PALS – Setup optimisation and application to macromolecular materials characterisation

Instituto Superior Técnico // Mestrado Integrado em Engenharia Física Tecnológica

Project MEFT

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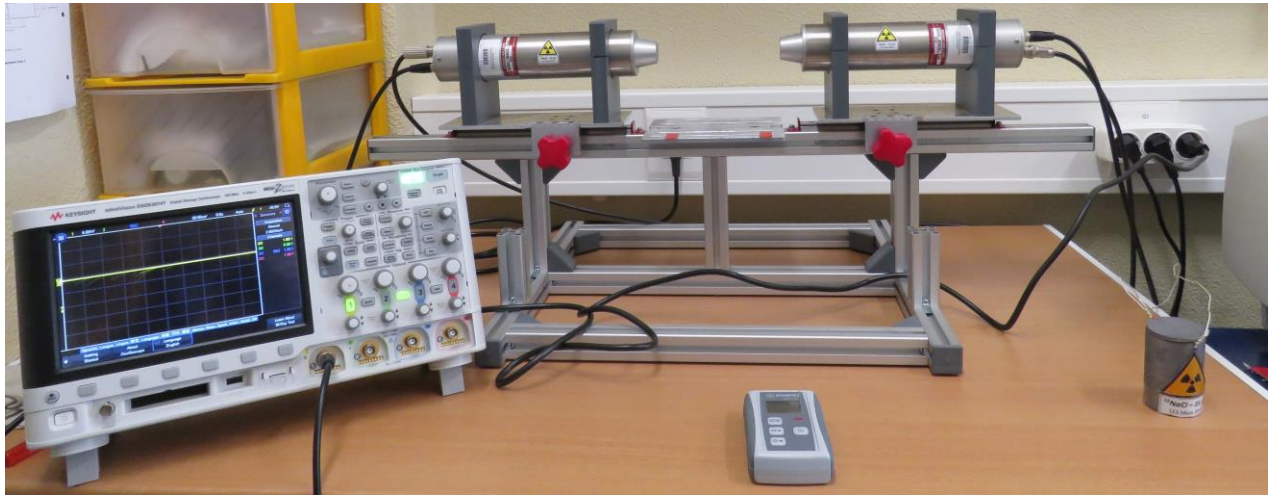
Objectives

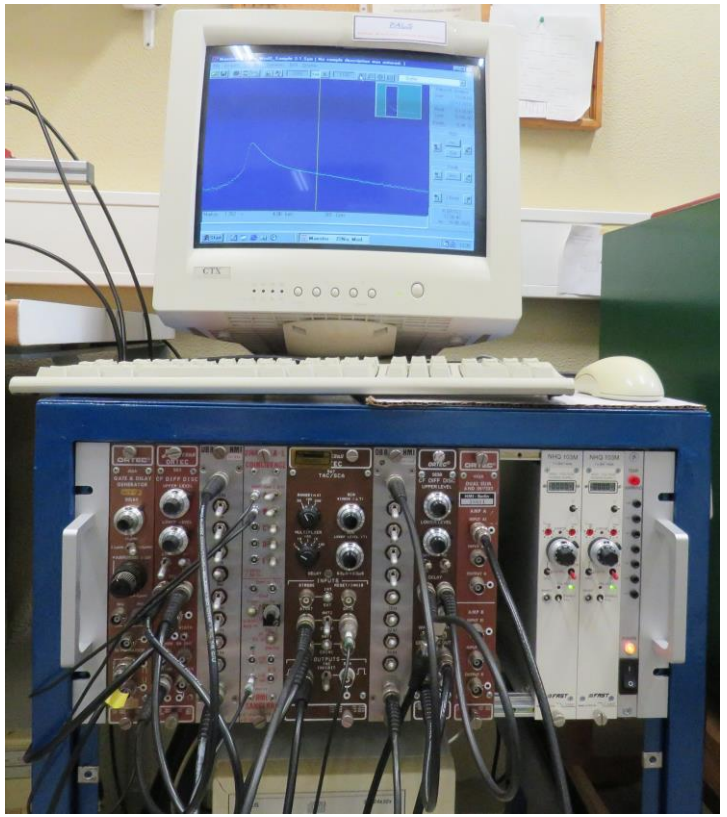
1^{st} Optimisation of a PALS spectrometer at the Centre for Nuclear Sciences and Technologies (C^2TN)

2^{nd} Application of the spectrometer to the study of the morphology and structure of a range of radiation processed polymer-based and hybrid materials, developed by the Radiation, Elements and Isotopes Group

PALS technique

- To perform a PALS analysis, it's necessary to have:
  - A source of positrons;
  - An experimental setup, for the detection of the positrons' lifetimes;

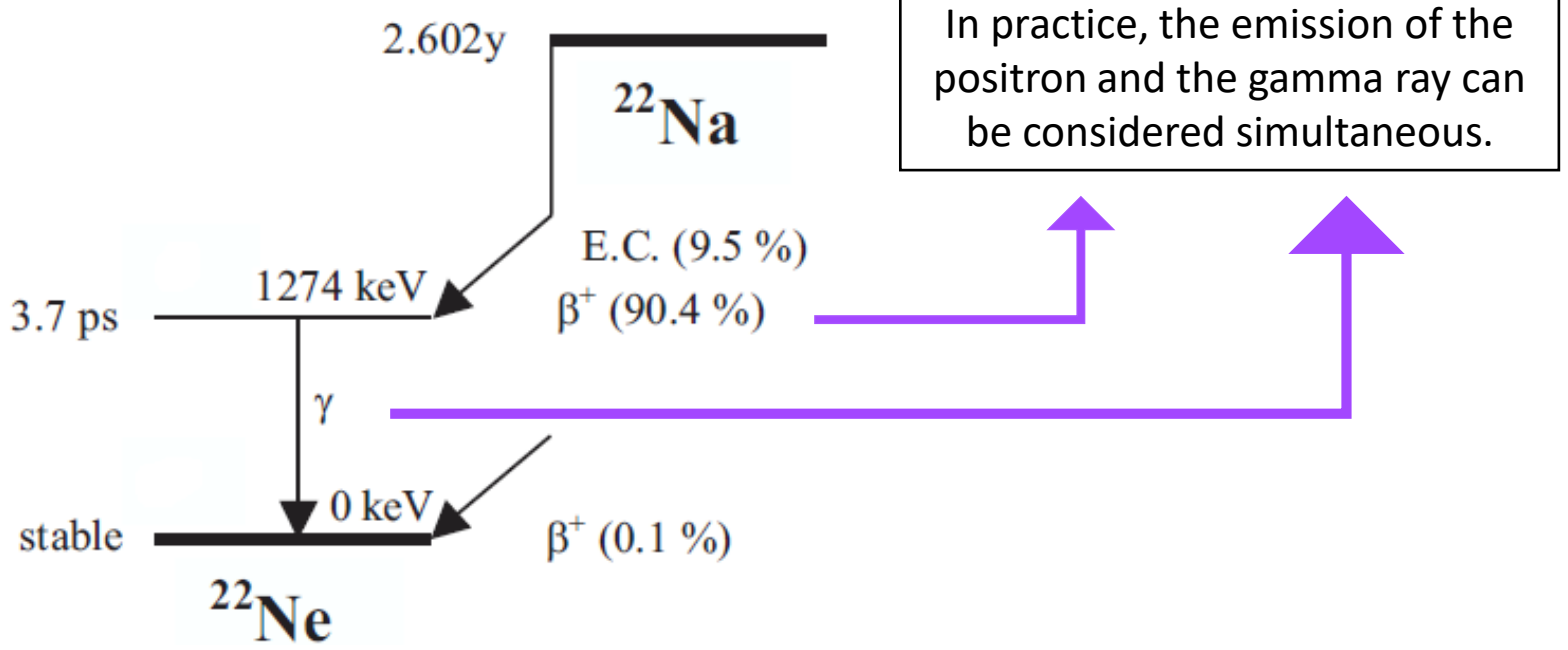




Positrons source

- In this work, a ^{22}Na radioactive source will be used as the positrons source. It is easy to handle and substitute and has a suitable half-life.

- ^{22}Na decay scheme:



In practice, the emission of the positron and the gamma ray can be considered simultaneous.

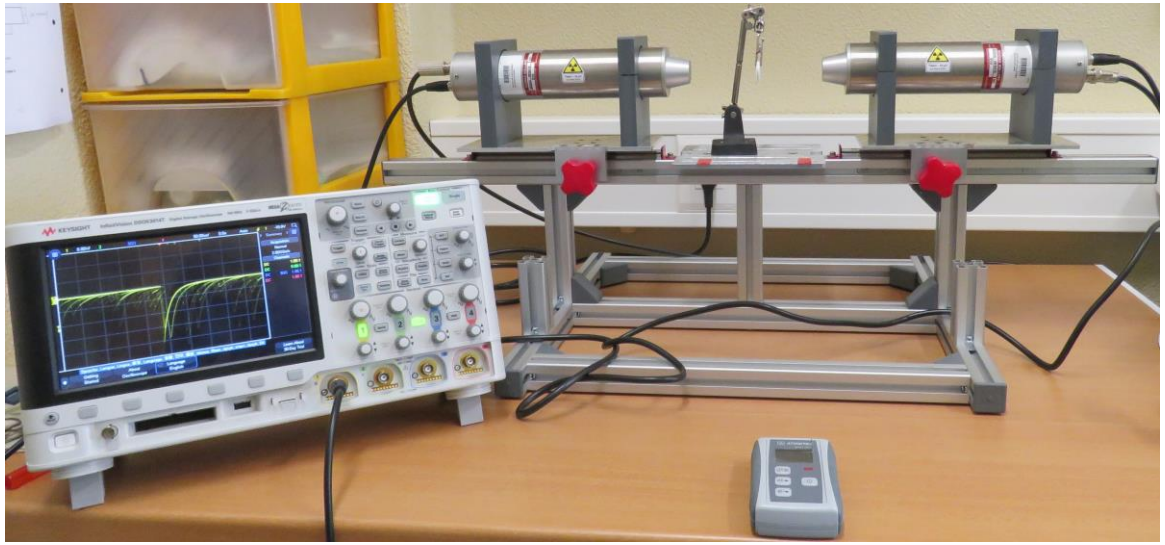
Adapted from [1]

Experimental setup

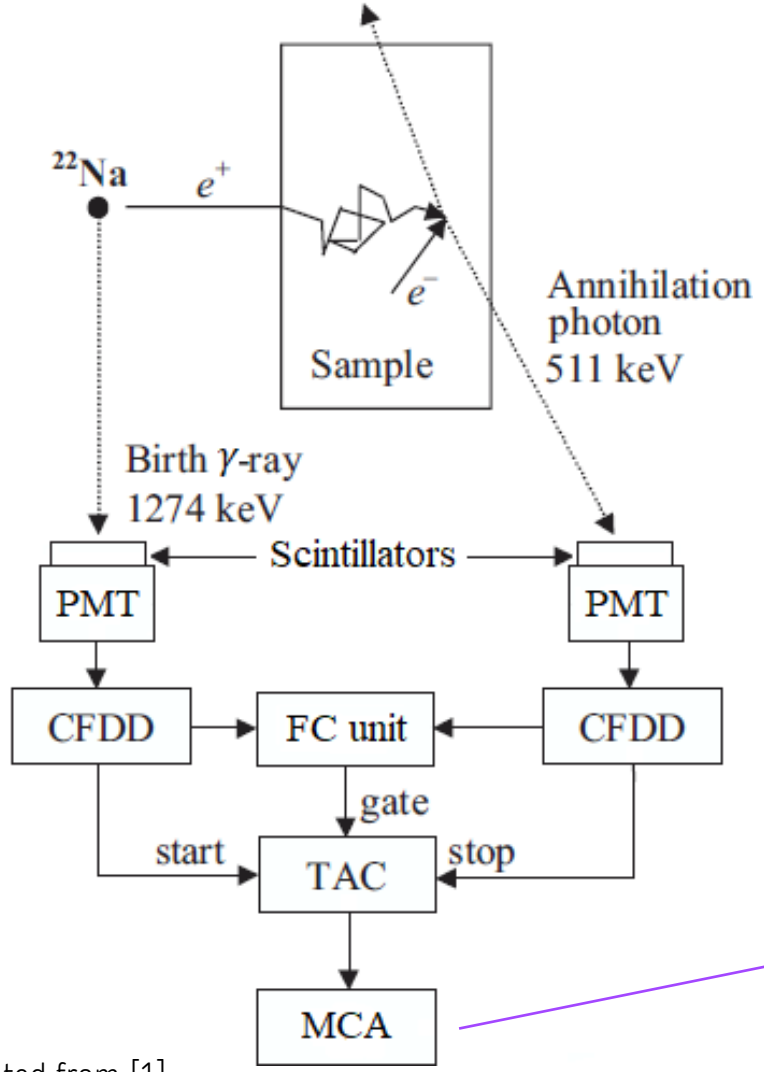
- The two fast scintillators detect

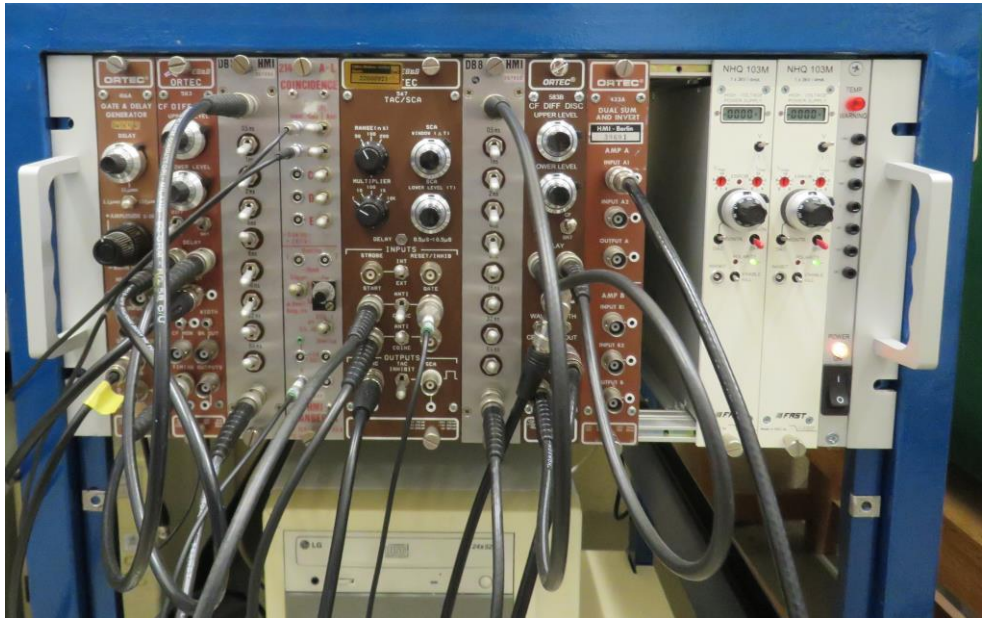
Start signal	Stop signal
↓ corresponds to	↓ corresponds to
Detection of the 1.274 MeV γ-ray from the de-excitation of ^{22}Ne	Detection of a 511 keV γ-ray resultant from an annihilation
↓ associated with	↓ associated with
Implantation of the positron into the material	Positron annihilation in the material

The time difference between the two signals gives the ***positron lifetime***.



Experimental setup





Positron lifetime spectrum: number of annihilation events of the implanted positrons versus their lifetime.

Adapted from [1]

References

[1] I. Procházka. “Positron annihilation spectroscopy”. Materials Structure 8.2 (2001), pp. 55–60.