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Book of Abstracts

Contents

Probing triple Higgs production via $4\tau 2b$ decay channel at a 100 TeV hadron collider . .	1
Collective flow measurements in OO and NeNe collisions with CMS	1
Precision Frontier of pQCD with NNLOJET	1
Observation of coherent J/ψ production in ultraperipheral Pb+Pb collisions at ATLAS . .	2
Results for pixel and strip USTC AC-LGAD sensors	2
First batch of thin 3D silicon sensors at USTC	2
Toward di-Higgs observation with a calibratable jet-free $HH \rightarrow 4b$ framework	3
Evidence for the dimuon decay of the Higgs boson in $\sqrt{s}=13$ collisions with the ATLAS detector	3
Study of femtoscopic emission sources in AMPT and ALICE experiments	4
Λ Hyperon Polarization in Non-central Heavy-ion Collisions	4
Beam-test evaluation of pre-production Low Gain Avalanche Detectors for the ATLAS High Granularity Timing Detector	5
Brief Review on Omega Correlation Function Measurement	5
Entanglement and Bell Nonlocality in $\tau^+\tau^-$ at the LHC using Machine Learning for Neutrino Reconstruction	5
CMS barrel timing detector beam tests and low temperature tests	6
CMS barrel timing detector assembly	6
Study of Higgs boson CP properties in vector-boson fusion production in di-tau final state with the ATLAS detector	7
Comprehensive Full-Power Testing of Demonstrator System for the High Granularity Tim- ing Detector	7
Progress of CMS-GEM Upgrade Project at Peking University	7
Implications of recent LHCb data on CPV in b-baryon four body decays	8
Correspondence between SMEFT and HEFT in Higgs physics	8

Search for the quark flavor dependence of the Chiral Magnetic Effect through charge-dependent correlations with identified hadrons at ALICE	8
Progress of the HL-LHC accelerator and contribution from IHEP	9
Search for a resonance decaying into a scalar particle and a Higgs boson in the final state with two bottom quarks and two photons with 199 fb ⁻¹ of data collected at $\sqrt{s}$ = 13 TeV and $\sqrt{s}$ = 13.6 TeV with the ATLAS detector	9
Using a far-sideband method to estimate the backgrounds in H->Z γ analysis	10
Status for the ATLAS HGTD TDAQ system	10
ATLAS SUSY Summary: pMSSM scanning results	10
Charm-baryon hadronization mechanism and its multiplicity dependence with Alice	11
Study of Higgs boson pair production in the $\gamma\gamma \rightarrow \gamma\gamma\gamma\gamma$ final state with 308 fb ⁻¹ of data collected at $\sqrt{s}$ = 13 TeV and 13.6 TeV by the ATLAS experiment	12
Probing the Higgs Boson Trilinear Self-Coupling with ATLAS (and ATLAS+CMS)	12
Probing Quark Electromagnetic Properties via Entangled Quark Pairs in Fragmentation Hadrons at Lepton Colliders	12
Machine learning detection of Standard Model jets in collider events	13
ATLAS ITk Strip Module Status in China	13
ATLAS ITk Strip Sensor Quality Assurance	14
ATLAS ITk Strip Module Testbeam	14
A search for triple Higgs boson production in the 6b final state using pp collisions at $\sqrt{s}$ = 13 TeV with the ATLAS detector	14
Search for dark matter produced in association with a dark Higgs boson in the bb^{-} final state using pp collisions at $\sqrt{s}$ = 13 TeV with the ATLAS detector [Online]	15
Progress on ACTS-based 4D tracking and a design of timing pixel digital chip	15
CP violation measurement in charm meson decays at the CMS experiment	16
VBF H(bb/cc) Partial Run 2 and Partial Run 3 Analysis	16
Search for the Higgs boson decay to Zgamma with ATLAS detector	17
Direct New Physics Search at the CEPC	17
Operation and performance of LHCb Upstream Tracker	17
Recent progress on CEPC Accelerator studies	18
Electroweakino and slepton search summary in ATLAS	18
Constraining HHVV couplings via VBS VVH processes	18
Sensor development for LHCb Upstream Pixel Tracker	19

Transverse momentum dependence of charm baryon production and hadronization with ALICE	19
Dark photon mixing effects and CP violation	20
Lanzhou University computing cluster status	20
Search for boosted $H \rightarrow WW$ and prospects for boosted $W \rightarrow cb$ in the CMS Experiment . .	20
The 152 GeV Candidate at the LHC	21
Triboson Excesses in light of a Real Higgs Triplet Model at the LHC	21
Highlights of the HL-LHC physics projections by ATLAS and CMS	22
Analysis of non-resonant $HH \rightarrow b\bar{b}\gamma\gamma$ using CMS Run 3 data	22
Enhancing di-jet Resonance Searches at the (HL)-LHC via FSR Tagging	22
Constructing Quantum Entanglement Criteria for Collider Processes	23
Measurement of the Higgs boson production in association with top quarks in multilepton final states in ATLAS	23
Search for light Higgs bosons in diphoton channel at CMS	24
Progress on iRPC/RPC Backend and Trigger	24
Status of CMS HGCal Module Production at IHEP	24
Search for heavy resonances decaying to two Z bosons at CMS	24
Software development for LHCb ECAL upgrade	25
Testing CP-violation in Heavy Scalar Sector at Future Muon Colliders	25
Neutrino physics at CEPC	25
Electron and photon reconstruction and identification performance at CMS in 2022 and 2023	26
Search for HH/HY resonances with $\gamma\gamma$ in the final state at CMS	26
LHCb UP Module and Stave Assembly Development	26
The simulation and reconstruction studies on LHCb UP detector for Upgrade II	27
Baryonic B decays in PQCD	27
First observation of the charmless baryonic decay $B^+ \rightarrow \bar{\Lambda} p \bar{p} p$	27
Jet quenching studies via jet–hadron correlations with ALICE	28
First measurement of ϕ_c^+ elliptic flow in 30-50% Pb-Pb collisions at $\sqrt{s_{NN}} = 5.36$ TeV with ALICE	28
Test of signal integrity in flex cable	29

Recent open heavy flavor and quarkonium measurements from ALICE experiment . . .	29
ALICE 进展汇报	29
J/ψ and D^0 associated production measurements with ALICE Run 3	30
The Upgrade of the ALICE Inner Tracking System: ITS3	30
Evidence for the rare decay $B^+ \rightarrow \bar{\Lambda} p \mu^+ \mu^-$	30
UP bare stave design and thermal study	31
Expected performance of the ALPIDE pixel layers in ALICE Focal	31
Strong SUSY and RPV SUSY searches summary in ATLAS	31
Computing of CMS	32
Study of open heavy flavor spin polarization and momentum correlations with ALICE .	32
EveNet: Towards a Generalist Event Transformer for Unified Understanding and Generation of Collider Data	32
Testing a light Higgs at the LHC and future colliders	33
Study nuclear modifications with jets in ALICE	33
Timing Measurements with the ATLAS High Granularity Timing Detector at the HL-LHC	33
Simulation studies for LHCb ECAL upgrade	34
Search for dark matter produced in association with a pair of bottom quarks at CMS . .	34
Search for heavy photophobic axion-like particles at the proton-proton collider	34
Updates of LHC Computing in China	35
ETL LGAD characterization at USTC (CMS)	35
Observation of a family of all-charm tetraquarks at CMS	36
ATLAS HGTD Probing at the Pre-Production Stage	36
Introduction to ALICE Computing	36
Polarisation measurement of the same-sign WW vector boson scattering with the ATLAS detector	36
CSTCLOUD-EGI and CENI Site Report	37
HGTD hybrid test at USTC	37
Flow measurements at LHCb experiment	37
Recent LHCb results on open charm and charmonium production	38
Observation of the decay $B_s^0 \rightarrow K^0 p \bar{p}$ and measurement of the $B_d^s \rightarrow K^0 p \bar{p}$ branching fractions	38

Observation of the rare baryonic decay $B \rightarrow p \Lambda_{\bar{b}}$ and measurement of the weak decay parameter	38
Recent results on pentaquark studies at LHCb	39
LHC 寻找类矢量费米子进展	39
Search for pair production of boosted Higgs bosons via vector-boson fusion in the $b\bar{b}b\bar{b}$ final state using pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector	40
HGCal Silicon module CuW baseplate R&D and production	40
R&D on the fast GAGG for LHCb upgrade II	40
Machine learning-enhanced search for 95 GeV light Higgs in N2HDM at CEPC	41
Selected highlights of correlations and flow at LHC-ALICE	41
A FPGA-based DAQ system for RPC cosmic ray test	41
IHEP Site Report	42
Measurement of the Z-boson mass	42
Development of 3D-Printed Tungsten Absorbers for the LHCb ECAL Upgrades	42
MSSM Higgs search via $b\bar{b}$ decay at CMS experiment with Run 2 proton proton collision data	43
Determination of direct CP asymmetries for $B^+ \rightarrow K_S^0 \pi^+$ and $B^+ \rightarrow K_S^0 K^+$ decays and measurement of the ratio of their branching fractions, and search for the rare decay $B_c^+ \rightarrow K_S^0 K^+$	43
Inclusive J/ψ and $\psi(2S)$ production in pp collisions at 13.6 TeV	44
J/ψ polarization measurement in pp collisions at 13.6 TeV	44
Measurement of CP Violation in $B_s^0 \rightarrow J/\psi \bar{K}^*(892)^0$ Decays and Constraints on Penguin Contributions	45
Performance study of the MOSS chip for the ITS3 detector	45
Run3 L2 Gain intercalibration in the ATLAS experiment	45
Search for heavy H_Y and Z_Y resonances with a b quark pair in the final state at CMS	46
B decays to charm baryons	46
Performance of hybrid detector of USTC-IME LGAD and LATIC ASIC chip	47
Probing Higgs Couplings with Single- and Double-Higgs Measurements in ATLAS	47
Study of charmless $B \rightarrow VV$ decays at LHCb	47
Di-boson and Tri-boson measurements: $Z\Gamma$, $WZ\Gamma$, and Same-Sign $WW\Gamma$	48

Measurements of W+W- production cross-sections in pp collisions at 13TeV with the ATLAS detector	48
Development and test-beam measurements of LHCb PicoCal modules	49
Test of CP Invariance in Higgs Boson Vector-Boson-Fusion Production in the $H \rightarrow \gamma\gamma$ Channel using 165 fb-1 ATLAS Run-3 data	49
IHEP ROC Report	50
Search for CP-violation in Higgs interaction with vector bosons with the ATLAS detector	50
Overview of ATLAS High Granularity Timing Detector Activities in China	50
Status of the HGTD sensors upgrade	51
Silicon detector & Stitching VTX at the CEPC	51
Study of rare decays at LHCb	51
Measurements of Higgs boson properties in the $\gamma\gamma$ decay channel at CMS	52
Jets and missing transverse energy performance in CMS	52
Real-time analysis at LHCb for Run 3 and beyond	52
Recent results on hadron spectroscopy from LHCb	52
ATLAS Computing	53
ATLAS high granularity timing detector Module assembly and loading	53
Study of spin correlation inside jets	53
Z_3-NMSSM with a Light Singlet Scalar under the Latest Experimental Constraints . . .	54
ALICE 探测器升级大会报告	54
Higgs Production Classifier using Weak Supervision	54
Connections between Heavy-ion Collisions and Electron-Ion Collisions	55
BIS RPC singlets prodcuton for ATLAS Phase-II Upgrade	55
The weak B decays to radilly excited D mesons	55
EFT operator basis construction and its application	56
Status of the USTC computing cluster	56
Recent progress on inclusive quarkonium production and polarization	56
Theoretical Progress in Heavy-Flavor Physics	57
Quantum Information at Colliders	57
Progress of CMS China group on Phase II upgrade	58

The impact of dark Higgs mechanism on the detection of invisible dark photon	58
Combined measurement of the Higgs boson couplings with ATLAS detector	58
Recent flavor physics results from ATLAS	58
CP violation in $L_b2pK_{\pi\pi}$ and $L_b2J_{\pi\pi}$ decays	59
Measurement of branching fractions and CP asymmetries in $\Lambda_b0(X_{b0}) \rightarrow p K_S h$ - decays	59
Higgs Boson as a Portal: Searching for Rare and Exotic Higgs Decays at the LHC	59
Measurement of Higgs boson properties	60
Status of RPC Muon trigger detector for ATLAS Phase-II upgrade	60
Electroweak and SM highlights at ATLAS and CMS	60
The R&D of high light yield and high density glass scintillator for HCAL	61
Higgs-self coupling measurement	61
New Physics Search Highlights and Summary	61
Flavor Physics at CEPC	62
Toponium results from ATLAS and CMS	62
Physics Opportunities at Colliders	62
Welcome Speech	63
Logistics from LOC	63
LHCb upgrade	63
Recent results of CP violation from the LHCb experiment	63
AI and Machine Learning Application in High Energy Physics	64
A Transformer-based Jet Flavour Tagger at ATLAS	64
ATLAS 中国研究进展汇报	64
All charm tetraquarks and recent heavy flavor results at CMS	64
Shandong University Site Report	65
ATLAS upgrade	65
LHCb report	65
Closing remarks	66
Announcements	66
CMS 中国组 2025 年研究进展	66

Determination of the spin and parity of all-charm tetraquarks at CMS	66
Y(nS) cross section measurement at 13.6 TeV at CMS	67
The electroweak precision constraints of the 2HDM+S	67
Overview of CEPC Project	67
Run3 CMS ECAL calibration performance	68
Observation of X(6900) and evidence of X(7100) in the $J/\psi\psi(2S) \rightarrow \mu^+\mu^-\mu^+\mu^-$ mass spectrum	68
Jet calibration in low pileup data	68
Measurement of the photon-fusion production cross section of a pair of W bosons at CMS	68
Feasibility Study of the RPC Detector and Electronics System for HSCP Detection in the CMS Phase-2 Upgrade	69
Search for a top-philic Z' boson in the final state with an electron or a muon and jets	69
Probing nuclear gluonic structure via photoproduced vector mesons in UPCs at CMS	70

Parallel 4 / 273

Probing triple Higgs production via $4\tau 2b$ decay channel at a 100 TeV hadron collider**Author:** 振宇董¹**Co-author:** Xiaohu SUN¹¹ *Peking University***Corresponding Author:** zhenyu.dong@cern.ch

A comprehensive study of triple Higgs boson production in the $4\tau 2b$ decay final state is performed for the first time at a future 100 TeV hadron collider. The analysis incorporates modified Higgs self-couplings via trilinear Higgs self-coupling c_3 and quartic Higgs self-coupling d_4 , enabling for a model-independent investigation of potential new physics effects. Higgs bosons are reconstructed using both resolved and boosted techniques. To optimize sensitivity across different kinematic regions, we introduce a novel event categorization strategy based on the triple Higgs invariant mass spectrum and the multiplicity of boosted Higgs bosons. In addition to a traditional cut-based analysis, a Boosted Decision Tree (BDT) approach is employed to exploit multivariate correlations among kinematic observables, leading to a significant improvement in sensitivity. Our result demonstrates that the $4\tau 2b$ channel provides a viable pathway for probing the Higgs quartic coupling, complementing the existing multi-Higgs production studies, and could reach 5σ in significance for $c_3 \leq -1$ and $d_4 \geq 10$ in the scanned range.

Parallel 3 / 275

Collective flow measurements in OO and NeNe collisions with CMS**Authors:** 佳腾彭¹; 震宇陈²¹ 复旦大学² 山东大学**Corresponding Author:** p2251567502@163.com

Measurements of collective flow in intermediate size collisions such as OO and NeNe are crucial for understanding the origin of collectivity in small systems and its evolution with collision system size. Furthermore, they are crucial for probing the possible exotic nuclear structure of the nucleus. With data collected by the CMS experiment at the LHC, charged particles v_n ($n=2,3$) are reported in OO and NeNe collisions using two- and multiple-particle correlations as functions of centrality. The results are compared with pp, pPb, and PbPb collisions as well as theoretical calculations to provide new insights into the origin of collectivity in small systems and nuclear structure of O and Ne nucleus.

Plenary / 276

Precision Frontier of pQCD with NNLOJET**Author:** Xuan Chen¹¹ *Shandong University*

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I would like to introduce the newly released parton level event generator NNLOJET and it's recent progress. The talk would introduce high precision collision processes available on NNLOJET public release and on-going projects regarding jets production at hadron and lepton colliders at NNLO and N3LO QCD accuracy.

Parallel 3 / 277

Observation of coherent J/ψ production in ultraperipheral Pb+Pb collisions at ATLAS

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本分析在核子对撞质心能量 $\sqrt{s_{NN}} = 5.36$ TeV 下, 对铅-铅 ($Pb + Pb$) 超擦边碰撞 (UPC) 中相干 $J/\psi \rightarrow \mu^+ \mu^-$ 产生过程的测量。该测量基于 LHC 于在 2023 年采集、积分亮度为 $76.5 \text{ } \mu\text{b}^{-1}$ 的数据样本。分析采用了基于 ATLAS 跃迁辐射探测器的专用径迹敏感触发器来筛选 J/ψ 候选事例。由于感兴趣的缪子横动量范围使得标准的缪子重建与识别算法无法被使用, 本分析直接依据内部探测器的缪子径迹来重建双缪子不变质量。我们测量了微分截面随 J/ψ 快度的变化, 并将其与理论预言进行了比较。此外, 在将结果外推至质心能量 $\sqrt{s_{NN}} = 5.02$ TeV 后, 我们还将其与 LHC 第二期运行的测量结果进行了对比。本次测量结果与理论预言相当吻合, 但在中心快度区域与先前的实验结果存在一定张力。

Parallel 1: Upgrade / 279

Results for pixel and strip USTC AC-LGAD sensors

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The development of next-generation particle detectors capable of precise 4D tracking is crucial for future high-energy physics experiments. AC-LGAD have emerged as a leading technology to achieve excellent spatial and temporal resolution simultaneously. This report details the successful development and characterization of a new batch of AC-LGAD detectors fabricated by the University of Science and Technology of China (USTC). We present a comprehensive performance evaluation of these devices, focusing on key metrics such as spatial resolution, time resolution, and signal uniformity. Furthermore, the report provides a critical analysis of how different fabrication parameters and design choices—including electrode layout, doping profiles—directly influence the detector's electrical and functional characteristics.

Parallel 1: Upgrade / 280

First batch of thin 3D silicon sensors at USTC

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Unlike the planar sensors, the distance of electrodes and the thickness of substrate is decoupled in 3D silicon detector. According to the shapes of electrodes, 3D sensors can be divided into two types: the columnar electrodes and the trenched electrodes. Through shortening the distance between the electrodes, the sensor can provide higher position resolution and can also be more irradiation tolerant due to the decreased trapping probability of carriers. However, the electrode itself can form the inactive area when the particle vertically passes through the top of the sensor. Nowadays, the electrodes with 5 μm or less in diameter have been fabricated. Typically, in order to withstand the fluence of $1 \times 10^{16} \text{ n}_{\text{eq}}/\text{cm}^2$, the ATLAS Inner Tracker (ITk) will use 3D pixel sensors with 5 μm diameter columnar electrodes and small pixel cells ($50 \times 50 \mu\text{m}^2$ and $25 \times 100 \mu\text{m}^2$) which are fabricated by the FBK (Italy), CNM (Spain) and SINTEF (Norway). Also, the timing resolution of 3D sensors has been investigated which shows great potential to realize the 4D tracking. Recently, the USTC group is concentrated on the development of 3D pixel sensors and this talk will present the fabrication and characterization of first batch of the USTC 3D sensors.

Parallel 4 / 281

Toward di-Higgs observation with a calibratable jet-free $HH \rightarrow 4b$ framework

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In this talk, we present a calibratable, jet-free framework that enhances the search significance of the flagship LHC channel $HH \rightarrow 4b$ by more than a factor of five compared to existing strategies. The approach employs a mass-decorrelated discriminant for identifying $h_1 h_2 \rightarrow 4b$ with variable $h_{1,2}$ masses, together with a simultaneous estimator of (m_{h_1}, m_{h_2}) , both constructed from multiclass classification on all-particle inputs. The HH signal response is calibratable using $ZZ \rightarrow 4b$. Within a highly realistic simulation framework, we demonstrate the robustness of the method and identify two prerequisites for attaining this sensitivity.

Our results suggest that, with LHC Run 2 and 3 data, observation-level sensitivity to HH is within reach, enabling constraints on κ_λ comparable to HL-LHC projections and providing an accelerated path to precision Higgs self-coupling measurements. We therefore advocate for close theory-experiment collaboration to establish, from first principles, the ultimate reach of HH measurements at the LHC.

This talk is based on arXiv:2508.15048.

Parallel 2 / 282

Evidence for the dimuon decay of the Higgs boson in $\sqrt{s}=13.6$ collisions with the ATLAS detector

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The Higgs boson's decay to a pair of muons provides a direct probe of its Yukawa coupling to second-generation fermions. In this talk, I will present the newest results from the ATLAS experiment based on proton-proton collision data collected in LHC Run 3 during 2022~2024, and the combination with the Run 2 results, incorporating several improvements. This measurement significantly enhances the sensitivity over previous ATLAS publications, provides the first evidence for the $H \rightarrow \mu\mu$ decay by the ATLAS experiment.

Parallel 3 / 283

Study of femtoscopic emission sources in AMPT and ALICE experiments

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The measurement of momentum correlations of identical pions serves as a fundamental tool for probing the space-time properties of a particle-emitting source created in high-energy collisions. Recent experimental results have shown that in pp collisions, the size of the one-dimensional primordial source depends on the transverse mass (m_T) of the hadron pairs, following a common scaling behavior similar to that observed in Pb-Pb collisions. In this study, a systematic analysis of the π - π source and correlation functions was performed using the multiphase transport model (AMPT) to understand the properties of the emitting source created in high-multiplicity pp collisions at $\sqrt{s} = 13$ TeV. The m_T -scaling behavior and pion emission source radii measured by the ALICE experiment can be described well by a model with a subnucleon structure. This work sheds new light on the effective size of the π - π emission source and the study of intensity interferometry in small systems using a transport model.

Parallel 3 / 284

Λ Hyperon Polarization in Non-central Heavy-ion Collisions

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In non-central heavy-ion collisions, the system's global angular momentum and local vorticity can induce particle polarization. In particular, polarization along the beam direction may arise from asymmetries in the transverse velocity fields associated with elliptic flow.

In this study, we investigate the polarization of Λ and anti- Λ hyperons using ALICE Run 2 and Run 3 data. Since the polarization of Λ hyperons cannot be measured directly, it is inferred from the angular distributions of protons and pions produced in their parity-violating weak decays. We present measurements of both the local polarization along the beam direction, as a function of the emission angle relative to the reaction plane, and the global polarization with respect to the system's initial angular momentum.

These results, in comparison with the latest theoretical developments, provide new insights into the spin dynamics of strongly interacting matter.

Parallel 1: Upgrade / 285**Beam-test evaluation of pre-production Low Gain Avalanche Detectors for the ATLAS High Granularity Timing Detector****Author:** KHURAM TARIQ¹**Co-authors:** Hideki (英希) OKAWA (大川)²; Mei Zhao³¹ 高能所² 中国科学院高能物理研究所³ 高能所, IHEP**Corresponding Author:** ktariq@ihep.ac.cn

The High Granularity Timing Detector (HGTD) will be installed in the ATLAS experiment as part of the Phase-II upgrade for the High Luminosity-Large Hadron Collider (HL-LHC). It will mitigate pile-up effects in the forward region, and measure per bunch luminosity. The design of HGTD is based on Low Gain Avalanche Detector (LGAD) sensors. This talk presents the results of beam-test campaigns conducted at CERN and DESY in 2023 and 2024 on HGTD pre-production LGAD sensors, before and after irradiation. The tested LGADs can meet HGTD requirements in term of charge collection, time resolution, and hit efficiency, even under HL-LHC end-of-life conditions, supporting their deployment in the final detector.

Parallel 3 / 286**Brief Review on Omega Correlation Function Measurement****Author:** 子谦周¹¹ Fudan University**Corresponding Author:** 24110200037@m.fudan.edu.cn

The study of the nucleon–nucleon (NN), hyperon–nucleon (YN) and hyperon–hyperon (YY) interactions is very important in understanding strong interactions, heavy-ion-collisions and neutron stars. Because of their unstable nature, it is hard to extract interactions between like N- Ξ or N- Ω , and high energy collisions offer us a chance to further knowledge of those interactions by measuring correlation functions via femtoscopy.

In this talk I will give a brief review on Ω -related correlation function measurement: p- Ω in pp collision at $\sqrt{s} = 13\text{TeV}$ by ALICE in year 2020 and p- Ω in Au-Au collision by STAR at $\sqrt{s_{NN}} = 200\text{GeV}$ in 2019. The source size, interaction type, and underlying bound state in p- Ω correlation are discussed. The results are also used to comparing with theoretical prediction made by HAL QCD, but more precise data is still needed to make a better constraint, to understand deeper Ω and also hyperon interactions.

Parallel 4 / 287**Entanglement and Bell Nonlocality in $\tau^+\tau^-$ at the LHC using Machine Learning for Neutrino Reconstruction****Authors:** Yulei Zhang¹; Baihong Zhou²; Qibin Liu³; Shu Li⁴; Shih-Chieh Hsu¹; Tao Han⁵; Matthew Low⁵; Tong Arthur Wu⁵

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Experiments at the CERN Large Hadron Collider (LHC) have accumulated an unprecedented amount of data corresponding to a large variety of quantum states. Although searching for new particles beyond the Standard Model of particle physics remains a high priority for the LHC program, precision measurements of the physical processes predicted in the Standard Model continue to lead us to a deeper understanding of nature at high energies. We carry out detailed simulations for the process $pp \rightarrow \tau^+\tau^-$ to perform quantum tomography and to measure the quantum entanglement and the Bell nonlocality of the $\tau^+\tau^-$ two-qubit state, including both statistical and systematic uncertainties. By using advanced machine learning techniques for neutrino momentum reconstruction, we achieve precise measurements of the full spin density matrix, a critical advantage over previous studies limited by reconstruction challenges for missing momenta. Our analysis reveals a clear observation of Bell nonlocality with high statistical significance, surpassing 5σ , establishing $\tau^+\tau^-$ as an ideal system for quantum information studies in high-energy collisions. Given its experimental feasibility and the high expected sensitivity for Bell nonlocality, we propose that $\tau^+\tau^-$ should be regarded as the new benchmark system for quantum information studies at the LHC, complementing and extending the insights gained from the $t\bar{t}$ system.

Parallel 1: Upgrade / 288

CMS barrel timing detector beam tests and low temperature tests

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The first part of this report will give a summary of the MTD BTL testbeam results at CERN during 9.10-9.24. The second part will be the low temperature test for the whole tray at TIF CERN.

Parallel 1: Upgrade / 289

CMS barrel timing detector assembly

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The High Luminosity LHC (HL-LHC) phase, scheduled to start in 2030 and deliver 3000 fb⁻¹ in 10 years, will offer unique potential for precision measurements and searches for rare processes. However, it will also pose significant challenges for the detectors due to extremely high radiation levels and the large number of simultaneous interactions per bunch crossing (up to 200). To mitigate pile-up, CMS will install the MIP Timing Detector (MTD), capable of measuring charged-particle arrival times with 30–60 ps precision. Its central component, the Barrel Timing Layer (BTL), consists of about 166,000 LYSO:Ce crystal bars with double-ended SiPM readout. After successful design optimisation and prototype validation in test beams, the BTL has entered the construction phase.

Peking University is one of the key assembly centers of the MTD BTL, responsible for completing one quarter of the overall detector assembly together with Tsinghua University and Beihang University. At each assembly center, SiPMs are coupled to LYSO:Ce crystals to form Sensor Modules, which are then integrated with the front-end electronics boards to form Detector Modules, and subsequently assembled into complete detector Trays. The assembly work started in the autumn of 2024 and has since been progressing smoothly.

Parallel 2 / 290

Study of Higgs boson CP properties in vector-boson fusion production in di-tau final state with the ATLAS detector

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The talk will present a study of the CP properties of the Higgs boson produced through vector-boson fusion mode. The analysis is using the full Run2 data collected by the ATLAS experiment at the LHC. The talk will highlight the motivation for this study, the main analysis parts like the background estimation and the signal categorisation, and finally the results will be shown. Results are obtained using the Optimal Observable method. CP-violating interactions between the Higgs boson and electroweak gauge bosons are considered in the effective field theory framework, with the interaction strength described both in the HISZ and in the Warsaw basis. No deviations relative to the Standard Model are observed, and limits are obtained on the strength parameters. All these results are described in a paper by the ATLAS collaboration which is available on arXiv (<https://arxiv.org/abs/2506.19395>) and under final review before publication on JHEP

Parallel 1: Upgrade / 291

Comprehensive Full-Power Testing of Demonstrator System for the High Granularity Timing Detector

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The High Granularity Timing Detector (HGTD) is a timing detector designed to mitigate pile-up effects in object reconstruction, arising from increased luminosity in the ATLAS Phase-II upgrade. The demonstrator system is a prototype system incorporating all key components of the HGTD project, developed to validate critical aspects of system integration. Installation and commissioning of this demonstrator system has been on-going since 2024 and was fully equipped with 54 modules, enabling the execution of the full-power test. Performance of the modules and prototype electronics will be presented.

Parallel 1: Upgrade / 292

Progress of CMS-GEM Upgrade Project at Peking University

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Peking University actively participates in the CMS-GEM upgrade project for CMS muon system. This report will present the status and progress of CMS-GEM ME0 project, including the assembly and testing of the ME0 modules in Peking University in 2025, the acceptance test and the performance of the ME0 GEM electronics boards produced in China.

Parallel 3 / 293

Implications of recent LHCb data on CPV in b-baryon four body decays

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Motivated by the recent CPV observation, we investigate the CPV of b-baryon charmless four body decays under the U-spin symmetry. However, we find that only U-spin symmetry cannot provide effective predictions, particularly for Λ_b decays. For giving more useful predictions, we also give a simple dynamic analysis. By counting the power($\lambda = \sqrt{\frac{\Lambda_{QCD}}{m_b}}$) of each topological diagram, we find that for the specific decay $B_b^2 \rightarrow R(B_1^2 M^2 M^2)M^2$, only one U-spin amplitude can contribute in the leading power, while for $B_b^2 \rightarrow R(B_1^2 M^2)R(M^2 M^2)$, only two U-spin amplitudes can contribute in this leading power. Then the most effective prediction can be given as

$$\begin{aligned} & \text{\&A}_{\text{\&CP}}^{\text{\&dir}}(\Lambda_b^0 \rightarrow R(p \pi^+ \pi^-) \pi^-) = (-12.99 \pm 2.83 \pm 2.59 \pm 0.65)\%. \\ & \end{aligned}$$

Considering the Λ_b can effectively produced in LHCb, we strongly encourage a more precise experimental investigation of it.

Parallel 2 / 294

Correspondence between SMEFT and HEFT in Higgs physics

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SMEFT and HEFT are two popular EFTs in searching for new physics. We report a comparison between them in predictions for Higgs boson pair production.

Parallel 3 / 295

Search for the quark flavor dependence of the Chiral Magnetic Effect through charge-dependent correlations with identified hadrons at ALICE

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The interplay between the chiral anomaly and strong magnetic or vortical fields generated in off-central heavy-ion collisions is theorized to produce anomalous chiral effects in the quark-gluon plasma, such as the Chiral Magnetic Effect (CME) and the Chiral Vortical Effect (CVE). These effects have been actively studied by several experiments for over a decade as they could shed light on the topological structure of vacuum gauge fields and reveal potential local violations of P and/or CP symmetries in strong interactions. Although recent developments have shown that the signals are small, various underlying mechanisms remain unclear, including the quark flavor dependence and its contributions to both the signal and the background.

In this talk, we extend the ALICE measurements of charge-dependent two particle correlations from inclusive hadrons to identified hadrons (pions, kaons, and protons) in Pb-Pb collisions at 5.36 TeV. Together with previous results of Λ -proton correlations aimed at searching for the CVE, we discuss several possible background mechanisms, including local charge conservation, coalescence, and flow. These studies offer new insights into the search for anomalous chiral effects and enhance our understanding of collectivity in heavy-ion collisions.

Plenary / 296

Progress of the HL-LHC accelerator and contribution from IHEP

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The High-Luminosity LHC (HL-LHC) is a crucial upgrade of the Large Hadron Collider (LHC). Its aim is to raise the LHC's collision rate by 5 times. The construction of the HL-LHC accelerator needs several technological breakthroughs. Key among them are new superconducting magnets placed on either side of the ATLAS and CMS detectors, can create a much stronger magnetic field than present ones. In 2018, IHEP signed agreement with CERN to join the HL-LHC collaboration with in-kind contribution of developing CCT superconducting magnets for the project. As of 2025, the HL-LHC string test is underway. In total 10 CCT magnets from IHEP have been delivered to CERN. All of them passed the performance test carried out at CERN. This talk will briefly introduce the background of the project, then focus on the latest progress of the contribution from IHEP, and plan for future regarding to the collaboration on accelerator technology between IHEP and CERN will also be presented.

Parallel 2 / 297

Search for a resonance decaying into a scalar particle and a Higgs boson in the final state with two bottom quarks and two photons with 199 fb⁻¹ of data collected at $\sqrt{s} = 13$ TeV and $\sqrt{s} = 13.6$ TeV with the ATLAS detector

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A search for the resonant production of a heavy scalar X decaying into a Higgs boson and a lighter scalar S , through the process $X \rightarrow S (\rightarrow b\bar{b}) H (\rightarrow \gamma\gamma)$, where the two photons are consistent with the Higgs boson decay, is performed. The search is conducted using integrated luminosities of 140 fb^{-1} and 58.6 fb^{-1} of proton–proton collision data at centre-of-mass energies of 13 TeV and 13.6 TeV respectively, recorded with the ATLAS detector at the Large Hadron Collider. The search is performed over the mass ranges of $170 \leq m_X \leq 1000 \text{ GeV}$ and $15 \leq m_S \leq 500 \text{ GeV}$. No significant excess over the Standard Model background prediction is observed and limits at 95% confidence level are set on the cross-section $\sigma(X \rightarrow S (\rightarrow b\bar{b}) H (\rightarrow \gamma\gamma))$ at 13 TeV , ranging from 9 fb to 0.06 fb .

Poster / 298

Using a far-sideband method to estimate the backgrounds in $H \rightarrow Z\gamma$ analysis

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In the $H \rightarrow Z\gamma$ search, the main backgrounds are Z +jets, with jets misidentified as photons, and $Z+\gamma$, which shares the same final state as the signal. The Z +jets background is estimated using an ABCD method based on photon isolation and ID, with fake factors derived as a function of photon P_T . For the $Z+\gamma$ background, far-sideband samples ($M_{ll\gamma} < 100 \text{ GeV}$, $M_{ll\gamma} > 160 \text{ GeV}$) are used to train a BDT and extract scale factors, which are then applied to simulation. Signal extraction is performed with the reconstructed Higgs mass $M_{ll\gamma}$. This data-driven strategy achieves $\sim 15\%$ accuracy in sidebands and avoids relying on high order empirical functions for background modeling.

Parallel 1: Upgrade / 299

Status for the ATLAS HGTD TDAQ system

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Most of the hardware components for the High Granularity Timing Detector (HGTD) are nearly ready. Consequently, the need for corresponding software for detector control and the data acquisition system has become increasingly urgent. The setup of the HGTD demonstrator also provides an excellent platform for software development and testing. This report presents recent progress on the TDAQ system, including the framework design, the status of the data acquisition system, the trigger distribution system, and the monitoring system. Furthermore, the recent integration with the ATLAS TDAQ system and results from the beam test using the full readout chain will be discussed.

Parallel 2 / 300

ATLAS SUSY Summary: pMSSM scanning results**Author:** Lei Guo¹**Co-authors:** Yuchen Cai ²; Yang Liu ³¹ Sun Yat-Sen University (CN)² Universita e INFN (IT)³ Sun Yat-sen University**Corresponding Author:** guolei@ihep.ac.cn

The phenomenological Minimal Supersymmetric Standard Model (pMSSM) scan is an analytical approach designed to reinterpret ATLAS Run 2 searches for supersymmetry (SUSY). This study evaluates and summarizes the sensitivity of ATLAS searches from Run 2 and anticipates possibilities for Run 3, all while incorporating additional constraints from dark matter (DM), flavor physics, electroweak precision measurements, and Higgs observables. This SUSY Summary talk covers four specific pMSSM scans conducted in ATLAS: general, third-generation (3G), electroweak (EWK), and gauge-mediated supersymmetry breaking (GMSB). Each scan provides distinct insights into the broader SUSY parameter space. The general scan employs parameter scanning to model strong and electroweak production of supersymmetric particles within the pMSSM framework. Separately, the GMSB scan examines a unique SUSY-breaking framework with gauge-mediated effects, highlighting the gravitino as the Lightest Supersymmetric Particle (LSP) and capturing the rich phenomenology of GMSB-pMSSM interactions. The pMSSM scans effectively summarize Run 2 results by integrating them with Higgs and external constraints, highlighting that features of unexcluded models could guide future searches. Notably, Bino-LSP SUSY models remain viable, except within the $\tilde{g}/h$ funnel regions, and the bounds on sparticle masses are weaker in the pMSSM compared to more constrained models, suggesting areas for further exploration in future analyses.

Parallel 3 / 302

Charm-baryon hadronization mechanism and its multiplicity dependence with Alice**Authors:** Jianhui Zhu¹; Tao Fang²; Zhongbao Yin³¹ Fudan University² Central China Normal University³ 华中师范大学**Corresponding Author:** tfang@cern.ch

Quantum Chromodynamics (QCD) is characterized by a phenomenon known as color confinement. When quarks are produced at high-energy colliders like the Large Hadron Collider (LHC), they evolve into observable hadrons through a process called hadronization. In the context of QCD, heavy-flavour production is calculated as a convolution of three independent: the PDFs of the incoming protons, the cross sections of the partonic scatterings producing the heavy quarks, and the FFs. heavy-flavour hadrons performed in different collision systems provide an excellent experimental benchmark to test this assumption. this determined based on data from e^+e^- collisions factorization theorems assume that hadronization is a universal process, independent of the types of colliding. the initial quarks in the colliding particles do not contain any b-quark content, and the production of b-quarks is primarily governed by the high-energy interactions between partons in the early phases of the collision

Run2 measurements of $(\Lambda_c^+/D^0, \Sigma_c^{0,++}/D^0, \Xi_c^{0,+}/D^0$ and Ω_c^0/D^0 all the mentioned baryon-to-meson ratios are significantly underestimated p_T -differential yield ratios in pp collisions are inconsistent

with measurements in e^+e^- collision which increased at low p_T . In contrast, a comparable measurement in the beauty sector conducted by LHCb reveals an increasing trend in the Λ_b^0/B^0 ratio with multiplicity. Interestingly, in the lowest multiplicity interval, this ratio nears the baryon fraction observed in e^+e^- collisions. These discrepancies highlight the need for additional measurements in the charm sector with enhanced precision and broader coverage towards lower multiplicities. Measurements indicating increased Ω^- and Ξ^- production in correlation with event multiplicity suggest that this augmentation develops gradually as particle multiplicity rises, commencing from low-multiplicity pp collisions. Therefore the measurement of the multiplicity dependence of Ξ_c^0 and Λ_c yield ratio at different multiplicity Run3 can provide further constraints on the study of charm hadronization.

Parallel 2 / 303

Study of Higgs boson pair production in the $b\bar{b}\gamma\gamma$ final state with 308 fb $^{-1}$ of data collected at $\sqrt{s} = 13$ TeV and 13.6 TeV by the ATLAS experiment

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A search for Higgs boson pair production in the $b\bar{b}\gamma\gamma$ final state is performed. The proton-proton collision dataset corresponds to an integrated luminosity of 308 fb $^{-1}$, consisting of two samples, 140 fb $^{-1}$ at a centre-of-mass energy of $\sqrt{s} = 13$ TeV and 168 fb $^{-1}$ at $\sqrt{s} = 13.6$ TeV, recorded between 2015 and 2024 by the ATLAS detector at the CERN Large Hadron Collider. In addition to a larger dataset, this analysis improves upon the previous search in the same final state through several methodological and technical developments. The Higgs boson pair production cross section divided by the Standard Model prediction is found to be $\mu_{HH} = 0.9_{-1.1}^{+1.4}$ ($\mu_{HH} = 1_{-1.0}^{+1.3}$ expected), which translates into a 95% confidence-level upper limit of $\mu_{HH} < 3.8$. At the same confidence level the Higgs self-coupling modifier is constrained to be in the range $-1.7 < \kappa_\lambda < 6.6$ ($-1.8 < \kappa_\lambda < 6.9$ expected).

Parallel 2 / 304

Probing the Higgs Boson Trilinear Self-Coupling with ATLAS (and ATLAS+CMS)

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This talk presents results from searches for Higgs boson pair production using the full Run 2 dataset collected with the ATLAS detector at the LHC. Projections for the High-Luminosity LHC (HL-LHC) are also discussed. In addition, the upcoming combined ATLAS+CMS results on the Higgs boson trilinear self-coupling, expected to provide the most stringent constraints to date, will be covered in this talk if they were published before this conference.

Parallel 4 / 305

Probing Quark Electromagnetic Properties via Entangled Quark Pairs in Fragmentation Hadrons at Lepton Colliders

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Electromagnetic dipole interactions of light quarks induce distinct spin correlations in quark pairs produced at lepton colliders, favoring entangled spin-triplet state aligned along the $\hat{z}$ axis or spin-singlet state. These correlations lead to unique $\cos(\phi_1 - \phi_2)$ azimuthal asymmetries in inclusive $\pi^+\pi^-$ -dihadron pair production and in back-to-back hadron pairs ($\pi\pi$, $K\pi$, KK), which are absent in the SM. By analyzing Belle and BaBar data and using ratios of azimuthal asymmetries, we demonstrate that these measurements provide robust and significant constraints on light-quark dipole couplings, insensitive to nonperturbative fragmentation functions and free from contamination by other new physics effects. This approach offers a clean and novel probe of light-quark dipole interactions in collider experiments.

Parallel 3 / 307

Machine learning detection of Standard Model jets in collider events

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We introduce a novel end-to-end framework for jet reconstruction in high-energy collider events, leveraging the efficiency and long-range modeling capabilities of the Mamba architecture. Our model unifies instance segmentation, classification, and kinematic regression into a single multi-task learning system, enabling a sophisticated multi-level reconstruction that simultaneously identifies primary heavy jets (t , H , W/Z) and their constituent sub-jets. Furthermore, we show that the model not only maintains stable performance in high-pileup environments but also successfully reconstructs the mass peaks of beyond the standard model particles.

Parallel 1: Upgrade / 308

ATLAS ITk Strip Module Status in China

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The LHC will be upgraded to High Luminosity (HL-LHC) to reach a peak instantaneous luminosity of $7.5 \times 10^{34} \text{ cm}^{-2} \text{s}^{-1}$, which corresponds to approximately 200 inelastic proton-proton collisions per beam crossing. The upgraded ATLAS Inner Tracker (ITk) strip system will cover 165 m^2 silicon which is 2.5 times the size of the current ATLAS silicon strip detector. China has committed to deliver 10% of the ITk Strip barrel modules. This talk will cover the tooling, hybrid, and module development and experience gained towards the final release.

Parallel 1: Upgrade / 309**ATLAS ITk Strip Sensor Quality Assurance****Author:** Zhan Li¹¹ IHEP**Corresponding Author:** lizhan@ihep.ac.cn

The ATLAS experiment will replace its Inner Detector with an all-silicon ITk for Phase-2. To ensure production quality of ATLAS18 silicon strip sensors—designed to withstand up to 4000 fb⁻¹—we establish a streamlined QA program built on standardized IV, CV, and CCE measurements at IHEP using a dedicated test piece (Mini sensor for CCE, MD8 for IV/CV). Irradiation tests are included as part of the QA to assess pre- and post-exposure performance. This talk will present the ATLAS community-endorsed QA procedures and the corresponding measurement setups implemented at IHEP.

Parallel 1: Upgrade / 310**ATLAS ITk Strip Module Testbeam****Author:** Lin Yang¹**Co-author:** Kun LIU¹¹ Tsung-Dao Lee Institute, Shanghai Jiao Tong University**Corresponding Author:** young-forest@qq.com

Beam test plays an essential role in validating the performance of silicon strip detectors for the ATLAS Inner Tracker (ITk) upgrade for the High-Luminosity LHC. This contribution presents recent beam test results for two ITk strip detector modules, highlighting both validation of analysis frameworks and insights into irradiation effects. As a cross-check of existing results and an exercise in using the Corryvreckan analysis framework, the performance of module SS_20USBMS0000406 was studied using data from the October 2024 test beam campaign. Building on this experience, a more comprehensive analysis was performed for module SS_20USBMS0000381, comparing its performance before (October 2024) and after (July 2025) irradiation. A noticeably narrower operating window is observed in the irradiated module, which is consistent with expectations from displacement damage in the silicon substrate.

Parallel 2 / 311**A search for triple Higgs boson production in the 6b final state using pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector****Authors:** Baihong Zhou¹; Haijun Yang²; Shu Li³; Jing Chen²; Xinzhu Wang²; Xuliang Zhu²¹ Tsung-Dao Lee Institute, Shanghai Jiao Tong Univ. (CN)² Shanghai Jiao Tong University³ TDLI, SJTU**Corresponding Author:** xinzhuwang@sjtu.edu.cn

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A search for the production of three Higgs bosons (HHH) in the $b\bar{b}b\bar{b}b\bar{b}$ final state is presented.

The search uses 126 fb^{-1} of proton-proton collision data at $\sqrt{s} = 13 \text{ TeV}$ collected with the ATLAS detector at the Large Hadron Collider. The analysis targets both non-resonant and resonant production of HHH . The resonant interpretations primarily consider a cascade decay topology of $X \rightarrow SH \rightarrow HHH$ with masses of the new scalars X and S up to 1.5 TeV and 1 TeV, respectively. In addition to scenarios where S is off-shell, the non-resonant interpretation includes a search for standard model (SM) HHH production, with limits on the tri-linear and quartic Higgs self-coupling set. No evidence for HHH production is observed. An upper limit of 59 fb is set, at 95% confidence level, on the cross-section for Standard-Model HHH production.

Parallel 2 / 312

Search for dark matter produced in association with a dark Higgs boson in the $b\bar{b}$ final state using pp collisions at $\sqrt{s} = 13 \text{ TeV}$ with the ATLAS detector [Online]

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A search is performed for dark matter particles produced in association with a resonantly produced pair of b-quarks with $30 < m_{b\bar{b}} < 150 \text{ GeV}$ using 140 fb^{-1} of proton-proton collisions at a center-of-mass energy of 13 TeV recorded by the ATLAS detector at the LHC. This signature is expected in extensions of the Standard Model predicting the production of dark matter particles, in particular those containing a dark Higgs boson s that decays into $b\bar{b}$. The highly boosted $s \rightarrow b\bar{b}$ topology is reconstructed using jet reclustering and a new identification algorithm. This search places stringent constraints across regions of the dark Higgs model parameter space that satisfy the observed relic density, excluding dark Higgs bosons with masses between 30 and 150 GeV in benchmark scenarios with Z' mediator masses up to 4.8 TeV at 95% confidence level.

Parallel 1: Upgrade / 313

Progress on ACTS-based 4D tracking and a design of timing pixel digital chip

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At the future collider High-Luminosity LHC (HL-LHC), the average number of the simultaneous pp interactions per event, or pile-up (μ), will rise to as much as 200. Resolving the pile-ups using time measurement has already been investigated during LHC Phase-II Upgrade, e.g. the ATLAS High Granularity Timing Detector (HGTD), which will be placed outside the ATLAS Phase-II Inner Tracker (ITk) endcap region. Meanwhile, the possibility of replacing the inner barrel layers of the ATLAS ITk with 4D pixel detector after Run 4 is foreseen as well. In the first part of the report, we will introduce the implementation of 4D tracking based on the common tracking software (ACTS) workflow. The performance of 4D tracking, e.g. efficiency and resolution, will also be discussed. In the second part, we will present a digital readout chip architecture for 4D pixel detectors, which is designed to overcome a significant increase in data rates resulting from high-precise time of arrival (ToA) information.

Parallel 3 / 314

CP violation measurement in charm meson decays at the CMS experiment

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The results of the first study of CP violation in the charm sector at the CMS experiment are presented. The analysis is based on the proton-proton collision data with the center-of-mass energy of $\sqrt{s} = 13$ TeV. The measured CP violation parameter is $A_{CP}(D^0 \rightarrow K_S^0 K_S^0) = (6.2 \pm 3.1(\text{stat.}) \pm 0.2(\text{syst.}) \pm 0.8(A_{CP}(D^0 \rightarrow K_S^0 \pi^+ \pi^-)))\%$, where the last uncertainty is due to the uncertainty in the reference channel asymmetry $A_{CP}(D^0 \rightarrow K_S^0 \pi^+ \pi^-)$. Further searches for charm CP violation with novel RUN 3 data and new refined analysis techniques are in progress.

Parallel 2 / 315

VBF H(bb/cc) Partial Run 2 and Partial Run 3 Analysis

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A search for the Standard Model (SM) Higgs boson decaying to a charm quark-antiquark pair ($\chi \rightarrow c\bar{c}$) and a bottom quark-antiquark pair ($\chi \rightarrow b\bar{b}$) via vector boson fusion (VBF) production is presented. For the $\chi \rightarrow c\bar{c}$ search, the analysis uses proton-proton collision data collected by the ATLAS detector at two centre-of-mass energies: 37.5 fb⁻¹ at $\sqrt{s}=13$ TeV from 2018, and 51.9 fb⁻¹ at $\sqrt{s}=13.6$ TeV from 2022 and 2023, corresponding to a total integrated luminosity of 89.4 fb⁻¹. The observed (expected) upper limit on the VBF $\chi \rightarrow c\bar{c}$ production cross-section times branching ratio is 41.4 (28.8) at the 95% confidence level (CL). The Higgs boson decay to a bottom quark-antiquark pair ($\chi \rightarrow b\bar{b}$) is simultaneously measured using the 51.9 fb⁻¹ of proton-proton collision data at $\sqrt{s}=13.6$ TeV collected during 2022 and 2023, corresponding to Run-3 data-taking period. The Observed (expected) VBF $\chi \rightarrow b\bar{b}$ event rate relative to the SM expectation is 0.96 (-0.31, +0.31). When combined with the previous search for $\chi \rightarrow c\bar{c}$ via associated production with a W or Z boson, the observed (expected) 95% CL interval on the Higgs-charm Yukawa coupling modifier, κ_C , is $|\kappa_C| < 1.1$ ($|\kappa_C| < 0.9$), representing the most stringent constraint to data from ATLAS data. In addition, this result is combined with the previous ATLAS measurement of VBF $\chi \rightarrow b\bar{b}$, leading

to the first evidence of VBF production with $\Xi \rightarrow b\bar{b}\gamma$, with observed (expected) significances of 3.3 (3.4) standard deviations.

Parallel 2 / 316

Search for the Higgs boson decay to $Z\gamma$ with ATLAS detector

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A search for the Higgs boson decay to a Z boson and a photon in the $\ell\ell\gamma$ ($\ell = e, \mu$) final state is performed using pp collisions at $\sqrt{s} = 13.6$ TeV recorded with the ATLAS detector at the Large Hadron Collider during 2022-2024, corresponding to an integrated luminosity of 165 fb^{-1} . The signal yield, normalised to the Standard Model prediction, is measured to be $\mu = 0.9^{+0.7}_{-0.6}$, compared to an expected value of $\mu = 1.0 \pm 0.7$. This corresponds to an observed (expected) signal significance of 1.4 (1.5) standard deviations for the background-only hypothesis. This result is combined with that of a similar search performed with 140 fb^{-1} of $\sqrt{s} = 13$ TeV pp collisions to provide the most stringent expected sensitivity to date to this rare decay, namely an observed (expected) signal strength of $\mu = 1.3^{+0.6}_{-0.5}$ ($\mu = 1.0^{+0.6}_{-0.5}$), corresponding to an observed (expected) significance of 2.5 (1.9) standard deviations. The measurement is consistent with the Standard Model expectation.

Parallel 4 / 317

Direct New Physics Search at the CEPC

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Direct New Physics Search at the CEPC

Parallel 4 / 318

Operation and performance of LHCb Upstream Tracker

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The Upstream Tracker (UT) is a four-layer silicon microstrip detector installed during the LHCb upgrade I. The UT is crucial for reconstructing charged particle trajectories, especially for long-lived particles beyond the acceptance of the vertex detector. The operation of the UT, including calibration, monitoring and strategies of tackling single-event upset issue will be addressed in this talk. Performance results since the first year of run3 data-taking with the UT in global at LHCb, regarding of the hit and tracking efficiency will also be mentioned, as well as the preliminary maintenance plan for the long shutdown 3 of the LHC.

Parallel 4 / 319

Recent progress on CEPC Accelerator studies

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This talk will summarize recent progress of the CEPC accelerator studies, in particular the R&D efforts in the Phase of CEPC Engineering Design Report.

Parallel 2 / 320

Electroweakino and slepton search summary in ATLAS

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Searches for electroweak supersymmetry are essential in the LHC SUSY program, as the strong SUSY particle mass limits now exceed ~ 2 TeV. We present a statistical combination of searches for chargino and neutralino production using 139 fb of proton-proton collisions at a center-of-mass energy of 13 TeV with ATLAS at the LHC. The combination integrates results from multiple final states to enhance the overall sensitivity to electroweak SUSY production. By combining the individual searches, the mass reach for supersymmetric particles is extended by 30 - 100 GeV, and the 95% C.L. cross-section upper limits of the original searches are decreased by 15%-40%. The IHEP SUSY group contributed to the analyses targeting the EWK 1L, SS2L/3L, Dita final states, which provide crucial sensitivity in the global interpretation.

Parallel 2 / 321

Constraining HHVV couplings via VBS VVH processes

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A search for the production of a Higgs boson in association with two vector bosons via vector boson scattering is presented. The search uses CMS data from proton-proton collisions at $\sqrt{s} = 13$ TeV collected from 2016 to 2018, corresponding to an integrated luminosity of 138fb^{-1} . Selected events are consistent with the presence of two jets originating from vector boson scattering and a Higgs boson decaying into a pair of b quarks, reconstructed as a single large-cone jet, while final states with 0, 1 or 2 charged leptons coming from the decays of the two vector bosons are studied.

The study constrains the quartic $VVHH$ coupling strength relative to the standard model, κ_{2V} , in the observed (expected) range $[0.40, 1.60]$ ($[0.34, 1.66]$) at 95% confidence level when the other Higgs boson couplings are fixed to their SM values. The process is also sensitive to the $WWHH$ and $ZZHH$ quartic couplings independently, whose strengths relative to the standard model are constrained in the observed (expected) ranges $[0.17, 1.84]$ ($[0.11, 1.89]$) and $[-0.37, 2.38]$ ($[-0.54, 2.54]$),

for κ_{2W} and κ_{2Z} respectively. A two-dimensional scan is performed to determine exclusion regions in the κ_{2W} - κ_{2Z} plane.

Parallel 1: Upgrade / 322

Sensor development for LHCb Upstream Pixel Tracker

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With the increasingly demanding requirements of high luminosity collider HL-LHC, High-Voltage CMOS (HV-CMOS) sensors, featured a deep n-well separating the transistors and the depletion region, had great radiation resistance and enhanced hit density processing capabilities, is considered as the technology option for LHCb upstream pixel tracker in LHCb Upgrade II. To reduce power density and incorporate more functionality in the same area, the next generation process of HV-CMOS: 55nm HV-CMOS processing sensor prototype called COFFEE has been designed and tested. In this talk, I will introduce the sensor development progress of COFFEE chips through COFFEE chip test. In COFFEE chip test, charge injection, laser and radioactive sources are used for testing the in-pixel circuit functionality, sensor performance and other functional modules. The test results are almost conformed to design expectations and simulation results.

Parallel 3 / 323

Transverse momentum dependence of charm baryon production and hadronization with ALICE

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Heavy quarks (i.e. charm quarks and beauty quarks) are one of the important probes to study the properties of strongly interacting partonic matter. Heavy quarks produced in the early stage of collisions will experience the whole evolution of the collision process. Therefore, Heavy-flavour observables carry important information of quark-medium interactions in an early phase of the QGP. The measurement of the production of heavy flavour hadrons and their interaction with the hot and dense medium are of great importance to investigate the energy loss mechanism of hard partons in the medium and to test the mass dependence of radiative energy loss. The measurement of the anisotropic flow of heavy-flavour hadrons can reveal the degree and mechanism of thermalization of quark matter, and the measurement of heavy-flavour baryon-to-meson yield ratios can shed light on the hadronization mechanism of quark matter.

In addition, measurements of the production of heavy-flavour hadrons in high-energy hadronic collisions provide important tests of QCD because perturbative techniques are applicable down to low transverse momentum thanks to the large masses of charm and beauty quarks. The production cross

sections of heavy-flavour hadrons can be calculated using the factorization approach as a convolution of three factors: the parton distribution functions (PDFs) of the incoming protons, the hard-scattering cross section at partonic level, which can be calculated perturbatively in powers of the strong coupling constant, and the fragmentation function, which parametrizes the non-perturbative transition of a heavy quark into a given heavy-flavour hadron species. It was generally assumed that the fragmentation functions are universal regardless of the collision system and energy. The measurement of the relative production of different heavy-flavour hadron species is sensitive to the fragmentation function used in pQCD-based calculations. Measurements of the production cross sections of different charm-hadron species, comparing in particular baryon and meson production in various collision systems and centre-of-mass energies, provide new insights into the properties of the fragmentation process.

The recent heavy-flavour baryon measurements in hadronic collisions at LHC energies indicated a significant difference in the fragmentation fractions of charm and beauty quarks into charm and beauty baryons compared to those measured in electron-positron and electron-proton collisions. These observations required a new approach for evaluating the charm-quark production cross section at midrapidity and the charm-quark fragmentation fraction based on the measurements of both charm mesons and baryons.

Parallel 4 / 324

Dark photon mixing effects and CP violation

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The dark photon portal, a leading framework for connecting the Standard Model (SM) with dark matter, is extended in this work to include several novel and consequential mechanisms. Beyond the standard kinetic mixing with the hypercharge field, we incorporate mass mixing via an additional Higgs doublet. Furthermore, we introduce a non-Abelian kinetic mixing between the $U(1)_X$ and $SU(2)_L$ gauge fields, achieved through a dimension-five operator involving a Higgs triplet. Most significantly, we present a renormalizable, CP-violating non-Abelian kinetic mixing scenario within the Type-III Seesaw model. This unified framework not only accounts for the origin of neutrino mass but also provides a viable exploration for the electron electric dipole moment (EDM), offering a multifaceted portal with rich phenomenological implications.

Parallel 4 / 325

Lanzhou University computing cluster status

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The LHCb Tier2 site has been successfully constructed in Lanzhou University and running smoothly, we will present the recent status of the computing cluster.

Parallel 2 / 326

Search for boosted $H \rightarrow WW$ and prospects for boosted $W \rightarrow cb$ in the CMS Experiment

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Boosted boson jet tagging has been a central focus of both theoretical and experimental high-energy physics research over the past decades, serving as a major driver of innovation at the energy frontier. We leverage the powerful ParT tagger in CMS to search for boosted $H \rightarrow WW$ and $W \rightarrow cb$ jets across multiple channels. Public results from the 0L-channel $H \rightarrow WW$ search will be presented, along with prospective results for the 0L- and 1L-channel $W \rightarrow cb$ search searches. The vital calibration strategies involved will also be discussed.

Parallel 4 / 327

The 152 GeV Candidate at the LHC

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Based on several features observed in the data collected during Run 1 of the LHC, a simplified model was proposed in which a heavy scalar, H , decays into a combination of the SM Higgs boson (h) and a new Higgs-like scalar, S . One implication of this model is the appearance of excesses in lepton production when the decay $S \rightarrow WW$ dominates. These excesses, referred to as the multi-lepton anomalies at the LHC, were subsequently identified. They include events with two or more leptons, missing transverse energy, and (b)-jets in the final state. Based on the invariant mass of lepton pairs, the mass of the new scalar is predicted to be $m_S = 150 \pm 5$ GeV.

The analysis of $\gamma\gamma$, $Z\gamma$, and WW sideband spectra in Run 2 data confirms the presence of a resonance at $m_S = 152 \pm 1$ GeV, with a global significance of 5.3σ . This represents the strongest excess observed at the LHC to date that is consistent with a narrow resonance beyond the SM. These findings strongly motivate further investigation at future high-precision facilities such as the CEPC.

Parallel 4 / 328

Triboson Excesses in light of a Real Higgs Triplet Model at the LHC

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Motivated by the multi-lepton anomalies at the LHC, a sideband analysis of $\gamma\gamma$, $Z\gamma$, and WW spectra in Run 2 data reveals a narrow resonance at $m_S = 152 \pm 1$ GeV with a global significance of 5.3σ , while the ZZ channel remains SM-like. This pattern is consistent with the Real Higgs Triplet (RHT) model with hypercharge $Y = 0$, in which S does not couple to ZZ at tree level. In this framework, triplet scalars can

be produced by Drell-Yan process and decay into electroweak bosons, leading to enhanced triboson final states. Intriguingly, ATLAS and CMS measurements exhibit a systematic elevation in VVV final states, where $V = W, Z$, including topologies like WWW, WWZ, and tWZ. We investigate whether the RHT model can account for these features through electroweak production and decay of triplet scalars, and discuss implications for future high-precision facilities such as the CEPC.

Parallel 2 / 329

Highlights of the HL-LHC physics projections by ATLAS and CMS

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The ATLAS and CMS experiments are unique drivers of our fundamental understanding of nature at the energy frontier. In this contribution to the update of the European Strategy for Particle Physics, we update the physics reach of these experiments at the High-Luminosity LHC (HL-LHC) in a few key areas where they will dominate the state-of-the-art for decades to come.

Poster / 330

Analysis of non-resonant HH->bbgammagamma using CMS Run 3 data

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A search for nonresonant Higgs boson pair production in the $b\bar{b}\gamma\gamma$ channel is performed using 61.9 fb⁻¹ of CMS data at $\sqrt{s} = 13.6$ TeV. Two analysis strategies are employed. The 2D fit approach yields a 95% CL upper limit of 11.0 (7.3 expected) times the SM prediction, while the 1D approach gives 7.4 (8.7 expected). Constraints on the self-coupling modifier κ_λ are set, excluding κ_λ outside -5 to 12 (2D) and -3.9 to 10.4 (1D).

Parallel 2 / 331

Enhancing di-jet Resonance Searches at the (HL)-LHC via FSR Tagging

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In this article, we investigate the possibility of enhancing the di-jet resonance search by tagging the final state radiation (FSR) jets, using an event-level deep neural network. It is found that solely relying on the 4-momenta of the leading three jets allows the algorithm to achieve good discriminating power that can identify the hardest FSR jet in signal, while rejecting that in background. Once the invariant mass is corrected using the tagged FSR jet, the mass resolution of the signal is greatly enhanced, and the sensitivity of the search is also improved by 10-20%. By crafting the input variables carefully, the algorithm introduces minimal mass sculpting for the background, and its applicability extends to a broad mass range. This work proves that FSR tagging can potentially enhance the di-jet resonance searches, suiting various stages of the physics programmes at the Large Hadron Collider (LHC) and High-Luminosity LHC (HL-LHC).

Parallel 4 / 332

Constructing Quantum Entanglement Criteria for Collider Processes

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Quantum entanglement, a profound feature of quantum mechanics where particles share interconnected states regardless of distance, has been extensively studied in low-energy systems like photons and atoms. Exploring entanglement in high-energy particle collisions offers unique opportunities to probe quantum phenomena under extreme conditions and test fundamental principles like non-locality. Here we demonstrate the observation of quantum entanglement between lambda and antilambda hyperons ($\Lambda\bar{\Lambda}$) produced in electron-positron collisions via the decay of the J/ψ particle. By analyzing the angular correlations of the protons and antiprotons emerging from the subsequent weak decays of the hyperons, we identify clear signatures of entanglement that violate classical limits derived for separable states. This result confirms that entanglement persists through both the strong interaction production process and the weak decay processes. Since a significant majority of these decay events occur at spacelike separation, meaning no classical signal could connect them, our findings provide strong experimental support for the nonlocal nature of quantum mechanics. The successful detection of entanglement in this hyperon-antihyperon system establishes a new methodology and platform for testing quantum foundations in relativistic particle physics, complementing traditional approaches and opening avenues for future investigations into decoherence or symmetry violations in high-energy collisions.

Parallel 2 / 333

Measurement of the Higgs boson production in association with top quarks in multilepton final states in ATLAS

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我们对多轻子末态下的 $t\bar{t}H$ 产生截面进行了精密测量, 并通过控制 $t\bar{t}W$ 背景提高灵敏度。在标准模型中, $t\bar{t}H$ 的分支比小、信号稀少, 且与 $t\bar{t}W/t\bar{t}Z$ 背景强相关, 使得信号提取十分具有挑战性。

本分析定义了六类按轻子数与类型划分的末态, 并采用全局拟合同时约束信号与背景。测得 $t\bar{t}H$ 产生截面为 $321^{+102}_{-99} \text{ fb}$, 与 SM 预言一致, 显著性为观测 3.3σ 、期望 5.3σ 。在 STXS 框架下完成了随希格斯横动量的微分测量; 同时进行的 $t\bar{t}H/t\bar{t}Hq$ 联合分析得到信号强度:

$\mu(\text{tH})=0.59^{+0.22}_{-0.20}$, $\mu(\text{tHq})=8.9^{+5.5}_{-5.0}$ 。CP 性质研究结果支持 SM 的 CP-even 预测，并以 1.8σ 排除了纯 CP-odd 假设。

与之前 80 fb^{-1} 的结果相比，本次分析整体不确定度降低约 60%，精度提升约 2.4 倍，提升了对 tH 过程的理解和测量精度。

Parallel 2 / 334

Search for light Higgs bosons in diphoton channel at CMS

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The latest results of search for light Higgs bosons in diphoton channel at CMS with Run2 data, are presented. The talks will cover both the low-mass results with the paper published by PLB in January 2025, and the very low-mass results which were released in March 2025.

Parallel 1: Upgrade / 335

Progress on iRPC/RPC Backend and Trigger

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Progress on iRPC/RPC Backend and Trigger

Parallel 1: Upgrade / 336

Status of CMS HGCal Module Production at IHEP

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This report is about the progress of producing CMS HGCal module in IHEP. The CMS China group will undertake approximately one-fifth of the production tasks for silicon modules and most of the CuW baseplates.

Parallel 2 / 337

Search for heavy resonances decaying to two Z bosons at CMS

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A search for heavy resonances decaying to two Z bosons in the four-lepton final state is presented, using the data collected by the CMS detector from 2016 to 2018, corresponding to an integrated luminosity of 138 fb^{-1} . No significant excess is observed, and upper limits on the production cross section multiplied by the branching ratio are computed as a function of the resonance mass and width, for different production modes. The results are projected to an integrated luminosity of 4 fb^{-1} and 6 fb^{-1} to estimate the sensitivities to be reached during the High-Luminosity LHC phases.

Parallel 1: Upgrade / 338

Software development for LHCb ECAL upgrade

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In Upgrade II, the LHCb detector is planned to operate at an instantaneous luminosity almost an order of magnitude larger than Upgrade I. The LHCb electromagnetic calorimeter in Upgrade II, or PicoCal, has gone through substantial development for both the hardware and the software. New algorithms need to be implemented in the LHCb software framework, to incorporate with the new layout and functionality of PicoCal. Here, the progress of these software development, mainly focused on the digitization and cluster reconstruction process, is presented.

Parallel 4 / 339

Testing CP-violation in Heavy Scalar Sector at Future Muon Colliders

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We propose a model-independent approach to test for CP (Charge-Parity)-violation in the scalar sector. We simply extend the Standard Model (SM) by introducing a heavy neutral scalar particle and the couplings of $h_2 VV$ ($V = W^\pm, Z$) and $h_2 h_1 Z$ vertices, where h_1, h_2 stand for the 125 GeV SM Higgs boson and the heavy neutral scalar particle we add respectively. This is possible at the future muon collider by exploiting h_2 production from Vector-Boson Fusion (VBF) and decay to $h_1 Z$. When the coupling parameters at the vertices $h_2 VV$ ($V = W^\pm, Z$) and $h_2 h_1 Z$ are both nonzero, CP-violation exists in the scalar sector. We simulate the signal and backgrounds for the processes mentioned above at the future muon colliders with the $\sqrt{s} = 10 \text{ TeV}$ (3 TeV) and the integrated luminosity of 10 ab^{-1} (0.9 ab^{-1}). Finally, we provided the discovery potential of CP-violation under different coupling parameters.

Parallel 4 / 340

Neutrino physics at CEPC

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I will give a short summary on the representative topics of neutrino physics at the future high energy lepton collider CEPC.

Parallel 4 / 341

Electron and photon reconstruction and identification performance at CMS in 2022 and 2023

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This talk presents the offline reconstruction and identification performance of electrons and photons at CMS using proton-proton collision data collected in 2022 and 2023 at a center of mass energy of 13.6 TeV. The corrections and scale factors derived and applied to collision data and simulation are also discussed.

Parallel 2 / 342

Search for HH/HY resonances with gammagamma in the final state at CMS

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The $H \rightarrow \gamma\gamma$ decay channel provides a clean final-state topology that allows the mass of a Higgs boson to be reconstructed with high precision. This presentation will show the latest results of the search for resonant di-Higgs production where one of the Higgs bosons decays to diphoton, using CMS data.

Parallel 1: Upgrade / 343

LHCb UP Module and Stave Assembly Development

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This summary covers key aspects of UP detector assembly development, including an overview of the detector's geometric structures, the dummy assembly process for UP detector modules, the design of subsequent automated fixtures, and an exploration of realizing automated assembly via robotic arms and gantries.

Parallel 1: Upgrade / 344

The simulation and reconstruction studies on LHCb UP detector for Upgrade II

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The LHCb experiment is preparing for its Upgrade II, during which the instantaneous luminosity will increase by at least a factor of five with respect to Run 3, reaching $1.0 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$. The increase in luminosity is very demanding on the detectors. To address these challenges, the current silicon micro-strip Upstream Tracker (UT) will be replaced by a new Upstream Pixel (UP) detector, consisting of four layers of MAPS-based pixel sensors. Located upstream of the dipole magnet, the UP detector is a crucial component of the LHCb tracking system. It provides fast momentum estimates for the trigger system and is essential for reconstructing long-lived particles. This talk will present detailed simulation and reconstruction studies of the UP detector, including investigations of new detector geometries, hit rate, tracking efficiency, ghost rate, and momentum resolution under Upgrade II conditions.

Parallel 4 / 345

Baryonic B decays in PQCD

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Baryonic two-body B mesons decays have been measured experimentally for some time, which provides an excellent ground for studying the QCD of baryonic B decays. In this work, we investigate the two-body doubly-charmed baryonic B decays in the perturbative QCD (PQCD) approach including higher twist contributions to the light-cone distribution amplitudes (LCDAs). The charmed baryon LCDAs are included up to the twist four and the effect of the subleading component of the B meson LCDAs is studied for details. With the inclusion of these higher-power contributions, the PQCD results on rates can explain the current experimental data well. Moreover, we note that the SU(3) symmetry breaking is important in the concerned processes and play an essential role in understanding the measurements of $\mathcal{B}(\bar{B}^0 \rightarrow \Lambda_c^+ \bar{\Lambda}_c^-)$ and $\mathcal{B}(B^- \rightarrow \Xi_c^0 \bar{\Lambda}_c^-)$. We also evaluate the angular asymmetries for the first time, which have neither been measured experimentally nor calculated theoretically. All these predictions can be tested in future.

Parallel 3 / 346

First observation of the charmless baryonic decay $B^+ \rightarrow \bar{\Lambda} p \bar{p} p$

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A search for the charmless baryonic decay $B^+ \rightarrow \bar{\Lambda} p \bar{p} p$ is performed using proton-proton collision data recorded by the LHCb experiment, corresponding to an integrated luminosity of 5.4 fb^{-1} . The branching fraction for this decay is measured for the first time relative to that of the topologically similar decay $B^+ \rightarrow J/\psi K^+$, with $J/\psi \rightarrow \bar{\Lambda} p K^-$. The branching fraction is measured to be $\mathcal{B}(B^+ \rightarrow \bar{\Lambda} p \bar{p} p) = (2.08 \pm 0.34 \pm 0.12 \pm 0.26) \times 10^{-7}$, where the first uncertainty is statistical, the second is systematic, and the third arises from the uncertainty in the normalization channel branching fraction. The CP asymmetry is measured to be $\mathcal{A}_{CP} = (5.4 \pm 15.6 \pm 2.4)\%$, where the uncertainties are statistical and systematic. The background-subtracted invariant-mass distributions of $\bar{\Lambda} p$ and $\bar{p} p$ pairs exhibit pronounced enhancements at both kinematic thresholds, in contrast to a uniform phase-space distribution.

Parallel 3 / 347

Jet quenching studies via jet–hadron correlations with ALICE

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In heavy-ion collisions, high- p_T partons traverse the hot and dense QCD medium, losing energy through induced gluon radiation and elastic scattering. This leads to modifications of jet structure compared to jets produced in vacuum. Measurements of the properties of the medium generated in Pb–Pb collisions at the LHC require reference measurements from more elementary pp and p–Pb collisions. The semi-inclusive recoil jet measurement provides precise, data-driven suppression of the large uncorrelated background and uniquely enables the exploration of medium-induced modification of jet production over a wide phase space, including low p_T for large jet resolution parameter R . Such measurement provides a good test for pQCD calculations, and sets as a reference for jet quenching and acoplanarity study in nucleus-nucleus collisions.

In this contribution, we report the semi-inclusive distribution of charged jets recoiling from a high- p_T charged hadron trigger in pp, p–Pb and Pb–Pb collisions with ALICE. The semi-inclusive recoil jet distribution as a function of p_T and $\Delta\varphi$ will be presented, where $\Delta\varphi$ is the relative azimuthal angle between trigger track and recoil jets. The R dependence and comparisons to theoretical models will also be discussed.

Parallel 3 / 348

First measurement of c^+ elliptic flow in 30-50% Pb-Pb collisions at $\sqrt{s_{NN}} = 5.36 \text{ TeV}$ with ALICE

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Heavy quarks (charm and beauty) are useful probes for investigating the properties of the quark-gluon plasma (QGP) generated in ultra-relativistic heavy-ion collisions. Their participation in the collective motion of the medium can be assessed by measuring the charm-hadron elliptic-flow coefficient, originating from the initial-state spatial asymmetry in non-central heavy-ion collisions. These measurements provide fundamental inputs to constrain theoretical models describing the charm-quark transport in the QGP, as well as its possible thermalization in the medium. In addition, the comparison between meson and baryon can provide further insights into medium-induced phenomena, such as the radial flow and the charm-quark hadronization via coalescence. In this contribution, the first measurements of charm baryon Λ_c^+ elliptic flow in 30-50% centrality intervals of Pb-Pb collisions at $\sqrt{s_{NN}} = 5.36$ TeV collected by the ALICE experiment during the LHC Run 3 are shown. The measurements are compared to model predictions that incorporate various implementations of heavy-quark interaction and hadronization with the QGP constituents.

Poster / 349

Test of signal integrity in flex cable

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Ongoing signal-integrity tests of the flex cable in the UP detector.

Plenary / 350

Recent open heavy flavor and quarkonium measurements from ALICE experiment

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ALICE topic talk: heavy flavor physics

Plenary / 351

ALICE 进展汇报

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ALICE 中文汇报

Parallel 3 / 352

J/ψ and D⁰ associated production measurements with ALICE Run 3

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Multiple Parton Interactions (MPI) represent an essential feature of hadron-hadron collisions, adding significant richness to the event structure observed in high-energy physics. These processes occur when several partons from each colliding hadron undergo interactions within the same collision. Among the MPI mechanisms, Double Parton Scattering (DPS) stands out as the most straightforward case, involving two independent parton scatterings taking place simultaneously. The characterization of DPS in proton-proton collisions typically relies on the effective cross section, a phenomenological quantity that reflects the transverse distribution and overlap of partons inside the proton. Investigations of DPS provide a useful window into the dynamics of Quantum Chromodynamics (QCD), in particular the behavior of multi-parton distributions and possible correlations in spin and color degrees of freedom.

The production of heavy quarks, such as charm and beauty, offers a sensitive probe of DPS because their large masses ensure that their creation is driven by hard-scattering processes. Measurements of charm-hadron pair production therefore serve as an effective tool to study DPS involving heavy quarks. In this work, we present new results on the production of D⁰-J/ψ pairs in proton-proton collisions at $\sqrt{s} = 13.6$ TeV. The analysis, carried out with the ALICE detector during Run 3 of the Large Hadron Collider (LHC), covers both midrapidity and forward rapidity regions.

Parallel 1: Upgrade / 353

The Upgrade of the ALICE Inner Tracking System: ITS3

Authors: Chunzheng Wang^{None}; Jiaqi Luo^{None}

The ALICE experiment at the LHC is continuously upgrading its detector systems to address the evolving challenges of future heavy-ion physics. This presentation introduces the upgrade of the ALICE Inner Tracking System to ITS3, which is planned for installation during Long Shutdown 3 and will be operational in LHC Run 4. Building on the state-of-the-art ITS2, the ITS3 project aims to significantly reduce the material budget, improve pointing resolution, and enhance tracking performance close to the interaction point. Key innovations include the use of bent, wafer-scale monolithic pixel sensors fabricated in a 65 nm CMOS process, enabling a more uniform material distribution and a closer placement to the beam pipe. An overview of the project timeline and expected performance improvements will be presented.

Parallel 3 / 354

Evidence for the rare decay $B^+ \rightarrow \bar{\Lambda} p \mu^+ \mu^-$

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A search for the rare decay $B^+ \rightarrow \bar{\Lambda} p \mu^+ \mu^-$ is performed using proton-proton collision data recorded by the LHCb experiment at a centre-of-mass energy of $\sqrt{s} = 13$ TeV, corresponding to an integrated luminosity of 5.4 fb^{-1} . An excess of events is found with respect to the background-only expectation, with a signal significance of 3.5 standard deviations, in the threshold-mass-enhanced region of $m(\bar{\Lambda} p) < 2.8 \text{ GeV}/c^2$. The branching fraction is measured to be $\text{cal}B(B^+ \rightarrow \bar{\Lambda} p \mu^+ \mu^-)|_{m(\bar{\Lambda} p) < 2.8 \text{ GeV}/c^2} = (1.70 \pm 0.60_{\text{stat}} \pm 0.19_{\text{syst}} \pm 0.14_{\text{ext}}) \times 10^{-8}$, where the last uncertainty is due to external inputs on $\text{cal}B(B^+ \rightarrow \bar{\Lambda} p J/\psi) \times \text{cal}B(J/\psi \rightarrow \mu^+ \mu^-)$. With no obvious signal observed in the high $m(\bar{\Lambda} p)$ region, an upper limit is set to be $\text{cal}B(B^+ \rightarrow \bar{\Lambda} p \mu^+ \mu^-)|_{m(\bar{\Lambda} p) > 2.8 \text{ GeV}/c^2} < 2.4 \times 10^{-9}$ at 90% confidence level.

Poster / 355

UP bare stave design and thermal stduy

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UP bare stave design and thermal stduy for LHCb Upgrade II

Parallel 1: Upgrade / 356

Expected performance of the ALPIDE pixel layers in ALICE Fo-cal

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The ALICE Forward Calorimeter (FoCal), to be installed during LS3 for Run 4, targets precision measurements of direct photons at forward rapidity and thus constrains gluon distributions in protons and nuclei. The expected performance of the electromagnetic section (FoCal-E) is assessed with SystemC models of ALPIDE-based pixel layers and SPS H2 beam data. In these studies, occupancy and BUSY-violation behaviour of the innermost chips are examined together with data-rate margins. Beam tests show that back-bias voltages reduce pixel occupancy by shrinking cluster size. Simulations further evaluate two mitigation options: periodic pixel masking (grid masking) and a pad-layer-driven regional trigger. Both approaches suppress BUSY violations and help maintain readout efficiency at high instantaneous rates. The results indicate that FoCal-E can support precision forward-photon measurements in Run 4.

Parallel 2 / 357

Strong SUSY and RPV SUSY searches summary in ATLAS

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Here shows the progress of strong SUSY particle searches at the ATLAS experiment with full Run2 data. These searching results are under consideration of multiple SUSY models including RPC/RPV models, models with long-lived SUSY particles. For RPC/RPV models, considering massless neutralino1, gluino masses are excluded up to 2 TeV ; the first/second generation squark masses are

excluded up to 1.8 TeV; the third generation squark masses are excluded up to 1.2 TeV. Considering SUSY models with long-lived particle, among all lifetime, gluino masses are excluded up to 2 TeV.

Parallel 4 / 358

Computing of CMS

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As LHC run3 keep taking more and more data (up to 244 fb-1 for CMS now), the demanding on the computing and storage, as well as the usage of GPU for machinelearning studies are keep increasing. in this presentation, I will give the status report of Chinese CMS computing resources, its usage, and feedbacks from users.

Parallel 3 / 359

Study of open heavy flavor spin polarization and momentum correlations with ALICE

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ALICE, heavy flavor, spin polarization, femtoscopy, momentum correlations

Parallel 4 / 360

EveNet: Towards a Generalist Event Transformer for Unified Understanding and Generation of Collider Data

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With the increasing size of the machine learning (ML) model and vast datasets, the foundation model has transformed how we apply ML to solve real-world problems. Multimodal language models like chatGPT and Llama have expanded their capability to specialized tasks with common pre-train. Similarly, in high-energy physics (HEP), common tasks in the analysis face recurring challenges that demand scalable, data-driven solutions. In this talk, we present a foundation model for high-energy physics. Our model leverages extensive simulated datasets in pre-training to address common tasks

across analyses, offering a unified starting point for specialized applications. We demonstrate the benefit of using such a pre-train model in improving search sensitivity, anomaly detection, event reconstruction, feature generation, and beyond. By harnessing the power of pre-trained models, we could push the boundaries of discovery with greater efficiency and insight.

Parallel 4 / 361

Testing a light Higgs at the LHC and future colliders

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The discovery of the 125 GeV Standard Model (SM) Higgs boson confirmed electroweak symmetry breaking, yet unresolved issues, including the hierarchy problem, dark matter, and baryon asymmetry, point to new physics with extended scalar sectors. Experimental anomalies around 95 GeV in channels like $b\bar{b}$, $\tau^+\tau^-$, and $\gamma\gamma$ have further sparked interest in a potential beyond-SM light Higgs boson. This talk explores prospects for testing this light scalar via signal simulation studies at the HL-LHC, HE-LHC, and future colliders (FCC-hh, CEPC), highlighting how Monte Carlo simulations and machine learning boost detection sensitivity. Representative models, such as Minimal Dilaton Model (MDM), Type-I Two-Higgs-Doublet Model (2HDM), flipped Next-to 2HDM (N2HDM), and Next-to Minimal Supersymmetric SM (NMSSM), are used to illustrate the reach of these colliders.

Parallel 3 / 362

Study nuclear modifications with jets in ALICE

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In heavy-ion collisions, the measurements of jets traversing the hot medium provide critical insights into the Quark-Gluon plasma, which manifest themselves in jet energy loss and substructure modifications. In this talk, we will present measurements of inclusive jet modifications in Pb-Pb collisions with ALICE experiment. We employ a variety of analysis techniques to extend the measurements to lower jet p_T . In addition, taking advantage of the major upgrades to the ALICE detector in Run 3, nuclear modifications and collective effects could be studied with improved precision. These measurements will quantify jet quenching effects, enhancing our understanding of the jet energy loss mechanisms.

Parallel 1: Upgrade / 363

Timing Measurements with the ATLAS High Granularity Timing Detector at the HL-LHC

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As the Large Hadron Collider enters the High-Luminosity era, several sub-detectors require major upgrades. The ATLAS High Granularity Timing Detector (HGTD), currently under development for the HL-LHC, is designed to mitigate pile-up levels of up to ~ 200 simultaneous proton-proton interactions by providing precise timing information in the forward region (roughly $2.4 < |\eta| < 4.0$). When vertex separation in z becomes insufficient, per-track timing (targeting $\sim 30\text{ ps}$) improves track-to-vertex association and thus enhances object reconstruction and background rejection. The HGTD will complement the upgraded all-silicon Inner Tracker (ITk) by adding a timing coordinate to spatial tracking. This talk presents simulation studies of the HGTD's timing performance, the effects on the time resolution, and the calibration strategies explored to date.

Parallel 1: Upgrade / 364

Simulation studies for LHCb ECAL upgrade

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The LHCb experiment at the Large Hadron Collider (LHC) will undergo a major upgrade of its electromagnetic calorimeter (ECAL) during Long Shutdown 4 (LS4). To optimize the ECAL design and enhance its physics performance, we evaluate the energy/time resolution through simulations of a single prototype based on different setups. Additionally, we evaluate the ECAL's response in different physics processes by simulating various decay channels. These studies provide key insights into the ECAL's design specifications and its expected performance in future LHCb data-taking.

Parallel 2 / 365

Search for dark matter produced in association with a pair of bottom quarks at CMS

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A search for dark matter (DM) particles produced in association with bottom quarks using proton-proton collision data at a center-of-mass energy of $\sqrt{s} = 13$ TeV, corresponding to an integrated luminosity of 138 fb^{-1} is presented. The search is performed in a final state with large missing transverse momentum and a pair of jets originating from bottom quarks. No significant excess of data is observed with respect to the standard model expectation. Results are interpreted in the context of a type-II two-Higgs-doublet model with an additional light pseudoscalar (2HDM+a). An upper limit is set on the mass of the lighter pseudoscalar, probing masses up to 260 GeV at 95% confidence level. Sensitivity to the parameter space with the ratio of the vacuum expectation values of the two Higgs doublets, $\tan \beta$, greater than 15 is achieved, capitalizing on the enhancement of couplings between pseudoscalars and bottom quarks with high $\tan \beta$.

Parallel 4 / 366

Search for heavy photophobic axion-like particles at the proton-proton collider

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Current experimental results indicate that if axion-like particles (ALPs) indeed exist, their interactions with photons are weak over a large mass range. Therefore, we assume that ALPs do not couple to diphotons and have conducted detailed analyses on the decay mode of such heavy photophobic ALPs into boson final states ($WW, \gamma Z$) at the High-Luminosity Large Hadron Collider (HL-LHC, $\sqrt{s} = 14\text{TeV}$) and larger colliders ($\sqrt{s} = 100\text{TeV}$). The signal process ($WWjj, \gamma Zjj, WWW$) and its corresponding background processes are simulated. Through preselection criteria and multivariate analysis, we finally derive the discovery sensitivities for the coupling constants g_{aWW} of the signal process ($WWjj, \gamma Zjj, WWW$) within the mass range of 100–4000 GeV at the 2σ and 5σ confidence levels, and simultaneously present the sensitivities for the product of the production cross section and branching ratio within the mass range of 100–4000 GeV. The results demonstrate that future LHC and larger colliders will have excellent detection capabilities for heavy photophobic ALPs.

Parallel 4 / 367

Updates of LHC Computing in China

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This report will summarize the new updates or highlights of Chinese LHC computing recently.

Parallel 1: Upgrade / 368

ETL LGAD characterization at USTC (CMS)

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The Endcap Timing Layer (ETL) of the CMS experiment's MIP Timing Detector (MTD) will employ Low-Gain Avalanche Diodes (LGADs). As a major breakthrough in silicon detector technology, LGADs boast two core advantages: outstanding time resolution and excellent signal-to-noise ratio. The experimental team has designed separate test schemes for LGAD test structures and sensor arrays, with all tests carried out on a probe station.

This report presents the laboratory characterization work on the 16×16-channel LGAD prototype sensor arrays and test structures developed for the ETL subsystem of the CMS experiment. It elaborates in detail on the design of the I-V (Current-Voltage) and C-V (Capacitance-Voltage) test setups used to measure key parameters, and also showcases the preliminary test results.

The relevant work provides crucial technical support for the performance optimization and engineering application of the MTD detector during the High-Luminosity LHC phase. Additionally, it accumulates key experience for the research, development, and testing of next-generation silicon-based timing detectors.

Parallel 3 / 369

Observation of a family of all-charm tetraquarks at CMS**Author:** Yilin Zhou¹¹ *Fudan University***Corresponding Author:** yilin.zhou@cern.ch

The CMS experiment reports the observation of three structures in the $\bar{c}c\bar{c}c \rightarrow \bar{c}+c-\bar{c}+c$ channel — $\bar{c}c(6600)$, $\bar{c}c(6900)$, and $\bar{c}c(7100)$ — each with a significance well above 5σ , confirming and extending the earlier Run 2 results. Strong interference effects among them, also above 5σ , indicate they share the same quantum numbers. A complementary search in the $\bar{c}c\bar{c}c(2\bar{c})$ channel reveals two structures consistent with $\bar{c}c(6900)$ and $\bar{c}c(7100)$. A spin-parity analysis favors a $J^{PC}=2^{++}$ assignment, a rare quantum number among known hadrons. Together, these findings strongly support the interpretation of these states as a family of all-charm tetraquarks, offering new insights into the dynamics of exotic resonances.

Poster / 370

ATLAS HGTD Probing at the Pre-Production Stage**Authors:** Hancen LU (鲁函岑)¹; Xiang CHEN(陈翔)²¹ *IHEP*² 上海交通大学 (SJTU)**Corresponding Author:** luhc@ihep.ac.cn

The High-Granularity Timing Detector (HGTD) is a key subdetector in the Phase-II upgrade of the High-Luminosity LHC (HL-LHC), playing a crucial role in mitigating pileup. As a critical step in HGTD module production, ASIC probing of ALTIROC-A directly affects subsequent detector module fabrication and assembly. This talk presents the recent progress and results of the HGTD ASIC probing campaign and outlines the upcoming test plan in preparation for production.

Parallel 4 / 371

Introduction to ALICE Computing**Author:** Xiao Han¹¹ *Institute of High Energy Physics, CAS***Corresponding Author:** hanx@ihep.ac.cn

This report summarizes ALICE computing activities in China. It introduces the participating institutes and the Chinese ALICE community, outlines the establishment and operation of the Tier-2 site at IHEP Beijing, and highlights its integration into the global computing infrastructure. The report also discusses operational experience and future plans for resource expansion and enhanced support of physics analysis.

Parallel 2 / 372

Polarisation measurement of the same-sign WW vector boson scattering with the ATLAS detector

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This proposal describes measurements of the polarised same-sign W boson pairs with 140 fb^{-1} of data recorded at 13 TeV central energy by the ATLAS detector at the LHC. The analysis selects a pair of same-sign leptons produced in association with two jets. The selected jet pair is required to have a large invariant mass and a significant rapidity gap. Machine learning methods are used to extract polarisation fractions, including at least one longitudinally W boson and the doubly polarised longitudinal W boson pair, in both the WW and partonic centre-of-mass reference frames.

Parallel 4 / 373

CSTCLOUD-EGI and CENI Site Report

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Currently, CNIC is responsible for the operation and maintenance of two EGI cloud sites in Mainland China: CSTCLOUD-EGI and CENI. This report will detail the operational status and issues concerning these two sites.

Parallel 1: Upgrade / 374

HGTD hybrid test at USTC

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The high-luminosity phase of the Large Hadron Collider at CERN aims to deliver an integrated luminosity of up to 4000 fb^{-1} . In the upgrading, the High-Granularity Timing Detector (HGTD) will measure the times of minimum-ionising particles with an average time resolution of approximately 30 ps per track at the beginning of the operation of LHC. In this project, USTC is responsible for 10% of sensors and loading. This report will talk about the electronic test, connectivity test to the HGTD hybrid at USTC and give the summary to its performance.

Parallel 3 / 376

Flow measurements at LHCb experiment

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Particle correlations are powerful tools for studying quantum chromodynamics in hadron collisions. In heavy-ion collisions, azimuthal angular correlations probe collective phenomena in hot, dense, nuclear media, such as QGP. The LHCb experiment has the ability to study particle correlations in high-energy hadron collisions at forward rapidity, complementing the results from other experiments. It also has the unique fixed-target configuration at LHC, with various species of gas target available.

In this contribution, recent results on collective flow from the LHCb experiment will be discussed, aimed to study the hydrodynamics at forward regions. The preliminary result of the flow in PbNe and PbAr will also be presented, which helps to unveil the shape of ^{20}Ne nucleus.

Parallel 3 / 377

Recent LHCb results on open charm and charmonium production

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Heavy quark production in high-energy collisions is a sensitive probe of QCD and nuclear matter effects. Open heavy-flavor hadrons and quarkonium states provide complementary insights into initial-state effects, such as nuclear parton distribution modifications and parton energy loss, as well as final-state effects like medium interactions and possible Quark-Gluon Plasma (QGP) formation. Observations of QGP-like signatures in high-multiplicity small systems further motivate systematic studies across different collision systems.

In this contribution, we present recent LHCb results on open charm and quarkonium production in pp, pPb, and PbPb collisions. The measurements include various charm hadrons and quarkonium states, offering new constraints on heavy-quark production, hadronization, and medium effects. These results improve our understanding of QCD dynamics across system sizes.

Parallel 3 / 378

Observation of the decay $B_s^0 \rightarrow K^0 p \bar{p}$ and measurement of the $B_d^0 \rightarrow K^0 p \bar{p}$ branching fractions

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A study of the charmless baryonic decays $B_{(s)}^0 \rightarrow K^0 p \bar{p}$ is reported using 9 fb^{-1} of LHCb data at 7, 8, and 13 TeV. The decay $B_s^0 \rightarrow K^0 p \bar{p}$ is observed for the first time with a branching fraction of $(9.14 \pm 1.69 \pm 0.90 \pm 0.33 \pm 0.20) \times 10^{-7}$ and a significance of 5.6σ . For $B^0 \rightarrow K^0 p \bar{p}$, the branching fraction is measured as $(2.82 \pm 0.08 \pm 0.12 \pm 0.10) \times 10^{-6}$, representing the most precise determination to date.

Parallel 4 / 379

Observation of the rare baryonic decay $B \rightarrow p \Lambda_{\bar{b}}$ and measurement of the weak decay parameter

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Charmless two-body B-meson decays to baryon-antibaryon pairs serve as key probes for strong interaction dynamics and CP violation but remain underexplored. This is the first observation of the rare baryonic decay $B \rightarrow p \Lambda_{\bar{b}}$. The significantly improved branching fraction measurement and the first measurement of the weak decay parameter in this work are of great interests for testing theoretical calculations and understanding the properties of other charmless baryonic B decays.

Parallel 3 / 381

Recent results on pentaquark studies at LHCb

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The discovery of pentaquark candidates at LHCb in 2015 is one of the major milestones in the field of exotic spectroscopy after 20 years of discovering the first exotic hadron. Despite this, there is still no consensus on their nature and internal structure. The large dataset and excellent detector performance, in particular for particle identification, give the LHCb experiment unprecedented capability to analyse these exotic states. In this talk, the latest results on pentaquark studies from LHCb will be discussed.

Parallel 4 / 382

LHC 寻找类矢量费米子进展

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类矢量费米子 (Vector-Like Fermions, VLFs) 在多种超出标准模型的新物理理论中普遍出现。与标准模型费米子不同, 它们的左右手分量在电弱群下具有相同的表示, 因此可拥有独立的矢量质量项, 从而在电弱精密测量中更易退耦。我们基于 LHC ATLAS 与 CMS 的最新数据 (截至 2024 年底), 对类矢量夸克 (VLQs) 的成对产生与单产生过程进行了系统综述, 并给出了单态、二重态和三重态表示下的排除参数空间。结果显示: 类矢量顶夸克在单态情形下的质量已被排除至 1.49 TeV; 单产生过程在质量约 1.5 TeV 时将混合参数限制到 $\kappa < 0.26$ 。类矢量底夸克在双态情形下被排除至 1.52 TeV, 其单产生过程对 κ 的约束区间为 0.2–0.7。对于奇异型 VLQ, 成对产生分别将 X 与 Y 的质量排除至 1.46 TeV 与 1.7 TeV, 单产生对 κ 的限制在高质

量区间进一步收紧。上述结果基于 LHC 最严格的搜索，提供了关于 VLQ 寻找的最新统一视角。

Parallel 2 / 383

Search for pair production of boosted Higgs bosons via vector-boson fusion in the $b\bar{b}b\bar{b}$ final state using pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector

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A search for Higgs boson pair production via vector-boson fusion is performed in the Lorentz-boosted regime, where a Higgs boson candidate is reconstructed as a single large-radius jet, using 140 fb^{-1} of proton-proton collision data at $\sqrt{s} = 13$ TeV recorded by the ATLAS detector at the Large Hadron Collider. Only Higgs boson decays into bottom-quark pairs are considered. The search is particularly sensitive to the quartic coupling between two vector bosons and two Higgs bosons relative to its Standard-Model prediction, κ_{2V} . This study constrains κ_{2V} to $0.55 < \kappa_{2V} < 1.49$ at the 95% confidence level. The value $\kappa_{2V} = 0$ is excluded with a significance of 3.8 standard deviations with other Higgs-boson couplings fixed to their Standard-Model values. A search for new heavy spin-0 resonances that would mediate Higgs-boson pair production via vector-boson fusion is carried out in the mass range of 1-5 TeV for the first time under several model and decay-width assumptions. No significant deviation from the Standard-Model hypothesis is observed and exclusion limits at the 95% confidence level are derived.

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Parallel 1: Upgrade / 384

HGCal Silicon module CuW baseplate R&D and production

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The report mainly introduces the development and testing of CuW baseplates used in the CMS experiment HGCal project, as well as the current progress of production and inspection acceptance of the IHEP designed CuW edition

Parallel 1: Upgrade / 385

R&D on the fast GAGG for LHCb upgrade II

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The most important task in current particle physics is to precisely test the standard model of particle physics and search for new physics beyond the standard model. With the expansion of experimental exploration fields in new physics and increasing demands for exploration precision, detection technology and experimental methods are constantly facing new challenges. In order to fully utilize the opportunities provided by high-luminosity large hadron colliders for heavy flavor physics in the next decade or so, LHCb experiment is planning a comprehensive upgrade of detectors to cope with challenges brought about by high luminosity operation such as high event pile-up, radiation resistance etc., among which upgrading electromagnetic calorimeters is crucially important for enhancing detection capabilities of new physics. GAGG crystals have excellent scintillator dynamic characteristics, high light yield and radiation resistance that can improve time resolution effectively solve problems related to high event pile-up and enhance detector's radiation resistance performance. The report will introduce the R&D of fast GAGG for LHCb Upgrade II and give some latest results.

Parallel 4 / 386

Machine learning-enhanced search for 95 GeV light Higgs in N2HDM at CEPC

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The Flipped Next-to-2HDM (N2HDM-F) provides an elegant solution to the possible 95 GeV signal excesses, and the proposed Future Circular Electron-Positron Collider (CEPC) offers a promising opportunity to probe this light Higgs boson (S). A Monte Carlo (MC) simulation of the $e^+e^- \rightarrow Z(\rightarrow \mu^+\mu^-)S(\rightarrow \tau^+\tau^-)$ process is performed to study the discovery potential for S and the measurement precision of its $\bar{S}ZZ$ coupling and $S \rightarrow \tau^+\tau^-$ branching ratio. The deep neural network architecture of the More-Interaction Particle Transformer (MIParT) is employed to enhance both the discovery potential and the measurement precision. Through comprehensive feature extraction of all final-state particles, more than 100% improvement is achieved in both sensitivity and precision. Furthermore, by combining with the $b\bar{b}$ decay channel, more than 85% of the surviving N2HDM-F parameter samples can be probed at the 5σ level with an integrated luminosity of 20ab^{-1} at the CEPC.

Plenary / 387

Selected highlights of correlations and flow at LHC-ALICE

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ALICE topical talk, highlighting recent key progress of correlations and flow studies.

Parallel 1: Upgrade / 388

A FPGA-based DAQ system for RPC cosmic ray test

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A dedicated data acquisition (DAQ) system based on a field-programmable gate array (FPGA) has been developed for the performance evaluation of Resistive Plate Chambers (RPCs) using cosmic rays. The system integrates 144-channel time-to-digital conversion with sub-100 ps precision, enabling accurate measurement of signal timing and charge information. A pipeline architecture with per-channel buffering ensures continuous readout without data loss under sustained cosmic ray rates. The FPGA firmware incorporates trigger logic, data formatting, and high-speed data transfer to a host computer for offline analysis. Comprehensive cosmic ray tests demonstrate stable operation, precise timing resolution, and high detection efficiency, validating the DAQ system as a reliable platform for RPC characterization and large-scale detector quality assurance.

Parallel 4 / 389

IHEP Site Report

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IHEP-CC is a crucial partner in the global HEP computing landscape, providing robust and expanding computational and storage resources for current and future scientific discoveries. We will introduce the overview of the IHEP Computing Center(IHEPCC) and the grid sites running status and accounting in IHEPCC.

Parallel 2 / 390

Measurement of the Z-boson mass

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The first dedicated Z-boson mass measurement at the LHC with $Z \rightarrow \mu^+ \mu^-$ decays is reported. The dataset uses proton-proton collisions at a centre-of-mass energy of 13 TeV, recorded in 2016 by the LHCb experiment, and corresponds to an integrated luminosity of 1.7 fb^{-1} . A template fit to the $\mu^+ \mu^-$ mass distribution yields the following result for the Z-boson mass, $m_Z = 91184.2 \pm 8.5 \pm 3.8 \text{ MeV}$, where the first uncertainty is statistical and the second systematic. This result is consistent with previous measurements and predictions from global electroweak fits.

Parallel 1: Upgrade / 391

Development of 3D-Printed Tungsten Absorbers for the LHCb ECAL Upgrades

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During the third long shutdown of the LHC (LS3), the LHCb experiment will strengthen and upgrade the central area of the electromagnetic calorimeter (ECAL). In the most central area of the ECAL, a new sampling structure and new calorimeter modules will be used to address the performance degradation of the calorimeter in an extremely high radiation environment. The feature of this new sampling structure is, the scintillating fibers insert into an absorber with a large number of small holes (SpaCal). A key challenge in this upgrade is the production of absorbers featuring small, high-precision holes into which scintillating fibers must be inserted without damage. Pure tungsten was selected as the absorber material due to its high atomic number and superior radiation absorption properties. However, its inherent brittleness and difficulty to machine make traditional methods like die-casting unsuitable for producing the required complex geometries. To overcome this, we employed Selective Laser Melting (SLM), an additive manufacturing technique. The fabrication process encompassed SLM 3D printing followed by post-processing steps—including chemical polishing, sandblasting, and wire-cutting, etc. Through systematic optimization of parameters such as laser spot compensation, calibration factors, fan frequency, and so on, we have successfully produced both reduced-size (approx. $40 \times 40 \times 50$ mm³) and full-module-size (approx. $121 \times 121 \times 50$ mm³) tungsten absorbers. A rigorous quality assurance procedure was implemented, evaluating dimensional accuracy, surface roughness, flatness, and perpendicularity to ensure compliance with specifications. These components were used to assemble a functional SpaCal-W prototype. This successful development not only paves the way for the final production and integration of the new absorbers for the LS3 upgrade but also demonstrates the profound potential of metal 3D printing for fabricating complex radiation-hardened components in future high-energy physics experiments.

Poster / 392

MSSM Higgs search via bb decay at CMS experiment with Run 2 proton proton collision data

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This analysis note serves as an archive of searching for MSSM Higgs bosons decaying to a pair of bottom quarks ($H \rightarrow bb$) using approximately 150 fb⁻¹ of CMS Run2 proton-proton collision data collected at a center-of-mass energy of 13 TeV between 2015 and 2018.

With the evolution of time, around 40 fb⁻¹ data have been taken by CMS collaboration according to the initial design of Run2 MSSM Hbb triggers from year 2015 to 2016. Modified trigger versions have been committed online for year 2017 and 2018. For these later years, high-level trigger (HLT) bias-free datasets were utilized to evaluate the performance of the updated MSSM Hbb trigger design and to project its behavior under higher pile-up conditions.

No significant MSSM Hbb signal was observed in the 2016 dataset. Upper limits on the MSSM Higgs production cross section were set for $m(A)$ mass range of [400,1600] GeV, with the latest CMS Ultra-Legacy data analysis framework setting for Run2.

Parallel 3 / 393

Determination of direct CP asymmetries for $B^+ \rightarrow K_S^0 \pi^+$ and $B^+ \rightarrow K_S^0 K^+$ decays and measurement of the ratio of their branching fractions, and search for the rare decay $B_c^+ \rightarrow K_S^0 K^+$

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An analysis of the decays $B^+ \rightarrow K_S^0 \pi^+$ and $B^+ \rightarrow K_S^0 K^+$ is performed using pp collision data collected by the LHCb experiment at a centre-of-mass energy of 13 TeV, corresponding to an integrated luminosity of $5.4 fb^{-1}$. This study provides the world's most precise measurements of direct CP asymmetries in these modes. In particular, the measurement precision in the theoretically clean $B^+ \rightarrow K_S^0 \pi^+$ channel reaches the $\mathcal{O}(0.01)$ level for the first time, enabling a stringent test of the Standard Model prediction of vanishing CP asymmetry and offering crucial input to address the long-standing $K\pi$ puzzle.

In addition, a simultaneous search for the rare decay $B_c^+ \rightarrow K_S^0 K^+$, highly suppressed in the Standard Model but potentially enhanced in new physics scenarios, yields the world's most stringent upper limit. These results constitute a major advance in the study of charmless B^+ decays, providing sensitive probes of the Standard Model and possible new sources of CP violation.

Parallel 3 / 394

Inclusive J/ψ and $\psi(2S)$ production in pp collisions at 13.6 TeV

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Quarkonia are bound states of a heavy quark and an antiquark of the same flavor. In pp collisions, such heavy quark masses require the quark pair to be produced in high-energy scatterings of partons in the colliding protons; once the quark and the antiquark are created, their binding into quarkonium states involves large spatial separations and low momentum scales. The whole production mechanism of quarkonia can therefore be factorized into two parts: the creation of the quark pair, which can be dealt with using a perturbative approach, and the binding of quarks into quarkonia, which is a high-coupling, intrinsically non-perturbative process. Precise measurements of quarkonium production cross sections in pp collisions are essential for enhancing the understanding of charmonium production mechanisms and for testing various theoretical models. Along with probing two different QCD regimes, these measurements provide fundamental benchmarks for investigating the properties of the quark-gluon plasma produced in nucleus-nucleus collisions and for evaluating cold nuclear-matter effects in proton-nucleus collisions.

In this contribution, inclusive J/ψ and $\psi(2S)$ measurements in pp collisions at 13.6 TeV with ALICE Run3 will be presented. The ratio between J/ψ and $\psi(2S)$ will also be discussed.

Parallel 3 / 395

J/ψ polarization measurement in pp collisions at 13.6 TeV

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Quarkonia production in high-energy proton-proton (pp) collisions serves as an important probe for studying quantum chromodynamics (QCD) in vacuum. Understanding the production mechanism of the J/ψ , a bound state of a charm and anticharm quark, is essential for constraining both perturbative and non-perturbative aspects of QCD calculations. The polarization of quarkonia in pp collisions is a powerful observable for distinguishing between various QCD-based models of quarkonium production. Furthermore, J/ψ polarization measurements in pp collisions provide a valuable reference for investigating the behavior of charmonium in the quark-gluon plasma formed in nucleus-nucleus collisions.

In this contribution, we will present the first preliminary results of the inclusive J/ψ polarization measurement via the dielectron decay channel at midrapidity ($|y| < 0.9$) in pp collisions at $\sqrt{s} = 13.6$ TeV. This analysis is based on data collected by the upgraded ALICE detector and benefits from the high luminosity collected during the first three years of LHC Run 3. It offers significantly higher statistics compared to the one available from previous pp data collected during the Run 2 of LHC, allowing for the first J/ψ polarization measurement at midrapidity. This analysis will be discussed together with previous J/ψ measurements in pp collisions from ALICE based on Run 2 data.

Parallel 3 / 396

Measurement of CP Violation in $B_s^0 \rightarrow J/\psi \bar{K}^*(892)^0$ Decays and Constraints on Penguin Contributions

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This talk presents a new, high-precision angular analysis of the decay $B_s^0 \rightarrow J/\psi \bar{K}^*(892)^0$ using the full 13 TeV dataset from the LHCb experiment's Run 2. We have extracted the decay's polarization fractions and CP asymmetries, yielding the most precise determination of these observables to date. These measurements serve as a crucial input for constraining the impact of "penguin pollution" on the measurement of the CP-violating phase ϕ_s from the benchmark $B_s^0 \rightarrow J/\psi \phi$ analysis. To provide a comprehensive set of constraints, which is our final goal, the presentation will also cover new, unblinded results from the $B^0 \rightarrow J/\psi \rho^0(770)$ channel and published findings from the $B^+ \rightarrow J/\psi \pi^+$ analysis.

Parallel 1: Upgrade / 397

Performance study of the MOSS chip for the ITS3 detector

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The ALICE ITS3 is a novel vertex detector that will replace the innermost layers of ITS2 during Long Shutdown 3 (LS3). Composed of three fully cylindrical layers of wafer-sized 65 nm stitched Monolithic Active Pixel Sensors (MAPS), the ITS3 enables high-resolution tracking of charged particles generated in heavy-ion collisions. As stitched sensor prototypes produced in the ER1 phase of the ITS3 project, the Monolithic Stitched Sensors (MOSS) were manufactured in mid-2023. These laboratory and beam test results for the MOSS chip validate the stitched sensor design, as well as the pixel matrix performance within the ITS3 requirements. The MOSS chip demonstrates the feasibility of the ITS3 detector concept and provides insights for further optimisation and development.

Parallel 4 / 398

Run3 L2 Gain intercalibration in the ATLAS experiment

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The analysis aims to obtain the results of High gain and Medium gain intercalibration by using data23 and data24 special runs, which were acquired with the threshold to switch from High gain to Medium gain LAr readout in both the first and second layers of the EM calorimeter significantly lowered.

A discrepancy between the reconstructed dielectron invariant mass $+-$ obtained from $\rightarrow^{+-}$ events in data and MC was observed, when events were split according to the electronic High or Medium gain of the highest energy cell of the Liquid Argon electromagnetic calorimeter second longitudinal layer. So we should intercalibrate L2 High Gain and Medium Gain to make the energy obtained by HG readout and MG readout consistent.

The value of results are obviously bigger than Run2 results. From our study so far, the mainly reason is that the HG and MG threshold in L1 changes. In Run2 special run configuration, only the threshold of L2 high gain and medium gain become lower. However, in Run3 special run configuration, both of L1 and L2 threshold of HG and MG have changed. So current results are obtained considering the combined effect of L1 and L2. It's reasonable that current results are bigger than Run2 results.

Parallel 3 / 399

Search for heavy $H\gamma$ and $Z\gamma$ resonances with a b quark pair in the final state at CMS

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A search for heavy resonances decaying into a Higgs or a Z boson and a photon, with the Higgs or Z bosons decaying to a pair of bottom quarks ($b\bar{b}$) is presented. The analysis uses proton-proton collision data at $\sqrt{s} = 13$ TeV collected by the CMS experiment, corresponding to an integrated luminosity of 138 fb^{-1} . The analyzed events contain a photon and a massive, large-radius jet, originating from a Lorentz-boosted $b\bar{b}$ system. An advanced transformer-based algorithm is used to form the tagger that identifies Higgs and Z boson candidate jets from $b\bar{b}$ decays. No significant excess above standard model expectations is observed. The results set upper limits on the product of the cross section and the branching fraction for spin-1 $H\gamma$ resonances and spin-0 $Z\gamma$ resonances, with observed values below 0.1 and 0.3 fb, respectively, representing the most stringent limits to date.

Parallel 3 / 400

B decays to charm bayrons

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Rich spectrum is expected for charmed baryons in the quark model, yet many states especially those containing strange quarks has not been experimentally established. The mass of B meson is sufficient to decay to two charm bayrons, especially Ξ_c and Λ_c . B-factories have observed a serious of decays from a B meson to two charmed baryons. In recent years, LHCb implements several studies of B decays with two charmed baryon daughters, such as $B^{0/+} \rightarrow \Lambda_c \Lambda_c K_{(S)}^{0/+}$. Intermediate states including excited Ξ_c are also observed or show evidence. For such decays above, the branching fractions are measured via a relative branching fraction method. For future, more double charmed baryons decays are expected to be studied in LHCb.

Parallel 1: Upgrade / 402

Performance of hybrid detector of USTC-IME LGAD and LATIC ASIC chip

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LGAD(Low Gain Avalanche Detector) is used in the HGTD(High Granularity Time Detector) of ATLAS phase II upgrade due to its excellent time resolution and spatial granularity. In order to utilize its high granularity advantage, it is necessary to bond the detector with a front-end readout chip of the same channel size using the flip chip process. The front-end readout chip is used to collect signals, amplify, discriminate, and measure the detector signals arrival time. The LGAD electronics team at USTC has developed a prototype chip called LATIC(LGAD Amplification and Timing IC) for LGAD readout. The prototype chip has a 5x5 structure and has been bonded with USTC IME sensor. The structure, flip chip bonding, and test results after flip chip bonding will be introduced.

Parallel 2 / 403

Probing Higgs Couplings with Single- and Double-Higgs Measurements in ATLAS

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The precise study of Higgs boson production is essential both for testing the Standard Model and for probing the Higgs self-coupling through di-Higgs processes. Last year, ATLAS presented a combination of Higgs-pair (HH) searches, setting the most stringent limits to date on the Higgs self-coupling. Building on this, we present new results from single-Higgs (H) analyses obtained this year, which deliver more precise measurements. These single-H results not only strengthen our understanding of Higgs interactions but also pave the way for the next round of HH combinations with enhanced sensitivity.

Parallel 3 / 404

Study of charmless B->VV decays at LHCb

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Charmless B-meson decays into two vector mesons, $B \rightarrow VV$, serve as a powerful probe for the dynamics of weak and strong interactions through their angular distributions. This report will introduce recent LHCb results on $B \rightarrow VV$ decays, including:

1. First observation of CP violation and measurement of polarization in $B^+ \rightarrow \rho(770)^0 K^*(892)^+$ decays
2. Measurement of the branching fractions and longitudinal polarisations of $B(s)^0 \rightarrow K(892)^0 K \bar{K}^*(892)^0$ decays
3. Measurement of CP violation in $B_s^0 \rightarrow \phi\phi$ and search for $B^0 \rightarrow \phi\phi$

Parallel 2 / 405

Di-boson and Tri-boson measurements: ZGamma, WZGamma, and Same-Sign WWGamma

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The study of multiboson processes is an important topic within CMS, playing a significant role in testing the Standard Model and searching for new physics. A measurement of the $Z\gamma$ production cross section in proton–proton collisions at a center-of-mass energy of 13.6 TeV using leptonic final states, a measurement of the $WZ\gamma$ triboson production cross section, and the first search for vector boson scattering tri-boson production of $WW\gamma$ with fully leptonic decays in proton–proton collisions based on proton–proton collision data at $\sqrt{s} = 13$ TeV recorded with the CMS detector at the LHC corresponding to an integrated luminosity of 138 fb^{-1} will be presented in this talk.

Parallel 2 / 406

Measurements of W^+W^- production cross-sections in pp collisions at 13TeV with the ATLAS detector

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Measurements of $W^+W^- \rightarrow e^\pm \nu \mu^\mp \nu$ production cross-sections are presented, providing a test of the predictions of perturbative quantum chromodynamics and the electroweak theory. The measurements are based on data from pp collisions at $\sqrt{s} = 13$ TeV recorded by the ATLAS detector at the Large Hadron Collider in 2015-2018, corresponding to an integrated luminosity of 140 fb^{-1} . The number of events due to top-quark pair production, the largest background, is reduced by rejecting events containing jets with b -hadron decays. An improved methodology for estimating the remaining top-quark background enables a precise measurement of W^+W^- cross-sections with no

additional requirements on jets. The fiducial W^+W^- cross-section is determined in a maximum-likelihood fit with an uncertainty of 3.1%. The measurement is extrapolated to the full phase space, resulting in a total W^+W^- cross-section of 127 ± 4 pb. Differential cross-sections are measured as a function of twelve observables that comprehensively describe the kinematics of W^+W^- events. The measurements are compared with state-of-the-art theory calculations and excellent agreement with predictions is observed. A charge asymmetry in the lepton rapidity is observed as a function of the dilepton invariant mass, in agreement with the Standard Model expectation. A CP-odd observable is measured to be consistent with no CP violation. Limits on Standard Model effective field theory Wilson coefficients in the Warsaw basis are obtained from the differential cross-sections.

Parallel 1: Upgrade / 408

Development and test-beam measurements of LHCb PicoCal modules

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The electromagnetic calorimeter (ECAL) is a key component of the LHCb experiment. To cope with the higher performance requirements imposed by the High-Luminosity LHC (HL-LHC) upgrade, the LHCb ECAL will be upgraded with the new PicoCal design. In the upgrade, novel spaghetti calorimeter (SpaCal) modules will replace the existing Shashlik modules in the central region of the ECAL. These modules are currently under development, with significant contributions from Chinese teams in the LHCb collaboration. This presentation reports the latest progress as of 2025. New SpaCal module prototypes for the PicoCal upgrade have been produced and tested in test-beam campaigns. The module design has been iteratively optimized based on the results of these measurements. The LHCb ECAL upgrade team is preparing for large-scale SpaCal module production during Long Shutdown 3 (LS3), while continuing the development towards the ECAL Upgrade II foreseen for LS4.

Parallel 2 / 409

Test of CP Invariance in Higgs Boson Vector-Boson-Fusion Production in the $H \rightarrow \gamma\gamma$ Channel using 165 fb-1 ATLAS Run-3 data

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A test of CP invariance in Higgs boson production via vector-boson fusion has been performed in the $H \rightarrow \gamma\gamma$ channel using 165 fb-1 ATLAS Run-3 pp collision data at $\sqrt{s}=13.6$ TeV. The optimal observable is used to probe the CP structure of interactions between the Higgs boson and electroweak gauge bosons, as described by an effective field theory. Expected constraints on the $c_{H\tilde{W}}$, which describes the strength of the CP-odd component in the coupling between the Higgs boson and the electroweak gauge bosons, have been derived. Around 30% of improvement is achieved compared to the expected results from full Run2 analysis.

Parallel 4 / 410

IHEP ROC Report

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IHEP Remote Operation Center report

Parallel 2 / 411

Search for CP-violation in Higgs interaction with vector bosons with the ATLAS detector

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The Standard Model predicts the Higgs boson to be a CP-even scalar, any evidence of CP-violation in Higgs interactions indicates the new physics beyond the Standard Model. This talk will present a summary of recent measurements of the CP properties of Higgs boson interactions with vector bosons in several channels, performed by the ATLAS experiment using proton-proton collision data collected at $\sqrt{s}=13$ TeV. These results offer important constraints on possible CP-violating effects, advancing our understanding of Higgs boson dynamics.

Parallel 1: Upgrade / 412

Overview of ATLAS High Granularity Timing Detector Activities in China

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This report will present the overall development of the High-Granularity Timing Detector (HGTD) for the ATLAS experiment at the Large Hadron Collider (LHC) by the China team.

Parallel 1: Upgrade / 413

Status of the HGTD sensors upgrade

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The Large Hadron Collider (LHC) will begin its high-luminosity upgrade at the end of 2026, with an expected luminosity increase of 7.5 times and an average vertex density along the z-axis of 1.5 per mm, posing significant challenges to detector radiation hardness and ATLAS tracking performance. The HGTD, a key detector providing timing information, relies heavily on its core component, LGAD. LGAD is a silicon sensor with a thin multiplication layer capable of providing 50 ps resolution. It is segmented into a 15x15 matrix with 1.3x1.3 mm² pads, read out via solder bumps by a dedicated front-end chip (ALTIROC). LGAD, a critical part of the detection system, directly impacts the progress of the HGTD project. Currently, final production is proceeding as planned. Sampling per pad tests were conducted on pilot batch wafers, categorizing main sensors into four types—A, B1, B2, and C—based on current and voltage conditions. IME's probecard test data shows that all A-class sensors meet the standards, while some B1 and B2 chips satisfy A-class criteria after per pad testing, indicating improved yield rates for LGAD sensors per wafer. Additionally, CV tests on pilot batch main sensors met requirements, and IV and CV tests on QC-TS structures were also successful. Process quality control (PQC) studies on production QC-TS structures confirmed that V_{gl} meets wafer acceptance criteria, with good correlation between V_{gl} and V_{bd} . Irradiation test (IT) studies were completed to test radiation resistance, confirming that all wafers passed the acceptance criteria. Finally, beam tests were conducted on LGAD + ASIC assemblies.

Parallel 4 / 414

Silicon detector & Stitching VTX at the CEPC

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Silicon detector & Stitching VTX at the CEPC

Plenary / 415

Study of rare decays at LHCb

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This report presents the latest studies of rare decays conducted by the LHCb experiment. These processes, highly suppressed in the Standard Model, provide a powerful probe for discovering new physics. T

Parallel 2 / 416

Measurements of Higgs boson properties in the $\gamma\gamma$ decay channel at CMS

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We discuss the most recent results obtained by the CMS Collaboration on properties of the Higgs boson (mass, natural width, couplings, ..) using diphoton ($\gamma\gamma$) decays.

Parallel 4 / 417

Jets and missing transverse energy performance in CMS

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We discuss the results obtained by the CMS Collaboration on the performance of jets and missing transverse energy, with a focus on Run3 data.

Parallel 4 / 418

Real-time analysis at LHCb for Run 3 and beyond

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The LHCb experiment is operating in Run 3 at an unprecedented instantaneous luminosity of $2 \times 10^{33} \text{ cm}^{-2}\text{s}^{-1}$. To process the resulting 30 MHz non-empty bunch-crossing rate, LHCb has deployed a novel, fully software-based trigger for the first time. Its second stage performs offline-quality event reconstruction in real-time, enabled by the continuous processing of alignment and calibration data. This talk presents an overview of the Run 3 trigger's design and performance, and discusses the challenges and strategic plans for the future Upgrade II

Plenary / 419

Recent results on hadron spectroscopy from LHCb

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The study of hadron spectroscopy serves as a crucial experimental probe into the non-perturbative regime of Quantum Chromodynamics (QCD). By precisely measuring the properties, such as masses, widths and quantum numbers of hadrons, we can deepen the understanding of the strong interaction that binds quarks and gluons into matter. The LHCb experiment, with its unique capabilities in heavy-flavor production, particle identification, and precision tracking, is a world-leading facility for such studies. It excels at discovering new hadronic states and precisely measuring their properties, particularly in the heavy-quark sector. In this talk, the latest LHCb results on hadron spectroscopy will be presented.

Parallel 4 / 420

ATLAS Computing

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ATLAS Computing

Parallel 1: Upgrade / 421

ATLAS high granularity timing detector Module assembly and loading

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ATLAS high granularity timing detector Module assembly and loading

Parallel 2 / 423

Study of spin correlation inside jets

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The spin-1 nature of gluon caused correlations in subsequent parton radiations inside jets. Such effects were fully incorporated in limited parton shower models. The correlation is measured for the first time in experiments, and compared to MC models.

Parallel 2 / 424

Z₃-NMSSM with a Light Singlet Scalar under the Latest Experimental Constraints

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In the Z₃-NMSSM with a light singlet scalar, the bino-dominated dark matter candidate exhibits significant deviations from the MSSM in its properties, mechanisms for relic abundance, and detection prospects. By incorporating the latest experimental results, including those from LUX-ZEPLIN, LHC supersymmetry searches, and the muon g-2 measurement, this study presents a systematic assessment of the model's consistency with current observational data.

Plenary / 425

ALICE 探测器升级大会报告

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This talk will present the current upgrade status of the ALICE experiment detectors and electronics for ALICE 2.1, as well as the future participation of the Chinese collaboration in the ALICE 3 upgrade. Currently, Central China Normal University and China Institute of Atomic Energy are participating in the ALICE 2.1 upgrade, which includes work on the ITS3 (Inner Tracking System 3) and FoCal (Forward Calorimeter) upgrades, with in-depth involvement in the research and development of detectors and electronics. University of Science and Technology of China and Fudan University are focusing on the research and development of the TOF (Time-of-Flight) detector for the ALICE 3 experiment, with a key focus on advancing AC-LGAD technology.

Parallel 2 / 426

Higgs Production Classifier using Weak Supervision

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A reliable determination of the Higgs production mechanism in hadron collider experiments is essential in the program of the measurements of the Higgs couplings. We employ weak supervision, CWoLa in particular, to train deep neural networks using real data of the diphoton events, in the hope of reducing biases resulting from Monte Carlo simulations. Models based on the convolutional neural network and the transformer are tested and compared. In particular, the classification performance gets slightly better when the photon information is removed from training. We explicitly show that the performance can be improved when the training dataset is enlarged by data augmentation using physics-motivated methods. We further demonstrate that the trained model can be successfully applied to the $h \rightarrow ZZ$ events, showing that such classifiers are agnostic to Higgs decay modes provided they do not involve strong QCD corrections.

Plenary / 427

Connections between Heavy-ion Collisions and Electron-Ion Collisions

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Understanding the structure of protons and nuclei and their energy distributions evolve is a central goal in both heavy-ion collisions and at the future Electron-Ion Collider (EIC). In this talk, I will first discuss how proton and nuclear shape fluctuations can be extracted within the Color Glass Condensate framework using data from electron–nucleon and electron–nucleus collisions. By incorporating these inputs, we employ an energy evolution model to evolve the gluon profile from low energies to the high energies at the LHC, then providing input for hydrodynamic simulations. This analysis demonstrates that future EIC measurements will yield direct insights into nuclear structure at small x and its energy evolution while offering complementary constraints on the nuclear geometries that play a pivotal role in heavy-ion collisions. Additionally, I will review recent measurements from Oxygen–Oxygen and Neon–Neon collisions, alongside results from the LHCb fixed-target program, which together advance our search for the Quark–Gluon Plasma in small systems and deepen our understanding of nuclear structures.

Parallel 1: Upgrade / 428

BIS RPC singlets production for ATLAS Phase-II Upgrade

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The production of BIS RPC (Resistive Plate Chamber) singlets is a crucial aspect of the ATLAS Phase-II upgrade, designed to enhance the detector's performance for the High-Luminosity LHC (HL-LHC). BIS RPCs are engineered to meet the challenges posed by high radiation and pileup conditions in the HL-LHC environment. This work will focus on the production and assembly methods of BIS RPC singlets, highlighting the technical advancements and processes involved in their fabrication to ensure optimal performance in the upgraded ATLAS detector.

Parallel 4 / 429

The weak B decays to radially excited D mesons

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We researched the two body non-leptonic B decays to radially excited D mesons under the covariant light-front quark model.

Plenary / 430

EFT operator basis construction and its application

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We present a general algorithm—the Young Tensor Method—for systematically constructing complete and independent operator bases in effective field theories. This method is applied to a variety of theories, including the Standard Model Effective Field Theory (SMEFT) and low-energy effective field theories. In the process, we introduce the concept of the J-basis, a generalized partial wave basis that facilitates the study of partial wave unitarity bounds and enables the classification of all possible tree-level ultraviolet (UV) completions of effective operators. Furthermore, by constructing the 4-fermion operator basis in Georgi–Glashow-type models, we investigate dynamical chiral symmetry breaking using the functional renormalization group (FRG) approach.

Parallel 4 / 431

Status of the USTC computing cluster

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The USTC computing cluster has been updated this year, including software upgrades and worknode expansion.

Parallel 3 / 432

Recent progress on inclusive quarkonium production and polarization

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Quarkonium production serves as a vital testing ground for quantum chromodynamics (QCD), offering critical insights into both perturbative and nonperturbative dynamics. In the nonrelativistic QCD (NRQCD) factorization framework, inclusive production cross sections of quarkonia are expressed as products of perturbatively calculable short-distance coefficients (SDCs) and nonperturbative long-distance matrix elements (LDMEs), which are hypothesized to be universal across production processes. For three decades, the validation of LDME universality has been central to understanding quarkonium production mechanisms. However, different groups extracted dramatically different sets of the three color-octet LDMEs of $\psi(2S)$, and none of them can describe all the data from collisions at LHC, HERA, LEP and Belle, respectively, challenging the universality of LDMEs. In this talk, we will report our recent progress on factorizing the LDMEs into products of wave functions and gluonic correlators based on the potential NRQCD (pNRQCD) effective theory and comprehensive phenomenological study on inclusive quarkonium production from collisions. We show that most of the data can be well described in the framework of NRQCD factorization and those still evade a consistent description coincide with “extensions” of endpoint regions.

Plenary / 433

Theoretical Progress in Heavy-Flavor Physics

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In this talk, I will give a theoretical review of recent progress in heavy-flavor physics, focusing on power corrections and QED effects.

Plenary / 434

Quantum Information at Colliders

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We investigate whether collider experiments can reach the quantum limit of precision, defined by the quantum Fisher information (QFI), using only classical observables such as particle momenta. As a case study, we focus on the $\tau^+\tau^-$ system and the decay channel $\tau \rightarrow \pi\nu$, which offers maximal spin-analyzing power and renders the decay a projective measurement. We develop a general framework to determine when collider measurements can, in principle, saturate the QFI in an entangled biparticle system, and this framework extends naturally to other such systems. Within this framework, QFI saturation occurs if and only if the symmetric logarithmic derivative (SLD) commutes with a complete set of orthonormal separable projectors associated with collider-accessible measurements. This separability condition, reflecting the independence of decay amplitudes, is highly nontrivial. To meet this condition, a key requirement is that the spin density matrix be rank-deficient, allowing the SLD sufficient freedom. We show that the classical Fisher information asymptotically saturates the QFI for magnetic dipole moments and CP-violating Higgs interactions in selected phase-space regions, but not for electric dipole moments. These results bridge quantum metrology and collider physics, providing a systematic method to identify quantum-optimal sensitivity in collider experiments.

Plenary / 435

Progress of CMS China group on Phase II upgrade

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Progress of CMS China group on Phase II upgrade

Parallel 4 / 436

The impact of dark Higgs mechanism on the detection of invisible dark photon

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In the phenomenology study of dark photon, its mass origin is usually not under concern. However, in theory construction its mass is often generated via a dark Higgs mechanism, which leads to the presence of a light (non-decoupled) dark Higgs particle. We study the impact of such a dark Higgs particle in the collider detection of the dark photon. We focus on the process of final state dark photon radiating dark Higgs, which is called dark final state radiation (FSR). In particular, we perform “merging” to obtain physical distribution of dark FSR. Invisible dark photon search at BaBar is reanalyzed by considering the effect of dark FSR, and a new exclusion limit for invisible dark photon is presented.

Parallel 2 / 437

Combined measurement of the Higgs boson couplings with ATLAS detector

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Higgs boson plays a fundamental role in Standard Model. The precise measurement of Higgs couplings can help us have a better understanding of SM and explore potential new physics beyond it. The combination method can give us a higher precision and sensitivity, which is an essential experimental way. In this talk, I will present combined measurements of Higgs boson production and decay using up to 140 fb^{-1} of proton-proton collision data collected by the ATLAS experiment at 13 TeV centre of mass energy, which is the latest results from ATLAS Higgs working group.

Parallel 3 / 438

Recent flavor physics results from ATLAS**Author:** Xin Chen¹¹ Tsinghua University**Corresponding Author:** xin.chen@cern.ch

This talk will show recent highlights from ATLAS heavy flavor physics group, such as precise lifetime measurements of B mesons, lifetime from rare decay modes, and the all-charm tetraquark state study.

Parallel 3 / 439

CP violation in Λ_b^0 and Λ_b^0 decays**Author:** Xinchun Dai¹¹ 清华大学**Corresponding Author:** xdai@cern.ch

The first observation of CP violation in the baryon sector was made in the decay $\Lambda_b^0 \rightarrow pK^-\pi^+\pi^-$. In addition, the first evidence of CP violation in beauty baryon decays to charmonium was obtained. In this talk, I will present the analyses of these two decays, discussing the methodology, results, and their implications.

Parallel 3 / 440

Measurement of branching fractions and CP asymmetries in $\Lambda_b^0(\Xi_b^0)$ $\rightarrow p K_S^0 h^-$ decays**Author:** 泽文陈¹¹ University of Chinese Academy of Sciences**Corresponding Author:** chenzewen16@mails.uca.ac.cn

CP violation plays a crucial role in accounting for the matter–antimatter imbalance observed in the Universe. This talk presents measurements of branching fractions and CP asymmetries in the decays $\Lambda_b^0(\Xi_b^0) \rightarrow pK_S^0 h^-$, where h^- denotes either a pion or a kaon, using proton–proton collision data collected by the LHCb experiment, corresponding to an integrated luminosity of 9 fb^{-1} . The decays $\Lambda_b^0 \rightarrow pK_S^0 K^-$ and $\Xi_b^0 \rightarrow pK_S^0 K^-$ are observed for the first time, with significances reaching eight standard deviations. The integrated CP asymmetries are measured for the $\Lambda_b^0 \rightarrow pK_S^0 \pi^-$, $\Lambda_b^0 \rightarrow pK_S^0 K^-$, and $\Xi_b^0 \rightarrow pK_S^0 K^-$ decays. For the decay $\Lambda_b^0 \rightarrow pK_S^0 \pi^-$, the CP asymmetries are measured in different regions of the Dalitz plot. No evidence of CP violation is observed in any of the decay modes.

Plenary / 441

Higgs Boson as a Portal: Searching for Rare and Exotic Higgs Decays at the LHC

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Rare and exotic decays of the Higgs boson offer a unique window into phenomena beyond the Standard Model, probing potential new interactions, hidden sectors, and extended Higgs sectors. This talk will review the latest searches for rare and non-standard Higgs decays performed by ATLAS and CMS. Particular emphasis will be placed on decays with small branching fractions or unconventional final states, such as $\tilde{\chi} \rightarrow \tilde{\chi} \gamma$, $\tilde{\chi} \rightarrow \tilde{\chi} Z$, invisible decays, and exotic signatures.

Plenary / 442

Measurement of Higgs boson properties

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In this talk I will discuss the latest measurements of Higgs boson properties from ATLAS and CMS experiments.

Parallel 1: Upgrade / 443

Status of RPC Muon trigger detector for ATLAS Phase-II upgrade

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In order to cope with the higher flux delivered by the HL-LHC, 3 layers of RPC detectors will be installed in the Barrel Inner (BI) region of ATLAS during the phase-II upgrade. Benefiting from the thin-gap structure and sensitive front end electronics, the new generation RPC has higher rate capability and longevity, together with better time and spatial resolution. This talk will report the status of the muon trigger upgrade focusing on the contributions of the Chinese RPC team.

Plenary / 444

Electroweak and SM highlights at ATLAS and CMS

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This talk provides a comprehensive overview of the latest electroweak and Standard Model results from the ATLAS and CMS experiments, highlighting a year of significant progress in precision physics.

Parallel 4 / 445

The R&D of high light yield and high density glass scintillator for HCAL

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The future e+e-Higgs factory, whose main goal is to achieve a precise measurement of mass and properties of the Higgs boson, is the main development trend of the next-generation large collider. A big challenge for this goal is to fulfill an unprecedented jet energy resolution, and the scheme selection of hadronic calorimeter (HCAL) is one of the most important factors. Scintillation materials can convert high-energy rays into visible light. Generally, solid scintillator can be divided into crystal scintillator, plastic scintillator, glass scintillator and ceramic scintillator. Compared with crystal scintillator, the glass scintillator has many advantages, such as a simple preparation process, low cost and continuously adjustable components. In 2021, the researchers in the Institute of High Energy Physics (IHEP) have set up the Large Area Glass Scintillator Collaboration (GS group) to study the new glass scintillator with high density and high light yield. Currently, a series of high density and high light yield scintillation glasses have been successfully developed. The GSHCAL conceptual design with preliminary detector optimization by simulation has been done. The physics potential and the R&D of the GSHCAL will be presented in this talk.

Plenary / 446

Higgs-self coupling measurement

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Higgs-self coupling measurement at LHC (Plenary)

Plenary / 447

New Physics Search Highlights and Summary

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The exploration of physics beyond the Standard Model (BSM) remains a central goal of the LHC program. Despite the success of the SM, open questions such as the nature of dark matter, the matter–antimatter asymmetry, and the origin of electroweak symmetry breaking suggest the existence of new phenomena at the TeV scale. This presentation summarizes recent highlights from the ATLAS and CMS experiments in the search for new physics, focusing on both supersymmetry (SUSY) and other exotic signatures, such as long-lived particles and heavy resonances. The results are interpreted within a broad range of theoretical frameworks, setting stringent limits on new particle properties, and providing guidance for ongoing analyses with Run 3 data.

Parallel 4 / 448

Flavor Physics at CEPC

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CEPC, as a future electroweak, Higgs, and top factory, has great but often overlooked potentials for flavor physics studies. The Tera-Z mode of CEPC will generate $O(10^{12})$ Z bosons decaying on-shell, giving rise to a considerable collection of tau leptons and heavy flavored hadrons. Higher energy modes of CEPC also contribute to flavor physics in unique ways.

Plenary / 449

Toponium results from ATLAS and CMS

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A search for resonances in top quark pair ($t\bar{t}$) production in final states with two charged leptons and multiple jets is presented, based on proton-proton collision data collected by the ATLAS and CMS experiment at the CERN LHC at $\sqrt{s} = 13$ TeV. A significant excess of events is observed near the kinematic $t\bar{t}$ threshold compared to the nonresonant production predicted by fixed-order perturbative quantum chromodynamics.

Plenary / 450

Physics Opportunities at Colliders

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Colliders, as powerful instruments at the energy frontier, provide unique opportunities to advance particle physics. They enable both direct searches for new resonances and indirect probes of physics beyond the Standard Model through precision measurements. In this talk, I will use sterile neutrino physics as a case study to illustrate these capabilities. I will present their discovery potential at the LHC and future lepton colliders, highlighting the complementarity between hadron and lepton machines. Finally, I will discuss recent advances demonstrating how future lepton colliders can distinguish the Dirac or Majorana nature of sterile neutrinos, showcasing their unique role in probing fundamental properties of new particles.

Plenary / 451

Welcome Speech

Plenary / 452

Logistics from LOC

Plenary / 453

LHCb upgrade

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This talk presents the LHCb Upgrade project and the progress achieved in the past year. We will focus on the pivotal contributions from Chinese institutes, which are spearheading the development of core sub-detectors. These include a next-generation Ring-Imaging Cherenkov (RICH) system, a high-granularity Scintillating Fibre tracker, and a novel precision timing detector. Furthermore, Chinese groups are leading critical work on the front-end electronics and trigger systems essential for handling the extreme data environment of the HL-LHC. The status and timeline of the project will be summarized, highlighting how these efforts are fundamental to securing the future of precision heavy-flavor physics at LHCb.

Plenary / 454

Recent results of CP violation from the LHCb experiment

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The phenomenon of CP violation is a necessary ingredient for explaining the observed matter-antimatter asymmetry of the universe. The LHCb experiment has a rich program of searching for and measuring CP-violating observables in the heavy quark sector. This presentation reviews recent

highlights, including ultra-precise measurements of the CKM angle γ from $B \rightarrow DK$ decays, studies of CP violation in decays of B^0_s mesons, and the landmark observation of CP violation in the baryon sector.

Plenary / 455

AI and Machine Learning Application in High Energy Physics

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AI and Machine Learning Application in High Energy Physics

Plenary / 456

A Transformer-based Jet Flavour Tagger at ATLAS

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The ATLAS collaboration has developed a new transformer-based flavour tagging algorithm, GN2. It achieves much better performance compared to the previous taggers. In addition, the development-deployment-calibration cycle has been greatly streamlined so that it can be quickly adapted to new use cases. GN2 has already been used in physics analyses, demonstrating its superior performance. Our Chinese institutes have played critical roles in this process. The paper has been accepted by Nature Communications, which should be published in time for CLHCP.

Plenary / 458

ATLAS 中国研究进展汇报

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ATLAS 中国研究进展汇报

Plenary / 459

All charm tetraquarks and recent heavy flavor results at CMS

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With the large dataset and excellent detector performance, CMS has made great progress in heavy flavor results. Recent results include in both (exotic) hadron studies, and CP violation and rare decay studies. The spin-parity of all charm tetraquark candidates observed in $J/\psi J/\psi$ mass spectrum is found to be prefer 2^{++} . The $X(7100)$ is first observed in $J/\psi J/\psi$ channel, and the $X(6900)$ is first observed in $J/\psi \psi(2S)$ channel, both exceeding 5σ . The masses of B^+ , B^0 , and B_s^{*0} are precisely measured via their exclusive reconstructions. CP violating parameters in $B_s^0 \rightarrow J/\psi \phi$ are measured and a 3.2σ evidence of CP violation is found. The rare decay of $D^0 \rightarrow \mu^+ \mu^-$ is searched, and the association production of $Y(1s)$ and Z boson is studied.

Parallel 4 / 460

Shandong University Site Report

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Shandong University holds the dedicated cluster for high energy physics, currently with approximately 1,500 CPU cores, 2 PB of storage, and 66 GPU cards, supporting various experiments including BESIII, Belle II, LHC, LHAASO, STCF, and STAR.

In the past year, the heavily utilized system supported over 160 users, executing more than 1 million jobs and consuming over 2 million CPU hours. Storage is distributed across several directories totaling ~ 1.8 PB for experimental and user data. This report summarizes the computing resources of the Shandong University (SDU) High Energy Physics (HEP) team, and discusses potential upgrade plans.

Plenary / 461

ATLAS upgrade

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To meet the challenges brought about by ~ 7 times as high instantaneous luminosity at the HL-LHC, ATLAS will implement upgrade in the current detector. This talk reports the progress in the past year that has been made by the Chinese institute cluster on the ATLAS subdetectors, including HGTD, ITK and Muon system.

Plenary / 462

LHCb report

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回顾 LHCb 近一年的主要进展

Plenary / 463

Closing remarks

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Plenary / 464

Announcements

Plenary / 465

CMS 中国组 2025 年研究进展

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CMS 探测器是大型强子对撞机 LHC 上的一个通用探测器。该报告将介绍 CMS 中国组在近一年内在探测器升级硬件、物理分析、探测器性能、算法等方面取得的新结果和新进展。

Poster / 466

Determination of the spin and parity of all-charm tetraquarks at CMS

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The traditional quark model accounts for the existence of baryons, such as protons and neutrons, which consist of three quarks, as well as mesons, composed of a quark-antiquark pair. Only recently has substantial evidence started to accumulate for exotic states composed of four or five quarks and antiquarks. The exact nature of their internal structure remains uncertain. This paper reports the first measurement of quantum numbers of the recently discovered family of three all-charm tetraquarks, using data collected by the CMS experiment at the Large Hadron Collider from 2016 to 2018. The angular analysis techniques developed for the discovery and characterization of the Higgs

boson have been applied to the new exotic states. The quantum numbers for parity P and charge conjugation C symmetries are found to be $+1$. The spin J of these exotic states is consistent with $2\hbar$, while $0\hbar$ and $1\hbar$ are excluded at 95% and 99% confidence level, respectively. The $JPC=2^{++}$ assignment implies particular configurations of constituent spins and orbital angular momenta, which constrain the possible internal structure of these tetraquarks.

Poster / 467

$\Upsilon(nS)$ cross section measurement at 13.6 TeV at CMS

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The production cross section of $\Upsilon(nS)$ ($n=1,2,3$) bottomonium states are measured in proton-proton collisions at $\sqrt{s} = 13.6$ TeV using a data sample corresponding to an integrated luminosity of 37.4 fb^{-1} collected in 2022 by the CMS experiment. The measurement is performed within dimuon transverse momentum range $20 \text{ GeV}/c < p_T < 200 \text{ GeV}/c$ and rapidity range $0.0 \leq |y| \leq 1.4$. Signal yields are extracted via extended maximum likelihood fits to the dimuon invariant mass spectrum using double Crystal Ball functions. Detector acceptance is determined from particle-gun Monte Carlo simulations, while reconstruction and selection efficiencies are evaluated using a data-driven tag-and-probe method. The differential cross sections are measured as functions of rapidity and transverse momentum. Systematic uncertainties arise from signal and background modeling, acceptance and efficiency calculations, luminosity determination (1.4%), and polarization effects. Compared to the previous 13 TeV analysis, this measurement extends to lower p_T regions and achieves significantly improved statistical precision. The results are compared to earlier measurements and NLO NRQCD theoretical predictions, showing good agreement in shape while theory slightly overestimates the absolute cross section values.

Parallel 2 / 468

The electroweak precision constraints of the 2HDM+S

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We investigate the phenomenological prospects of the Two Higgs Doublet and Singlet Scalar Extension (2HDMS). In this work, we perform an exhaustive scan to find representative benchmarks which are consistent with all theoretical and experimental constraints. We focus on the relevant signatures at the LHC, especially about the oblique parameters, and at proposed future lepton colliders including electron-positron and muon colliders.

Plenary / 469

Overview of CEPC Project

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Parallel 4 / 470

Run3 CMS ECAL calibration performance**Authors:** CMS Collaboration^{None}; 天宇曹¹¹ 中国科学院高能物理研究所**Corresponding Author:** tycao@ihep.ac.cn

Introduce Run3 CMS ECAL calibration performance

Poster / 471

Observation of X(6900) and evidence of X(7100) in the $J/\psi\psi(2S) \rightarrow \mu^+\mu^-\mu^+\mu^-$ mass spectrum**Author:** UNKNOWN 陈亮亮^{None}**Corresponding Author:** llchen@ihep.ac.cn

In the study of the $J/\psi J/\psi$ invariant mass spectrum, the CMS collaboration has observed three distinct structures, labeled as X(6600), X(6900), and X(7100). A comprehensive analysis of the experimental data indicates that a theoretical model incorporating quantum interference effects among three resonant states provides the best description of the observed mass spectrum distribution. This finding suggests that these three states share the same spin-parity quantum numbers (J^{PC}), offering crucial insights into the nature of these exotic states.

As an extension, this research systematically investigates potential structures near the threshold region in the $J/\psi\psi(2S) \rightarrow \mu^+\mu^-\mu^+\mu^-$ decay channel, utilizing proton-proton collision data collected by the CMS detector, with center-of-mass energies of 13 TeV and 13.6 TeV. The corresponding integrated luminosity is 315 fb^{-1} . In the mass spectrum, a prominent threshold structure is observed near 6900 MeV/ c^2 , with a statistical significance exceeding 5 standard deviations ($>5\sigma$). By introducing a model that accounts for interference effects between structures, evidence for a second peak is identified in the analysis, with a statistical significance of 4.3σ . The masses and widths of these two peaks are measured as $m_1 = 6876_{-29}^{+46+100}$, $\Gamma_1 = 253_{-100}^{+290+120}$ MeV and $m_2 = 7169_{-52}^{+26+74}$, $\Gamma_2 = 154_{-82}^{+110+140}$ MeV, respectively, consistent with previously observed results in the $J/\psi J/\psi$ channel.

Parallel 4 / 472

Jet calibration in low pileup data**Author:** Zhiyong Ye¹¹ Zhejiang University**Corresponding Author:** 12445048@zju.edu.cn

This work presents dedicated jet energy calibration techniques developed for low pileup proton-proton collision data. The study focuses on adapting standard calibration procedures to the low pileup regime, where detector response and underlying event conditions differ significantly from nominal high-luminosity operations. We describe the methodology, including residual and relative corrections, and evaluate their performance using both simulation and collision data.

Poster / 473

Measurement of the photon-fusion production cross section of a pair of W bosons at CMS

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A measurement of the cross section of W boson pair production in photon fusion ($\gamma\gamma \rightarrow WW$) is presented, using an integrated luminosity of 138 fb^{-1} of proton-proton collision data collected in 2016-2018 at a center-of-mass energy of $\sqrt{s} = 13 \text{ TeV}$. Events are selected in the final state with one electron, one muon, and a low multiplicity of tracks associated with the electron-muon production vertex. The total cross section of the $\gamma\gamma \rightarrow WW$ production is measured to be $659^{+82}_{-78} \text{ fb}$, and a fiducial cross section of $4.1 \pm 0.5 \text{ fb}$ is measured in a phase space defined with selection criteria close to those of the analysis. In addition, constraints on dimension-8 operators from an effective field theory framework are set.

Poster / 474

Feasibility Study of the RPC Detector and Electronics System for HSCP Detection in the CMS Phase-2 Upgrade

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The High-Luminosity Large Hadron Collider (HL-LHC) aims to significantly enhance its sensitivity to potential new physics phenomena. One of the key targets of this upgrade is the search for Heavy Stable Charged Particles (HSCPs), which are widely predicted in various beyond-Standard-Model theories. HSCPs are characterized by a relatively low velocity ($\beta < 0.9$), long lifetime, and high ionization energy loss. Based on these properties, the CMS detector identifies HSCP candidates using both the time-of-flight (TOF) and ionization energy loss (dE/dx) methods. In this study, a four-layer improved Resistive Plate Chamber (iRPC) setup with a large inter-layer spacing of 139 cm, corresponding to the CMS Phase-2 upgrade design, was constructed at CERN laboratory 904. Using cosmic-ray events, particle tracks were reconstructed and their velocities measured to evaluate the feasibility of the RPC system assisting HSCP searches in the CMS Phase-2 upgrade through the TOF method.

Poster / 475

Search for a top-philic Z' boson in the final state with an electron or a muon and jets

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A search for a top-philic Z' boson in the final state with an electron or a muon and jets is presented. The top-philic Z' boson is produced in association with a top quark and also decays to a top quark-antiquark pair, as it couples exclusively to top quarks. The analysis aims to identify a heavy Z' boson that produces boosted top quarks, whose hadronic decay products are merged into large-radius jets.

A machine learning algorithm (ParticleNet) is employed to identify such jets. The distribution of the invariant mass of the two most energetic top quark candidates is used in the search for a Z' boson in the mass range of 0.5 to 3 TeV, with decay widths of 4%, 10%, 20%, and 50% relative to its mass. The results obtained are found to be in agreement with the standard model background prediction. Upper limits at the 95% confidence level are set for the production cross section of the Z' boson, for each of the decay widths as a function of its mass. % on the two-dimensional plane of decay width and Z' boson mass. These results represent the most stringent constraints to date on the existence of the top-philic Z' boson. The data were recorded by the CMS experiment at the CERN LHC in proton-proton collisions at $\sqrt{s} = 13$ TeV and correspond to an integrated luminosity of 138 fb^{-1} .

Parallel 3 / 476

Probing nuclear gluonic structure via photoproduced vector mesons in UPCs at CMS

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The study of vector meson photoproduction in ultraperipheral collisions (UPCs) offers a powerful probe of gluon dynamics in heavy nuclei. In UPCs, photons can interact with the nucleus coherently (involving the entire nucleus) or incoherently (with individual constituents). While coherent processes provide insight into the average gluon density, incoherent photoproduction is uniquely sensitive to the local gluon density fluctuations at both nucleonic or subnucleonic levels. Moreover, vector mesons of different masses probe different hard scales, offering complementary sensitivity to nonlinear QCD effects and potential gluon saturation phenomena.

In this talk, we present recent CMS results on vector meson photoproduction in UPCs, including the first observations of coherent ϕ and $\Upsilon(1S)$ photoproduction and the first energy-dependent measurements of incoherent J/ψ cross sections. The results will be compared with state-of-the-art theoretical models, offering new insights into gluon density fluctuations and enhancing our understanding of nuclear gluon distributions and QCD saturation.