

Nuclear Physics in Taiwan

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Physics Dept., NTU

- Neutrinos (TEXONO, Taiwan Experiment on Neutrino)
- Nuclear properties probed by high precision atomic spectroscopy
- Collaborations: LEGS/ Spring-8, d-bar/u-bar @ FNAL
- Theory

TEXONO Collaboration

Taiwan EXperiment On Neutrino



Collaboration :

- **Taiwan** (AS, INER, KSNPS, NTU, NCU, NCCU)
- **China** (IHEP, CIAE, THU, NJU, NKU)
- **Turkey** (METU)
- **India** (BHU)

+ *Close Partnership (KIMS Collaboration in S. Korea)*



Henry T.K. Wong, Academia Sinica, Taipei

Neutrino magnetic moment

Kuo-Sheng Nuclear Power Plant



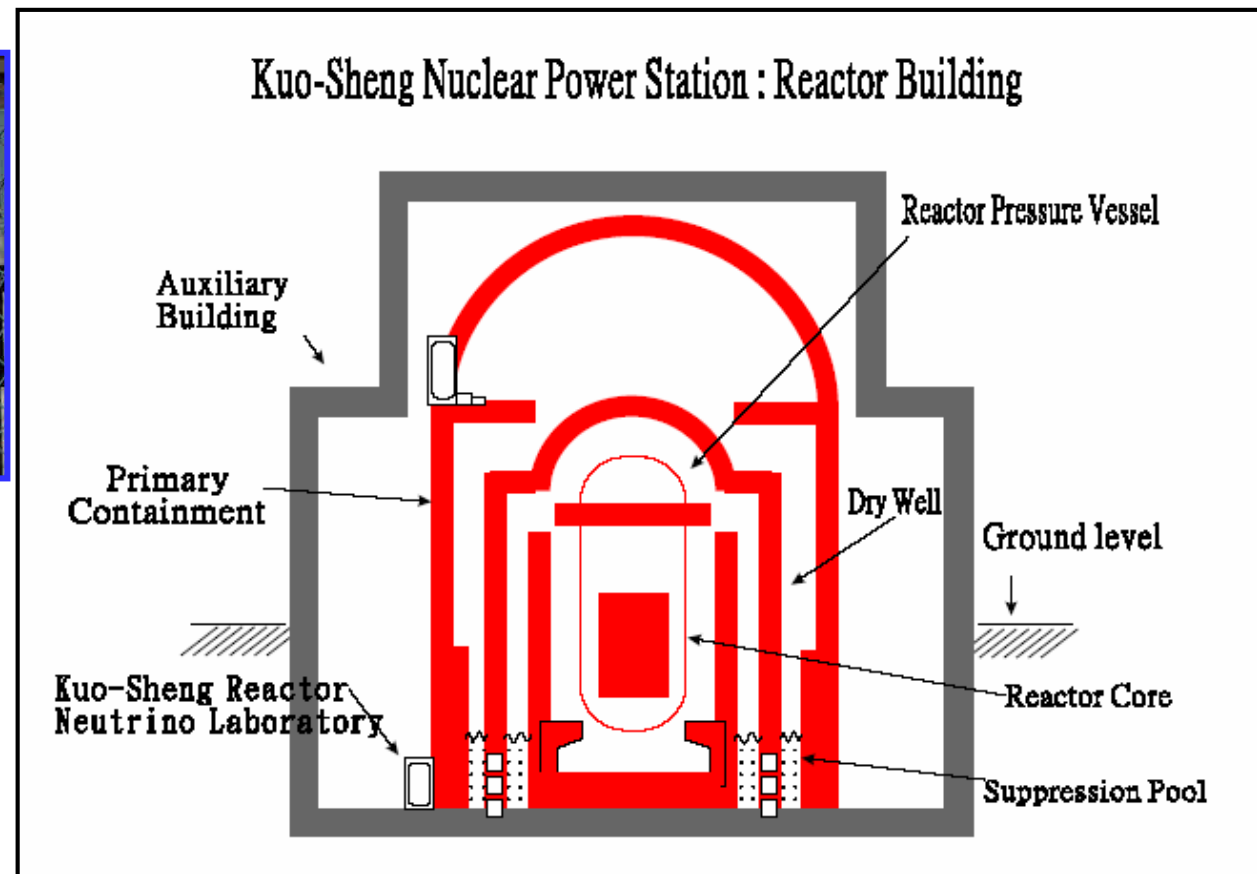
KS NPS-II : 2 cores × 2.9 GW



Powerful collaboration. Scientists from Taiwan and mainland China are studying neutrino emissions from this nuclear power plant outside Taipei.



Kuo Sheng Reactor Neutrino Laboratory



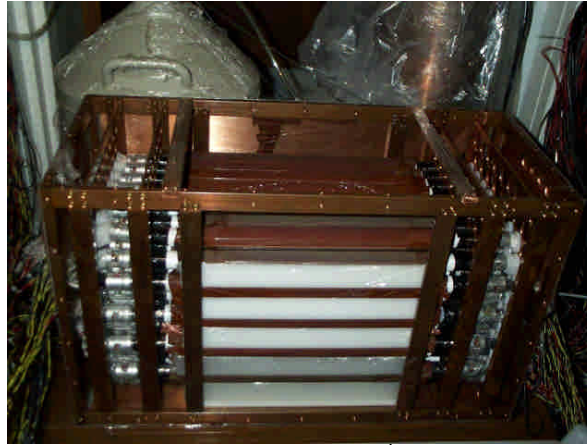
- 28 m from core#1 @ 2.9 GW
- Shallow depth : ~30 meter-water-equivalent
- Reactor Cycle : ~50 days OFF every 18 months

KS Laboratory : Detectors

ULB-HPGe [1 kg]



CsI(Tl) [200 kg]



ULE-ULB-HPGe
Prototype [20 g]



FADC Readout
[16 ch., 20 MHz, 8 bit]



Multi-Disks Array [600 Gb]

Limit:

$$\mu_{\nu}(\nu_e) < 7.4 \times 10^{-11} \mu_B \quad @ \quad 90\% \text{ CL}$$

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week ending
4 APRIL 2003

Limit on the Electron Neutrino Magnetic Moment from the Kuo-Sheng Reactor Neutrino Experiment

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(TEXONO Collaboration)

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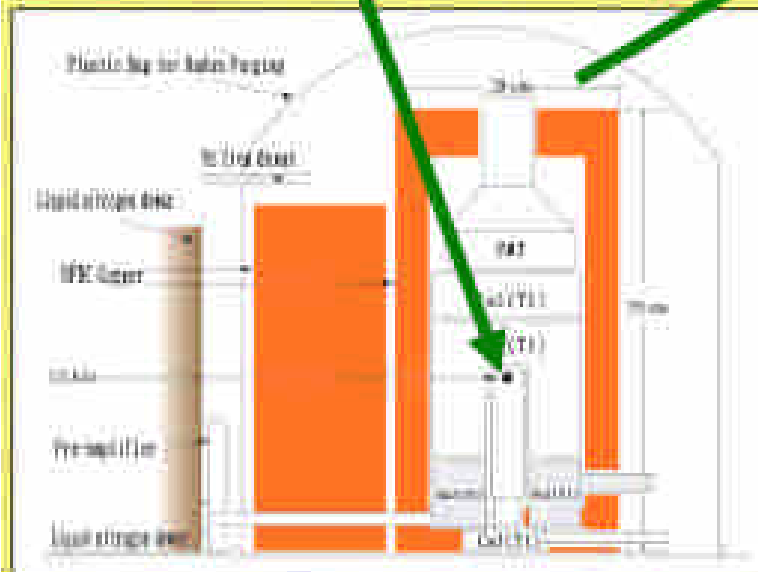
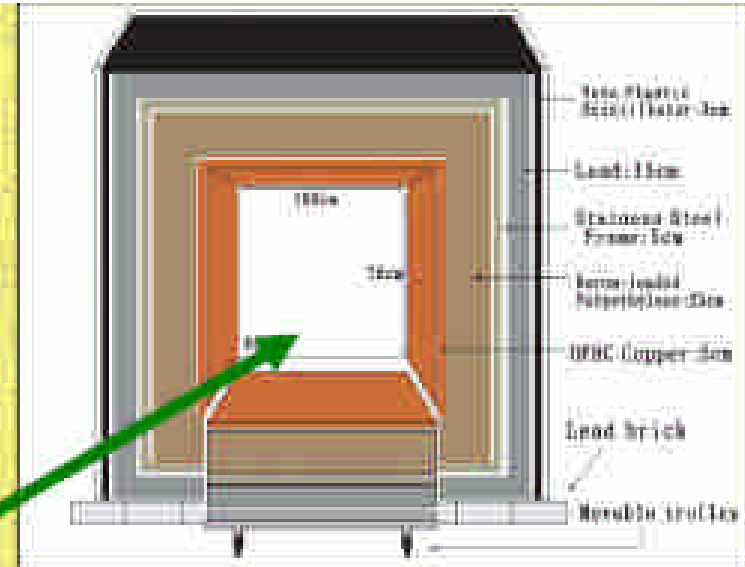
A search of neutrino magnetic moment was carried out at the Kuo-Sheng Nuclear Power Station at a distance of 28 m from the 2.9 GW reactor core. With a high purity germanium detector of mass 1.06 kg surrounded by scintillating NaI(Tl) and CsI(Tl) crystals as anti-Compton detectors, a detection threshold of 5 keV and a background level of $1 \text{ kg}^{-1} \text{ keV}^{-1} \text{ day}^{-1}$ at 12–60 keV were achieved. Based on 4712 and 1250 h of reactor ON and OFF data, respectively, the limit on the neutrino magnetic moment of $\mu_{\nu} < 1.3 \times 10^{-10} \mu_B$ at 90% confidence level was derived. An indirect bound of the $\bar{\nu}_e$ radiative lifetime of $m_{\nu}^2 \tau_{\nu} > 2.8 \times 10^{18} \text{ eV}^3 \text{ s}$ can be inferred.

Final Results: Phys. Rev. D 75(2007)

WIMP

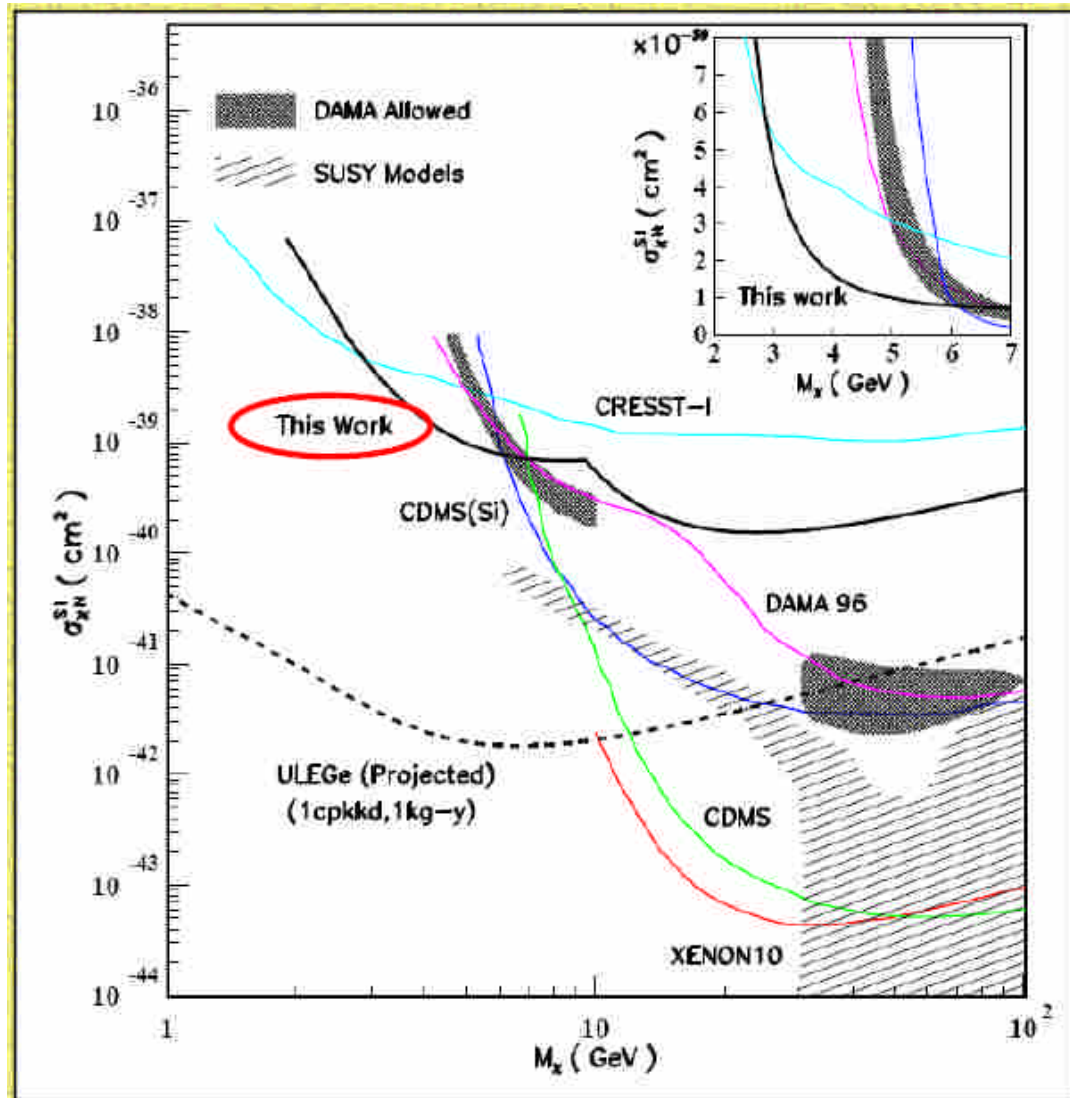
TEXONO Detector & Shieldings

4X5g
ULEGe



- **Candidate Events:** selected by Anti-Compton [$ACV: \gamma$] and Cosmic-Ray [$CRV: \mu$] vetos & Pulse-Shape Discrimination [$PSD: \text{electronic noise}$]
- **Critical Issues:** Signal efficiencies for trigger, DAQ & Selection
- **Non-Ge Efficiency [DAQ, ACV, CRV]:** evaluated by Random Trigger events.

Exclusion Plot: Spin-Independent Couplings

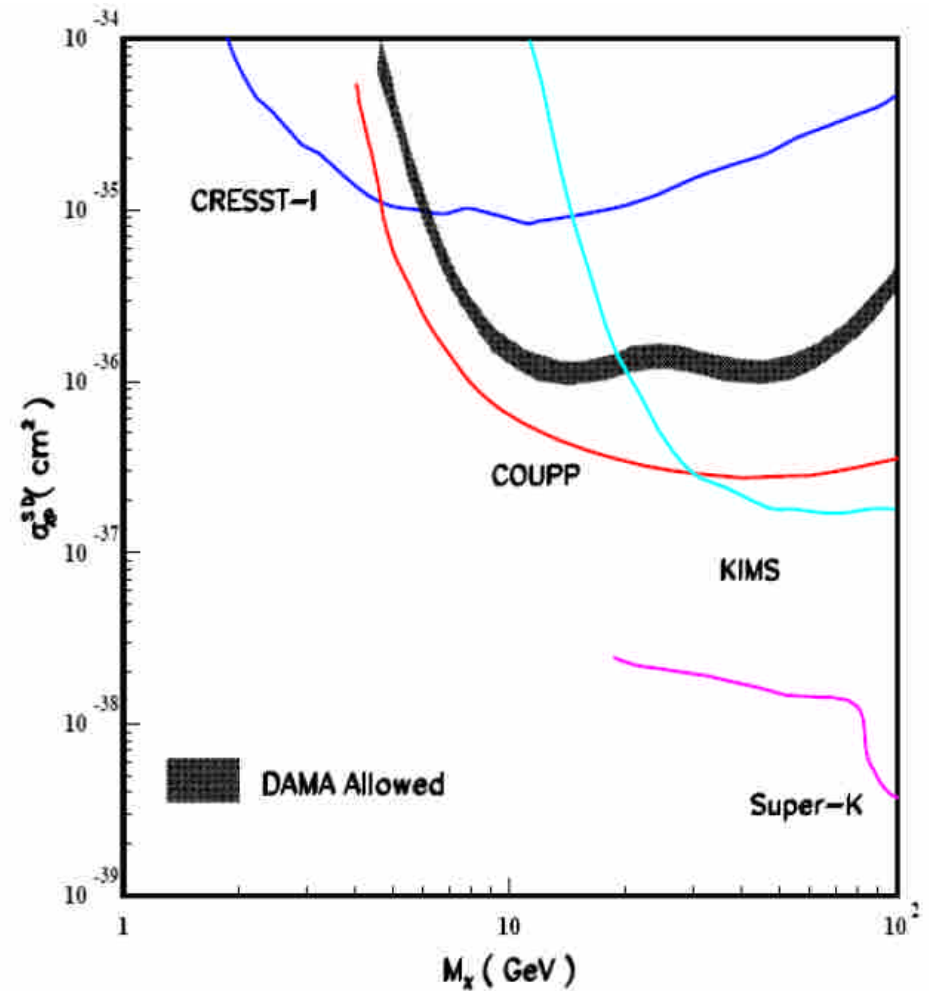
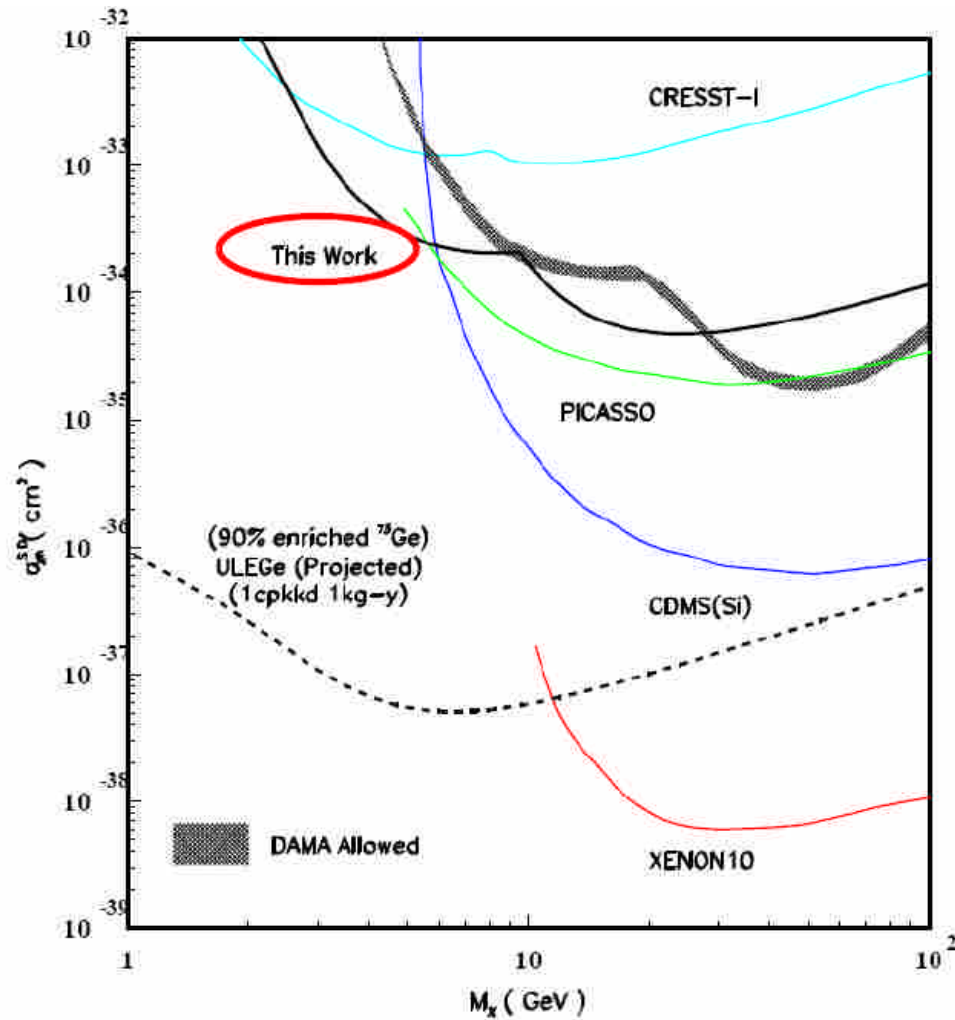


TEXONO : 20 g
 ULEGe at
 220 eV threshold
 \Rightarrow low WIMP
 masses [PRD 2009]



Data Taking at KS
 with 500 g Point-
 Contact Ge Underway

Exclusion Plot: Spin-Dependent Couplings



NEXT

- Operating ULEGe @ Mt. Jin-Ping Tunnel in 2010

Li-Bang Wang, National Tsing-Hua U., Hsin-Chu



2006 Dissertation Award in Nuclear Physics Recipient

Li-Bang Wang
LANL

Citation:

"For his outstanding and innovative experimental work to precisely measure the charge radius of the exotic and short-lived isotope ${}^6\text{He}$ by laser spectroscopic studies of single atoms stored in a magneto-optical trap. The result helps to reveal the nature of weakly bound nuclei and serves as a key benchmark for nuclear models."



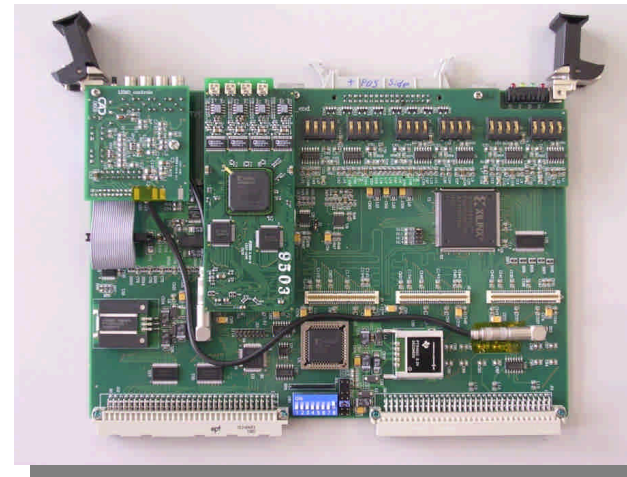
Probing helium isotope properties (e.g. ${}^6\text{He}$, ${}^8\text{He}$) by high precision atomic spectroscopy with atom or ion traps.

Wen-Chen Chang, Academic Sinica, Taipei



LEPS, Spring-8

- Flash Analog Digital Convertor (FADC)



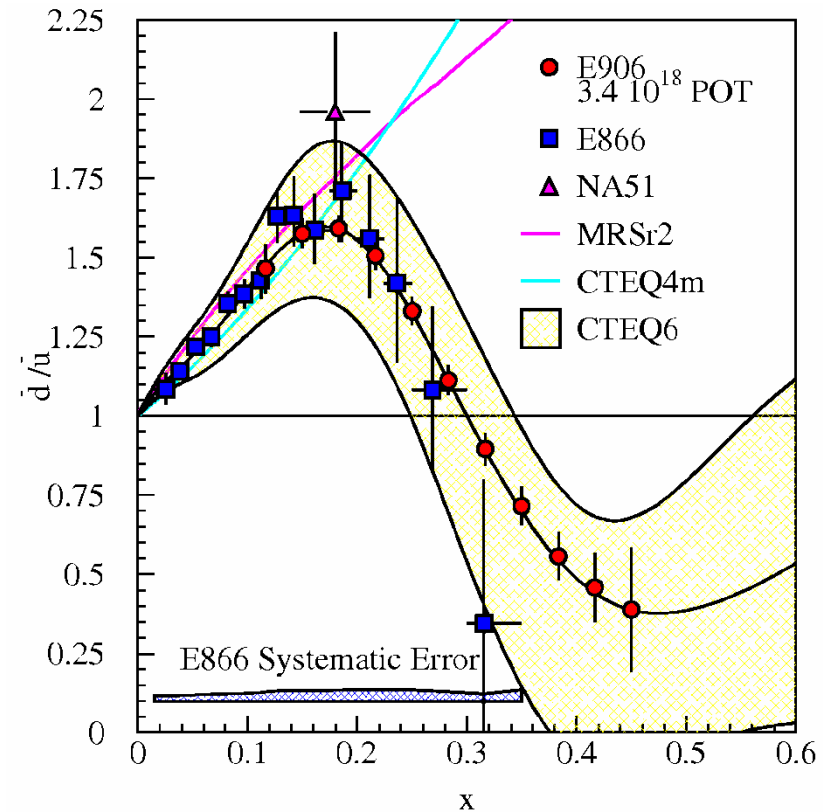
- Analyses: ϕ -meson and hyperon photoproduction from p and d at low energies (including 2 PRL's).

E906 Experiment at FNAL (2010~)

Ratio of Drell-Yan cross sections

$$\left. \frac{\sigma^{pd}}{2\sigma^{pp}} \right|_{x_b \gg x_t} \approx \frac{1}{2} \left[1 + \frac{\bar{d}(x_t)}{\bar{u}(x_t)} \right]$$

- In KTeV hall, Fermilab E906/Drell-Yan will extend the measurements of d-bar/u-bar into large x region using 120 GeV proton beam from the Main Injector.
- **The experiment is approved to start in June, 2010.**



E-906/Drell-Yan Collaboration

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Obiageli Akinbule
Brandon Bowen
Mandi Crowder
Tyler Hague
Donald Isenhower
Ben Miller
Rusty Towell
Marissa Walker
Shon Watson
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Yoshiyuki Miyachi

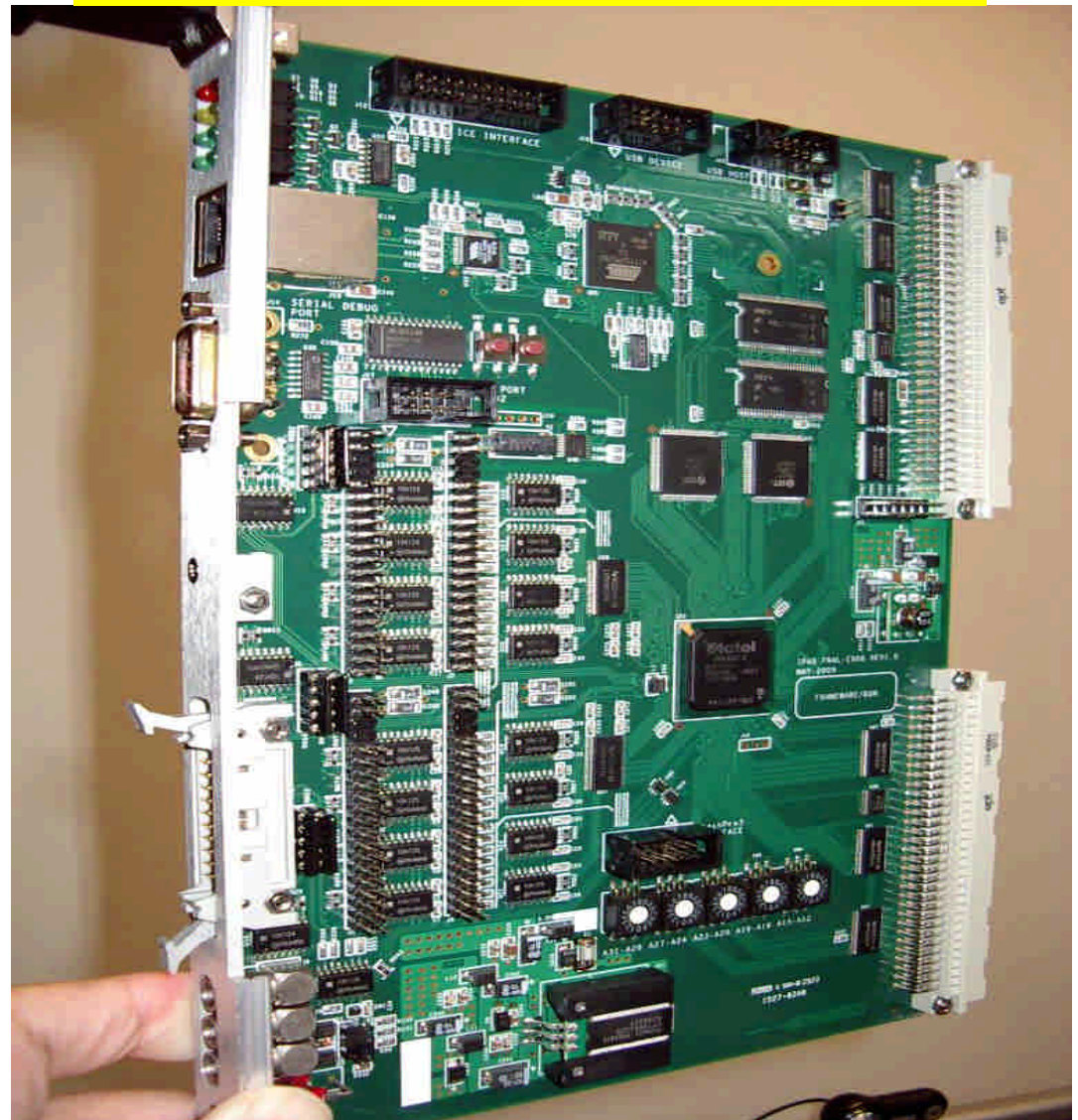
*Co-Spokespersons

E906 Experiment at FNAL (2010~)

64-channel coincidence register modules

For the preparation of the start-up of E906 experiment, Taiwan group are in charge of

- Pre-amplifier cards and coincidence register modules for the readout of MWPC and drift chamber.
- Level-2 trigger.
- On-site DAQ.



Future Plan

- **LEPS:**
 - Implementation of polarized HD target for the double-polarization experiment.
 - LEPS2 upgrade.
- **E906 in FNAL:**
 - Plan to operate in 2010-2013.
- **High-flux 30/50 GeV proton beam in JPARC:**
 - Di-muon and hadron physics experiment.
 - After 2014.

Nuclear Theory

- 5 faculty members below 45 yrs old
- With backgrounds in lattice QCD, effective field theory, many body, heavy ion collisions, atomic physics, and string theory
- “Happy hours” every Friday afternoon