



# Dimuon Measurement at J-PARC

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# Dimuon Measurement at J-PARC

## ■ P04

- Dimuon measurement at J-PARC
- unpolarized proton beam and target
- p+p, p+d, and p+A
- 30GeV at the beginning, then 50GeV
- at 30 GeV, quarkonium production should be studied. → talk by Jen-Chieh Peng
- at 50 GeV, d-bar/u-bar asymmetry at larger x is the major target
- also, d-bar/u-bar asymmetry inside nucleus, parton energy loss are interesting topics.

## ■ P24

- Dimuon measurement with polarized beam/target.
- Talk by Yuji Goto.



# Performance of the 50-GeV PS

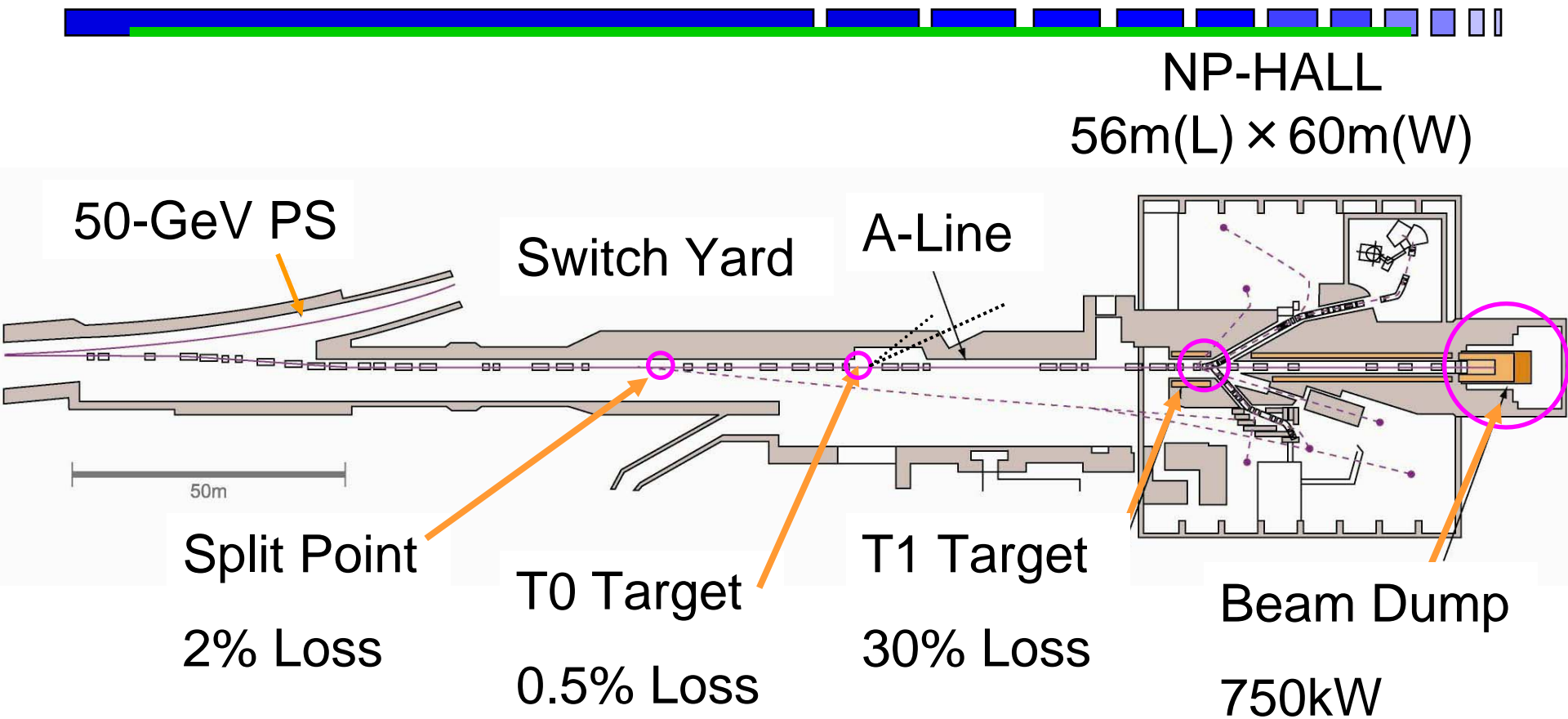
Numbers in red are design values.

Numbers in parentheses are ones for the beginning of Phase 1. Energy recovery of the linac to 400 MeV is planned just after the completion of the Phase-1 construction in 2009.

- Beam Energy :  $50 \text{ GeV}$   $E_{\text{Linac}} = 400 \text{ MeV}$   
( $30 \text{ GeV}$  for **Slow Beam**)  $E_{\text{Linac}} = (180 \text{ MeV})$   
( $30 \text{ GeV}$  for **Fast Beam**)
- Repetition:  $3.4 \sim 5\text{-}6 \text{ s}$
- Flat Top Width :  $0.7 \sim 2\text{-}3 \text{ s}$
- Beam Intensity:  $3.3 \times 10^{14} \text{ ppp}$ ,  $15 \mu\text{A}$   
( $2 \times 10^{14} \text{ ppp}$ ,  $9 \mu\text{A}$ )
- Beam Power:  $750 \text{ kW}$   
( $270 \text{ kW}$ )



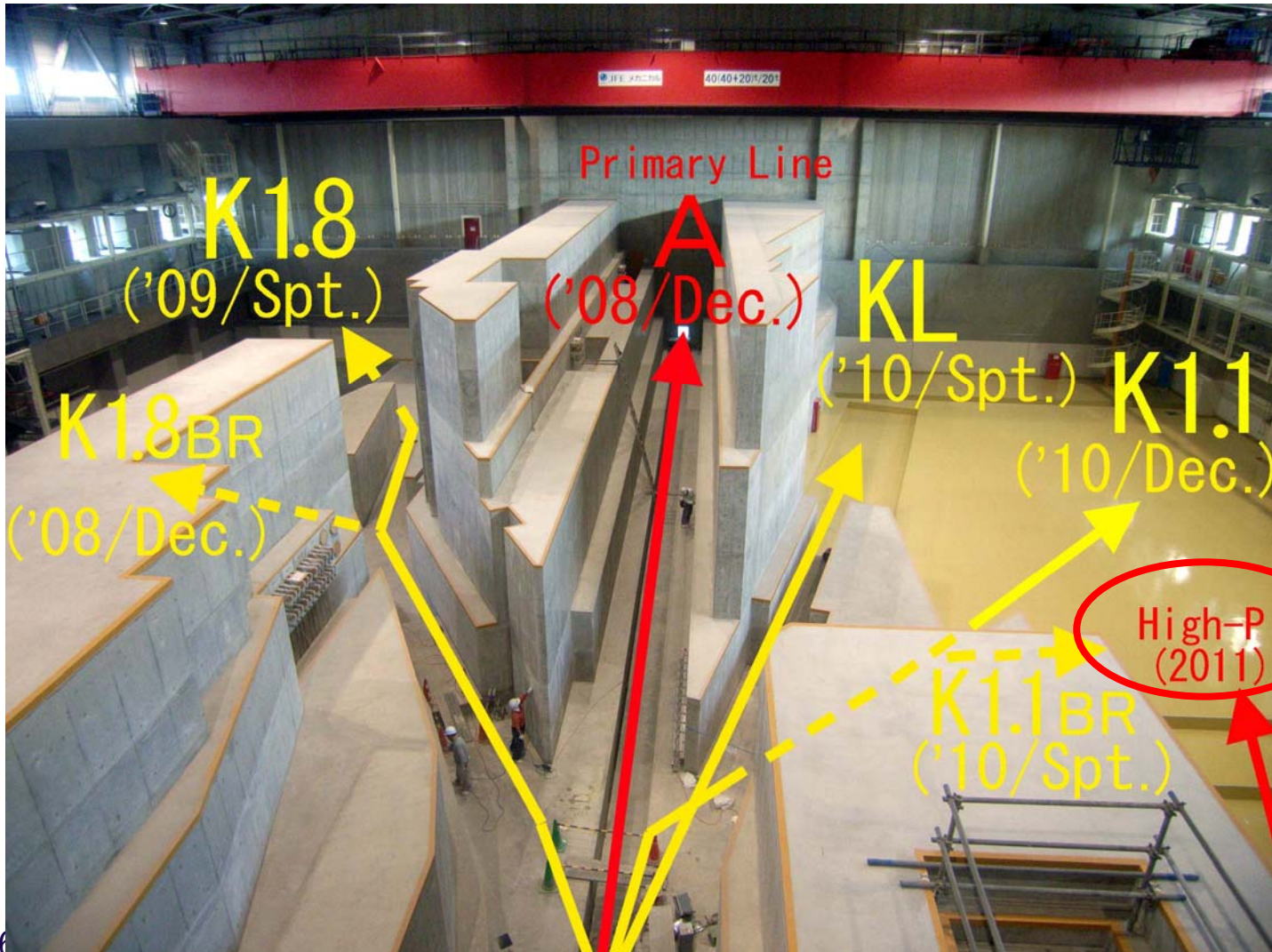
# Slow Extraction Beamline (Phase 1)



Plan to extend the hall downstream (~50m)  
in the Phase 2.



# Beamlines at the Hadron Hall

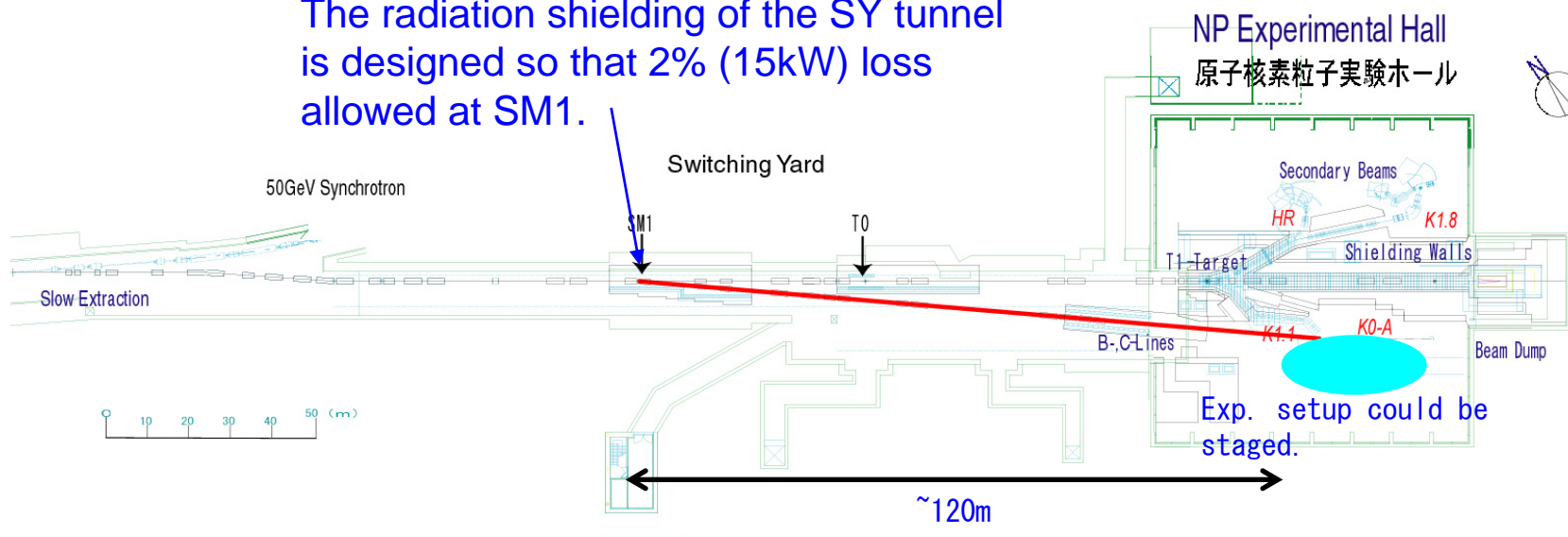




# What is the High Momentum Beamline?

- Primary beams: proton (Phase 1), polarized proton and heavy ions (future) up to 51 GeV/c.
- Secondary beams: proton, pion, kaon, etc.

The radiation shielding of the SY tunnel is designed so that 2% (15kW) loss allowed at SM1.





## P04: Measurement of High-Mass Dimuon Production at the 50-GeV Proton Synchrotron

needs 30 and 50 GeV,  $10^{12}$  protons per sec.



## Collaboration

Abilene Christian University, Argonne National Laboratory,  
Duke University, High Energy Accelerator Research Organization,  
University of Illinois at Urbana-Champaign, Kyoto University,  
Los Alamos National Laboratory, Pusan National University, RIKEN,  
Seoul National University, Tokyo Institute of Technology,  
Tokyo University of Science, Yamagata University

## Collaboration members

J.K. Ahn, J. Chiba, Seonho Choi, D. Dutta, H. Gao, Y. Goto,  
L.D. Isenhower, T. Iwata, S. Kato, M.J. Leitch, M.X. Liu, P.L.  
McGaughey, J.C. Peng, P. Reimer, M. Sadler, N. Saito, S.  
Sawada, T.-A. Shibata, K.H. Tanaka, R. Towell, H.Y. Yoshida

(Spokesperson: S. Sawada and J. C. Peng)





# Structure of the Nucleon Sea: Previous Data

- pQCD – Gluon splitting? i.e.  $\bar{d}(x) = \bar{u}(x)$

- NMC (Gottfried Sum Rule)

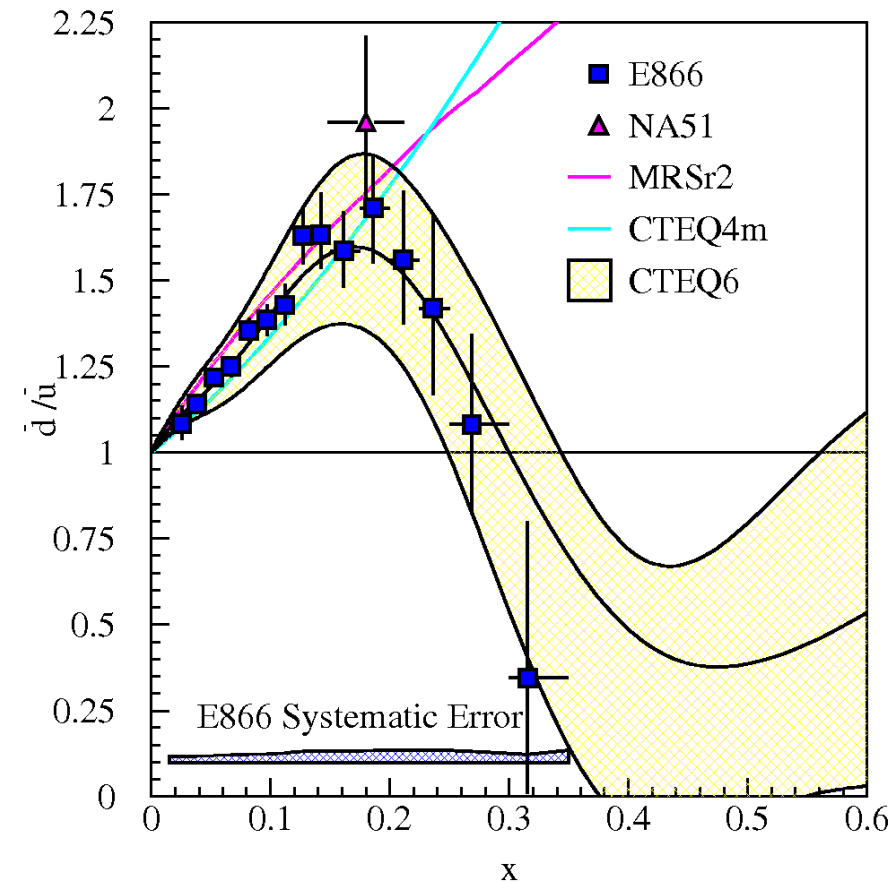
$$\int_0^1 [\bar{d}(x) - \bar{u}(x)] dx \neq 0$$

- NA51 (Drell-Yan)

$$\bar{d} > \bar{u} \text{ at } x = 0.18$$

- E866 (Drell-Yan)

$$\bar{d}(x)/\bar{u}(x) \text{ for } 0.015 \leq x \leq 0.35$$

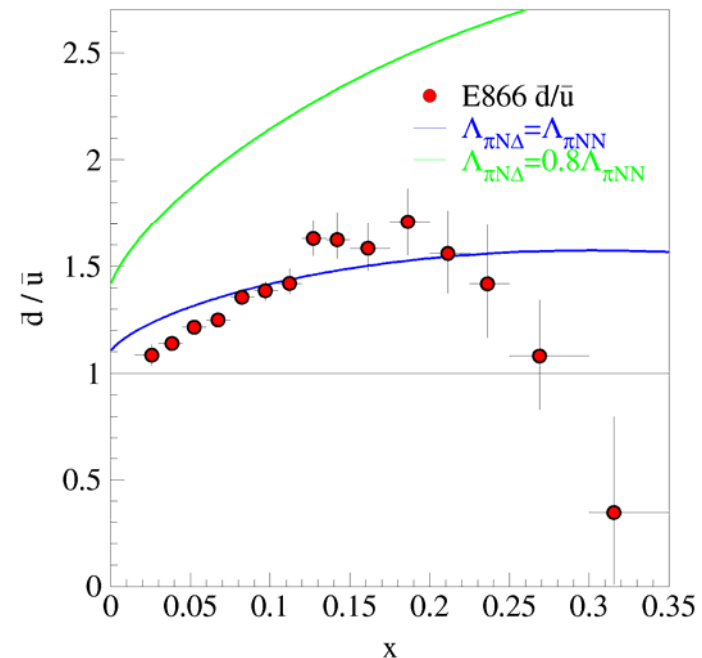
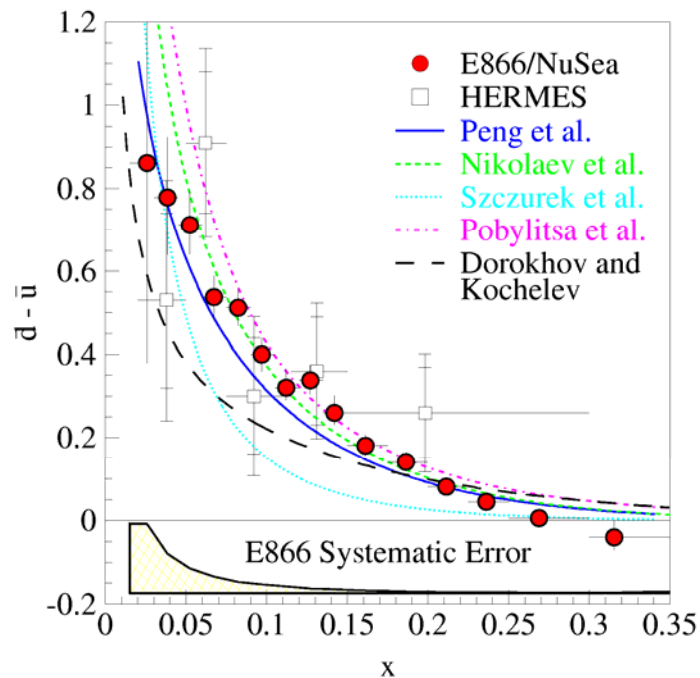
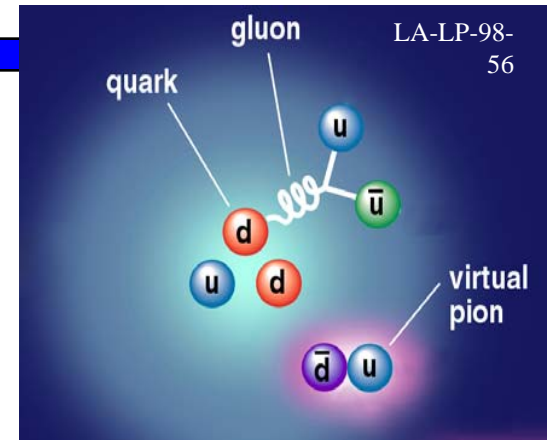




# Structure of the Nucleon Sea: Interpretation?

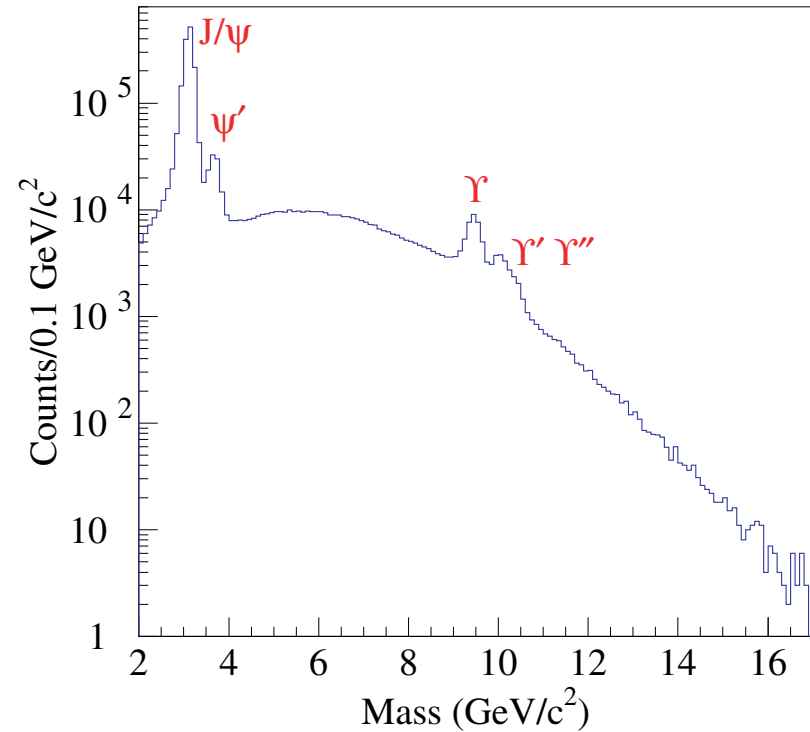
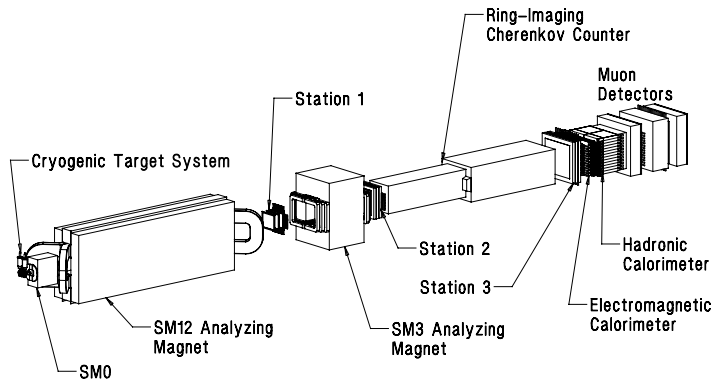
- Meson Cloud? Chiral Solitons? Instantons?

$$\bar{d}(x) > \bar{u}(x)$$





# Proposal of Experiment



1

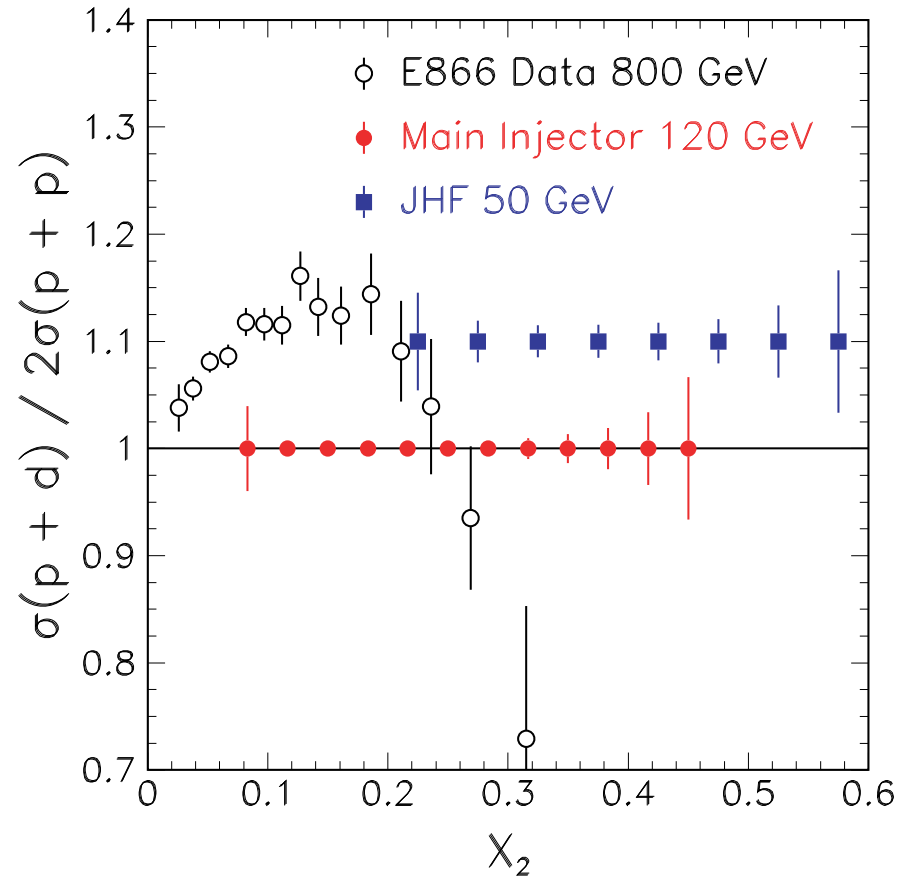


# d-bar/ubar at Large x using 50 GeV Protons

- DY cross section is ~16 times larger at 50 GeV than at 800 GeV.

$$\frac{d\sigma_{DY}}{dx_1 dx_2} \approx \frac{1}{s} \text{ at fixed } x_1, x_2$$

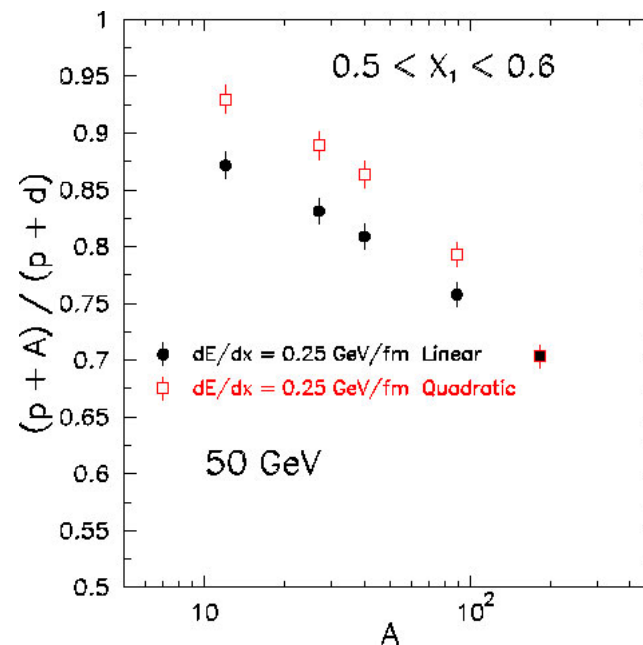
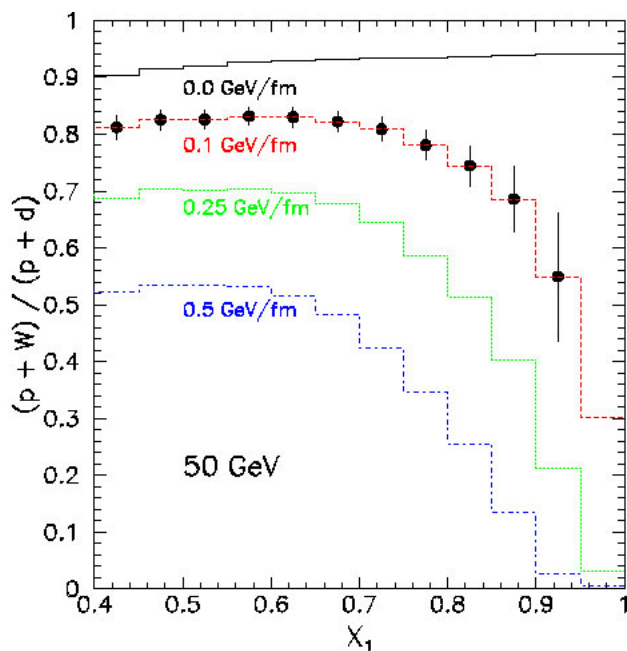
- J-PARC can measure d-bar/u-bar at larger x.





# Quark Energy Loss with DY at 50 GeV

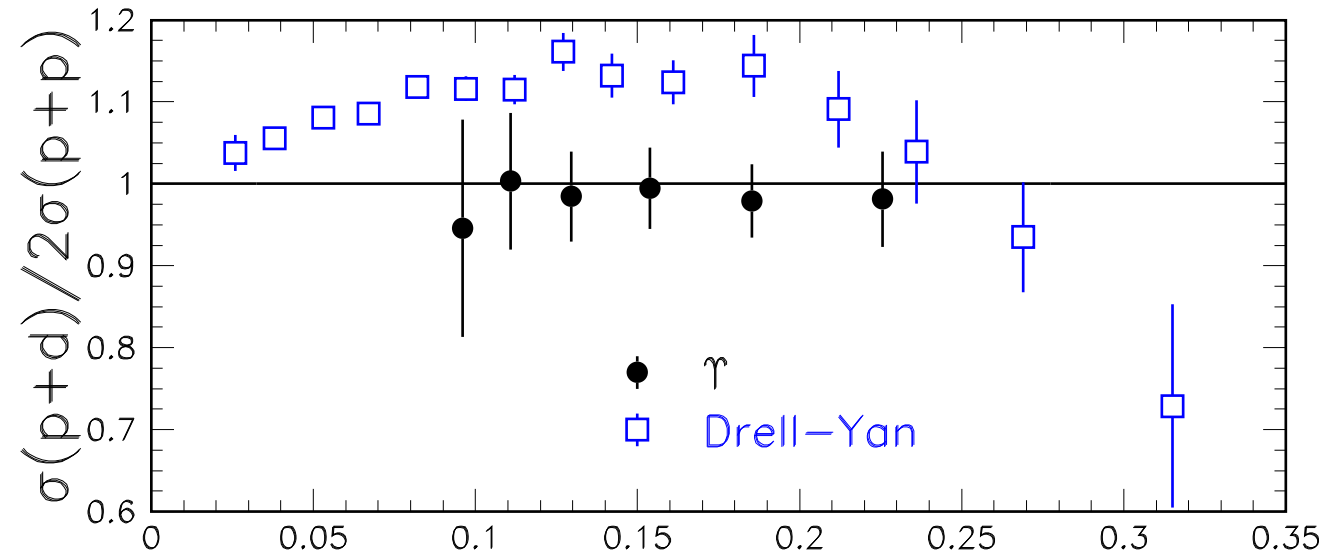
- At 50 GeV, energy loss can be well measured.
  - Fractional energy loss is larger at 50 GeV. Effect is amplified.
- Possible to test the L dependence of the LPM effect from the A dependence.





# Quarkonium production at 30 GeV

800 GeV  $\sigma(p+d \rightarrow \mu^+ \mu^- X) / \sigma(p+p \rightarrow \mu^+ \mu^- X)$



To appear in PRL,  
arXiv: 0710.2344

$$\text{Drell-Yan: } \sigma^{pd} / 2\sigma^{pp} \approx \frac{1}{2} [1 + \bar{d}(x) / \bar{u}(x)]$$

$$J/\Psi, \Upsilon: \sigma^{pd} / 2\sigma^{pp} \approx \frac{1}{2} [1 + g_n(x) / g_p(x)]$$

- pdとppの比の（エネルギーによる）変化を測定することにより、生成過程を明らかに出来る。
- もしも30GeVでq+qbarが支配的なら、J/Psi生成を核子構造の測定に用いることが出来る。



- FNAL E906 Experiment
  - Similar experiment using 120 GeV protons (p+p, p+d, and probably p+A)
  - Scientifically approved
  - Preparation continues, seeking Japanese participation
  - Expect experiment runs from 2010, for 2 years
  - Apparatus is considered to be shipped to Japan after E906
  - Reuse at J-PARC is being considered in the design
  - We (KEK/Kyoto/RIKEN/TokyoTech) have applied to US-Japan cooperation money to participate in E906.
- J-PARC Experiment even after E906
  - Difference of beam energy should be important
    - Lower energies lead to extension of large x region, clearer measurement of energy loss, ...
    - Check of consistency
    - Quarkonium production
  - Also fruitful, and more complete understanding of the nucleon structure with polarized beams in the future (see Goto-san's talk)



# P24: Polarized Proton Acceleration at J-ARC

## Collaboration

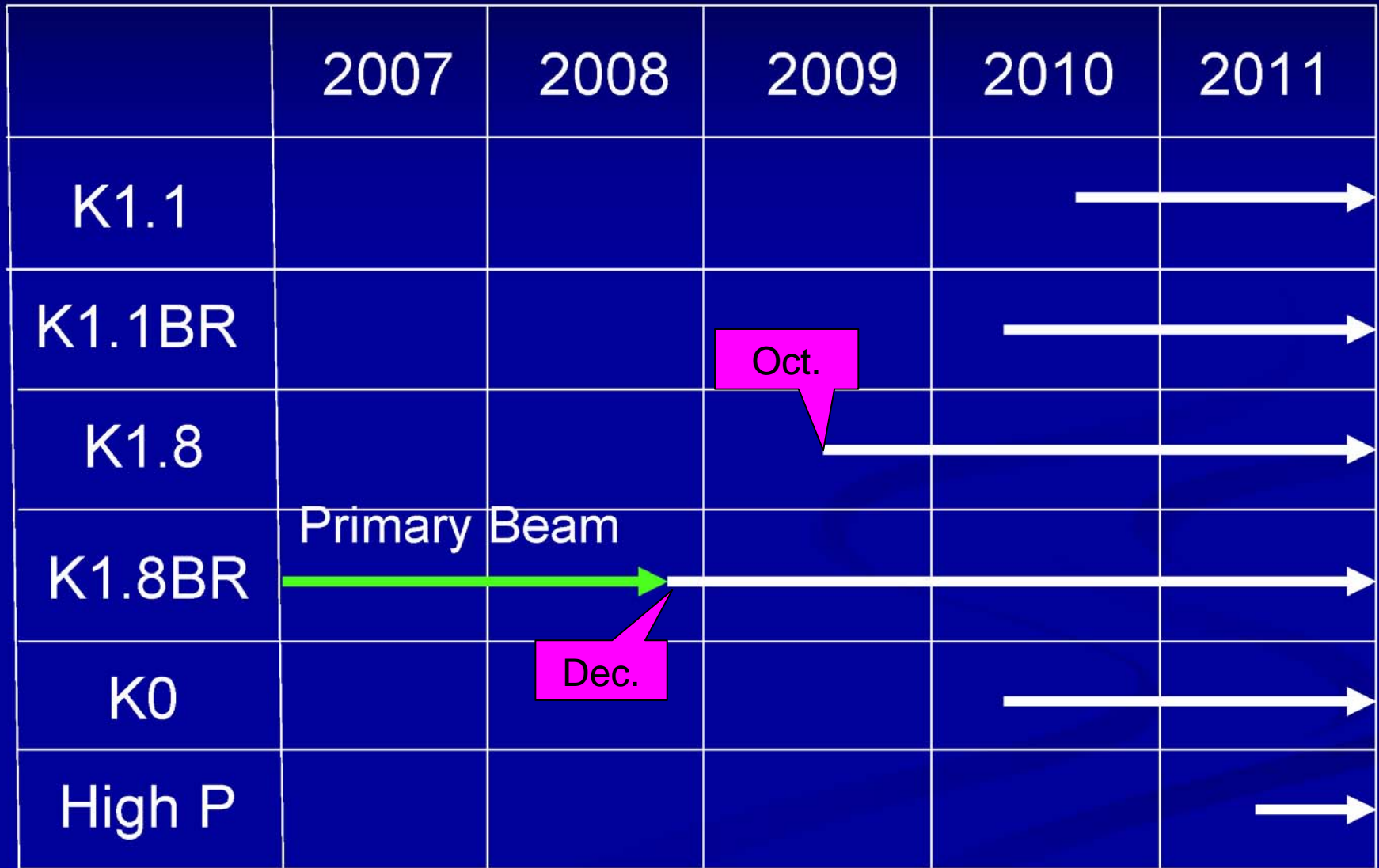
- Argonne National Laboratory
  - D.F. Geesaman, P.E. Reimer
- Brookhaven National Laboratory
  - M. Bai, H. Huang, A.U. Luccio, T. Roser, A. Zelenski
- University of Illinois at Urbana-Champaign
  - M. Grosse Perdekamp, J.-C. Peng
- KEK
  - S. Ishimoto, S. Kumano, A. Molodjontsev, C. Ohmori, N. Saito, H. Sato, S. Sawada, J. Takano
- Kyoto University
  - K. Imai
- Los Alamos National Laboratory
  - M. Brooks, X. Jiang, G. Kunde, M.J. Leitch, M.X. Liu, P.L. McGaughey
- RCNP, Osaka University
  - K. Hatanaka
- RIKEN
  - Y. Fukao, Y. Goto, A. Taketani
- RIKEN BNL Research Center
  - R. Seidl, M. Togawa
- Rikkyo University
  - K. Kurita
- Tokyo Institute of Technology
  - T.-A. Shibata
- Tokyo University of Science
  - J. Chiba
- Yamagata University
  - N. Doshita, T. Iwata, K. Kondo





- PAC recommendation for P04 is “defer”.
- Dimuon measurement, especially the physics impact of d-bar/u-bar is now depend upon the results of E906.
- Quarkonium at 30 GeV is an unique physics case.
- Also if the polarized beam/target is available, the experiment is very much interesting.
- We have applied for US-Japan money. Also, we have been doing efforts to realize the high-momentum beam line.

# A possible Schedule of Beam Delivery



Neutrino





# Cost & Schedule: Magnets from the World

- Total cost if constructed from scratch: \$5-8M??
- We have no budget so far to construct a high momentum beam line. But we are doing every effort to construct it with as small cost as possible, e.g. reuse of second-hand magnets...
- Already from SLAC, Saclay, CERN, ...
- Large dipole magnets from ANL (previously used for the polarized beam line at FNAL) are under process!
- The high momentum beam line can be constructed by using some of these second-hand magnets.
  
- The high momentum beam line can be constructed even at the beginning of the hadron hall operation from the viewpoint of the facility design.



Large dipole magnets at the Meson Pol beam line (FNAL)