

# Low mass dielectron measurements at J-PARC

S.Yokkaichi <http://rarfaxp.riken.go.jp/~yokkaich/>, K. Ozawa,

K. Aoki, H. En'yo, H. Hamagaki, M. Naruki, R. Muto, S. Sawada, M. Sekimoto,

F. Sakuma, K. Shigaki

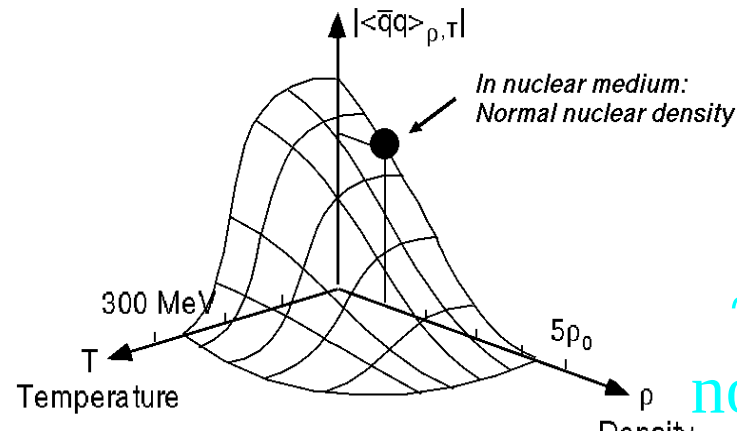
(RIKEN, Univ.of Tokyo, Kyoto Univ, CNS Univ. of Tokyo, KEK, Hiroshima Univ.)

## Chiral symmetry and dense/hot QCD

- confinement-deconfinement transition  
~ at the same temperature as the chiral phase transition (in Lattice calc.)
- The origin of hadron mass  
~ spontaneous breaking of the chiral symmetry
- Broken symmetry is expected to restore in finite density/temperature

**Theoretical prediction: Spectral modification of mesons in a medium due to the chiral symmetry restoration**

schematic fig. of restoration

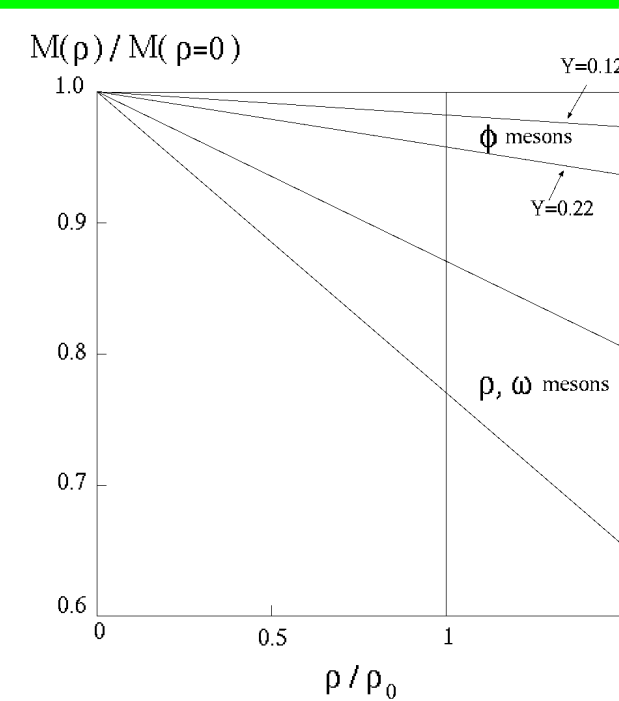


~1/3 restored at the normal nuclear density

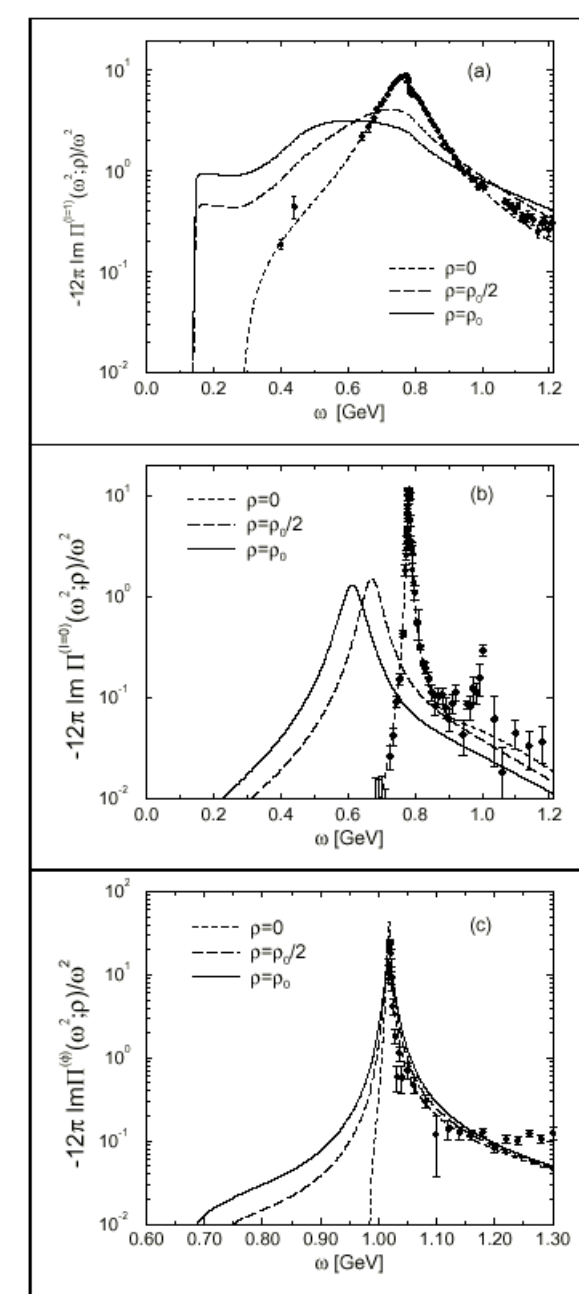
'mass shift' of  $\omega$ ,  $\rho$ ,  $\phi$  (Hatsuda & Lee, 1992)

$$\frac{m_{\omega}^*}{m_{\omega}} = 1 - (0.15 \pm 0.05) \frac{\rho}{\rho_0}$$

$$\frac{m_{\rho}^*}{m_{\rho}} = 1 - (0.16 \pm 0.06) \frac{\rho}{\rho_0}$$

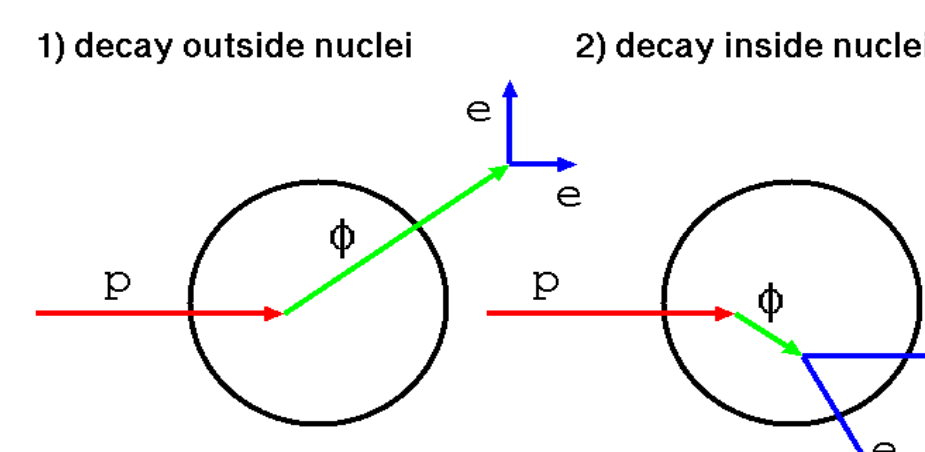


Klinge, Kaiser, Weise, NPA624(97)527

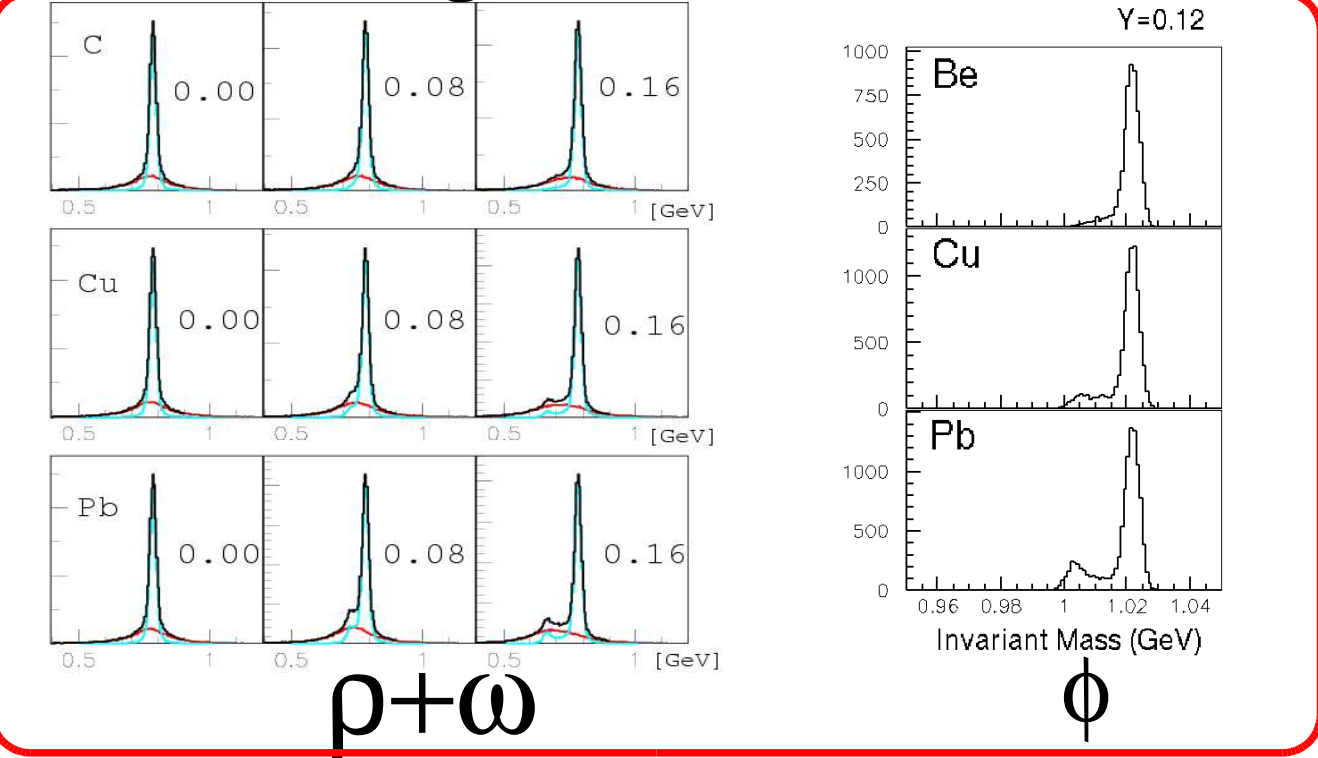


Experimental approach :

Measurements of the meson mass spectra decaying in nuclei using the electron probe



expected signal in simple MC calc. including nuclear size etc.



Overlaid spectra of mesons decaying inside & outside nuclei could be seen.

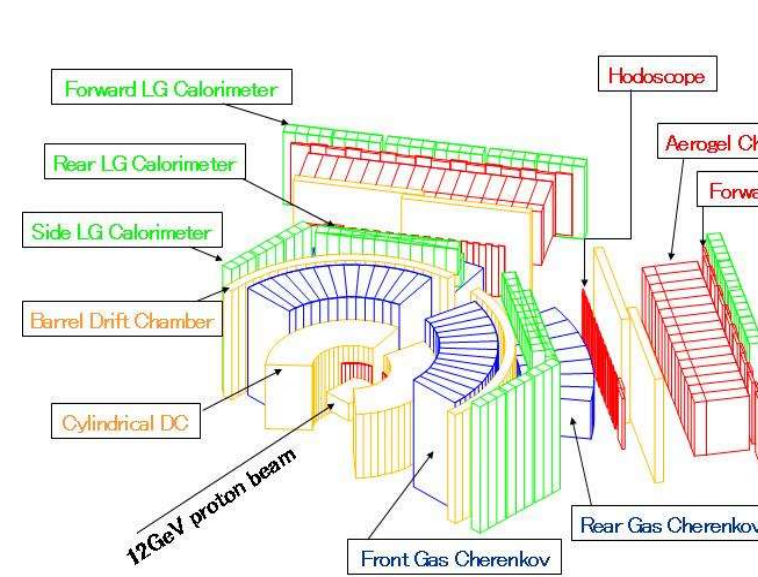
'double peak' or 'excess' structure caused by

the life and velocity of mesons  
nuclear size and density distribution

## KEK-PS E325 experiment

12GeV p+A reaction

measured  $e^+e^- / K^+K^-$  pairs



First observation of the meson spectral modification in nuclei with the electron probe ('98-'02)

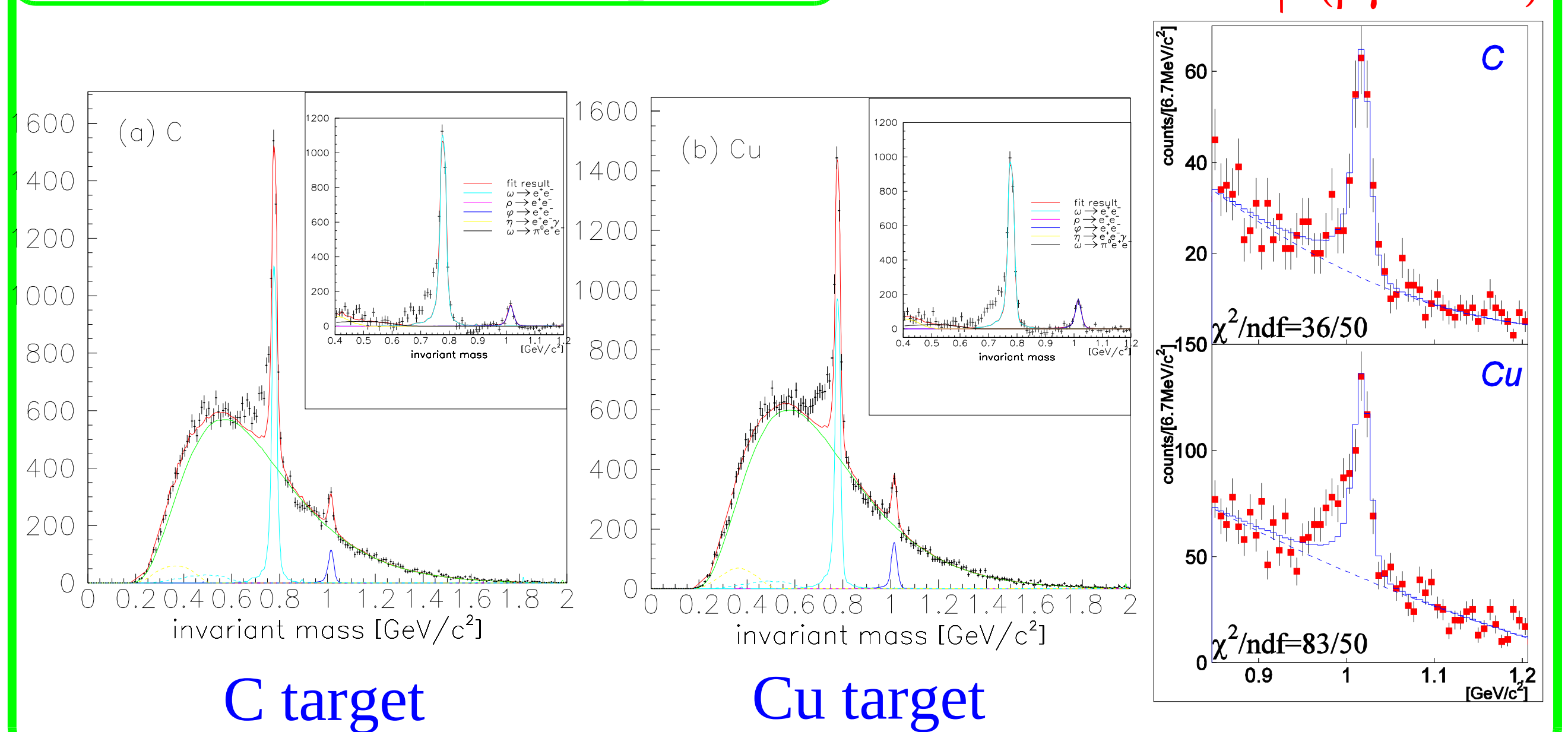
Mass spectra cannot be reproduced by known hadronic sources.

→ Excesses are observed on the low-mass sides of  $\omega$  &  $\phi$

(PRL 96(2006)092301, nucl-ex/0511019

QM2006. 19 Nov, parallel (photon & dilepton) 17:40-18:00 )

## $e^+e^-$ invariant mass spectra



## Proposed experiment at J-PARC 50-GeV PS

using 30- 50 GeV p+A reaction at primary beam line

high intensity ( $10^{10}$  ppp) beam and

thin (0.1% interaction length) target to reduce background

→ 10MHz interaction on targets

Main goal :  $\sim 10^5 \phi \rightarrow e^+e^-$  for each target

100 times as large as E325 (in 5 weeks operation) enables:

- kinematical dependence of the 'modified' component momentum dependence of the modification (dispersion relation in nuclear matter)

- new nuclear targets : smaller : proton ( $\text{CH}_2$  -C subtract)

larger : Pb

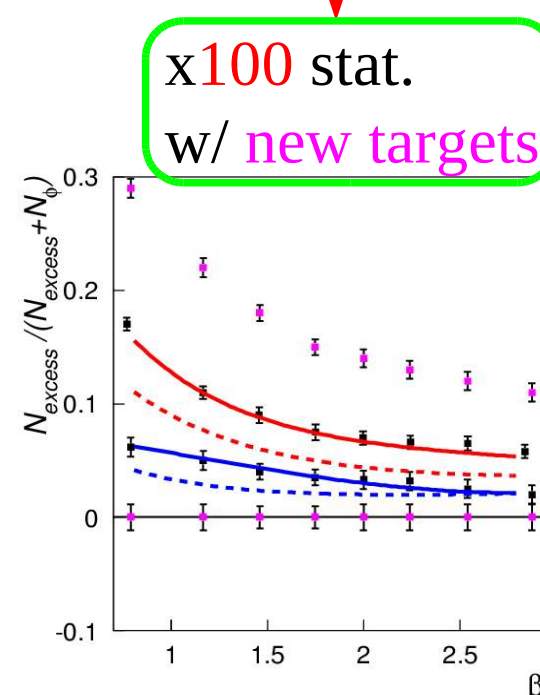
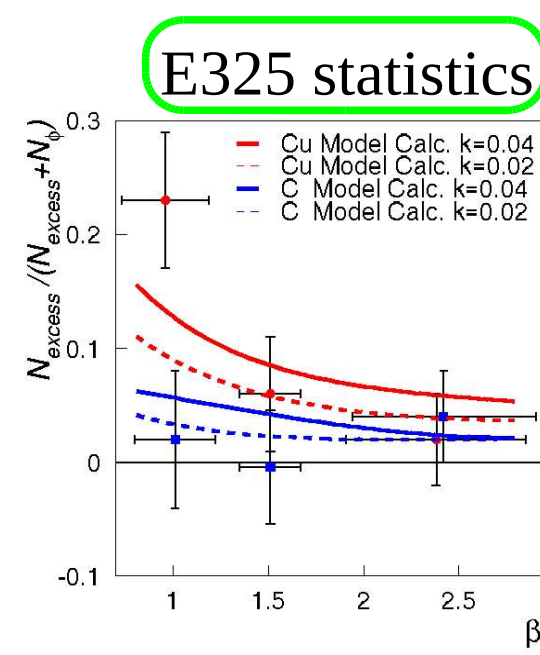
- collision geometry : for larger nuclei (as Pb)

with 10 MeV of mass resolution

$\omega$ ,  $\rho$  and  $J/\psi$  can be collected at the same time

higher stat. of  $\omega$ ,  $\rho$  than E325 with different A targets

$\sim 1000 J/\psi$  are expected in the 50 GeV operation



→ approach to the chiral symmetry restoration in nuclear matter.

(Proposal No.16 for J-PARC)

## Proposed new spectrometer

- To achieve :

larger acceptance (E325  $\times \sim 5$ )

high rate capability (E325  $\times \sim 10$ )

GEM Tracker @  $r=200/400/600\text{mm}$

0.2mm pos. reso. for 10MeV mass res.

→ 0.7mm pitch strip readout

5KHz/mm<sup>2</sup> @ most forward

1KHz/mm<sup>2</sup> @ 60deg.

HBD (hadron blind detector) @  $r=600-1100\text{mm}$

1/100 pion rejection

10x10cm<sup>2</sup> trigger tiles

Lead Glass EMCal @  $r=1140\text{mm}$

<1/1000 pion rejection with HBD

12x12cm<sup>2</sup> trigger tiles

Trigger : 2 x [tracker\*HBD\*LG] coin.

+ large opening angle

- Main trigger background

electron from upstream

accidental coin. of two EID counters

fine segmentation of the trigger counters

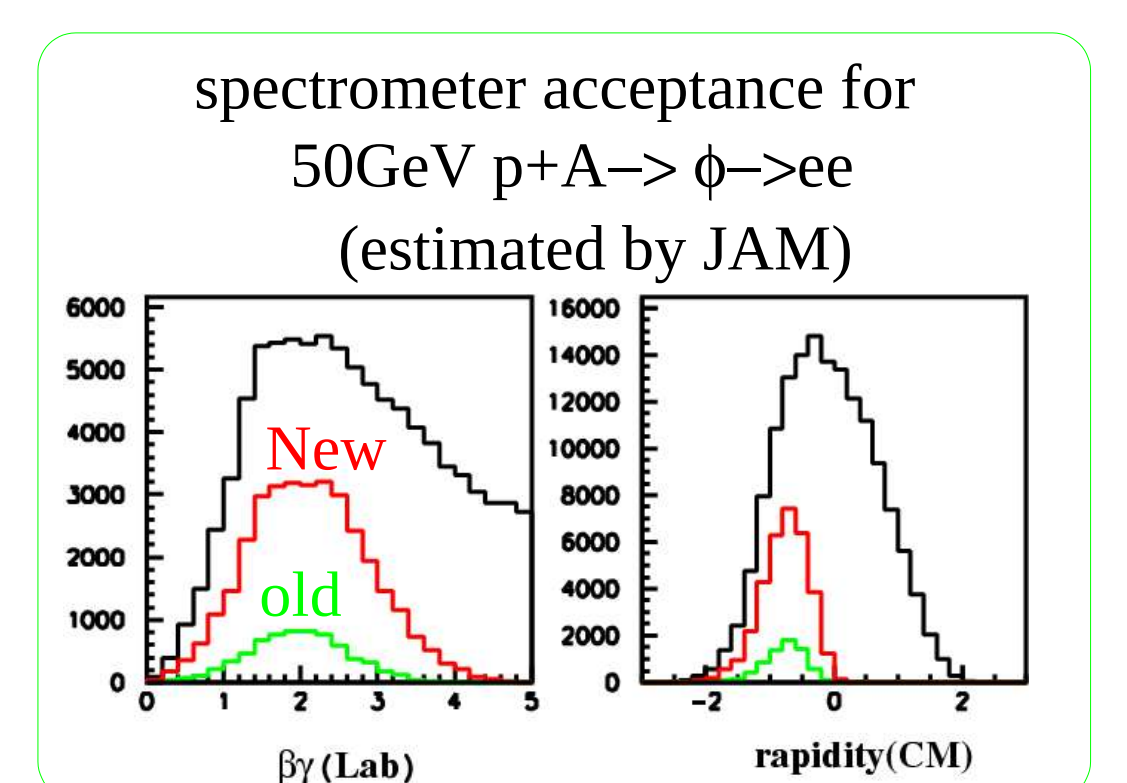
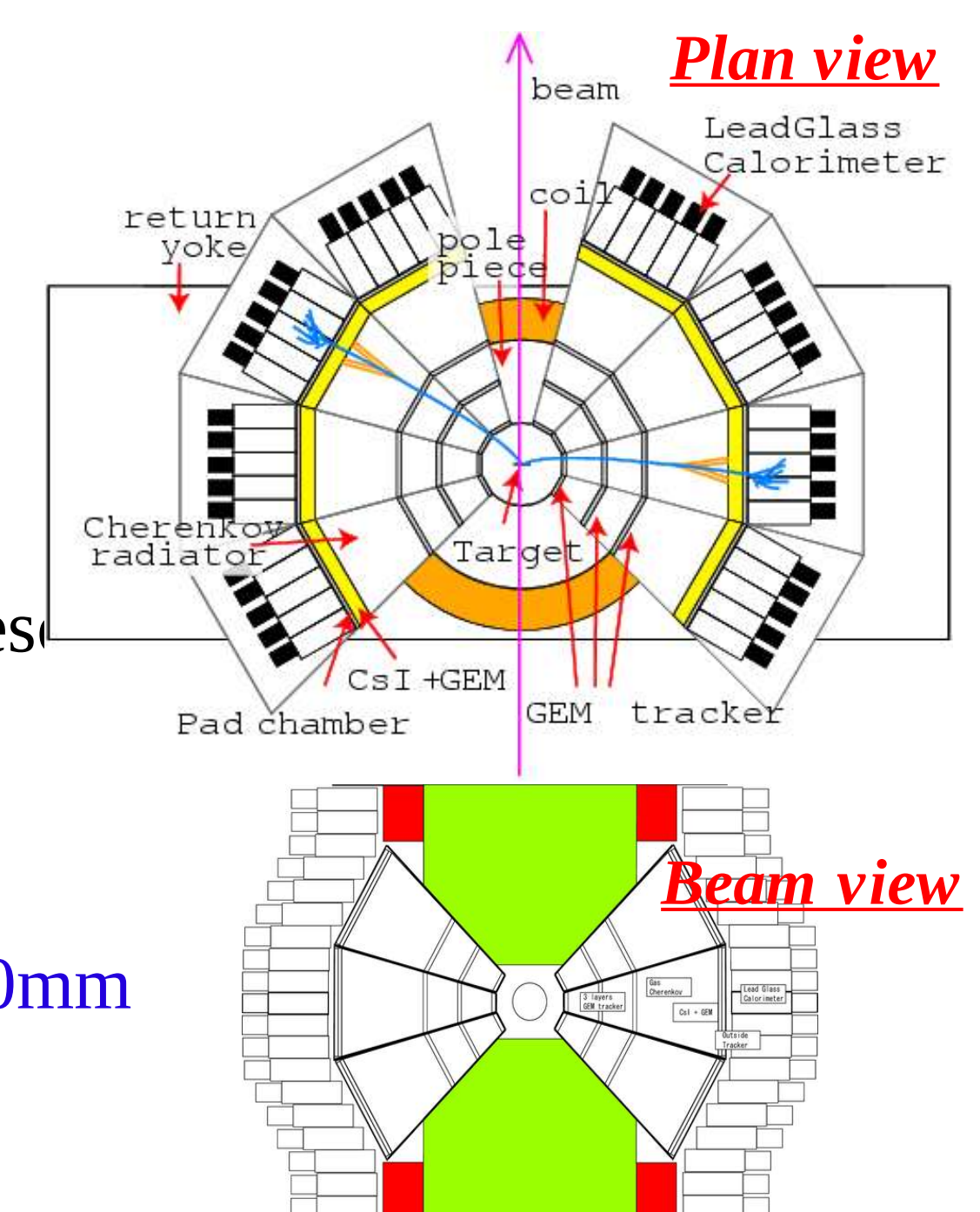
- Main offline background

combinatorial  $e^+e^-$  pairs from  $\pi^0$  Dalitz /  $\gamma$  conversions

S/N is kept  $\sim 1/1.5$  of E325

- Cost estimation

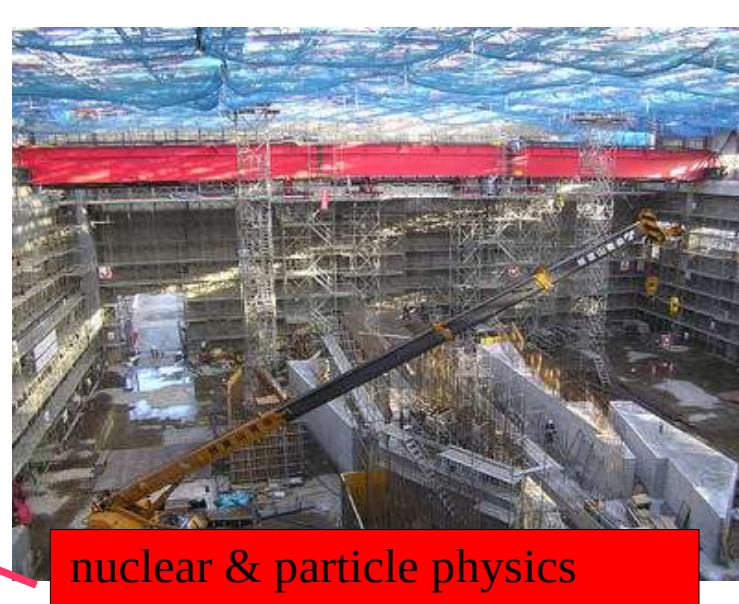
\$5M including \$2M electronics & \$1M GEM



## J-PARC 50-GeV PS is under construction



50GeV Proton Synchrotron(PS)



nuclear & particle physics experimental facility

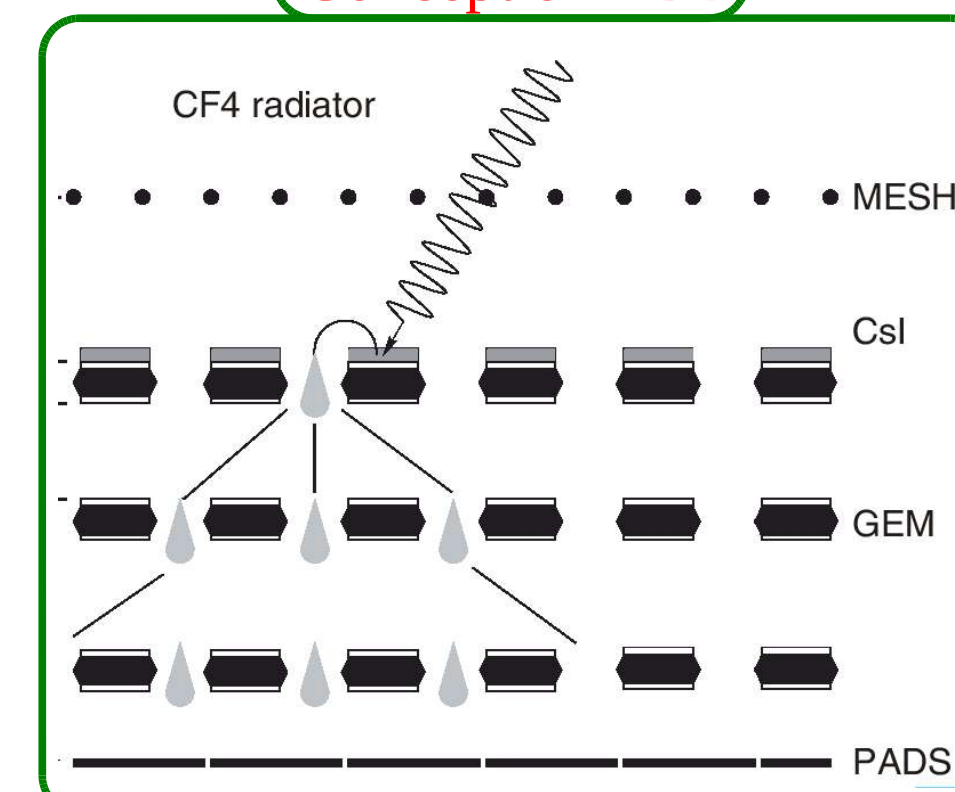
Construction is on going at Tokai, JAPAN

- first beam will be delivered in 2008 for hyper nuclei exp.
- 50 GeV,  $3.3 \times 10^{14}$  ppp, 15  $\mu\text{A}$ , 3.4 s repetition / 0.7 s duration (30 GeV,  $2 \times 10^{14}$  ppp, 9  $\mu\text{A}$ , 1.0 s duration at phase-1)
- primary beam line is under discussion for phase-1

<http://j-parc.jp/index-e.html>

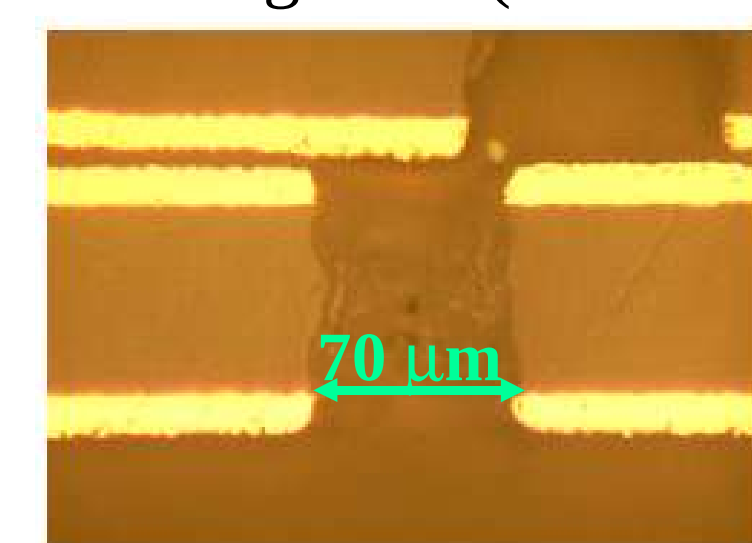
## Development of GEM/HBD at CNS, U-Tokyo

Concept of HBD



CsI photocathode / windowless  
detect Cherenkov photons from electrons

- GEM made in Japan with a dry-etching method is working well. (NIM A525(04)529)



Cross section of a GEM foil

- CsI-coated GEM is operated now. Beam test is planned in Dec.2006 at Hiroshima