Overview of Experiment E05-115 at JLAB

Spectroscopic Investigation of Lambda Hypernuclei in the Wide Mass Region by the Reaction (e,e'K^+)

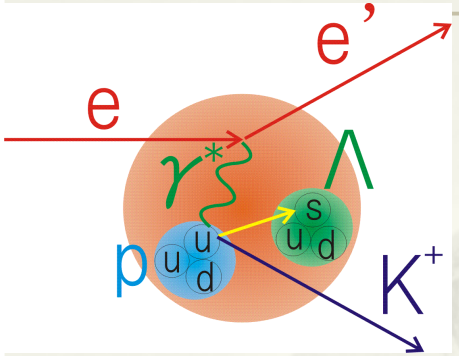
Hampton University

Chunhua Chen

Outline

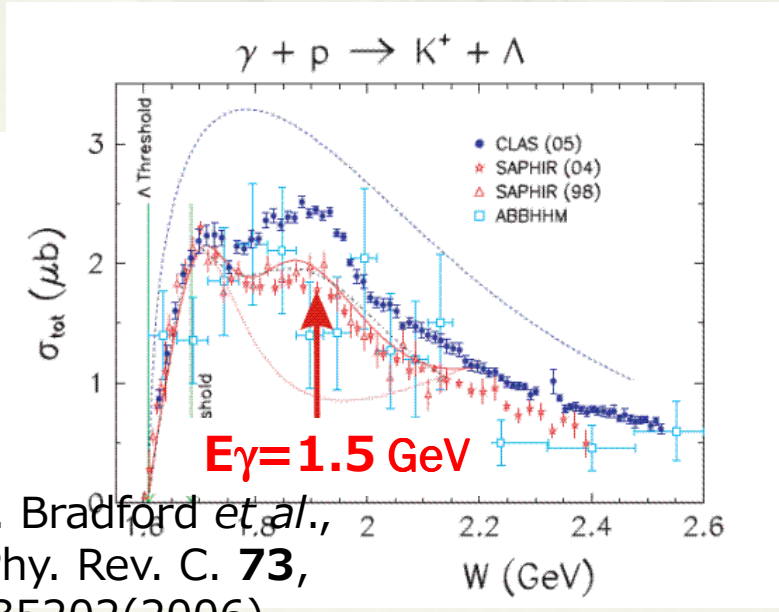
- **Introduction**
- **Exp. Setup and Improvements**
- **Data Summary**

Λ hypernuclear spectroscopy via (e,e'K$^+$)



Merits of (e,e'K$^+$) experiment

- ☺ Large momentum transfer
  → Excitation of deeply-bound state
- ☺ p to Λ reaction → Mirror or Neutron-rich hypernuclei
- ☺ Spin-flip/non-flip production
- ☺ High Energy Resolution due to CEBAF beam's quality



R. Bradford *et al.*, Phy. Rev. C. **73**, 035202(2006)

CEBAF Bird's-eye photo

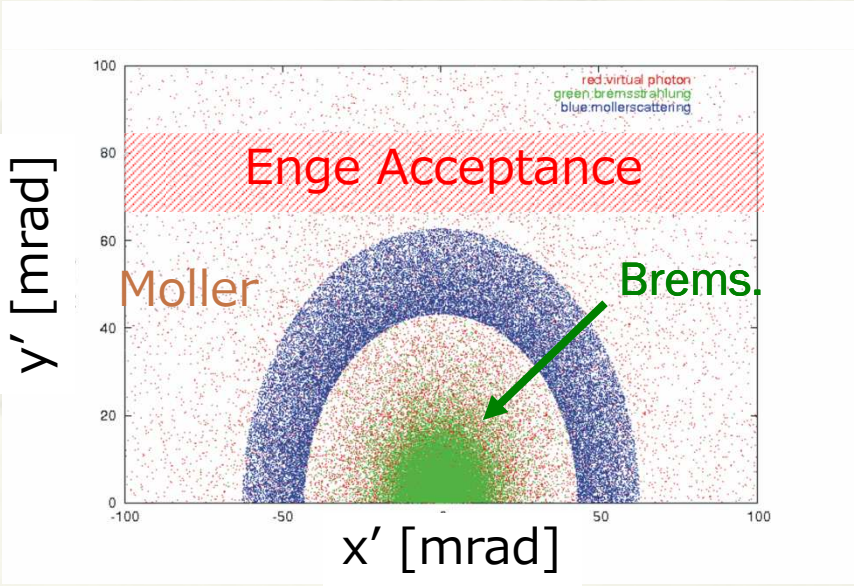
Previous (e,e'K$^+$) experiments in JLab-HallC

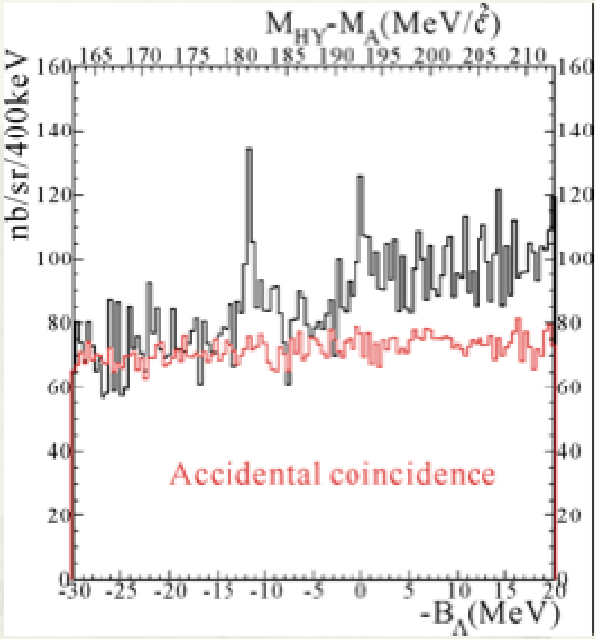
2000 1st Experiment : $^{12}_{\Lambda}$B

☺ First successful Λ hypernuclear spectroscopy via (e,e'K$^+$) reaction

☹ Limited energy resolution because of using existing Spectrometer on K$^+$ side(SOS)

☹ A lot of backgrounds on e' side (0° tagging)





E89-009 $^{12}_{\Lambda}$B
440h x 0.66μA

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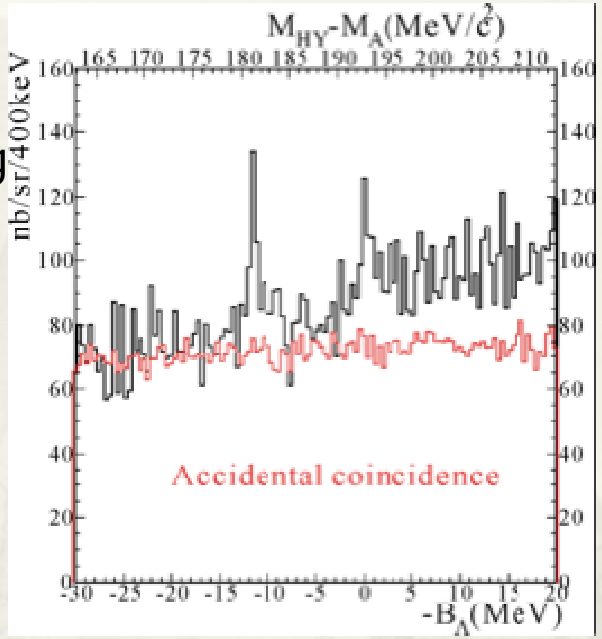

E89-009 $^{12}_{\Lambda}$B
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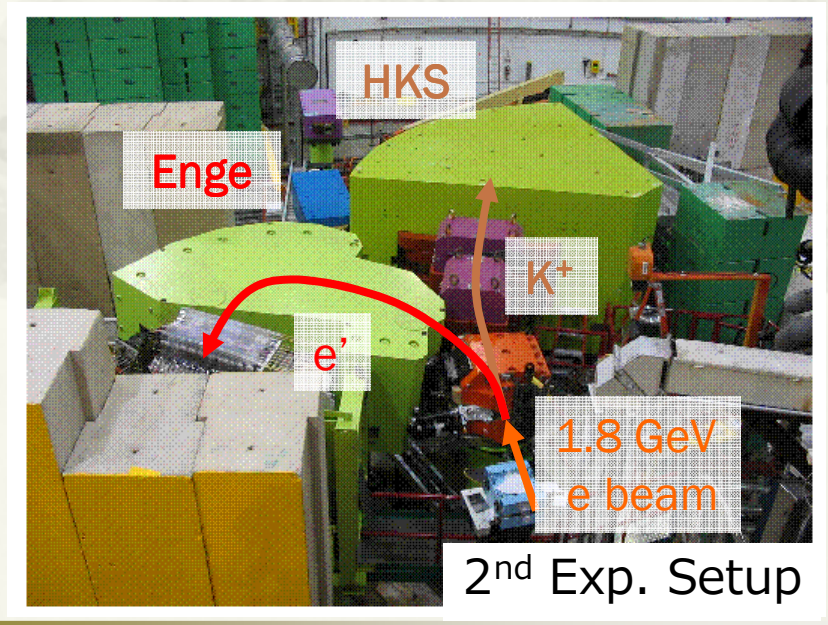
2005 2nd Experiment : $^{7}_{\Lambda}$He $^{12}_{\Lambda}$B, $^{28}_{\Lambda}$Al

☺ Newly-constructed **HKS** for K$^+$ side



2nd Exp. Setup

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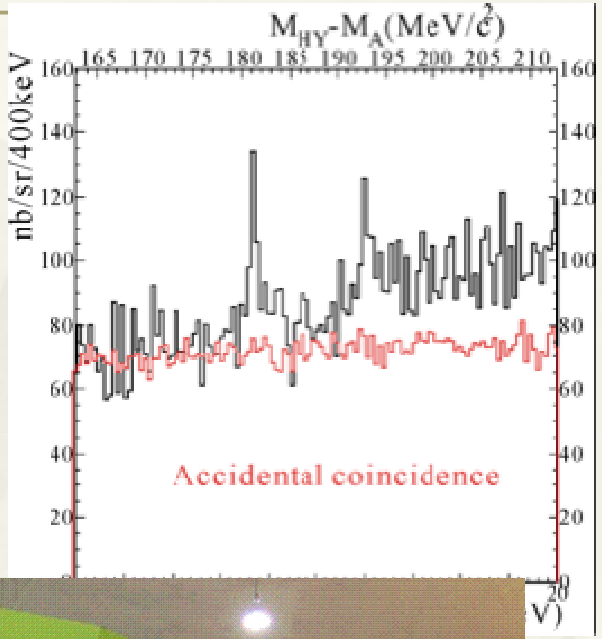
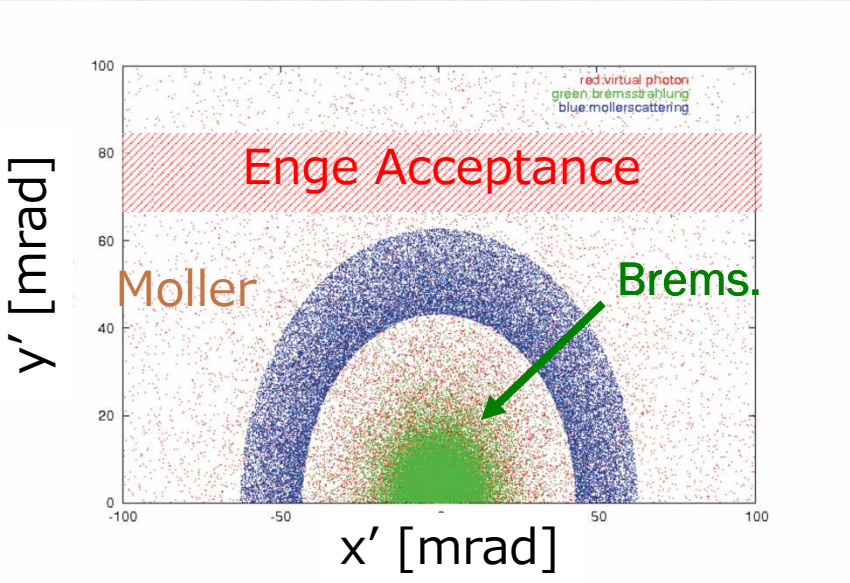
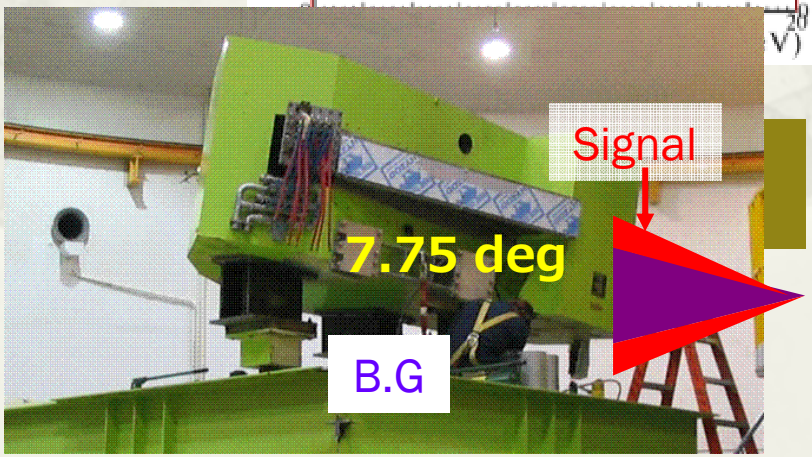
☺ Apply **"Tilt Method"** for e' side







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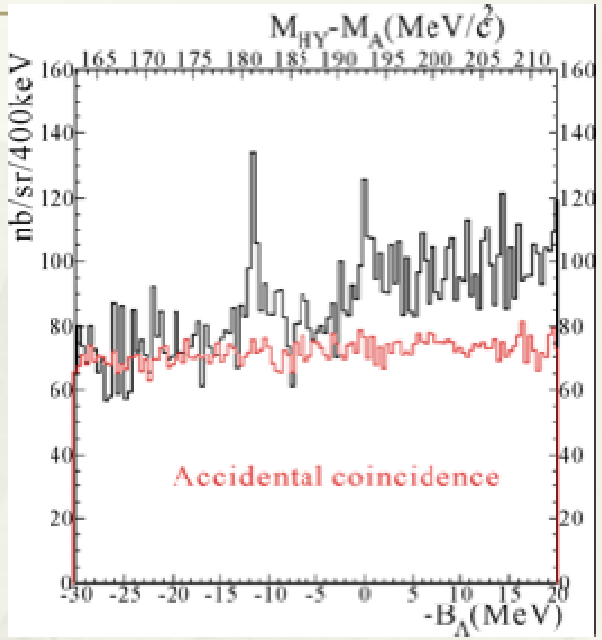

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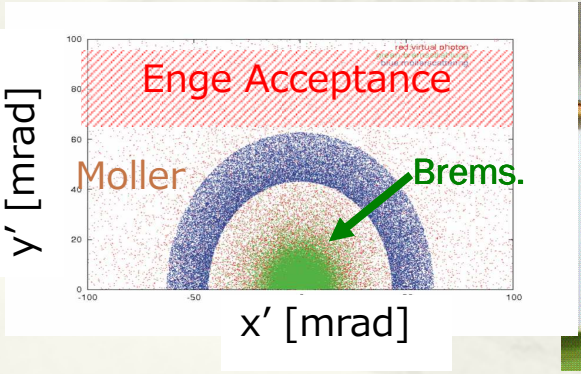
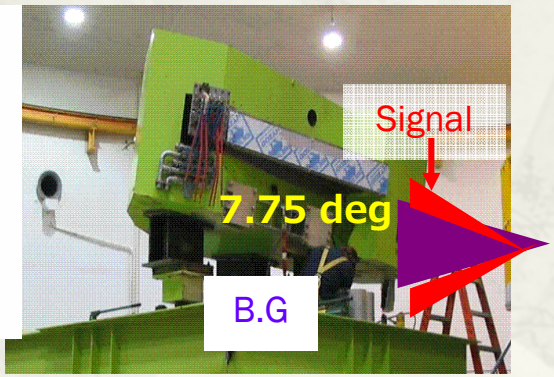




E89-009 $^{12}_{\Lambda}$B
440h x 0.66μA

	Beam	Target	e' Rate
1st Exp.	0.67μA	^{12}C, 22 mg/cm^2	200 MHz
2nd Exp.	30μA	^{12}C, 100 mg/cm^2	1 MHz

1/40000 Background per Luminosity

E05-115

The 3rd Generation (e,e′K+) Hypernuclear Spectroscopy

Aug. ~ Oct. 2009

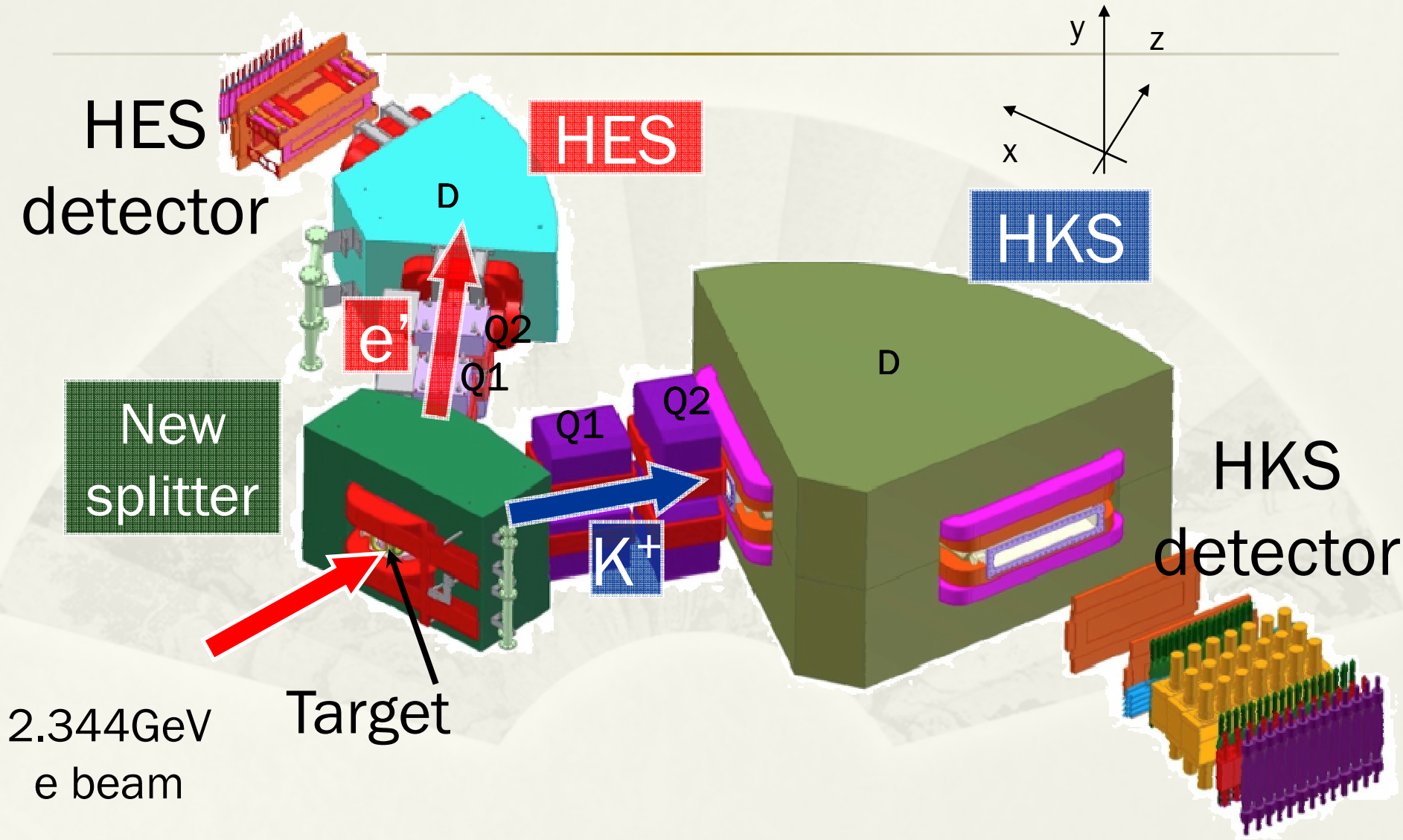
- Medium - heavy hypernuclear spectroscopy

  ^{52}Cr(e,e'K$^+$) $^{52}_{\Lambda}$V

  - Λ hyperon bound in the mean field
  - quark picture vs. conventional picture
- Light Λ hypernuclear spectroscopy
  - ΛN interaction, *ls* coupling, Charge Symmetry Breaking
    - p shell hypernuclei **$^{12}_{\Lambda}$B , $^{7}_{\Lambda}$He, $^{10}_{\Lambda}$Be , and $^{9}_{\Lambda}$B**
  - Calibration by the elementary process p(e,e'K$^+$)Λor Σ: H_2O and CH_2

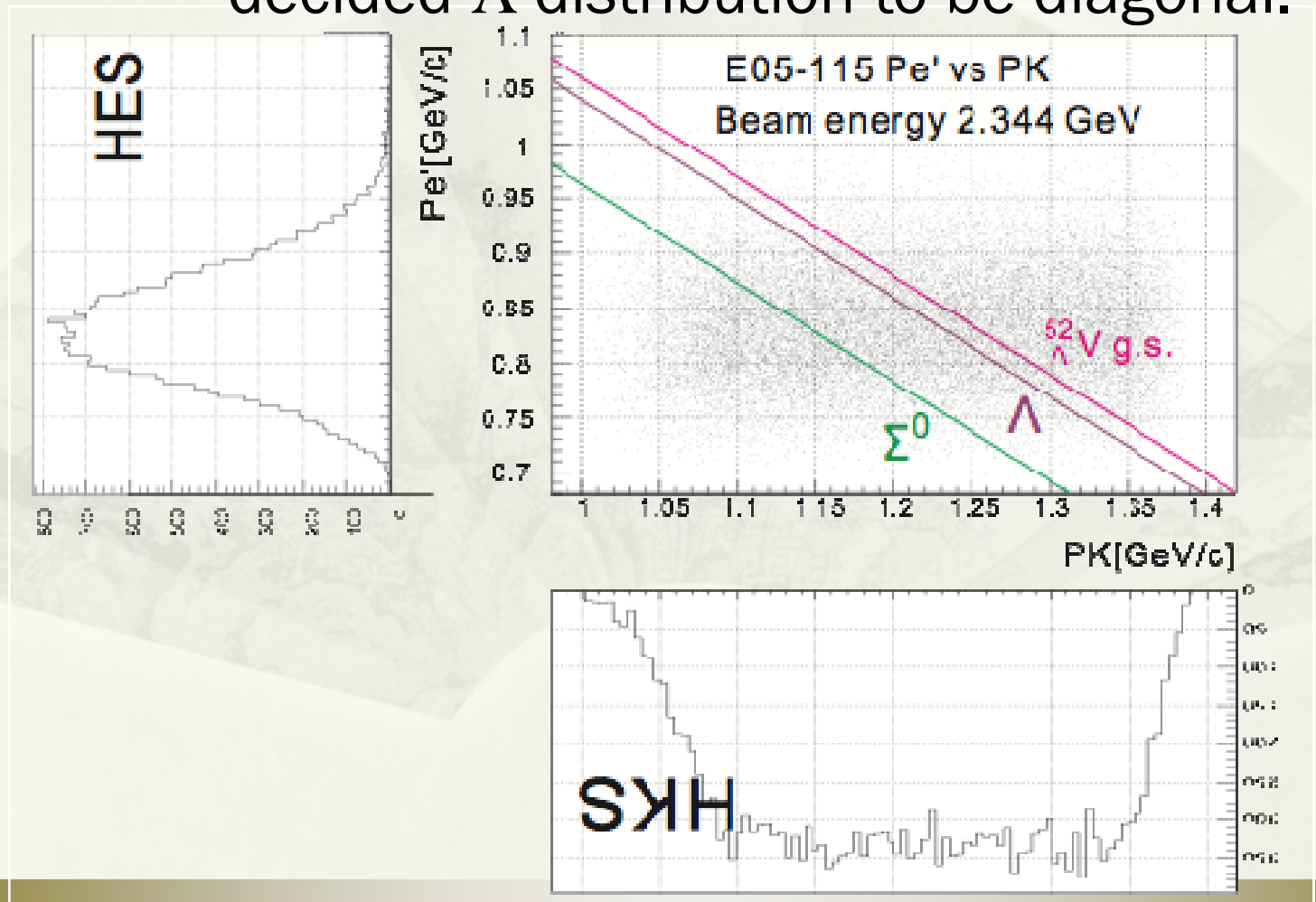
Application of newly developed
HES (High-resolution Electron Spectrometer)

E05-115 setup



Momentum Acceptance

Momentum acceptance between K^+ and e' are decided Λ distribution to be diagonal.



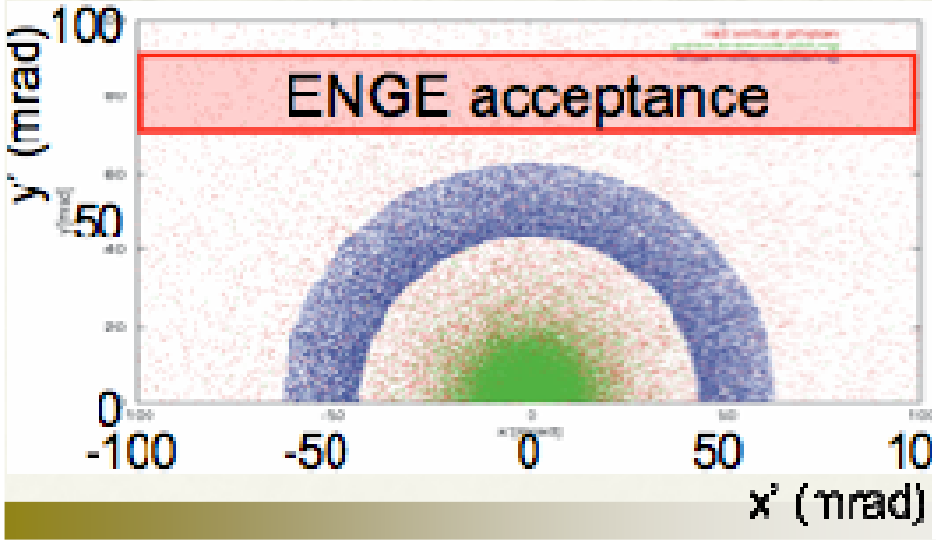
Experimental Improvements

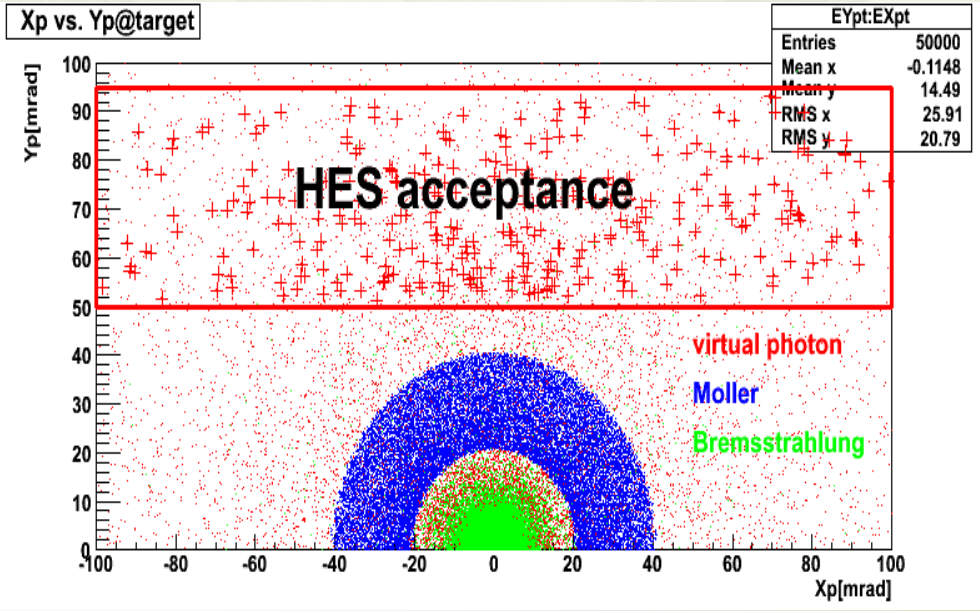
◆ Beam Energy 1.8 →2.344 GeV

Background electrons go more forward

S/N Ratio ↑

Beam Current ↑





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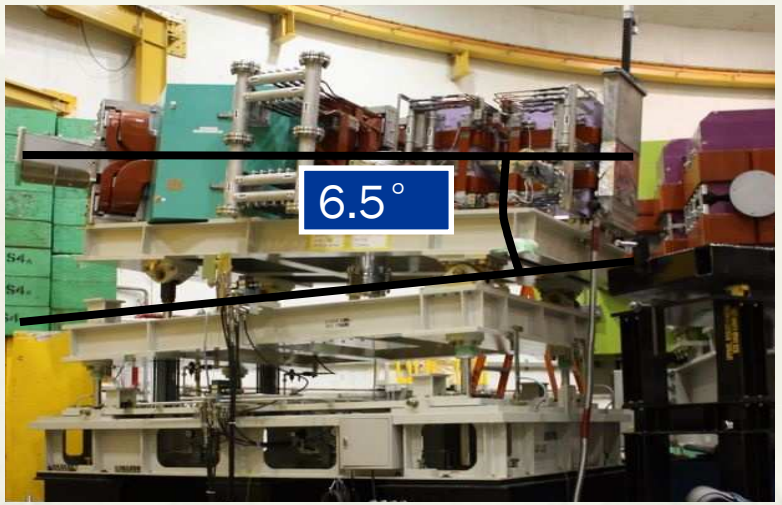

◆Brand-new e' spectrometer, HES

Enlarge acceptance ↑

Virtual Photon Yield ↑

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◆Brand-new e' spectrometer, HES

Enlarge acceptance ↑

Virtual Photon Yield ↑

Tilt Method Works More Effective

Statistics

Small Cross Section ($^{52}_{\Lambda}$V<100nb/sr)

Coincidence experiment

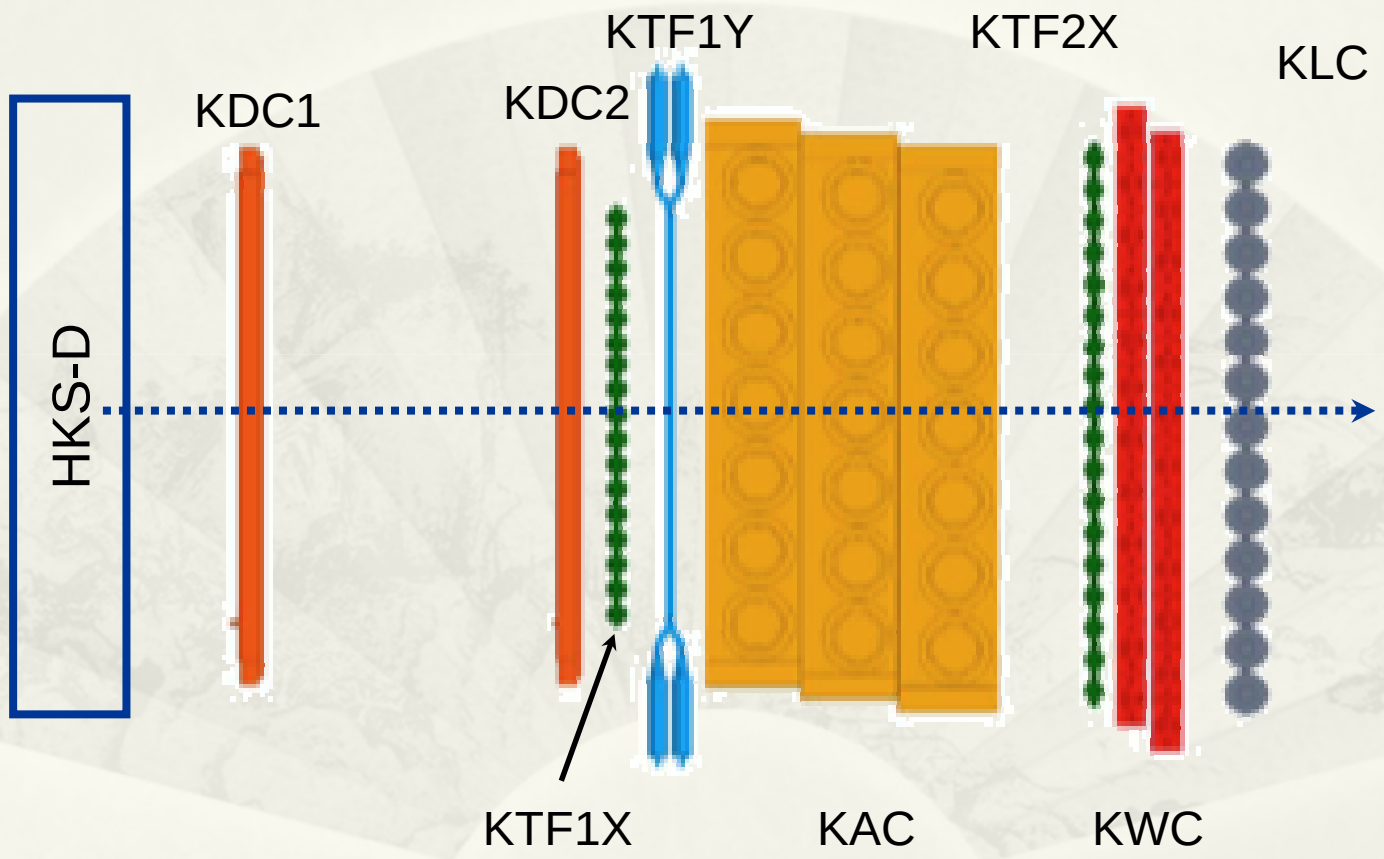
Wide Mass Region

Experimental Improvements

Design Energy Resolution

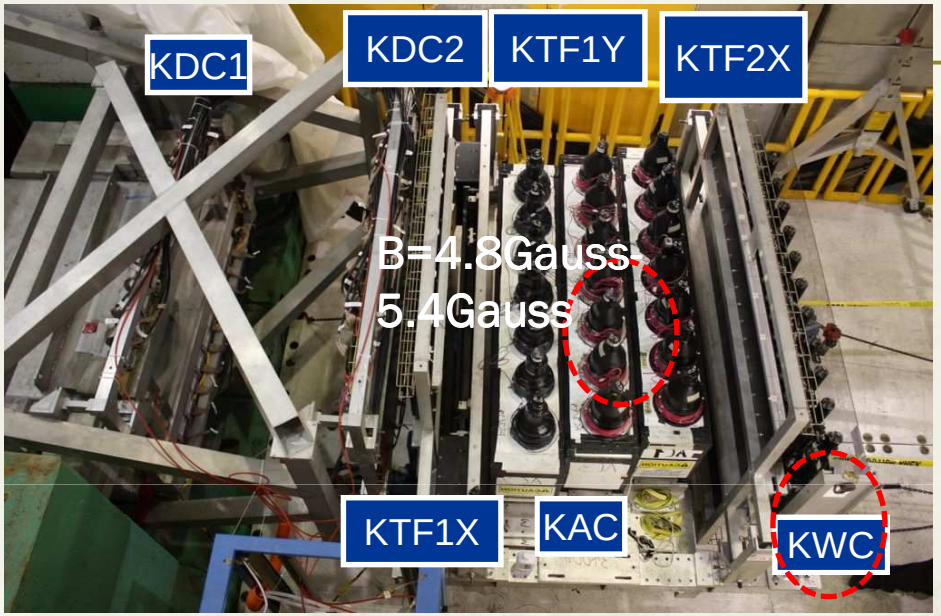
Target	^{7}Li	^{10}B	^{12}C	^{52}Cr
HKS momentum(keV)	210	210	220	220
HKS angle (keV)	100	70	60	10
HES momentum (keV)	160	160	160	170
HES angle (keV)	90	60	50	10
Beam energy (keV)	≦160			
Target (100mg/cm^2)	≦100	≦110	≦110	≦90
Overall (keV)	**≦350**	**≦340**	**≦340**	**≦330**

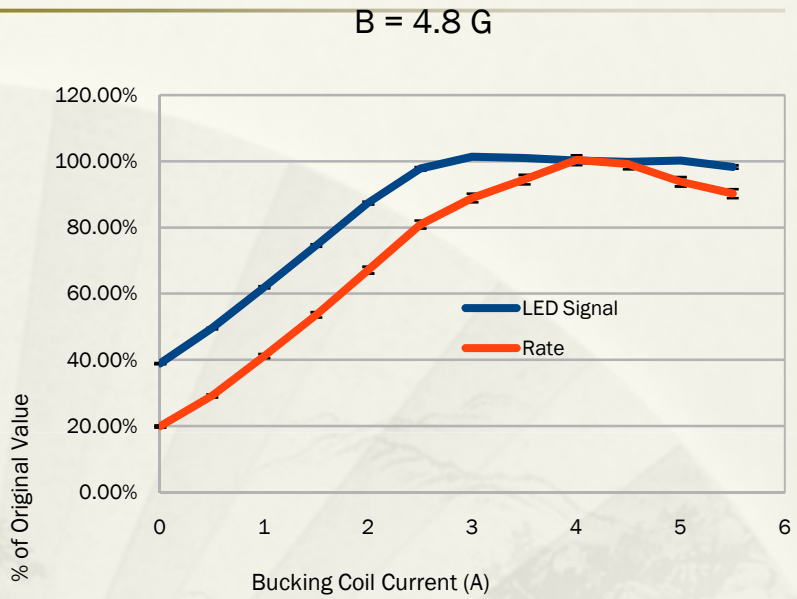
HKS Detectors



HKS Detectors-Bucking Coil

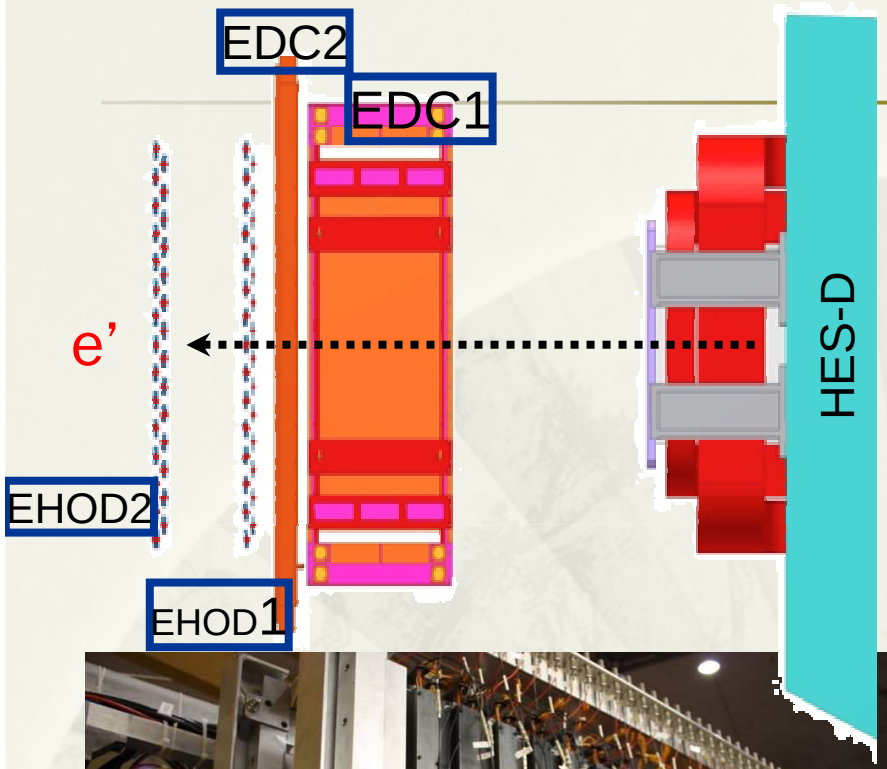
HKS-D

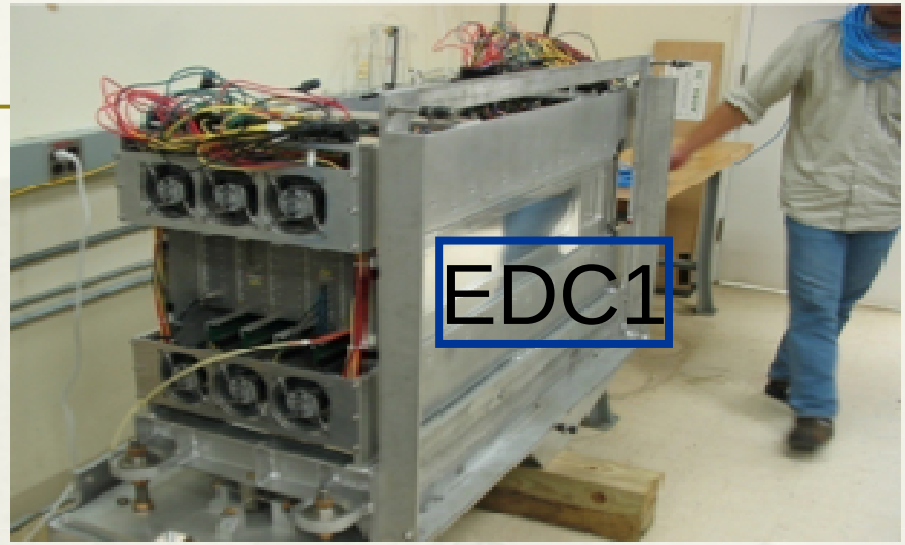


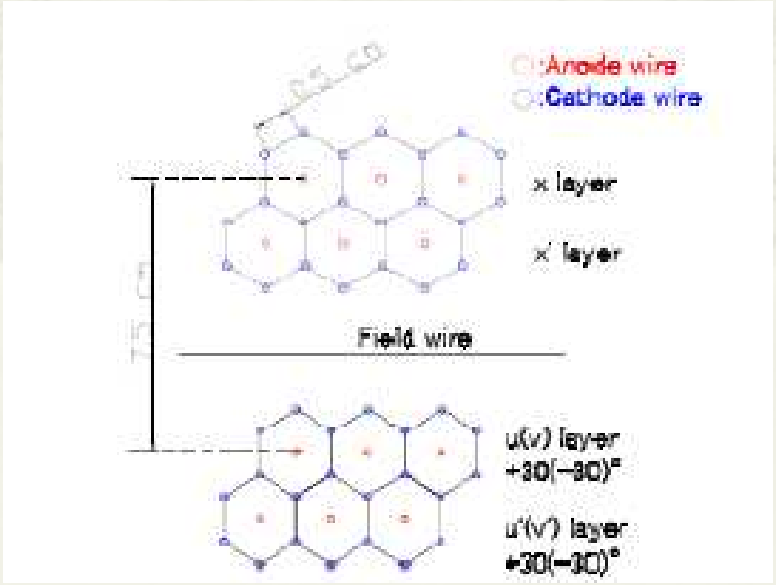


Bucking coil is used to help to cancel external magnetic field that is along axis of PMTs of Cherenkov detectors

HES Detectors







Data summary

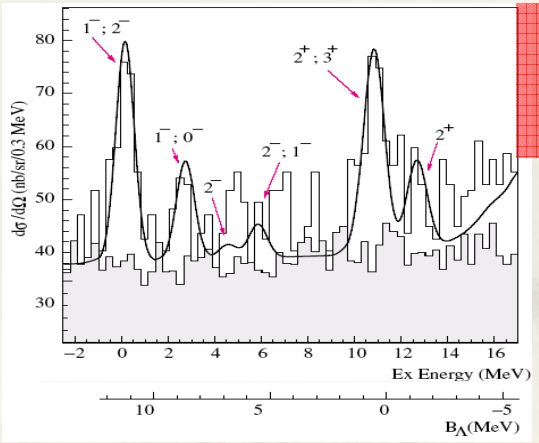
Quasi-free Λ & expected g.s. yields

Target	Number of Quasi-Free Λ (observed)	Quasi-Free Λ Cross Section (assumed)	Hypernuclei (g.s) Cross Section (assumed)	Expected number of g.s
^{7}Li	6.4 x10^{4}	1.0 μb/sr	21 nb/sr	1300
^{9}Be	4.5 x10^{4}	1.2 μb/sr	4 nb/sr	150
^{10}B	4.8 x10^{4}	1.3 μb/sr	21 nb/sr	780
^{12}C	3.4 x10^{4}	1.5 μb/sr	112 nb/sr	2500
^{52}Cr	1.4 x10^{4}	4.7 μb/sr	69 nb/sr	210

- Cross section of QF Λ is assumed as $0.2*A^{0.8}$ [μb/sr]
- # of g.s is calculated as (# of Λ)*(g.s cross section)/(QF Λ cross section)
- Cross Section of ^{9}Be is derived by Progress of Theoretical Physics Supplement No.117 (1994) pp. 151-175 (M. Sotona and S. Frullani) and other cross sections are summarized in E05-115 experiment proposal (JLab PAC 28 and 33).

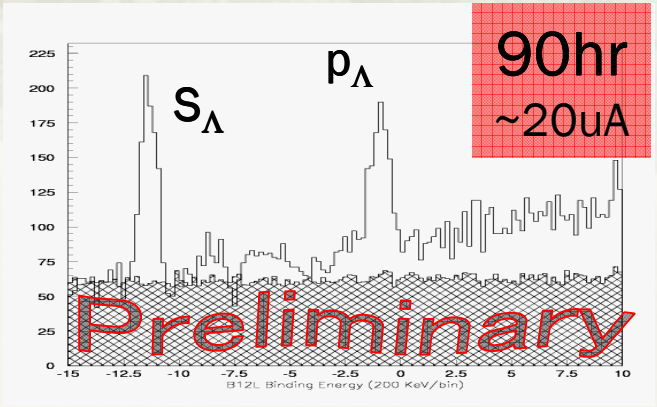
$^{12}_{\Lambda}$B Spectrum

1st Experiment (E89-009)



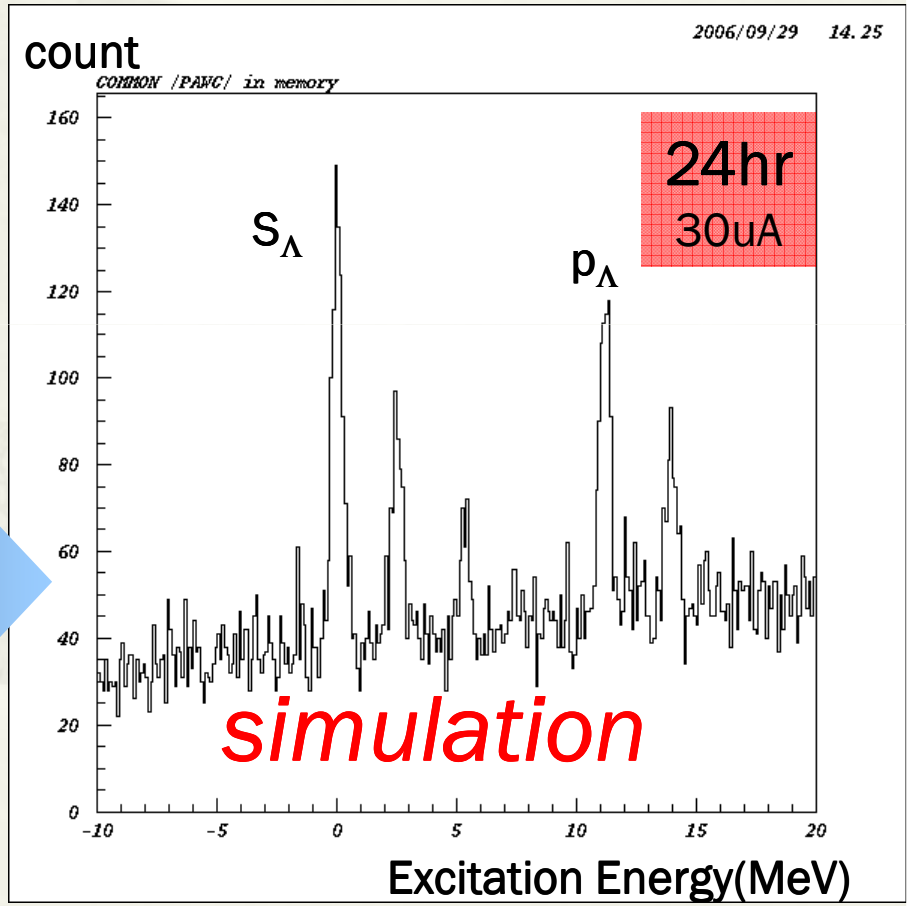
292hr
0.66uA

2nd Experiment (E01-001)



90hr
~20uA

3rd Experiment (E05-115)

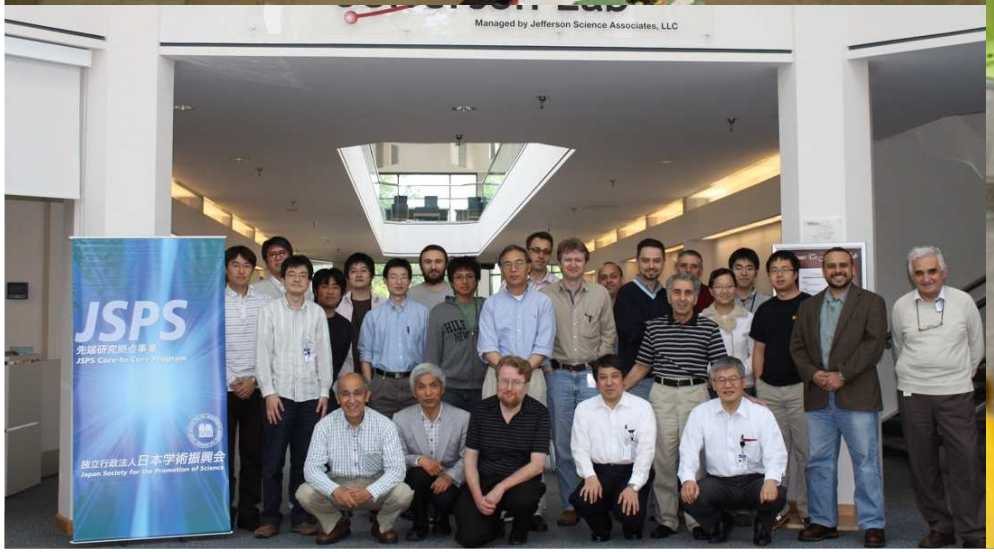


24hr
30uA

Summary and To do

- The third gen. exp. E05-115 (HKS-HES) successfully finished, both HES and HKS worked well.
- To Do
  - Tracking is going on, multiplicity comes from high luminosity should be taken care.
  - Timing,PID,Optics, Kinematics, and Missing Mass

Thank you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