Nuclear Weak Responses By Measuring Nuclear Gamma Rays From Muon Capture Reactions

(*MuSIC Collaboration*)

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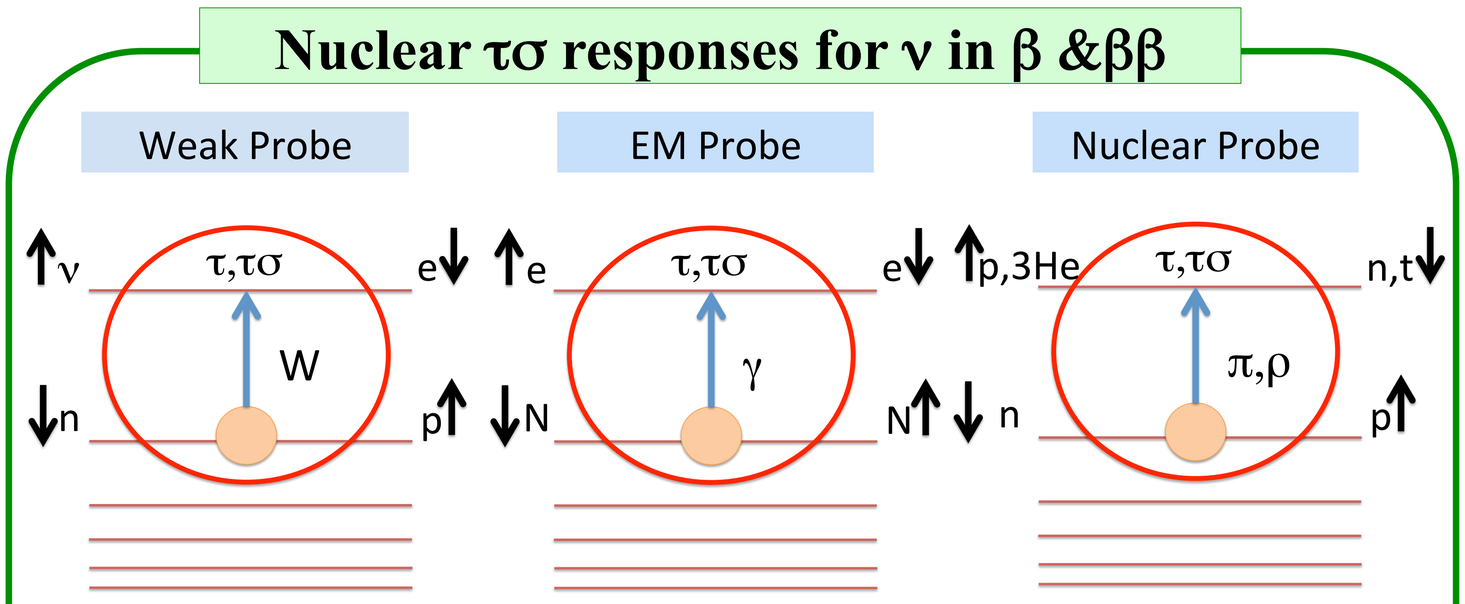
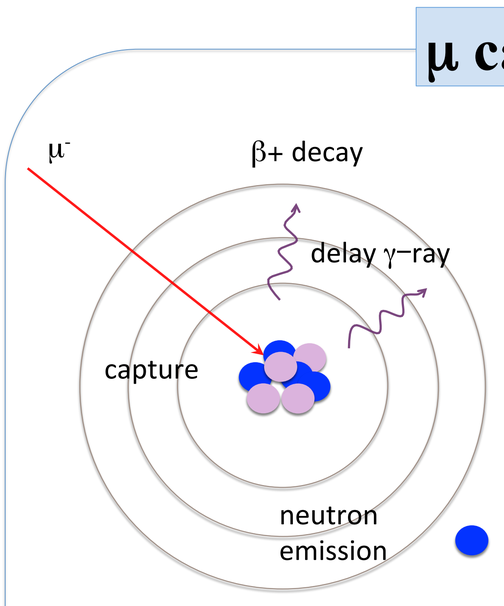
Objectives;

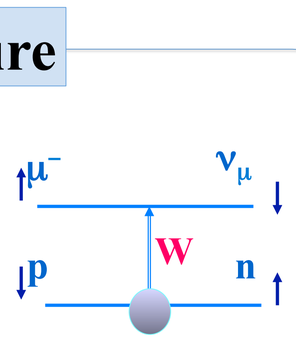
1. Nuclear weak β^+ responses by measuring μ –X, prompt and delayed γ rays from μ capture reactions.
2. To study the gross distribution of the weak strength distribution by measuring delayed γ rays from isotopes produced by (μ, nγ) on ^{100}Mo.
3. The feasibilities of weak nuclear responses study by the μ from MuSIC.

Nuclear τσ responses for ν in β &ββ



μ capture





1. Large momentum transfer
2. J=0,±1,±2,..
3. Capture rate ~1 (Z>10)
4. Branching Ratio ~1

^{100}Mo(μ,xnγ)$^{100-x}$Nb

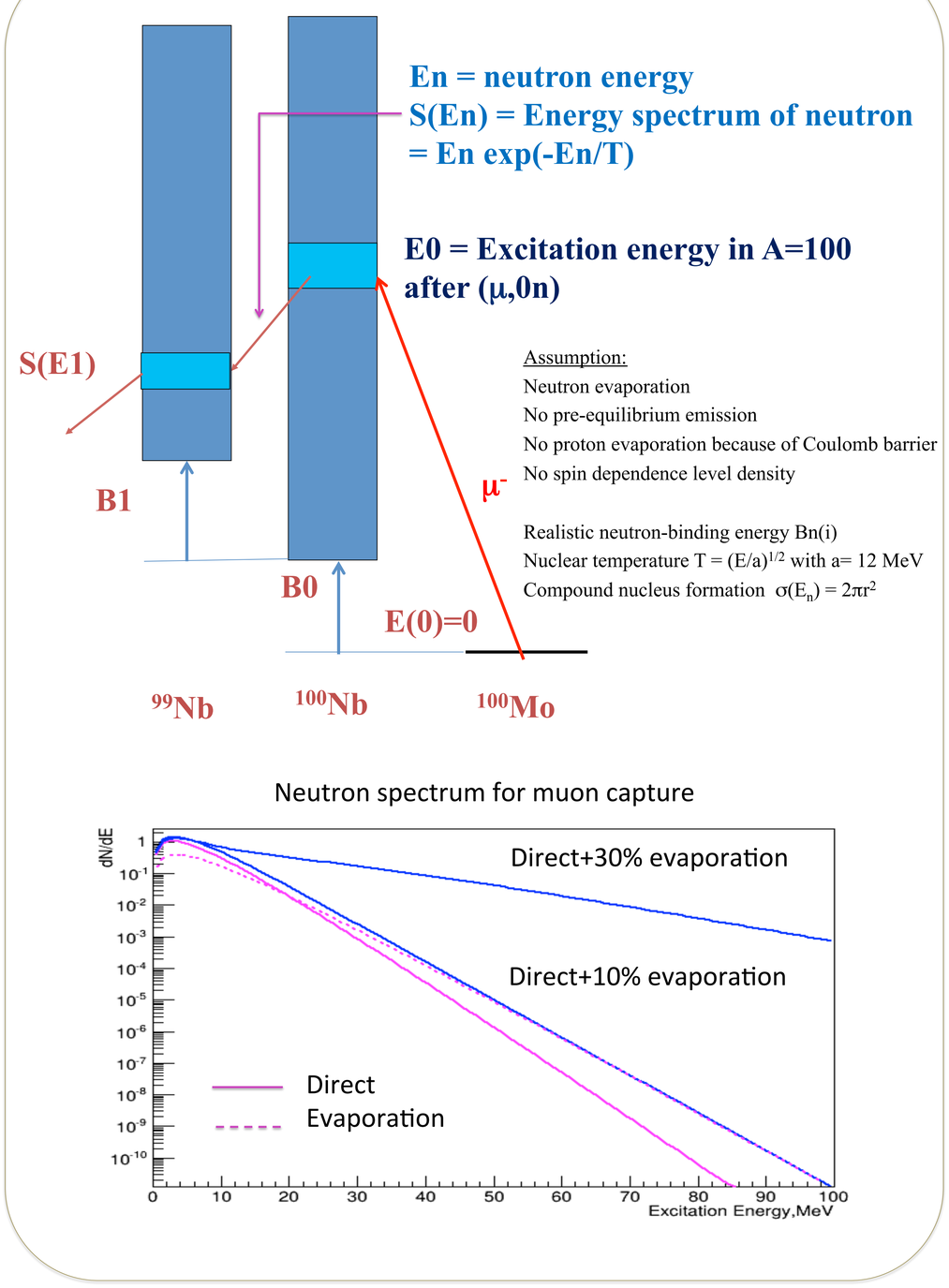
Nuclear weak Response

$N = [M]E$

$N(x) = \Sigma\, M(x,i)E(i)$

$E(i) = \Sigma\, M(x,i)^{-1}N(x)$

Calculator Model



Assumption:
- Neutron evaporation
- No pre-equilibrium emission
- No proton evaporation because of Coulomb barrier
- No spin dependence level density

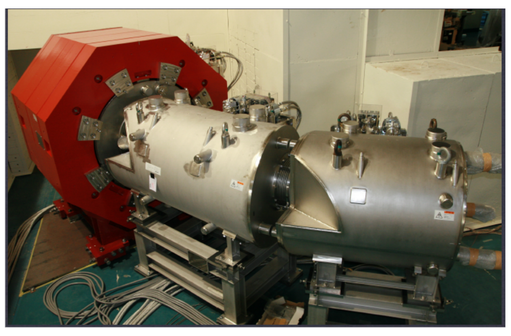
Realistic neutron-binding energy Bn(i)

Nuclear temperature $T = (E/a)^{1/2}$ with a= 12 MeV

Compound nucleus formation $\sigma(E_n) = 2\pi r^2$

Neutron spectrum for muon capture

Demonstration by MuSIC



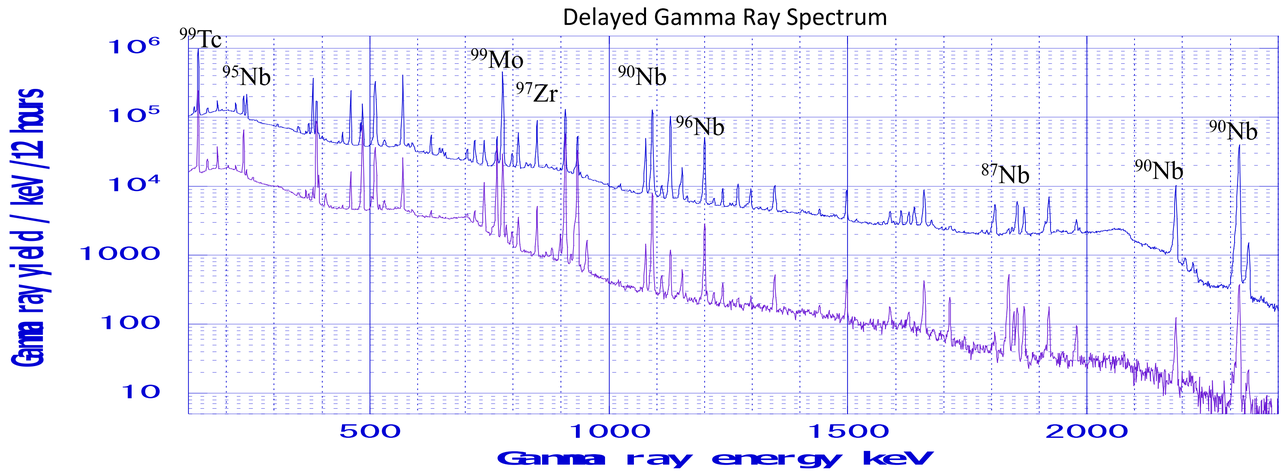
μ+Mo with protons

p=2.35x10^3 μ (1mA ,1hr),

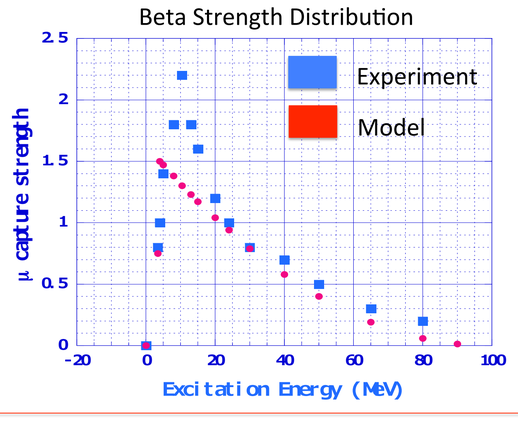
stopped μ=3.5x10^9

Mass Number	RI (Half life)	Gamma ray energy (keV)
99	Mo(66)-*^{m}Tc(6)	181.2, 739.5, *140.5
97	*Nb(1.2)-Zr(17)	*658.1,743.4
96	Nb(23.4)	459.9, 568.8, 778.2,1200.2
95	^{m}Nb(86.6)-*Nb(839.28)	204.1, *765.8
92	Nb(244.8)	934.5
90	*Nb(14.6)-*Zr	141.2,1129.2, *2319.0
89	Nb(1.2)-*Zr(78.4)	507.4, 587.8, *908.9
87	Y(13.4,79.8)	380.8, 388.5, 484.8

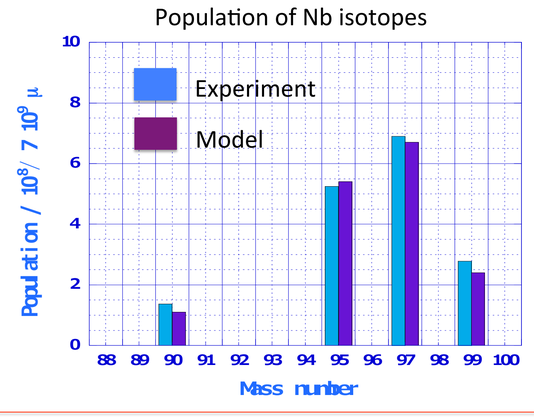
Delayed Gamma Ray Spectrum



Beta Strength Distribution



Population of Nb isotopes



Concluding Remarks

- 0νββ was a unique probe to study the fundamental properties of neutrinos beyond the standard model.
- We can determine the β+ responses by measuring the delayed gamma ray following the muon capture reaction.
- The strength distribution as a function of excitation energy reproduces the relative population of each Nb isotope.
- The GR like distribution was observed which was centered at 8-10MeV.
- The present MuSIC beam line was not yet completed, thus the transport line is not long enough to avoid pion contaminations.

References

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