

A multi NaI(Tl) detector array for medium energy γ -ray spectroscopy

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Abstract. An array of seven hexagonal NaI(Tl) detectors has been set up for measuring γ -ray spectra in the energy region $5 \text{ MeV} \leq E_\gamma \leq 40 \text{ MeV}$ with good accuracy. This is in contrast to earlier set ups which mostly used one large sized (about 10 inches $\phi \times 15$ inches long) NaI(Tl) detector. This set up has been made for the study of γ decay of GDR based on high spin states and ultra-dipole radiations.

The array has been provided with the following features: a) TOF discrimination against neutrons, b) pile up detection and elimination, c) active and passive shielding to cut down background and d) an array of trigger counters for multiplicity dependence measurements. The well known program EGS4 has been used to determine the response of the array for γ -rays in the energy region 5–40 MeV and several test measurements have been carried out to confirm the validity of the calculated response functions. Some typical γ -ray spectra from α and ^{16}O induced reactions measured at VECC, Calcutta and Pelletron accelerator at TIFR are also shown.

Keywords. 5–40 MeV gamma-ray; hexagonal NaI(Tl) detector array; time of flight; pile up; pulse shape discrimination; response; folding; unfolding.

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1. Introduction

The study of high energy γ -rays from nuclear collisions has been of great interest in the last few years. These studies can broadly be classified into two categories. The first one is the study of gamma decay of isovector giant $E1$ resonance built on excited nuclear states. These photons are emitted in competition with other particles such as neutrons, protons and alphas, from an excited compound nucleus formed in low energy heavy ion collisions and shed light on nuclear structure, e.g. the shape evolution as function of spin, excitation energy etc. (Snover 1986; Gaardhøje *et al* 1984; Chakrabarty *et al* 1987a). Study of non-statistical or bremsstrahlung γ -ray emission in nucleus–nucleus collisions forms the second category. These γ -rays manifest themselves as an approximately exponential tail in the γ -ray spectrum for $E_\gamma > 20 \text{ MeV}$. Although the production mechanism of these hard photons is not well understood at present (Tam *et al* 1988; Nakayama and Berstch 1987), it is hoped that their study will enhance our understanding of the early phase of the collision. While there exist very many measurements of pre-equilibrium particle spectra, the presence of final state interactions with the residual nucleus makes their interpretation difficult. High energy photons are inherently clean probes and, because of their weak coupling to the nucleons, have a long mean free path in the nuclear medium.