3.2.1 Estimation of entrance window deformation

The entrance window design is of special importance as it has to withstand two mutual contradictory requirements: it should be thin to transmit the TR photons produced in the radiator but robust enough to maintain the planarity of the chamber against the pull of the wires during the assembly. The most critical moment for the entrance window deformation is after the cathode wire installation. The supporting structure, on which the 180 $CuBe$ cathode wires of 80 μm diameter are glued, is composed of the entrance window (Fig. 3.2.2 a) on which two ledges are added, the "cathode ledge" and two pushing "chamber wall" ledges (see Tab. 3.2.1). Each wire is tensioned to 100 cN.

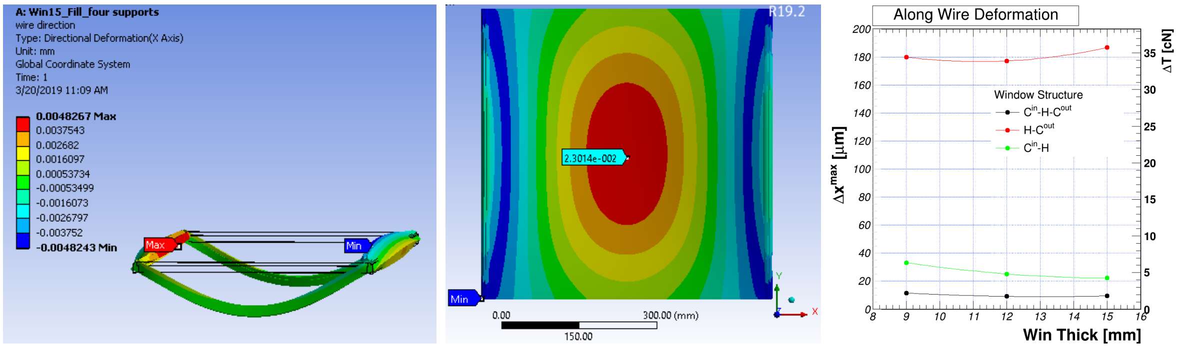

Figure 3.2.3: Deformation of the ROC ledges (left) and the entrance window (middle) induced by the cathode wires pull when glued to the frame and a summary of frame deformation (right) for different entrance window structures according to figure legend.

In Fig. 3.2.3 the color code encrypts the value of the deformation of the ledges parallel to the wires (left) and of the "drift plane" perpendicular to it (middle). The values are given in mm and the maximum values are on the level of 2×5 μm for the ledges and 23 μm for the drift electrode. In order to optimize the entrance window design a set of nine structures were tested for three HC thicknesses of 9, 12 and 15 mm and three structures with two or one carbon planes towards the drift plane ("in") or/and radiator ("out") according to the figure legend (see Fig. 3.2.3 right). As it can be seen from the figure there is little variation for different thicknesses of one window structure but a major difference between the $HC - C^{out}$ and the default $C^{in} - HC - C^{out}$ sandwich. A compromise solution from the structural stability of the chamber which renders the minimum absorption is $C^{in} - HC$. For a HC thickness of 9 mm a contraction of the chamber along the wires of 30 μm is estimated and a maximum deviation from nominal tension on the cathodes of 7 cN[15]. Such deviations are within the specifications as derived from previous experiences (see production of ALICE TRD). The implications of this strategy on the absorption of the TR photons will be followed elsewhere (see section 5.3.2).

3.2.2 Inner wall integration

In the TRD TDR, a concept of independent units attachment procedure to a monolithic support structure is proposed for the mechanical integration of the modules. Obviously such a compact and modular design optimizes the installation and maintenance of the TRD system as it skips an intermediate integration step (e.g. super-module). Additionally to the general support structure concept, for the inner part of the wall, where particle fluxes are the highest, the secondary particle production in the passive material becomes an issue, for the TRD system itself but also

[15] The deformation of the entrance window with pressure variation during detector operation, of a dynamical nature, was not quantified for the TRD-2D prototype. On the other hand the gas system (see section 3.5) is tuned for the TDR version of the TRD having stronger requests in this respect. Therefore we assume for the TRD-2D a negligible effect.

for downstream systems. It makes sense to look for concepts which rather optimize the material budget. The TRD-2D ROC was designed based on this optimization criteria as sketched in Fig. 3.2.4.

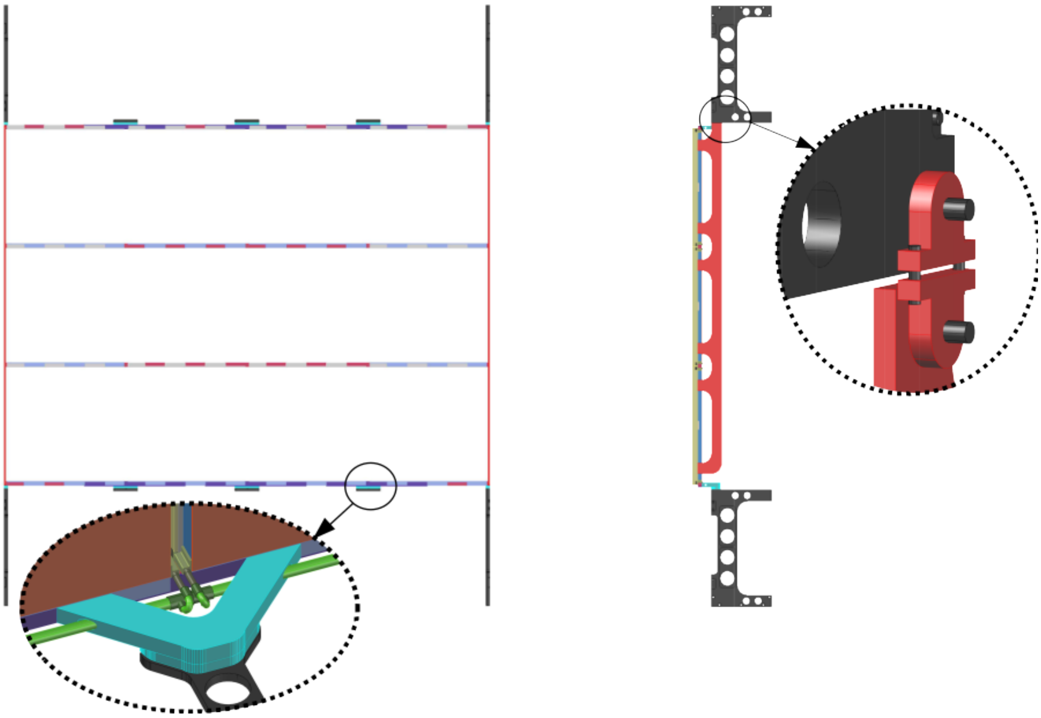

Figure 3.2.4: The supporting structure of ten TRD-2D ROCs for integration in a *super inner-module* by horizontal $FR4$ crossbeams coated with 2 mm thick Al profile with a detail of one bottom support (left plot) and the lateral reinforcement with a detail on the connection lock (right plot).

The Al profiles mounted on two chamber edges (see Fig. 3.2.1) are used to interlock a ROC with an upper and bottom neighbors in a stack structure. A guiding FR4 crossbeam is inserted horizontally between rows of chambers to stabilize the structure. To keep the planarity of the structure, thin Al profiles are inserted as vertical poles, between columns of chambers, locking the FR4 crossbeams on a plane. The assembly works as a brick wall with the back-panel structures of the TRD-2D ROC used to transport the weight from the upper chambers to a support. A reduction of the material budget in the inner regions of the TRD wall from 75.8 $kg/layer$ Al [49] to 11.7 $kg/layer$ Al and 4.3 $kg/layer$ FR4 is thus obtained, with implications to be quantified in secondary particle production[16].

As a consequence of the introduction of the light TRD-2D structure, the original TRD wall support has to be modified such as the weight of the top chambers has to be transported to the outer frame through different paths. In Fig. 3.2.5 two versions of support structures are presented to recover the structural strength (proposed extra posts are marked in blue). In the left panel an intermediate wrt the TDR version is shown in which some structure is also found behind the TRD-2D modules. A material budget price tag of 22 $kg/layer$ is attached to it [50]. A more radical approach is presented in the right panel where, at the cost of approximately 370 $kg/layer$, an outer frame structure is imagined which pushes the material budget to regions of relatively low particles rates outside the sensitive area of the CBM experiment. Detailed simulation of the geometry and its implication on physics observables are in progress.

[16] Work in progress.

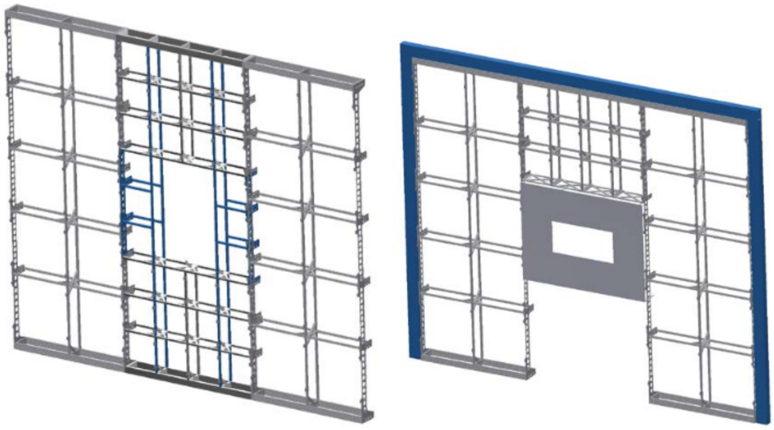

Figure 3.2.5: Two possible scenarios (see blue beams) proposed here [50] for reinforcing the central part of the TRD wall due to the new light structure in the present proposal.

3.2.3 Inner wall installation and maintenance

As discussed above, the optimization of the mechanical support structure of the inner wall had the consequence of imposing a special connection between all 10 ROCs from a layer. The structure thus formed is light and not self supporting. Therefore, we have to rely on additional structures for assembling it, transporting it to the experimental hall and inserting it in the TRD frame. For these operations we are proposing two devices: *the mounting frame* and *the mounting table*.

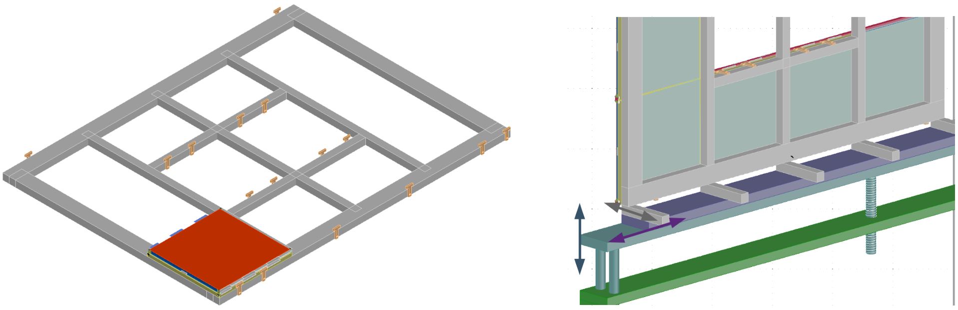

Figure 3.2.6: The mounting devices for installation and maintenance work of the TRD-2D system; *the mounting frame* (left) used to assemble and to position the inner supermodules structure outside the experimental setup and a detail of *the mounting table* (right) used to insert it in the TRD frame.

The mounting frame, sketched in Fig. 3.2.6 left, is a rigid structure, supporting one inner-supermodule, horizontally and vertically. It is used in the installation phase to precisely align the ROCs wrt each other, to transport them to the experimental hall and to insert them in the TRD frame. In the maintenance phase it is used to extract the inner supermodule from the frame and to transport it to the maintenance area.

The mounting table, shown in Fig. 3.2.6 right, is a device which can be attached to the TRD outer-frame and it offers three translations as it is suggested in the figure by the arrows. The device is used to hold the mounting frame in front of the TRD inner-frame and align it wrt a target and support it until the TRD-2D structure is secured in the inner-frame.

Since the installation/maintenance of the TRD-2D inner region has to be performed independent of the installation of the radiators for the outer ROCs, the only possibility is to insert it from the front of the wall. This extra requirement implies that the total outer frame has to be enlarged by $\approx 120\ cm$ to allow for a larger opening of the inner frame and a full exposure of the