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Third generation Nuclear Physics instruments with MPGD gas technology

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Spectroscopy of nuclei far from stability and astrophysics studies are of major interests in a number of nuclear physics laboratories. In view of limiting beam intensities and the low energy multi-particle emission, (examples: n+12C = 3a (Ref 1), 14N(paaa) Ref 2 or 20Mg(βpα) Ref 3), the instrumentation calls for gas detection medium with a 4p solid angular cover and precise tracking capacities. As a result, TPCs devices are widely deployed in nuclear laboratories. Nevertheless, some difficult issues have yet to be resolved. Specifically, beams entering the reaction corridor in the gas volume have dE/dx which are considerably larger than reaction other products to be tracked. This leads to a very large dynamic ranges which rapidly reaches the sparking levels at amplification zone. Other issues like gas mixtures for active targets are present. We will present third generation instruments which are being developed (TeBAT (Texas A&M) , GADGET2(FRIB USA), PUMA(TUD Germany) , ATOM-X(IBS, N. Korea)). They attempt to reach very safe and stable operating conditions to measure full kinematic and particle ID of the reaction products for a wider range of incident beams. This on-going evolution is the outcome of experience gained with MPGD detectors over the years combined with recent developments in particle physics (resistive mircomegas, capacitive spreading, sectorised GEM with different gains) and very wide dynamic range micro-electronics. In this paper we will give a brief account of four developments and the present status for four instruments. TeBAT and ATOM-X are portable TPCs having Silicon/CsI auxiliary envelop to study a wide range of reaction and decay studies. GADGET2 is a novel TPC setup within a Ge 4p cover to investigation astrophysics via particle decay studies. PUMA-TPC/Barrel is the detection for a unique experiment to study anti-proton annihilate on exotic nuclei at CERN. 1. Nature Communications volume 13, Article N°: 2151 (2022) 2 J. Bishop et al., Publication in press 3. C. Wrede et al., accepted experiment at FRIB, US

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