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Utilization of the $^{93}Nb(n,n')^{93}Nb^m$ reaction for reactor neutron dosimetry.

For the measurement of large ($\Phi_{fast} > 10^{18} \frac{n}{cm^2}$) fast neutron fluences in research reactors, the reaction $^{93}Nb(n,n')^{93}Nb^m$ is fairly seldom used (Lloret, Hegedüs). The reason is that the excitation function for the production of the ^{93}Nb isomeric state (half-life≈11.4 years) by inelastic neutron scattering is nearly unknown. Also the determination of the absolute $^{93}Nb^m$ activity is difficult, e.g. due to the bad knowledge of the conversion coefficients α_{tot} and α_K.

But, for neutron dosimetry purposes one does not necessarily need absolute activity values, if one irradiated niobium foil (e.g. 10 mm ∅ and 0.1 mm thick) is accepted to be a reference source to other irradiated niobium foils (of the same original material). If the cross section measurements and the fluence determinations are both based on the same reference source $^{93}Nb^m$ as an arbitrary activity standard, the possible inaccuracy of this activity value would not matter.
Such an accepted reference source could be deposited at one central institution. Once the reference source activity is defined (at present within 30% of the true absolute activity value) niobium sources with activities determined relative to this reference source could be supplied together with non-irradiated niobium foils to interested laboratories.

It is proposed to count the $K_{\alpha+\beta}$ X-rays by means of a semiconductor detector, Ge(Li) or Si(Li) provided with a beryllium window. A typical spectrum displayed on a MCA from a 0,5 cm^3 Ge(Li)detector is shown in the figure. But, one can also count the K X-rays in an integral assembly such as the IAEA rhodium counter (NaI, Be-window).

Two parasitic activities can disturb the measurements. One, $^{92}Nb(T_{1/2} = 10,1\ d)$, produced by the fast neutron reaction $^{93}Nb(n,2n)^{92}Nb$, emitting also the niobium K X-rays, must be allowed to decay during some weeks before the measurements are performed.

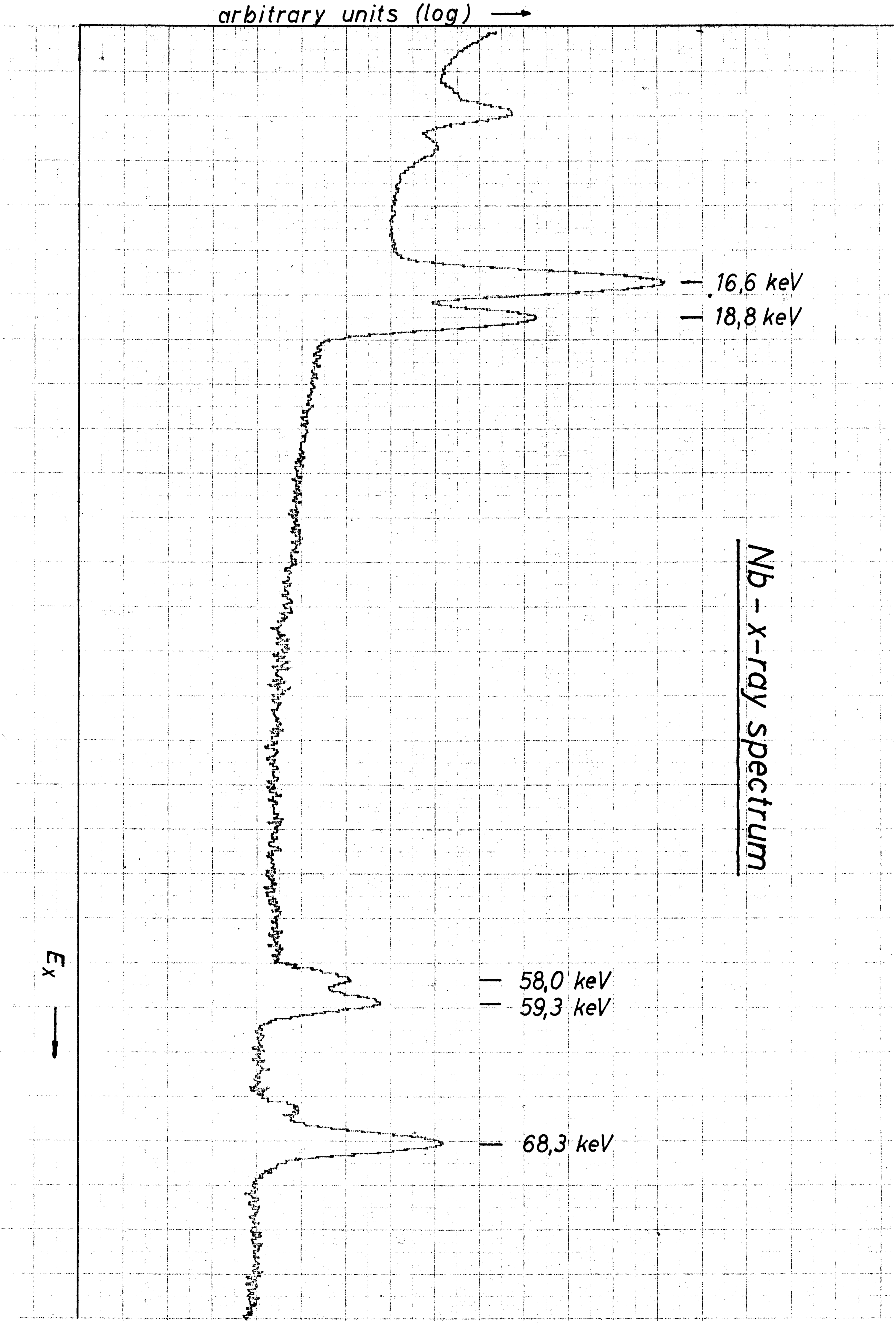
The other parasitic activity, ^{182}Ta ($T_{1/2}$ = 115 d) produced by thermal neutrons, $^{181}Ta(n,\gamma)^{182}Ta$, has a continuous contribution to the 16,6 keV region. The presence of this activity is due to the tantal impurity in niobium. However, if necessary, one can put the sample into a Cd-box to reduce this activity.

Also an "integral cross section" or reaction rate ratio (relative to a standard detector) in a known standard neutron field could be determined relative to such a reference niobium source.

Literature

1. LLORET, R., PI/DOS.(NT) 321-68-73 CEA-CEN, Grenoble

2. HEGEDÜS, F., Thesis, University Strasbourg


arbitrary units (log)
16,6 keV
18,8 keV
Nb - x-ray spectrum
58,0 keV
59,3 keV
68,3 keV
E_x