Facilities &

Current and Planned Experiments in S= -2 Systems in Japan

- Current

  KEK-PS : E176, E224, E248, E373, E522

- Planned

  J-PARC : L06, L07, L10

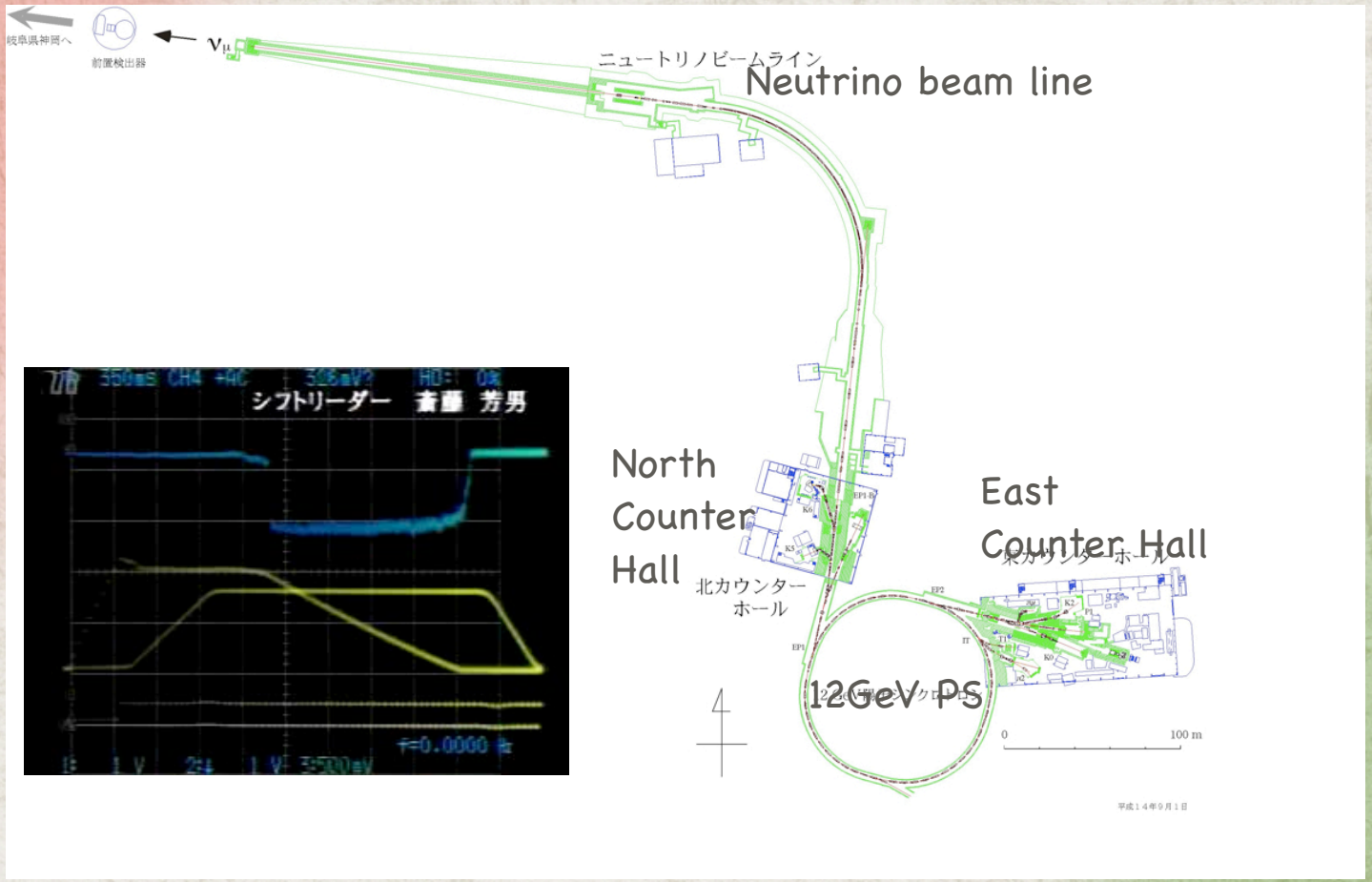
IEIRI Masaharu (KEK)

Cascade Physics @ J Lab

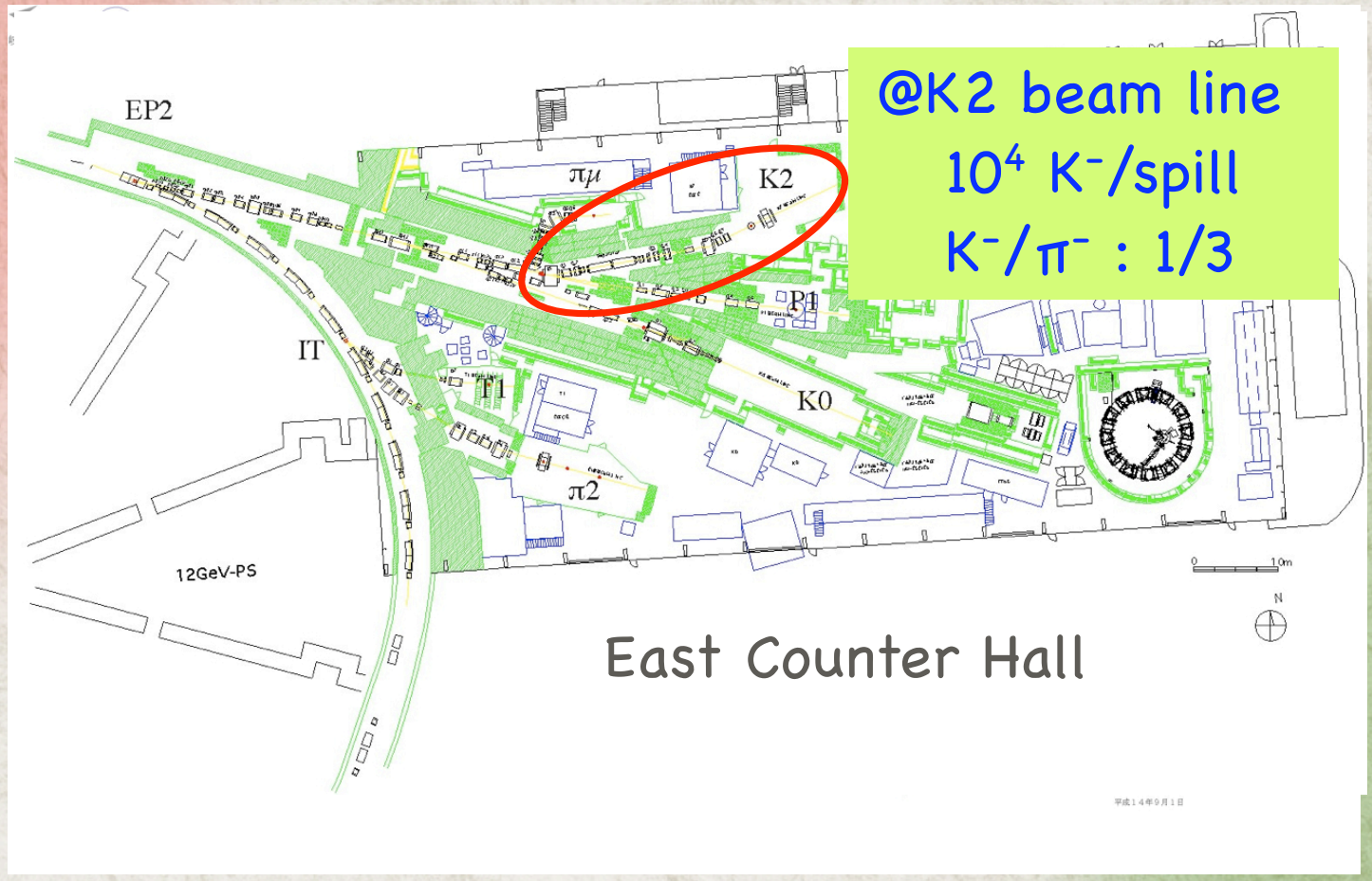
December 1-3, 2005

KEK 高エネルギー加速器研究機構

Current : KEK 12GeV PS facility



Current : KEK 12GeV PS facility



@K2 beam line
10^4 K^-/spill
K^-/π^- : 1/3

Current : KEK 12GeV PS Experiments

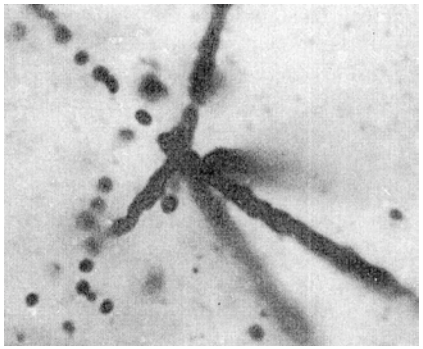
Nuclear Physics with Strangeness : S = -2 physics

E114, E117, E132, E140, E150, E160, E166, E167, E175, E176, E187, E218, E224, E248, E251, E287, E289, E307, E336, E369, E373, E419, E438, E452, E462, E471, E508, E509, E518, E521, E522, E548, E549, E559, E566, E570

No.	Spokesperson	Subject	Beam line	Method	Beam time	Status
E176	K. Imai	Search for ΛΛHypernuclei and/or H-Particle	K2	Emulsion+SSD	1988.3-1989.3	finished
E224	K. Imai	Search for H-Particle	K2	Scintillating fiber	1991.2-1992.2	finished
E248	H. Kawai	Search for H-Particle via $pp \rightarrow K^+K^+X$	P1	primary proton + H_2 target	1997.2-1997.6	analysis
E373	K. Nakazawa	Study of Double Strange Nuclei by Emulsion-Scintllating fiber Hybrid Methods	K2	Emulsion + Scintillating fiber	1998.2-2000.6	analysis
E522	K. Imai	Search for H-dibaryon resonance via $^{12}C(K^-, K^+ \Lambda\Lambda)$ and Study of Ξ^-N interactions	K2	Scintillating fiber	2002.10-2004.2	analysis

Current : KEK 12GeV PS
E176 & E373 [Emulsion]

E176



$^{13}_{\Lambda\Lambda}\mathrm{B}$ in ~80 Ξstops

$\Delta B_{\Lambda\Lambda} = 4.9 \pm {}^{0.7}_{0.8}$ MeV

$\Delta B_{\Lambda\Lambda} \backsim 0$ MeV

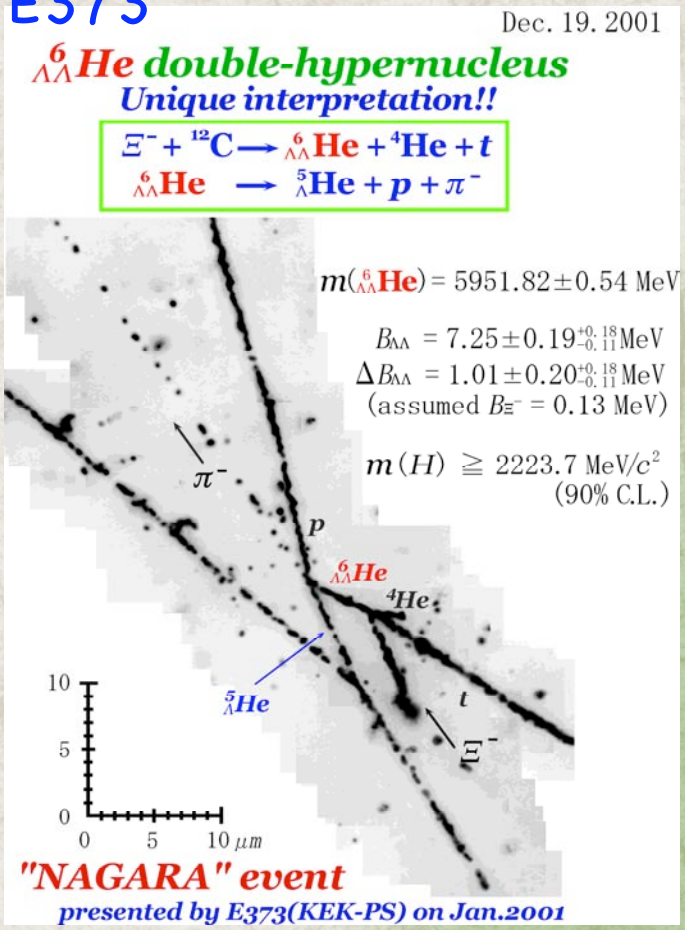
or

$^{10}_{\Lambda\Lambda}\mathrm{Be}$

$\Delta B_{\Lambda\Lambda} = -4.8 \pm {}^{0.7}_{0.8}$ MeV

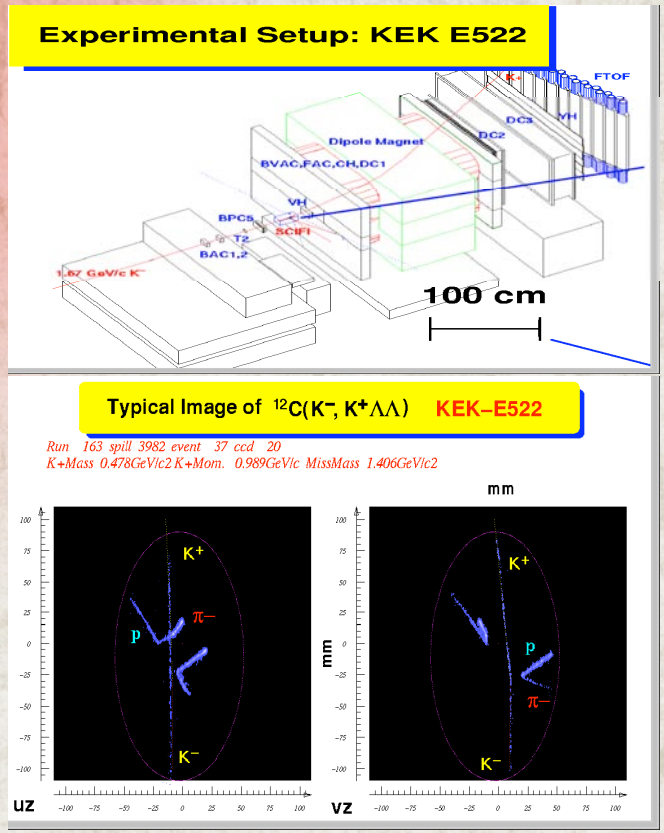
S.Aoki et al, PTP.85(1991)1287

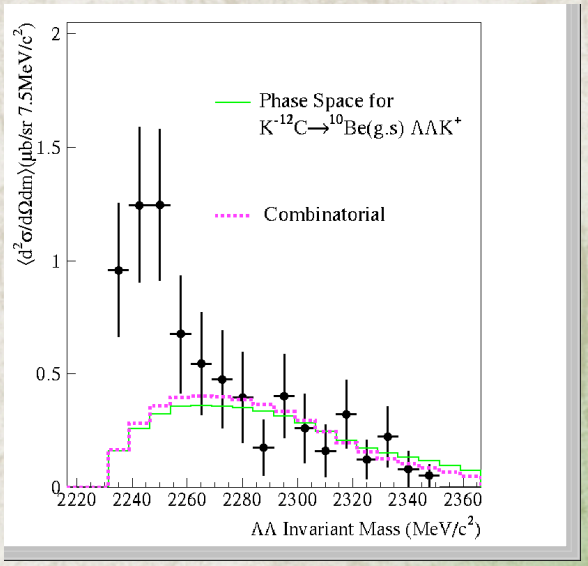
E373



Phys. Rev. Lett.87 (2001) 212502.

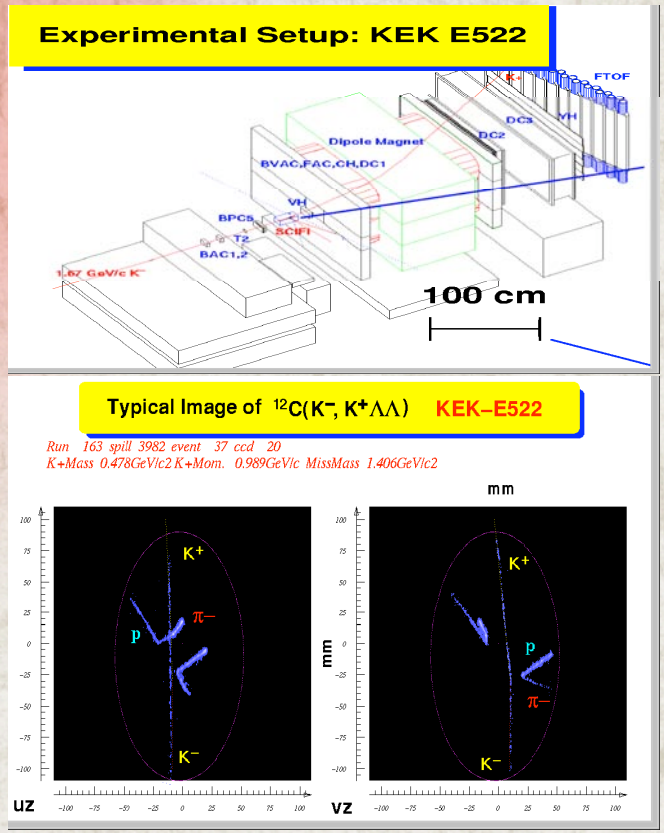
Current : KEK 12GeV PS
E224 & E522 [SciFi]





Invariant mass of ΛΛ produced by (K-,K+) reaction in Scifi target.
A peak is seen at the threshold.

Current : KEK 12GeV PS
E224 & E522 [SciFi]



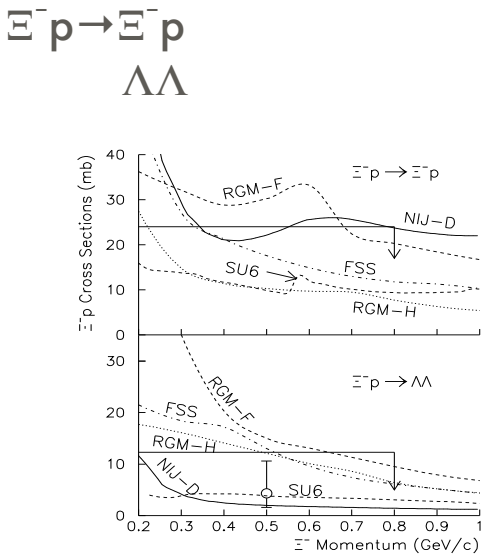
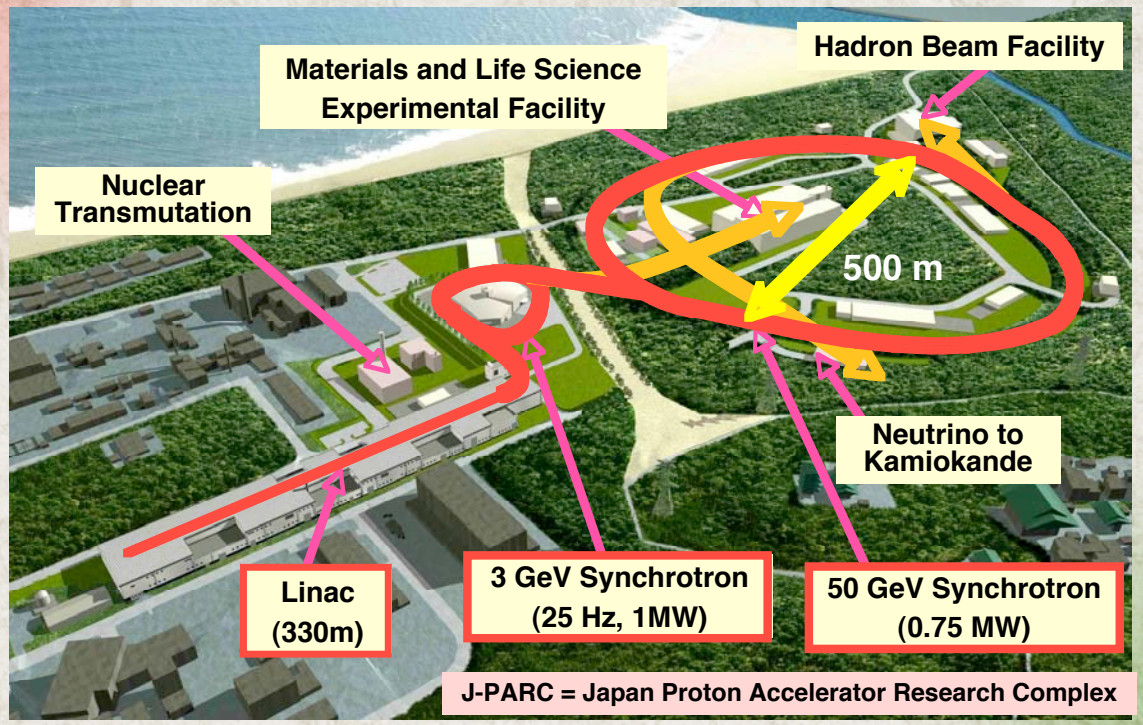


Fig. 2. Upper limits on the Ξp cross sections at 90% confidence level, indicated by arrows, are compared with theoretical estimates of RGM-F, RGM-H, FSS, Nijmegen-D, and SU_6 quark model. In the bottom panel a data point represents the result obtained from $\Xi^{-12}C \rightarrow \Lambda\Lambda$ reaction assuming the effective proton number of 3.5. Poisson statistical error is quoted only.

KEK-PS 12GeV operation for physics users will be closed at the end of this month.

Intensity is not so high, but we get these results thanks to its stable operation.

Construction : J-PARC facility



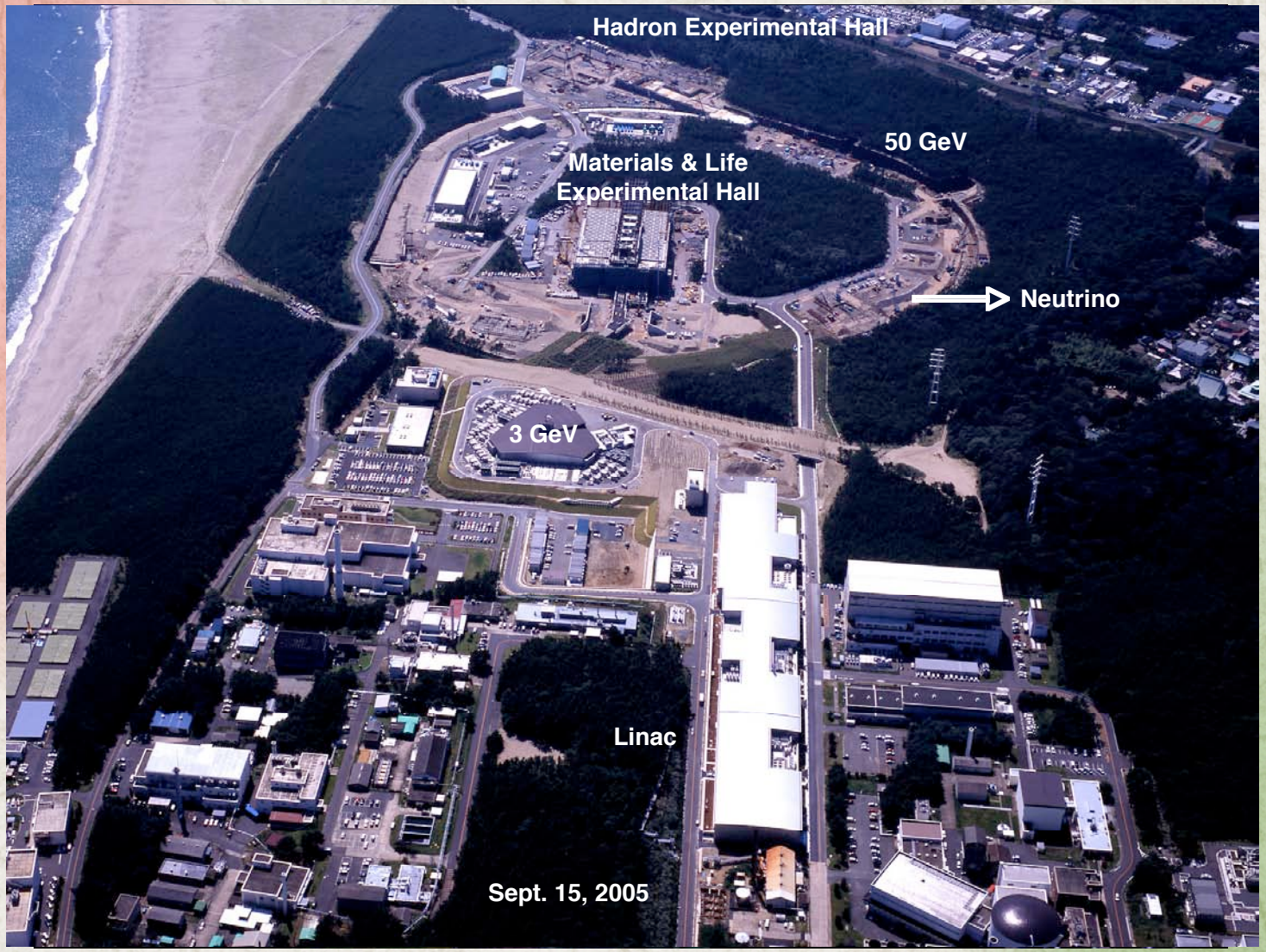
Joint Project between KEK and JAEA

KEK 高エネルギー加速器研究機構

Construction : J-PARC

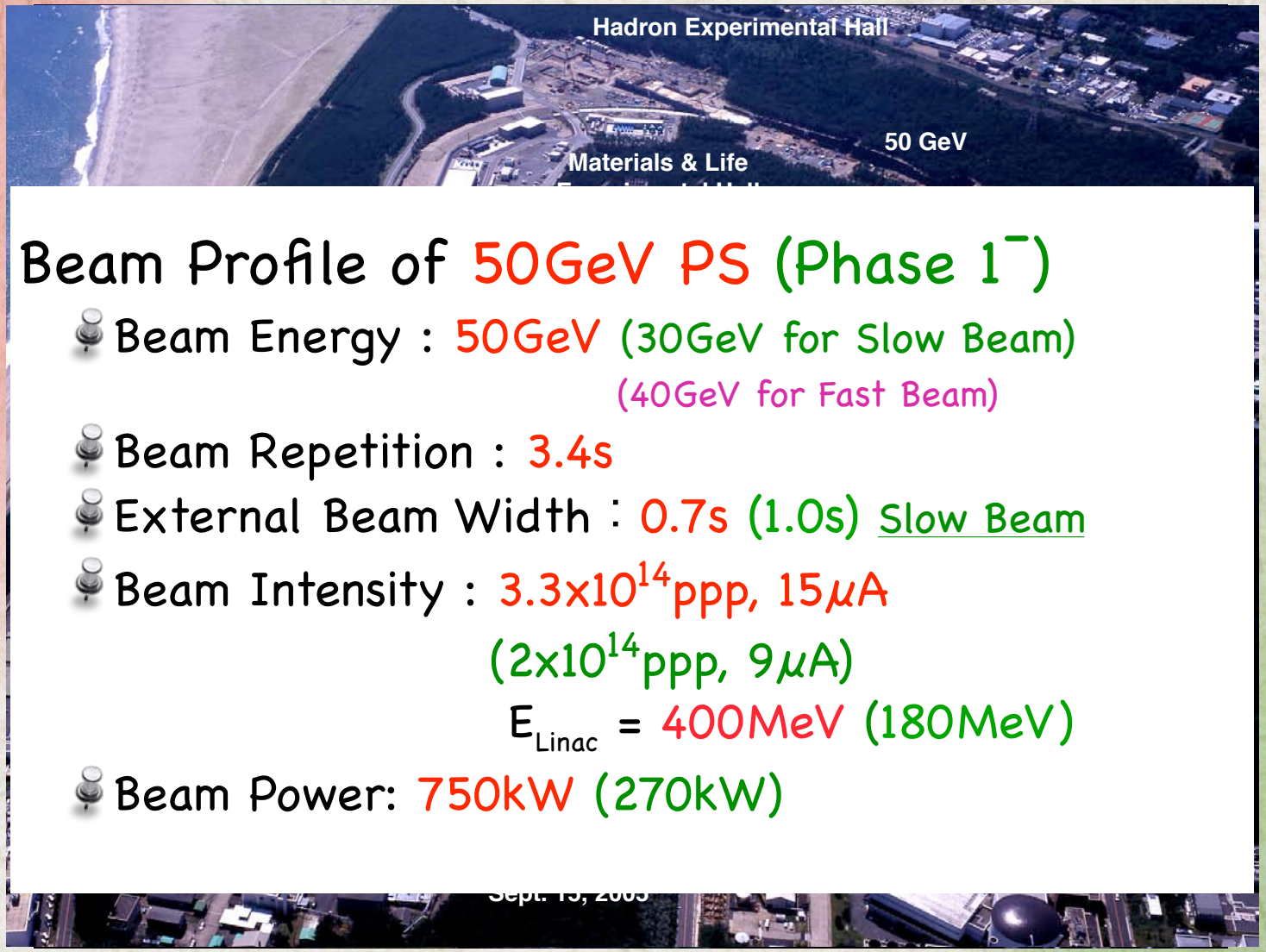
KEK
高エネルギー加速器研究機構

Construction : J-PARC



KEK
高エネルギー加速器研究機構

Construction : J-PARC

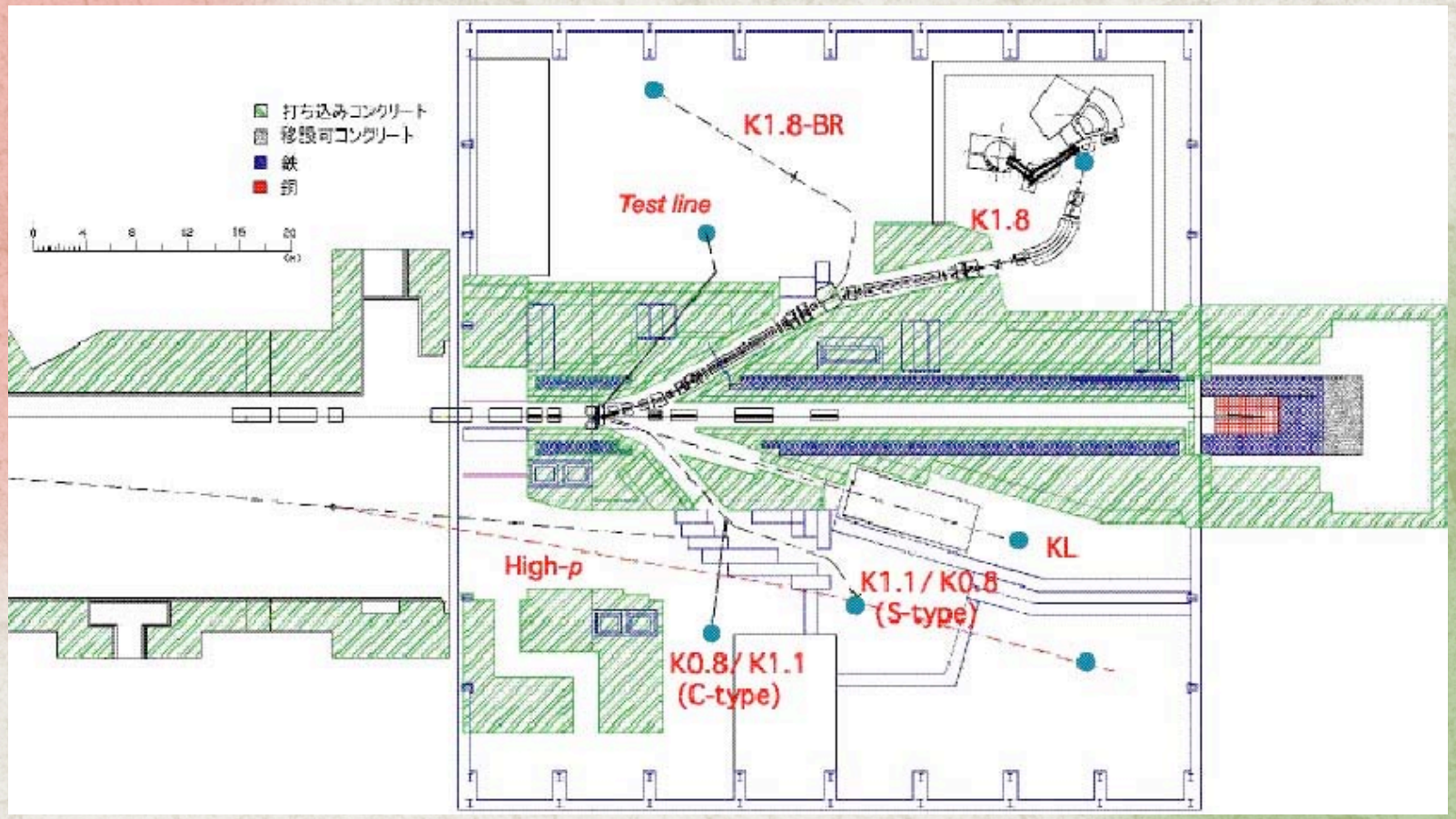


Beam Profile of 50GeV PS (Phase 1)

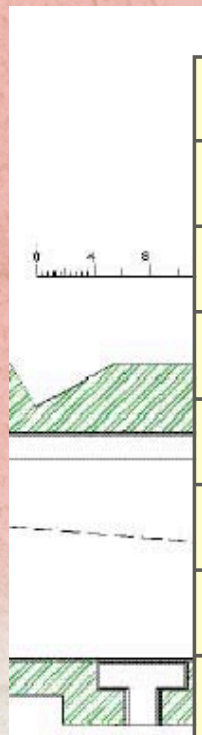
- Beam Energy : 50GeV (30GeV for Slow Beam)
  (40GeV for Fast Beam)
- Beam Repetition : 3.4s
- External Beam Width : 0.7s (1.0s) Slow Beam
- Beam Intensity : 3.3×10^{14}ppp, 15μA
  (2×10^{14}ppp, 9μA)
  E_{Linac} = 400MeV (180MeV)
- Beam Power: 750kW (270kW)

KEK 高エネルギー加速器研究機構

Construction : J-PARC
facility : Hadron hall



Construction : J-PARC facility : Hadron hall



	K1.8	K1.1	K1.1BR
Length (m)	46.4	24	26.9
Acceptance (msr.%)	2.7	16.5	4.9
K^- Intensity (ppp)	-	-	-
1.8 GeV/c	1.0E+07	-	-
1.1 GeV/c	4.9E+05	4.1E+07	1.0E+07
Electro-static Separator	6m-7.5MV/m×2	2m-7.5MV/m×2	6m-5MV/m×1
Separation/Size(rms)	10.8	4.2	6.5
Beam Mom.Resol.(%)	0.07	-	0.05

Planned : J-PARC Experiments

- Letters on Intent called in 2003 for J-PARC 50GeV Synchrotron.
- 30 LOIs were submitted.

No.	Spokesperson	Subject	Requested beam	Momentum Range (GeV/c)
L06	K. Imai	New Generation Spectroscopy of Hadron Many-Body Systems with Strangeness S = -2 and -1	K-	0.8, 1.1, 1.8
L07	M. Ieiri	Hyperon-Proton Scattering Experiments at the 50-GeV PS	K-, π+	1.0-1.6
L08	H. Noumi	High-Resolution Reaction Spectroscopy of S=-1 Hypernuclei	π±	1.0-1.2
L09	T. Fukuda	Neutron-rich Λ hypernuclei by the double-charge exchange reaction	K-/π-	0.9/1.0
L10	T. Nagae T. Kishimoto M. Iwasaki	Study of Dense Kbar Nuclear Systems	K-	0.9, 2-3
L21	S. Ajimura	Precise Measurement of the Nonmesonic Weak Decay of A = 4,5 Λ Hypernuclei	K-/π+	0.8/1.0

L06 and L10 were selected as Day-1 Experiments

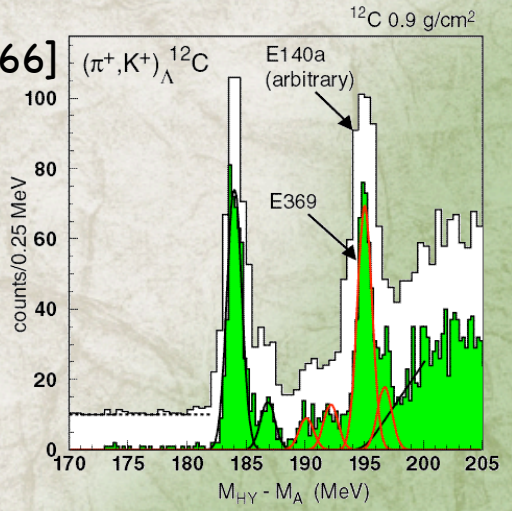
KEK 高エネルギー加速器研究機構

Planned : J-PARC : LoI : L06 [1]

New Generation Spectroscopy of Hadron Many-Body Systems with Strangeness S = -2 and -1

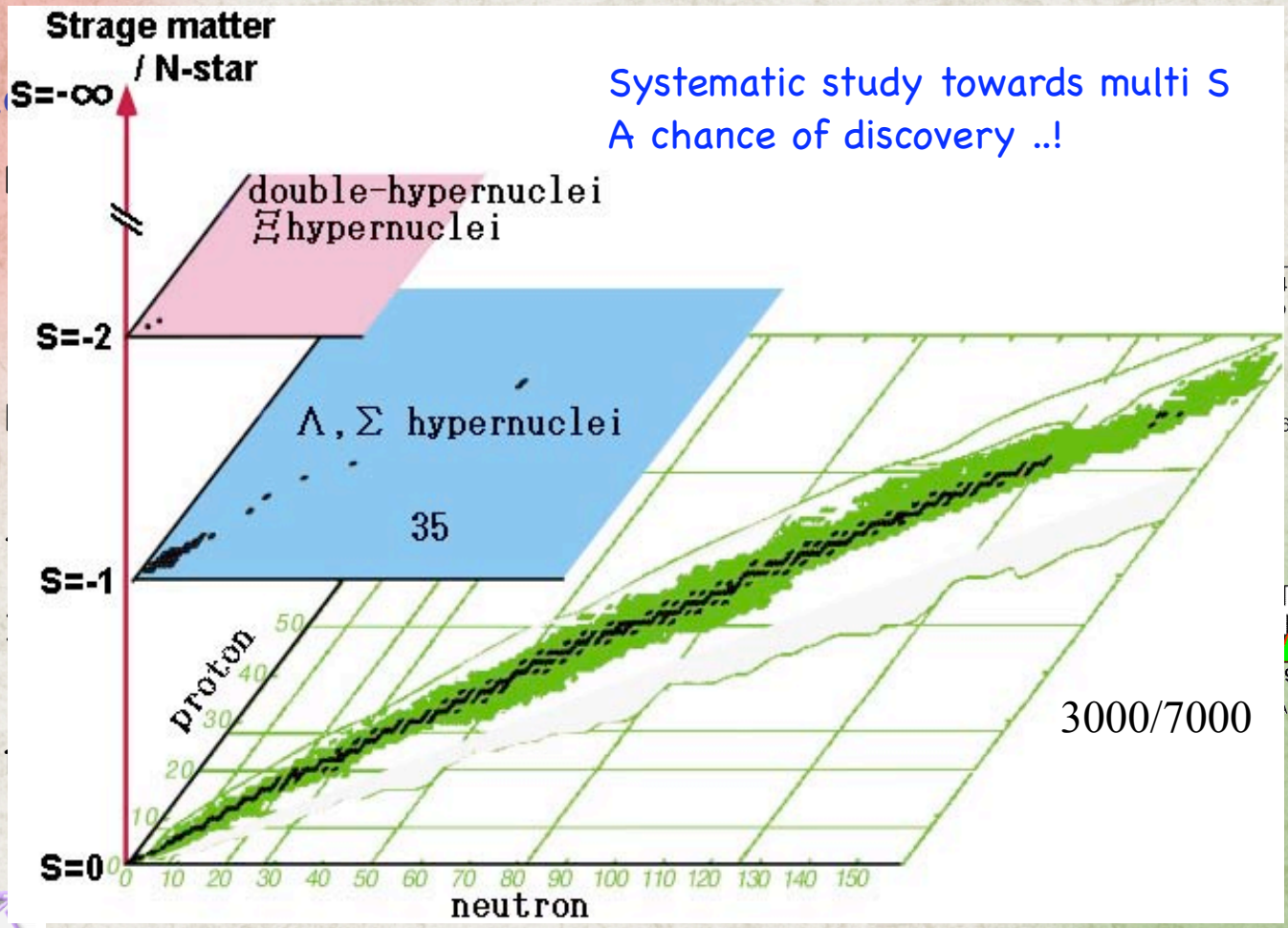
Recent Progress of Strangeness Nuclear Physics

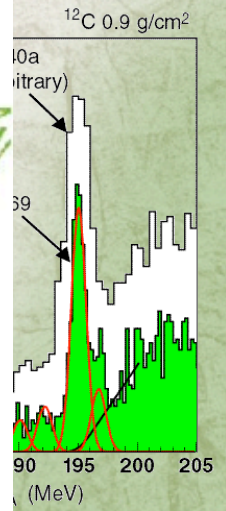
- High resolution (π^+,K^+) spectroscopy at SKS [E140, E336, E369]
  shell structure of Λ-nuclei and more
- γ-spectroscopy with Hyperball [E419, E509, E518, E566]
  hyperfine structure due to spin-dependence
- Lifetime and n/p ratio up to Y [E307, E462, E508]
  origin of weak nuclear force
- Bound Σ hypernuclei ($^4He_\Sigma$) [AGS-E905]
- Inclusive (π^-,K^+), (K^-,K^+) reactions [E438, AGS-E885]
  Σ-potential, Ξ-potential
- Double hypernuclei ($^6He_{\Lambda\Lambda}$) [E176, E224, E373, E522]
  $\Lambda\Lambda$ intearction, H-dibaryon



Planned : J-PARC : LoI : L06 [1]

New Generation Spectroscopy of Hadron Many-Body Systems with Strangeness S = -2 and -1

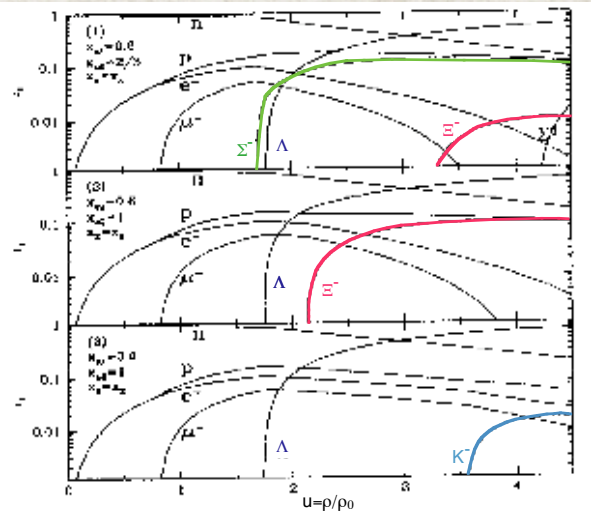




Planned : J-PARC : LoI : L06 [2]

New Generation Spectroscopy of Hadron Many-Body Systems with Strangeness S = -2 and -1

- Λ, Σ^-, Ξ^-, K^- in Neutron Star Core ?
  - Chemical Potential: $\mu_B = m_B + \frac{k_F^2}{2m_B} + U(k_F)$



BNL E885

$U_\Sigma<0, U_\Xi<0$

$U_\Sigma>0, U_\Xi<0$

$U_\Sigma>0, U_\Xi>0$

KEK E438

Planned : J-PARC : LoI : L06 [3]

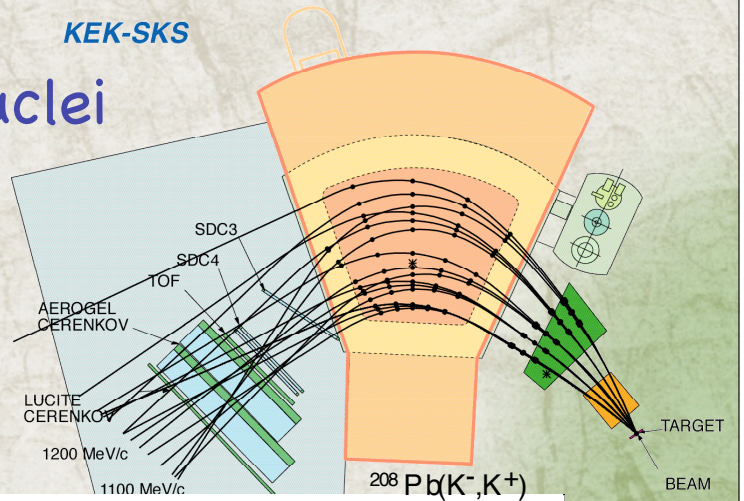
New Generation Spectroscopy of Hadron Many-Body Systems with Strangeness S = -2 and -1

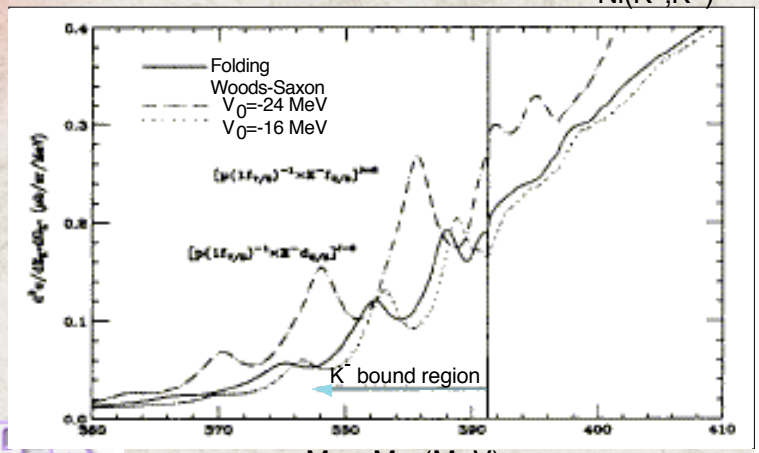
(K^-,K^+) Spectroscopy Ξ-Hypernuclei

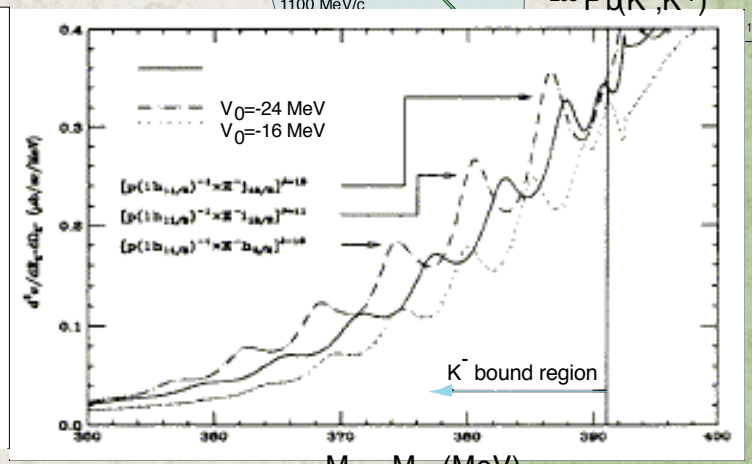
2 MeV_{FWHM} resolution

6 events/day/MeV for 50 msr, 2g/cm^2-thick Pb

in 20 days

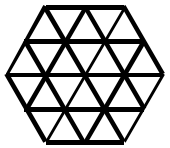
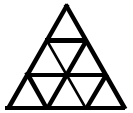
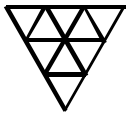






Planned : J-PARC : LoI : LO7 [1]

Hyperon-Proton Scattering Experiments at the 50-GeV PS

27s		S= 0 NN (T=1) S=-1 ΣN (T=3/2) ΣN-ΛN (T=1/2) S=-2 ΣΣ (T=2) ΞN-ΣΛ-ΣΣ (T=1) ΞN-ΣΣ -ΛΛ (T=0) S=-3 ΞΣ (T=3/2) ΞΣ-ΞΛ (T=1/2) S=-4 ΞΞ (T=1)
10a		S= 0 NN (T=0) S=-1 ΣN-ΛN (T=1/2) S=-2 ΞN-ΣΛ (T=1) S=-3 ΞΣ (T=3/2)
10s		S=-1 ΣN (T=3/2) S=-2 ΞN-ΣΛ-ΣΣ (T=1) S=-3 ΞΣ-ΞΛ (T=1/2) S=-4 ΞΞ (T=0)
8a		S=-1 ΣN-ΛN (T=1/2) S=-2 ΞN-ΣΛ (T=1) ΞN-ΣΣ -ΛΛ (T=0) S=-3 ΞΣ-ΞΛ (T=1/2)
8s		S=-1 ΣN-ΛN (T=1/2) S=-2 ΞN-ΣΛ (T=1) ΞN (T=0) S=-3 ΞΣ-ΞΛ (T=1/2)
1a		S=-2 ΞN-ΣΣ -ΛΛ (T=0)

Planned : J-PARC : LoI : LO7 [1]

Hyperon-Proton Scattering Experiments at the 50-GeV PS

E522

$\Xi^- p \rightarrow \Xi^- p$

$\Lambda\Lambda$

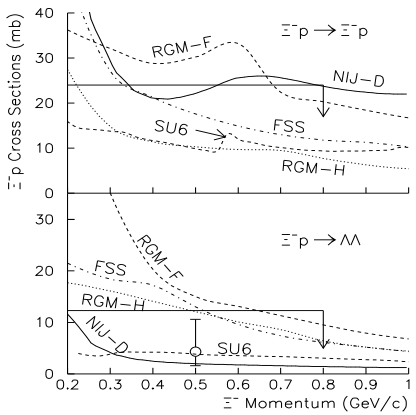


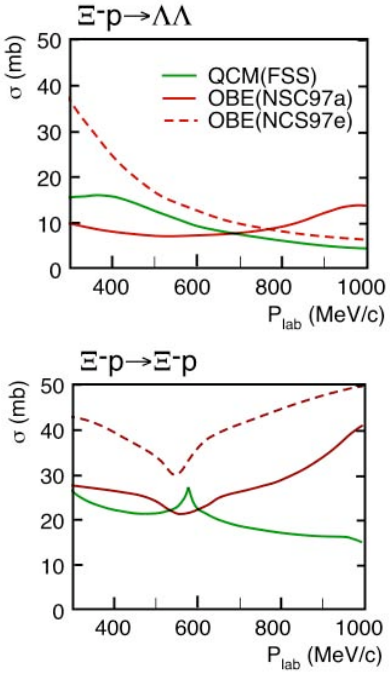
Fig. 2. Upper limits on the Ξp cross sections at 90% confidence level, indicated by arrows, are compared with theoretical estimates of RGM-F, RGM-H, FSS, Nijmegen-D, and SU_6 quark model. In the bottom panel a data point represents the result obtained from $\Xi^{-12}C \rightarrow \Lambda\Lambda$ reaction assuming the effective proton number of 3.5. Poisson statistical error is quoted only.

1a

Models

S=-2

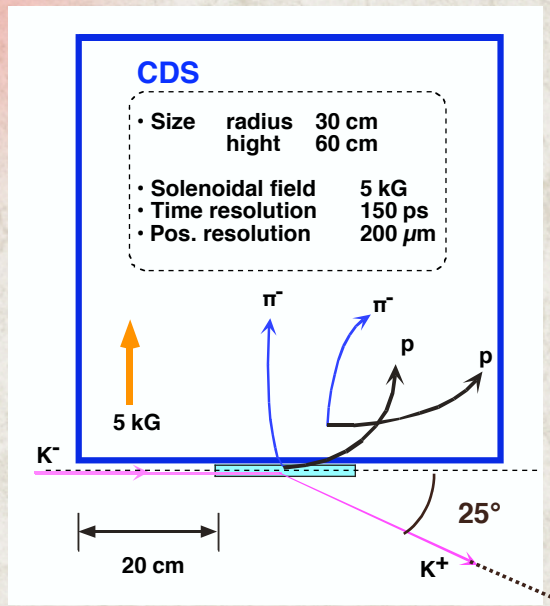
$\Xi^- p \rightarrow \Lambda\Lambda$, $\Xi^- p \rightarrow \Xi^- p$

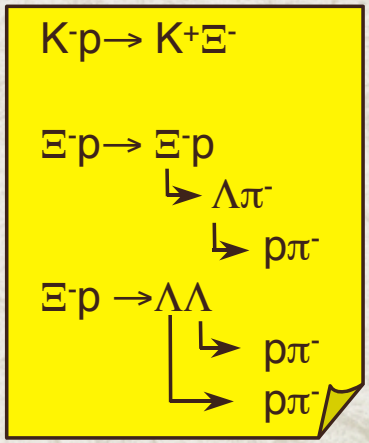


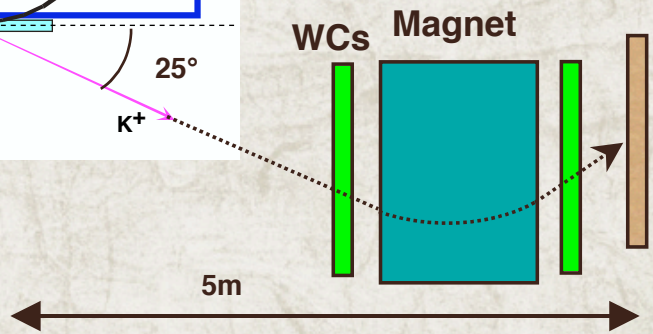
Planned : J-PARC : LoI : LO7 [2]

Hyperon-Proton Scattering Experiments at the 50-GeV PS

$\Xi^- p$ scattering : a setup & simulation



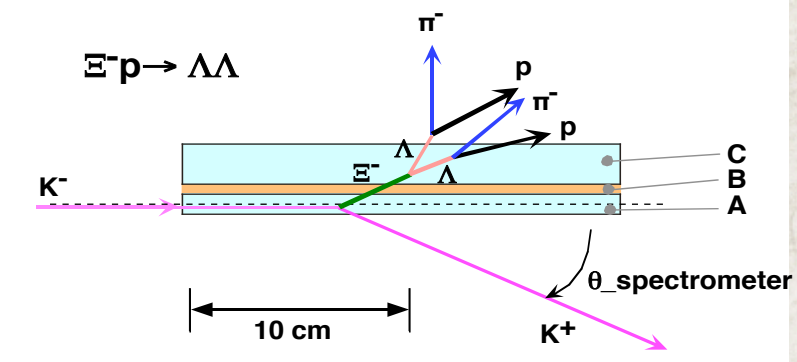




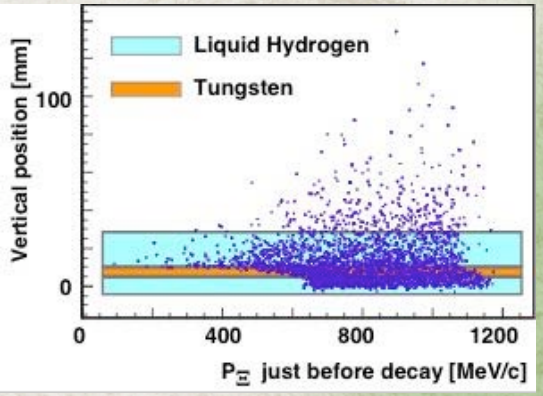
Planned : J-PARC : LoI : LO7 [2]

Hyperon-Proton Scattering Experiments at the 50-GeV PS

$\Xi^- p$ scattering : a setup & simulation



- Target 5 cm wide × 20 cm long
  - A: production 1 cm Liq. Hydrogen
  - B: degrader 0.5 cm Tungsten
  - C: scattering 2 cm Liq. Hydrogen
- K^+ spectrometer
  - θ_spectrometer ~ 25° at center
- K^- beam (assumption @ LOI)
  - Intensity 10^7 K^-/sec
  - Momentum 1.7 GeV/c
  - Size σ_horizontal 15 mm
  - σ_vertical 1 mm

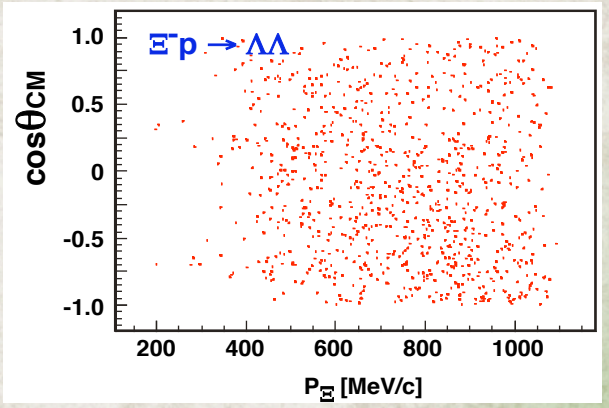


Planned : J-PARC : LoI : LO7 [3]

Hyperon-Proton Scattering Experiments at the 50-GeV PS

$\Xi^- p$ scattering : expected

• K^- intensity	[s^{-1}]	10^7
• Number of Hydrogen	[/cm2]	8.5×10^{23}
• Spectrometer	[deg]	25
• Spectrometer TOF	[m]	5
• Trigger rate (K^+)	[s^{-1}]	11
• Momentum of Ξ^-	[MeV/c]	300 - 1100

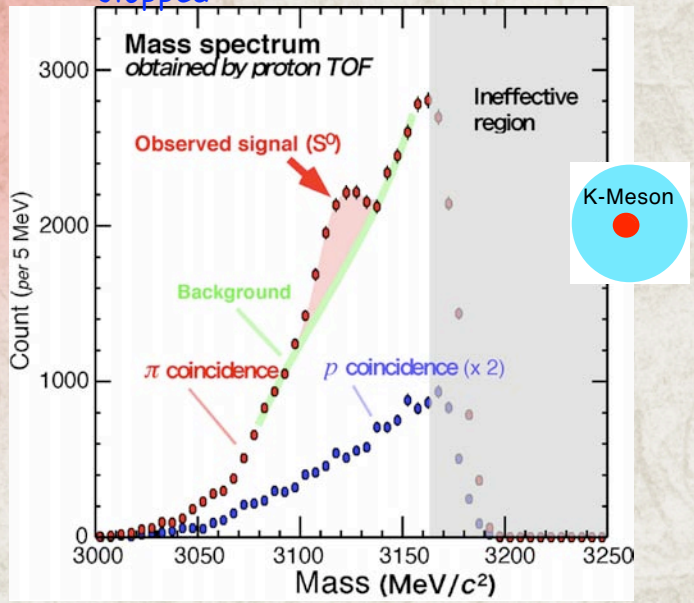


		$\Xi^- p \to \Xi^- p$	$\Xi^- p \to \Lambda\Lambda$
• reaction rate	[s^{-1}]	0.009	0.0043
• 100 days		78000	37000
• Detectable number		2300	550

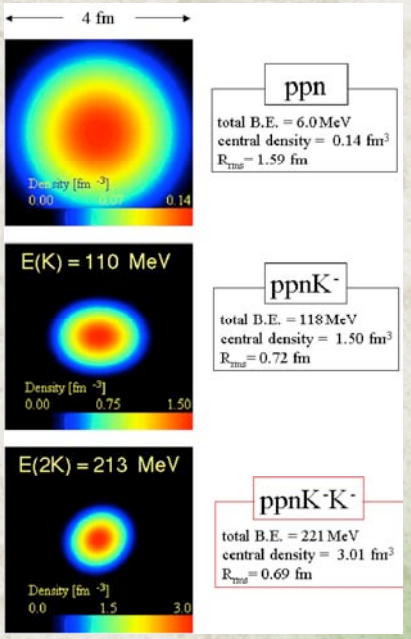
Planned : J-PARC : LoI : L10

Study of Dense Kbar Nuclear Systems

$^4He(_{stopped}K^-, p)$ E471, E549



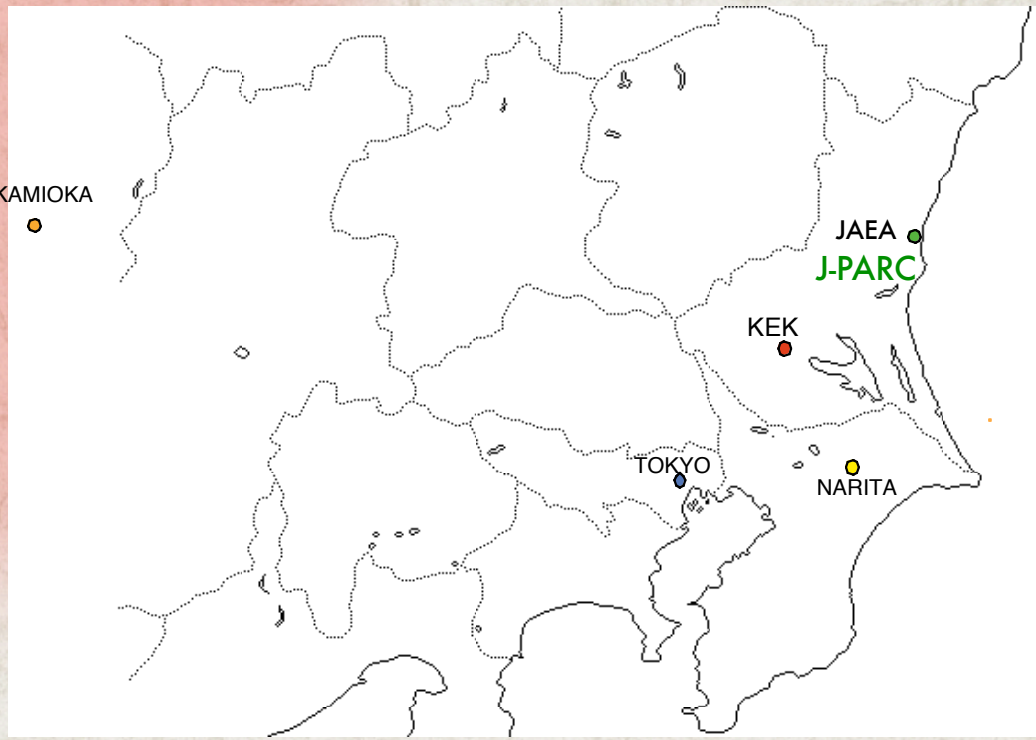
Experiment by M. Iwasaki, et al.

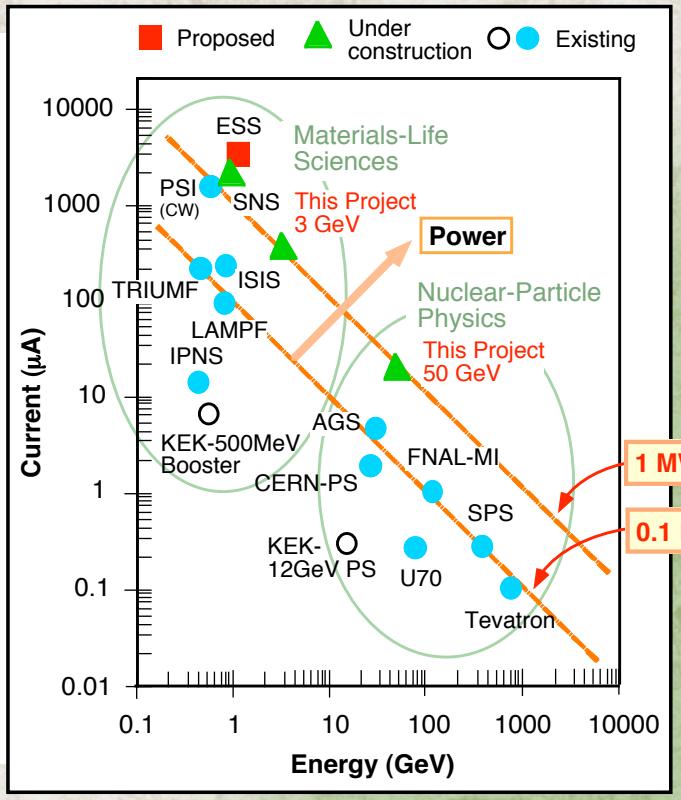


Theory by Y. Akaishi, et al.

KEK 高エネルギー加速器研究機構

J-PARC : outlook [1]



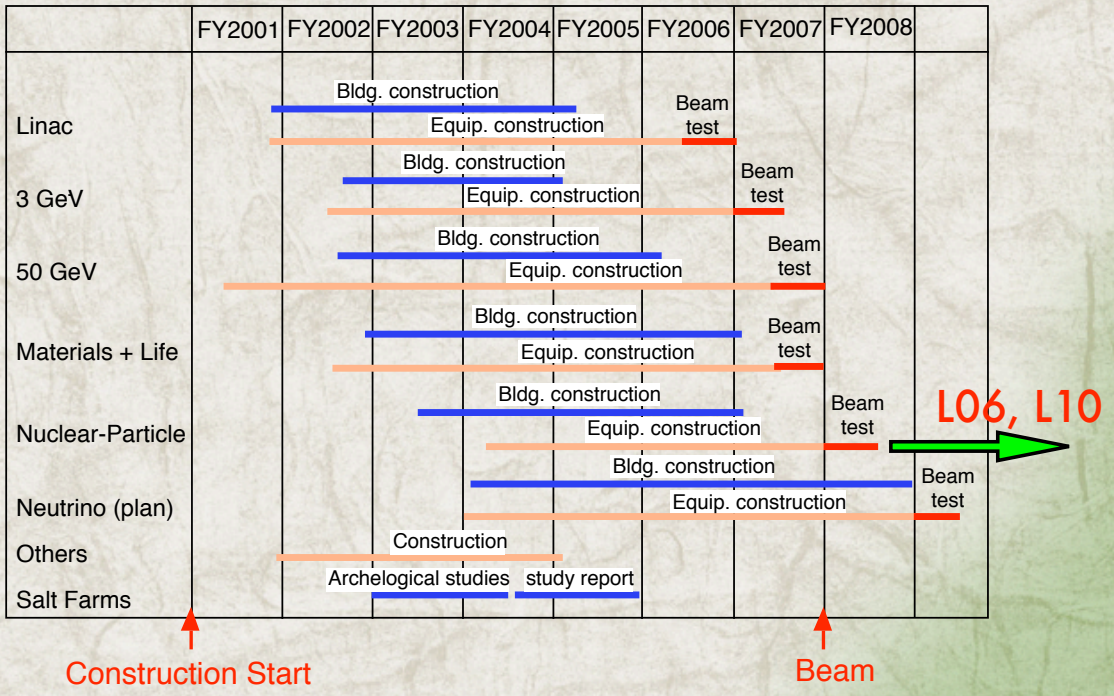


http://j-parc.jp/NuclPart/index_e.html

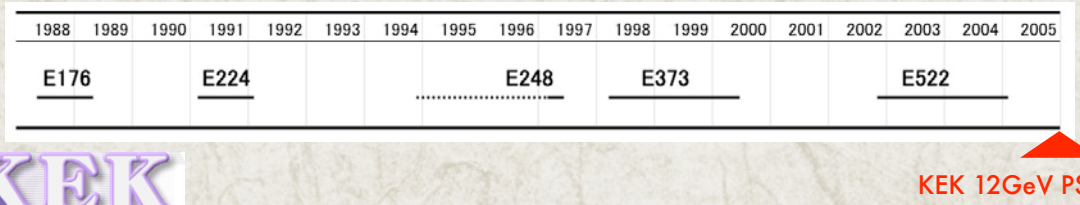
J-PARC : outlook [2]

J-PARC

Construction Schedule (as of Oct., 2003)

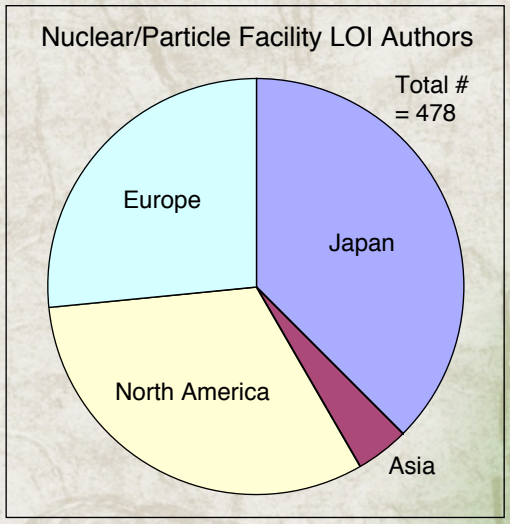


KEK-PS



J-PARC : outlook [3]

- Announce of LoI call : July 2002
  Thirty LoI's were submitted by early 2003
  - Strangeness nuclear physics 6
  - Nuclear/hadron physics 7
  - Kaon decay physics 4
  - Muon physics 3
  - Neutrino physics 1
  - Future facilities 9
  - (http://www-ps.kek.jp/jhf-np/LOIlist/LOIlist.html)



- 478 physicists with 2/3 from outside Japan.
  Committee meetings:
  - March 22, 2003
  - June 26-28, 2003

- The real proposals:
  - Most likely, the call for the proposal will be made soon.

Your proposal and your collaboration are welcome!

KEK 高エネルギー加速器研究機構

Thank you

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