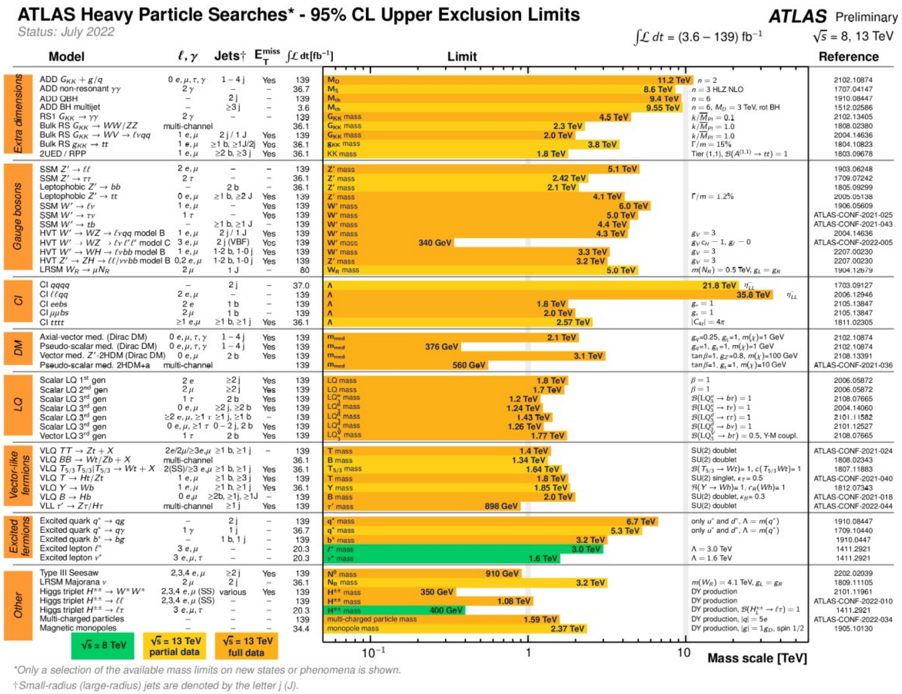
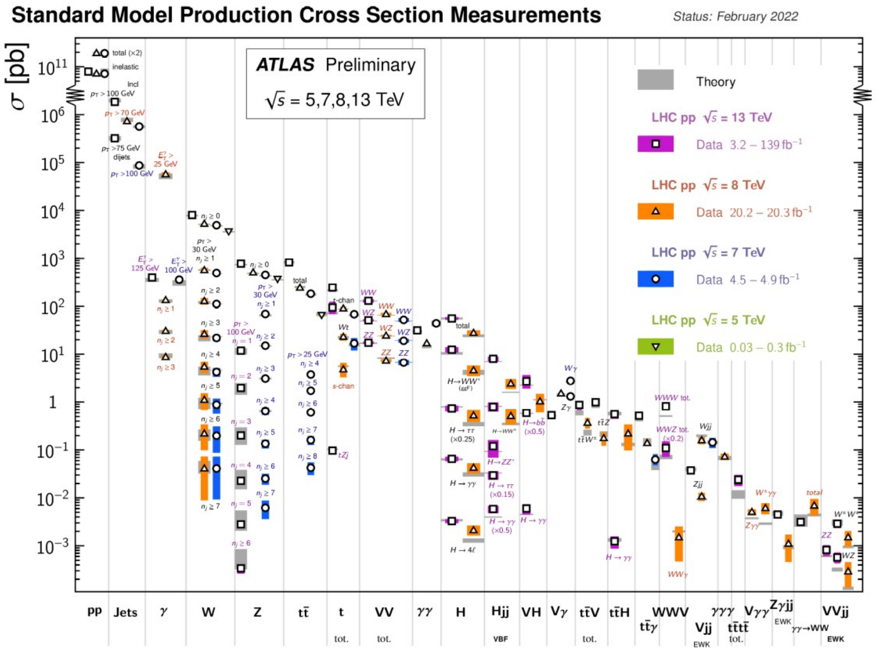
Postdoctoral position on ALAS EFT and Higgs measurements

https://emploi.cnrs.fr/Offres/CDD/UMR5814-LOUDAI-042/Default.aspx?lang=EN

Introduction



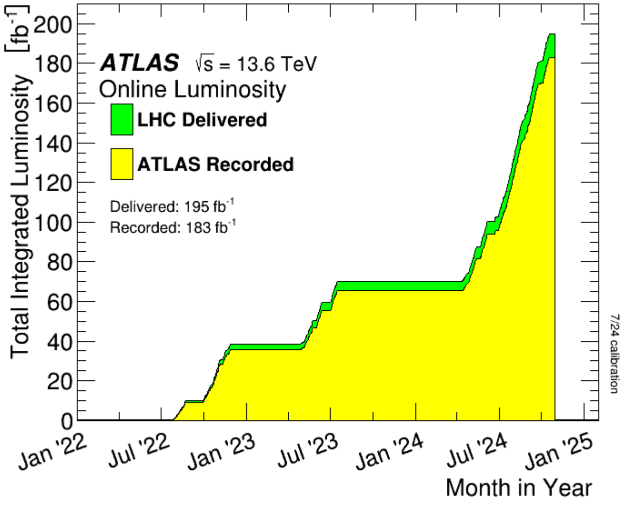
No new physics found so far, mass limits reaching O(1 TeV) in many cases...



... but the LHC is maturing into a precision measurement machine!

LHC past, present, future

Run 2 **2015-2018**	13 TeV	140 fb^{-1}
Run 3 **2022-2025**	13.6 TeV	300-400 fb^{-1}
Run 4+ **2029-…**	14 TeV	4000 fb^{-1}



Already more Run 3 than Run 2 data collected!

Collision energy won't increase much, but a lot more data is coming!

→ Even more precision (if we can control systematics, theory…)

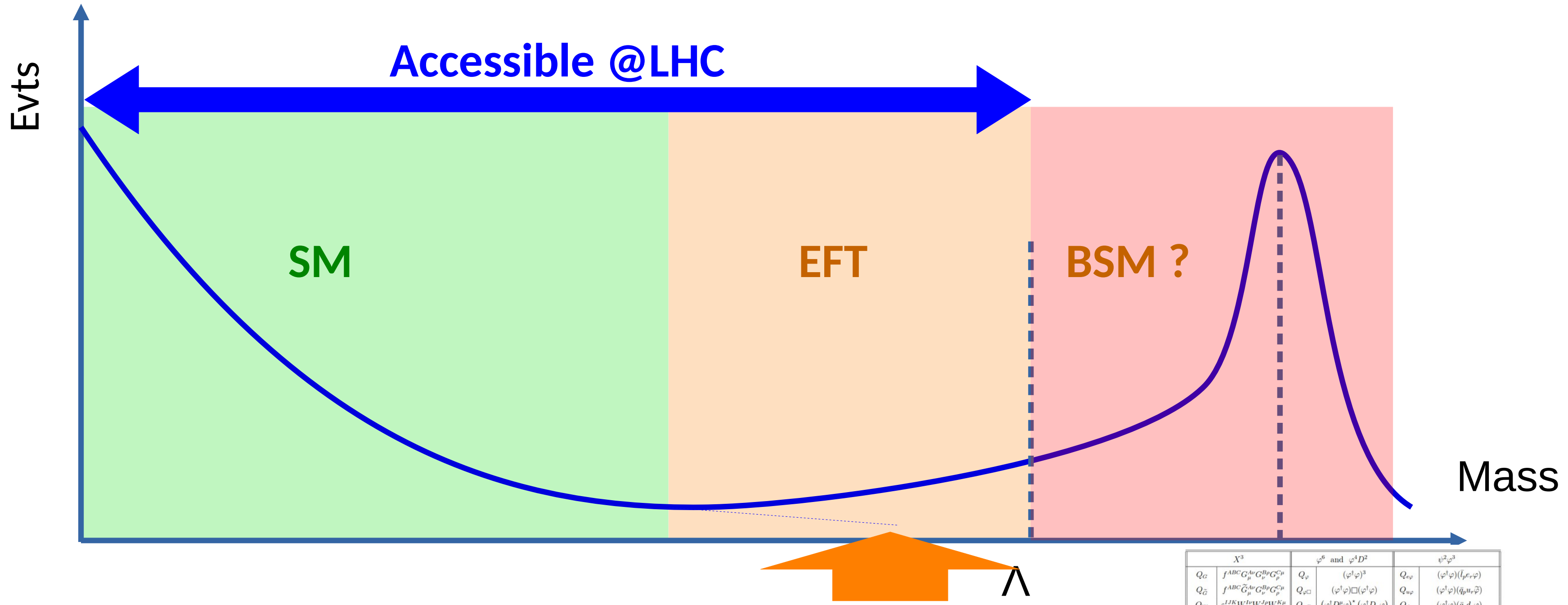
→ Opportunity to develop better analysis techniques ("ML revolution")

⇒ Look for BSM **indirectly**, through deviations from SM predictions

EFTs: a generic framework for to search from deviations from SM

Relevant to all sectors of the SM, in particular **Weak bosons, Higgs, Top, DY**, …

→ Effects typically rise with energy, but low-Q^2 precision measurements also contribute



$$\mathscr{L}_{EFT} = \mathscr{L}_{SM} + \sum_i \frac{c_i^{(6)}}{\Lambda^2} O_i^{(6)} + \ldots$$

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	$\varepsilon^{IJK} W_\mu^{I\nu} W_\nu^{J\rho} W_\rho^{K\mu}$	$Q_{\varphi D}$	$(\varphi^\dagger D^\mu \varphi)^\star (\varphi^\dagger D_\mu \varphi)$	$Q_{d\varphi}$	$(\varphi^\dagger \varphi)(\bar{q}_p d_r \varphi)$
$Q_{\widetilde{W}}$	$\varepsilon^{IJK} \widetilde{W}_\mu^{I\nu} W_\nu^{J\rho} W_\rho^{K\mu}$				
$X^2 \varphi^2$		$\psi^2 X \varphi$		$\psi^2 \varphi^2 D$	
$Q_{\varphi G}$	$\varphi^\dagger \varphi\, G_{\mu\nu}^A G^{A\mu\nu}$	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}	$(\bar{q}_p \sigma^{\mu\nu} d_r) \varphi\, B_{\mu\nu}$	$Q_{\varphi ud}$	$i(\widetilde{\varphi}^\dagger D_\mu \varphi)(\bar{u}_p \gamma^\mu d_r)$

EFT@LHC Project

Project members

The candidate would join LAPP Annecy

Nicolas Berger (leader)
Marco Delmastro
Lucia Di Ciaccio
Tetiana Hryn'ova
Narei Lorenzo Martinez
Emmanuel Sauvan
Rahul Balasubramanian
Post-doctoral position

LAPP Annecy

Lydia Fayard
Nicolas Morange
Nikola Makovec
Dimitris Varouchas
+1 post-doc

IJClab Orsay

Sabine Kraml
Lohan Sartore

LPSC Grenoble

Romain Madar
Adrien Auriol

LPC Clermont

Kyle Cranmer
U. of Wisconsin

Ilaria Brivio
Bologna U.

Veronica Sanz
U. of Valencia

Tevong You
King's college London

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EFT@LHC Project objectives

Axis 1 : Improving EFT measurements

→ High E sensitivity + new variables (CP)

→ Make use of modern ML tools

Apply to Higgs, dibosons (WW, WZ, ZZ, Zγ), top and Drell-Yan (pp→ll)

Axis 3 : FAIR publication of results

→ Publish results beyond Gaussian approximation : Poisson effects in tails, correct treatment of systematics.

→ Publish likelihoods (full or simplified)

Axis 2 : EFT predictions

→ State-of-the art predictions and tools

→ Higher orders in loops, EFT

→ Uncertainties

Axis 4 : Combined fits

→ Perform Diboson+Higgs+Top+DY fits within and outside ATLAS

→ Investigate less flavor symmetries (DY, Top + flavor measurements), CP even/odd

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within and outside ATLAS

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Overarching goals

- Improve EFT global combinations in several directions (hoping to see first hints of BSM!)
- Train junior researchers in interesting topics at the crossroads of theory and experiment
- Promote better theory/experiment links in the EFT sector: improve sharing of experimental results and collaboration on analysis and fitting techniques, tools, ….

ATLAS @ LAPP Annecy

LAPP is located in **Annecy**, about 50 km south of CERN

~150 staff working mainly on particle and astroparticle physics

The ATLAS group is involved in several physics topics:

- Higgs boson physics ($H \to \gamma\gamma$ in particular)
- Dibosons/VBS
- Drell-Yan
- EFT analyses

Hardware: Involvement in LAr Calorimeter and ITk Pixels Upgrade projects

Position details

The position is for **2 years** (likely not exendable), starting **in Spring 2025**

Ph. D. in particle physics, **received <2 years before the start of the position** is required**.**

Candidates will contribute to ATLAS EFT and Higgs measurements.

Looking in particular for :

- **A strong background in experimental particle physics, in particular LHC experiments**
- **Excellent collaboration and team-building abilities**
- **Experience with modern software tools (data analysis, machine learning, etc.)**

Some experience with Higgs and EFT physics analysis can also be useful.

The candidate is expected to be based in the Annecy area, with frequent travel to CERN

Some knowledge of French is a plus, but not required.

Starting salary ~3000€/month (before tax)