18pSG-1

J-PARCにおけるΞハイパー核分光実験の実験計画（２）

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日本物理学会2011年秋季大会@弘前大学
2011/09/18

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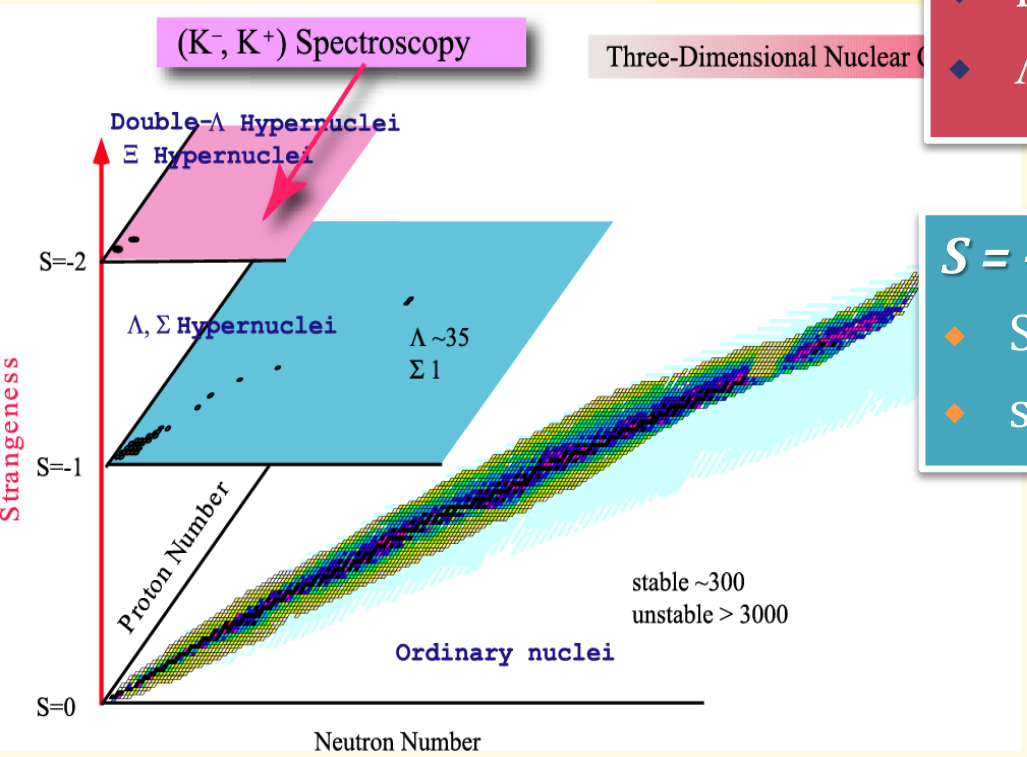
Introduction



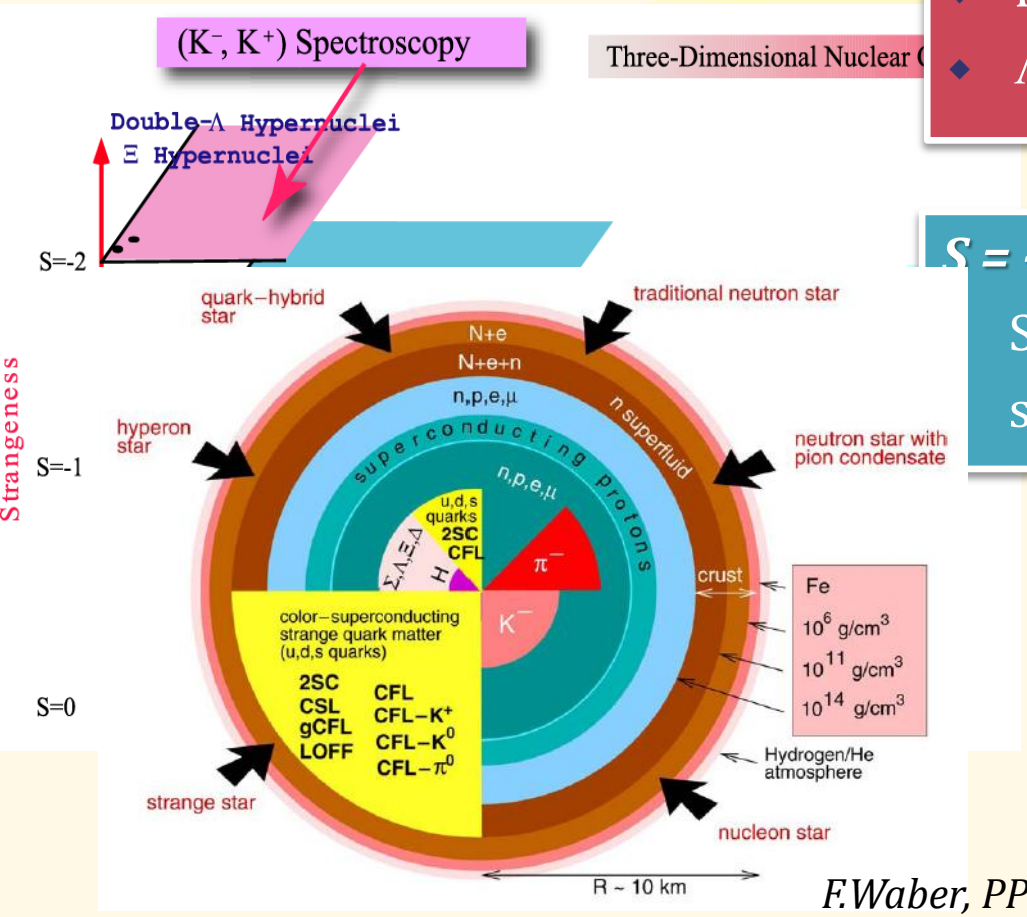
S = -2

- From now at J-PARC
- ΛΛ-hypernuclei , Ξ-hypernuclei

S = -1

- So far : Λ,Σ-hypernuclei
- successful theoretical understanding.

Introduction



S = -2

- From now at J-PARC
- ΛΛ-hypernuclei , Ξ-hypernuclei

S = -1

So

su

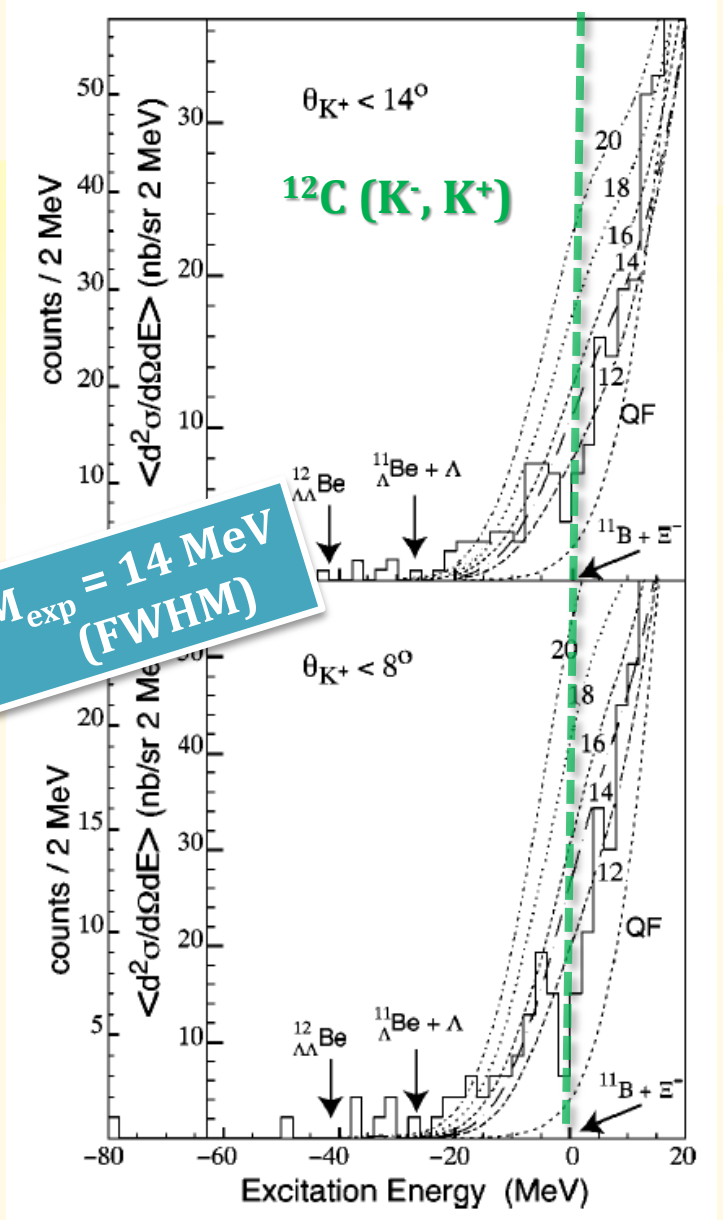
- No definite evidence for a bound state.
- Strangeness in dense nuclear matter, (ex.. core of N.S.)
- Theoretical predictions are quite different for Ξ-N int

F.Waber, PPNP54(2005)193

Experimental information is strongly awaited.

Ξ-hypernuclei : previous experiment

- Previous experiment : BNL-E885
  - not clear evidence of Ξ-hypernuclear bound state.
    - because of limited mass resolution
  - suggest weakly attractive potential of -14 MeV depth.
    - by shape analysis and counts in bound region

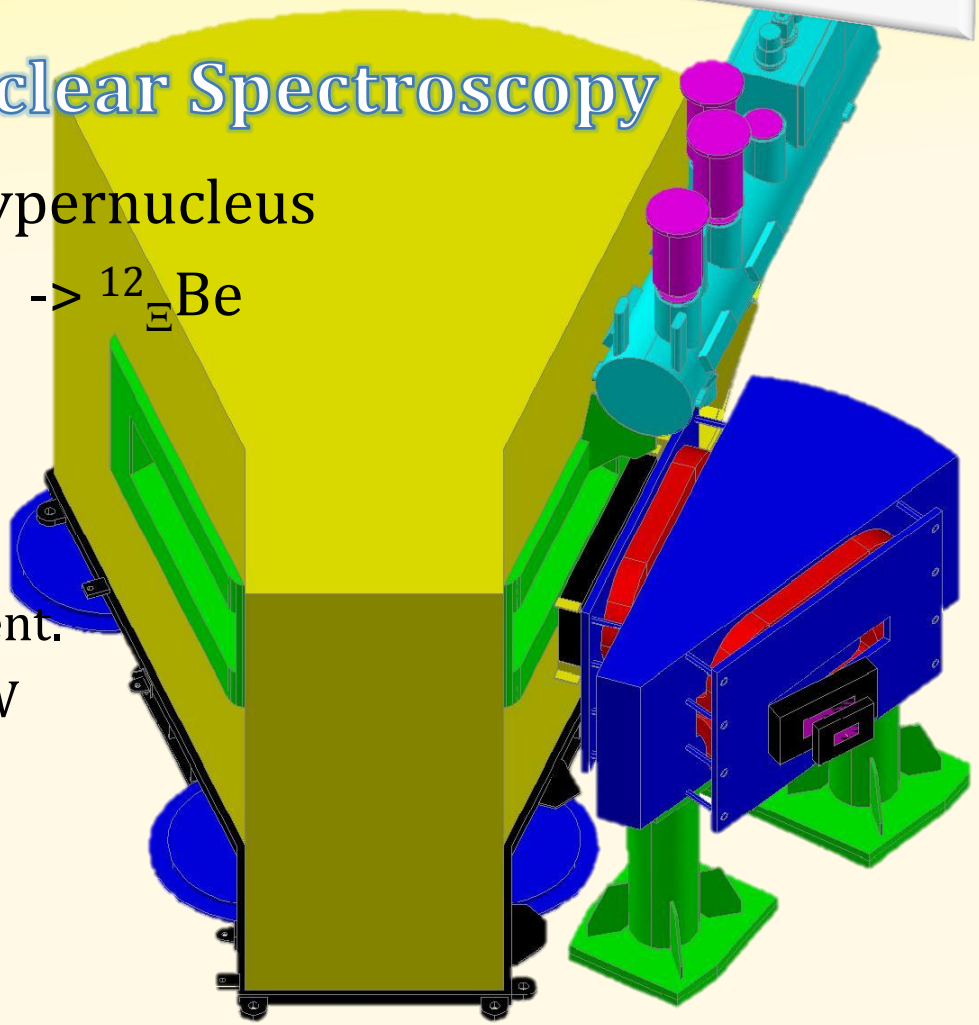


P.Khaustov et al., PRC61(2000)054603

Experiment

J-PARC E05: Ξ-Hypernuclear Spectroscopy

- Spectroscopic study of Ξ-hypernucleus
- using $^{12}C(K^-, K^+)$ reaction ; -> $^{12}_{\Xi}Be$
- Missing mass spectroscopy
  - **high-resolution (~3MeV)**
  - **enough statistics**
- Only J-PARC can do this experiment.
  - <= 1.4 x 10^6 K^-/spill @ 270kW



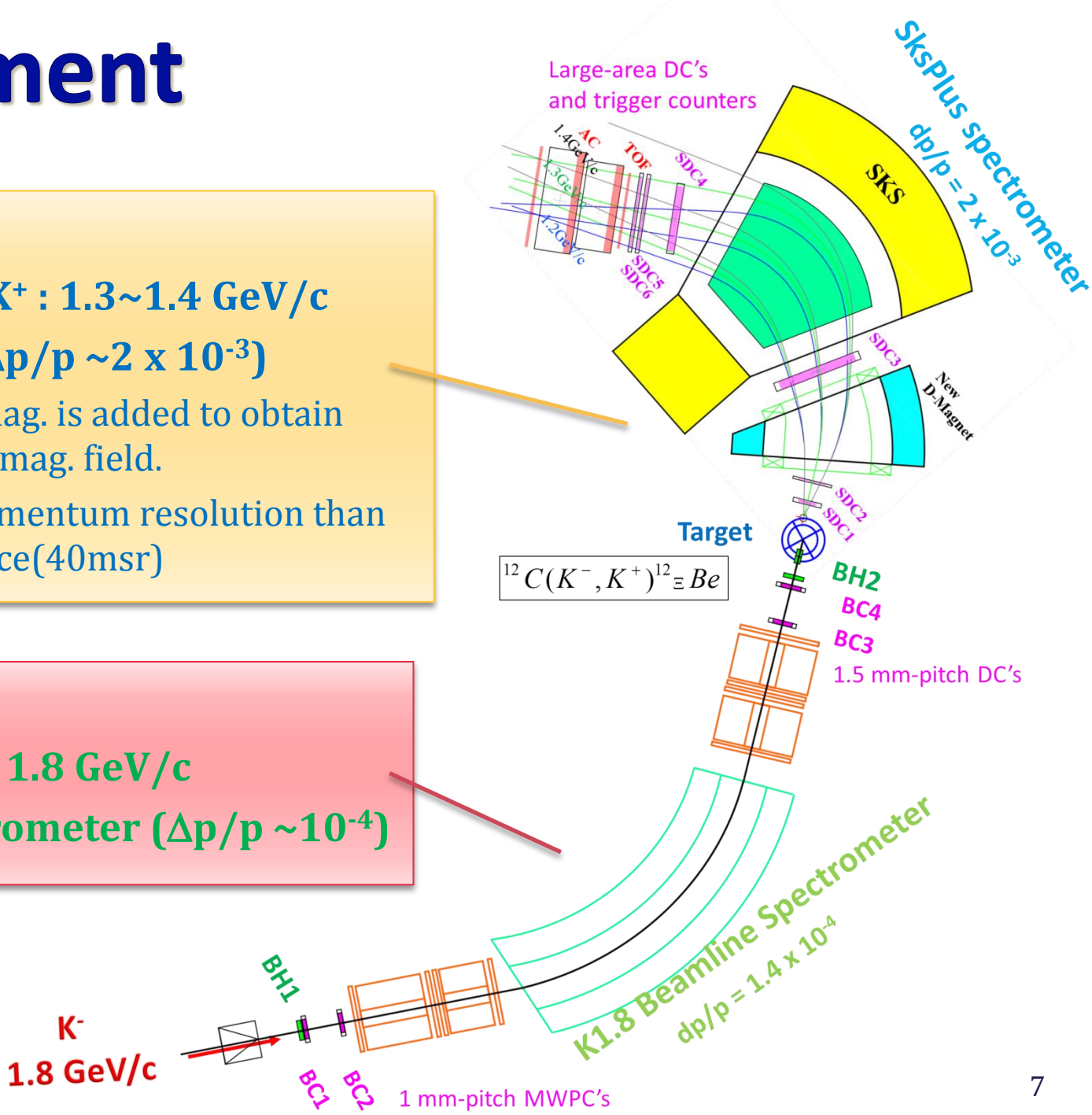
Experiment

SksPlus

- outgoing K^+ : 1.3~1.4 GeV/c
- SksPlus ($\Delta p/p$ ~2 x 10^{-3})
  - New D-mag. is added to obtain stronger mag. field.
  - prior momentum resolution than acceptance(40msr)

K1.8 beam line

- incident K^- : 1.8 GeV/c
- Beam Spectrometer ($\Delta p/p$ ~10^{-4})



Constraint...

- Accelerator intensity is very limited.
  - **now, ~% of design value (270kW)**
- In original E05 plan, statistics are miserable. => not realistic

Modified plan, we have.

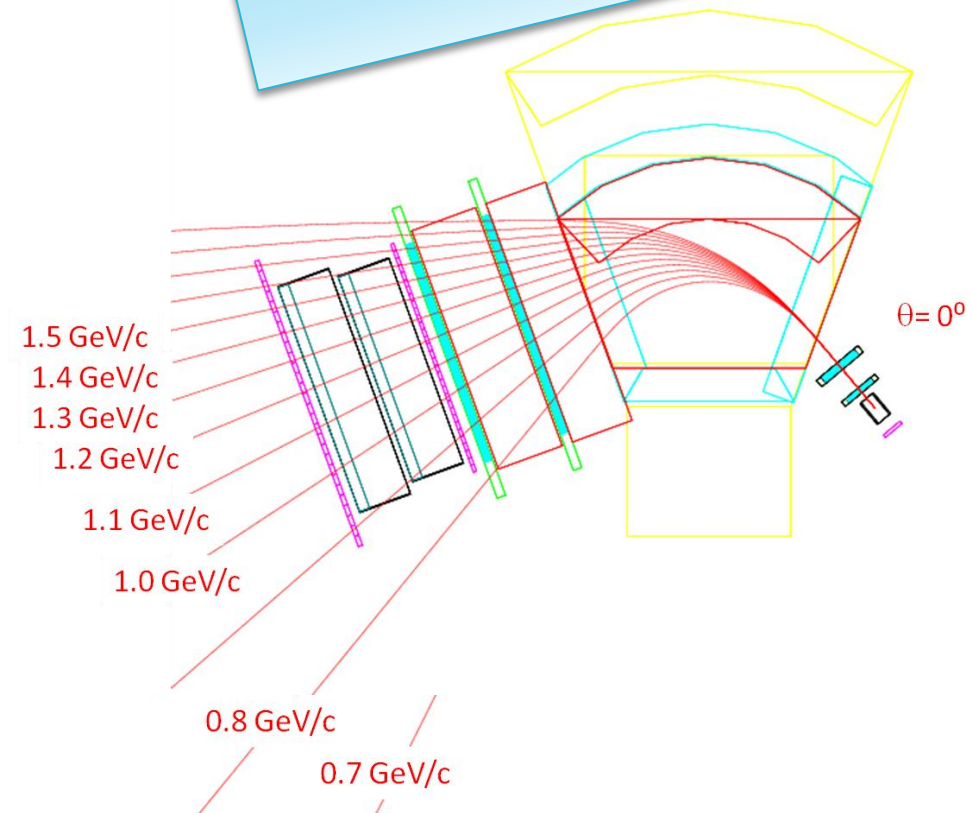
2011.Jul PAC

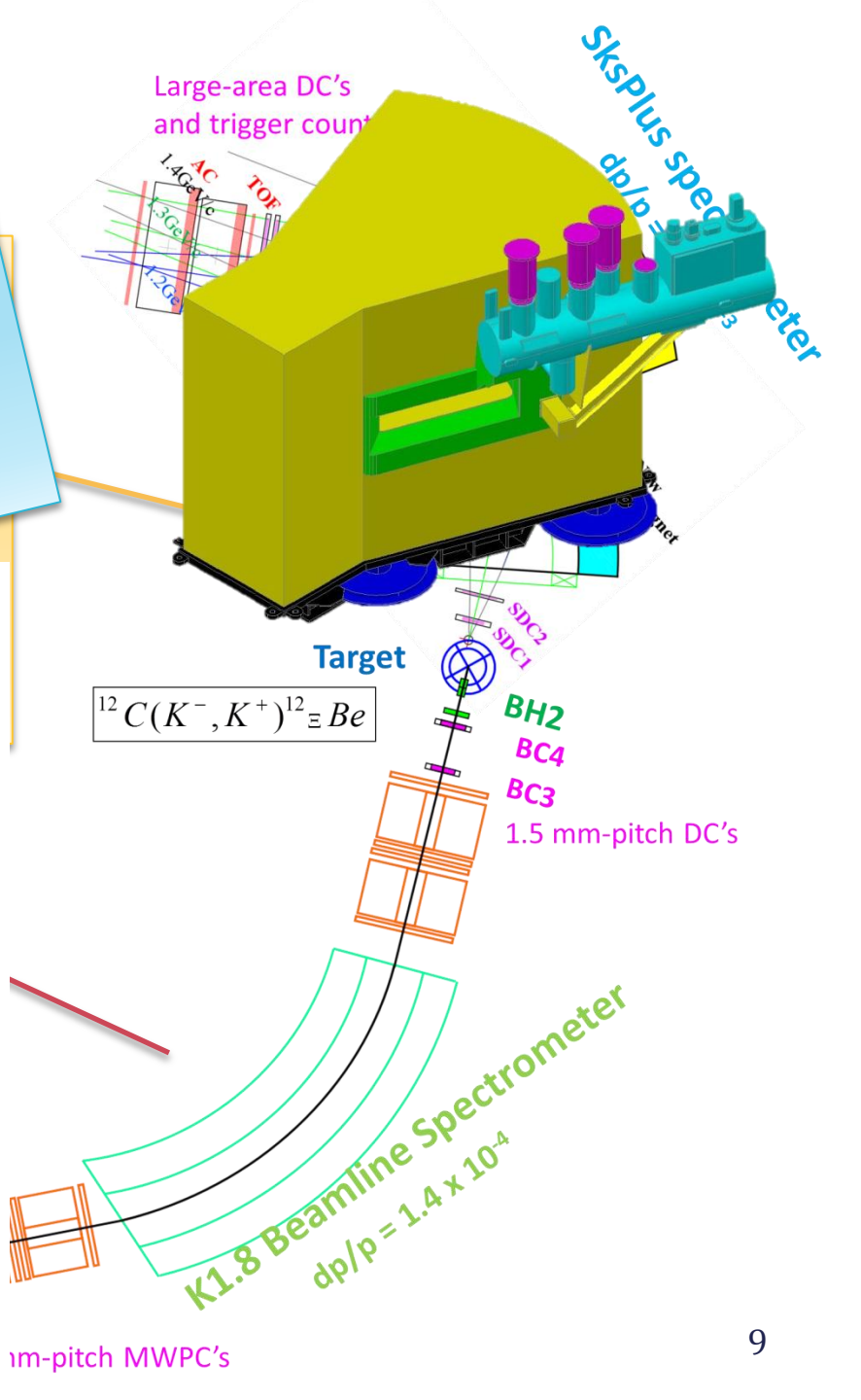
Plan made after the earthquake		
	User operation	Accelerator study
2011.6–11(shutdown)	SX collimators	
2011.12–2012.6	3 kW	5 kW
2012.7–2012.9(shutdown)	Ti chambers (SMS)	
2012.10–2013. 6	10 kW	50 kW
2013. 7–2014. 1 (shutdown)	Li 400MeV/50 mA, Ti chambers (ESS)	
2014. 2–2014. 6	50 kW	100 kW
2014.7 – 9(shutdown)		
2014. 10–	100 kW	

Experiment

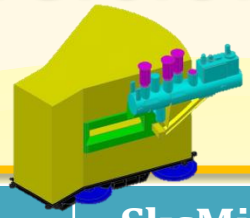
modified SKS

- Original SKS is not suited for analyzing high momentum K+.
- Modification of configuration is needed.





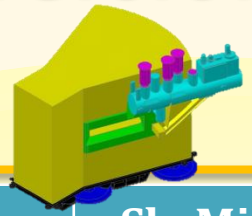
E05 (low intensity beam version)



mod. SKS

	SksPlus	Sks0v2	SksMinus
Acceptance [msr]	40	80	100
K^+ Survival Rate	0.5	0.6	0.6
dp/p [%]	0.20	0.24	0.27
ΔM [MeV]	3.3	3.7	4.0
Y($^{12}_{\Xi}$Be) [/month]	30	55	70

E05 (low intensity beam version)



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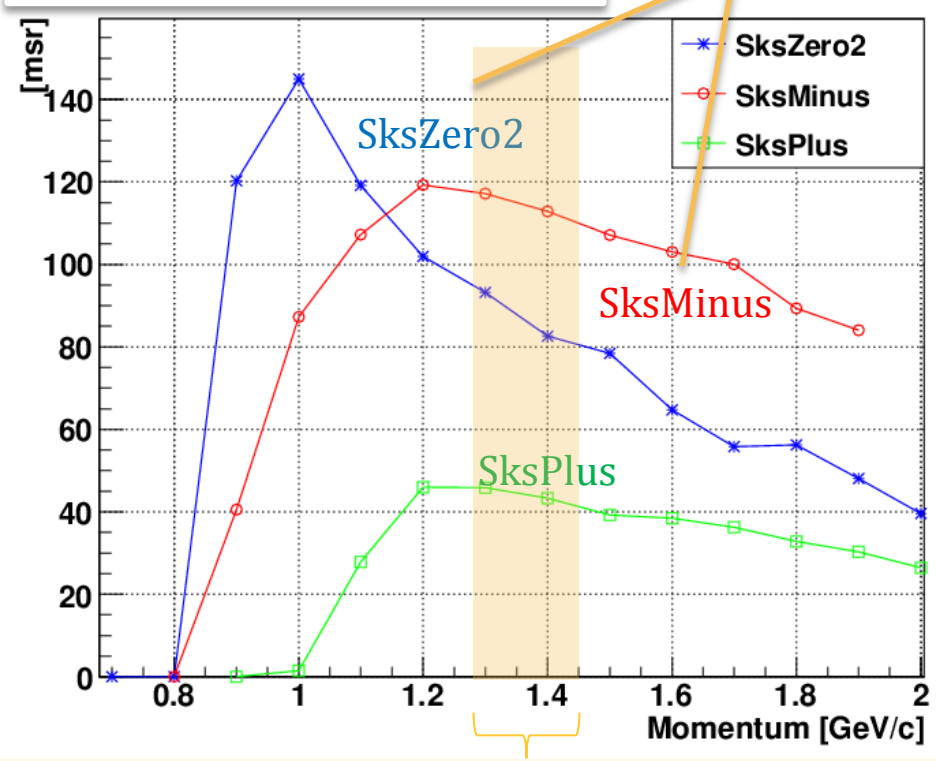
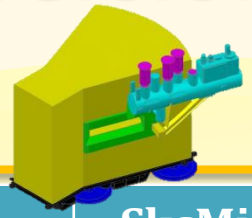
Momentum Acceptance

mod. SKS



Ξ-hyp.

E05 (low intensity beam version)



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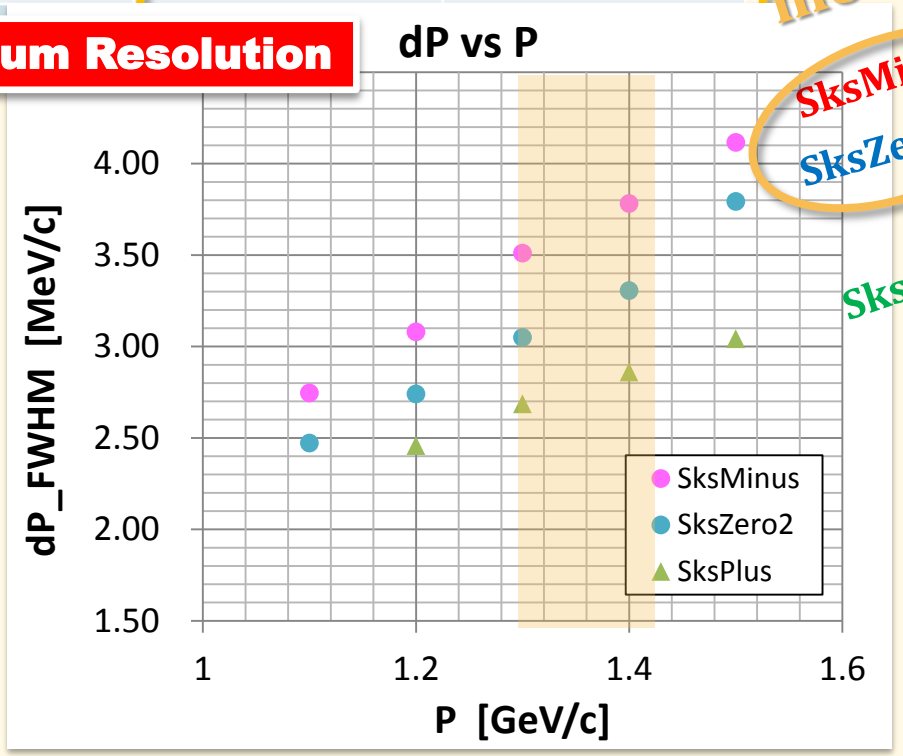
Momentum Resolution



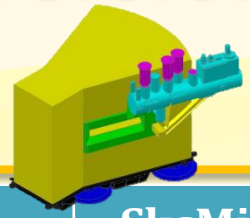
mod. SKS

SksMinus

SksZero2

SksPlus

E05 (low intensity beam version)



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E05 (low intensity beam version) : Yield Estimation @ 30kW

Supposition

- **4.5×10^5** K^-/spill @ 30kW

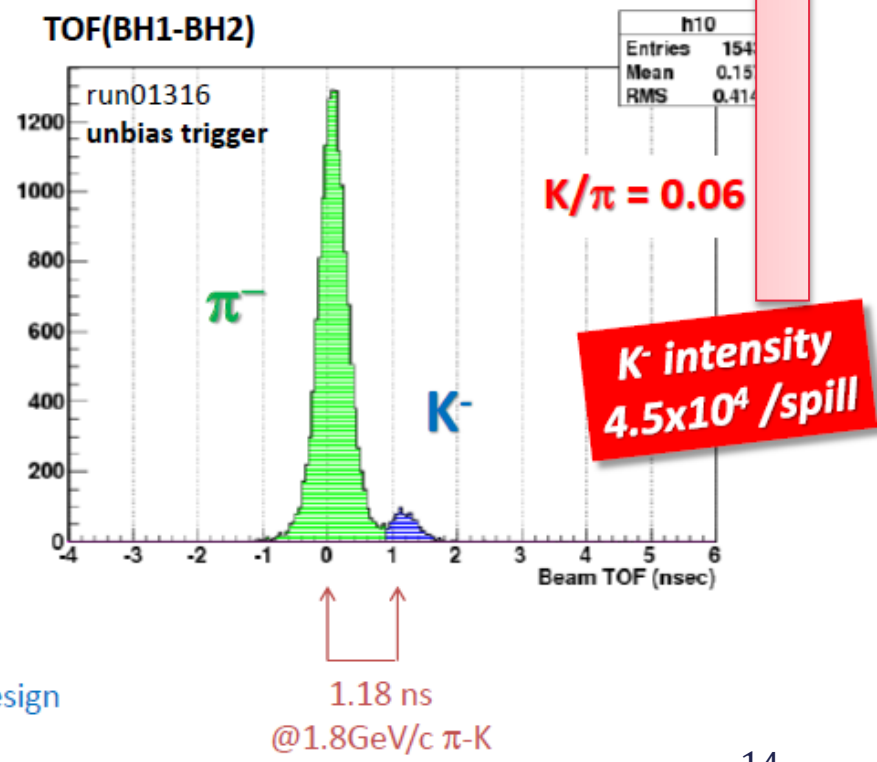
Kaon measurement @ J-PARC K1.8 <3kW>

Date : 2010 Nov. 16
MR intensity : **3.8e12** (3.0 kW)
T1 : **Pt** target
2ndary beam : **-1.8 GeV/c**

Plot Condition :
BH1/BH2 (# of Clusters) = 1

Separator Condition
ESS1 : 400kV/10cm
ESS2 : 400kV/10cm
about half of full HV

Slit Condition [mm]
IFX : ±130
IFY : (+1.5, +3.5) ← half of design opening
Mom: ±180
MS1 : ±2.35
MS2 : ±2.5



E05 (low intensity beam version) : Yield Estimation @ 30kW

Supposition

- 4.5×10^5 K^-/spill @ 30kW
- modified SKS : 100msr

$$Y(^{12}_{\Xi}\mathrm{Be}) = N_{beam} \times N_{target} \times d\sigma/d\Omega \times \Delta\Omega \times f_{decay} \times f_{analysis}$$

$$= 4.5\times10^5[/\mathrm{spill}] \times 24\times3600/6\ [\mathrm{spill/day}] \times 5.4 \times 6.02\times10^{-7}/12\ [/\mu\mathrm{b}] \times 0.042[\mu\mathrm{b/sr}] \times 0.1\ [\mathrm{sr}] \times 0.6 \times 0.5$$

$$= 2.3\ \mathrm{events/day}$$

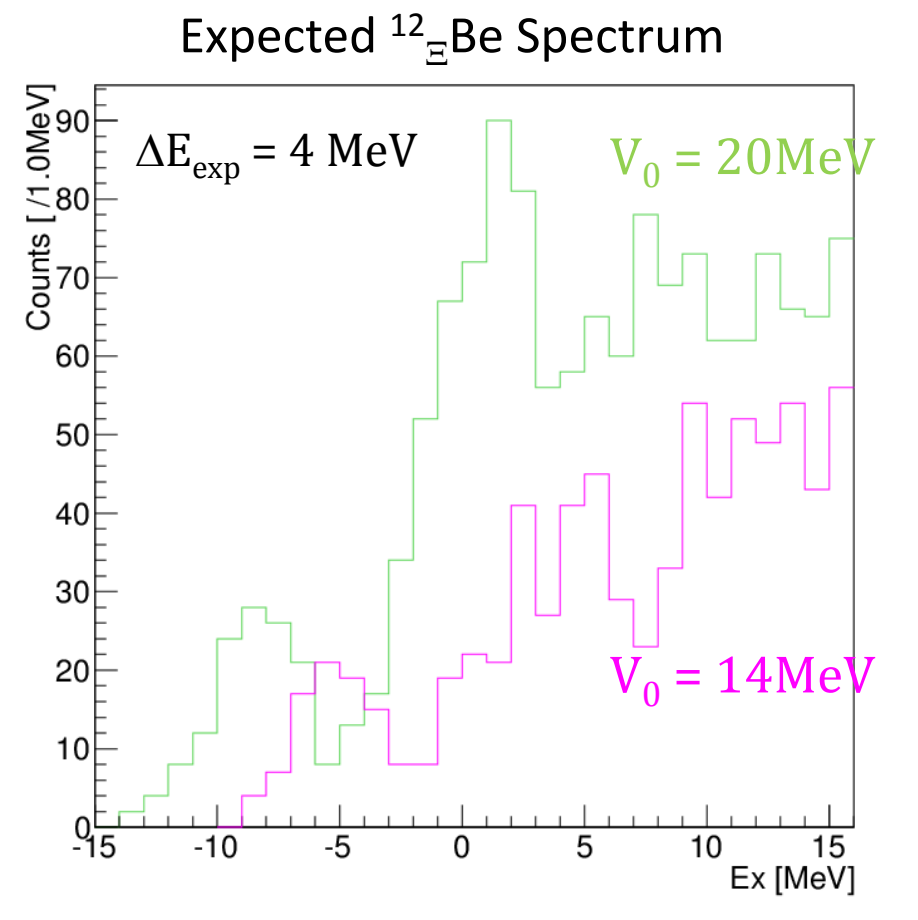
$$= 70\ \mathrm{events/month}$$

40% statistics of proposal one

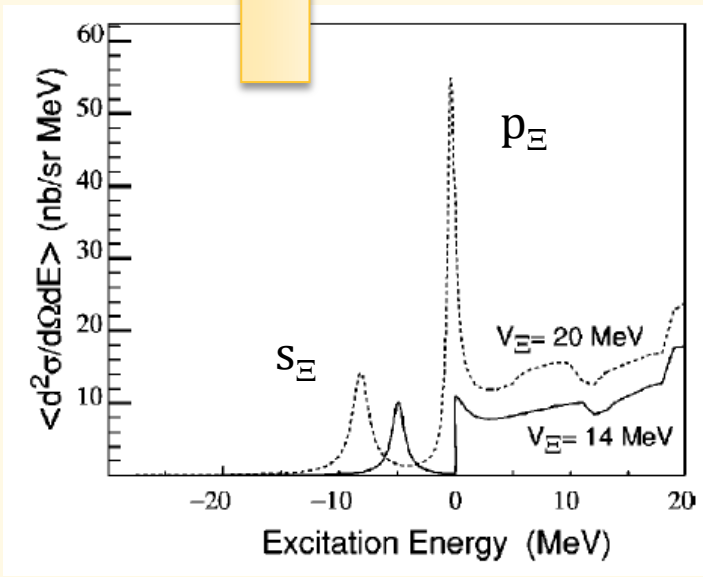
We can take ~70/month statistics at 30kW as the first step of E05.

E05 (low intensity beam version) : Expected Spectrum 1

in case of W.S. potential



DWIA spectra from
P.Khaustov et al.,
PRC 61 (2000) 054603

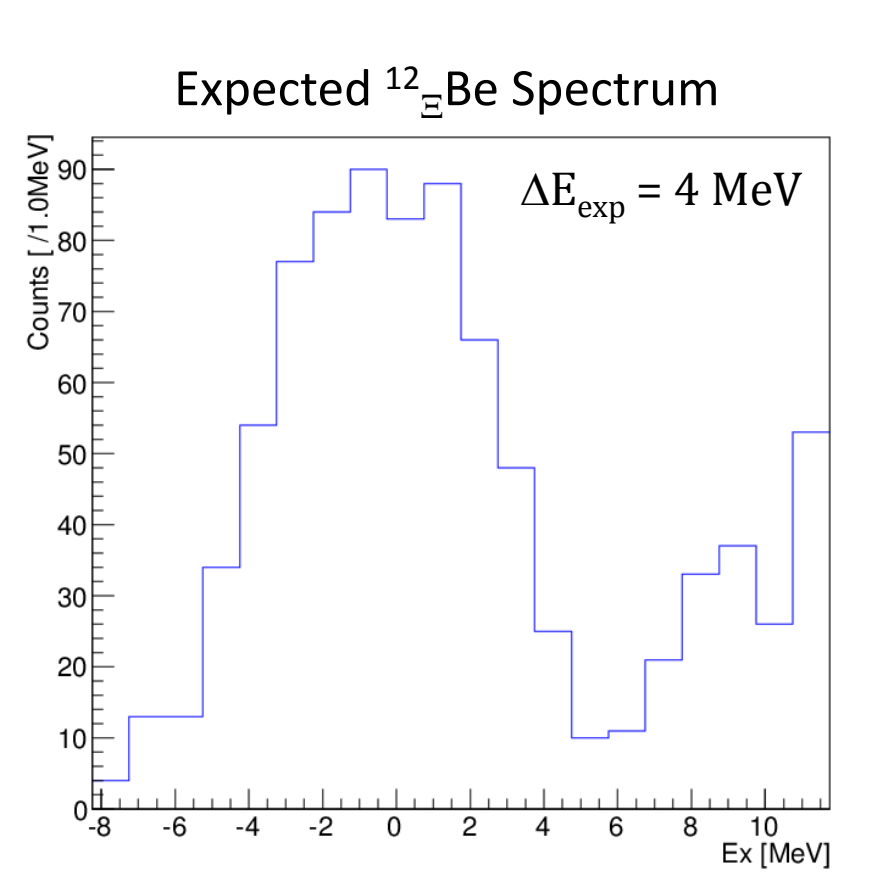


✓ **can identify bound state.**

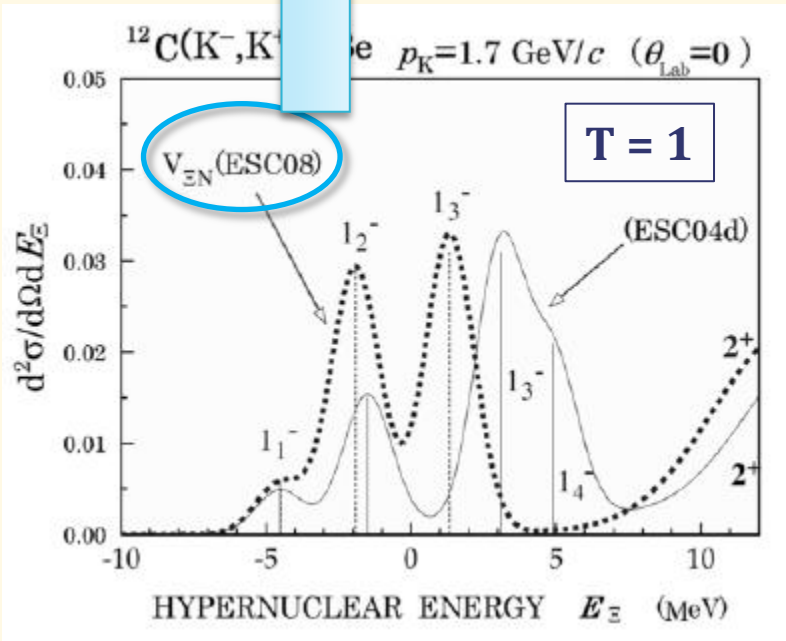
simple peak structure

E05 (low intensity beam version) : Expected Spectrum 2

in case of ESC08a int.



DWIA spectrum from
T. Motoba and S. Sugimoto, NP A 835 (2010) 223.



- ✓ **difficult to separate 2 peaks.**
- ✓ **lack of resolution → need higher-resolution system (< 2MeV)**

S-2S

Summary

- J-PARC E05 is planed to observe Ξ-hypernuclei via (K^-,K^+) missing mass spectroscopy.
- It provides essential information to S=-2.
- We are preparing modified experimental plan for low intensity version.
  - Larger acceptance
  - Acceptable resolution
  - Modest yield → Expected spectrum
- Possibility to start exp. at ~30kW as the first step.