# Charged Particle FLOW measurement for $|\eta|<5.3$ with the PHOBOS detector

Inkyu Park (Univ. of Rochester)
for the PHOBOS Collaboration

# PHOBOS Collaboration


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## UNIVERSITY OF MARYLAND

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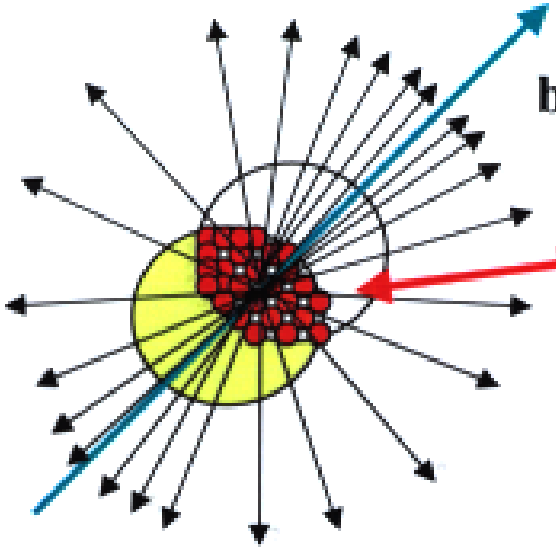
*spokesperson

# Physics Goal of RHIC & Flow




Initial state anisotropy → Flow

Equation of state → Flow strength

Degree of thermalization ↗

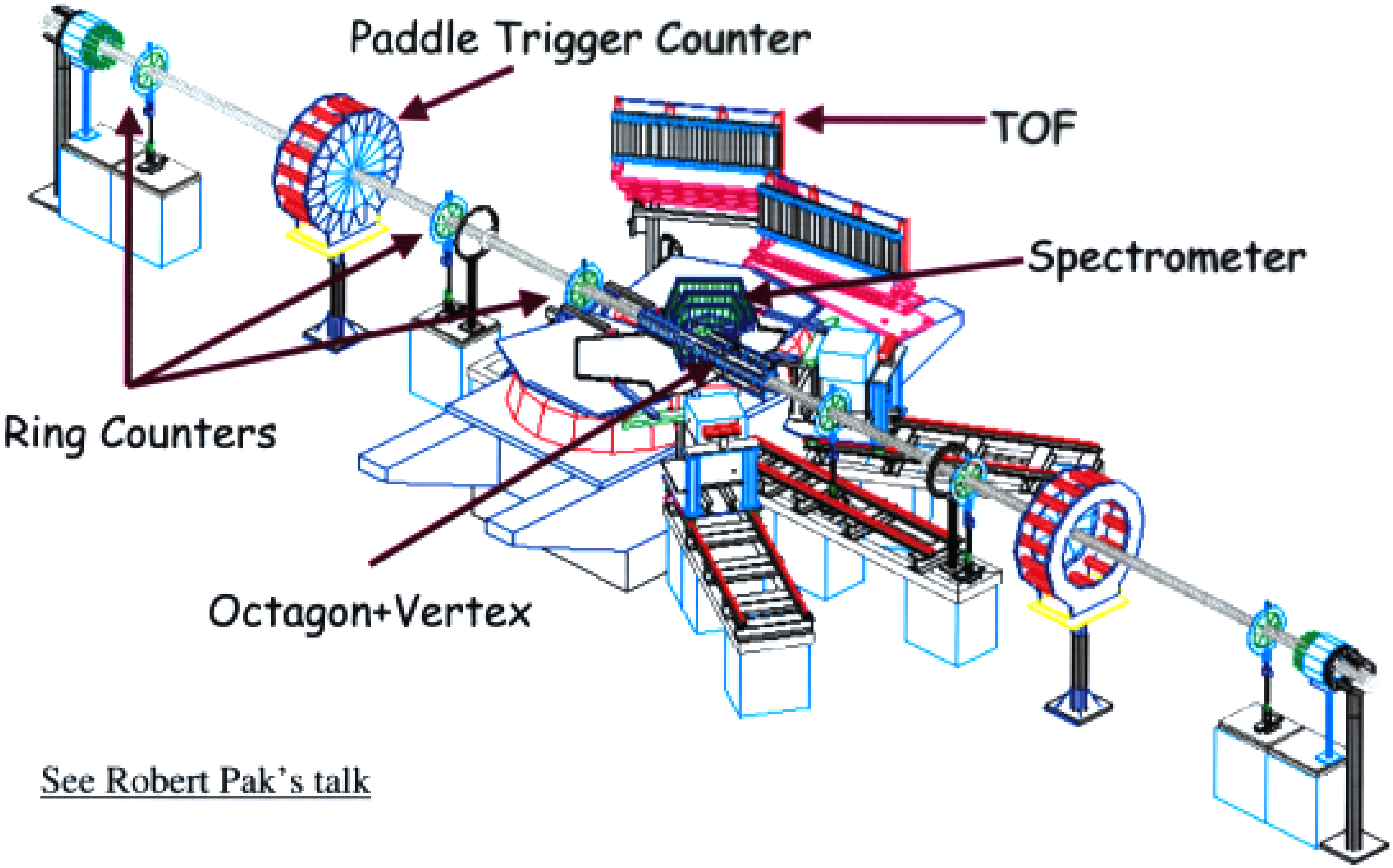
$$dN/d(\phi - \Psi_R) = N_0 (1 + 2V_1 \cos(\phi - \Psi_R) + 2V_2 \cos(2(\phi - \Psi_R)) + \dots)$$

Directed flow ↑ (V₁) Elliptic flow ↑ (V₂)

In-plane OR Out-of-plane

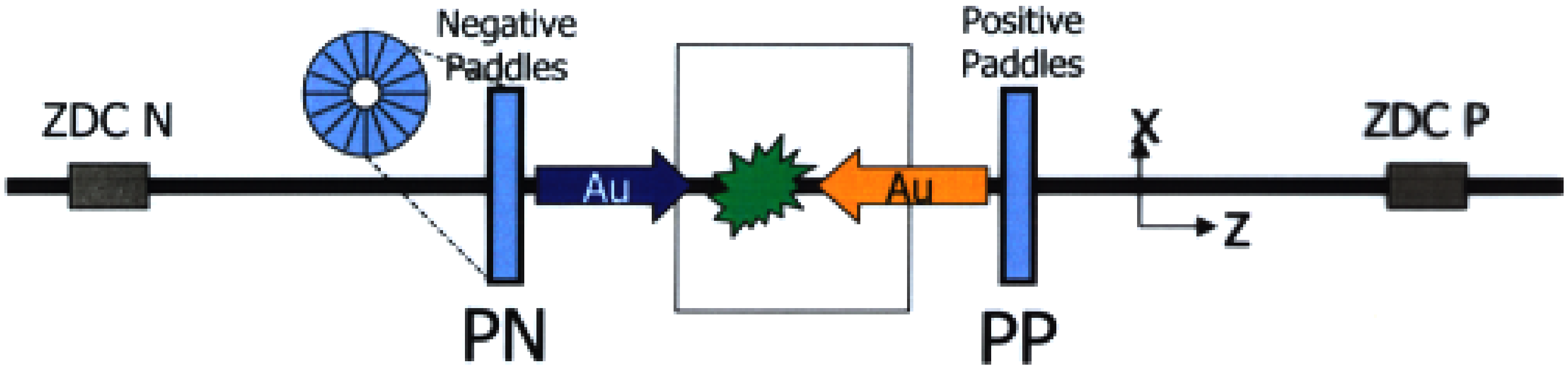
affect other physics: HBT, Spectra, etc

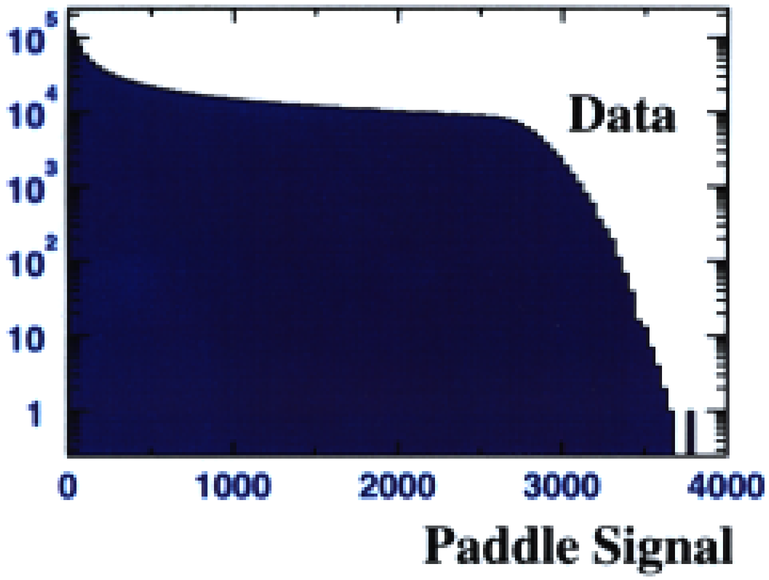
# PHOBOS Detector setup 2000

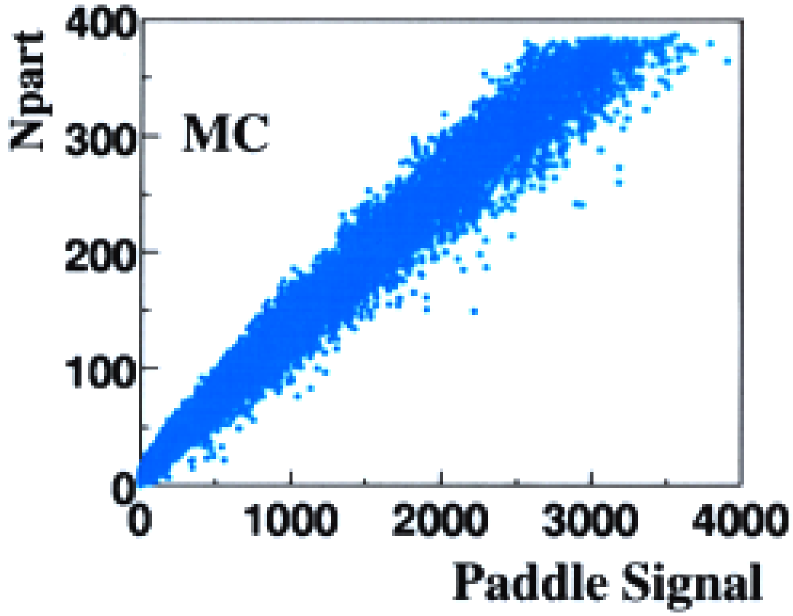



See Robert Pak's talk

# Paddle counters : Trigger & Centrality

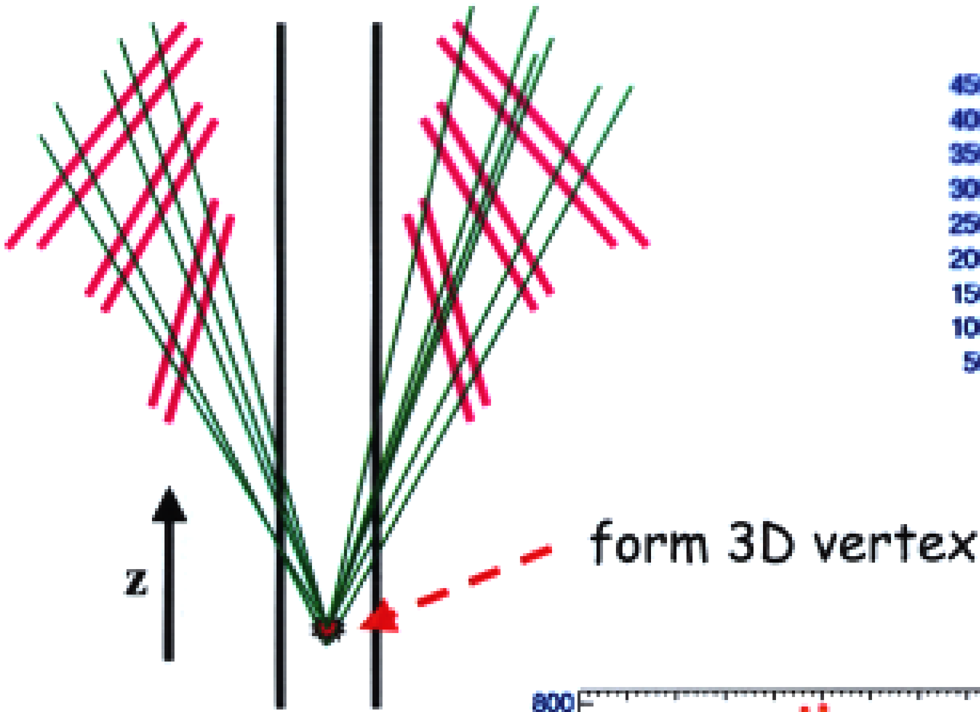


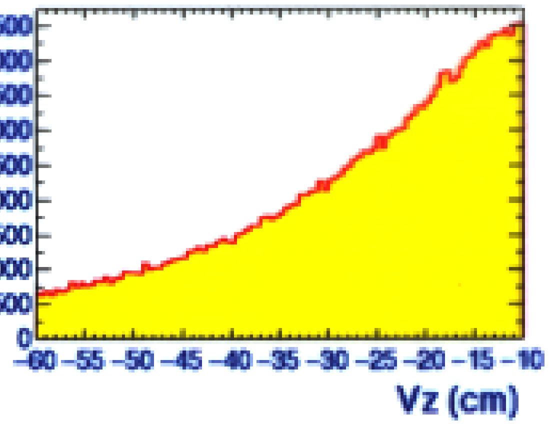



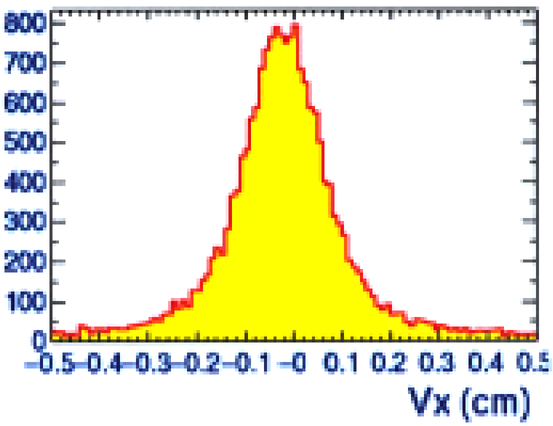



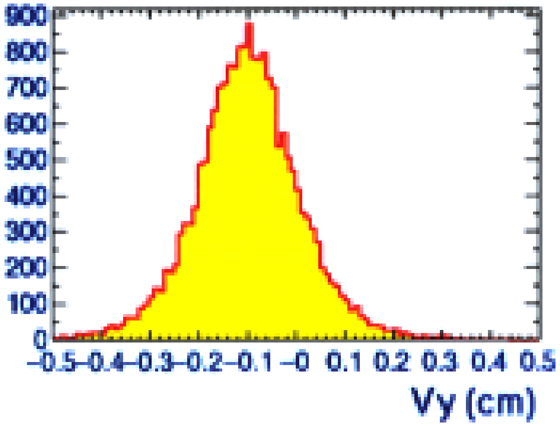

See Judith Katzy's talk

# Spectrometer : Vertex Reconstruction



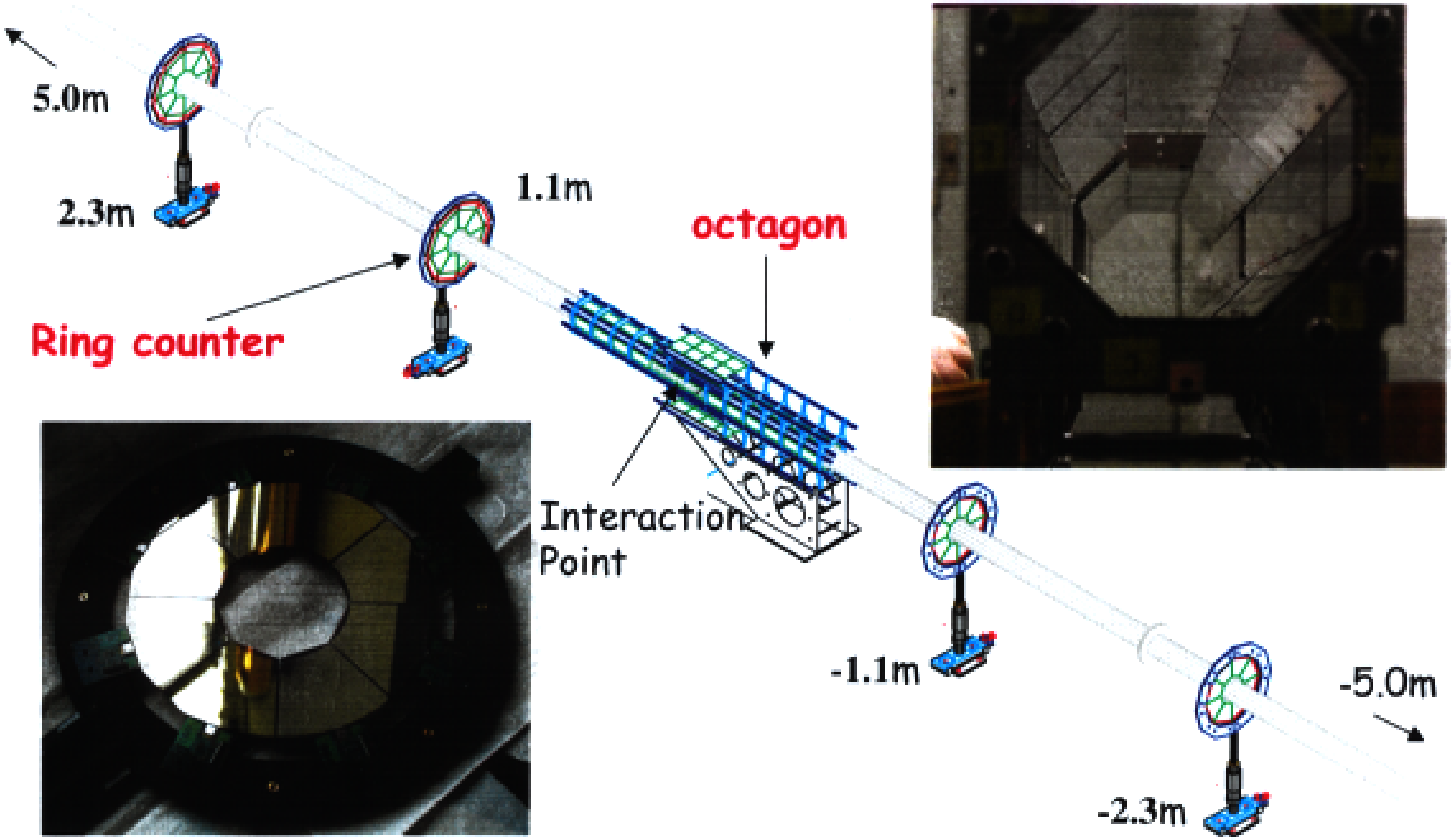



# Octagon and Ring detectors

- $|\eta| < 5.3$ ($\Delta\eta = 0.05–0.1$), $0 \leq \phi \leq 2\pi$ ($\Delta\phi = 2\pi/32 – 2\pi/64$)



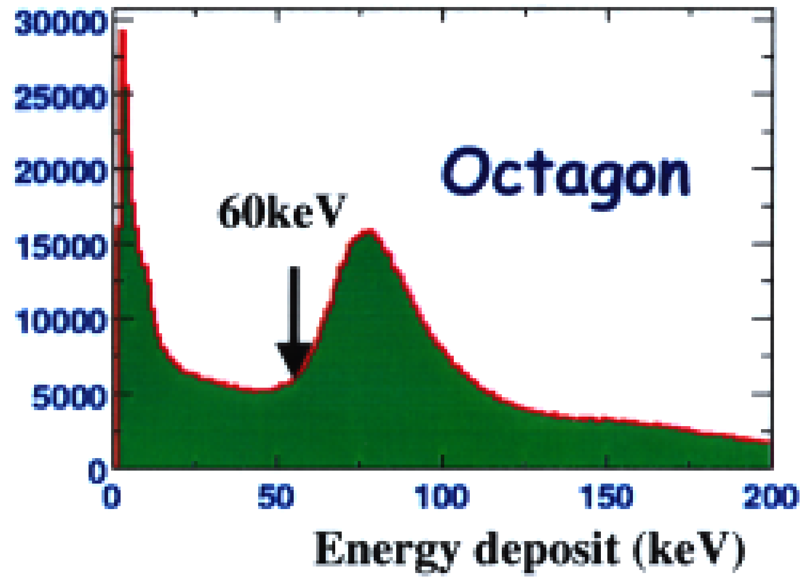
# Hit Definition

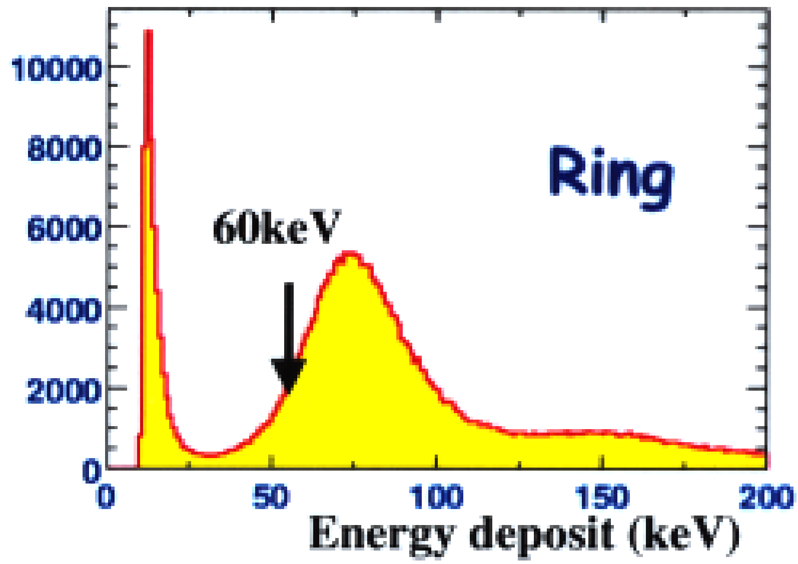
Charged particle ↔ deposit energy in pad ↔ hit ⊕ event vertex

⇓

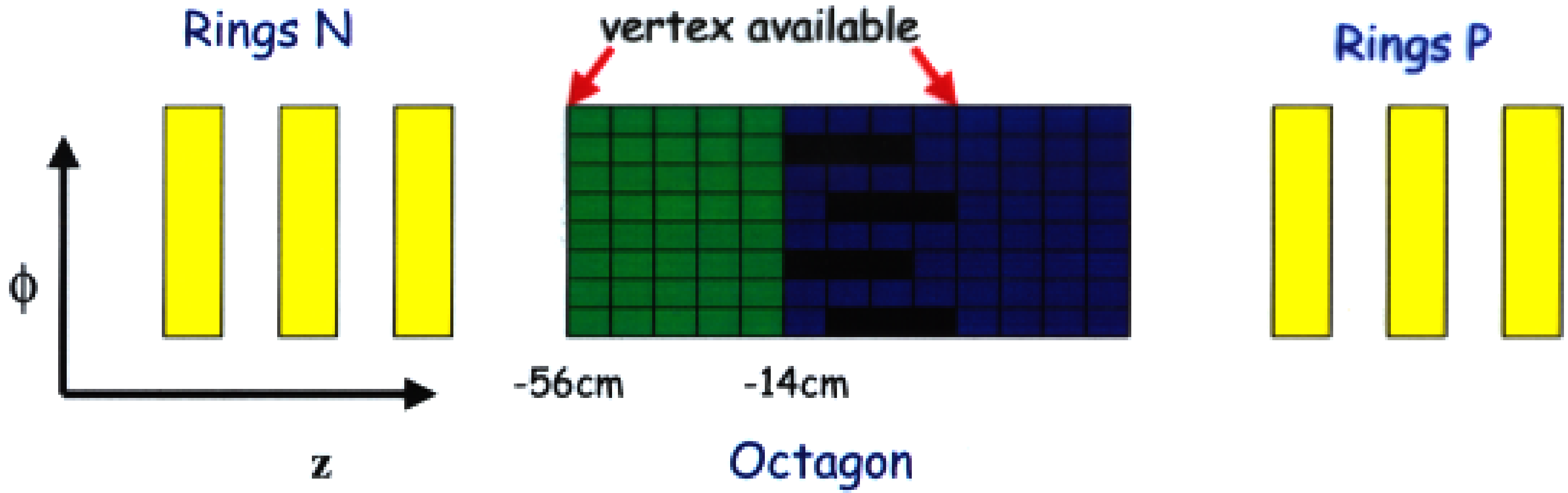
Particle direction

1 hit = pad with energy > 60 keV



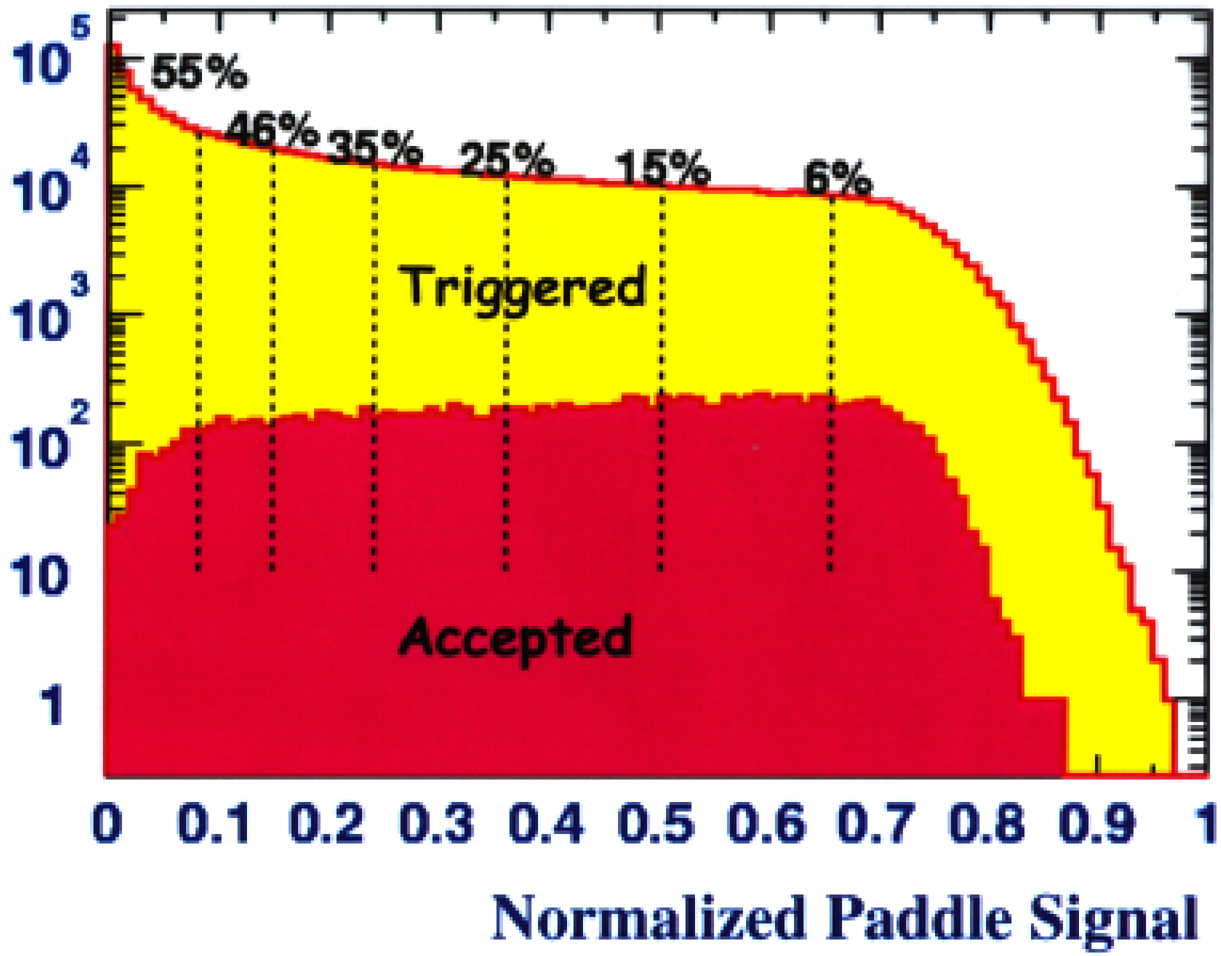



# Event Selection



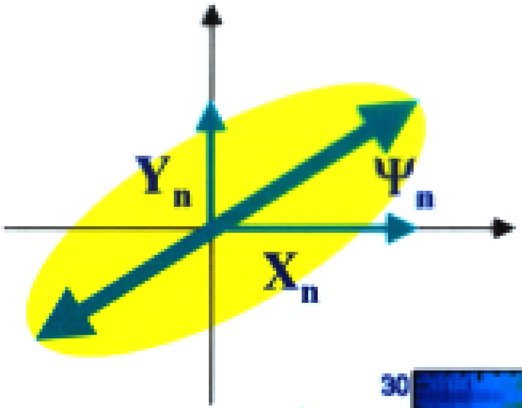

- To cover pseudo-rapidity -2.0 to 2.0, only events with vertex -38cm to -30 cm are used
- Rings will cover $3.0 < |\eta| < 5.3$
- 13K events are used finally for the analysis

# Centrality Bins



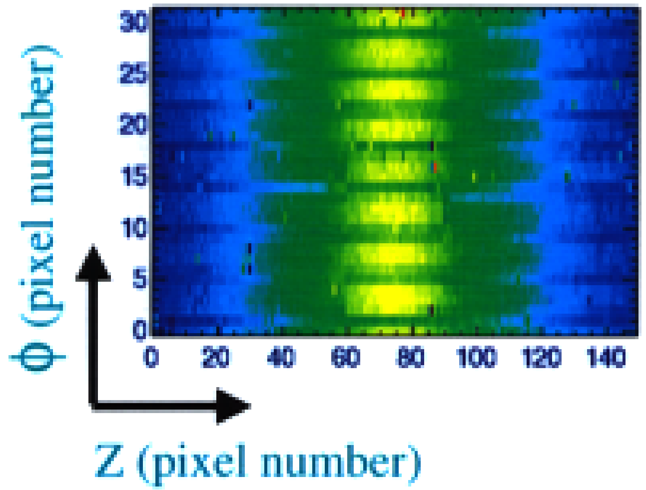

Acceptance affected by various strict vertex cuts

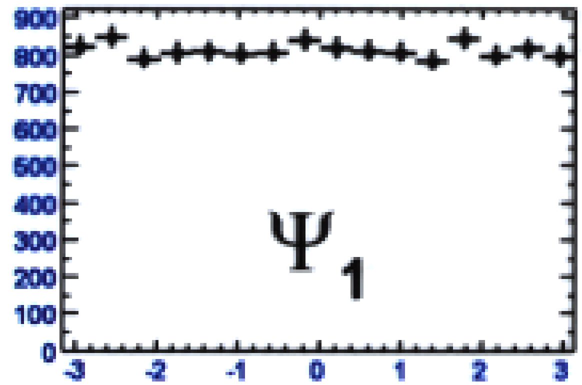
# Event Plane Reconstruction

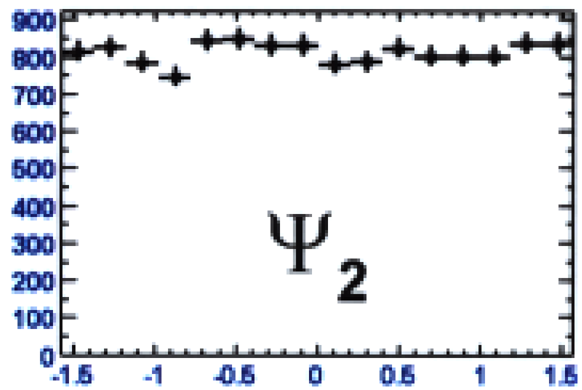



$$\Psi_n = \tan^{-1} ( X_n / Y_n ) / n$$

$$(X_n, Y_n) = ( \Sigma\, w \cos(n\phi), \Sigma\, w \sin(n\phi) )$$

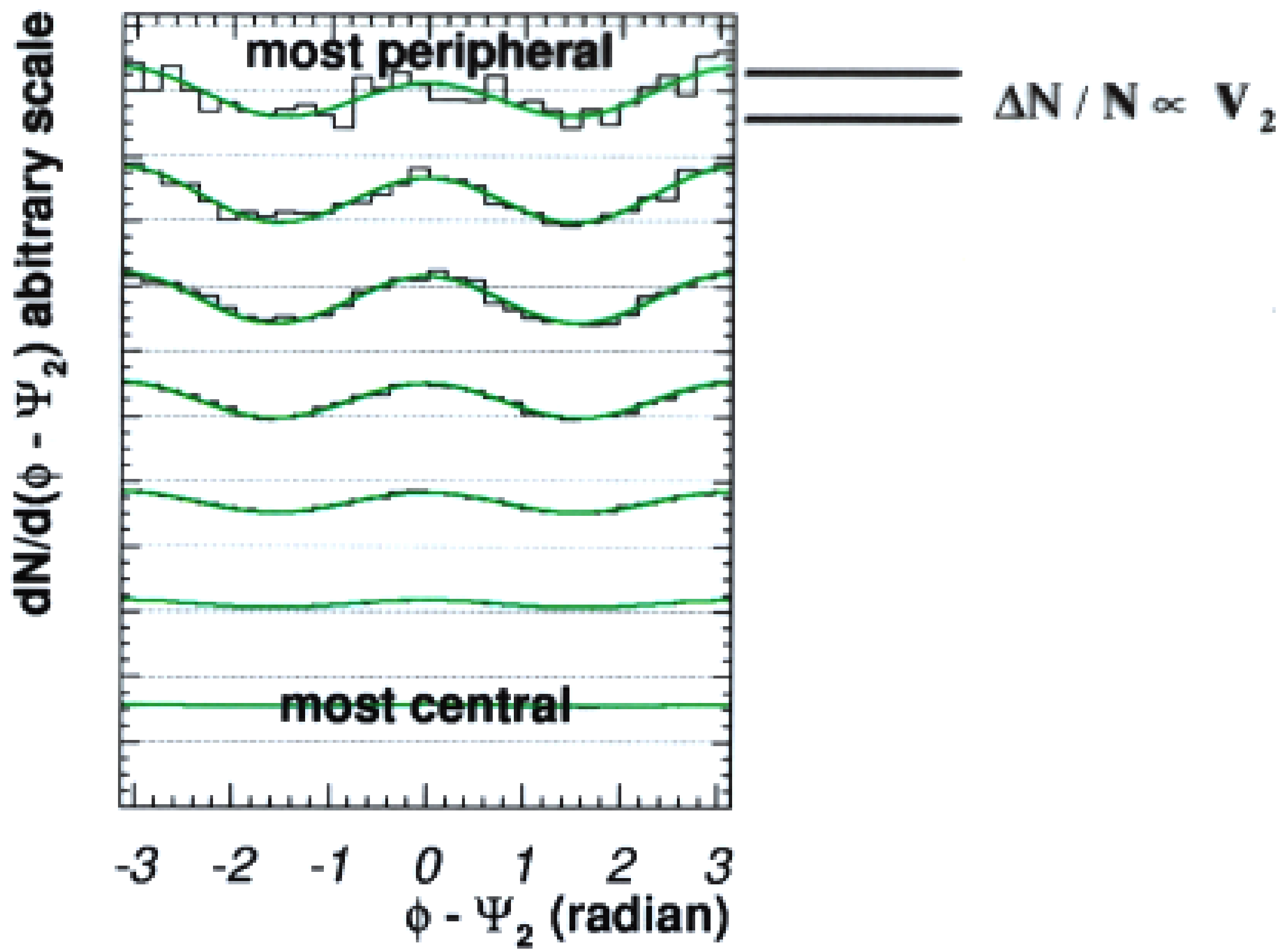



w is weight to compensate for detector related azimuthal asymmetries (inverse of hit density)

# Particle distribution w.r.t. Event Plane



# Flow Analysis* (Subevent correlation)

- If we know the reaction plane perfectly: $V_n = \langle \cos(n(\phi - \Psi_R)) \rangle$


- In real experiment, $\Psi_R$ is unknown: use $\Psi_n$

$$V_n^{obs} = \langle \cos(n(\phi - \Psi_n)) \rangle$$

$$\langle \cos(n(\Psi_n^{a,b} - \Psi_R)) \rangle = \left( \langle \cos(n(\Psi_n^a - \Psi_n^b)) \rangle \right)^{1/2}$$

- Finally, correct for event plane resolution

$$V_n = V_n^{obs} / \langle \cos(n(\Psi_n - \Psi_R)) \rangle$$

* Phys. Rev. C 58, 1671

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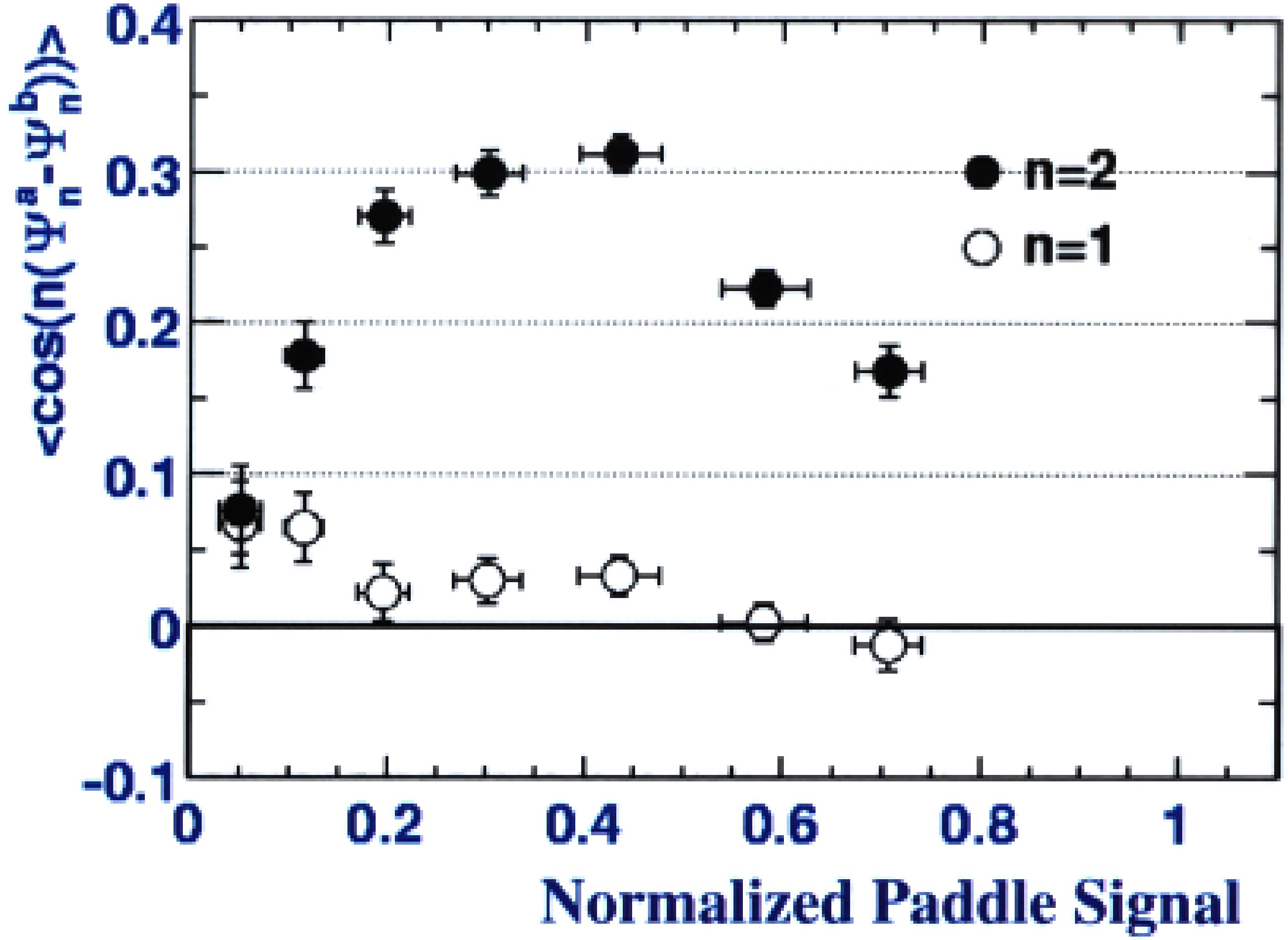
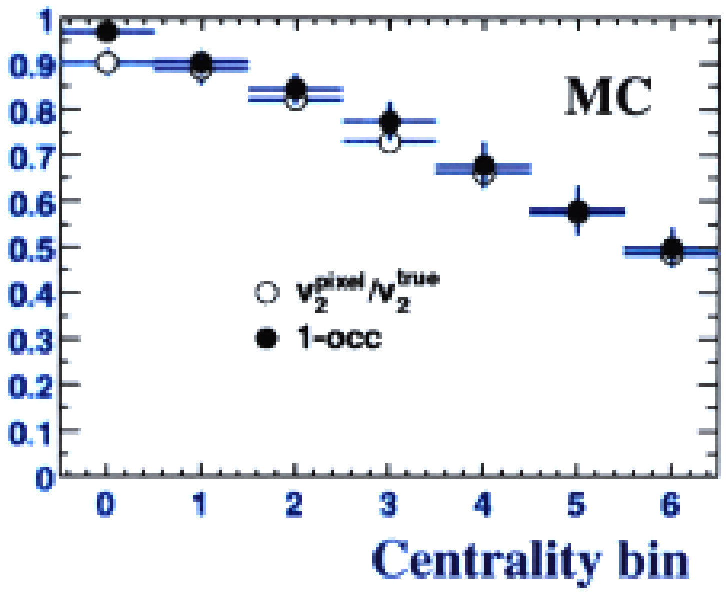
# Subevent Plane Correlation



# Occupancy Correction

$$V_2^{raw} = < \cos(2(\phi_{hit} - \Psi_2)) >$$

With our hit counting method, high occupancy reduces flow signal



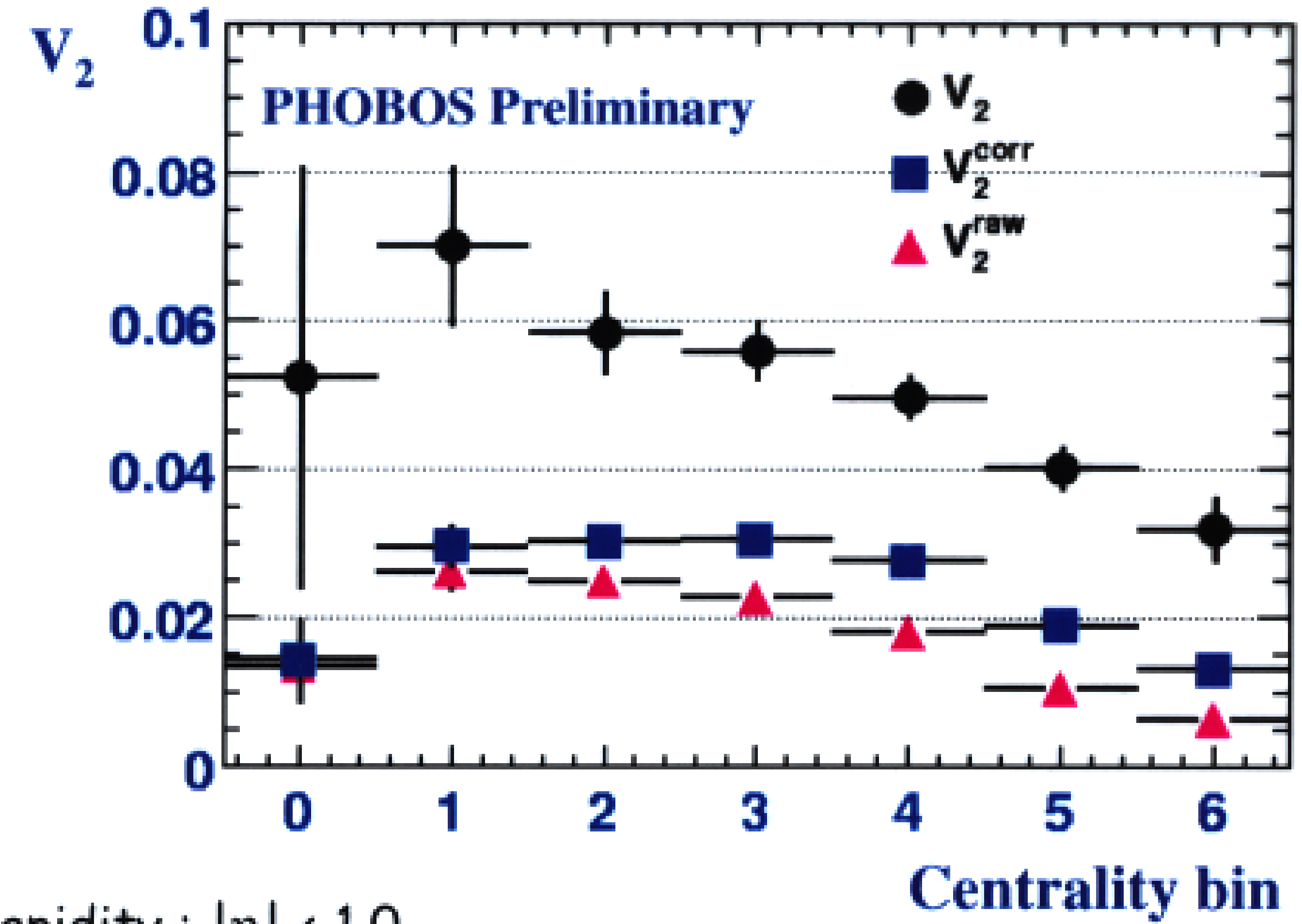

Occupancy = fraction of hit pads

$$V_2^{corr} = V_2^{raw} / (1 - Occ)$$

Independent of the magnitude of flow

$$V_2 = V_2^{corr} / \left( < \cos(2(\Psi_2^a - \Psi_2^b)) > \right)^{1/2}$$

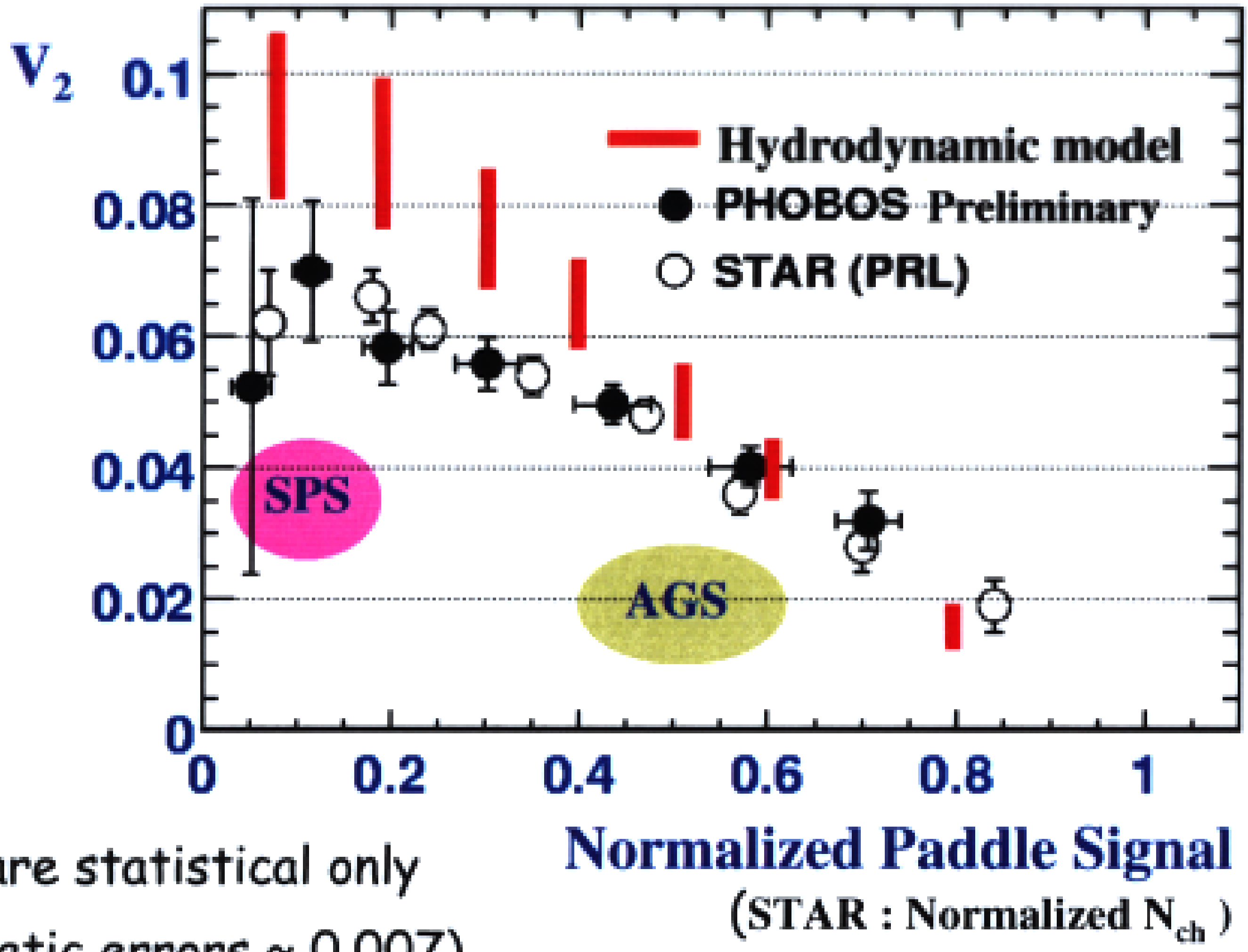
# Centrality Dependence




midrapidity : $|\eta| < 1.0$

# Centrality Dependence

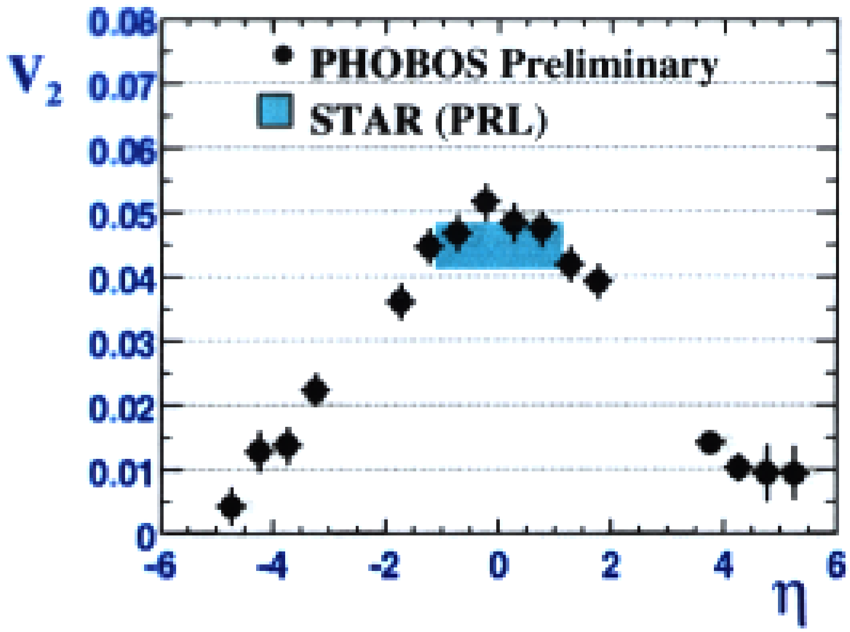
midrapidity : $|\eta| < 1.0$

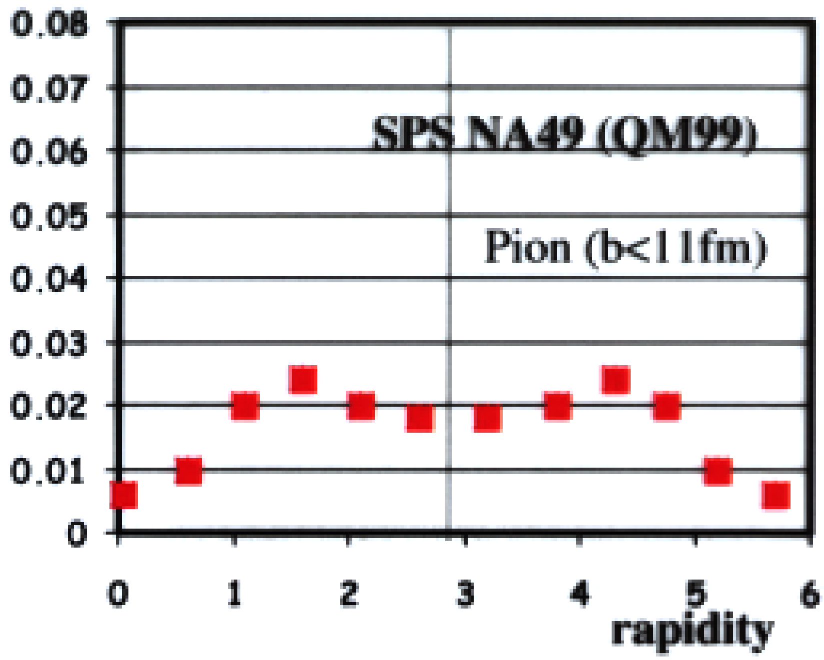



Errors are statistical only

(systematic errors ~ 0.007)

# Pseudorapidity dependence of $V_2$




- PHOBOS Errors are statistical only (systematic errors ~ 0.007)
- STAR : averaged over their centrality

# Summary

- Elliptic Flow at midrapidity reaches 6-7% in peripheral collisions, and drops in central collisions
- Elliptic Flow is a strong function of pseudorapidity
- Indication of sensitivity to $V_1$ (we are studying…)

**Thank you!**