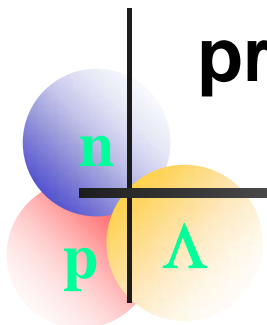


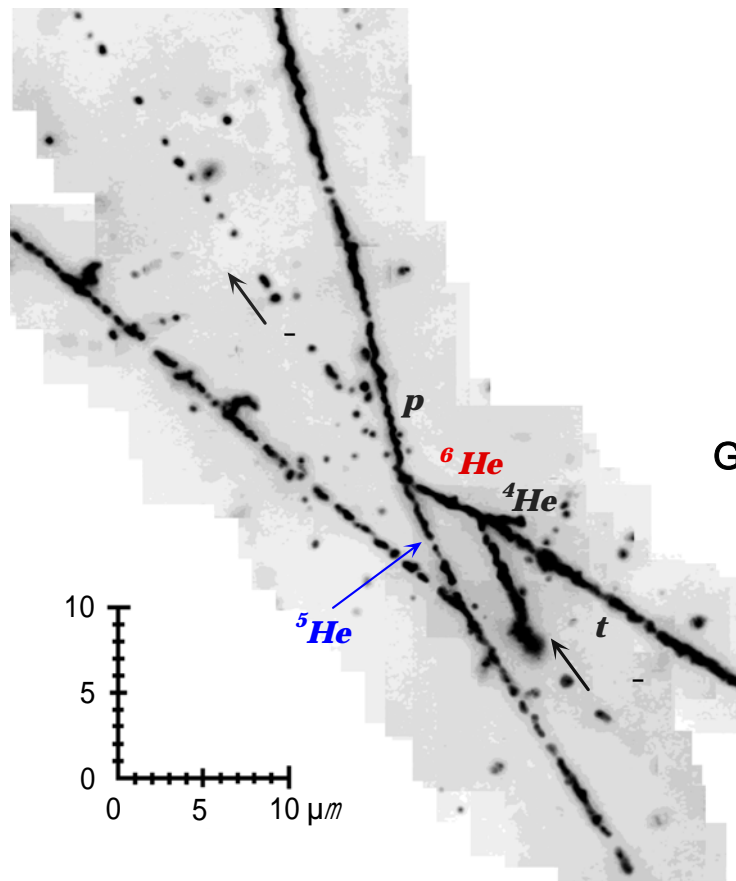
progress report on the E07 experiment

Jan.08,2008
J-PARC.PAC



Systematic Study of Double Strangeness System with an Emulsion-Counter Hybrid Method

NAGARA event (KEK-E373)



Kyoto: E.Hayata, M.Hayata, M.Hirose, K.Imai, S.Kamigaito,
A.Okamura, K.Tanida, M.Togawa, T.Tsunemi

Gifu: M.Kawasaki, Y.Nakanishi, K.Nakazawa, K.T.Tint, M.Ukai

Tohoku: K.Hosomi, T.Koike, Y.Ma, K.Shirotori, H.Tamura

AMU: R.Hasan

BNL: R.E.Chrien

CIAE: Y.Y.Fu, C.P.Li, Z.M.Li, J.Zhou, S.H.Zhou, L.H.Zhu

Chonnam: J.Y.Kim

Dongshin: M.Y.Pac

Fukui: T.Yoshida

Gyeongsang: K.S.Chung, S.H.Kim, J.S.Song, C.S.Yoon

KEK: M.Ieiri, H.Noumi, N.Saito, M.Sekimoto, H.Takahashi

Nagoya: K.Hoshino, T.Kawai, B.D.Park, T.Sato, T.Watabe

NIRS: N.Yasuda

OsakaCity: K.Yamamoto

Pusan: J.K.Ahn, S.Y.Ryu

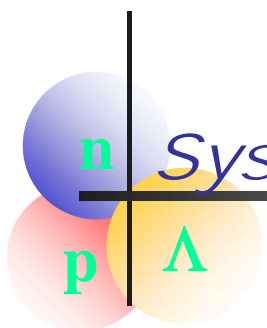
Shanxi: D.H.Zhang

Toho: C.Fukushima, M.Kimura, S.Ogawa, H.Shibuya

UCL: D.H.Davis, D.Tovee

U.Houston: Ed.Hungerford

U.New-Mexico: B.Bassalleck



Systematic Study of Double Strangeness System with an Emulsion-Counter Hybrid Method

J-PARC E07

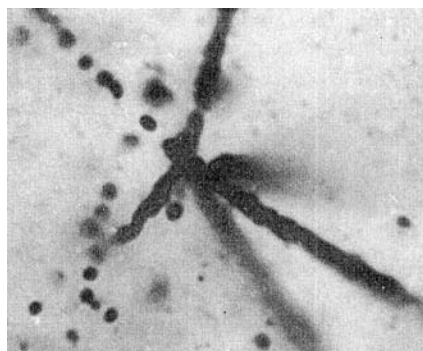
K.NAKAZAWA

(Gifu Univ.)

PS-E373

PS-E176

in $\sim 80 \Xi$ stops

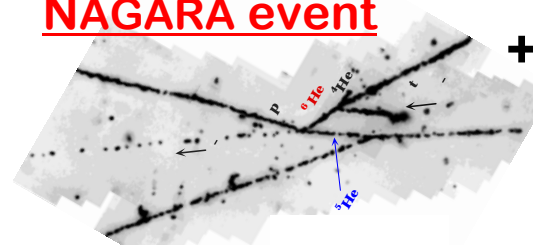


Double-Hypernucleus
with sequential decay
surely exists.

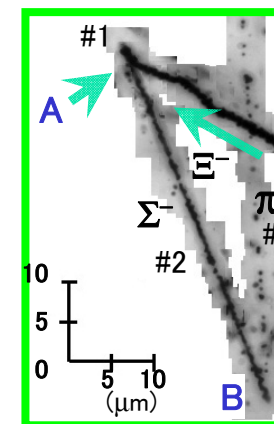
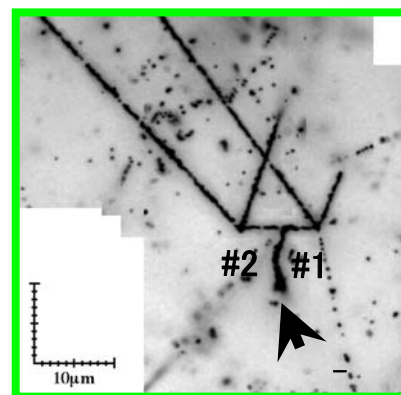
in $\sim 700 \Xi$ stops

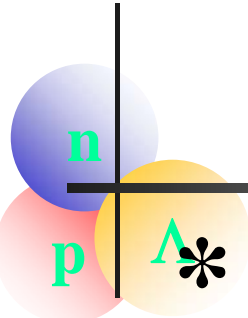
NAGARA event

+6 cand.



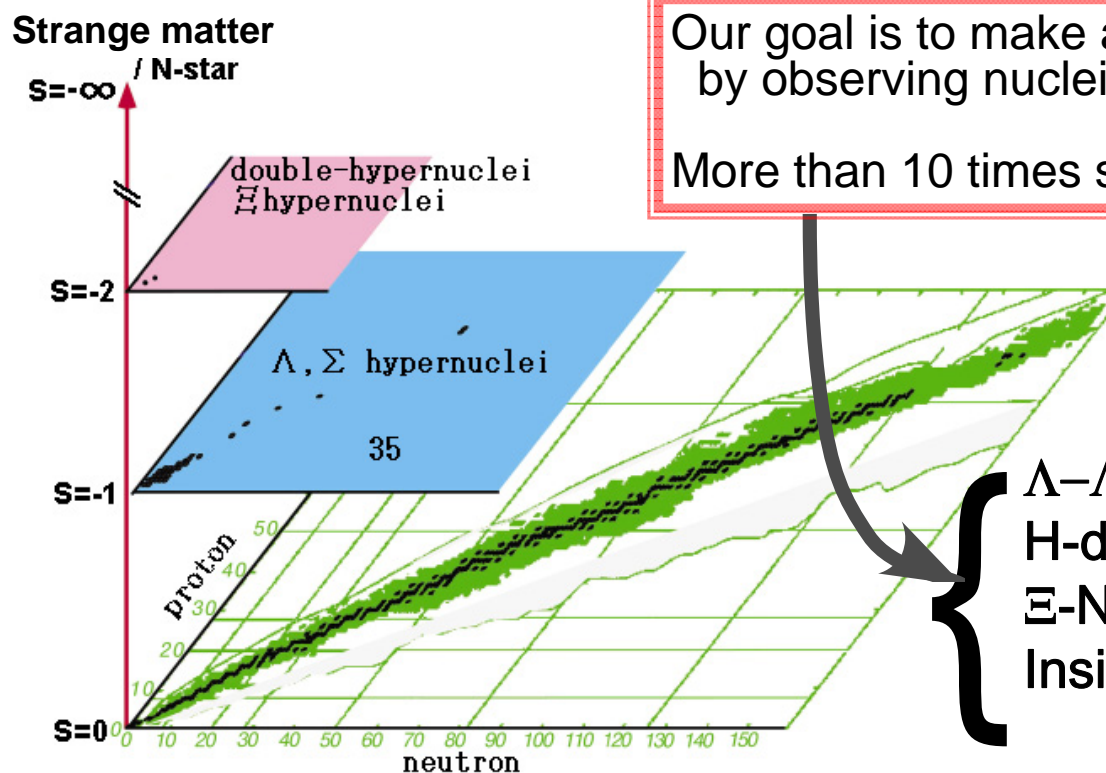
$B_{\Lambda\Lambda} = 1.01 \pm 0.20$ MeV for $\Lambda^6_\Lambda\text{He}$





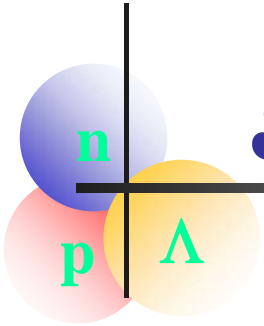
Motivation of the E07 experiment

Λ* detection of **10² or more candidate events** with $S = -2$,
→ **Discovery of 10** or more nuclear species.



Our goal is to make a **S=-2 nuclear chart**,
by observing nuclei with S=-2 as many as possible.
More than 10 times statistics than previous E373.

Λ-Λ Interaction,
H-dibaryon,
Ξ-Nucleus Interaction,
Inside Neutron Stars (Quark-star?)



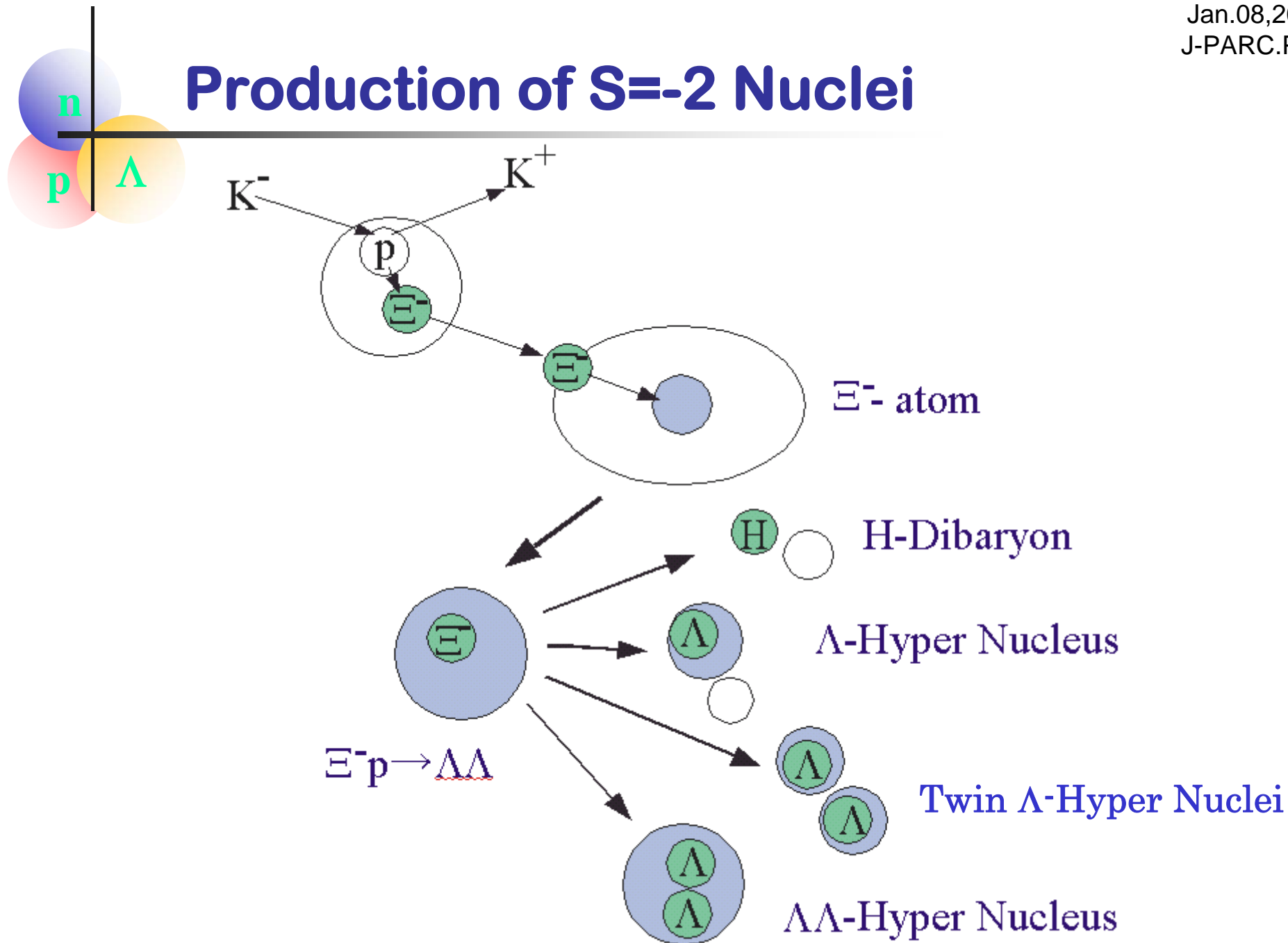
Summary

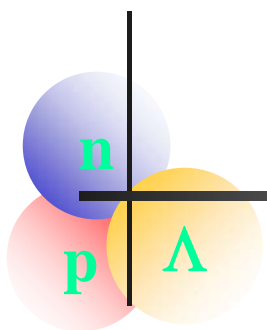
The 1st PAC on Jun.30,2006

Physics

- 1) **S=-2 nuclear chart** by $\sim 10^2 \Lambda\Lambda Z$ via $10^4 \Xi^-$ -stopping events.
=> $\Delta B_{\Lambda\Lambda}$ of **several nuclides** will provide definitive information on $\Lambda\Lambda$ interaction and structure of S=-2 nuclei.
- 2) **H-dibaryon state** in S=-2 system?
=> measure A-dependence of $\Delta B_{\Lambda\Lambda}$ & Σ^- -decay mode of $\Lambda\Lambda Z$.
- 3) **Ξ^- -nucleus potential**
=> detection of **twin hypernuclei**
=> First measurement of **X-ray** of Ξ^- -atom

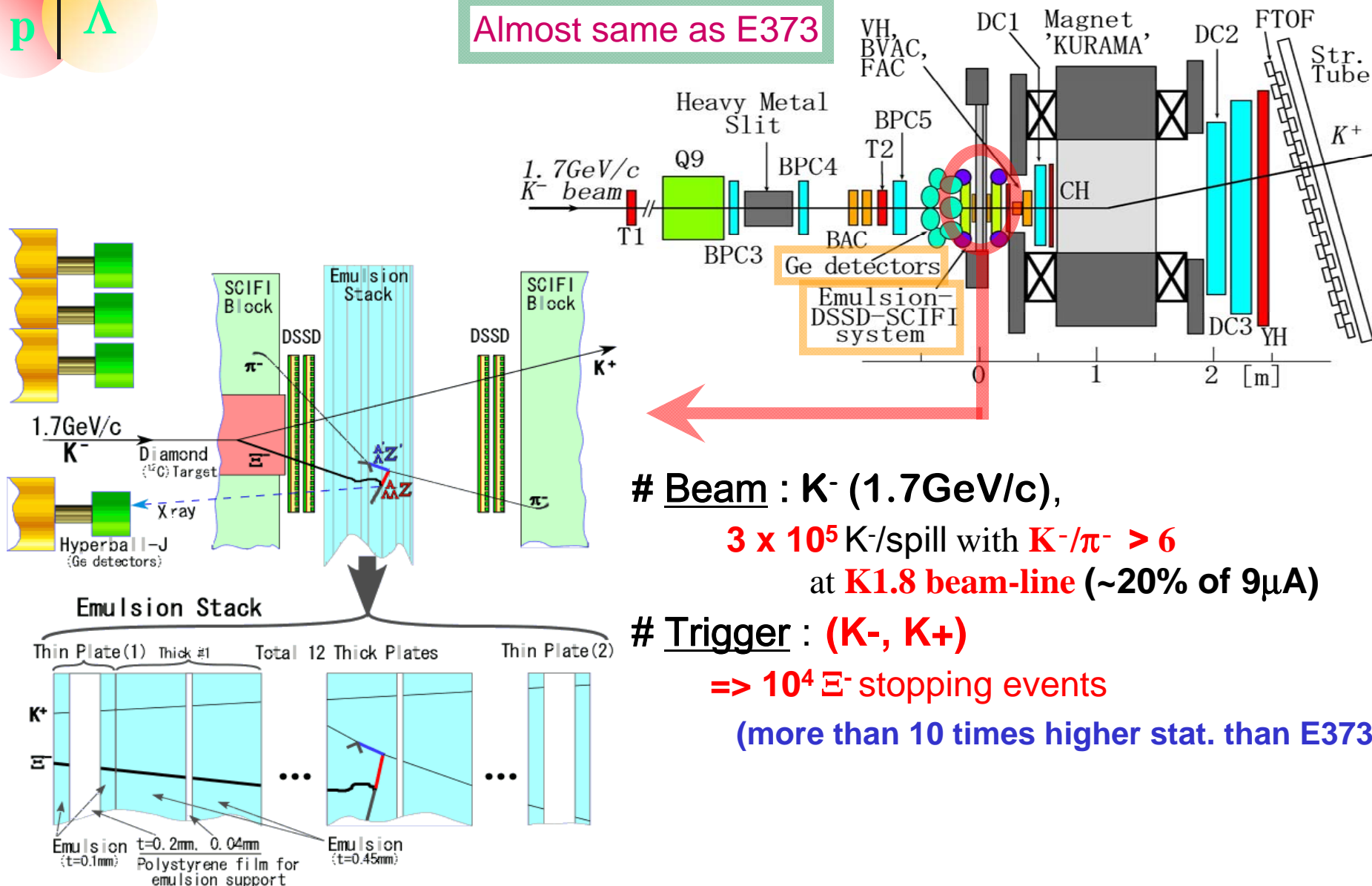
Production of S=-2 Nuclei





Setup of the proposed experiment

Almost same as E373



Beam : K^- (1.7GeV/c),

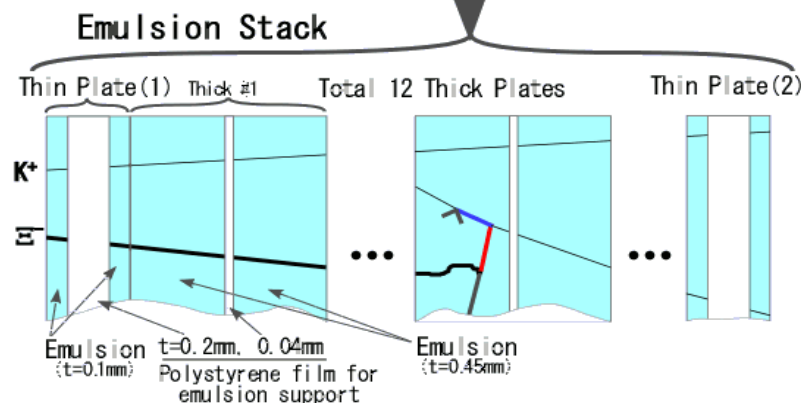
3×10^5 K^- /spill with $K^-/\pi^- > 6$

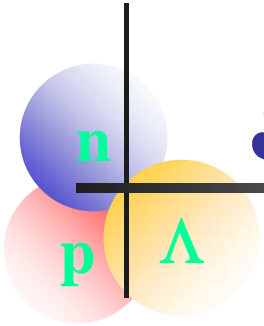
at **K1.8 beam-line** (~20% of $9\mu A$)

Trigger : (K^- , K^+)

=> 10^4 E^- stopping events

(more than 10 times higher stat. than E373)





Summary

The 1st PAC on Jun.30,2006

Readiness of the Experiment ('Kakenhi / Tokubetsu-Suishin' : \$3M)

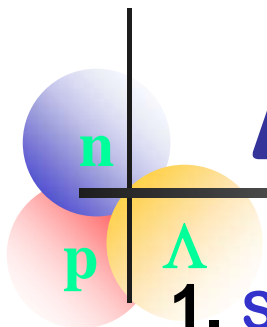
- + **DSSD** (Double-sided Si Strip Detector)
- + **Scanning system** (6=>10 systems : high speed and better efficiency)
- + **Emulsion** (50%)
- + **Hyperball-J** (other budgets)

Requested Beam and Time (K-, K+) trigger

3×10^5 K⁻/spill with **$K^-/\pi^- > 6$** at **K1.8 beam-line** (~20% of 9μA)
150 hours for detector tuning and **600** hours for beam exposure

Detector : DSSD, Emulsion, Hyperball, KURAMA spectrometer, etc.

Almost Ready



List of questions from the PAC and our reports on today

1. Spectrometer magnet : KURAMA

1st PAC minutes [Jul. 2, 2006]

==> FIFC [Nov. 2006]

==> 2nd PAC minutes [Jan. 12, 2007]

The PAC received a report from the FIFC committee on the evaluation of the experiment. There is no major technical problem in the experiment. The FIFC judges that the installation of **Kurama** magnet is both possible and preferable for acquiring more statistics.

TODAY : Setting status of Kurama and SKS magnet at the K1.8 line

2. Alignment between the DSSD and the emulsion

FIFC [Nov. 2006]

==> 2nd PAC minutes [Jan. 12, 2007]

The FIFC considers that good alignment between the two DSSD detectors and the emulsion stack is important for an efficient scanning. The strategy of the alignment procedure is, however, not well documented and reviewed.

Originally, there was nothing problems [PS-E176(KEK)]

TODAY : 2-1. Review of alignment in PS-E176(KEK)

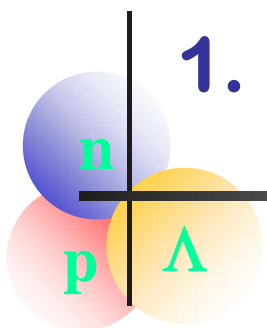
2-2. test of New alignment method

2-3. Performance of Developed DSSD (Double-sided Si Strip Detector)

3. Our strategy

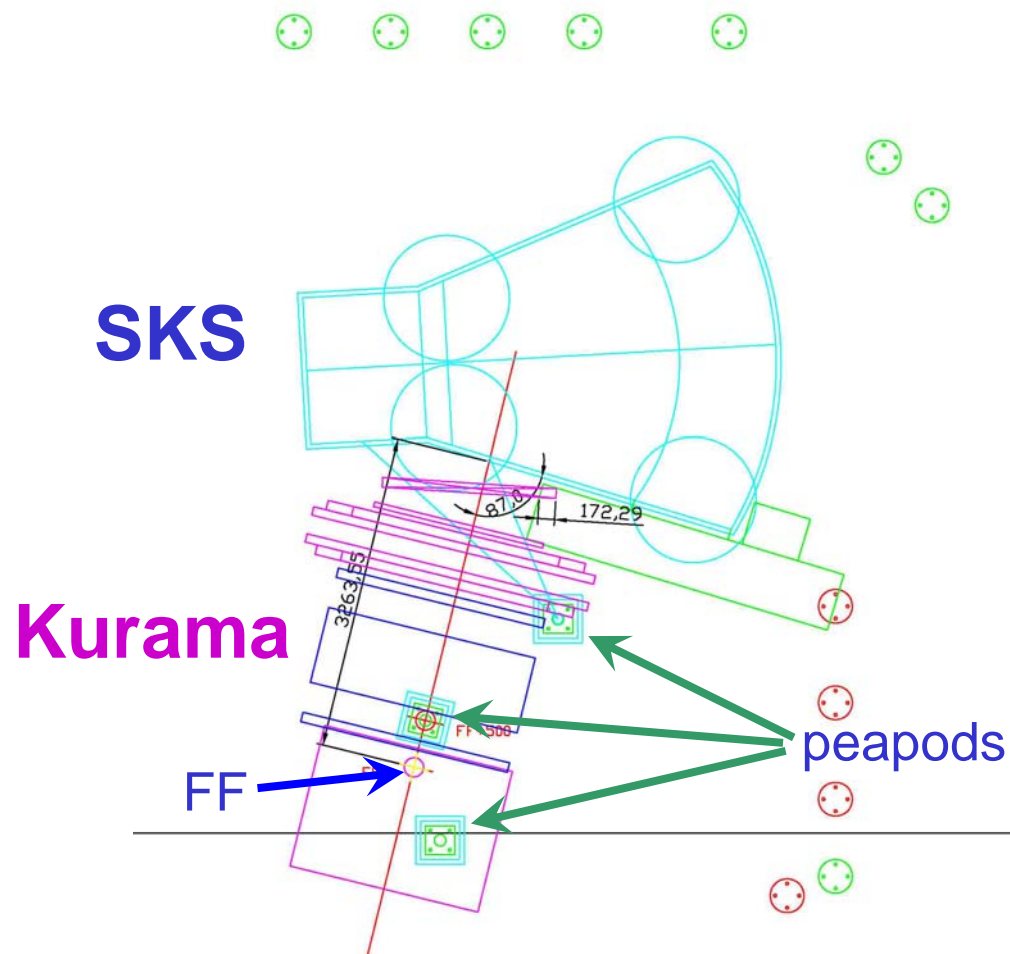
budget, preparation schedule

1. *Setting status of Kurama and SKS magnet at the K1.8 area*



by T.Takahashi

K1.8 area



Three peapods shall be set in suitable position for each experiments using SKS.

We can locate **Kurama in K1.8 with SKS.**

Plan (prof. T.Takahashi)
in FY08 :
transfer SKS from KEK to J-PARC.

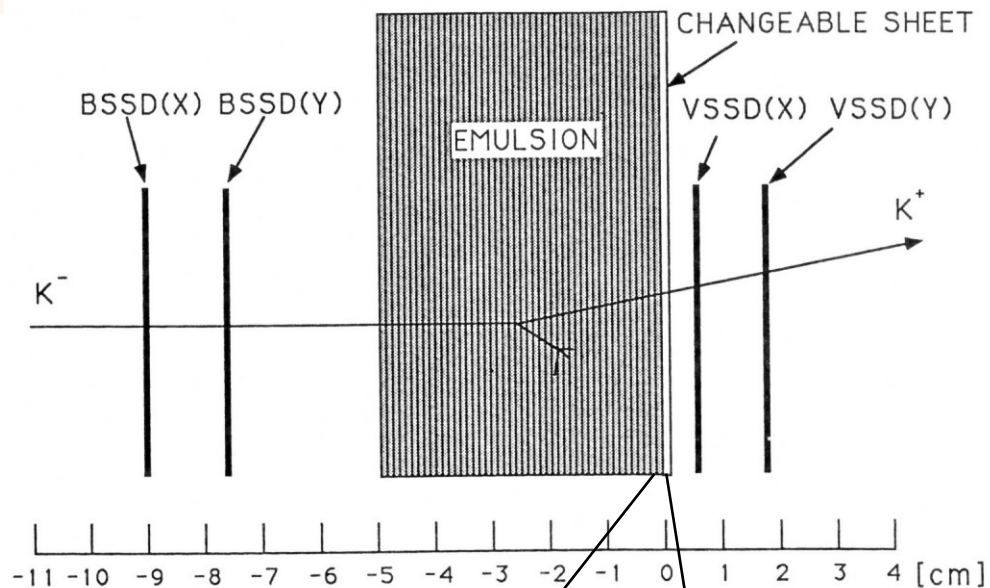
2. Alignment between the DSSD and the emulsion

2-1. Review of alignment in PS-E176 (KEK)

SSD Specification KEK Preprint 94-163

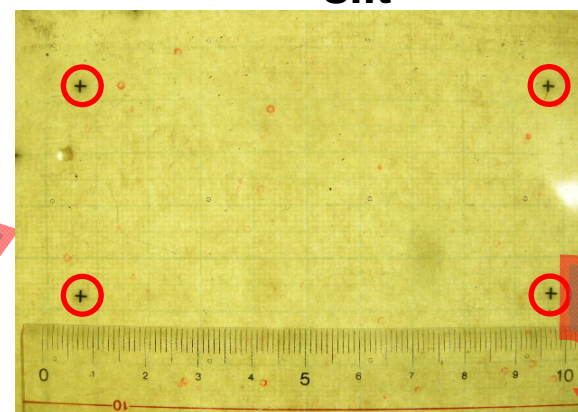
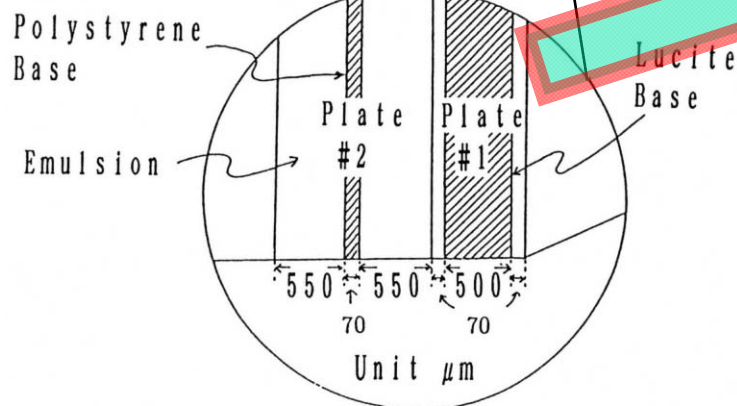
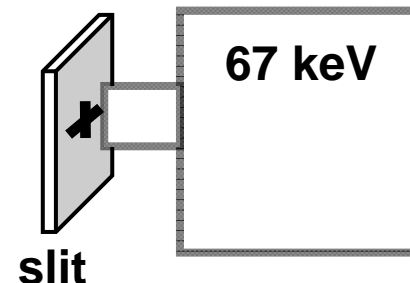
size : 50mm x 50 mm x 0.3mm

Strip pitch : 42 μ m



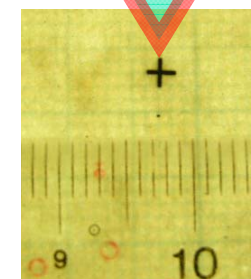
X-ray gun

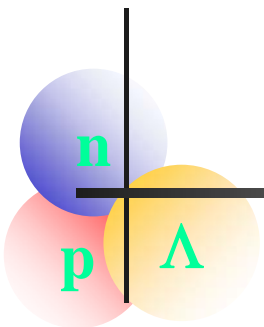
67 keV



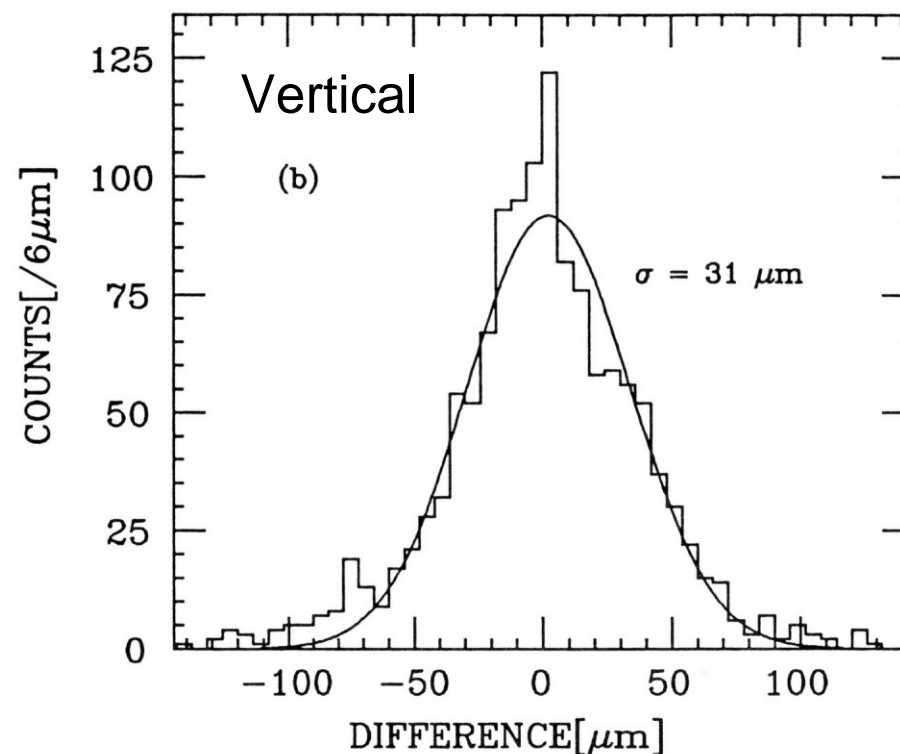
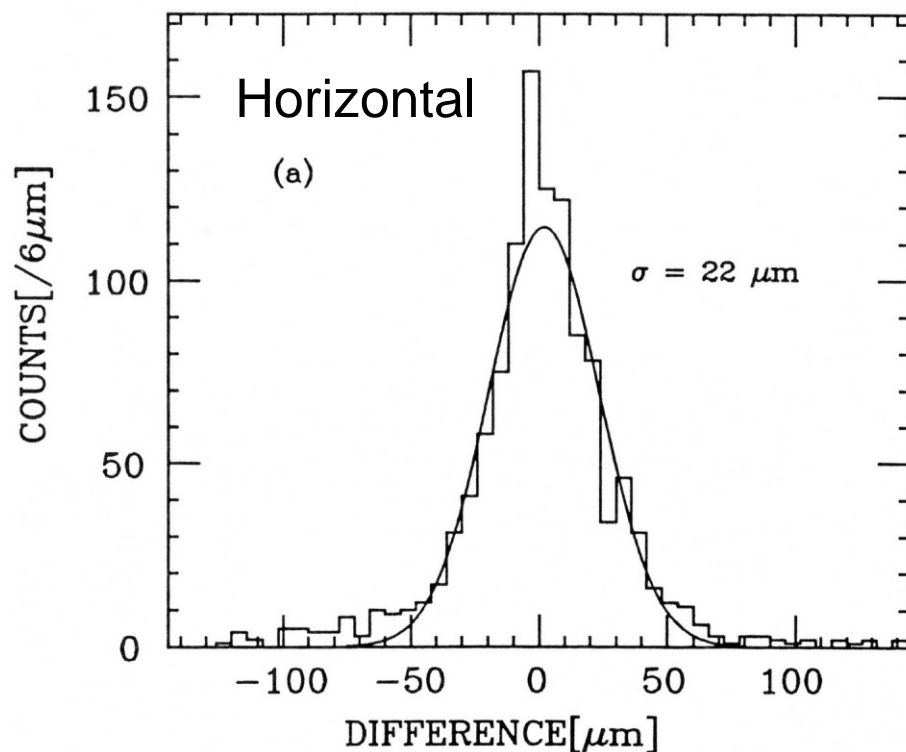
Emulsion Plate #1

SSD \Leftrightarrow Em.
 $\sigma_{x,y} \sim 0.1\text{mm}$

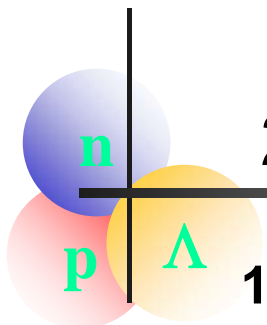




Position accuracy distribution. [Final
SSD=> (Em sheet) => Em stack.
after the calibration using a few thousand tracks



Alignment using X-ray is well applicable for E07 as PS-E176.

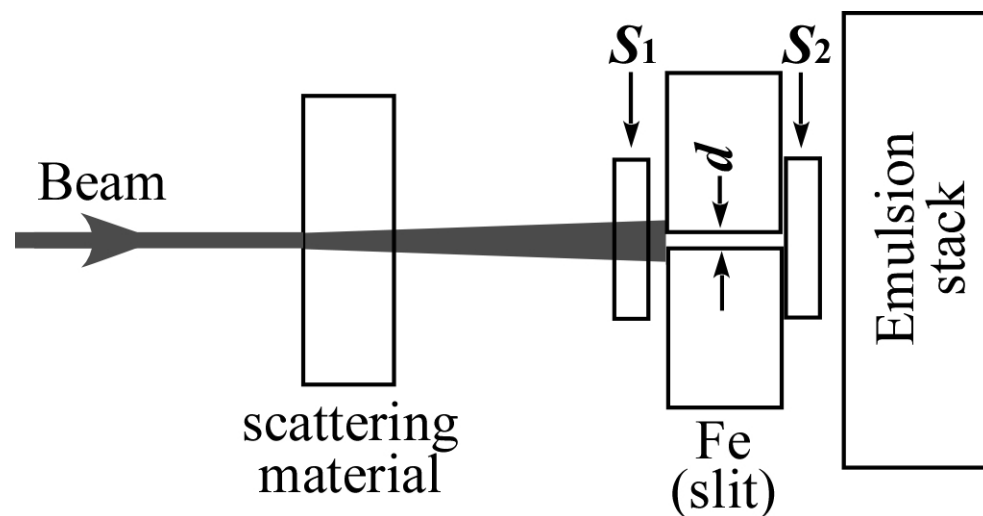


2-2. test of New alignment method

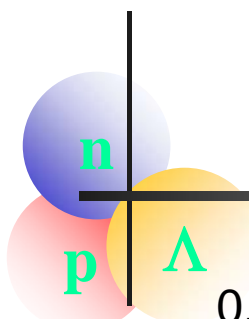
1. X-ray generator is so heavy to be installed in beam line.
2. Safety for the exchange of the emulsion stacks.

==> beam spot painting on DSSD and the emulsion

Test exp. of beam spot at RCNP- R80 (Dec.,2007)



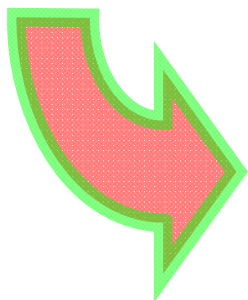
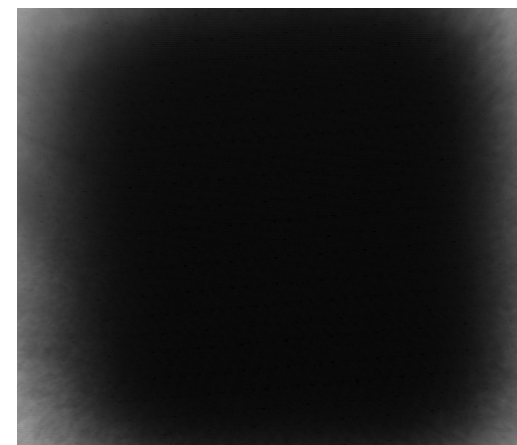
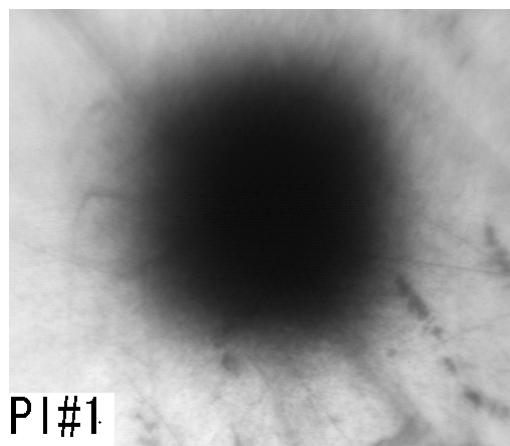
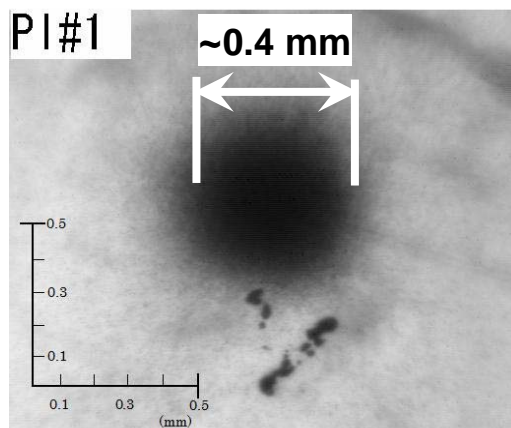
- Beam **Proton**(65 MeV, 355MeV/c)
- slit size
 $d = 0.3 \times 0.3, 0.5 \times 0.5, 1.0 \times 1.0$ [mm²]
- Track density in the Emulsion
 $0.5, 1.0, 5.0, 10.0$
 $\times 10^5$ protons/[mm²]
- Thickness of Fe slit **10 mm**



Beam spot (R80 at RCNP)

exposed beam density = 10×10^5 [protons/mm²]
0.3 x 0.3 [mm²] 0.5 x 0.5 [mm²]

1.0 x 1.0 [mm²]



Accuracy

$0.4/\sqrt{12} \sim 0.1$ [mm]

good enough alignment
for the experiment

Yield estimation at K1.8 @30GeV 9μA (Sanford-Wang, TRANSPORT & TURTLE)

for 10×10^5 [protons/mm²] through 0.3x0.3 [mm²] slit

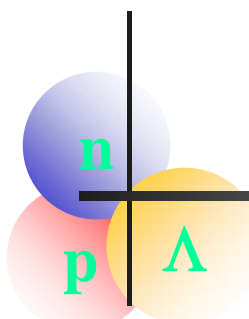
300 MeV/c : 120 spills

400 MeV/c : 40 spills

500 MeV/c : 20 spills

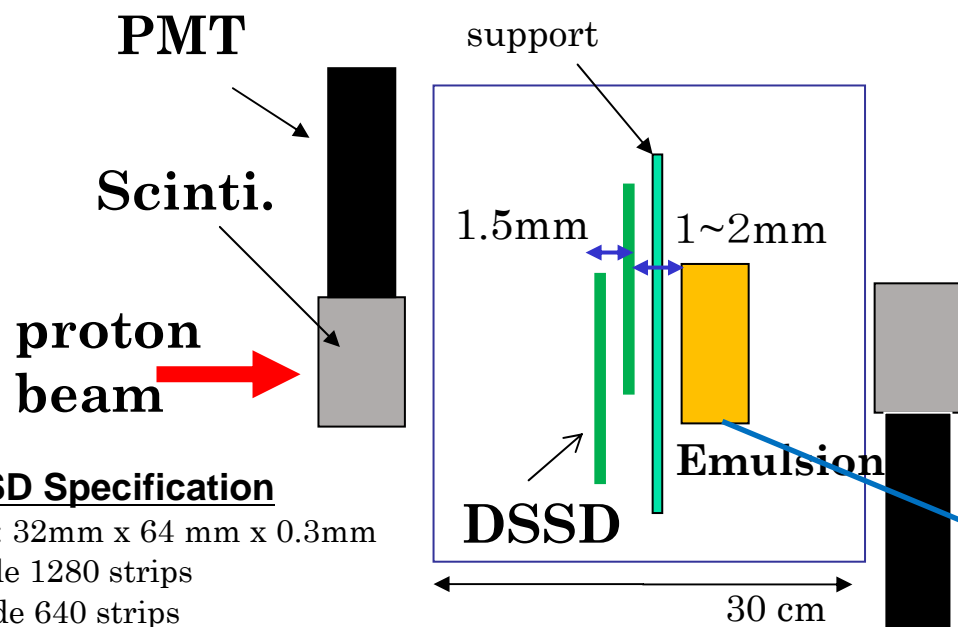
reasonable
beam time

preliminary



2-3. performance of developed DSSD

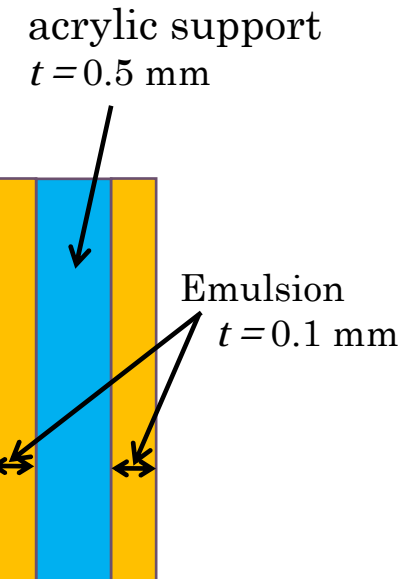
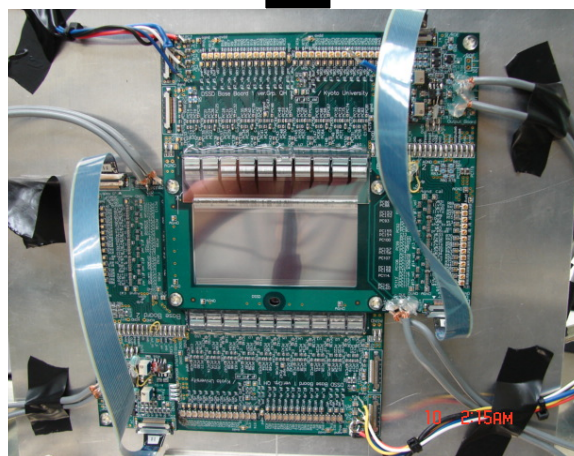
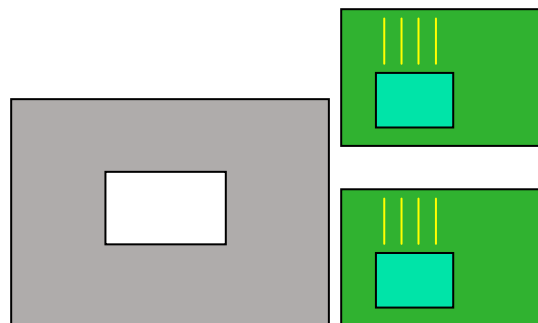
Test exp. of DSSD at RCNP- R78 (Dec.,2006)

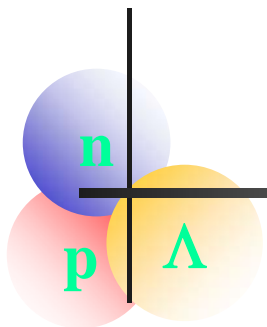


- Beam **Proton**(136.2 MeV)
- Incident angle
 $0^\circ, 15^\circ, 20^\circ, 30^\circ, 45^\circ, 50^\circ$
- Track density in the Emulsion
 $3 \text{ protons}/[\text{mm}^2]$
- Gap [DSSD \Leftrightarrow DSSD]
1.5mm
- Gap [DSSD \Leftrightarrow emulsion]
1~2mm

DSSD Specification

size : 32mm x 64 mm x 0.3mm
P-side 1280 strips
N-side 640 strips
Strip pitch : 50 μm ($\Delta r=14.4 \mu\text{m}$)
S/N ratio : p-side 31.03 ± 0.16
n-side 24.46 ± 0.13

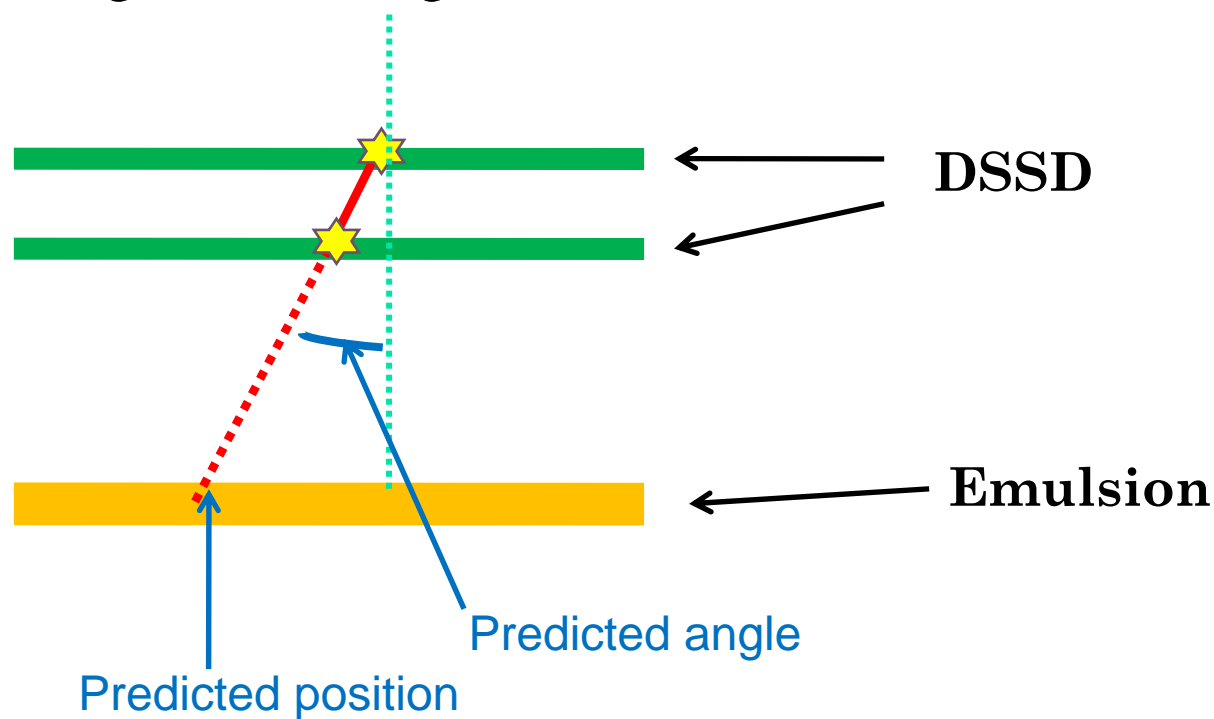




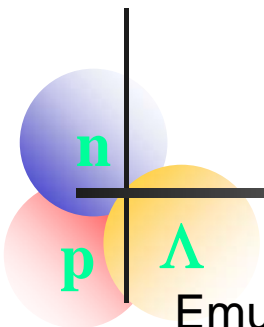
Track reconstruction

Condition

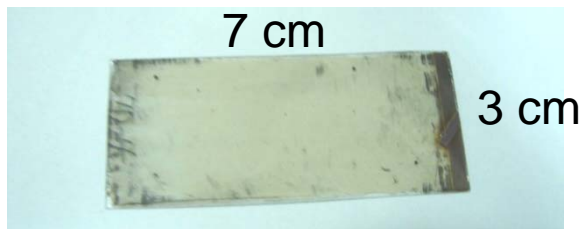
- Signal ADC $> 3\sigma_{\text{noise}}$
- Clustering (ADC weighted)



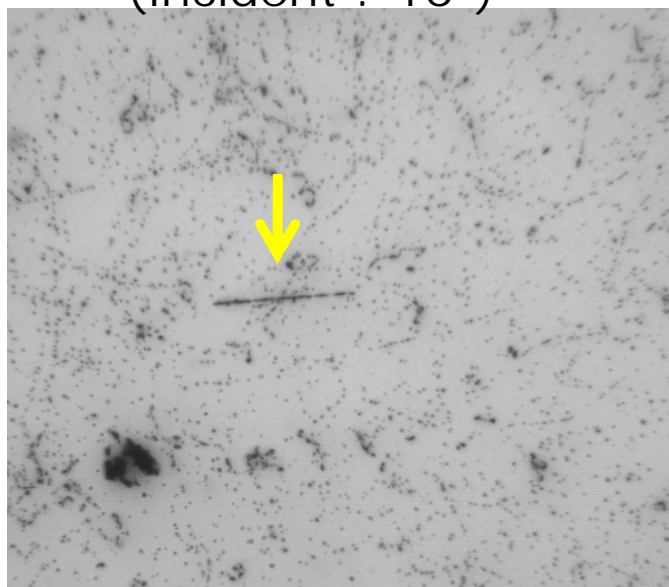
Scanning of protons in the emulsion



Emulsion Plate



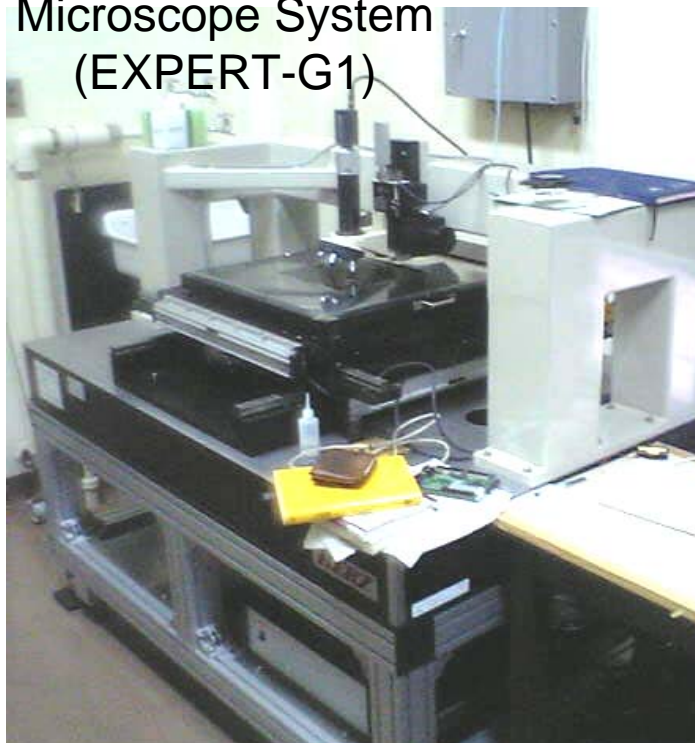
Microscope image
of proton track
(incident : 10°)



$\sim 100 \mu\text{m}$

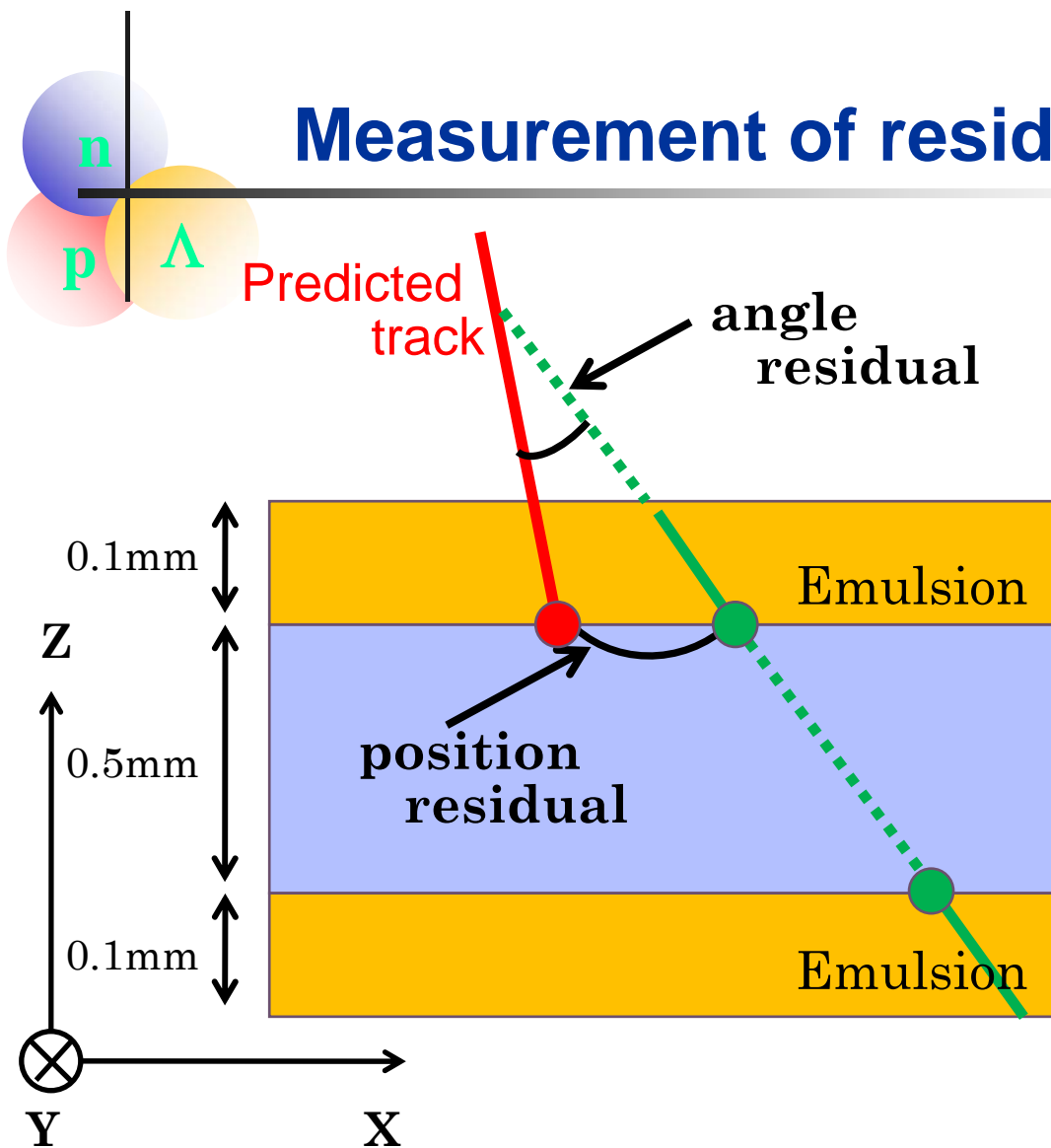
$\sim 100 \mu\text{m}$

Microscope System
(EXPERT-G1)

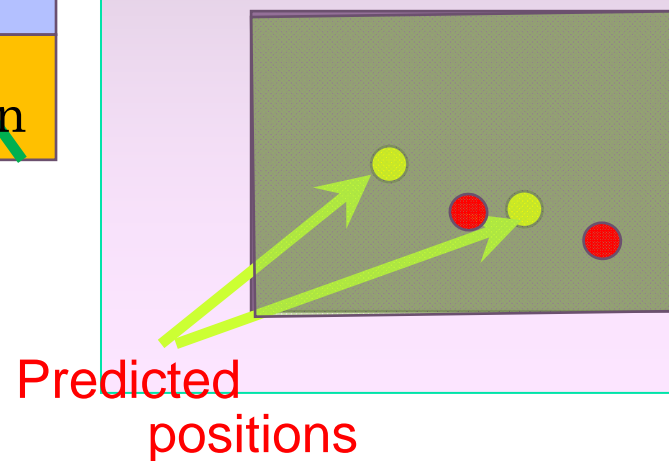


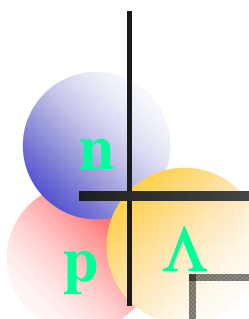
**Scanned ~ 100 tracks
/ each angle exposure**

Measurement of residuals (position, angle)



Aligned the Emulsion with DSSD so as to minimize the sum of the residual by iteration.





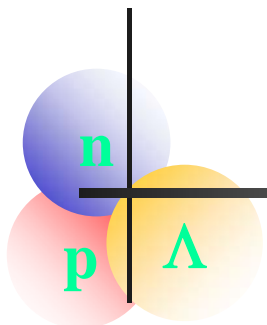
Result of residuals (position, angle)

	Position (μm)		Angle (mrad)			
	x	y	x	y		
E07	0°	19.9 +/- 1.8	19.5 +/- 1.9	19.1 +/- 1.8	11.5 +/- 1.0	
	15°	16.4 +/- 1.4	25.6 +/- 0.8	8.9 +/- 0.8	11.4 +/- 0.7	
	25°	45.3 +/- 6.8	26.0 +/- 2.3	10.6 +/- 0.8	13.8 +/- 1.2	
	30°	42.3 +/- 6.6	15.7 +/- 1.6	12.3 +/- 3.7	11.8 +/- 1.7	
	45°	41.3 +/- 5.0	21.0 +/- 2.2	7.6 +/- 0.8	15.3 +/- 1.4	
		20 ~ 45	DSSD	10 ~ 20	X-ray ?	
E373 N.I.M. A 417 (1998) 220-229	194 (163)	113 (137)	Fiber- bundle	44 (-)	25 (-)	X-ray
E176 KEK Preprint 94-163	~ 100 (22)		SSD	-	-	X-ray

for Ξ -tracking S/N ~ 1/3

S/N ~ 3

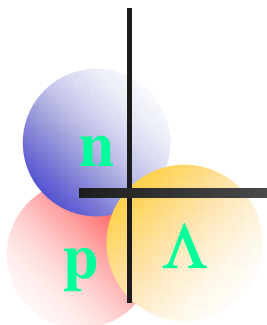
good enough!!



3. Strategy

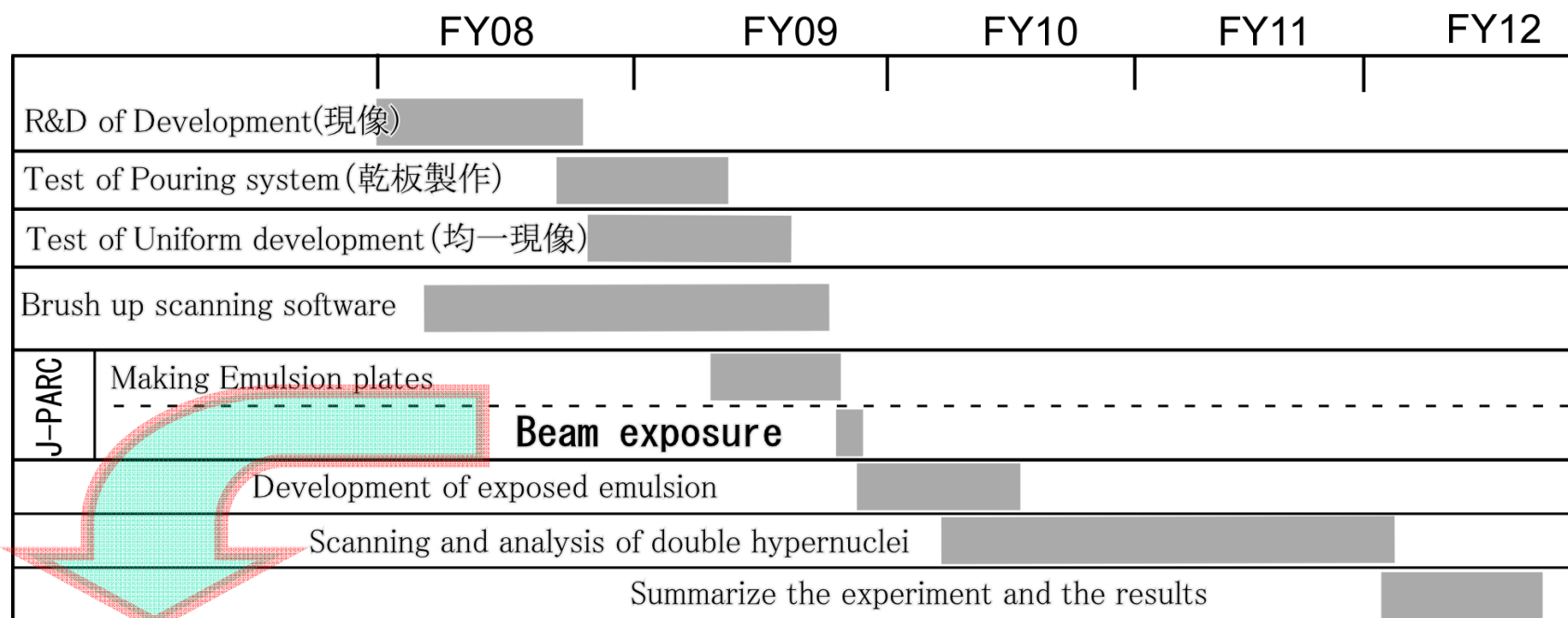
3-1. Budget application for FY08-12

	x10 ⁶ yen	Funding Category [JSPS : Kakenhi]
Emulsion	35	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <p>Basic A</p> <p>¥ 46 M</p> </div> <div style="text-align: center;"> <p>Basic S</p> <p>¥ 180 M</p> <p>(including ¥30M for Counters, Chambers, etc. ¥50M for Microscope)</p> </div> </div>
Post Doc.	12	
Tank for development	8	
chiller	7	
Chemicals for development	10	
Waste liquid treatment	7	
Expendable supplies	2	

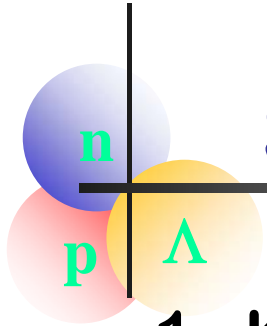


3-2. Our preparation schedule

(related part to the Emulsion work)



our beam request 20% of 9 μ A
Kurama use E07 & E03 (K1.8)



Summary

1. Kurama magnet shall be located in K1.8 area without disturbance.
2. Alignment between DSSD and Emulsion has no problem.
 - 2-1. It is reliable using X-ray as PS-E176.
 - 2-2. Beam spot method can be effective.
 - 2-3. DSSD detectors are well working.
3. Budgetary application has been done for FY08-12. Our preparation is going for the beam exposure on FY09.