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Astroparticle, Particle, Space Physics and Detectors for Physics Applications - S Giani 2012-08-02

The exploration of the subnuclear world is done through increasingly complex experiments covering a wide range of energy and performed in a large variety of environments ranging from particle accelerators, underground detectors to satellites and the space laboratory. Among recent advances one has to indicate, for instance, first results obtained from space and LHC experiments and progress done in preparation of the latter experiments upgrades, including plans for the LHC machine upgrade. The achievement of these research programs calls for novel techniques, new materials and instrumentation to be used in detectors, often of large scale. Therefore, fundamental physics is at the forefront of technological advance and also leads to many applications. Among these, medical applications have a particular importance due to health and social benefits they bring to the public. Contents:Space Experiments and Cosmic Rays ObservationsProduction and Propagation of Cosmic Rays in the Galaxy and HeliosphereDark Matter Searches, Underwater and Underground ExperimentsHigh Energy Physics ExperimentsTracker and Position Sensitive Detectors CalorimetryAdvanced Detectors, Particles Identication, Devices and Materials in RadiationBroader Impact Activities, Treatments and Software Application Readership: Post-graduate students, researchers and engineers.
Keywords:Astroparticle;Particle;Space Physics;Cosmic Ray Physics;Heliosphere;Dark Matter;Double-Beta Decay

Discovery in Physics - Katharina Morik 2022-12-31

Machine learning is part of Artificial Intelligence since its beginning. Certainly, not learning would only allow the perfect being to show intelligent behavior. All others, be it humans or machines, need to learn in order to enhance their capabilities. In the eighties of the last century, learning from examples and modeling human learning strategies have been investigated in concert. The formal statistical basis of many learning methods has been put forward later on and is still an integral part of machine learning. Neural networks have always been in the toolbox of methods. Integrating all the pre-processing, exploitation of kernel functions, and transformation steps of a machine learning process into the architecture of a deep neural network increased the performance of this model type considerably. Modern machine learning is challenged on the one hand by the amount of data and on the other hand by the demand of real-time inference. This leads to an interest in computing architectures and modern processors. For a long time, the machine learning research could take the von-Neumann architecture for granted. All algorithms were designed for the classical CPU. Issues of implementation on a particular architecture have been ignored. This is no longer possible. The time for independently investigating machine learning and computational architecture is over. Computing architecture has experienced a similarly rampant development from mainframe or personal computers in the last century to now very large compute clusters on the one hand and ubiquitous computing of embedded systems in the Internet of Things on the other hand. Cyber-physical systems' sensors produce a huge amount of streaming data which need to be stored and analyzed. Their actuators need to react in real-time. This clearly establishes a close connection with machine learning. Cyber-physical systems and systems in the Internet of Things consist of diverse components, heterogeneous both in hard- and software. Modern multi-core systems, graphic processors, memory technologies and hardware-software codesign offer opportunities for better implementations of machine learning models. Machine learning and embedded systems together now form a field of research which tackles leading edge problems in machine learning, algorithm engineering, and embedded systems. Machine learning today needs to make the resource demands of learning and inference meet the resource constraints of used computer architecture and platforms. A large variety of algorithms for the same learning method and, moreover, diverse implementations of an algorithm for particular computing architectures optimize learning with respect to resource efficiency while keeping some guarantees of accuracy. The trade-off between a decreased energy consumption and an increased error rate, to just give an example, needs to be theoretically shown for training a model and the model inference. Pruning and quantization are ways of reducing the resource requirements by either compressing or approximating the model. In addition to memory and energy consumption, timeliness is an important issue, since many embedded systems are integrated into large products that interact with the physical world. If the results are delivered too late, they may have become useless. As a result, real-time guarantees are needed for such systems. To efficiently utilize the available resources, e.g., processing power, memory, and accelerators, with respect to response time, energy consumption, and power dissipation, different scheduling algorithms and resource management strategies need to be developed. This book series addresses machine learning under resource constraints as well as the application of the described methods in various domains of science and engineering. Turning big data into smart data requires many steps of data analysis: methods for extracting and selecting features, filtering and cleaning the data, joining heterogeneous sources, aggregating the data, and learning predictions need to scale up. The algorithms are challenged on the one hand by high-throughput data, gigantic data sets like in astrophysics, on the other hand by high dimensions like in genetic data. Resource constraints are given by the relation between the demands for processing the data and the capacity of the computing machinery. The resources are runtime, memory, communication, and energy. Novel machine learning algorithms are optimized with regard to minimal resource consumption. Moreover, learned predictions are applied to program executions in order to save resources. The three books will have the following subtopics: Volume 1: Machine Learning under Resource Constraints - Fundamentals Volume 2: Machine Learning and Physics under Resource Constraints - Discovery Volume 3: Machine Learning under Resource Constraints - Applications Volume 2 is about machine learning for knowledge discovery in particle and astroparticle physics. Their instruments, e.g., particle accelerators or telescopes, gather petabytes of data. Here, machine learning is necessary not only to process the vast amounts of data and to detect the relevant examples efficiently, but also as part of the knowledge discovery process itself. The physical knowledge is encoded in simulations that are used to train the machine learning models. At the same time, the interpretation of the learned models serves to expand the physical knowledge. This results in a cycle of theory enhancement supported by machine learning.

Astroparticle, Particle, Space Physics and Detectors for Physics Applications - S. Giani 2012

The exploration of the subnuclear world is done through increasingly complex experiments covering a wide range of energy and performed in a large variety of environments ranging from particle accelerators, underground detectors to satellites and the space laboratory. Among recent advances one has to indicate, for instance, first results obtained from space and

LHC experiments and progress done in preparation of the latter experiments upgrades, including plans for the LHC machine upgrade. The achievement of these research programs calls for novel techniques, new materials and instrumentation to be used in detectors, often of large scale. Therefore, fundamental physics is at the forefront of technological advance and also leads to many applications. Among these, medical applications have a particular importance due to health and social benefits they bring to the public. Sample Chapter(s). Science highlights from the Fenni Observatory (5,046 KB). Contents: Space Experiments and Cosmic Rays Observations; Production and Propagation of Cosmic Rays in the Galaxy and Heliosphere; Dark Matter Searches, Underwater and Underground Experiments; High Energy Physics Experiments; Tracker and Position Sensitive Detectors; Calorimetry; Advanced Detectors, Particles Identication, Devices and Materials in Radiation; Broader Impact Activities, Treatments and Software Application. Readership: Post-graduate students, researchers and engineers.

Technology Meets Research - 60 Years Of Cern Technology: Selected Highlights - Christian W Fabjan 2017-04-27

'The contributions from leading scientists of the day collected in this relatively slim book document CERN's 60-year voyage of innovation and discovery, the repercussions of which vindicate the vision of those who drove the foundation of the laboratory — European in constitution, but global in impact. The spirit of inclusive collaboration, which was a key element of the original vision for the laboratory, together with the aim of technical innovation and scientific excellence, are reflected in each of the articles in this unique volume.'CERN Courier'Big' science and advanced technology are known to cross-fertilize. This book emphasizes the interplay between particle physics and technology at CERN that has led to breakthroughs in both research and technology over the laboratory's first 60 years. The innovations, often the work of individuals or by small teams, are illustrated with highlights describing selected technologies from the domains of accelerators and detectors. The book also presents the framework and conditions prevailing at CERN that enabled spectacular advances in technology and contributed to propel the European organization into the league of leading research laboratories in the world.While the book is specifically aimed at providing information for the technically interested general public, more expert readers may also appreciate the broad variety of subjects presented. Ample references are given for those who wish to further explore a given topic.

Calorimetry - Richard Wigmans 2017-10-06

Particle physics is the science that pursues the age-old quest for the innermost structure of matter and the fundamental interactions between its constituents. Modern experiments in this field rely increasingly on calorimetry, a detection technique in which the particles of interest are absorbed in the detector. Calorimeters are very intricate instruments. Their performance characteristics depend on subtle, sometimes counter-intuitive design details. Written by one of the world's foremost experts, Calorimetry is the first comprehensive text on this topic. It provides a fundamental and systematic introduction to calorimetry. It describes the state of the art in terms of both the fundamental understanding of calorimetric particle detection, and the actual detectors that have been or are being built and operated in experiments. The last chapter discusses landmark scientific discoveries in which calorimetry has played an important role. This book summarizes and puts into perspective the work described in some 900 scientific papers, listed in the bibliography. This second edition emphasizes new developments that have taken place since the first edition appeared in 2000.

Discovery and Measurement of the Higgs Boson in the WW Decay Channel - David Hall 2015-06-15

This thesis describes the stand-alone discovery and measurement of the Higgs boson in its decays to two W bosons using the Run-I ATLAS dataset. This is the most precise measurement of gluon-fusion Higgs boson production and is among the most significant results attained at the LHC. The thesis provides an exceptionally clear exposition on a complicated analysis performed by a large team of researchers. Aspects of the analysis performed by the author are explained in detail; these include new methods for evaluating uncertainties on the jet binning used in the analysis and for estimating the background due to associated production of a W boson and an off-shell photon. The thesis also describes a measurement of the WW cross section, an essential background to Higgs boson production. The primary motivation of the LHC was to prove or disprove the existence of the Higgs boson. In 2012, CERN announced this discovery and the resultant ATLAS publication contained three decay channels: gg, ZZ, and WW.

Large Area Networked Detectors for Particle Astrophysics - Pierre Sokolsky and Gus Sinnis

Data Analysis in High Energy Physics - Olaf Behnke 2013-08-30

This practical guide covers the essential tasks in statistical data analysis encountered in high energy physics and provides comprehensive advice for typical questions and problems. The basic methods for inferring results from data are presented as well as tools for advanced tasks such as improving the signal-to-background ratio, correcting detector effects, determining systematics and many others. Concrete applications are discussed in analysis walkthroughs. Each chapter is supplemented by numerous examples and exercises and by a list of literature and relevant links. The book targets a broad readership at all career levels - from students to senior researchers. An accompanying website provides more algorithms as well as up-to-date information and links. * Free solutions manual available for lecturers at www.wiley-vch.de/supplements/

The Search for Supersymmetry in Hadronic Final States Using Boosted Object Reconstruction - Giordon Stark 2020-03-13

This thesis represents one of the most comprehensive and in-depth studies of the use of Lorentz-boosted hadronic final state systems in the search for signals of Supersymmetry conducted to date at the Large Hadron Collider. A thorough assessment is performed of the observables that provide enhanced sensitivity to new physics signals otherwise hidden under an enormous background of top quark pairs produced by Standard Model processes. This is complemented by an ingenious analysis optimization procedure that allowed for extending the reach of this analysis by hundreds of GeV in mass of these hypothetical new particles. Lastly, the combination of both deep, thoughtful physics analysis with the development of high-speed electronics for identifying and selecting these same objects is not only unique, but also revolutionary. The Global Feature Extraction system that the author played a critical role in bringing to fruition represents the first dedicated hardware device for selecting these Lorentz-boosted hadronic systems in real-time using state-of-the-art processing chips and embedded systems.

Discovery of the Higgs Boson - Aleandro Nisati 2016-08-26

The recent observation of the Higgs boson has been hailed as the scientific discovery of the century and led to the 2013 Nobel Prize in physics. This book describes the detailed science behind the decades-long search for this elusive particle at the Large Electron Positron Collider at CERN and at the Tevatron at Fermilab and its subsequent discovery and characterization at the Large Hadron Collider at CERN. Written by physicists who played leading roles in this epic search and discovery, this book is an authoritative and pedagogical exposition of the portrait of the Higgs boson that has emerged from a large number of experimental measurements. As the first of its kind, this book should be of interest to graduate students and researchers in particle physics.

Machine Learning at the Belle II Experiment - Thomas Keck 2018-12-29

This book explores how machine learning can be used to improve the efficiency of expensive fundamental science experiments. The first part introduces the Belle and Belle II experiments, providing a detailed description of the Belle to Belle II data conversion tool, currently used by many analysts. The second part covers machine learning in high-energy physics, discussing the Belle II machine learning infrastructure and selected algorithms in detail. Furthermore, it examines several machine learning techniques that can be used to control and reduce systematic uncertainties. The third part investigates the important exclusive B tagging technique, unique to physics experiments operating at the Y resonances, and studies in-depth the novel Full Event Interpretation algorithm, which doubles the maximum tag-side efficiency of its predecessor. The fourth part presents a complete measurement of the branching fraction of the rare leptonic B decay “B→tau

nu", which is used to validate the algorithms discussed in previous parts.

Search for the Higgs Boson Produced in Association with Top Quarks with the CMS Detector at the LHC - Cristina Martin Perez 2022-02-09

In this work, the interaction between the Higgs boson and the top quark is studied with the proton-proton collisions at 13 TeV provided by the LHC at the CMS detector at CERN (Geneva). At the LHC, these particles are produced simultaneously via the associate production of the Higgs boson with one top quark (tH process) or two top quarks (ttH process). Compared to many other possible outcomes of the proton-proton interactions, these processes are very rare, as the top quark and the Higgs boson are the heaviest elementary particles known. Hence, identifying them constitutes a significant experimental challenge. A high particle selection efficiency in the CMS detector is therefore crucial. At the core of this selection stands the Level-1 (L1) trigger system, a system that filters collision events to retain only those with potential interest for physics analysis. The selection of hadronically decaying τ leptons, expected from the Higgs boson decays, is especially demanding due to the large background arising from the QCD interactions. The first part of this thesis presents the optimization of the L1 τ algorithm in Run 2 (2016-2018) and Run 3 (2022-2024) of the LHC. It includes the development of a novel trigger concept for the High-Luminosity LHC, foreseen to start in 2027 and to deliver 5 times the current instantaneous luminosity. To this end, sophisticated algorithms based on machine learning approaches are used, facilitated by the increasingly modern technology and powerful computation of the trigger system. The second part of the work presents the search of the tH and ttH processes with the subsequent decays of the Higgs boson to pairs of τ lepton, W bosons or Z bosons, making use of the data recorded during Run 2. The presence of multiple particles in the final state, along with the low cross section of the processes, makes the search an ideal use case for multivariant discriminants that enhance the selectivity of the signals and reject the overwhelming background contributions. The discriminants presented are built using state-of-the-art machine learning techniques, able to capture the correlations amongst the processes involved, as well as the so-called Matrix Element Method (MEM), which combines the theoretical description of the processes with the detector resolution effects. The level of sophistication of the methods used, along with the unprecedented amount of collision data analyzed, result in the most stringent measurements of the tH and ttH cross sections up to date.

Statistical Methods for Data Analysis in Particle Physics - Luca Lista 2017-10-13

This concise set of course-based notes provides the reader with the main concepts and tools needed to perform statistical analyses of experimental data, in particular in the field of high-energy physics (HEP). First, the book provides an introduction to probability theory and basic statistics, mainly intended as a refresher from readers' advanced undergraduate studies, but also to help them clearly distinguish between the Frequentist and Bayesian approaches and interpretations in subsequent applications. More advanced concepts and applications are gradually introduced, culminating in the chapter on both discoveries and upper limits, as many applications in HEP concern hypothesis testing, where the main goal is often to provide better and better limits so as to eventually be able to distinguish between competing hypotheses, or to rule out some of them altogether. Many worked-out examples will help newcomers to the field and graduate students alike understand the pitfalls involved in applying theoretical concepts to actual data. This new second edition significantly expands on the original material, with more background content (e.g. the Markov Chain Monte Carlo method, best linear unbiased estimator), applications (unfolding and regularization procedures, control regions and simultaneous fits, machine learning concepts) and examples (e.g. look-elsewhere effect calculation).

The Digital Journey of Banking and Insurance, Volume III - Volker Liermann 2021-10-27

This book, the third one of three volumes, focuses on data and the actions around data, like storage and processing. The angle shifts over the volumes from a business-driven approach in "Disruption and DNA" to a strong technical focus in "Data Storage, Processing and Analysis", leaving "Digitalization and Machine Learning Applications" with the business and technical aspects in-between. In the last volume of the series, "Data Storage, Processing and Analysis", the shifts in the way we deal with data are addressed.

QCD Radiation in Top-Antitop and Z+Jets Final States - Kiran Joshi 2015-06-12

This thesis contains new research in both experimental and theoretical particle physics, making important contributions in each. Two analyses of collision data from the ATLAS experiment at the LHC are presented, as well as two phenomenological studies of heavy coloured resonances that could be produced at the LHC. The first data analysis was the measurement of top quark-antiquark production with a veto on additional jet activity. As the first detector-corrected measurement of jet activity in top-antitop events it played an important role in constraining the theoretical modelling, and ultimately reduced these uncertainties for ATLAS's other top-quark measurements by a factor of two. The second data analysis was the measurement of Z+2jet production and the observation of the electroweak vector boson fusion (VBF) component. As the first observation of VBF at a hadron collider, this measurement demonstrated new techniques to reliably extract VBF processes and paved the way for future VBF Higgs measurements. The first phenomenological study developed a new technique for identifying the colour of heavy resonances produced in proton-proton collisions. As a by-product of this study an unexpected and previously unnoticed correlation was discovered between the probability of correctly identifying a high-energy top and the colour structure of the event it was produced in. The second phenomenological study explored this relationship in more detail, and could have important consequences for the identification of new particles that decay to top quarks.

Combinatorial Kalman Filter and High Level Trigger Reconstruction for the Belle II Experiment - Nils Braun 2019-08-06

Combinatorial Kalman filters are a standard tool today for pattern recognition and charged particle reconstruction in high energy physics. In this thesis the implementation of the track finding software for the Belle II experiment and first studies on early Belle II data are presented. The track finding algorithm exploits novel concepts such as multivariate track quality estimates to form charged trajectory hypotheses combining information from the Belle II central drift chamber with the inner vertex sub-detectors. The eventual track candidates show an improvement in resolution on the parameters describing their spatial and momentum properties by up to a factor of seven over the former legacy implementation. The second part of the thesis documents a novel way to determine the collision event null time T0 and the implementation of optimisation steps in the online reconstruction code, which proved crucial in overcoming the high level trigger limitations.

Searches for CP Violation in Charmed Meson Decays - Hamish Gordon 2014-06-07

Our current understanding of the fundamental building blocks of the Universe, summarised by the Standard Model of particle physics, is incomplete. For example, it fails to explain why we do not see equal, or almost equal, numbers of particles and their antiparticle partners. To explain this asymmetry requires, among other effects, a mechanism known as charge-parity (CP) violation that causes differences between the rates at which particles and antiparticles decay. CP violation is seen in systems containing bottom and strange quarks, but not in those with up, charm or top quarks. This thesis describes searches for particle-antiparticle asymmetries in the decay rates of charmed mesons. No evidence of CP violation is found. With current sensitivities, an asymmetry large enough to observe probably could not be explained by the Standard Model. Instead an explanation could come from new physics, for example contributions from supersymmetric or other undiscovered heavy particles. In the thesis, the development of new techniques to search for these asymmetries is described. They are applied to data from the LHCb experiment at CERN to make precise measurements of asymmetries in the D^+->K^-K^+pi^+ decay channel. This is the most promising charged D decay for CP violation searches.

Emerging Trends in Computing and Expert Technology - D. Jude Hemanth

2019-11-07

This book presents high-quality research papers that demonstrate how emerging technologies in the field of intelligent systems can be used to effectively meet global needs. The respective papers highlight a wealth of innovations and experimental results, while also addressing proven IT governance, standards and practices, and new designs and tools that facilitate rapid information flows to the user. The book is divided into five major sections, namely: “Advances in High Performance Computing”, “Advances in Machine and Deep Learning”, “Advances in Networking and Communication”, “Advances in Circuits and Systems in Computing” and “Advances in Control and Soft Computing”.

The XVIII International Conference on Strangeness in Quark Matter (SQM 2019) - Domenico Elia 2020-10-03

This book focuses on new experimental and theoretical advances concerning the role of strange and heavy-flavour quarks in high-energy heavy-ion collisions and in astrophysical phenomena. The topics covered include • Strangeness and heavy-quark production in nuclear collisions and hadronic interactions, • Hadron resonances in the strongly-coupled partonic and hadronic medium, • Bulk matter phenomena associated with strange and heavy quarks, • QCD phase structure, • Collectivity in small systems, • Strangeness in astrophysics,• Open questions and new developments.

Measurement of Higgs Boson Production Cross Sections in the Diphoton Channel - Ahmed Tarek Abouelfadl Mohamed 2020-11-12

This thesis presents the measurement of the Higgs boson cross section in the diphoton decay channel. The measurement relies on proton-proton collision data at a center-of-mass energy $\sqrt{s}$ = 13 TeV recorded by the ATLAS experiment at the Large Hadron Collider (LHC). The collected data correspond to the full Run-2 dataset with an integrated luminosity of 139 fb-1. The measured cross sections are used to constrain anomalous Higgs boson interactions in the Effective Field Theory (EFT) framework. The results presented in this thesis represent a reduction by a factor 2 of the different photon and jet energy scale and resolution systematic uncertainties with respect to the previous ATLAS publication. The thesis details the calibration of electron and photon energies in ATLAS, in particular the measurement of the presampler energy scale and the estimation of its systematic uncertainty. This calibration was used to perform a measurement of the Higgs boson mass in the $H \to \gamma\gamma$ and $H \to 4l$ channels using the 36 fb−1 dataset.

Study of Double Charm B Decays with the LHCb Experiment at CERN and Track Reconstruction for the LHCb Upgrade - Renato Quagliani 2018-11-04

This book discusses the study of double charm B decays and the first observation of B0->D0D0Kst0 decay using Run I data from the LHCb experiment. It also describes in detail the upgrade for the Run III of the LHCb tracking system and the trigger and tracking strategy for the LHCb upgrade, as well as the development and performance studies of a novel standalone tracking algorithm for the scintillating fibre tracker that will be used for the LHCb upgrade. This algorithm alone allows the LHCb upgrade physics program to achieve incredibly high sensitivity to decays containing long-lived particles as final states as well as to boost the physics capabilities for the reconstruction of low momentum particles.

Artificial Intelligence For High Energy Physics - Paolo Calafiura 2022-01-05

The Higgs boson discovery at the Large Hadron Collider in 2012 relied on boosted decision trees. Since then, high energy physics (HEP) has applied modern machine learning (ML) techniques to all stages of the data analysis pipeline, from raw data processing to statistical analysis. The unique requirements of HEP data analysis, the availability of high-quality simulators, the complexity of the data structures (which rarely are image-like), the control of uncertainties expected from scientific measurements, and the exabyte-scale datasets require the development of HEP-specific ML techniques. While these developments proceed at full speed along many paths, the nineteen reviews in this book offer a self-contained, pedagogical introduction to ML models' real-life applications in HEP, written by some of the foremost experts in their area.

Supersymmetric Beasts and Where to Find Them - Marco Valente 2022-03-05

After an extensive overview of the Standard Model and of the theory and phenomenology of Supersymmetry, this book describes the recent development of the ATLAS Particle Flow algorithm, a hadronic reconstruction technique aiming at enhancing the sensitivity of the experiment to new physics through the combination of the information from different ATLAS sub-detectors. The first ever ATLAS strong SUSY search exploiting this technique is also described, reporting the results and exclusion limits obtained using the complete proton-proton collision dataset recorded by the ATLAS experiment during the second Run of the Large Hadron Collider (LHC).

Physics with Electrons in the ATLAS Detector - Kurt Brendlinger 2018-01-30

This thesis presents two production cross-section measurements of pairs of massive bosons using final states with leptons, made with the ATLAS detector at the Large Hadron Collider. The first measurement, performed using data collected in 2012 at center-of-mass energy $\sqrt{s}$ = 8 TeV, is the first fiducial and differential cross-section measurement of the production of the Higgs Boson when it decays to four charged leptons (electrons or muons). The second measurement is the first fiducial and inclusive production cross-section measurement of WZ pairs at center-of-mass energy $\sqrt{s}$ = 13 TeV using final states with three charged leptons. A significant portion of the thesis focuses on the methods used to identify electrons from massive boson decay—important for many flagship measurements—and on assessing the efficiency of these particle identification techniques. The chapter discussing the WZ pair cross-section measurement provides a detailed example of an estimate of lepton background in the context of an analysis with three leptons in the final state.

Progress in Pattern Recognition, Image Analysis, Computer Vision, and Applications - Marcelo Mendoza 2018-02-09

This book constitutes the refereed post-conference proceedings of the 22nd Iberoamerican Congress on Pattern Recognition, CIARP 2017, held in Valparaíso, Chile, in November 2017. The 87 papers presented were carefully reviewed and selected from 156 submissions. The papers feature research results in the areas of pattern recognition, image processing, computer vision, multimedia and related fields.

Searching for Squarks - Samuel Jones 2020-08-27

This thesis focuses on searches for squarks with the ATLAS detector in "compressed" scenarios where the scalar top is very close in mass to the lightest supersymmetric particle. These models are theoretically appealing because the presence of a quasi-degenerate scalar top enhances the self-annihilation cross-section of the lightest supersymmetric particle, acting therefore as a regulator of the dark matter relic density. Two main analyses are presented: the first is a search for scalar tops decaying to charm quarks. The identification of jets originating from the charm quark is very challenging due to its short lifetime. The calibration of tools for charm-tagging has paved the way to measuring the decay of the Higgs boson to pairs of charm quarks. The second analysis presented is the development of a novel technique for reconstructing low momentum b-hadrons. This tool has enabled the ATLAS collaboration to explore topologies that were previously inaccessible.

Advances in Jet Substructure at the LHC - Roman Kogler 2021-05-10

This book introduces the reader to the field of jet substructure, starting from the basic considerations for capturing decays of boosted particles in individual jets, to explaining state-of-the-art techniques. Jet substructure methods have become ubiquitous in data analyses at the LHC, with diverse applications stemming from the abundance of jets in proton-proton collisions, the presence of pileup and multiple interactions, and the need to reconstruct and identify decays of highly-Lorentz boosted particles. The last decade has seen a vast increase in our knowledge of all aspects of the field, with a proliferation of new jet substructure algorithms, calculations and measurements which are presented in this book. Recent developments and algorithms are described and put into the larger experimental context. Their usefulness and application are shown in many demonstrative examples and the phenomenological and experimental effects influencing their performance are discussed. A comprehensive overview is given of measurements and searches for new phenomena performed by the ATLAS and CMS Collaborations. This book

shows the impressive versatility of jet substructure methods at the LHC.
Proceedings of the XXIV DAE-BRNS High Energy Physics Symposium, Jatni, India - Bedangadas Mohanty 2022-10-05
This book presents proceedings from the XXIV DAE-BRNS High Energy Physics (HEP) Symposium 2020, held at the National Institute of Science Education and Research, Jatni, Odisha, India. The contributions cover a variety of topics in particle physics, astroparticle physics, cosmology and related areas from both experimental and theoretical perspectives, namely (1) Standard Model Physics, (2) Beyond Standard Model Physics, (3) Relativistic Heavy-Ion Physics & QCD, (4) Neutrino Physics, (5) Particle Astrophysics & Cosmology, (6) Detector Development Future Facilities and Experiments, (7) Formal Theory, (8) Societal Applications: Medical Physics, Imaging, etc.
Higgs boson potential at colliders: status and perspectives - Biagio Di Micco 2020-12-18
Questo documento riassume lo stato attuale degli ricerche studi, teorici e sperimentali, sulla produzione di coppie di bosoni di Higgs, e sui vincoli, sia diretti che indiretti, al valore del termine di auto-interazione del bosone di Higgs, con l'intento di servire da referenza per i prossimi anni. Il documento discute lo stato degli studi teorici, includendo le più recenti stime della sezione di produzione di coppie di bosoni di Higgs, sviluppi sulle teorie di campo efficaci, e studi su specifici scenari di nuova fisica che possono contribuire alla produzione di due bosoni di Higgs. Sono presentati i più recenti risultati sperimentali sulle ricerche di coppie di bosoni di Higgs e sui limiti diretti e indiretti al termine di auto-interazione, ottenuti al Large Hadron Collider di Ginevra, con una panoramica delle tecniche sperimentali. Infine, sono discusse le capacità dei collisionatori futuri di determinare il termine di auto-interazione del bosone di Higgs. Questo lavoro è iniziato come raccolta di contributi della conferenza "Di-Higgs ai Colliders", che ha avuto luogo a Fermilab dal 4 al 9 settembre 2018, ma gli argomenti discussi vanno al di là di quelli presentati alla conferenza, includendo ulteriori sviluppi.
Scalar Boson Decays to Tau Leptons - Cécile Caillol 2017-11-15
This thesis presents a study of the scalar sector in the standard model (SM), as well as various searches for an extended scalar sector in theories beyond the SM (BSM). The first part of the thesis details the search for an SM Higgs boson decaying to taus, and produced by gluon fusion, vector boson fusion, or associated production with a vector boson, leading to evidence for decays of the Higgs boson to taus. In turn, the second part highlights several searches for an extended scalar sector, with scalar boson decays to taus. In all of the analyses presented, at least one scalar boson decays to a pair of taus. The results draw on data collected by the Compact Muon Solenoid (CMS) detector during proton–proton collisions with a center-of-mass energy of 7 or 8 TeV.
The Road to Discovery - John Alison 2014-09-11
The research presented here includes important contributions on the commissioning of the ATLAS experiment and the discovery of the Higgs boson. The thesis describes essential work on the alignment of the inner tracker during the commissioning of the experiment and development of the electron identification algorithm. The subsequent analysis focuses on the search for the Higgs boson in the WW channel, including the development of a method to model the critical W+jet background. In addition, the thesis provides excellent introductions, suitable for non-specialists, to Higgs physics, to the LHC, and to the ATLAS experiment.
Search for Higgs Boson Pair Production in the $b\bar{b}$ τ+ τ- Decay Channel - Luca Cadamuro 2018-12-06
This thesis presents innovative contributions to the CMS experiment in the new trigger system for the restart of the LHC collisions in Run II, as well as original analysis methods and important results that led to official publications of the Collaboration. The author's novel reconstruction algorithms, deployed on the Field-Programmable Gate Arrays of the new CMS trigger architecture, have brought a gain of over a factor 2 in efficiency for the identification of tau leptons, with a very significant impact on important H boson measurements, such as its decays to tau lepton pairs and the search for H boson pair production. He also describes a novel analysis of HH → bb tautau, a high priority physics topic in a difficult channel. The original strategy, optimisation of event categories, and the control of the background have made the result one of the most sensitive concerning the self-coupling of the Higgs boson among all possible channels at the LHC.
Physics with Photons Using the ATLAS Run 2 Data - Stefano Manzoni 2019-08-02
The work presented in this book is based on the proton-proton collision data from the Large Hadron Collider at a centre-of-mass energy of 13 TeV recorded by the ATLAS detector in 2015 and 2016. The research program of the ATLAS experiment includes the precise measurement of the parameters of the Standard Model, and the search for signals of physics beyond the SM. Both these approaches are pursued in this thesis, which presents two different analyses: the measurement of the Higgs boson mass in the di-photon decay channel, and the search for production of supersymmetric particles (gluinos, squarks or winos) in a final state containing two photons and missing transverse momentum. Finally, ATLAS detector performance studies, which are key ingredients for the two analyses outlined before, are also carried out and described.
XXIII DAE High Energy Physics Symposium - Prafulla Kumar Behera 2021-05-18
This volume presents the peer-reviewed proceedings of the XXIII DAE-BRNS High Energy Physics Symposium 2018, which was held at the Indian Institute of Technology Madras, India, on 10-15 December 2018. Gathering selected contributions, the book highlights the latest developments and research trends in physics, detectors and instrumentation relevant to all branches of particle physics, astroparticle physics and closely related fields. The major topics covered include Standard Model physics, beyond Standard Model physics, neutrino physics, cosmology, formal theory, heavy ion physics & quantum chromodynamics (QCD), particle detectors and future experiments. Given the range of topics discussed, the book will be useful for beginners as well as advanced researchers in the field.
Neutrino Physics in Present and Future Kamioka Water-Čerenkov Detectors with Neutron Tagging - Pablo Fernández Menéndez 2018-07-21
This book discusses the upgrade of the Super-Kamiokande (SK) detector, which consists in the addition of a salt of gadolinium into the detector's water, the goal being to endow it with a very high-efficiency ability to detect neutrons: the SuperK-Gd project. This will substantially improve the scientific value of the SK detector because, among others, neutron production is related to the matter–antimatter character of the interacting neutrino. In this book the authors develop several procedures for maximizing the impact of neutron tagging in various physics analyses involving a broad range of neutrino energy. They thoroughly study the impact of new backgrounds introduced by Gd in key physics analyses, most remarkably including the search for the Diffuse Supernova Neutrino Background. At GeV energies, the neutron tagging improvements are evaluated by performing a complete neutrino oscillation sensitivity study using atmospheric and long baseline neutrinos, with a focus on the neutrino mass hierarchy and the leptonic CP violation. In order to prove the relevance of neutron tagging with the available data, the authors apply the neutron-tagging tools developed here to the 4th phase of the SK detector, which is already capable of detecting a low fraction of the neutrons produced through hydrogen-neutron captures. A global oscillation analysis of the SK's atmospheric neutrino data is also conducted.
Top Quark Pair Production - Anna Christine Henrichs 2013-10-04
Before any kind of new physics discovery could be made at the LHC, a precise understanding and measurement of the Standard Model of particle physics' processes was necessary. The book provides an introduction to top quark production in the context of the Standard Model and presents two such precise measurements of the production of top quark pairs in proton-proton collisions at a center-of-mass energy of 7 TeV that were observed with the ATLAS Experiment at the LHC. The presented measurements focus on events with one charged lepton, missing transverse energy and jets. Using novel and advanced analysis techniques as well as a good understanding of the detector, they constitute the most precise measurements of the quantity at that time.
Higgs Boson Decays into a Pair of Bottom Quarks - Cecilia Tosciri 2021-10-22

The discovery in 2012 of the Higgs boson at the Large Hadron Collider (LHC) represents a milestone for the Standard Model (SM) of particle physics. Most of the SM Higgs production and decay rates have been measured at the LHC with increased precision. However, despite its experimental success, the SM is known to be only an effective manifestation of a more fundamental description of nature. The scientific research at the LHC is strongly focused on extending the SM by searching, directly or indirectly, for indications of New Physics. The extensive physics program requires increasingly advanced computational and algorithmic techniques. In the last decades, Machine Learning (ML) methods have made a prominent appearance in the field of particle physics, and promise to address many challenges faced by the LHC. This thesis presents the analysis that led to the observation of the SM Higgs boson decay into pairs of bottom quarks. The analysis exploits the production of a Higgs boson associated with a vector boson whose signatures enable efficient triggering and powerful background reduction. The main strategy to maximise the signal sensitivity is based on a multivariate approach. The analysis is performed on a dataset corresponding to a luminosity of 79.8/fb collected by the ATLAS experiment during Run-2 at a centre-of-mass energy of 13 TeV. An excess of events over the expected background is found with an observed (expected) significance of 4.9 (4.3) standard deviation. A combination with results from other \Hbb searches provides an observed (expected) significance of 5.4 (5.5). The corresponding ratio between the signal yield and the SM expectation is 1.01 +- 0.12 (stat.)+ 0.16-0.15(syst.). The 'observation' analysis was further extended to provide a finer interpretation of the V H(H → bb) signal measurement. The cross sections for the VH production times the H → bb branching ratio have been measured in exclusive regions of phase space. These measurements are used to search for possible deviations from the SM with an effective field theory approach, based on anomalous couplings of the Higgs boson. The results of the cross-section measurements, as well as the constraining of the operators that affect the couplings of the Higgs boson to the vector boson and the bottom quarks, have been documented and discussed in this thesis. This thesis also describes a novel technique for the fast simulation of the forward calorimeter response, based on similarity search methods. Such techniques constitute a branch of ML and include clustering and indexing methods that enable quick and efficient searches for vectors similar to each other. The new simulation approach provides optimal results in terms of detector resolution response and reduces the computational requirements of a standard particles simulation.

Observation of a New State in the Search for the Higgs Boson at CMS - Giovanni Petrucciani 2014-12-04

This book describes the searches that lead to the discovery of a Higgs boson performed at CMS, one of the two main experiments at the CERN LHC. After an overview of the theory and of the CMS experiment, all search channels are described, with emphasis on the ones with the best sensitivity. The statistical methodology used to analyse and the outcomes of the searches and the discovery results are then presented in detail.

Searches for the Supersymmetric Partner of the Top Quark, Dark Matter and Dark Energy at the ATLAS Experiment - Nicolas Maximilian Köhler 2019-09-13

Astrophysical observations implying the existence of Dark Matter and Dark Energy, which are not described by the Standard Model (SM) of particle physics, have led to extensions of the SM predicting new particles that could be directly produced at the Large Hadron Collider (LHC) at CERN. Based on 2015 and 2016 ATLAS proton-proton collision data, this thesis presents searches for the supersymmetric partner of the top quark, for Dark Matter, and for DarkEnergy, in signatures with jets and missing transverse energy. Muon detection is key to some of the most important LHC physics results, including the discovery of the Higgs boson and the measurement of its properties. The efficiency with which muons can be detected with the ATLAS detector is measured using Z boson decays. The performance of high-precision Monitored Drift Tube muon chambers under background rates similar to the ones expected for the High Luminosity-LHC is studied.

Methodology of Social Research - Dr. Vidyapati Gautam 2021-09-11

Social scientists are divided into camps of support for particular research techniques. These disputes relate to the historical core of social theory (positivism and antipositivism; structure and agency). While very different in many aspects, both qualitative and quantitative approaches involve a systematic interaction between theory and data. The choice of method often depends largely on what the researcher intends to investigate. For example, a researcher concerned with drawing a statistical generalization across an entire population may administer a survey questionnaire to a representative sample population. There are no laws in social science that parallel the laws in natural science. Law in social science is a universal generalization about a class of facts. A fact is an observed phenomenon, and observation means it has been seen, heard or otherwise experienced by the researcher. A theory is a systematic explanation for the observations that relate to a particular aspect of social life. Concepts are the basic building blocks of theory and are abstract elements representing classes of phenomena. Axioms or postulates are basic assertions assumed to be true. Propositions are conclusions drawn about the relationships among concepts, based on analysis of axioms. This book is designed for students at the beginning of their journey in social research. It aims to provide an accessible, practically oriented introduction to social research methods. The research methods included in this book are selected on the basis of their relevance to contemporary social research practice. Contents: • Survey Methodology • Multimethodology • Observational Field Research • Scientific Methods in Social Work Research • Critical Action Research in Social Work • Evaluation Design and Methods • Ethics and the Ruling Relations of Research Production • Multivariate Statistics • Statistical Power • Descriptive Research