

A cartoon illustration of a city street scene. On the left, a purple character with a worried expression is running. In the center, two red, round characters with faces and limbs are looking surprised. One red character is holding a red hat. On the right, the front of a blue car is visible. The background shows a grey building and a sidewalk with a manhole cover.

Searching for the Double Higgs Production

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Overview

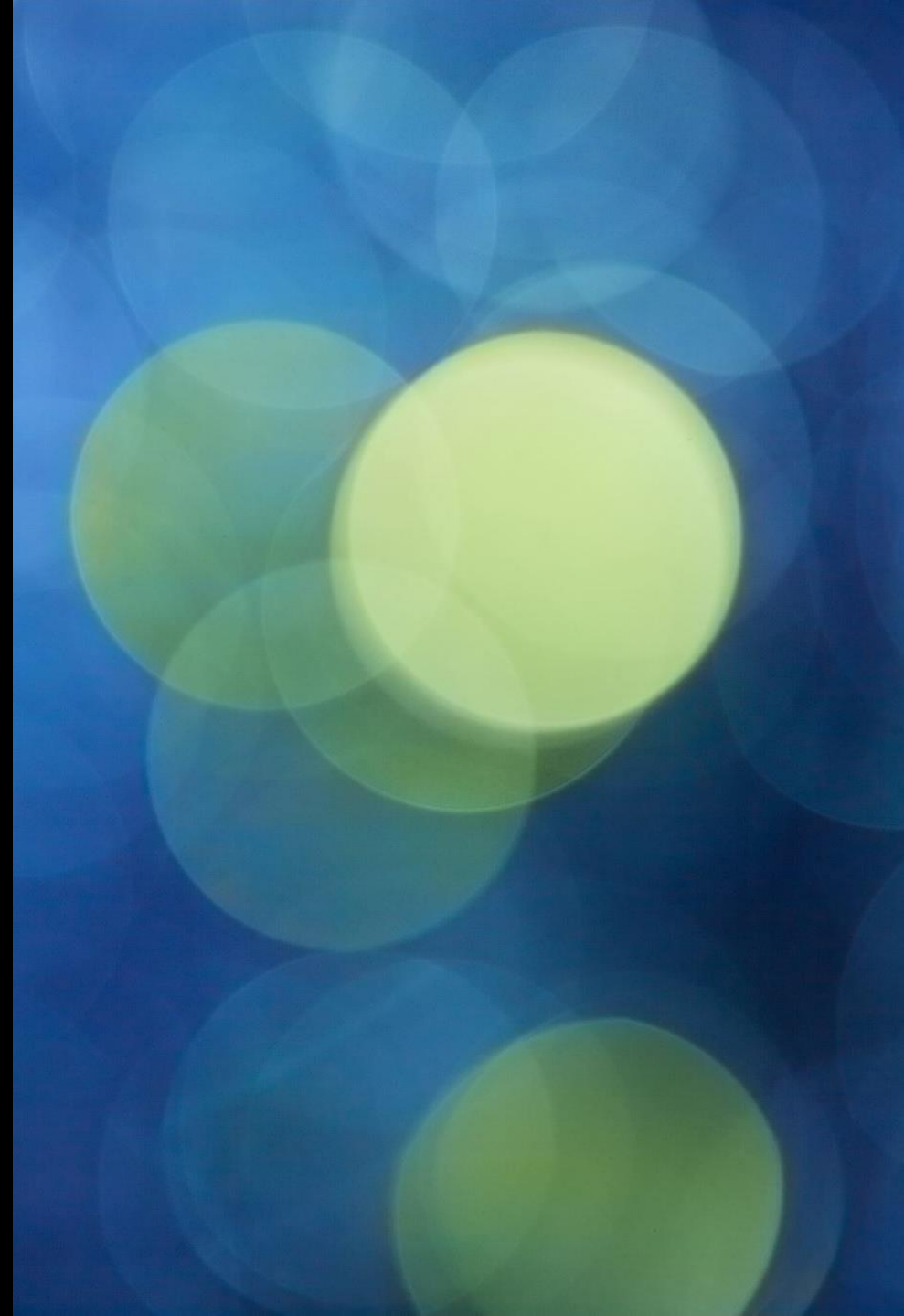
Hunting for potential

Double Higgs in the Standard model (SM)

Double Higgs decays

Chosen Double Higgs production

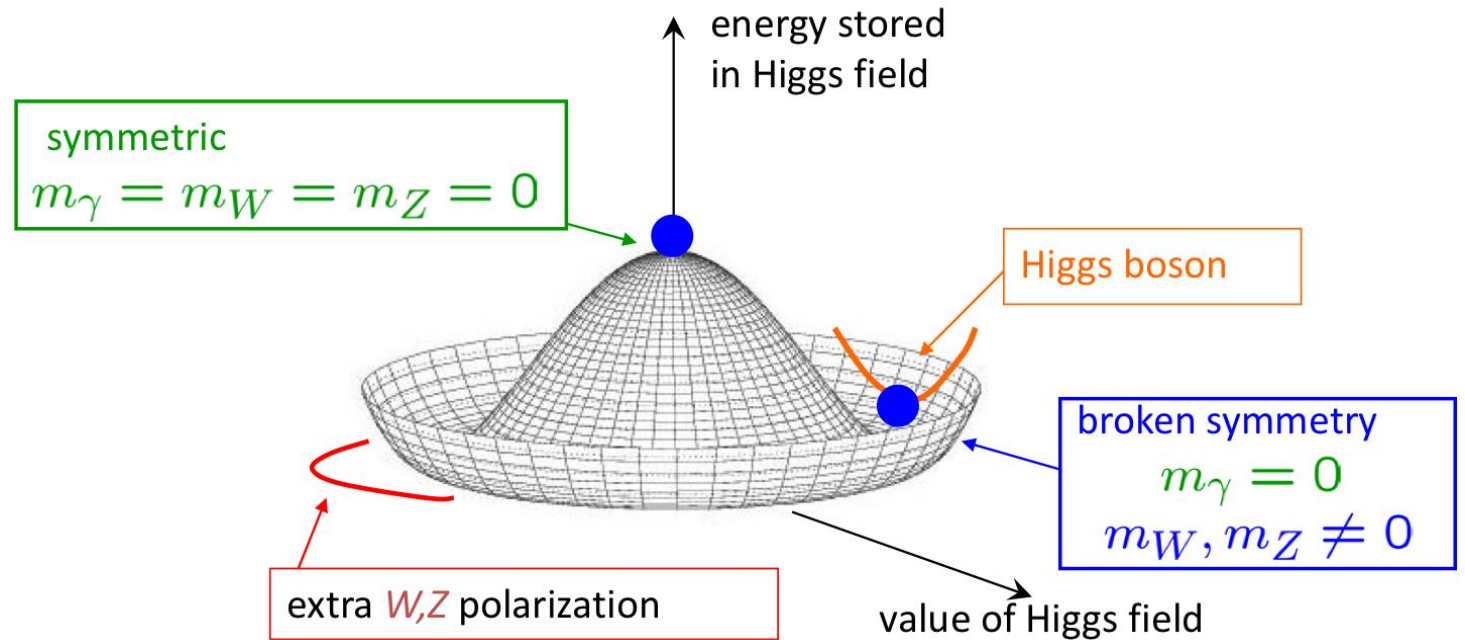
Using simulations to find the DiHiggs



Hunting for Potential

Why is the finding the DiHiggs important?

- Higgs potential in SM
- What finding the DiHiggs can tell us



Double Higgs in the SM

- Higgs potential: $V(\varphi) = -\frac{1}{2} \mu^2 \varphi^2 + \frac{1}{4} \lambda \varphi^4$
- Expand around the vacuum expectation value: $V(\phi) \rightarrow V(v + h)$
- Math happens here

$$V(h) = V_0 + \frac{1}{2} m_h^2 h^2 + \frac{m_h^2}{2v^2} v h^3 + \frac{1}{4} \frac{m_h^2}{2v^2} h^4 + \dots$$

Mass Term

Higgs trilinear self-coupling

Higgs quadratic self-coupling

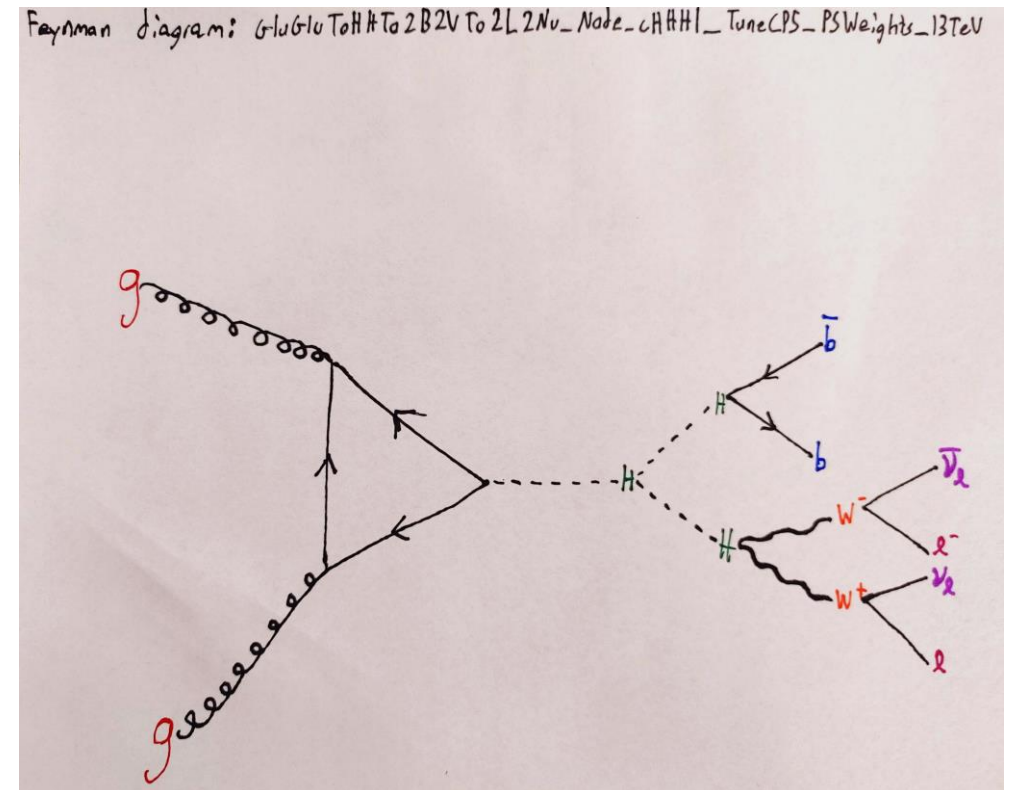
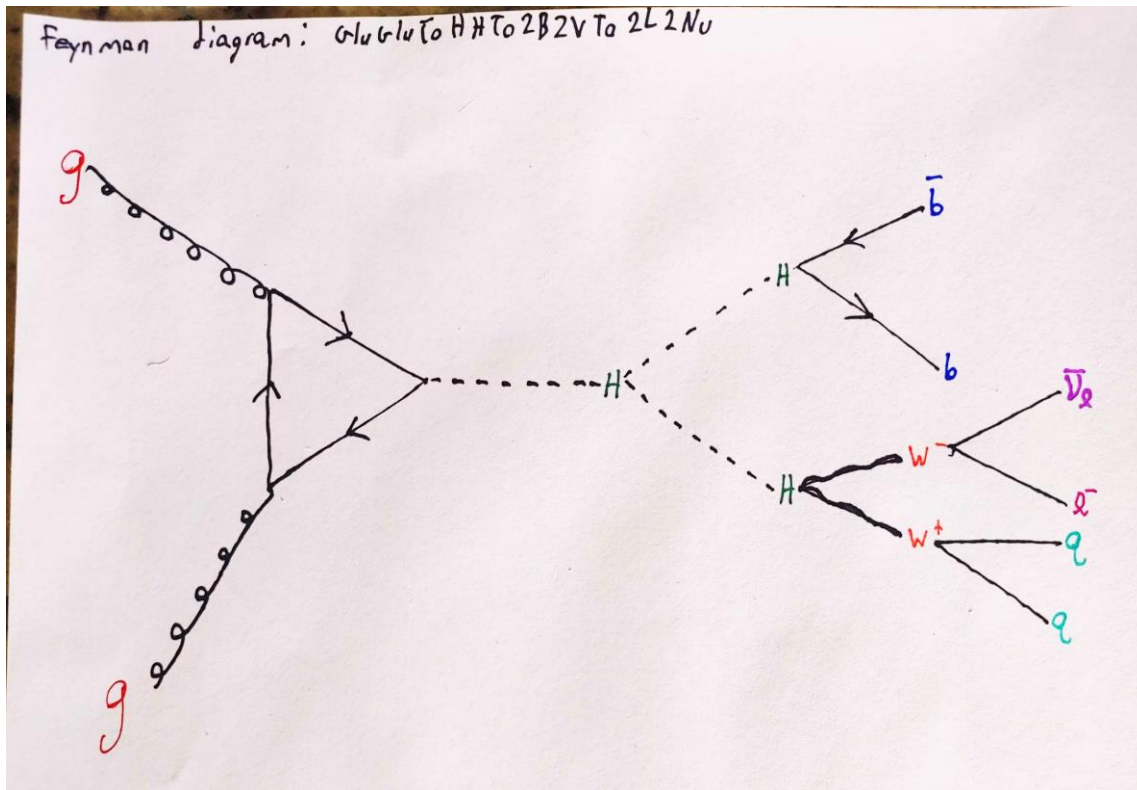
	mass →	charge →	spin →					
QUARKS	0.3 MeV/c ²	2/3	1/2	u	1.28 GeV/c ²	2/3	1/2	c
				up				charm
	173.2 GeV/c ²	2/3	1/2	t				top
					gluon			
LEPTONS	0.5 MeV/c ²	-1/3	1/2	d	105.7 MeV/c ²	-1/3	1/2	μ
				down				muon
	1.777 GeV/c ²	-1/3	1/2	b	1.777 GeV/c ²	-1/3	1/2	τ
					tau			
GAUGE BOSONS	0	0	0	g	0	0	0	H
				gluon				Higgs boson
	0	0	0	γ				
				photon				
LEPTONS	0.511 MeV/c ²	-1	0	e	105.7 MeV/c ²	-1	0	μ
				electron				muon
	1.777 GeV/c ²	-1	0	τ				
					Z boson			
LEPTONS	<0.2 eV/c ²	0	0	ν_e	<0.17 MeV/c ²	0	0	ν_μ
				electron neutrino				muon neutrino
	<0.17 MeV/c ²	0	0	ν_μ	<18.2 MeV/c ²	0	0	ν_τ
					tau neutrino			
GAUGE BOSONS	0	0	0	Z	80.4 GeV/c ²	0	0	W
				Z boson				W boson

Double Higgs decays

	bb	WW	$\tau\tau$	ZZ	YY
bb	34%				
WW	25%	4.6%			
$\tau\tau$	7.3%	2.7%	0.39%		
ZZ	3.1%	1.1%	0.33%	0.069%	
YY	0.26%	0.10%	0.028%	0.012%	0.0005%

Chosen Double Higgs Production

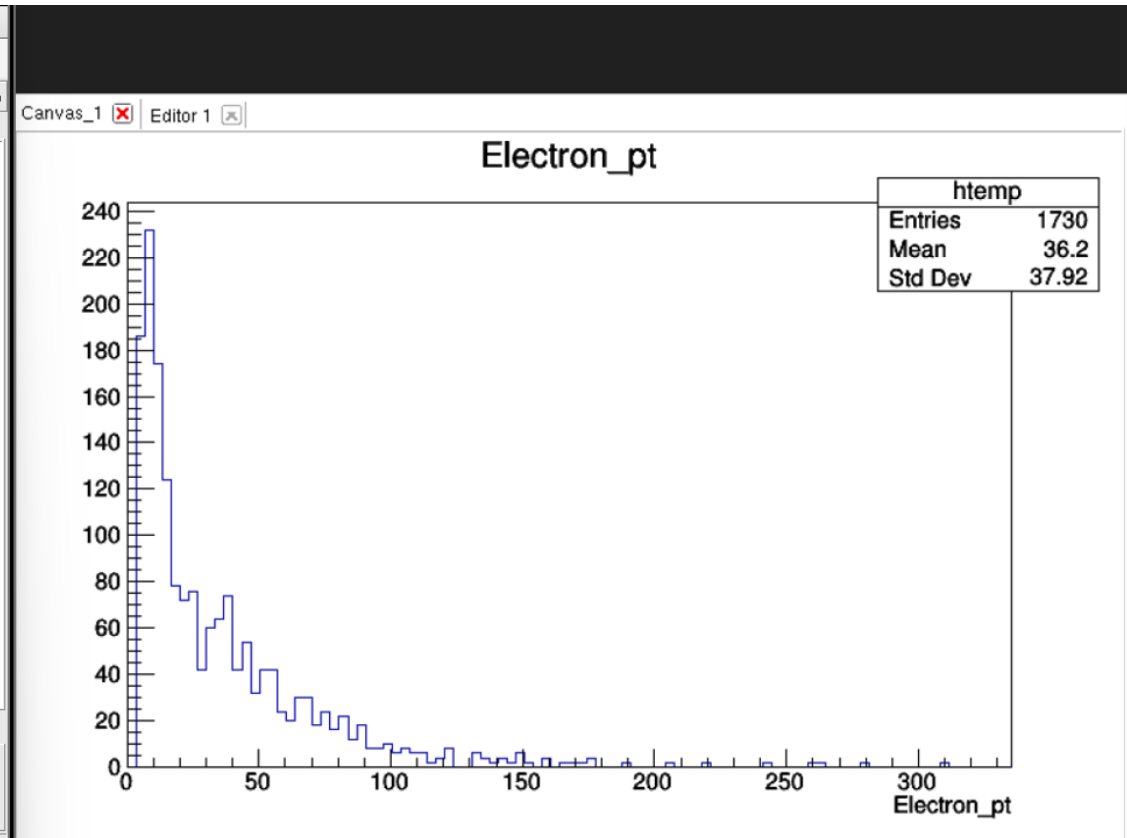
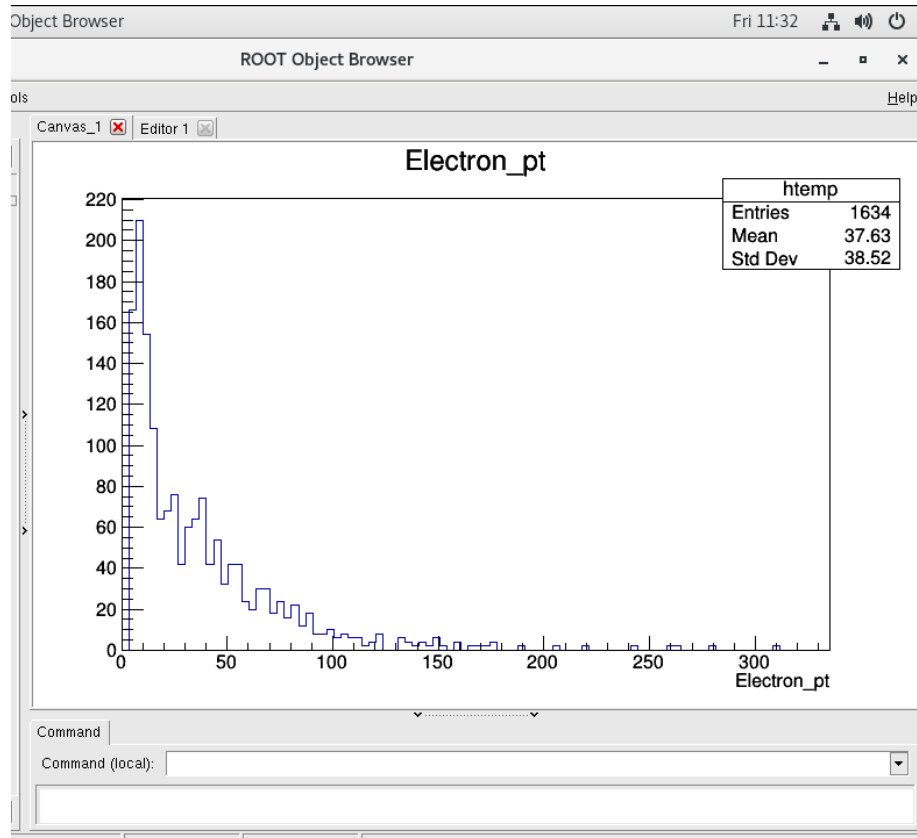
- The bbWW is the DiHiggs decay chosen to analyze
 - The DiHiggs has a very low chance of occurring
 - There is a lot more background (tt-bar) noise that occurs



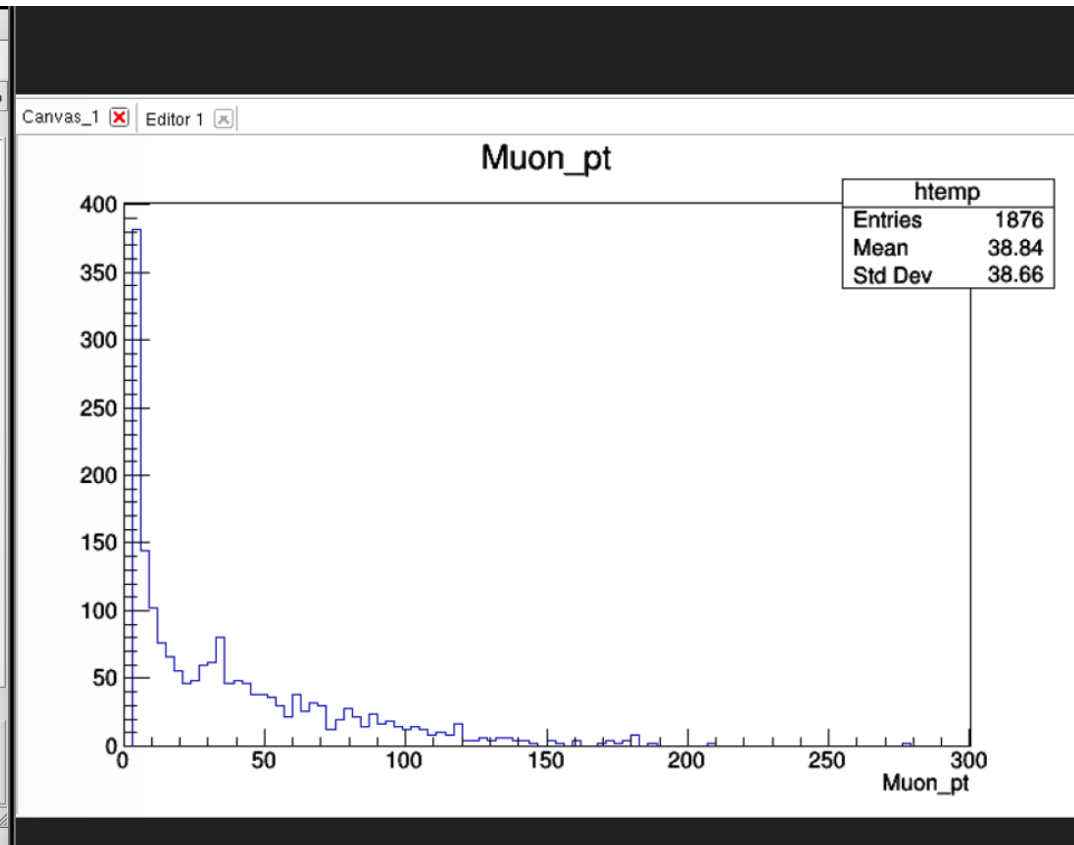
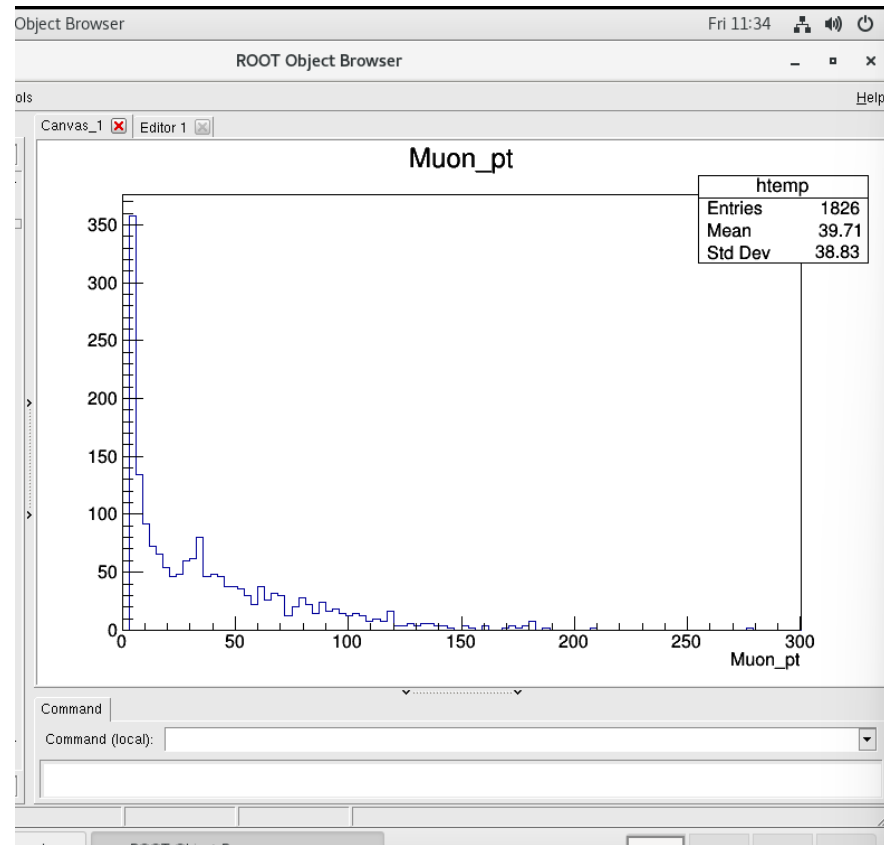
The background of the slide is a simulated ECG tracing on a grid. The tracing is green and shows several cardiac cycles. Labels for leads are visible: 'I', 'aVR', 'V1' at the top; 'II', 'aVL', 'V2' in the middle; 'III', 'aVF', 'V3' below that; and 'II' at the bottom left. The text 'Using Simulations to find the DiHiggs' is overlaid in white, centered on the grid.

Using Simulations to find the DiHiggs

Preselection



Preselection



Preselection

