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Low mass resonances@LHC

AAP A*MIDEX “Interdisciplinarité 2022”

IPhU day 2023

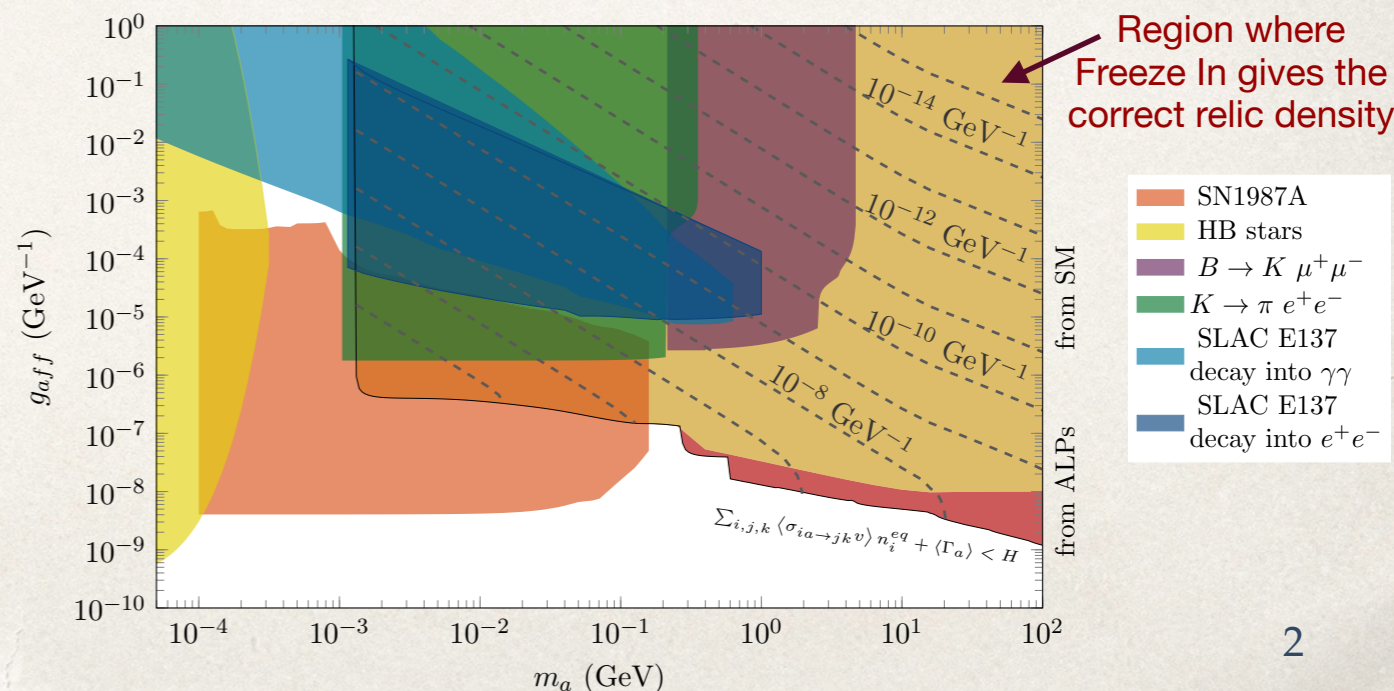
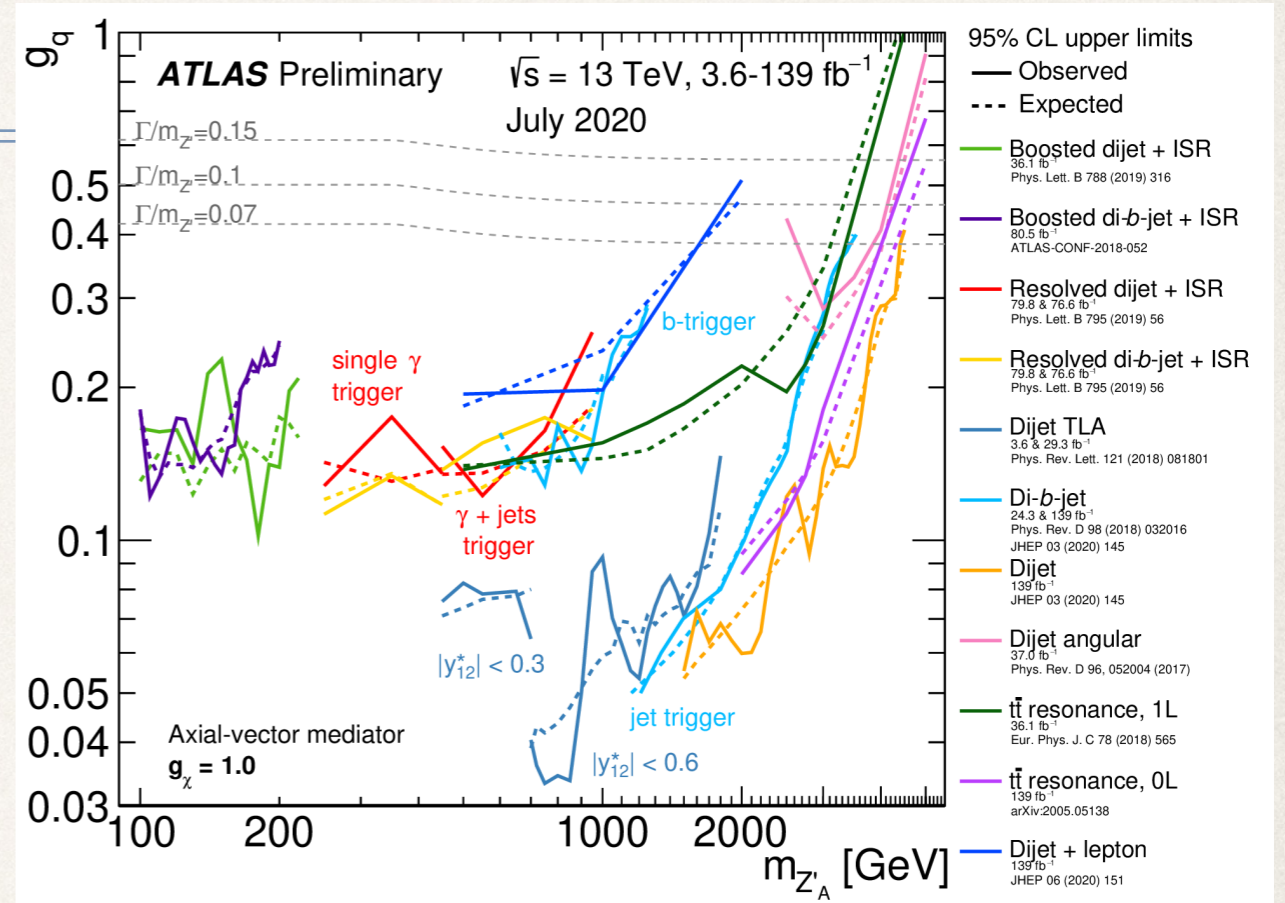


Aoife Bharucha CPT
Lorenzo Feligioni CPPM

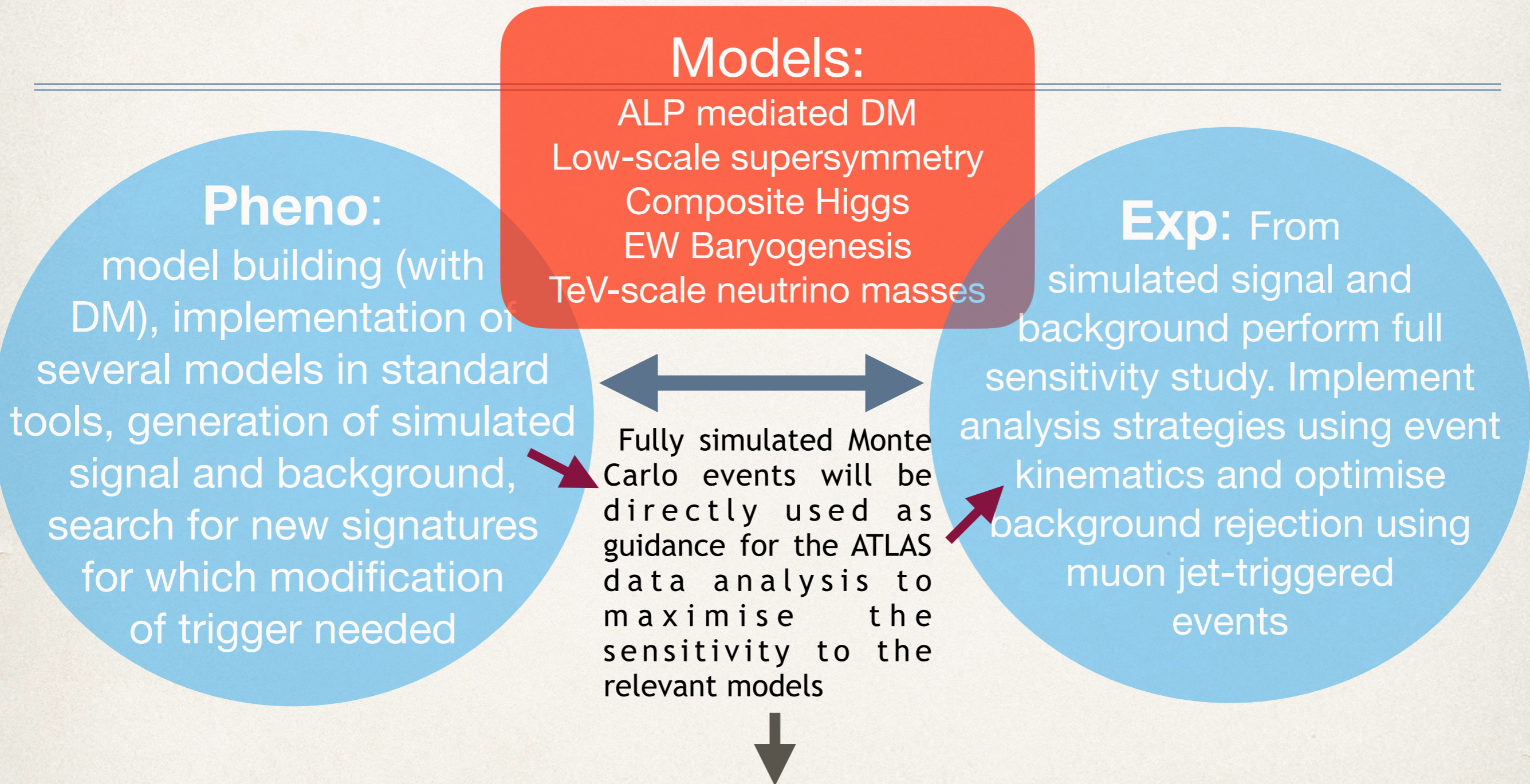


Low mass resonances@LHC: Intro

- So far the LHC experiments have succeeded in excluding large regions of parameter space of possible BSM models
- However, resonance searches@LHC leave **area of opportunity for low mass resonances below EW scale**
- Such light states are ubiquitous in model of BSM physics, for example as **mediators to DM** as studied by phenomenologists@CPT
- ATLAS team@CPPM proposes a new Run 3 analysis to probe this region via the **$b\bar{b}$ final state**. Expertise in b jets. Propose triggering on the muons found in b-jets to probe lower masses.



Interdisciplinarity of project



Obtain projected sensitivity to different models, crucial information for pheno community. Implement new analyses strategies for Run3 but also guide the experimental strategy in the post Run 3 era

Structure of the project

	Part I: Build low-mass resonance models suitable for studying via $b\bar{b}$ at ATLAS	Part II: Generate signal and background events in various models
Description of the activity	<p>(a) Build different models containing low mass particle with potential to be seen at ATLAS via $b\bar{b}$, check existing experimental constraints. Implement models in standard tools (Feynrules/SARAH) and generate model files for MonteCarlo event generation.</p> <p>(b) Calculation of the production rates for the various <i>single, associate, or pair production channels</i> and the branching ratio to $b\bar{b}$. Determination of the signatures of each model which are most promising.</p> <p>(c) Verify by theorists in collaboration with ATLAS team whether proposed signatures would be triggered on, or if an extension is needed</p>	<p>(a) Use event generators (e.g. Pythia) and fast detector simulation frameworks (Delphes) to generate Signal and Background events, making use of ATLAS group expertise. Outcome will allow to converge on an optimised analysis strategy.</p> <p>(b) Optimisation and commissioning of muon plus b-jet. If needed, specialised b-tagging algorithms with fast tracking, for TLA, and using tracks reconstructed with partial detector information, for PEB, will have to be commissioned</p>
Output	<ol style="list-style-type: none"> 1. Model files for MonteCarlo event generation 2. Choice of signatures for specific models which have the potential to be constrained by ATLAS 3. Publication “Review of light resonance 	<ol style="list-style-type: none"> 1. Publication “LHC sensitivity to novel signatures testable with ATLAS $b\bar{b}$ triggers” 2. It will further influence the ATLAS strategy for the post-Run 3 era.

References

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[Search for doubly and singly charged Higgs bosons decaying into vector bosons in multi-lepton final states with the ATLAS detector using proton-proton collisions at \$\sqrt{s}=13\$ TeV](#), ATLAS Collaboration • Georges Aad (Marseille, CPPM) et al., 2101.11961 [hep-ex], *JHEP* 06 (2021), 146

Low mass resonances@LHC: The team

Key players in the design, commissioning, data quality assessment and calibration of the b-jet trigger, leading expertise on fully hadronic analyses.

L2C/LUPM/CPT phenomenologists have recognised expertise in SUSY models, (composite) Higgs sector, DM models + implications for collider phenomenology.

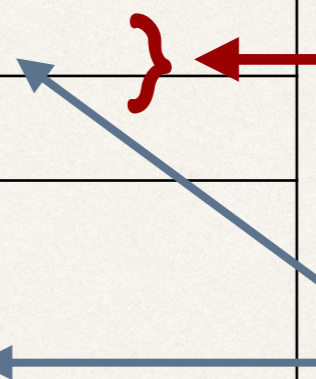
Established interdisciplinary collaboration between the pheno+exp members: the ATLAS-CPPM and the L2C/LUPM theory groups collaborated in Run 2 via the PESBLADe project (2014-2019) funded by the Labex OCEVU (L2C, LUPM), with LF as PI



IPhU Labs and other Partners		
CPT	Pheno	Aoife Bharucha
CPPM	Exp	Lorenzo Feligioni
LUPM - UMR5299 Université de Montpellier - Campus Triolet Place Eugène Bataillon - CC 72 34095 Montpellier Cédex 05	Pheno	Felix Brümmer
L2C - UMR5221 Université de Montpellier - Campus Triolet Place Eugène Bataillon - CC 69 34095 Montpellier Cédex 05	Pheno	Gilbert Moulta, Michele Frigerio

Coordinators of the Particle Physics Working Group within IPhU.

OCEVU funded a collaborative project between CPT and LUPM centred on the recasting of LHC results which had AB and FB as PIs.



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Proponents are part of a collaborative phenomenological-experimental project, with LF as PI, funded by the Institute de Physique de l'Univers (IPhU)

Low mass resonances@LHC: The budget

Postdoc working on BSM pheno boost related CPT activity, benefit ATLAS group + strengthen existing relations between the CPT, CPPM and the Montpellier labs the LUPM and the L2C

Operating	
	€2000
<i>Short justification: These costs include the travel expenses to national and international conferences as well as for the cost of travelling between Montpellier and Marseille for the collaboration within the project. Note that the BSM@Terascale IphU project could also contribute towards these costs.</i>	
Equipment/ Investment	
	€2000
<i>Short justification : To cover the cost of a computer for the postdoc.</i>	
Salary	
	€ 104k
<i>Short justification : This would cover the cost of a two-year contract for a phenomenologist post-doc, assuming professional experience of more than 3 years.</i>	

The success of this proposal will provide leverage when applying for local (a doctoral (IPhU/ED) fellowship) and national (ANR) funding to work on the interface between pheno and the ATLAS experiment