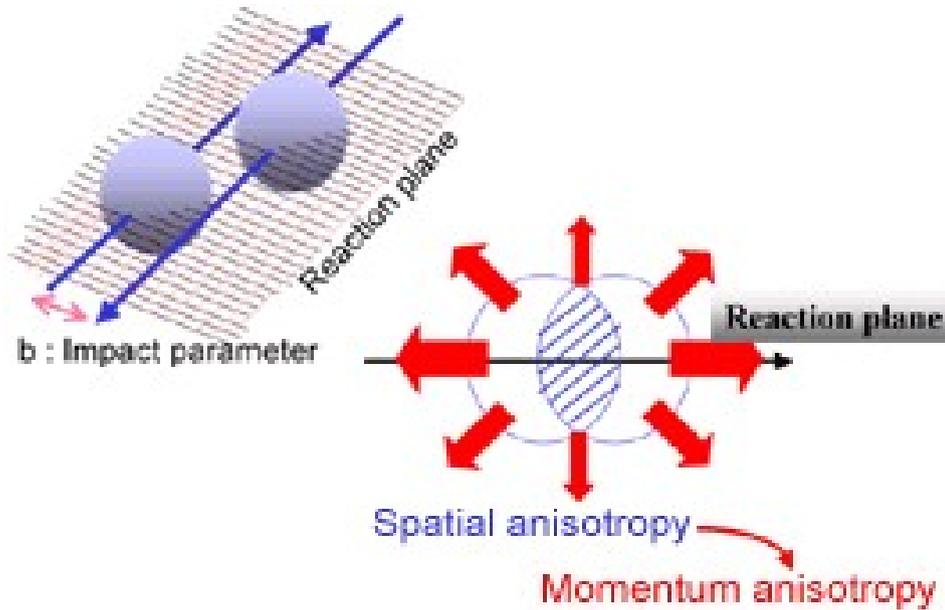


Elliptic flow measurements  
of J/Psi and light hadrons  
in 200A GeV Au+Au collisions  
at RHIC-PHENIX

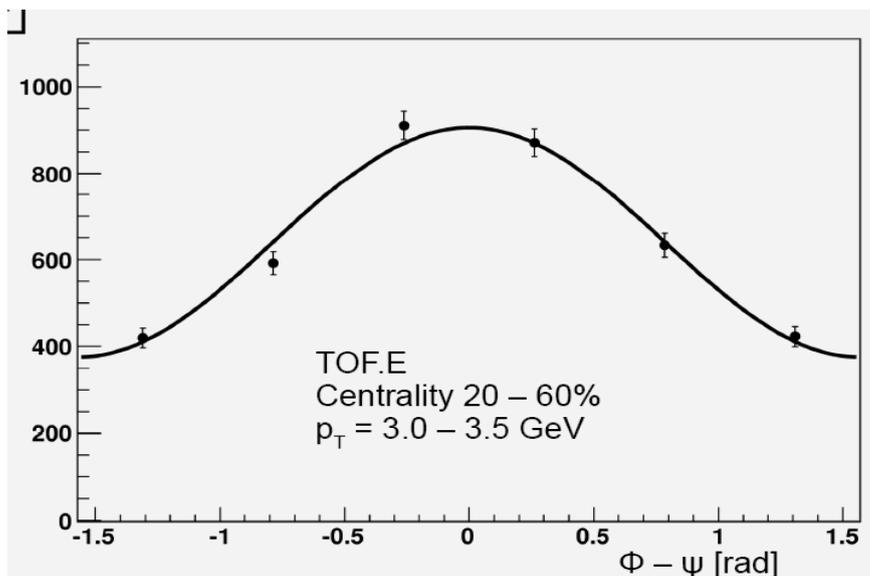
Yoshimasa Ikeda  
for the PHENIX collaboration  
(University of Tsukuba)

# Azimuthal anisotropy



Spatial anisotropy in non-central collision provides azimuthal anisotropy of particle emission.

The large anisotropy is an evidence of the formation of a hot and dense partonic matter.

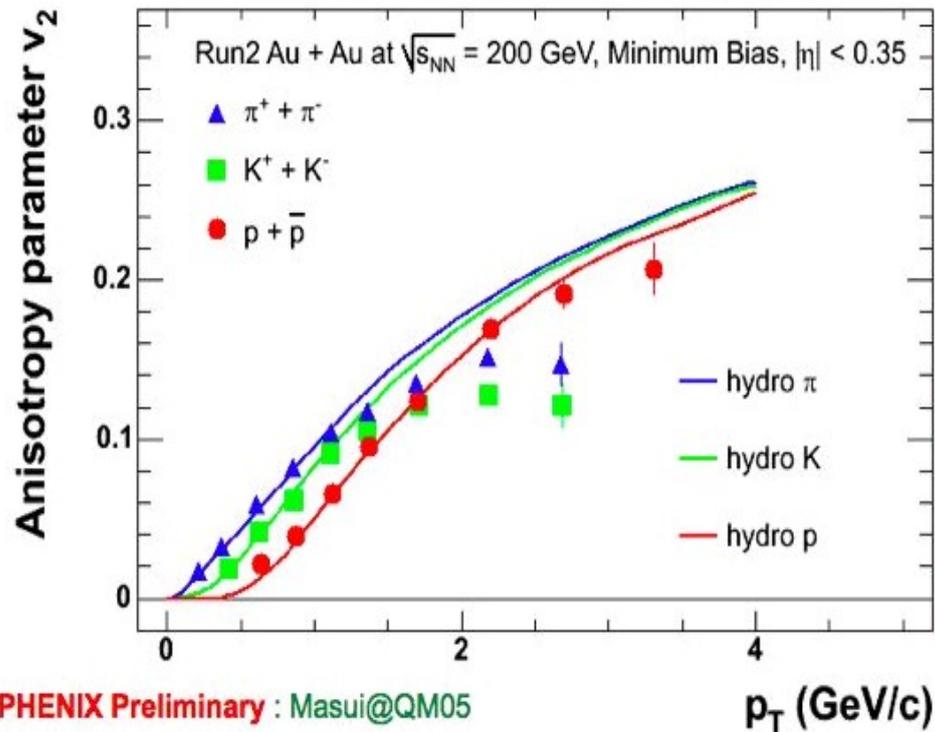


$$\frac{dN}{d\Phi} \propto 1 + 2v_2 \cos 2(\Phi - \Psi)$$

$\Psi$  : reaction plane angle

# Motivation of $v_2$ measurement

PHENIX : P.R.L. 91, 182301 (2003)



PHENIX Preliminary : Masui@QM05

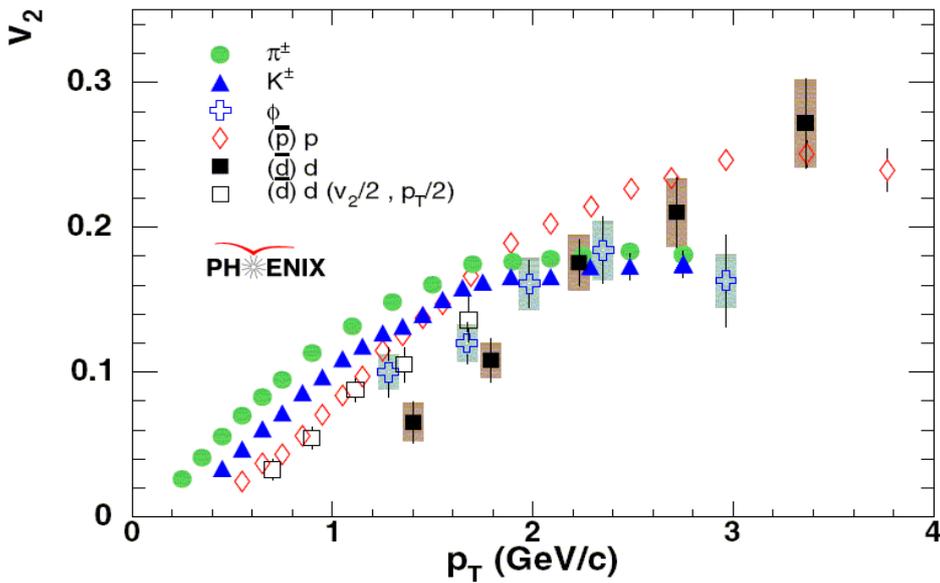
Large  $v_2$  was observed in RHIC

The values agreed with hydro-dynamical models

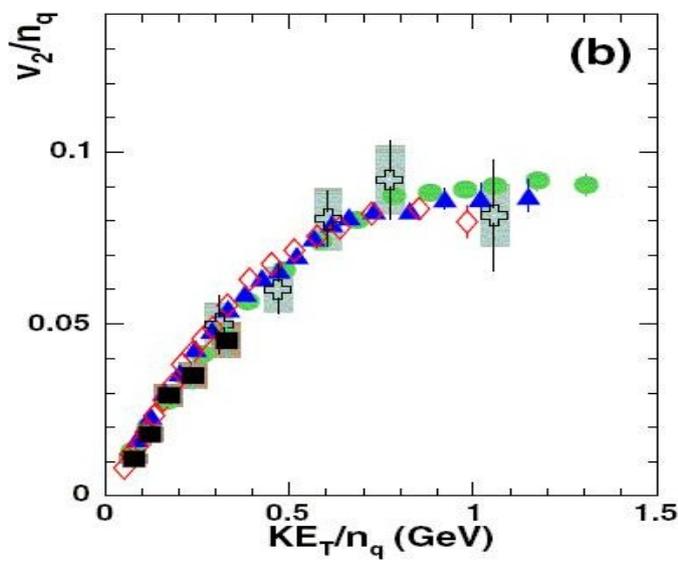
It suggests rapid thermalization and quark flow.

# $kE^T$ and quark number scaling

PHENIX. PRL. 99, 052301 (2007)



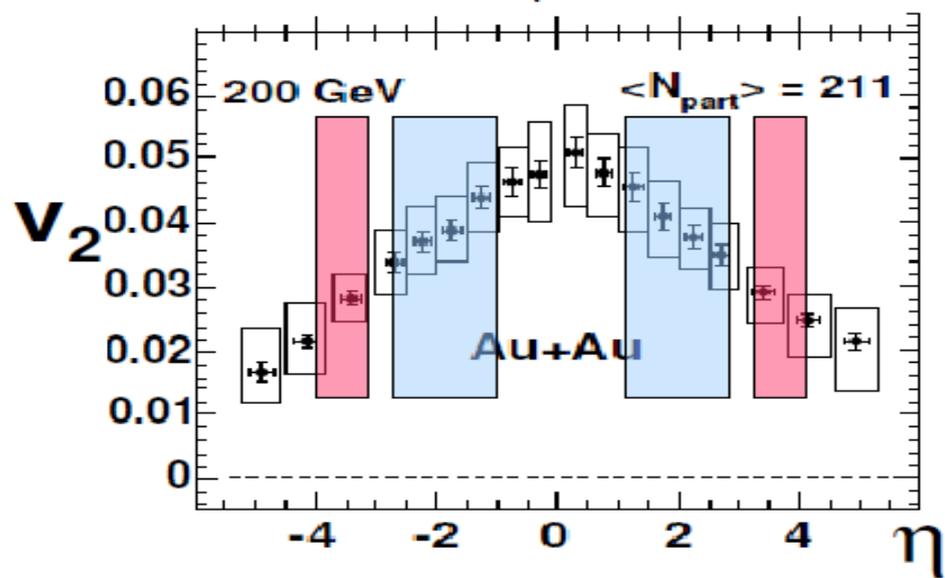
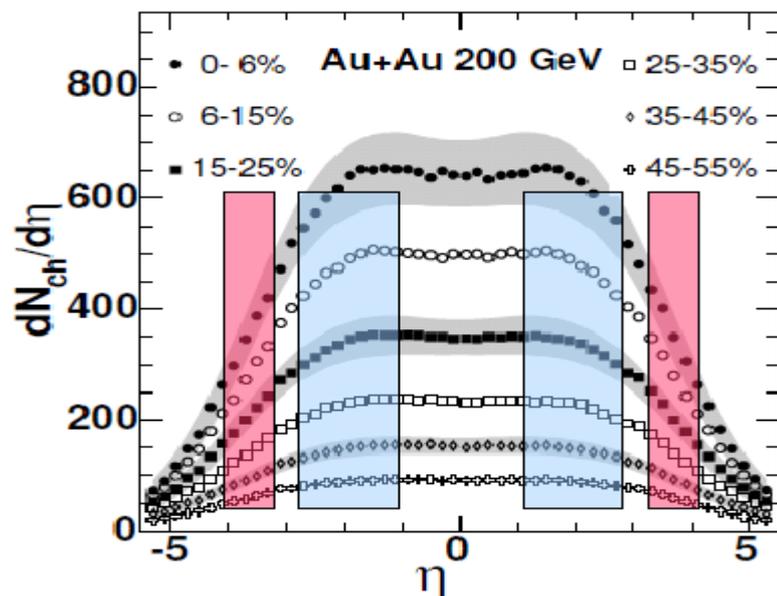
- The values of  $v_2$  are in proportion to the number of quarks
- heavy particle shifts to high  $p_T$
- These agree very well by  $kE_T/n_q$  scaling at low  $p_T$  range.



$$KE_T = \sqrt{(M^2 - P_T^2)} - M$$

# New reaction plane detector "RxP"

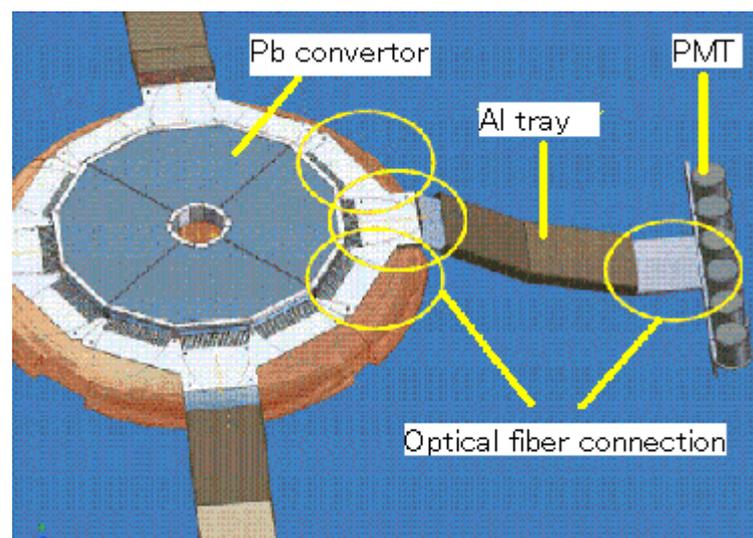
PHOBOS, PRL. 91, 052303 (2003) RxP measure more particles and the particles with more large  $v_2$ .



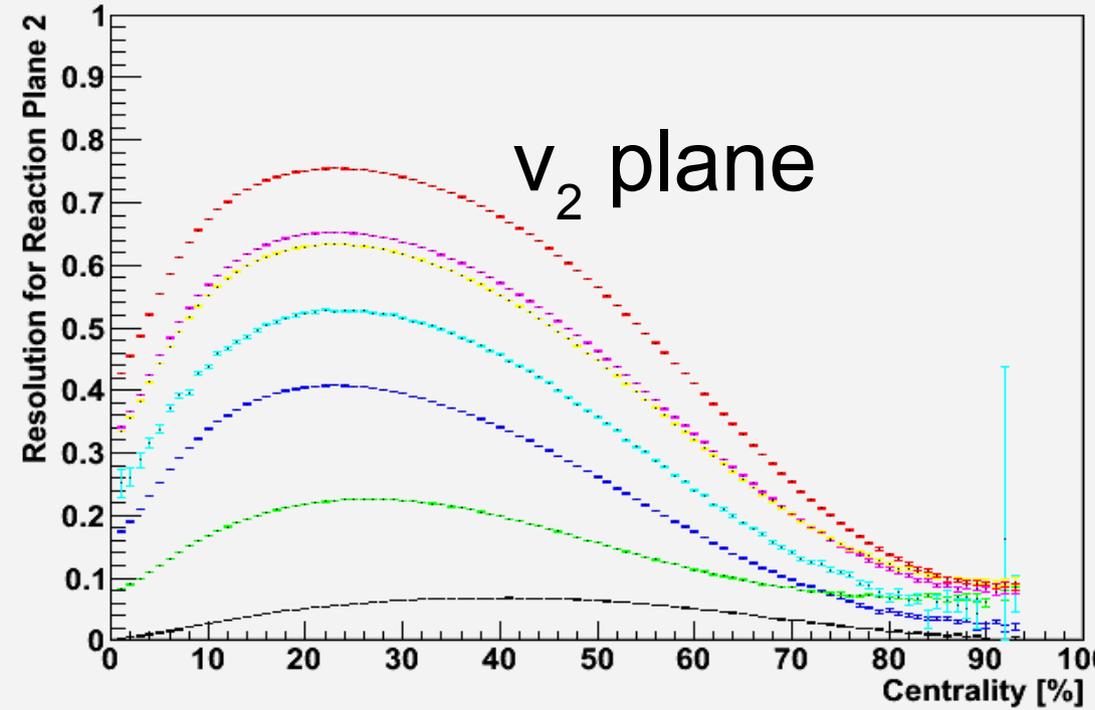
RxP measure more particles and the particles with more large  $v_2$ .

RxP :  $\eta = \pm 1 \sim 2.8$  (blue)

BBC :  $\eta = \pm 3.1 \sim 4$  (red)



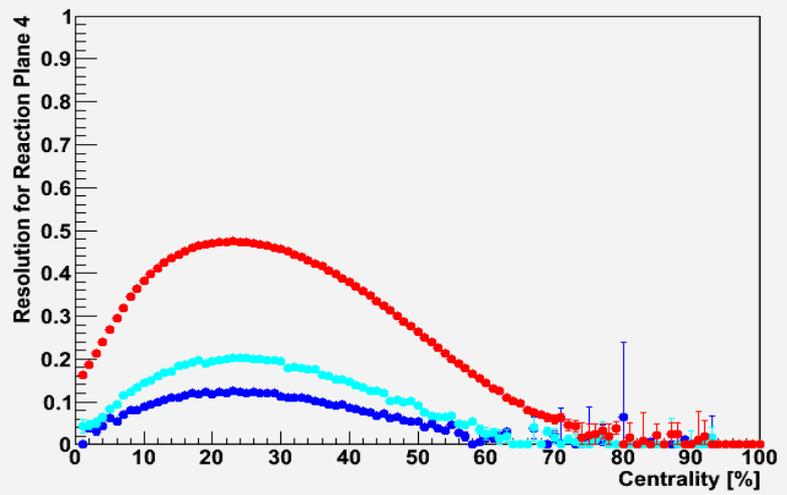
# New Reaction Plane Resolution



- RxP  $|\eta| = 1.0 - 2.8$
- RxPinner  $|\eta| = 1.5 - 2.8$
- RxPouter  $|\eta| = 1.0 - 1.5$
- MPC  $|\eta| = 3.0 - 4.0$
- BBC  $|\eta| = 3.1 - 3.9$
- CNT  $|\eta| = 0 - 0.35$
- SMD  $|\eta| > 6$

new

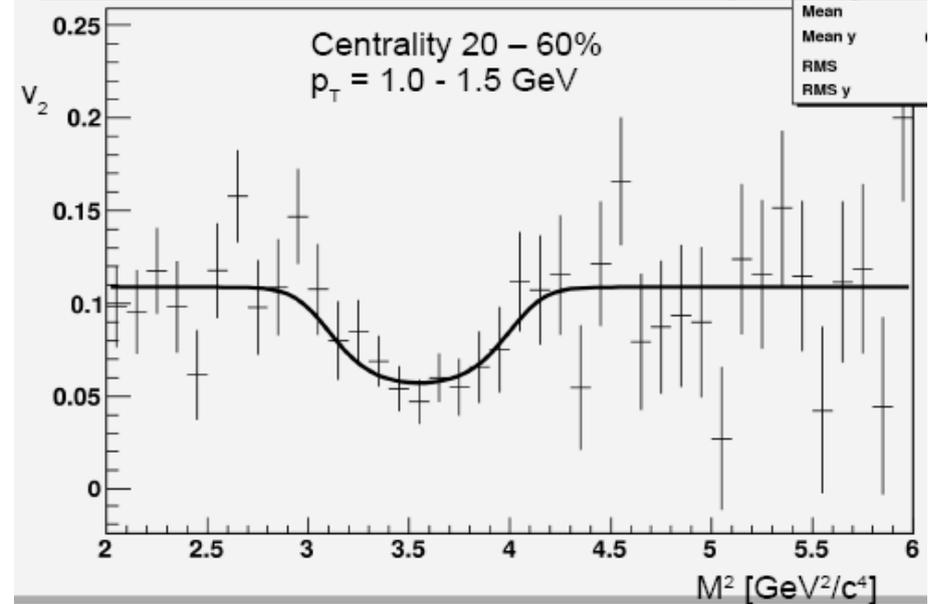
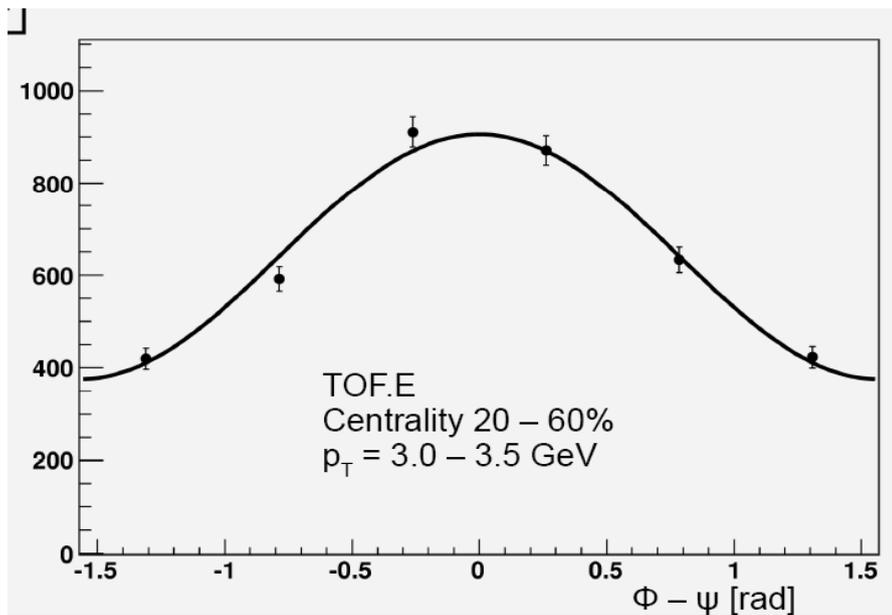
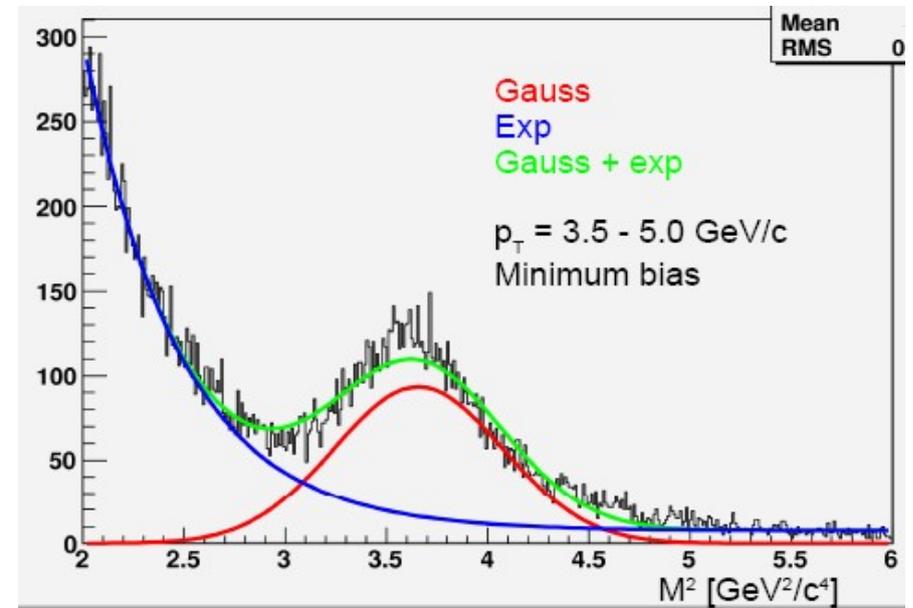
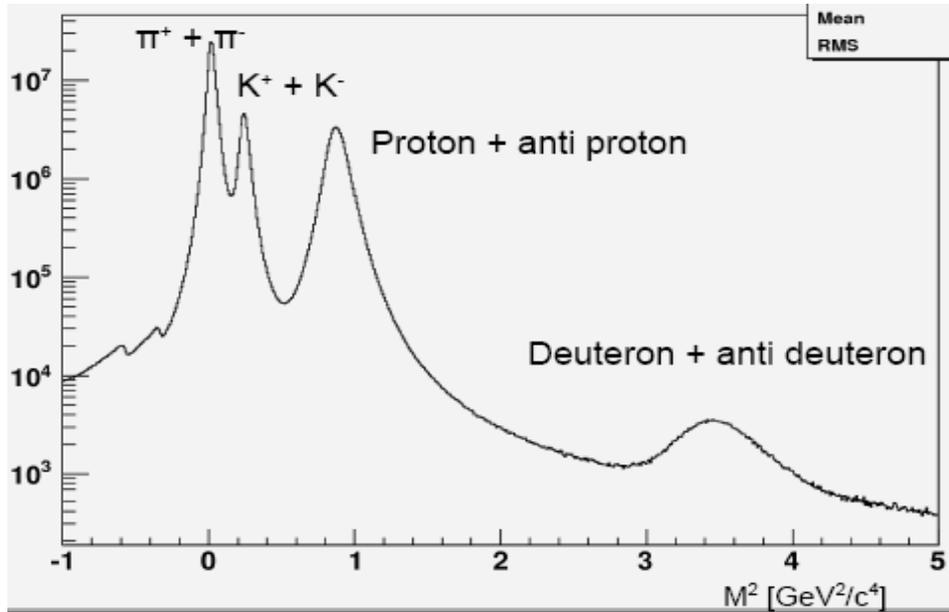
old



$$v_{2\text{observe}} = v_{2\text{real}} \times \langle \cos 2(\Psi_{\text{real}} - \Psi_{\text{observe}}) \rangle$$

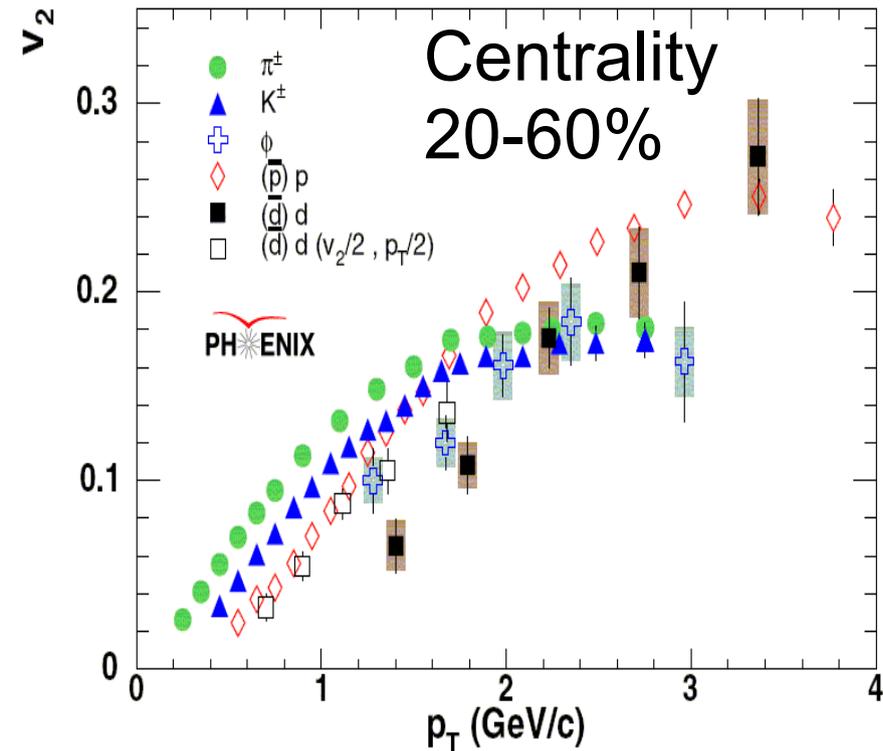
$$\delta v_2 \sim \frac{1}{\langle \cos 2(\Psi_{\text{real}} - \Psi_{\text{observe}}) \rangle} \times \frac{1}{\sqrt{N}}$$

# How to get PID $v_2$ (deuteron)



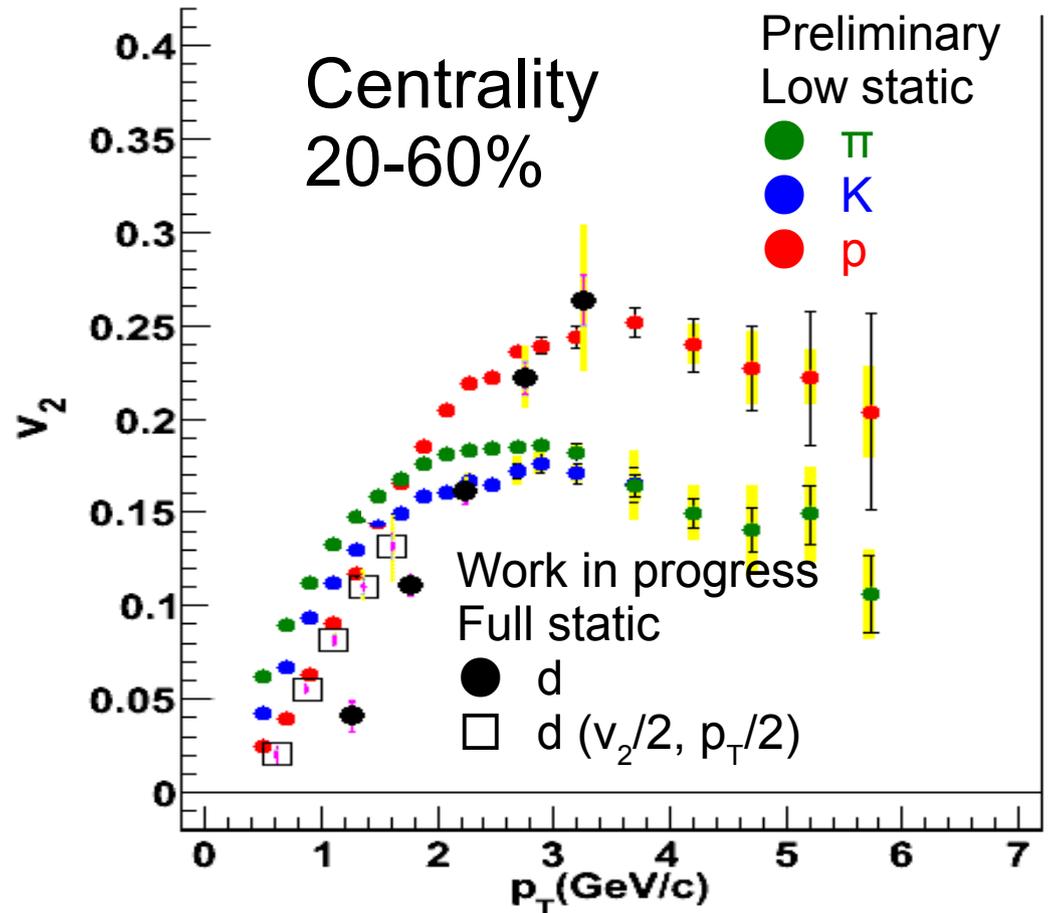
# $v_2$ before and after

PHENIX. PRL. 99, 052301 (2007)



## Before (Run4)

BBC RP resolution ( $< 0.4$ )  
0.8 billion events

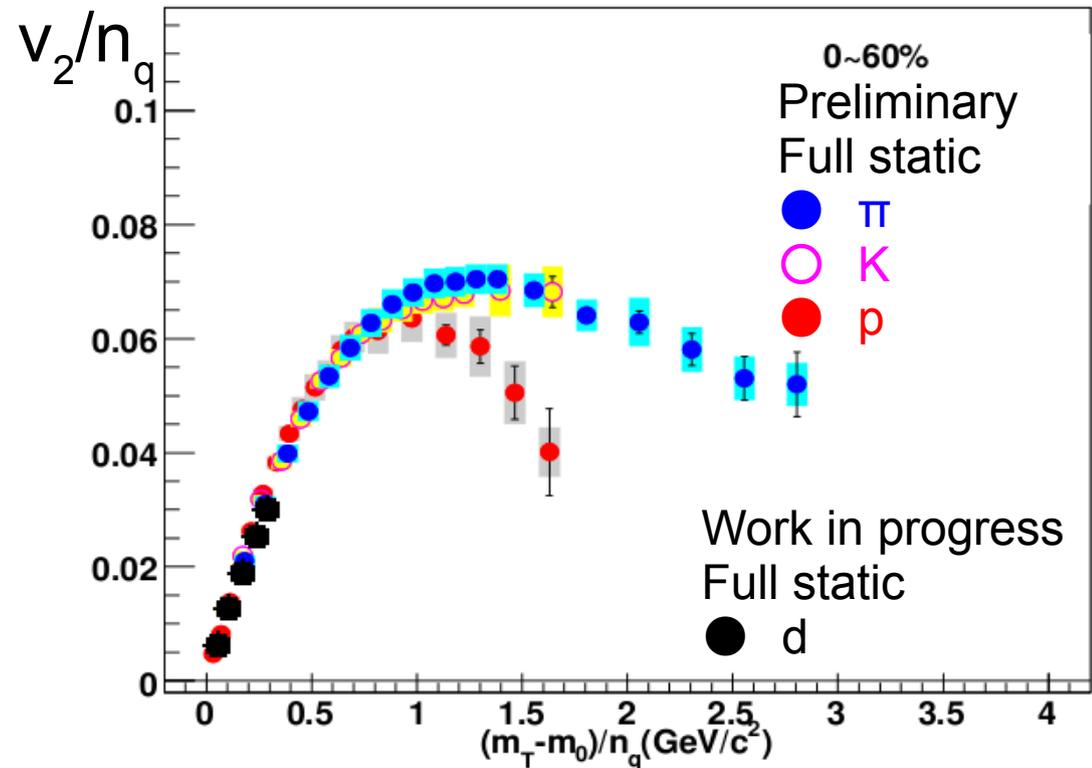
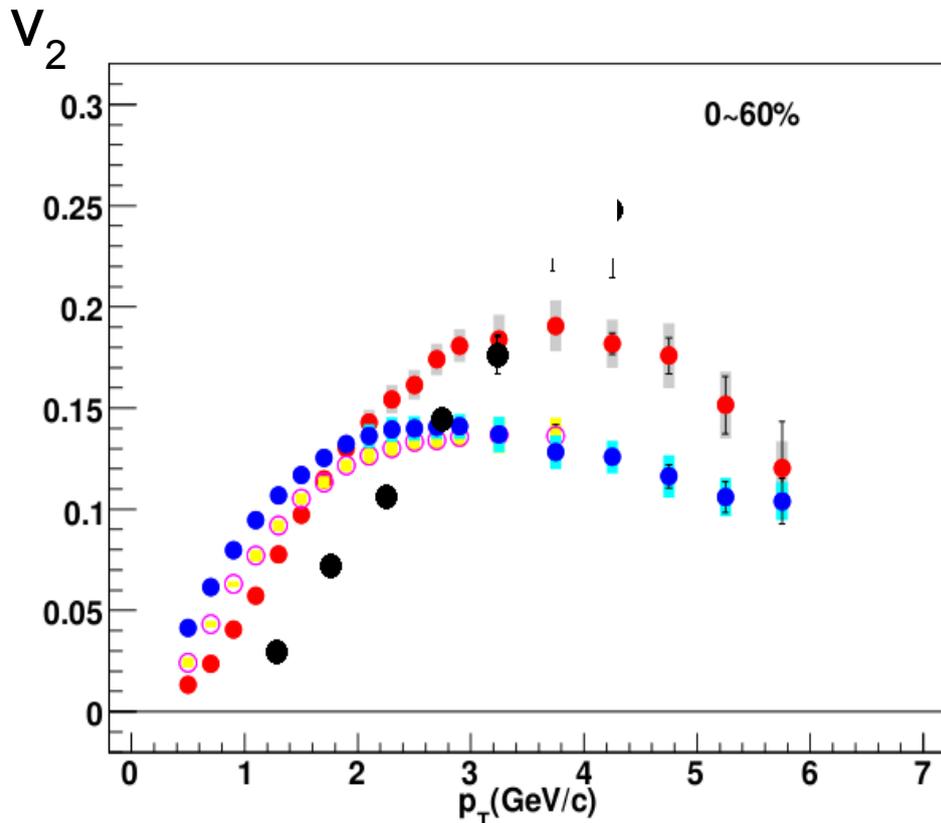


## After (Run7)

Better resolution of RxP ( $< 0.75$ )  
Higher statistical (3.5 billion)

# Quark number and $KE_T$ scaling

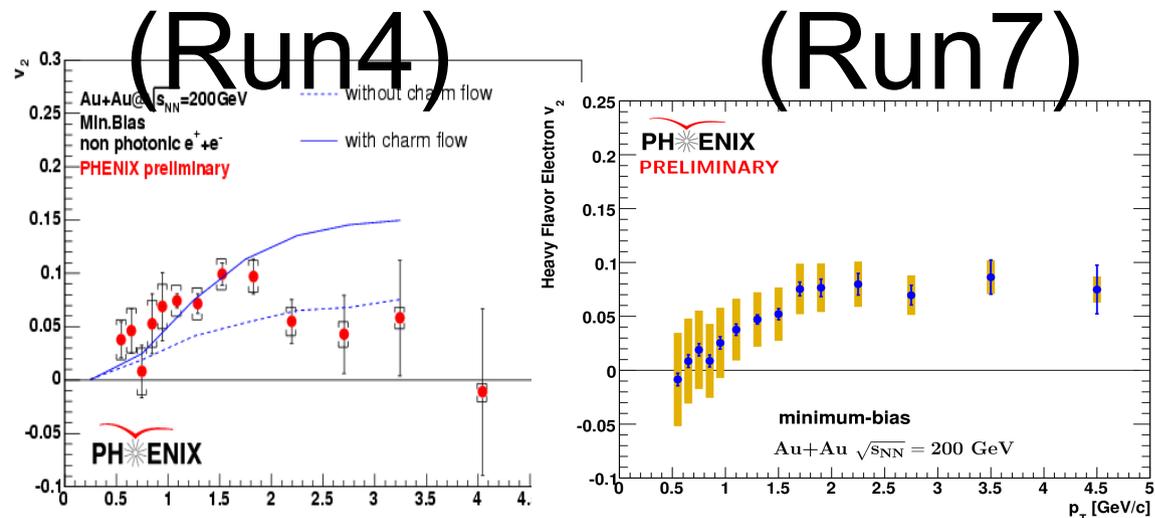
$$KE_T = \sqrt{(M^2 - P_T^2)} - M$$



The  $v_2$  of proton and anti-proton show clear deviation from the number of quark scaling at  $KE_T/n \approx 1$  GeV.

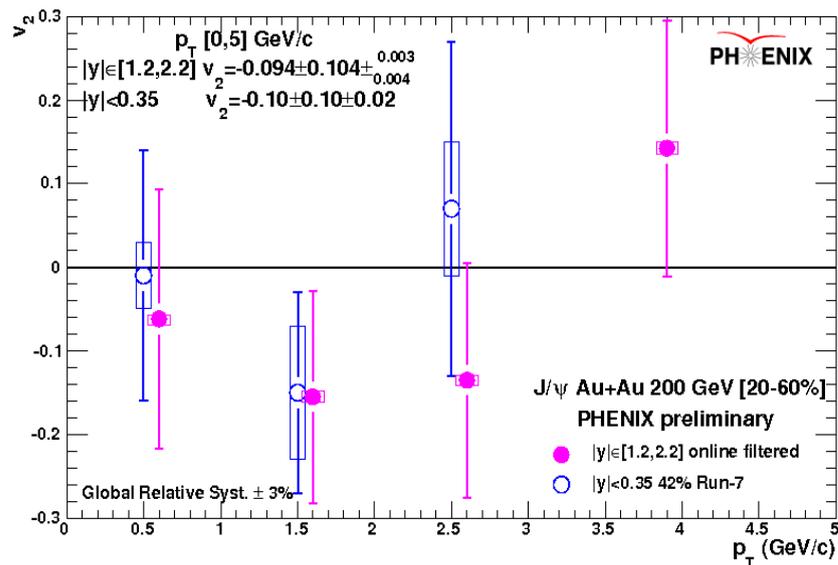
This may indicate a change of particle production mechanism.

# Heavy flavor and J/ $\psi$ $v_2$



The data at low  $p_T$  favor the models that include quark level elliptic flow of charm.

B meson decay becomes a significant source above 2.5 GeV/c



# Summary

RxP has worked very well during the PHENIX Run7 period and demonstrated the design performance.

resolution is improved by a factor of two (0.4  $\Rightarrow$  0.75)

We are analyzing the data with RxP.

$\pi$ , K, proton, deuteron, single electron and J/ $\Psi$  have been measured and also preparing for the publications.

(Anti)Proton show clear deviation from mesons.

Please wait for  $\Lambda$  and  $\Phi$ .

# Back up

# Reaction Plane Detector (RxP)

The reaction plane detector was installed just before Run7 (2007).

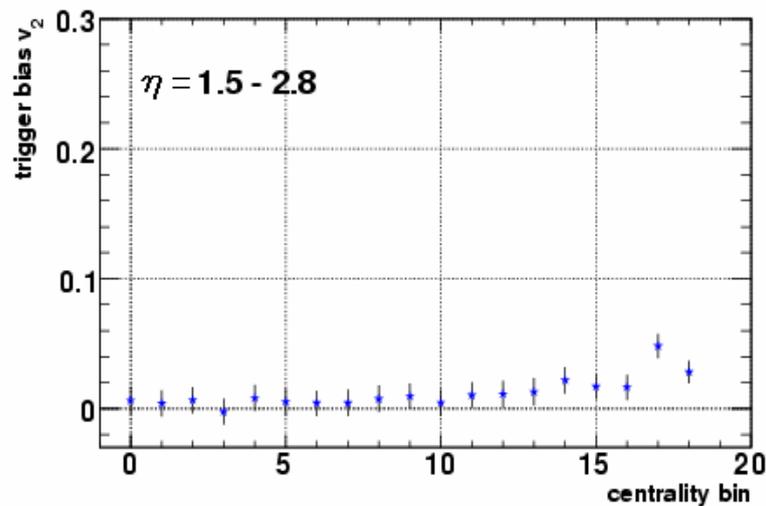
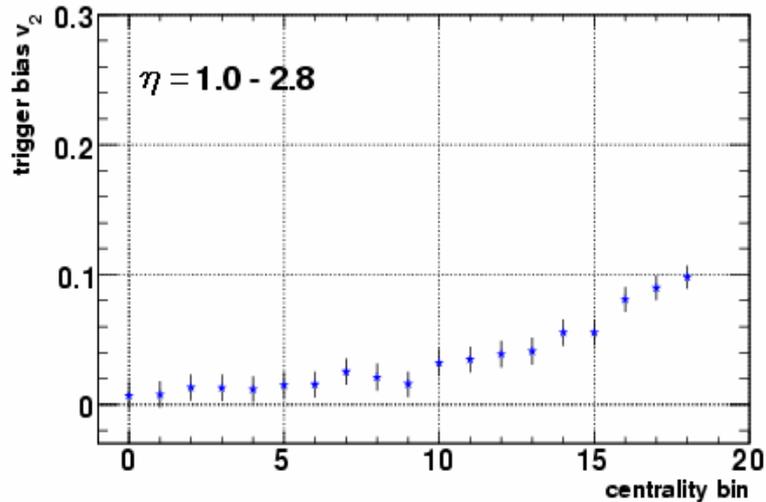


35cm

Collision point

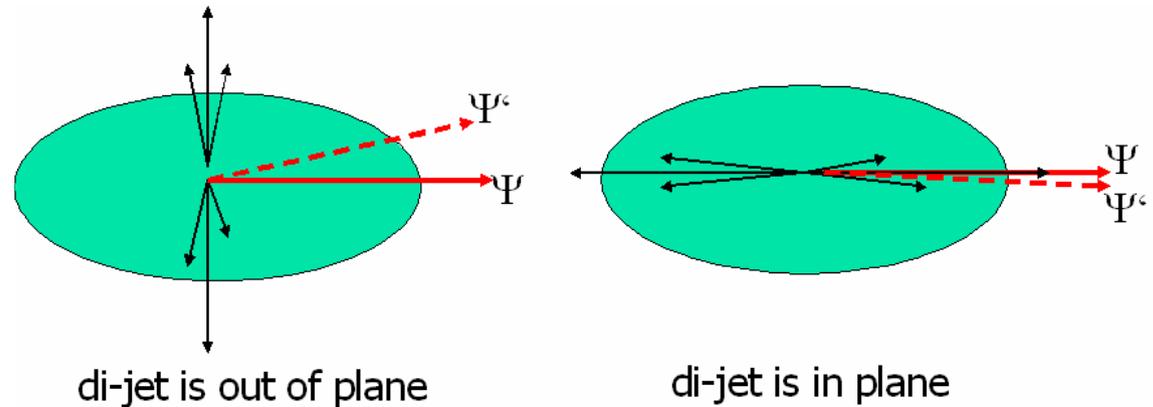


# Correlation effect

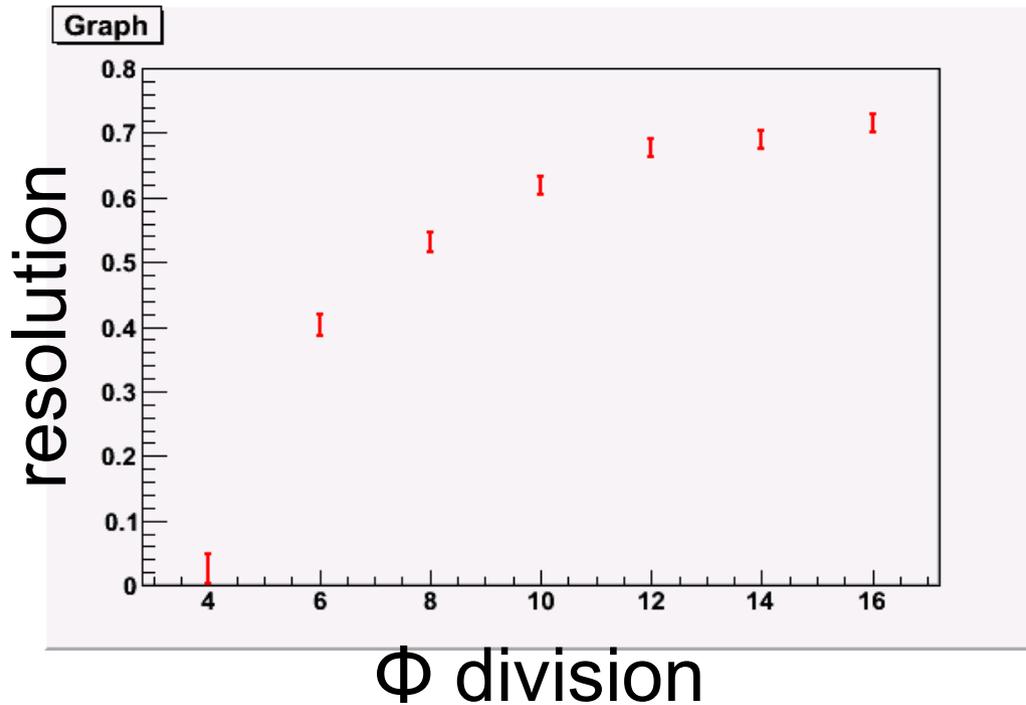


$v_2$  is over estimated by correlation effect.

According to HIJING+PYTHIA, the effect by jet does not have any problem with  $\eta > 1.5$



# Design and Geant simulation



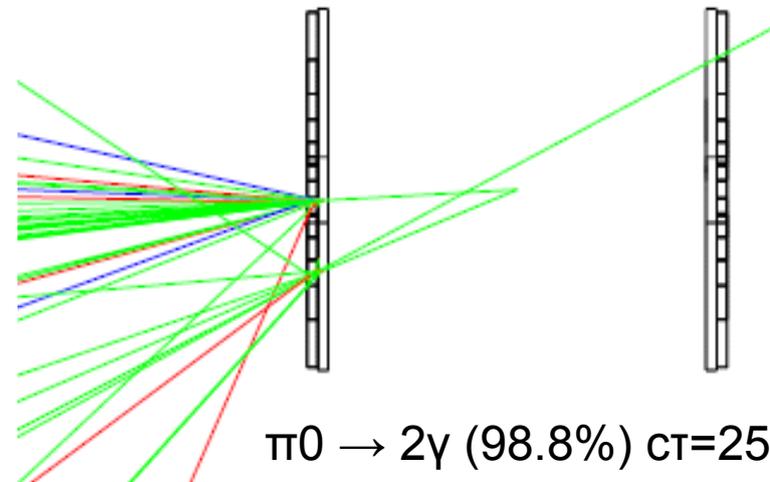
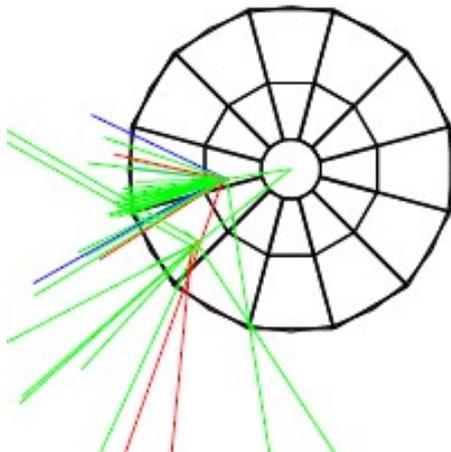
Detector parameters  
were optimized with  
Geant simulation

Thickness

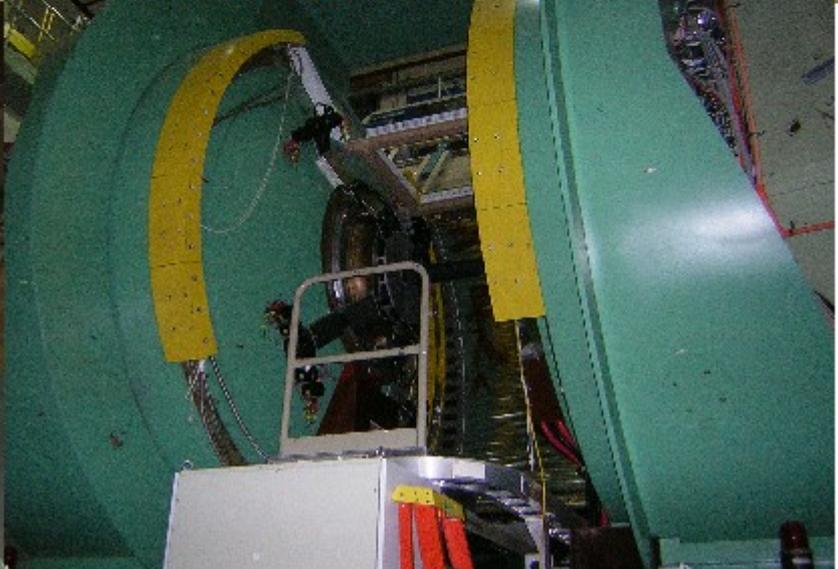
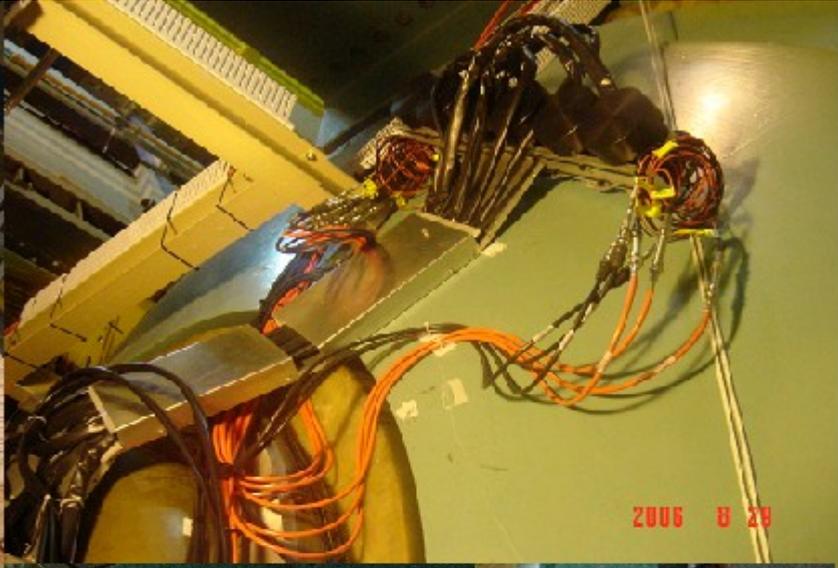
Scintillator 2cm

Converter 2cm

$\Phi$  division into 12



$\pi^0 \rightarrow 2\gamma$  (98.8%)  $\sigma_T=25.1$ [nm]



# Configuration of RxP

