Accelerating the search for mass bumps using the Data-Directed Paradigm

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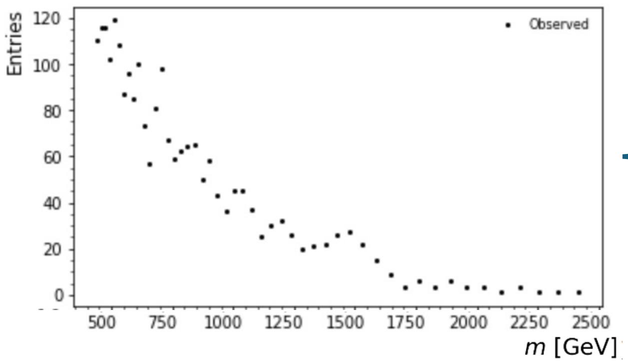
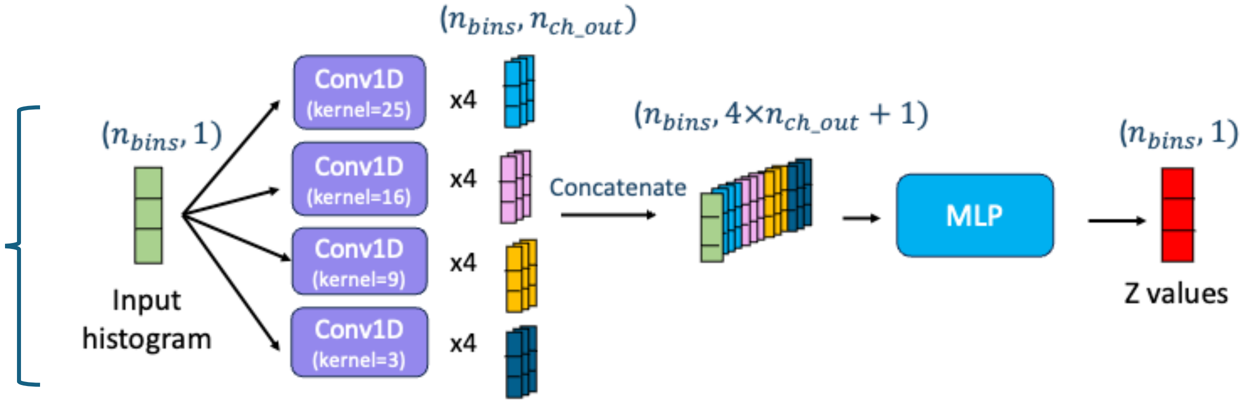
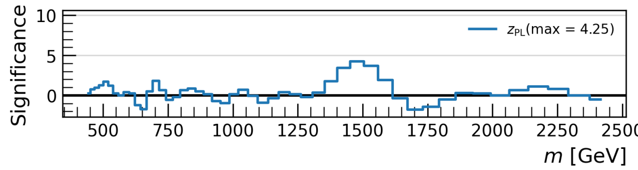
What ?

- We want to maximize our chances to **find new physics** in collider data
- Train a neural network to **identify mass bumps in real data** without the need of simulation or analytical fit to estimate the background



Invariant mass histogram





Bin-by-bin statistical significance

Why ?

- Exploit the **discovery potential of the data**
  - Impossible to check all final states with a traditional analysis
  - Many possible resonances in unexplored final states → bumps

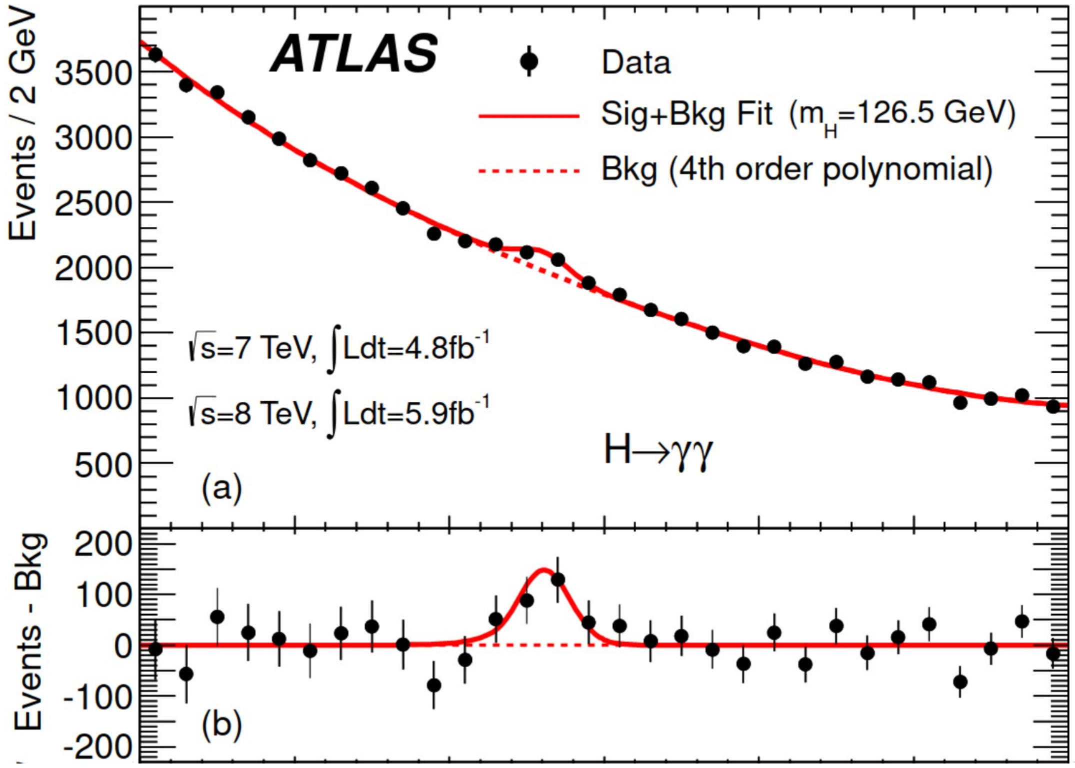
Existing searches for two-body resonances[1]

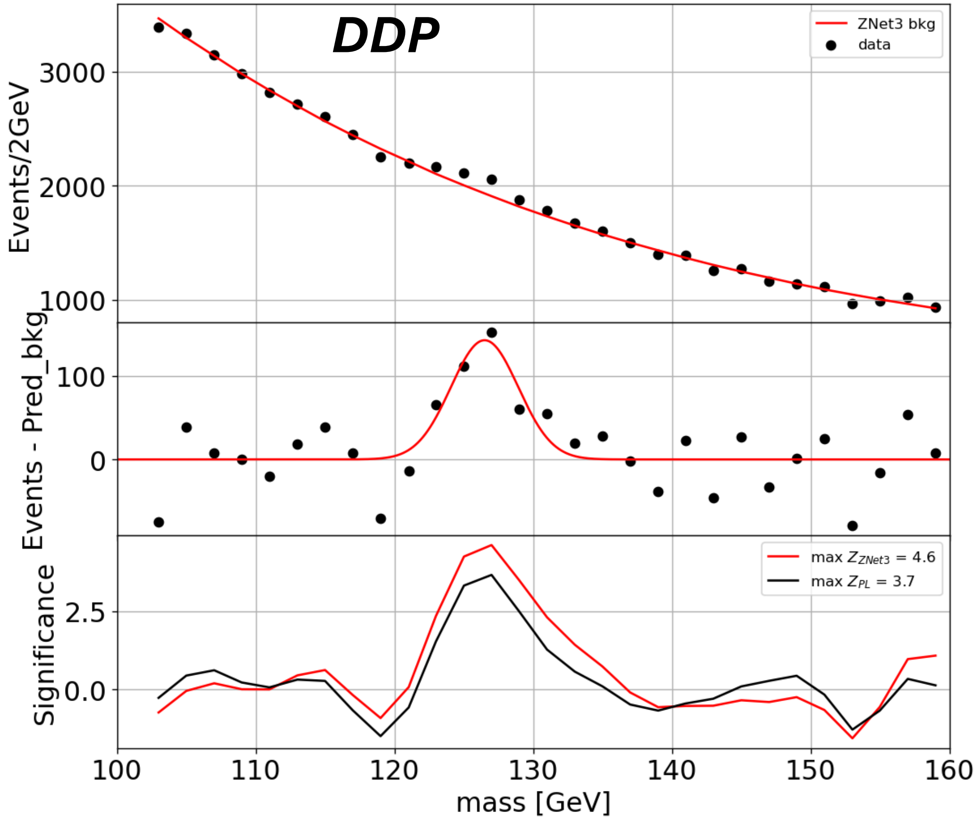
	e	μ	τ	q/g	b	t	γ	Z/W	H	BSM $\to SM_1 \times SM_1$				BSM $\to SM_1 \times SM_2$			BSM $\to$ complex			
										q/g	γ/π^0's	b	$\cdots$	tZ/H	bH	$\cdots$	$\tau qq'$	eqq'	$\mu qq'$	$\cdots$
e	[37,38]	[39,40]	[39]	∅	∅	∅	[41]	[42]	∅	∅	∅	∅		∅	∅	∅	∅	[43,44]	∅	
μ		[37,38]	[39]	∅	∅	∅	[41]	[42]	∅	∅	∅	∅		∅	∅	∅	∅	∅	[43,44]	
τ			[45,46]	∅	[47]	∅	∅	∅	∅	∅	∅	∅		∅	∅	∅	[48,49]	∅	∅	
q/g				[29,30,50,51]	[52]	∅	[53,54]	[55]	∅	∅	∅	∅		∅	∅	∅	∅	∅	∅	
b					[29,52,56]	[57]	[54]	[58]	[59]	∅	∅	∅		[60]	∅	∅	∅	∅	∅	
t						[61]	∅	[62]	[63]	∅	∅	∅		[64]	[60]	∅	∅	∅	∅	
γ							[65,66]	[67–69]	[68,70]	∅	∅	∅		∅	∅	∅	∅	∅	∅	
Z/W								[71]	[71]	∅	∅	∅		∅	∅	∅	∅	∅	∅	
H									[72,73]	[74]	∅	∅		∅	∅	∅	∅	∅	∅	
BSM $\to SM_1 \times SM_1$: q/g										∅	∅	∅		∅	∅	∅	∅	∅	∅	
BSM $\to SM_1 \times SM_1$: γ/π^0's											[75]	∅		∅	∅	∅	∅	∅	∅	
BSM $\to SM_1 \times SM_1$: b												[76,77]		∅	∅	∅	∅	∅	∅	
⋮																				
⋮																				

[1] J. H. Kim et al., version 1, 10.48550/ARXIV.1907.06659 (2019), https://arxiv.org/abs/1907.06659

Promising result

- **Finding the Higgs bump**
  - Predicted significance matches the ATLAS significance within error [2]





[2] *ATLAS Collaboration. Physics Letters B 716 (2012). doi:10.1016/j.physletb.2012.08.020*

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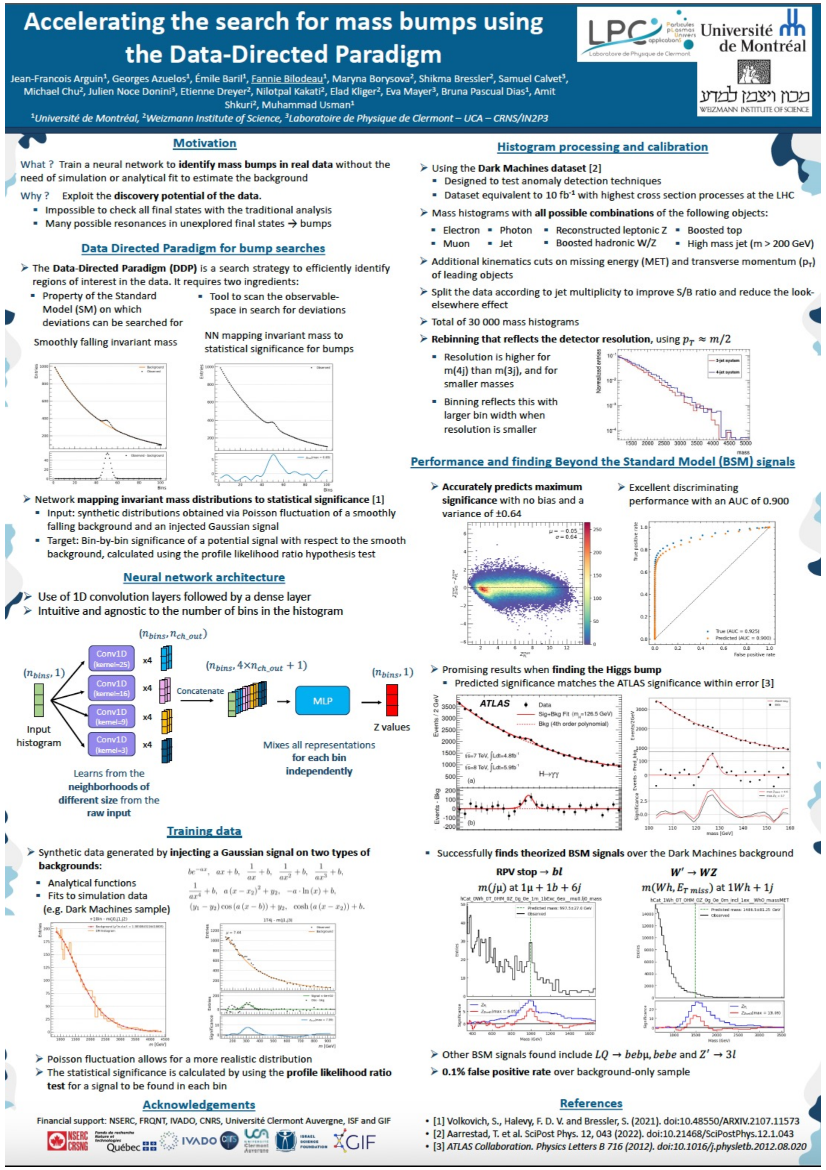
More promising results !

More on the training data !

Poster 18



More on the pre-processing of the histograms !

Come ask questions !