Neutron Detection by Large NaI Crystal

A. Lavagno¹ and G. Gervino²

1. Department of Applied Science and Technology, Politecnico di Torino and INFN Torino, Italy
2. Department of Physics, Università di Torino and INFN Torino, Italy

In present days new neutron detection methods are under development due to the global shortage of $^3$He and the toxicity of BF$_3$. The performance of a cylindrical NaI crystal, 4" diameter and 8" length as indirect neutron detector have been investigated. Measurements were performed with bare and shielded NaI detector. The indirect detection of neutrons by photons has several advantages:

a) this method can in principle be suited by any gamma spectrometer with only slight modifications that do not compromise its gamma spectrometry measurements;

b) fission neutron sources and neutron generators can be discriminated thanks to their different gamma energy spectra, a discrimination easily done by NaI spectrometer.

Main neutron reactions inside NaI crystal
Typical gamma spectra obtained with NaI. Spectrum I, was collected when $^{256}$Cf neutron source was in place, Spectrum II, was obtained after the removal of the neutron source.

Gamma detection taken with a NaI cylinder. The green line shows the $^{256}$Cf spectra, the dark blue line shows the background, the light blue line shows the same background measurement taken after the neutron source measurement: the increasing counting rate from around 2.0 up to 5 MeV in the background indicates that the NaI crystal was slightly activated by the neutron flux.

The preliminary results demonstrate that a neutron detection ability can be added to a NaI spectrometer with only slight modifications. One of the future goals will be to find a proper neutron moderator specifically studied for home security applications. A 10 cm thick poliethylene shield could be a reasonable solution, a good compromise between size, weight, neutron thermalization performance and increasing of neutron detection efficiency.