K1.8/K1.8BR status and plan

14th J-PARC PAC Meeting

2012 March 16

T.Takahashi (KEK)

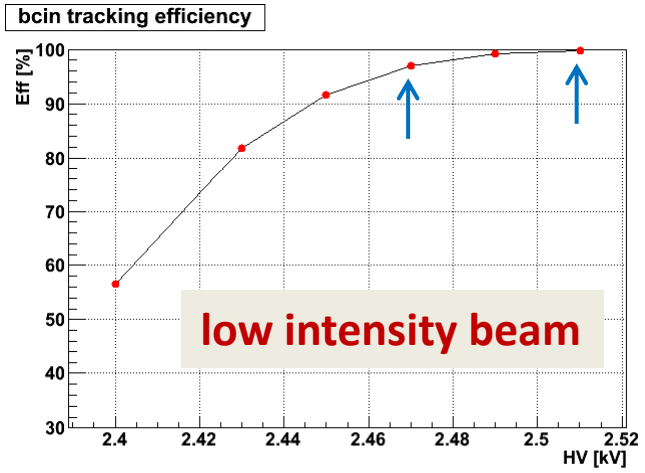
1. Summary of the Achievements in RUN40
2. Run plan by Summer
   - E15 at K1.8BR
   - E27 and Other Studies at K1.8

Achievements in RUN40 (Summary)

- E19 2nd step Run at 2.0 GeV/c was completed. [K1.8]
  - 8.7×10^{10} π^- on Liq-H_2 with 1.7M/spill beam
    (7.8×10^{10}, 1.1M/spill at 1.92GeV/c in 2010 RUN)
- K^- beam tuning @1.8 GeV/c & measurement [K1.8]
  - 48.1k/spill@3.3kW,Pt ⇔ 44.1k/spill by TURTLE & S.W.
- K^- beam tuning @1.0 GeV/c for E15 [K1.8BR]
  - 33k/spill@3.3kW (K/ALL=0.33)
- CDS commissioning with ^{4}He target for E15 [K1.8BR]
  - ~ 6×10^8 K^- on target, ~ 20M events were recorded
- Range Counter for E27 had been installed. [K1.8]
  - E27 is ready to run 1st step RUN

E19 2nd step RUN [K1.8]

Thanks to
- the improvement of duty factor: 13.7%→17.6%
- optimization of the operation voltage of MWPC
  2.51kV→2.47kV

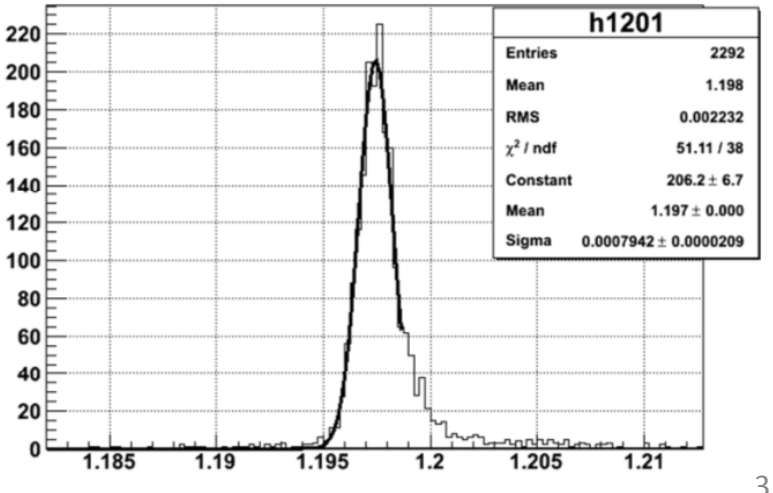


We could use **1.7M/spill** beam instead of the previous 1.1M/spill by keeping the same hit multiplicity and track-finding efficiency (~95%) as RUN37.

- Θ^+ RUN at 2.0 GeV/c 8.7×10^{10} π^-
- Σ^+ RUN at 1.37 GeV/c 8.5×10^{8} π^+
- Σ^- RUN at 1.37 GeV/c 4.8×10^{9} π^-
- Σ^- RUN at 1.45 GeV/c 8.8×10^{9} π^-

ΔM=1.87MeV/c^2(FWHM)
⇔ 1.86MeV/c^2(FWHM) 1st step RUN

Σ^- at 1.37GeV/c



E19 1st step results

subimitted to arXiv
(appeared on Mar. 19)
will be submitted to PRL soon

Search for the Θ^+ pentaquark via the $\pi^- p \to K^- X$ reaction at 1.92 GeV/c

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The Θ^+ pentaquark baryon was searched for via the $\pi^- p \to K^- X$ reaction in a missing-mass resolution of 1.4 MeV/c^2(FWHM) at J-PARC. π^- meson beams were incident on the liquid hydrogen target with the beam momentum of 1.92 GeV/c. No peak structure corresponding to the Θ^+ mass was observed. The upper limit of the production cross section averaged over the scattering angle of 2° to 15° in the laboratory frame was obtained to be 0.26 μb/sr in the mass region of 1.51−1.55 GeV/c^2. The upper limit of the Θ^+ decay width using the effective Lagrangian approach was obtained to be 0.72 MeV/c^2 and 3.1 MeV/c^2 for $J^P_\Theta = 1/2^+$ and $J^P_\Theta = 1/2^-$, respectively.

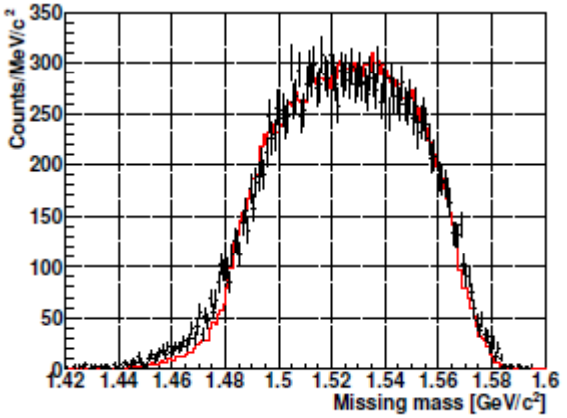


FIG. 2. The missing mass spectrum and the background shape for the $\pi^- p \to K^- X$ reaction at the beam momentum of 1.92 GeV/c. The black points with error bars are the experimental data. The contribution of the simulated background is indicated by red histogram.

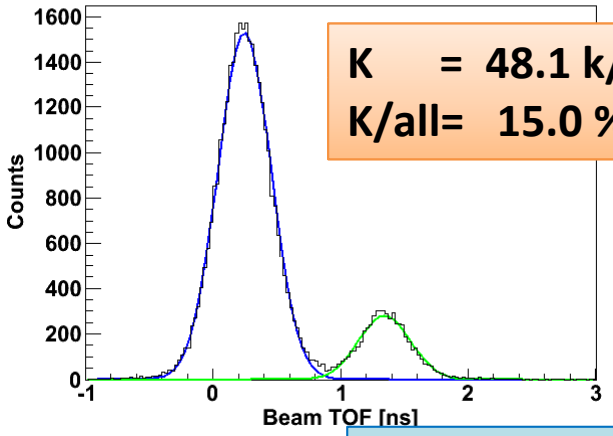
Kaon Intensity at K1.8BL
K^- at 1.8GeV/c 3.3kW

CM's scan at MS1=±1.17mm, MS2=±1.25mm

ESS1 = ±250 kV, ESS2 = ±200 kV
IFH =±130 mm
IFV =-1.0 mm / +3.0 mm ,
MOM =±180 mm

Maximum K-yield

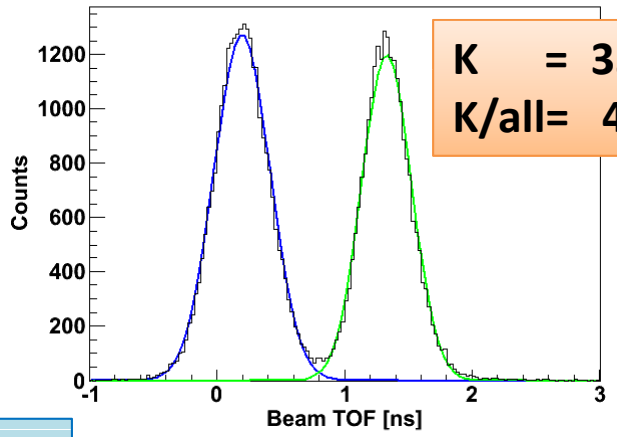
CM1,2 = 446, 336A
CM3,4 = 320, 280A



K = 48.1 k/spill
K/all= 15.0 %

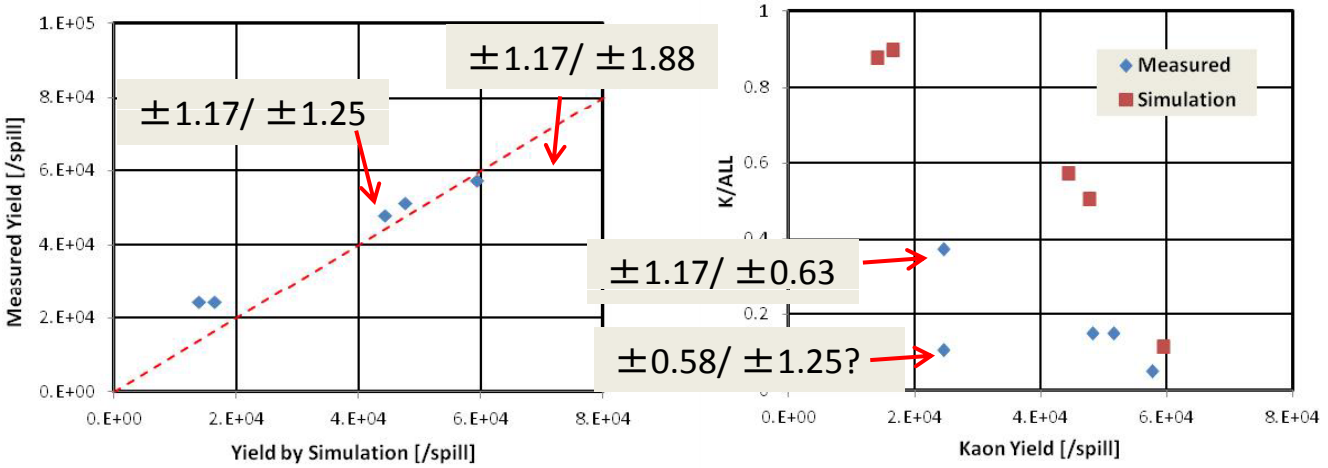
Maximum K/all

CM1,2 = 450, 340A
CM3,4 = 312, 292A



K = 33.8 k/spill
K/all= 45.4 %

Slit opening dependence

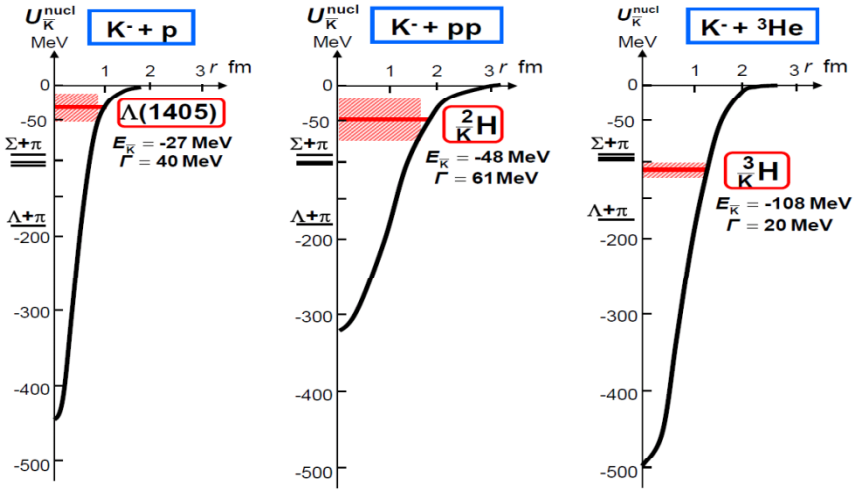


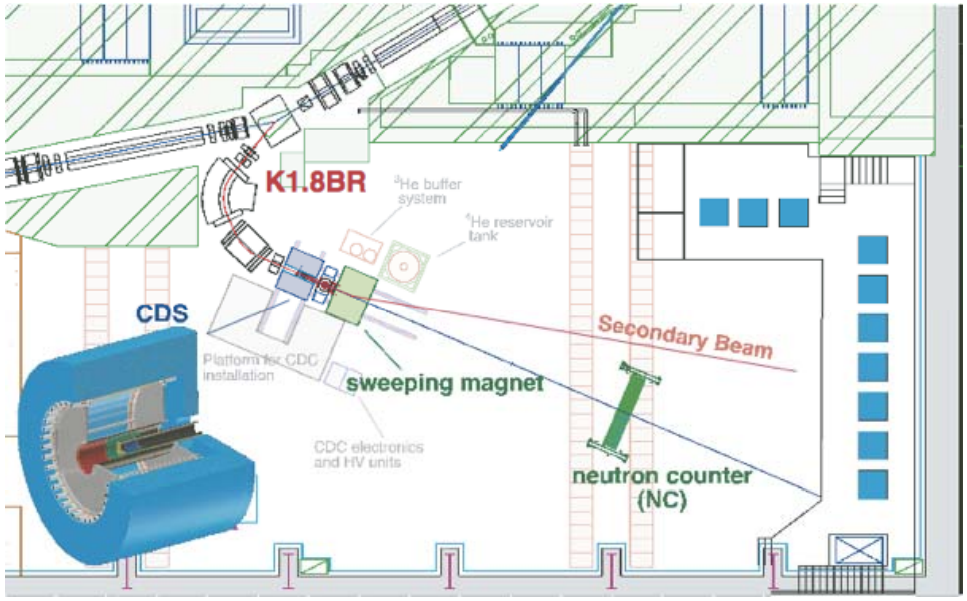
Yield is well reproduced by TURTLE with S.W.P. cross section.

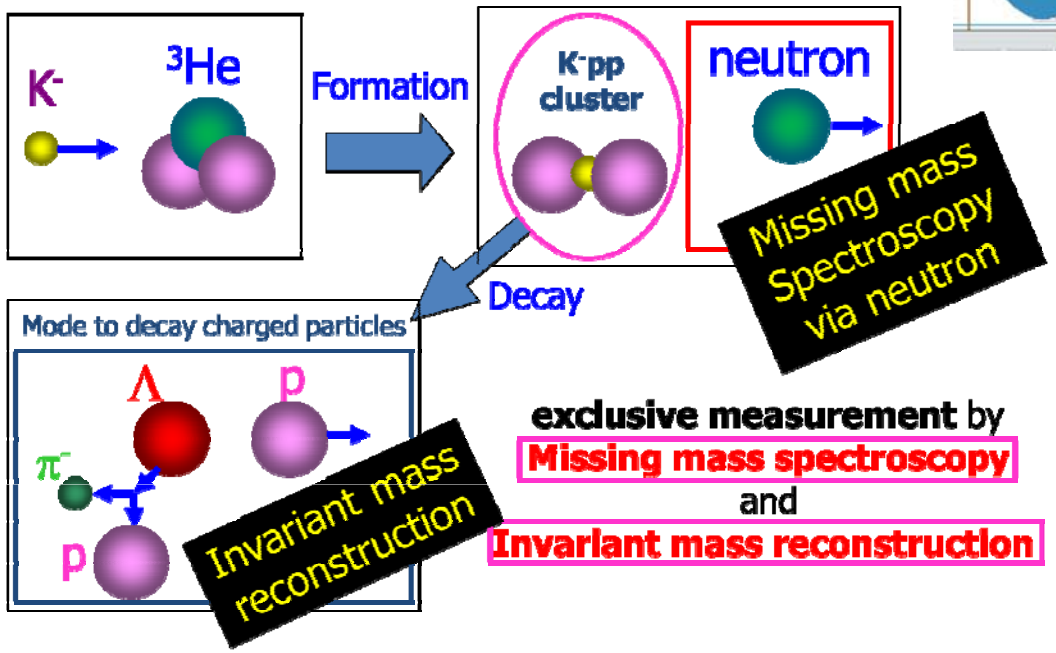
Kaon ratio: should be understood

RUN Plan at K1.8BR
—E15—

E15: $\bar{K}N$ Interaction Study by Nuclear Bound-States





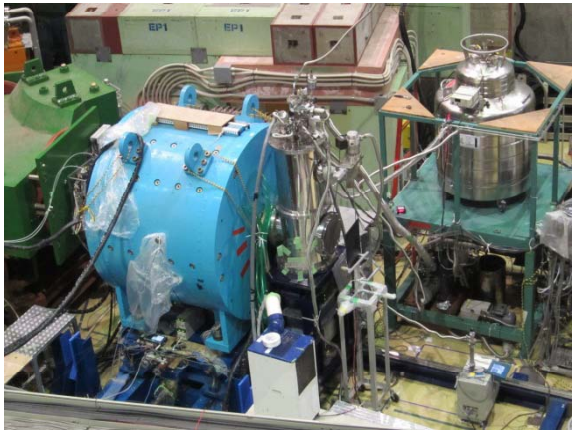


exclusive measurement by
Missing mass spectroscopy
and
Invariant mass reconstruction

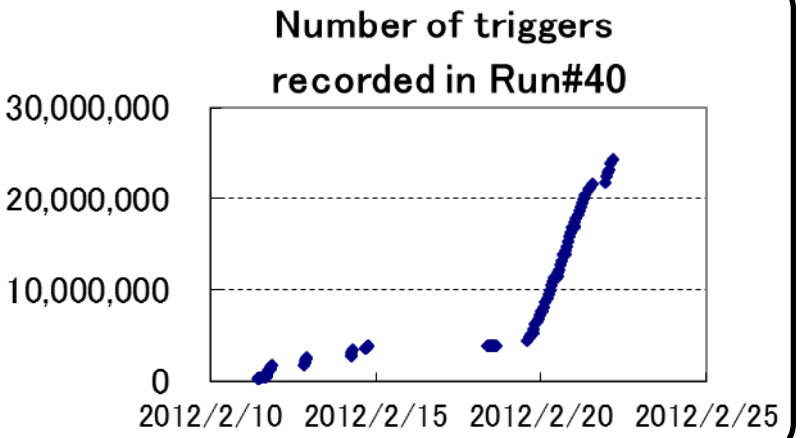
search for K⁻pp bound state using

³He (1GeV/c K⁻, n) reaction

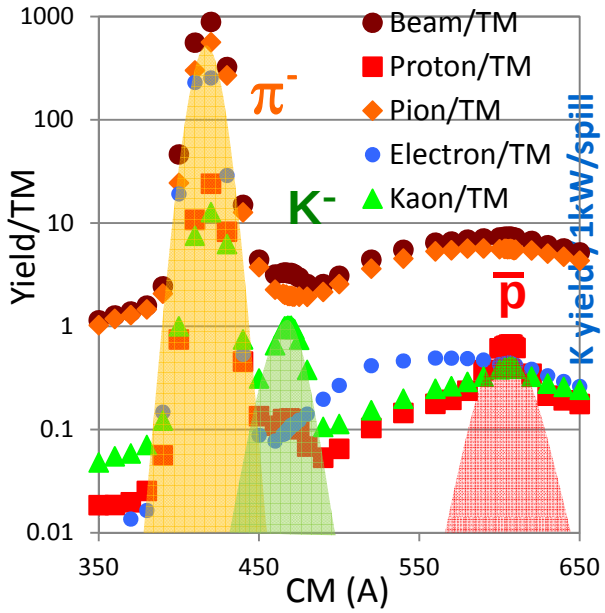
Preliminary Results of Run#40

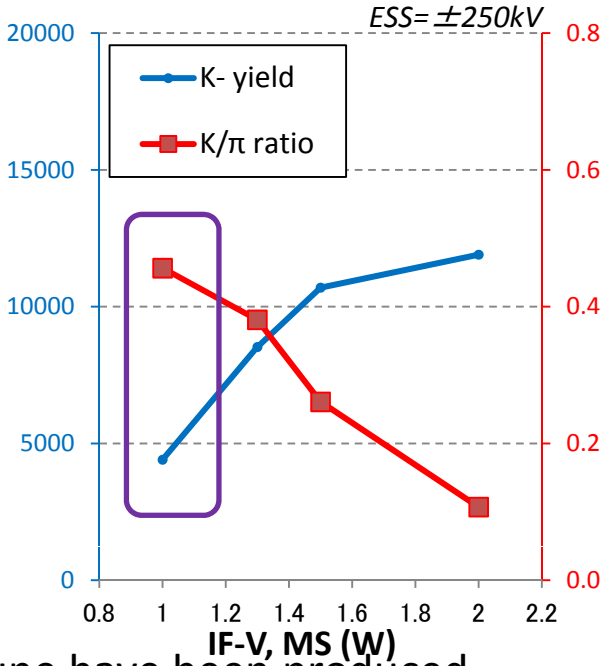


Run time: 19-22 Feb
Beam PW: 3.3kw
~6x10^{8} K^{-} on Target
~25M events recorded



- **1.0 GeV/c beam tuning was completed!**





[/spill]	3.3kW	10kW
beam intensity	100k	300k
K⁻ yield	33k	100k
E15 trig. rate	700	2.1k

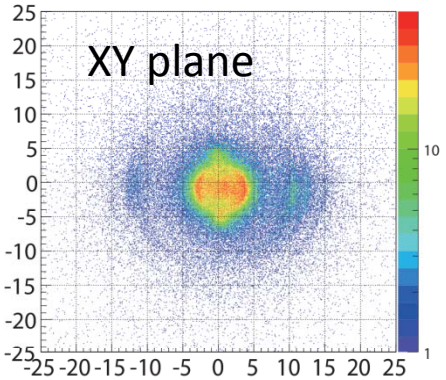
expected

Parameters for Kaon tune have been produced

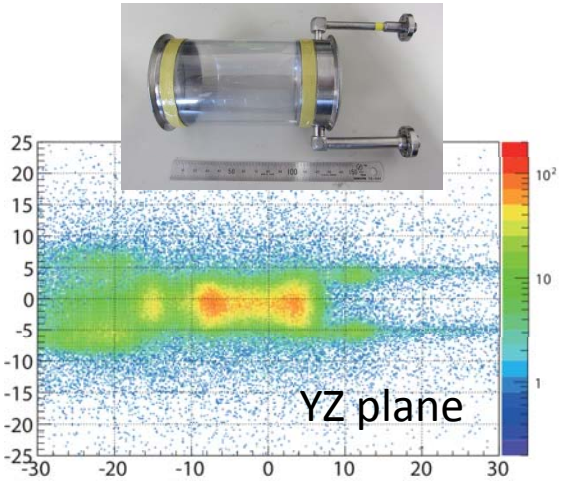
We can receive more than 10kW beam-power!

Preliminary Results of Run#40 (Cont'd)

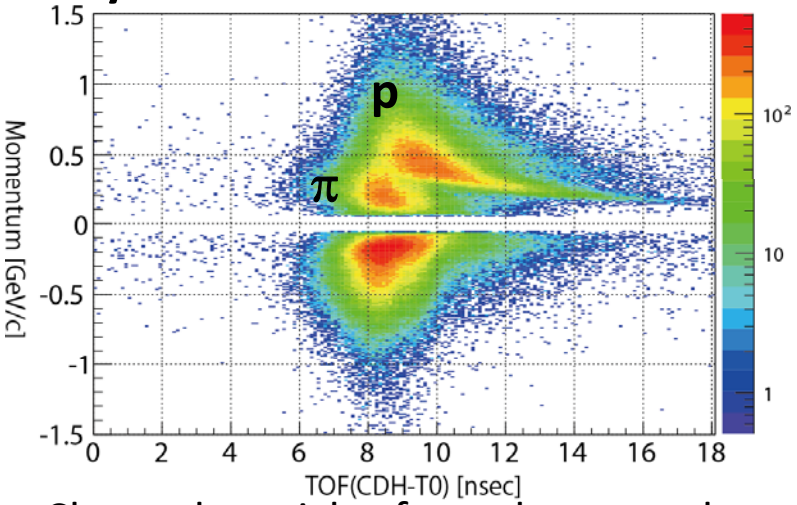
- **CDS and Liquid Helium target system successfully worked!**



Liquid ^{4}He inside

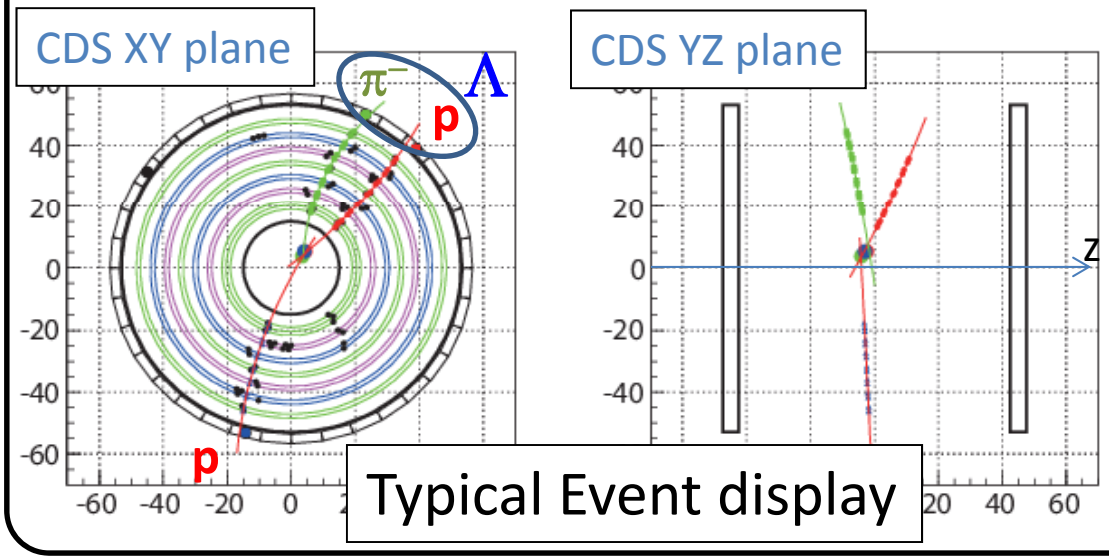


Target-images together with material around has been reconstructed by the CDS

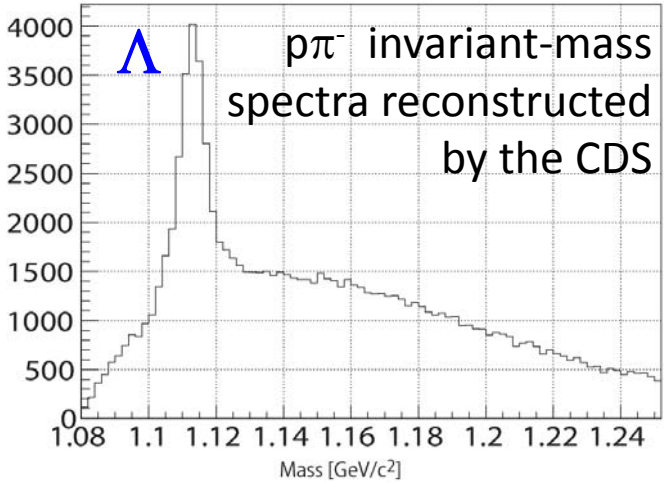


Charged particles from the target have been successfully identified by the CDS

- **Ready to explore kaonic-nuclei physics @ K1.8BR!**



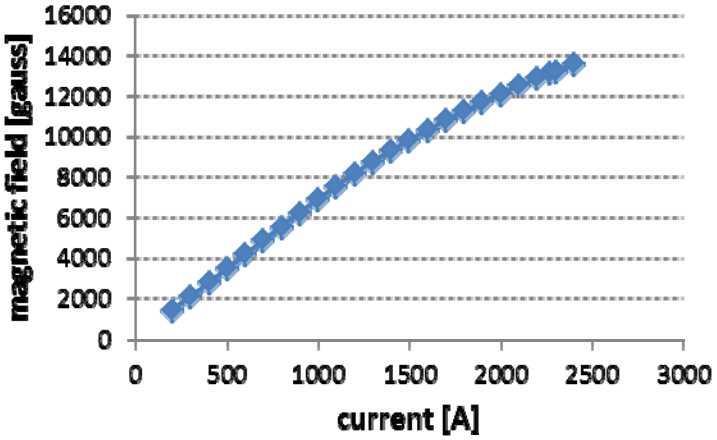
Typical Event display



~10,000 Λs have been accumulated

Preparation Status

- **Beam Sweeping Magnet**



will be transferred to J-PARC and installed in May 2012

- **Neutron Counter**

- ✓ transfer from KEK to J-PARC was completed.
- ✓ all components (counter, readout, cable, etc.) have been ready

will be installed in April 2012

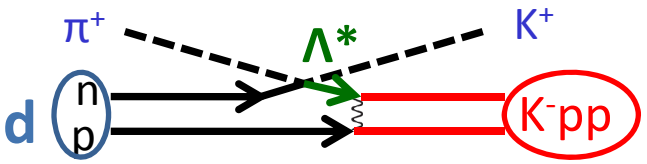
Schedule for E15

2012.3	**14th PAC**	
2012.3-4	*Preparation*	*Neutron Counter:* *INSTALLATION @ J-PARC*
2012.5	*Preparation*	*Beam-Sweeping Magnet :* *TRANSFER, KEK→J-PARC & INSTALLATION @ J-PARC*
2012.6	**Engineering Run**	**5-10kW, 1week: trigger/detector tuning** **5-10kW, 1week: data taking**
2012.7	**15th PAC**	
2012.7-9	**Shutdown**	
2012.10-	**Production Run**	**10kW, 3weeks: ^{3}He(K^-,n/p)**

RUN Plan at K1.8
— E27 & other studies—

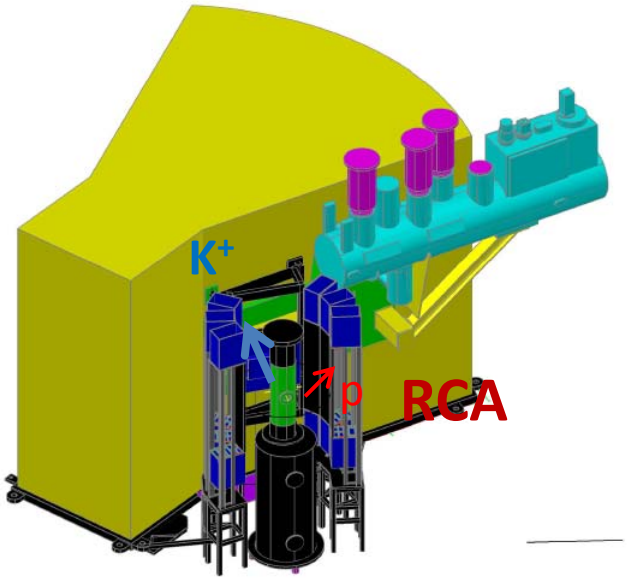
E27: Search for "K^-pp" bound state in the $d(\pi^+,K^+)X$ reaction

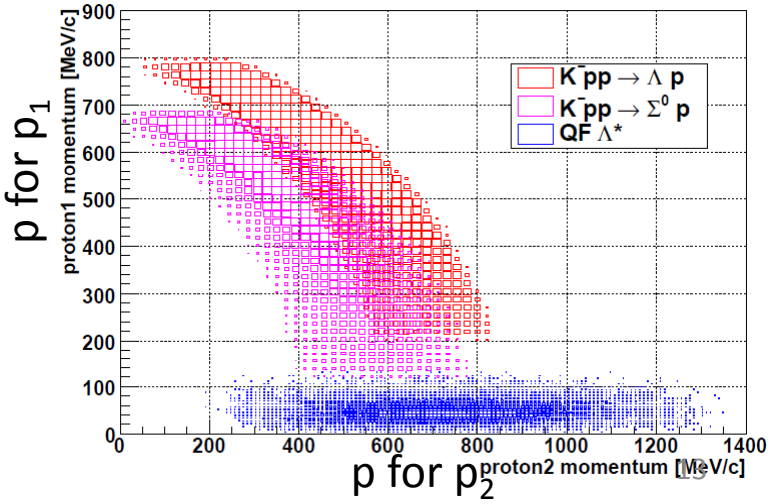
- "K^-pp" is produced through Λ^* doorway in the $d(\pi^+,K^+)$ reaction



- Semi-exclusive measurement by Range Counter Array (RCA) in order to suppress quasi-free B.G.
  - $K^-pp \rightarrow \Lambda\ p_1,\ \Lambda \rightarrow p_2\ \pi^-$
  - $K^-pp \rightarrow \Sigma^0\ p_1,\ \Sigma^0 \rightarrow (\Lambda\gamma) \rightarrow p_2\ \pi^-\ \gamma$
  - $\pi^+d \rightarrow \Lambda^*\ K^+\ p_{1s},\ \Lambda^* \rightarrow \Sigma\ \pi,\ \Sigma^+ \rightarrow p_2\ \pi^0$
- Original Proposal: 5M/spill beam
  - 6×10^4 Λ^* /day

  Assuming 1% trapping probability
  - 600 bound states/day (inclusive)
  - ~300 events/40 days (exclusive) with ε_{RCA} ~14% for two protons





Handling with high-rate beam

High rate study for the beamline chambers.

- ◆Up to 3.5 M/spill for BC1,2 (upstream)
- ◆Up to 5 M/spill for BC3,4 (downstream)

With same condition as production run.

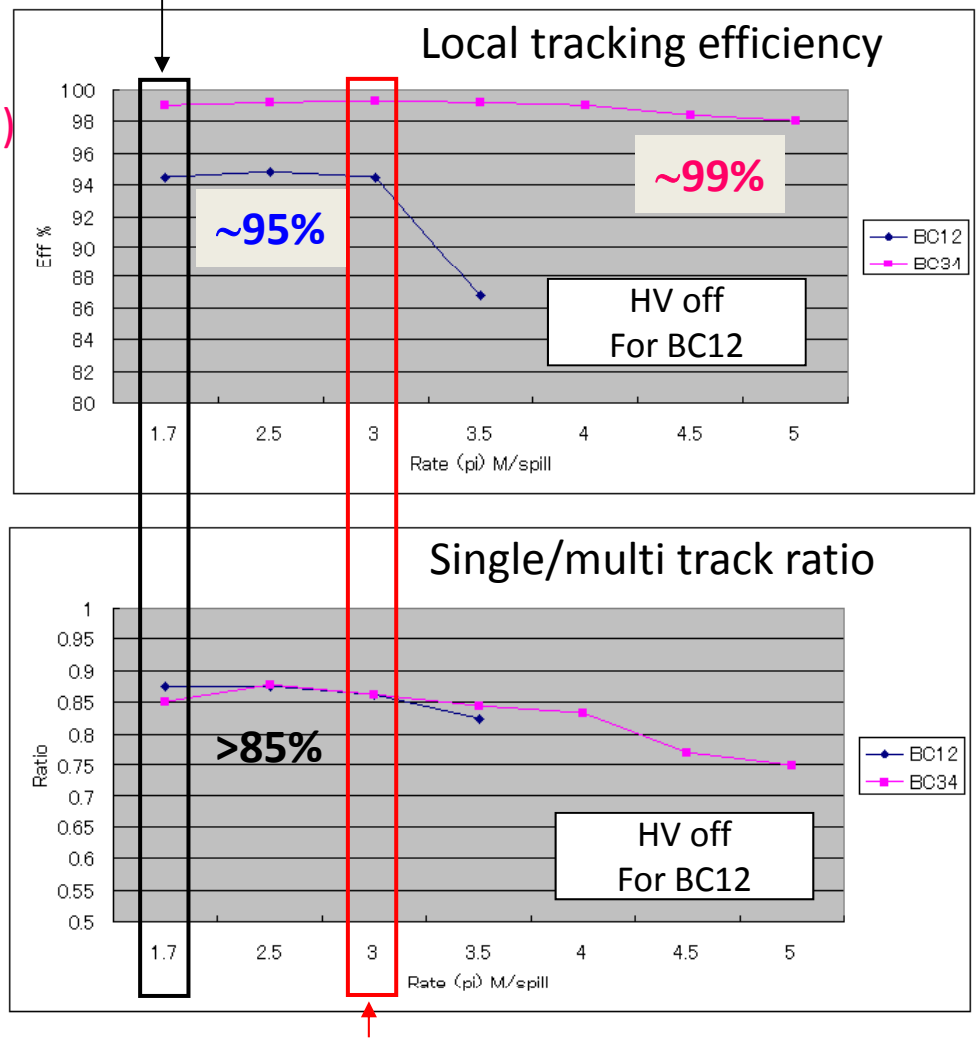
Following cuts are included,
- ◆Beam TOF cut
- ◆X^2 cut (< 30)

No performance degradation

up to **3 M/spill** beam rate.

New fiber tracker with high-rate ability will be installed upstream.

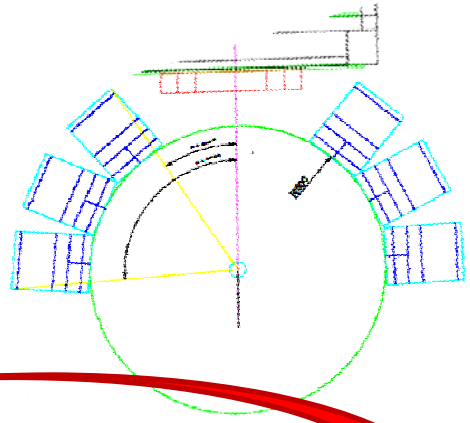
Σ^- production @ 1.45 GeV/c



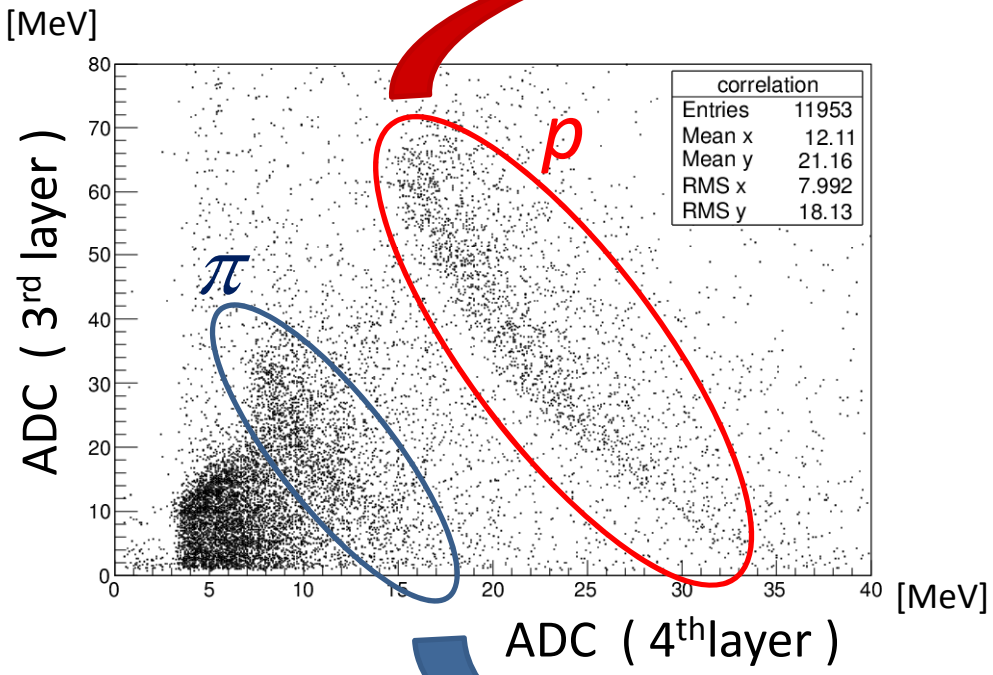
Possible to use 3 M/spill beam in the next run.

E27 Range Counter

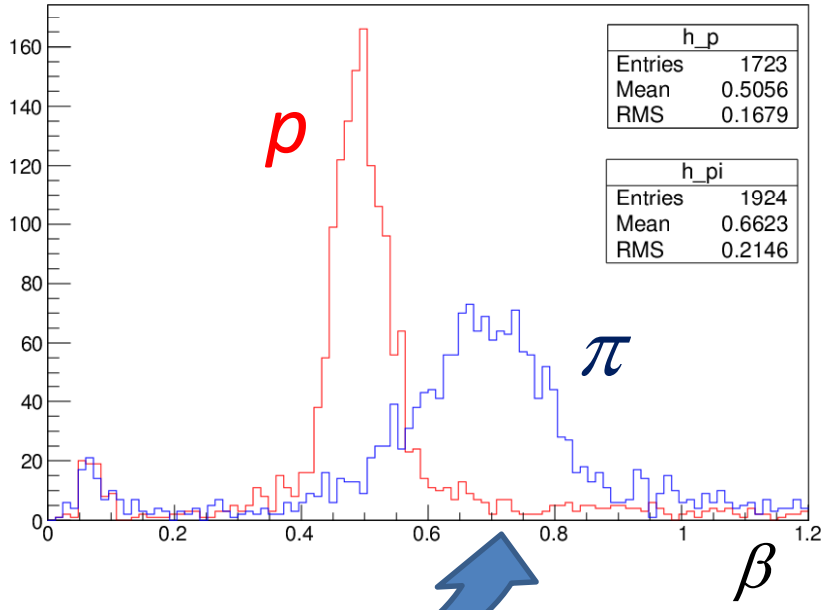
RC has been already installed.



ADC correlation for the events stopped at 4th layer



β of p and π



The performance of PID is sufficient !!

E27: The first step Goal

3M π^+/spill

- Inclusive d(π^+,K^+)X spectrum @2.2 < Mx <2.5GeV/c^2.
  - The first measurement of this reaction and this missing mass region. → 5.1*10^5 Λ(1405)'s @10 days

  →To evaluate the maximum value of the cross section, and to understand the background shapes.
  - p(π^+,K^+)X for one day

  →contribution of "p" in "d"

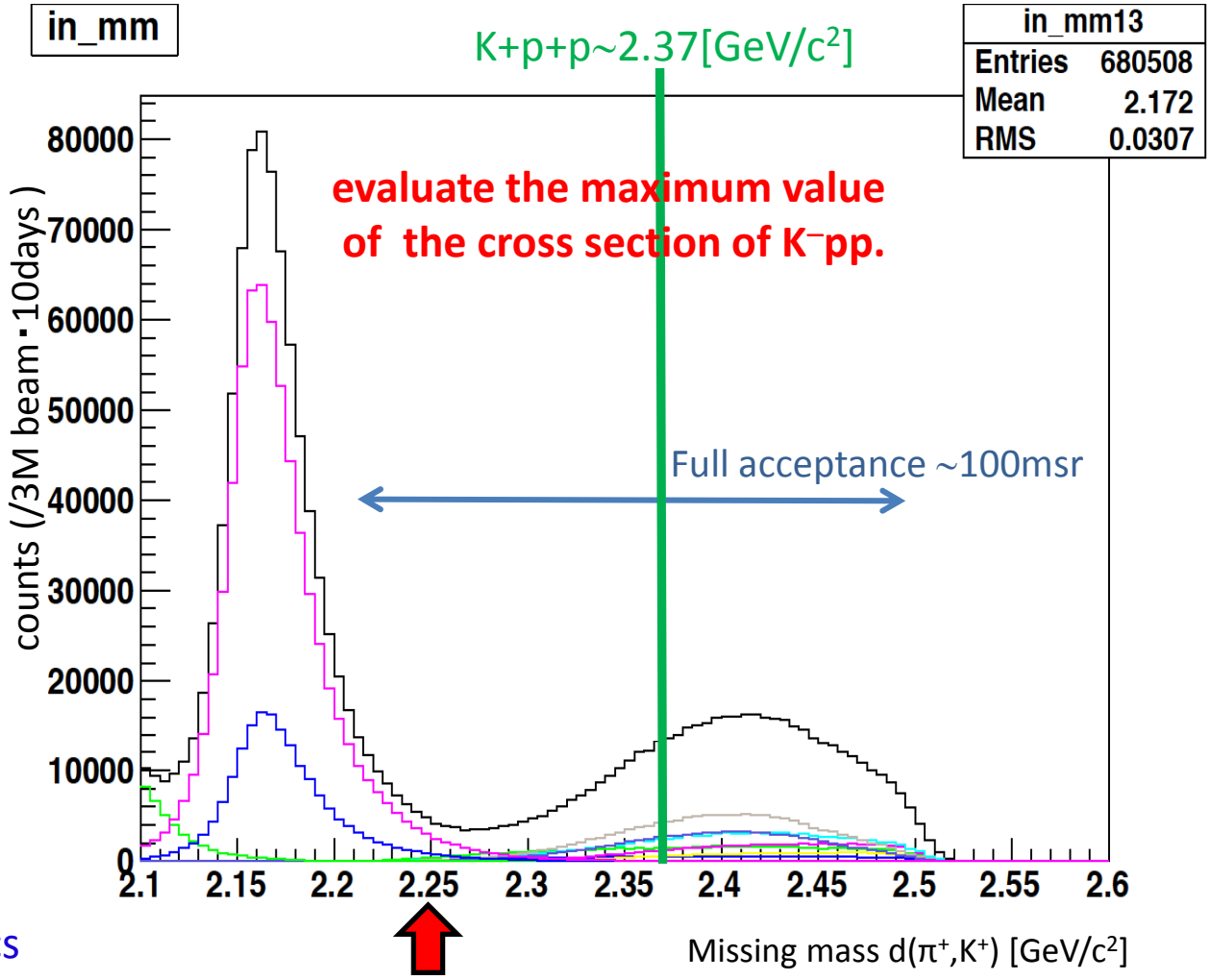
- Check the feasibility of coincidence measurement
  - One proton tag/Two proton tag

E27: Expected inclusive spectrum (Background Processes)

P_π=1.7GeV/c, SKS=350A

10 days with 3M/spill beam

- π^+ "n" → Σ^0 K^+ 120.6μb
- π^+ "n" → Λ K^+ 174.7μb
- π^+ "n" → $\Lambda(1405)$ K^+ 20.6μb
- π^+ "n" → $\Sigma\pi K^+$ 40μb
- π^+ "n" → $\Sigma^0(1385)K^+$ 76.7μb
- π^+ "n" → $\Lambda\pi K^+$ 13.7μb
- π^+ "p" → Σ^+ K^+ 470μb
- π^+ "p" → $\Sigma^+(1385)K^+$ 124μb
- π^+ "p" → $\Lambda\pi K^+$ 40μb
- π^+ "p" → $\Sigma\pi K^+$ 28.9μb



150—255 times as many statistics
as the past experiments for Y*reaction.

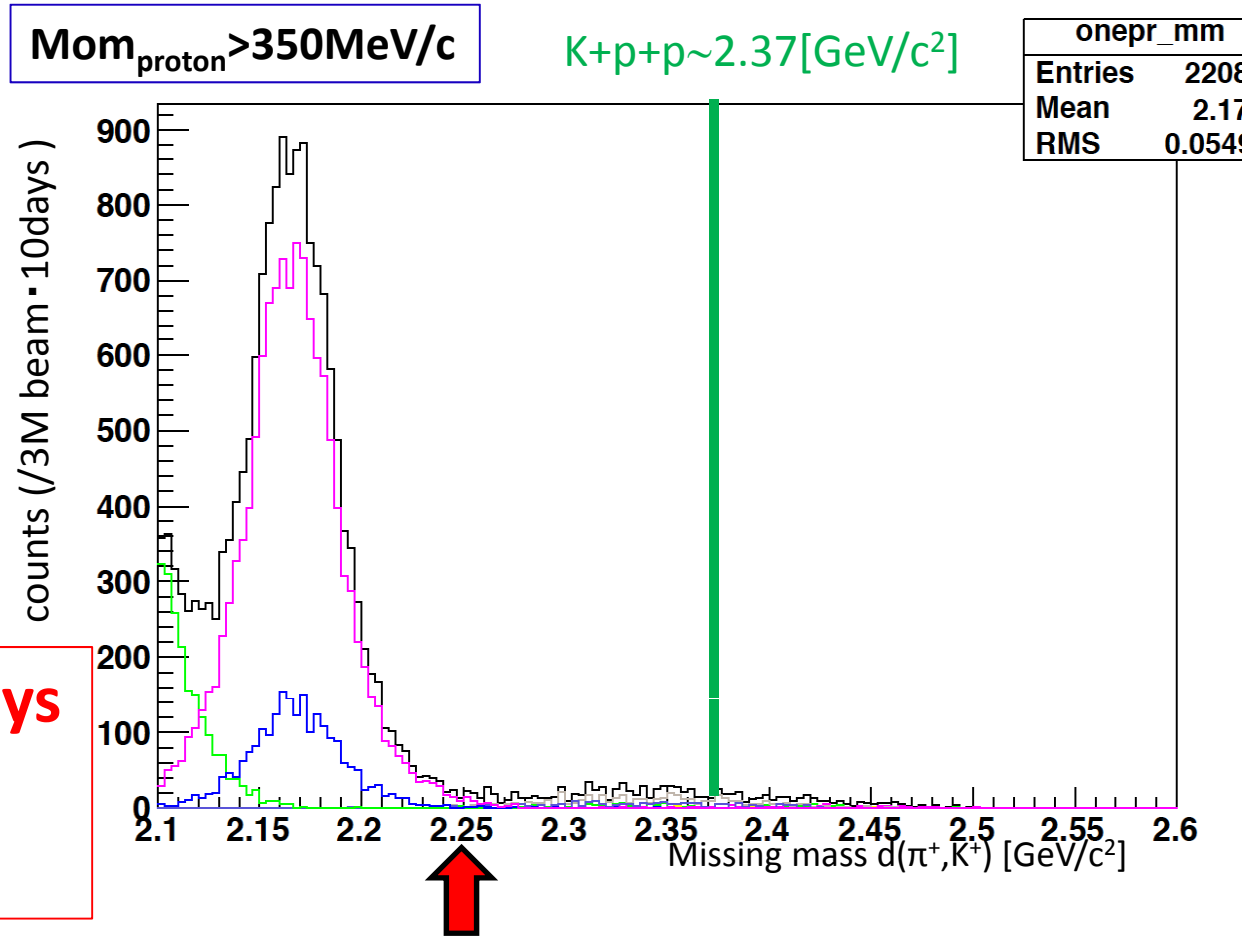
FINUDA, DISTO

E27: Expected B.G. spectrum with one proton tag

P_π=1.7GeV/c, SKS=350A

10 days with 3M/spill beam

- π^+ "n" → Σ^0 K^+
- π^+ "n" → Λ K^+
- π^+ "n" → $\Lambda(1405)$ K^+
- π^+ "n" → $\Sigma\pi K^+$
- π^+ "n" → $\Sigma^0(1385)K^+$
- π^+ "n" → $\Lambda\pi K^+$
- π^+ "p" → Σ^+ K^+
- π^+ "p" → $\Sigma^+(1385)K^+$
- π^+ "p" → $\Lambda\pi K^+$
- π^+ "p" → $\Sigma\pi K^+$



K^-pp = 177events/10days with one proton tag (1% sticking)

FINUDA, DISTO

→ **K^-pp = 39events /10days with two proton tag**
(we assume background free for two proton tag)

Near Future (2012.10—) Plan at K1.8

Following Exp. become inside the scope to be carried out.

- E13 1st step:
  - $^{4}_{\Lambda}$He 10 days with **10kW**
  - $^{19}_{\Lambda}$F 20 days with **10kW**

- E10 $^{6}_{\Lambda}$H via the ^{6}Li(π^-,K^+) (part.1)
  21 days with **3M/spill beam**
  100 counts for 10nb/sr (assumed)
  with 3.5g/cm^2 target

Spectrometer resolution check by observing $^{12}_{\Lambda}$C
Kaon beam study

Summary
Run Plan by Summer (K1.8/K1.8BR)

- E15 Commissioning & Engineering Run [K1.8BR] ~2 weeks
  - neutron-counter commission 1 week
  - Engineering RUN with full setup 1 week

- E27 1st step Run with 3M/spill beam [K1.8] ~2 weeks
  - Commissioning & Calibration 2—3 days
  - H(π^+,K^+) 1 day
  - D(π^+,K^+) 10 days

- Beam line & SKS study for future [K1.8]
  - Resolution check by ^{12}C(π^+,K^+)$^{12}_{\Lambda}$C 1 day
  - Kaon beam tuning & measurement 1 day

10kW User Beam Operation is requested !

HYP 2012 BARCELONA

XI International Conference on Hypernuclear and Strange Particle Physics

First Circular

The 11th International Conference on Hypernuclear and Strange Particle Physics (HYP2012) will take place in Barcelona (Spain) from Monday October 1st through Friday October 5th 2012.

The HYP conference brings together theoreticians and experimentalists working on the physics of hadron processes and bound nuclear systems containing strangeness. This area of research covers a broad variety of topics, including the physics of Λ hypernuclei, multistrange systems, kaonic nuclear clusters and the role of strangeness in extreme forms of matter. Over the years, the conference has always been open to including new and challenging problems, extending its frontiers to emerging subfields in nuclear and particle physics.

This will be the eleventh in the series of conferences, held periodically every three years, following the successful HYP-X of Tokai (Japan) in 2009. The HYP2012 conference will include plenary and contributed talks, as well as poster sessions, all of them taking place in the main auditorium and auxiliary rooms of the Cosmocaixa, Science Museum of Barcelona. The location will allow visitors to combine the joy of physics with the broad cultural and artistic offer of the city, the magnificent architectural heritage of Gaudí, as well as the pleasant mediterranean weather and food.

We would like to show **a lot of results from J-PARC**,
not only E19 but also other experiments, at this conference

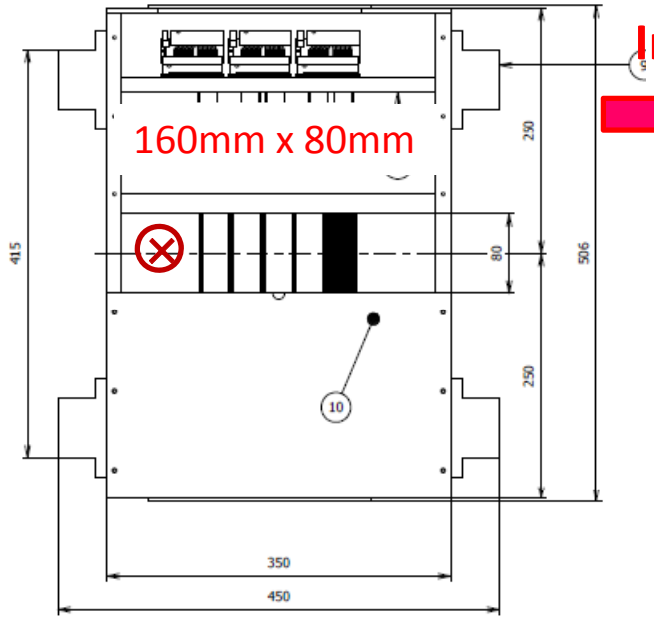
backups

Impact of June RUN
Setup change time estimate

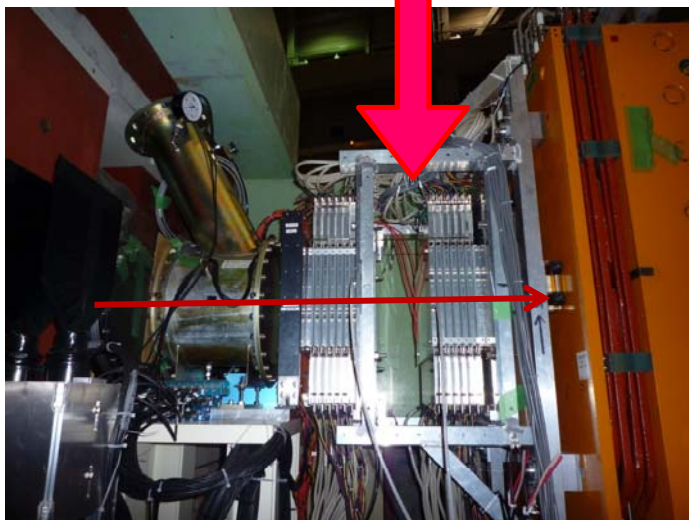
- Setup for E27 (Liq.Target & Range Counter) and E13 (Hyperball-J) is conflict.
  - E27 -> E10 a few days
  - E27 -> E13 3 months or more
    - to install HBJ and test it
- HBJ installation during Summer S.D.

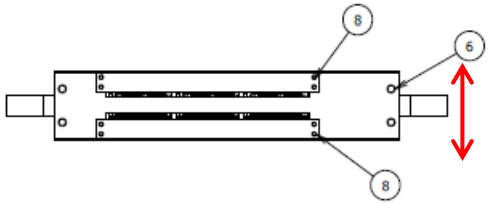
  if E27 is completed.
  - E10 <-> E13 if HBJ is pre-installed and tested, 1month to change SKS downstream detector configuration

Beamline Fiber Tracker



Install between BC1 and BC2 (B.S. upstream)





70mm

Momentum Reconstruction at Beam Spectrometer

5 parameters (X,Y,X',Y',δ) should be determined.

X_{out},Y_{out},X'_{out},Y'_{out} from downstream tracker

X_{in} from BFT

should select single hit by tight time gate

E10: n-rich Λ hypernuclei ($^{6}_{\Lambda}$H and $^{9}_{\Lambda}$He)

FINUDA: 3 candidates for $^{6}_{\Lambda}$H M.Agnello et al, PRL 108 (2012) 042501

$K^- + {}^6Li \rightarrow {}^6_{\Lambda}H + \pi^+$ $\quad$ ${}^6_{\Lambda}H \rightarrow {}^6He + \pi^-$

T_{tot} (MeV)	$p(\pi^+)$ (MeV/c)	$p(\pi^-)$ (MeV/c)	M (MeV)	B^5_Λ (MeV)	B^3_Λ (MeV)	M (MeV)	B^5_Λ (MeV)	B^3_Λ (MeV)
202.5	251.3	135.1	5802.33	3.11	1.41	5801.41	4.03	2.33
202.7	250.0	136.9	5803.45	1.99	0.29	5802.73	2.71	1.01
202.1	253.8	131.2	5799.97	5.47	3.77	5798.66	6.78	5.08

Table 1: Kinematic features, $^{6}_{\Lambda}$H mass, M, and binding energy with respect to $(\Lambda + {}^5H)$, B^5_Λ, and $(\Lambda + {}^3H + 2n)$, B^3_Λ, from production (col. 4, 5, 6) and decay (col. 7, 8, 9) reactions of the three $^{6}_{\Lambda}$H candidate events. $T_{tot} = T(\pi^+) + T(\pi^-)$. The errors are $\sigma(T_{tot})$=1.3 MeV, $\sigma(p_{\pi^+})$=1.1 MeV/c, $\sigma(p_{\pi^-})$=1.2 MeV/c, σ(M)=$\sigma(B_\Lambda)$=0.96 MeV for production reaction, =0.84 MeV for decay reaction.

Important to confirm the existence of $^{6}_{\Lambda}$H !
- Bound state or not?
- Binding energy?

Yield Estimate

11nb/sr ($^{10}_{\Lambda}$Li, KEK-PS E521)
3.5g/cm^2 target
3M/spill beam

100 events / 3 weeks

2012 Autumn after
improvement of duty factor
introduction of high-rate detectors

Check of the resolution for SksMinus' by $^{12}C(\pi^+,K^+)^{12}_{\Lambda}C$ reaction (1 day)

E19 1st step Results

- U.L. of dif. C.S. 0.26μb/sr [2° －15°]
- U.L. of total C.S. and Width
  - using Effective Lagrangian model by Hyodo
    - only pole-terms (s- and u- channel)
  - only E19 data
    - ½+ case: 0.21 μb ⇒ 0.72 MeV (PV,Fc)
    - ½ - case: 0.31 μb ⇒ 3.1 MeV (PS,Fc)
  - combined with E559 data
    - ½+ case: 0.21 μb ⇒ 0.41 MeV (PV,Fs)
    - ½ - case: 0.31 μb ⇒ 1.7 MeV (PS, Fs)

E19 Theoretical Predictions

σ_{tot} of the $\pi^- p \rightarrow K^- \Theta^+$ reaction at Plab ~ 1920 MeV and the $K^+ p \rightarrow \pi^+ \Theta^+$ reaction at Plab ~ 1200 MeV. All the numbers are given in units of $\Gamma\Theta/(1\ \mathrm{MeV})$ [μb]

		$\pi^- p \rightarrow K^- \Theta^+$		**$K^+ p \rightarrow \pi^+ \Theta^+$**	
J^P	F.F.	PS	PV	PS	PV
$J^P = 1/2^+$	Fs	9.2	0.51	119	9.6
	Fc	5.3	0.29	595	46
$J^P = 1/2^-$	Fs	0.18	0.40	1.9	4.2
	Fc	0.10	0.23	9.6	20
$J^P = 3/2^+$	Fs		10		94
	Fc		5.9		478
$J^P = 3/2^-$	Fs		5.5		8572
	Fc		3.2		40544

T. Hyodo et al., arXiv:1203.0598 [nucl-th]