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AGENCIA
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Universidad de Oviedo

ICTEA
Instituto Universitario de Ciencias y
Tecnologías Espaciales de Asturias



Top quark y bosón de Higgs: tras las huellas de la nueva física

Del LHC del CERN a los futuros aceleradores

Sergio Sánchez Cruz

What are we made of?

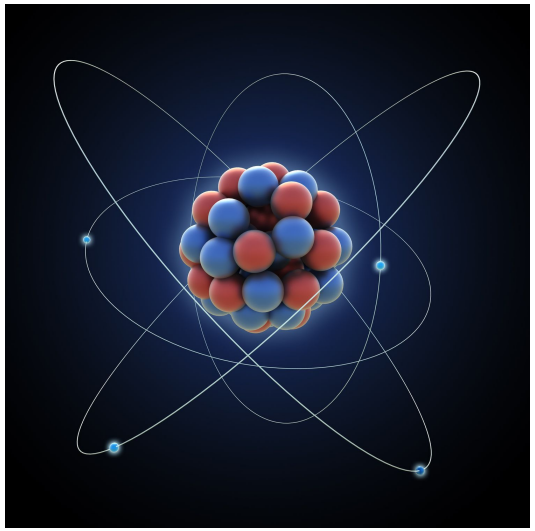
QUARKS **GAUGE BOSONS** **SCALAR BOSON**

u Up		
d Down		

LEPTONS

e Electron		

I GENERATION **II GENERATION** **III GENERATION**



What are we made of?

QUARKS

u Up		
d Down		

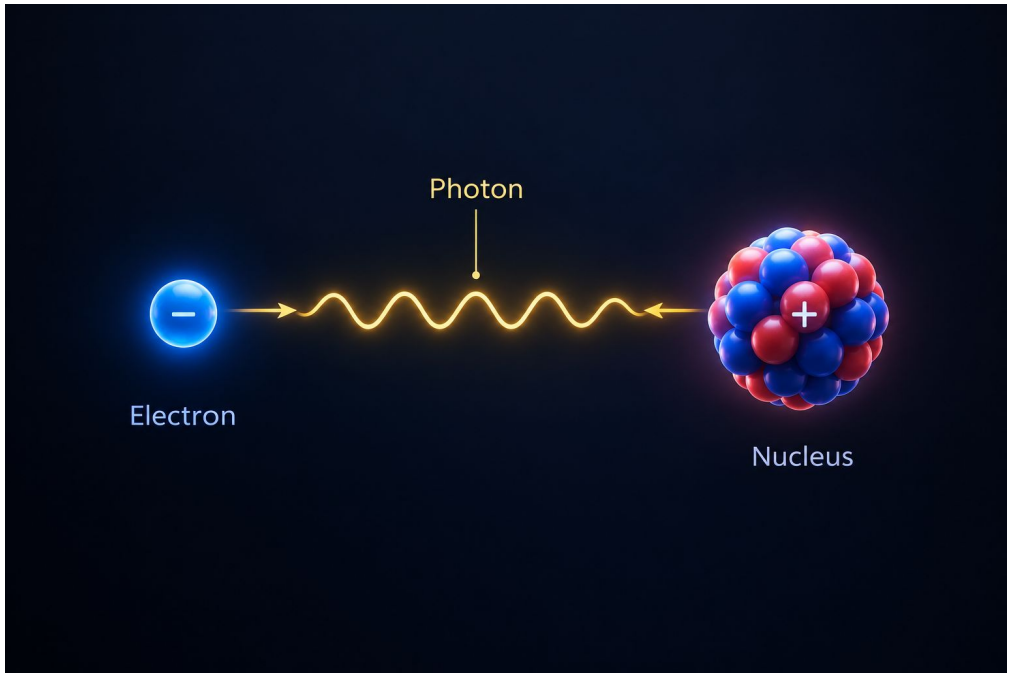
LEPTONS

e Electron		
I GENERATION	**II GENERATION**	**III GENERATION**

GAUGE BOSONS

γ Photon

SCALAR BOSON



What are we made of?

QUARKS

u Up		
d Down		

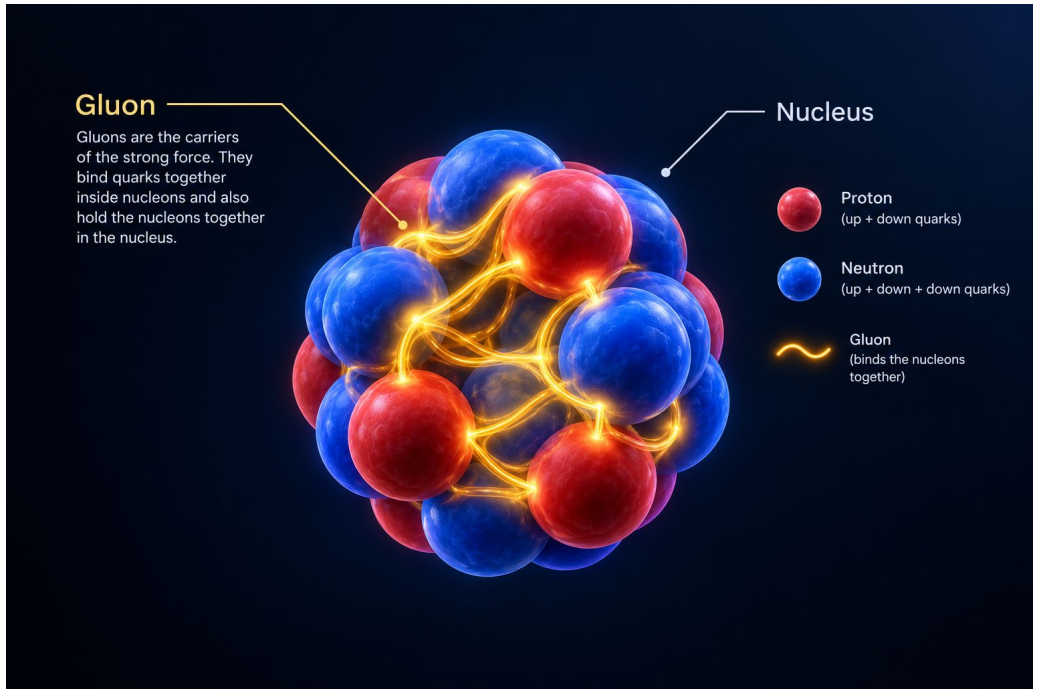
LEPTONS

e Electron		
I GENERATION	**II GENERATION**	**III GENERATION**

GAUGE BOSONS

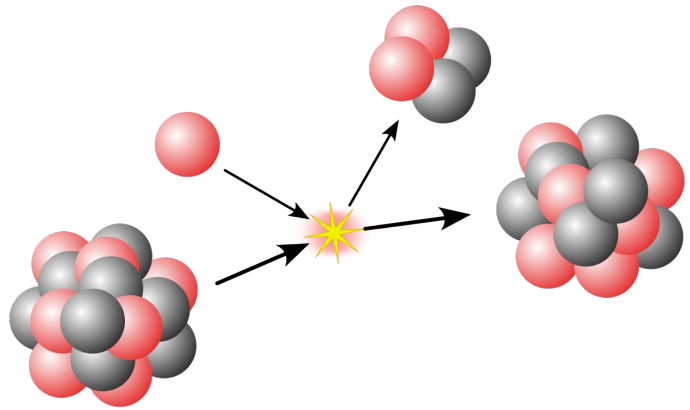
γ Photon
g Gluons

SCALAR BOSON



What are we made of?

QUARKS			GAUGE BOSONS	SCALAR BOSON
u Up			γ Photon	
d Down			g Gluons	
LEPTONS				
e Electron			$W^{\pm}$ $W^{\pm}$	
ν_e ν_e			Z^0 Z^0	
I GENERATION	**II GENERATION**	**III GENERATION**		



What are we made of?

QUARKS

u Up	c Charm	t Top
d Down	s Strange	b Bottom

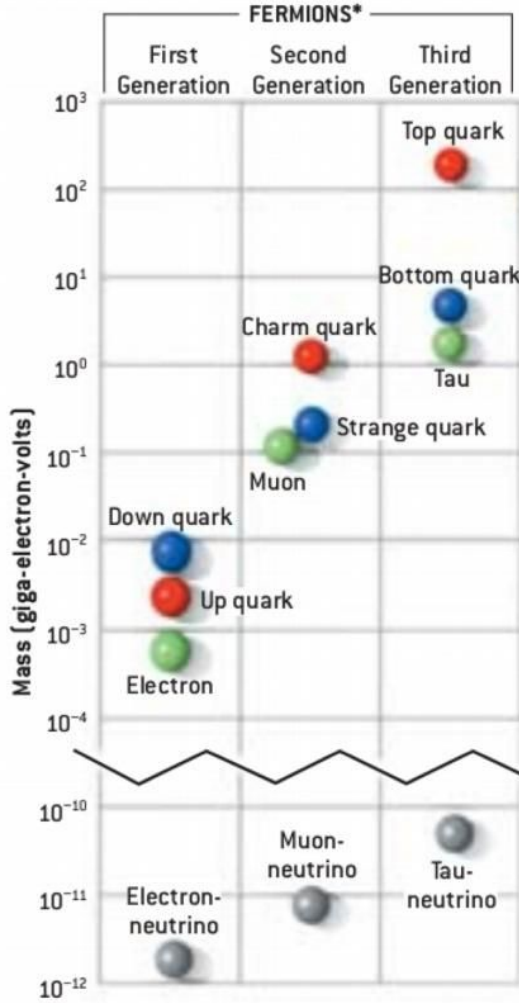
LEPTONS

e Electron	μ Muon	τ Tau
ν_e ν_e	ν_μ ν_μ	ν_τ ν_τ
I GENERATION	**II GENERATION**	**III GENERATION**

GAUGE BOSONS

γ Photon
g Gluons
$W^\pm$ $W^\pm$
Z^0 Z^0

SCALAR BOSON



What are we made of?

QUARKS

u Up	c Charm	t Top
d Down	s Strange	b Bottom

LEPTONS

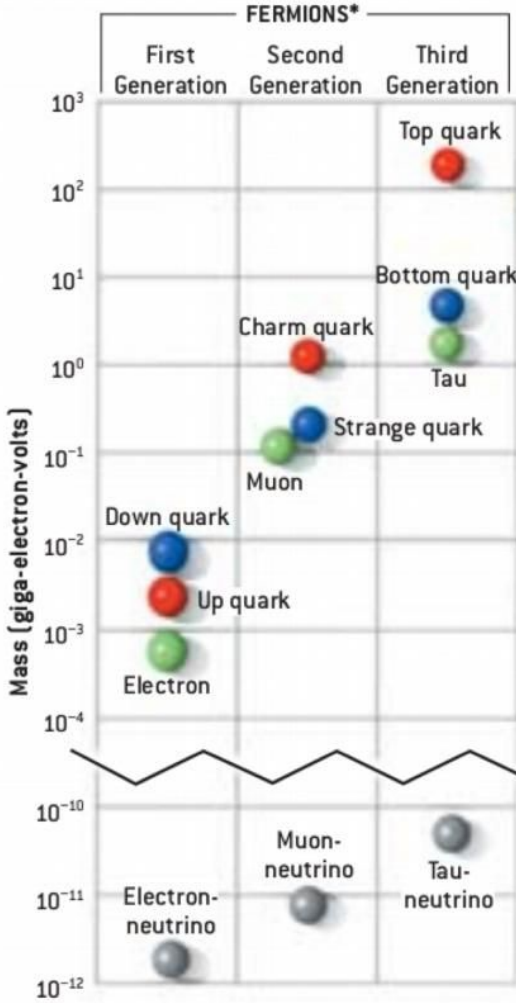
e Electron	μ Muon	τ Tau
ν_e ν_e	ν_μ ν_μ	ν_τ ν_τ
I GENERATION	**II GENERATION**	**III GENERATION**

GAUGE BOSONS

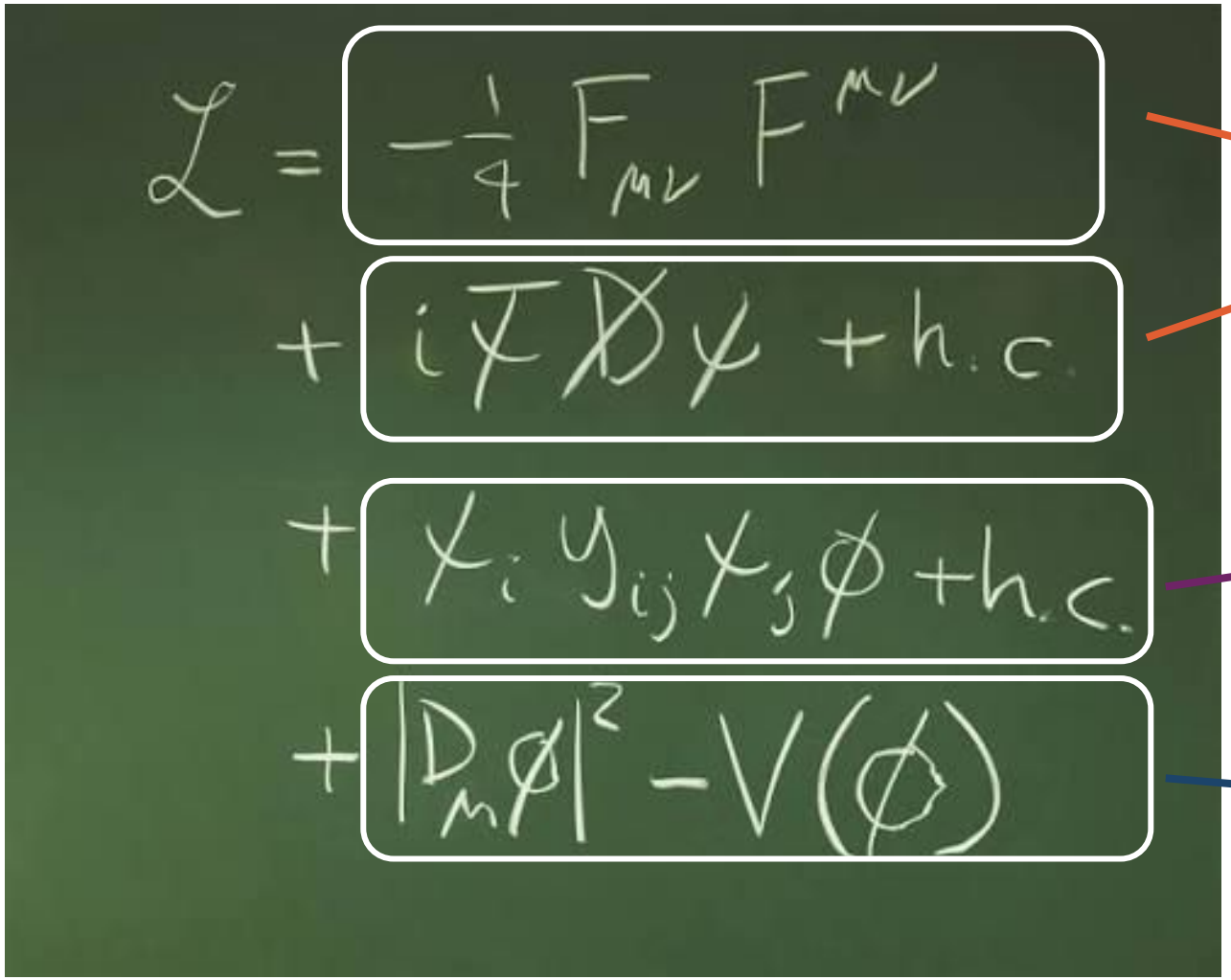
γ Photon
g Gluons
$W^\pm$ $W^\pm$
Z^0 Z^0

SCALAR BOSON

H Higgs



The SM lagrangian

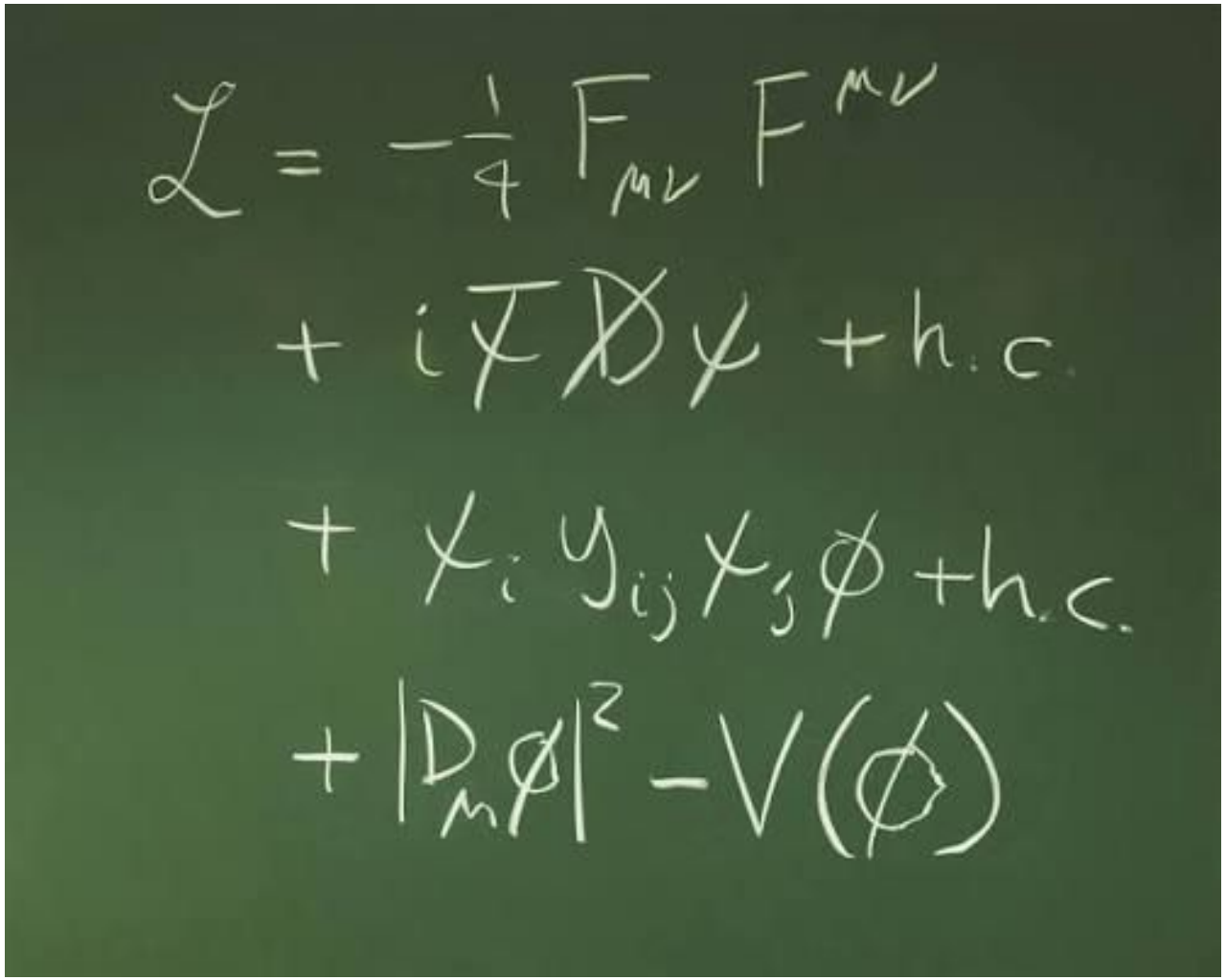


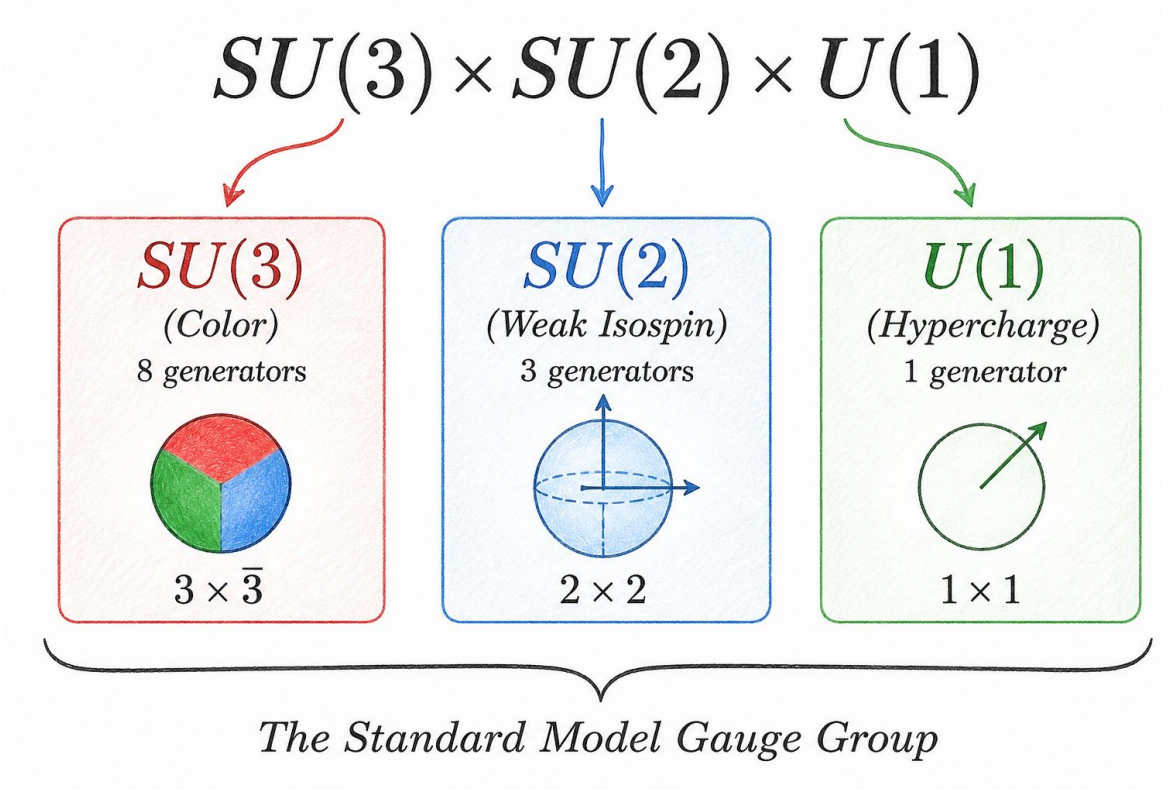
Kinematics of gauge bosons and fermions (and their interactions)

Yukawa couplings: induce mass to fermions

Higgs boson kinematics and potential

The SM symmetries





The standard model independent parameters

18* independent parameters → the rest can be determined from them

1 Gauge sector — 3

Gauge couplings of the three SM interactions

- $g_1,\ g_2,\ g_3 \quad (U(1)_Y \times SU(2)_L \times SU(3)_C)$

2 Fermion sector — 13

Yukawa couplings (fermion masses and mixing)

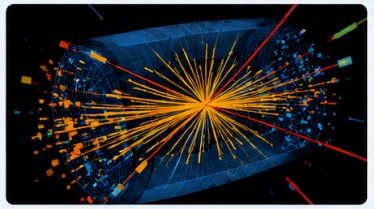
- 9 charged fermion masses (6 quarks + 3 charged leptons)
- 4 CKM parameters (3 mixing angles + 1 CP phase)

3 Higgs sector — 2

Higgs potential parameters

- 2 parameters (e.g. μ^2 and λ)

From Standard Model Parameters to Boson Masses



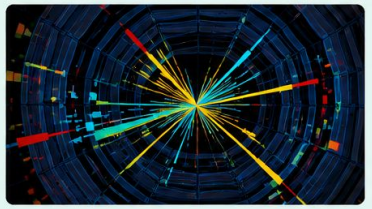
1. Higgs boson

Scalar self-coupling

$$m_H = \sqrt{2\lambda}\, v$$

Inputs

- v: Higgs vacuum expectation value
- λ: Higgs self-coupling



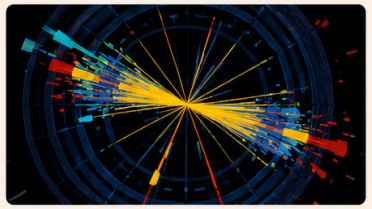
2. W boson

Charged weak interaction

$$m_W = \frac{gv}{2}$$

Inputs

- g: weak $SU(2)_L$ gauge coupling
- v: Higgs vacuum expectation value



3. Z boson

Neutral weak interaction

$$m_Z = \frac{v}{2}\sqrt{g^2 + g'^2}$$

Inputs

- g: weak $SU(2)_L$ coupling
- g': hypercharge $U(1)_Y$ coupling
- v: Higgs vacuum expectation value

*Plus the neutrinos masses and the strong CP term

What can the SM explain?

The SM describes almost every experiment on Earth in the past 20 centuries:

- Electromagnetism → chemistry, biology
- Strong and electroweak forces → nuclear physics

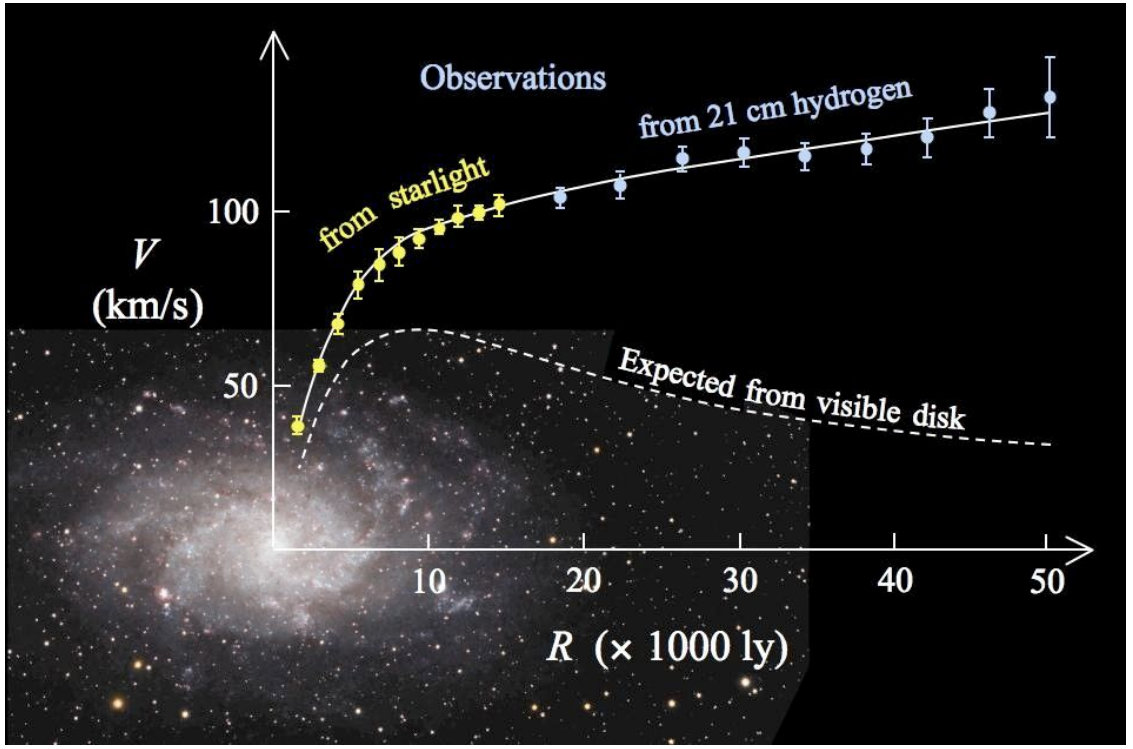


What can't the SM explain?

Gravity

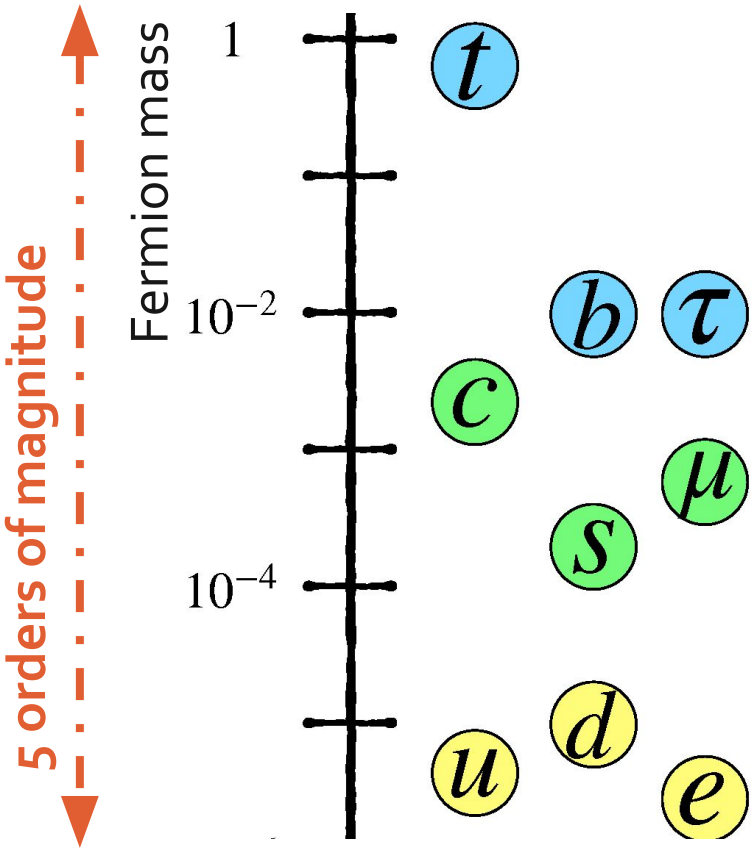
Dark matter

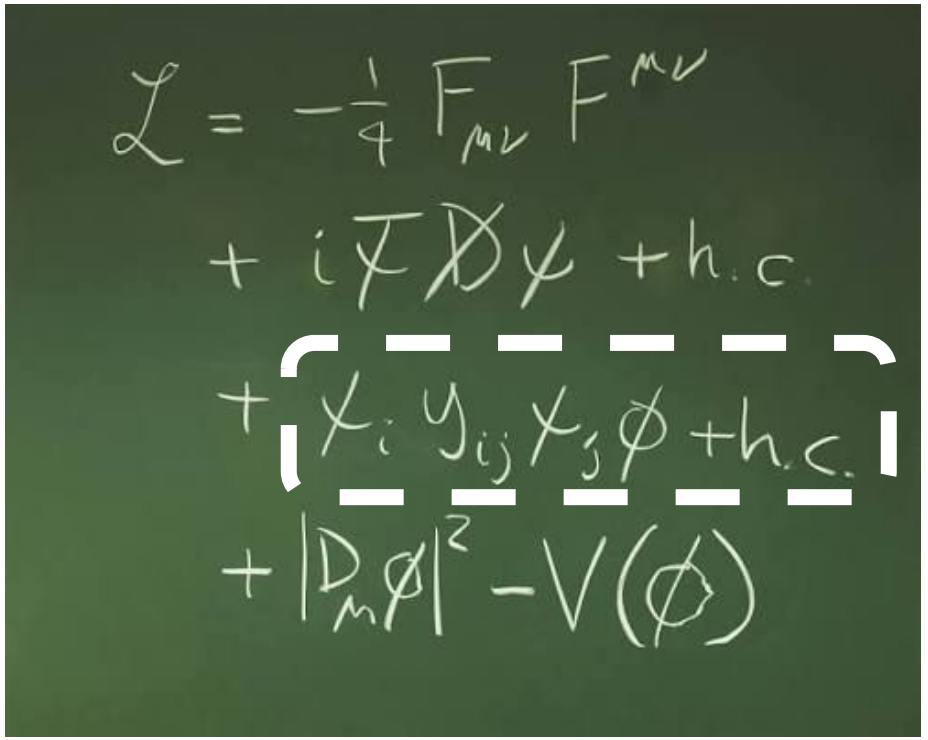
Neutrino masses





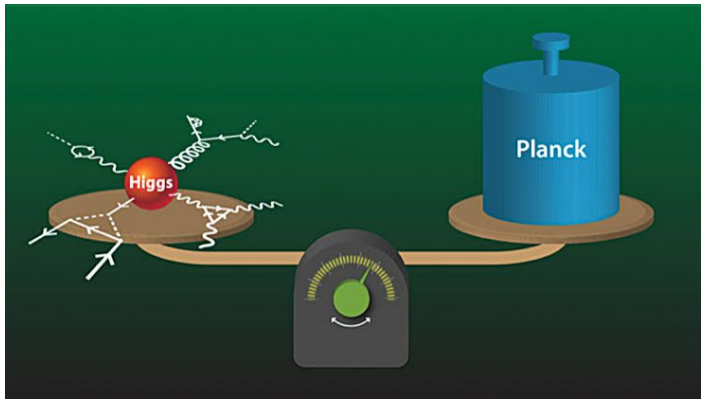
What looks fishy in the SM?
The flavor problem



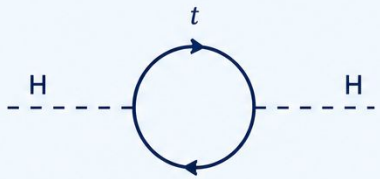




What looks fishy in the SM?
The naturalness problem



2 Quantum loops



Particles in loops (e.g. top quark) contribute to the Higgs mass.

3 Large corrections

$$\delta m_h^2 \sim \frac{1}{16\pi^2} g^2 \Lambda^2$$

The corrections grow with the high-energy scale Λ.

4 Huge difference in scale

Higgs mass
125 GeV
(10^2 GeV)

vs

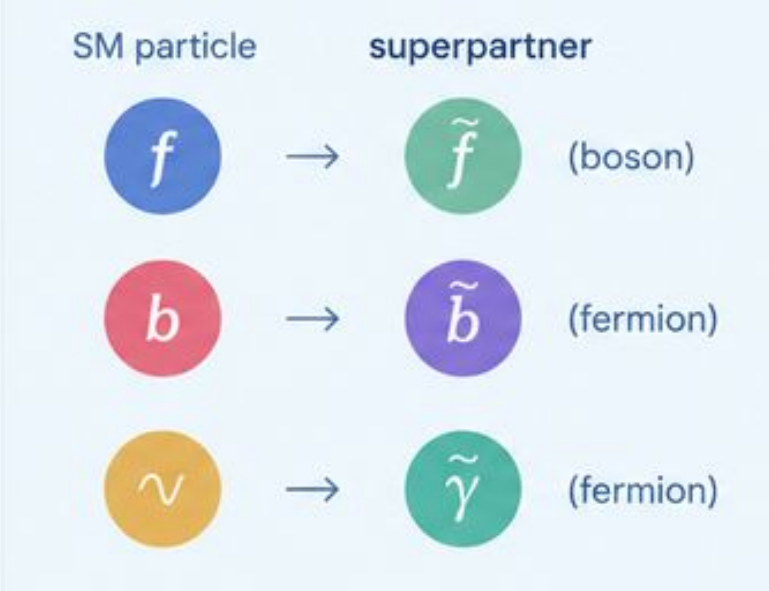
Planck scale
10^{19} GeV
(10^{19} GeV)

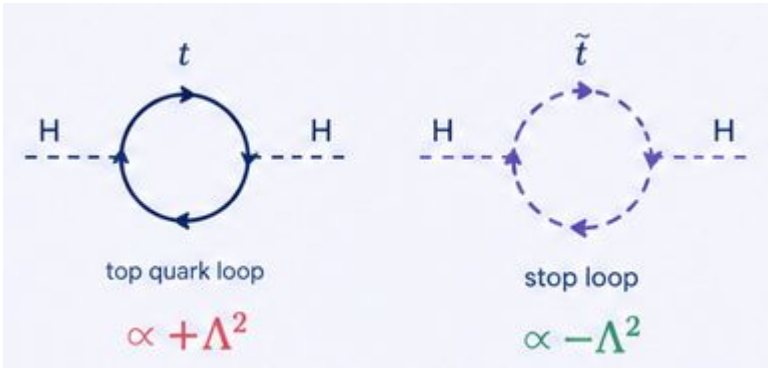
~ 10^{17} times larger



SUSY or not SUSY?

SUSY = SUperSymmetry





$$\delta m_h^2 \sim \frac{1}{16\pi^2} m_{\text{SUSY}}^2$$

(instead of $\sim \Lambda^2$)

e.g:

- quark ⟶ squark
- top ⟶ stop
- gauge bosons ⟶ gauginos
- gluons ⟶ gluinos

"If SUSY particles are not much* heavier than the Higgs, it would be a solution to the hierarchy problem"

The Large Hadron collider at a glance

27 km
Circumference of the ring

13.6 TeV
Center-of-mass energy

40 million/s
Collision rate

4
Particle interaction points



Colliding protons and heavy ions, the "effective" collision energy is lower than 13.6 TeV

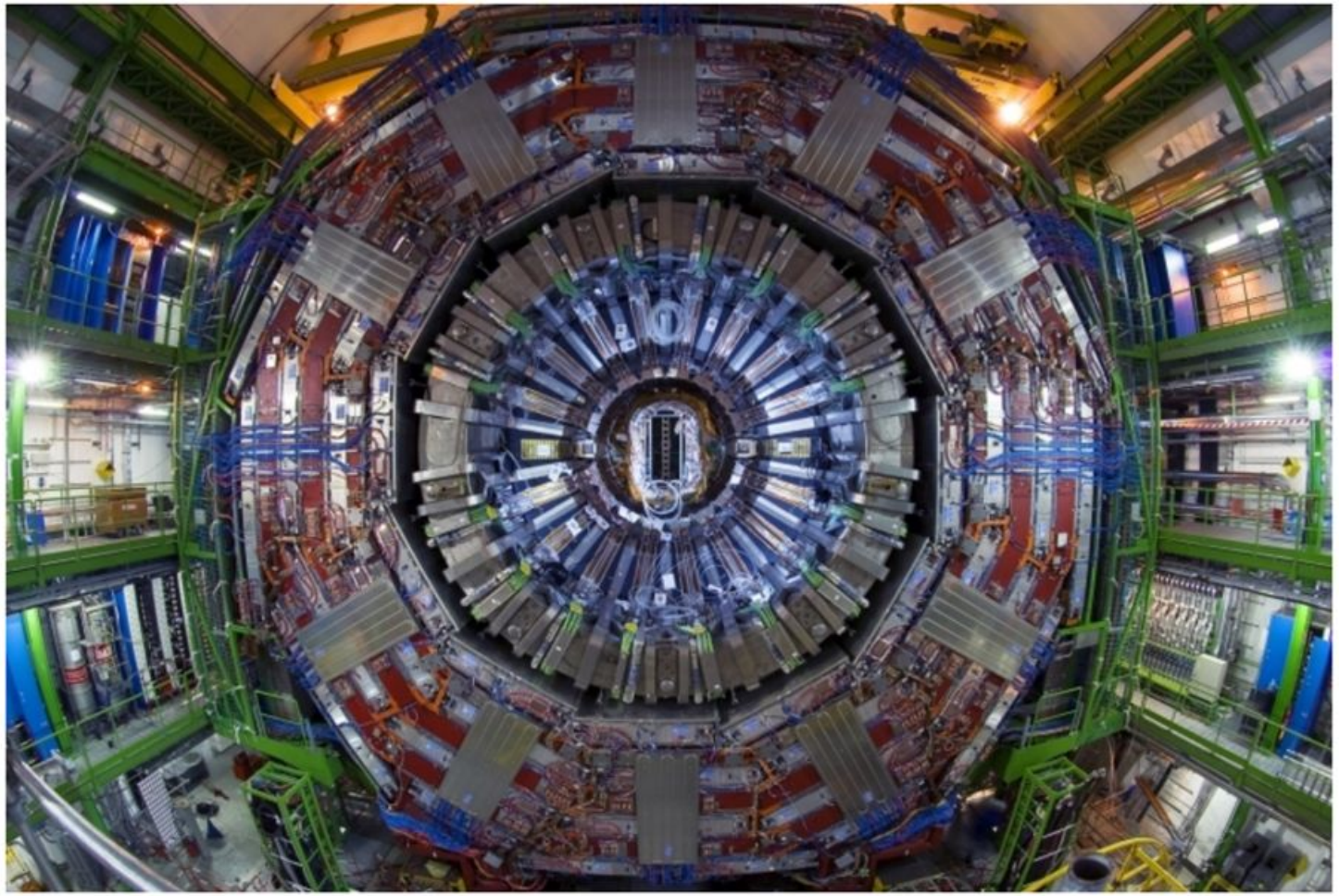
The CMS experiment

21 m
Detector length

15 m
Detector diameter / height

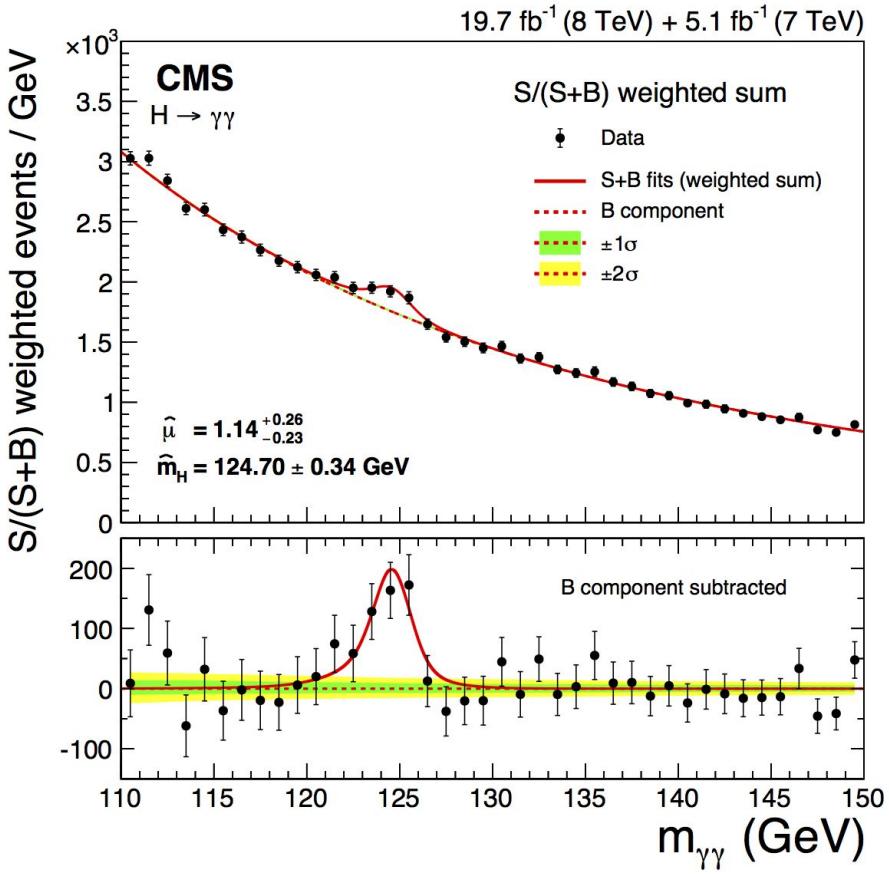
14,000 tonnes
Total detector weight

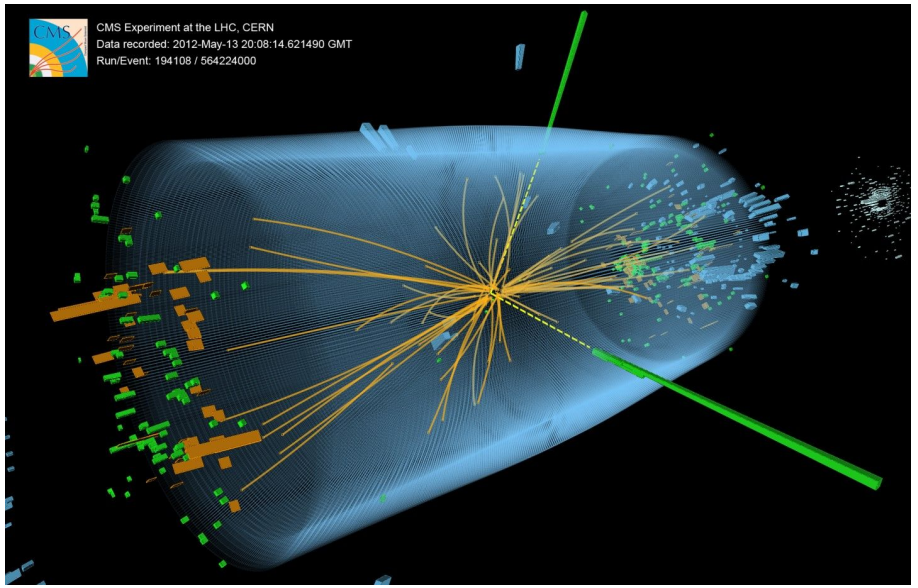
3.8 T
Solenoid magnetic field



General purpose detector: meant to detect a broad range of physical signatures

The Higgs discovery







The SM was “completed” with the discovery of the Higgs boson in 2012

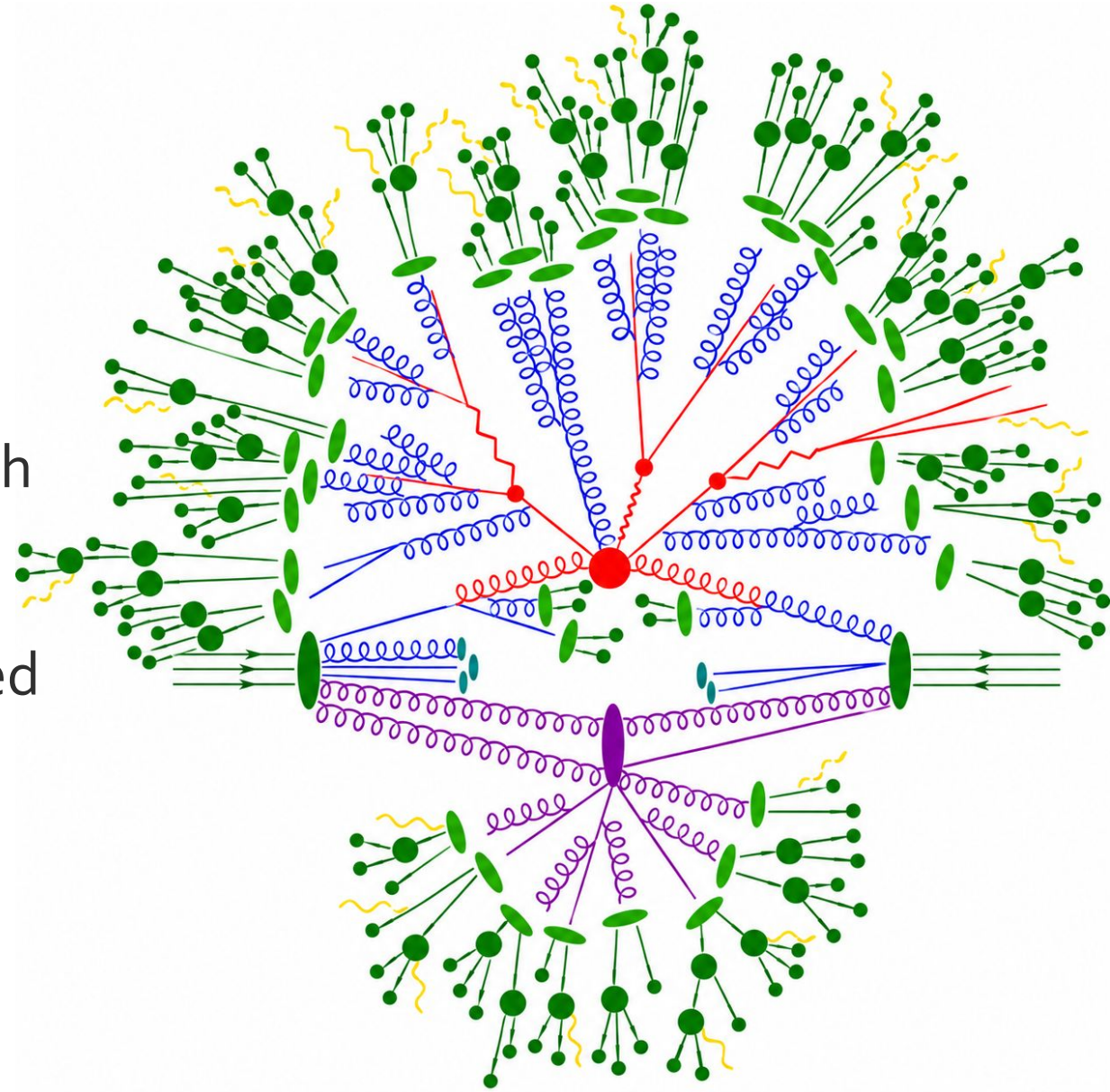
The Standard Model at work

Incoming protons: proton PDFs are not calculable (yet)

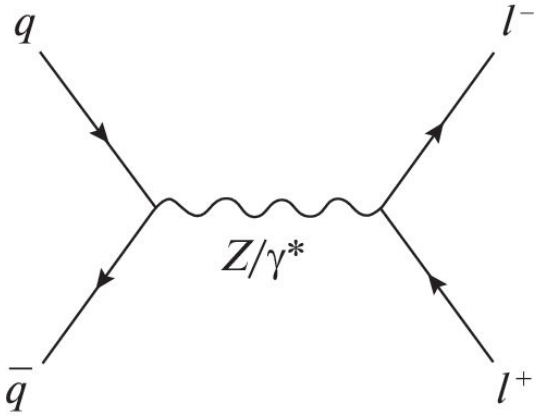
Hard scattering: from first principles but with perturbative expansions

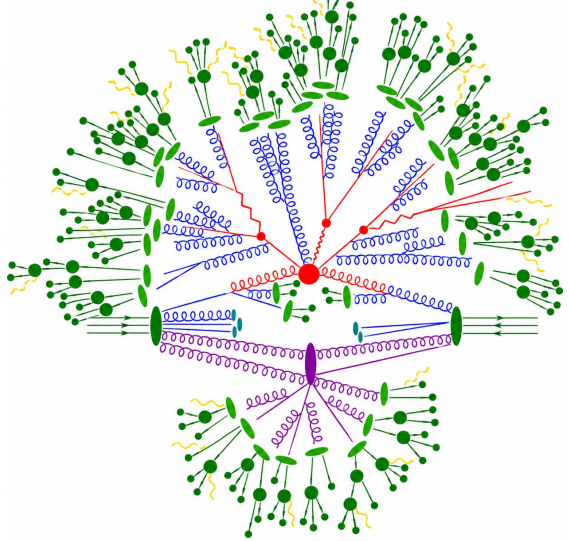
Parton shower: non-perturbative QCD, based on first principles, but approximations

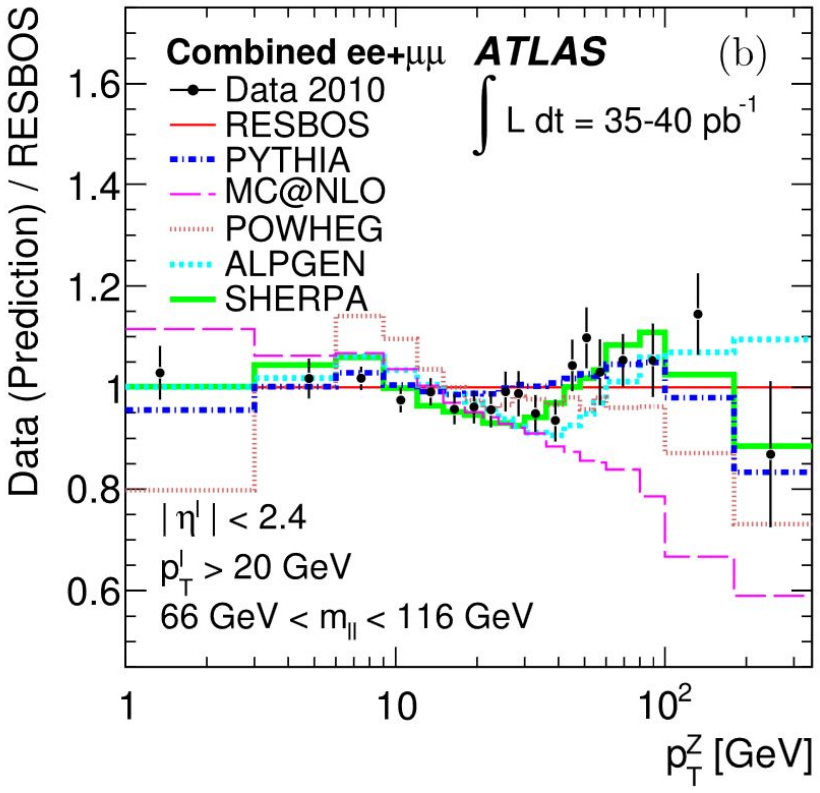
Hadronization: non-perturbative, generally not calculable, using phenomenological models



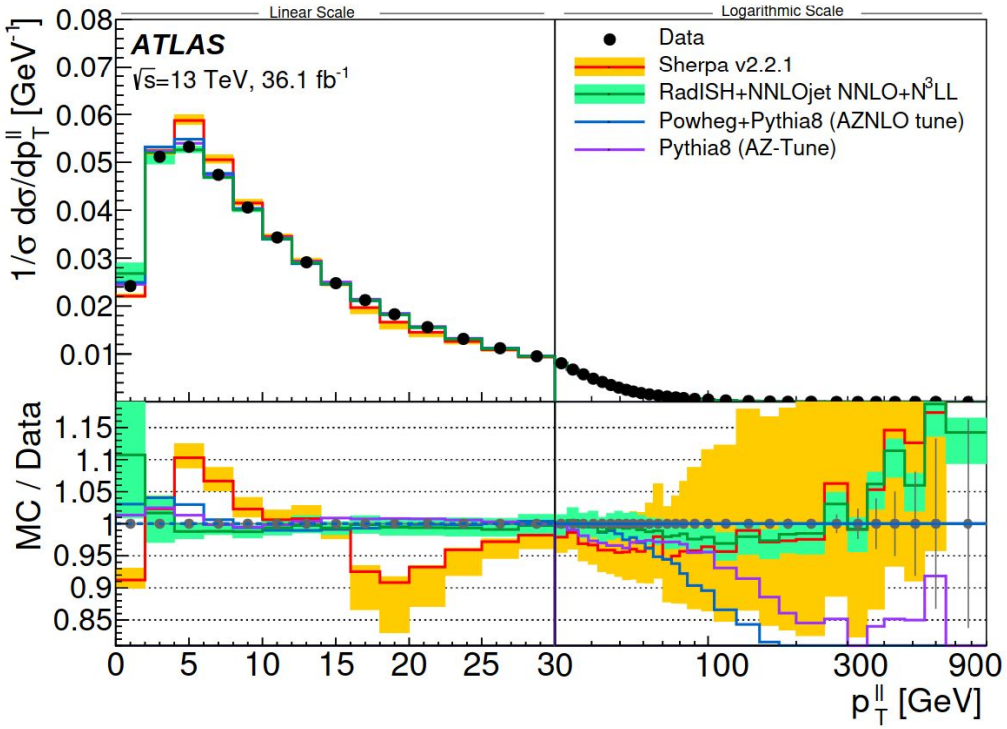
Standard model measurements at the LHC







1000 more data
10 years of theory and experiment developments

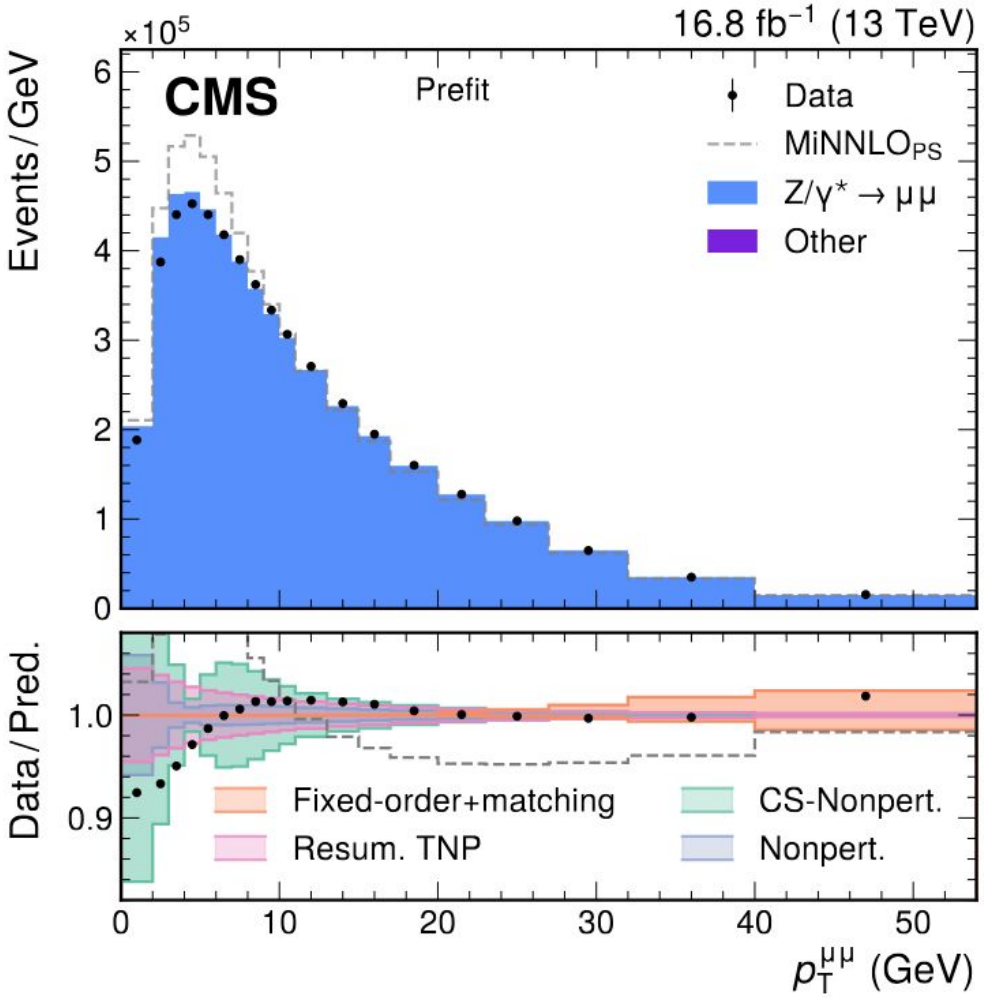


PLB 705 (2011) 415-434

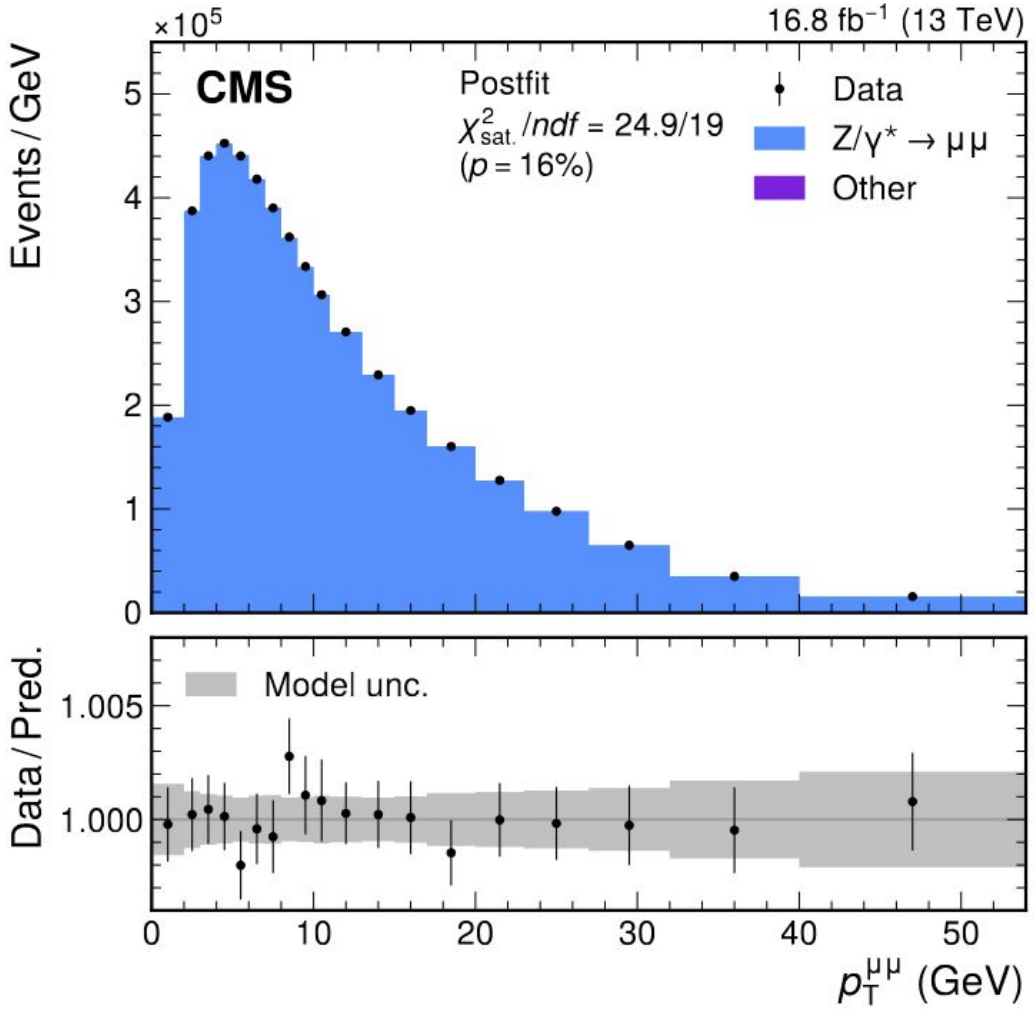
Eur. Phys. J. C 80 (2020) 616

When data and theory joint forces

Nature 652, pages 321–327 (2026)

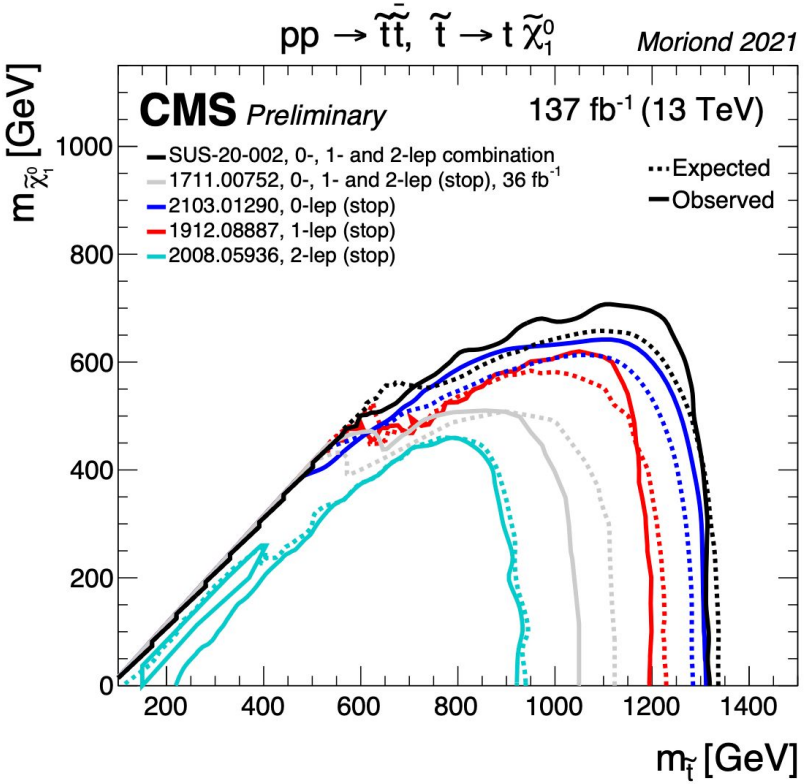


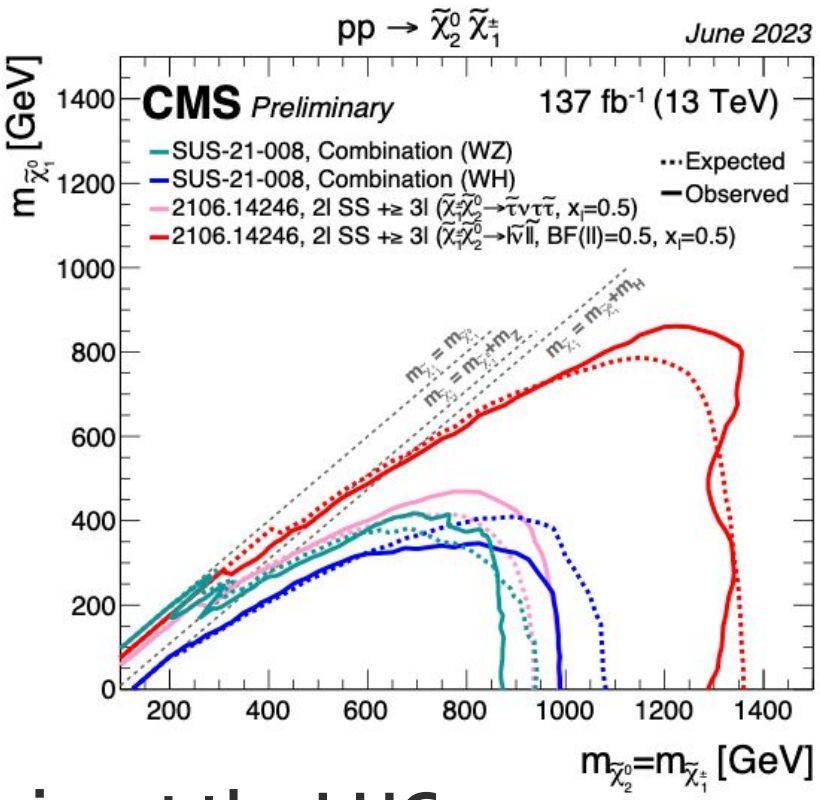
What does data tell us about the theory?

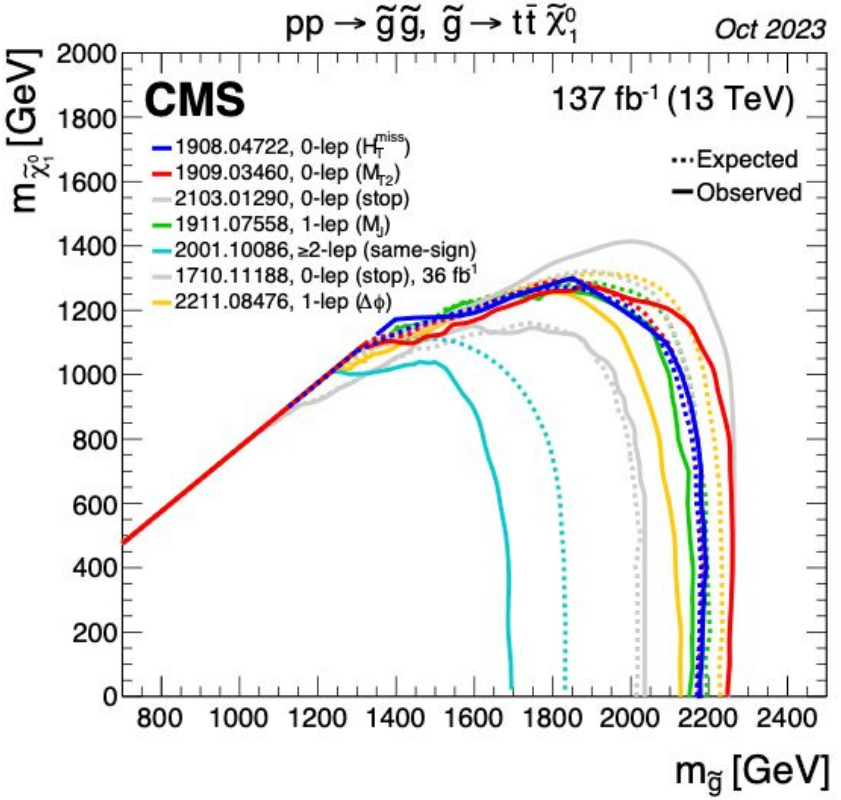


What about SUSY?

Ref: CMS BSM summary plots





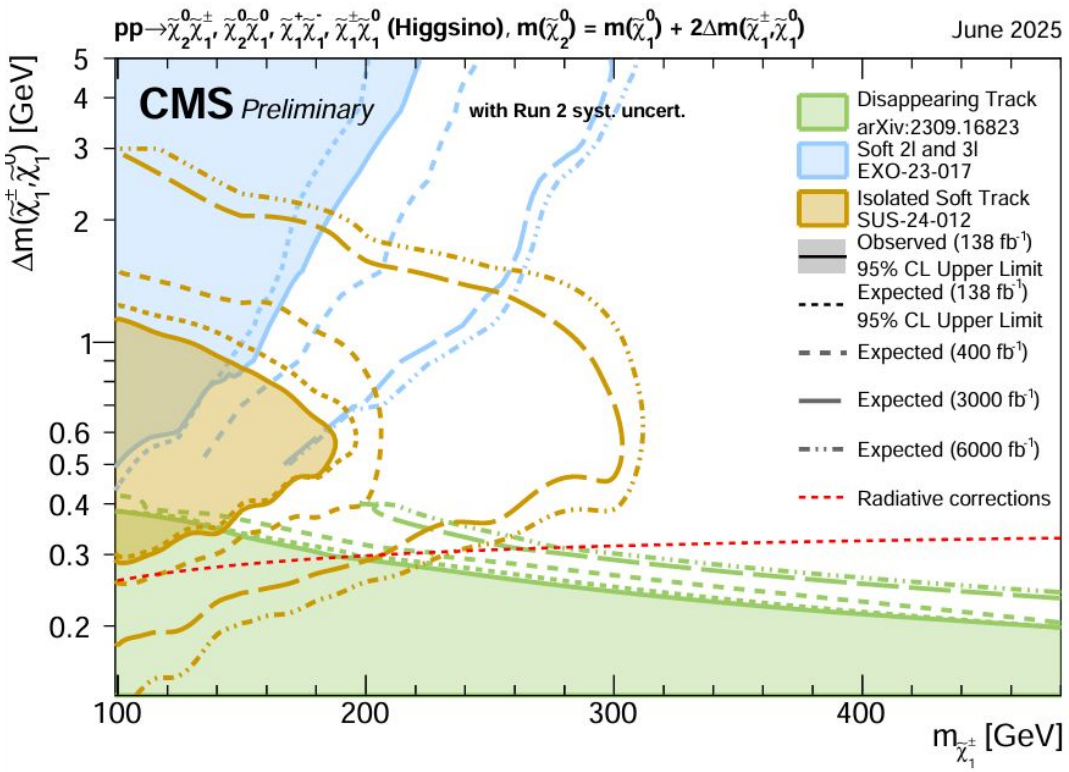


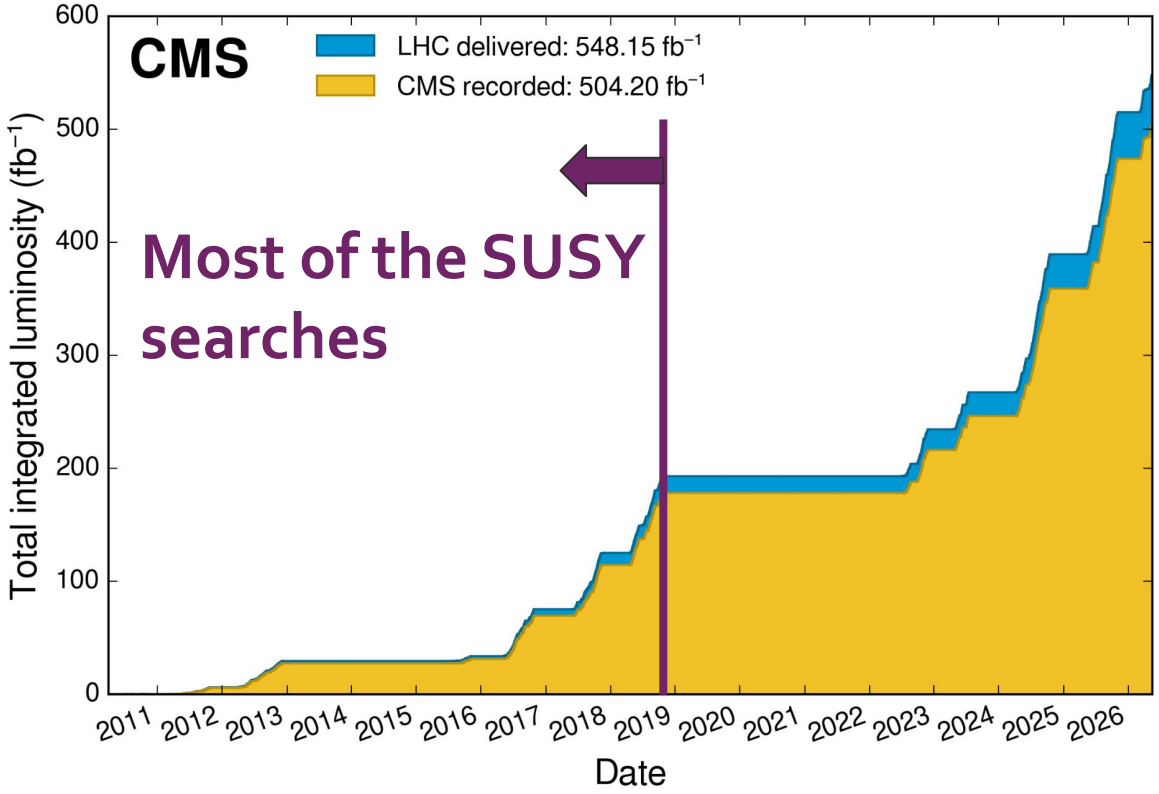
Bottomline: no sign of physics at the LHC

Message to the experts → limits only true for simplified models, they are much weaker in full models

More direct searches for new physics

- The SUSY programme is not yet over





Ref: CMS BSM summary plots

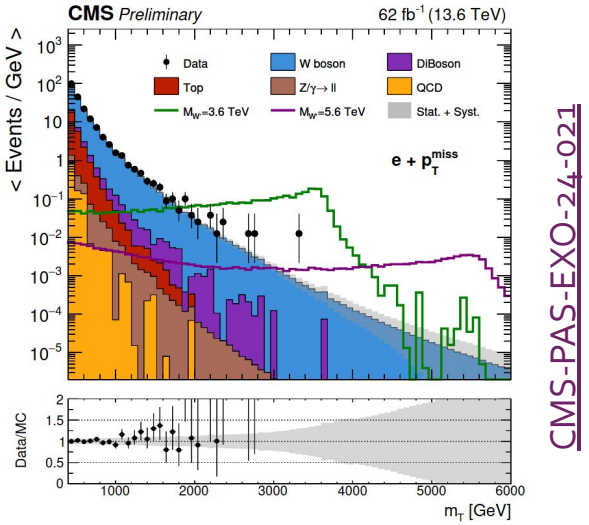
More direct searches for new physics

01

NEW RESONANCES

Z' / W', gravitons, heavy bosons

A bump in high-mass lepton, photon or jet spectra



CMS-PAS-EXO-24-021

02

DARK SECTOR

Dark matter, dark photons, hidden-sector particles

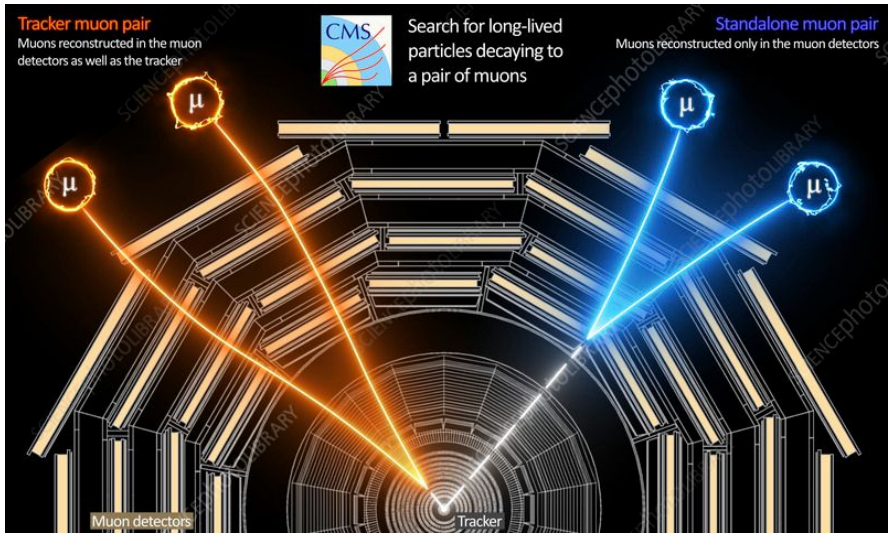
Missing transverse momentum; visible or semi-visible decays

03

LONG-LIVED PARTICLES

Dark photons, heavy neutral leptons, exotic states

Displaced vertices/jets, delayed signals, disappearing tracks



04

UNUSUAL MATTER / STRUCTURE

Leptoquarks, extra dimensions, heavy or highly charged states

Lepton–jet combinations, unusual ionisation or event topology

What if the new particles not there?

The **"problems"** that motivated us to look for SUSY **are still there**!

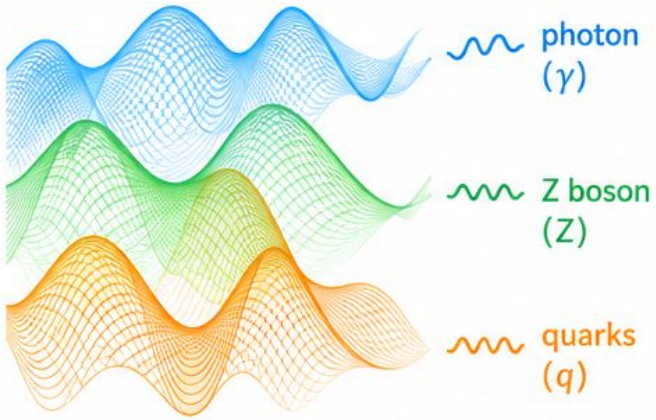
Those "problems" also suggest that the **new physics can't be VERY* far**

What if, still, the LHC is **not energetic enough to produce new particles**?



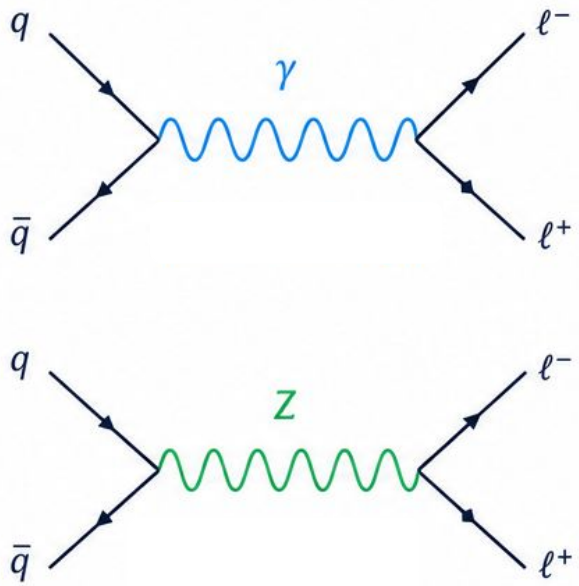
Effective field theories

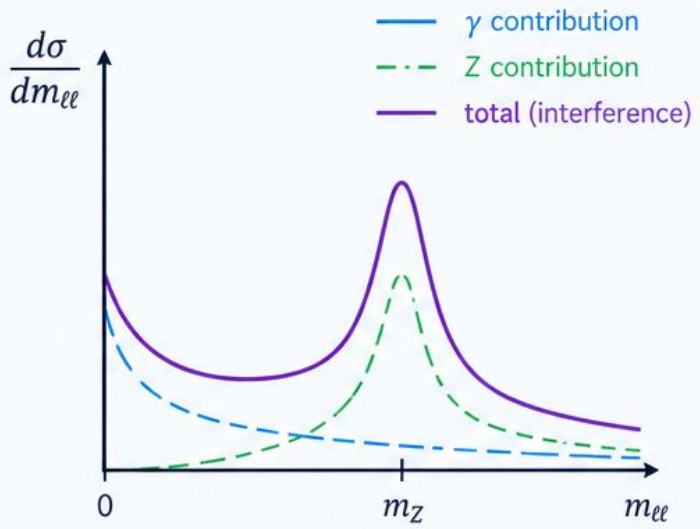
1 Particles are fields



Each particle is an excitation of a quantum field.

2 Interference





The photon and Z amplitudes contribute to the same final state and **interfere**, shaping the spectrum.

Fields
Particles = excitations of quantum fields

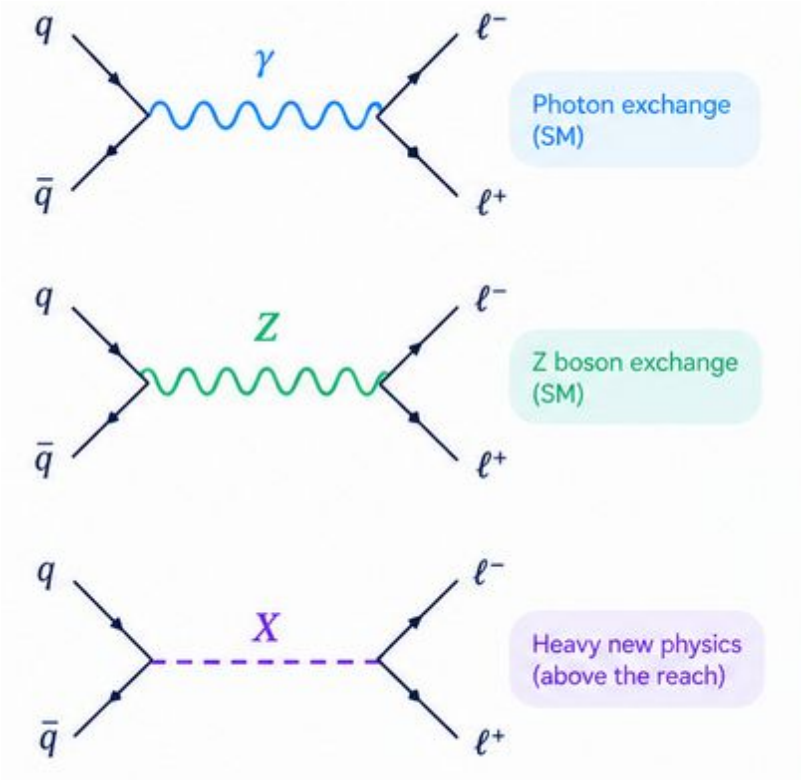
→

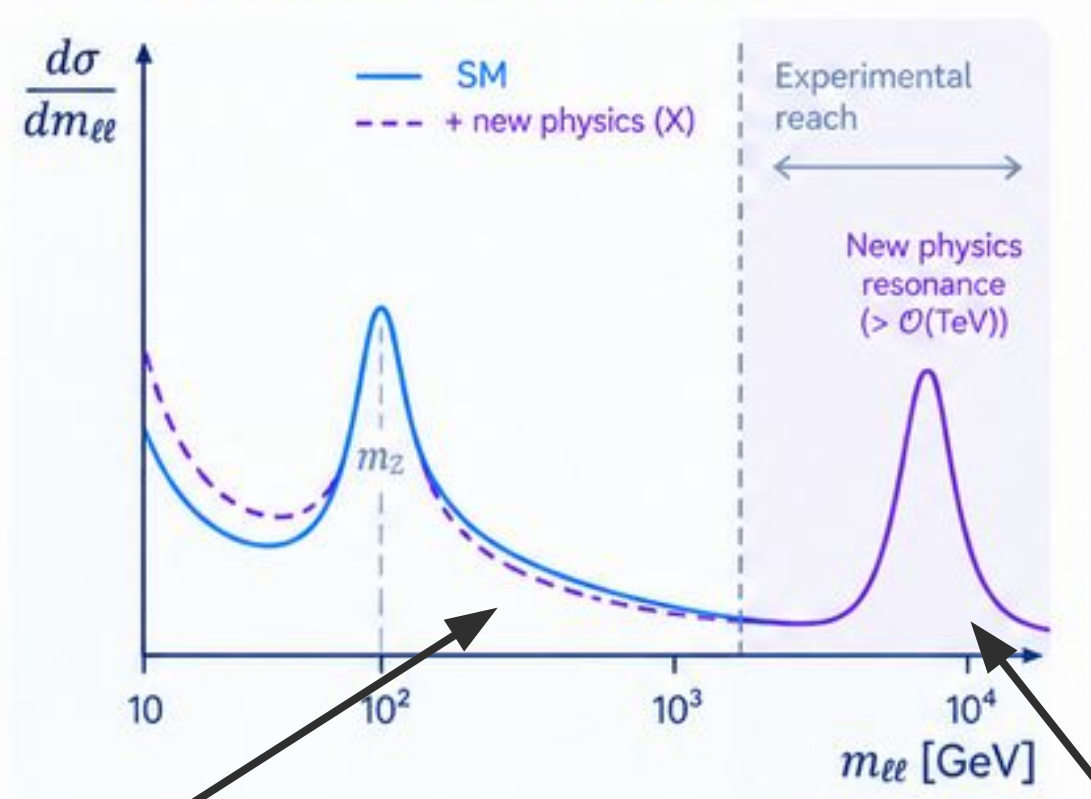
Interference
Amplitudes add up, changing probabilities

→

Observable
Measured as the $m_{\ell\ell}$ spectrum

Effective field theories





Indirect searches for new physics

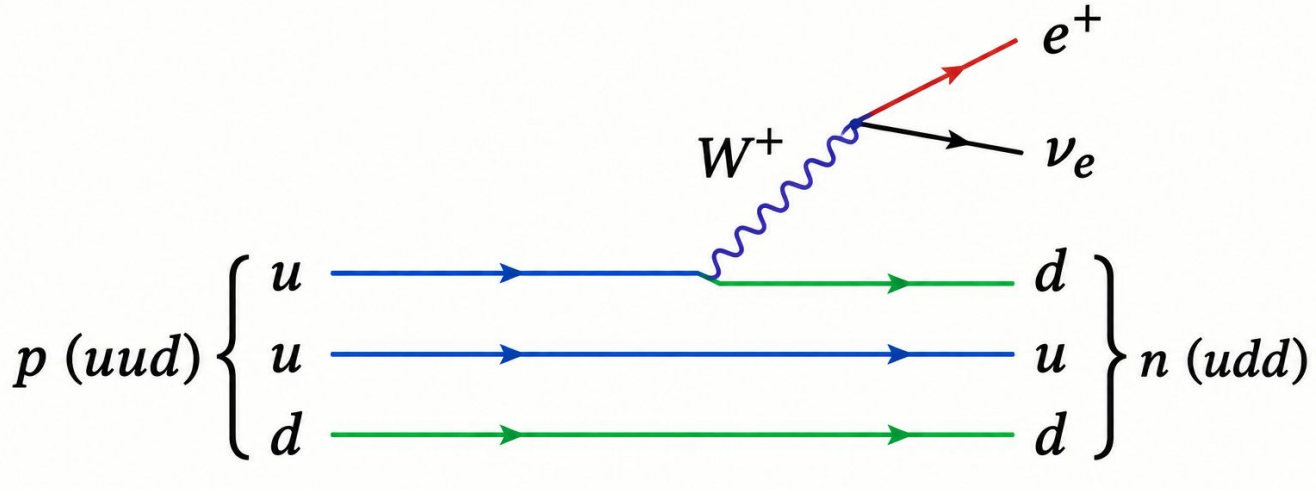
Direct searches for new physics

Effective field theories in real life



Limiting factor of the pp-chain:

$^1H + {}^1H \longrightarrow {}^2H + e^+ + \nu_e$

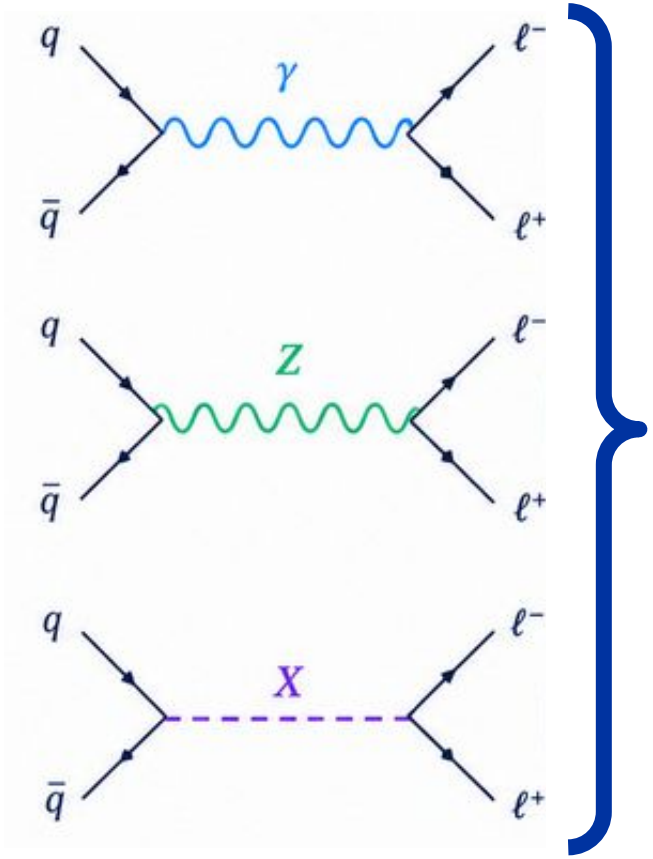


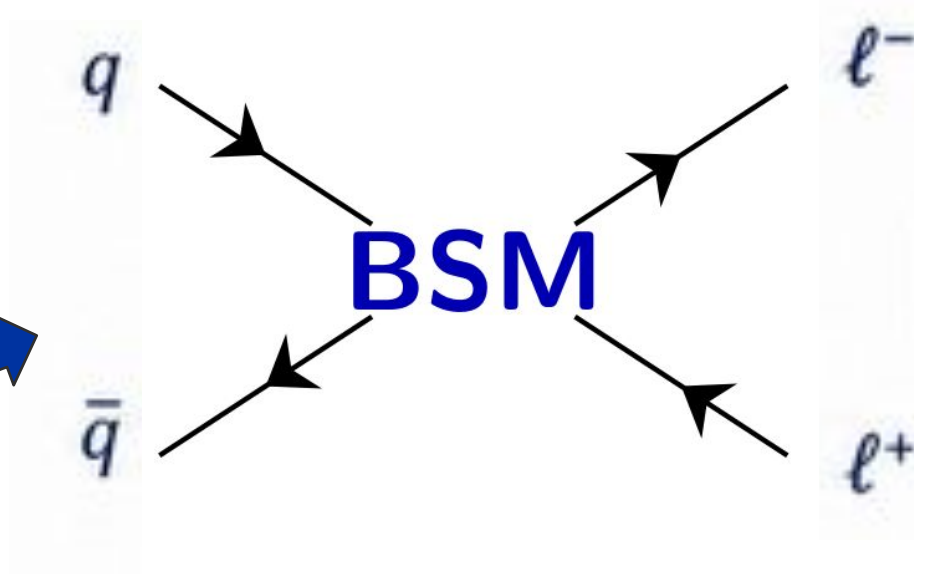
Typical energy of the quarks ⟶ O(100 MeV)

W boson mass ⟶ 80 GeV (1000 times more!!)

The reaction is only possible through a very virtual W boson

The SM effective field theory





$$\mathcal{L} = \mathcal{L}_{SM} + \sum_i \frac{C_i}{\Lambda^2} O_i^{(6)}$$

operator involving only SM fields

coupling and new physics scale

The SM effective field theory

$$\mathcal{L} = \mathcal{L}_{SM} + \sum_i \frac{C_i}{\Lambda^2} O_i^{(6)}$$

X^3		φ^6 and $\varphi^4 D^2$		$\psi^2\varphi^3$	
Q_G	$f^{ABC} G_\mu^{A\nu} G_\nu^{B\rho} G_\rho^{C\mu}$	Q_φ	$(\varphi^\dagger\varphi)^3$	$Q_{e\varphi}$	$(\varphi^\dagger\varphi)(\bar{l}_p e_r \varphi)$
$Q_{\widetilde{G}}$	$f^{ABC} \widetilde{G}_\mu^{A\nu} G_\nu^{B\rho} G_\rho^{C\mu}$	$Q_{\varphi\Box}$	$(\varphi^\dagger\varphi)\Box(\varphi^\dagger\varphi)$	$Q_{u\varphi}$	$(\varphi^\dagger\varphi)(\bar{q}_p u_r \widetilde{\varphi})$
Q_W	$\varepsilon^{IJK} W_\mu^{I\nu} W_\nu^{J\rho} W_\rho^{K\mu}$	$Q_{\varphi D}$	$\left(\varphi^\dagger D^\mu \varphi\right)^\star \left(\varphi^\dagger D_\mu \varphi\right)$	$Q_{d\varphi}$	$(\varphi^\dagger\varphi)(\bar{q}_p d_r \varphi)$
$Q_{\widetilde{W}}$	$\varepsilon^{IJK} \widetilde{W}_\mu^{I\nu} W_\nu^{J\rho} W_\rho^{K\mu}$				

$X^2\varphi^2$		$\psi^2 X\varphi$		$\psi^2\varphi^2 D$	
$Q_{\varphi G}$	$\varphi^\dagger\varphi\, G_{\mu\nu}^A G^{A\mu\nu}$	Q_{eW}	$(\bar{l}_p \sigma^{\mu\nu} e_r)\tau^I \varphi W_{\mu\nu}^I$	$Q_{\varphi l}^{(1)}$	$(\varphi^\dagger i \overleftrightarrow{D}_\mu \varphi)(\bar{l}_p \gamma^\mu l_r)$
$Q_{\varphi\widetilde{G}}$	$\varphi^\dagger\varphi\, \widetilde{G}_{\mu\nu}^A G^{A\mu\nu}$	Q_{eB}	$(\bar{l}_p \sigma^{\mu\nu} e_r)\varphi B_{\mu\nu}$	$Q_{\varphi l}^{(3)}$	$(\varphi^\dagger i \overleftrightarrow{D}_\mu^I \varphi)(\bar{l}_p \tau^I \gamma^\mu l_r)$
$Q_{\varphi W}$	$\varphi^\dagger\varphi\, W_{\mu\nu}^I W^{I\mu\nu}$	Q_{uG}	$(\bar{q}_p \sigma^{\mu\nu} T^A u_r)\widetilde{\varphi} G_{\mu\nu}^A$	$Q_{\varphi e}$	$(\varphi^\dagger i \overleftrightarrow{D}_\mu \varphi)(\bar{e}_p \gamma^\mu e_r)$
$Q_{\varphi\widetilde{W}}$	$\varphi^\dagger\varphi\, \widetilde{W}_{\mu\nu}^I W^{I\mu\nu}$	Q_{uW}	$(\bar{q}_p \sigma^{\mu\nu} u_r)\tau^I \widetilde{\varphi} W_{\mu\nu}^I$	$Q_{\varphi q}^{(1)}$	$(\varphi^\dagger i \overleftrightarrow{D}_\mu \varphi)(\bar{q}_p \gamma^\mu q_r)$
$Q_{\varphi B}$	$\varphi^\dagger\varphi\, B_{\mu\nu} B^{\mu\nu}$	Q_{uB}	$(\bar{q}_p \sigma^{\mu\nu} u_r)\widetilde{\varphi} B_{\mu\nu}$	$Q_{\varphi q}^{(3)}$	$(\varphi^\dagger i \overleftrightarrow{D}_\mu^I \varphi)(\bar{q}_p \tau^I \gamma^\mu q_r)$
$Q_{\varphi\widetilde{B}}$	$\varphi^\dagger\varphi\, \widetilde{B}_{\mu\nu} B^{\mu\nu}$	Q_{dG}	$(\bar{q}_p \sigma^{\mu\nu} T^A d_r)\varphi G_{\mu\nu}^A$	$Q_{\varphi u}$	$(\varphi^\dagger i \overleftrightarrow{D}_\mu \varphi)(\bar{u}_p \gamma^\mu u_r)$
$Q_{\varphi WB}$	$\varphi^\dagger\tau^I\varphi\, W_{\mu\nu}^I B^{\mu\nu}$	Q_{dW}	$(\bar{q}_p \sigma^{\mu\nu} d_r)\tau^I \varphi W_{\mu\nu}^I$	$Q_{\varphi d}$	$(\varphi^\dagger i \overleftrightarrow{D}_\mu \varphi)(\bar{d}_p \gamma^\mu d_r)$
$Q_{\varphi\widetilde{W}B}$	$\varphi^\dagger\tau^I\varphi\, \widetilde{W}_{\mu\nu}^I B^{\mu\nu}$	Q_{dB}	$(\bar{q}_p \sigma^{\mu\nu} d_r)\varphi B_{\mu\nu}$	$Q_{\varphi ud}$	$i(\widetilde{\varphi}^\dagger D_\mu \varphi)(\bar{u}_p \gamma^\mu d_r)$

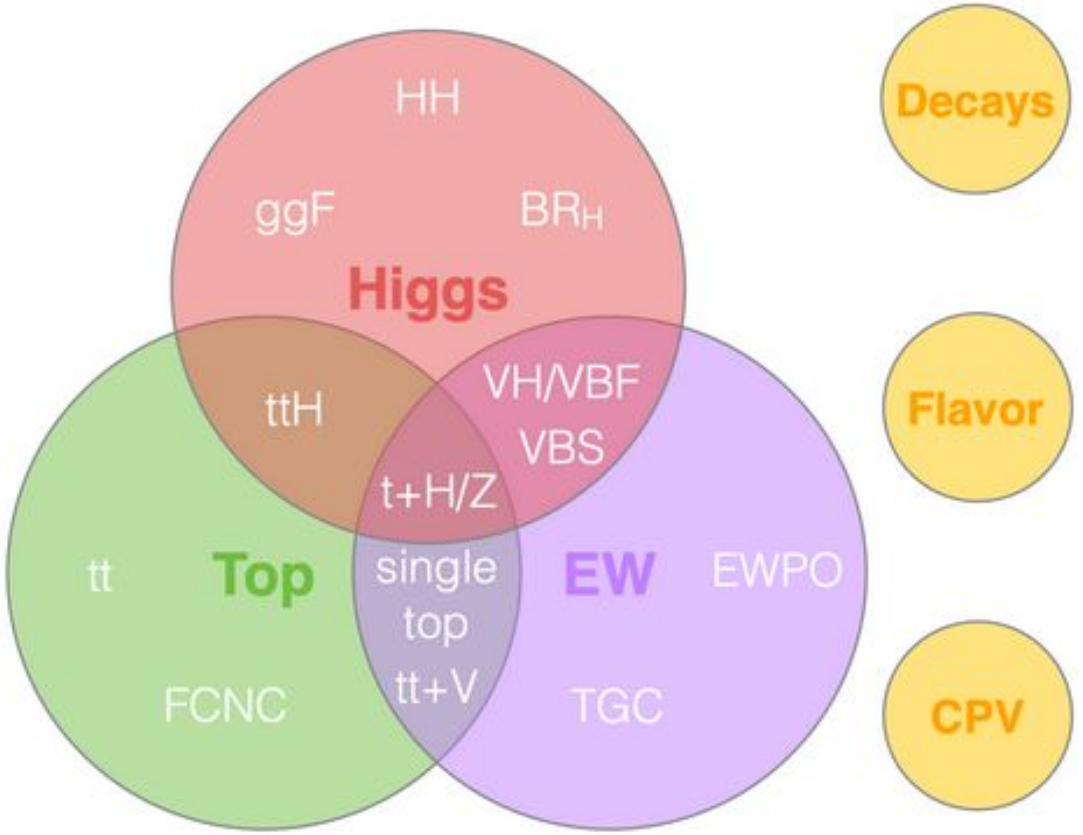
In total, 2499 operators!!

New physics could induce many operators at the same time, and they **can cancel each other**

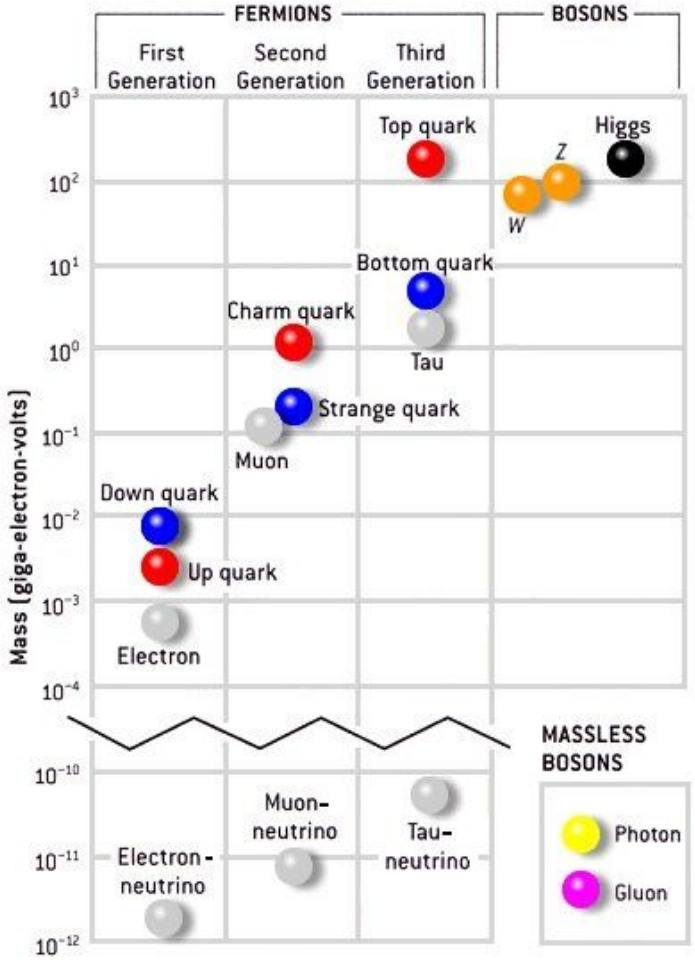
The SMEFT, the strategy

New physics could be ~**anywhere**, and 2499 operators are not possible to test simultaneously

In practice, focusing on in "sectors"

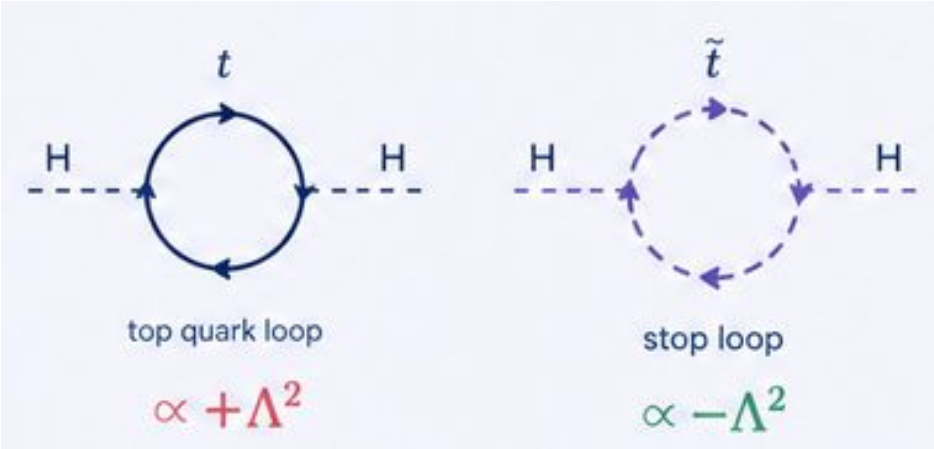


What sectors are more important?
A *clearly unbiased* assessment



The **Higgs and the top** are the most massive particles in the SM

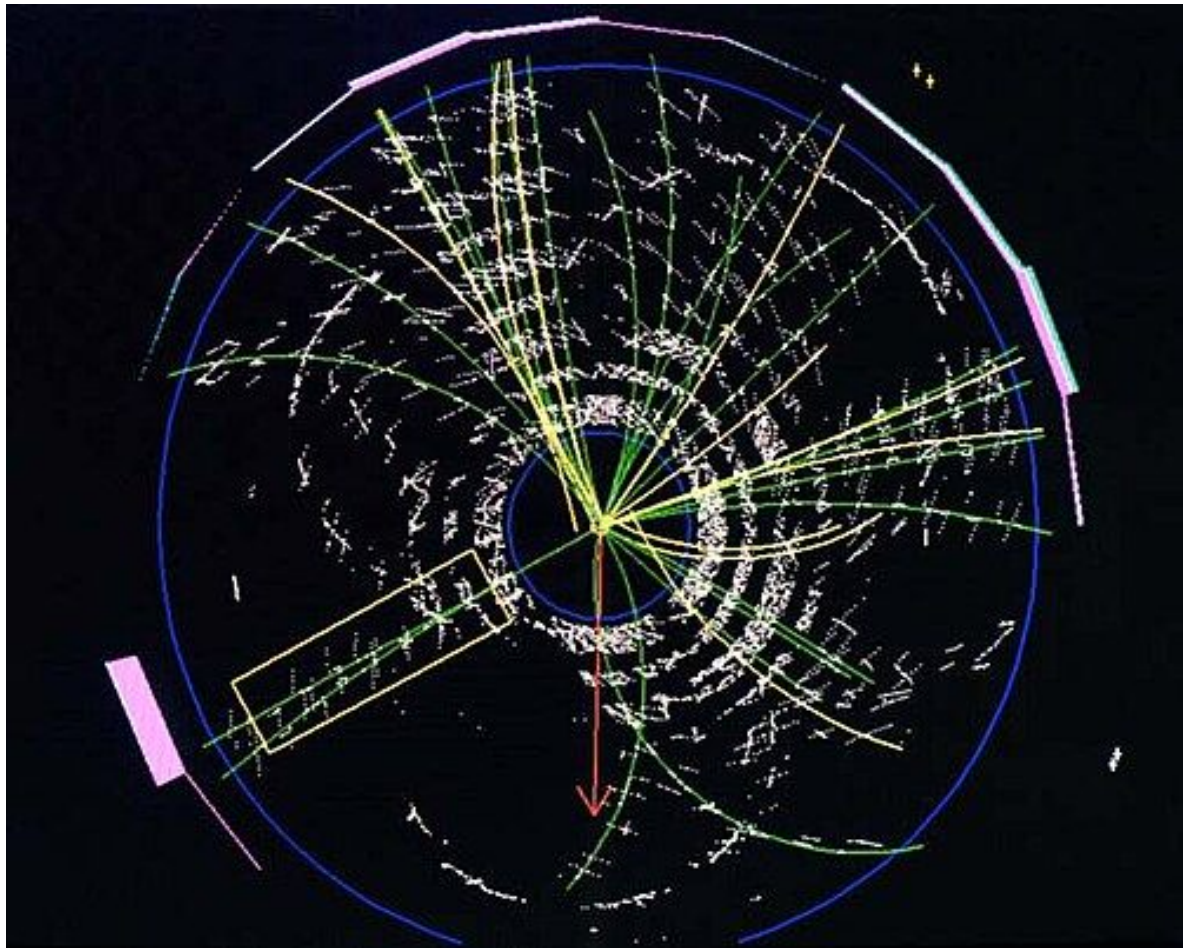
They are directly connected to the fundamental problems of the SM: **naturalness** and **flavor**



The top quark - everybody's second favourite particle

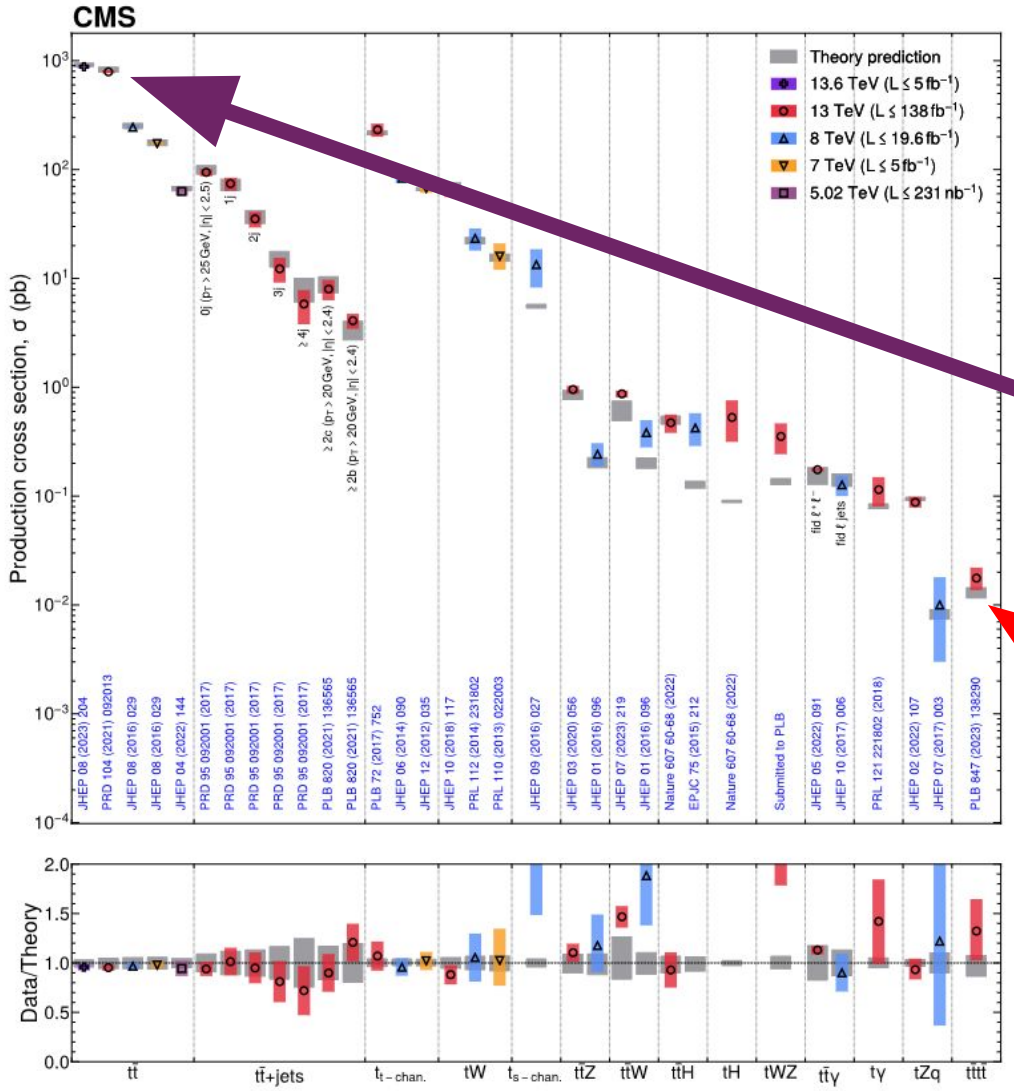
The top quark was observed 30 years ago at the Tevatron

It has been studied with a great level of detail, but some aspects remain elusive



Top quark event display, CDF

The top landscape in a nutshell

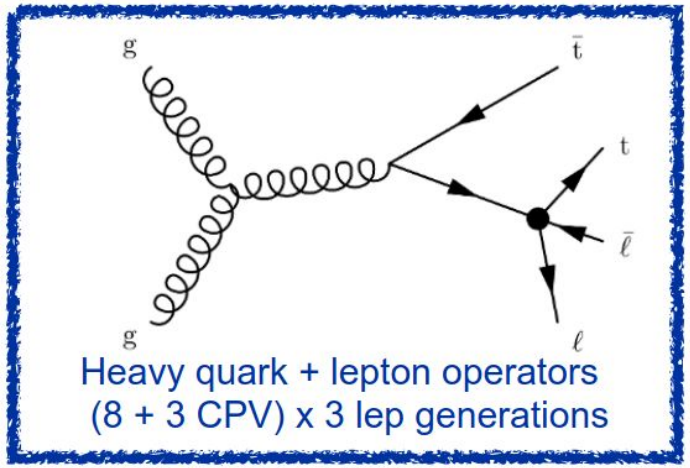


"From precision measurements to the rarest processes"

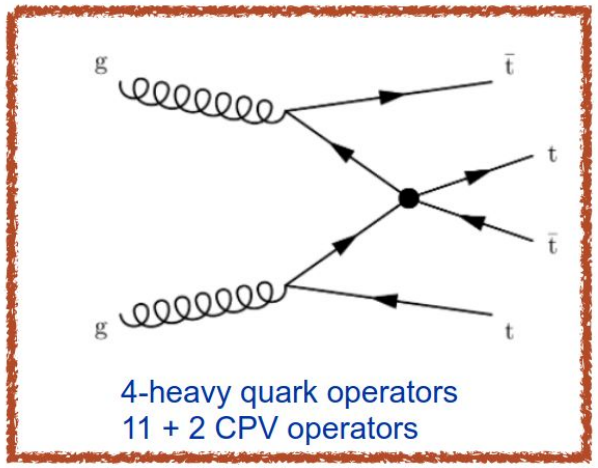
top-antitop production: ~500 million events until now - **studied to death**

4top production: ~4000 events until now → potentially large new physics contributions, only explorable now!

The top quark sector of the SMEFT

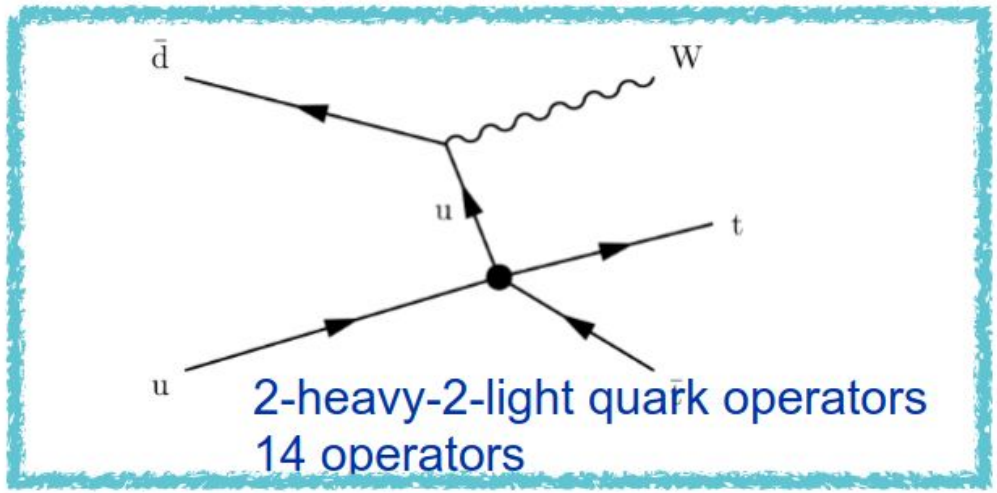


Heavy quark + lepton operators
(8 + 3 CPV) x 3 lep generations

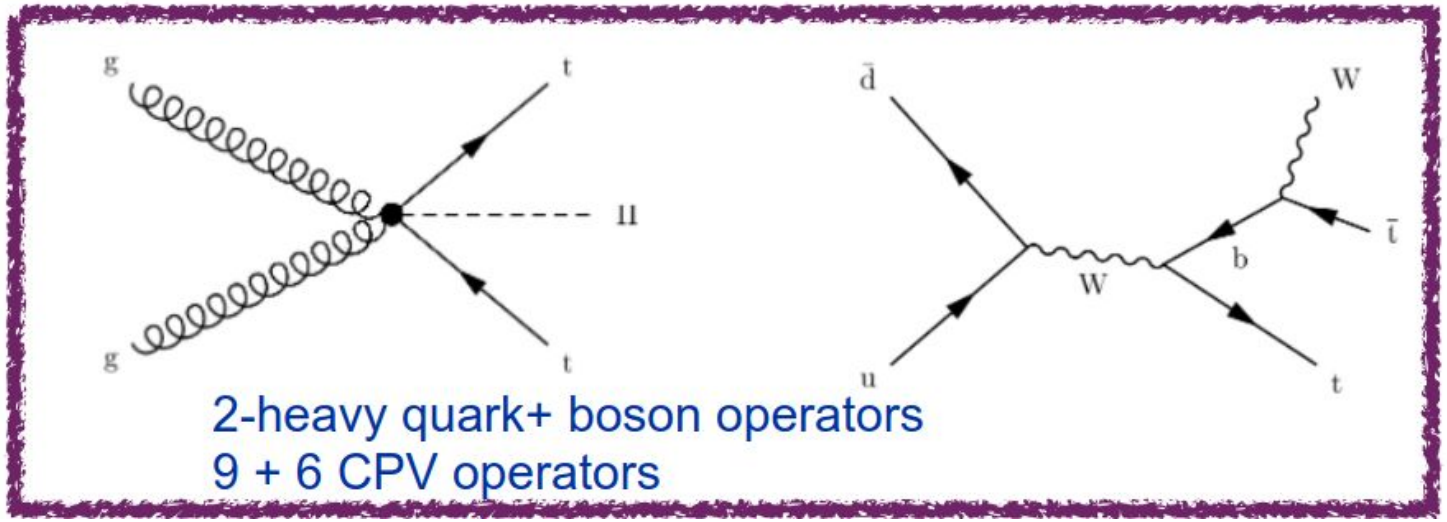


4-heavy quark operators
11 + 2 CPV operators

Operators generating lepton flavor violation, FCNCs, etc are also possible - see the backup

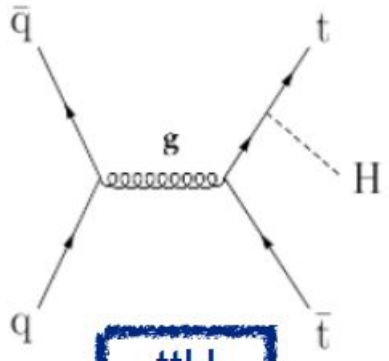


2-heavy-2-light quark operators
14 operators

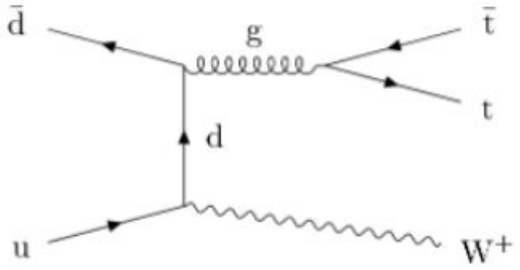


2-heavy quark+ boson operators
9 + 6 CPV operators

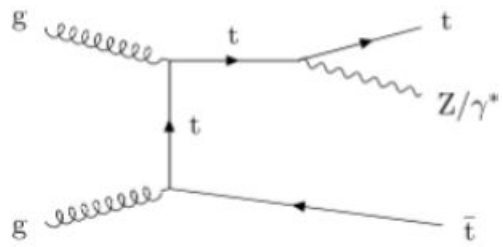
Studying rare top production



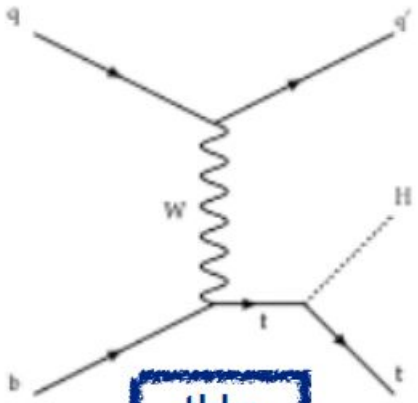
ttH



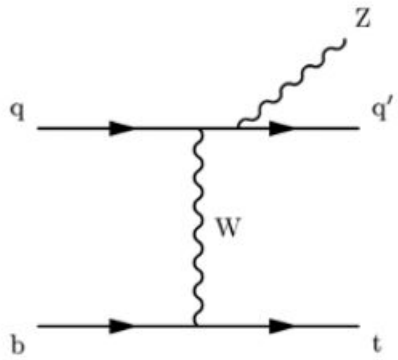
ttW



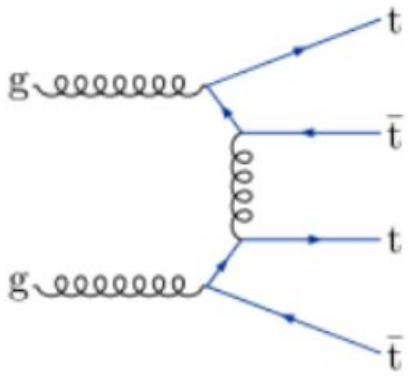
ttZ



tHq



tZq

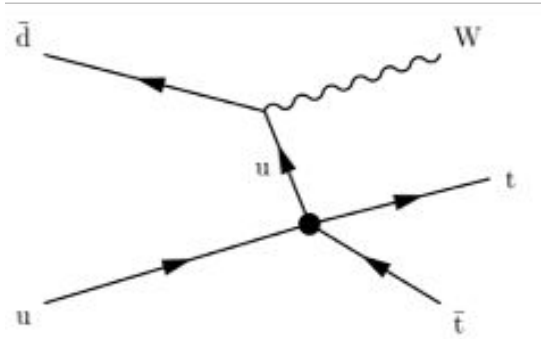


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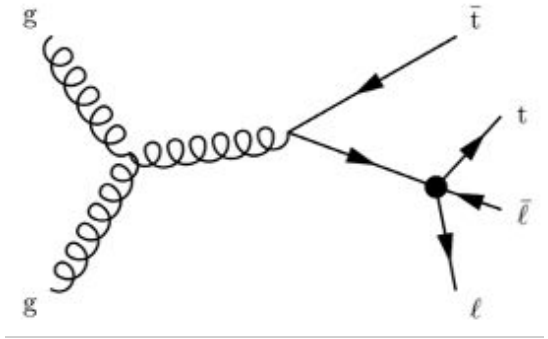
JHEP 12 (2023) 068

Observables considered

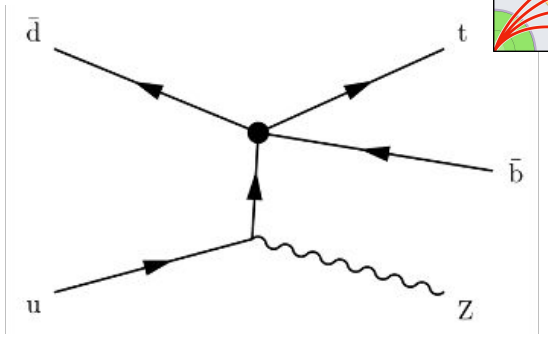
JHEP 12 (2023) 068



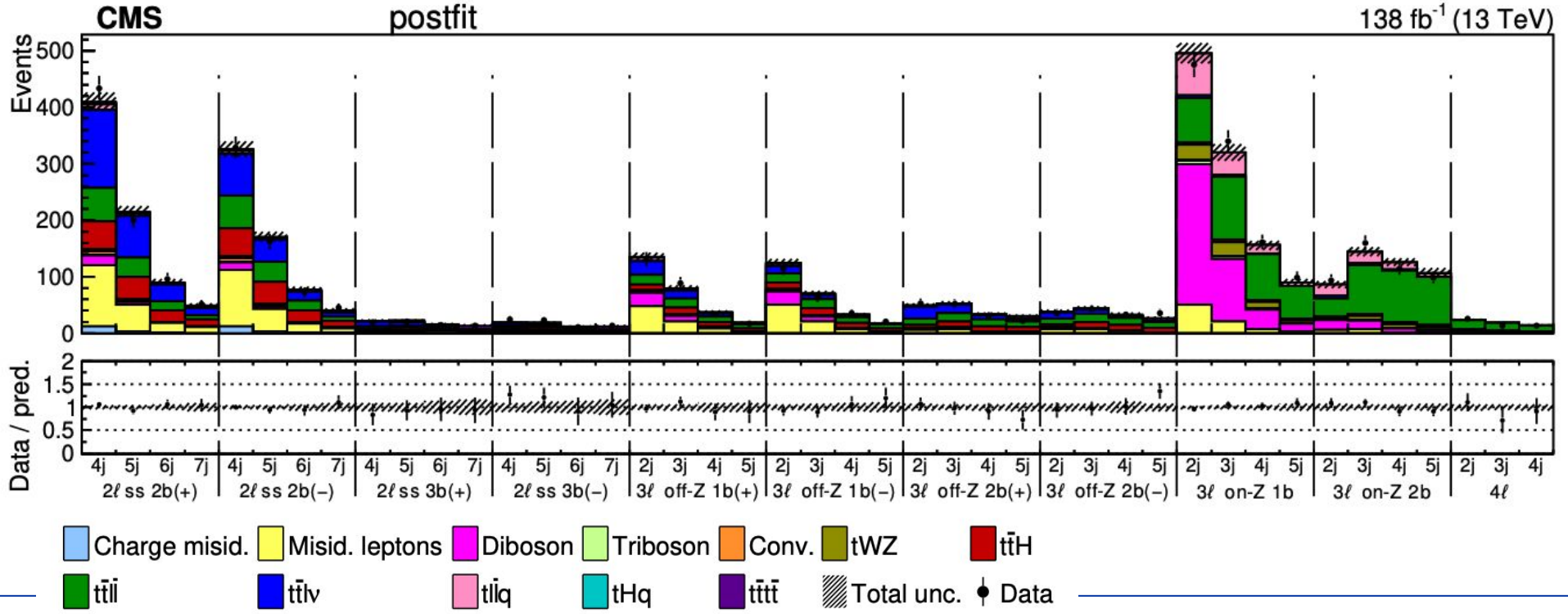
2-heavy-2-light quarks op.



2-top-2-lepton op.

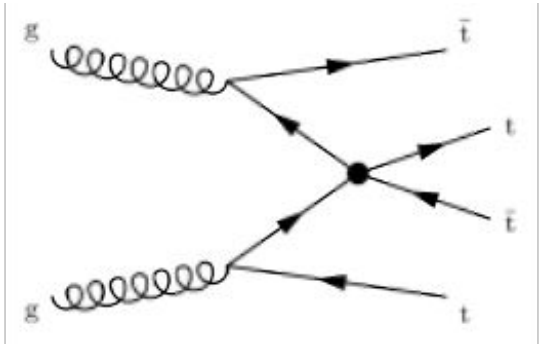


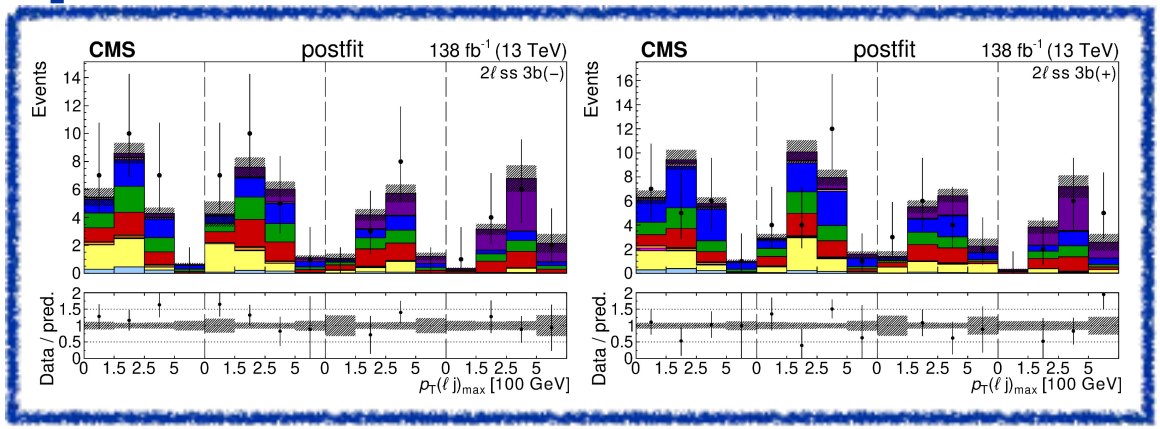
2-heavy-2-light quark op.

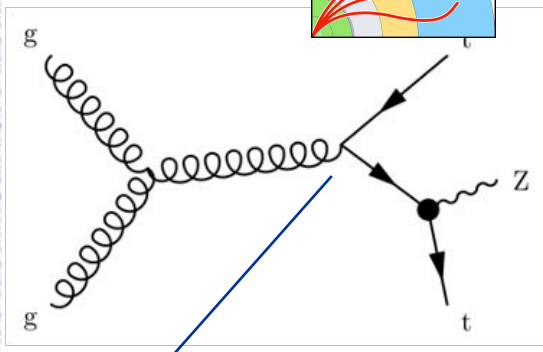


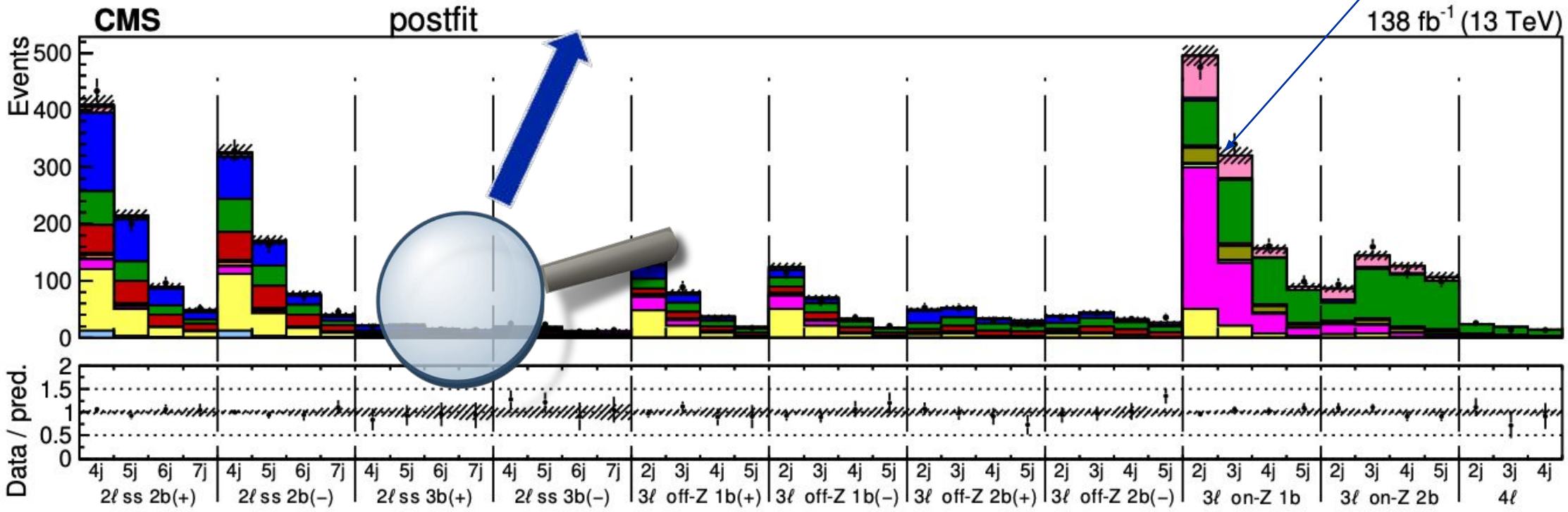
Studying rare top production

JHEP 12 (2023) 068







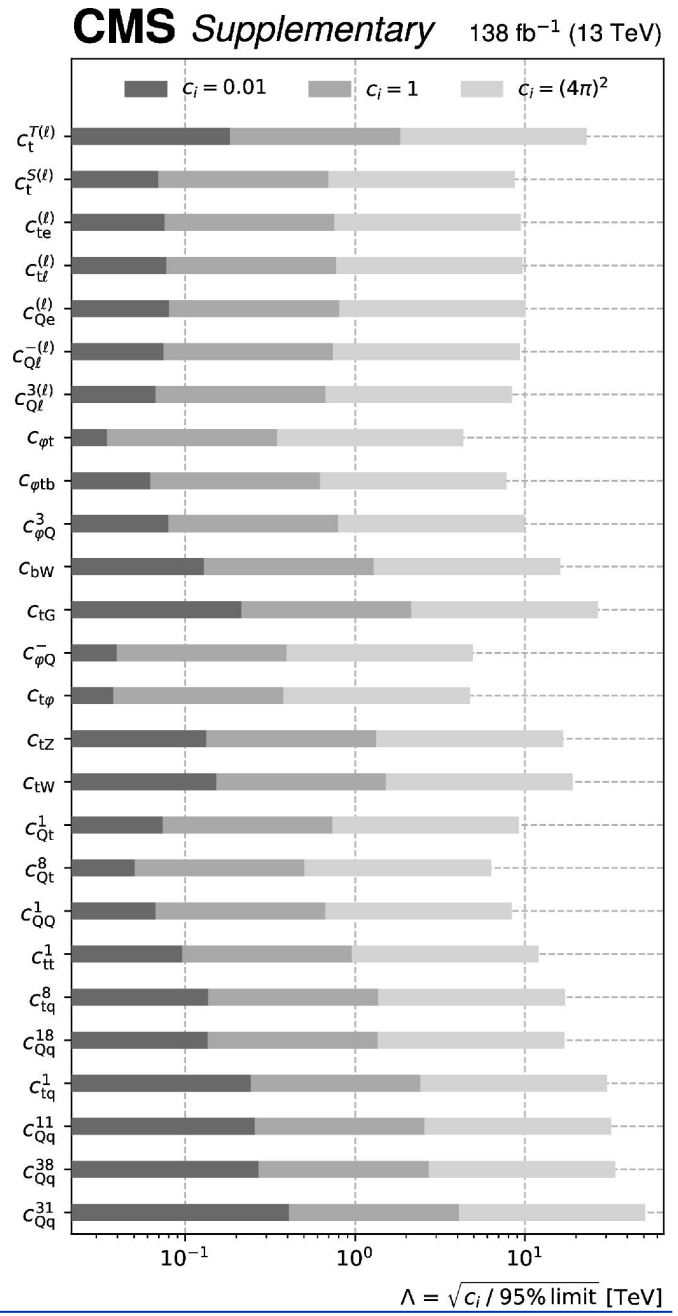


Studying rare top production

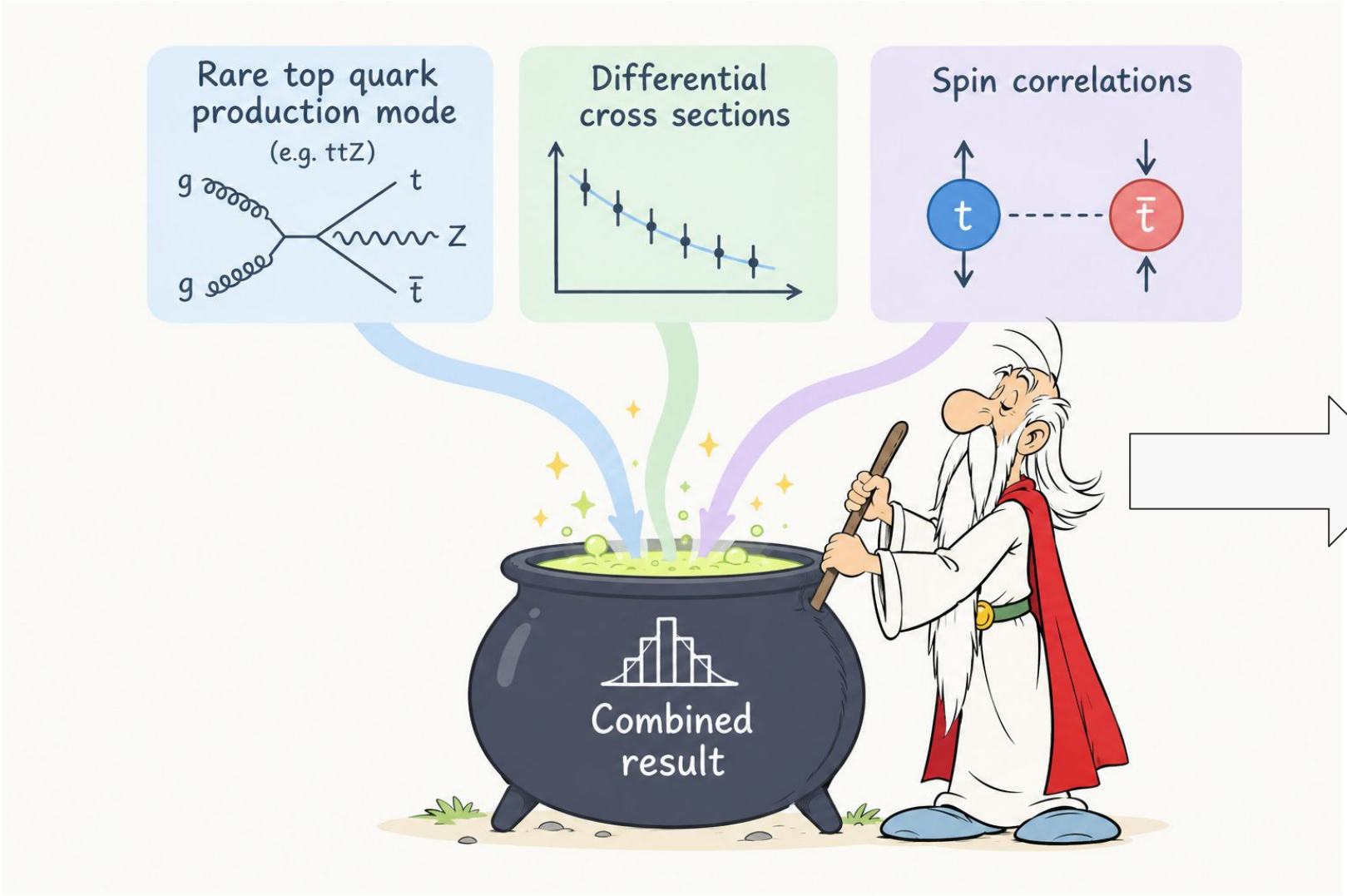
Setting limit on the operators based on the number of observed events in all the regions studied

Setting limits up to 4 TeV on the scale of new particles → probing an energy much larger than the reactions taking place!!

Results with a larger dataset will be released soon → increased sensitivity reach



The top "combination"

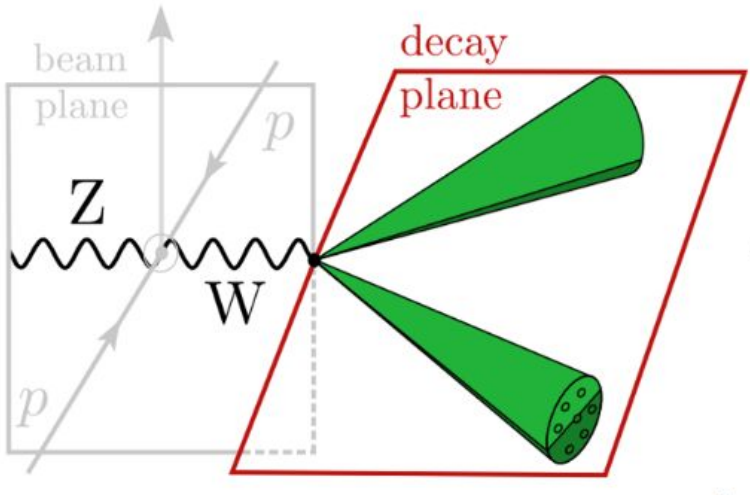


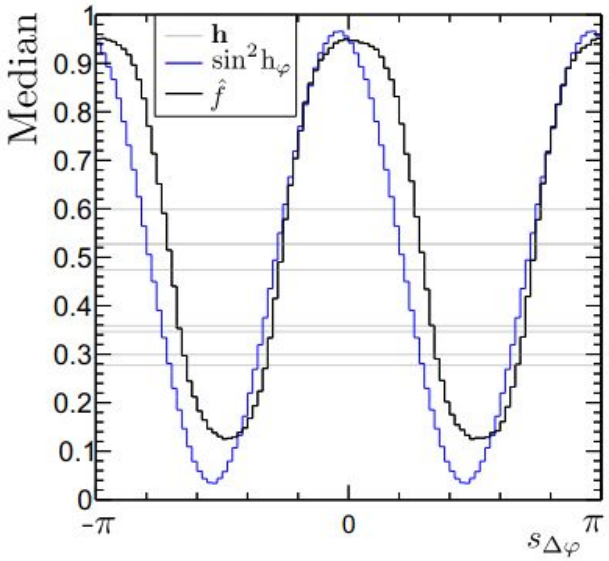
Preliminary result: we **will likely not manage to probe the full parameter space at the LHC**

How to get the most out of the LHC?

Easy way: build observables using machine learning

Machine learning algorithms can be greatly enhanced when profiting from physics-induced symmetries → **equivariant neural networks**





Rotation-equivariant neural network

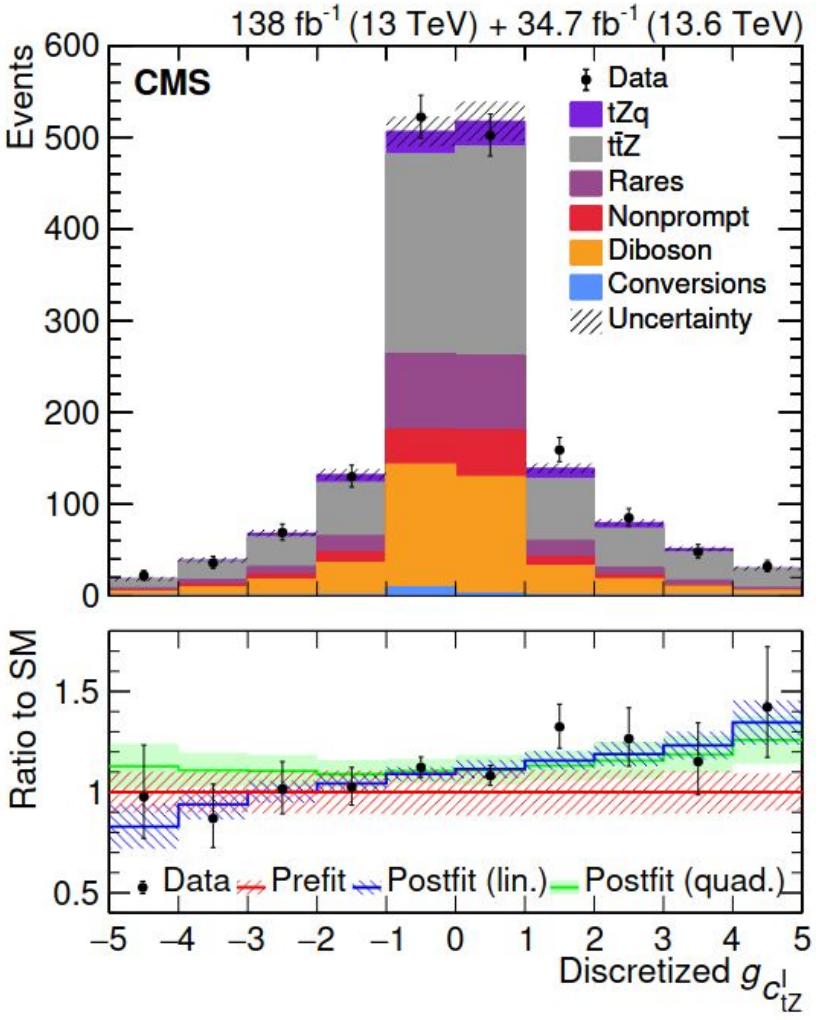
PRD 109, 076012, PRD 110, 096023 (2024), PLB 869 (2025) 139857

How to get the most out of the LHC?

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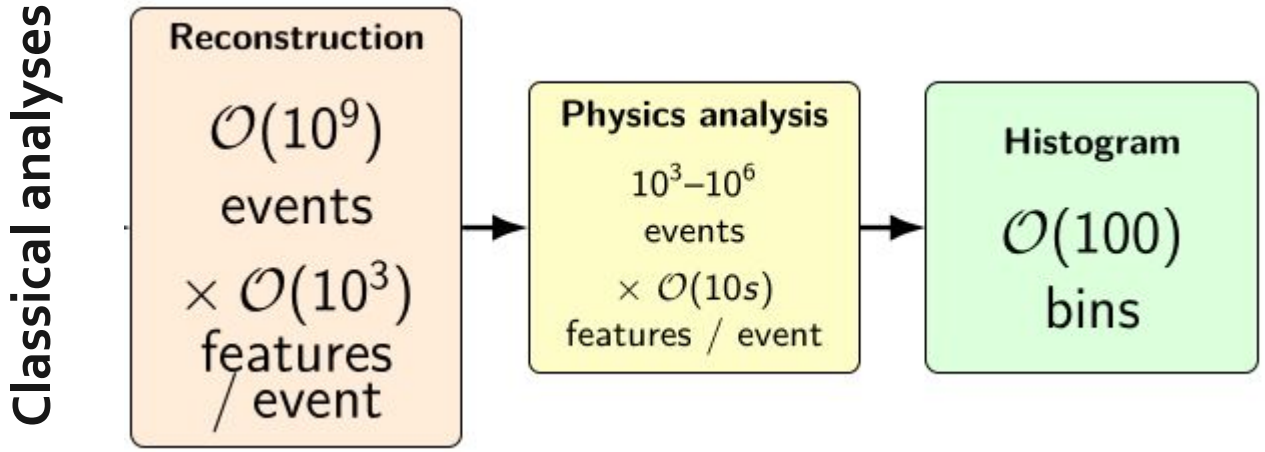
CP-equivariant neural network:
symmetric for CP-conserving processes



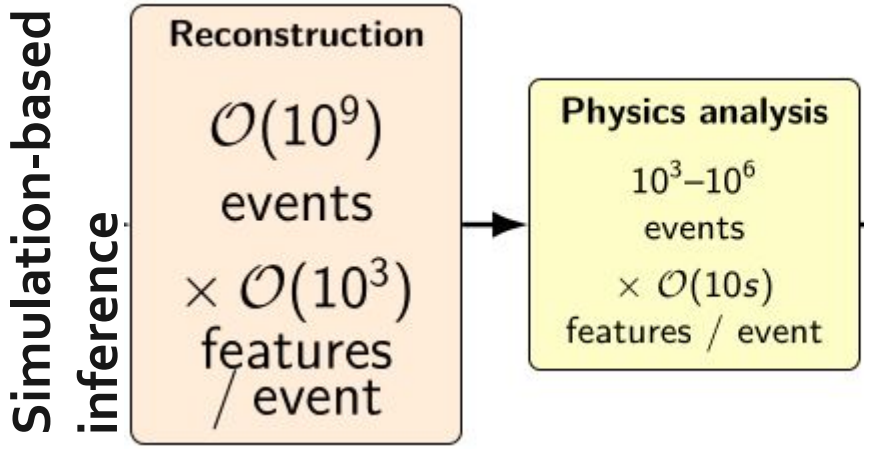
PRD 109, 076012, PRD 110, 096023 (2024), PLB 869 (2025) 139857

How to get the most out of the LHC?

More complicated: don't build observables, use the full information → simulation based inference



$$\mathcal{L}_{\text{bin}}(\boldsymbol{\theta}, \boldsymbol{\eta}) = \prod_{i=1}^{B} \frac{\nu_i(\boldsymbol{\theta}, \boldsymbol{\eta})^{n_i} e^{-\nu_i(\boldsymbol{\theta}, \boldsymbol{\eta})}}{n_i!} \pi(\boldsymbol{\eta})$$



$$\mathcal{L}(\boldsymbol{\theta}, \boldsymbol{\eta}) = \text{Poisson}(N|\nu(\boldsymbol{\theta}, \boldsymbol{\eta})) \prod_{e=1}^{N} p(\boldsymbol{x}_e|\boldsymbol{\theta}, \boldsymbol{\eta})\ \pi(\boldsymbol{\eta})$$

Colab with HEPHY-Vienna, Nikhef, and others. arXiv:2604.13157 accepted by JHEP

Simulation-based inference

The name of the game is to obtain a "surrogate" model of the ***per-event probability***

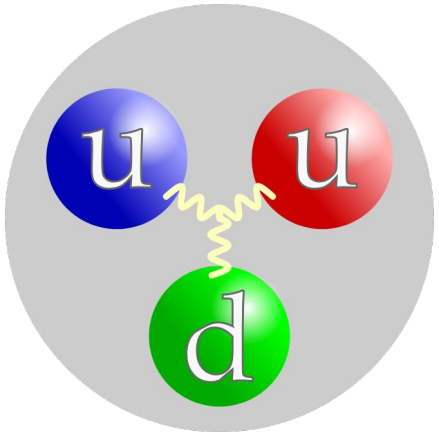
$$\mathcal{L}(\boldsymbol{\theta}, \boldsymbol{\eta}) = \text{Poisson}(N|\nu(\boldsymbol{\theta}, \boldsymbol{\eta})) \prod_{e=1}^{N} p(\mathbf{x}_e|\boldsymbol{\theta}, \boldsymbol{\eta})\ \pi(\boldsymbol{\eta})$$

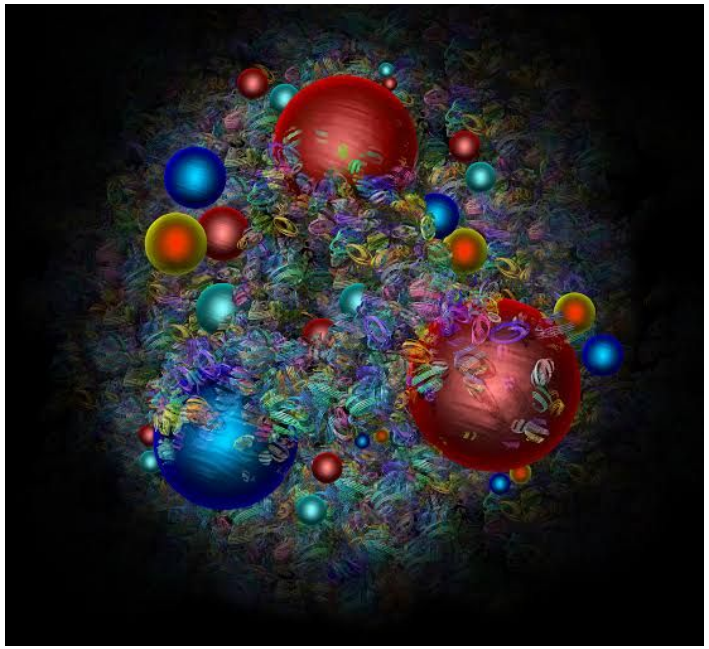
The surrogate can be parametrized with **neural networks**, trained using simulations

More details in an upcoming technical seminar

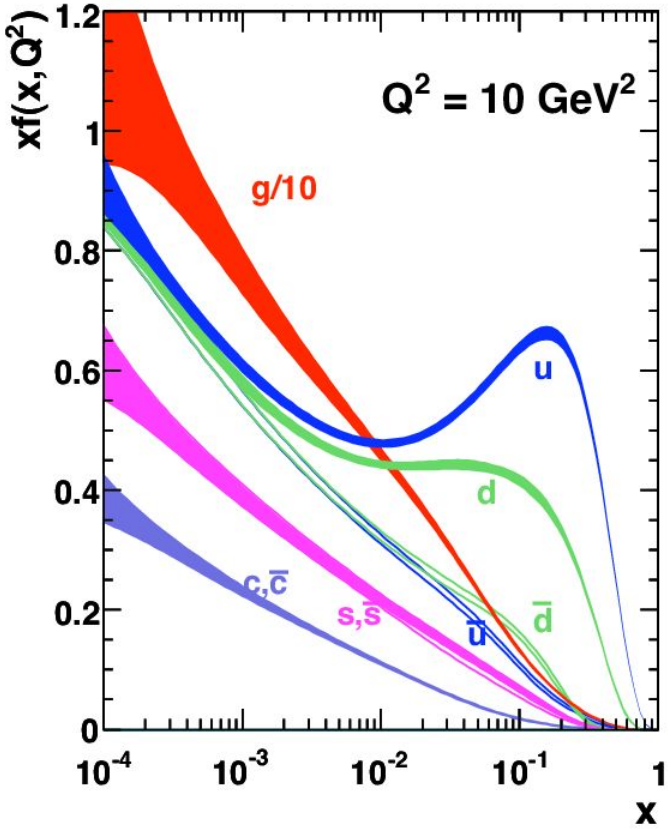
Simulation-based inference at work

Simulation-based inference is most powerful for complex models, with many parameters, such as the SMEFT





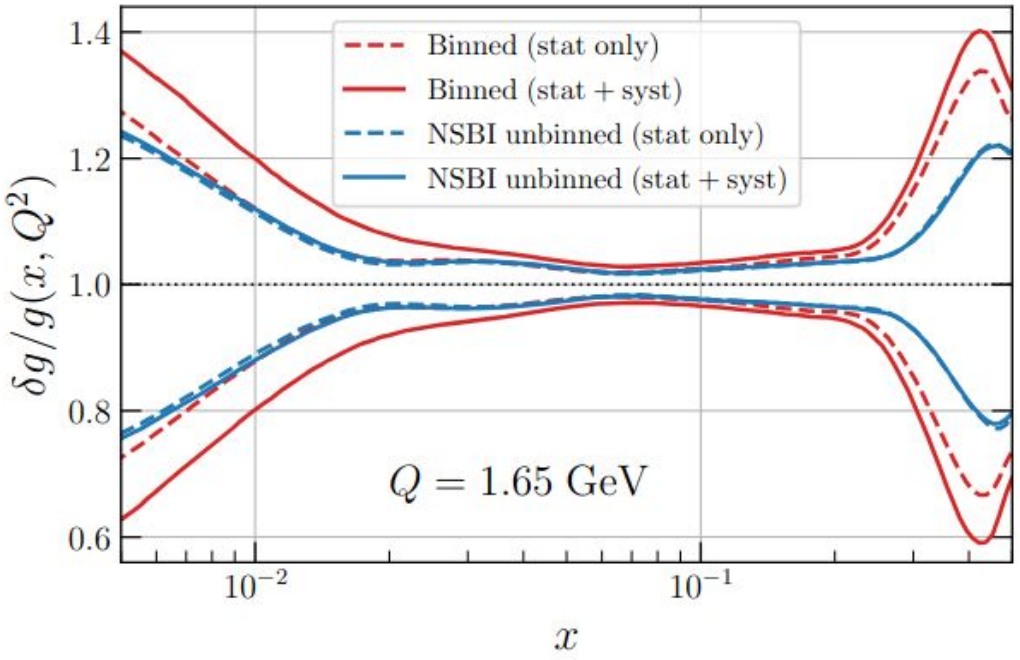
CERN-GRAPHICS-2019-001



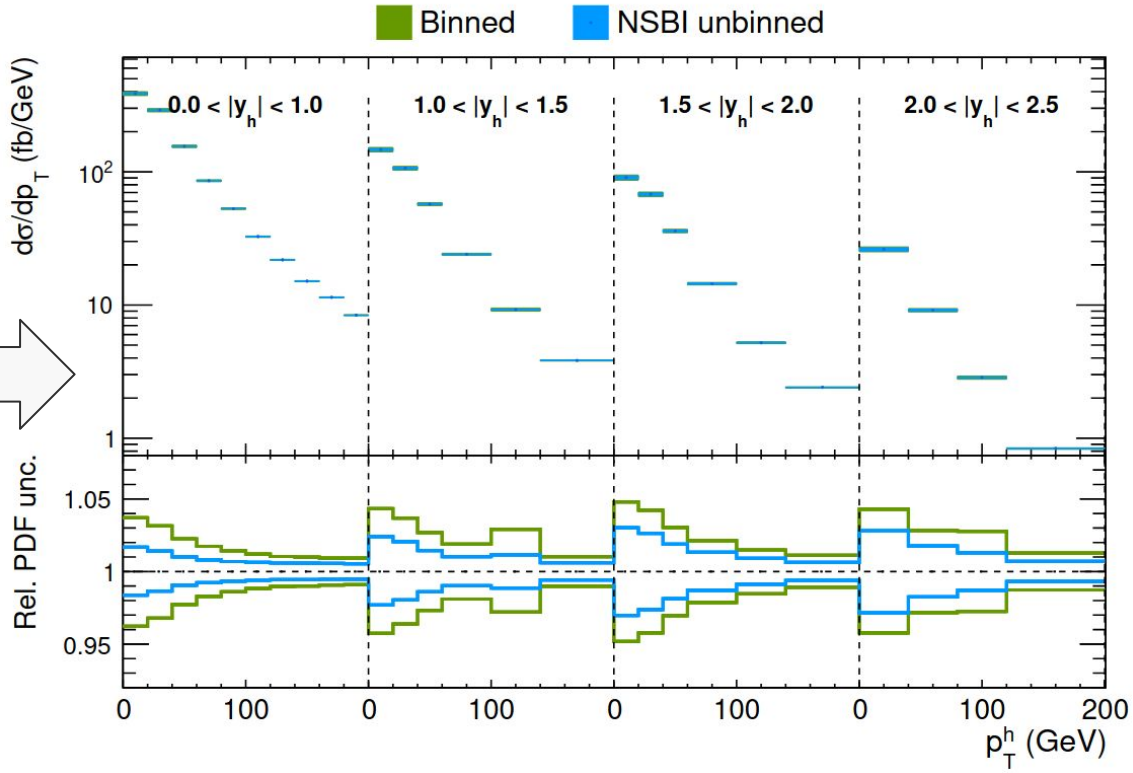
The proton is a complex yet "common" system, its structure cannot be computed (yet)!

Colab with HEPHY-Vienna, Nikhef, and others. arXiv:2604.13157 accepted by JHEP

Simulation-based inference at work



Significant decrease in pdf uncertainty



Up to a factor of 2 reduction in **uncertainty for the prediction (assuming pdfs only for ttbar)**

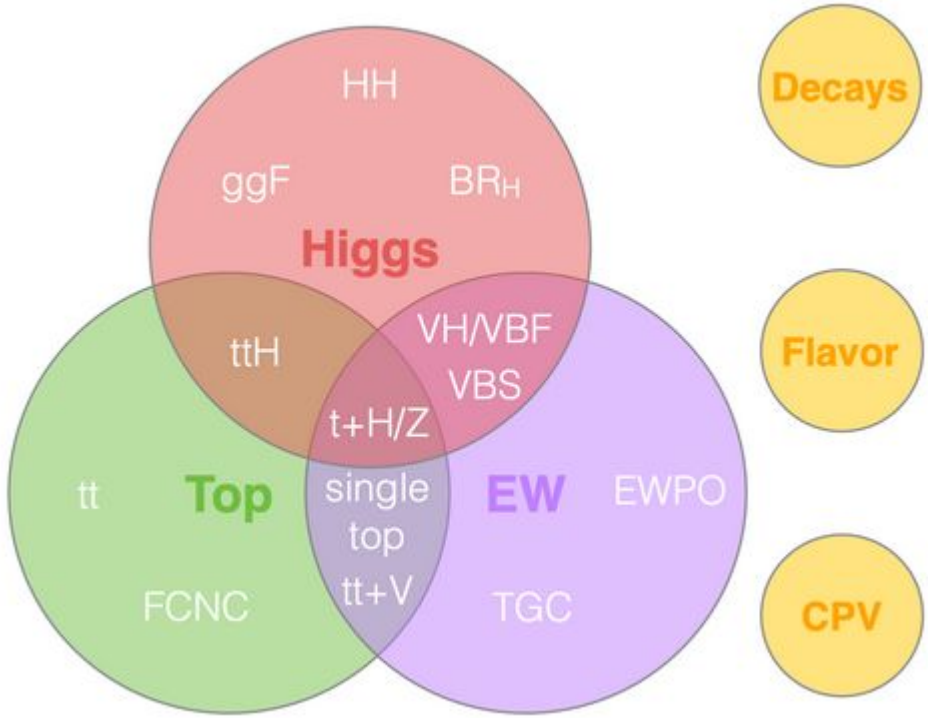
Potential to constrain theoretical uncertainties using the data

Colab with HEPHY-Vienna, Nikhef, and others. arXiv:2604.13157 accepted by JHEP

The SMEFT, the strategy

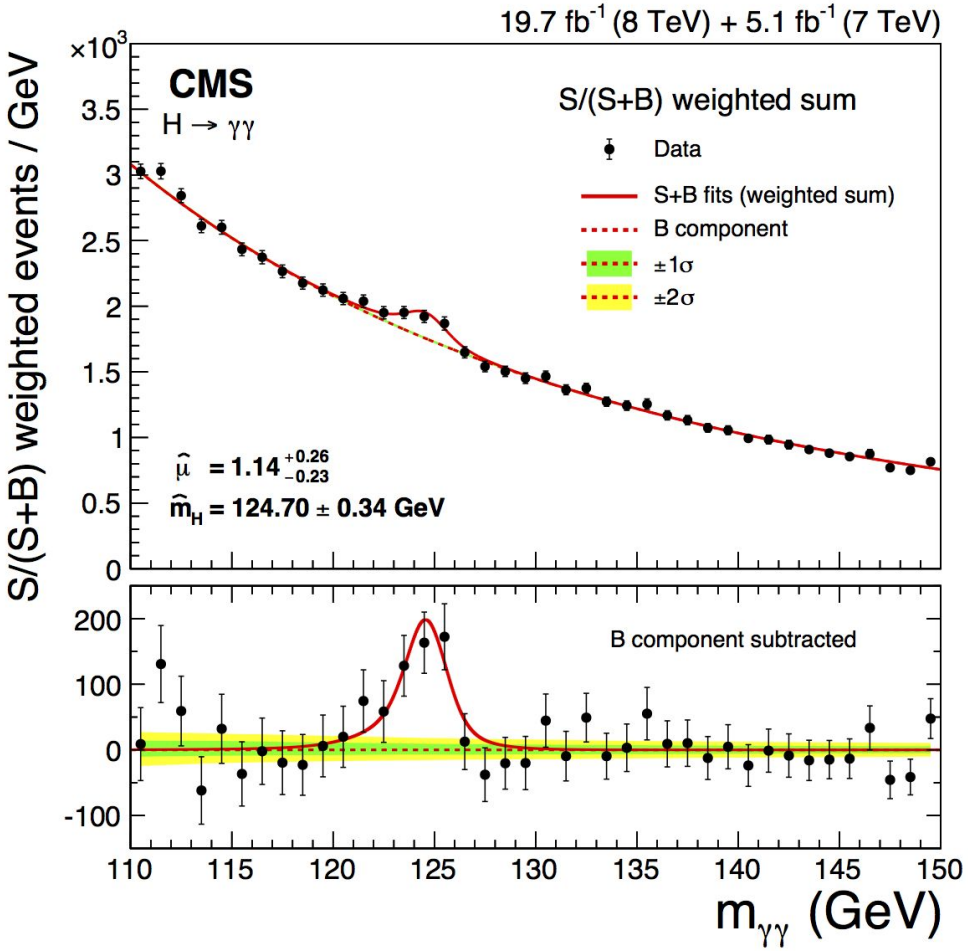
New physics could be ~**anywhere**, and 1499 operators are not possible to test simultaneously

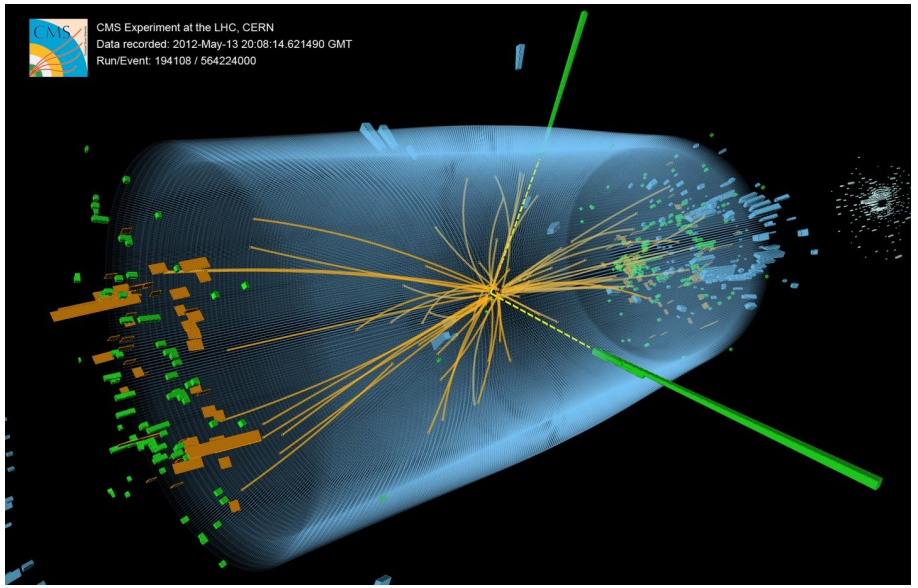
In practice, focusing on in "sectors"



This program is only possible through a great development of theoretical work on the SM on the past years!!

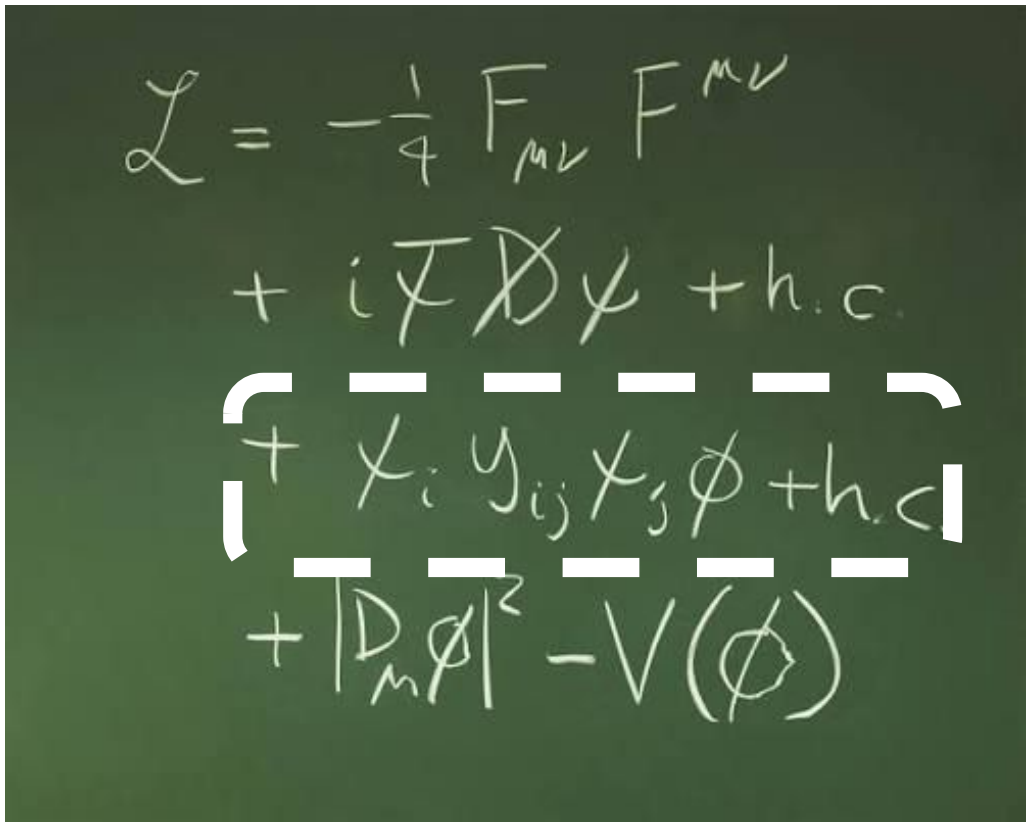
The Higgs discovery

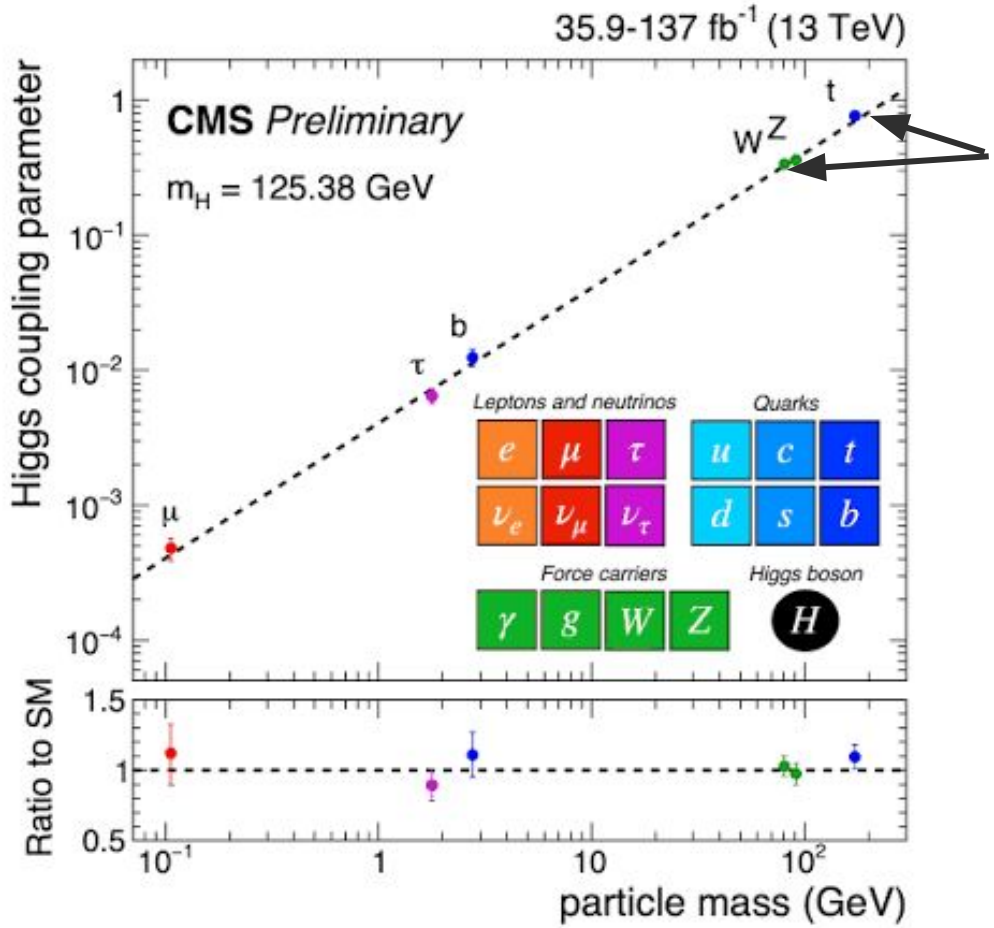






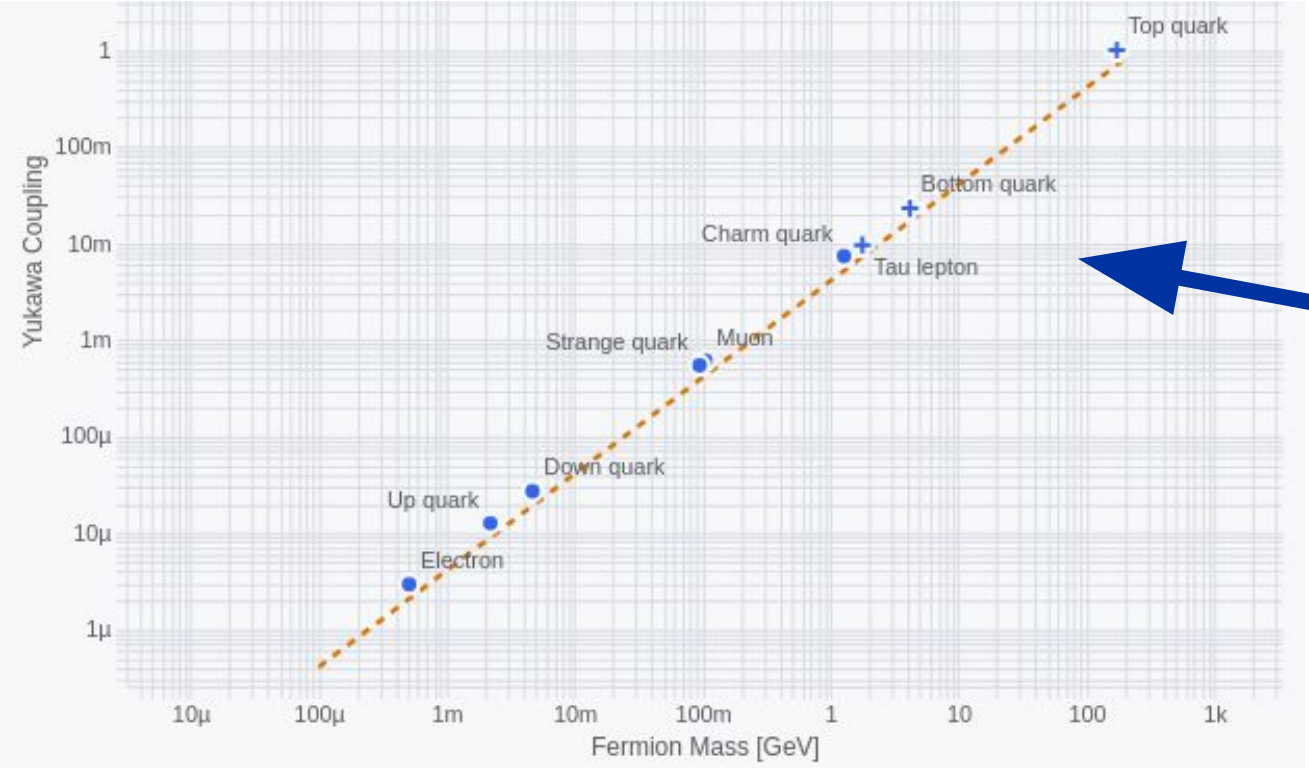
What do we know about the Higgs

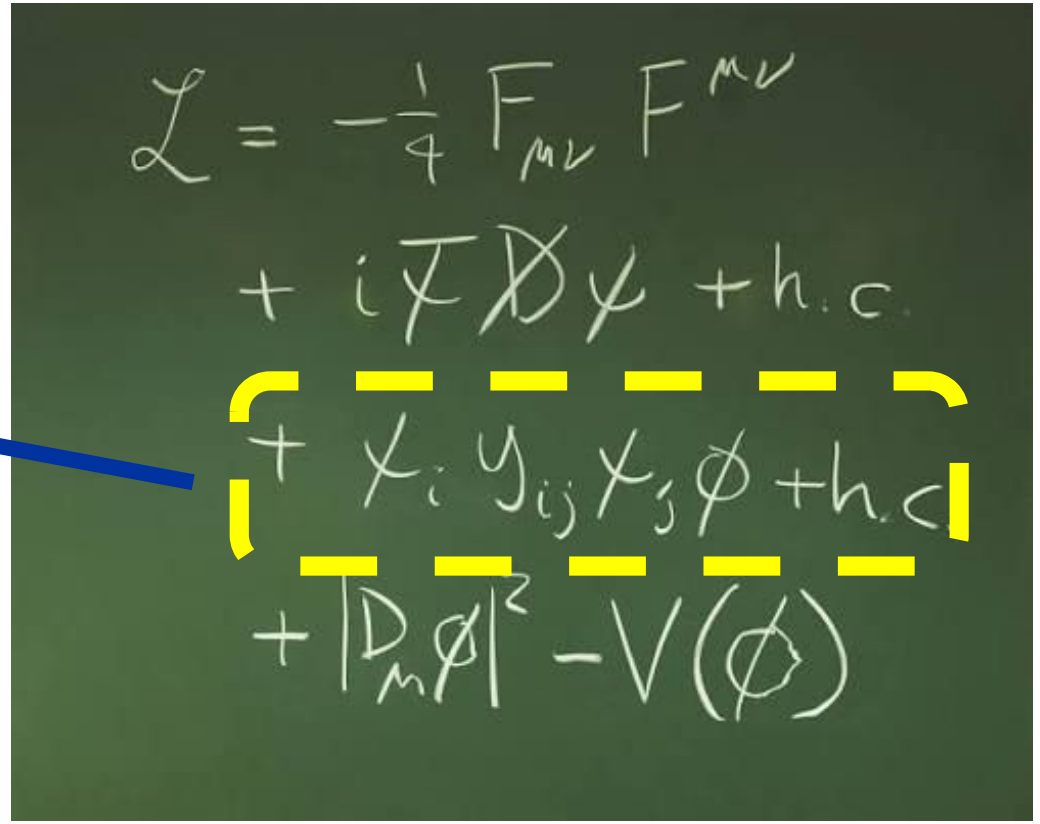




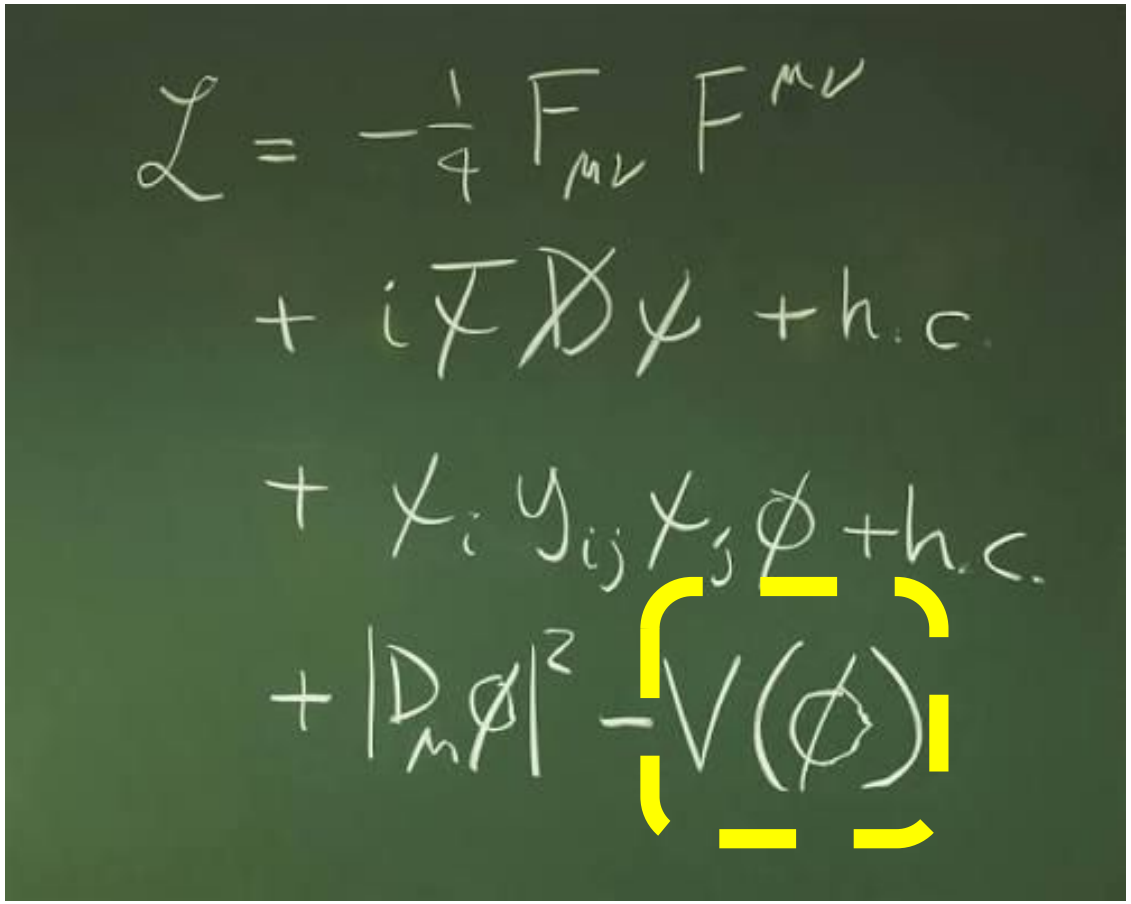
Made in Oviedo

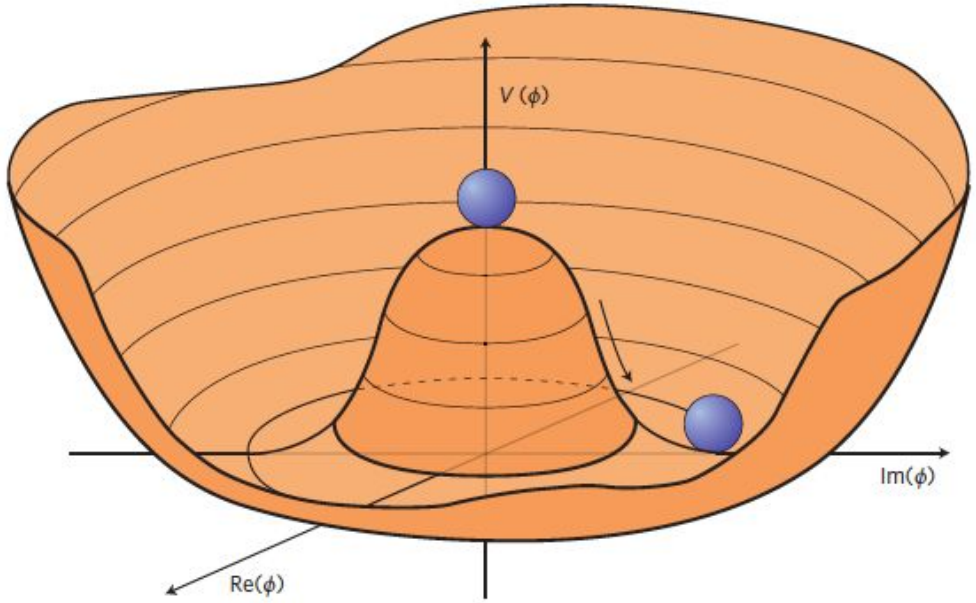
What don’t we know about the Higgs





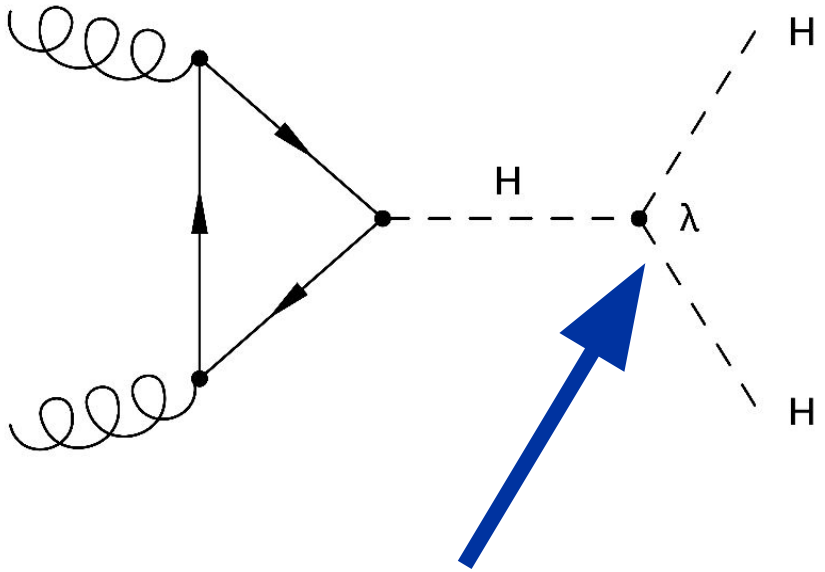
What do we know about the Higgs?

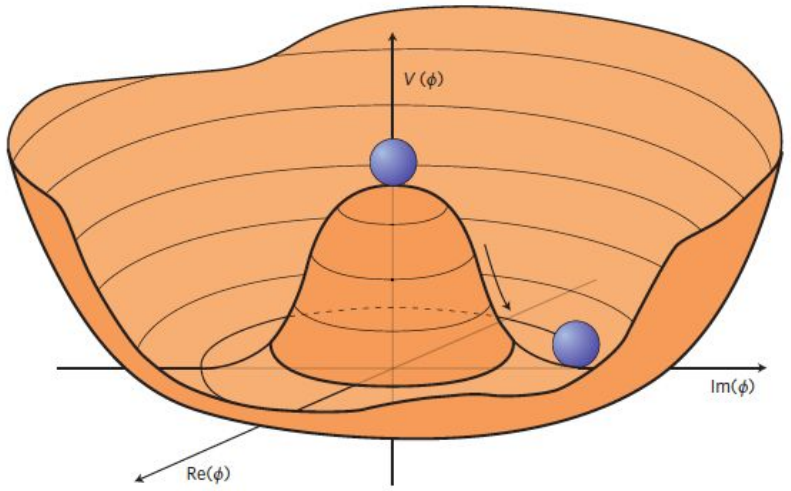




$$V(h) = -\mu^2 h^2 + \lambda h^4$$

How can we explore the Higgs potential



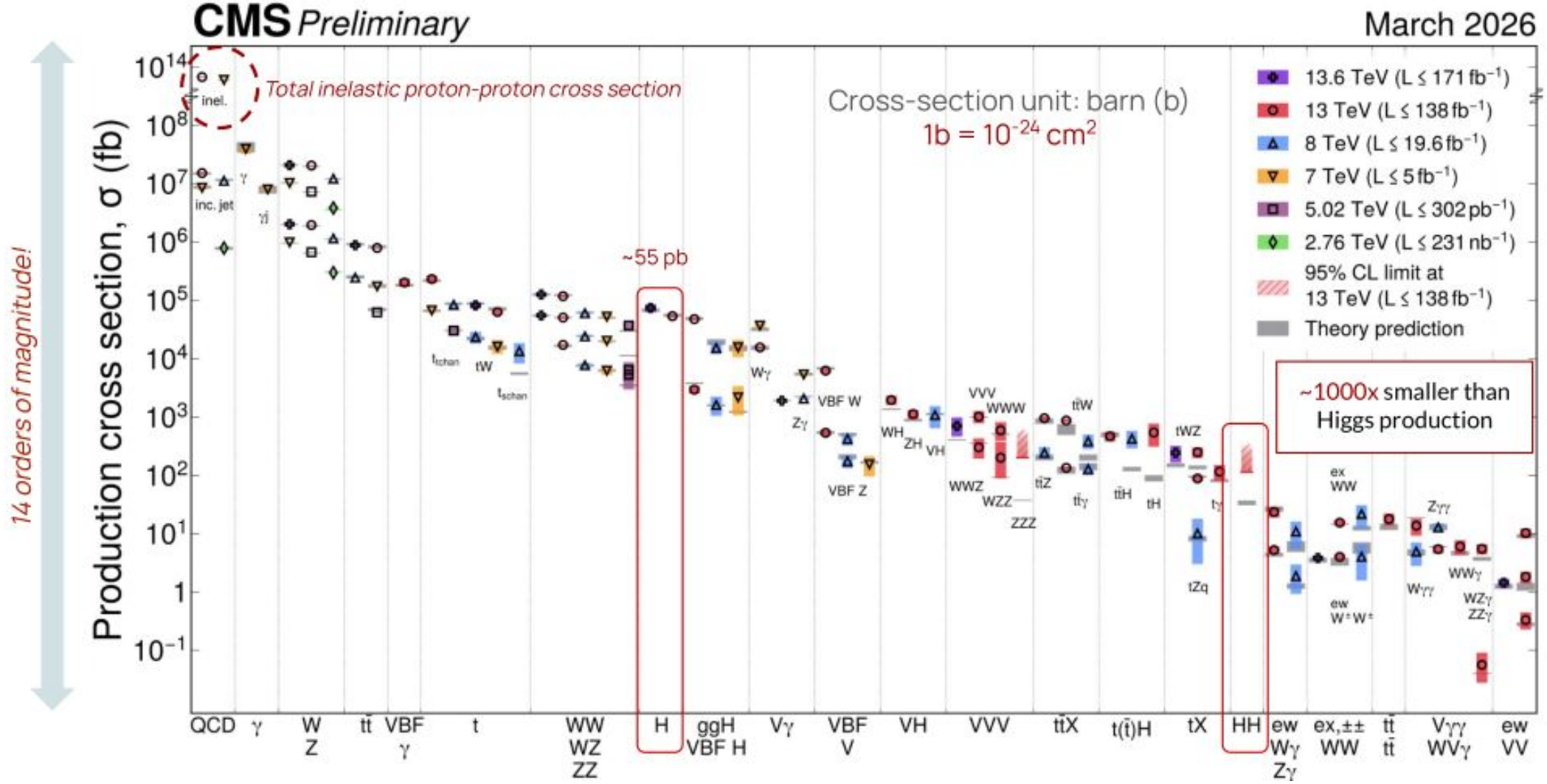


$$V(h) = \lambda v^2 h^2 + \lambda v h^3 + \frac{1}{4}\lambda h^4$$

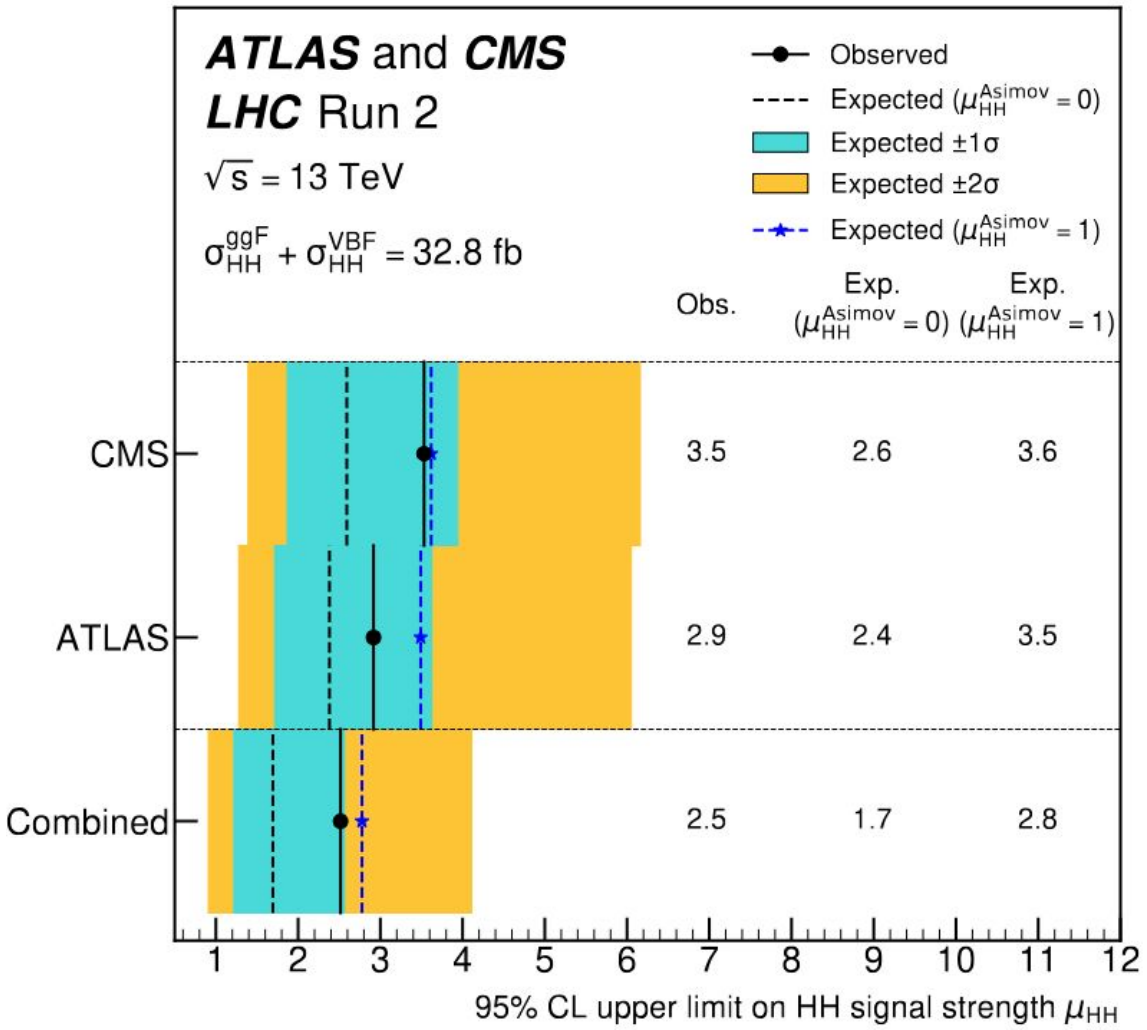
Higgs self-coupling is given by the quartic term in the potential

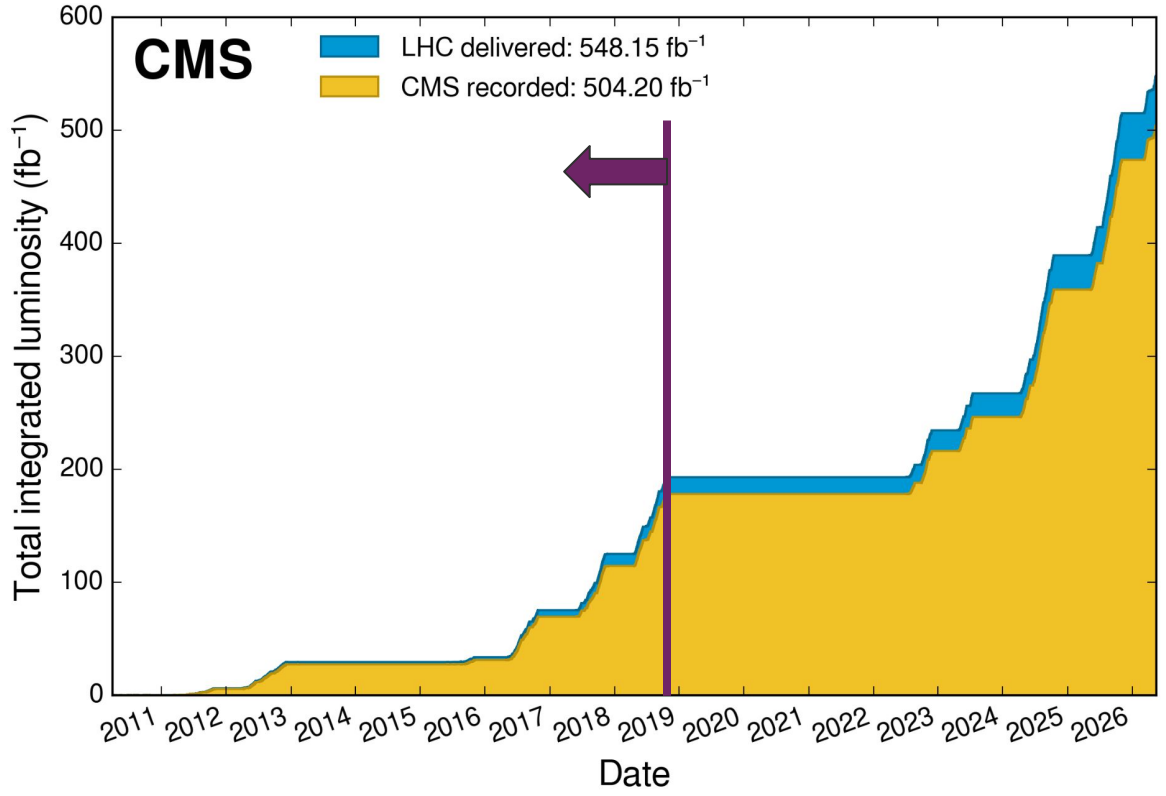
The study of Higgs pair production is one of the main scientific targets of the LHC until the end of the programme

How can we explore the Higgs potential



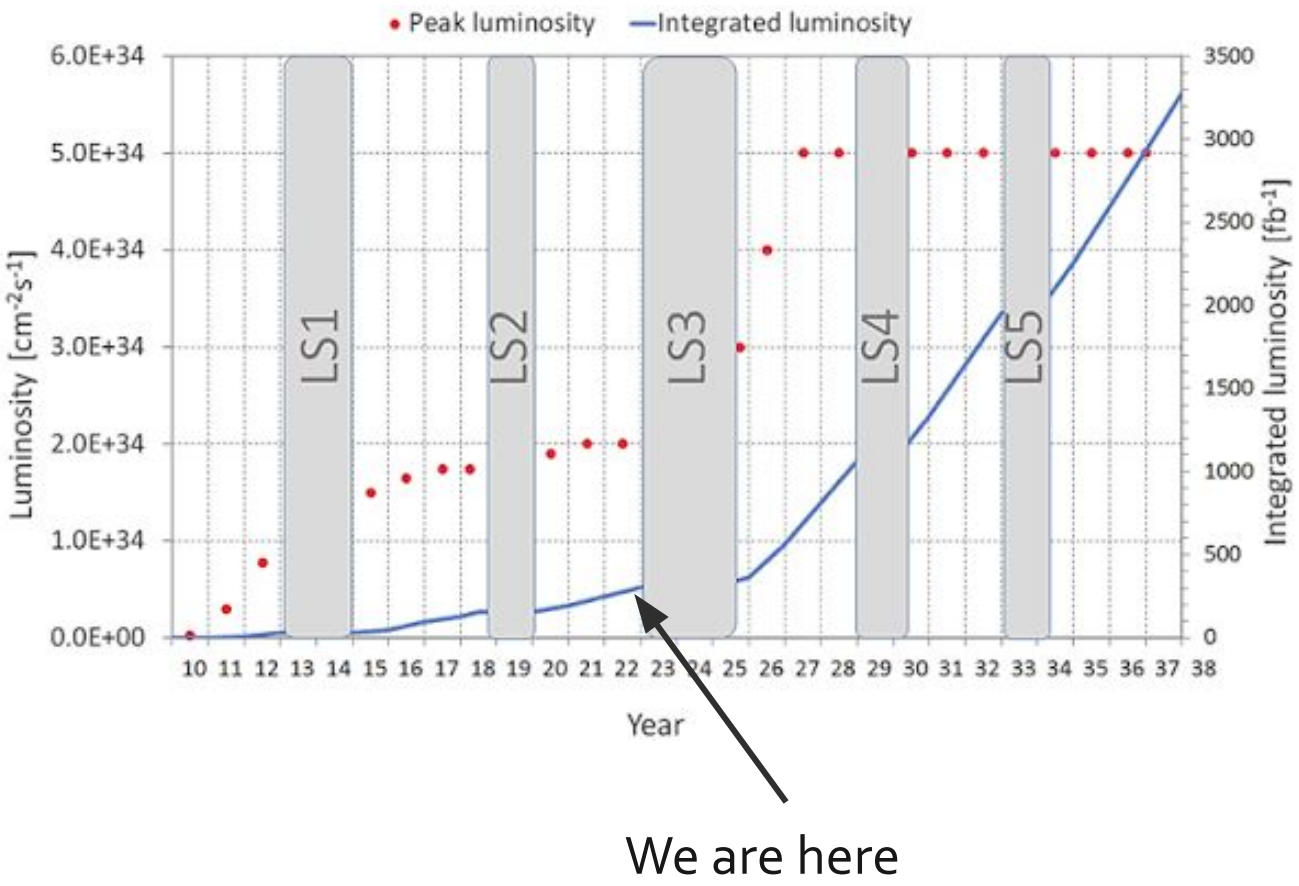
How can we explore the Higgs potential





not enough data so far for an observation

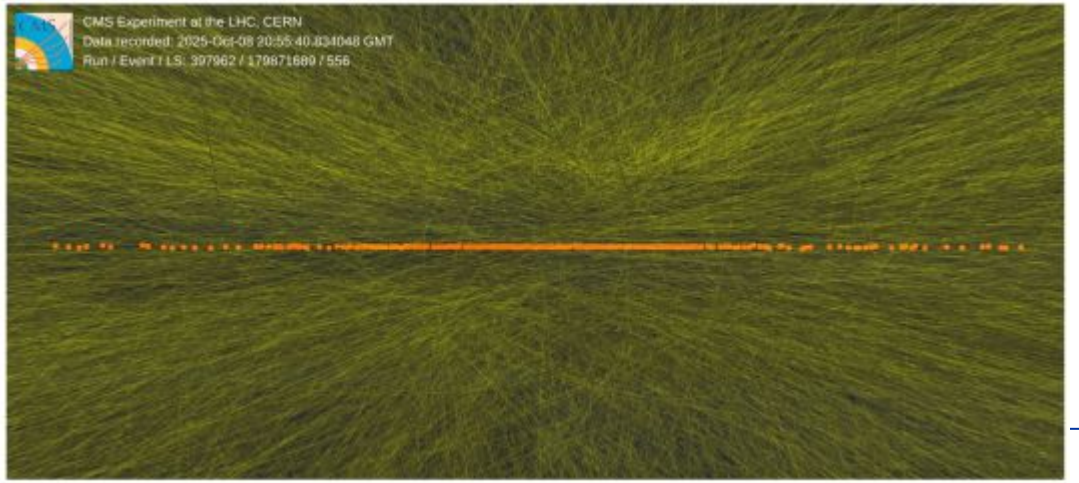
The HL-LHC



We will take approximately 1 order of magnitude more data at the HL-LHC

But:

- more challenging environment
- radiation degradation in the detectors
- higher luminosity → challenging to collect all events

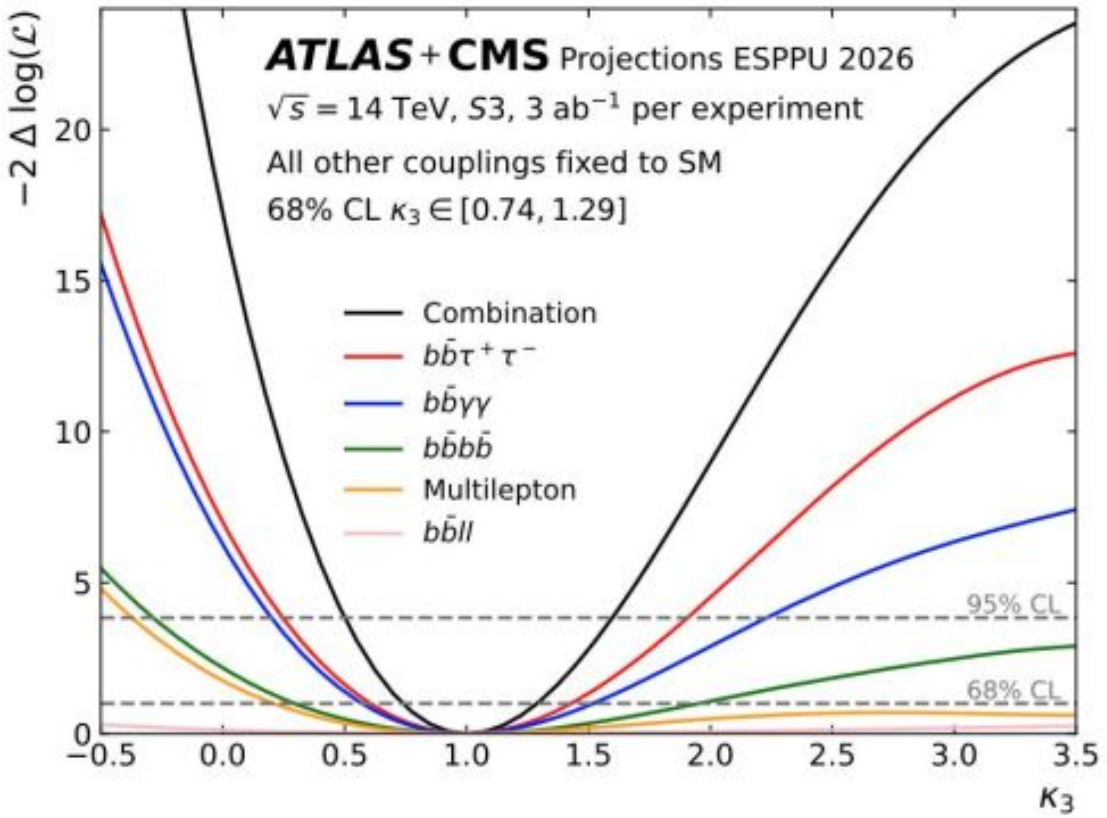


How can we explore the Higgs potential

HH → bbbb
- Highest branching ratio
- Huge multijet background

HH → bbγγ
- Tiny branching ratio
- Excellent mass resolution

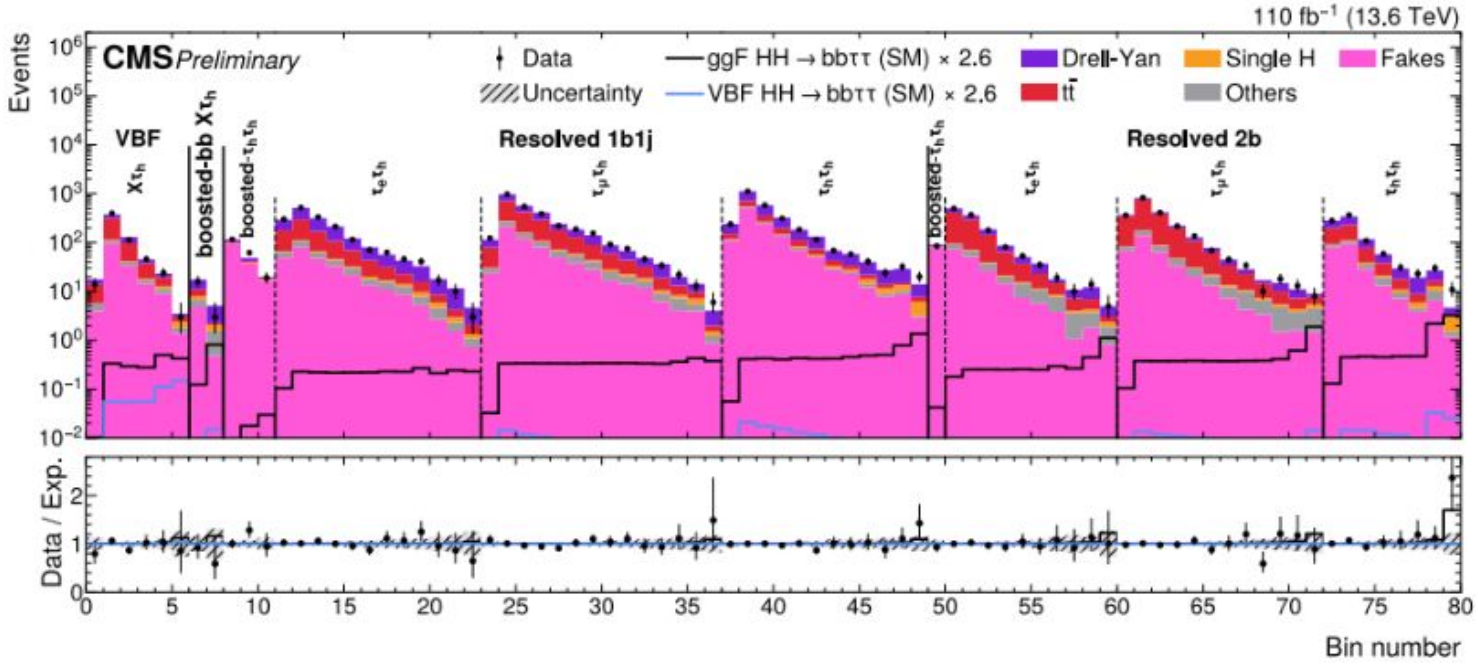
HH → bbττ
- Moderate background
- Moderate branching ratio

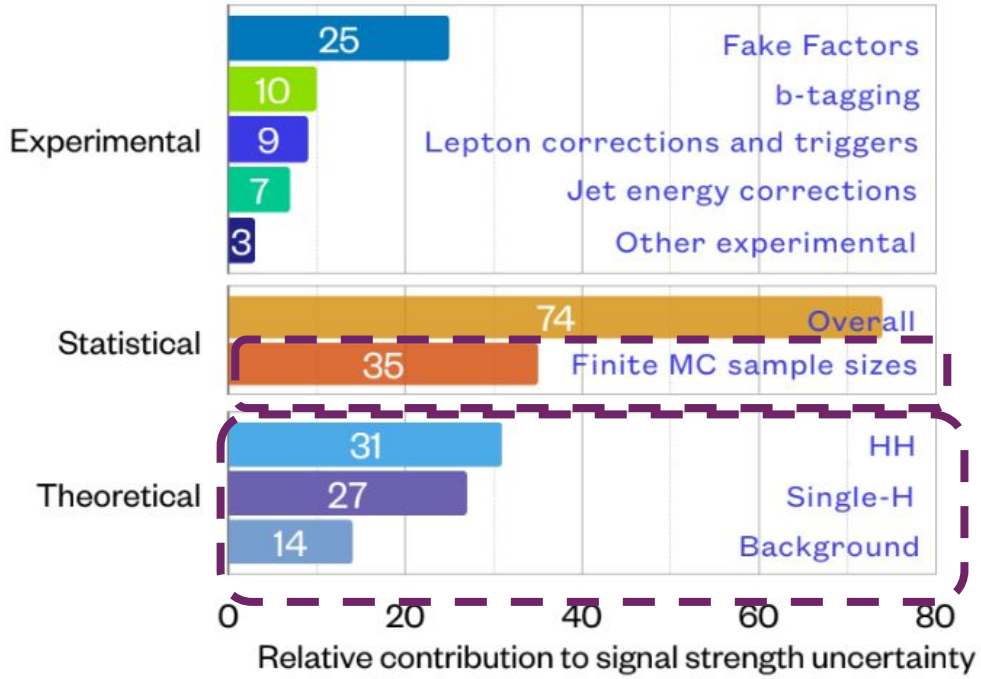


We expect the HL-LHC to be able to observe di-Higgs production…
- **But we need to actually do it**

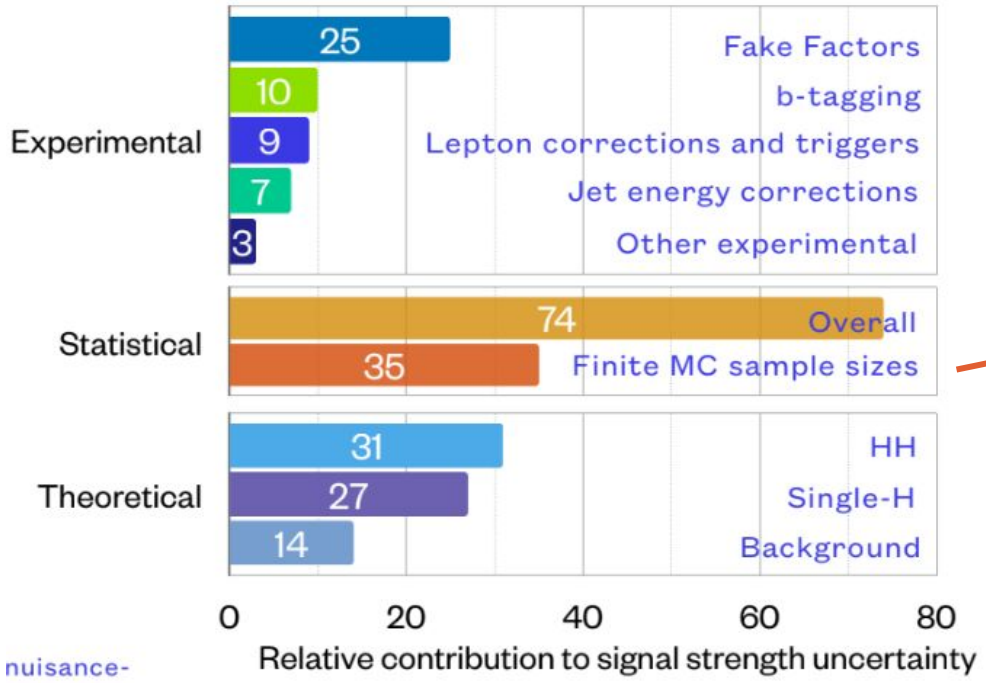
Di-Higgs production in the bbττ channel

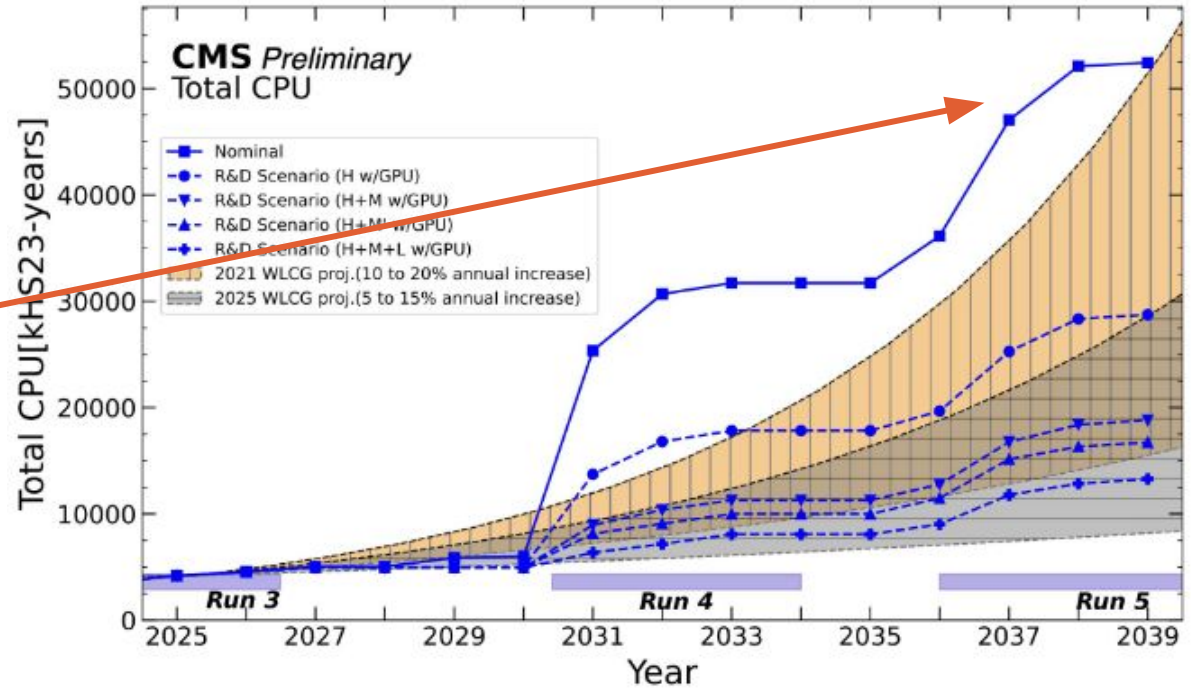
- Recent search for HH in the bbττ (by collaborators, HEP-Uniovi has recently joined the effort)
- Setting (expecte) limits on 4 times the SM expectation





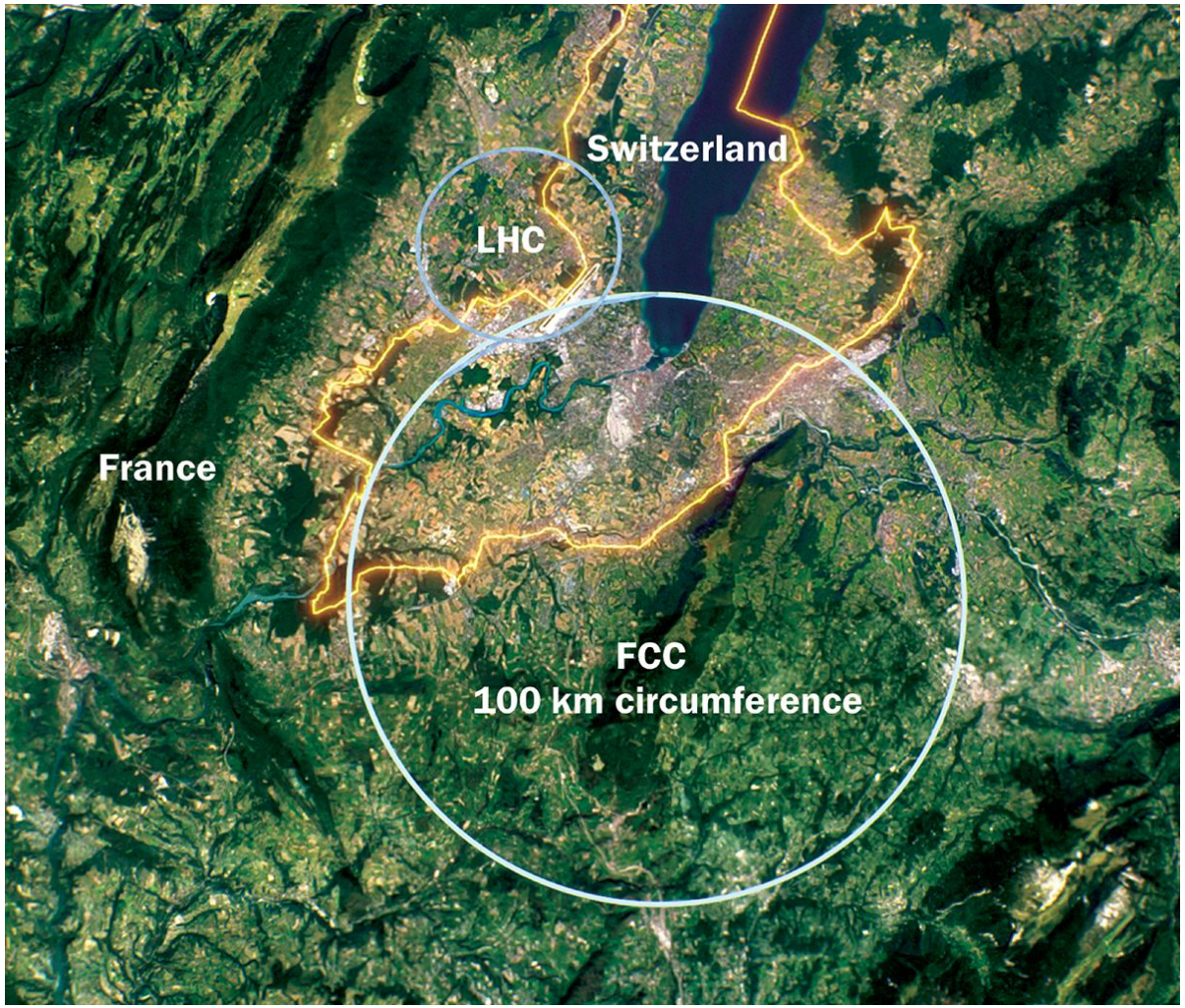
Di-Higgs production in the bbττ channel

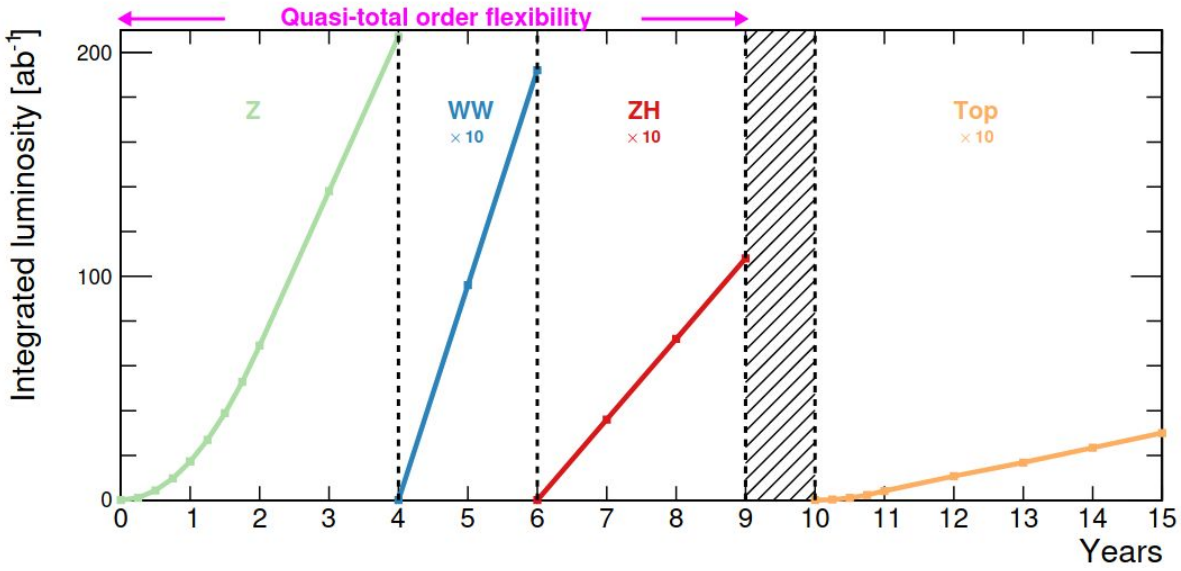




- More than just taking data!! → Technical and physics developments are needed
- Production of simulations is a clear example, more work will be done from object selection to the end of the analysis

What comes after? The FCC-ee

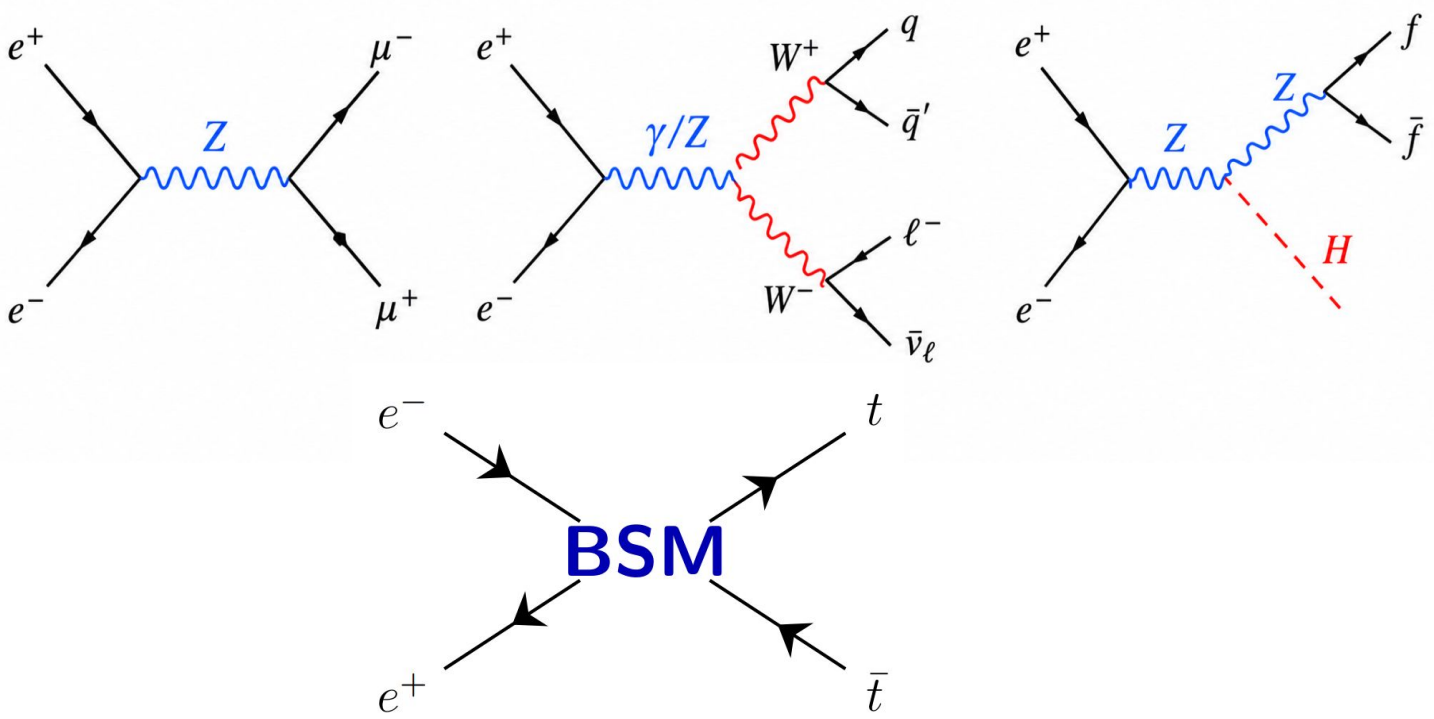


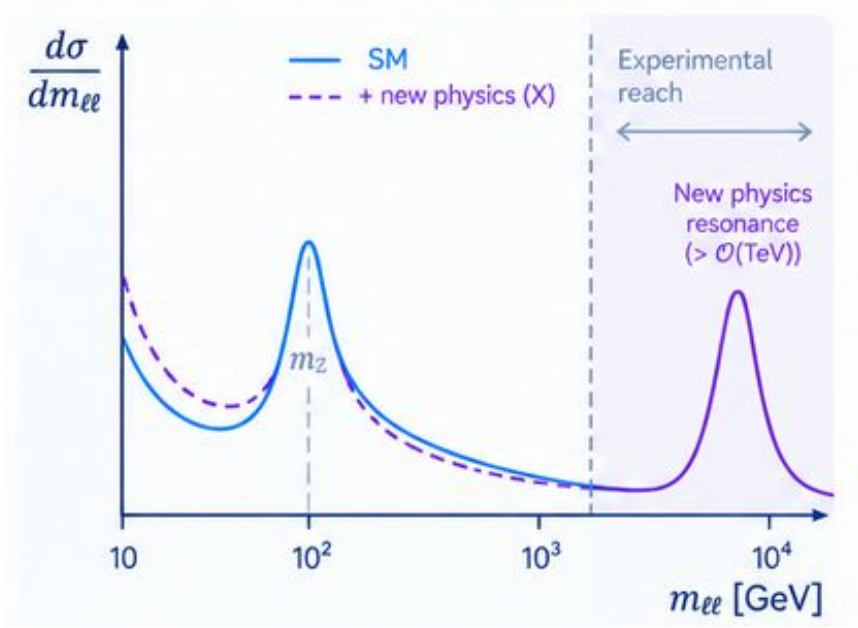


Colliding electrons up to 365 GeV

Electrons are fundamental particles
→ fixed "effective" collision energy

Indirect searches at the FCC-ee





Colliding electrons up to 365 GeV

Z ($6 \cdot 10^{12}$ Z bosons)

WW ($2 \cdot 10^8$ W pairs)

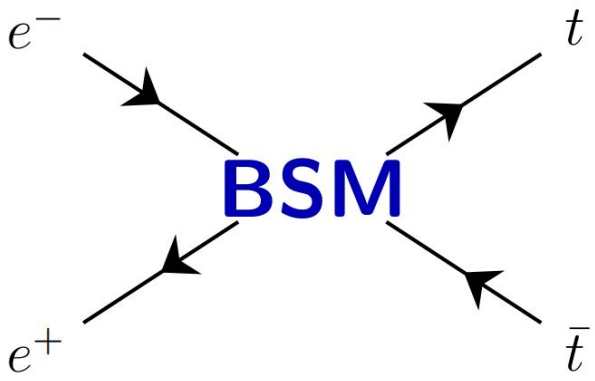
ZH ($3 \cdot 10^6$ Higgses)

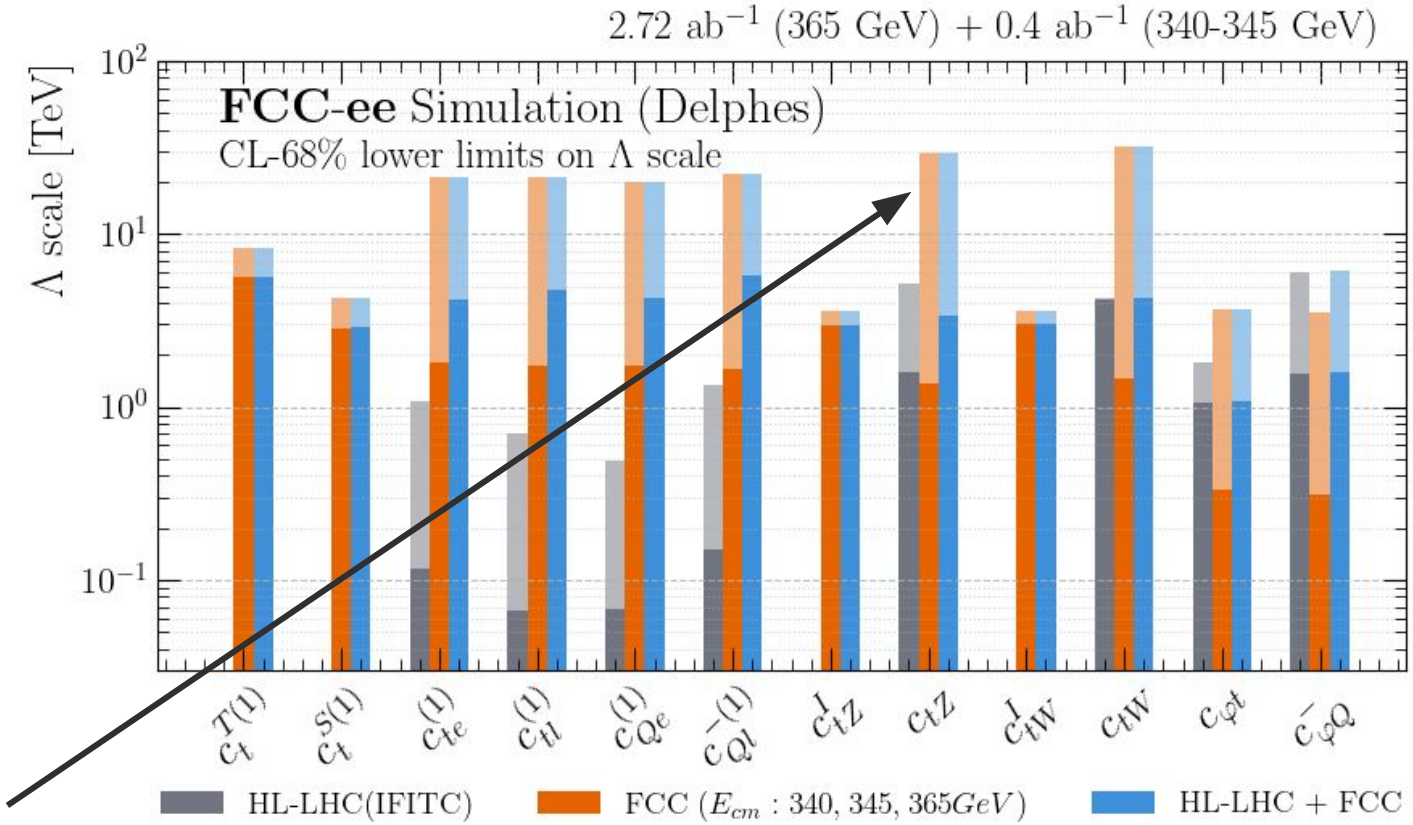
tt ($2 \cdot 10^6$ ttbar pairs)

FCC paradigm → measure the SM with great precision to pin down discrepancies from new particles

Measurements of ttbar production

Sensitivity studies are needed to guide the detector design and define the running program



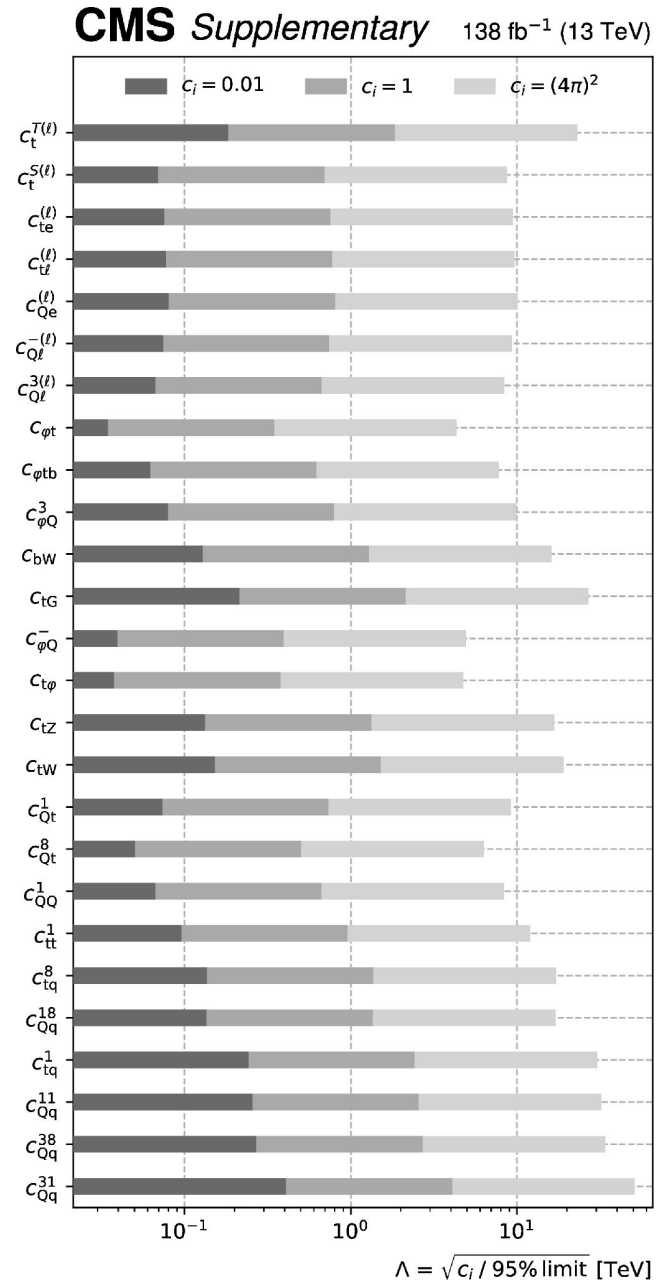


What sensitivity do we expect to new particles coupling to top?

Sensitivity to new particles up to 30 TeV, 100 larger than the collision energy

Conclusions

- The SM has (so far) survived to the LHC physics program
- Indirect searches provide a way to extend the LHC's energy reach
  - Indirect searches need a **complete understanding of the SM** and **robust theoretical predictions**
  - Indirect searches need advanced observables for an efficient use of the data
  - The Higgs and top sectors are the most promising, with the observation of **HH being the next flagship of the LHC**
- The **FCC-ee will open a new frontier in the search for new physics**, reaching unprecedented energies

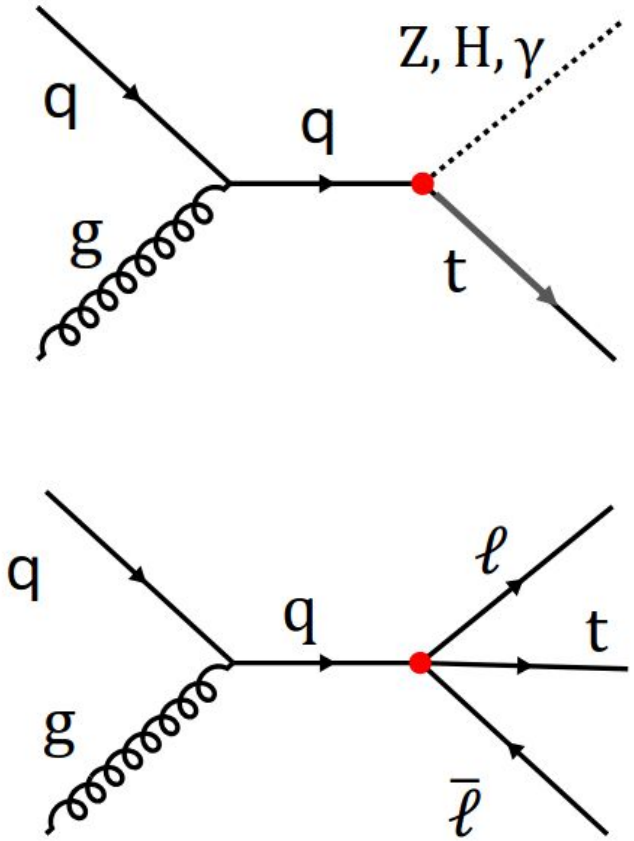


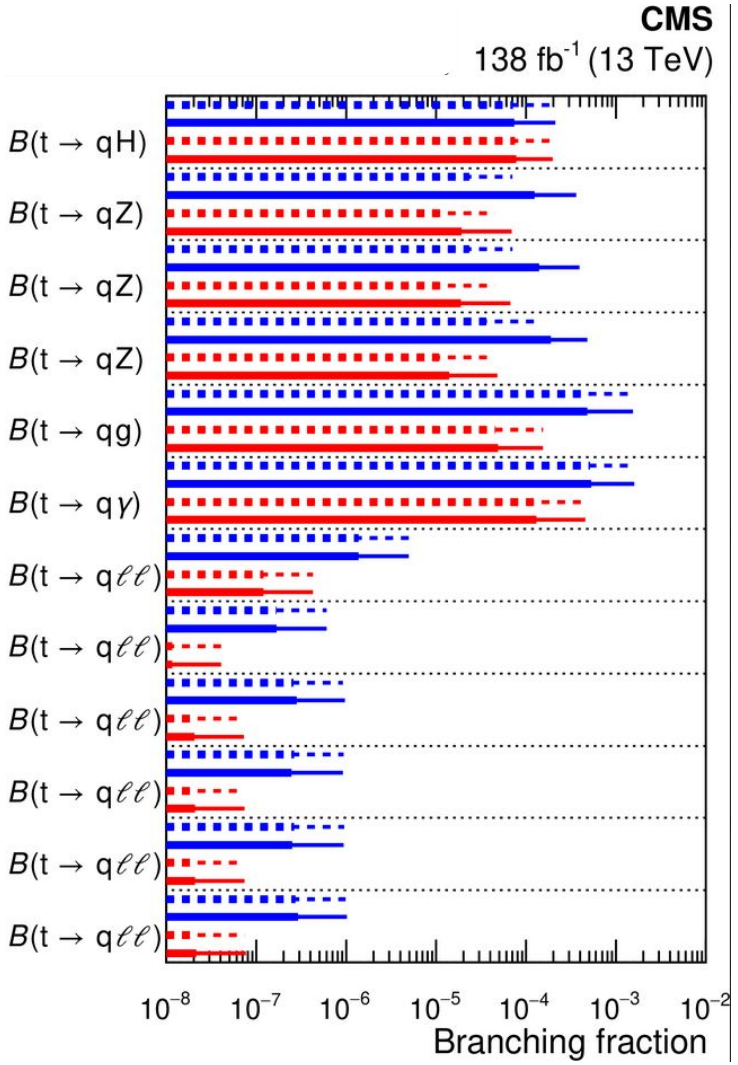
Acknowledgements

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Back-up

Forbidden transitions in the SM - flavor-changing neutral currents





arXiv:2608.19547, submitted to PRL, collaboration with Notre Dame University

First CMS EFT combination

- Statistical combination of CMS results, mostly particle-level cross sections
- Considering 64 independent Wilson coefficients

- **Higgs physics**: H → γγ
  - Including gluon fusion, VBF, ttH
- **Top physics**:
  - ttbar (l+jets)
  - t(t)X: dedicated EFT analysis (analysis at reconstruction level)

- **EWPO from LEP and SLC**
- **Electroweak sector**
  - WW
  - Wγ
  - Z → νν
- **Inclusive jet production**

- **Only a taste of the CMS physics programme, but covering most sectors**