



RIKEN

2008.06.06

# Present status of J-PARC E15/E17

M. Iwasaki

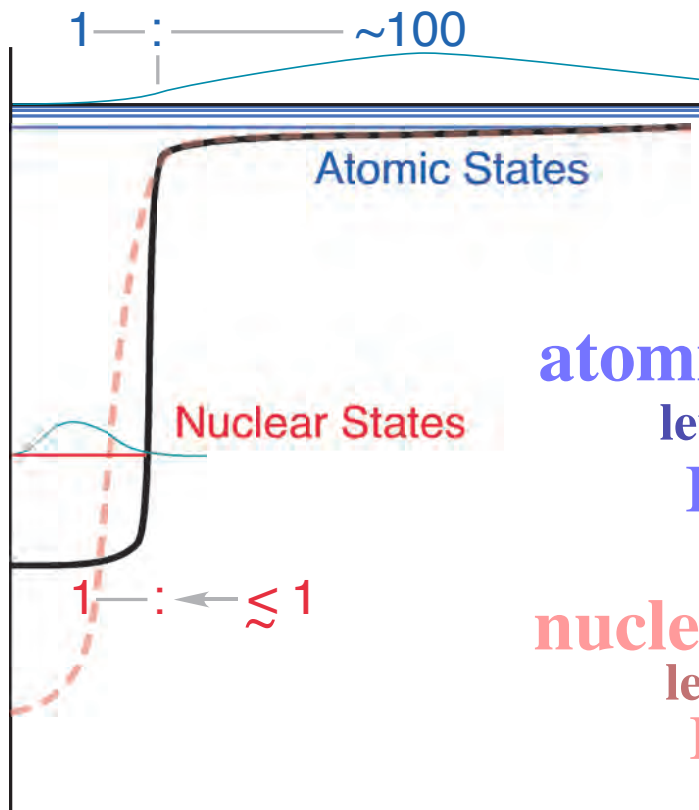
**Advanced Meson Science Lab.**



独立行政法人 理化学研究所  
仁科加速器研究センター

# Study of $\bar{K}N$ interaction by E17 / E15

sharing resources: area, setup etc.



strongly attractive in  $I=0$  channel

## atomic states

level shift and absorption width

E17:  $K^- - {}^3\text{He } 3d - 2p$  x-ray

$K$  at rest

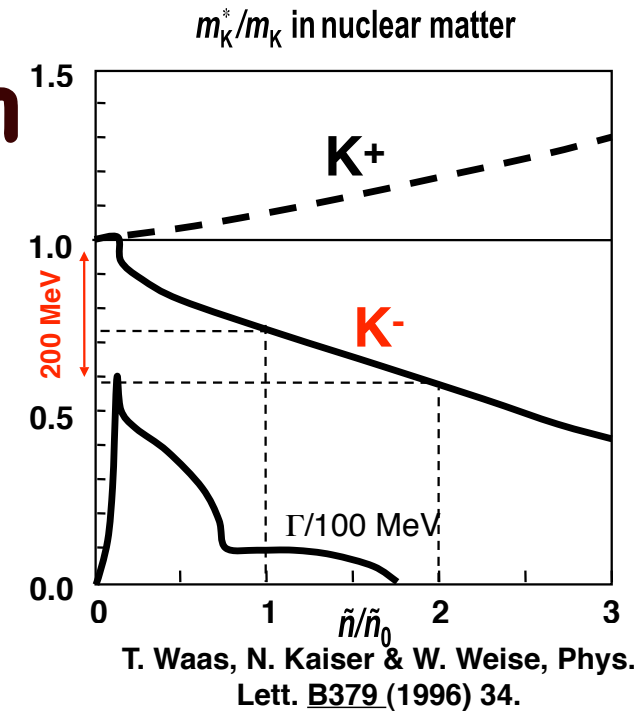
## nuclear states

level energy and decay width

E15:  ${}^3\text{He}(K^-, n)$  missing &

invariant mass

$K$  @ 1 GeV/c

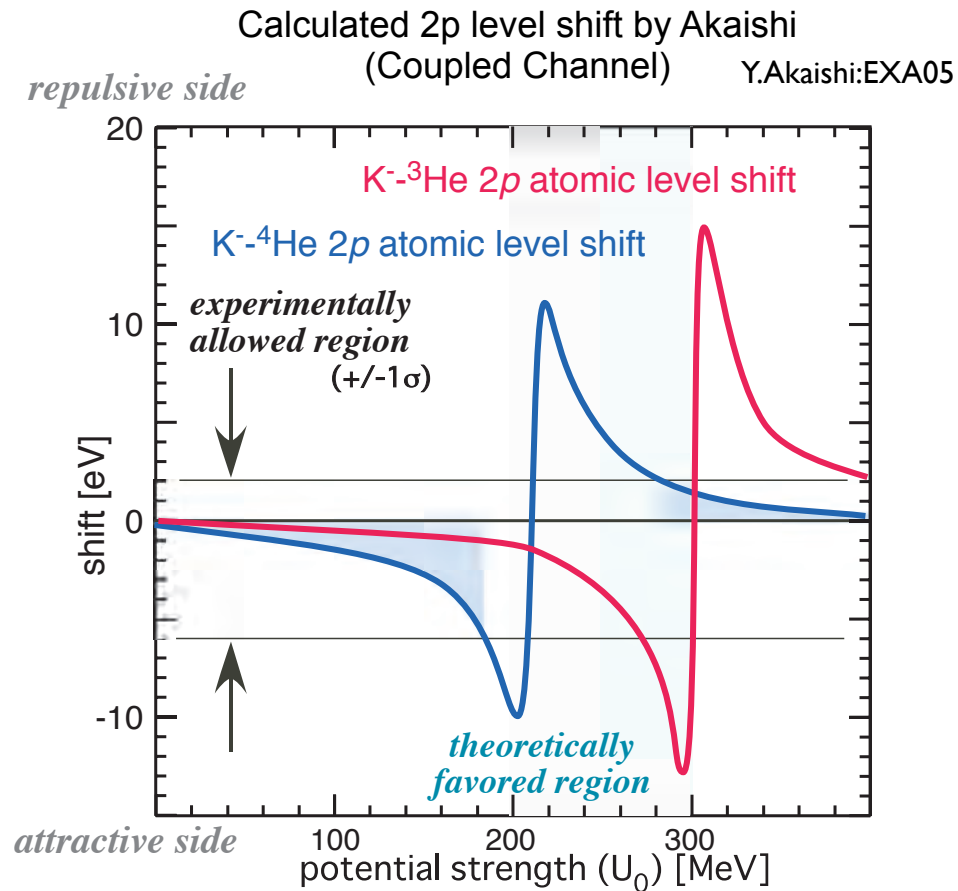


# $\bar{K}N$ study by atomic states

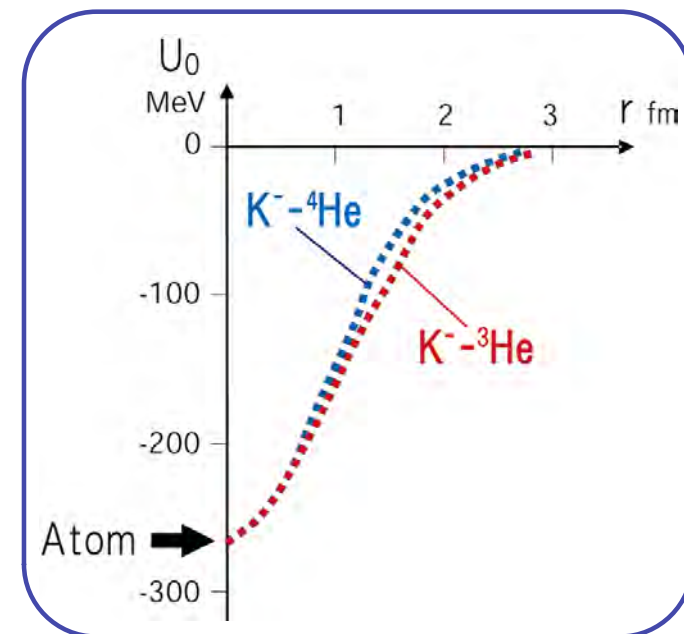
K at rest

level shift and absorption width

E17:  $K^- - {}^3\text{He}$   $3d - 2p$  x-ray



$U_0$ : real part of the  $K^-$ -He  
local potential

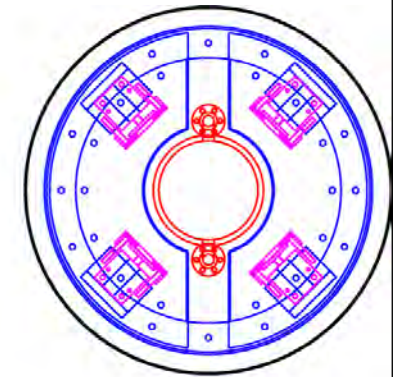
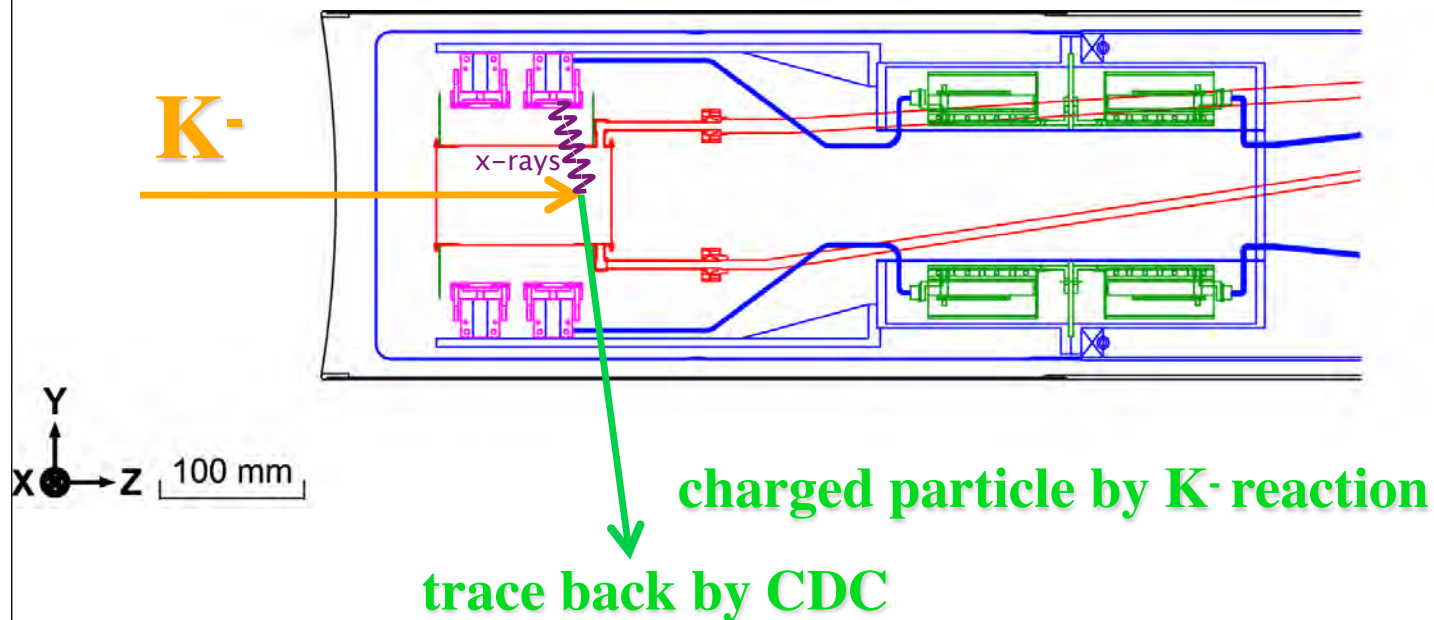
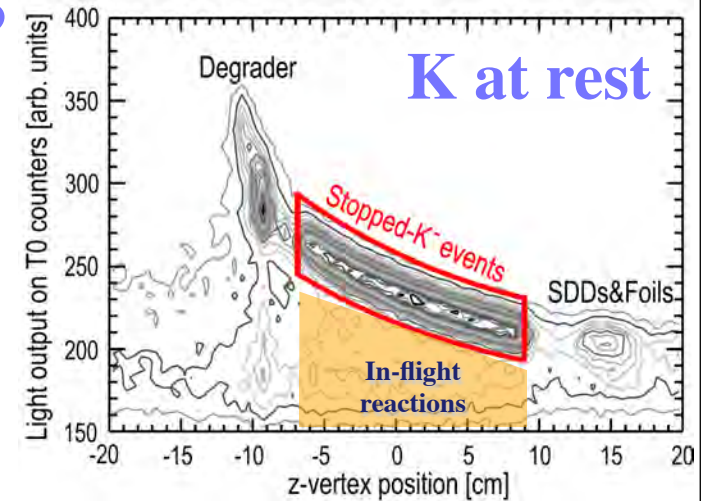


# $\bar{K}N$ study by atomic states

level shift and absorption width

E17:  $K^- ^3\text{He } 3d - 2p$  x-ray

application of well proven  
experimental method in KEK PS-E570

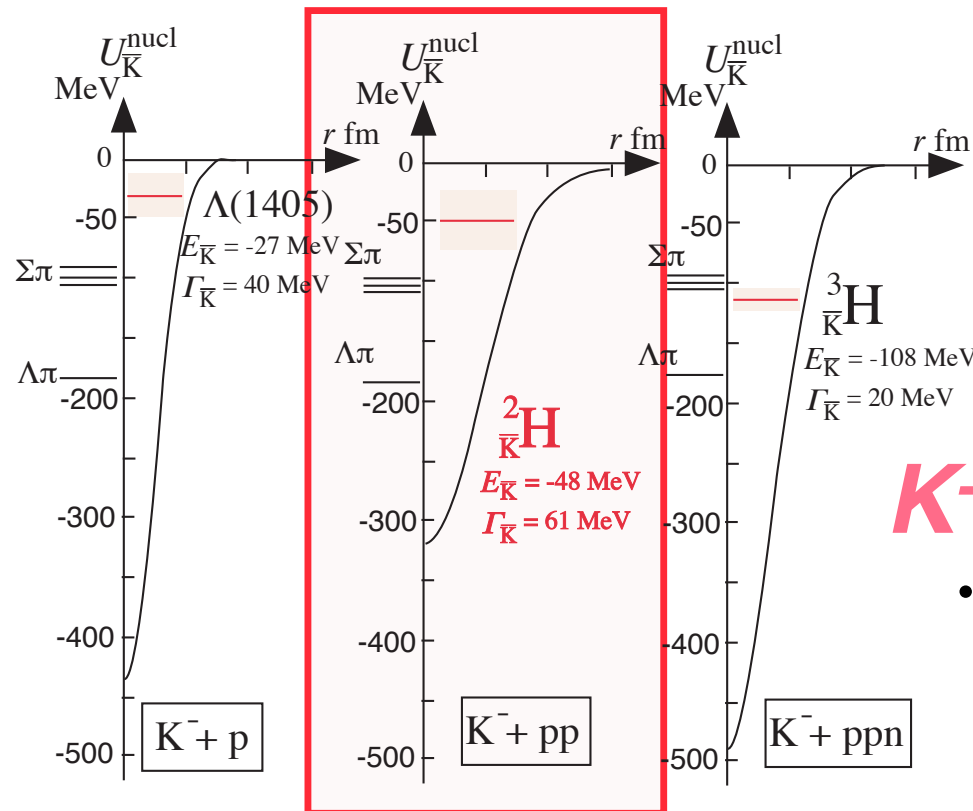


# $\bar{K}N$ study by nuclear states

K @ 1 GeV/c

level energy and decay width

E15:  ${}^3\text{He}(\bar{K}^-, n)$  missing & invariant mass



**$K^-pp$**

- **simplest system**  
less excited states  
less ambiguity  
*full kinematical reconstruction*
- **minimum absorption**  
multi-nucleon absorption

T. Yamazaki, Y. Akaishi / Physics Letters B 535 (2002) 70

# New data from Osaka group

(one of new data : in-flight)

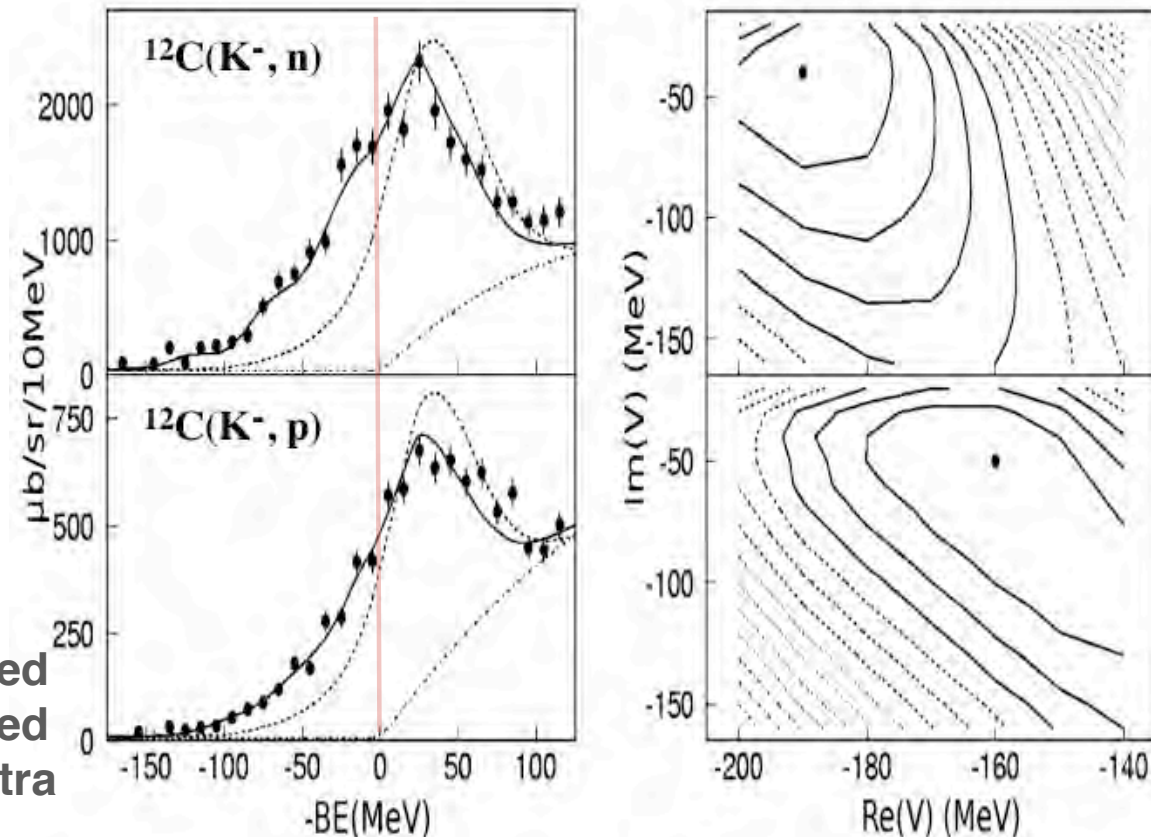
in-flight ( $K^-$ , n) reaction @ 1 GeV/c

*indicating very deep potential  
Kaon condensation?*

T. Kishimoto et al., Prog. Theor. Phys. 118 (2007) 181

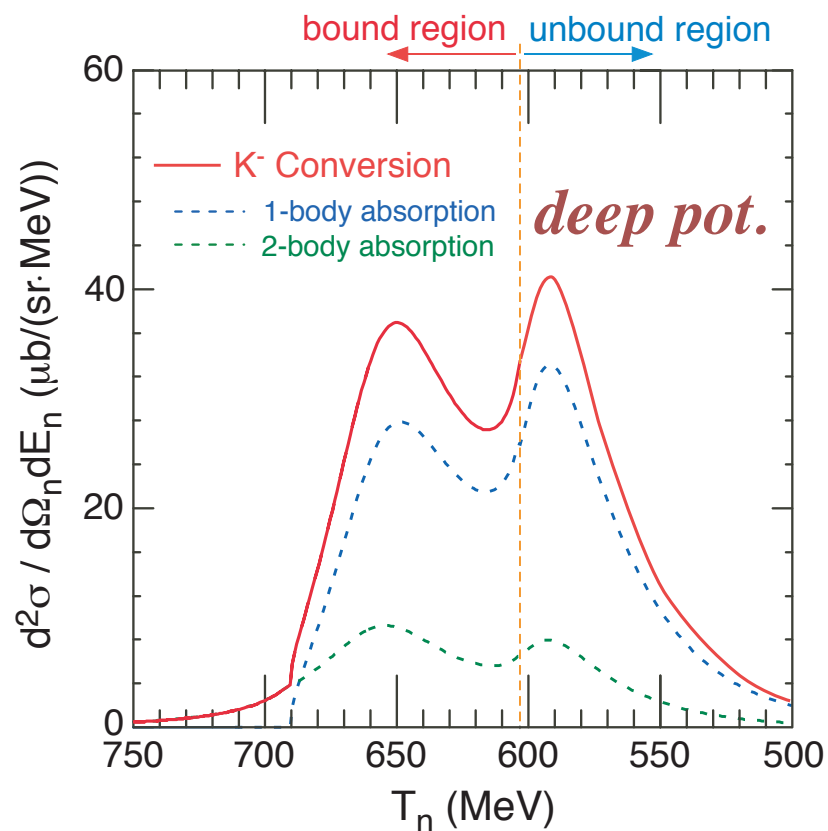
*fit = Green's function*

- deep & wide KN pot.  
Re(V)  $\sim$  200 MeV  
Im(V)  $\sim$  50 MeV
- lower background  
in-flight ensures ...  
2N process suppressed  
kinematically separated  
not seen in the spectra

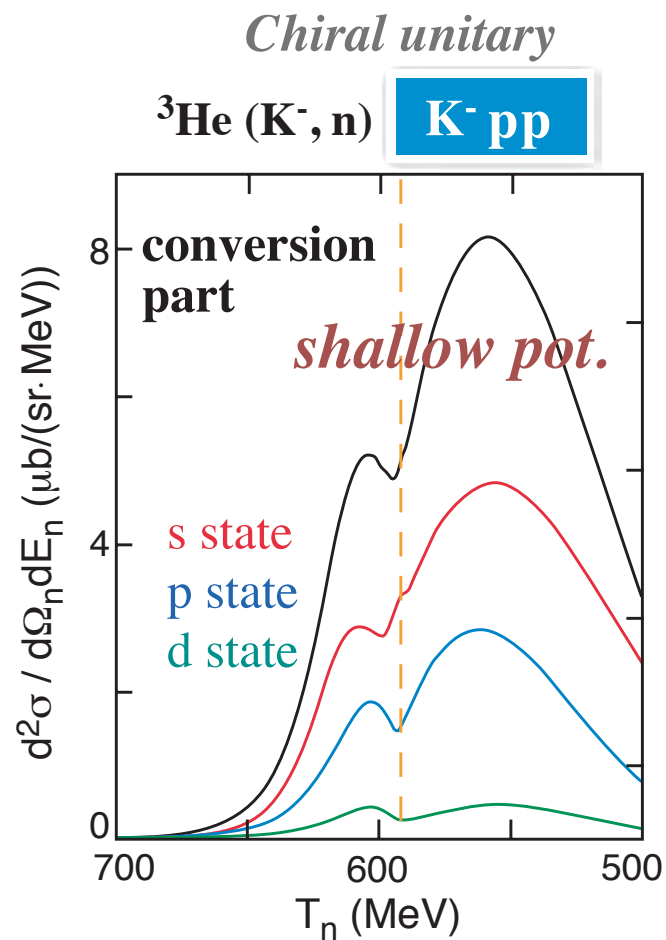


# Theoretical progress

- bound state will be seen
- yield  $5 \sim 40 \mu\text{b} / (\text{sr MeV})$
- resolution must  $< 20\text{MeV}$



T. Koike, T. Harada, Phys. Lett. B652 (2007) 262

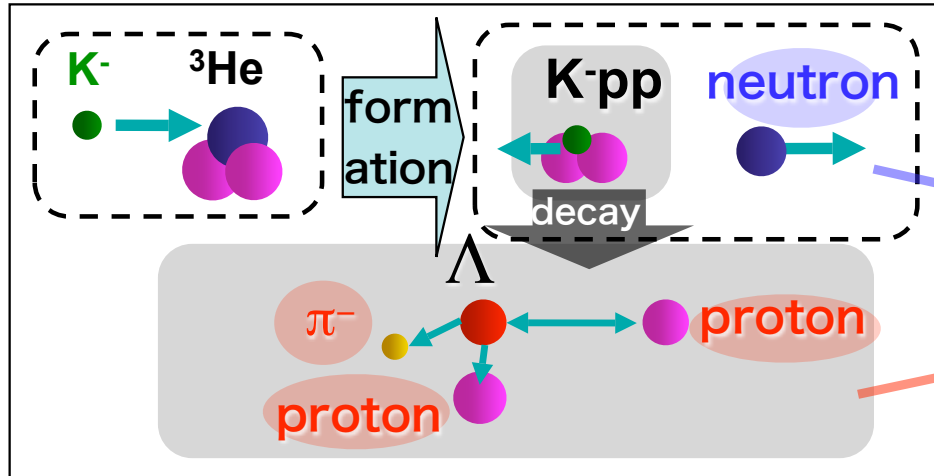


J. Yamagata, S. Hirenzaki, H. Nagahiro, D. Jido, Mod. Phys. Lett. A accepted. Proc. of Chiral07.



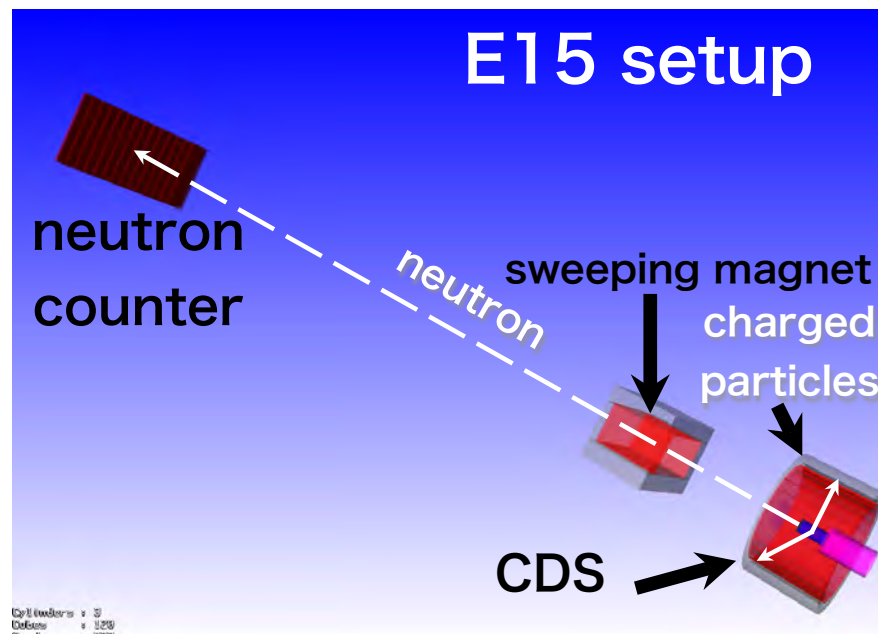
# KN study by nuclear states level energy and decay width

E15:  ${}^3\text{He}(\text{K}^-, \text{n})$  missing & invariant mass



- ▶ lightest :  $\text{K}^- \text{pp}$
- ▶ observation of “formation” and “decay”

cf.  $\Sigma^\pm \pi^\mp \rho$  decay channel  
can also be tagged  
by  $\pi^+ \pi^-$  tag

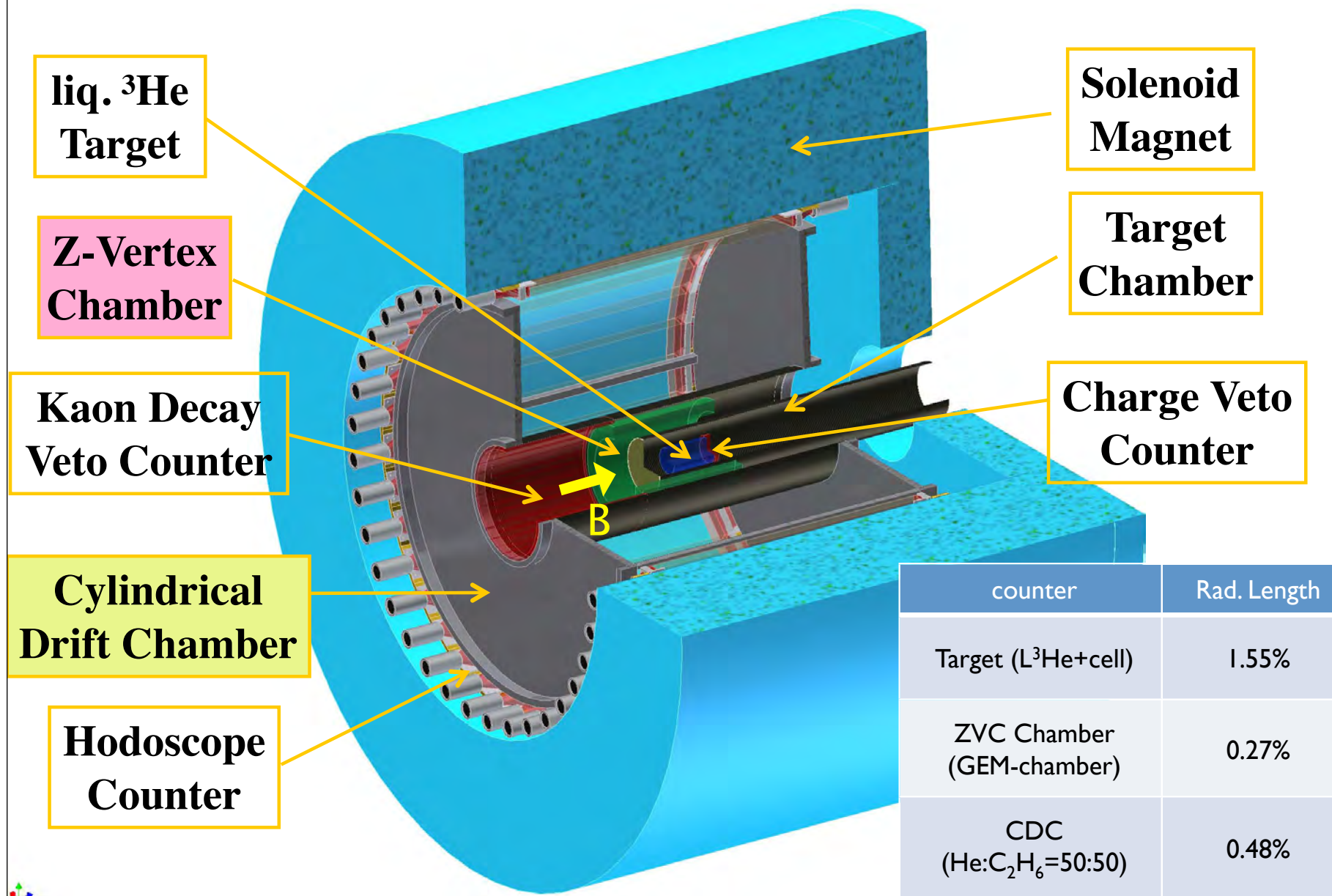


- Cylindrical Detector System
  - 1) solenoid
  - 2) CDC
  - 3) hodoscope
- ${}^3\text{He}$  target
- neutron counter
- beam line detector

competitor  
**FOPI @ GSI aiming same physics!**



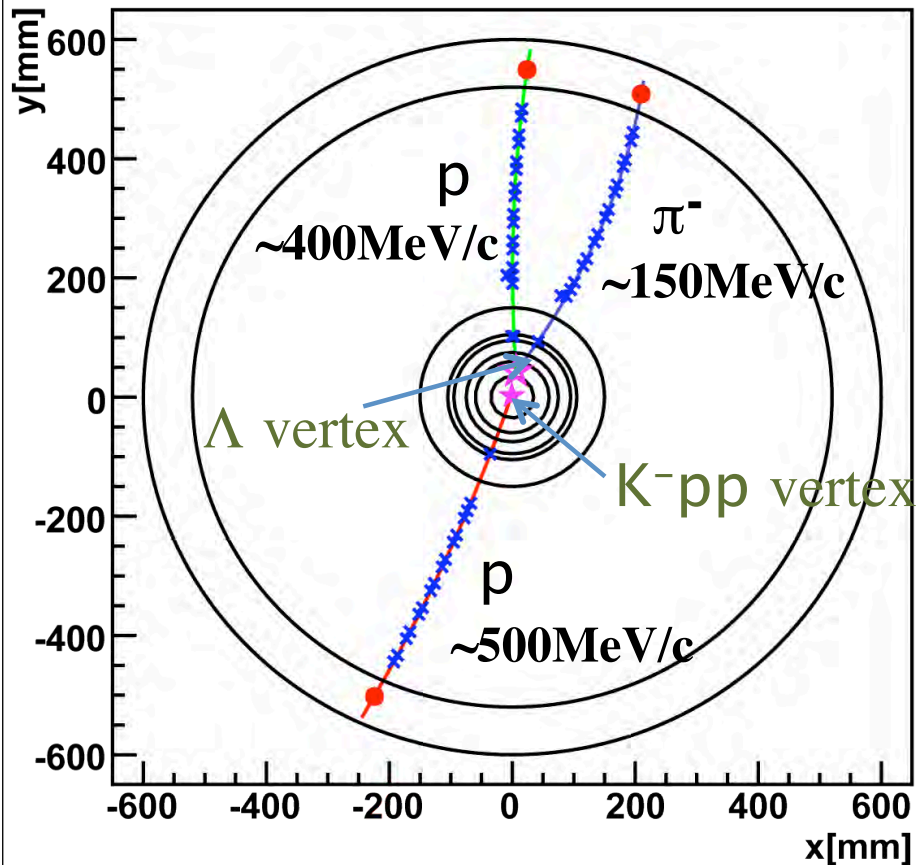
# CDS overview



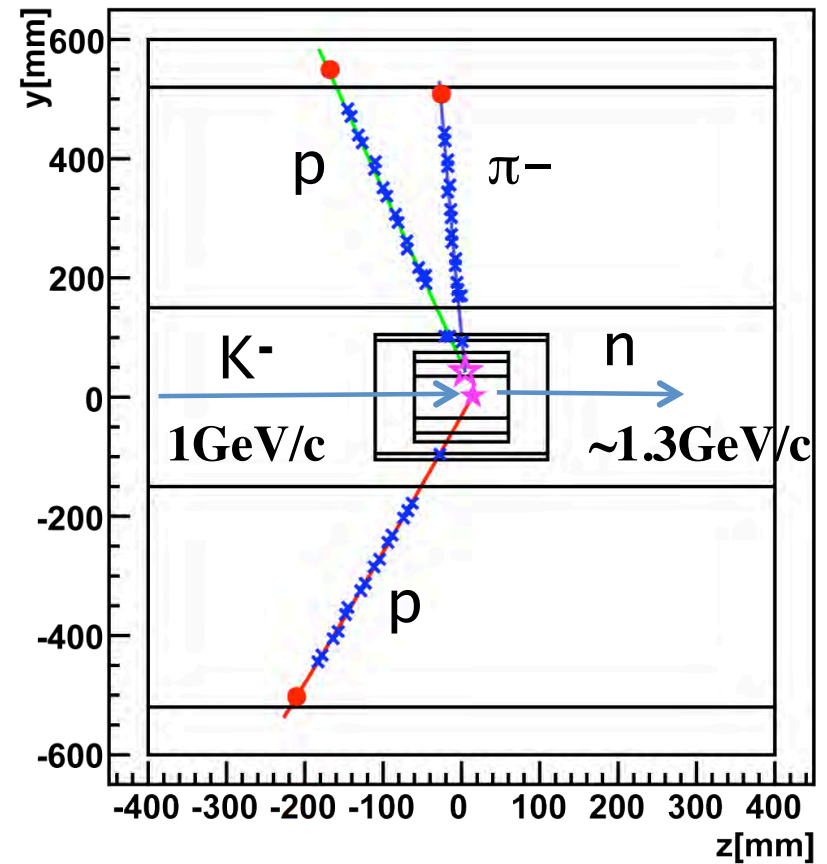
# K<sup>-</sup>pp event display

- binding energy = 100MeV
- Geant4 simulation
- with forward neutron

CDS xy-plane

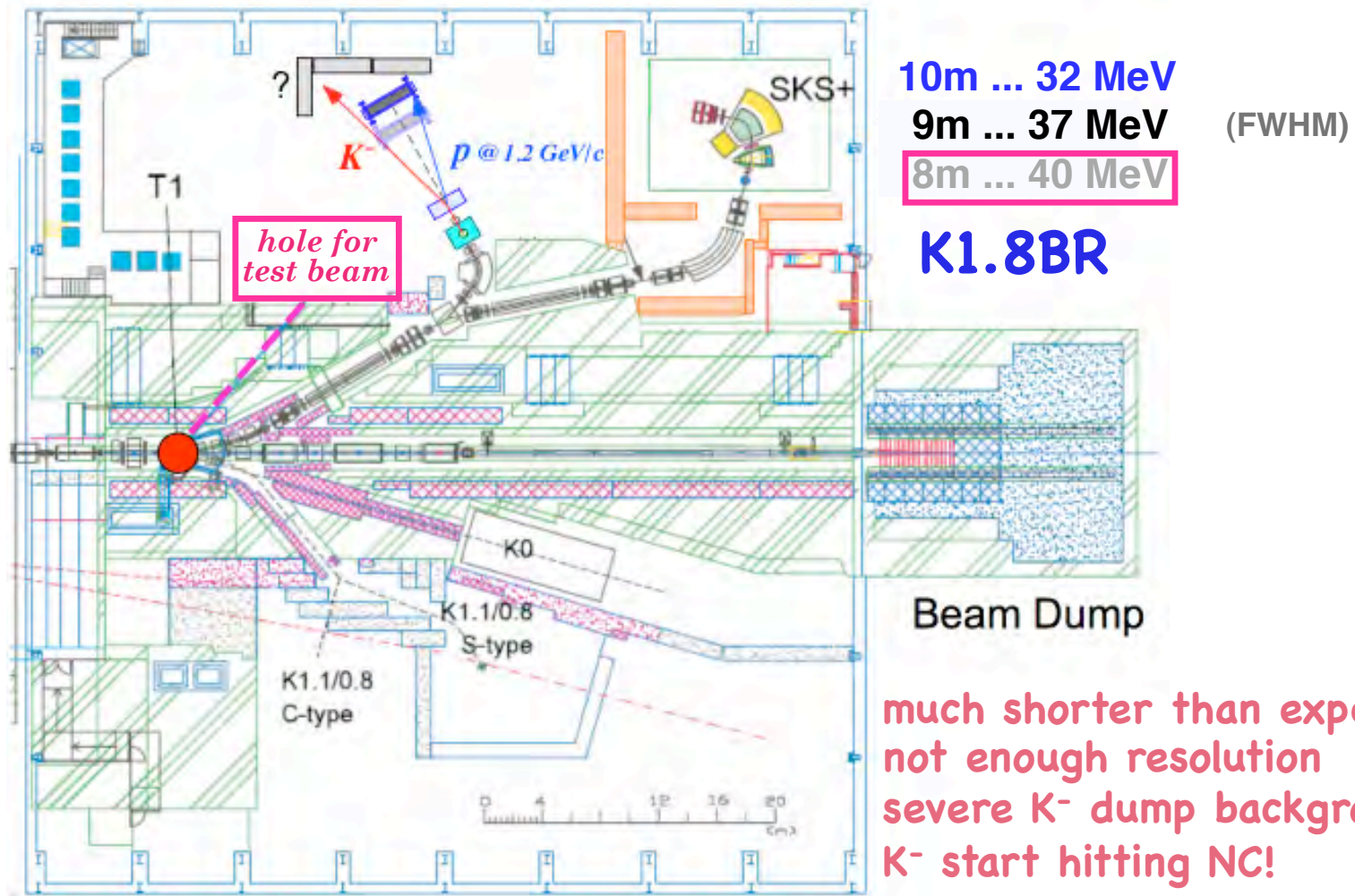


CDS zy-plane



# Where to do ... ?

radiation safety not allow us to place NC where we wish ...

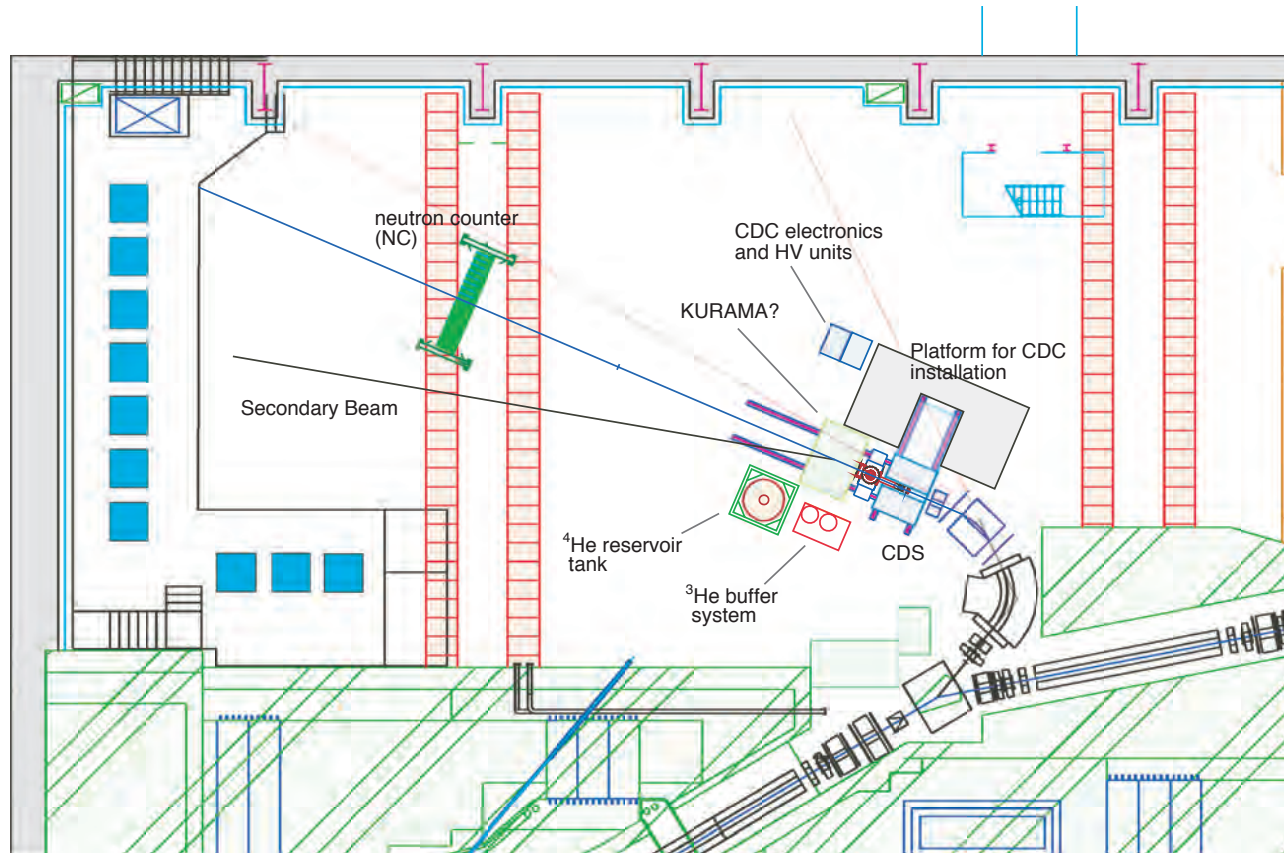




# Why not K1.8BR ?

extraction angle modification

enough resolution  
small K<sup>-</sup> dump background  
well separated K<sup>-</sup> beam



final shape for E15  
realized until Sept. 2009

15m ... 20 MeV

(FWHM)

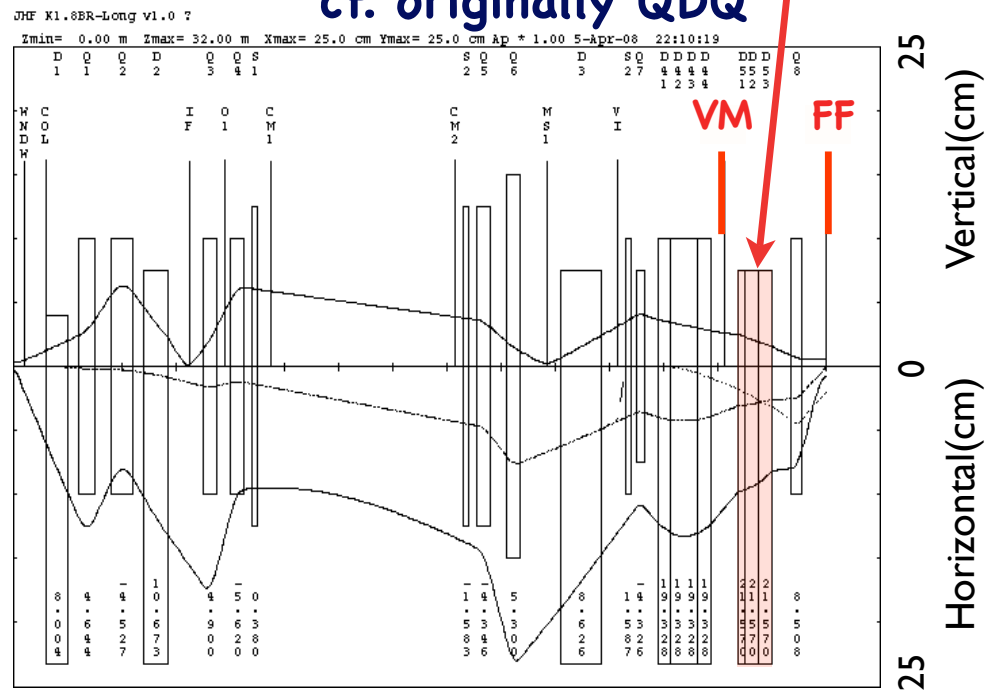
as in proposal

# K1.8BR Op.1 proposed by Noumi

QDDQ configuration

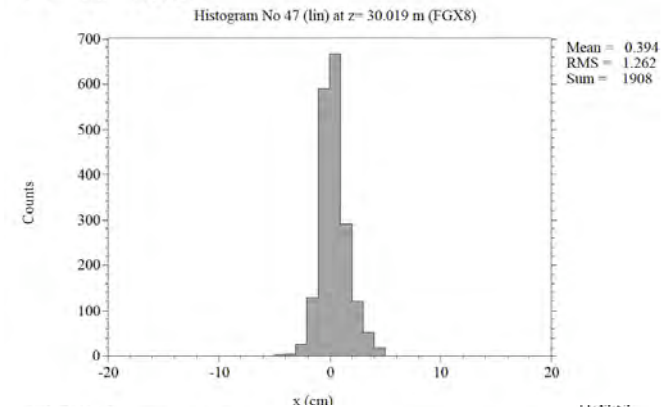
cf. originally QDQ

added dipole



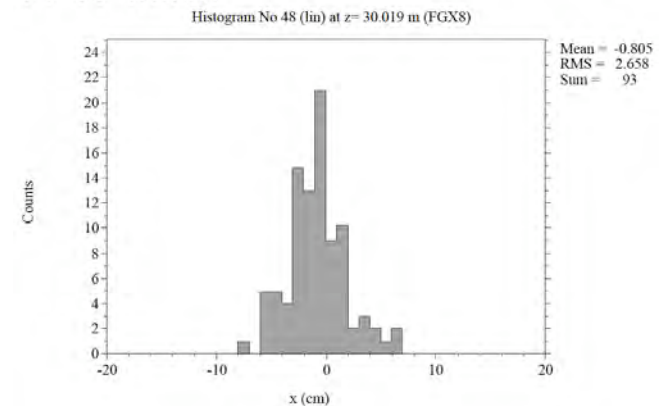
FF-X kaon

08:12:21



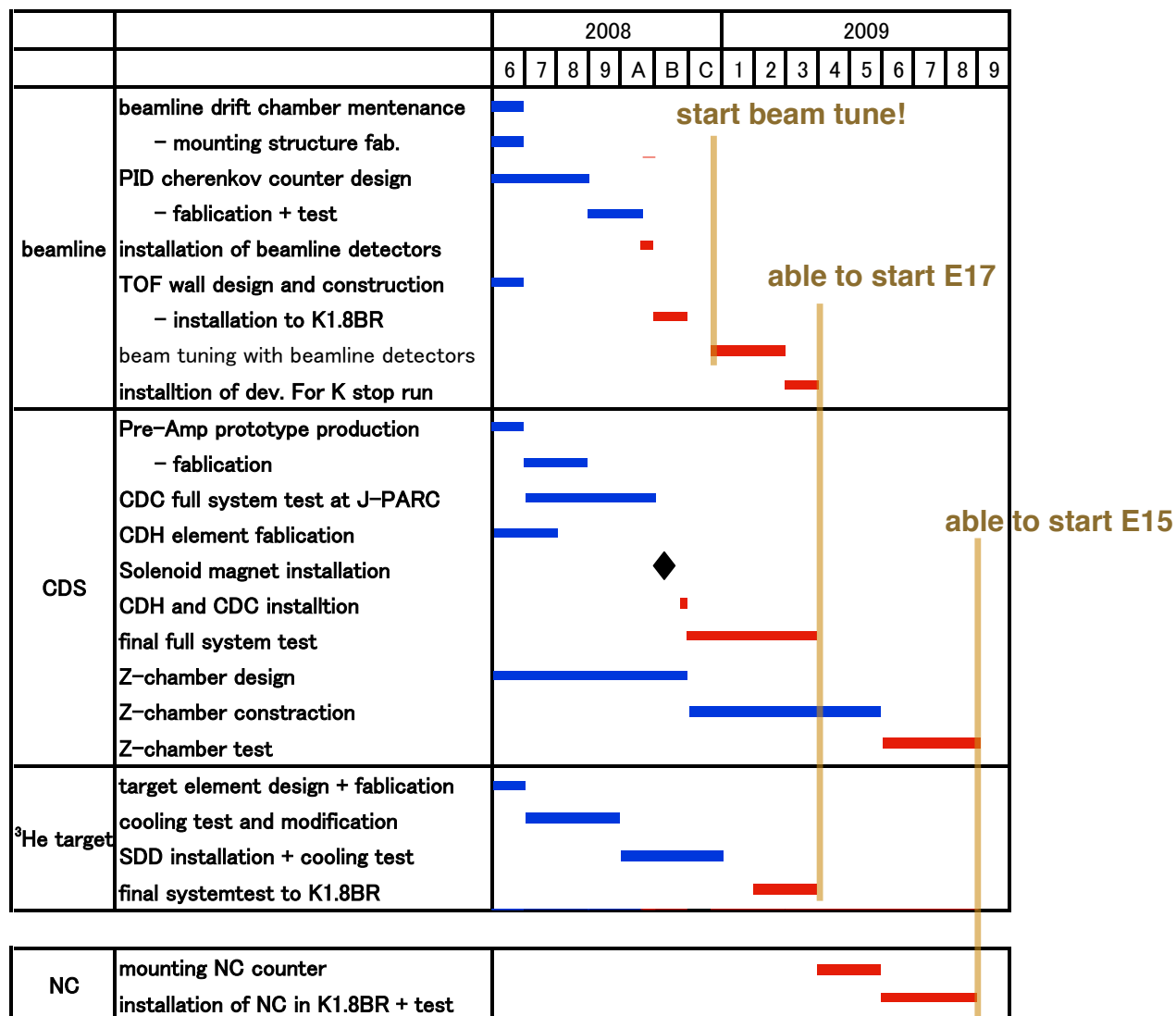
FF-X muon

11:43:53



$\Delta p/p \sim 0.7 \%$  (@  $\Delta\theta \sim 5$  mrad by VM to FF tracking)

# Time table



# Beam tune

most devices are ready  
(from previous exp.  
/ well proven)

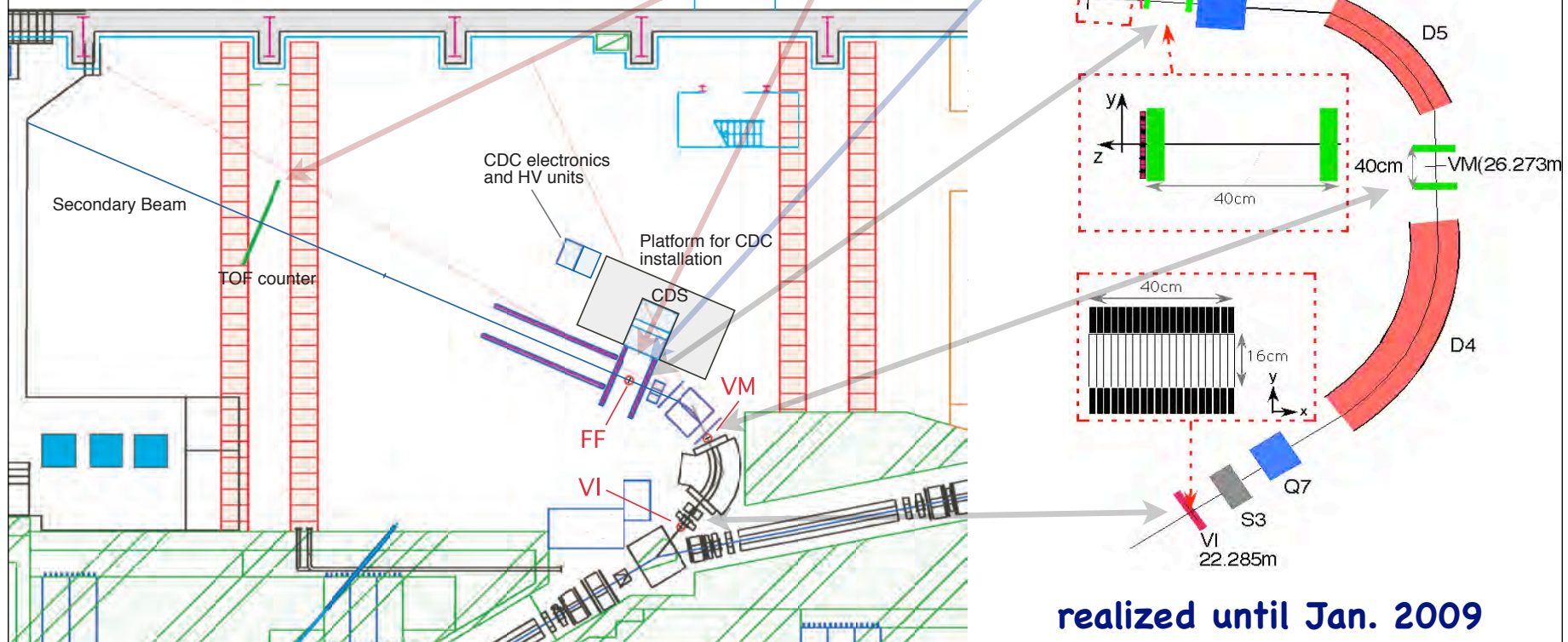
- realize on-line beam tuning by
- based on scaler (hardware)
- beam profile by simple chamber analysis

## TOF

	0.7 GeV/c t (nsec)	1.0 GeV/c t (nsec)
e	50.03	50.03
$\mu$	50.60	50.31
$\pi$	51.03	50.52
K	61.31	55.83
p	84.22	68.74
d	149.18	107.51

## PID by Cherenkov

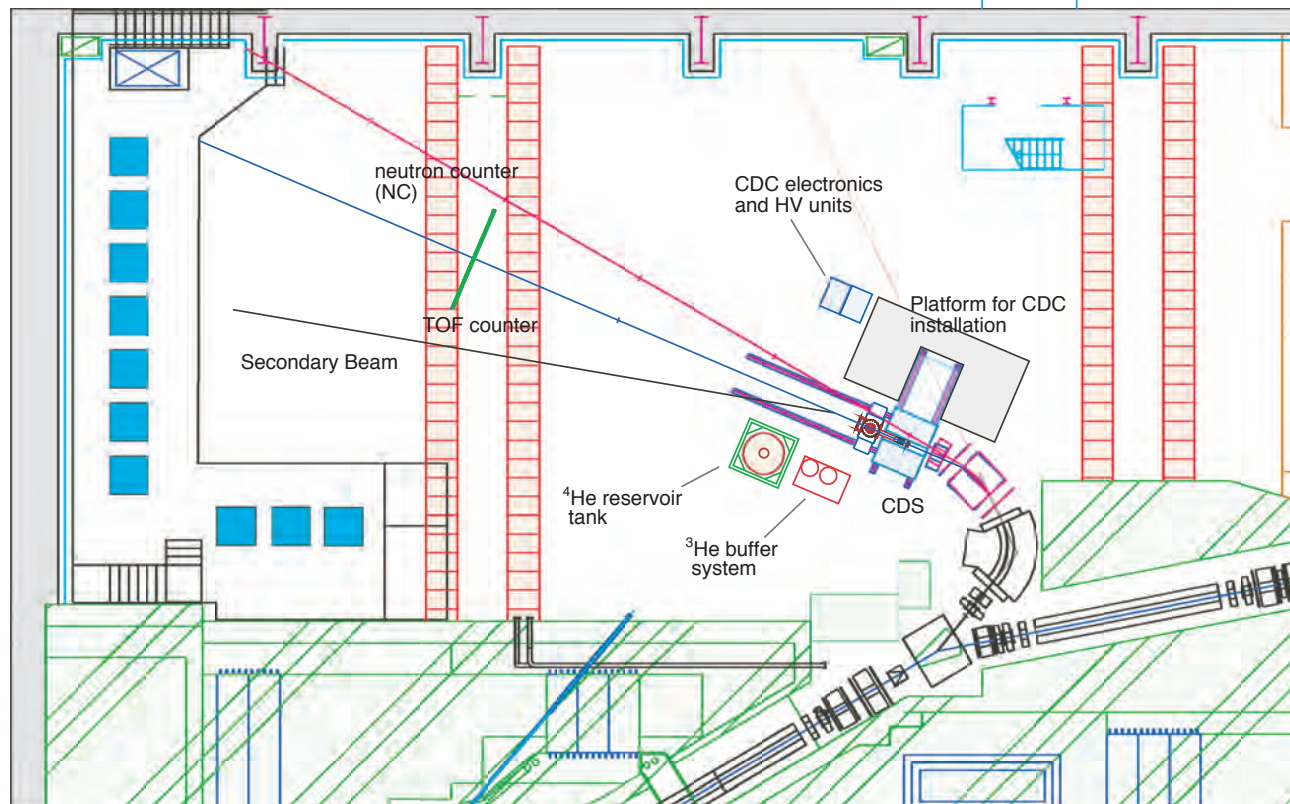
0.7 / 1.0 (GeV/c)	Water (n=1.33)	Aerogel (n=1.05)	Gas (n=1.003?)
e	Y / Y	Y / Y	Y / Y
$\pi$ ( $\mu$ )	Y / Y	Y / Y	N / N
K	Y / Y	N / N	N / N
p	N / N	N / N	N / N





# E17 mode

## target & CDS installation

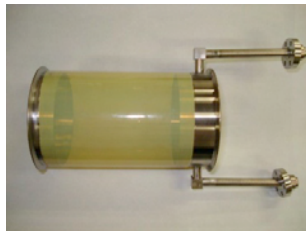
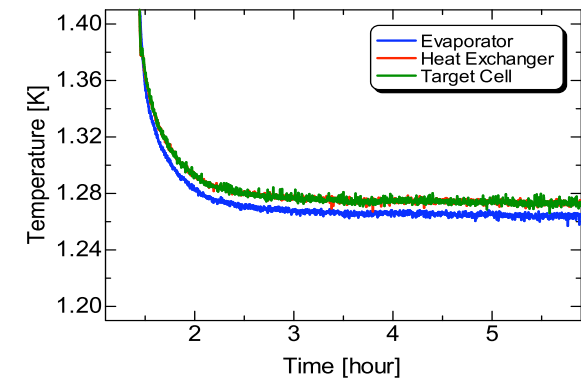
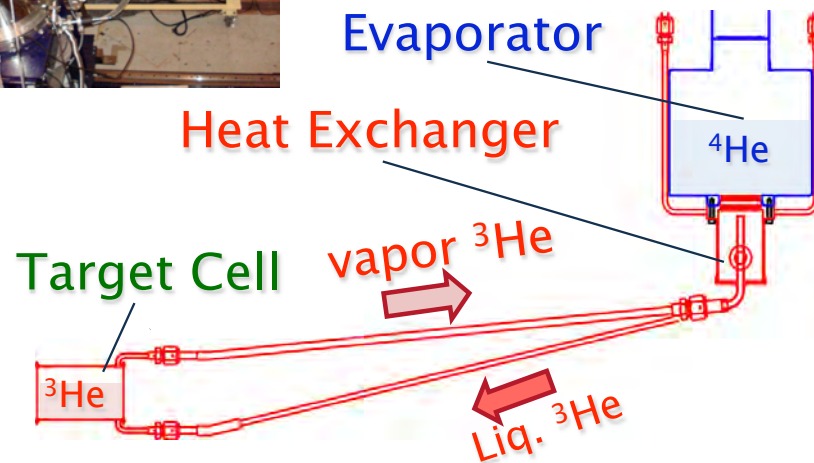


realized until April 2009

# $^3\text{He}$ target is ready

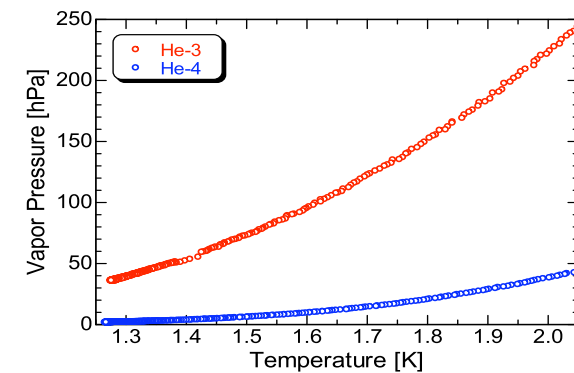


Temperature in the Target Cell	1.3 K
Pressure in the Evaporator	36 hPa
Liq. $^4\text{He}$ Consumption	45 L/day
Heat Load to the 1K Parts	0.19 W

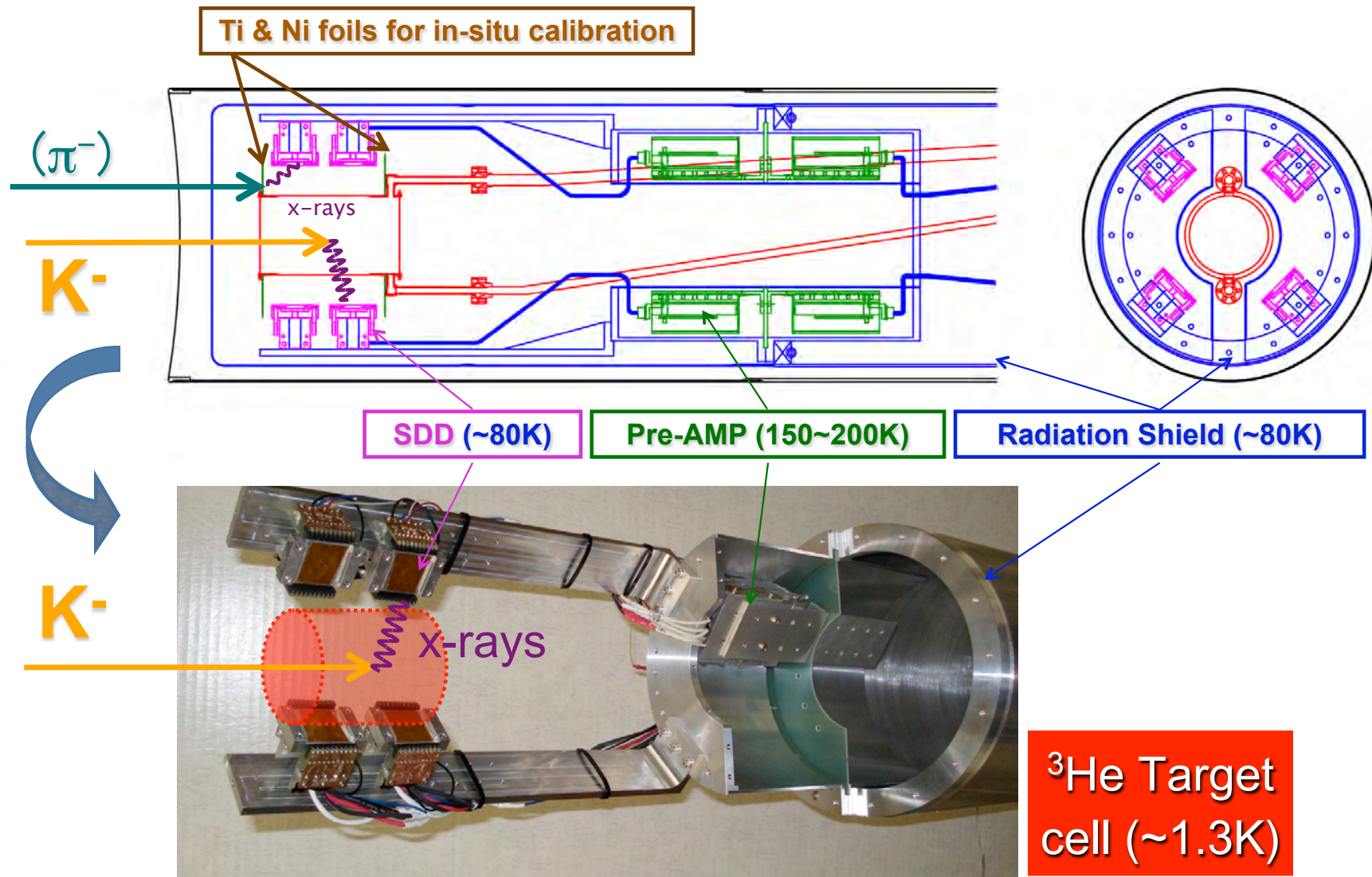


Pressure Tight (>1atm)  
Impurity-free (Fe, Cu,...)  
High Radiolucency @6.3 keV

Frame: Pure Titanium  
Cylinder: MICTRON (para-type aramid film)TORAY



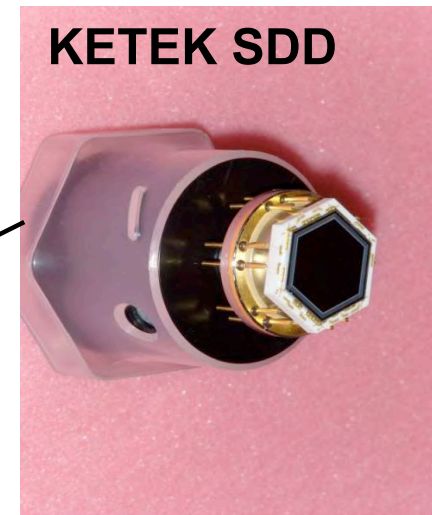
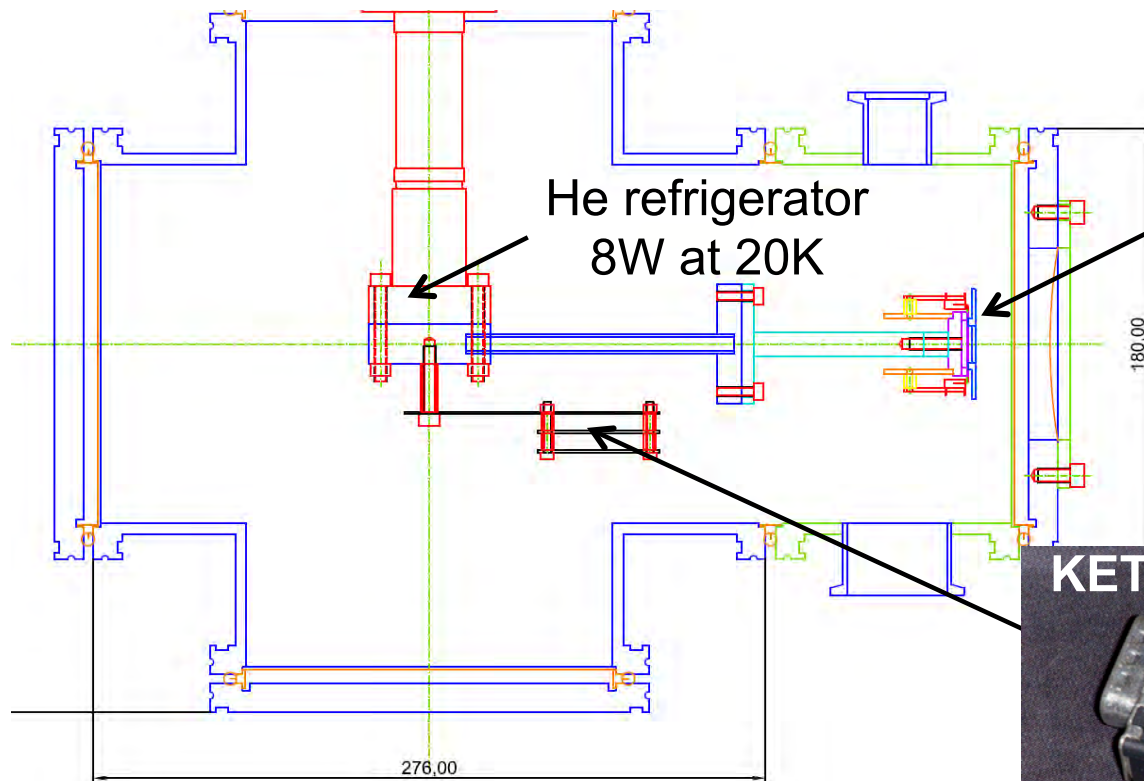
# SDD support work / PreAmp test





# SDD test at SMI

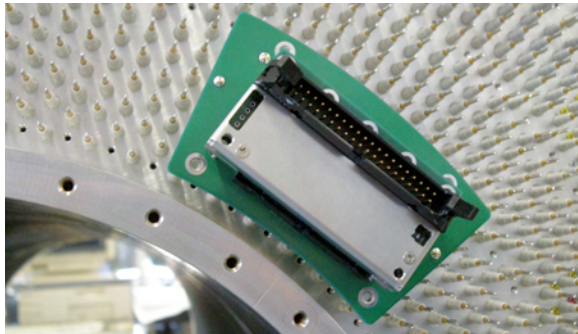
- SDD test of peak stability and energy resolution under 70 ~ 170 K using an  $^{55}\text{Fe}$  source
- pre-amplifier board test in vacuum under 70 ~ 200 K



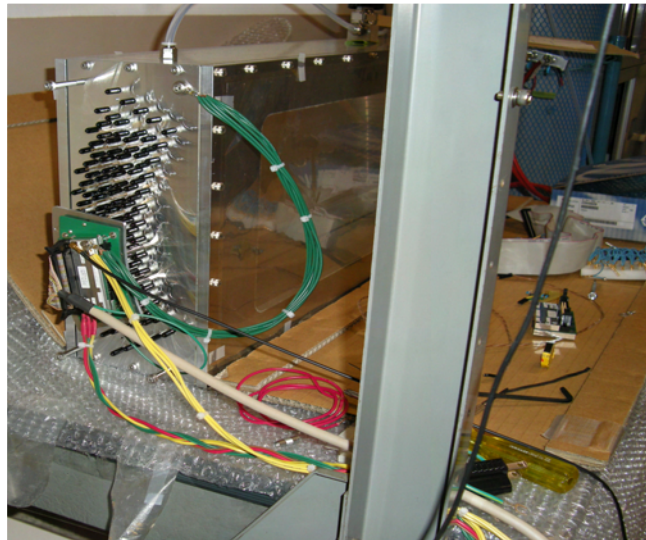
•test bench at SMI (Vienna, Austria)

# CDC status

- PreAmp Discr. board  
test board on April/2008



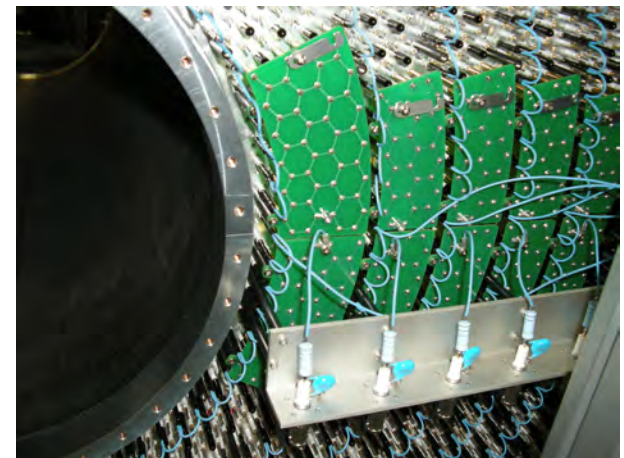
*board on CDC for mounting test*



*board test on proto-type*

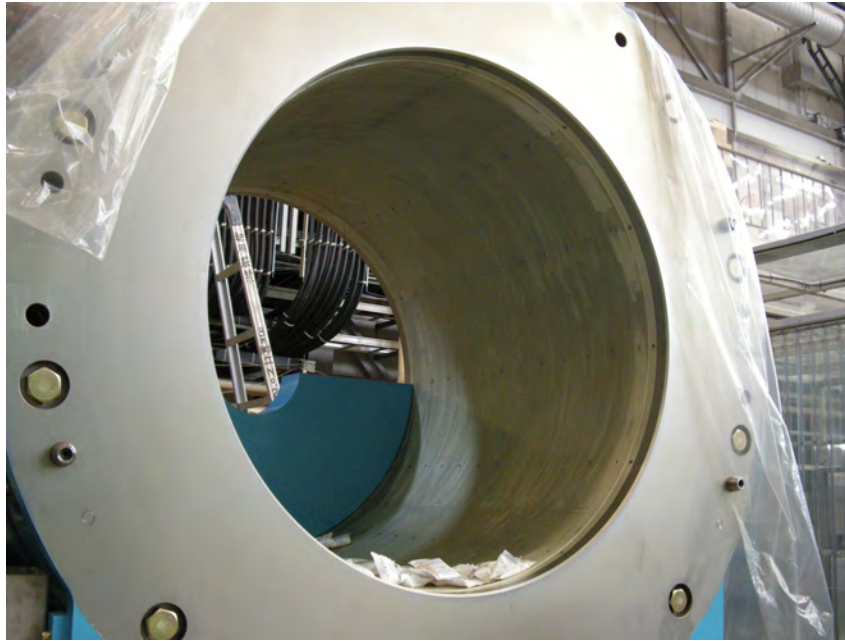
- H.V. circuit board  
completed on Feb/2008

← opposite side →





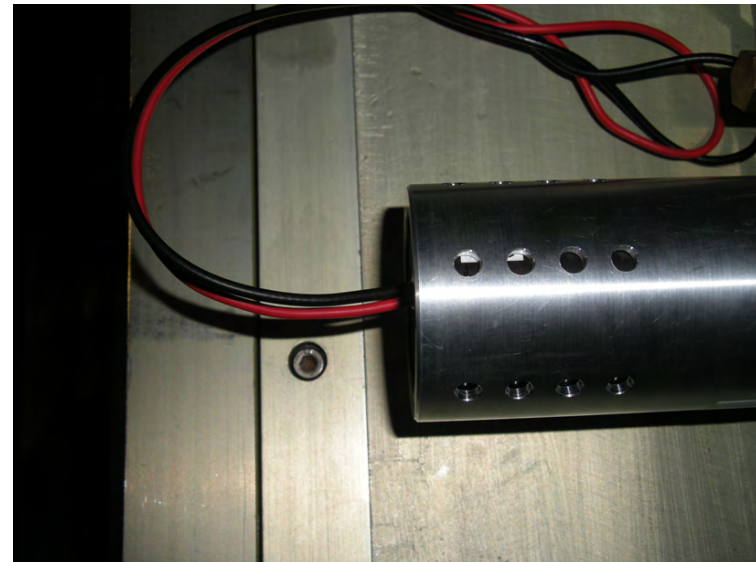
# Solenoid magnet & CDH



CDH/CDC support structure

- design Jul.
- fabrication Aug.

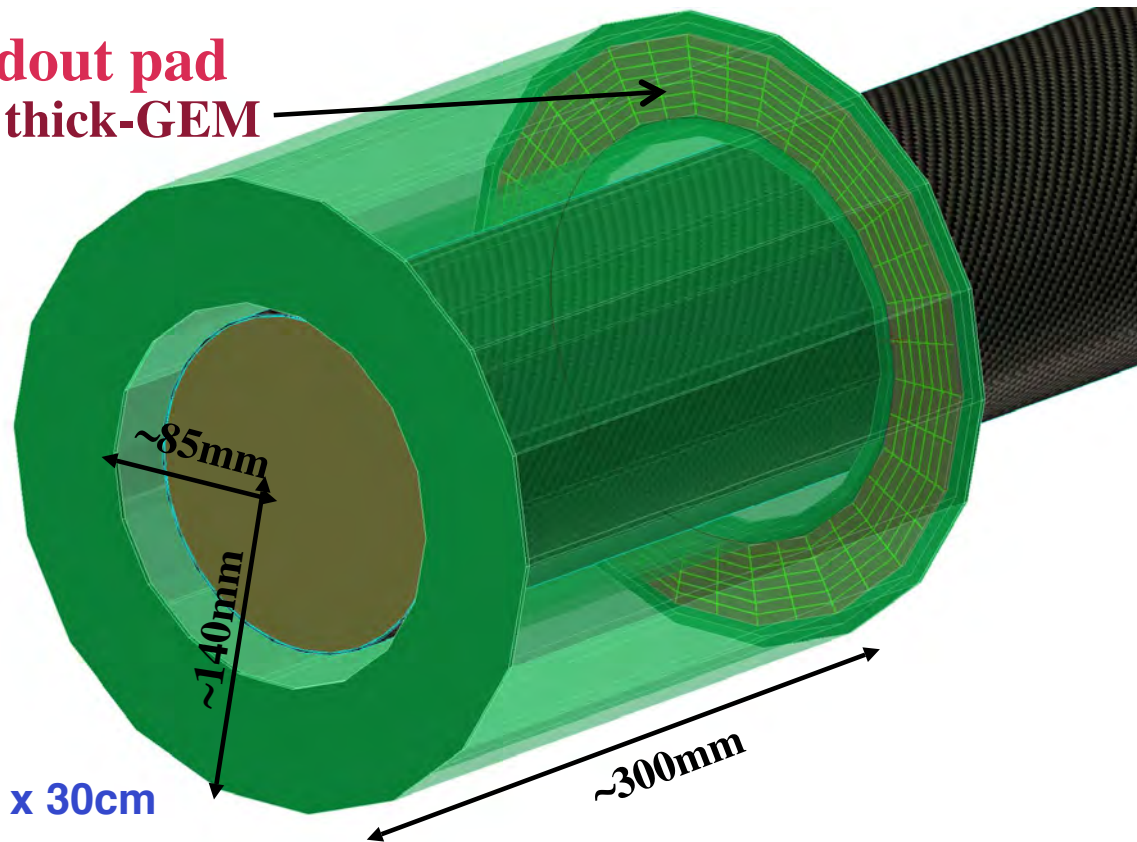
Prototype CDH placed in Solenoid



# ZVC design work

*TPC based z-vertex chamber (ZVC)*

**GEM and readout pad**  
**double stage thick-GEM**



HV : 6.5kV

drift: 150V/cm(P10) x 30cm

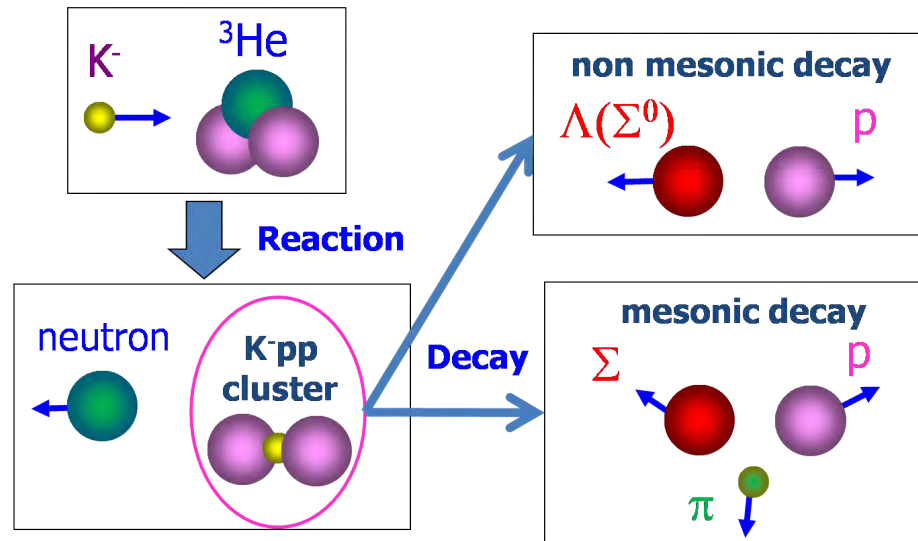
amp: + 2kV(GEM)

read-out : 36 ch x 3 layer = 108 ch

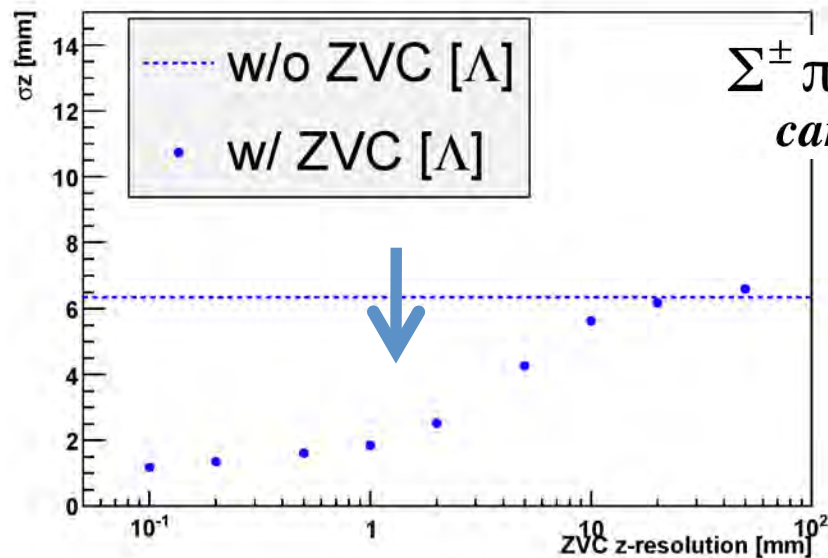
acceptable hit rate few kHz/spill



# mesonic decay mode



ZVC (z-chamber) allows  $\Sigma$ -ID!

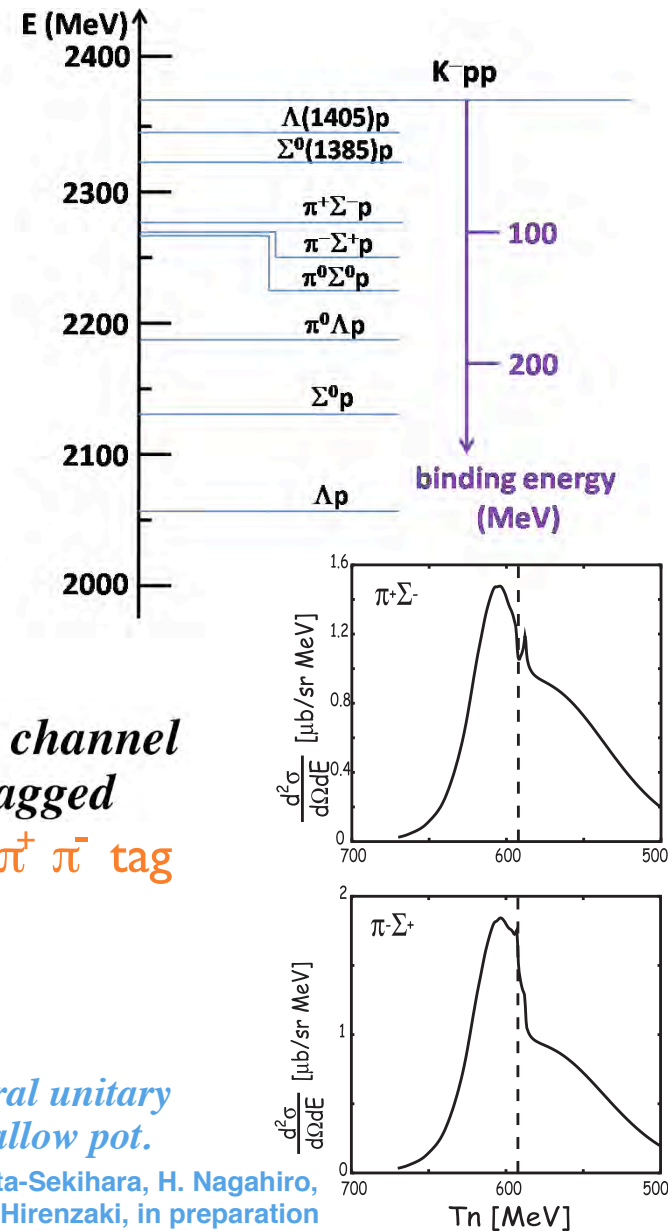


$\Sigma^\pm \pi^\mp p$  decay channel  
can also be tagged

by  $\pi^+ \pi^-$  tag

Chiral unitary  
shallow pot.

J. Yamagata-Sekihara, H. Nagahiro,  
D. Jido, S. Hirenzaki, in preparation



# Summary

... to be ready for the first DC beam ...

- realize E17 & E15 as cascade exp. at K1.8BR

  - KN interaction : need to be studied!

  - clarify the situation of deeply bound kaonic state

    - most of the theory at present give bound state  
width will be as wide as  $> 30$  MeV

  - E17 need a longer beam time for beam line extension

- utilize well proven device / circuit

  - device from previous exp.  
proven circuit ... TKO based UNIDAQ

- both E17/E15 preparation is in good shape

  - target date : April 2009! cf. previously : Sep. 2009

# *updated E15/E17 member list*

Shuhei Ajimura <sup>1</sup>, George Beer <sup>2</sup>, Hyoungchan Bhang <sup>3</sup>, Paul Buehler <sup>4</sup>, Luigi Busso <sup>5,6</sup>,  
Michael Cargnelli <sup>4</sup>, Junsei Chiba <sup>7</sup>, Seonho Choi <sup>3</sup>, Catalina Curceanu <sup>8</sup>,  
Diego Faso <sup>5,6</sup>, Hiroyuki Fujioka <sup>9</sup>, Yuya Fujiwara <sup>10</sup>, Tomokazu Fukuda <sup>11</sup>,  
Carlo Guaraldo <sup>8</sup>, Ryugo S Hayano <sup>12</sup>, Toshihiko Hiraiwa <sup>13</sup>, Albert Hirtl <sup>4</sup>, Masami Iio <sup>9</sup>,  
Mihai Iliescu <sup>8</sup>, Takashi Ishikawa <sup>12</sup>, Shigeru Ishimoto <sup>14</sup>, Tomoichi Ishiwatari <sup>4</sup>, Kenta Itahashi <sup>9</sup>,  
Masaaki Iwai <sup>14</sup>, Masahiko Iwasaki <sup>9,10</sup>, Bertalan Juhasz <sup>4</sup>, Paul Kienle <sup>4,15</sup>, Johann Marton <sup>4</sup>,  
Yasuyuki Matsuda <sup>12</sup>, Yutaka Mizoi <sup>10</sup>, Ombretta Morra <sup>5,16</sup>, Tomofumi Nagae <sup>13</sup>,  
Hiroyuki Noumi <sup>1</sup>, Hiroaki Ohnishi <sup>9</sup>, Shinji Okada <sup>8</sup>, Haruhiko Ota <sup>9</sup>,  
Dorel Pietreanu <sup>8</sup>, Atsushi Sakaguchi <sup>17</sup>, Fuminori Sakuma <sup>9</sup>, Masaharu Sato <sup>9</sup>,  
Michiko Sekimoto <sup>14</sup>, Diana Sirghi <sup>8</sup>, Florin Sirghi <sup>8</sup>, Philipp Schmid <sup>4</sup>, Shoji Suzuki <sup>14</sup>,  
Takatoshi Suzuki <sup>12</sup>, Hideyuki Tatsuno <sup>12</sup>, Makoto Tokuda <sup>10</sup>, Dai Tomono <sup>9</sup>, Akihisa Toyoda <sup>14</sup>,  
Kyo Tsukada <sup>9</sup>, Ebarhard Widmann <sup>4</sup>, Toshimitsu Yamazaki <sup>9,12</sup>, Heejoong Yim <sup>3</sup>, Johannes Zmeskal <sup>4</sup>

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<sup>5</sup>INFN Sezione di Torino, Italy

<sup>6</sup>Università di Torino, Italy

<sup>7</sup>Tokyo University of Science, Japan

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<sup>10</sup>Tokyo Institute of Technology, Japan

<sup>11</sup>Osaka Electro-Communication University, Japan

<sup>12</sup>University of Tokyo, Japan

<sup>13</sup>Kyoto University, Japan

<sup>14</sup>High Energy Accelerator Research Organization (KEK), Japan

<sup>15</sup>Technische Universität München, Germany

<sup>16</sup>INAF-IFSI, Sezione di Torino, Italy

<sup>17</sup>Osaka University, Japan

# unfixed

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- **long beam time at full intensity (as requested)**  
*beam scheduling with other experiments at K1.8*
- **time sharing of sweeping magnet (KURAMA)**  
*scheduling with other experiments at K1.8*  
*(GC availability: negotiation with SKS group)*
- **D5 (18D48 from SLAC) maintenance**  
*need a commitment from beam channel group*
- **liquid helium retrieval line and re-liquify system**  
*need further discussion*
- **$^3\text{He}(\text{K}^-, \text{p})$  spectroscopy?**  
*need further work*

**Thank you!**