# Vertex Reconstruction for High Luminosity pp Running at STAR

- STAR-Spin luminosity requirements
- Method of the vertex reconstruction
- Application to the pileup rejection

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for STAR Collaboration

BNL, April 8, 2000
ALICE/STAR Meeting

# STAR Spin Program

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## Spin Structure of the proton:

• $\Delta G(x)$ in $\vec{p}$: direct extraction for $x_g \in [0.01, 0.3]$
via $\vec{p}+\vec{p} \rightarrow \gamma + \text{jet} + X$ @ $\sqrt{s}$ =200 GeV + 500 GeV

$$\frac{\sigma_{qg\rightarrow q\gamma}}{\sigma_{pp}} \sim 10^{-5}$$

| | | **Enhanced Luminosity** | | | | |
|---|---|---|---|---|---|---|
| $\sqrt{s}$ (GeV) | $\sigma_{NDIF}$ (mb) | L /$10^{32}$ ($cm^{-2}$ $s^{-1}$) | # inter /bunch (nondifr.) | total rate (MHz) | Trigger …. Level 0 ( Hz ) | Level 3 ( Hz ) |
| p+p 200 | 32 | 0.8 | 0.27 | 3 | ≤ 4 | 4 |
| p+p 500 | 36 | 2.0 | 0.87 | 8 | ≤ 60 | 15 |

TPC readout time 40μs leads to pileup of tracks

- Level 0 : **hard photon in EMC**
  - "high tower" (tower $E_T$ >5 GeV)
  - "trigger tower" ( $E_T$ >10 GeV in (Dh, Df )=(0.2, 0.2) patch )
- Level 1 : g **isolation cut**
  - limit for surrounding patches
- Level 3 : **online pileup filter**

# *Events Piled up in the TPC*

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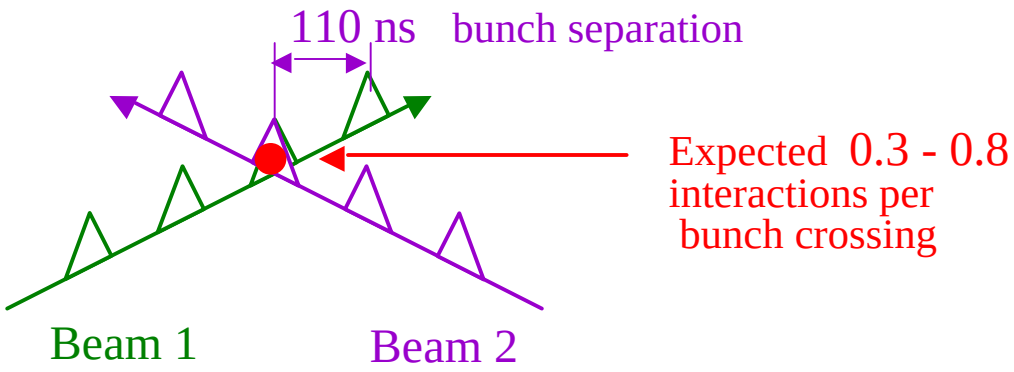
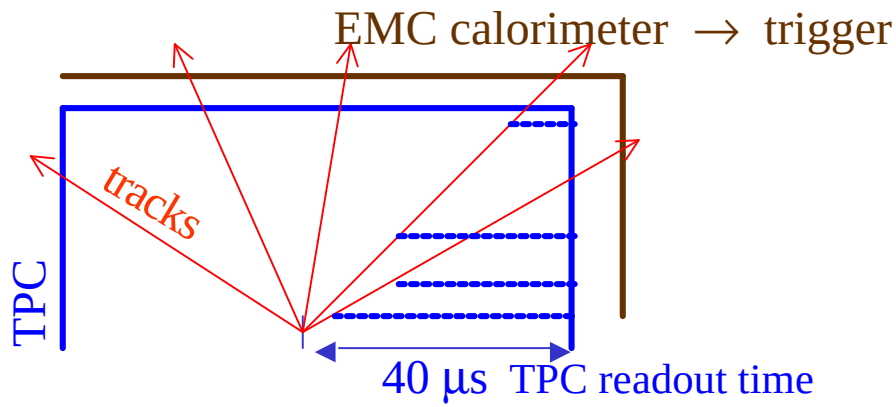
*Enhanced Luminosity p+p collisions @ STAR*




**Trigger event is piled-up with ~200-600 min bias p+p events**




- identification of tracks from the trigger event
- ONLINE reduction of the data volume

# Example of 2 Piled up Events

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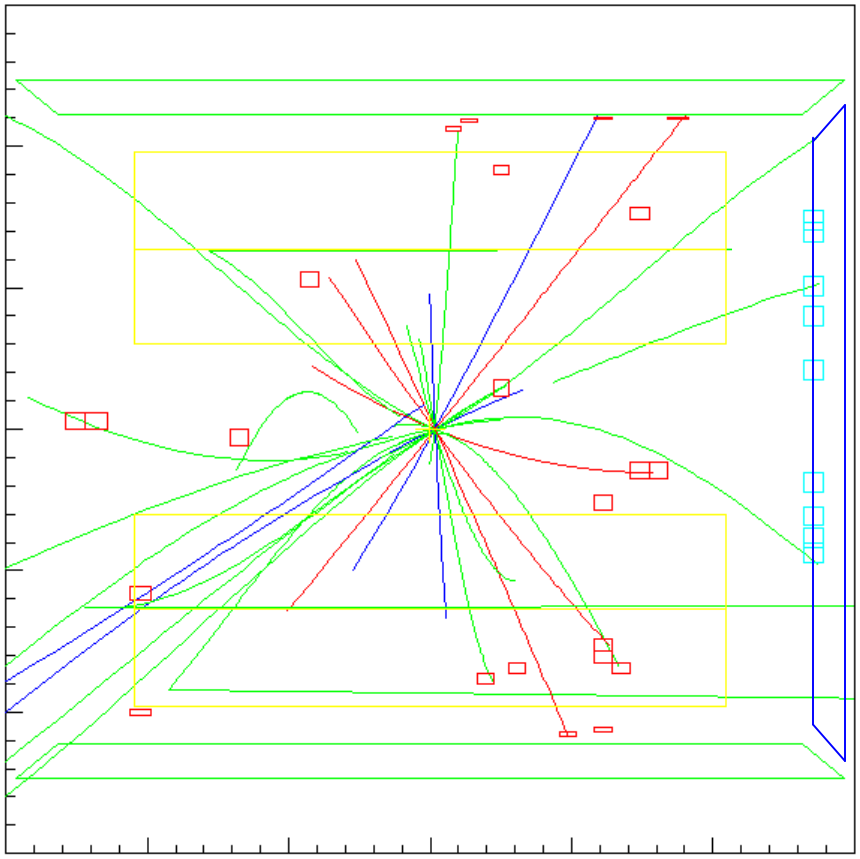
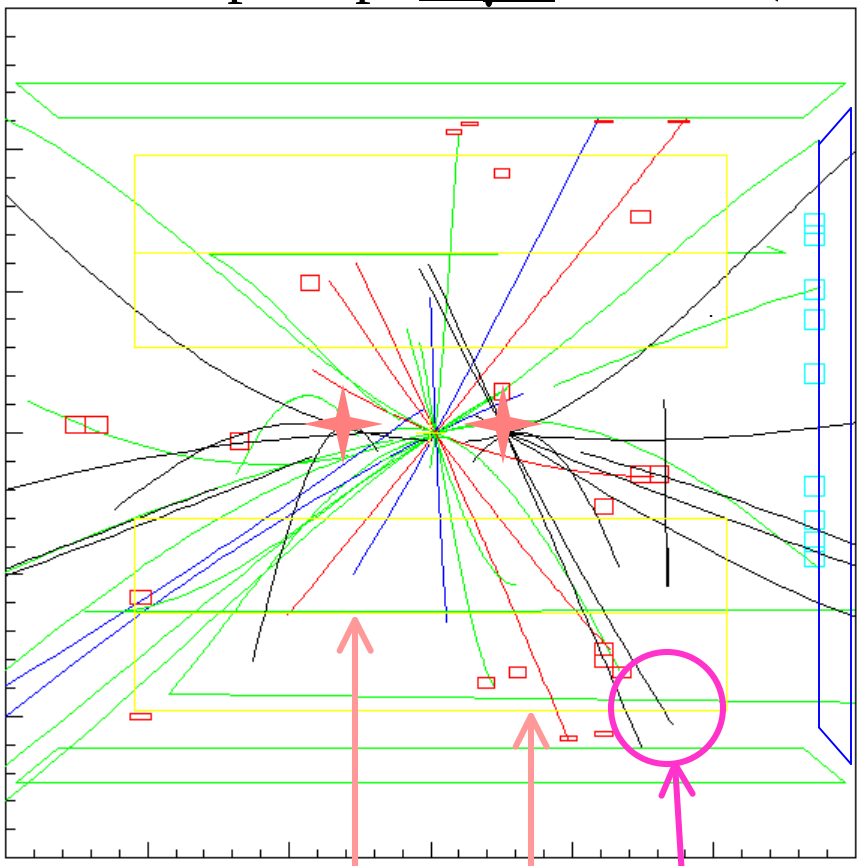
## p+p event

($p_T$ >10 GeV) @ 200 GeV



## The same p+p event

+ 1 pileup 10μs earlier *(black)*




Color coding :

- green $p_T$ <500 MeV/c
- blue $p_T \in [0.5, 1]$ GeV/c
- red $p_T$ >1 GeV/c

# Piled up Tracks Reconstructed in TPC

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**p+p @ 200 GeV, 0.27 inter/bunch**

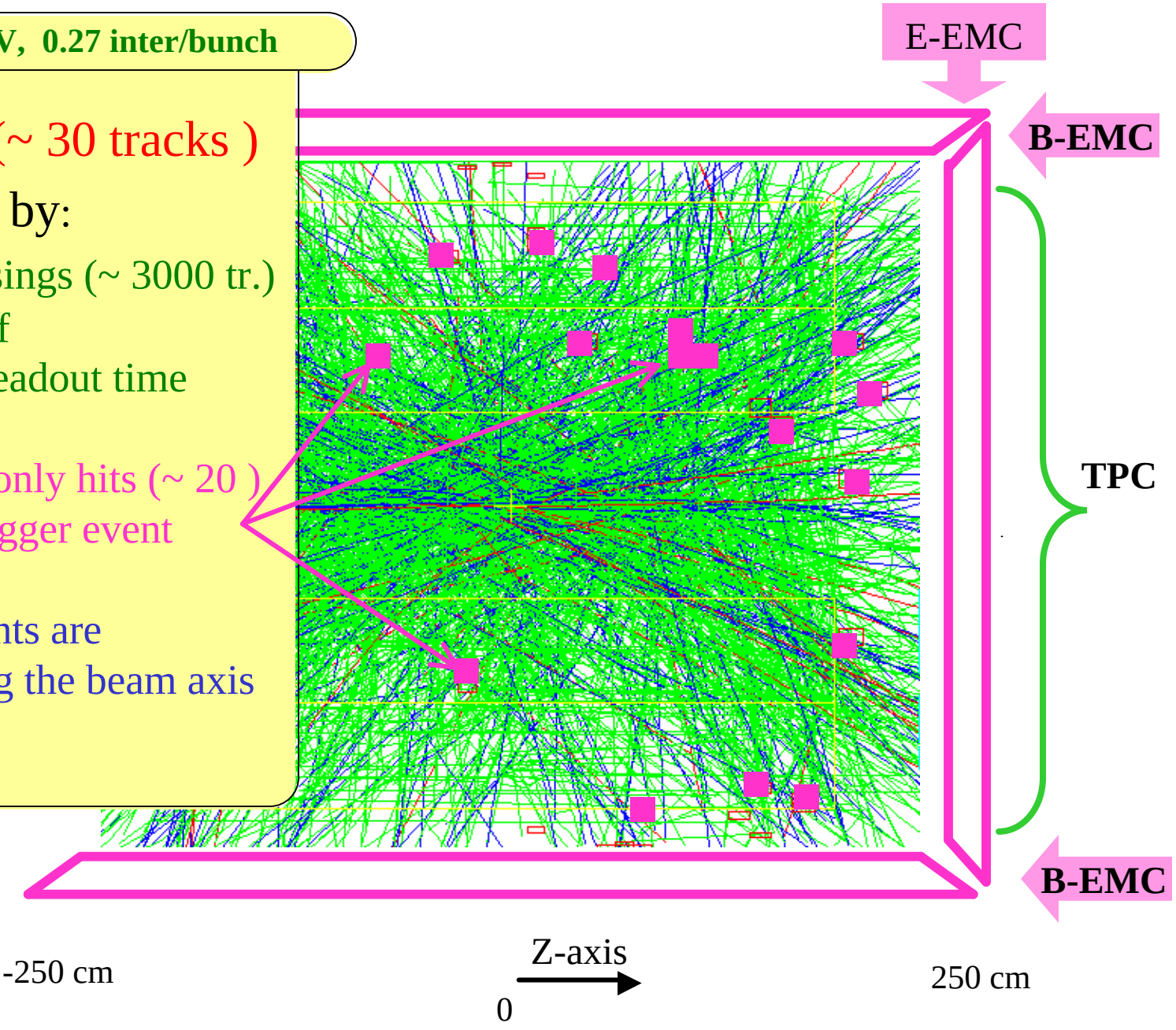
p+p event (~ 30 tracks )

screened by:

735 bunch crossings (~ 3000 tr.)
during 40μs of
the TPC readout time

- EMC records only hits (~ 20 )
  from the trigger event

- the pileup events are
  displaced along the beam axis
  (± 200 cm)



# Vertex Finder - Method

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Goal: Identify vertex position ($Z_V$) for the trigger event

Method:

- **reconstruct** all (~3000) tracks in TPC

*( numbers refer to p+p @ 200 GeV, 0.27 inter/bunch )*

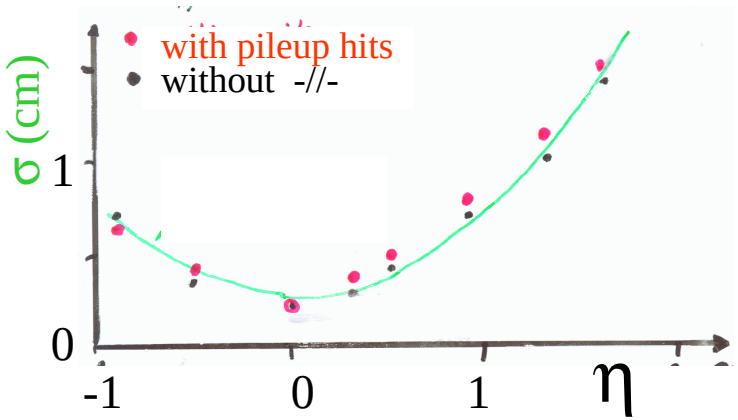
- **preselect** (4 ± 3) **tracks** from the trigger event:
  - # TPC clusters >20 (of 45)
  - $R_{XY}^{DCA} < 1.3$ cm (primary track)
  - $|Z^{DCA}| < 15$ cm (diamond size)
  - track matched with EMC (~20 ) towers

- find maximum of the **likelihood($Z_V$)** defined as:

$$\ln \mathbf{L}(Z_V) \equiv \sum_i \frac{(Z_i^{DCA} - Z_V)^2}{s(\eta_i)^2},$$

truncated at $|Z_i^{DCA} - Z_V| > 2\sigma_i$

Z-resolution depends on pseudorapidity



# Vertex Finder - Performance at √s=200 GeV

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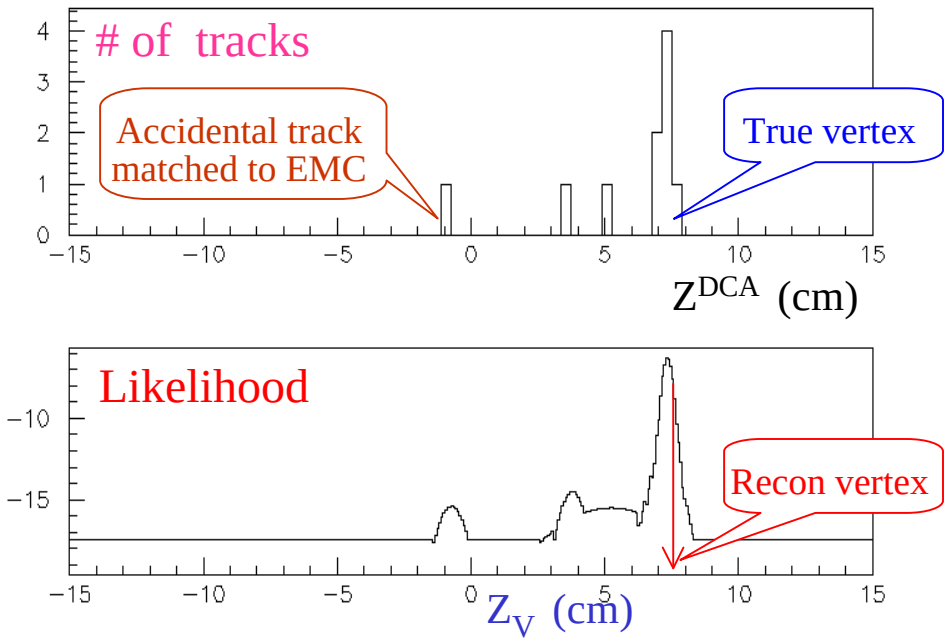
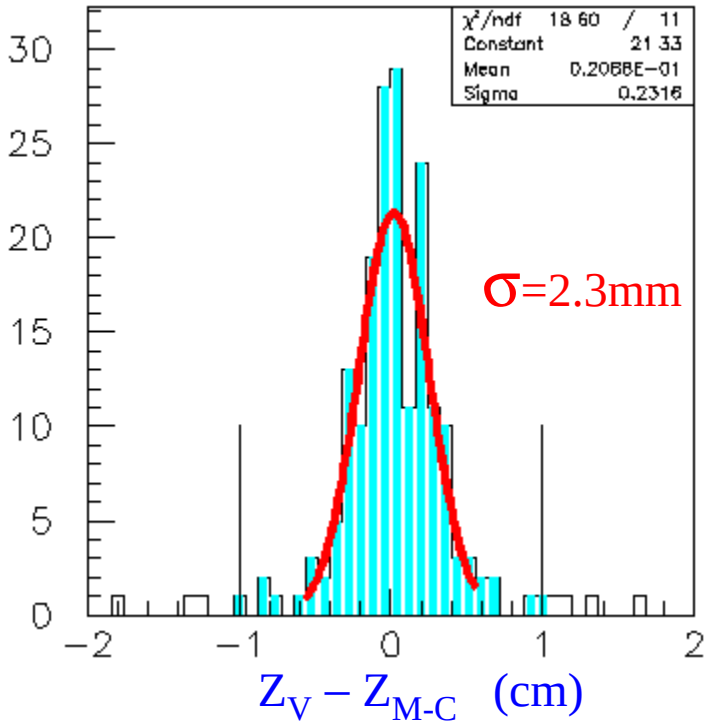
Nondiffractive minb p+p ⟶ 0.27 inter/bunch

quark-gluon Compton scattering event
mixed with minb,
processed by GSTAR+ TRS+TCL+TPT




- 85 % eve with $|Z_V - Z_{MC}| < 1$cm
- Found 1.3 vertices/event
- "best vertex" resolution in Z




*Tested with p+p @200 GeV , $h_q \hat{I}$ [1.0, 1.3]*

# Vertex Finder at √s=500 GeV

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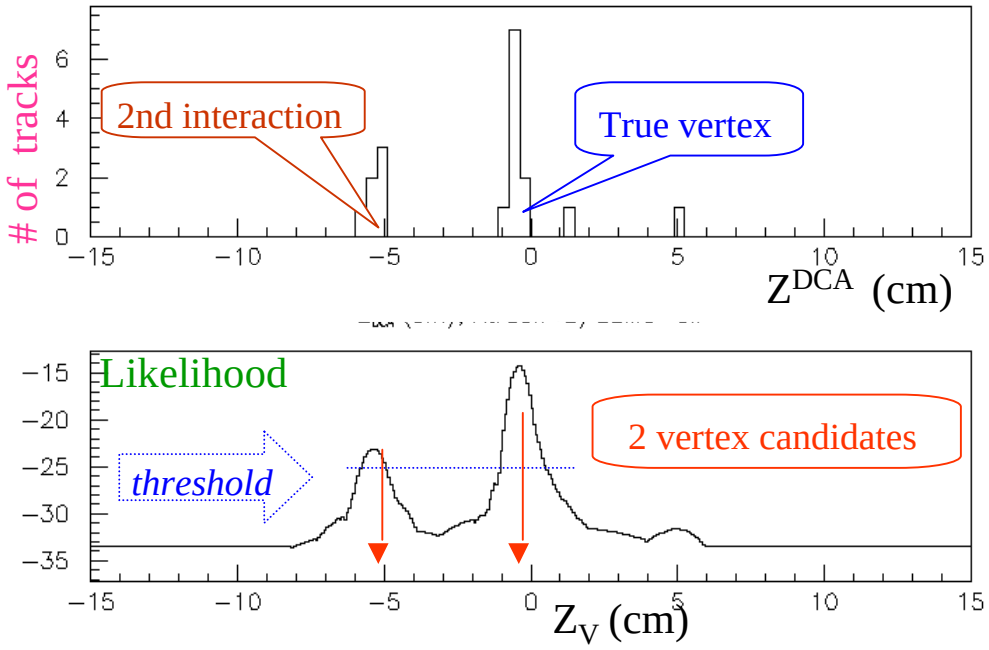
Nondiffractive minb p+p ⟶ 0.77 inter/bunch

Often the second interaction in the trigger bunch crossing




Work in progress

- expected more>1 vertices/event

# Evaluation of the Pileup Filter

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**Pileup Filter**

accepts tracks (& TPC clusters):

- $| Z_i^{DCA} - Z_V | < 4\sigma_i$

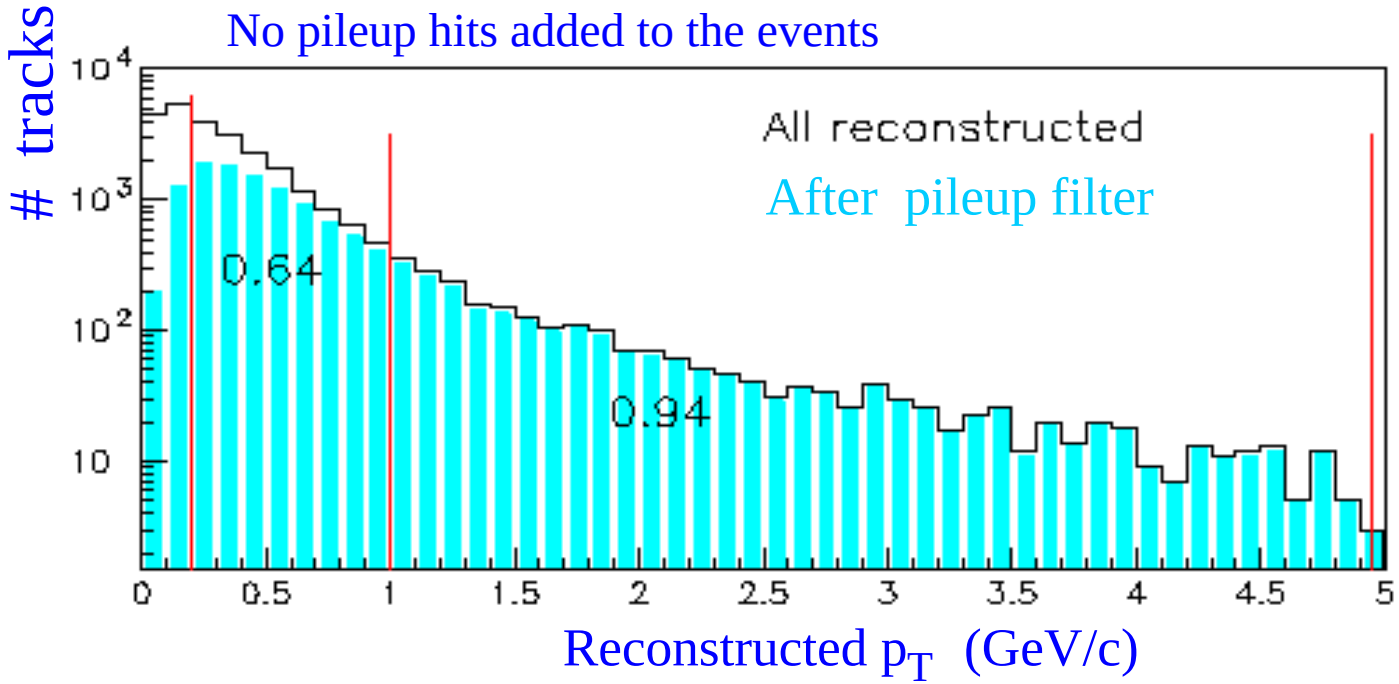
or

- matched to the EMC towers

- Data volume reduction 1:50 ✓
- 50% of tracks from trigger event preserved

Do the preserved tracks include the physics ?

No pileup hits added to the events




Conclusion 1:
only the low $p_T$ tracks are lost

*Tested with p+p @200 GeV , $h_q \hat{I} [1.0, 1.3]$*

# Impact on Reconstruction of Partons Kinematics

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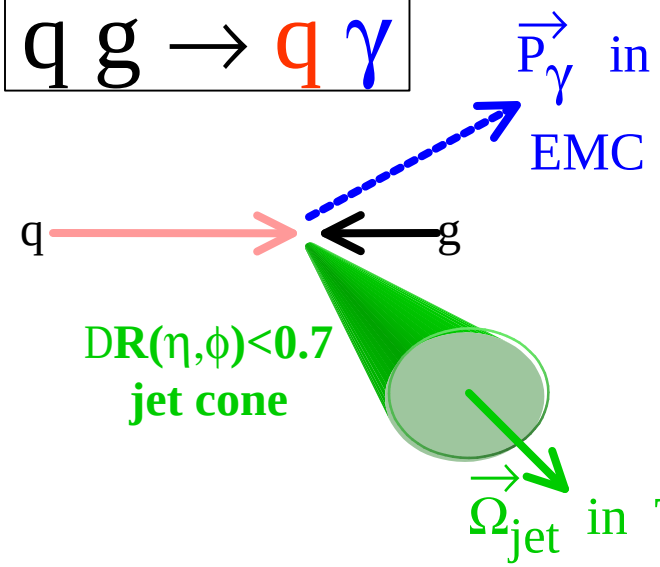
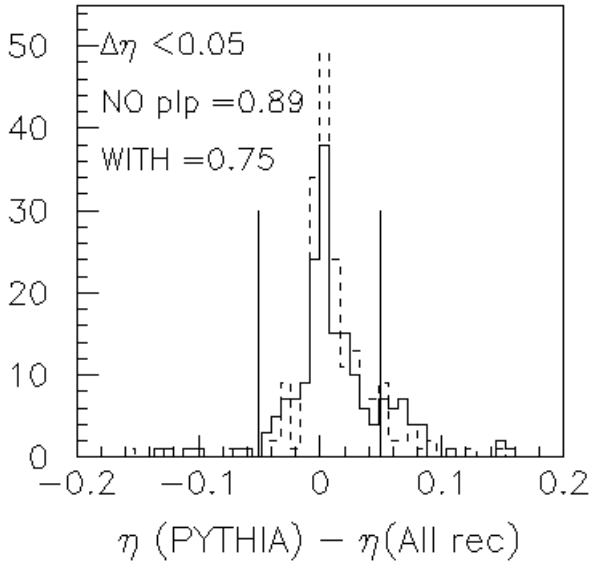
$q\,g \rightarrow q\,\gamma$

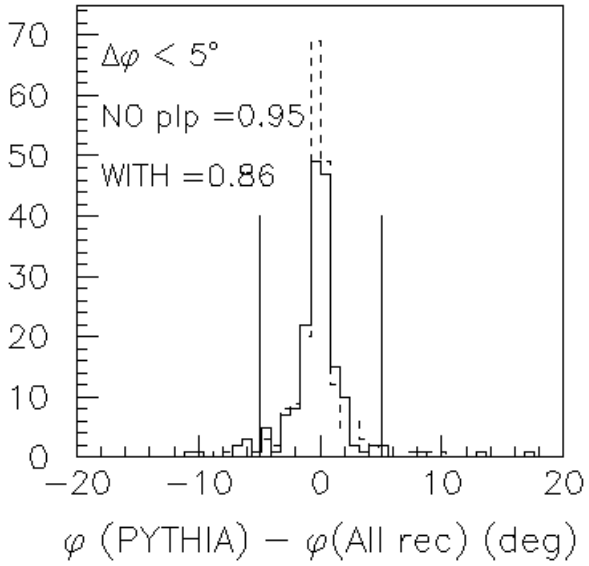


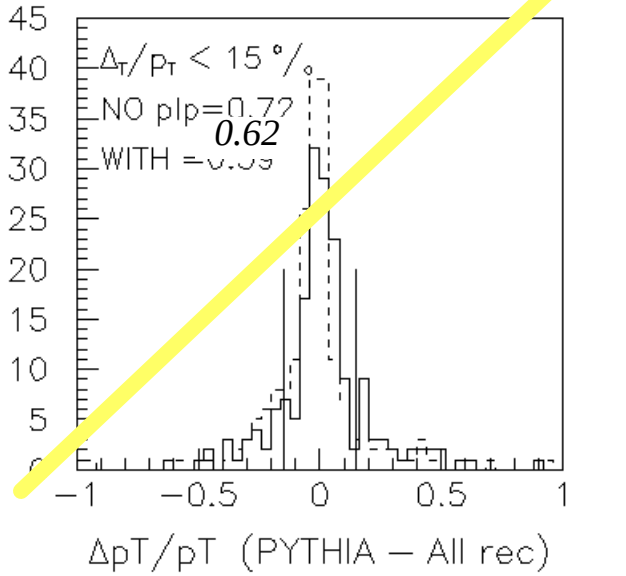

Conclusion 2:

Tracks relevant for the reconstruction of $q\,g \rightarrow q\,\gamma$ kinematics preserved

Error contribution to … due to not reconstructed tracks in the TPC




*Tested with p+p @200 GeV , $h_q$ Î [1.0, 1.3]*