J-PARCにおけるK中間子原子核探索実験のための円筒形ドリフト・チェンバーの開発 (J-PARC E15実験)

理研　佐久間　史典

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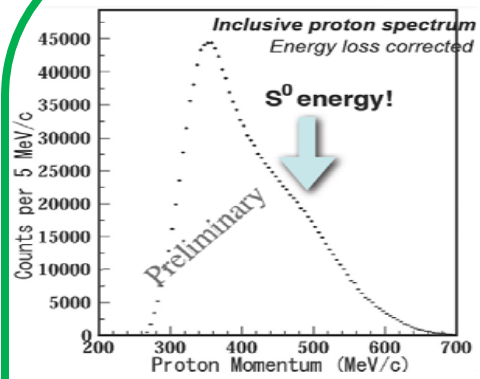
- **Physics Motivation**
- **J-PARC E15 Experiment**
- **CDC**
- **Summary**

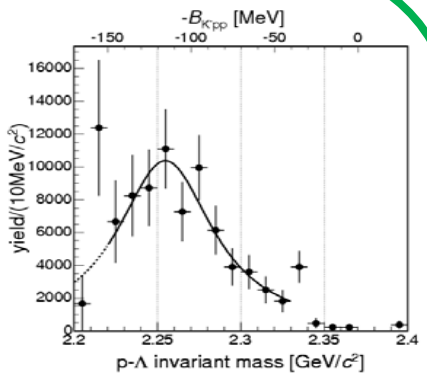
計48名、6ヶ国、15機関

Physics Motivation

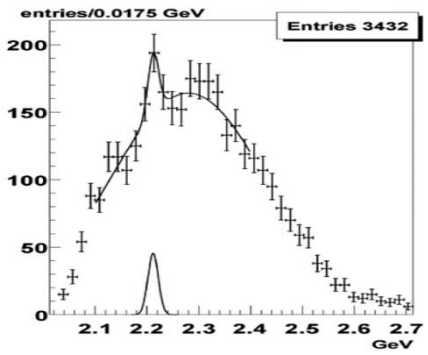
K中間子原子核は本当に存在するのか?



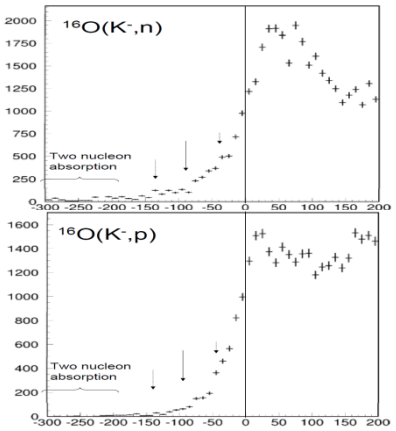
E549@KEK-PS



FINUDA@DAΦNE

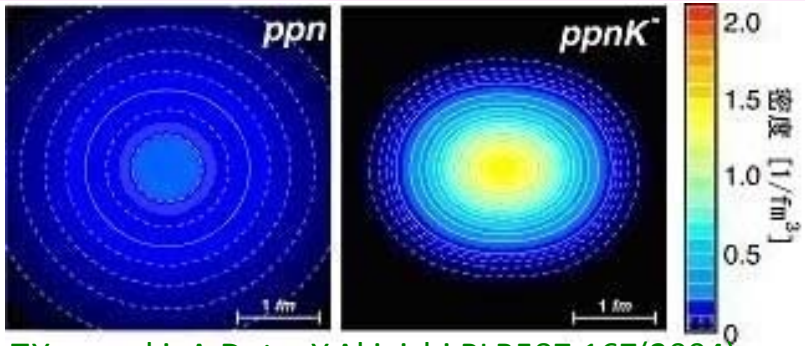


OBELIX@CERN-LEAR



E548@KEK-PS

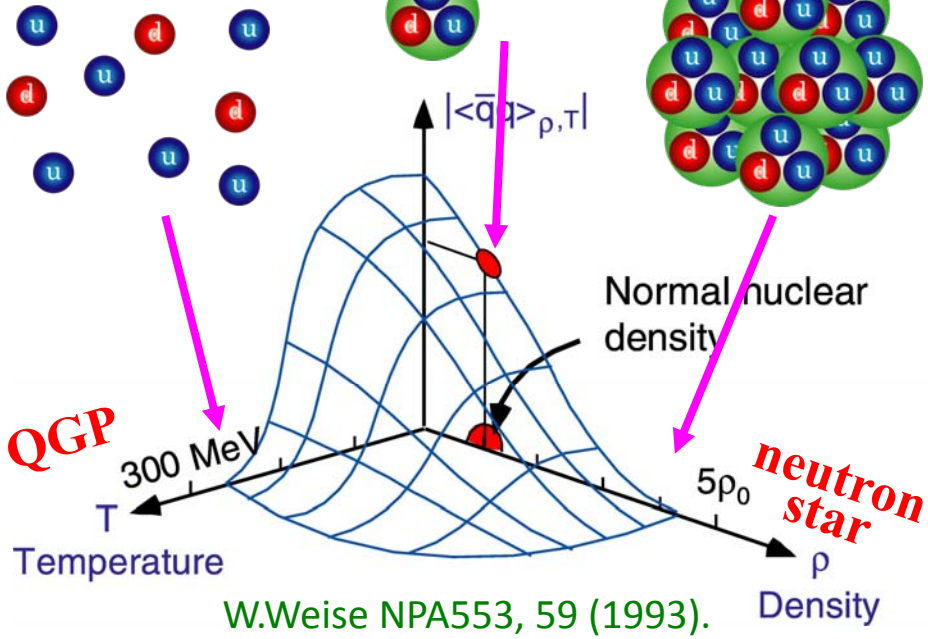
さらなる実験的証拠が必要



T.Yamazaki, A.Dote, Y.Akiaishi PLB587,167(2004).

KEK-PS

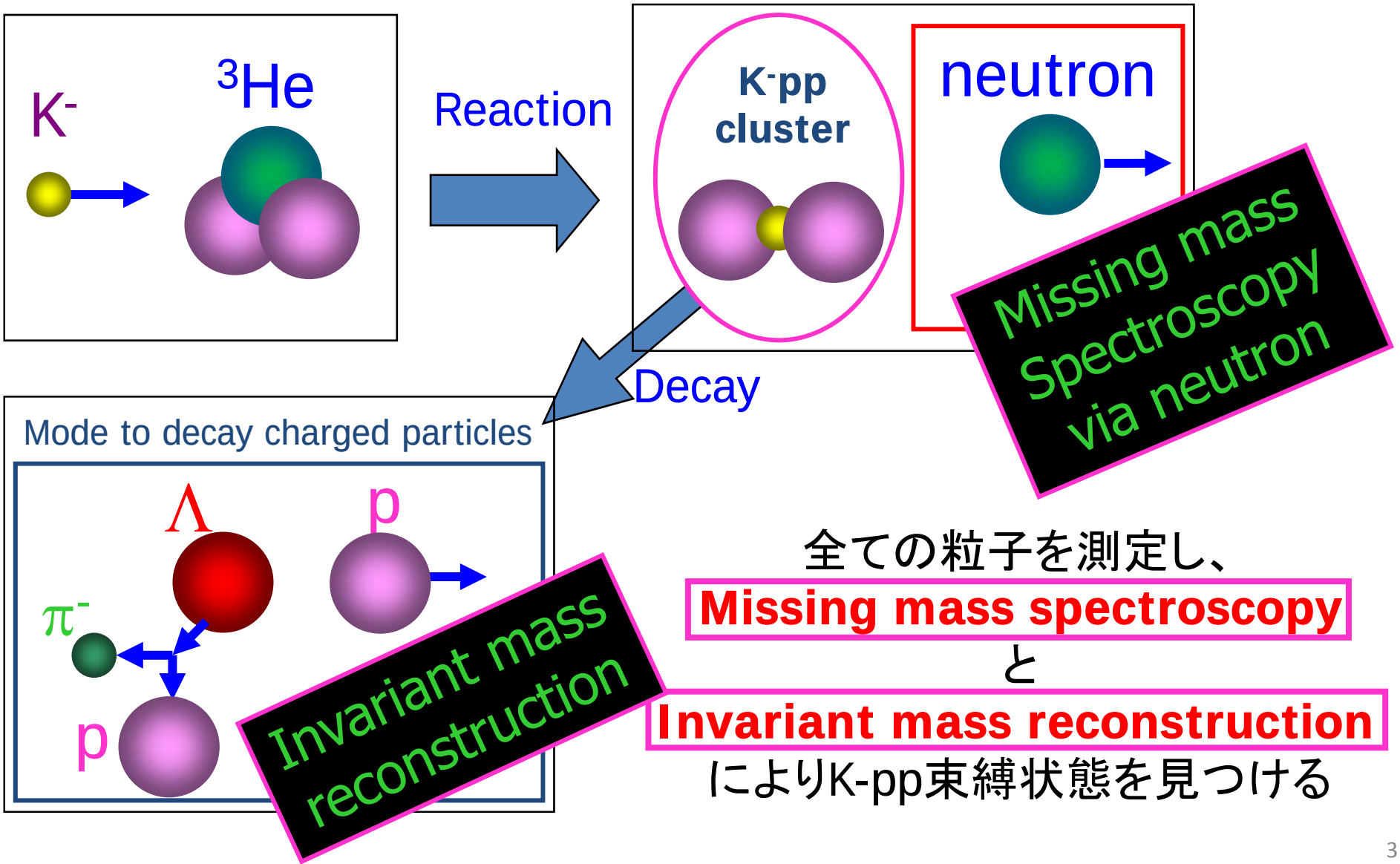
SPS, RHIC, LHC



W.Weise NPA553, 59 (1993).

J-PARC E15 Experiment

^{3}He(K^-,n) 反応を用いて**K-pp**束縛状態を見つける



全ての粒子を測定し、

Missing mass spectroscopy

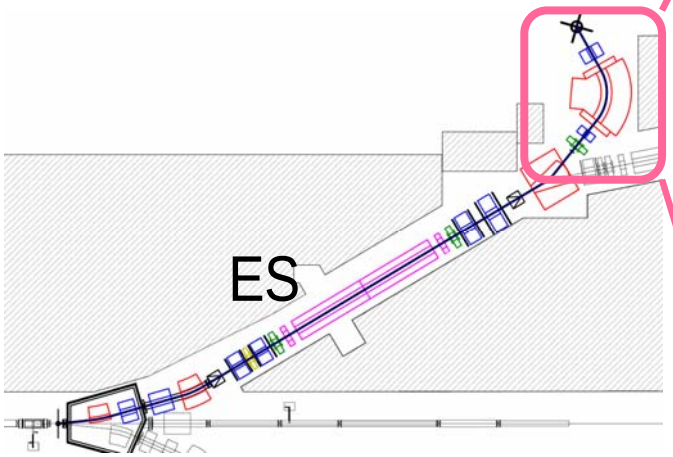
と

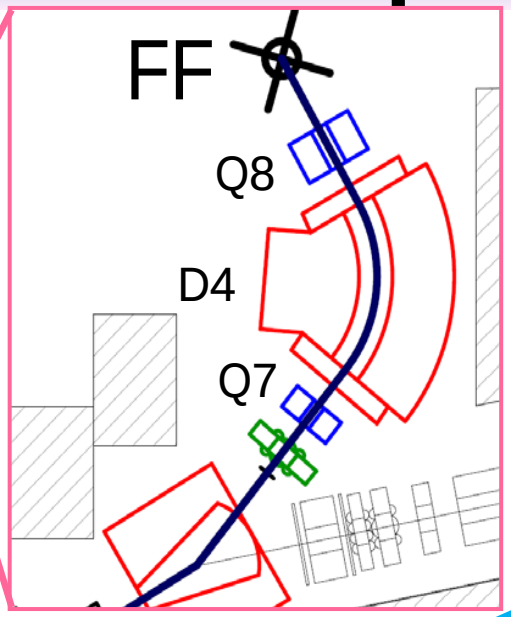
Invariant mass reconstruction

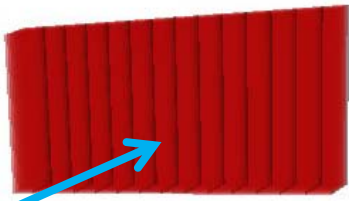
によりK-pp束縛状態を見つける

E15 Setup

J-PARC
K1.8BR Beam Line

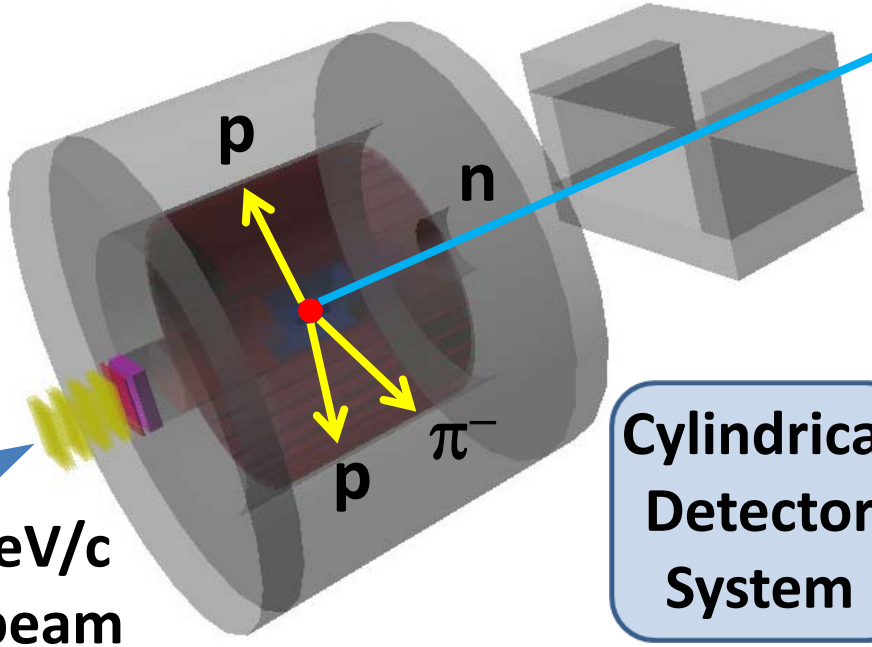






ToF Wall

flight length = 12m



Sweeping Magnet

Cylindrical Detector System

1GeV/c K- beam

mass resolution for K-pp

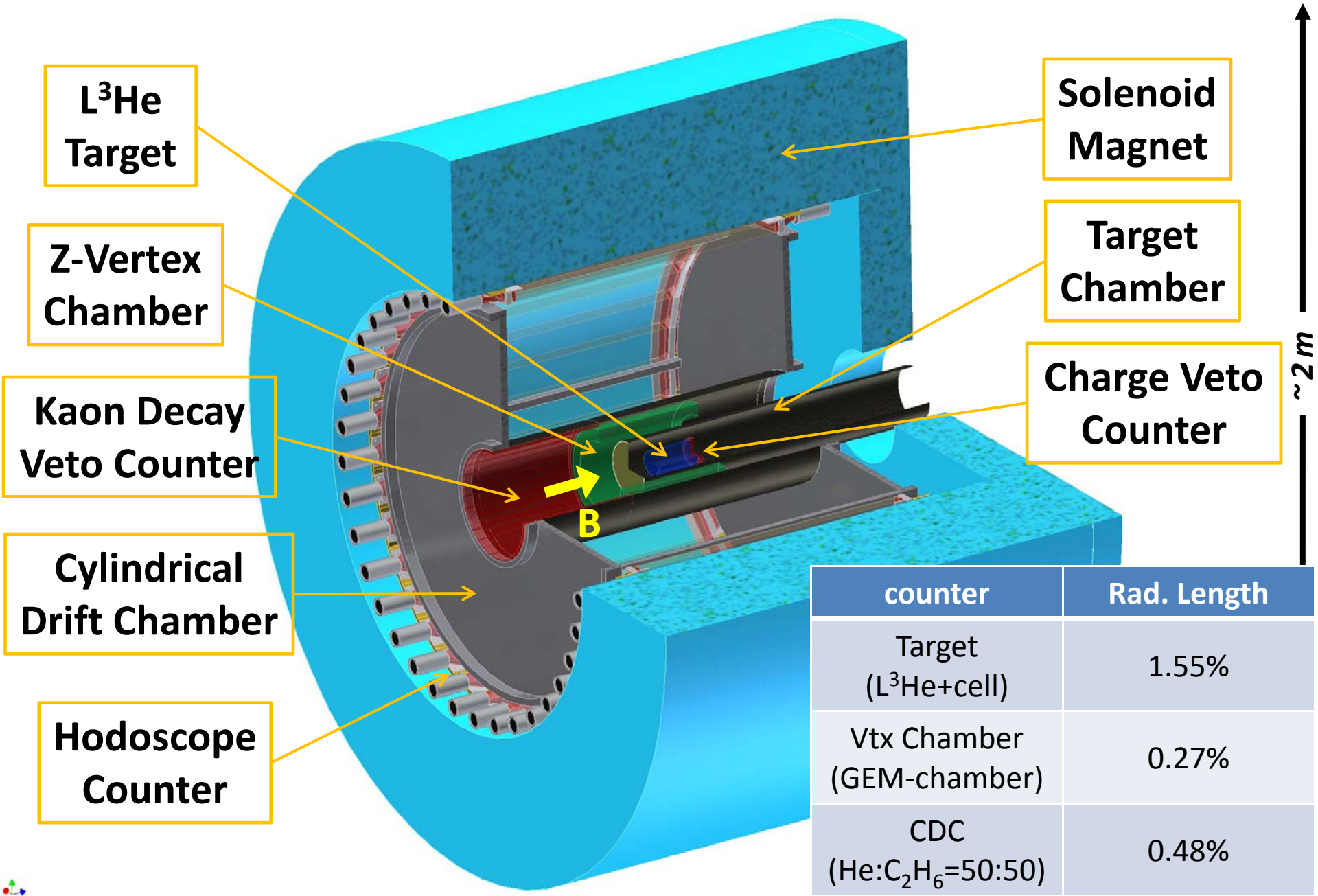
invariant mass

σ = 19MeV/c^2 (σ_{CDC} = 250μm)

missing mass

σ = 12MeV/c^2 (σ_{ToF} = 150ps)

Cylindrical Detector System (CDS)

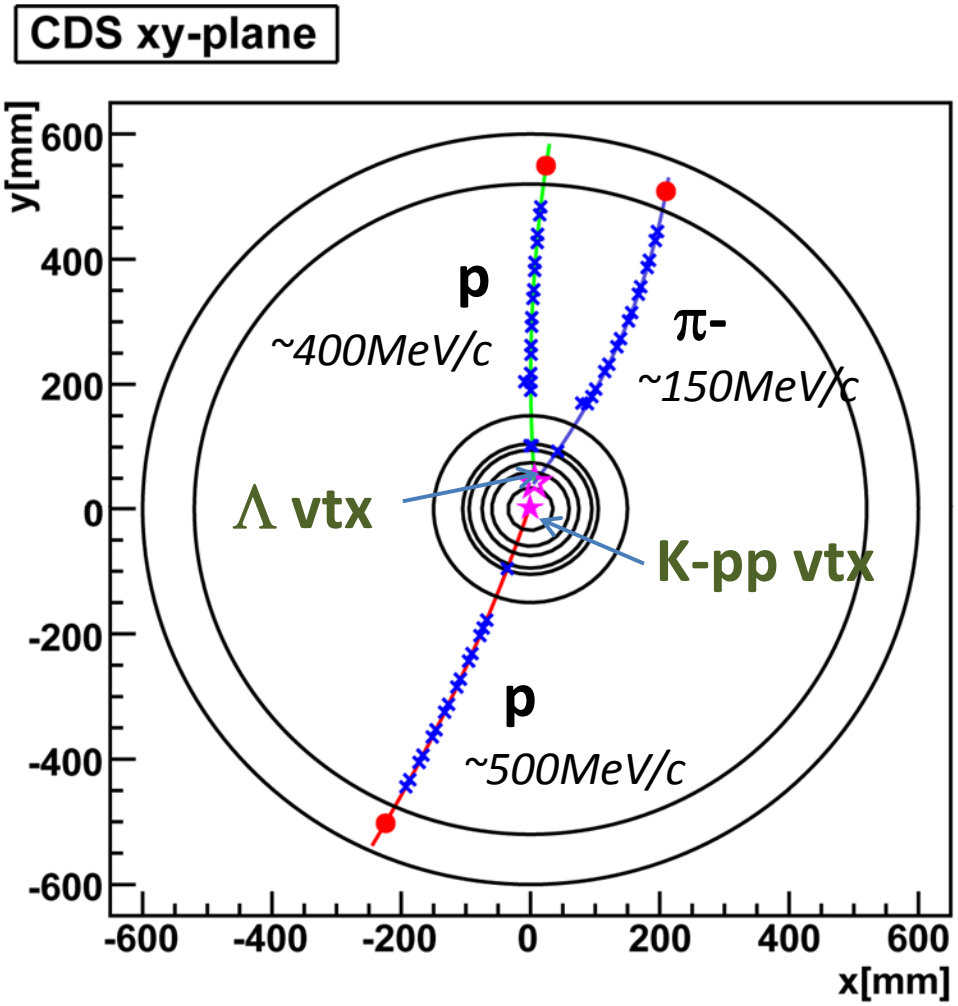


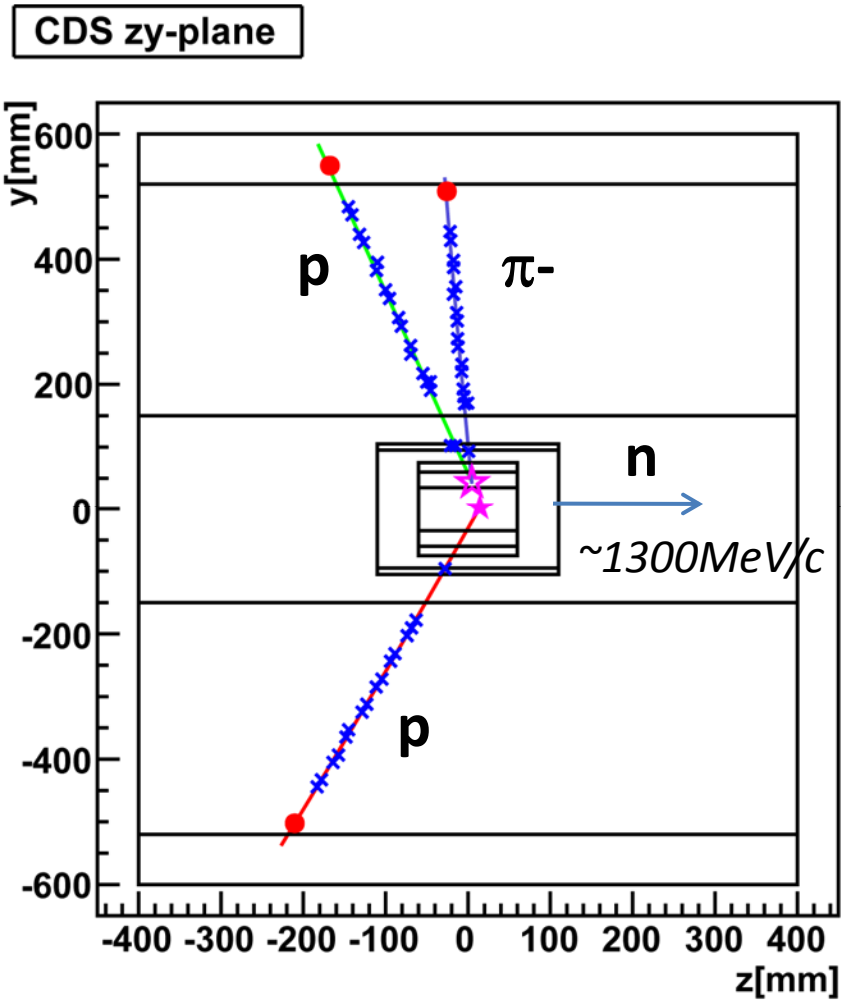
counter	Rad. Length
Target (L^3He+cell)	1.55%
Vtx Chamber (GEM-chamber)	0.27%
CDC ($He:C_2H_6$=50:50)	0.48%

Event-display for K-pp

- binding energy = 100MeV/c^2
- Geant4を用いたシミュレーション
- 前方neutronを要求

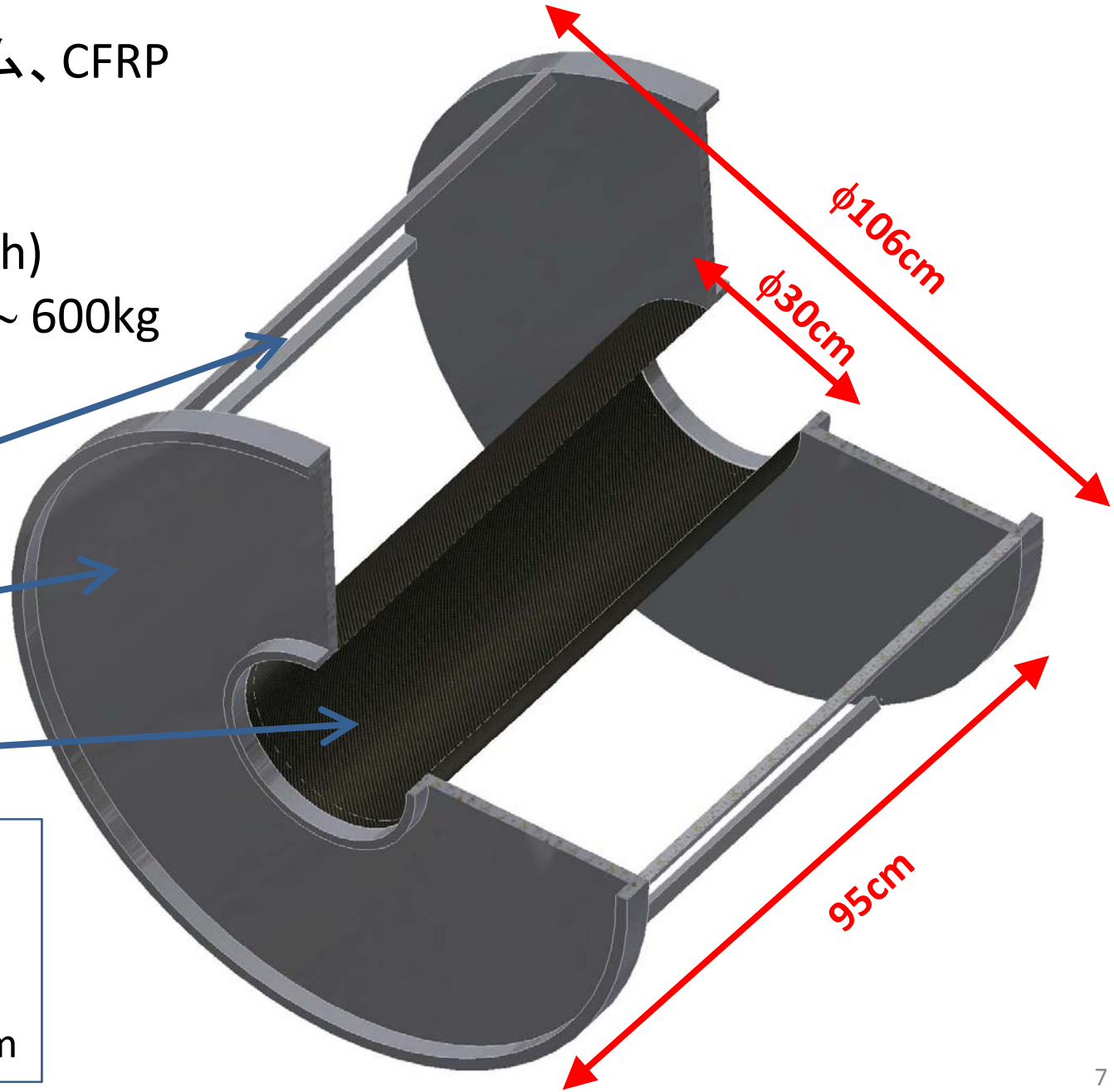
Calculated using Geant4





Cylindrical Drift Chamber (CDC)

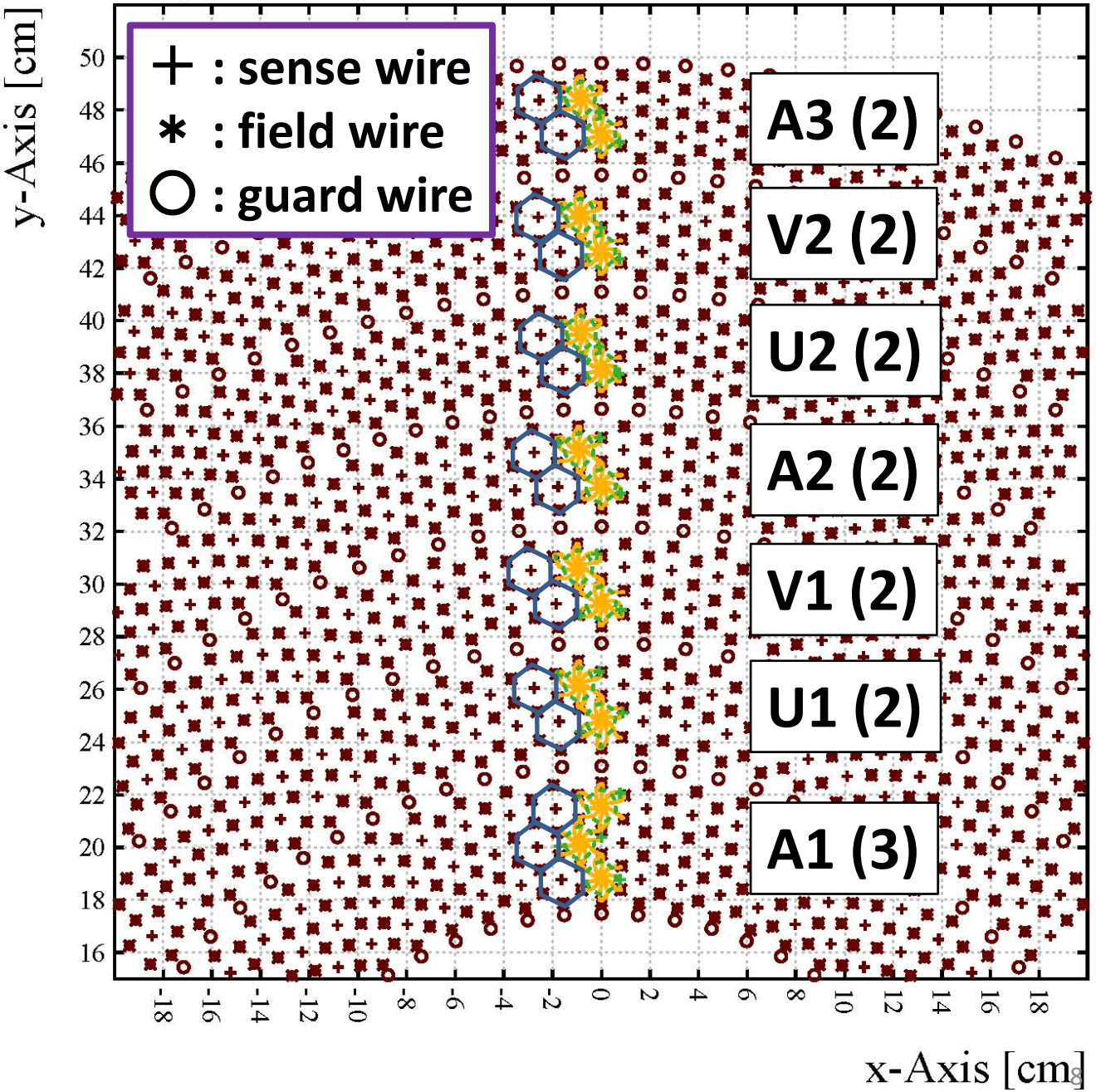
- ●材質 : アルミニウム、CFRP
- ●重量 : ~ 100kg
- ●ワイヤー数 : 8136
  (読み出し : 1816ch)
- ●総ワイヤー張力 : ~ 600kg



sense wires:
Au-plated W, ϕ30μm
field & guard wires:
Au-plated Al, ϕ100μm

Cell Configuration

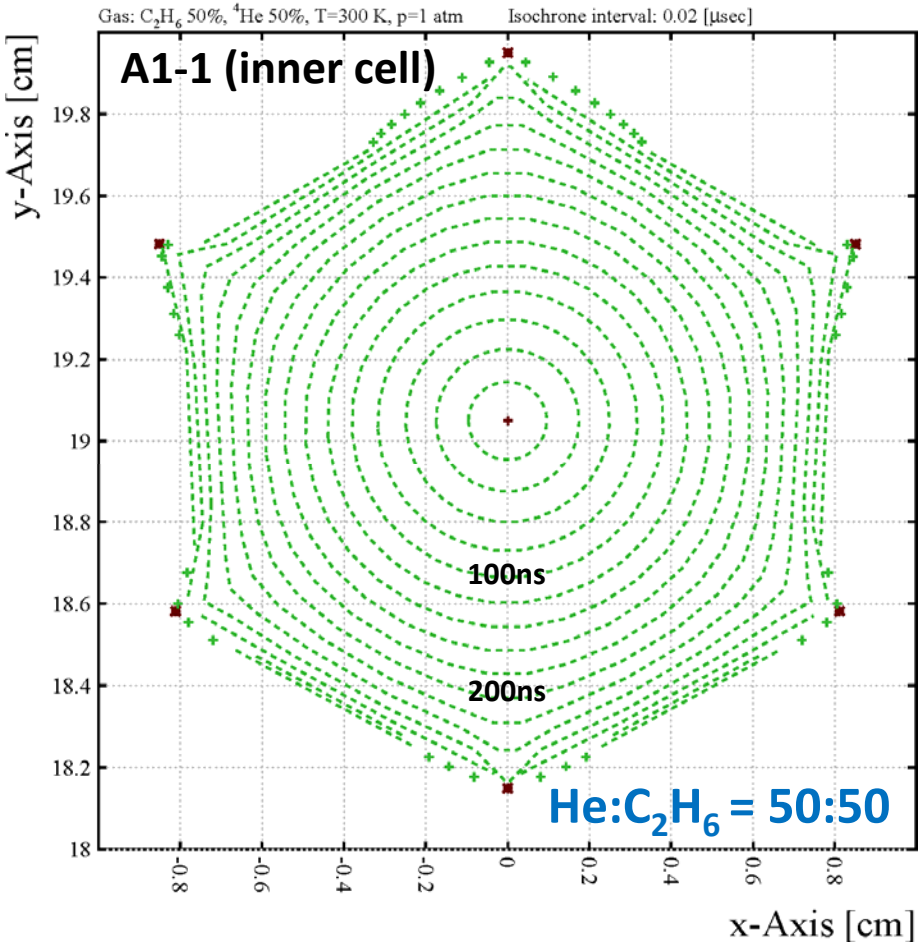
- 六角形セル
  (drift length~9mm)
- 7 super layers
  (AUVAUVA)
- 15 layers
  (r = 19.05~48.45cm)
- wire length = 82cm
- solid angle = 2.6π



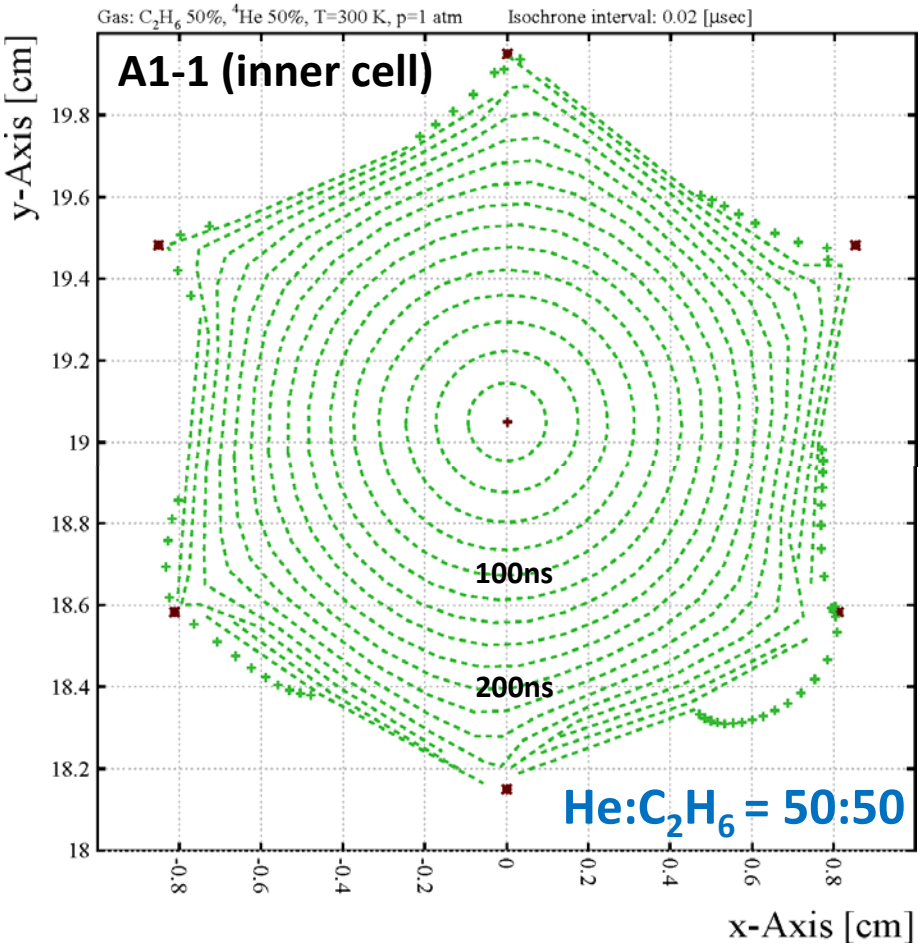
Isochrones of Drift Time

Calculated using garfield-9

w/o magnetic field



w/ magnetic field (0.5T)



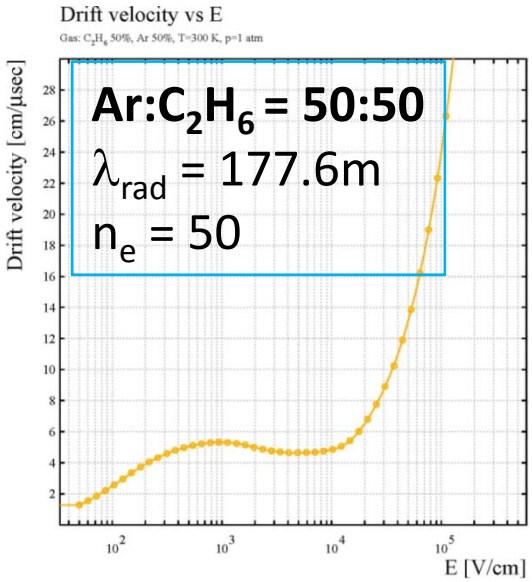
磁場によって形はあまり変わらない

Gas Mixture

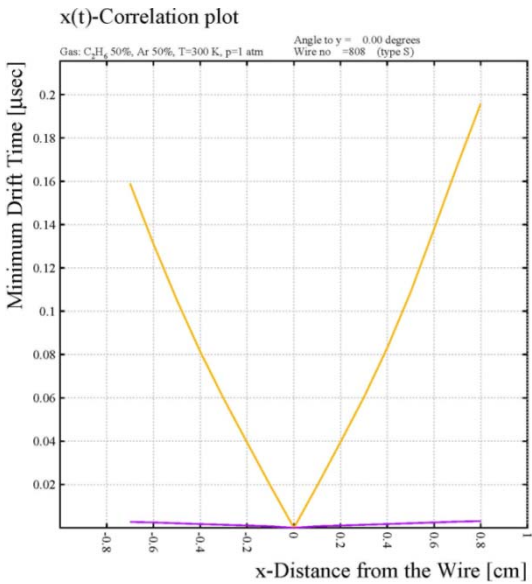
Calculated using garfield-9

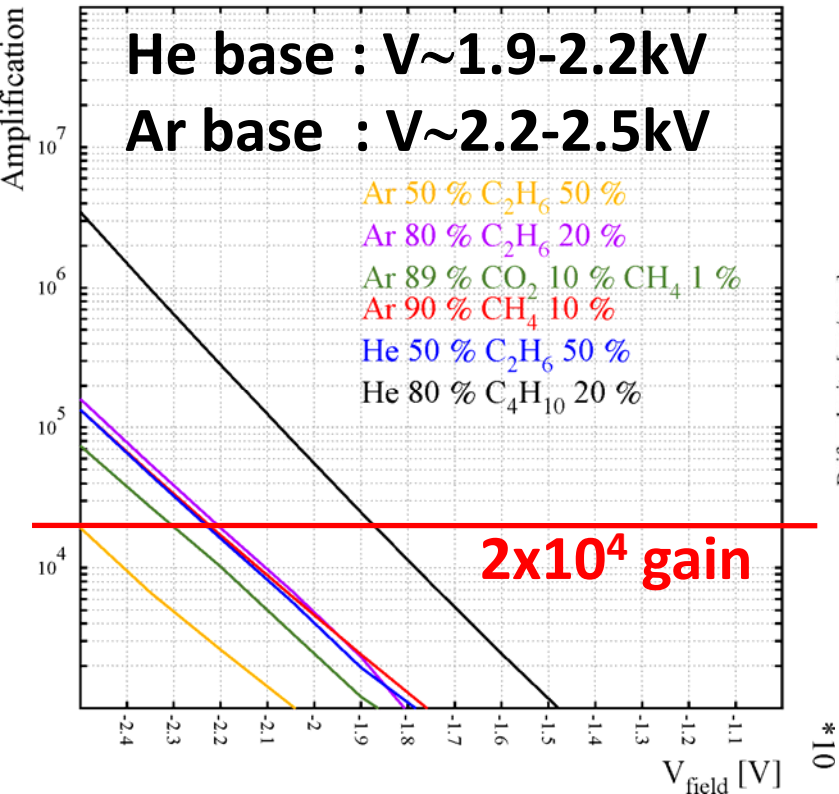
- $Ar:C_2H_6$ = 50:50を使用
- $He:C_2H_5$ = 50:50など He-baseのガスの使用も考慮

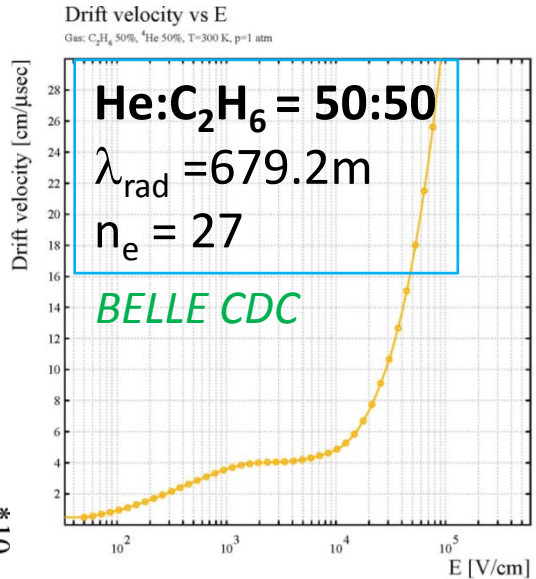
velocity vs. E

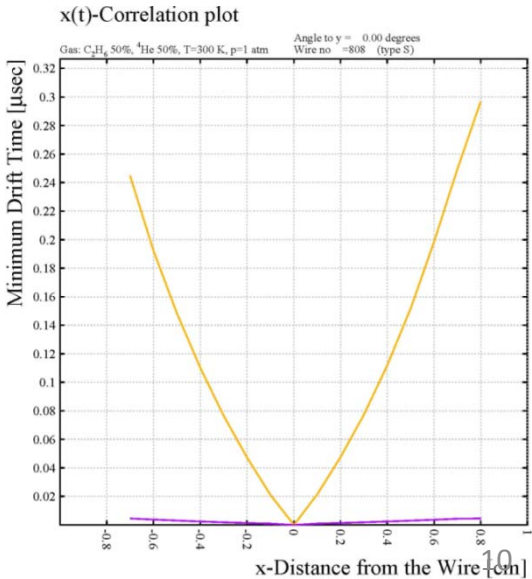


xt relation





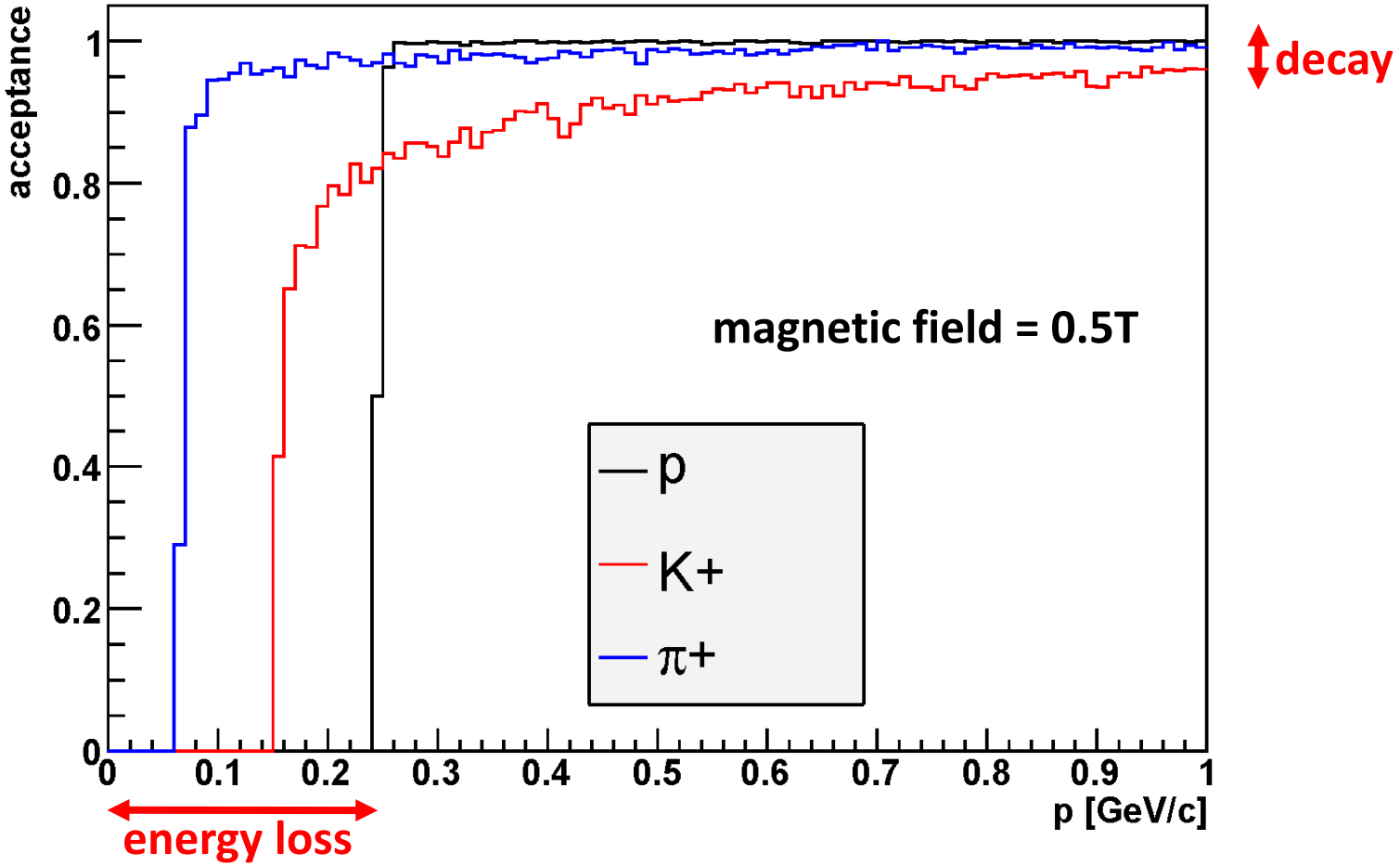




Geometrical Acceptance

- generated at the center of CDS
- 0<p<1 GeV/c, flat distribution
- 60<θ<120 degree, flat distribution
- accepted = track with a CDH-hit

Calculated using Geant4

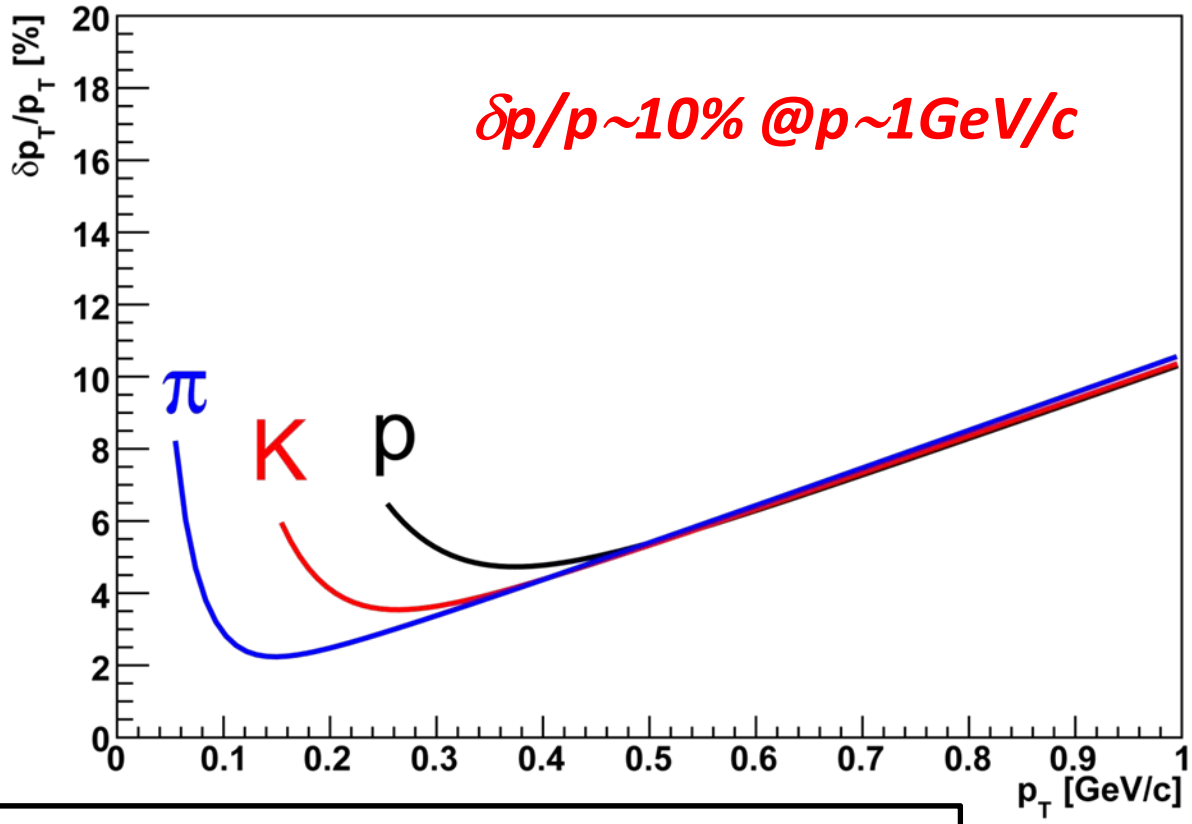


proton>250MeV/c, kaon>150MeV/c, pion>50MeV/c

Spectrometer Performance

momentum resolution for π, K, p

Calculated using Geant4



expected mass resolution for K-pp and Λ

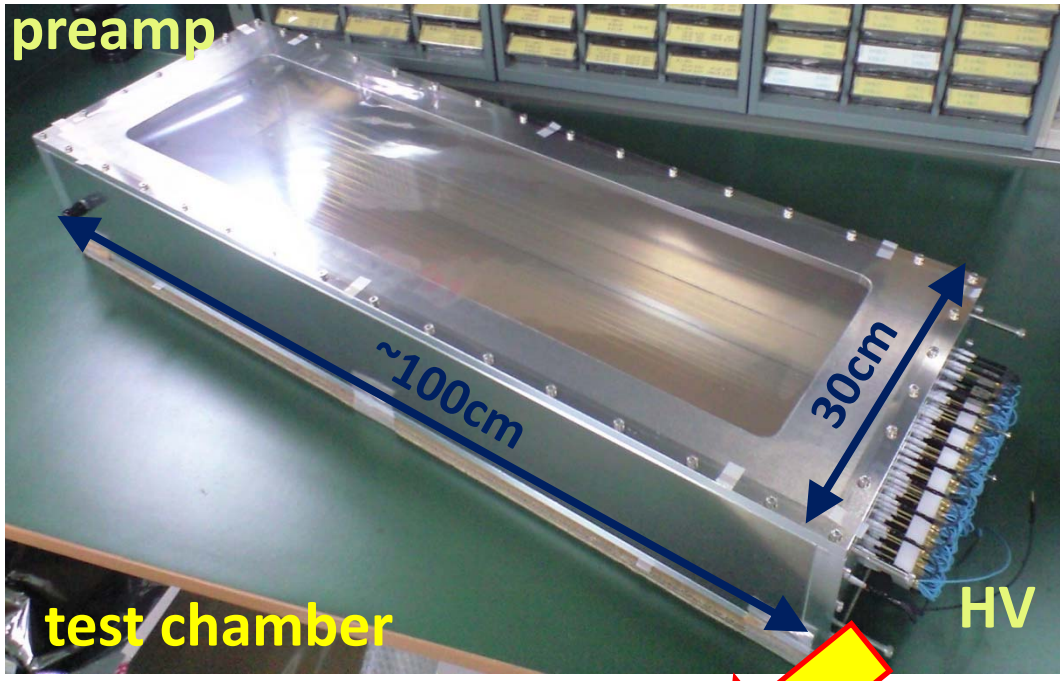
mass resolution	K-pp	Λ
w/o chamber-smearing	5.8 MeV/c^2	1.6MeV/c^2
w/ chamber-smearing	18.7MeV/c^2	2.5MeV/c^2

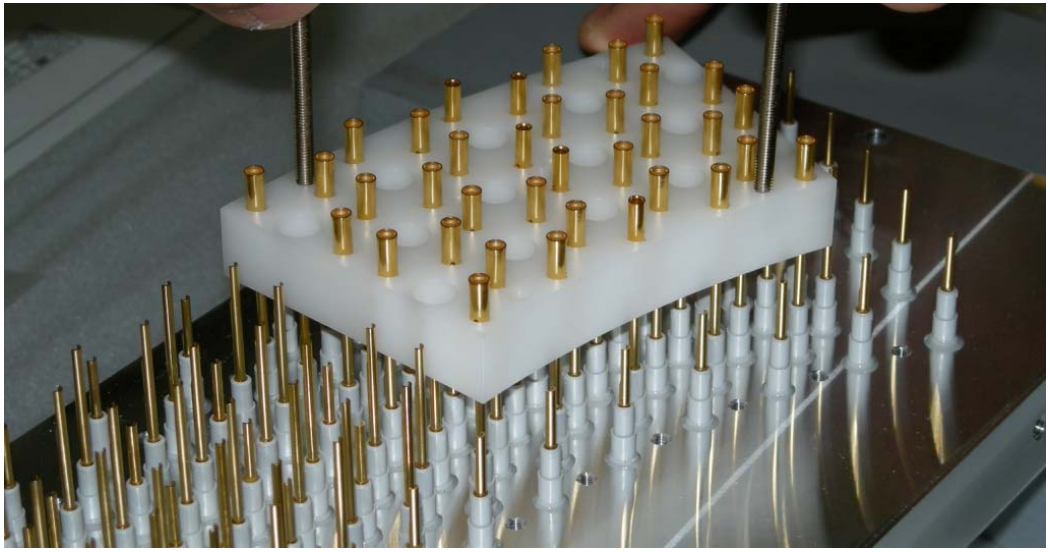
Present Status of CDC

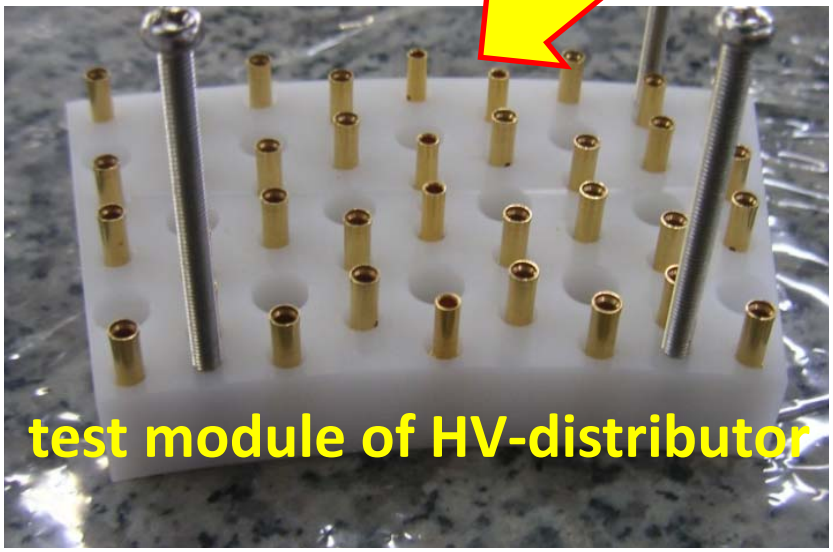
●CDCの基本設計は済み、2008年初頭に完成予定

●試作機を作製し、HV-distributor, preamp-boardのテストを行っている

●今後、試作機を用いてガスのテストなどを行う予定

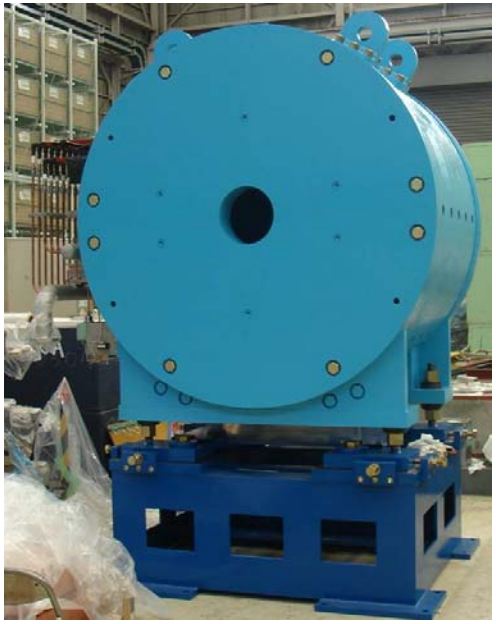






Summary

- J-PARC E15実験はK中間子原子核(K-pp束縛状態)の探索を行う
- E15実験の主要な検出器であるCylindrical Drift Chamberは、2008年始めに完成予定であり、現在はHV,プリアンプ周りをテスト機を用いてテストしている
- E15実験のスペクトロメーターは、2009年始めのビームタイムに向けて着々と準備が進められている



Solenoid Magnet

Target System

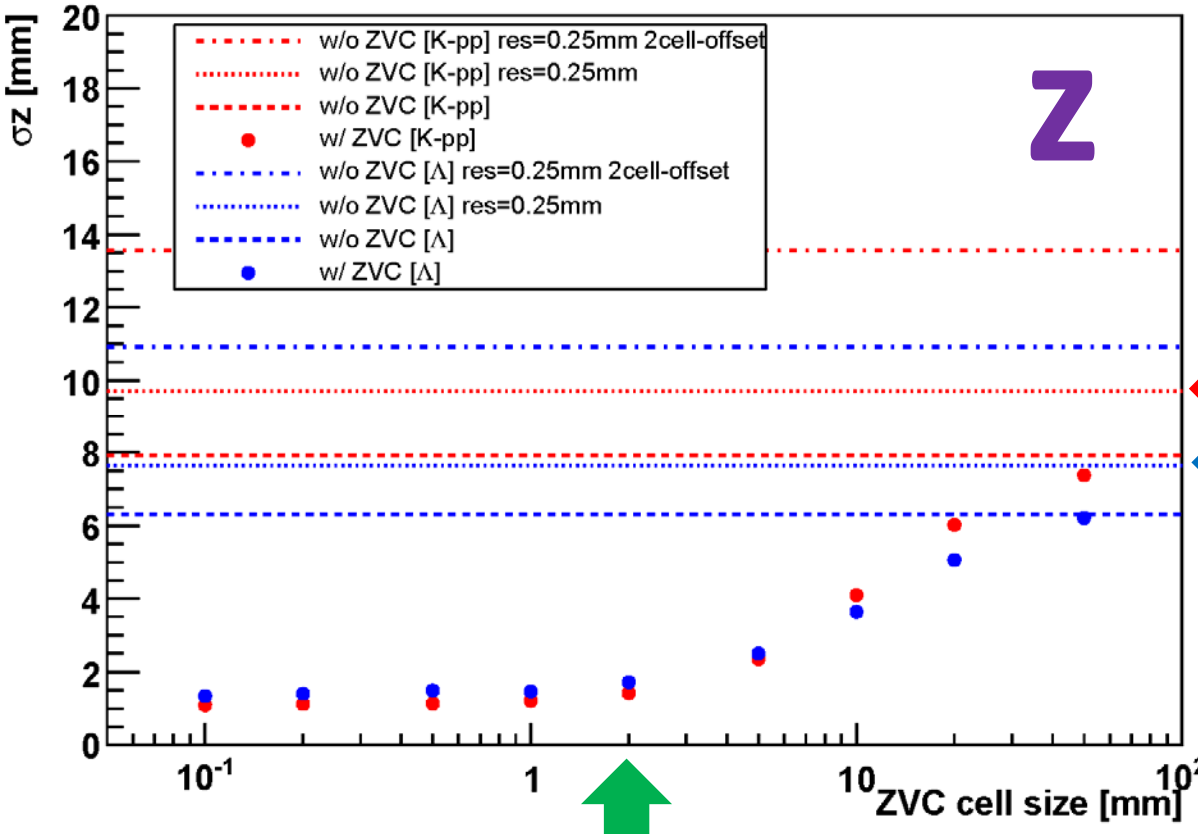
ToF Wall

backup

Detailed Cell Configuration

layer number	wire direction	super-layer	number of cells	radius [cm]	cell width [degree]	drift length [cm]	offset angle [degree]	tilt angle [degree]
1	X	A1	72	19.05	5	0.83	0	0
2	X’			20.4		0.89		0
3	X			21.75		0.95		0
4	U	U1	90	24.85	4	0.87	12	3.72
5	U’			26.2		0.91		3.92
6	V	V1	100	29.3	3.6	0.92	10.8	3.95
7	V’			30.65		0.96		4.12
8	X	A2	120	33.75	3	0.88	0	0
9	X’			35.1		0.92		0
10	U	U2	150	38.2	2.4	0.80	7.2	3.43
11	U’			39.55		0.83		3.55
12	V	V2	160	42.65	2.25	0.84	6.75	3.59
13	V’			44		0.86		3.71
14	X	A3	180	47.1	2	0.82	0	0
15	X’			48.45		0.85		0

Vertex Resolution

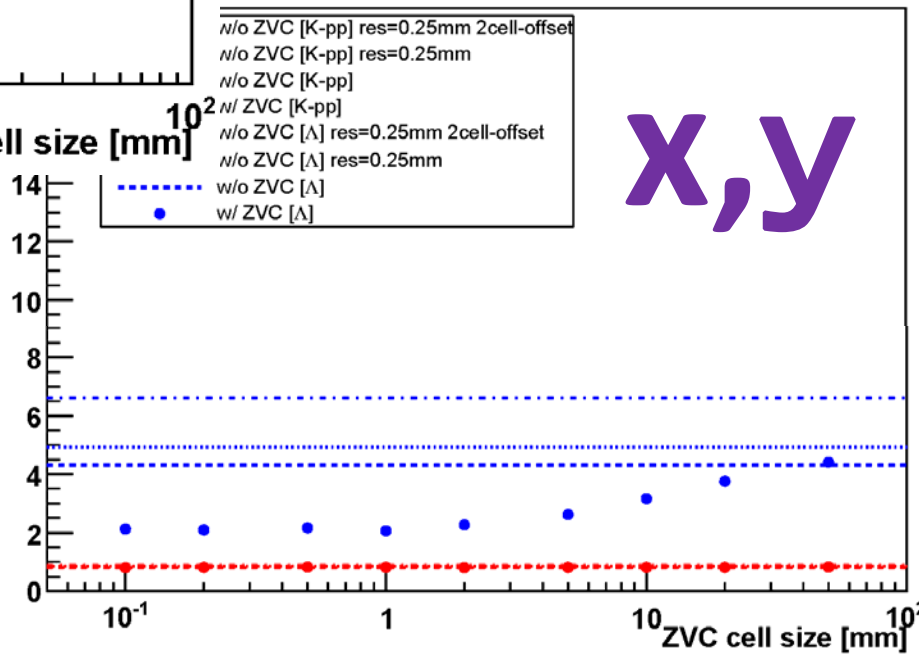


Z

K-pp (~10mm)

Λ (~8mm)

K-pp, Λ (~2mm)



x,y