Thursday 17th November, 2022
Today's Paper

The 2022 Chronicle

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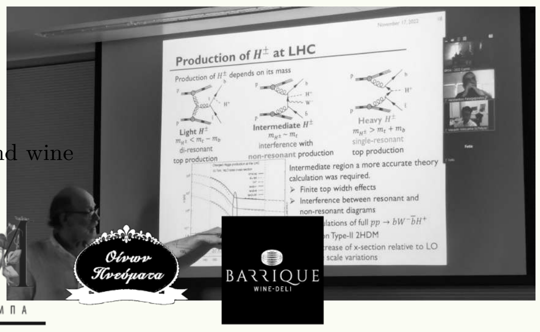
Fotios Ptochos Promoted to Professor!

Congratulations to Fotios Ptochos for his promotion to the rank of Full Professor, effective November 2022. This promotion recognizes Prof. Ptochos' achievements in scholarship, teaching in physics and research in high-energy physics (HEP), and his overall service to the CDF and CMS Collaborations. He is a Harvard University PhD in physics graduate (1998) and has been active in HEP-research, both in detector development and physics analyses since 1987. In particular, from 1987 to 1988 he worked in the development of a technique to monitor the purity of Liquid Argon (LAr) for the first ever prototype of the ICARUS detector, a technique that was subsequently used in the experiment. From 1989 to 1994 he worked in the characterization of various Tetramethyl liquids as part of a research project to find appropriate warm liquids media for the envisioned calorimeter detectors at SSC. He also worked in the construction, installation and calibration of the Central Muon Extension (CMX) system for the CDF detector. From 1994 to 1996 he developed an algorithm to improve electron identification for the CDF end-plug ECAL based on the information from the calorimeter and hits on the silicon tracker detector. The algorithm led to the development and implementation of the PHOENIX tracker system in the CDF-II detector. In the period of 2000–2003, he was the coordinator of the group responsible for the development, installation, maintenance and performance monitoring of the CDF-II Hadronic Calorimeter (HCAL) timing system. For the entire period of the Tevatron Run-II (2001-2011) he served as the coordinator of the CDF central HCAL calibration (CHA and WHA), maintenance and performance group. Since 2004, when he joined the faculty of the UCY Physics Department, he has been involved in the UCY HEP group activities related to the construction and running of the CMS ECAL at CERN. In 2009, he initiated th[illegible] group in the activities rela[illegible]e C[illegible]ng detector. He was also [illegible] in t[illegible]pment of the dual-readout calorimetry concept in a total absorption HCAL for future linear-collider experiments.

Professor Ptochos has led numerous physics analyses, spanning from precision measurements on properties of heavy flavour quark production and their use as probes for searching for the SM and SUSY Higgs bosons, to searches for BSM physics including SUSY, extra dimensions and other exotic processes. He has tremendous experience in heavy flavour tagging techniques and algorithms, tau-lepton identification techniques and new physics model building. He was the first ever recipient of the "Fermi National Accelerator Laboratory Fellowship" and has co-coordinated multiple research program funded primarily by the European Commission (EC) via Marie Skłodowska-Curie Actions, the Cyprus Research Promotion Foundation (RPF) through Didaktor or Excellence Hubs programs, the European Regional Development Fund, and UCY. Professor Ptochos is the author and co-author of more than 1700 publications in refereed scientific journals and a member of the editorial group in charge for producing the education material for the entire Cyprus Secondary Education. In addition, he has been the supervisor of the research activities of six postdoctoral fellows, five PhD and eleven MSc students, as well as the theses projects of more than 20 undergraduate students.



Top Quark, Last Piece of Matter, Appears to Be in Place

We establish the existence of the top quark using a 67 pb^{-1} data sample of pp collisions at $\sqrt{s} = 1.8$ TeV collected with the Collider Detector at Fermilab (CDF). Employing techniques similar to those we previously published, we observe a signal consistent with $t\bar{t}$ decay to WWbb, but inconsistent with the background prediction by 4.8σ. Additional evidence for the top quark is provided by a peak in the reconstructed mass distribution. We measure the top quark mass to be $176 \pm 8(\text{stat.}) \pm 10(\text{sys.})$ GeV/c^2, and the $t\bar{t}$ production cross section to be $6.8^{+3.6}_{-2.4}$ pb.

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Physicists Find Elusive Particle Seen as Key to Universe

Results are presented from searches for the standard model Higgs boson in proton–proton collisions at and 8 TeV in the Compact Muon Solenoid experiment at the LHC, using data samples corresponding to integrated luminosities of up to 5.1 fb^1 at 7 TeV and 5.3 fb^1 at 8 TeV. The search is performed in five decay modes: $\gamma\gamma$, ZZ, $\tau^+\tau^-$, and $b\bar{b}$. An excess of events is observed above the expected background, with a local significance of 5.0 standard deviations, at a mass near 125 GeV, signalling the production of a new particle. The expected significance for a standard model Higgs boson of that mass is 5.8 standard deviations. The excess is most significant in the two decay modes with the best mass resolution, $\gamma\gamma$ and ZZ; a fit to these signals gives a mass of $125.3 \pm 0.4(\text{stat.}) \pm 0.5(\text{syst.}$ GeV. The decay to two photons indicates that the new particle is a boson with spin different from one.

Spooky Multi-Muon Events Puzzle Physicists

CDF recently submitted a paper that helped to explain several long standing puzzles associated with the production of bottom quarks at the Tevatron. And in addition to solving these problems, researchers observed something perhaps even more interesting, a new, bigger puzzle.

The work begins with a recent CDF measurement of the rate at which bottom and antibottom quarks are produced at the Tevatron. The analysis uses muons produced in the decay of bottom quarks to identify the signal events. Although previous measurements showed deviations from the predicted production rates, this newer, more precise measurement was found to agree well with the theoretical expectation. Interestingly, CDF found that the previous measurements could be explained by a source of background events that had not been previously identified. Earlier analyses were unable to separate this source of background from the bottom-quark signal, causing researchers to miscount the number of bottom quarks produced.

The source of these background events, whimsically called "ghost events", is the new puzzle. The properties of this background are quite different than background sources that had been previously identified. In particular, the ghost events contain more muons than are expected from known background sources.

The paper is just the beginning of the story. Ghost-busters have been called in and are working to refine our understanding of these events to see whether they provide evidence for new physics beyond the Standard Model or whether these events exploited some lack of understanding of the detector. The Tevatron may still have some surprises in store for us, and only time will tell whether we should believe in ghosts.

The following physicists played a leading role in this analysis: From left to right: Min Jeong Kim, Fotis Ptochos, Fabio Happacher. Not shown: Paolo Giromini.

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Higgs boson: a tool to discover new physics: $H^{\pm}$

A search for a charged Higgs boson $H^{\pm}$ decaying into a heavy neutral Higgs boson H and a W boson is presented. The analysis targets the W decay into a pair of tau leptons with at least one of them decaying hadronically and with an additional electron or muon present in the event. The search is based on proton-proton collision data recorded by the CMS experiment during 2016–2018 at $\sqrt{s}$ = 13 TeV, corresponding to an integrated luminosity of 138 fb^{-1}. The data are consistent with standard model background expectations. Upper limits at 95% confidence level are set on the product of the cross section and branching fraction for an $H^{\pm}$ in the mass range of 300–700 GeV, assuming an H with a mass of 200 GeV. The observed limits range from 0.085 pb for an $H^{\pm}$ mass of 300 GeV to 0.019 pb for a mass of 700 GeV. These are the first limits on $H^{\pm}$ production in the $H^{\pm} \to HW^{\pm}$ decay channel at the LHC.

Search for charged Higgs bosons!

A search for charged Higgs bosons ($H^{\pm}$) decaying into a top and a bottom quark in the all-jet final state is presented. The analysis uses LHC proton-proton collision data recorded with the CMS detector in 2016 at $\sqrt{s}$ = 13 TeV, corresponding to an integrated luminosity of 35.9 fb^{-1}. No significant excess is observed above the expected background. Model-independent upper limits at 95% confidence level are set on the product of the $H^{\pm}$ production cross section and branching fraction in two scenarios. For production in association with a top quark, limits of 21.3 to 0.007pb are obtained for $H^{\pm}$ masses in the range of 0.2 to 3 TeV. Combining this with a search in leptonic final states results in improved limits of 9.25 to 0.005 pb. The complementary s-channel production of an $H^{\pm}$ is investigated in the mass range of 0.8 to 3 TeV and the corresponding upper limits are 4.5 to 0.023 pb. These results are interpreted using different minimal supersymmetric extensions of the standard model.