



清华大学  
Tsinghua University

# HIAF上的K介子束流线 初步探讨

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see王晓云报告

**Table 1**

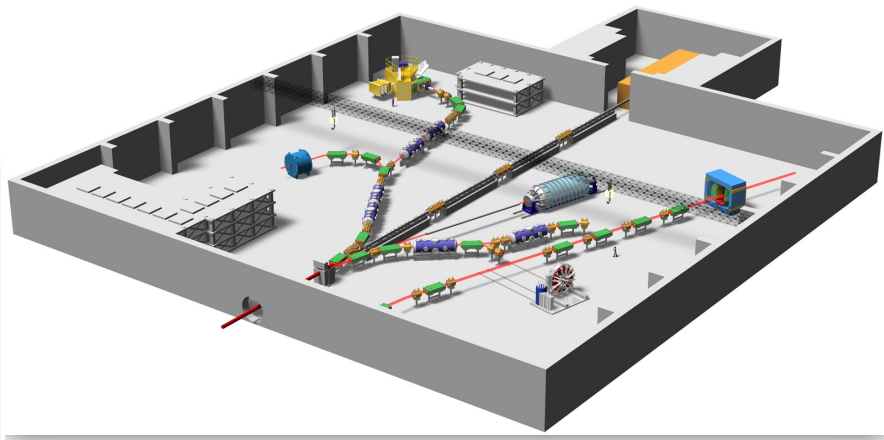
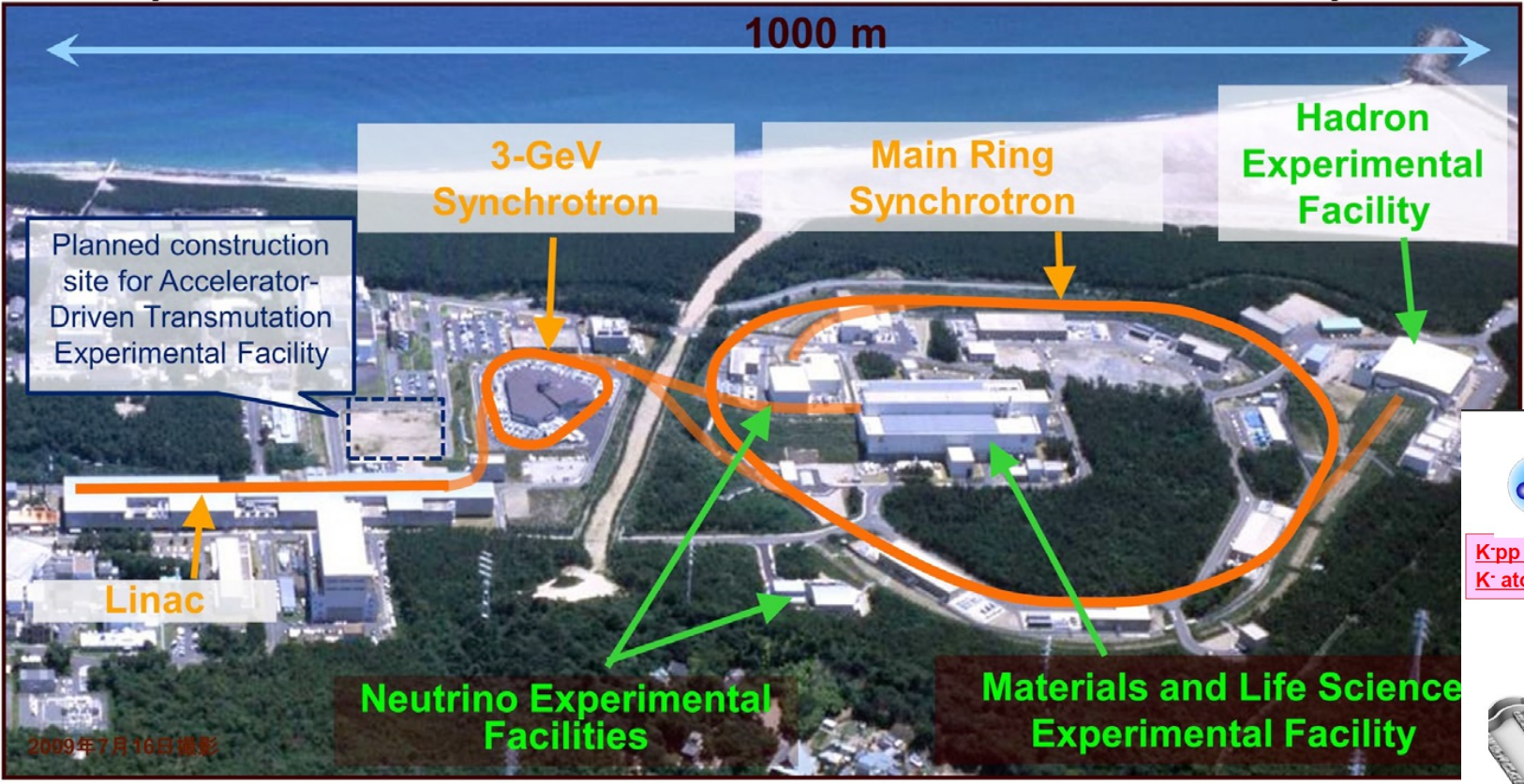
Kaon decay experiments being reviewed in this article.

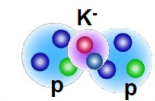
Lab	Accelerator		Experiment	Kaon decay
KEK	KEK-PS	(12 GeV)	E246 ✓ E391a ✓	$K^+$ at rest $K_L^0$
BNL	AGS	(25 GeV)	E949 ✓, E787 ✓	$K^+$ at rest
KEK - JAEA <sup>a</sup>	J-PARC Main Ring	(30 GeV)	$K^0$ TO TREK	$K_L^0$ $K^+$ at rest
IHEP, Protvino	U-70	(70 GeV)	ISTRA + ✓ OKA	$K^-$ in flight $K^\pm$ in flight
CERN	SPS	(400 GeV)	NA48 ✓ NA48/1 ✓ NA48/2 ✓ NA62	$K_L^0, K_S^0$ $K_S^0$ $K^\pm$ in flight $K^+$ in flight
FNAL	Tevatron	(800 GeV)	KTeV ✓	$K_L^0, K_S^0$
INFN, Frascati	DAΦNE	( $\sqrt{s} \sim 1.02\text{GeV}$ )	KLOE ✓ KLOE-2	$K_L^0 + K_S^0, K^+ + K^-$ $K_L^0 + K_S^0, K^+ + K^-$



# J-PARC

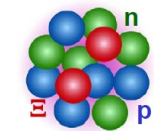
## Japan Proton Accelerator Research Complex





$K^-$

$p$   $p$



$n$

$p$

- $\Xi$  hypernuclei
- $\Lambda\Lambda$  hypernuclei
- $\Xi$ -atomic X-rays
- $\Lambda$  hypernuclear  $\gamma$  rays
- Neutron-rich  $\Lambda$  hypern.
- Pentaquark  $\Theta^+$  search
- $K^-pp$  bound state
- ...

$K^-pp$  bound states

$K^-$  atomic X rays

K1.8

K1.8BR

$K^0_L$  rare decays

KL

phi meson mass in nuclei

Dump

30 GeV primary beam

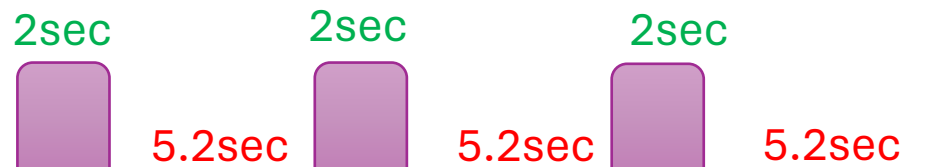
COMET/High momentum line under construction

COMET:  $\mu$ -e conversion search

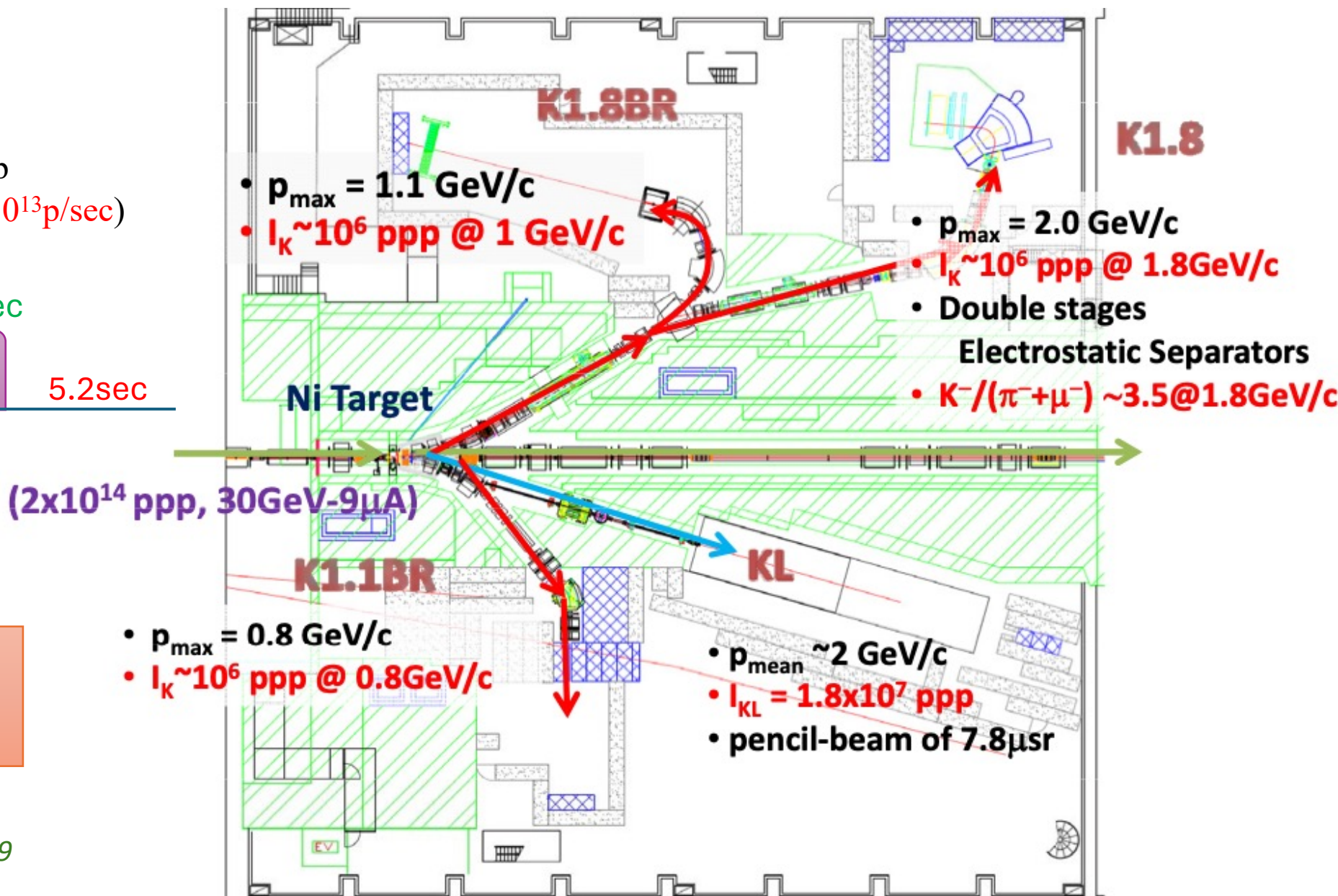
## ➤ J-PARC :

### □ 质子束流 :

- ✓ 能量=30GeV
- ✓ 亮度峰值=  $2 \times 10^{14}$ ppp  
(or 95kW,  $9 \mu\text{A}$ ,  $5.6 \times 10^{13}$ p/sec)
- ✓ 束包结构 (慢引出)



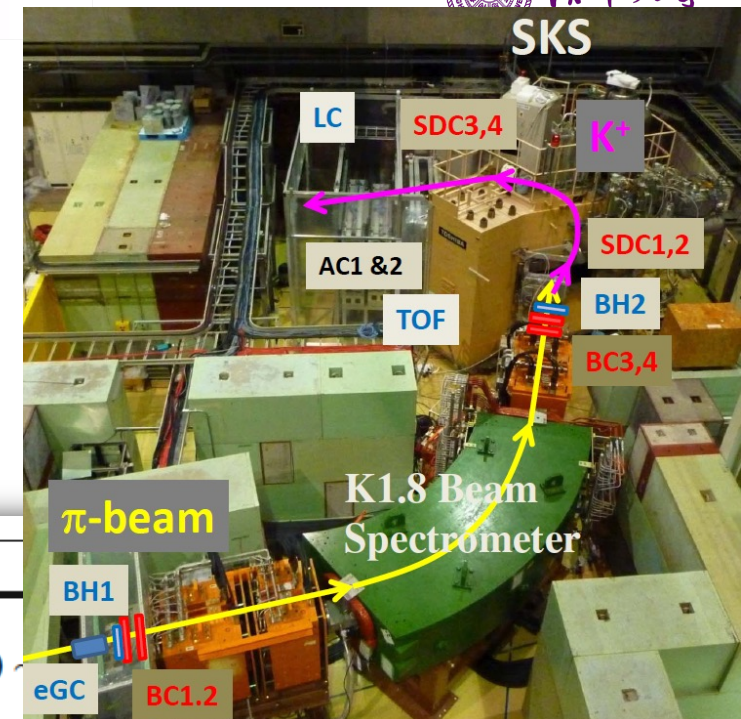
注：峰值亮度不是唯一指标，还要考虑束流稳定性，比如一年的积分亮度



### ➤ J-PARC :

- ❖ K1.8:  $P_K \sim 1.8 \text{ GeV}/c$  for  $\Xi$  Hyperon production (45米)
- ❖ K1.8BR:  $P_K = 0.8 \sim 1.2 \text{ GeV}/c$ , for  $\Lambda$  Hypernuclei Physics, Kaonic Nuclei etc.
- ❖ K1.1BR:  $P_K \leq 0.8 \text{ GeV}/c$ , for stopped-kaon experiments.
- ❖  $K_L$ :  $P_K = 1.8 \text{ GeV}/c$ ,  $L = 10^6 \text{ s}^{-1}$

	K1.8	K1.8BR	K1.1	K1.1BR	KL
Design					
Max. mom. (GeV/c)	2.0	1.1	1.1	1.1	$\sim 2(0$
Prod. angle (degrees)	-6	-6	+6	+6	+16
Length (m)	45.8	31.3	27.9	21.5	20.6
Acceptance (msr·%)	1.5	2.0	1	5.0	7.8E-3
Separator	6 m×2	6 m×1	2 m×2	2 m×1	
Max. field	80 kV/cm	80 kV/cm	50 kV/cm	50 kV/cm	
Measured Performance	ES1/ES2 50/40 kV/cm	ES1 50 kV/cm	under const.	ES1 40 kV/cm	
Kaon intensity/ $10^{14}$ proton on Pt 6 cm K/all	$K^-$ (1.8 GeV/c) $1.3E+6^S$ 0.15	$K^-$ (1 GeV/c) $8.1E+5$ 0.23	$K^+$ (1 GeV/c) $1.6E+6$ 0.47		KL $2.1E+7$



$$p/\text{spill} = 2/(2+5.52) \text{ p/sec} \\ \sim 0.27 * \text{s}^{-1}$$



## ➤ J-PARC :

*H. Ohnishi, F. Sakuma and  
T. Takahashi / Progress in  
Particle and Nuclear  
Physics 113 (2020) 103773*

**Table 1**

Status of the experiments at the hadron experimental facility described in this article.

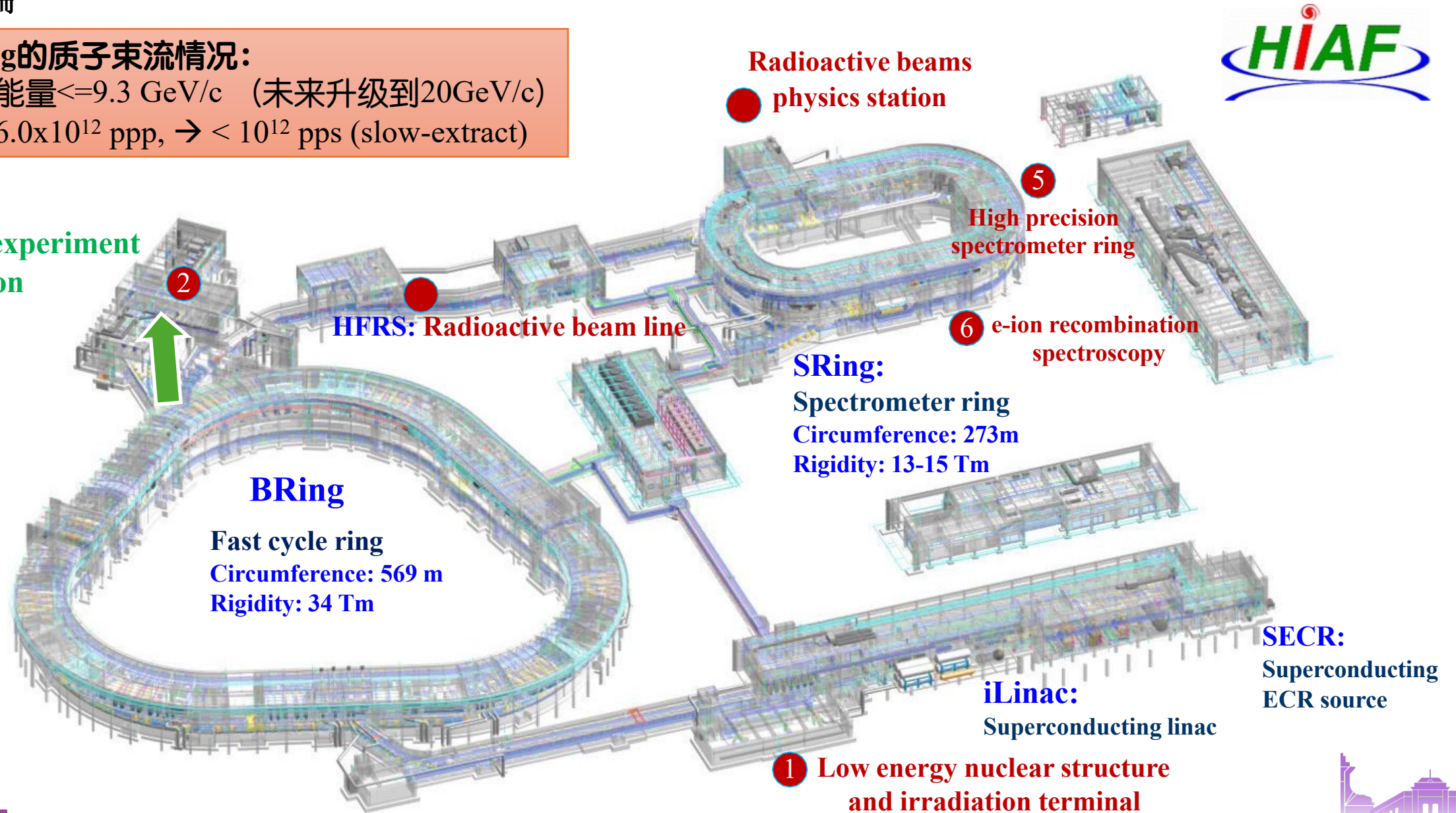
Subsection	Experiment		Beamline	Beam particle	Status
3.1.1	E19	High-resolution search for $\Theta^+$ pentaquark in $\pi^-p \rightarrow K^-X$ reactions	K1.8	$\pi^-$	Completed
3.1.2	E42	Search for $H$ -dibaryon with a large acceptance hyperon spectrometer	K1.8	$K^-$	Forthcoming
3.1.3	E45	3-body hadronic reactions for new aspects of baryon spectroscopy	K1.8	$K^-$	Forthcoming
3.1.4	E72	Search for a narrow $\Lambda^*$ resonance using the $p(K^-, \Lambda)\eta$ reaction with the hypTPC detector	K1.8BR	$K^-$	Forthcoming
3.1.5	E50	Charmed baryon spectroscopy via the $(\pi^-, D^{*-})$ reaction	high-p	$\pi^-$	Planned
3.1.6	E16	Electron pair spectrometer at the J-PARC 50-GeV PS to explore the chiral symmetry in QCD	high-p	$p$	Ongoing
3.1.7	E26	Direct measurements of $\omega$ mass modification in $A(\pi^-, n)\omega$ reaction and $\omega \rightarrow \pi^0\gamma$ decays	K1.8	$\pi^-$	Planned
	E29	Study of in medium mass modification for the $\phi$ meson using $\phi$ meson bound state in nucleus	K1.8BR	$\bar{p}$	Planned
3.2.1	E57	Measurement of the strong interaction induced shift and width of the 1st state of kaonic deuterium at J-PARC	K1.8BR	$K^-$	Forthcoming
3.2.2	E62	Precision spectroscopy of kaonic helium $3\ 3d \rightarrow 2p$ X-rays	K1.8BR	$K^-$	Completed
3.2.3	E31	Spectroscopic study of hyperon resonances below $\bar{K}N$ threshold via the $(K^-, n)$ reaction on deuteron	K1.8BR	$K^-$	Completed
3.2.4	E27	Search for a nuclear $\bar{K}$ bound state $K^-pp$ in the $d(\pi^+, K^+)$ reaction	K1.8	$\pi^+$	Completed
	E15	A search for deeply-bound kaonic nuclear states by in-flight ${}^3\text{He}(K^-, n)$ reaction	K1.8BR	$K^-$	Completed
3.3.1	E10	Production of neutron-rich $\Lambda$ -hypernuclei with the double charge-exchange reactions	K1.8	$\pi^-$	Completed
3.3.2	E13	Gamma-ray spectroscopy of light hypernuclei	K1.8	$K^-$	Completed
3.3.3	E63	Proposal of the 2nd stage of E13 experiment	K1.1	$K^-$	Planned
3.3.4	E40	Measurement of the cross sections of $\Sigma p$ scatterings	K1.8	$\pi^\pm$	Ongoing
3.3.5	E07	Systematic study of double strangeness system with an emulsion-counter hybrid method	K1.8	$K^-$	Completed
3.3.6	E05	Spectroscopic study of $\Xi$ -hypernucleus, ${}^{12}_{\Xi}\text{Be}$ , via the ${}^{12}\text{C}(K^-, K^+)$ reaction	K1.8	$K^-$	Completed
	E70	Proposal for the next E05 run with the S-2S spectrometer	K1.8	$K^-$	Forthcoming
3.3.7	E03	Measurement of X-rays from $\Xi$ -atom	K1.8	$K^-$	Forthcoming

## ➤ 高能终端

### ✓ BRing的质子束流情况:

- 能量 $\leq 9.3$  GeV/c (未来升级到20GeV/c)
- $6.0 \times 10^{12}$  ppp,  $\rightarrow < 10^{12}$  pps (slow-extract)

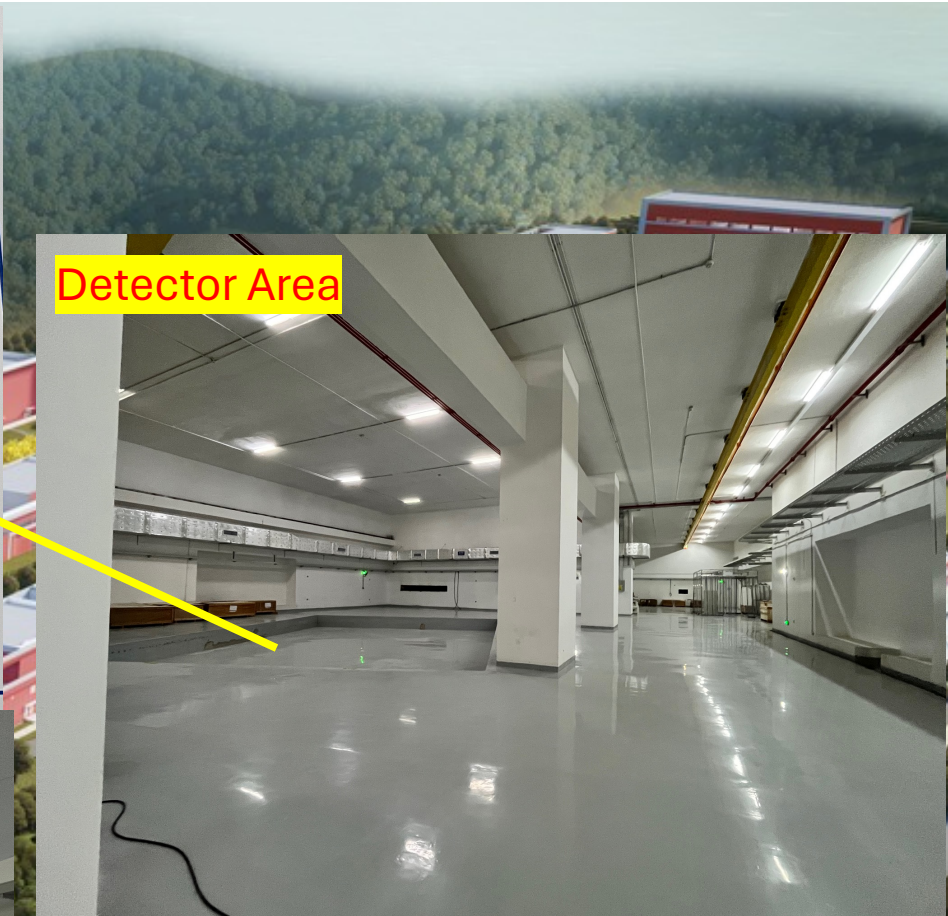
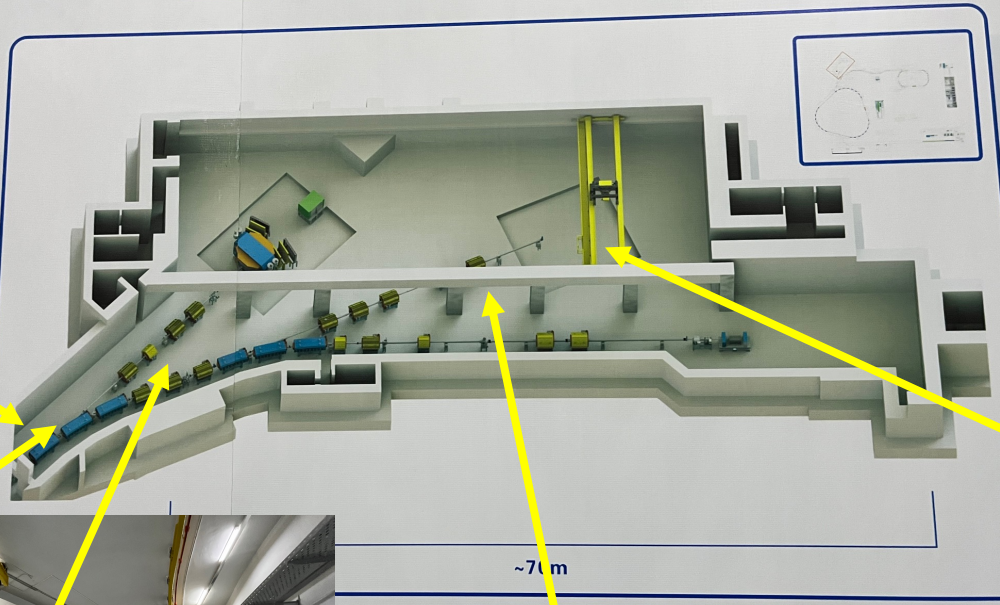
High energy experiment station





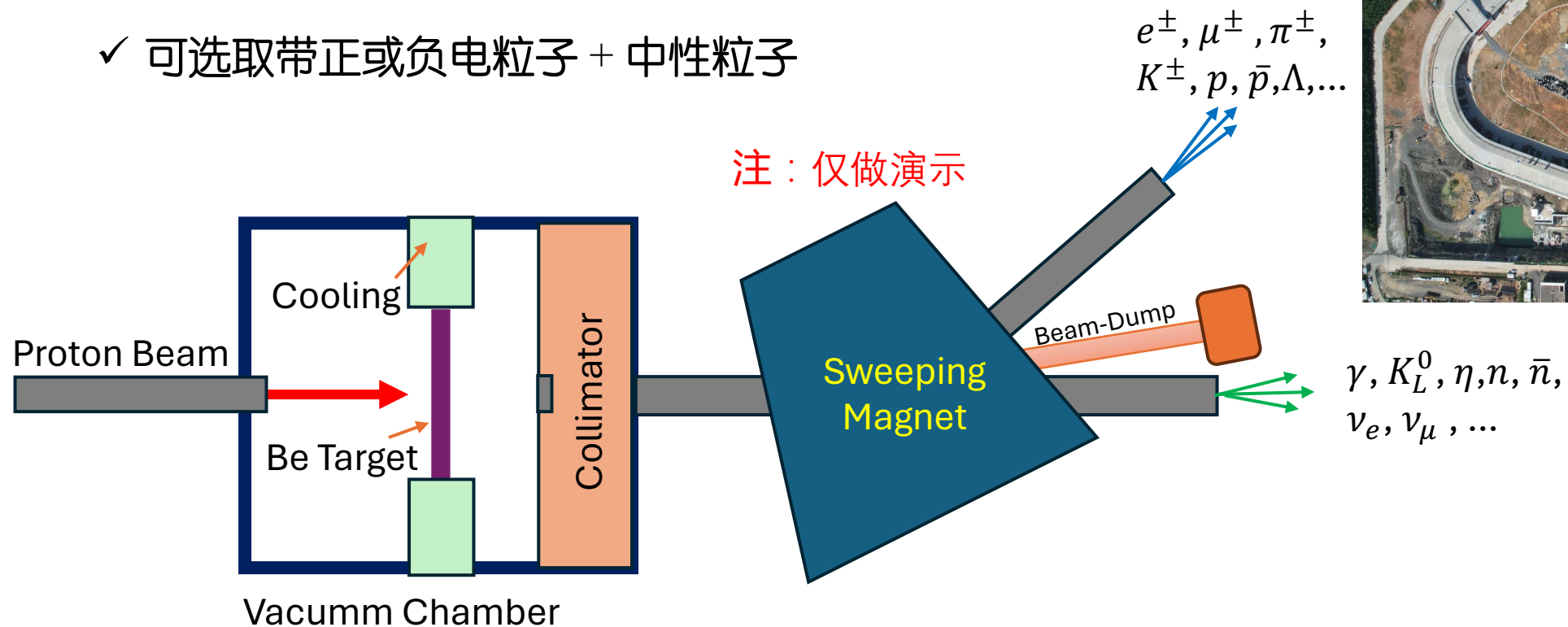
///  
环  
超  
器  
叉  
折  
景

## 高能综合终端



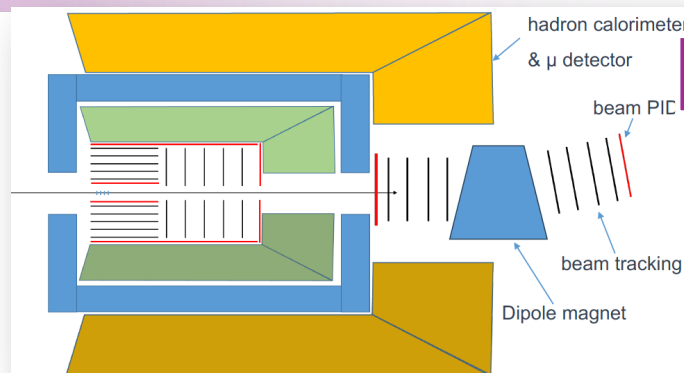
### ➤ 如何产生次级粒子束流

- ✓ 高能质子轰击Be靶（或者Pt靶）
- ✓ 二级磁铁将带电次级粒子与质子束流分离
- ✓ 可选取带正或负电粒子 + 中性粒子



### ➤ 带电粒子束流的分离和甄别

- ✓ 通过多种磁铁筛选特定动量的带电粒子
- ✓ 静电场进行 $\pi/K$ 分离
- ✓ 通过粒子甄别探测器区分不同次级粒子
- ✓ 使用全方位探测器系统测量稀有衰变

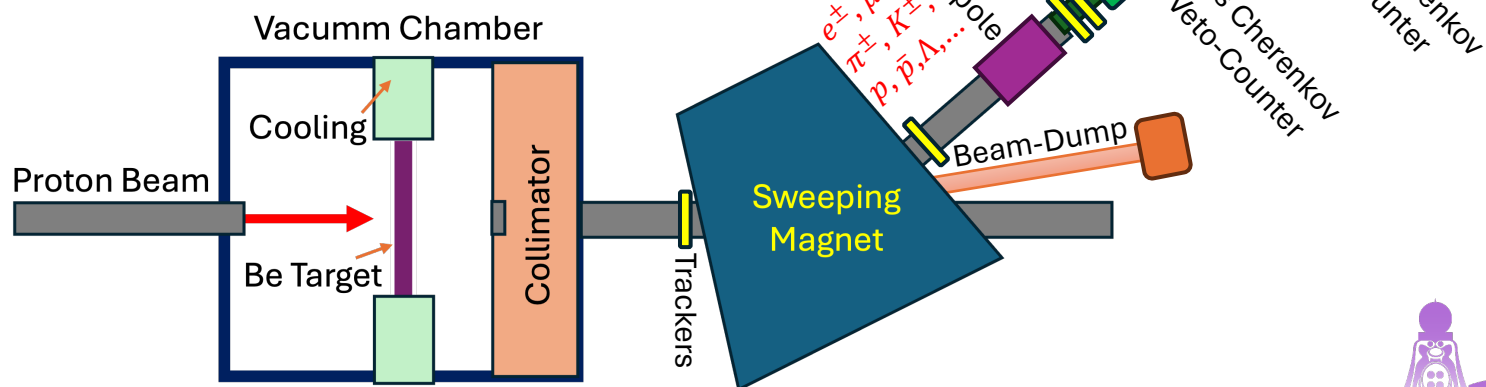


仇浩的报告

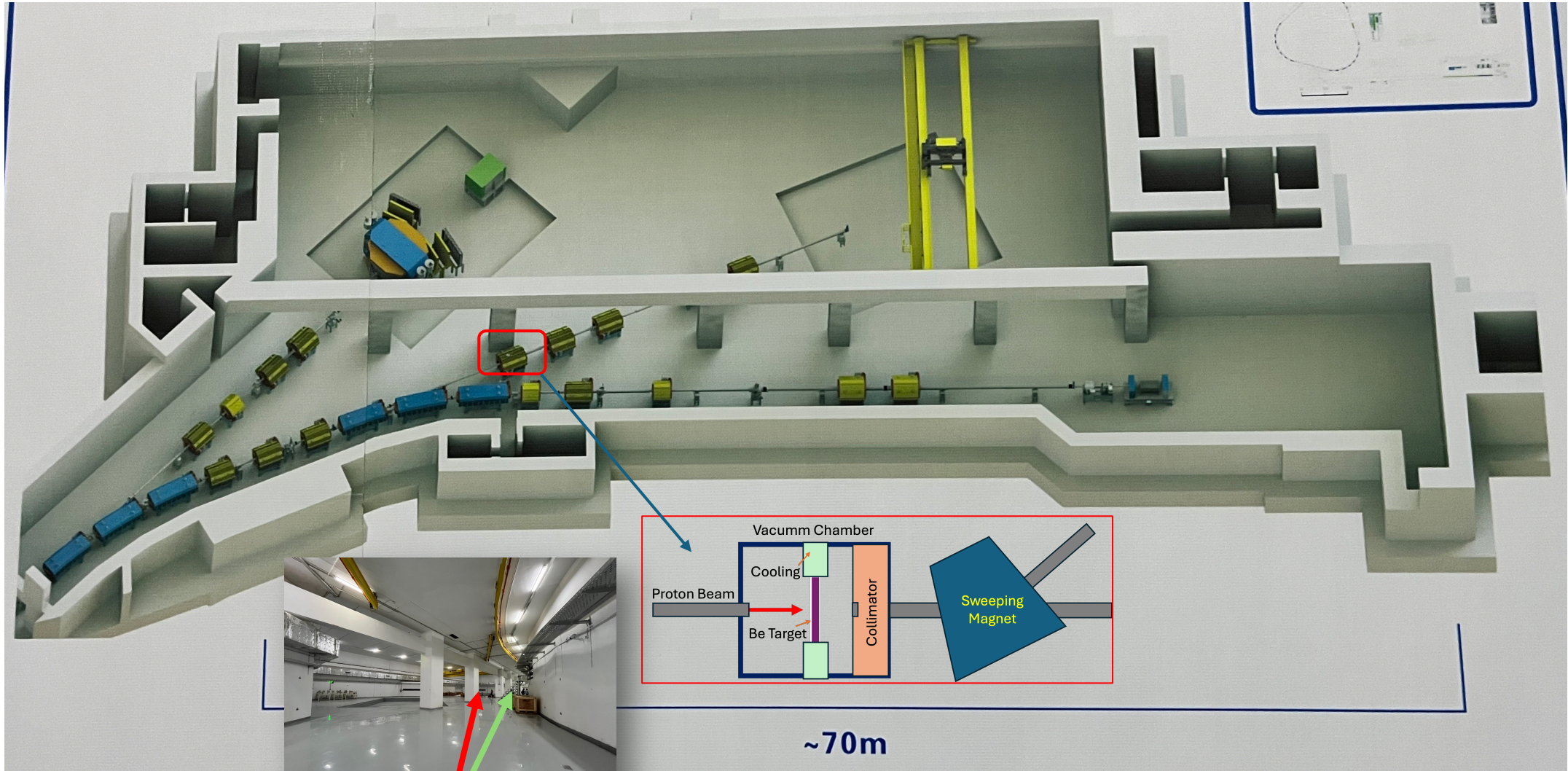
问题：对探测器系统的总精度要求？

### 粒子甄别:

- $e^\pm, \mu^\pm$  rejected by Gas Cherenkov Counter
- $\pi^\pm, K^\pm$  separated by Gas & Aerogel Cherenkov
- $K^\pm, p, \bar{p}$  separated by TOF & Water Cherenkov



## ➤ 次级粒子产生靶点：



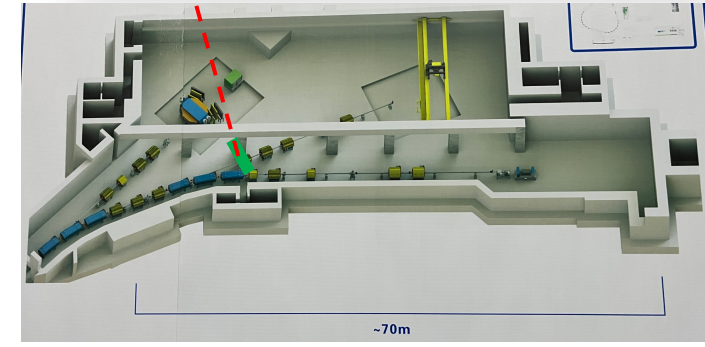
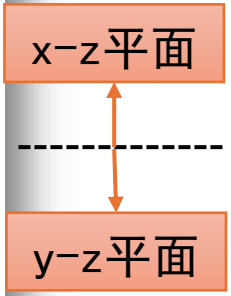
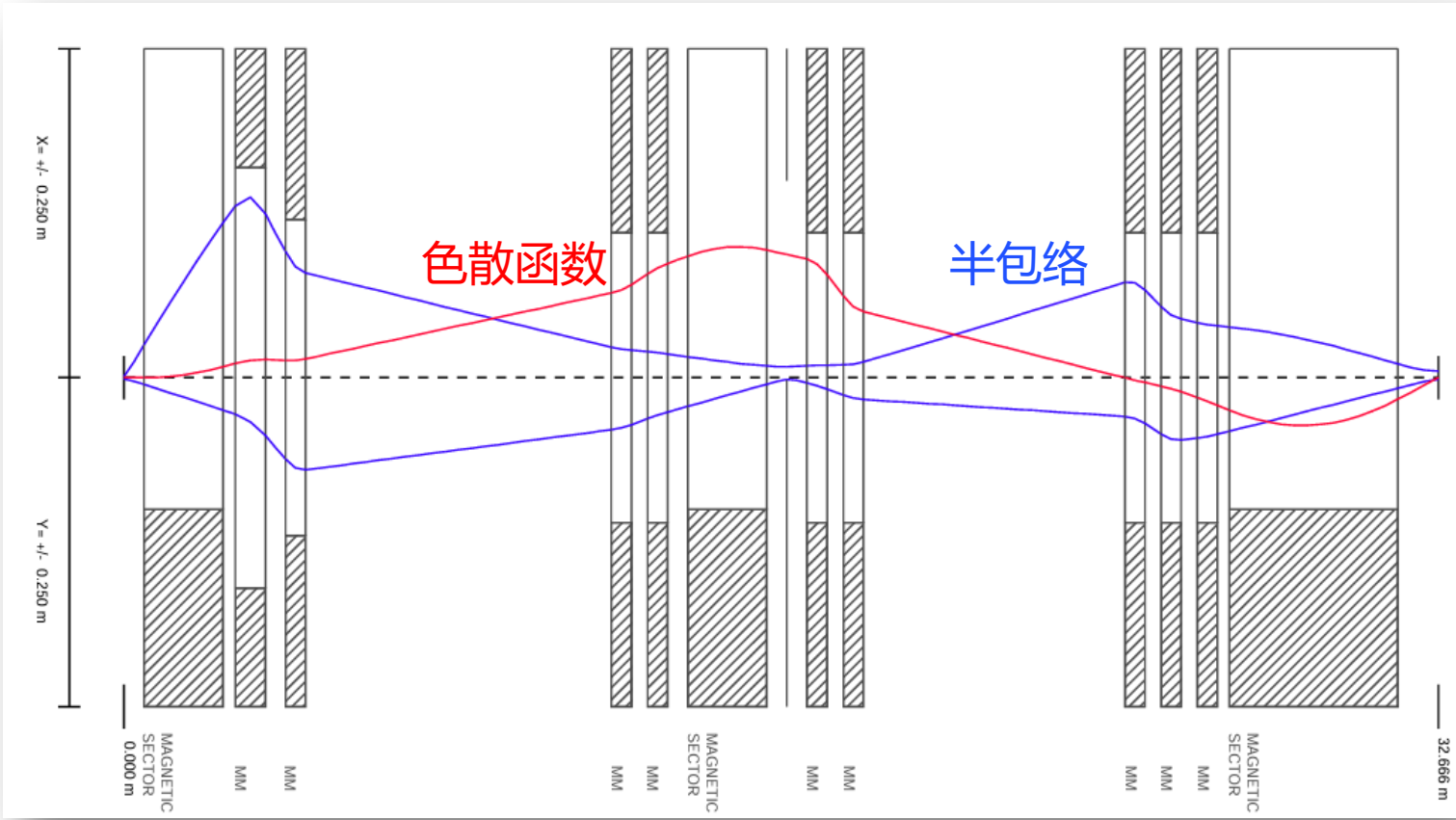
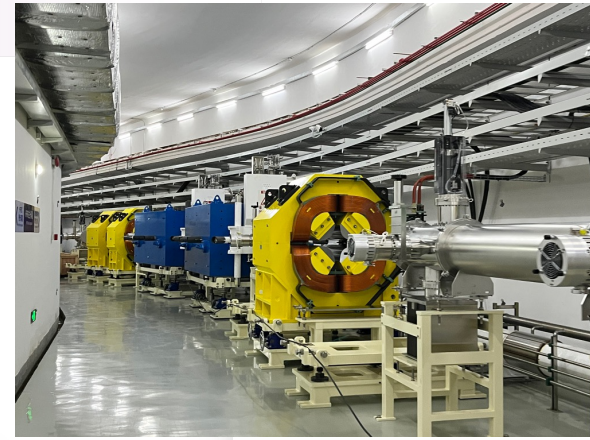
质子束流方向

空间大致满足，可能高度（7m）会有限制



## ➤ 带电粒子束流的分离和甄别

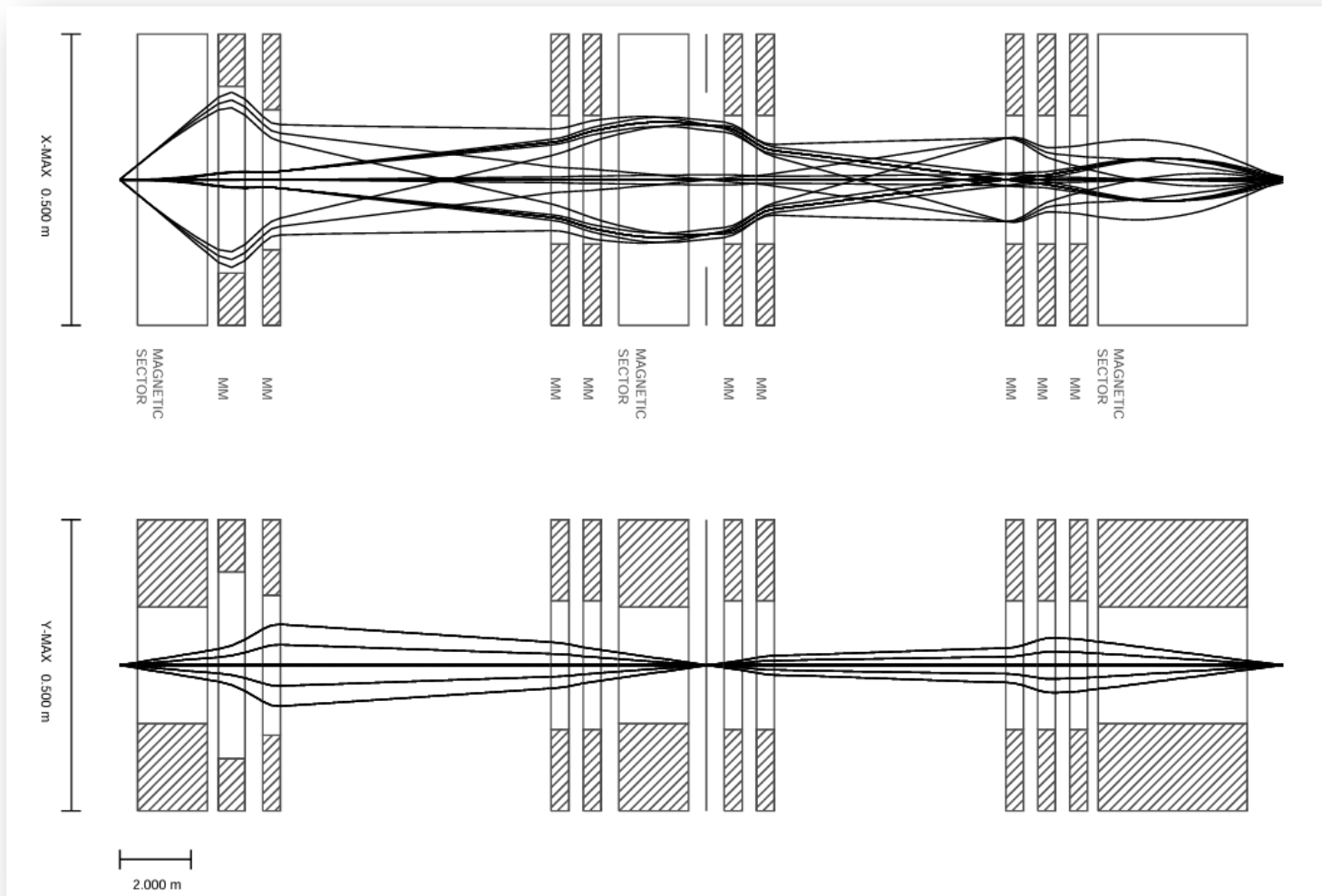
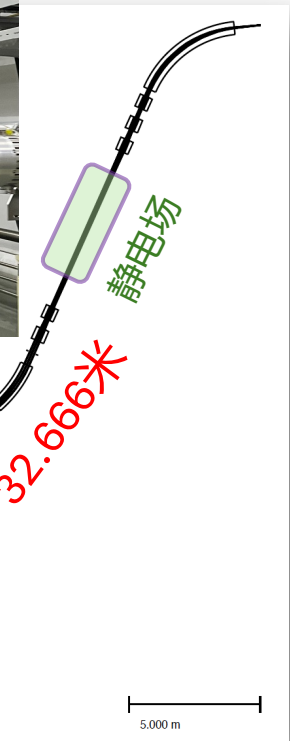
- ✓ 正在与近物所加速器团队高度合作设计束流分离线 (王科, 申国栋, 冒立军)
- 束流筛选粒子动量和角度范围 (~1.5msr%, same as J-PARC K1.8) :   
 $\delta P/P \sim +/- 2\%$ ,  $\theta(x\text{方向}) \sim +/- 50\text{mrad}$ ,  $\phi(Y\text{-方向}) \sim +/- 15\text{mrad}$



## ➤ 带电粒子束流的分离和甄别

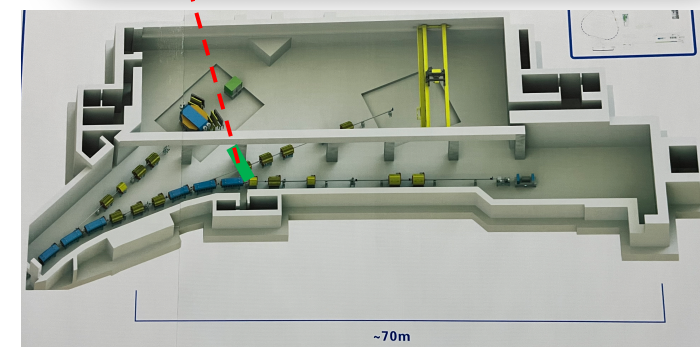
❑ **总长32.67米**：3个二级磁铁，9个四级磁铁，2个静电场，若干多极磁铁

❑ **预估造价**：磁铁 100 万+电源50万+真空设备+束流诊断系统 ~ 300万+其他？



x-z平面

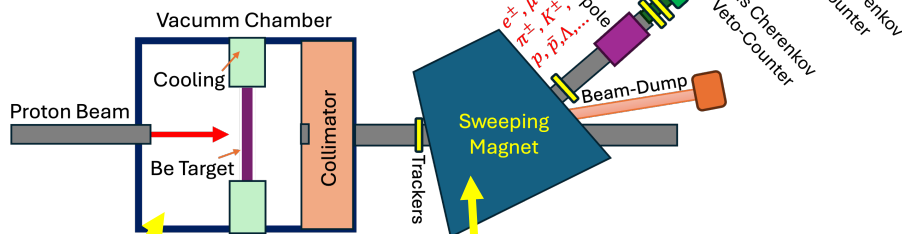
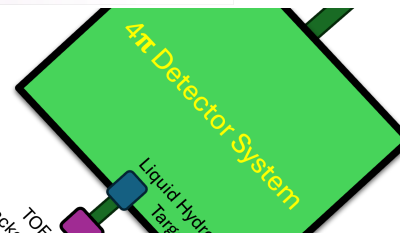
y-z平面



➤ 带电粒子束流的分离和甄别

❑ K介子次级束流分离技术与HFERS类似，**或更简单**

❑ 磁铁和其他硬件条件已具备



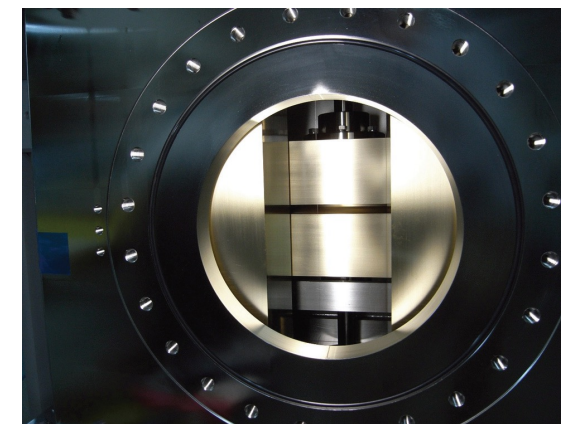
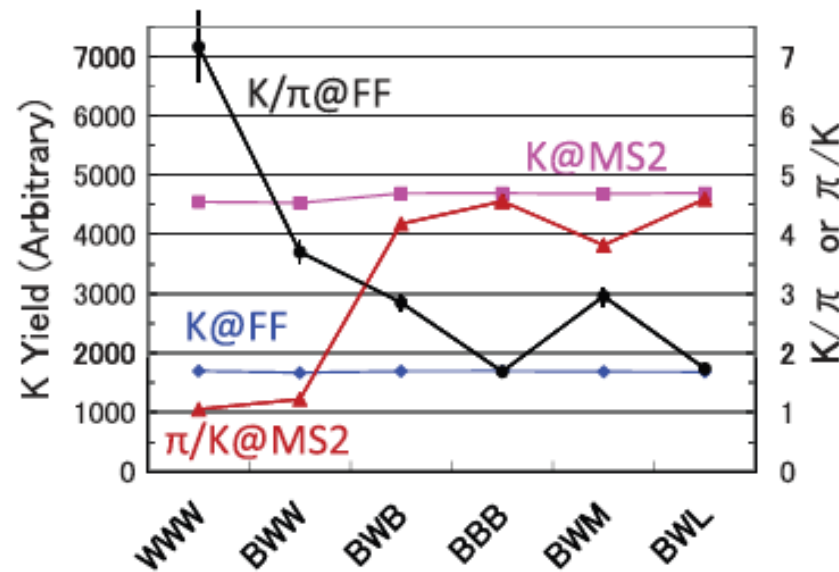
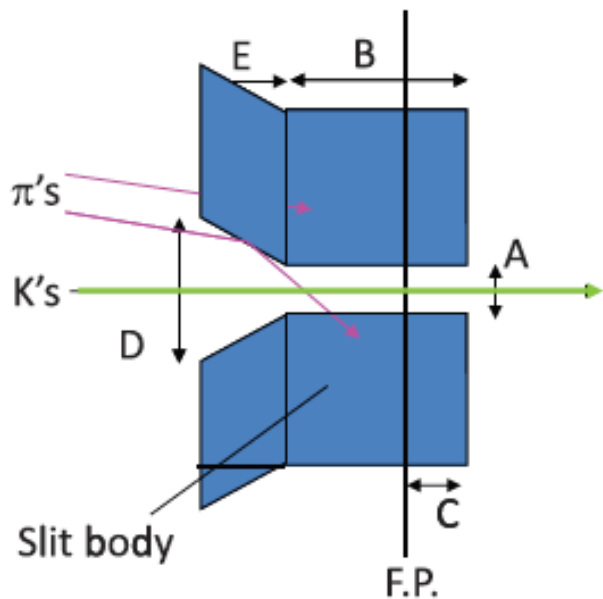
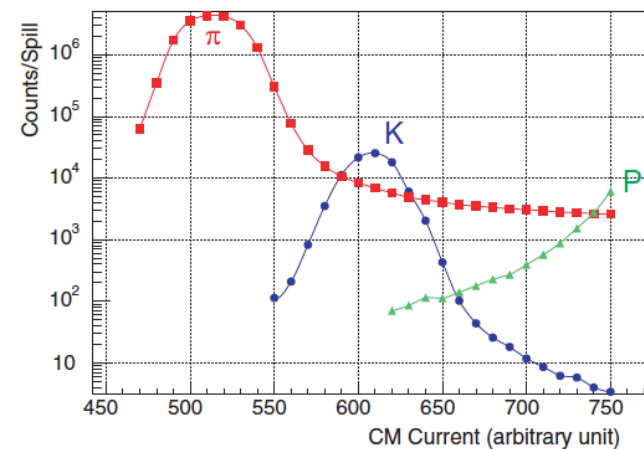
## ➤ 带电粒子束流的分离和甄别

❑  $\pi/K$ 介子分离技术需要大量模拟和研发

❑ J-PARC办法:

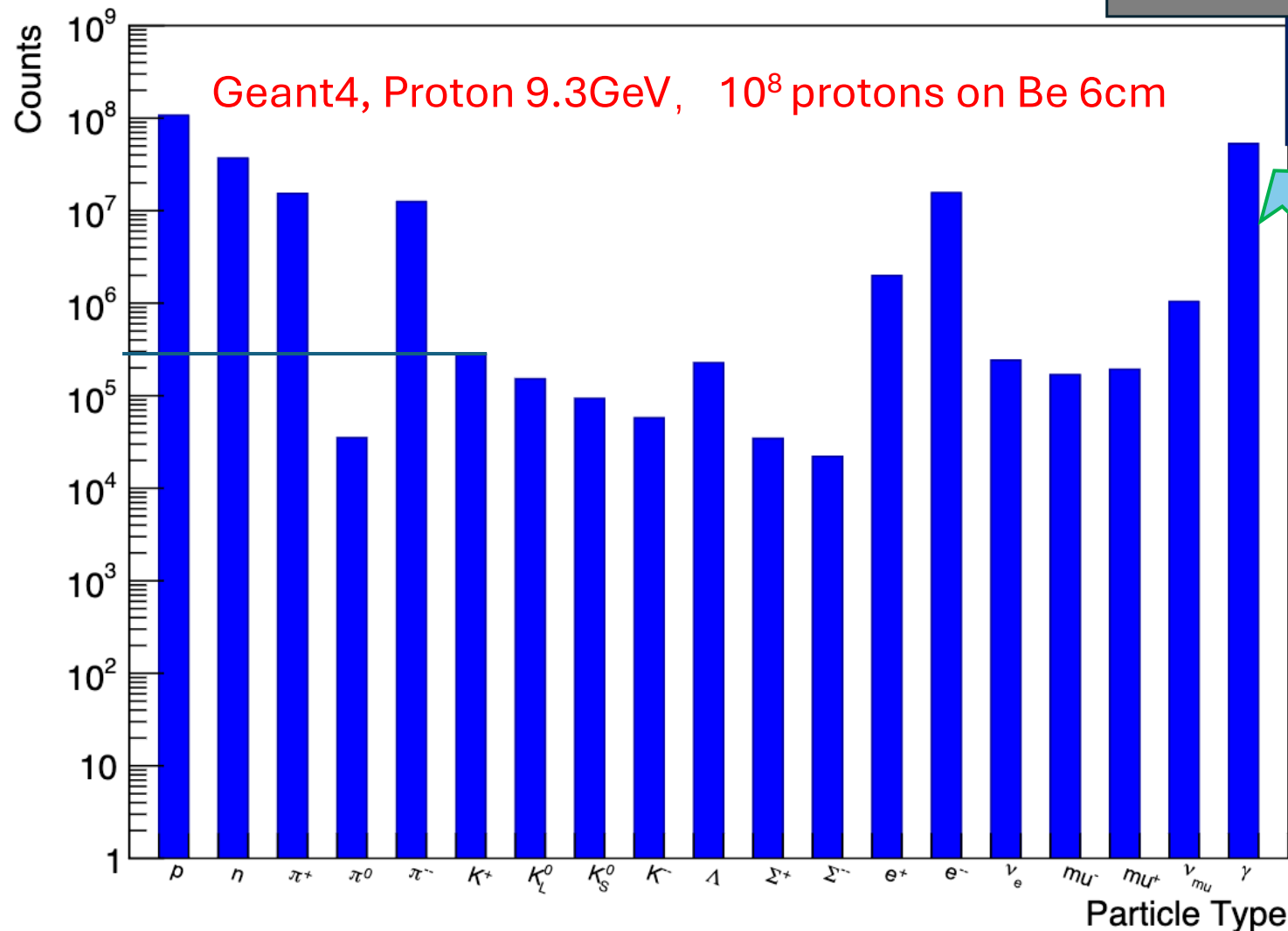
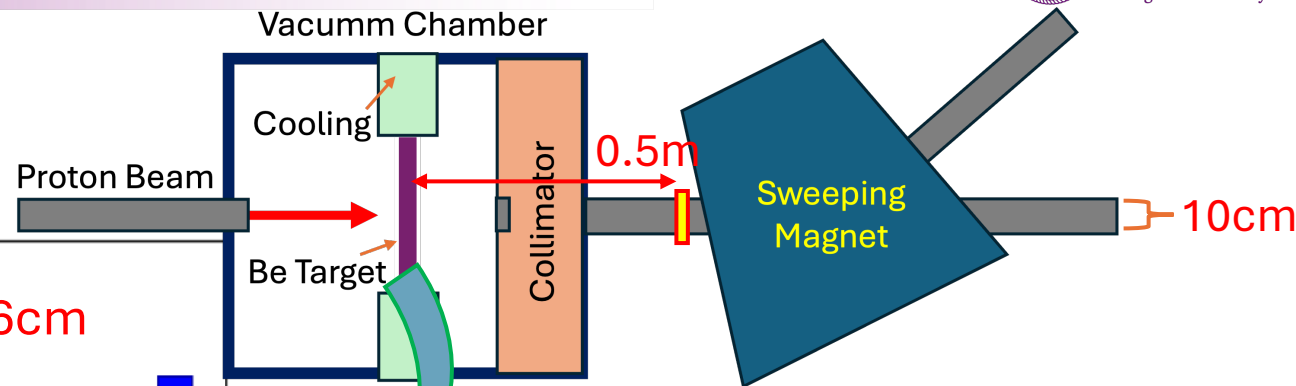
- ✓ 静电场分离器 (electrostatic separator, ES)
- ✓ 多组狭缝 (Slits)
- ✓ 多组切伦科夫探测器 (Gas+Aerogel+Water)

K1.1BR ES



### 次级粒子束流的亮度

✓ Geant4模拟 $10^8$  质子轰击Be靶 (厚度=6cm)



$\pi^\pm$ : 寿命  $\tau = 2.603 \times 10^{-8} s$ ,  $c\tau = 7.805m$

$K^\pm$ : 寿命  $\tau = 1.238 \times 10^{-8} s$ ,  $c\tau = 3.711m$

$K_L^0$ : 寿命  $\tau = 5.116 \times 10^{-8} s$ ,  $c\tau = 15.34cm$

- 1.0GeV/c:

- $\pi^\pm$ :  $d = 0.9904 \times 7.234 \times 7.805m = 55.92m$

- $K^\pm$ :  $d = 0.897 \times 2.259 \times 3.711m = 7.52m$ ,

- $K_L^0$ :  $d = 0.897 \times 2.259 \times 15.34m = 31.08m$

- 4.0GeV/c:

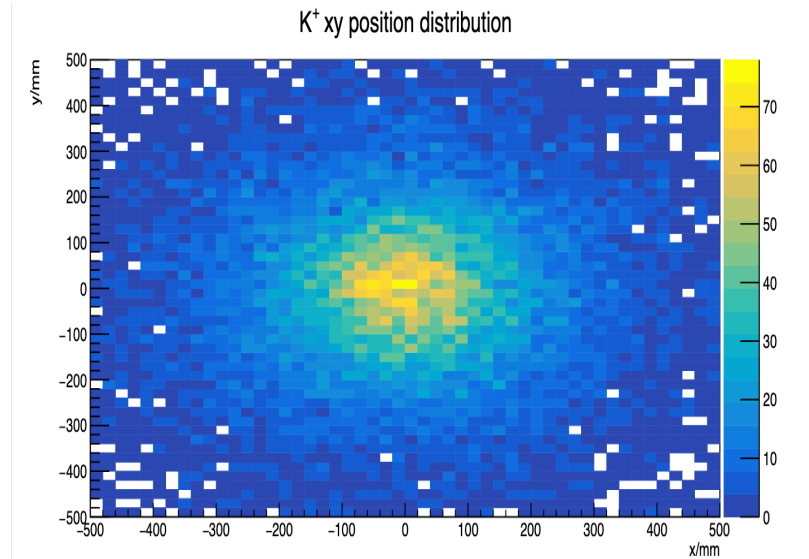
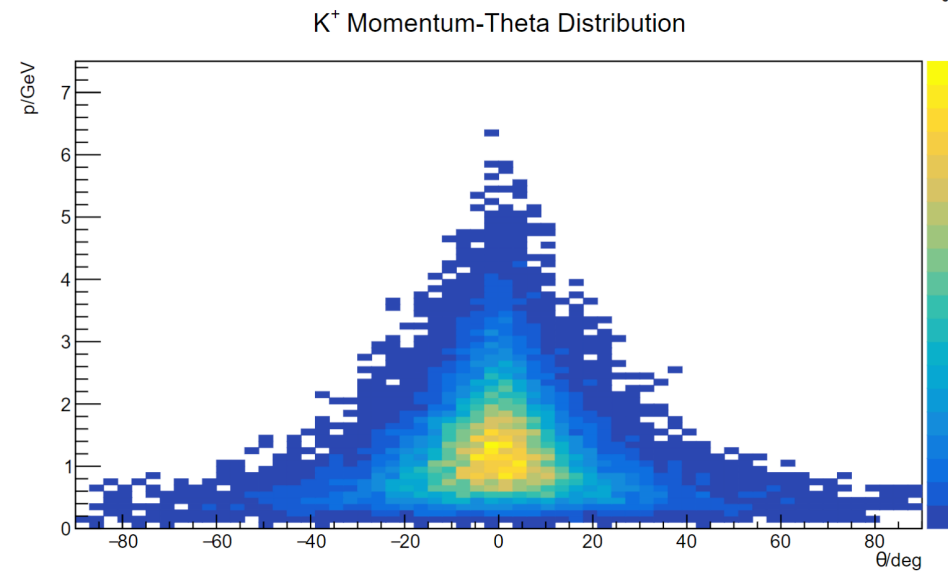
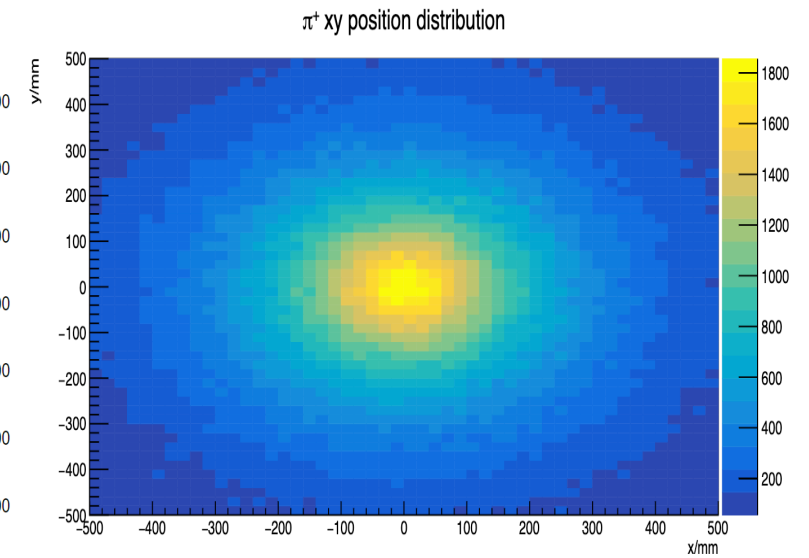
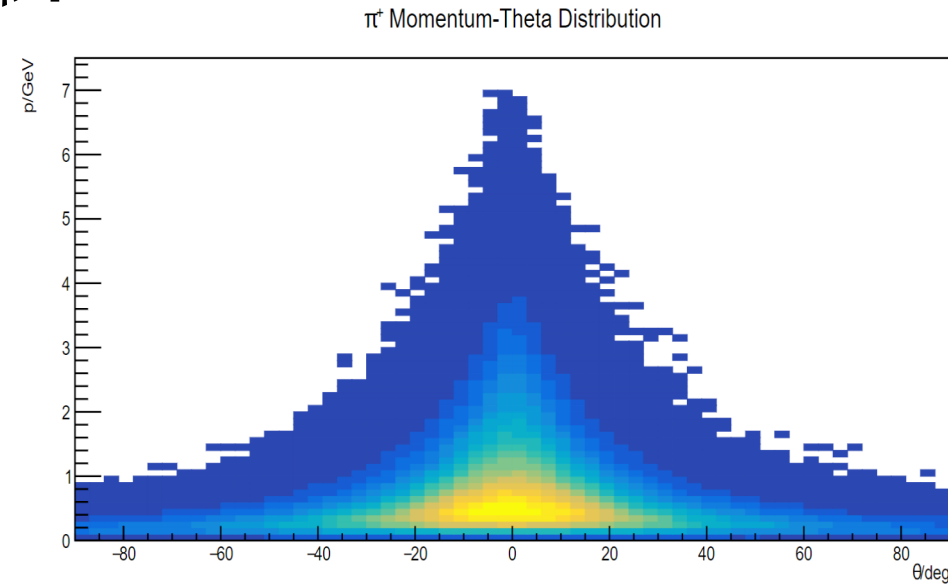
- $\pi^\pm$ :  $d = 0.99939181 \times 28.677 \times 7.805m = 223.69m$

- $K^\pm$ :  $d = 0.992 \times 8.164 \times 3.771m = 30.05m$

- $K_L^0$ :  $d = 0.992 \times 8.164 \times 15.34 = 124.23m$

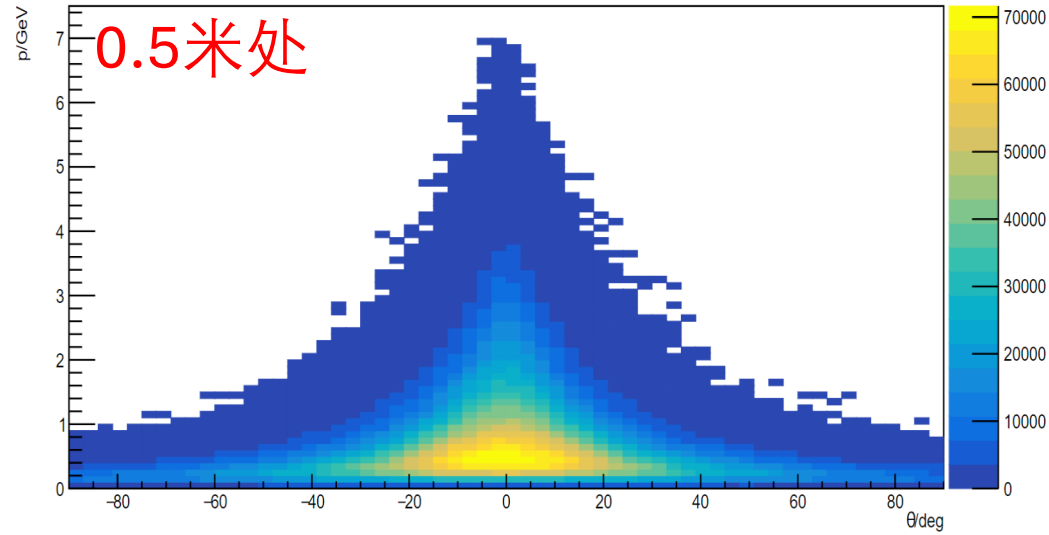
➤ 反应点的动量和角度分布：

- 9.3GeV质子:  $10^8$
- Be靶厚度=6cm

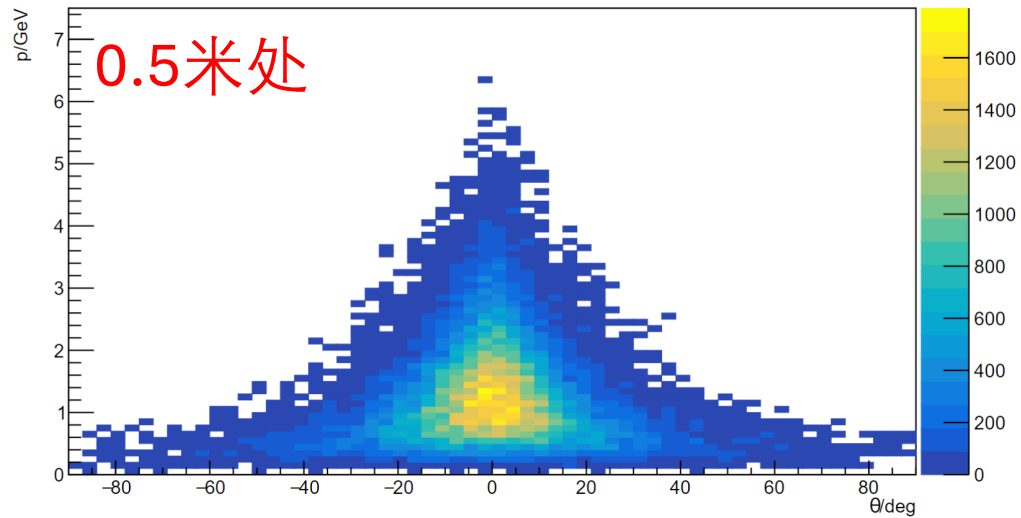


► 飞行一段距离后的粒子数分布(不加任何动量角度筛选):

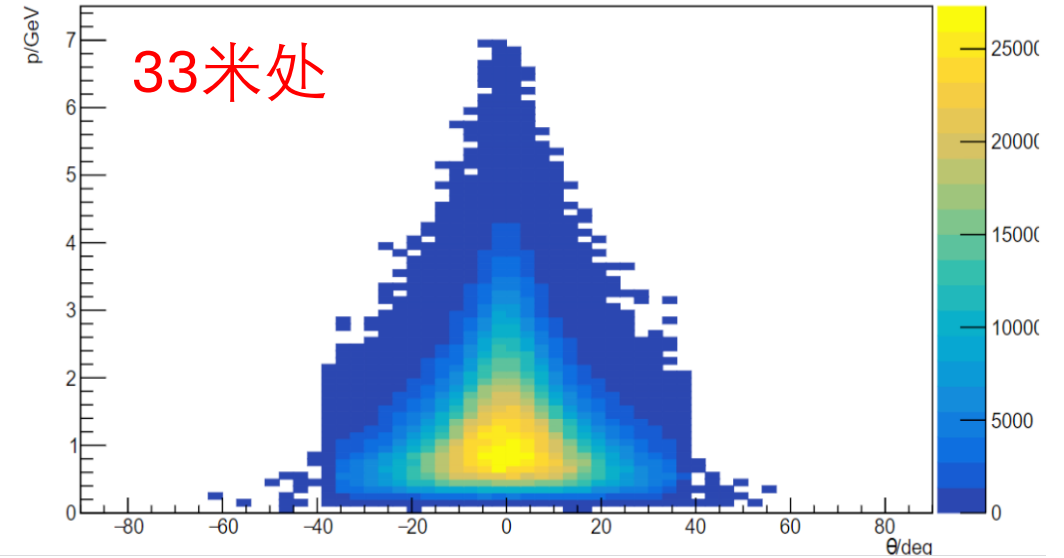
$\pi^+$  Momentum-Theta Distribution



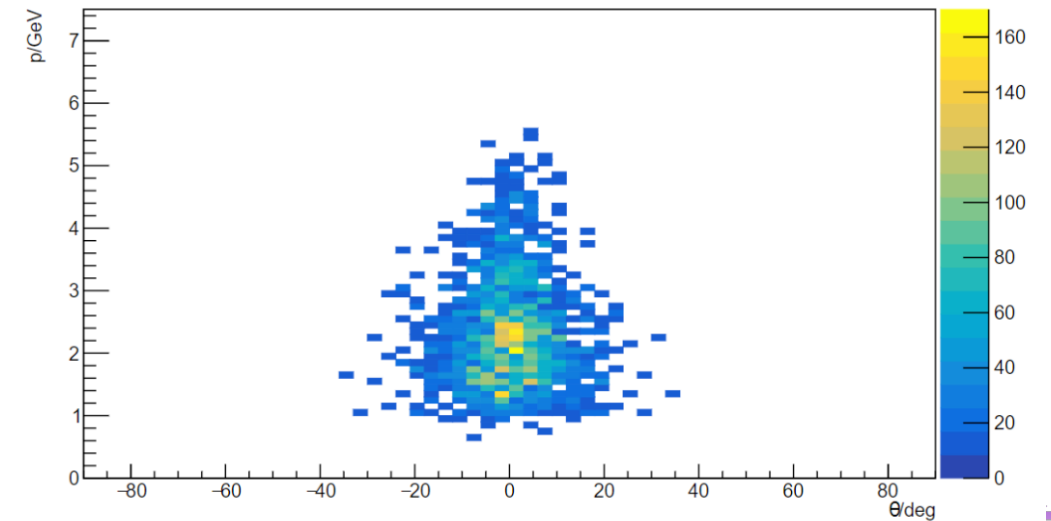
$K^+$  Momentum-Theta Distribution



$\pi^+$  Momentum-Theta Distribution



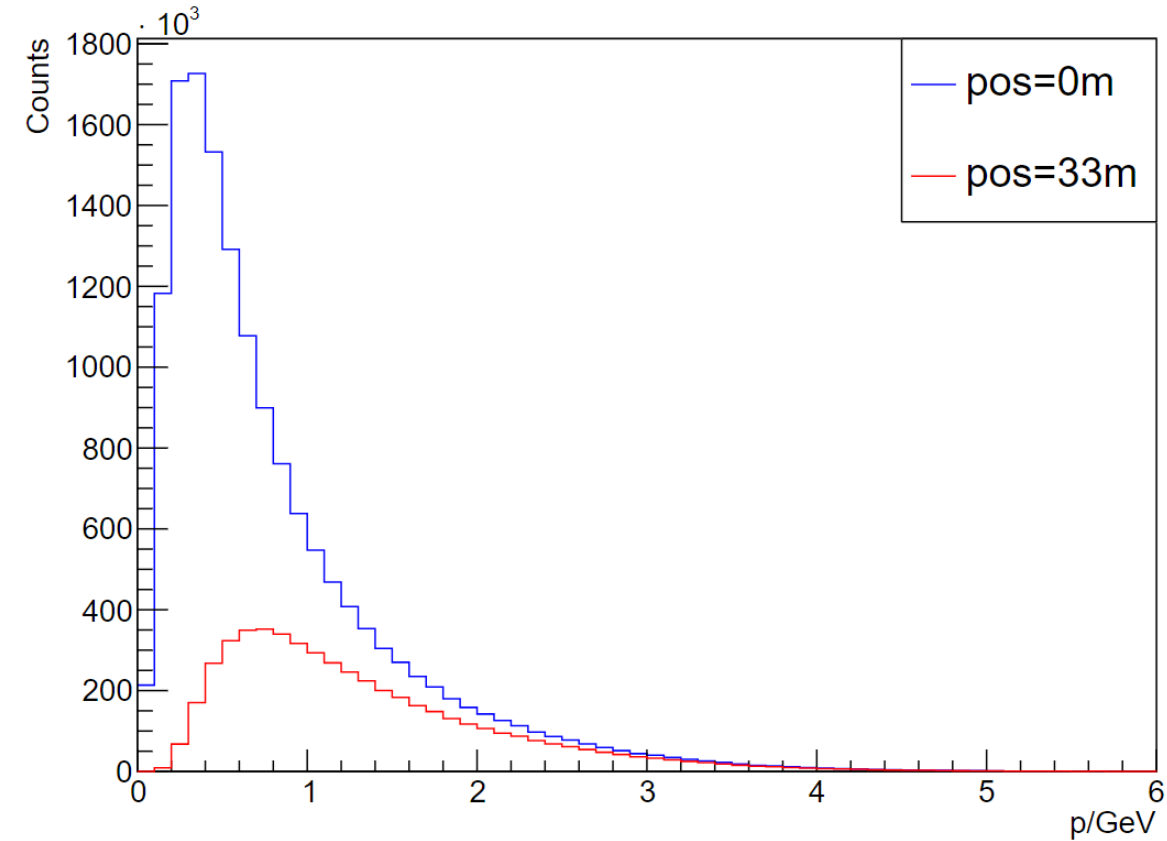
$K^+$  Momentum-Theta Distribution



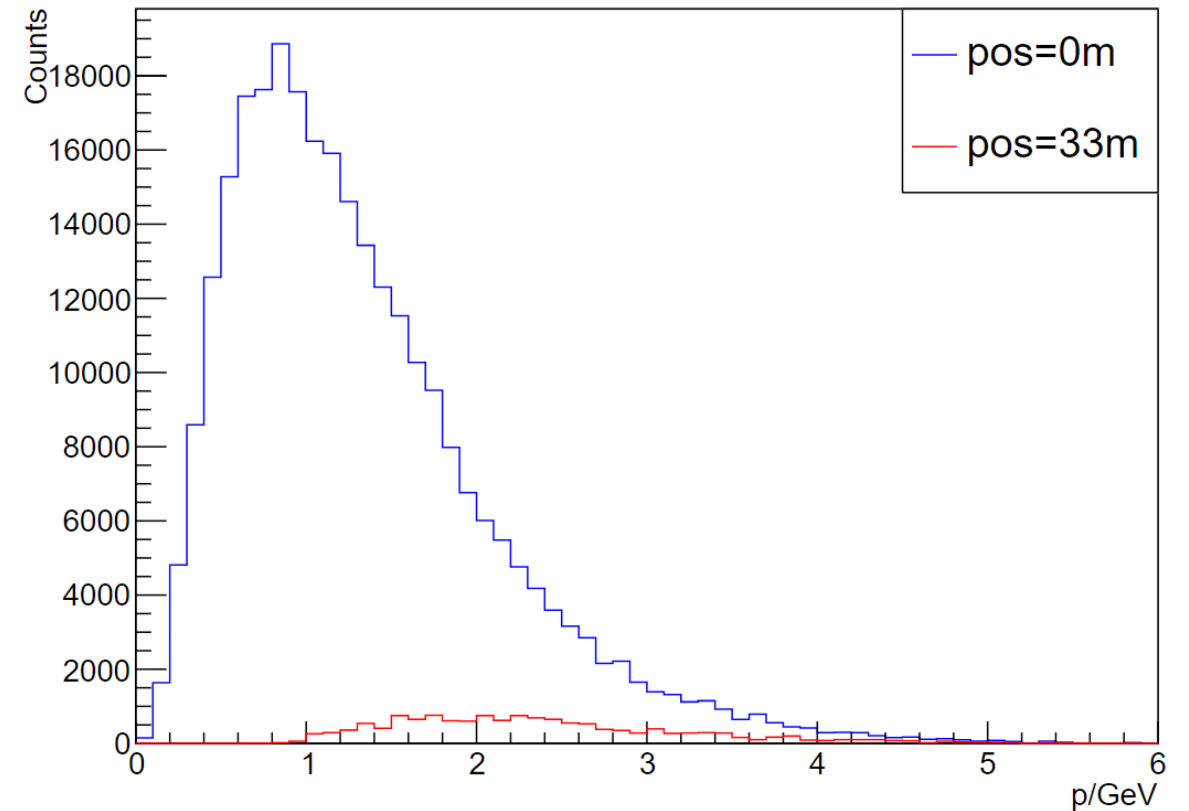
➤ 次级粒子束流的动量分布：

□ 9.3GeV质子:  $10^8$ , Be靶厚度=6cm

$\pi^+$  Momentum Distribution

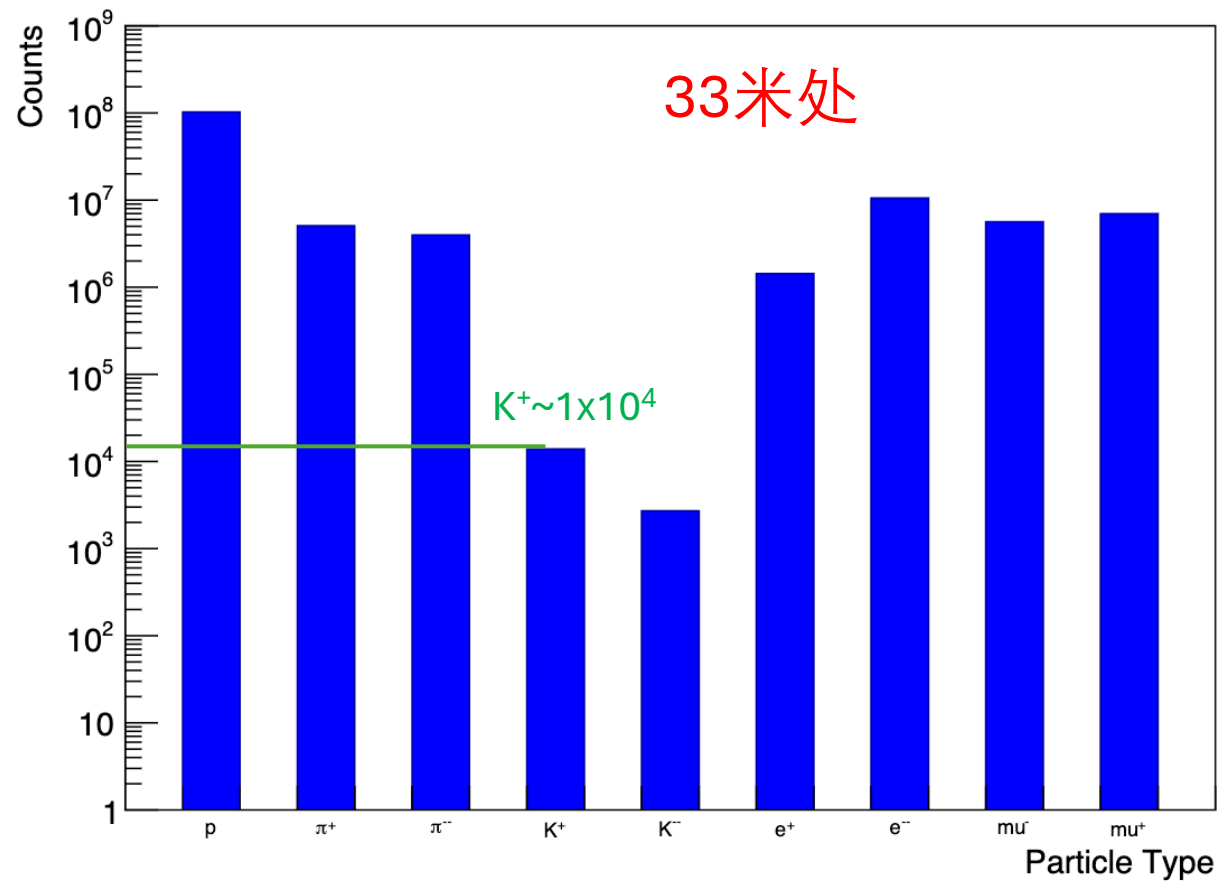
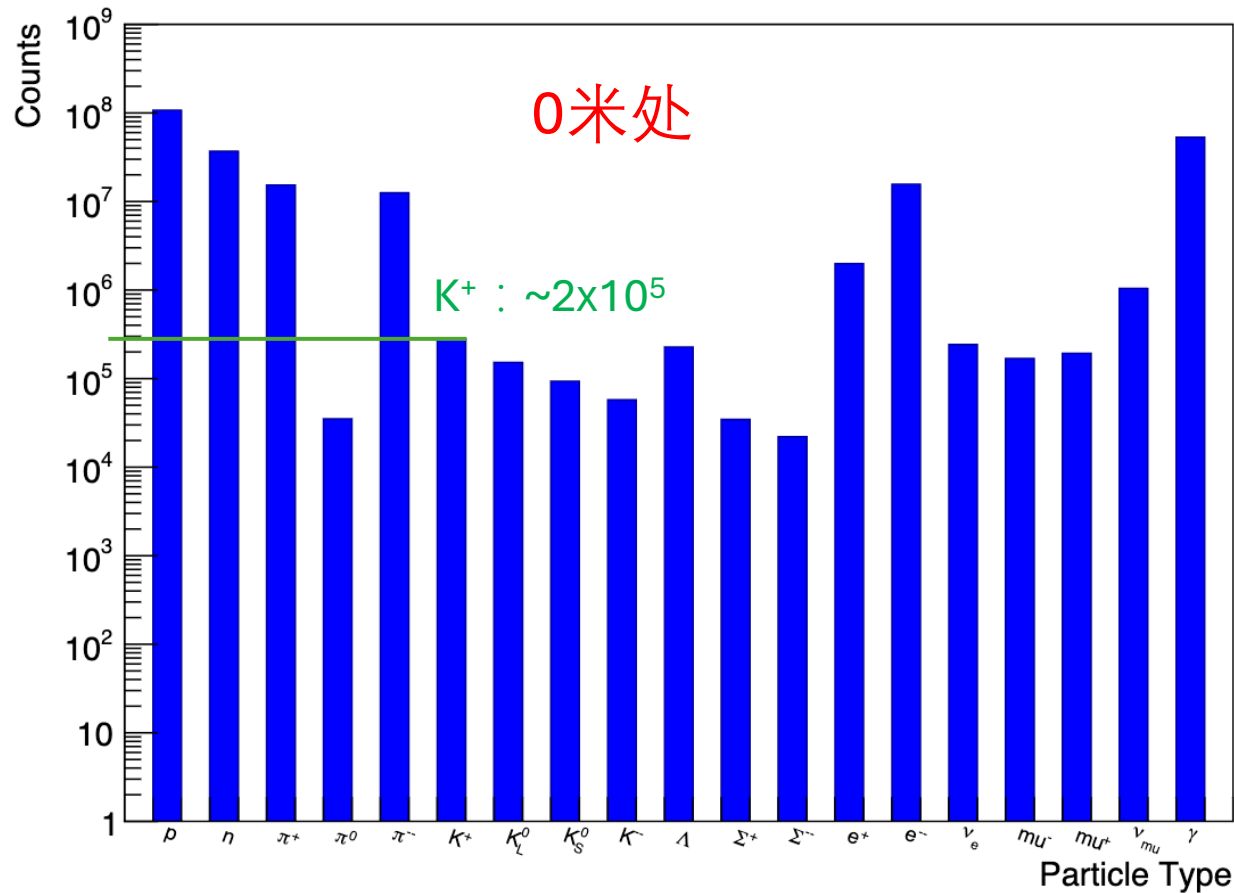


$K^+$  Momentum Distribution



➤ 飞行一段距离后的粒子数分布(不加任何动量角度筛选)：

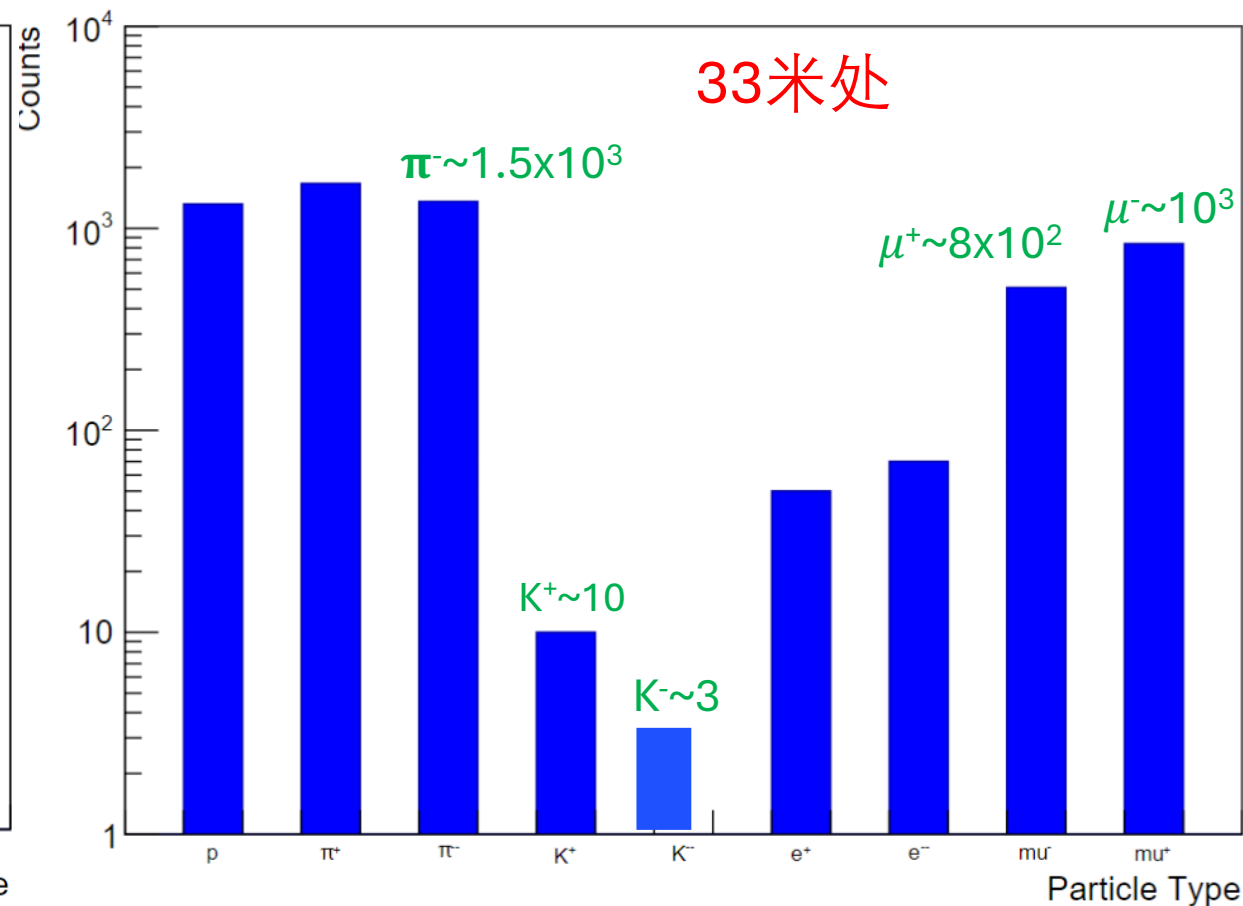
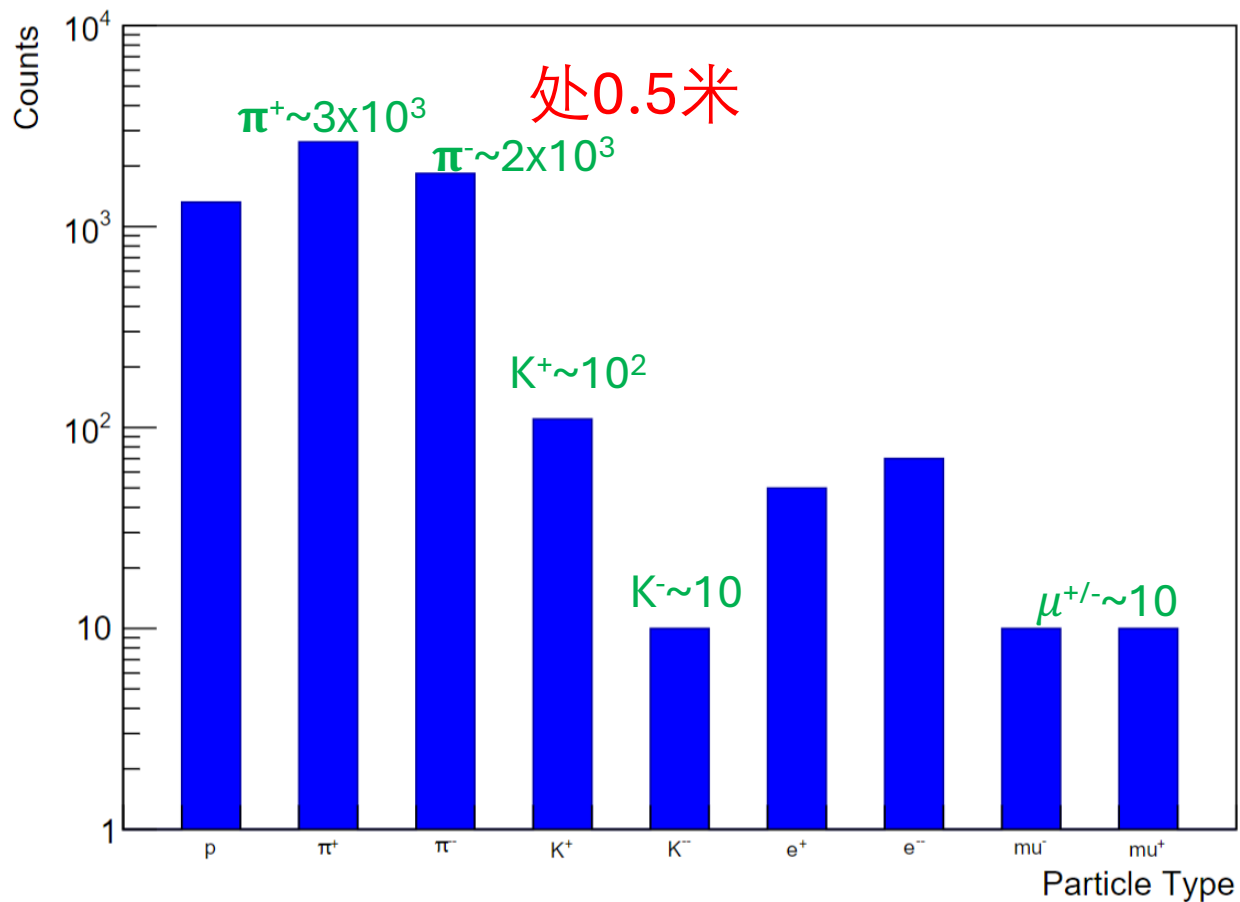
□ 9.3GeV质子:  $10^8$ , Be靶厚度=6cm



➤ 飞行一段距离后的粒子数分布：

□ 9.3GeV质子:  $10^8$ , Be靶厚度=6cm

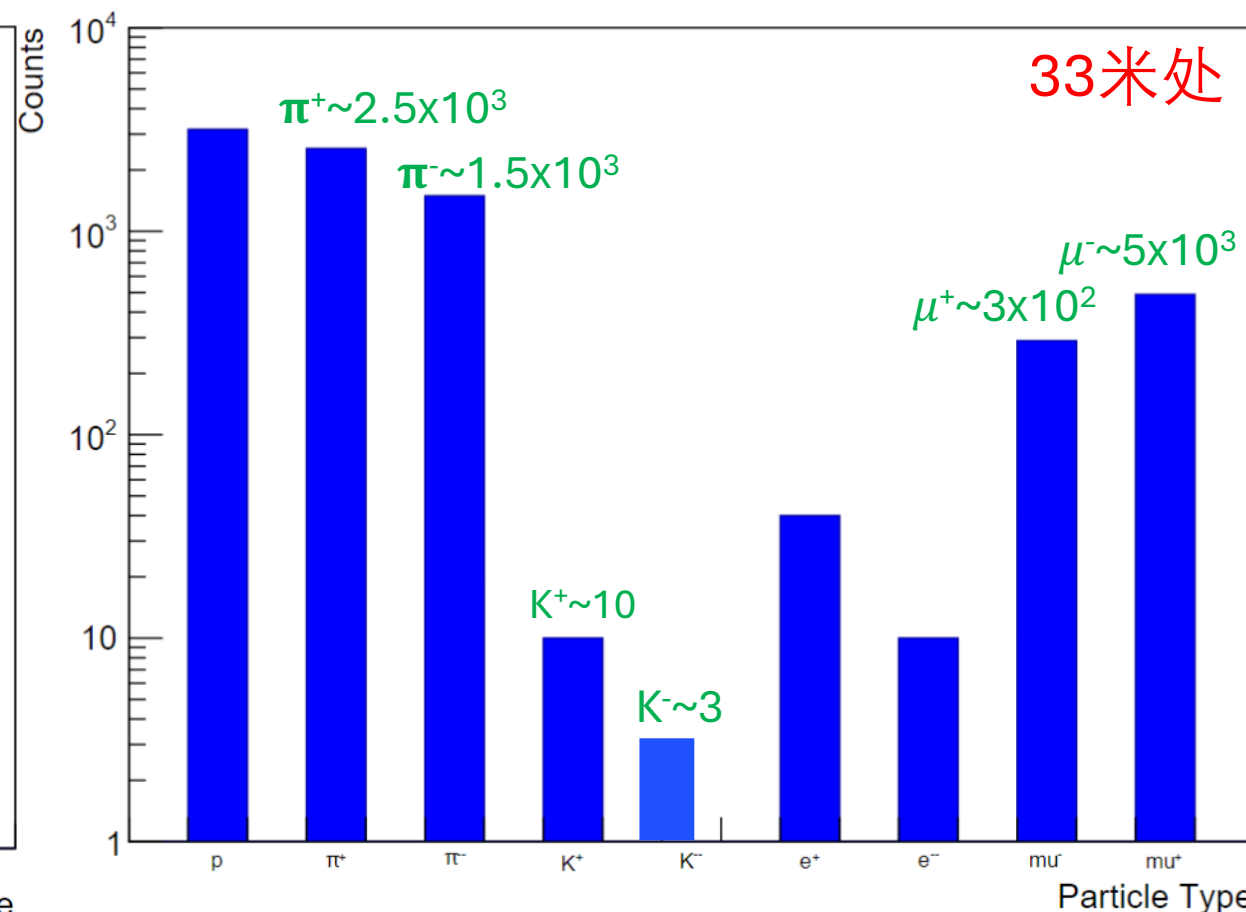
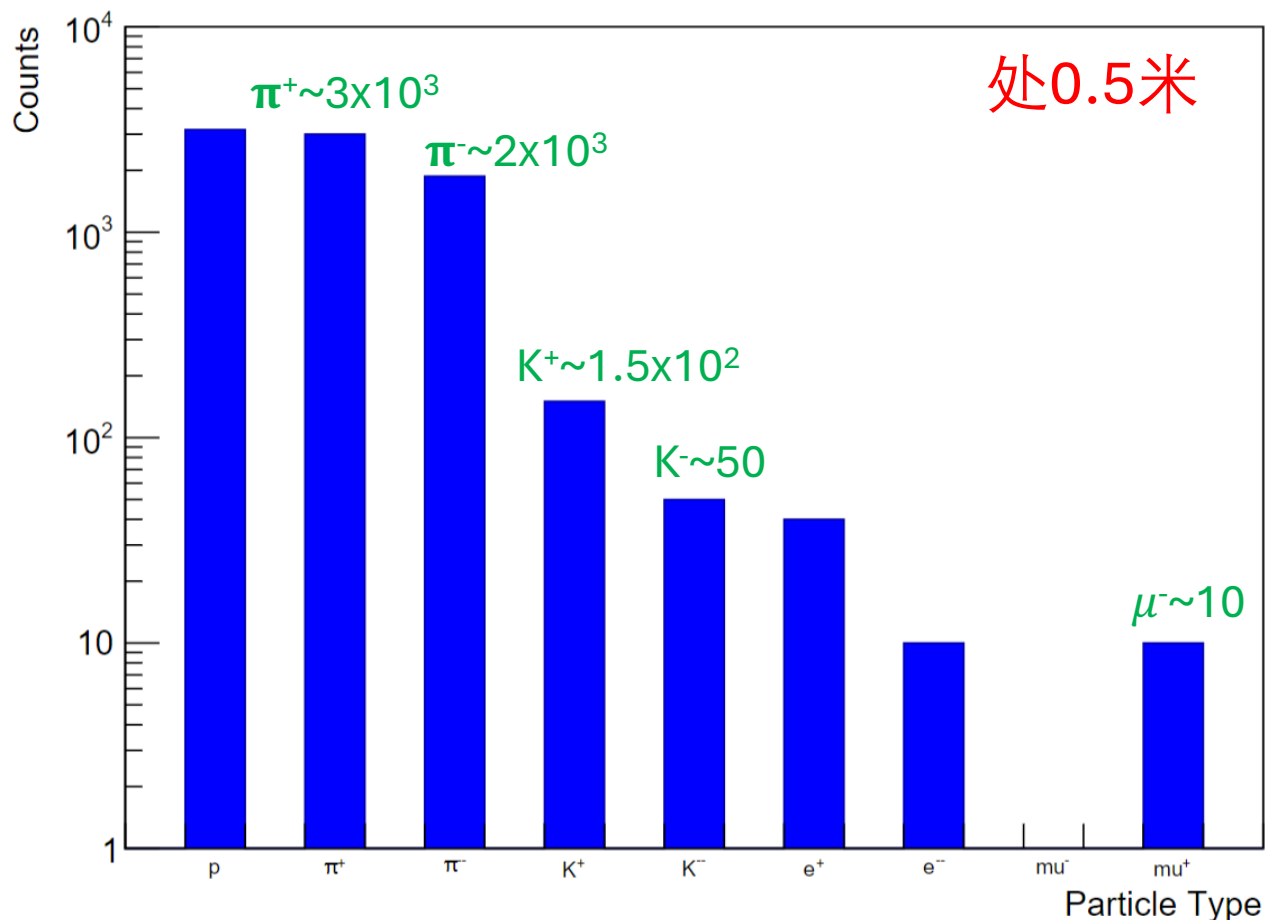
□ 束流线选择粒子动量空间:  $P=1.322 \pm 2\%$ , 角度为  $xz \pm 50\text{mrad}$ ,  $yz \pm 15\text{mrad}$



➤ 飞行一段距离后的粒子数分布：

□ 9.3GeV质子:  $10^8$ , Be靶厚度=6cm

□ 束流线选择粒子动量空间:  $P=2.23 \pm 2\%$ , 角度为  $xz \pm 50\text{mrad}$ ,  $yz \pm 15\text{mrad}$



### ➤ HIAF次级粒子束流的亮度：

- B-Ring亮度：  $1.8 \times 10^{12}$  p/sec (快引出),  $4.5 \times 10^{11}$  p/sec (慢引出)。
- 9.3GeV质子束流  $1.8 \times 10^{12}$  p/sec (FE) + 6cm Be靶
- 经过32.6米的束流线后(加了动量和角度筛选)，不同强子的数目：  
 $P=2.23 \pm 2\%$ ，角度为  $xz \pm 50\text{mrad}$ ,  $yz \pm 15\text{mrad}$

L (s <sup>-1</sup> )	$\pi^+$	$\pi^-$	$K^+$	$K^-$	$\mu^+$	$\mu^-$
6cm Be	$4.5 \times 10^7$	$2.7 \times 10^7$	$1.8 \times 10^5$	$0.6 \times 10^5$	$4.8 \times 10^6$	$9 \times 10^7$
6cm Pt	$1.3 \times 10^8$	$8.1 \times 10^8$	$3.6 \times 10^6$	$1.2 \times 10^6$	$1.4 \times 10^7$	$2.7 \times 10^8$

✓ 如果采用 6cm Pt (Platinum),  $K^+$ 统计增加~20倍

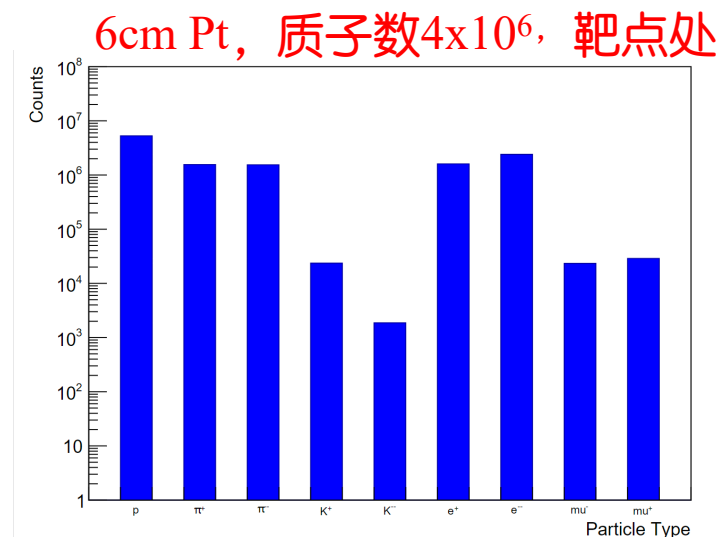
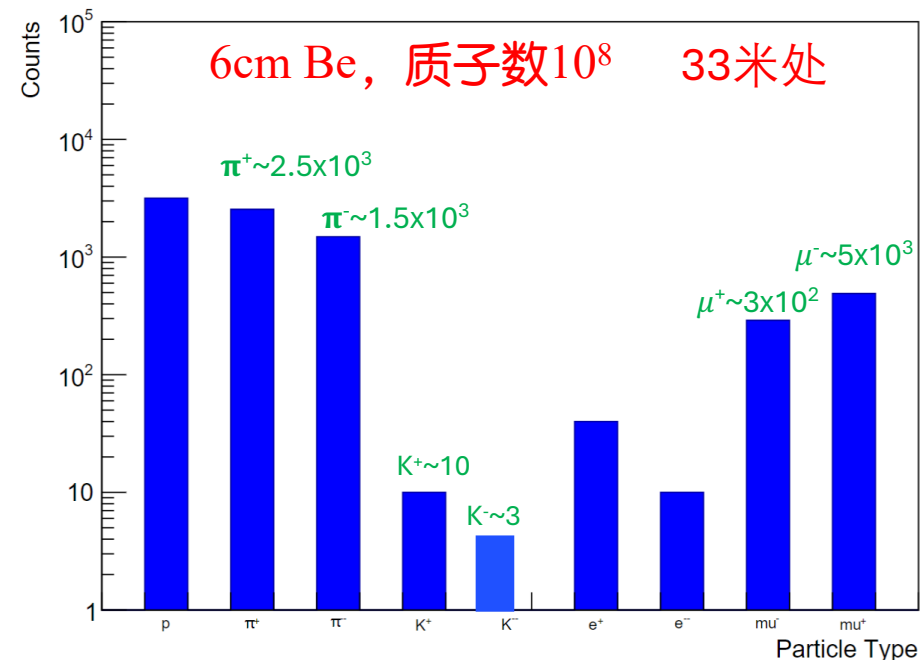
- 下一步： ✓ 比较SMASH, JAM2, GiBUU结果

### ➤ 对比J-PARC的K介子束流

- 30GeV质子束流, 亮度=  $5.6 \times 10^{13}$  p/sec, 6cm Pt 靶

✓ K1.8:  $P_K=2.0$  GeV/c,  $L = 1.9 \times 10^6$  s<sup>-1</sup>

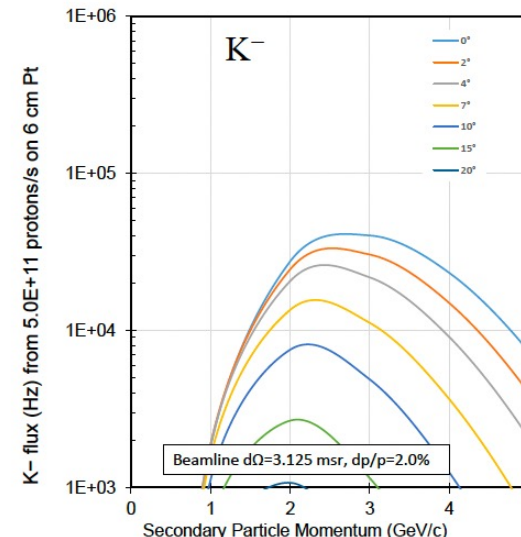
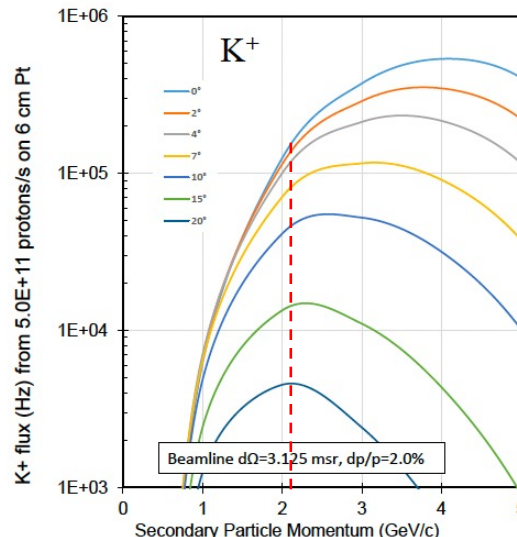
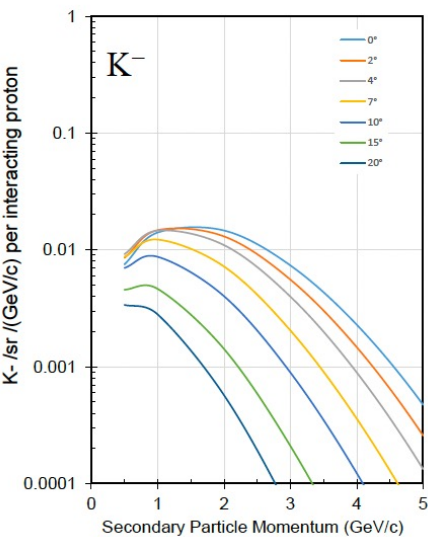
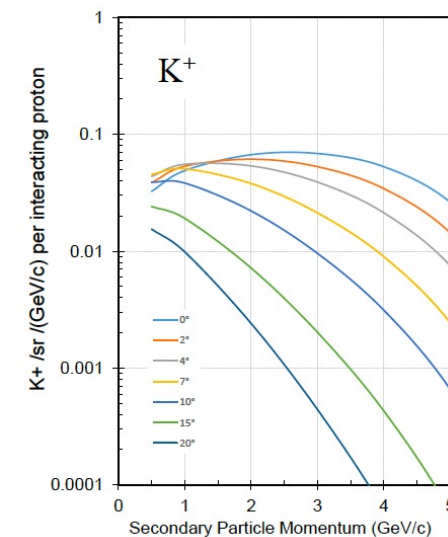
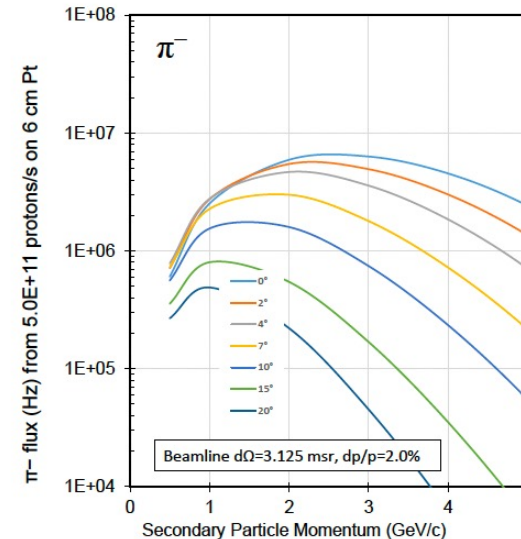
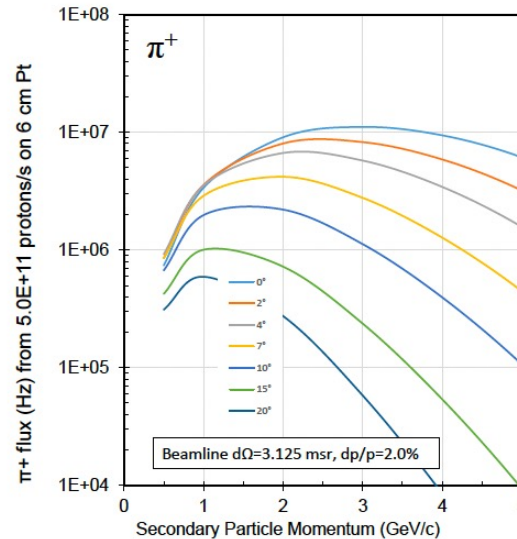
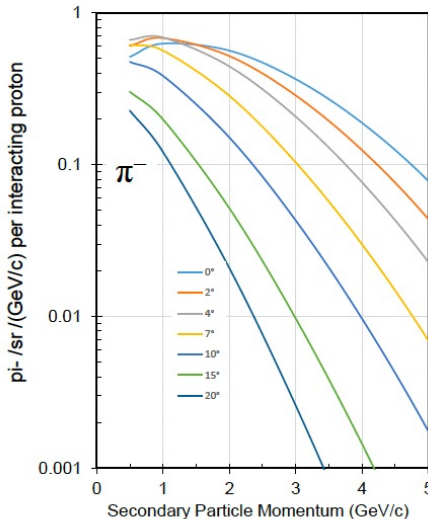
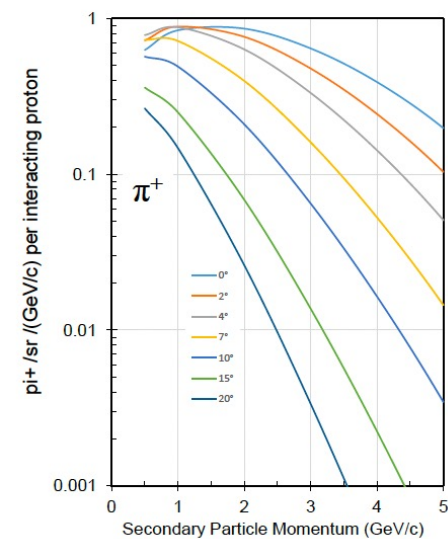
✓ K1.8BR:  $P_K=0.8 \sim 1.2$  GeV/c, expected  $L \leq 5.5 \times 10^6$  s<sup>-1</sup> (K/Pi~7.0)



➤ 比较其他模拟 : [arXiv:2108.07591v2](https://arxiv.org/abs/2108.07591v2) (Models have tuned with exp. data)

8 GeV/c Protons on Be Production Target

Incident Proton Momentum 8 GeV/c at 30m



HIAF simulation w/  
Geant4

- ✓ 9.3GeV
- ✓  $1.8 \times 10^{12}$  p/sec
- ✓ 6cm Be
- ✓ L=33m
- ✓ 1.5msr%

AGS@BNL Protons:

- ✓ 8GeV, CW
- ✓  $5 \times 10^{11}$  p/sec
- ✓ 6cm Pt
- ✓ L = 30m
- ✓  $3.125 \text{ msr} * \Delta p/p \sim 2\%$   
=6.25msr%

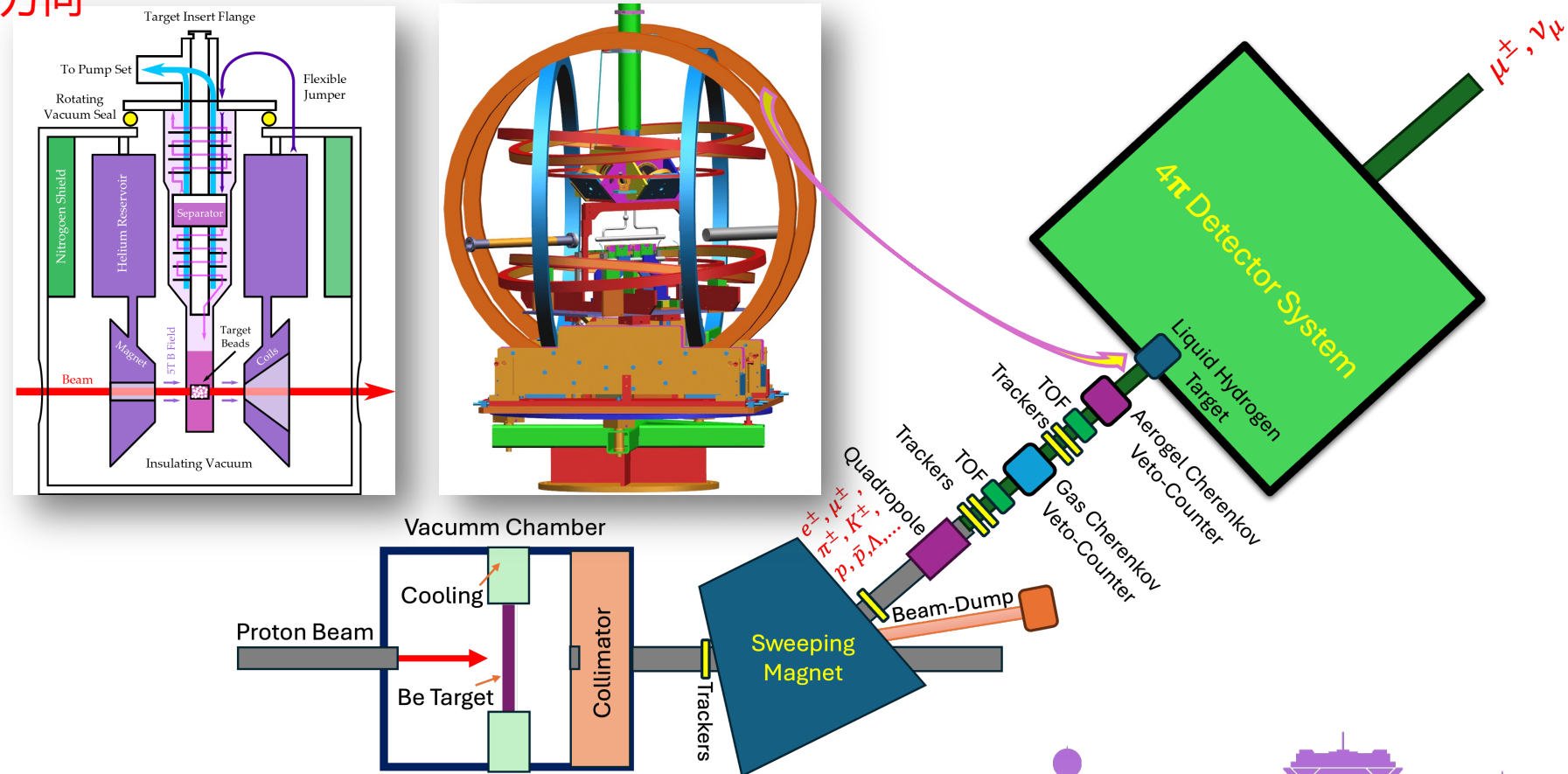
对应HIAF流量：  
 $K^+ \sim 1.35 \times 10^6 \text{ s}^{-1}$



➤ 极化靶+全覆盖型多功能磁谱仪：

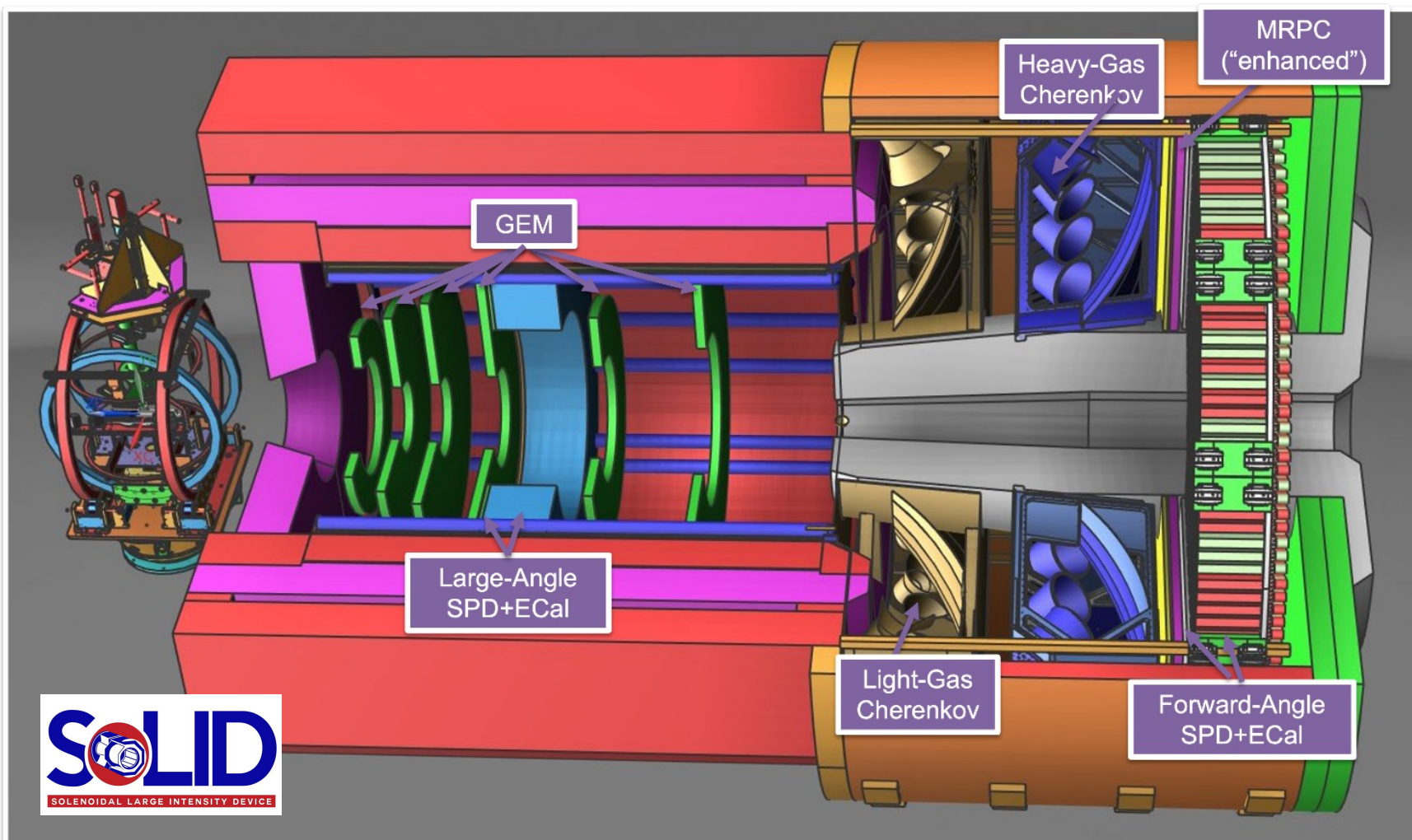
- ❑ 非极化液态氢，固体原子核
- ❑ 纵向&横向极化质子（NH<sub>3</sub>）和中子（He<sup>3</sup>）

✓ 也可测量末态质子的极化方向

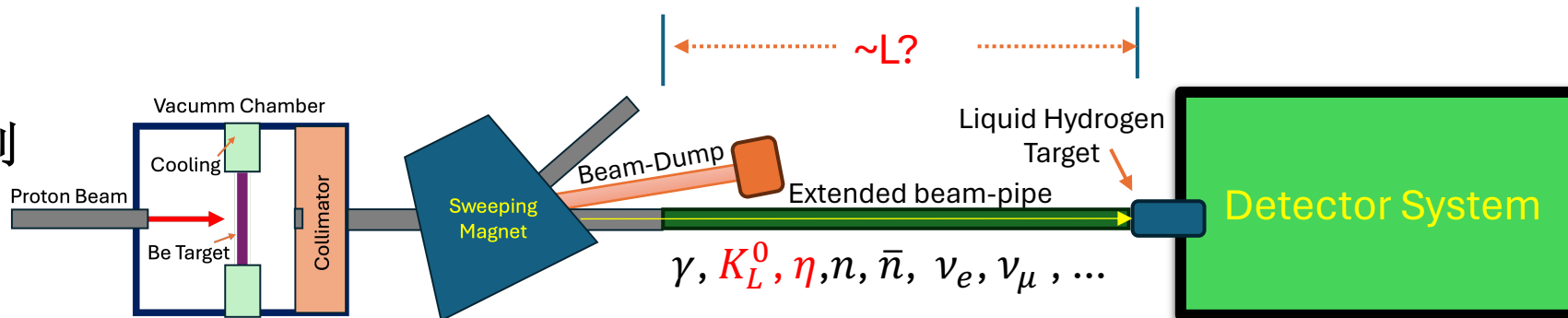


➤ 极化靶+全覆盖型多功能磁谱仪：

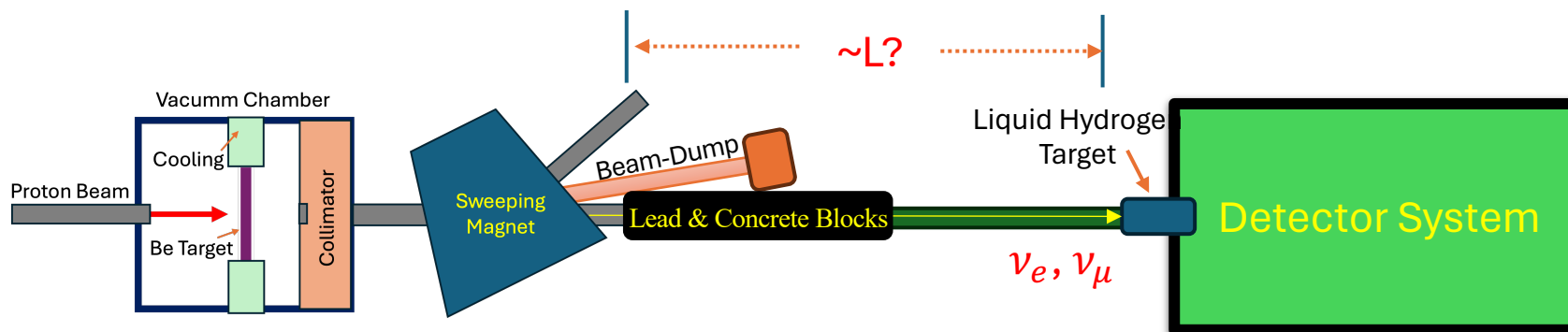
- ❑ 现有极化靶需要放磁铁外面
- ❑ 新型极化靶：利用螺旋管磁铁的强磁场保持极化（李夏卿报告）



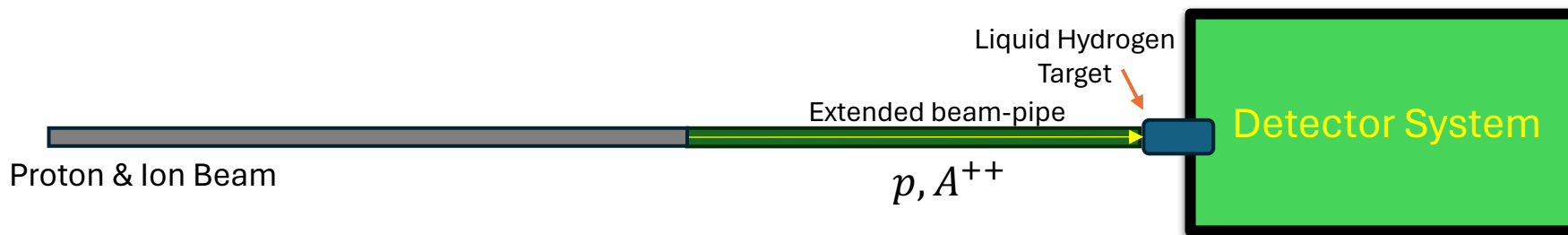
➤ 中性粒子束流的分离和甄别



➤ 纯中微子束流：

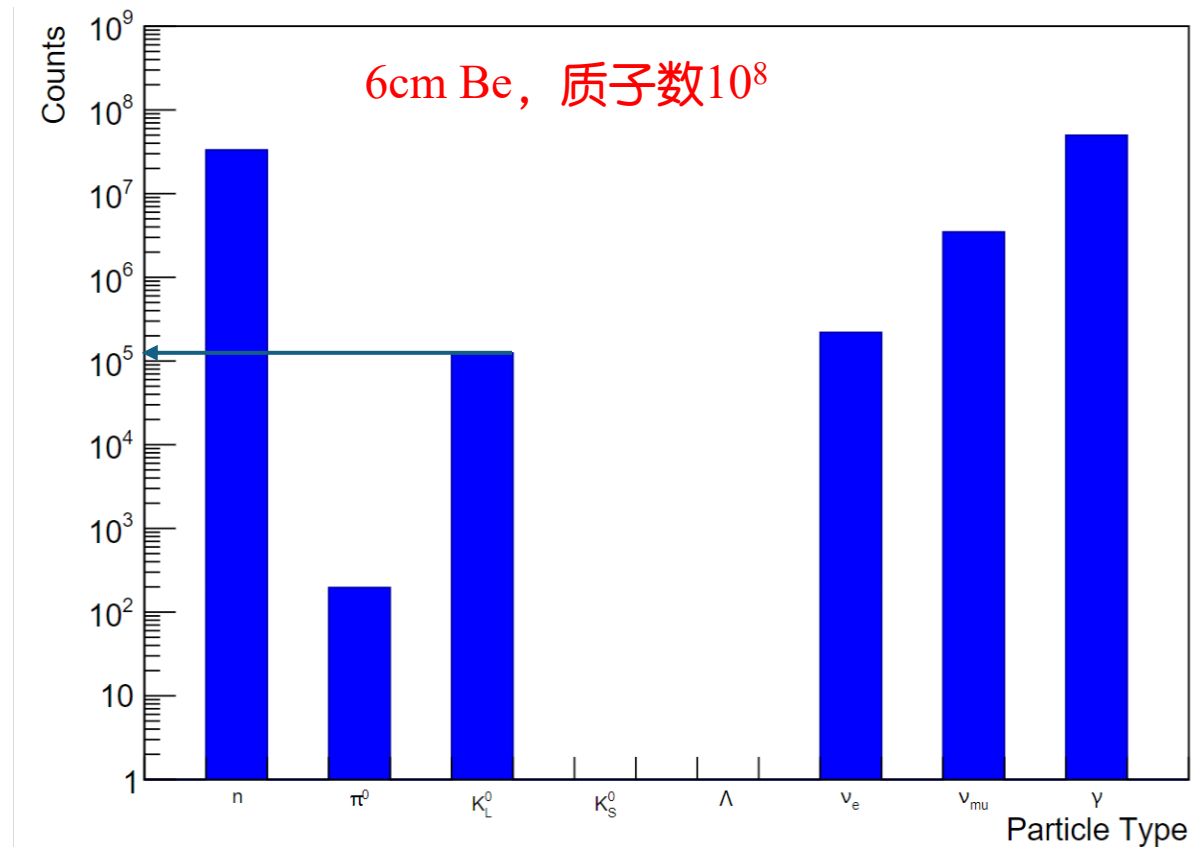


➤ Bring直接提供的束流：



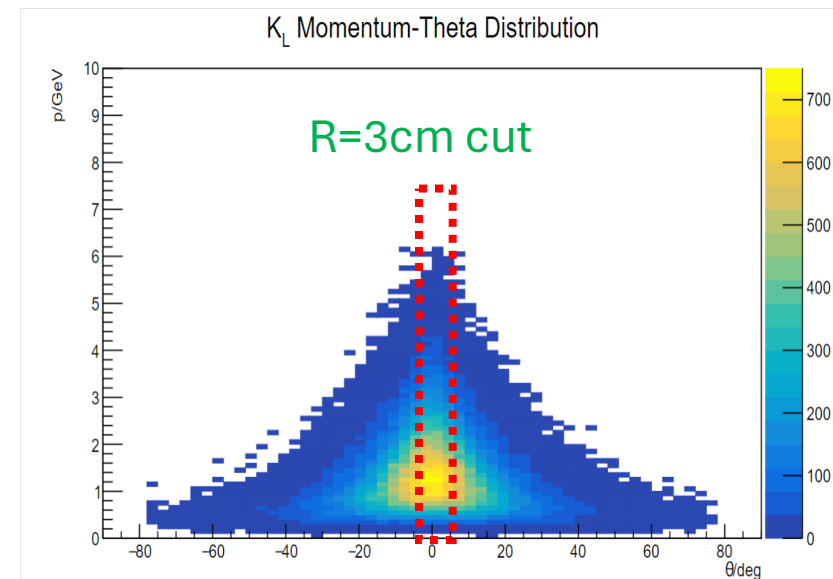
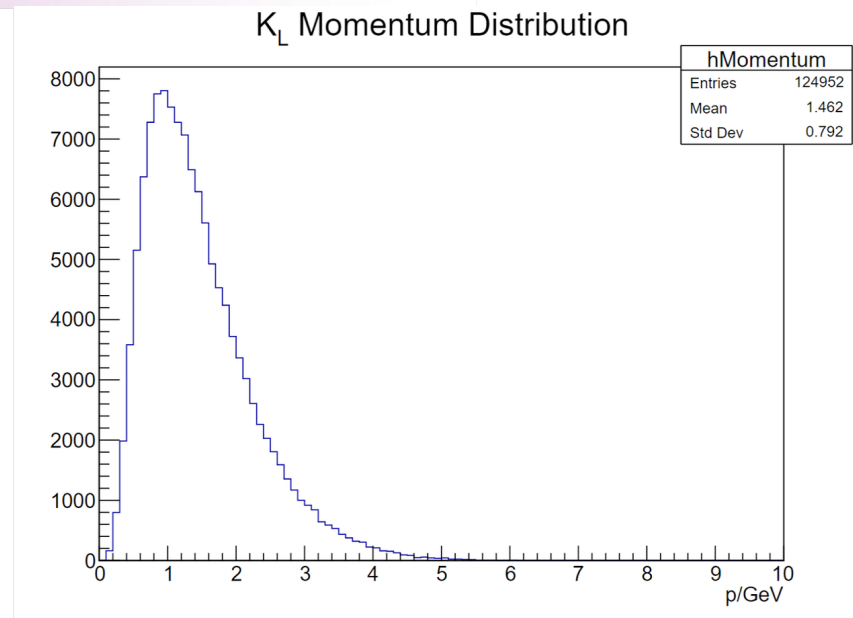
## ➤ 中性粒子束流的分离和甄别

❑ 飞行5m后，不做任何筛选



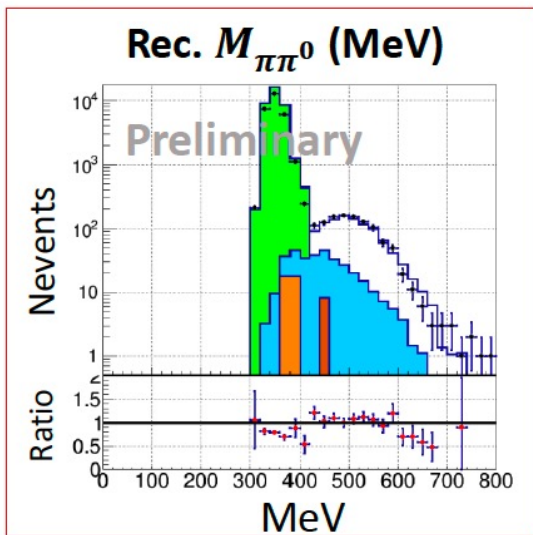
❑ 考虑中子和光子本底，可能不太适合用Pt靶

❑ 中性粒子无法再次聚焦，具体亮度，需要考虑探测器摆放位置，和LH2靶半径，

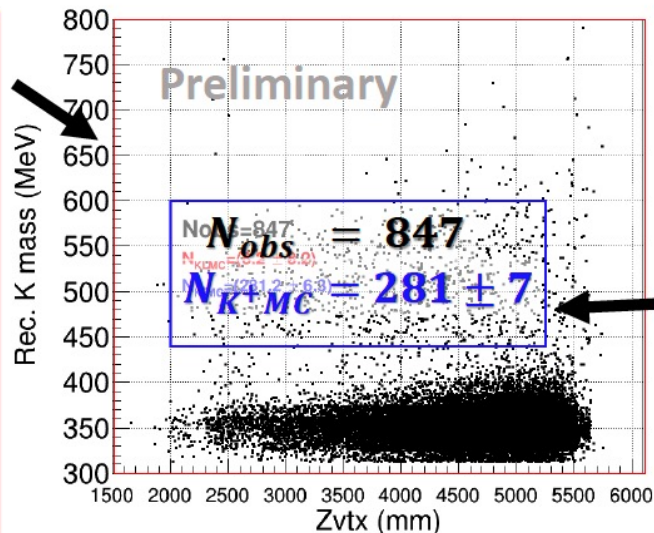


## ➤ J-PARC $K_L^0$ Beam & KOTO Experiment :

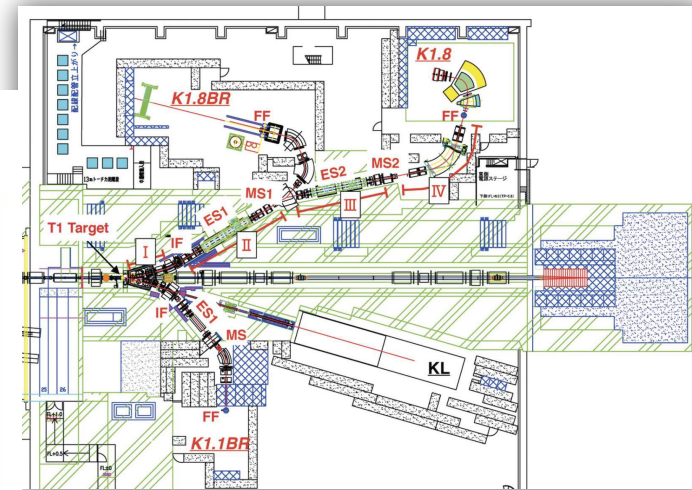
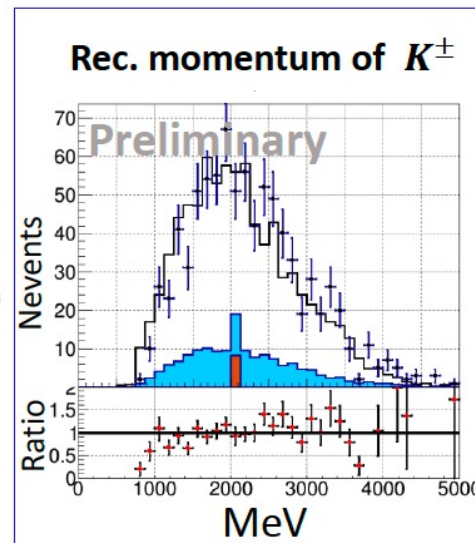
Projected mass distribution



Data in 2020 run

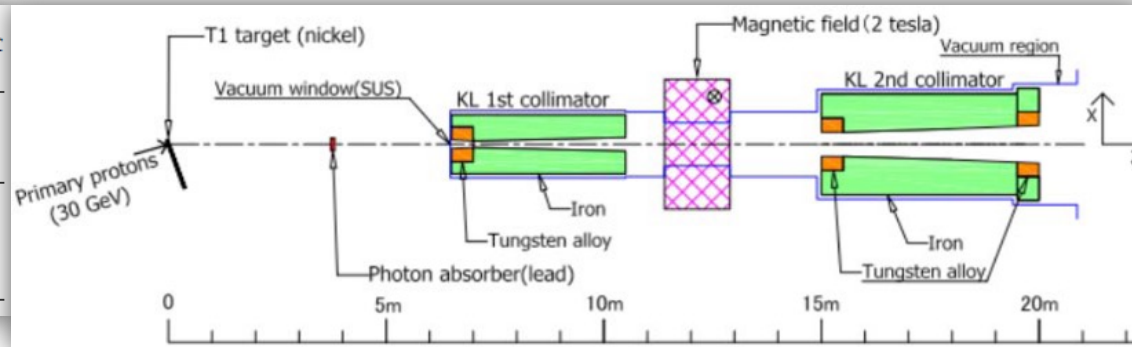


Distribution of events in the signal region



**Table 7**  
Resultant  $K_L^0$  flux at the exit of the beam line. The  $K_L^0$  yields for the Ni and the Pt targets and their ratio were summarized, together with the expectations by MC simulations. The first uncertainties are statistical and the second ones are systematic (discussed in Section 4.3).

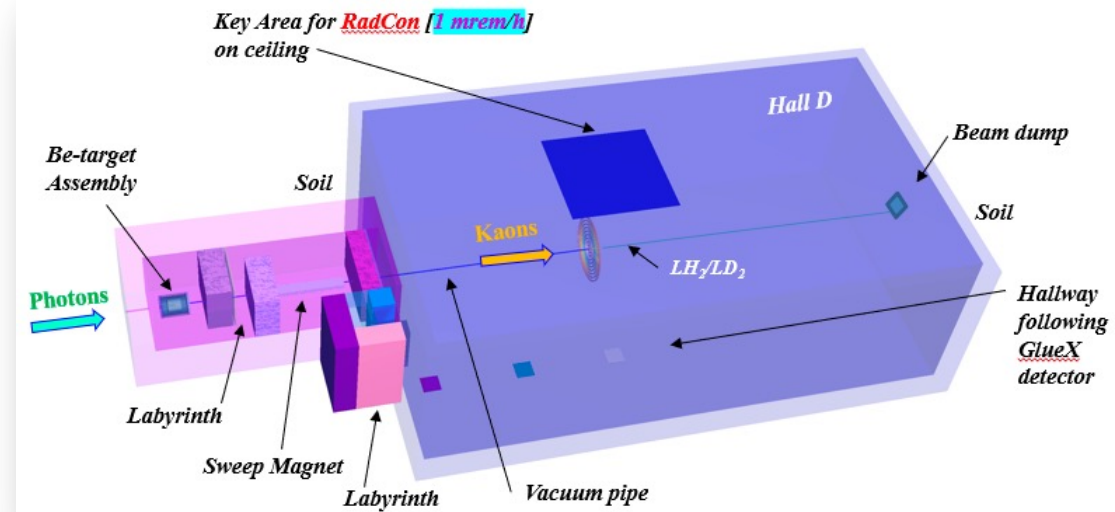
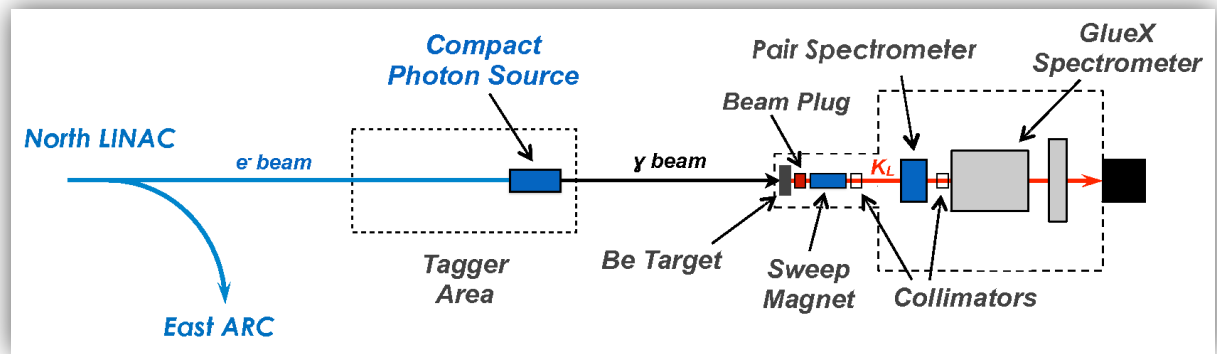
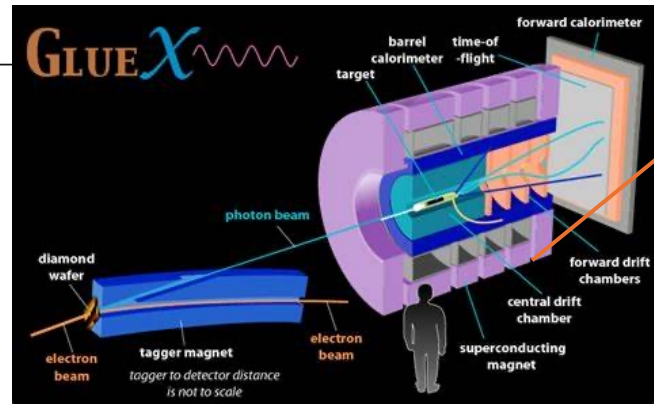
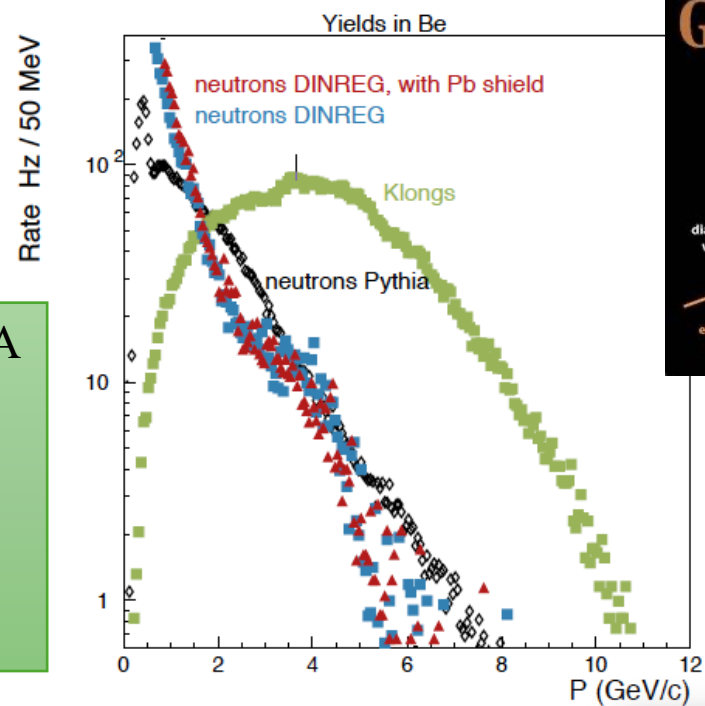
Target	Flux (normalized to $2 \times 10^{14}$ POT)			
	Data	GEANT4	GEANT3	FLUKA
Ni (5.4-cm-long)	$(1.94 \pm 0.05^{+0.25}_{-0.24}) \times 10^7$	$0.74 \times 10^7$	$1.51 \times 10^7$	$2.07 \times 10^7$
Pt (6.0-cm-long)	$(4.19 \pm 0.09^{+0.47}_{-0.44}) \times 10^7$	$1.52 \times 10^7$	$2.38 \times 10^7$	$3.24 \times 10^7$
Pt/Ni ratio	$2.16^{+0.38}_{-0.36}$	2.05	1.58	1.56



## ➤ JLab Hall-D $K_L^0$ Beam :

- ❑ 高能光子产生 $K_L$
- ❑ 2026年开始安装,
- ❑ 2028年开始数据采集

- Electron beam:  $E=12\text{GeV}$ ;  $I_e=5\mu\text{A}$
- Radiator (rad. length) 10%
- Be target:  $R=3\text{cm}$ ,  $L=40\text{cm}$
- LH2 target:  $R=3\text{cm}$ ,  $L=30\text{cm}$ :
- Distance Be-LH2: 20m
- $K_L$  Rate:  $10^4 \text{ s}^{-1}$



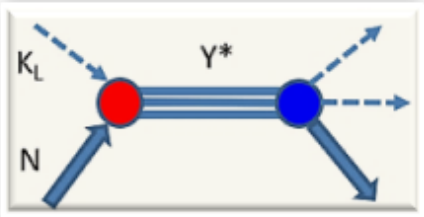
### ➤ JLab Hall-D $K_L^0$ Beam :

- ✓  $K_L$  与质子和 “中子” 反应产生奇异夸克
- ✓ 研究奇异夸克强子态的性质
- ✓ 稀有衰变，新物理

	Target $\rightarrow$ <i>Proton</i>	<i>Neutron</i> [first measurements]
Elastic & Charge-Exchange	$K_L p \rightarrow K_S p$ $K_L p \rightarrow K^+ n$	$K_L n \rightarrow K_S n$ $K_L n \rightarrow K^- p$
Two-body with $S = -1$	$K_L p \rightarrow \pi^+ \Lambda$ $K_L p \rightarrow \pi^+ \Sigma^0$	$K_L n \rightarrow \pi^0 \Lambda$ $K_L n \rightarrow \pi^0 \Sigma^0$
Two-body with $S = -2$	$K_L p \rightarrow K^+ \Sigma^0$ $K_L p \rightarrow K^+ \Sigma^{0*}$	$K_L n \rightarrow K^0 \Sigma^0$ $K_L n \rightarrow K^0 \Sigma^{0*}$
Three-body with $S = -2$	$K_L p \rightarrow \pi^+ K^+ \Sigma^-$ $K_L p \rightarrow \pi^+ K^+ \Sigma^{*-}$	$K_L n \rightarrow \pi^+ K^- \Sigma^0$ $K_L n \rightarrow \pi^+ K^- \Sigma^{0*}$
Three-body with $S = -3$	$K_L p \rightarrow K^+ K^+ \Omega^-$ $K_L p \rightarrow K^+ K^+ \Omega^{*-}$	$K_L n \rightarrow K^+ K^0 \Omega^-$ $K_L n \rightarrow K^+ K^0 \Omega^{*-}$

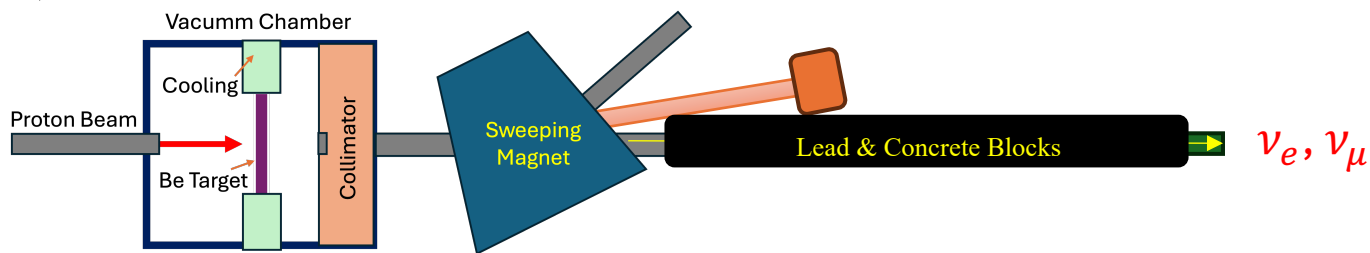
• To search for “missing” hyperons, we need measurements of production reactions:

$\Sigma^*$ :	$K_L^0 p \rightarrow \pi \Sigma^* \rightarrow \pi \pi \Lambda$
$\Lambda^*$ :	$K_L^0 p \rightarrow \pi \Lambda^* \rightarrow \pi \pi \Sigma$
$\Xi^*$ :	$K_L^0 p \rightarrow K \Xi^*, \pi K \Xi^*$
$\Omega^*$ :	$K_L^0 p \rightarrow K^+ K^+ \Omega^*$



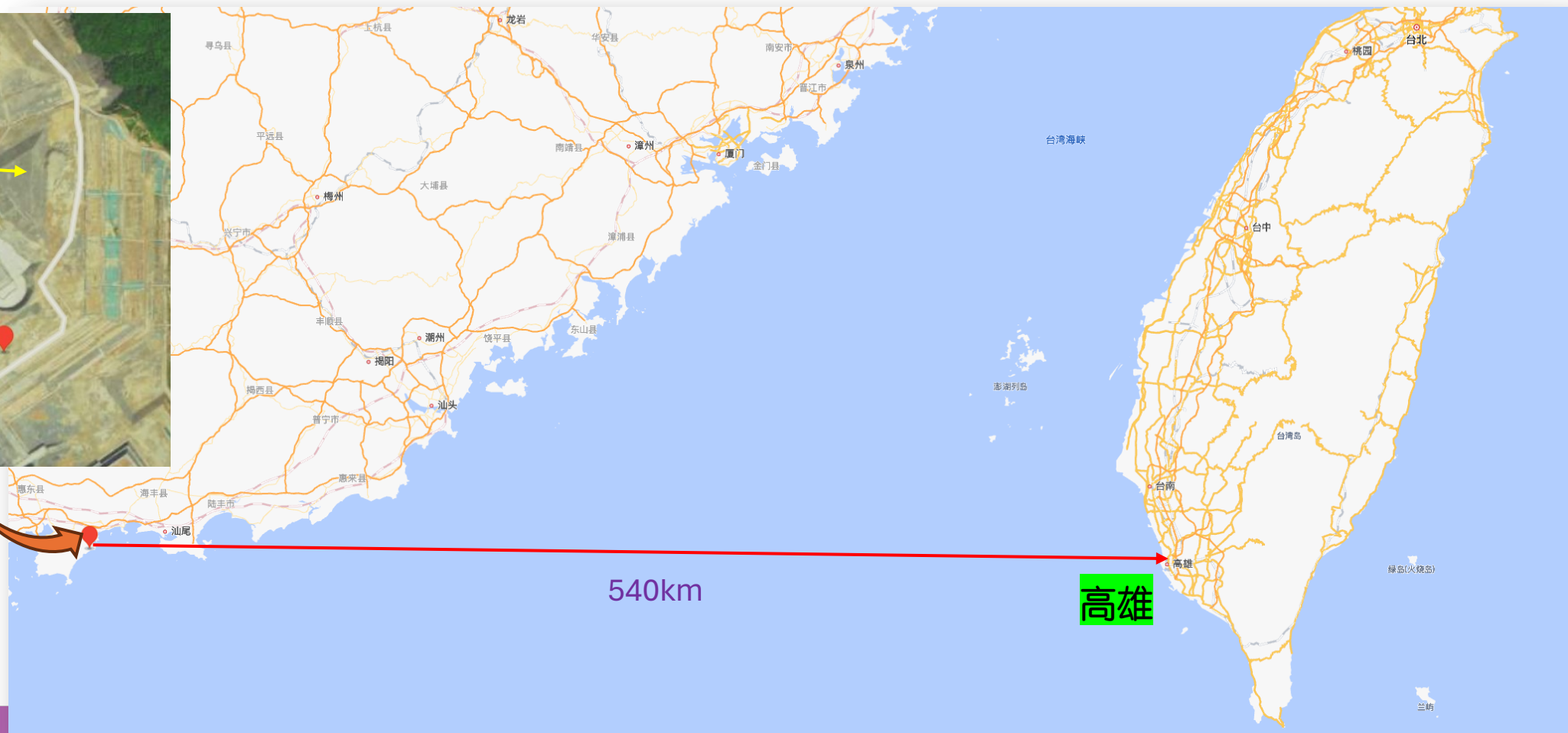
The diagram shows a red circle representing a hyperon  $Y^*$  being produced from the interaction of a  $K_L$  (dashed arrow) and a nucleon  $N$  (solid arrow). The  $Y^*$  then decays into two particles, shown as dashed arrows.

## ➤ 中微子束流



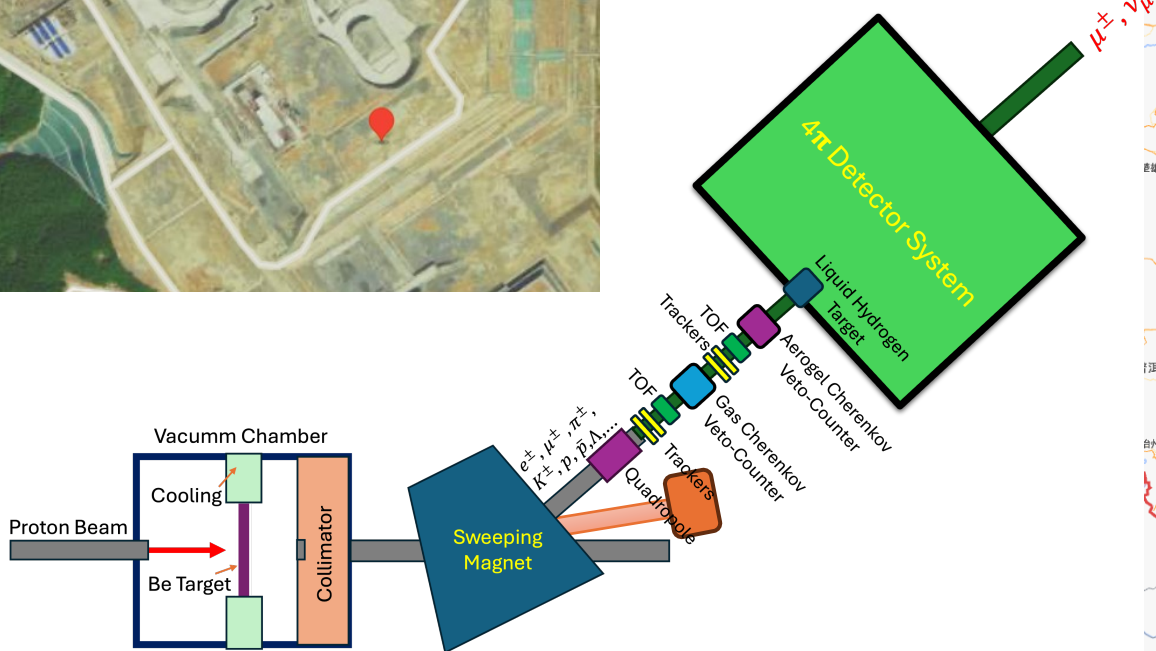
## HIAF与其他装置距离:

- 现有准直方向: 距高雄约540km



## ➤ 中微子束流

- 通过调整质子束流入射方向，或Sweeping Magnet的磁场强度来控制介子弯曲方向→控制中微子出射方向



## HIAF与其他装置距离:

- 距锦屏地下实验室约1470km (FermiLab→DUNE=1300km)
- 距离江门中微子地下实验室 (JUNO) 约270km



- J-PARC 已经拥有多条K介子束流和运行近10年的实验项目(K1.8 line:  $P_K \leq 2.0 \text{ GeV}/c$   $K^-$ ,  $10^6$  p/sec)
- HIAF vs J-PARC:
  - HIAF: 9.3 GeV,  $1.8 \times 10^{12}$  p/sec (快引出)
  - J-PARC: 30 GeV,  $5.6 \times 10^{13}$  p/sec (慢引出)
- HIAF高能终端可设计一条K-介子束流线
  - 总长32.6米, 磁铁部分造价<300W RMB, 空间足够, 无大的技术挑战 (除了pi/K分离)
  - $\delta P/P \sim \pm 2\%$ ,  $\theta(x\text{方向}) \sim \pm 50\text{mrad}$ ,  $\phi(Y\text{-方向}) \sim \pm 15\text{mrad}$
  - 预计提供 $P_K = 1.5 \sim 5 \text{ GeV}/c$  K介子 ( $10^6$  p/sec), 可采用Pt靶提高通量
- 相比J-PARC, HIAF的侧重点建议:
  - 集中在高动量K介子产生 $\Xi$ 或更重强子态
  - 与BEPC & STCF的物理高度互补
  - 采用高精度+全覆盖性磁谱仪
  - 引入极化靶
  - 多少K亮度&能量? 探测器分辨率?
- 需要加强实验团队: 吸引更多来自BEPC的实验合作者 + 学习&参与J-PARC实验和物理分析



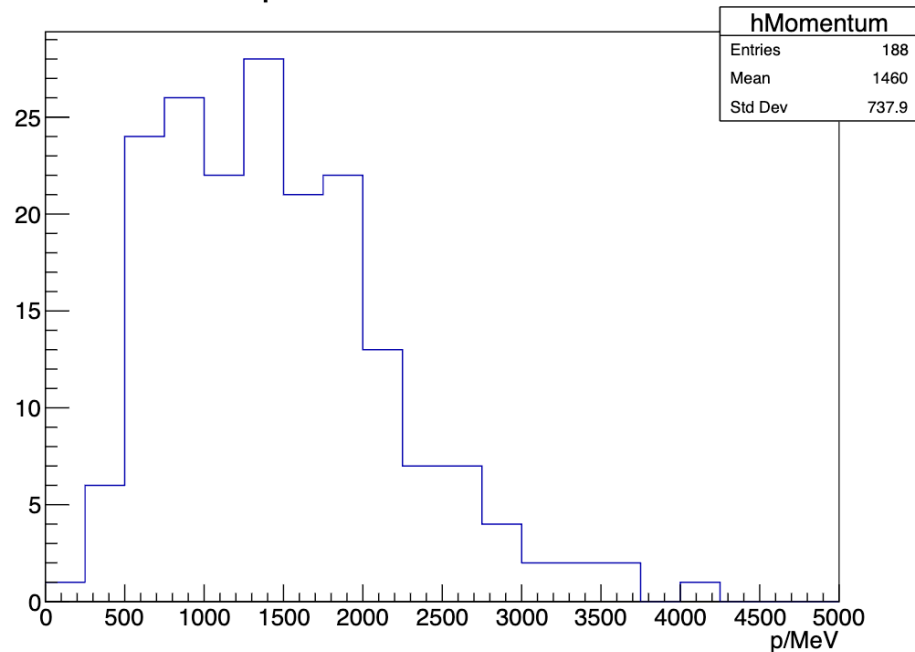
# THANKS!



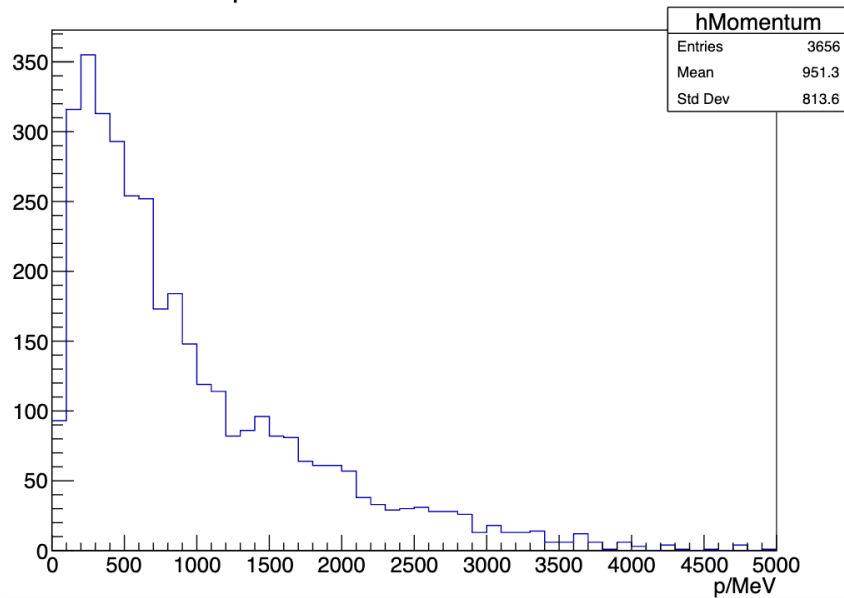
清华大学  
Tsinghua University

➤ 次级粒子束流的动量分布：

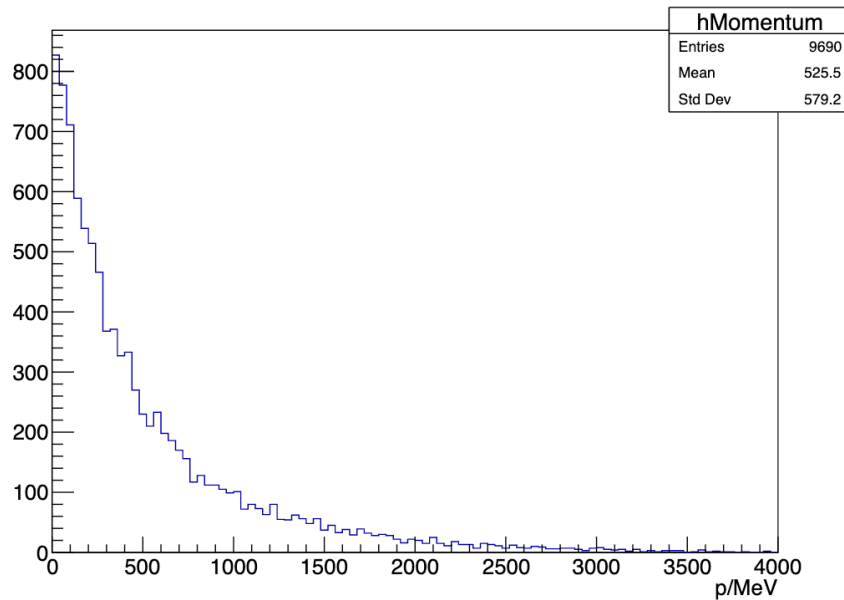
$\eta$  Momentum Distribution



$\mu^+$  Momentum Distribution

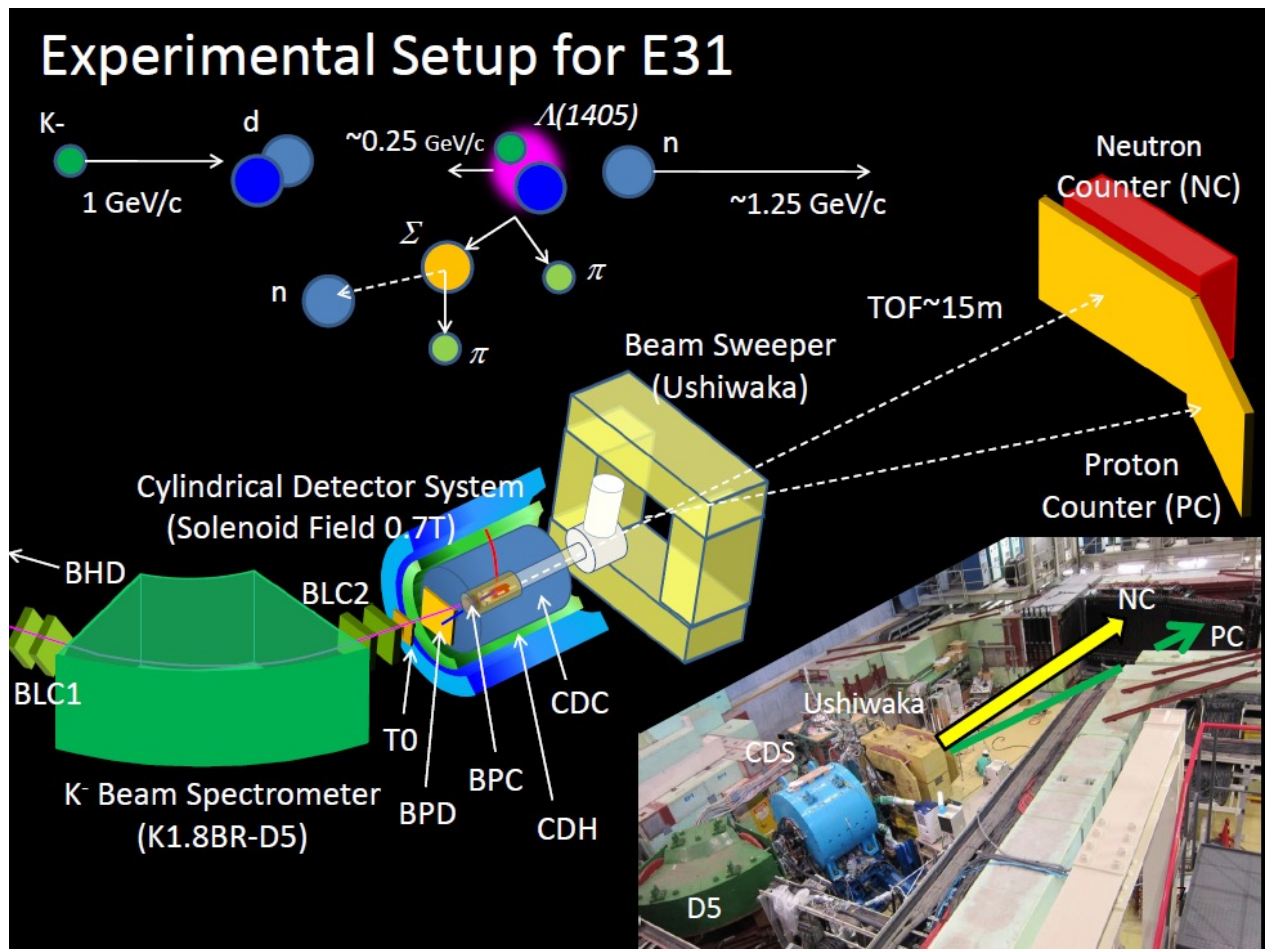


$e^+$  Momentum Distribution



## ➤ J-PARC :

### Experimental Setup for E31



### Conceptual layout of the D\*– spectrometer

