中国科学院上海应用物理研究所
Shanghai Institute of Applied Physics, Chinese Academy of Sciences

Beam Energy Dependence of Hypertriton Production and Lifetime Measurement at RHIC STAR

Yuhui Zhu[1,2] for the STAR Collaboration

1. Shanghai Institute of Applied Physics, CAS (SINAP)
2. Brookhaven National Laboratory, STAR Group

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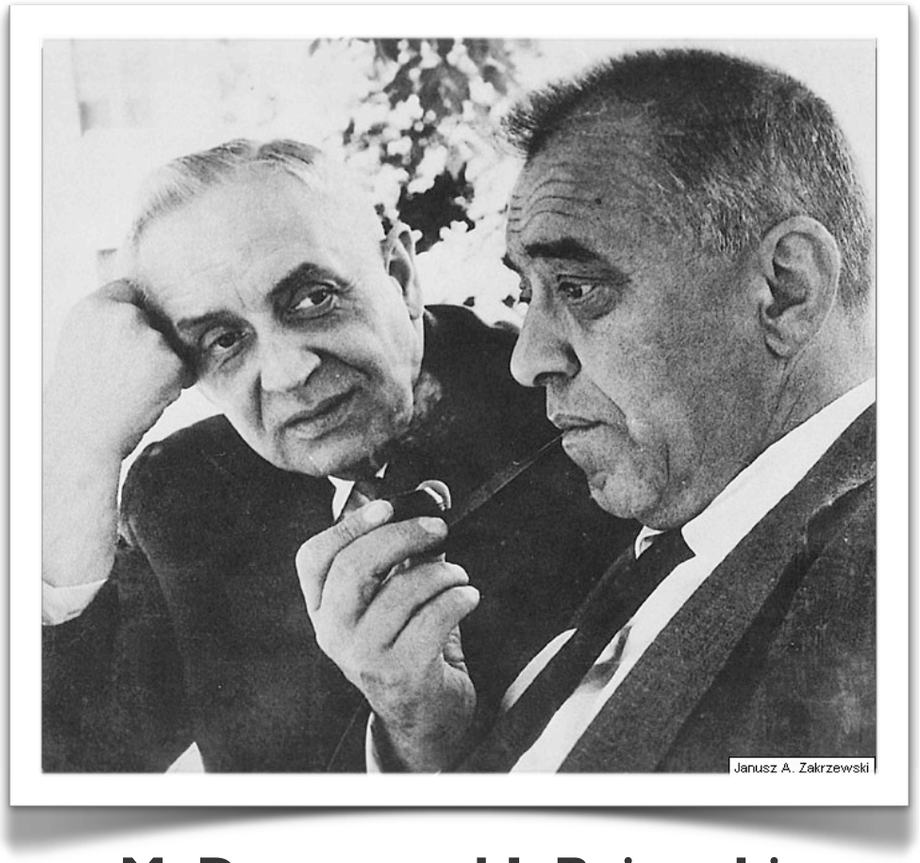
Outline

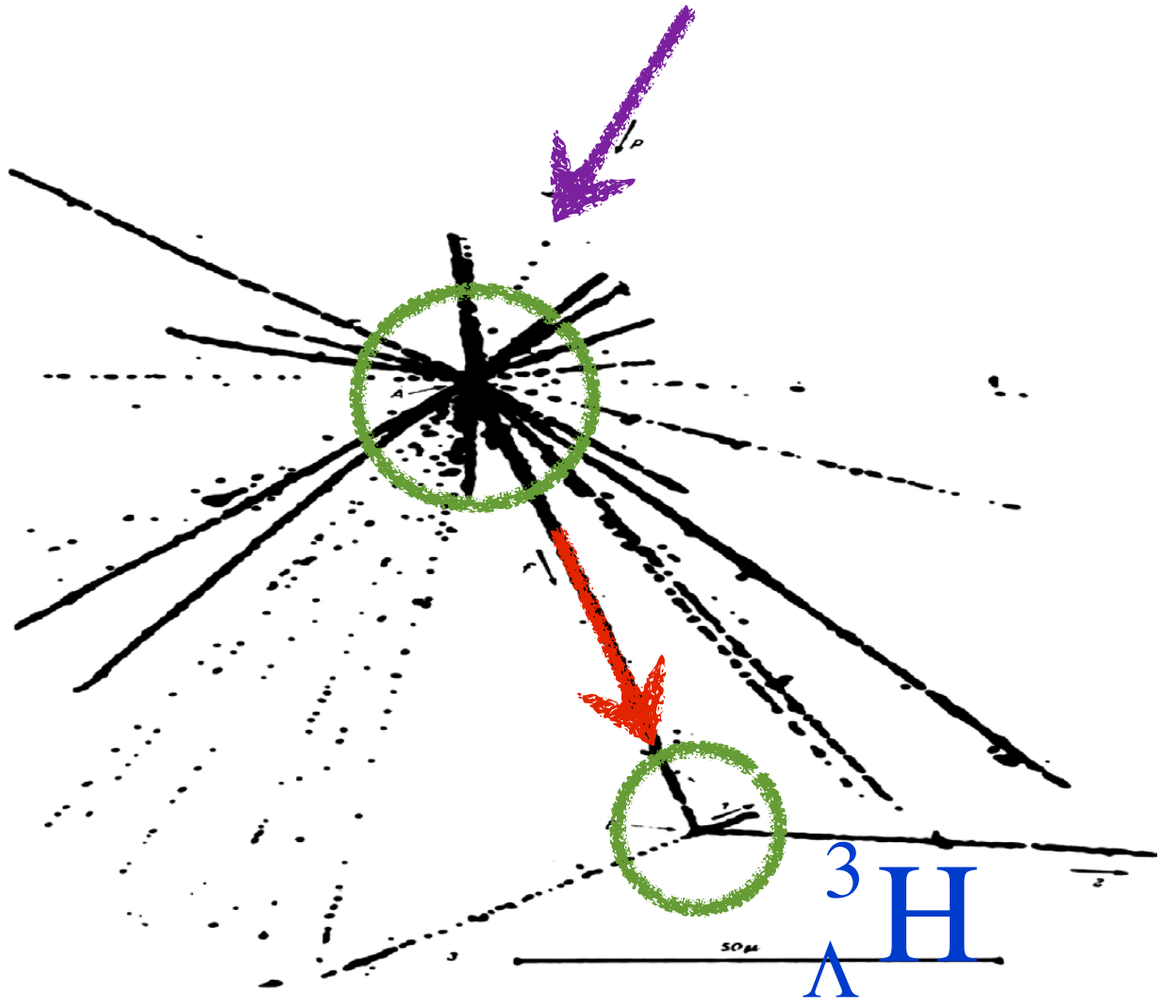
- Background and Motivation
- Analysis Method and Preliminary Results
  - ${}^{3}_{\Lambda}\mathrm{H}+{}^{3}_{\bar{\Lambda}}\bar{\mathrm{H}}$ Raw Yield in Run10 Data(7.7,11.5,39,200GeV)
  - $({}^{3}_{\Lambda}\mathrm{H}+{}^{3}_{\bar{\Lambda}}\bar{\mathrm{H}})/({}^{3}\mathrm{He}+{}^{3}\overline{\mathrm{He}})$ Raw Ratio in Run10 Data
  - Raw Lifetime Measurement
- Conclusions and Outlook

Background and Motivation

The first observation of hypernucleus is made by Danysz and Pniewski in 1952 in a cosmic ray experiment



M. Danysz and J. Pniewski, Phil. Mag. 44 (1953) 348



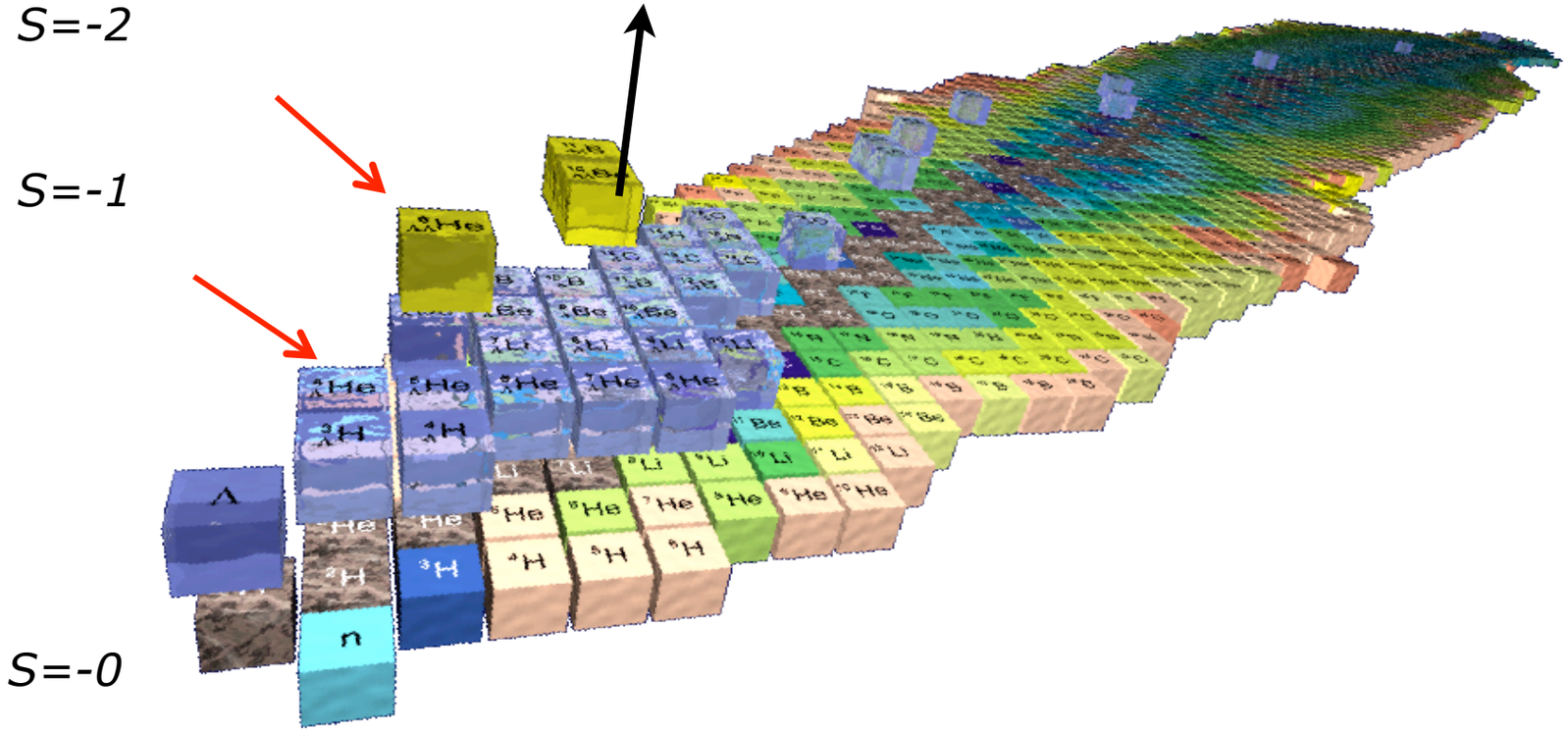
It was finally confirmed that the hyper fragment composed a bound Lambda

Background and Motivation

- A New Dimension to the World of Nuclei

$$^{10}_{\Lambda\Lambda}\mathrm{Be} \rightarrow {}^{9}_{\Lambda}\mathrm{Be} + p + \pi^-$$

$$\searrow \quad p + {}^4\mathrm{He} + {}^4\mathrm{He} + \pi^-$$



Hyperon-Nucleon Interaction(Y-N)

2.991GeV	**Mass?**	2.809GeV
0.13 ± 0.05MeV	**Binding Energy?**	8.48MeV
~2.63e-10s	**Lifetime?**	12.32 years

$^{3}_{\Lambda}\mathrm{H}$

^{3}H

Y-N Interaction

Help to study strong interaction itself

Help to study the properties of neutron stars

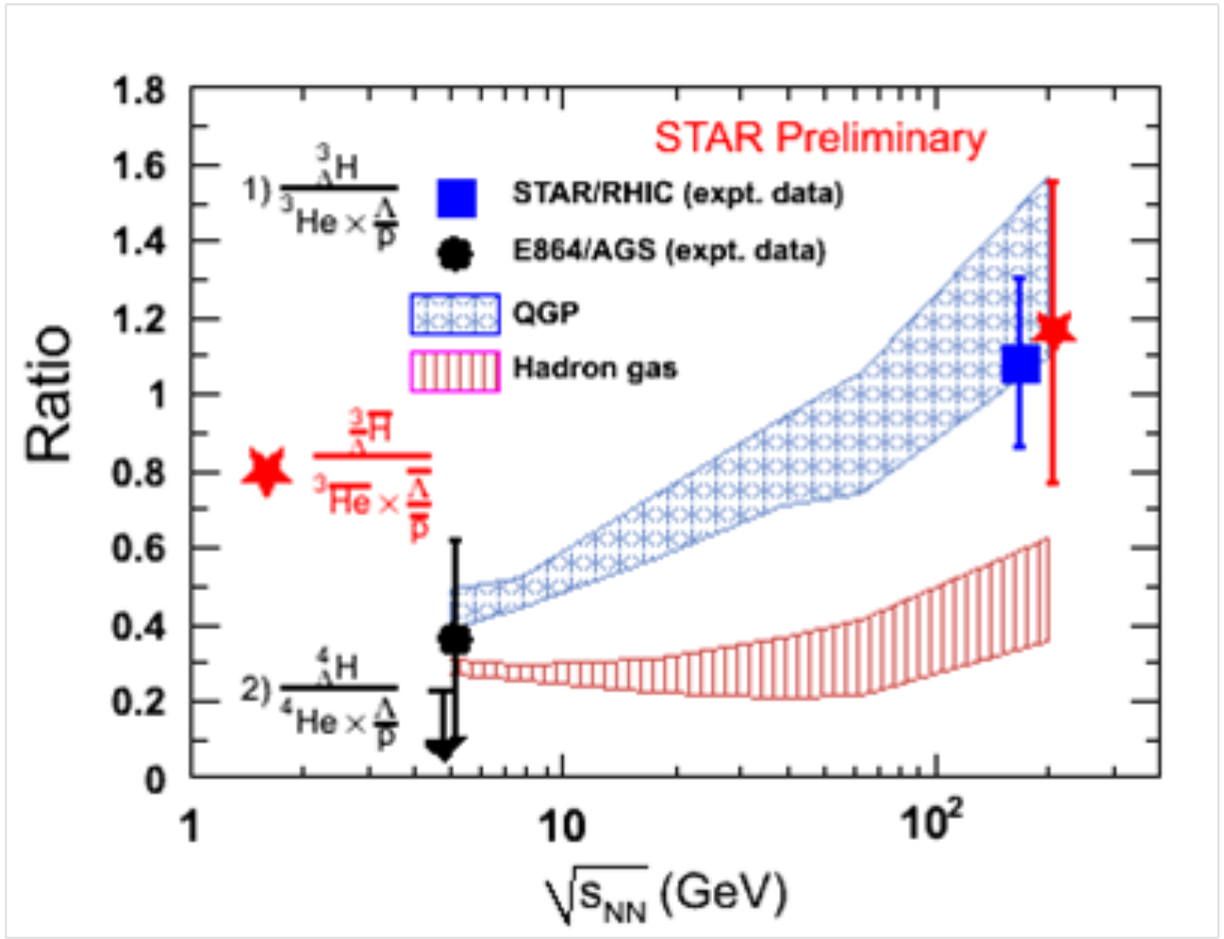
Hypernucleus provides an indirect way to study Y-N interaction

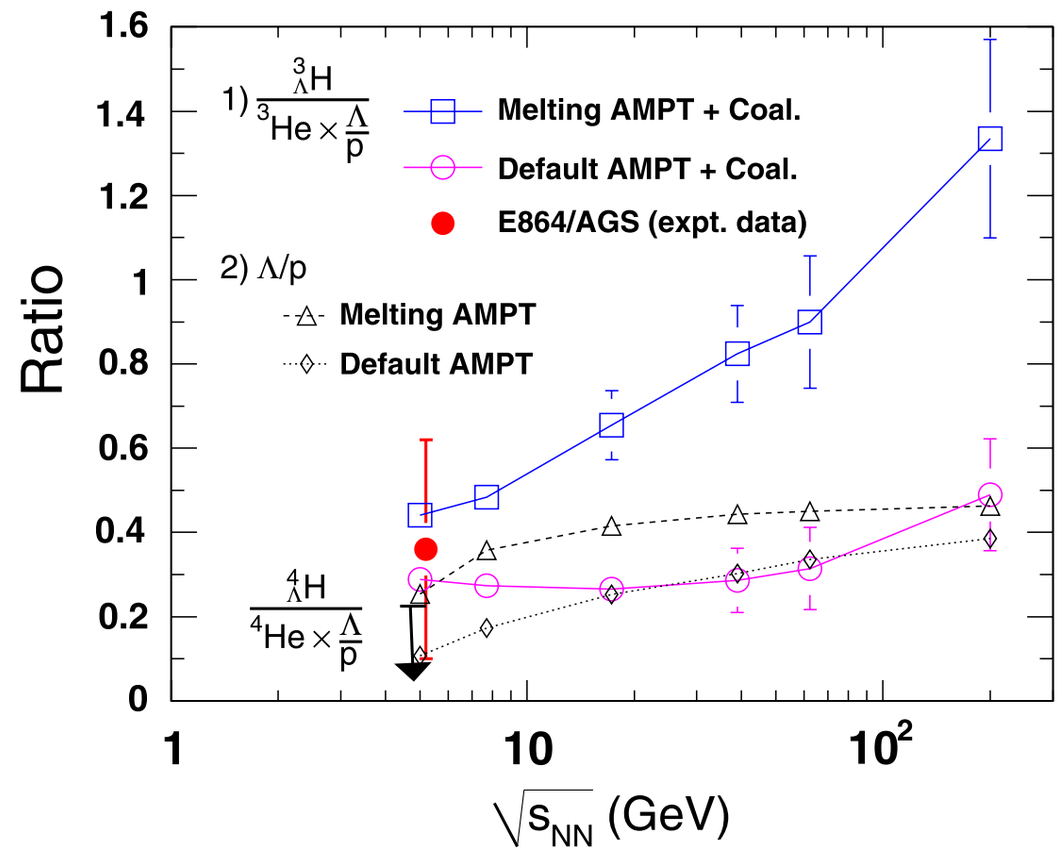
Physics from BES data

Strangeness Population Factor

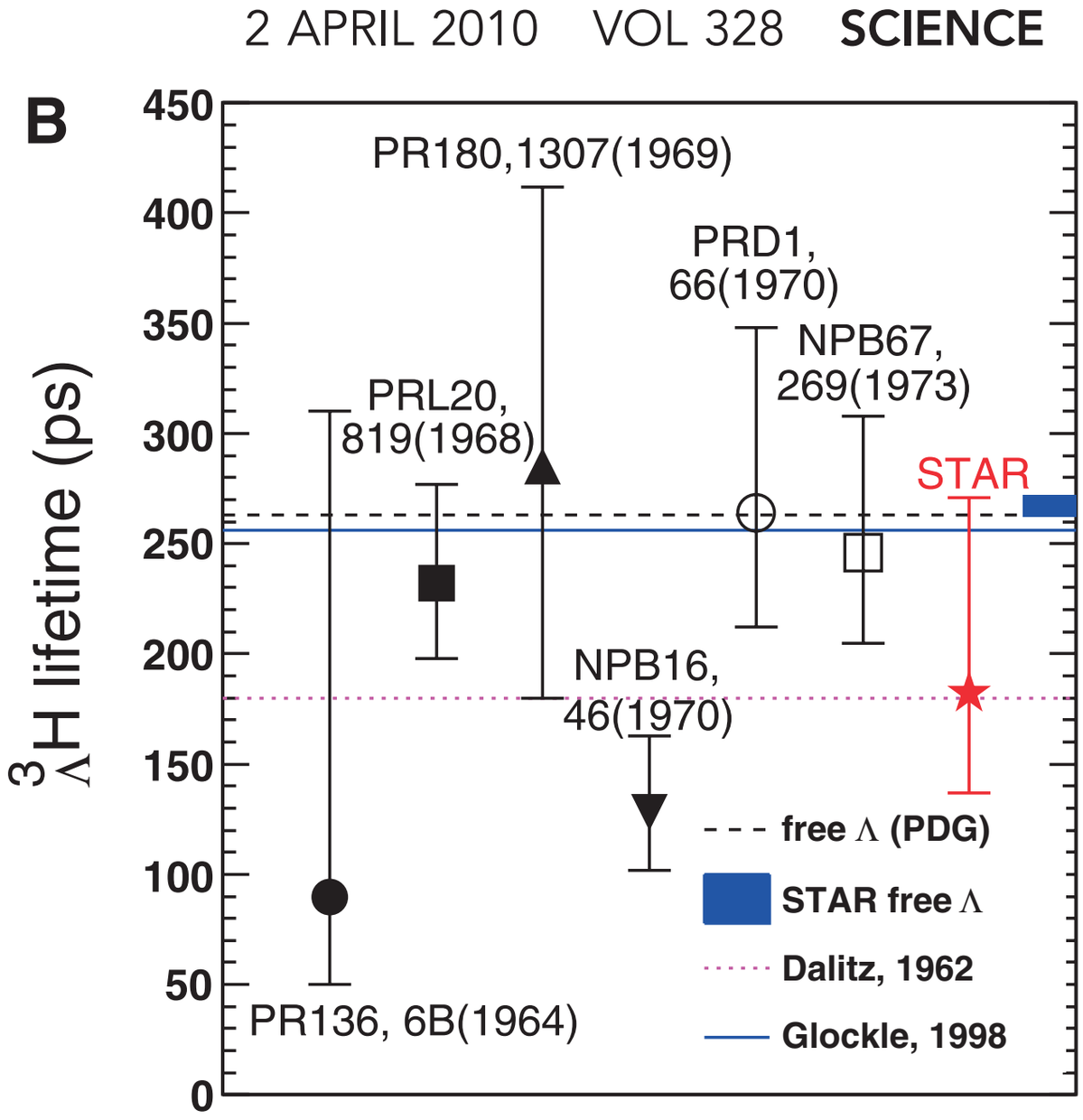
$$S_3 = {}^{3}_{\Lambda}\mathrm{H}/({}^{3}\mathrm{He} \times \Lambda/p)$$

PRL 95(2005) 182301, PRC 74(2006) 054901, PRD 73(2006)014004 **S.Zhang et al., PLB 684 (2010) 224**





Lifetime Measurement of $^{3}_{\Lambda}\mathrm{H}$



STAR Latest Measurement

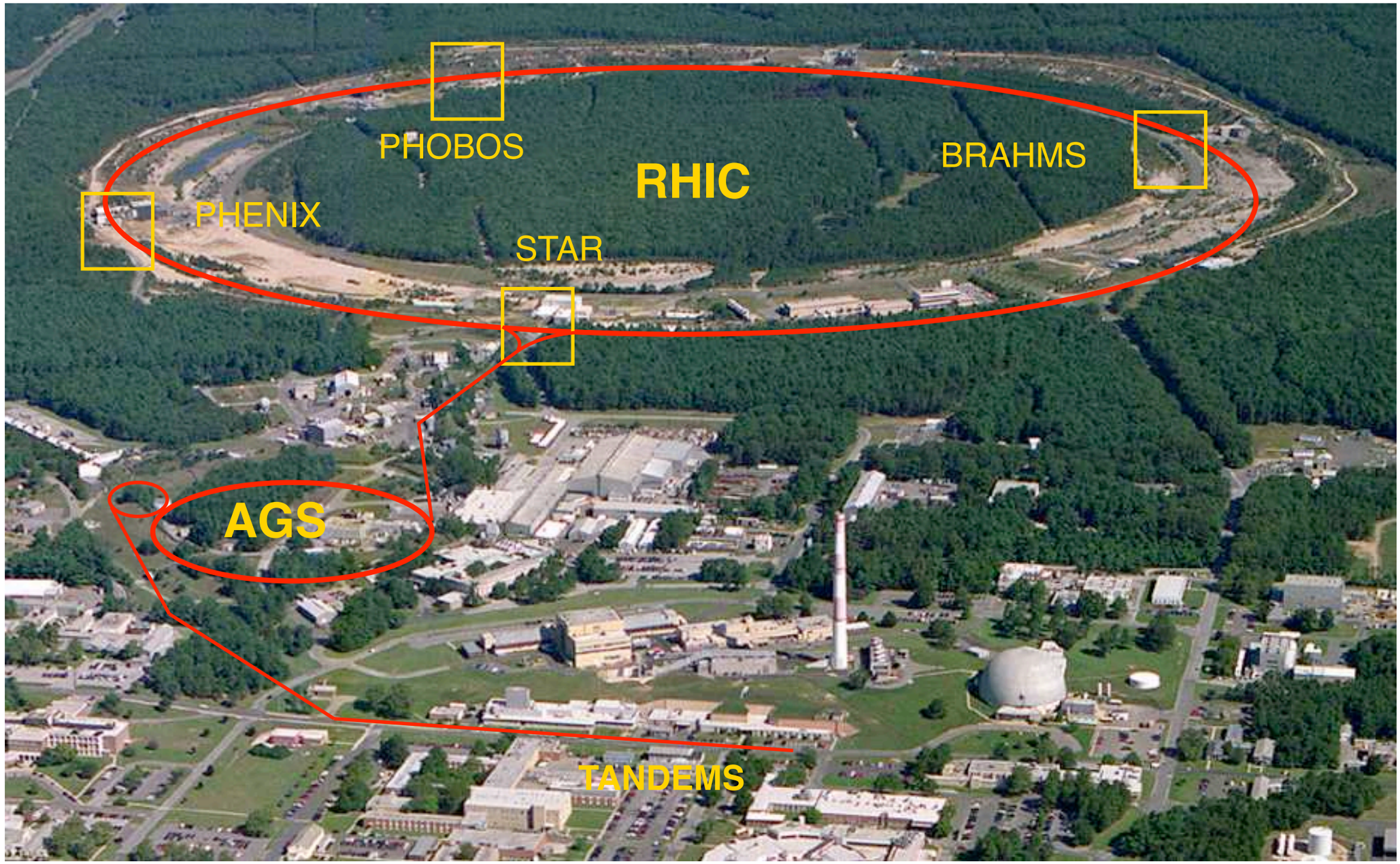
Run4 200GeV	minbias	22M
Run4 200GeV	central	23M
Run7 200GeV	minbias	68M

$$182^{89}_{45} \pm 27\, ps$$

Experimental Analysis

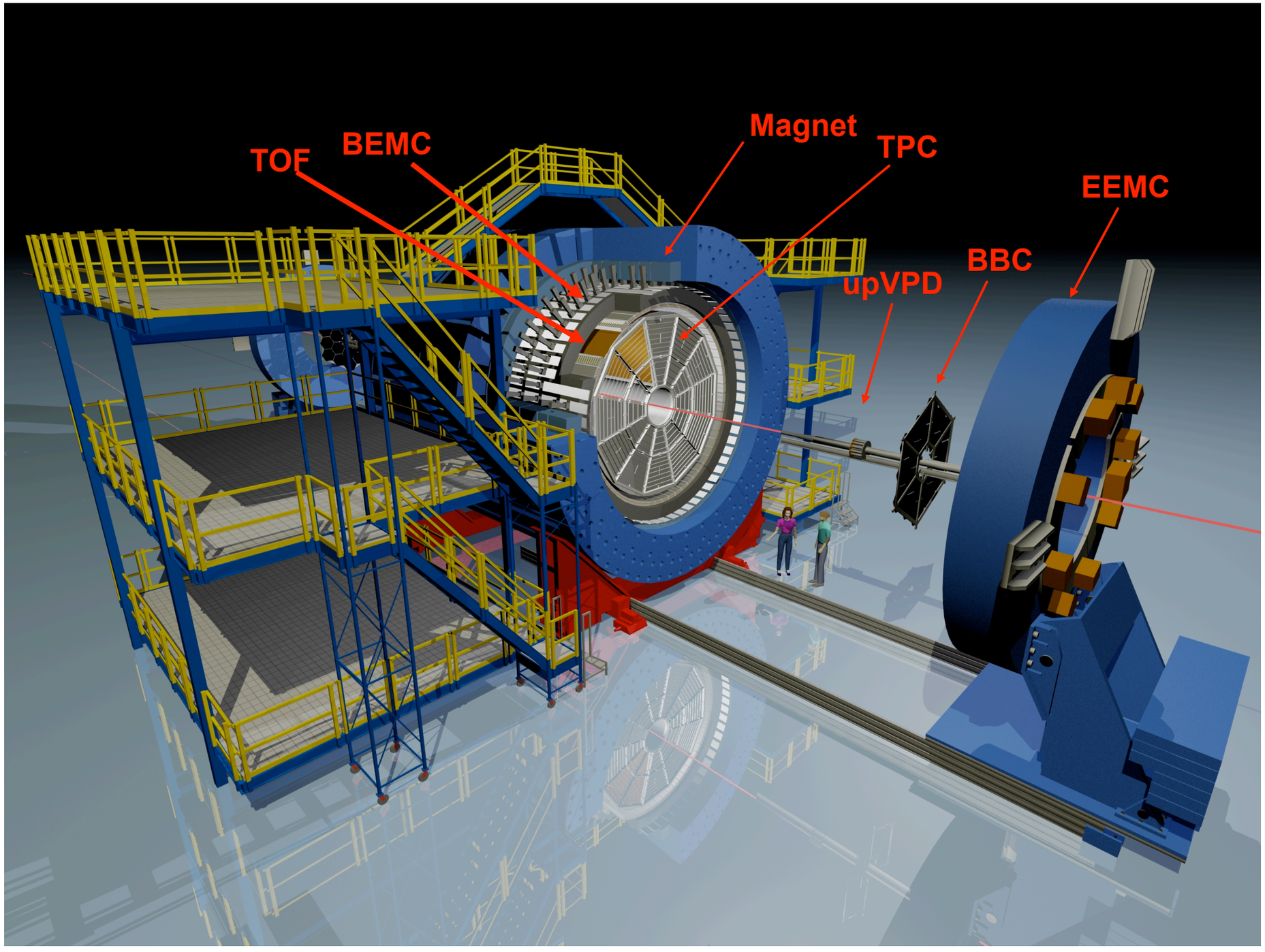
Relativistic Heavy Ion Collider

- Bird's eye view of RHIC



The Solenoid Tracker At RHIC (STAR)

- STAR Overview



Analysis

- Dataset and Event-level Cuts

Energy	Trigger	|Vz|	RefMult	Events
7.7GeV	minbias	<70cm	>4	4.11M
11.5GeV	minbias	<50cm	>5	11.01M
39GeV	minbias	<40cm	>7	141.5M
200GeV	minbias	<30cm		199.03M
200GeV	central	<30cm		124.19M

- Track-level Cuts

nHitsFit	nHitsDedx	nHitsFit/nHitsPoss
>25	>15	>0.52

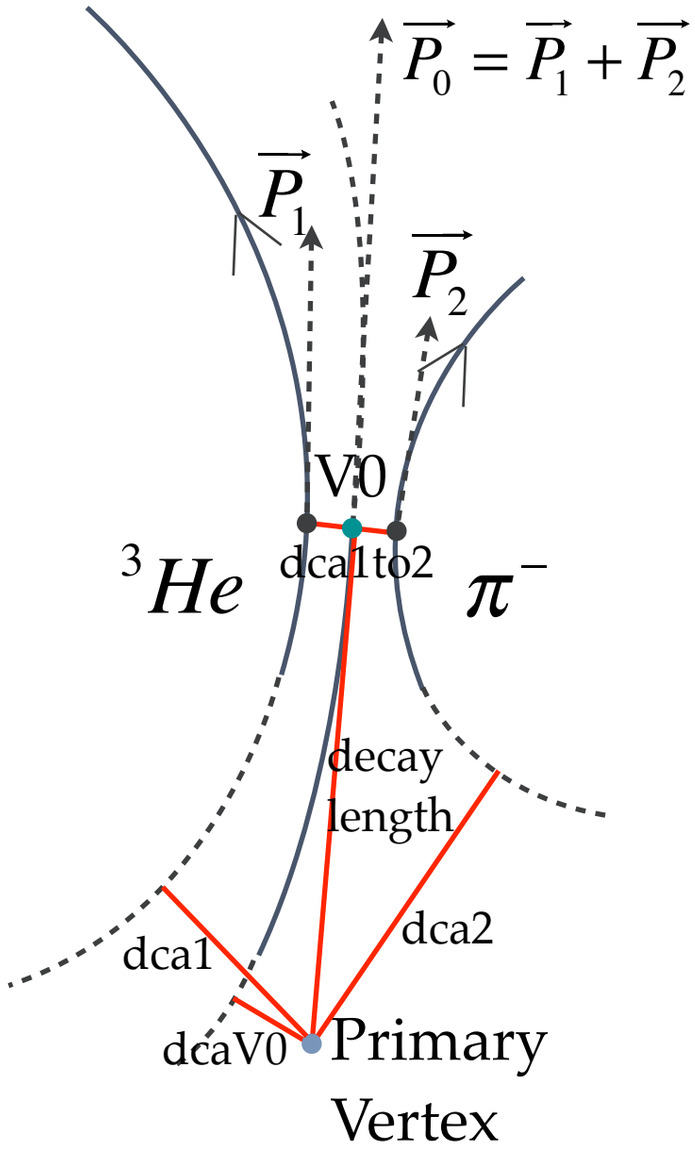
- V0 cuts

V0 Parameters	Cuts	V0 Par	Cuts
DcaV0	<0.6cm	Dca2	>0.8cm
Dca1to2	<1cm	V0DecLen	>2.4cm

- Technique

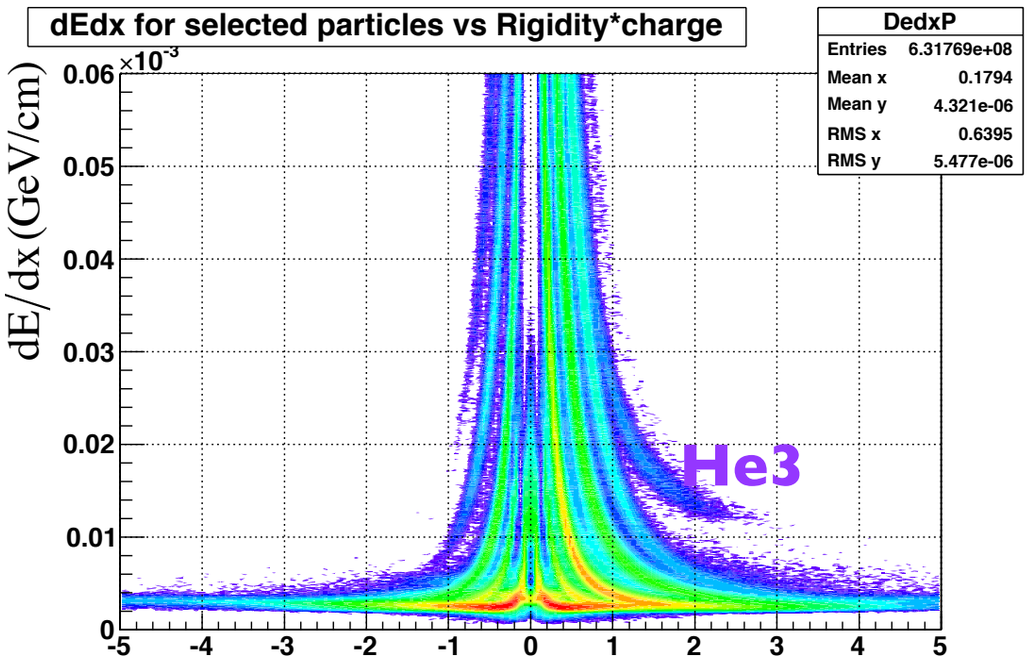
Secondary vertex finding technique

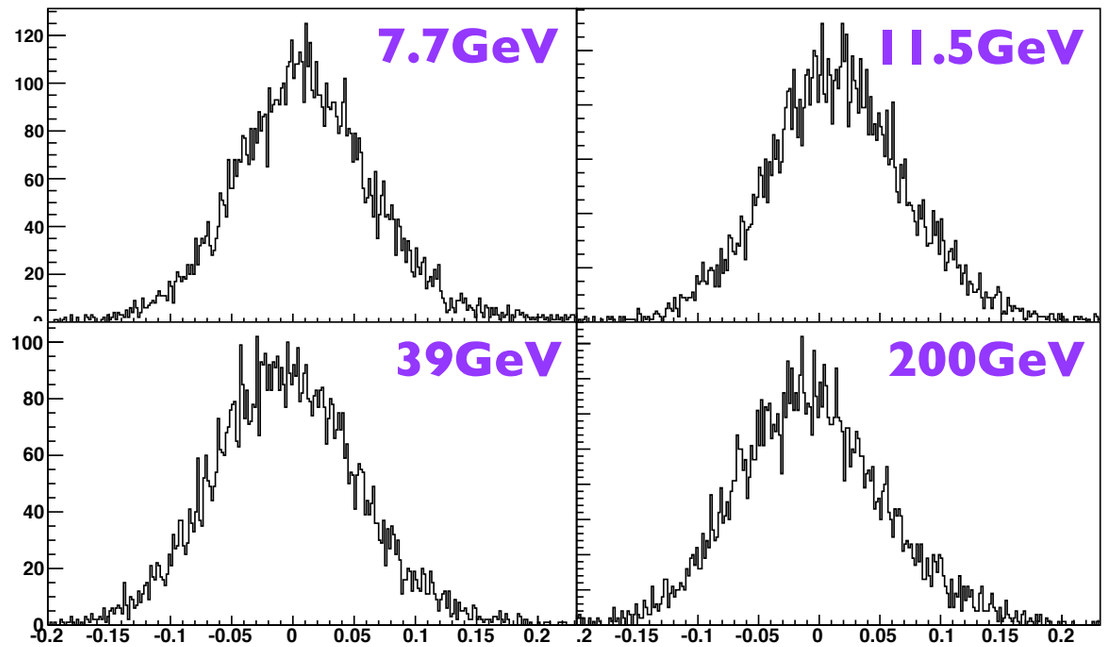
$${}^{3}_{\Lambda}H \rightarrow {}^{3}He + \pi^{-}$$



Daughter Identification

- ^3He





Rigidity >1GeV/c && Dca < 1cm && |ZHe3| < 0.2

	7.7	11.5	39	200(minbias)	200(central)
^3He	9909	7623	7640	4963	7402
$^3\overline{He}$	0	0	155	1997	2842

$$Z = \ln\left(\frac{dE/dx^{data}}{dE/dx^{Bichsel}}\right)$$

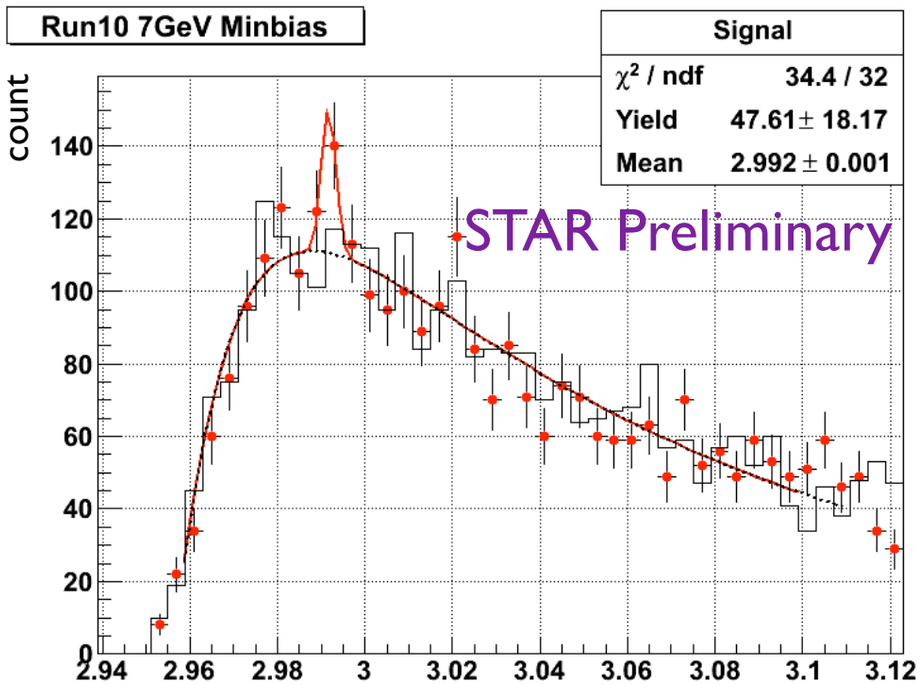
Theory curve: Phys. Lett. B 667 (2008) 1

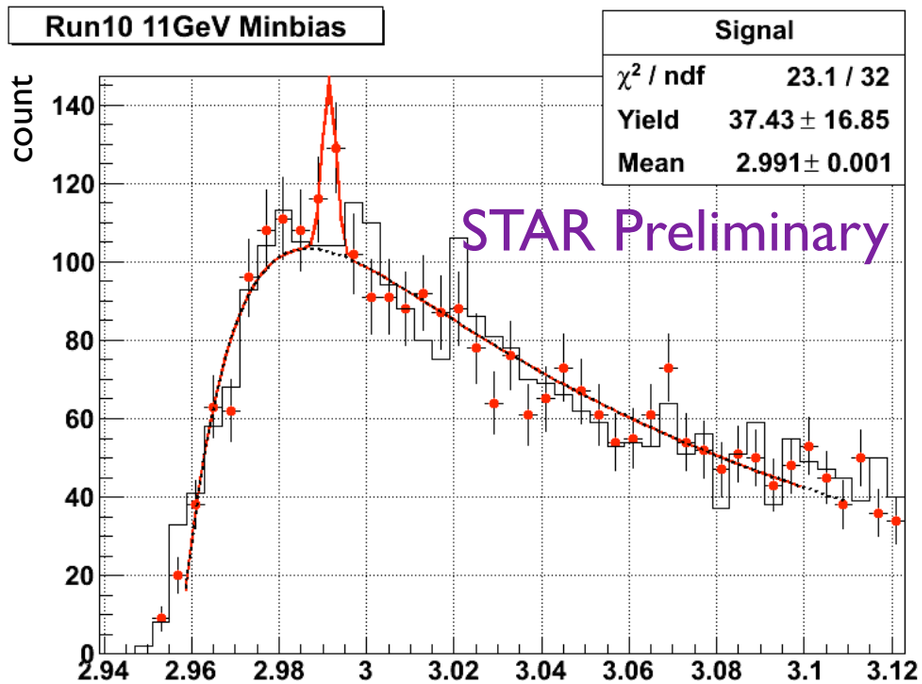
- π^-

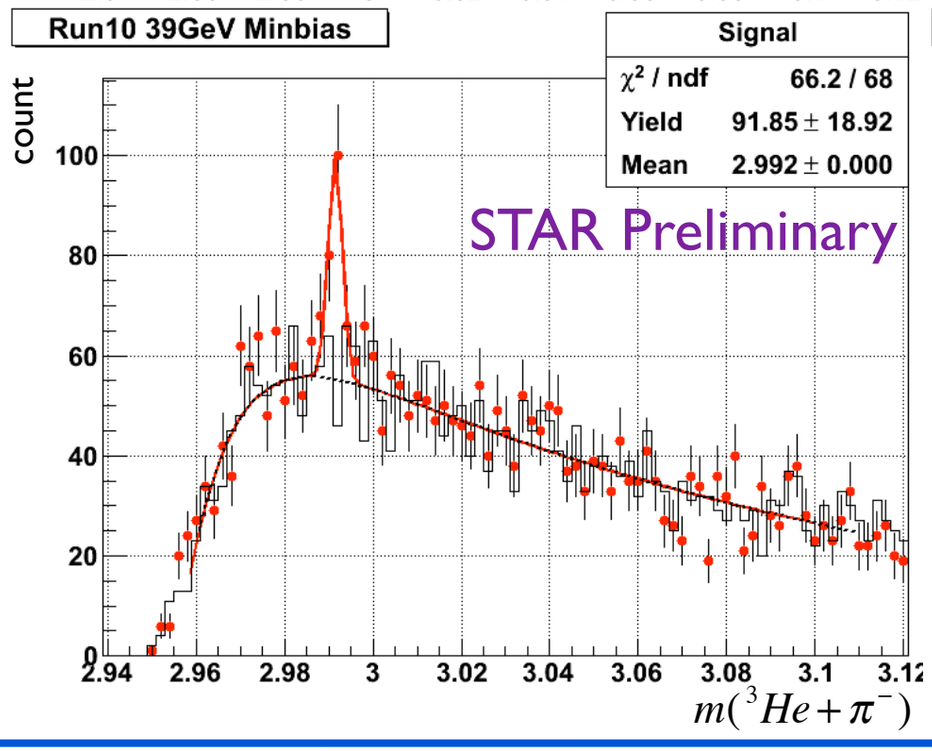
$$|n\sigma_\pi| < 2$$

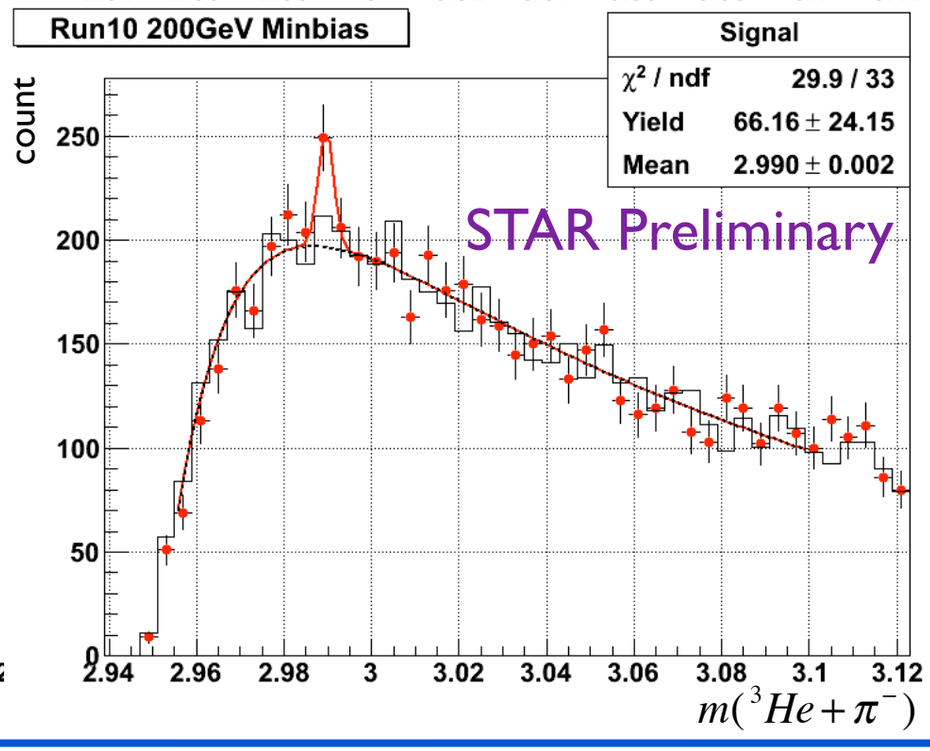
Signal Extraction

- ${}^{3}_{\Lambda}\mathrm{H}+{}^{3}_{\bar{\Lambda}}\bar{\mathrm{H}}$ Raw Yields







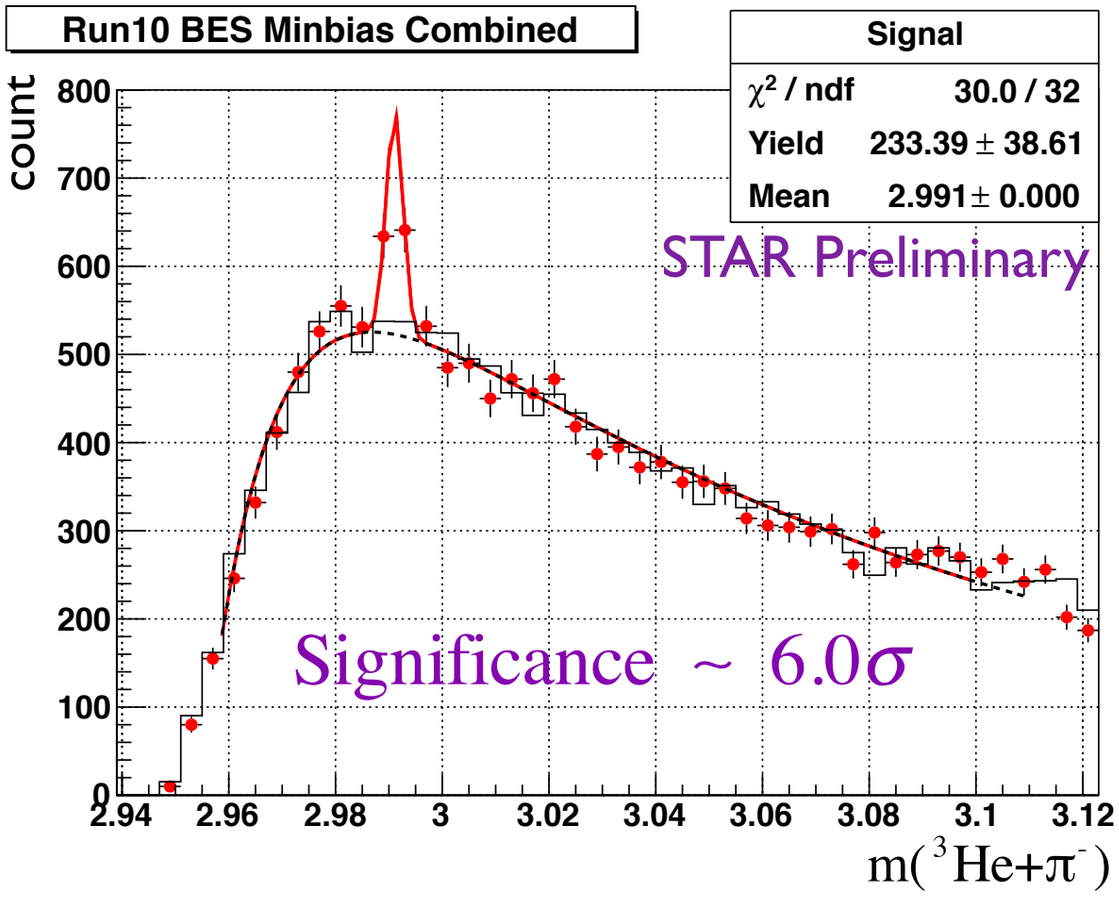


Signal Extraction

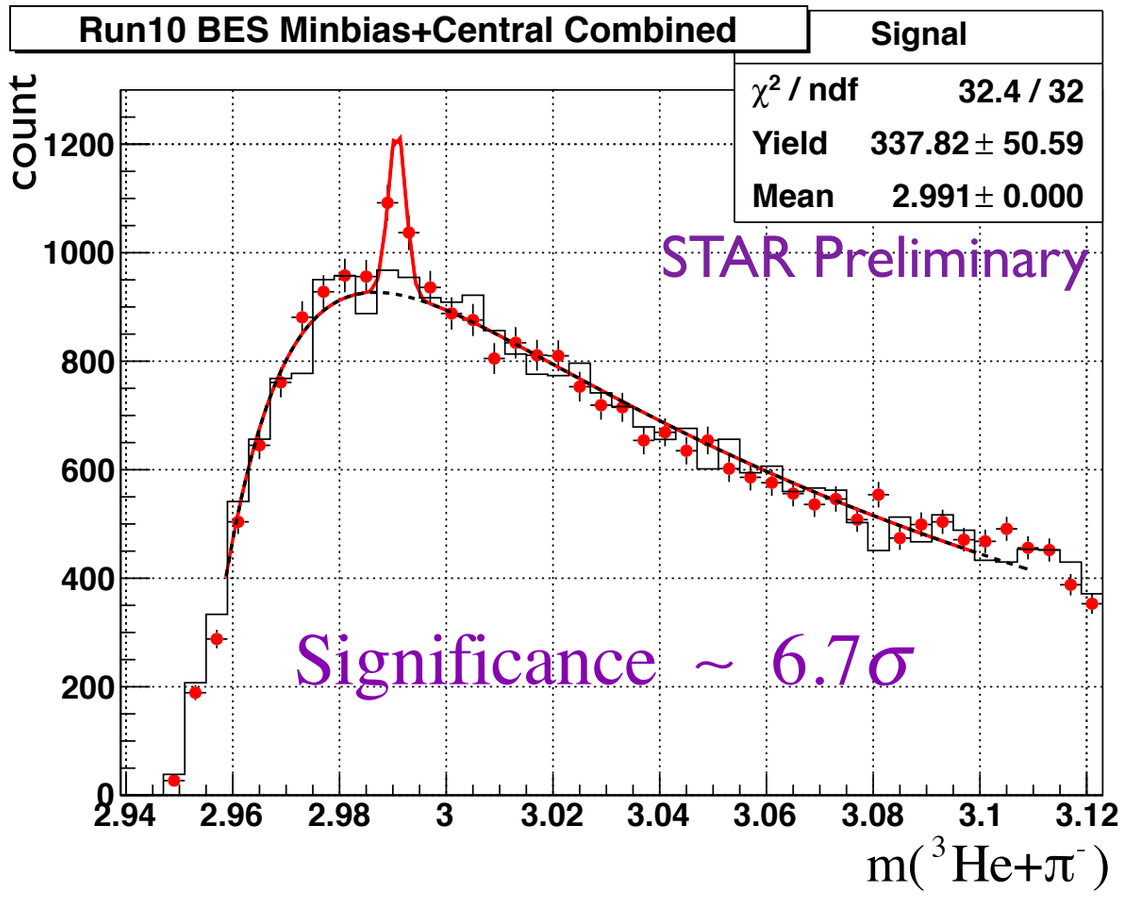
- Run10 Combined Raw Signal $\left({}^{3}_{\Lambda}\mathrm{H}+{}^{3}_{\bar{\Lambda}}\bar{\mathrm{H}}\right)$

Combine all the results to prove the correctness of separate signals

Only minbias

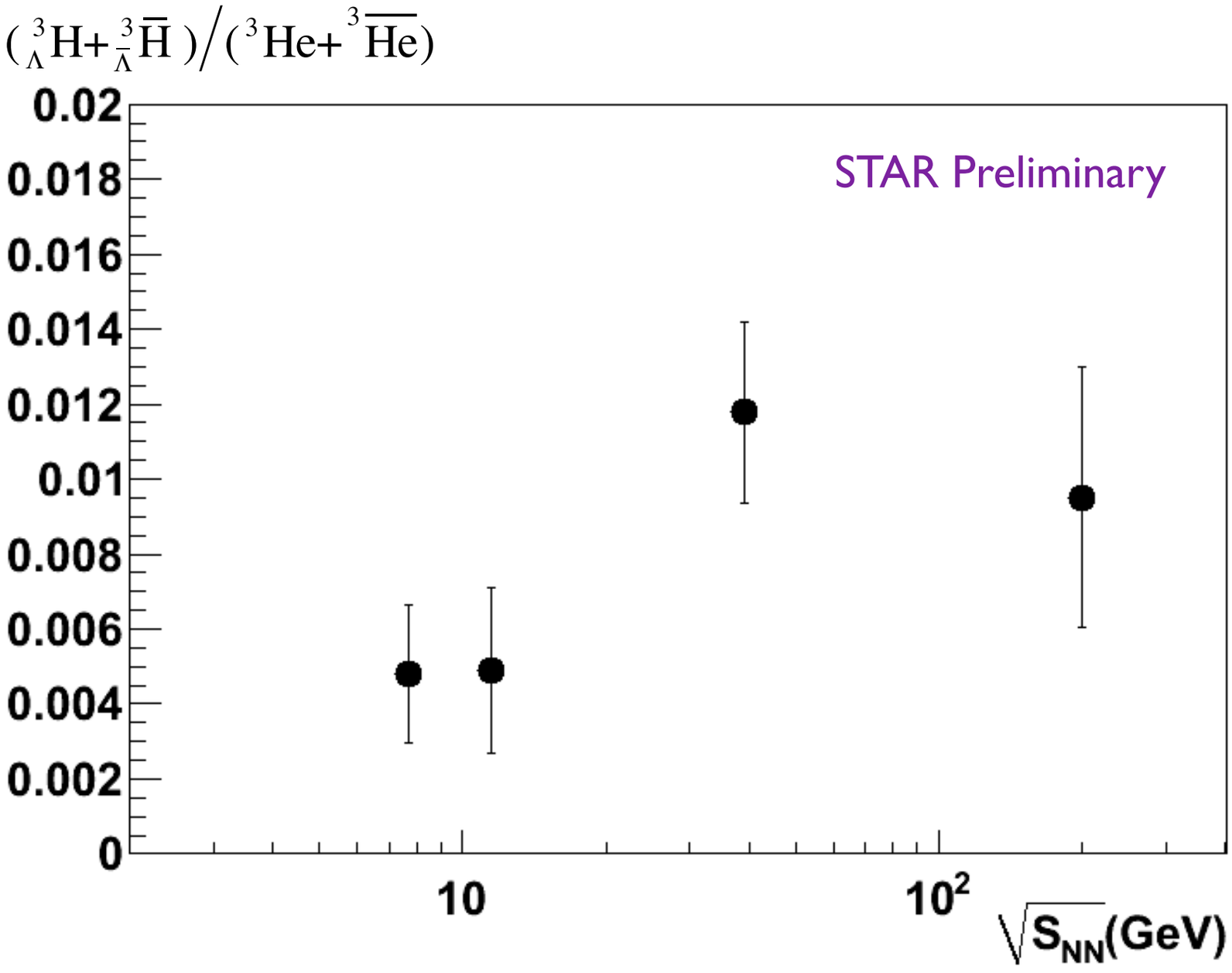


minbias+central



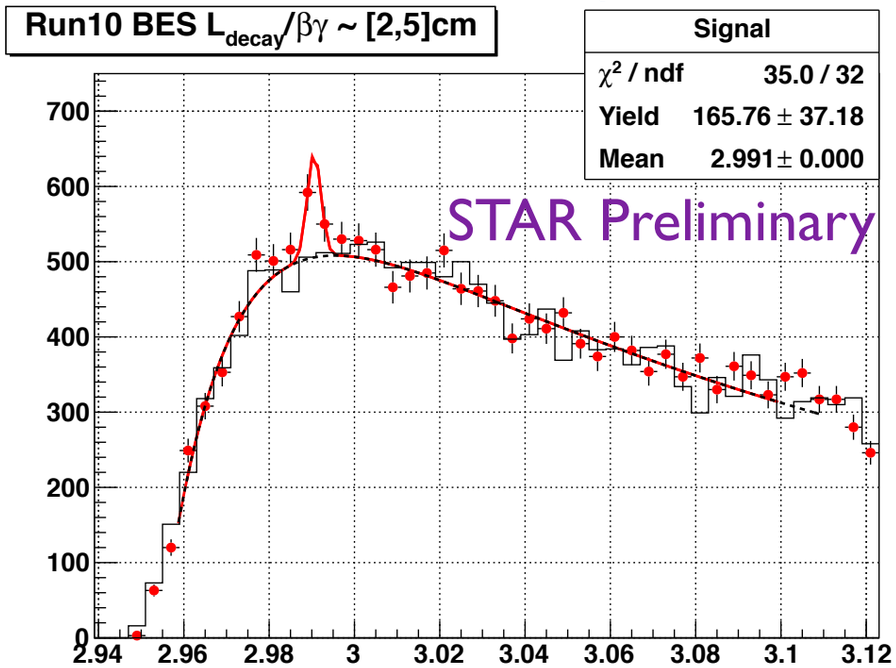
$\left({}^{3}_{\Lambda}\mathrm{H}+{}^{\overline{3}}_{\overline{\Lambda}}\overline{\mathrm{H}}\right)\Big/\left({}^{3}\mathrm{He}+{}^{\overline{3}}\overline{\mathrm{He}}\right)$ Raw Ratio

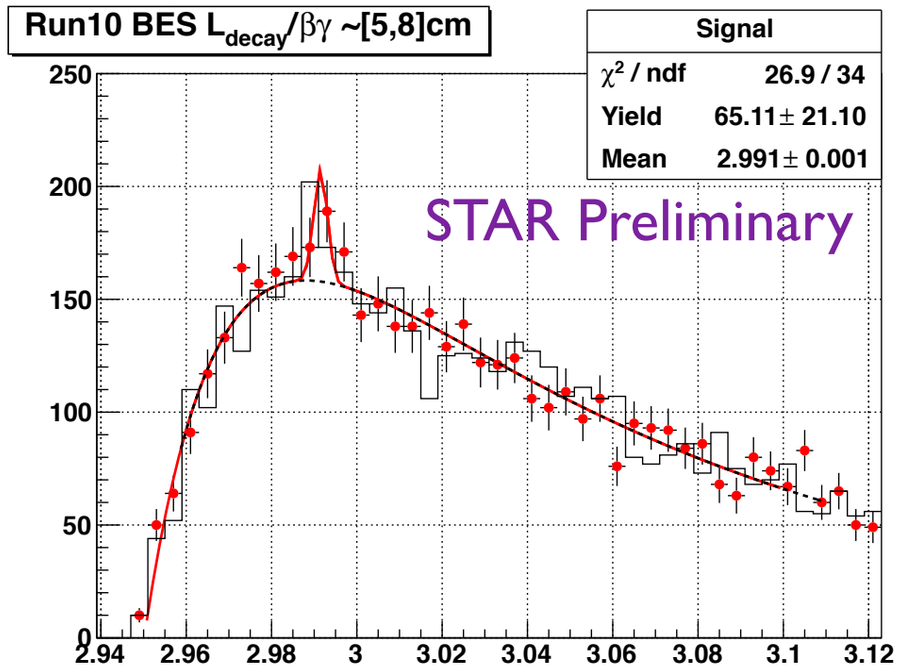
- Beam Energy Dependence

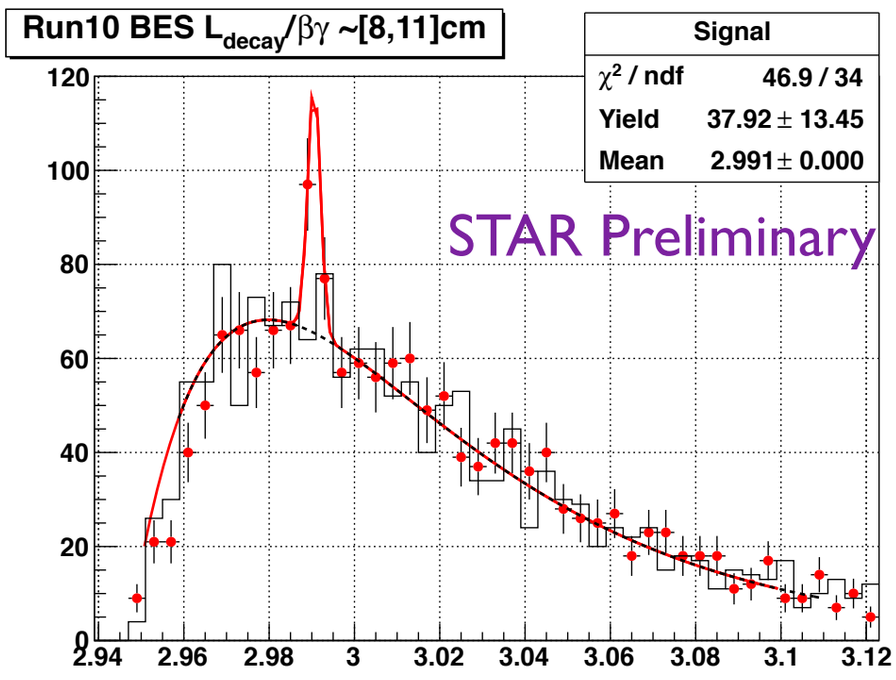


Lifetime Measurement

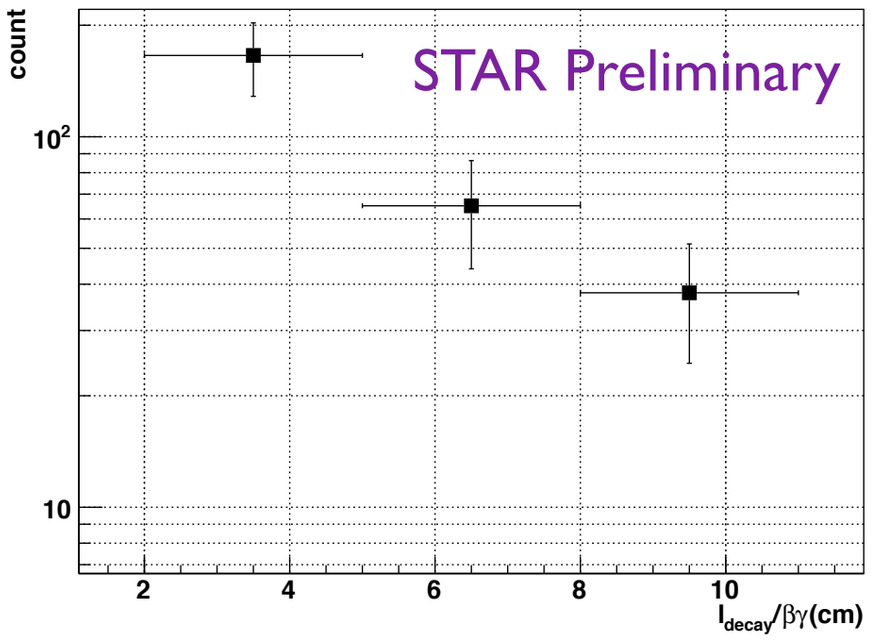
- Combine Data(Uncorrected Yield)







$$N(t) = N(0)e^{-t/\tau} = N(0)e^{-l/(\beta\gamma c\tau)}$$



Conclusions and Outlook

- ${}^{3}_{\Lambda}\mathrm{H}+{}^{3}_{\bar{\Lambda}}\bar{\mathrm{H}}$ raw yield is derived in 7.7, 11.5, 39, 200GeV data.
- Beam energy dependence of $({}^{3}_{\Lambda}\mathrm{H}+{}^{3}_{\bar{\Lambda}}\bar{\mathrm{H}})\Big/({}^{3}\mathrm{He}+{}^{3}\overline{\mathrm{He}})$ uncorrected ratio is shown.
- Raw lifetime measurement of combined BES data is shown.
- Further efficiency correction will be applied to obtain physical quantities (yields and lifetime)
- New datasets from Run11 data(19.6GeV, 27GeV) and 200 GeV will be added in the future.

Thanks!