Hadron Beam Subgroup 2006

- 9 Physicists + 6 Engineers
- We got 2 New members in 2007.

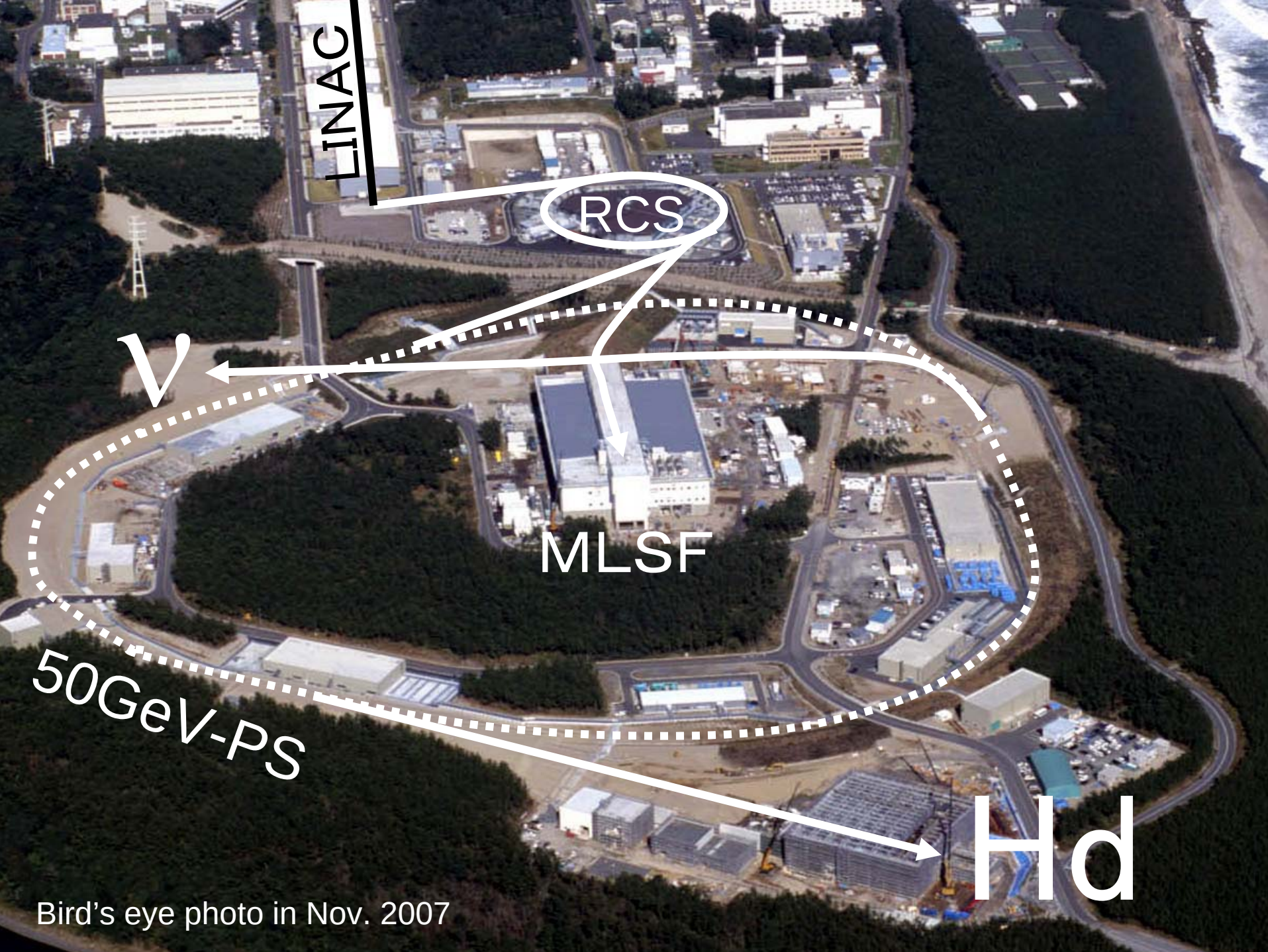
We need more!!

Hadron Facility of J-PARC

At NP@J-PARC/June 1st 2008

Kazuhiro Tanaka for

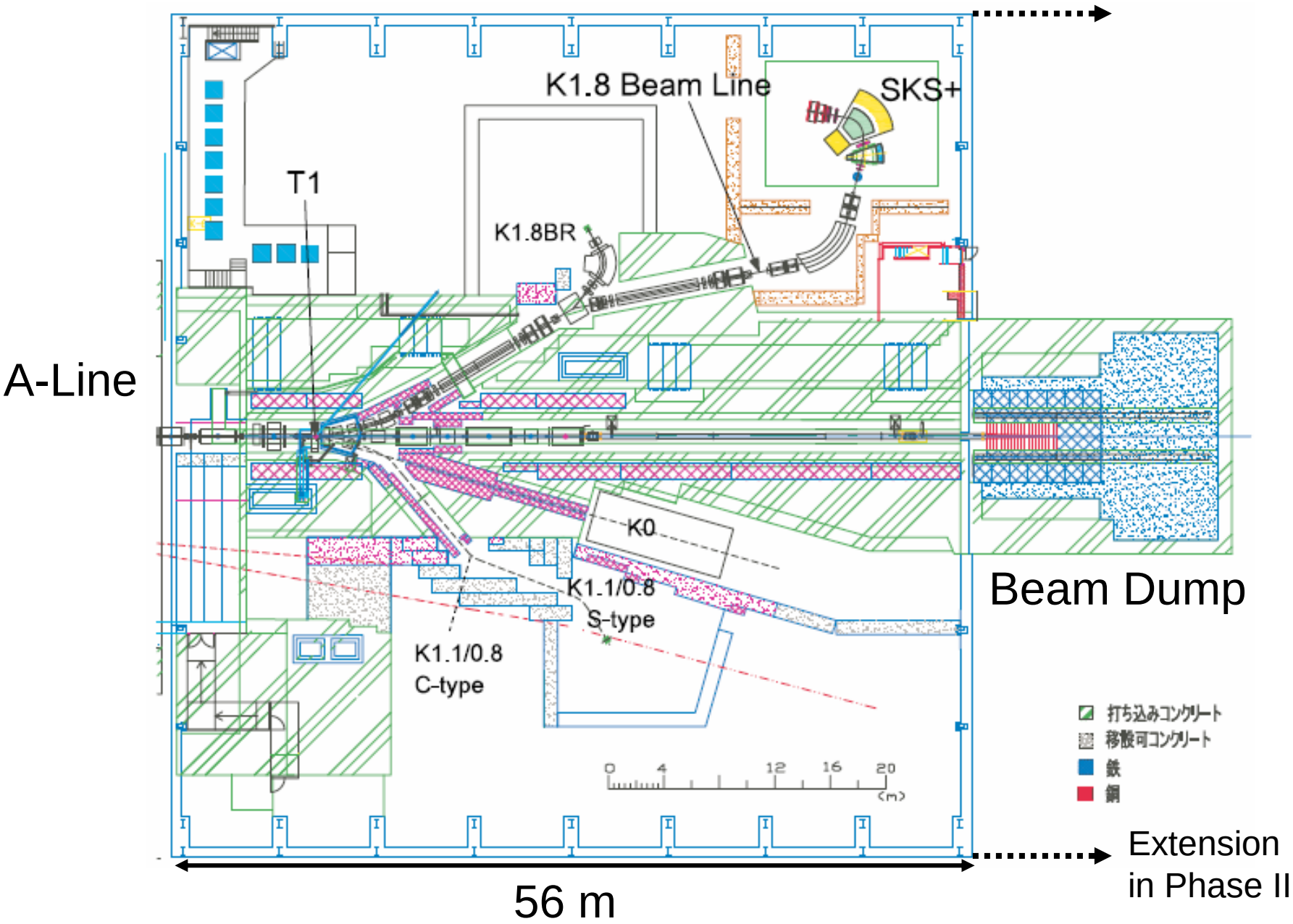
Hadron Facility Construction Team



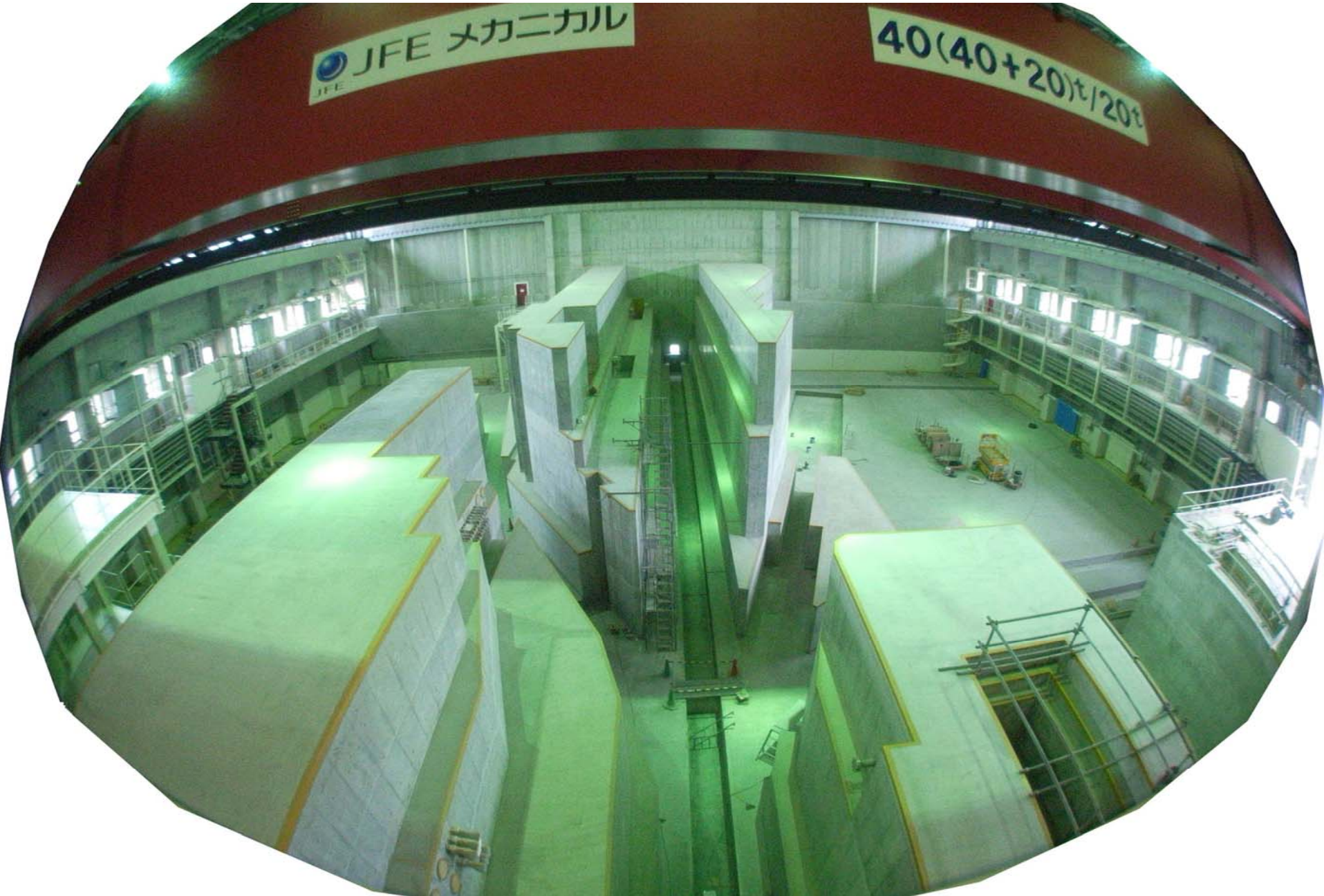
Bird's eye photo in Nov. 2007

Hadron Facility in May 2008

Hadron Experimental Hall (Phase I)

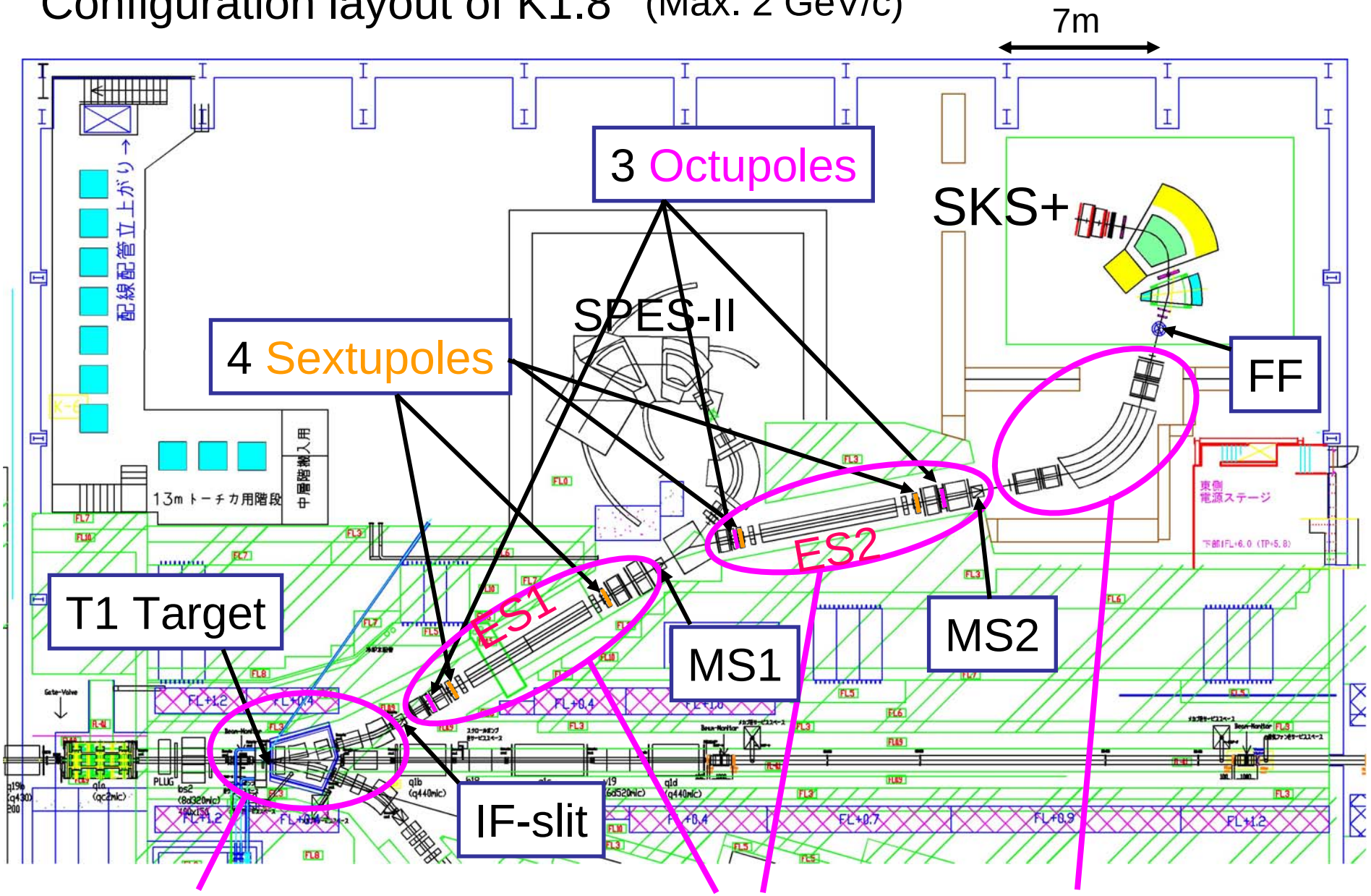


Hadron Facility in May 2008

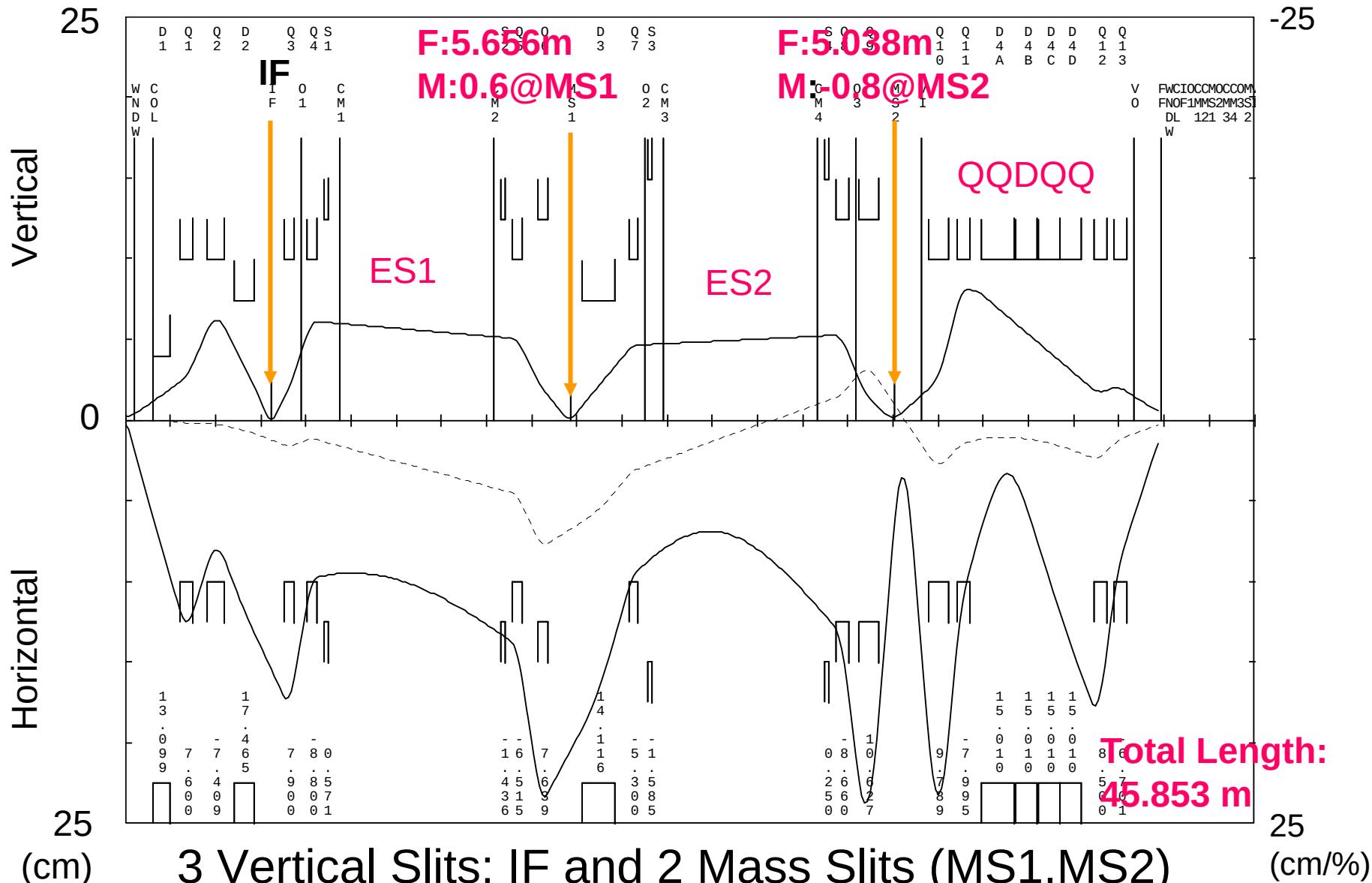


Hadron Facility in May 2008

Configuration layout of K1.8 (Max. 2 GeV/c)



K1.8 Beam Line Optics (Beam envelope to the 1st Order)



3 Vertical Slits: IF and 2 Mass Slits (MS1,MS2)
to purify kaon beam with 2 Electrostatic Separators

Beam Analyzer

For Ξ hypernuclear Spectroscopy by (K^-,K^+) [E05]

ΔE~3 MeV (FWHM) together w/ SKS+

VO → VI (Point to Point Optics)

1st Order Resolution :

R11=-0.44, R12=0, R16=1.57 cm/%

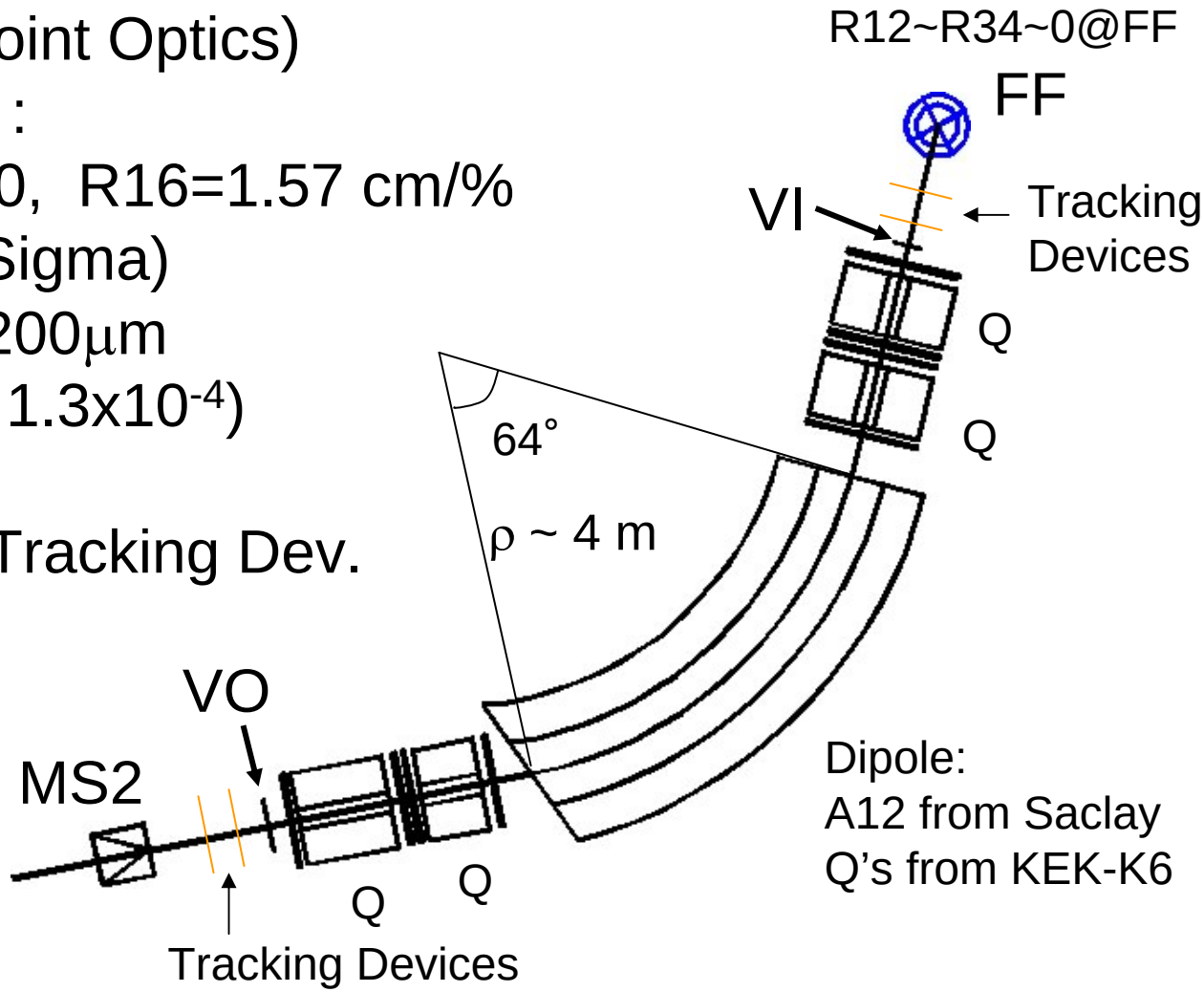
dp/p~1.4×10^{-4} (in Sigma)

assuming σ_x~200μm

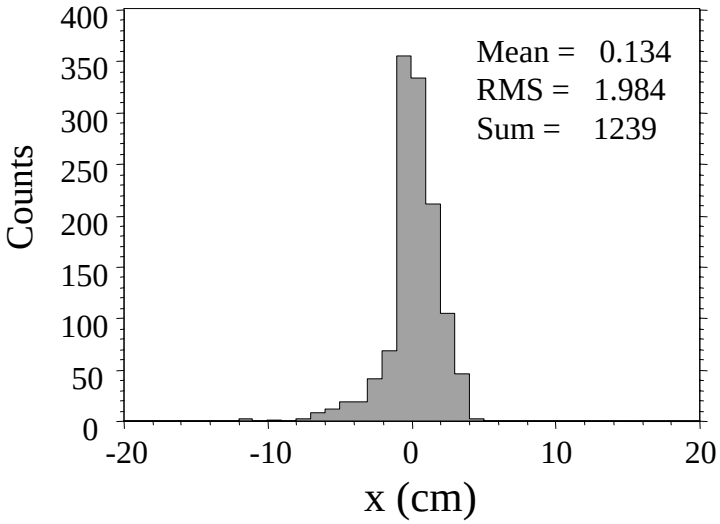
(c.f. in case of K6: 1.3×10^{-4})

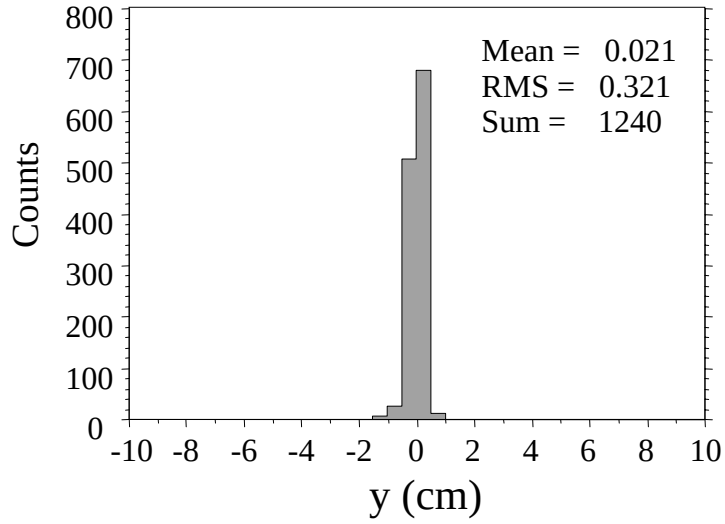
→h.o. correction:

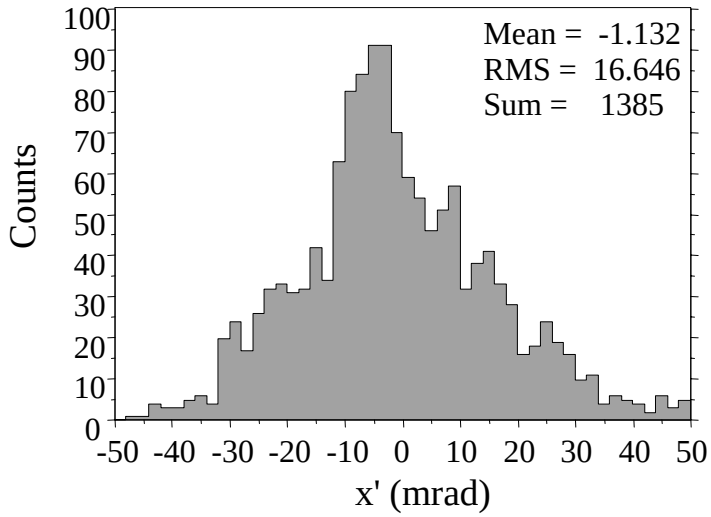
orbit analysis w/ Tracking Dev.

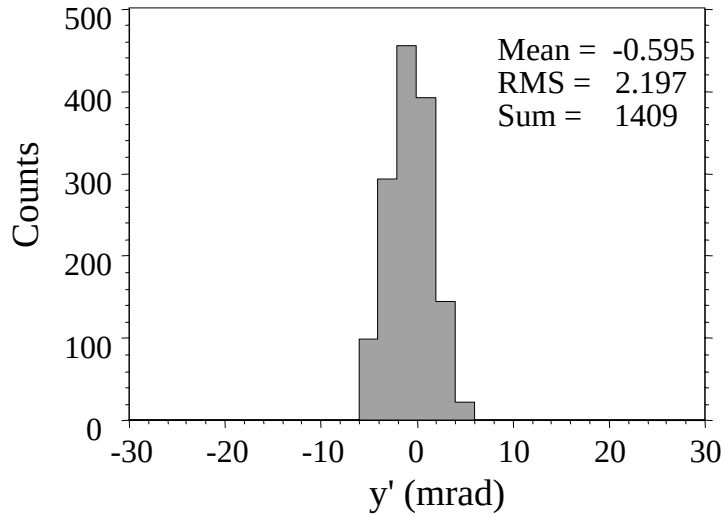


Kaon Beam Profile at FF of K1.8









K1.8 Performance Summary

051011

	K1.8 (50 GeV-15μA)	(30 GeV-9μA)
Max. Mom. (GeV/c)	2	
Length (m)	45.853	
Acceptance (msr.%)	1.4	
$K^-(\pi)$ Intensity (ppp)#		
1.8 GeV/c	6.6E+06	1.4E+06
1.5 GeV/c	2.7E+06	0.54E+06
1.1 GeV/c	0.38E+06	0.08E+06
Electro-static Separator	750kV/10cm 6m×2	
Single Rate @ MS2 @ 1.8 GeV/c$	＞33E+06	＞8E+06
K^-/π^- @ FF @ 1.8 GeV/c	8	6.9
X/Y(rms) size @ FF (mm)	19.8/3.2	

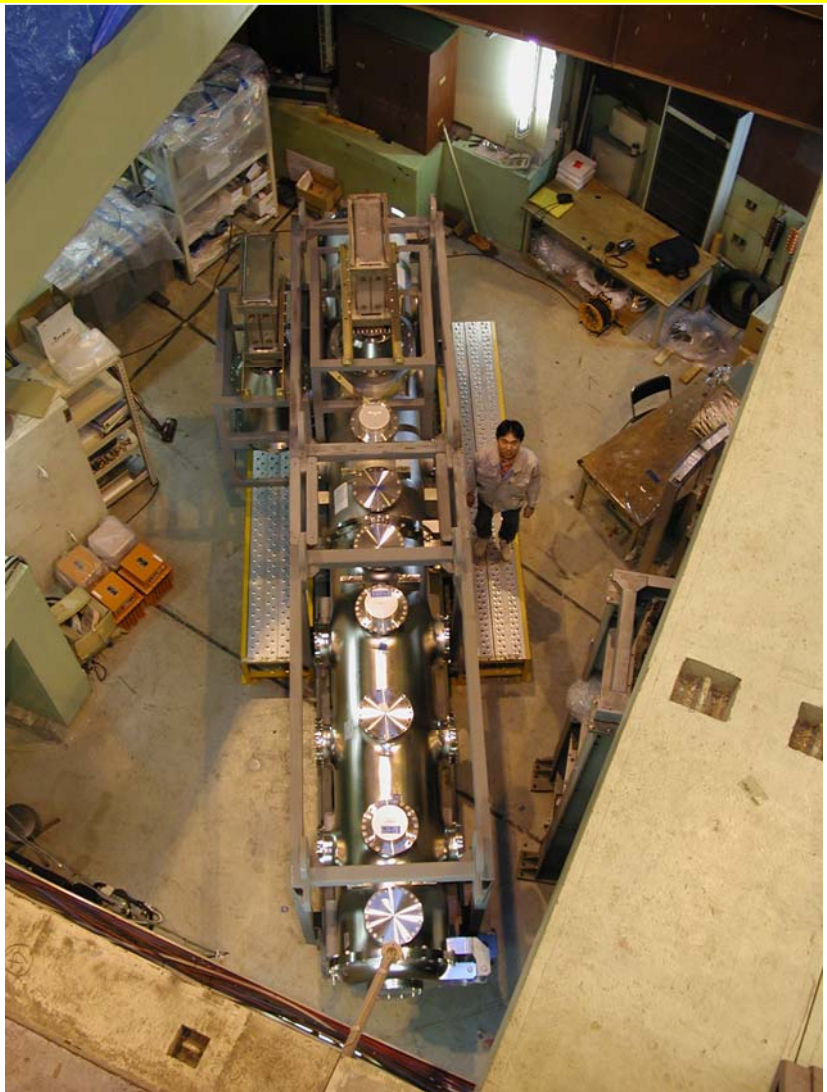
using Sanford-Wang formula, assuming 1pulse=3.53s（0.7s flat top)

$ Signle Rate Estimation for Trigger/Tracking Devices to be placed just after MS2

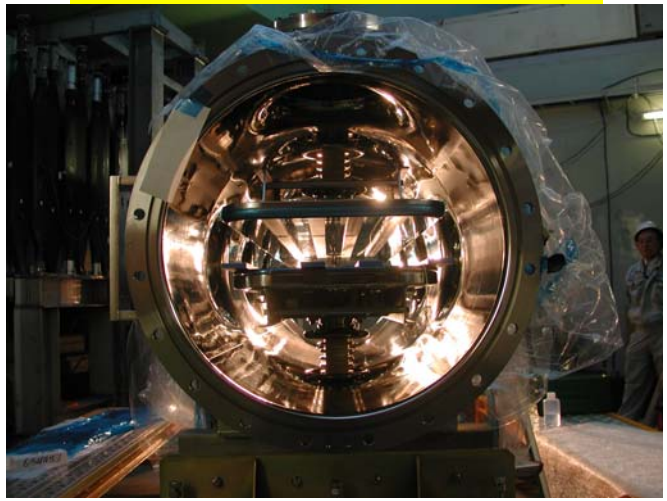
静電セパレータ(ESS)

- 新たに開発されたK1.8初段用耐放射線性ESS

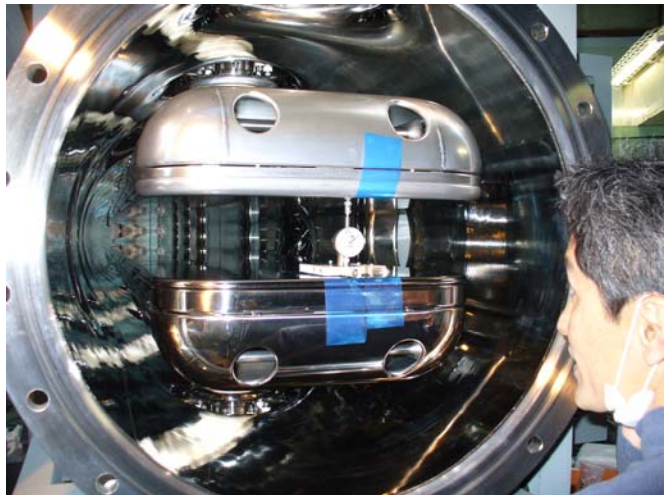
EP1Bケイブで前後段組上げられた6m ESS



連結前の前段3mの内部



6m連結後の電極間隔出し



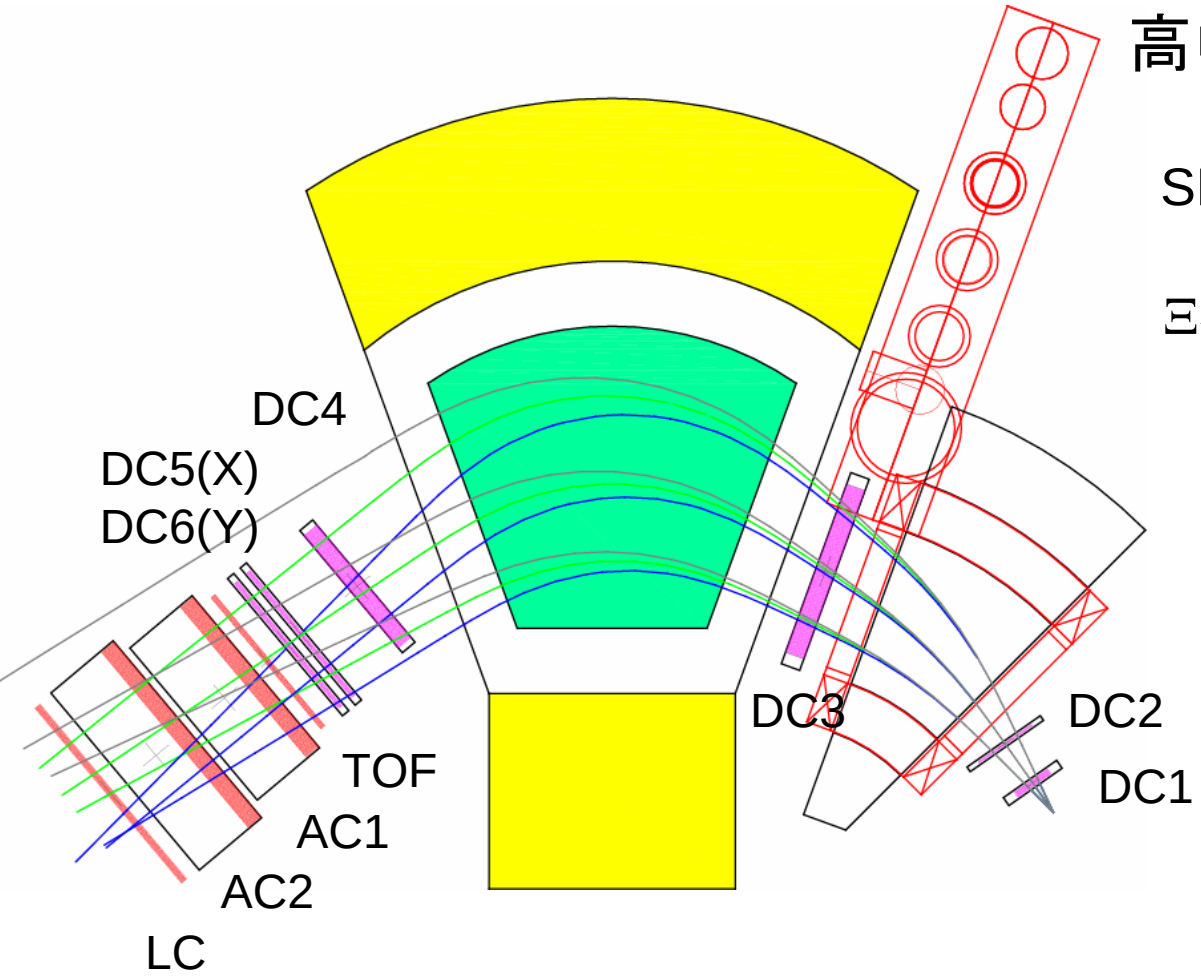
K1.8 Magnets!!

ビームライン	磁石名	型式	ギャップ/ボア[mm]	磁極幅[mm]	磁極長[mm]	再利用磁石	磁場(1.8GeV/c)[kG]	磁場(2.0GeV/c)[kG]	コイル	備考
K1.8	D1	5C216SMIC	80	250	800		13.10	14.55	間接MIC	真空内、偏向角10°
K1.8	Q1	NQ312MIC	160		600		6.08	6.76	間接MIC	真空内
K1.8	Q2	NQ416MIC	200		800	νアーク部Q416?	-7.41	-8.23	MIC	
K1.8	D2	8D218SMIC	120	400	900		17.47	19.41	MIC	偏向角15°
K1.8	Q3	Q410	200		500	K2Q6	7.90	8.78	BT	
K1.8	O1	O503	250		150		1.00	1.11	BT	
K1.8	Q4	Q410	200		500	K2Q7	-8.80	-9.78	BT	
K1.8	S1	SX504	250		200		0.57	0.63	BT	
K1.8	CM1	4D604V	300	200	200		3.76	4.18	BT	
K1.8	CM2	4D604V	300	200	200		3.76	4.18	BT?	
K1.8	S2	SX504	250		200	K6SX	-1.44	-1.60		
K1.8	Q5	Q510	250		500	K2Q4	8.20	9.11		
K1.8	Q6	NQ610	300		500	K4Q7	9.17	10.19		
K1.8	D3	6D330S	170	1000	1500	SiRENE	14.12	15.68		偏向角20°
K1.8	Q7	Q408	200		400	K3Q6	-5.30	-5.89		
K1.8	O2	O603	300		150		1.75	1.94		
K1.8	S3	SX604	300		200		-1.59	-1.76		
K1.8	CM3	4D604V	300	300	200	K6CM1	3.76	4.18		
K1.8	CM4	4D604V	300	300	200	K6CM2	3.76	4.18		
K1.8	S4	SX604	300		200		0.25	0.28		
K1.8	Q8	NQ512	250		600	K6Q4	-8.90	-9.89		
K1.8	O3	O603	300		150		1.25	1.39		
K1.8	Q9	NQ518	250		900	K6Q3	10.35	11.50		
K1.8	Q10	NQ418	200		900	K6Q6	9.79	10.88		
K1.8	Q11	NQ412	200		600	K6Q7	-8.00	-8.88		
K1.8	D4	13D489S	200	660	4468	A12	15.01	16.68		偏向角64°
K1.8	Q12	NQ412	200		600	K6Q8	8.50	9.44		
K1.8	Q13	NQ412	200		600	K6Q9	-6.70	-7.45		
K1.8BR	S3	SX404	200		200	K2SX	0.49			
K1.8BR	Q7	Q306	150		300	旧K0北	-5.65			
K1.8BR	D4	8D440S	200	400	1988	K6D2(KAMAE)	19.33			偏向角60°
K1.8BR	Q8	Q408	200		400	πμQ4	8.10			

※K1.8BR磁石の磁場は1.1GeV/c用

H19年度製造

SksPlus Spectrometer

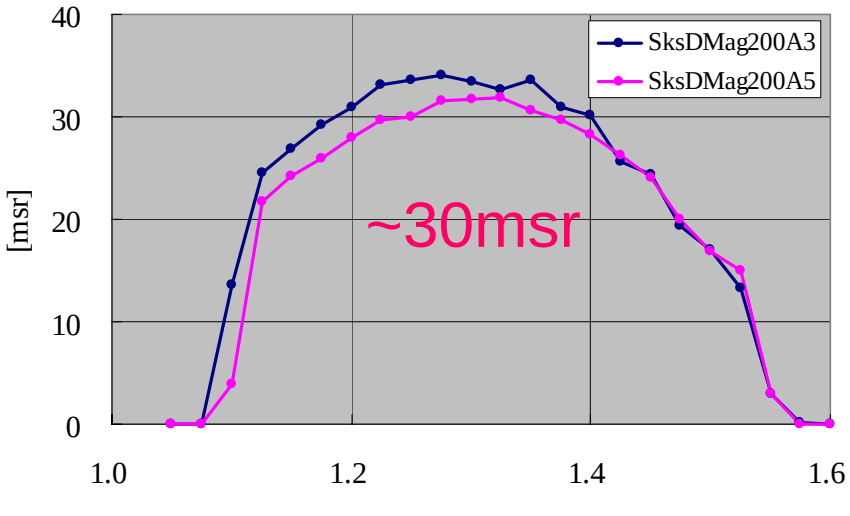


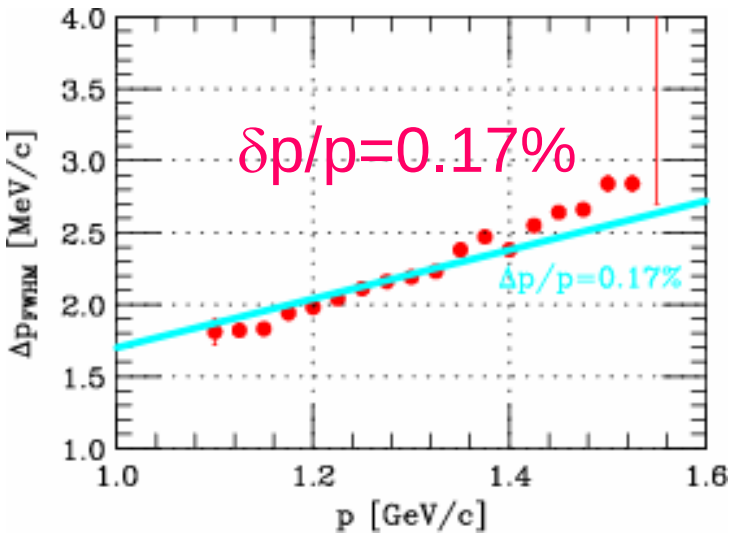
高中心運動量対応

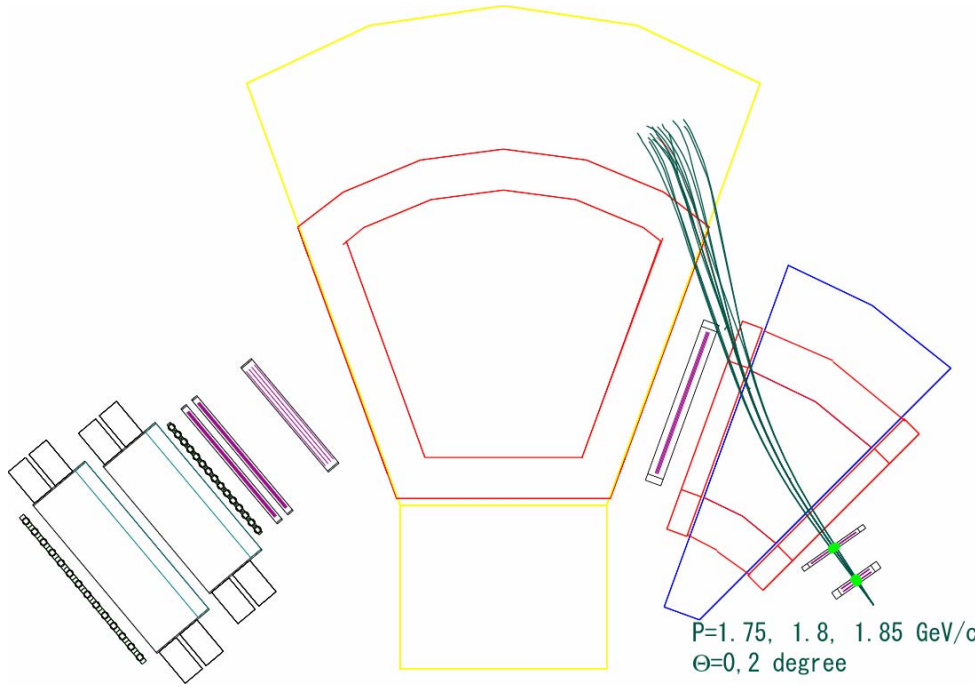
SKS(100° Bend, 400A)では
900MeV/c
Ξ核スペクトロスコピーでは、
1.3GeV/cが必要

D磁石(~1.5T, 20cm Gap)を追加
Totalで95° Bend

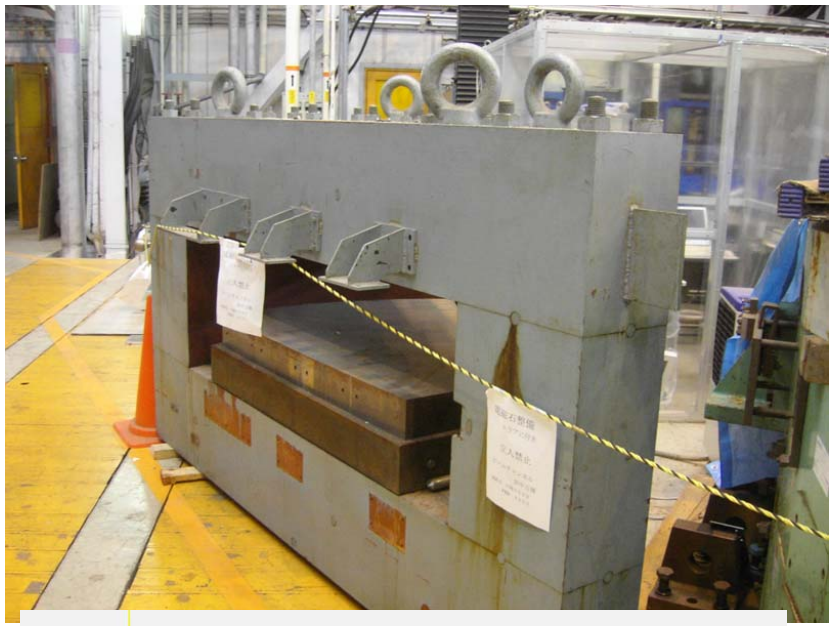
SksPlus Spectrometer

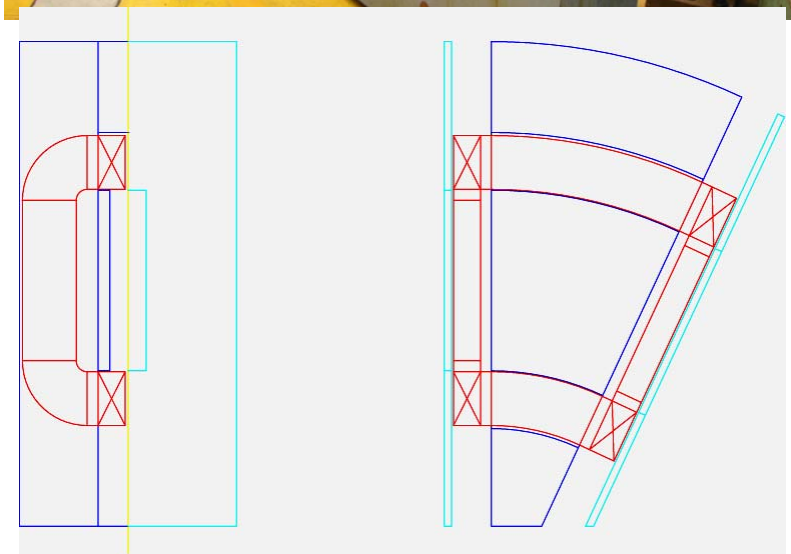






+Dipole





- Recycled Iron yoke
- Window Frame型
- Gap 20cm
- 98 turns/coil
- 1.5T (2000A)
- 310 kW　P.S.

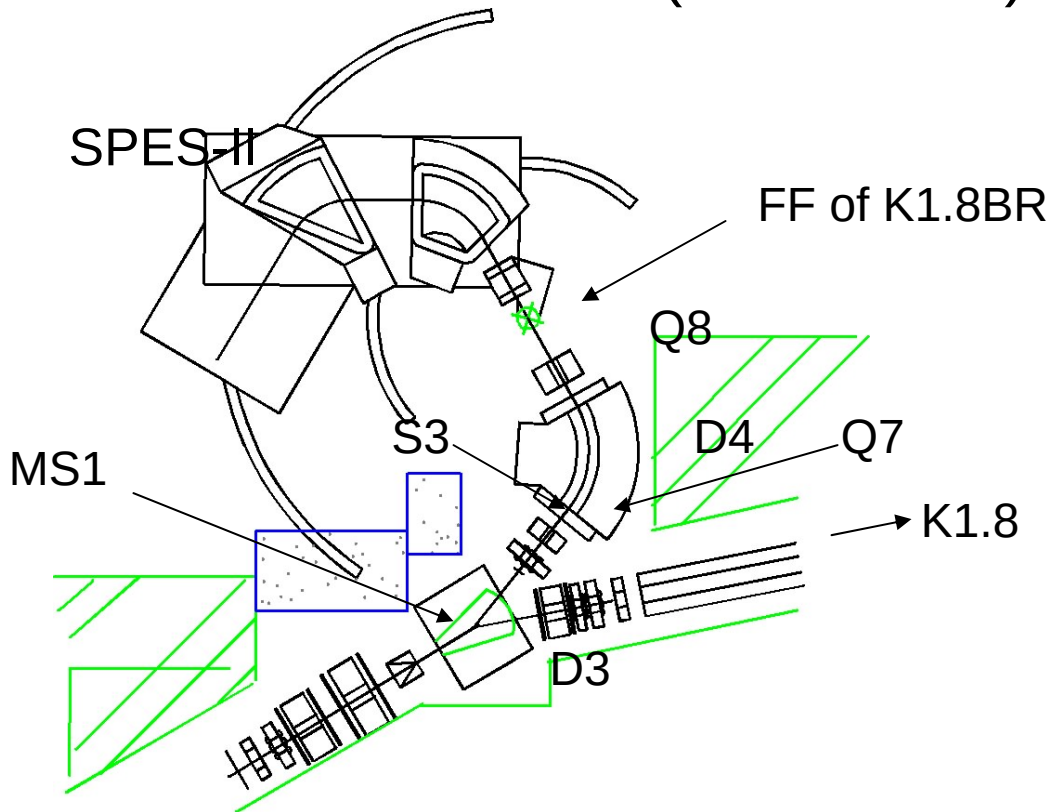
特定領域科研費　H19年度

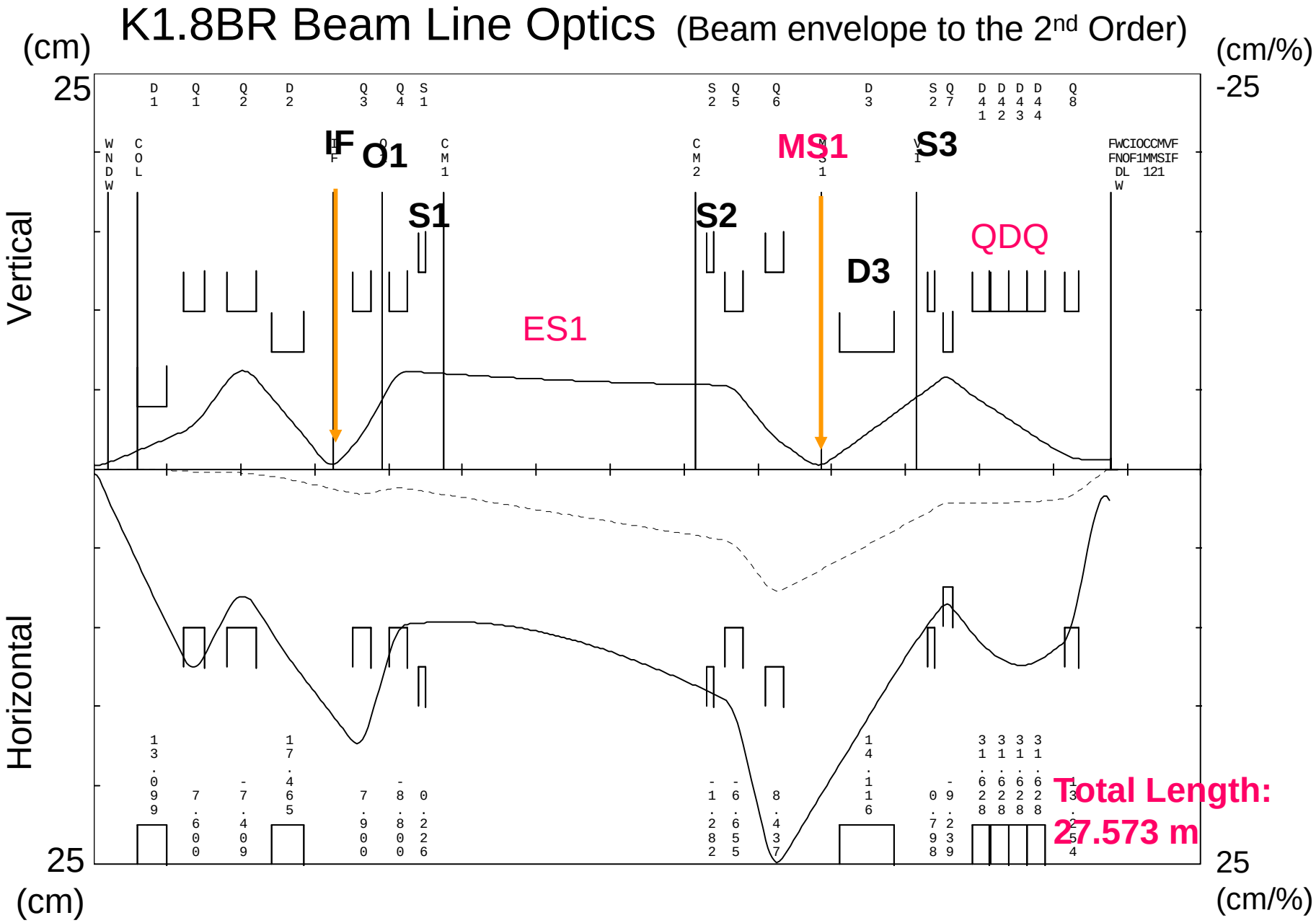
K1.8BR option

- Concept
- Optics
  Beam envelope/Profile@FF
- K1.8BR performance summary

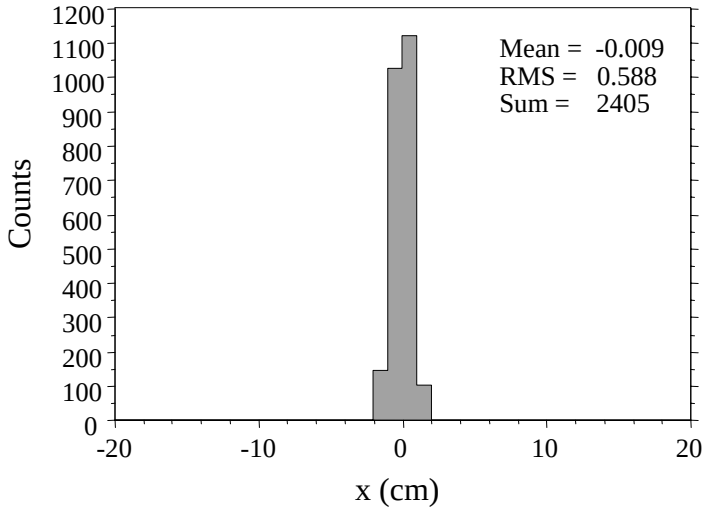
K1.8BR Beam Line

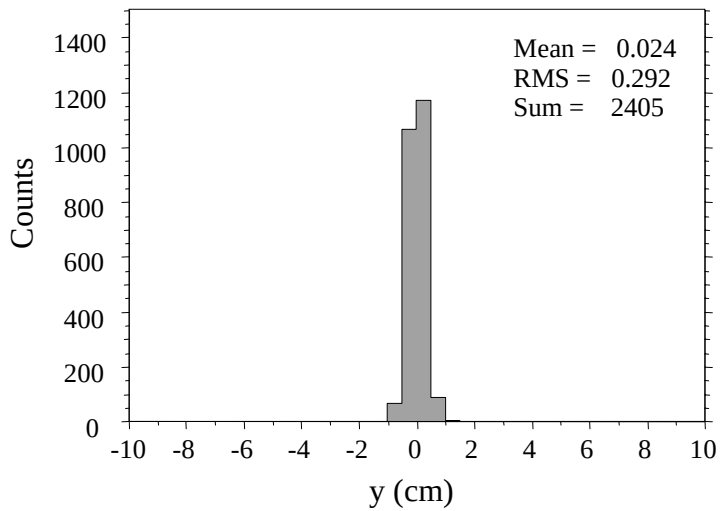
- Branch at D3 of K1.8
  Beam bent opposite side at D3, +SQDQ to focus at FF
  Time sharing with K1.8
  helpful for efficient experimental execution/coordination
- Single ES Stage, Shorter BL (27.6m)
  Intensity of K- at 1.1 GeV/c:~15 times > K1.8
  Intense Low Momentum Kaon (<1.2 GeV/c)

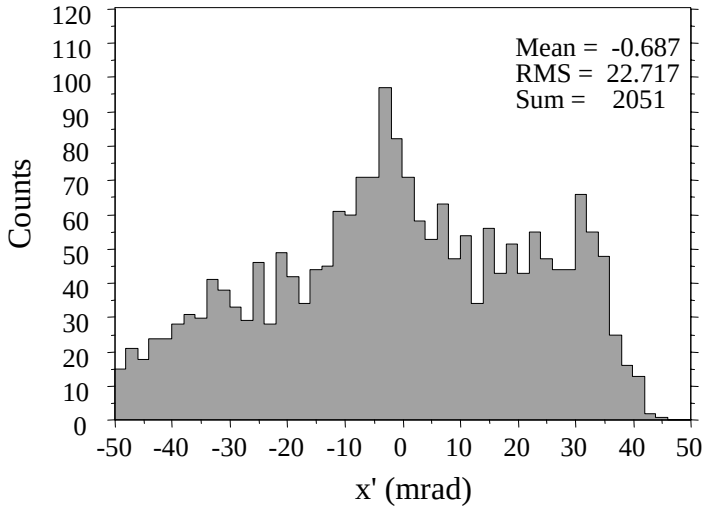


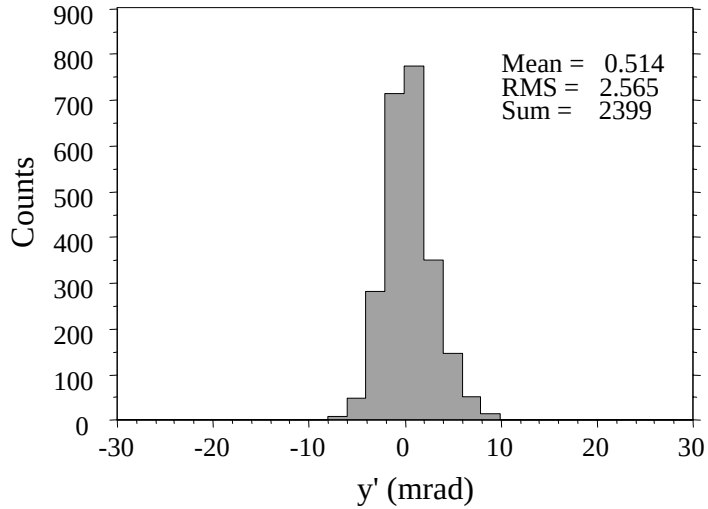

K1.8BR Beam Line Optics (Beam envelope to the 2nd Order)
(cm)
25
Vertical
Horizontal
25
(cm)
(cm/%)
-25
25
(cm/%)
D1 Q1 Q2 D2 Q3 Q4 S1 S2 Q5 Q6 D3 S2 Q7 D41 D42 D43 D44 Q8
WNDW COL IF Q1 CM1 CM2 MS1 S3 FWCIOCCMVF FNOF1MMSIF DL 121 W
S1
S2
S3
MS1
QDQ
D3
ES1
Total Length:
27.573 m

Beam Profile at FF of K1.8BR （S3 on)









K1.8BR Performance Summary

2005.10.11

	K1.8BR (50 GeV-15μA)	(30 GeV-9μA)
Length (m)	27.573	
Acceptance (msr.%)	2.5¥	
K^- Intensity (ppp)#		
1.1 GeV/c	5.5E+06	1.2E+06
0.8 GeV/c	1.0E+06	0.2E+06
0.6 GeV/c	0.1E+06	0.02E+06
Electro-static Separator	500kV/10cm 6m	
Single Rate@D3out @1.1 GeV/c$	＞30E+06	＞7E+06
K^-/π^- @ FF@1.1 GeV/c&	7.5	6.8
X/Y(FWHM) size @ FF (mm)	5.9/2.9	

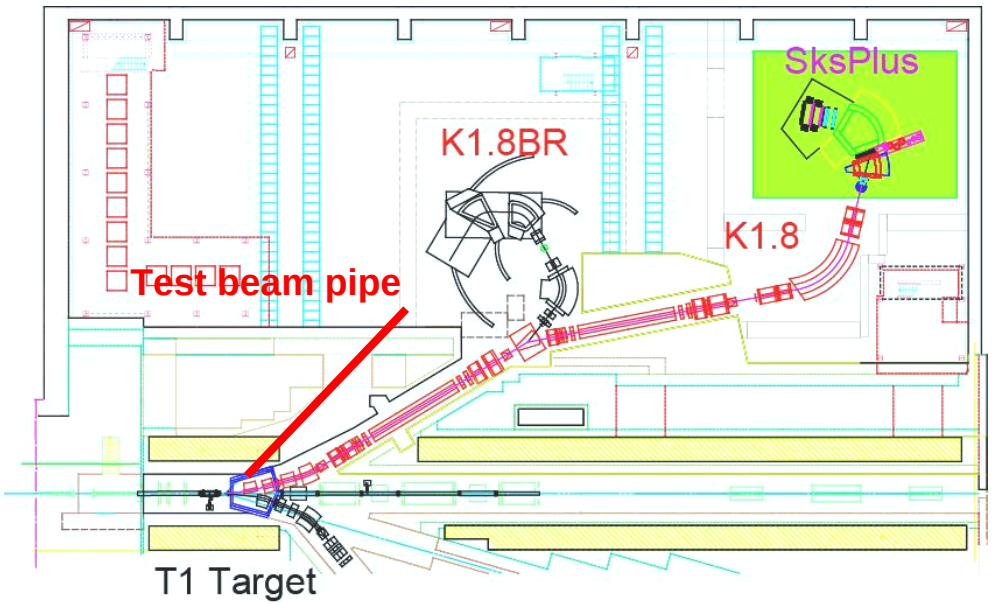
¥ IF/MS1 Heavy Alloy: IF opening 4 mm, MS1 opening 4.66 mm

using Sanford-Wang formula, assuming 1pulse=3.53s（0.7s flat top)

$ Signle Rate Estimation for Trigger/Tracking Devices to be placed just after D3

& cloud π not included

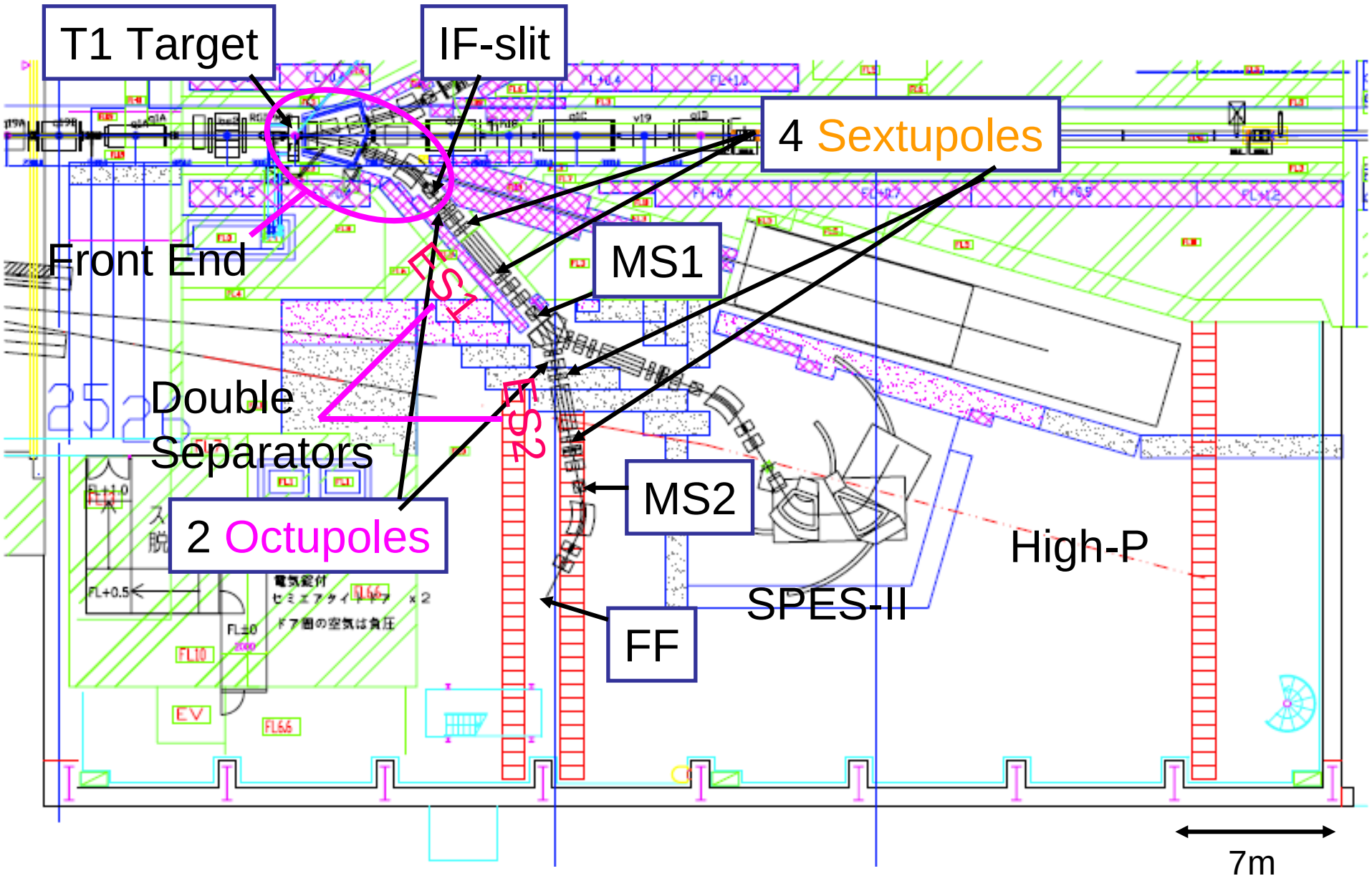
Vacuum Pipe for Test Beam



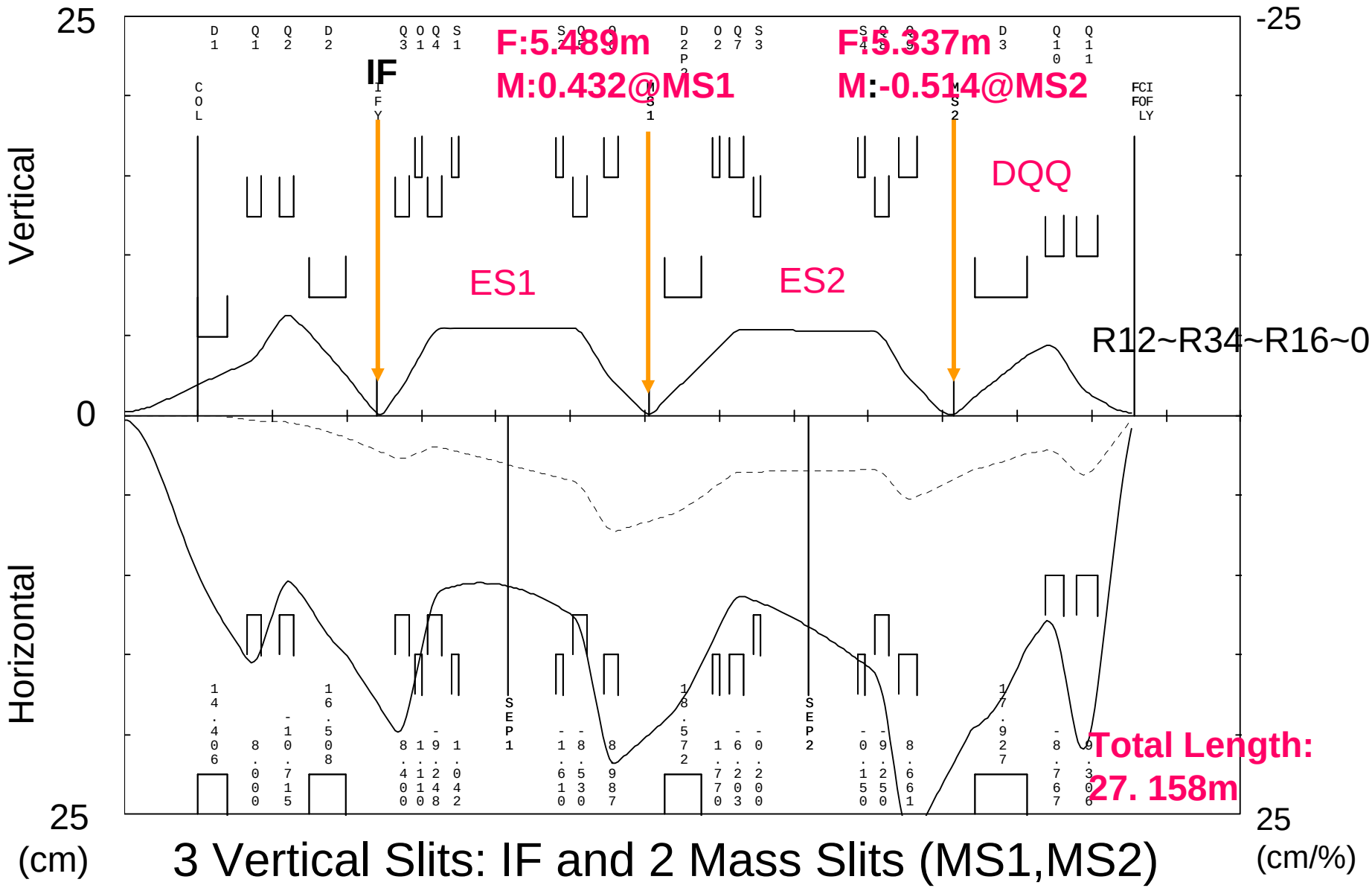
Hadron Facility in May 2008

Hadron Facility in May 2008

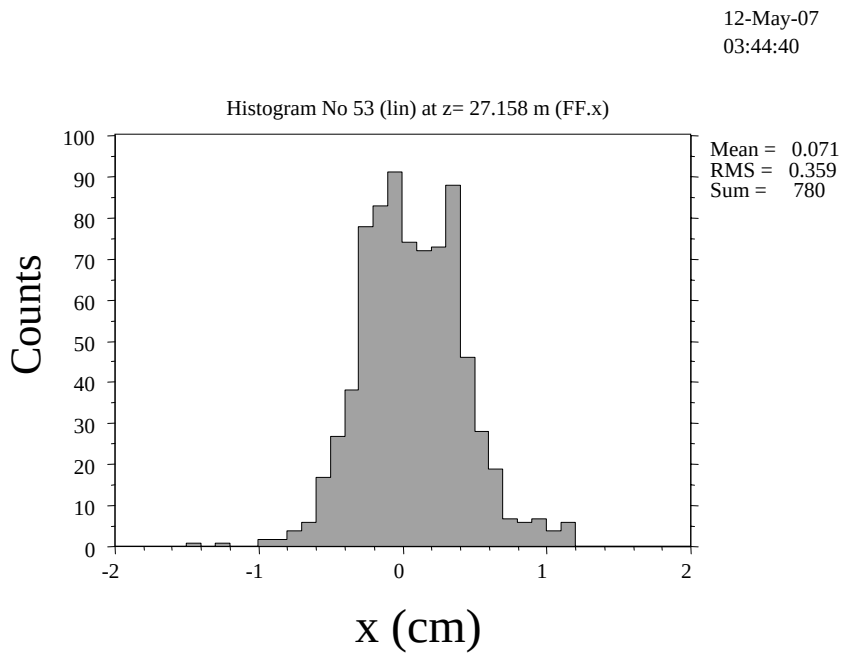
Configuration layout of K1.1c (Max. 1.1 GeV/c)

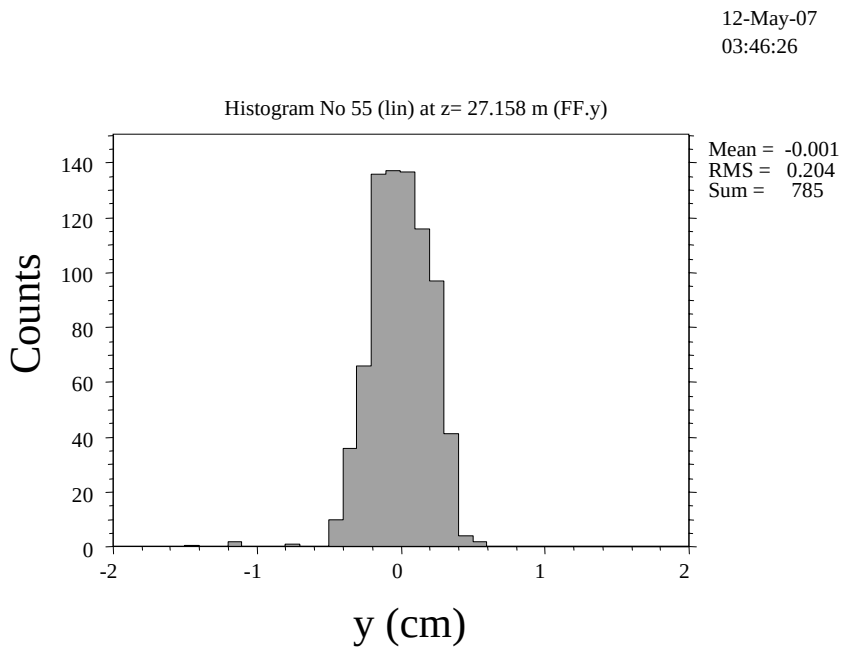


K1.1c Beam Line Optics (Beam envelope to the 1st Order)



3 Vertical Slits: IF and 2 Mass Slits (MS1,MS2)
to purify kaon beam with 2 Electrostatic Separators





$\sigma_X \sim 3.6$ mm

$\sigma_Y \sim 2$ mm

Beam Profile at FF

Performance Summary

2007.5.12

For 30 GeV-9μA primary protons on the 54mm Ni Target	K1.8BR	K1.1c (BHK)	K1.1c (2)
Length (m)	27.573	27.158	27.158
Acceptance (msr.%)	2.5¥	1.2	2.1
K^- Intensity (ppp)#			
1.1 GeV/c	1.2E+06	0.6E+06	1.1E+06
0.8 GeV/c	0.2E+06		
0.6 GeV/c	0.02E+06		
Electro-static Separator	500kV/10cm 6m	750kV/10cm 2mx2	750kV/10cm 2mx2
Signles Rate @D3out(MS2) @1.1 GeV/c$	>7.7E+06	>1.4E+06	>7.4E+06
$K^-/(\pi^-+\mu^-)$ @ FF@1.1 GeV/c&	0.9	3.0	0.74
X/Y(FWHM) size @ FF (mm)	5.9/2.9	8.5/4.7	

¥ IF/MS1 Heavy Alloy: IF opening 4 mm, MS1 opening 4.66 mm

using Sanford-Wang formula, assuming 1pulse=3.53s（0.7s flat top)

$ For Signles Rate Estimation for Trigger/Tracking Devices

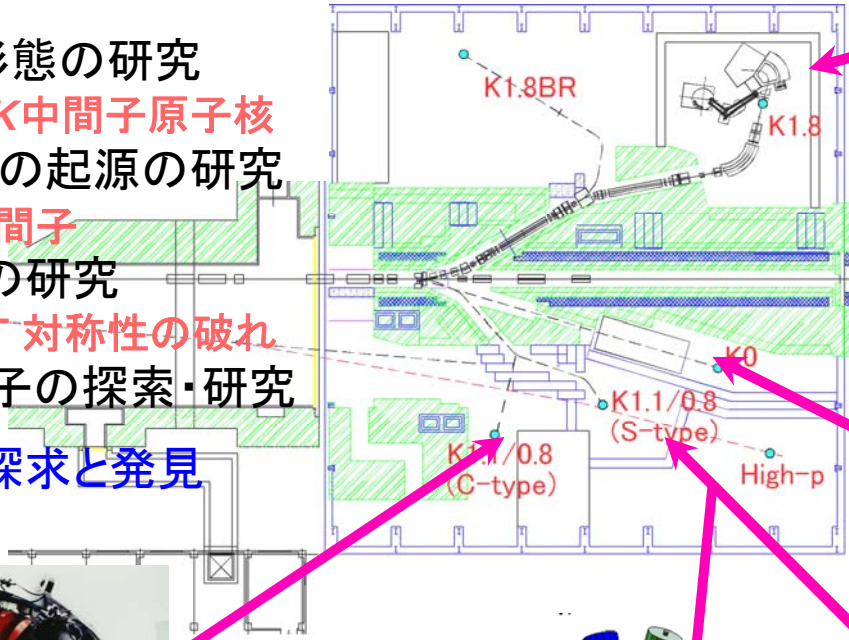
& cloud π not included

Spectrometers for Hd-Hall

物質世界の核心 素粒子と原子核の成り立ちを探る！

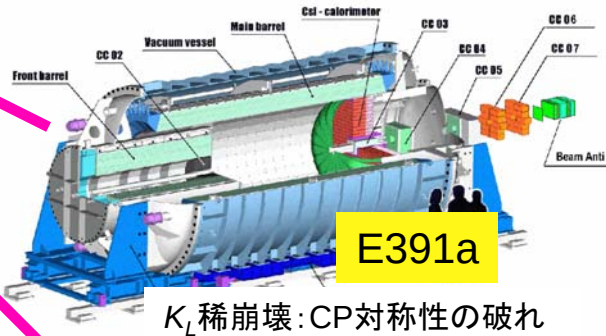
- 世界最高強度のK中間子等のハドロンビーム
- 世界最高性能を誇る測定器群

- 新しい核物質形態の研究
  ハイパー核、K中間子原子核
- ハドロンの質量の起源の研究
  バリオンや中間子
- 基本的対称性の研究
  CP 対称性、T 対称性の破れ
- エキゾチック粒子の探索・研究
- 未知の現象の探求と発見



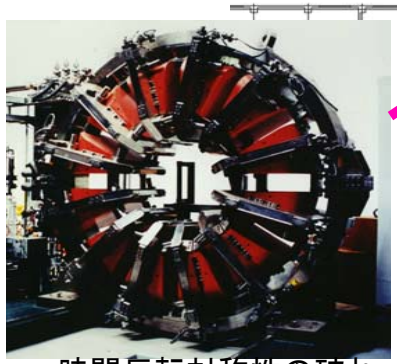
SKS spectrometer

ハイパー核分光



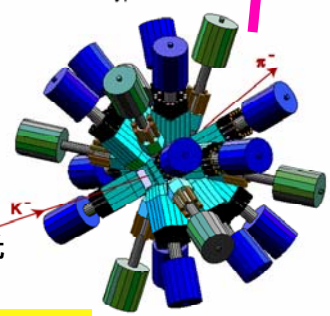
E391a

K_L稀崩壊：CP対称性の破れ



時間反転対称性の破れ

Toroidal spectrometer



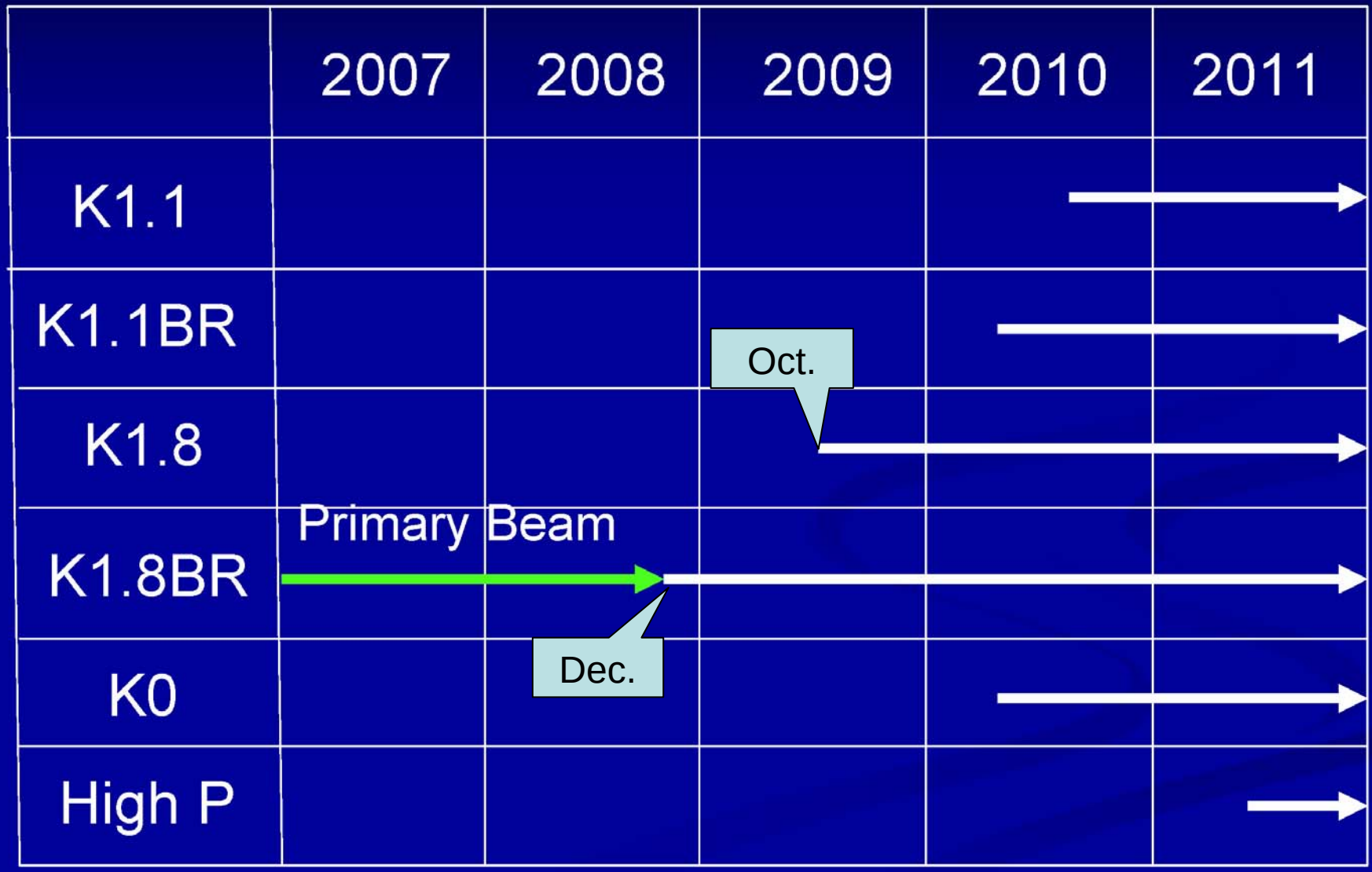
ハイパー核
ガンマ線分光

HyperBall

SPES-II

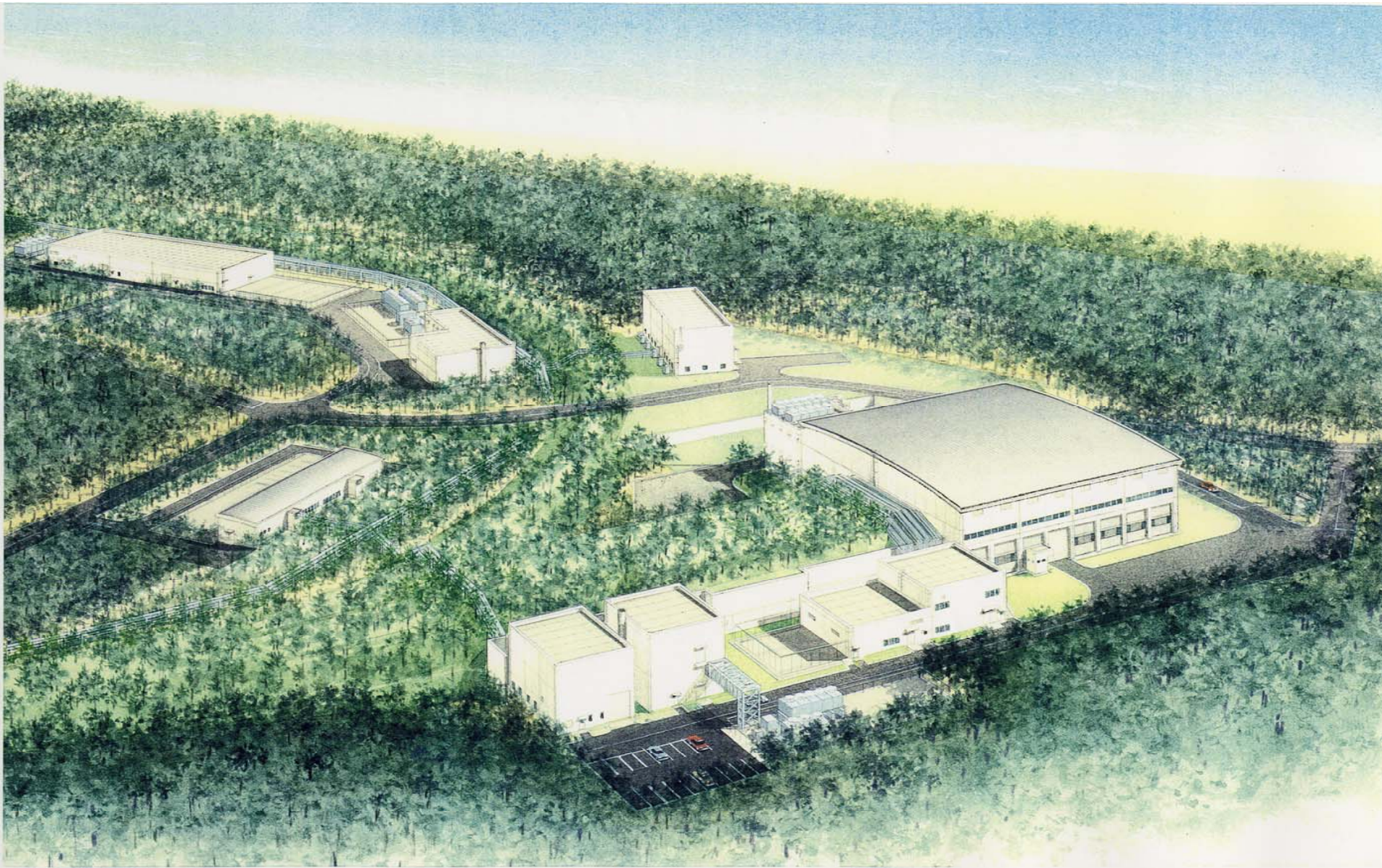
ハイパー核分光

A possible Schedule of Beam Delivery



Neutrino

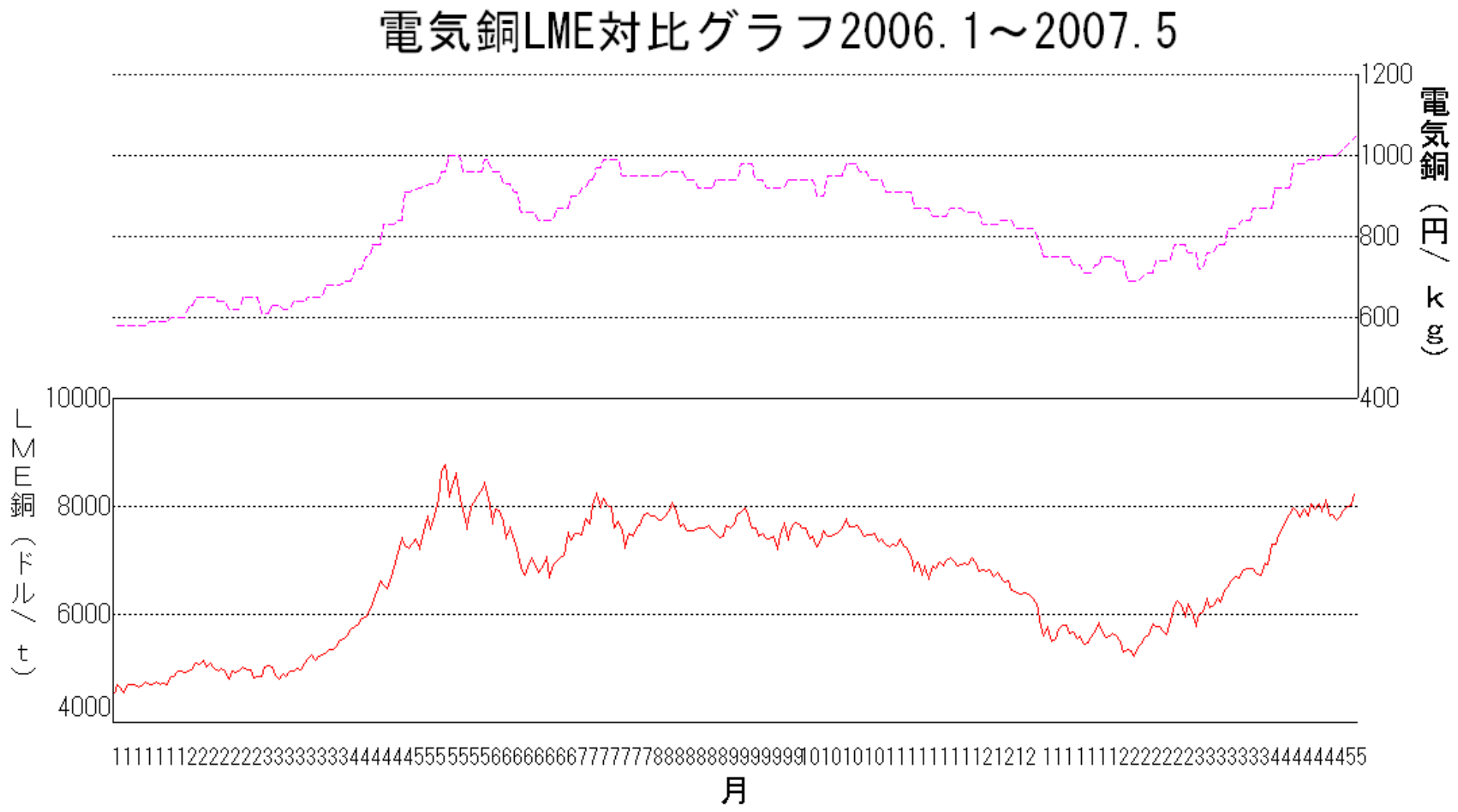
Hadron Hall in Summer 2009?



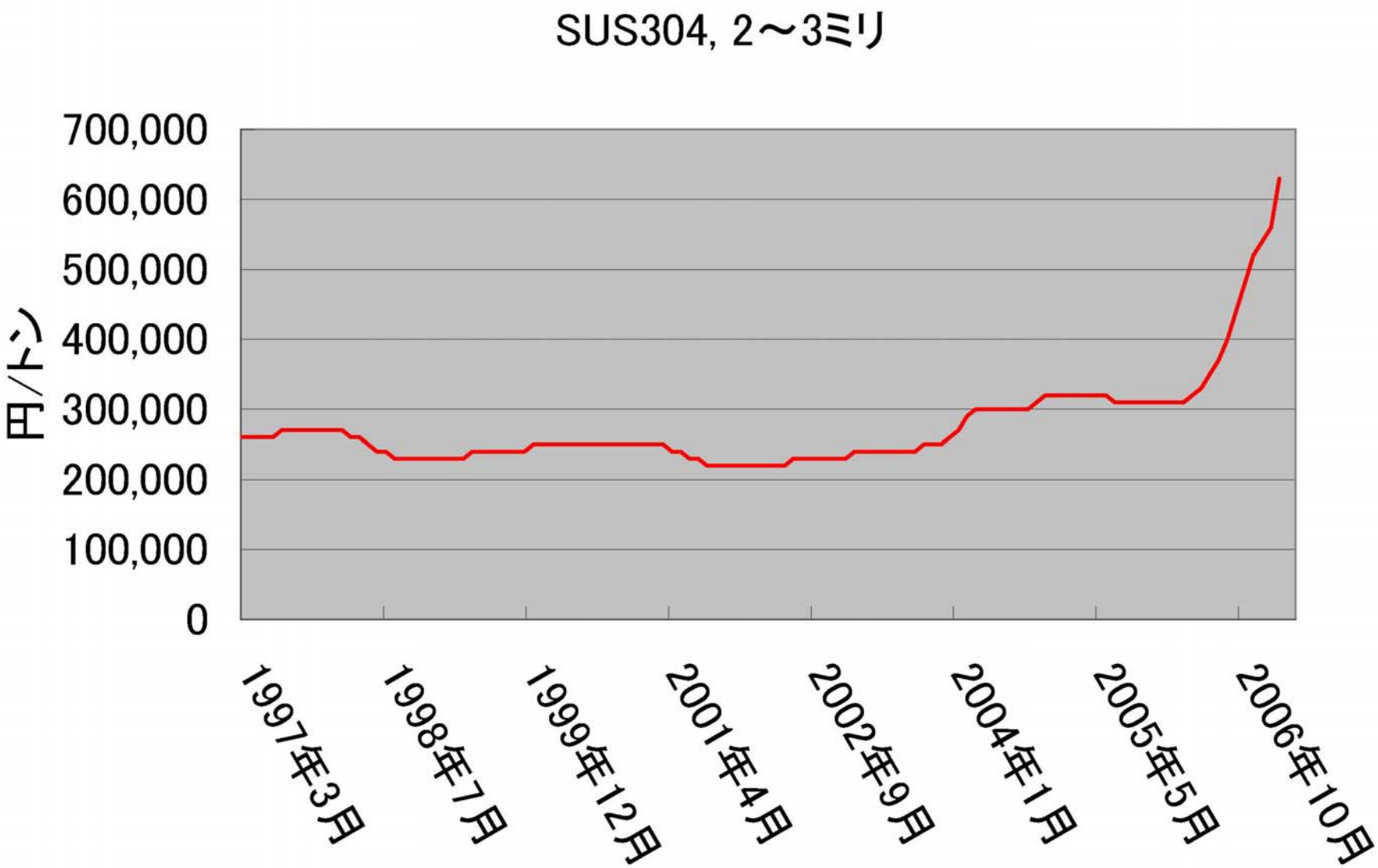
Dates of Remember

- July 2007: Start of magnet Inst. In Hd-Hall
- Nov.2007: Start of Dry-run of 50GeV-PS(MR)
- Feb.2008: Inst. of Beam Abort Devices of MR
- May 2008: Beam commissioning of MR(3GeV)
- July 2008: Inst. Of Slow Ext. Devices of MR
- Dec.2008: Beam commissioning of MR（30GeV)
  Start of Slow Extraction
- Feb.2009: End of the first Sloe Extraction
- April2009: Start of Neutrino Beam Operation
  with Fast Extraction
- Oct.2009: Second Slow Extraction for Physics

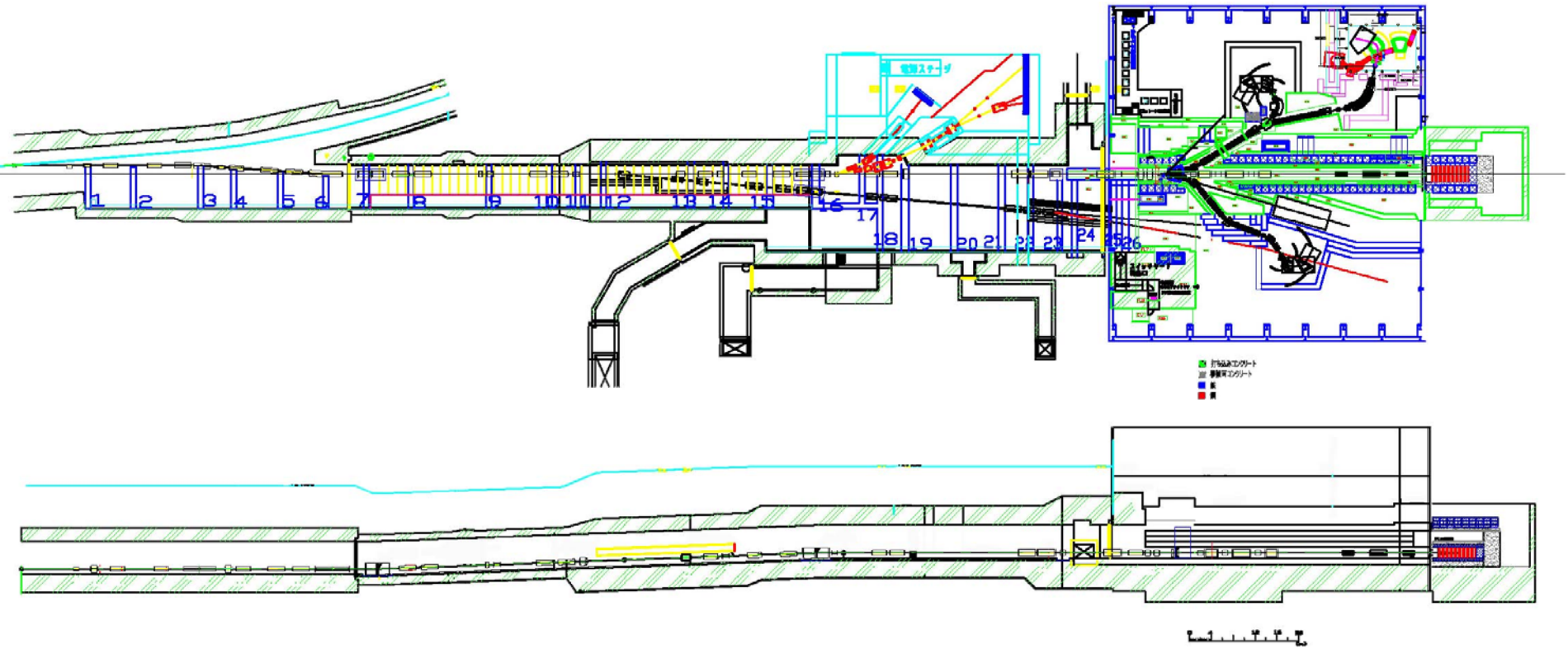
Worry? Price of Copper



Worry! Price of SUS304

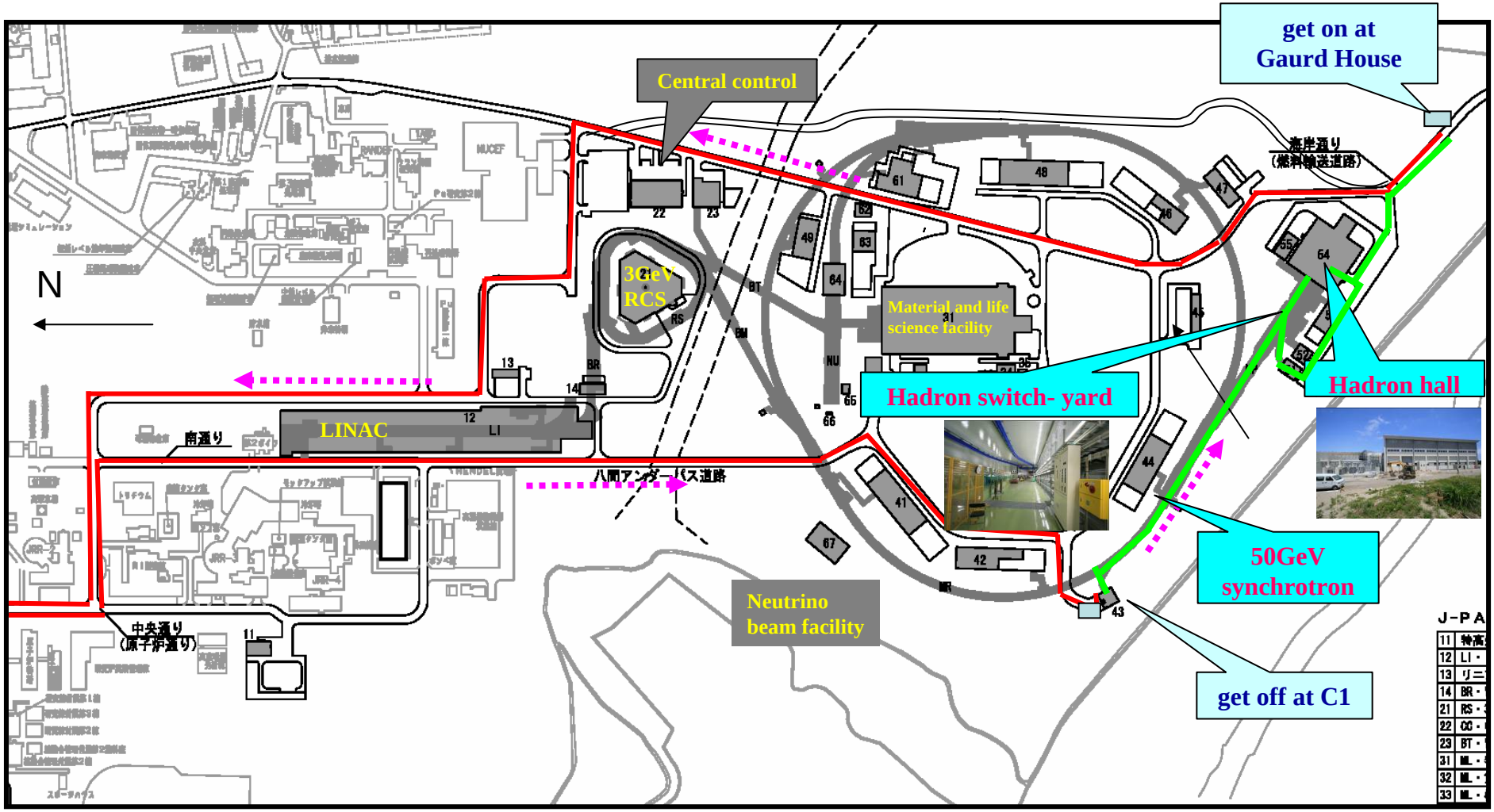


No Conclusion?
or
Seeing is Believing!

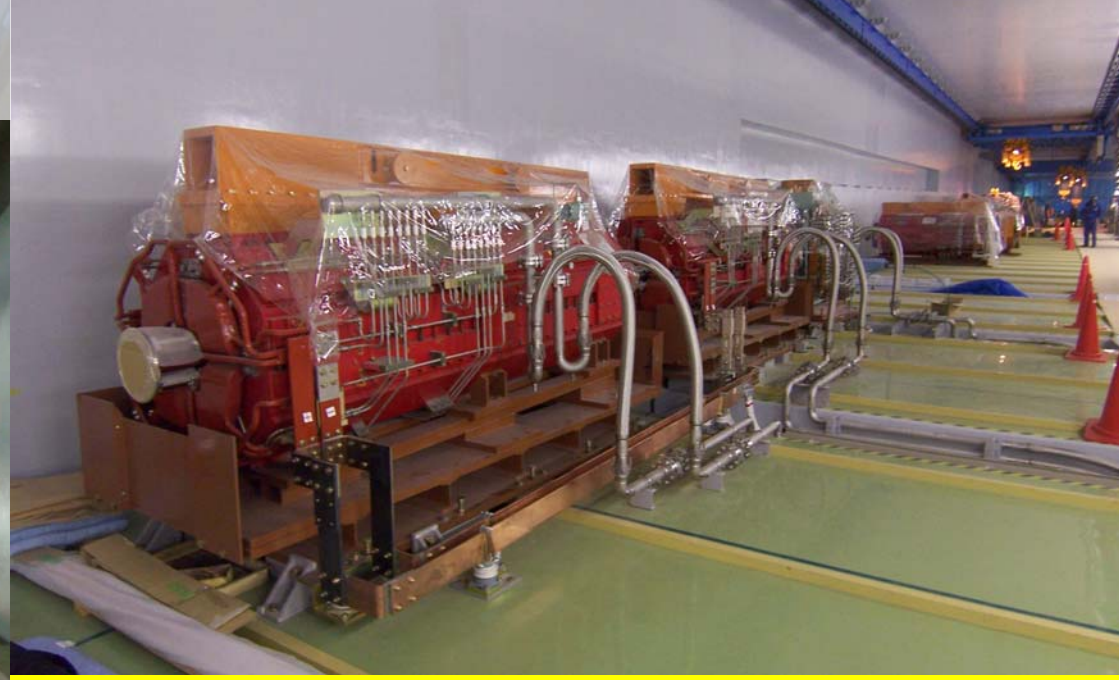


J-PARC Tour Map

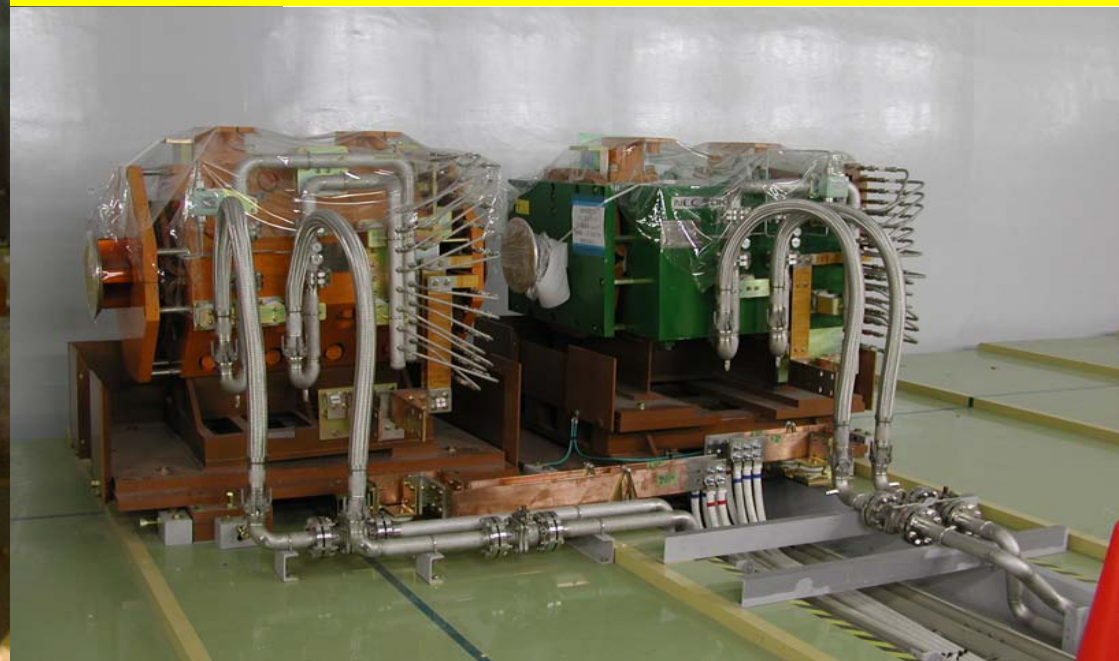
NP@J-PARC
1st-2nd, June, 2007
Tokai, JAPAN



- Please follow a tour guide.
- The participants are formed into 6 groups. The group number is indicated on the right-bottom corner of your name tag. Only the group 1, 2 is guided in English.



Water & DC Power line to magnets



From the unloading platform of the Hadron Hall…

Attention

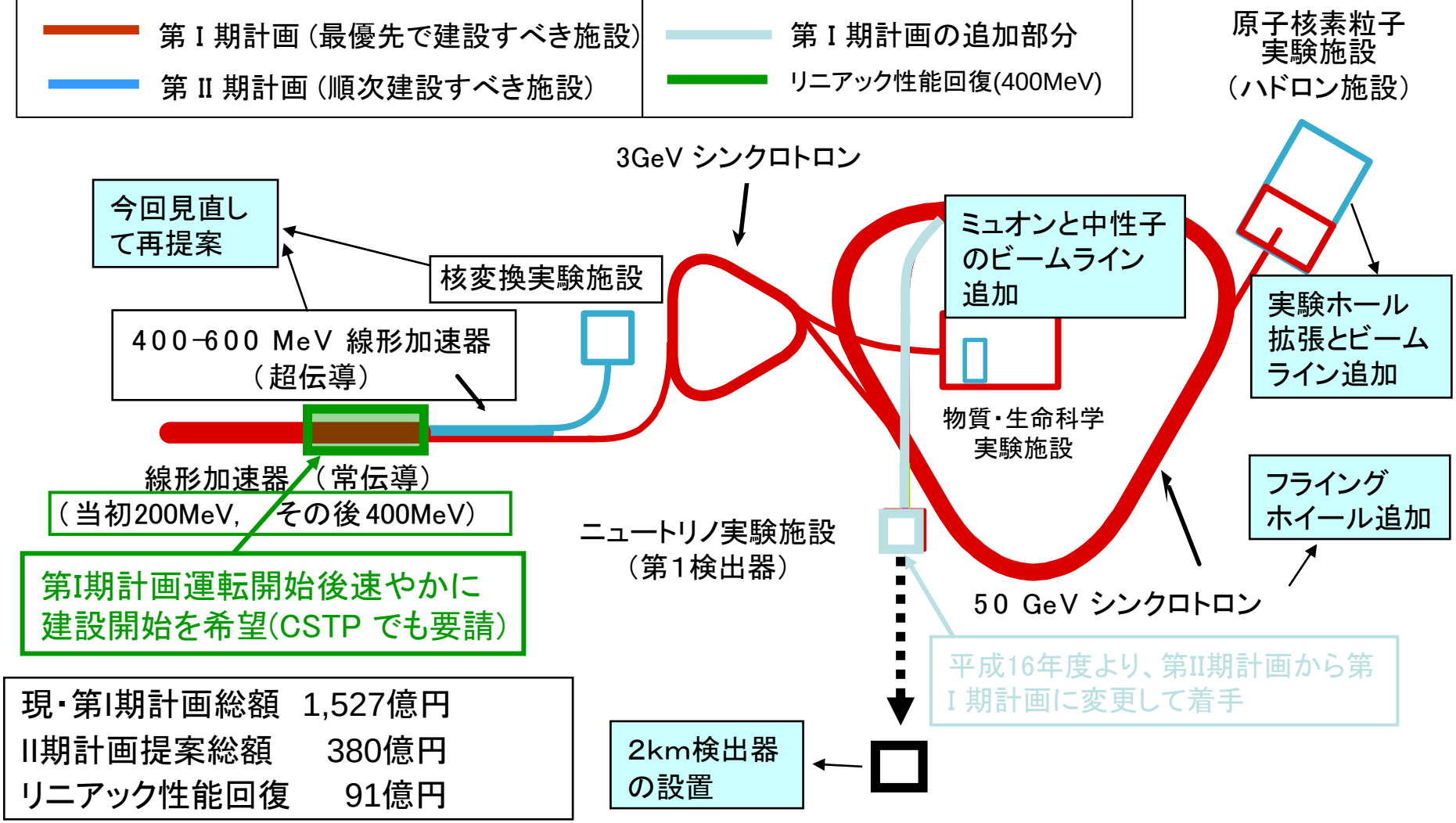
- J-PARC is currently a construction site. Please be careful!
- Please make sure of taking a hard hat before entering the site.
- There are some pits and scaffoldings. Mind your step and watch your head!
- A tour guide will lead you throughout the tour. Please follow him. He is an expert in construction of the beam lines and plans to propose an experiment on the site.
- In a radiation controlled area, there are radioactive components like second-hand magnets. Don’t take anything out.

Addendum

II期計画について

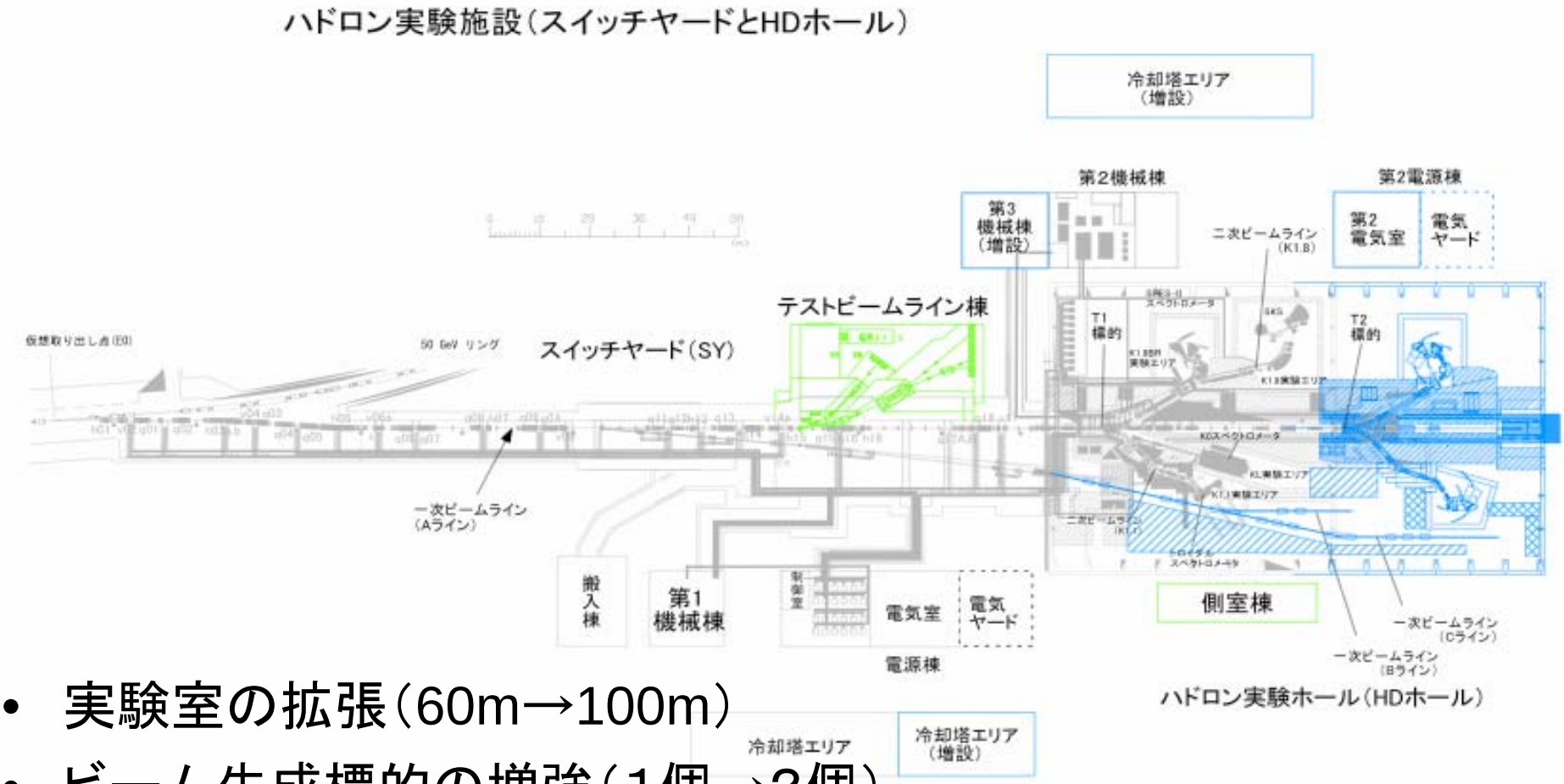
第I期計画と第II期計画の現状

平成12年度事前評価の結果	平成15年度作業部会の結果
第 I 期計画（最優先で建設すべき施設）	第 I 期計画の追加部分
第 II 期計画（順次建設すべき施設）	リニアック性能回復(400MeV)



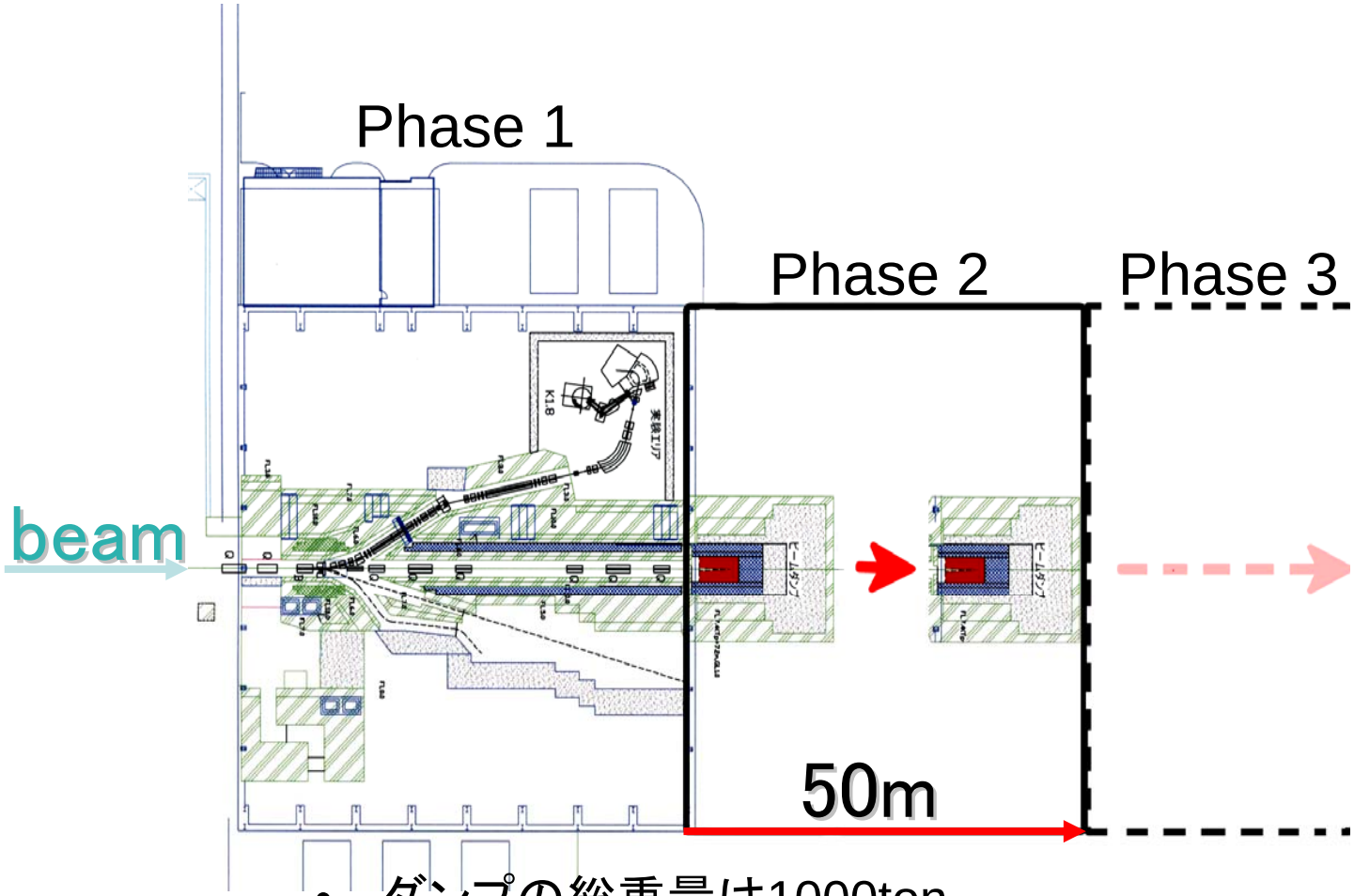
現・第I期計画総額	1,527億円
II期計画提案総額	380億円
リニアック性能回復	91億円

ハドロン実験施設-第II期計画



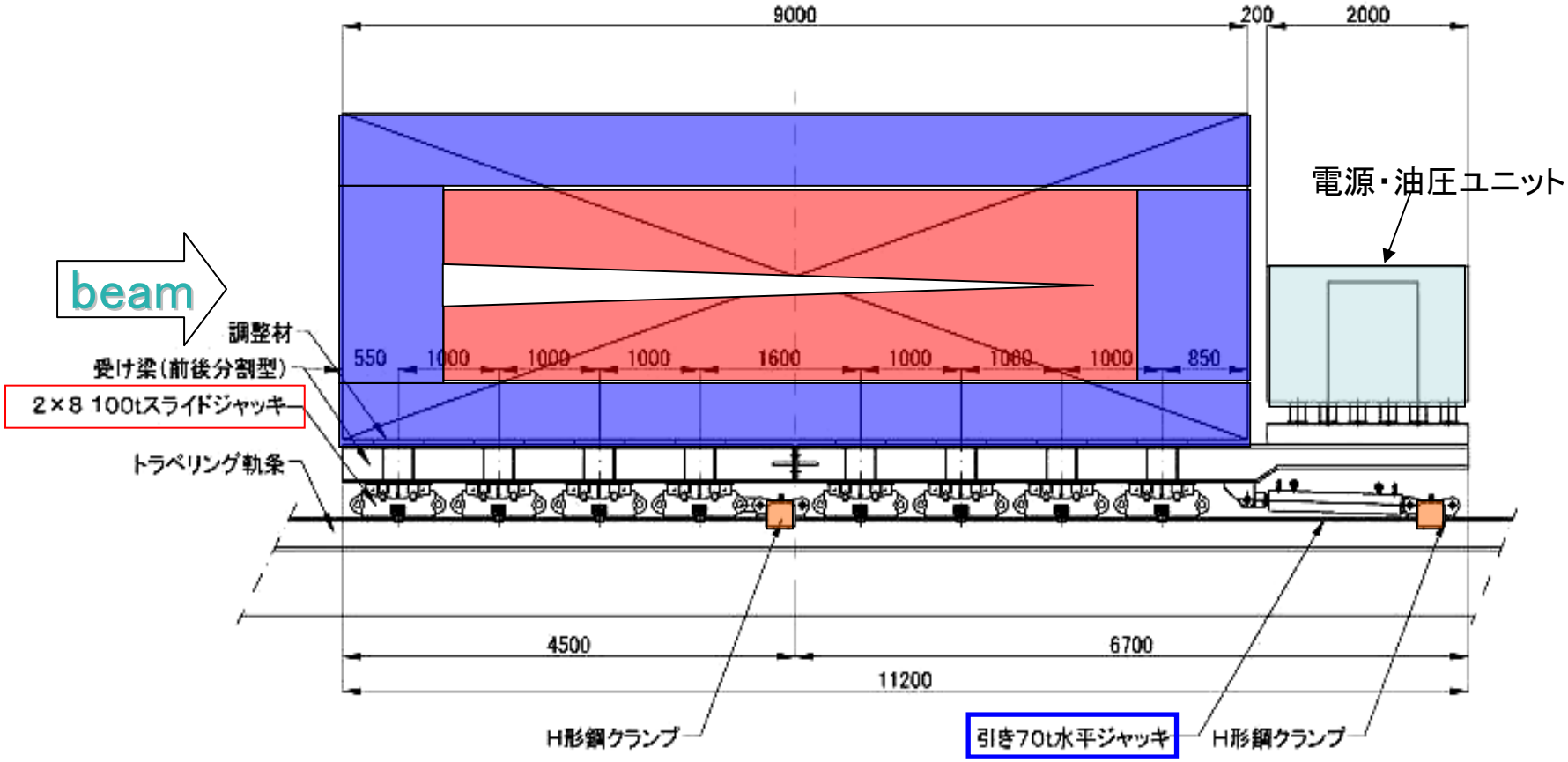
- 実験室の拡張（60m→100m）
- ビーム生成標的の増強（1個→2個）
- 二次ビームラインの整備
- 各種付属施設の拡充

ビームダンプを50m下流に引越！



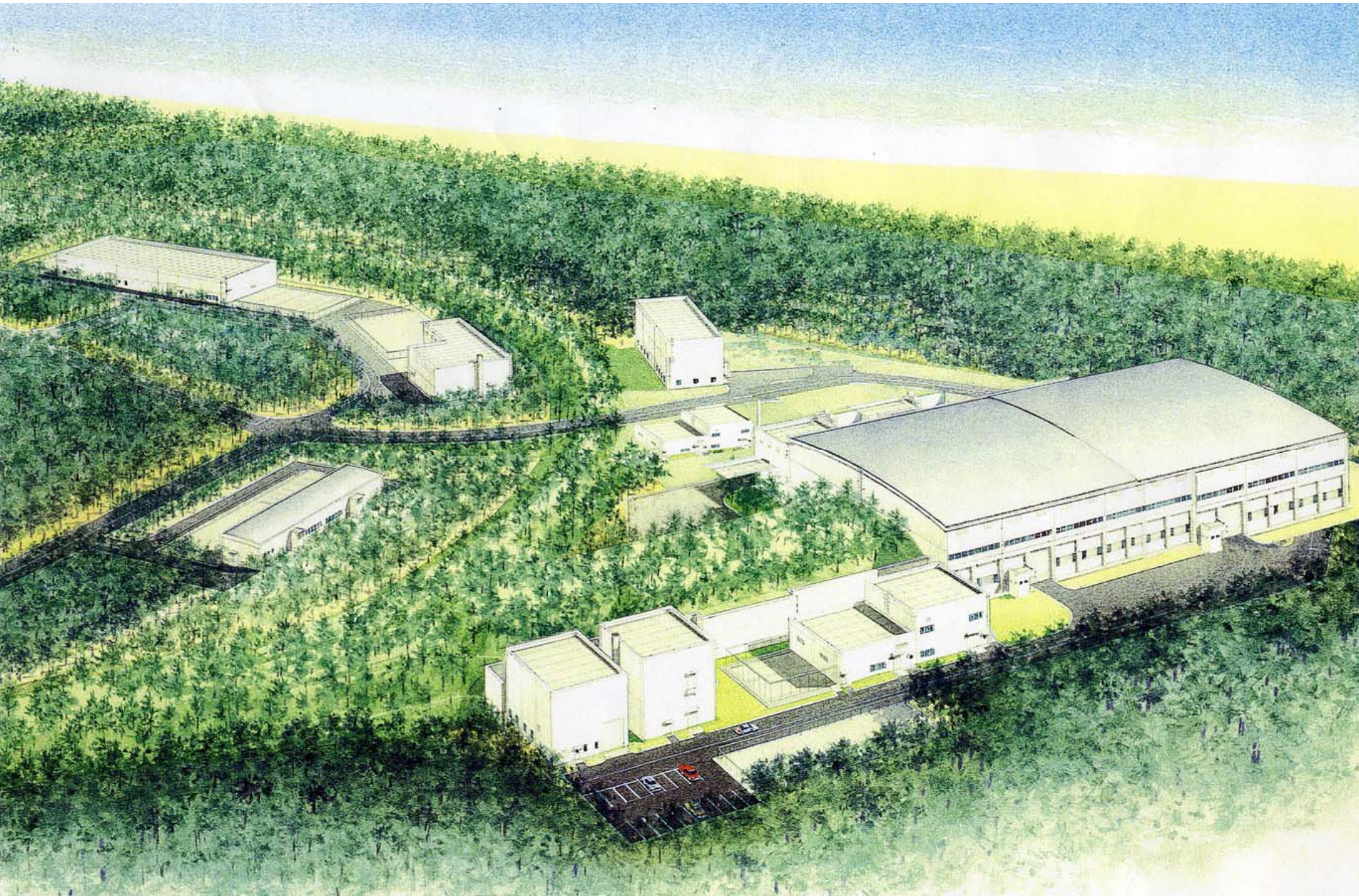
- ダンプの総重量は1000ton
- 移動は1日（8時間）以内に完了する！
- さらなる拡張も、もちろん可能！！

ダンプ移動の技術は確立！

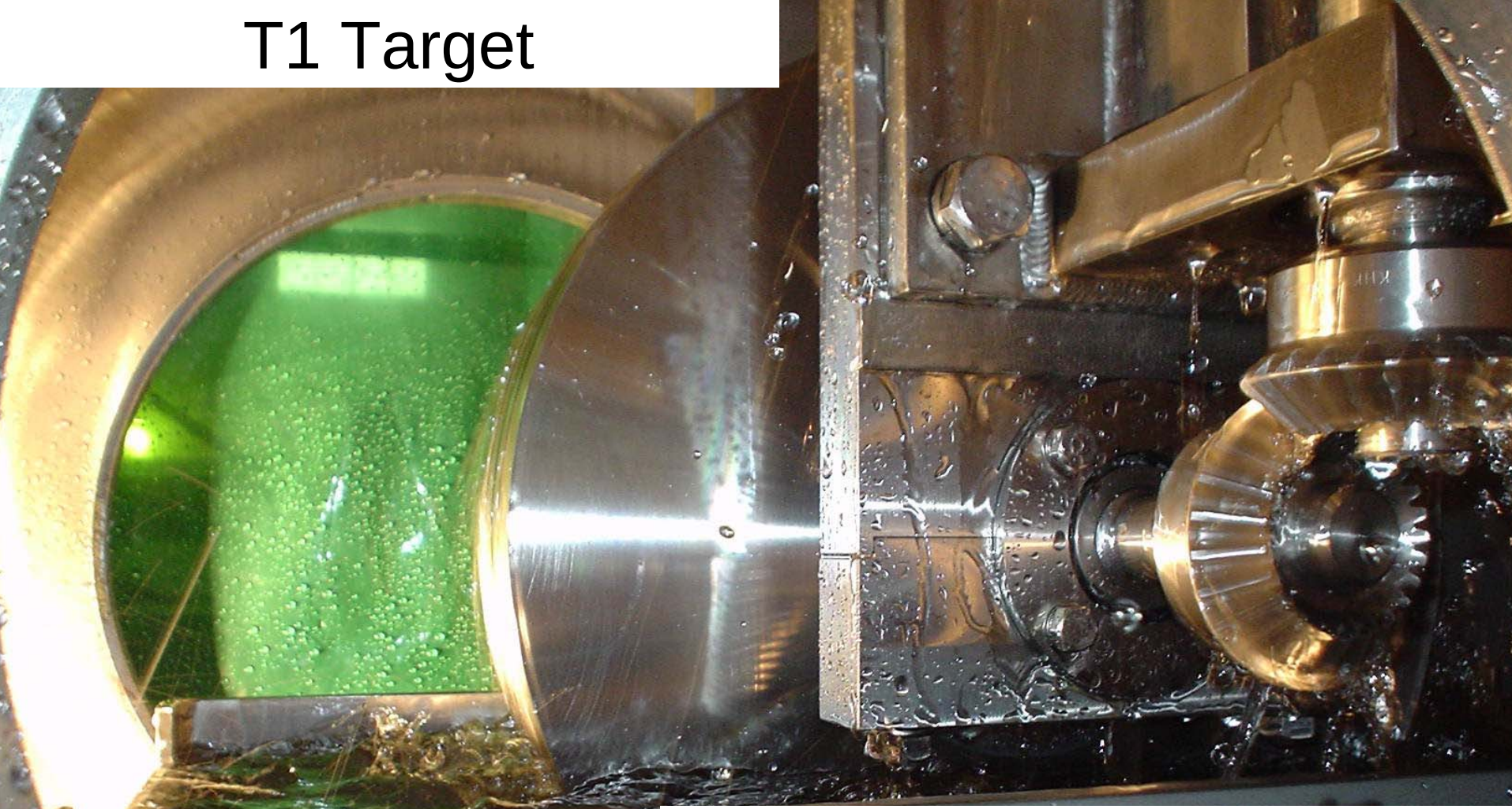


- 尺取り虫法でトラベリング軌道上を移動
- 放射線的にも問題なし(十分作業可能)！

Hadron Experimental Facility (*Phase II*)



T1 Target



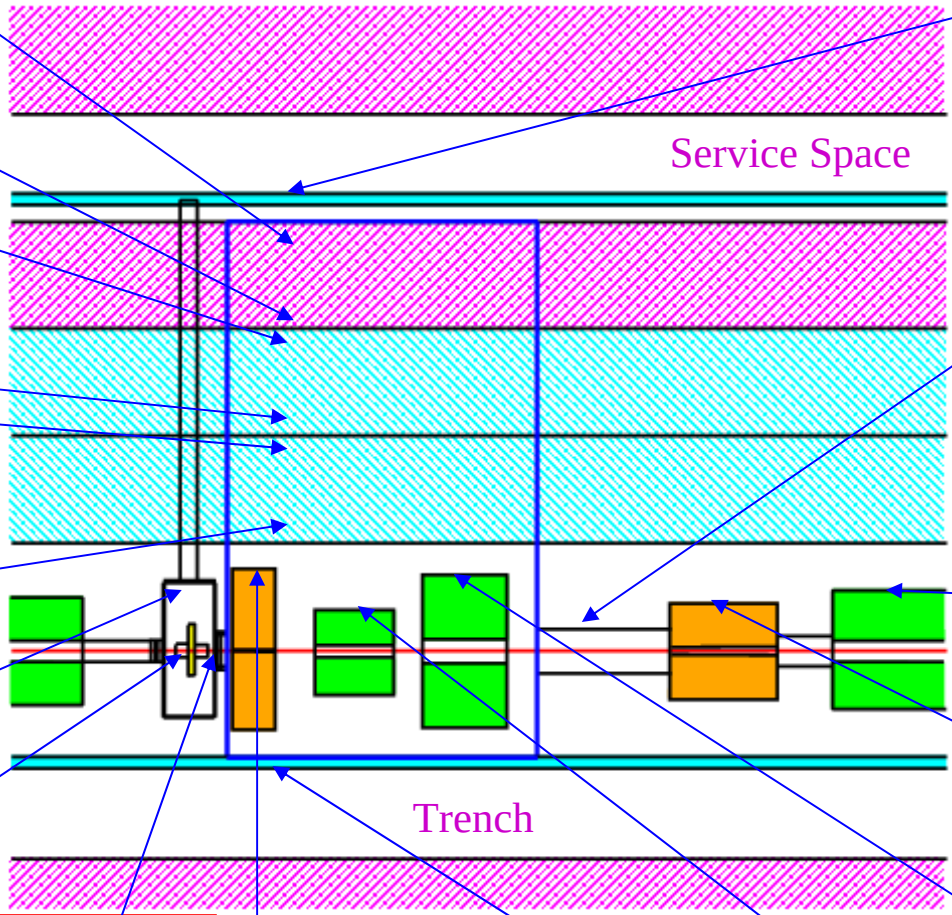
● 実証機(2号機)での長期試運転

- 東カウンター1次ラインモックアップ
- 回転駆動部、冷却水循環系、組み込み遮蔽体

- これまで; 回転駆動系3000時間,
  冷却系1200時間の運転

Residual Dose

30Days Operation/1Day Cooling
1Year Operation/Half Year Cooling



Concrete
7.9 μSv/h
0.03 μSv/h

Concrete
5.3 mSv/h
1.6 μSv/h

Iron
60 μSv/h
11 μSv/h

Iron
430 μSv/h
160 μSv/h

Iron
1.1 mSv/h
460 mSv/h

Iron
170 mSv/h
460 mSv/h

T1 Vessel
2.2 Sv/h
850 mSv/h

T1 Target
650 Sv/h
230 Sv/h

Vacuum Seal
30 Sv/h
11 Sv/h

Collimator
380 mSv/h
100 mSv/h

Iron Base
560 mSv/h
210 mSv/h

D1
530 mSv/h
270 mSv/h

Q1
62 mSv/h
33 mSv/h

Collimator
710 mSv/h
420 mSv/h

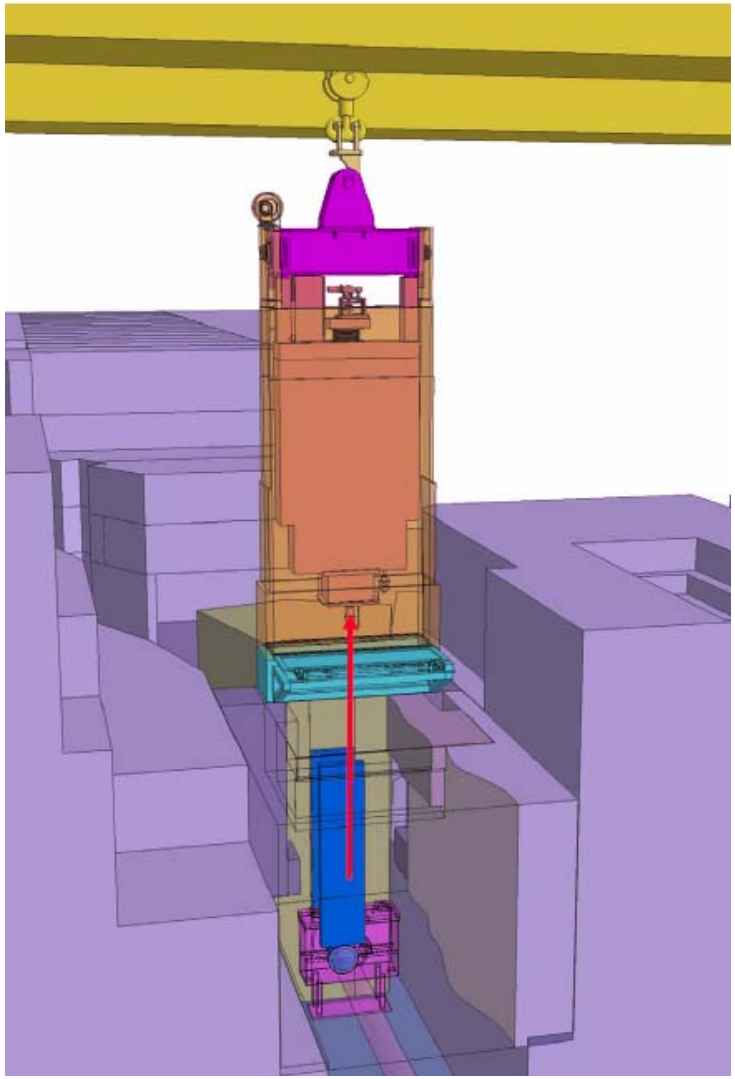
q1B
110 mSv/h
49 mSv/h

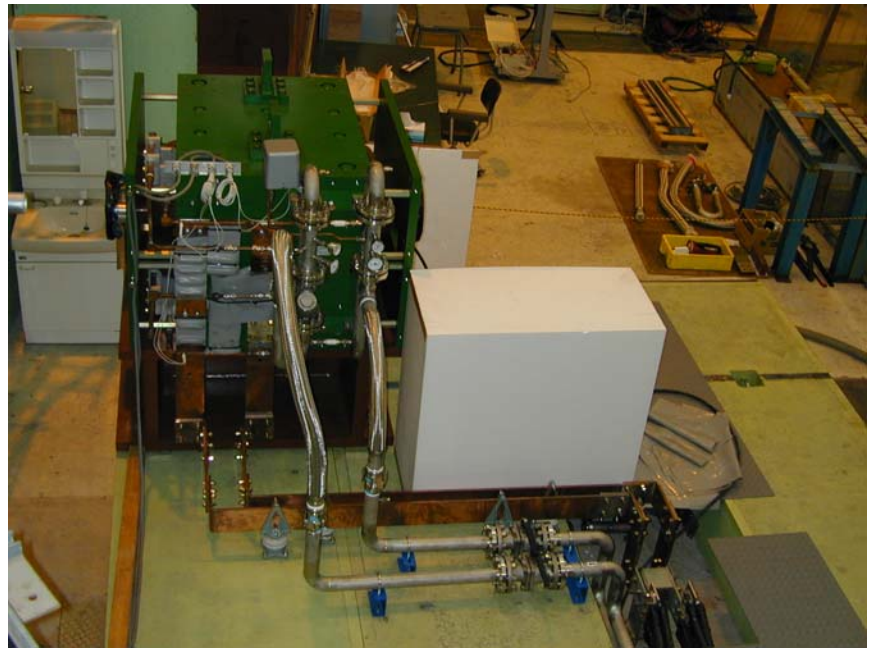
Vacuum Duct
SUS 3.2 Sv/h
1.2 Sv/h
Ti 1.1 Sv/h
97 mSv/h

Water Pipe (SUS)
8.4 μSv/h
2.4 μSv/h

Maintenance

Full Remote with crane and cask



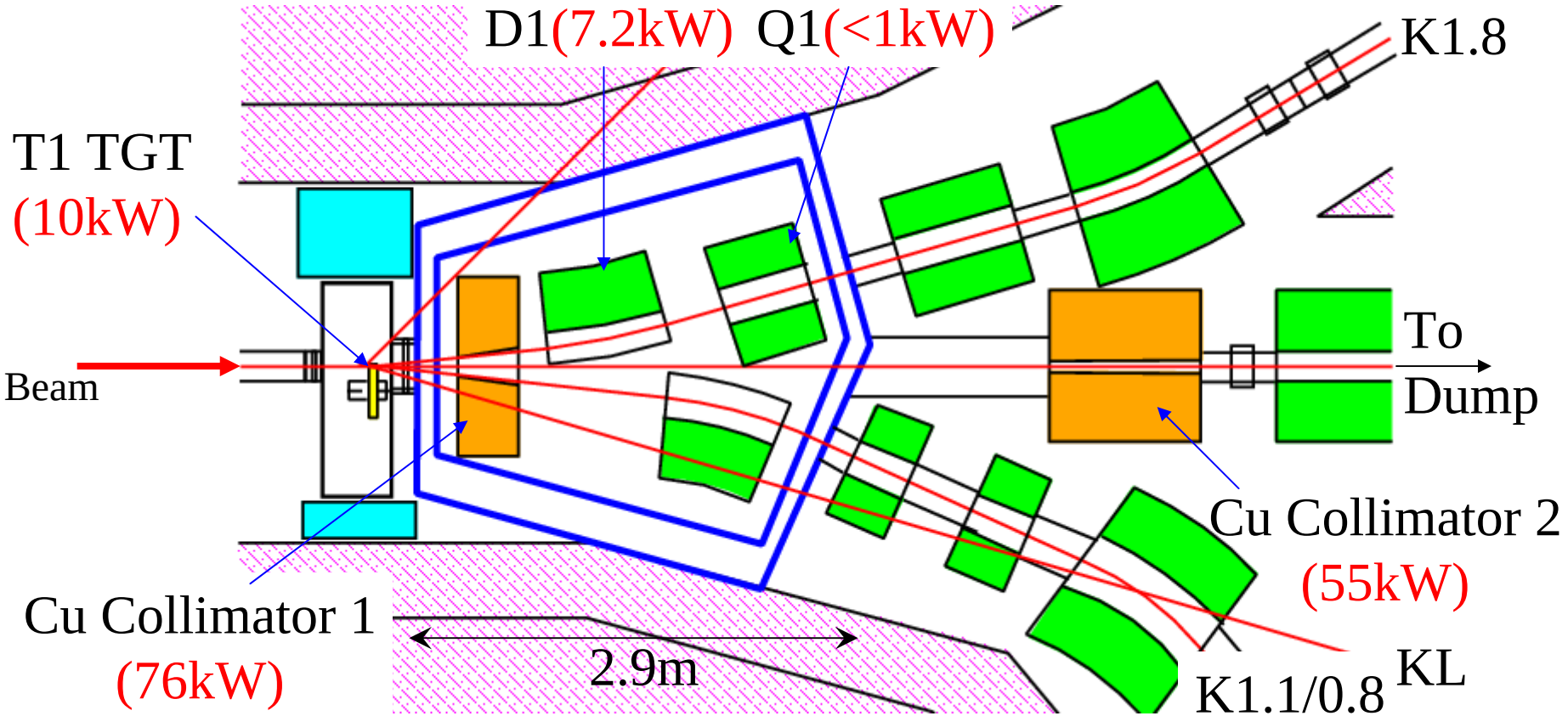


Semi-Remote

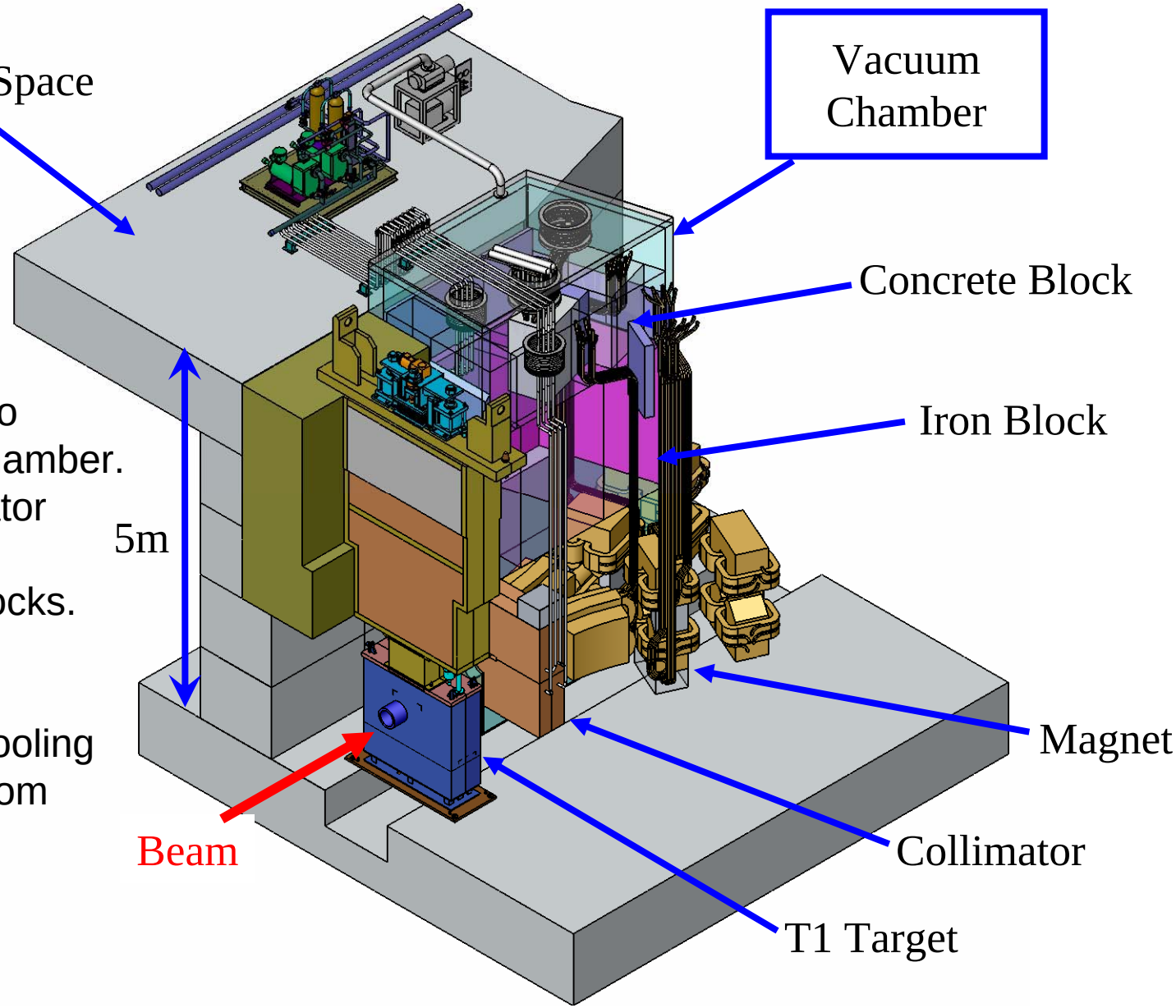
- Quick Connection/Disconnection
  - ✓ Lever Coupler for Cooling Water
  - ✓ Knife Switch for Electricity
  - ✓ Bellow Expander (Vacuum)
  - ✓ Chain Cramp for Vacuum Flange

Energy Deposit around the T1 Target

T1 (Ni t54mm) is irradiated with 50 GeV 15μA (0.75 MW) proton beam.
A power of 200 kW is released at T1.



T1 and Vacuum Chamber



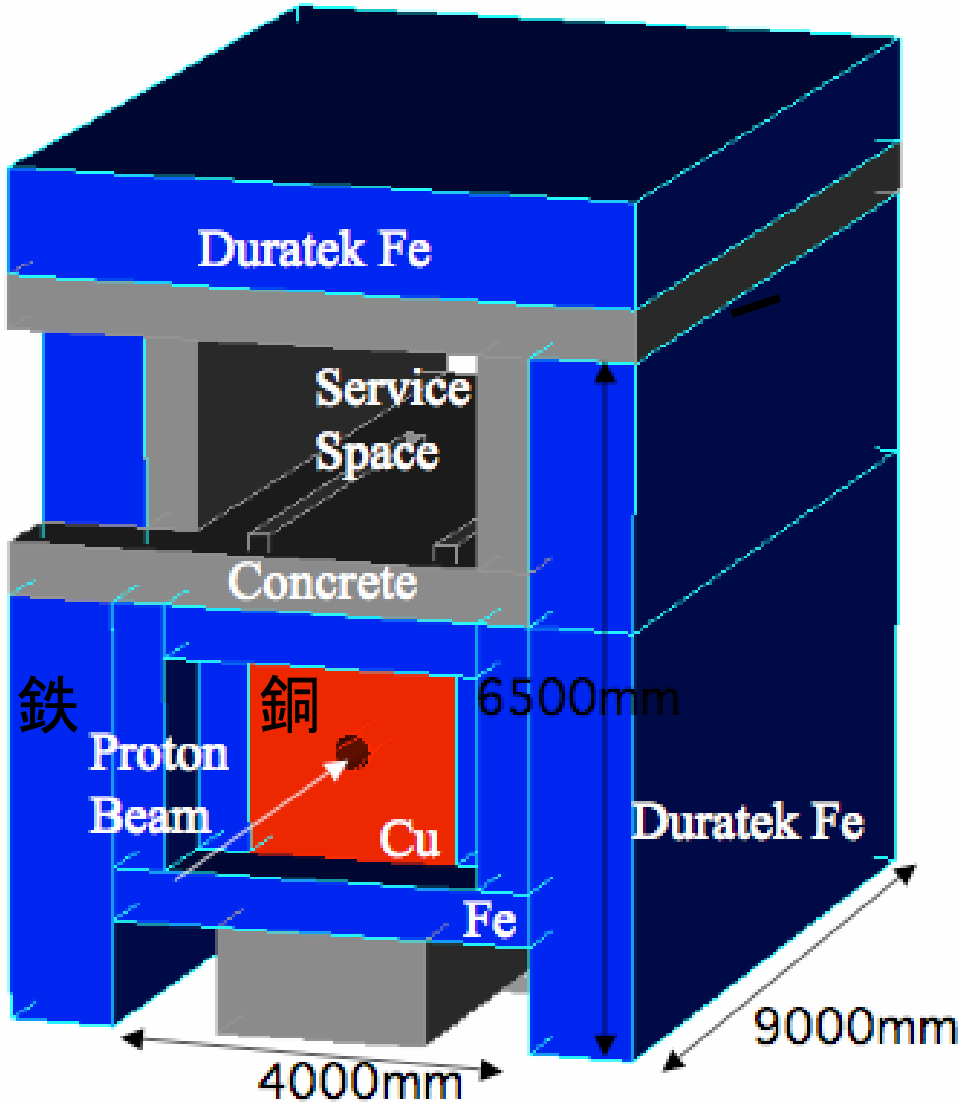
- Shield blocks are also inside the vacuum chamber.
- Each magnet/collimator has module structure unified with shield blocks.
- Chamber lid is at the service space level.
- Electric power and cooling water are provided from the service space.

ビームダンプ部材の製作

工場での銅ブロック材の検収

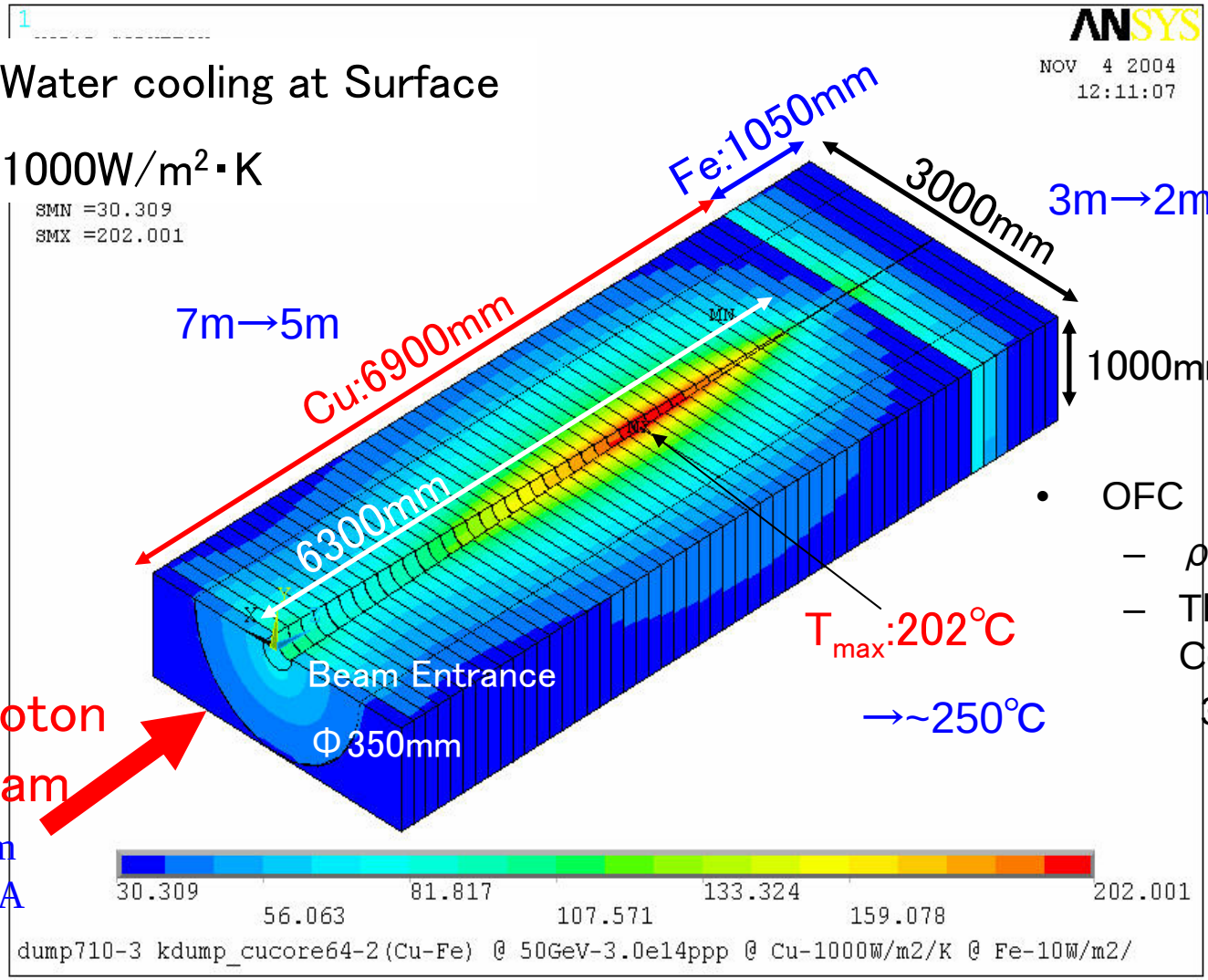
納品された鉄ブロック

ビームダンプ概念図



Beam Dump - Heat analysis by MARS & ANSYS

K. Agari (calculated by A. TOYODA & M. MINAKAWA)

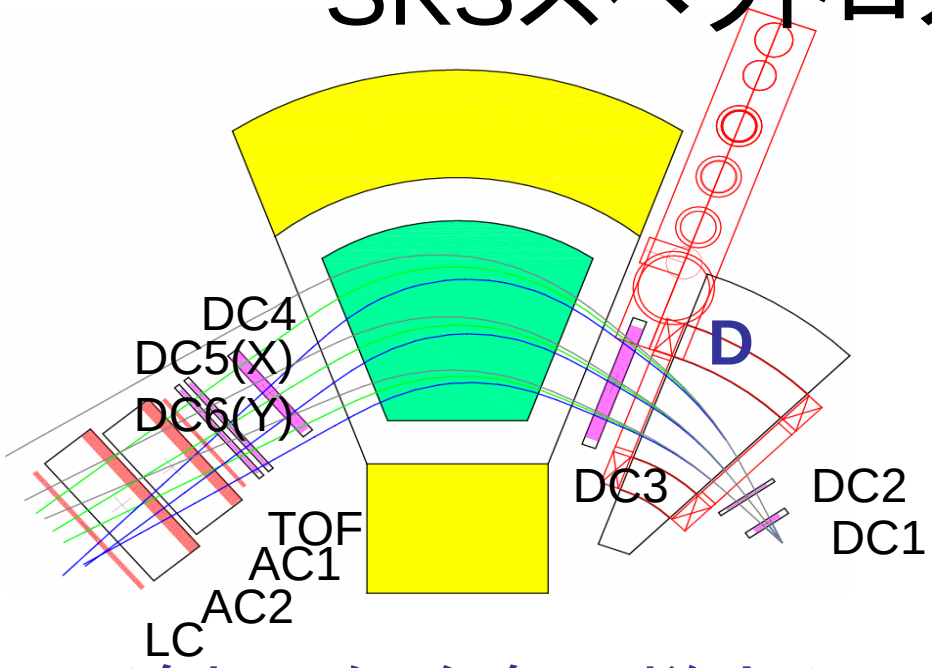


Proton beam
50GeV-15μA
(750kW)

- OFC
  - ρ =8.9[g/cm³]
  - Thermal Conductivity 390 [W/m/K]

We have to reduce the volume of Cu…

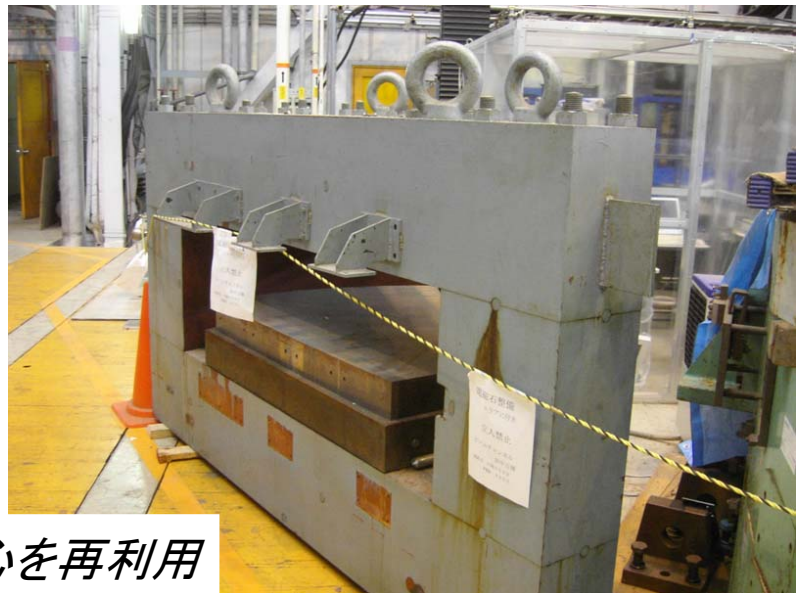
SKSスペクトロメータの改造



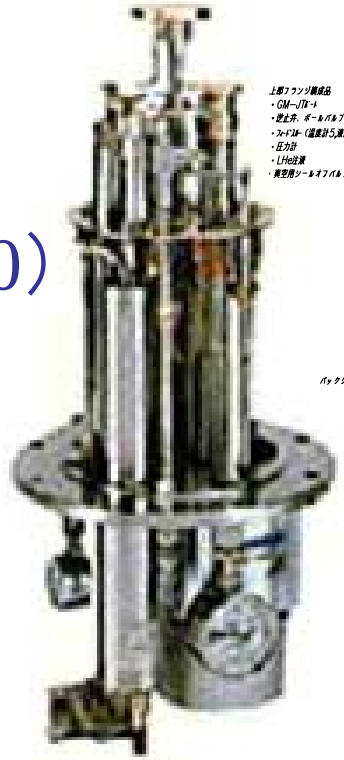
再凝縮小型冷凍機による冷却

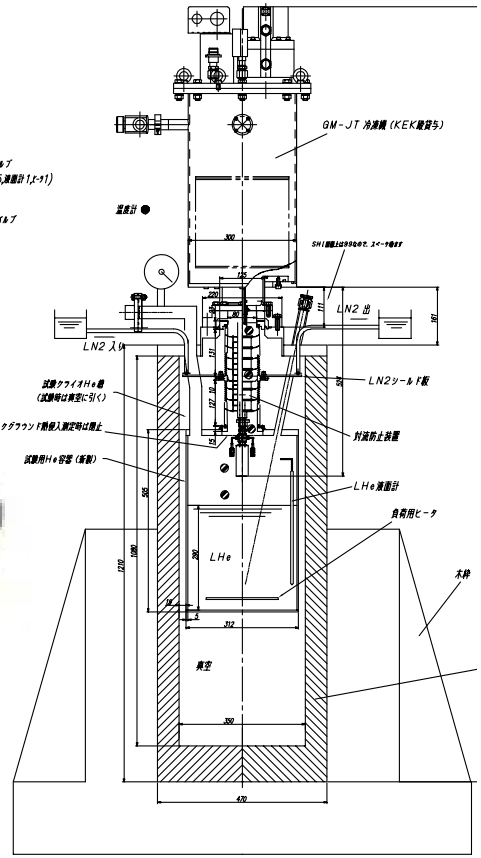
- 現在ポートからの熱侵入量評価試験準備
- 冷凍能力の評価を行う

D の追加で偏向角の増大（H19, 20）



この磁石鉄心を再利用





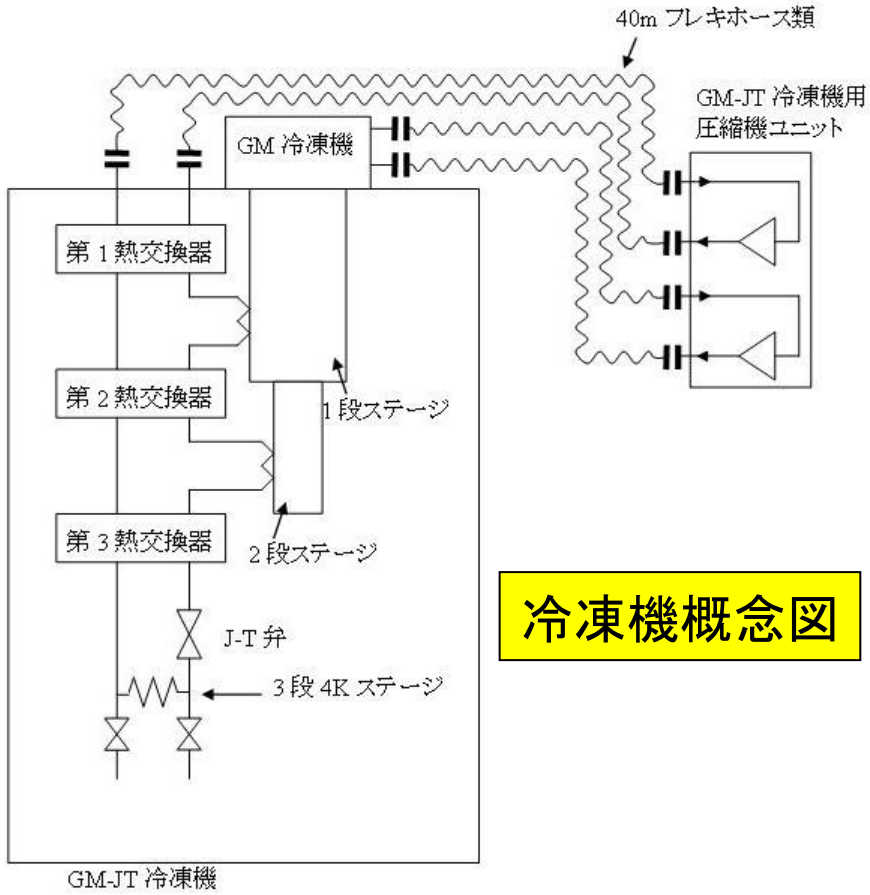
SKS冷却用小型冷凍機

- 超伝導磁石冷却：中型冷凍機は止め、GM-JT小型冷凍機

工場での試運転

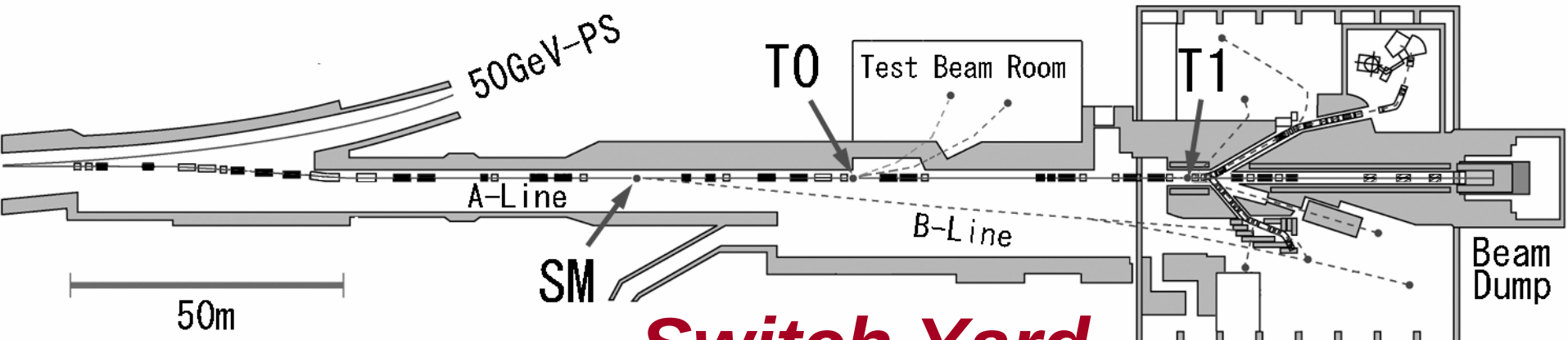
3.5W @ 4K @50Hz

コイル冷却用：2台



冷凍機概念図

Magnets for Hadron Beam Facility (Hd)



Switch Yard

Hadron Hall

42 Magnets for A-line

- Black Square: Quadrupole Magnets (24)
- Blank Square: Dipole Magnets (18)
- 17 **Polyimide Insulation (PI)** Magnet (6Q's + 11D's)
- 13 **Mineral Iinsulation Cable (MIC)** Magnets (5Q's + 8D's)
  - 12 Conventional Q's (QC1 & QC2) with Epoxy Insulation

Most Magnets are Recycled Magnets!!!!