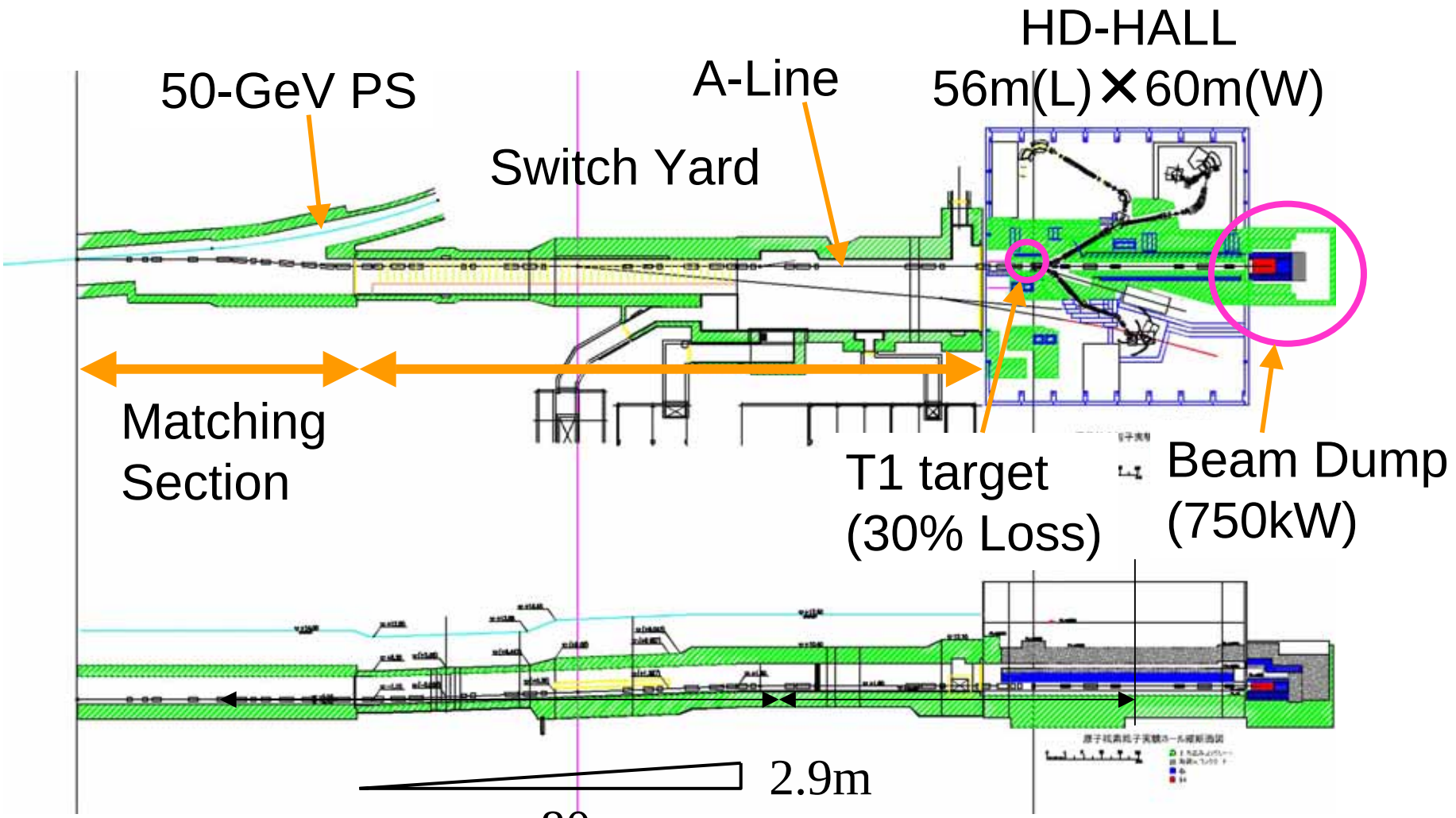
Primary and Secondary Beam Lines in the Hadron-Beam Line Facility

KEK H. Noumi

Contents:

1. Primary Beam Line (Phase I)



1. Primary Beam Line (Phase I)

- Configulation of the SEB Line

  5 sections (4 nodes and beam dump)

  Section 1…Matching Section: a beam ellipsoid matched at MP

  Section 2…beam transferred from MP to SM

  SM: branch B-Line/High-p BL in future

  Section 3…beam transferred from SM and forcused at T0

  T0: target station for Test BLs in future

  Section 4…beam transferred from T0 and forcused at T1

  T1: target station for Secondary BLs

  Section 5…beam transferred from T1 to a Beam Dump

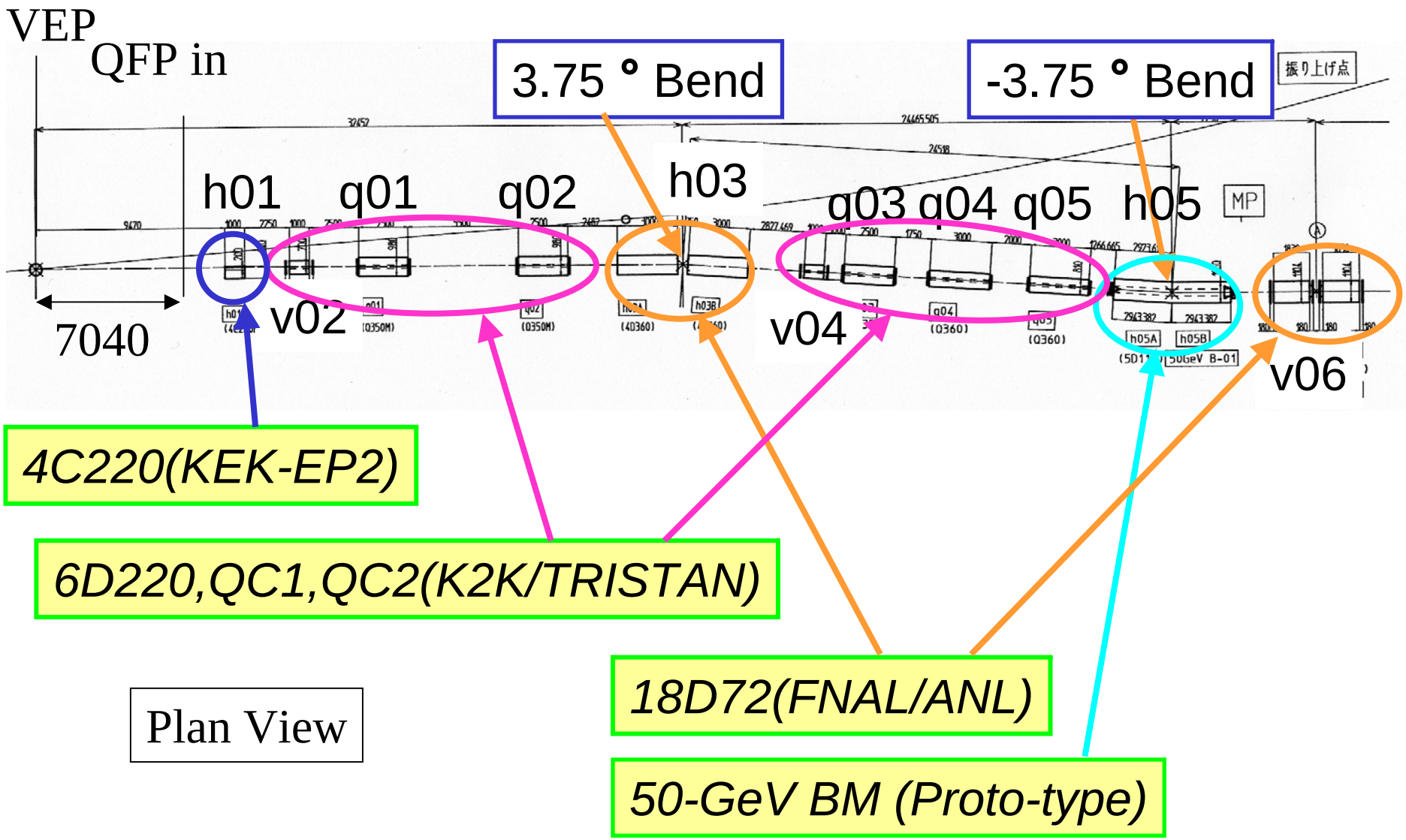
- Summary of Magnets used for the SEB Line

  18 Bending Mags: 24 Quadrupoles Mags (Phase I: 30 GeV)

  → 40 second hand magnets

  from KEK/FNAL/ANL…

Magnet Recycling in the Matching Section



Optical Parameters of SE Beam at QFP-in

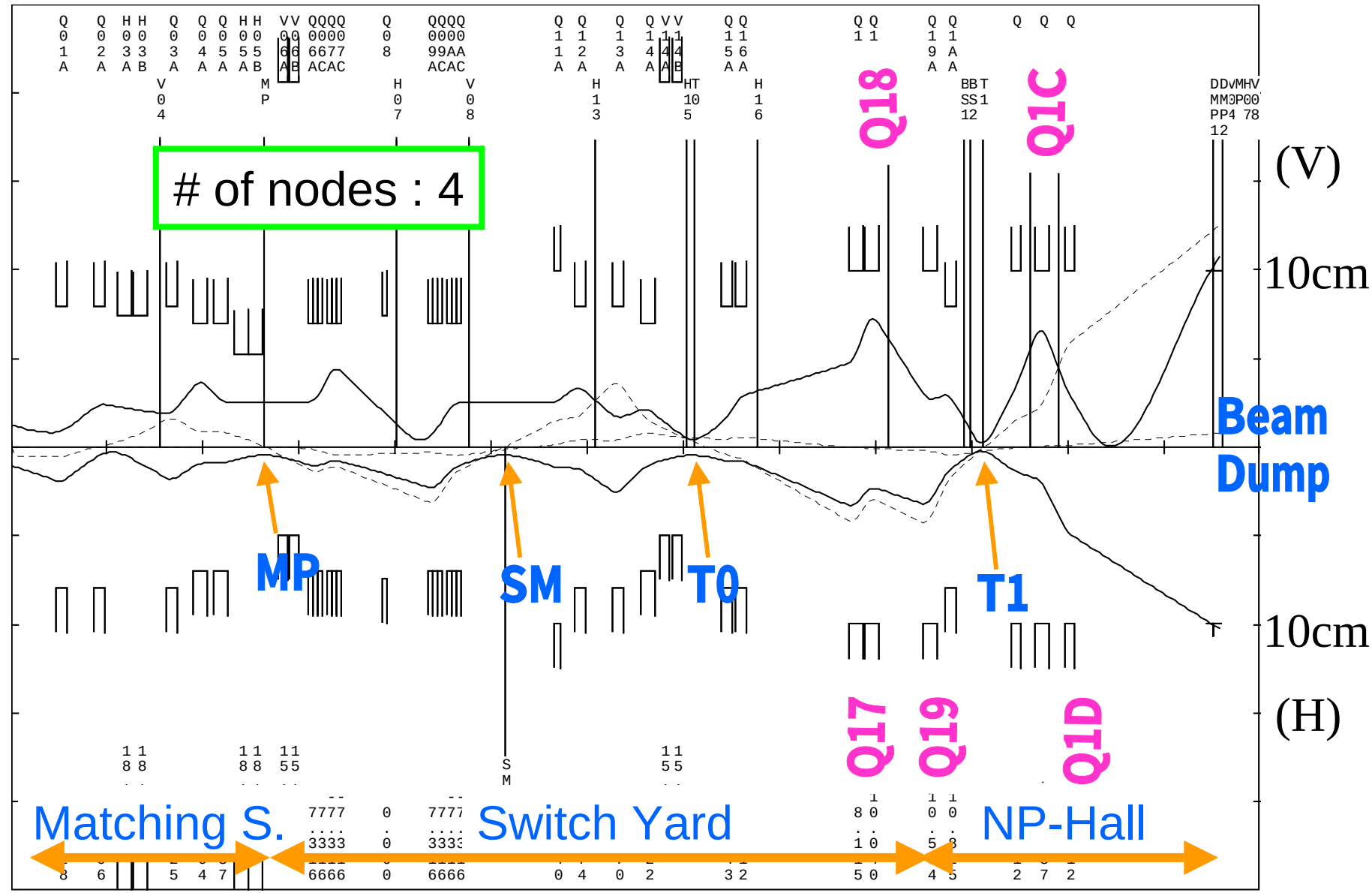
For 30 GeV from Tomizawa (2002.10.2)

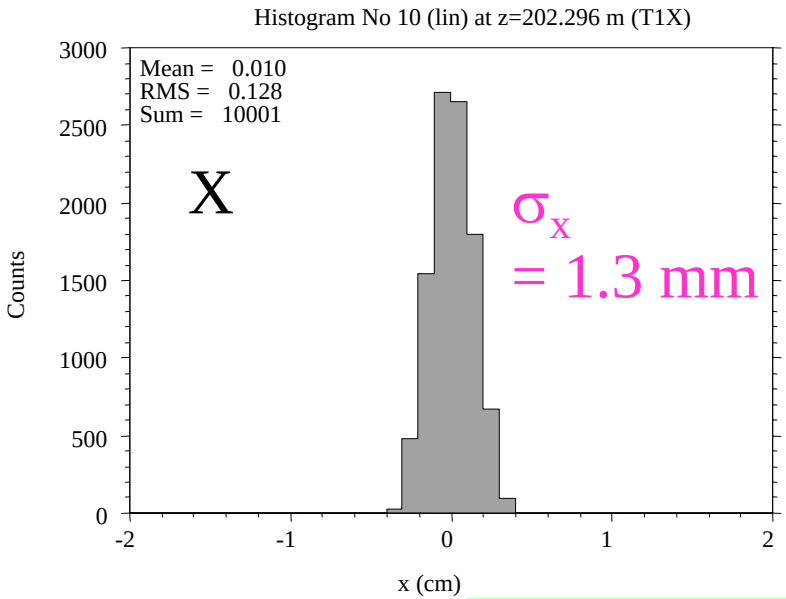
Horizontal		Vertical	
ε_H (mm mr)	4.4π	ε_V (mm･mr)	10.4π
α_H	-2.21	α_V	1.133
β_H (m)	26.476	β_V (m)	16.629
dp/p (%)	0.31		
η(cm/%)	0.518		
η'(mr/%)	0.084		

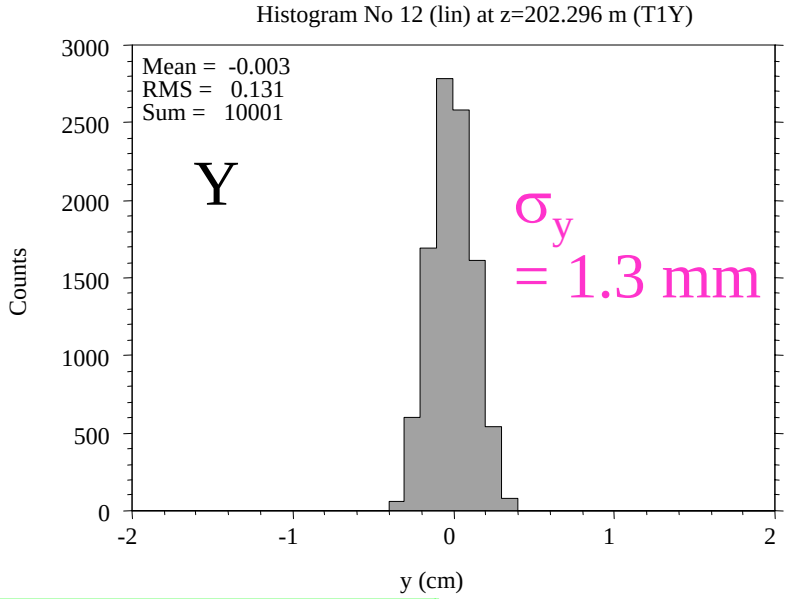
Emittance (50 GeV) ; ε_H = 2.7π, ε_V = 6.3π

Full Acceptance ; ε_H = 10.3π, ε_V = 24.4π mm･mr

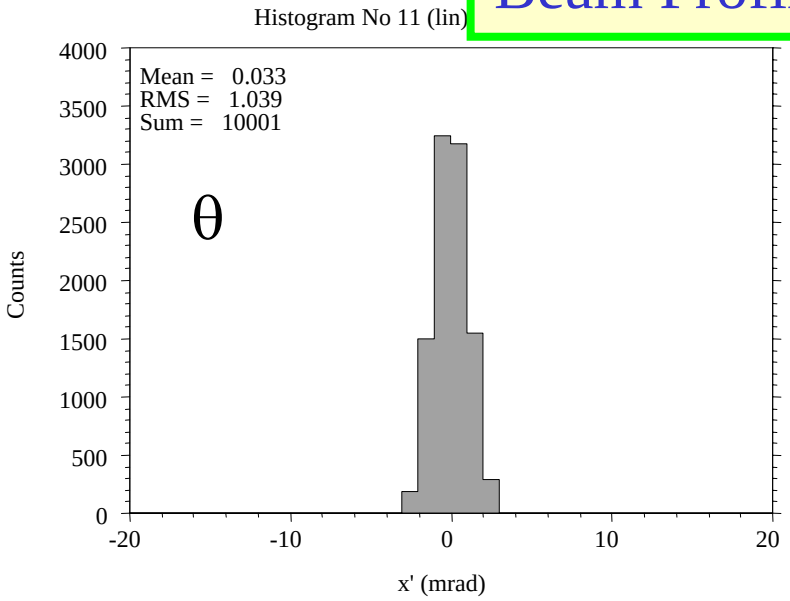
Beam Envelope (30 GeV SEB:ε_H=4.4π / ε_V=10.4π mm･mr)

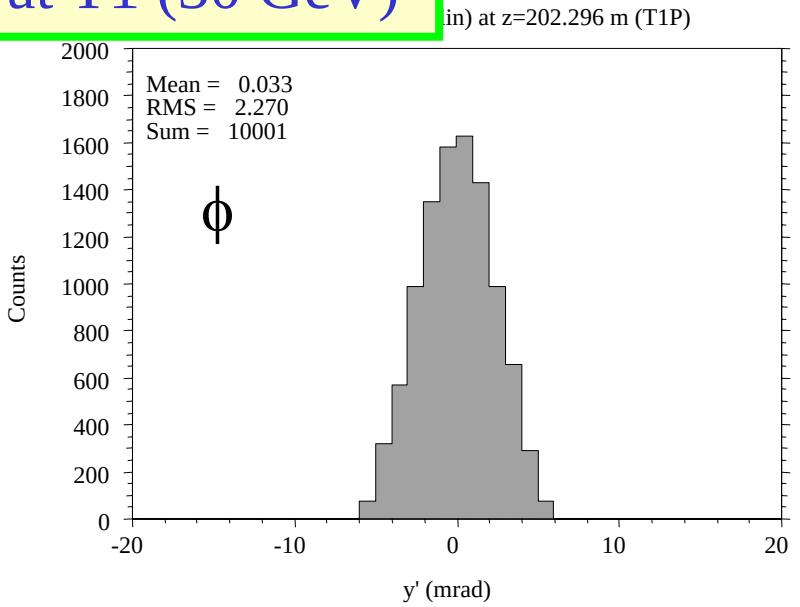




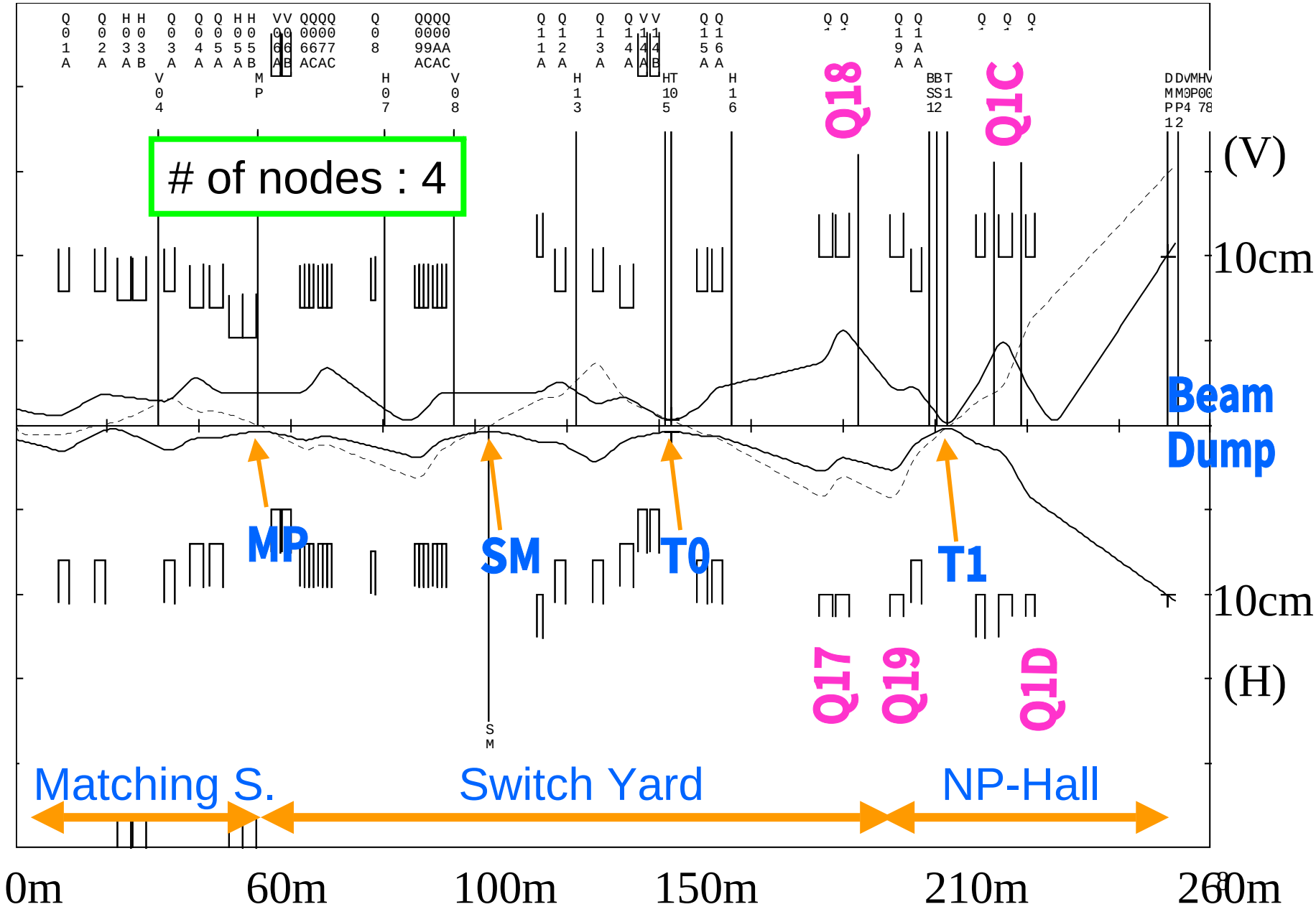


Beam Profile at T1 (30 GeV)

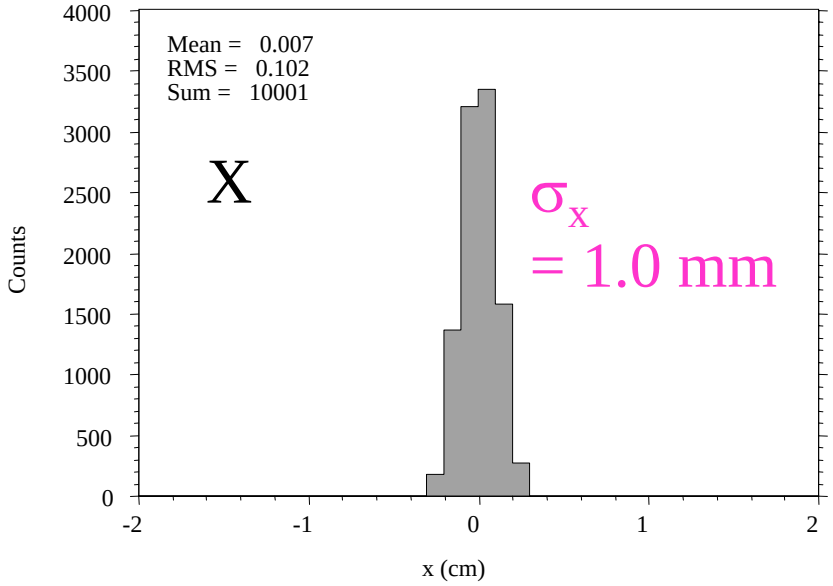




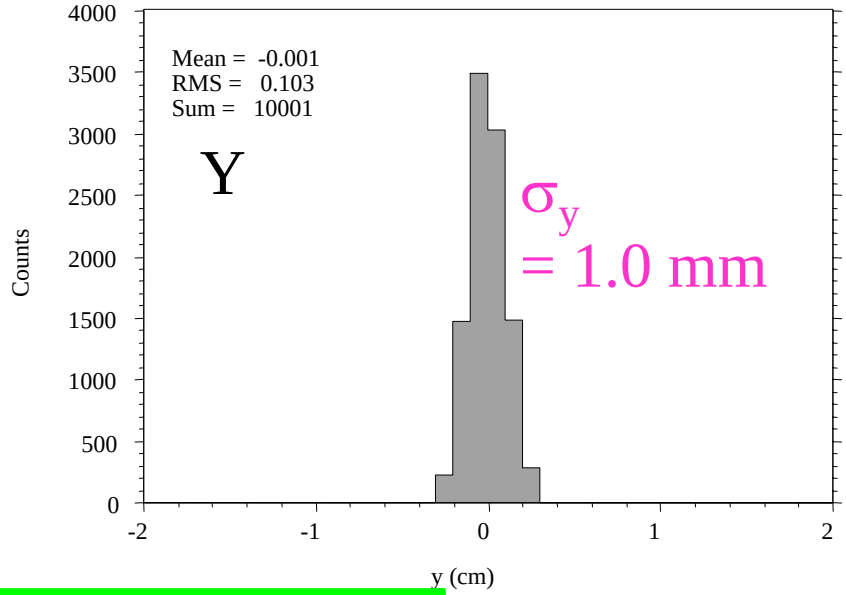
Beam Envelope (50 GeV SEB: ε_H=2.7π / ε_V=6.3π mm·mr)



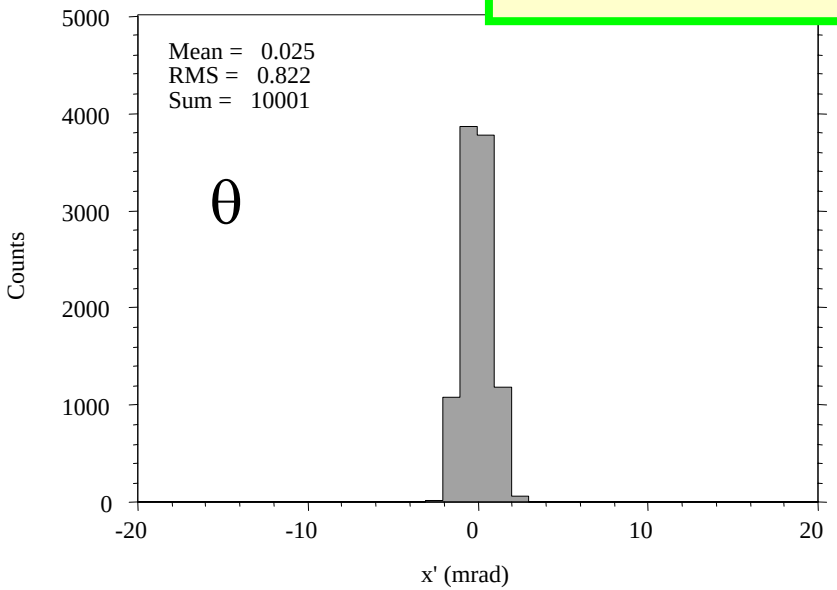
Beam Profile at T1 (50 GeV)

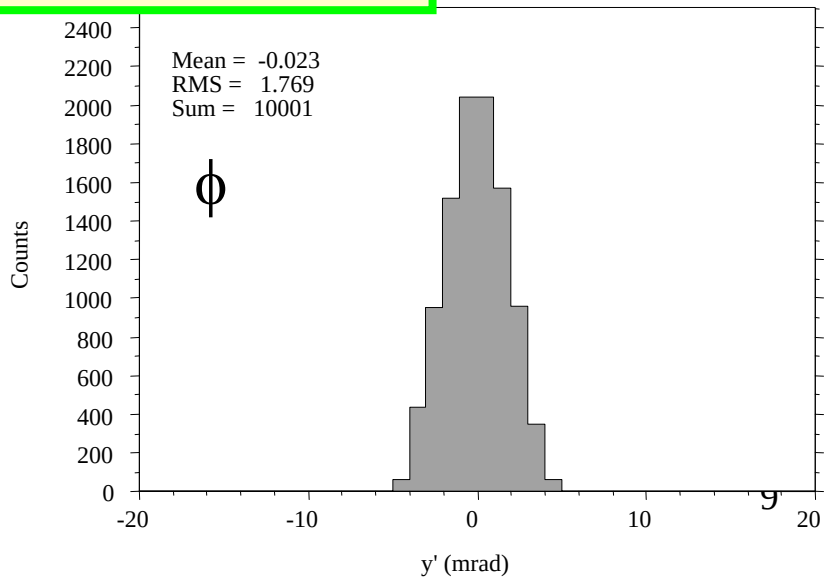


σ_x = 1.0 mm

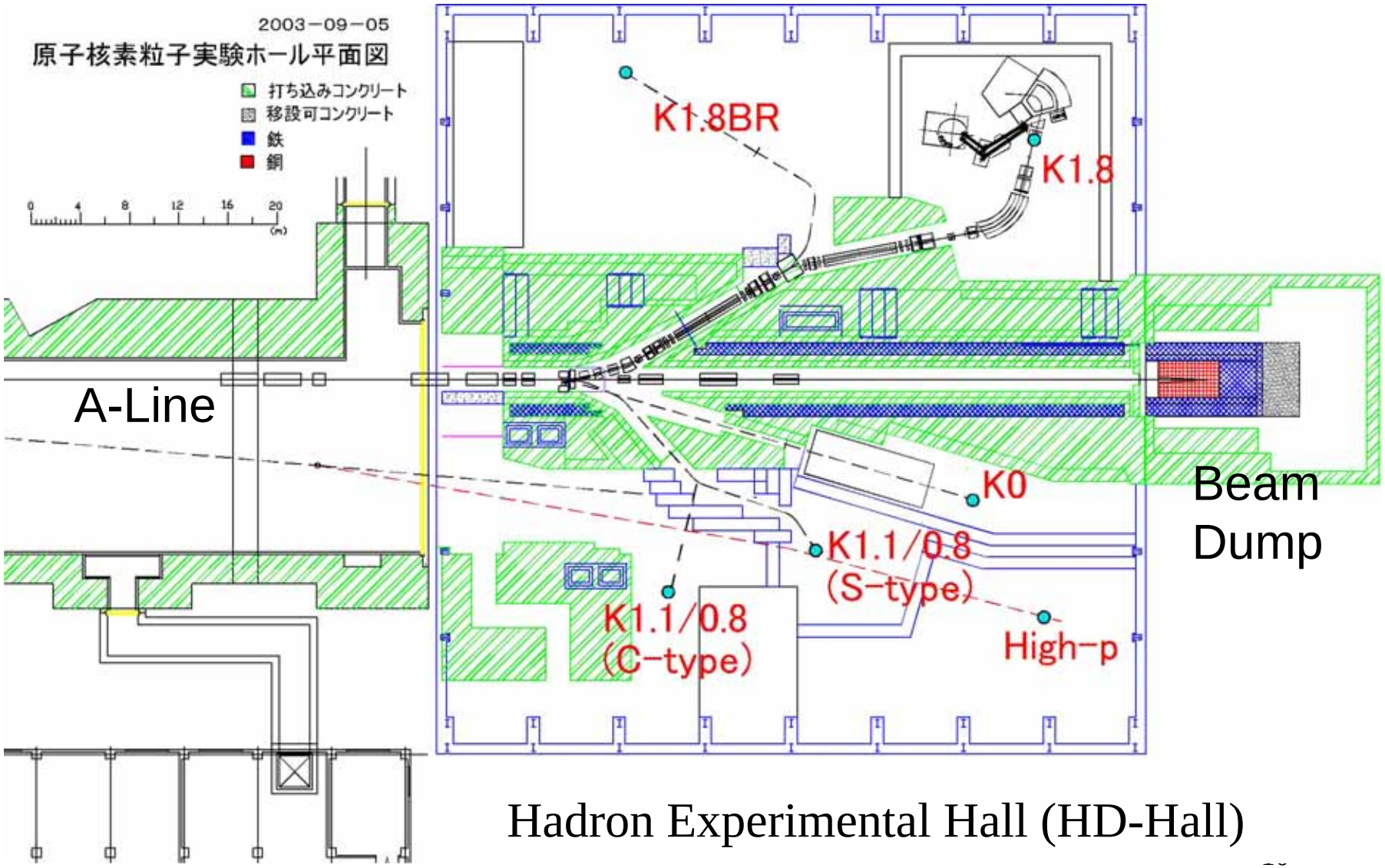


σ_y = 1.0 mm





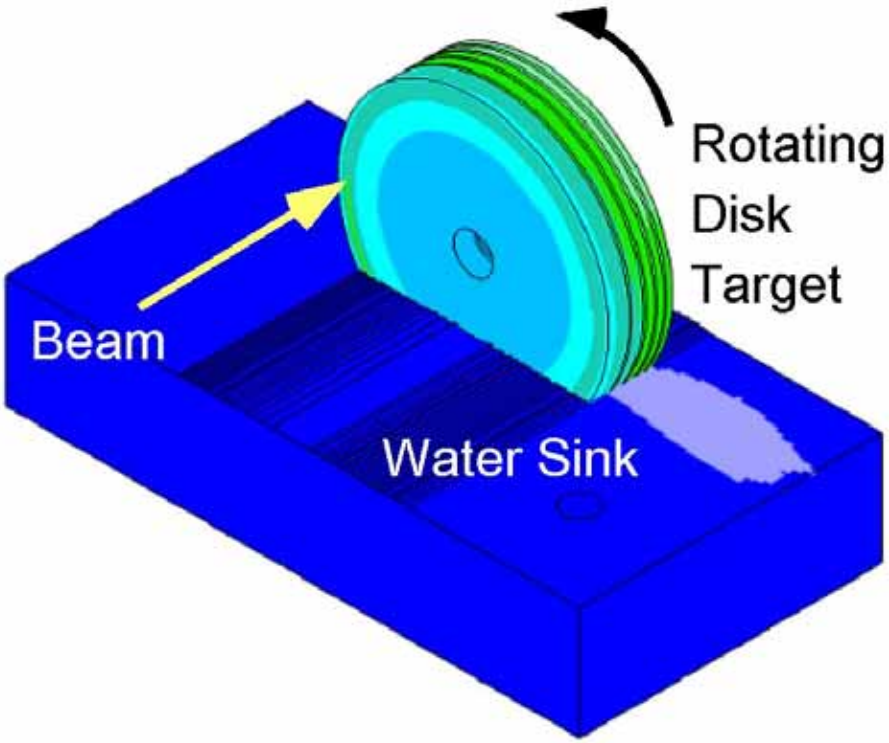
2. Secondary Beam Lines (Phase I)



Hadron Experimental Hall (HD-Hall)

T1 Target MARS+StarCD/ANSYS

(Yamanoi & Minakawa)



T1 Target:

Ni rotating disks

(t54mm: 30% int. length)

divided into 5 disks

3mm gap btwn disks

Direct Water Cooling

~80℃ Max. at 750kW (cal.)

2.1 Layout plan at T1 (Phase I)

- Protection from 200 kW heat deposit in the T1-front area
  - → Collimator before D1 (q1B)
  - → Water-cooled D1(Q1) yoke

  Hard to cool beam pipes in magnet poles & vacuum flanges

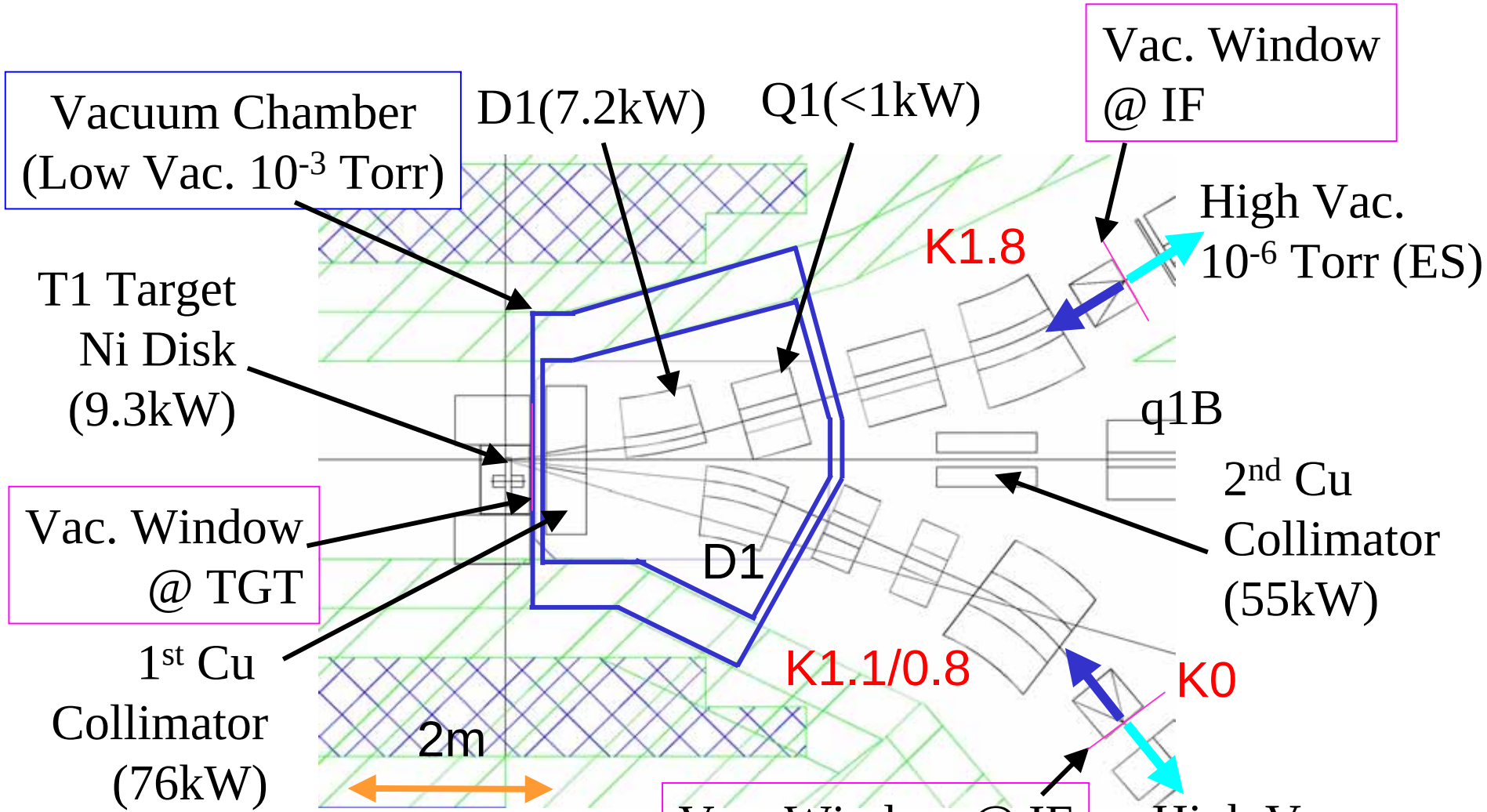
  →Front-end elems MUST be in Vacuum
  Careful design for safety maintenance: need R&D

- Only a production target in Phase I, T1
  - → shared by 2 charged/1 neutral kaon beam lines

  Prod. Angle : -6 ° (K1.8), +6 ° (K1.1/0.8), +16 ° (K0)

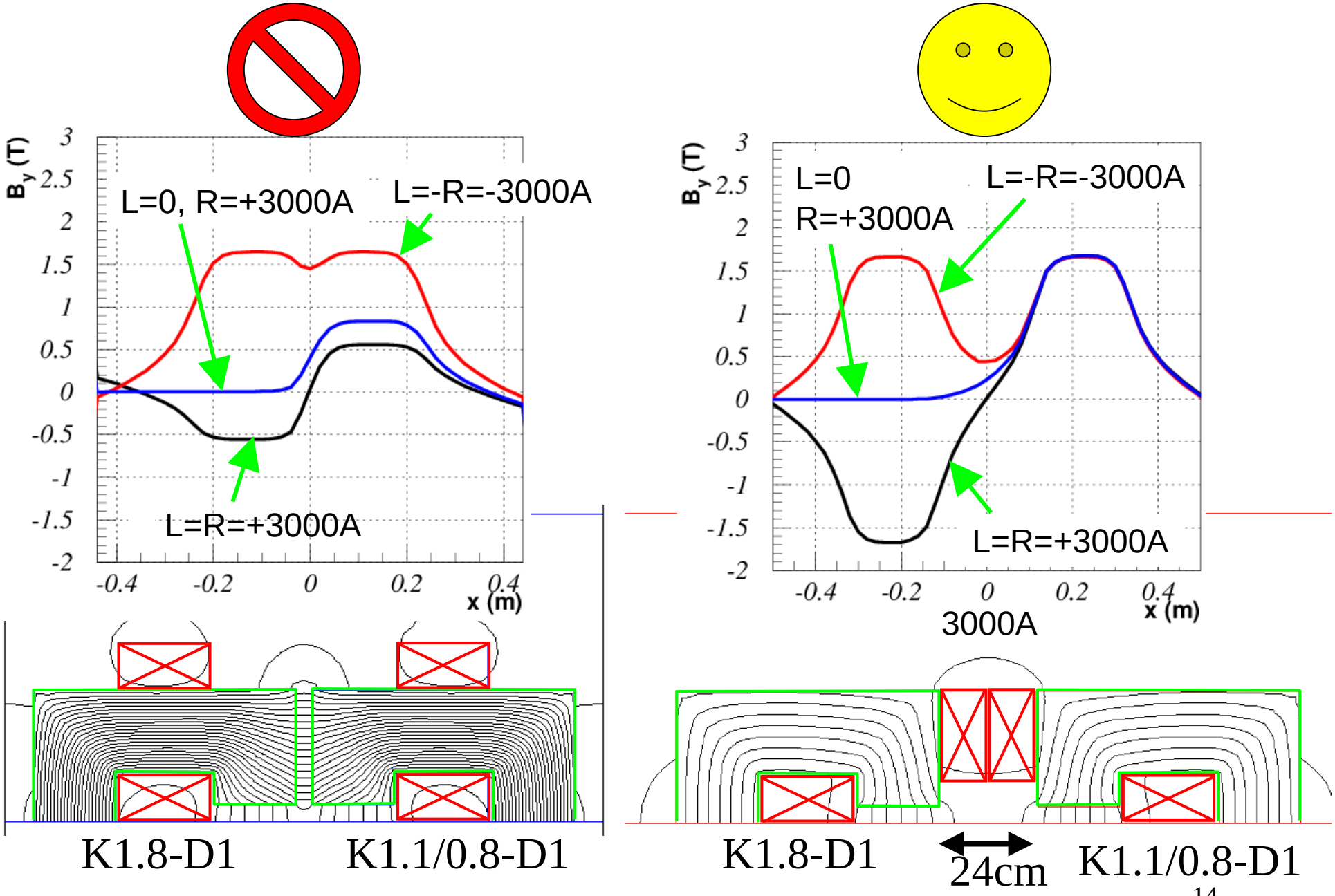
- Layout w/o any Interference of Magnetic Fields
  btwn K1.8-D1/Q1 and K1.1/0.8-D1

2.1 Layout plan at T1 (Phase I)



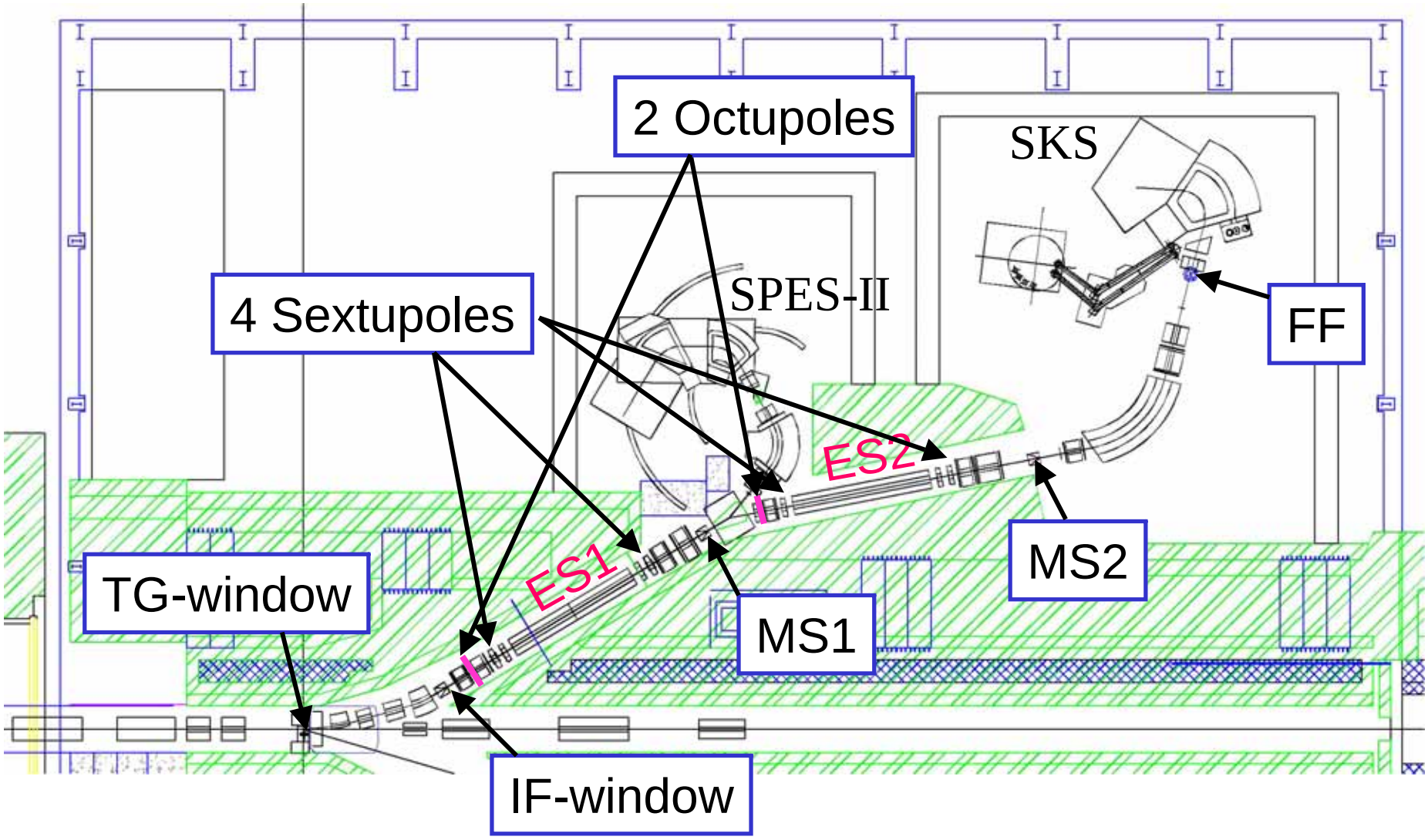
T1 & CVC

⇒ Takahashi's Talk in Joint Session (SEB User)



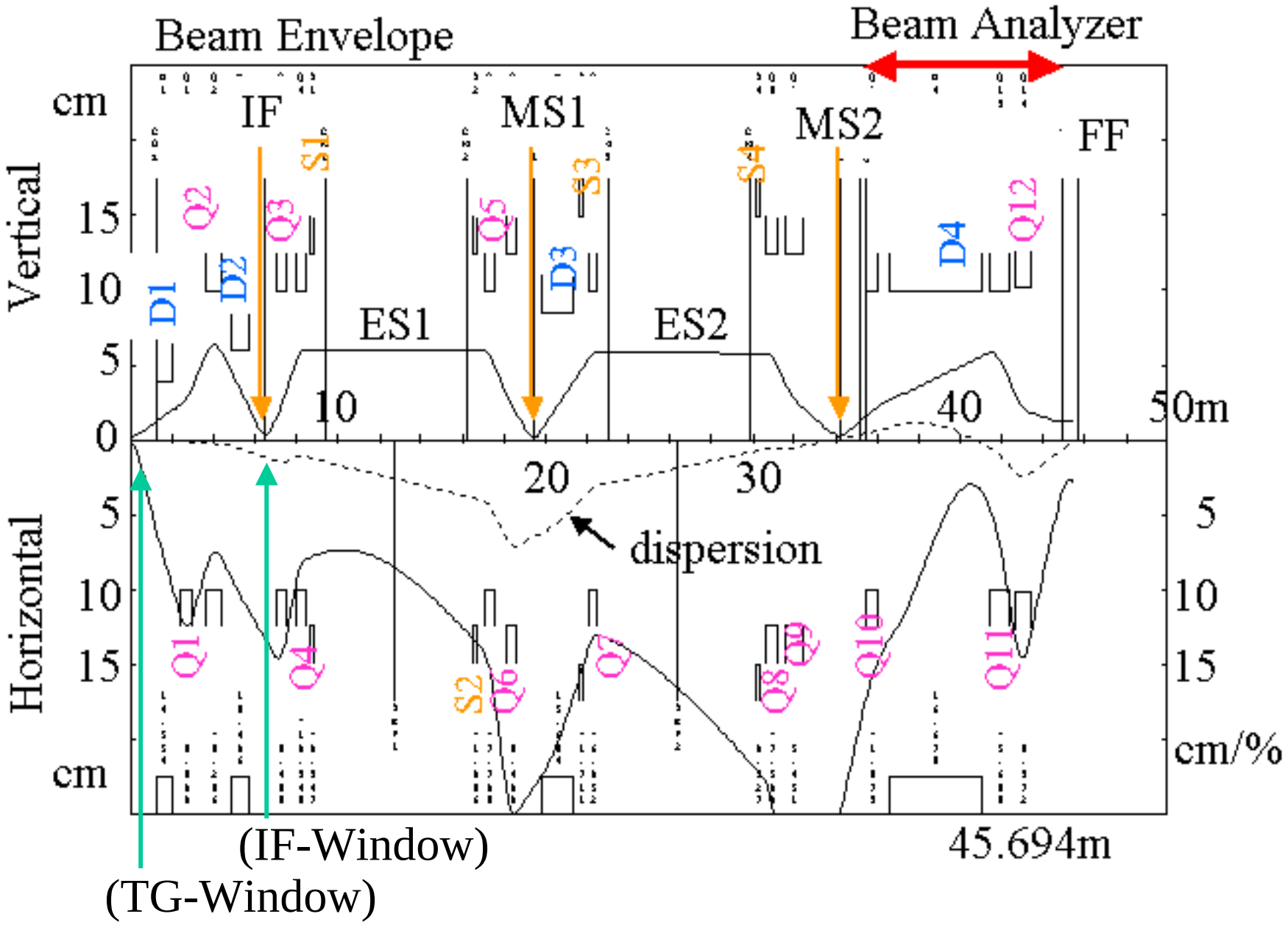
(Calculated by H. Takahashi)

2.2 K1.8 Beam Line



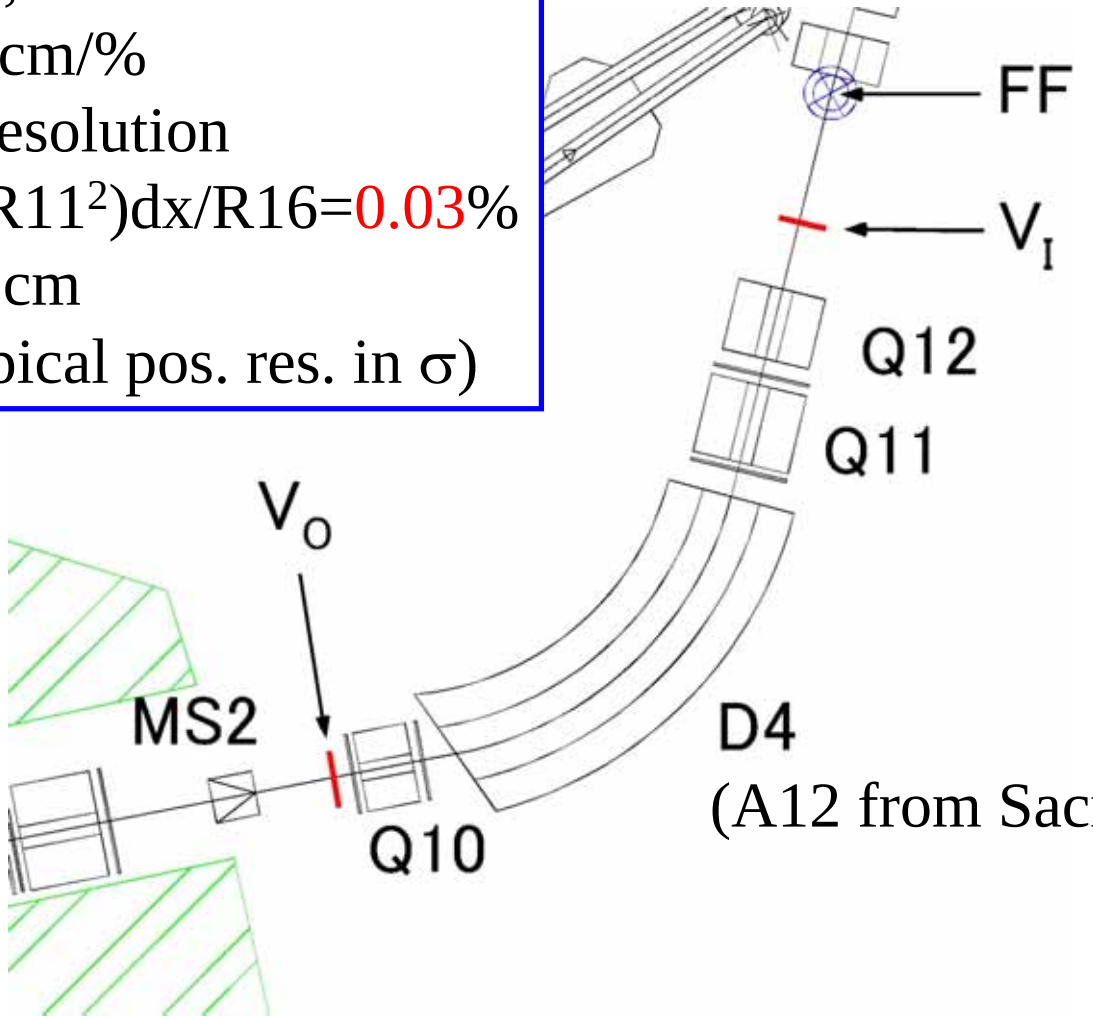
⇒ Decay TURTLE (3rd Order Optics + ES Field)

K1.8 Beam Line Optics



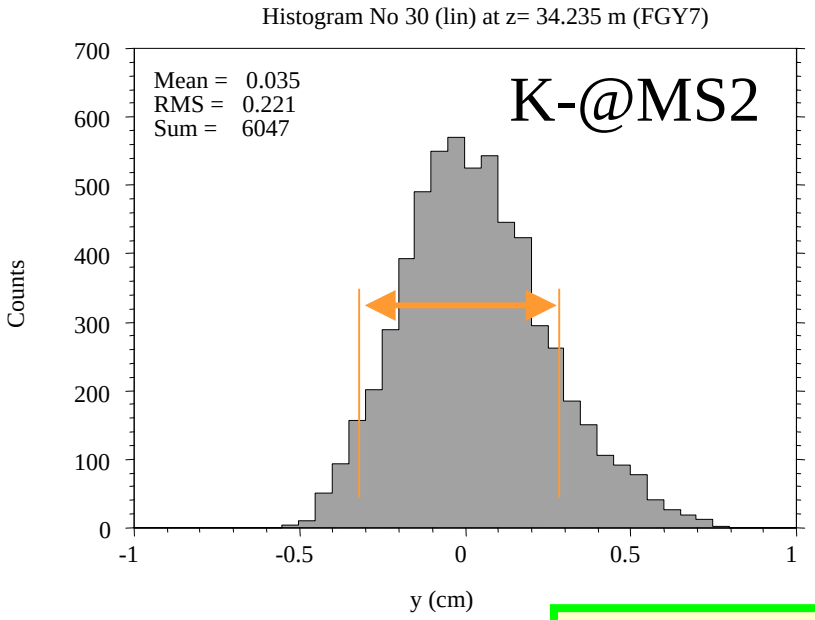
Beam Momentum Analyzer

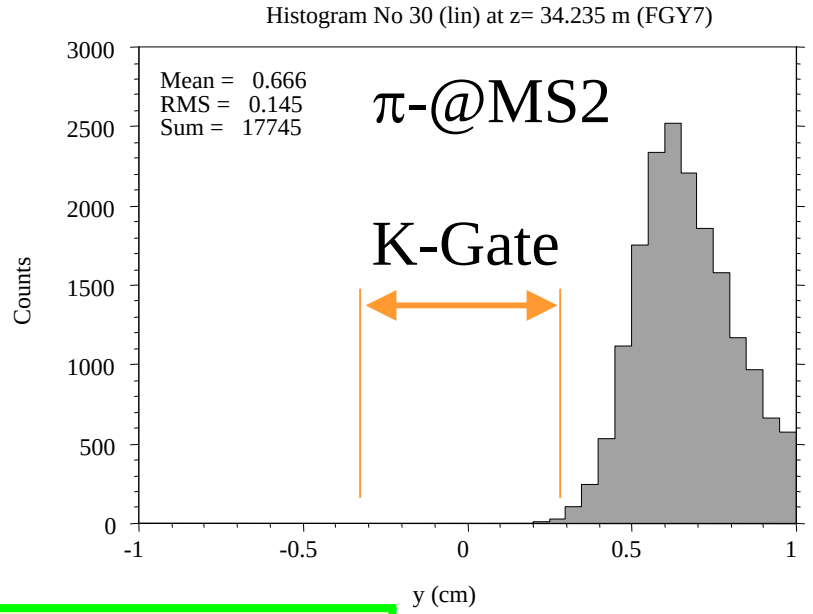
- Beam Analyzer (Vo→Vi):
  R11=-0.174, R12=0
  R16=0.725 cm/%
- 1st Order Resolution
  dp=sqrt(1+R11²)dx/R16=0.03%
  for dx=0.02cm
  (typical pos. res. in σ)



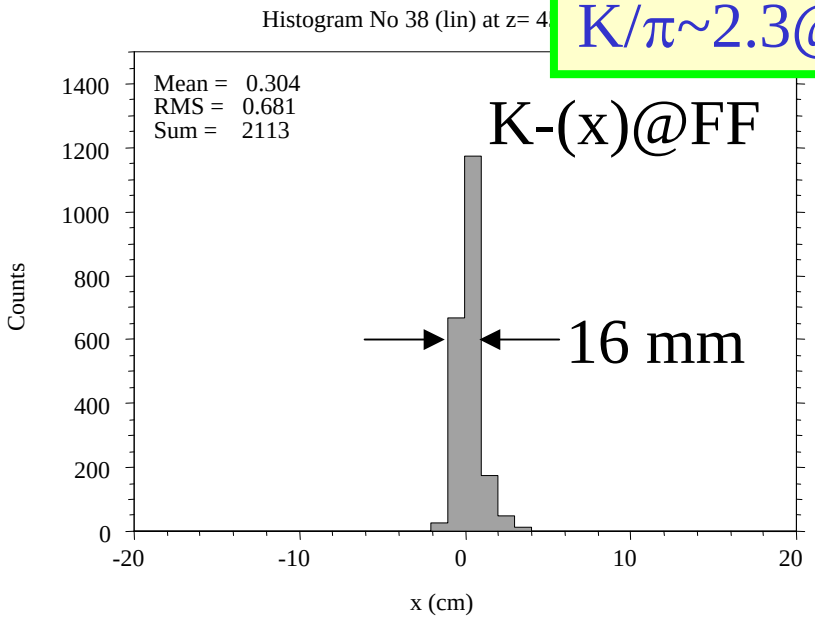
(A12 from Sacray)

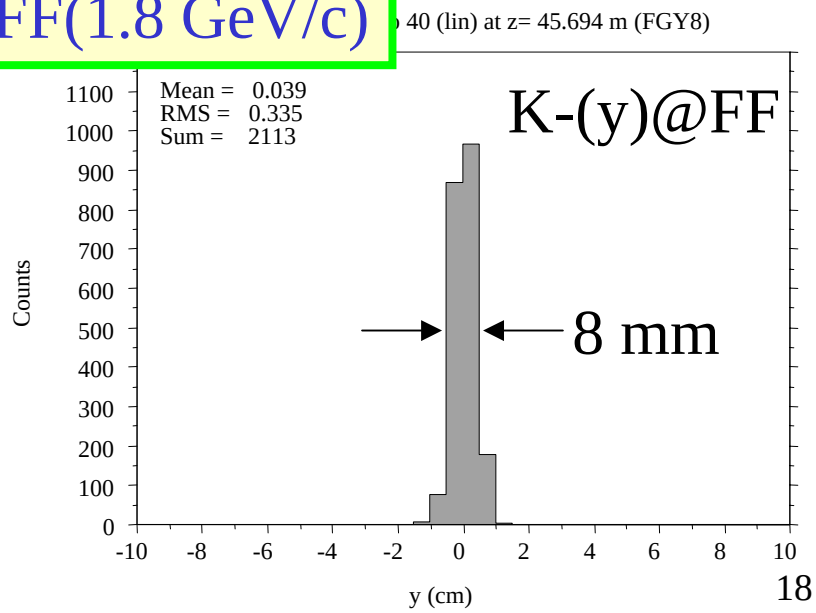
w/ TG, IF-windows (SUS-200μm,50μm)　　MS1 **Opening:±2** mm





K/π~2.3@FF(1.8 GeV/c)





3rd Order Optics → Two octupoles are to be installed.

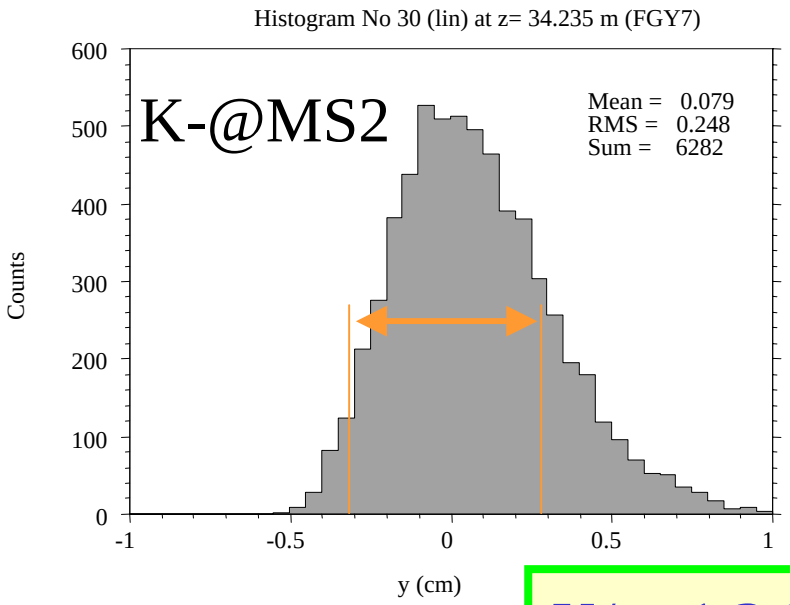
	K1.8 (50 GeV-15μA)	(30 GeV-9μA)
Max. Mom. (GeV/c)	2	
Length (m)	45.694	
Acceptance (msr.%) &	2.03(2.00%)	
$K^-(\pi)$ Intensity (ppp)#		
1.8 GeV/c	9.6E+06	2.0E+06
1.1 GeV/c	0.6E+06	0.1E+06
Electro-static Separator	750kV/10cm 6m×2	
K^-/π^- @ 1.8 GeV/c $	2.3(1.3%)	2.6
X/Y(FWHM) size @ FF (mm)	16/8	

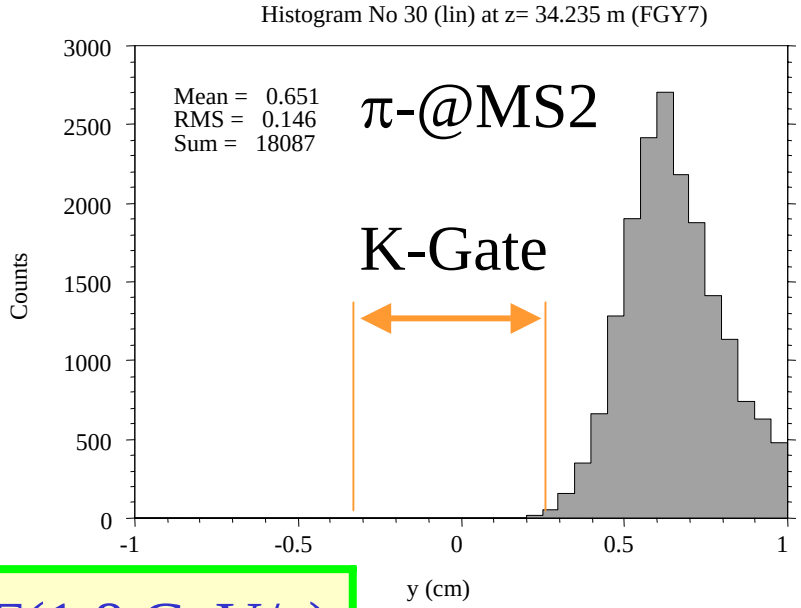
& MS1 opening: ±2mm, MS2 opening: -3.25mm,+2.75mm

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

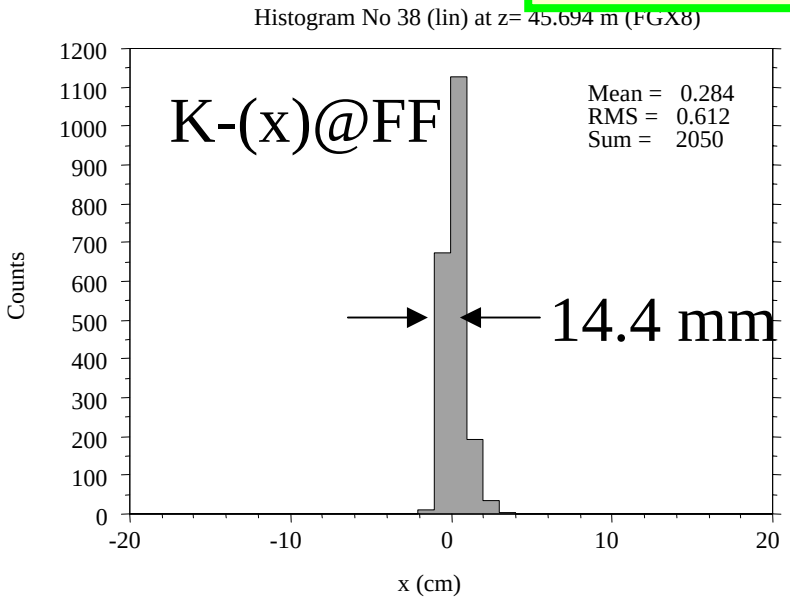
$ cloud π not included, % values in () for no octupoles

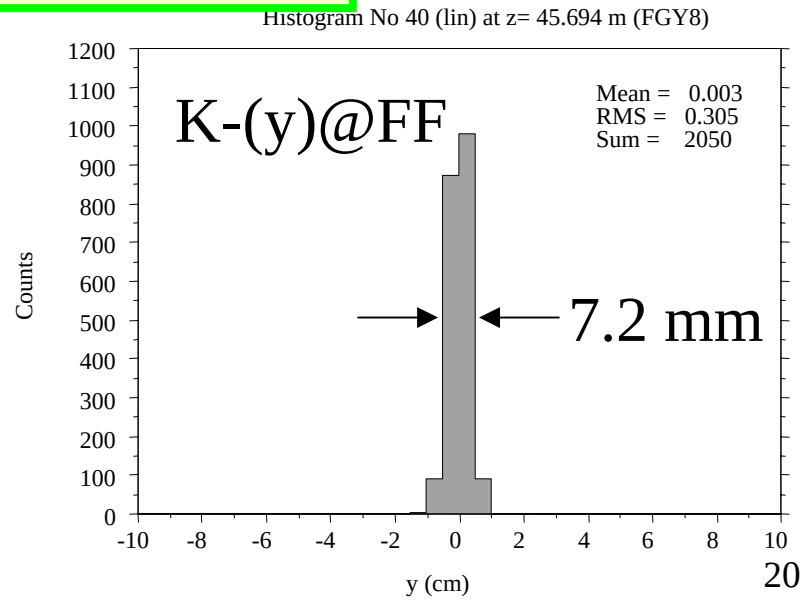
No Octupoles: TG, IF-windows (SUS-200μm,50μm)





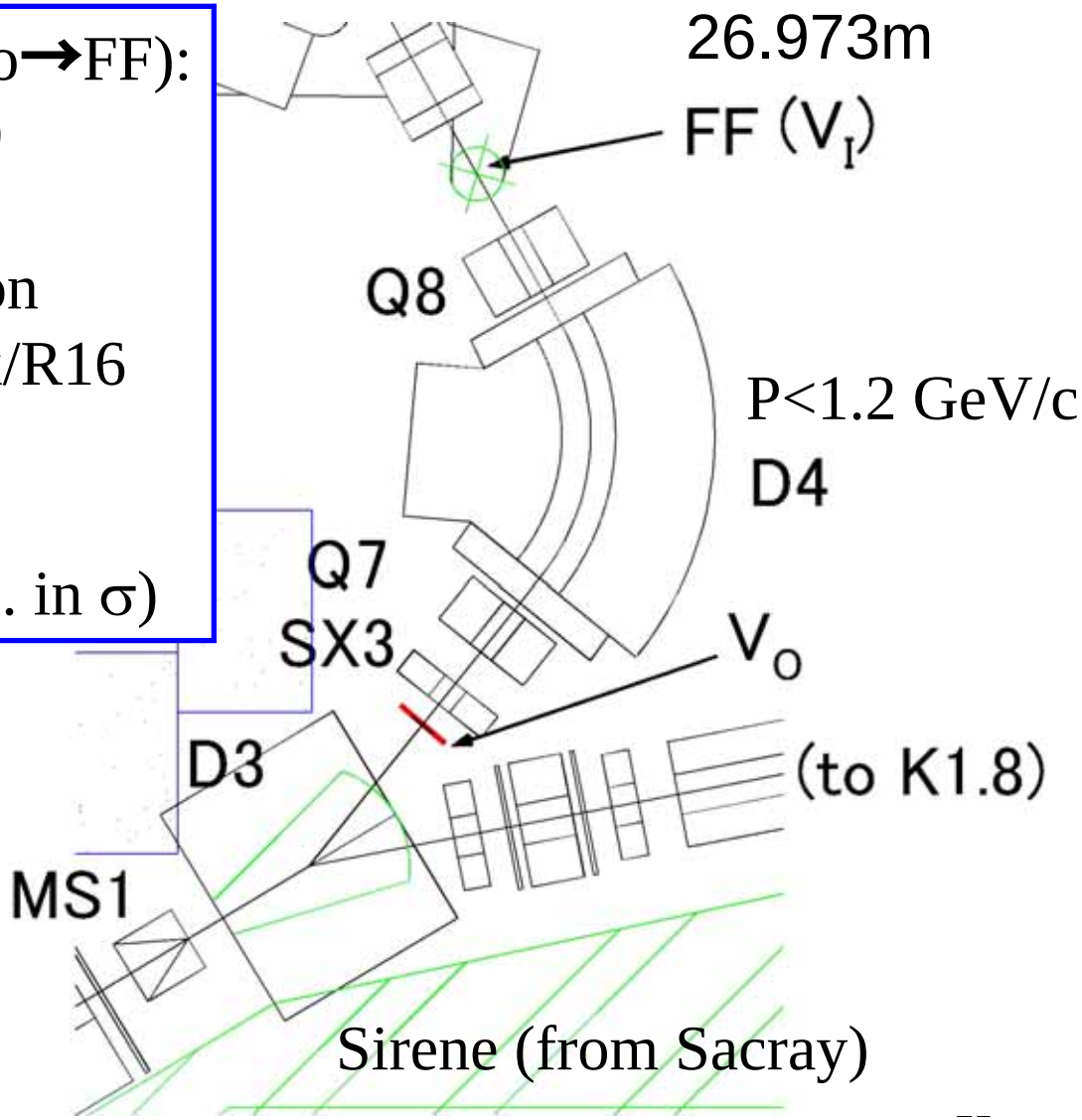
K/π~1.3@FF(1.8 GeV/c)



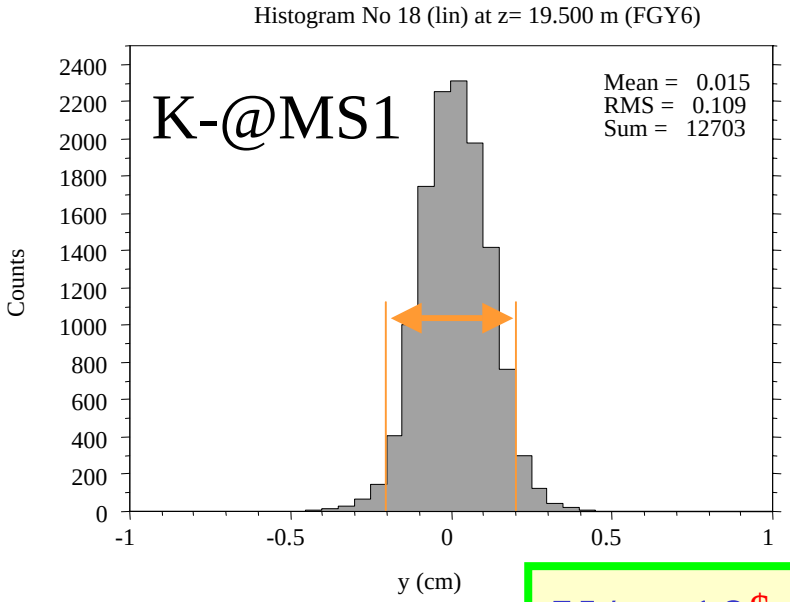


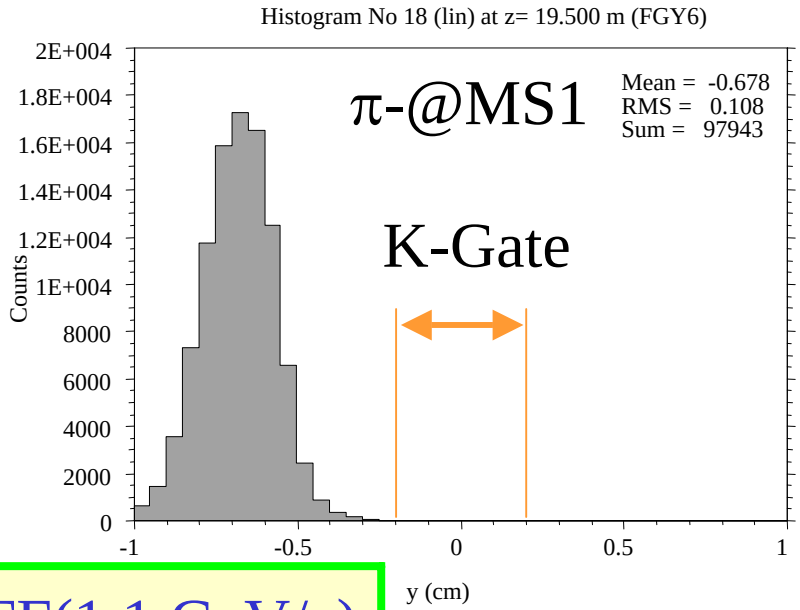
K1.8BR Line (Option I)

- Beam Analyzer (Vo→FF):
  R11=-0.36, R12=0
  R16= 1.06 cm/%
- 1st Order Resolution
  $dp=\sqrt{(1+R11^2)}\,dx/R16$
  =0.02%
  for dx=0.02cm
  (typical pos. res. in σ)

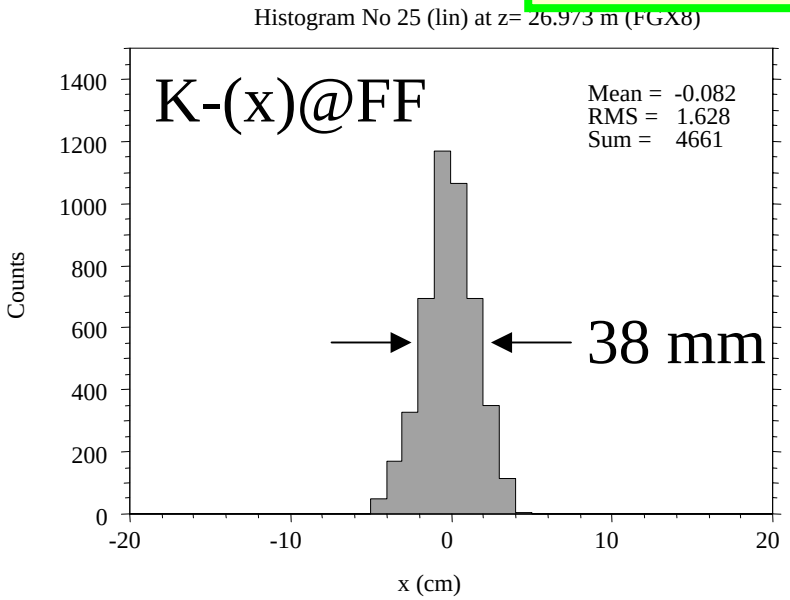


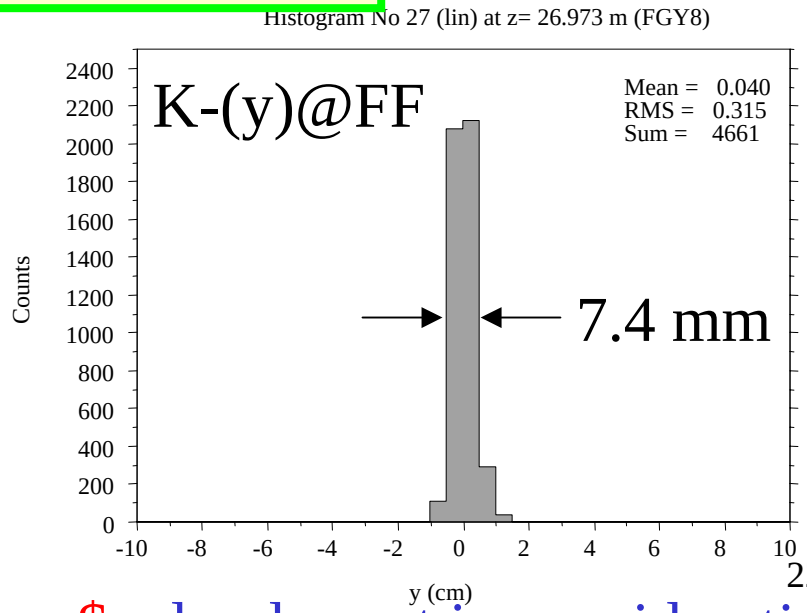
K1.8BR, ES1=500kV/10cm





K/π~10$@FF(1.1 GeV/c)





$: cloud π not in consideration

K1.8BR Beam Line 3rd Order Optics

2004.7.30

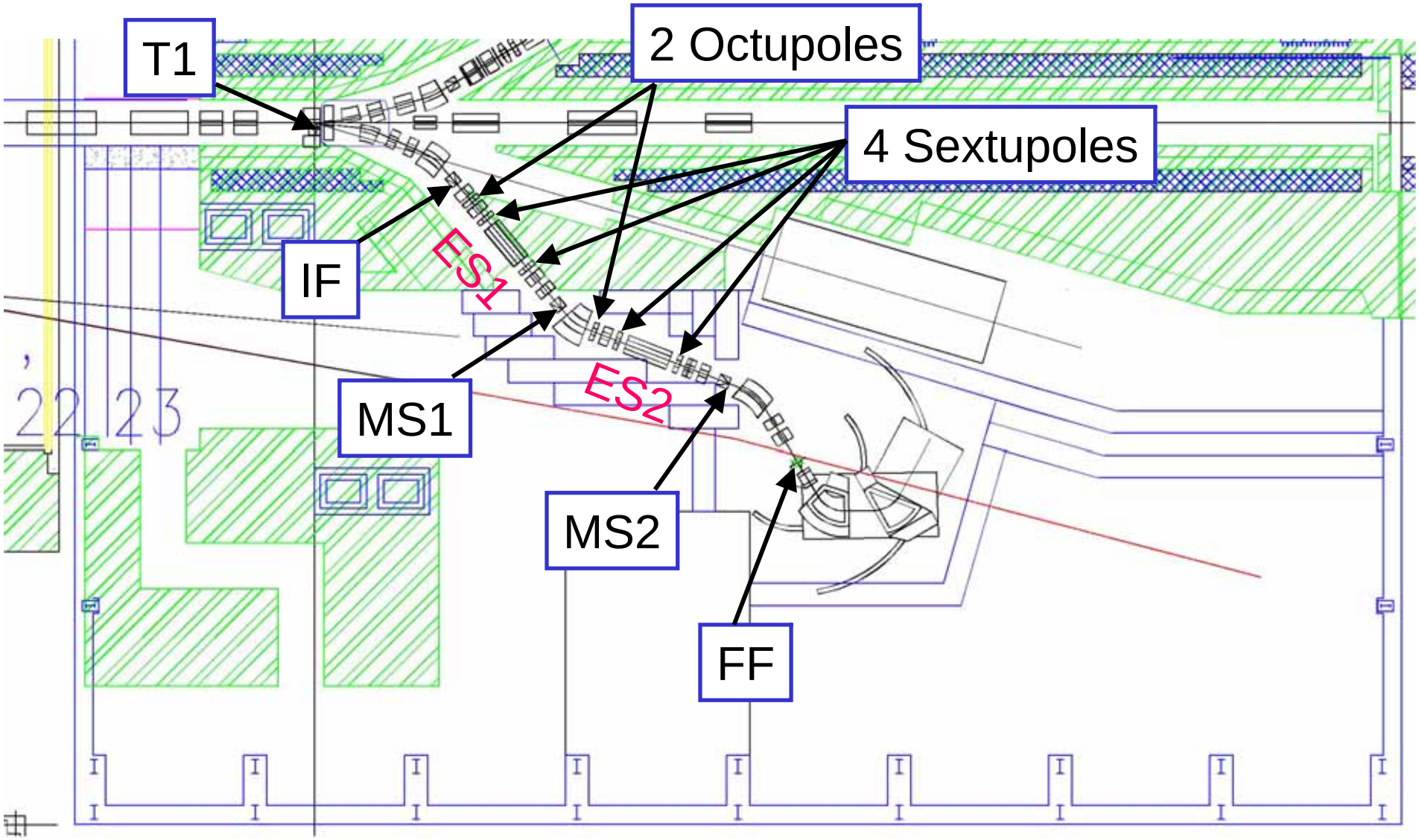
	K1.8BR(Option I) (50 GeV-15μA)	(30 GeV-9μA)
Length (m)	26.973	
Acceptance (msr.%)	4.5¥	
K^- Intensity (ppp)#		
1.1 GeV/c	9.1E+06	2.0E+06
0.8 GeV/c	1.7E+06	0.4E+06
0.6 GeV/c	0.2E+06	0.05E+06
Electro-static Separator	500kV/10cm 6m	
K^-/π^- @ 1.1 GeV/c $	10	12
X/Y(FWHM) size @ FF (mm)	10/6	

¥ MS1 opening: ±2mm

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

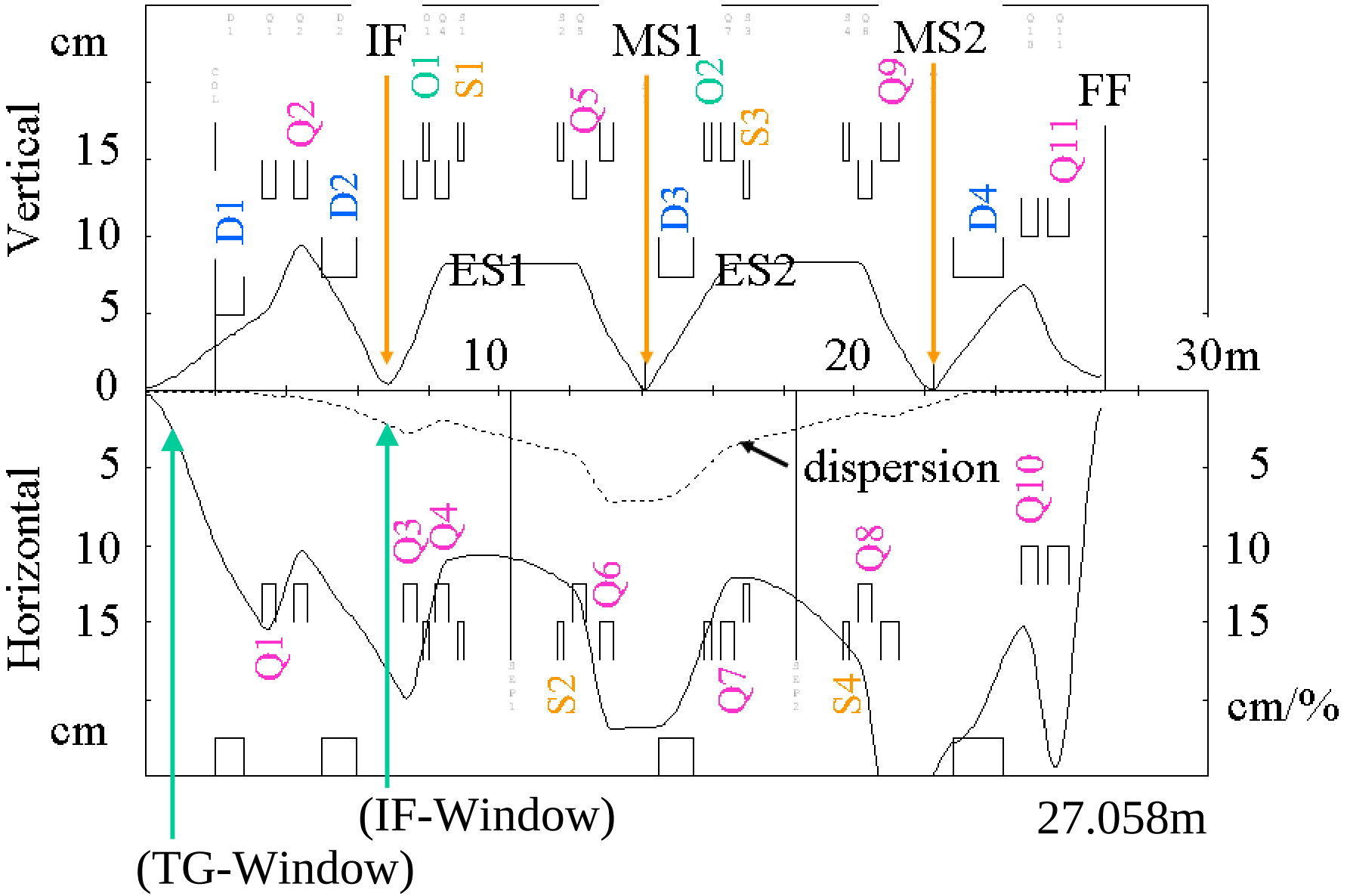
$ cloud π not included

2.3 K1.1/0.8 Beam Line (S-Type)

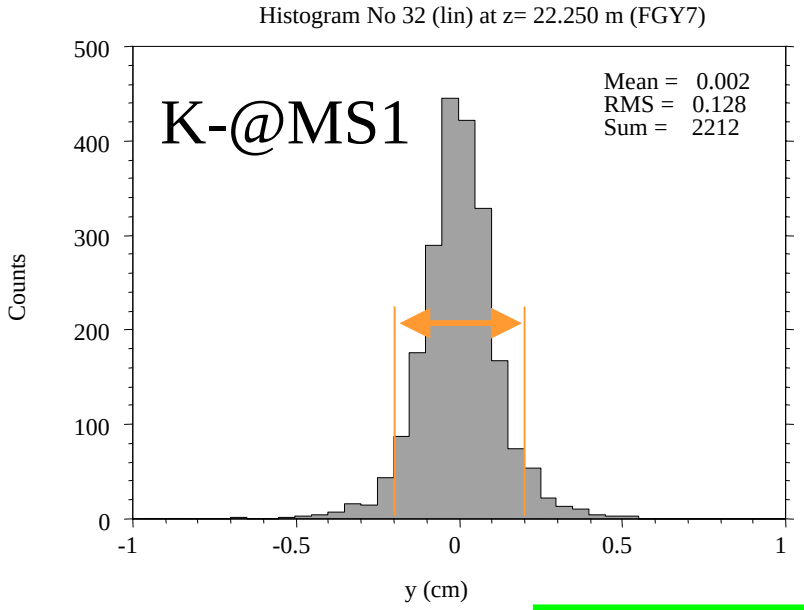


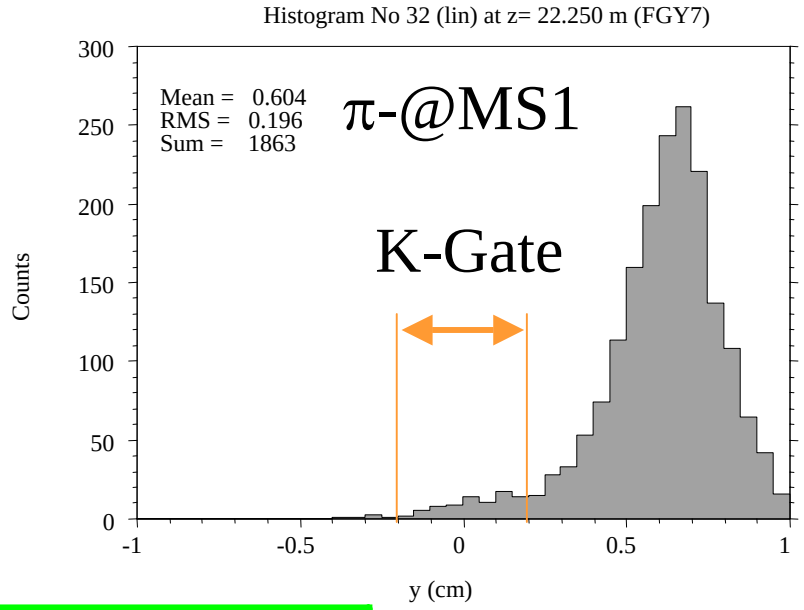
⇒ Decay TURTLE (3rd Order Optics)

K1.1 Beam Line Optics

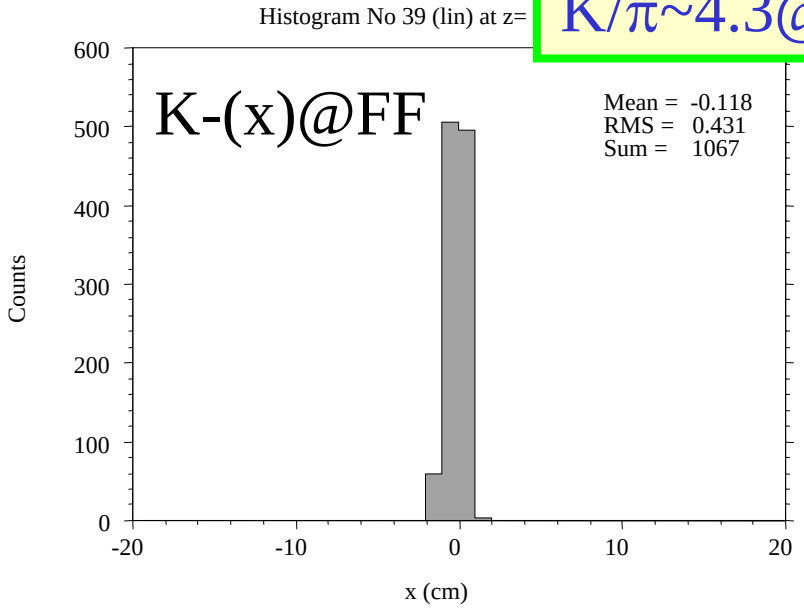


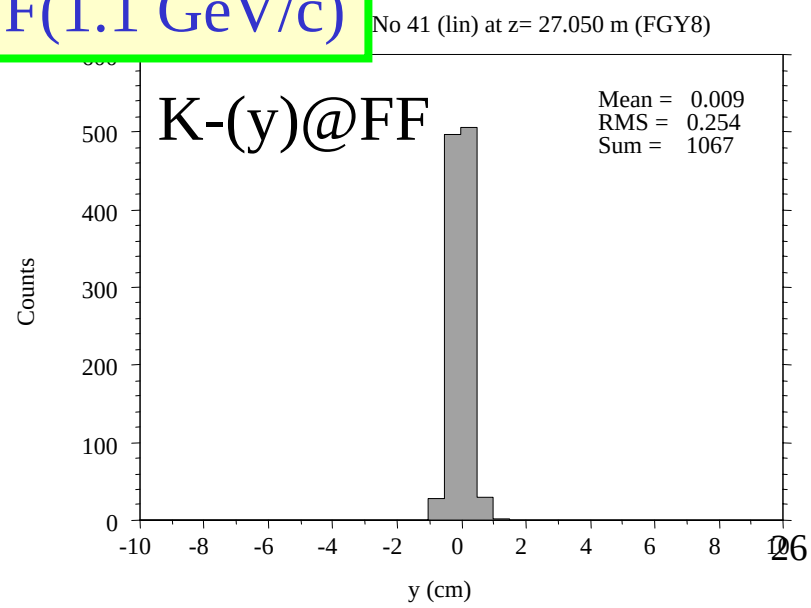
w/ TG, IF-windows (SUS-200μm,50μm)　　MS1 **Opening:±1** mm





K/π~4.3@FF(1.1 GeV/c)





K1.1 Beam Line 3rd Order Optics

2004.7.30

	K1.1 (50 GeV-15μA)	(30 GeV-9μA)
Max. Mom. (GeV/c)	1.1	
Length (m)	27.05	
Acceptance (msr.%)	4.1¥	
K^- (K^+) Intensity (ppp)#		
1.1 GeV/c	9.1E+06(81E+06)	2.0E+06(11E+06)
0.8 GeV/c	1.7E+06(18E+06)	0.4E+06(2.5E+06)
0.6 GeV/c	0.2E+06(2.6E+06)	0.05E+06(0.4E+06)
Electro-static Separator	750kV/10cm 2m×2	
K^-/π^- @ 1.1 GeV/c$	4.3	4.7
X/Y(FWHM) size @ FF (mm)	10/6	

¥ MS1 opening: ±1mm, MS2: ±2mm

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

$ cloud π not included

Comment on K1.1/0.8 C-type

K1.1/0.8 C-type:

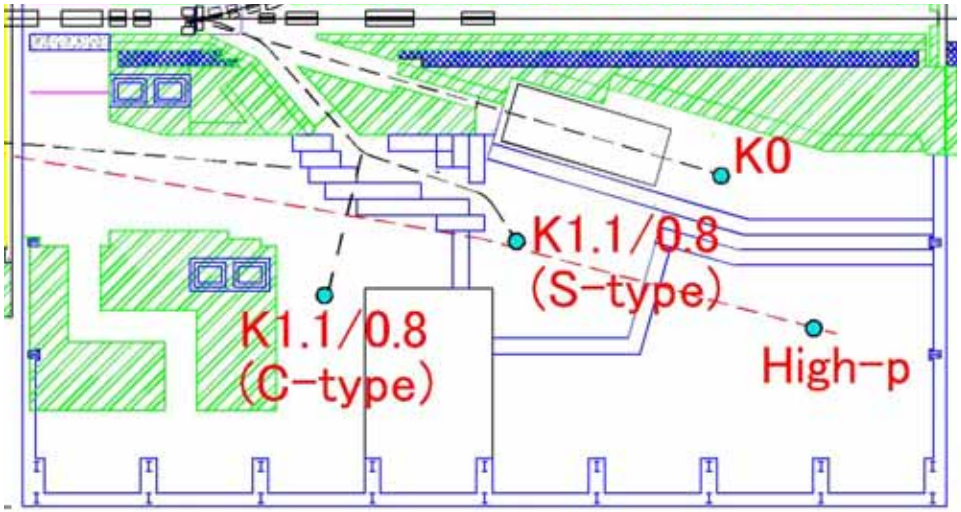
branches at D3, turns to the opposite side of K1.1/0.8 S-type

To be optimized for K-decay phys.

⇒lower momentum, shorter BL

Time sharing with K1.1/0.8 S-type for strangeness nucl. phys.

No conflict with High-p BL



3. Summary

1. Primary beam line (Phase I)
   Matching S. + Slope1 (SM) Slope2 + T0 + A-Line + T1 + Dump
   Using Second-hand Magnets
   Beam Spot at T1: σ~1.3 (1) mm for 30 (50) GeV
   realistic drawings for magnets, beam pipes, monitors, etc.
   in progress. (latest SEB parameters to be considered…)

2. Layout at T1
   Water cooled Ni Disk Target: 30% int. length
   200 kW heat deposit:
   hardly design a beam pipe in the D1 gap
   ⇒ Collimator/D1/Q1 in Vacuum Chamber
   Takahashi's talk tomorrow morning (SEB User J. Sess.)
   Careful layout to avoid magnetic interference
   btwn K1.8-D1/Q1 & K1.1/0.8-D1