The oPS measurement in Double Chooz

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The aim of the Double Chooz experiment is to measure the neutrino mixing angle theta-13 by detecting the reactor electron anti-neutrino via inverse beta decay. The positron-neutron delayed coincidence yields sizeable background suppression; a further contribution might come from the development of techniques for an efficient identification of positrons. Pulse shape discrimination, a well-established technique for background rejection in liquid scintillator detectors, fails in separating positrons from electrons, as they give rise to identical light pulses. However, in some cases the positron decay is delayed by the formation of a positron-electron metastable bound state, called ortho-positronium (o-Ps), which introduces a delay between the light signal from the positron energy deposition in the scintillator and the one from the annihilation gammas. The consequent deformation in the positron-induced light pulse can be exploited to identify positrons with the pulse shape discrimination, as already successfully done statistically in Borexino.
In Double Chooz, we performed the first o-Ps formation tagging on an event-by-event basis. We also measured the o-Ps formation probability and its lifetime, finding (44+/-13)% and (3.68+/-0.23)ns respectively. These values are in good agreement with independent measurements obtained with a dedicated setup.