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Design and testing of a dynamic support frame structure for the CMS tracker installation process

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The installation process of the new Outer tracker (OT) and Barrel timing layer (BTL) -detectors in CMS will be a demanding operation, due to their combined weight is ~20% heavier than the old silicon strip tracker. This means that some of the existing installation tooling from the past cannot be re-used.

The dynamic support frame structure, often referred as the "eiffel tower", is used in the final installation motion when the tracker is brought into the middle of CMS inside the ECAL bore. The eiffel tower is fixed to the end of the tracker, and it is then used to pull the tracker in while rolling on top of bearing rollers. The structure is heavily loaded during the operation, as it's carrying a large portion of tracker's weight in an extended cantilevered configuration. In a structural study it was concluded, that the old eiffel tower would not be fit for the heavier boundary conditions of the phase-2 upgrade.

For the new eiffel tower several structural improvements were made. The horizontal section of the new structure was built from commercially available heavy-duty aluminum truss elements, and the vertical section was custom built around it. A lot of usability improvements were implemented to the system in parallel, mainly related to the longitudinal movement mechanism of the horizontal section.

A large-scale load test setup was built to mimic the real loading conditions. The whole motion path needed in the installation was successfully tested, and the behavior of different structural elements was scrutinized. The FEM-analysis of the structure conducted earlier was benchmarked, and the measured value on the total deflection was satisfactorily close to the simulated one. Some improvements were done and tested on the longitudinal motion mechanism, and ideas to enhance the adjustability of the system were realized.

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