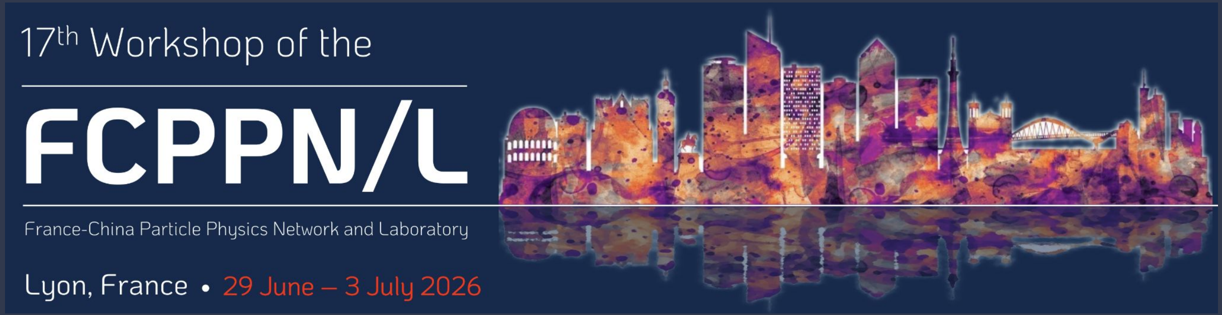
CMS Highlights

Jessy DANIEL, on behalf of the CMS collaboration



OUTLINE

I. Run 3 data taking & detector performances

II. Recent Physics Highlights
- ❖ SM Physics
- ❖ B-Physics
- ❖ Top Physics
- ❖ Higgs Physics
- ❖ BSM Physics

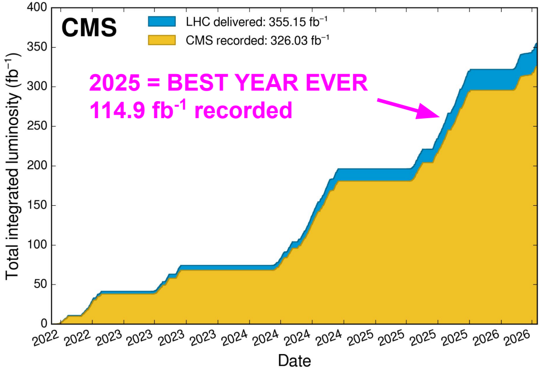
III. LS3 & CMS Phase II Upgrade

Many more recent results !
This is a personal (biased) choice of analysis

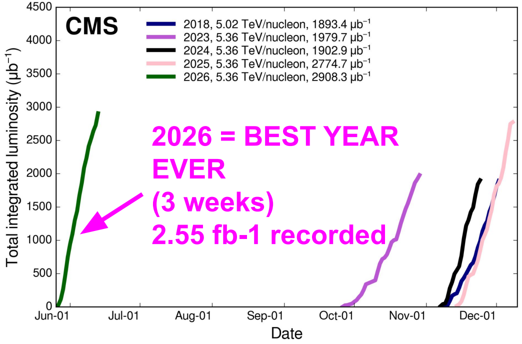
CMS Data Taking in Run 3

Proton Physics :
- ❖ Efficiency : 92 %
- ❖ Data certification efficiency : 97 %

ML usage → **improvement of 3-4% w.r.t Run 2**



Heavy Ion (PbPb) physics :

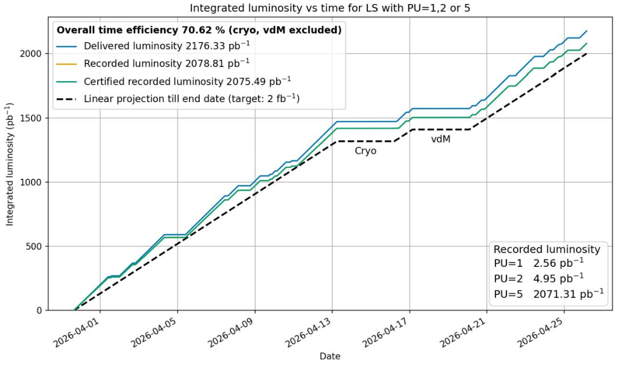


2025 special run : 10 days of light ions
- ❖ p–O (9.62 TeV) : 46.6 nb^{-1} recorded
- ❖ O–O (5.36 TeV) : 9 nb^{-1}
- ❖ Ne–Ne (5.36 TeV) : 0.87 nb^{-1}

10x target

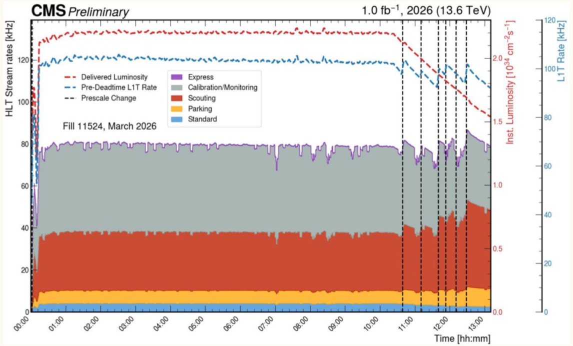
HIN-25-008 HIN-25-014 HIN-25-015

2026 special run :
Low PU=5 (3 weeks)
→ W mass
→ SM cross-sections precisions
→ PU=1,2 for diffractive physics



Trigger strategy:
maximizing physics coverage within bandwidth and computing limits

Proton Physics :
- ❖ **L1 Trigger : ~100kHz**
- ❖ **HLT rate (main+parking) : ~10kHz**
- ❖ **HLT scouting rate : ~30kHz**



Ion Physics :
- ❖ **L1 Trigger : ~120-130kHz**
- ❖ **DAQ Bandwidth up to 38 GB/s**

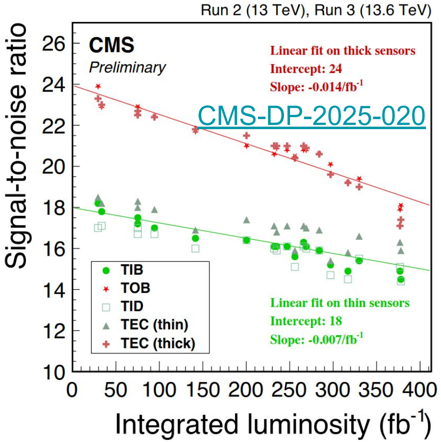
↓

Collection of all hadronic events + enhancement of ultraperipheral collision (UPC) triggered events from tracking zero suppression

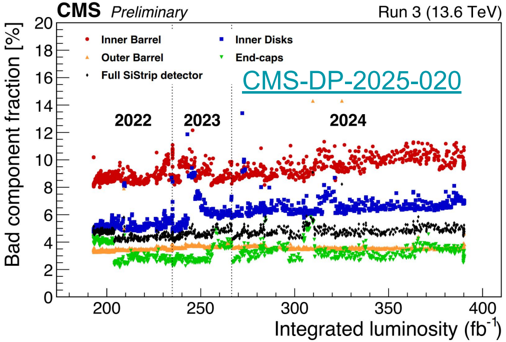
CMS Detector Performance in Run 3

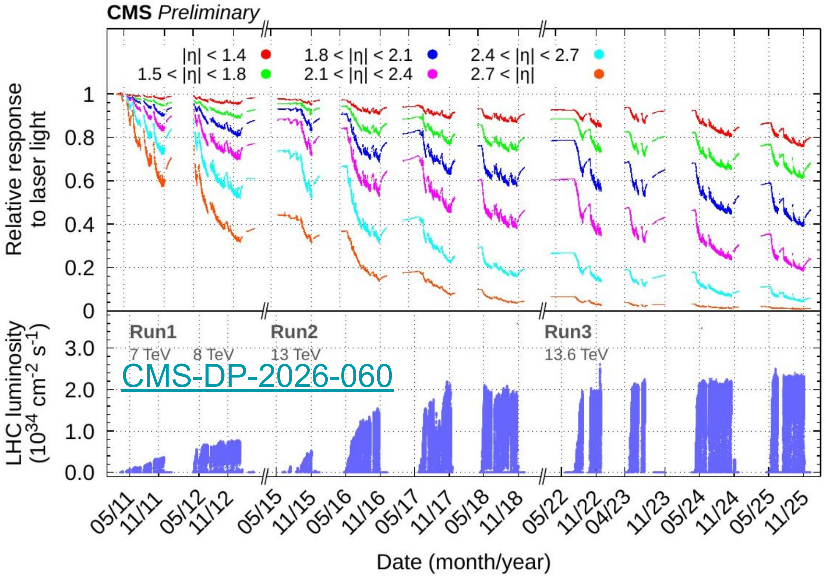
- The detector is **beyond design luminosity / radiation dose**
  - **Large radiation damage** can be seen in tracker and endcap+forward calorimeters
  - **Enormous effort to mitigate** the radiation damage effects

Tracker S/B ratio through time



Number of bad components in Tracker through time



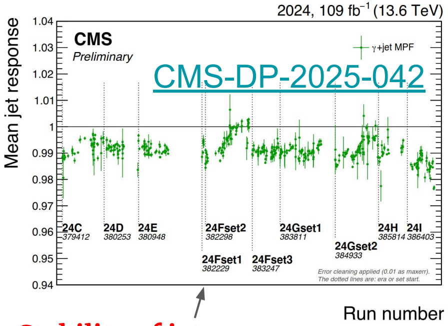


ECAL response to laser light
→ Crystals transparency loss

CMS Detector Performance in Run 3

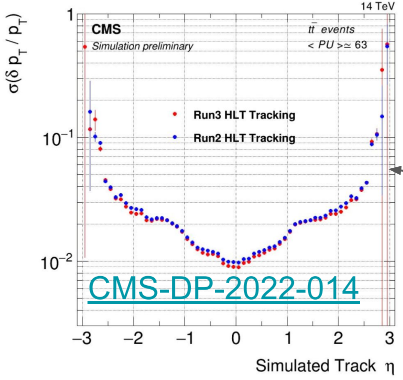
- The detector is **beyond design luminosity / radiation dose**
  - **Large radiation damage** can be seen in tracker and endcap+forward calorimeters
  - **Enormous effort to mitigate** the radiation damage effects

- **But our global performances stay excellent !**



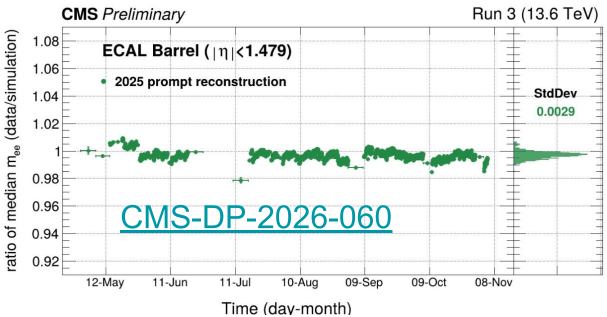
CMS-DP-2025-042

Stability of jet energy response

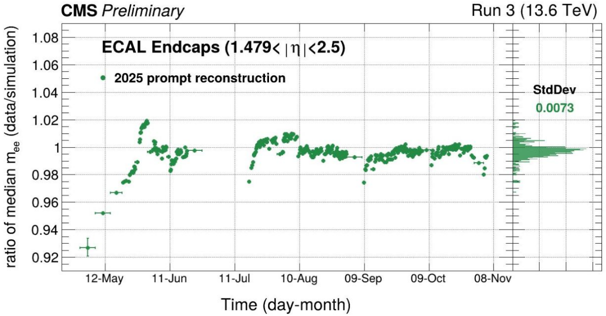


CMS-DP-2022-014

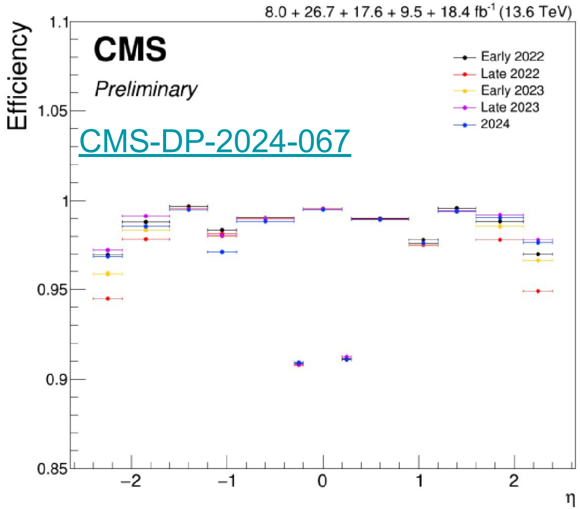
Still excellent pT resolution



CMS-DP-2026-060



Stability of m(ee) over time in ECAL

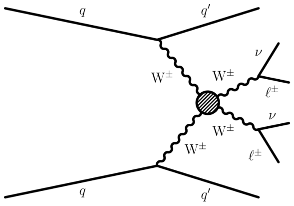


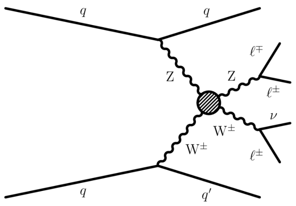
CMS-DP-2024-067

Muon reconstruction efficiency ~98%
Consistent through detector

More details in CMS DP notes

Measurement of Vector Boson Scattering (VBS) in WW and WZ channels at 13.6 TeV





Motivation : VBS directly **probes the EW sector and quartic gauge couplings**

Goals : After observation with Run 1+2 (arxiv 2005.01173)-> getting into precision measurement

- ❖ Using pure **leptonic channels**
- ❖ With data collected in 2022-2024 (171 fb^{-1}) at 13.6 TeV

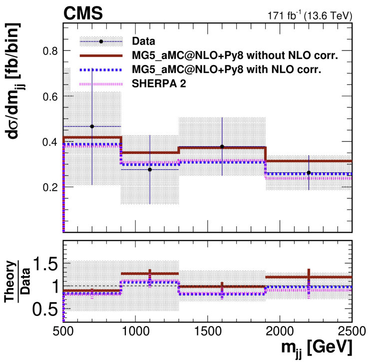
SMP-25-013

Submitted to JHEP

Results :

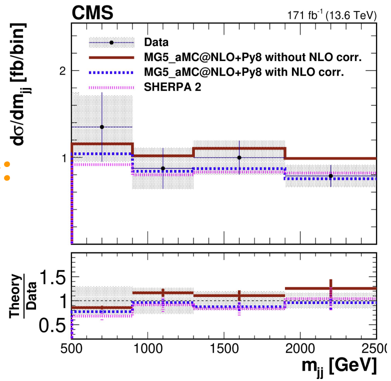
- ❖ **EW-induced production of $W^{\pm}W^{\pm}$ and WZ observed at significance of > 5σ each**
- ❖ Differential measurements performed in m_{jj}, m_{ll}, N_j, $\Delta\eta_{jj}$, $\Delta\varphi_{jj}$
- ❖ Inclusive and differential fiducial cross section in **good agreement with SM predictions**
- ❖ Analysis still statistically limited

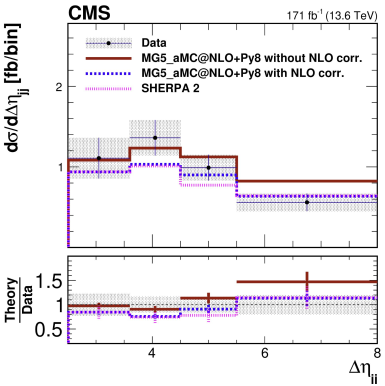
EW W±Z :



Process	$\sigma\mathcal{B}$ (fb)	Predictions (fb) MADGRAPH5_aMC@NLO without NLO corrections	MADGRAPH5_aMC@NLO with NLO corrections	SHERPA without NLO corrections
EW $W^{\pm}W^{\pm}$	3.81 ± 0.38 0.33 (stat) ± 0.18 (syst)	4.27 ± 0.38	3.51 ± 0.31	3.37 ± 0.50
EW+QCD $W^{\pm}W^{\pm}$	4.32 ± 0.40 0.36 (stat) ± 0.18 (syst)	4.75 ± 0.52	3.99 ± 0.44	—
EW WZ	1.43 ± 0.26 0.23 (stat) ± 0.12 (syst)	1.45 ± 0.13	1.25 ± 0.11	1.24 ± 0.19
EW+QCD WZ	4.75 ± 0.35 0.27 (stat) ± 0.22 (syst)	4.59 ± 1.07	4.39 ± 1.05	—

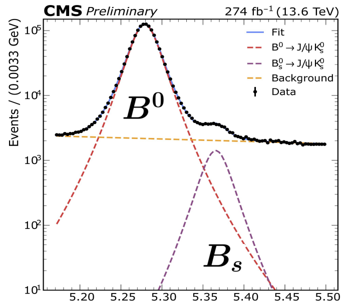
EW W±W±:





CMS B-Physics Highlights

Measurement of time-dependent CP violation in $B^0_{(s)} \to J/\Psi K^0_s$ → CMS enters the sin(2β) program !



BPH-26-005

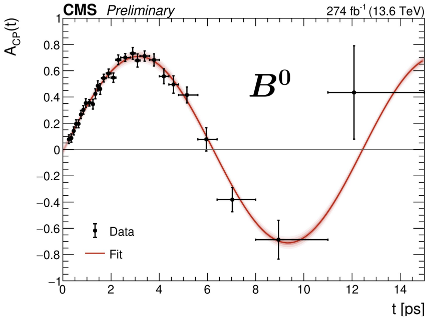
- **Motivations :**
  - ➢ Key flavour probes of CP violation
  - ➢ Precise measurements of the CKM elements → indirect constraints on generic BSM scale
- **First measurement of sin(2β) and sin(2βs) at CMS**
- With data collected in 2022-2025 (274 fb^{-1}) at 13.6 TeV, **>1.5 millions candidates**
- **Online Selection by a high-rate dimuon trigger** (Data parking)
- State-of-the-art **AI-based flavour tagging**
  + novel precision-analysis techniques (for time calibration, etc)
- **Results :**
  - ➢ **CPV in B^0**: precision comparable to LHCb Run 2 result
  - ➢ **CPV in B$_s$**: factor ~2 improvement over previous precision

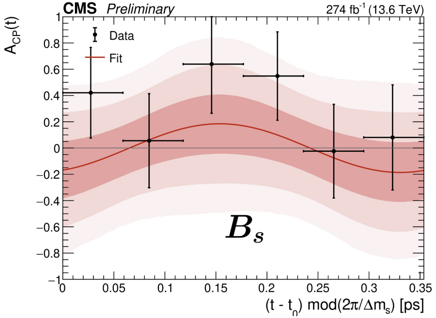
Mixing induced CPV

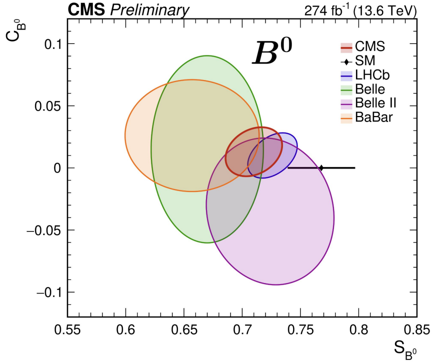
Direct CPV

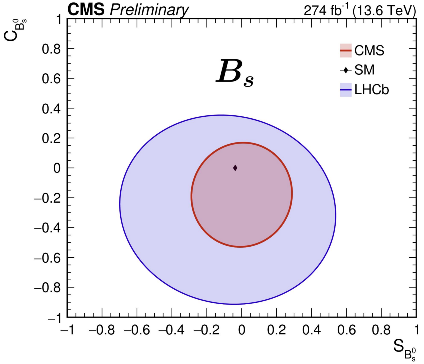
$$
\boxed{
\begin{aligned}
S_{B^0} &= 0.710 \pm 0.013\,(\text{stat}) \pm 0.009\,(\text{syst})\,,\\
C_{B^0} &= 0.013 \pm 0.011\,(\text{stat}) \pm 0.006\,(\text{syst})\,,\\
S_{B^0_s} &= 0.00 \pm 0.19\,(\text{stat}) \pm 0.00\,(\text{syst})\,,\\
C_{B^0_s} &= -0.18 \pm 0.23\,(\text{stat}) \pm 0.01\,(\text{syst})\,.
\end{aligned}
}
$$

All results are in agreement with SM !







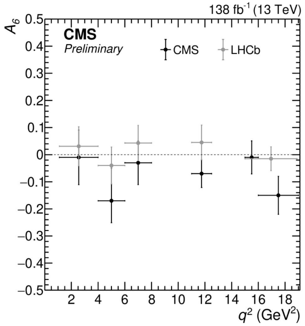


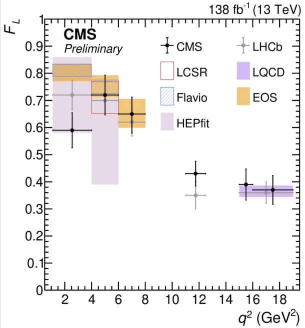
Exploring rare decays

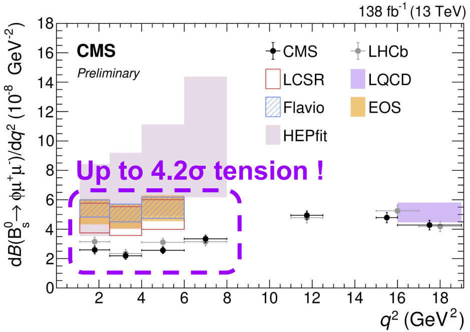
BPH-23-003

Measurement of differential branching fractions and angular observable of $B_s^0 \to \phi\mu^+\mu^-$ at 13 TeV (Run 2)

- **FCNC process, sensitive to NP effects in the loops**
- Differential BF in bins of dimuon invariant mass (q^2)
- Differential angular analysis determining :
  - A CP asymmetry parameter (A_6)
  - The longitudinal polarization of the ϕ meson (F_L)
- **Results :**
  - **Competitive with LHCb results**
  - Angular observables **in agreement with SM and LHCb**
  - **BF exhibits up to 4.2σ tension w.r.t SM theory predictions** (consistent with LHCb results)
  - Still statistically limited (expect improvement with Run 3)







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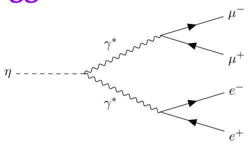
BPH-24-001

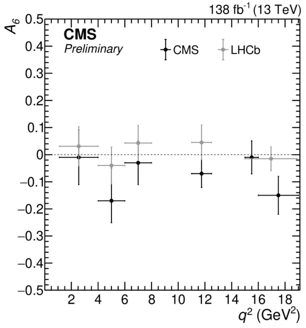
Submitted to PRL

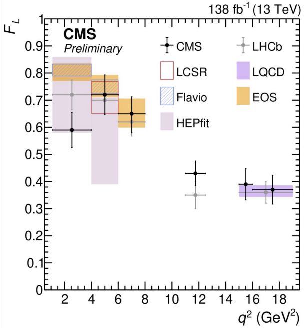
Observation of $\eta \to \mu^+\mu^-e^+e^-$

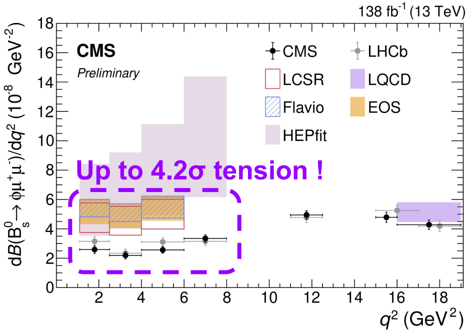
- **Motivation** : a Double Dalitz rare decay, **sensitive to NP effects + provides hadronic light-by-light input to muon g-2 calculations**
- Follows the observation of rare decay $\eta \to \mu\mu\mu\mu$ in 2023 (BPH-22-003)
- Using data parking with **high-rate dimuon trigger** with 2022 data (38 fb^{-1})
- **Normalization channel : $\eta \to \mu\mu\gamma$**
- **Results :**
  - **First observation of this rare decay**
  - $\boxed{\mathcal{B}(\eta \to \mu^+\mu^-e^+e^-) = (2.4 \pm 0.8) \times 10^{-6}}$
  - **2 orders of magnitude improvement in experimental sensitivity !**

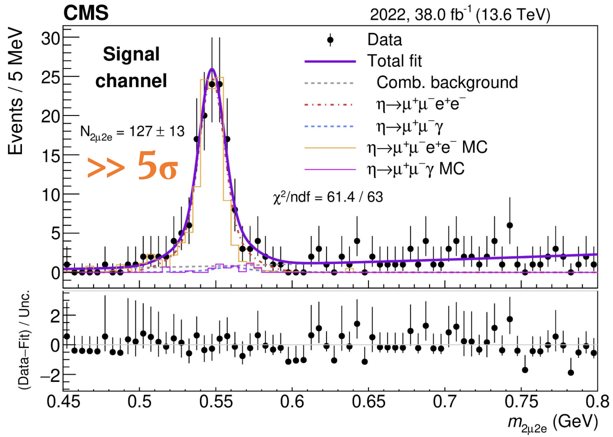


Consistent with SM









Heavy quark bound-state spectroscopy

BPH-25-009

Observation of a peaking structure in the $\Upsilon(1S)\phi(1020)$ final state with Run 2 data

$\mu^+\mu^-$ K^+K^-

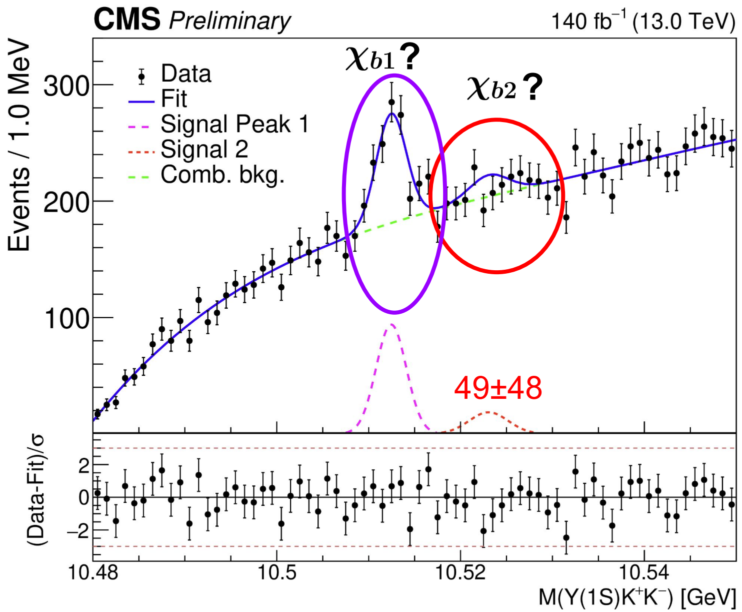
- **Motivation** : The strongly bound bottomonium (bb) system = **rich spectrum** → **tool for verifying perturbative and nonperturbative QCD**
- **A peaking structure is observed**, consistent with $\chi_{b1}(3P)$ bottomonium state
  - **Yield** : 450±59 (>8σ significance)
  - **Peak mass** : 10512.60 ± 0.21 (stat) ± 0.20 (syst) ± 0.11(M_Υ) MeV

    BUT : absence of the expected χ_{b2}(3P) Spin-2 partner !

Intriguing interpretation....

- **Is there a source of suppression ?**
  - Could be same process than for $\chi_{b2}(2P), \chi_{b1}(2P) \rightarrow \Upsilon\omega$?

    → factor 4 suppression according to arxiv:2512.08363 (BaBar)
  - Additional suppression due to detector acceptance and/or reconstruction efficiency ?
- **Exotic interpretation ?**
  - **Tetraquark bbss state or hybrid state ? Accidental χ_{b1} mass proximity ?**
  - **Contributions from χ_{b1} + exotic state (possible to disentangle?)**

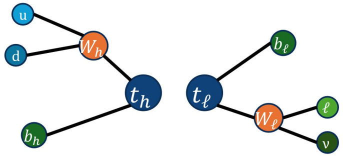


Toponium ?

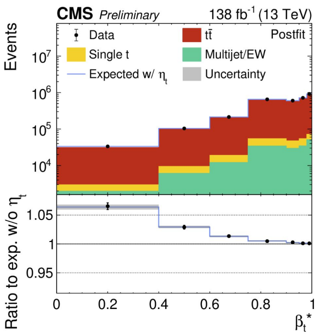
TOP-25-002

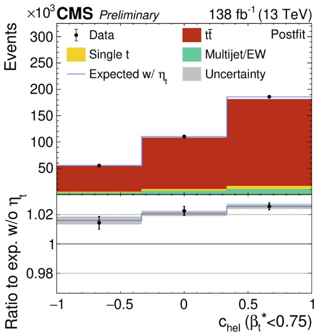
Observation of a pseudoscalar excess at the top quark pair production threshold in the single lepton channel

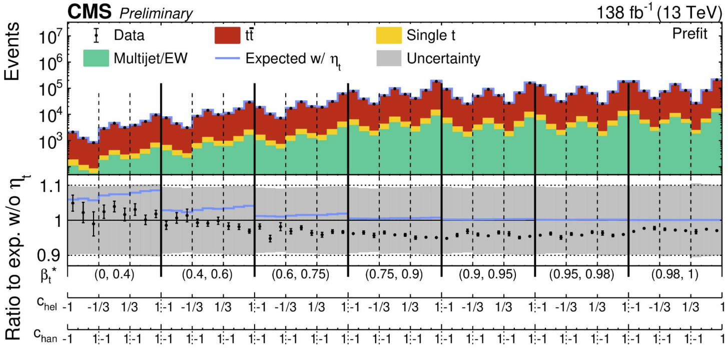
- Based on Run2 data (138 fb^{-1})
- Less sensitive to top quark mass and jet energy scale than dileptons channel TOP-24-007
- Examines the **relative velocity** between t and $\bar{t}$ + exploits the **angular distributions** of the $t\bar{t}$ decay products (sensitivity to the spin correlation and parity of the $t\bar{t}$ system) → **63 bins** in total

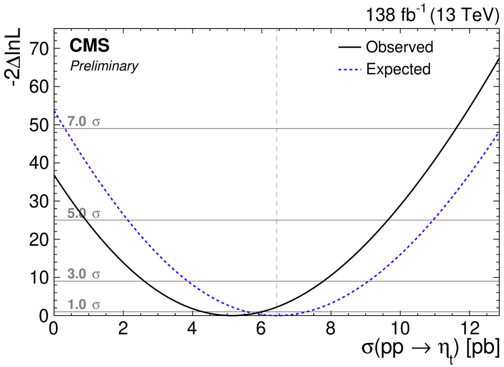


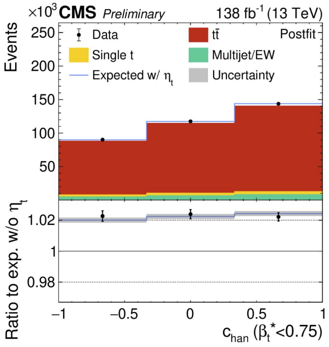
- **Results** :
  - Excess observed with a cross-section $\sigma(\eta_t) = 5.1 \pm 0.9\ pb$
  - Bkg-only hypothesis excluded with **6.1σ significance**
  - **Consistant with a color singlet pseuscalar toponium**
  - **New statistically independent confirmation of toponium production**
- **Further theoretical investigations needed to accurately model the tt threshold region**







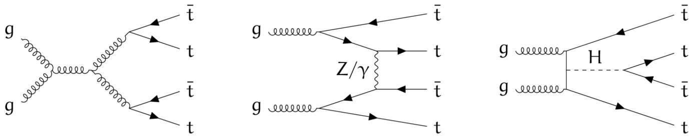




Multi-top final states

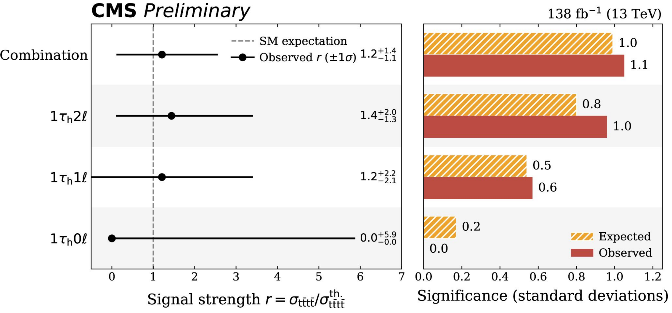
TOP-24-017

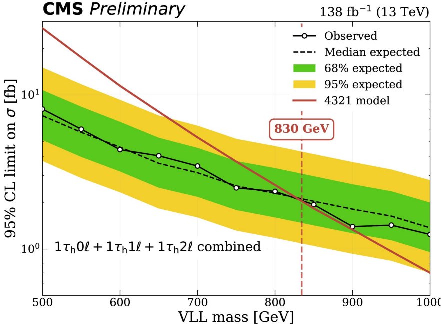
4-top production in final states with hadronic tau at Run 2



- This 25% BR channel was still unexplored
- **Motivations** :
  - **Sensitivity to BSM scenarios** with enhanced third-generation couplings
  - Complement established **multi-lepton searches**
  - **Possible deviation from SM seen in other final states**
- Three channels explored : τ_h + 0,1,2 leptons (e or μ)
- **Results** :
  - **Cross-section consistent with SM prediction within 1σ**
  - **Lower limit set to 830 GeV in search for vector-like leptons** (4321 model)

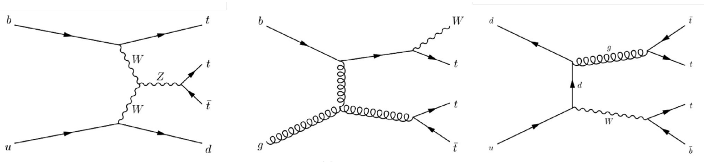
$$\boxed{\sigma(t\bar{t}t\bar{t}) = 16\,^{+14}_{-12}\,(\text{stat})\,^{+12}_{-8}\,(\text{syst})\,\text{fb} = 16\,^{+18}_{-15}\,\text{fb}}$$





TOP-24-006

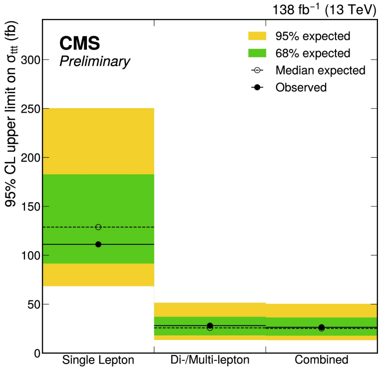
Search for 3-top production in leptonic channels at Run 2



- Final states with 1, 2 (same sign) or ≥ 3 leptons
- **First LHC analysis specifically targeting 3-top-quark production**
- **Results** :
  - No deviation from SM predictions
  - Upper limit set on the signal cross-section :

$$\sigma_{ttt} < 25\ (26\ exp.)\ fb$$

$$\sigma_{ttt}^{SM} = 2.05\ fb$$

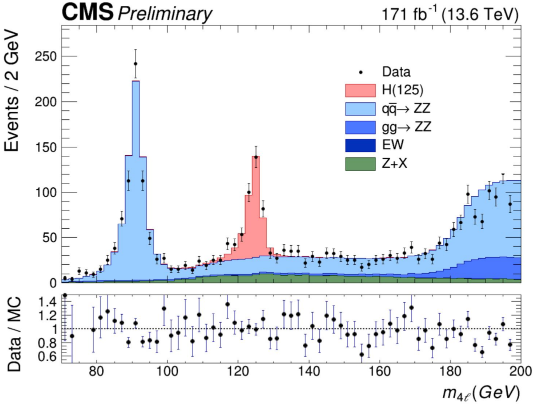


Higgs Properties

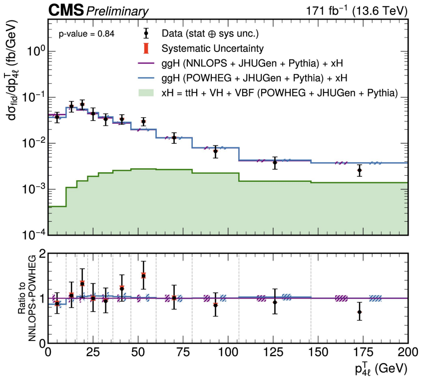
HIG-25-015

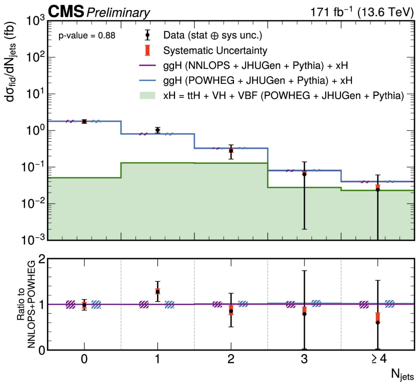
Measurement of inclusive and differential Higgs production cross-sections in H→ZZ→4l at 13.6 TeV

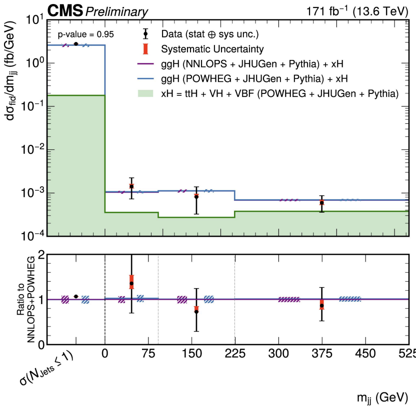
- Based on 2022+2023+2024 data (171 fb^{-1})
- **Motivations** : **probing couplings, inspecting the process kinematics, and isolate BSM effects**
- Cross sections **measured in a fiducial region** closely matching the experimental acceptance
- **Extended set of differential cross-sections are measured**
- **Dedicated measurements targeting the production of the Higgs boson via vector boson fusion**
- **Results** : **All cross-sections are in agreement with SM**

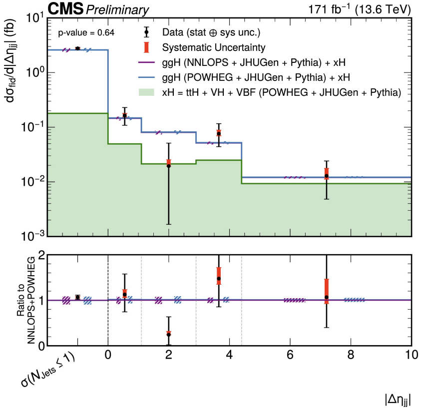


$$\sigma_{\text{fid}} = 3.11^{+0.22}_{-0.22}(\text{stat.})^{+0.14}_{-0.12}(\text{syst.})\text{ fb}$$





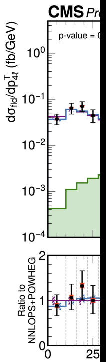


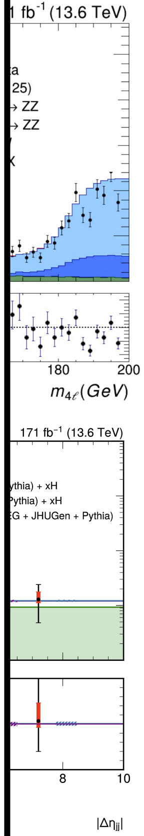


Higgs Properties HIG-25-015

Measur

- Bas
- Mot
- Cros
- Exte
- Ded
- Res



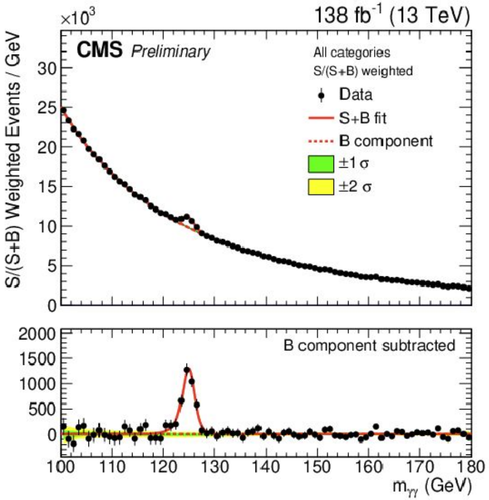


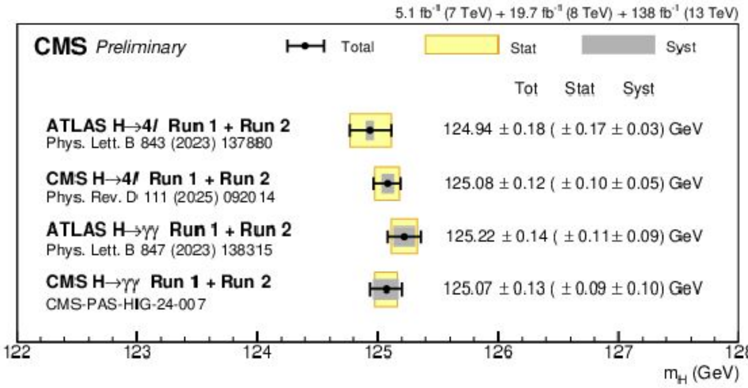
Measurement of the Higgs boson mass in H→γγ in Run 1 and 2

HIG-24-007

- ➢ Improved Run 2 mass :
- ➢ **New m(H→γγ) reference** using Run 1+2 data (consistent with other measurements)
- ➢ **Systematics are now at statistical uncertainty level**

$$\boxed{m_{\mathrm{H}} = 125.14 \pm 0.10\,(\mathrm{stat}) \pm 0.11\,(\mathrm{syst})\,\mathrm{GeV}}$$

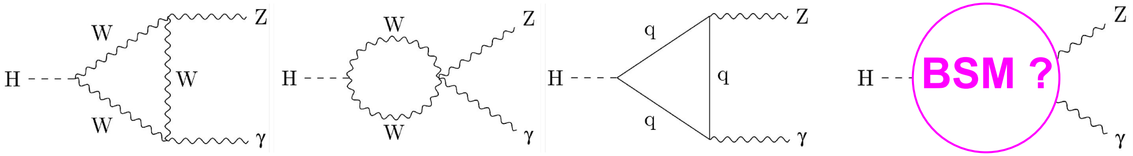


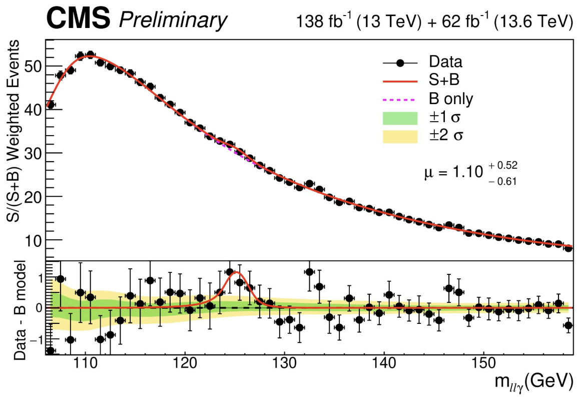


Dedicated talk by Fabio Iemmi this afternoon !

Rare Higgs decays

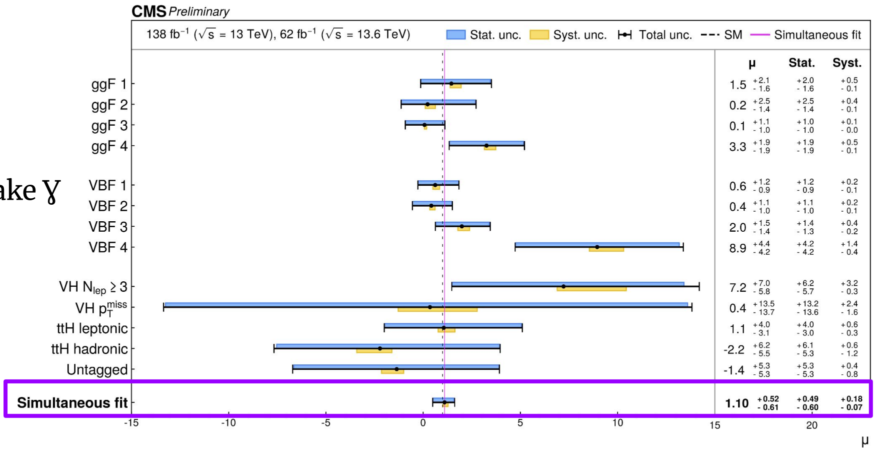
Search for the rare Higgs boson decay H->Zɣ in Run 2 + Run 3





- **Motivations** :
  - ➢ Loop induced process → **BSM sensitive to new particles** entering the loop diagram
  - ➢ **Probe if Higgs is a composite Nambu-Goldstone particle** arising from the strongly interacting sector
- Run 2 + 2022-2023 data samples (200 fb^{-1})
- Dilepton final state (Z→ll)
- Newly optimized trigger strategy
- **Optimized categories for ggF, VBF, ttH and VH (13 categories)**
- Challenge : **large non-resonant background** from SM (pp->Zɣ) and Z+fake ɣ
- **Results :**
  - ➢ **Obs (exp.) signal strength :** $\boxed{\mu = 1.10^{+0.52}_{-0.61}\ (1.00^{+0.49}_{-0.46})}$
  - ➢ **Obs (exp.) excess significance :** $\boxed{\sigma = 1.9\ (2.3)}$
  - ➢ **High degree of compatibility across the categories**

HIG-25-010

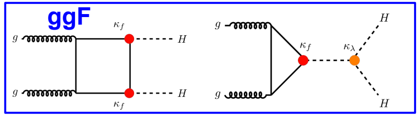


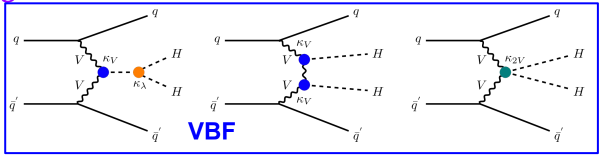
Double Higgs & Higgs potential

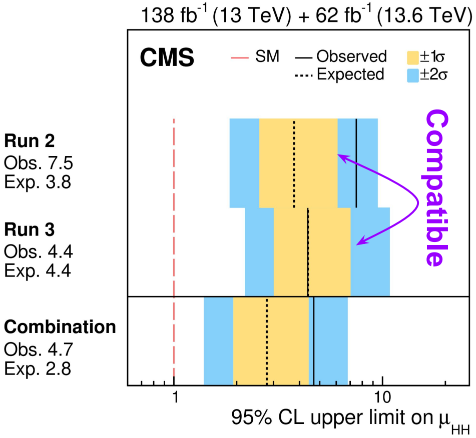
HIG-24-010
Submitted to PRD

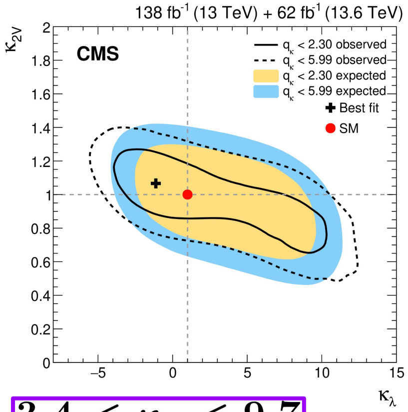
Measurement of HH production in 4b final state

- 2022-2023 data (62 fb^{-1}) + Re-analysis or Run 2 data
- **Independently measures** both resolved and merged topologies
- Targets ggF and VBFHH productions
- **Improved sensitivity** w.r.t Run 2 thanks to :
  - Dedicated parking stream (larger rate : 150Hz in 2023)
  - Improved trigger
  - Analysis sophistication (ML, b-tagging based on a particle transformer)









$\mu_{HH} < 4.4$

46% improvement w.r.t Run 2 analysis

$3.4 < \kappa_\lambda < 9.7$

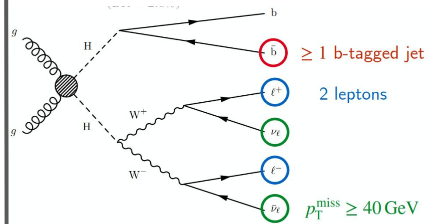
$0.68 < \kappa_{2V} < 1.38$

Most stringent limit to κ_{2V} to date !

HIG-25-018
Submitted to JHEP

HH→bbWW

- 2022+2023 data
- Resolved + boosted topologies
- Search for ggF and VBF HH productions
- Targeting **di-leptons** events
- **Sensitivity improved** with :
  - refined classification strategy
  - additional triggers
  - enhanced **b-tagging (particle transformer based)**

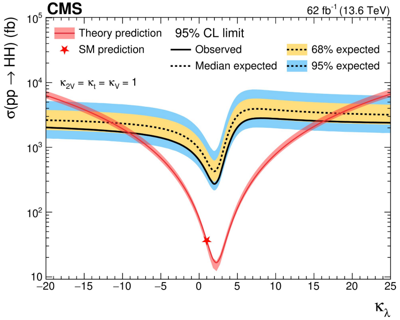


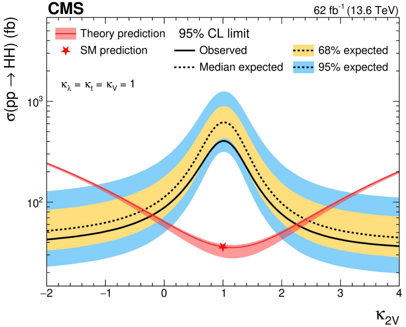
$\mu_{HH} < 12.0\ (exp.\ 18.5)$

~30% improvement w.r.t Run 2 analysis

$-9.1 < \kappa_\lambda < 15.7$

$-0.20 < \kappa_{2V} < 2.25$





CMS Higgs Physics Highlights

HIG-24-010
Submitted to PRD

Double Higgs & Higgs potential

HIG-25-018
Submitted to JHEP

M

❖ 2022–20
❖ Indepe
❖ Targets
❖ Improv
➢ Dedica
➢ Impro
➢ Analys

Run 2
Obs. 7.5
Exp. 3.8

Run 3
Obs. 4.4
Exp. 4.4

Combination
Obs. 4.7
Exp. 2.8

μ_H

46% i
Run 2

oductions

$18.5)$

analysis

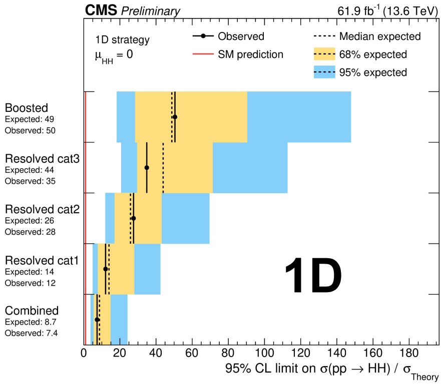
2.25

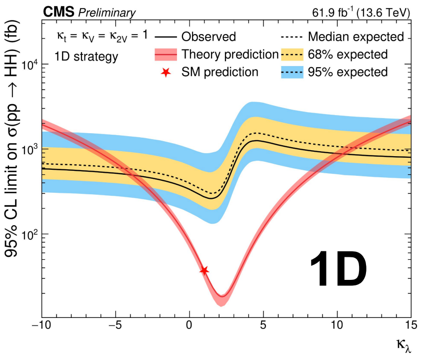
HH→bbγγ at Run 3

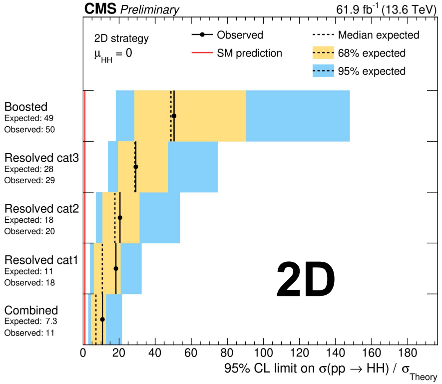
HIG-25-007

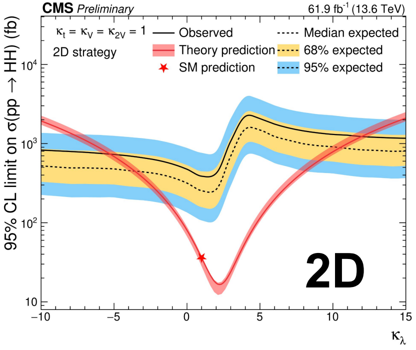
❖ 2022+2023 data (Early Run 3 results)
❖ Resolved + Boosted topologies
❖ 2 complementary & consistent approaches :
➢ 1D fit to $m_{\gamma\gamma}$: $\boxed{\mu_{HH} < 7.4\ (8.7)}$
$\boxed{-3.9 < \kappa_\lambda < 10.1}$
➢ 2D fit to $(m_{\gamma\gamma}, m_{jj})$: $\boxed{\mu_{HH} < 11.0\ (7.3)}$
$\boxed{-6.1 < \kappa_\lambda < 12.8}$

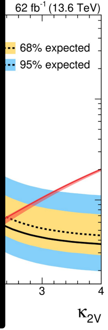
Dedicated talk by E.Didier-Esteve this afternoon !







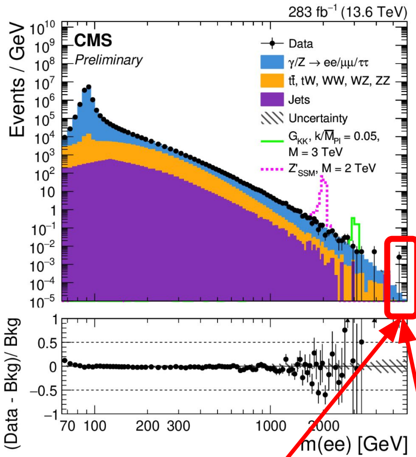


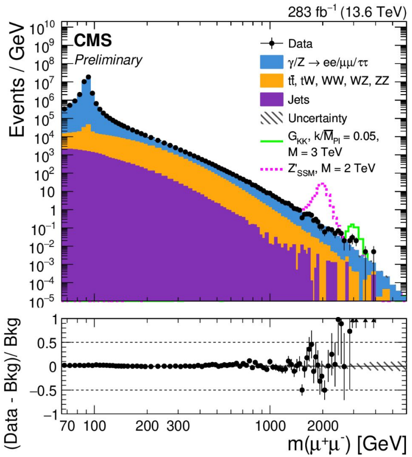


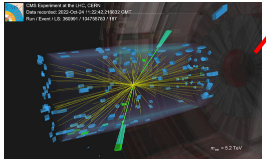
Inclusive search for high-mass dilepton resonances

- Run 3 data collected in 2022-2025 (283 fb^{-1})
- Improvement w.r.t run 2 analysis :
  - Double dataset in size
  - Increased collision energy
- Focus on two very energetic same-flavor leptons
- Covering large mass range from 200 GeV to 6 TeV
- **Results** :
  - No significant excess above SM has been observed
  - **Largest excess : 2.6σ (local) at 5.2 TeV**
  - Interpretation and **mass limits** (most stringent to date) :
    - Spin-1 : Heavy Z' gauge boson (SSM or E_6-based models)
    - Spin-2 : Kaluza-Klein gravitons

EXO-25-021



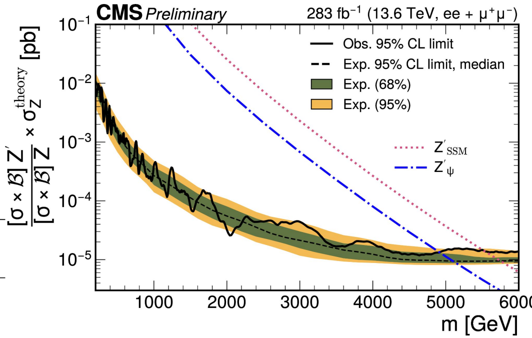


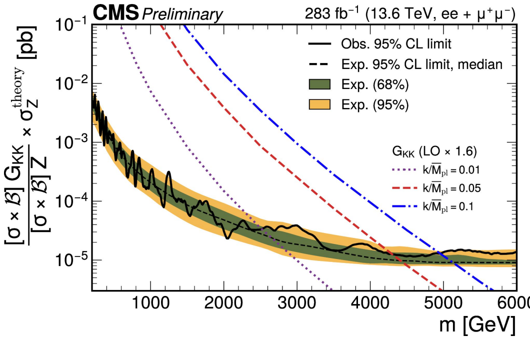


One very energetic event at 5.2 TeV !

Channel	Z'_{SSM} Obs. [TeV]	Z'_{SSM} Exp. [TeV]	Z'_{ψ} Obs. [TeV]	Z'_{ψ} Exp. [TeV]
ee	5.00	5.30	4.50	4.65
$\mu\mu$	5.50	5.50	4.85	4.90
ee+$\mu\mu$	5.55	5.80	4.95	5.15

Channel	$k/\overline{M}_{Pl}=0.01$ Obs. [TeV]	$k/\overline{M}_{Pl}=0.01$ Exp. [TeV]	$k/\overline{M}_{Pl}=0.05$ Obs. [TeV]	$k/\overline{M}_{Pl}=0.05$ Exp. [TeV]	$k/\overline{M}_{Pl}=0.1$ Obs. [TeV]	$k/\overline{M}_{Pl}=0.1$ Exp. [TeV]
ee	2.50	2.50	3.90	4.10	4.60	4.75
$\mu\mu$	2.35	2.45	4.00	4.25	4.90	4.90
ee+$\mu\mu$	2.5	2.8	4.4	4.4	5.0	5.2



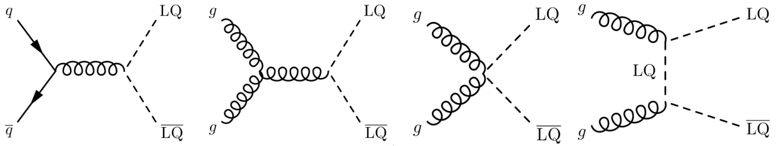


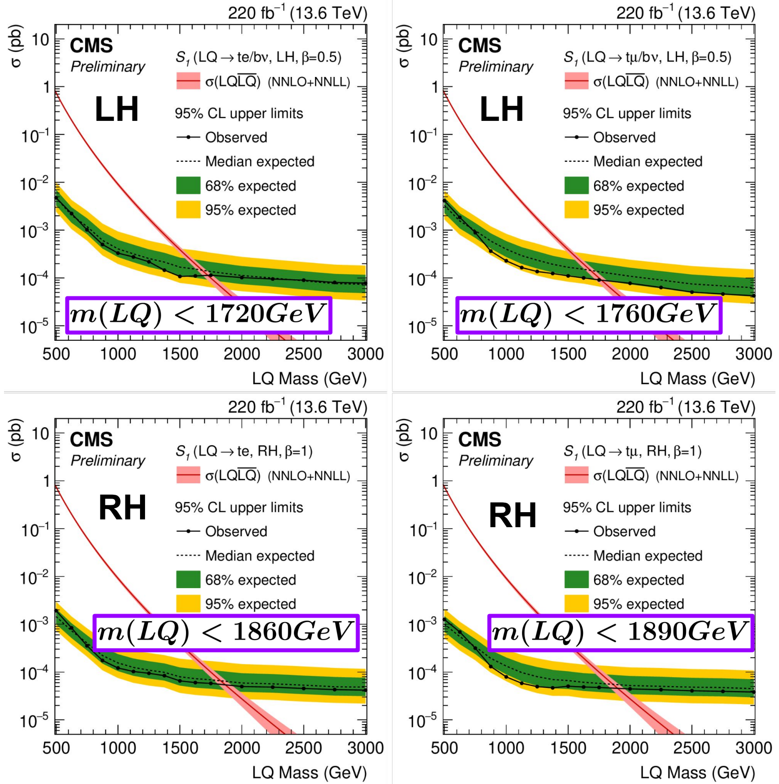
CMS BSM Highlights

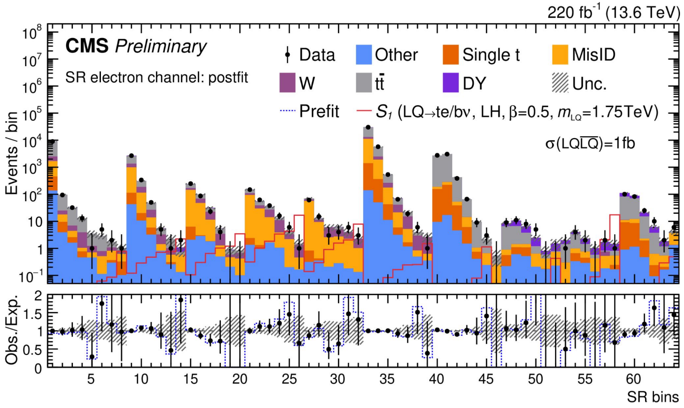
Search for leptoquarks (LQ) coupling to 3rd gen quarks and 1st/2nd gen leptons at 13.6 TeV collisions

B2G-25-011

- **Motivation :** LQ emerge in many BSM scenarios
- Based on 2024-2025 Run 3 data (220 fb^{-1})
- **Both Right (RH) and Left handed (LH) Yukawa couplings are considered**
- Selecting events with 1 to 4 leptons + >1 b-tagged jet + hadronic top jets
  - 1-2 leptons targets LQ LQ→ tl bν -> LH couplings only
  - 2-4 leptons targets LQ LQ → tl tl -> LH or RH couplings
- Considers both events with or w/o large radius (dR=1.2) jets, for hadronic top quark consideration
- **No discrepancy with SM prediction observed**
- **Measured the most stringent limits to date on LQ masses for such models**







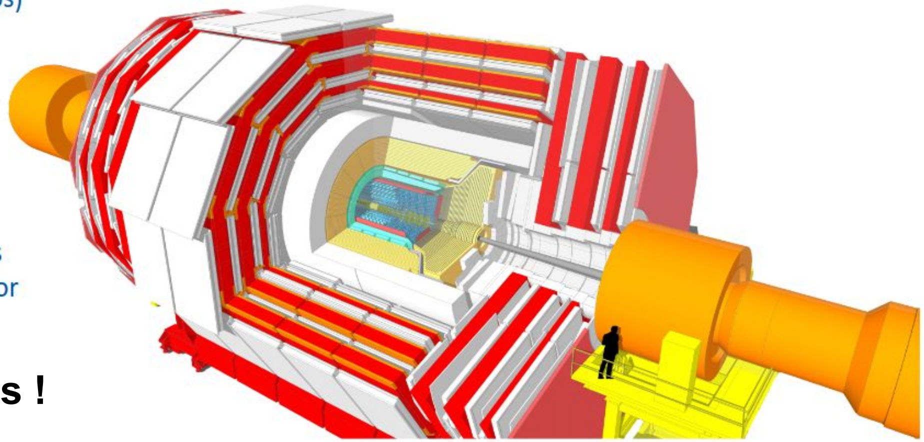
Only the magnet remains untouched!

Fully replace !

Tracker
- High granularity (pixels + strips)
- Extended coverage to η=3.8
- Tracking for L1 trigger

New detector !

MIP timing detector
- Barrel: crystals + SiPMs
- Endcap: LGADs (Low Gain Avalanche Diodes)
- ~30 ps timing resolution



Barrel calorimeter
- ECAL+HCAL: New BE electronics
- ECAL single crystal granularity for L1 trigger with precise timing

New electronics !

Muon detectors
- DT + CSC: new FE/BE readout
- RPC: new BE electronics
- New GEM/RPC
- Extended coverage to η=3

Change electronics + RPC/GEM

Endcap calorimeter (HGCAL)
- High granularity + precision timing "5D" calorimeter
- Si hexagonal pads and SiPM on Pb/W-SS Tiles

New detector !

Level-1 Trigger
- 750 kHz L1 output
- 40 MHz data scouting
- Tracks at 40 MHz
- Particle Flow selection

DAQ and High Level Trigger
- Full optical readout
- Heterogenous architecture
- 60 TB/s event network
- 7.5 kHz HLT output

Beam radiation and luminosity
- New neutron and mixed-field radiation monitors
- Beam abort and timing capabilities
- Bunch-by-bunch luminosity

Production done or in progress for all components
Integration in preparation

Summary

- **Run 3 is now over**
  - **Best data taking period**, recorded large pp and PbPb datasets + special runs
  - **Excellent performances** despite large radiation damages, thanks to the collaboration efforts
- **Many new physics results** in Standard Model, B- ,Top, Higgs, Beyond the Standard Model & Heavy Ion physics :
  - Many new results with (partial) Run 3 data + Continuing analysing Run 2 data
  - Still a lot of data to process and analyse -> **The journey is just beginning !**
- **Phase-2 CMS Upgrade is in preparation & production started**
  - **6 times more data to come at HL-LHC era with a brand new fantastic detector**
- **Other analysis and more details will be presented this afternoon :**

2:00 PM → 3:45 PM CMS

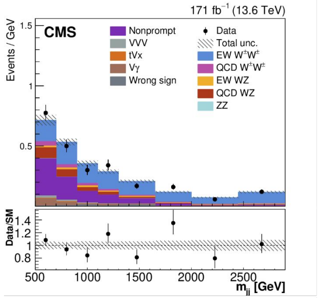
2:00 PM	Higgs boson property measurements with H->GammaGamma Speaker: Fabio Iemmi (IHEP CAS)	15m
2:15 PM	Search for non-resonant HH->bbgg with Run3 data Speaker: Eva Didier-Esteve (IP2I)	15m
2:30 PM	Search for (very)low-mass Hgg resonances Speaker: Benjamin Massoteau (IP2I)	15m
2:45 PM	VBS WWgamma and HHWWZZ Speaker: Ruobing Jiang (Peking University)	15m
3:00 PM	Multiboson et HGCAL Speaker: Tianyu Mu (Peking University)	15m
3:15 PM	Combined Higgs boson measurements at CMS Speaker: Chen Zhou (Peking University)	15m
3:30 PM	Search for X->HH/HY->WWgammagamma at CMS Speaker: Mingshui Chen (University of Florida)	15m

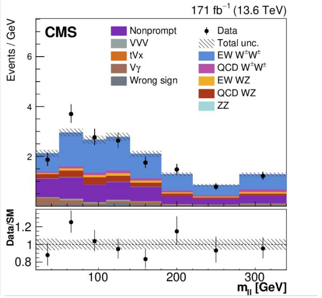
THANK YOU FOR YOUR ATTENTION !

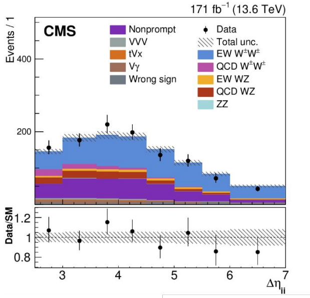
SMP-25-013
Submitted to JHEP

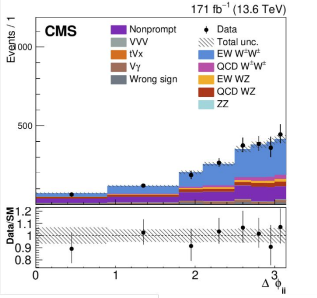
Measurement of Vector Boson Scattering (VBS) in WW and WZ channels at 13.6 TeV

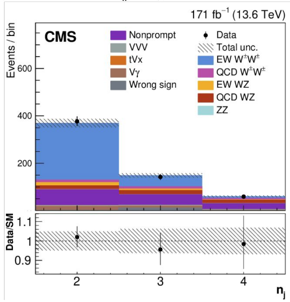
- W±W±jj → ℓ±ν ℓ±ν jj
  - 2 same sign-lepton away from Z, missing transverse energy, VBS jets
  - main bkg due to non-prompt leptons (data driven)
- W±Zjj → ℓ±ν ℓ±ℓ∓ jj
  - 3 leptons, two opposite-sign same-flavor under Z window, missing transverse energy, VBS jets
  - main bkg due to QCD WZ (MC): BDT for discrimination
- Key improvements with respect to Run 2 :
  - Increased integrated luminosity
  - Refined signal extraction with an updated fitting strategy
  - Improved non-prompt background estimate enabled by better lepton selections



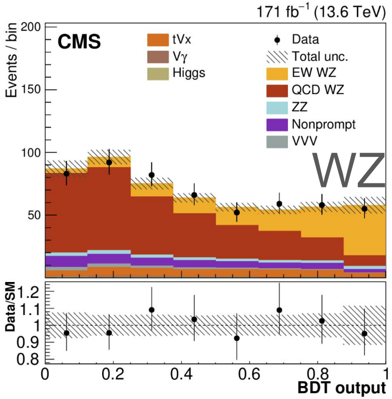




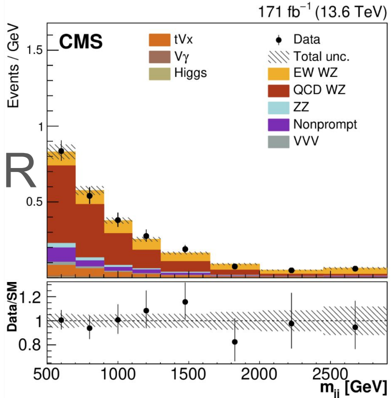




WW SR



WZ SR



SMP-25-013
Submitted to JHEP

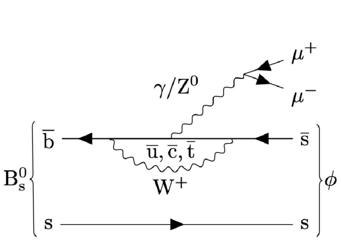
Measurement of Vector Boson Scattering (VBS) in WW and WZ channels at 13.6 TeV

Variable	$W^{\pm}W^{\pm}$ SR	WZ SR
Leptons	2 leptons, $p_T > 25/20$ GeV	3 leptons, $p_T > 25/10/20$ GeV
$\|m_{\ell\ell} - m_Z\|$	>20 GeV (ee)	<15 GeV
$m_{\ell\ell}$	>20 GeV	—
$m_{\ell\ell\ell}$	—	>100 GeV
p_T^{miss}	>30 GeV	
b quark veto	Required	
p_T^j	>50 GeV	
$\max(z_\ell^*)$	< 0.75	<1.0
m_{jj}	>500 GeV	
$\Delta\eta_{jj}$	>2.5	

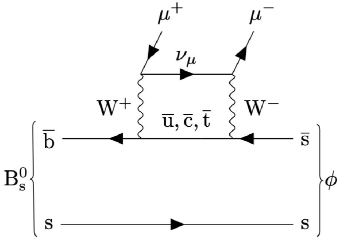
Process	$\sigma\mathcal{B}$ (fb)	Predictions (fb) MADGRAPH5_aMC@NLO without NLO corrections	MADGRAPH5_aMC@NLO with NLO corrections	SHERPA without NLO corrections
EW $W^{\pm}W^{\pm}$	3.81 ± 0.38 0.33 (stat) $\pm$ 0.18 (syst)	4.27 ± 0.38	3.51 ± 0.31	3.37 ± 0.50
EW+QCD $W^{\pm}W^{\pm}$	4.32 ± 0.40 0.36 (stat) $\pm$ 0.18 (syst)	4.75 ± 0.52	3.99 ± 0.44	—
EW WZ	1.43 ± 0.26 0.23 (stat) $\pm$ 0.12 (syst)	1.45 ± 0.13	1.25 ± 0.11	1.24 ± 0.19
EW+QCD WZ	4.75 ± 0.35 0.27 (stat) $\pm$ 0.22 (syst)	4.59 ± 1.07	4.39 ± 1.05	—

Exploring rare decays

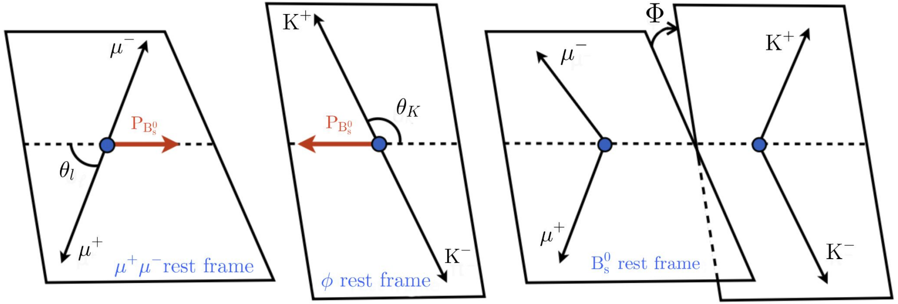
Measurement of differential branching fractions and angular observable of $B_s^0 \to \phi\mu^+\mu^-$

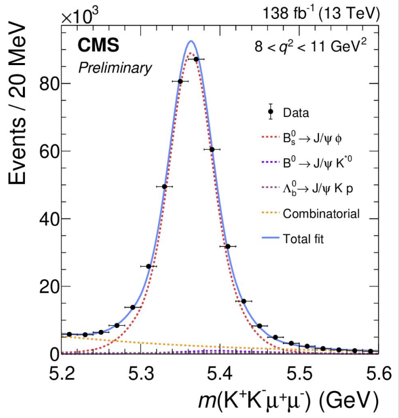


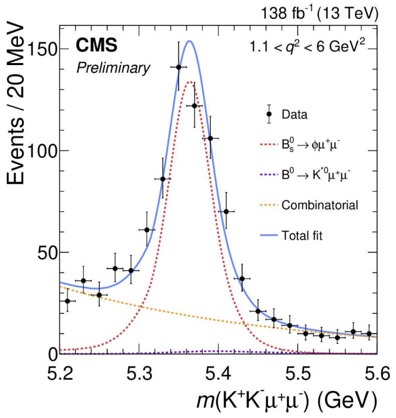
(a) Penguin diagram

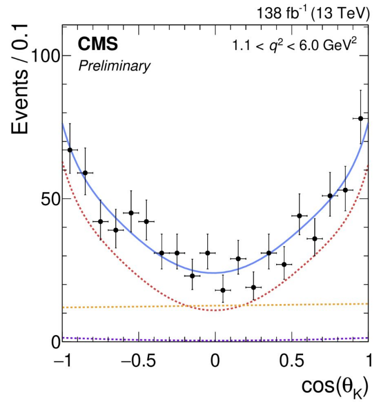


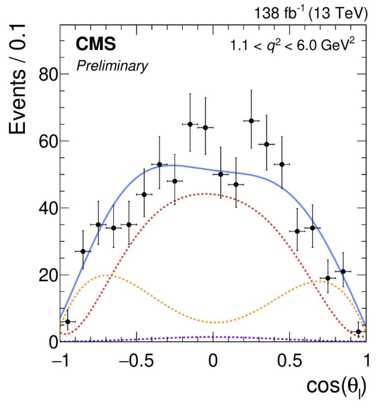
(b) Box diagram











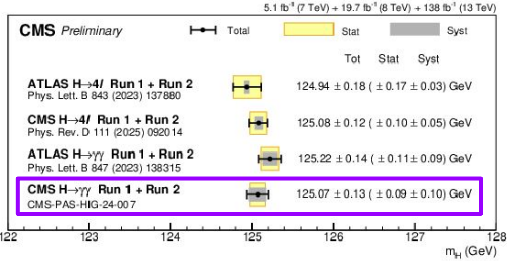
CMS Higgs Physics Highlights

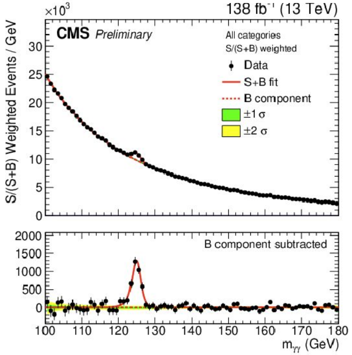
Higgs Properties

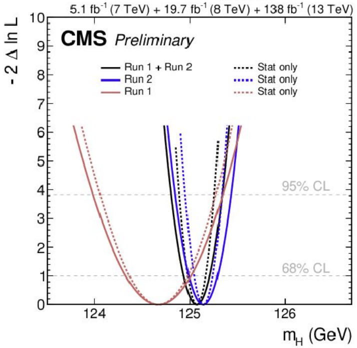
HIG-24-007

Measurement of the Higgs boson mass in H→ɣɣ in Run 1 and 2

- ❖ Refine detector calibration : new **precise ECAL calibration** to correct for radiation damage
- ❖ State-to-the-art analysis techniques
- ❖ **Results :**
  - ➢ Improved Run 2 mass : $\boxed{m_{\mathrm{H}} = 125.14 \pm 0.10\,(\mathrm{stat}) \pm 0.11\,(\mathrm{syst})\,\mathrm{GeV}}$
  - ➢ New m(H→ɣɣ) reference using Run 1+2 data (consistent with other measurements)
  - ➢ **Systematics are now at statistical uncertainty level**







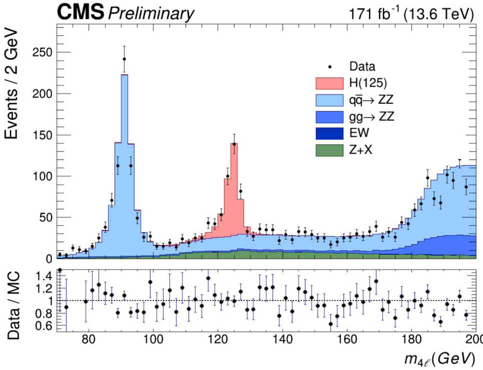
HIG-25-015

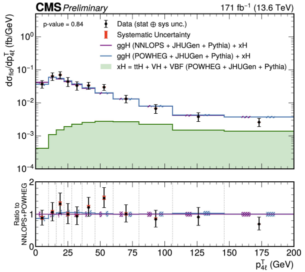
Measurement of inclusive and differential Higgs production cross-sections in H→ZZ→4l at 13.6 TeV

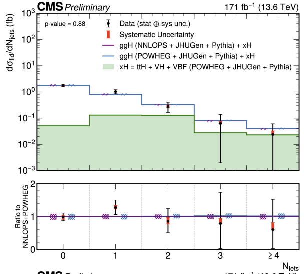
- ❖ Based on 2022+2023+2024 data (171 fb^{-1})
- ❖ Cross sections **measured in a fiducial region** closely matching the experimental acceptance
- ❖ **Extended set of differential cross-sections are measured**
- ❖ **Dedicated measurements targeting the production of the Higgs boson via vector boson fusion** are also performed

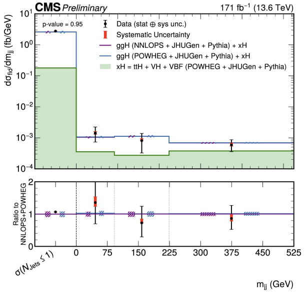
❖ **Results :** All cross-sections are in agreement with SM

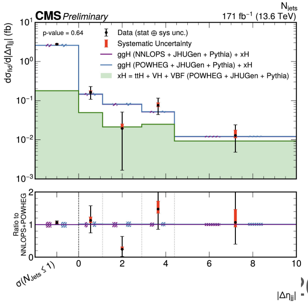
$$\boxed{\sigma_{\mathrm{fid}} = 3.11^{+0.22}_{-0.22}(\mathrm{stat.})^{+0.14}_{-0.12}(\mathrm{syst.})\ \mathrm{fb}}$$







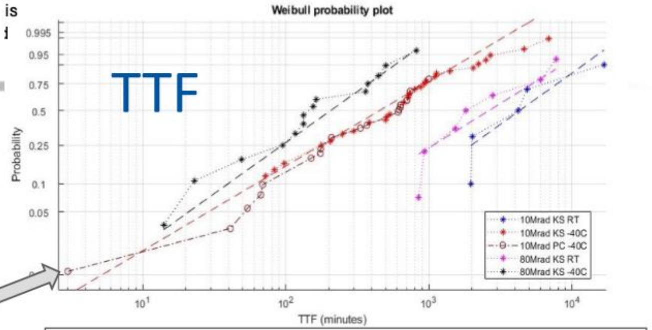




Slide from Filip Moortgat at LHCP 2026

bPOL – DCDC converter inside the detector

Some facts



TTF shows an exponential behavior

bPOL_V6 has issues after irradiation (TID), enhanced by cold

- **Detrimental overvoltage after 'time in stress zone'**
- & **drift of internal voltage**
- & **basic functionality** (does not regulate to 2.5V)
- & **…**

Stress condition: V_in applied while chip disabled

bPOL_V6: Unconstrained operation is likely possible for **TID of 1MRad**

bPOL_V6: Limit time in stress zone for **TID> 1 Mrad**;

Time to Fail (TTF) for 1% of detectors is in the order of 30 - 200 seconds *(95% CL)*

& time in stress zone is 10 – 40 ms per power cycle

First version of the **new ASIC, bPOL12V_FX1 launched** in new technology – expect bare ASICs in June

- **There is a clear risk, FX1 may not work**
- **A working FX1 ASIC addresses most, probably all issues and is for sure better**