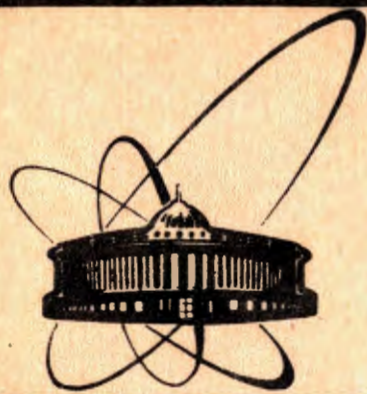


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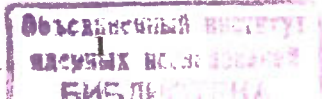
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ALPHA-SPECTRA OF SHORT-LIVED
ISOTOPES $A = 150-158$

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The α -decay studies of the short lived isotopes of rare earth elements started in Leningrad Institute of Nuclear Physics in the 70th [1] have been continued in the Laboratory of Nuclear Problems (LNP) of the Joint Institute for Nuclear Research in 1987-92 on the YASNAPP-2 facility [2]. The results of these studies were published in papers [3-5]. But, as usual the possibilities of presenting the obtained α -spectra in these publications was limited. Meanwhile for the planning and performance of the future experiments in our or other laboratories it is very important to have such spectra. Thus the purpose of this paper is the presentation of the atlas of the α -spectra of the short lived isotopes of rare earth elements measured in the Laboratory of Nuclear Problems in 1987-92.

Experimental technique for measuring of the α -spectra. The description of the YASNAPP-2 facility is given in [2]. To produce neutron deficient isotopes of rare earth elements a tungsten target was irradiated by an extracted proton beam from Dubna phasotron: $E_p = 660$ MeV, $J_p \leq 2 \mu\text{A}$. The target was at the same time the surface ionization ion source of the "hot cavity" type. A tungsten ampoule of the ion source was heated up to 2500°C . Nuclei produced in spallation reactions diffused into the ampoule cavity were ionized and entered the mass-separator. The α -spectrum measurements were carried out with the spectrometric sets ELGA [6,7] and UMCS [8]. The block diagram of the experiments is shown on the figure 1. Si(Au) surface barrier detectors with diameters 6-10 mm and half-width between 15 and 25 keV were used. ELGA and UMCS sets are equipped with spectrometric electronics produced by ORTEC company [9]. Some blocks were constructed in the LNP [10]. The control system is based on the IBM XT, AT personal computer and Camac-controllers [11,12]. The system allows one to control proton and ion beams and source transportation arrangements. The control system allows one also to visualize and to analyze spectra in the course of the measurements. Values of α -energies recommended by A.Rytz [13] were used for energy calibration.



Figures 2-5 show the α -decay chains for nuclei of Dy, Ho, Er, Tm, Yb, Lu with $A=150-158$. The analogous information is presented in the table. There are E_{α} (keV) and $T_{1/2}$ values for the ground states in the upper part of each cell and E_{α} and $T_{1/2}$ of isomeric states below. The values measured or made more precise in these experiments are marked by stars. The accuracy of the α -particle energies in our measurements was better than 5 keV. Values of branching ratios - b_{α} one can find in the compilation [13].

Atlas of the α -particle spectra consists of the graphs numbered by the A-value of the separated mass. In order to show the possibilities of studying the delayed proton spectra the ^{147}Dy spectrum of β -delayed protons is shown in graph A=147.

The information on the measuring conditions for the spectra presented in the atlas is contained in the legends above the graphs. Let us cite for example the interpretation of some legends.

A=150 The α -particle spectrum of A=150 isobars measured on June 19, 1989 on ELGA set. In the upper graph numbers of counts is in linear scale (lge). Proton irradiation of the target was continuous (T_p -nonstop). A=150 ions arrived at the ELGA set during 960 s (T_i). Four 240 s and eight 480 s exposures were made (T_m). The start points of T_i and T_m coincided for all spectra measured on ELGA set. The sum spectrum of many such cycles of measurements is presented. Weak 4522 keV, 36 s line arises from admixture of the neighbouring mass.

A=152... Start point of T_p coincides with those for T_i and T_m .

A=153 The α -particle spectrum of A=153 isobars measured on 28 November 1991 on UMCS set. Proton irradiation of the target (T_p) and entering of the A=153 ions to the collector of UMCS set lasted for 6 s. The measurements of the spectra on UMCS set began 0,5-1,0 s after the end of the ion collection. Each circle of the measurements contains 13 one second exposures (T_m). During the exposures proton and ion beams were switched out. The sum spectrum is presented.

	150	151	152	153	154	155	156	157	158
Lu						5657 70 ms	5453 0.73 s*	4939 * 9.6 s*	4656 * 10.4 s
Yb					5331 0.42 s	5205 * 1.6 s	4686 26 s	4505 37 s	4059 1.6 m
Tm				5101 * 2.5 s 5111 1.6 s	4961 8.3 s 5037 3.5 s	4460 23 s * 4460 47 s *	4234 84 s		
Er			4804 10.3s	4677 36 s	4168 3.8 m	4012 5.3 m			
Ho		4522 36 s 4611 47 s	4389 2.4 m 4456 51 s	3910 2 m 4013 9.3 m	3724 3.2 m 3936 11.8 m				
Dy	4235 7.2 m	4069 18 m	3620 2.4 h						

Table. The information on alpha-decay of rare earth nuclei with $A=150-158$. In the upper part of each cell there are E_{α} (keV) and $T_{1/2}$ (sec) values for the ground state. The same values for isomeric state - below.

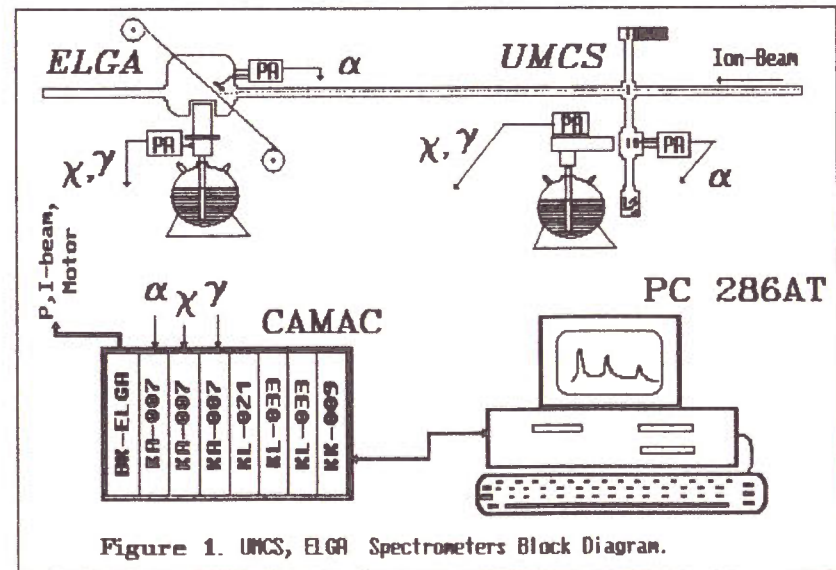
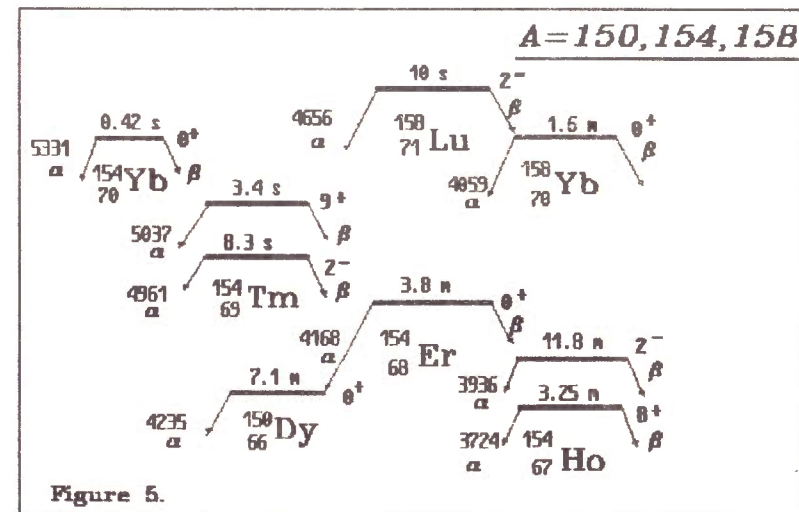
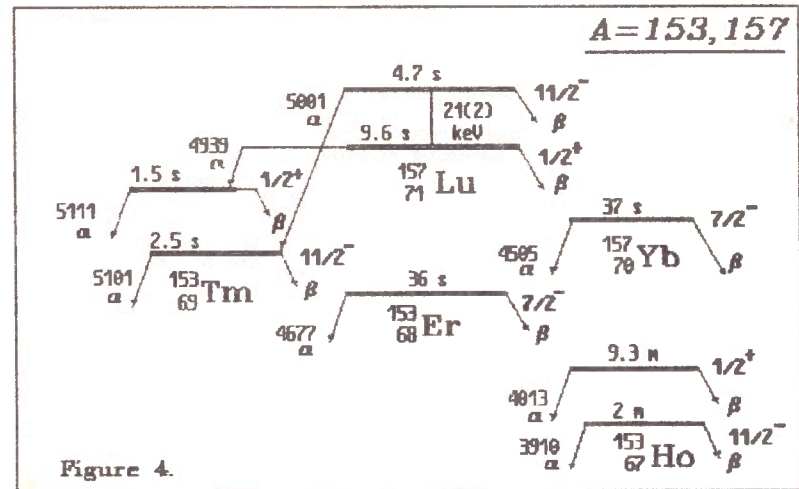
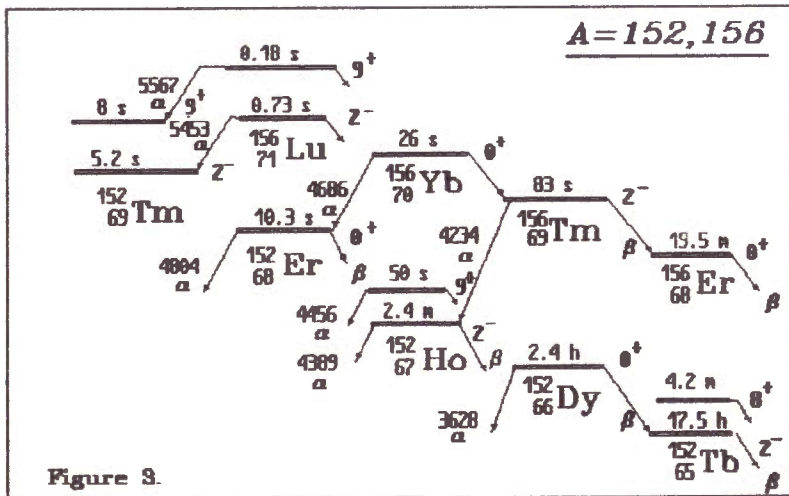
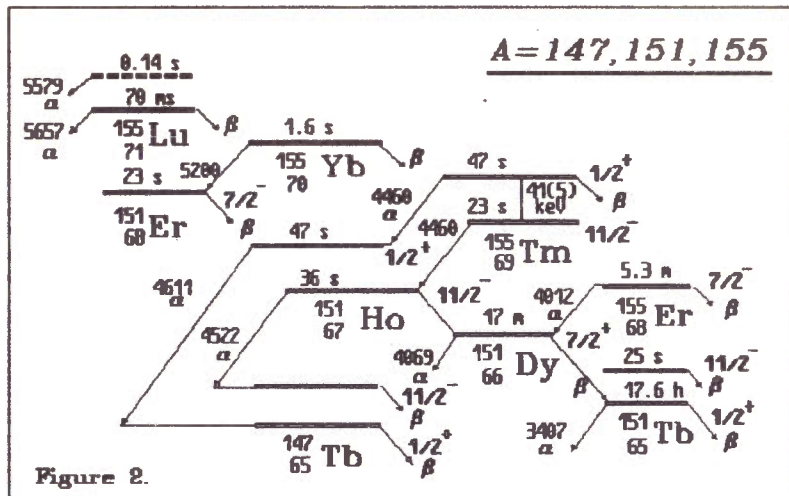
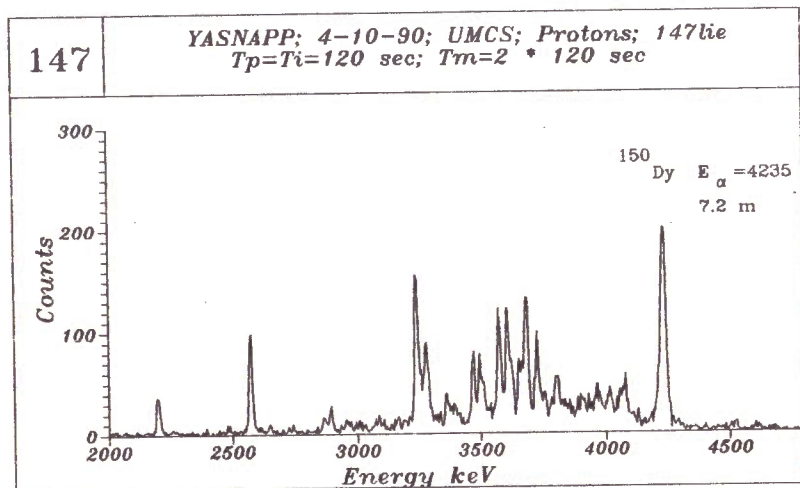


Figure 1. UMCS, ELGA Spectrometers Block Diagram.



A=154.3 The A=154 spectrum of α - γ coincidences with a 100-160 keV window in the γ -spectrum registered by BaF₂-scintillator (3.8*2.5 cm³). Above is the single α -spectrum. Coincidence spectrum mainly repeats single one (random coincidences). The new appeared α -group 4834 keV, 8,3 s has been identified as the α -decay of ^{154g}Tm; 8,3 s on the excited state of ¹⁵⁰Ho.

A=155.5 The measuring conditions of α - γ -coincidences for A=155.5 are the same as in the case of A=154.3. The appeared α -group is connected with fine structure of ¹⁵¹Ho α -decay.



Note

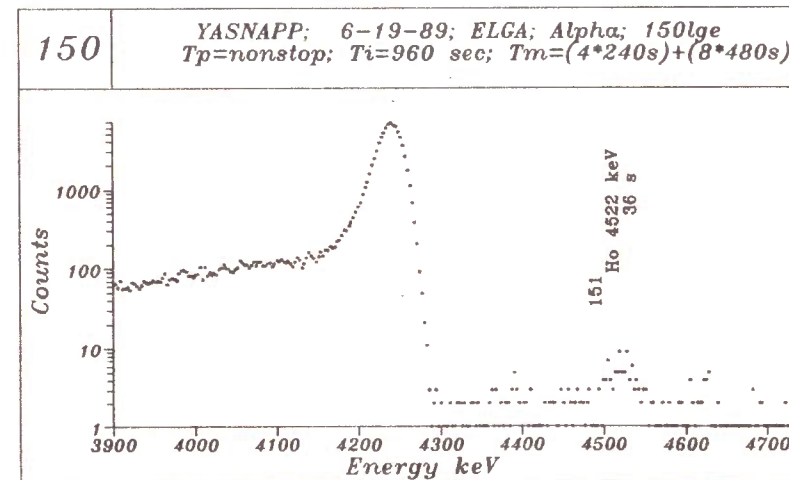
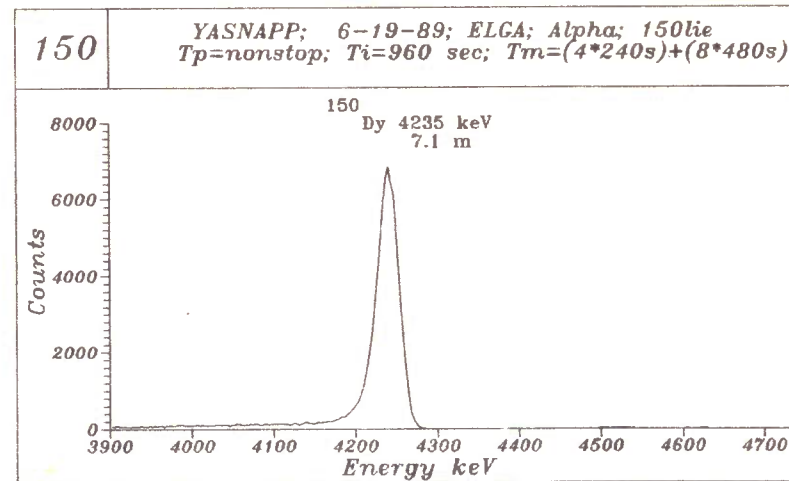
YASNAPP - abbreviation of russian words Nuclear Spectroscopy On Proton Beam - the name of programm and experimental complex for studies of nuclei far from in LNP in JINR

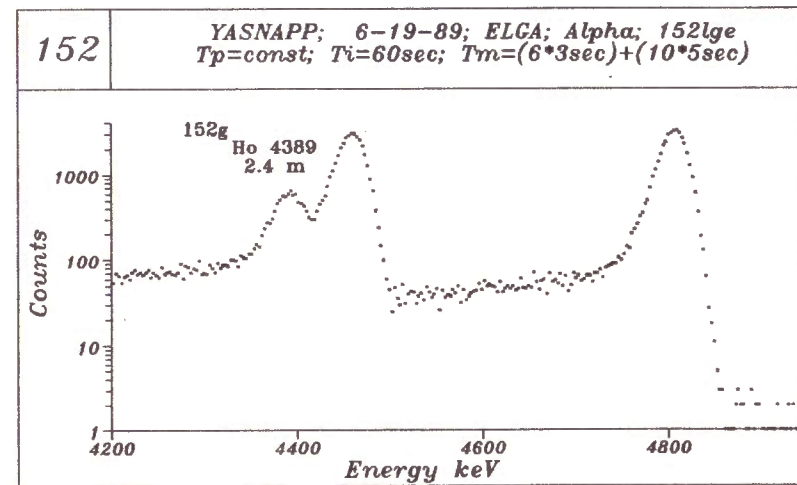
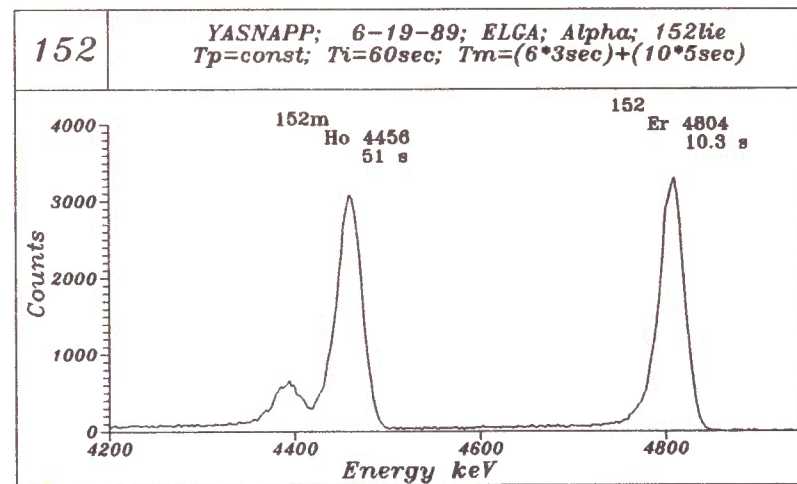
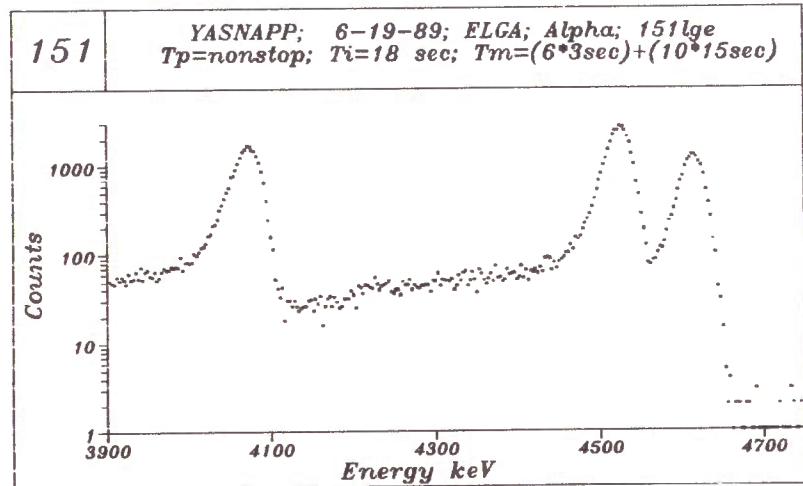
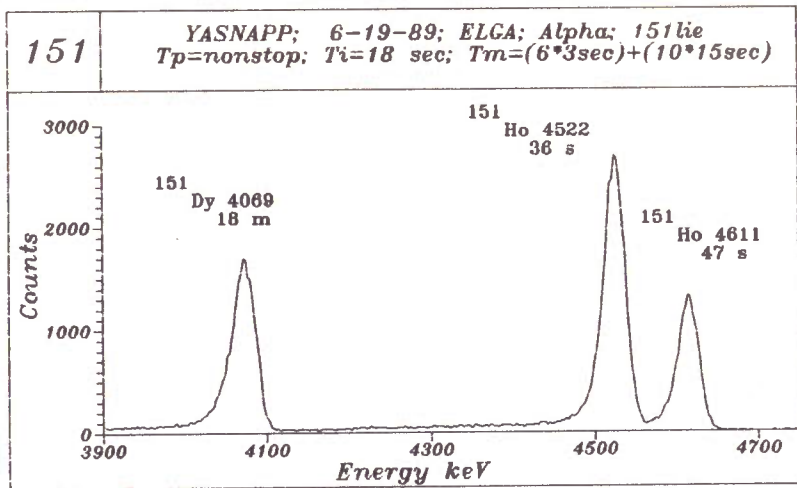
UMCS - Universal Multi detectors Correlation Spectrometer from University Marrii Curie Sklodowskiej (Lublin, Poland)

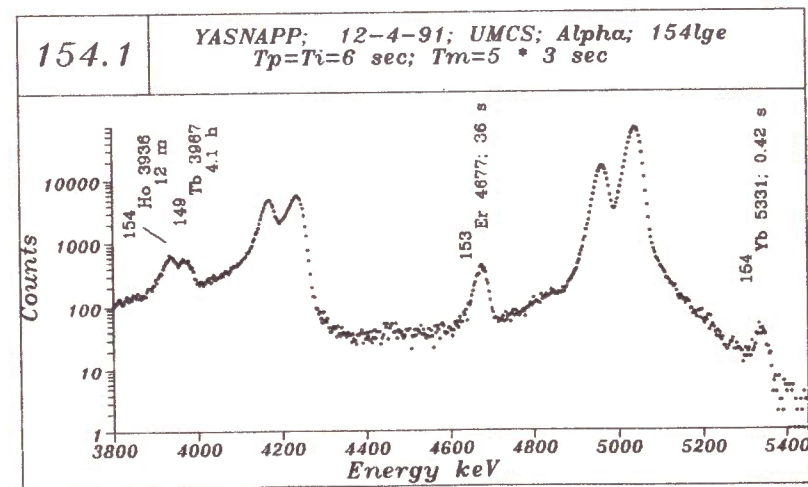
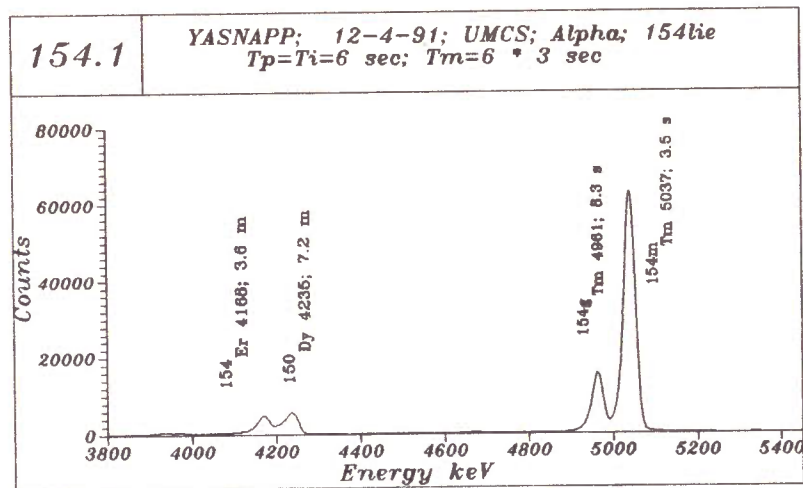
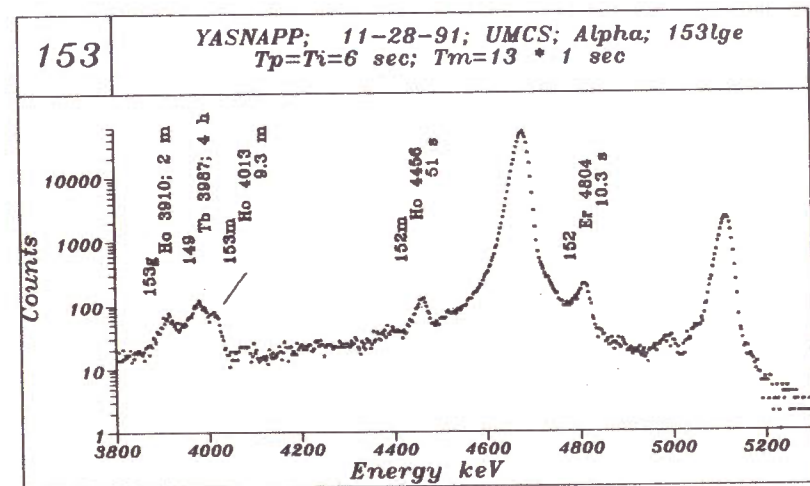
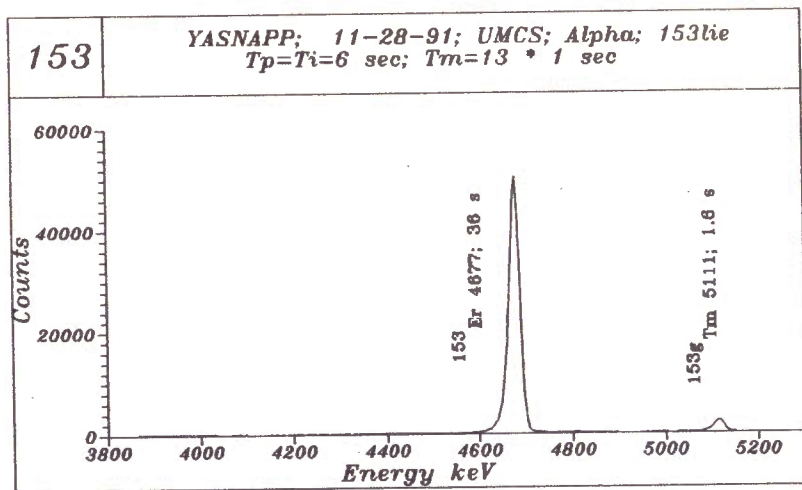
ELGA - (on next spectra) - electron - gamma - alpha - spectrometervic set

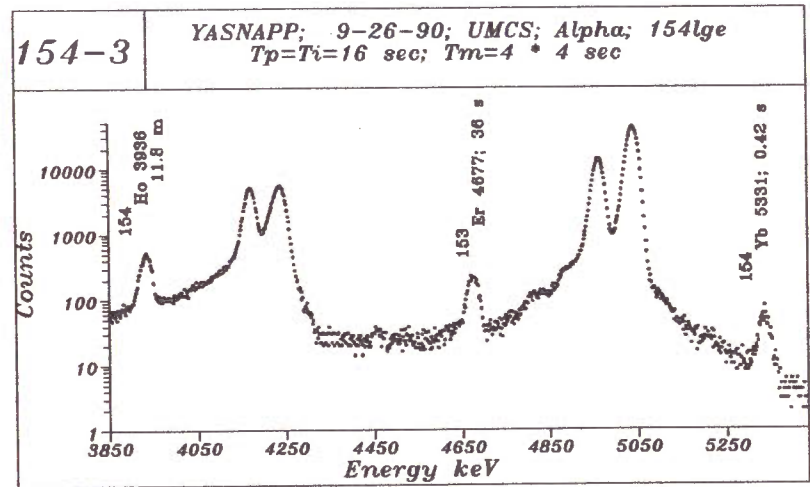
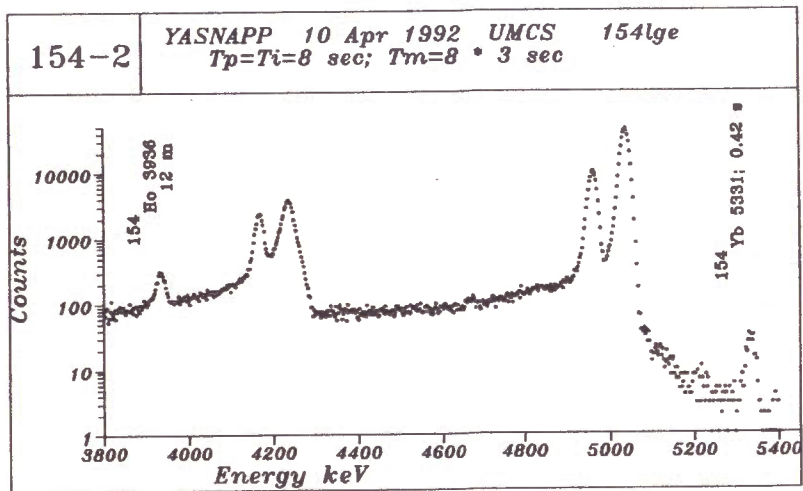
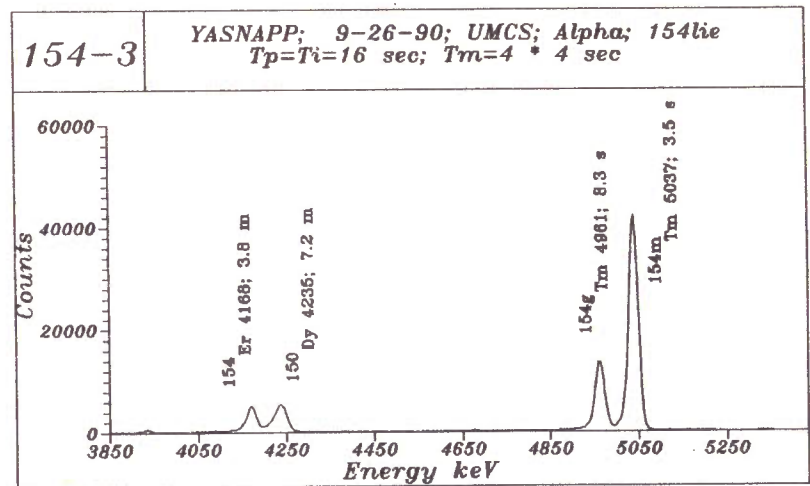
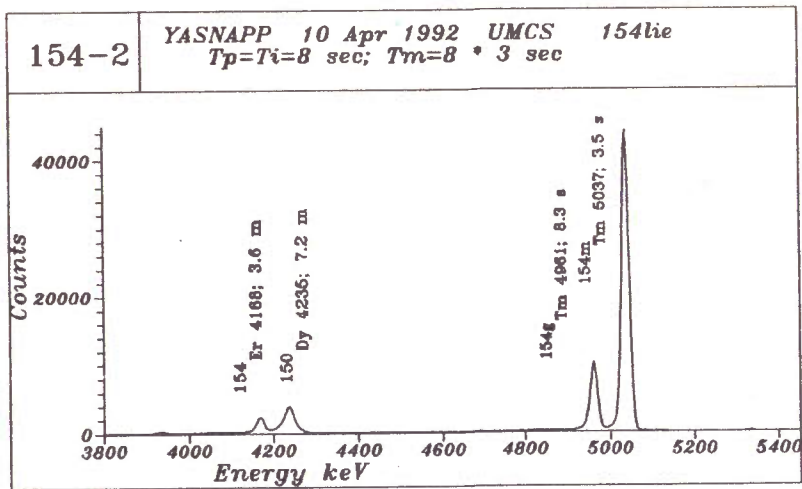
lie (lge) - linear (logarithmic) scale

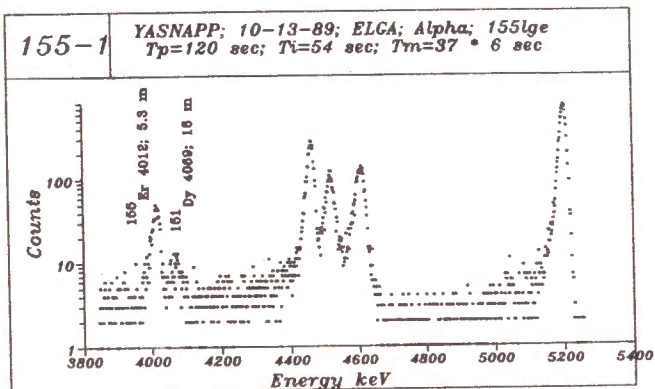
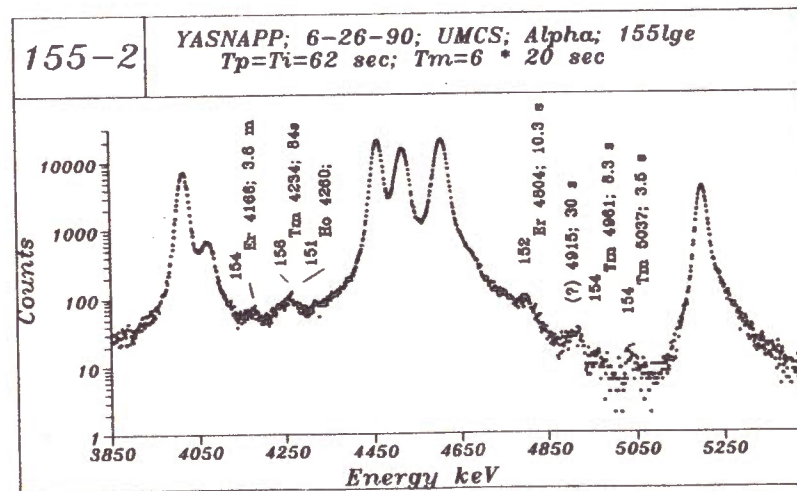
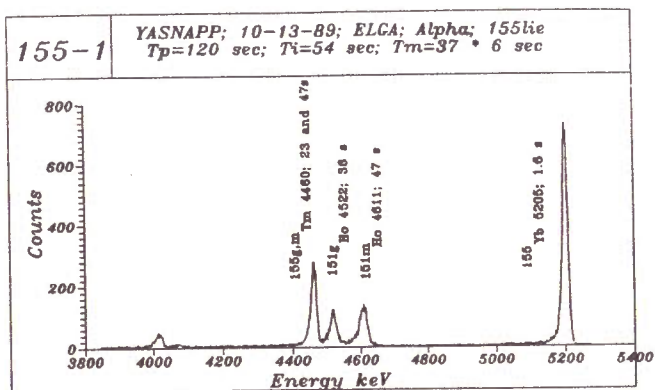
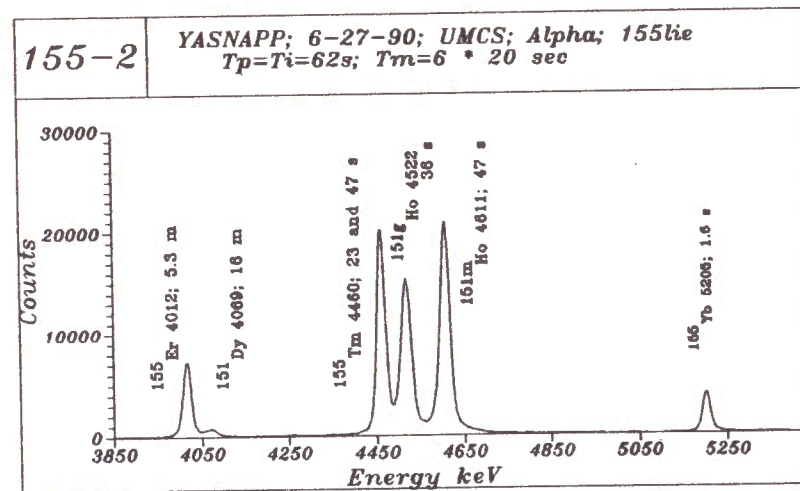
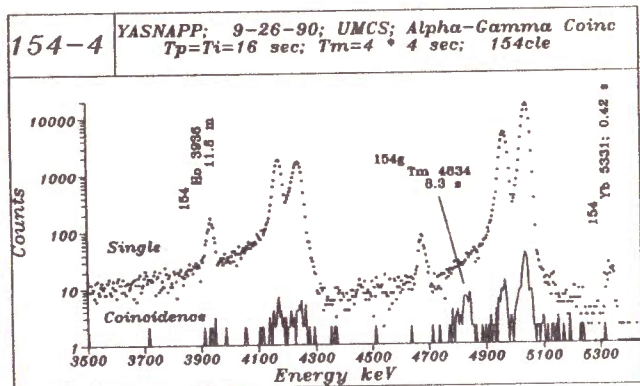
Tp, Ti and Tm - times of proton irradiation, ion collection and spectrum expositions, respectively

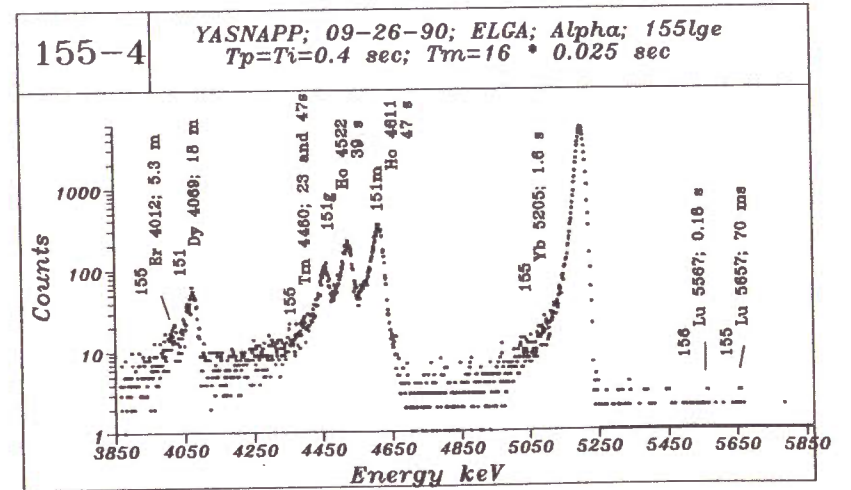
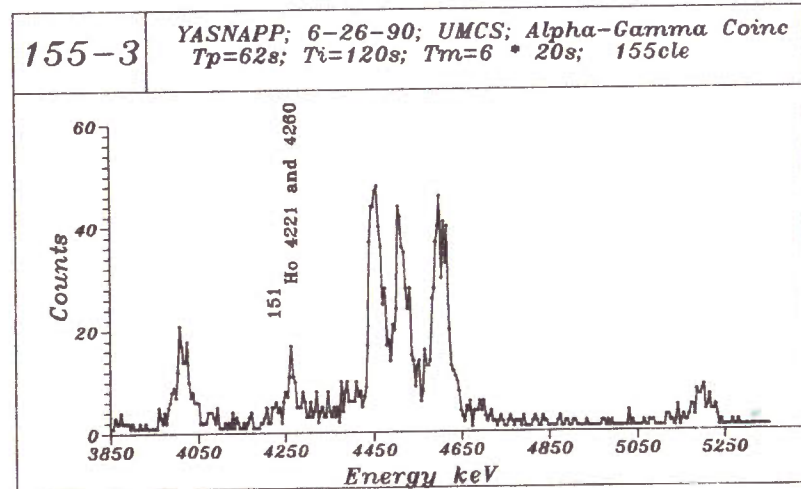
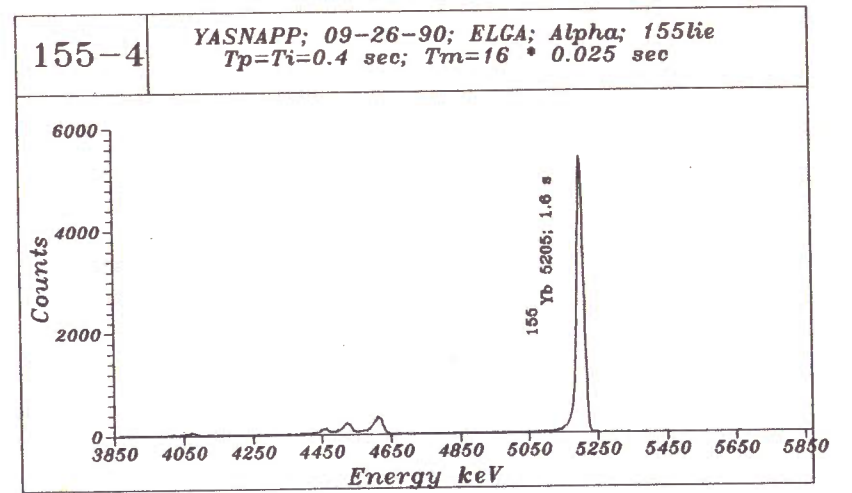
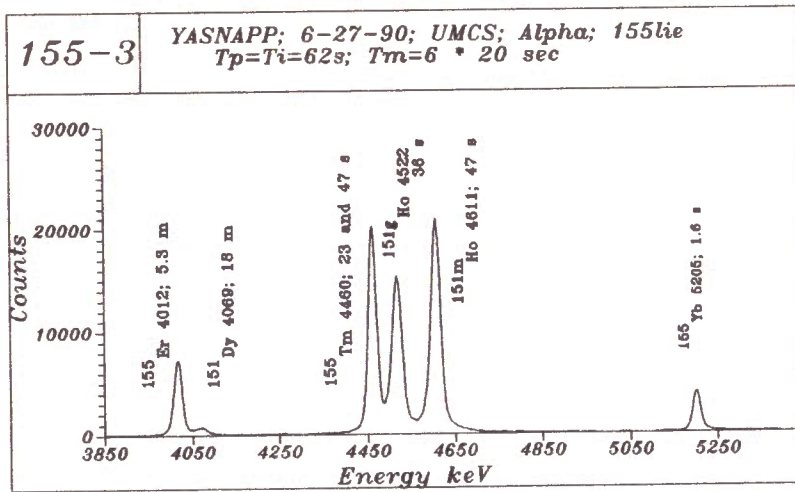


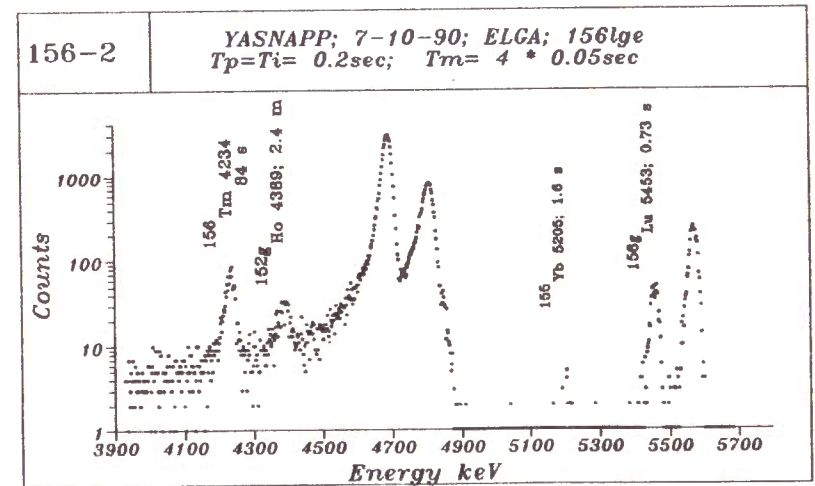
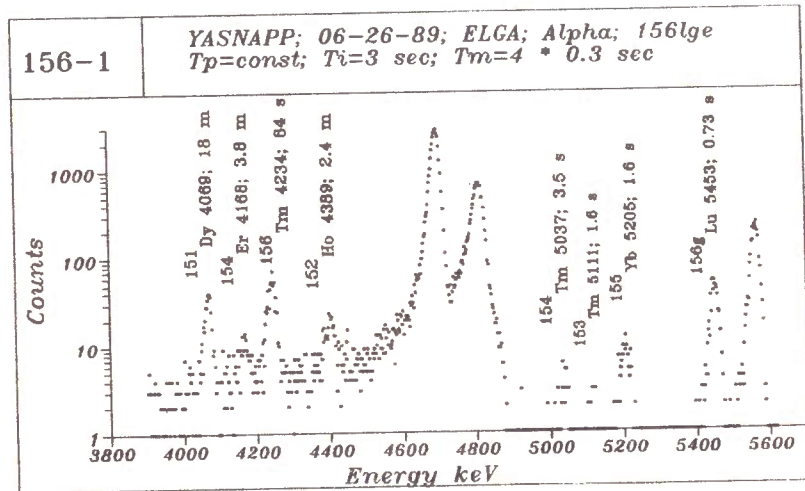
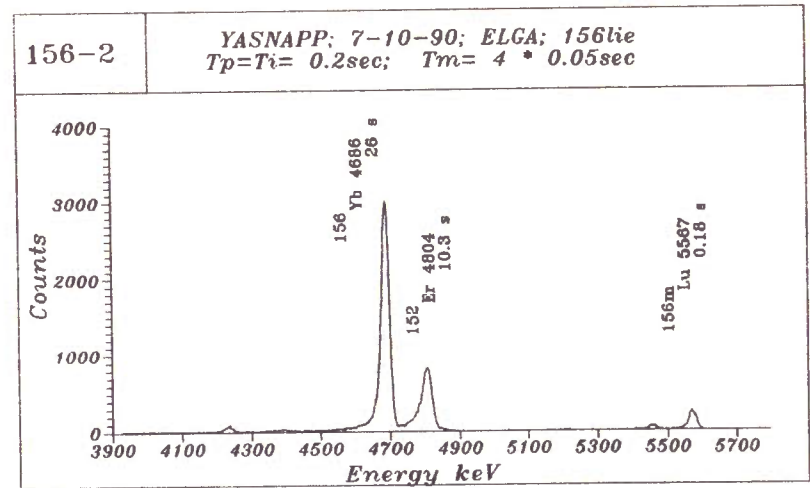
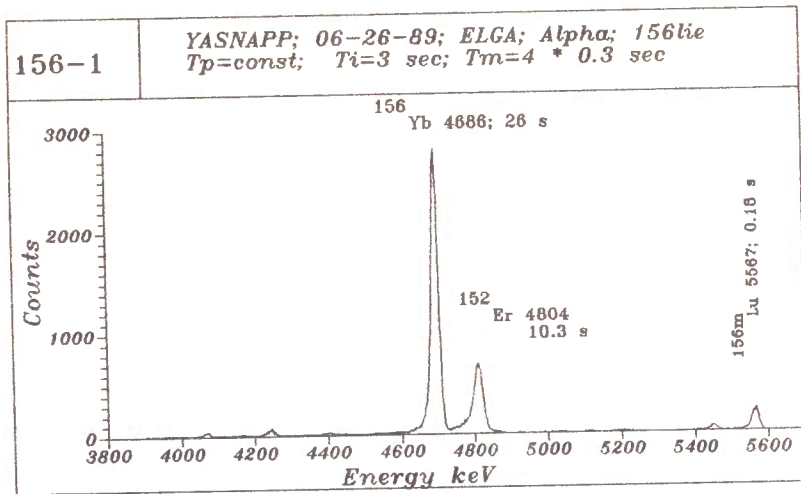


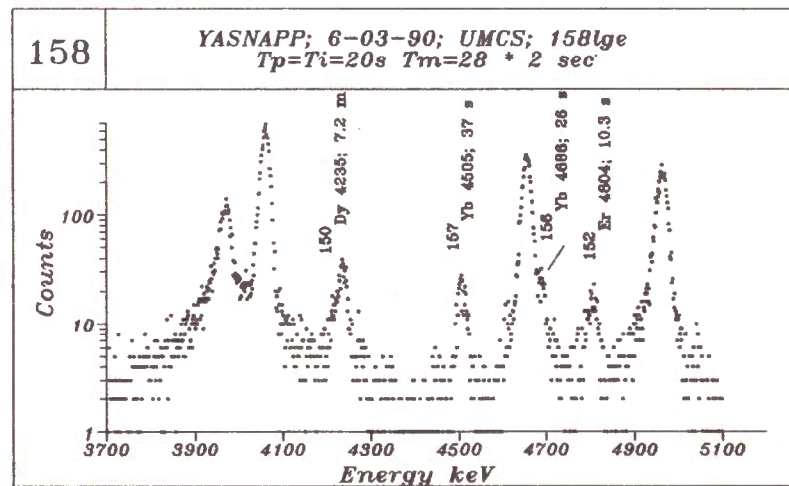
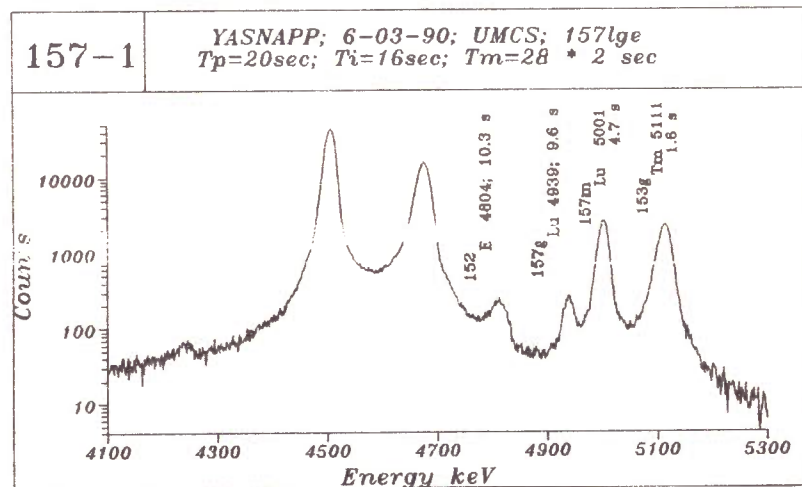
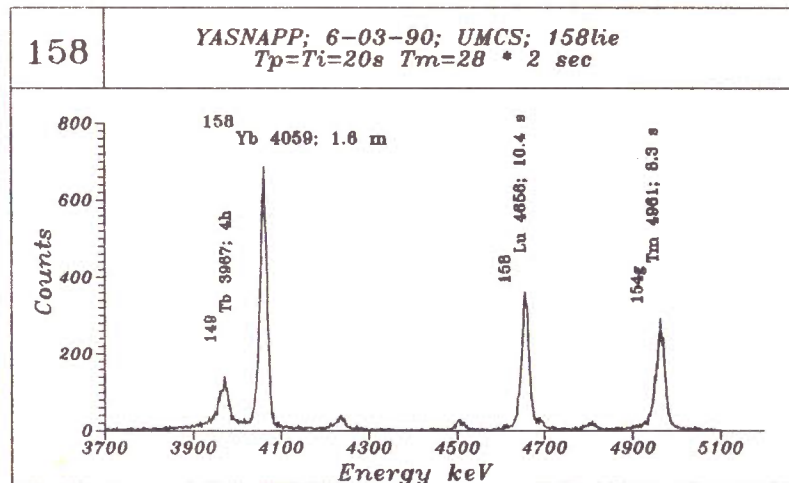
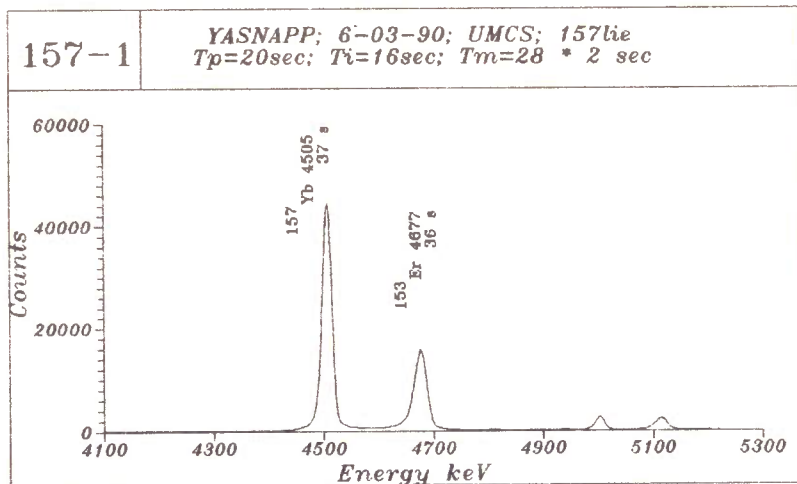












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