Low mass dielectron measurements at J-PARC

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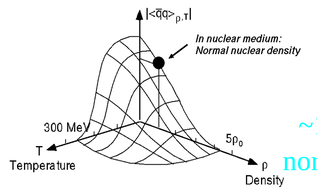
Chiral symmetry and dense/hot QCD

- confinement-deconfinement transition
  ~ at the same temparature 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

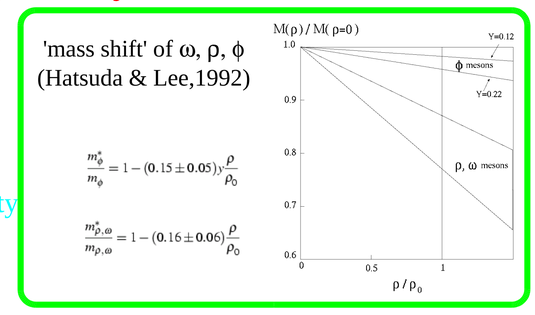


~1/3 restored at the normal nuclear density

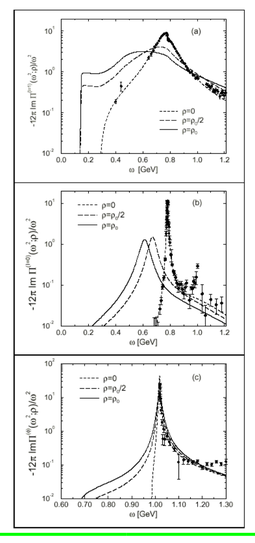
'mass shift' of ω, ρ, φ (Hatsuda & Lee,1992)

$$\frac{m_\phi^*}{m_\phi} = 1-(0.15\pm0.05)\frac{\rho}{\rho_0}$$

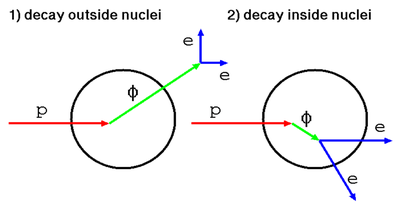
$$\frac{m_{\rho,\omega}^*}{m_{\rho,\omega}} = 1-(0.16\pm0.06)\frac{\rho}{\rho_0}$$



Klingle,Kaiser,Weise, NPA624(97)527

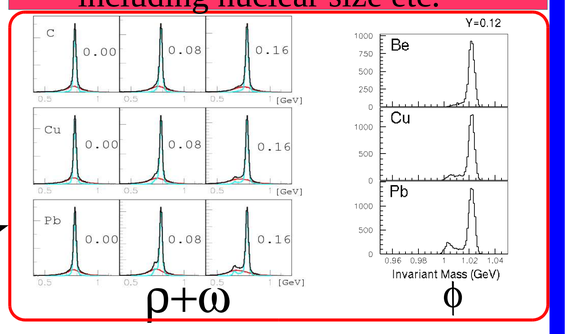


Experimental approach :
Measurements of the meson mass spectra decaying in nuclei using the electron probe



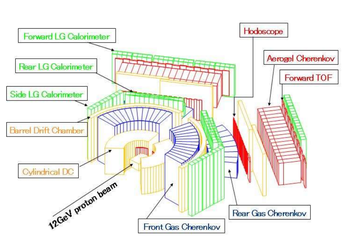
Overlaid spectra of mesons decaying inside & outside nuclei could be seen.
'double peak' or 'excess' structure caused by
the life and velocity of mesons
nuclear size and density distribution

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



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)

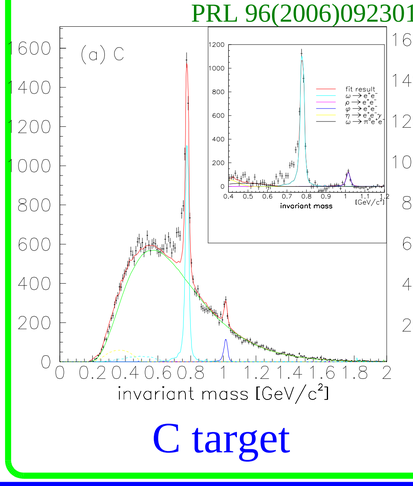
Mass spectra cannot be reproduced by known hadronic sources.

→ Excesses are observed on the low-mass sides of ω & φ

(PRL 96(2006)092301, PRL98(2007)042501, PRL98(2007)152302
INPC2007. 4 Jun. parallel 16:25)

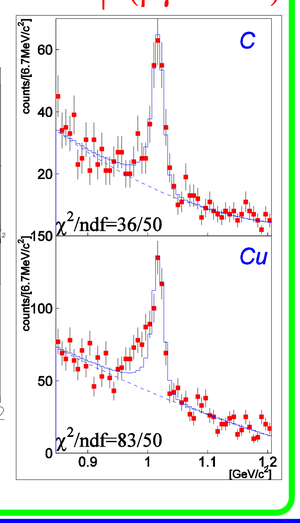
e^+e^- invariant mass spectra

PRL 96(2006)092301



C target Cu target

PRL 98(2007)042501
φ (βγ < 1.25)



Proposed experiment E16 at J-PARC

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 : ~10^5 $\phi \to e^+e^-$ for each target

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

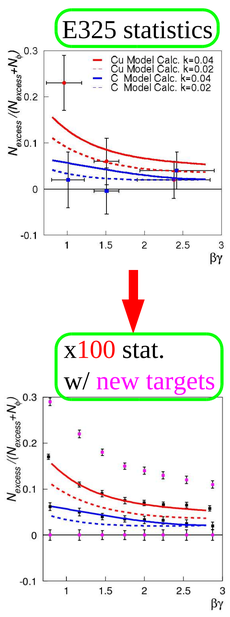
- kinematical dependence of the 'modified' component
  → momentum dependence of the modification
  (dispersion relation in nuclear matter)
- new nuclear targets : smaller : proton (CH_2 -C subtract)
  larger : Pb
- collision geometry : for larger nuclei (as Pb)

with 10 MeV of mass resolution

ω, ρ and J/ψ can be collected at the same time
higher stat. of ω, ρ than E325 with different A targets
~1000 J/ψ are expected in the 50 GeV operation

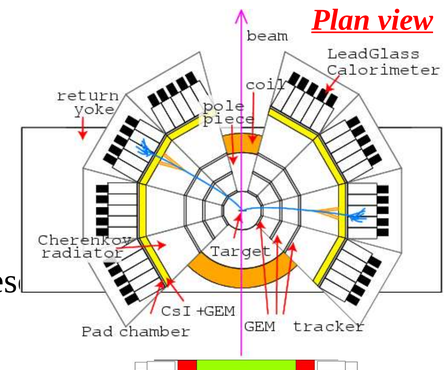
→ approach to the chiral symmetry restoration in nuclear matter.

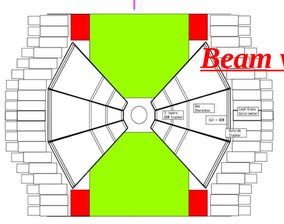
(Proposal No.16 approved (stage1) on 2007/3 by J-PARC-PAC)



Proposed new spectrometer

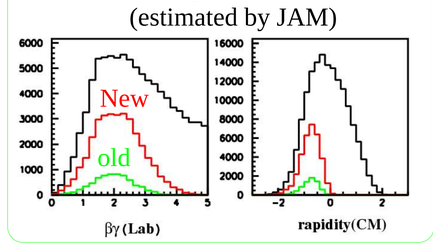
- To achieve :
  larger acceptance (E325 x~5)
  high rate capability (E325 x~10)





GEM Tracker @ r=200/400/600mm
0.2mm pos. reso. for 10MeV mass res
-> 0.7mm pitch strip readout
5KHz/mm² @ most forward
1KHz/mm² @ 60deg.
HBD (hadron blind detector) @r=600-1100mm
1/100 pion rejection
10x10cm² trigger tiles
Lead Glass EMCal @ r=1140mm
<1/1000 pion rejection with HBD
12x12cm² trigger tiles
Trigger : 2 x [tracker*HBD*LG] coin.
+ large opening angle

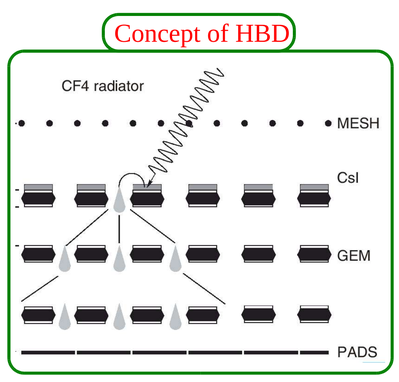
spectrometer acceptance for 50GeV p+A–> φ–>ee (estimated by JAM)



- 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 π^0 Dalitz /γ conversions
  S/N is kept ~1/1.5 of E325
- Cost estimation
  $5M including $2M electronics & $1M GEM

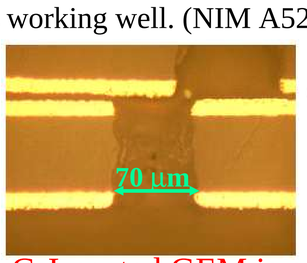
Development of GEM/HBD at CNS, U-Tokyo

Concept of HBD



CsI photocathode / windowless
detect Cherenkov photons from electrons

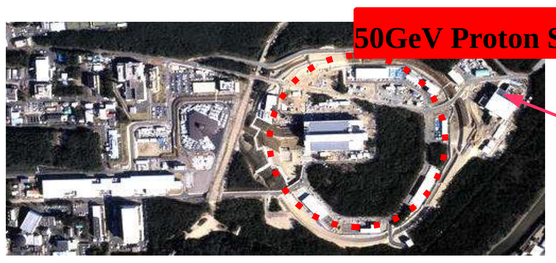
- GEM made in Japan with a dry-etching method is working well. (NIM A525(04)529)

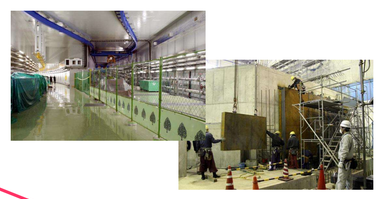


Cross section of a GEM foil

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

J-PARC 50-GeV PS is under construction





Construction is on going at Tokai, JAPAN

- first beam will be delivered in 2008 for hyper nuclei exp.
- 50 GeV, 3.3x10^{14} ppp, 15 μA, 3.4 s repitition / 0.7 s duration
  (30 GeV, 2x 10^{14} ppp, 9 μA, 1.0 s duration at phase-1)
- primary beam line is under discussion for phase-1

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