Points of Osaka efforts for DBD

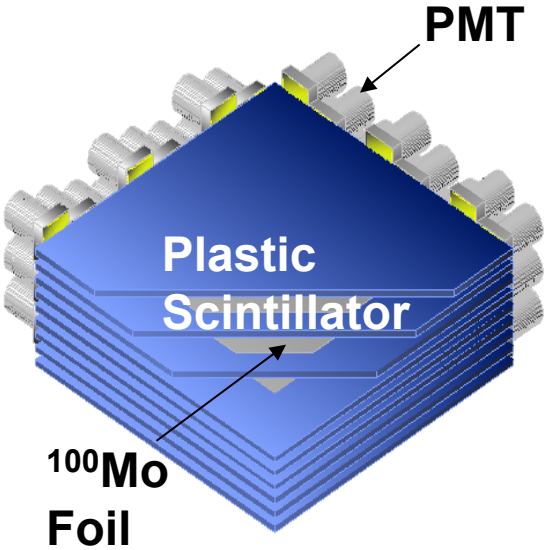
On behalf of MOON/CER collaborations Hiro Ejiri

1. Individual ββ/tracks to find/confirm 0νββ events and the Majorana ν-mass process
2. ββ isotopes with Q>3 MeV to enlarge S/N
3. Multilayer modules for possible scale-up and compact volume for tonne scale exp.
4. Experimental studies of nuclear matrix elements $M^{0\nu}$ to reduce theory uncertainty

Review Vergados Ejiri Simkovic Rep. Prog. Phys. 75 (2012) 106301

MOON PL Detector for QD-IH $0\nu\beta\beta$

Multilayer modules, extension from 2-layer ELEGANT V(1990-)



A. Individual β_1, β_2 by 2 PL scintillators

B. E_1, E_2, $W(\theta_{12})$ correlations

C. Detector $\neq\beta\beta$ source , other isotopes

D. E-resolution of PL σ~2.2 – 1.7 %

E. ^{100}Mo ^{82}Se with large $Q_{\beta\beta}$ ~3 MeV and large phase volume $G^{0\nu}$

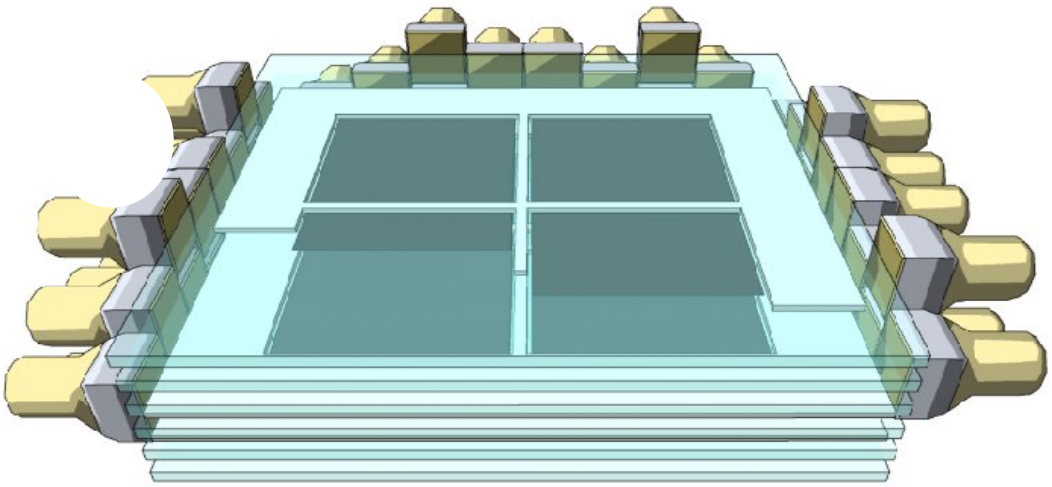
F. Compact detector volume of 50 m^3/ton of $\beta\beta$ isotopes. Two orders of magnitude smaller than S-NEMO

H. Ejiri et al, PRL 85 (2000)

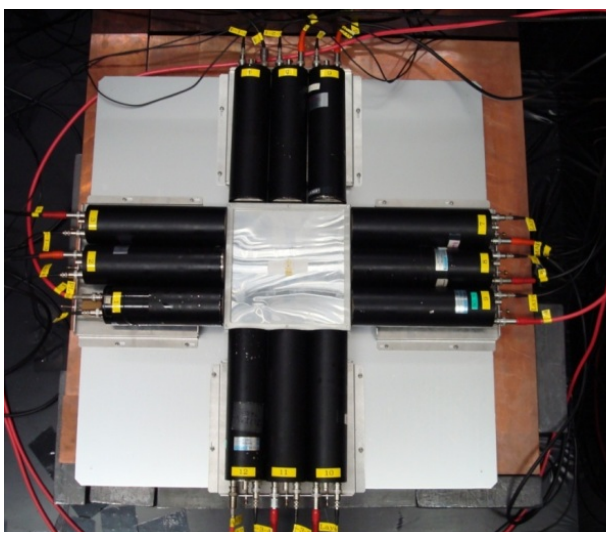
H. Ejiri, et al., European Physics J, 162 (2008) 239

H. Ejiri, 2010 Prog. Particle Nuclear Physics 64 249

MOON PL & NaI R&D

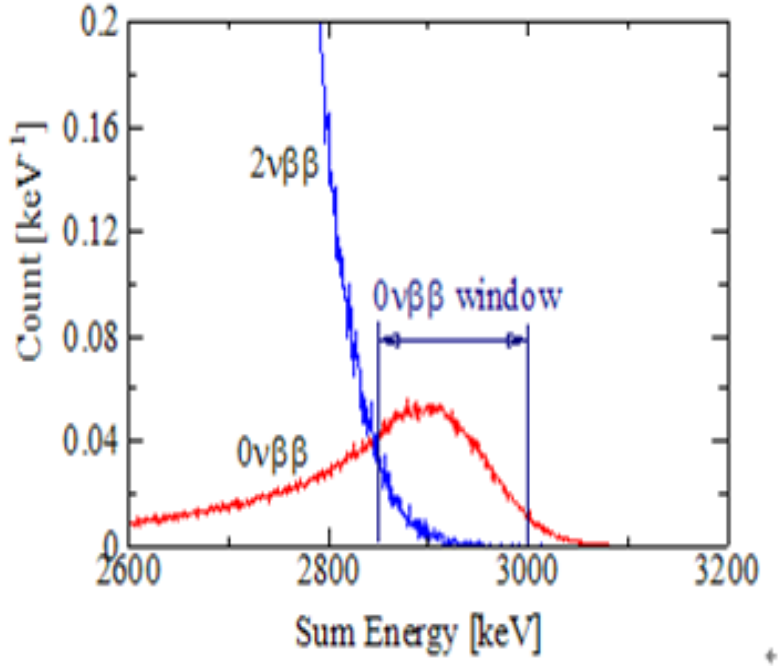


PL MOON 1 1m x 1m x 0.015m σ~1.7%



NaI 0.18m x 0.18m x 0.005m plates
σ~1.7%.

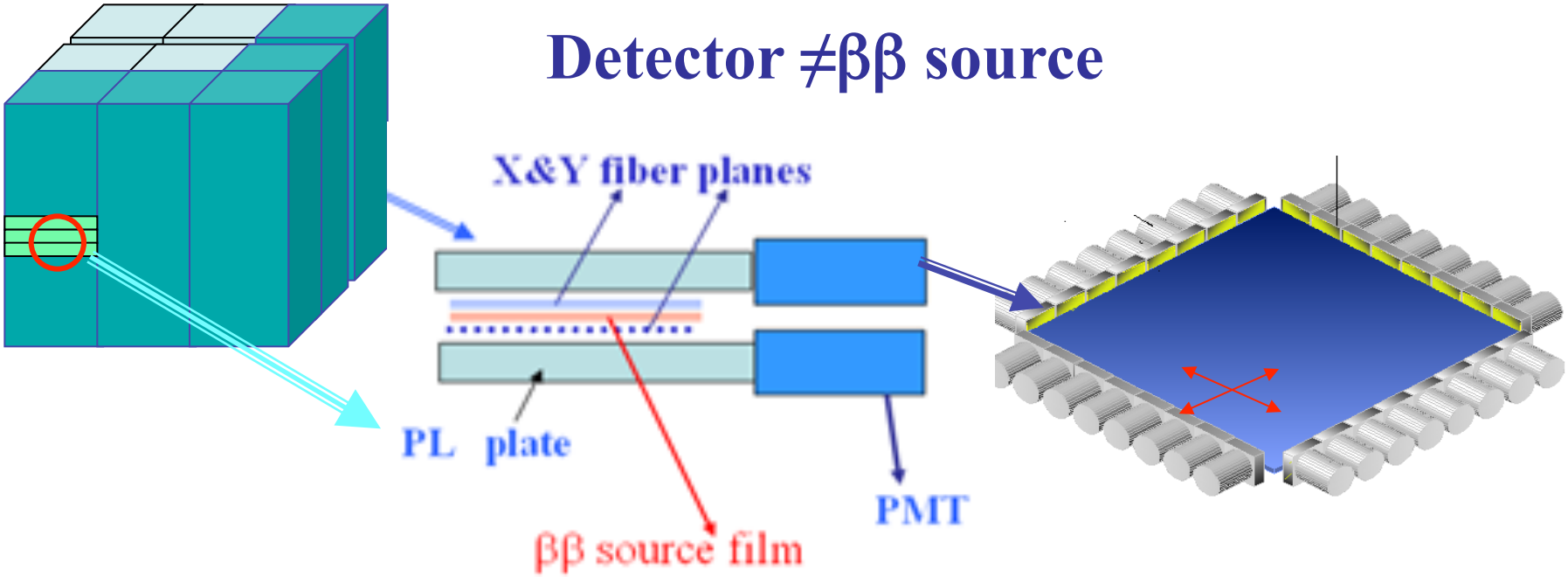
σ~ 1.7% @ $Q_{\beta\beta}$



Simulation spectra for ^{82}Se 70 meV

MOON OSAKA CTU FNAL HU ICU JINR LANL UNC TU UW VNIIEF

Detector ≠ββ source



Assuming detector 30 m^3 with 0.48 tonne ββ source

Sensitivity with $M^{0\nu}$=3 and 2 ton year run

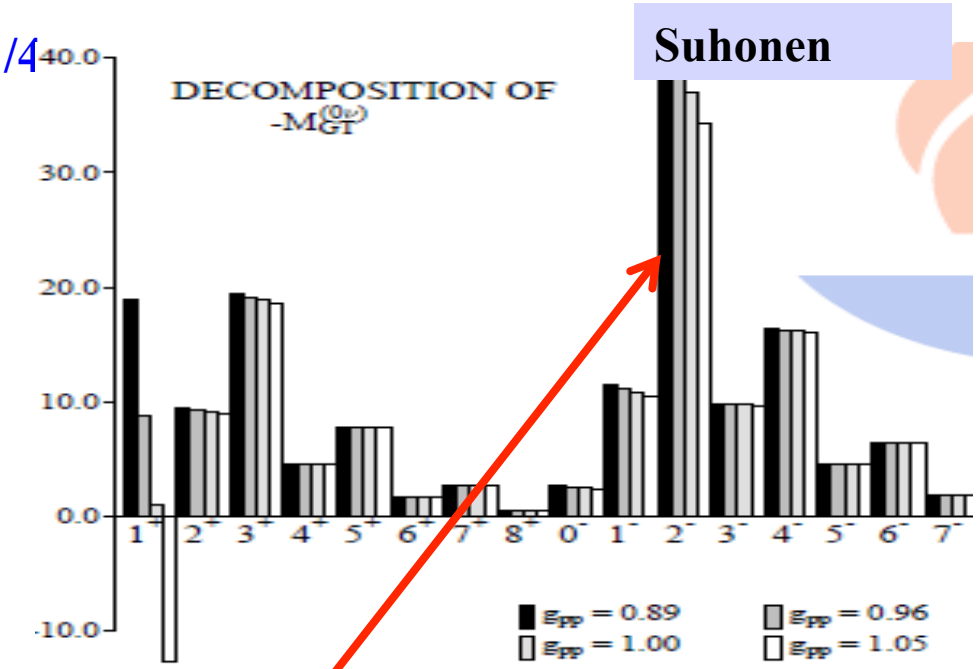
<m> ~ 44– 31 meV for ^{100}Mo – ^{82}Se

In case of smaller $M^{0\nu}$=1.5, 32 ton year run

Nuclear matrix element for 0νββ

$m_\nu = k\,(M^{0\nu})^{-1}\,(N_{\beta\beta})^{-1/4}\,(BG)^{1/4}$

An uncertainty of $M^{0\nu} = (g_A)^2\,M(\text{model})$ by a factor 2.5 gives that of required $N_{\beta\beta}$ isotopes or BG level by a factor 40.

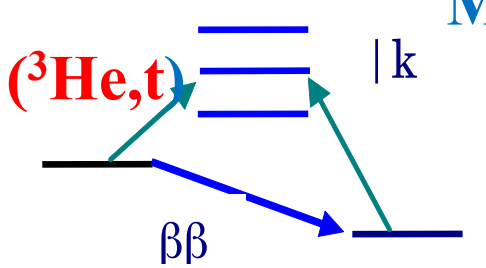


2- main component of $M^{0\nu}$

Experimental studies of $M^{0\nu}$

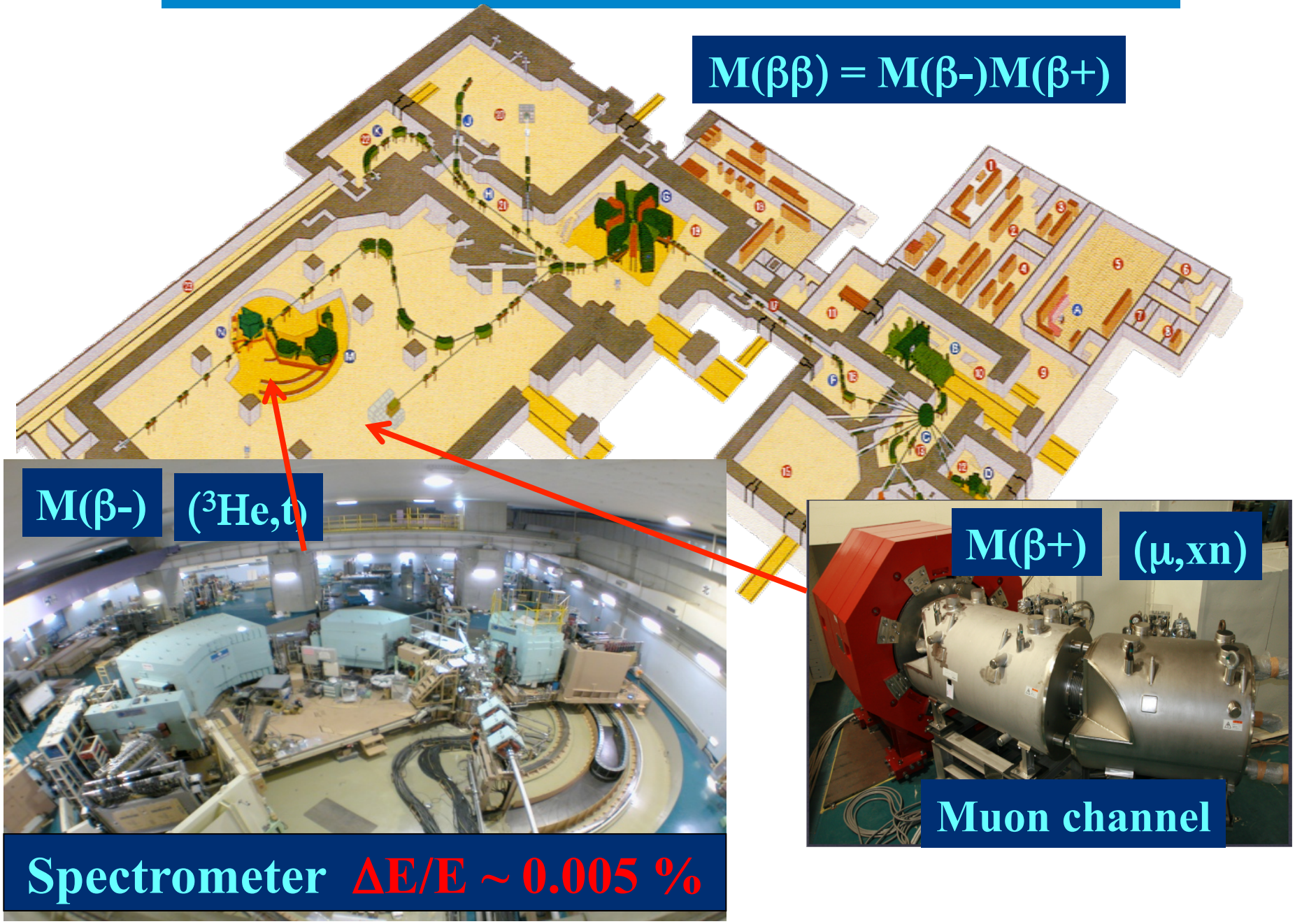
CER(Charge exchange reaction) at RCNP Osaka

Munster(Frekers), MSU, KVI

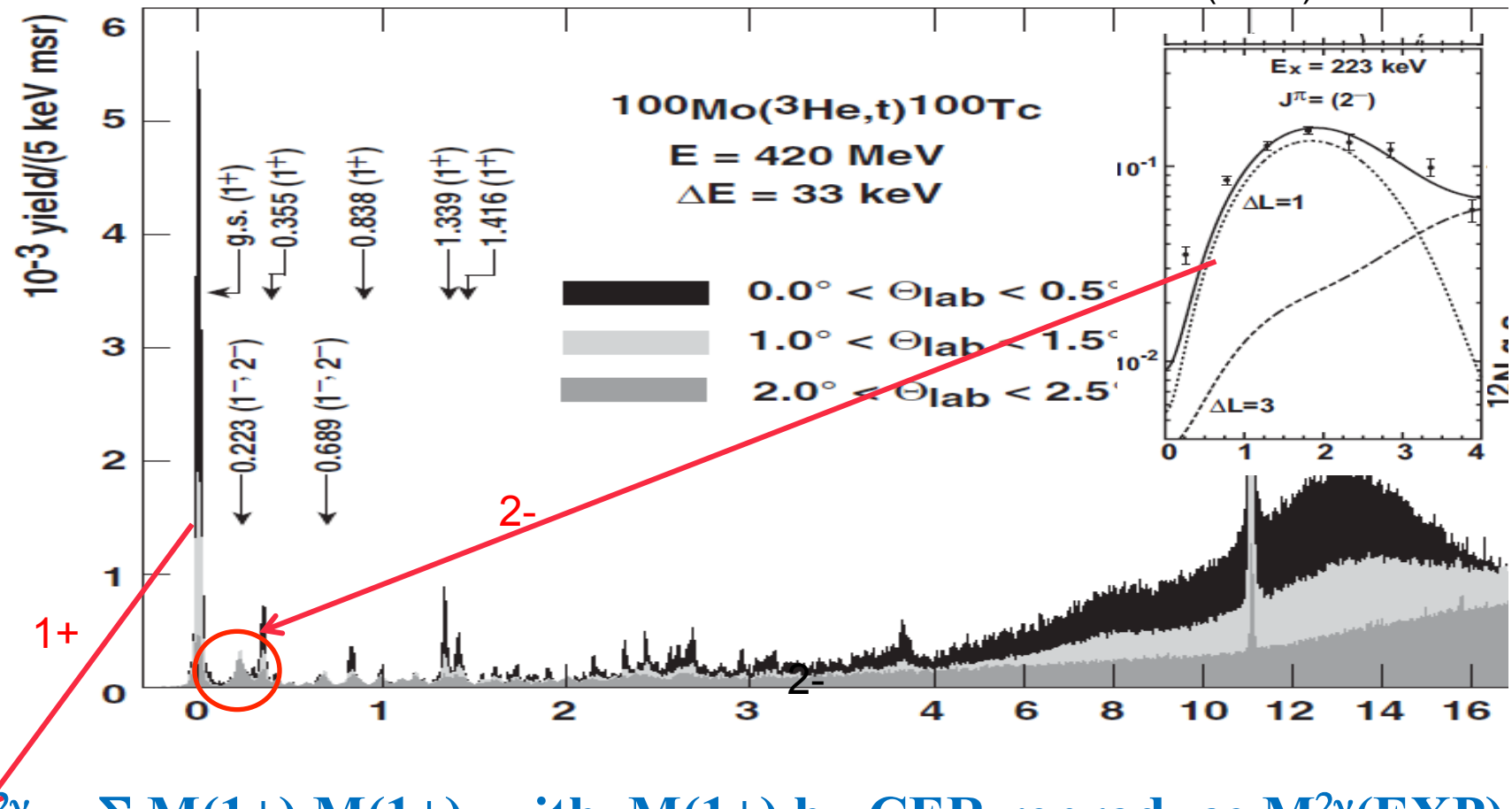


(d,^{2}He), (μ,ν) MuSIC

RCNP Osaka Cyclotron Facility



Thies et al PR C 86 (2012) 044309



$M^{2\nu}$ =Σ M(1+) M(1+) with M(1+) by CER reproduce $M^{2\nu}$(EXP).
g_A (exp) =0.9 H. Ejiri JPSJ 78 (2009) 074201, 81(2012)033201.

M(J=2-) for $M^{0\nu}$ is observed/identified. The exp. suggests CER provides information on $M^{0\nu}$ and on g_A, which are very important.

Low E ^{71}Ga solar/^{51}Cr-^{37}Ar ν_e question

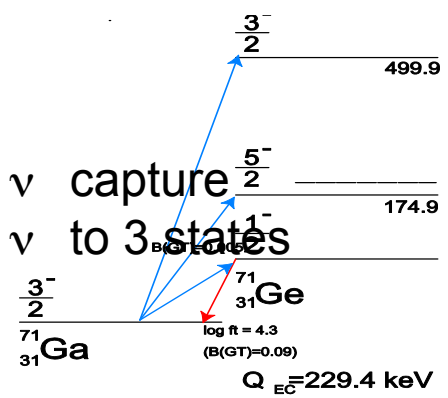
D. Frekers, H. Ejiri, et al PL B 705 134 2011

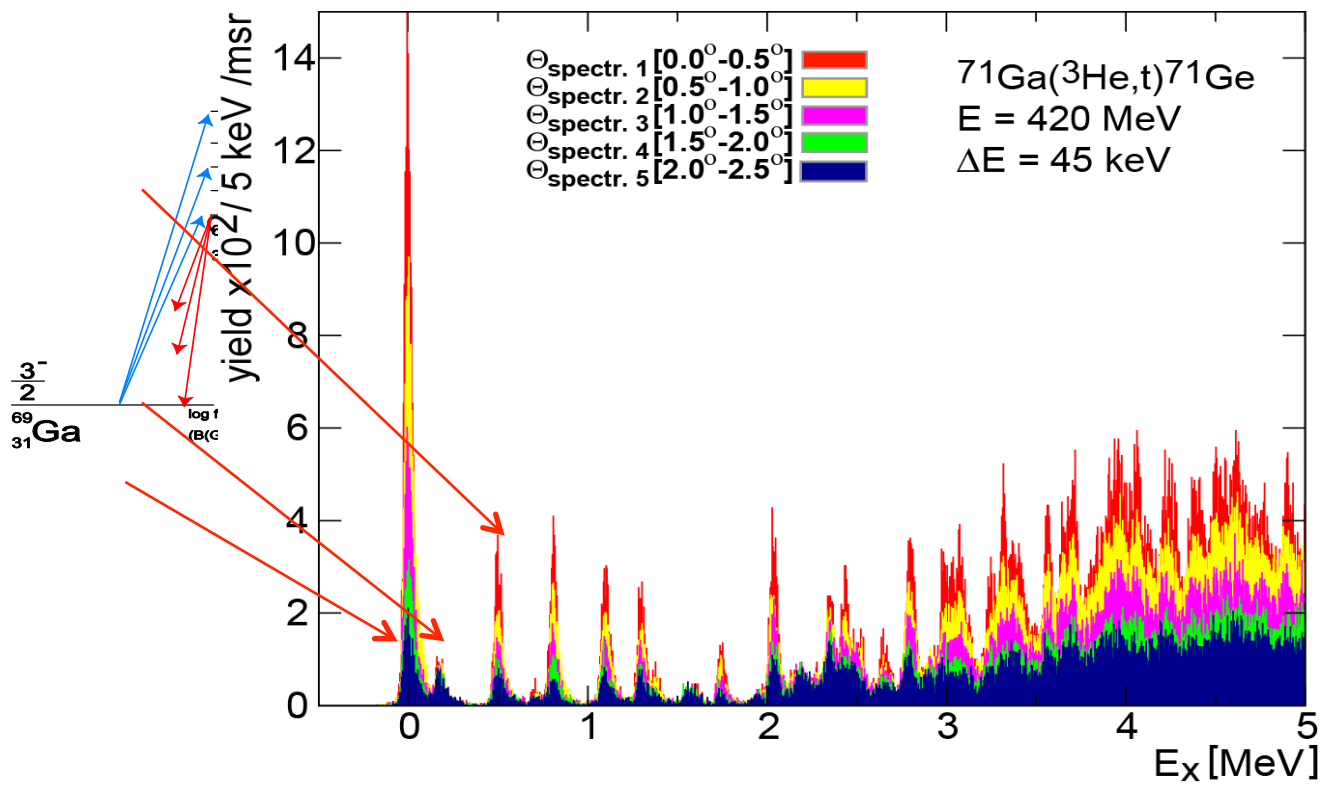
ν-capture of ^{71}Ga: σ(Exp)/σ(Estimate)= R=0.87±0.05

1. Exp. ? Detectors efficiency ??,

2. Estimayed σ(Estimate) ??

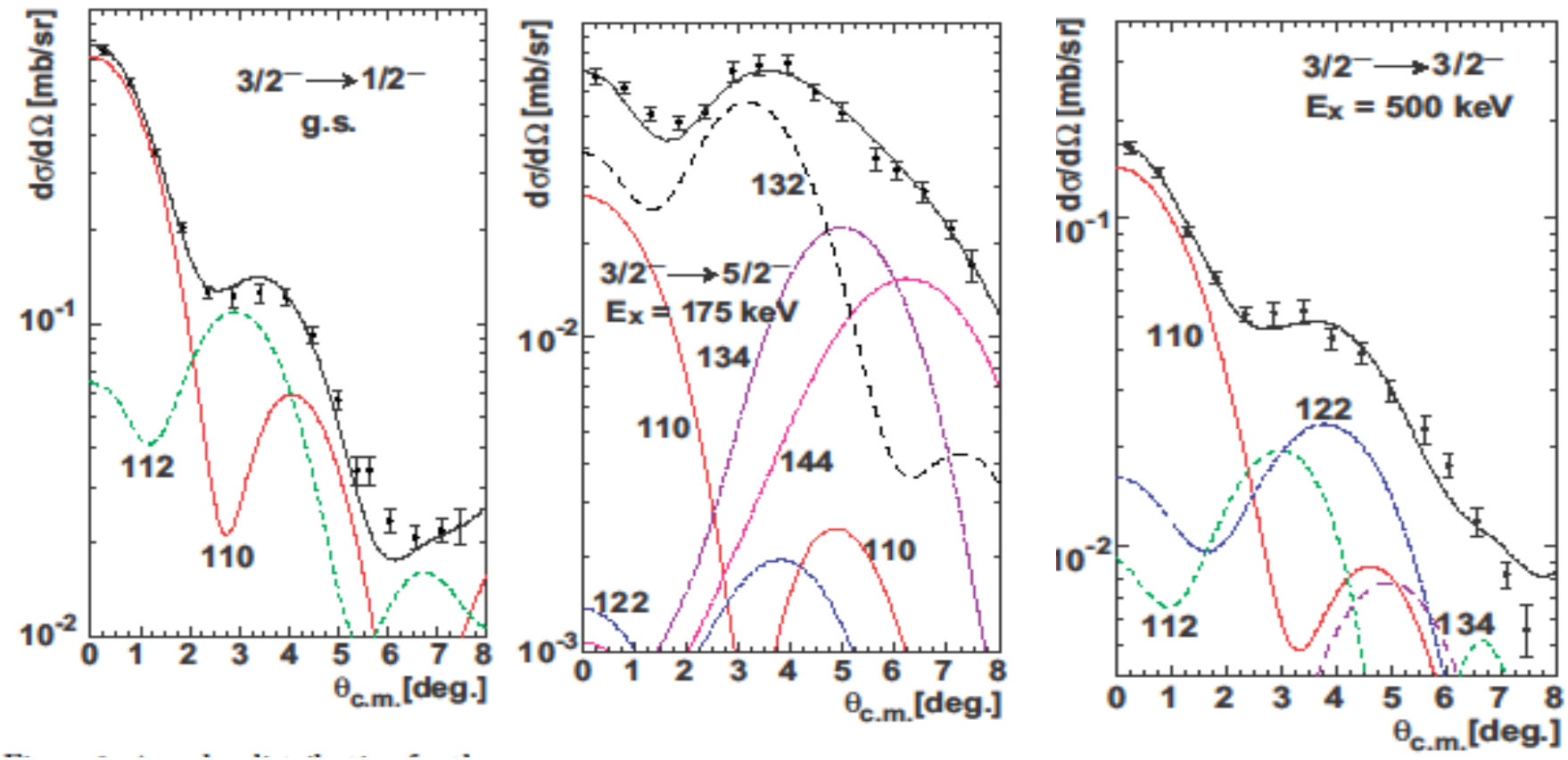
3. A new physics ?? Low-energy ν oscillation to sterile ν





$^{71}Ga \rightarrow ^{71}Ge$

ground state, 1 st state, 2nd state



$^{71}Ga(\nu,e)^{71}Ge$ nuclear responses ($B(GT) = M^2$). The cross section σ(Exp) based on measured B(GT) supports σ(Estimate). Thus the deficit of 0.87 is NOT due to $\sigma(\nu,e)$, but due to detector efficiency or a new physics.