MOON

Mo Observatory Of Neutrino

H. Ejiri

J. Engel*

R. Hazama

P. Krastev#

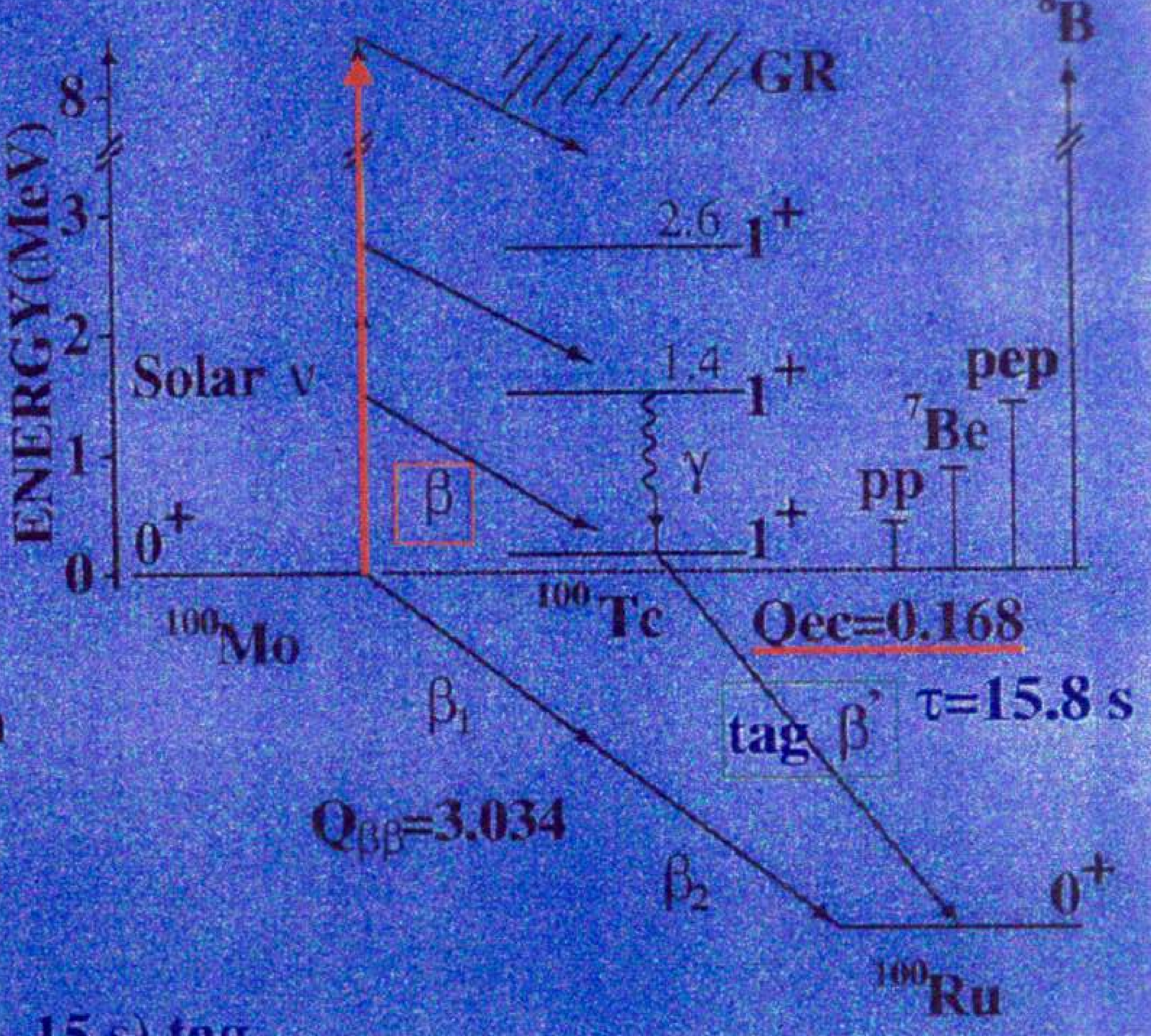
N. Kudomi†

R.G.H Robertson

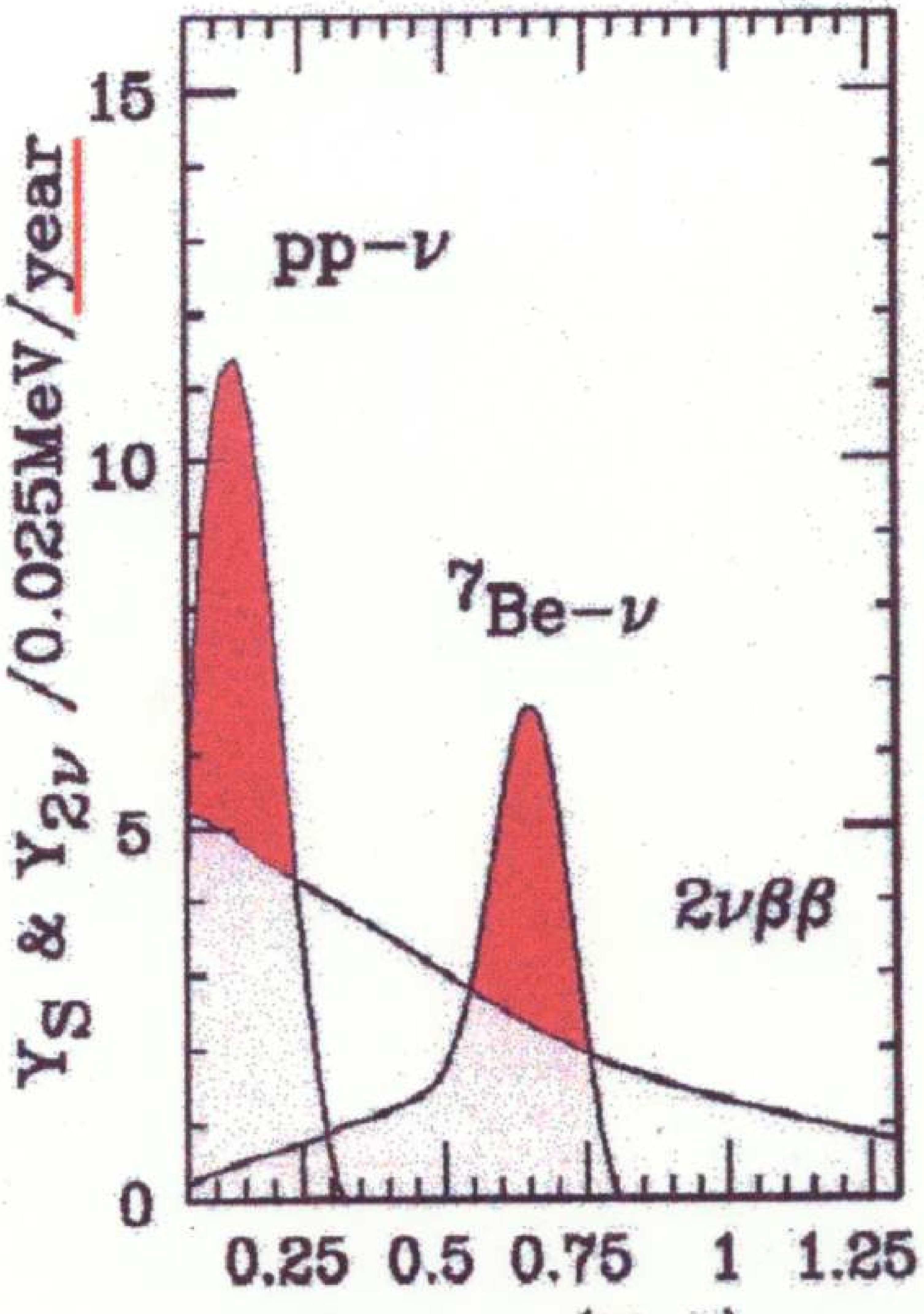
Nucl.Phys.Lab. & Dept.Phys. Univ. of Washington,USA
* Dept.Phys.&Astro., Univ. of North Calorina, USA
# Dept.Phys, Univ. of Wisconsin, USA
† Research Center for Nucl.Phys, Osaka Univ., Japan

Unique Points of ^{100}Mo Solar-ν Studies

- CC real-time spectroscopic detector
- E_{th} = 0.168 MeV
- Large matrix element, $0^{+} \longrightarrow 1^{+}$
- Ground state transition - matrix element can be measured
- ^{100}Tc decay (3.2 MeV-β, 15 s) tag solar-ν capture



MOON



Bdf irreductible :

Coincid. fortuite de 2

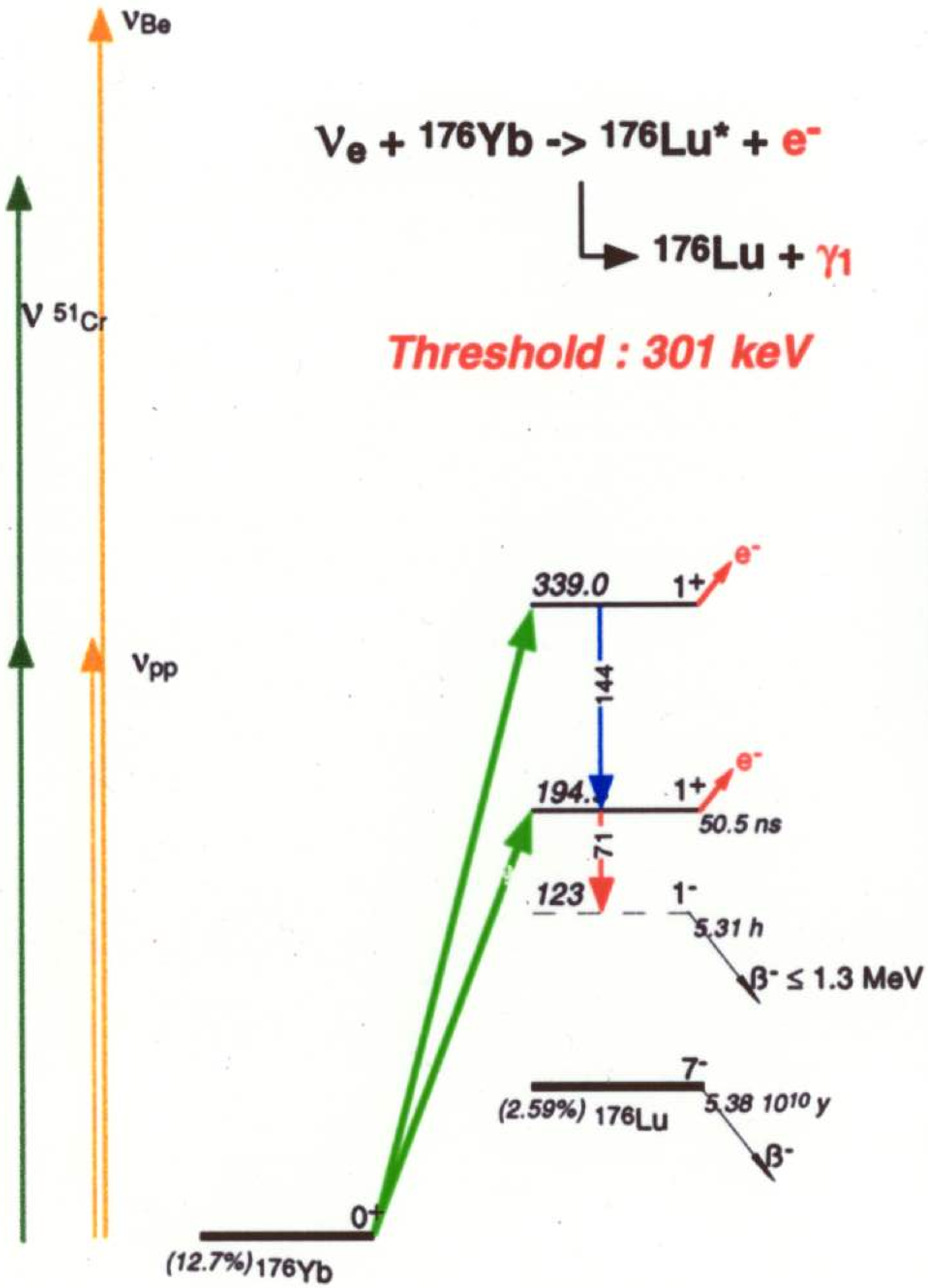
2 - β decay !!!

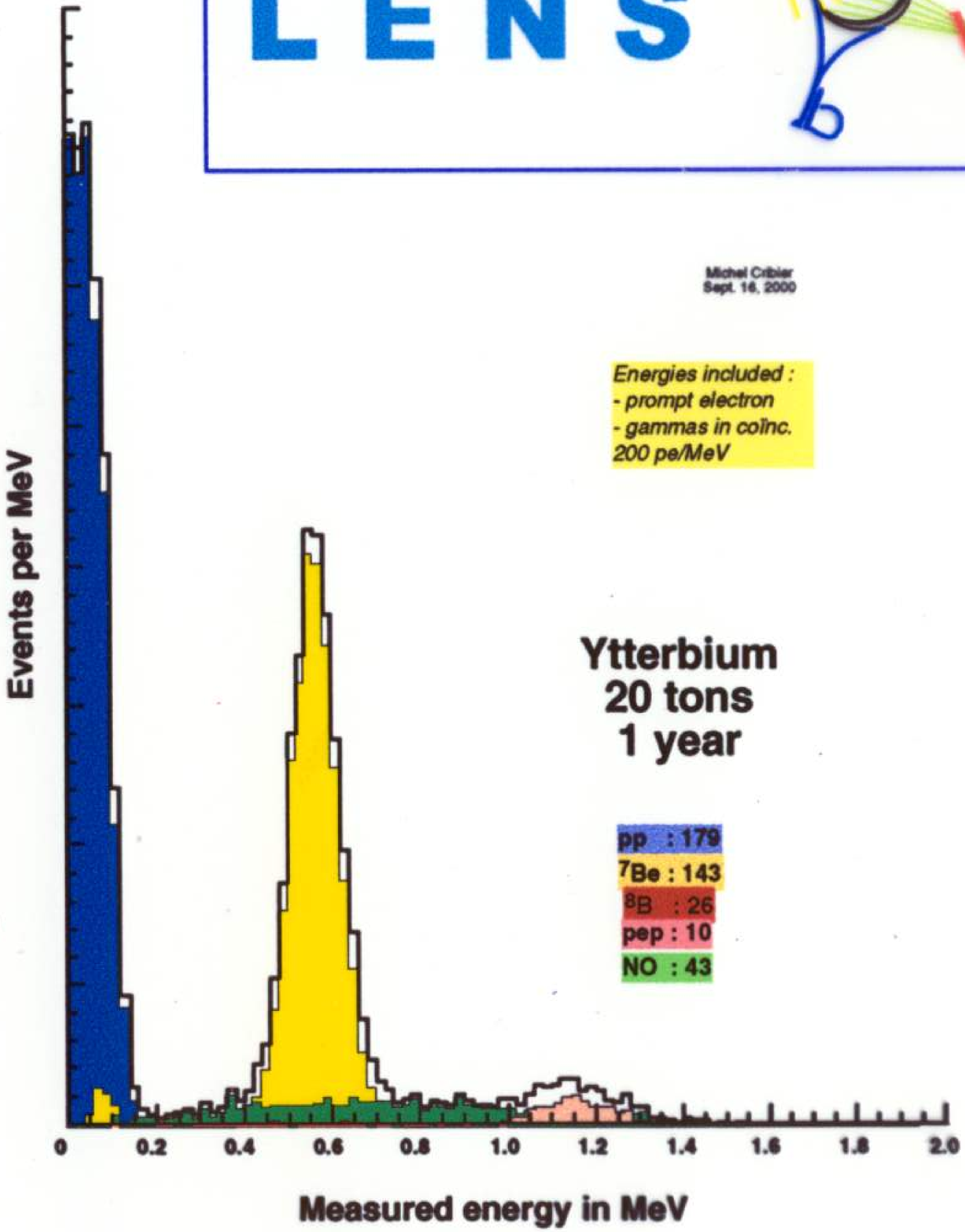
LENS

$\nu_e + {}^{176}Yb \rightarrow {}^{176}Lu^* + e^-$

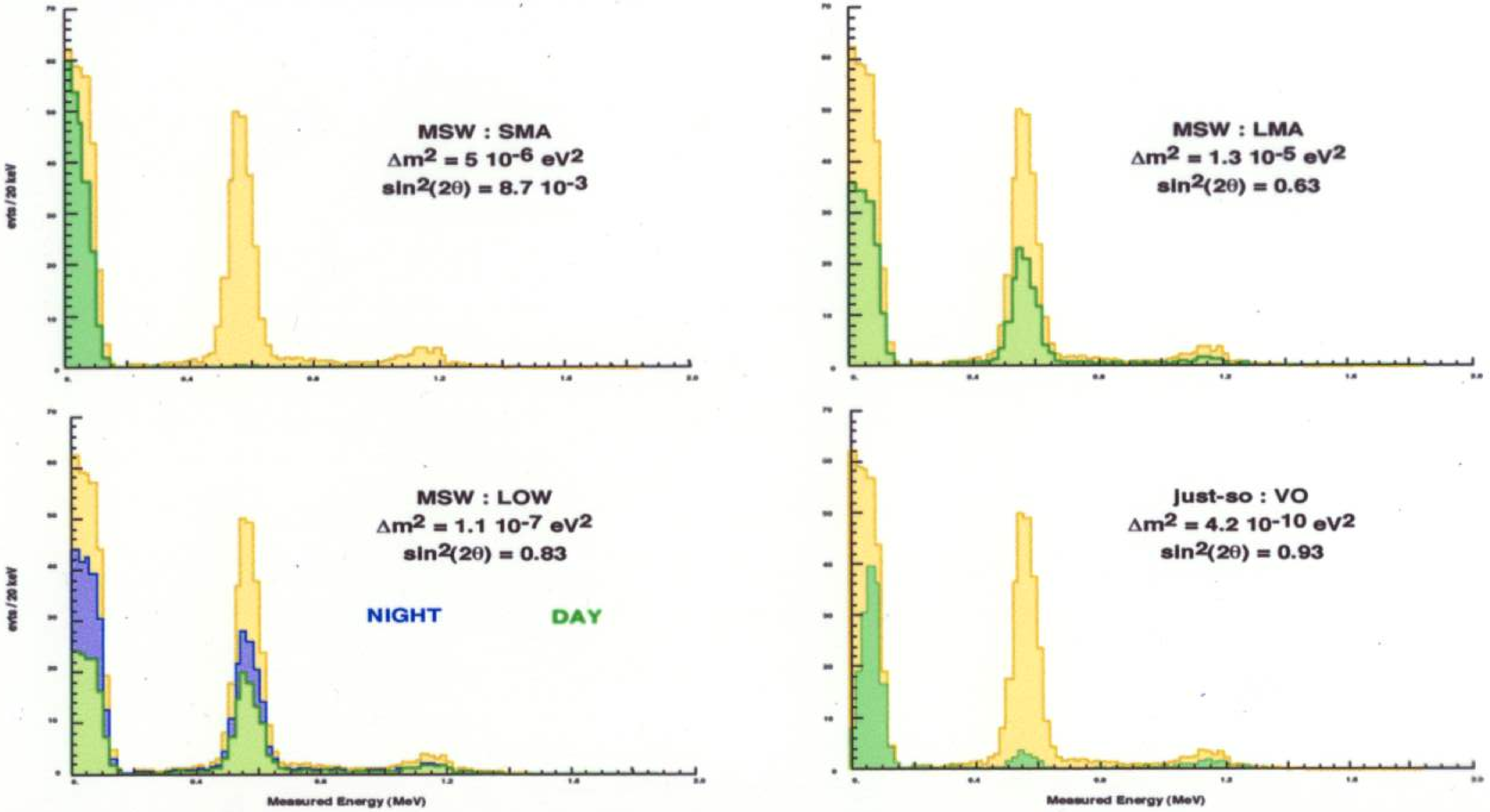
$\hookrightarrow {}^{176}Lu + \gamma_1$

Threshold : 301 keV





Disentangle the puzzle



115 In

Indium to detect Solar Neutrinos

❑ A very old idea…1976

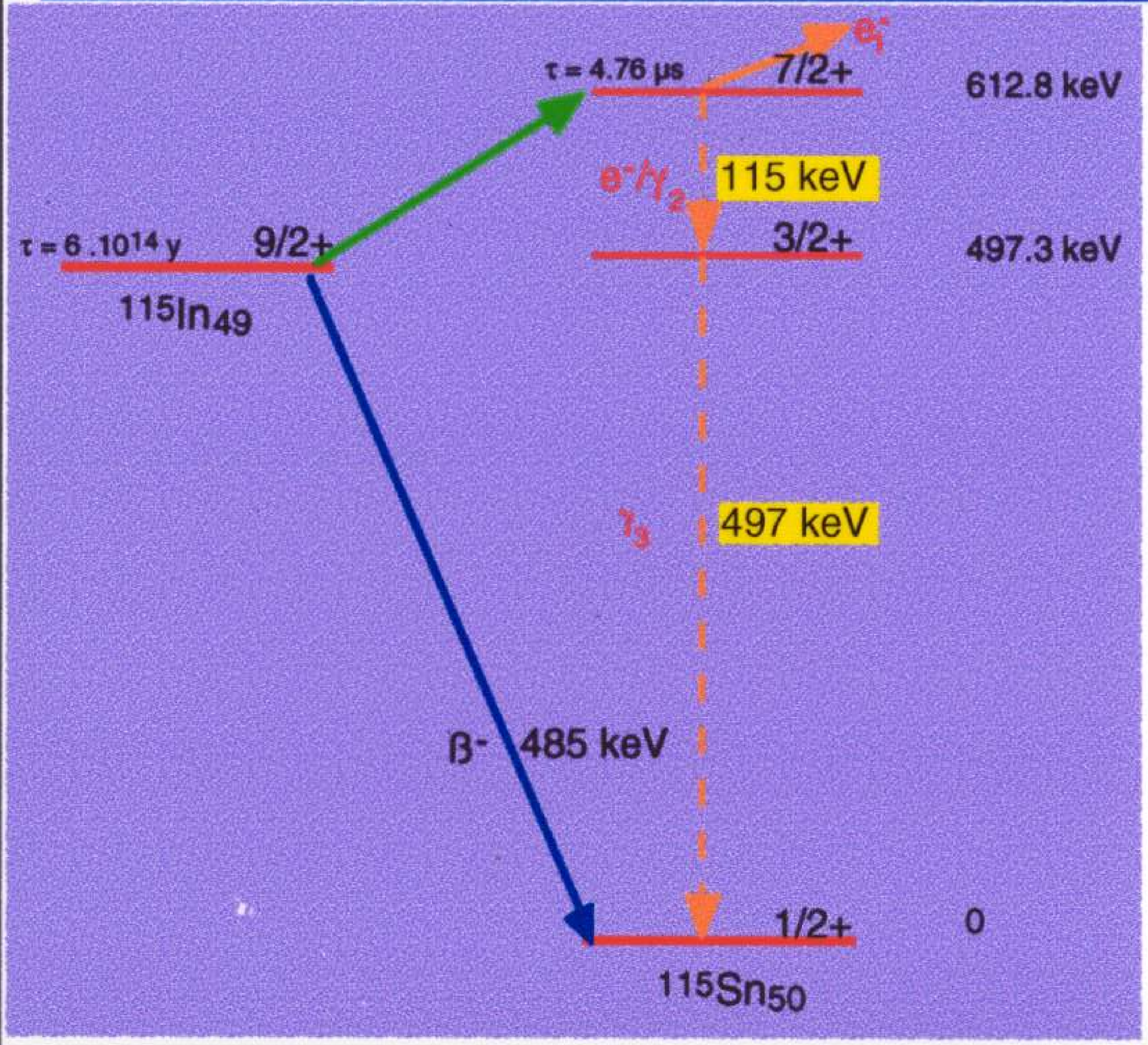
- R.S. Raghavan : PRL 37 (1976) 259
- Many groups, everywhere
- Many techniques :
  - → Liquid scintillators, crystals, semi-conductors, supra conductors…

❑ A new (*very recent*) hope

- R.S. Raghavan : hep-ex/0106054

115 In

Detection scheme



Important Rate

3.6 tons : 1 int./day

- pp : 260 / year
- ^{7}Be : 66 / year

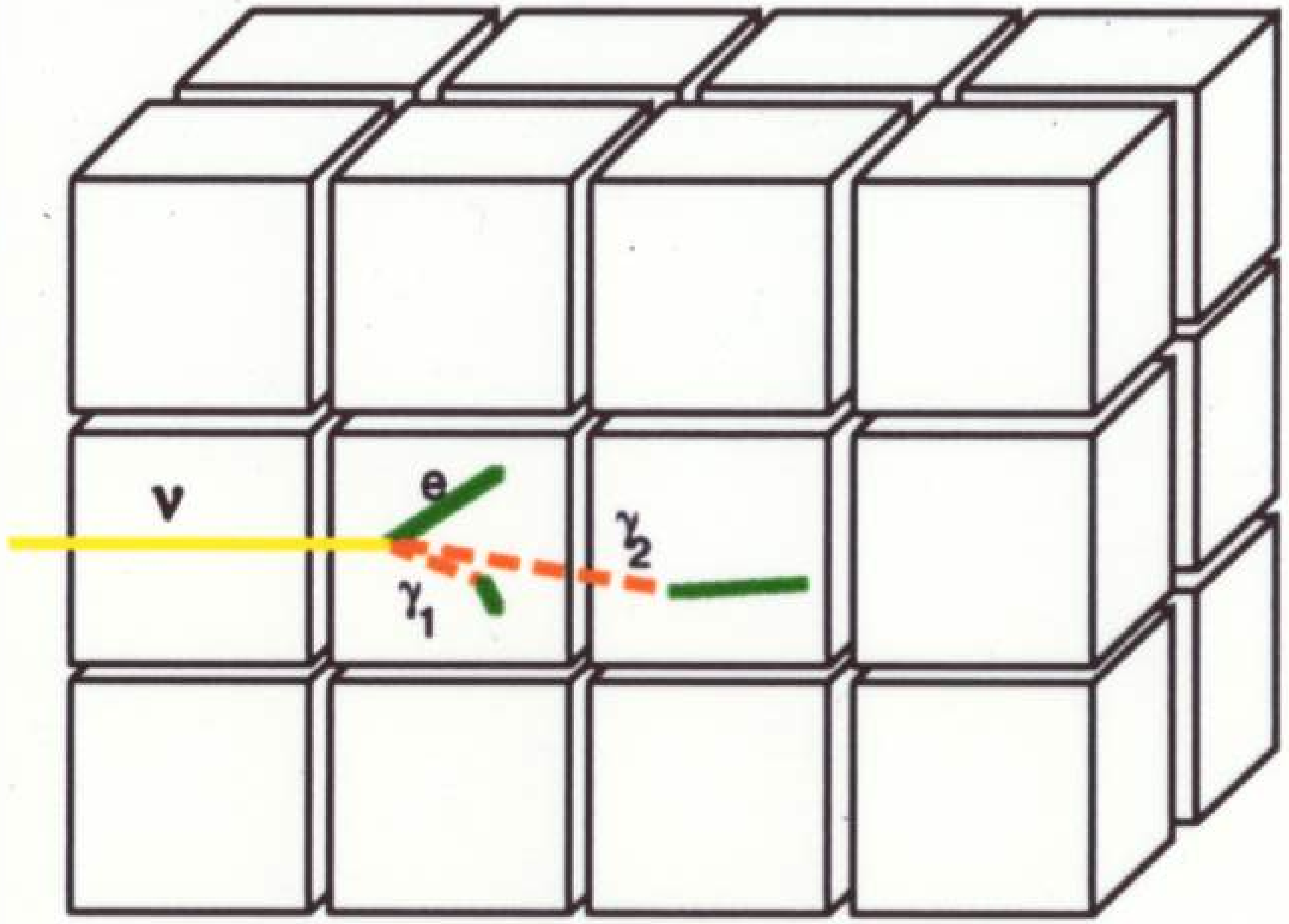
- **Spectrum measurement**

$$T_\nu = T_{e1} - 128\ keV$$

- **Good neutrino tag**
  - spatial and time coinc. : e1 + e/γ2
  - Delayed coinc. : γ2 + γ3
  - Sizeable energy
  - Sizeable time
  - ...

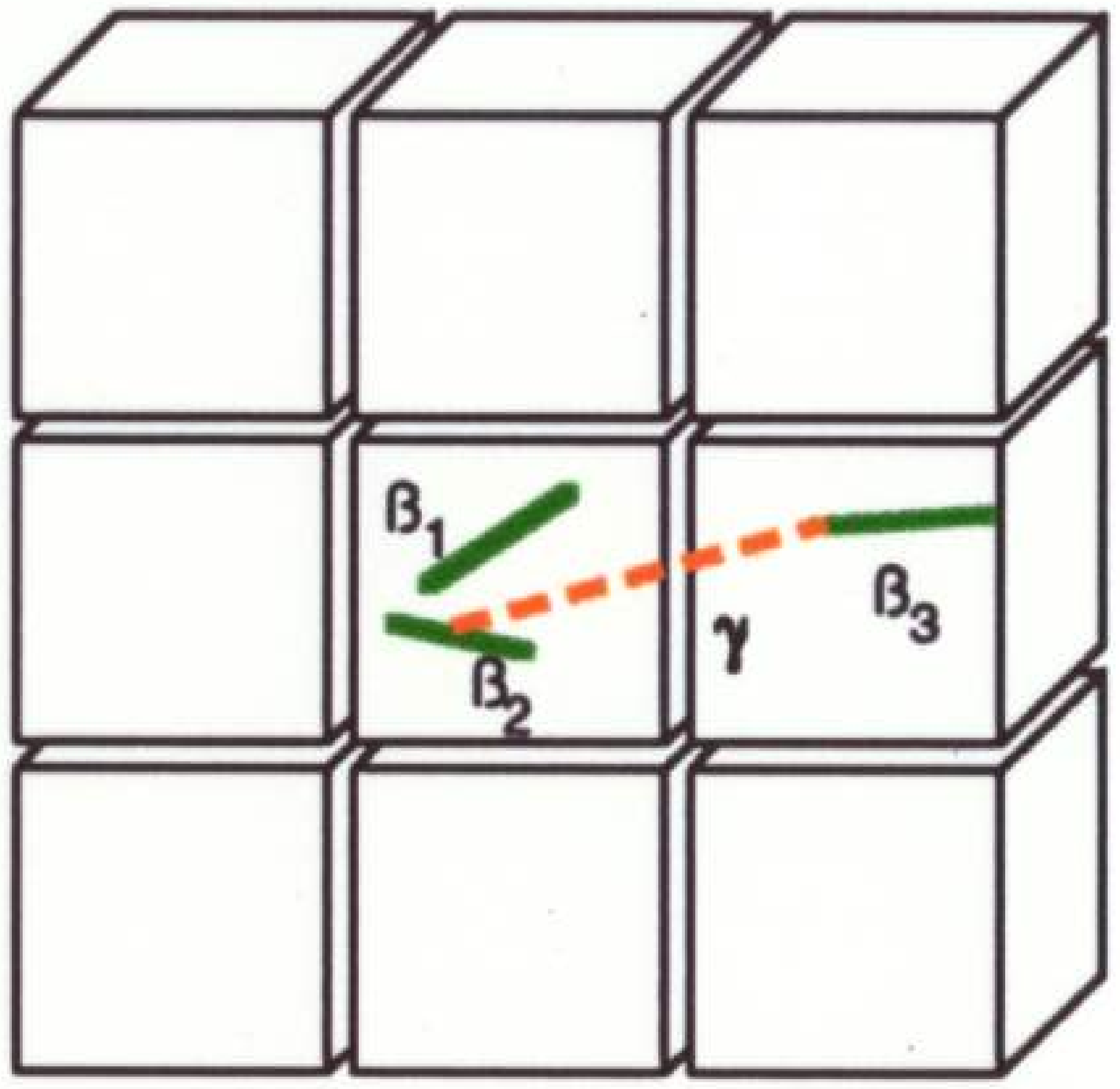
115 In

Signal and backgrounds



In 4 tons of Indium :
-1 solar neutrino per day
- 9 10^{10} ß up to 495 keV

Example of a background
- 1 ß-In
- 1 ß-In + bremst.



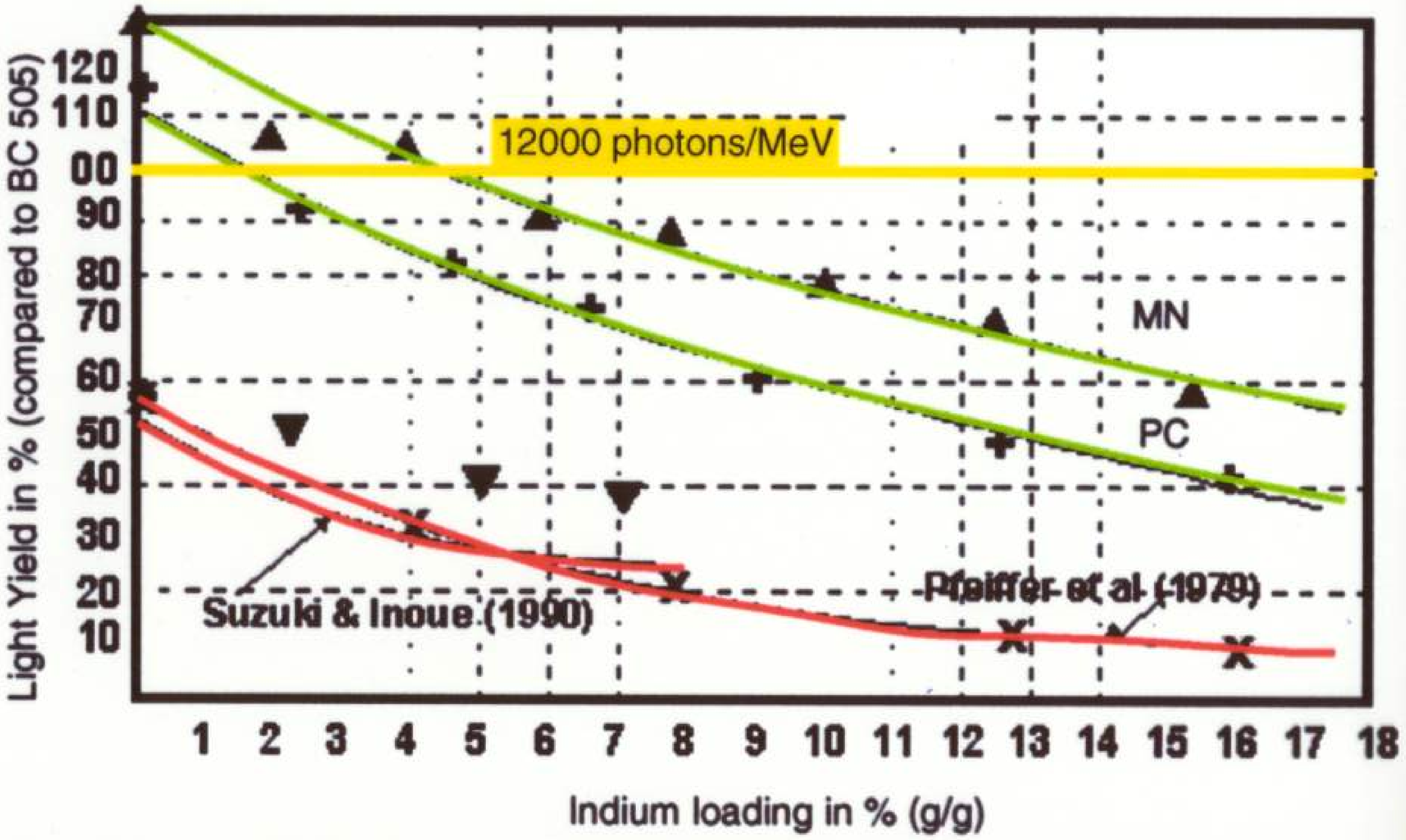
To fight need | Energy resolution
Spatial resolution

115 In

What's new in metal loaded liquid scintillator ?

❑ A new recipe obtained at Bell Labs

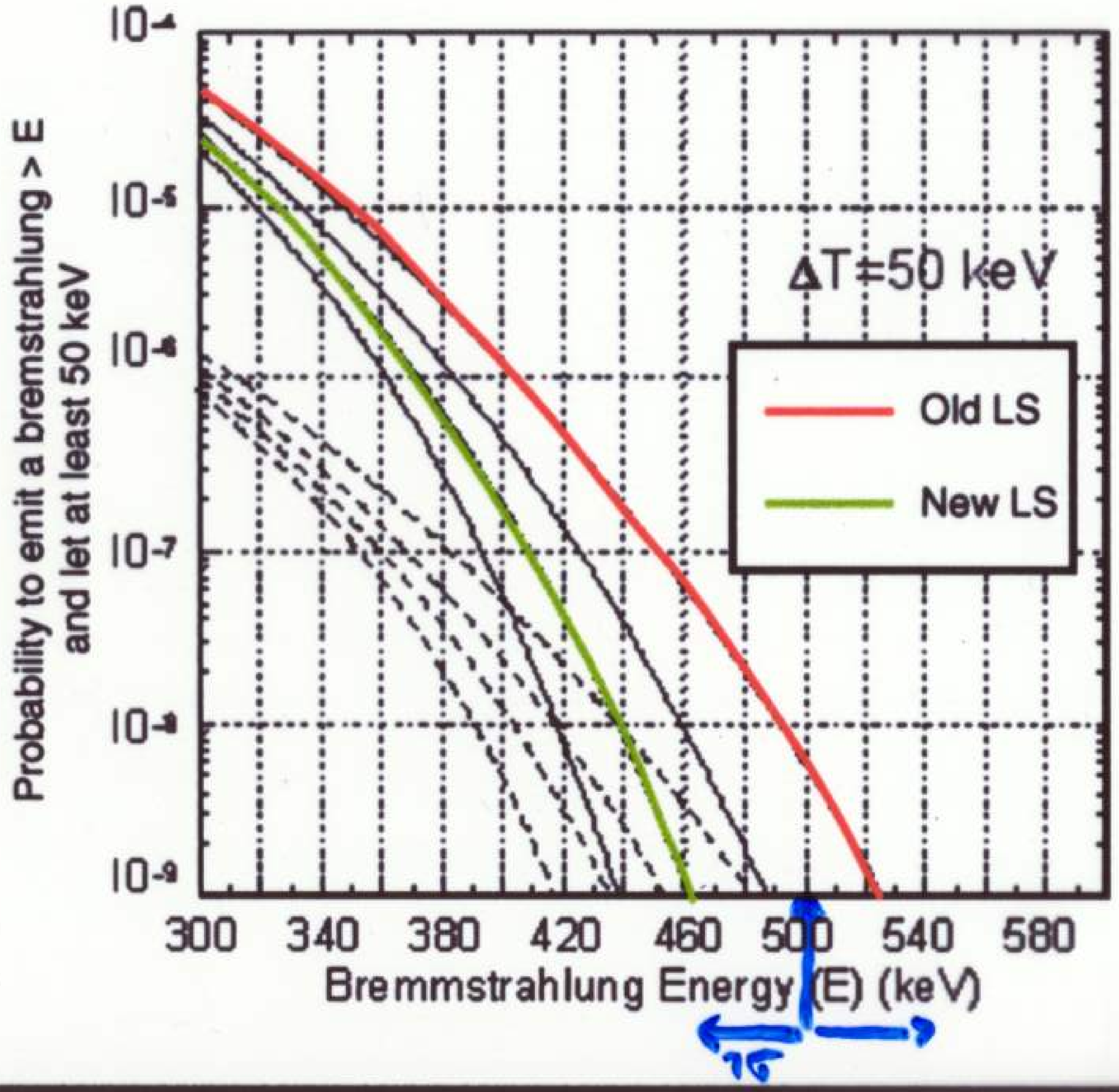
- Developped for Yb-LENS
- High metal loadir
- High light output
- Transparent (≈ 2.
- Stable ? (more than few months)



115 In

Impact on background rejection

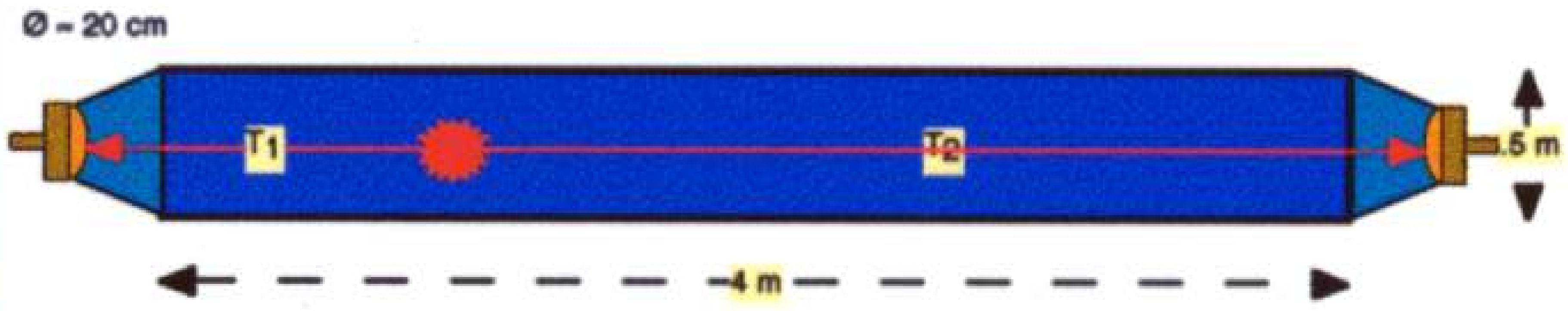
- **Seems a modest improovement :**
  - 120 -> 300 pe/MeV or 10% -> 5%
- **Tails of distribution**
  - Improove by 100
- **Needs important segmentation**
  - 100000 cells



A possible detector

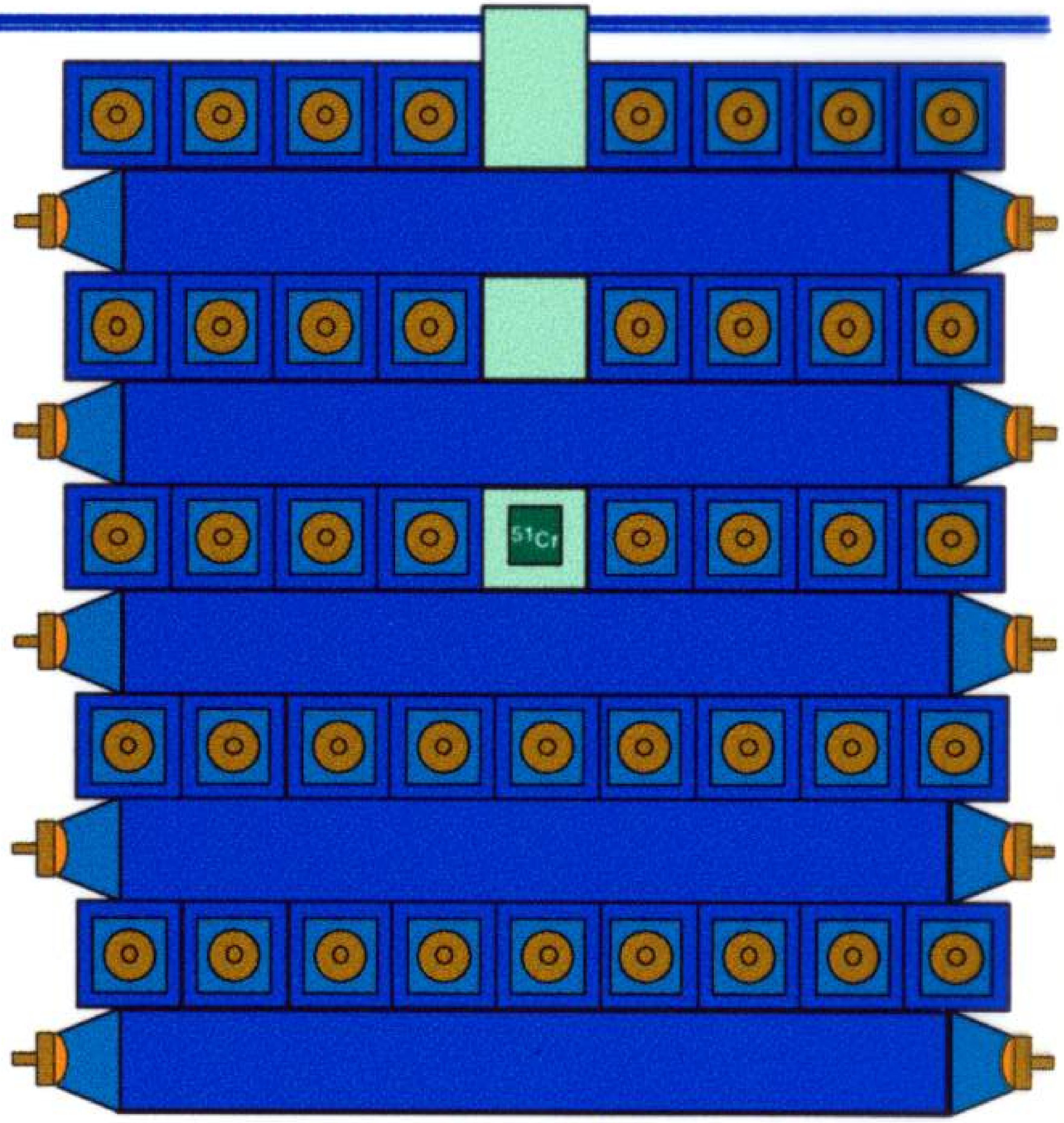
❑ *A unit module...*

- 100 kg Yb
- technique :
  - → liquid scintillator

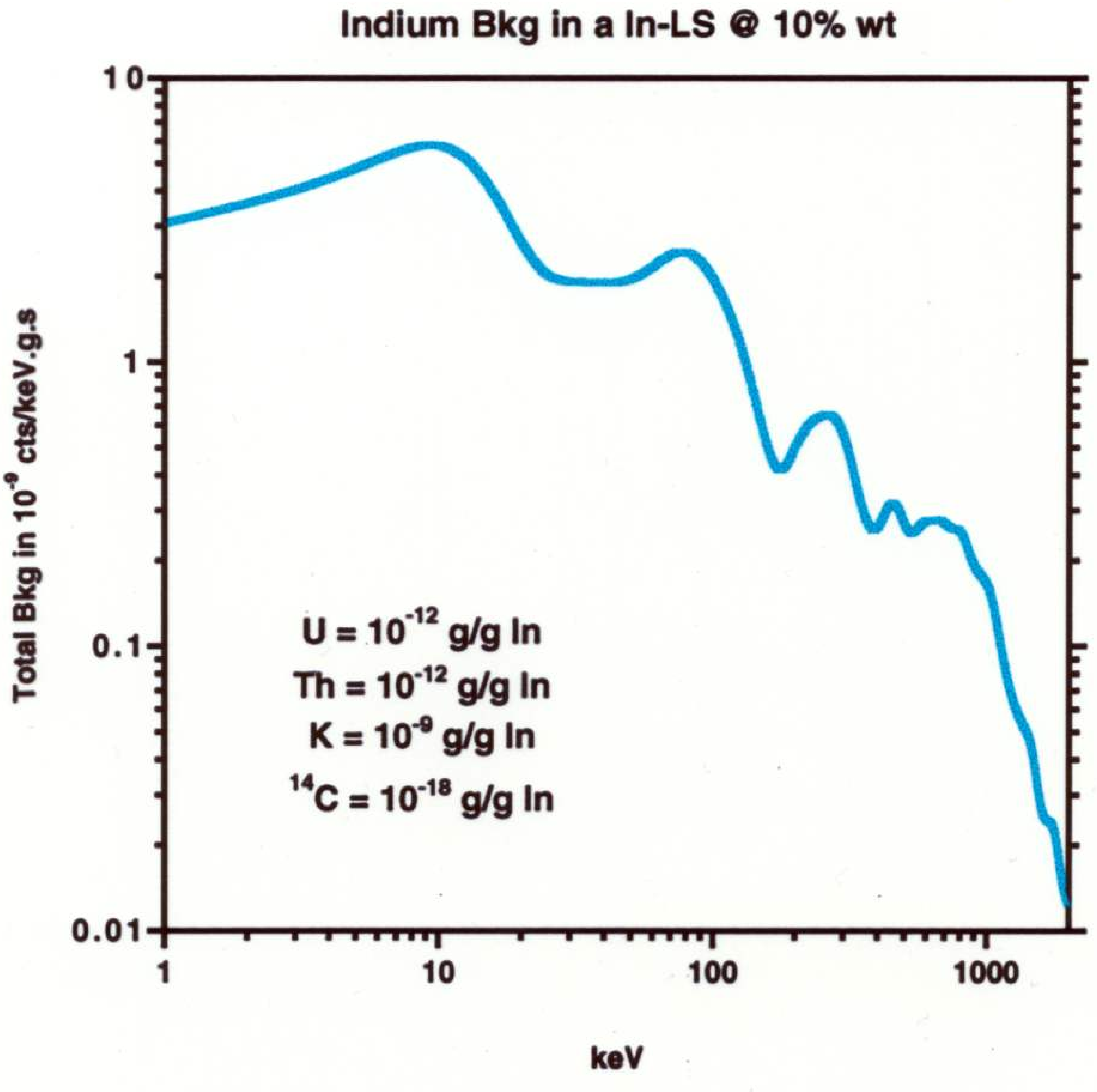


- 1 m^3
- localisation $\Delta V/V \approx 15\%$
- energy $\Delta E/E < 20\%$

Contacts :
- R. Raghavan raju@lucent.com
- M. Cribier cribier@hep.saclay.cea.fr



...repeated 100 times



Indium Bkg in a In-LS @ 10% wt
Total Bkg in 10^-9 cts/keV.g.s
10
1
0.1
0.01
1
10
100
1000
keV
U = 10^-12 g/g In
Th = 10^-12 g/g In
K = 10^-9 g/g In
14C = 10^-18 g/g In

^{115}In

Carte d'identité

- **Indium**
    - découvert en 1863
    - baptisé : raie indigo dans son spectre
  - masse atomique : 114.818
  - nombre atomique : 49
  - 2 isotopes stables :
    - ^{113}In : 4.28 %
    - ^{115}In : 95.72 %
  - densité : 7.31 g/cm^3
  - Températures :
    - critique : 3.40 K
    - Debye : 108.8 K
    - fusion : 156 °C
    - ébulition : 2070 °C
  - Prix $\approx$ 1 F/g (99.99%)
  - Radioactif (^{115}In) :
    - $t_{1/2} = 4.41\ 10^{14}$ y
    - activ. spéc. : 0.261 Bq/g
    - β^- jusqu'à 485 keV
  - neutron capture σ
    - 202 b -> ^{116}In ($T_{1/2}$ = 16s)

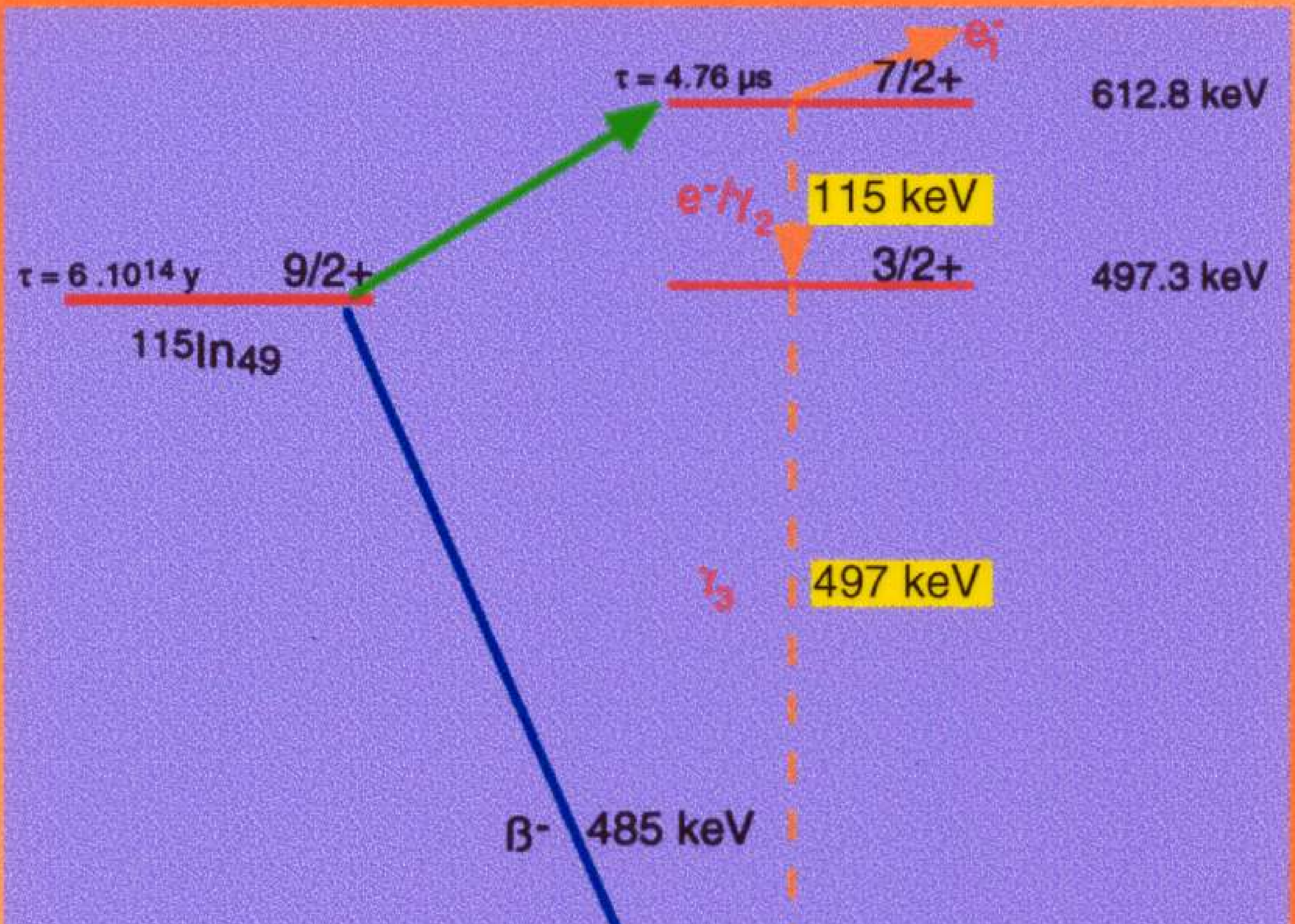
Indium & Solar Neutrinos

115 In

- **Detection scheme**

$\nu_e + {}^{115}In \rightarrow {}^{115}Sn^* + e^-$; $T_e = T_\nu - 128\ keV$

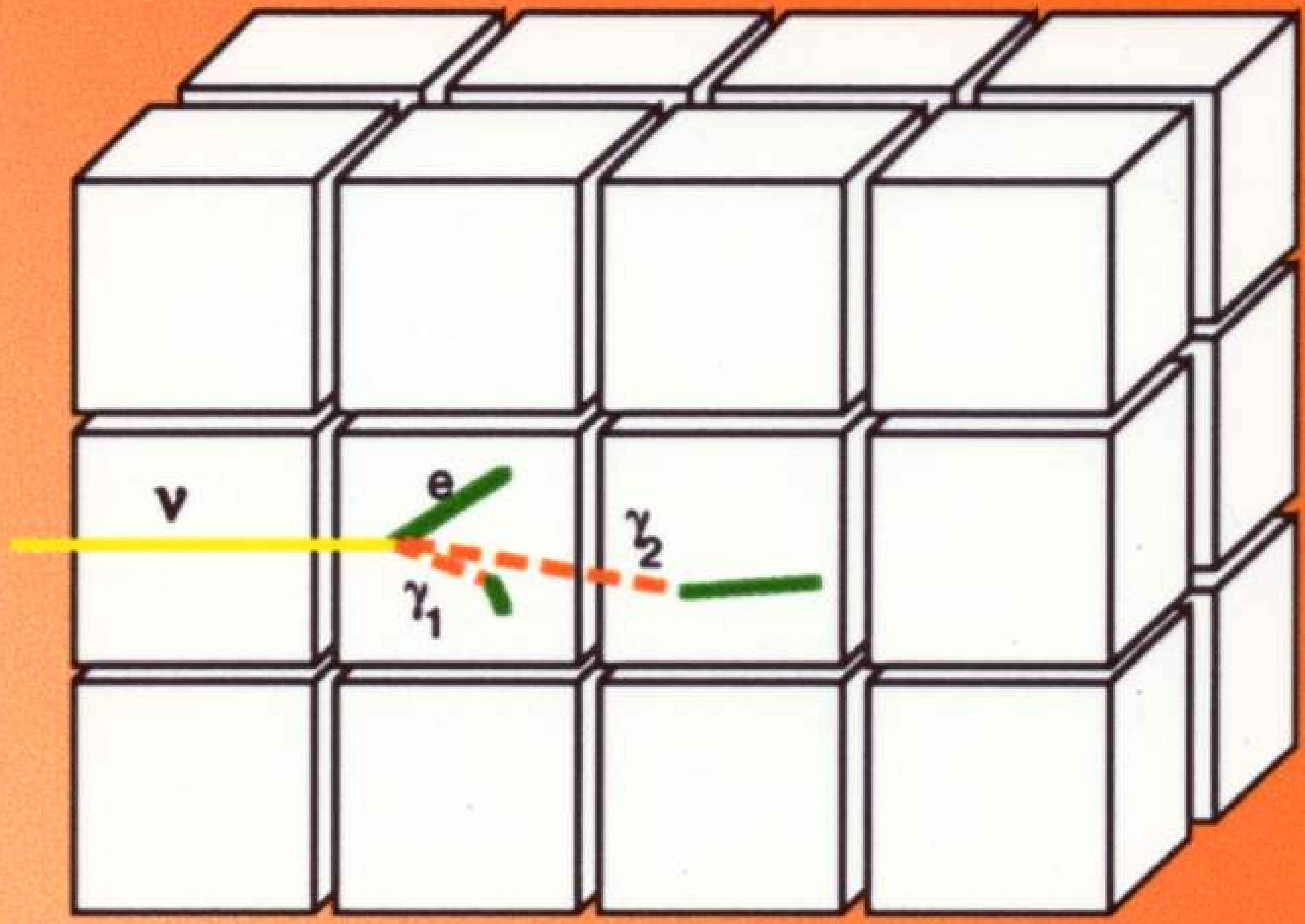
$\Rightarrow {}^{115}Sn + \gamma_1 + \gamma_2$ **Mesure du spectre en énergie**



- **Rate : 639 SNU**
  - 3.2 10^{-12} int./s.g ; 1 int./day => 3.61 t
    - pp : 468 SNU ; 260 / year
    - ^{7}Be : 116 SNU ; 66 / year

Le signal

- Les photons dans In métal
  - γ_1 115 keV
    - $<\lambda> \approx .76$ mm
    - e- : 45% ; photoélec. : 48% ; Compt. : 7%
  - γ_2 495 keV
    - $<\lambda> \approx 13.5$ mm
    - photoélec. : 20% ; Compt. : 80%
- Un détecteur segmenté
  - 3.6 t $\approx$ 1 m^3
  - 3 10^5 cellules (m = 10g d'In)



1° corrél. spat. : e- & γ_1

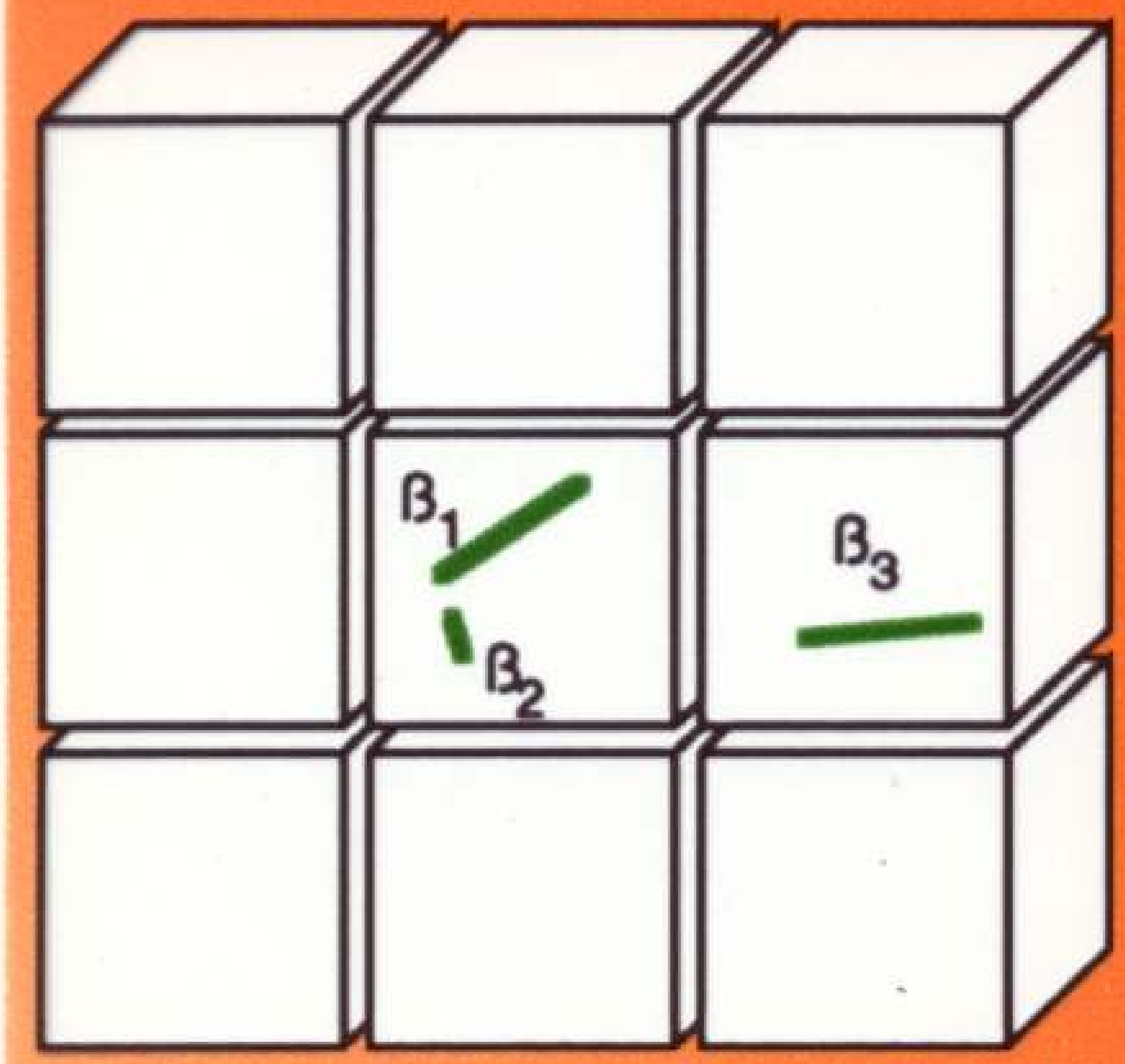
2° corrél. temp.: γ_1 & γ_2

115 In

Bruits de fond intrinsèques à l'indium

d'après N. Booth

- Hypothèses : $\delta E = 1$ keV, $\delta t_1 = 10$ ns
- 3 ß de l'Indium
  simulant les dépots d'énergie (δt_2=10µs)

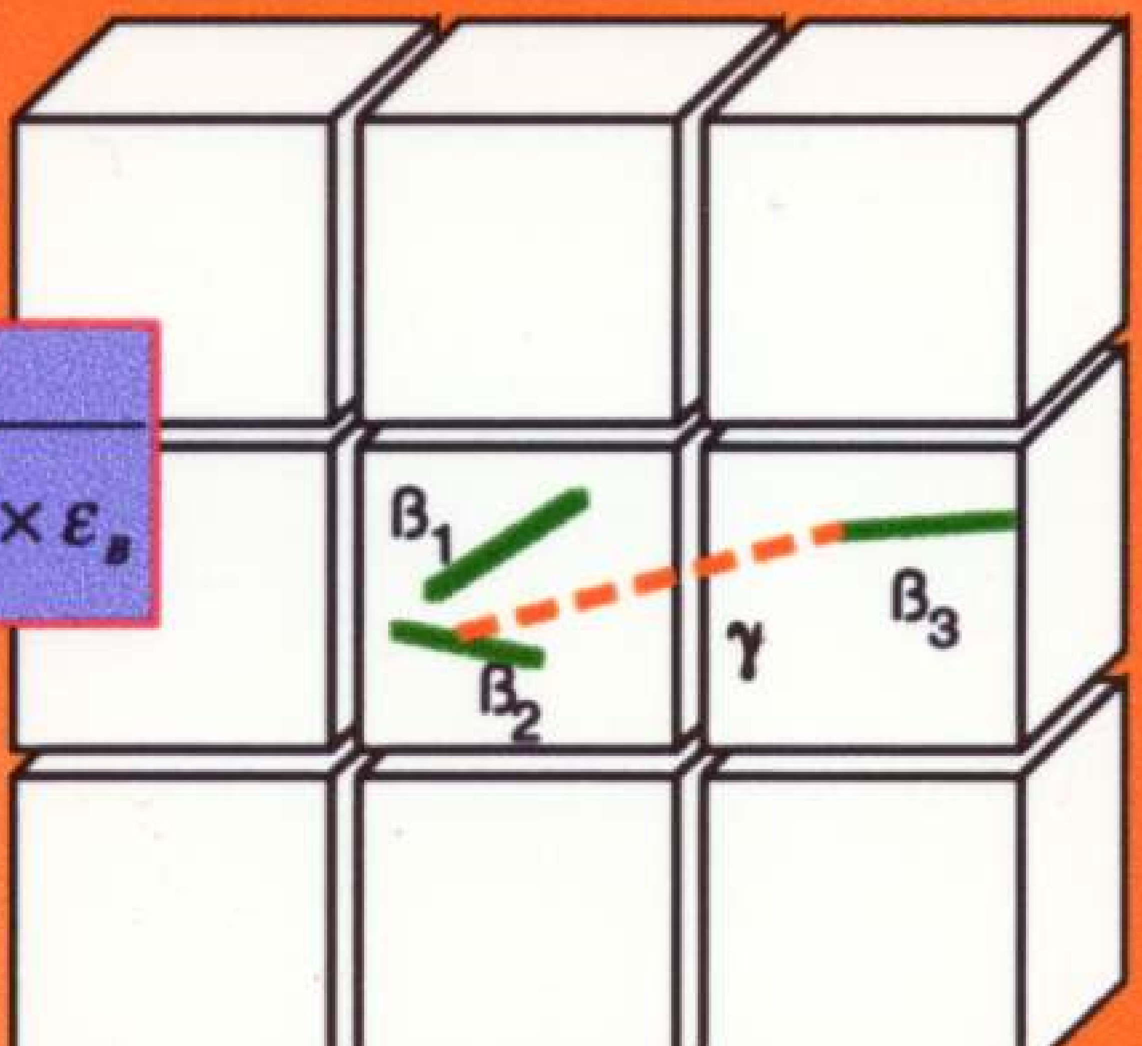


$$\frac{m\Phi\sigma \times \varepsilon_s}{(mD)^3\,\delta t_1 \delta t_2 \left(\delta E \middle/ E_{\max}^{\beta\ In}\right) \times 27 \times \varepsilon_B}$$

$$\frac{S_{pp}}{R_{\beta\beta\beta}} \approx \frac{150}{1}$$

- 2 ß In, le 2° fait un Bremstrahlung

$$\frac{S_{pp}}{R_{\beta\beta}} = \frac{m\Phi\sigma \times \varepsilon_s}{(mD)^2\,\delta t_2 \left(\delta E \middle/ E_{\max}^{\beta\ In}\right) \times P_{Brem}(E_\gamma > 100keV) \times 27 \times \varepsilon_B}$$

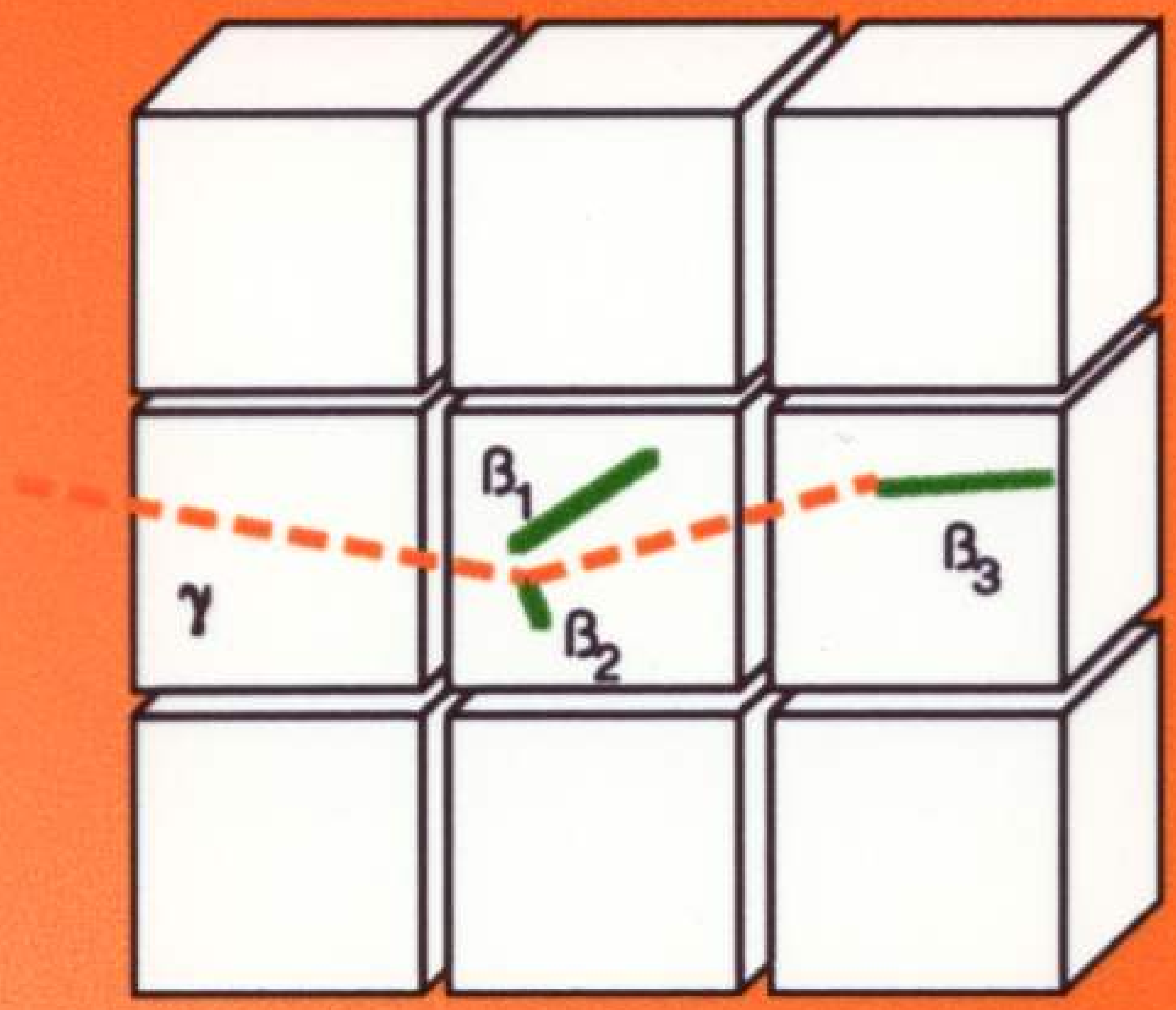


négligeable

^{115}In

Bruits de fonds exogènes

- 1 ß In + γ (ext.) avec 2 int. compton



Hyp. :
10^{-9} γ /keV.s.g @ 500 keV

$$\boxed{\frac{S_{pp}}{R_{\beta\gamma}} \approx \frac{150}{1}}$$

- Impuretés radioactives
  - Ex: Bi-Po