Charged-particle detection devices in present and forthcoming nuclear physics experiments

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Detection of charged particle delivers essential information in most nuclear physics experiments. Both in decay and reaction measurements, this type of radiation is extensively used for identification of the exit channel ("tagging") and more quantitative energy measurements.

With the advent of radioactive ion beams, detection efficiency has become a key aspect of charged-particle detection. Large-surface arrays of solid-state detectors have been employed to ensure a good angular coverage. In reaction studies, the characteristics of collisions in inverse kinematics also require a fine position resolution of the detected particles. This has been mostly achieved by using segmented or position-sensitive detection elements. Important results in decay and reaction studies have been obtained by a number of such devices at different facilities in the world, and we will briefly review some of those.

A new generation of charged-particle detection devices is now being designed and tested, to be used at the forthcoming radioactive ion beams facilities which are being built worldwide. From an early stage, the new arrays were designed to be coupled to other devices – γ-ray, neutron arrays, spectrometers – to optimise detection efficiency. New developments in solid-state devices concern especially particle identification through pulse-shape analysis.

Parallel to solid-state devices, gaseous detectors have been mostly employed in specific applications such as beam diagnostics and as detection stages in spectrometers. In the last ten years, however, the concept of a gaseous "active target" has been successfully applied to nuclear structure studies. These devices provide a full reconstruction of the particle trajectories, allowing the use of a large target thickness without compromising on the energy resolution.

The new-generation setups face common challenges: the collection of a large number of parameters from a contained space, and the high dynamic range of the physics signals. This has led to the development of dedicated front-end electronics systems, which are now integrated parts of the design of the new devices.