Study of Kaonic nuclear bound system and Λ(1405) at J-PARC K1.8BR

Shun ENOMOTO

RCNP, Osaka Univ.

For J-PARC E15 & E31 collaboration

Snp12 @ Osaka Electro. Univ.
Aug. 27, 2012

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- **J-PARC E15 & E31 experiment**
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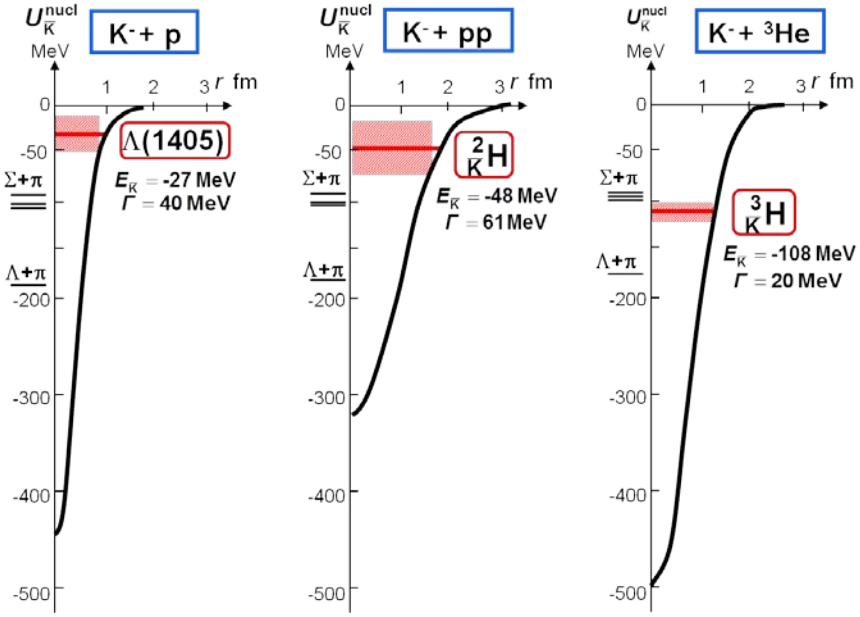
Introduction

✔Dose the simplest Kaonic nuclei “K-pp” exist?

✔How much deeply bound ?

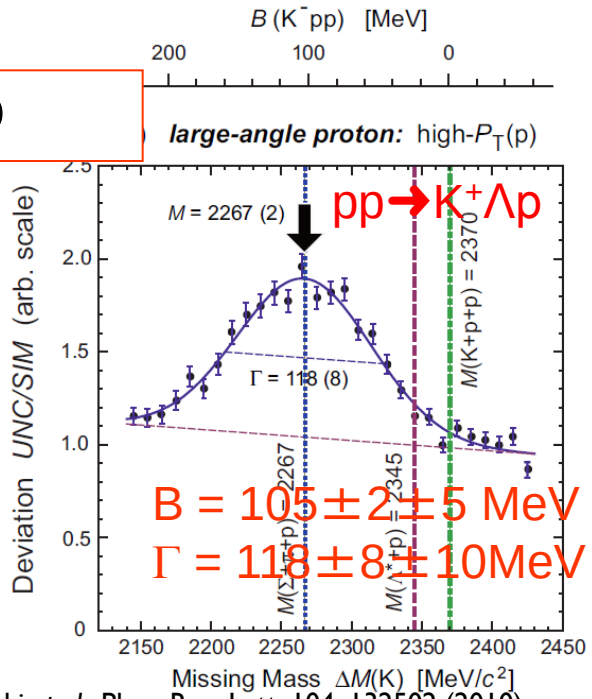
✔Λ(1405): deeply bound KbarN state or not ?



Y. Akaishi & T. Yamazaki, Phys. Rev. C65 (2002) 044005.

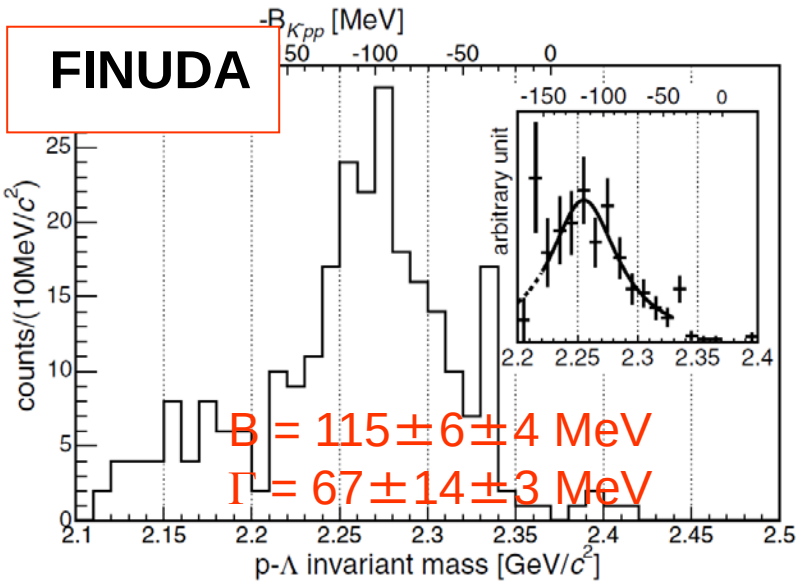
Y. Akaishi & T. Yamazaki, Phys. Lett. B535 (2002) 70.

DISTO



T. Yamazaki *et al.*, Phys. Rev. Lett. 104, 132502 (2010)

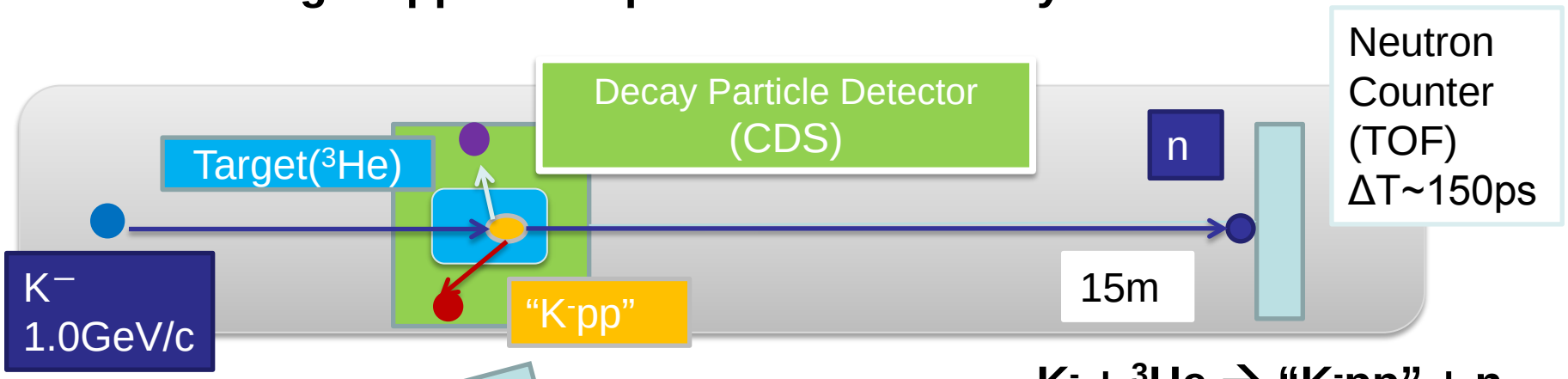
FINUDA

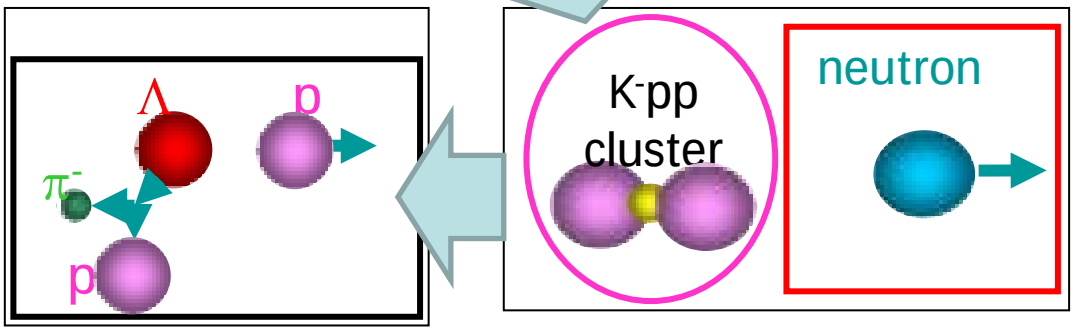


M.Agnello *et al.* , PRL 94, 212303 (2005)

J-PARC E15 Experiment

- **Search for K^-pp bound state by using In-flight $^3He(K^-,n)$ Reaction**
- **Measuring "K^-pp" from production to decay .**

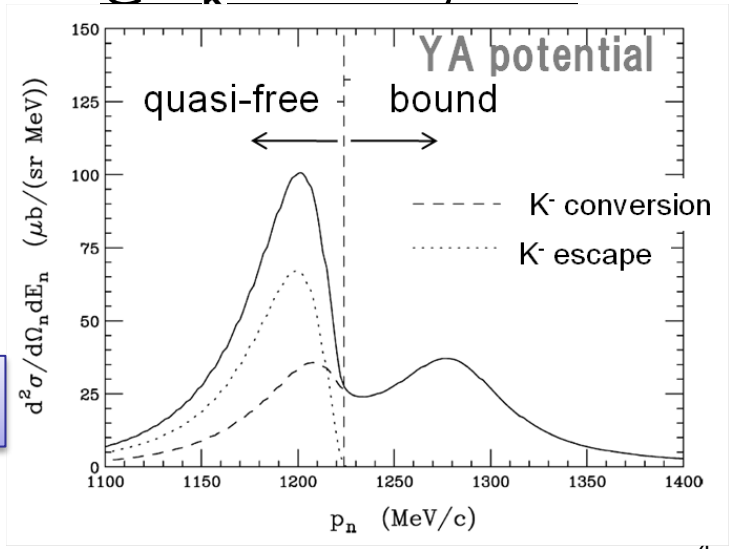




Invariant mass of Decay particles (Λ+p)

Missing-Mass of neutron

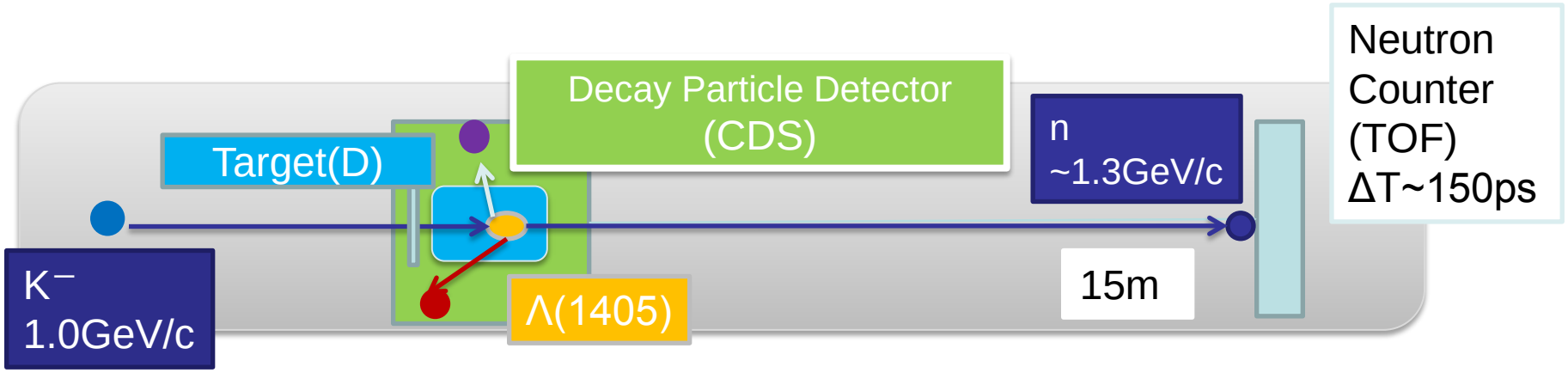
$K^- + {}^3He \rightarrow$ "K^-pp" + n
@ P_K=1GeV/c, θ=0°



T.Koike and T.Harada. , PLB652 (2007) 262

J-PARC E31 Experiments

Spectroscopic study of Hyperon Resonances below KbarN threshold via the (K^-,n) reaction on Deuteron.

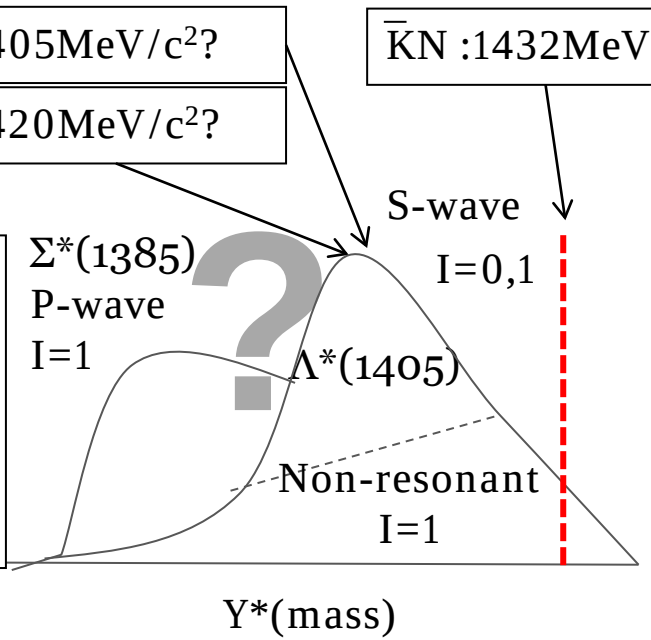


Purely I=0

Λ(1405) and BG(NR/∑*)

- S-wave,I=0

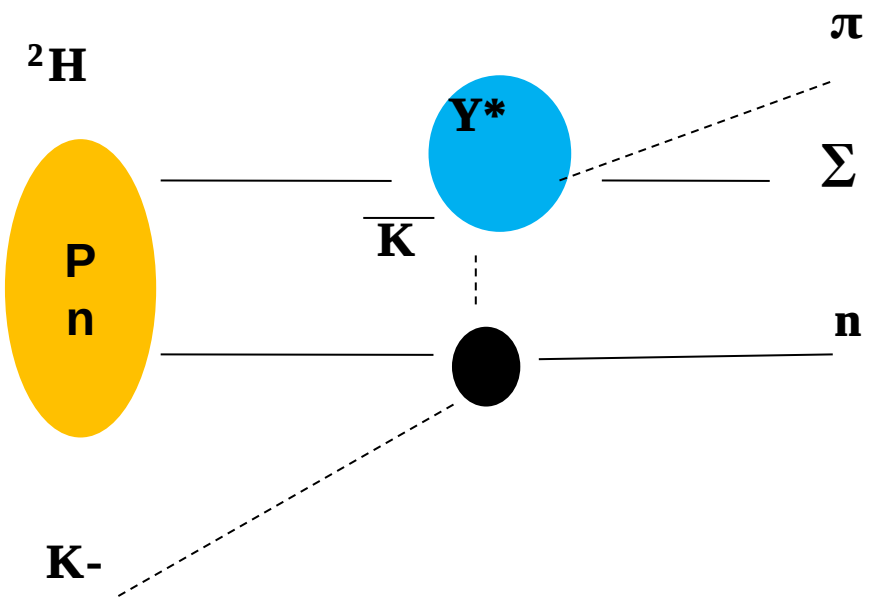
- **Possible ID of I=0 in KbarN→π∑**
- **Possible decomposition of I=0 amplitude.**



J-PARC E31 [the(K-,n) reaction on Deuteron.]

Motivation

・To clarify whether Λ(1405) is KbarN resonant state.

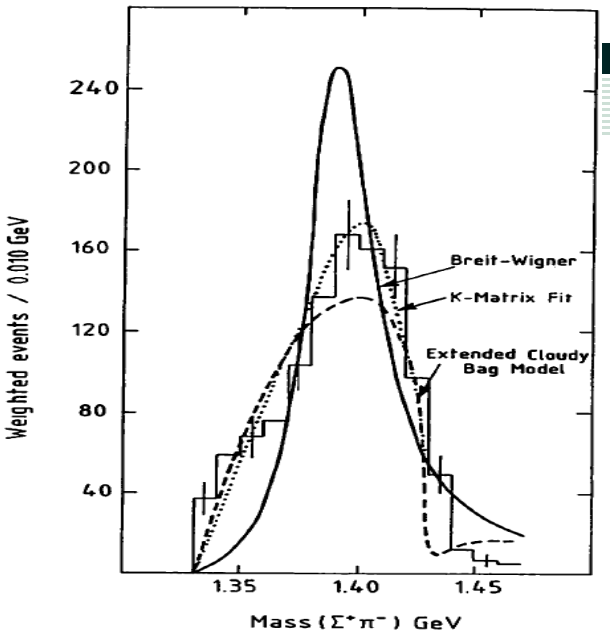


d(K-,n) reaction is KbarN direct reaction.

J-PARC E31 experiment

1406.5MeV/c^2

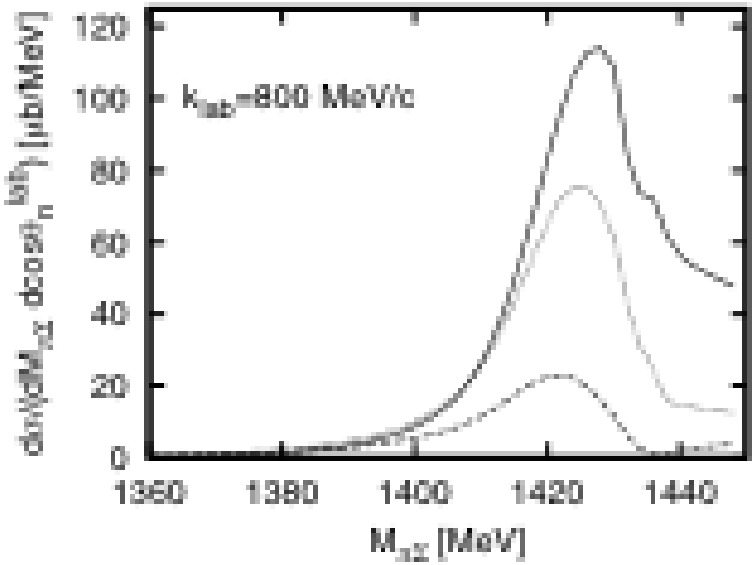
R. J. Hemingway, Nucl. Phys. B 253, 742 (1985)



1420MeV/c^2

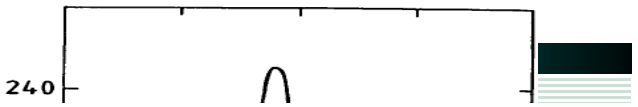
Chiral Unitary Model predicted.

- D.Jido, A.Oller, E. Oset A.Ramos, and –G. Meissner, Nuclear Physics A 725, 181-200, 2003
- D. jido, E. Oset and T. Sekihara, Eur. Phys. J A42(2009) 257



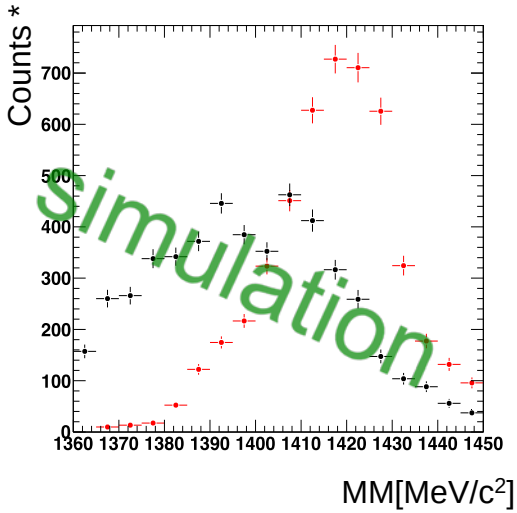
D. Jido et al, EPJA42('09)257

J-PARC E31 experiment

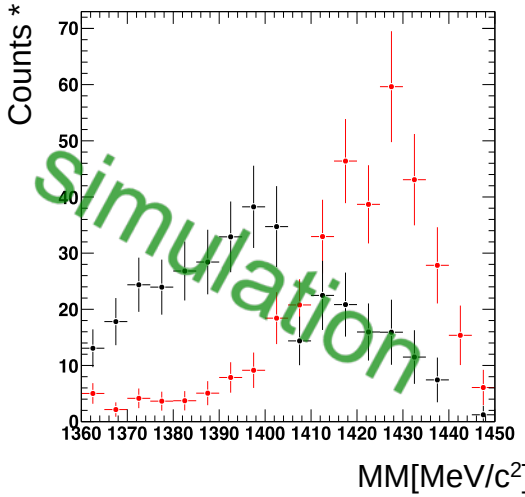


Expected missing mass spectra

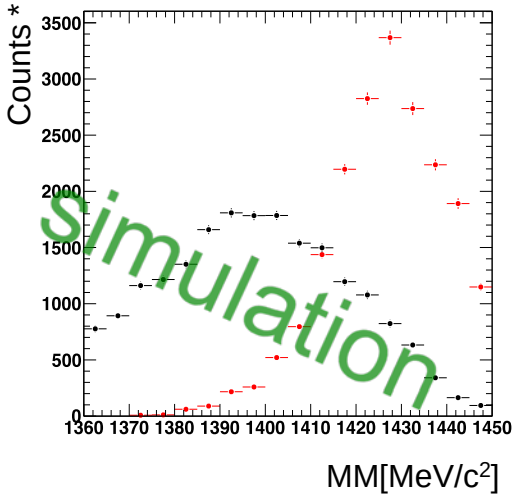
$\pi^-\Sigma^+$ decay mode



$\pi^0\Sigma^0$ decay mode



$\pi^+\Sigma^-$ decay mode



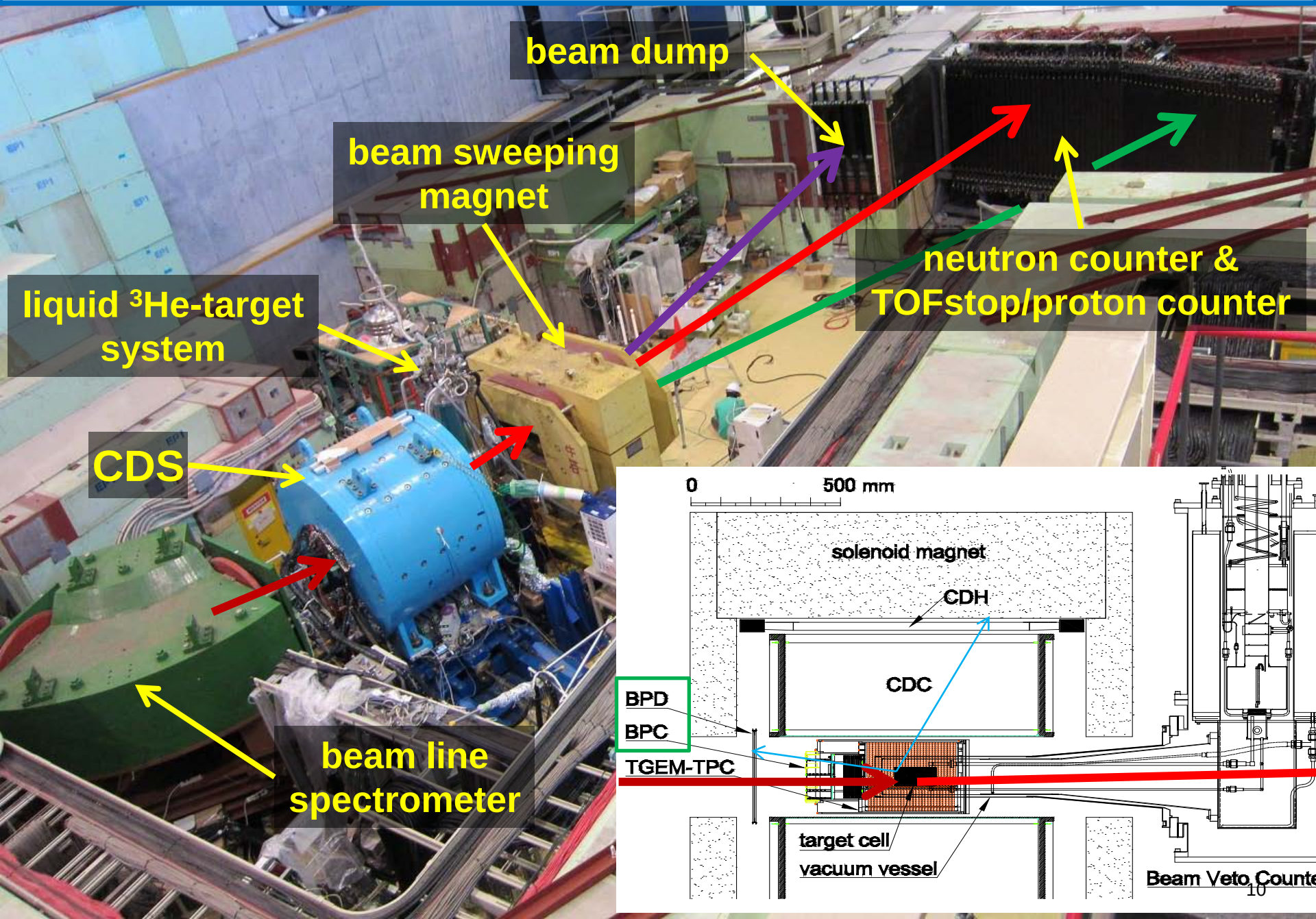
$$MM_X = \sqrt{(\vec{P}_K + \vec{P}_d - \vec{P}_n)^2}$$

Calculated by **chiral unitary model [1]** / **data [2]**.

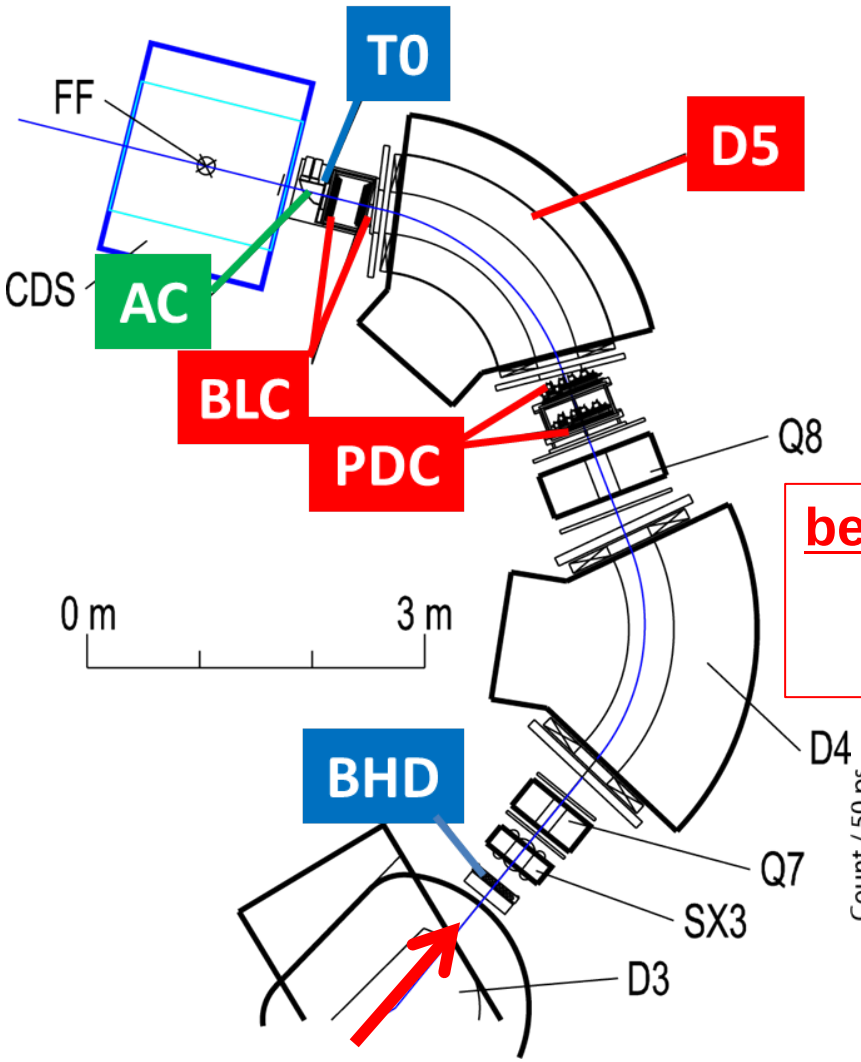
[1]D. jido, E. Oset and T. Sekihara, Eur. Phys. J A42(2009) 257
[2]R. J. Hemingway, Nucl. Phys. B 253, 742 (1985)

Status of J-PARC E15 / E31

the completed K1.8BR spectrometer [Jun. 2012]



Kaon Beam Spectrometer



beam trigger: BHD & T0

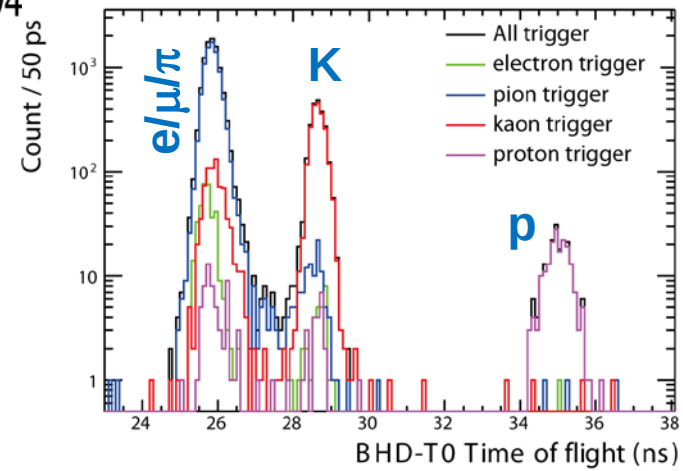
- ✓ plastic scintillator arrays
- ✓ TOF length (BHD-TO) = 7.7m
- ✓ $\sigma(TOF_{BHD\text{-}T0})$ = 160ps

kaon identification at trigger level: AC

- ✓ mirror reflection type aerogel Cherenkov counter (index = 1.05)
- ✓ π detection eff. = 96% (th=5p.e.)

beam momentum: D5 & PDC & BLC

- ✓ dipole and wire drift chambers
- ✓ expected momentum resolution = 0.1%



TOF(BHD-T0)

- **Run#40**
- **+1.0 GeV/*c***
- **ESS1 = +/-250kV**

Cylindrical Detector System (CDS)

solenoid magnet

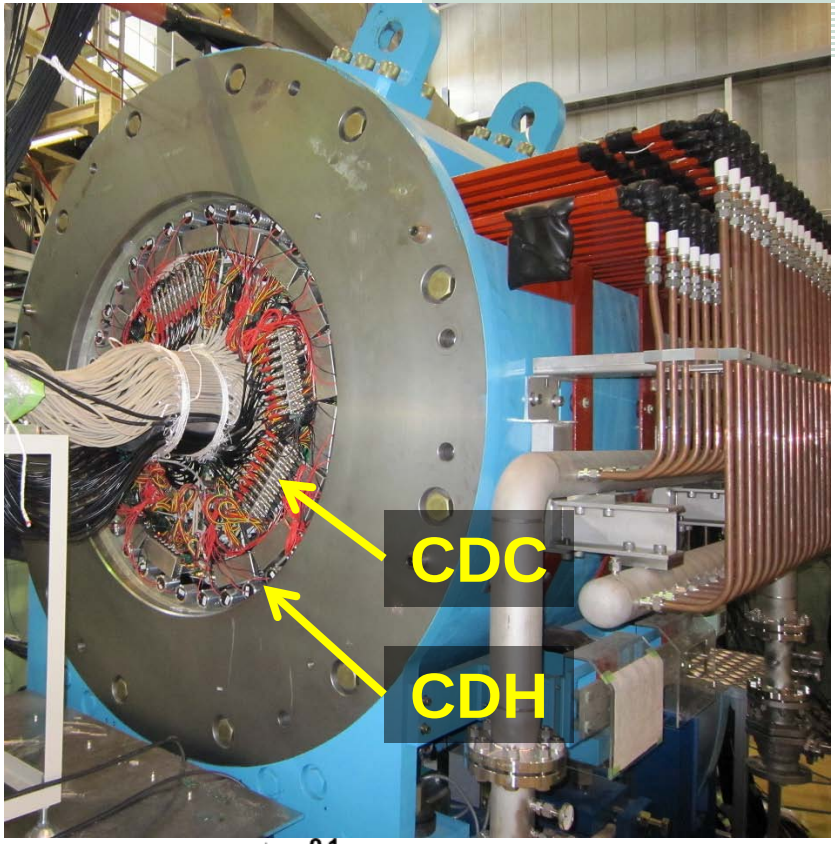
- ✓bore ϕ1.18m, length 1.17m
- ✓0.7T operation

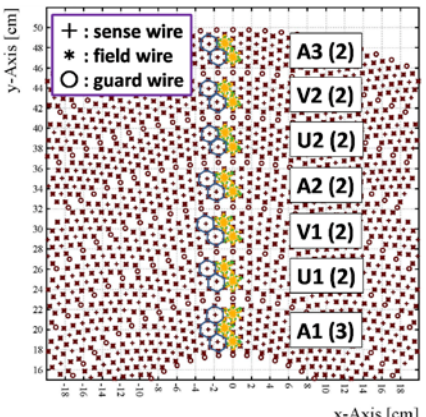
CDH (Cylindrical Detector Hodoscope)

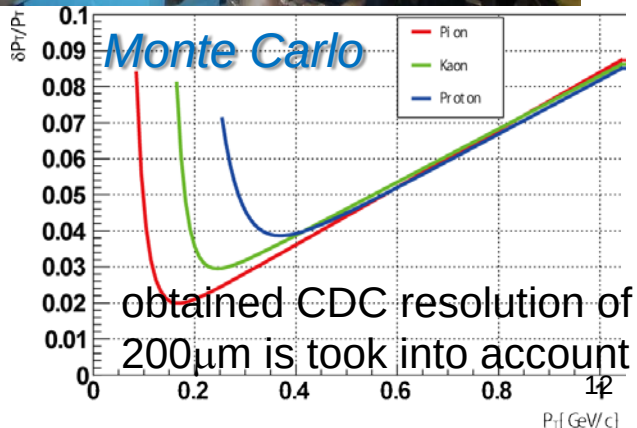
- ✓36 plastic scintillators
- ✓FM-PMTs
- ✓$\sigma(TOF_{T0\text{-}CDH})$ = 160ps

CDC (Cylindrical Drift Chamber)

- ✓wire drift chamber
- ✓15 layers, 1816ch
- ✓solid angle = 2.6π
- ✓gas = Ar:C_2H_6/50:50





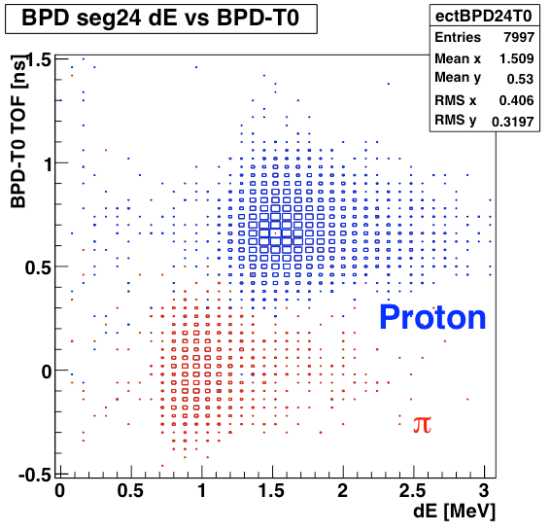


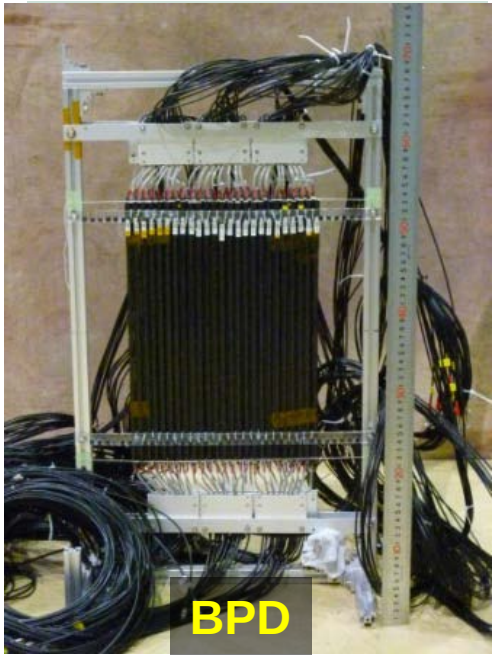
obtained CDC resolution of 200μm is took into account

Backward Proton Detector (BPD & BPC)

BPD (Backward Proton Detector)

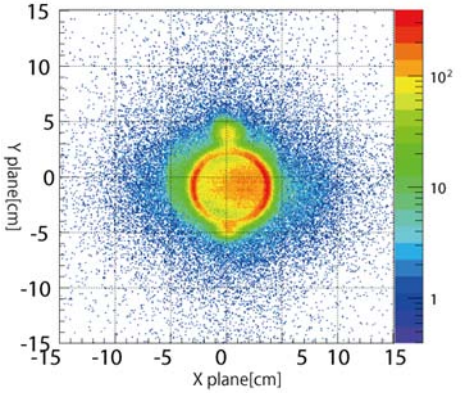
- ✓70 plastic scintillators
- ✓MPPC
- ✓$\sigma(TOF_{T0\text{-}BPD})$ = 160ps



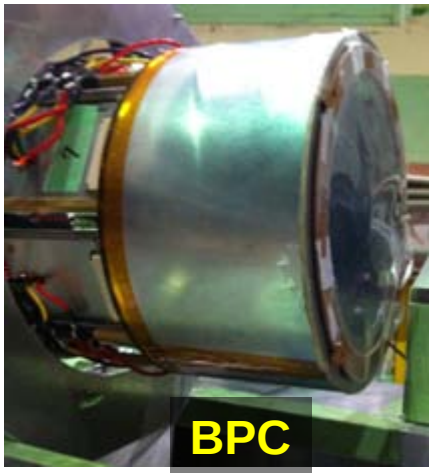


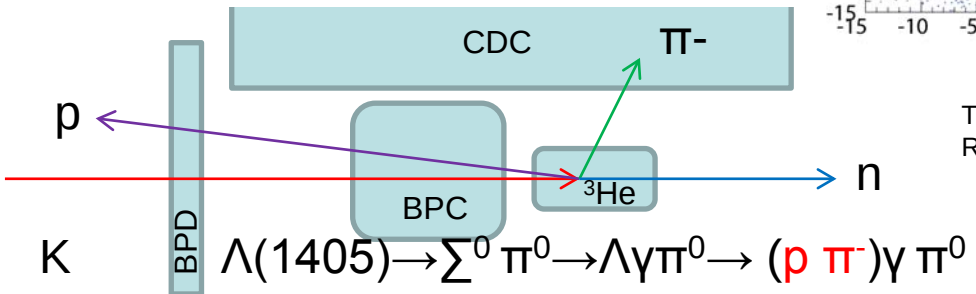
BPC (Backward Proton Chamber)

- ✓wire drift chamber
- ✓8 layers
- ✓@ upstream of Target.

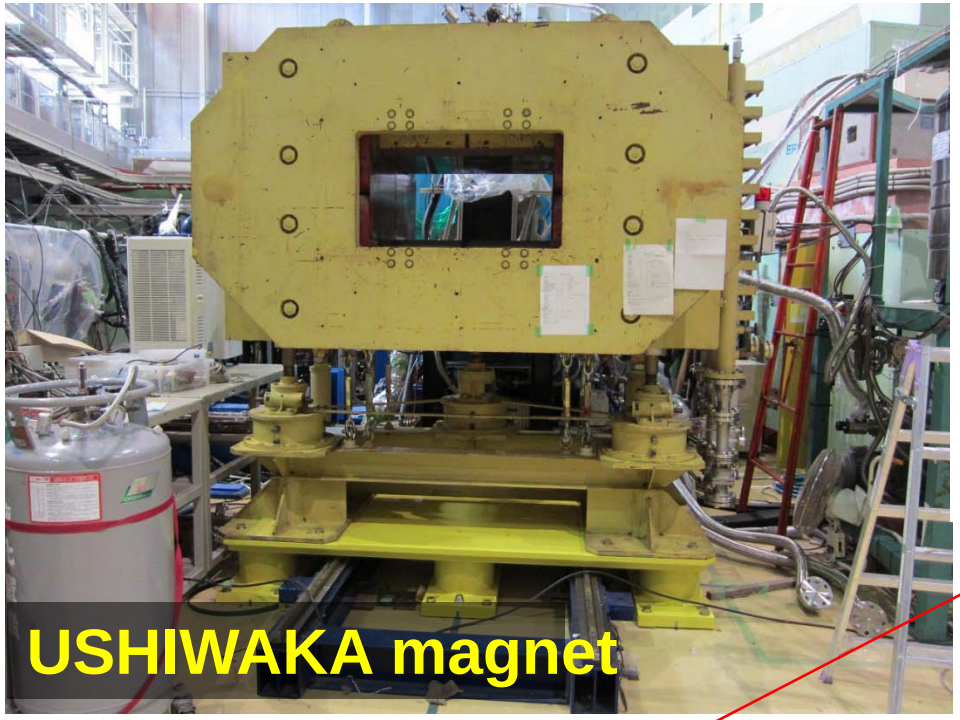


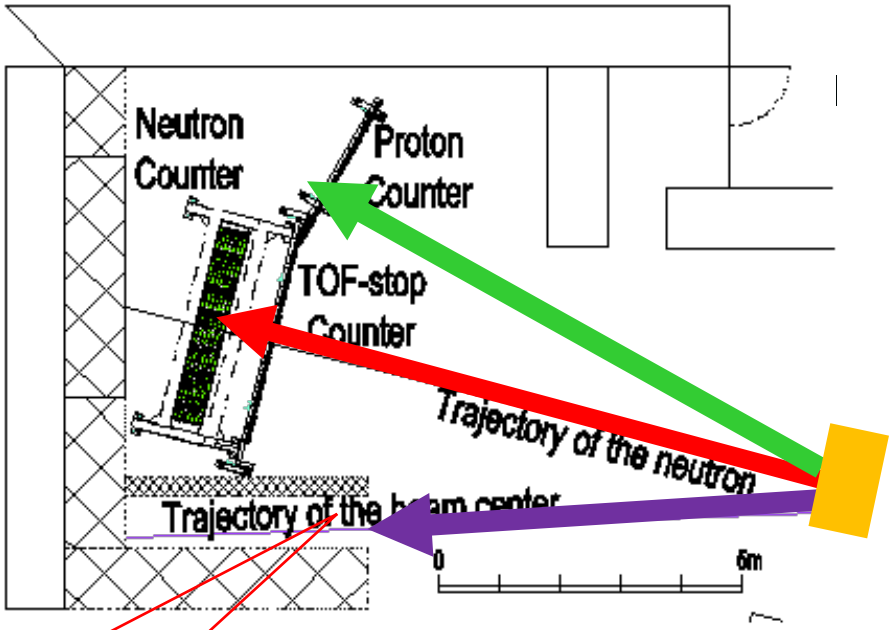
Target image
Request CDHhit

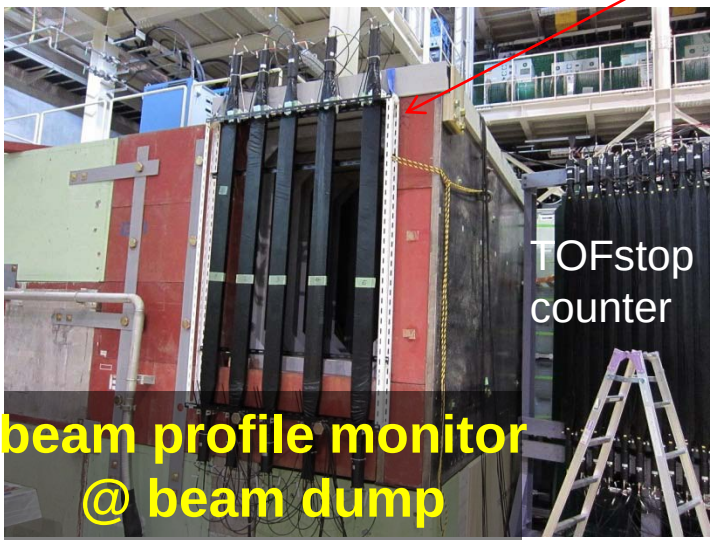


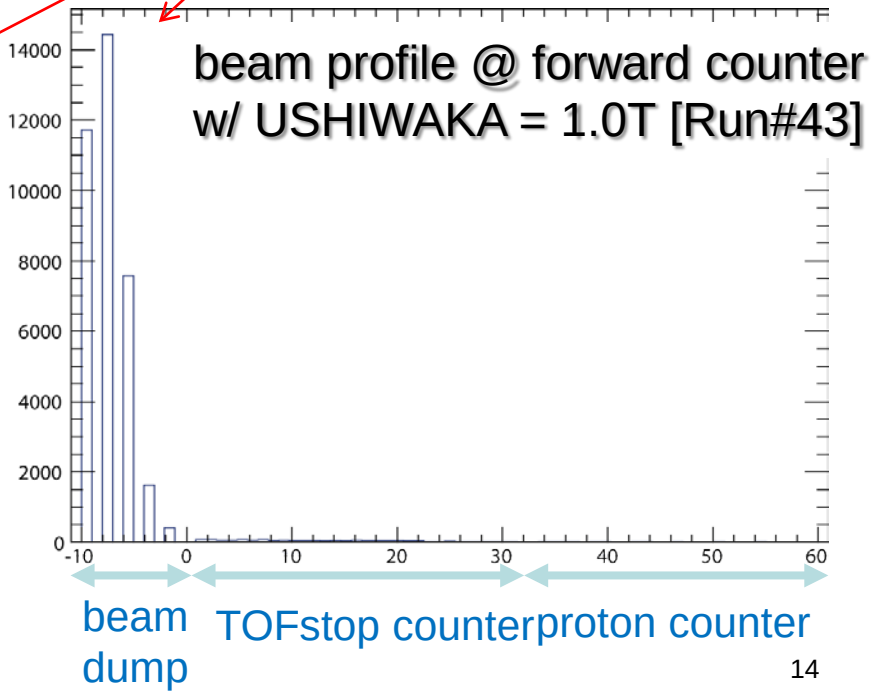


Beam Sweeping Magnet









Neutron Counter

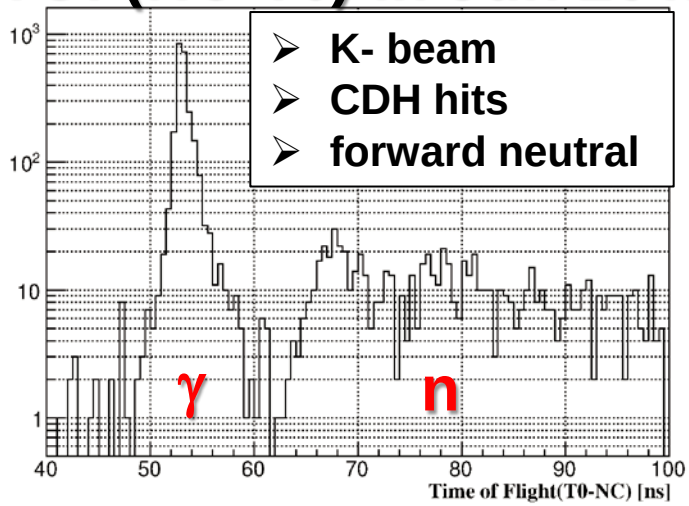
Neutron counter

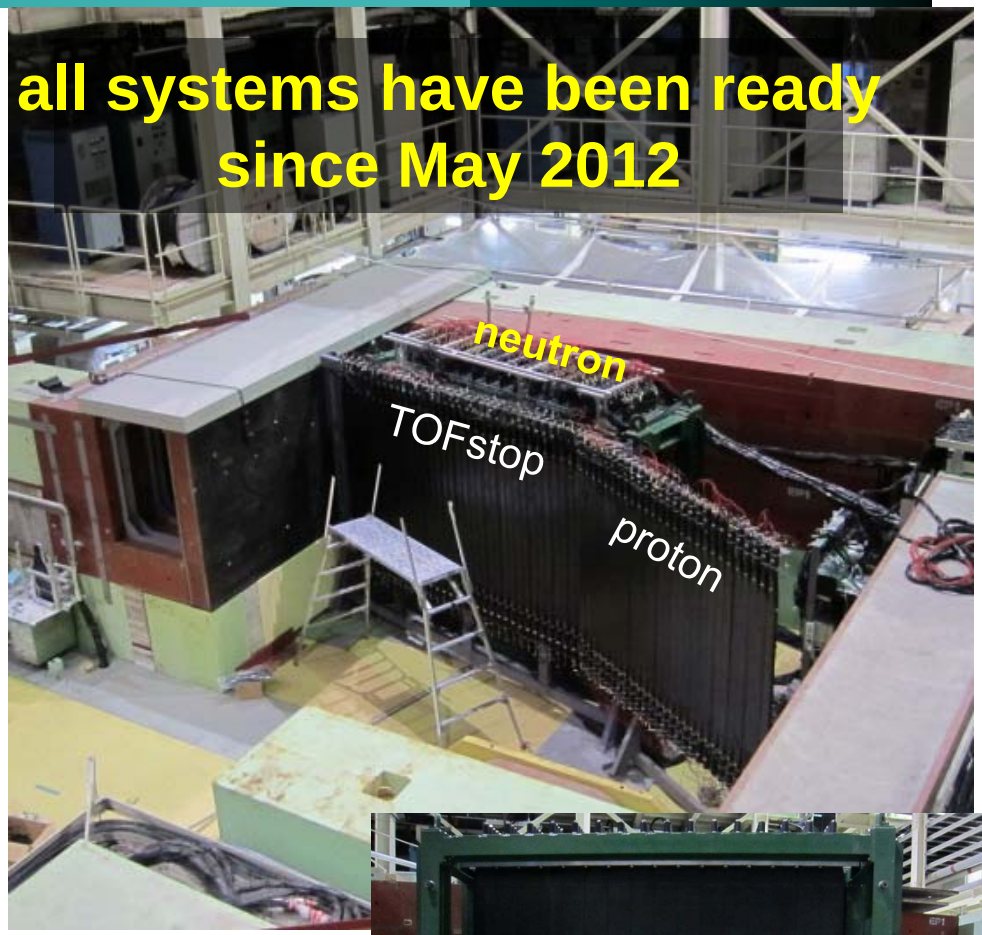
- ✓plastic scintillator array
- ✓16 segments * 7 layers
  [320(w)*150(h)*35(d)cm]

TOFstop / proton counter

- ✓plastic scintillators
- ✓32+27 segments

TOF(NC-T0) in Jun 2012





neutral particles (γ & n) have been successfully detected and identified by the NC

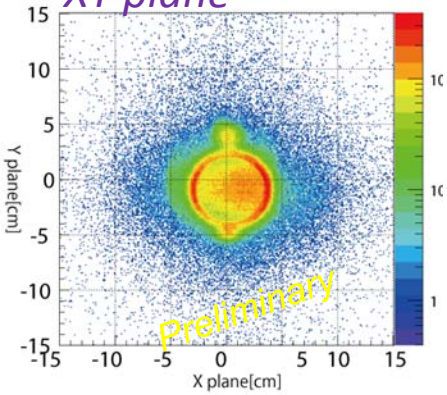
Analysis Status
Engineering run

CDS Performances

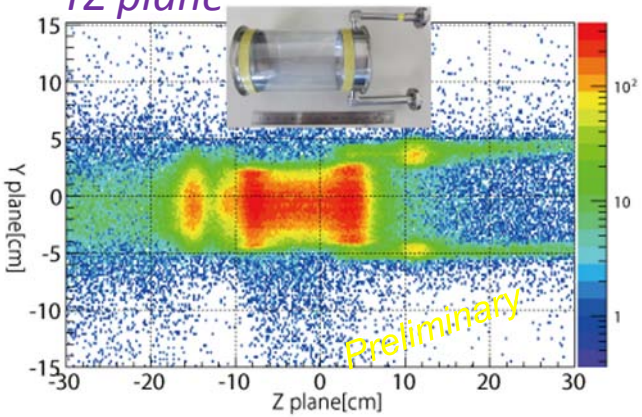
event vertex

Liquid ^{4}He(run#40)/ ^{3}He(run#43) inside

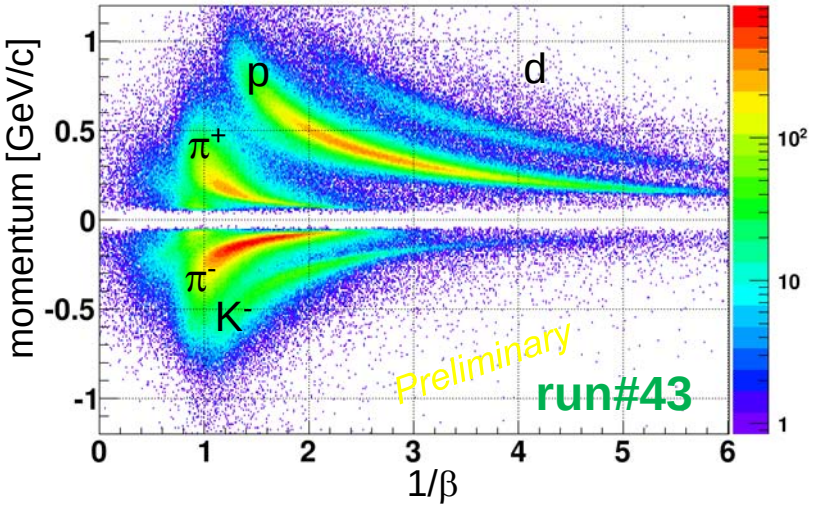
XY plane



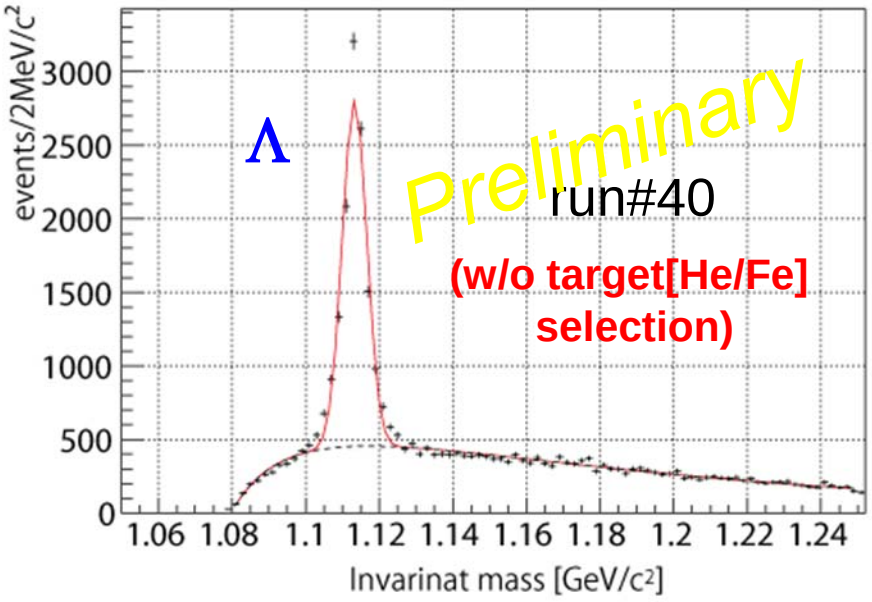
YZ plane



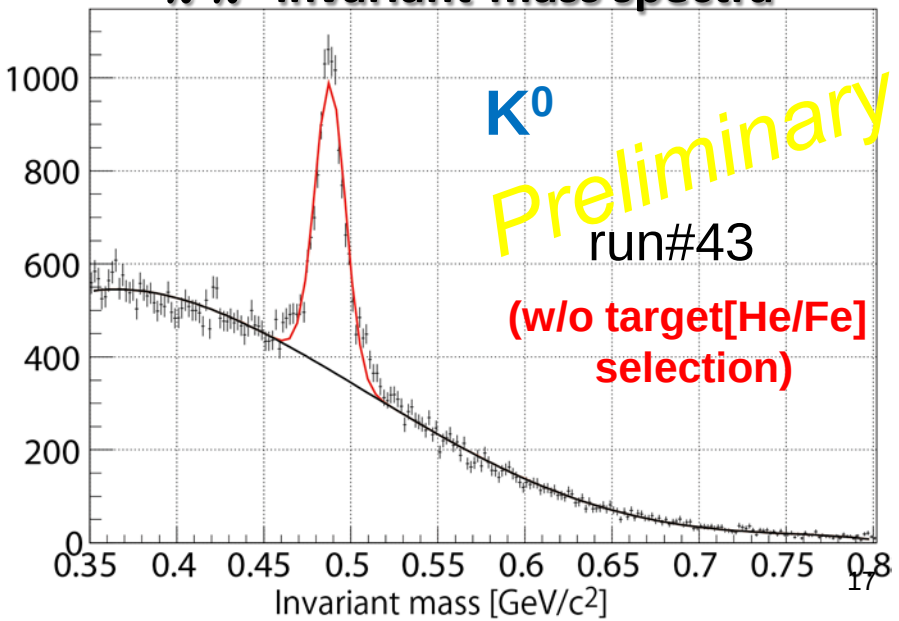
pID



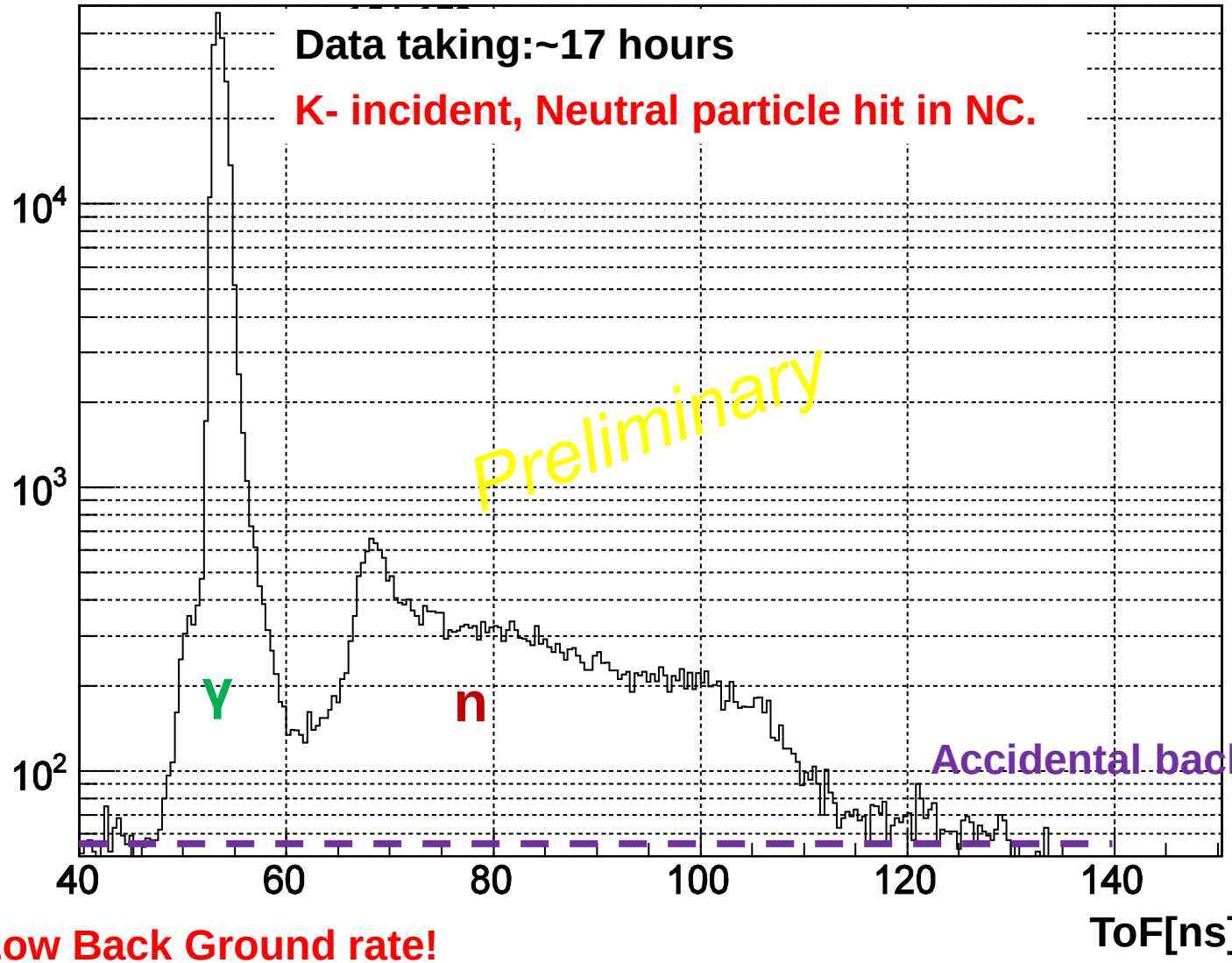
pπ⁻ invariant-mass spectra



π⁺π⁻ invariant-mass spectra

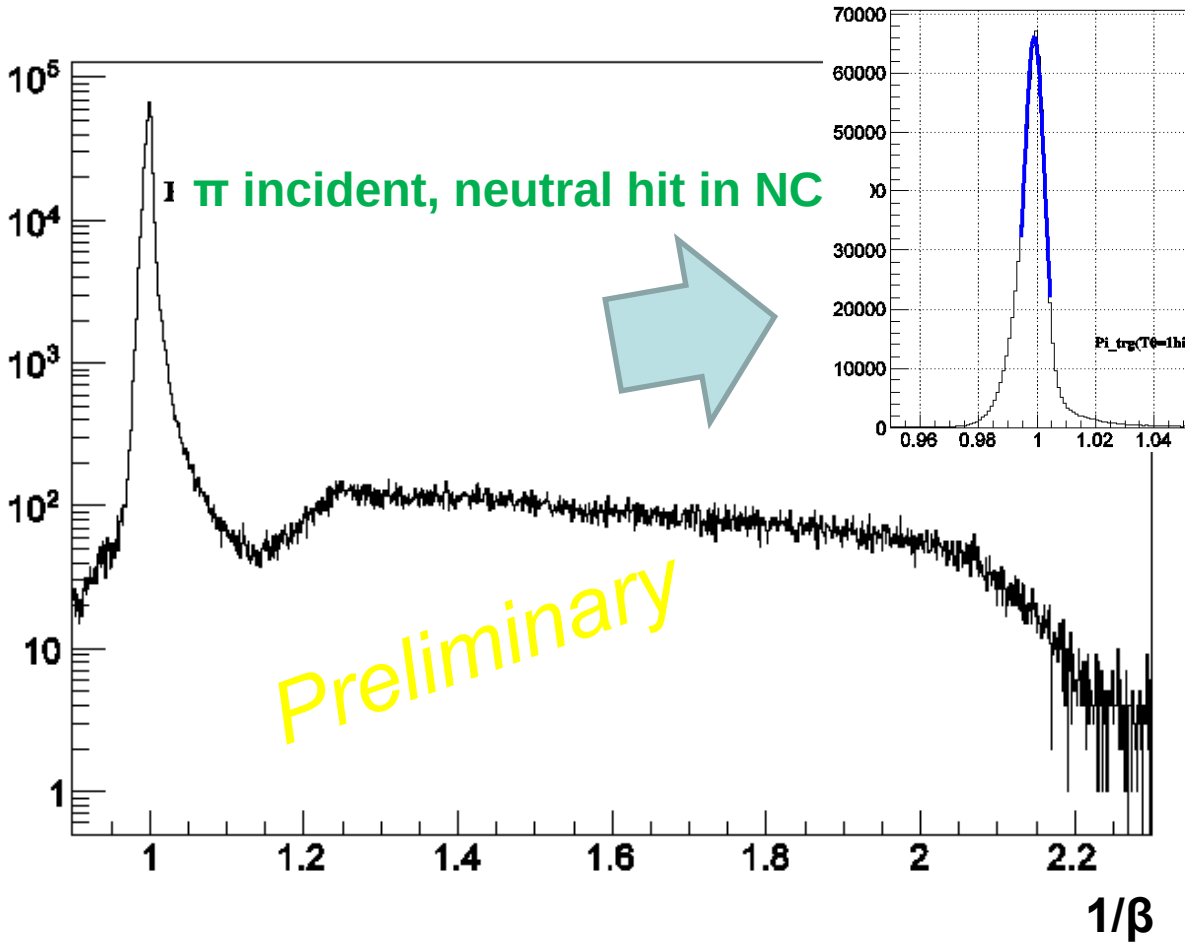


TOF measurement [T0-NC]



Low Back Ground rate!

1/β Time response of NC



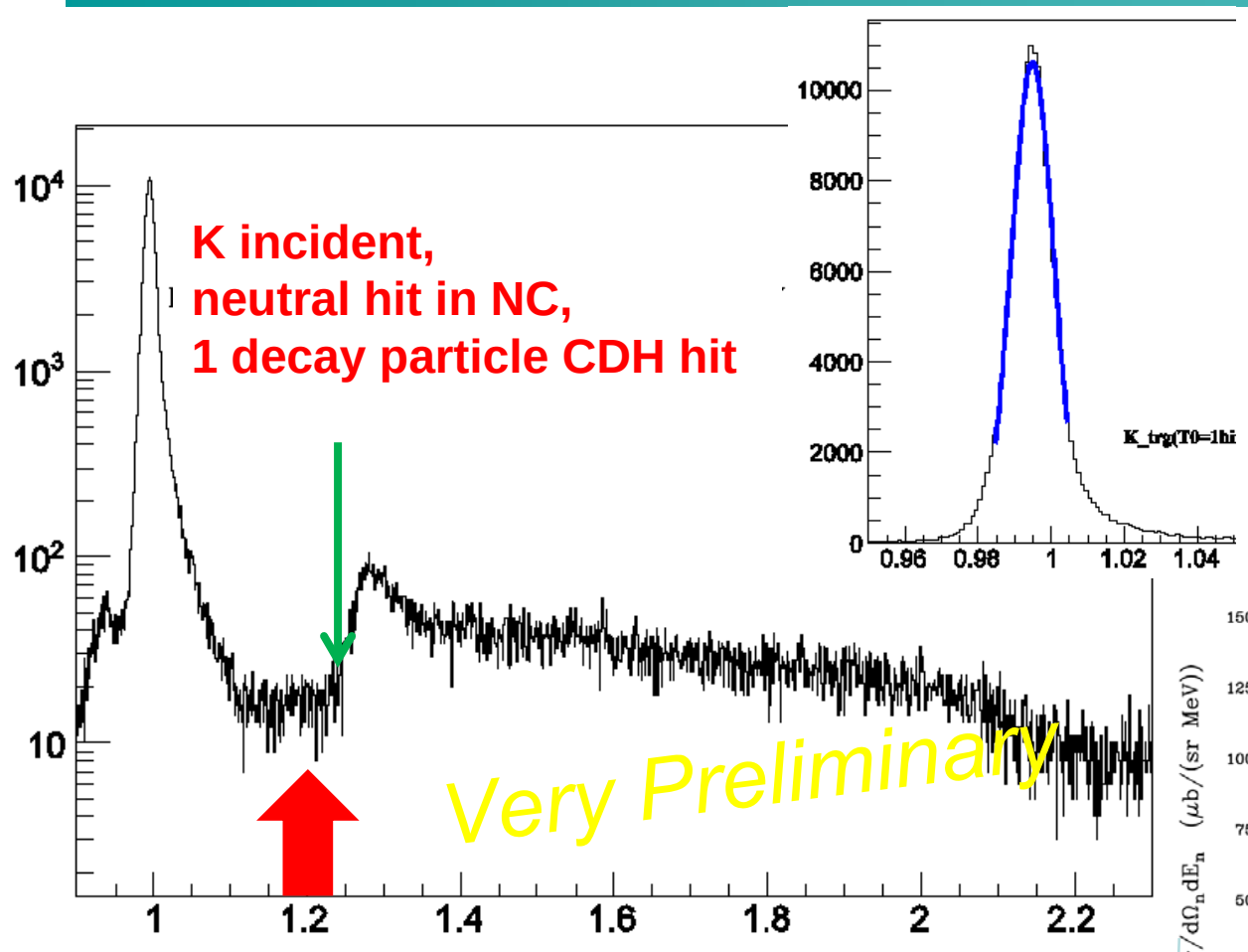
γ- peak

σ(1/β) =0.0036

Flight path ~15[m]

Time resolution ~180[ps]

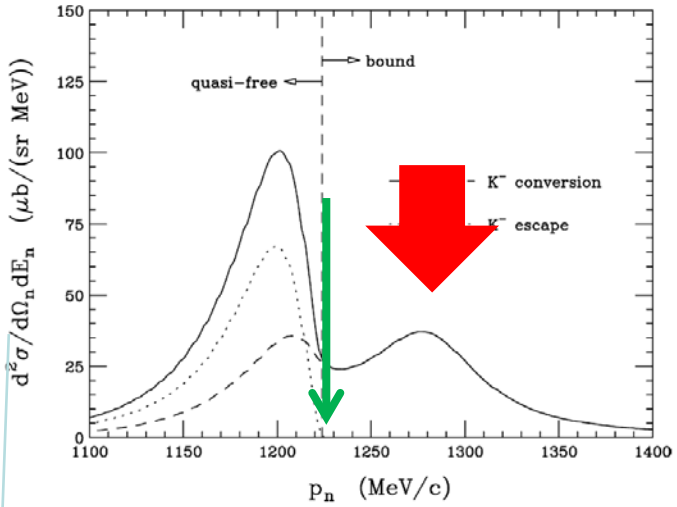
1/β spectrum of scattered neutral particles (K^- beam)



γ- peak

σ(1/β) =0.0057

Vertex point is assumed target center.
Resolution must be improved



Bound state event?
Analyzing now.

Summary

- Search for deeply-bound kaonic nuclear state and Spectrosopic study of Λ(1405) will be performed by the (in-flight K^-, n) reaction @K1.8br.

- Engineering run with full-setup @Jun. 2012.

- All system work well !!

- Production run will start in next winter.

Physics data is coming soon !!

Back up

The J-PARC E15 Collaboration

http://ag.riken.jp/J-PARC/collaboration/

S. Ajimura[a], G. Beer[b], H. Bhang[c], M. Bragadireanu[e], P. Buehler[f], L. Busso[g,h], M. Cargnelli[f], S. Choi[c], C. Curceanu[d], S. Enomoto[i], D. Faso[g,h], H. Fujioka[j], Y. Fujiwara[k], T. Fukuda[l], C. Guaraldo[d], T. Hashimoto[k], R. S. Hayano[k], T. Hiraiwa[j], M. Iio[o], M. Iliescu[d], K. Inoue[i], Y. Ishiguro[j], T. Ishikawa[k], S. Ishimoto[o], T. Ishiwatari[f], K. Itahashi[n], M. Iwai[o], M. Iwasaki[m,n*], S. Kawasaki[i], P. Kienle[p], H. Kou[m], Y. Ma[n], J. Marton[f], Y. Matsuda[q], Y. Mizoi[l], O. Morra[g], T. Nagae[j$], H. Noumi[a], H. Ohnishi[n], S. Okada[n], H. Outa[n], K. Piscicchia[d], M. Poli Lener[d], A. Romero Vidal[d], Y. Sada[j], A. Sakaguchi[i], F. Sakuma[n], M. Sato[k], A. Scordo[d], M. Sekimoto[o], H. Shi[k], D. Sirghi[d,e], F. Sirghi[d,e], K. Suzuki[f], S. Suzuki[o], T. Suzuki[k], H. Tatsuno[d], M. Tokuda[m], D. Tomono[n], A. Toyoda[o], K. Tsukada[r], O. Vazquez Doce[d,s], E. Widmann[f], T. Yamazaki[k,n], H. Yim[t], and J. Zmeskal[f]

(a) Research Center for Nuclear Physics (RCNP), Osaka University, Osaka, 567-0047, Japan
(b) Department of Physics and Astronomy, University of Victoria, Victoria BC V8W 3P6, Canada
(c) Department of Physics, Seoul National University, Seoul, 151-742, South Korea
(d) Laboratori Nazionali di Frascati dell' INFN, I-00044 Frascati, Italy
(e) National Institute of Physics and Nuclear Engineering - IFIN HH, Romania
(f) Stefan-Meyer-Institut für subatomare Physik, A-1090 Vienna, Austria
(g) INFN Sezione di Torino, Torino, Italy
(h) Dipartimento di Fisica Generale, Universita' di Torino, Torino, Italy
(i) Department of Physics, Osaka University, Osaka, 560-0043, Japan
(j) Department of Physics, Kyoto University, Kyoto, 606-8502, Japan
(k) Department of Physics, The University of Tokyo, Tokyo, 113-0033, Japan
(l) Laboratory of Physics, Osaka Electro-Communication University, Osaka, 572-8530, Japan
(m) Department of Physics, Tokyo Institute of Technology, Tokyo, 152-8551, Japan
(n) RIKEN Nishina Center, RIKEN, Wako, 351-0198, Japan
(o) High Energy Accelerator Research Organization (KEK), Tsukuba, 305-0801, Japan
(p) Technische Universität München, D-85748, Garching, Germany
(q) Graduate School of Arts and Sciences, The University of Tokyo, Tokyo, 153-8902, Japan
(r) Department of Physics, Tohoku University, Sendai, 980-8578, Japan
(s) Excellence Cluster Universe, Technische Universität München, D-85748, Garching, Germany
(t) Korea Institute of Radiological and Medical Sciences (KIRAMS), Seoul, 139-706, South Korea

(*) Spokesperson
($) Co-Spokesperson

J-PARC E31 Collaboration

- S. Ajimura[1], G. Beer[2], H. Bhang[3], M.Bragadireanu[8],P. Buehler[4], L. Busso[5,6], M. Cargnelli[4], S. Choi[3], C. Curceanu[8], S. Enomoto[1], D. Faso[5], H. Fujioka[13], Y. Fujiwara[12], T. Fukuda[11], C. Guaraldo[8], T. Hashimoto[12],R. Hayano[12], T. Hiraiwa [13], M. Iio[9],K. Inoue[1], N. Ishibashi[17], T. Ishikawa[12], S. Ishimoto[14], T. Ishiwatari[4], K. Itahashi[9], M. Iwai[14], M. Iwasaki[9,10],S. Kawasaki[1], P. Kienle[15], H. Kou[10],J. Marton[4], Y. Matsuda[12], Y. Mizoi [10], O. Morra[5], T. Nagae[13], H. Noumi [1], H. Ohnishi[9], S. Okada[8], H. Outa[9],Y. Sada[13], A. Sakaguchi[17], F. Sakuma[9], M. Sato[12], M. Sekimoto[14],H. Shi[12], D. Sirghi[8], F. Sirghi[8], S. Suzuki[14], T. Suzuki[12], H. Tatsuno[12], M. Tokuda[10], D. Tomono[9], A. Toyoda[14], K. Tsukada[9], E. Widmann[4], T. Yamazaki[9,12], K. Yoshida[17], H. Yim[3], B. Wünschek[4], J. Zmeskal[4]

- *1. Research Center for Nuclear Physics, Osaka University, Japan*
- *2. University of Victoria, Canada, 3. Seoul National University, South Korea*
- *4. Stefan Meyer Institut fur subatomare Physik, Austria,*
- *5. INFN Sezione di Torino, Italy , 6.Universita' di Torino, Italy*
- *8. Laboratori Nazionali di Frascati dell'INFN, Italy*
- *9. RIKEN, Japan, 10. Tokyo Institute of Technology, Japan*
- *11. Osaka Electro-Communication University, Japan, 12. University of Tokyo, Japan*
- *13. Kyoto University, Japan, 14. High Energy Accelerator Research Organization (KEK), Japan*
- *15. Technische Universitat Munchen, Germany, 16. INAF-IFSI, Sezione di Torino, Italy*
- *17. Osaka University, Japan*