The CMS group

LIP Advisory meeting
Lisbon, April 2026

M.Araújo, P.Batista, A.Boletti, R.Bugalho, T.Camporesi, D.Cardoso, C.DaCruz e Silva, G.DaMolin, M.Ferreira, L.Ferramacho, M.Gallinaro, R.Guitton, J.Hollar, H.Legoinha, N.Leonardo, G.B.Marozzo, N.Oliveira, J.Seixas, P.Silva, R.Silva, M.Silveira, J.Varela, J.Wulff

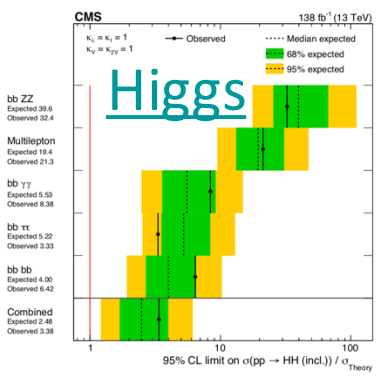
FCT Fundação para a Ciência e a Tecnologia

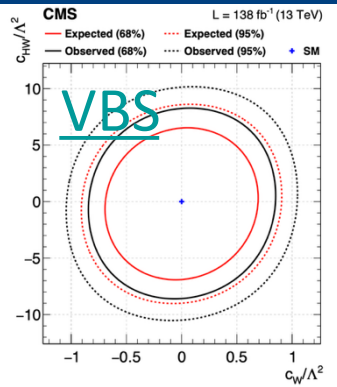
2024.00238.CERN, 2024.01191.CERN, PTDC/FIS-PAR/1214/2021, aMUSE - EU MSCA-RISE-2020 101006726, MuCol - EU HORIZON-INFRA-2022-DEV-01-01 101094300

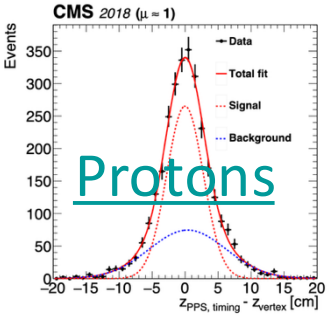
Horizon 2020 European Union Funding for Research & Innovation

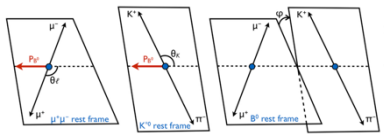
Physics, Operations, Upgrades

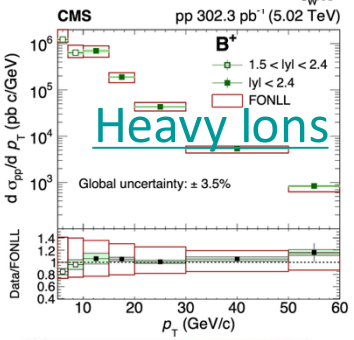
- Physics analyses
  - pp ($\gamma\gamma$) & heavy ion collisions
  - precision measurements & searches (rare processes, BSM)
  - Top, Higgs, B, EWK, Dark matter, Heavy Ions, Quarkonia
- Detector maintenance & operations
  - Precision Proton Spect. (PPS), EPRs, detector/on-call shifts, computing
- Upgrades
  - PPS, Timing Detector (MTD), ECAL, HGCAL
- DRD1 (gas) and DRD3 (silicon)
- Training & Outreach
  - CERN, LIP, IST, Masterclasses, summer stage, etc.

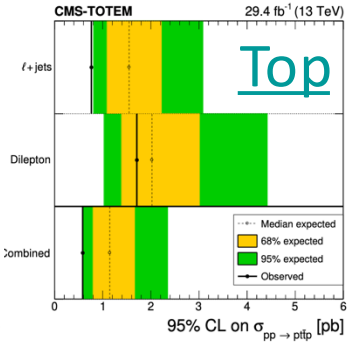


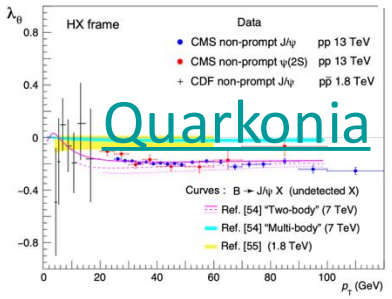


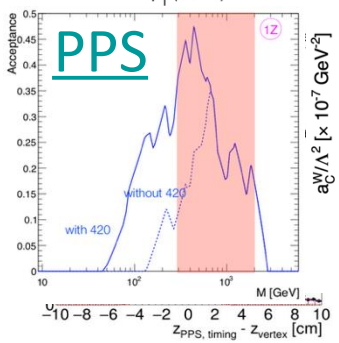


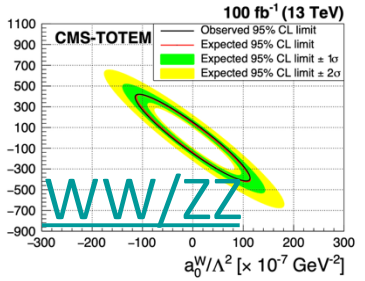












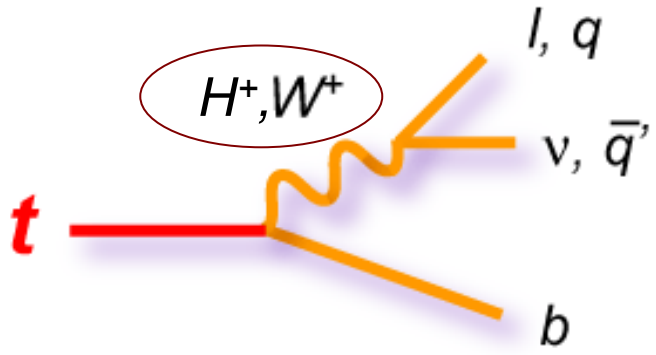
Other activities

- Organization of 15th course on “Physics at the LHC”
- Organization of workshop on “Machine Learning for Physics”
- Organization of “Flavour Physics at LHC” school

Top quarks and tau leptons

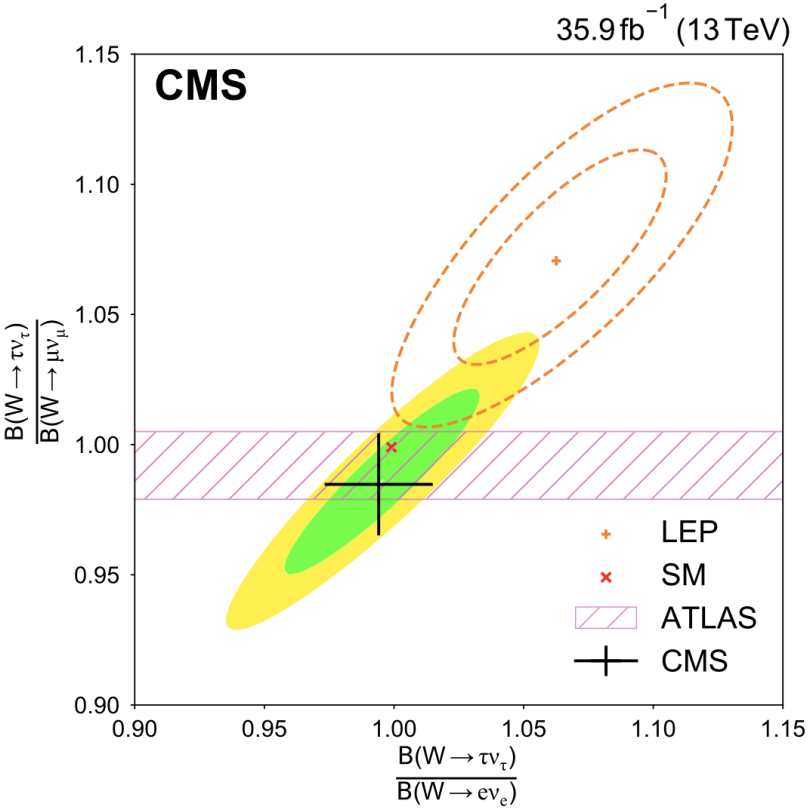
JHEP 02 (2020) 191, PRD105(2022)072008

- Lepton flavor universality: check consistency with SM expectations



	CMS	LEP	ATLAS
$R_{\mu/e}$	1.009 ± 0.009	0.993 ± 0.019	1.003 ± 0.010
$R_{\tau/e}$	0.994 ± 0.021	1.063 ± 0.027	$\cdots$
$R_{\tau/\mu}$	0.985 ± 0.020	1.070 ± 0.026	0.992 ± 0.013
$R_{\tau/\ell}$	1.002 ± 0.019	1.066 ± 0.025	$\cdots$

With full Run2 dataset, ongoing
(PhD student: G. Da Molin)

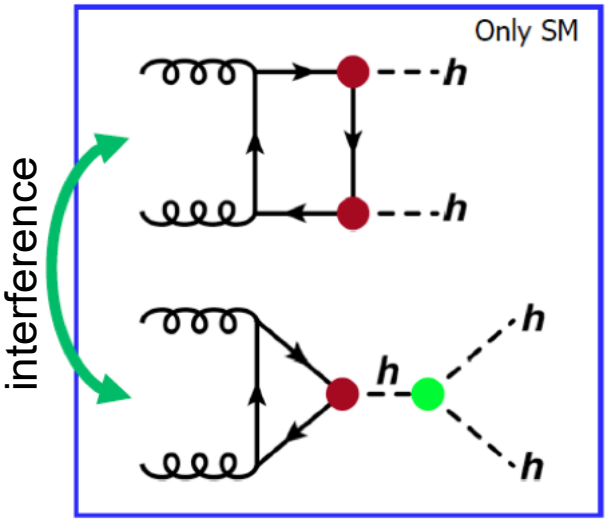


- Study LFU in top quark decays
- t⟶(τν)b decay exclusively involves 3rd gen. leptons/quarks

Double Higgs production

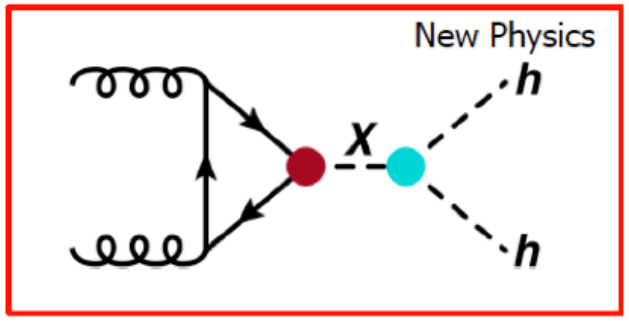
arXiv:1902.00134, Mach.Learn.Sci.Tech. 1(2020)045006, Rev. Phys. 5 (2020) 100045, arXiv:2105.07530, arXiv:2206.09401

non-resonant production



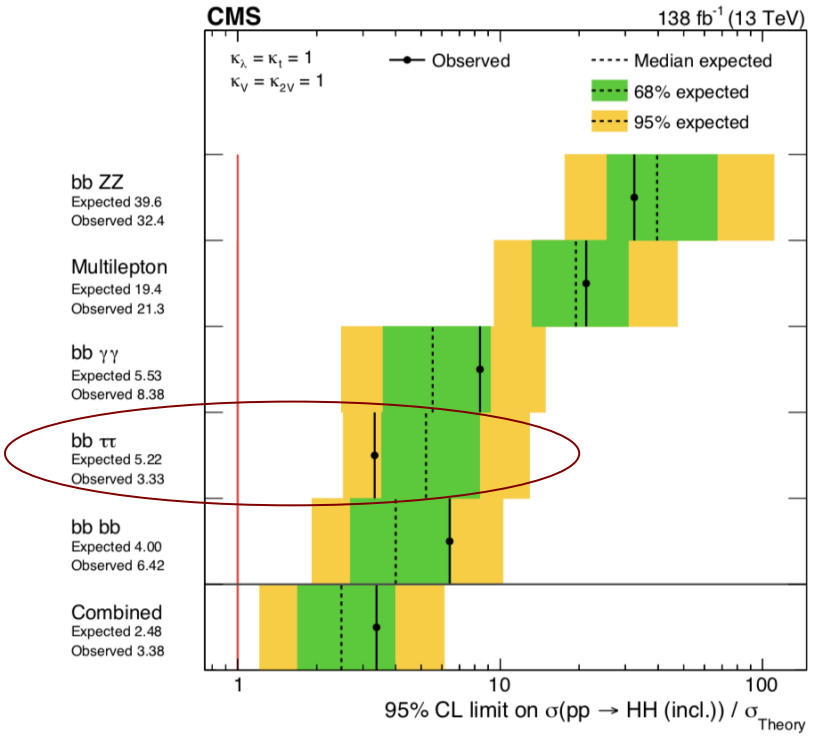
⇒ Run2/3: 2016-2024 (310 fb^{-1})

resonant production



⇒ Run2: 2016-2018 (138 fb^{-1})

HH production search ongoing
(PhD students: J. Wulff, R. Guitton)



- Destructive interference in SM
- In SM, only σ=33fb at 13 TeV
- Not yet at the SM sensitivity

Vector Boson Scattering

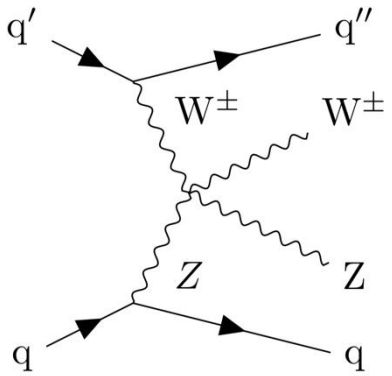
arXiv:2005.09889, arXiv:2106.01393, arXiv:2410.04210, CMS-SMP-24-013

- VV production via VBS (V=W,Z,γ)
  - Purely EW process (QCD treated as bkg)
  - V self-interactions precisely predicted
- Small cross section: similar for EWK and QCD processes
- Study same-sign WW production
- Include tau leptons in final state
  - could enhance sensitivity to BSM wrt light leptons

VBS (full Run2)
PhD student G.B.Marozzo and U.Perugia

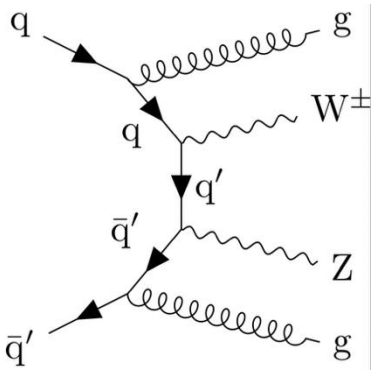
WW incl. taus (Run3)
PhD student G.B.Marozzo

ssWW EW signal: σ=27 fb

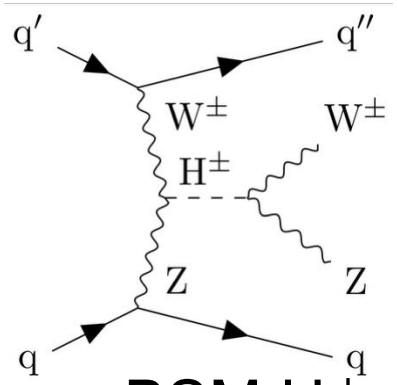


VBS WZjj

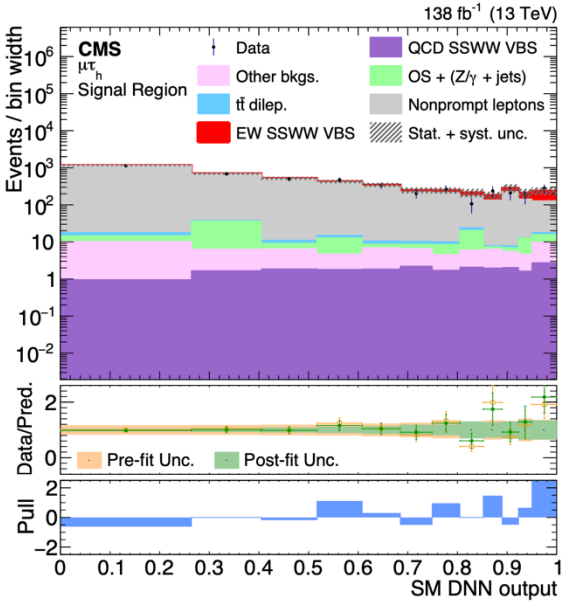
QCD bkg: σ=26 fb



Non-VBS WZjj

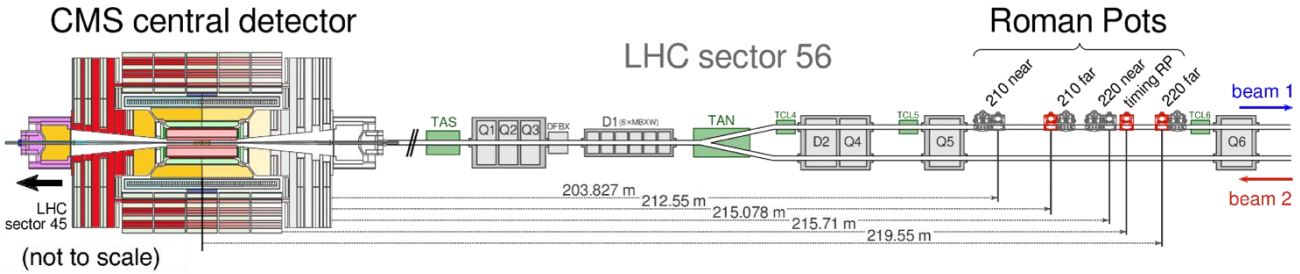


BSM $H^{\pm}$



Physics w/ forward protons

JHEP 07(2018)153, arXiv:2210.05854, arXiv:2211.16320, arXiv:2310.11231

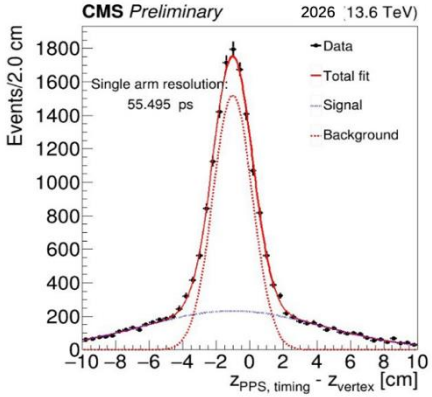


Exclusive tau pairs and charged Higgs
MSc students M.Ferreira and P.Batista

Proton reconstruction

arXiv:2210.05854

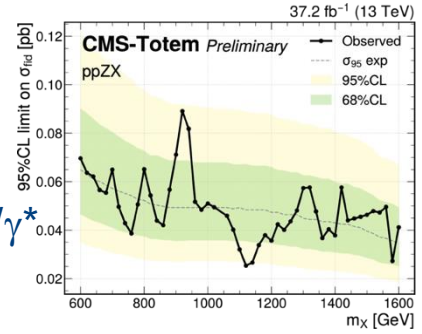
PPS collected more than 350/fb of data in Run2/3



Zγ+X production

arXiv:2303.04596

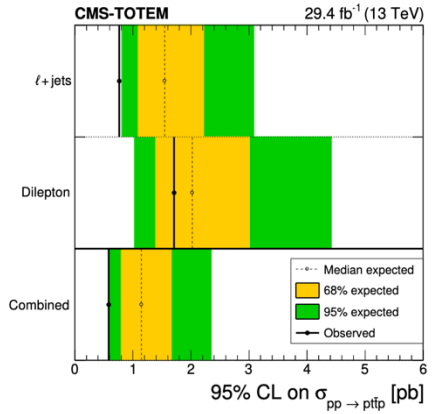
Search for anomalous Z/γ* central production with 2017 data



Exclusive top quark pairs

arXiv:2310.11231

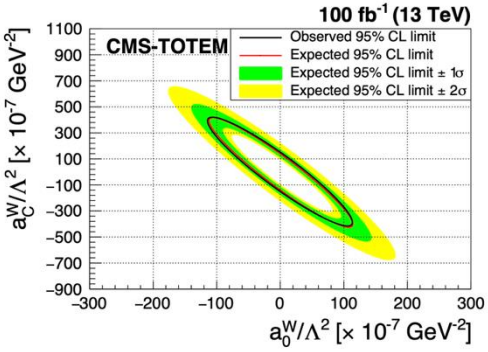
Search for central exclusive production of ttbar pairs in pp interactions with tagged protons



Exclusive WW/ZZ

arXiv:2211.16320

Search for γγ⟶WW/ZZ with forward protons

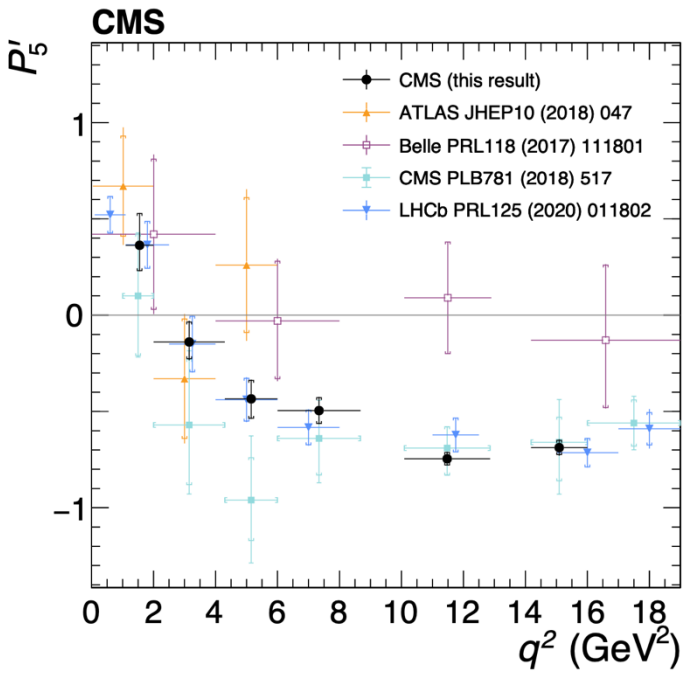


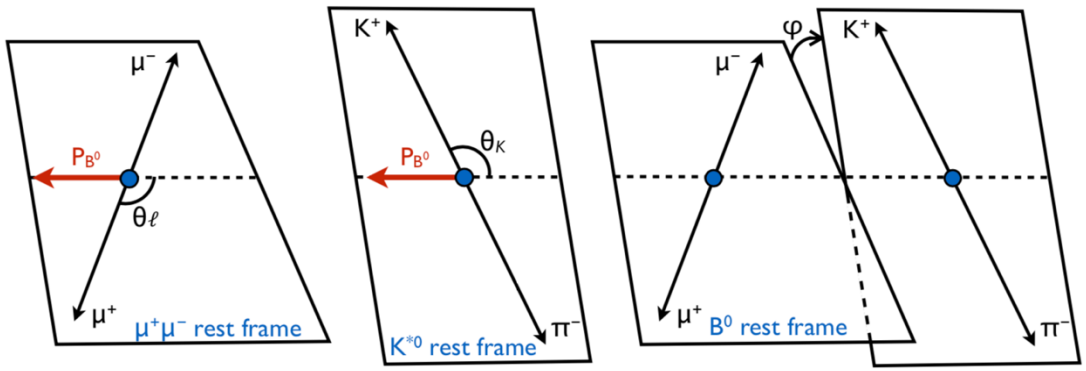
B-physics

arXiv:2007.02434, arXiv:2411.11820

A. Boletti

- Indirect search for NP
  - May provide sensitivity beyond collision energy
- Precise measurements and rare decays
  - NP through virtual contributions
- Explore b⟶sμμ transitions
  - B⟶μμ, B⟶K*μμ
- Study decay rates and angular variables
  - Measure BRs and lifetime
  - $B^0 \longrightarrow K^*(K^+\pi^-)\mu\mu$ (FCNC)
  - $B_s \longrightarrow J/\psi(\mu\mu)\phi(KK)$ (CPV)
- Goldmine in “parked” dataset



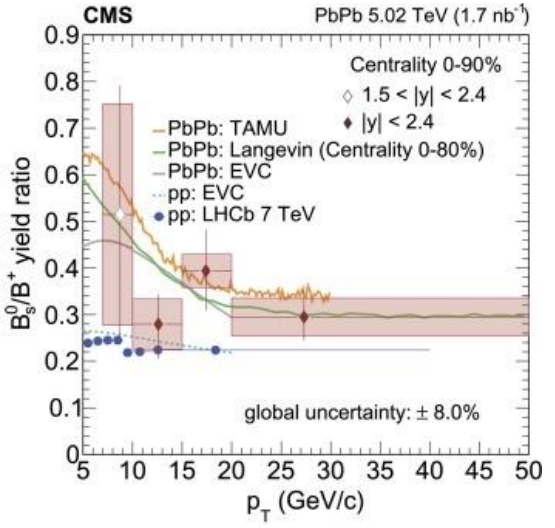


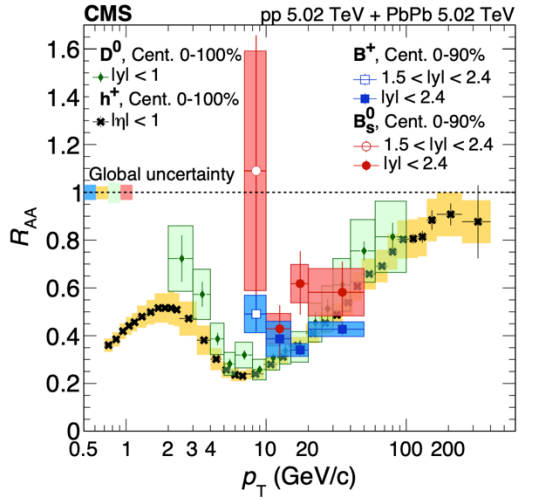
Heavy Ions

PLB 829(2022)137062, arXiv:2409.07258

PhD student H. Legoinha (ongoing)

- Explore heavy ion collisions at highest energies
- CMS has excellent capability to study low p_T probes in HI
- Detected B mesons in ion collisions
- Explore heavy flavour as probe of QGP
  - Ratio of B_s/B^+ production yields
  - Nuclear modification factor R_{AA}
- In Run3:
  - Heavy quarks as probes QGP dynamics and effects
  - Study exotic hadrons: X(3872) composition, constrain hadronization models





Detector Upgrades

The HL-LHC will provide an integrated luminosity of 3000 fb^{-1} over 10 years of operation. It will present many technological challenges. We are preparing by developing new detectors and by upgrading the current ones.

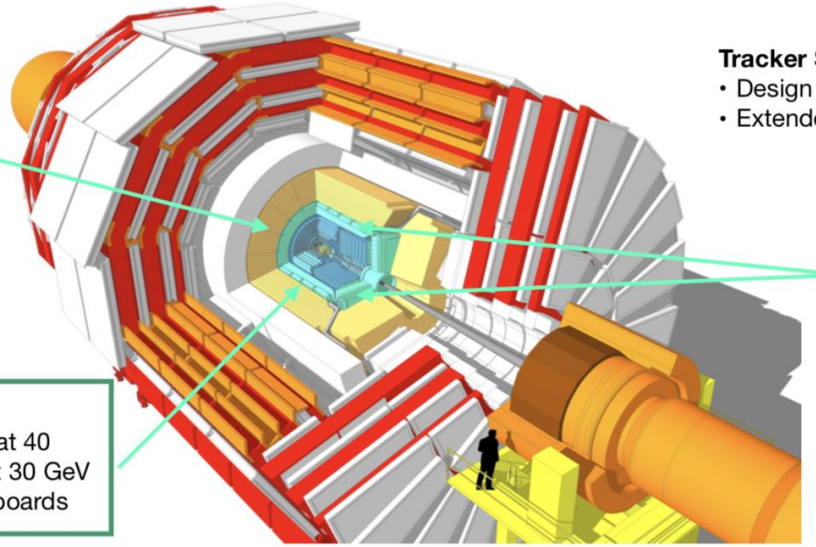
LIP Contributes to

Calorimeter Endcap
- 3D showers and precise timing
- Si, Scint+SiPM in Pb/W-SS

Muon systems
- DT & CSC new FE/BE readout
- RPC back-end electronics
- New GEM/RPC $1.6 < \eta < 2.4$
- Extended coverage to $\eta \approx 3$

LIP Contributes to

Barrel Calorimeters
- ECAL crystal granularity readout at 40 MHz with precise timing for e/γ at 30 GeV
- ECAL and HCAL new Back-End boards

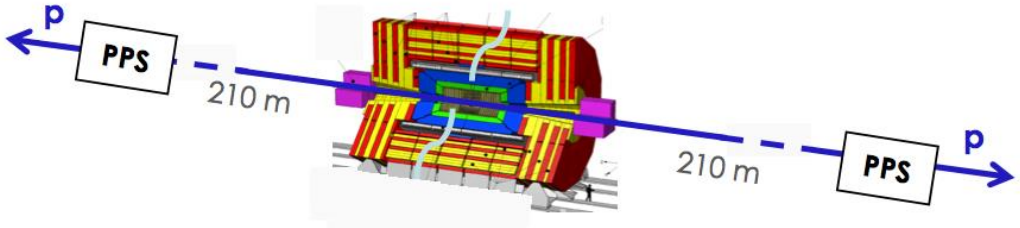


Tracker Si-Strip and Pixels increased granularity
- Design for tracking in L1-Trigger
- Extended coverage to $\eta \approx 3.8$

LIP Contributes to

MIP Timing Detector - MTD
- Barrel layer: Crystals + SiPMs
- Endcap layer: Low Gain Avalanche Diodes

L1-Trigger/HLT/DAQ
- Tracks in L1-Trigger at 40 MHz
- PFlow-like selection 750 kHz output
- HLT output 7.5 kHz



LIP contributes to

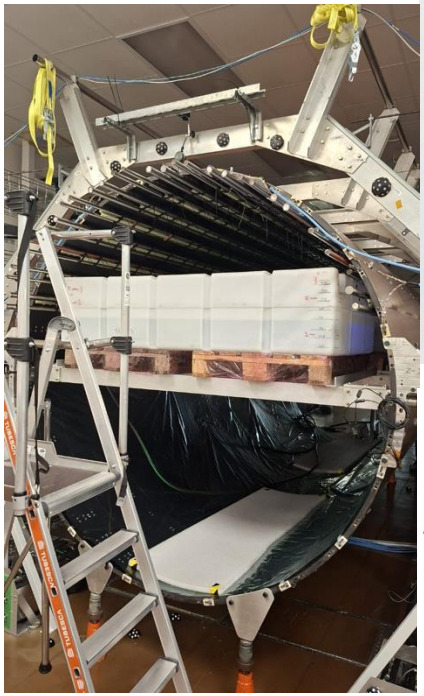
Precision Proton Spectrometer
Detector design and physics prospects

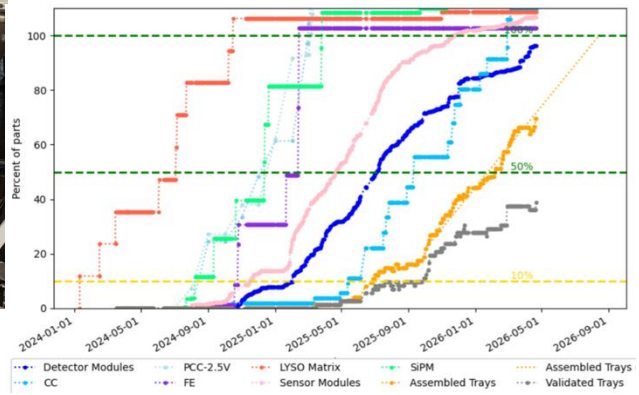
MIP Timing Detector

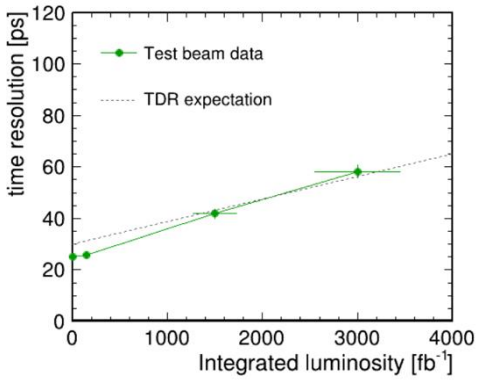
JINST 19 (2024) 12, P12020, JINST 19 (2024) 05, P05048, arXiv:2504.11209

Electronics for the Barrel Timing Layer

- TOFHiR2 read-out ASIC and BTL FE boards fully produced and validated (330k ch.)
- Expected timing resolution performance confirmed via tests with laser and test beam
- Testing, assembly, validation of BTL “trays”
  - Trays being prepared and shipped to CERN
  - Integration and commissioning planned between 2026 and 2027
  - LIP group members responsible for BTL integration/commissioning
  - Monitoring of temperatures, powering, and readout status





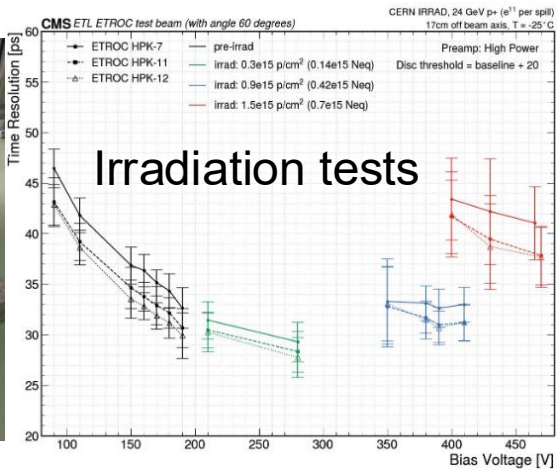


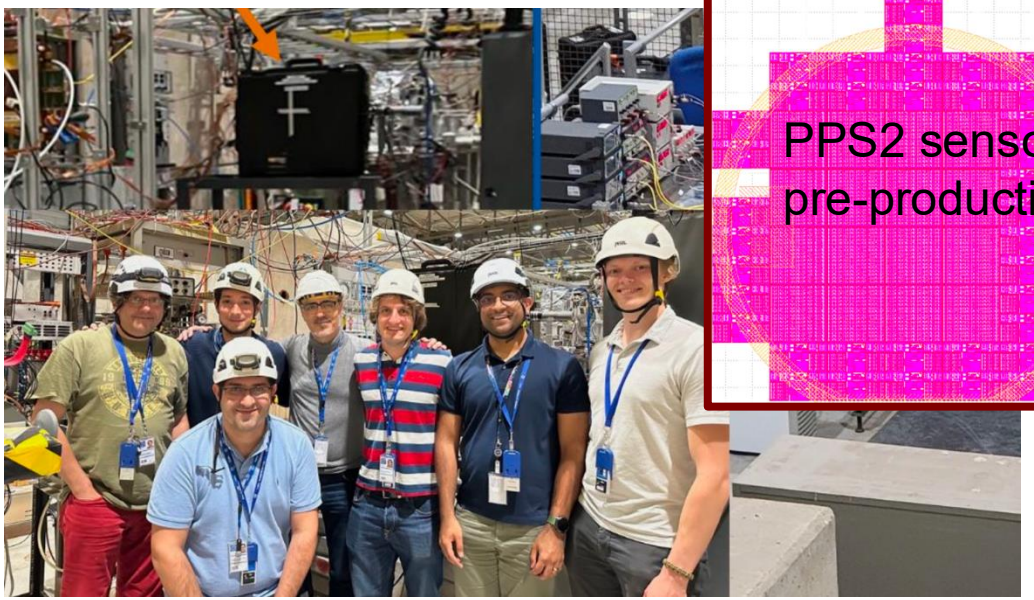
CERN North Area
H8 beam lines

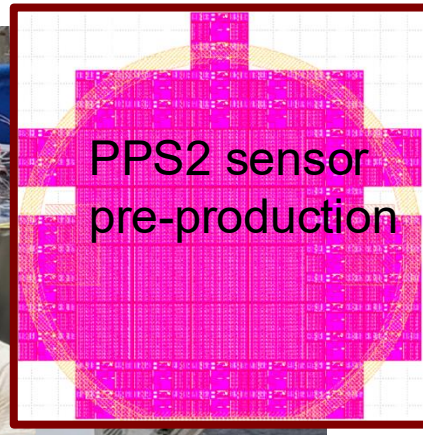
Precision Proton Spectrometer

arXiv:2412.13780

- PPS2 approved for HL-LHC
- Timing detectors
  - LGAD sensors and associated electronics for the HL-LHC upgrade
  - challenging near beam non-uniform irradiation
- Preparations for PPS2 ongoing
  - irradiation studies at CERN
  - sensor characterization (Lisbon, CERN)
  - tests with FNAL team on electronics and sensor performance
  - test beam activities in 2025/2026
  - new sensor design and simulation
  - sensor pre-production arrived @CERN







Electromagnetic Calorimeter (ECAL)

2025 Test beam:
- DAQ development applications
- Electronics setup and connections
- Shifts and data analysis

ECAL in Run3:
- ECAL as Detector On Call (DOC) and DGL: daily reports meeting at CMS RC, weekly presentations

Others task:
- Studied the laser (used for the transparency monitoring) jitter
- Studied the ADC calibration in different configuration scenarios

Phase-2 preparations:
- DAQ developments
- Preparations for ECAL refurbishment, DB, monitoring
- ECAL disassembly and assembly: “Enforneur”

Recent MSc and PhD theses

ALMA MATER STUDIORUM · UNIVERSITÀ DI BOLOGNA
UNIVERSITÉ CLERMONT AUVERGNE
TECHNISCHE UNIVERSITÄT DORTMUND

International Master in Advanced Methods in Particle Physics

CERN-THESIS-2024-184, Sept. 2024

Lorenzo Valla

Optimisation of the local reconstruction in a high granular calorimeter using a heterogenous computing model

Author: Daniela CARDOSO

Supervisor: Dr. Pedro FERREIRA DA SILVA, Dr. Michele GALLINARO

CERN CDS: Master thesis, May 2025

Daniela Cardoso

Higgs boson properties and tau lepton identification at the $\sqrt{s} = 3$ TeV Muon Collider

2601.01674, Apr. 2026 - Kevin Dewyspelaere

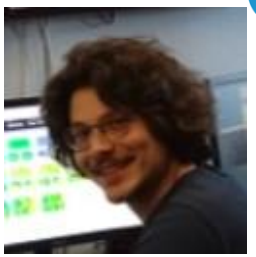
TÉCNICO LISBOA

UNIVERSIDADE DE LISBOA
INSTITUTO SUPERIOR TÉCNICO

Search for top squarks in the four-body decay mode with single lepton final states in proton-proton collisions at the Large Hadron Collider

CERN-THESIS-2023-133

Diogo Carlos Chasqueira de Bastos



Diogo Bastos

TÉCNICO LISBOA

Probing Quark Hadronization with B mesons at the LHC

Simão Moreira Costa

Thesis to obtain the Master of Science Degree in
Physics Engineering

Simão Costa

CERN-THESIS-2023-282, Dec. 2023

Ciências ULisboa

Study of central and exclusive production of charged Higgs boson pairs with forward proton tagging at the LHC, and projections for the HL-LHC

Pedro Miguel Carvalho Batista

Pedro Batista

CERN CDS: Master thesis, Dec. 2025

JHEP 2306(2023)060, July 2023
Now in private sector

Summary

- The LIP-CMS group is active in several physics topic/working groups
- Top, Higgs, Searches, Heavy Ions, B-physics, SM and γγ physics
- Several papers/results from Run2 data, with more to come from Run2 data and now Run3 (ending Summer 2026)
- LIP members perform various service tasks in the collaboration, as well as outreach, teaching, and organizational activities
- Major contributions to the CMS upgrade for HL-LHC (ECAL, MTD, PPS)


Photo from Jornadas 2024

SWOT

Strengths

- Group well integrated in the Collaboration. Several senior physicists with long experience in HEP and strong impact. Several coordination positions, including leadership of the PPS sub-detector, convenership in physics groups, and leading role in several physics analyses. **Leadership** in areas of the Phase-2 Upgrades

Weaknesses

- Difficulty in attracting researchers to Portugal
- **Funding** insufficient to support young researchers. Lack of stable National funding at regular intervals. Funding not matched to increasing prices. EU funds are explored but cannot guarantee long-term goals of experiments

Opportunities

- **Strong** participation of Portuguese industry, world leader in segments of microelectronics IP market, in the CMS Phase-2 Upgrades for HL-LHC

Threats

- **Unclear career prospects for senior physicists of the group** with key responsibilities in the group and in the Collaboration

backup

Challenging years: 2026-2031

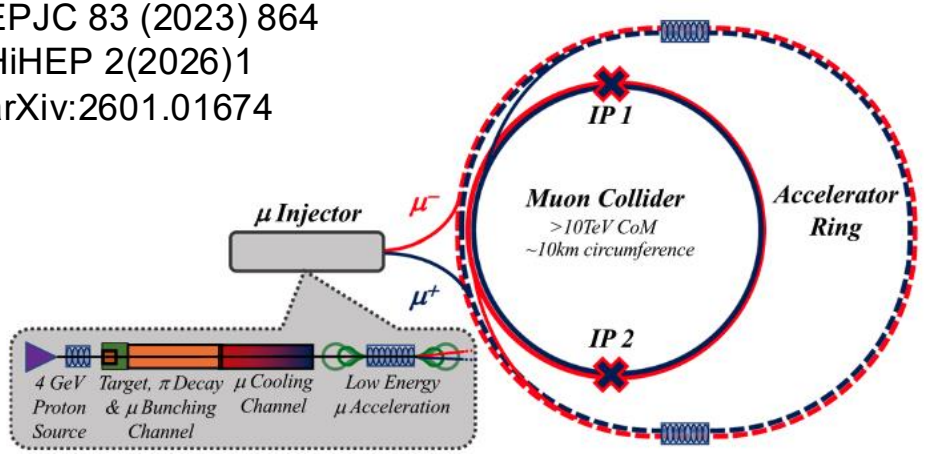
CMS will be facing an unprecedented situation in the next 5 years:

- 2026-27: Exploit the delivered luminosity for **physics** (Run 3)
- 2026-29: Complete the **upgrade** program construction, including detectors, software, all infrastructure and services needed
- 2026-28: **Decommission** the legacy systems that will not be part of the CMS upgrade detectors (services, infrastructure), ensure legacy systems are maintained and/or consolidated to guarantee full HL-LHC exploitation
- 2027-31: **Install and commission** the CMS Upgrade (infrastructure, services, detectors and software)

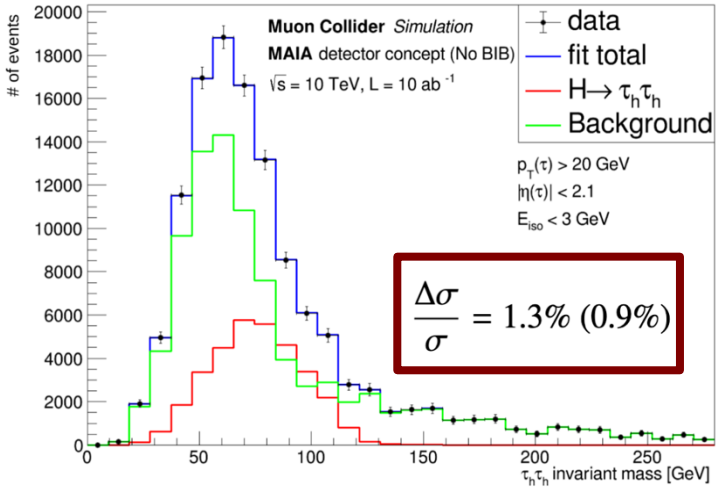
Higgs boson properties and tau lepton identification at the 10 TeV Muon Collider

- The Muon Collider: a Higgs Factory
  - It foresees two stages: 3 TeV and 10 TeV
- Algorithm for tau lepton reconstruction and identification (TauFinder)
  - Track/tau performance assessment and energy corrections
  - BIB not included in the study
- $H \rightarrow \tau\tau$ identification
- $H \rightarrow \tau\tau$ cross section measurement
  - Use BDT for S-B separation

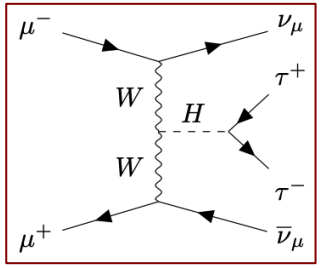
EPJC 83 (2023) 864
HiHEP 2(2026)1
arXiv:2601.01674



L.Valla MSc thesis (CERN-THESIS-2024-184)

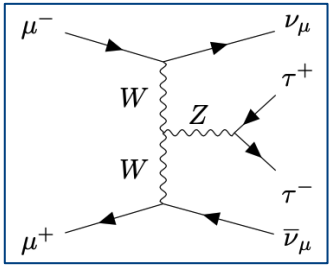


Signal

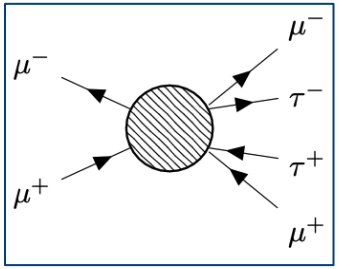


σ=31 fb

Background



74 fb

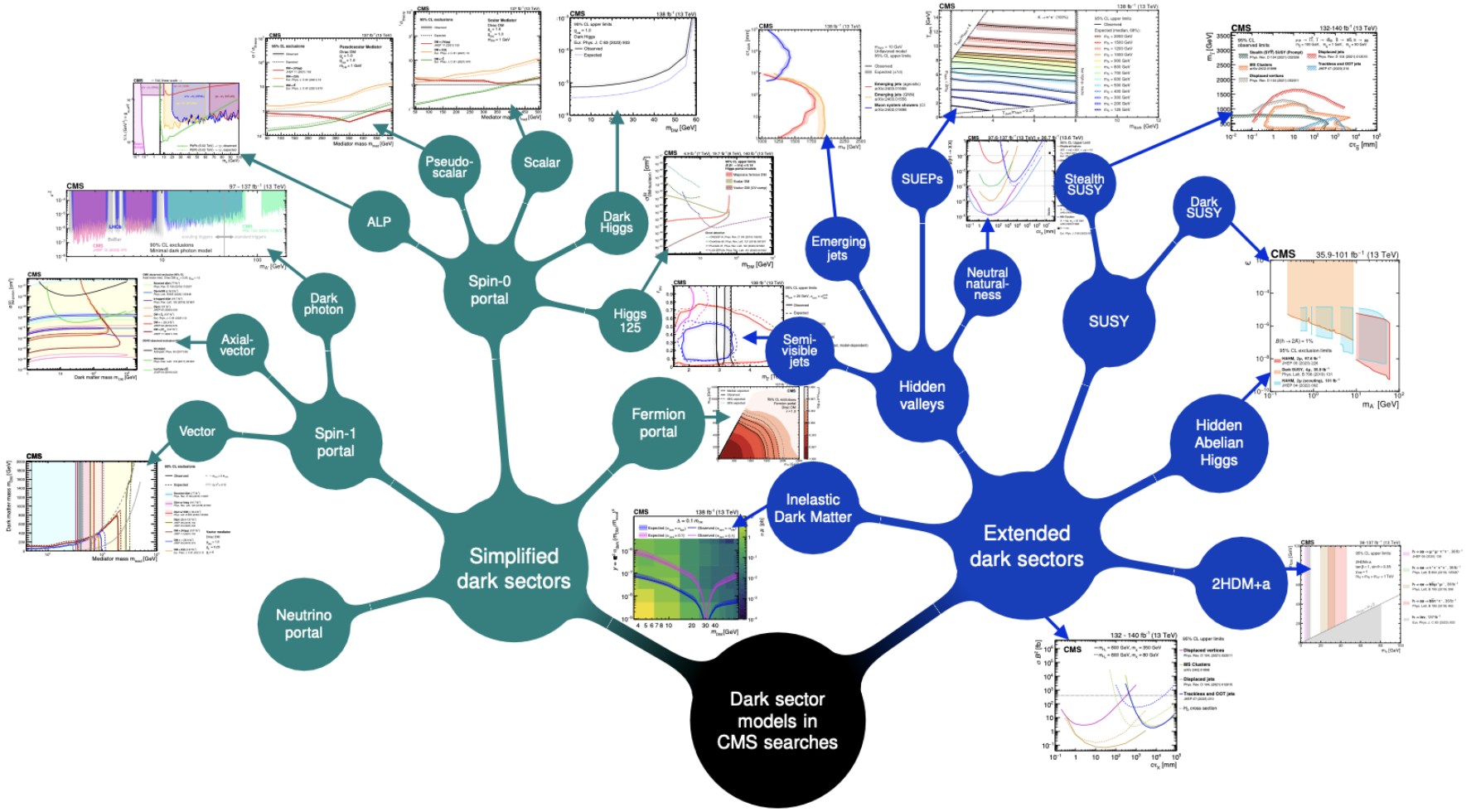


193 fb

Dark Sector searches

JHEP 03 (2020) 025, arXiv:2405.13778

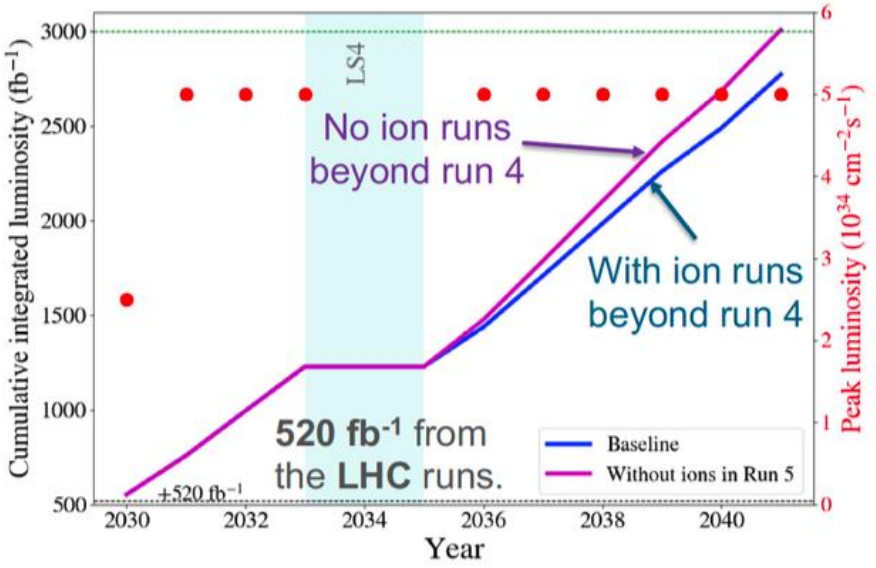
- Review of recent searches for particles and interactions belonging to dark sector and dark mediators



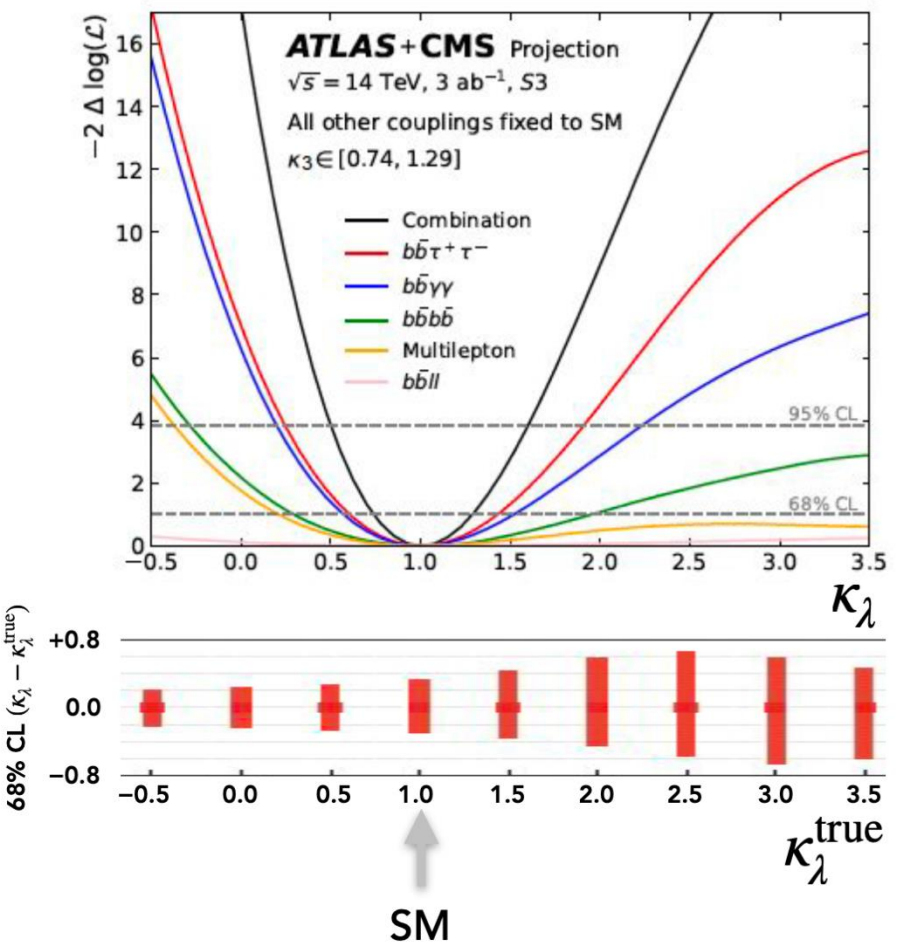
HL-LHC: Higgs self-coupling

arXiv:1902.00134

Revised projections: Uncertainty for SM (k_λ=1) of 30%



	Statistical-only		Statistical + Systematic	
	ATLAS	CMS	ATLAS	CMS
$HH \to b\bar{b}b\bar{b}$	1.4	1.2	0.61	0.95
$HH \to b\bar{b}\tau\tau$	2.5	1.6	2.1	1.4
$HH \to b\bar{b}\gamma\gamma$	2.1	1.8	2.0	1.8
$HH \to b\bar{b}VV(ll\nu\nu)$	-	0.59	-	0.56
$HH \to b\bar{b}ZZ(4l)$	-	0.37	-	0.37
combined	3.5	2.8	3.0	2.6
	Combined		Combined	
	4.5		4.0	

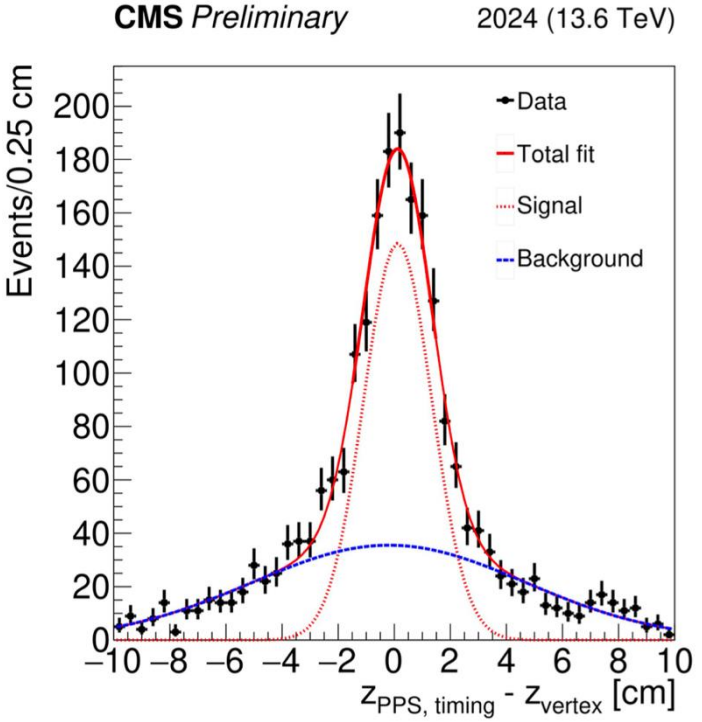


Operations and Maintenance

CMS-DP-2024-008, CMS-DP-2024-118

J.Hollar (PPS system manager, L2)
PhD students G.B.Marozzo, G.Da Molin

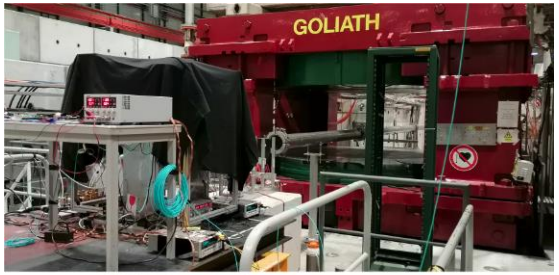
- Precision Proton Spectrometer (PPS)
  - Detector operations
  - Performance in Run 3 and efficiency of the pixel detector
  - Performance: 2024 Efficiency and two-arm vertex resolution with timing detectors
- Tau identification: improvements with ParticleNet algorithm in Tau POG
- MC contact: sample production for SMP PAG
- Detector shifts (trigger, on-call, etc.)

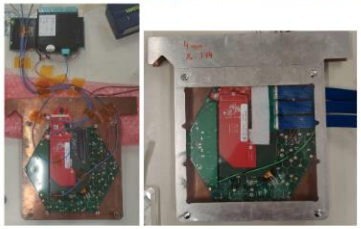


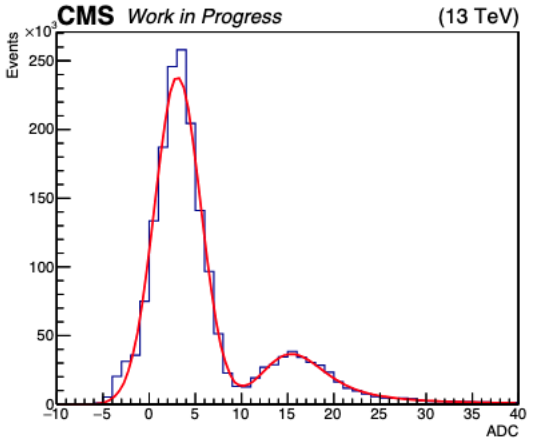
HGCAL

MSc student D.Cardoso

- The High Granularity Calorimeter (HGCAL) is being prepared for Phase 2 of the LHC
- In July and September 2024, beam tests were carried out at CERN with module prototypes
- Perform channel intercalibration, measure MIP peak







Report 2025

Executive Summary

The Compact Muon Solenoid (CMS) experiment at the LHC is a major scientific endeavor, and the research at the LHC is central to the quest for the fundamental physics laws of nature. LIP is a member of the CMS Collaboration at the LHC since its creation in 1992.

LIP had a leading role in the design and construction of important components of the CMS detector, namely the Data Acquisition System of the ECAL sub-detector used for the measurement of electrons and photons and the Trigger System that performs the online selection of the interesting collisions. Since the LHC start-up in 2010, LIP made major contributions to the CMS physics program, in particular: the discovery and characterization of a Higgs boson; measurements of the top quark properties; the first observation of the rare Bs; studies of B and Y mesons in pp and heavy ion collisions; measurements of the J/psi, Upsilon and χc polarizations; searches for charged Higgs, chargino, top squark, and for Dark Matter; search for exclusive processes; study of vector boson scattering processes. A group member served as Deputy Spokesperson of the Collaboration in 2012-13.

The group contributed to the Phase-1 Upgrade of the experiment by building and installing new High-Speed Optical Links (oSLB-oRM) that interface the ECAL electronics to the trigger system. During the long-shutdown (LS2) the group has been involved in the preparation of the PPS and the ECAL detectors.

The LIP group is leading the development of the new forward Precision Proton Spectrometer (PPS). PPS demonstrated -for the first time- the feasibility of operating a near-beam proton spectrometer at high luminosity, and it has been taking data on a regular basis since 2015. A member of the group is serving as PPS Project Coordinator.

Report 2025 - II

In the High-Luminosity phase of the LHC (HL-LHC) physics program expected to start in 2030, the accelerator will provide an additional integrated luminosity of 3000 fb-1 over 10 years of operation. The group participates in the construction of a new Timing Detector and in the upgrade of the Barrel and Endcap calorimeters. The group is also involved in the upgrade of the PPS detector, specifically in the area of precision timing detectors. The group is responsible for the design and construction of the readout system including a high-performance TOF ASIC for time measurement, installation and commissioning of the Barrel Timing Layer (BTL). In collaboration with the Portuguese industry, LIP provided a high-performance ADC ASIC for the ECAL front-end electronics resistant to radiation, and is participating in the ECAL module integration performance studies. The CMS upgrade also includes the complete replacement of the Endcap calorimeters with a new high-granularity sampling calorimeter. LIP collaborated with Portuguese industry by supplying a high-current low-voltage regulator (LVR) resistant to radiation for the High-Granularity Calorimeter (HGCAL) front-end system.

The group is actively involved and contributing to the physics analyses in the areas of Standard Model, Top quark, Higgs boson, Exotica, B mesons, SUSY, quarkonia, heavy ions, and PPS physics. Members of the LIP group coordinated the CMS Forward FSQ (2013-2014) and the B (2014-2016) Physics groups. Two former members of the group, now with CERN, coordinated in 2015-16 the CMS Higgs and Top physics groups.

Report 2025 - III

8 Articles in international journal (with direct contribution from team)

CMS Collaboration (2379 authors): "Bottom quark energy loss and hadronization with B+ and Bs0 nuclear modification factors using pp and PbPb collisions at root sNN=5.02 TeV", J. High Energy Phys. 2 (2025) 195 - DOI:10.1007/JHEP02(2025)195

Y. Meng et al. (52 authors): "PICOSEC Micromegas precise-timing detectors: development towards large-area application and integration", J. Instrum. 20 (2025) C03015 - DOI:10.1088/1748-0221/20/03/C03015

A. Utrobicic et al. (50 authors): "Single channel PICOSEC Micromegas detector with improved time resolution", Nucl. Instrum. Methods Phys. Res. Sect. A-Accel. Spectrom. Dect. Assoc. Equip. 1072 (2025) 170127 - DOI:10.1016/j.nima.2024.170127

C. da Cruz e Silva, J. Hollar, M.Gallinaro, G. da Molin, G. Marozzo, et al: "Properties of carbon-infused silicon LGAD devices after non-uniform irradiation with 24 GeV/c protons", Nucl.Instrum.Meth.A 1076 (2025) 170417 - DOI:https://doi.org/10.48550/arXiv.2412.13780

CMS collaboration: "Dark sector searches with the CMS experiment", Phys.Rept. 1115 (2025) 448 - DOI:https://doi.org/10.1016/j.physrep.2024.09.013

CMS Collaboration (2389 authors): "Angular analysis of the B0 -> K*(892)0m+m- decay in proton-proton collisions at root s=13 TeV", Phys. Lett. B 864 (2025) 139406 - DOI:10.1016/j.physletb.2025.139406

F.Addesa et al.: "The CMS barrel timing layer: test beam confirmation of module timing performance", Nucl.Instrum.Meth.A 1081 (2026) 170823 - DOI:https://doi.org/10.48550/arXiv.2504.11209

CMS collaboration: "Study of same-sign W boson scattering and anomalous couplings in events with one tau lepton from pp collisions at 13 TeV", JHEP 2510 (2025) 219 - DOI:https://link.springer.com/article/10.1007/JHEP10(2025)219

4 Preprints (arXiv etc.)

S.White, A.Boletti: "Amplitude Walk in Fast Timing: The Role of Dual Thresholds", arXiv:2507.07127

M. Araujo: "Measurement of the polarizations of prompt and non-prompt J/Psi and Psi(2S) mesons produced in pp collisions at 13 TeV", https://repository.cern/records/zd28s-epk10

K.Dewyspelaere, G.Da Molin, G.B. Marozzo, M.Gallinaro: "Tau lepton reconstruction at the Muon Collider: Cross section measurement of the H->tautau process", https://zenodo.org/records/17651561

J. Varela et al.: "Performance of the front-end electronics of the CMS electromagnetic calorimeter barrel for the High-Luminosity LHC", arXiv:2511.17261

1 Proposals or related studies

N.Leonardo, A.Boletti, H.Legoinha: "Flavour as a tool towards new physics", European Strategy Discussion

Report 2025 - IV

Theses

3 Master

Daniela Cardoso: "Optimization of the local reconstruction in a high granular calorimeter using a heterogenous computing model" (finished), IST, Pedro Ferreira da Silva and Michele Gallinaro

Pedro Batista: "Study of central and exclusive production of charged Higgs boson pairs with forward proton tagging at the LHC, and projections for the HL-LHC" (finished), FCUL, Jonathan Hollar and João Nuno Pires

Madalena Ferreira: "Search for central exclusive production of tau+ tau- pairs in proton-proton collisions at the LHC" (ongoing), UA, Jonathan Hollar, Carlos Azevedo and Michele Gallinaro

6 PhD

Mariana Araújo: "Quarkonium production studies at LHC energies: towards the understanding of bound-state formation by the strong force" (finished), IST, Pietro Faccioli and Carlos Lourenço

Johan Wulff: "Timing Detectors and Measurements of Higgs Boson Properties" (ongoing), IST, Michele Gallinaro and Jonathan Hollar

Giacomo Da Molin: "Study of lepton universality in top quarks pairs events" (ongoing), IST, Michele Gallinaro and Pedro Silva

Giovanni Marozzo: "Search for New Physics in gauge boson scattering with the CMS experiment at the Large Hadron Collider" (ongoing), IST, Jonathan Hollar and Michele Gallinaro

Henrique Legoinha: "Probing the primordial quark gluon plasma with heavy flavour" (ongoing), IST, Nuno Leonardo

Raphaël Guitton: "Measurements of Higgs boson properties and search for BSM physics" (ongoing), IST, Michele Gallinaro

Report 2025 - V

3) Experiment operation and maintenance

a) Physics objects development:

LIP members pursued participation in the activities of POGs (Physics Object Groups) for Tau identification (G.B.Marozzo) and in the validation of forward proton alignment and reconstruction efficiency (G.B.Marozzo, J.Hollar). A member of the LIP/CMS group (J.Hollar) led the preparation of the reference paper describing key features of the proton reconstruction procedure, efficiency and reconstruction. Results of single time-of-flight and tracking sensor efficiencies, and vertex position reconstruction with PPS timing detectors using Run3 data were published. Group members (R.Guitton, G.B.Marozzo) are the MC contacts in the SMP and HIG Physics Analysis Groups (PAGs) for the production of simulation samples; one group member (G.DaMolin) is the "Combine" contact in the Top PAG.

b) PPS commissioning and operation:

Under the leadership of LIP members serving as PPS Project Managers (J.Varela, J.Hollar), PPS collected over 300fb-1 of data in Run2 and Run3 combined. The group had leading roles in the PPS DAQ system (J.Hollar) and the Timing detectors (M.Gallinaro). LIP made major contributions to the timing detector electronics, online software, and detector operations. Since 2021, a LIP member has served as Project Manager (J.Hollar). Members of the group are actively involved in physics analyses using PPS data (MSc student M.Ferreira; M.Gallinaro, J.Hollar), and had leading roles in the first PPS physics publications. Group members served as experts-on-call (PPS-DOC).

c) Computing: A member of the group served as LIP/CMS interface with the LIP's Tier2 group.

d) General: The group provided central shifts and EPR work according to the rules of the CMS collaboration. A group member took part in the ion data operations at CERN-P5 (Nov-Dec 2025); group members participated in test beam activities at the CERN-Prevessin site.

4) Phase 2 Upgrades (HL-LHC)

The activities towards the Phase-2 upgrade carried by the group are organized in four areas:

a) R&D in the Barrel Timing Layer: Development of the frontend readout system of the timing detector (LYSO crystals and SiPMs) based on a fast-timing TOF ASIC provided by Portuguese industry (full LIP responsibility).

b) R&D for the PPS timing detectors: Develop LGAD sensors and associated electronics for use as timing detectors in the HL-LHC PPS upgrade, resistant to highly non-uniform radiation and with good (~40-50ps per plane) time resolution.

c) R&D in the ECAL frontend readout system: Development of the new ECAL readout system based on a new 160MS/s low power ADC ASIC provided by Portuguese industry (CEA Saclay, INFN-Torino and LIP responsibility).

d) R&D on the High Granularity Calorimeter: Support to the development of low voltage regulator (LVR) ASIC resistant to radiation provided by the Portuguese industry.

While a) and b) are the main focus of the current LIP/CMS group activities, c) and d) were developed in collaboration with the Portuguese industry and were successfully completed.

In the context of the detector R&D activities, group members joined the newly formed DRD1 (gas detectors) and DRD3 (solid state detectors) collaborations, continuing earlier involvement in RD51 (PICOSEC, Micromegas gas detector for precise time measurements) and RD50 (LGAD, silicon sensor for fast timing applications at the HL-LHC), respectively.

Report 2025 - VI

Group members have the following coordination positions in the CMS collaboration structure:

- PPS Coordinator (Level-1), since 2021 (J.Hollar)
- B-Physics Data Analysis Coordinator (Level-3), since 2023 (A.Boletti)
- Standard Model (SMP) PAG Monte-Carlo contact, since 2023 (G.B.Marozzo)
- Combine Top PAG contact, since 2025 (G.DaMolin)
- Higgs (HIG) PAG Monte-Carlo contact, since 2025 (R.Guitton)
- MTD/BTL commissioning coordinator, since 2024 (A.Boletti)
- LHC HF WG co-convener, since 2021 (N.Leonardo)
- CMS Young Scientist Committee Portugal regional representative, since 2024 (G. Da Molin)

LIP group members participate in the following CMS structures:

- CMS Collaboration Board (M.Gallinaro, J.Varela)
- CMS Finance Board (M.Gallinaro, J.Varela)
- CMS Management and Executive Boards (J.Hollar)
- CMS Publication Board (N.Leonardo)
- ECAL and HGCAL Institution Boards (J.Varela)
- MTD and PPS Institution Board (M.Gallinaro)
- MTD Steering Committee (J.Varela)

Organized Events

3 Advanced Training Events

14th Course on Physics at the LHC, LIP Lisbon, 2025-02-17 - 2025-07-04

Machine Learning for Physics, Lisbon, 2025-03-13 - 2025-03-14

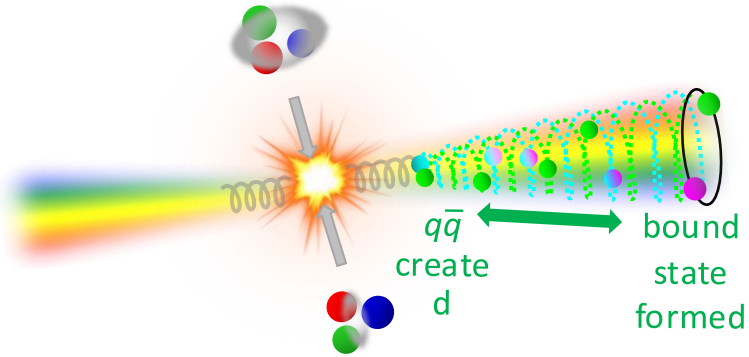
Flavour physics at LHC School, CERN, 2025-05-26 - 2025-05-30

Quarkonia

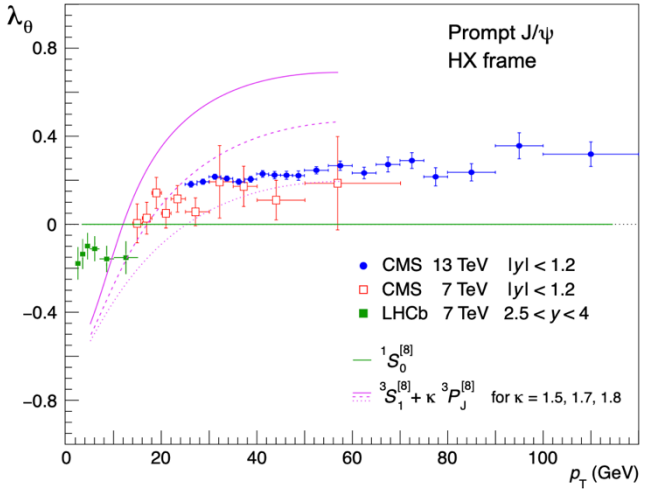
arXiv:2406.14409

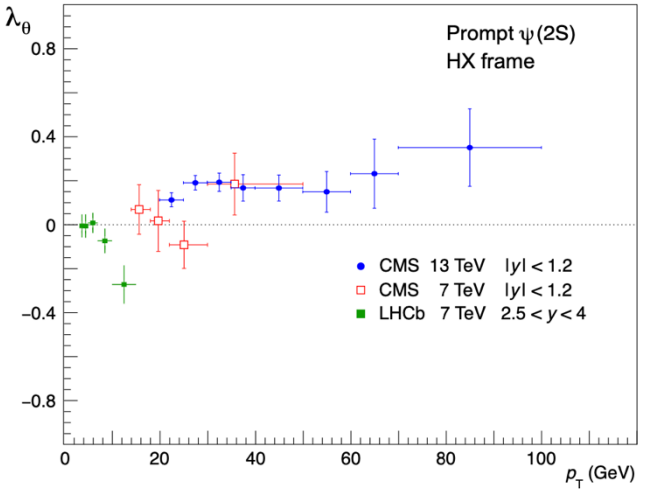
- Measure polarization of prompt and non-prompt J/Psi and Psi(2S) mesons at 13 TeV
- The heavy c and b masses allow to study the (long-distance) bound state formation without complications caused by the (short-distance) qq creation step
- Polarization is the best observable to understand how the bound states are formed
- CMS measurements (with LIP leadership) highlighted and solved long-term puzzles

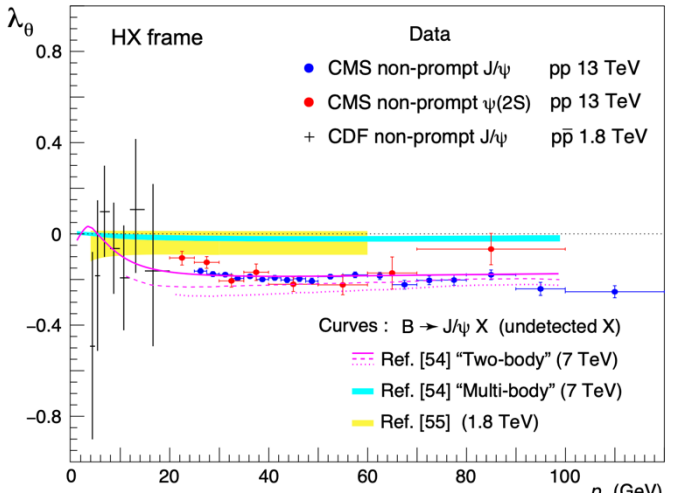
PhD student M.Araujo, P.Faccioli, C.Lourenço, J.Seixas



⇒ much improved S-wave polarization measurements using Run 2 data



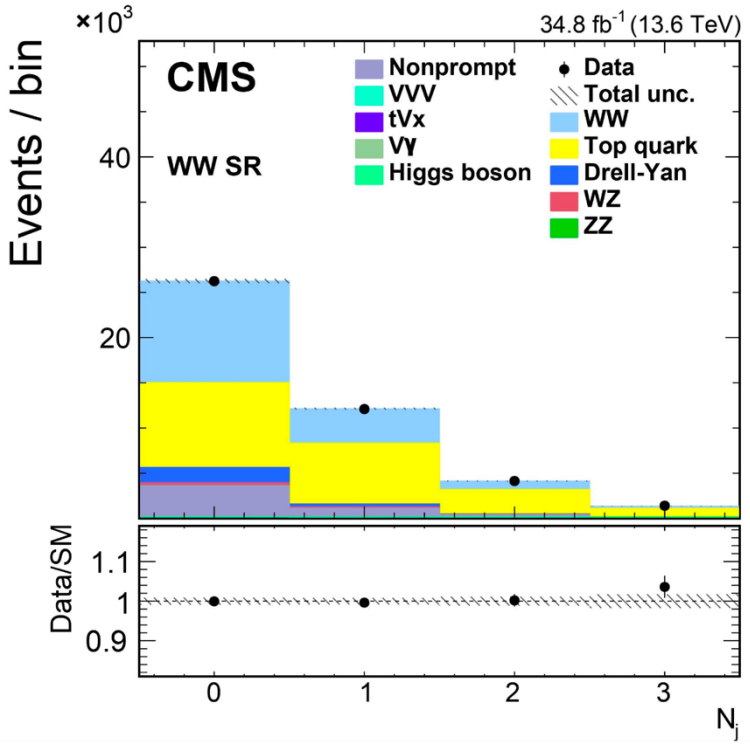




WW ($e/\mu,\tau_h$)

- WW production at 13.6 TeV
- Include tau leptons
- Define CRs and SR
- Combine and fit

Ongoing with Run3 dataset
(PhD student: G.B.Marozzo)



- Study WW production, where one W decays to a light **lepton** (e, μ) and other to hadronic **tau** (τ_h).
- **First measurement** at LHC

Current status:

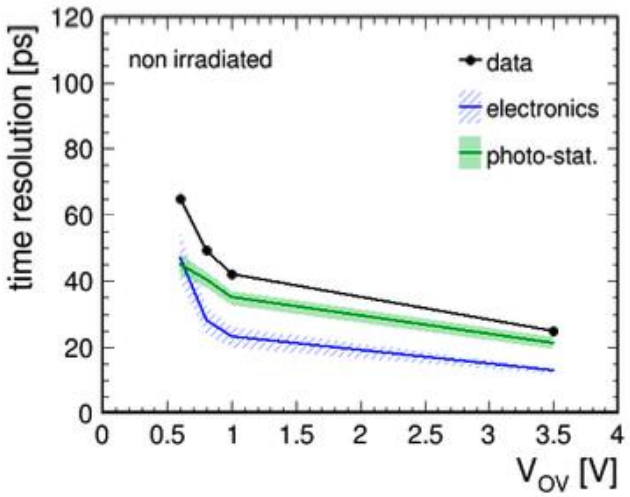
- Analysis workflow for Run3 (**2022+2023)** dataset
- Refined background estimation for **tau Fake Rates**
- Finalized **systematics** estimation
- Ongoing approval process

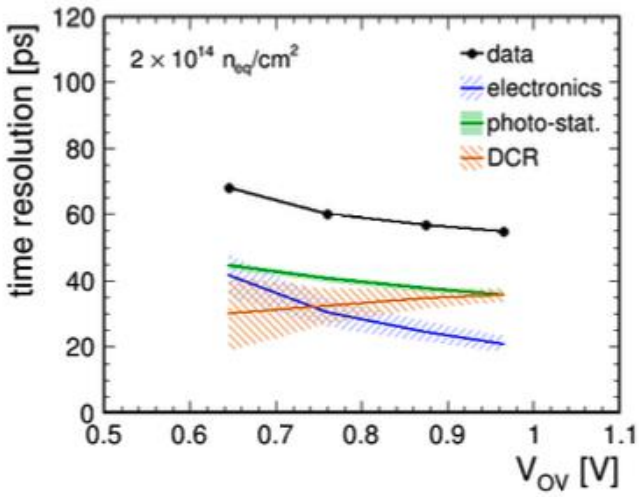
MTD/BTL module characterization

arXiv:2504.11209

Extensive test beam campaign in 2024

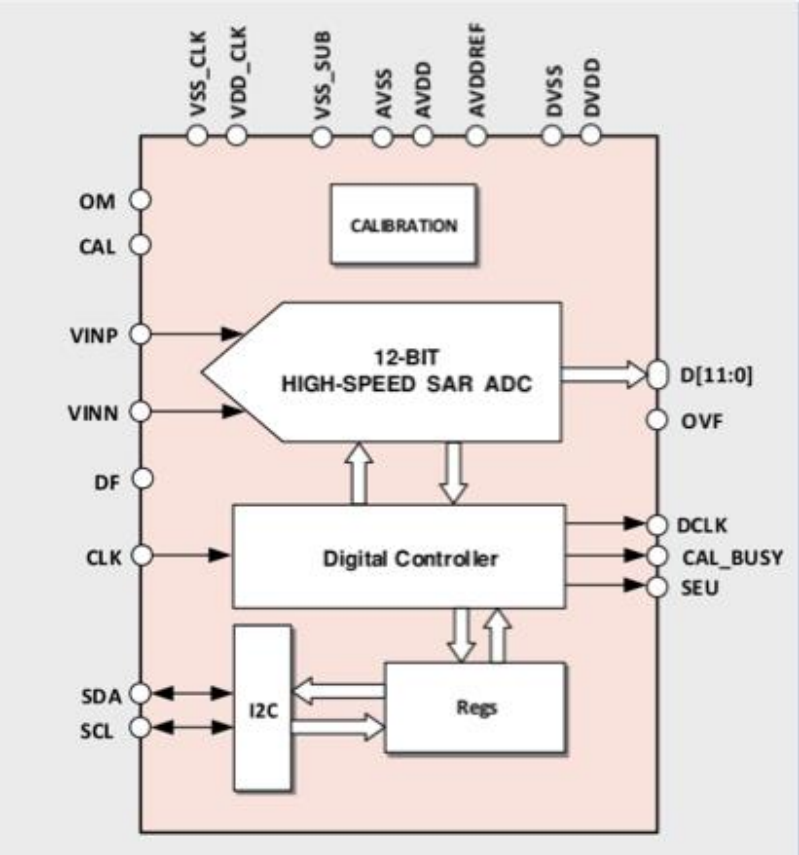
- Full system tests
- Reach desired performance of detector modules (radiation tolerance, time resolution, uniformity)





ECAL

- Long term LIP responsibility for ECAL electronics/DAQ
- HL-LHC: full replacement of electronics to meet new trigger/pileup requirements
- Collaboration with Portuguese industry developing new low-power ADC IP block
- 12 bit resolution with sampling rate of 160MS/s
- First design provided and integrated in LITE-DTU chip for evaluation since 2020



HGCAL: new rad-hard ASIC

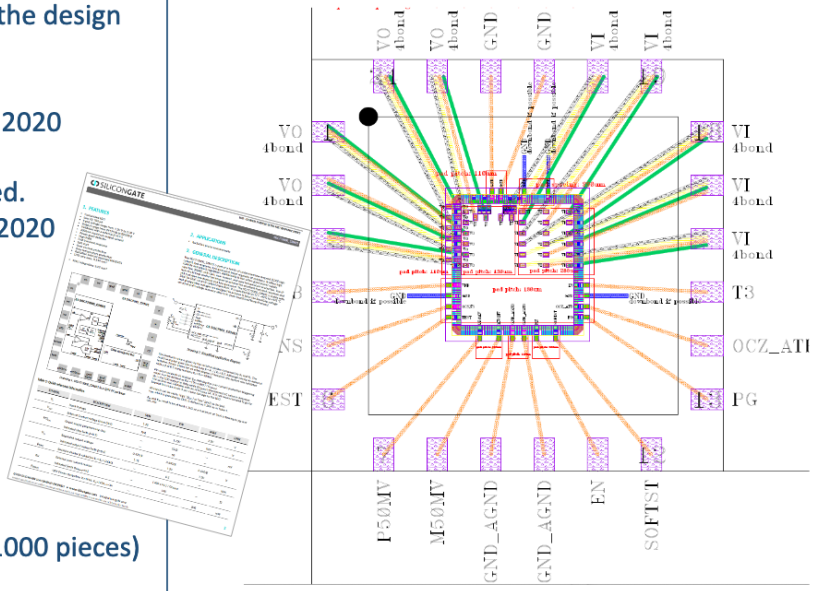
New rad-hard ASIC developed by Portuguese industry performs well

CERN contract placed with SiGate in Portugal for the design and electrical characterization.

- TSMC 130nm, CRN01 LDO submission March 2020
- Electrical characterization done at SiGate
- Very detailed characterization report delivered.
- Excellent results shown by Sandro at TWEPP 2020
- Also presented to ESE
- Data Sheet available.

TID testing at CERN to 1.1Grad, all fine.
SEE tests planned in May 2021

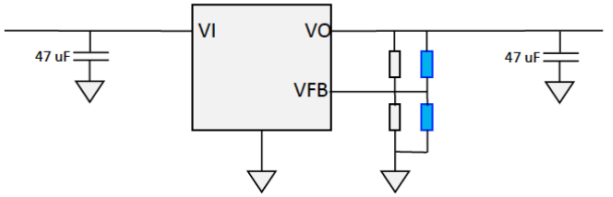
- A 2nd (slightly modified) design ongoing
- CRN02 design review April 2021
- Prototyping on Omega's ALTIROC Eng Run (~1000 pieces)
- Full production later this year
- Could be of interest to other projects.



QFN24 Package

Summary Specifications

- Tech : 130nm CMOS
- I_{max} : 3A
- Vin_{max} : 2 V
- Adjustable V_{out} : 1.0 - 1.5 V
- V_{out}-V_{in} : 175 mV @ I_{max}
- OverTemp, overI protection
- Digital adjust : +/- 50 mV control
- Digital enable
- Max dissipation : 500 mW**
- Small form factor



Binning into 2 or 3 types for voltage adjustment using resistors mounted on the boards

DCDC Module Design

LD bPOL12 module

Slide from presentation at CMS week (April 2021)