# ULTIMATE NEMO3

# SENSITIVITY

- PHASE 1 : present "CAMEMBERT"
- PHASE 2 : new CAMEMBERT

IF

experimental bb is OK

(or some evidence ! )

$^{208}Tl$ , $^{214}Bi$, neutrons ....

could be $\simeq$ 10 kg of $^{82}Se$

$\simeq$ 1 kg of $^{150}Nd$

Tokyo 9 May 2002

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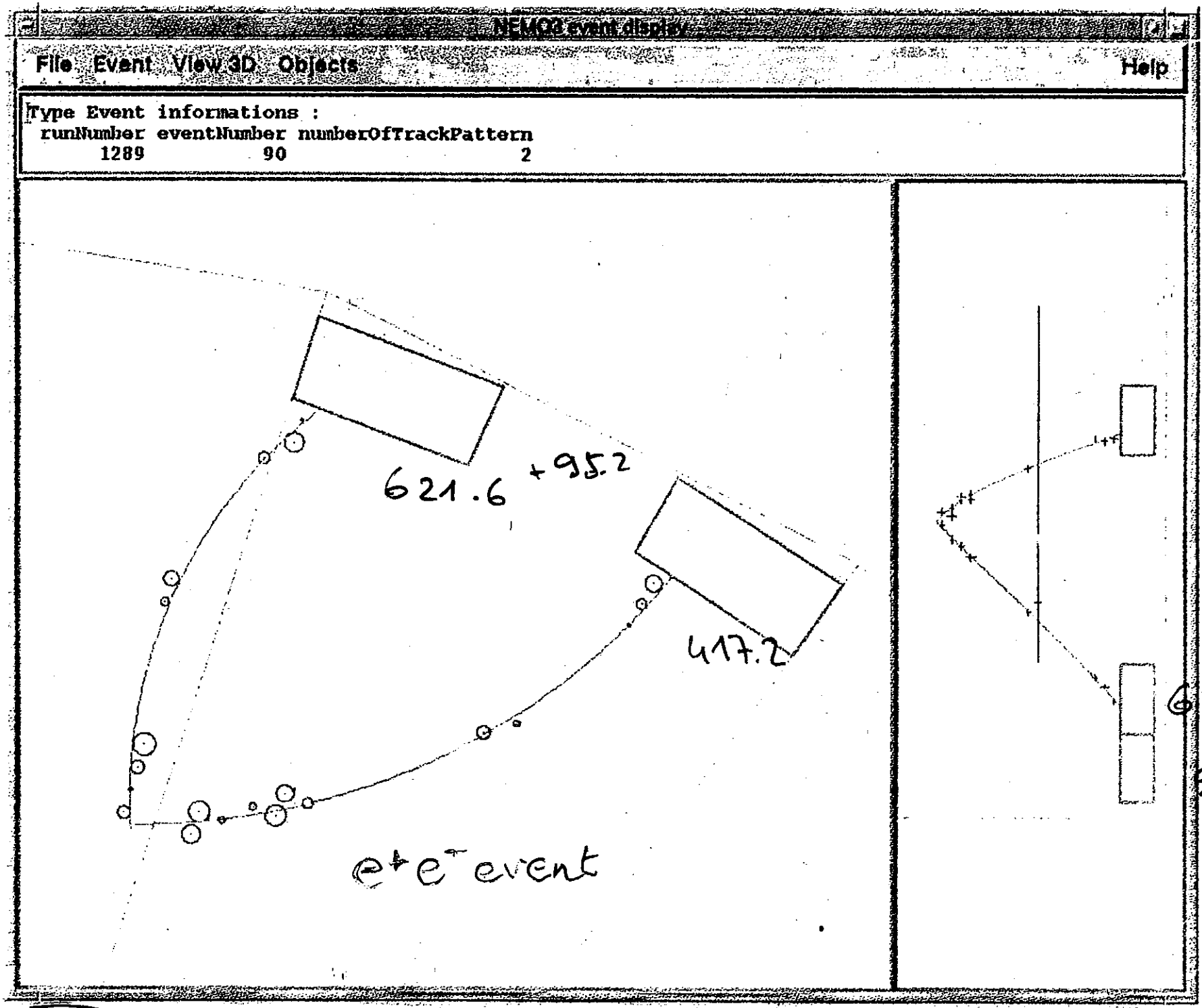

NEMO3 event display
File Event View 3D Objects Help
Type Event informations :
runNumber eventNumber numberOfTrackPattern
1289 90 2
621.6
+95.2
417.2
e+e- event
621.6
95.2
keV

# NEMO3: expected performances in 5 years of data taking

*Efficiency ($\beta\beta0\nu$) in[2.8-3.2] MeV 14 %*
*External background: 0 event*

***For 7 kg of $^{100}Mo$($Q_{\beta\beta}$= 3.038 MeV)***

**Internal Background**:

| | | |
|---|---|---|
| $^{208}$Tl | < 1.4 | events |
| $^{214}$Bi | < 1.4 | events |
| $\beta\beta(2\nu)$ | 3.9 | events |

**< 6.7 background events expected in 5 years**

↓

5 $\beta\beta0\nu$ events excluded

**$T_{1/2} > 5.\ 10^{24}$ y → $< m_\nu > < 0.2 - 0.7$ eV**

***For 1 kg of $^{82}Se$ ($Q_{\beta\beta}$= 2.995 MeV)***

↓ Rejection of « hots spots »

**< 0.15 background events expected in 5 years**

↓

2.5 $\beta\beta0\nu$ events excluded

**$T_{1/2} > 1.5\ 10^{24}$ y → $< m_\nu > < 0.6 - 1.2$ eV**

# Expected sensitivity of NEMO-3

$\varepsilon = 15\%$
$^{214}Bi = 300\ \mu Bq$, $^{208}Tl = 20\ \mu Bq$

| | | Phase 1 | | | Phase 2 | |
|---|---|---|---|---|---|---|
| | | $^{100}Mo$ 7 kg | $^{82}Se$ 1 kg | $^{150}Nd$ 50 g | $^{150}Nd$ 1 kg | $^{82}Se$ 10 kg |
| Background in $Q_{\beta\beta}$ events/year | | 1.3 | 0 | 0 | 0.1 | 0.1 ($T_{1/2}(2\nu) \approx 10^{20}$ y) |
| 1 year | $T_{1/2}(0\nu)$ | $1.2\ 10^{24}$ | $3\ 10^{23}$ | $10^{22}$ | $1.5\ 10^{23}$ | $2\ 10^{24}$ |
| | $\langle m_\nu \rangle$ | 0.5 – 1.4 | 1.3 – 2.7 | 1.8 – 10 | 0.5 – 2.5 | 0.5 – 1.7 |
| 5 year | $T_{1/2}(0\nu)$ | $5\ 10^{24}$ | $1.5\ 10^{24}$ | $5\ 10^{22}$ | $0.7\ 10^{24}$ | $10^{25}$ |
| | $\langle m_\nu \rangle$ | 0.2 – 0.7 | 0.6 – 1.2 | 0.8 – 4.5 | 0.2 – 1.2 | 0.25 – 0.75 |

!!! Nuclear matrix elements !!!
"best" 50 g $^{150}Nd$ ≈ "worst" 7 kg $^{100}Mo$

# Sensitivity of NEMO3 to measure sources of background

## *Design NEMO3:*

10 kg
- $^{208}$ Tl in source foils < 0.02 mBq/kg
- $^{214}$ Bi in source foils < 0.3 mBq/kg
- neutron flux < $10^{-8}$ n cm$^{-2}$ s$^{-1}$

## *Sensitivity NEMO3:*

$\Rightarrow$ **$^{208}$ Tl in source foils**

measured by channel $e\gamma$ 's ($E\gamma = 2.6$ MeV)
or $^{212}$ Bi $\rightarrow$ $^{212}$ Po $e(\gamma)\alpha$ (300 ns)

< 2 μBq/kg after 1 year of data

$\Rightarrow$ **$^{214}$ Bi in source foils**

measured by channel $e\gamma\,\alpha$
($^{214}$ Bi $\rightarrow$ $^{214}$ Po $\rightarrow$ $^{210}$ Pb; $T_{1/2}$ = 164 μs )

< 2 μBq/kg after 1 year of data

$\Rightarrow$ **neutrons** measured by $e^-$ crossing > 4 MeV

< $10^{-9}$ n cm$^{-2}$ s$^{-1}$

**Sensitivity to 100 kg of isotopes**

# Some comments about a $\beta\beta0\nu$ « future »

⇒ *NEMO3 starts running with several nuclei:*

($^{100}$Mo, $^{82}$Se, $^{150}$Nd, $^{116}$Cd, $^{130}$Te, $^{48}$Ca, $^{96}$Zr)

if **a signal in 50 g of $^{150}$Nd** and
**no signal in 7 kg of $^{100}$Mo** or 1 kg $^{82}$Se **?**

if **a signal in** $2\beta0\nu$ $\mathbf{0^+ \rightarrow 2^+}$ **?**

⇒ *NEMO3 phase 2*

**10 kg $^{82}$Se**: experiment « zero background »

**1 kg $^{150}$Nd**: ≈ 1/7 detector, 3 sectors replaced

**D.O.E. starts purification for $^{82}$Se and $^{150}$Nd**
(with INEEL ; Idaho Falls)

# Next generation of experiment NEMO4 ?

***10 kg → 100 kg*** *(100 % enrich.)* ***...and not 1 ton !***

**⇒ Europe has to help development on enrichment technics in Russia**

**⇒ Sources purification ($^{214}$Bi and $^{208}$Tl):**

→ 10 kg: good results obtained for NEMO3
($^{100}$Mo, $^{48}$ Ca, $^{116}$Cd, $^{150}$Nd, $^{96}$Zr, $^{nat}$Te)

→ 100 kg: sensitivity of NEMO3 will validate 100 kg in one year

**⇒ development must be done in Ge detector**

to increase the sensitivity by a factor 100
(or at least by a factor 10)

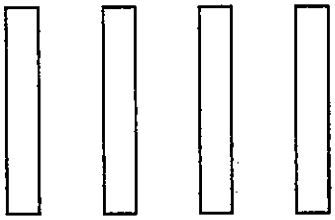
NEMO3: Ge in LSM: $^{208}$Tl < 100 μBq/kg
100 kg as we need: $^{208}$Tl < 1 μBq/kg

improve !

**How to ~~increase~~ ΔE/E ?**

⇒ **calorimeter:** Silicium ($e^-$) + small scintillator ($\gamma$) ?

⇒ **active source:**



e = 10 μm x 5

**⇒ R&D and ideas...**

**The last comment but not the least**

***Which nucleus do we have to choose?***

In some calculations, 100 kg A1 ≡ 1 ton A2 !!!!

**Efforts on Nuclear Matrix calculations for 100 kg have to be done**