Detectors and spectrometers for hypernuclear experiment at Hall C

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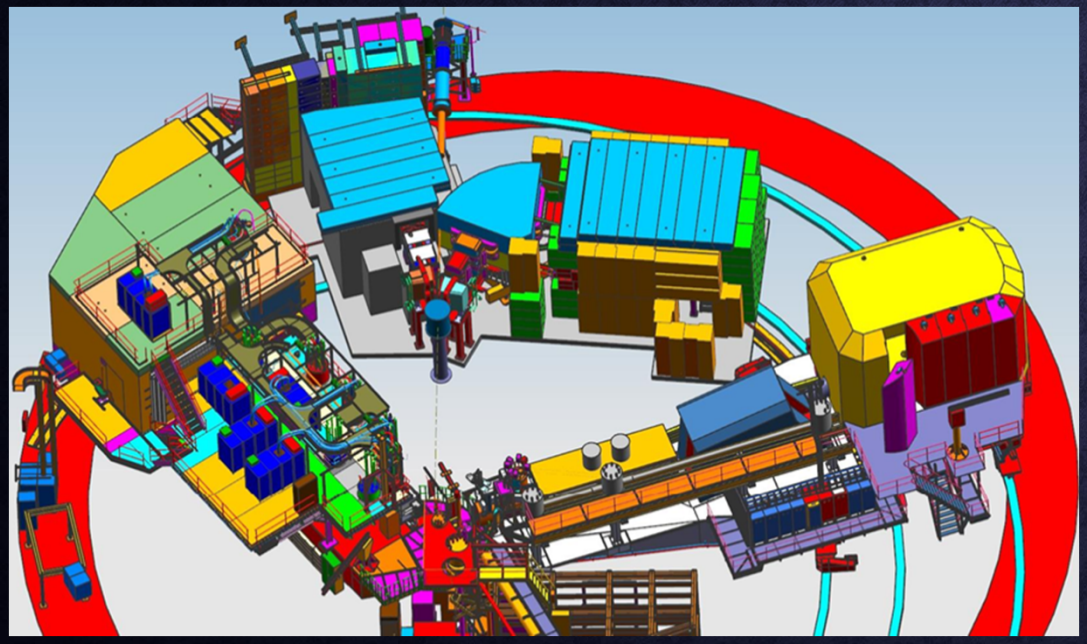
KYOTO UNIVERSITY

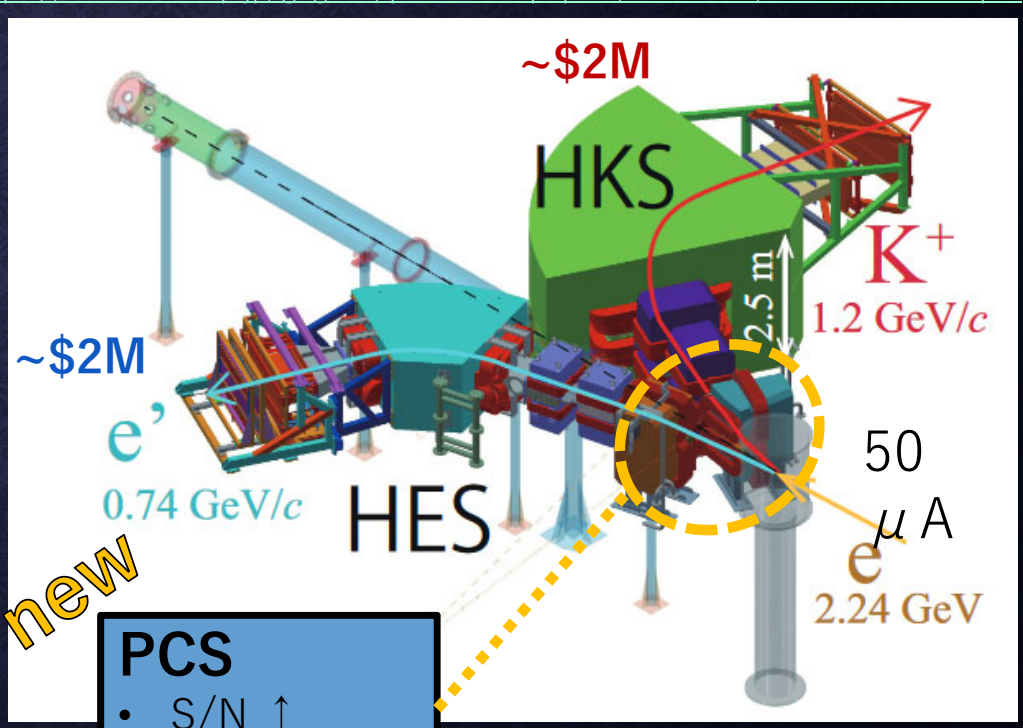
Next experiment at JLab Hall C (FY2026~)

Hall A (original proposal) → Hall C



Steven Lassiter & Bert Metzger, JLab Hypernuclear Collaboration Meeting 2022, online, Dec 2022, https://wiki.jlab.org/tegwiki/index.php/Hypernuclear_CollaborationMeeting_2022Dec

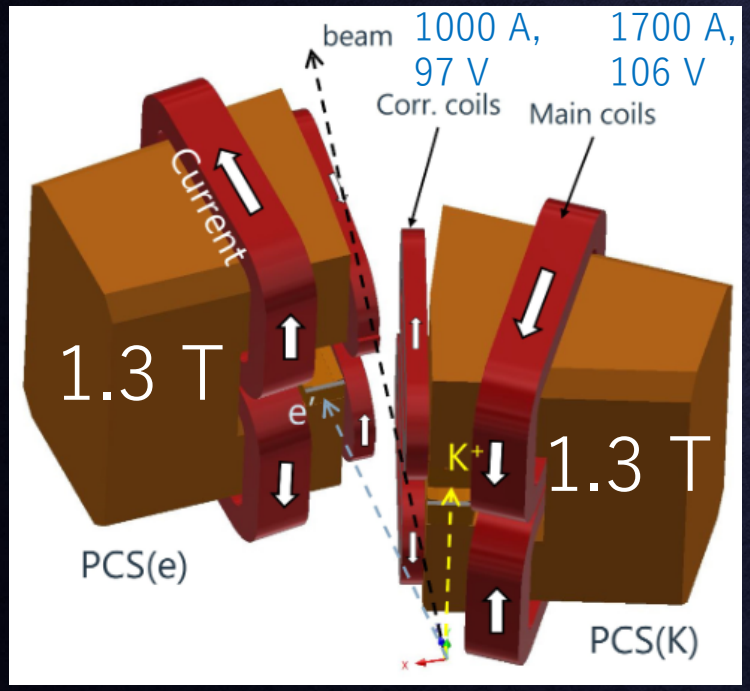
Schematic from LOI12-23-013 (TG et al., LoI to PAC51): https://researchmap.jp/gogami/published_papers/42361620/attachment_file.pdf



Existing spectrometers HES and HKS are going to be used

New magnet PCS

(Pair of charge separation dipole magnets)

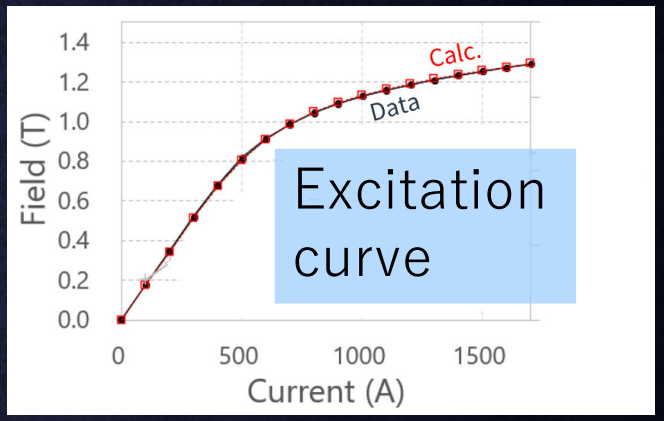


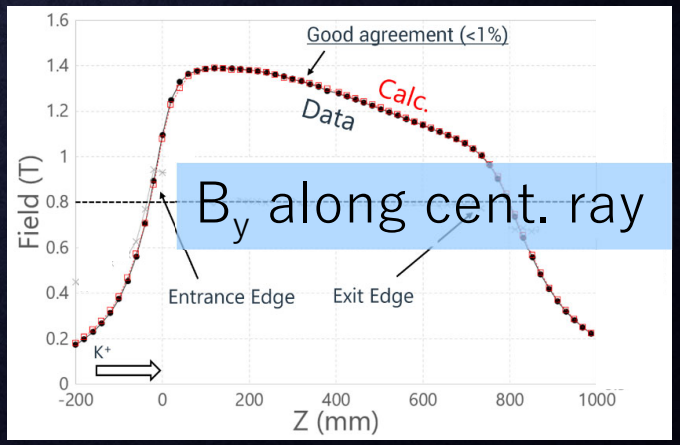
Mar 2020 @TOKIN, Japan

Shipping

Feb 2022 @ JLab

Measurement vs. TOSCA calc.





It worked as expected !!

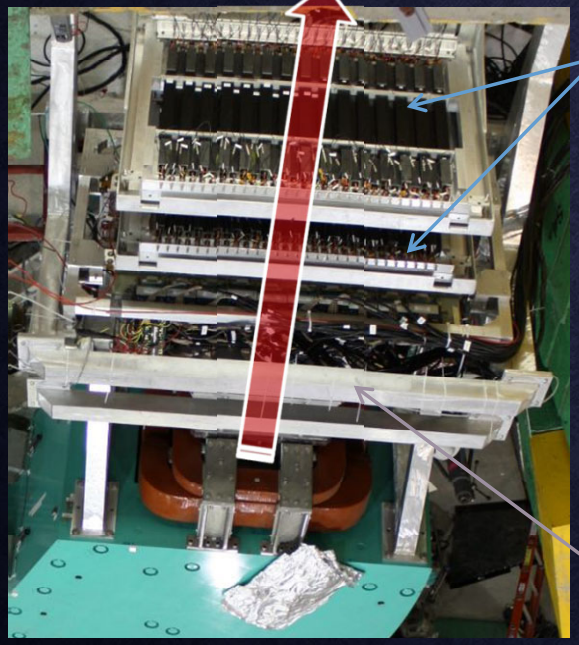
科研費 KAKENHI

Supported by KAKENHI:
No. 17H01121 (**33,500,000 JPY**)
No. 18H05459 (**144,100,000 JPY**)

> $ 1 M

Particle Detectors in HES and HKS

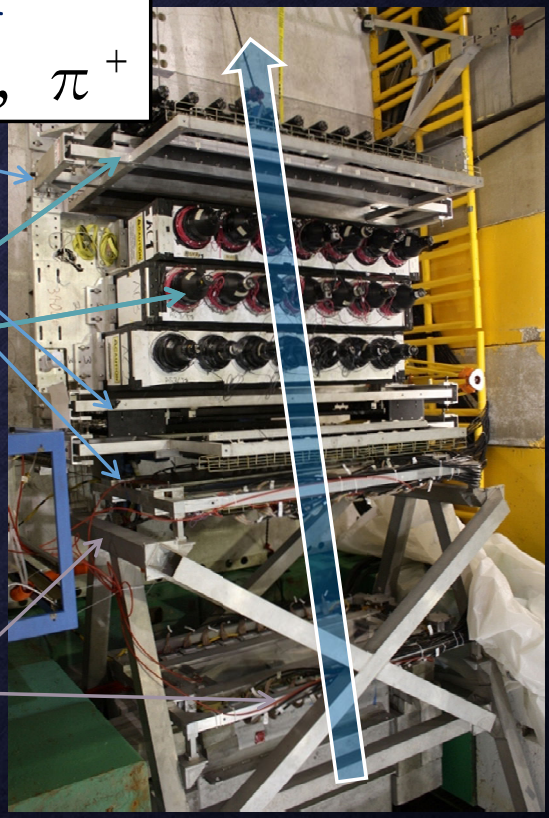
HES



TOF walls
(Plastic scintillators)

Cherenkov detectors
- Aerogel (n=1.05)
- Water (n=1.33)

Drift chambers



HKS

Detectors are existing, and being commissioned at ESB

Necessary TDC/ADC

Spec.	Detector	ADC	TDC
HKS	KDC1, KDC2	N/A	360+360
	KTOF1X, KTOF2X,KTOF1Y)	88	88
	AC	42	42
	WC	48	48
HES	EDC1, EDC2	N/A	1098+360
	ETOF1, ETOF2	116	116

ex.) FB 1877

Low resolution TDC

720 → 8 (768 ch)

1458 → 16 (1536 ch)

ex.) FB 1875

High resolution TDC

88 → 2 (128 ch)

116 → 2 (128 ch)

ADC ch	178	116
FADC	12 (192 ch)	8 (128 ch)

+ VTPs for trigger

Pre-trigger modules for level 2 stage trigger

Spect.	FADC (96 ch/mod.)	LR TDC (64 ch/mod.)	HR TDC
HES	12	8	2
HKS	8	16	2
Total	**20**	**24**	**4**

Necessary power supplies for magnets

Side	Magnet	Power /V		Current /A		Remarks
		Max.	Operation	Max.	Operation	
HES	PCS-e (S)	97	11	1000	109	
	PCS-e (L)	106	12	1700	186	
	Q1	89	45	800	440	
	Q2	87	61	800	560	
	D	197	169	1065	916	
HKS	PCS-K (S)	97	68	1000	705	
	PCS-K (L)	106	75	1700	1200	
	Q1	160	130	875	712	
	Q2	54	37	450	306	
	D	165	165	1140	1140	

Assuming linear behavior, Need to look at excitation curves (↑)

The currents are being optimized by using Geant4 simulation

Target list (solid targets)

Approved beam time can be fond here

Target	Areal density [/(g/cm²)]	Length in X_0 (x/X_0)	Beam				Remarks
			Energy (/GeV)	Intensity (/ μ A)	Approved time (/h)	Proposing time (/h)	
^{6}Li	100	1.40×10^{-3}	2.24	50		120	LOI12-23-013
^{9}Be	100	1.53×10^{-3}				336	
^{11}B	100	1.87×10^{-3}				60	
^{27}Al	100	4.16×10^{-3}				672	LOI12-23-016
^{40}Ca	150	9.31×10^{-3}			**230** ➡	456	E12-15-008
^{48}Ca	150	7.76×10^{-3}			**278** ➡	552	
^{208}Pb	150	23.5×10^{-3}		20	**480** ➡	480+ α	E12-20-013
CH_2	500	11.2×10^{-3}		2	**61** ➡	120	Common calibration
$^{nat.}$C	150	3.51×10^{-3}		50	**86** ➡	168	
					1135 ➡	**2964** (+ α + **DPS**)	

Plan

2023 | 2024 | 2025 | 2026

2 | JFY2023 | JFY2024 | JFY2025 | JFY2026

Long stay of Japanese students

ERR

PAC

LOI12-23-011
LOI12-23-013
LOI12-23-016

PAC

- **New proposals**
- Beam time extension (Hall A → Hall C)

Installation

Experiment

Backup

CSB $^{3}_{\Lambda}\mathrm{H}$ lifetime puzzle

$nn\Lambda$ bound puzzle

Invariant mass spectroscopy by RHI beam @LHC, RHIC, GSI

- YN scat. exp.
- Femotoscopy

Strangeness	2B	Coupled channel	3B
-1	Y N	ΛN-ΣN	N Y N
-2	Y N	ΞN-ΛΛ	N Y N

Many Body effect (Cluster, deformation)

- Space observation
- Graviton wave meas.

Neutron star puzzle

J-PARC E63

J-PARC E94

JLab LOI12-23-013

CSB $^{3}_{\Lambda}$H lifetime puzzle

JLab E12-19-002

JLab LOI12-23-011

$nn\Lambda$ bound puzzle

Invariant mass spectroscopy by RHI beam @LHC, RHIC, GSI

- YN scat. exp.
- Femotoscopy

JLab C12-20-013 (C2)

Strangeness	2B	Coupled channel	3B
-1		ΛN-ΣN	
-2		ΞN-ΛΛ	

JLab LOI12-23-016

Many Body effect
(Cluster, deformation)

- Space observation
- Graviton wave meas.

J-PARC E70

J-PARC E75

J-PARC E96

JLab E12-15-008

JLab E12-20-013

Neutron star puzzle

Publications

Hall A

- B. Pandey et al., PRC 105, L051001 (2022)
- K.N. Suzuki et al., PTEP 2022, 1, 013D01 (2022)
- F. Garibaldi et al., PRC 99, 054309 (2019)
- G. M. Urciuoli et al., PRC 91, 034308 (2015)
- F. Cusanno et al., PRL 103, 202501 (2009)
- G. M. Urciuoli et al., NIMA612, 56–68 (2009)
- M. Iodice et al., PRL 99, 052501 (2007)

Hall C

- TG et al., PRC 103, L041301 (2021)
- TG et al., NIMA 900, 69–83 (2018)
- TG et al., PRC 94, 021302(R) (2016)
- TG et al., PRC 93, 034314 (2016)
- Y. Fujii et al., NIMA795, 351–363 (2015)
- L. Tang et al., PRC 90, 034320 (2014)
- S.N. Nakamura et al., PRL 110, 012502 (2013)
- TG et al., NIMA 729, 816–824 (2013)
- L. Yuan et al., PRC 73, 044607 (2006)
- T. Miyoshi et al., PRL 90, 232502 (2003)