Conference Abstracts

Collider Physics - QCD / 3

Measuring the production of D^* mesons within jets at the ATLAS experiment

Author: Eric Liu[1]

[1] *University of Birmingham (GB)*

Charm quark fragmentation functions describe the probability of charm quarks hadronising into particular charm hadrons. Understanding such functions will provide valuable data for studies in- volving charm hadrons, such as the development of flavour tagging algorithms and MC event gener- ators. This talk will discuss the approach to the measurement of the charm fragmentation function

by analysing the production of D^* mesons within jets, using the ATLAS low pileup Run 2 pp col- lision data at $\sqrt{s} = 13$ TeV. D^{*+} candidates are reconstructed from their decay into $D^0\pi^+$ and subsequently $D^0 \to K^-\pi^+$, and its charge conjugate. The measurement of the charm fragmenta- tion function for D^* mesons has only been performed once in ATLAS, using Run 1 data. This study will aim to improve on the precision of the previous measurement.

Beyond the Standard Model / 4

The supersymmetric landscape after Run 2 ATLAS searches

Author: Ben Hodkinson[1]

[1] *University of Oxford (GB)*

The ATLAS Collaboration has performed a range of searches for supersymmetry (SUSY) which have produced null results and extensive limits on sparticle masses in simplified scenarios. However, many SUSY scenarios could have evaded detection through a richer phenomenology not captured by simplified models. I will present the constraints from Run 2 ATLAS searches for the electroweak production of supersymmetric particles, interpreted in the 19-parameter phenomenological MSSM [1]. I will also discuss the complementarity of these searches to additional constraints, such as limits from dark matter experiments. These results provide an overview of the electroweak SUSY landscape after the ATLAS Run 2 search programme and highlight places SUSY could yet be awaiting discovery in Run 3 data.

[1] ATLAS Collaboration, JHEP 2024 (2024) 106

Detectors and Instrumentation / 5

Materials screening at Boulby Underground Laboratory

Author: Alice Hamer[None]

The Boulby UnderGround Screening (BUGS) facility is a world-class materials screening lab based at the Boulby Underground Laboratory in North Yorkshire. The facility has been, and continues to be used for screening a wide variety of parts and materials prior to their use in low background experiments in the UK and worldwide. The BUGS facility is continuously improving and currently houses a range of detectors capable of assessing samples of various shapes and sizes through gamma spectroscopy, surface alpha counting, radon emanation measurements, and mass spectrometry. In this talk I will give an overview of the BUGS facility, including recent improvements that have been implemented, and discuss some of the different types of detectors and their applications.

Beyond the Standard Model / 6

Trigger-Level Analysis searches for dijet resonances produced in association with initial-state photons with Run 3 ATLAS data at the LHC

Author: Maximilian Amerl[1]

[1] *The University of Manchester (GB)*

Trigger-Level Analyses are an alternative strategy to record data and trigger on low-mass or low- momentum final states with the ATLAS detector. The premise of the workflow is to save minimal information comprised of only the trigger-level objects needed to reconstruct final state processes, and the information needed to calibrate those objects. This reduces the size of events stored to disk, thereby allowing much higher rate triggers with looser thresholds than in standard approaches to be used. This talk will give an overview of the application of Trigger-Level Analysis in an early Run 3 dijet resonance search for Z'dark matter mediators produced in association with initial state photons. Since the analysis team is yet to publish final results at the time of the conference, the focus of the talk will be on various jet calibration and performance studies that are essential to using non-standard objects in analyses. An outlook on the complementarity of the search results with those of other dark matter experiments will also be discussed.

Poster session / 7

METNetSig: a ML-approach to estimate the MET Significance

Author: Alberto Plebani[1]

Co-author: Ben Hodkinson [2]

[1] *University of Cambridge (GB)*

[2] *University of Oxford (GB)*

The Missing Transverse Energy (MET) is a variable that is used to quantify the energy (or transverse momentum) that is not reconstructed by the ATLAS detector. In recent years, an ML-approach to estimate the MET has been developed in ATLAS, called METNet, which uses a Neural Network to combine the Working Points used to reconstruct the MET into a new WP.
In this contribution, we present an ML-based definition of the MET Significance ($MET\ /\sigma_{MET}$), which is a key variable in many BSM searches due to its discrimination between events with real MET (i.e., neutrinos or potential BSM) from events with fake MET (i.e., missing energy caused by a mis-reconstruction of the objects). Currently, the state-of-the-art MET significance is an object- based significance, which uses the resolutions of the objects entering the MET calculation. METNet- Sig extends METNet by performing a constrained regression on a gaussian negative-log-likelihood loss function to predict a confidence interval as well as providing a central value for the MET.
This model currently holds a greater separation power with respect to the Object-based MET Signif- icance, and we are working on finalizing the validation in order to include this in the consolidated recommendations, as a new single WP for both MET and MET Significance to be used for all ATLAS analyses.

Beyond the Standard Model / 8

The QSHS Haloscope, Axion Dark Matter, and Cavity Tuning

Author: Claude Mostyn[None]

Axions are a wave-like dark matter candidate, first proposed to solve the strong CP problem of quantum chromodynamics. Axions have many properties currently expected of dark matter, with the last decade seeing the start of many axion experiments and collaborations across the world.
A brief summary on the aims, design, and status of the Quantum Sensors for the Hidden Sector (QSHS) axion dark matter haloscope and quantum device test-bed is given. A particular focus is placed on mechanising the cavity at 10 mK and tracking the mode of interest for searches, as well as the overall data taking and analysis procedure.

Poster session / 9

Enabling technologies for future axion searches

Author: Annora Sundararajan[None]

The success of current axion experiments depends critically on overcoming technical challenges related to instrumentation. My work focuses on two key areas: first, the development of an inter- mediate receiver chain for the Quantum Sensors for the Hidden Sector (QSHS) project; and second, the implementation of a Data Acquisition System, which incorporates a second heterodyning stage using digital signal processing techniques. I will the progress achieved in these areas.

Poster session / 11

Measuring Tau Identification Efficiency in $t\bar{t}$ Events Using the AT- LAS Detector

Author: Sudev Pradhan[1]

[1] *University of Sheffield (GB)*

This poster presents a study on the tau (τ) identification efficiency in $t\bar{t} \rightarrow \ell\tau_{\text{had}}\nu\bar{\nu}b\bar{b}$ events, using 29 fb^{-1} of proton-proton collision data at $\sqrt{s} = 13.6$ TeV, recorded by the ATLAS detector during LHC Run-3. A tag-and-probe method is applied to measure the efficiency of the RNN-based tau-ID algorithm, focusing on hadronically decaying tau leptons (τ_{had}) in events enriched with top quark- antiquark pairs.

Key distributions, such as transverse momentum (p_T) and pseudorapidity (η) of τ_{had}, along with RNN scores, are analyzed to evaluate the algorithm's performance. Scale factors for τ -ID are extracted through simultaneous fitting, incorporating systematic uncertainties and nuisance parameters. The results provide insight into tau-ID performance in a challenging $t\bar{t}$ environment, offering valuable contributions to precision modeling of tau decay processes in the ATLAS experiment.

Detectors and Instrumentation / 12

New Physics Studies at a Future Electron-Ion Collider Experiment: Study of Misalignment and Realignment for the High-Performance DIRC in Particle Identification

Author: Afaf Wasili[None]

The rich physics program at EIC reuqires excellent Particle Identification (PID) over a large momentum and angle range. Hence, a key component of the EIC detector ePIC are advanced ToF (Time of Flight) and Ring Imaging Cherenkov (RICH) detectors. In addi- tion, a new type of Cherenkov detector will be used which is called high-performance DIRC (hpDIRC) detector. It utilizes internally reflected Cherenkov light to achieve precise hadron identification, particularly for pions (π) and kaons (K), ensuring clear separation of these particles for accurate measurements.
Tiny misalignments at the hierarchical or sensor level can degrade the detector's per- formance. This presentation explores the impact of realistic misalignment scenarios on Cherenkov angle accuracy and discusses strategies to mitigate these effects. We high- light the use of track-based realignment techniques, demonstrating that the hpDIRC can achieve over 4σ π/K separation up to 6 GeV/c, even under challenging alignment con- ditions. All studies are based on Geant4 Monte Carlo simulations using a standalone simulation framework including the hpDIRC geometry.

Neutrino Physics / 13

Measuring Atmospheric Neutrino Mixing Without Unitarity

Author: Rory Ramsden[1]

[1] *King's College London*

With neutrino physics becoming more precise comes the opportunity to validate the unitary nature of the lepton mixing matrix which underpins it. While the assumption of unitarity for the 3×3 matrix is exploited in neutrino oscillation measurements, deviations of unitarity could hint at several neutrino mass generation models which are reliant on such. Efforts have been made to present global fit results with the best precision achieved for the electron row from reactor and long-baseline neutrino data while atmospheric neutrino measurements can be utilised to better constrain the muon and tau rows. This talk presents sensitivities from atmosperic neutrino Monte Carlo simulations of the 50 kiloton Super-Kamiokande water-Cherenkov detector in Gifu, Japan to the mixing matrix parameters.

Analysis and Reconstruction Methods / 14

Machine Learning driven improvements for the high-mass MSSM search in the di-tau final state with CMS

Author: Irene Andreou[1]

[1] *Imperial College London*

The search for high-mass Higgs bosons within the Minimal Supersymmetric Standard Model (MSSM) framework represents one of the most compelling flagship analyses of the CMS experiment at the

Large Hadron Collider (LHC). The $\tau^+\tau^-$ decay channel provides enhanced sensitivity at high masses due to large branching ratios, but significant challenges arise from Standard Model backgrounds, such as $Z \to \tau^+\tau^-$ and jets misidentified as hadronically decaying taus (τ_h). To address these chal- lenges, advanced machine learning (ML) techniques are being developed to improve the sensitivity of the analysis. A boosted decision tree (BDT) is employed to correct mismodeling in simulations where jets are incorrectly reconstructed as τ_h, while systematic ML-driven optimization is being studied to develop an orthogonal discriminant for improving signal-to-background separation. These meth- ods, applied to the data collected between 2022–2024, will lead to more accurate background modelling in high-mass MSSM Higgs boson searches. By incorporating high-dimensional parame- ter spaces into the analysis, these methods enable more robust and reliable estimates, increasing our confidence in the outcomes of the search. This work underscores the potential of ML approaches to tackle complex challenges in collider physics and sets a strong foundation for future explorations of beyond-the-Standard-Model phenomena.

Poster session / 15

Studying T-violation at Belle II

Author: Yuka Okada[1]

[1] *Queen Mary University of London*

Belle II is a particle detector operating at the SuperKEKB accelerator located in KEK (High Energy Particle Research Organization) in Tsukuba, Japan. The facility collides electrons and positrons at centre of mass energy close to $\Upsilon(4S)$ resonance, which primarily decays into pairs of B mesons. The detector is designed to study light mesons and tau leptons. Entangled pairs of neutral B mesons can be used to study T-violation.

T is a discrete symmetry of space-time where physical processes are invariant under time reversal. At a quantum level the violation of this symmetry, T-violation, may have important implications on our understanding of fundamental physics. As CP and T are equivalent under CPT theorem, T-violation will be able to probe phenomena such as the matter-antimatter asymmetry in the universe. If the magnitude of any CP and T violation differ, then that has deeper ramifications for our understanding of physics.

This talk will provide an overview of the Belle II detector and its role in exploring T-violation through the study of B meson decays, as well as a brief outline of potential future developments in this area of research.

Beyond the Standard Model / 17

Searches for rare decays of B mesons into final states including four or six muons at LHCb

Author: Thomas Long[1]

[1] *University of Cambridge (GB)*

Searches for rare decays of B mesons into final states including four or six muons are performed using proton-proton collision data recorded by the LHCb experiment, corresponding to an integrated luminosity of 5.6 fb^{-1}. These decays are experimental signatures of hierarchical sectors beyond the Standard Model proceeding via flavor-violating heavy vectors and a set of light pseudo-Goldstone bosons $a_{1,2}$ spanning a range of lifetimes. The decay modes of interest are $B^0_s \to \mu^+\mu^-\mu^+\mu^-$, $B^+ \to K^+\mu^+\mu^-\mu^+\mu^-$, $B^0_{(s)} \to \mu^+\mu^-\mu^+\mu^-\mu^+\mu^-$ and $B^+ \to K^+\mu^+\mu^-\mu^+\mu^-\mu^+\mu^-$. Expected upper limits are set at the 95% confidence level on their branching fractions and in the event of a discovery, they will be measured.

Collider Physics - Flavour / 18

Direct measurement of physical coefficients in the B->πμμ de- cay

Author: Xiaohan Wang[1]

[1] *Imperial College (GB)*

With measurements in the b->sll transitions made by the LHCb showing deviations with the Stan- dard Model, a similar measurement on the B->πμμ decay involving a suppressed b->dll transition has been proposed for a potentially more sensitive probe on the new physics. To maximise the ex- perimental sensitivity, an unbinned maximum likelihood fit is applied to the dimuon mass spectrum using the full Run I and Run II datasets. The decay amplitudes are described by an effective field theory (EFT), including both the local and non-local hadronic components. The analysis aims to produce a two-dimensional likelihood profile of the EFT parameters, which can be included in the global fit.

Collider Physics - Electroweak (EW) and Higgs / 19

Measurement of the UPC process γγ->ττ cross-section in proton- proton collisions with the LHCb detector

Author: Yiwei Liu[1]

[1] *Imperial College (GB)*

The production of lepton pairs in two-photon UltraPeripheral Collision (UPC) draws significant in- terest for its characteristics of low extra hadronic activities. In particular, the $\gamma\gamma \to \tau\tau$ process provides a clean channel of tau lepton production. Such a property enables a precise measure- ment of tau anomalous magnetic moment a_τ , providing a valuable probe of Beyond Standard Model Physics.

By carrying out a preliminary analysis of $\tau\tau$ decaying into the $e\nu_e\nu_\tau$, $\mu\nu_\mu\nu_\tau$ state, the potential to cleanly isolate the signal signature from background in LHCb's Run 2 dataset is investigated. Fur- ther research should establish the precision with which a measurement of the ultraperipheral di-tau production cross-section can be made, and therefore determine the feasibility of an a_τ measurement at the LHCb experiment.

Analysis and Reconstruction Methods / 20

An angular analysis of the $B^0 \to D^*\mu\nu$

Author: Hasret Nur[1]

[1] *University of Glasgow (GB)*

$b \to cl$ angular analyses can provide valuable input of understanding New Physics in semileptonic B decays. An angular analysis of the $B^0 \to D^*\mu\nu$ decay is presented utilizing data collected by the LHCb experiment with $3fb^{-1}$ integrated luminosity. Measurements of $R(D^*)$ $R(D)$ show a ˜3.2σ deviation from Standard Model (SM) predictions, motivating a detailed study of angular observables. A five-dimensional binned fit is used for extracting the New Physics (NP) contributions via the Wil- son coefficients. Additionally the form factor parameters from CLN, BGL and BLPR are measured in a Standard Model scenario. In this contribution the blinded results of this analysis are presented. A key aspect of this work is an extensive set of NP toy studies exploring different NP scenarios, with multiple free WC parameters, providing insights into the parameter space relevant for effective filed theories concerning NP contributions. These results improve constraints on hadronic form factors and NP operators, offering valuable input for future theoretical and experimental developments in semileptonic B decays.

Analysis and Reconstruction Methods / 21

Observation of the $K^+ \to \pi^+\nu\bar{\nu}$ decay and measurement of its branching ratio by the NA62 experiment at CERN

Author: Chandler Baynham Kenworthy[1]

[1] *University of Birmingham (GB)*

The $K^+ \to \pi^+\nu\bar{\nu}$ decay is a golden mode for flavour physics. Its branching ratio is predicted with high precision by the Standard Model to be less than 10^{-10}, and this decay mode is highly sensitive to indirect effects of new physics up to the highest mass scales. A new measurement of the $K^+ \to \pi^+\nu\bar{\nu}$ decay by the NA62 experiment at the CERN SPS is presented, using data collected in 2021 and 2022. This new data-set was collected after modifications to the beamline and detectors and at a higher instantaneous beam intensity with respect to the previous 2016–2018 data taking. Using the NA62 data-set from 2016–2022, a new measurement of $\mathcal{B}(K^+ \to \pi^+\nu\bar{\nu}) = \left(13.0^{+3.3}_{-2.9}\right) \times 10^{-11}$ is reported, and for the first time the $K^+ \to \pi^+\nu\bar{\nu}$ decay is observed with a significance exceeding 5σ.

Collider Physics - Flavour / 22

Search for charge-parity violation in radiative charm $D^0 \to \phi\gamma$ decays

Author: Abhishek Bohare[1]

Co-author: Mark Richard James Williams [1]

[1] *The University of Edinburgh (GB)*

Radiative decays of charmed hadrons are highly sensitive to flavor-changing processes, which are governed by the Standard Model (SM) but could also be influenced by new physics (NP). This sen- sitivity arises due to the Glashow-Iliopoulos-Maiani (GIM) suppression mechanism, which signifi- cantly restricts processes such as $|\Delta c| = |\Delta u| = 1$. The radiative charm decay $D^0 \to V\gamma$, where $V = \bar{K}^{*0}$ (Cabibbo-favored) or ϕ, ρ^0, ω (Cabibbo-suppressed), is particularly sensitive to indirect NP effects due to its significant loop amplitude. Within the SM, Charge-Parity (CP) violation in charm decays is expected to be small, making radiative decays an excellent probe for potential NP beyond the SM.

This work presents one of the first searches for CP violation in $D^0 \to \phi\gamma$ decays using data collected during Run 2 of the LHCb experiment at the Large Hadron Collider (LHC), CERN, Switzerland. The analysis is performed on proton-proton collision data corresponding to an integrated luminosity of approximately 6 fb^{-1}, recorded at a center-of-mass energy of 13 TeV. The D^0 mesons are recon- structed from $D^{*+} \to D^0\pi^+$ decays, allowing for the determination of the initial flavor state. A three-dimensional simultaneous fit technique is employed to extract the signal yield while mitigat- ing large background contributions from π^0 and combinatorial decays. This study utilizes the unique capabilities of LHCb, including high-statistics data, precise vertex reconstruction, improved triggers during Run 2, and excellent photon detection, to set the most stringent constraints on CP violation in this rare charm decay mode. A significant deviation from the SM expectation of CP asymmetry at the order of 10^{-3} could indicate contributions from physics beyond the SM.

Keywords: CP violation, radiative charm decays, LHCb, new physics, beyond the Standard Model.

Neutrino Physics / 23

The Pacific Ocean neutrino experiment: new developments and physics case

Author: Beatrice Crudele[1]

[1] *UCL*

The study of cosmic neutrinos will open new discovery opportunities in elementary and astro- particle physics in the next decades, when several new neutrino telescopes in the northern hemi- sphere will come online. One of these detectors is the Pacific Ocean Neutrino Experiment (P-ONE), a multi-cubic kilometre detector off the coast of Vancouver Island, British Columbia. The first full line of P-ONE is set to be deployed by summer 2025 and will be followed by the demonstrator phase the subsequent years. The full detector is planned to be operational by the end of the decade joining the network of neutrino telescopes scattered across the world, pushing us into a new era of high-energy neutrino astronomy. In this talk I will present the current status of the experiment and its expected performance, along with sensitivity studies focusing on the physics of the galactic centre as a laboratory for particle and astrophysics.

Collider Physics - Electroweak (EW) and Higgs / 24

Measurement of high-mass di-tau production using $\sqrt{s}$ = 13 TeV proton-proton collision data collected with the ATLAS detector

Author: Peng Wang[1]

[1] *University College London (GB)*

This analysis involves measuring the fiducial differential cross sections of high-mass di-lepton pro- duction with two hadronically decaying taus, using the full ATLAS Run-2 data. One of the main motivations for this analysis is that it provides good sensitivity to a compelling BSM theory (LeptoQuark) that explains the anomalous b-hadron decay fractions observed at both BaBar and LHCb.

In this analysis, the visible di-tau invariant mass distribution is measured and unfolded to the particle level and is compared with the theory predictions from Sherpa 2.2.11 and Powheg Box+Pythia 8. The CONTUR package is used to evaluate the sensitivity of this measurement to the inclusive SMEFT model and other BSM theories.

Cosmic Messengers / 25

Constraining Fuzzy Dark Matter With Galactic-Center Resonant Dynamics

Author: Barry Ginat[1]

Co-author: Bence Kocsis

[1] *University of Oxford*

In this talk I will discuss the influence of axion dark-matter cores on the orbits of stars at the Galactic center. This dark matter candidate condenses into dense, solitonic cores, and, if a supermassive black hole is present at the center of such a core, its central part forms a 'gravitational atom'. Here, I will present a calculation of the atom's contribution to the gravitational potential felt by a Galactic-center star. I will then describe the angular-momentum dynamics this potential induces, and show that they are similar to vector resonant relaxation. Its influence is found to be sufficiently strong that such a dynamical component should be accounted for in Galactic-centre modelling. For the Milky Way, the atom is expected to be somewhat spherically asymmetric, and we use this to derive a stability condition for the disc of young, massive stars at the Galactic centre – if the atom's mass is too large, then the disc would be destroyed. Thus, the existence of this disc constrains the mass of the axion particles. I will show that plausible parameter values imply that m_a is excluded in the range

3×10^{-20} eV
$lesssim m_a$
$lesssim 6.5 \times 10^{-20}$ eV – a region which is mostly unconstrained.

Poster session / 26

Understanding the impact of detector systematics on future HK analyses

Author: Ellie O'Brien[1]

[1] *University of Sheffield*

Hyper Kamiokande (HK) is a next generation water Cherenkov detector, currently under construc- tion in the Gifu Prefecture of Japan and due to begin operations in 2027.
The main physics goal of HK is to make the first observation of asymmetries in neutrino and antineu- trino oscillations that arise from the CP violating phase. This is achieved by looking at oscillations within a neutrino beam produced at the J-PARC accelerator facility in Tokai. Other goals include searching for proton decay and detecting neutrinos from nearby supernovae and other astrophysical sources.
Addressing all of these goals requires the accurate reconstruction of neutrino interactions over a wide range of energies. This poses a challenge within a large-scale water Cherenkov detector as variations in detector qualities such as water properties may affect the quality of the reconstruction. It is important to quantify the effects these uncertainties will have on high-energy oscillation anal- yses and low-energy measurements.
This poster will present work being done to better understand the impact of detector systematics on event reconstruction in HK, with the aim of establishing a workable scheme for including these systematic uncertainties in future HK analyses.

Collider Physics - Flavour / 27

Search for rare b -> s tau tau processes in baryonic decays at the LHCb experiment

Author: Josh Bex[1]

[1] *University of Cambridge (GB)*

This talk will present a search for rare $b \to s\tau^+\tau^-$ transitions via the decay $\Lambda_b^0 \to pK^-\tau^+\tau^-$, using $5.4\ \mathrm{fb}^{-1}$ of data collected by the LHCb experiment. New Physics explanations for anomalies in combined fits to $R(D)$ and $R(D^*)$ predict enhanced branching fractions of several orders of magnitude for $b\ \ s\tau^+\tau^-$ processes. This analysis reconstructs τ-leptons through their muonic decays, utilising a selection centred on a multi-class BDT. In this talk I will outline a preliminary selection and expected upper limit for the branching fraction of $\Lambda_b^0 \to pK^-\tau^+\tau^-$.

Cosmic Messengers / 28

Tau neutrino measurement using track sample in IceCube

Authors: Alex Wen[1]; Archie Millsop[2]; Carlos Arguelles Delgado[1]; Teppei Katori[2]

[1] *Harvard University*

[2] *King's College London*

At the IceCube Neutrino Observatory, muon neutrinos are identified by characteristic long tracks due to high energy muons through the charged current (CC) interactions. On the other hand, ~17% of tauons resulting from tau neutrino CC interactions decay to muons and produce long tracks. However, energy sharing between hadronic showers and a muon is different between muon neutrino CC interaction and tau neutrino CC interaction. Therefore, careful recnonstruction of hadron shower energy, or inelasticity, can be used to statistically separate tau neutrinos. Here, we use low energy IceCube track sample, covering 500 GeV - 20 TeV, to look for tau neutrinos potentially the lowest energy astrophysical neutrino signals.

Collider Physics - QCD / 29

Probing the Dead Cone Effect in b-Jet Substructure Using the Lund Jet Plane and Graph Neural Network Track Origin Tagging in ttbar Events with the ATLAS Detector

Author: Hanfei Cui[1]

[1] *University College London*

This study measures the Lund jet plane and the dead cone effect in b-jets from single-leptonic and di-leptonic $t\bar{t}$ events. Using the Cambridge/Aachen algorithm for jet reclustering, we look for sup- pressed emissions at small angles indicative of the dead cone effect. We employ a novel graph neural network based jet flavour tagger (GN2) that labels over 80% of b-hadron decay tracks via its auxiliary task output. This enhances jet reclustering and sensitivity in the dead cone region. Track p_T frag- mentation analysis validates these findings in momentum space. Ongoing work focuses on refining unfolding procedures and evaluating systematic uncertainties to ensure robust conclusions.

Detectors and Instrumentation / 30

Characterization of an ASIC-based readout system for the SAND experiment

Authors: Antonio Di Domenico[1]; Camilla Maggio[2]; Carlo Tintori[2]; Yuri Venturini[2]

Co-authors: Andrea Abba [3]; Andrea Picchi [2]; Annalisa Mati [2]; Daniele Ninci [2]; Paolo Gauzzi [1]; Vincenzo Bottiglieri [2]

[1] *Sapienza Universita e INFN, Roma I (IT)*

[2] *CAEN SpA*

[3] *Nuclear Instruments Srl*

The System for on-Axis Neutrino Detection (SAND), part of the Deep Underground Neutrino Experi- ment (DUNE), is designed to monitor the long-term stability of the neutrino beam at Fermilab. SAND reuses the lead scintillating-fiber electromagnetic calorimeter (ECAL) of the KLOE experiment with excellent time and energy resolutions. The calorimeter is read-out by approximately 5000 PMTs requiring a cost-effective, high-channel-density readout system capable of matching the stringent ECAL performance. Traditional analog electronics impose excessive dead time, while fully digital solutions present significant cost constraints. An ASIC-based approach provides a viable alternative, balancing performance and scalability. This study evaluates the Radioroc front-end ASIC for energy measurements, complemented by timing measurements performed with the FERS A5203 picoTDC unit. The tests were carried out using a signal generator producing pulses that mimic PMT signals, with a programmable attenuator

enabling an amplitude sweep over a 60 dB range before reaching the Radioroc. In the final detector configuration, the Radioroc front-end, originally designed for SiPM readout, will interface with ECAL PMTs through a fast-inverting amplifier integrated into the PMT housing. Energy resolution was assessed by comparing the Radioroc ADC chain with the ToT-based estimation from FERS A5203. Results indicate that for large signals (>100 mV), the ADC provides superior resolution, whereas for smaller signals, the ToT method proves to be more effective. The complementarity of these approaches extends the dynamic range of acquired energies, enhancing measurement capabilities. These results appear very promising in satisfying both energy and time resolutions requirements for the SAND calorimeter, confirming the suitability of this ASIC-based solution for high-density readout in neutrino physics experiments.

Beyond the Standard Model / 31

Search for new physics in all-hadronic $t\bar{t}t\bar{t}$ using ML

Author: Shahzad Sanjrani[1]

[1] *University of Bristol (GB)*

There is current interest in searching for beyond the standard model particles produced in association with a top quark pair, $tt + X(X \quad tt)$. This project focuses on a top-philic Z' resonance model that may significantly enhance the $tt\ tt$ cross section. The all-hadronic channel is explored in the resolved regime using a novel machine learning algorithm, SPA-Net, which performs permutation- invariant jet-parton assignment to reconstruct events. This talk presents initial limits using this network to discriminate signal against large QCD multijet- and tt -dominated backgrounds. Studies shown use Monte Carlo simulations of proton-proton collision data gathered by the CMS detector at the LHC.

Detectors and Instrumentation / 32

QUEST-DMC: Superfluid bolometer development for dark matter direct detection

Author: Elizabeth Leason[None]

QUEST-DMC aims to utilise the tiny (10^{-7} eV) energy gap in superfluid helium-3 to perform a low threshold dark matter search, capable of probing the lowest particle dark matter masses. The detector consists of a superfluid bolometer cell, instrumented with nanowire resonators - which measure quasiparticle damping forces from energy deposits. The nanowires are read out using quantum sensors, essential for achieving low noise and energy thresholds. A bolometer with SQUID readout of two nanowires was operated for 6 months in 2024, at temperatures down to 0.3mK. Here, results of the nanowire characterisation, bolometer operation and development of energy calibration schemes will be presented.

Poster session / 33

Radon emanation measurements at Boulby

Author: Sophie Carroll[None]

Radon emanation from materials presents a major background to rare event experiments. This poster will present the dual-detector radon emanation system operating at Boulby Underground Labora- tory, which uses two 80L electrostatic alpha detectors. By incorporating a radon concentration line, this will enhance its sensitivity to 222Rn to below 0.1 mBq, providing more accuracy at characterising radioactive emissions from materials to help to build a comprehensive background model.

Poster session / 34

Hyper-Kamiokande Light Injection System and Detector System- atics

Author: Unik Limbu[1]

[1] *University of Liverpool*

The poster presents a review of the light injection (LI) system, a critical calibration tool for the upcoming Hyper-Kamiokande (Hyper-K) experiment, a next-generation Water Cherenkov detector designed to study neutrino properties with unprecedented precision. Neutrino oscillations, charge- parity (CP) violation, and proton decay searches are among the key physics goals of Hyper-K, mak- ing accurate detector calibration essential. The LI system plays a vital role in ensuring the detector' s photodetectors are well-calibrated by injecting controlled pulses of light into the water volume, allowing for precise measurements of optical properties and detector response. This work also ex- plores the impact of water parameters such as Rayleigh scattering and absorption on the system' s performance using Water Cherenkov Simulation (WCSim). Understanding these effects is crucial for refining event reconstruction and improving overall detector sensitivity. The poster presents our latest simulation results and discusses their implications for the LI system's optimisation in Hyper- K.

Detectors and Instrumentation / 35

Muon Tracking in an Opaque Scintillator Detector with LiquidO

Author: Jess Lock[1]

[1] *University of Sussex*

The LiquidO Consortium is bringing a novel approach to particle detection by using opaque scin- tillator to achieve self-segmentation down to the millimetre scale. Opacity via short scattering length stochastically confines scintillation photons close to the point of production and arrays of wavelength-shifting fibres trap and transmit the light to, typically, silicon photomultipliers.

At Sussex, we use 64-fibre detector prototypes with a 3.2 mm fibre pitch. The prototypes are char- acterised with cosmic ray muons, and using a wax-based opaque scintillator a one-dimensional po- sition resolution of 0.45 mm is achieved. This talk will discuss the muon tracking capabilities of a small-scale LiquidO detector, as well as compare the performance of the prototypes with transparent and opaque scintillator.

Detectors and Instrumentation / 36

Simulating LiquidO detectors for prototype research and devel- opment

Author: Ben Cattermole[1] [1] *University of Sussex*

LiquidO is a novel detector technology that uses the stochastic confinement of scintillator light in an opaque medium to increase particle identification efficiency. To collect this light a lattice of wavelength-shifting fibers runs through the medium, which are then read out using SiPMs. The unique particle identification down to the MeV scale and subsequent background rejection capabil- ities of the LiquidO technology make it ideal for neutrino detection. LiquidO will be used in the AntiMatter-Otech detector, a reactor anti-neutrino experiment currently under development for in- stallation at the Chooz nuclear power plant. At the University of Sussex we are building prototypes to help develop technology for this future detector. My research involves simulations of such detec- tors, built in a Geant4 based simulation toolkit called RATPAC 2. Alongside prototyping, these simu- lations are used to generate large event response datasets and study light propagation. We use these datasets to design efficient algorithms for particle identification and tests with machine learning. In my presentation I will give an overview of the LiquidO technique, exploring light ball formation to illustrate why the LiquidO technique is powerful and discuss reconstruction of events.

Analysis and Reconstruction Methods / 37

Novel Machine Learning techniques for high-dimensional den- sity estimation and photon shower calibration

Author: Paul Felix Kruper[1]

[1] *Imperial College (GB)*

A large part of High Energy Physics is dedicated to correcting wrong distributions due to detector mismodelling, experimental measurement limitations and an insufficient theoretical understanding of non-perturbative processes. This often results in deviations between MC and data distributions, that require a lot of time to correct - especially in very high-dimensional, highly correlated feature spaces. As a result, I will present novel Machine Learning techniques that simultaneously correct the deviations across the entire feature space with first-order gradient boosting and Wasserstein-based regression. The ML models presented allow an improved probability density estimation of the under- lying distributions, and are used to enhance the calibration of photon showers in the electromagnetic calorimeter (ECAL) of CMS. These new approaches can be used to generally minimise analysis un- certainties and increase the sensitivity to New Physics at the LHC in Run 3 and beyond.

Poster session / 38

Measurement of the muon electric dipole moment at the Fermi- lab g-2 experiment

Author: Katherine Ferraby[1]

[1] *University of Liverpool (GB)*

A summary of the analysis of the measurement of the electric dipole moment of the muon at the fermilab g-2 experiment, which was done using 25% of the total dataset. The sensitivity of the future measurement, using the full statistics, and an optimal weighting method, will be shown.

Terrestrial Dark Matter Searches / 39

Waveform simulations for the LUX-ZEPLIN experiment

Author: Nicholas Fieldhouse[1]

[1] *University of Oxford*

The LUX-ZEPLIN (LZ) experiment is a dual-phase time projection chamber with the primary aim of detecting WIMPs through direct detection methods. Light from scintillation within the detector is collected with arrays of PMTs and is recorded as waveforms in our data. LZ fundamentally relies on our understanding of all the information encoded in these waveforms . It is therefore paramount that we have an in-depth understanding of how these waveforms are produced from the initial in- teraction right up to the start of the analysis chain. Simulations of these processes can help to verify our understanding of our detector and furthermore predict the outcome of various effects we may observe; anything from validating our own analysis chain to training machine learning algorithms to producing potential WIMP signals. All this and more can be done with accurate waveform simula- tions. In this talk, I will present the waveform simulation methods for the LUX-ZEPLIN experiment and their capability to advance the experiment's discovery potential for all searches.

Collider Physics - Flavour / 40

Status of Measurements of CKM angle γ with $B_d^0 \to D^{\pm}$

Author: Lucas Arthur Foreman[1]

[1] *The University of Manchester (GB)*

The status of the work towards a measurement of the CKM angle γ with $B_d^0 \to D^{\pm}$ decays in the LHCb run 2 data set is presented. The work presented includes signal isolation, time resolution studies, and neutral B meson flavour tagging. Neutral B meson flavour tagging is an integral component of analyses of this kind, which allows for the separation of B_d^0 and $\overline{B}_d^0$ events. This analysis includes first results for use of the new, neural network based, inclusive flavour tagger in parallel with conventional tagging techniques. Measurement of the CKM angle γ is an important avenue for testing the standard model and each new measurement helps us to reach an ever greater level of precision. This measurement will improve the LHCb γ combination, which is currently the world's most precise direct measurement and contains contributions from over 30 measurements.

Terrestrial Dark Matter Searches / 41

Electron capture decays in the LUX-ZEPLIN (LZ) experiment

Author: Olivia Valentino[None]

Electron capture (EC) decays of Xe-125 and Xe-127 constitute a known background in dark matter searches with dual phase xenon time projection chambers (TPCs) such as the LUX-ZEPLIN (LZ) experiment. The signals produced by these processes present a lower charge-to-light ratio compared to β-particle interactions of the same energy, which is attributed to enhanced recombination at the EC site as a consequence of denser ionisation tracks created by the Auger effect. Double electron capture (DEC) decays of Xe-124 are the rarest radioisotope decays ever measured, and they present additional ionisation suppression in LXe TPCs from even more complex decay-site topologies. In this talk I will present the measurements of ionisation yield attenuation in Xe-125 and Xe-127 EC decays in LZ and how these were used to infer DEC charge yields used to constrain the Xe-124 LL- and LM-capture decays observed in the recent WIMP search.

Terrestrial Dark Matter Searches / 42

Investigating the isolated S1 backgrounds in the LUX-ZEPLIN (LZ) experiment

Author: Linda Di Felice[1] [1] *Imperial College London*

The LUX-ZEPLIN (LZ) experiment features a liquid xenon time projection chamber designed to de- tect weakly interacting massive particles (WIMPs) with exceptional sensitivity. Among its back- ground signals, scintillation-only events are particularly challenging to study due to their poor spa- tial reconstruction; yet, they play a significant role by contributing to accidental coincidence back- grounds that can obscure WIMP-like signals.
I investigate the origin and nature of these scintillation-only events by analysing photon hit patterns and leveraging the double photon electron effect. Specifically, I will discuss whether the light emitted by these events is in the vacuum ultraviolet (VUV) range, characteristic of xenon scintillation, and explore their possible sources within the detector. This research not only contributes to the broader effort to refine background models, ultimately improving the reliability of the LZ experiment's search for dark matter, but will also be of fundamental importance for the design and optimisation of future detectors, paving the way for the next generation of dark matter experiments.

Terrestrial Dark Matter Searches / 43

Towards a 0nbb decay search in the LUX-ZEPLIN experiment: mitigating gamma-ray backgrounds

Author: Elisa Elena Jacquet[None]

Dual-phase xenon time projection chambers (TPCs), such as the one at the core of the LUX-ZEPLIN (LZ) experiment, are expected to be well-suited for the search of the neutrinoless double beta decay of ^{136}Xe. In LZ, this rare-event search is primarily limited by the presence of gamma ray backgrounds in the signal's energy region of interest from the decays of ^{214}Bi and ^{208}Tl. These backgrounds, multi- site interactions mis-reconstructed as single-site, can be mitigated by exploiting differences between the topologies of multiple versus single scatters in the TPC. In this talk, I present a new method to unfold event topologies through the deconvolution of detector response from signal waveforms. This technique enables higher granularity in topology reconstruction, and a more effective mitigation of gamma-ray backgrounds.

Collider Physics - Flavour / 44

Measurements of charge and CP asymmetries in b-hadron decays using top-quark events collected by the ATLAS detector in pp col- lisions at $\sqrt{s} = 13$TeV

Author: Asim Mohammed Aslam[1]

[1] *University of London (GB)*

Same- and opposite-sign charge asymmetries are measured in top-quark pair events in which a b- hadron decays semileptonically to a muon, using data corresponding to an integrated luminosity of 139 fb−1 from proton–proton collisions at a centre-of-mass energy of $\sqrt{s} = 13$TeV collected with the ATLAS detector at the Large Hadron Collider at CERN. The charge asymmetries are based on the charge of the lepton from the top-quark decay and the charge of the muon from the semilep- tonic decay of a b-hadron and are measured in a fiducial region corresponding to the experimental acceptance. The measurement investigates the excess over the Standard Model reported by the D0 experiment and looks to improve upon the statistically limited $\sqrt{s} = 8$TeV measurements made at ATLAS using the full Run 2 dataset and new analysis techniques.

Terrestrial Dark Matter Searches / 45

DD Reflector Neutrons as a Probe of Low Energy Xenon Micro- physics

Author: Jacopo Siniscalco[None]

While the microphysics of Xenon in dual-phase TPCs is generally well understood, fully characteris- ing the behaviour of nuclear recoils at very small (keV-scale) energies presents a series of challenges that contribute to many uncertainties in this regime. Thanks to its unique ability to calibrate in-situ using low energy deuterium-deuterium (DD) reflector neutrons, LUX-ZEPLIN is well positioned to provide valuable insight to our models. In this talk, I will present on the development of data qual- ity cuts applicable to these datasets. Furthermore, I will demonstrate how this data can be used in a new procedure to constrain microphysical parameters such as the mean charge yield and its fluctuations.

Terrestrial Dark Matter Searches / 46

Recent results from the LUX-ZEPLIN (LZ) dark matter experi- ment

Author: Albert Baker[1]

[1] *King's College London*

LUX-ZEPLIN (LZ) is a dark matter direct detection experiment operating over a kilometre under- ground at the Sanford Underground Research Facility in Lead, South Dakota, USA. At its core, the LZ detector consists of a dual-phase xenon time projection chamber, with an active volume con- taining 7 tonnes. This talk will cover the recent world-leading results from the primary LZ search for weakly interacting massive particles (WIMPs), as well as reporting on the current status of the experiment and searches for other new physical phenomena.

Neutrino Physics / 47

Central Value Spread Dial and Exploring the Shallow Inelastic Region

Author: Callum Greg Cox[1]

[1] *Rutherford Appleton Laboratories and Royal Holloway (University of London)*

The Deep Underground Neutrino Experiment (DUNE) is a next generation long-baseline neutrino experiment. The experiment will study the changes in the neutrino flavour within the neutrino beam produced at Fermi National Accelerator Laboratory [FNAL, IL] and later measured at the Sanford Underground Research Facility [SURF, SD]. DUNE notably aims to study neutrino oscillations, deter- mine their mass ordering, measure the amount of CP violation in neutrino oscillations, and perform precision measurements of the PMNS mixing parameters. DUNE's intense neutrino beam, energy regime and detector size means that, over time, rather than being limited by statistical uncertainties, it will instead be limited by systematic uncertainties due to the modelling of the neutrino flux and cross-sections. The latter, in particular, represents the largest source of systematic uncertainties for DUNE analyses. This talk will describe the ways in which cross-section effects impact DUNE oscil- lation analyses, and will also present recent efforts to parametrise uncertainties related to neutrino interactions with matter.

Collider Physics - Flavour / 49

Amplitude analysis of $B^+ \to D^- K^+ \pi^+$ decays

Author: Aleksandrina Docheva[1]

Co-author: Mark Peter Whitehead [1]

[1] *University of Glasgow (GB)*

In this talk, I present an amplitude analysis of $B^+ \to D^- K^+ \pi^+$ decays using the full data samples collected by the LHCb experiment at the Large Hadron Collider in Run I and II. The structure in the Dalitz plot of the decay allows us to study excited neutral charm meson states in the $m(D^- \pi^+)$ system, measuring masses, widths and quantum numbers. The study of excited charm states is well motivated by a strong theory community, with their expected spectrum being well predicted.

Furthermore, I will outline a search for two exotic states, the T^*_{cs} tetraquarks, contributing to the $B^+ \to D^- K^+ \pi^+$ decays in the $m(D^- K^+)$ system. In recent years several exotic states have been discovered, but in most cases their exact nature is unknown. The exotic hadron candidates have been seen in $m(D^- K^+)$ mass distributions in final states containing two charm mesons. Studying their production (or absence) in $B^+ \to D^- K^+ \pi^+$ decays can help to shed light on their nature.

Poster session / 50

New Developments in BSM Particle Searches at MicroBooNE

Author: Joseph Bateman[None]

The MicroBooNE Liquid Argon Time Projection Chamber (LArTPC) was situated along two neu- trino beam lines, making it a powerful tool for Beyond the Standard Model analyses. Located 8° off-axis from the 120 GeV Neutrinos from the Main Injector (NuMI) beam, MicroBooNE benefited from a reduced neutrino background, enabling sensitive searches for rare meson decays into BSM particles.

The MicroBooNE BSM program continues to set world-leading limits across a broad spectrum of BSM models with e^+e^- , $^{+-}$, and ^{0} final states. By expanding the signal simulation to consider mesons decaying in flight rather than only at rest, the latest Higgs Portal Scalar e+e- result doubles the expected scalar flux at the MicroBooNE detector and sets the world's strongest limit on the model for scalar masses between 110 and 155 MeV. Heavy Neutral Lepton (HNL) limits set by MicroBooNE are the most stringent for HNL masses between 35 and 175 MeV, and include the first direct constraint of the ^{0} decay channel. The use of timing to select a sample rich in long-lived BSM particles was first demonstrated in by MicroBooNE in a search for HNLs decaying to . Recent advancements in timing resolution, down to the nanosecond scale, enables future analyses to select between beam bunches, significantly reducing background rates and increasing sensitivity. MeV scale reconstruction allows MicroBooNE to set blip-based millicharged particle limits, and will assist in rejecting neutral pions, a dominant background process for many BSM searches.

Detectors and Instrumentation / 51

Adaptation of MINOS photomultipliers for low cost, large scale applications in contemporary particle physics experiments

Author: Alex Sells[None]

The conclusion of the MINOS neutrino experiment created the availability of hundreds of Hama- matsu Multianode Photomultiplier tubes. This talk will detail a new electronics system encom- passing power and readout for the R5900-00-M64 model tailored to the updated requirements of contemporary and future experimental particle physics. It comprises exclusively low voltage input requirements, low power consumption and ease of manufacture, for economical large scale deploy- ment.
The design encompasses two custom made PCBs; a Cockroft-Walton powerbase constructed from standard commercially available components, and a DAQ board centered around the WEEROC MAROC 3A chip, from which readout is performed via FPGA and computer system. This appa- ratus is envisioned to provide a light detection system with proven particle physics credentials for a modern day application.

Poster session / 53

Constraining Primordial Non-Gaussianity: Analysis of the Rela- tivistic Galaxy Bispectrum with Euclid and SKA

Authors: Chris Clarkson[1]; Mihir Bhatnagar[1]

[1] *Queen Mary University of London*

Initial matter density perturbations during the primordial era are set in motion by inflation, subse- quently dictating the formation and evolution of the large-scale structure of the universe. In this research, we explored primordial non-Gaussianity in large scale structures of the universe at red- shifts z = 1.0 and z = 1.5, focusing on the improvements the new and upcoming Euclid and SKA surveys will provide in refining non-Gaussianity (f_nl) measurements, a critical test for inflation- ary theory and the standard model. Developing and applying an an advanced model of the bispec- trum, we analyzed how systematic uncertainties due to observational biases such as galaxy bias, redshift space distortions, and gravitational lensing constrain non-Gaussianity measurements, un- der the framework of complex statistical analysis based on two-point and three-point correlators. Probing the bispectrum up to the largest currently measurable scale (k ≤ 10e-4/Mpc) from Euclid and SKA surveys, we included matter density perturbations from the observed background up to the second order, ensuring theoretical predictions accurately match with observations of large scale structure and evolution. SKA was shown to achieve tighter constraints on f_nl up to 5.65 from our analysis, outperforming the constraint set by Euclid at f_nl = 25.0. These improved constraints are attributed to the distinct observational biases present in SKA's 21-cm neutral hydrogen background signatures, which differ from the galaxy clustering measurements made by Euclid. Despite these advancements, the simplest models of inflation predict an f_nl ≈ 1, a benchmark that remains chal- lenging to achieve even with the upcoming state-of-the-art instruments such as SKA. Nevertheless, this research underscored the importance of SKA's improved systematics to further clarify cosmic inflation. Moreover, it confirmed established key features of non-Gaussianity, including peaks in the bispectrum of both instruments at equality scales, the downward trend in non-Gaussianity at larger k-scales, and signatures of Baryonic Acoustic Oscillations (BAO) at sub-horizon scales. Finally, the need for higher order correlators and contributions to GR effects is established, along with the po- tential use of cosmological gravitational waves, to enhance observational precision and expand the range of observable scales. Steps towards these advancements will further refine the constraints on non-Gaussianity (f_nl).

Detectors and Instrumentation / 54

ITk Pixel Multi Module Readout Tests

Author: Juliette Martin[1]

[1] *University College London (GB)*

As part of the upgrades to the ATLAS detector to be performed during Long Shutdown 3 (LS3), which is scheduled from 2026-2030, the current ATLAS Inner Detector (ID), is to be replaced with an all-silicon Inner Tracker (ITk). The ITk is comprised of an inner silicon pixel and outer silicon strip detector and will provide higher radiation tolerance, granularity, and readout rate, to cope with the requirements of the harsh radiation conditions of the high-luminosity Large Hadron Collider (HL- LHC). In Run 4, ATLAS will be entirely read out using the Front-End Link EXchange (FELIX) data acquisition system. In advance of larger-scale system tests for ITk Pixel, studies are ongoing using bench-top multi-module setups. These allow the testing of multiple ITkPix pixel modules using FELIX, before the arrival of final detector structures and large-scale system tests. These studies are essential for verification of readout structures in preparation for operation of the full ITk pixel detector. This talk will present an overview of the ITk Pixel readout chain and explore key results from these tests.

Terrestrial Dark Matter Searches / 55

The Environmental Monitoring Station: Measuring Cavern Back- grounds for the LUX-ZEPLIN experiment

Author: Ellie Bishop[1]

[1] *University of Edinburgh*

LUX-ZEPLIN (LZ) is the world's most sensitive direct dark matter detector. It is located deep un- derground at the 4850 ft level at the Sanford Underground Research Facility (SURF) in Lead, South Dakota. This is a quiet environment, shielded from cosmic rays. LZ utilises 7 tonnes of liquid xenon in a time projection chamber as a target for extremely rare dark matter particle interactions. LZ primarily looks for weakly interacting massive particles (WIMPs) which are one of the leading can- didates for dark matter. LZ has been designed to be very sensitive to rare signals, however this means that it is also sensitive to the remaining backgrounds we cannot remove or completely shield against. Characterising and mitigating these backgrounds is crucial. The Environmental Monitoring Station (EMS) consists of a suite of detectors which measure key cavern backgrounds. Demonstrat- ing a complete and thorough understanding of our backgrounds is vital for physics searches with LZ. In this talk I will discuss the design of the EMS and present preliminary results from analysis of EMS data.

Neutrino Physics / 56

Using Stopping Cosmic Muons for Calibrations at DUNE

Author: Alexandra Moor[1]

[1] *University of Sheffield (GB)*

The Deep Underground Neutrino Experiment (DUNE) is an upcoming Fermilab experiment that is expected to start taking data in the late 2020s. Consequently, a significant portion of the current work revolves around modelling, prototyping, and other forms of preparation, much of it using Monte-Carlo simulation before a full-scale dataset has been produced. One of the key contributions to this is detector calibration. Detector calibration provides analysts with the tools to map between detector observables and their corresponding physical qualities, which is necessary to produce ac- curate results. This talk will demonstrate methods of calibrating the energy deposited by stopping cosmic muons, by examining their charge depositions in a 10kt fiducial mass DUNE Far Detector module which makes use of LArTPC technology.

Cosmic Messengers / 57

Digital processing and filtering in the PUEO experiment

Author: Hugo Pumphrey[1]

[1] *University College London*

Neutrinos produced in the highest energy extragalactic phenomena propagate through space, pre- serving energy and direction. Detection of these ultra-high-energy neutrinos can act as a telescope and as a method to probe physics at a new energy scale. At the EeV energy scale, neutrino-induced electromagnetic showers can be observed via the Askaryan effect. As the shower traverses a dense medium, a significant excess of uncompensated negative charge builds up, leading to coherent ampli- fication of radio Cherenkov emission and resulting in a detectable pulse. Elevating a radio payload over the continentally vast, dense and radio transparent Antarctic ice cap, gives the best chance of detection. The Payload for Ultra-high Energy Observations (PUEO) experiment, will be equipped with commercially available RFSoC technology and capable of real-time digital processing. One can utilise a digital biquad notch filter to remove known anthropogenic frequencies reducing the trigger threshold before truncating the data, reducing valuable storage consumption.

Analysis and Reconstruction Methods / 58

Quantum machine learning in particle physics

Author: Marcin Jastrzebski[1]

[1] *UCL*

Particle physics has seen a surge of interest in understanding the impact of quantum computers on the field. From allowing one to more naturally simulate quantum fields to providing aid in the most computationally expensive pieces of analysis, proposals to find useful quantum advantage abound.

While quantum hardware and algorithms are currently still in their early stages, rapid progress is being made. This exploratory phase will pave the way for new ideas and techniques needed to fully exploit future large quantum computers.

Along with other emerging quantum technologies like sensing and networks, the whole world, and particle physics with it, can enter a completely new era. In this talk I will give a gentle and high-level introduction to quantum computing for particle physics with a focus on quantum machine learning. I will also highlight some of the contributions from my group in this evolving field.

Beyond the Standard Model / 59

Rotation compensation system for MAGIS-100 and measurement of laser pointing jitter

Author: Henry Throssell[None]

The next generation of long baseline atom interferometers is under construction; these will look for ultralight dark matter and mid-band gravitational waves. Atom interferometers are also suscepti- ble to the Coriolis force, which can cause unwanted phase shifts and obscure signals. The design and characterisation of an ultra-high-vacuum bottom reflecting mirror system for the active com- pensation of the Coriolis effect and the implementation of phase-shear readout for the MAGIS-100 experiment are reported. A measurement of the bottom reflecting mirror's pointing jitter noise with an analysis of how this noise source impacts the atomic phase is presented. The analysis demon- strates that the system has an rms angular jitter of 33 nrad, and the total phase shift due to the pointing jitter is calculated to be 1.1 mrad, well below the expected atom shot noise limit. The analy- sis is then further extended to cover a range of future experimental parameters that MAGIS-100 will cover, and it is found that this systematic error is of low order.

Accelerator Innovations / 60

Essential Aspects of a Muon Collider Demonstrator

Author: Rohan Kamath[1]

[1] *Imperial College London*

Muon colliders offer high-luminosity, multi-TeV collisions with minimal synchrotron radiation, but their feasibility depends on advancements in muon production, cooling, and storage. The proposed Muon Collider Demonstrator complex addresses two key aspects: with the neutrinos from Stored Muons (nuSTORM) experiment for muon storage, and the 6D cooling demonstrator for muon cool- ing.

The 6D cooling demonstrator extends the MICE experiment by incorporating longitudinal emittance reduction alongside transverse ionisation cooling. The design utilises solenoids for tight focusing, dipoles for dispersion, wedge absorbers for differential energy loss, and RF cavities for reacceler- ation. This paper presents a full implementation of a cooling channel in BDSIM, a Geant4-based simulation tool, along with validation against codes like G4BeamLine, and tracking studies optimis- ing a rectilinear cooling lattice.

Detectors and Instrumentation / 61

Development of a Retro-reflection Platform for the MAGIS and AION Experiments Towards Kilometre-scale Atom Interferome- try

Author: Andrew Carroll[1] [1] *University of Liverpool*

MAGIS and AION are a pair of next-generation quantum sensors that aim to explore fundamen- tal physics with atom interferometry. This new experimental regime is capable of probing a di- verse range of physical phenomena by creating unprecedented macroscopic superpositions of mat- ter waves, including detecting mid-band (0.1-10 Hz) gravitational waves, testing theories of wave- function collapse, searches for new fundamental forces and dark matter candidates, as well as capa- bilities in precision metrology to measure Newton's constant and the fine structure constant and test the Equivalence Principle. MAGIS-100 will be a strontium atom interferometer located at Fermilab with a 100-metre vertical baseline, building on previous work done over 10-metre scales, and with the intention of providing a development platform for future kilometre-scale experiments. AION is a sister consortium which is planning to build a 10-metre prototype at the University of Oxford, with plans to upgrade to a 100-metre baseline. The collaboration between MAGIS and AION will facilitate the development of the technologies required to build such an ambitious experiment, as well as providing multiple independent observatories for gravitational waves.

The University of Liverpool is developing a retro-reflection platform for both MAGIS and AION. This platform will be capable of performing phase-shear detection - a method of state detection which allows the phase and contrast of the interferometry fringes to be inferred in a single measurement - as well as compensating for the Coriolis effect which becomes significant over such large baselines. The design, development and status of this platform, as well as future plans towards kilometre-scale and spaced-based iterations, will be presented.

Neutrino Physics / 62

Impact of flux systematics on ND fits

Author: Koustubh APTE[1]

[1] *Imperial College London*

T2K is a long-baseline neutrino oscillation experiment located in Japan, designed to investigate the properties of neutrinos by measuring their oscillations between different flavours. The experiment' s oscillation analysis requires precise predictions of event rates, where systematic uncertainties, par- ticularly those related to neutrino flux, play a significant role. The experiment has a near detector (ND280) that constrains the unoscillated flux, and this information is propagated to the far detector to improve predictions. In the T2K experiment, systematic uncertainties related to neutrino flux are parameterised in bins of neutrino energy by flavour, detector, and beam configuration and in- corporated into a covariance matrix prior to near detector (ND280) fits. These fits constrain the unoscillated flux which can be propagated to the far detector. This approach effectively reduces un- certainties in the predicted event rates, which are crucial for precise measurements of oscillation pa- rameters. However, it limits the interpretability of the ND constraint in the context of the systematic properties driving this uncertainty, as the post-fit uncertainties only provide the total uncertainty without isolating contributions from individual underlying systematics. This work aims to address this limitation by incorporating the impact of leading flux systematics into the fit as their own pa- rameters. This novel fitting approach will potentially allow the post-fit results to directly quantify the impact of ND constraints on each underlying flux systematic. By disentangling the individual contributions, this work provides valuable insights into the dominant sources of uncertainty affect- ing the predicted event rates. Such insights are particularly relevant for Hyper-Kamiokande, where systematic uncertainties will dominate due to its higher statistical precision, motivating potential strategies for external constraints on key systematics.

Analysis and Reconstruction Methods / 63

Jet mass reconstruction in the CMS level-1 trigger for the HL- LHC

Author: Liam Robertshaw[1]

[1] *University of Bristol (GB)*

The High Luminosity upgrade to the LHC (HL-LHC) will increase the rate of proton-proton collisions by a factor of approximately seven, yielding greater statistics for physics analyses but also creating a challenging pileup environment. To exploit the increased luminosity and maintain physics sensitiv- ity, the CMS detector will undergo many significant upgrades, including to its level-1 trigger (L1T) subsystem. A new architecture has been designed which has to reduce the event rate from 40MHz to 750kHz in 12.5 microseconds. This talk is centred on the development and implementation of new algorithms to meet these requirements, specifically those focussed on jets. Jets are strong sig- natures of interesting physics, thus efficient level-1 jet reconstruction is paramount for the HL-LHC detectors. We will discuss jet mass reconstruction and its practicality as a potential trigger. Physics processes where the jet mass may be useful for tagging fermionic decays of beyond standard model bosons are explored, before then investigating the efficiency for a hypothetical light Higgs decay. Lastly, we look at implementing the trigger in firmware, discussing the potential latency and re- source usage.

Neutrino Physics / 64

Neutron Backgrounds in the SuperNEMO Experiment

Author: Sam Pratt[None]

SuperNEMO is an R&D experiment designed to search for neutrinless double beta decay, a hypo- thetical, lepton-number-violating decay. The detector has a separated tracker-calorimeter structure allowing both the topology and energy of the electron pair from the decay to be studied.
If seen, $0\nu\beta\beta$ would tell us about the nature of the neutrino and would be the rarest process to ever be observed. An ultra-low background is therefore required to be able to search for this decay. A poten- tial background that could, in rare circumstances, mimic the signal of a $0\nu\beta\beta$ event in the detector is caused by neutrons originating from radioactive processes in the rock of the lab where SuperNEMO is housed.
To understand this effect simulations have been performed to model how the neutron background will affect SuperNEMO’s sensitivity, and the effect of neutron shielding in mitigating this back- ground.

Poster session / 65

Study of Atmospheric Neutrinos at JUNO

Author: Ziou He[None]

The Jiangmen Underground Neutrino Observatory (JUNO) is a multi-purpose neutrino experiment located in Guangdong Province, China, featuring a 20-kton liquid scintillator (LS) detector. Its excel- lent energy resolution, large detector volume, and exceptional background control provide a unique opportunity to explore key topics in neutrino and astroparticle physics. JUNO’s primary objectives are to determine the neutrino mass ordering (NMO) and precisely measure related neutrino oscilla- tion parameters. The experiment is nearing the completion of its LS filling phase.

Atmospheric neutrinos are sensitive to NMO through matter effects and can enhance JUNO’s overall sensitivity when combined with reactor neutrino analyses. The collaboration has employed leading models of neutrino flux, Earth structure, and neutrino interactions to predict the event rate in the detector. This poster presents a study of atmospheric neutrinos at JUNO, in particular the event rate prediction and its systematics.

Poster session / 66

Status of the SNO+ Experiment

Author: Benjamin Tam[1]

[1] *University of Oxford*

The SNO+ Experiment is a versatile liquid scintillator neutrino detector situated at SNOLAB, with the primary goal of searching for neutrinoless double beta decay. In addition to ongoing measure- ments of reactor antineutrinos, solar neutrinos, geoneutrinos, supernova neutrinos, and other exotic phenomena, the SNO+ experiment is now preparing for an upcoming phase capable of neutrinoless double beta decay. Recent preliminary results, upgrades to the detector hardware, and the upcoming physics capabilities of the experiment will be discussed.

Poster session / 67

Wire Plane Transparency: Commissioning the Time Projection Chambers for the Short Baseline Near Detector

Author: Bethany McCusker[1]

[1] *Lancaster University*

The Short Baseline Near Detector (SBND) serves as the near detector for Fermilab's Short Baseline Neutrino (SBN) programme. It is a 112-ton Liquid Argon Time Projection Chamber (LArTPC) de- signed to study neutrino-argon interactions and search for new physics phenomena such as sterile neutrinos. Situated just 110 m from the Booster Neutrino Beam (BNB), SBND just began its first physics run and is expected to record over two million neutrino interactions annually. Commission- ing the time projection chambers of the SBND is crucial for optimising detector performance. Each of the two anodes is composed of three charge-sensing wire planes which detect drifting ionisation electrons from charge particles traversing the detector. The wire planes, arranged with different 2D orientations, facilitate the 3D reconstruction of neutrino interactions. Electron transport induces signals on the first two planes, with the signal being collected by the rear plane. The first two in- duction planes require transparency to ensure all drift electrons reach the collection plane. This transparency depends on the bias voltages applied to the wires and the spacing between them. Fine- tuning these bias voltages ensures the optimisation of wire plane transparency. In this poster, I will demonstrate how transparency can be assessed by analysing the waveforms from cosmic-ray muon tracks traversing the detector at specific orientations.

Detectors and Instrumentation / 69

Performance and Monitoring of LUX-ZEPLIN's Outer Detector

Author: Megan Carter[None]

LUX-ZEPLIN (LZ) is a direct detection experiment with the primary aim of searching for Weakly Interacting Massive Particles (WIMPs), one of the leading candidates for dark matter. Central to this search is the ability to identify and distinguish signals from any background events, with neutron in- duced signals presenting a particular challenge due to their similarity to those produced by WIMPs. The Outer Detector (OD) plays a critical role in this effort by identifying and vetoing such neutron events. In order for this to be done effectively, accurate energy calibrations are required, as well as a thorough understanding of the detector's neutron-tagging efficiency. The ongoing monitoring of the outer detector is also crucial in ensuring performance is consistent and high levels of precision are maintained. Such monitoring includes studies of single photoelectron responses, after-pulsing effects, and analysis of detector stability over time. This talk will explore how these efforts sup- port high sensitivity of the LZ experiment to WIMP search and other effects beyond the standard model.

Neutrino Physics / 70

Constraining cross section uncertainties for a DUNE Long-baseline analysis

Author: Abigail Katharine Peake[1]

[1] *University of London (GB)*

The DUNE Near Detector (ND) will have sufficiently high statistics to constrain the contributions from the neutrino flux, interaction cross-section, and detector efficiency. Neutrino-nucleus cross- sections will be a large source of systematic uncertainty for DUNE. It is therefore crucial to constraint this uncertainty as much as possible in order to make precision measurements of the neutrino os- cillation parameters using the DUNE Far Detector (FD). One way of separating these uncertainties as a function of neutrino energy is by moving the DUNE ND off-axis (DUNE PRISM). It is also im- portant to select projections and binning for the DUNE event rate that is not only most sensitive to neutrino oscillation but also directly correlates to the interaction kinematics and where the detector systematics can be well motivated. In this talk, I will explore the benefits of different sets of analysis projections. I will also discuss how DUNE PRISM can constrain cross-section uncertainties.

Poster session / 71

Characterising and simulating silicon photomultiplier detector response for the DarkSide-20k veto detector.

Author: Pritindra Bhowmick[1]

[1] *University of Oxford/STFC*

DarkSide-20k is a direct detection dark matter search experiment that will search for dark matter candidates with masses from the keV to Plank scale. The detection signature is scintillation produced by energy deposition in a 51-tonne dual-phase liquid Argon time projection chamber (TPC) and surrounding veto region. Argon scintillation is detected by 27 m2 of novel low-noise cryogenic silicon photomultiplier (SiPM) array detectors. The poster will focus on SiPM array photodetector characterisation for the veto and simulation of realistic detector and electronics response.

Detectors and Instrumentation / 72

DarkSide-20k veto photodetector assembly

Author: Ash Ritchie-Yates[None]

DarkSide-20k is a direct dark matter detection experiment which employs a Liquid Argon Time Pro- jection Chamber (TPC) to search for dark matter interactions. A principal background for these searches in DarkSide-20k are radiogenic neutrons introduced by contaminations in the detector ma- terial. To reduce this background, DarkSide-20k tags neutron interactions in an Inner Veto detector surrounding the central TPC instrumented by Silicon Photo-Multiplier (SiPM) array light detectors termed veto Photo Detector Units (vPDU)s. vPDUs are currently being produced and quality tested by a consortium of groups across the UK.

Controlling the deposition of radon and its progeny in this process is crucial to achieve the low back- ground goals of DarkSide-20k. By modeling the disequilibrium in the radon decay chain, including processes such as deposition, ventilation, and attachment to aerosol particulates within the photo- sensor assembly clean room, we can estimate surface activity levels and assess contamination risks. These results provide practical insights for refining assembly workflows and achieving the stringent background requirements.

This talk/poster covers the vPDU assembly and testing currently being carried out, and the cleaning processes and assembly conditions necessary to assure the preservation of the radiopurity of the detector material.

Neutrino Physics / 73

Far-Detector Neutral Current Pi_0 Events for T2K's Oscillation Analysis

Author: Marvin Pfaff[1]

[1] *Imperial College (GB)*

Current neutrino experiments are making world-leading measurements of the PMNS parameters and are continuing to collect data and improve their analyses to push towards the precision era. In such efforts, new data targeting neutral current π^0 interactions are being added to the T2K oscilla- tion analysis. This sample constrains the π^0 background in the electron neutrino appearance dataset as well as the unoscillated neutral current background in muon disappearance samples. In addition, understanding these π^0 events may allow poorly reconstructed electron-like events to be added into the analysis. Work on the inclusion of this sample is currently ongoing and may be presented.
Furthermore, for precision measurements, solely relying on the assumption of unitarity will no longer be viable in the precision era but needs to be tested. To achieve this, new presentations are needed that can directly test unitarity or allow theorists and global fitters more precise com- binations without assuming unitarity. Some of such possible presentations will also be briefly dis- cussed.

Detectors and Instrumentation / 74

Inductively Coupled Plasma Mass Spectrometry at the Boulby Underground Laboratory.

Author: Sid Ahmed Maouloud[1]

[1] *The University of Edinburgh*

Achieving unprecedented material radiopurity is paramount for ultralow background (ULB) physics experiments searching for rare events. In the BoulB laboratory, we have established a dedicated Inductively Coupled Plasma Mass Spectrometry (ICP-MS) facility to address this challenge. This pre- sentation will first provide a concise overview of ICP-MS fundamentals. Subsequently, we will detail our specific ICP-MS system and the analytical methods we have developed for ultrasensitive quanti- tative analysis of elemental impurities, particularly long-lived radioisotopes like U-238, and Th-232, K-40, in detector materials. We will explore the capabilities and practical challenges encountered in our system when meeting the stringent radiopurity demands of current and future generations of ULB detectors, showcasing examples relevant to groundbreaking discoveries in astroparticle and high-energy physics.

Analysis and Reconstruction Methods / 75

Experience of using ACTS to implement GBTS as a new seeding method for the ATLAS ITk.

Author: Rosie Hasan[1]

[1] *Royal Holloway, University of London (GB)*

The High Luminosity LHC (HL-LHC) is set to begin in 2029 and will be Run 4 of the ATLAS de- tector. As part of the phase 2 upgrade, the ATLAS Inner tracking system will be replaced with an all-silicon Inner Tracker(ITk). The higher luminosity will cause an increase in pileup, the number of interactions per crossing, resulting in more tracks, increasing the computational complexity of track reconstruction. A Common Tracking Software (ACTS) is an experiment-independent software toolkit, for the development of track reconstruction software. This talk will describe importing a new seeding method, GBTS (Graph Based Track Seeding), into this platform and implementing the ACTS algorithm into ATLAS software. This will be discussed as a case study of using the ACTS platform for the ATLAS ITk.

Poster session / 76

Measurement and Simulation of the Ambient Gamma Background in the QUEST-DMC Experiment

Author: Elizabeth Bloomfield[1]

[1] *University of Oxford*

The Quantum Enhanced Superfluid Technologies for Dark Matter and Cosmology (QUEST-DMC) ex- periment aims to search for sub-GeV dark matter with a quantum-amplified superfluid 3He calorime- ter. Cosmic rays and radiogenic backgrounds are expected to be dominant backgrounds in the region of interest, between eV to keV scale recoil energies, for a dark matter search. Characterising these backgrounds in an ultra-low temperature cryostat is not only imperative for dark matter searches but is also of increasing interest for quantum sensor and qubit development. Ambient gammas are part of the radiogenic background and are usually produced from the surrounding environment (natural radioactive isotopes in the soil, rocks, and building materials etc), as well as cosmic ray interactions with the atmosphere. This poster shows the measurement of the ambient gamma spectra in and around the QUEST-DMC cryostats using a sodium iodide (NaI) detector and simulations of expected energy deposition in the bolometer using this data.

Poster session / 78

Characterisation of Carbon Fibre thermal expansion coefficient for the tracking system of the MUonE experiment

Author: Giorgia Cacciola[1]

[1] *University of Liverpool (GB)*

There is a long-standing discrepancy between theory and experiment in the evaluation of the muon g-2. The leading order hadronic contribution to the muon anomalous magnetic moment, aμHLO is the highest source of uncertainty in this evaluation. The MUonE experiment aims to measure aμHLO with high precision using a novel approach. The MUonE experiment will take place in CERN's North area, using the M2 beam line which produces 160 GeV muons, which will be scattered on a fixed low Z target. The experiment has a modular structure composed of multiple 1m long tracking systems that have individual targets. aμHLO can be evaluated by the extraction of the effective electromagnetic coupling from the shape of the differential cross section of the μ-e elastic interactions. The main challenge for MUonE is to keep the systematic error at the level of 10ppm in the signal region. In order to meet this requirement, the longitudinal distances within a tracking station must be stable at the level of 10μm. The current tracking system mechanics is made of Invar, a material which meets the stringent requirements on the longitudinal stability, despite high production costs. In order to optimize the production, an investigation of carbon fibre as an alternative material was carried out. Results of a study to characterize its thermal expansion will be presented.

Poster session / 79

Background simulation techniques and expected sensitivity to sub-GeV dark matter in the QUEST-DMC experiment

Author: Robert Smith[None]

QUEST-DMC (QUantum Enhanced Superfluid Technologies for Dark Matter and Cosmology) uses a superfluid helium-3 target cooled to 140 μK to search for eV-keV scale recoil energies from inter- actions with sub-GeV mass dark matter candidates. As the target volume of a QUEST bolometer is extremely small (<1cm^3) it is CPU intensive to produce high statistics simulations of background in- teractions with sources originating from outside the experiment cryostat. These simulations are sped up by creating intermediate particle generators using partially attenuated spectra, dubbed 'rethrow- ing'. Expected detected energies and rates are produced through the application of a data-driven response model to the final simulated spectra. This talk will outline this background simulation, the subsequent applied response model, dark matter search prospects with existing data from a proto- type QUEST bolometer and ultimate sensitivity estimates in the experiment.

Terrestrial Dark Matter Searches / 80

Commissioning of the MIGDAL detector with fast neutrons at ISIS/NILE

Author: Lex Millins[1]

[1] *University of Birmingham (GB)*

Dark matter makes up most of the mass content in the universe, yet its nature remains one of the biggest unanswered questions in physics. Many experiments are searching for WIMP-like dark mat- ter directly and exploiting improvements in sensitivity thanks to the Migdal effect, a rare atomic process. However, this process is yet to be observed in nuclear scattering. The MIGDAL experiment aims to make the first unambiguous observation of the Migdal effect in nuclear scattering. A low pressure Optical Time Projection Chamber (OTPC) is used to perform 3D imaging of the character- istic Migdal signal - an electron and a nuclear recoil sharing a common vertex. Nuclear recoils are induced using fast neutrons from a D-D generator which scatter in the gaseous volume. Both ionisa- tion charge and scintillation light are read-out and these measurements are combined for complete three-dimensional track reconstruction.
In this talk I will discuss the detector performance and results of commissioning with fast neutrons at the Neutron Irradiation Laboratory for Electronics (NILE) at Rutherford Appleton Laboratory in the UK.

Beyond the Standard Model / 81

Search for long-lived particles with the ATLAS muon spectrome- ter

Authors: Julian Friedrich Wack[1]; Michael Revering[2]; Paul Jones[1]

[1] *University of Cambridge (GB)*

[2] *University of Cambridge*

Many BSM models predict the existence of neutrally-charged long-lived particles (LLPs) with macro- scopic lifetimes. When these LLPs decay back into SM particles within the ATLAS fiducial volume, they leave a striking signature in the form of displaced vertices (DVs). Due to its large size and pre- cise tracking capabilities, the ATLAS muon spectrometer (MS) is a powerful tool for LLP searches. This contribution will discuss the most recent ATLAS search for MS DVs using the full Run 2 dataset. Results are interpreted in terms of scalar portal, axion-like particle, and dark photon models, con- stituting the most stringent ATLAS limits in the very long lifetime regime. The talk will focus on a dedicated analysis channel targeting Z-associated LLP production. The triggering and selection strategy considers leptonic decay modes of the Z boson and maximises the selection efficiency while practically eliminating backgrounds.

Poster session / 82

Determination of the Absolute Neutrino Mass using Quantum Technologies

Author: Seb Jones[None]

The observation of neutrino oscillations provides proof of non-zero neutrino masses. However, these same neutrino oscillation experiments do not provide information on the absolute scale of these masses, which remain unknown. The neutrino masses may be accessed via measurement of the shape of the tritium beta-decay energy spectrum with a particularly sensitive technique known as Cyclotron Radiation Emission Spectroscopy (CRES). The Quantum Technologies for Neutrino Mass (QTNM) collaboration aims to utilise CRES, along with state-of-the-art techniques from ex- perimental Atomic, Molecular and Optical (AMO) physics, recent advances in the development of ultra-low-noise microwave amplifiers and other quantum technologies, to build a demonstrator ap- paratus suitable for measuring the absolute neutrino masses.

Poster session / 83

Phase 1 of the MUonE Experiment at CERN

Author: Clement Loic Devanne[1]

[1] *University of Liverpool (GB)*

The measurement of the muon anomalous magnetic moment (g−2) exhibits a significant discrep- ancy with the Standard Model. The dominant theoretical uncertainty arises from the leading-order hadronic contribution a_µˆHLO, evaluated using data-driven approaches based on e+e− to hadron cross-section data, or recent lattice QCD results. However, tensions within these methods compli- cate the comparison between theory and experiment, underlining the importance of an independent validation. The MUonE experiment, conducted at CERN, aims to resolve this through an innova- tive method by measuring the running of the electromagnetic coupling constant , directly sensitive to a_µˆHLO, through muon-electron elastic scattering in the space-like region. This is achieved by directing a 160 GeV muon beam onto a low-Z target.

The phase 1 of MUonE, will deploy all key-components planned for the final experiment after the Long Shutdown 3, including high-precision silicon trackers, a spectrometer to measure the beam mo- mentum, an electromagnetic calorimeter, a muon filter, and an advanced data acquisition system. The goals of this first run are to validate the full detector setup under operational conditions, optimize data acquisition and reconstruction techniques, perform comprehensive studies of systematic uncer- tainties and background processes. Additionally, Phase 1 will provide a direct measurement of the hadronic contribution to the running of alpha with ˜20% statistical accuracy and similar systematics. The setup and the status of the experiment in preparation of the 2025 run will be presented.

Detectors and Instrumentation / 84

Strong-field QED measurement tests at FACET-II using new elec- tron detector concept

Authors: Antonios Athanassiadis[1]; Louis Helary[2]; Luke Hendriks[3]; Ruth Magdalena Jacobs[2]; Jenny List[2]; Gudrid Moortgat-Pick[4]; Evan Ranken[2]; Ivo Schulthess[2]; Matthew Wing[3]

[1] *Universität Hamburg, DESY*

[2] *DESY*

[3] *UCL, DESY*

[4] *Universität Hamburg*

Recent advancements in laser technology have made it possible to probe the non-perturbative regime of quantum electrodynamics in strong electromagnetic fields. This regime, also known as strong- field quantum electrodynamics (SFQED), is still largely unexplored. The LUXE experiment planned at DESY will study the transition into the SFQED regime. SFQED interactions, such as non-linear Compton scattering and Breit-Wheeler pair production, will be produced by high-energy electrons interacting with a strong electromagnetic field created by a high-intensity laser. A prototype of the electron detector system, responsible for measuring the electrons that have undergone SFQED interactions at LUXE, was recently set up at the FACET-II beam line at SLAC. The prototype consists of a segmented straw Cherenkov detector, and a scintillator screen and camera set-up. It made its first measurements last November in collaboration with the SFQED experiment E320 at SLAC. This talk will discuss LUXE, the prototype, and the first results obtained from the measurements with E320.

Collider Physics - Flavour / 85

Lb->Lc+ Lc-˜ n: A first study of purely baryonic decays with a neu- tron

Authors: Eduardo Rodrigues[1]; Ned Francis Howarth[1]

[1] *University of Liverpool (GB)*

We present an ongoing search for the decay mode $\Lambda^0_b \to \Lambda_c^+ \bar{\Lambda}_c^- \bar{n}$, utilising pp collision data collected at a center of mass energy of $\sqrt{s}$ = 13 TeV recorded by the LHCb detector. The sample was collected in 2016-2018 during Run 2 of the Large Hadron Collider. This analysis marks the first search at the LHC featuring a final-state neutron, offering a unique probe into the dynamics of baryonic decays. The analysis employs a missing-momentum style approach to reconstruct the neutron, adapting techniques from LHCb semileptonic analyses that are characterised by an undetected neutrino. The study contributes to the emerging experimental field of purely baryonic decays, a sector with only one other experimentally observed process to date. By exploring this decay channel, we aim to provide new insights into the underlying mechanisms of weak decays involving baryons and to test the predictions of the Standard Model in this relatively unexplored regime.

A Phase-Corrected method to measure the CKM γ angle

Author: Jozie Meldrum[1]

Co-authors: Benedict Donald C Westhenry [2]; Camille Normand [2]; Evelina Mihova Gersabeck [3]; Jonas Rademacker [2]; Shenghui Zeng [2]

[1] *University of Bristol*

[2] *University of Bristol (GB)*

[3] *University of Freiburg (DE)*

The CKM angle γ is a free parameter of the Standard Model of particle physics that determines the level of CP-violation in the quark sector. Measurements of this parameter test the unitarity property of the CKM matrix and act as a sensitive probe for physics beyond the SM. As such, it is a focus of several analyses at LHCb. Direct measurements are usually limited by factors such as model-bias, external inputs or sample size. The Phase Correction method presented in this talk
avoids all these problems, promising a new, precise gamma measurement using the golden channel:
$B^{\pm} \rightarrow [K^0_S \pi^+ \pi^-]_D K^{\pm}$.

A large source of uncertainty in γ can come from D-decay strong-phase models. We use both LHCb and BESIII datasets to explore the phase space of the D-decay. From them, we determine the strong- phase correction terms necessary to free the description of the strong-phase from any model bias. The unbinned LHCb and BESIII fits maximise the information from both datasets.

Here, I will present the phenomenology of the method and the progress of the ongoing measure- ment. Our studies show that this has the potential to be the most precise single γ measurement to date.

Testing the Quantum nature of reality with Higgs bosons

Author: Theo Maurin[1]

[1] *University of Glasgow (GB)*

The ATLAS Collaboration has recently observed quantum entanglement in top-quark pairs using 13 TeV proton-proton collision data—marking the first observation of entanglement in fundamen- tal quarks and at the highest energy scales ever probed and exposing limitations in state-of-the-art Monte Carlo simulations at the same time. Building on this milestone, this talk will explore new measurements aimed at accessing maximally entangled states in Higgs boson decays. In particular, I will discuss the reconstruction of entangled vector boson states using quantum tomography observ- ables, highlighting the potential of collider experiments to probe quantum information concepts in novel ways.

Probing the Standard Model with Electroweak Bosons at LHCb

Author: Keira Farmer[1]

[1] *The University of Edinburgh (GB)*

High precision measurements of electroweak physics provide compelling tests of the Standard Model. To make such measurements a good understanding of both the detector alignment conditions and the initial state is required. The talk will discuss studies towards both at LHCb. First, a measurement of, and correction for, curvature biases will be presented, based on arxiv:2311.04670. This approach improves the Z boson invariant mass resolution by 20% and is a key step in LHCb's precision elec- troweak programme. Second, studies towards a new measurement that probe the intrinsic charm content of the proton will be presented. The LHCb collaboration's measurement of Z bosons pro- duced in association with a charm-jet presented event yields that could be explained by the proton having an intrinsic charm component. It is theorised that this charm content could be accessed at LHCb through the study of events containing both a Z boson and D meson. This analysis is now underway, and the talk will present the latest status of this measurement.

Accelerator Innovations / 90

Development of novel beam instrumentation for in vivo and in vitro end stations for Laser-hybrid Accelerator for Radiobiologi- cal Applications (LhARA)

Author: Rehanah Razak[1]

[1] *Imperial College London*

Radiotherapy is a cornerstone of modern cancer treatment, utilising x-ray photons, electrons and ion beams to non-invasively target cancerous tumours, effectively. The Laser-hybrid Accelerator for Radiobiological Applications (LhARA) is a novel laser-driven accelerator system currently under development that aims to transform Particle Beam Therapy (PBT) by enabling flexible, high-flux multi-ion irradiations for radiobiological studies. Unlike conventional PBT systems, LhARA seeks to harness laser-driven proton and ion beams, offering a platform for investigating the radiobiological effects of ultra-high dose rate (FLASH) and spatially fractionated radiation therapy.

A critical challenge in this endeavour is the precise focusing and shaping of proton and light ion beams at the in vivo and in vitro end stations, without the limitations imposed by mechanical colli- mation. This study presents the development of a novel, magnetically focussed beam delivery system designed to produce minibeams (beams with a diameter of less than 1 mm). The proposed method consists of a double quadrupole triplet configuration to focus the beam. The first quadrupole triplet focuses an initially broad 1 cm beam distribution into a high-intensity focal spot, while the second triplet ensures controlled divergence to produce the required 1 mm spot distribution with an energy of 15 MeV, for the low energy in vitro end station's experimental requirements.

This approach offers several advantages over traditional collimation techniques, including enhanced beam transmission efficiency, reduced scatter-induced dose perturbations and the potential for pre- cise spatial dose modulation. The experimental validation of this method will mark a significant step towards the realisation of a next-generation radiobiological research facility. Future work will focus on optimising beam transport dynamics, characterising dose delivery precision and expanding the technique for multi-ion beam applications.

Poster session / 91

Online Event Classification for JUNO Data Acquisition

Author: Yaoqi Cao[None]

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20-kiloton underground liquid scintillator detector located in Guangdong, China, which is currently filling in the liquid scintillator. JUNO's primary physics goal is to determine the neutrino mass hierarchy with high precision. Additionally, it is designed to detect a wide range of neutrino interactions, covering an energy range from MeV to GeV.

To efficiently manage the high event rate and diverse physics signals, JUNO implements the Online Event Classification (OEC) system to pre-classify detected events and retain essential raw information. The OEC system can use the offline waveform reconstruction algorithm on the Data Acquisition (DAQ) system, while at the same time, the FPGA TQ can also be used for waveform reconstruction. Additionally, the OEC will distinguish different event types according to their physical characteristics, and the waveforms of some event types that require storage will be stored. By integrating optimized classification and data retention strategies, OEC plays a crucial role in balancing bandwidth efficiency while preserving key physics data, supporting JUNO's extensive physics program as data-taking is now underway. This poster will introduce how the OEC system is designed to classify events at JUNO.

Poster session / 92

Sensitivity Ceilings for the QUEST-DMC Detector

Author: Neda Darvishi[1]

Co-author: QUEST-DMC Collaboration

[1] *Royal Holloway University of London*

The QUEST-DMC experiment utilises surface-based superfluid helium-3 bolometers to search for sub- GeV dark matter with low energy thresholds. This talk outlines the impact of the dark matter stop- ping effect on QUEST-DMC's projected sensitivity for both spin-dependent and spin-independent interactions. Our analysis employs two complementary strategies: (i) a straight-line path for dark matter scattering, and (ii) a semi-analytic diffusion model that accounts for large-angle deviations, particularly relevant for lighter dark matter particles. By comparing these approaches, we highlight how the choice of scattering model influences sensitivity estimates. Given atmospheric overburden and complete Earth blocking from below, the QUEST surface run covers several orders of magnitude of unexplored dark matter parameter space at large scattering cross sections.

Collider Physics - QCD / 93

Quarkonium Parton Showe in Herwig 7

Authors: Aidin Masouminia[1]; Peter Richardson[1]

[1] *IPPP, Durham University*

I will discuss the implementation of quarkonium parton shower and decay in Herwig 7, integrat- ing non-relativistic QCD factorisation with spin-colour projections. Both colour-singlet and colour- octet channels are included, capturing S- and P-wave states and feed-down effects from higher ex- citations. The wavefunction formalism at small quark–antiquark separations is matched to short- distance coefficients, ensuring consistent spin correlations and polarisation. Comparisons with LHC data for charmonium and bottomonium show significant improvements over previous versions, con- firming the accuracy of the new parameter tune. This development extends Herwig's capabilities for heavy-flavour physics, enabling precise quarkonium predictions and stringent tests of QCD in high- energy collisions. This quarkonium parton shower will become available to the public with the release of Herwig-7.4.0.

Search for displaced dimuons using Run 3 Data Scouting at CMS

Author: Prijith Pradeep[1] [1] *Imperial College (GB)*

A search is performed for long-lived particles decaying to pairs of muons by the CMS experiment recording proton-proton collisions at a centre-of-mass energy of 13.6 TeV at the LHC. The data is collected using a special stream which stores collision event information from 2022 and 2023 produced only by the High Level Trigger (HLT) system of CMS, thereby reducing the size of an event. This data collection programme, known as "Data Scouting", enables the relaxation of event selection requirements in the trigger system by lowering the thresholds for objects such as the transverse momentum for muons.

The analysis focuses on the properties of dimuon vertices, which are pairs of muons originating from a common point displaced with respect to the collision. These properties, such as the trans- verse displacement, the precision of the displacement measurement of the vertex and the opening angle between the muons are optimised using displaced J/Ψ's as a proxy for displaced dimuons. Events are categorised in terms of the displacement, proximity of other particles, magnitude, and relative orientation of the momentum of the vertex with respect to the collision point, leading to 40 dimuon categories. These selections are designed to be model independent and the event yields are interpreted under a range of models such as the Hidden Abelian Higgs Model and Dark Shower Models which provide candidates for Dark Matter production.

This analysis is an improvement on the Data Scouting search performed for long-lived particles with data collected in Run 2 of the LHC's operation. A rigorous treatment of the systematic un- certainties associated with the mismodelling of the simulation is performed, and is tailored for the trigger and reconstruction systems at the HLT. Preliminary estimates of the upper limit at 95% confi- dence level on branching fractions of long-lived particle decays to dimuons are competitive for low lifetimes and surpass the Run 2 analysis for high lifetimes despite the lower integrated luminosity collected.

Search for μ+ → e+e+e− at the Mu3e experiment and the Commis- sioning of the Pixel Tracker.

Author: Charles Kinsman[1]

[1] *University of Liverpool*

The Mu3e experiment is dedicated to observing charged lepton flavour violation. This is observed through the neutrinoless decay of a muon to two positrons and an electron. The experiment is sit- uated around the Compact Muon Beam Line (CMBL) at the Paul Scherrer Institut, which produces muons at a rate of 10E8 Hz. The experiment aims to observe the decay or exclude a branching ratio greater than 10E-16. To achieve this, there must be greater than 10E17 muons stopped in the detec- tor. This detector must have a minimum reconstruction efficiency of 20%. The physical background for this decay is the Standard model approved decay with neutrinos. Our suppressible background comes from combinatorics. These sources of background must be suppressed to below the 10E-16 level. The first focus of this research is the pixel tracking detector of the experiment and under- standing the effect the efficiency has on the physical output of the experiment. Initially, a tracking algorithm was used to measure and analyse the tracking and vertex reconstruction efficiency of the pixel detector. From this, an alternative tracking algorithm is used to identify inefficiencies in the de- tector and reconstruct tracks that would otherwise be missed. Mu3e is a high-intensity experiment and thus a high reconstruction efficiency is critical. By optimising both algorithms under realistic detector conditions, inefficient or noisy pixel sensors can be identified, and track reconstruction ef- ficiency can be recovered. The results of these algorithms are presented. In addition to work on the efficiency of the pixel detector, a status of the University of Liverpool's contribution to the pixel sensor quality control is provided.

Analysis and Reconstruction Methods / 96

Optimising the LUX-ZEPLIN Neutron Veto using MOO

Author: Nathan Pannifer[None]

Located 1.5 km underground, the LUX-ZEPLIN experiment uses a 7t liquid xenon time projection chamber to search for weakly interacting dark matter (WIMPs) and other beyond-standard-model physics. Interactions between neutrons and xenon are not readily distinguishable from WIMPs. To be able to perform direct detection searches of dark matter, this background must be removed, for which LZ has a dedicated outer detector (OD) acting as a neutron veto. Optimising the neutron veto inherently involves a compromise between efficiently rejecting background neutron events while minimising the amount of deadtime incurred. Using concepts from multi-objective optimization (MOO), a custom algorithm has been implemented to efficiently calculate the so-called Pareto fron- tier - the set of optimal choices where improving one objective necessarily requires compromising another. This allows for quick selection of the best parameters (coincidence, pulse area threshold, time window), and helps with tuning the veto to maximize physics reach. The suite of tools intro- duced will be beneficial for a wider variety of analysis applications.

Detectors and Instrumentation / 97

Characterisation of the next generation fast-timing photon-detectors

Author: Alexander Davidson[1] [1] *University of Warwick (GB)*

Owing to their single photon sensitivity and fast rise time micro-channel-plate photomultipliers (MCP-PMT) make a good candidate for photon detectors for the proposed Time Of Internally Re- flected Cherenkov light detector (TORCH) detector. TORCH has a target time resolution per photon of approximately 70\,ps, required to achieve a 3σ separation of pions and kaons at 10 GeV/c over a 10\,m flight distance.

A major challenge for TORCH is the high detector occupancy expected during the high-luminosity phase of the LHC. A new high granularity anode for a square MCP-PMT has been developed with Photek, which has a higher special resolution and lower per pixel occupancy. This talk will cover the characterisation studies that have taken place on the high granilarity MCP-PMT; from measurements of cross-talk, transit time spread to gain and QE uniformity. Rate capability and expected lifetime were evaluated by gain vs event rate measurements and by studying ion feedback through time delay of after pluses.

Collider Physics - Flavour / 98

Search for Bs->phi eta' decays in Run 1+Run 2 dataset of LHCb

Authors: Matthew David Needham[1]; Ozlem Ozcelik[1]; Yiming Liu[1] [1] *The University of Edinburgh (GB)*

Flavour Changing Neutral Current (FCNC) decays of B^0_s meson into a pair of charmless mesons has been the subject of much experimental and theoretical interest. The decay process is predominated by the loop-level $b \to s\bar{s}s$ progress, which is suppressed in the Standard Model. This analysis is aimed to measure the branching fraction of the rare decay mode $B^0_s \to \phi\eta'$, which is further suppressed because of the cancellation of final states amplitudes in its form factor, and is not observed yet. This analysis used the full Run 1 and Run 2 dataset of LHCb, corresponding to an integrated luminosity of $3 + 6fb^{-1}$. Multiple selection methods are applied on the dataset in this analysis, including cut the kinematics of the primary B^0_s meson and the decay products, and specific vetoes for the peaking components in the background. An MVA classifier is also trained for further separation of signal from combinatorial backgrounds. The signal region of the data is still blinded at this stage, but a CLs analysis is carried out for the sensitivity of the signal with the background model obtained. Either the branching fraction can be measured for the first time with this analysis, or a limit lower than previous works set.

Poster session / 102

Axion contribution to the mass-radius relation of stellar compact objects

Author: Momchil Naydenov[1]

[1] *Sofia University "St. Kliment Ohridski"*

A phenomenological Lagrangian for the interaction between a pseudo-scalar (axion-like) field and massive fermions is constructed and its statistical properties are discussed. For a gas comprised of neutrons which interact with axions we compute the equation of state, where causality and ther- mal equilibrium are explored. Numerical solution of the Tolman-Oppenheimer-Volkoff equations present the influence of this additional interaction on the mass-radius dependence for static spher- ical stars. According to our model the presence of the hypothetical axion can contribute up to 3% increase of a neutron star's mass. Observable properties of the system are considered within astro- physics and collider experiments.

Detectors and Instrumentation / 103

Pixel Detector Development for Future Collider-Based Particle Physics Experiments

Author: Fuat Ustuner[1]

[1] *The University of Edinburgh (GB)*

High-voltage CMOS (HV-CMOS) technology is one of the latest technologies used for tracking de- tectors. They provide cost-effective high radiation tolerance, fast charge collection and low power consumption. HV-CMOS is a full commercial process that is suitable for large-area applications. The integrated sensor and readout design also allow for much easier detector assembly, compared to the hybrid pixel detector technology. These advantages make them one of the promising solutions for particle tracking detector development in high-energy physics experiments.

ATLASPix3.1 chip is the first full reticle size monolithic HV-CMOS sensor including two shunt low- dropout (LDO) regulators. It comprises 132x372 pixels with a pitch of 50µm x 150µm, fabricated using TSI 180nm HV-CMOS technology. The shunt-LDO regulators enable chip operation via serial powering. Serial powering entails the usage of a single, constant current source to operate the chips in a chain. This structure is aimed at minimising power consumption, with a focus on efficiency and sustainability in electrical distribution materials.

The multi-chip quad module system, comprising four ATLASPix3.1 chips within a 4x4 cm2 area, fa- cilitates shared powering and data transmission. Due to the multi-chip quad module structure, its integration of the serial powering schema, and the array of benefits it offers, these modules prove highly advantageous for large-scale applications.

This presentation will provide an overview of the preliminary results in the single ATLASPix3.1 chip characterisation on the serial powering approach, discuss developments and the changes in the new quad-module design and outline the prototyping multi-quad-module structures based on serial pow- ering. Finally, the early-stage findings on the powering and readout studies of the multi-chip quad module will be presented.

Terrestrial Dark Matter Searches / 104

The Latest Results on New Physics Searches in Low-Energy Elec- tron Recoils from the LZ Experiment

Author: Kaan Yuksel Oyulmaz[1]

[1] *University of Edinburgh*

The LZ experiment, located at the Sanford Underground Research Facility in Lead, South Dakota, utilises a dual-phase xenon time projection chamber (TPC) with a 7-ton active volume to detect dark matter candidates. Recently, the LZ experiment announced world-leading sensitivity results in one of the strong candidates for dark matter, Weakly Interacting Massive Particles (WIMPs), based on a total exposure of 4.2±0.1 tonne-years achieved over 280 live days of LZ operation. In this talk, I will present a search for beyond standard model physics using electronic recoil signature. This research investigates several models, including solar axion-like particles, and the electromagnetic interactions of solar neutrinos such as magnetic moment, and millicharge. The study also examines axion-like particles, hidden photons, and mirror dark matter models as potential candidates for dark matter.

Neutrino Physics / 105

Constraining an Oscillation Analysis using Detector Systematics for the DUNE Liquid Argon Near Detector

Author: Tiago Tavares Alves[1]

[1] *Imperial College (GB)*

DUNE is a next generation long-baseline neutrino experiment which will make precision measure- ments of the neutrino oscillation parameters including δ_{CP} , and determine the neutrino mass hier- archy. DUNE will use a megawatt neutrino beam and two detector complexes, Near and Far, located at Fermilab and SURF, respectively. In contrast to the current generation of long baseline neutrino oscillation experiments, DUNE will not be statistically limited and therefore it is paramount to quan- tify the key sources of detector systematic uncertainty in both detector complexes. This talk will present a workflow representing the procedure DUNE will utilise to identify and parametrise a va- riety of detector systematics in ND-LAr, one of the near detectors in the Near Detector Complex, arising from acceptance studies, reconstruction, and calibration, using a data driven approach to con- tribute to the ultimate goal of accurately understanding the nature of neutrinos. The work begins on establishing a new particle gun production workflow, creating new samples that can be used to help identify these physical effects and how the uncertainties in the detector can be quantified.

Detectors and Instrumentation / 106

BUTTON WbLS Detector development at Boulby underground Lab

Author: James Gooding[1]

[1] *University of Liverpool*

BUTTON is a water medium scale WbLS and Cherenkov technology testbed. It is designed to prove the capabilities of advanced photosensors and fill media including water based liquid scintillator (WbLS) in a low background facility. BUTTON features a volume of 30 mˆ3 which has been de- signed with specially compatible materials for use with Gadolinium (Gd) doped water, WbLS and also Gd doped WbLS. The experiment is under construction over a km below sea-level in a deep underground lab on the east coast of England. The design of this experiment has been driven by flexibility allowing replacement of PMT modules with future advanced photosensors, fill materials and insertion of a multitude of calibration devices. These advancements can inform the design of fu- ture water Cherenkov or exotic fill neutrino detectors for nonproliferation or astro/particle physics applications.

Poster session / 107

BUTTON and Beyond: Integrating Novel Technologies in RAT- PAC for Precision Neutrino Detection

Author: Adam Tarrant[1]

[1] *University of Liverpool*

Next-generation neutrino detectors will require new simulation and reconstruction software. For water and scintillator-based neutrino detectors, RATPAC is a leading simulation framework. The latest release, RATPAC-two, brings several enhancements over the original version, improving both the usability and collaboration potential between experiments. With the 30-tonne BUTTON exper- iment at Boulby Underground Laboratory about to begin operations, direct comparisons between data and simulation are now feasible. This talk will highlight the integration of novel technologies, including Water-based Liquid Scintillators (WbLS) and Large Area Picosecond Photodetectors (LAP- PDs), within the RATPAC framework. These innovations hold significant promise for improving the precision of neutrino measurements in the few MeV range, particularly for sources such as reactors and core-collapse supernovae. Starting with BUTTON, the WbLS program at Boulby lays the foun- dation for a potential 1-kton WbLS neutrino detector and future dark matter experiments.

Beyond the Standard Model / 108

First-Order Quantum Corrections to Fifth Forces

Author: Michael Udemba[1]

Co-author: Peter Millington [1]

[1] *University of Manchester*

Non-linear scalar-tensor theories of modified gravity have been considered as candidates for dark matter and dark energy. Often, they possess screening mechanisms which allow them to evade detection from local experiments. Much is understood of their classical behaviour, but their quantum nature is relatively unexplored. We discuss a Green's function method for obtaining the leading order quantum corrections to the classical symmetron field in the vicinity of a spherically symmetric extended source.

Collider Physics - QCD / 109

Centrality Dependence of Global and Azimuthal of Λ Hyperon Polarization In heavy-ion collisions

Author: Sahr Alzhrani[None]

Using a (3+1)D hydrodynamic model, we analyze Λ hyperon polarization in heavy-ion collisions at √sNN = 200 GeV, revealing a strong dependence on initial conditions and QGP viscosity. The model accurately reproduces hadronic flow observables and predicts higher-order azimuthal oscilla- tions in longitudinal polarization. Novel correlations between polarization and anisotropic flow are proposed, offering new experimental tests. A system-size study confirms a dependence consistent with vorticity, providing crucial constraints on quark-gluon plasma dynamics and spin-polarization mechanisms.

Beyond the Standard Model / 110

Anomaly Detection techniques for New Physics searches at the ATLAS experiment

Author: Jennifer Curran[1]

[1] *The University of Edinburgh (GB)*

Despite extensive efforts by many High Energy Physics experiments, no significant evidence for New Physics (NP) has been found. Novel analysis techniques, such as unsupervised Machine Learn- ing (ML), have been proposed to try and extend the reach of these searches. This analysis uses unsupervised ML algorithms to perform event-based Anomaly Detection (AD) to search for BSM physics using Run 2 and early Run 3 data collected by the ATLAS experiment. The final states under consideration are those containing at least two leptons, where the leptons considered are electrons and muons. A wide range of theorised BSM particles could produce such final states within the ATLAS detector. For example, the heavy Higgs boson decaying to pairs of SM Z-bosons and SUSY stop pairs decaying to top quark, W-boson and neutralino pairs. By exploiting data-driven analysis methods to produce results that are independent of a specific signal model, the analysis can probe for BSM physics in a fully model independent way. This talk would present an overview of these novel anomaly detection techniques as well as an update on the status of this ATLAS analysis.

Poster session / 111

Measurement of the Higgs to invisible branching fraction at the FCC-ee

Author: Stephen Randles[1]

[1] *University of Liverpool (GB)*

The FCC-ee is the proposed first phase of a next generation particle collider the Future Circular Col- lider with the first phase having electrons and positrons collided. The analysis shows the expected sensitivity, using statistical errors only, to the branching fraction of Higgs to invisible decay for the ZH process at the e^+e^- Future Circular Collider running at centre-of-mass energies of $\sqrt{s} = 240$ GeV and $\sqrt{s} = 365$ GeV with integrated luminosities of 10.8 ab^{-1} and 3 ab^{-1} respectively. The decays of the Z to electrons, muons, b-quarks, c-quarks and lighter quarks were investigated. It is found that a 25% measurement is possible if a Standard Model branching fraction of 0.106% for the process H
$\to ZZ^* \to \nu\nu\nu\nu$ is assumed. The $Z \to qq$ channel has the best sensitivity. Additional new physics Higgs to invisible decays could be observed with a sensitivity of greater than 5σ if the branching fraction exceeds 0.13% or could be excluded at 0.051% at 95% confidence level.

Collider Physics - Flavour / 112

Charm mixing and CPV using four-body decays at LHCb

Authors: Guy Wilkinson[1]; Jairus Patoc[1]; Martin Tat[2]

[1] *University of Oxford (GB)*

[2] *Heidelberg University*

The search for mixing-related CP violation in the charm sector is a topic of significant interest, as this phenomenon is predicted to occur at an extremely suppressed level within the Standard Model. Consequently, any observable signal at the current experimental sensitivity could provide compelling evidence for New Physics. Such measurements can be achieved through phase-space binned analyses using multi-body decays of neutral charm mesons. Preliminary studies of charm- mixing and CPV will be presented using the channels $D \to h^+h^-\pi^+\pi^-$ $(h = K, \pi)$ conducted using data collected by LHCb during Run 2 of the LHC.

Terrestrial Dark Matter Searches / 113

XLZD@Boulby: The Most Environmentally Sustainable Large-Scale Physics Experiment

Authors: Asher Cunningham Kaboth[1]; Jonathan Hays[1]; Robert Renz Marcelo Gregorio[2]

[1] *University of London (GB)*

[2] *Queen Mary University London*

The XLZD experiment will be the largest and most sensitive direct detection dark matter search to date, demanding significant infrastructure and resources. To minimise its environmental impact, preconstruction efforts are underway to quantify, reduce, and offset emissions across the project lifecycle. This includes emissions tracking, sustainable material selection, and for the first time in a large-scale physics experiment, the application of digital twin simulations specifically for modelling environmental impact under various scenarios. These initiatives align with STFC, UKRI, and HMG sustainability strategies, with the ultimate goal of achieving carbon-neutral operations while main- taining the highest scientific standards. By pioneering these sustainability strategies for large-scale physics experiments, XLZD aims to establish a sustainability framework that can serve as a model for future experiments.

Detectors and Instrumentation / 114

Characterisation of Veto Photodetectors for DarkSide-20k: Cryo- genic Testing Results

Author: Sudikshan Ravinthiran[1]

[1] *PhD Student*

Silicon Photomultipliers (SiPMs) have been chosen as the dedicated optical readout technology for the upcoming DarkSide-20k experiment. This novel technology is being adopted as a replacement for photomultiplier tubes (PMTs) in the DarkSide-20k detector, due to the higher quantum efficiency, lower radiopurity and reduced noise levels at cryogenic temperatures of SiPMs relative to PMTs. Large-area SiPM arrays featuring an active area of 400 cm² with four-channel readout, termed Photo Detection Units (PDUs), are currently being assembled and tested. These PDUs will be used in both the Time Projection Chamber (TPC) and the veto system. The UK groups on DarkSide-20k are re- sponsible for assembling and testing the veto PDUs (vPDUs), ensuring their quality assurance and quality characterisation before they are sent at LNGS for installation in the dark matter search de- tector. This talk will focus on the cryogenic characterisation of vPDUs in dedicated cryogenic test stands in the UK.

Analysis and Reconstruction Methods / 115

Validation and Calibration of Machine Learning Models: Particle Identification and Eye-Disease Prognosis

Author: Robert John McNulty[1] [1] *University of Liverpool (GB)*

With the increasing volume and complexity of data, machine learning (ML) models are becoming indispensable tools for identifying patterns within structured datasets. However, as these models grow in complexity, it becomes challenging to determine whether they are truly learning meaning- ful relationships or capturing unintended artifacts. This lack of interpretability leads to mistrust, particularly in high-stakes domains.
In clinical settings, prognostic models must be fully explainable to clinicians and patients to ensure confidence in medical decisions. Similarly, in particle physics, ML-based classification models must be demonstrably aligned with known physical principles, such as those described by the Standard Model. This work focuses on the validation and further development of a diagnostic ML model for predicting eye disease progression. Additionally, we explore how these validation methodologies can be adapted for the identification of hadronic tau decays in ATLAS, ensuring robust and inter- pretable ML applications across disciplines.

Beyond the Standard Model / 116

Preliminary results from the proANUBIS demonstrator with 104 fb-1 of Run 3 LHC data

Authors: Aashaq Shah[1]; Anna Jane Mullin[1]; Michael Revering[2]; Oleg Brandt[1]; Paul Swallow[2]

[1] *University of Cambridge (GB)*

[2] *University of Cambridge*

The proposed AN Underground Belayed In-Shaft (ANUBIS) experiment aims to search for long-lived particles within ATLAS underground cavern as a valuable addition to the dark matter programme at the CERN Large Hadron Collider. A prototype detector, proANUBIS, has been installed in ATLAS' cavern and has been collecting data since 2024. This data will allow for studies of the expected backgrounds for the ANUBIS experiment and the development of analysis tools that would allow for the synchronisation with ATLAS events. We will report on the current analysis efforts using the 104 fb-1 dataset from 2024, hardware developments and the latest sensitivity projections.

Beyond the Standard Model / 117

A search for heavy neutral and charged BSM Higgs bosons in the bbWW final state at the ATLAS detector

Author: Rachel Ashby Pickering[1]

[1] *University of Warwick (GB)*

Two-Higgs-Doublet-Models are theoretical extensions of the standard model that can account for some of its unanswered questions, for example the source of the matter/antimatter asymmetry in the Universe. They predict 5 bosons, the scalar/pseudoscalar H/A and the charged H+ and H-, alongside the h (the standard model Higgs boson). This talk will present the (currently blind) search for the decay of A/H $\rightarrow$ H+W- $\rightarrow$ btw- $\rightarrow$ bbWW (+charge conjugate) at the ATLAS detector, a decay mode which has never previously been searched for. The search covers the mass ranges 300 < mA < 1000 GeV and 200 < mH+ < 800 GeV. The recent tensions at 400 GeV between the ATLAS and CMS results in A$\rightarrow$ tt searches therefore also motivate this search. This talk will cover the theory and motivations behind the search, and the techniques and challenges of the analysis.

Collider Physics - Flavour / 118

Search for Charged Lepton Flavour Violation at LHCb

Author: Marcus Jonathan Madurai[1]

[1] *University of Birmingham (GB)*

Charged Lepton Flavour Violation (cLFV) is only permitted in the Standard Model of Particle Physics through the oscillation of a neutrino, and hence has branching fractions of the order 10^{-54}, well below the reach of current experiments. Therefore, searches for cLFV have direct sensitivity to new physics models that would enhance the production of such modes, where any observation provides clear evidence for physics beyond the Standard Model. This analysis, using the $B^{\pm} \rightarrow \pi^{\pm}\mu^{\pm}e^{\mp}$ decay channel, is the first search for cLFV in the $b \rightarrow d\ell^{\pm}\ell'^{\mp}$ quark transition at the LHC. In the absence of a signal observation, the world's best upper limit on it's branching fraction will be set. This talk will present the analysis strategy, current status and the expected sensitivity for this search at LHCb.

Collider Physics - Electroweak (EW) and Higgs / 119

First look: W and Z bosons at the LHCb Upgrade Experiment with 2024 p-p collision data

Author: Luke Grazette[1]

[1] *University of Warwick (GB)*

Electroweak physics is foundational to particle physics' Standard Model via the spontaneous sym- metry breaking and the emergent Higgs mechanism. Through this, the electroweak parameters can be interpreted as precision tests of the Standard Model with the possibility to suggest new physics. The LHCb Upgrade I represents a major change for LHCb, including running at an instantaneous luminosity 5 times larger than previously possible.
This is particularly important for precision electroweak physics at the LHCb - which uses muonic decay channels to extract information about the W and Z bosons - as several published measure- ments are statistically limited while using LHCb legacy data.
This talk will cover the first look at the production of W and Z bosons at this new detector, and future prospects with the ongoing data-taking of the LHCb Upgrade I.

Terrestrial Dark Matter Searches / 120

Prospects for non-standard low mass dark matter candidate searches with DarkSide-20k

Author: Conner Roberts[None]

DarkSide-20k, a 51 t dual-phase Liquid Argon Time Projection Chamber (LAr TPC), is designed to detect dark matter particles, which potentially comprise up to 85% of the universe's matter. Tradi- tionally direct detection experiments focus on velocity and moment-independent interactions (either spin-independent or spin-dependent), which have not yielded positive results, leading to significant parameter space exclusions. This talk emphasises the importance of exploring beyond these standard interactions, considering isospin-violating, and momentum and velocity-dependent interactions. We will discuss the use of model-independent, non-relativistic effective field theory operators to describe dark matter-argon nucleus interactions and the potential of DarkSide-20k to test spin-dependent in- teractions with world-leading sensitivity.

Beyond the Standard Model / 121

Search for low-mass resonances decaying into two photons in a range between 66 GeV and 110 GeV with the ATLAS detector

Author: Cheng Jiang[1]

[1] *University of Edinburgh*

The discovery of the Higgs boson at 125 GeV has provided profound insights into the origin of fundamental particle masses in the Standard Model and the mechanism of electroweak symmetry breaking. However, theories beyond the Standard Model suggest the potential existence of addi- tional Higgs bosons in extended parameter spaces. Intriguingly, Run 2 data from both the CMS and ATLAS experiments revealed a non-negligible local excess around 95.4 GeV in the diphoton decay channel. To investigate this anomaly, new searches for low-mass resonances decaying into two photons have been conducted using 13.6 TeV proton-proton collision data collected by the ATLAS detector between 2022 and 2024, corresponding to an integrated luminosity of 168 fb^{-1}.

This analysis focuses on the reconstructed diphoton invariant mass spectrum in the range of 66 GeV to 110 GeV. Two complementary approaches are employed: a model-independent search for a generic spin-0 resonance and a model-dependent search targeting an additional Higgs boson pre- dicted by BSM scenarios. By incorporating advanced multivariate analysis techniques and refined statistical modeling, stringent upper limits at 95% confidence level (CL) are established to both the total production cross-section and the fiducial cross-section times branching ratio.

Poster session / 122

Transformer for Energy Calibration in the ATLAS Electromag- netic Calorimeter

Author: Cheng Jiang[1]

[1] *University of Edinburgh*

In the ATLAS experiment, electrons and photons are reconstructed from energy clusters detected in the electromagnetic calorimeter. To accurately determine their energy, corrections must be applied to the measured energy from these clusters. These adjustments account for energy losses occurring within the passive material of the calorimeter itself. Traditional Multi-variant Analysis methods like Boosted decision tree use high-level cluster variables to correct the raw deposited energy to match the true particle energy.

To fully explore the potential of this task, we decided to delve deeper into lower-level data. Trans- former models are well-suited for this, as they can process graphs of arbitrary sizes and excel at cap- turing long-range dependencies between cells. We rebuilt the processing pipeline with a transformer model implemented in the SALT framework. New loss and architecture designs are introduced for energy calibration tasks. These techniques lead to an improvement of up to 40% in energy resolution of unconverted photons. Adversarial training modules mitigate Data-MC differences, and an addi- tional uncertainty-aware network is implemented to quantify prediction confidence and improve model robustness.

Poster session / 123

The Cutting (HyPER)Edge of Kinematic Reconstruction

Author: Zihan Zhang[1]

Co-authors: Ethan Lewis Simpson [1]; Reinhild Peters [1]

[1] *The University of Manchester (GB)*

At the Large Hadron Collider, the kinematic reconstruction of heavy, short-lived particles is crucial for precision measurements of the Standard Model and searches for new physics. Performing kine- matic reconstruction in events with a high multiplicity of final-state objects is especially challeng- ing due to the extensive potential combinatoric assignments. To address this, we present HyPER, a graph Neural Network that utilizes hypergraph representation learning for reconstructing the origin states from among the detected final states. HyPER discovers relational information using message-passing on a conventional graph structure, and studies higher-order correlations through the introduction of a hypergraph structure, to identify probable parent particles. HyPER is tested on simulated all-hadronic $t\bar{t}$ events and shown to perform favorably compared to existing state-of- the-art reconstruction techniques, while demonstrating superior parameter efficiency. The novel hypergraph approach allows the method to be applied to particle reconstruction in a multitude of different physics processes.

Collider Physics - Flavour / 124

The Search for local CP violation in D0 -> pi+pi-pi0 decays with the amplitude analysis

Author: Lanxing Li[1]

Co-authors: David Friday [1]; Elisabeth Maria Niel [2]; Evelina Mihova Gersabeck [3]

[1] *The University of Manchester (GB)*

[2] *CERN*

[3] *University of Freiburg (DE)*

We present a search for CP violation in the Cabibbo-suppressed $D^0 \to \pi^+\pi^-\pi^0$ mode with more than 1.6M signal candidates, allowing for the most precise amplitude modelling of this decay to date. The measurement uses data sample of pp collisions collected by the LHCb experiment from 2016 to 2018, corresponding to an integrated luminosity of 5.4 fb^{-1}. The D^0 mesons are reconstructed from $D^{*+} \to D^0\pi^+$ decays allowing the flavour at production to be inferred from the charge of the spectator pion. The obtained amplitude model is used to perform the search for CP violation. The CP violating variables can be extracted from the magnitudes and phases of the amplitude model. With respect to the dominant $\rho(770)$ resonances, we reach a statistical sensitivity of 0.1\% for our blinded result.

Poster session / 125

Study of Gas Properties for Dark Matter Searches using Spherical Proportional Counters

Authors: Konstantinos Nikolopoulos[1]; Patrick Knights[2]; Peter Walters[None]

[1] *Hamburg University (DE)*

[2] *University of Birmingham*

The Spherical Proportional Counter, a novel gaseous detector, has been employed in direct, light- particle dark matter searches thanks to its radiopure material construction, single-electron energy threshold, and ability to operate with low-mass nuclie gases. The detector consists of a grounded spherical shell filled with gas and a central readout anode. Gases containing low-mass nuclei such as hydrogen, carbon, and neon are used in the detector to provide good kinematic matching to light particle DM. The design of a proposed future experiment, DarkSPHERE, which could be operated in the Boulby Underground Laboratory, is well underway. Helium-methane gas mixtures, intended for use in DarkSPHERE, require characterisation. Simulation and experimental measurement of gas properties will be presented alongside studies on the effect of changing the gas composition.

Neutrino Physics / 126

Investigating Neutrino-Nucleus Interactions: Inclusive Cross-Sections Across Various Materials at MINERvA

Author: Akeem Hart[1]

[1] *Queen Mary University of London*

The MINERvA experiment is a high-statistics, scintillator-based neutrino-scattering experiment lo- cated within the intense NuMI beamline at Fermilab. Designed with multiple nuclear targets—includ- ing iron, lead, water, graphite, plastic scintillator, and helium, MINERvA is able to directly compare neutrino interactions across different nuclear environments in the same neutrino beam.

MINERvA has produced and continues to produce a wealth of results that are beneficial to the wider neutrino physics community, helping refine neutrino interaction models and reducing uncertainties to the levels required for the success of next-generation neutrino experiments, such as DUNE and Hyper-Kamiokande.

This talk covers an ongoing study of inclusive neutrino-nucleus interactions across all nuclear tar- gets, excluding helium, with a peak beam neutrino energy E_ν of approximately 6 GeV. This study aims to provide new insights into neutrino interactions in a relatively unexplored energy regime and contribute to ongoing efforts to improve understanding of neutrino-nucleus scattering.

Poster session / 127

electron neutrino and muon neutrino cross section measurements with nuSTORM

Author: WONJONG CHANG[1]

[1] *University of Warwick/STFC RAL*

nuSTORM (neutrinos from STORed Muons) is a future generation accelerator-based neutrino exper- iment that is currently in the planning stage. The aim of this project is to study neutrino-nucleus interactions and neutrino cross-sections with high precision, which is required for more precise oscillation measurements at long baseline experiments. Uniquely, it can make high-statistical mea- surements of electron-neutrino and antineutrinos cross-sections in the GeV energy range. It also provides an opportunity to explore BSM (Beyond Standard Model) physics such as lepton flavour violation, neutrino trident, large extra dimensions. In addition, nuSTORM can serve as a test bench for future muon colliders. In nuSTORM, neutrinos are produced by the decay of muons stored in a production ring rather than by hadron decay, which greatly reduces hadronic uncertainties in the flux. The production ring is able to store muons with varied central momentum in the range of about 1-6 GeV/c, producing well-defined neutrino fluxes and it will be the first of its kind. Cross-section evaluation for the latest set of nuSTORM fluxes on Ar has been done with GiBUU, a state-of-the-art event generator. The cross-section evaluated will be shown.

Neutrino Physics / 128

Performance Evaluation of the Muon Window for DUNE Near Detector

Author: Callum Reynolds[1]

[1] *Queen Mary University of London*

DUNE is a next generation long-baseline experiment with the key goals to conduct a comprehen- sive program of neutrino oscillation measurements, search for proton decay in several modes, and to detect and measure the neutrino flux from core-collapse supernova within our galaxy. DUNE will have a far detector that will observe neutrinos after travelling 1300km, where they may have oscillated, and a near detector close to the origin of the neutrinos to make measurements before os- cillations have occurred. The near detector design is evolving, the design in my analysis comprises the Near-Detector Liquid Argon (ND-Lar), The Muon Spectrometer (TMS), and the System for on Axis Neutrino Detection (SAND). I have been analysing a new design for the muon window for the ND-LAr, evaluating the impact the energy loss in ND-LAr's non-sensitive material has on the muon energy resolution, targeting 3% at muon energy 600MeV.

Terrestrial Dark Matter Searches / 129

XLZD: the Next-Generation Liquid Xenon Rare-Event Observa- tory

Author: Alberto Uson[1]

[1] *University of Edinburgh*

The future XLZD collaboration, which combines the LZ, XENONnT, and DARWIN experiments, aims to fully cover the WIMP parameter space down to the neutrino fog limit, becoming the ultimate dark matter effort in the search for WIMPs. XLZD will utilise a 60-80 ton liquid xenon time projection chamber, providing the immense exposure required for this challenging endeavour. Additionally, this future detector will also present excellent sensitivity to ^{136}Xe neutrinoless double beta decay and astrophysical neutrinos from the atmosphere, the Sun, and galactic supernovae. The location of the experiment is yet to be determined, however; the Boulby Underground Laboratory is one of the lead candidates to host it. In this talk, I will mainly discuss the broad physics opportunities enabled by this future rare-event observatory.

Beyond the Standard Model / 130

A new international effort to measure the neutron electric dipole moment

Author: W. Clark Griffith[1] [1] *University of Sussex*

The experimental search for a neutron Electric Dipole Moment (EDM) provides an extremely sen- sitive probe for CP violating physics beyond the Standard Model. The most precise measurement comes from a PSI based experiment giving an upper bound of $1.8\ \ 10^{-26}$ $e$cm (90% CL) on the neutron EDM, by measuring spin precession of ultracold neutrons generated from a solid deuterium source and stored in a room temperature measurement cell. A follow-on experiment at PSI (n2EDM) is currently seeking to improve the neutron EDM sensitivity to the 10^{-27} $e$cm level using dual pre- cession cells, and there are also several other experiments in America and Europe using similar methods with similar sensitivity goals. Pushing to sensitivity beyond this level will require a differ- ent technique and likely also consolidation of the various neutron EDM efforts. There is an emerging international collaboration (nEDMSF) seeking to build a new neutron EDM experiment in Europe based on in-situ ultracold neutron production and measurement in superfluid helium capable of reaching 10^{-28} $e$cm sensitivity. In this talk I will describe the current neutron EDM experimental landscape and then discuss the future nEDMSF experiment.

Collider Physics - Electroweak (EW) and Higgs / 131

Test of CP-invariance of the Higgs boson in vector-boson fusion production in the H→γγ channel with the ATLAS detector

Author: Firdaus Soberi[1]

Co-authors: Dominik Duda [1]; Philip Clark [2]

[1] *The University of Edinburgh (GB)*

[2] *The University of Edinburgh*

The abundance of matter over antimatter in the Universe is one the confounding puzzles of modern physics. The Sakharov's conditions require C and CP violation as an essential ingredient to explain the cosmic baryon asymmetry. So far, the only source of CP-violation observed is through the com- plex phases of the quark mixing (CKM) matrix in the flavour-changing weak interactions. However, the magnitude is many orders below what is needed to account for the asymmetry. Although the Higgs boson interaction with other particles is determined to be CP-conserving (CP-even), there are extended Higgs sector models that allow admixtures between CP-even and additional CP-odd Higgs which could induce new sources of CP violation. Previous analyses have been utilising the angular and differential cross section distributions to look into the CP structure of the Higgs interac- tions however dedicated CP-odd observable would better enhance the sensitivity to probe for new physics.

This work presents the test for CP-invariance in the H→γγ channel via vector boson fusion using Run3 data of the ATLAS experiment at the Large Hadron Collider (LHC) in proton-proton collision at a center-of-mass energy of 13.6TeV. The analysis is designed to probe CP-violation in the HVV interaction vertex using an Optimal Observable (OO) approach. A multi-classifier is used to separate the contributions coming from the VBF signal and the main backgrounds from the gluon-gluon fusion Higgs production and the irreducible non-resonant diphoton production. The background template is constructed using a data-driven approach within a sideband control region. Maximum likelihood fits to the Wilson coefficient are performed to constrain CP-violating effects by shape-fit to the OO which are expected to be symmetric around zero in the SM.

Poster session / 132

2l+MET signature from two-component dark matter at the LHC

Author: Alexander Belyaev[1]

Co-authors: Atri Dey ; Manimala Chakraborti ; Rakhi Mahbubani [2]; Shu Chen [3]; Stefano Moretti [4]; Tania Natalie Robens [2]; Venus Keus [5]

[1] *University of Southampton & Rutherford Appleton Laboratory*

[2] *Rudjer Boskovic Institute (HR)*

[3] *University of Southampton*

[4] *Science and Technology Facilities Council STFC (GB)*

[5] *Dublin Institute for Advanced Studies (DIAS)*

The talk will cover an exploration on the dilepton plus missing transverse energy (MET) signature from LHC run-III to search for two-component scalar Dark Matter (DM). The model discussed in this work is a 3-Higgs Doublet Model (3HDM) where two of the doublets are inert from the Stan- dard Model (SM) and the other one is active and also the SM Higgs doublet, hence an I(2+1)HDM. Each inert sector will provide a scalar DM particle with a discrete symmetry of Z2xZ2 applying on the doublets, and therefore the model will provide two-component DM. The work studies the model parameter space on the masses of two DM particles and the mass differences between the DMs and the next-to-lightest neutral states in each dark sector. Despite the numerical analysis is performed within the I(2+1)HDM for illustrative purposes, this approach makes our essentially largely model-independent and thus suitable for interpretations in other two-component scalar DM scenarios giving rise to the dilepton plus MET signature.

Collider Physics - Flavour / 133

Measurement of the B^0 lifetime using $B^0 \to J/\psi K^{*0}$ decays with the LHCb detector

Author: David Bacher[1]

[1] *University of Oxford (GB)*

A measurement of the effective lifetime in $B^0 \to J/\psi K^{*0}$ decays will be performed utilizing data collected in 2024 with the newly upgraded LHCb Upgrade I detector. Effective lifetime measure- ments of *b*-mesons offer a precise probe for weak decays in the Standard Model. These lifetimes can be calculated within the Heavy Quark Expansion (HQE) framework, though precise theoretical predictions are generally limited to ratios of lifetimes. As such, absolute measurements of the effec- tive lifetime serve as important reference points for both Standard Model and New Physics theory models. Furthermore, the well-known decay $B^0 \to J/\psi K^{*0}$ provides an ideal channel to study and validate the performance of the LHCb Upgrade I detector. Preliminary results from ongoing studies toward the measurement of the $B^0 \to J/\psi K^{*0}$ effective lifetime will be presented in this talk.

Collider Physics - Flavour / 134

Charmless B->VV decays

Author: Francesca Swystun[1]

[1] *University of Cambridge (GB)*

A charmless $B \to V V$ decay consists of a B-meson to two spin-one vector decay with a four hadron final state. The decay amplitude for a given $B \to V V$ decay is described by a basis of three am- plitudes, where a particiular interest in these decays stems from the expected hierarchy in these vector-vector amplitudes being violated for modes involving penguin decays (this is often referred to as a 'polarisation puzzle').

Using the full Run 1 and Run 2 LHCb collision data set studies are on-going to provide both precision branching fraction measurements and, through amplitude analysis, measurements of the CP-average and CP-asymmetry of the amplitudes and polarisation variables for these decays.

Poster session / 135

Hiding fifth forces with radiative symmetry breaking.

Author: Lukasz Bunio[1]

Co-author: Peter Millington [1]

[1] *University of Manchester*

Scalar-tensor theories of gravity are a class of modified gravity theories that offer an alternative to Einstein's general theory of relativity. The main aim of these theories is to address long-standing challenges of modern physics, such as the nature of dark matter and the origin of the accelerated expansion of the Universe. The latter of these problems can be addressed by the so-called fifth forces that appear in the scalar-tensor theories, though they are heavily constrained by the local tests of gravity conducted within the Solar System. These constraints can be however evaded by the introduction of the screening mechanisms, that suppress such forces in regions of high ambient density.

The screening mechanism is usually introduced to the theory at a level of classical action and can suffer radiative instability, which can be cured by fine-tuning of the model's parameters. An al- ternative approach was proposed in [1]. The authors showed that the one-loop Coleman-Weinberg spontaneous symmetry breaking can result in the screening mechanism analogous to the symmetron model. This poster presents an ongoing work on the extension of the calculation presented in [1], in which the modification due to second-order gravitational operators is considered.

[1] Burrage, C., Copeland, E.J. and Millington, P. (2016). Radiative Screening of Fifth Forces. Physical Review Letters, 117(21)

Poster session / 136

Electroforming at Boulby deep underground laboratory

Author: Giovanni Rogers[1]

[1] *University of Birmingham (GB)*

Rare event searches, such as those for dark matter and neutrinoless double beta decay, require in- creasingly sensitive detectors. A critical aspect of this is the reduction of backgrounds in the detector material.
High-grade copper is an attractive choice for detector materials, due to its commercial availability and lack of long-lived radioisotopes, the longest being 67Cu with a half-life of 61.8 hours. Despite this, copper still represents a dominant background, caused by impurities implanted during manufac- turing or cosmogenic activation. To combat this, some experiments have turned to electroforming, a manufacturing method in which copper from solution is deposited onto a model by applying a cur- rent. Because of its favorable electrochemical properties, copper is preferentially plated compared to contaminants making the final product much purer and less active, often below the sensitivity of available assay detectors. In this contribution, the progress towards constructing a copper elec- troforming facility at Boulby, the UK's deep underground laboratory, will be outlined, which is key for several proposed future experiments such as DarkSPHERE. The near-term future plans to fully electroform a spherical proportional counter in the facility will also be presented.

Collider Physics - Electroweak (EW) and Higgs / 137

A 95 GeV Higgs Boson within a 2-Higgs Doublet Model

Authors: Alexander Belyaev[1]; Rachid Benbrik[2]; Mohammed Boukidi[2]; Manimala Chakraborti[1]; Stefano Moretti[3]; Souad Semlali[4]

[1] *University of Southampton*

[2] *Cadi Ayyad University, Morocco*

[3] *University of Southampton & Uppsala University*

[4] *University of Southampton & Rutherford Appleton Laboratory*

This talk will focus on the implications of the excesses observed around 95 GeV in the di-photon and di-tau invariant mass distributions by the CMS collaboration at the LHC, together with the long- standing discrepancy observed around the same mass region at the Large Electron-Positron (LEP) collider in the b-bbar final state. The latest ATLAS search in the di-photon final state reveals an excess of events within the same mass range, albeit with a bit lower significance, thereby corroborating the observations made by CMS. We have found that all three excesses can be explained simultaneously within the general 2HDM Type-III where the lightest CP-even Higgs boson serves as the source of the excesses, while satisfying up-to-date theoretical and experimental constraints. Characteristic features of the model parameter space explaining the data will also be pointed out making way for further exploration of the model in the near future. In particular, the 2HDM Type-III predicts a significant enhancement in the ttbar-associated production of the SM-like 125 GeV Higgs boson. Such an effect can be tested soon at the High Luminosity LHC (HL-LHC).

Neutrino Physics / 138

Simulated Data Studies for the T2K Experiment Neutrino Oscil- lation Analysis

Author: Adam Speers[1]

[1] *Lancaster University*

Simulated data studies (SDS) are a method to test alternative particle interaction models within the T2K neutrino oscillation experiment. This work is focused on interactions in the ND280, T2K's near detector. Monte Carlo (MC) simulations are fitted to ND280 data and are subsequently used to inform the predictions of neutrino event rates at the far detector, Super-Kamiokande. The MC methods used by the experiment use a single set of models; therefore, it is important to investigate any potential biases introduced by the choice of model. A total of 19 simulated data sets, representing alternative models, are analysed using the Generalized and Unified Neutrino Data Analysis Method (GUNDAM) fitter. While this analysis is focused on ND280, a complete SDS analysis will include a far detector fit as well. This presentation will discuss the current status of this work.

Detectors and Instrumentation / 139

Simulations of the Outer Detector for the XLZD Experiment

Author: Sean Hughes[None]

The XENON-LUX-ZEPLIN-DARWIN (XLZD) Experiment will search for Weakly Interacting Massive Particles (WIMPs) using a 60-80T liquid xenon time projection chamber (LXe-TPC) and 1kT Outer Detector (OD) for suppression of neutron background which is indistinguishable from WIMPs sig- nals. The optimisation of the OD in such a detector like XLZD is crucial and is examined in detail here using a Geant4 simulation 'XLZD Sandbox'. The simulation can flexibly modify the OD ge- ometry and media (Gadolinium (Gd) loaded Water-based Liquid Scintillator, Gd-Liquid Scintillator, Gd-Water) for optimisation of the OD design, maximising neutron tagging efficiency and minimising background rate.

Detectors and Instrumentation / 140

Designing new ultra-radiopure, high-strength electroformed Cu- based alloys, for rare event searches

Author: Dimitra Spathara[1]

Co-authors: Konstantinos Nikolopoulos [2]; Patrick Knights [1]

[1] *University of Birmingham*

[2] *Hamburg University (DE)*

Several search approaches have been employed for Dark Matter (DM), with "direct detection"being one of the most prominent. It aims to observe DM from the Milky Way halo via its coherent elastic scattering off a nucleus.

Electroformed copper (EFCu) is a material of choice for large-scale detectors thanks to its favor- able radiochemical, thermal, and electrical properties. To fulfil the unique radiopurity requirements, experiments pioneer large-scale, additive-free Cu electroformation. This novel technique leads to extreme radiopurities with contamination below 10-14 grams of 232Th and 238U per Cu gram. How- ever, Cu is highly ductile and of low strength, limiting its use for moving mechanical, high-pressure, and load-bearing parts.

Our work addresses materials challenges by developing high radiopure Cu-based alloys with signif- icantly higher strength compared to Cu. This would improve the capability for experiments such as DarkSPHERE, a large-scale fully electroformed underground spherical proportional counter operat- ing under high pressure to probe uncharted territory in the search for DM. It is also vital for other rare event searches, including searches for neutrinoless-double β-decay.

Poster session / 141

Insights from the proANUBIS demonstrator using Run 3 LHC col- lision data

Author: Julian Friedrich Wack[1]

[1] *University of Cambridge (GB)*

The proposed AN Underground Belayed In-Shaft (ANUBIS) experiment aims to search for long-lived particles (LLPs) within CERN's ATLAS underground cavern as a valuable addition to the LLP pro- gram at CERN. Recent efforts to realise the ANUBIS experiment include the installation and com- missioning of a prototype detector, proANUBIS, which has been collecting LHC collision data since 2024. This data will allow for studies of the expected backgrounds for the ANUBIS experiment, and development of analysis and reconstruction tools. This poster will report on the operation and per- formance of proANUBIS during Run 3 LHC collisions as well as current event alignment and vertex reconstruction efforts.

Poster session / 142

Reworking vTiles to improve photodetector production yield for Darkside-20k

Authors: Isobel Sargeant[1]; Maaike Helena Bloem[2]

[1] *Science and Technology Facilities Council*

[2] *Science and Technology Facilities Council STFC (GB)*

Darkside-20k is a dual-phase liquid argon time projection chamber designed to search for dark mat- ter interactions. Interactions in the argon are observed using silicon-photomultiplier (SiPM) array detectors, composed of SiPMs assembled onto a printed circuit board to form a vTile. During pro- duction, the vTiles undergo quality assurance and quality control (QA/QC) testing at ambient and cryogenic temperatures, with a cumulative yield of devices passing QA/QC to date of 87% after production of 1400 vTiles. If a vTile fails QA/QC, specialised testing is conducted to identify the defective SiPM. vTiles with high dark count rates are imaged using a long exposure sCMOS camera, and a "Bed of Nails"circuit board is used to measure the IV characteristics of individual SiPMs. This poster outlines the rework process for replacing individual SiPMs, to enable these vTiles to be rein- troduced into the production pipeline for integration into the veto instrumentation. As of January 2024, reworking 96 vTiles has increased the total cumulative production yield to 92%.

Plenaries / 143

WIMPs and wellbeing: setting limits without exceeding your own

Author: Sally Shaw[1]

[1] *University of Edinburgh*

The search for Dark Matter particles has spanned 40 years. Definitive results remain elusive, and the heat is on. In this talk, I will explore both the physics and the people of dark matter research: the challenges we face (which are not just the backgrounds in our detectors), the realities of work- ing in high-pressure environments—both above and below ground - and the critical role of public engagement in demystifying particle physics research. Finally, I will reflect on what we can do to stay connected to the reasons we began this journey in the first place - the wonders and mysteries of the universe!

Poster session / 144

Isolated S1 signals in the Lux-Zeplin detector

Author: Rory Matheson[None]

We investigated the rate of isolated S1 accidental signals in the Lux-Zeplin detector in the period following a major power cut at the Sanford Underground laboratory. We found increases in peaks in isolated S1 rate, often corresponding to adverse conditions in the detector. We also found the timeseries of single scatter signals over the same period and apply an XY cut on an activity hotspot region in order to compare this to our isolated S1 signal timeseries.

Detectors and Instrumentation / 145

Enhancing Supernova Neutrino Detection in DUNE: Optimizing Pandora Reconstruction and Energy Estimation

Author: Matthew James Osbiston[1]

[1] *University of Warwick (GB)*

The Deep Underground Neutrino Experiment (DUNE) will allow for the detection of low-energy neutrinos from core-collapse supernovae, providing critical insights into core-collapse supernova processes such as neutronization and accretion. However, reconstructing these interactions in liq- uid argon time projection chambers (LArTPCs) presents significant challenges due to the low-energy depositions, and background contamination from radiological sources. To address these challenges, the Pandora multi-algorithm reconstruction software is being optimized for the efficient reconstruc- tion of \nu_e CC interactions at the tens of MeV energy scale. These interactions differ substantially from those expected from other neutrino sources at DUNE, such as those from the LBNF beam. Accu- rate energy reconstruction is then essential for determining the neutrino energy spectrum and con- straining supernova neutrino emission models. This work explores novel techniques that integrate deep learning with traditional reconstruction algorithms to improve the neutrino reconstruction efficiency and energy resolution. It will then assess the impact of systematic uncertainties.

Collider Physics - Electroweak (EW) and Higgs / 146

Searching for H^+ -> W^+ h at ATLAS

Author: Luke Baines[1]

[1] *University of London (GB)*

Charged Higgs bosons Image appear in many Higgs-sector extensions to the Standard Model (SM). Searches for such a singly-charged Higgs scalar have been carried out at ATLAS and other collab- orations, but until now the decay into a W boson and SM-like Higgs Image (ImageGeV) remained unexplored.
Here, we present a search for the decay Image with both Image and Image boosted, using the full ATLAS Run 2 dataset. Results are presented alongside a resolved-channel analysis, with a set of combined exclusion limits where the boosted channel provides results in the higher mass region (ImageTeV).
As well as providing an overview of the analysis strategy & results, this presentation will cover some alternative methods which were tested but not included in the final analysis. This includes studies on the use of mass-parametrized neural networks, attention-head networks for improving categorisation efficiency over hand-reconstruction, and adversarial-loss functions to reduce mass sculpting.

Plenaries / 147

Particle Physics Today and Tomorrow

Author: Mark Thomson[1]

[1] *CERN*

Plenaries / 148

Collider phenomenology, EFTs and future prospects

Author: Tevong You[1]

[1] *King's College London*

Plenaries / 149

Formal theory developments

Author: Mariana Carrillo Gonzalez[1] [1] *Imperial College London*

Plenaries / 150

Lattice QCD and BSM update

Author: Davide Vadacchino[None]

Plenaries / 151

Electroweak-scale physics at the LHC and beyond

Author: Chris Pollard[1]

[1] *University of Warwick (GB)*

Plenaries / 152

LHC upgrades: machine, detectors, and sustainability

Author: Andreas Korn[1]

[1] *University College London (GB)*

Plenaries / 153

QTFP physics impact

Author: Ashlea Amanda Kemp[1]

[1] *Royal Holloway, University of London*

Plenaries / 154

Quark and lepton flavour physics

Author: William Barter[1] [1] *University of Edinburgh*

Plenaries / 155

Neutrino experimental updates

Authors: Patrick James Dunne[1]; Patrick James Dunne[1]

[1] *Imperial College (GB)*

Plenaries / 156

Long-lived particles at accelerators

Author: Anne-Marie Magnan[1]

[1] *Imperial College (GB)*

Plenaries / 157

Multimessenger Update

Author: Ellis Owen[None]

Plenaries / 158

Latest news from Boulby

Author: Sean Paling[None]

Plenaries / 159

Dark matter direct searches

Author: Adam Brown[1] [1] *University of Sheffield*

Plenaries / 160

Gravitational Waves updates

Author: Patricia Schmidt[None]

Plenaries / 161

Axion Experiment and Theory

Author: David Marsh[1]

[1] *King's College London*

Plenaries / 162

EDIA plenary

Author: Sheila Kanani[None]

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