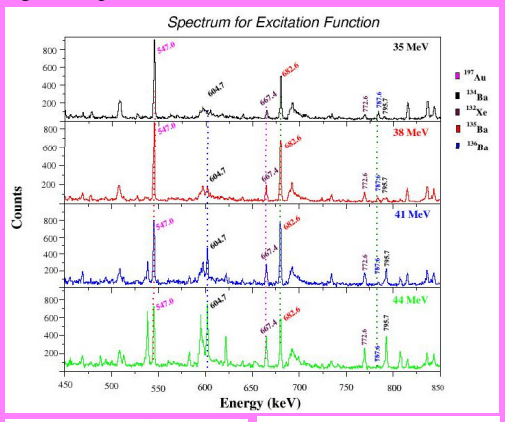
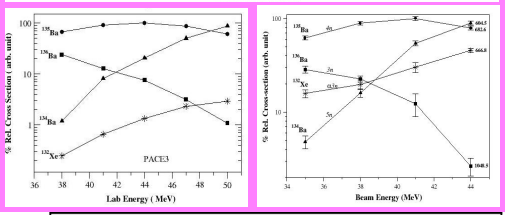
Particle Identification in CsI(Tl) detectors

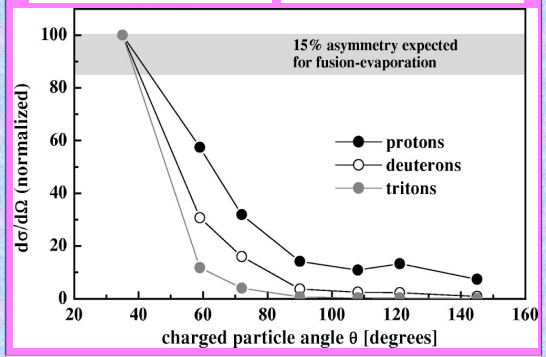
Introduction

- Fusion evaporation reactions generally used to study excited levels of nuclei at high spin.
- Compton Suppressed gamma detector arrays have been used for these studies.
- In addition to gamma detector arrays, charged particle detectors also help in channel selection, studying different gating conditions, doppler correction of gamma rays emitted in flight *etc.*
- Combining this charged particle and gamma detector arrays, spectroscopic study of neutron rich nuclei is possible through incomplete fusion reactions.
- The crystal of CsI(Tl) coupled with photodiode and light guide is one of the compact size detector system being used in various 4p charged particle detector arrays.

- Production of relatively neutron rich isotopes through incomplete fusion reactions induced by Li, Be, B projectiles.
  Examples: ^{9}Be + ^{130}Te reaction producing ^{132}Xe.
- Light ions produced in ICF are forward focused.





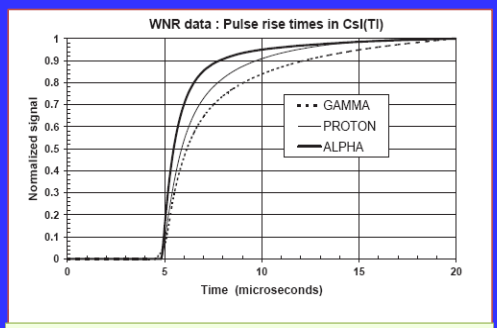


Collaboration

R. Palit[1], V. V. Parkar[1], Anil Raghav[1], H. V. Panchal[1], P. K. Joshi[1], I. Mazumdar[1], H.C. Jain[2], S. Santra[3], R. K. Bhowmik[4], Rakesh Kumar[4], S. Venkataramanan[4], Suresh Kumar[5]

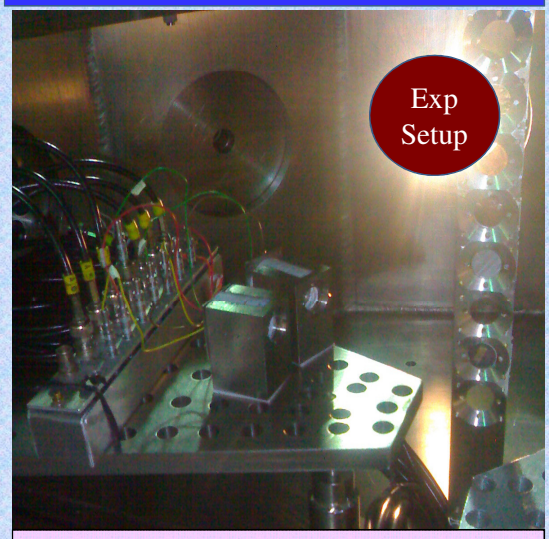
[1]*Tata Institute of Fundamental Research, Mumbai*
[2]*University of Mumbai, Mumbai*
[3]*Bhabha Atomic Research Centre, Mumbai*
[4]*Inter University Accelerator Centre, New Delhi*
[5]*Delhi University, New Delhi*

Pulse shape analysis



Radiation Protection Dosimetry 110, 219 (2004)

- Pulse shape discrimination (P.S.D.) is a method of discriminating between different particle types (protons, alpha-particles, electrons etc.) by exploiting the dependence of the shape (decay time) of a scintillation pulse on the ionisation density in the track of the exciting particle.
- The CsI(Tl) scintillation crystal is widely used for charged-particle discrimination, since its scintillation light is composed of a slow and a fast component, the amplitude ratio of which as well as the decay-time constant of the fast component vary with the type of the particle .



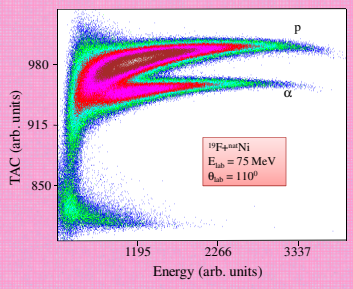
Two CsI(Tl) detectors of this type have been tested in the online experiment at BARC-TIFR Pelletron accelerator facility, Mumbai

Array of 16 detectors being built at TIFR

Results

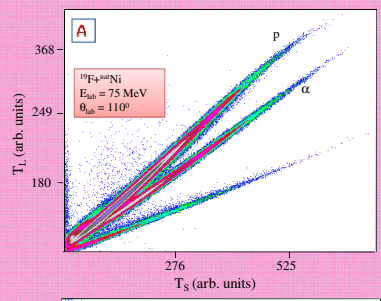
(i) Zero crossover method:

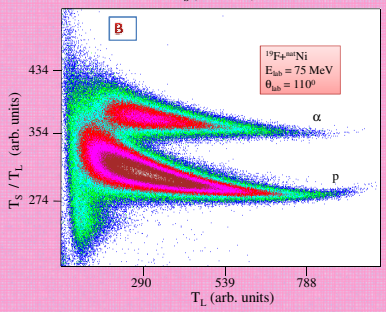
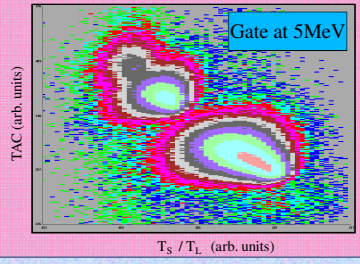
In this method, the time difference between arrival time of the pulse and its zero crossover time are used to trigger a TAC (Time to Amplitude Converter). Since the zero crossing time is dependent only on pulse shape, this time measurement uniquely determines the pulse shape and hence particle type. Hence by plotting zero crossover time (TAC) vs energy (fully integrated unipolar pulse), the particle ID can be obtained. The following figure shows the results of this method.



(ii) Ballistic deficit method :

In this method, the particle discrimination is achieved through a short-time-constant bipolar shaper and a long-time-constant unipolar shaper. The particle-type information is derived by dividing the output amplitude of the bipolar shaper with that of the unipolar shaper. Bipolar pulse carries particle information as its zero crossover time and amplitude are dependent on particle rise time and hence on particle type. The typical spectrum of long-time-constant unipolar (T_L) vs. short-time-constant bipolar (T_S) signals is shown in 'A' and the corresponding ballistic deficit figure is shown in 'B'.





(iii) Combination of above two methods (TAC vs. T_S/T_L):