

**Supervisor's report on the PhD thesis
by Kristina Mihule**

Studies of Higgs boson in its decay to a pair of tau-leptons and search
for excited tau-lepton with the ATLAS detector

The PhD thesis is devoted to the ATLAS experiment and consists of two topics that the student worked on: the Higgs boson mass reconstruction in the $H \rightarrow \tau\tau$ decay channel and the search for the excited τ -lepton. While the former topic is crucial for the $H \rightarrow \tau\tau$ measurement and its comparison with the Standard model predictions, the latter represents one of the searches for the beyond Standard model phenomena.

Kristina Mihule was actively involved in the ATLAS-related work since the beginning of her PhD study. First she worked on the time calibration of the Tile Calorimeter and co-authored an ATLAS note on this subject [1]. She also joined the effort on the data-quality follow-up by serving as Data Quality Validator, Data Quality Leader and CALO FWD shifter. Her contribution in the TileCal community is well recognised, she was delegated to present TileCal results at several international conferences (a talk at the 4th International Conference on Particle Physics and Astrophysics in 2018; 2 posters at Lepton-Photon 2019, where she won a prize for the best poster; a poster at the Pisa meeting on Advanced Detectors in 2022).

Meanwhile she joined our effort in studying the $H \rightarrow \tau\tau$ decay within the ATLAS HLeptons group. She concentrated on the Higgs boson mass reconstruction in this particular channel, which represents a challenge due to the presence of 2-4 neutrinos in the final state. Her work resulted in two conference contributions (talks at Higgs Couplings 2019 and Higgs 2021) and several performance plots were made public [2]. She contributed to the final paper dealing with the whole Run 2 dataset [3].

After a short break due to the maternity leave in 2020 we decided to start another study – the search for excited τ -leptons. Kristina was the driving force in this effort since the very beginning and performed several important steps (benchmark model definition, selection of the signal and control regions, identification of sensitive variables). She pushed the analysis up to the stage when the Editorial Board was formed. The analysis was recently approved by the ATLAS Collaboration and is awaiting the final sign-off in coming days [4]. Kristina also presented some of her studies at ATLAS Week (CERN 2022) and ATLAS Exotics workshop (Amsterdam 2022).

I would like to conclude that Kristina did a lot of work and contributed to two ATLAS analyses. She presented her results at many ATLAS meetings, several international conferences and co-authored many ATLAS papers.

I am convinced that the thesis meets the criteria of a PhD thesis and I propose that it is accepted as such. I also recommend that Kristina Mihule is granted with a PhD title after a successful thesis defence.



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References

- [1] T. Davídek, L. Fiorini, M. Mlynáriková, K. Petukhova, A. Solodkov, Time calibration and monitoring in the Tile Calorimeter, ATL-TILECAL-INT-2020-003, CERN, Geneva, 2020
- [2] <https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PLOTS/TAU-2019-001/index.html>
- [3] ATLAS Collaboration, Measurements of Higgs boson production cross-sections in the $H \rightarrow \tau^+\tau^-$ decay channel in pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector, JHEP 08 (2022) 175
- [4] <https://atlas-glance.cern.ch/atlas/analysis/papers/details?id=15066>