

Kuo-Sheng Neutrino Experiment :

Status and First Results

- **TEXONO Collaboration : Overview**
- **Kuo-Sheng Neutrino Laboratory**
- **First Results with ULB-HPGe**
- **Status and Plans**

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WIN02, Jan 02

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HISTORY

Initiate: **Chang Chung-Yun, 1996**

First Collaboration Meeting/Official Start: **October 1997**

First Paper Submitted: **October 1998**

KS Reactor Experiment Installation: **June 2000**

First Ph.D.: **Liu Yan, July 2000**

First Data Taking: **January 2001**

First Physics Data Taking: **June 2001**

[†] **Taiwan EXperiment On Neutrino.**

Home Page @ <http://hepmail.phys.sinica.edu.tw/textono/index.html/>

KS Experiment:

- **Elaborate Electronics & Shieldings**
- **Flexible Detector Possibilities**
- **Full Recording of Pulse Shape+Timing Info**
- **Study Neutrino Properties & Interactions**

R&D Projects:

- **CsI(Tl) for Dark Matter**
- **Low Energy Neutrino Detection:
loaded Gd/Yb crystals, ULE –HPGe**
- **AMS for Radiopurity Measurements**
- **Upgrade FADCs for LEPS/SPring-8
+FPGA on-board processing**

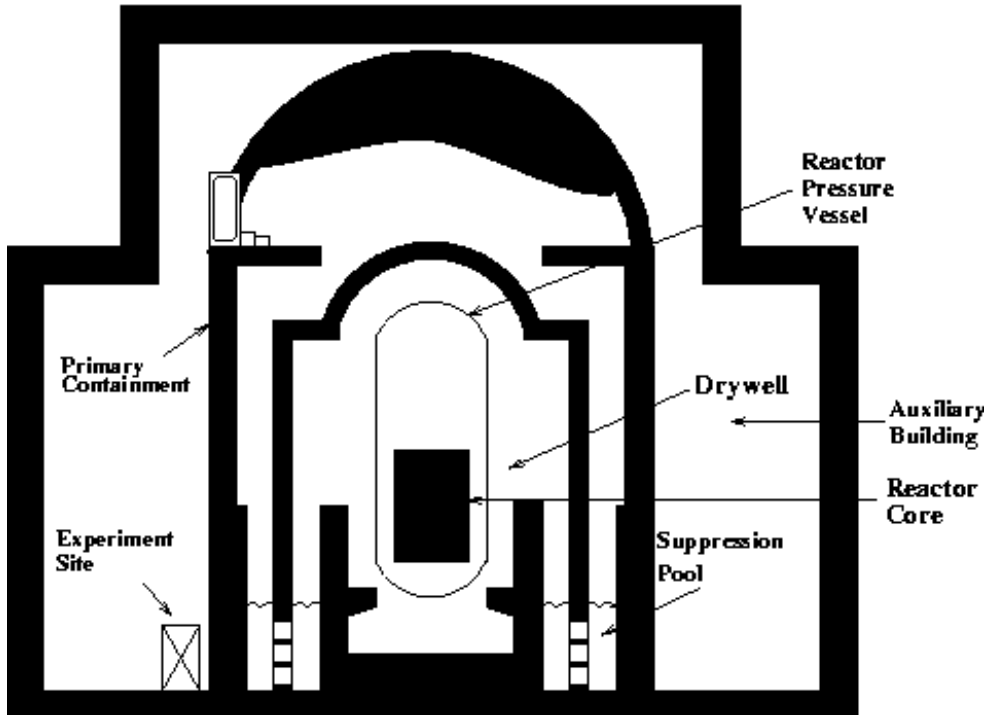
Kuo-Sheng Nuclear Power Plant



KS NPS-II :
2 cores X 2.9 GW



Kuo-sheng Nuclear Power Station : Reactor Building



KS v Lab:
28 m from
core#1

Kuo Sheng Reactor Neutrino Laboratory



Front Gate

Front View

**(cosmic vetos,
shieldings,
control room**



Shielding (Sept 2000)

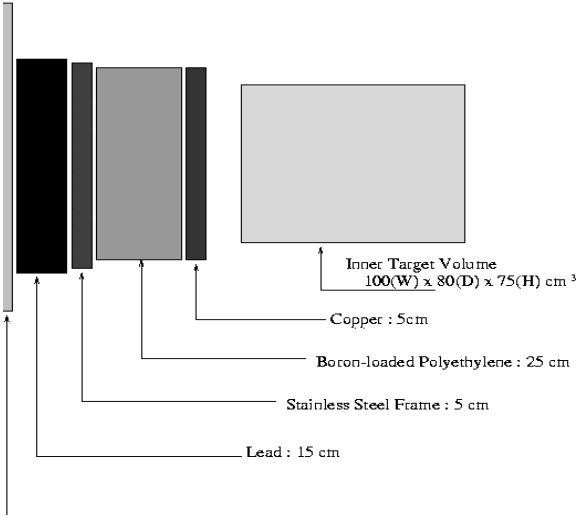


**Inner Target
Volume**

KS Expt. : Period I Configuration

Period I : June 01 – March 02 (60 days OFF)

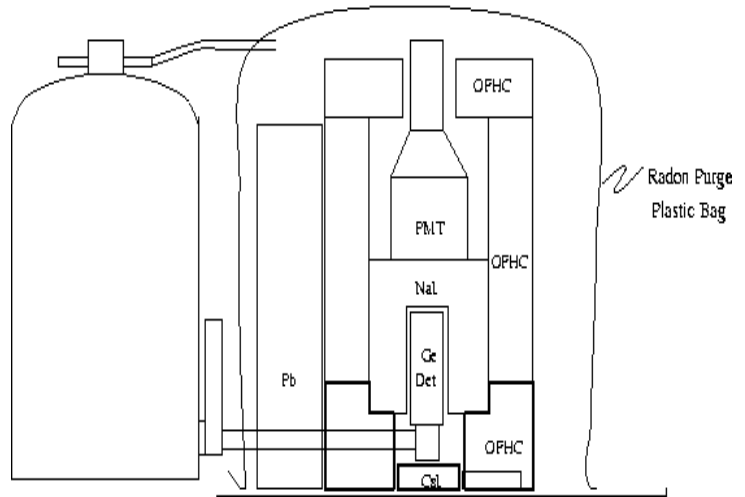
Shielding Design
[Only One out of Six Sides Shown]



Shielding & Veto

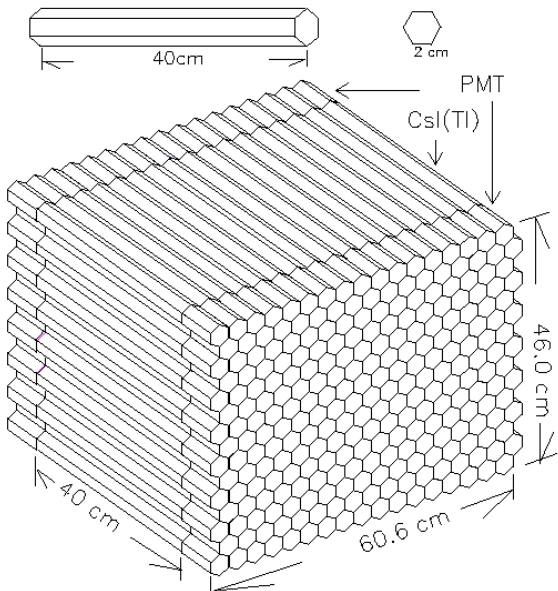
[one side]

Kuo-Sheng Experiment : HPGe Detector



ULB-HPGe + Anti-Comptons

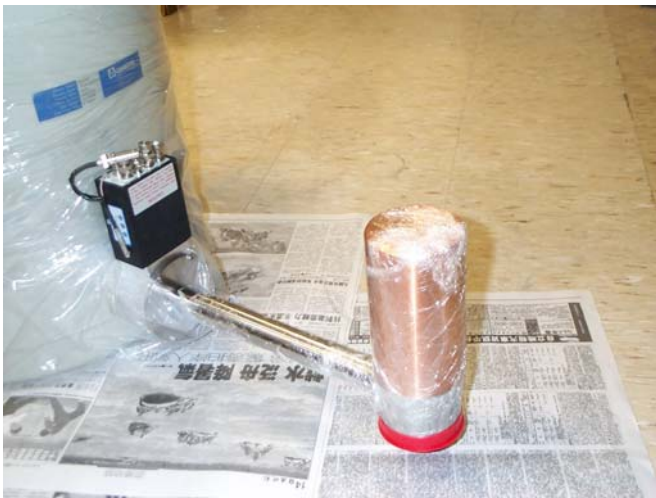
CsI(Tl) Longitudinal View Cross-Sectional View



CsI(Tl) Array

KS Expt: Period I Detectors

ULB-HPGe [1 kg]



CsI(Tl) [46 kg]



Flash ADC Module



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



Multi-Disks
Array
[600 Gb]

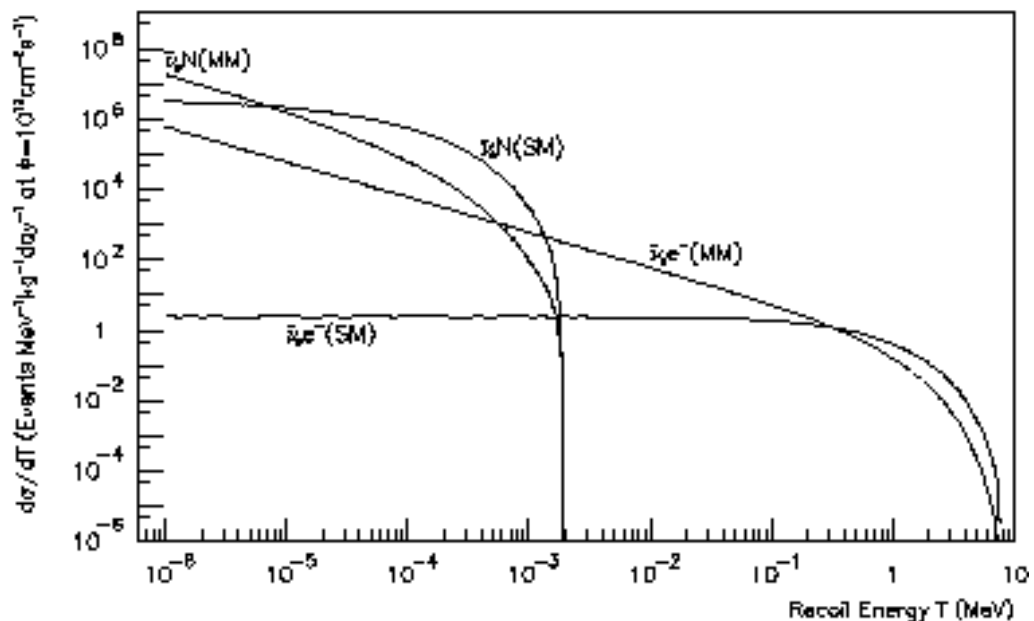
μ_ν with Reactor $\bar{\nu}_e$

⊙ μ_ν :

- parametrize possible $\nu_i^L \rightarrow \nu_j^R + \gamma$ vertices
- Both $i=j$ “diagonal”
& $i \neq j$ “transition” moments

⊙ Experimental Probe:

- Study $\bar{\nu}_e + e^- \rightarrow \nu_X + e^-$
- Focus on Low Recoil Energy
 - $\sigma_{\mu\nu} \propto T^{-1}$
 - decouple SM “background”
(LE Reactor $\phi(\bar{\nu}_e)$ not accurate)



- Look for Excess in Reactor ON/OFF

⊙ Neutrino Radiative Decay (Γ_ν):

- $\sigma_{\mu\nu}$ & Γ_ν related
- Same vertices, Real γ for Γ_ν

KS/P1/Ge/ $\mu\nu$ Data

⊙ Data Volume:

- ↪ Expected total 170/60 days ON/OFF
- ↪ Reported here : 62/46 days ON/OFF

⊙ HPGe Performance:

- ↪ 1.06 kg mass
- ↪ 0.4 keV RMS at 10 keV
- ↪ Threshold 5 keV [Unique data]

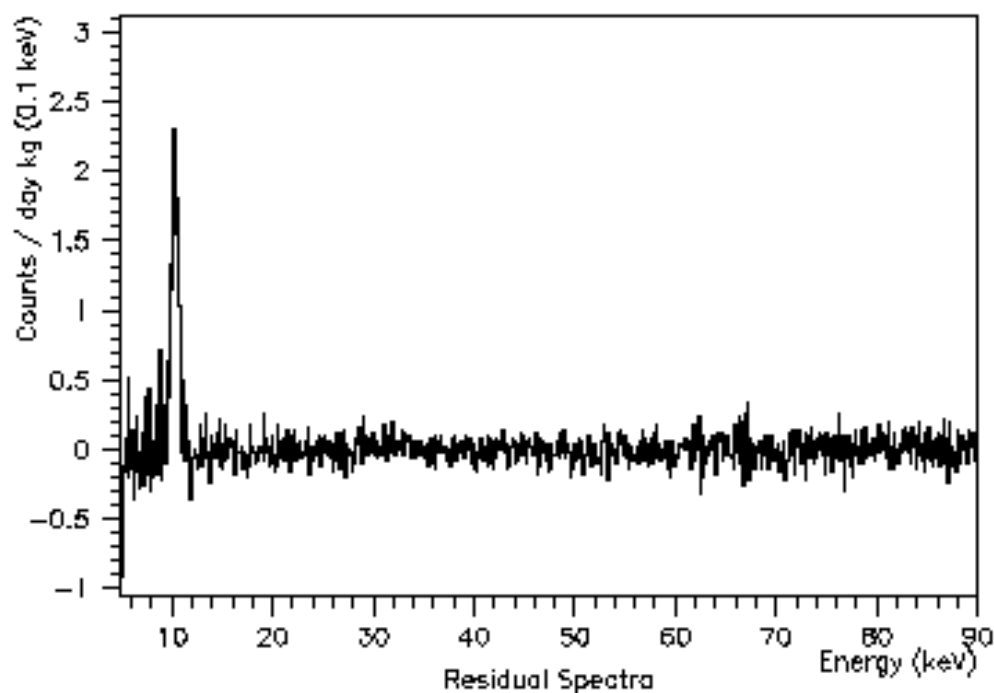
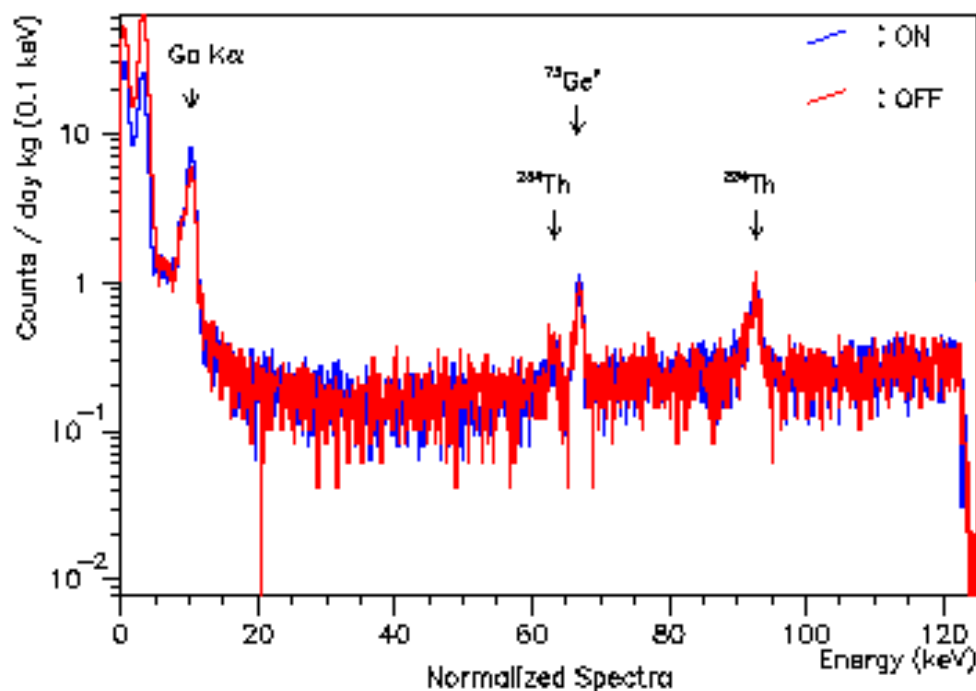
⊙ Analysis:

- ↪ Cosmic Veto (5 μ s)
- ↪ Anti-Compton (Well+Base detectors)
- ↪ Pulse Shape Disc. (veto elect. noise)
- ↪ Timing Analysis (veto clusters)
- ↪ (not yet implemented here)

⊙ Efficiencies Normalization:

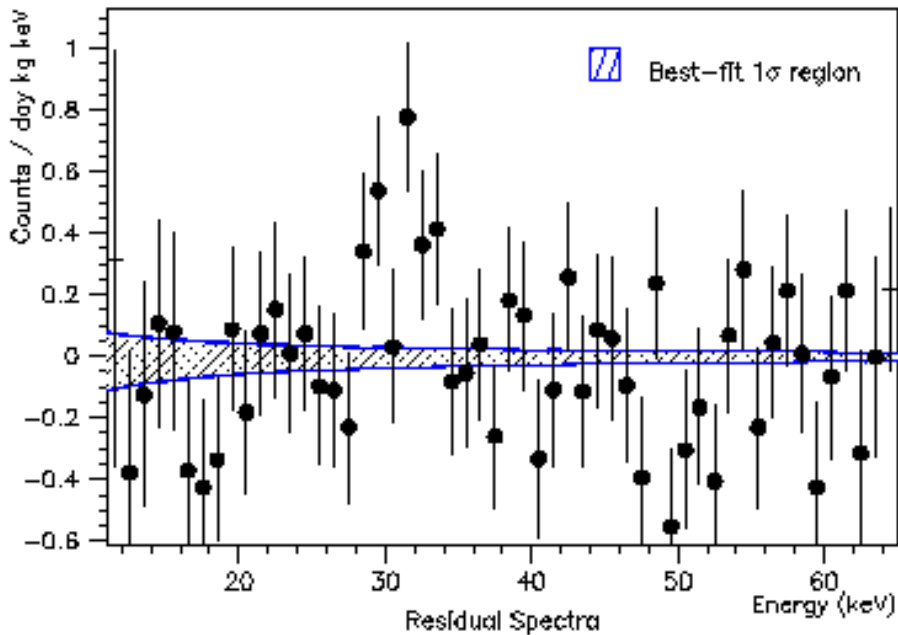
- ↪ DAQ book-keeping
- ↪ Monitor random triggers
- ↪ Monitor residual ^{40}K peaks
- ↪ Monitor 10 keV Ga X-rays peak

KS/P1/Ge : Latest Analysis



Based on 62/46 days of ON/OFF Data

KS/P1/Ge : First Results



- ⊙ Fit Residual Data > 12 keV to

$$\phi_{SM} + \mu_\nu^2 \phi_{MM} [10^{-10} \mu_B]$$

- ⊙ Best Fit (@ $\chi^2/\text{dof} = 79/78$) :

$$\mu_\nu^2 = -0.76 \pm 3.41$$

↪ (comparable sensitivities to
direct search world-limits)

- ⊙ Improvement expected from:

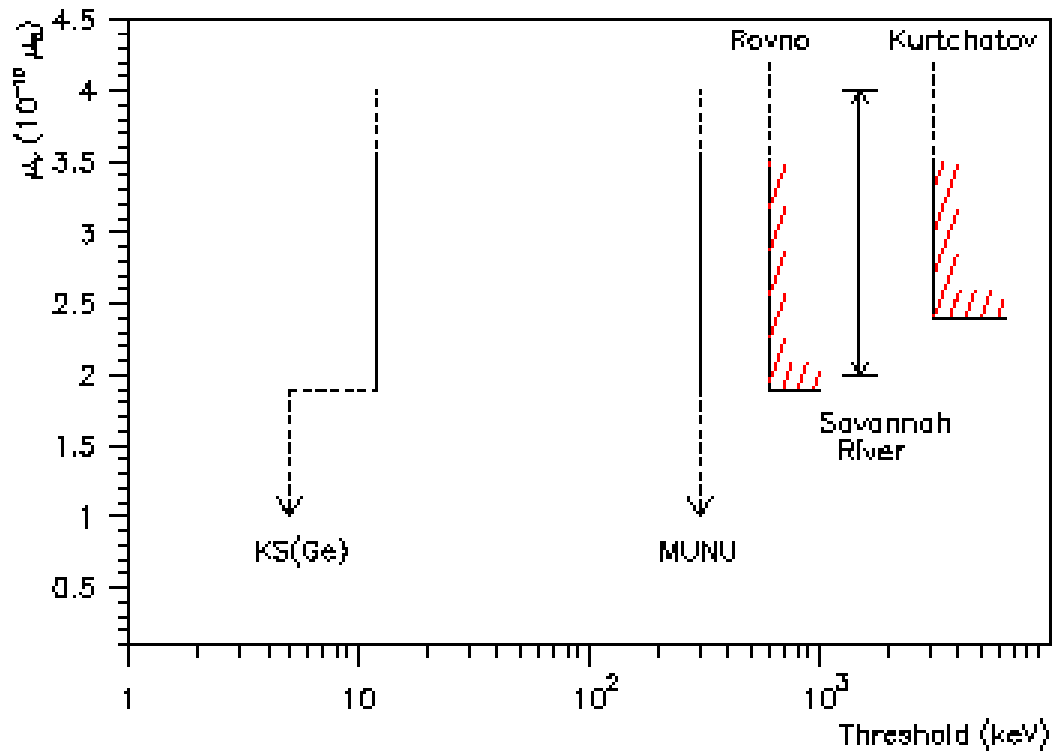
↪ more data

↪ complete and improved analysis

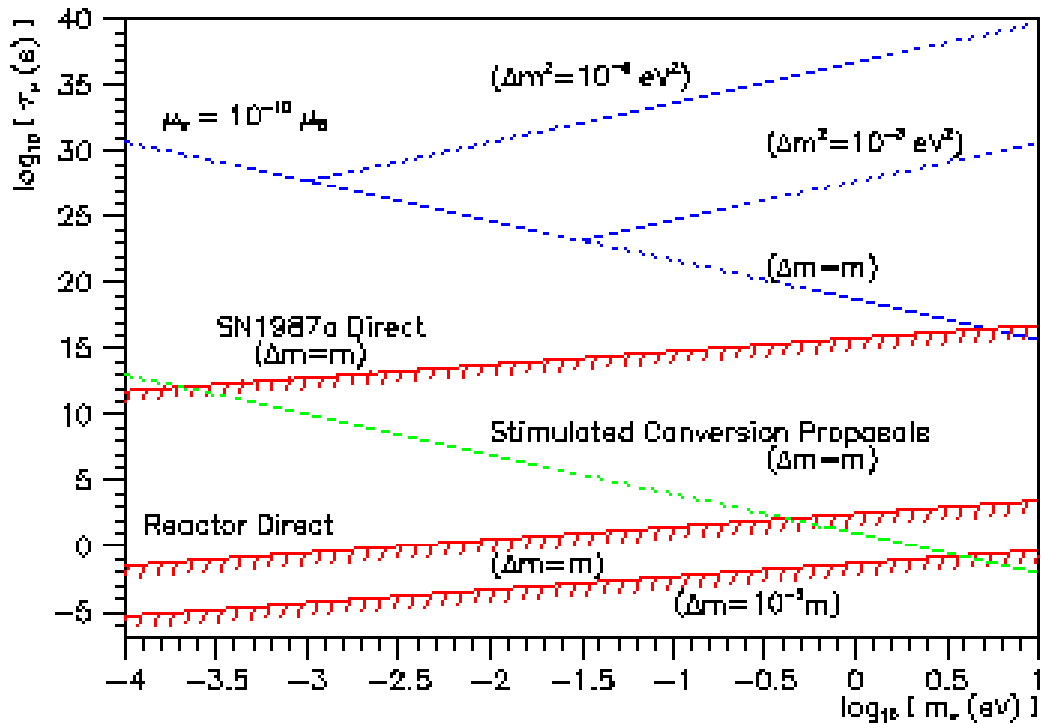
↪ treatment of threshold region

- ⊙ More data taking with upgraded hardware in P2 (2nd half 2002)

Reactor $\mu_{\nu}(\bar{\nu}_e)$ Sensitivities



Γ_{ν} Sensitivities



KS Expt : P1 Analysis

ULE-HPGe : UNIQUE Low Threshold Data

⊙ Established Problem :

μ_ν & Γ_ν for $\bar{\nu}_e$ from



⊙ + Speculative Analysis :

* Study ν_e Flux from Reactor

→ From neutron excitation producing

e.g. ^{51}Cr , ^{55}Fe

→ μ_ν and Γ_ν for ν_e (distinct energy and timing)

* Anomalous Neutrino Interactions in Matter

→ Anomalous energy deposition X (>eV)



(similar analysis as accelerator ν_μ)

* Study Possible Nuclear Transitions

→ e.g. $^{73}\text{Ge}^0$ decays by 2γ 's (53.4 keV, 13.3 keV)

separated by $\tau_{\frac{1}{2}} = 4.6 \mu\text{s}$

CsI(Tl) detector : Technical Run

⊙ Event Reconstruction

⊙ Background Studies

⊙ Optimize for P2, e.g., $\sigma(\bar{\nu}_e - e)$

SUMMARY

- ⊙ **TEXONO Collaboration[†]:**
 - ↔ **Built Up & Growing**
 - ⊙ **Kuo-Sheng Neutrino Lab.*:**
 - ↔ **Established & Operational**
 - ↪ **Flexible & Modular design**
 - ↔ **Physics data taking since June 2001**
 - ↪ **Unique HPGe low threshold data**
 - ↪ **Bkg. level ~ Udrgd. CDM expts.**
 - ↔ **Expect results on μ_ν (Γ_ν) soon**
 - ↔ **Preparation for P2 data taking**
 - ↪ **improved HPGe Config.**
 - ↪ **150⁺ kg CsI(Tl)**
- [Welcome Ideas/Comments/Suggestions
for Possibilities Beyond]**
- ⊙ **Diversified R&D Program in Parallel**
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* **FIRST Particle Physics experiment in Taiwan.**

† **FIRST Research Collaboration among groups from
Taiwan and China.**