ECal/MPD
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MPD NICA

Technical Design Report
of the
Electromagnetic calorimeter (ECal)

Dubna 2017

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2.3 New geometry – projective

Studies of the calorimeter (MC and beam tests) showed that the initially selected geometry of the calorimeter has an unpleasant feature - the increase in the number of hits at large angles of incidence of the particles. Moreover, the part of the hits which are separated from the main shower and thus not included in the total energy deposition in the shower are also increases . This leads to a reduction of the total energy of hits collected in the cluster. Therefore, when the particle incidence angle is increased reconstructed energyis decreased.

Two different geometry was studied – no projective geometry for the modules orientation(Fig. 2.3.1) and projective geometry (Fig. 2.3.2).

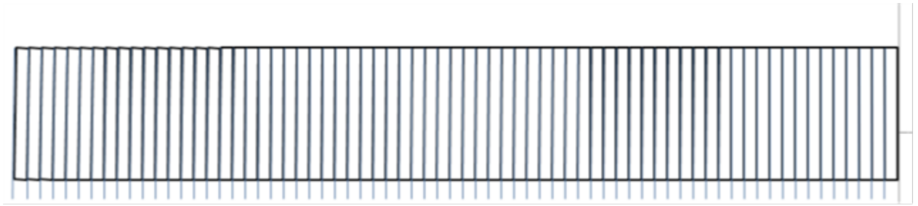


Figure 2.3.1: *View of the some modules of the non projective geometry in the Z plane.*

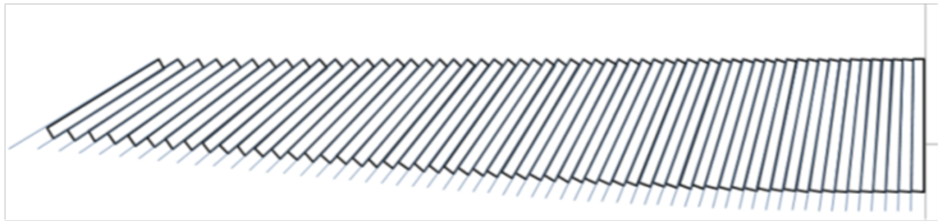


Figure 2.3.2: *View of the some modules of the projective geometry in the Z plane.*

The found effect is particularly significant for low-energy particles which dominate at MPD energies.

MC study.

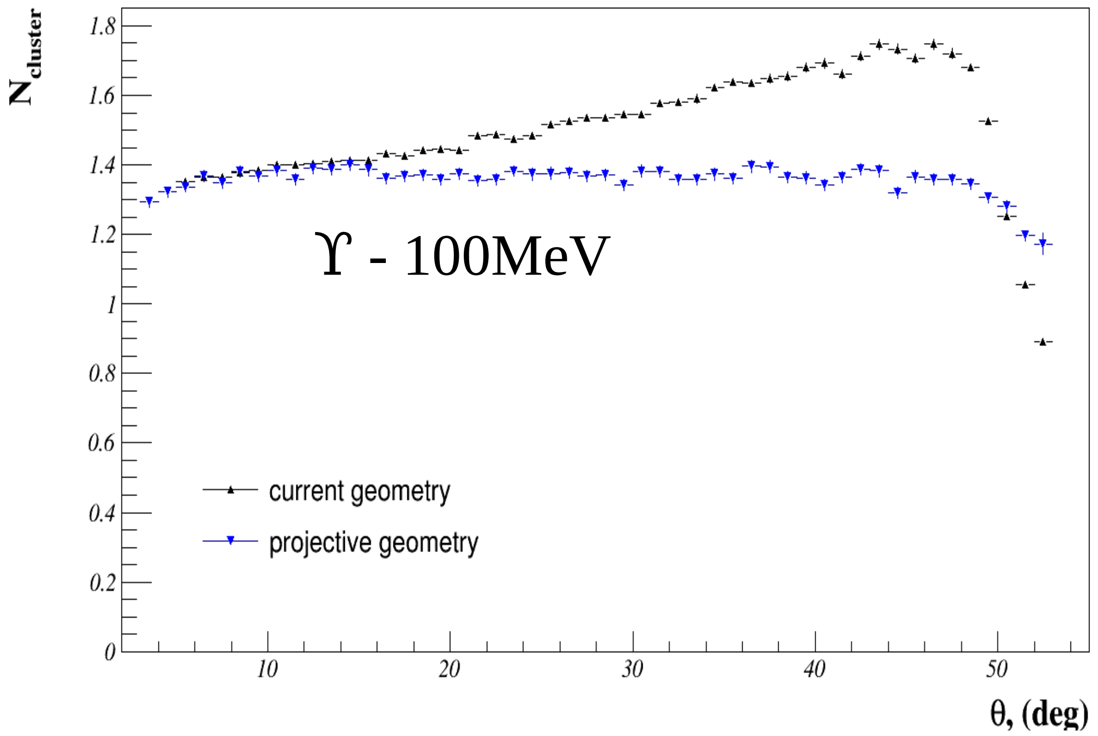


Figure 2.3.3: *Distribution of the number of clusters vs angle θ (Photons beam with energy 100MeV).*

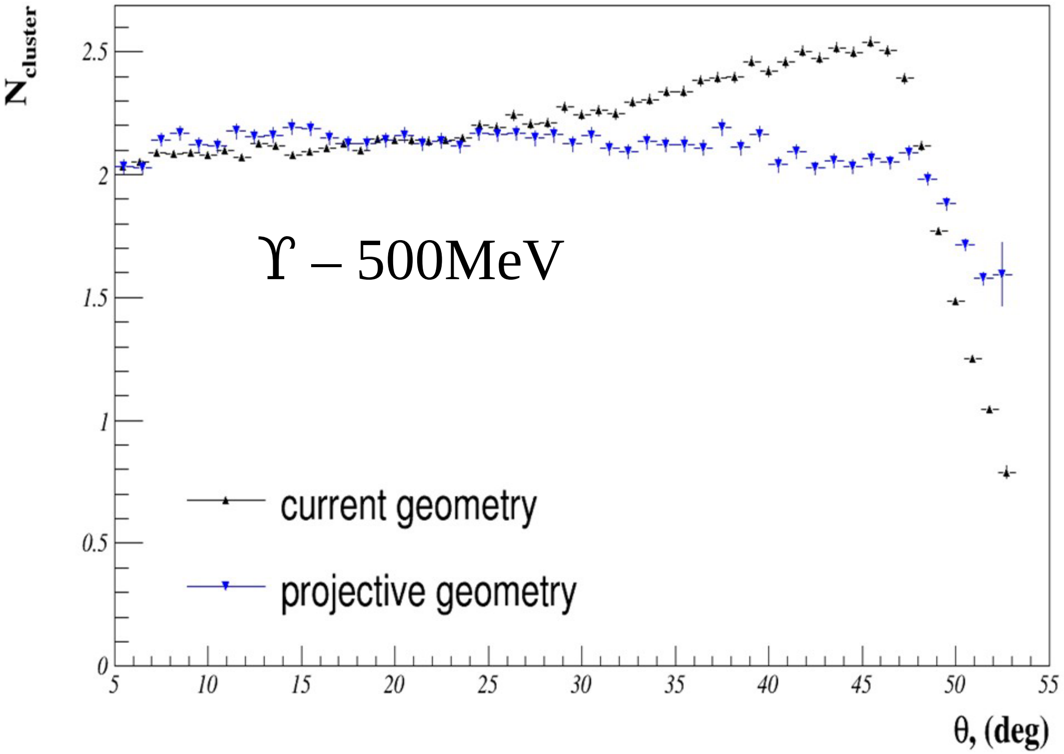


Figure 2.3.4: *Distribution of the number of clusters vs angle θ (Photons beam with energy 500MeV).*

The proposed projective geometry completely removes the angular dependence of the characteristics of the calorimeter

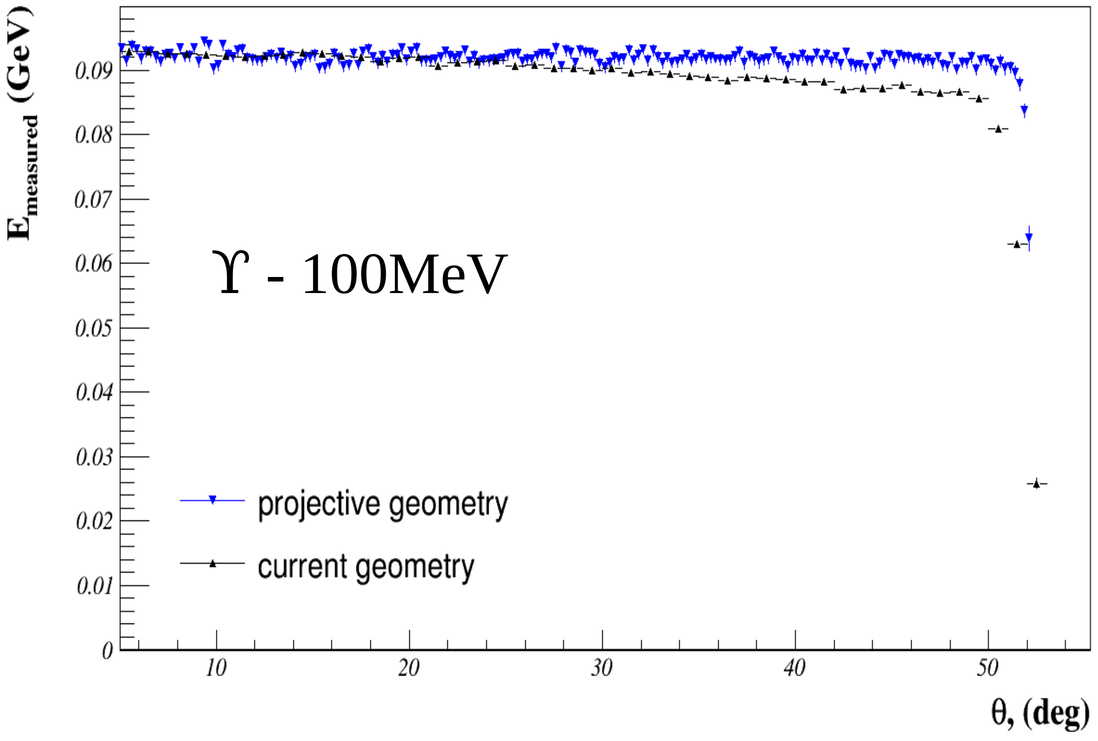


Figure 2.3.5: *Distribution of the energy measured of vs angle θ (Photons beam with energy 100MeV).*

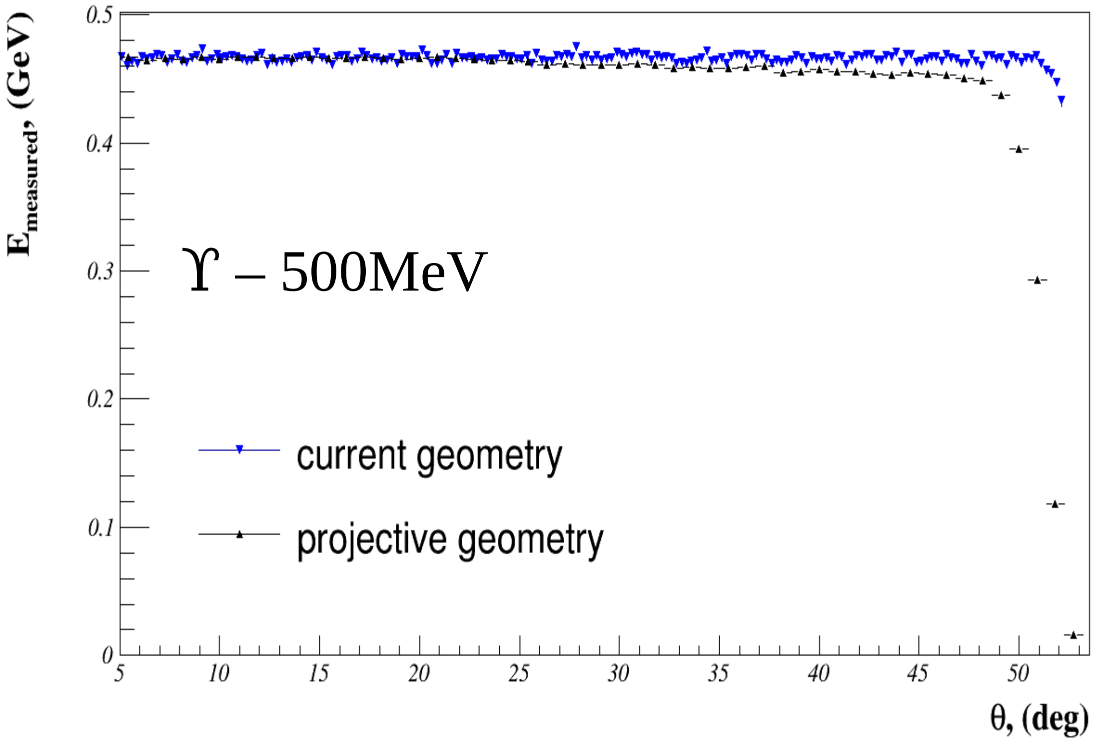


Figure 2.3.6: *Distribution of the energy measured of vs angle θ (Photons beam with energy 500MeV).*

The efficiency of detection of photons and electrons were evaluated using MC. Particles considered as a reconstructed if their energy and the coordinate of differ from the generated no more than a predetermined value. Typically this value was fixed at the level 2 σ

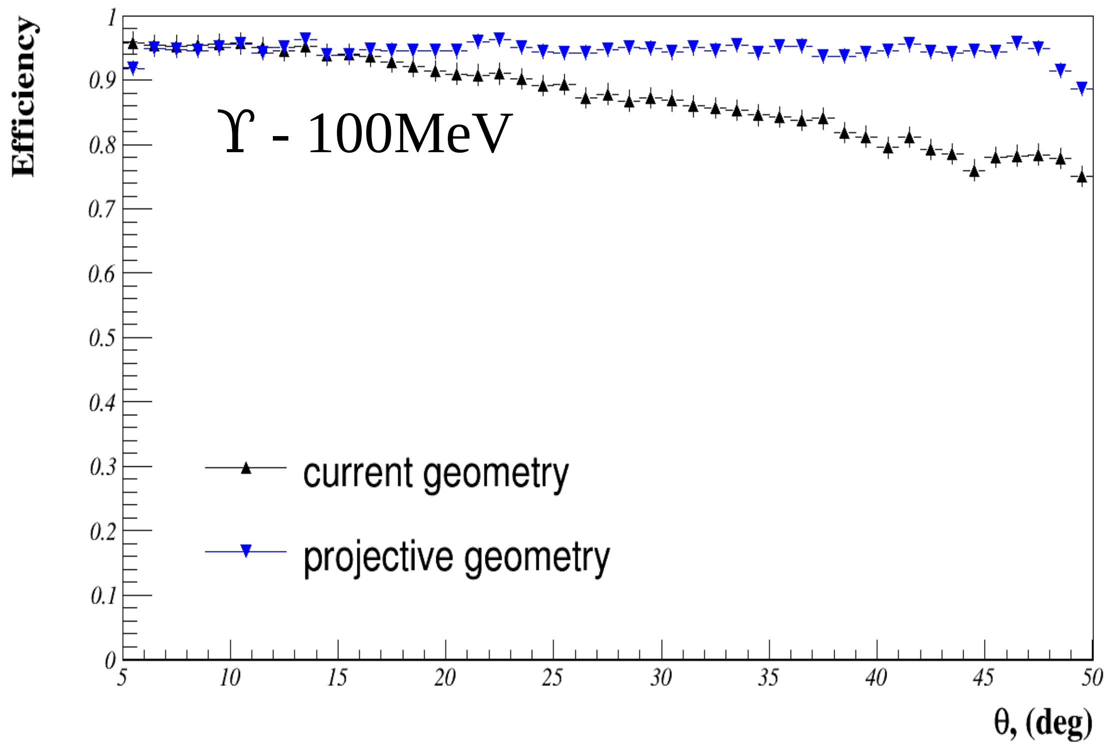


Figure 2.3.7: *Distribution of the efficiency of vs angle θ (Photons beam with energy 100MeV).*

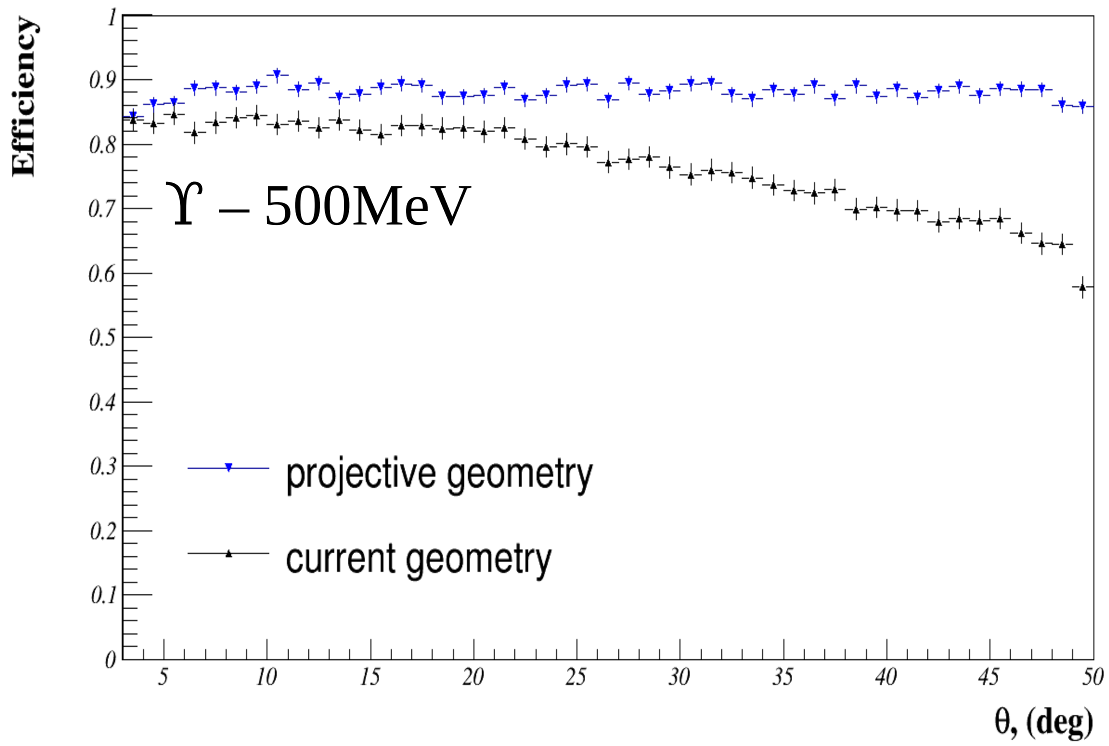


Figure 2.3.8: *Distribution of the efficiency of vs angle θ (Photons beam with energy 500MeV).*

Obviously, this affect not only affects the efficiency of detection of particles,

but also on the energy resolution of the calorimeter.

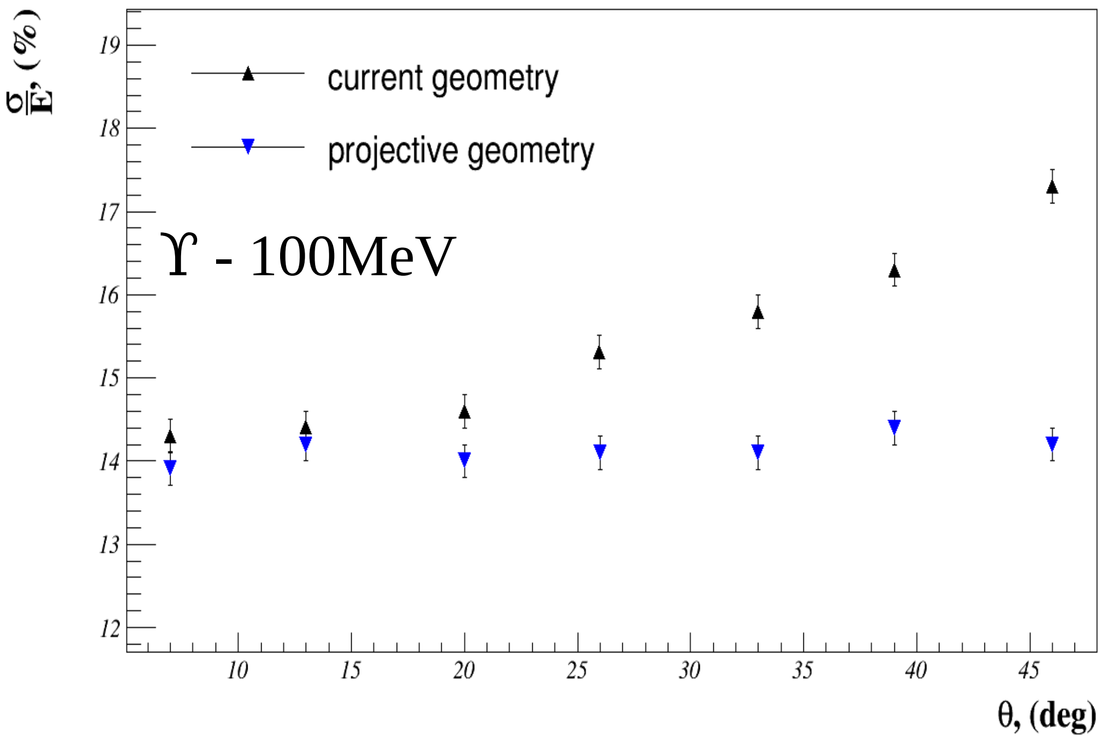


Figure 2.3.9: Distribution of the energy resolution of vs angle θ (Photons beam with energy 100MeV).

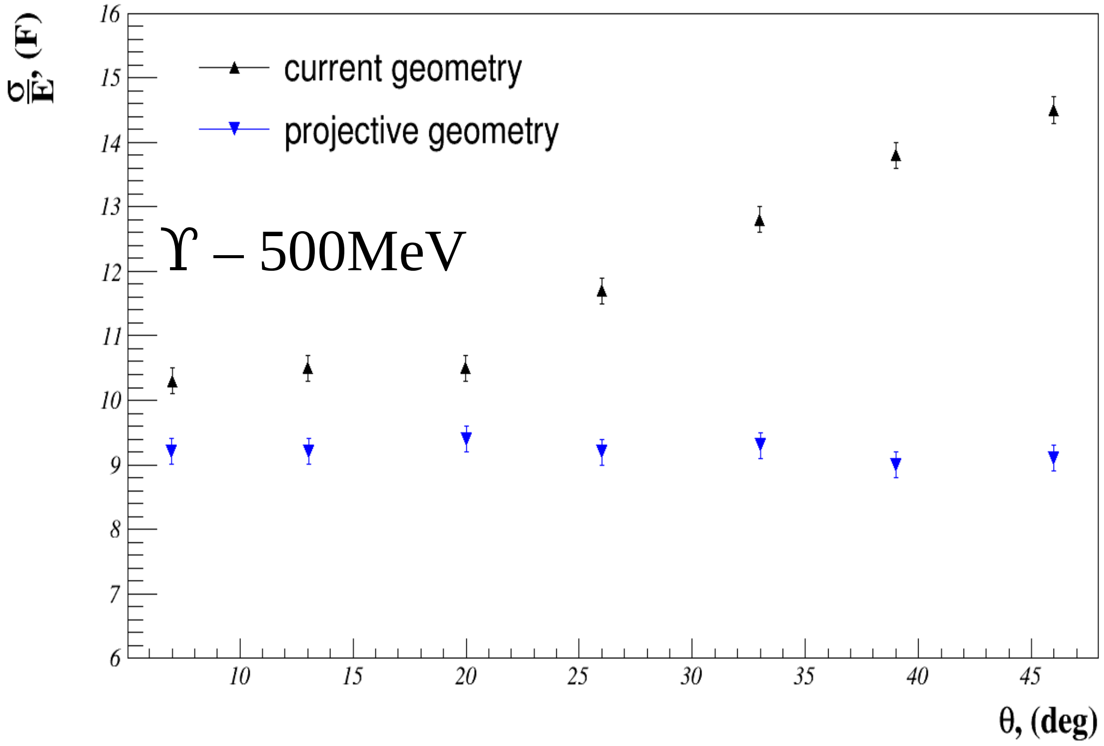


Figure 2.3.10: Distribution of the energy resolution of vs angle θ (Photons beam with energy 500MeV).

5 Projective geometry

5.1 Fundamentals of the Design of the ECal

The change of the calorimeter design to the with a projective arrangement of the modules (Fig. 5.1.1 and Fig. 5.2.2) led to several important consequences. Improving the performance of the calorimeter, the emergence of additional stiffening elements in the form of a honeycomb, the possibility of placing additional components on the edges of the sectors. There is a need to make some changes in the module design, redesign readout electronics.

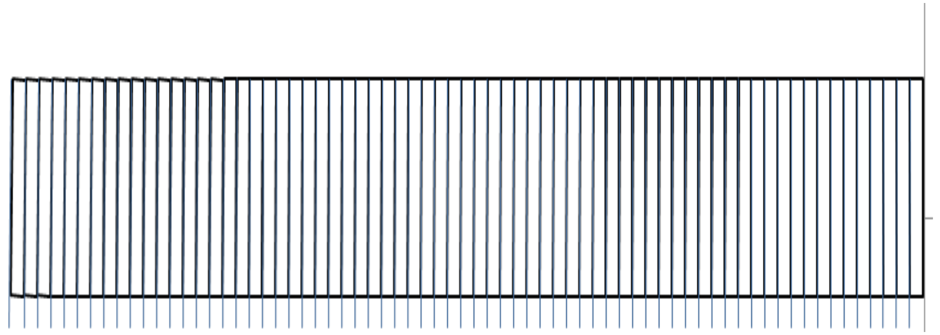


Figure 5.1.1: *Z plane of the non projective geometry.*

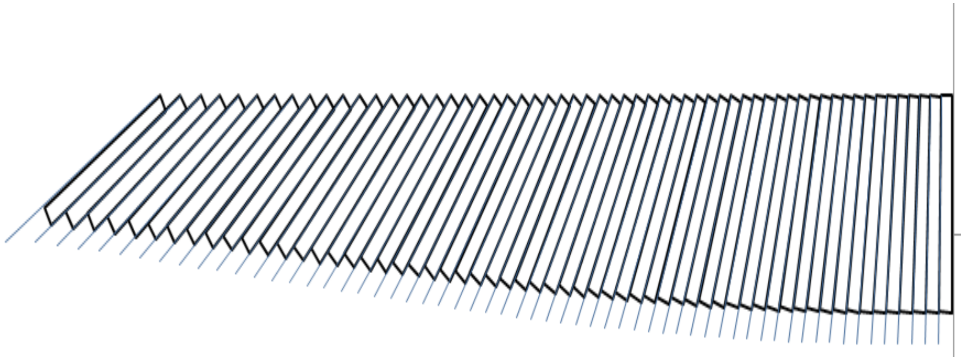


Figure 5.1.2: *Z plane of the projective geometry.*

Calculations have been made on the choice of the angle of inclination for the modules. The aim of the calculations is to select a single for all modules tilt angle at which the deviation of the aiming point from the center of the MPD will be minimal (Fig. 5.1.3 and Fig. 5.1.4).

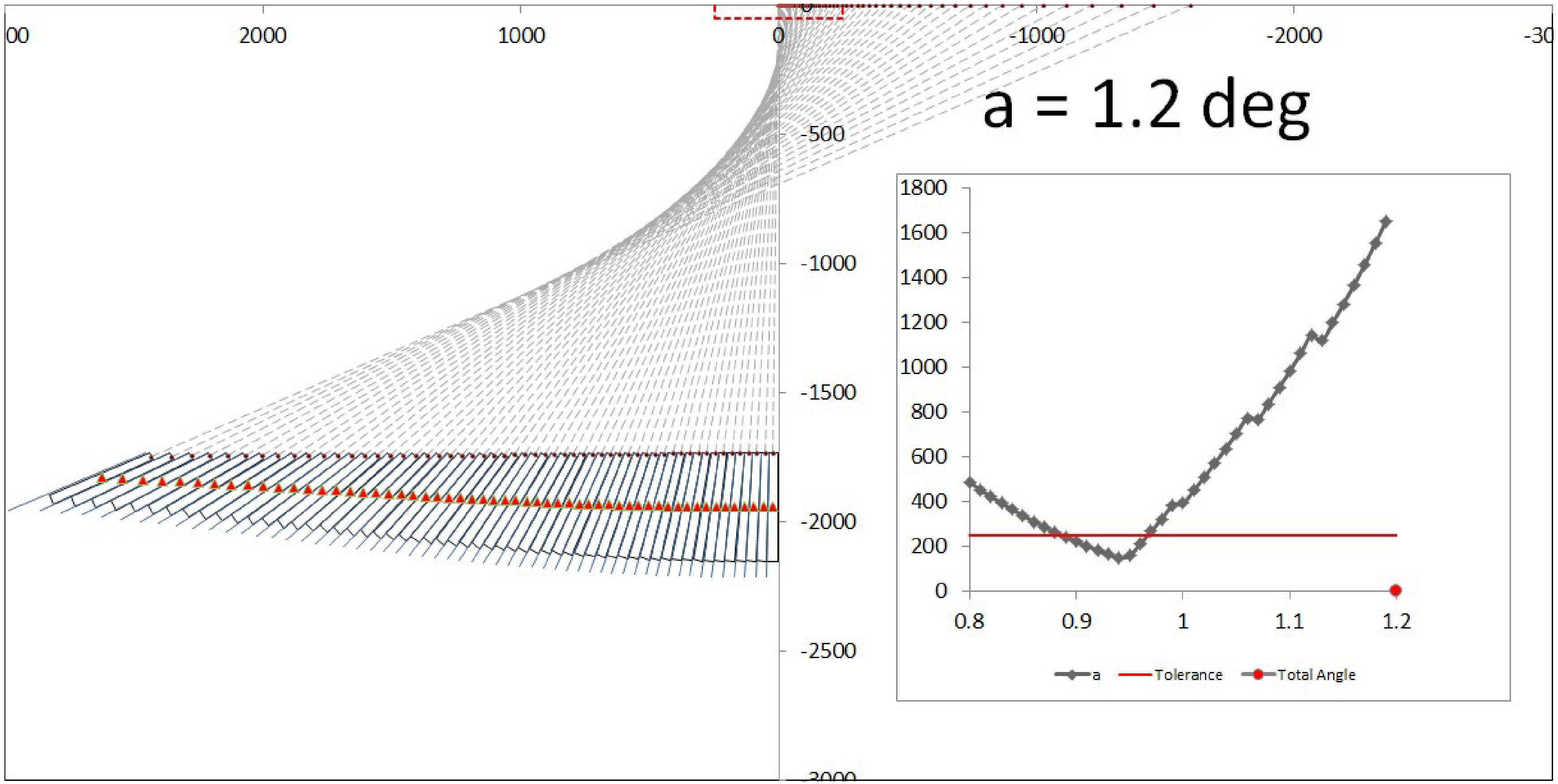


Figure 5.1.3: *Optimization of the location of ECal modules in the Z plane (a = 1.2deg).*

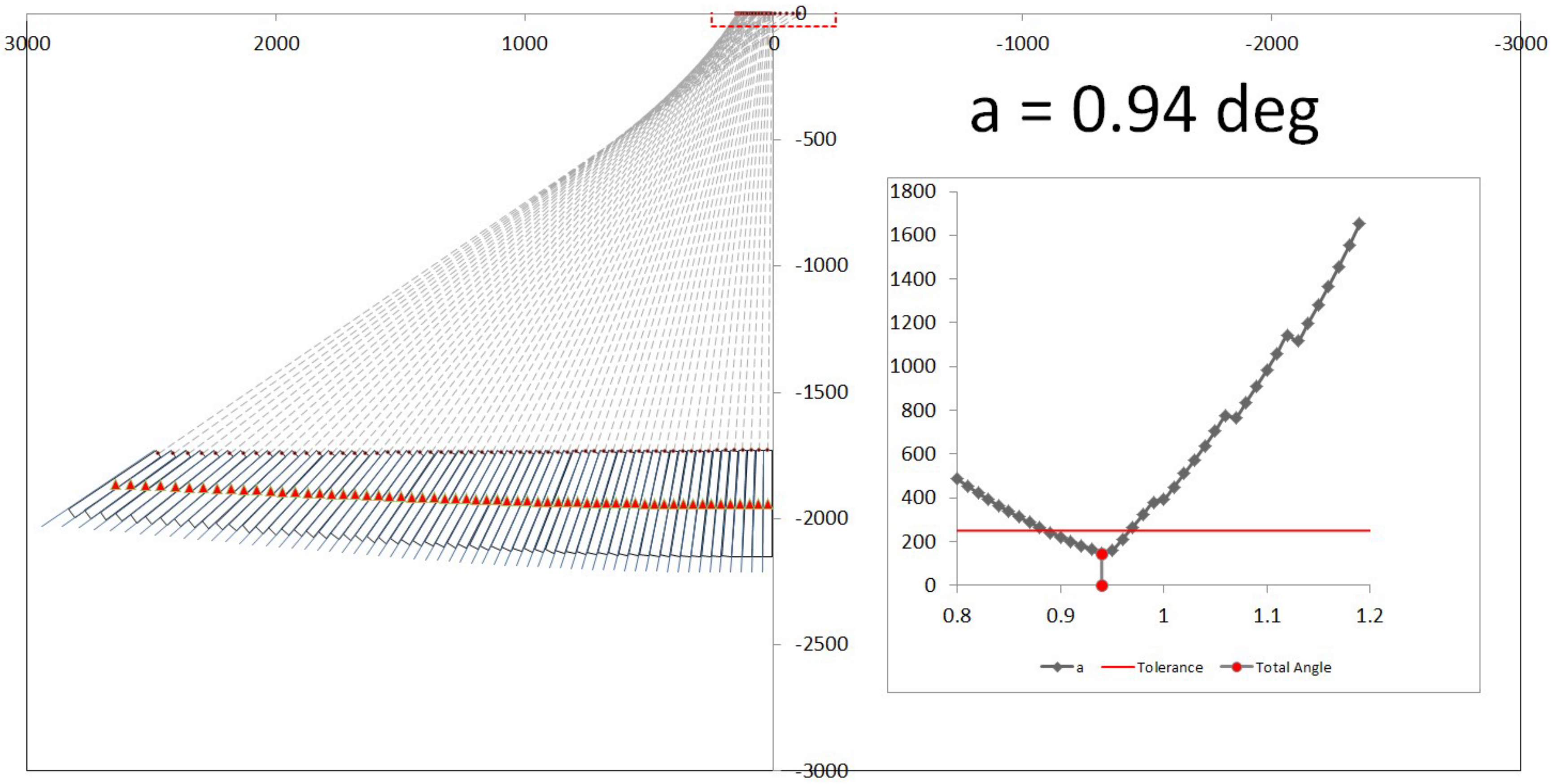


Figure 5.1.4: *Optimization of the location of ECal modules in the Z plane (a = 0.94deg).*

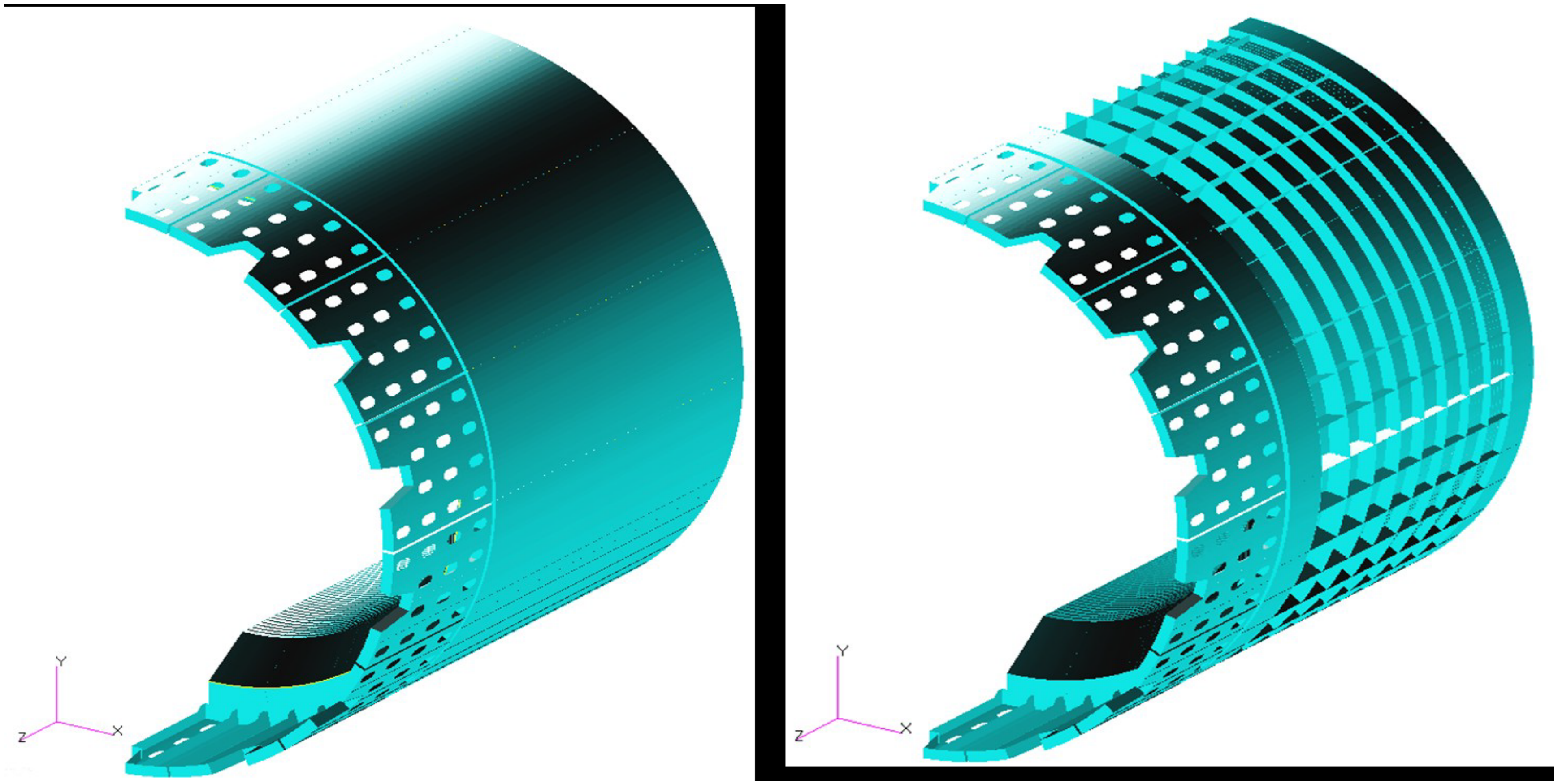
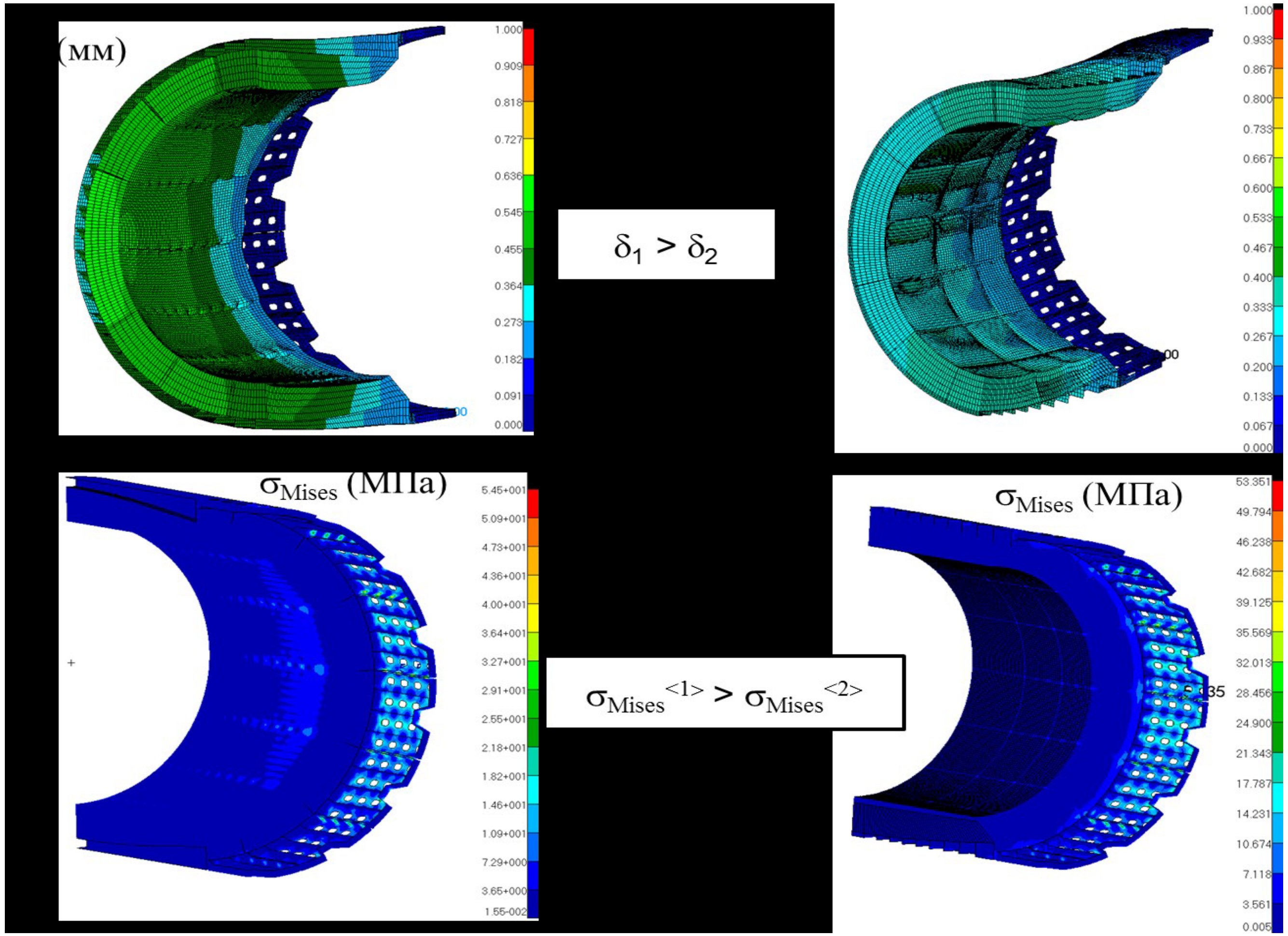


Figure 5.1.5: *Two schemes of the organization of the power structures fixing sectors – № 1 (in left) and № 2 (in right).*



Despite the fact that the minimum deviation is achieved when the tilt angle is 0.94 degrees, for simplicity it was decided to adopt this angle as 0.9 degrees. Two schemes (Fig. 5.1.5) of the organization of the power structures fixing sectors of the calorimeter was proposed.

The calculation of stresses and displacements in structures under the action of the weight of the calorimeter for both schemes was done.

It is shown that scheme № 2 has greater reliability.

Calorimeter modules are collected in the cassette of 16 units - 2 rows of 8. Such a segmentation is not fundamentally important, these numbers are selected for easier organization of electronics readout.

The primary support structure is the pencil case, which consist of the mounting plate and honey-comb structure.

Honeycomb have a thickness of about 0.3mm, which ensures sufficient rigidity of the entire structure and has no significant impact on the characteristics of the calorimeter.

Mounting plate provides a rigid connection of honeycomb, filled by the calorimeter modules, and the next structure element - the block. Inside the mounting panel is reserved enough space for the electronic board serving all 16 channels of the calorimeter which are supported by one panel.

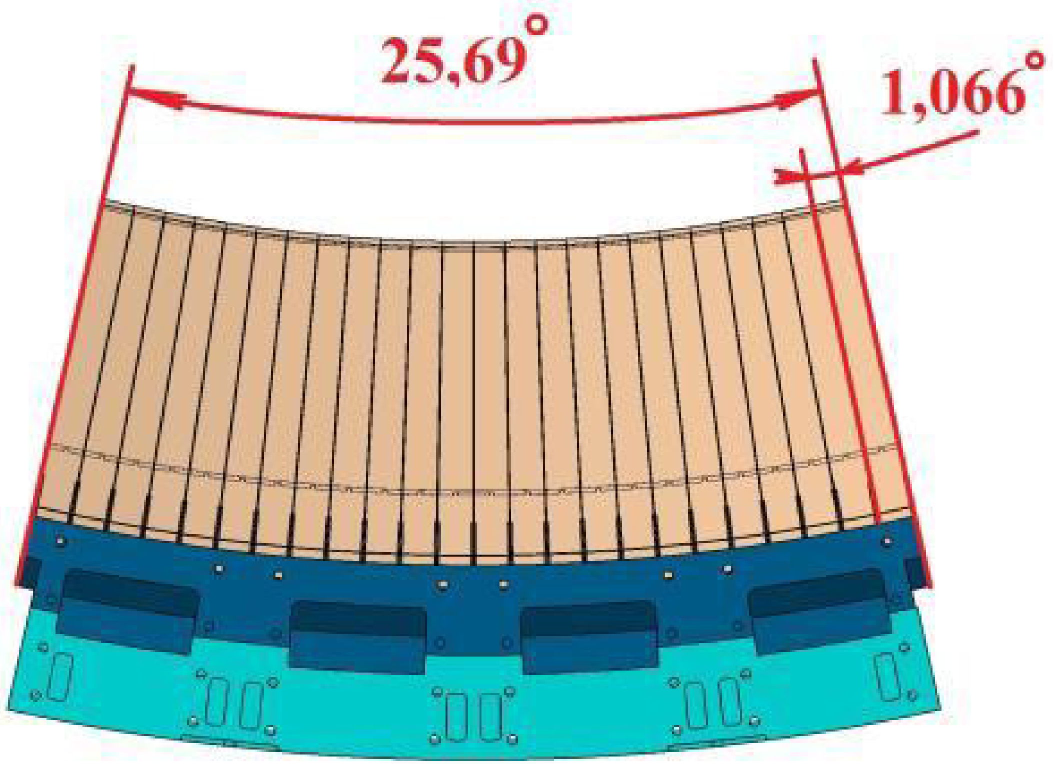


Figure 5.1.7: *One block.*

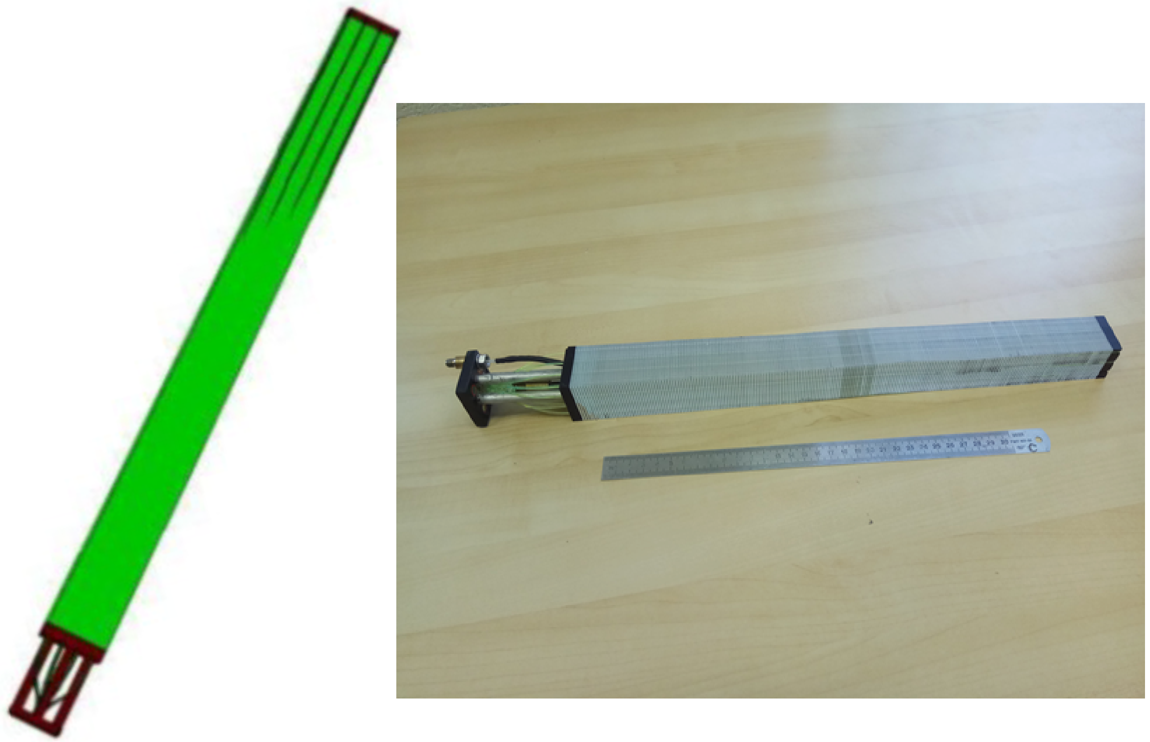


Figure 5.1.10: *The ECal module.*

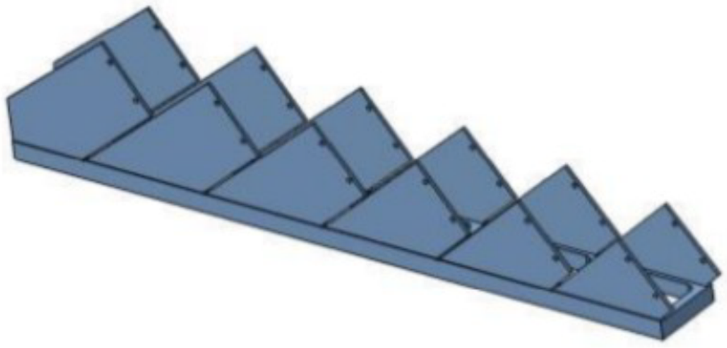


Figure 5.1.9: The mounting plate (supporting frame).

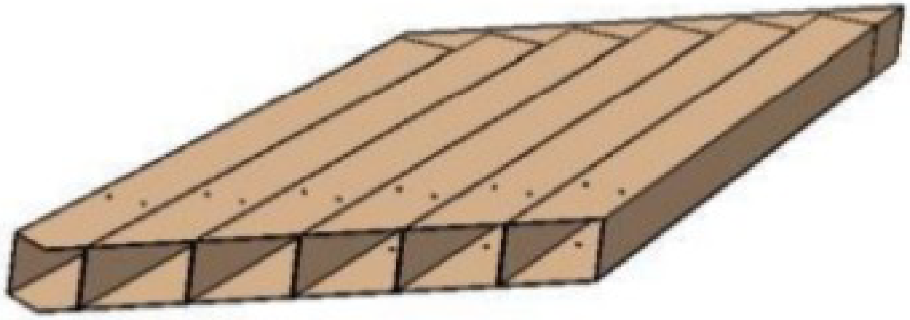


Figure 5.1.8: *The honeycomb structure.*

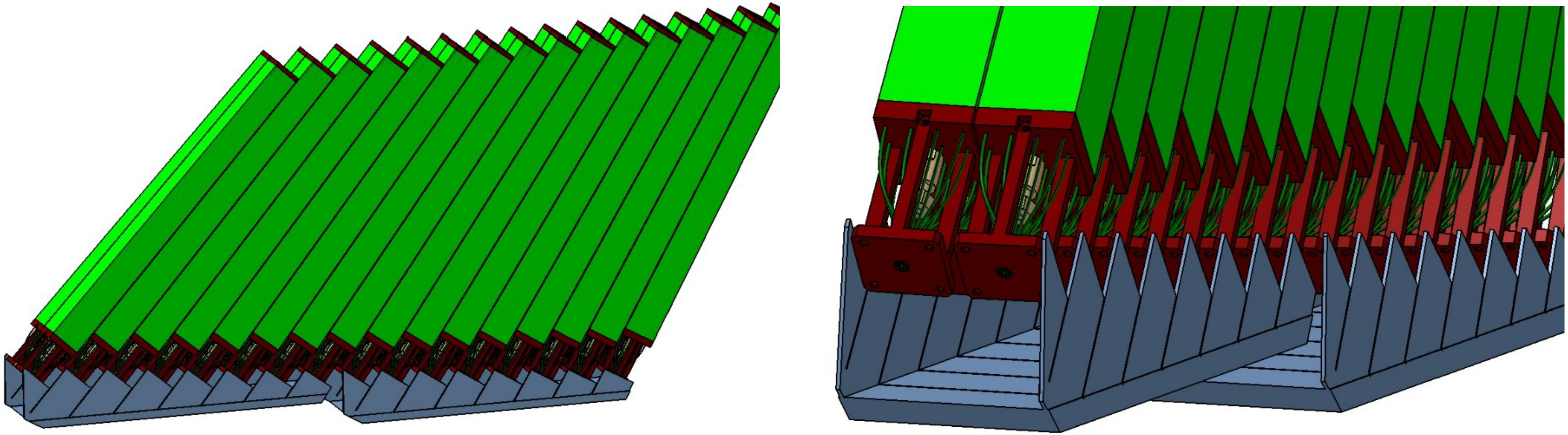


Figure 5.1.11: *Assembled unit.*

The block consists from 2 to 4 cassettes in the longitudinal dimension and 12 cassettes in the transverse dimension.

Three types of blocks are distinguished from each other by its geometry, which varies with distance from the detector center.

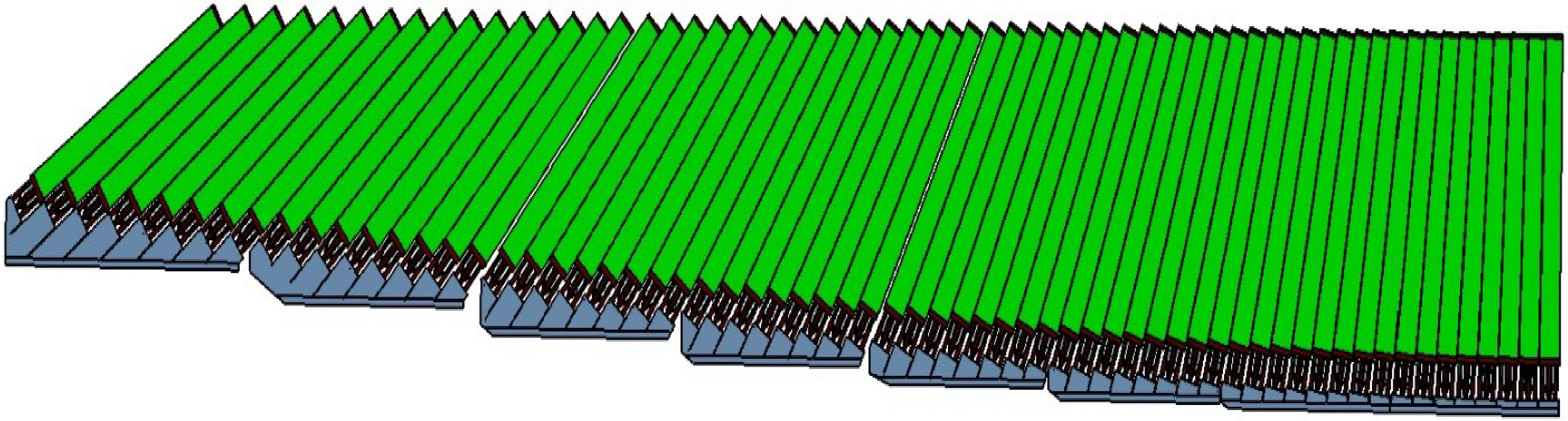


Figure 5.1.12: *One pro-sector.*

These three blocks are form pro-sector with 768 calorimeter modules, as shown in figure 5.1.12.

Each block is mounted on a (Fig. 5.1.13), for the external blocks this base is even reinforced by stiffeners (Fig. 5. 1. 14).

Figure 5.1.13: *Base of central block.*

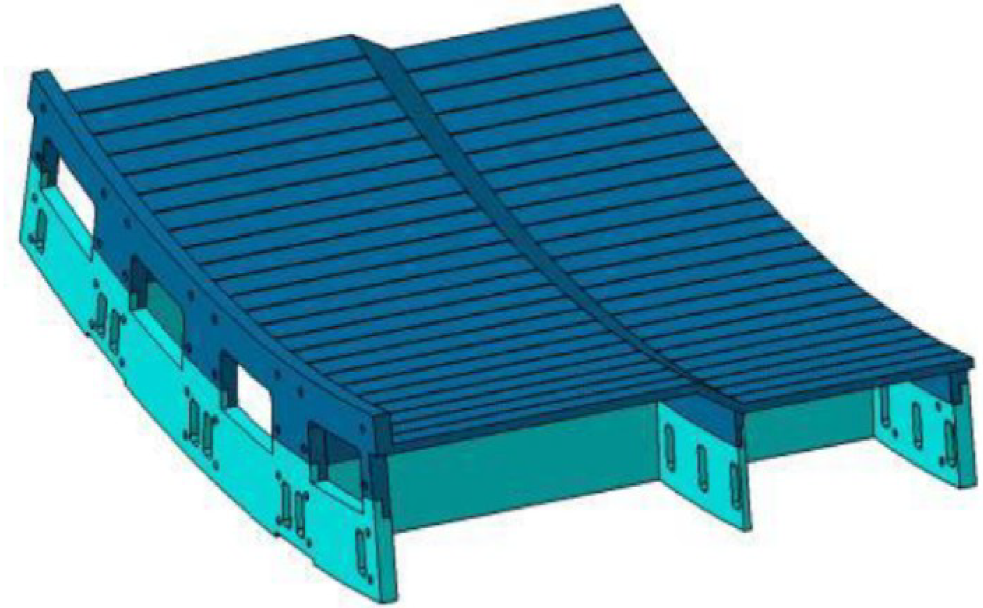


Figure 5.1.14: *Base of side blocks.*

The inner surface of each block closed by the reinforced panel which later (after Assembly of the calorimeter) will form the internal power cylinder of the calorimeter.

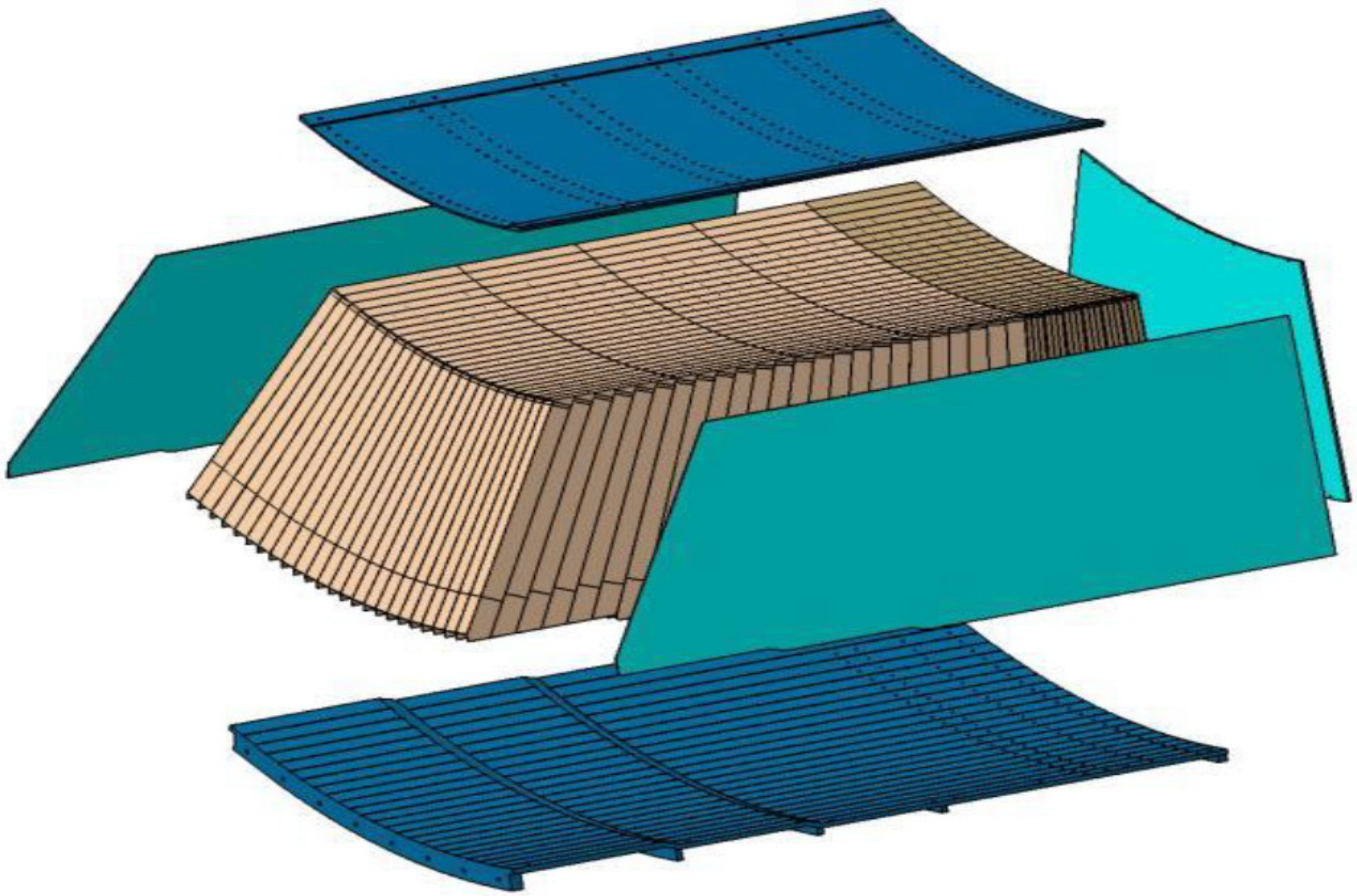


Figure 5.1.15: *Power structure element.*

The side surface of the block closed by the panel which is also the power structure element (Fig. 5.1.15).

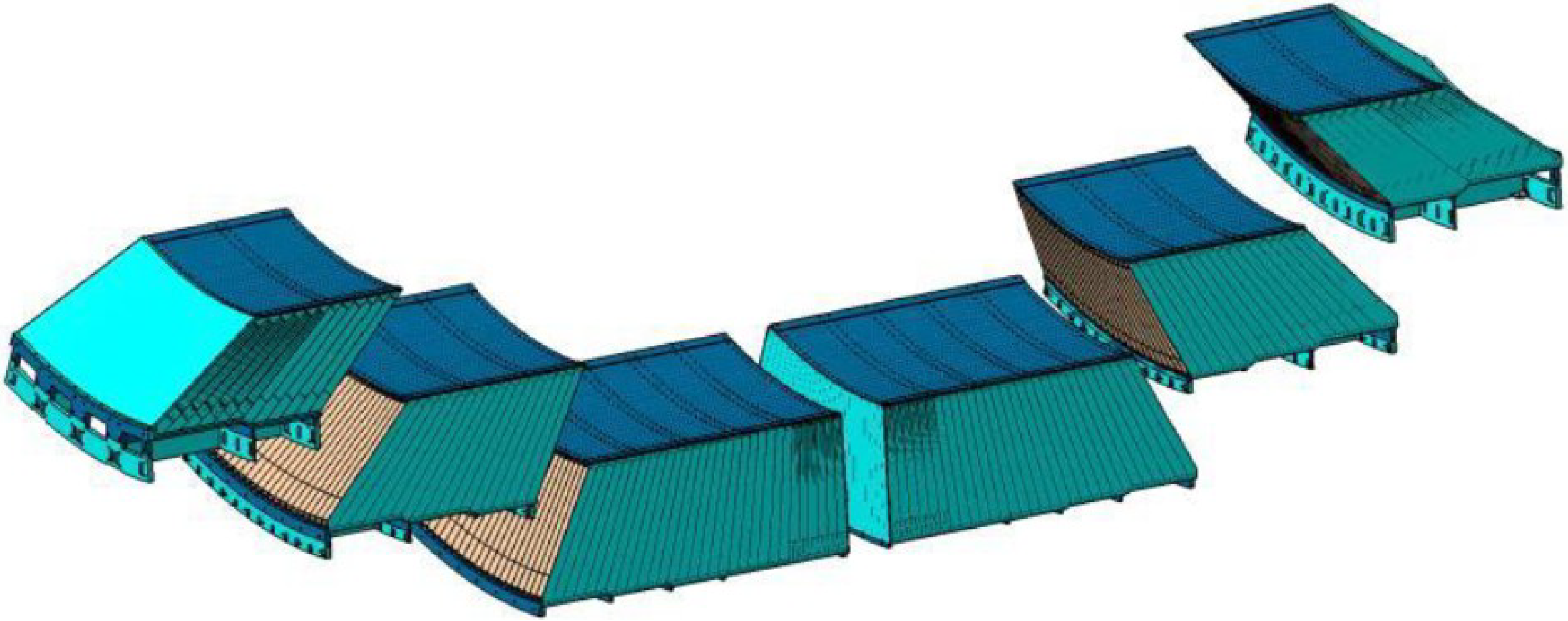


Figure 5.1.16: *Assembly*.

Figure 5.1.17: *Frame of the sector.*

In the assembling of ECal blocks in the sector use transportation containers. The blocks are installed from the edges to the center from two sides.

Assembling of the calorimeter sector is produced on the frame (Fig. 5.1.17) starting from the inner blocks and ended by the outer blocks (Fig. 5.1.16).

After assembling sector is a single element with the necessary rigidity to enable transportation to the place of assembling of the calorimeter and manipulation during calorimeter assembling (Fig. 5.1.18).

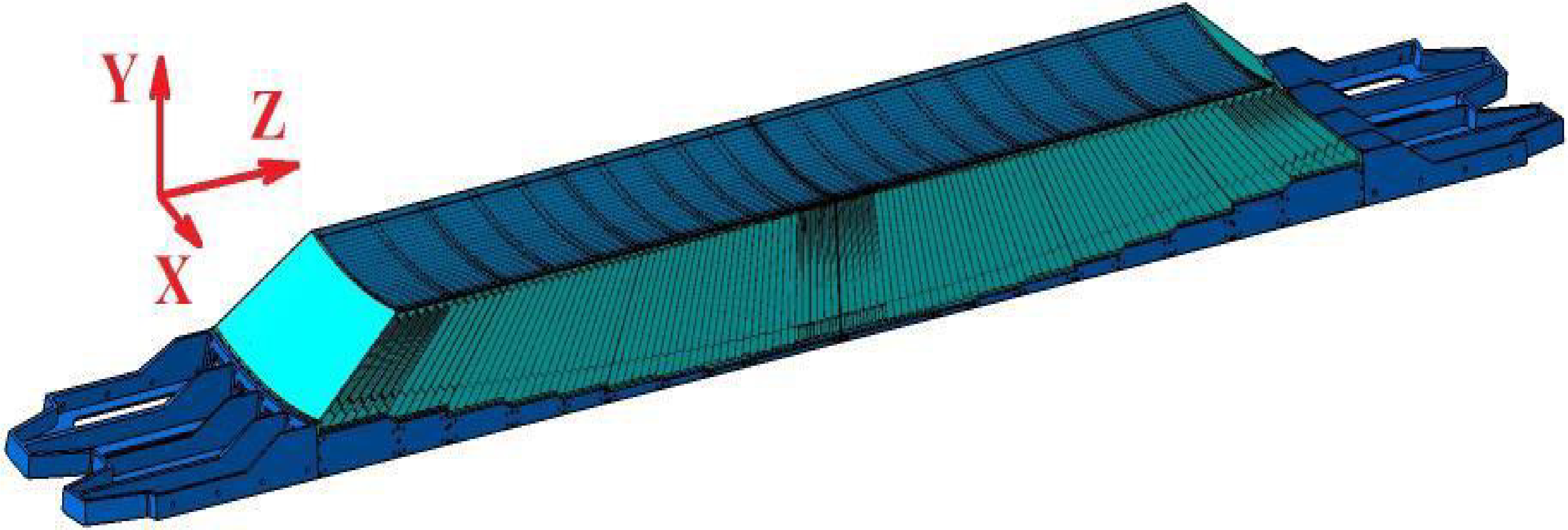


Figure 5.1.18: *The sector is ready for introduction.*

5.2 Block assembling

Assembling is going on the turning slipway (Fig. 5.2.1). The assembling procedure includes both mechanical installation of modules and installation of electronics and testing in together with the modules of the calorimeter.

Outer screen of the block, which is part of the power structure supporting the 70-ton calorimeter, is installed in the first place (Fig. 5.2.2).

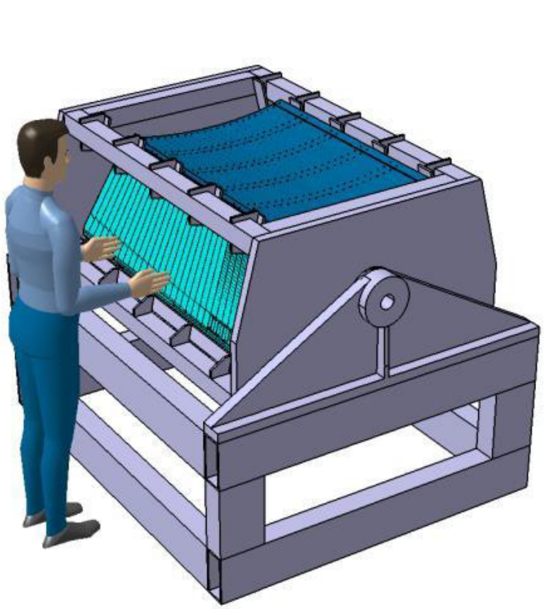


Figure 5.2.1: *The turning slipway.*

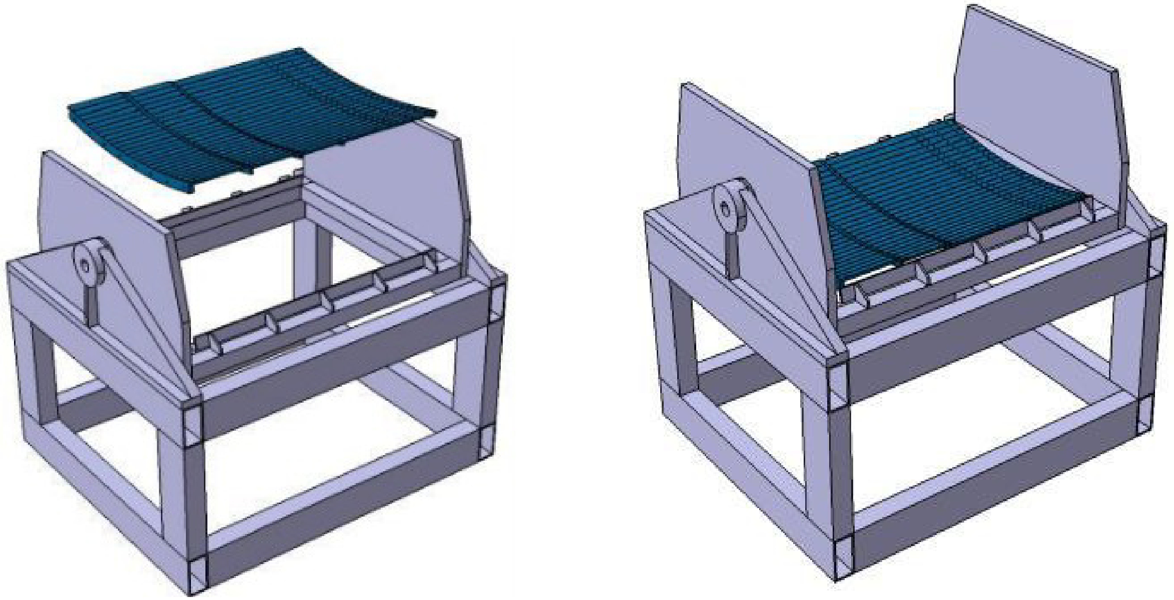


Figure 5.2.2: *The turning slipway.*

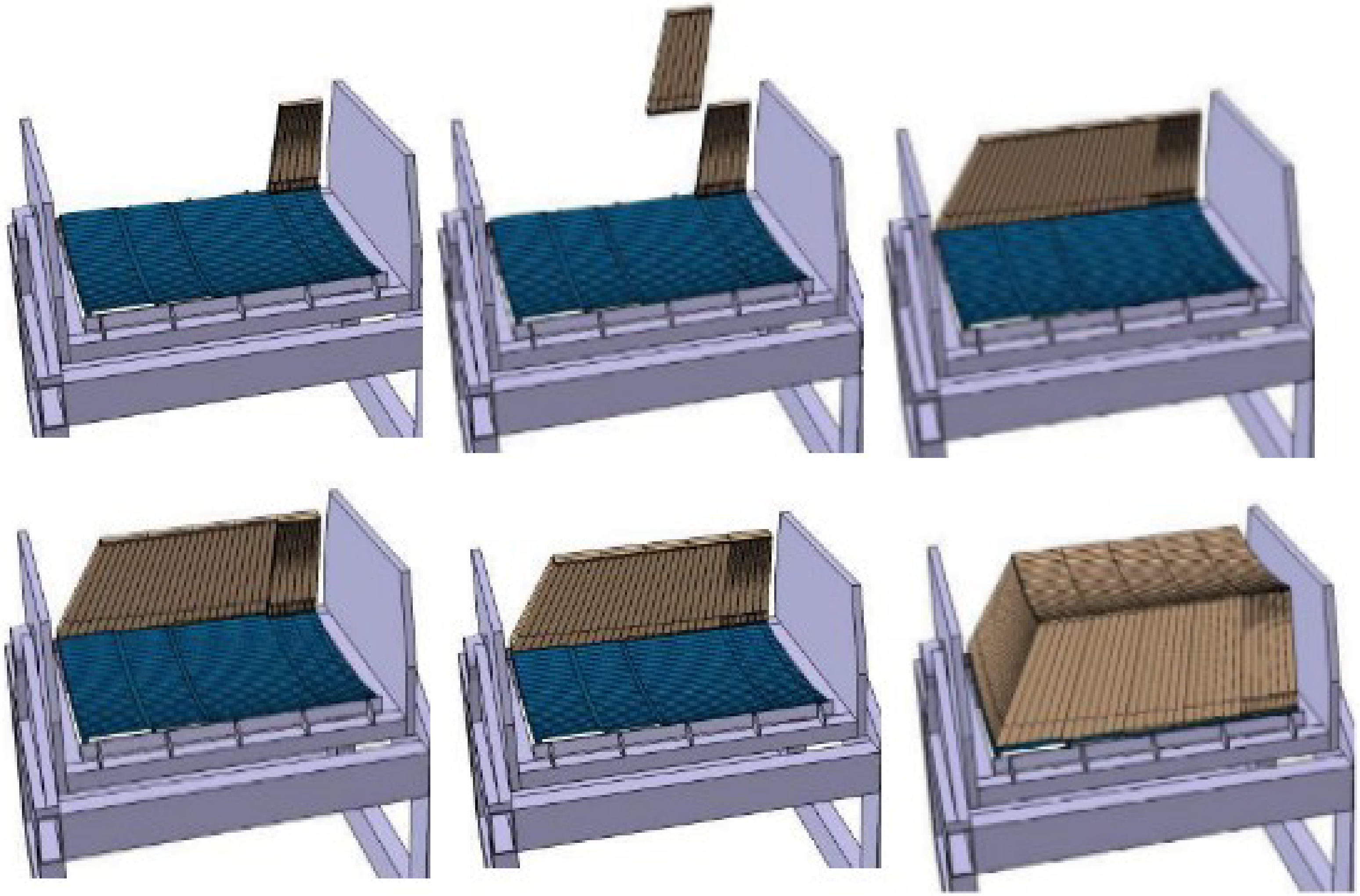


Figure 5.2.3: *Assembling stages.*

After installing all of the cassettes unit are installed side walls, the inner shell and the frames.

This allows to flip the unit 180 degrees.

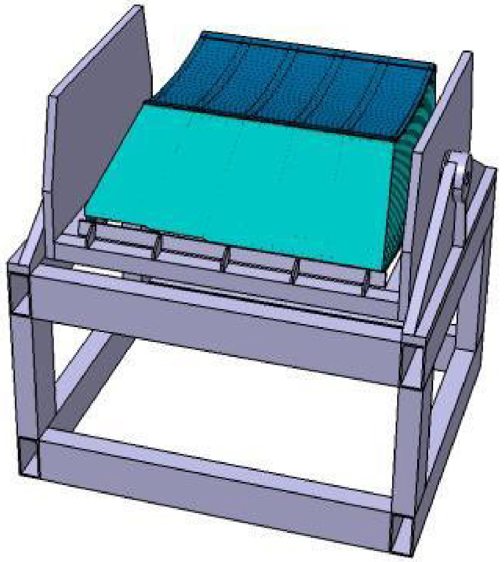


Figure 5.2.5: *Stand collection module.*

After rotating the block using the frame of the turntable, dismantle the unit from the fixture for further assembling in the sector and the installation in the transport container.

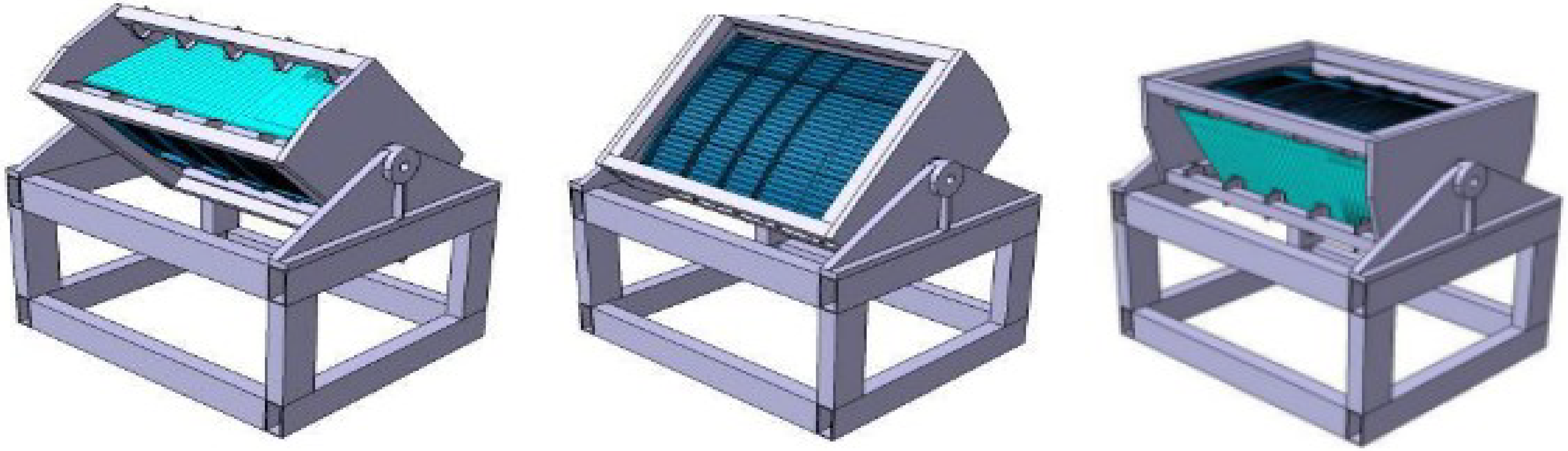


Figure 5.2.7: *Rotation of the block.*

5.3 Sector assembling

In the assembling of ECal blocks in the sector use transportation containers.

The blocks are installed from the edges to the center from two sides.

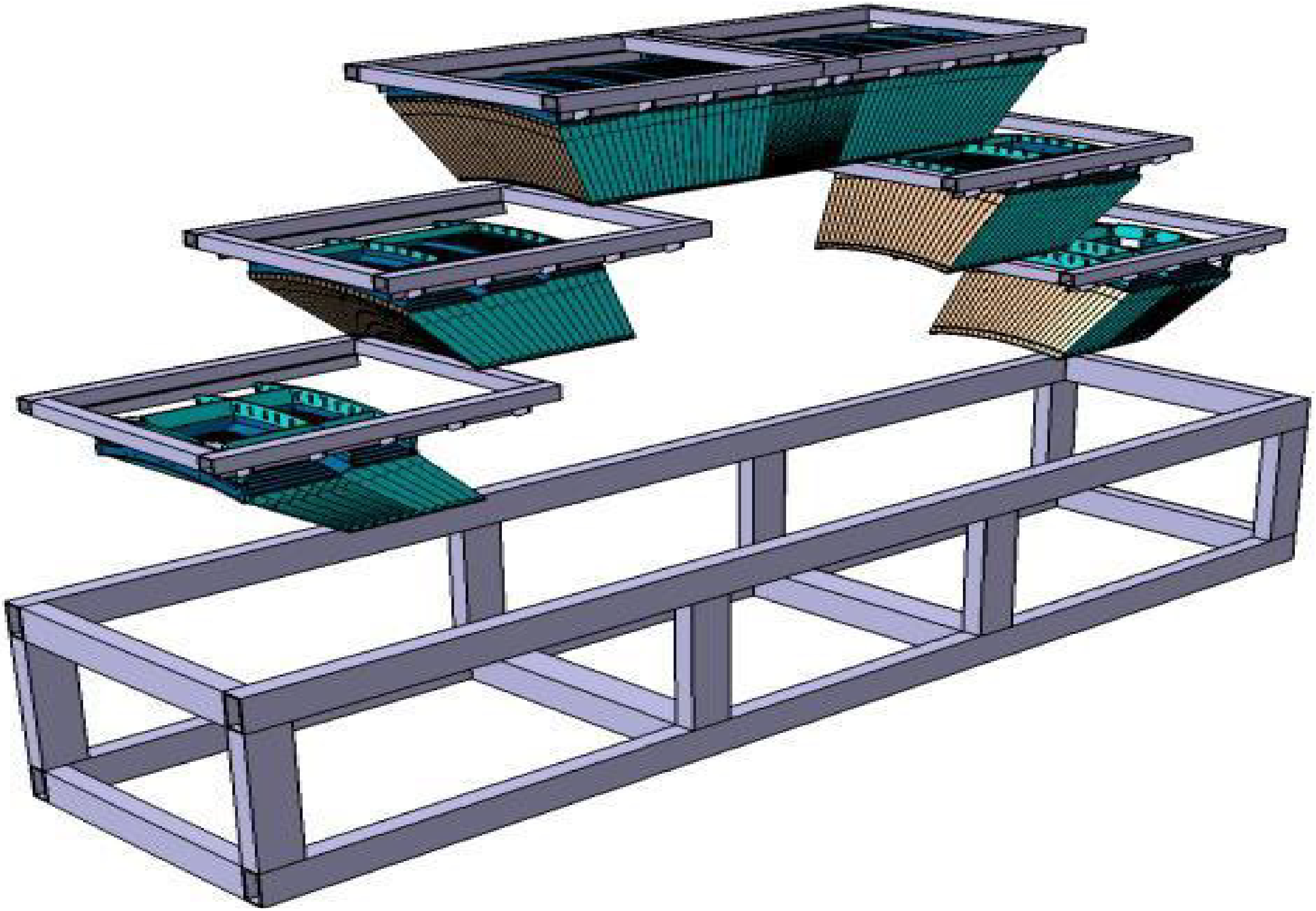


Figure 5.3.1: *The transportation containers.*

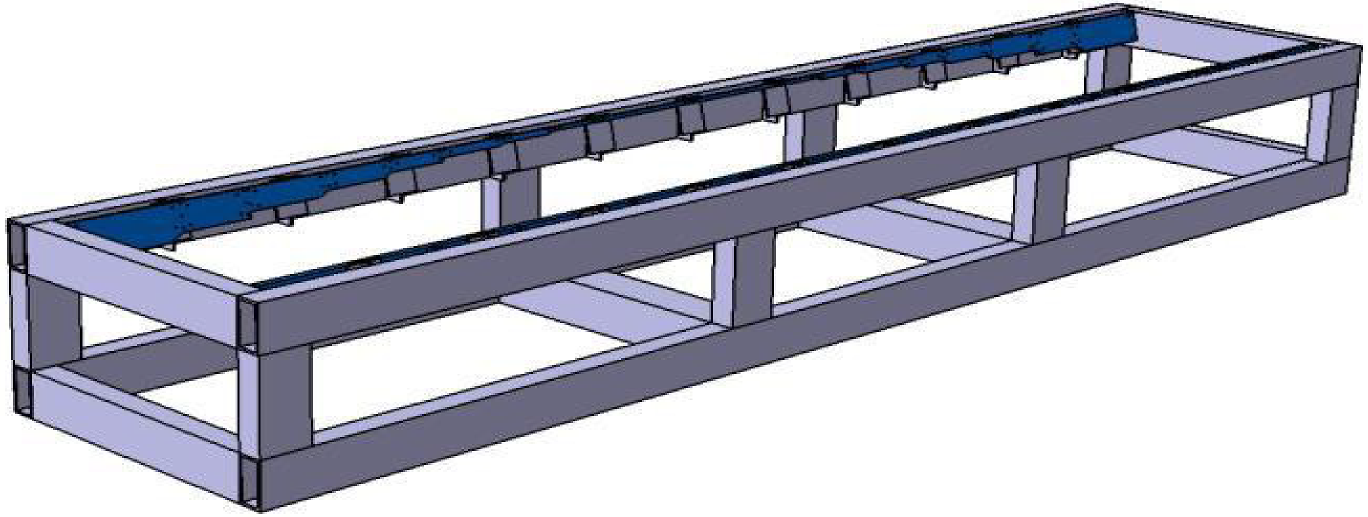


Figure 5.3.2: *The transportation containers.*

After that, the download of external blocks of Ecal. After connecting the blocks with the side walls of the sector and their fixing to the transport container is carried out dismantling of the frame of the turntable. The same procedure are carried out with blocks 2 and 3.

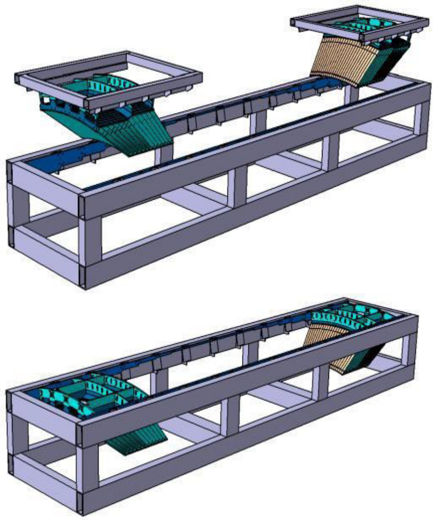


Figure 5.3.4:

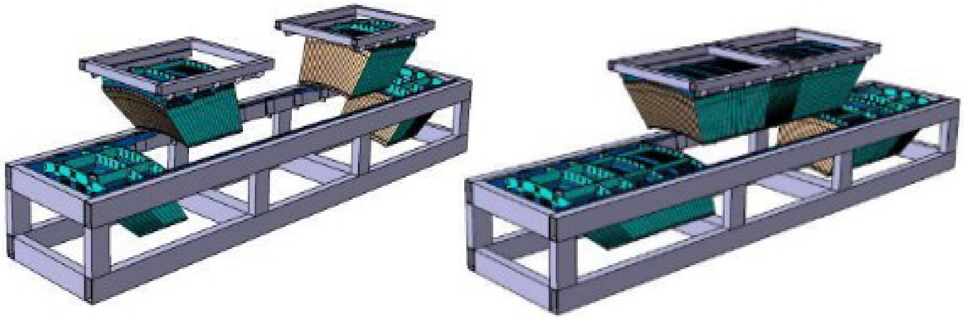


Figure 5.3.5: *Blocks 2 and 3 installation.*

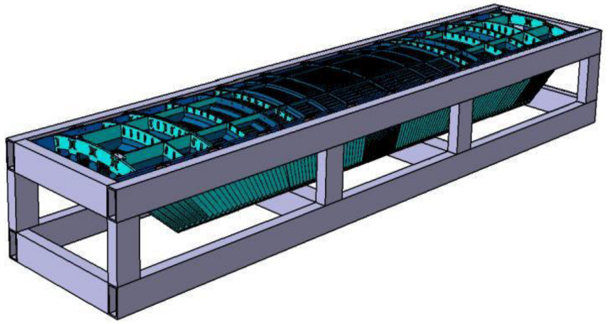
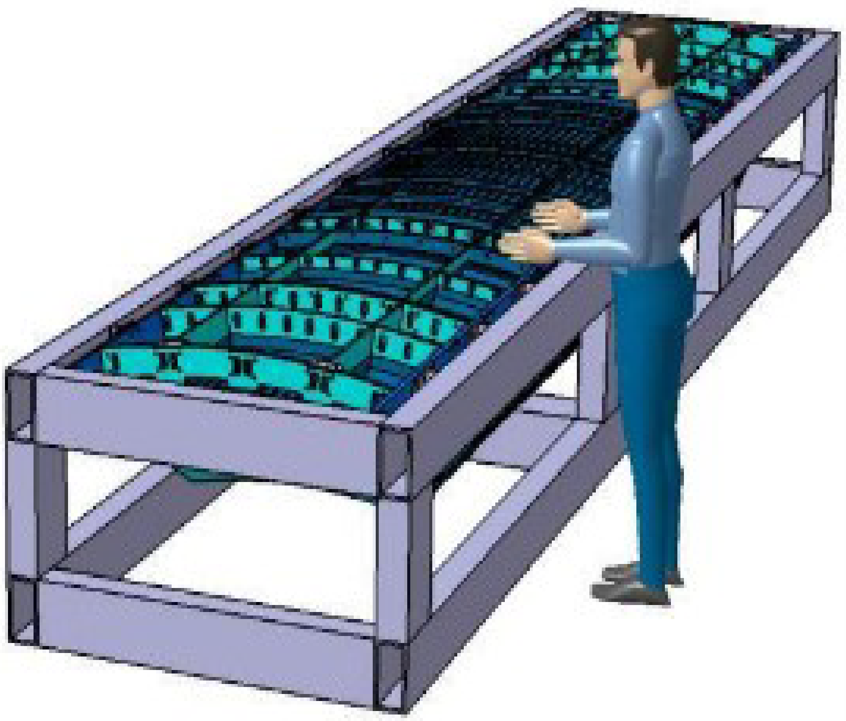
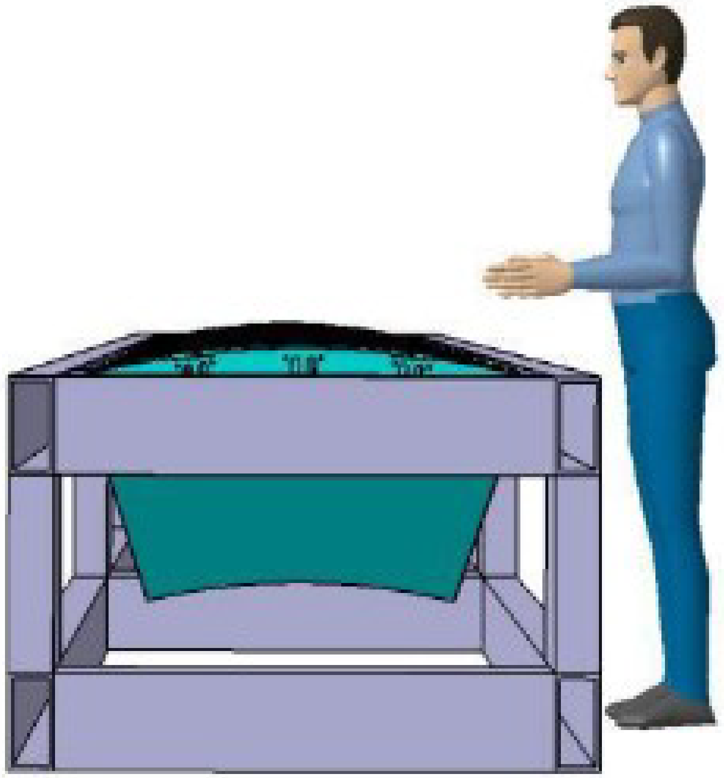


Figure 5.3.6: *Full sector.*

After assembling of the blocks in the sector ECal it is possible to make final installation of the electronics.





1. Организация TDR

2. Электроника

- Кратность
- Механика