The AX-PET Demonstrator: Performance and first results

The AX-PET project is to build and test a demonstrator for a high resolution, high sensitivity PET (Positron Emission Tomography) scanner.

A novel geometrical arrangement of long axially oriented LYSO scintillating crystals, interleaved by arrays of wave length shifter strips (WLS) orthogonal to the crystals, allows a precise 3D identification of the photon interaction point. This is valid both for photoelectric absorption at 511 keV and for Compton scattering down to deposited energies of about 100 keV.

Crystals (3 × 3 × 100 mm$^3$ each) and WLS strips (0.9 × 40 × 3 mm$^3$ each) are individually readout using MPPCs (from Hamamatsu) as photo-detectors. Their insensitivity to magnetic fields allows possible future combination of the proposed PET with MRI.

Two AX-PET modules (48 LYSO crystals and 156 WLS each, arranged in 6 layers) have been built and fully characterized in dedicated test setups at CERN, with point-like $^{22}$Na sources. Their performance in terms of energy and spatial resolution has been assessed, both individually and for the two modules used in coincidence ($\text{R}_{\text{FWHM}} \sim 11.6\%$ at 511 keV; $\sigma_{\text{axial}} \sim 0.65$ mm).

Detailed Monte Carlo (MC) simulations of the detector have been developed, based on GEANT4 and GATE simulation packages. An excellent agreement between data and MC is achieved. A dedicated image reconstruction software has also been developed and tested, using both simulated and real data ($^{22}$Na sources). According to simulations, up to 70% of the Compton interactions could be included in the reconstruction, significantly improving the sensitivity of the scanner.

The two modules are mounted on a gantry, allowing for various geometrical arrangements. A rotating source holder is placed at the center of the gantry between the modules. Starting from May 2010, this setup will be used for measurements with phantoms filled with radiotracers, at the ETH Institute for Radio-pharmaceutical Science in Zurich.

The AX-PET detector performance, together with the very first results from the modules used with phantoms, will be presented.