Vector-like Leptons

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In this talk:

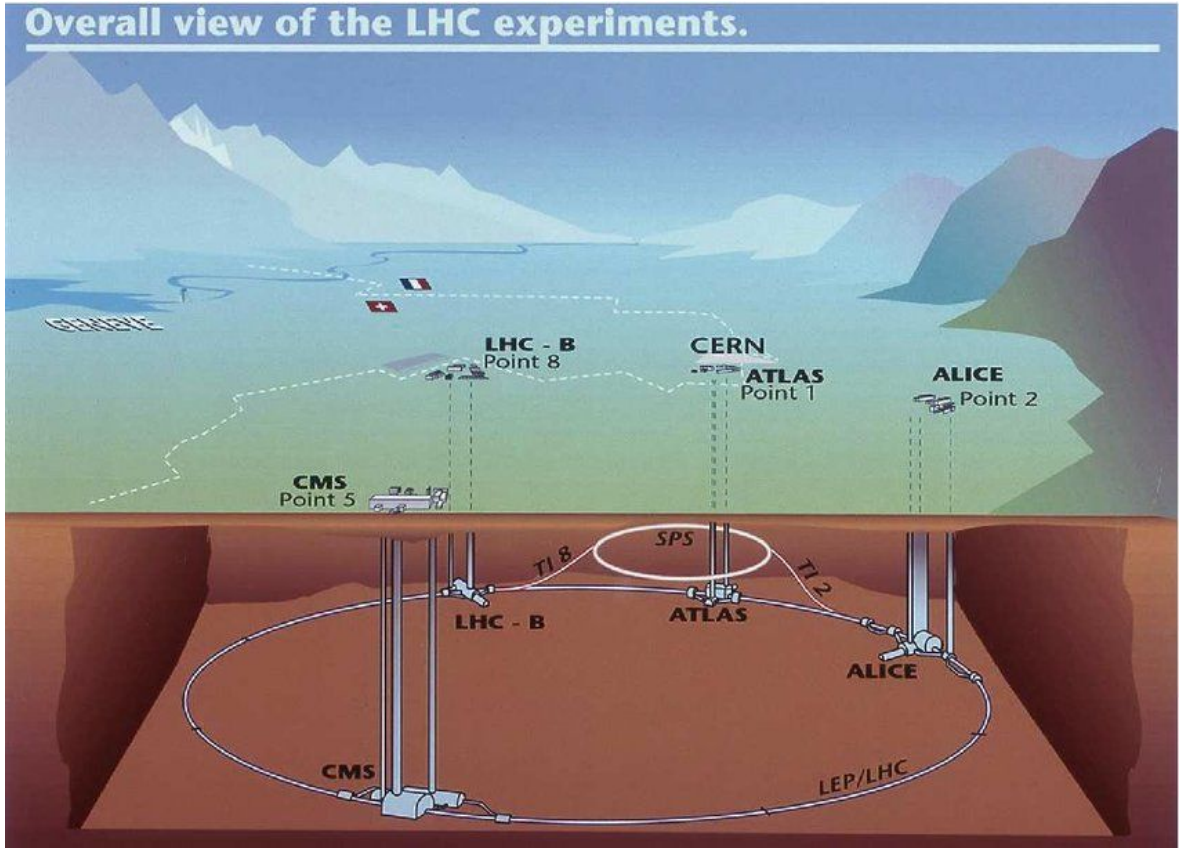
- What are Vector-like Leptons?
- How do we find them?
- What has Brynn been doing all summer?
  - Making Cuts
  - Choosing Signal & Control Regions
  - Checking Confidence Limits

A Quick Reminder:

- Vector-like Leptons (VLLs) are a simple extension to the Standard Model (SM)
- New 4th family of leptons
- Small mixing with SM leptons, mainly taus
- These are the symbols we use to describe them:

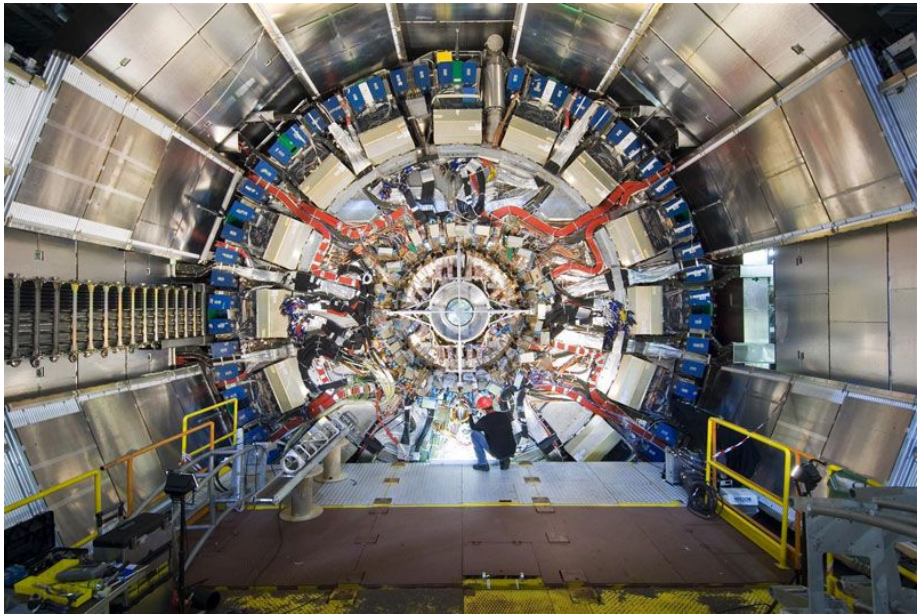
$$\begin{pmatrix} \nu' \\ \tau' \end{pmatrix} + \begin{pmatrix} \bar{\nu}' \\ \bar{\tau}' \end{pmatrix}$$

The Detector at CERN:

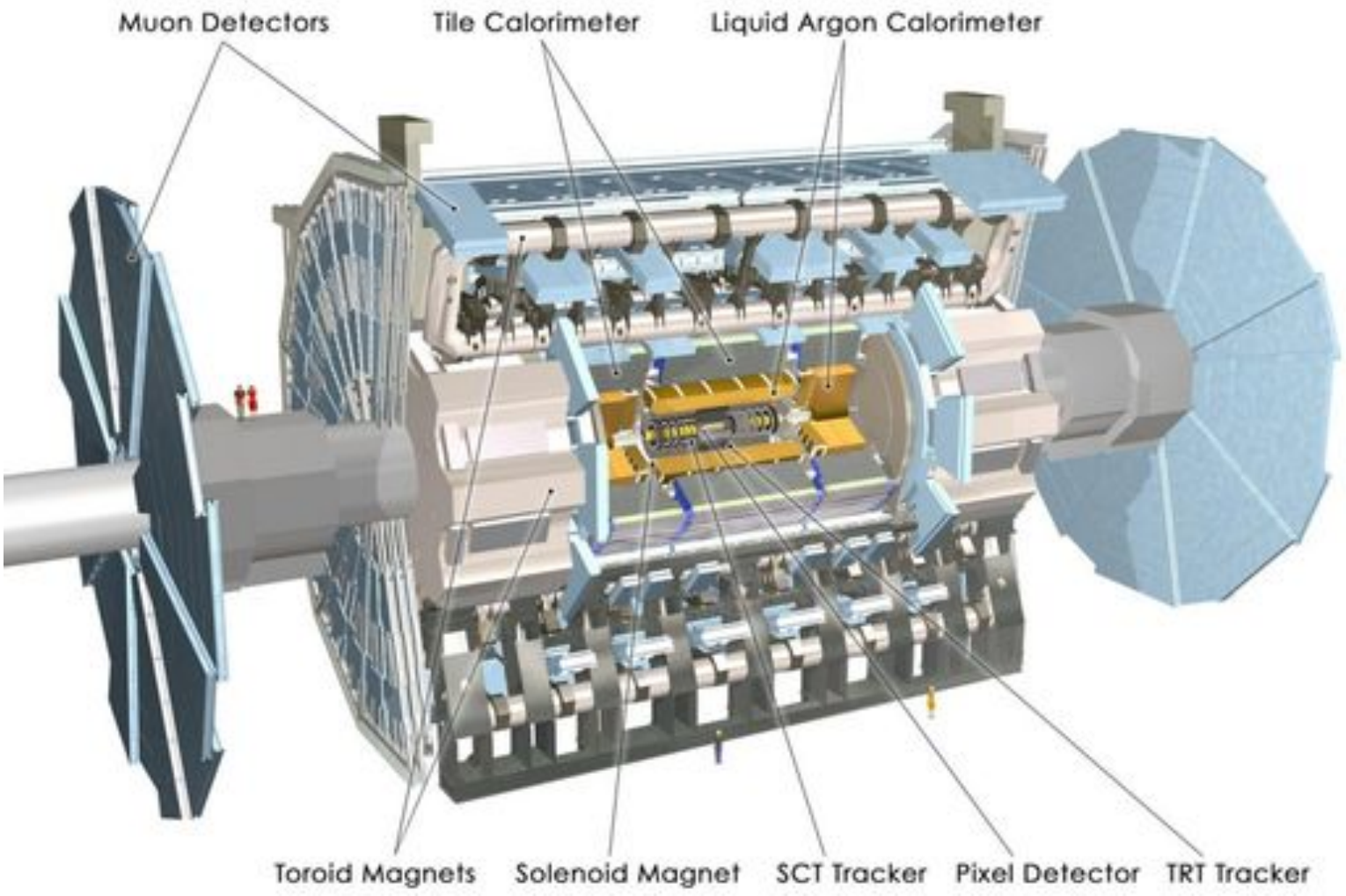


Hardware of the Search:

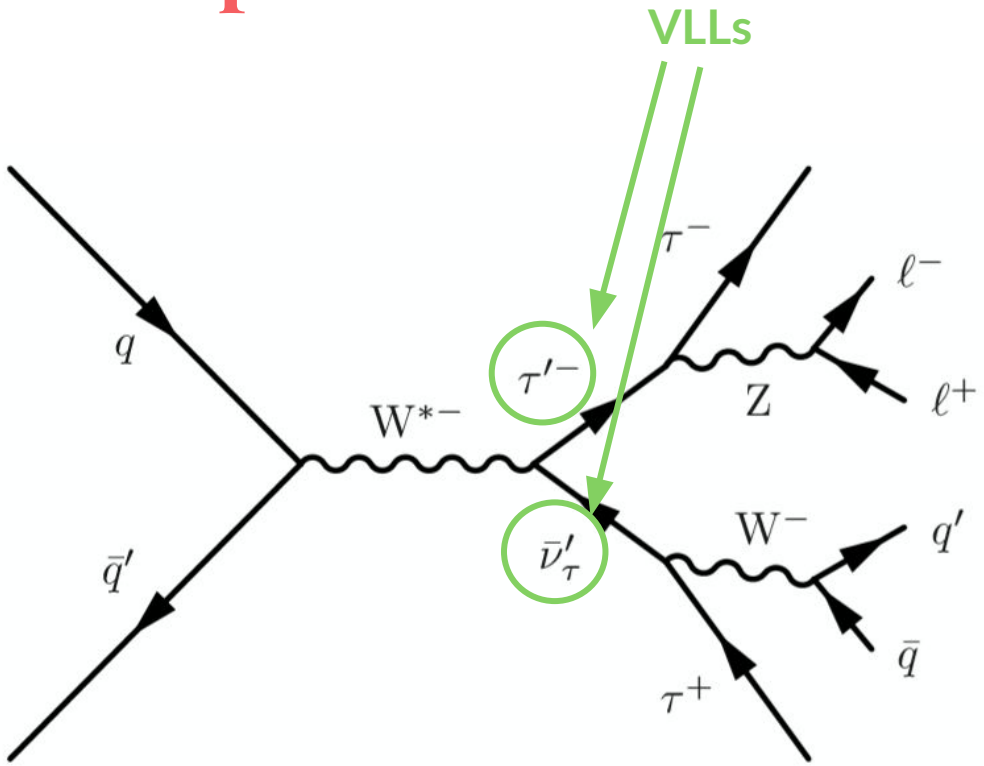
- LHC is the highest energy collider with collisions at a very high rate
- Use proton-proton collisions (pp) in the ATLAS particle accelerator
- Different kinds of detectors designed to look for various particles
- Search for specific decay patterns that would indicate presence of VLL



ATLAS detector, atlas.ch

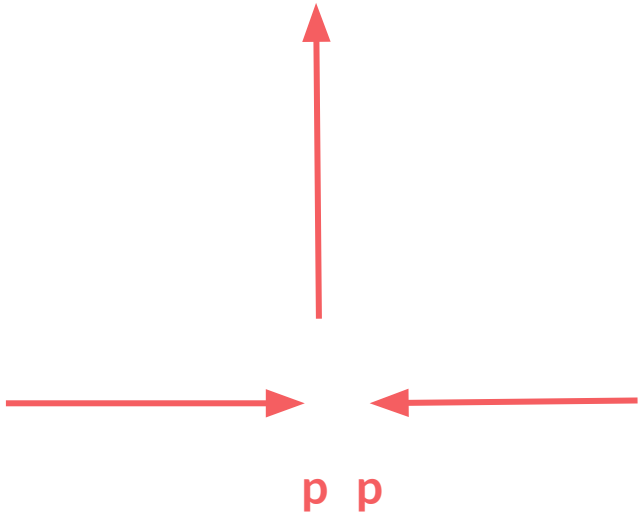

Muon Detectors
Tile Calorimeter
Liquid Argon Calorimeter
Toroid Magnets
Solenoid Magnet
SCT Tracker
Pixel Detector
TRT Tracker

VLL Decay Example:

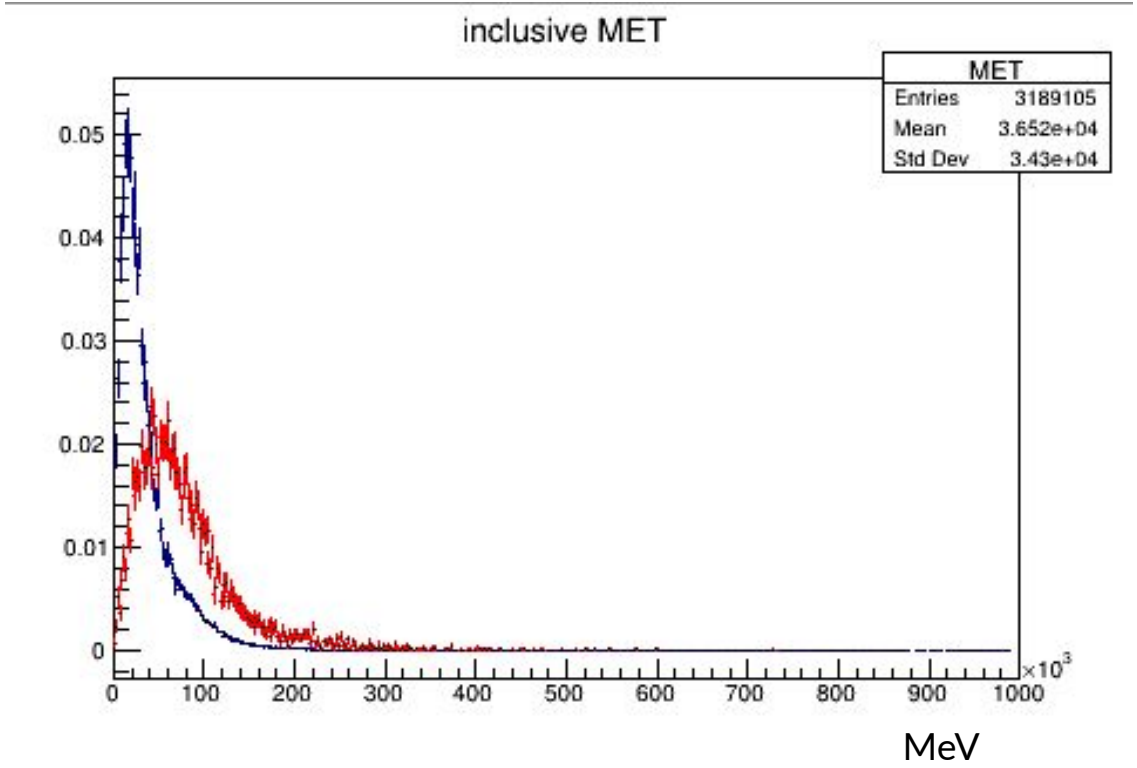


Making Cuts:

- Thousands of events, and only a couple will have what we want. How to sort through the background?
- Make cuts! Cuts on missing ET and LT
- Want to be able to distinguish the signal from the background ...

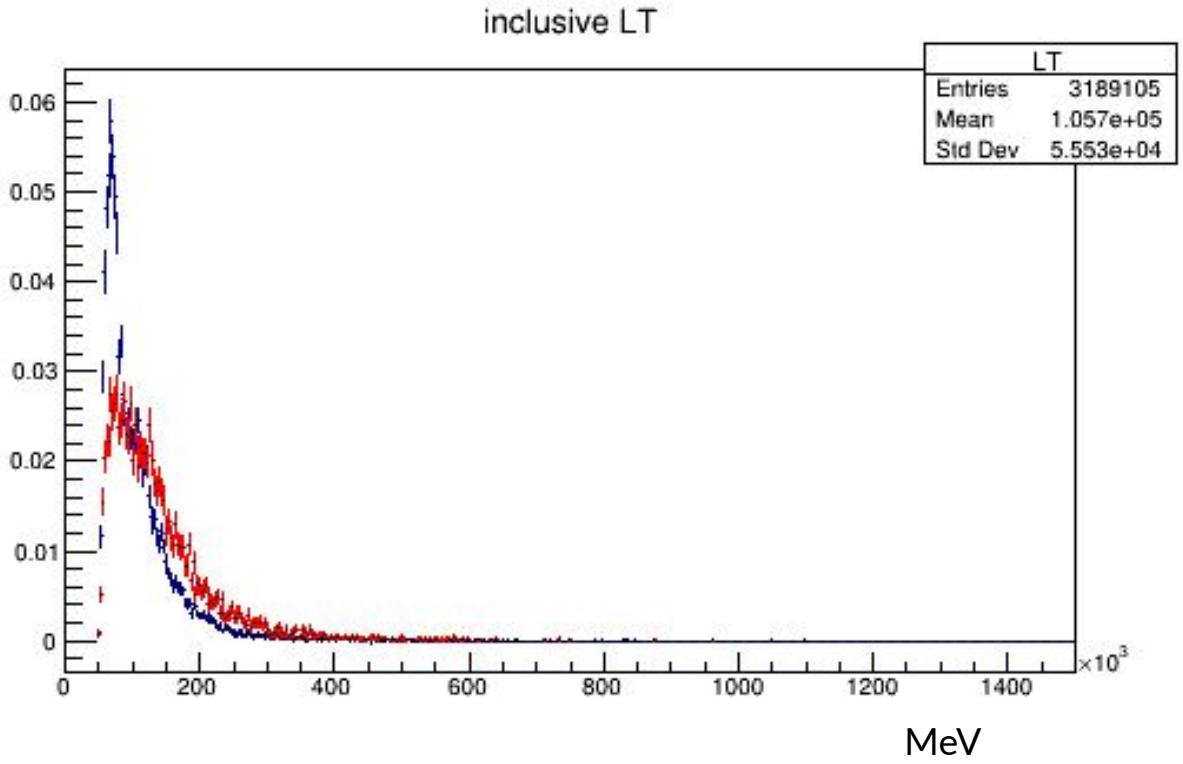


MET Signal v. Background:



Key:
Background
Signal

LT Signal v. Background:



Key:
Background
Signal

Signal Regions & Control Regions

- Signal Regions are certain combinations of cuts and leptons that are well-suited to showing the signal (the data where hopefully VLLs are)
- Control Regions are certain combinations of cuts and leptons that give us confidence in our predictions about background
- 5 backgrounds: top, diboson, multiboson, w-jets, and z-jets

2emu_0ta 2emu_1ta 2emu_2ta

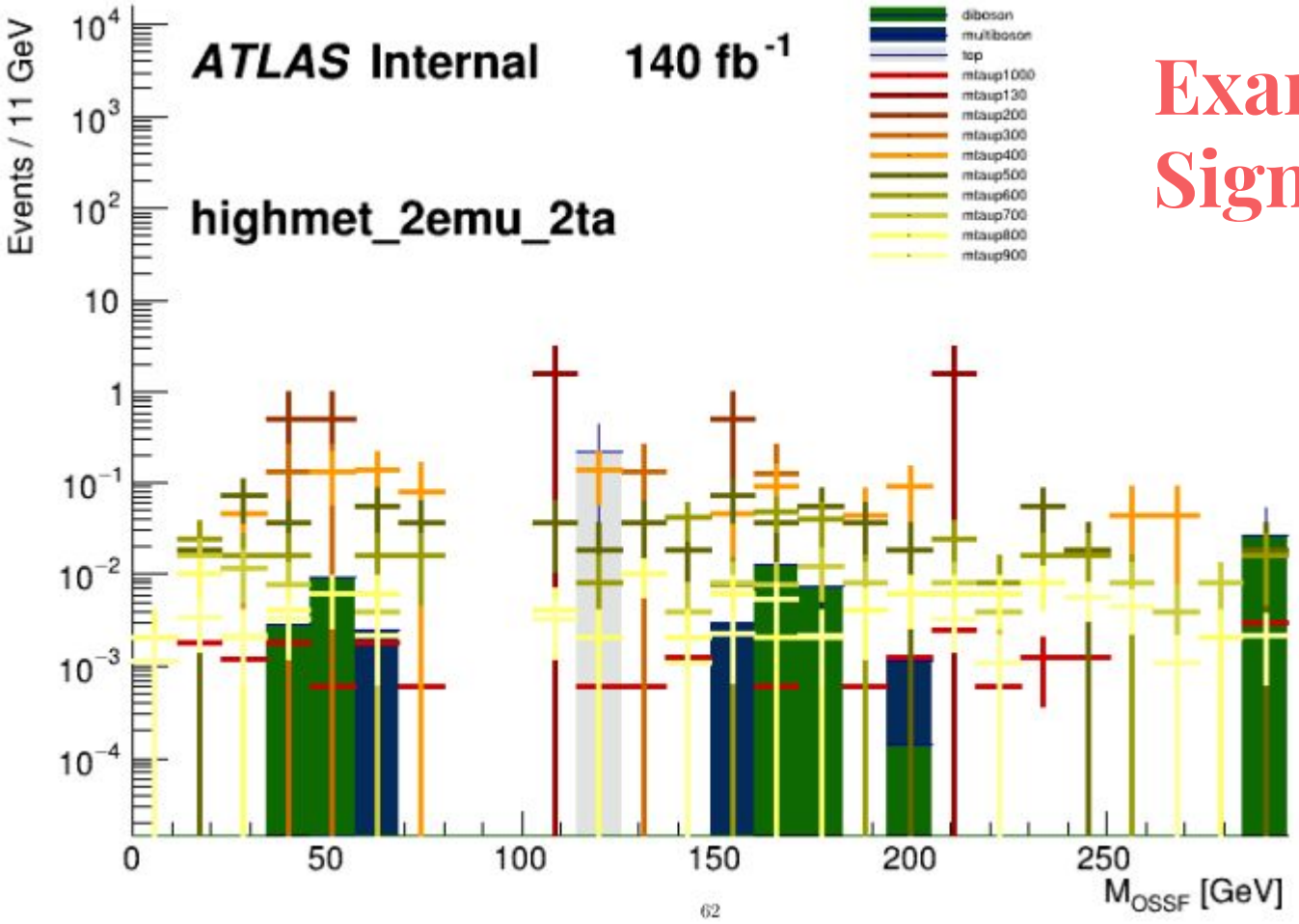
3emu_0ta 3emu_1ta 4emu

Choosing Control Regions:

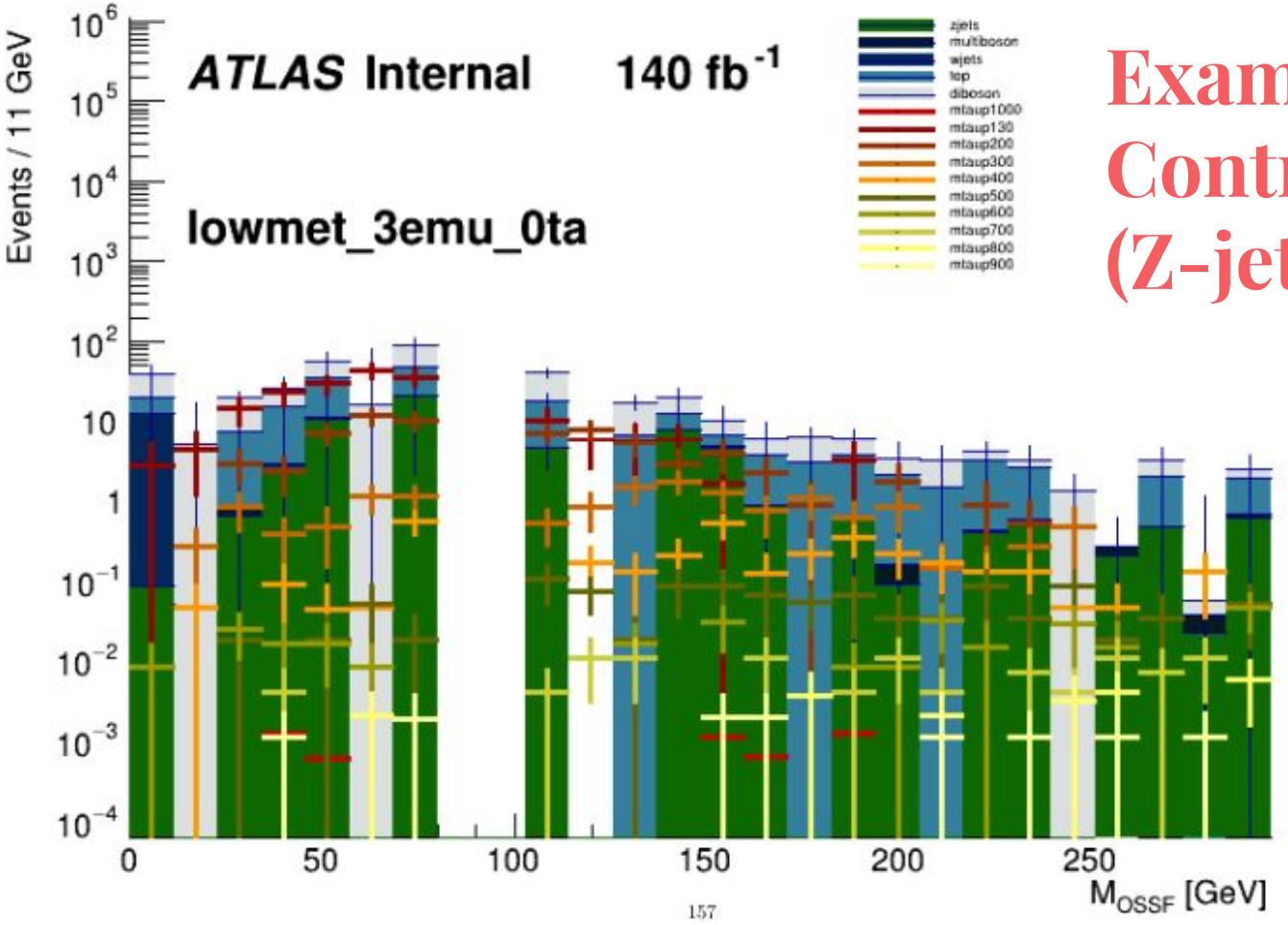
- What backgrounds need a control region?
- “Yield” of a background tells us how many events occurred for that background within a region

TOP	high MET	medium MET	low MET
2emuNOOSSF_0ta	4590.06	71635.9	43523.3
2emuOSSF_0ta	2607.58	34876.1	20507.7
2emuNOOSSF_1ta	79.7376	0	548.867

MULTIBOSON	high MET	medium MET	low MET
2emuNOOSSF_0ta	7.75663	29.9929	14.6389
2emuOSSF_0ta	2.44936	11.7922	5.49061
2emuNOOSSF_1ta	2.0783	0	7.67195



Example: Signal Region



Example: Control Region (Z-jets)

My Regions

Signal Regions (high MET):

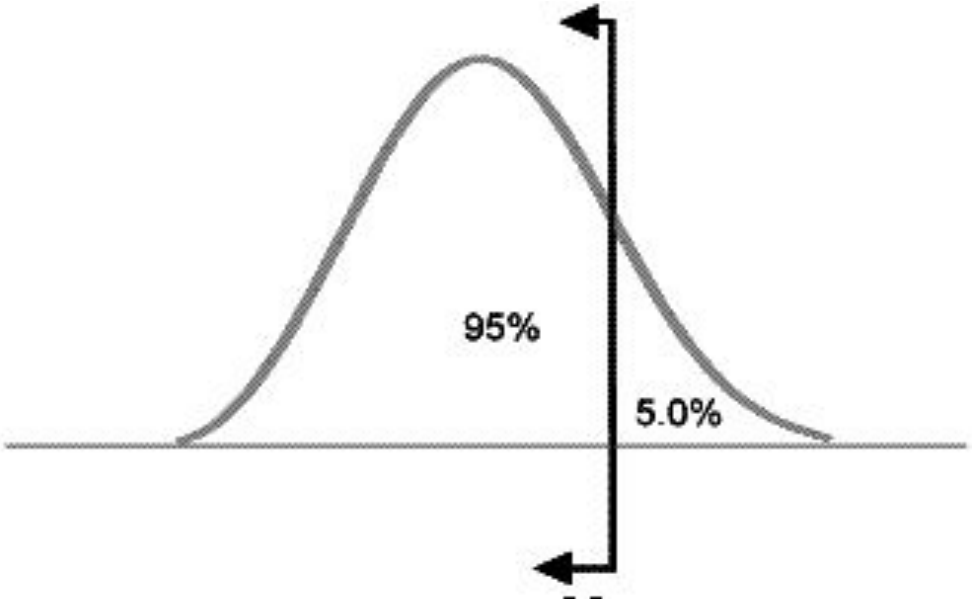
- 2emuNOOSSF_1ta
- 2emuOSSF_1ta
- 2emu_2ta
- 3emu_0ta
- 3emu_1ta
- 4emu

Control Regions:

- lowmet_2emuNOOSSF_0ta for z-jets
- medmet_2emuOSSF_0ta for top

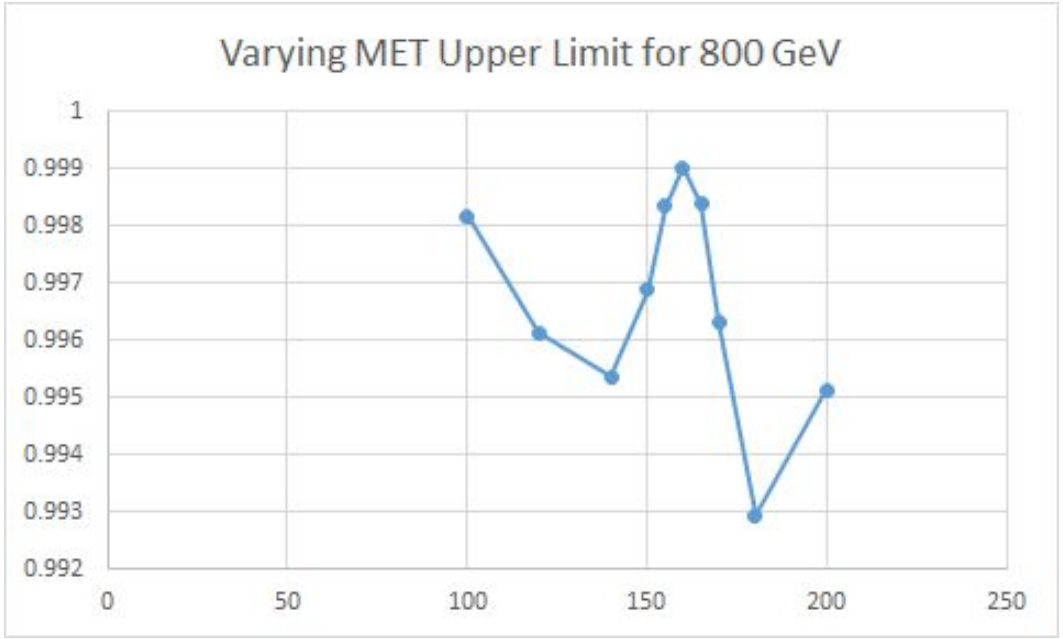
95% Confidence Limit:

- Measure by which we evaluate how sensitive we are to VLLs in a run
- Compares the simulated data to expected data
- Compare many confidence limits from different cut-combinations to see which combination produces the best confidence limit



Optimization

- Running the code many times with different cuts to see which is the most sensitive to VLLs
- Changing the upper limit for MET for tau prime mass of 800 GeV
- Can see peak around 150 to 160 MeV, that is where we keep the limit at now



That’s all, folks! Questions?