Università degli Studi di Torino

High Efficiency Large Volume Multiparametric Neutron Detector for Nuclear Physics and Nuclear Astrophysics Measurements

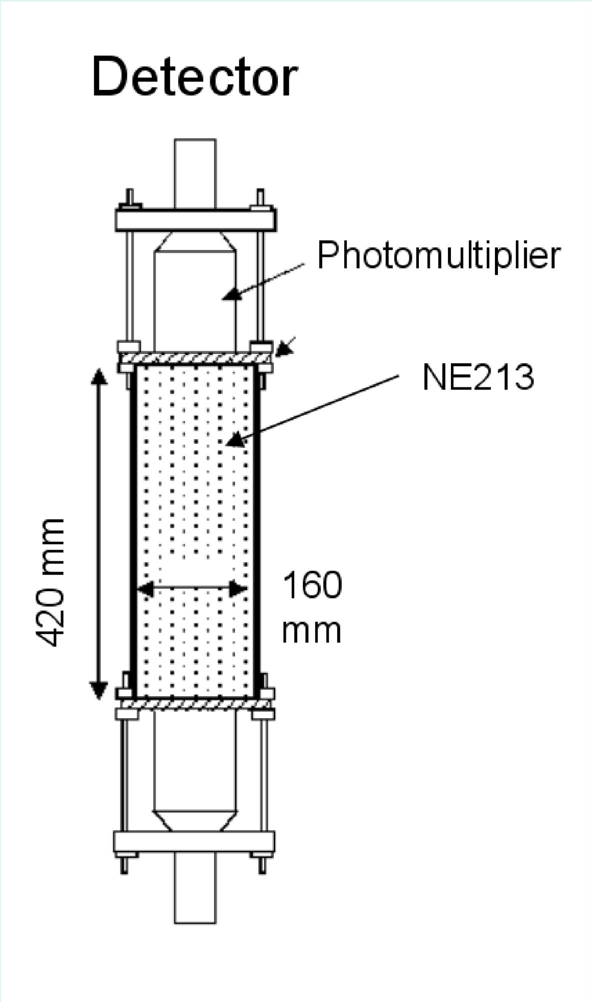
Andrea Lavagno
Dipartimento di Fisica
Politecnico di Torino
Corso Duca degli Abruzzi, 24 - 10129 Torino
Italy
alavagno@polito.it

Giampiero Gervino
Dipartimento di Fisica Sperimentale
Università di Torino
via Pietro Giuria, 1 – 10125 Torino
Italy
gervino@to.infn.it

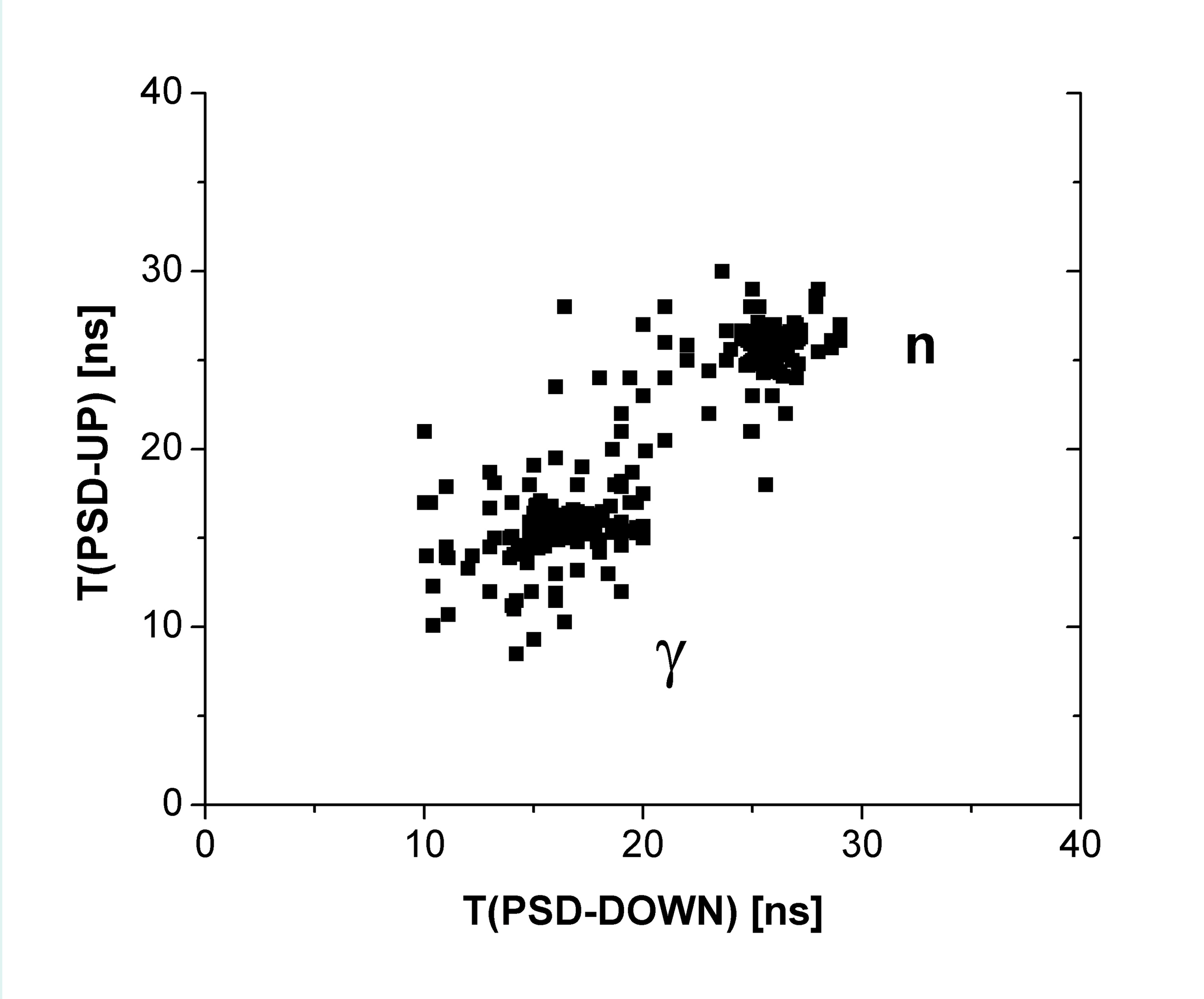
Ciro Marino
Dipartimento di Fisica Sperimentale
Università di Torino
via Pietro Giuria, 1 – 10125 Torino
Italy
ciro.marino@unito.it

Monitoring neutron emission with efficient detectors is the most straightforward way to study physics problems such as fission of heavy nuclei, where neutrons are preferentially emitted because of the Coulomb barrier, the (α,n) reactions among them we mention ^{13}C(α,n) ^{16}O and ^{26}Ne(α,n) ^{25}Mg that are essential to understand the evolution of AGB (asymptotic giant branch) stars and the production of elements heavier than Fe via slow neutron capture s-process. A large volume (more than 5 l) neutron detector has been realized by organic liquid scintillator: the detector shows a very good performance for high efficiency measurements at low and very low neutron rate in the 0.03-10 MeV energy range. γ-n discrimination has been jointly performed by standard pulse shape discrimination and the digital charge comparison method, the results obtained by the two techniques are presented and discussed. A very good γ-n discrimination down to 100 kee with good efficiency has been achieved.

The **detector**: The detector was designed to measure neutron flux enetering perpendicular to the detector axis. The Aluminum container 3 mm thick is filled with 5 l of NE123 liquid scintillator. A Hamamatsu R1250 photomultiplier is coupled to the top and to the bottom side of 10 mm thick Pyrex glass.



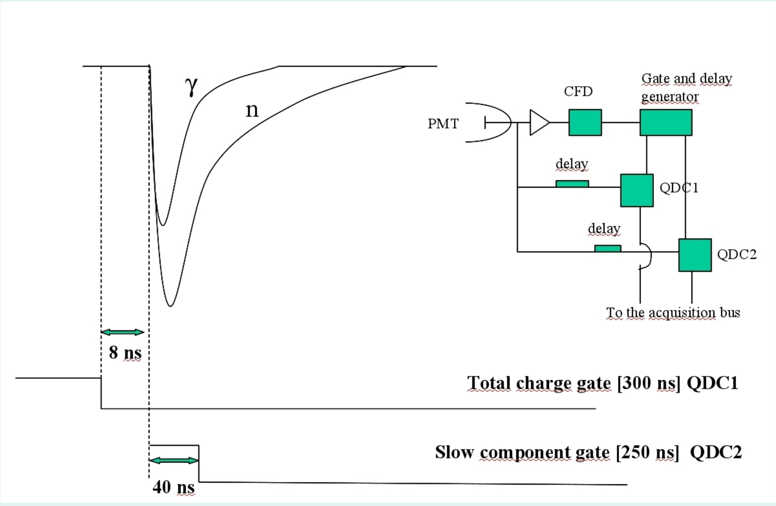
Detector



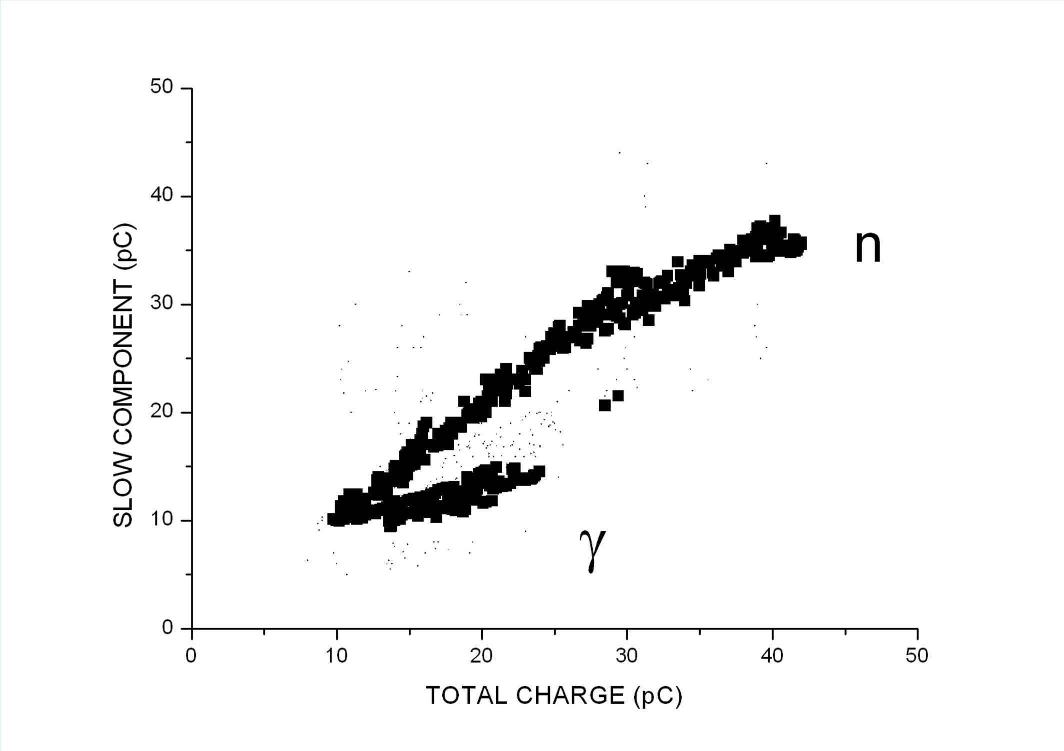
Two dimensional spectrum of the time distribution of the PSD Canberra 2160A module: the vertical and horizontal axis shows the upper and lower photomultiplier respectively. The γ-n discrimination from Am-Be source can be noticed.

Comparing the γ-n discrimination obtained by standard PSD method based on Camberra 2160A module (see *above bidimensional spectrum*) and the digital charge comparison method (see *below spectra*) we have seen that the latter gives the best results both from the amount of the γ's contamination under the neutron peak (10% against 4%) and the lower limit of energy reached (500 kee against 100 kee)

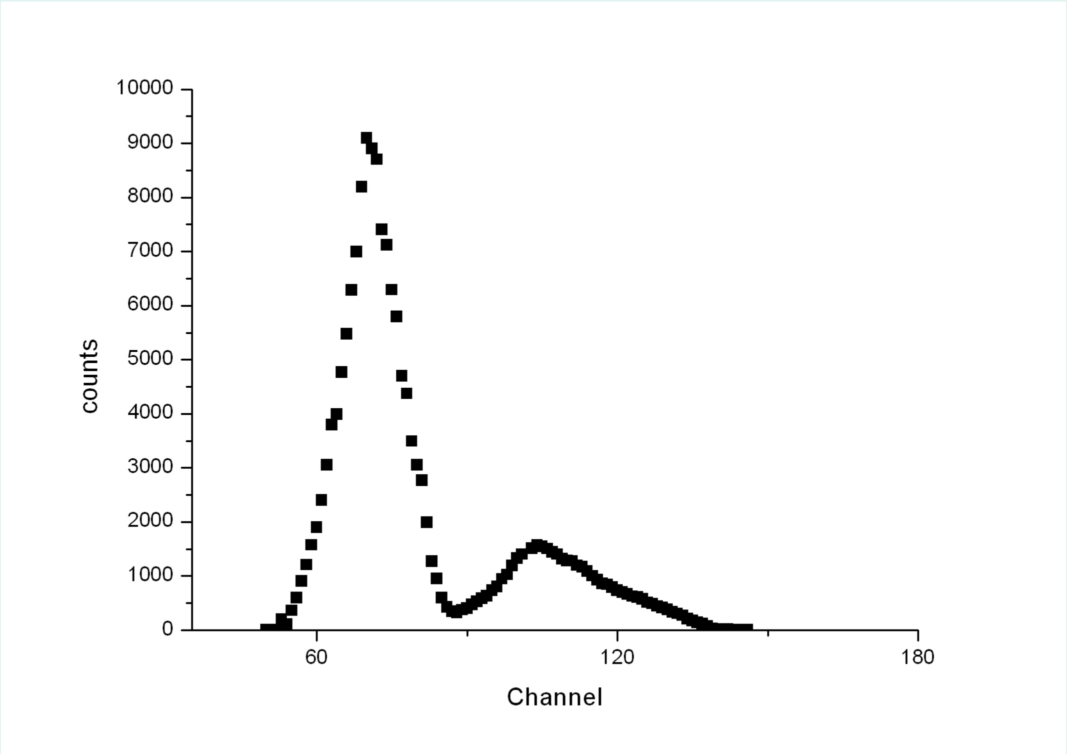
n-γ discrimination spectrum at 100 kee gate measured with a higher gain of the photomultiplier by charge comparison method. The shown good separation of gamma and neutron peaks means that a very effective n-gamma discrimination is achieved down to 100 kee. The γ's contamination in the neutron area is evaluated to be less than 4%.



NIM Electronic block diagram and time relation between photomultiplier pulse and gates at the input of QDCs used to measure γ-n discrimination by digital-charge comparison method.



Two dimensional scatter plot of the charge in the slow component vs the total charge (pC) collected by QDC from an Am-Be source.



γ-n discrimination spectrum measured with the gate set at 100 kee. Note the good separation between the γ peak (the higher and thinner one) and the neutron peak.

References

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[4] 4 C. Casella et al., Nucl. Instr. and Meth. A 489 (2002) 160.