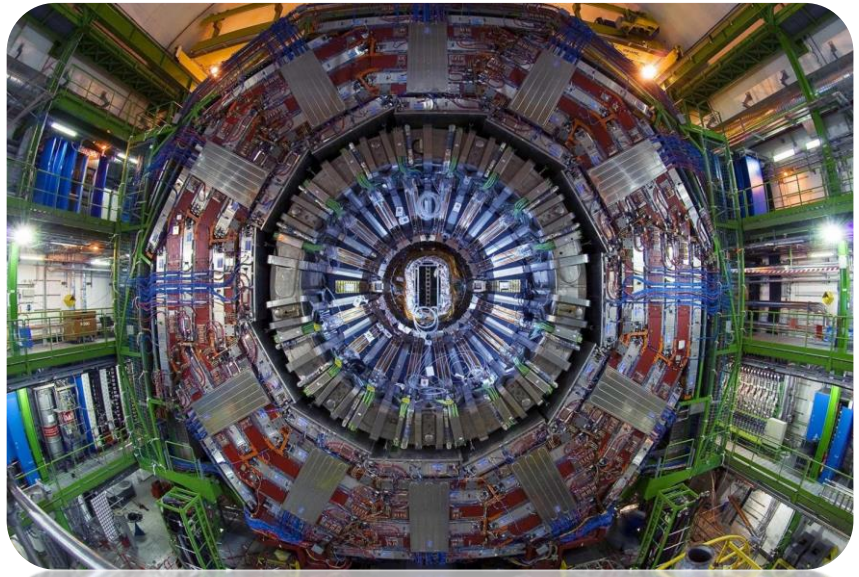
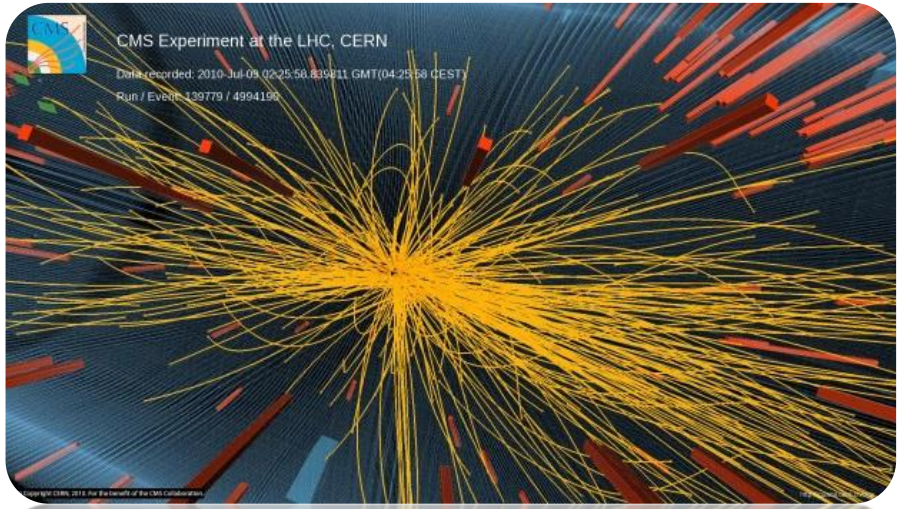
Towards an Improved Estimator of the W Boson Recoil



Cavan Day-Lewis



The Goal

We plan to use machine learning to estimate the hadronic recoil in a $W \rightarrow lv$ decay using $\sqrt{s} = 13\ TeV$ 2016 data from the CMS experiment.

- The standard model gives good predictions of the mass of the W and Z bosons.
- We know experimentally the Z^0 mass to a relatively high precision, unfortunately the same cannot be said for the W Bosons.
- But why is it harder to measure the W boson mass?
  - Simply put: because there are too many unknowns. How do we overcome this?

The Challenge

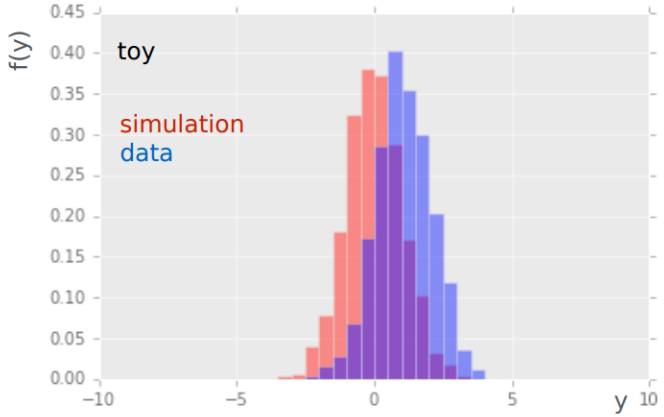
- *Definition:* **Hadronic Recoil** - The sum of the momentum of all the other particles in a collision other than the bosons. It is therefore, equal to the momentum of the bosons.

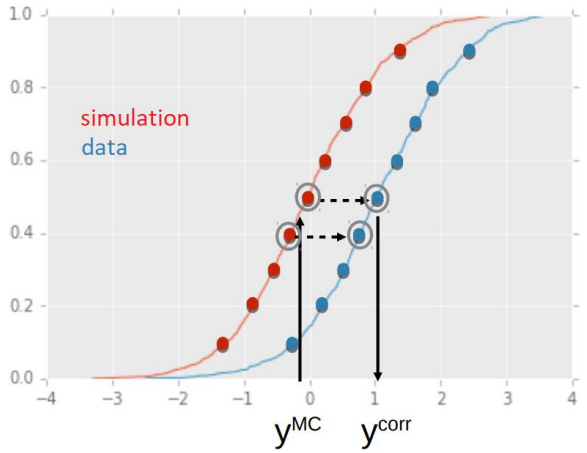
$$y = f(x)$$

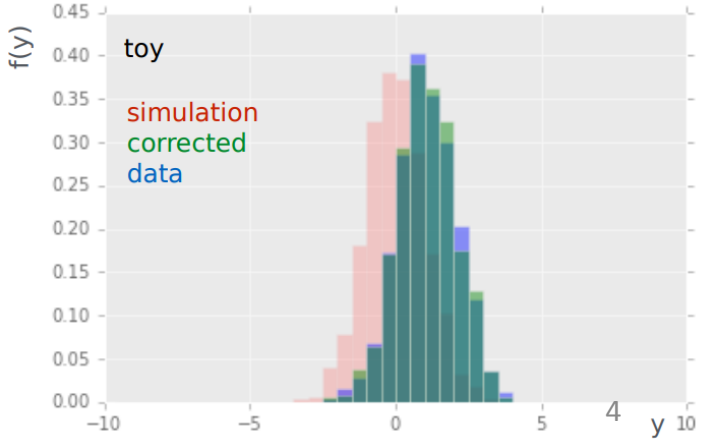
- y = hadronic recoil
- x = 'features of the recoil' (transverse momentum, sphericity, rho to name a few)

How do we use machine learning?

- To begin with we are looking to calibrate the inputs and recoil estimators using data from $Z^0 \rightarrow ll$ decays.
- We are training the boosted decision tree on Monte-Carlo simulations and we look at how the simulations need to be corrected in order to match the CMS data using quantile regression.
- Quantile regression:
  - Is a method of regression which looks to perform different corrections for individual quantiles of the data.

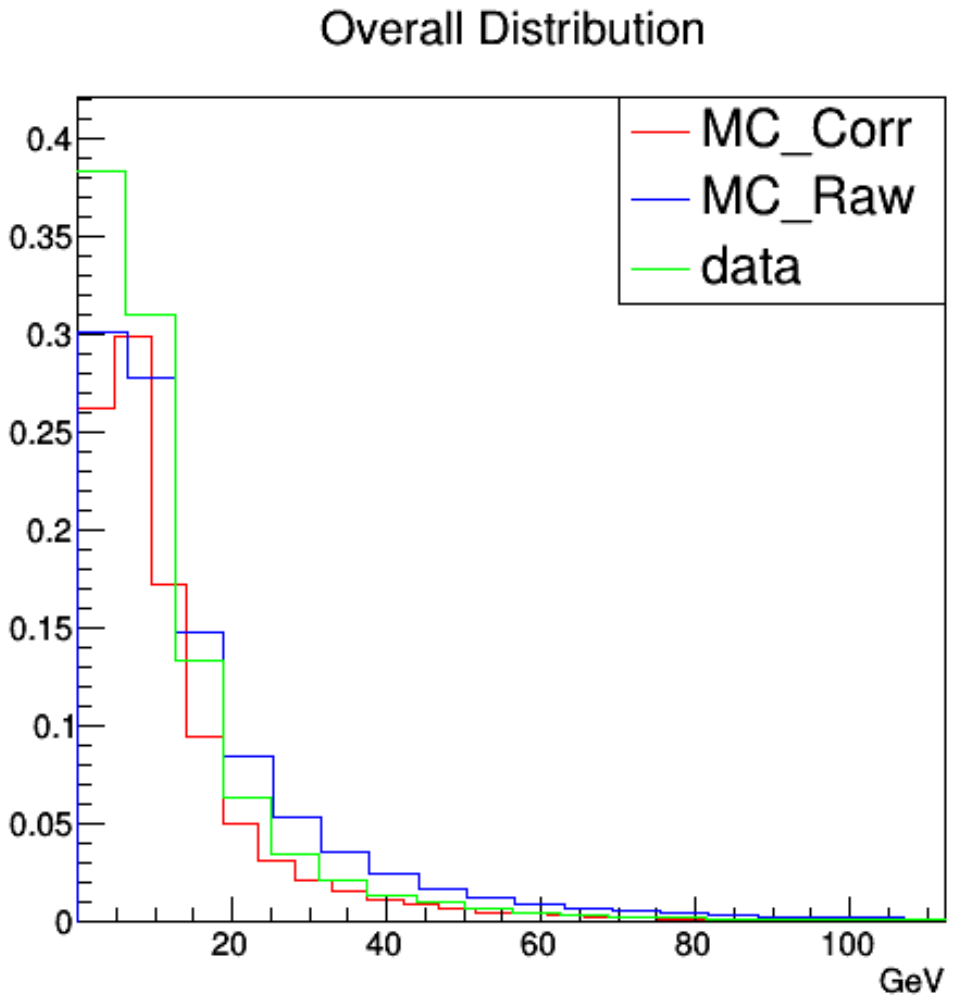






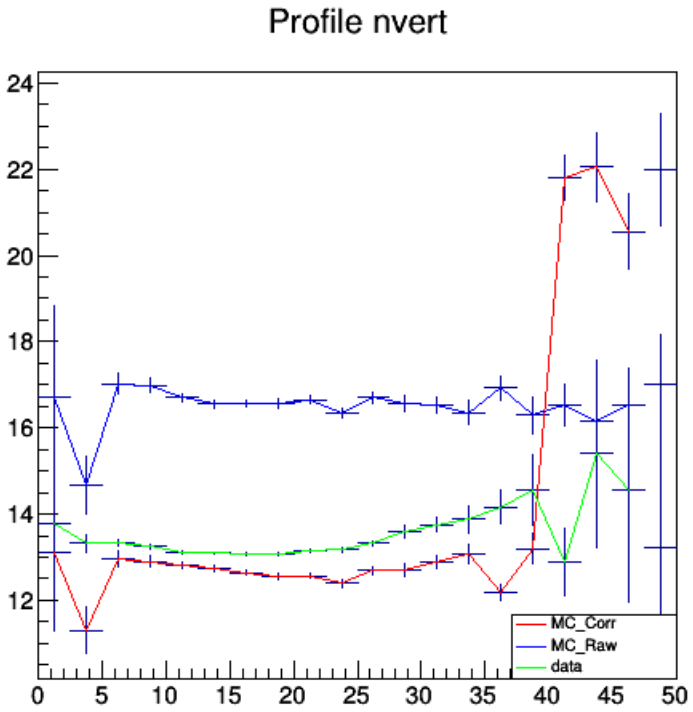
Results

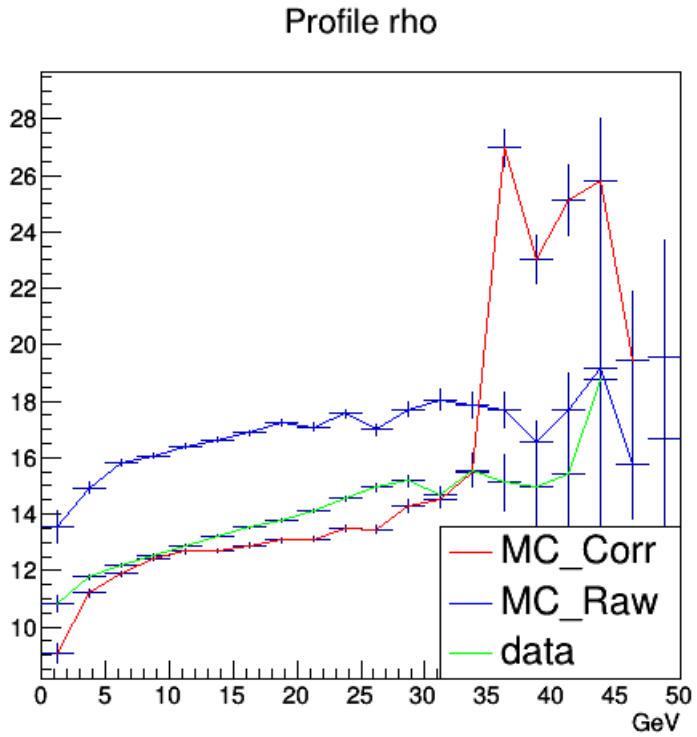
- After quantile morphing the agreement between data and simulation is improved.
- Further tuning of the training is needed to describe all features



Results

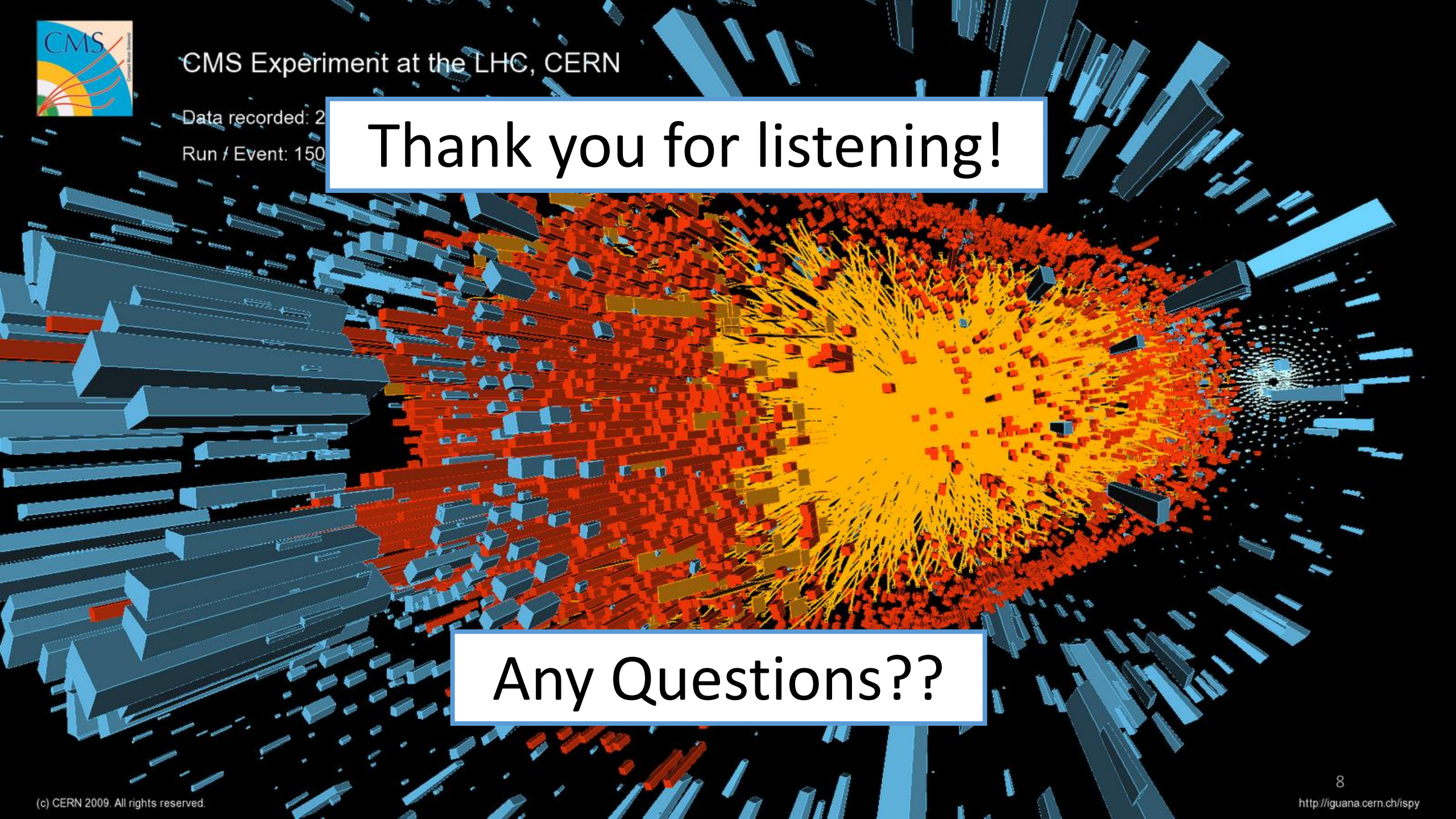
- Average is overall better described as a function of pileup sensitive variables





Still to come

- So I still have 6 weeks left of my project
- Soon we will have optimized the machine learning algorithm
- The next step is to apply it Monte Carlo simulations of $W \rightarrow lv$ decays.
- With that we will then quantify any systematic errors in our result and see if we are any closer to a measurement of the mass of the W boson.


CMS Experiment at the LHC, CERN
Data recorded: 2
Run / Event: 150
Thank you for listening!
Any Questions??
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