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## Development of scintillation detectors for nuclear physics research

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The Nuclear Innovation Unit at CIEMAT covers a broad scientific program on neutron-induced reaction cross-section measurements (capture, fission, activation and charged particle production),  $\beta$ -delayed neutron emission,  $(\alpha, n)$  reaction studies, and is also involved in applications such as the characterization of nuclear waste and neutron dosimetry.

We have developed over the years several kinds of detectors based mainly on scintillators. In the field of neutron detection and spectroscopy, we have designed and built the liquid scintillator-based MODular Neutron time-of-flight SpectromETER (MONSTER) for decay and reaction studies.

CIEMAT has contributed actively to the development of new detectors for the world-leading n\_TOF facility at CERN, particularly in the field of  $\gamma$ -ray detectors. In this context, CIEMAT has designed and constructed the sTED, a liquid scintillator detector optimized for the high counting rates of n\_TOF EAR2. This detector has been fully operational with 9 modules since 2022 and has been used in more than 10 neutron capture cross-section measurements. More recently, in 2025, 18 additional modules were added with MRR funding, increasing the detection efficiency by a factor of three. The new sTED configuration has been commissioned and is ready to be used at n\_TOF. In addition, further  $\gamma$ -ray detectors (LaBr<sub>3</sub>, EJ315 and Clover HPGe) have been acquired with MRR funding and will be commissioned in the coming months.

The experience acquired in  $\gamma$ -ray calorimetry with inorganic scintillators is currently being applied in a research project with the nuclear industry, for the construction of a high-performance low and intermediate-level waste characterization system.

Finally, detection systems based on <sup>3</sup>He and CLYC have been developed for neutron measurements in various environments such as underground laboratories, proton therapy facilities, and nuclear waste repositories. Extensive R&D has been made for applications of CLYC scintillators, for combined neutron and  $\gamma$ -ray dosimetry. In this talk, we will present technical details on the R&D carried out and some ongoing activities in scintillation detector developments.

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