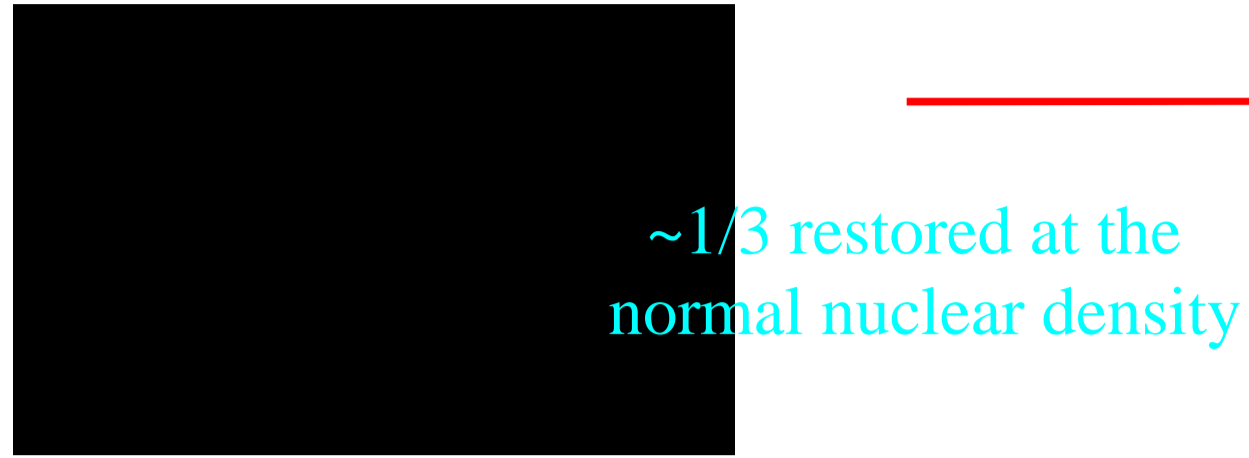


## Chiral symmetry and dense/hot QCD

- 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 and/or finite temperature

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

schematic fig. of restoration



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

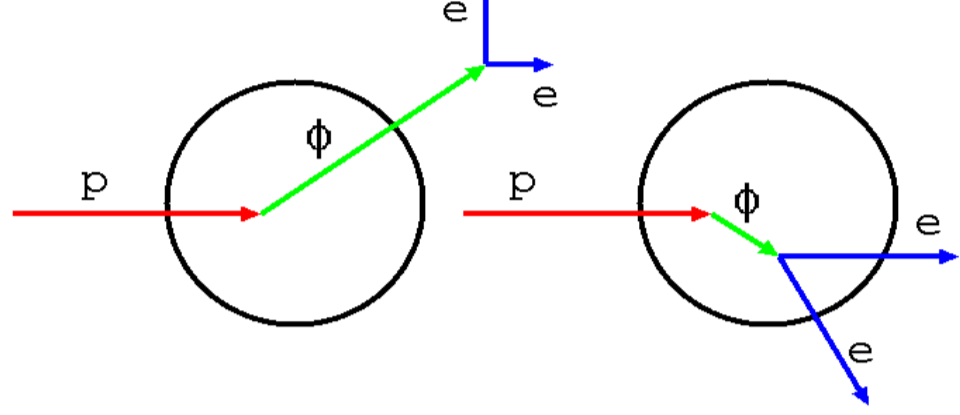
$$\frac{m_{\omega}^*}{m_{\omega}} = 1 - (0.15 \pm 0.05) \frac{\rho}{\rho_0}$$

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

Experimental approach :

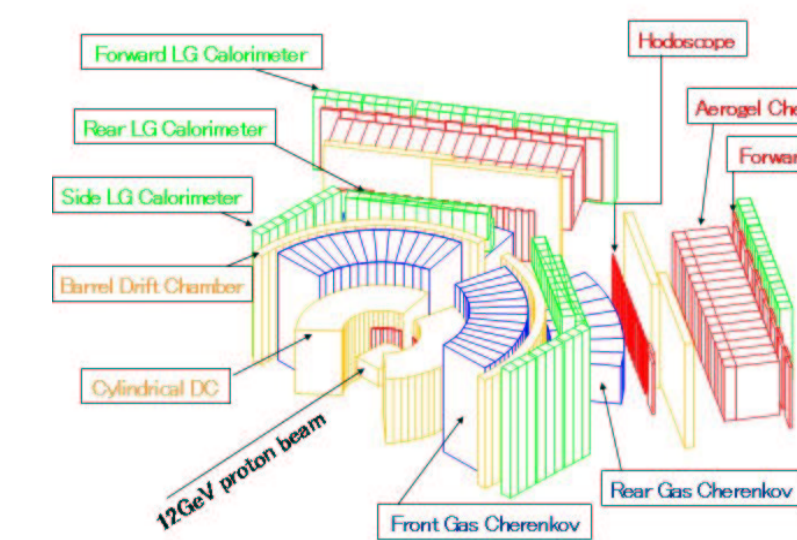
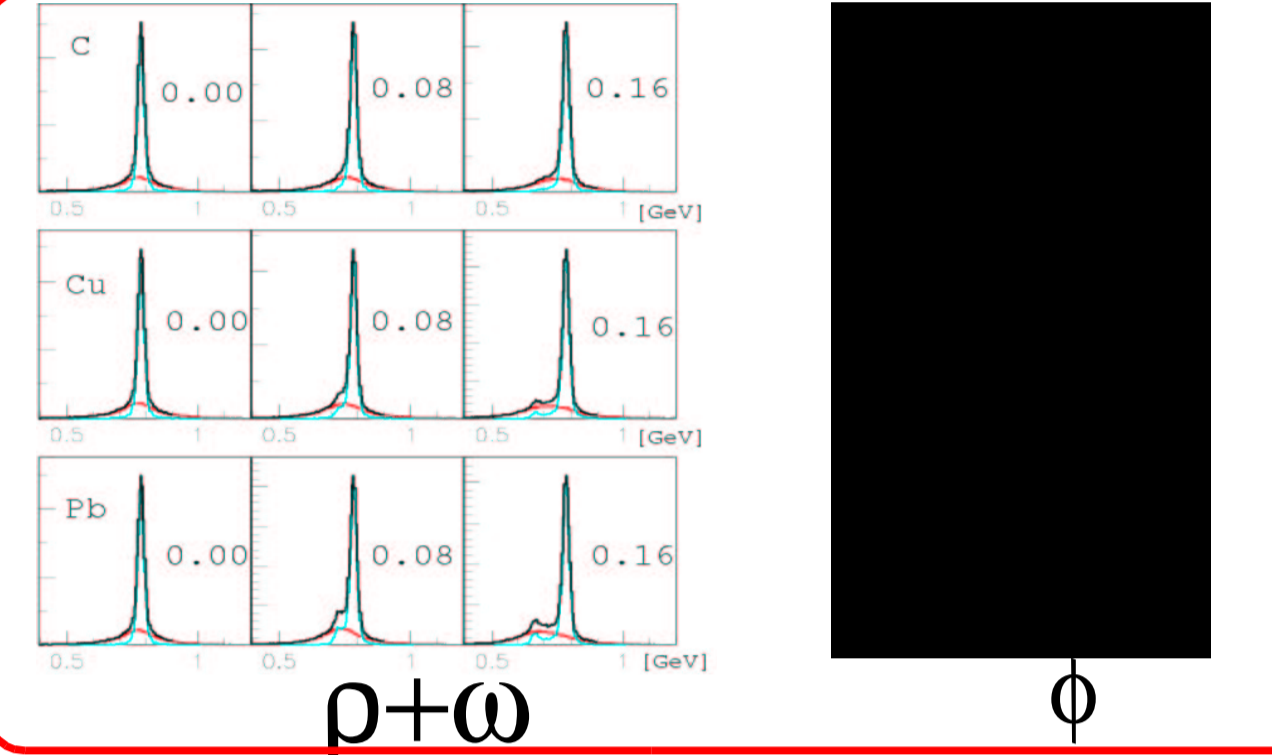
Measurements of the meson mass spectra decaying in nuclei using electron probe

1) decay outside nuclei 2) decay inside nuclei



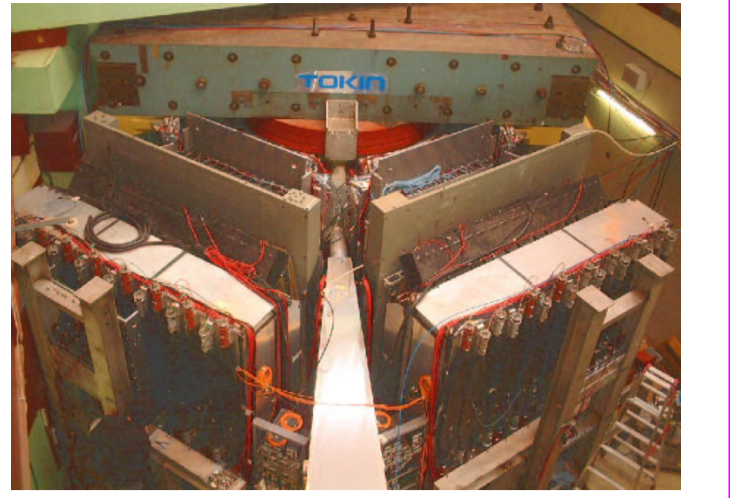
'Overlaid spectra of mesons decaying inside & outside nuclei could be seen. double peak' or 'excess' structure caused by life and velocity of meson nuclear size and density distribution

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



KEK-PS E325

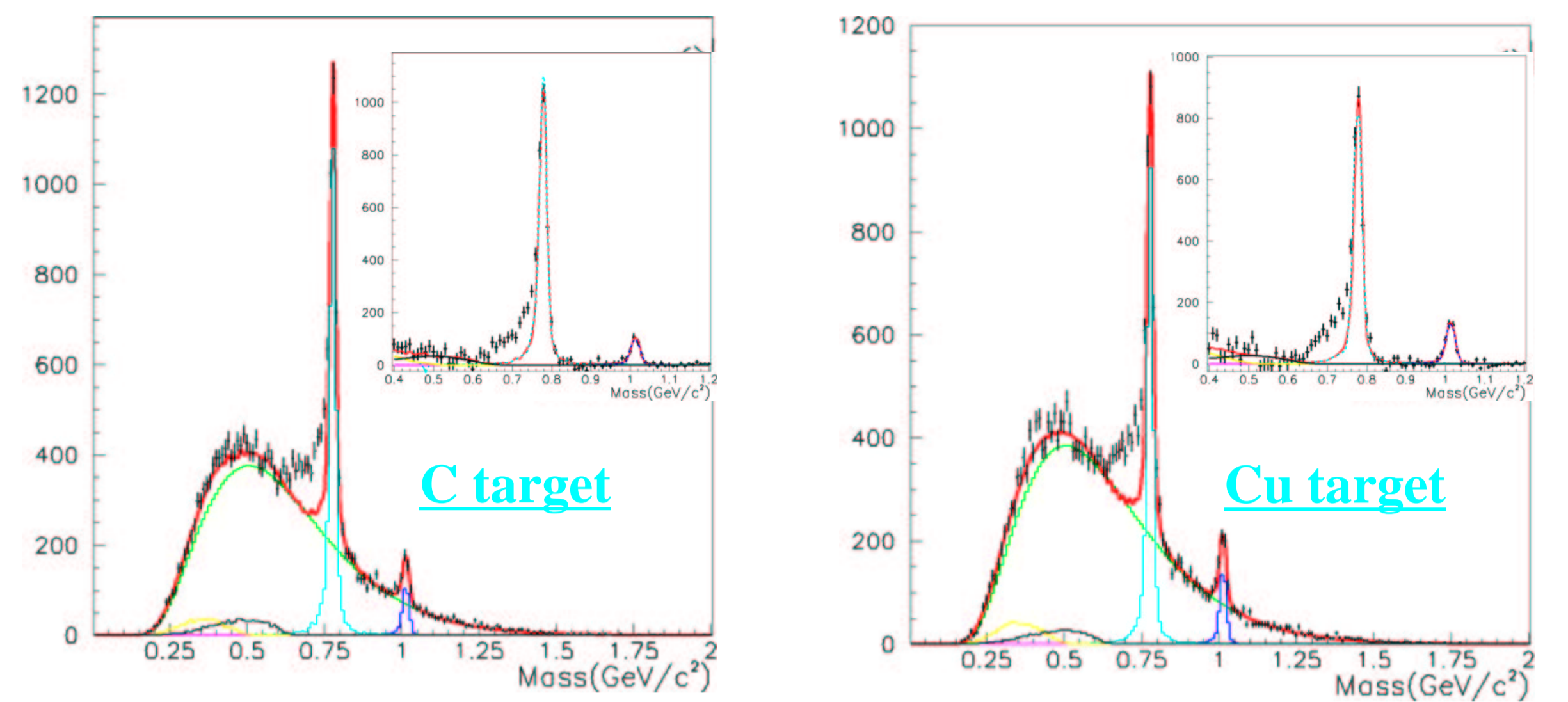
12GeV p+A reaction measure ee / KK



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

suggests the chiral symmetry restoration in nuclei (normal nuclear density)

preliminary result with high statistics



(from the data taken in 2001/2002 beam time)

Mass spectra cannot be reproduced by known hadronic sources.

(PRL 86(2001)5019, Nucl. Phys. A721(2003)297, QM2004. 13 Jan, parallel 2 (EMprobe) -5, poster Instruments-3)

## Vector meson measurements at J-PARC 50-GeV PS

Satoshi Yokkaichi (RIKEN), <http://rarfaxp.riken.go.jp/~yokkaich/>  
 Kyoichiro Ozawa (CNS, Univ. of Tokyo),  
 Shin'ya Sawada (KEK)

### Advanced project at J-PARC 50GeV PS

- using 30- 50 GeV p+A reaction at primary beam line
- thin (0.1% interaction length) target to reduce background
- high intensity ( $1 \times 10^9 \sim 10^{10}$  ppp) beam for high statistics
- slowly moving mesons which have large probability of decaying in nuclei

Main goal : 5000~50000  $\phi \rightarrow ee$  for each target

- 10-100 times as large as E325's statistics, in 100 shifts operation
- velocity dependence of 'modified' component
- new nuclear targets : proton ( $\text{CH}_2$ -C subtract), Pb

narrow width -> sensitive to modification  
 free from  $\omega$ - $\rho$  interference

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

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

100-1000  $J/\psi$  are expected in 50GeV operation

Normal nuclear density (p+A)

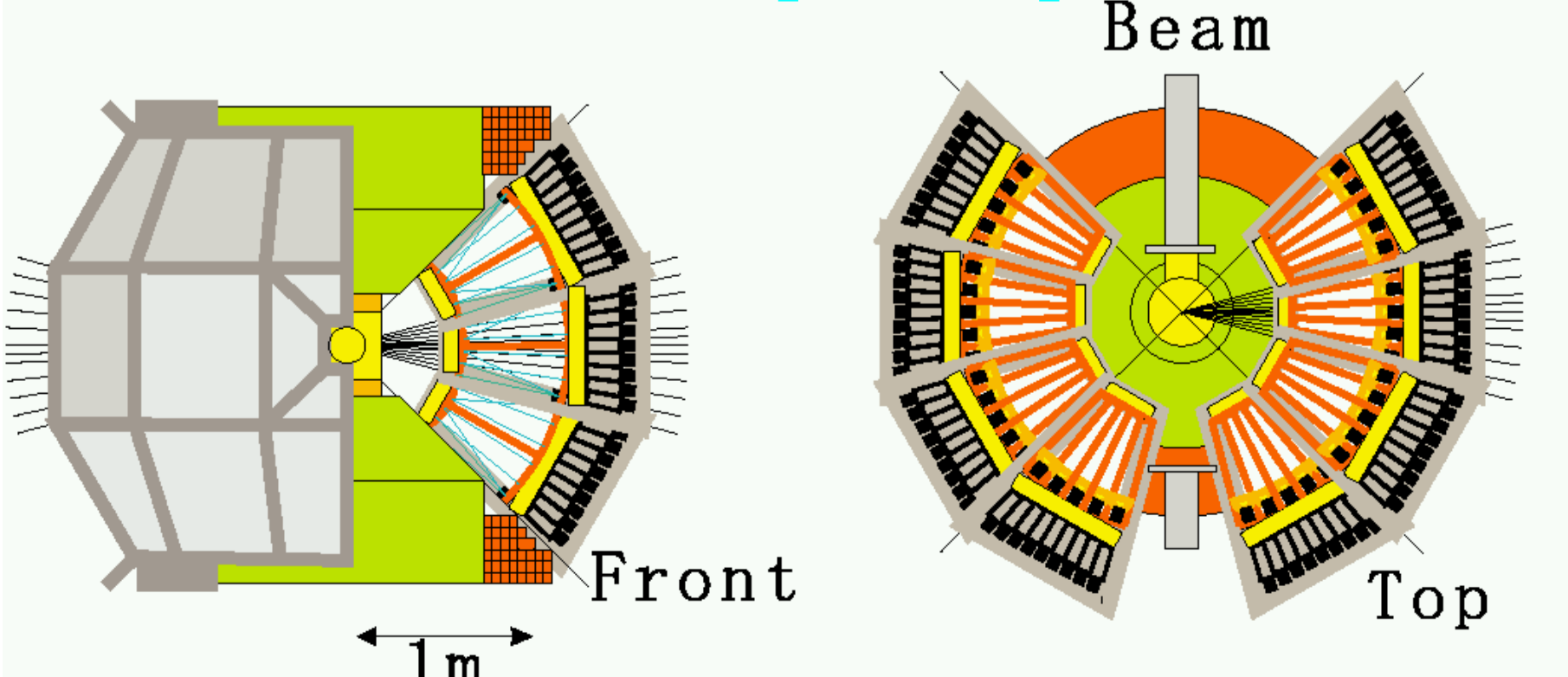
but also highest matter density (A+A, ~20GeV/u) in the future

### Spectrometer : two options

- Reuse of E325 spectrometer or
- Newly constructed larger acceptance spectrometer using Gas Electron Multiplier (GEM) as a Cherenkov photon sensor and/or tracker

For higher intensity beam (i.e. high interaction rate) and higher statistics, (B) is needed !

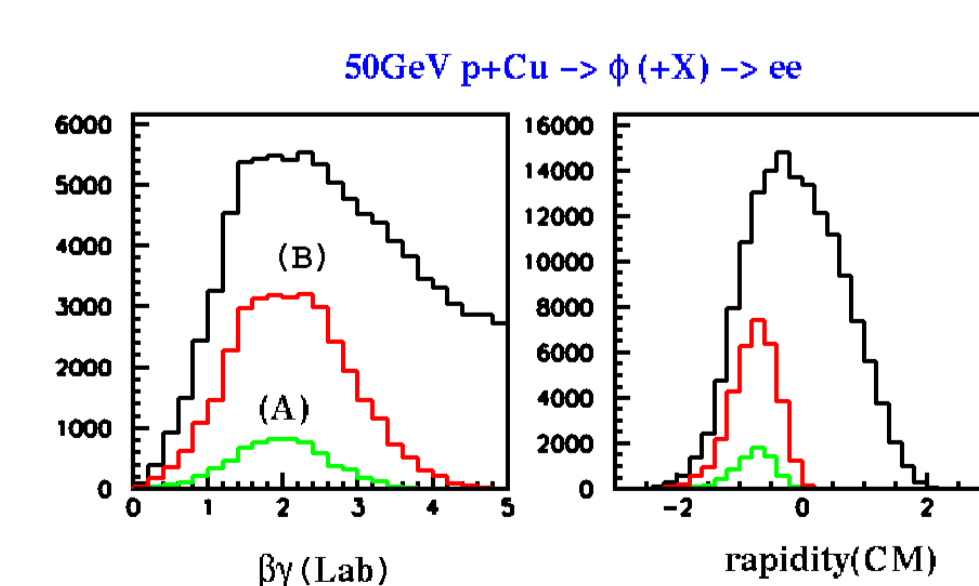
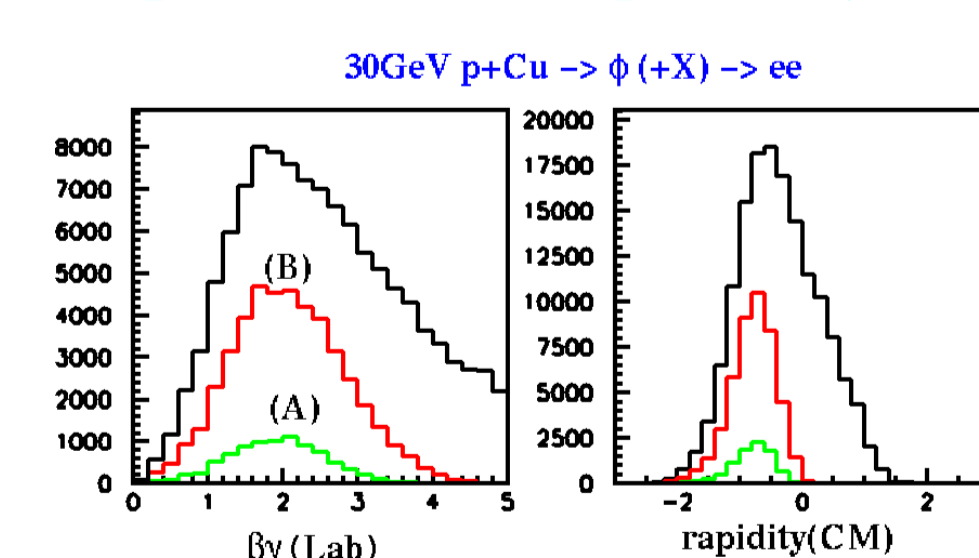
Schematic view of Proposed Spectrometer (B)



(Letter of Intent No.11 for J-PARC nuclear/particle physics)

<http://www-ps.kek.jp/jhf-np/LOIlist/LOIlist.html>

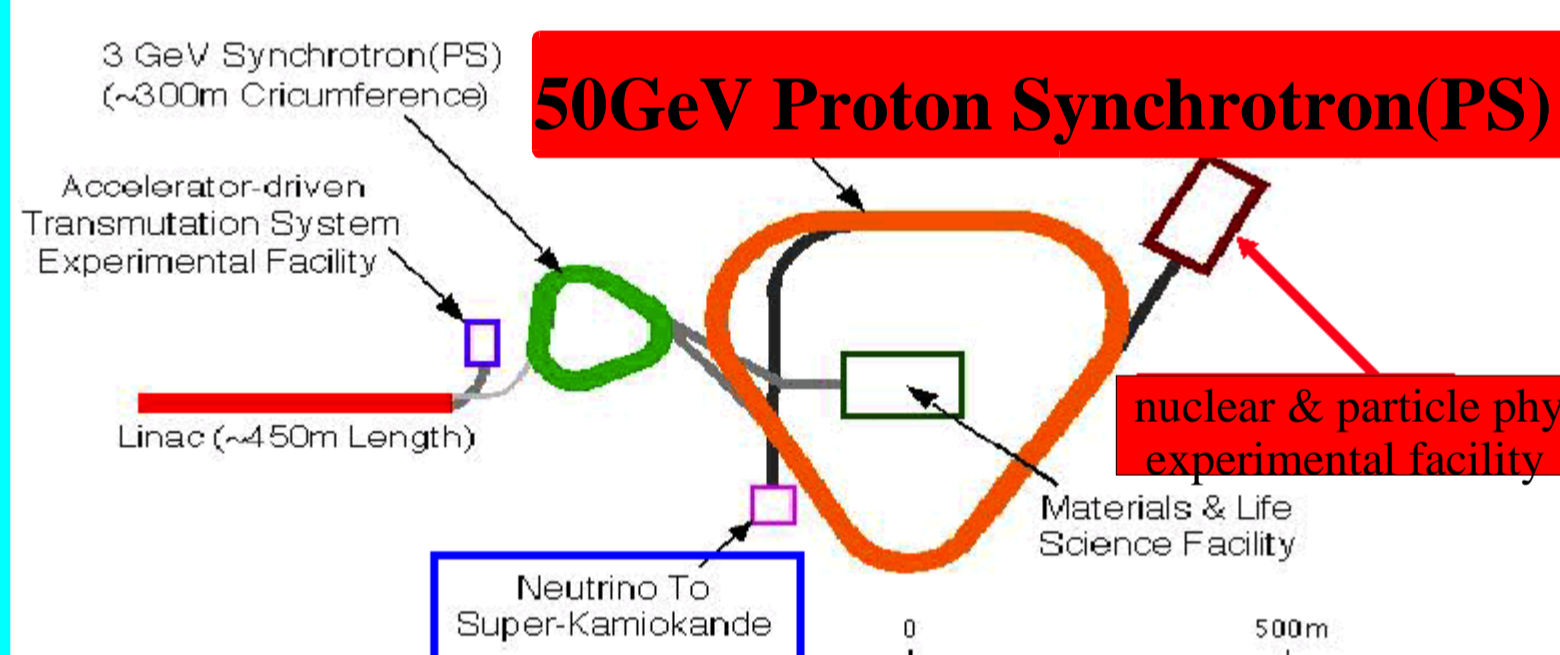
spectrometer acceptance  $\phi \rightarrow ee$



Electron ID:  
 Two stage operation of Gas Cherenkov and Lead Glass

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

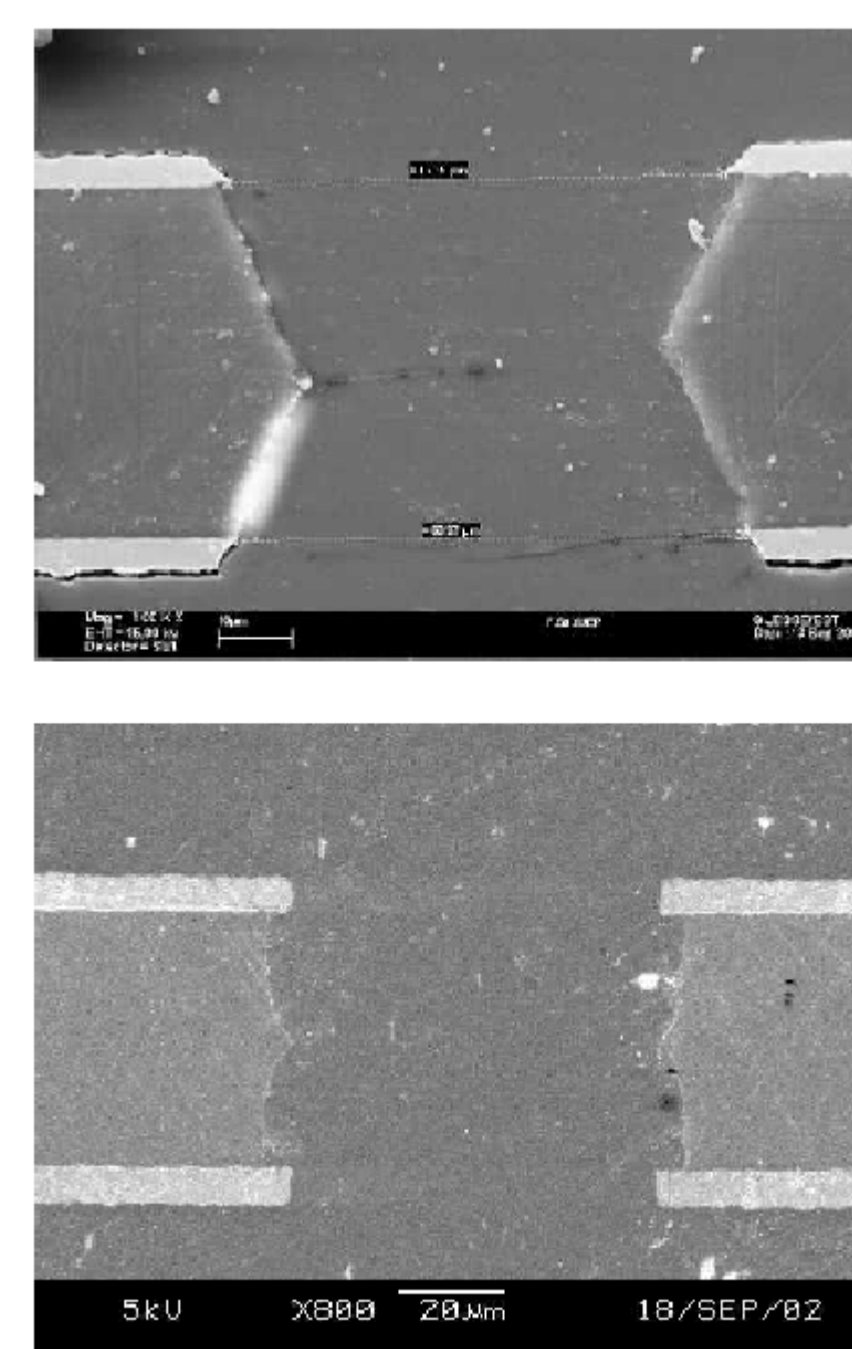
(J-PARC : Japan Proton Accelerator Research Complex)



Construction is on going at Tokai, JAPAN

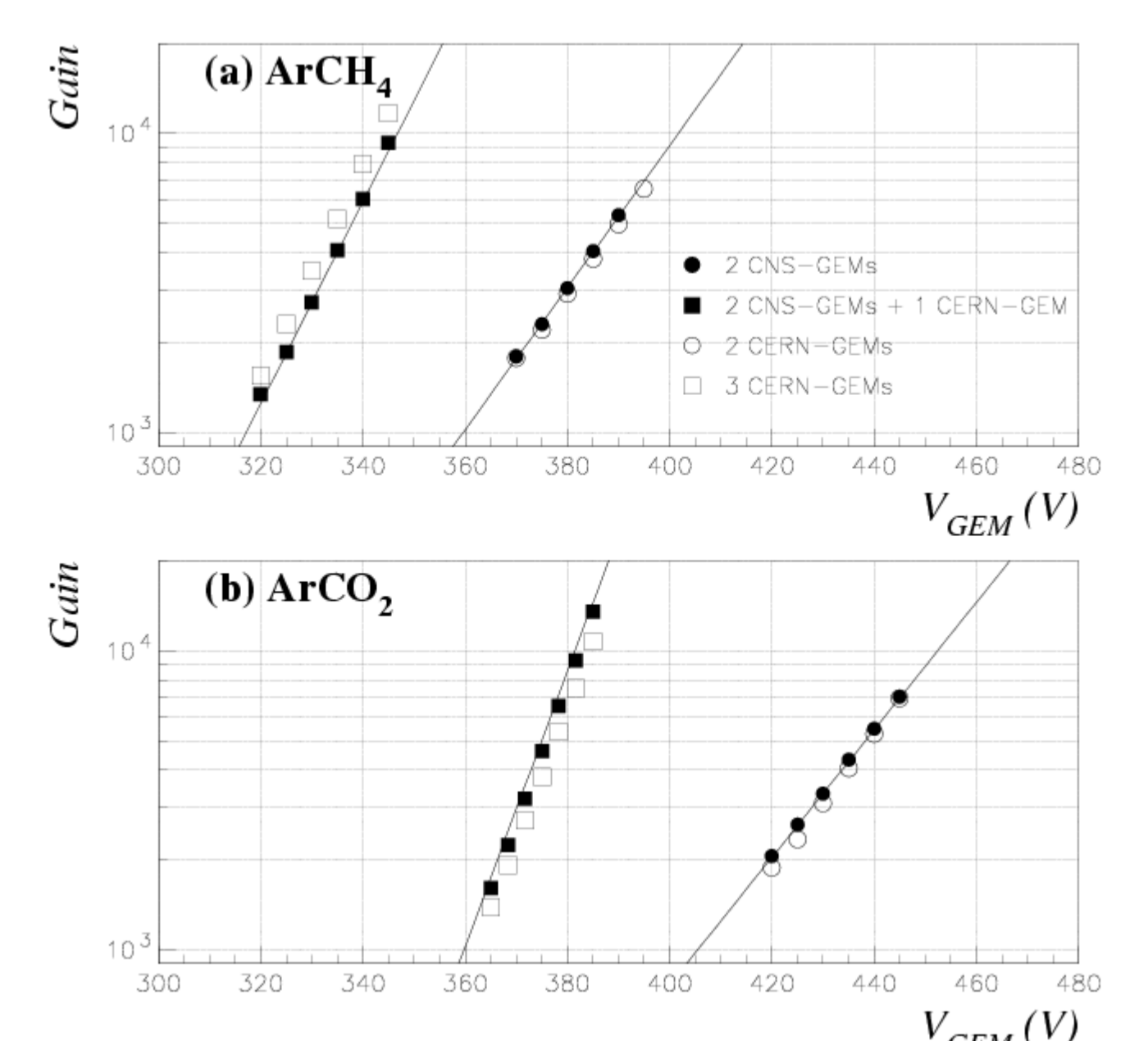
- first beam is planned in 2008 for hyper nuclei experiments.
  - 50GeV,  $3.3 \times 10^{14}$  ppp,  $15 \mu\text{A}$ , 3.4s repetition/0.7s duration (30GeV,  $2 \times 10^{14}$  ppp,  $9 \mu\text{A}$ , 1.0s duration at phase-1)
  - primary beam line is under discussion for phase-1 (LoI No. 14)
  - heavy ion acceleration is under discussion for phase-2 or after
- [http://www-ps.kek.jp/jhf-np/index\\_e.html](http://www-ps.kek.jp/jhf-np/index_e.html)

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



Cross section of GEM foil

Made in CERN (upper) & made in Japan (lower) has been tested.



Gain curve using X-ray source

Japanese foil is working as well as CERN's.

(M. Inuzuka et al, submitted to NIM, QM2004 poster Instruments 23)