from  to 

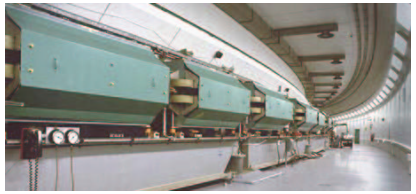
Current and Future Kaon programs at KEK/J-PARC

Takeshi K. Komatsubara (KEK-IPNS)

13 May 2004 Workshop on Future Kaon Experiments at the AGS

Outline [in the next 25 slides, 20 minutes]

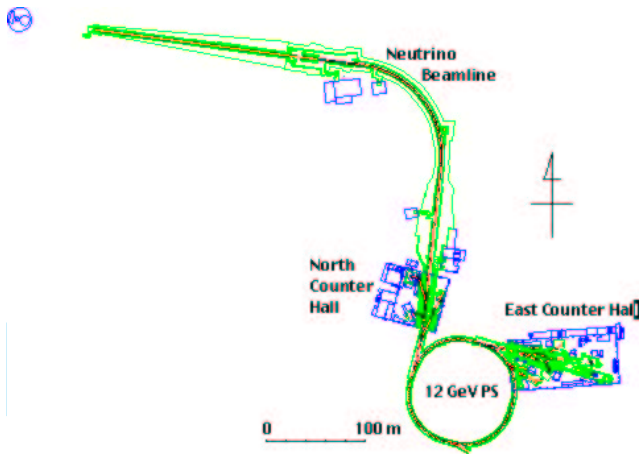
- current program:
  KEK-PS (by 2005 ?)
  - E246: T-violating P_t in $K^+ \to \pi^0 \mu^+ \nu$ [final results]
  - E391a: CP-violating decay $K_L^0 \to \pi^0 \nu \bar{\nu}$ [running]
- future program:
  J-PARC new 50GeV-PS (from 2009 ?)
  - Accelerator
  - Letters of Intent for J-PARC kaon experiments
  - Beamline Layout plan



	KEK-PS	BNL-AGS
1960		Experiments started (32GeV).
1964	(the year I was born)	$\mathrm{K}_L^0 \to \pi^+\pi^-$
1977	Experiments started (12GeV).	
	E10: $\mathrm{K}^+ \to \pi^+\nu\bar{\nu}$	
	E89,104: $\mathrm{K}^+ \to \mu^+\nu_H$	
	E137: $\mathrm{K}_L^0 \to \mu e$	$\mathrm{K}_L^0 \to \mu e$
		$\mathrm{K}^+ \to \pi^+\mu^+e^-$
		$\mathrm{K}^+ \to \pi^+\nu\bar{\nu}$
1993		Booster
	E162: $\mathrm{K}_L^0 \to \pi^+\pi^-e^+e^-$	
	E246: P_t in $\mathrm{K}^+ \to \pi^0\mu^+\nu$	
	E391a: $\mathrm{K}_L^0 \to \pi^0\nu\bar{\nu}$	

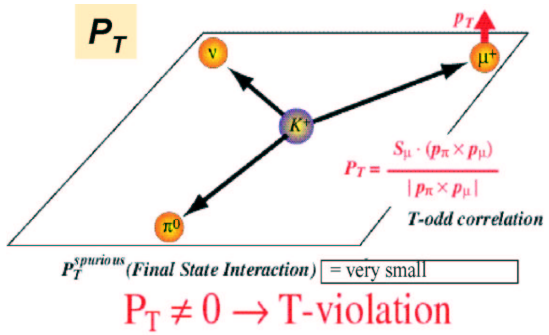
* 1992$\sim$ US-Japan kaon program (BNL-E787/E949, FNAL-KTeV)

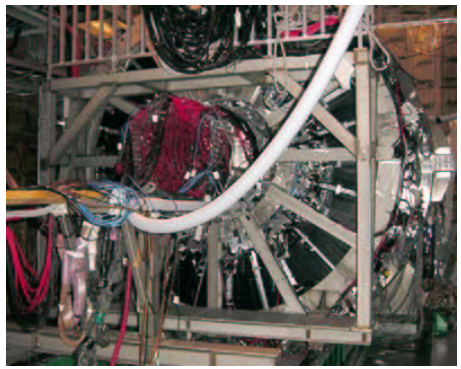
12GeV KEK-PS in the New Millennium

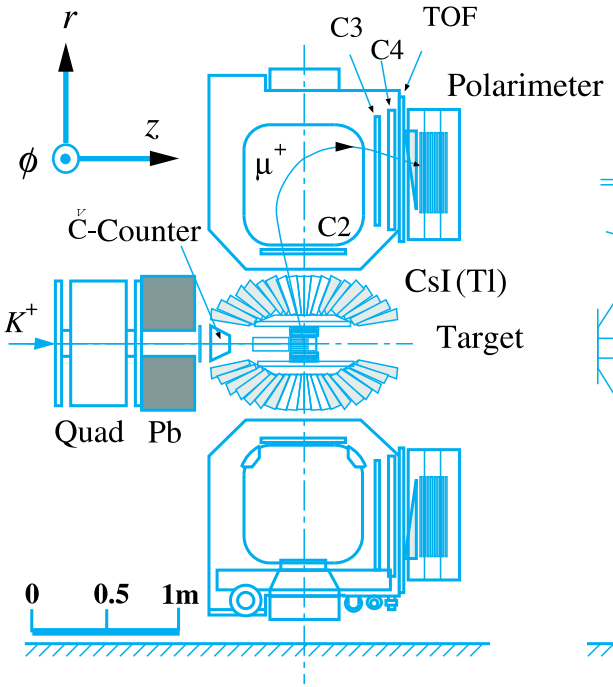


	Fast Ext to ν Beamline	Slow Ext to East Hall North Hall	
protons per pulse	6.5	2.5	$\times 10^{12}$
beam spill	1.1 micro	2.0	sec
cycle	every 2.2	every 4.0	sec
operation in a year	6	2∼4	months

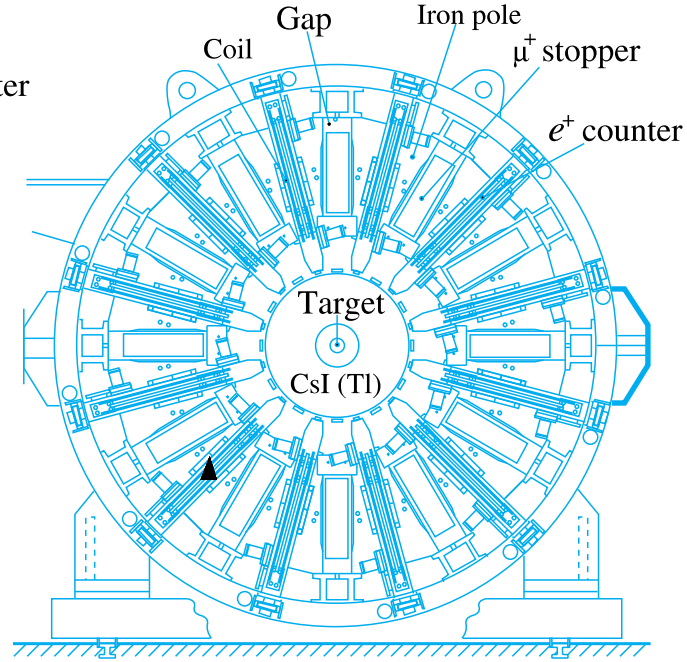
E246/E470 http://www-ps.kek.jp/e246/ at N-Hall



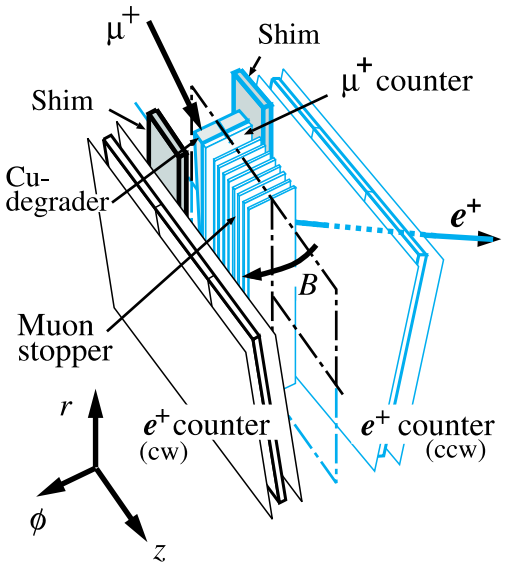




(a)



(b)

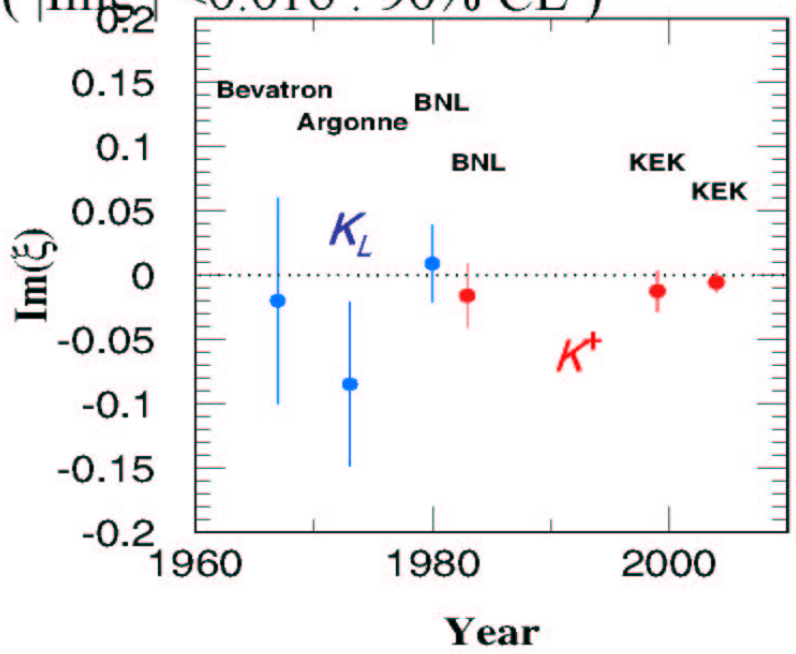


(c)

Result

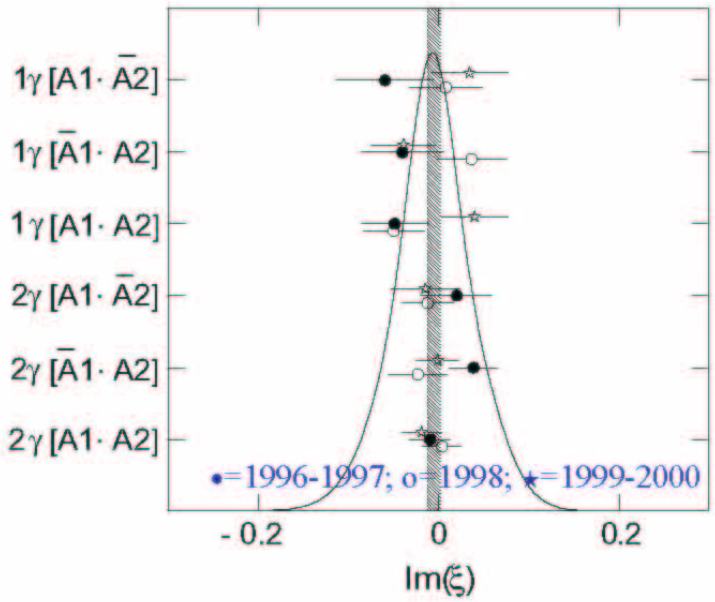
$P_T = -0.0018 \pm 0.0023(\text{stat}) \pm 0.0011(\text{syst})$
$(|P_T| < 0.0051 : 90\%\ \text{CL})$

$\text{Im}\xi = -0.0055 \pm 0.0073(\text{stat}) \pm 0.0036(\text{syst})$
$(|\text{Im}\xi| < 0.016 : 90\%\ \text{CL})$



Systematics check

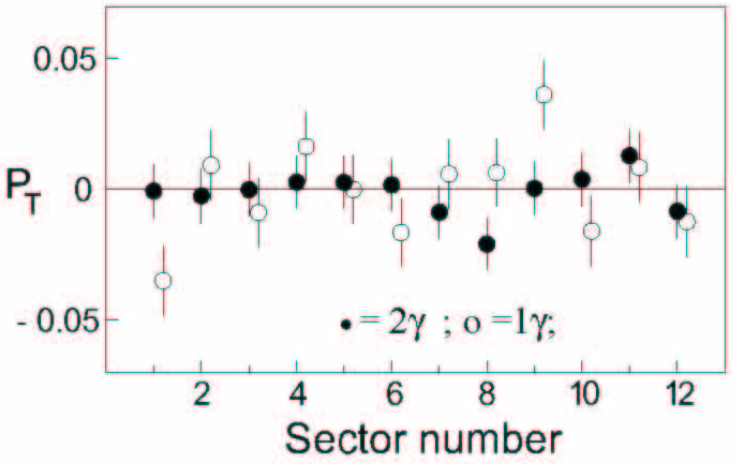
Consistency among data



$\mathrm{Im}\xi = -0.0055 \pm 0.0073$

$(\chi^2/dof = 0.78)$

Sector dependence

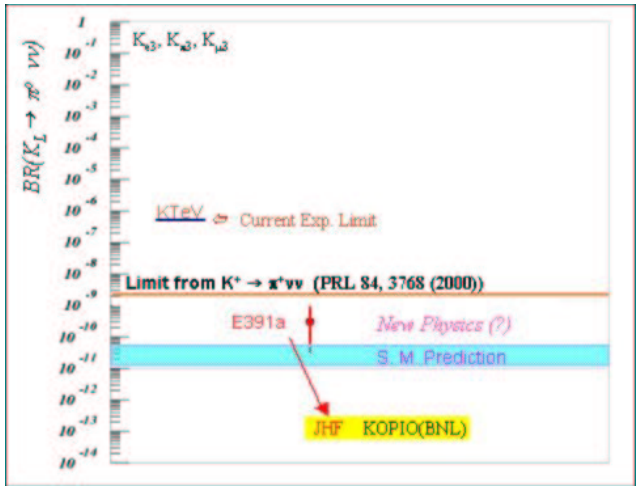


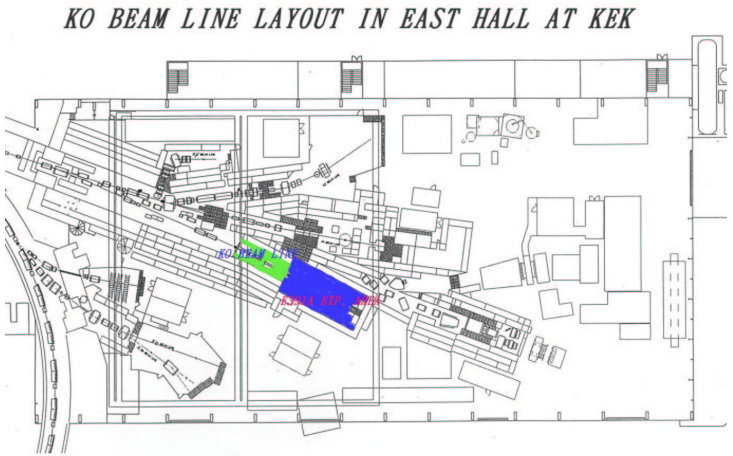
Decay plane rotation

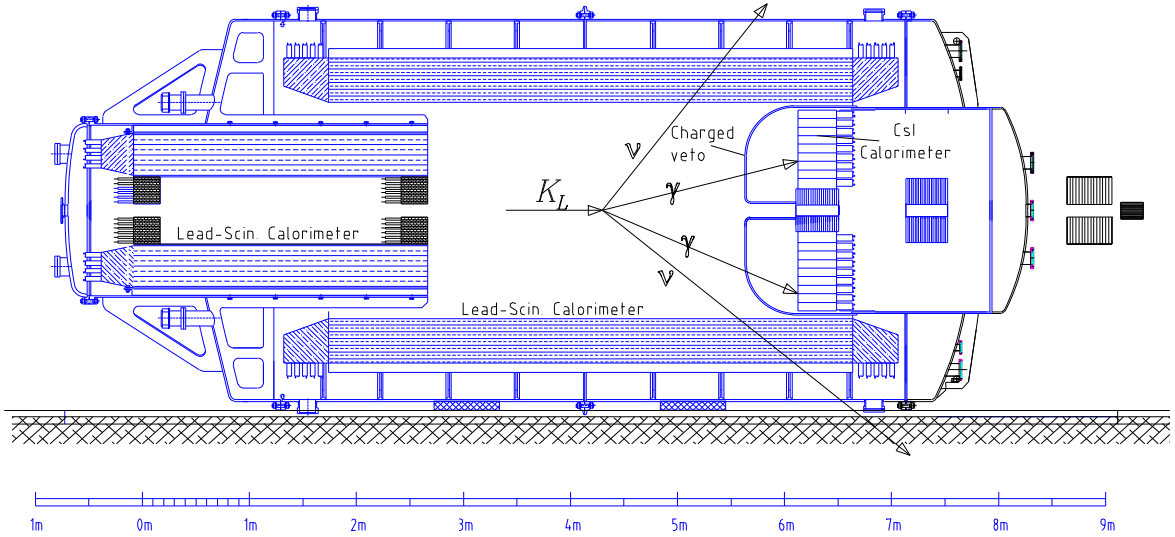
$|\theta_r(fwd) - \theta_r(bwd)| \leq 4.6\times10^{-4}$ rad

$|\theta_z(fwd) + \theta_z(bwd)| \leq 2.6\times10^{-4}$ rad

E391a http://www-ps.kek.jp/e391/ at E-Hall







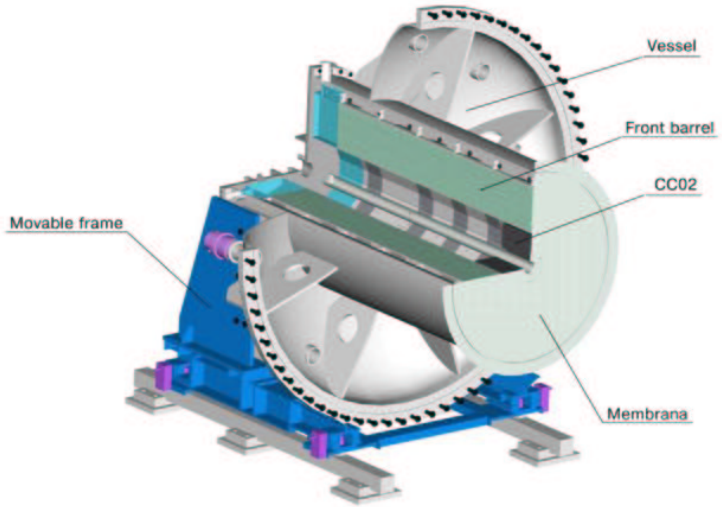


Fig.2

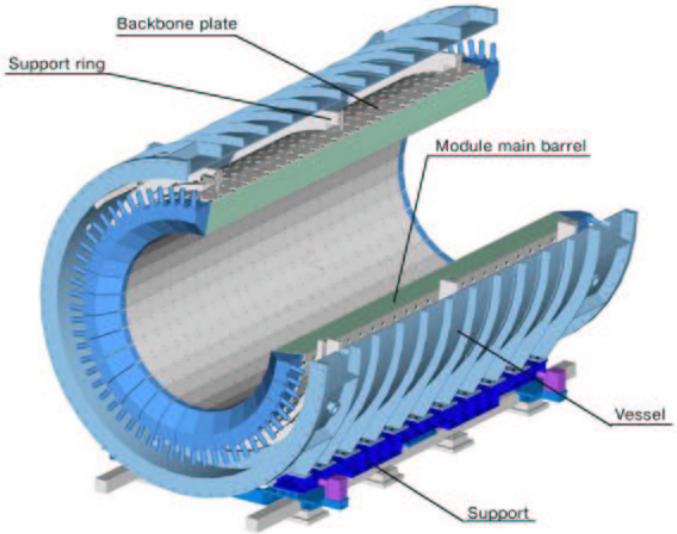


Fig.3

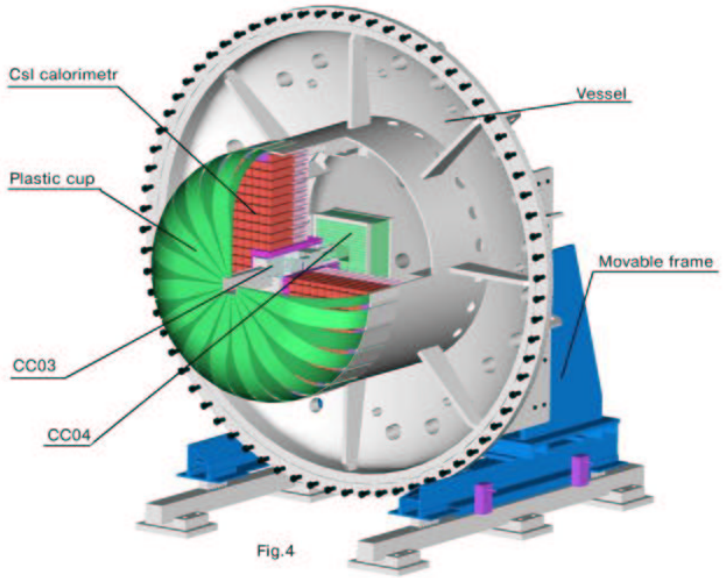
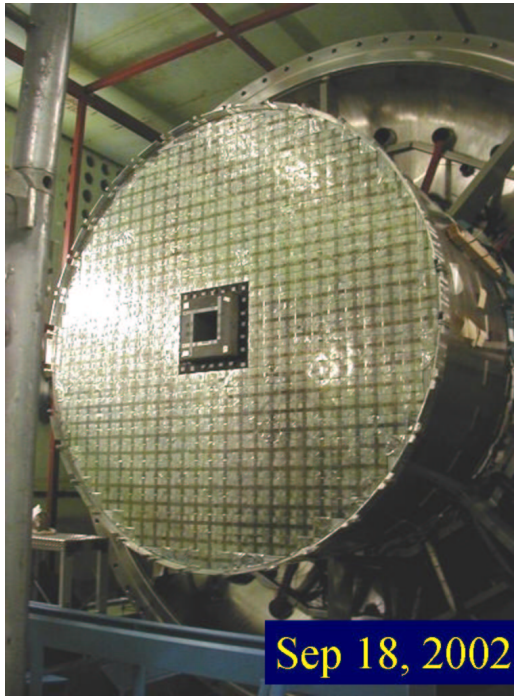
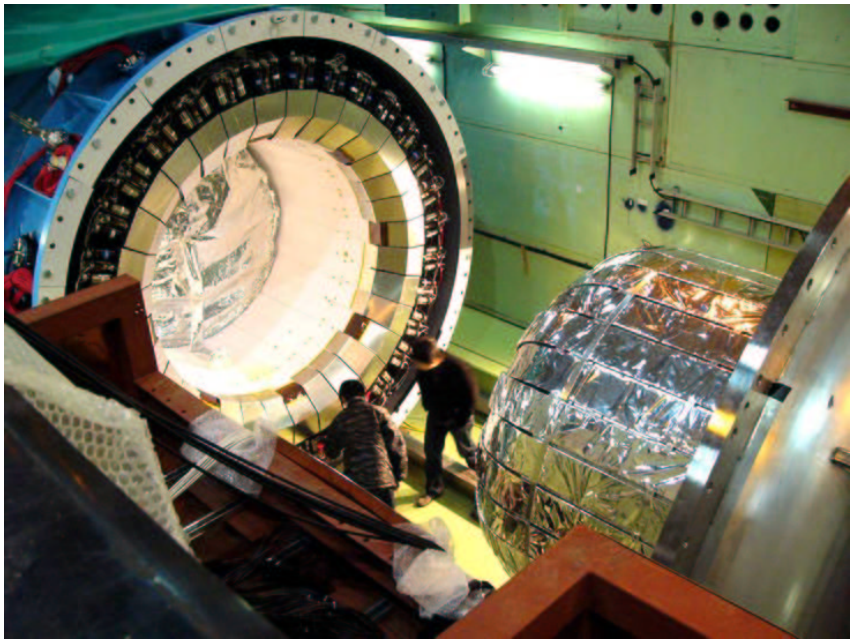
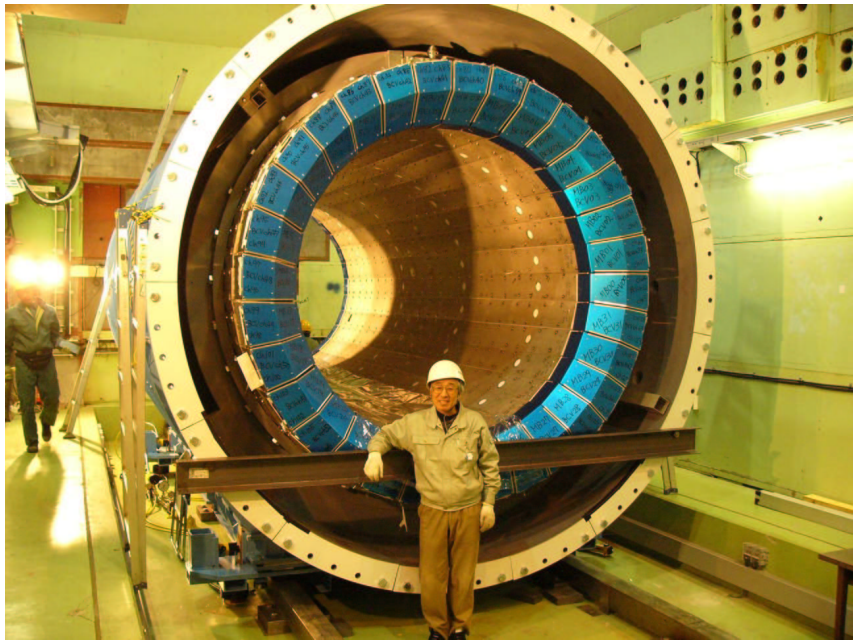


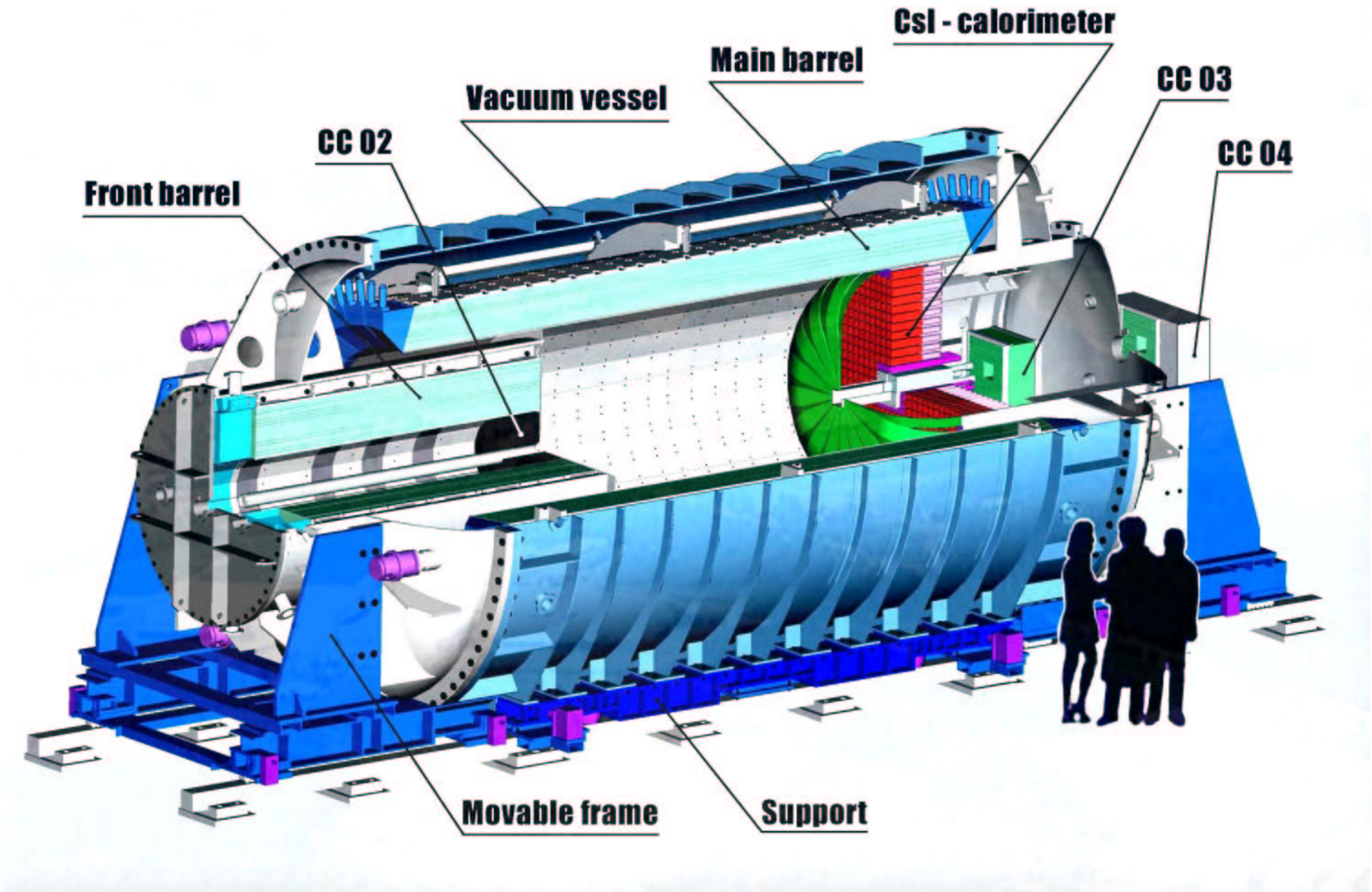
Fig.4


Sep 18, 2002



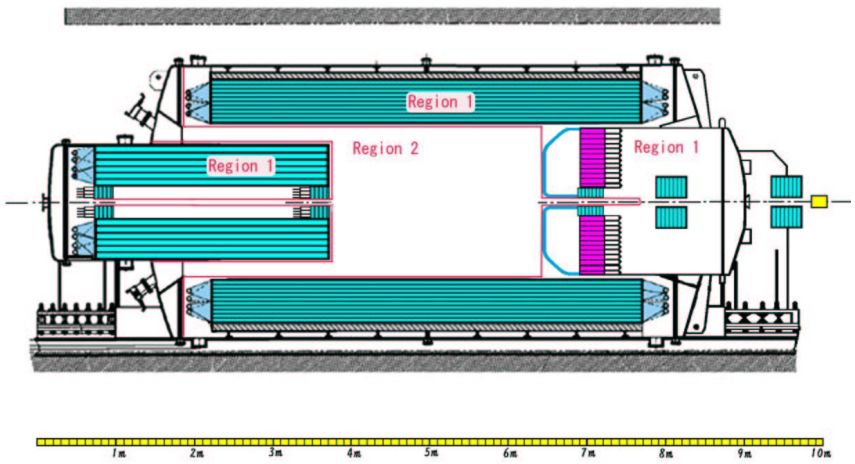


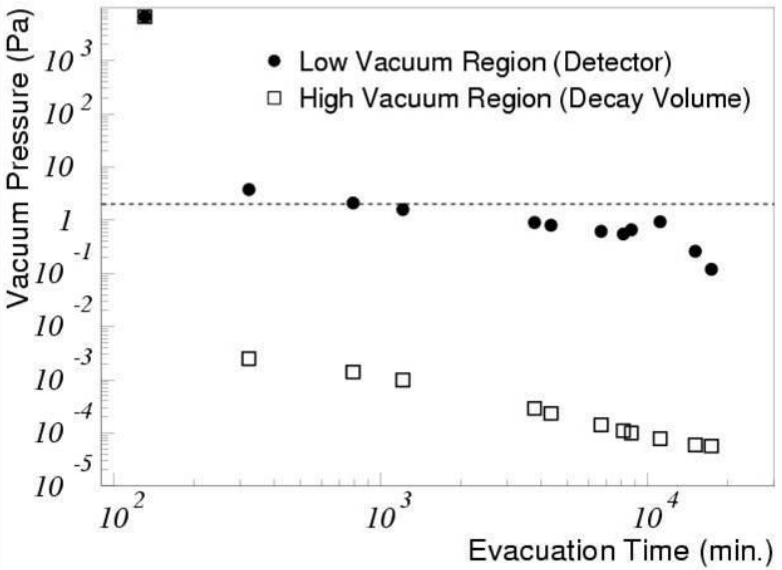

Jan/21/2004


CsI - calorimeter
Main barrel
CC 03
Vacuum vessel
CC 02
CC 04
Front barrel
Movable frame
Support

"Differential pumping" for high vacuum (π^0 by neutrons)

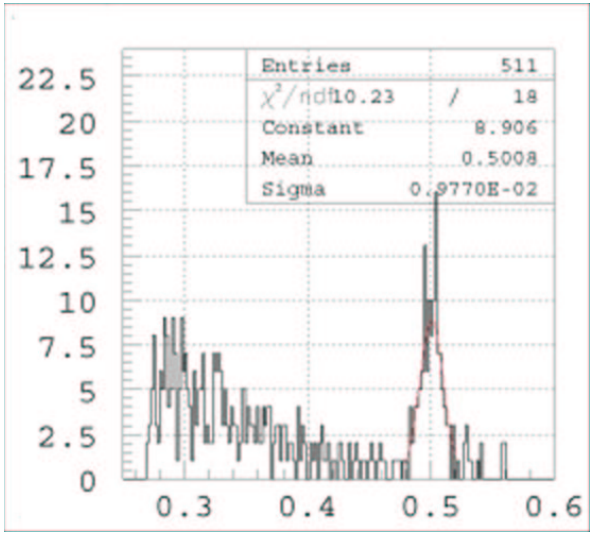
- backgound <0.1
- Goal: 10^{-5} Pa
  (10^{-4} Pa for E391a)
- thin "membrane"
  to separate into
  1. low vacuum: < 0.1 Pa
  2. high vacuum:
     1.21×10^{-5} Pa achieved



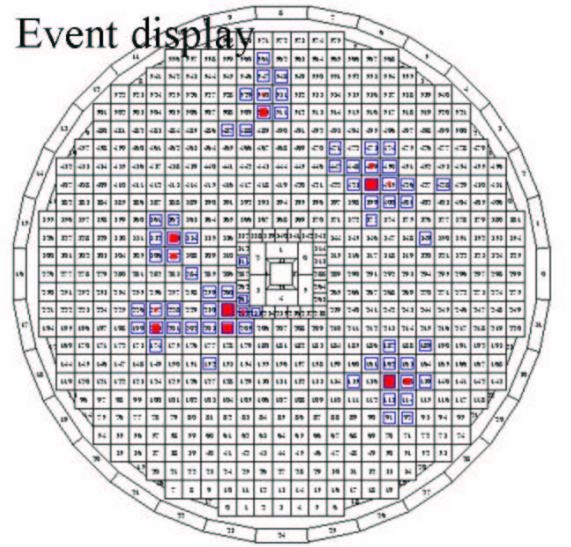


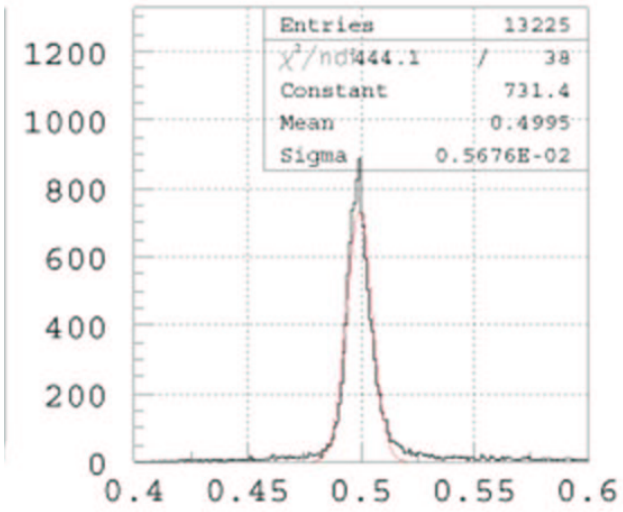
E391a Data Taking (from 18 Feb 2004)

		E391a	E787
Ev size	Bytes	6K	100K
		ADCs	TDs
Tr rate	Hz	500	100
Data flow	B/spill	6M	10M
	B/Day	120G	240G



$K^0_L \to \pi^0\pi^0$

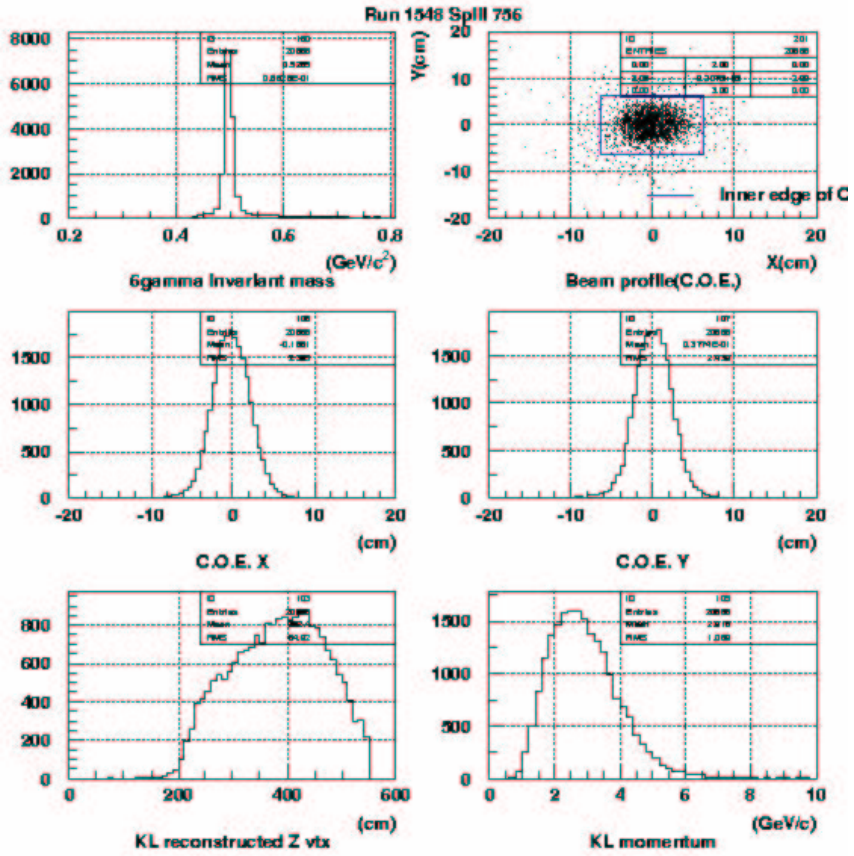




$K^0_L \to \pi^0\pi^0\pi^0$

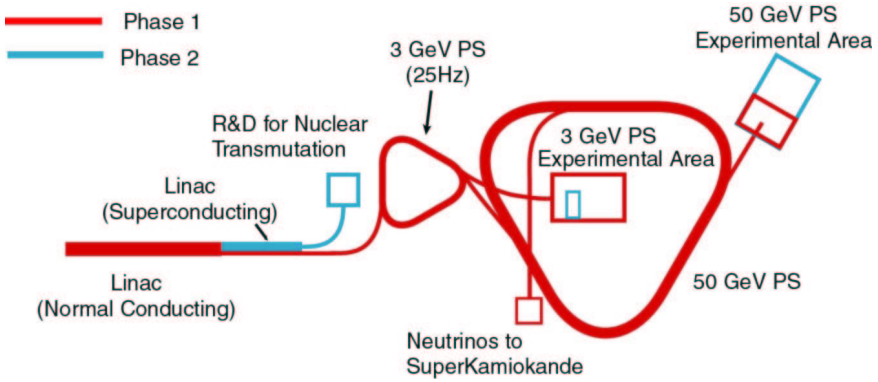
E391a Run-1 (by the end of June 2004): status and prospects

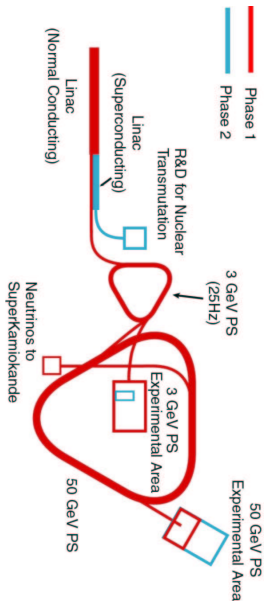
- stable data taking
  - $N_{CLS} \geq 2$ w/vetoes : manageable Trigger rate
  - DAQ Live Time 75%
- Online accidental loss: 10%:
  - clean neutral beam
  - "pencil" concept: okay
- S.E.S (ratio to $K_L^0 \to \pi^0\pi^0\pi^0$): $\sim 4 \times 10^{-10}$ w/o very tight PV
  - break the KTeV upper limit
  - below the Grossman-Nir limit (1.4×10^{-9})
  - reachable to Buras theory (3.1×10^{-10}) ?



Schedule from KEKPS to J-PARC

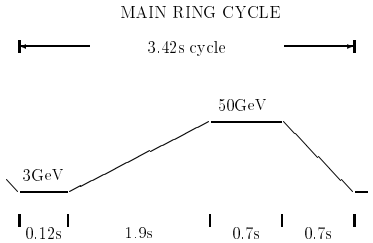
JFY	month	KEKPS	J-PARC
2001			construction start
2004	~ Jun 04	Slow Ext for E391a	* Hadron Hall construction start
	Sep 04	Fast Ext for K2K	
	~ Mar 05		
2005	Apr 05	SlowEx ??	* ν facility construction start
	~ Jun 05	hadron experiments	
		E391a Run-2 ??	
2008			construction finish


Phase 1
Phase 2
3 GeV PS
(25Hz)
50 GeV PS
Experimental Area
R&D for Nuclear
Transmutation
3 GeV PS
Experimental Area
Linac
(Superconducting)
Linac
(Normal Conducting)
50 GeV PS
Neutrinos to
SuperKamiokande



* photos taken by TKK on 9 April 2004 at the J-PARC site

J-PARC 50GeV-PS operation (Slow Ext)



	KEK-PS	AGS	J-PARC Phase-1	J-PARC mod	
proton energy	12	24	30	30	GeV
protons per pulse	2.5	65	200	100	10^{12}/spill
cycle	4.0	6.4	3.42	4.42	sec
average current	0.1	1.63	9.5	3.6	μA
beam spill	2.0	4.1	0.7	1.7	sec
duty factor	0.50	0.64	0.20	0.39	
instantaneous rate	1.3	16	286	59	10^{12}/sec

Nuclear and Particle Physics Experiments at J-PARC

2002	Jul	Call for LoI's
	Sep	NP02 International Workshop @Kyoto
2003	Jan	30 LoI's were submitted.
		http://www-ps.kek.jp/jhf-np/LOIlist/LOIlist.html
	Mar	The Nuclear and Particle Physics Facility Committee (NPFC)
		was organized as a "pre-PAC".
		1st NPFC meeting
	Jun	2nd NPFC meeting
	Aug	letter from Project Director (S.Nagamiya) to each LoI

Table 1 Summary of Letters of Intent and requested beams

Contact Person(s)	Requested Beam	Momentum Range (GeV/c)	Phase-1						Phase-2	Future Possibilities							
			K1.8	K1.1	K0.8	KL	Test Beam	High Mom.	Neutrino	High-resol. line	Several GeV Separated	Heavy Ion	Pol. Proton	PRISM	PRISM-II	Fast Extraction	NuFact-J
K. Imai	K-	0.8, 1.1, 1.8	○	○													
M. Ieiri	K-, π+	1.0-1.6	○	○													
H. Noumi	π+/-	1.0-1.2								○							
T. Fukuda	K-/π-	0.9/1.0		△						○							
T. Nagae et al.	K-	0.9, 2-3		○							○						
S. Ajimura	K-/π+	0.8/1.0		○													
V.V. Sumachev et al.	π+/-	0.6-2.1	△														
A.D. Krisch	p	51						○					○				
S. Yokkaichi	p	31, 51						○				○					
H. Spinka, S. Sawada	π,K,p	< 6						○			○						
	pol.-p/HI											○	○				
J.-C. Peng, S. Sawada	p, pol.p, HI							○				○	○				
T. Murakami	p	30						○				○					
	p, π-	4.0-14.0						○									
L. Nemenov	p	30(50)						○									
T.K. Komatsubara	K+	0.6-0.8			○												
T. Inagaki	KL	~2				○											
C. Rangacharyulu	K+				○												
Yu. Kudenko, J. Imazato	K+	0.6-0.7			○												
S. Shimizu	K+	0.6-0.7			○												
K. Nishikawa	neutrino	~0.8							○								
B.L. Roberts	_+															○	
Y.K. Semertzidis et al.	_+														○		
PRIME Group	_-													○			
S. Komamiya	e,_,π,K,p	0.5-2, <10					○										
S. Sawada	π,K,p, primary	> 5						○			○	○	○				
PRISM Group	μ													○	○		
Y. Kuno, R.S. Hayano	anti-p, → ..													△		○	△
Y. Kuno, Y. Mori	neutrino																○
V. Obraztsov, T. Tsuru	K-	~12									△						
T. Kishimoto																	
K. McDonald et al.	p	50														○	

five LoI's for J-PARC kaon experiments

- K_L neutral beamline
  - L-05: $\mathrm{K}_L^0 \to \pi^0\nu\bar{\nu}$ [T.Inagaki(KEK)]

    $\Longleftarrow$ KEK-E391a

- K^+ beamline of low-momentum $(0.6 - 0.8\mathrm{GeV}/c)$
  - L-04: $\mathrm{K}^+ \to \pi^+\nu\bar{\nu}$ [T.Komatsubara(KEK)]

    $\Longleftarrow$ BNL-E949/E787
  - L-19: T-violation in K^+ decays [J.Imazato(KEK)/Yu.Kudenko(INR)]

    $\Longleftarrow$ KEK-E246
  - L-16: medium-rare K^+ decays [C.Rangacharyulu(Saskatchewan)]

    $\Longleftarrow$ KEK-E470
  - L-20: K_{e3} branching ratio [S.Shimizu(Osaka)]

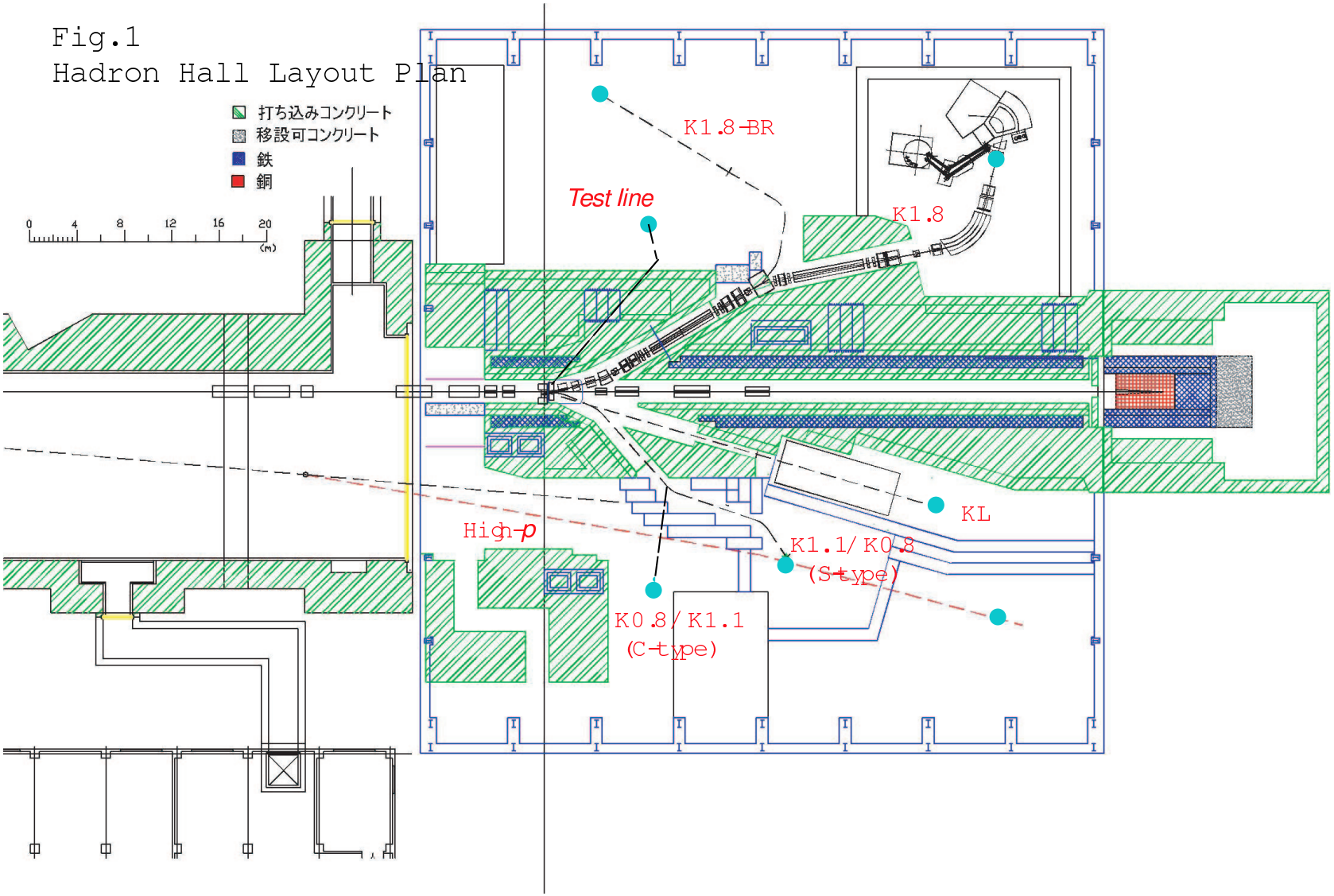
    $\Longleftarrow$ KEK-E470/E246

NP Experiments at J-PARC (cont.)

2003	Sep	Instructions of Director to the construction team
		(based on NPFC's assessment)
		on the Beamline Layout of the Hadron Hall
		- Day-1 experiments
		- Phase-1 experiments (including kaon experiments)
	Dec	domestic mini-workshop on the J-PARC kaon beamlines
2004	Feb	3nd NPFC meeting
		Report on the Beamline Layout plan
		http://www-ps.kek.jp/jhf-np/Layout/Layout.html

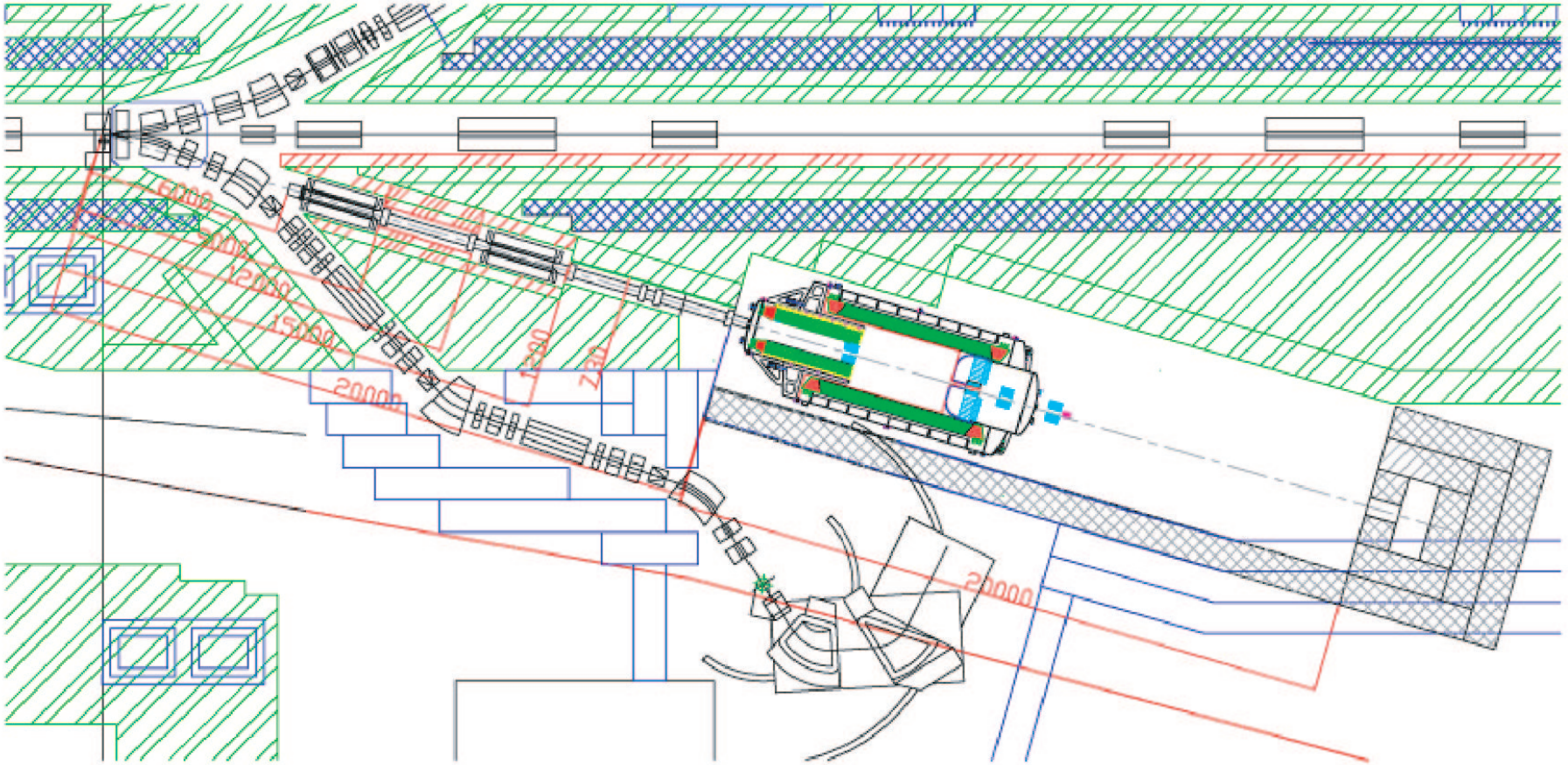
Hadron Hall Layout Plan

Fig.1
Hadron Hall Layout Plan



KL line at 16deg and K1.1 line(S-type)

Fig.2 Layout of K1.1 (S-type) and KL lines



K0.8/K1.1 line(C-type) and high-memontum line

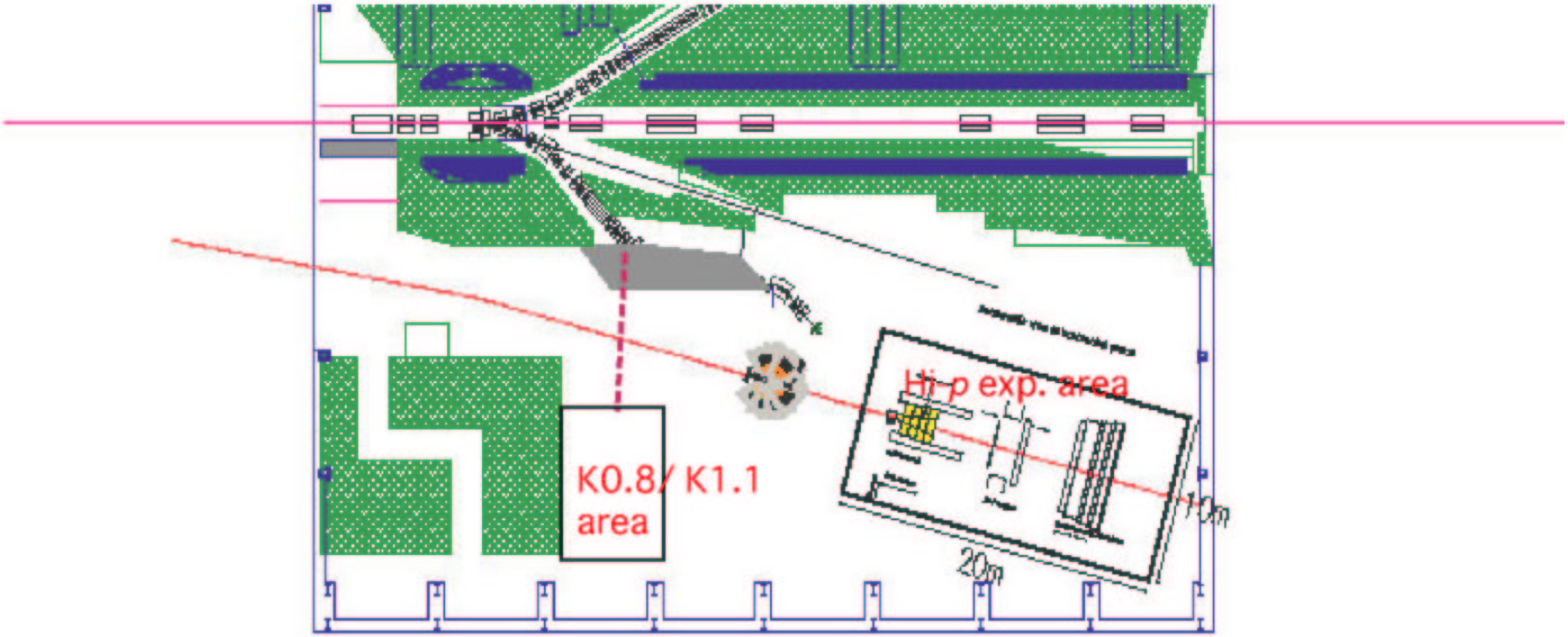


Fig.3 High momentum line and beam crossing scheme

NP Experiments at J-PARC: near-term schedule

2004	Aug	NP04 International Workshop @Tokai
	autumn ??	Call for full-Proposals
2005	summer ??	deadline of the Day-1 Proposals
2008		J-PARC first beam ??
2009		Day-1 experiments start ??

Summary : from  to 

- current program at KEK-PS
  - E246 T-violation in $\mathbf{K^+ \longrightarrow \pi^0 \mu^+ \nu}$:
    final result (to be submitted)
  - E391a $\mathbf{K_L^0 \longrightarrow \pi^0 \nu \bar{\nu}}$:
    amazing start-up; would reach $\boldsymbol{O(10^{-10})}$
    The concept of "pencil" beamline worked,
    and is promising in the future.
- future program at J-PARC new 50GeV-PS
  - Beamline Layout plan has been prepared,
  - We proceed to prepare a full-Proposal of
    "Kaon Physics at J-PARC"


NP04
The 3rd International Workshop on Nuclear and Particle Physics at J-PARC
Organizing Institutes: High Energy Accelerator Research Organization (KEK)
Japan Atomic Energy Research Institute (JAERI)
Strangeness Nuclear Physics Experiments
Nuclear/ Hadron Physics Experiments
Neutrino Experiments
Kaon Rare Decay Experiments
Muon Rare Decay Experiments
Physics with Low-Energy Anti-Protons
Aug. 2-4, 2004 at Tokai, Ibaraki, Japan
Aug. 24-26, 2004 at KEK (Neutrino session)
http://j-parc.jp/NP04
Photo: J-PARC site taken in Feb. 2004
Contact:
toshiyuki.takahasi@kek.jp
takashi.kobayashi@kek.jp (Neutrino)
Local organizing committee
S.Nagamiya (KEK/JAERI; Chairperson)
K.Imai (Kyoto)
J.Imazato (KEK)
T.Kobayashi (KEK)
T.Komatsubara (KEK)
T.Nagae (KEK)
K.Nishikawa (Kyoto)
S.Sawada (KEK)
T.Takahashi (KEK; Scientific secretary)
M.Takasaki (KEK)
T.Yamanaka (Osaka)