Thursday 17th November, 2022
Today's Paper

# The 2022 Chronicle

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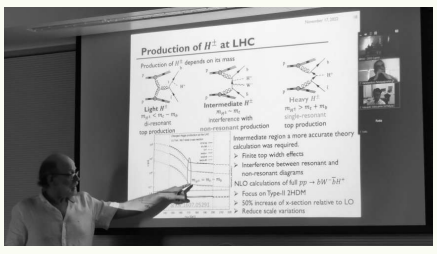
## Fotios Ptochos Promoted to Professor!

Congratulations to Fotios Ptochos for his promotion to the rank of Full Professor, effective from Thursday 17th 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 since 1987. In particular, from 1987 to 1988 he worked in the development of a technique to monitor the LAr purity for the first ever prototype of the ICARUS detector. From 1989 to 1994 he worked in the characterization of various Tetramethyl liquids for the envisioned calorimeter detectors at the SSC. He also worked in the construction, installation and calibration of the CMX system for the CDF detector. From 1994 to 1996 he developed an algorithm to improve electron identification for the CDF endplug ECAL, which led to the development and implementation of the PHOENIX tracker system in CDF-II.

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 HCAL timing system. For the entire Tevatron Run-II (2001-2011) he served as the coordinator of the CDF central HCAL calibration, 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 efforts related to the CMS tracking detector and was 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 the first ever recipient of the "Fermi National Accelerator Laboratory Fellowship" and has co-coordinated multiple research program funded primarily by the EC via Marie Skłodowska-Curie Actions, the Cyprus RPF through Didaktor and Excellence Hubs programs, the ERDF, and UCY. He is the author and co-author of more than 1850 publications in refereed scientific journals and co-editor of education material for the entire Cyprus Secondary Education. He has supervised 6 postdoctoral fellows, 5 PhD and 11 MSc students, as well as projects of more than 20 undergraduate students.

## 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.

## Spooky Multi-Muon Events Puz 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 expectati Interestingly, C found that the p vious measureme could be explained a source of backgrou events that had been previously id tified. Earlier analy were unable to s arate this source background from bottom-quark sig causing researchers miscount the num of bottom quarks p duced.

The source of th background eve whimsically ca "ghost events", is new puzzle. The pr erties of this ba ground are quite ferent than ba ground sources t had been previou identified. In par ular, the ghost eve contain more mu than are expec from known ba ground sources.

The following physicists played a leading role in this analysis: From left to right: Min Jeong Kim Fotis Ptohos, Fabio Happacher.

## 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 4.8$\sigma$. 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.

## 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.

## 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. production in ass tion with a top qu limits of 21.3 to 0.0 are obtained for masses in the rang 0.2 to 3 TeV. Com ing this with a se in leptonic final st results in improved its of 9.25 to 0.005 The complementar channel productio an $H^{\pm}$ is investigate the mass range of to 3 TeV and the responding upper its are 4.5 to 0.023 These results are terpreted using d ent minimal supers metric extensions o standard model.

## Charged Higgs boson Hunting

$t \to bH^{\pm} \to \tau^{\pm}\nu_{\tau}$.....25 May 2012
$H^{\pm} \to tb$ and $H^{\pm} \to \tau\nu$.....31 August 2015
$H^{\pm} \to \tau^{\pm}\nu_{\tau}$ .....11 March 2019
$pp \to t(b)H^{\pm} \to tb$, all-jet.....21 January 2020
$pp \to t(b)H^{\pm} \to W^{\pm}H^0(\tau\tau)$.....4 July 2022

## Master of Masterclasses

Another particle physics masterclass was organized at the University of Cyprus by Professor Fotios Ptochos for the 8th year in a row. It took within the framework of the IPPOG effort, with the aim of informing young students about the research being carried out at CERN and the wider field of Particle Physics. Department of Physics. The event you took place on Saturday 07 March 2020 at the University of Cyprus Campus between 9:00 - 17:00. It included lectures about the world of elementary particles, detection methods, and the technology developed starting with basic research in both this and related fields of physics. Students had a unique opportunity to analyze data from proton-proton collisions, as recorded by the CMS detector at CERN's LHC. They discussed their findings with students from other countries as well as scientists at CERN through a video conference.