

# **Confirmation of kaons in the J-PARC K1.8BR beamline**

Y.Fujiwara

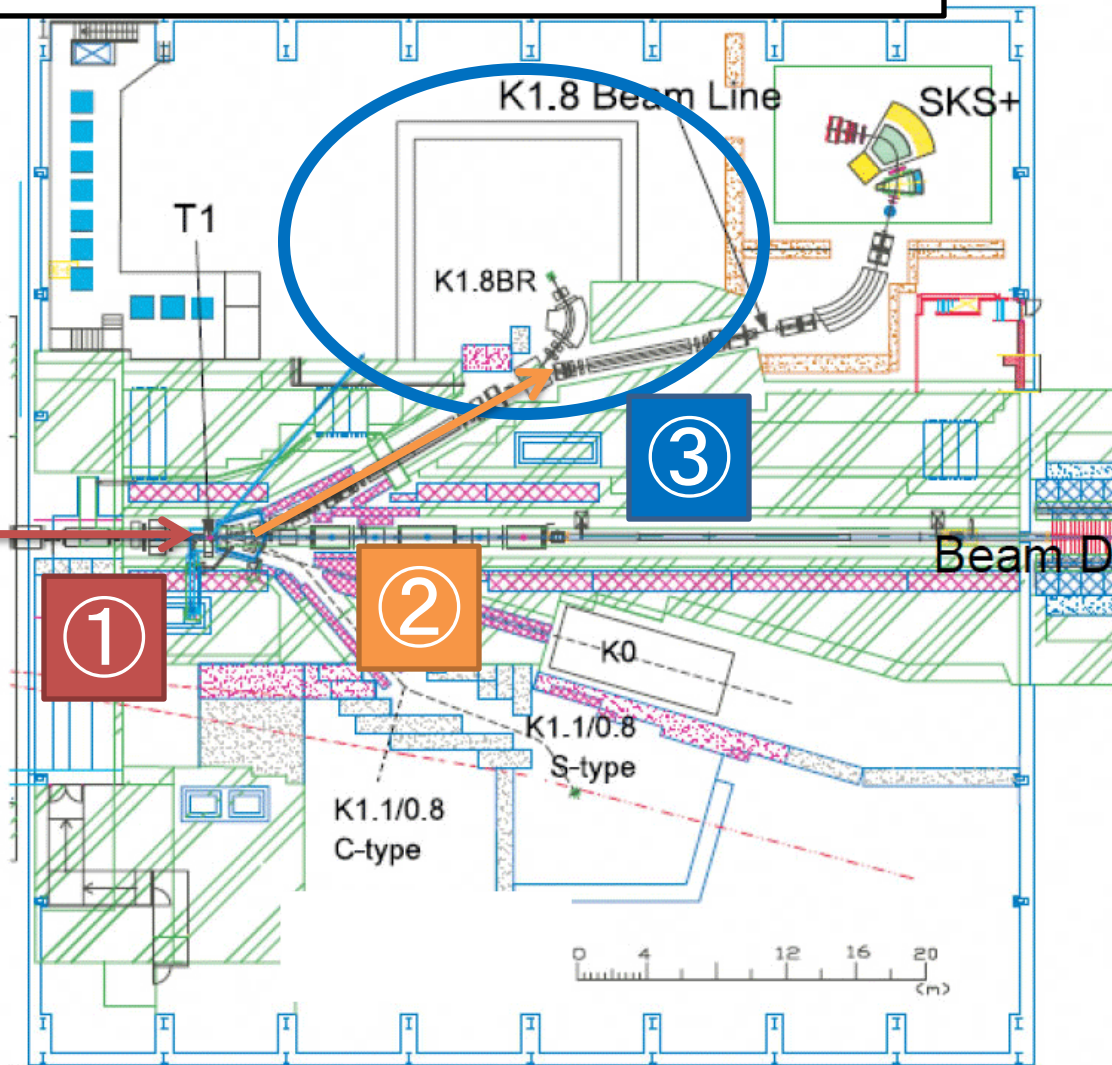
For E15/E17 collaboration

(In collaboration with KEK Hadron beamline group)

The University of Tokyo

# K1.8BR beamline

K1.8 "Branch" Kaon beamline.



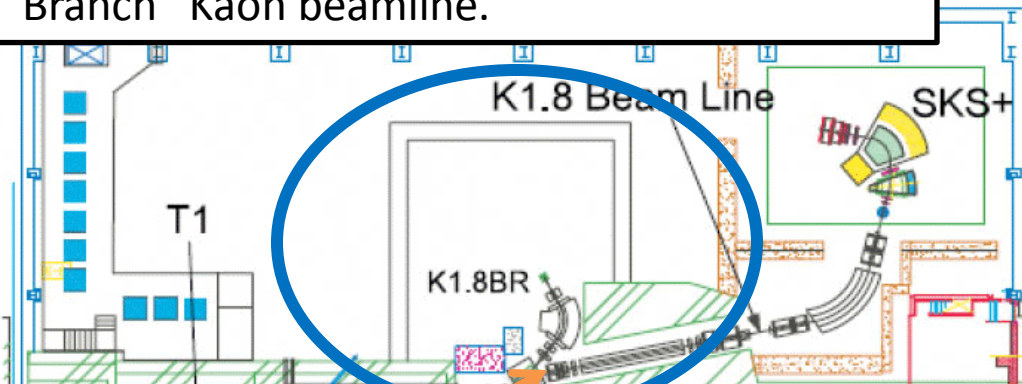
①  
Proton Beam  
30GeV 9 $\mu$ A

②  
Secondary particle  
Momentum  $\sim 1.1$ G  
eV/c  
(K1.8BR)

③  
K1.8BR K beam  
Experimental area  
E15/E17

# Introduction of K1.8BR beamline

K1.8 "Branch" Kaon beamline.



Poster session on Thursday

E17:

T05 T.Ishiwatari "Precision spectroscopy of kaonic  $^3\text{He}$   $3d$   $2p$  x-rays at J-PARC"

T04 T.Ishiwatari "Adjustment of the SDDs for experiment E17 at J-PARC"

E15:

T10 K. Tsukada "A search for deeply-bound kaonic nuclear states at J-PARC"

①

Proton Beam  
30GeV 9 $\mu$ A

②

Secondary particle  
Momentum  $\sim 1.1$ G  
eV/c  
(K1.8BR)

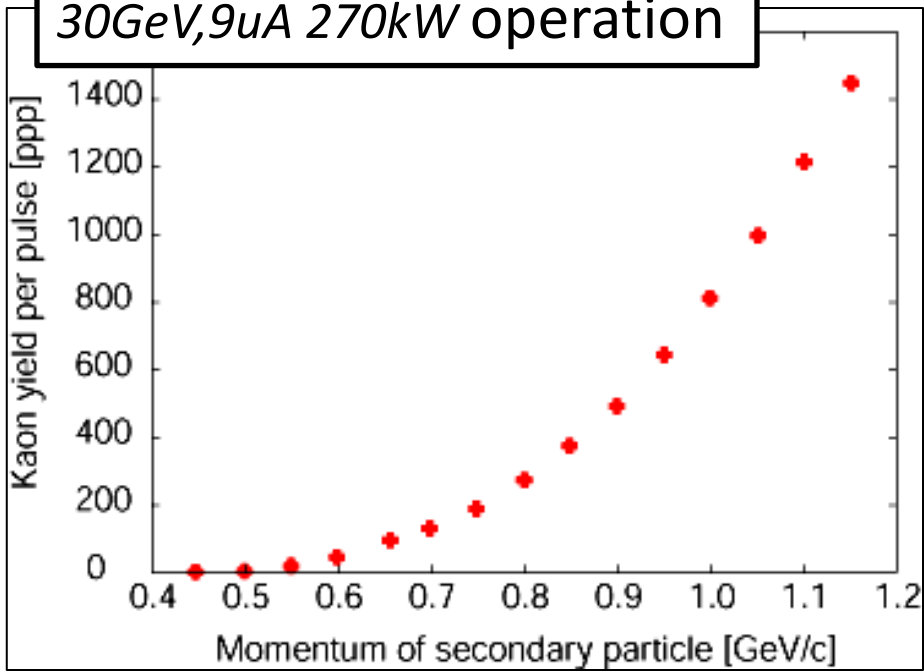
③

**K1.8BR K beam**  
**Experimental area**  
**E15/17**

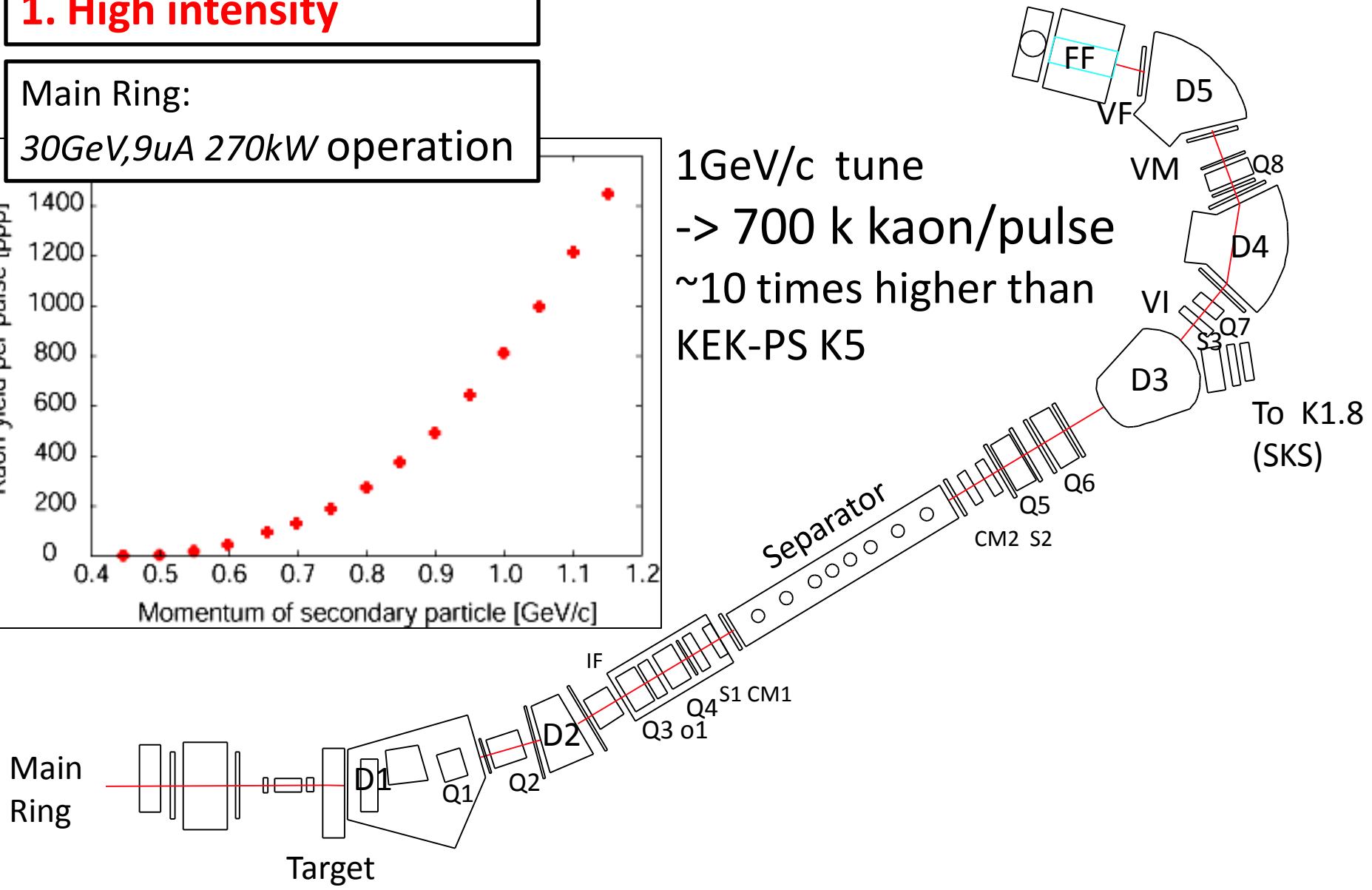
# K1.8BR beamline **feature**

**1. High intensity**

Main Ring:  
30GeV, 9uA 270kW operation



1GeV/c tune  
-> 700 k kaon/pulse  
~10 times higher than  
KEK-PS K5



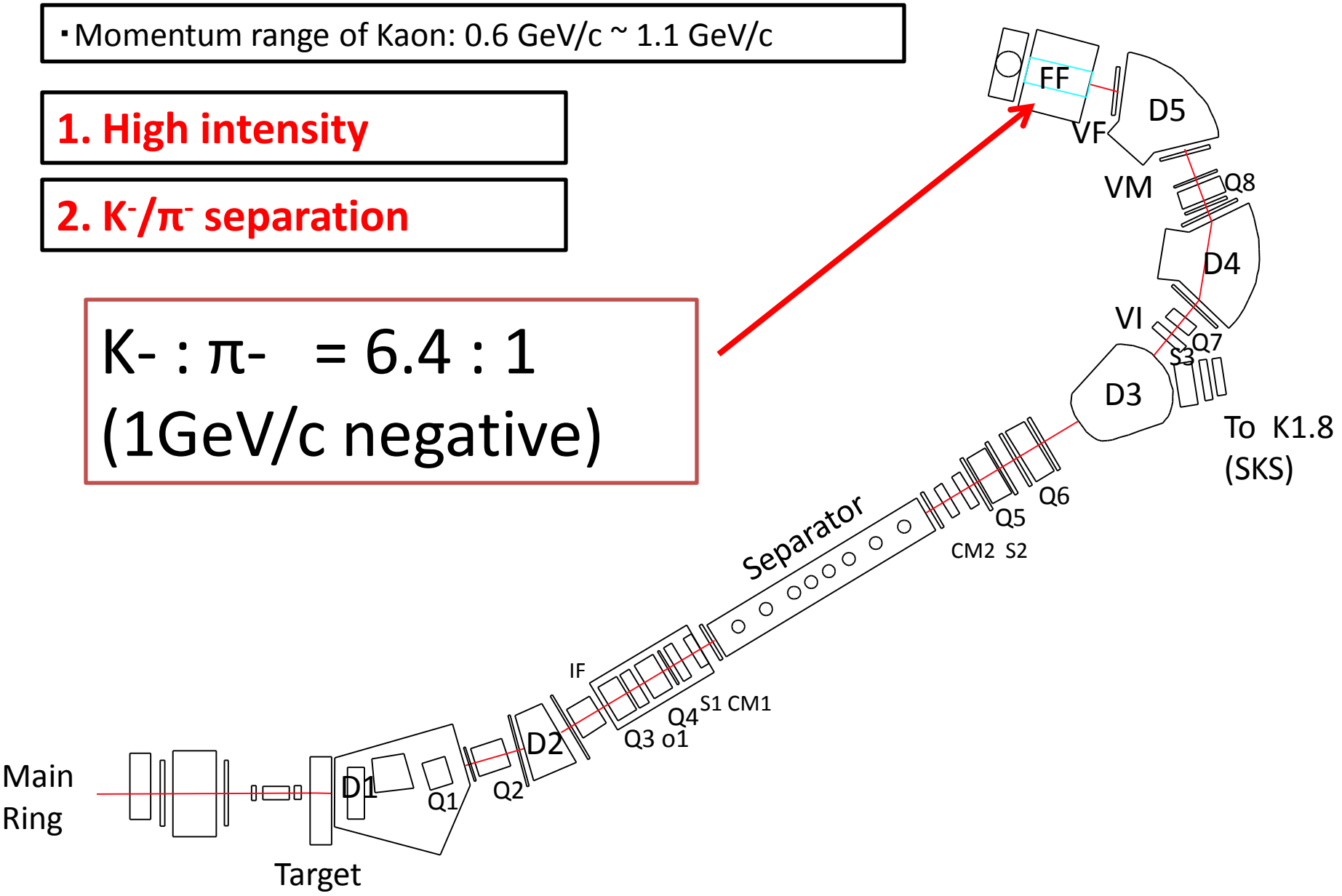
# K1.8BR beamline **feature**

▪ Momentum range of Kaon: 0.6 GeV/c ~ 1.1 GeV/c

**1. High intensity**

**2.  $K^-/\pi^-$  separation**

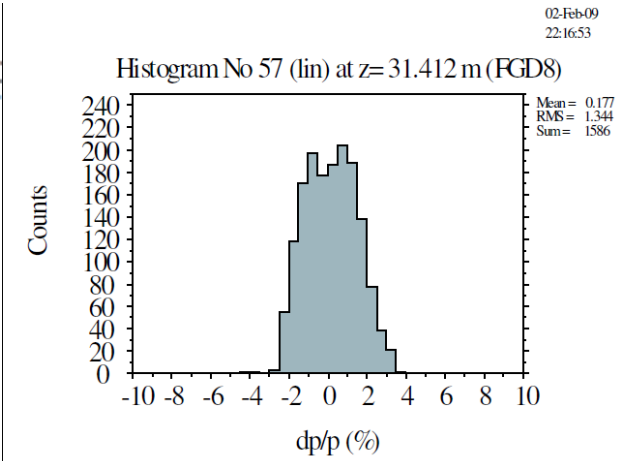
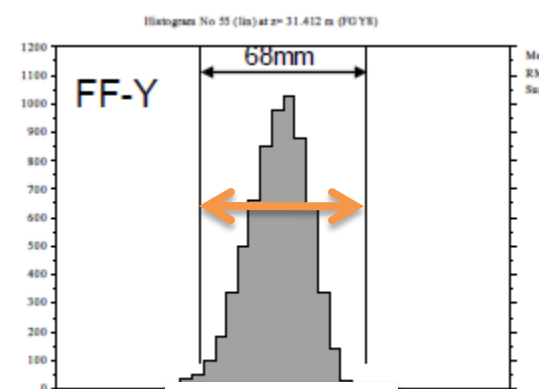
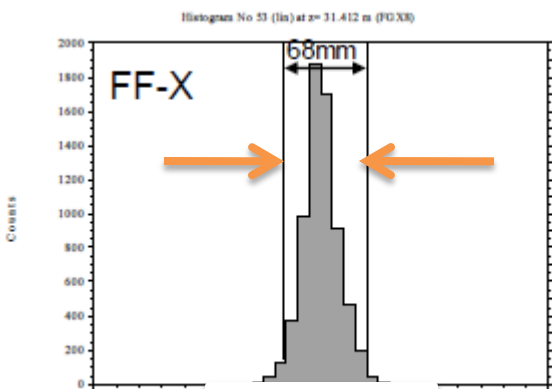
$K^- : \pi^- = 6.4 : 1$   
(1 GeV/c negative)



# K1.8BR beam profile and dp/p design

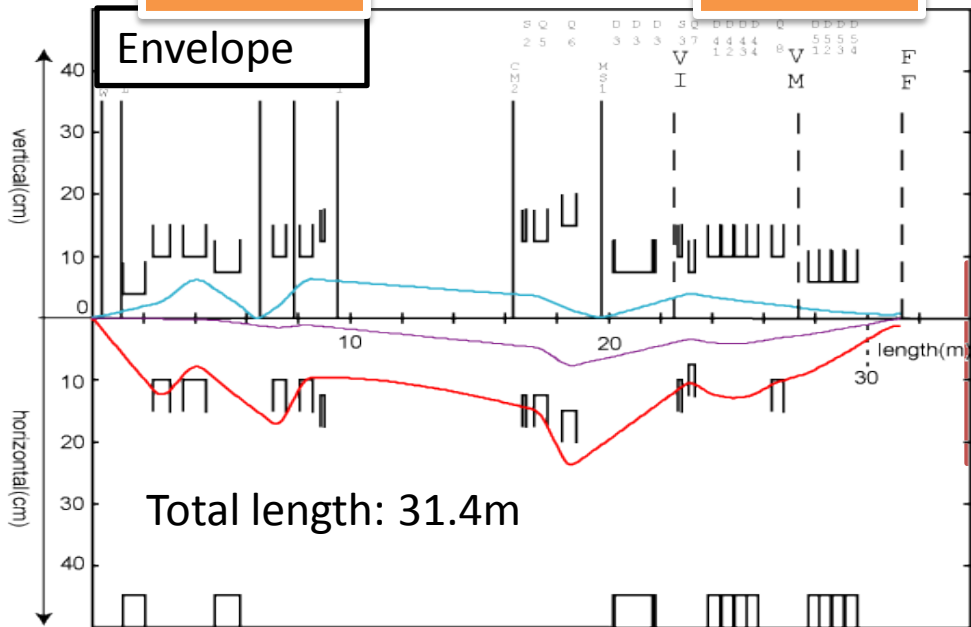
Beam profile at Final Focus

Momentum bite



70 mm

70 mm



Calculated by Prof.Noumi (RCNP)

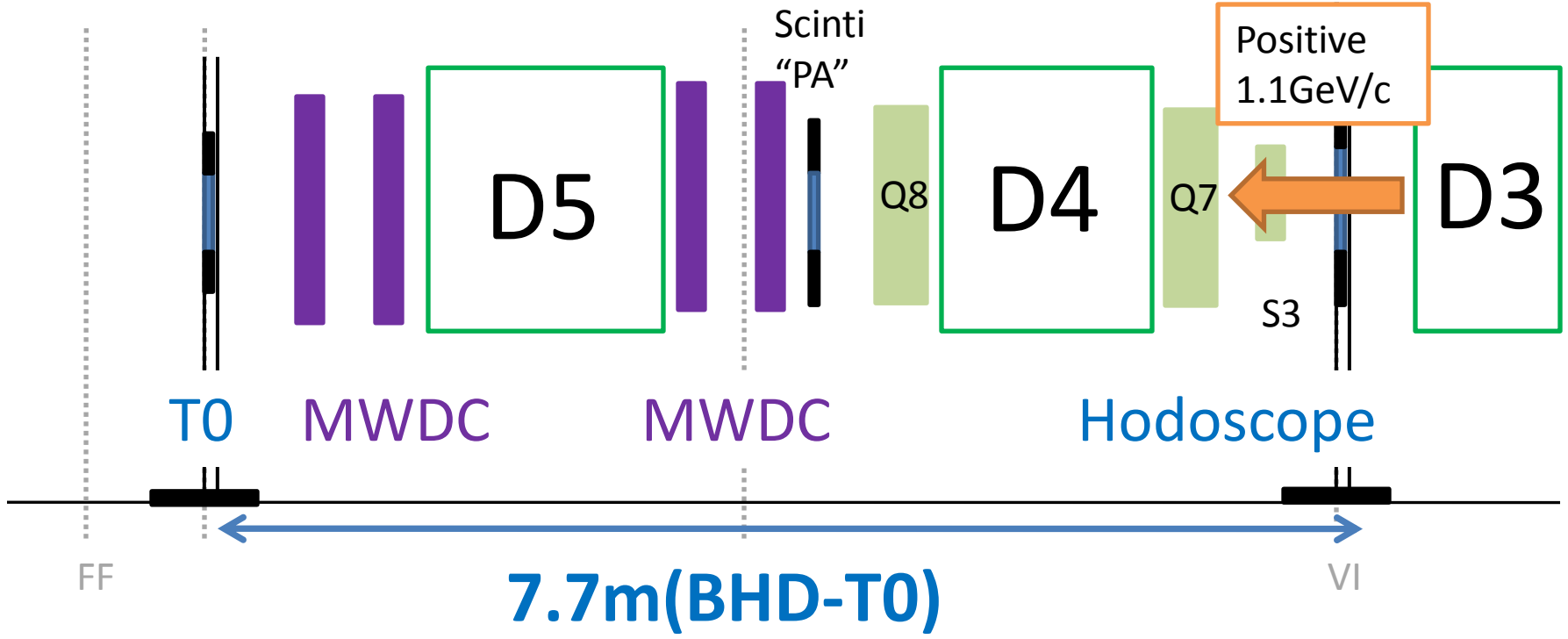
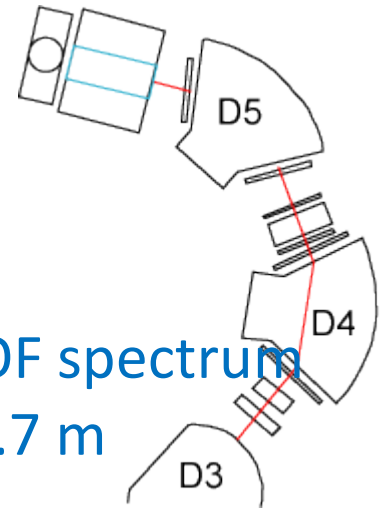
- Beam spot:  $R \sim 70\text{mm}$
- $dp/p \sim \pm 2\%$

# Beamline detectors and the measurement

K1.8BR construction was completed in January 2009.

By using beamline detectors, Beamline test was performed in Feb.2009.

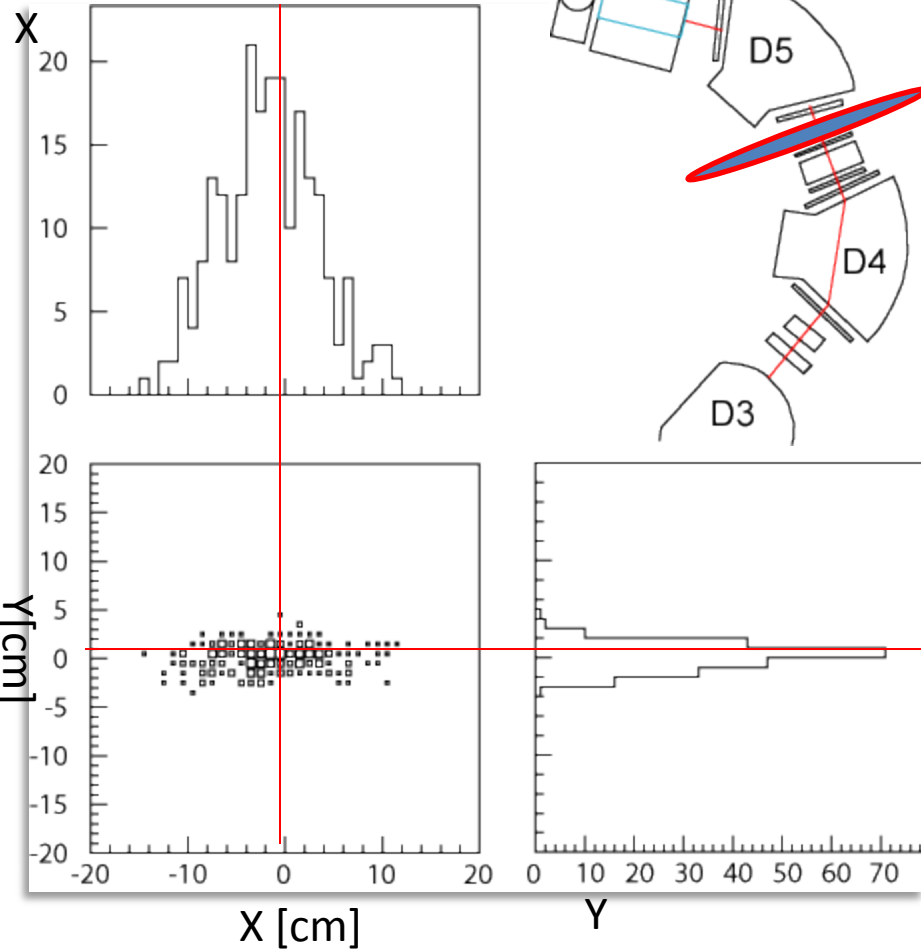
- 1. Alignment check: Beam profiles
- 2. Composition of the particles: separator tuning and TOF spectrum
- 3. Kaon formation by TOF measurement, Flight path = 7.7 m



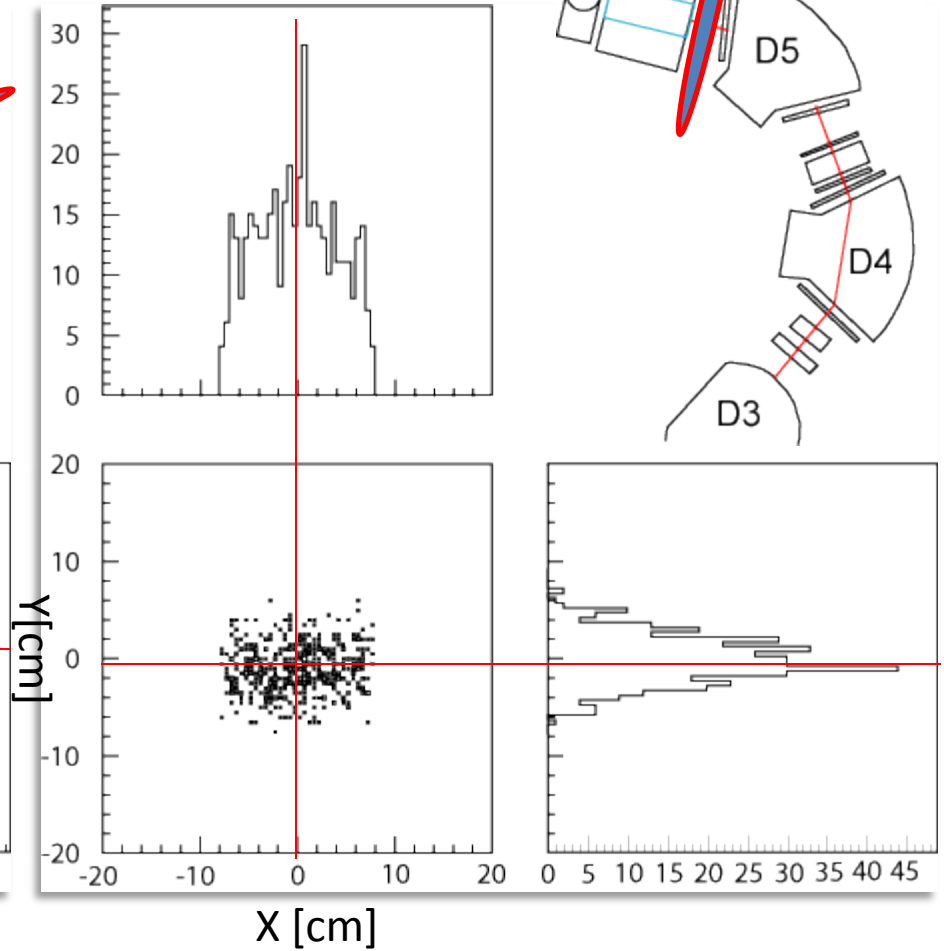
# 1. Beam transport

1shot, Intermediate focus – ( $x: \pm 11.4\text{mm}$ ,  $y: 14/-11.8\text{mm}$ )

## Upstream of D5



## Exit of K18BR

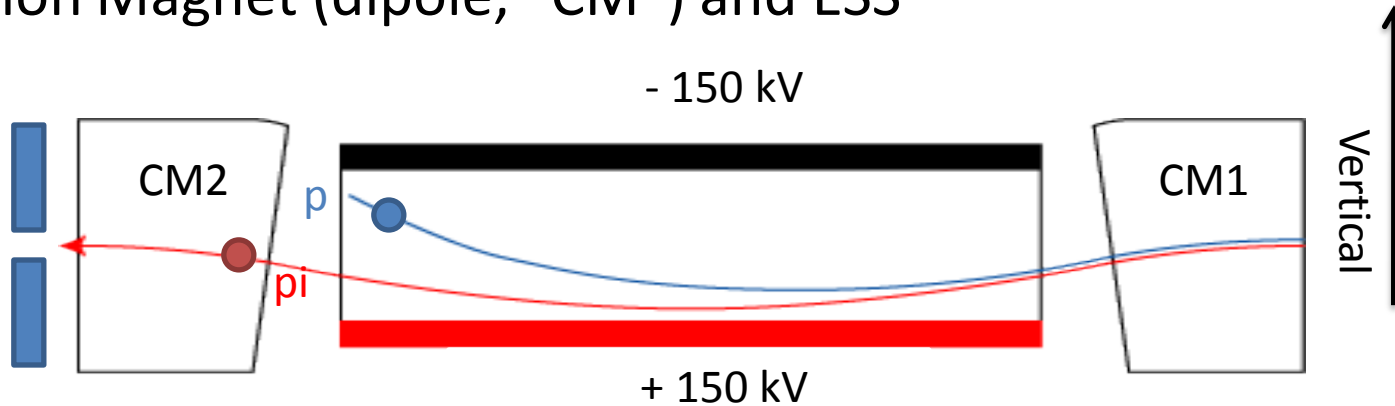


- Alignment OK. Beam goes through K1.8BR.
- Dispersion: Fine tuning will be preformed



## 2.CM scan(Particle separation)

Correction Magnet (dipole, "CM") and ESS



Electro-static separator:

- [Rating]  $\pm 200$  kV , Here  **$\pm 150$  kV.**
- 100 mm gap
- 6 m length

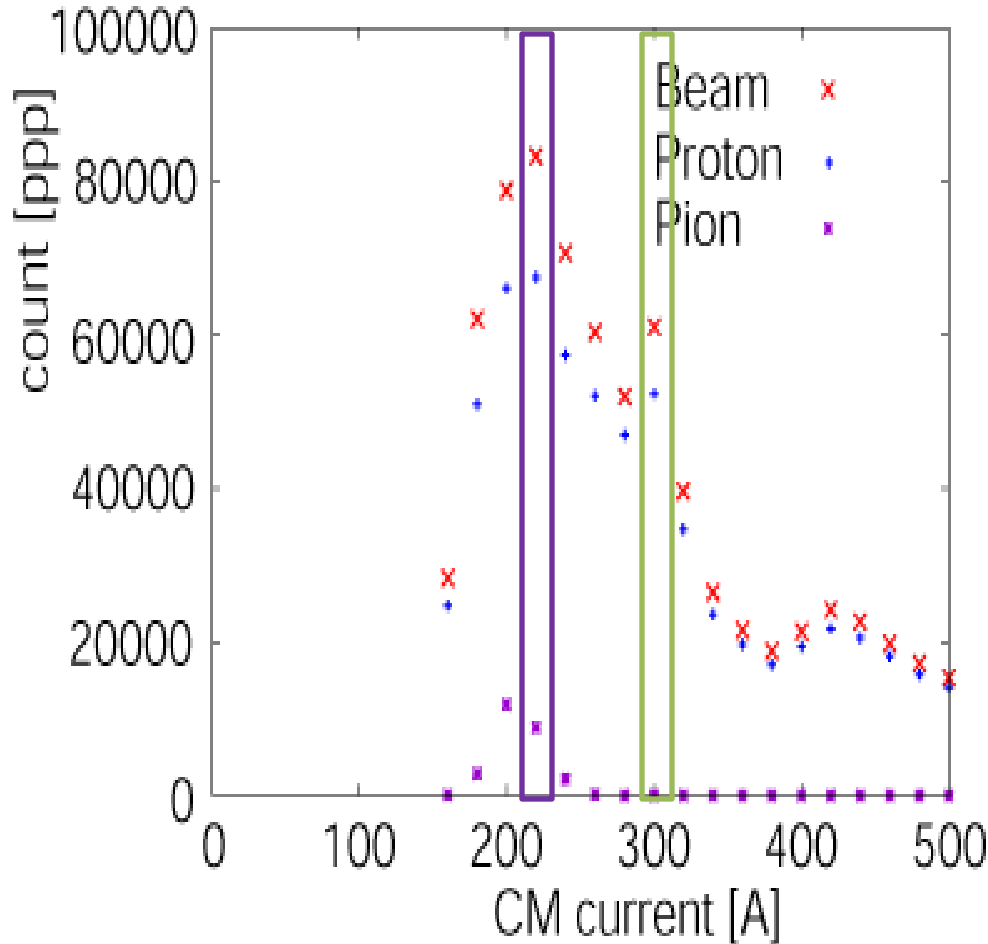
Particle trajectory is depend on the velocity and the momentum of the particle.

To select the kind of particle = To adjust bending angle of CM1,2 magnet

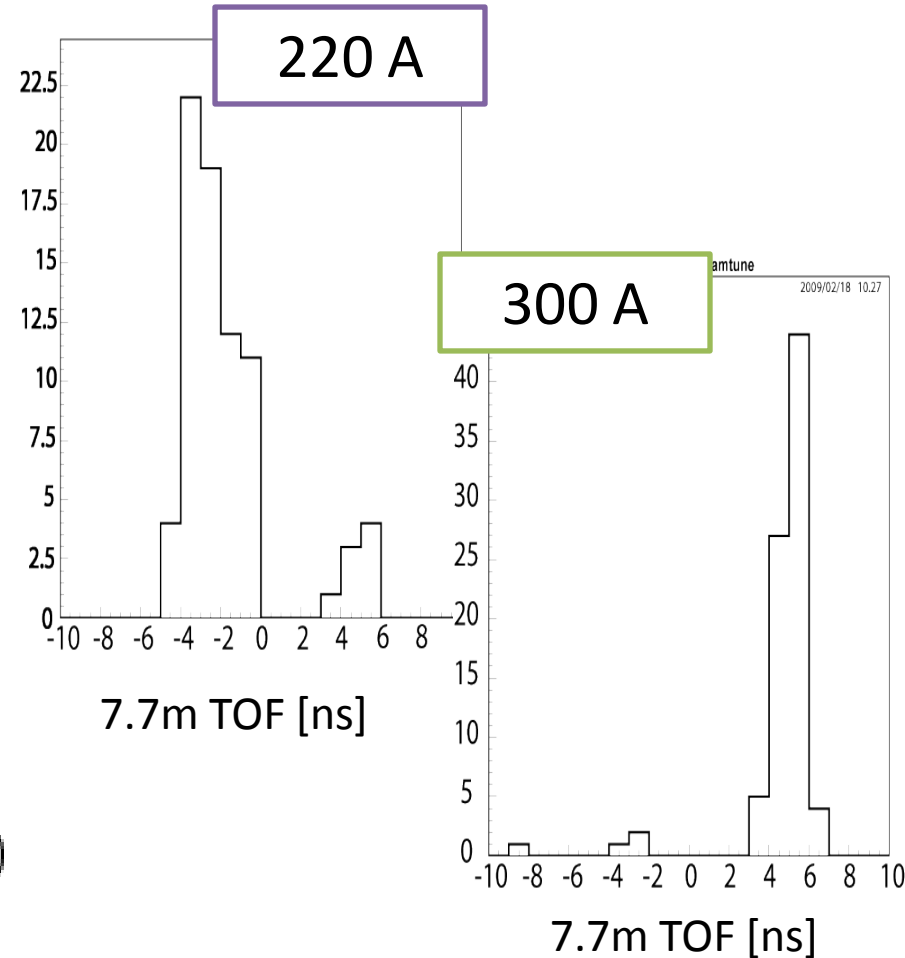
Composition of the particle is understood from CM scan.

# 2.CM scan(Particle separation)

Each measurement : 1 pulse,



TOF spectrum



- Separator operation good (Because Q1 parameter was wrong, the separation was bad)
- In TOF spectrum, Pion/Proton enhancement due to CM current is clearly seen.

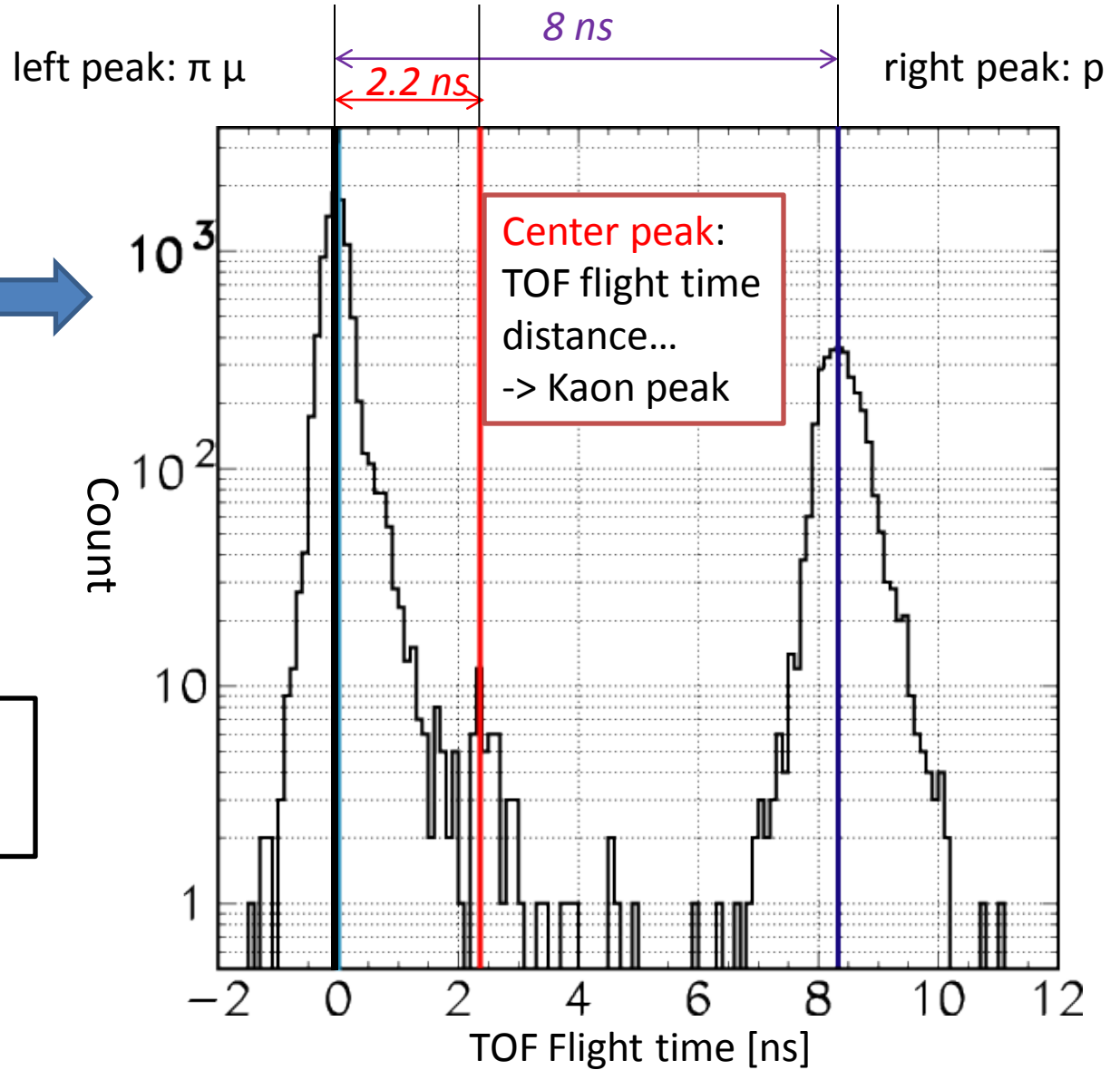
# 3. Kaon confirmation

-Separator OFF.  
-K-pi ~ 1:600

Slewing  
correction &  
Offset tune



$t_p - t_\pi = 7.9\text{ns}$   
 $t_K - t_\pi = 2.3\text{ns}$



Kaon confirmed in K1.8BR beamline.

# Summary

- K1.8BR construction had been finished.
  - K/pi ratio: 6:1 @Final Focus
  - Kaon ppp:  $7 \cdot 10^5$  @MR 30GeV 9uA, 1.1GeV/c tuning
  - Spot size: R=70mm@Final Focus
  - Detector: Momentum resolution is
  - Online particle identification performed by Cherenkovs
- Kaon formation was confirmed in K1.8BR beamline
  1. Beam profile were checked with drift chambers.
  2. CM scan shows the composition of the particle in the beam
  3. TOF spectrum – Kaon peak was confirmed.

# Outlook

- Install Cherenkov counters. Then perform PID more precisely.
- Fine tuning of magnet.
- Separator 300kV -> 400kV
- Momentum measurement
- Range measurement for E17, Momentum tuned to be 0.7GeV/c will be performed in FSY 2009.
- Operation start
  - E17 Experiment will be started at 2010 spring.
  - Some experiments via Stopped K reaction are proposed. (P30- $\Lambda(1405)$  via stopped K- d reaction)
  - E15 Experiment will be started at 2011~2012.

# J-PARC E15 and E17 collaboration

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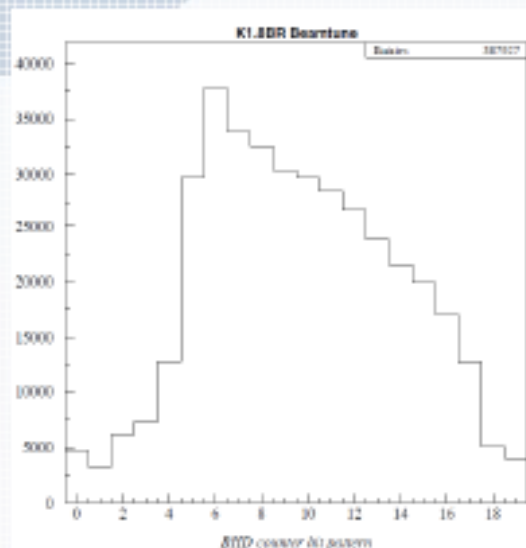
(17) National Institute of Physics and Nuclear Engineering - IFIN HH, Romania

# Backup

# Beam profile measurements



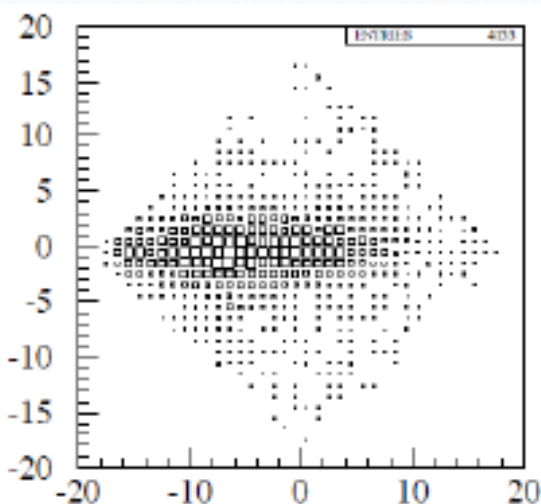
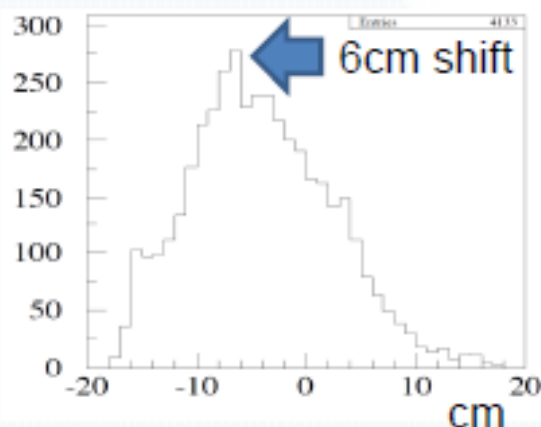
Beam profile at **D3-out**  
seen from upstream



1 counter  
= 2cm width

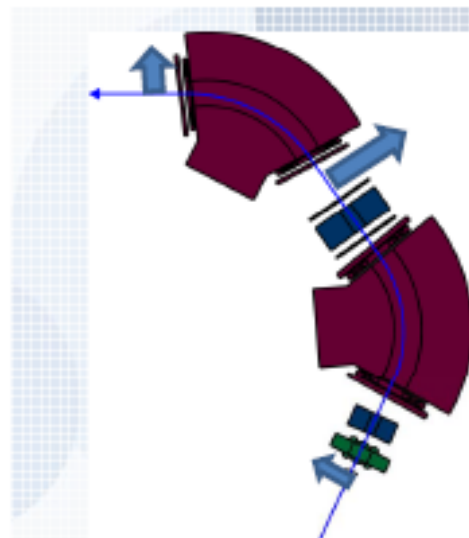
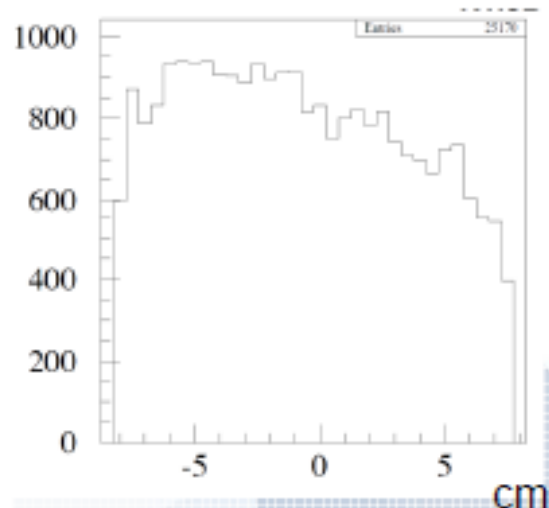
The same unseparated  
beam run snapshots:  
Trigger=BHD × PA × T0

Beam profile at **D4-out**  
seen from downstream



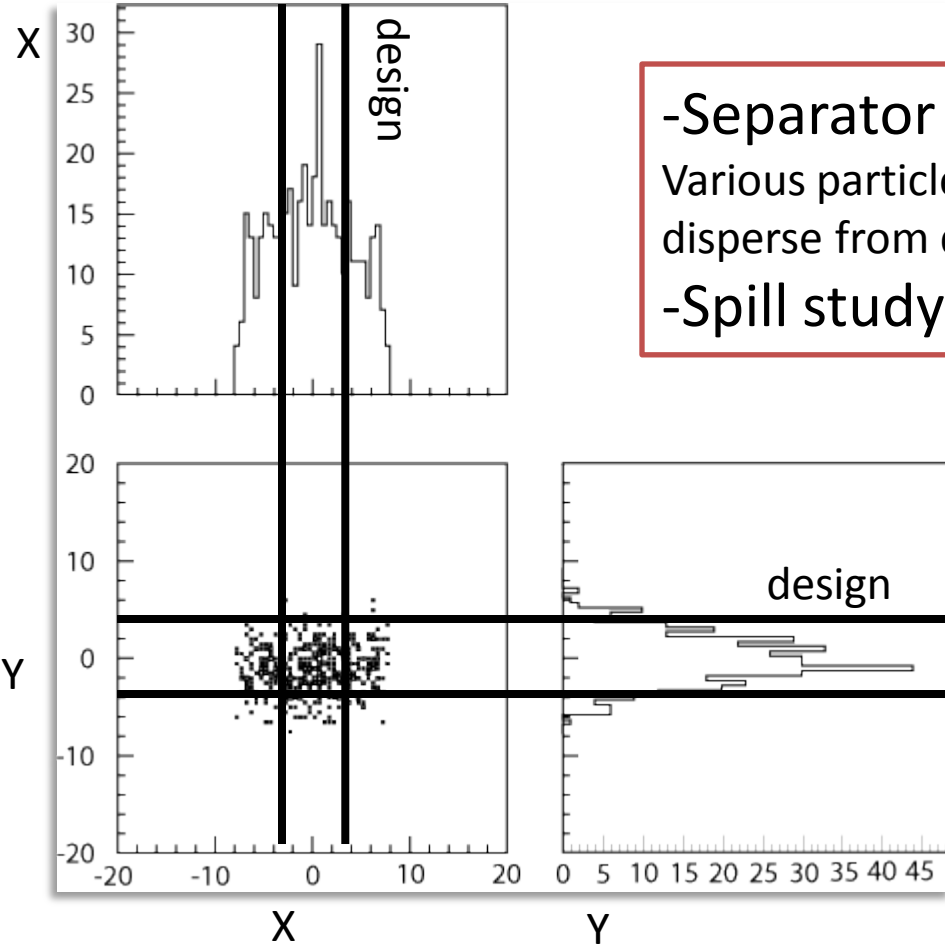
Incident position at D5in (cm)

Beam profile at **D5-out**  
seen from downstream



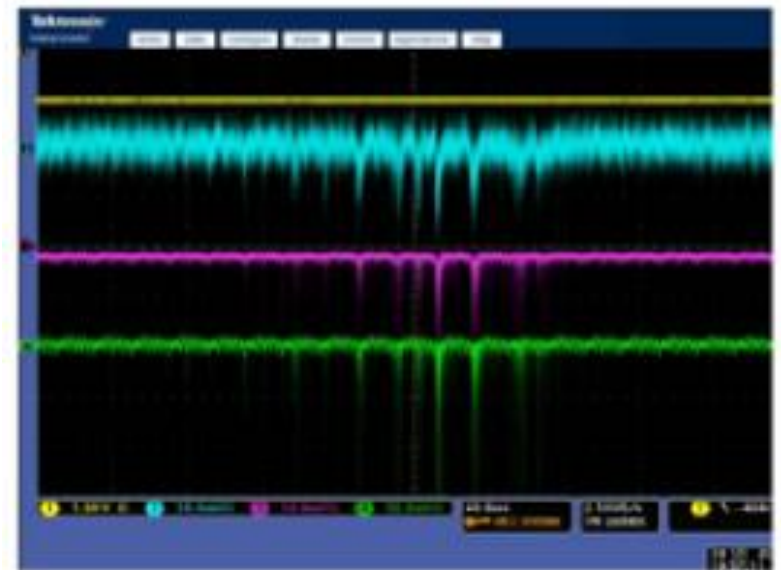


# 1' Compare to "design"



- Separator voltage: 150 kV (Normal 500kV)
- Various particles were transported, so momentum bite disperse from design value.-> x-direction dispersion.
- Spill study: Spike in the spill

RF off,  $\xi \sim 0$

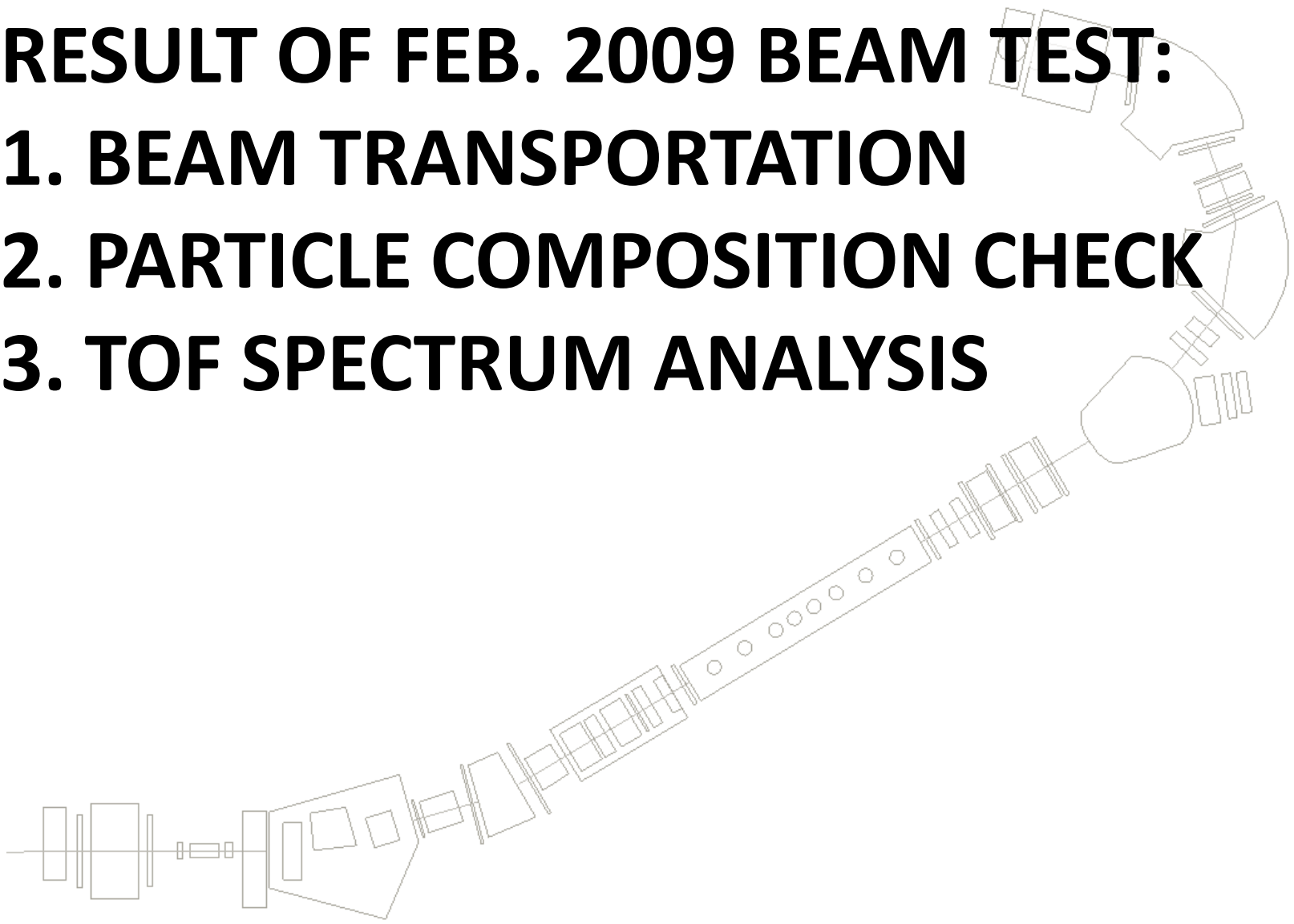


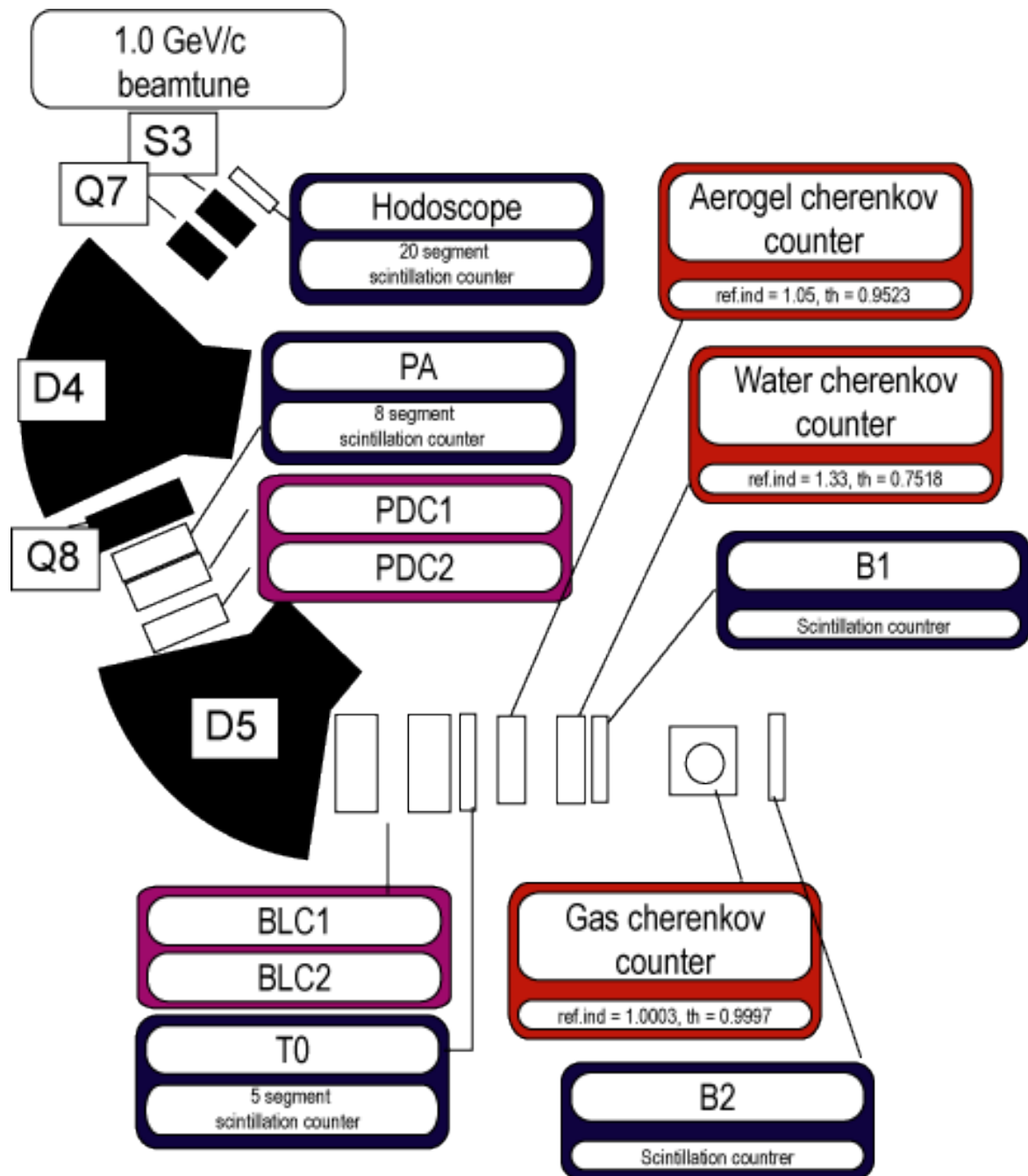
# **RESULT OF FEB. 2009 BEAM TEST:**

**1. BEAM TRANSPORTATION**

**2. PARTICLE COMPOSITION CHECK**

**3. TOF SPECTRUM ANALYSIS**





# Contents

- Motivation
- K1.8BR component
- K1.8BR design values
- CM scan result
- 1000shot unseparated operation result
- Profile
- Summary and outlook

# Result

- CM scan
- Separator turned on.
- Two magnet are placed forward / backward of separator, Kick up and kick down the beam. Different particle moves along different orbit.
- CM scanning and TOF spectrum ---  
Timing/Kind of particle correlation confirm

Under BHD multiplicity =1, T0 multiplicity=1 (total event 80000->18000)

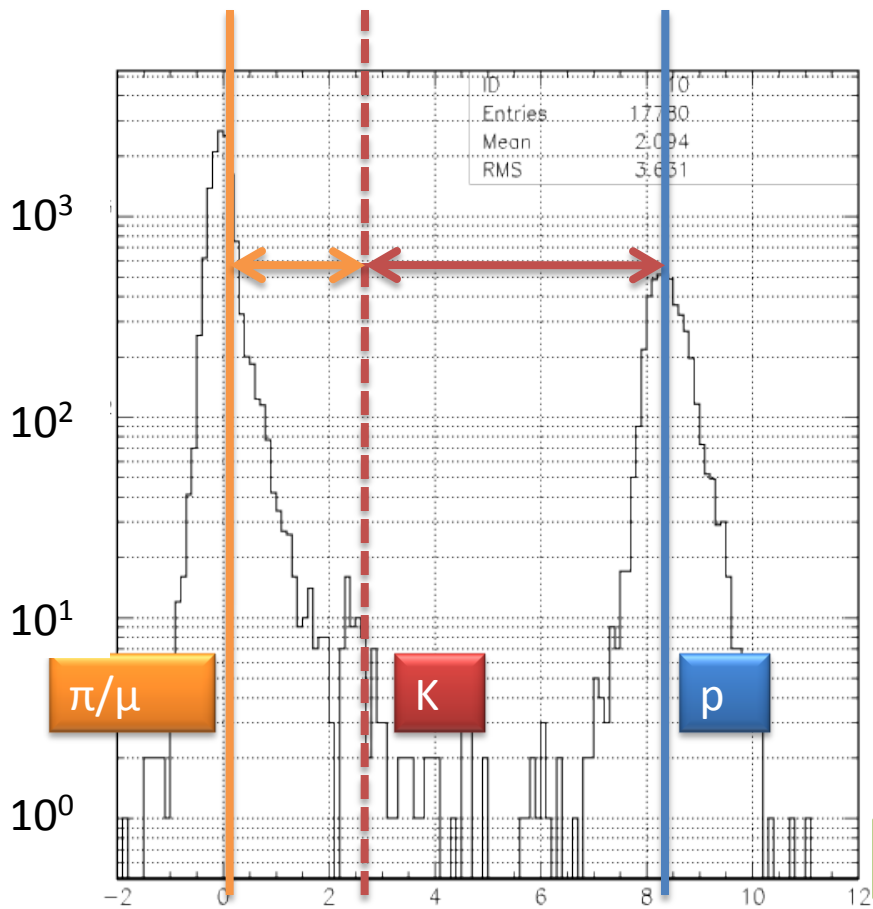
Kaon  $100 * 18000/80000 = 22.5$

800 shot

30GeV,  
0.4uA  
(9uA)

RF OFF

0.7s flat



$\pi/\mu$

K

p

$t_p - t_K = 5.602\text{ns}$ ,  $t_p - t_\pi = 7.863\text{ns}$   
 $t_K - t_\pi = 2.261\text{ns}$ ,  $t_p - t_\mu = 7.951\text{ns}$

~20 Kaon detected as we assumed

0.1s

200 event/spill (1event=0.5ms)

1.1GeV/c

0kV  $\sim K/(\pi + p) = \sim 1/1000$

Separator  
0kV  
(500kV)

Multi =1

20 BHD

\*18000/80000

7.7m

Multi =1

5 T0

Ni target

Separator

20 BHD

5 T0

# Motivation

- **K1.8BR beamline** construction was finished in Jan. 2009.
- This is a **secondary particle** beamline at the J-PARC hadron hall.
- In this beamline, Two experiment have been scheduled: **E15/ E17** ( $3\text{He}(K^-,N)X$  reaction)
- **Checking** the beam **transportation** at K1.8BR is important. Especially Kaon formation
- Used Positive charge beam. (Loss suppression)

# Introduction of K1.8BR beamline

The first beamline in the J-PARC hadron hall.

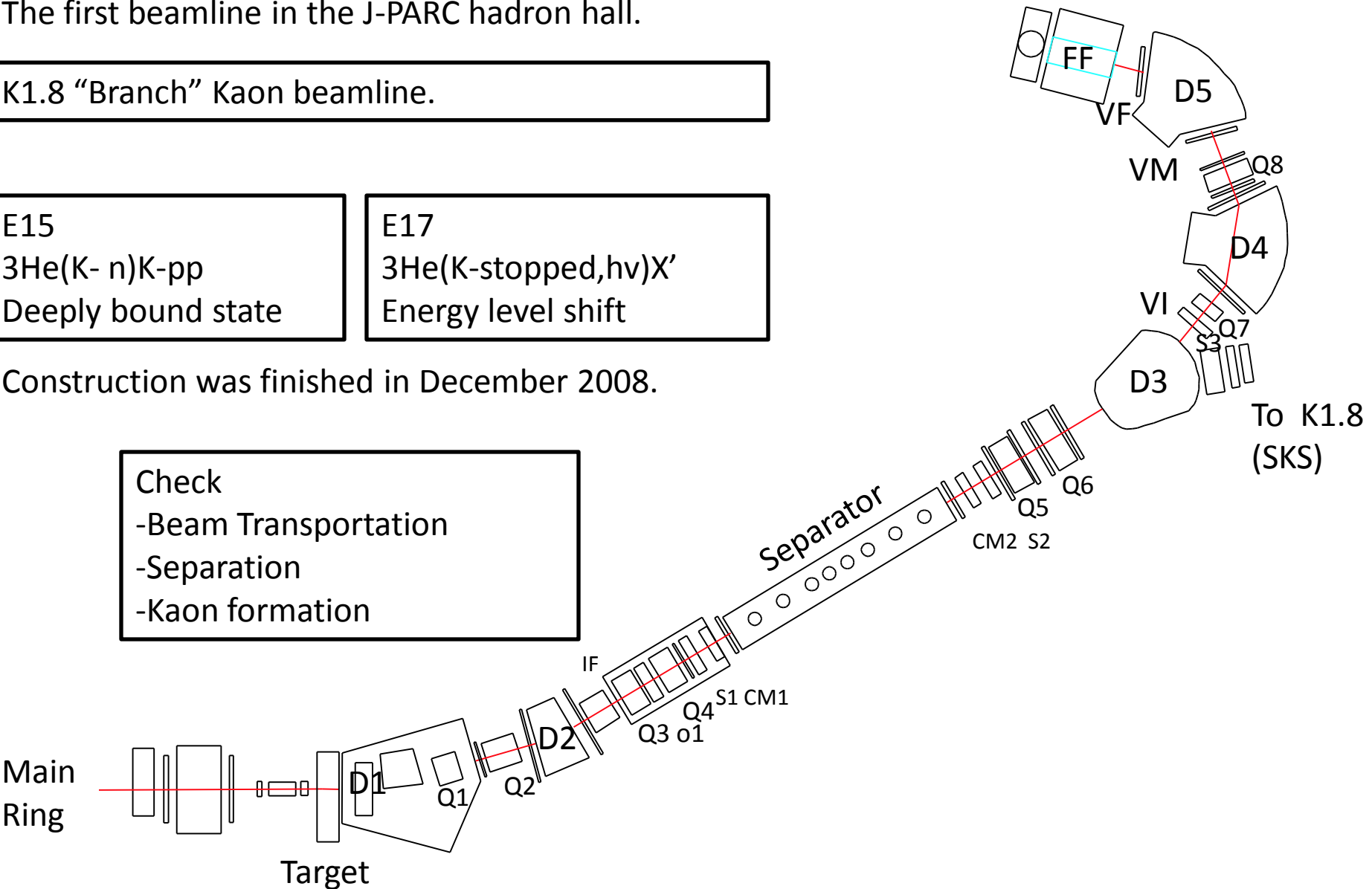
K1.8 "Branch" Kaon beamline.

E15  
3He(K- n)K-pp  
Deeply bound state

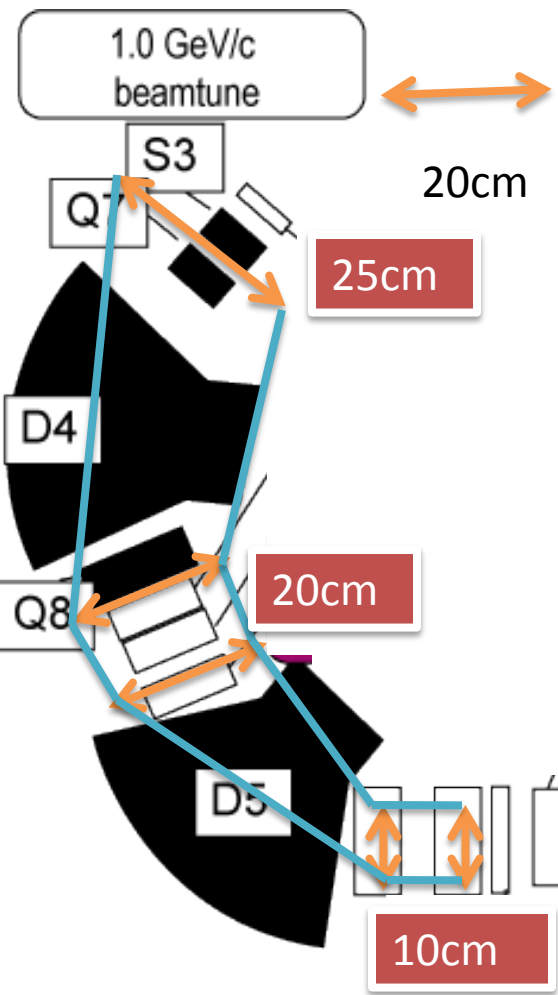
E17  
3He(K-stopped, hv)X'  
Energy level shift

Construction was finished in December 2008.

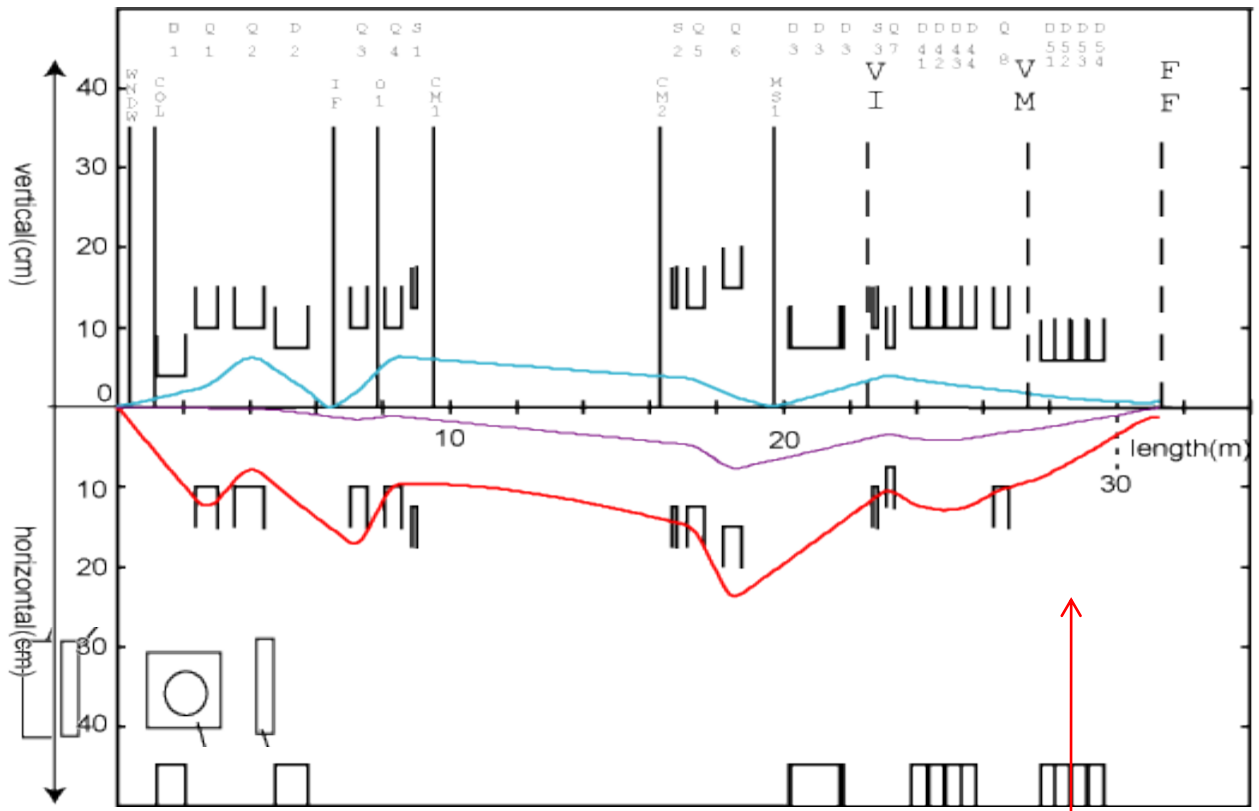
Check  
-Beam Transportation  
-Separation  
-Kaon formation







Calculated Beam envelope



Beam profile :: spread  
 -> need to be tuned.

The First Beam profile

# Beamline detectors

	T0	BLC1,2	PDC1,2	PA	BHD
Time res.	70ps			70 ps	70 ps
Pos.res		200um	200um		
Trigger	○			○	○
TOF	Stop				start

T0 BLC1,2
PDC1,2 PA
BHD



FF