Supervisor's report on the doctoral thesis of Chainika Chauhan

Thesis submitted in July 2025 at the Faculty of Mathematics and Physics, Charles University
Thesis title: Search for new phenomena using the production of four top quarks at the Large Hadron Collider
Thesis supervisor: Mgr. Peter Berta, Ph.D., Institute of Particle and Nuclear Physics, Faculty of Mathematics and Physics, Charles University, Prague

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The doctoral thesis of Chainika Chauhan deals with the search for new phenomena using the production of four top quarks at the Large Hadron Collider. The four-top-quark final state is an ideal ground for looking for physics beyond Standard Model due to the large energy scale involved in this process.

Chainika Chauhan has been actively involved within the research at the ATLAS experiment. In the first year of her doctoral studies, she became an ATLAS author based on her qualification task within the ATLAS Inner Tracker (ITk) upgrade project. She continued to work on this upgrade project also after finishing the qualification period, and produced multiple tools and graphical user interfaces needed for the user access management in the ITk Production database.

Starting from the second academic year, Chainika investigated the production of four top quarks which was the main research topic. Chainika was the leading researcher in an international group of researchers focusing on the search for a new heavy scalar or pseudo-scalar heavy Higgs Boson produced in an association with two top quarks, with Higgs Boson decaying into a pair of top quarks. This physics measurement was performed using proton-proton collisions at a center-of-mass energy of 13 TeV collected by the ATLAS detector at the Large Hadron Collider. Chainika performed crucial research work for this measurement, such as extraction of the parameter of interest using profile likelihood fit, validation of the obtained results, and evaluation of limits on the cross section of the BSM models under study. Chainika presented and discussed her progress regularly at the work meetings of the ATLAS experiment. The difficult topic of the PhD project required good analytical and computing skills, and it also required skills to communicate and cooperate with other researchers. I can state that Chainika played the major role in forming the content of all the work she presents in her thesis. I confirm that Chainika always worked in a very focused way and rather independently.

Chainika's research work has yielded valuable scientific results and it led to a publication in a scientific journal (Eur. Phys. J. C 85, 573 (2025)). Chainika presented her research at international conferences (International Conference on High Energy Physics 2024 and CORFU2024). From both conferences, the presented material was submitted to proceedings. She has demonstrated collaboration with foreign researchers and she was selected to participate in several summer schools (ESHEP 2024, CERN School of Computing 2023).

The presentation of the results of the research work reaches a high professional level. Besides the actual research work, the thesis contains a summary of the Standard Model, description of the ATLAS experiment and the planned upgrade of the tracking detector, the state of the art for the

four-top-quark cross section measurements, and a description of the statistical methods used in the research.

In summary, I evaluate the submitted doctoral thesis as excellent. This dissertation demonstrates the author's abilities for independent creative work. I recommend that Chainika Chauhan is awarded with a PhD degree.

In Prague, 16.9.2025 Peter Berta