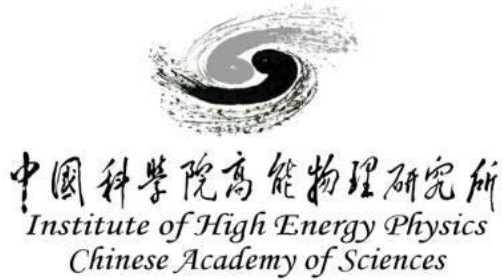
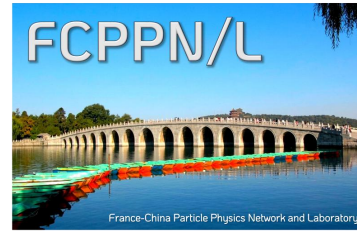


CMS FCPPN/L Projects



Junquan Tao
IHEP/CAS Beijing



with Claude CHARLOT (LLR Palaiseau), Guoming CHEN (IHEP/CAS Beijing), Suzanne GASCON-SHOTKIN (IP2I Lyon), Qiang LI (PKU) and Chen Zhou (PKU)



Lyon, France

29 June – 3 July 2026

IP2I, Campus scientifique de la Doua

17th Workshop of the

FCPPN/L

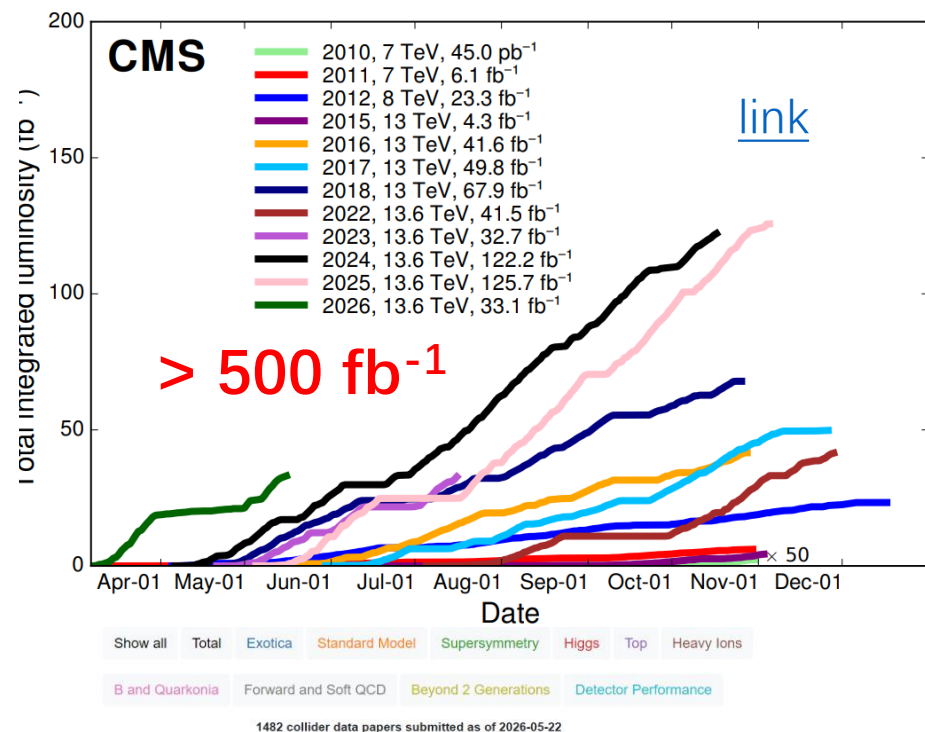
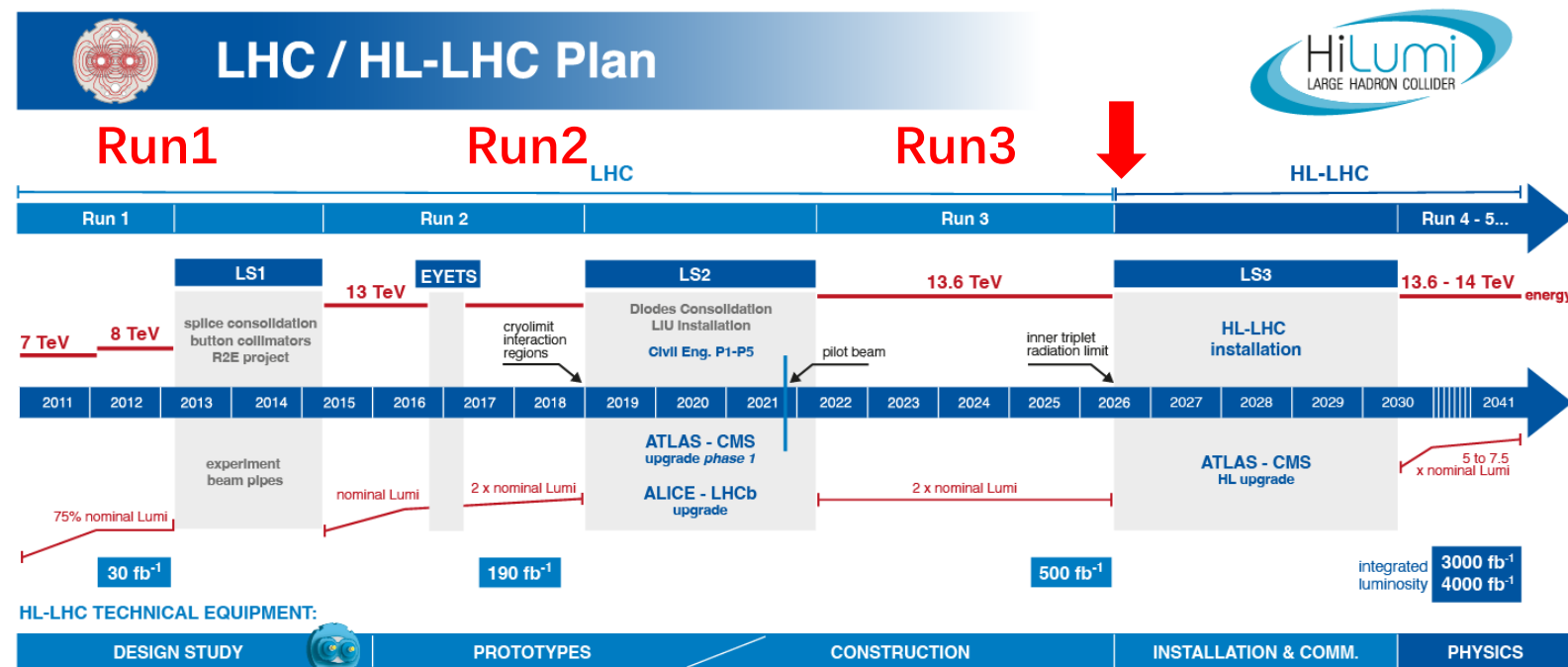
France-China Particle Physics Network and Laboratory



La Région
Auvergne-Rhône-Alpes
vi|eurbanne

CMS and France-China collaboration

➤ Data-taking started in 2010 ... 16 years ago!



link

HL-LHC CIVIL ENGINEERING:

DEFINITION

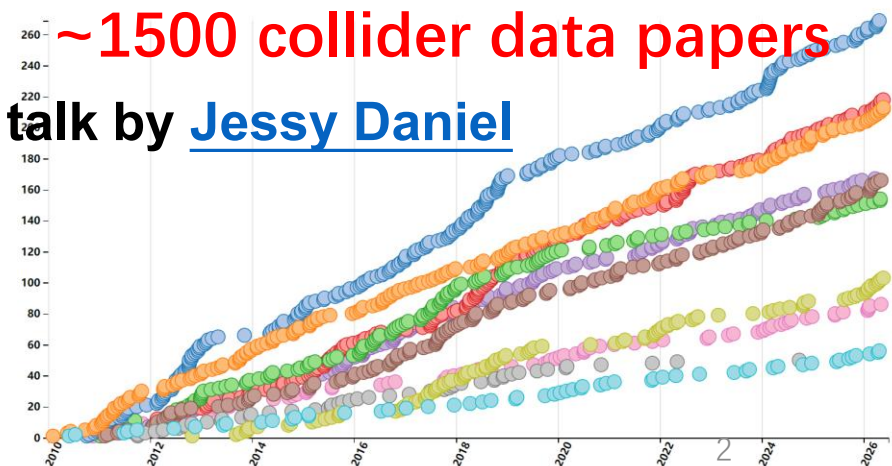
EXCAVATION

BUILDINGS

Dedicated CMS highlights talk by [Jessy Daniel](#)

➤ France-China collaboration on CMS since 2007 ... 20 years!

- First visit of IP2I CMS scientists at IHEP in 2006 Summer
- Pre-FCPPL workshop at IHEP in December 2006

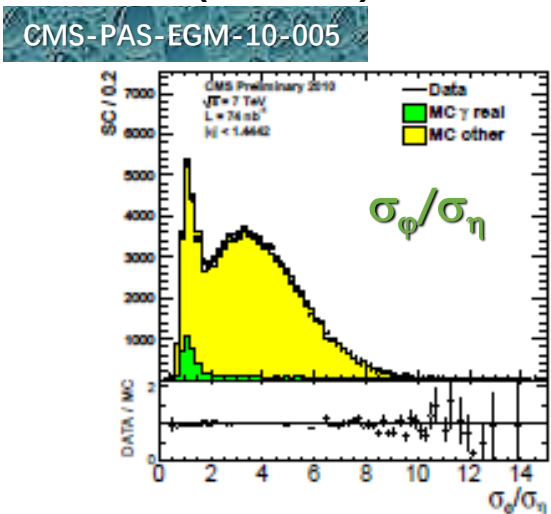


CMS in FCPPL/N: 20 years of exchanging **people** + **ideas**

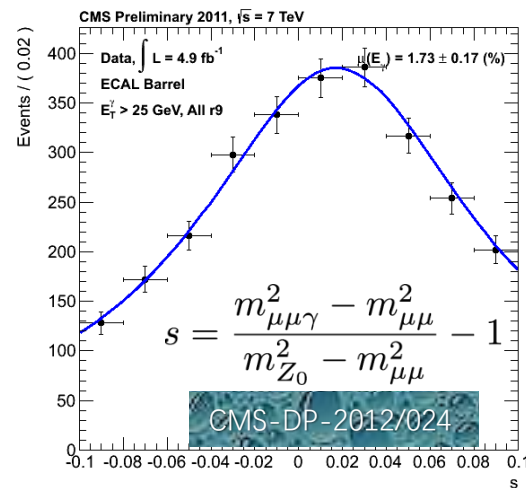
IHEP-IP2I: Collaboration started in 2007 (one of the longest-lived in FCPPL)

- On virtually **all aspects touching photons in CMS**: ECAL calibration and performance, photon identification, direct photon measurements, discovery of a Higgs boson and measurement of its properties, theoretical interpretations, HH/HY searches and searches for new diphoton resonances
- Since 2007, FCPPL-financed exchanges have benefitted **over 20 people** (IHEP and IP2I postdocs and doctoral students), some for multiple visits
- Making possible significant contributions to **~50 CMS published papers/public results**
- And support in establishing **2 co-PhD theses financed by prestigious scholarships (CSC, Eiffel)**

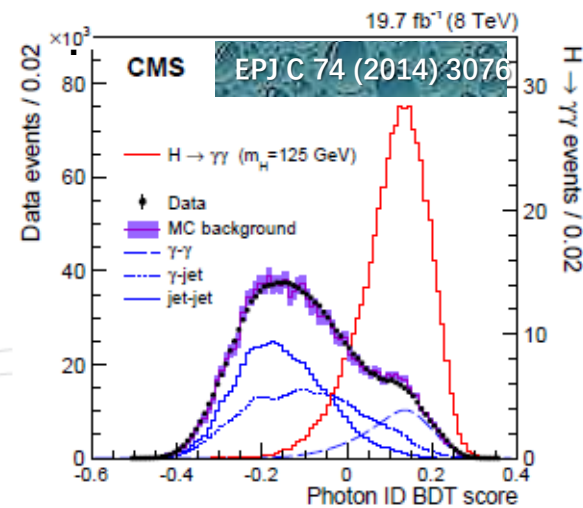
❖ Cluster/Photon commissioning (2008-...)



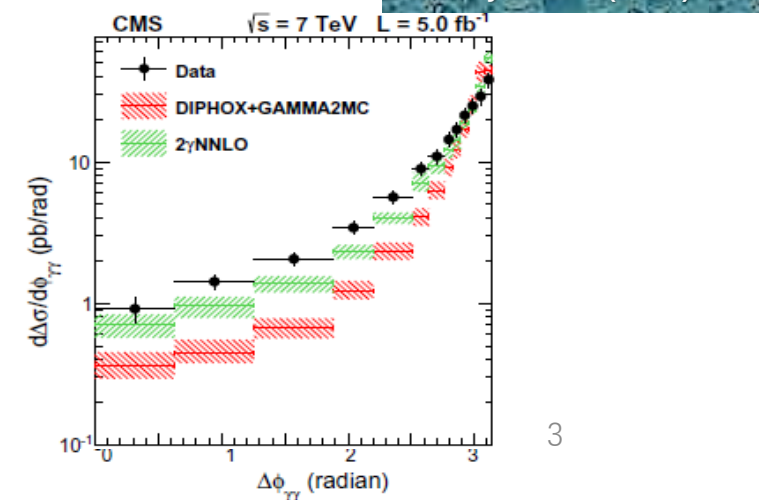
❖ Photon energy scale extraction with $Z \rightarrow \mu\mu\gamma$ (2007-...).



❖ γ/π^0 discrimination for photon ID (2008-...)

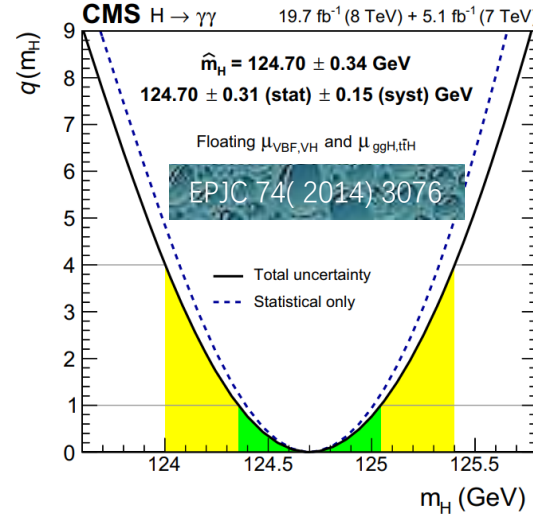
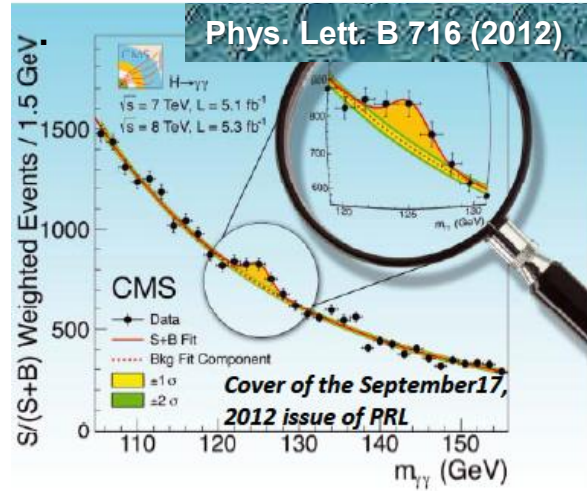


❖ $\gamma\gamma + X$ differential cross section measurement (2010-...)

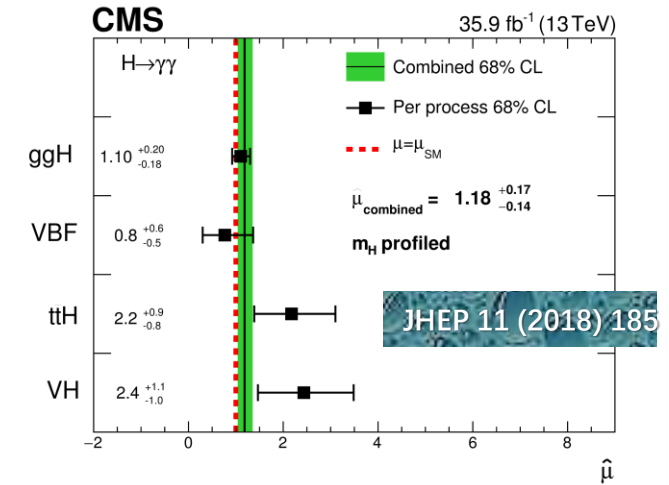
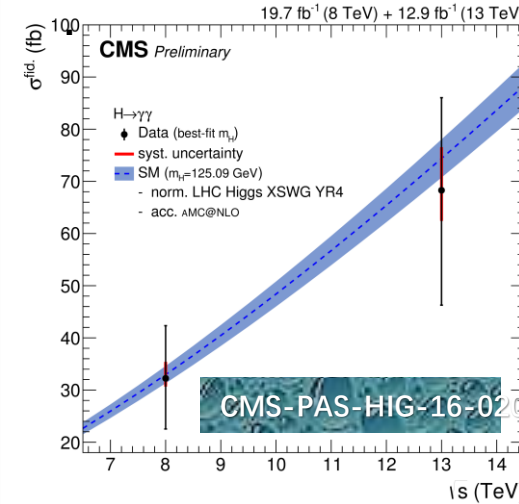


IHEP-IP2I: Higgs bosons discovery and its properties

❖ Discovery and measurement of a Higgs boson (2012-...)

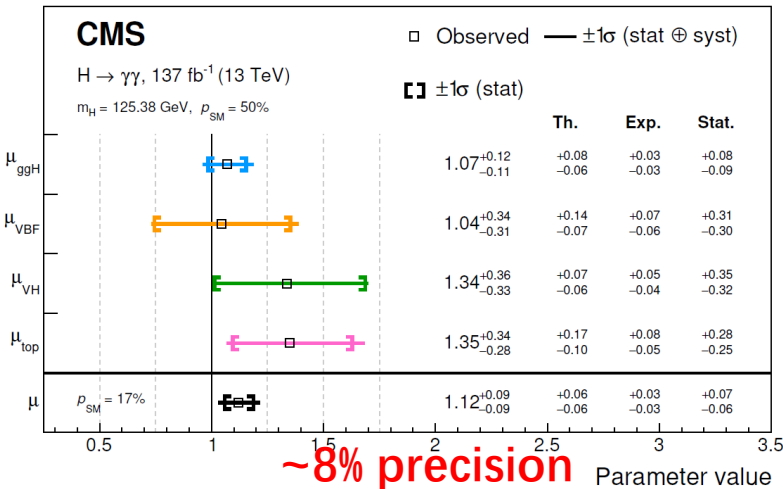


❖ ReDiscovery and measurement of the Higgs boson (2015-...)

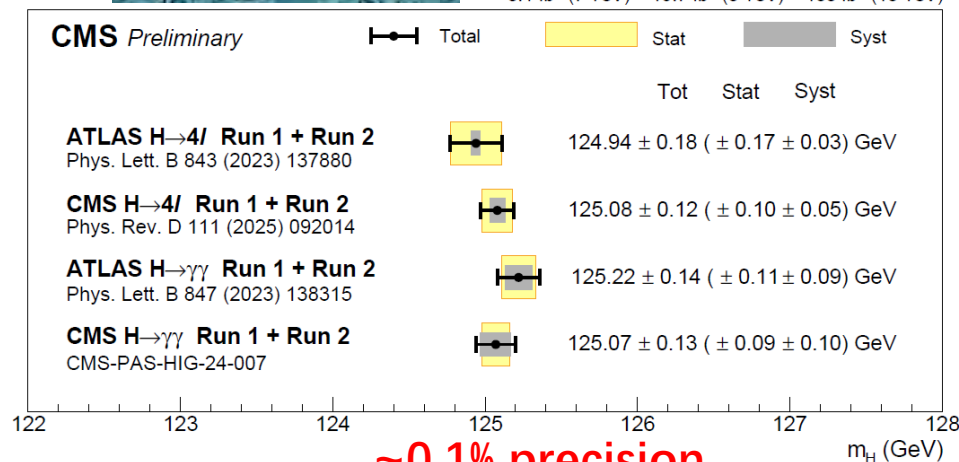


❖ Precise measures with full Run 2 data : strengths, (self-)couplings, CP, XS, mass and with (2019-...)

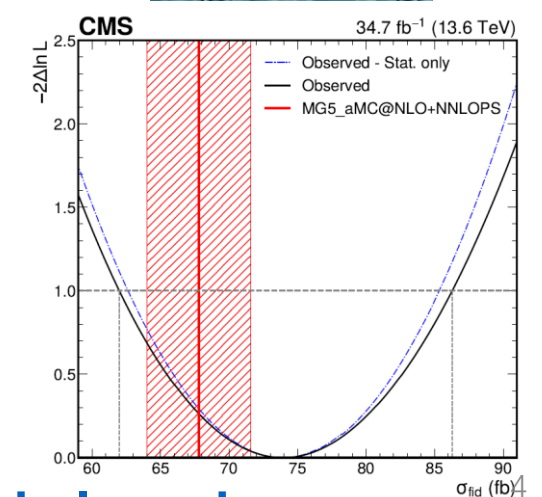
JHEP 07 (2021) 027



CMS-PAS-HIG-24-007



JHEP 09 (2025) 070



Dedicated talk of $H \rightarrow \gamma\gamma$ properties by [Fabio Lemmi](#)

IHEP-IP2I: lighter diphoton resonance searches

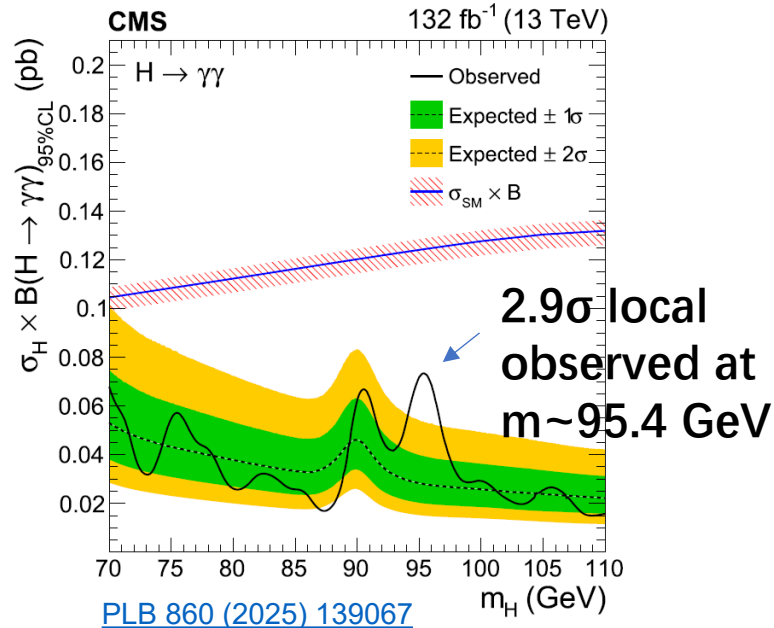
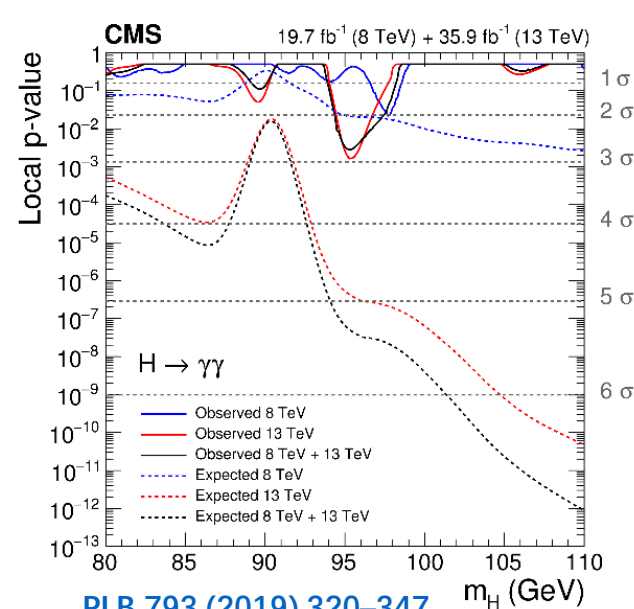
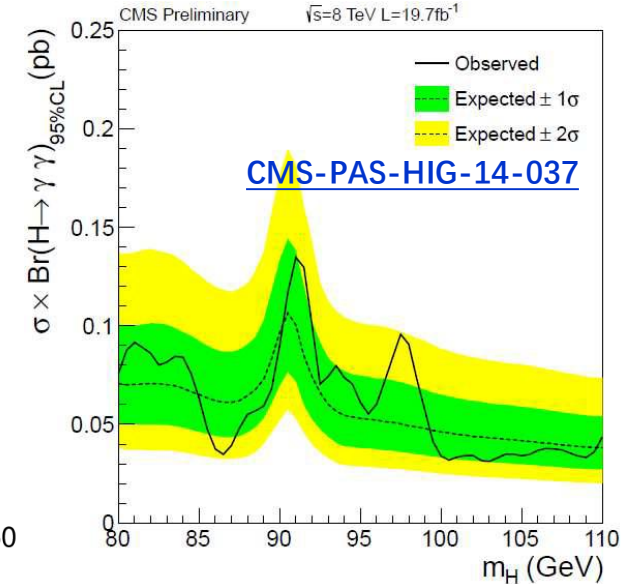
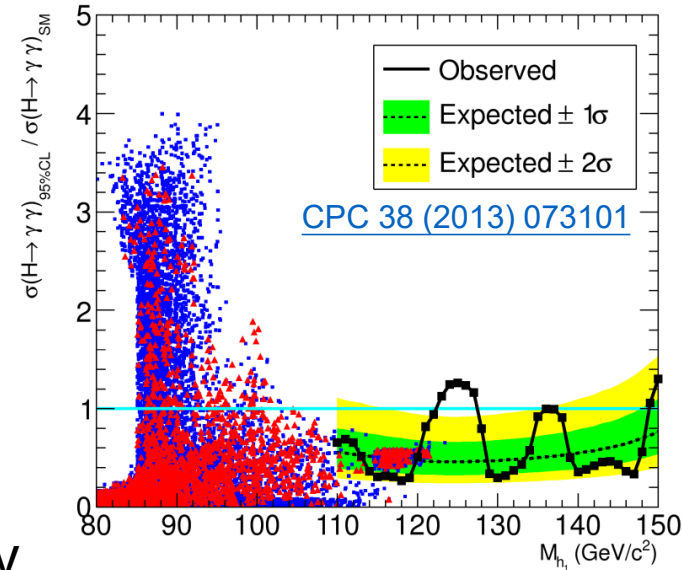
- Many **BSM models** (e.g. 2HDM, NMSSM) predict additional Higgs bosons : some of which could have **masses < 125 GeV**

See dedicated talk by [Benjamin MassotEAU](#)

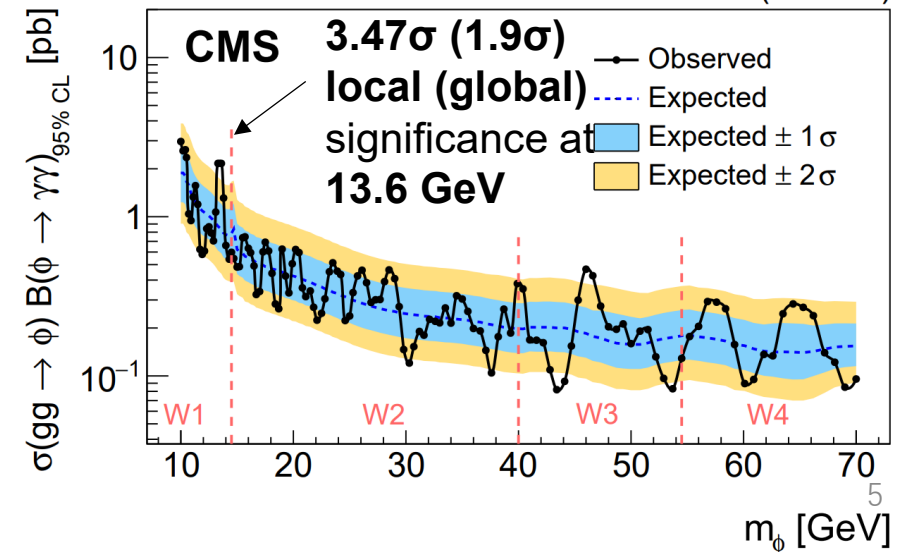
- ❖ Feasibility study for a 2nd lighter Higgs boson (2013-...)

NMSSM: [Chin. Phys. C 38 \(2013\) 073101](#)
2HDM: [JHEP12 \(2016\) 068](#)
NMSSM: [Chin. Phys. C 42 \(2018\) no.10, 103107](#)
Georgi-Machacek model: [Chin. Phys. C 46 \(2022\) 8, 083107](#)

- ❖ Search for a 2nd lighter Higgs boson in 8+13 TeV data (2013-...)



- ❖ Contributions to very-low-mass ($10 < m_{\gamma\gamma} < 70$ GeV) case inherits heavily from low-mass case



IHEP-IP2I: non-resonant and resonant di-Higgs searches

❖ HH: probes Higgs self-coupling, and also sensitive to BSM

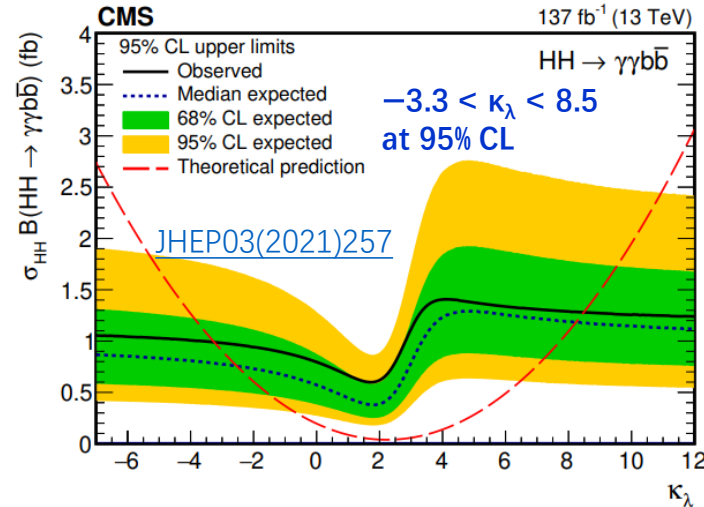
❖ Search for non-resonant and resonant HH: $bb\gamma\gamma$, $WW\gamma\gamma$ and HH/HY combinations (2018-...)

✓ Non-resonant and resonant HH→bbγγ: Run2 and Run3

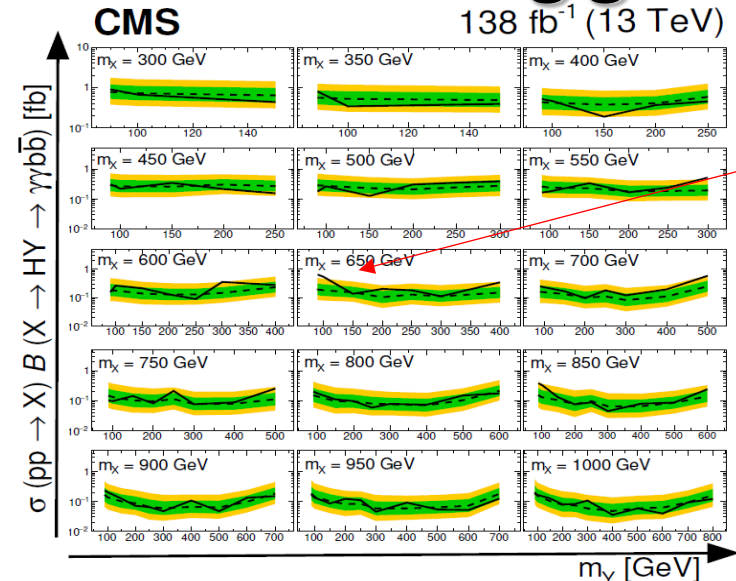
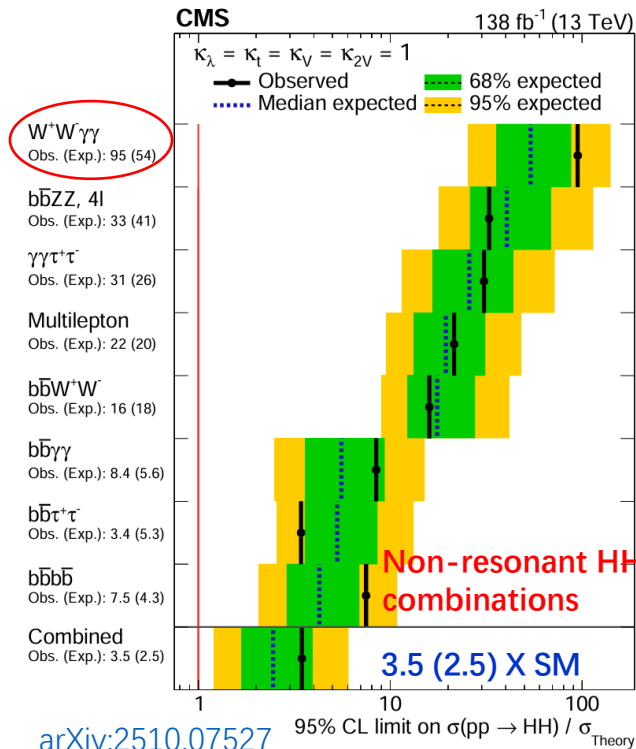
See Eva Didier-Esteve's talk "Search for non-resonant HH→bbγγ with Run3 data"

✓ Non-resonant and resonant HH→WWγγ: Run2

See Mingshui Chen's talk "Search for X→HH→WWγγ at CMS"



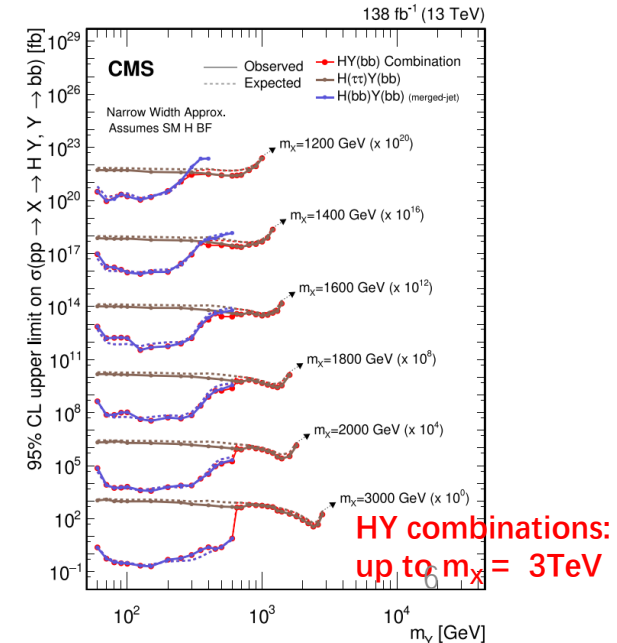
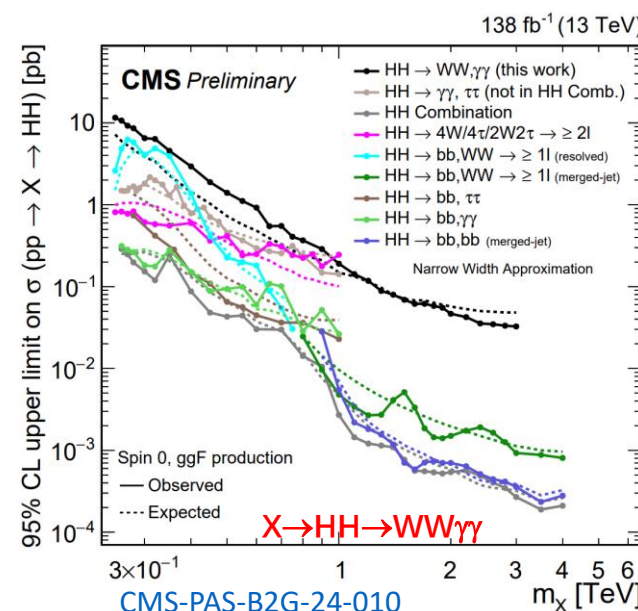
HH→WWγγ: CMS-PAS-HIG-21-014



3.8σ local (2.8σ global) for $m_X = 650$ GeV and $m_Y = 90$ GeV

(Spin-0) X → HY → γγb $\bar{b}$
Expected limit ±1 σ
Expected limit ±2 σ
Expected 95% upper limit
Observed 95% upper limit

Phys. Rept. 1115 (2025) 368-447



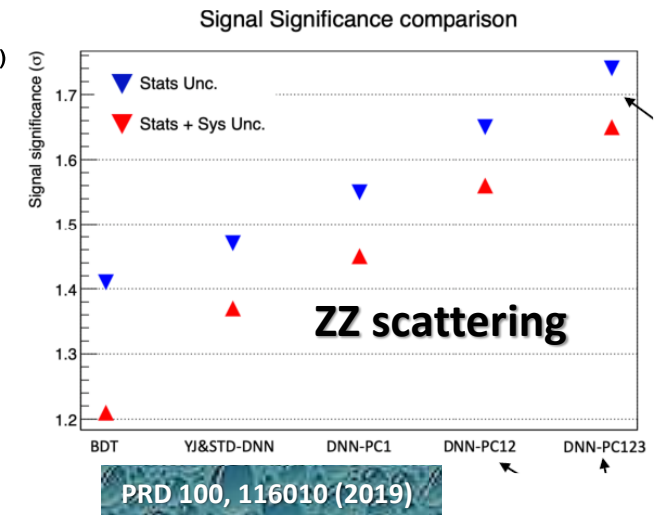
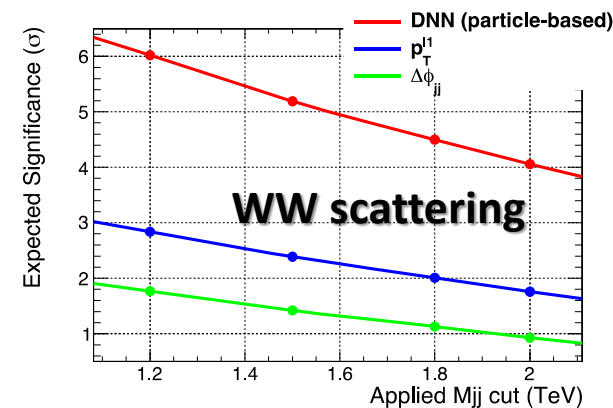
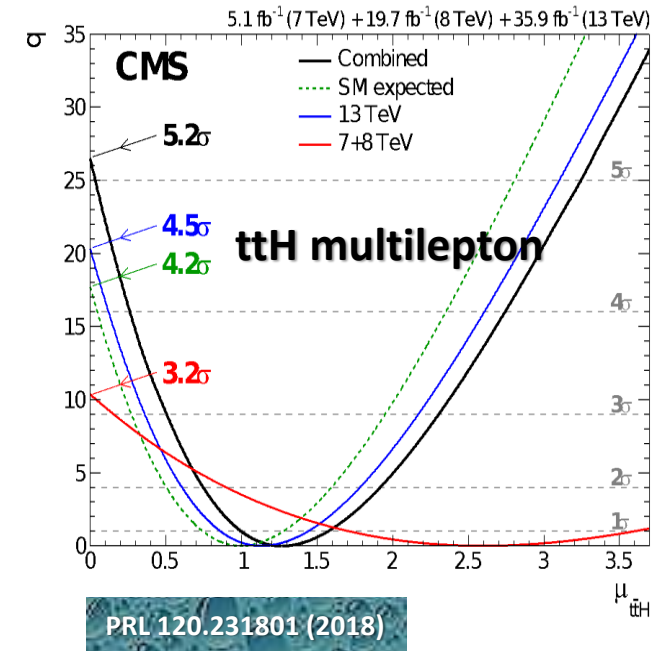
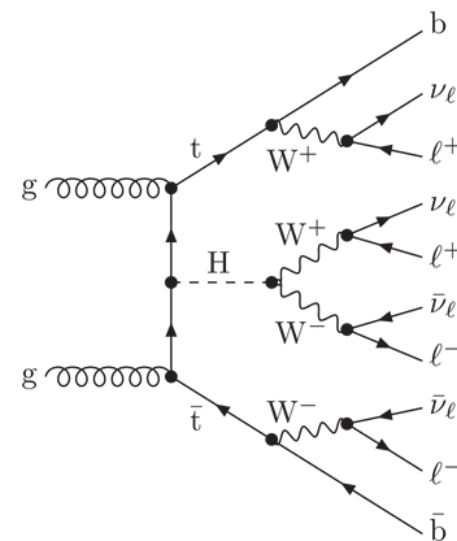
IHEP-IP2I-PKU collaboration since 2026

- **PKU joined** IHEP-IP2I collaboration since 2026: common interests in Higgs boson properties, searches for non-resonant and resonant HH (HY)
[See Chen Zhou's talk "Combined Higgs boson measurement at CMS"](#)
- **2025-2026 team:**
 - ✓ **IP2I** (7): Jessy DANIEL, Eva DIDIER-ESTEVE, [Suzanne GASCON-SHOTKIN](#), Maxime GOUZEVITCH, Benjamin MASSSOTEAU, Alejandro SALINAS DELGADO, Christian VEROLLET
 - ✓ **IHEP** (9): Javlonbek BAKHROMOV, Tianyu CAO, [Guoming CHEN](#), Mingshui CHEN, Fabio IEMMI, Tahir MUNIR, Shaowei SONG, Junquan TAO, Jin WANG
 - ✓ **PKU** (2): Chuxue YANG, [Chen ZHOU](#)
- Current focus: **Standard Model Higgs boson measurements through the $H \rightarrow \gamma\gamma$ channel, non-resonant and resonant HH/HY searches with one $H \rightarrow \gamma\gamma$ and searches for low-mass (<125 GeV) Higgs boson in the $\gamma\gamma$ channel**
- **2026 FCPPL grant "CMSHIGPHO"** requested to support
 - ✓ IP2I student Benjamin's 1-month stay at IHEP
 - ✓ IHEP student Tahir's 2-month stay at IP2I
- **Other source of financing:**
 - ✓ **CAS international student visiting grant:** IP2I student Eva's 3-months stay at IHEP
 - ✓ **CSC scholarship:** PKU student Chuxue's stay at IP2I for one year

CMS in FCPPL/N: PKU-IPHC-IP2I collaboration

PKU-IPHC-IP2I Collaboration started in 2015 as PKU-IPHC, then added IP2I in 2017: Jeremy ANDREA (IPHC), Qiang Li (PKU) and Nicolas CHANON (IP2I)

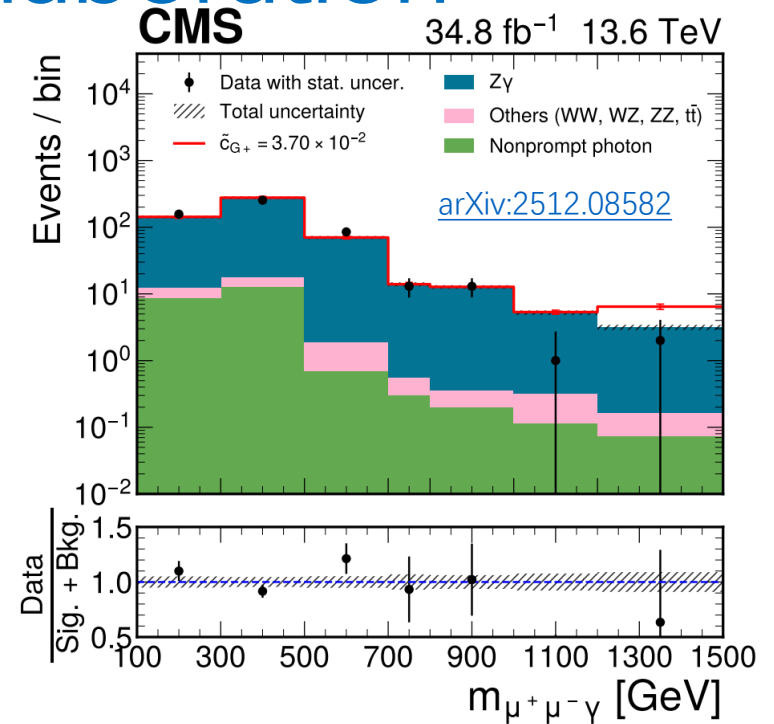
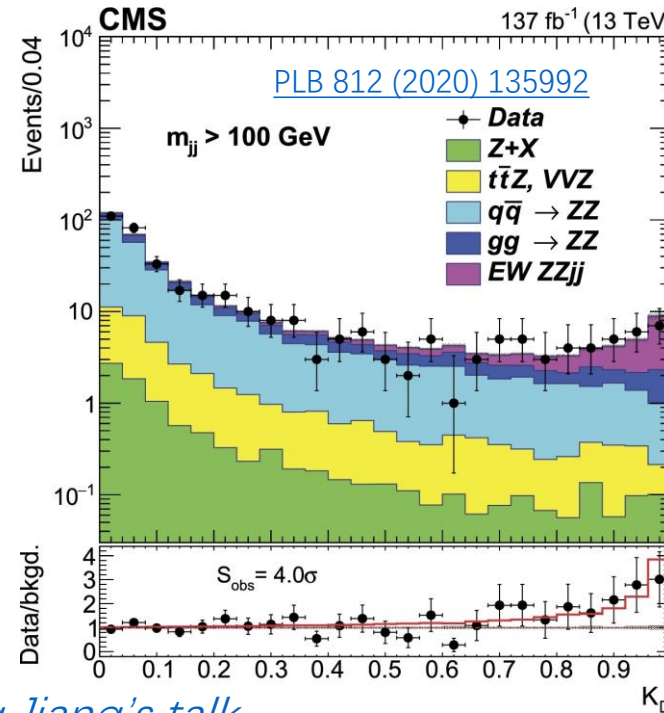
- Focus: Matrix Element and deep learning techniques for top-Higgs and WW/ZZ scattering leading to **6 published papers/public results**
- **Main results: $t\bar{t}H$ observation**, *Phys. Rev. Lett.* **120**, 231801 (2018); *Full Run 2*, *Eur. Phys. J. C* **81** (2021) 378, direct measurement of the top-Higgs coupling
- **Published two phenomenology studies:** “Polarization Fraction Measurement in same sign WW scattering using Deep Learning”, *Phys. Rev. D* **99**, 033004 (2019), “Polarization fraction measurement in ZZ scattering using Deep Learning”, *Phys. Rev. D* **100**, 116010 (2019)
- **Collaboration suspended in 2020-2021 but could be re-activated in the future**



CMS in FCPPL/N: PKU-LLR collaboration

PKU-LLR: Collaboration started in 2020. Focused on **EW production of VBS ZZ**, **Z γ production cross section** and **nTGC**, making significant contributions to **2 CMS published/public papers** and **1 phenomenology paper**; now **VBS same-sign WW γ measurement** and **Doubly Charged Higgs research (Run2)**, **Search for HH $\rightarrow$ WWZZ (Run2+partial Run3)** and **HGCAL trigger towers and reconstruction**

Learn more in [Tianyu Mu's talk](#) and [Ruobing Jiang's talk](#)



Measured EW production of VBS ZZ, or Z γ fiducial cross section, agrees with SM prediction

Z γ : for the first time in the context of latest framework of effective field theory based on dimension-8 operators, 95% CL limits on neutral triple gauge couplings (nTGC) was set

Limits	Expected		Observed	
	Lower	Upper	Lower	Upper
$h_{4\gamma}^Z$	-1.01×10^{-6}	1.01×10^{-6}	-8.17×10^{-7}	8.20×10^{-7}
$h_{3\gamma}^Z$	-8.34×10^{-4}	8.58×10^{-4}	-6.67×10^{-4}	6.88×10^{-4}
h_3^Z	-7.01×10^{-4}	6.96×10^{-4}	-5.69×10^{-4}	5.48×10^{-4}
$\tilde{c}_{G+}$	-3.83×10^{-2}	3.79×10^{-2}	-3.05×10^{-2}	3.06×10^{-2}
$\tilde{c}_{G-}$	-3.09	3.18	-2.44	2.54
$\tilde{c}_{\tilde{B}W}$	-1.24	1.26	-0.98	1.00

[arXiv:2512.08582](#)

- **2025-2026 team**: Tianyu Mu (PKU), Ruobing Jiang (PKU), **Qiang Li** (PKU), **Claude Charlot** (LLR) and Jean-Baptiste Sauvan (LLR)
- **2026 FCPPL grant “MultiBoson”** requested to support
 - ✓ 2-months stay for PKU students Tianyu and Ruobing at LLR
 - ✓ 1-month stay of Jean-Baptiste or Claude at PKU
- **Other source of financing:**
 - ✓ **CSC** grant: support Tianyu’s 1.5-year stay at LLR, in 2025-2026
 - ✓ **CSC** grant: support Ruobing’s 1.5-year stay at LLR, starting in 2026

CMS in FCPPL/N: Summary



- **France-China collaboration on CMS:** a productive cooperation since 2007
 - ✓ **IHEP-IP2I** since 2007, now **IHEP-IP2I-PKU** in 2026
 - ✓ **PKU-IPHC-IP2I** between 2015-2019
 - ✓ **PKU-LLR** since 2020
 - ✓ ECAL calibration and performance, photon reconstruction and identification, SM measurements, Higgs boson discovery and precise measurements of its properties, HH/HY searches and searches for new diphoton resonances, HGCal software ...
- **IHEP, IP2I** and **IPHC** have hosted **FCPPN/L workshop**, regularly contribute members of scientific committee

CITY	DATE
Beijing (IHEP)	12/2006
Lyon	04/2010
Strasbourg	03/2016
Lyon	07/2026



Acknowledgements

- ❖ THANKS to the FCPPN/L and to the local organizers!
- ❖ We are looking forward to your continued support!
- ❖ For many more years!



FCPPN/L

Merci



France-China Particle Physics Network and Laboratory

谢谢