PHENIX and Light Vector Mesons: Report to Working Group

Xie Wei, Z. Fraenkel, A. Milov, I. Ravinovich and I. Tserruya, WIS

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Procedure and Basics

- Input parameters
- Acceptance

Present Configuration

- Signal to Background
- Pion rejection and electron efficiency

Benefits of Detector in a Field Free Region

- Detector without pid
- Hadron blind detector

Input Parameters and Procedure

- **Central Au-Au collisions:**
  $\pi^+ = \pi^- = \pi^0 = 3000$ in full space
  $\Longrightarrow (\frac{dN}{dy})_{y=0} = 475\pi^+ = \pi^- = \pi^0$

- **Ideal tracking** of charged particles in magnetic field using a look-up table. Ideal response (no multiple scattering, no physical processes ...). Momentum smeared according to:
  $\frac{\sigma_p}{p} = 0.005 * \sqrt{1+p^2}$

- **Track $\mathbf{p}_t > 200$ MeV.**

- **Background:**
  - π^0 Dalitz decay
    Generator: routines from PISA
  - γ Conversions $(X/X_0) = 1\%$ at Vertex (beam pipe + MVD)
    Generator: routines from GEANT 3.21

- **Signal:**
  - $\phi \rightarrow e^+e^-$
  - $\phi/\pi^0 = 0.015$
  - Generator : rv_phi

Φ Meson

- **Acceptance**

  $\star$ $\frac{(dN/dy)_{|y|<0.5}}{N_{total}} = 16\%$

  $\star$ $\frac{N_\phi(acc.,p_t>200)}{dN/dy)_{|y|<0.5}} = 2.9\%$

  $\star$ Single arm acceptance is negligible

- **Rate**

  Assuming $\phi/\pi^0 = 0.015$ and $N_{\pi^0} = 3000$:

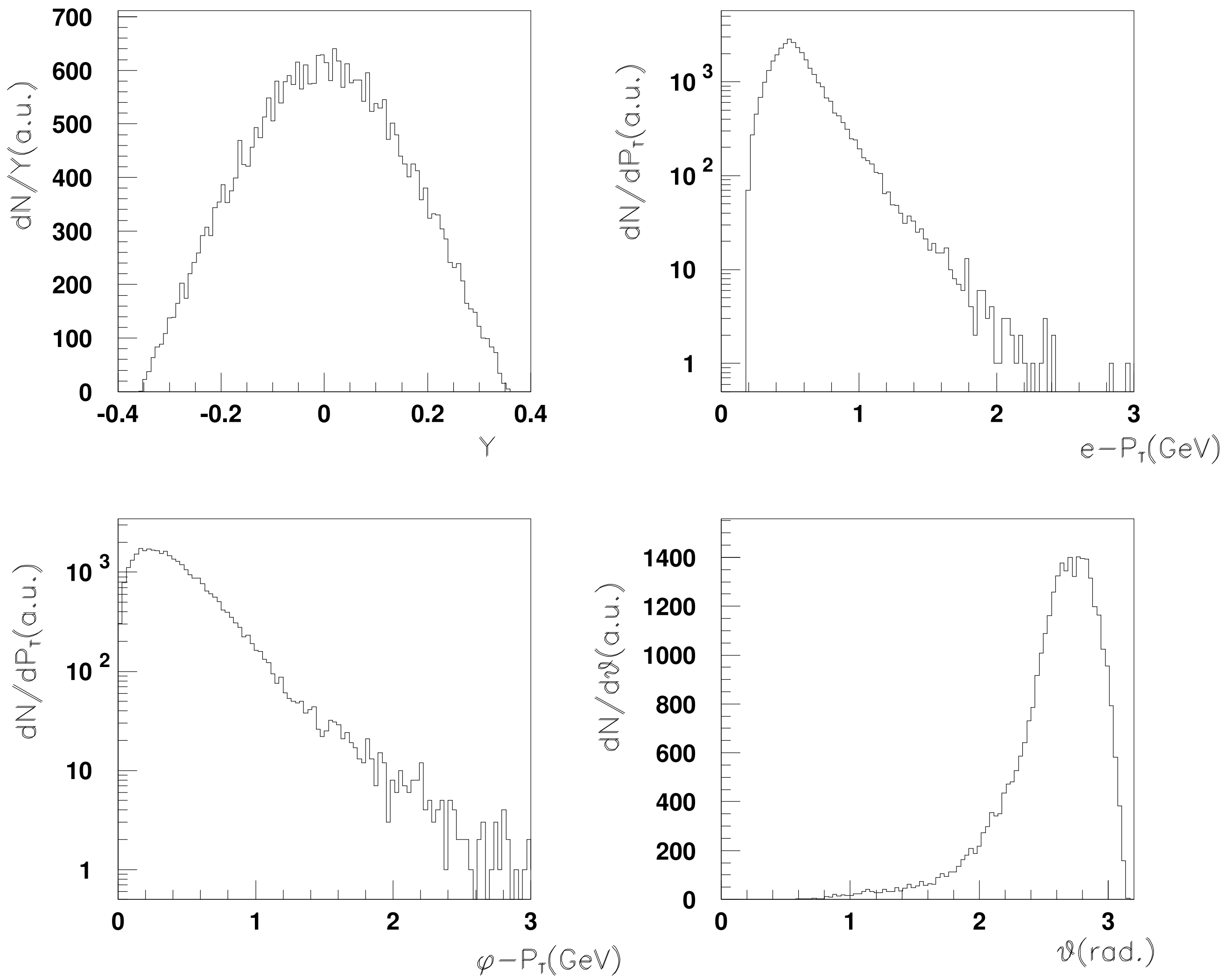
  $\star$ $N_\phi(acc., p_t > 200) = 0.015*0.16*0.029*3*10^{-4}*N_{\pi^0}$

  $\star$ $= 2.1 * 10^{-8} * N_{\pi^0}$

  $\star$ $= 6.2 * 10^{-5}$ per central Au-Au event.

Φ Meson Distributions

$\phi \rightarrow e^+e^-$ two central-arm acceptance
track $p_t > 200$ MeV.



Tracks per Event in Present PHENIX Configuration

(Only tracks with $p_t > 200$ MeV are counted.)

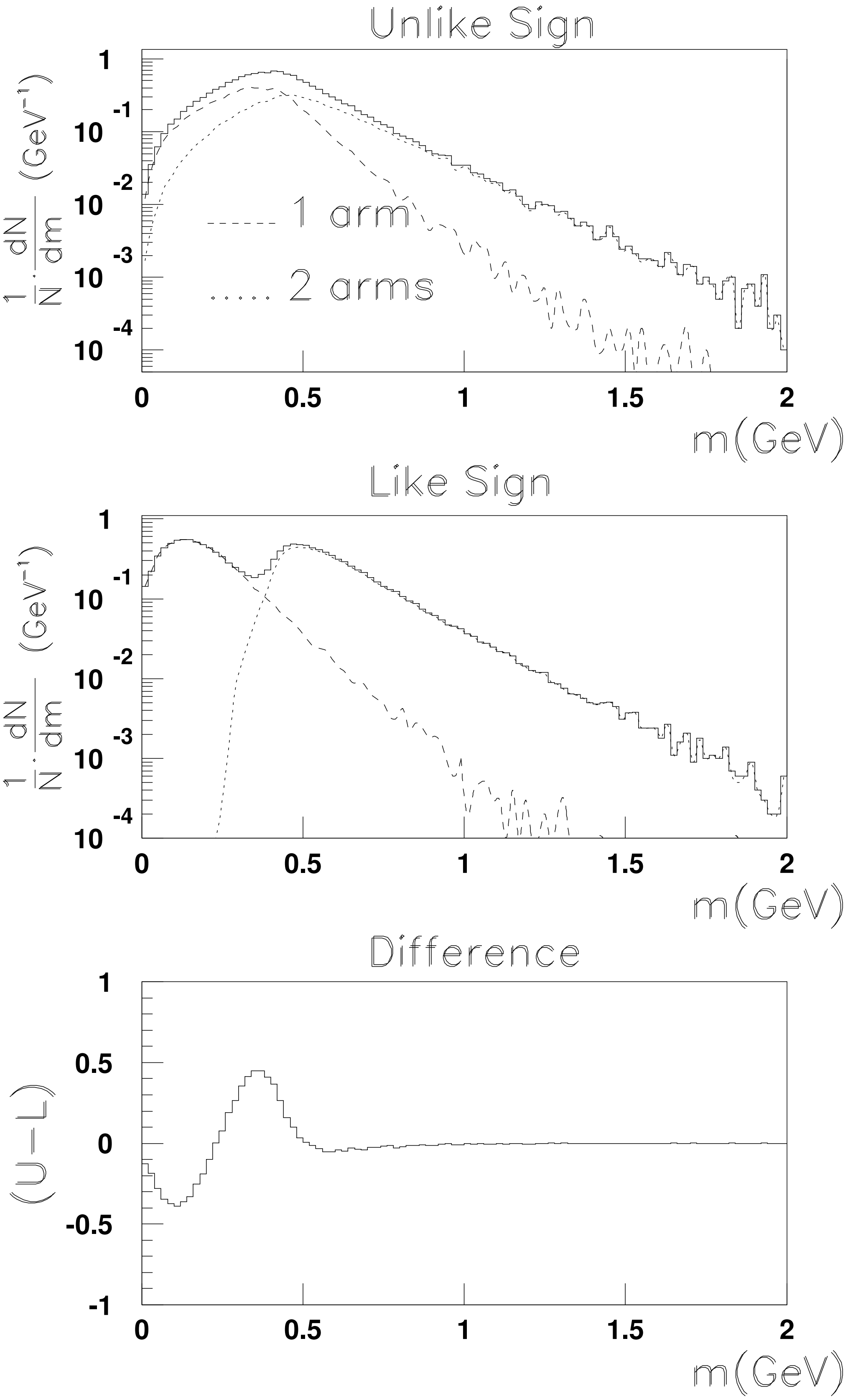
e-tracks

	singles	pairs
$\pi^0 \rightarrow e^+e^-\gamma$	0.51	0.06
$\gamma \rightarrow e^+e^-$	0.62	0.07
Total	1.13 tr/evt	0.13 tr/evt

$\pi^\pm$ tracks 208 tr/evt

Signal ϕ $6.2 * 10^{-5}\phi$/evt

Unlike and Like Sign Mass Spectra



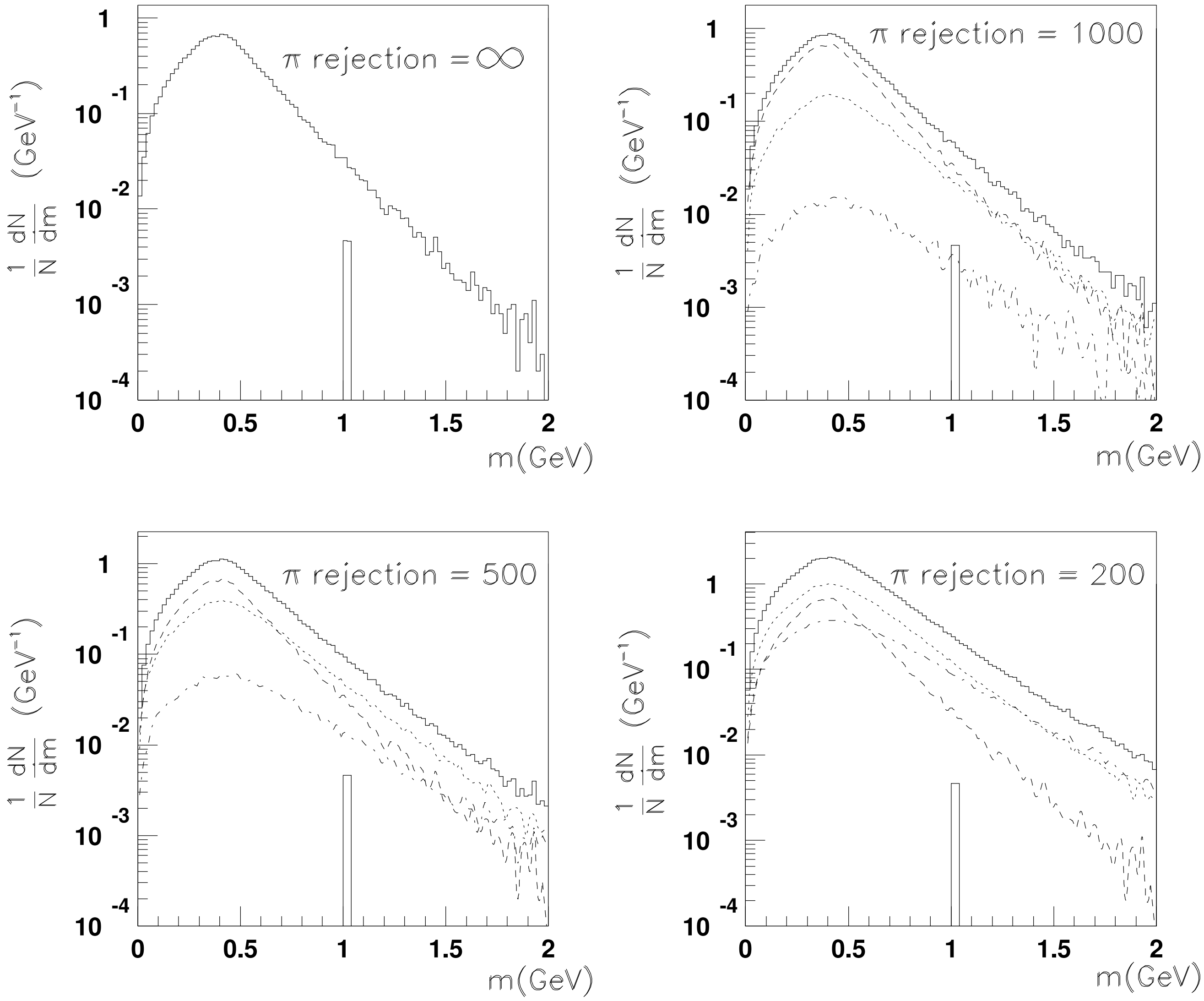
Combinatorial Background Mass Spectra

total

ee

$e\pi$

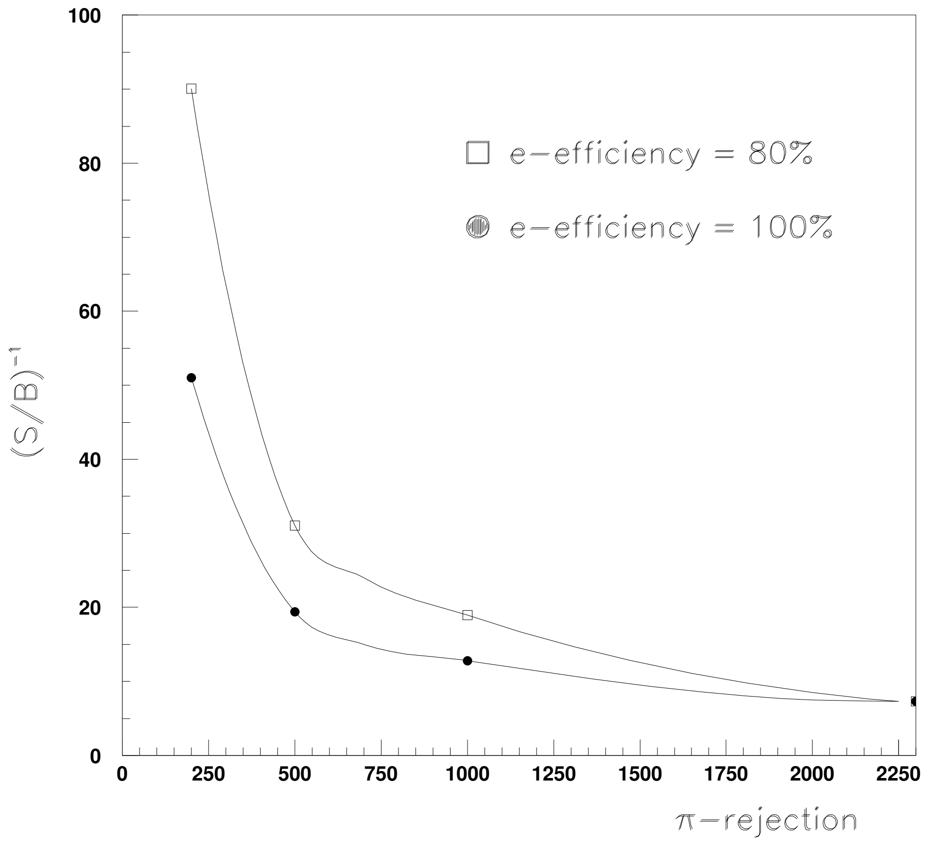
$\pi\pi$



Signal to Background Ratio

- ⋆ remove tracks forming a pair with m $<$ 130 MeV
- ⋆ yield: $\pm 1.5\sigma$ integral around ϕ mass
- ⋆ For $\epsilon = 100$ %:

π rejection	$(S/B)^{-1}$
inf.	7
1000	12
500	19
200	51



Note: If MVD outside acceptance:

$$X/X_0 = 1\% \quad \Longrightarrow \quad 0.29\ \%$$
$$(S/B)^{-1} = 7 \quad \Longrightarrow \quad 2.7$$

Tracks per Event in Modified PHENIX Configuration

- **Modified Configuration:**
  - ⋆ Field free region:
    B = 0 at r $\leq$ 60 cm
    B as in present PHENIX at r > 60 cm
  - ⋆ Detector in field free region

- **Hits in inner detector** (no p_t cut)

e-hits

$\pi^0 \rightarrow e^+e^-\gamma$	4.1	(2.7 pairs + 1.4 singles)
$\gamma \rightarrow e^+e^-$	5.1	(4.6 pairs + 0.5 singles)
Total	9.2 e-hits/evt	

$\pi^\pm$ hits 280 π/evt

- **Tracks in outer detectors** (p_t > 200 MeV)

e-tracks	singles	pairs
$\pi^0 \rightarrow e^+e^-\gamma$	0.5	0.1
$\gamma \rightarrow e^+e^-$	0.6	0.1
Total	1.10 e-trks/evt	0.2 pairs/evt

$\pi^\pm$ tracks 208 π/evt

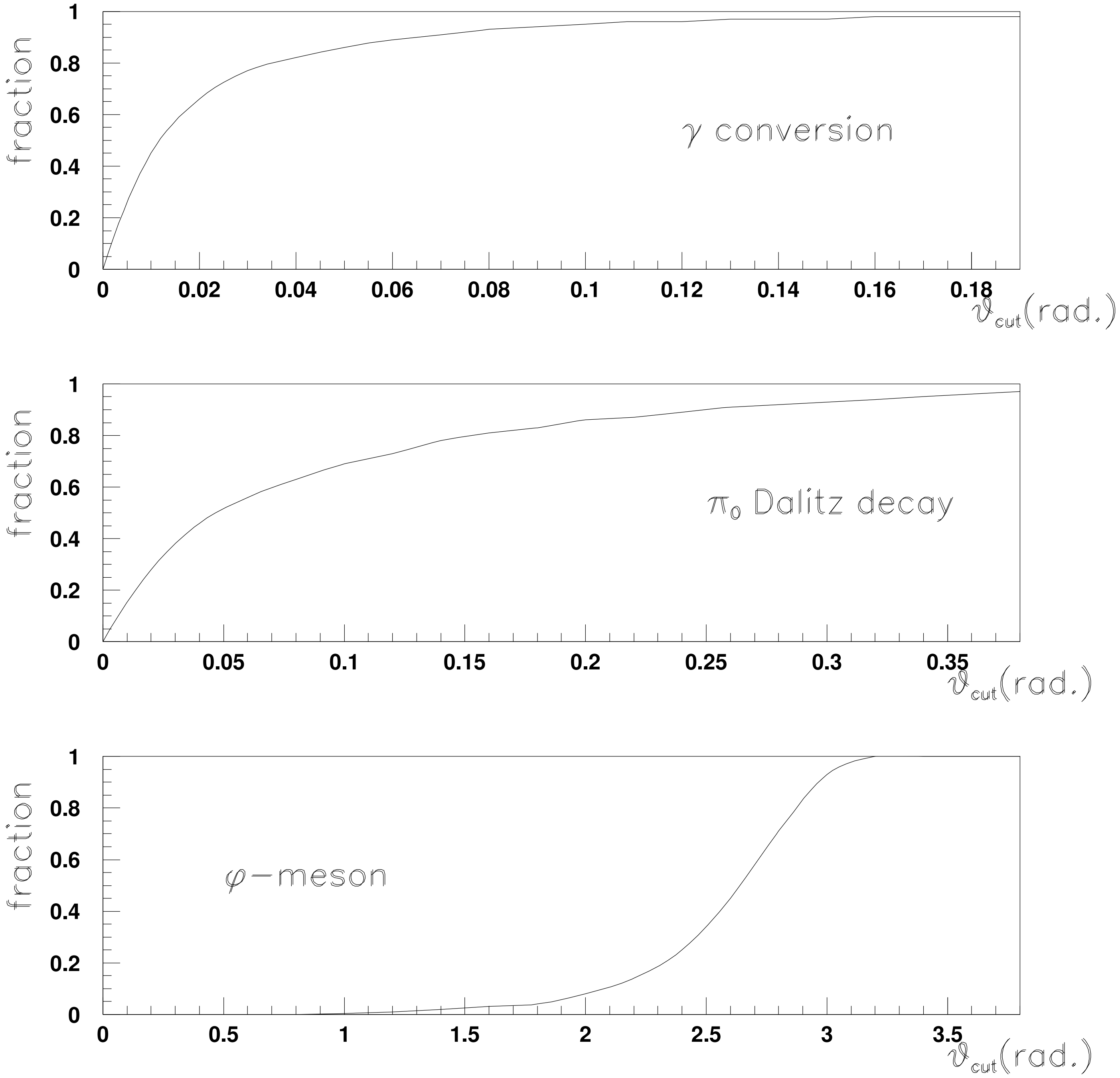
Note: There is a matched hit in the inner detector for:
- ⋆ 91 % of the ϕ tracks.
- ⋆ 83 % (173/208) of the pion tracks.
- ⋆ 71 % (.79/1.10) of the single e-tracks.
  (and 90 % of those (.71/.79) have their partner in inner detector)

Opening Angle cut

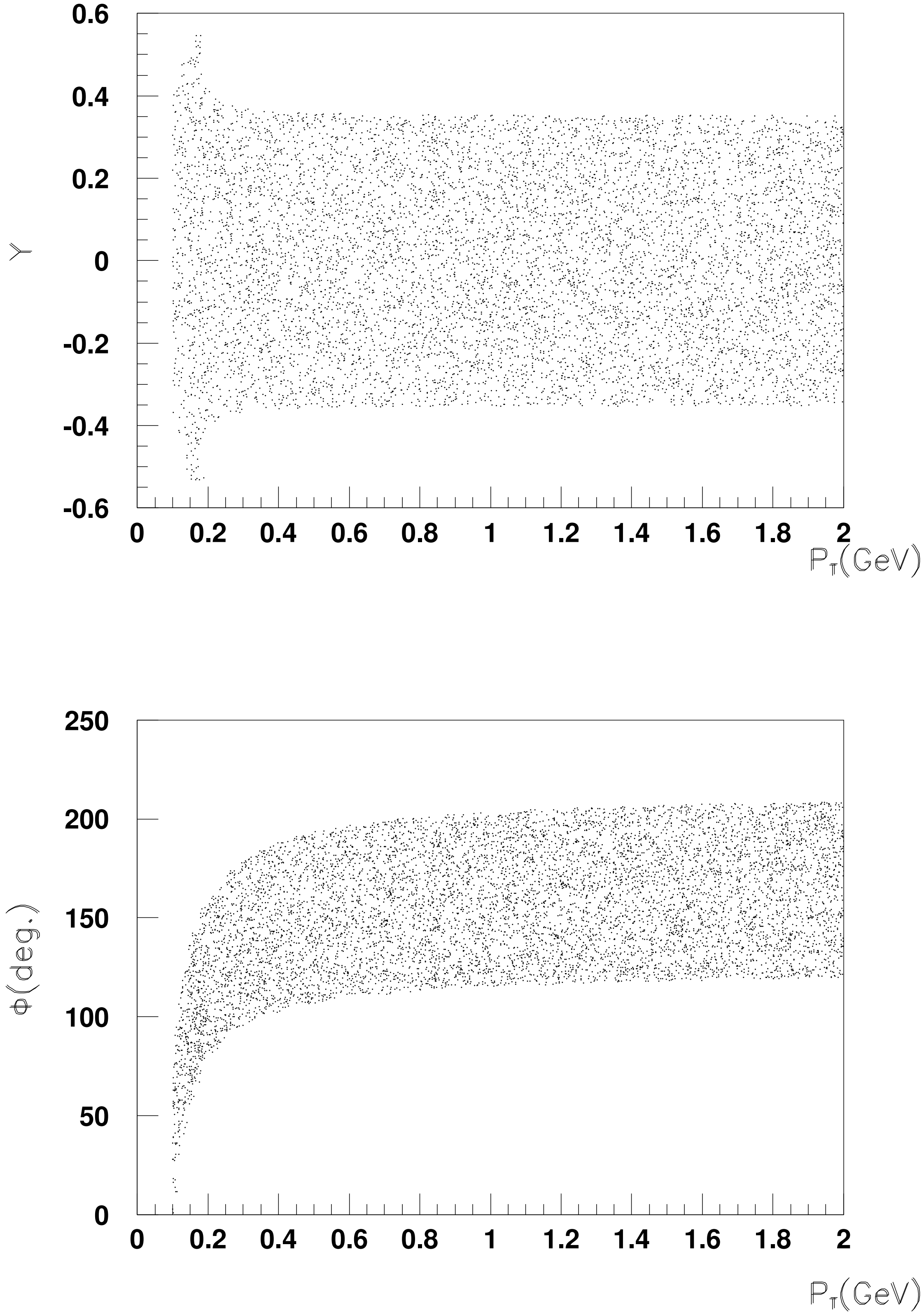
Fraction rejected by opening angle cut

π^0 Dalitz decay and γ conversions: at least one track $p_t > 200$ MeV

ϕ meson: both tracks $p_t > 200$ MeV



Track Acceptance



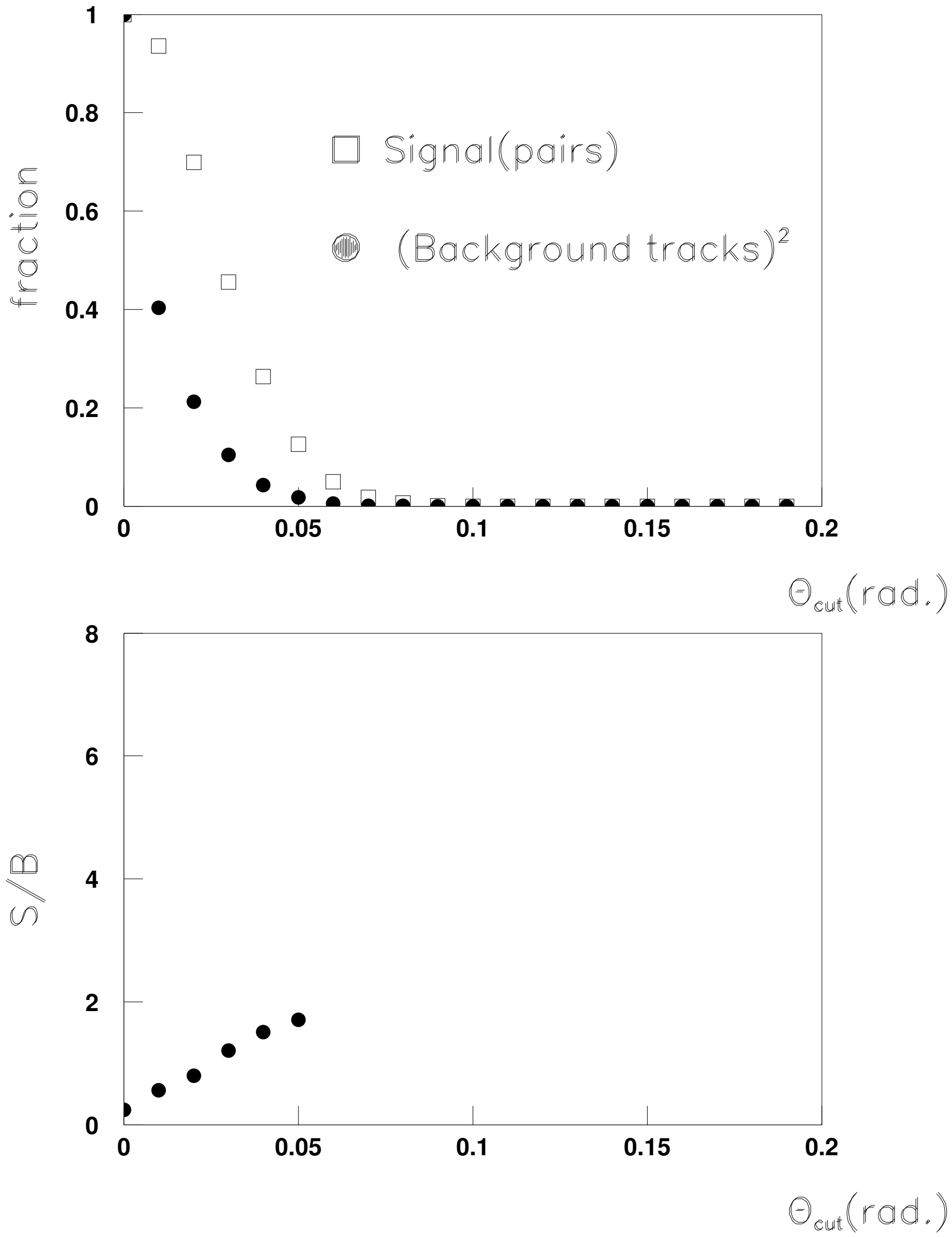
Rejection steps

- Remove tracks forming a pair with m $<$ 130 MeV in outer detectors
- Remove tracks with no matched hit in inner detector
- Apply close hit cut in inner detector:
  - ⋆ I. All hits
  - ⋆ II. Only “single” hits i.e. hits not belonging to tracks
  - ⋆ III. Only e-hits

Signal to Background - I

Close hit cut: all hits in inner detector

π-rejection $= \infty$, electron efficiency $= 100\%$

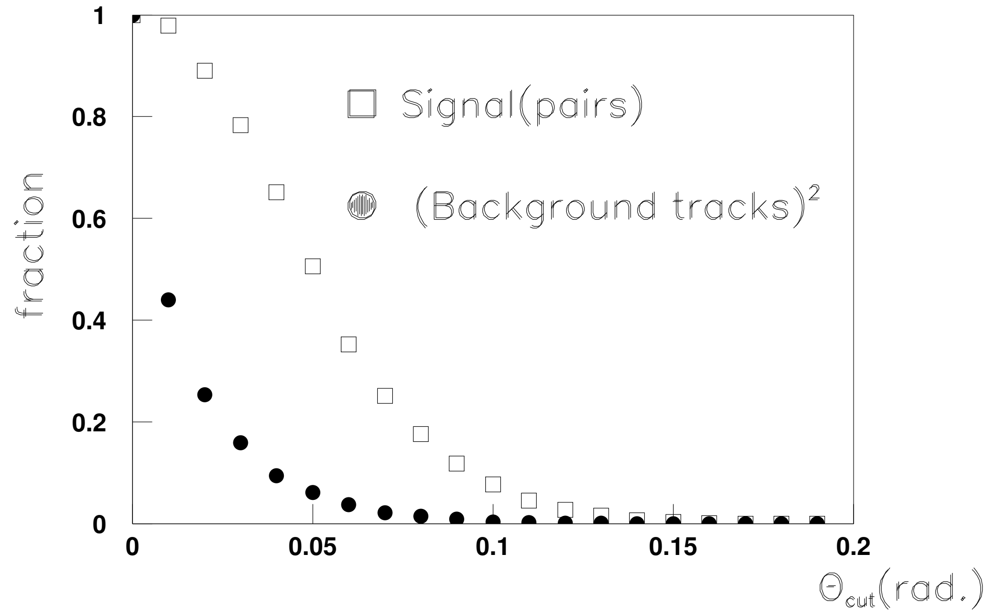


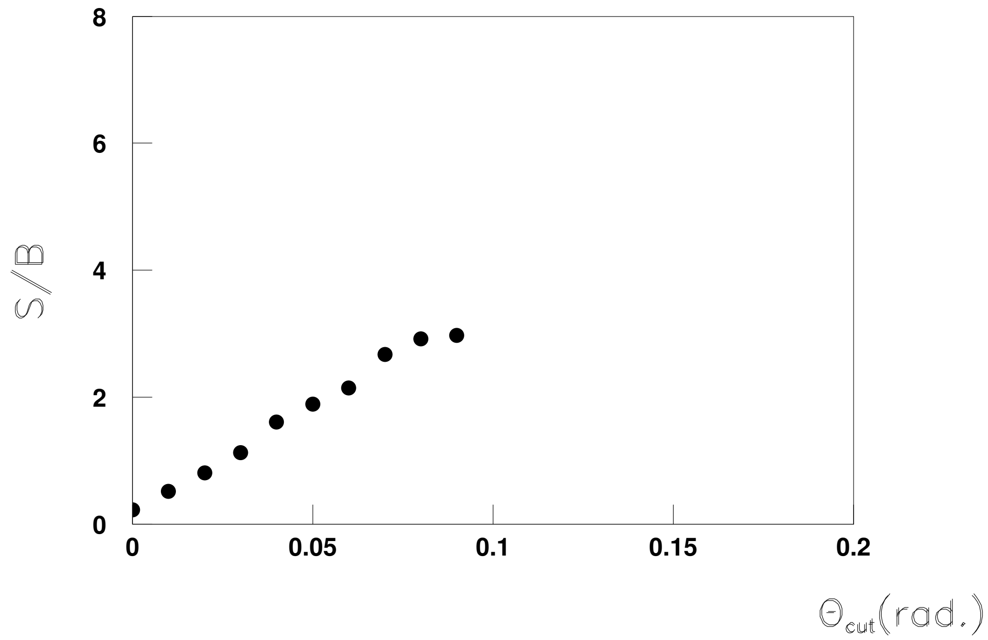
⋆ We loose the signal by random close hits with the 280 π + 9 e of inner detector

Signal to Background - II

Close hit cut: "single" hits (not belonging to tracks)

π-rejection $= \infty$, electron efficiency $= 100\%$



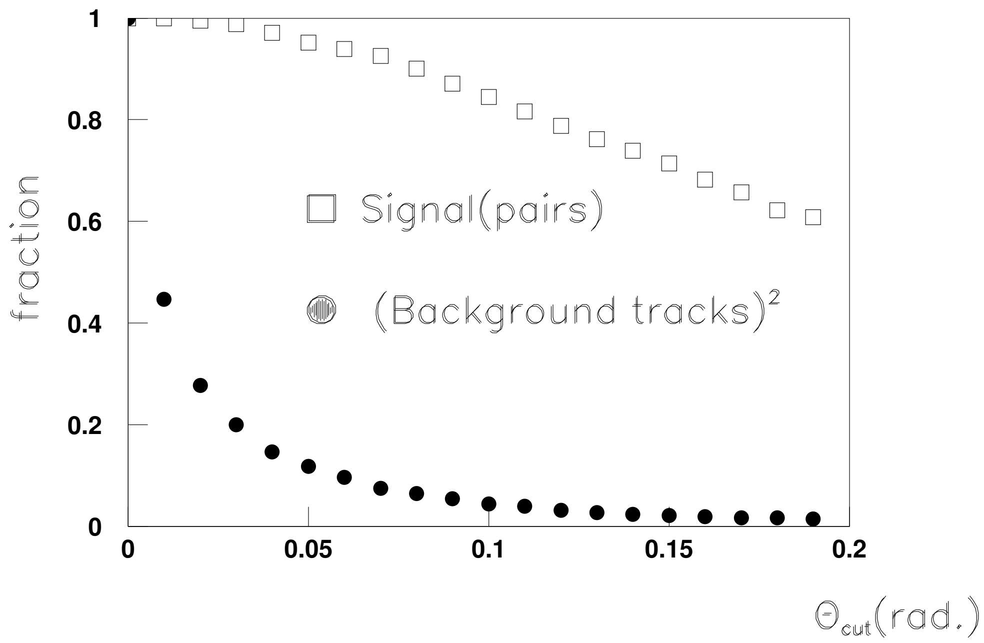


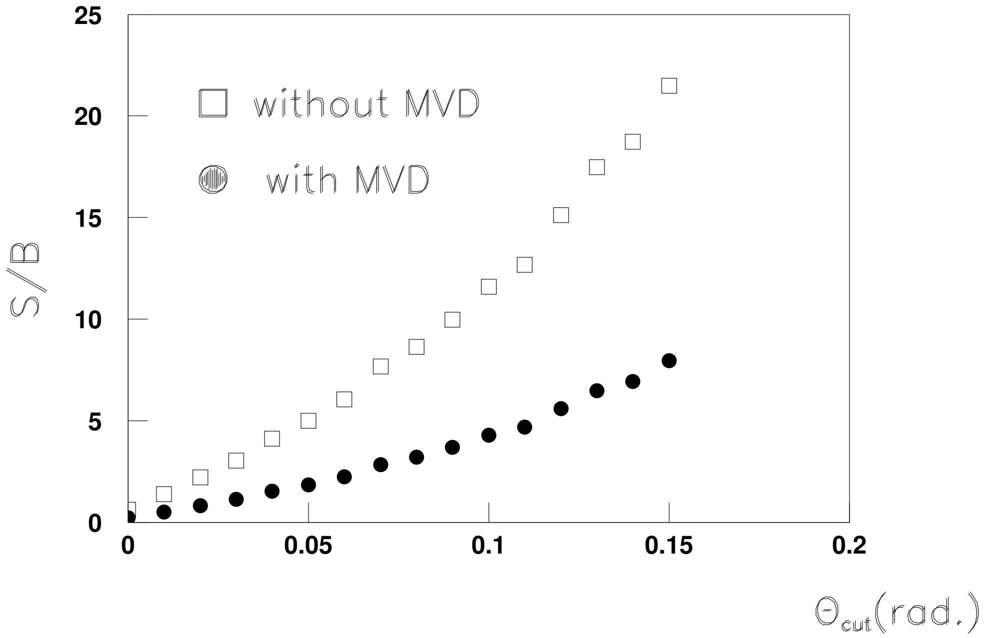
$\star$ We loose the signal by random close hits with the "single" 107 π + 9 e of inner detector

Signal to Background - III

Close hit cut: electron hits

π-rejection $= \infty$, electron efficiency $= 100\%$





⋆ We loose the signal by random close hits with the 9 e of the inner detector

⋆ S/B limited by the ~10% of the tracks which have their partner outside the fiducial acceptance

Conclusions

- Usefulness of an excellent Si-pixel detector in the inner area is limited by random veto of signal

- MVD outside the two-central arm acceptance

- Need a hadron blind detector in field free region:
  - ⋆ no fakes
  - ⋆ excellent electron efficiency
  - ⋆ excellent double hit resolution
  - ⋆ with a veto area?