



# **PNU at STAR (2003.10 - 2018.08)**

**for the STAR 25th celebration**

**In-Kwon YOO (Pusan National University, PNU, South Korea), Dec.17, 2025**



# Beginning in 2003

In-Kwon YOO

October 29, 2003

## Pusan National University

Request of New Collaboration for the STAR at RHIC

### 1 General informations

- Location
  - Republic of Korea (South Korea)
  - Busan City : the 2nd capital at southern coast of korean peninsular
- Pusan National University (PNU)
  - Total Faculty Members : 800 Professors
  - Department of Physics : 32 Professors, 300 undergraduate students, 100 graduate students
  - Nuclear Physics : 4 Professors and 20 graduate students
  - Nuclear Research Institute (NuRI) : founded in Oct. 2003
- Nuclear Physics Faculty
  - Prof. Yoo, I.-K. : NA49 at SPS / CBM at GSI / (STAR at RHIC)
  - Prof. Ahn, J.K. : LEPS at SPring-8 / E391a, E521, E522, pol.n at KEK
  - Prof. Kim, H.Ch. : Theorist (hadron physics)
  - Prof. Lee, Ch.W. : Theorist (astrophysics)
- Experimental Nuclear Physics Laboratory @ phys.PNU
  - Nuclear Data Group : environmental radioactivity control near atomic power plants
  - Detector Development : LSC, Compton-suppressed Gamma detector, Growing of crystal scintillator, MWPC etc.

### References

- [1] S.U.Chung et al., BNL-QGS-03-0210 (2003)
- [2] T.Nakano et al., LEPS collaboration, Phys.Rev.Lett.91 (2003) 012002
- [3] C. Alb et al., NA49 collaboration, hep-ex/0310014 (PRL submitted)

### 2 STAR @

- Group Leader : Yoo, In-Kwon
- Group Members : Kim, Byung-Chul (PhD student)/ Choi, Hyun-Ah (PhD student)

#### 2.1 Motivation

We are so much interested in the new hadron spectroscopy at STAR, which is initiated and proposed by S.U.Chung [1]. Especially our colleague J.K.Ahn contributed to the penta-quark particle ( $\Theta^+$ ) discovery[2] at LEPS in SPring-8, which awoke us a new idea to initiate looking for any penta-quark particle at the NA49 in SPS/CERN. This idea was suggested to the NA49 by I.-K.Yoo, who is an official collaborator of the NA49, and accordingly in October 2003 the NA49 discovered an another penta-quark particle ( $\Xi^{--}$ ) in pp collisions at 158 AGeV [3]. Additionally we plan to extend this program to heavy ion collisions at NA49. As an extension of such 'exotic' particle study and especially regarding the bound system of the exotic particles, it must be very interesting to investigate not only the penta-quark particles, but also the tetra-quark state or quark-gluon bound states with hadron spectrometer at RHIC environment including heavy ion collisions.

#### 2.2 Research issues

- The implementation of required triggers for the hadron spectrometer.
- The data analysis of the central production (AA collisions as well as pp collisions) looking for the exotic resonances.

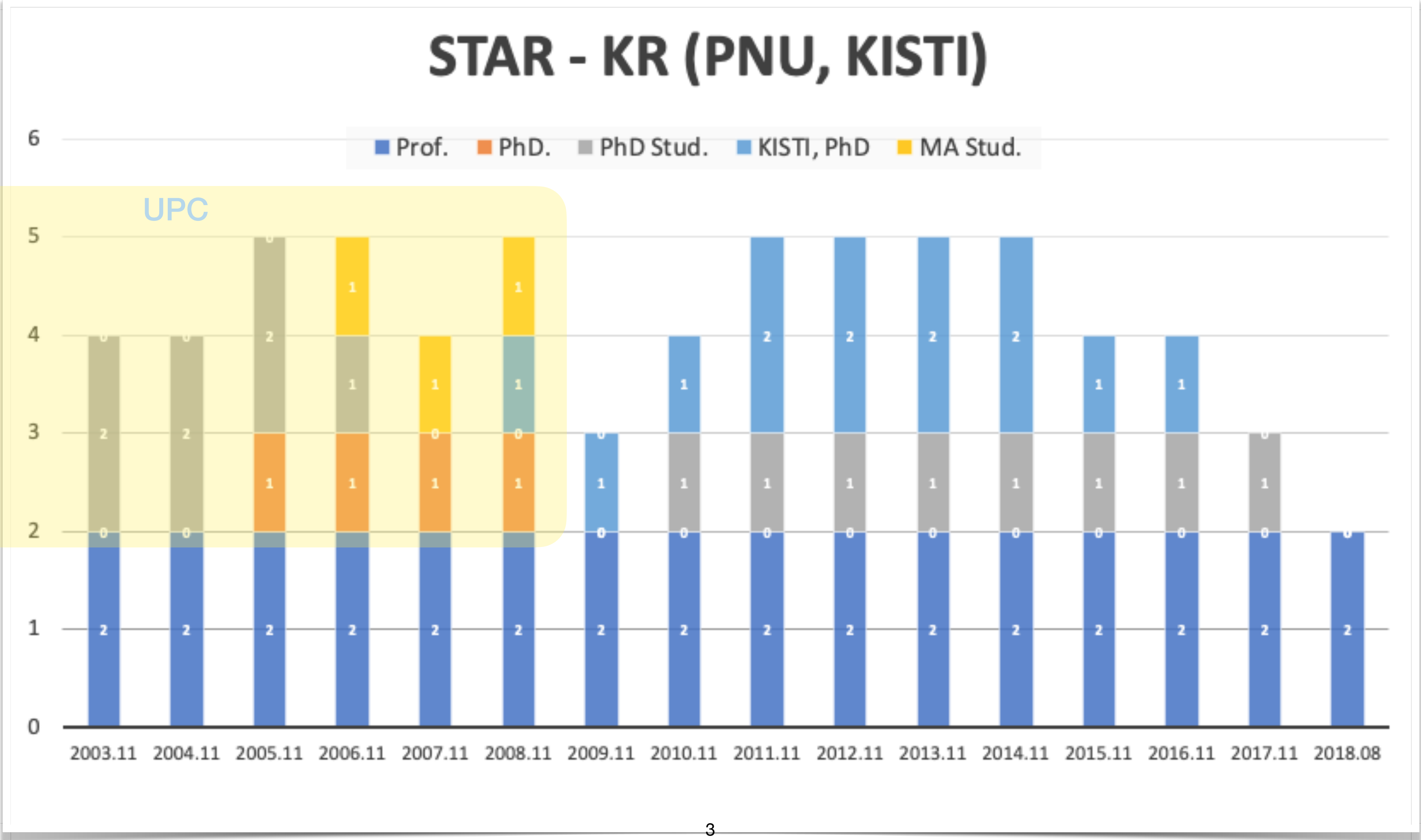
Fiscal Year	Manpower	Roman Pot	Trigger System	Data analysis	Total
FY2004	2s		50%	50%	100%
FY2005	2s + 1p		50%	50%	100%
FY2006	2s + 1p		50%	50%	100%
FY2007	1s' + 1p		20%	80%	100%
beyond	2s'		20%	80%	100%

s:PhD student, p:post-doctoral researcher (planned), s':new PhD student (planned)

- Budget from BB21 (Brain Busan 21) : personnel expenses (2 PhD students) only : approved for 3 years.



# Manpower



HACHoi

BChKim

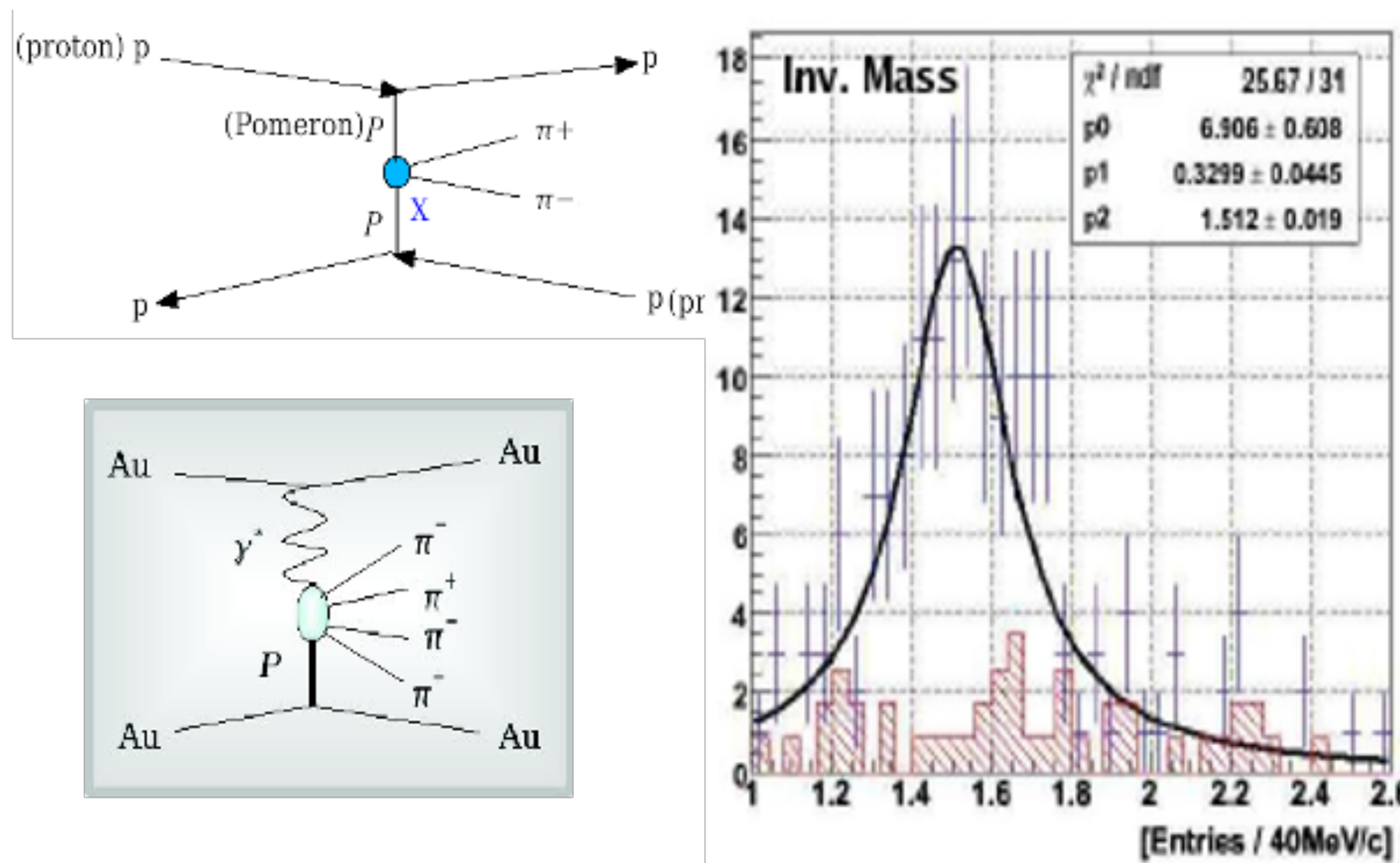
BGrube

CHLee

IKY

# Search for the exotic particle via PWA

HAC Choi, BChKim, BGrube & SUChung in UPC



Vector Meson in  $q\bar{q}q\bar{q}$  system from Double-Pomeron (pp) and Photon-Pomeron (AuAu-UPC) interaction



Nuclear Physics B - Proceedings Supplements

Volumes 179–180, August 2008, Pages 117–124

## Photoproduction in Ultra-Peripheral Heavy Ion Collisions at STAR

B. Grube <sup>a, b</sup>, the STAR Collaboration

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<https://doi.org/10.1016/j.nuclphysbps.2008.07.015>

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We present recent STAR results on photoproduction in ultra-peripheral relativistic heavy-ion collisions. In these collisions the impact parameter of the beam particles is larger than the sum of their nuclear radii, so that they interact via their long-range Coulomb fields. STAR has measured the production of  $\rho^0$  (770) mesons in exclusive reactions as well as in processes with mutual nuclear excitation of the beam particles. We present results for the  $\rho^0$  production cross section in Au-Au collisions at  $\sqrt{s_{NN}} = 200\text{GeV}$  for coherent as well as incoherent coupling. The dependence of the cross section on the  $\rho^0$  rapidity is compared to theoretical models. We also studied the ratio of coherent  $\rho^0$  to direct  $\pi^+\pi^-$  production as well as the  $\rho^0$  helicity matrix elements and we observe interference effects in the  $\rho^0$  production. In addition STAR has measured the production of  $\rho^0$  mesons in d-Au collisions at  $\sqrt{s_{NN}} = 200\text{GeV}$  and that of  $e^+e^-$ -pairs in Au-Au at  $\sqrt{s_{NN}} = 200\text{GeV}$ . We also see an enhancement around  $1510\text{MeV}/c^2$  in  $\pi^+\pi^-\pi^+\pi^-$  final states in Au-Au collisions at  $\sqrt{s_{NN}} = 200\text{GeV}$ .

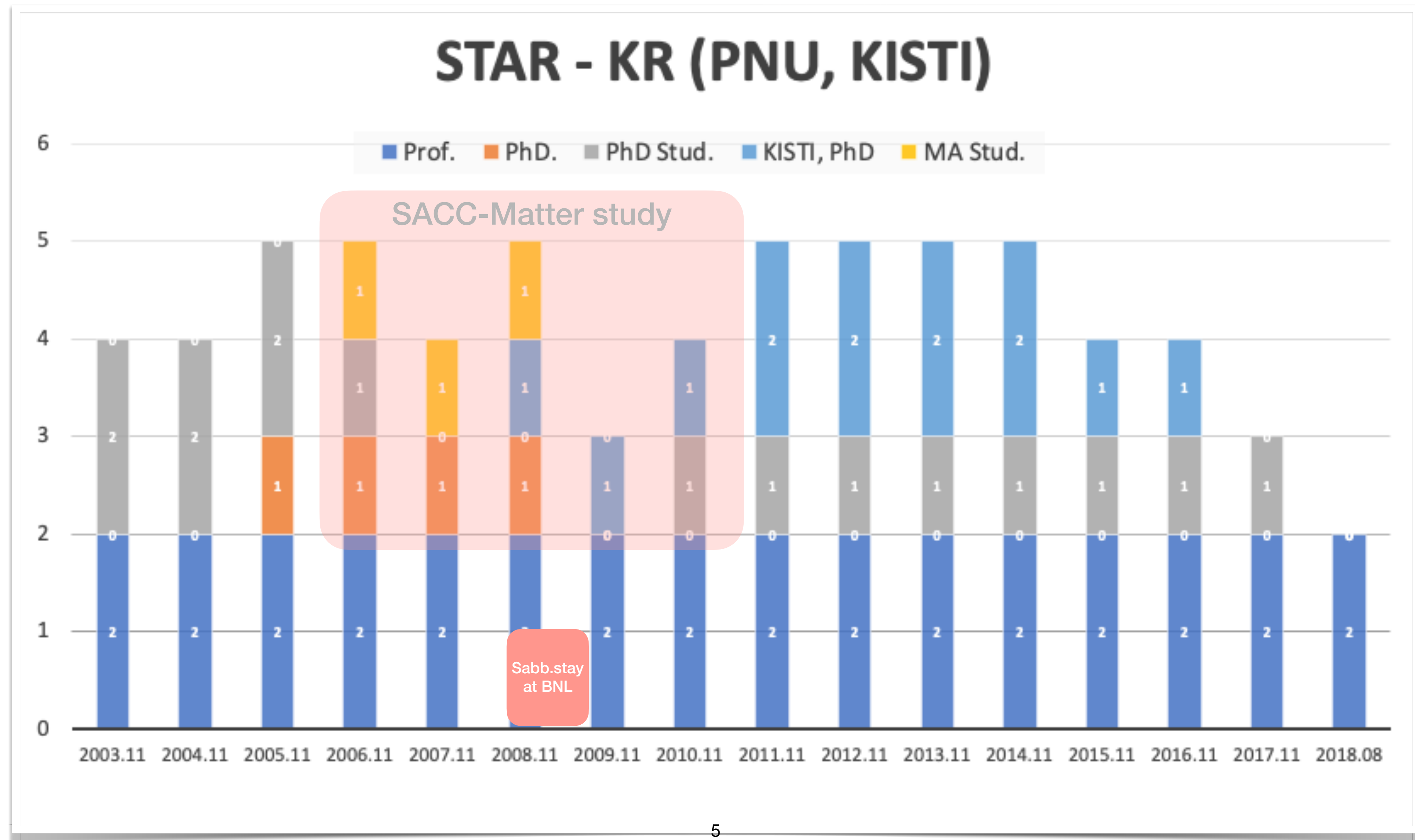
# Manpower

KEChoi

SDLee

CHLee

IKY





# STAR Asian Computing Center (SACC)

SDLee, KEChoi, IKY

Overview  
Analysis Level  
Production Level  
Time Plan

Software Installation @ KISTI  
Data Analysis : KyungEon's Job  
Data Transfer

Data Transfer : Network

Overview  
Analysis Level  
Production Level  
Time Plan

Software Installation @ KISTI  
Data Analysis : KyungEon's Job  
Data Transfer

Data Transfer : Storage

## Storage @ KISTI

- 1 Which machine?  
-> SUN Cluster(from SDLee's presentation, right figure)
- 2 Where?  
-> NFS(preferred) or Tape

According to Dr.Lee's presentation at STAR Council Meeting...

- NFS : 20TByte
- Tape : 50TByte

## SUN Cluster@KISTI

Item	Cluster system
	Phase 1
Manufacturer & Model	SUN C48
Architecture	
Processor	AMD Opteron 2GHz (Barcelona)
Operating System	Cent OS
Nodes	188
CPU cores	3,008 (16/node)
Rpeak	24TFlops
Memory	6TB
Disk storage	207TB
Tape storage	422TB
Interconnection network	Infiniband 4X DDR
Cooling	Chilled water cooling
Delivery date	Jan, 2008

## Short "traceroute" test by KyungEon

```

[rcas6018] ~/$ traceroute hamel.ksc.re.kr
traceroute Warning: hamel.ksc.re.kr has multiple addresses; using 150.183.5.227
 1 sw33.s206.rcf.bnl.gov (130.199.206.24)  0.264 ms  0.212 ms  0.279 ms
 2 isis.s19.bnl.gov (130.199.19.1)  0.751 ms  0.665 ms  0.661 ms
 3 shu.v500.bnl.gov (130.199.136.25)  0.786 ms  0.709 ms  0.666 ms
 4 anon.bnl.gov (130.199.3.24)  1.129 ms  1.092 ms  1.092 ms
 5 198.124.216.177 (198.124.216.177)  5.256 ms  1.266 ms  1.629 ms
 6 aocr1-bnlmr1.es.net (134.55.217.58)  3.185 ms  3.129 ms  3.134 ms
 7 ch1ccr1-aofacr1.es.net (134.55.218.93)  30.029 ms  29.990 ms  34.277 ms
 8 ch1s1dn1-ch1cr1.es.net (134.55.207.34)  30.185 ms  30.136 ms  30.137 ms
 9 ch1s1mr1-ch1s1dn1.es.net (134.55.219.26)  30.279 ms  30.105 ms  30.138 ms
10 198.125.140.14 (198.125.140.14)  81.730 ms  81.739 ms  81.723 ms
11 134.75.108.209 (134.75.108.209)  196.415 ms  196.194 ms  196.168 ms
12 opa113.kreonet.net (134.75.20.254)  196.115 ms  196.093 ms  196.111 ms
13

```

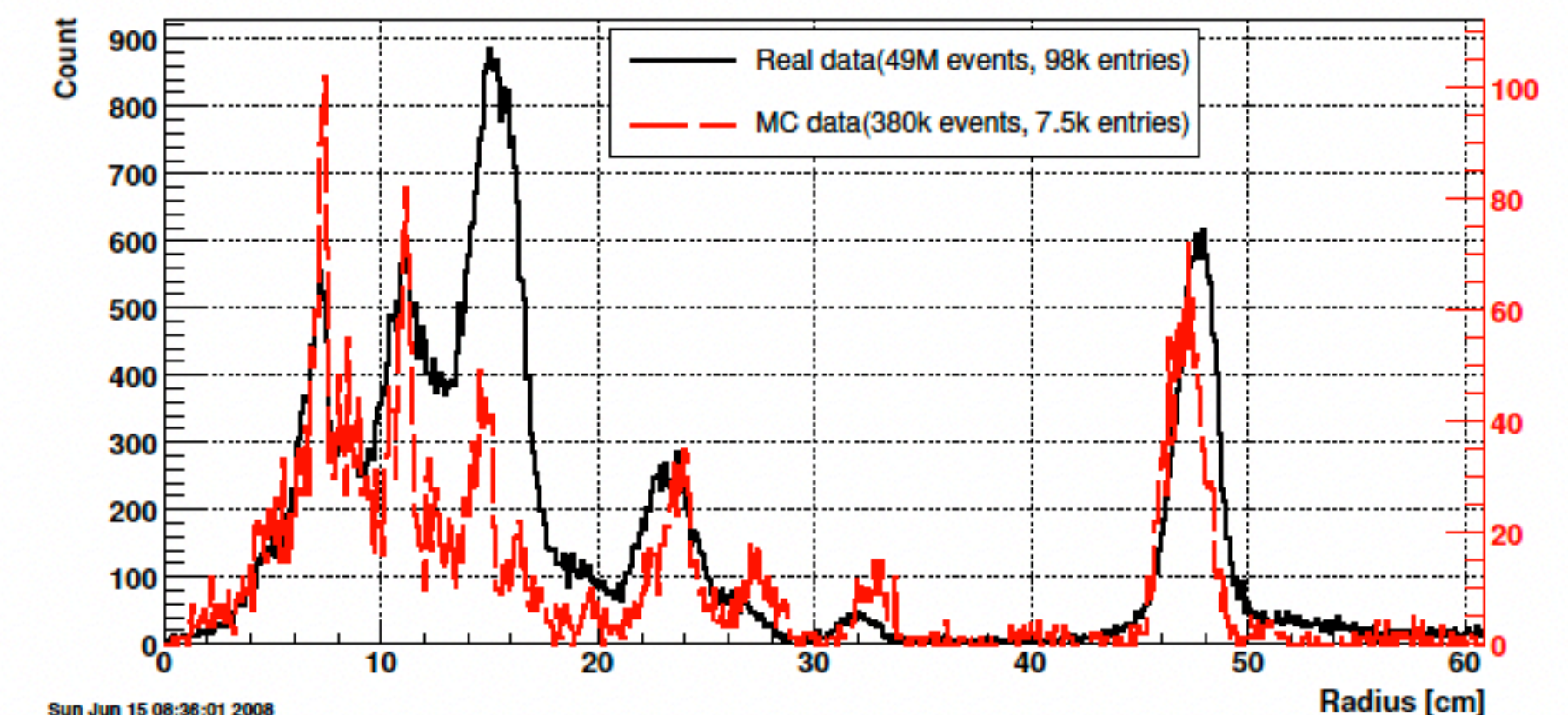
- RCF(STAR)
- 4 Steps(@ BNL)
- > 1 Step(Some)
- > 3 Steps(@ E)
- > 1 Step(Some)
- > 2 Steps(in K)

Motivation  
Analysis  
Conclusion & Outlook

Data set & Cuts  
Real Data Analysis  
Comparison with MC data

Real data vs. MC data (Data is not normalized, just scaled)

Radial Distribution of conversion vertices

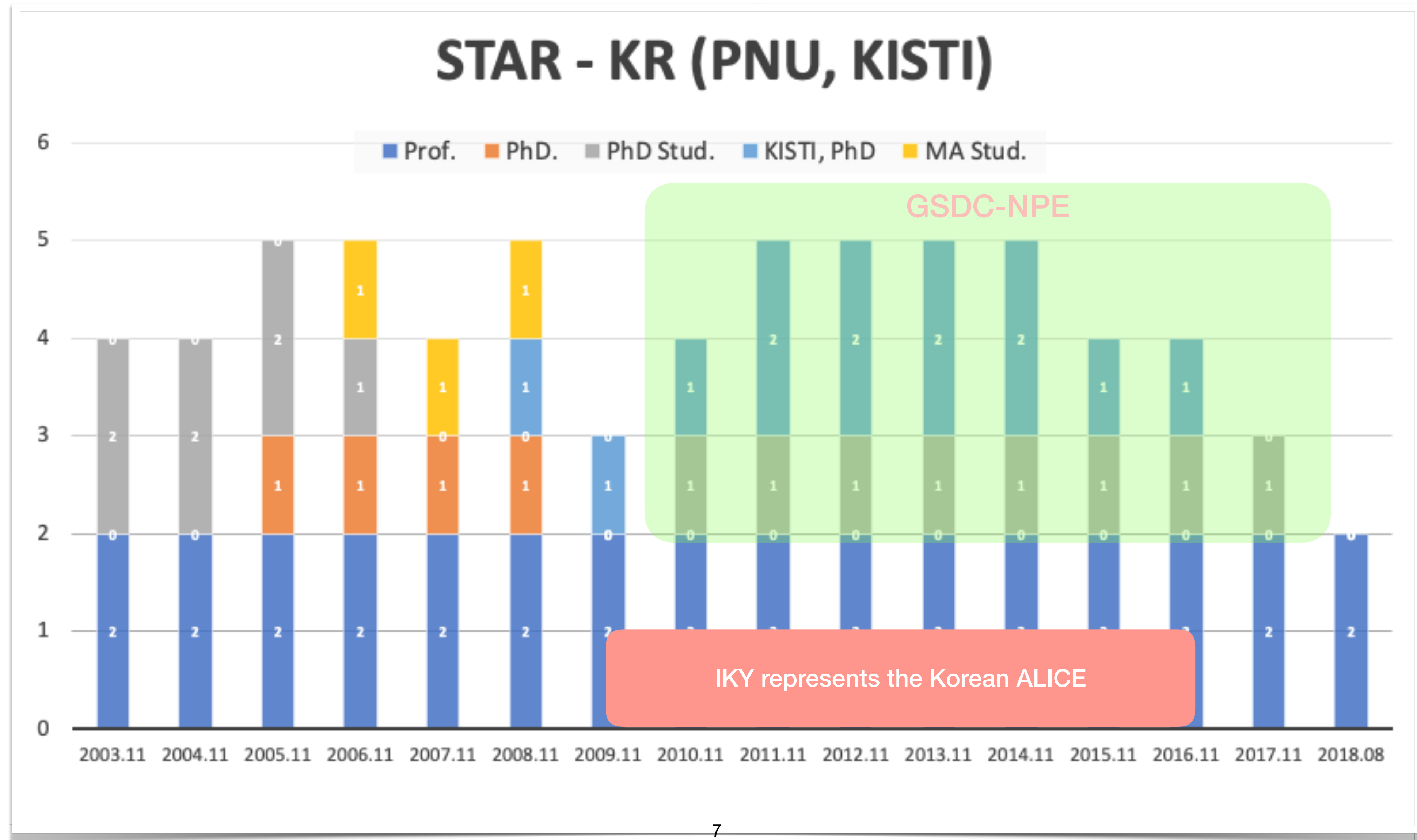


- Distribution is systematically different on SVT region!
- Relative height between SVTs, SSD and TPC can be different: Cut dependence
- Relative height between Real and MC data should be similar!
- 0.2 % survived from Real data and 1.97 % survived from MC data



# Manpower

KSOh  
SYNoh  
  
CHLee  
IKY



# GSDC & NPE Analysis

## KSOh, IKY & SYNoh

Memorandum of Understanding between the STAR Collaboration and Global Science experimental Data hub Center (GSDC)

November 16<sup>th</sup>, 2012

The purpose of this memorandum is to document the understanding between your group at the GSDC and the STAR Collaboration concerning the level of effort committed by members of your group to research and service work on STAR during the 2012-2015 timeframe. This MOU is made under the governance of the STAR Bylaws.

Group Participation on STAR at BNL

As stated in the STAR Bylaws, “Scientists including graduate students, engineers, and other technically oriented persons intending to make a significant contribution to [the STAR Collaboration] over a period of at least one year are eligible to be members.” The members of the group who plan to make a significant contribution to STAR and the percentage of their time which will be committed to this effort during the period 2012-2015 are the following:

Participant	Title	% Research	% Service	Description
Haengjin Jang	Ph.D.		20	Group leader
Seo-Young Noh	Ph.D.		100	System Administrator

(1) Additional remarks on major institutional commitments for support of STAR sub-systems, software and computing responsibilities, etc.

STAR and GSDC (Global Science experiment Data hub Center) agree in principle that GSDC provides the following computing resources for STAR data analysis:

Resource \ Year	Y. 2012	Y. 2013	Y. 2014**
CPU*	1024	1024	1024
Disk Storage (TB)	50	50	50

\* All cores are dedicated to STAR experiment and they will be hyperthreaded.

\*\* It is expected to increase the total number of CPU up to 2048 according to the STAR’s physics program need.

In order for successful collaboration and sustainable service, STAR and GSDC agree in principle that persons shown in the table will be primarily contact points in communications:

Physical Review D

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Measurements of  $D^0$  and  $D^*$  production in  $p + p$  collisions at  $\sqrt{s} = 200$  GeV

PDF

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L. Adamczyk<sup>1</sup>, G. Agakishiev<sup>19</sup>, M. M. Aggarwal<sup>30</sup>, Z. Ahammed<sup>49</sup>, A. V. Alakhverdyants<sup>19</sup>, I. Alekseev<sup>17</sup>, J. Alford<sup>20</sup>, B. D. Anderson<sup>20</sup>, C. D. Anson<sup>28</sup> et al. (STAR Collaboration)

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Phys. Rev. D **86**, 072013 – Published 31 October, 2012

Export Citation

DOI: <https://doi.org/10.1103/PhysRevD.86.072013>

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Abstract

We report measurements of charmed-hadron ( $D^0, D^*$ ) production cross sections at midrapidity in  $p + p$  collisions at a center-of-mass energy of 200 GeV by the STAR experiment. Charmed hadrons were reconstructed via the hadronic decays  $D^0 \rightarrow K^- \pi^+$ ,  $D^{*+} \rightarrow D^0 \pi^+ \rightarrow K^- \pi^+ \pi^+$  and their charge conjugates, covering the  $p_T$  range of 0.6–2.0 and 2.0–6.0 GeV/c for  $D^0$  and  $D^{*+}$ , respectively. From this analysis, the charm-pair production cross section at midrapidity is  $d\sigma/dy|_{y=0}^{\text{cc}} = 170 \pm 45(\text{stat})_{-59}^{+38}(\text{sys}) \mu\text{b}$ . The extracted charm-pair cross section is compared to perturbative QCD calculations. The transverse momentum differential cross section is found to be consistent with the upper bound of a fixed-order next-to-leading logarithm calculation.

PhD. KSOh

CHARM AND BOTTOM HADRON PRODUCTION VIA SEMI-LEPTONIC DECAY CHANNEL IN RELATIVISTIC HEAVY ION COLLISIONS

BY  
KUNSU OH

DISSERTATION  
for the degree of Doctor of Philosophy  
in Department of Physics, Pusan National University, 2017

Busan, Korea

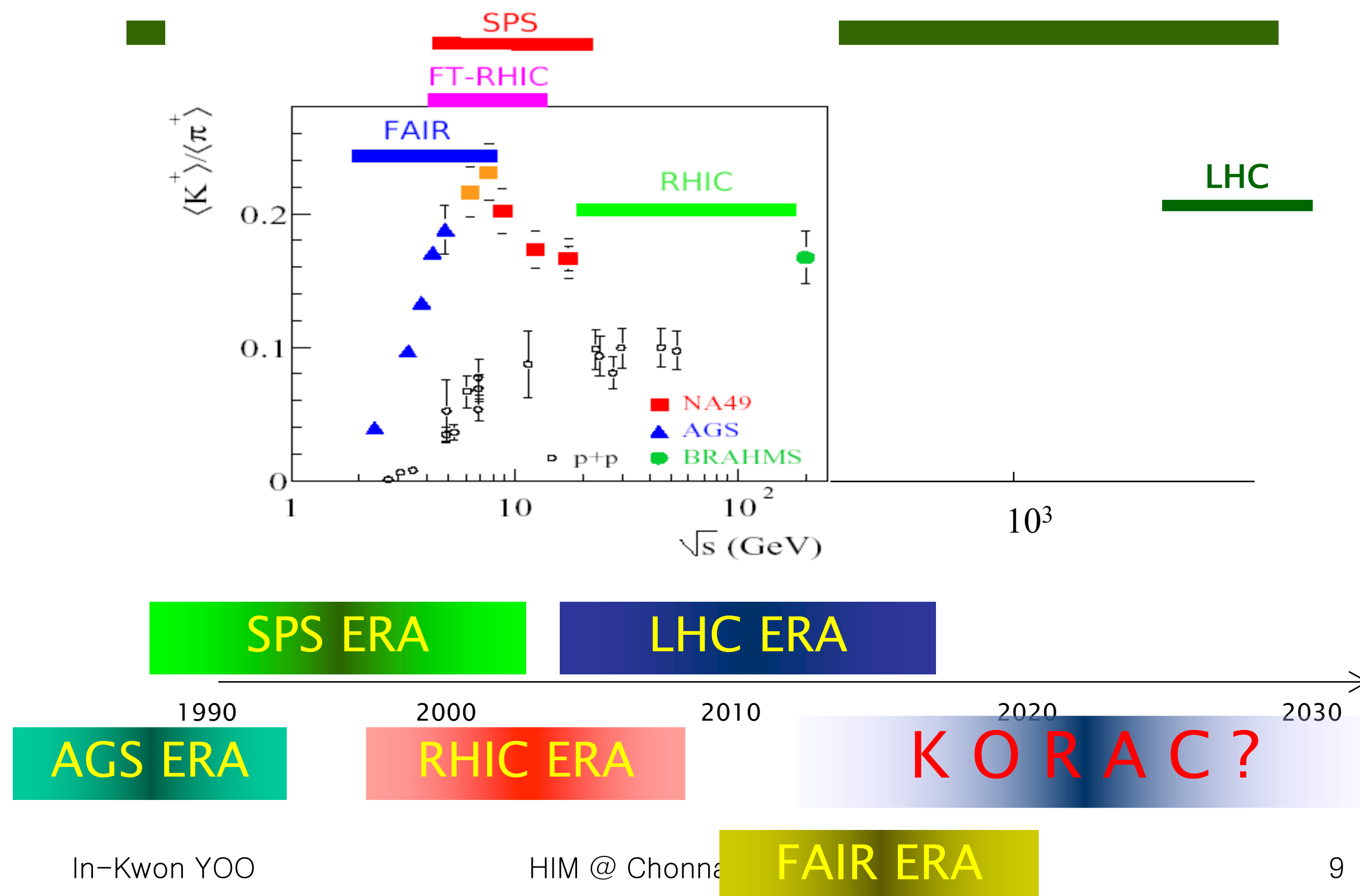
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# Ambition in 2003 & NOW in 2026

HIM (Heavy Ion Meeting) 2004-2025 + ATHIC2006-2026 + SQM2022 + QM2027

## Possible experimental landscape



- RHIC ERA extended to NOW!
- LHC ERA extended to .. 2040
- KORAC → RAON realized! (despite still long way to go)
- FAIR(CBM) postponed to 2028
- What comes next? FCC? EIC! FRIB! ...
- Going ON.. on..