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Mechanical design and integration at R3B-FAIR experiment

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The R3B experimental setup within the FAIR facility in Darmstadt (Germany), is designed to study Reactions with Relativistic Radioactive Beams. The aim of the R3B collaboration is to create a flexible setup that can accurately measure these reactions, with a focus on efficiency, wide coverage, and precise results, to better understand high-energy radioactive beam interactions. The group DSN in the University of Vigo has been actively involved in the mechanical design and integration of different elements of the R3B setup as well the overall R3B integration activities towards FAIR.

The R3B experimental set-up includes several detectors that are used in different configurations depending on the reaction to be studied. The main elements of R3B are the Neutron Large Area Neutron Detector (NeuLAND), the calorimeter for in-flight detection of gamma rays and high-energy charged particles (CALIFA), the GSI Large Acceptance Dipole (GLAD) and a set of dedicated tracking and Time-of-Flight (ToF) detectors primarily consisting of high-response scintillating fibers and silicon detectors.

Our group designed and installed the whole mechanical structure of CALIFA, holding more than 2 tons of CsI(Ta) crystals. The innermost structure of CALIFA uses thin-wall (0.27 mm) carbon fiber envelopes to hold the 2544 individual crystals in place. The 43 different sensor shapes are located in 24 envelope shapes. The project involved the design of the manufacturing process and the hand-made production of the 584 envelope parts, as well the assembly of the setup. A gantry-like structure with mobile platforms allows for splitting the detector and mounting operations.

Inside the reaction chamber, surrounded by CALIFA, we designed a structure to securely position different tracker silicon detectors around the target. This structure ensures accurate alignment of FOOT and ALPIDE detectors around foils or the liquid-H₂ targets, also providing movement, cooling and cable management through the flanges. The challenge is the compact design due to the limited volume and the many different components inside.

Our group collaborates with the detector-lab team developing new scintillator fiber detectors using the MPPC array Hamamatsu S13552. On the one hand, designing the cooling system for the electronics boards, a compact system to cool down the PCBs of the read-out electronics in vacuum. On the other hand, with the design of the first fibers-detector based on this technology for tracking close to the GLAD magnetic field.

At this moment we are designing tracking detectors for the proton arm spectrometer (PAS) based 0.5mm scintillating fibers coupled to Hamamatsu S13552 MPPCs. PAS will serve as a primary R3B detector system just behind the GLAD dipole, tracking protons and light charged particles. PAS comprises three detection planes covering about 2.5m x 1m, making it the largest Sci-Fi detector in R3B and a challenging mechanical design due to the fibers sizes and the modularity desired.

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