November 14, 2022
Today's Paper

The 2022 Chronicle

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, 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 the involvement of the group in the activities related to the CMS tracking detector. He was also involved in the development 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 co-coordinator of the research program "High-Energy Physics with the CMS Experiment at LHC, CERN" that received funding by the Cyprus RPF (2007-2012). He was also the coordinator of the research project "Search for light neutral NMSSM Higgs bosons at CMS", also funded by the Cyprus RPF (2009- 2012) and co-coordinator of a European Regional Development Fund with title "The Regional Europe at the centre of the modern scientific research - A Collaboration between Greece and Cyprus in High-Energy Physics and Cosmology" (2006-2008). He was also the coordinator of a three-year research project on "Search for neutral SM and MSSM Higgs bosons in the decay channel $H^0/A^0/h^0 \to \tau^+\tau^-$"" funded by the Cyprus RPF (2011-2014). He was also the first ever recipient of the "Fermi National Accelerator Laboratory Fellowship" for international senior researches (2007-2008). Soon after he was the Scientist in Charge of a Marie-Curie Intra-European Fellowship (IEF) entitled "HLTaus: A Level-1 Tau Trigger for CMS at HL-LHC" (2014-2016) and of a two year project funded by UCY on "Tau hadronic triggers in the HL-LHC era" (2016-2018). Most recently he coordinated two research projects funded by the Cyprus RPF on "Search for a charged Higgs boson in a neutral Higgs boson and a W boson final state" and "Search for charged Higgs bosons decaying to W and neutral Higgs bosons with deep learning techniques" (2019-2021). He is also a member of the European COST action CA16108 on "VBS scan (Vector Boson Scattering)" (2018 – 2021). Professor Ptochos has been 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 (student instruction books and corresponding laboratory activities, teachers' instruction manuals) 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.

Search for charged Higgs bosons decaying into a top and a bottom quark in the all-jet final state

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.

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 ± 0.4(stat.) ± 0.5(syst. GeV. The decay to two photons indicates that the new particle is a boson with spin different from one.

November 14, 2022
Today's Paper

The 2022 Chronicle

CDF publishes multi-muons!

We report a study of multi-muon events produced at the Fermilab Tevatron collider and recorded by the CDF II detector. In a data set acquired with a dedicated dimuon trigger and corresponding to an integrated luminosity of 2100 pb^{-1}, we isolate a significant sample of events in which at least one of the muon candidates is produced outside of the beam pipe of radius 1.5 cm. The production cross section and kinematics of events in which both muon candidates are produced inside the beam pipe are successfully modeled by known QCD processes which include heavy flavor production. In contrast, we are presently unable to fully account for the number and properties of the remaining events, in which at least one muon candidate is produced outside of the beam pipe, in terms of the same understanding of the CDF II detector, trigger, and event reconstruction. Several topological and kinematic properties of these events are presented in this paper. These events offer a plausible resolution to long-standing inconsistencies related to $b\bar{b}$ production and decay.

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 $H^{\pm} \rightarrow HW^{\pm}$ decay channel at the LHC.

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±8(stat.)±10(sys.) GeV/c^2, and the $t\bar{t}$ production cross section to be $6.8^{+3.6}_{-2.4}$ pb.

Multi-Muons In CDF: The Mystery Continues

We present a phenomenological conjecture of new physics that is suggested by the topology and kinematic properties of the multi-muon events recently reported by the CDF collaboration. We show that the salient features of the data can be accounted for by postulating the pair production of three new states h_1, h_2, and h_3 with masses in the range of 15, 7.3, and 3.6 GeV/c^2, respectively. The heavier states cascade-decay into the lighter ones, whereas the lightest state decays into a τ pair with a lifetime of the order of 20 ps.