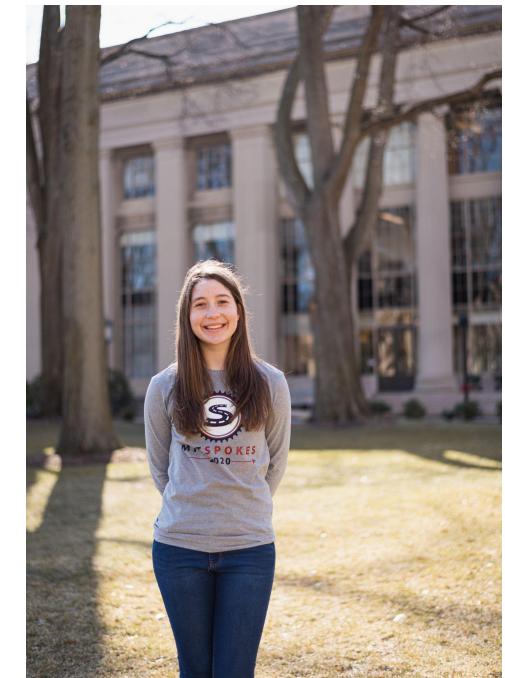


Searching for Rare Higgs Decays in CMS Data Using SubMIT

Charlotte Wickert
Mariarosaria D'Alfonso

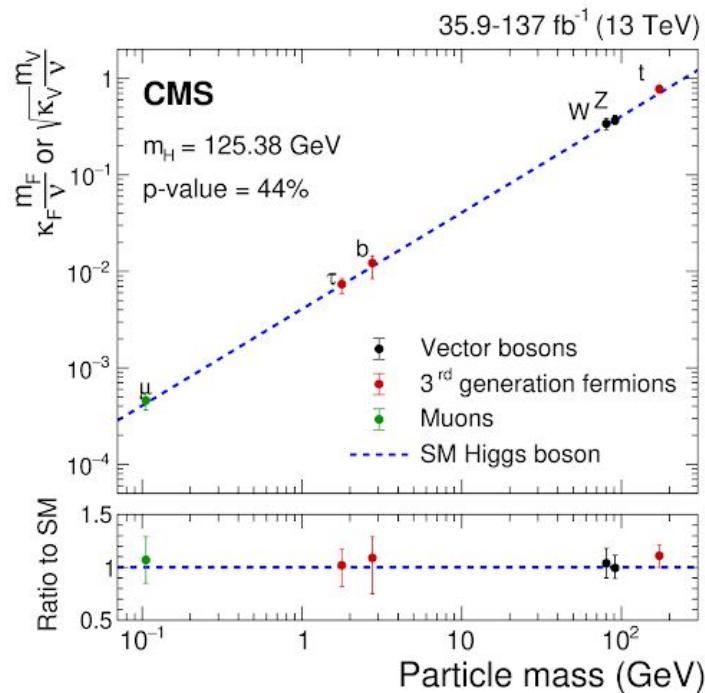
Who Am I?

- 3rd year undergraduate studying Physics and Nuclear Science and Engineering
- Previous research in computational reactor physics
- Started working on this project at the beginning of IAP
- In my free time I like playing and listening to music, rock climbing, and reading!



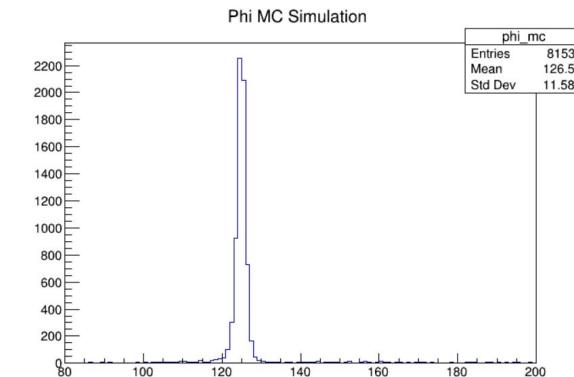
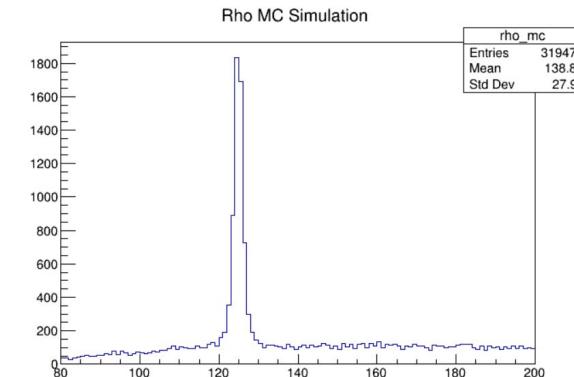
Introduction

- Higgs boson interaction with first and second generation quarks has not been experimentally confirmed
- SM describes fermion interactions through Yukawa couplings
- The current search is for Higgs boson decays into exclusive final states $\phi\gamma$ and $\rho\gamma$

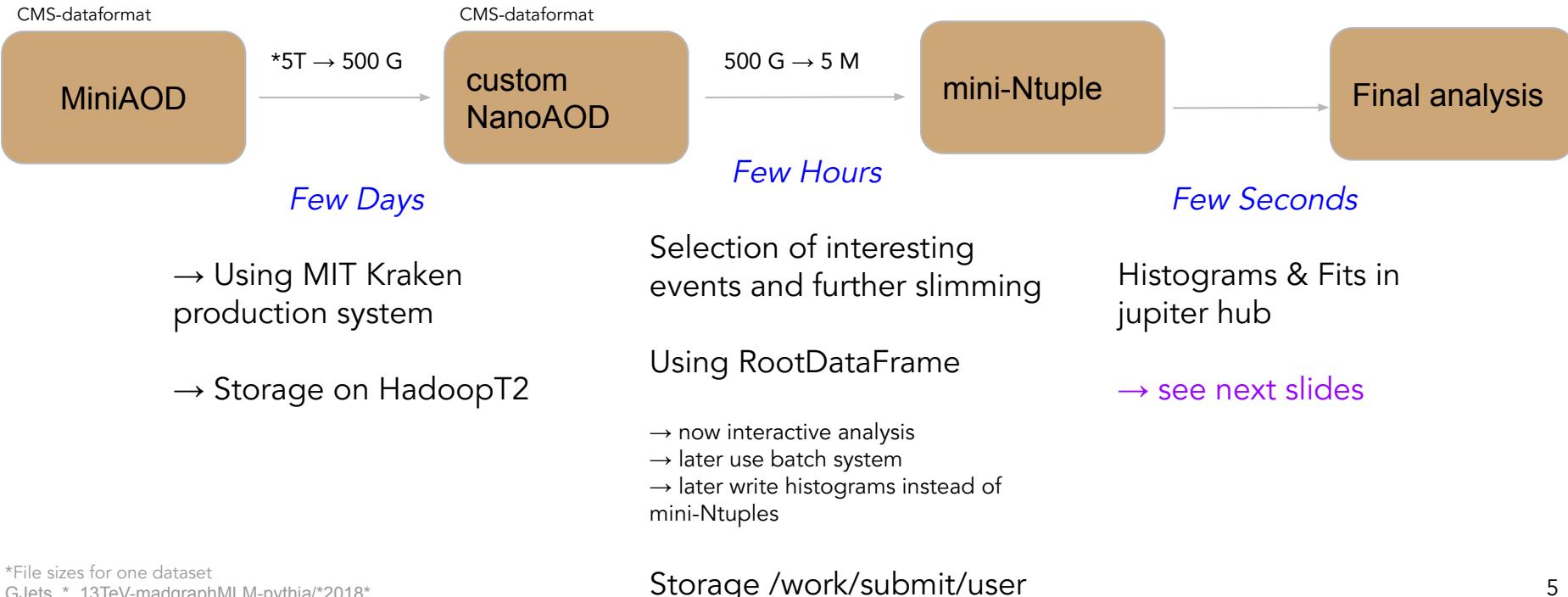


Process

- Simulation
 - Fit background and signal separately
 - Blind signal region for full data set
- Data
 - Apply same techniques
 - Parameters from simulated fits provide starting values for data fits
 - Data comes from three different years 2016, 2017, 2018
- All fits generated with the help of a jupyter notebook created by graduate student K. Yoo



Analysis Workflow

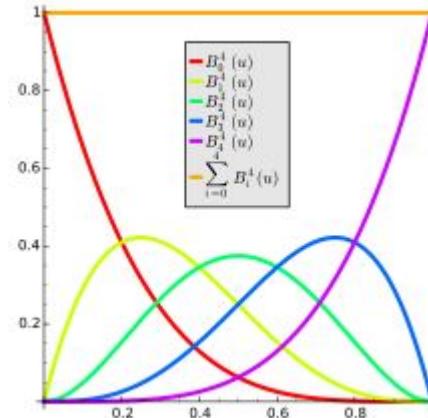
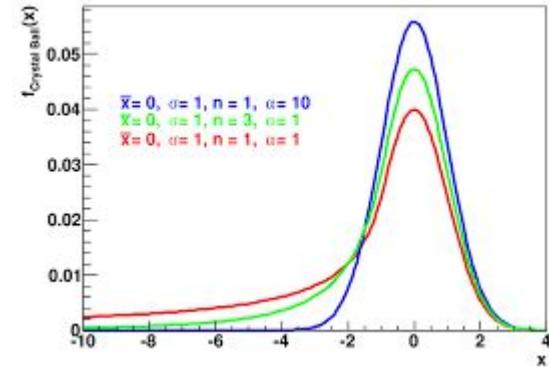


Final Analysis Setup

- Setup submit account
- Install conda
- Create a conda environment
 - Install root with conda forge in that environment
- Open jupyter notebook with [https://submit00.mit.edu/jupyter/user/\[name\]](https://submit00.mit.edu/jupyter/user/[name])
- Data flow
 - Mariarosaria transfers the data to her directory on the submit machine
 - I can access the data from my own account

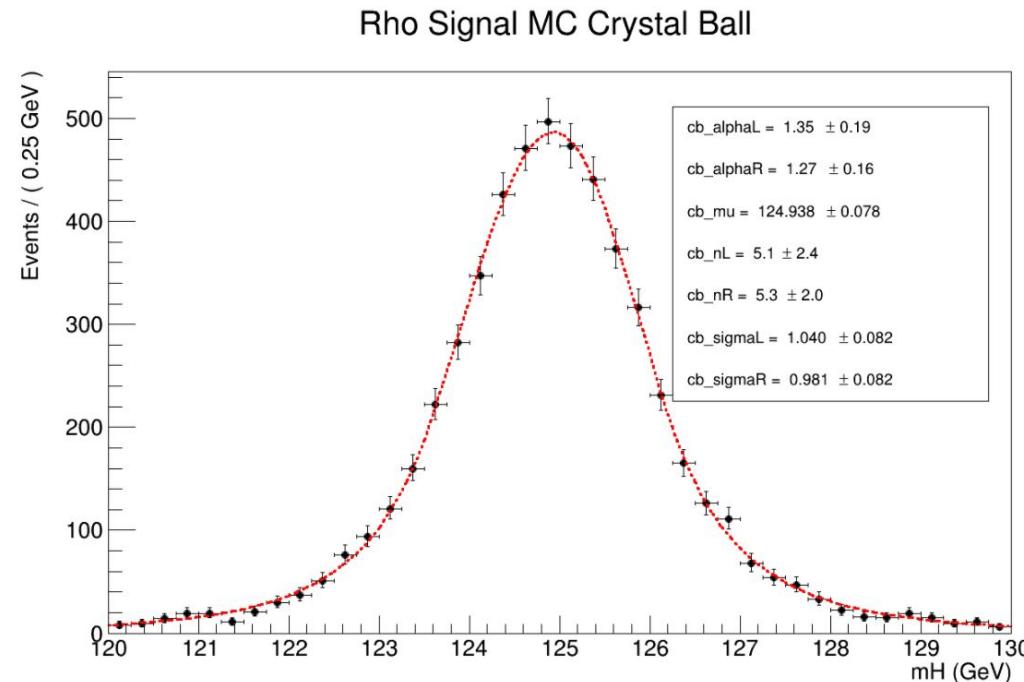
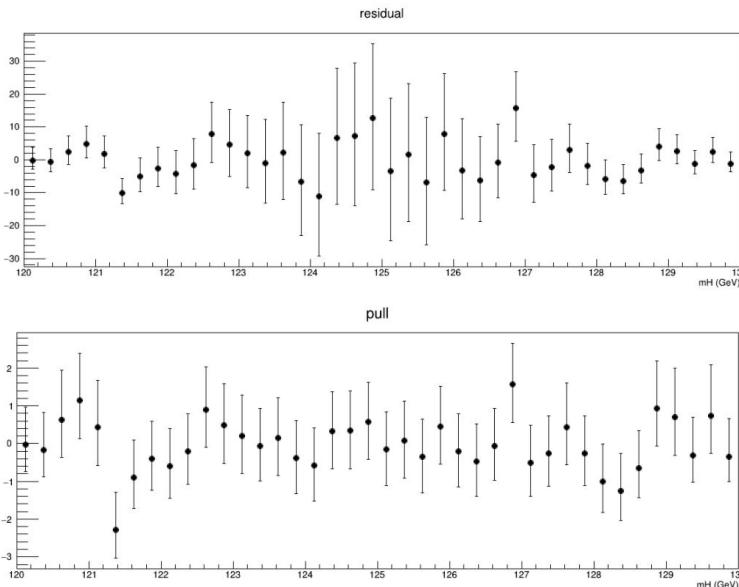
Fit Functions

- Signal - A peak
 - Started with Gaussian fit
 - Moved to a modified Gaussian fit called Crystal Ball fit
- Background - Smooth function
 - 4th order Bernstein polynomial fit convoluted with a Gaussian



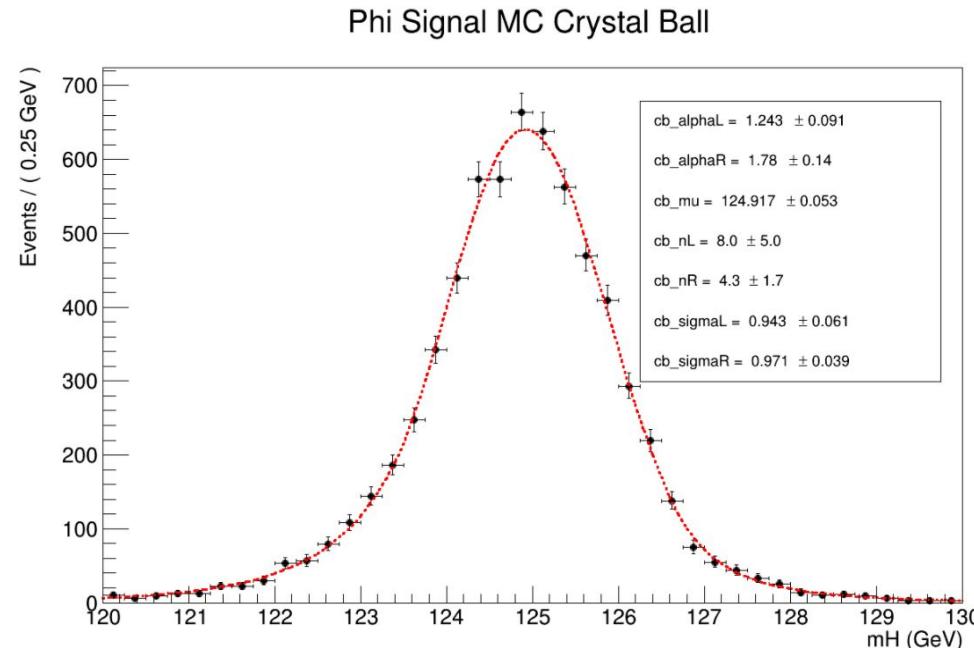
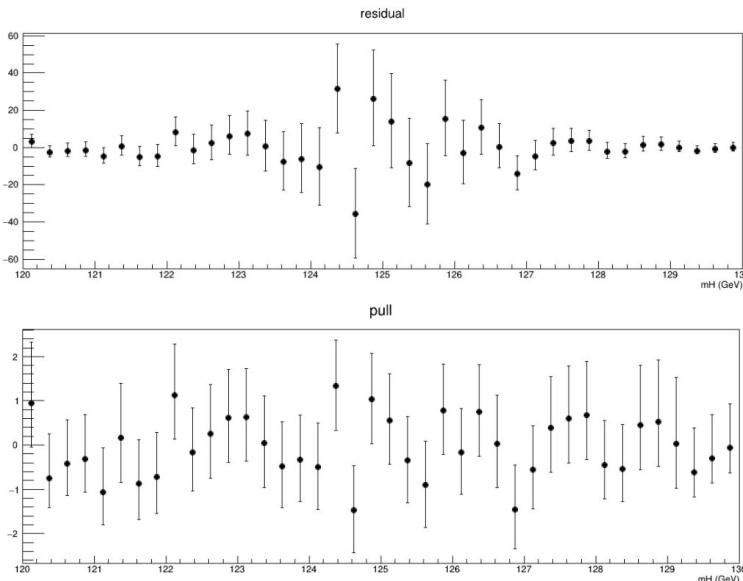
Rho Signal MC Crystal Ball

- xlow/hi: 120/130 nbins: 40
- prob: 0.93



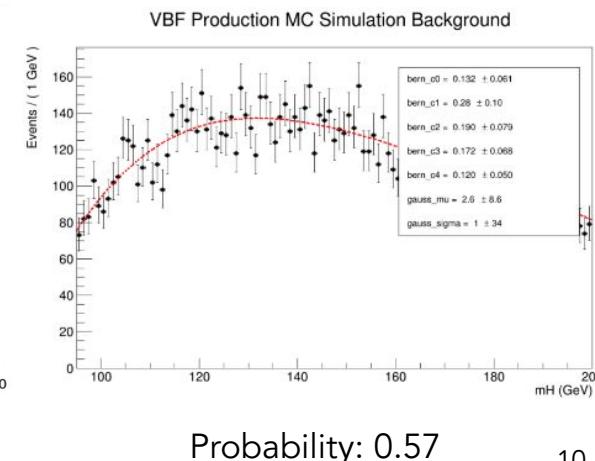
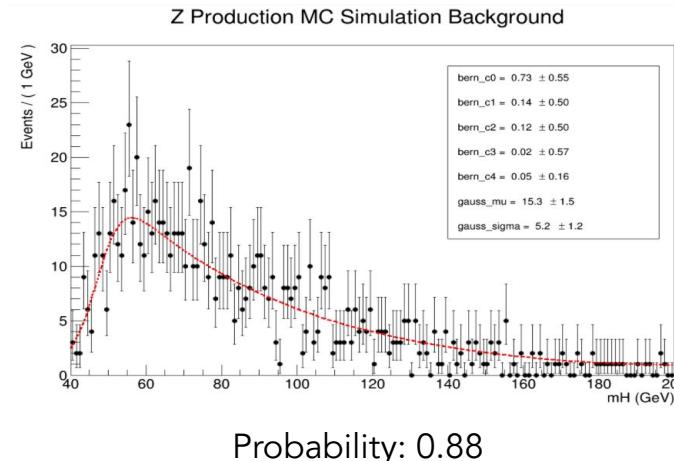
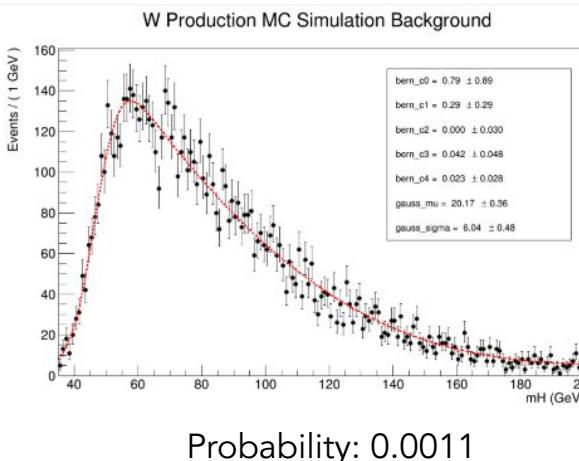
Phi Signal MC Crystal Ball

- xlow/hi: 120/130 nbins: 50
- prob: 0.98



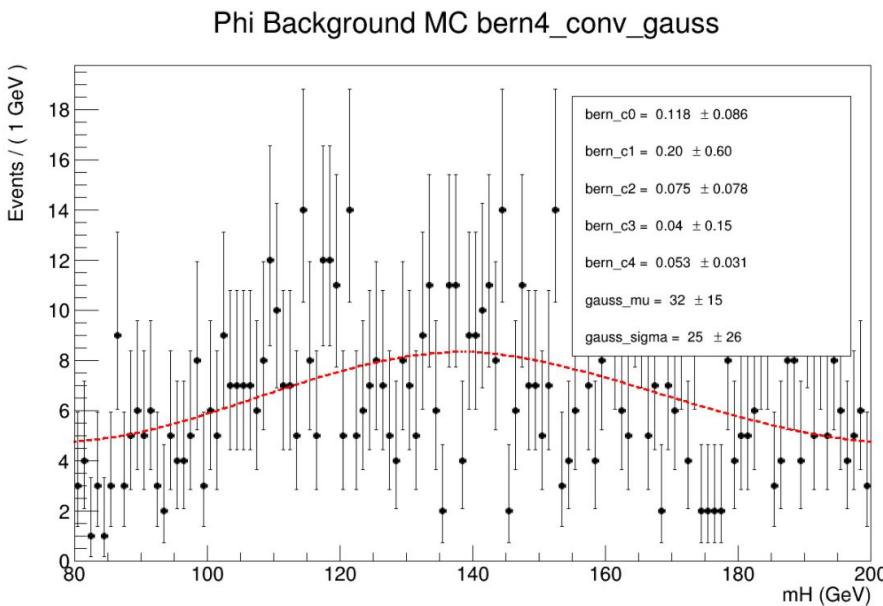
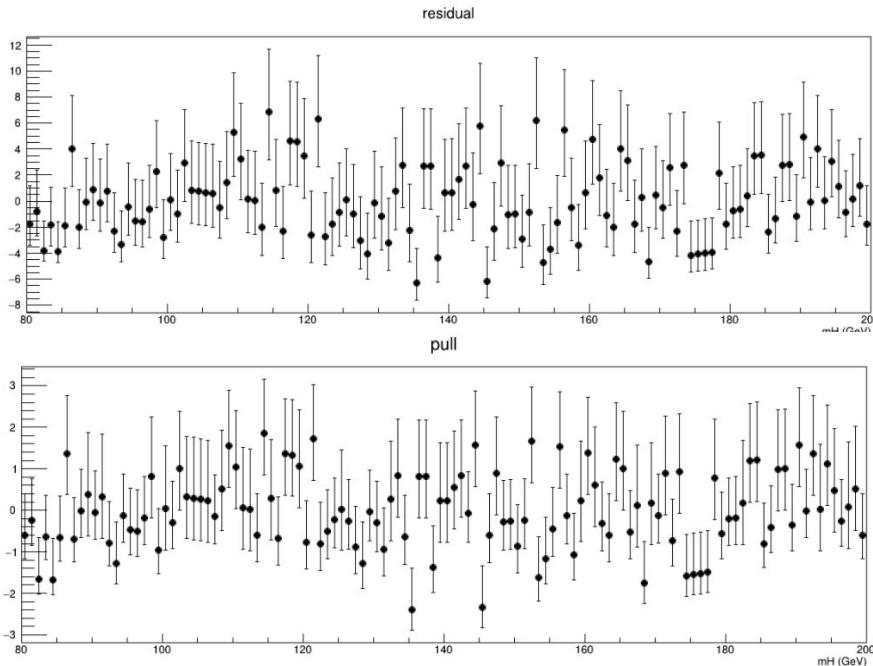
Background

- Replicated previous fits for Z and W production and extended the process for VBF with RooFit
 - chi2FitTo() function
 - 4th degree polynomial convoluted with a gaussian



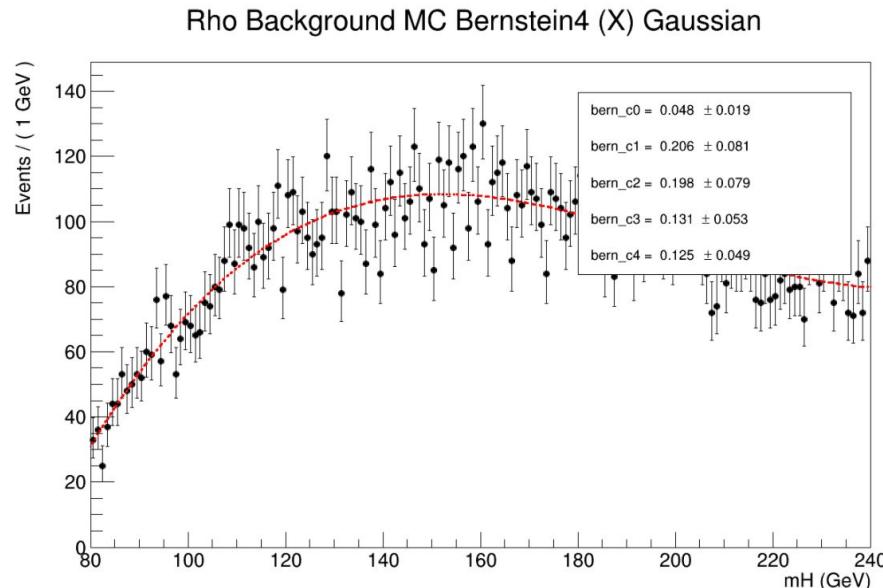
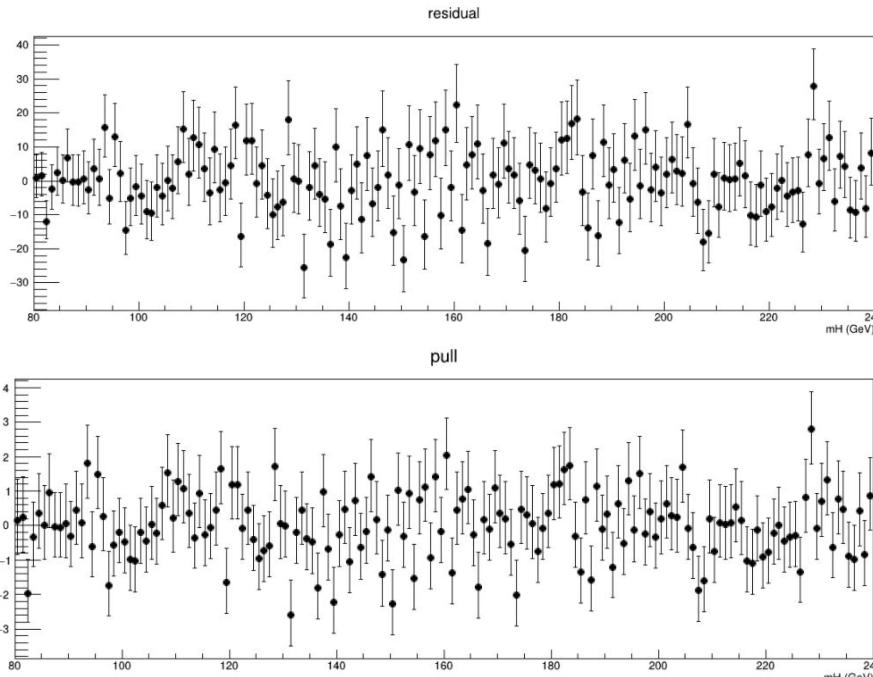
Phi MC Bernstein4 (X) Gaussian

- Probability: 0.35



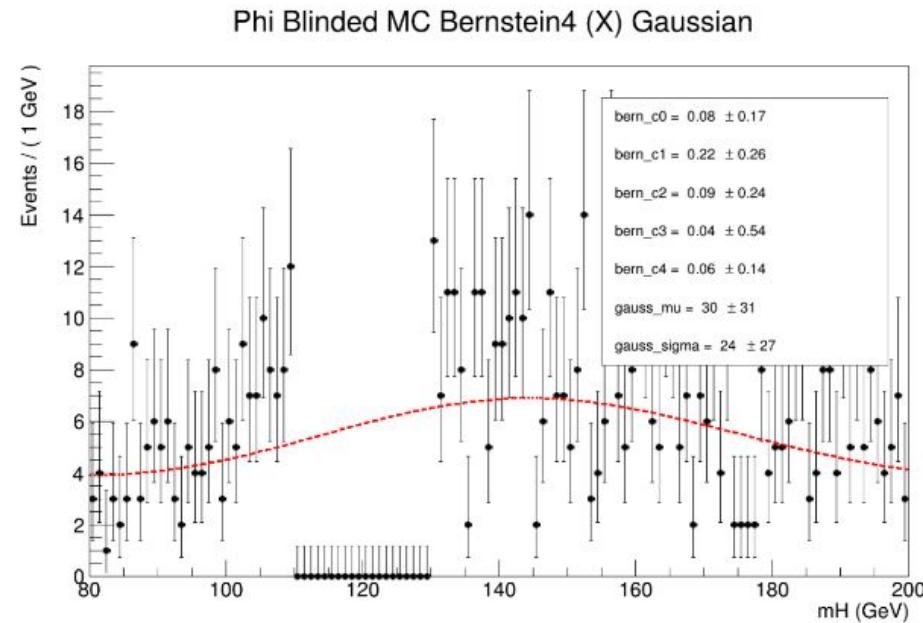
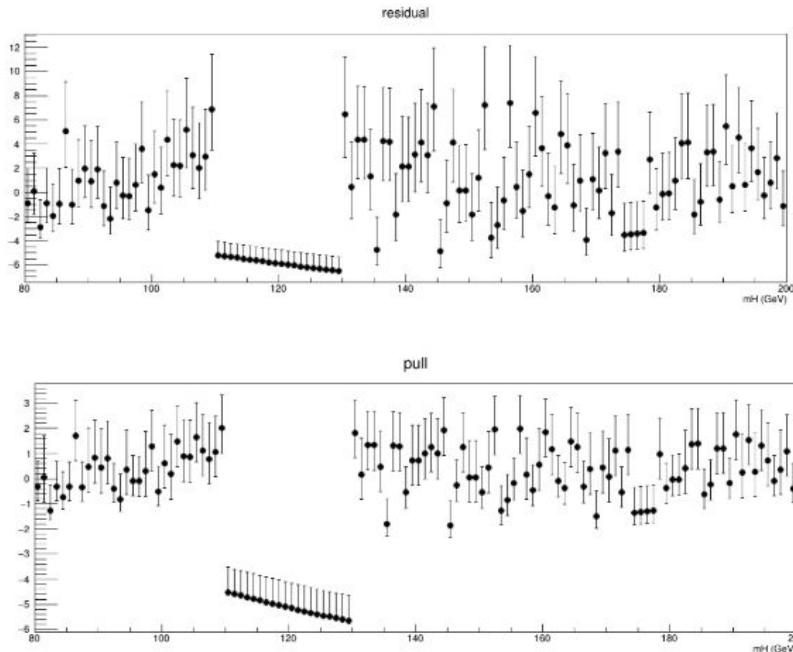
Rho MC Bernstein4 (X) Gaussian

- Probability: 0.409



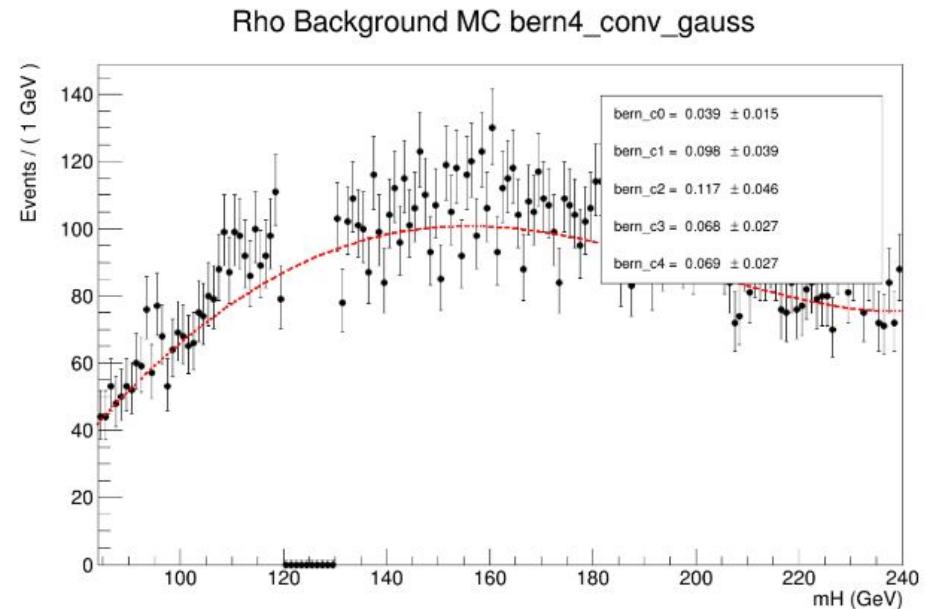
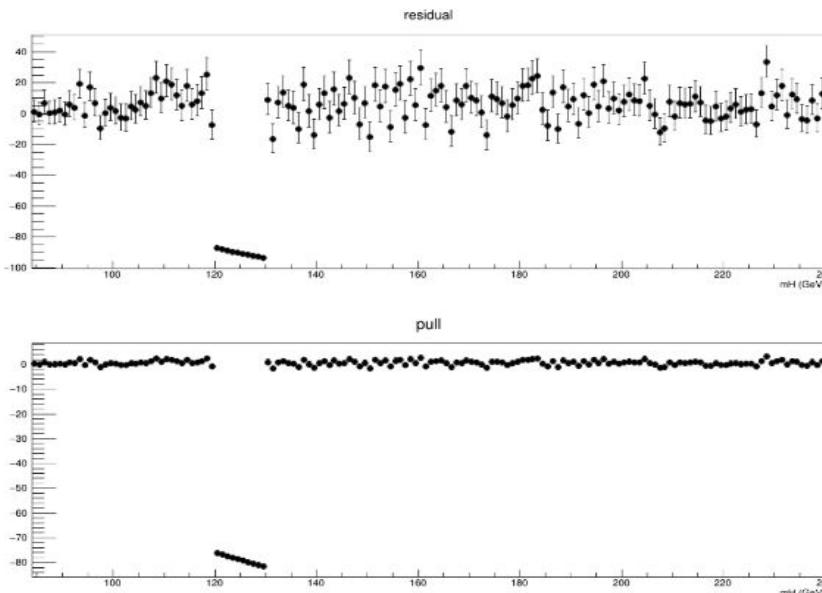
Phi Blinded MC Bernstein4 (X) Gauss

- Probability: 0.0099



Rho Blinded MC Bernstein4 (X) Gauss

- Probability: 0.030



Next Steps

- Fix blinding issue
 - Normalize with respect to the side bands
 - Create separate histograms and fit them together
 - Use another alternative to RooFit
- Apply the same strategies to fit the data



Questions

