Hadron Experimental Hall and High-Momentum Beamline at J-PARC

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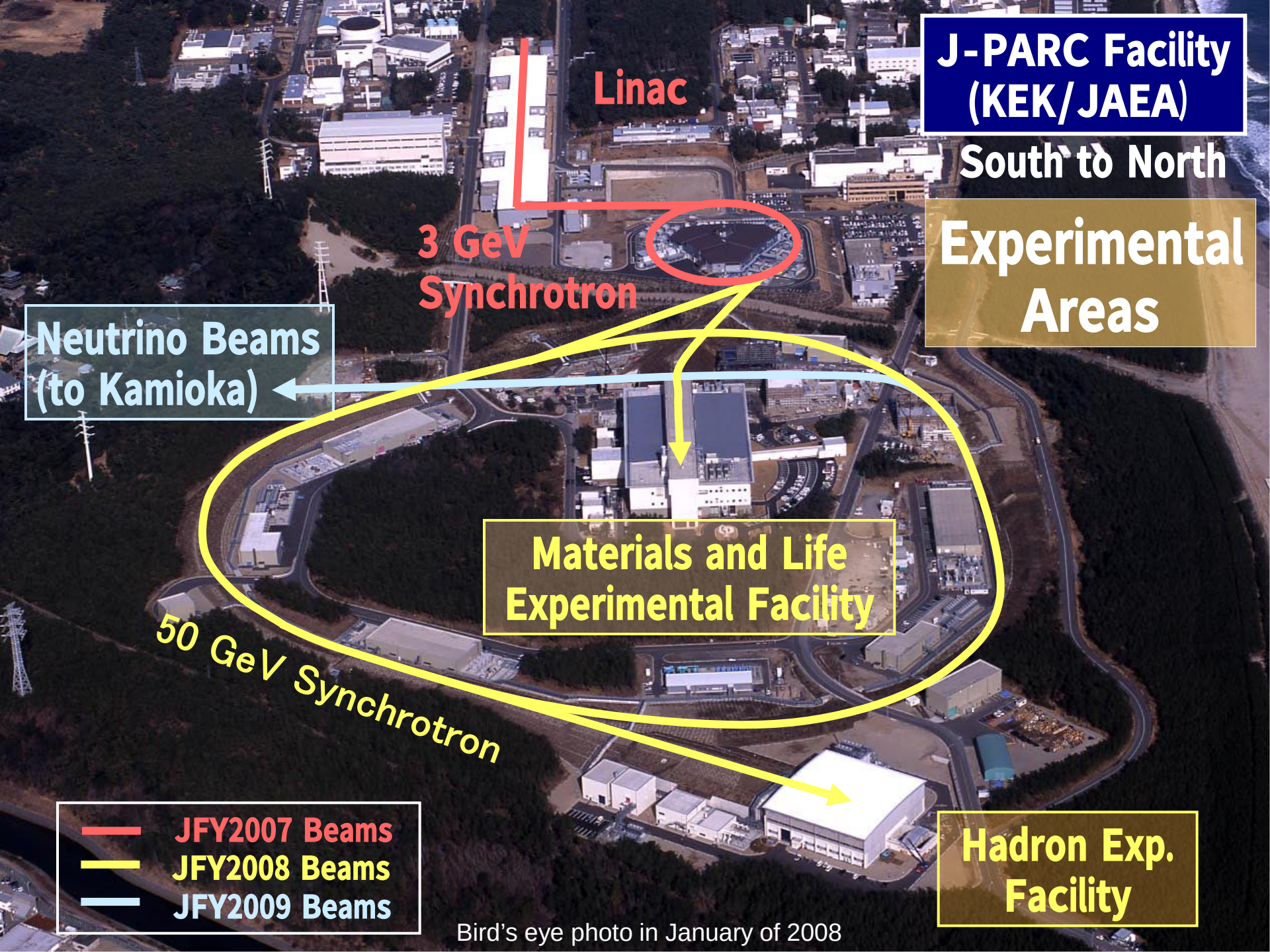
Contents

- Overview of J-PARC and Hadron Experimental Facility (Hadron Hall)
- Hadron Hall
- High-momentum Beam Line and COMET
- Extension
- Summary


J-PARC Facility
(KEK/JAEA)
South to North
Linac
3 GeV
Synchrotron
Experimental
Areas
Neutrino Beams
(to Kamioka)
Materials and Life
Experimental Facility
50 GeV Synchrotron
JFY2007 Beams
JFY2008 Beams
JFY2009 Beams
Hadron Exp.
Facility
Bird's eye photo in January of 2008

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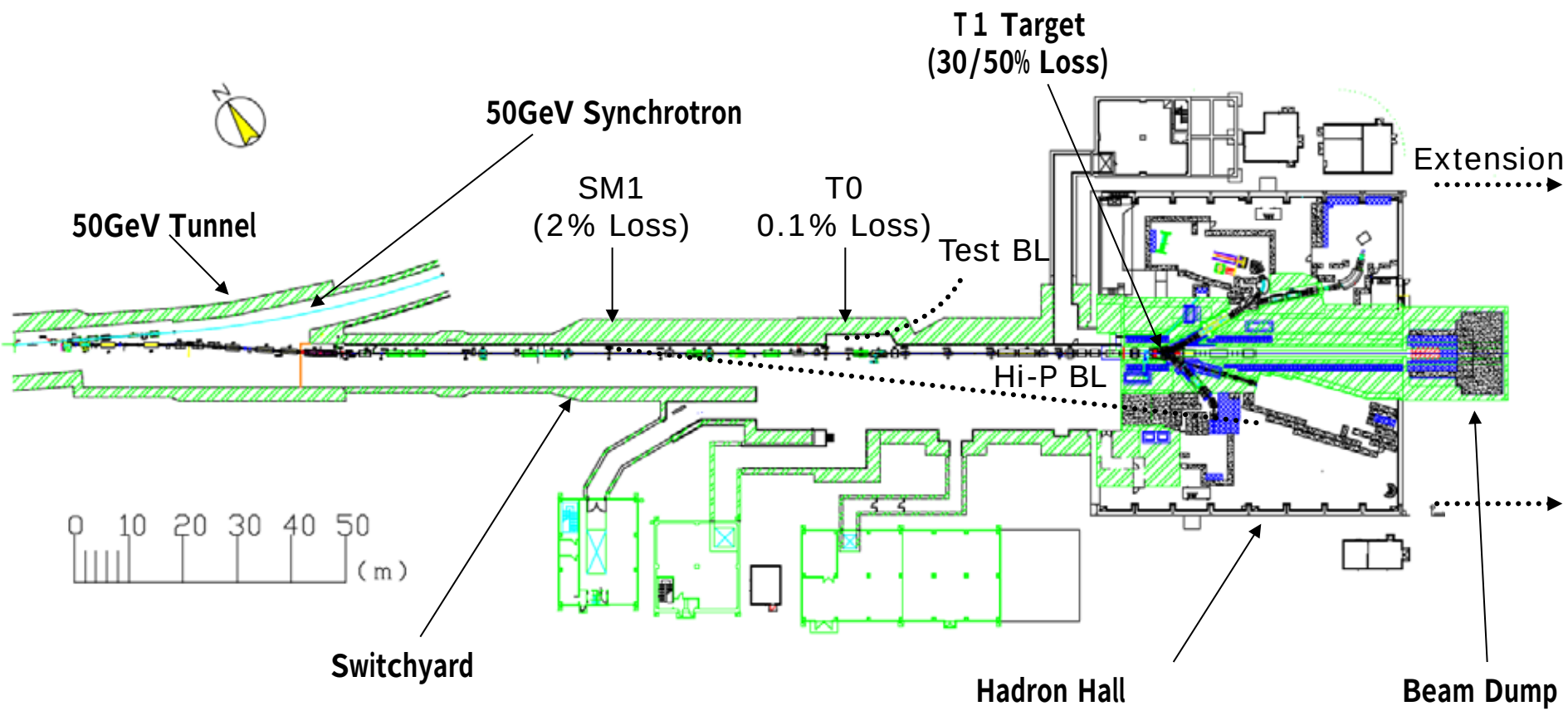
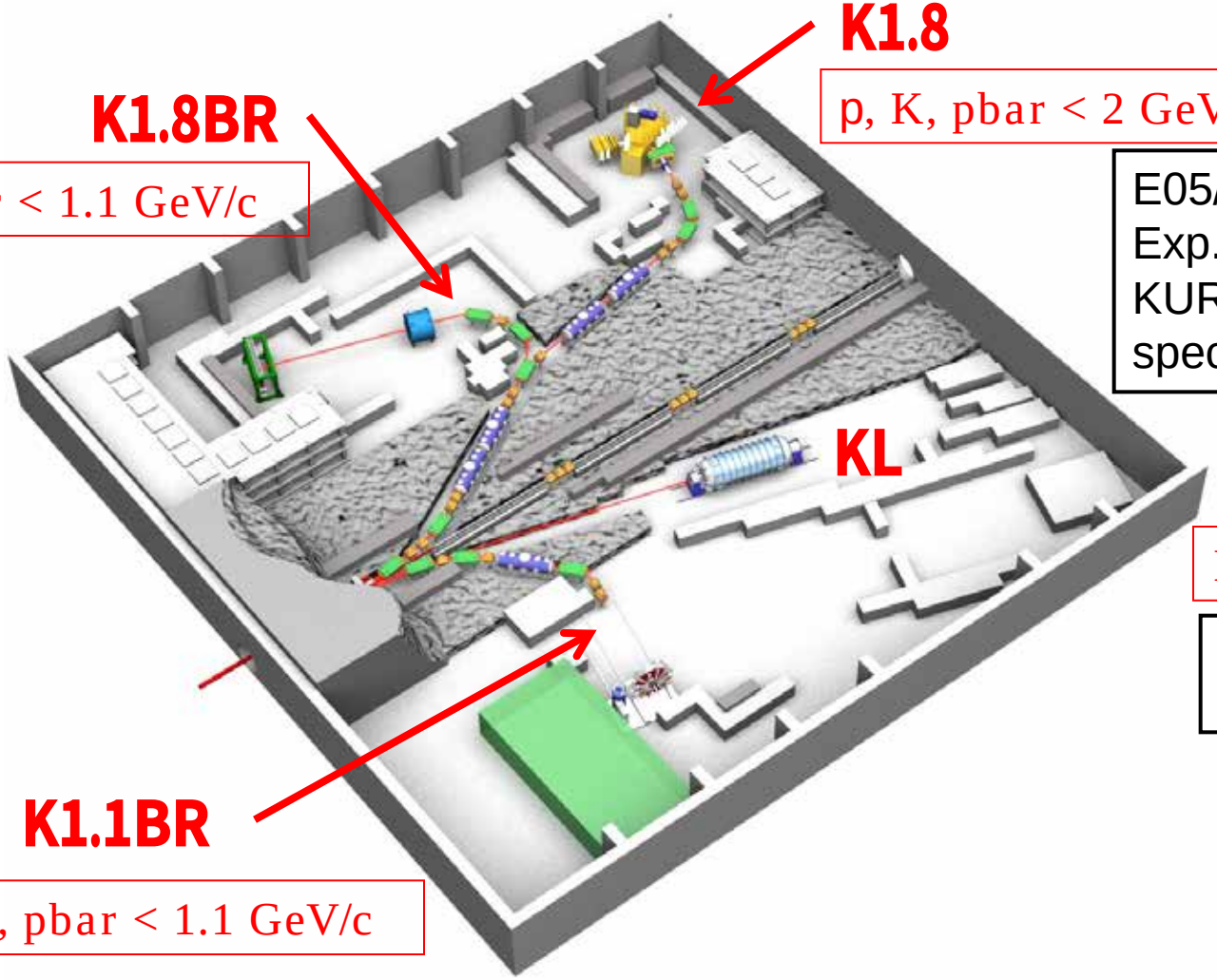
Hadron Experimental Facility (Current Layout)



Current Hadron Hall



K1.8

p, K, pbar < 2 GeV/c

E05/07/10/13/19 /27 Exp. (SKS & KURAMA spectrometers)

K1.8BR

p, K, pbar < 1.1 GeV/c

E15/17 Exp.

KL

Neutral K

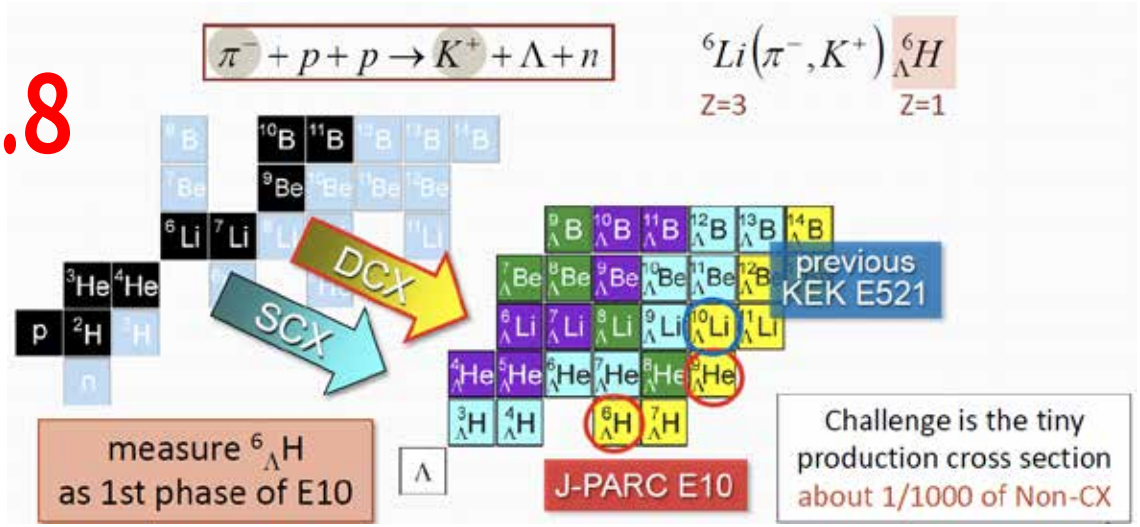
Kaon rare decay: KOTO

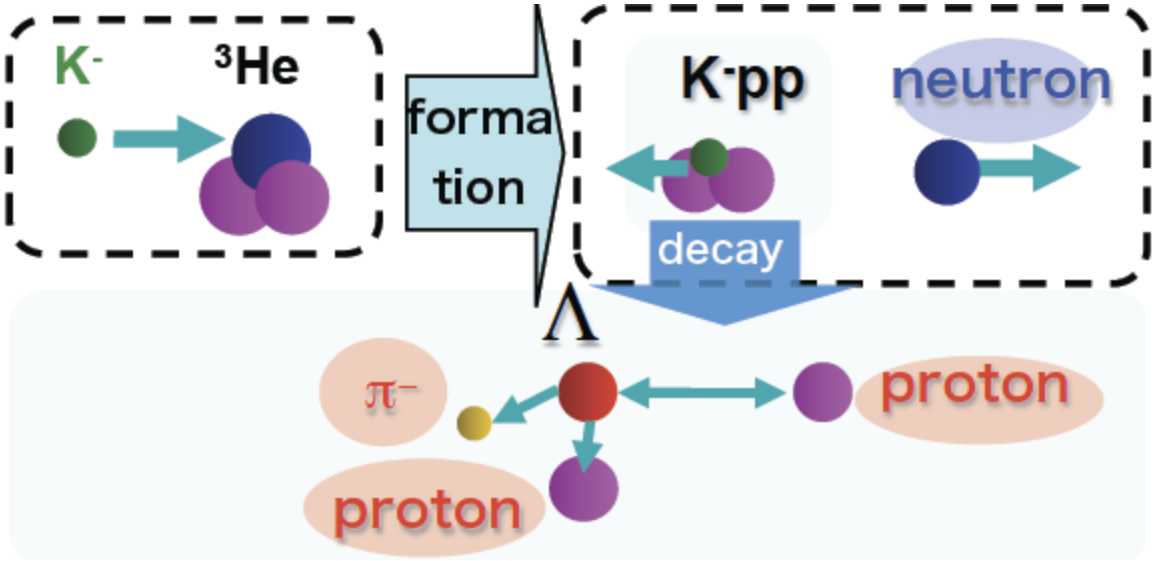
K1.1BR

p, K, pbar < 1.1 GeV/c

Experiments now and in the near future

E10@K1.8



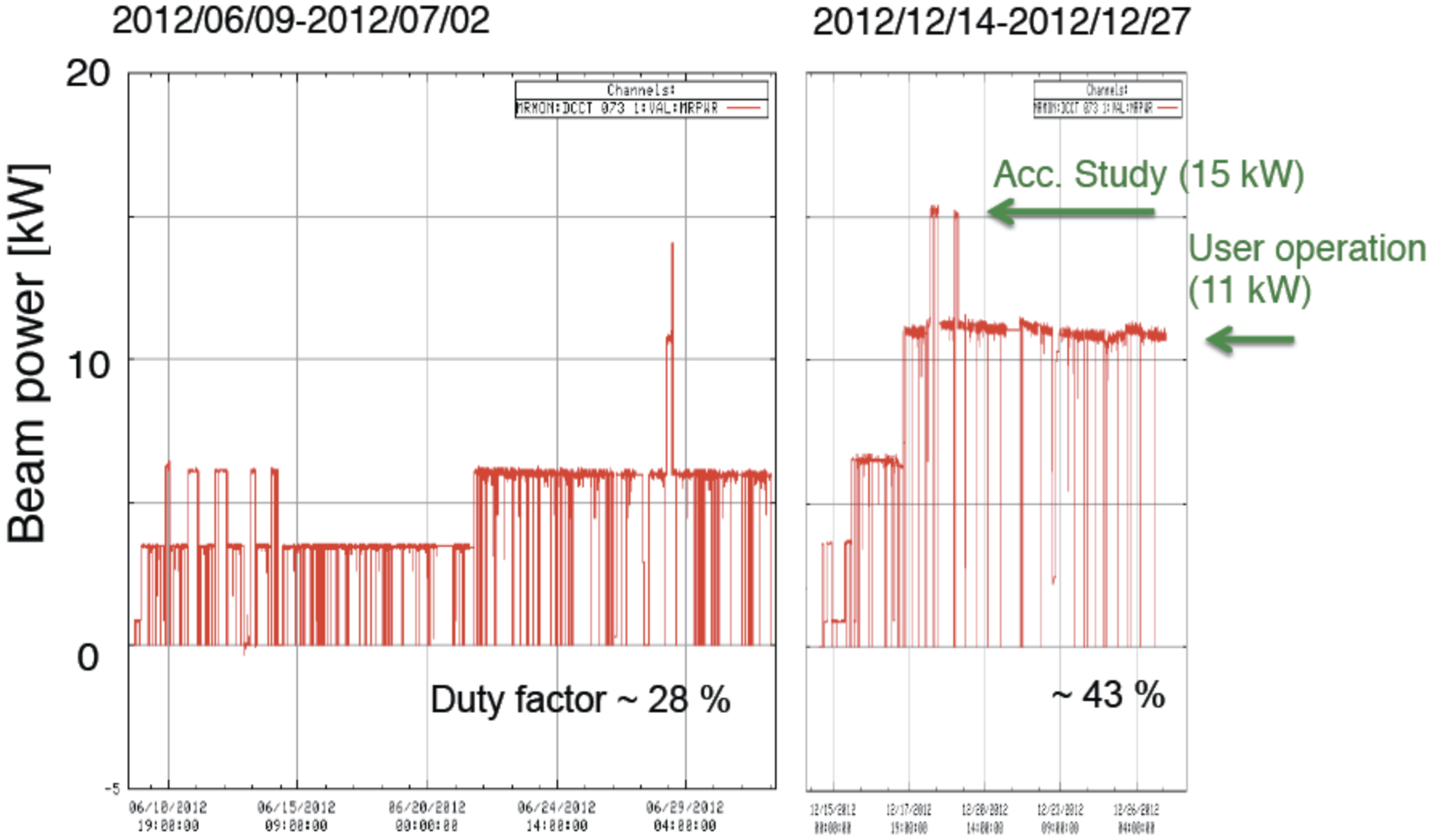


E15@K1.8BR

Beam power of SX operation

T. Koseki

MR cycle time : 6.0 s.



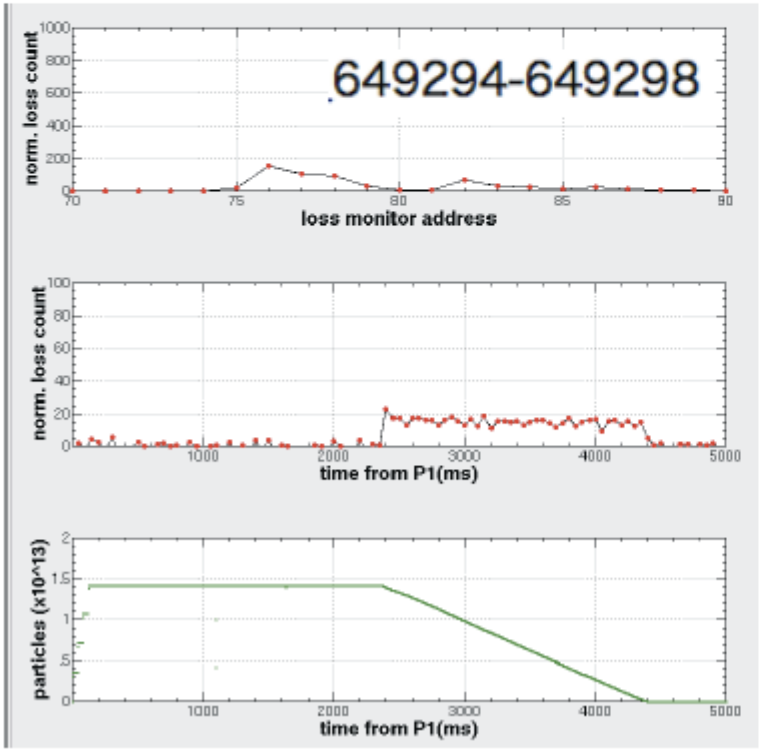
Duty factor was improved by new transverse RF system.

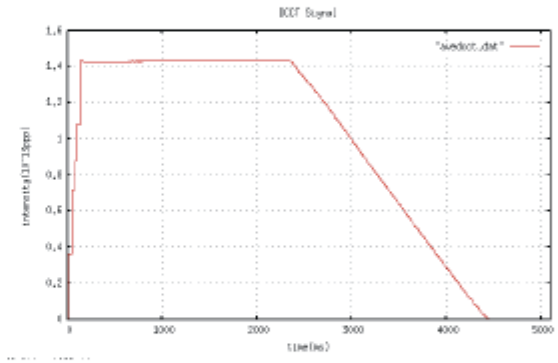
T. Koseki

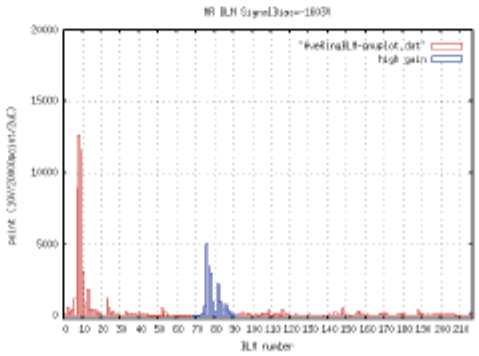
Extraction efficiency for 11kW beam

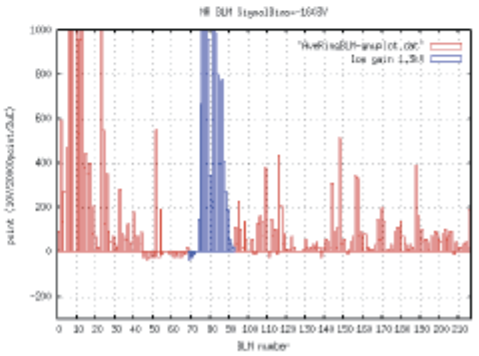
Real Time Dynamic Bump at 11kW beam very well worked

Average extraction efficiency is 99.5% at 11kW Operation





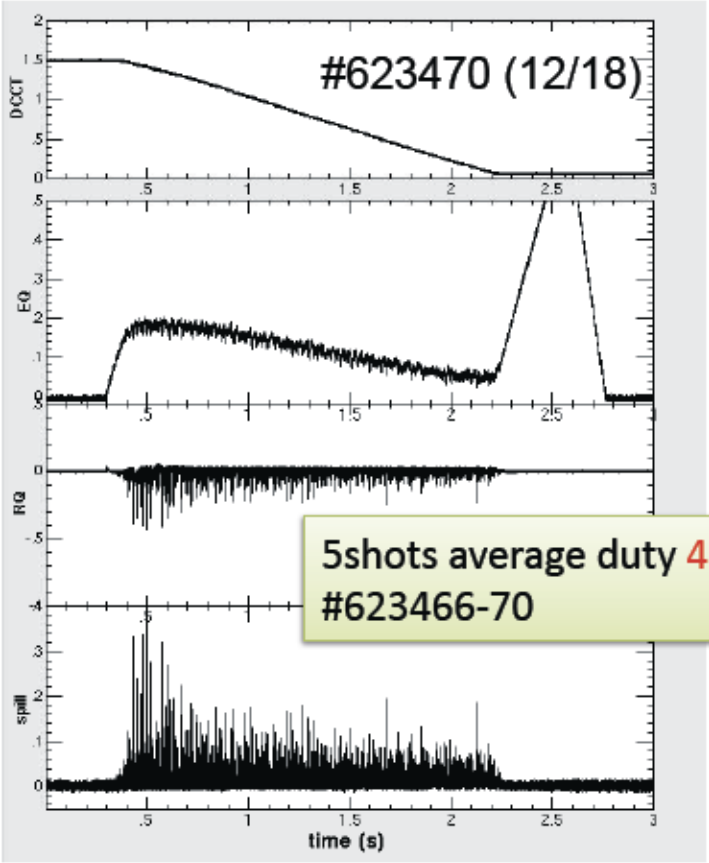




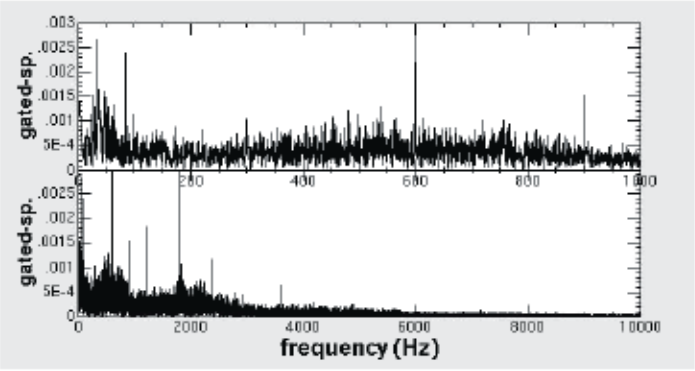
T. Koseki

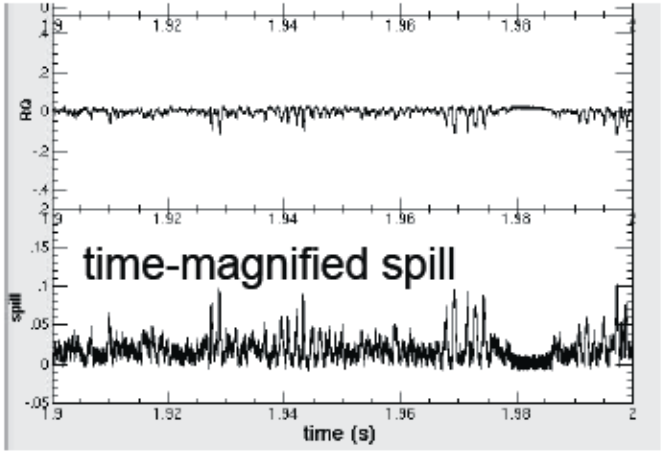
Spill structure of 11 kW beam

Optimized EQ,RQ spill feedback parameters
Transverse RF 3kW/each electrode, 1kHz width from 95.067MHz coil short ON



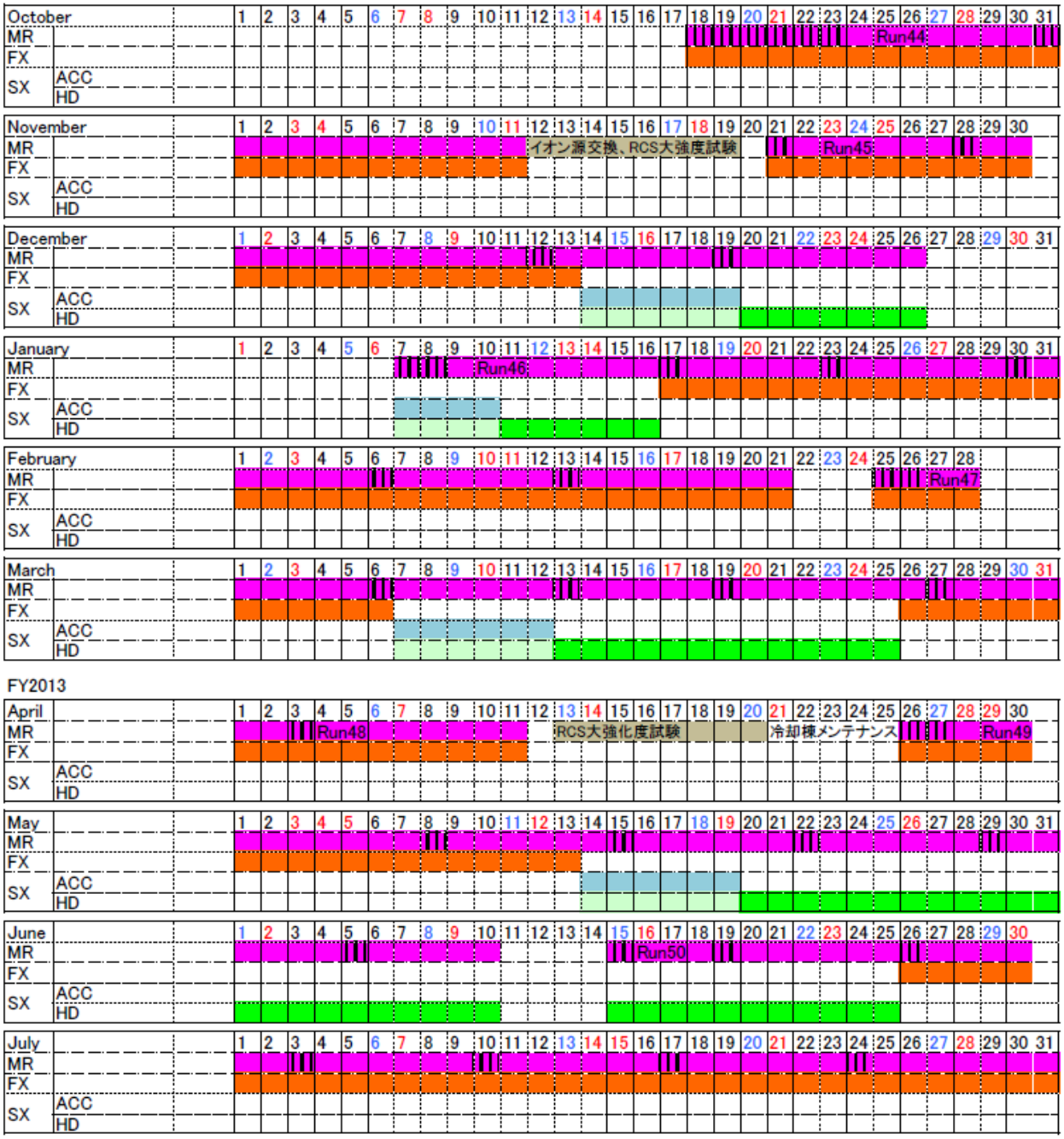
5shots average duty 43%
#623466-70





ver.120905

FY2012



FY2013

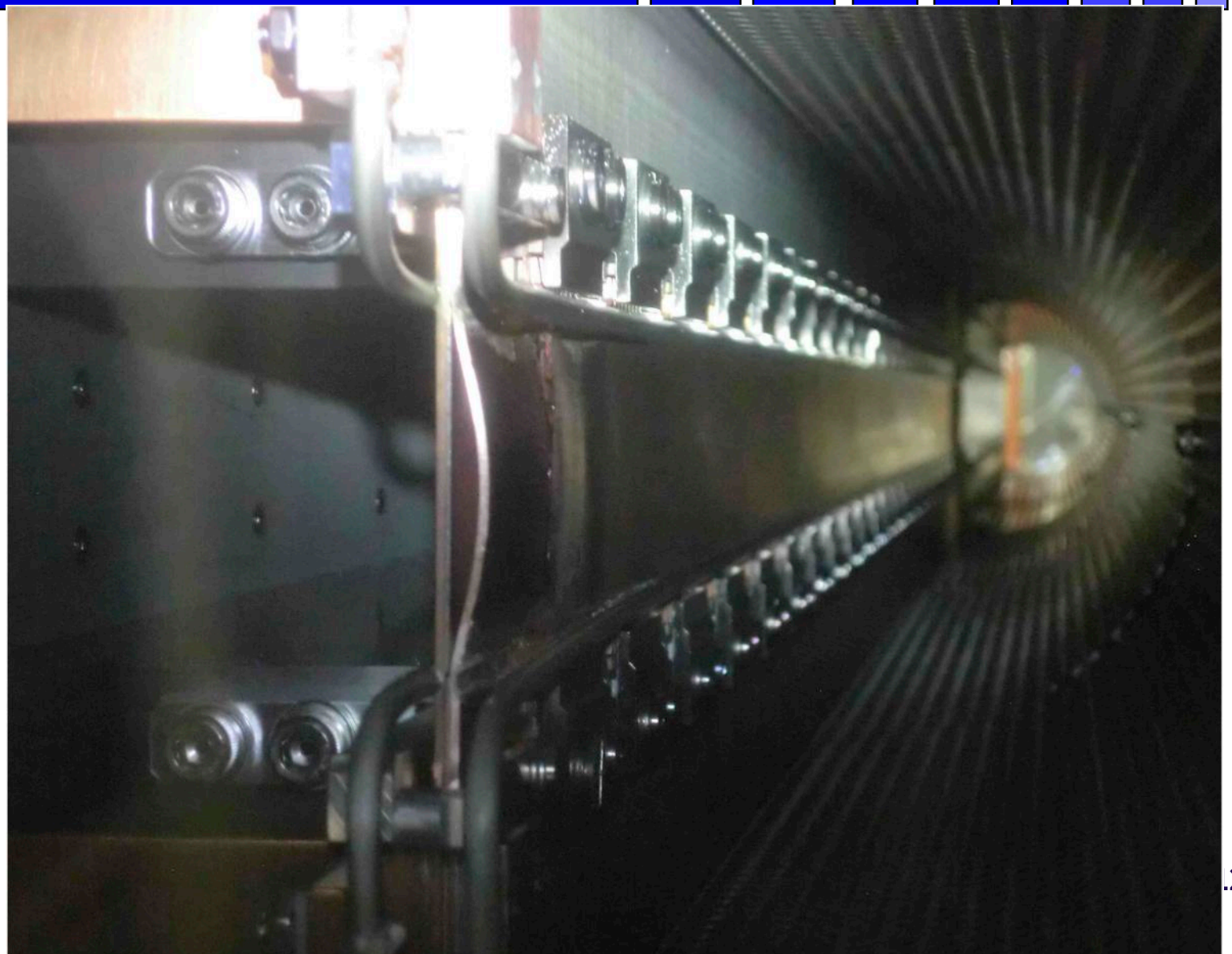
6 à 10kW oper.

15kW oper.

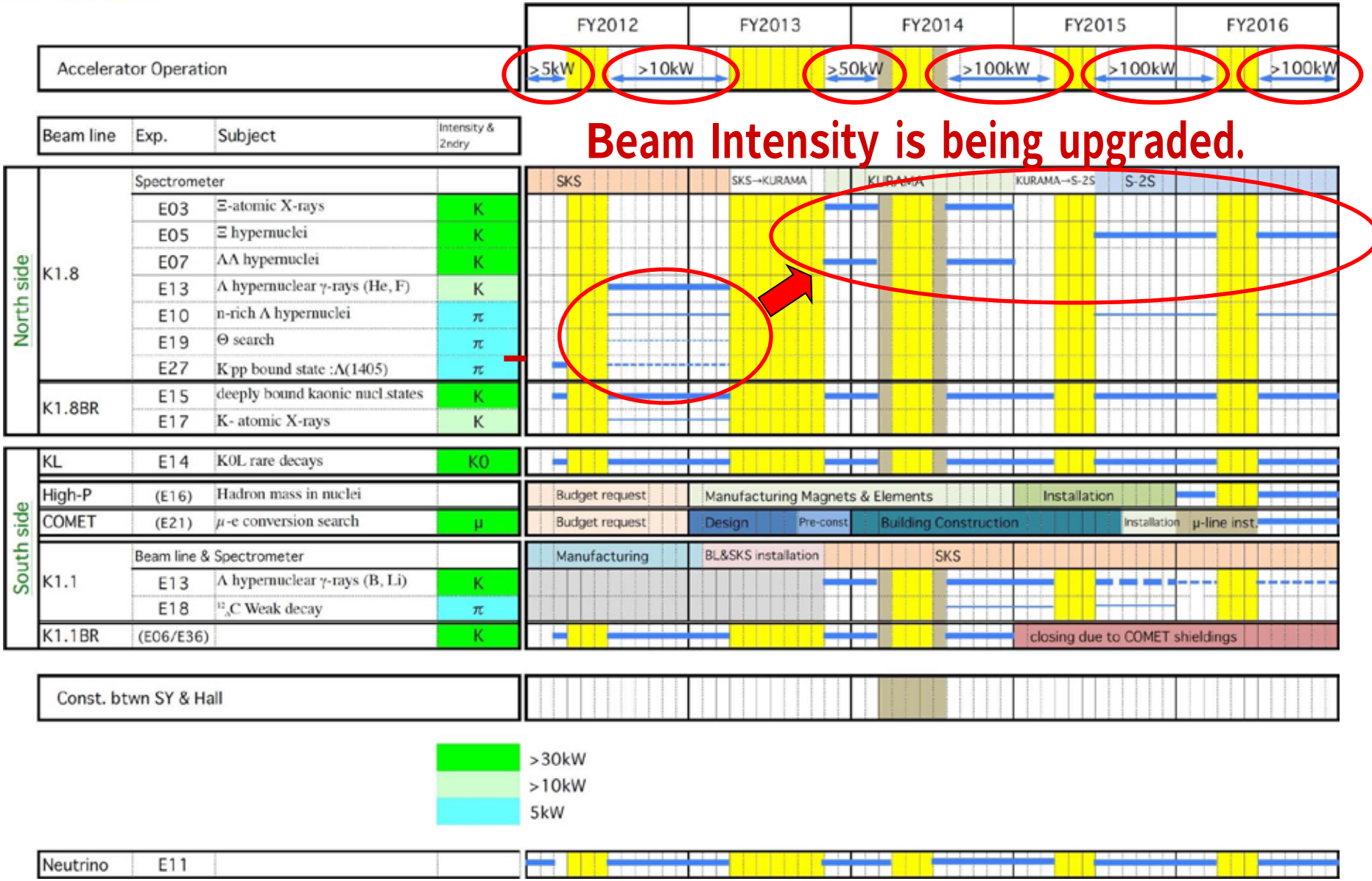
20kW oper.

>20kW oper.

Problem at a septum magnet for slow extraction



Season of Fruits at Hadron Hall Comes!



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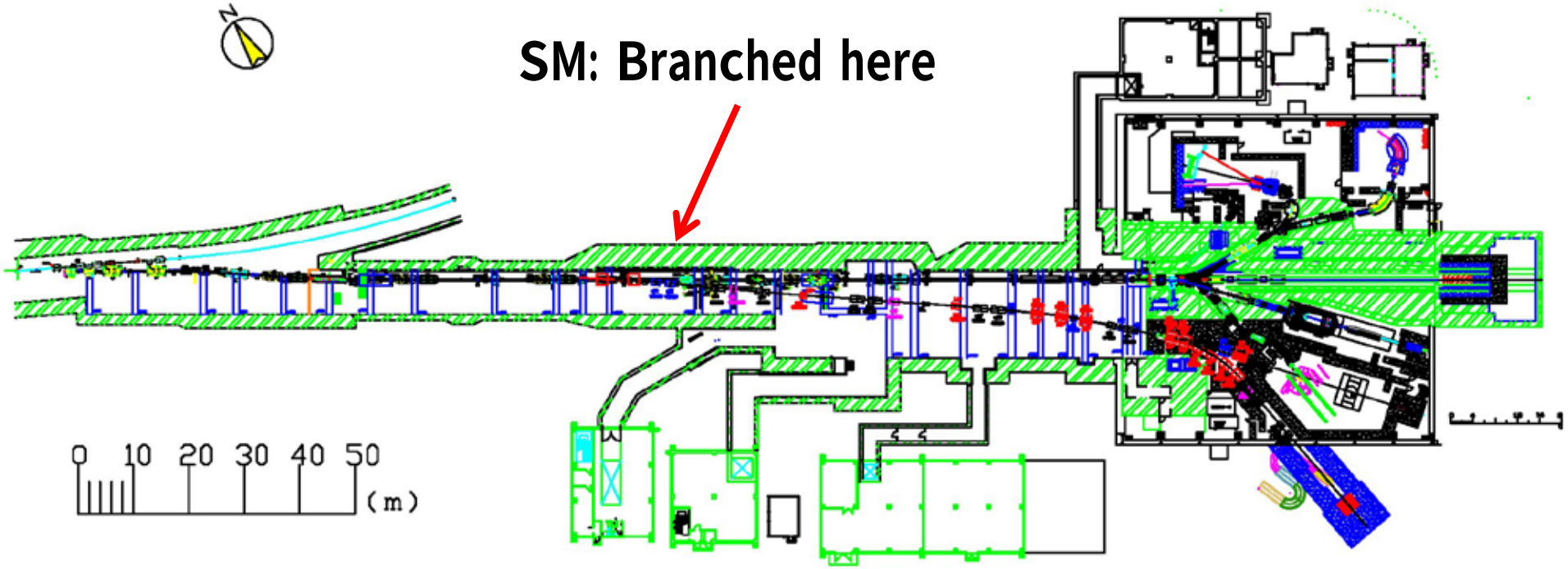
High-p and COMET

- New primary Proton Beam Line
  = High-momentum BL + COMET BL
- Originally 3 years of construction.
- All the construction was approved by the supplementary budget of JFY2012.
  - Total amount = 35-oku Yen ~ USD35M
  - Money has to be spent until the end of JFY2013, with some extreme exceptions.

New Primary Proton Beam Line



High-p and COMET

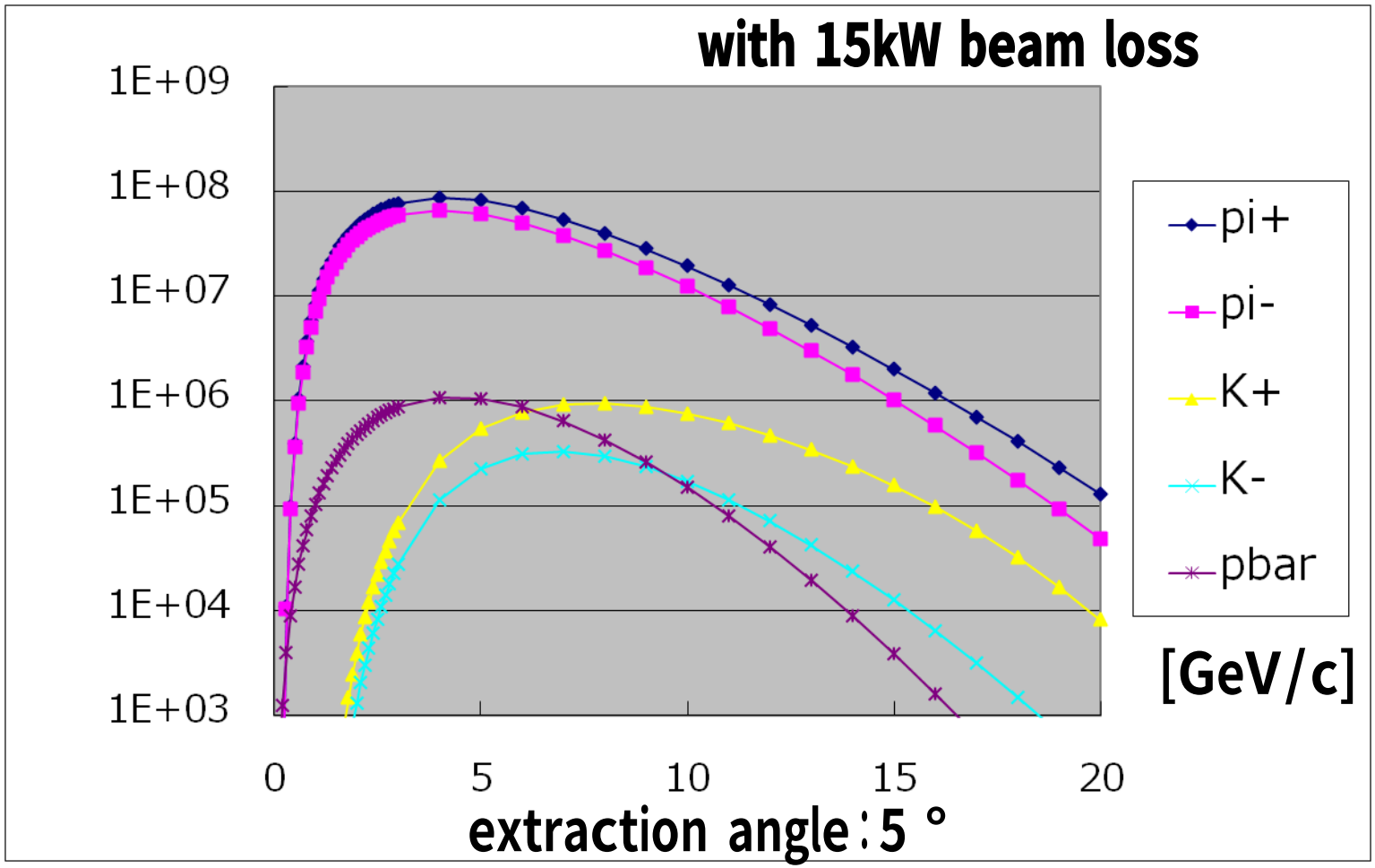
- New primary Proton Beam Line
  = High-momentum BL + COMET BL
- High-momentum Beam Line
  - Primary protons (~10^{10} – 10^{12}pps)
    - E16 (phi meson) is considered to be the first experiment.
  - Unseparated secondary particles (pi, …)
    - High-resolution secondary beam by adding several quadrupole and sextupole magnets.
- COMET
  - 8 GeV, 50 kW protons
  - Branch from the high-momentum BL
  - Annex will be built at the south side.

Available beam on high-p beam line

primary beam	30GeV	10^{10}/s	E16
		10^{12}/s	P04 etc.
	8GeV	10^{14}/s	COMET
secondary beam	<30GeV		Hadron physics

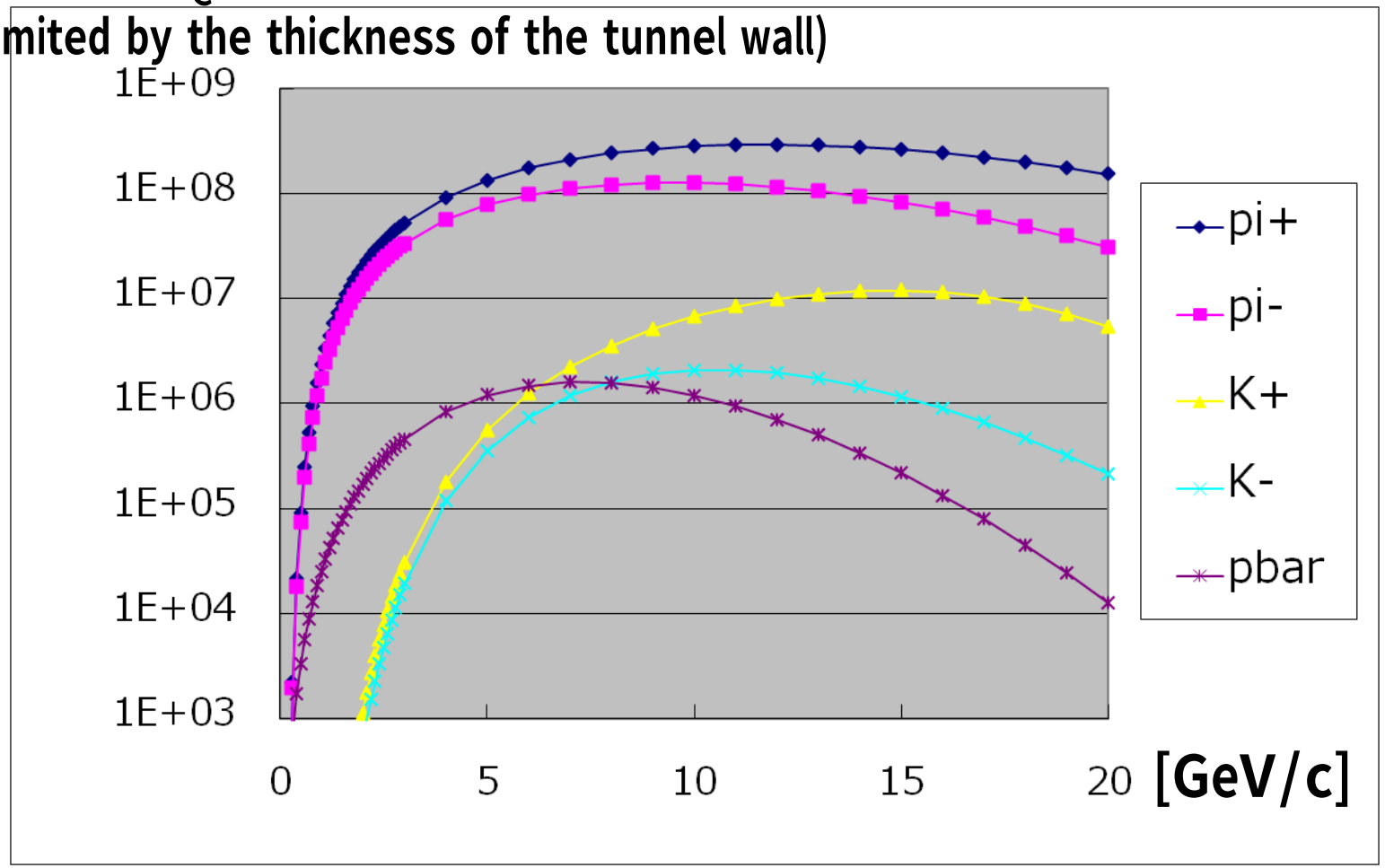
Unseparated Secondary Beam Intensity

beam loss limit @ SM1:15kW
(limited by the thickness of the tunnel wall)



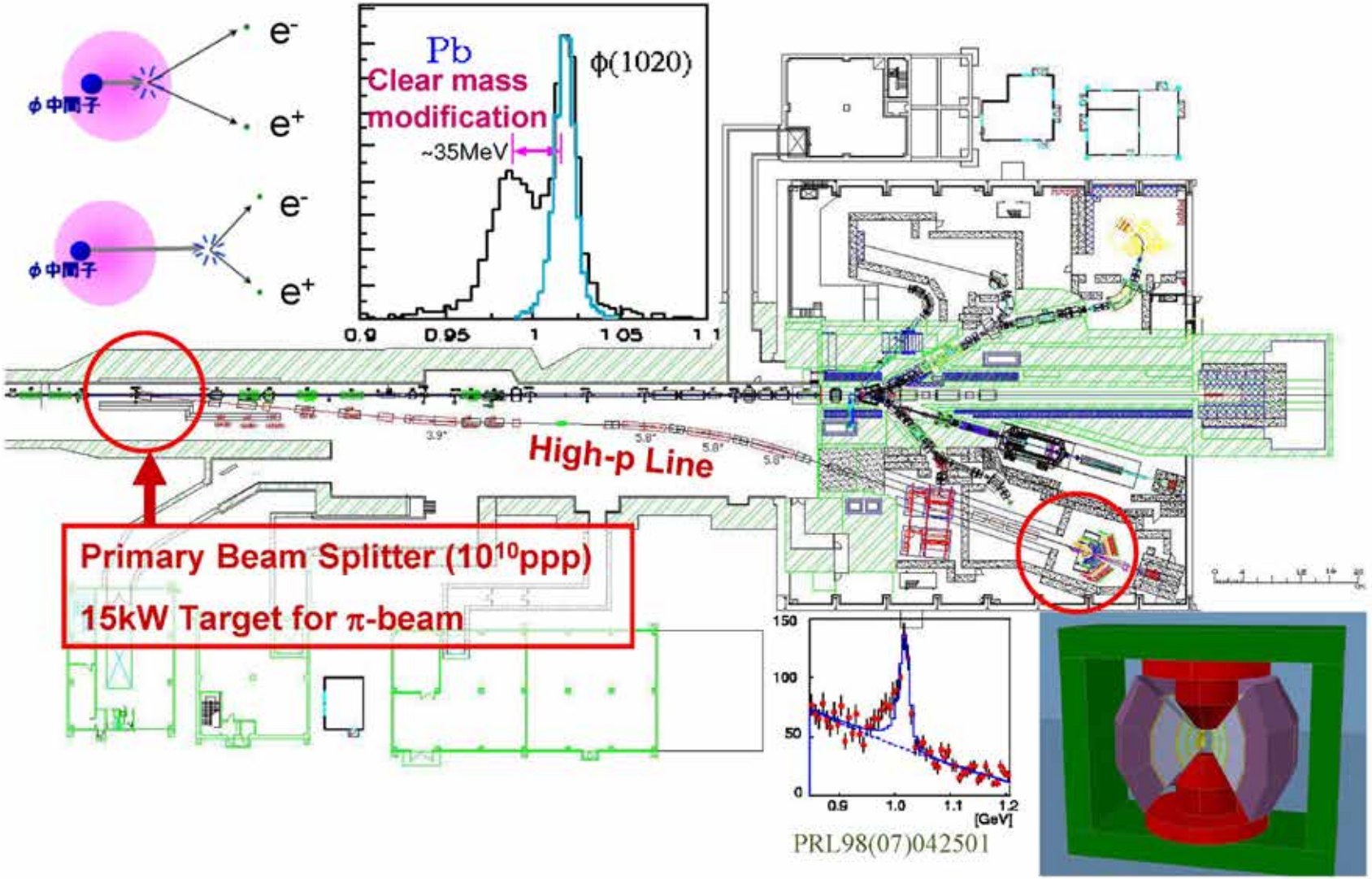
Secondary Beam Intensity

beam loss limit @ SM1:15kW
(limited by the thickness of the tunnel wall)



extraction angle：0 °

High-p Line and E16 Spectrometer

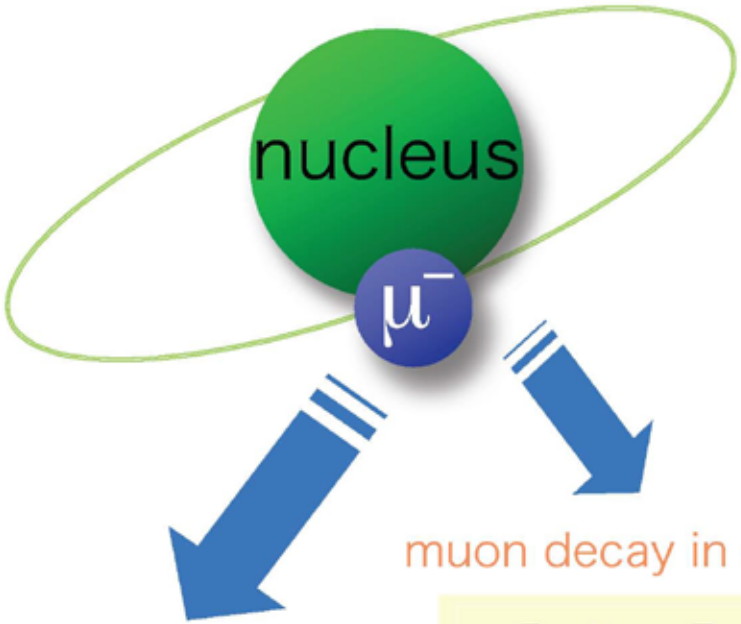


PRL98(07)042501

Mihara at PAC in March, 2012.

What is mu-e Conversion ?

1s state in a muonic atom



muon decay in orbit

$$\mu^- \rightarrow e^- \nu \bar{\nu}$$

nuclear muon capture

$$\mu^- + (A,Z) \rightarrow \nu_\mu + (A,Z-1)$$

Neutrino-less muon nuclear capture (= μ-e conversion)

$$\mu^- + (A,Z) \rightarrow e^- + (A,Z)$$

lepton flavours changes by one unit

- $E_{\mu e} \sim m_\mu - B_\mu$
  - B_μ: binding energy of the 1s muonic atom

$$B(\mu^- N \rightarrow e^- N) = \frac{\Gamma(\mu^- N \rightarrow e^- N)}{\Gamma_{(\mu^- N \rightarrow \nu N')}}$$

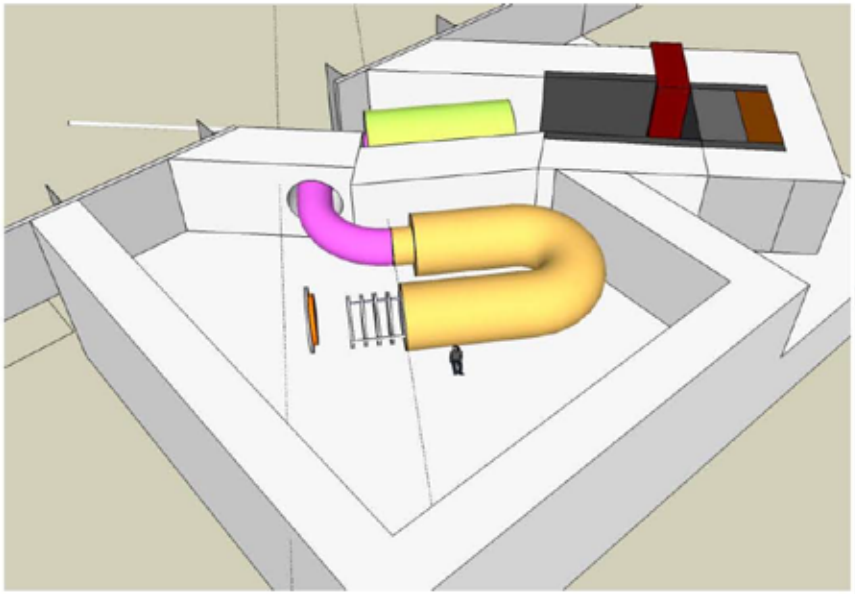
Mihara at PAC in March, 2012.

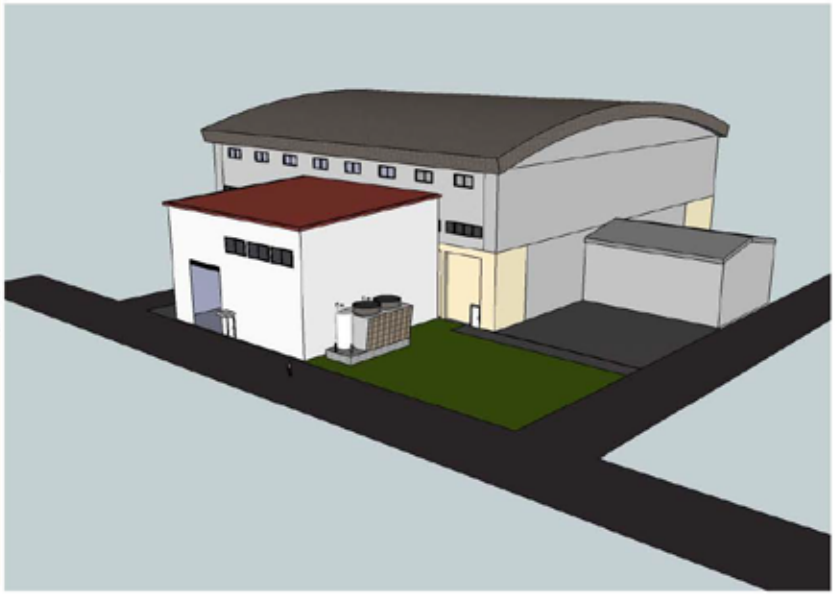
COMET Phase-I Goal

- As an intermediate goal of the COMET experiment
  - gain experience to reach the final goal
- 7×10^{-15} sensitivity (90% C.L.)
  - better than the current limit by SINDRUM-II (7×10^{-13}) and compatible to MEG sensitivity
- Involve more collaborators

Extension of the hall

- COMET target and beam dump should be located outside the hall to keep enough space for COMET experiment.
- Hall will have an Annex at the south side.

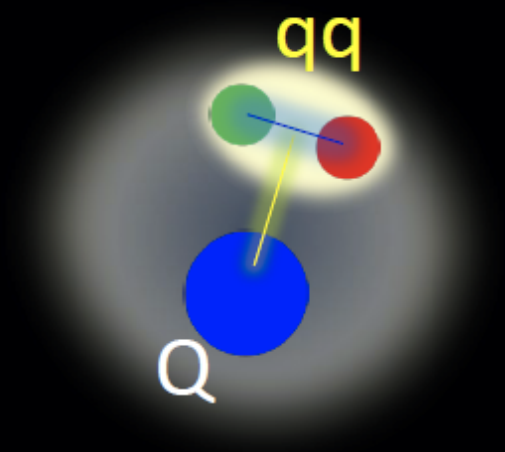




Charmed Baryon Spectroscopy via the (π, D^{*-}) reactions

H. Noumi
Research Center for Nuclear Physics
Osaka University
for the P50 collaboration

Charmed Baryon



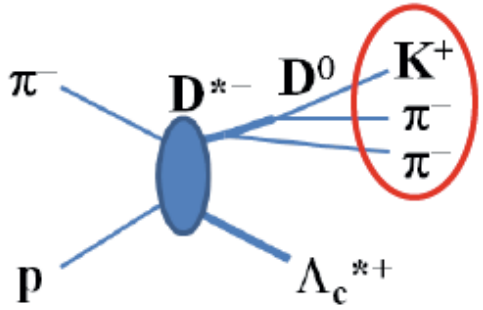
$V_{CMI} \sim [\alpha_s/(m_i m_j)]^*(\lambda_i,\lambda_j)(\sigma_i,\sigma_j)$

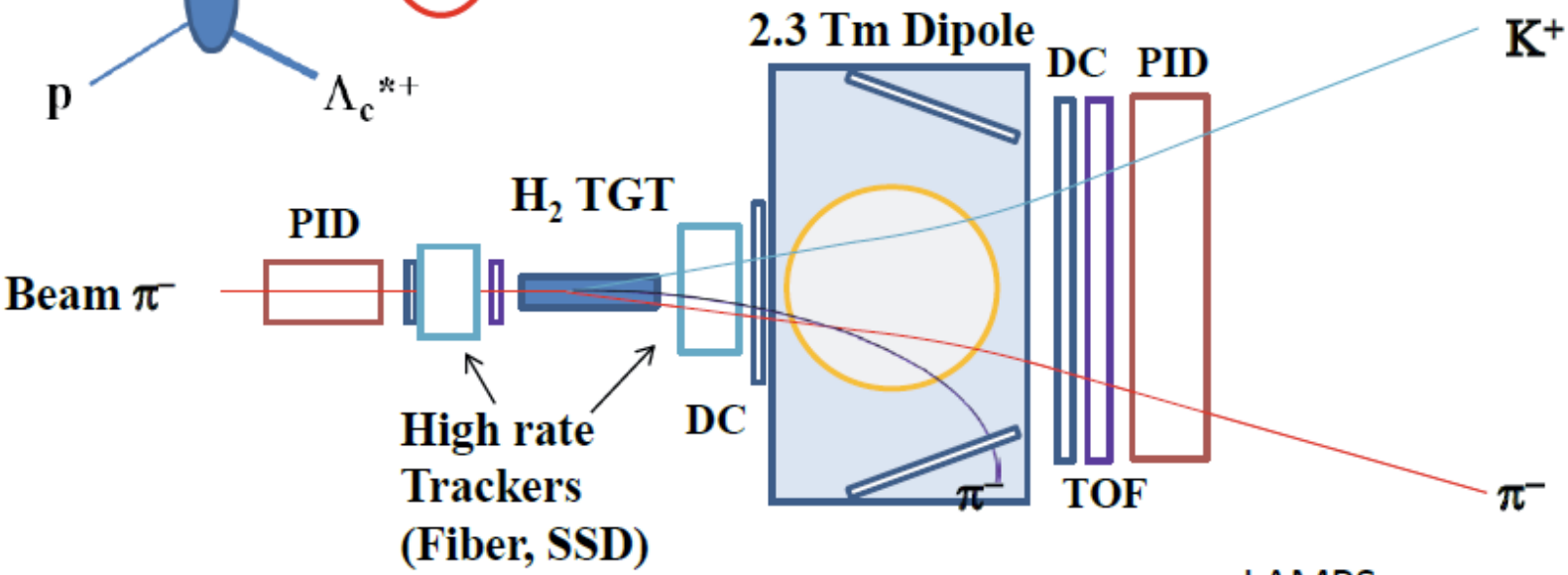
Weak CMI with a heavy Quark

- [qq] is well Isolated and developed

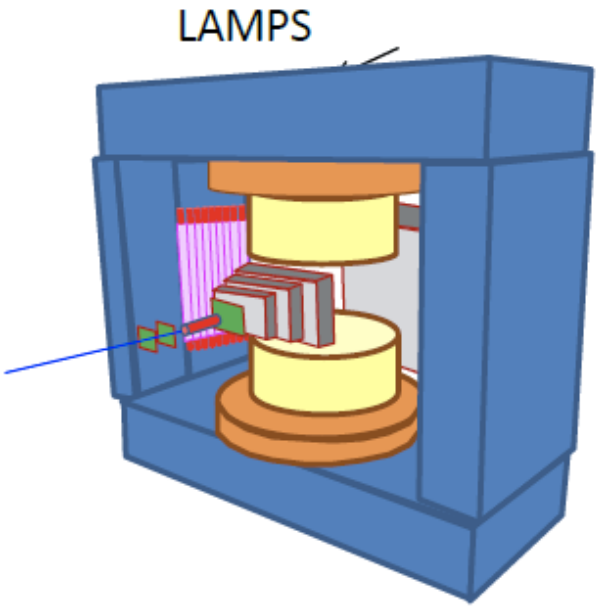
- Level structure of Y_c^* provides diquark properties
  - "diquark mass"

Spectrometer Concept





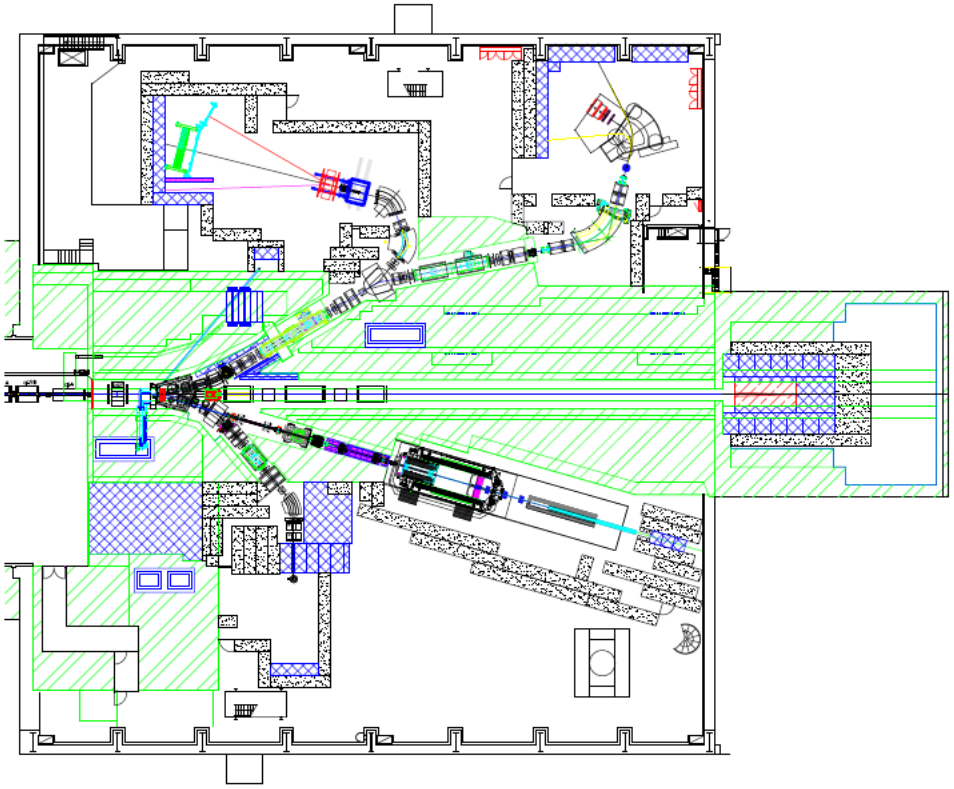
- Large Acceptance, Multi-Particle
  - *K*, π from D^0 decays
  - Soft π from D^{*-} decays
  - (Decay products from Y_c^*)
- High Resolution
- High Rate
  - SFT/SSD op. >10M/spill at K1.8



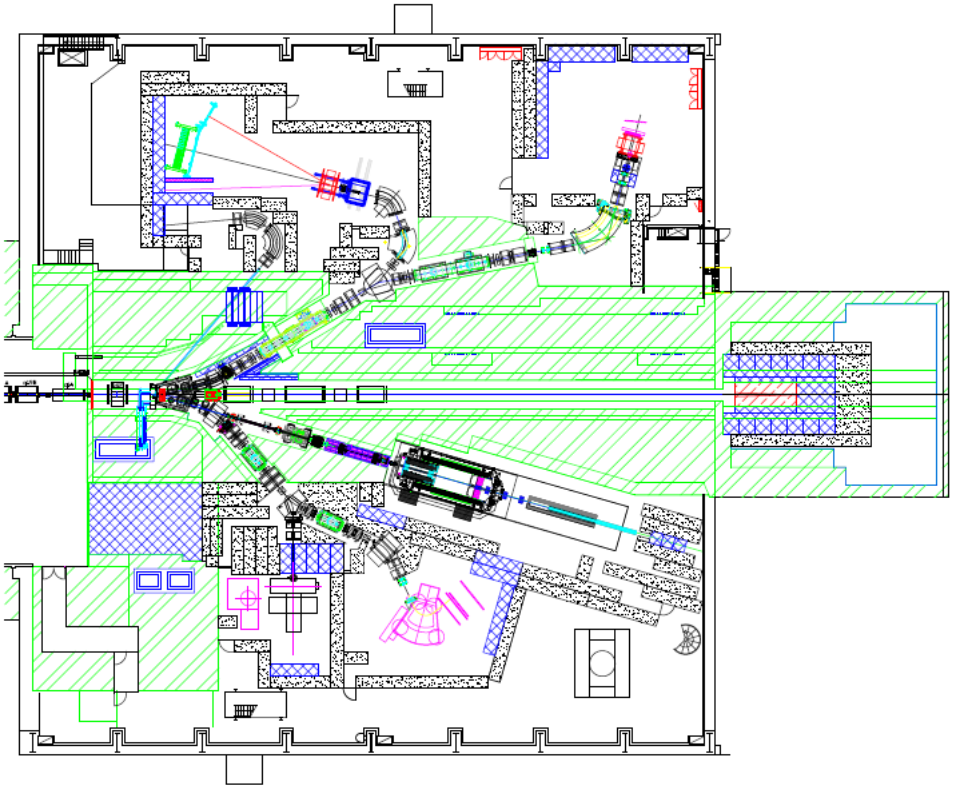
Schedule

	FY2013	FY2014	FY2015
Manufacturing Magnets, Power Supply, etc.			
Civil construction (utility building) and utilities (electricity and cooling water (PW1))			
Installing Magnets, Power Supply, etc.			
Commissioning			

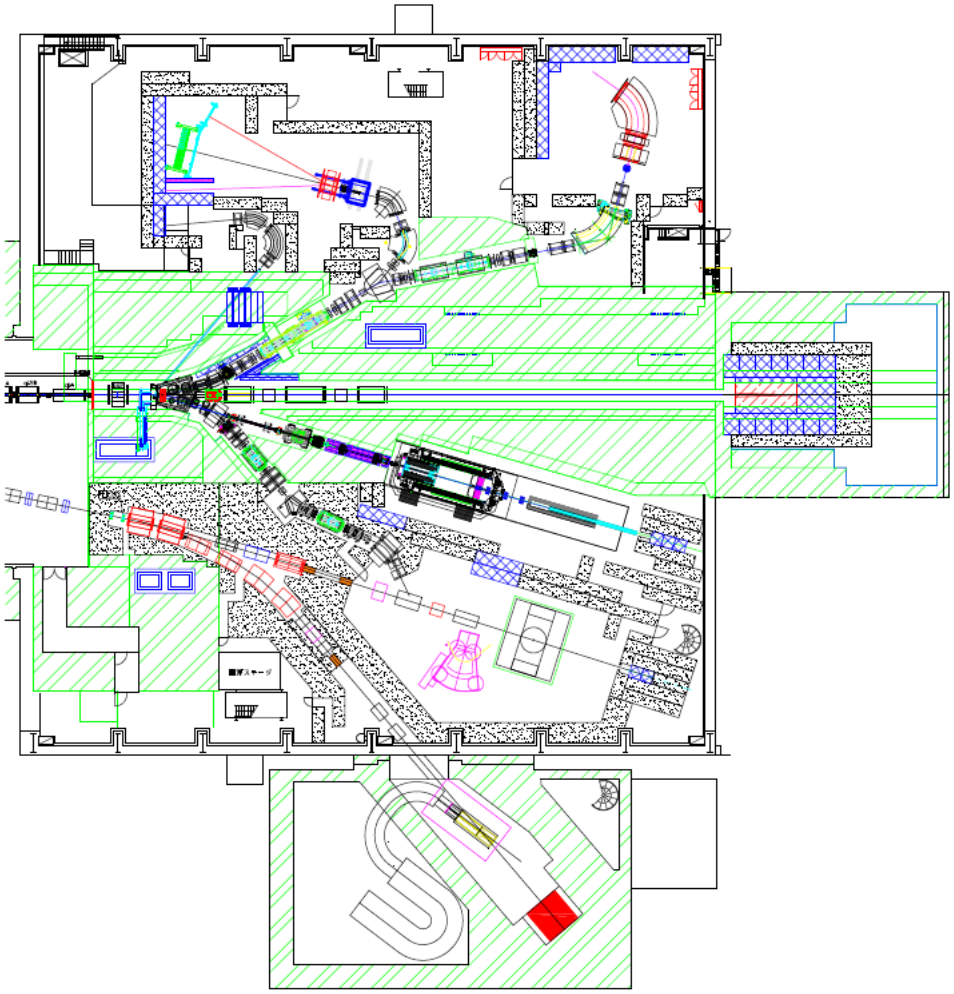
Hadron Hall in Coming Years: Present



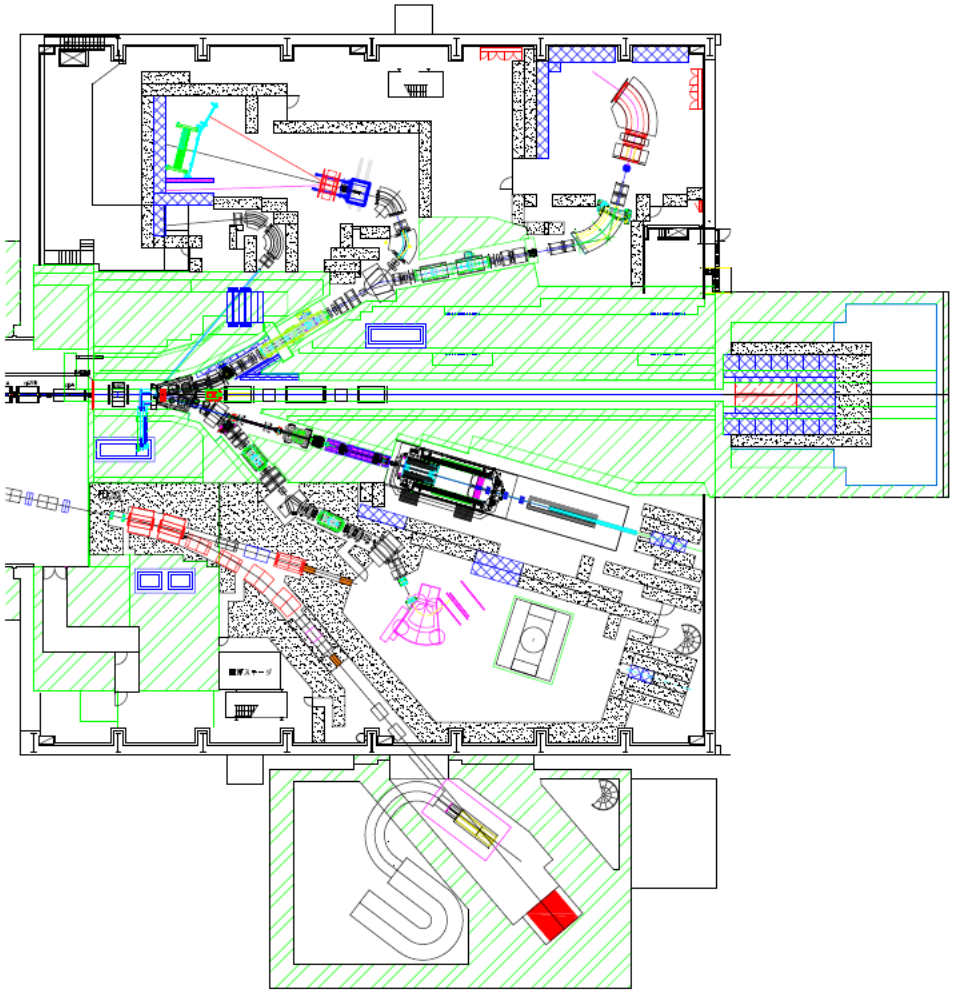
Hadron Hall in Coming Years: 2014-



Hadron Hall in Coming Years: 2016-



Hadron Hall in Coming Years: ?-



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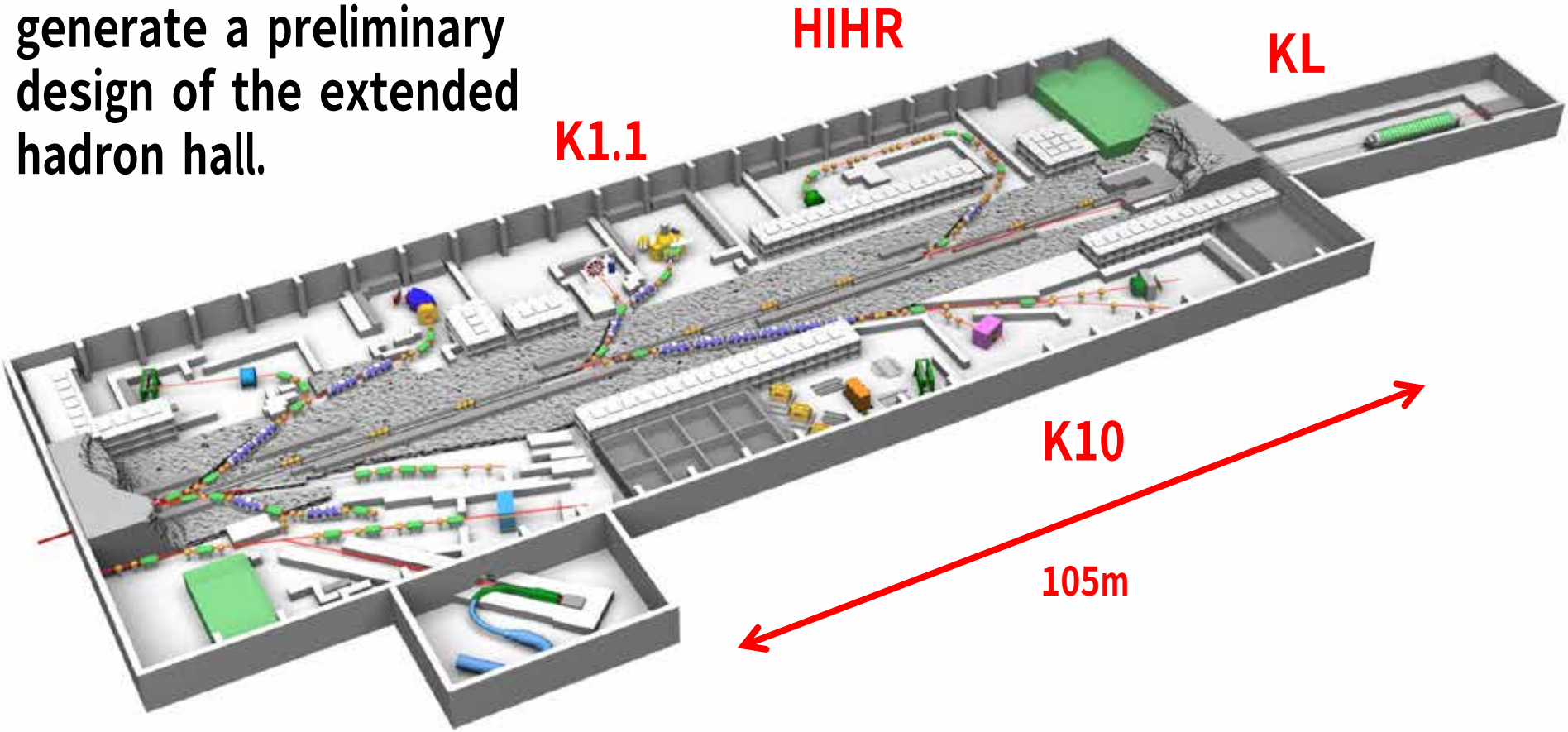
Extended Hadron Hall

A task force has worked to generate a preliminary design of the extended hadron hall.



Beam Lines at the Extended HH

Beam Lines and Major Physics Cases under discussion

- K10
  - High-momentum separated beams up to 6 (with electro-static separators) or to 10 (with RF separators) GeV/c.
  - Physics with kaons and antiprotons are under discusstion.
- HIHR
  - High-intensity and high-resolution beams up to 2 GeV/c.
  - One stage separator à presumably pions are used.
  - High resolution spectroscopy of S=-1 hyper nuclei.
- K1.1
  - Moved from the existing hall.
  - A lot of physics cases remaining.
- KL
  - Neutral kaon beam line with 5deg angle to the primary beam.
  - Essential to the step-2 KOTO experiment.

Summary

- Physics experiments have started at the Hadron Hall of J-PARC, and the first physics paper was published from the E19 experiment. More to come soon.
- The funding for the high-momentum beam line with COMET has been approved by the government!
- The extension of the Hadron Hall is the next step. A working group discusses physics cases and beam lines.
- Let's discuss to generate good physics cases!