# Development and Production of a Box for Storage and Shipping of HDIs in the Upgrade of the CMS Experiment

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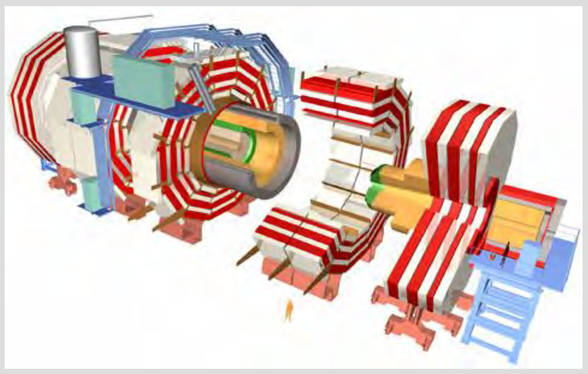
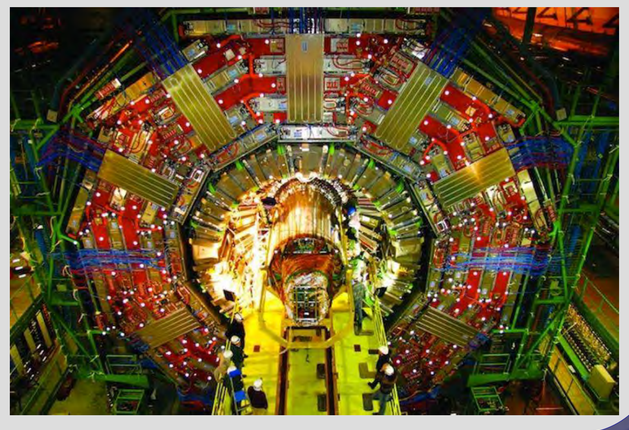
## The CMS Experiment

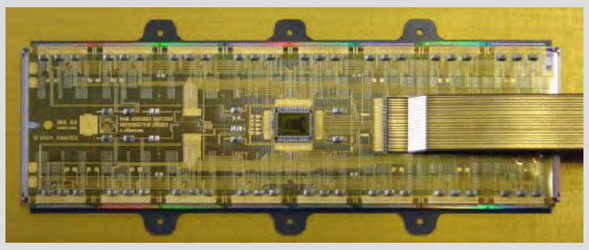


The Large Hadron Collider at CERN has begun operations at 7 TeV center of mass energy. CERN plans to run at this energy until the end of 2012 with the goal of providing an integrated luminosity of a few $fb^{-1}$ to the CMS and ATLAS experiments. The LHC will then shut down for 1.5 to 2 years to make the revisions necessary to run at ~14 TeV. Operation will resume in 2014. In 2017/18, there will be another long shutdown to prepare the LHC to operate at and eventually above the design luminosity of $2 \times 10^{34}$ $cm^{-2}s^{-1}$. Operation will then resume with the luminosity rising gradually during this period to $2 \times 10^{34}$ $cm^{-2}s^{-1}$. The two long shutdowns provide CMS an opportunity to carry out improvements to make the experiment more efficient, to repair problems that have been uncovered during early operations, and to upgrade the detector to cope with the ultimate luminosity that will be achieved during this period.



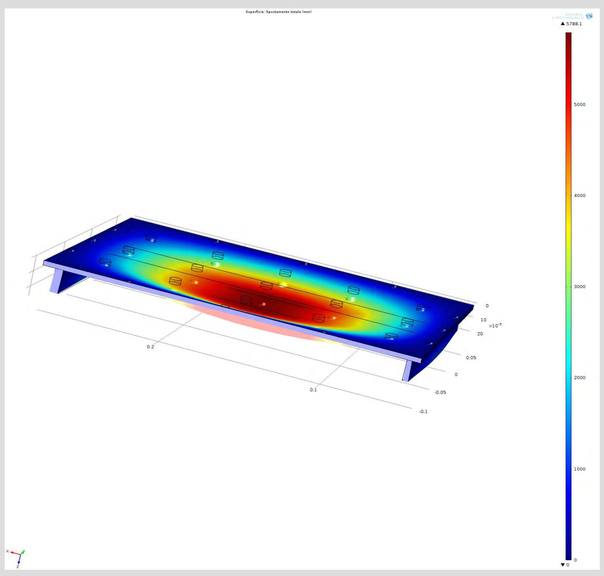
## The Pixel Upgraded Detector

The proposed upgraded pixel detector has only one type of sensor module with two rows of 8 ROCs each. This will simplify considerably the sensor production, module assembly, and testing. The active area of the module is 16.2x64.8 $mm^2$. The pixel size will remain the same as before, 100 x 150 $\mu m^2$. For the sensors our baseline is to use the same n+-on-n technology as for the current detector. The sensor is bump-bonded to 16 ROCs which for Layers 1 and 2 for BPIX, will be thinned down to 75 $\mu$m. For the rest of the layers and the end-cap disks, the ROCs will be thinned down to about 200 $\mu$m. A high density interconnect (HDI) is glued on top of the sensor with wire bond pads to connect to the corresponding pads on the ROCs. Electrical signals will be sent from/to the ROCs through the HDI and then to the downstream electronics.



The TBM chip will be mounted on the HDI as well. A small clip is glued to the ends of the module to allow the assembly of the module to its support structure [1].

## Use of COMSOL Multiphysics®



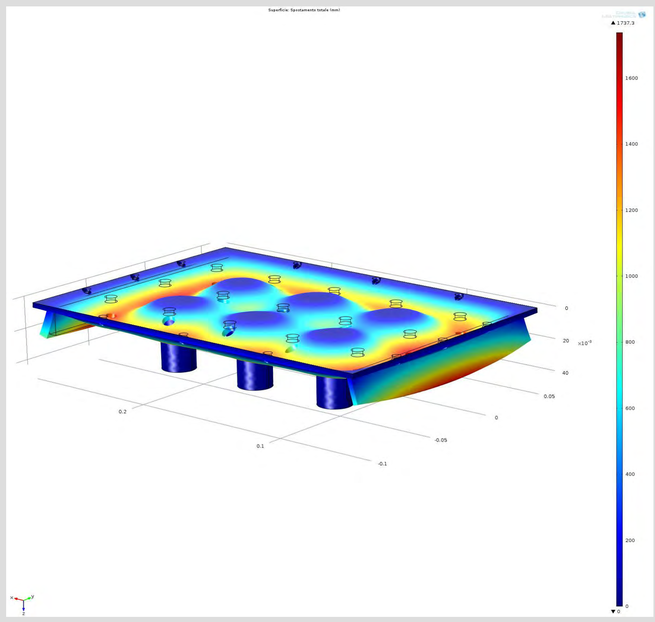

At INFN Catania we designed a box for storing and shipping of the HDIs. The study of the box was very difficult for two reasons: the box and its contents are to be sealed under vacuum and the material used to fabricate the box must not electrically charge up, that is it must be ESD-safe, yet should not be metal to limit weight. The development of the box has been performed with support of the COMSOL® code and finite elements studies for both design and dimension optimization.

It's possible to completely describe the strain conditions at a point with the deformation components, (*u*, *v*, *w*) in 3D, and their derivatives. You can express the shear strain in a tensor form, ε*xy*, ε*yz*, ε*xz*, or in an engineering form, $\gamma_{xy}, \gamma_{yz}, \gamma_{xz}$.

The model simulates using The Solid, Stress-Strain application mode (for 3D geometries). The plastic box is subjected outside to a pressure of about $10^2$ – $10^5$ Pa. To withstand these pressures were assessed two possible configurations:

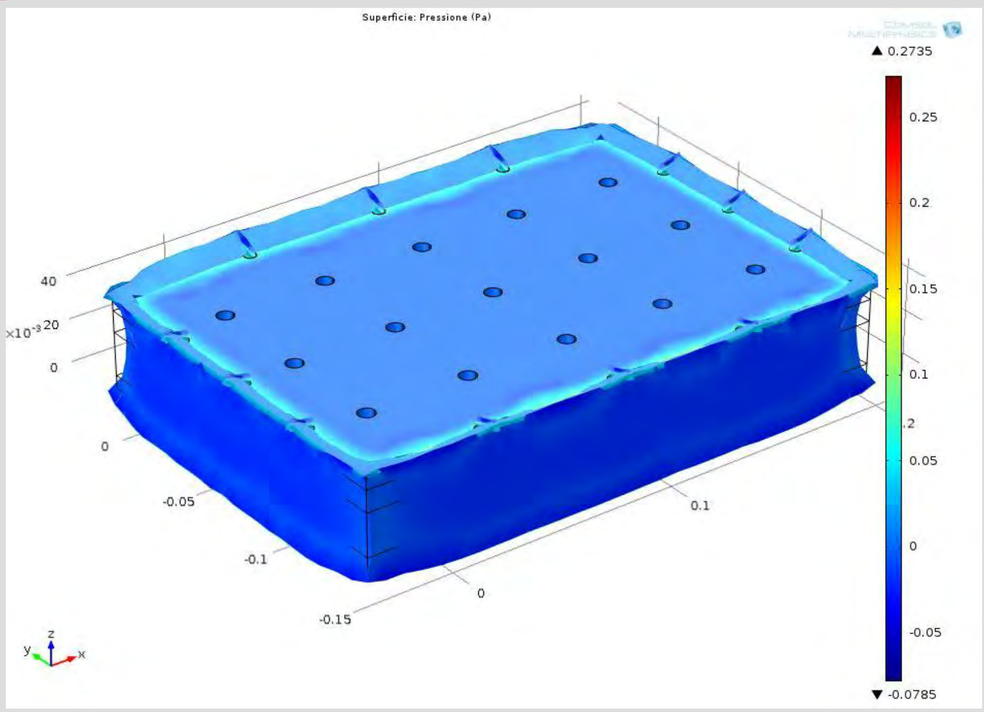
1 - The first configuration with the presence of some cylinders inside the structure, in a direction parallel to that of the pressure. (Right figure).

2 - The second configuration and 'been studied with the support beams to the box in order to make the cover of the box a reticular structure (left figure).




## Conclusion

In conclusion, with COMSOL Multiphysics® we were able to optimize shipping box design for HDI's transport and also with FEM simulations we were able to optimize the material to be used. In particular, choice went for PE1000HWD which provides significant property together with mechanical characteristic not download current.




## Reference

[1] Technical Proposal for the Upgrade of the CMS detector through 2020 – CMS Collaboration - CERN-LHCC-2011-006 ; CMS-UG-TP-1 ; LHCC-P-004

Excerpt from the Proceedings of the 2012 COMSOL Conference in Boston