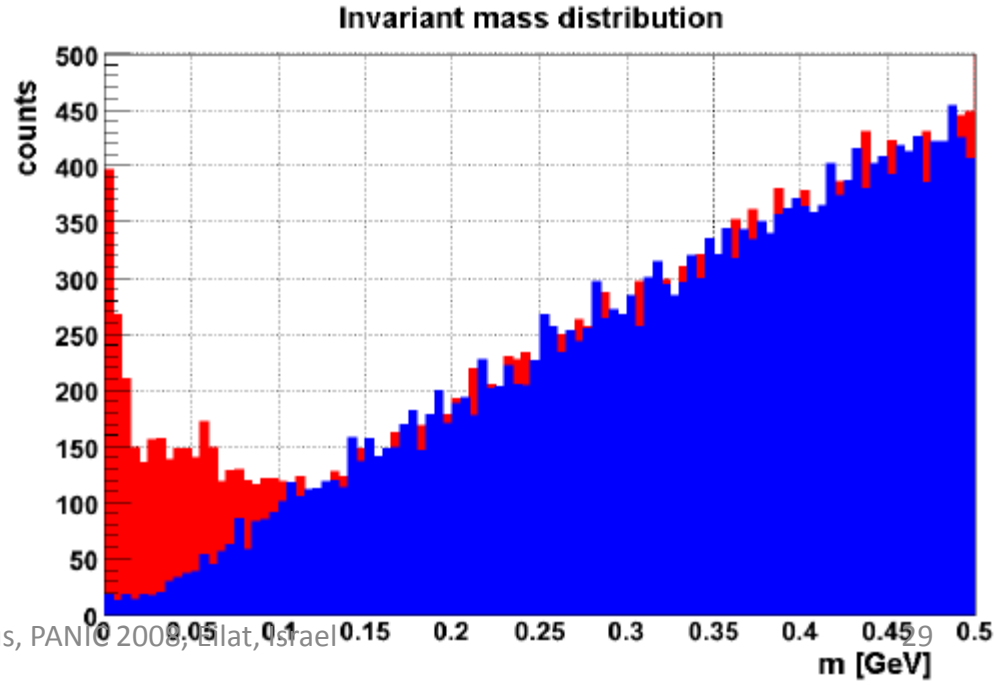

η,φ SMD cluster size - electrons
counts
1200
1000
800
600
400
200
0
10
9
8
7
6
5
4
3
2
1
0
η cluster size
0
1
2
3

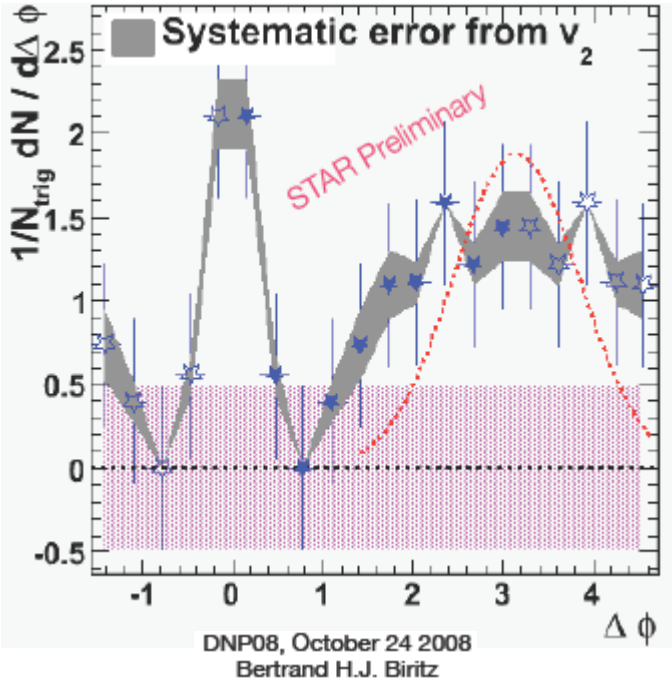

η, φ SMD cluster size - hadrons
×10³
counts
3500
3000
2500
2000
1500
1000
500
0
10
9
8
7
6
5
4
3
2
1
0
η cluster size
0
1
2
3
4
5
6
7
8
9
10
φ cluster size


Ionization energy distribution after all selection cuts
counts
10^3
10^2
10
1
1
2
3
4
5
6
7
8
dE/dx [keV/cm]


p_T spectrum
counts
10^6
10^5
10^4
10^3
10^2
10
0
2
4
6
8
10
12
14
16
18
20
p_T [GeV]

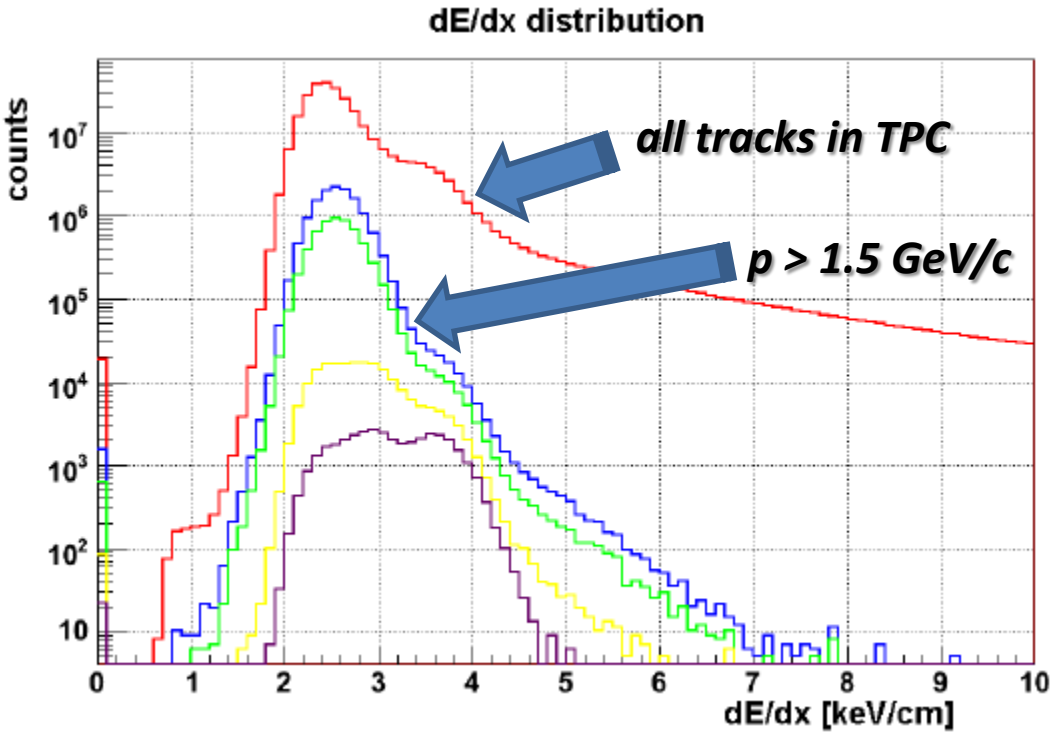

Invariant mass distribution
counts
450
400
350
300
250
200
150
100
50
0
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
m [GeV]


Invariant mass distribution
counts
500
450
400
350
300
250
200
150
100
50
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
m [GeV]


Systematic error from v2
STAR Preliminary
1/Ntrig dN / dΔ φ
2.5
2
1.5
1
0.5
0
-0.5
-1
0
1
2
3
4
Δ φ
DNP08, October 24 2008
Bertrand H.J. Biritz

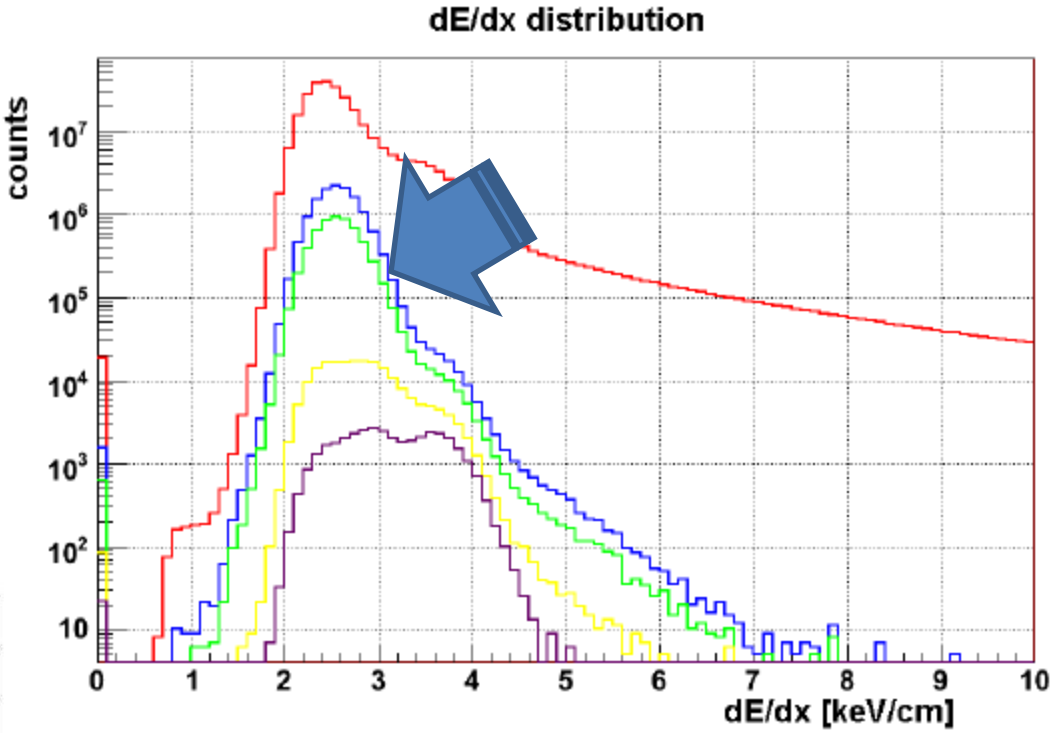
Electron identification

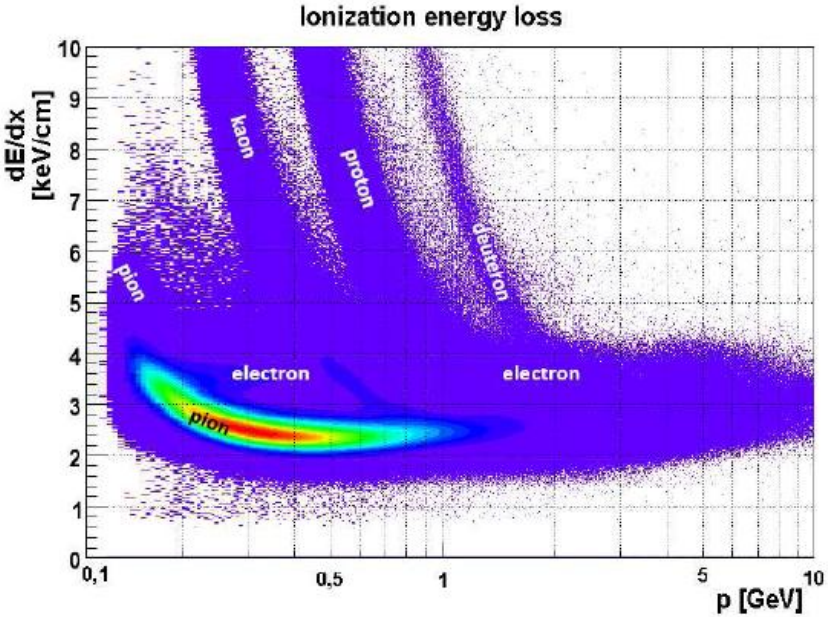
TPC: all tracks



Electron identification

TPC: all tracks
p > 1.5 GeV/c

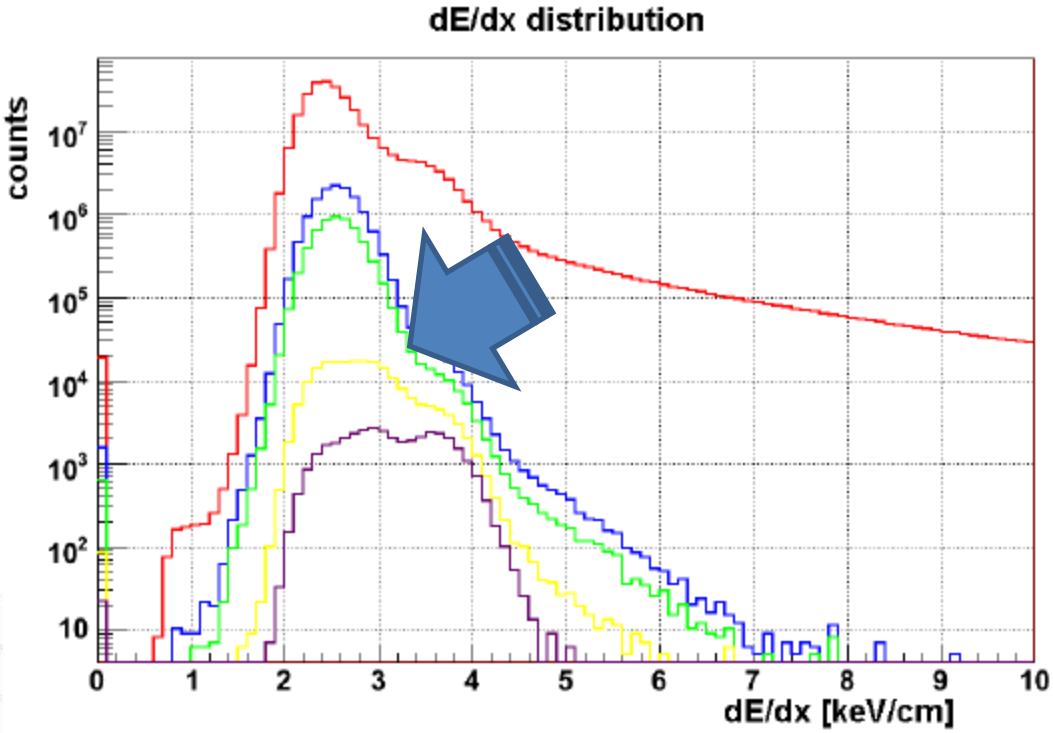


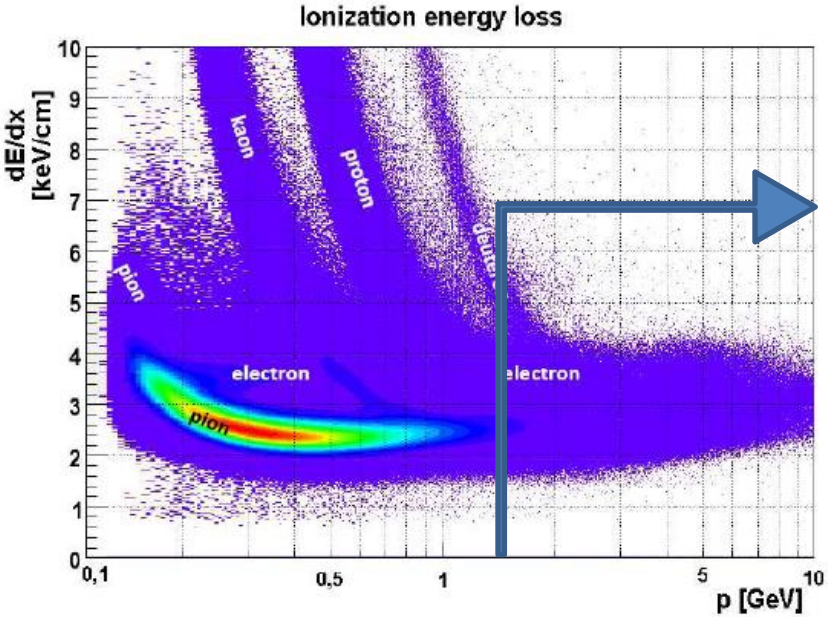


Electron identification

TPC: all tracks
$p > 1,5$ GeV/c

BEMC: good track projection

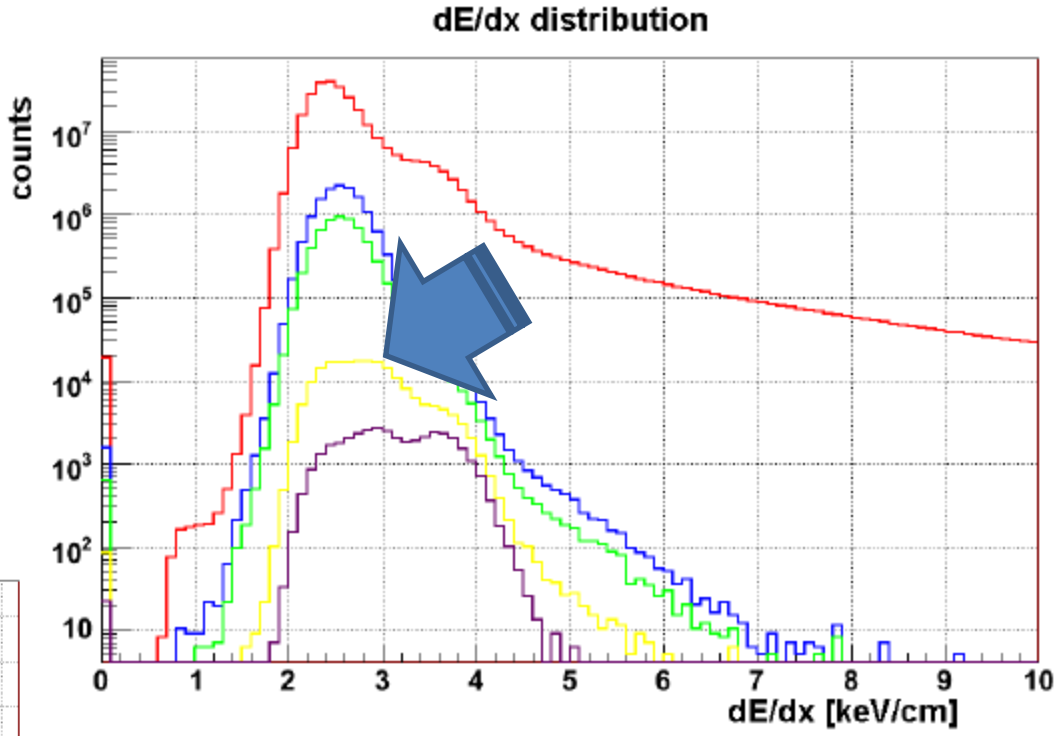


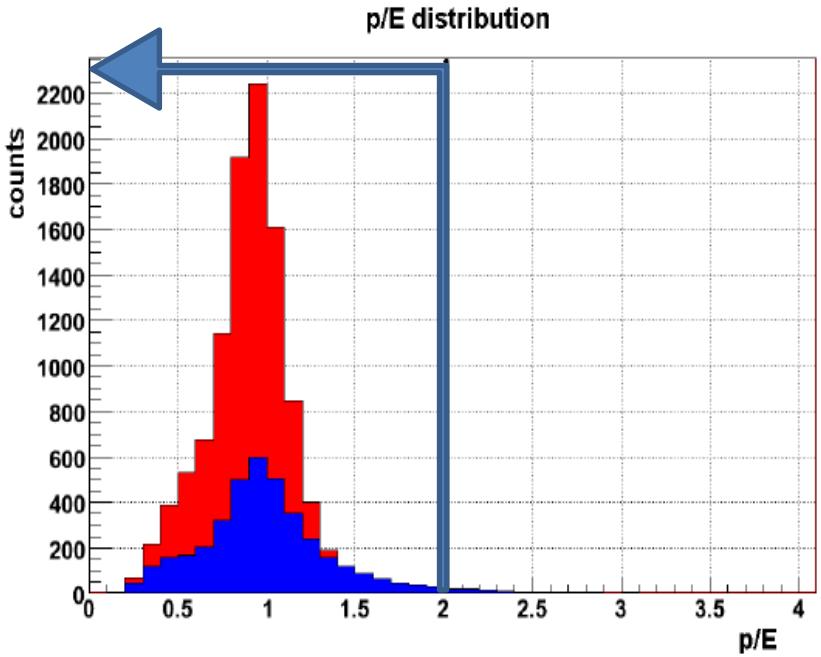


Electron identification

TPC: all tracks
$p > 1{,}5$ GeV/c

BEMC: good track projection
$p/E_{TOW} : 0 - 2$



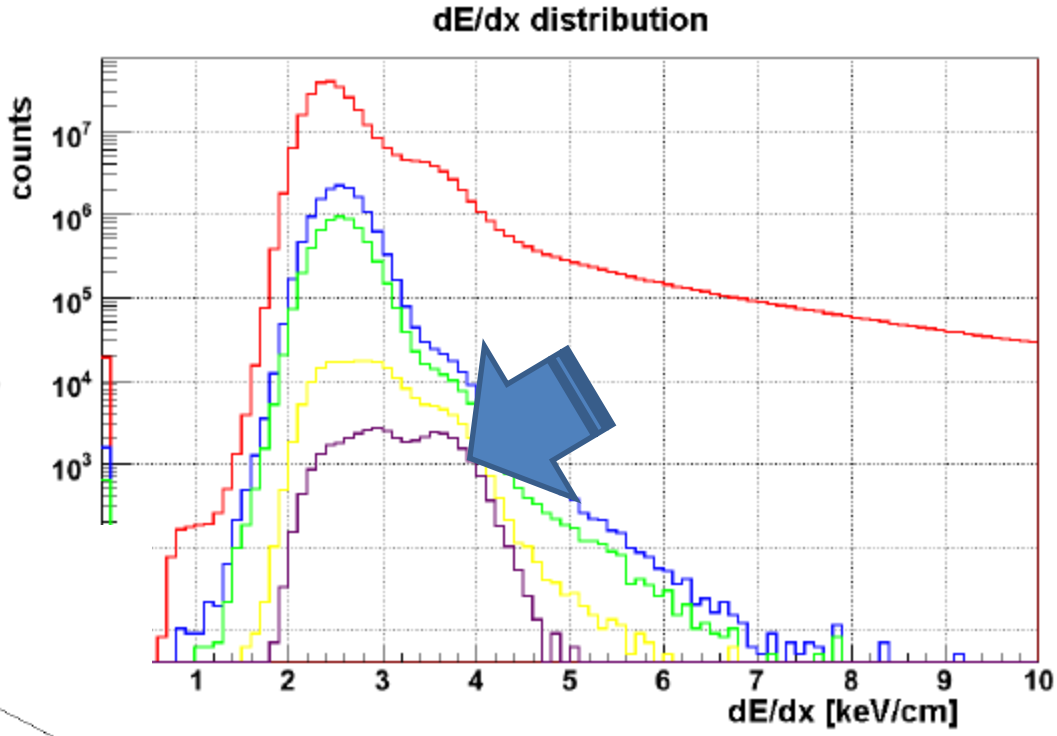


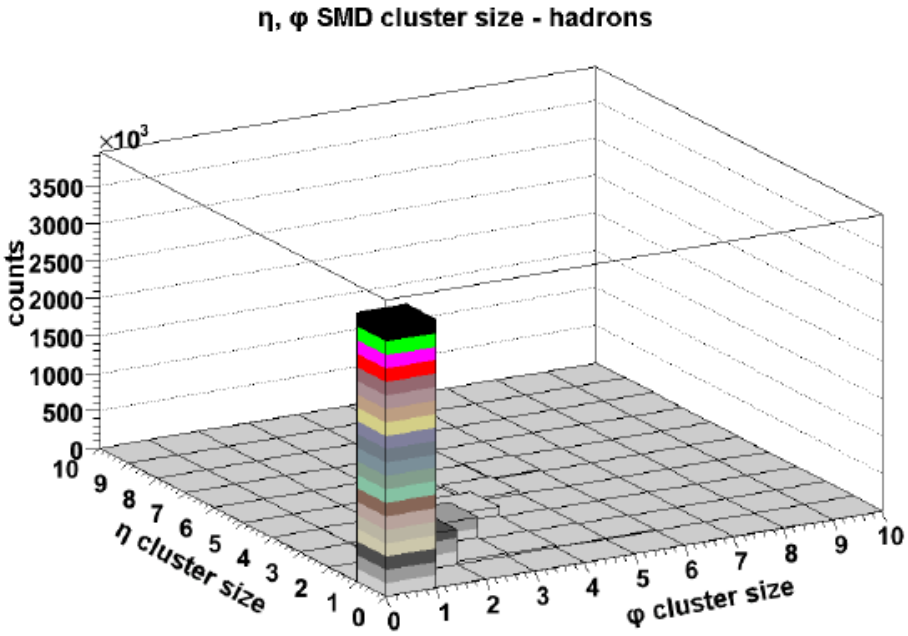
Electron identification

TPC: all tracks
$p > 1{,}5$ GeV/c

BEMC: good track projection
p/E_{TOW} : 0 – 2

BSMD: electron/hadron shower shape (cluster size $\geq$ 2)



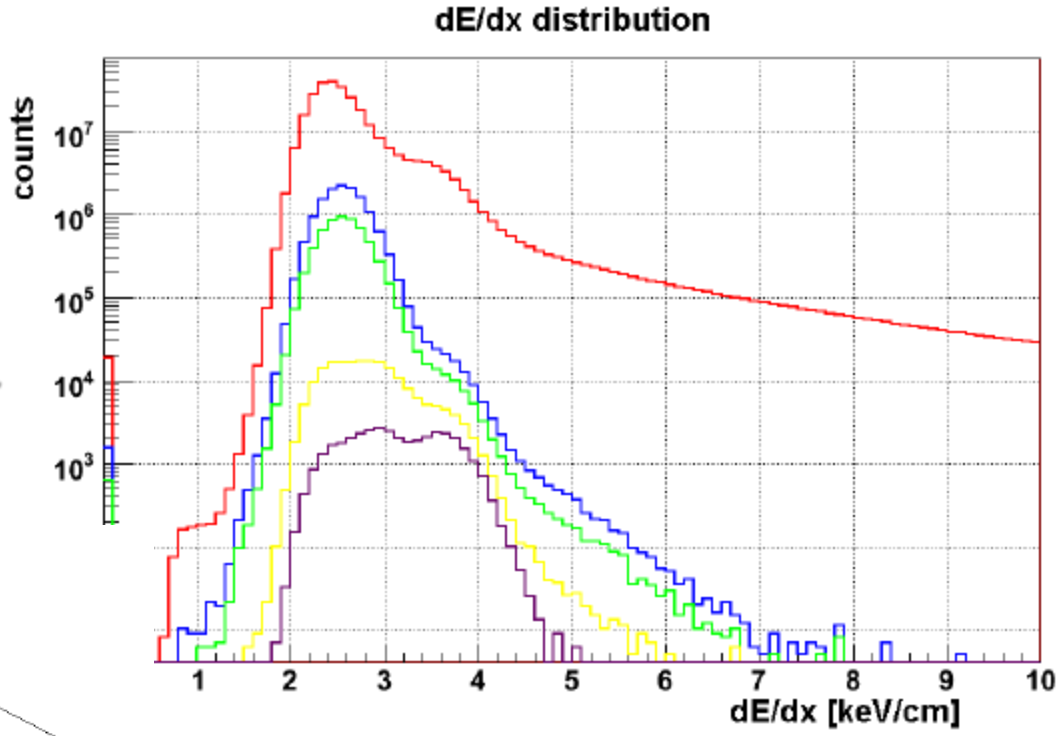


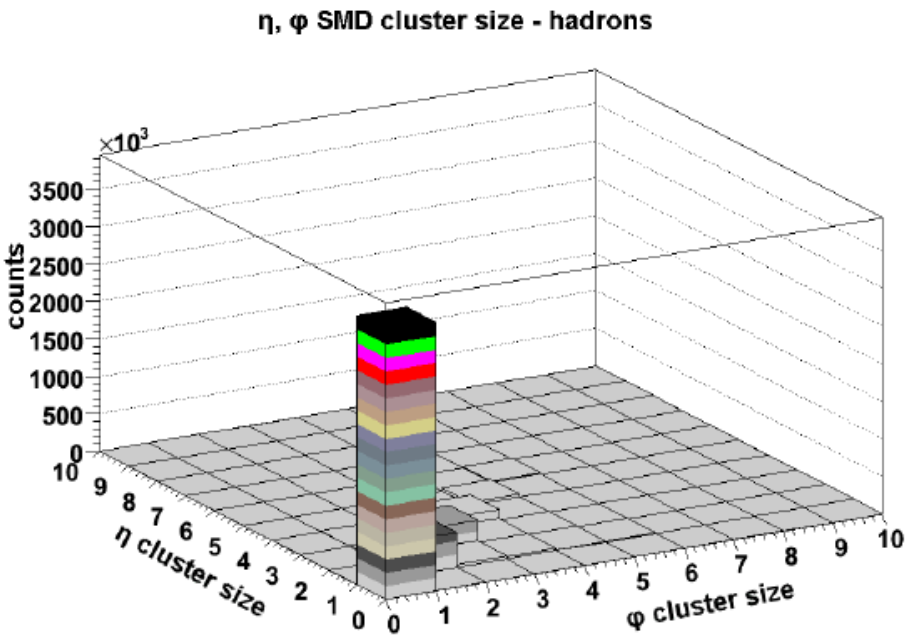
Electron identification

TPC: all tracks
$p > 1{,}5$ GeV/c

BEMC: good track projection
$p/E_{TOW} : 0 - 2$

BSMD: electron/hadron shower shape (cluster size ≥ 2)



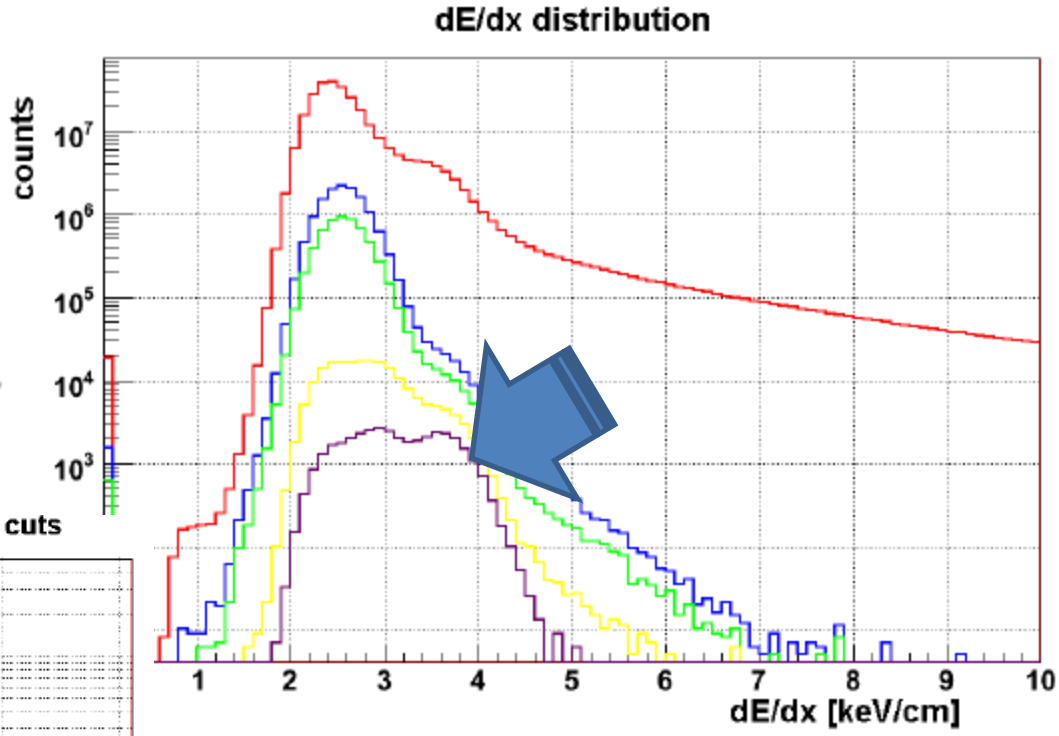


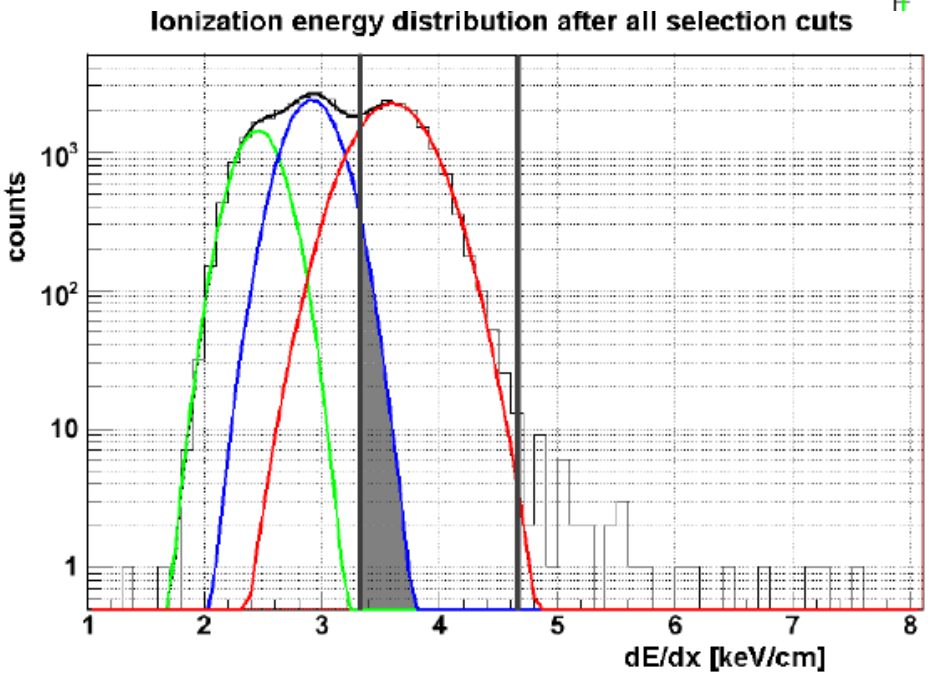
Electron identification

TPC: all tracks
$p > 1{,}5$ GeV/c

BEMC: good track projection
$p/E_{TOW} : 0 - 2$

BSMD: electron/hadron shower shape (cluster size ≥ 2)





primary vertex	-20 cm – + 20 cm
reference multiplicity	> 14 particles
# of fit points in TPC	20 – 50
# of fit points in TPC/max fit pts	> 0,52
pseudorapidity	-0,7 – +0,7
DCA	< 2 cm
momentum	> 1,5 Gev/c
p/E	0 – 2
SMD cluster size	$\geq$ 2
dE/dx	3,31 – 4,64 keV/cm

momentum	> 0,1 GeV/c
dE/dx	2,97 – 4,64 keV/cm
DCA	< 2 cm
pair invariant mass	< 150 MeV/c^2