Search for the third 1^+ state of ^{30}Al

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The zone known as “Island of Inversion” is a region in the chart of nuclides near the shell closure N=20 and Z around 12. In this region the neutron shell structure is inverted and the configuration of the *sd* shell is replaced by the *pf* shell as the ground state configuration. Since its discovery in 1975 it has been studied to find out its borders and the microscopic origin of the phenomenon.

In the IS414 experiment we have explored the neutron rich nuclides in the “Island of Inversion” populated by beta decay from ^{30,31,32}Na in the ISOLDE facility, at CERN, Geneva. We employed gamma spectroscopy and the coincidences technique fast-timing to measure the half lives of excited states. With this experiment we were able to study nuclides that belong to the island and its borders, as well as some further nuclides like ^{30}Al that can provide information in the evolution of the neutron configuration from the “Valley of Stability” to the “Island of Inversion”.

In this study the was populated by beta decay from , produced by bombarding a thick target of 45 g/cm^2 UC_x at 2100 ºC with 1.4 GeV protons from the PSB at CERN. The reaction products were positive ioniced and the isotopes with mass A = 30 were separated by a dipole and implanted in an aluminum foil in the center of the measuring device. Here we had 5 detectors: a beta plastic scintillator NE111A and four gamma detectors perpendicular between them and the beam line. There were two BaF_2 crystals with fast timing response and two HPGe with high energy resolution.

The data was acquired simultaneously in an analog system optimized for fast-timing and a digital one optimized for the selection of time window connected with the impact of the proton pulses with the target. Due to the difference in half lives between ^{30}Al ($T_{1/2}$=3.6 s) and their parents ^{30}Mg ($T_{1/2}$=335 ms) and ^{30}Na ($T_{1/2}$=48 ms) we were able to select a time window in order to optimize the photopeaks intensity in the ^{30}Al HPGe spectrum. This has allowed us to do a coincidence study with the previous known transition in the nuclide. With this technique we have elaborated a new level scheme with new levels and transitions in addition to a higher energy accuracy than in previous works. Moreover, the half live of the first three lower energy levels has been measured for the first time. With this information we have identified two possible candidates for a third 1^+ state.