ABOUT FEASIBILITY OF MEASUREMENT OF ELECTRON ENERGY BY METHOD OF RESONANT ABSORPTION OF PHOTONS IN A MAGNETIC FIELD

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- **Earlier has been shown that the gain of electron energy because of resonant absorption of laser light by electrons in a magnetic field is given by expression [1,2]:**

$$\frac{d\gamma}{dt} = \xi\omega\sqrt{\frac{2\Omega}{\gamma}} \qquad (1)$$

where $\gamma = \varepsilon/mc^2$ **the electron relativistic factor,** $\xi = eE/mc\omega$ **the parameter of laser intensity,** E **the amplitude of electric field of a wave,** ω **the photon frequency,** $\Omega = \omega_c/\omega$, $\omega_c = eB/mc$ **and** B **the quantity of magnetic field.**

From (1) it follows that the gain of electrons energy depends from γ **and it enables to measure absolute energy of positrons.**

The basic purpose of this work is consideration of experimental approbation of RA method on lower energies 10 - 70 MeV. The expediency of approbation of RA method on low energies is caused by the minimal financial expenses, by opportunity of use of the standard laser of low power and using of magnet concerning simple in making.

Taking into account that electron can absorb only an integer ν of photons the gain of electron energy $\Delta\varepsilon$ can be written as:

$$\Delta\varepsilon = \nu \cdot \hbar\omega \qquad \textbf{(2)}$$

Using the relation

$$E[V/cm] \cong 19{,}4 \cdot \sqrt{I_{las}[w/cm^2]} \qquad \textbf{(3)}$$

between intensity of the laser I_{las} and amplitude of electric field E of wave and relation (2), the expression (1) can be written as:

$$\nu \cdot \hbar\omega = 19{,}4 \cdot c\tau \cdot \sqrt{I_{las}} \cdot \sqrt{\frac{2\Omega}{\gamma}} \qquad \textbf{(4)}$$

If $\nu = 1$ then in (4) $\tau = \tau_0$ represents the time necessary for formation of a photon absorption and then:

$$\hbar\omega = 19{,}4 \cdot c\tau_0 \cdot \sqrt{I_{las}} \cdot \sqrt{\frac{2\Omega}{\gamma}} \qquad \textbf{(5)}$$

Thus, when the electron pass through magnetic field B then for the given parameters ω, Ω, I_{las} and γ the absorption of a photon occurs only at the certain value of time $\tau = \tau_0$. which will be registered by detector "D" (Fig.1).

- **From (5) follows, that for known parameters** $\omega, \tau_0, I_{las}, \Omega$ **we can calculate the** γ **factor of electron:**

$$\gamma = \left(\frac{19{,}4 \cdot c\tau_0}{\hbar\omega} \right)^2 \cdot I_{las} 2\Omega \qquad \textbf{(6)}$$

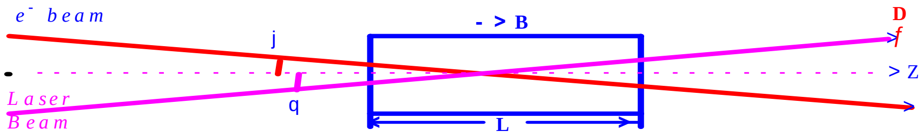

Fig.1

For finding the time of photon absorption τ_0 **is used the parameters of electron beam of linear accelerator of Yerevan sinchrotron. Parameters of the linac are:**

1. Energy	**10-70 MeV**
2. $\Delta E / E$	$2 \cdot 10^{-2}$
3. Repetition rate	**50 Hz**
4. Pulse length	**0.5 – 1** $\mu\sec$
5. Norm. emittance	**0.7** $\pi \cdot mm \cdot rad$
6. Bunch length	$\leq 35 p\sec$
7. Number of particales/bunch	$5 \cdot 10^7$

So, this linear accelerator gives out the "pack" (or "series") of electron bunches (number of of bunches - 3000) with pulse length $T_{3000} = 0.5 - 1\mu\sec$ **,with number of electrons** $\approx 2 \cdot 10^{11}$ **electron/pulse, bunch length** $\Delta t \leq 35 p\sec$ **and time interval between two neighbor bunches** $t \approx 0.35$ **nsec (Fig.2).**

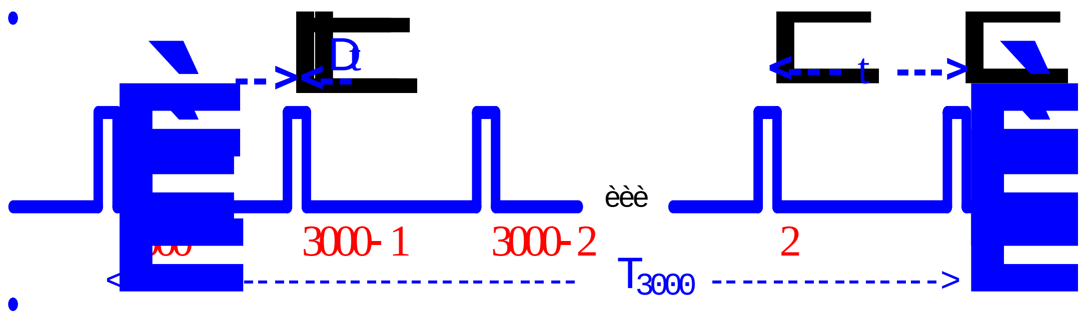

Fig.2

When the "series" of electron bunches pass through magnetic field then detector D will register consecutive reduction of number of the absorbed photons.

The dependence of photons number falling on detector D from time has the shape, shown on Fig.3.

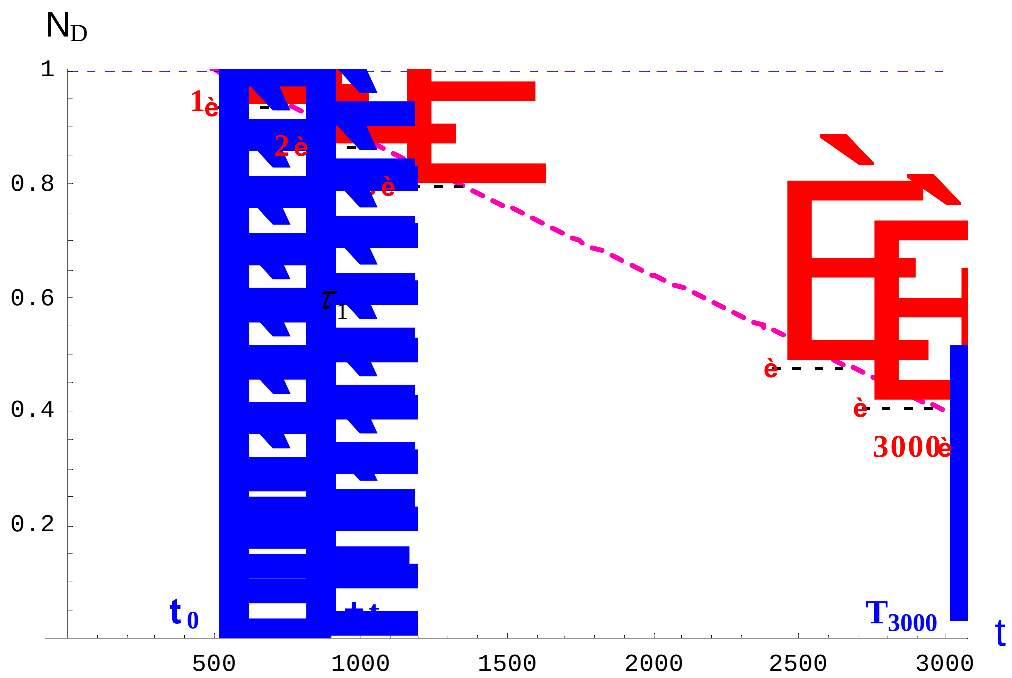

Fig.3

It is obvious that the detector D will register the fact of absorption of photons by first electron bunch (the first from 3000 bunches) only after the expiration of time τ_0 of electron passage in magnetic field. Thus it is clear that only one absorption of photons by an electron bunch is not enough for measurement of time τ_0. As one of possible version, the time τ_0 can be found if to take the length of magnet such that the same electron bunch direcly after of the first absorption of photons could absorb photons in second time.

Really, absorption of photons by the first electron bunch the detector registers this fact by signal of some moment of time τ_1 (Fig. 4). The second absorption of photons by the same electron bunch will register detector by signal on the expiration of time τ_0 after of the first absorption signal (Fig.4).

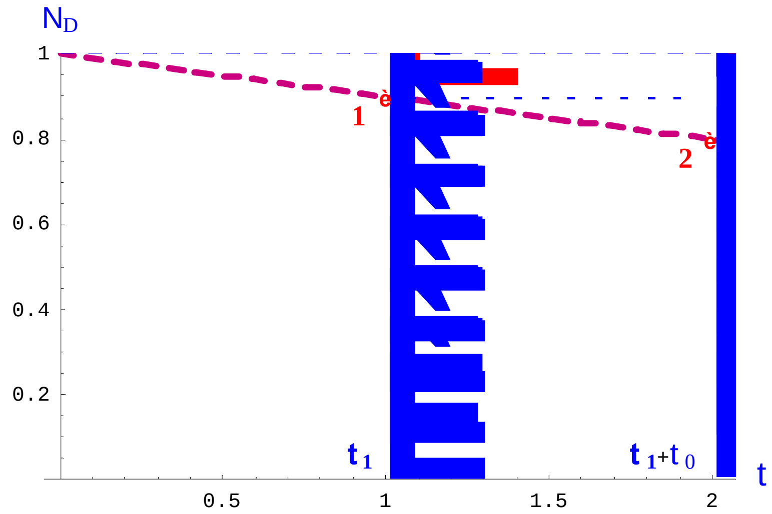

Fig.4

For reliable synchronization of pulses of electron bunch (~ 1microsec) and of laser beam it is necessary to take the duration of laser pulse more in many times (for example 10-20 microsec). In relation (6) the quantities of ω and Ω are stable and they can be determined with sufficient accuracy. For precise determination of the γ factor of electrons according to (6) it is necessary to measure the values of I_{las} and τ_0 for each pulse of an electron bunch.

REFERENCES

1.R.A. Melikian, D.P. Barber. Proc. 7th EPAC, Vienna, June 2000.

2. V.P. Milantiev. Uspekhi Fiz. Nauk, 167, №1 (1997) 3.