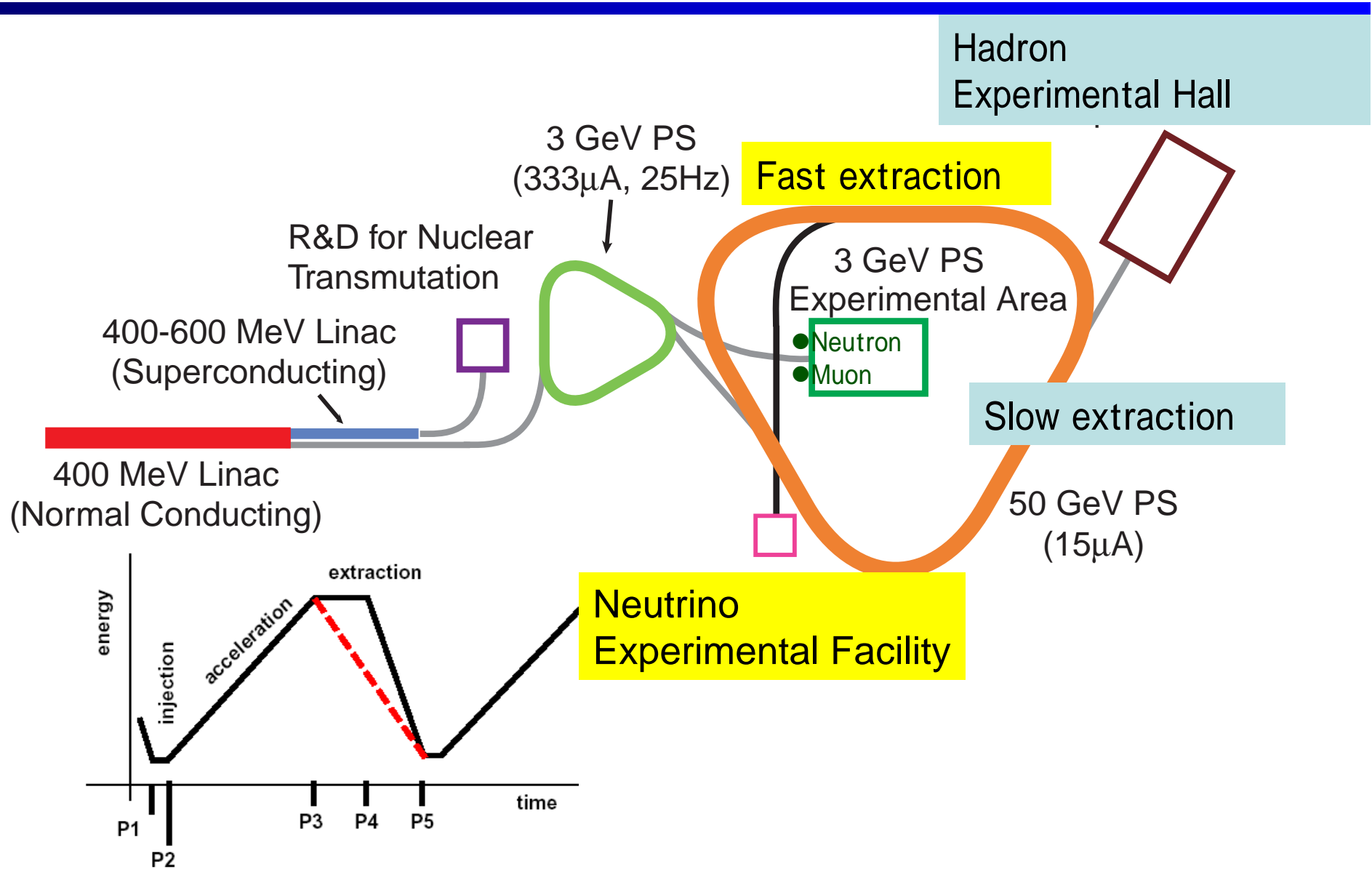

Overview of Nuclear and Particle Physics Facilities

J. Imazato

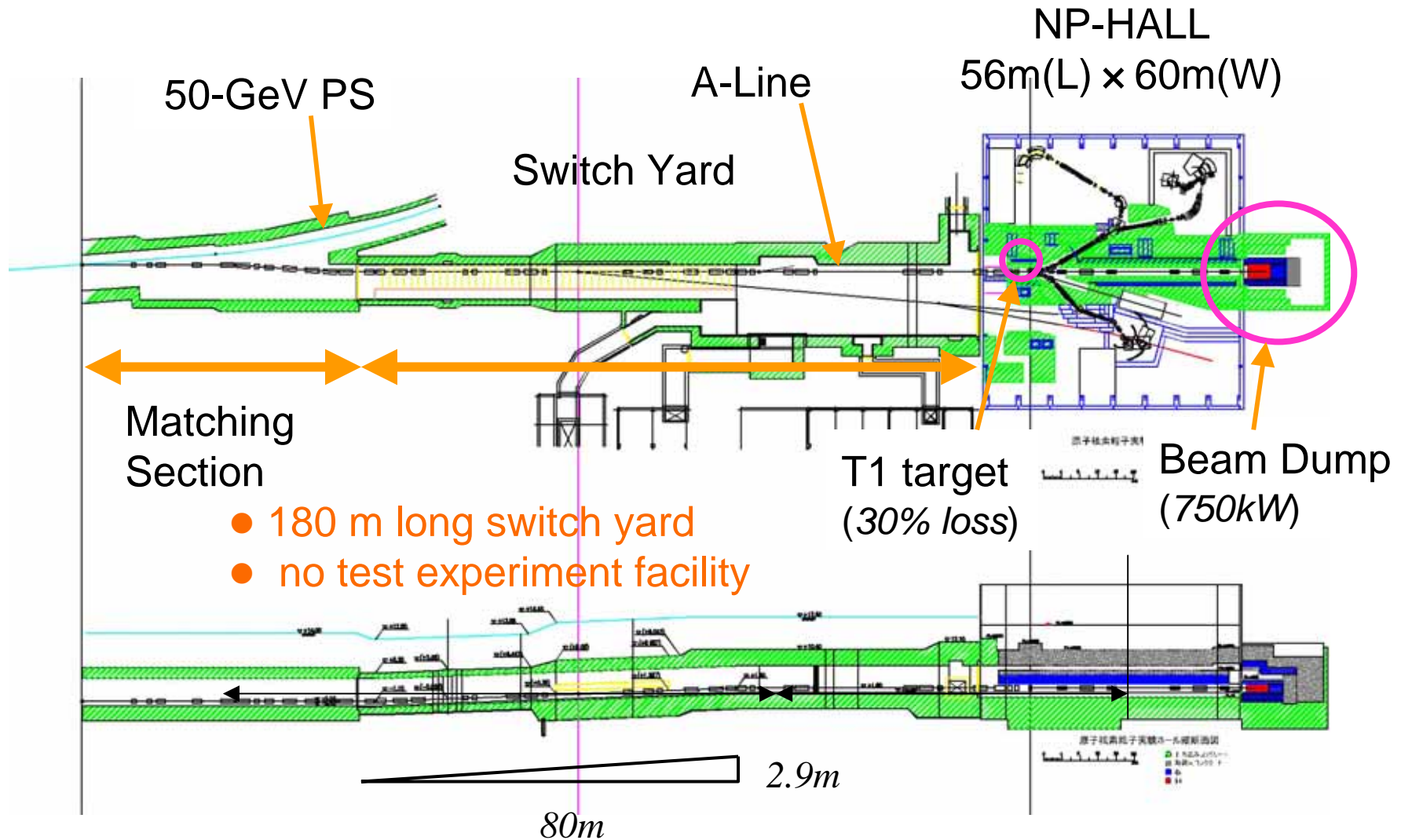
J-PARC Nuclear and Particle Physics Group

1. 50-GeV PS experimental facility design
2. Construction
 - Status
 - R&D of beamline elements
 - Schedule
3. Beamline plan
4. Others

50-GeV PS facilities



Hadron Experimental facility (Phase 1)



Slow-extraction beam

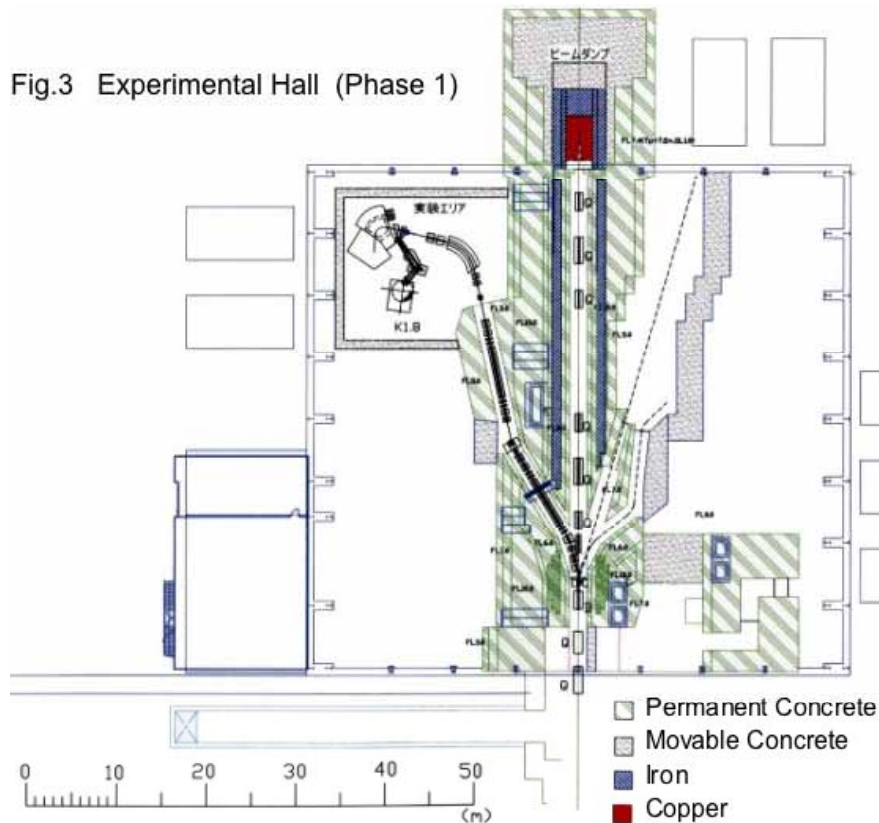
| $E(\text{GeV})$ | Harm.# | Bunch | Period (s) | $I (\mu\text{A})$ | $P (\text{kW})$ | Spill(s) | $D.F.$ | $E_{\text{lin}}(\text{MeV})$ |
|------------------|--------|-------|------------|-------------------|-----------------|----------|--------|------------------------------|
| 30* | 9 | 8 | 3.53 | 9 | 270 | > 0.7 | > 20 % | 181 |
| 30* | 18 | 15 | 4.08 | 14.4 | 432 | > 0.7 | > 17 % | 181 |
| <for comparison> | | | | | | | | |
| 30 | 9 | 8 | 3.53 | 15 | 450 | > 0.7 | > 20 % | 400 |
| 40 | 9 | 8 | 3.53 | 15 | 600 | 0.7 | 20 % | 400 |
| 50 | 9 | 8 | 3.53 | 15 | 750 | 0.7 | 20 % | 400 |

* The ratio of per bunch intensity between 181 MeV and 400 MeV of 0.6 is assumed.

- Beam energy is limited to 30 GeV due to electricity and cooling water capacities in Phase 1
- We are requesting a variable $D.F.$ depending on experiments.

Experimental Hall (Phase 1)

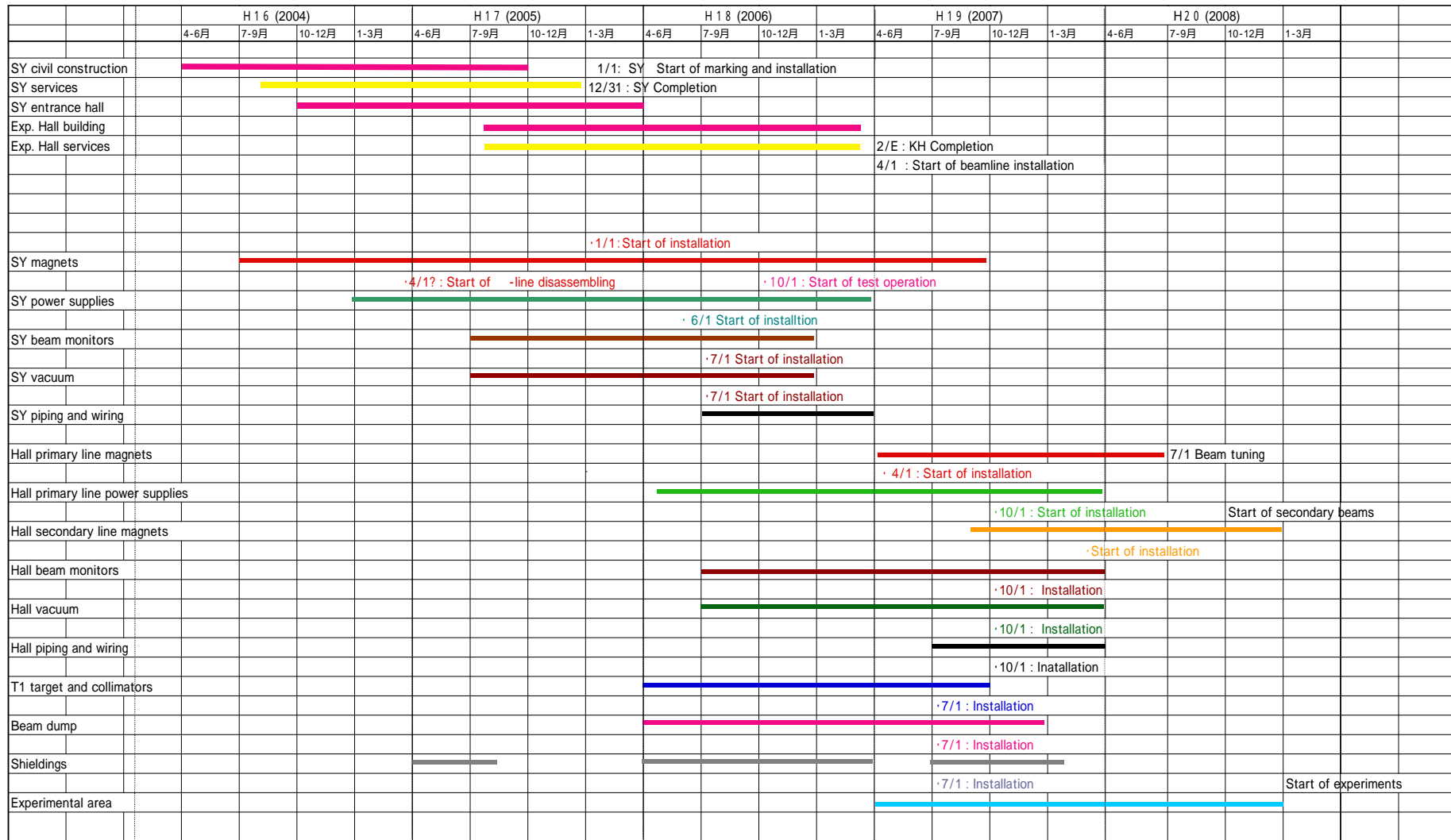
Fig.3 Experimental Hall (Phase 1)



- Hall size : 60m (W) x 56 m (L)
- Floor level : -6.4 m from ground level
- Beam height : 2.0 m above floor
- Primary line : A- line (straight line)
- T1 target : rotating Ni disks water-cooled
- T1 length : 30 % beam loss equiv.
- T1 heat load: 9.3 kW
- Beam dump: Cu blocks with tapered beam inlet
- Dump power: 750 kW maximum

Construction time schedule

as of May 2004



- Two month delay in SY construction due to the recent underground water problem

Building construction schedule

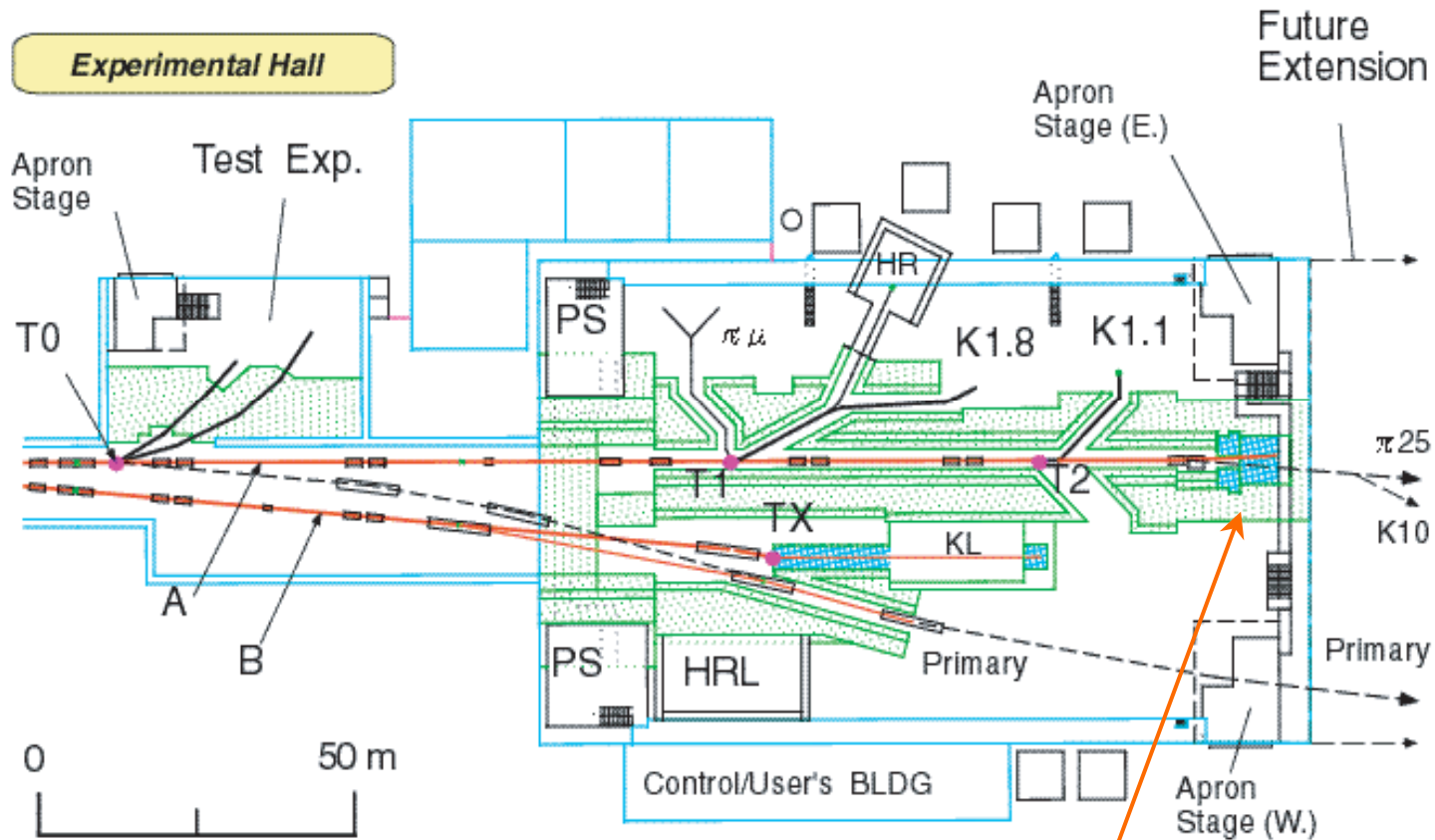


Switchyard completion
 (U) End of February, 2006
 (D) End of August, 2006

Hall completion
 End of March, 2007

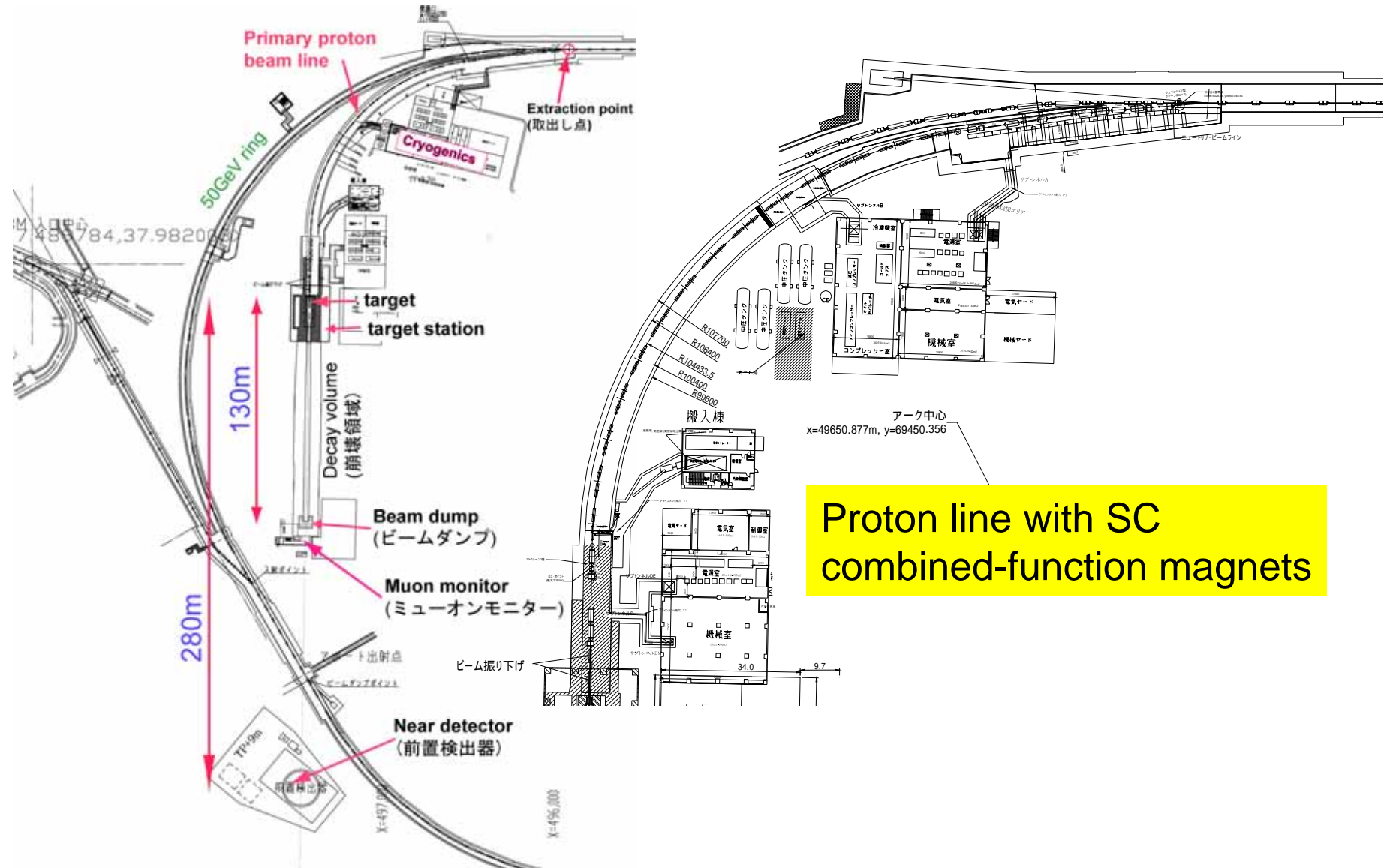
| | | |
|---|---------------|-------|
| 凡 | 計画建物 (13年補) | 2001 |
| | 計画建物 (14年単) | 2002 |
| | 計画建物 (15年単) | 2003 |
| | 計画建物 (15年国債) | 2003~ |
| | 計画建物 (16年国債) | 2004~ |
| | 計画建物 (17年単) | 2005 |
| | 計画建物 (17年国債) | 2007~ |
| | 計画建物 (18年単) | 2006 |
| | 計画建物 (19年度以降) | 2007~ |
| | 屋外ヤード | |

Phase-2 Hall



- Hall size = 60m (W) x 100 m (L)
- More than 2 target stations
- Test beam facility
- Beam dump will be rolled down

Neutrino facility



Proton line with SC combined-function magnets

Fast-extraction beam

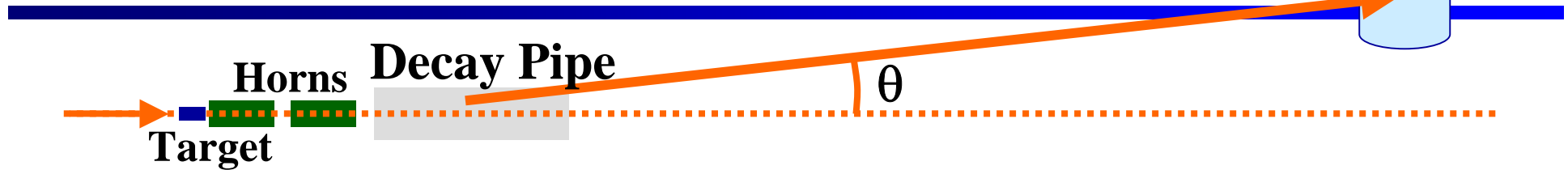
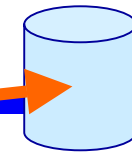
| E (GeV) | Harm.# | Bunch | Period (s) | I (μ A) | P (kW) | E_{lin} (MeV) |
|------------------|--------|-------|------------|----------------|----------|------------------------|
| 40* | 9 | 8 | 3.53 | 9 | 360 | 181 |
| 40* | 18 | 15 | 3.38 | 17.4 | 700 | 181 |
| <for comparison> | | | | | | |
| 40 | 9 | 8 | 3.53 | 15 | 600 | 400 |
| 50 | 9 | 8 | 3.53 | 15 | 750 | 400 |

* The ratio of per bunch intensity between 181 MeV and 400 MeV of 0.6 is assumed.

- Beam energy is limited to 40 GeV due to the lack of a flywheel.

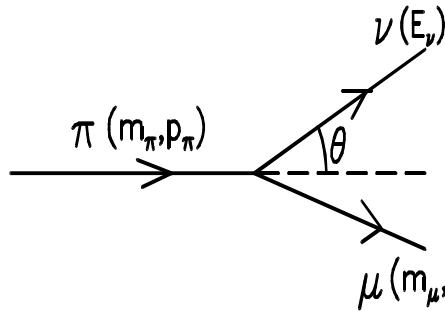
Off-axis beam

Far Det.

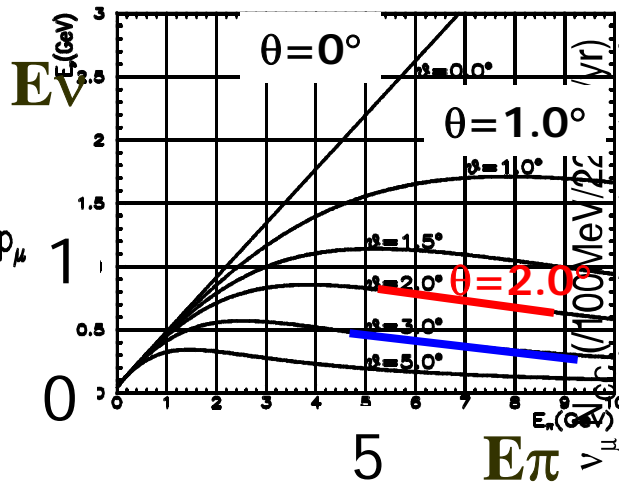


WBB w/ intentionally misaligned beam line from det. axis

Decay Kinematics



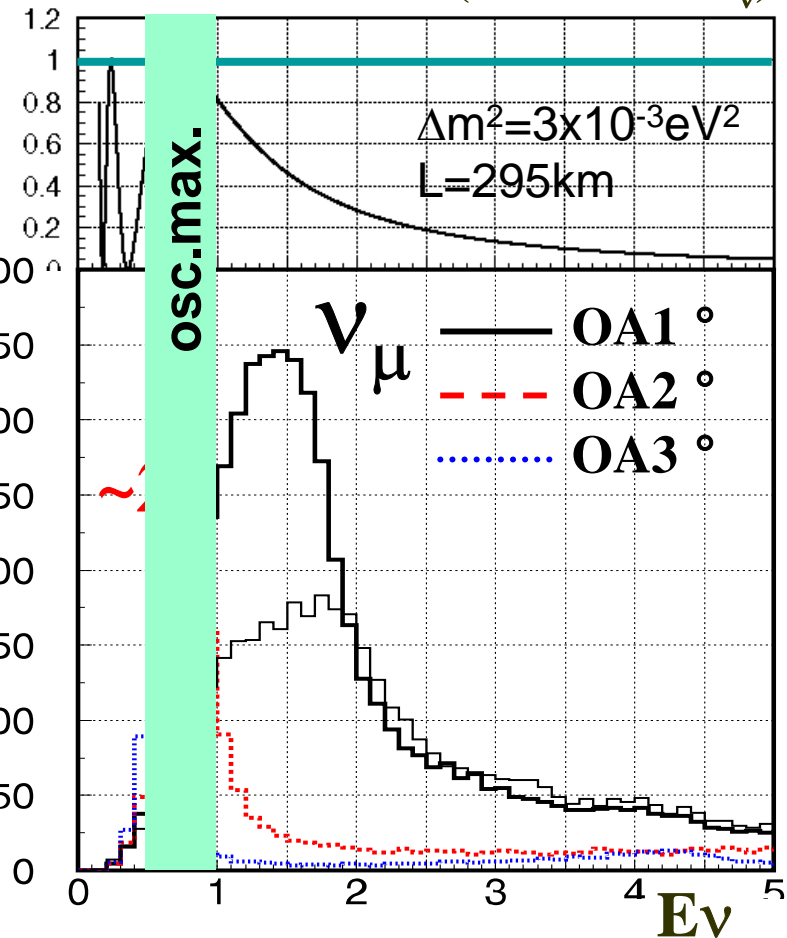
$$E_\nu = \frac{m_\pi^2 - m_\mu^2}{2(E_\pi - p_\pi \cos \theta)}$$



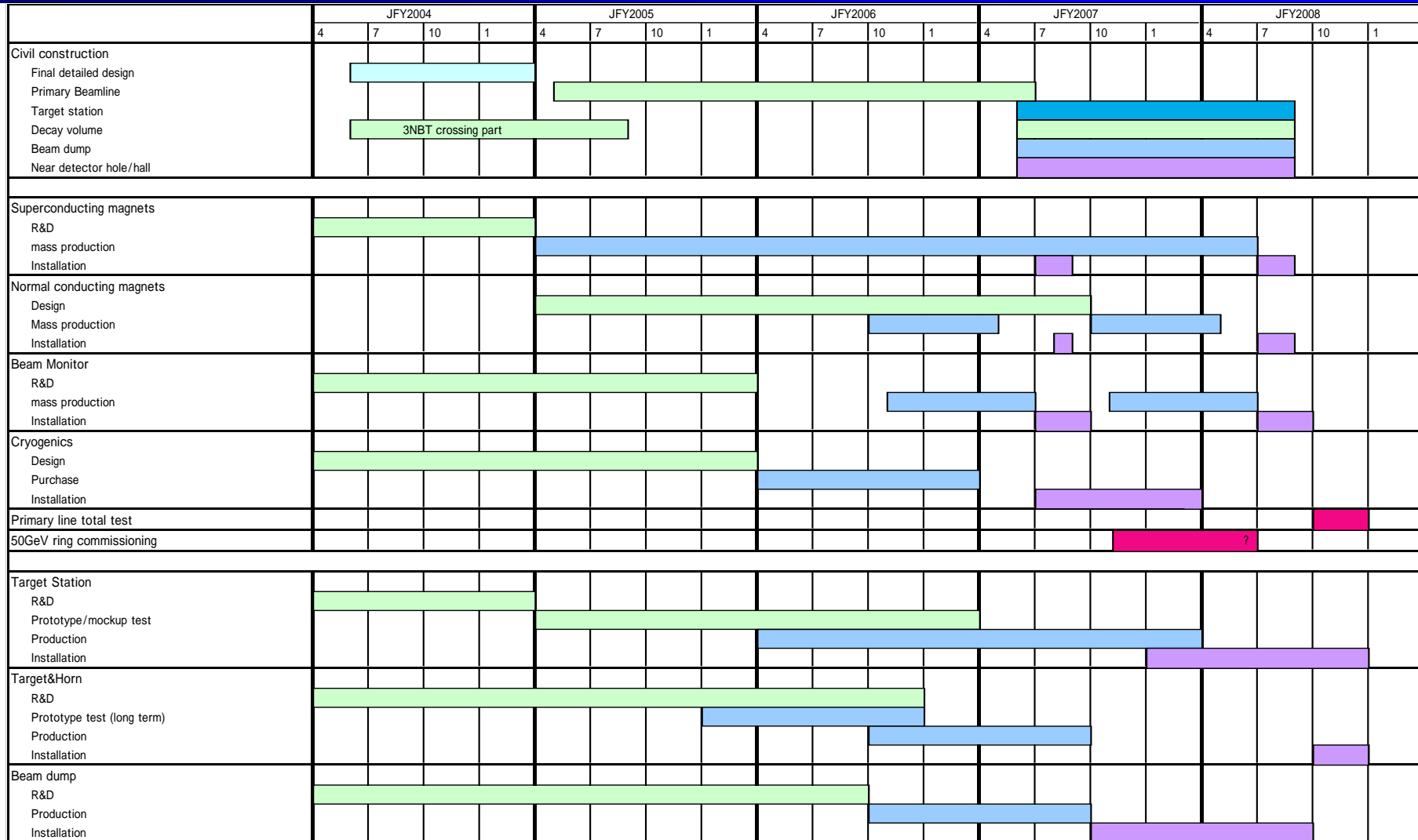
~ 3000 CC int./22.5kt/yr

ν_e : 1.0% (0.2% @ peak);

$$\text{Osc. Prob.} = \sin^2(1.27 \Delta m^2 L / E_\nu)$$



Neutrino facility time schedule as of June 2004



- There is a mismatch between the building and instrument schedule, which has still to be fixed.

Construction status in 2004

Hadron Experimental facility

- High radiation hard quad : Q440MIC
- Radiation hard magnet coils
- MI conductor
- T1 target proof model
- Other R&Ds
 - Beam dump, Vacuum chamber, Beam monitor, DCS, ...

Neutrino Experimental Facility

- Decay volume 3NBT crossing part
- SC magnet prototype and proof model
- Other R&Ds and designs
 - Target, Horn, Target station, Beam dump, Cryogenics system, ...

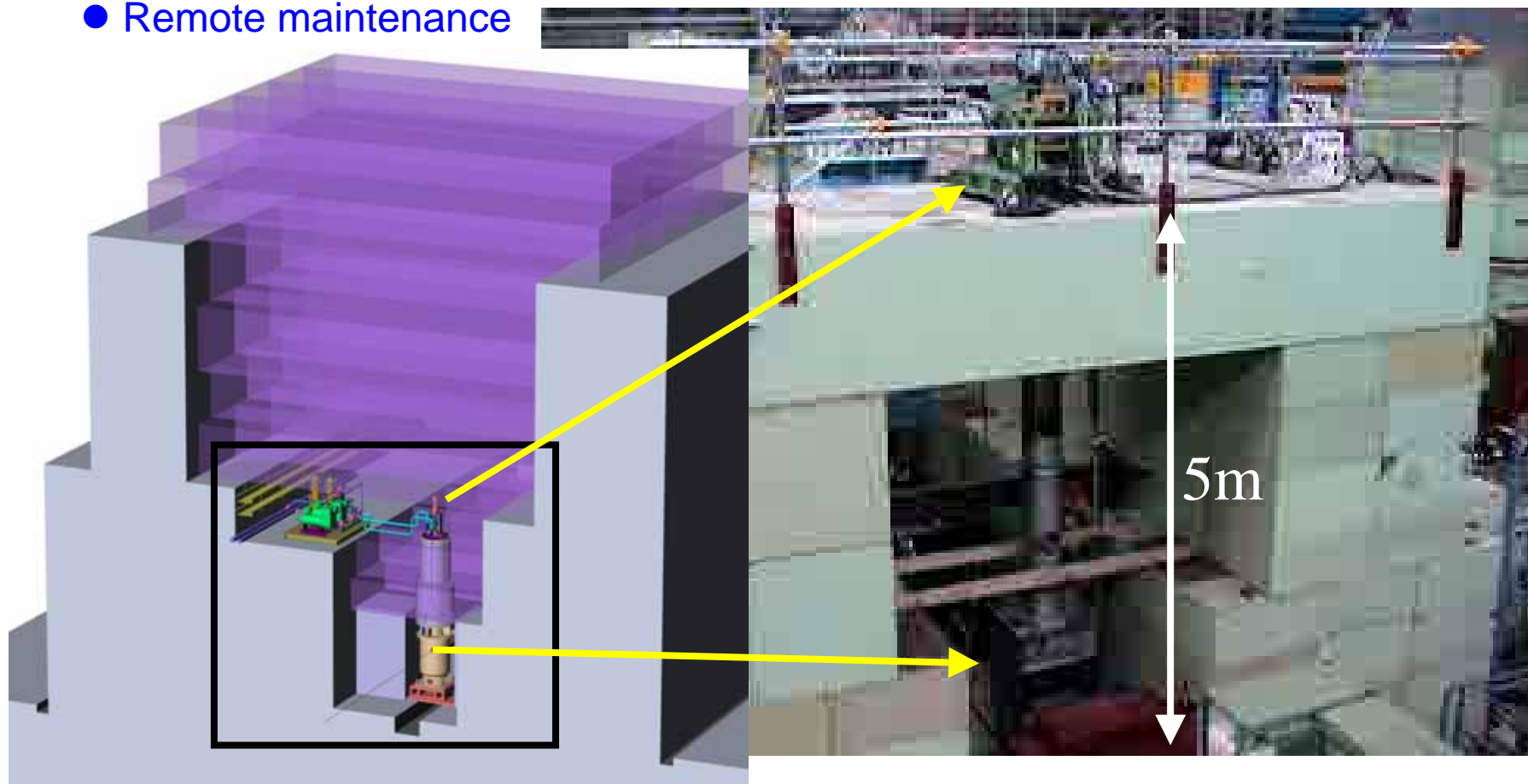
R&D in the facility construction group

| Item | Method | R&D |
|-------------------|-------------------------------|---|
| T1 target | rotating disks | <ul style="list-style-type: none"> • drive mechanism • water cooling characteristics • maintenance process |
| v target | graphite rod | <ul style="list-style-type: none"> • cooling characteristics • thermal shock • irradiation effects |
| A-line beam dump | Cu block | <ul style="list-style-type: none"> • water-cooling characteristics • attachment of cooling channel |
| v horn | Al 3 horn system | <ul style="list-style-type: none"> • welding of Al, <i>etc.</i> |
| Rad-hard magnet | inorganic magnet | <ul style="list-style-type: none"> • MIC conductor with high capacity • water cooling peripherals |
| v line arc magnet | combined-function SCM | <ul style="list-style-type: none"> • windings, color, <i>etc.</i> • cryostat |
| Beam monitor | SSEM RGBPM Loss monitor | <ul style="list-style-type: none"> • prototype • prototype • prototype |
| Junctions | quick disconnect system | <ul style="list-style-type: none"> • water, power, vacuum, crane-hook |
| Power feedthrough | inorganic bus-bar | <ul style="list-style-type: none"> • insulation, thermal stress |

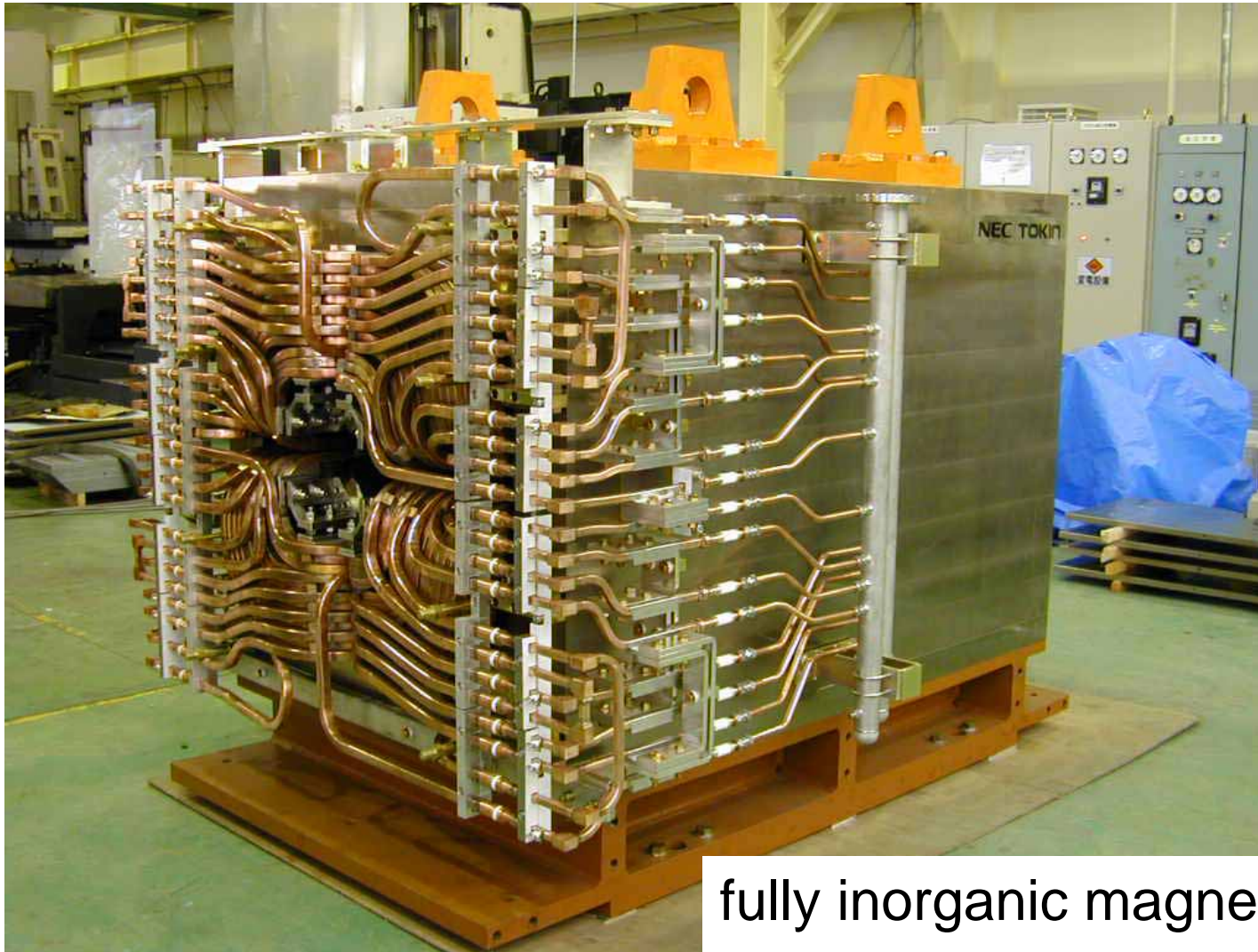
Test of T1 target prototype

- Water cooling
- Rotating Ni disks
- Remote maintenance

East Hall mock-up



Development of beamline elements



fully inorganic magnet

Equipment transferred from 12-GeV PS

| Item | Quantity | From | To |
|-----------------------|----------|------------------------|----------------------------|
| Bending magnet | 18 | ν line <i>etc.</i> | hadron SY primary line |
| Quadrupoles | 21 | ν line <i>etc.</i> | hadron SY primary line |
| Magnet power supply | >69 | E-, and N-Hall | hadron hall and neutrino |
| Secondary magnets | 42 | K6, K5 <i>etc.</i> | K1.8, K1.1 in hadron hall |
| Iron shielding blocks | 5,000 t | E-, and N-Hall | hadron hall, neutrino line |
| Concrete blocks | 12,000 t | E-, and N-Hall | hadron hall, neutrino line |
| DC separator | 2 | K5 and K6 | K1.1 in hadron hall |
| Horn power supply | 1 | ν line | ν line |

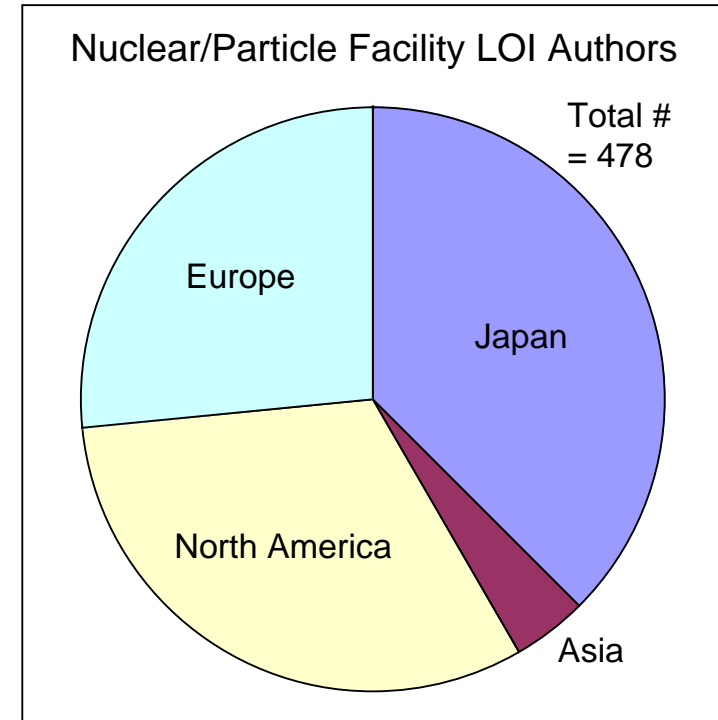
Budget request for transfer

For secondary lines

- No budget for secondary lines included in J-PARC
Secondary lines have to be transferred from the 12-GeV PS.
- 4 year plan from 2005 to 2008
 - Dismantle of beamlines at the 12 GeV PS
 - Modification of magnets and power supplies for J-PARC
 - Transfer of magnets and PSs to J-PARC
 - Transfer of DCS's to J-PARC
 - Transfer of shielding to J-PARC
 - Preparation of spectrometers for J-PARC and transfer
 - Other equipment for experimental area
- Hope to prepare for Day-1 and other Phase-1 experiments.

Letters of Intent

- Announce of Lol call : July 2002
- Thirty Lol's were submitted by early 2003
 - Strangeness nuclear physics : 6
 - Hadron physics : 7
 - Kaon decay : 5
 - Neutrino oscillation : 1
 - Muon decay : 3
 - Facility : 8
- NPFC Committee meetings:
 - March 22, 2003
 - June 26-28, 2003
 - February 16, 2004
- Review by June 2003 meeting
 - Day-1 experiments : 2 + test line
 - Phase1 experiment : 16



- Call for full proposals: sometime this year
- Formation of PAC: sometime next year ?

Summary of LoI (1)

Table 14

Summary of Proposed Experiments (Letters of Intent) at the 50 GeV PS of J-PARC

July, 2003

p. 1 / 2

| | | | | | Schedule* |
|--|----------------------|--|------------------|---------------|-----------|
| <Strangeness Nuclear Physics> | | | | | |
| LOI-06 | K. Imai | New Generation Spectroscopy of Hadron Many Body Systems with Strangeness $S = -2$ and -1 | K- | 0.8, 1.1, 1.8 | Day -1 |
| LOI-07 | M. Ieiri | Hyperon Proton Scattering Experiments at the 50 GeV PS | K-, + | 1.0 -1.6 | Phase -1 |
| LOI-08 | H. Noumi | High Resolution Reaction Spectroscopy of $S = -1$ Hypernuclei | + / - | 1.0 -1.2 | Phase -1 |
| LOI-09 | T. Fukuda | Neutronrich Λ hypernuclei by the double charge exchange reaction | K-/ - | 0.9 /1.0 | Phase -1 |
| LOI-10 | T. Nagae et al. | Study of Dense Nuclear Matter with Strangeness | K- | 0.9, 2-3 | Day -1 |
| LOI-21 | S. Ajimura | Precise Measurement of the Nonmesonic Weak Decay of $A = 4, 5$ Λ Hypernuclei | K-/ + | 0.8 /1.0 | Phase -1 |
| <Hadron Physics> | | | | | |
| LOI-01 | V.V.Sumachev et al. | Measurements of the spin rotation parameters A and R in the resonance region of πN elastic scattering | + / - | 0.6 -2.1 | Phase -1 |
| LOI-03 | A.D. Krisch | Analysing power A_n in 50 GeV very-high $-P^2$ proton-proton elastic scattering | p | 51 | Phase2+ |
| LOI-11 | S. Yokkaichi | Electron pair spectrometer at the JHF 50 GeV PS to explore the chiral symmetry in QCD | p | 31, 51 | Phase -1 |
| LOI-13 | H. Spinka, S. Sawada | Hadron Spectroscopy at J-PARC | ,K,p, pol.-p/ HI | < 6 | Phase -1 |
| LOI-15 | J.C. Peng, S. Sawada | Physics of High Mass Dimuon Production at the 50GeV Proton Synchrotron | p, pol.p, HI | | Phase -1 |
| LOI-18 | T. Murakami | Energy Dependence of Intermediate Mass Fragment Angular Distribution | P/ p, - | 30 /4.0 -14.0 | Phase -1 |
| LOI-23 | L. Nemenov | Lifetime Measurement of $\pi^+ \pi^-$ and $\pi^\pm K^\pm$ atoms to test low energy QCD | p | 30 (50) | Phase -1 |
| <Kaon Decay Physics> | | | | | |
| LOI-04 | T. Komatsubara | Study of the Rare Decay $K^+ \rightarrow \pi^+ \nu \nu$ with Stopped Kaon Beam at J-PARC | K+ | 0.6 -0.8 | Phase -1 |
| LOI-05 | T. Inagaki | Measurement of the $K_L^0 \rightarrow \pi^0 \nu \nu$ Branching Ratio | KL | -0.2 | Phase -1 |
| LOI-16 | C. Rangacharyulu | Study the Kaon Decay physics at JHF | K+ | | Phase -1 |
| LOI-19 | Y.Kudenko, J.Imazato | Search for Tviolation in K^+ decays | K+ | 0.6 -0.7 | Phase -1 |
| LOI-20 | S. Shimizu | Precise Measurement of the $K^+ \rightarrow \pi^0 e^+ \nu$ (Ke3) Branching Ratio | K+ | 0.6 -0.7 | Phase -1 |

Summary of LoI (2)

| | | | | | |
|--------------------|-------------------------|---|-----------------------|-------------|----------|
| <Neutrino Physics> | | Neutrino Oscillation Experiment at JHF | neutrino | ~0.8 | p.2/2 |
| LOI-12 | K.Nishikawa | | | | |
| <Muon Physics> | | An Improved Muon ($g-2$) Experiment at J-PARC | $\mu+$ | | Phase2+ |
| LOI-17 | B.L. Roberts | | | | |
| LOI-22 | Y.K. Semertzidis et al. | | | | |
| LOI-25 | PRIME Group | An Experimental Search for the $\mu^- \rightarrow e^-$ Conversion Process Towards an Ultimate Sensitivity of the Order of 10^{-18} with PRISM | $\mu-$ | | Phase2+ |
| <Facility> | | Testbeam Facilities at J-PARC Construction of a High Momentum Beam Line at the 50 GeV Proton Synchrotron The PRISM Project – A Muon Source of the World Highest Brightness by Phase Rotation – Request for a Pulsed Proton Beam Facility at J-PARC A Study of a Neutrino Factory in Japan (NufactJ) A hadron spectroscopy experiment with RF separated high energy K^\pm beam at JHF A branch of Laboratory of Nuclear Studies of Osaka University (OULNS) at JPARC Studies of a Target System for a 4MW, 50 GeV Proton Beam | e, μ , π ,K,p | 0.5 -2, <10 | Day -1 |
| LOI-02 | S. Komamiya | | | | |
| LOI-14 | S. Sawada | | π ,K,p, primary | > 5 | Phase -1 |
| LOI-24 | PRISM Group | | μ | | Phase2+ |
| LOI-26 | Y.Kuno, R.S.Hayano | | anti-p, μ , .. | | N/A |
| LOI-27 | Y. Kuno, Y. Mori | | neutrino | | N/A |
| LOI-28 | V.Obraztsov, T.Tsuru | | K- | -12 | Phase2+ |
| LOI-29 | T. Kishimoto | | | | N/A |
| LOI-30 | K. McDonald et al. | p | 50 | Phase2+ | |

(*) Recommendation by the second Nuclear and Particle Physics Facility Committee held on June 26-28, 2003 on experiments in the Hadron Hall. The neutrino oscillation experiment (LOI-12) had been reviewed in the first meeting with the evaluation of high priority. Final approval of experiments in Phase 1 will be done in the Program Advisory Committee (PAC), which will be formed henceforth, based on full proposals. The meaning of 4 categories of “Day-1, Phase-1, Phase2+, N/A” are ;

Day-1 : Experiments which are recommended to start at the beginning of the Hadron Facility when the first beam will be delivered.

Phase-1: Experiments which are possible to run in the Phase-1 scale of the experimental hall, and which are appropriate to run.

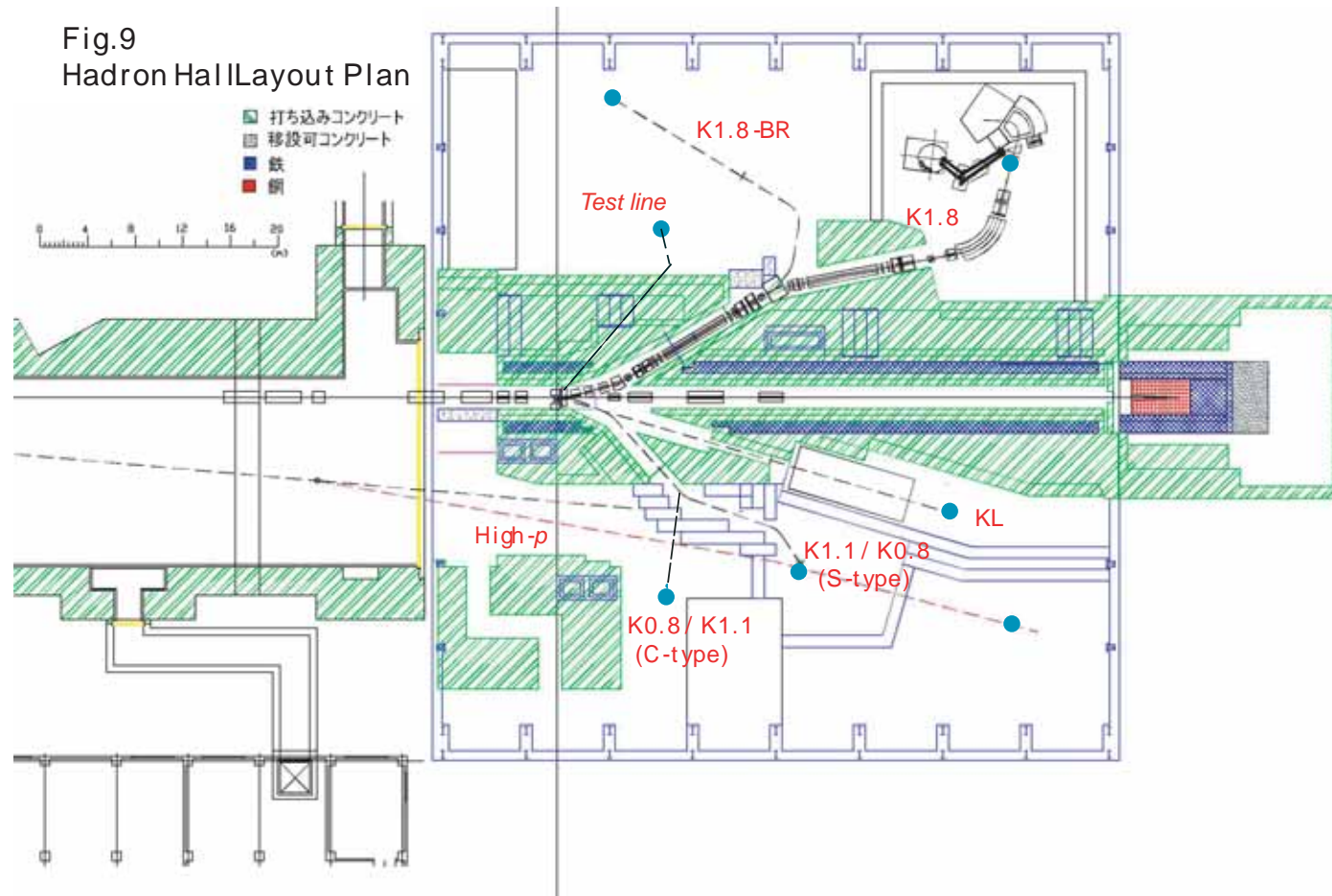
Phase2+: Experiments which are possible to run in Phase 2 or in later period waiting for future extensions of the facility.

N/A : Subjects which were not evaluated in the committee meeting.

Beamline layout plan

- Guideline in layout designing
 1. Make all attempts to construct beamlines requested by Day-1 experiments (K1.8 and K1.1).
 2. Positive consideration of installing a test line.
 3. Shield structure and beamline layout which enables to accommodate any Phase-1 experiment. (it is difficult to change the concrete structure in the future.)
- Working group in the construction group
 - From September 2003 to January 2004
 - Feasibility check of T1 extraction scheme, experimental area *etc.*
- “Phase-1 layout plan” reported to NPFC3 in Feb.2004.
 - General approval, but
 - Necessity to feedback users response
 - Lol experimental groups and this workshop*

Possible secondary lines in Phase 1

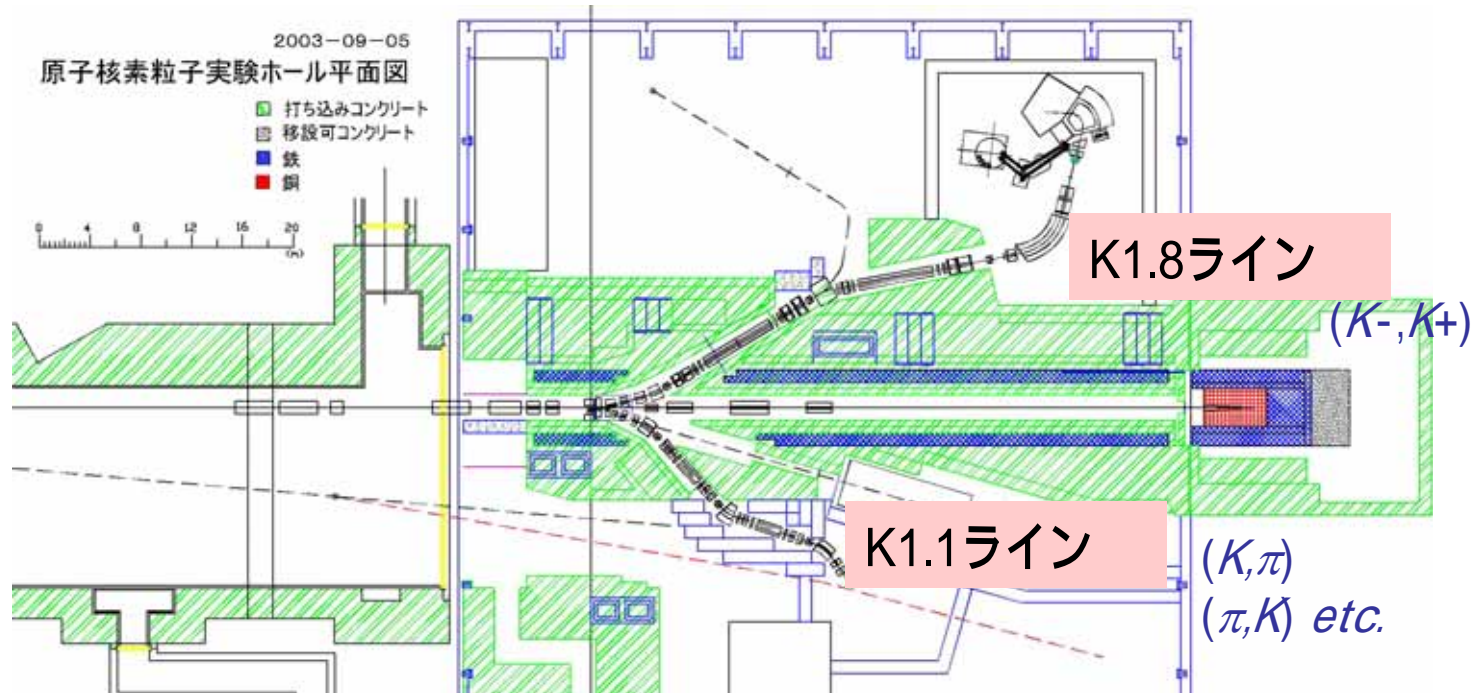


- Plan made by the beamline working group
- Presented to 3rd NPFC in Feb.2004

Possible beamlines in Phase 1

| Beam line | Target | Angle | Relation to other line |
|-----------|--------|-------------|---|
| K1.8 | T1 | -6 degrees | no conflicts |
| K1.1 | T1 | +6 degrees | coexistence with K0.8 |
| K0.8 | T1 | +6 degrees | coexistence with K1.1 |
| KL | T1 | +16 degrees | no conflicts |
| K1.8-BR | T1 | -6 degrees | branch of K1.8 |
| High- p | SM1 | - | conflict with K1.1/0.8 if S-type |
| Test beam | T1 | | several options are under consideration |

Strangeness nuclear physics



L06: New Generation Spectroscopy of Hadron Many-Body Systems with Strangeness $S=-2$ and -1

L07: Hyperon-Proton Scattering Experiments at the 50-GeV PS

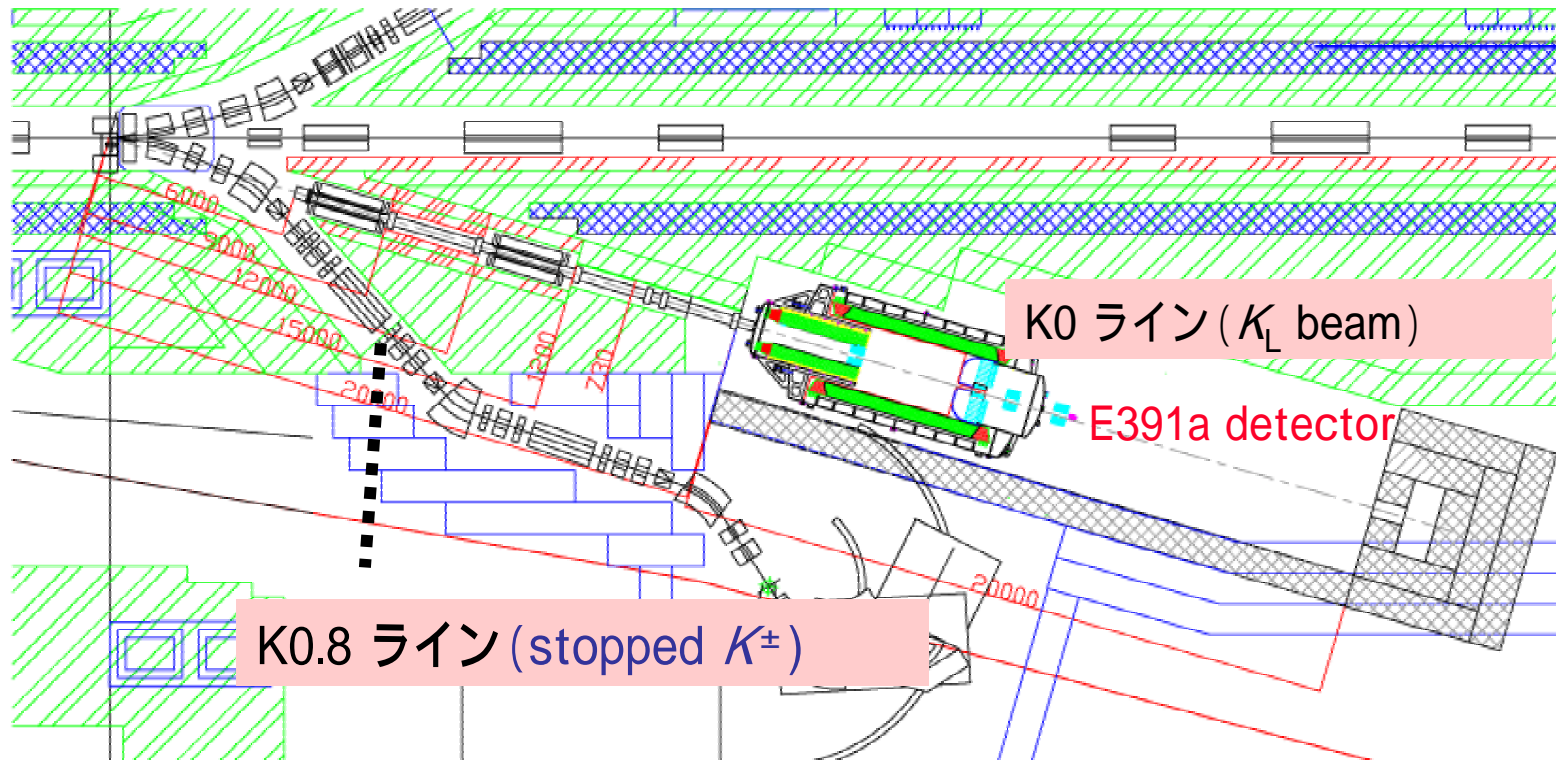
L08: High-Resolution Reaction Spectroscopy of $S=-1$ Hypernuclei

L09: Neutron-rich hypernuclei by the double-charge exchange reaction

L10: Study of Dense K Nuclear Systems K Nuclear Systems

L21: Precise Measurement of the Nonmesonic Weak Decay of $A = 4, 5$ Hypernuclei

Kaon decay physics



LoI-04 Study of the Rare Decay $K^+ \rightarrow \pi^+ \nu \nu$ with Stopped Kaon Beam at J-PARC

LoI-05 Measurement of the $K_L^0 \rightarrow \pi^0 \nu \nu$ Branching Ratio

LoI-16 Study the Kaon Decay physics at JHF

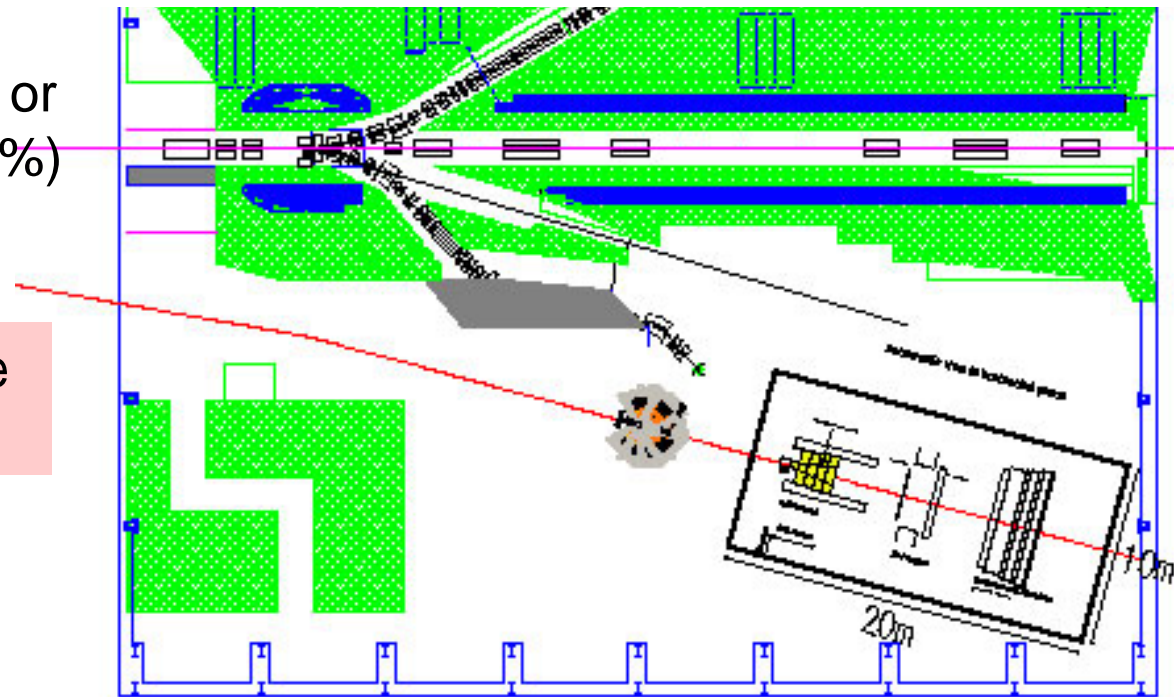
LoI-19 Search for T violation in K^+ decays

LoI-20 Precise Measurement of the $K^+ \rightarrow \pi^0 e^+ \nu$ ($Ke3$) Branching Ratio

High momentum beam physics

- Beam stealer or
- Thin target (2%) at SM1

Primary C-line
High- p beam



- LoI-01: Measurements of the spin rotation parameters A and R in the resonance region of πN elastic scattering
- LoI-11: Electron pair spectrometer at the JHF 50 GeV PS to explore the chiral symmetry in QCD
- LoI-13: Hadron Spectroscopy at J-PARC
- LoI-15: Physics of High Mass Dimuon Production at the 50GeV Proton Synchrotron
- LoI-18: Energy Dependence of Intermediate Mass Fragment Angular Distribution
- LoI-23: Lifetime Measurement of $\pi^+ \pi^-$ and $\pi^\pm K^\pm$ atoms to test low energy QCD

Transferred spectrometers

| Spectrometer | Experiments | Proposal (LoI) |
|--------------|--|--------------------|
| SKS* | hyper-nuclear spectroscopy | L06, L09, L10, L21 |
| Toroidal | kaon decay with stoppoed K | L16, (L19), L20 |
| E391a | $K_L \rightarrow \pi^0 \nu \nu$ rare decay | L05 |
| SPES-II | hyper-nuclear spectroscopy <i>etc.</i> | |
| KURAMA | hyperon scattering | L07 |

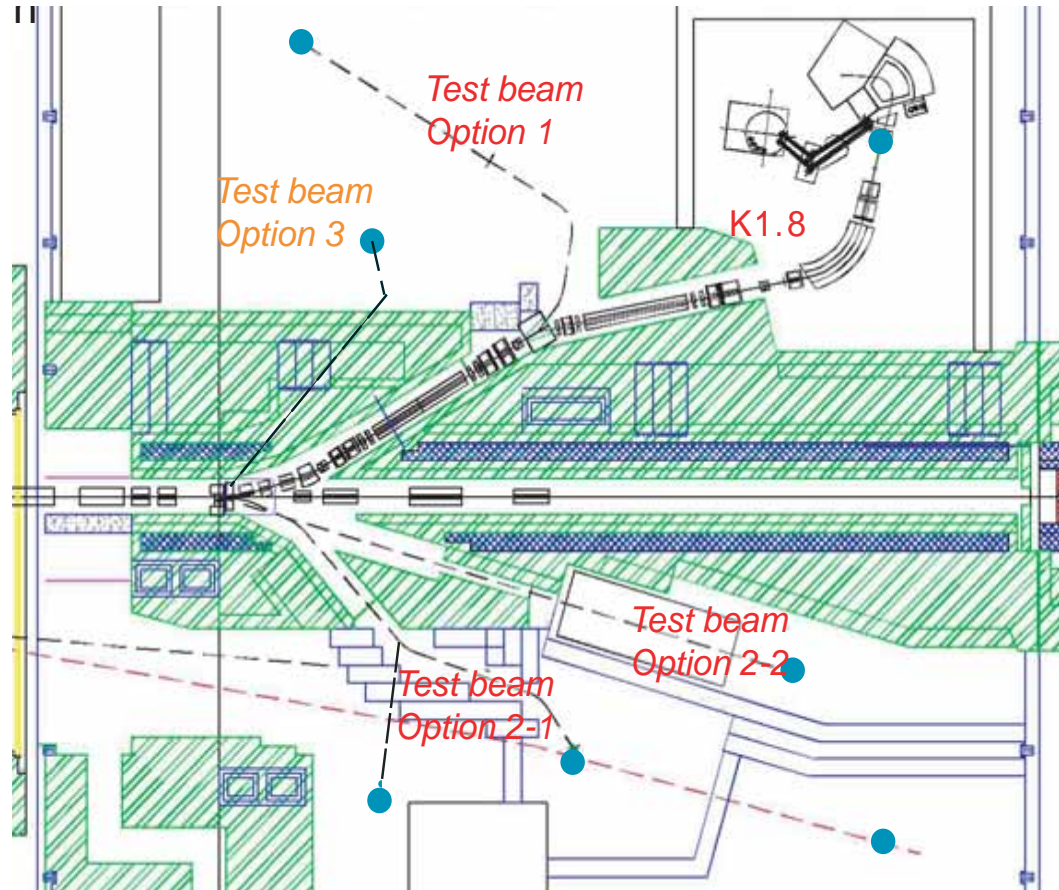
* SKS spectrometer is for Day-1 experiments.

Test beam request

Lol-02: Test beam facilities at J-PARC;
Request by High Energy Physics Committee

| | Must/ Indispensable | Should/ required | desired | Preferred/ optional |
|---------------------|---|---------------------|---------------------------|------------------------|
| momentum | 0.5~2GeV/c easy tunable | Up to 10GeV/c | | |
| mom. bite | Less than 1% | | Analyzing magnet | |
| Intensity [/sec] | Electrons: 1~10 Inclusive: 1~100 Easily tunable | | Up to ~100 Up to ~1000 | |
| Particle species | Unseparated e, mu, pi, K, p, p-bar | | DC separator | e-enriched tertiary |
| Time structure | Flat-top | | | Chopper |

Test beam options

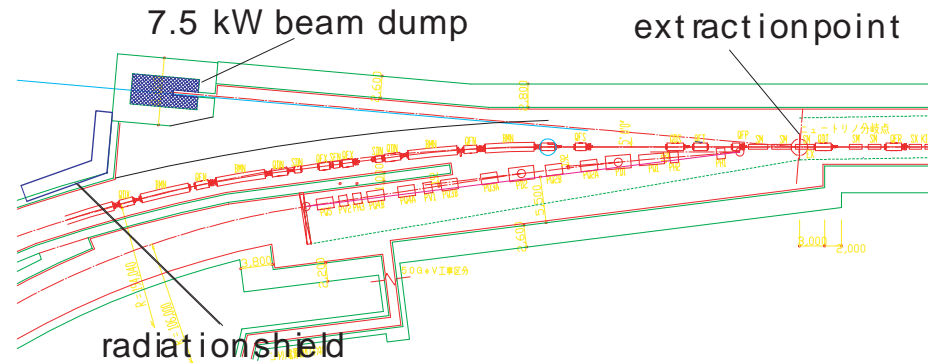


- Option-3 : $230 \pi/s$ of 2 GeV/c through a $3\text{cm}\phi$ hole at 30 GeV x $9\mu\text{A}$
- Realistic proposal will be made by fall this year
- No budgetary measures at the moment

Preparation for future extension

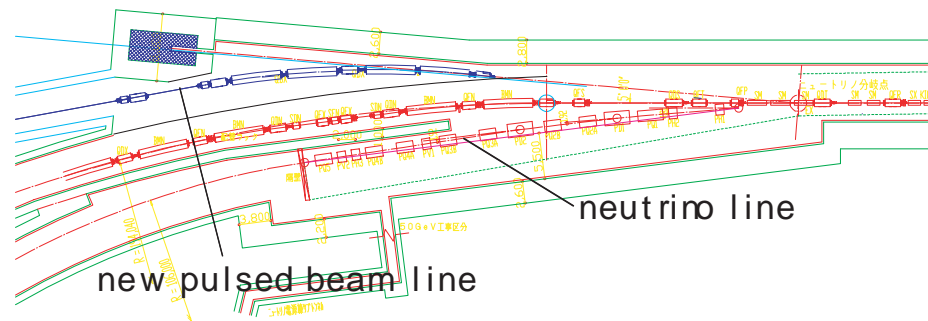
Phase 1

Extension port with concrete shielding to avoid soil activation



Future plan

- Muon source (PRISM)
- Anti-proton facility



PAC and experimental program

- Final approval of Day-1 experiments
 - Decision by PAC of the J-PARC organization
 - Based on full proposals
- Call for full proposals
 - Soon (sometime in this year?)
 - By whom?
 - Submission time?
- Creation of PAC
 - After establishment of the J-PARC organization scheme
 - Sometime next year
 - Where to put, in J-PARC center or in IPNS?

Summary

- The construction of J-PARC 50-GeV experimental facilities is going on aiming for the completion in 2007 and 2008 for the hadron hall and neutrino facility, respectively. This year the civil engineering started practically and manufacturing of instruments started, too.
- We expect the first beams in 2008 both for hadron and neutrino facilities.
- We are going to do our best to find resources for secondary lines in the hadron hall. Cooperation with users will be very important, in designing beamlines and also in construction.
- The beamline layout in Phase-1 hadron hall will be fixed sometime in the near future. Comments from users are welcome and also very necessary.