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NEW THERMAL NEUTRON DETECTOR – LiF(W)

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It is well known that lithium containing phosphors are more preferable for thermal neutrons detection owing to the unique ($n + {}^6Li \Rightarrow {}^4He + {}^3H + Q$) reaction. This reaction is particularly desirable since no gamma ray is realized. For interaction with thermal neutrons, the energy division between the alpha (^{4}He) and triton (^{3}H) is uniquely defined and a rather narrow line is obtained. The alpha and triton share the energy Q of 4.78 MeV inversely proportional to their respective masses. Thus, the triton receives 4/7 of total energy while the alpha receives 3/7. The neutron peak appears at approximately 3 MeV permitting effective discrimination against all natural gamma rays. Therefore, an inorganic LiI(Eu) scintillator is widely known. However, high hygroscopy of LiI crystal, insufficient transparency to own emission, high sensitivity to background and iod activation by neutron decrease operation characteristics of LiI(Eu) detector.

A new LiF(W) scintillator is deprived of the mentioned shortcoming. Its main characteristics are given in the table. The calculation has showed that absorption coefficient of thermal neutrons by LiF(W) crystal of natural isotope composition is equal to 4.40 cm^{-1}. Therefore, for practically complete absorption of thermal neutrons LiF(W) detector's thickness can be no more than 0.7 cm. Little thickness of the detector in combination with a small atom number of lithium fluoride (Z_{eff} = 8.2) provide the possibility of thermal neutron detection on background γ-radiation. Though conversion efficiency of LiF(W) crystals is one order lower than that of LiI(Eu) crystals, nevertheless the pulse height spectrum of scintillations excited by thermal neutrons from plutonium-beryllium source is characterized by a clear peak of full absorption. For all this, the half-width of peak makes 12-14% (crystal size – dia. 60×5 mm, RC = 40 μs).

	LiF(W)	LiI(Eu)
Wavelength of maximum emission (nm)	430	470
Decay constant (μs)	40	1.4
Index of refraction (at wavelength of maximum emission)	1.40	1.96
Hygroscopicity	no	very
Density (kg/m^3)	2640	4080
Effective atomic number	8.2	52
Light output relative to NaI(Tl) (%)	3.5	35
Absorption coefficient of thermal neutrons (cm^{-1})	4.40	1.46
Melting point (K)	1133	719