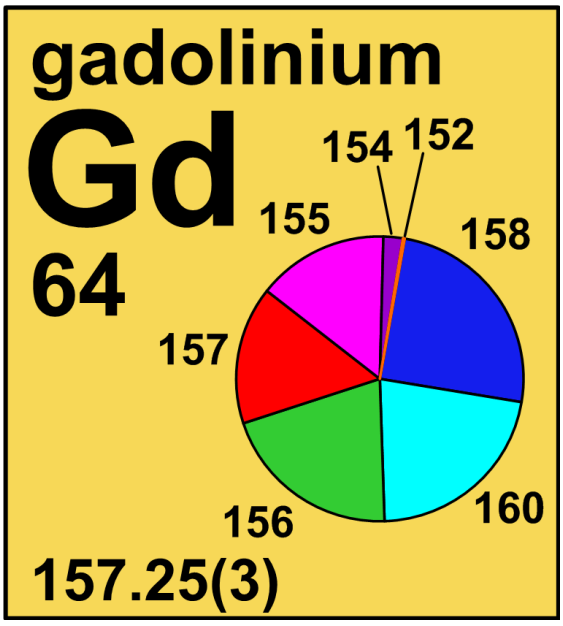
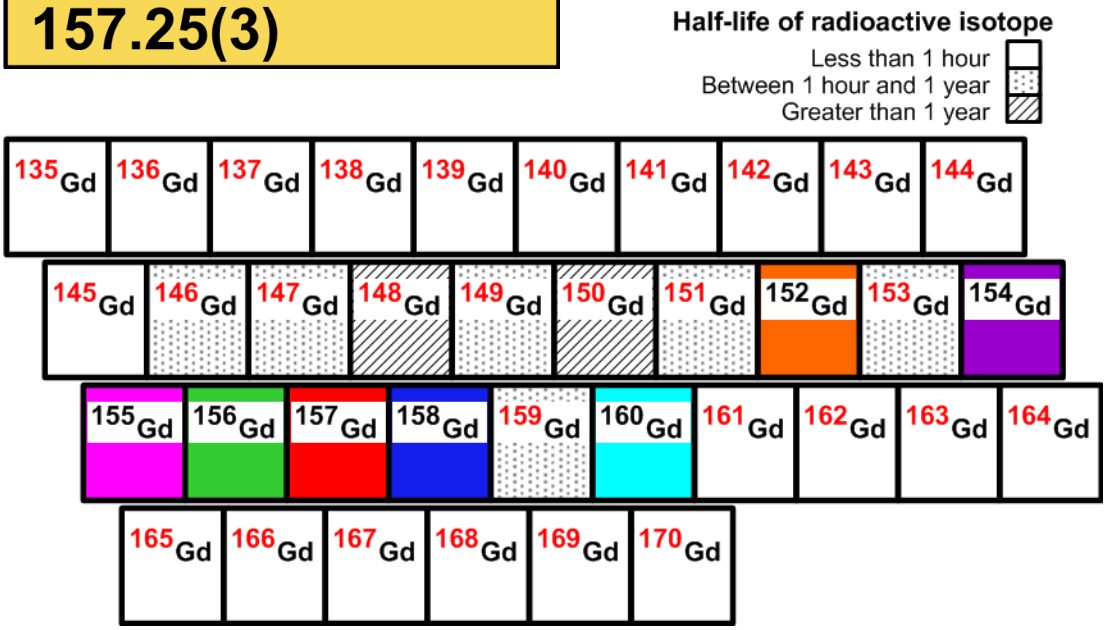
4.64 gadolinium



Stable isotope	Relative atomic mass	Mole fraction
^{152}Gd	151.919 80	0.0020
^{154}Gd	153.920 87	0.0218
^{155}Gd	154.922 63	0.1480
^{156}Gd	155.922 13	0.2047
^{157}Gd	156.923 97	0.1565
^{158}Gd	157.924 11	0.2484
^{160}Gd	159.927 06	0.2186



4.64.1 Gadolinium isotopes in Earth/planetary science

The lunar surface is continuously exposed to cosmic radiation, and the interaction between planetary material and **cosmic rays** produces secondary **neutrons**. The neutron flux can be investigated using the large neutron capture cross sections of ^{149}Sm, ^{155}Gd, and ^{157}Gd. For example, ^{157}Gd will absorb neutrons and be converted to ^{158}Gd. On a cross plot of $n(^{158}\text{Gd})/n(^{160}\text{Gd})$ **isotope-amount ratio** and $n(^{157}\text{Gd})/n(^{160}\text{Gd})$ isotope-amount ratio (Figure 4.64.1), values will move from the lower right corner to the upper left corner of the cross plot with increasing time or increasing flux.

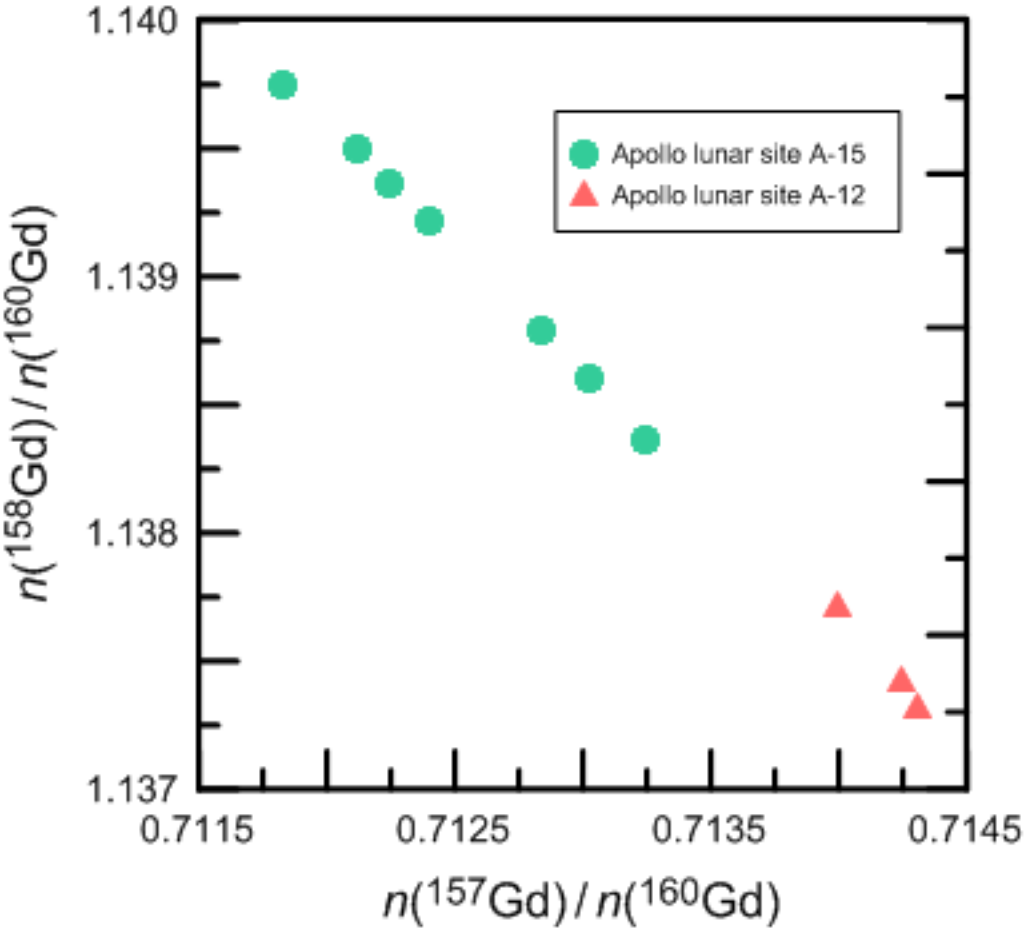


Fig. 4.64.1: Cross plot of $n(^{158}Gd)/n(^{160}Gd)$ and $n(^{157}Gd)/n(^{160}Gd)$ **isotope-amount ratios** of samples from Apollo lunar sites A-12 and A-15 (modified from [449]).

4.64.2 Gadolinium isotopes in medicine

The addition of ^{157}Gd to Neutron Capture Therapy (NCT) has been shown to be more effective at targeting tumors than the previous method of using only ^{10}B for the treatment (Figure 4.64.2) [450]. ^{153}Gd (with a **half-life** of 0.66 years) is used in the production of **photon** line sources (an optical source that emits one or more spectrally narrow lines as opposed to a continuous spectrum) to manufacture ^{153}Gd line sources [451]. ^{153}Gd is also used as a photon source of the dual-photon absorptiometry (DPA) technique that is used to measure bone mineral content (BMC). Studies for this technique have been conducted in horses and humans [452, 453].

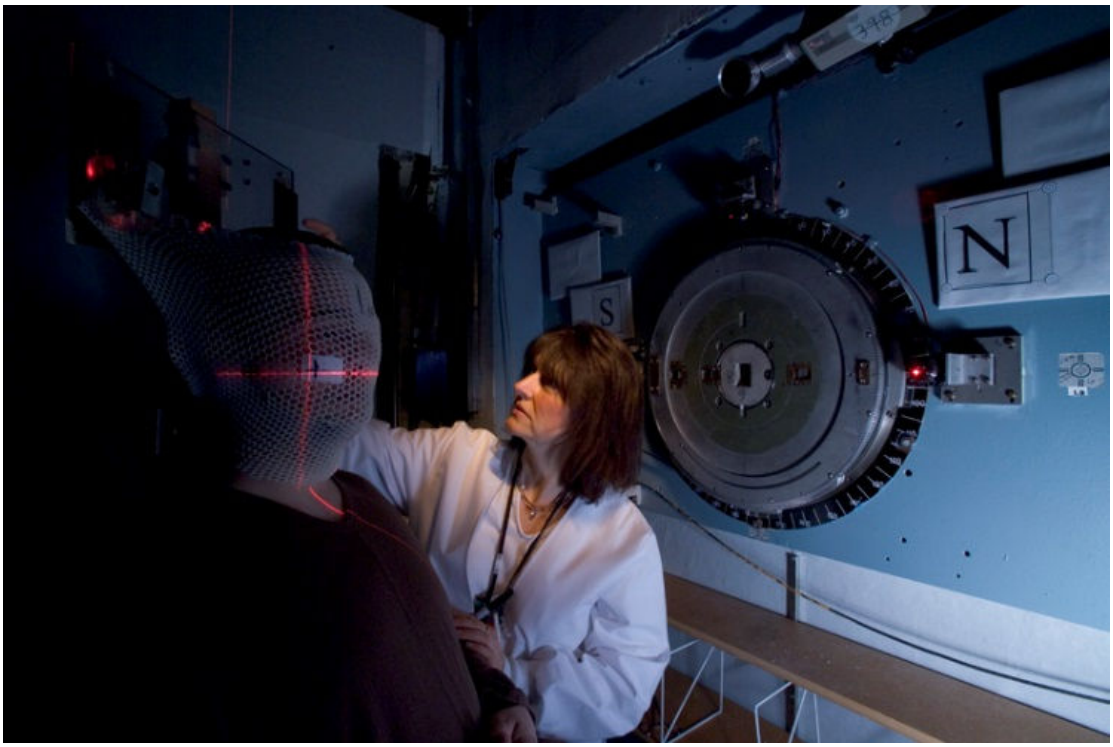


Fig. 4.64.2: Patient undergoing **neutron** therapy. The red lasers cross to target the patient's tumor. A beam of neutrons is fired at the target to stop the growth and eradicate the tumor. (Photo Source: Reidar Hahn, Fermilab Visual Media Services Photo Database, Fermi National Accelerator Laboratory) [454].