The Capabilities of PHENIX in the Strangeness Sector

Workshop on Flow and Strangeness Production in Heavy Ion Collisions

September 27, 1999

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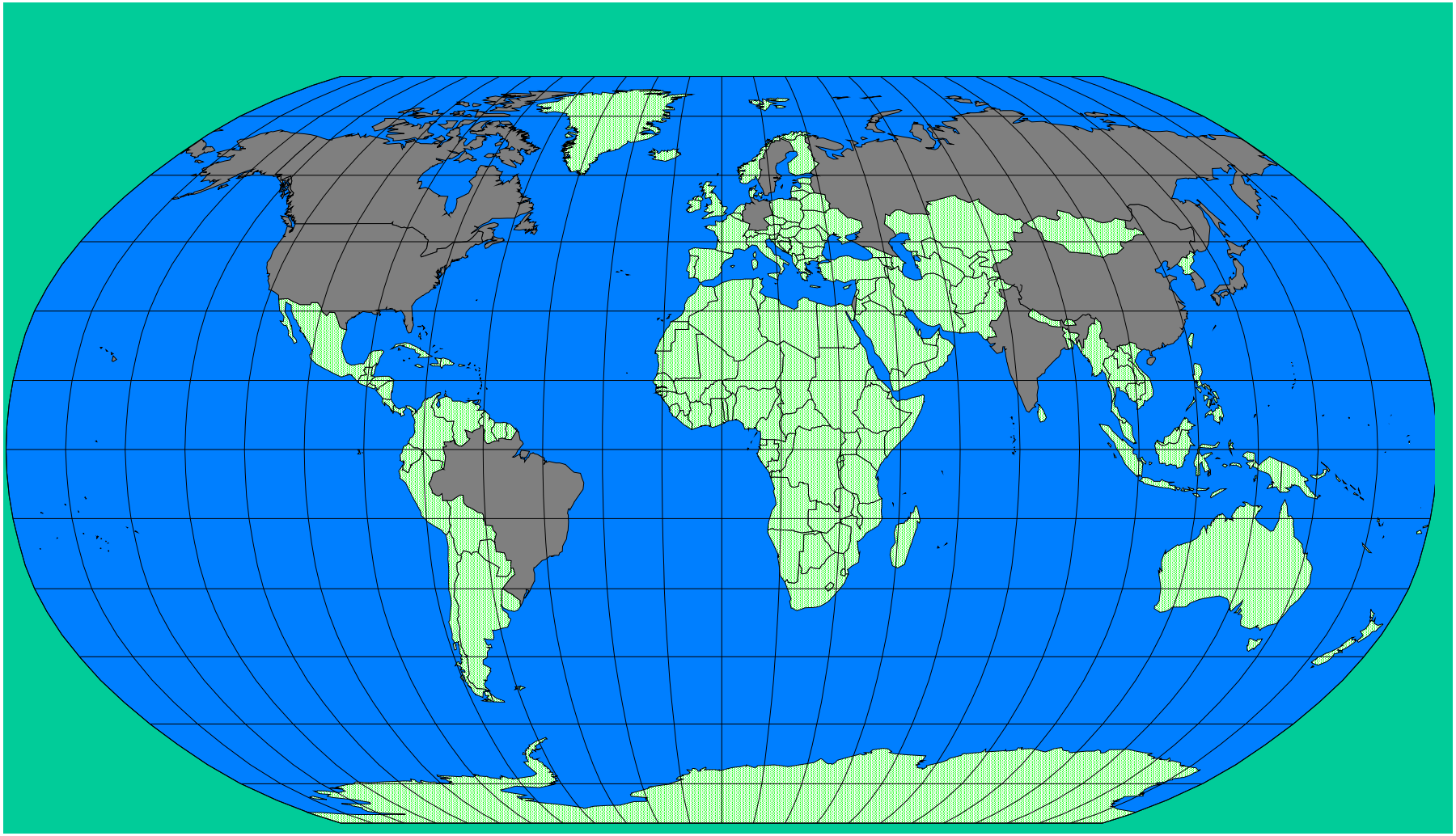
Outline:

- PHENIX experiment overview
- General PHENIX physics overview
- Strangeness measurement capabilities
  - Kaon measurements
  - Phi meson measurements

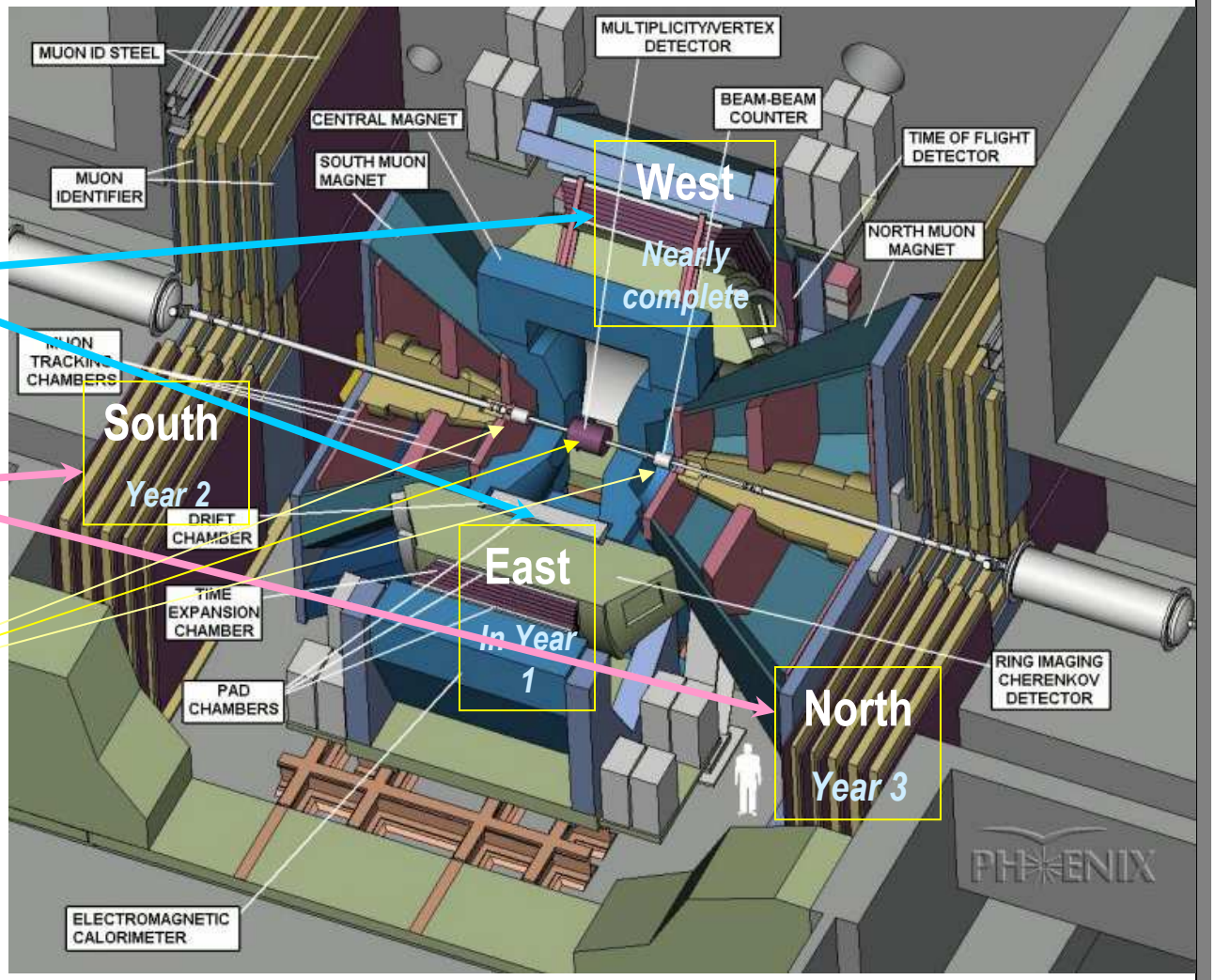
Countries Participating in PHENIX (shaded)

(430 physicists, 43 institutions, 11 countries)



Complete PHENIX Lay-out

- 2 "central" spectrometers
- 2 "forward" spectrometers
- 3 "global" detectors



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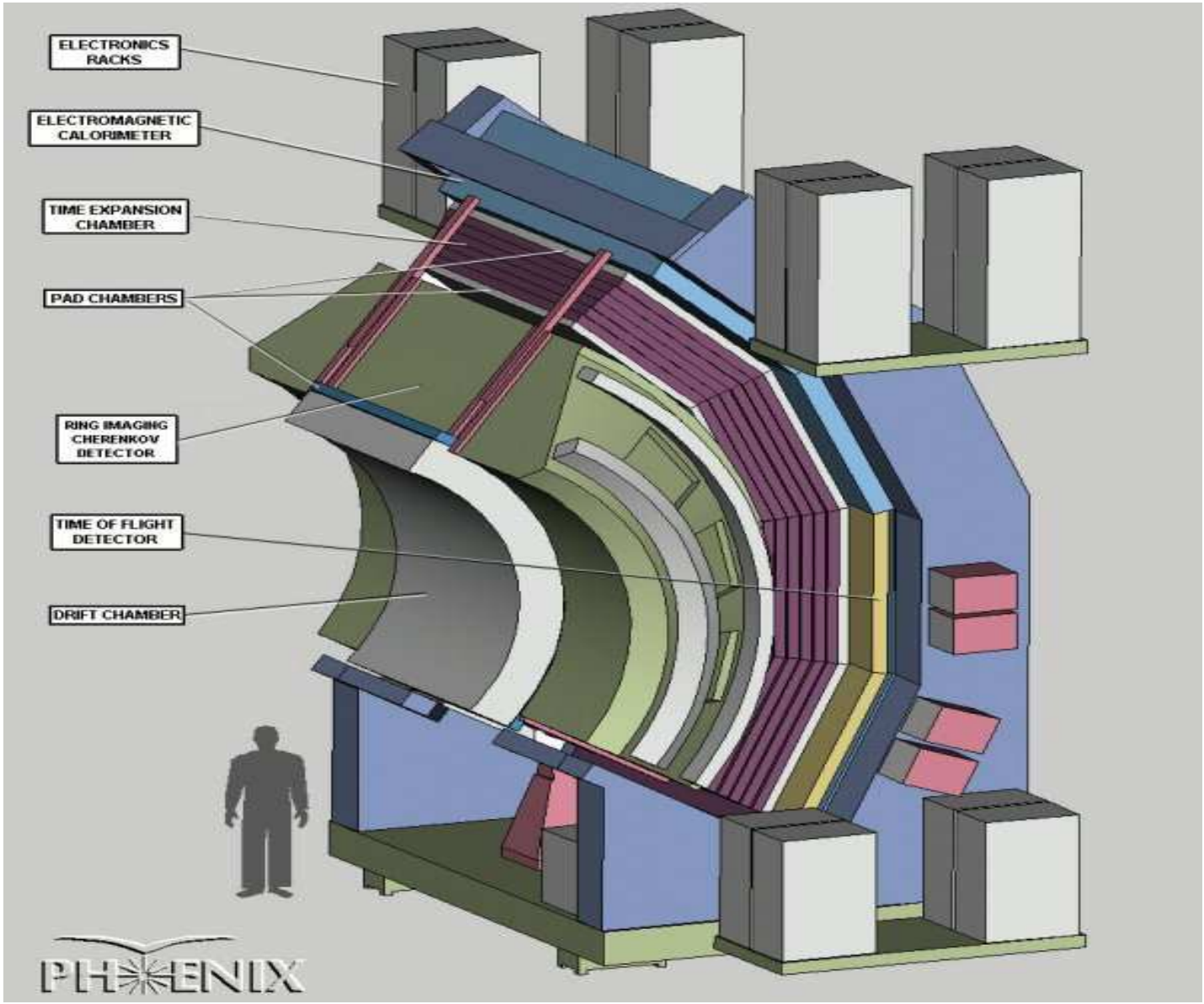
PHENIX Year One: Central Arm Spectro-meter



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PHENIX in April 1999

PHENIX Today

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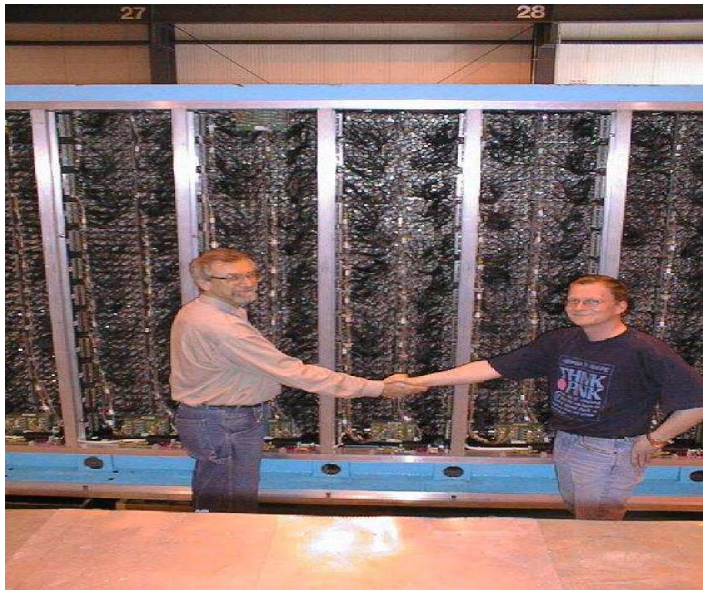
RICH

PHENIX Detector Installation

Time
Expansion
Chamber

Pad
Chambers

Calorimeters



PHENIX Year 1 Physics Program

- PHENIX can record essentially all events RHIC can make (in Year-1)
  - ➔ 120M *unbiased* Au-Au events
- Physics reach:

An extensive program addressing all collision timescales:

- How big is it?
- How bright is it?
- How long does it live?
- How strange is it?
- How did it get that way?

Timescale	Probe	Required Elements	Available Year-1?
Initial Collision	***Hard Scattering***		
	Single "jet" via leading particle	E or W	Yes
	photon + "jet"	E and W	Yes?
Deconfinement	***High-Mass Vector Mesons***		
	J/Ψ, Ψ' screening	N, S, E+W	Observation
	Υ (non)screening	N,S	No
Chiral Restoration	***Low-Mass Vector Mesons***		
	ρ, ω, ϕ mass, width	E+W	Yes?
	ϕ branching ratios	E+W	Yes?
QGP Thermalization	***Photons***		
	π^0, η, η'	E	Yes
	continuum direct; very soft	E	Yes
QGP Thermalization	***Dileptons***		
	non-resonant: 1-3 GeV	N,S,E+W	Yes?
	soft continuum, <1 GeV	E+W	No
QGP Thermalization	***Heavy Quark Production***		
	open charm	(N or S) + E	No
	open charm via single lepton	N,S,E	Yes
Hadronization	***Hadrons***		
	HBT Interferometry, π/K	E	Yes
	strangeness production: K, ϕ	E	Yes
	spectra of identified hadrons	E	Yes
Hydrodynamics	***Global Variables***		
	E_T, dN/dy	E, MVD	Yes

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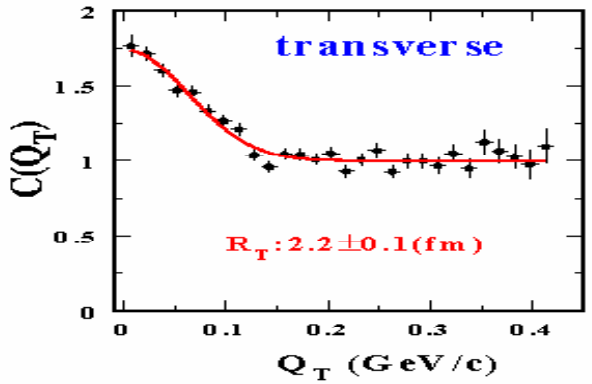
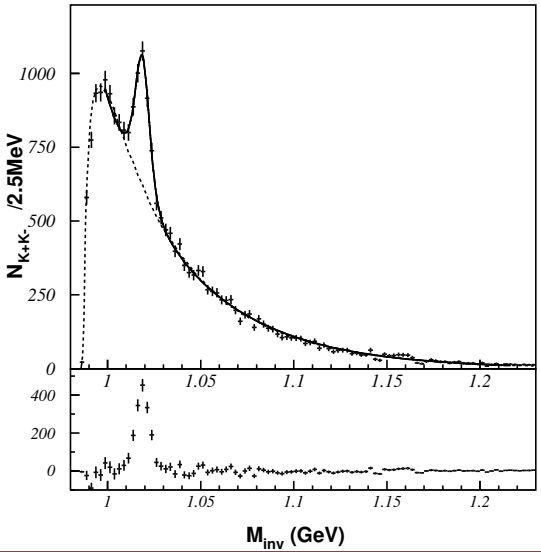


NA44:

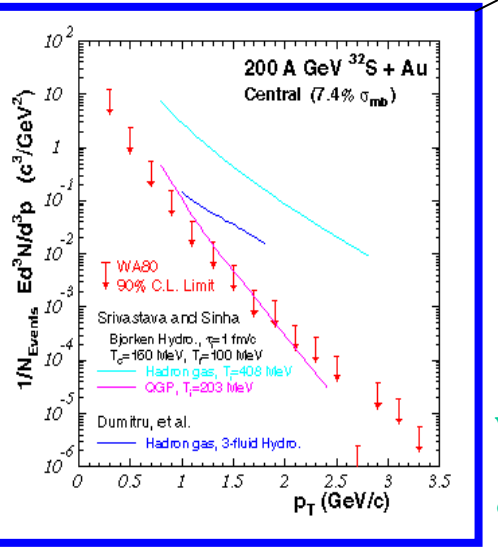
- How big is it?
- How long does it live?

E859:

- How strange is it?



PHENIX

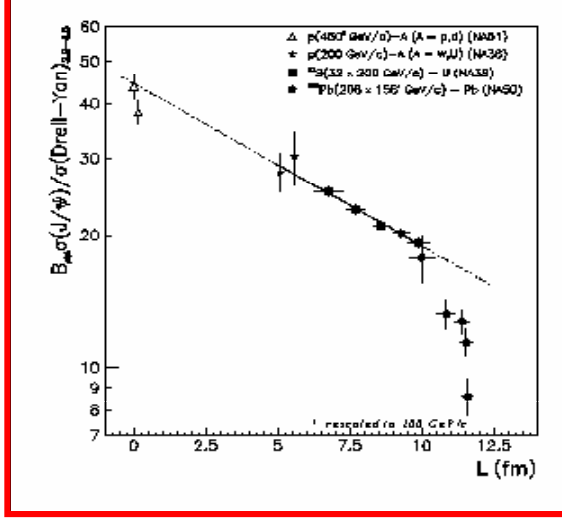


WA80:

- How bright is it?

NA50:

- How did it get that way?

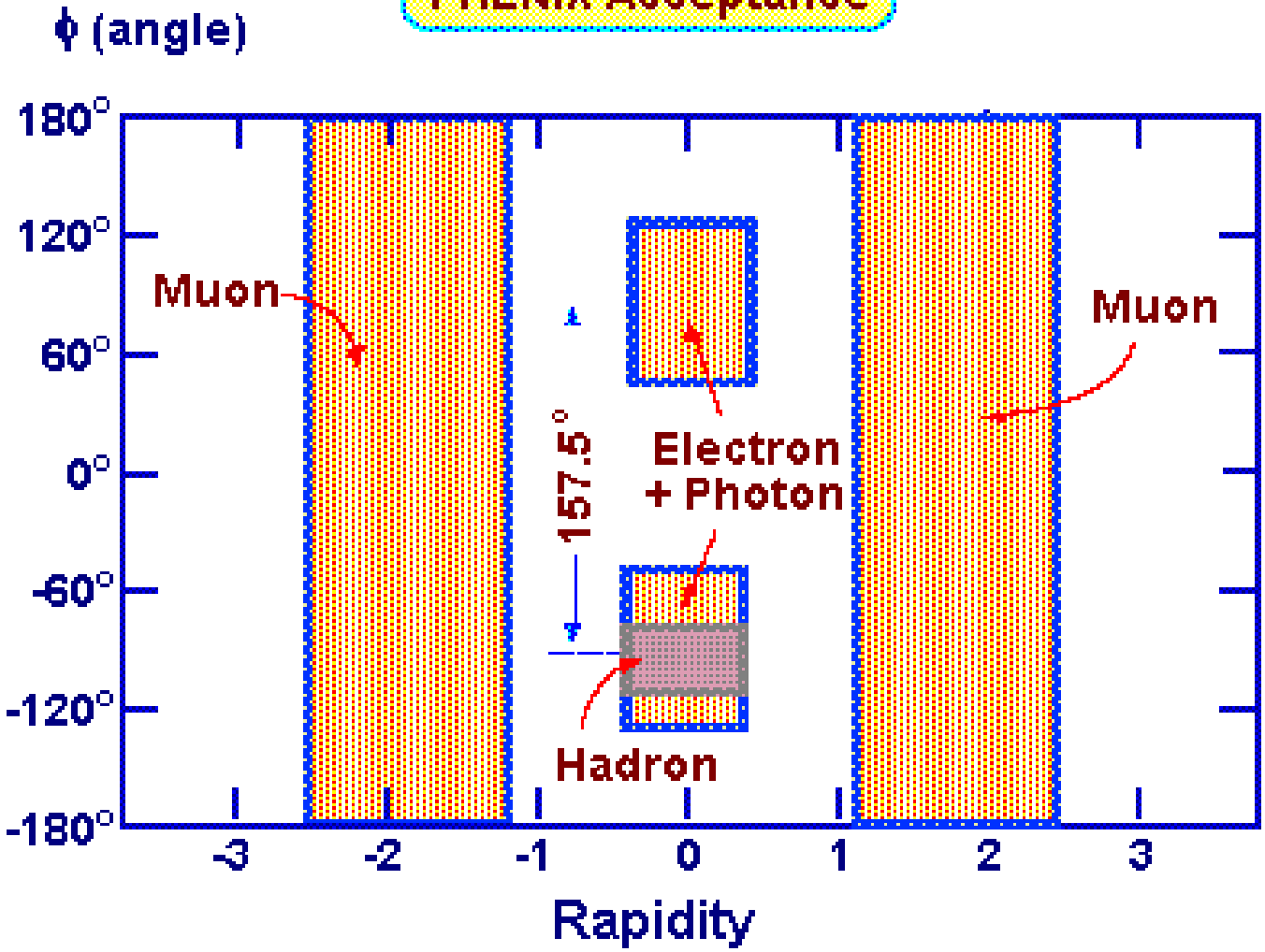


PHENIX: Strangeness Measurements

- Charged kaon spectra
- K/π Ratios
- Charged kaon HBT measurements
- Phi meson production:
  - mass
  - width
  - branching ratios

PHENIX

PHENIX Acceptance



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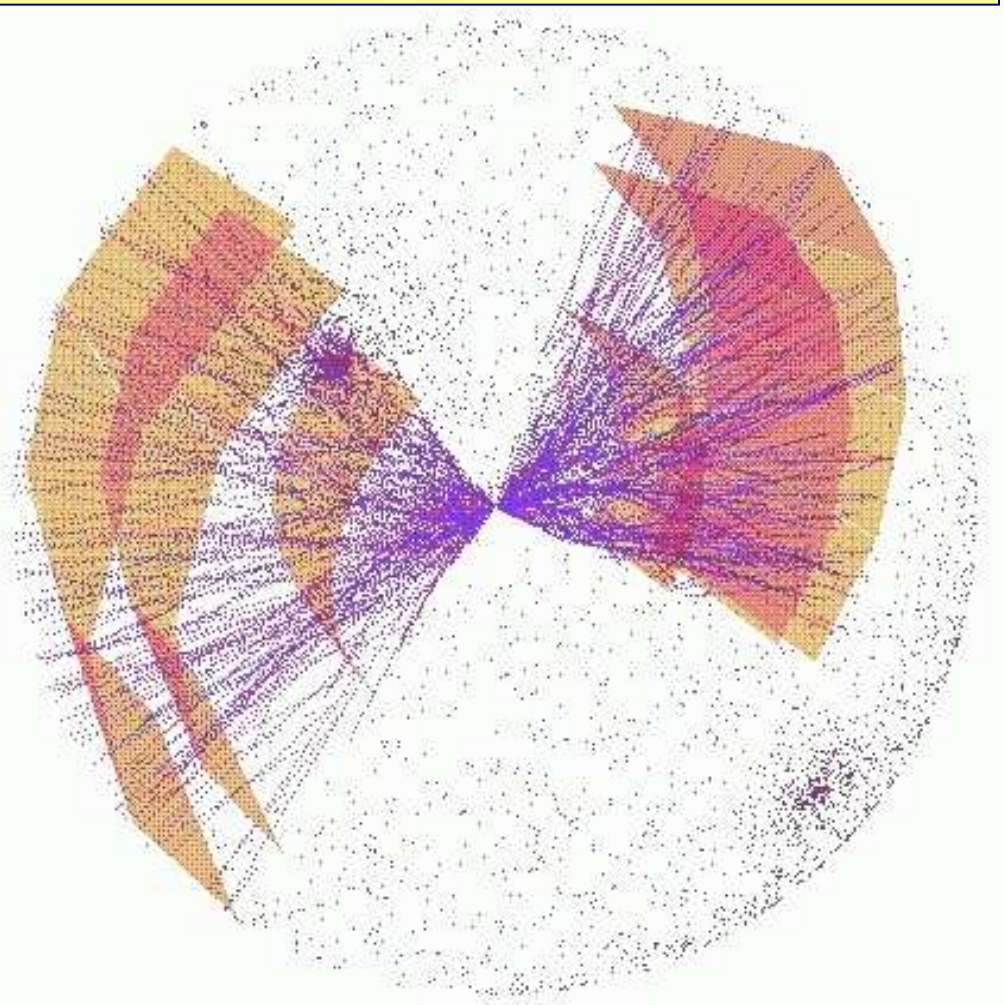
One central HIJING Au+Au event in the PHENIX central arms. Lines are accepted particle trajectories.



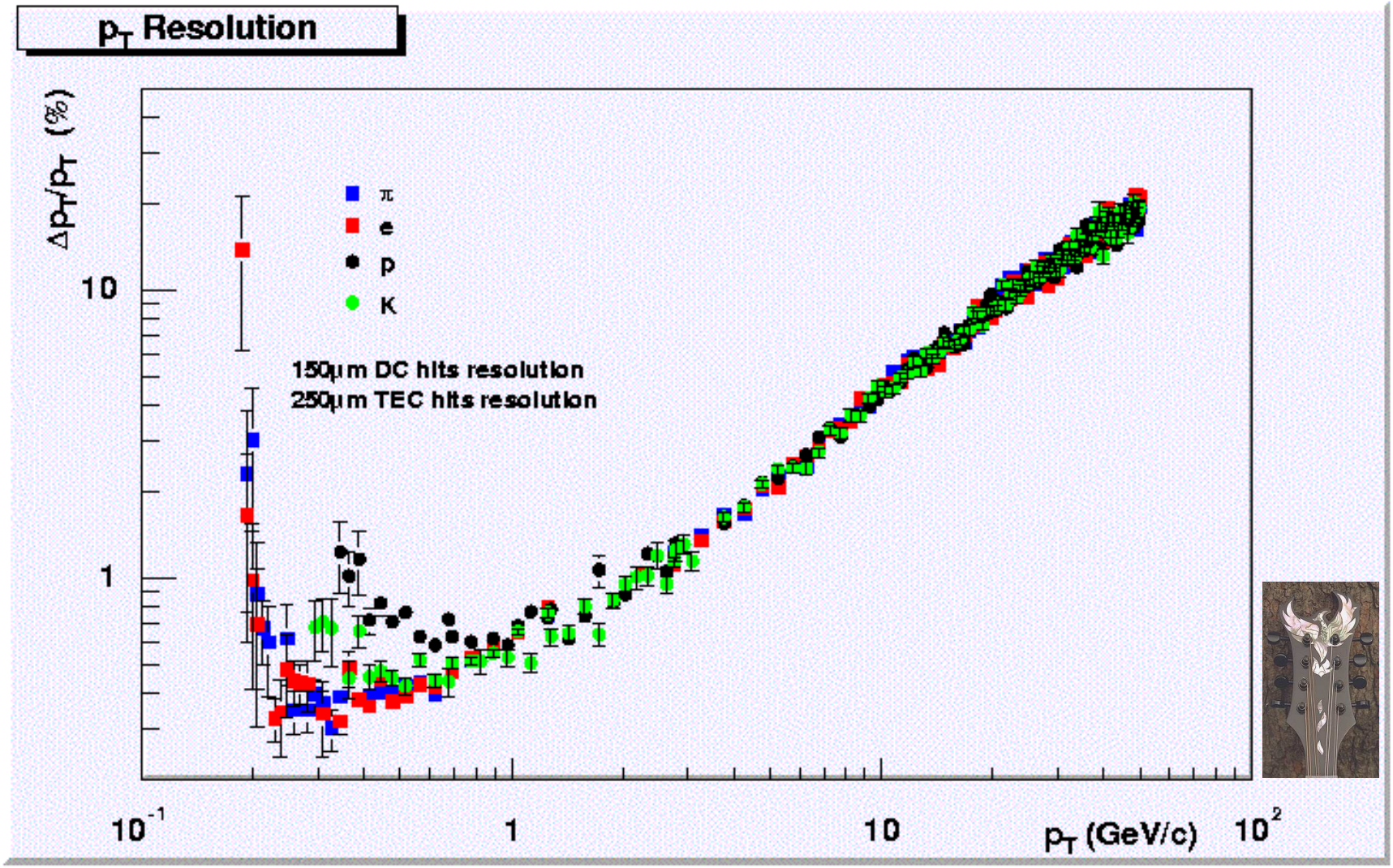
Rate is not a problem!

- ~400-600 charged particle tracks per event
- ~100 central events per second
- ~5 kaons per event

Rates...

Beams	Central?	Accepted Events per sec	$2\pi^+$ pairs (M per day)	$2K^+$ pairs (per day)	Vector res. (per day)
p-p	MB	7177	0.276	30	413
O-O	MB	3867	3.82	413	1127
Si-Si	MB	2597	8.79	950	1401
Cu-Cu	MB	1280	25.8	2787	1685
I-I	MB	641	60.3	6519	1823
Au-Au	MB	406	101	10859	1873
p-p	Cn	2479	9.55	1031	1426
O-O	Cn	1371	23.5	2541	1665
Si-Si	Cn	796	46.8	5053	1789
Cu-Cu	Cn	344	120	13003	1887
I-I	Cn	162	266	28699	1926
Au-Au	Cn	101	434	46836	1939
p-O	MB	6699	0.462	50	516
p-Si	MB	6480	0.569	62	563
p-Cu	MB	6116	0.783	85	642
p-I	MB	5756	1.05	113	719
p-Au	MB	5511	1.26	136	772
Si-Cu	MB	1161	29.3	3168	1711
Si-I	MB	1003	35.3	3813	1745
Si-Au	MB	925	39.0	4216	1761

Kaon Measurements: Transverse Momentum Resolution



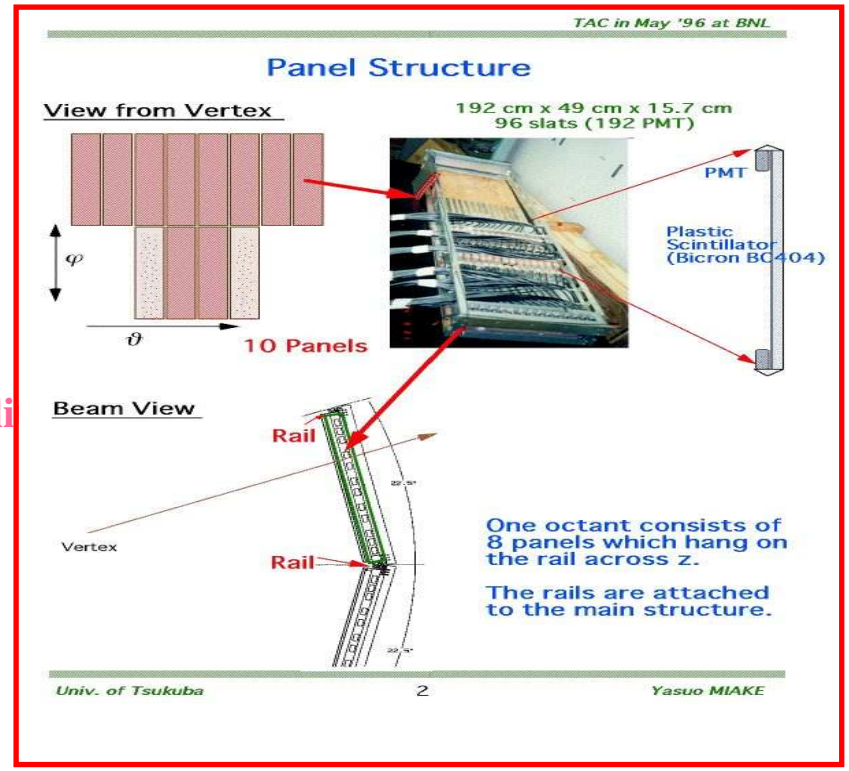
- **Excellent PID for hadrons**
  - **Measure time difference between Beam-Beam (START) counters and "TOF" wall or EmCal elements.**
  - Beam-Beam Counters:
    - **2 x 64 Cerenkov radiators + PMT's**

      σ ~ 50 ps
  - Time-of-Flight (TOF) wall:
    - **~ 2000 PMT's reading out ~1000 "slats"**

      σ ~ 80 ps
  - Electromagnetic Calorimeter:
    - **Both PbSc and PbGl have timing capabili (greatly extends coverage)**

      σ(PbSc) ~ 300 ps *(or better for hadrons)*

      σ(PbGl) ~ 400 ps



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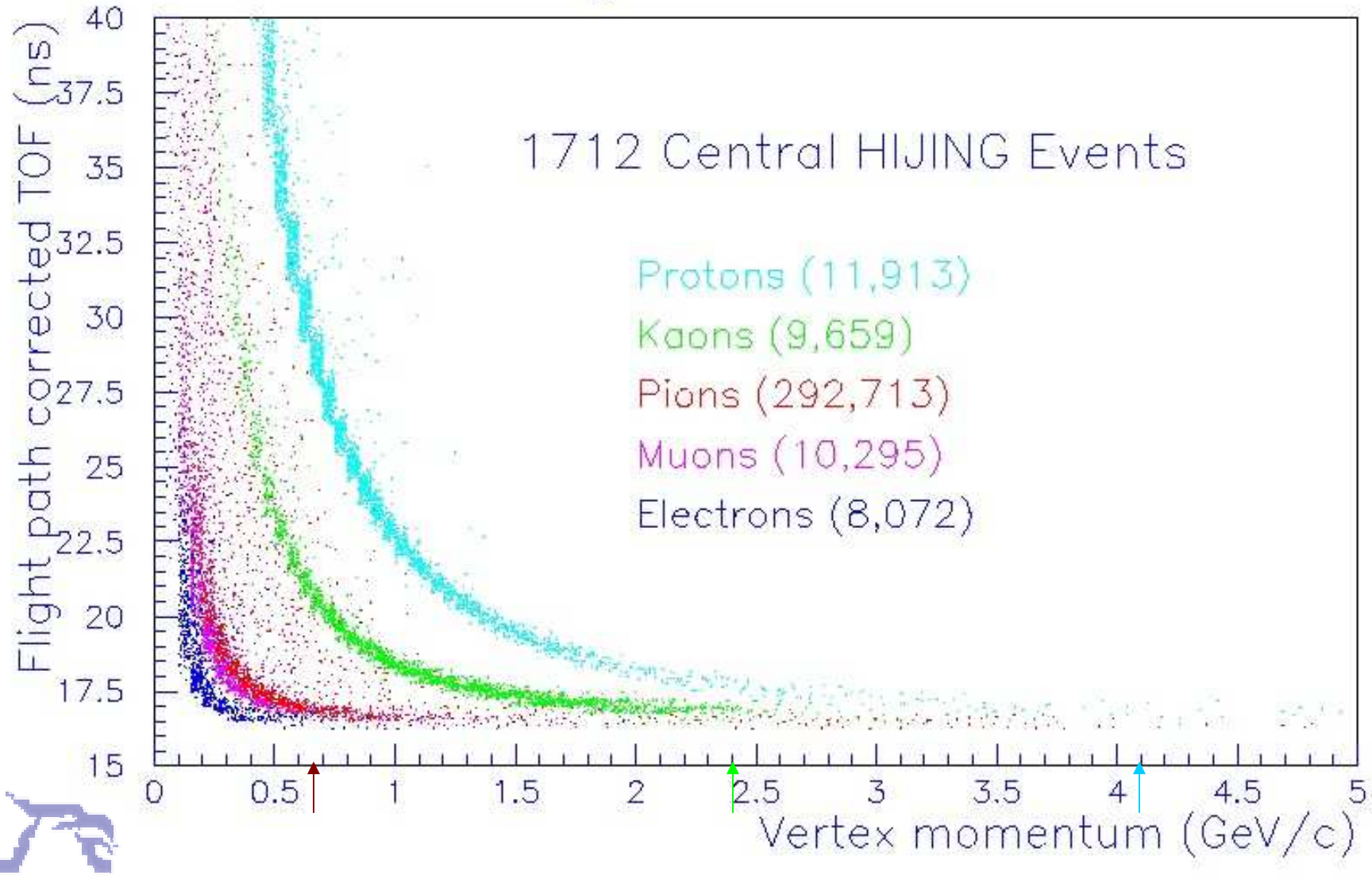
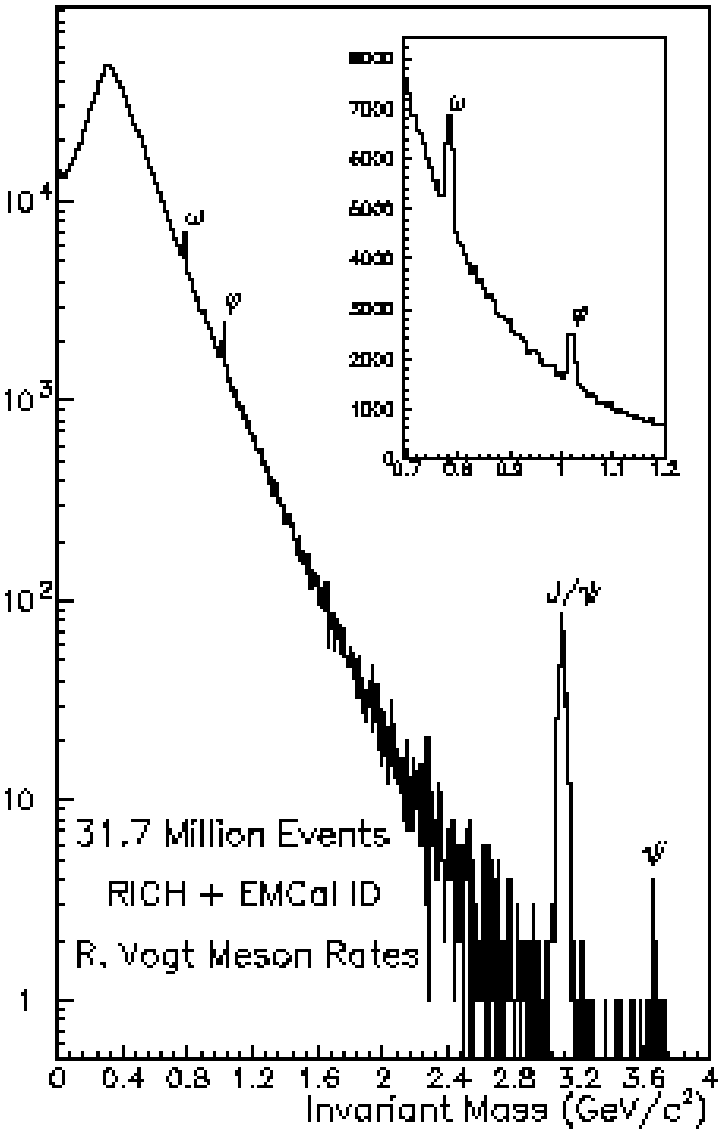
Particle ID Using TOF in PHENIX Central Arms



$\phi \rightarrow e^+ e^-$

- Again, rate is not the major problem.
- This plot represents:
  - ~10 weeks at 1% design luminosity
  - ~1 week at 10% design luminosity
  - ~1 week at 100% design luminosity (without a trigger)
  - ~1 week at 10 x design luminosity (without a trigger)



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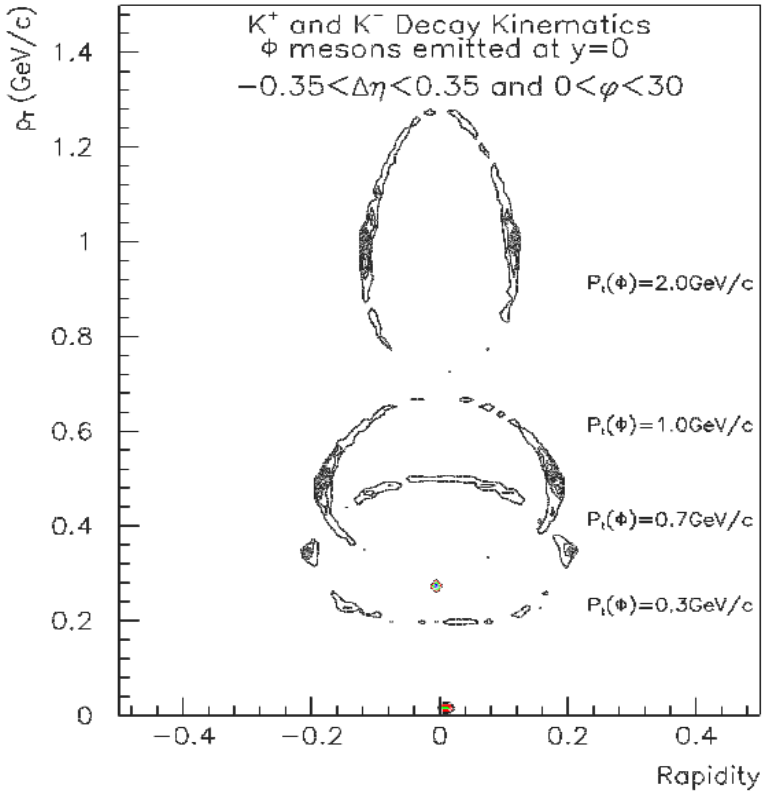
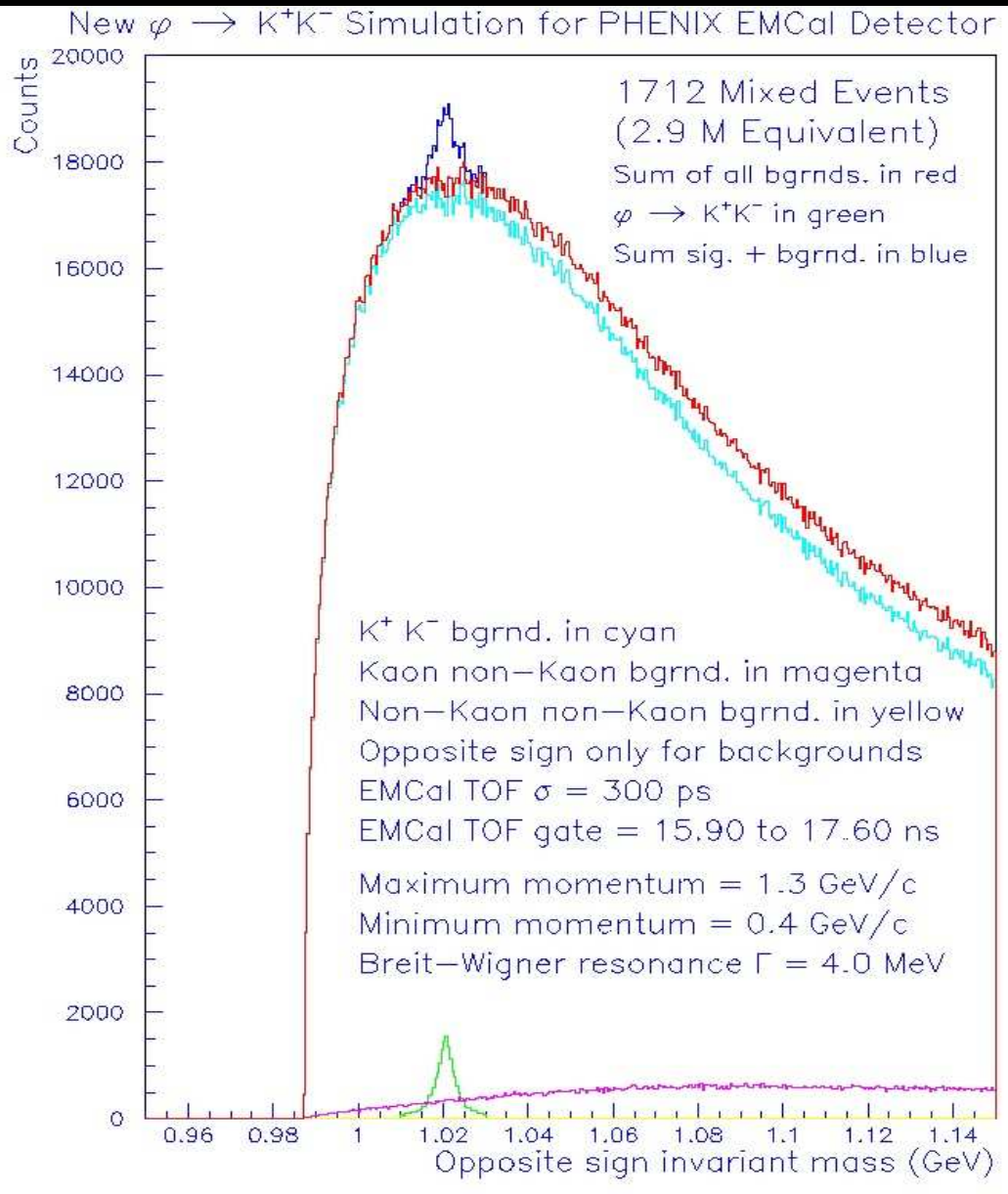
$\phi \rightarrow K^+ K^-$

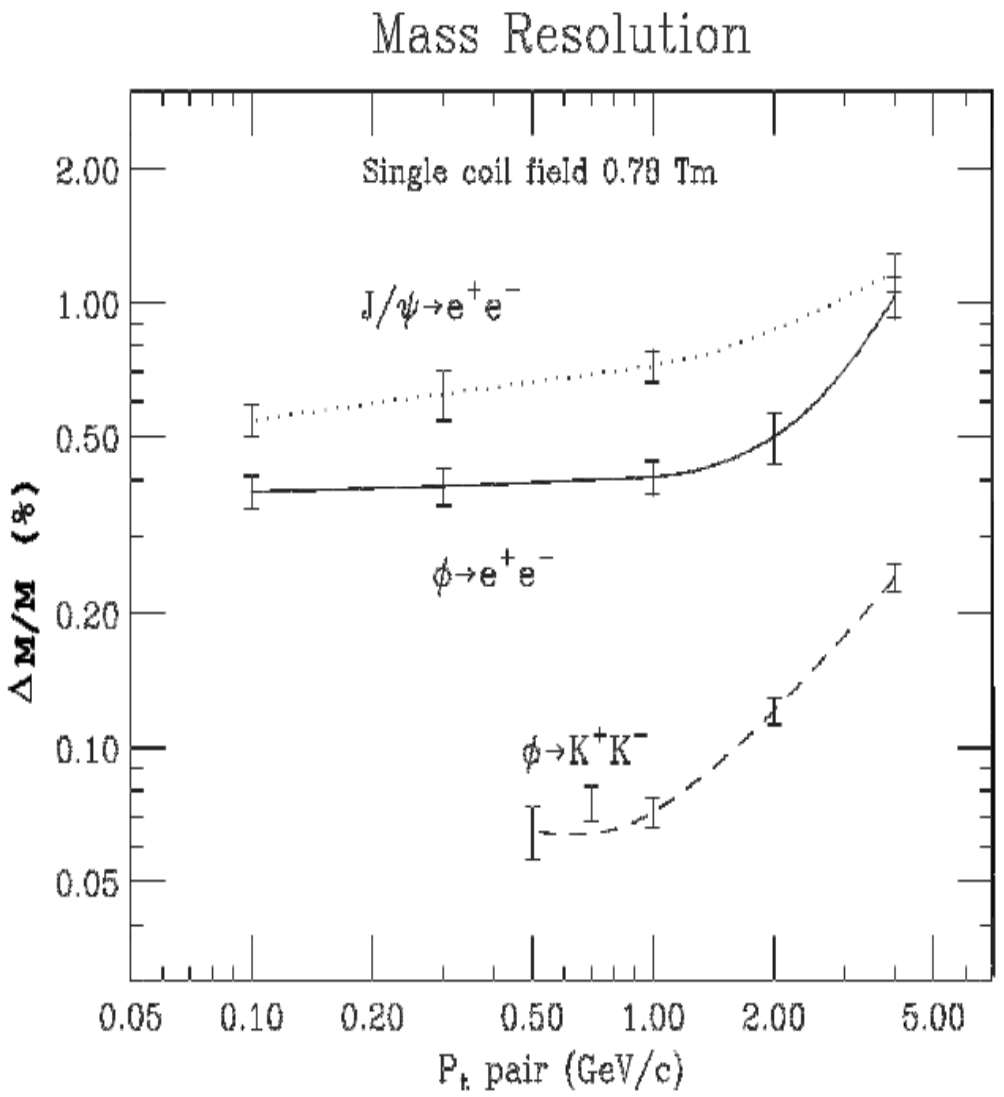
Invariant mass analysis from simulation



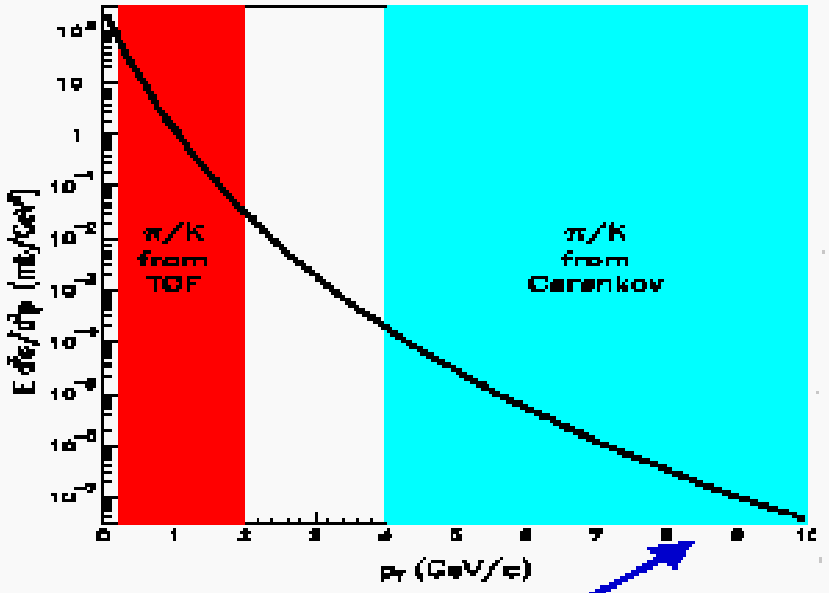


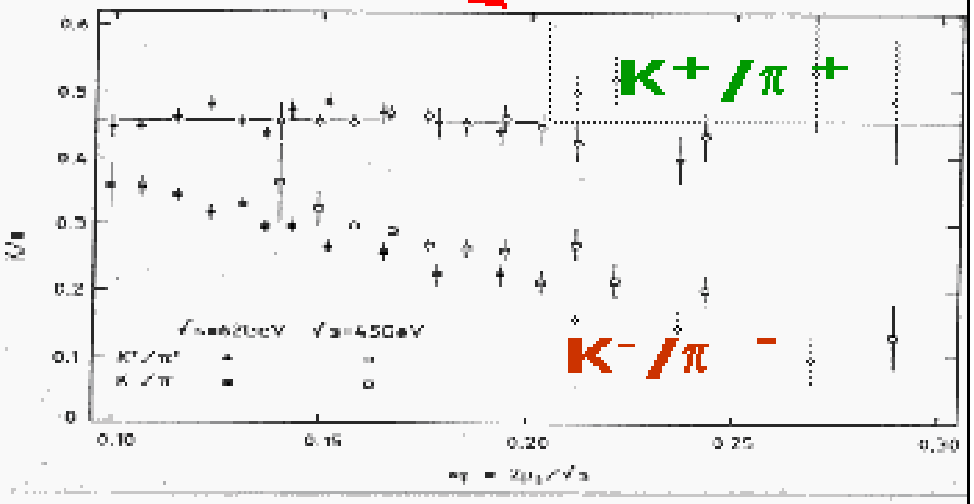
Φ Measurements in PHENIX

- PHENIX can measure ϕ decay in "all" channels:
  - K^+K^-
  - e^+e^-
  - $\mu^+\mu^-$
  - *In-medium effects could alter branching ratios (Lissauer and Shuryak)*
- We will take about one E859 measurement / day



- "High p_T $K^{\pm}$ / $\pi^{\pm}$ Production in p-p Collisions at the ISR: Strangeness Suppression and Gluon Effects", A. Breakstone *et al., Phys. Lett.* B135, 512 (1984).





- PHENIX has good PID capabilities for K^- :
- Perhaps takes on additional significance in a medium which ***enhances*** strangeness...

Conclusions

As PHENIX rises, so do the peaks...

- PHENIX will provide high rate measurements of kaon spectra starting when RHIC becomes operational.
- PHENIX will provide accurate measurements of phi mesons starting next calendar year.
- Stay tuned for exciting results rising soon!