points in the diagram of peak/total-ratios vs energy.

6 The authors compare their peak/total ratios with those obtained by Heath[5]) in 1957. Since that time, Heath et al. have improved their methods, setting up an almost new gamma-ray spectrum catalogue[6]) in 1964. Among other things they have also revised their peak/total-ratios for the 10 cm source-crystal distance, in the worst case (^{28}Al, 1.78 MeV) by 4%. It is a pity that Leutz et al. have not referred to this report, which is also a very useful text-book on how to perform accurate gammaspectrometric analyses.

7. The authors also compare their results (the comparison is referred to in the abstract) with those calculated by Miller for radiation parallelly incident on a naked crystal. If a comparison should have been justified, the experimental results should have been corrected for the influence of attenuation in reflector and canning, transmission of beta radiations, etc. Further, the comparison should have been made with the peak/total-ratios calculated by Miller for a point source. These calculations are available at least for the 10 cm distance used by the authors[7]). As an example, consider a 4″ dia. × 4″ hgt crystal and a gamma energy of 1.17 MeV. The experimental peak/total-ratios by Leutz et al. exhibit for this crystal size and 10 cm source-crystal distance a considerable spread. Following the line drawn by the authors, 1.17 MeV would give a peak/total-ratio of 0.43. Miller has for parallelly incident radiation calculated a ratio of 0.52. The discrepancy between these figures is considerably reduced if Millers calculations for 10 cm source-crystal distance are used, giving 0.49.

For one crystal size (4″ dia. × 4″ hgt) quite close agreement between experimental peak/total-ratios and those calculated by Miller has been reported[2]).

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A reply to the above criticism

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As mentioned in our paper [Nucl. Instr. and Meth. **40** (1966) 257–260] the peak/total-ratios for NaI(Tl) crystals were determined with relative errors of about ±5% in order to reduce the measurements of γ-intensities absorbed in NaI(Tl)-crystals to measurements of the corresponding total absorption peaks. This technique is particularly important for analysing complex γ-spectra and anti-Compton spectra.

To be precise, these absorbed γ-intensities must include the counting rates of:

1. Total absorption peak,
2. Compton continuum,
3. Pair escape peaks,
4. Iodine escape peak

However, they must not include:

5. Any intensities arising from other radiations accompanying the γ-transitions in question, such as X-rays, conversion electrons, and β particles
6. Any intensities from γ-quanta scattered outside the NaI(Tl) crystals. This means in particular not the backscatter intensity.

The peak/total-ratios indicated in our paper were obtained by paying careful attention to points 1–6. If necessary, corrections were made to meet the above requirements. Therefore, backscatter intensities and peaks arising from characteristic X-rays were always substracted from the Compton continua, because these intensities must not be taken into account for the applications mentioned above.

As far as the crystal housing and related questions are concerned, we listed the interesting data in table 1. According to these data, the peak/total-ratios are

TABLE 1

Supplementary data of scintillation assemblies used for the measurements of peak/total-ratios.

Crystal dimensions	Crystal housing: Al-can thickness	Crystal housing: Al_2O_3 package	Maximum β-energy stopped in crystal housing and source holder	Influence of crystal housing: loss of source intensity at 120 keV	loss of source intensity at 1 MeV	relative error induced by Compton scattering[†]: at 120 keV Al + Al_2O_3	at 1 MeV Al + Al_2O_3	at 120 keV Fe[+] + Al_2O_3	at 1 MeV Fe[+] + Al_2O_3
(inch)	(mm)	(mg/cm²)	(MeV)	(%)	(%)	(%)*	(%)**	(%)*	(%)**
1 × 1	0.4	300	1.1	5.7	2.5	0.5	1.4	0.9	2.4
2 × 2	0.4	300	1.1	5.7	2.5	0.5	1.3	0.9	2.2
3 × 3	0.5	320	1.2	6.3	2.7	0.4	1.2	0.7	2.1
4 × 4	0.8	430	1.5	8.9	3.9	0.4	1.6	0.7	2.0
5 × 5	0.8	570	1.8	10.7	4.7	–	1.7	–	2.0
8 × 4	0.5	500	1.4	8.7	3.8	–	1.1	–	1.4
9 × 6.5	0.5	510	1.5	8.8	3.9	–	1.0	–	1.3
8 × 8	0.5	520	1.5	8.9	3.9	–	1.0	–	1.3

[†] The relative error is given by: $\Delta R/R = \{R + (1-R)(1+\Delta)\}^{-1} - 1 \simeq -\Delta(1-R)$; R means peak/total-ratio, Δ means the relative increase of intensity in the Compton continuum by Compton scattering in the crystal housing

* We assumed that half of the intensity, Compton-scattered in the crystal housing, will reach the crystal

** We assumed that 70% of the intensity, Compton-scattered in the crystal housing, will reach the crystal

[+] Thickness of Fe-can: 0.5 mm.

practically unaffected by the use of different crystal cans up to stainless steel of 0.5 mm thickness. This is due to the Al_2O_3-reflector, which in most cases causes more γ-interactions than the metal cans. Therefore, our peak/total ratios can be used within the indicated limits of error ($\pm$ 5%) for all NaI(Tl) crystals canned in conventional housings, because variations of error between different housings are small compared with our limits of $\pm$ 5%.

The peak/total-ratio for the 2.62 MeV γ-transition of ^{208}Tl was obtained in the following way: The source was encapsulated in a brass container of 0.5 mm thickness. This deviation from the source holders used for all other γ-sources was not mentioned in our paper. Therefore, all β particles were stopped in this source envelope and in the crystal housings. The unwanted γ-intensities were substracted by applying the corresponding peak/total-ratios to their total absorption peaks, which arise from these unwanted γ-intensities in the ^{208}Tl-spectra.

The energy resolutions obtained with our crystals are not outstanding compared with the average production results in the past two years. At the present time, energy resolutions as low as the 10% to 12% quoted by G. Bengtsson are no longer usual (even for well type crystals), and it would be hard to recognize total absorption peaks in complex γ-spectra within reasonable limits of error using older NaI(Tl) crystals with low resolution. We separated the total absorption peaks from the Compton continua by drawing the low energy flanks of these peaks as symmetrical reflections of the high energy flanks.

We thank G. Bengtsson for extending our list of references