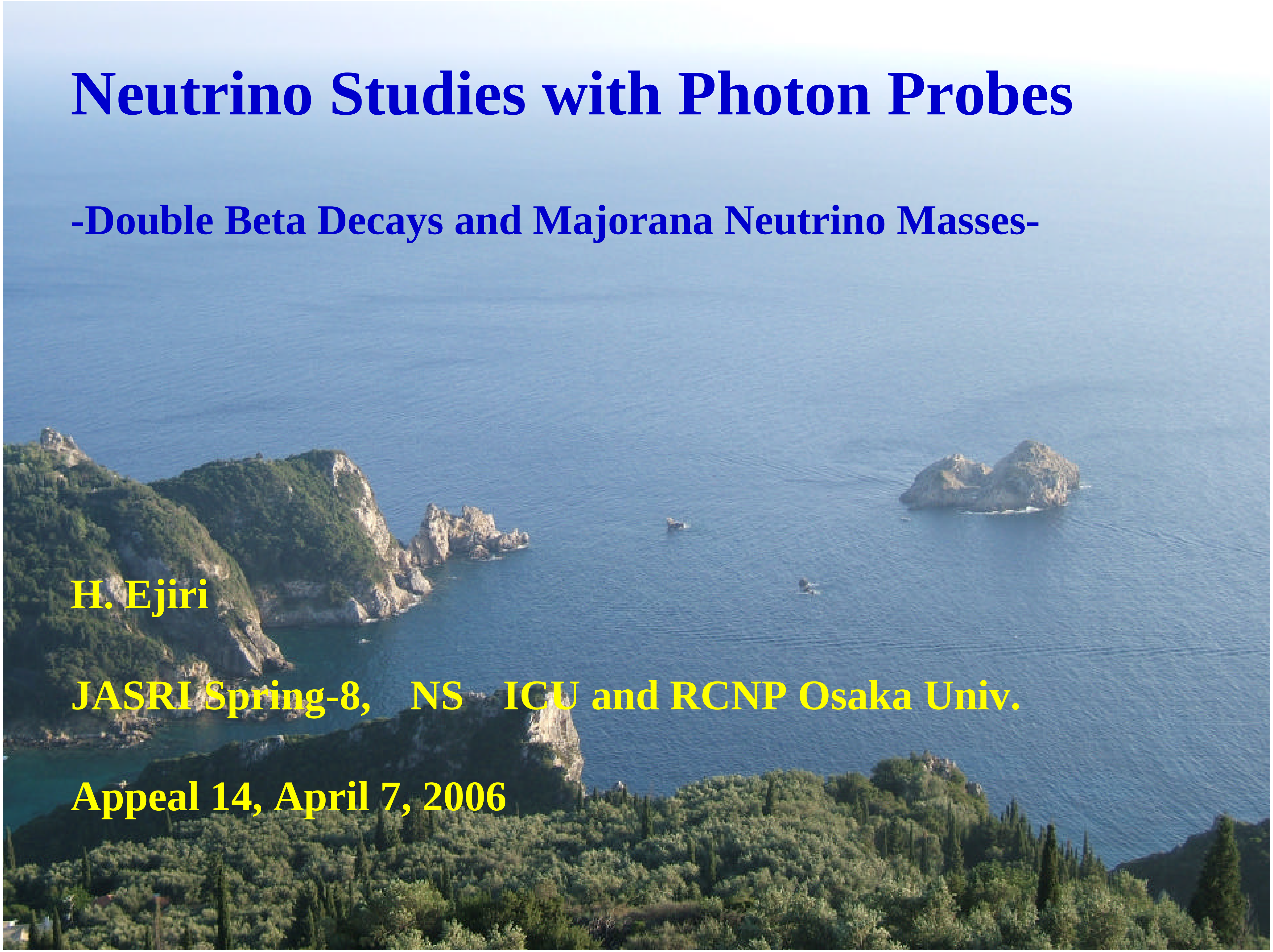


Neutrino Studies with Photon Probes

-Double Beta Decays and Majorana Neutrino Masses-

H. Ejiri

JASRI Spring-8, NS ICU and RCNP Osaka Univ.

Appeal 14, April 7, 2006

I. Neutrinos and photons in n mass studies by bb.

II. bb **Experiments, the present and future**

III. MOON* for n mass studies by scintillation photons

IV. Neutrino nuclear responses and MeV photons

V. Concluding remarks

*** Mo Observatory Of Neutrinos**

Comments on JASRI

Thank Dr Yamashita, Dr Kawashima and all JASRI accelerator colleagues.

Neutrinos and Photons in bb-n studies

- n's are key particles for new physics beyond SM

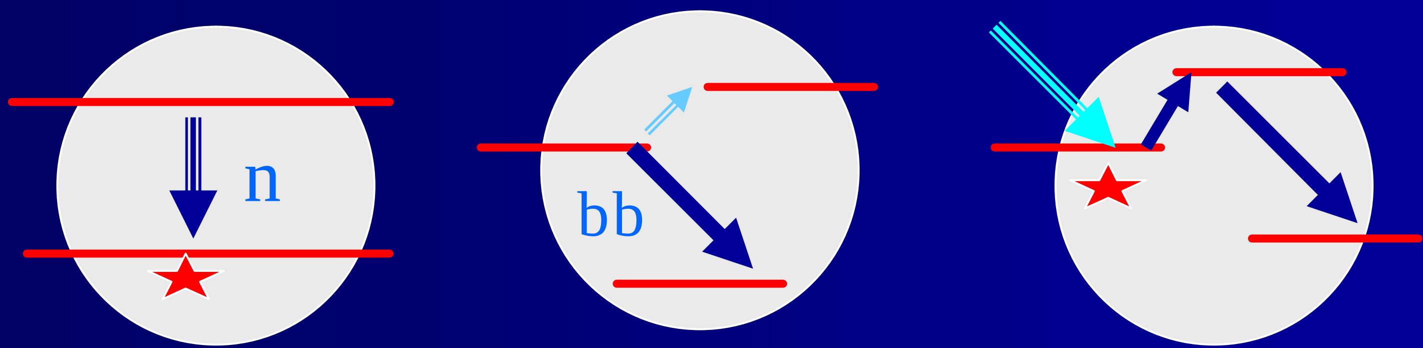
- Fundamental questions
- Majorana nature n = Anti-n ?
- Absolute Mass ?, Mixings (oscillation) & phases ?

- n's have no electric, no color charges, only weak charge.
- Invisible experimentally since visible =EM interaction.

- n's are studied by converting
- n to e : charged lepton-electron via WEAK(10^{-1}/y)
- e to photons, which is visible through EM.(10^{22}/y)
- n mass by double electrons via double WEAK (10^{-25}/y)

Neutrino study in nuclear micro laboratories

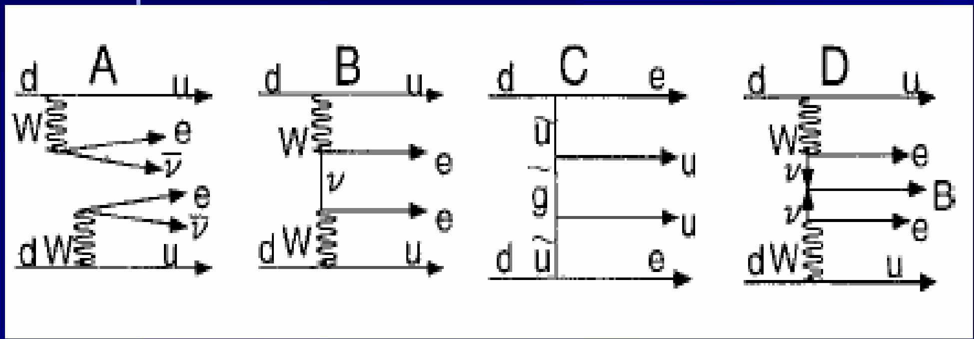
- **Nuclei , being made of nucleons in quantum states, are**
- **excellent micro-laboratories to study fundamental properties of particles** n**’s and weak interactions.**
- bb **decays in nuclei, where** n**-exchange between 2 n is enhanced by 10^7, and BG single** b **is forbidden.**
- **Inverse** b **decays by astro-**n**’s to select astro-**n**’s.**

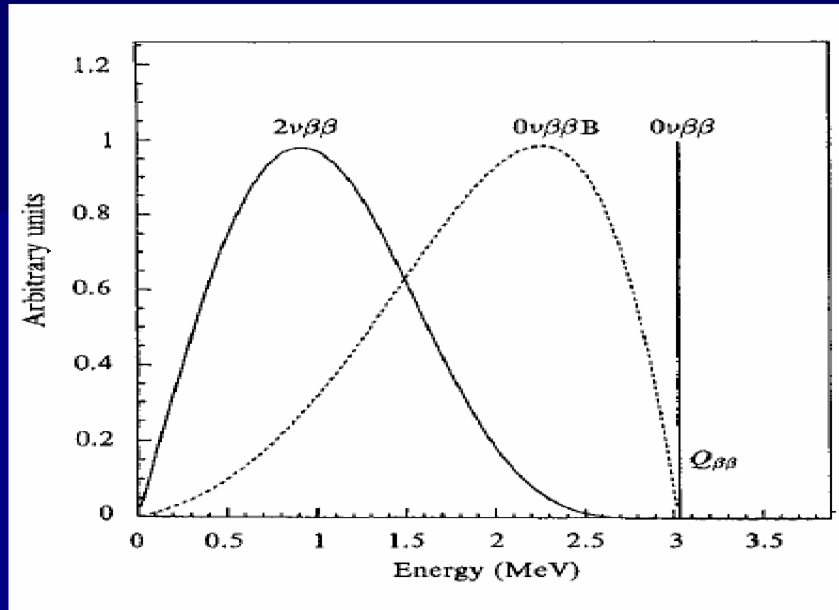


- **Crucial:** n **nuclear responses** ★

Neutrino studies by bb decays

H. Ejiri Invited Review bb **and** n.
JSPS 74, 2101, Aug.05 .





2nbb D**L=0 T**^{2n} **= G**^{2n} **|M**^{2n}**|**^{2} **M**^{2n} **=M(**t s t s**) Res.**

0nbb D**L=2 T**^{0n} **= G**^{0n} **|M**^{0n}**|**^{2} **|<m>|** ^{2} **, RHC, SUSY, Maoron.**

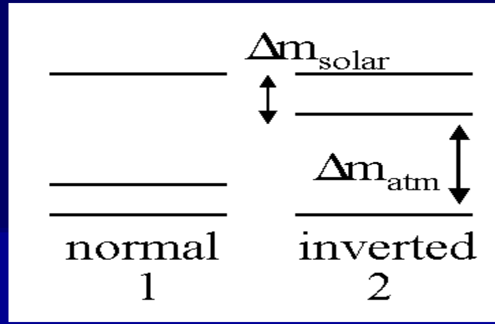
M^{0n} **is crucial**

bb **is the most sensitive and realistic way to study**

1. **Majorana nature of** n, n **= anti-**n
2. **Majorana** n **mass scale and spectrum in the range of 50-5 meV suggested by oscillation data.**

bb and Majorana n masses

$$\begin{bmatrix} |\nu_e\rangle \\ |\nu_\mu\rangle \\ |\nu_\tau\rangle \end{bmatrix} = \begin{bmatrix} c_3c_2 & s_3c_2 & s_2e^{-i\delta} \\ -s_3c_1 - c_3s_1s_2e^{i\delta} & c_3c_1 - s_3s_1s_2e^{i\delta} & s_1c_2 \\ s_3s_1 - c_3s_1s_2e^{i\delta} & -c_3s_1 - s_3c_1s_2e^{i\delta} & c_1c_2 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & e^{i\phi_2/2} & 0 \\ 0 & 0 & e^{i(\phi_3/2+\delta)} \end{bmatrix} \begin{bmatrix} |\nu_1\rangle \\ |\nu_2\rangle \\ |\nu_3\rangle \end{bmatrix},$$



< m$_n$> = S k$_i$ exp(i f$_i$) m$_i$

Using k$_i$ dm$_s$, dm$_a$ given by n oscillations

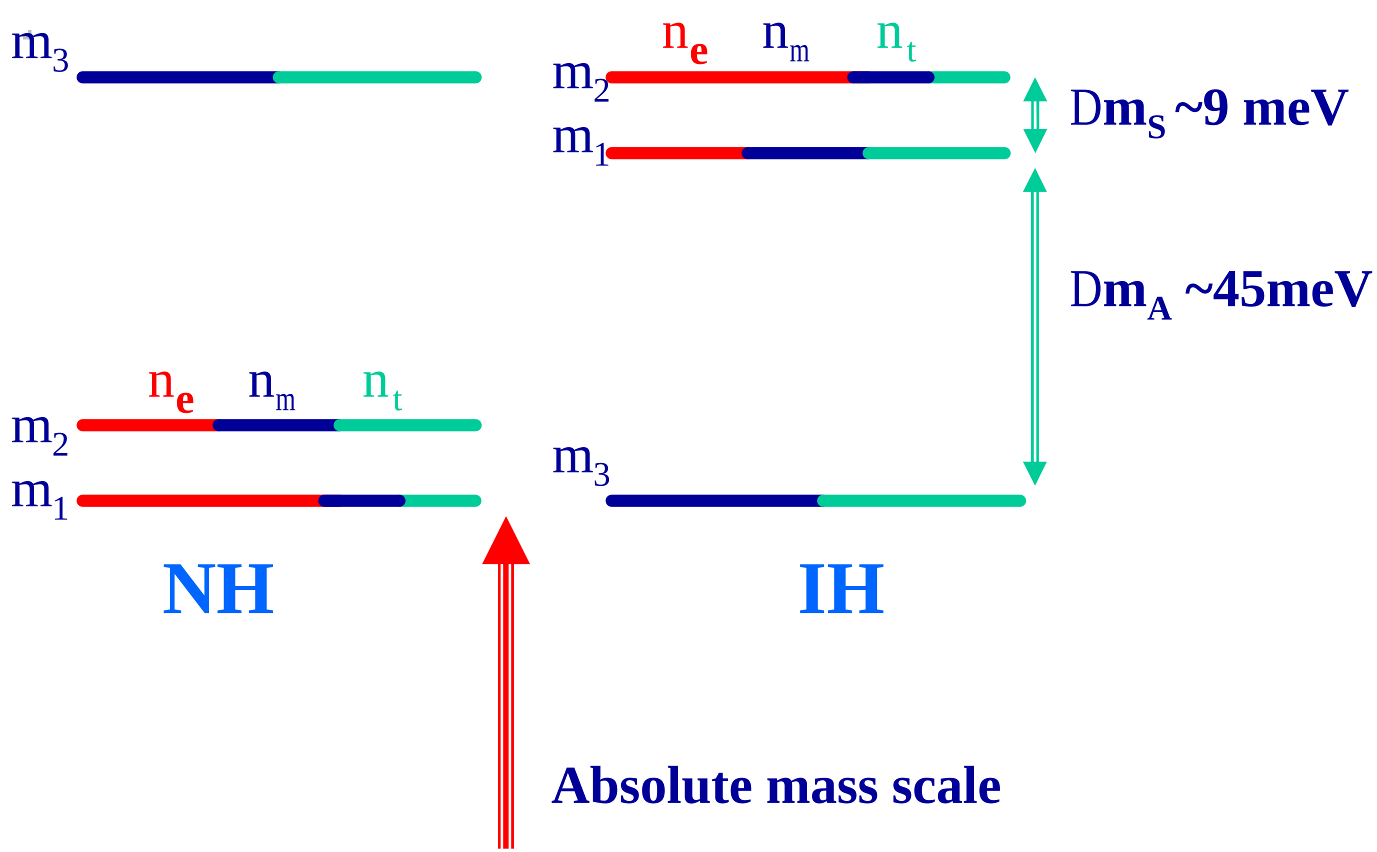
$$NH \quad < m_\nu >= c_2^2c_3^2m_1 + c_2^2s_3^2e^{i\phi_2}(\delta m_S^2 + m_1^2)^{1/2} + s_2^2e^{i\phi_3}(\delta m_A^2 + m_1)^{1/2},$$

$$IH \quad < m_\nu >= s_2^2m_1 + c_2^2c_3^2e^{i\phi_2}(\delta m_A^2 - \delta m_S^2 + m_1^2)^{1/2} + c_2^2s_3^2e^{i\phi_3}(\delta m_A^2 + m_1)^{1/2}$$

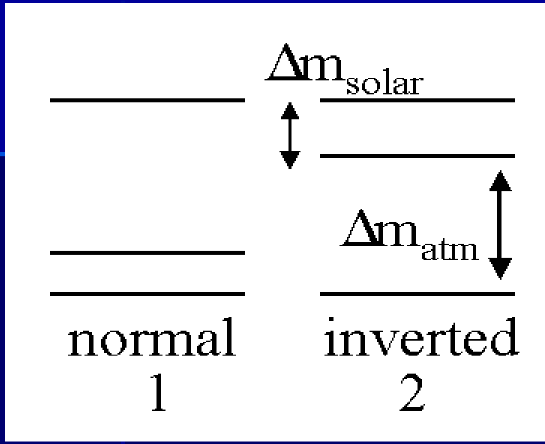
where c_i and s_i are $cos\theta_i$ and $sin\theta_i$ with $\theta_1 \sim \pi/4$, $\theta_2 \sim 0$, $\theta_3 \sim \pi/6$,

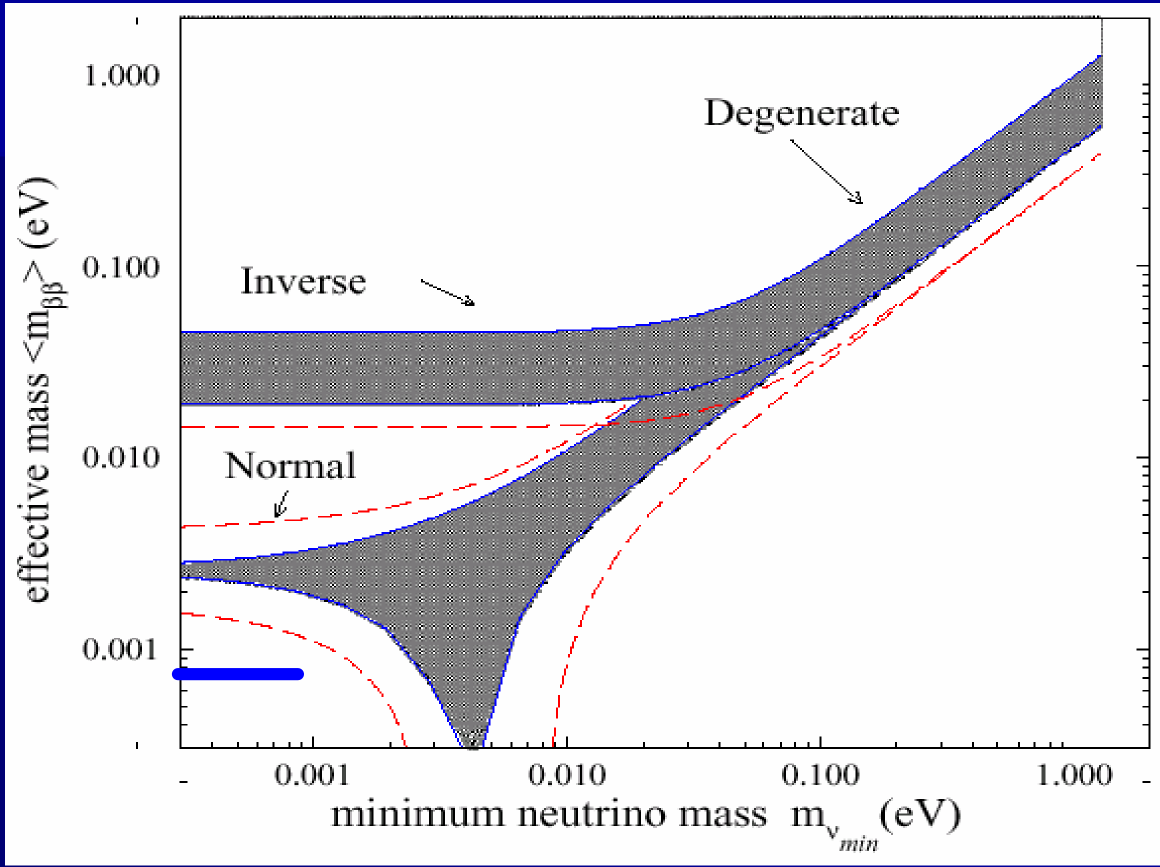
Non zero T^{0n} leads absolute mass scale in the 0.1-0.01 eV range, the mass spectrum, and f$_i$. sin^{2}2q$_{13}$ < 0.15.

Neutrino mass spectra



Majorana n masses in QD, IH. NH





QD > 100 meV
IH-U ~ 46 meV
IH-L ~ 23 mev
NH ~ 2.5 meV

Nuclear matrix elements within 20 % is indispensable for identify the mass spectrum and the Majorana phases.

Energy and angular correlations of 0nbb rays

H. Ejiri, Invited review paper JPSJ 74 05 2101

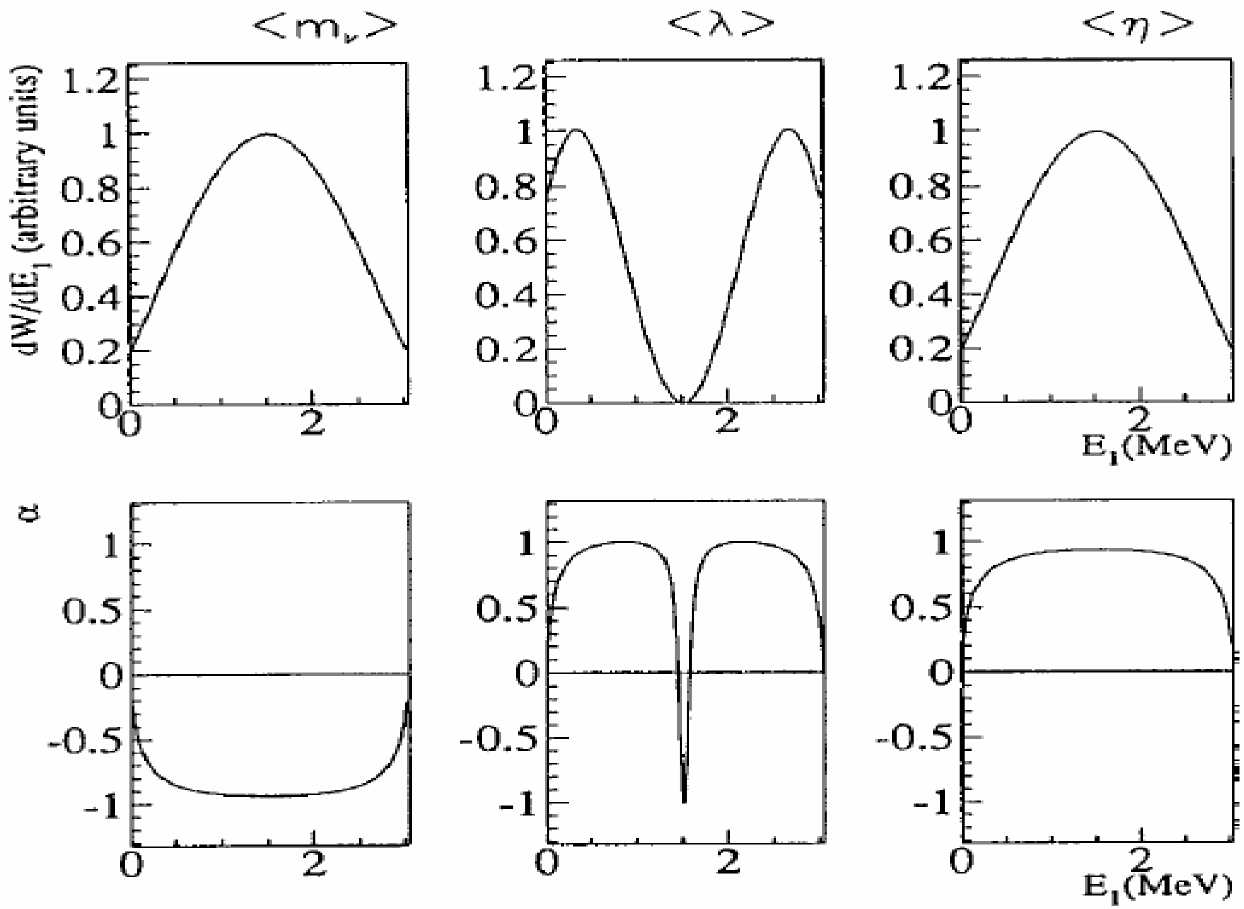


Fig. 4. Energy and angular correlations for the ^{100}Mo $0\nu\beta\beta$ proce caused by the mass and right-handed current terms of $\langle m\rangle$, $\langle\lambda\rangle$ and $\langle\eta$ Top: Calculated single-β spectra. Bottom: $\beta_1 - \beta_2$ angular correlatic coefficients α defined by $W(\theta_{12}) = 1 + \alpha\cos\theta_{12}$.[4)]

II. Double beta decay experiments

0nbb **status**

Table VI. Limits on neutrino-less double β^- decays. $Q_{\beta\beta}$: Q value for the $0^+ \to 0^+$ ground state transition. $G^{0\nu}$: kinematical factor (phase space volume)^a in units of 10^{-14} y^{-1}, $T^{0\nu}_{1/2}$: half-life limits in units of 10^{24} y and $\langle m_\nu \rangle$: limit on the effective ν mass in units of eV.

isotope	$Q_{\beta\beta}$ MeV	$G^{0\nu}$ 10^{-14} y^{-1}	$T^{0\nu}_{1/2}$ 10^{24}	$\langle m_\nu \rangle$ eV	Comments
^{48}Ca	4.276	4.46	> 0.014	< 7.2-45	b
^{76}Ge	2.039	0.44	$> 19(12^*)$	$< 0.35(\approx 0.44^*)$	$c(c')$
^{76}Ge	2.039	0.44	> 16	< 0.33-1.35	d
^{82}Se	2.992	1.89	> 0.19	< 1.3 - 3.2	e
^{100}Mo	3.034	3.17	> 0.35	< 0.7 - 1.2	f
^{116}Cd	2.804	3.24	> 0.17	< 1.7	g
^{128}Te	0.876	0.12	> 7.7	< 1.1 - 1.5	h
^{130}Te	2.529	2.86	> 0.75	< 0.3 - 1.6	i
^{136}Xe	2.467	3.03	> 0.44	< 1.8 - 5.2	j
^{150}Nd	3.368	13.4	> 0.0012	< 3	k

a: $G^{0\nu} = ln2G^{(0\nu)}$, where $G^{(0\nu)}$ is for $(T^{0\nu}_{1/2})^{-1}$ in ref,[23] b: ref.[97] c: ref.[81] c': ref.[31] *: finite values, d: ref.[30] e: ref.[32] f: ref.[32] g: ref.[99] h: geochemical method ref.[90] i: ref.[100] j: ref.[101] k: ref..[85]

CUORITINO 1.8 10 ^{24} y 90% CL ~ 0.2 – 1 eV

Perspectives of $<m_n>$ by bb

$$T^{0n} = G\,|M^{on}|^2\,|<m_n>|^2, \quad G = k(Z)\,Q_{bb}^{5}\ .$$

$$N^{0n} > [\,N_{BG}]^{1/2}$$

- $m_n^{-1} \sim S\,t^{\,1/4}$ Sensitivity $S = S_n$(nuclear) x S_d(detector)
- $S_n = M^{\,0n}\,k(Z)^{1/2}\,Q_{bb}^{\;5/2}$
- $S_d = [N_{bb} / N_{BG}]^{1/4}$ $N_{BG} \sim N(2nbb) + RI$ per ton of N_{bb}

- **Present experiments : limited to 0.3 ~ 1 eV by the detector S_D.**
- **Next generation bb detectors with 20 ~ 30 meV**

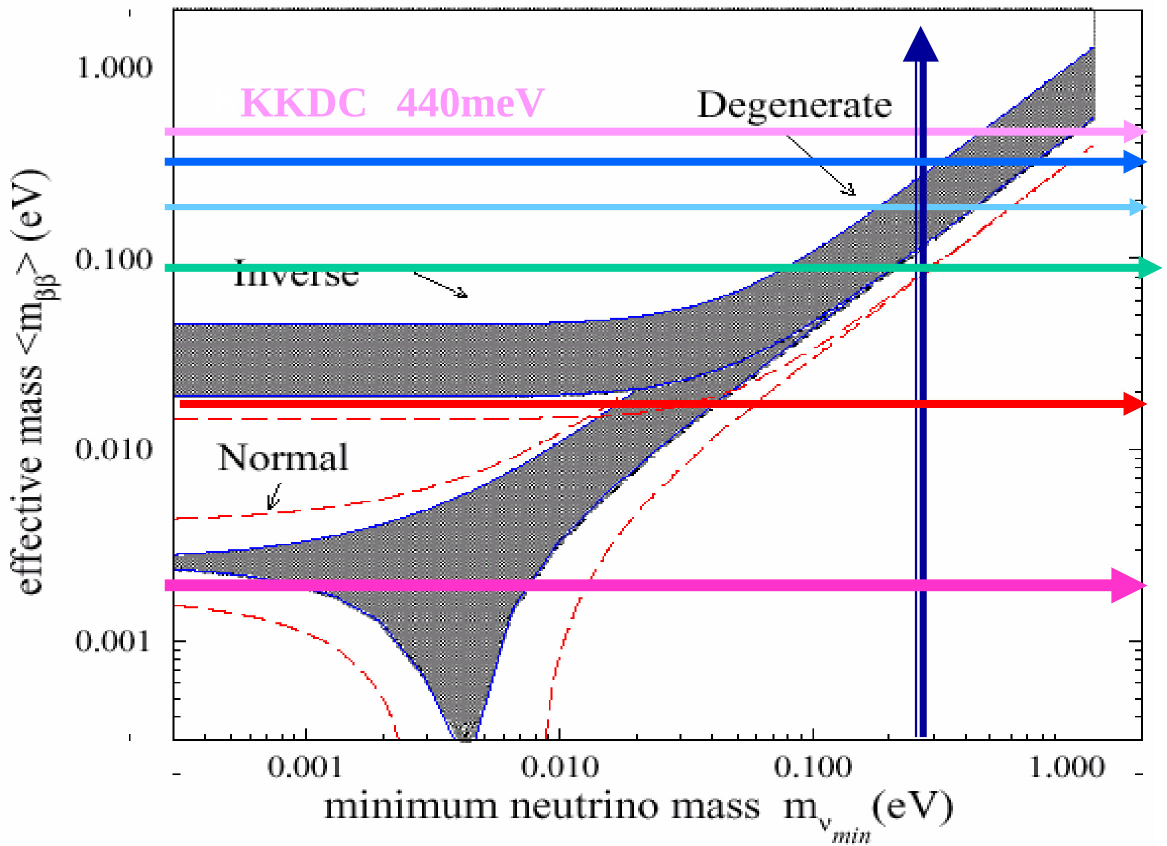
- **Large phase space/Q value to get a large nuclear sensitivity**
- **Large Detector with N_{bb} ~ tons to get at least a few signals.**
- **Small BG and/or good resolution.**

Future projects

Table VII. Isotopes and detectors to be used for future $\beta\beta$ experiments. A: isotope abundance ratio, $Q_{\beta\beta}$: Q value in units of MeV, and S_N: nuclear sensitivity[4)] in units of 10^{-24} y^{-1} $(eV)^{-2}$

Isotope	A %	$Q_{\beta\beta}$ MeV	$S_N 10^{-24} y^{-1} (eV)^{-2}$	Experiment/collaboration
^{48}Ca	0.187	4.276	0.11	CANDLES[a]
^{76}Ge	7.8	2.039	0.22	MAJORANA[b] GENIUS[c] GERDA[d]
^{82}Se	9.2	2.992	0.86	Super-NEMO[e]
^{100}Mo	9.6	3.034	2.02	MOON[f]
^{116}Cd	7.5	2.804	0.90	COBRA[g] CAMEO[h]
^{130}Te	34.5	2.529	0.73	CUORE[i], COBRA[g]
^{136}Xe	8.9	2.467	0.13	EXO[j], XMASS[k]
^{150}Nd	5.6	3.368	11.3	DCBA[l] SNO++

Present and future bb experiments



QD

NEMO3 ~ 300 meV

CUORITINO ~ 200 meV

Majorana-GERDA 100 me

Future phase 2 IH 25 meV

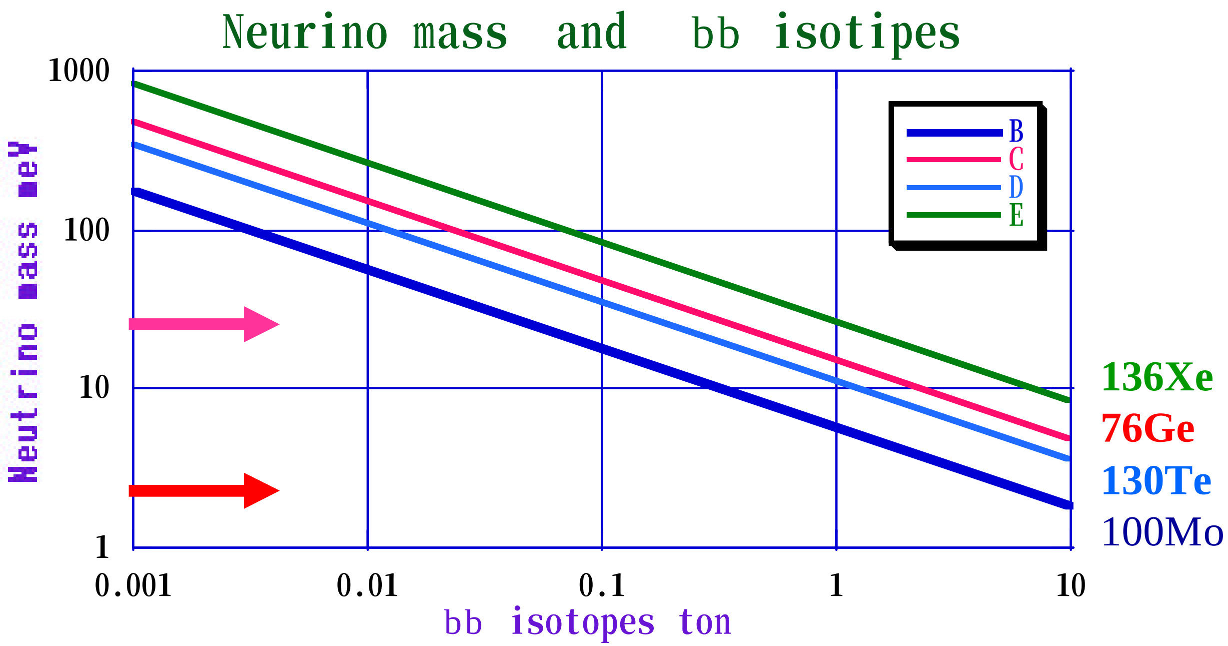
MOON

Future phase 3 NH 2 meV

Cosmological < 230 ~ 120 meV

Katrin Single b ~ 200 ~ 300 meV

Neutrino mass sensitivity

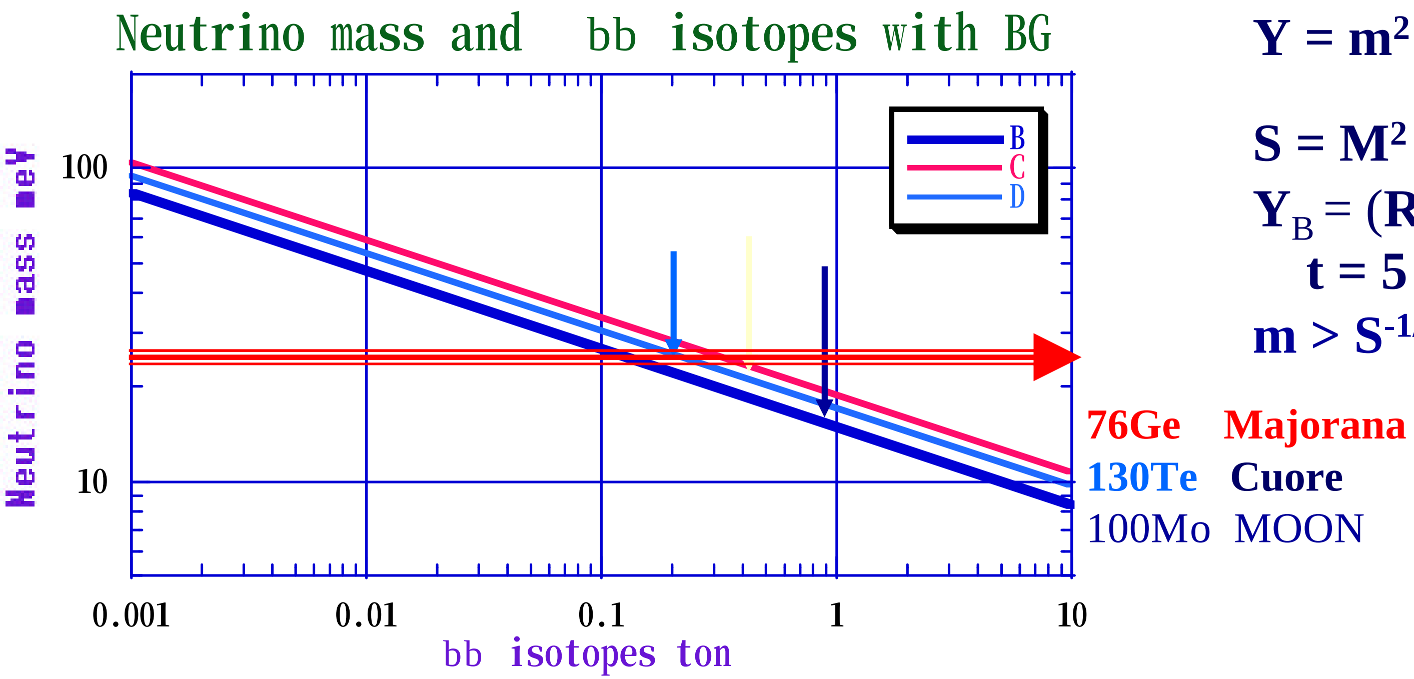


$Y = m^2\ S\ N\ t > 2$

$S = M^2\ G,\ G = Q^5$

$t = 5\ y$

$m > S^{-1/2}\ 0.63\ N^{-1/2}$



$Y = m^2\ S\ N\ t > Y_B^{1/2}$

$S = M^2\ G,\ G = Q^5$

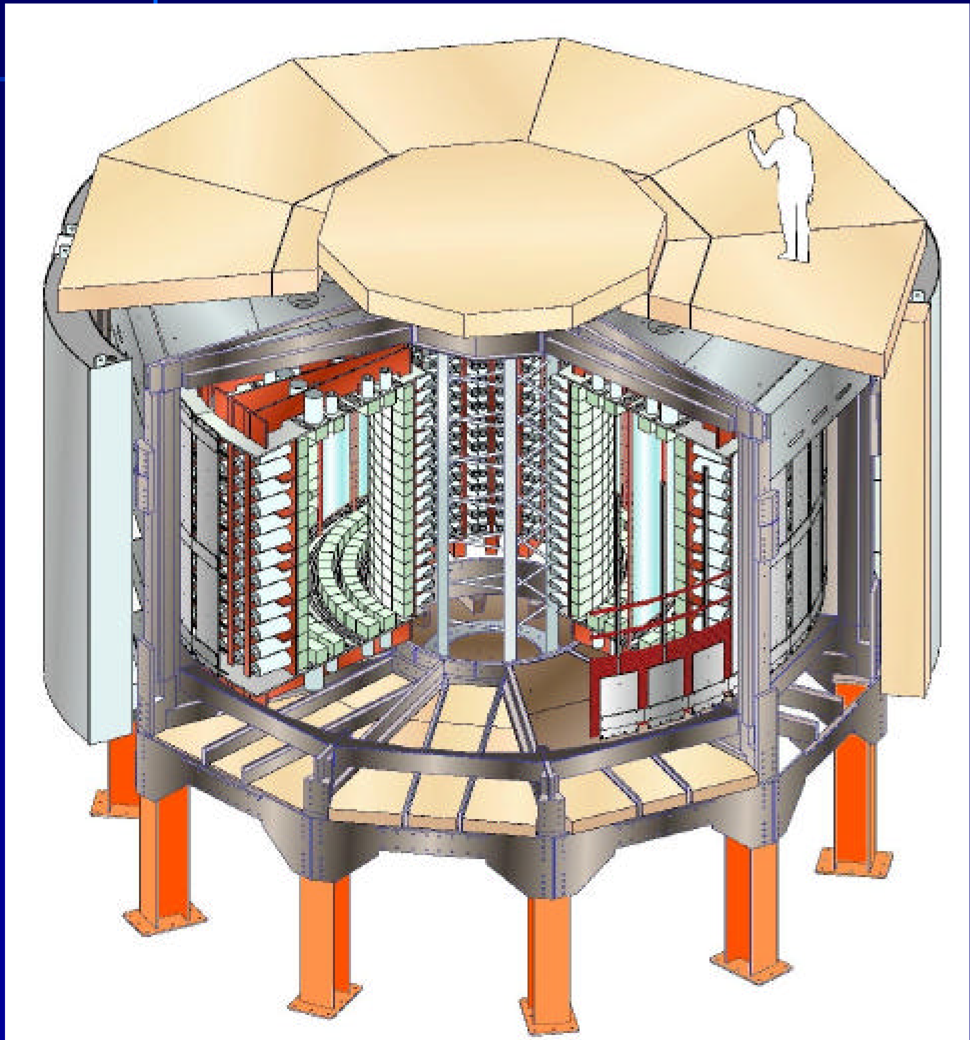
$Y_B = (RI + 2nbb)\ N\ t$

$t = 5\ y$

$m > S^{-1/2}\ 0.45\ Y_B^{1/4}\ N^{-1/4}$

Present Exps.

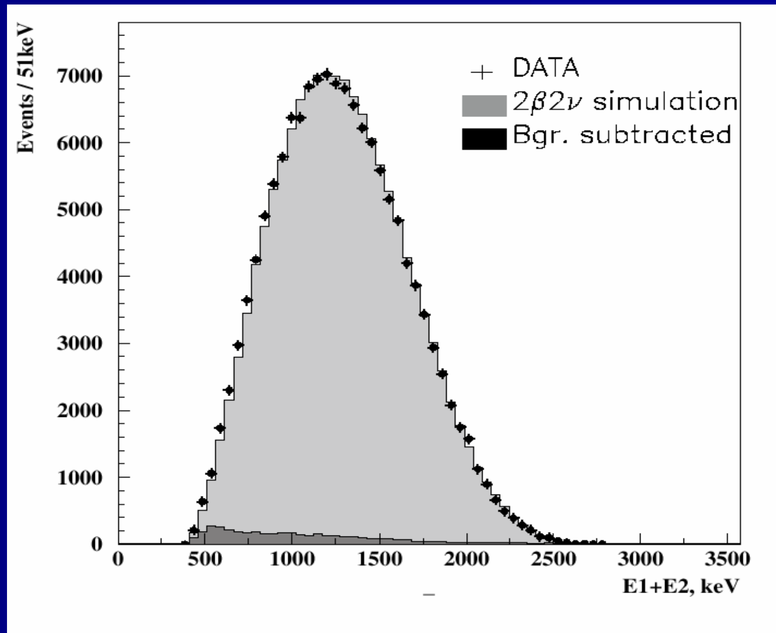
NEMO 3 **Fréjus 4800 m.w.e.**



Source: **10 kg of bb isotopes**
cylindrical, S = 20 m², 60 mg/cm²

Tracking detector:
drift wire chamber operating in Geiger mode (6180 cells)
Gas: He + 4% ethyl alcohol + 1% Ar + 0.1% H_2O

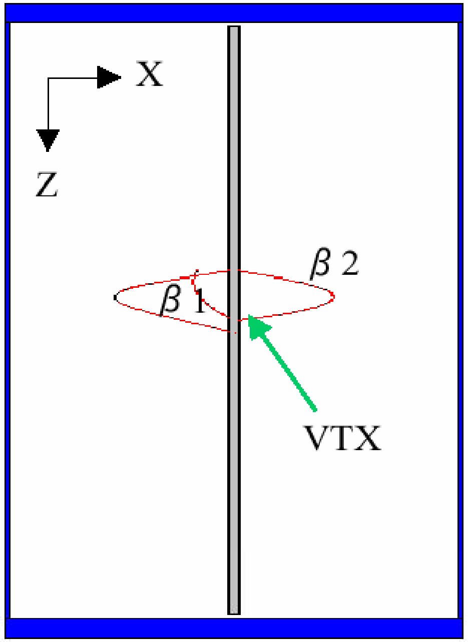
Calorimeter:
1940 plastic scintillators coupled to low radioactivity PMTs

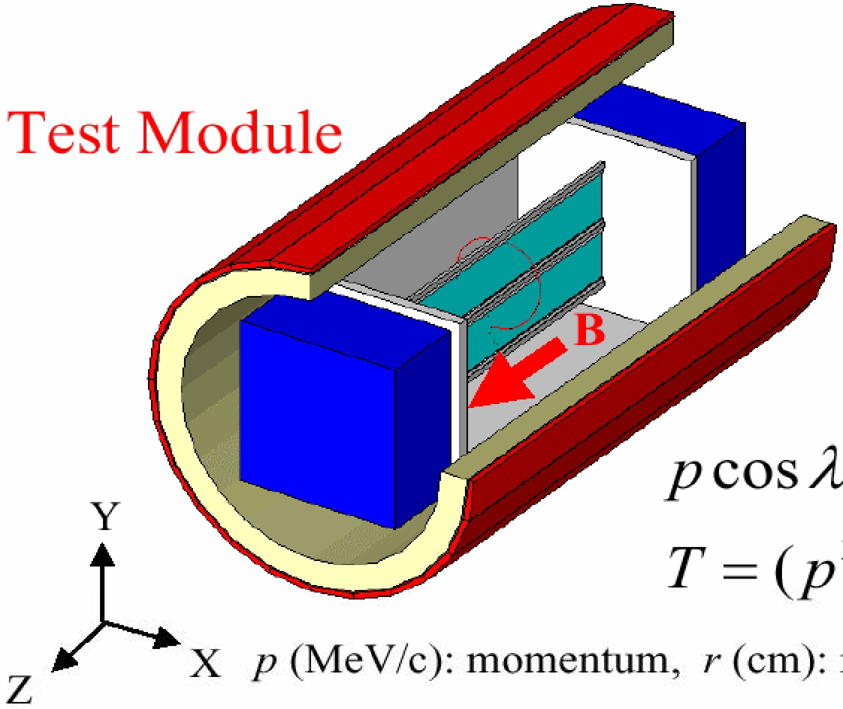


Energy spectrum of $E_\beta + E_\beta$ from ^{100}Mo by NEMO

DCBA Drift Chamber Beta Analyzer

N. Ishihara KEK





DCBA

Drift **C**hamber
Beta-ray **A**nalyzer

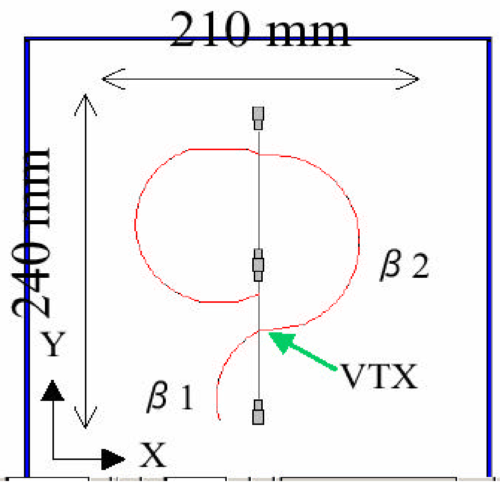
^{150}Nd$\rightarrow$^{150}Sm+2e$^-$

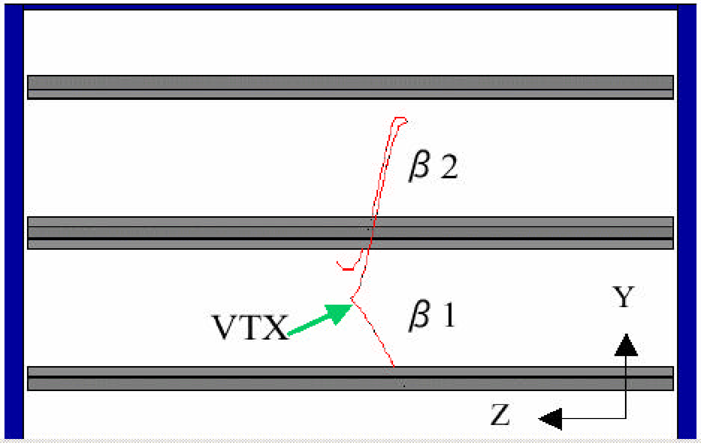
$$p\cos\lambda = 0.3rB,$$

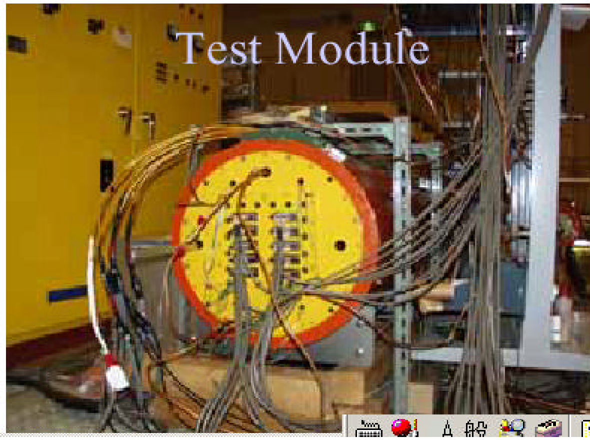
$$T = (p^2 + m_e^2)^{1/2} - m_e$$

p (MeV/c): momentum, r (cm): radius, λ: pitch angle

B (kG): mag. field, m_e (MeV/c^2): electron mass







III. MOON for bb in ^{100}Mo.

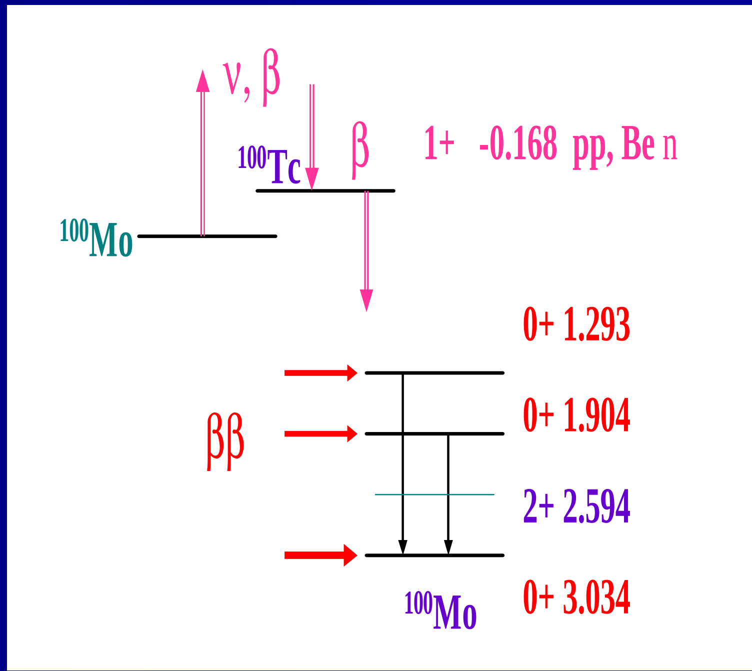
Molybdenum Observatory Of Neutrinos

Neutrino studies in Mo nuclear micro laboratories

MOON Molybdenum Observatory Of Neutrinos

Osaka, UW, JINR, Tokushima, VNIIEF, LANL, FNAL, ICU, UNC, Prague,

- A. Double beta decay spectroscopy with m_n~25 meV.
- B. Low energy pp &^{7}Be solar n_e with s ~ 10 % with 1 y



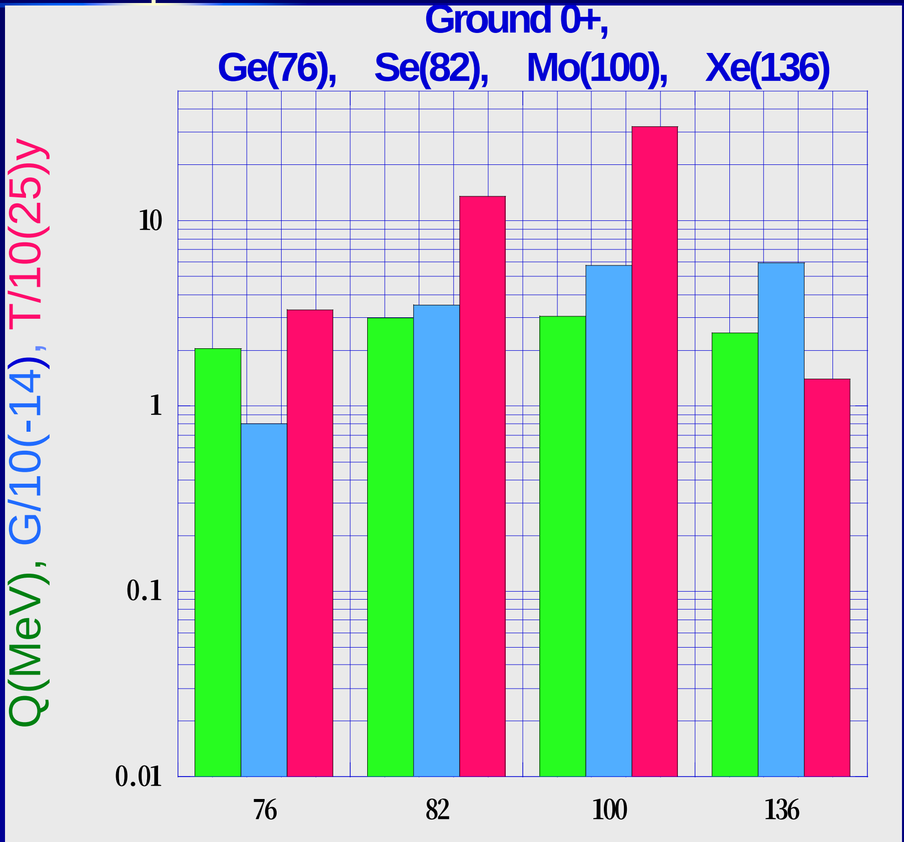
- 1. large phase space for bb-n's
- Large energy most RI.
- 2. Large response for solar n's.
- 3.Larg sensitivities for bb and
- solar-n by the two b-rays
- to select. n-signals.

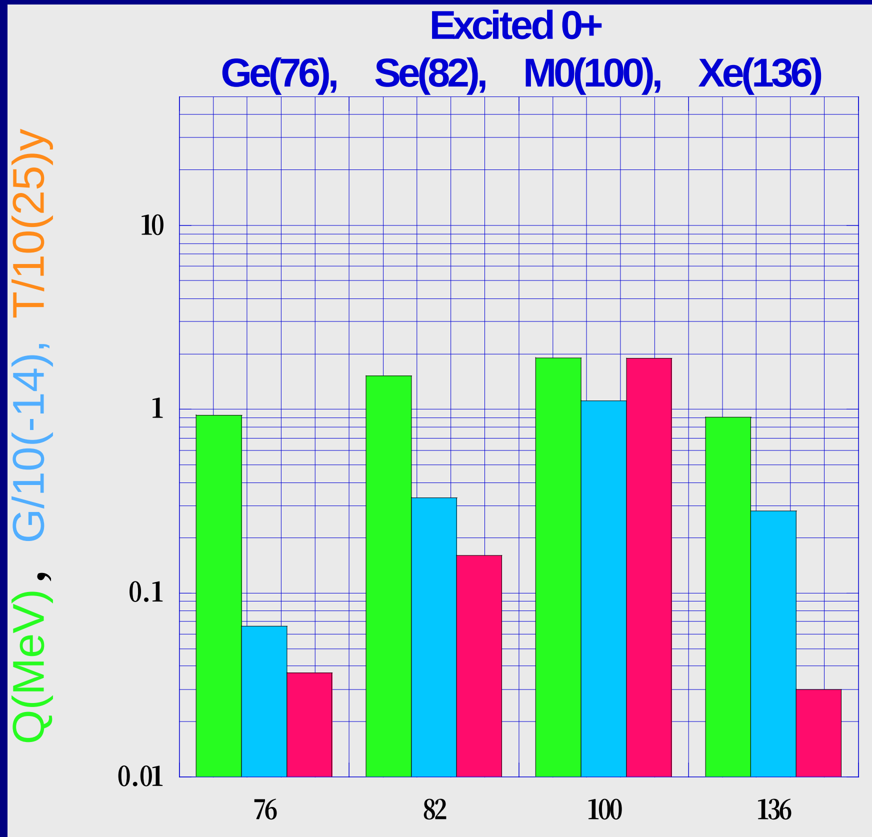
- 4. Based on the **ELEGANT**
- (**ELE**ctron **GA**mma ray**N**eutrino **T**elescope)
- http://ewi.npl.washington.edu

Transition rates, Q values, phase volumes

Ground excited 0+ states in ^{76}Ge, ^{82}Se, ^{100}Mo, and ^{136}Xe

QRPA matrix elements by Simkovic et al 04

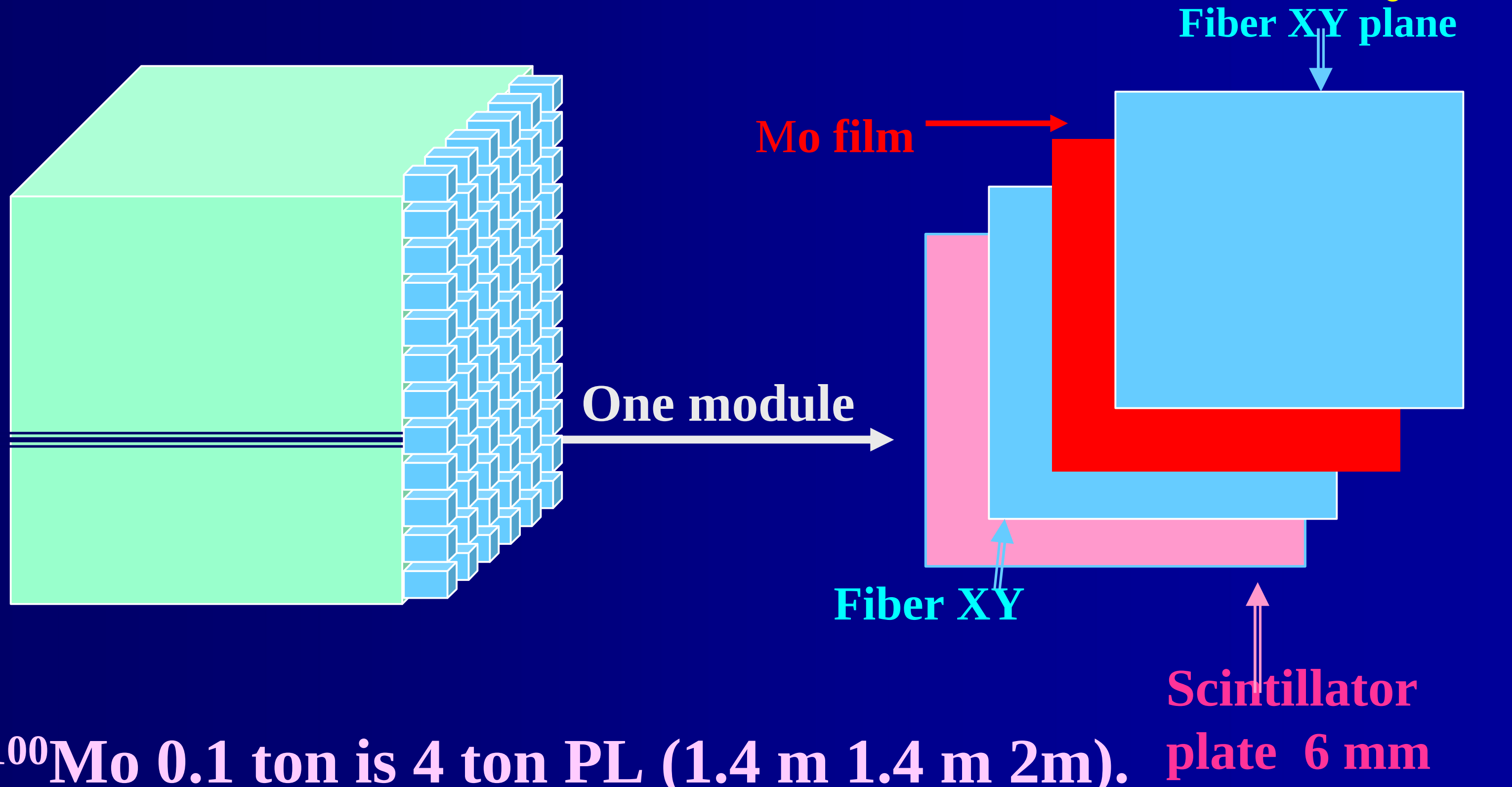




MOON detector concept

A Supermodule of Mo films and fiber/plate scintillators*.

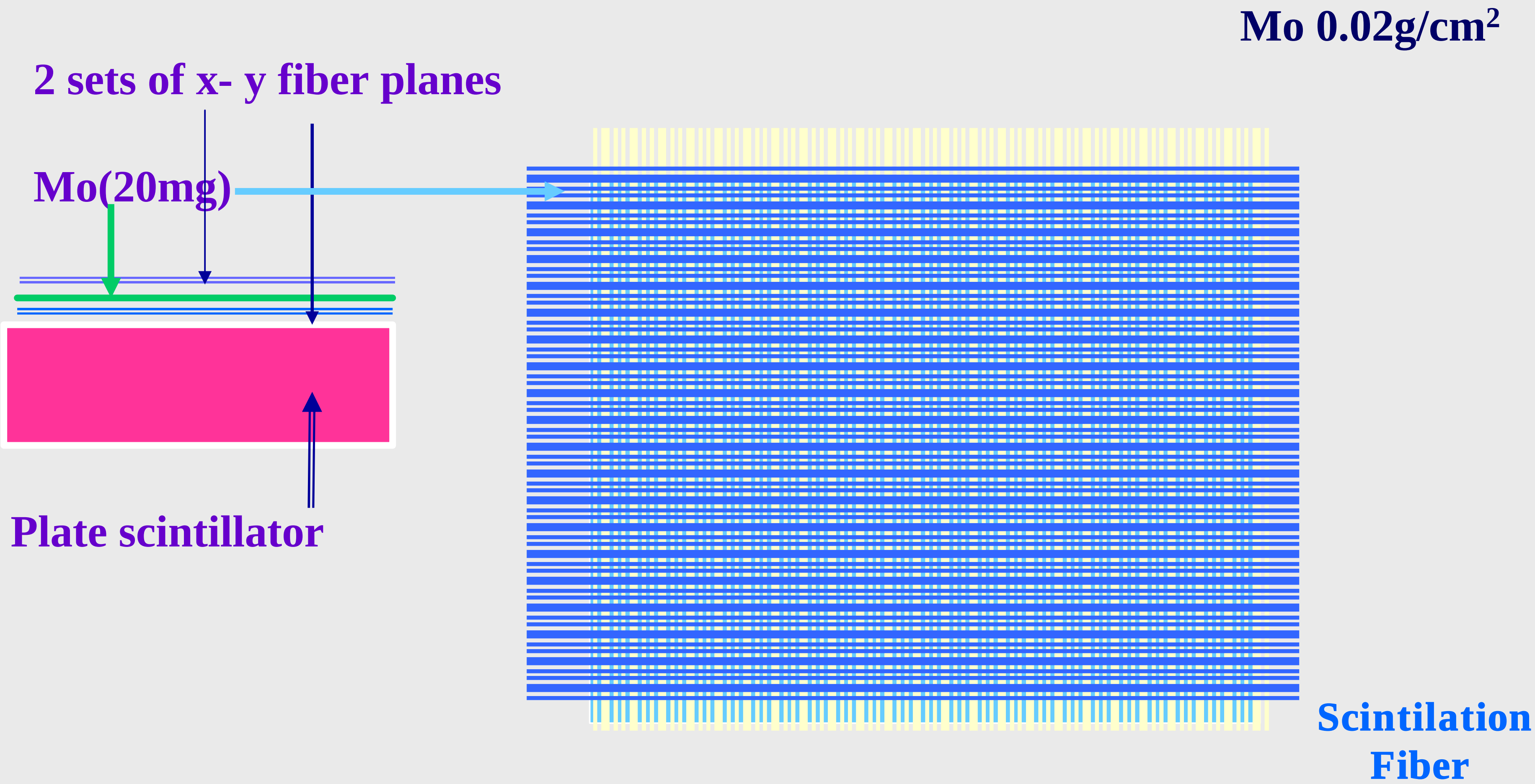
1. Position read-out by fibers with 4 mm - 0.4 mm
2. Energy read-out by plate scintillators with
   E resolution s ~ 2.5 % including the Mo film (20 mg / cm2).
3. Enriched ^{100}Mo 0.5~ 1 ton by centrifugal separation of MoF_6 gas



4. One unit: ^{100}Mo 0.1 ton is 4 ton PL (1.4 m 1.4 m 2m).

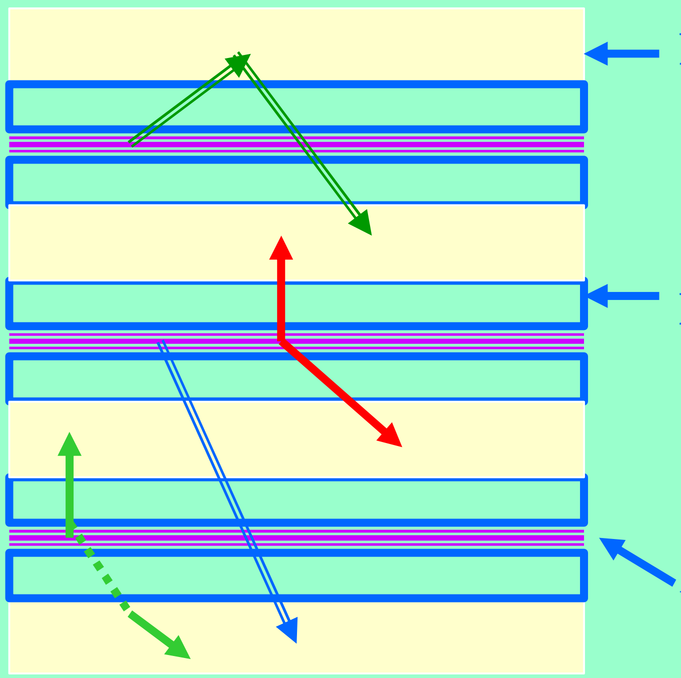
B. Liq.Ar with Mo film UW. Ionizations and lights give better DE.

MOON Plastic fiber-Mo Ensemble



Resolution loss is appreciable. One X plane with 0.4 mm with effective 0.09 MeV loss. $s(Q) = s_P(Q)(1+k)$, where $k = (1/2)\,[(s_f/s_p)^2 - 1]\,[0.09/1.5]$, where s_f/s_p is the ratio of the plate fiber resolutions at 1 MeV. It is proportional to the the photon collection efficiency ratio of 70%/14% = 5. Thus fiber makes the resolution worse by k=12 %.

Position sensitive detector



PL 1200-1200-18 mm for

Energy 0.5 -2.5 MeV with s ~ 2.1 % at Q.

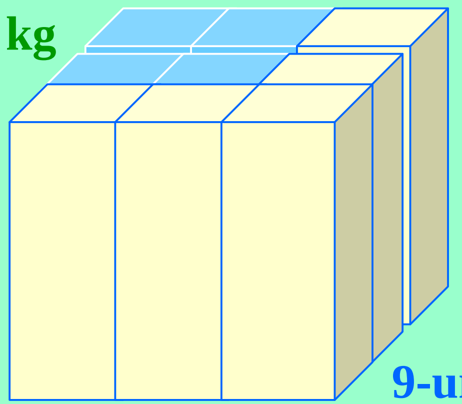
Drift chamber 1160-1160-8 mm.

Position DX ~ 1mm, DY ~ 50 mm by charge ratio.

Angular distribution by the total charge and PSA

bb source 1000-1000 mm 20 mg/cm^2

4 units 120 kg



9-units 270 kg

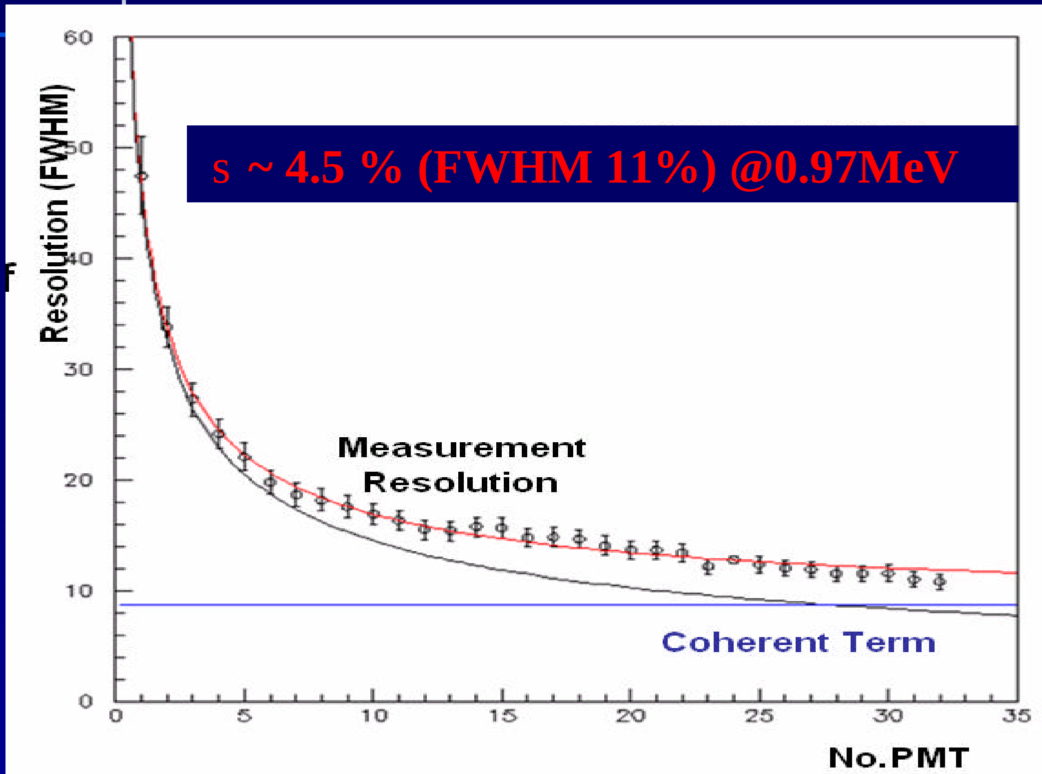
One module bb **source 1m-1m 20 mg/cm^2 = 0.2 kg**

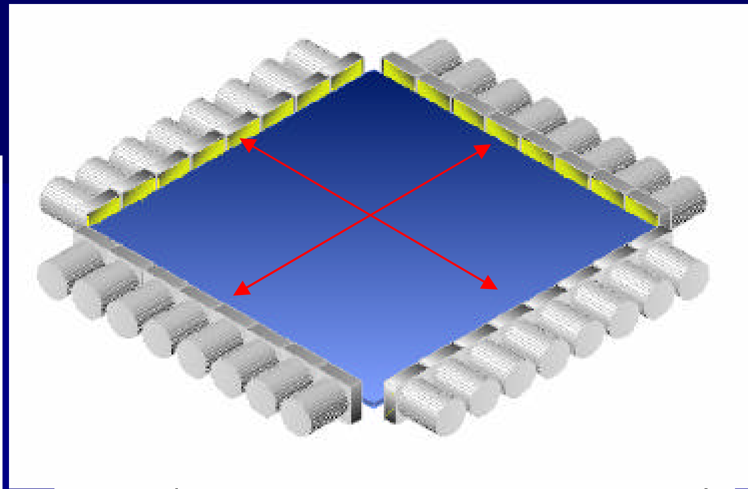
PL+2DF 1.2 m – 1.2 m 4 cm

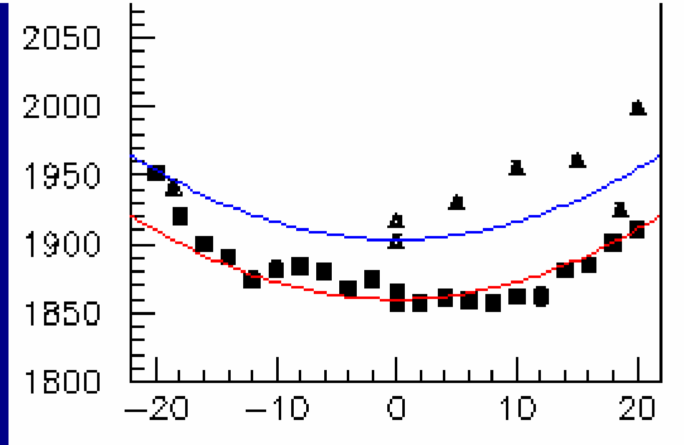
One unit 150 modules, 30 kg, 1.2m – 1.2m – 6 m

Medium size PL with 0.53 m 0.53m 0.01 m.

Medium PL (0.53 m 0.53 m 0.01 m) with
32 Hamamatsu 60 mm sq. R6236-01 PM







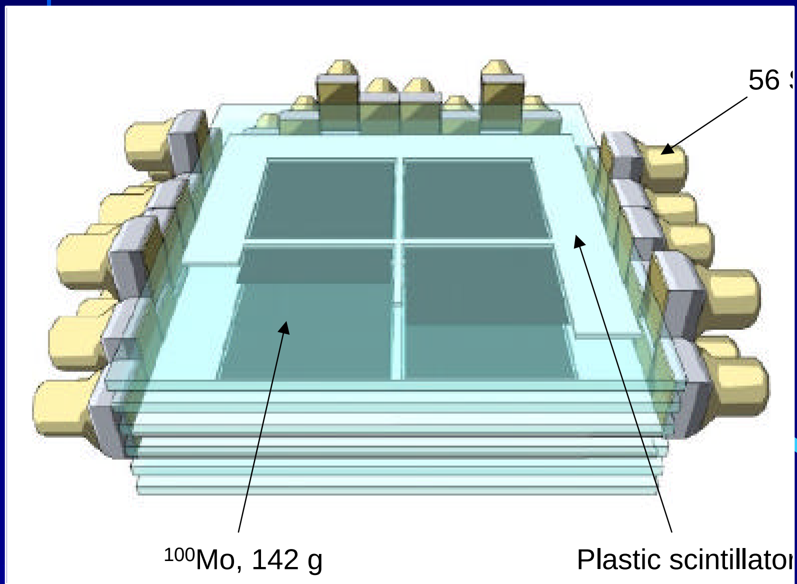
N=10 K / MeV, T = 65 %, QE=30 %.
s ~ 3% (FWHM 7%) @ 3MeV
with s ~1.35 % stat., ~2.7% non-stat.

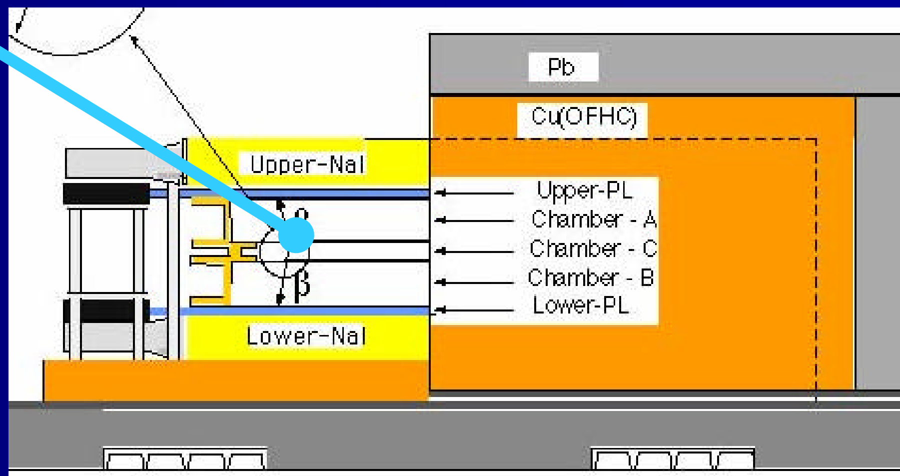
Left/right photon yield ratio gives position. 2.5 % / 20 cm
can be corrected with of 2 cm

MOON 1 Proto type MOON in operation since April 2005

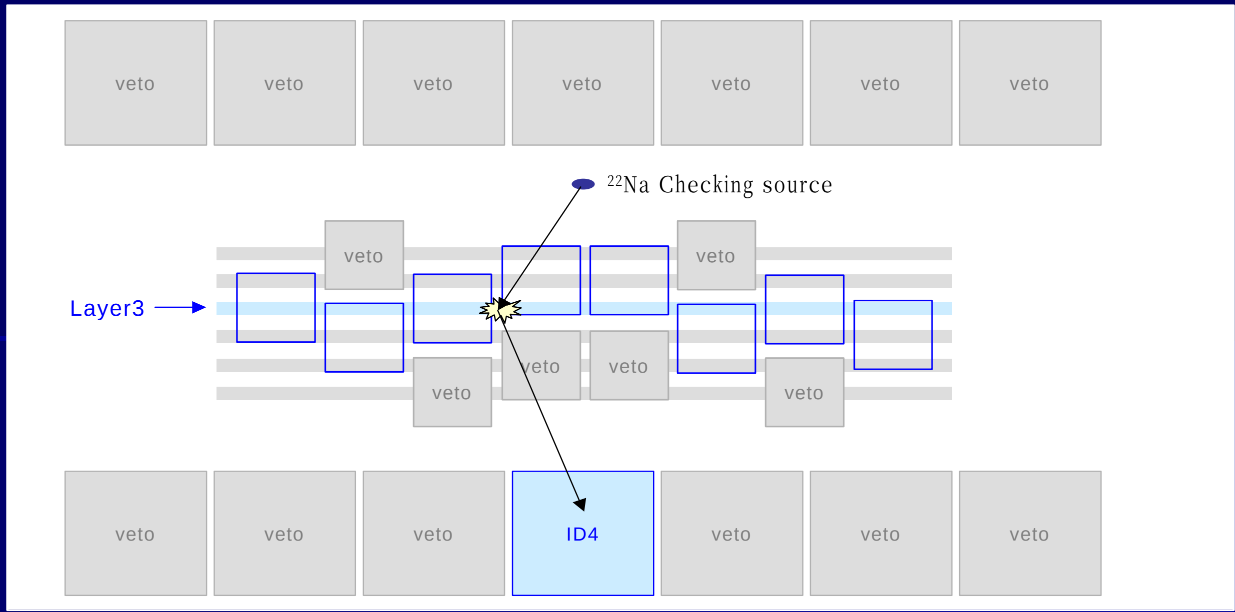
Plate sintillator ensemble inside the ELEGANT V Pb-Cu NaI shield

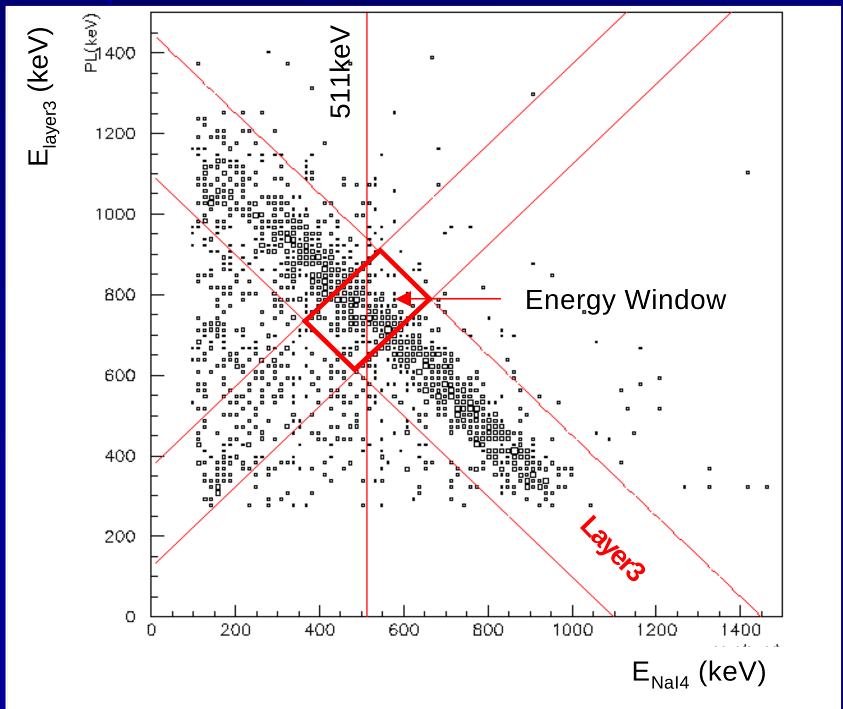
- **6-layers of PL 53×53×1cm^3 Mo-Foil 160g @20mg/cm^2×2**

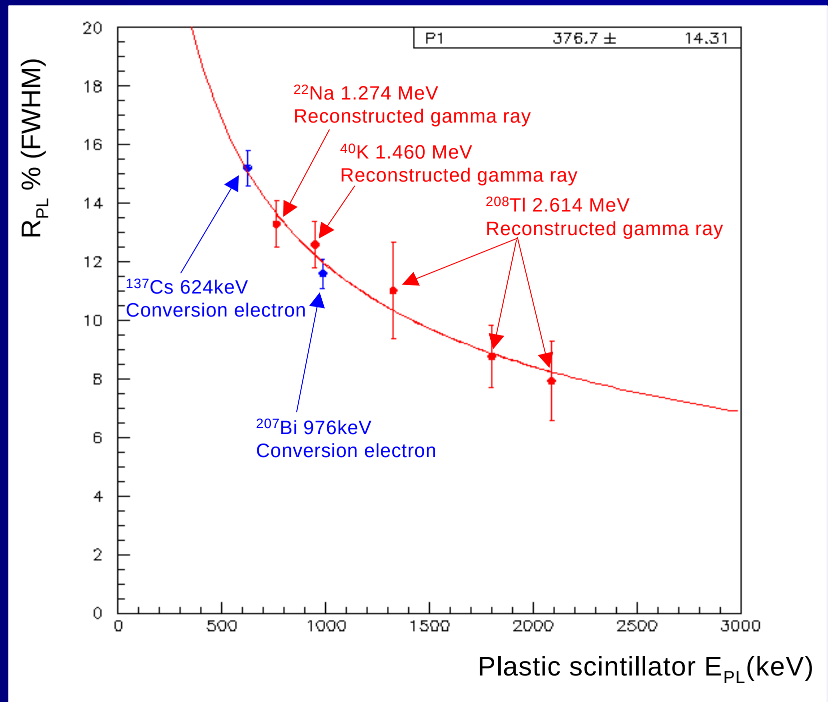




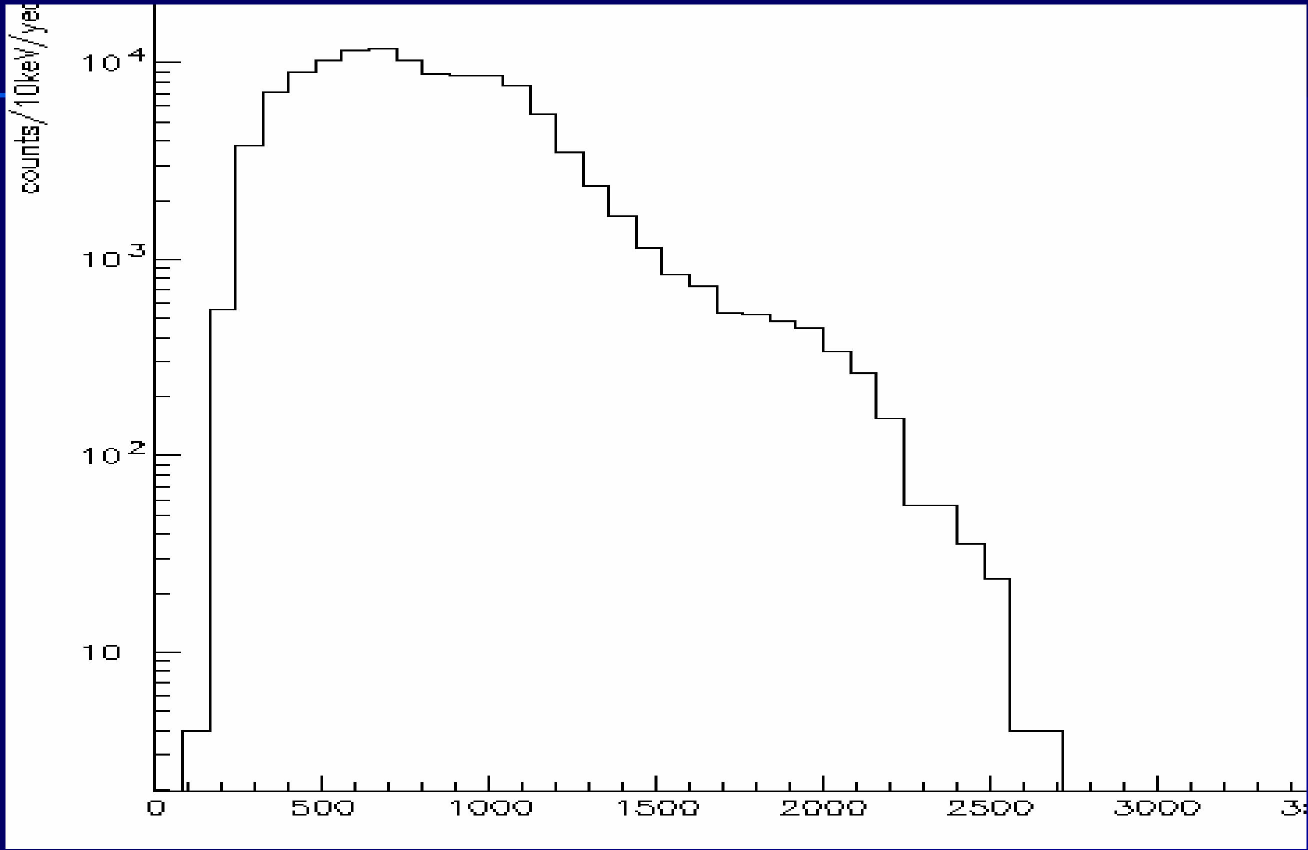
Energy Resolution







2-PL Energy sum spectrum



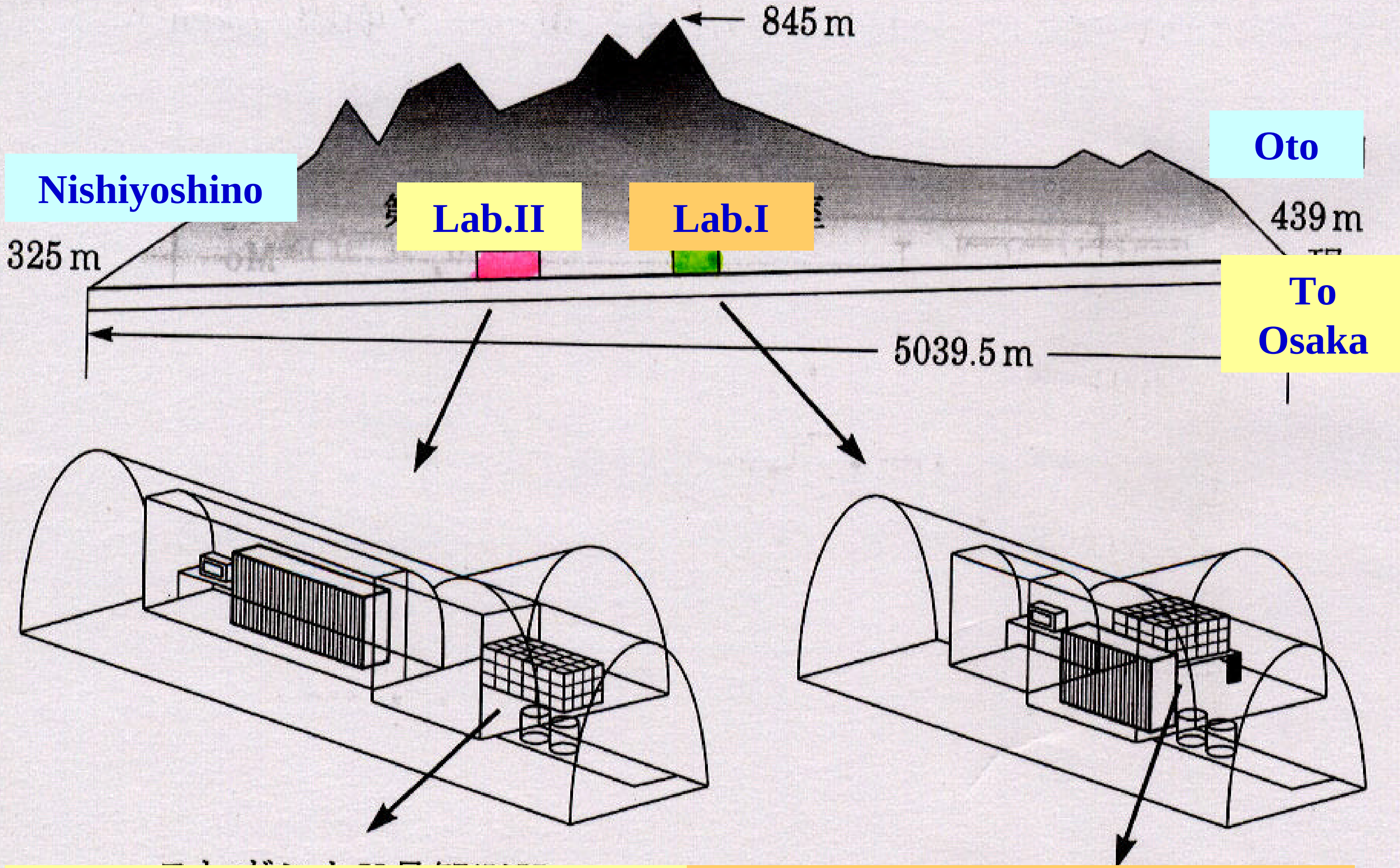
Test run 0 count per 0.5 kg keV year

Oto Cosmo Observatory

Unused 5 km tunnel
1400 m we

Cosmic m
4 10^{-3} /m^2/s
Neutron
4 10^{-1}/m^2/s
Rn
10 Bq/m^3

60 km south of Osaka, near Int. Airport



ELEGANT V
Double beta decays of ^{100}Mo and dark matter

ELEGANT VI
Double beta decays of ^{48}Ca and dark matter

bb experiment mass sensitivity

$m_n = 17\ [S^{0n}]^{-1/2}\ [B^{2n}]^{1/4}\ [s/3\%]^{1.5}\ [e/0.3]^{-1/2}\ [n_b]^{-1/4}$

2s CL with 5 t y S^{0n} in 10^{-24}, B^{2n} /t y, s % , n_b/t

Isotope	Q	G	$[S^{0n}]^{1/2}$	$[B^{2n}]^{1/4}$	m_n(meV)	
^{82}Se	2.992	1.9.	0.79	1.3	28	17*
^{100}Mo	3.034	3.2	1.1	2.45	38	23*
^{116}Cd	2.804	3.2	0.68	1.7	42	25*
^{150}Nd	3.368	13.4	2.12	2.53	20(41)	12*(25)

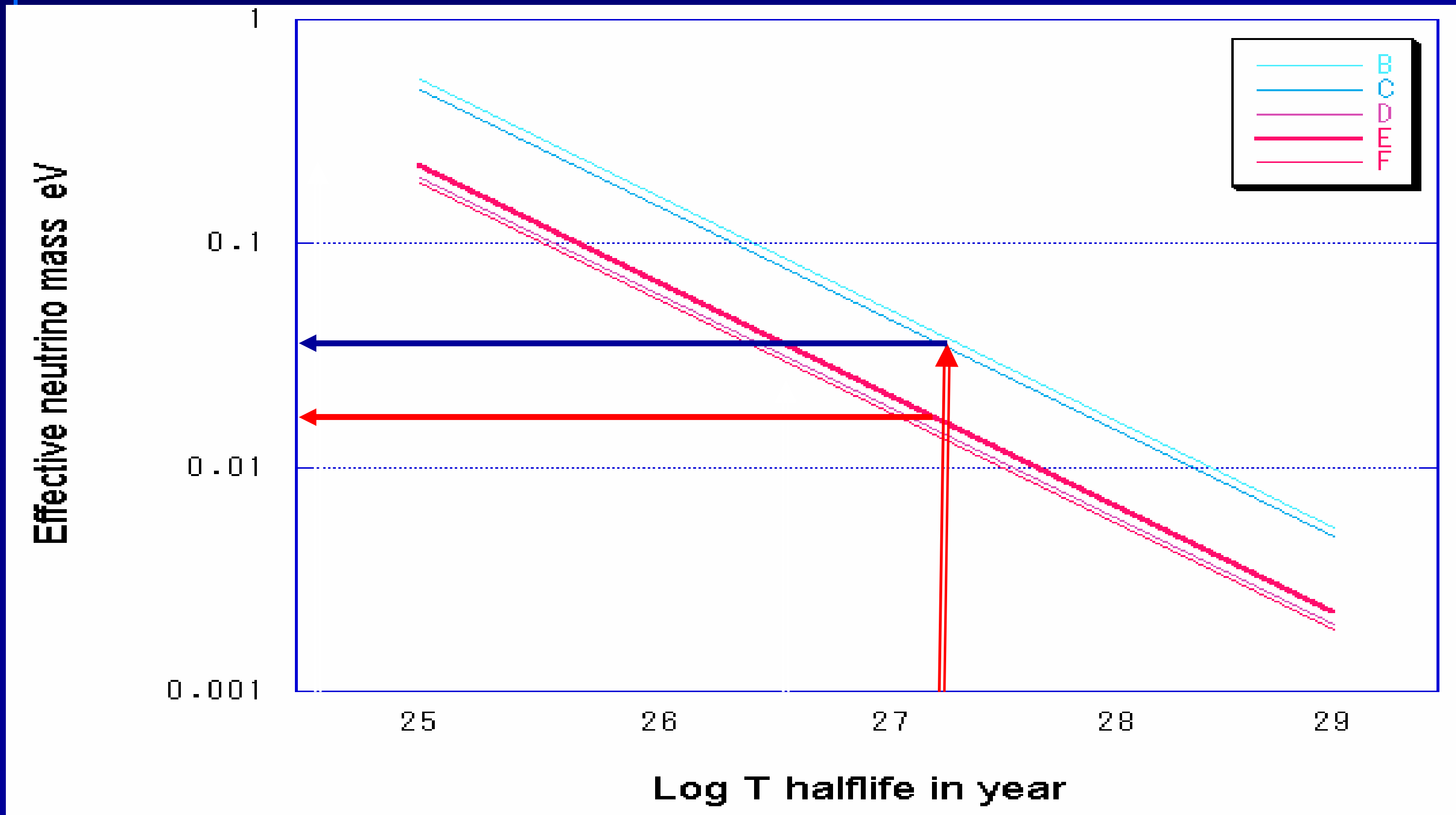
1. IH mass of 30-40 meV and 20-25 meV below IH are achieved by s=3~2.1*% (7~5* %) resolutions.
2. Se82 is good because of small B^{2n} and large Q if M^{0n} is around 3.
3. Mo100 is good because of large G and S^{0n} if M^{0n} is around 3.
4. Nd150 is good because of the very large G and Q. Natural Nd can be used if M^{0n} is OK.
5. Selection should be made by semi-experimental and theoretical M^{0n}

IV. Neutrino nuclear responses by photon and neutrino probes

$$T^{0\nu} = G^{0\nu} |M^{0\nu}|^2 |<m>|^2$$

$M^{0\nu}$ nuclear matrix element: linear to ν mass

Nuclear theory calculations are sensitive to nuclear structures, uncertainty of a factor 2. Experimental data relevant to $M^{0\nu}$.



B:Rodin-03 QRPA, C:Rodin-03 RQRPA, D:Simkovis01 QRPA E:Suhonen02 QRPA F:Faessler98 RQRPA

III. Nuclear proves for n response studies

Isospin $\langle t Y_L \rangle$ and spin isospin $\langle t\, s\, Y_L \rangle_J$

- **0nbb**
- **L=0,1,2,3,4,5,**
- **E < 50 MeV**

Nuclear Responses for $0\nu\ \beta\ \beta$

$$H(r_1, r_2, \tau_1, \tau_2, \sigma_1, \sigma_2) \sim f(r_1, r_2)\ \tau_1 \tau_2 \sigma_1 \sigma_2 \ldots$$

$$f(r_1, r_2) = 1/|r_1 - r_2|$$

q=04.GeV/C

ℓ=0−6

Separable Form for Nucleon $r_n < r_i, r_j <$ Nuclear R_N

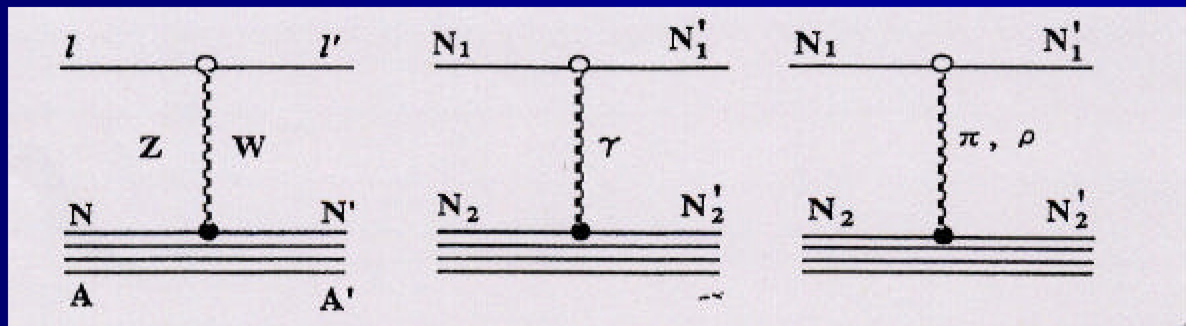
$f(r_1, r_2) \sim \sum_\ell f_\ell\, h_\ell(r_1)\, h_\ell(r_2)$ Ejiri, Belyaev

$M^{0\nu} \sim \Sigma f_\ell < 0_f | T_\ell^+ | i >< i | T_\ell^+ | 0_i >$ $T_\ell = h_\ell(\gamma)\, \tau\, \sigma$

$M^{0\nu} \sim \Sigma M_\ell^+(SP) M_\ell^-(SP) + (M_\ell^+(GR)\ M_\ell^-(GR) \rightarrow \varepsilon)$

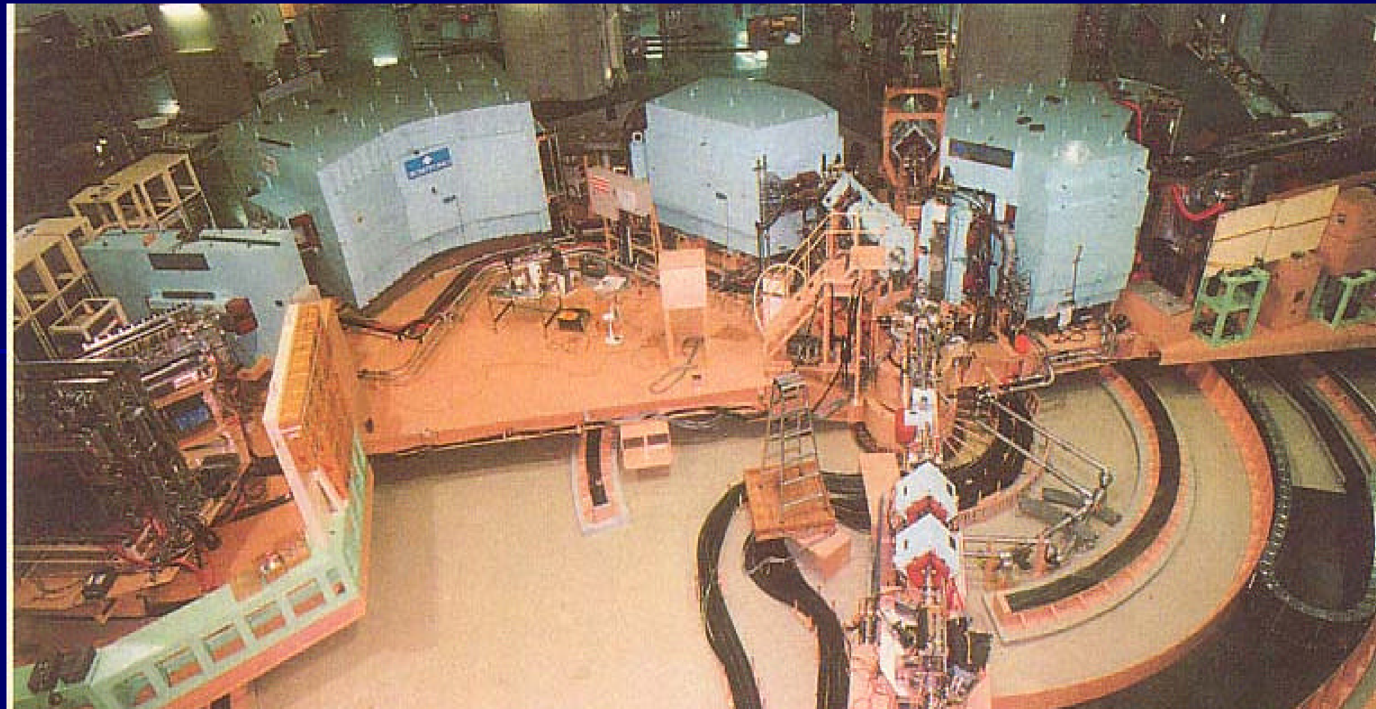
Studied by τ^- and τ^+ Charge Exchange Reactions

Weak, EM, and hadron probes forspin isospin responses for n

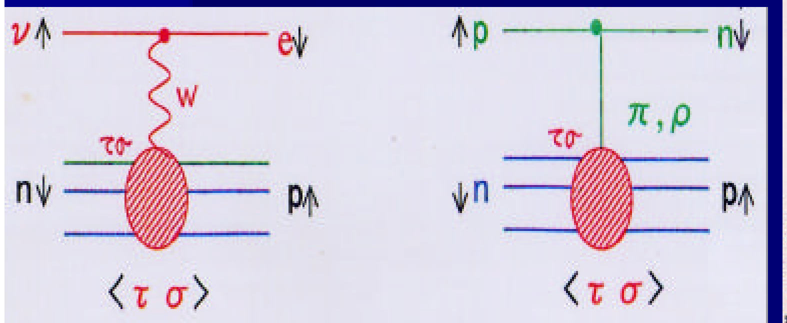


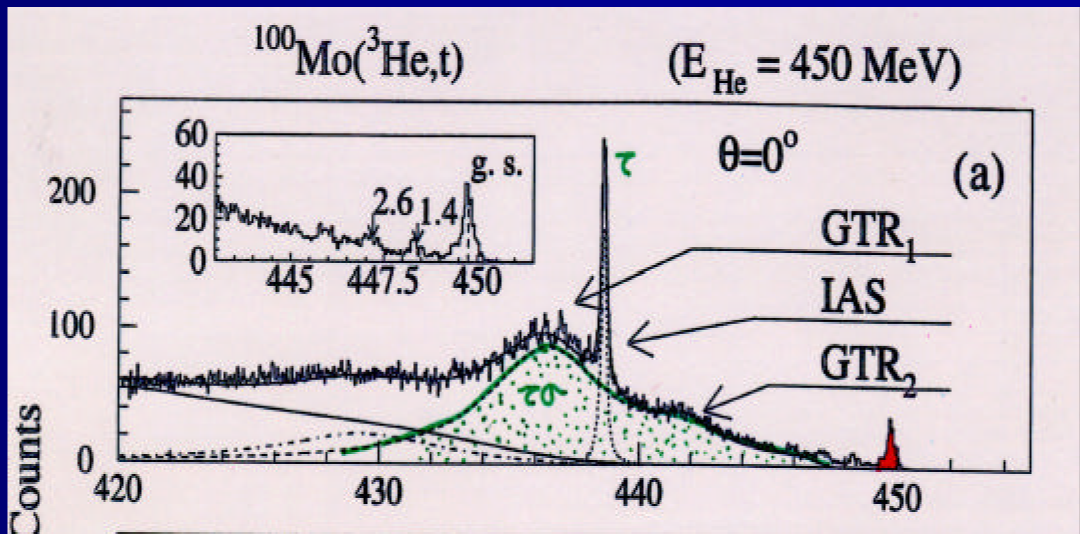
RCNP Osaka Univ.

Charge Exchange Spin-flip Reactions



H.Ejiri, Phys. Rep. 338 (2000) 265





M^b from IAS g

IAS-GR interference gives
M^b and sign

H. Ejiri PRL 21 '68, H. Ejiri PR 38 '78

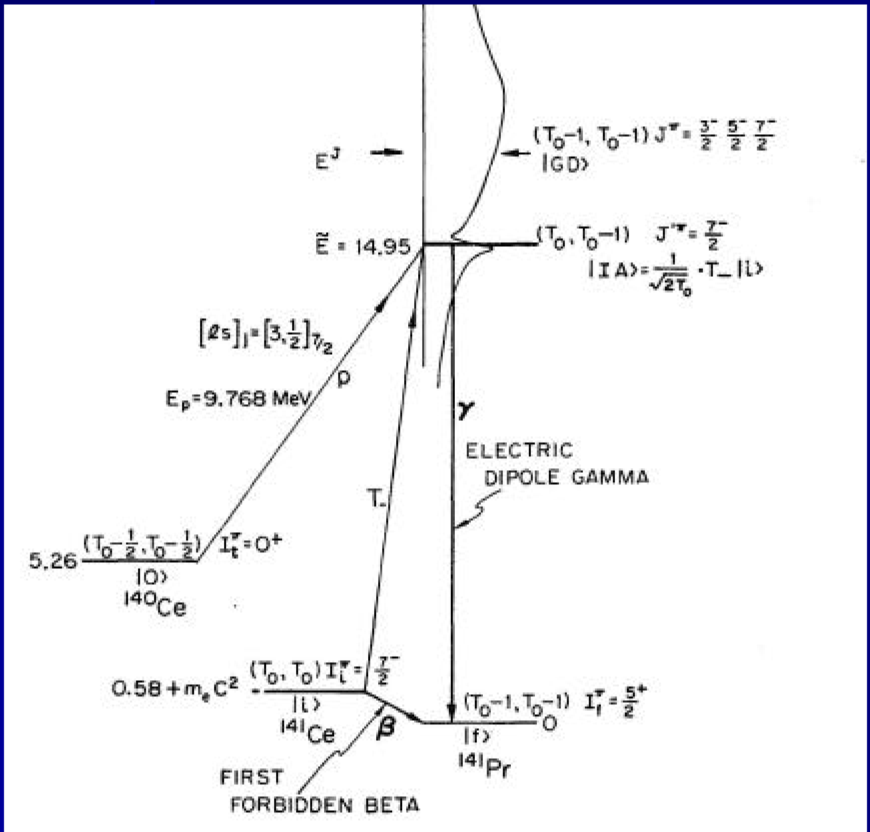
$$g_v m_{1\mu}^{\beta} = g_v \sum_{\lambda\nu} a_\nu^+ \langle \nu | r Y_{1\mu} | \lambda \rangle b_\lambda .$$

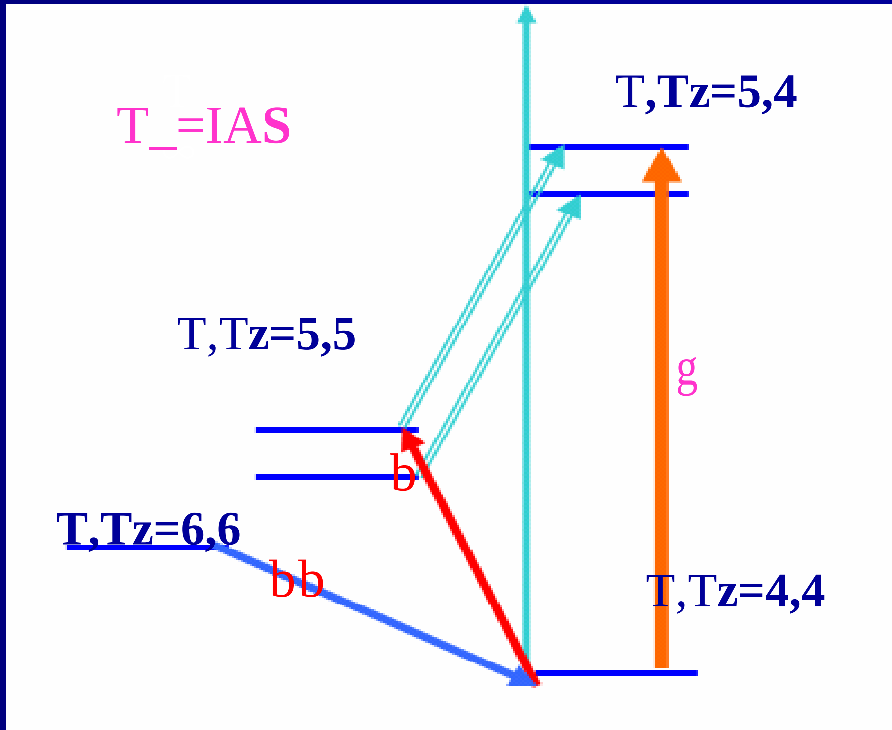
$$|g_v M^\beta| = \sqrt{2T_0} |eM_{IA}^\gamma| \frac{g_v}{e}$$

$$g_v i\xi 0^\beta = -g_v i\xi m^\beta (\Lambda - 1.2\Lambda_1 - 1),$$

where $\langle m^\beta \rangle = \langle r \rangle$, $\Lambda = -i\langle \alpha \rangle / \xi \langle r \rangle$ and $\Lambda_1 = i\langle \sigma \times r \rangle / \langle r \rangle$.

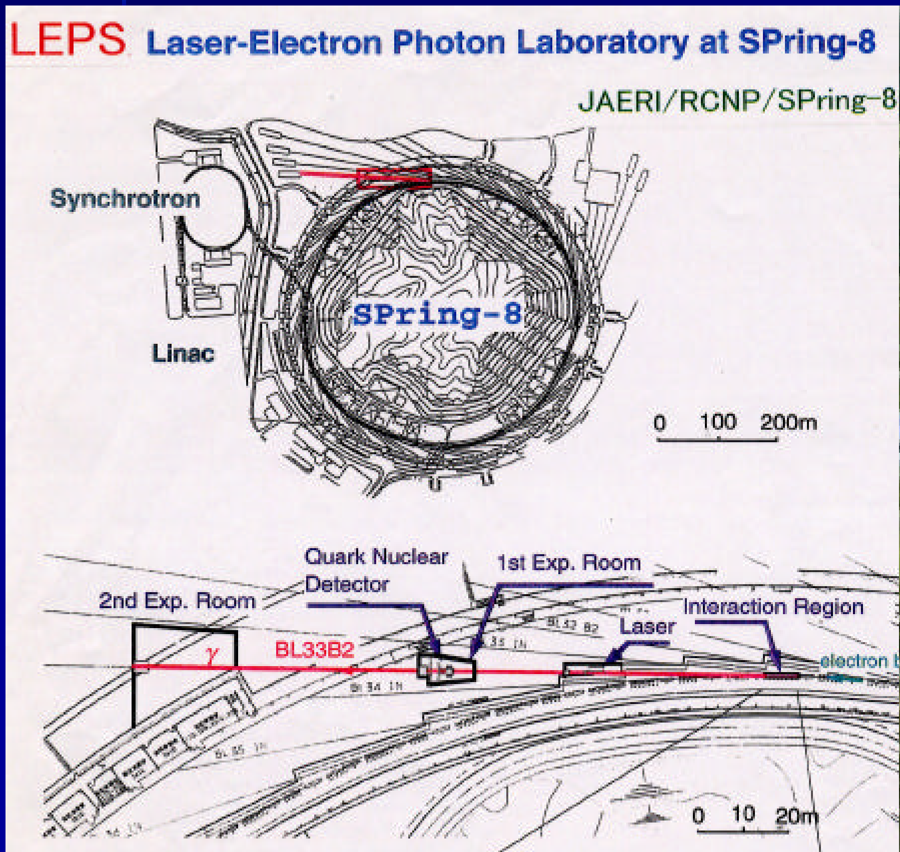
<r> from IAS γ, Λ from CVC , and one gets (σxr).





GeM Photons :GeV-MeV Laser Electron photons

- GeM LEPS Spring-8 are unique probes
- Real photons in a wide energy range of multi GeV – MeV
- Energy spectra with peak at the max energy.
- Polarizations ~ 100 % for E1-M1 vector axialvector

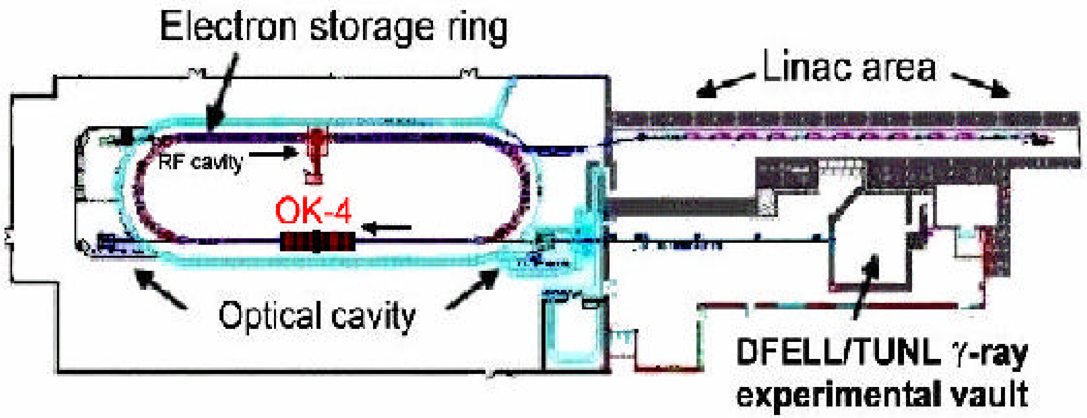


Spring-8 LEPS multi-GeV 10^6 g

HIGS MeV photons

HIγS (High Intensity γ-ray Source)

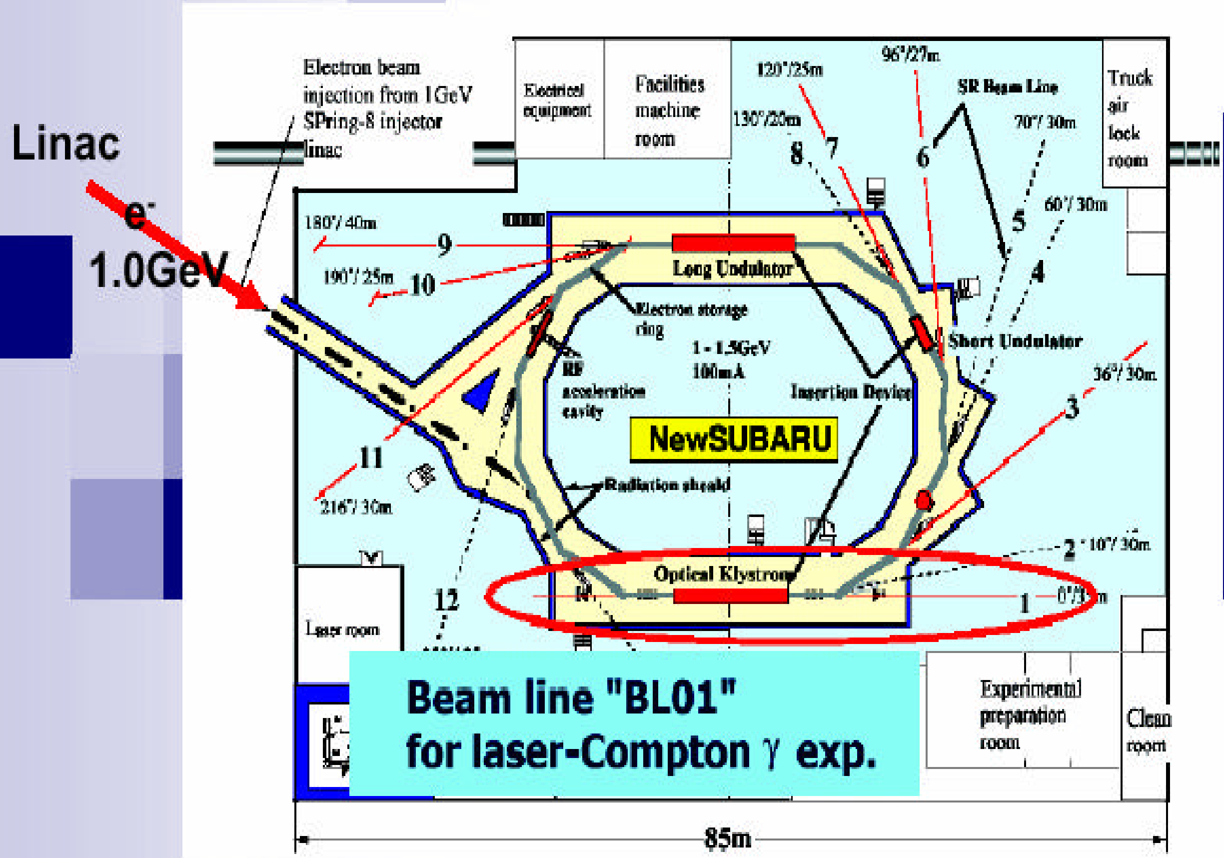
- Intra-cavity Compton Backscattering of FEL photons by electrons circulating in the 1.2GeV Duke Storage Ring



- E_γ = 2~70 MeV, $\Delta E_\gamma/E_\gamma \sim 1\%$, $\Phi_\gamma \sim 10^7$ /MeV/s ($\rightarrow 10^9$)

NewSUBARU

Laser-backscattered γ source@ NewSUBARU



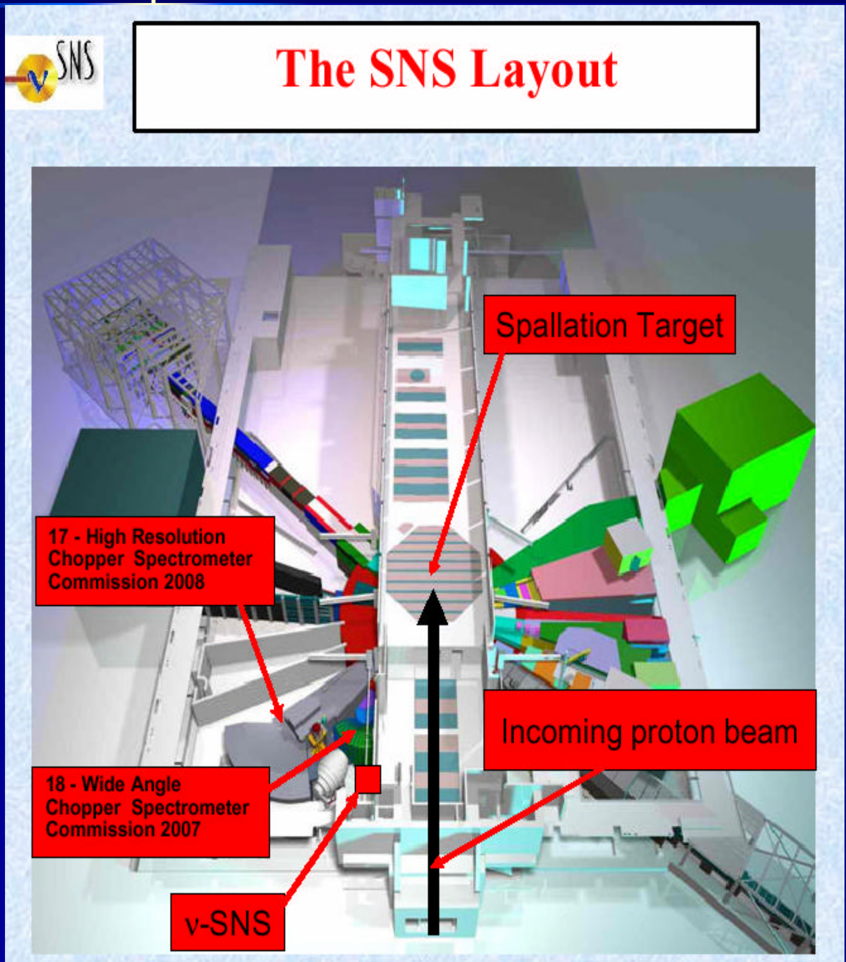
E_γ ; 17 ~ 40 MeV (1.06μ Nd-YVO_4)

Φ_γ ~ 10^6 photons/s, $\Delta E_\gamma/E_\gamma$ = 2%

K. Aoki, S. Miyamoto,

NIM A516 (2004) 228-2

Neutrino Weak probes



Low energy Neutrinos

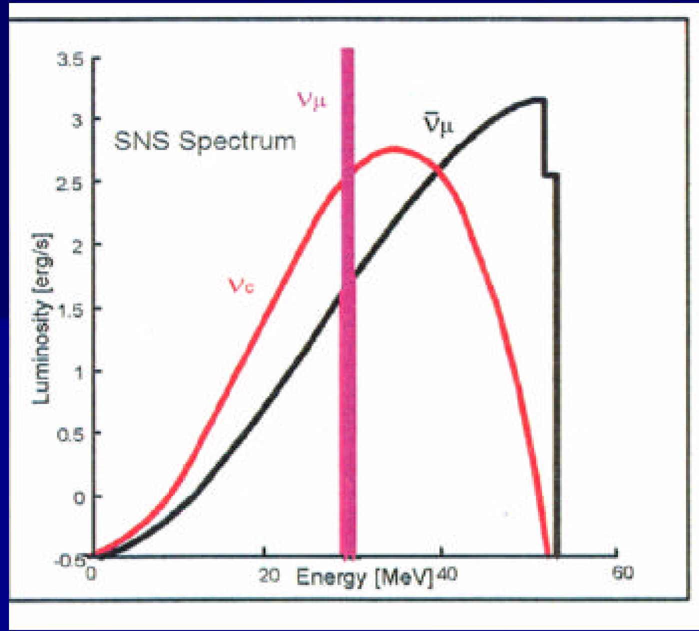
Stopped p^+ SNS/ORLaND

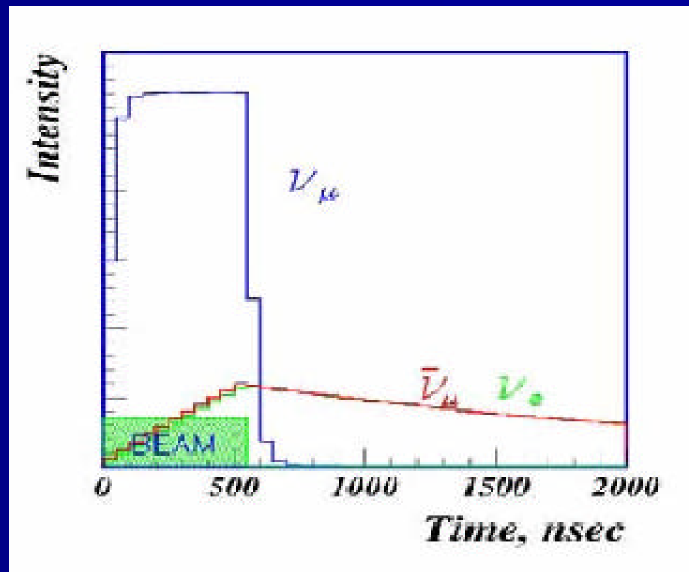
$p + Hg \rightarrow n\ p^+$

$p^+ \rightarrow m^+ + n_m$ $m^+ \rightarrow e^+ + n_e$ + anti-n_m

Intense (~10^{15}/sec) n's from 1 MW p, time structures and n spectra are used to study astro nuclear with large detectors(10 tons) for s ~ 10^{-41-42} cm^2

Source	E GeV	Np	Nn
SNS	1	6 10^{15}	7 10^{14}
J—PARC	3	1.2 10^{15}	3 10^{14}






V. Concluding remarks

Concluding remarks

1. 0nbbX **decays are realistic probes for the Majorana nature of** n **and absolute** n **masses in QD and IH, and in NH in future.**
2. **Calorimetric exps of Cuore, Exo, Majorana/GERDA and others, spectroscopic exps of MOON/Super-NEMO and others are promising to search for the QD and IH masses of 100-25 meV.**
3. n **nuclear responses relevant to** 0nbb **are studied experimentally at RCNP by hadrons at HIGS and LEPS Spring-8/SUBARU by photo-reactions through IAS and** n**-probes in future as well.**
4. **MOON as Majorana/Mo Observatory Of Neutrinos with multi-layer PL modules is realistic by novel photon detection for DBD spectroscopic experiment with the IH 25 meV mass sensitivity.**

5. Welcome to IOMN (International Observatory of Majorana Neutrinos) as discussed in Osaka Feb. 2006 and NDM06 at Paris, http://events.lal.in2p3.fr/conferences/NDM06/

INTERNATIONAL STATEMENT ON NEUTRINOLESS DOUBLE-BETA DECAY

Avignone F, Barabash A, Ejiri H, Elliott S, Fiorini E,

Haxton W, Gratta G, Jullian S, Kochetov O, Minakata H,

Lalanne D, Morales A, Morales J, Petcov S, Suhonen J.

1. **Fundamental** n **properties studied by DBD: (1)Majorana nature &** DL ¹ **0, the** n **mass spectrum & mass scale, possibly CP. DBD is realistic for studying these fundamental** n **properties.**
2. **2. Next-generation DBD exps with <m> ~ 25 meV discover non-zero effective** n **mass if** n**'s are Majorana and the QD or IH.**

3. Form an international DBD network in order to endorse a coordinated approach to executing next-generation DBD probes

http://www.rcnp.osaka-u.ac.jp/~ejiri/DBD-Lett

Reference

n **responses** **H.Ejiri, Phys. Rep. 338 (2000) 265.**

H. Ejiri Nucl. Instr. Methods, 503 (2003) 276

H. Ejiri Nucl. Instr. Methods, 503 (2003) 276

Review bb **H.Ejiri, JPS (2005) 2104 Invited Review**

http://jpsj.ipap.jp/link?JPSJ/74/2101

ELEGANT bb **H. Ejiri, et al., Phys. Rev. 65 (2001) 065501**

MOON bb **solar and super nova** n

H.Ejiri, el al., Phys, Rev. Lett.,85 (2000) 2917

H.Ejiri, J.Engel, N.Kudomi, PL B530 (2002) 27

H.Ejiri, Czech.J.Phys.54: B317-B325 2004

Symposium http://www.spring8.or.jp/ext/en/appeal/nnr05

MOON collaboration

- P.J.Doe, R.G.H.Robertson*, D.E.Vilches, J.F.Wilkerson、D. I. Will.
  CENPA, Univ. Washington.

- H.Ejiri*, R. Hazama, K.Ichihara, Y.Ikegami, H. Ishii, T.Itahashi N.Kudomi, K.Matsuoka, H. Nakamura, M.Nomachi+, T. Ogama, T. Shima, Y.Sugaya,
- RCNP, and Physics OULNS, Osaka Univ.

- S.R.Elliott, LANL
- J.Engel. Phys.Astronomy, Univ. North Carolina.
- M.Finger, and K. Kuroda, Phys. Charles Univ. Prague
- K.Fushimi, K. Ichihara, GAS, Tokushima Univ. Tokushima
- M. Greenfield, ICU, Tokyo.
- A.Gorin, I.Manouilov, A.Rjazantsev. High Energy Physics, Protvino.
- A. Para FNAL
- A. Sissakian, V. Kekelidze, V. Voronon, G. Shirkov A. Titov, JINR
- V. Vatulin, V. Kutsalo, VNIIEF
- S. Yoshida, Tohoku Univ. Sendai

- * Contact persons.


Thank you for your attention.
Welcome to the bb n network to give rise to the DBD n experiment

Comments on JASRI from international science views.

JASRI. as one of the top research lab,
with excellent scientists, technicians, & facilities,
are supposed to contribute
to the progress of science and technology in the world.

Crucial are followings

- 1. Be active in original research works.
- 2. Attract and support users through their scientific and technical
- levels, which are motivated and kept via their research works.
- 3. Collaborate with outside researchers.
- 4. Open to and responsible for science & technology
- communities as well as public i.e. tax payers.
- 5. Promote science and technology addressed for future progress.
- 6. Critical and constructive comments on projects around .
- 7. TOP DOWN: Scientists and technicians, being at

  TOP, should do as they believe for science and technology.
  Administrative officials and bureaucrats, being at
  BOTTOM, support them.

Scientific and technical activities should be open at the web.site, and reviewed internationally.

Proposal of an APPEAL Lab. in the west pacific

1. Astro-particle physics with photons and neutrinos.
2. Electron, photon, and neutrino detectors.

3. Laser technologies for MeV-GV LEPS.
4. New electron photon accelerator complex.
5. Related science and technology

Open to all scientists and technicians.

Workshop for APPEAL lab. to discuss objectives, group-members, budget and related problems.
Let's start up now by calling for volunteers.

http://www.spring8.or.jp/ext/en/appeal/