Charm Research in Heavy Ion Experiment

For the HIM_SRC (Center for Quark Matter)

Pusan National Univeristy
HIPEx Lab.
In-Kwon YOO

Research Strategy

1. Computing Infrastructure
2. Warming up
   - Λ^*/K^* at SPS
3. Charm Production at RHIC
   - $D \rightarrow K^-\pi^+$
   - $\Lambda_C \rightarrow pK^-\pi^+$
4. Charm Production at LHC

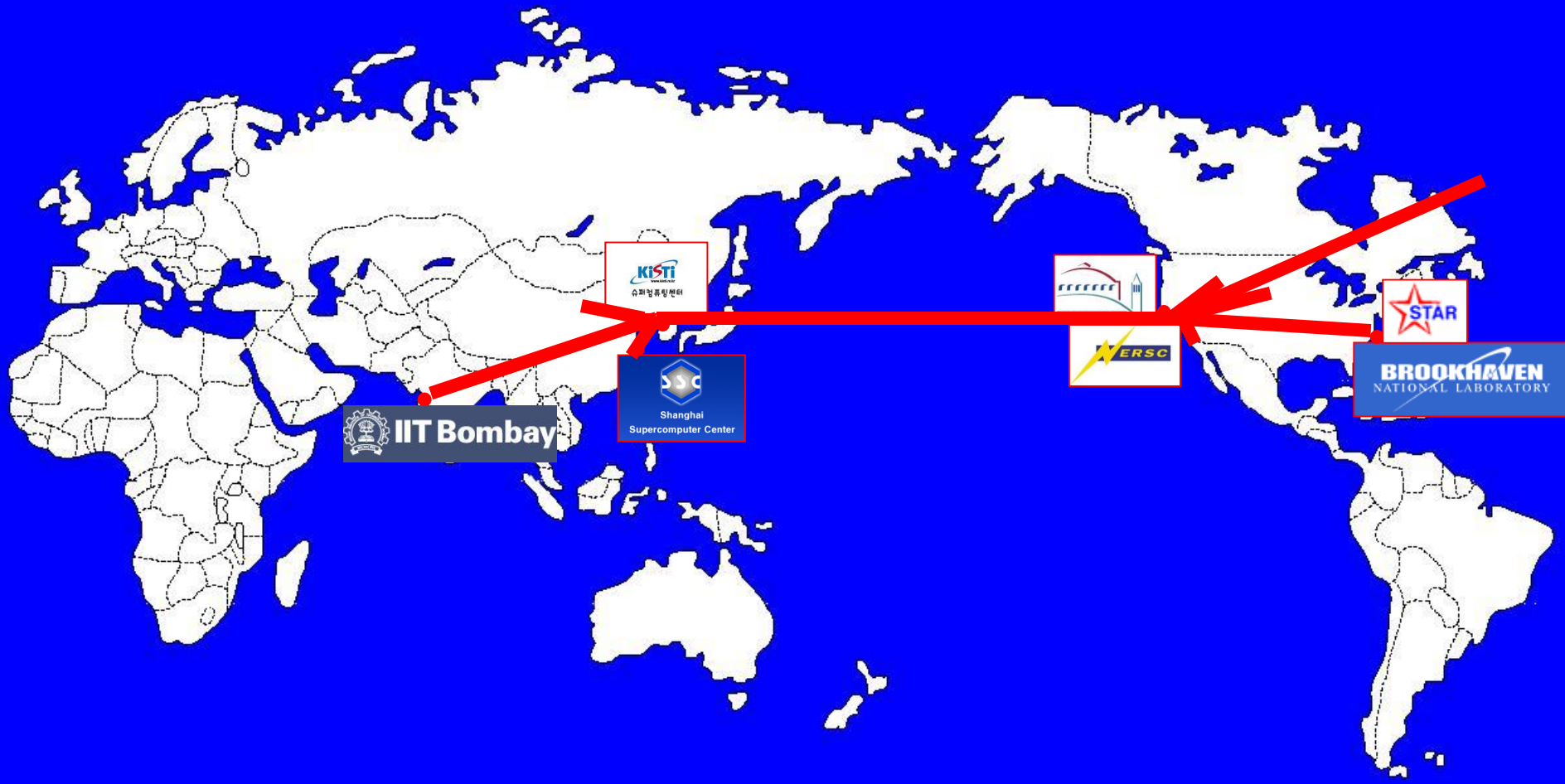
Star Asian Computing Center

- Computing Infrastructure with massive data from STAR
  - Frontier Research
  - Maximum Use of IT resources in Korea
    - Data Transfer
    - Cluster Computing with Supercomputer
    - Mass Storage
- Korean Institute for Science and Technology Informations (KISTI @ Daejoen)
  - Korean HUB for GLORIAD + KREONET
  - Super Computing Resources
  - Mass Storage Management

→ Asian Supercomputing HUB :

- BNL – NERSC – KISTI – SSC etc.

STAR Computing



Cluster system

Dr. SDLee in KISTI

Item	Cluster system	
	Phase 1	Phase 2
Manufacturer & Model	SUN C48	SUN Fusion
Architecture	Cluster	
Processor	AMD Opteron 2GHz (Barcelona)	Intel Xeon 3.3GHz+ (Gainestown)
Operating System	Cent OS	Cent OS
Nodes	188	2,688
CPU cores	3,008 (16/node)	21,504 (8/node)
Rpeak	24TFlops	286TFlops
Memory	6TB	64.5TB
Disk storage	207TB	1PB
Tape storage	422TB	2PB
Interconnection network	Infiniband 4X DDR	Infiniband 4X DDR
Cooling	Chilled water cooling	Chilled water cooling
Delivery date	Jan, 2008	2Q, 2009

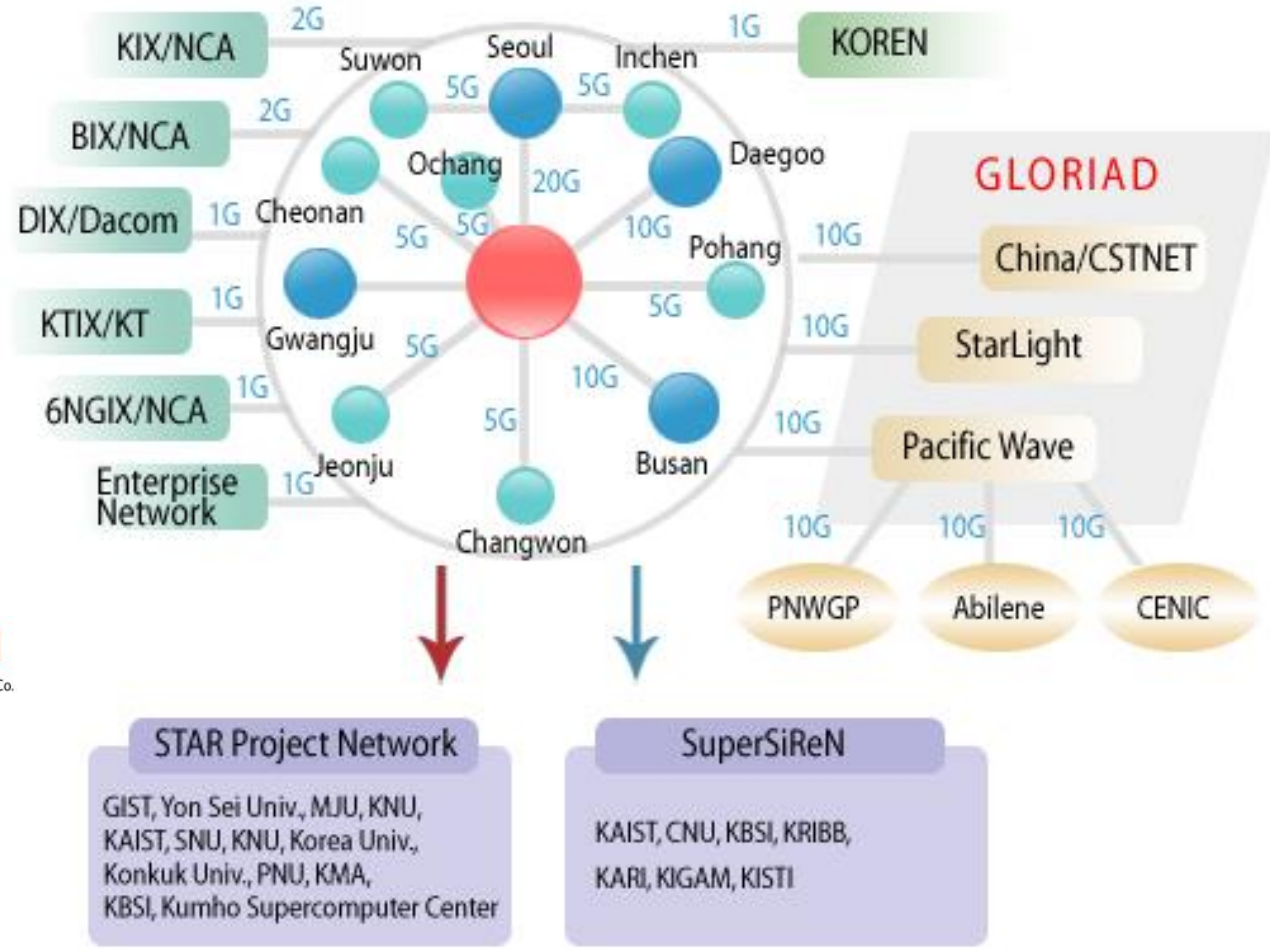
✹ Phase 2 system(286TFlops) includes 24TFlops for phase 1 system replacement

SMP system

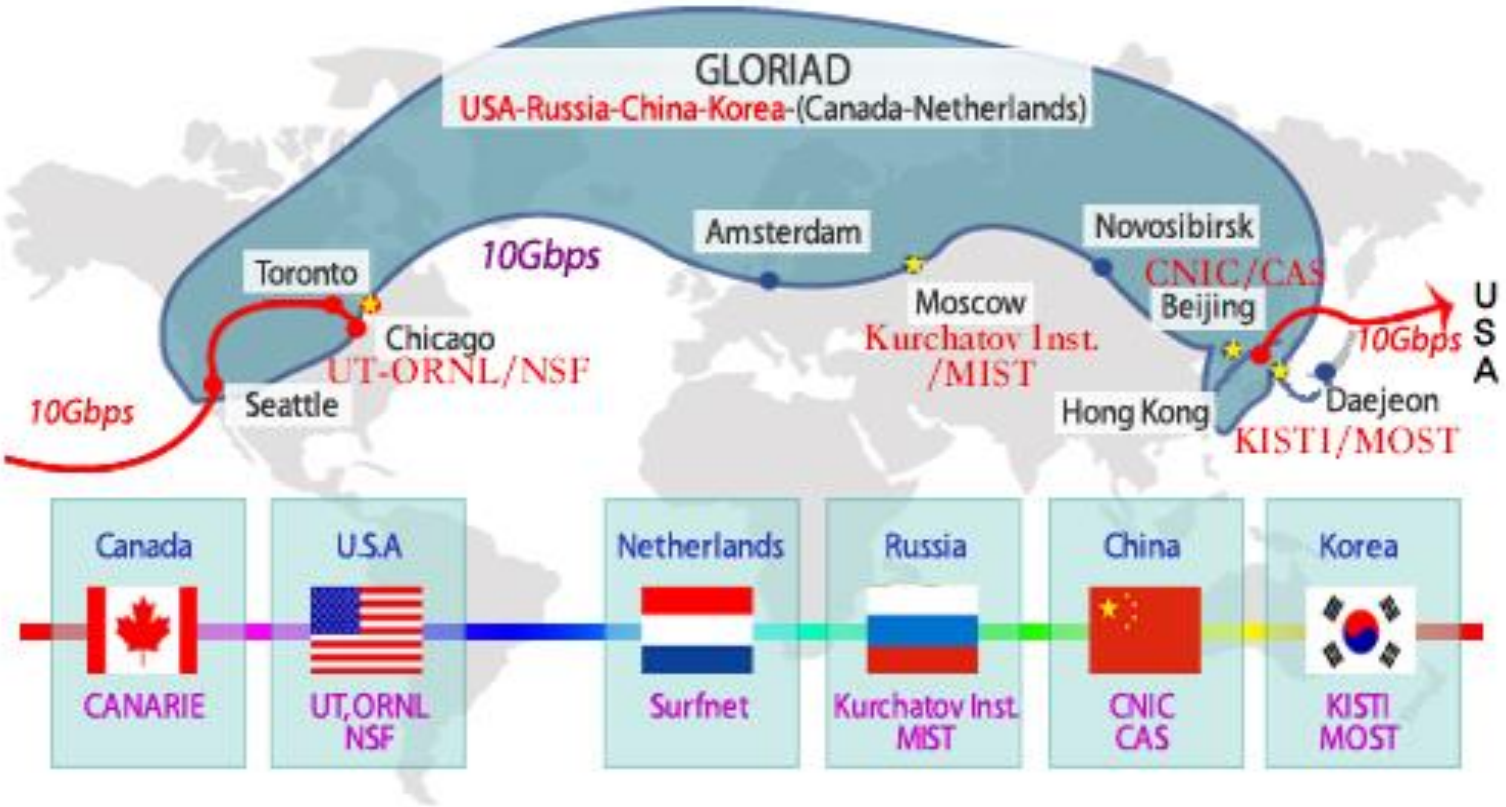
Item	SMP system	
	Phase 1	Phase 2
Manufacturer & Model	IBM p595	IBM p6H
Architecture	SMP	
Processor	POWER5+ 2.3GHz	POWER6 5GHz+
Operating system	AIX 5.3	AIX 5.3+
Nodes	10	24
CPU cores	640 (64/node)	1,536 (64/node)
Rpeak	5.9TFlops	30.7TFlops
Memory	2.6TB	9.2TB
Disk storage	63TB	273TB
Tape storage	-	
Interconnection network	HPS	Infiniband 4X DDR
Cooling	Air-cooling	Air-cooling
Delivery date	Sept, 2007	1Q, 2009

Research Networks

- KREONET



GLORIAD


GLORIAD
USA-Russia-China-Korea-(Canada-Netherlands)
Toronto
10Gbps
Amsterdam
Novosibirsk
CNIC/CAS
Moscow
Kurchatov Inst.
/MIST
Beijing
10Gbps
USA
Chicago
UT-ORNL/NSF
10Gbps
Seattle
Hong Kong
Daejeon
KIST1/MOST
Canada
U.S.A
Netherlands
Russia
China
Korea
CANARIE
UT,ORNL
NSF
Surfnet
Kurchatov Inst.
MIST
CNIC
CAS
KISTI
MOST

What-to-Do List at KISTI-PNU in 2008

- STAR Software Infrastructure (SofI)
- Data Location Tools
  - Resource Monitoring Tools
  - Web Sanity, Documentation Tools
  - HPSS Tools & Services
- Data Transfer (20~50TB) from NERSC/BNL to KISTI
- Data Locating and Service Setup (Data Carousel)
- Root4STAR/ STARSim Setup/Configuration
- Computing
  - Code Optimization
  - Parallel Computing

SACC Working Group

- PNU
  - IKYoo / JHKim (PhD st.) / KEChoi (MA st.)

- BNL (STAR)
  - Jlauret : STAR S&C Leader / JDunlop : STAR Deputy

- LBNL (PDSF)
  - NXu : STAR Spokesperson, MoUs

- SSC (Tsinghua Univ.)
  - ZXiao : KR-CN Funding Agency

Plan of STAR Collaboration at KISTI

- **KISTI Resources Plans for STAR**

Items		2008	2009	2010	2011
KISTI's SUN Cluster System		4th Superom 1st phase AMD Opteron 2GHz (Barcelona)		4th Supercom 2nd phase system Intel Xeon 3.3GHz+ (Gainestown)	
KISTI Resources Plans for STAR					
minimum #of CPUs		32~150	150~250	about 500	about 700
Storage	Disk(TB)	20	100	200	500
	Tape(TB)	50	200	500	1000
Network	GLORIAD	~10G		~20G	

- **KISTI Manpower for STAR**

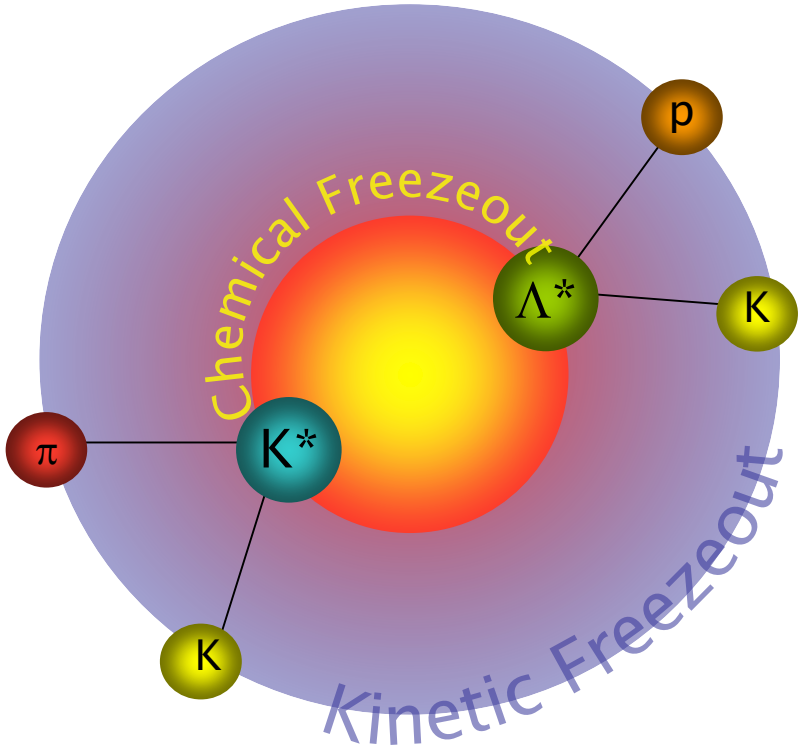
Network Specialist Dr. Dong Kyun KIM, Computer Scientist

System Engineer Mr. Jun WOO, Computer Engineering (Master Degree)

Storage Manager Mr. Kelvin CHOI, Computer Science (Master Degree)

Physics Research Dr. Hyun Woo KIM, Physicist (Particle Physics)

Λ*/K* Motivation

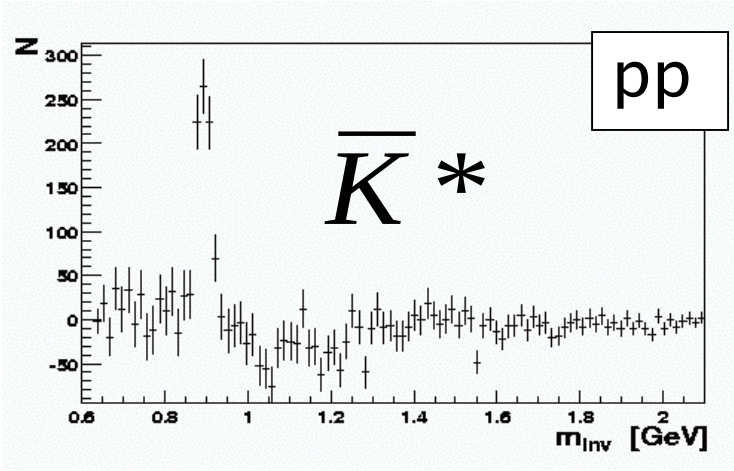


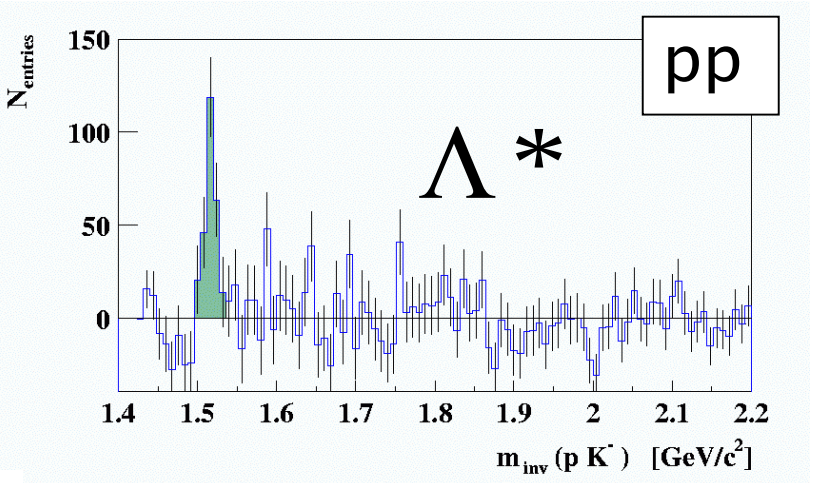
- How many K*, Λ* at chemical freeze-out?
- How long do they live?
- How many are their daughter absorbed in medium?

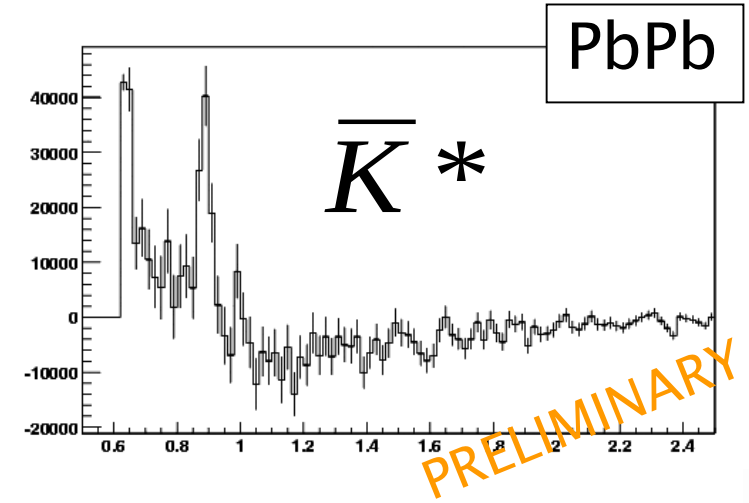
Resonance	K(892)	Λ(1520)
Decay channel	K + π	p + K
Width [MeV]	50.8	15.6
Life time [fm/c]	3.9	13

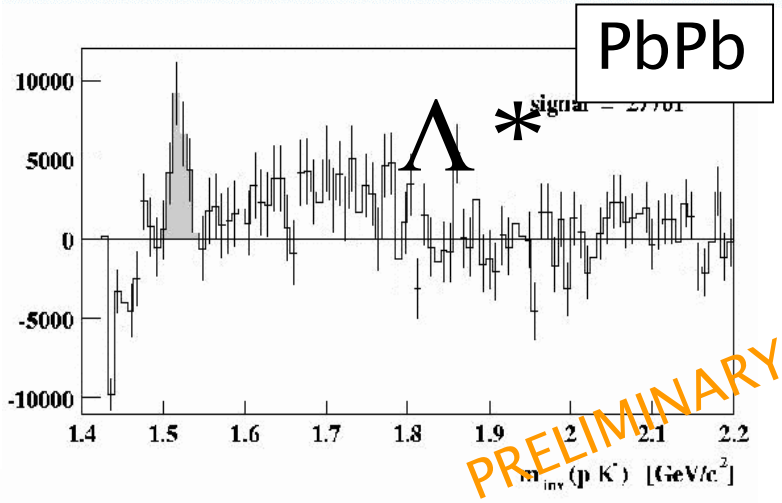
Comparison of p+p, Pb+Pb @ 158 AGeV

Signal Reconstruction

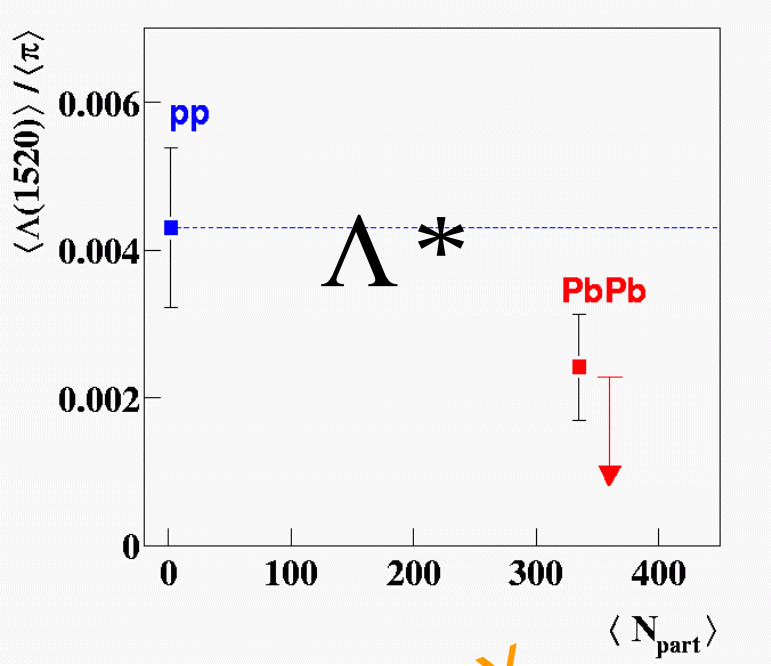




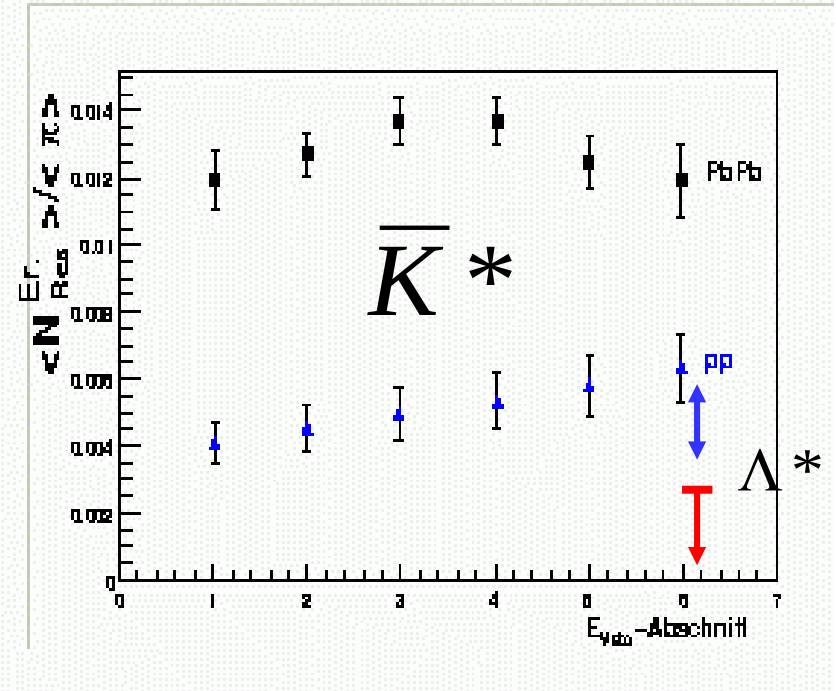




Results



PRELIMINARY



peripheral ⟷ central

Discussion & Outlook

- Strangeness Enhancement vs. Suppression
- Suppressed Λ^* ➔
  Medium Effect ? (excited) Baryon Effect ?
- Lifetime ($\Delta\tau$) betw. chemical and kinetic freezeout $>$ 4fm/c (K* lifetime) ?
  (UrQMD ➔ $\Delta\tau$ ~ 5fm/c !)

- Consistency check
- System Size dependency check for Λ^*

- http://fermium.phys.pusan.ac.kr/HeavyIon/CERN/NA49/na49@KISTI/Lambda1520KISTI.htm

Secondary Vertex Resolution Study at STAR

< Motivation >

(1) Secondary Vertex Resolution shows Position Resolution of our Detector

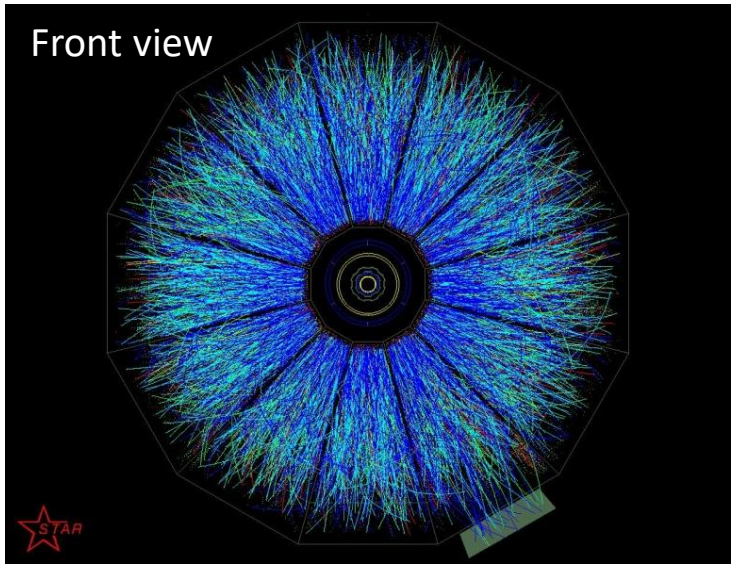
(2) Secondary Vertex Resolution information can be used as a cut which has short decay length like D-meson(123.0)

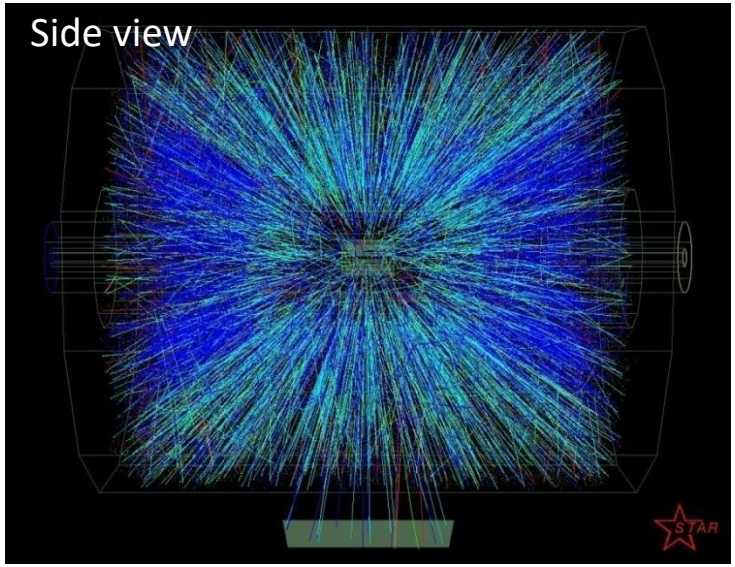
< How ? >

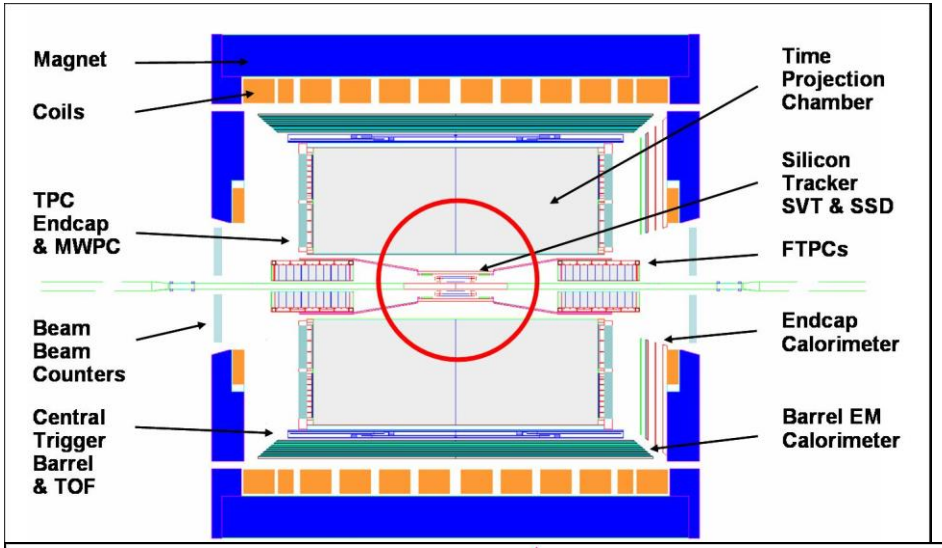
: We can reconstruct secondary vertices which from Conversion Gamma at our material budget and compare with real material budget

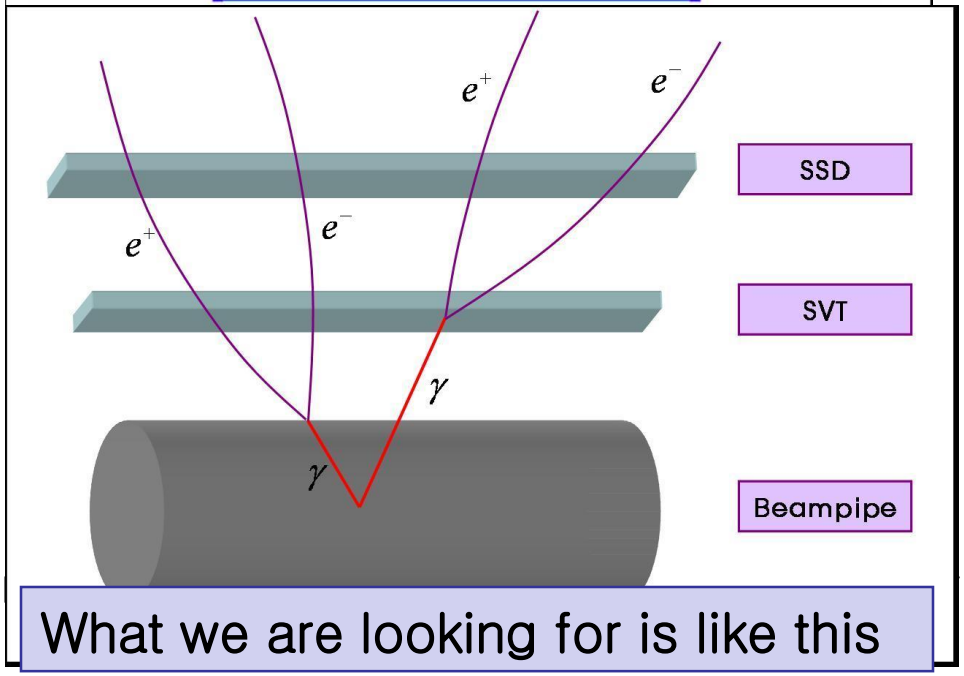
KEChoi in PNU

STAR Detector & Conversion Gamma





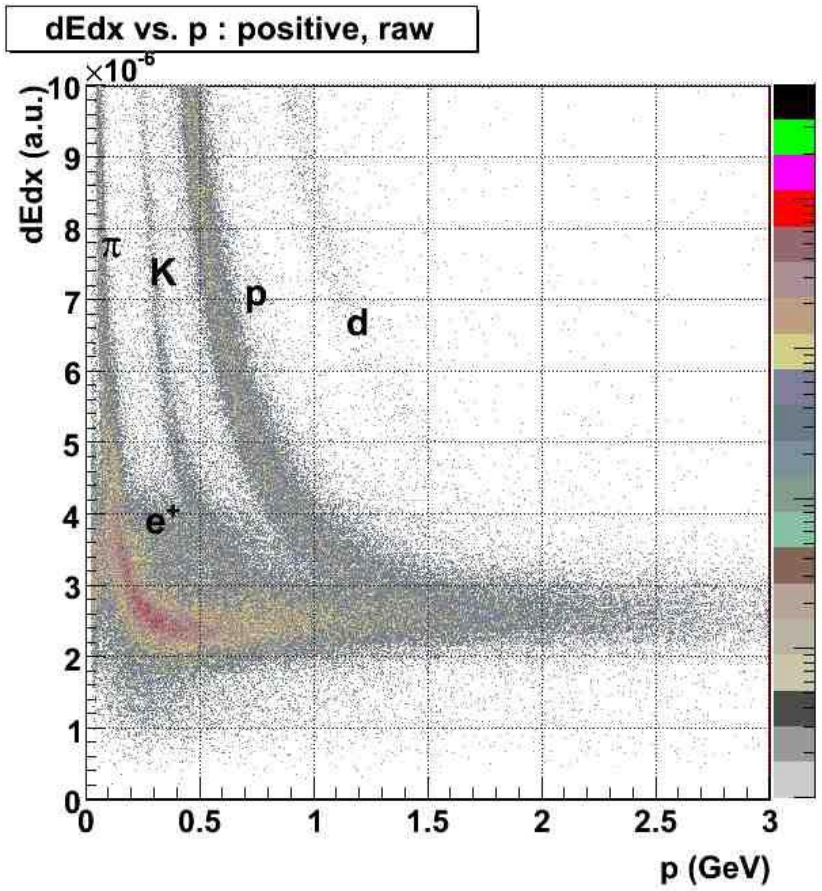




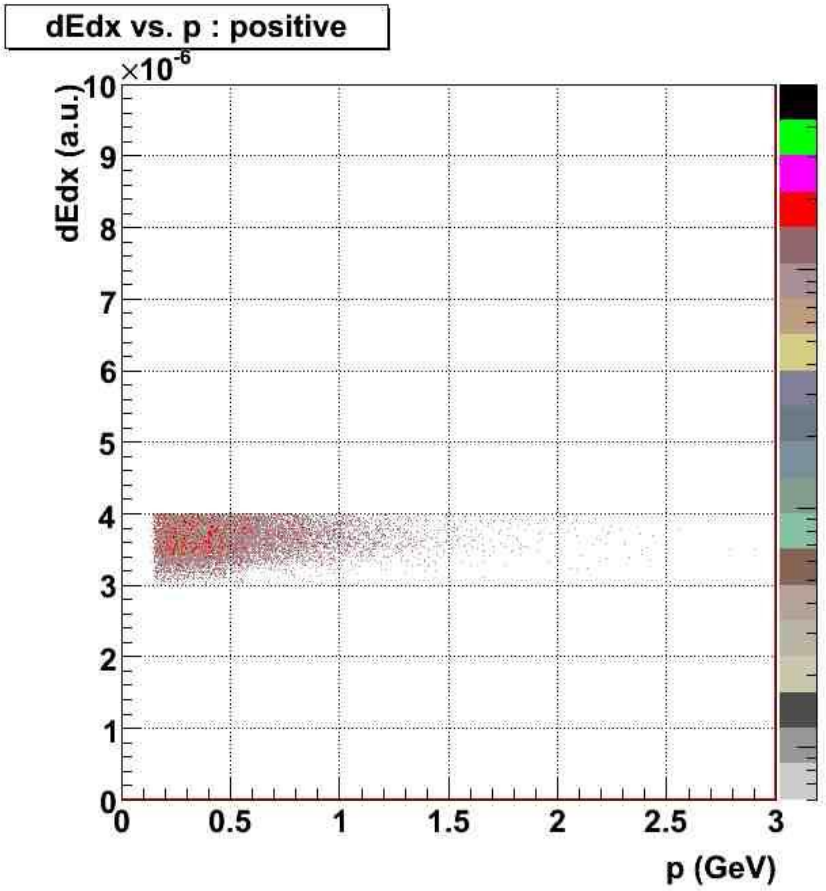
What we are looking for is like this

Dataset & Particle Identification

Dataset : CuCu@200GeV
Number of event : 30M events



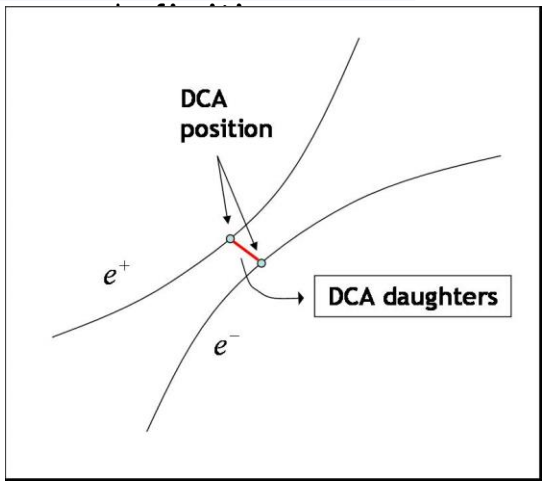
[All track]

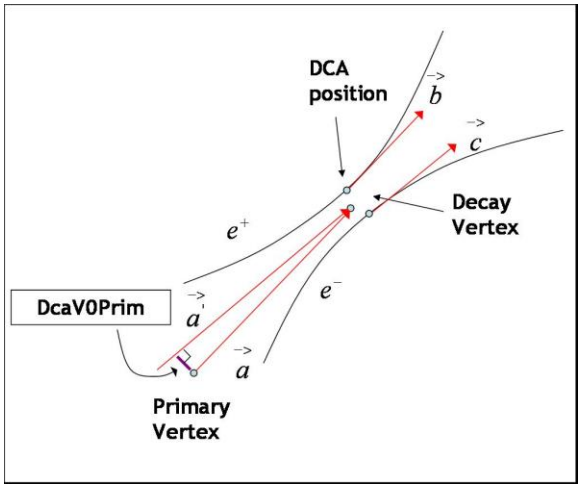


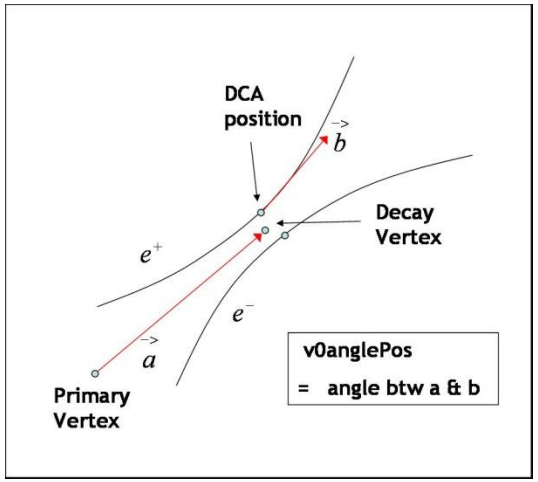
[Selected electron track]

Applied Cuts

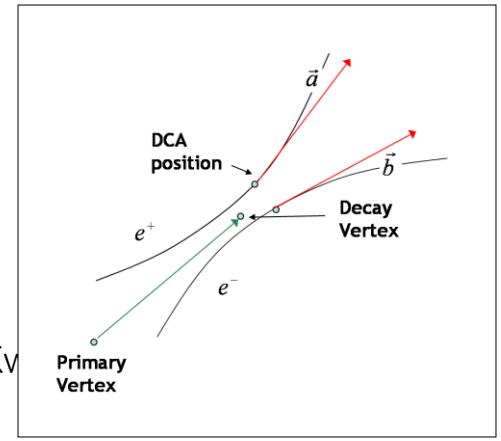
Part I. V0

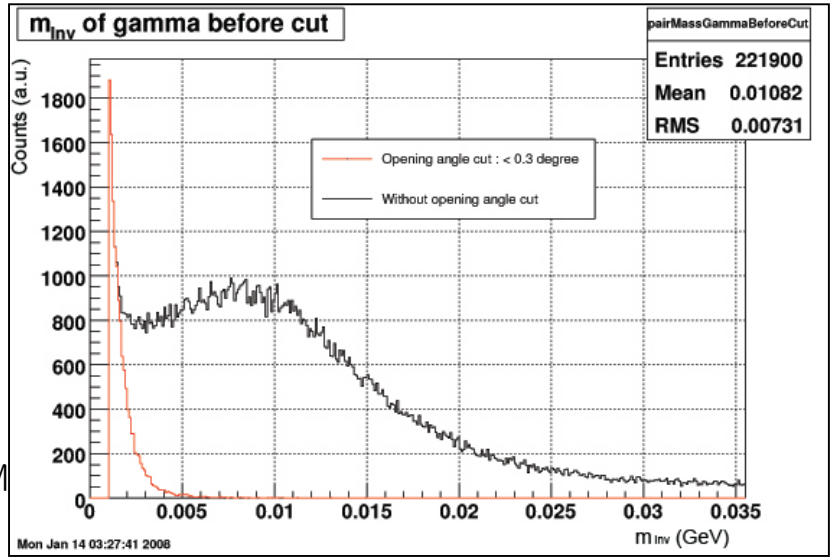




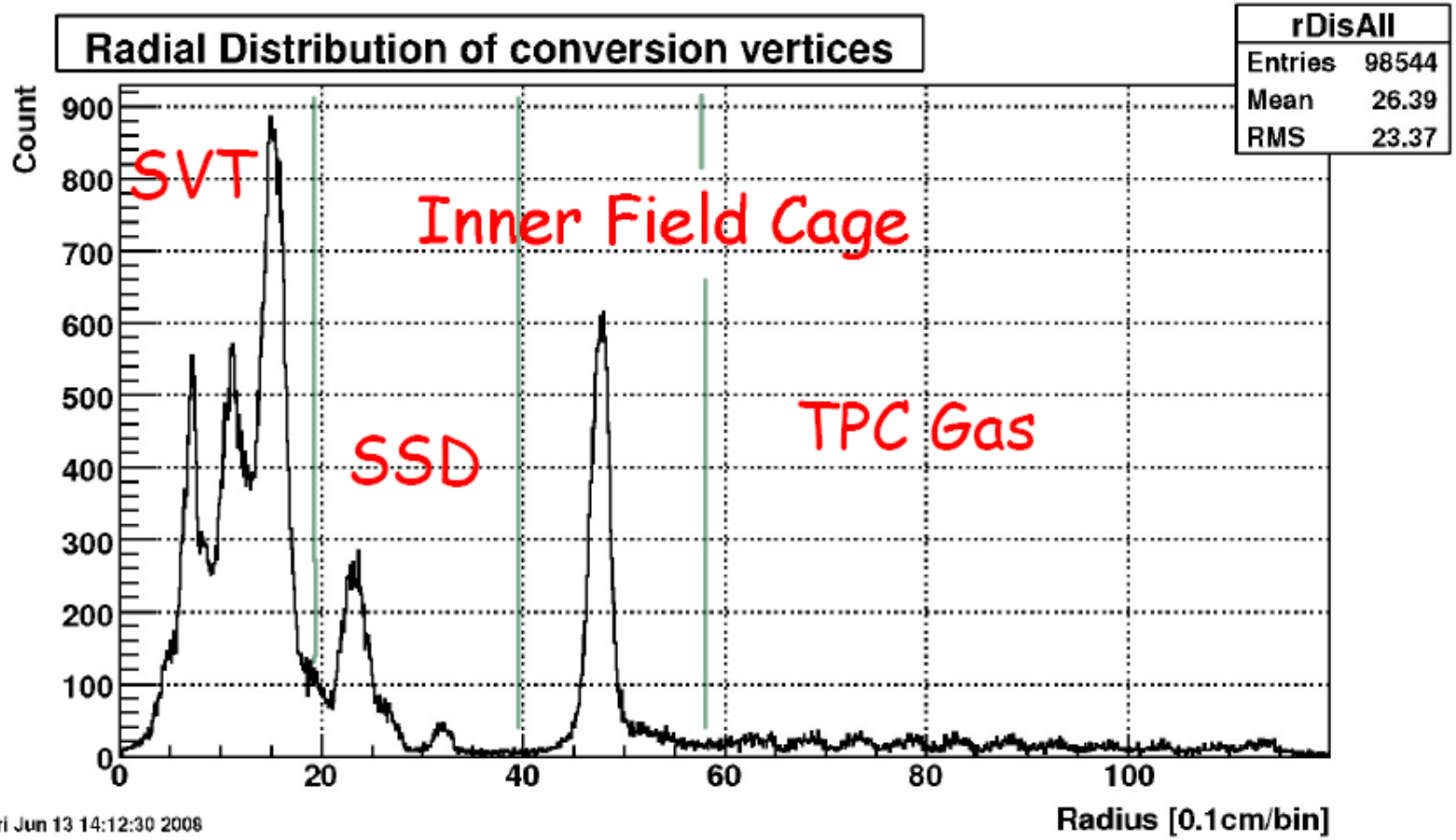


Part II. Opening Angle Cut :
Remove electrons from Dalitz decay





Radial distribution of conversion vertex

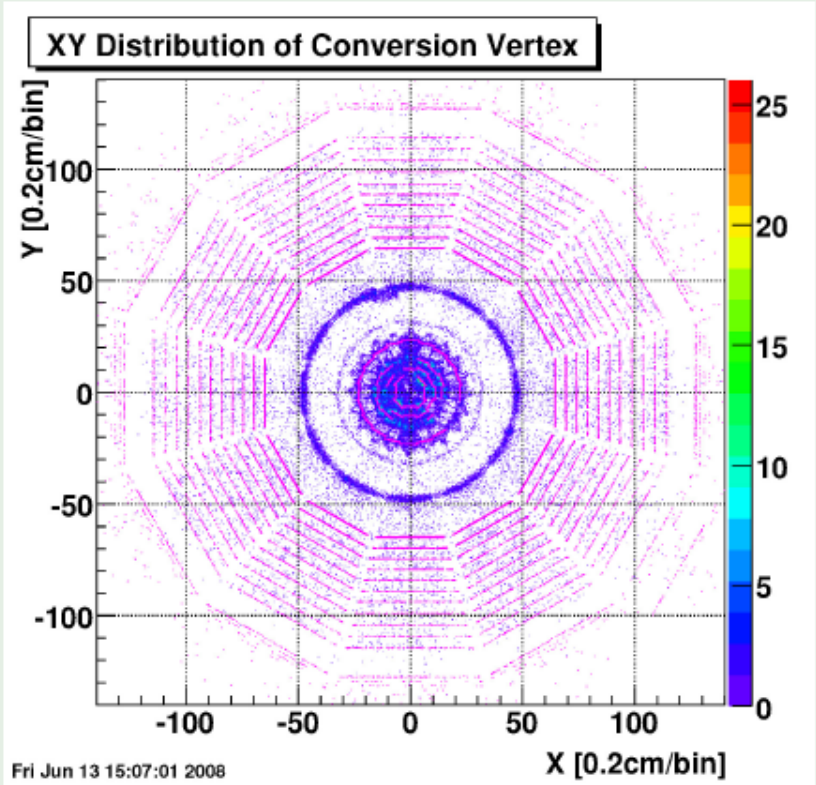


(1) Separation

- We can "clearly" distinguish Three SVT, One SSD and Inner Field Cage of TPC

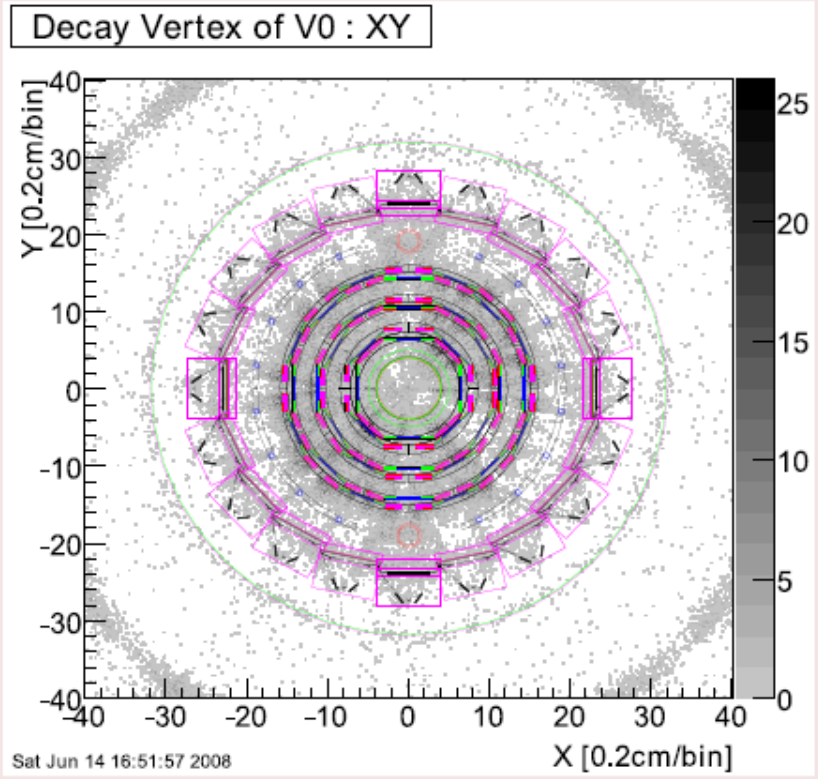
Transverse distribution of conversion vertex

Full Scale



- Purple : first hit of track

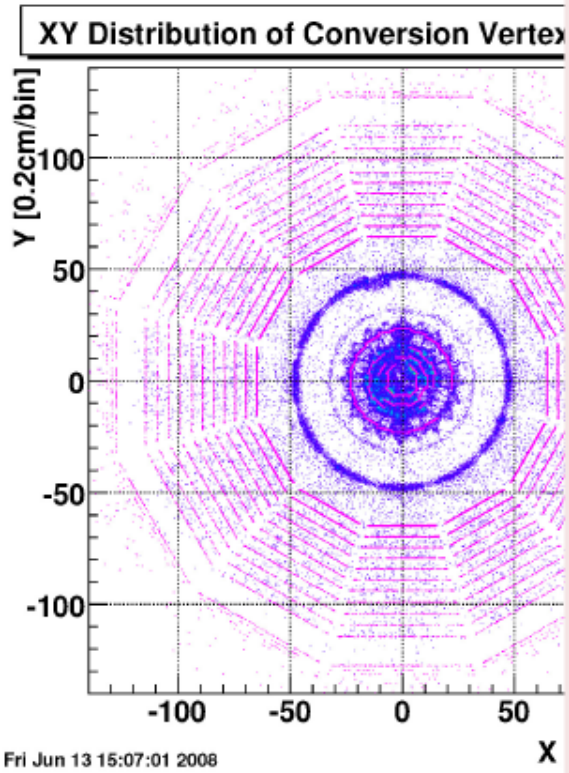
SVT + SSD



- Color : Material by GEANT

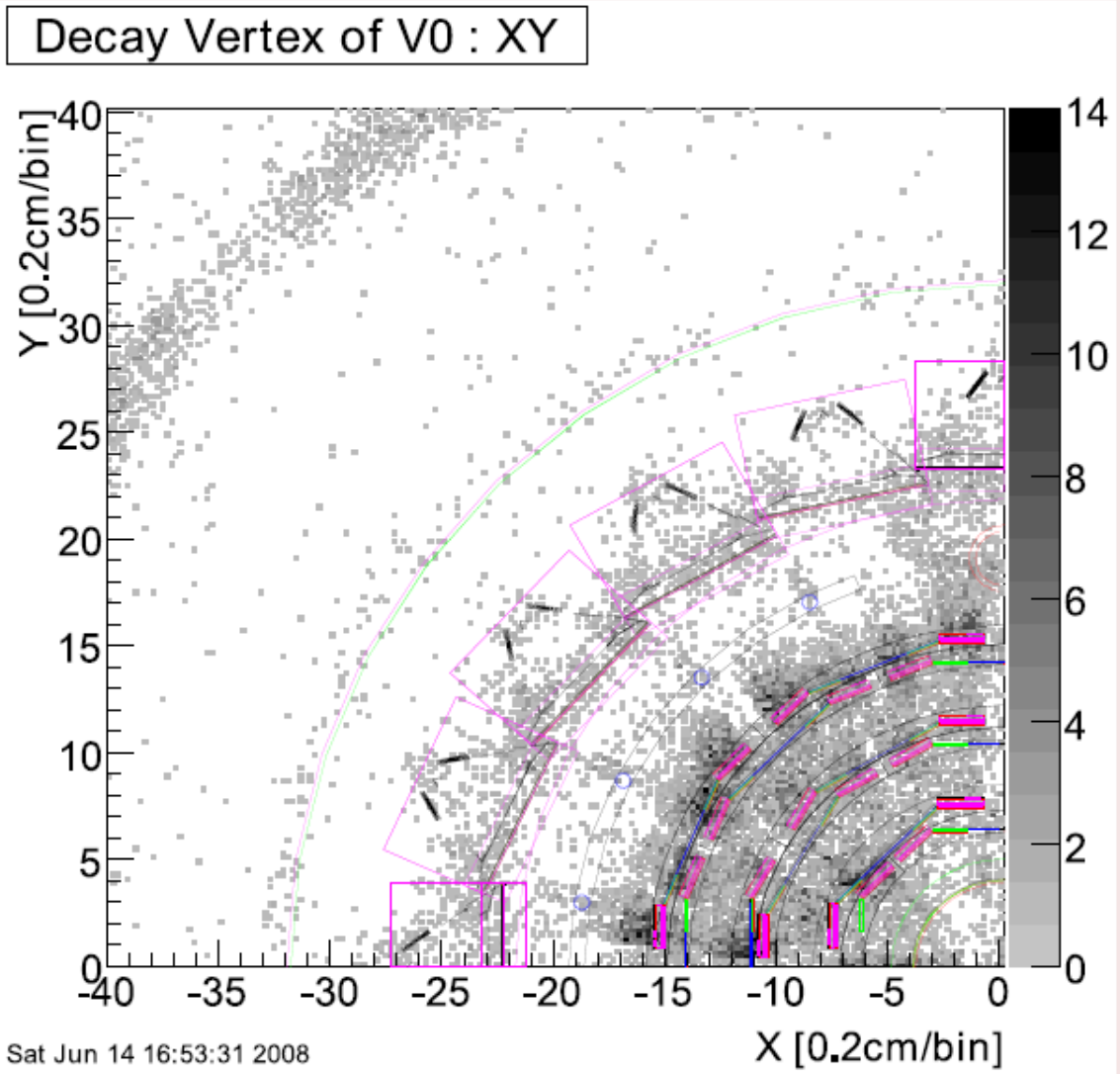
Transverse distribu

Full Scale



- Purple : first hit of t

Zoom



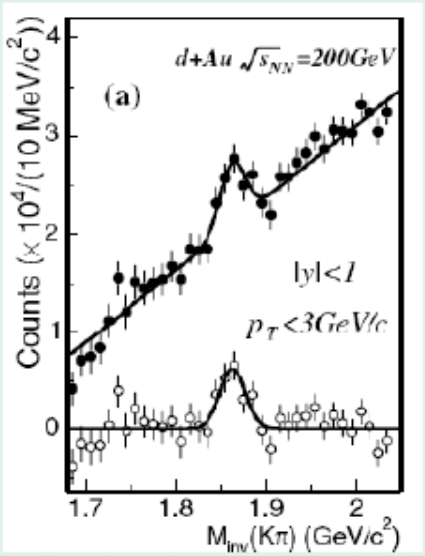
HIPEX interest : D^0 Analysis

D^0 from Kπ in dAu & AuAu

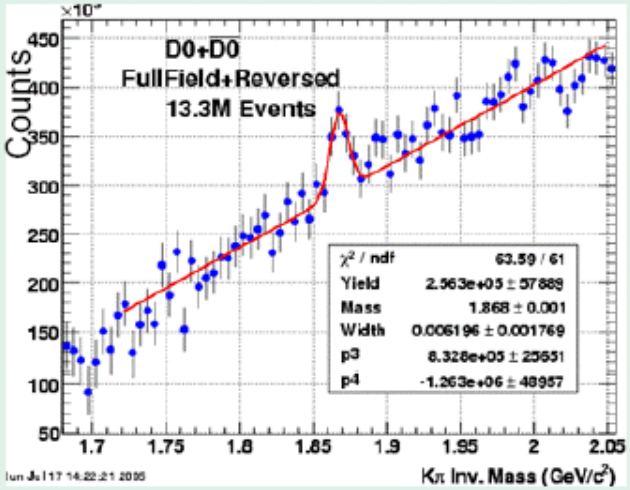
D^0 from Kπ in d+Au & Au+Au

D^0 measured via Kπ channel in Au+Au, d+Au.

p_t spectra obtained, yields measured.



D^0 Peak Reconstructed from Kπ in d+Au, STAR Collaboration, J. Adams *et al.*, Phys. Rev. Lett. 94, 062301 (2005).

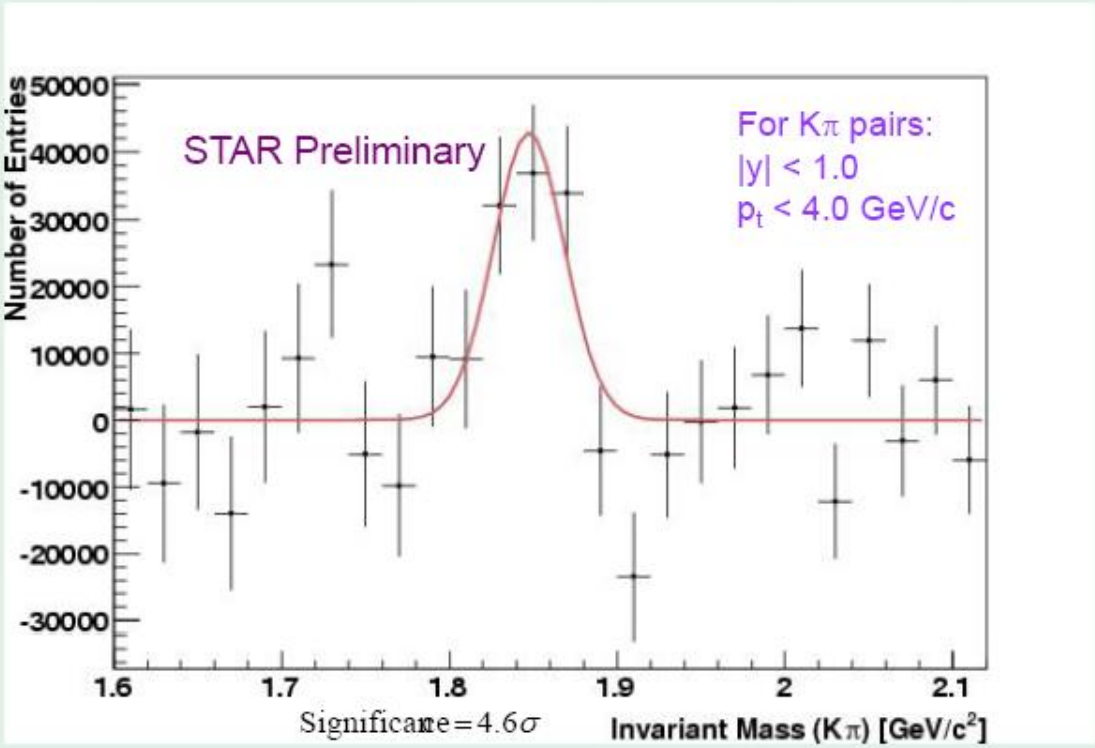


D^0 Peak Reconstructed from Kπ in Au+Au, STAR Preliminary

HIPEX interest : D^0 Analysis

D^0 from Kπ in CuCu by Stephen

$D^0 + \overline{D}^0$ in Minimum Bias Cu+Cu



$$\sigma = \frac{S}{\sqrt{S + (1 + \frac{1}{n_{rot.}})B}}$$

$D^0 \to K^-\pi^+, \overline{D}^0 \to K^+\pi^-,$

$B.R. = 3.80 \pm 0.07\%$

PDG mass $= 1.8645 \pm 0.0003$ GeV/c^2

June 16, 2008

6

HIPEX interest : D^0 Analysis

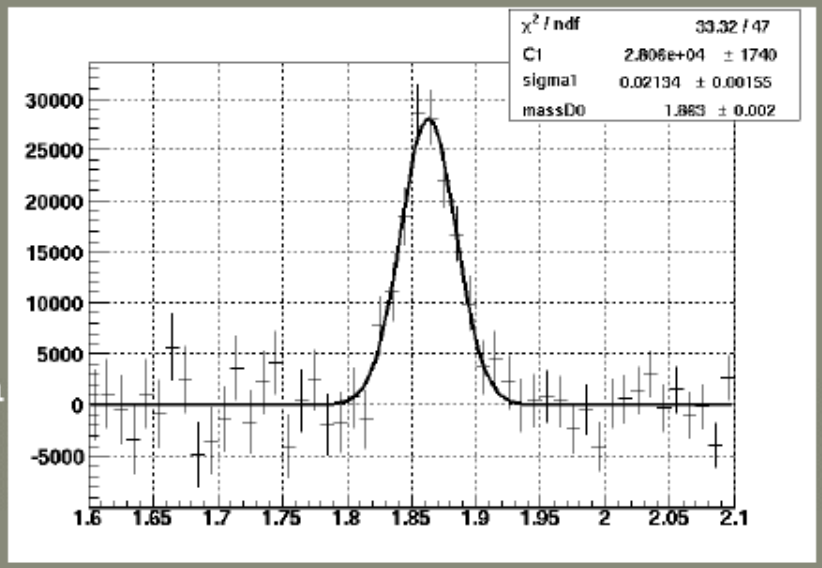
D^0 from Kπ in CuCu with Silicon hit(s) by Sarah

D^0+D^0bar Invariant Mass

13.5 M events

Cuts Used

- |pvZ| < 20 cm
- TPC hits ≥ 15
- SVT hits ≥ 1
- D0 dca PV < 0.1 cm
- decay length < 0.1 cm
- Daughters dca PV < 0.1 cm
- Daughters dca < 0.1 cm
- |KaonNσ| < 2.0
- |PionNσ| < 2.0
- PosCosθDecayD0 < 0.6
- NegCosθDecayD0 > -0.6



150k signal !?!?

4

Outlook

- SACC@KISTI (Oct08)
- STAR
  - D Analysis with SVT (Nov08)
  - Λ_C Reconstruction with SVT (Feb09)
  - Θ_C → Dp Reconstruction (09)
- NA49
  - Λ^* Signal at SPS (Fall 08)
- ALICE
  - Λ_C Simulation (Winter 08)