The mechanical design of the BARREL section of the detector CALIFA*

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The detector CALIFA (CALorimeter for the In Flight detection of gamma-rays and light charged pArticles) is one of the key detectors of the R3B experiment of FAIR. CALIFA will feature a high photon detection efficiency and good energy resolution even for beam energies approaching 1 AGeV, as well as the required calorimetric properties for detection of multiple gamma-ray cascades. For the detection of protons in coincidence, both the crystal length and the passive materials must be optimized.

CALIFA consists of two sections, a Forward EndCap and a cylindrical Barrel. The optimum cost-effective solution for the BARREL, covering an angular range from 43 to 140 degrees, is based on CsI(Tl) crystals. The BARREL will consist of almost 2000 crystals providing the angular resolution necessary to correct for the Doppler shift of the gammas emitted in-flight by the reaction products. The engineering design was aided with mechanical calculations using finite elements analysis with ANSYS and physics simulations with GEANT4. The design optimization was focused in the segmentation of crystals (increasing the segmentation helps for the energy resolution, but limits the calorimetric properties), and the amount of structural materials (with the motto 'the less, the better' to minimize the proton energy losses in the passive material).

The engineering design solution proposed for the core of the BARREL is based in a honeycomb-like structure made of epoxy based **carbon fiber composites**. The calculations performed confirm that such structure would conform the active region demands for physics, as well as the structural needs to support and tightly hold the many crystal units. The amount of passive (structural) material is **less than 0.7%** of the total mass of the whole active region.

The overall design conditions imposed by the project for the active core include: i/ a robust and safe structure; ii/ a minimum of structural material; and iii/ a tight definition of the static positioning and orientation of the active elements.

The CsI(Tl) crystals must be kept in a dry atmosphere. Moreover, the response of the crystal + photosensor (APD) is temperature dependent. To cope with the resolution requirements the active volume will be filled with nitrogen renewed in a closed loop at controlled temperature. That will be accomplished by means of a modular cover of the BARREL which is a key part of the external structure of the detector, that holds too the electronic front-end modules.

The standing structure, based in a gantry-like solution with moving platforms, must support the active core, allowing for the partition of the system in two autonomous symmetric halves, and the possibility to make a longitudinal shift between the halves to allow for a clearance of the forward angles, as well as helping in the setup of the Forward EndCap.

The TDR was approved by the end of 2012. The construction of the BARREL will start in 2013, with the so called DEMONSTRATOR, a structure based in CALIFA mechanical design solutions, covering 20% of the detector active elements, and ready for physics experiments in 2014 at GSI.

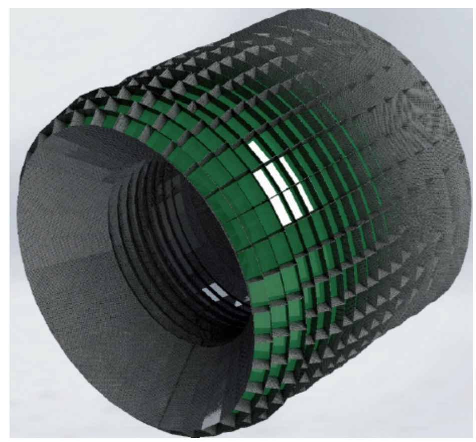

Figure 1: View of the active region of the BARREL. With almost 2000 crystals tightened by a honeycomb-like structure made of CF composites, it contributes to less than 0.7% of the mass.

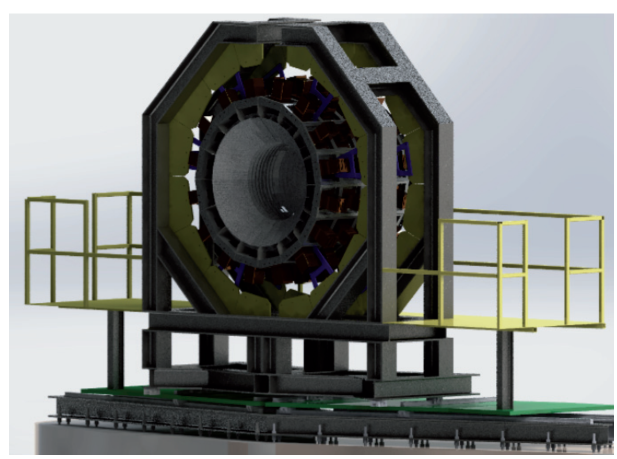

Figure 2: View of the external structure which allows for the splitting and longitudinal shifting of the active region. It also supports all the associated electronic modules.

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