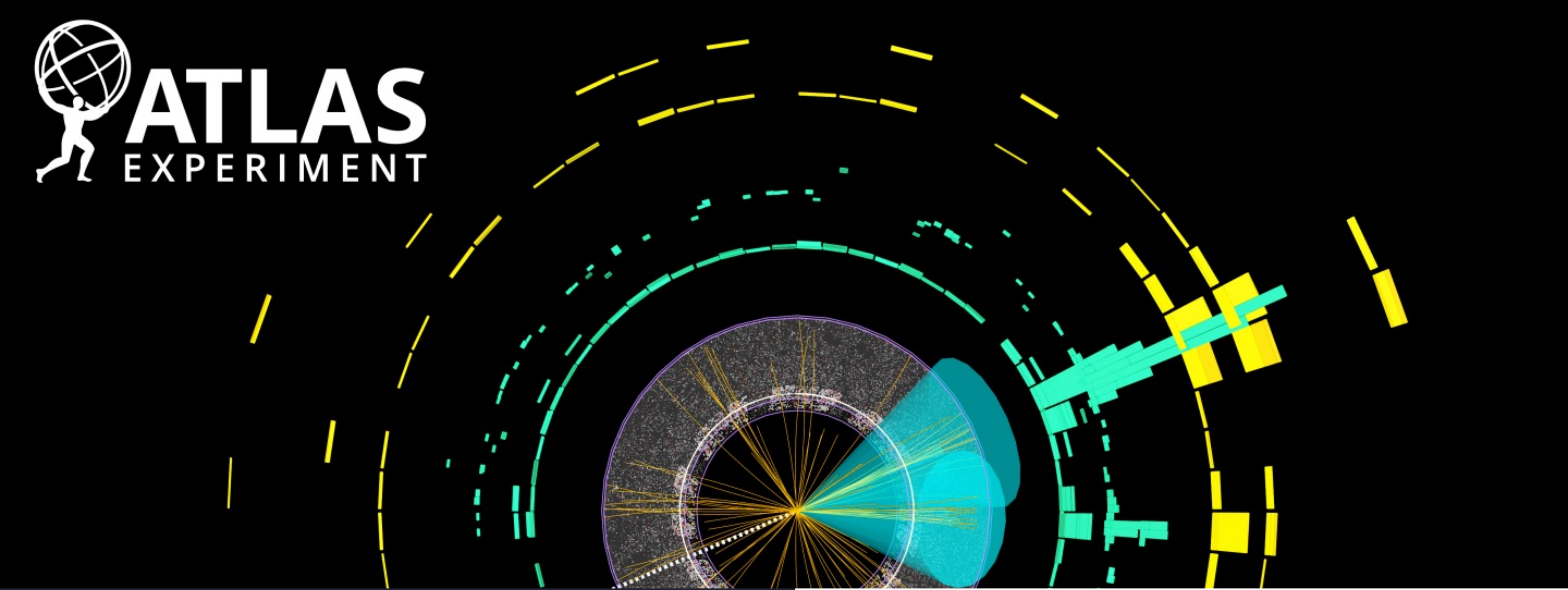

H → c c~:
Higgs-Charm Coupling

Dr. Chung Kao

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Alec Piccone

Particle Mass and the Higgs Boson

- Fundamental particles obtain mass by interacting with the Higgs field
  - Stronger the interaction, greater the mass obtained
  - More massive particles are more strongly ‘coupled’ to the Higgs field
- Higgs boson: scalar (spin-0) boson associated with Higgs field

-SO-

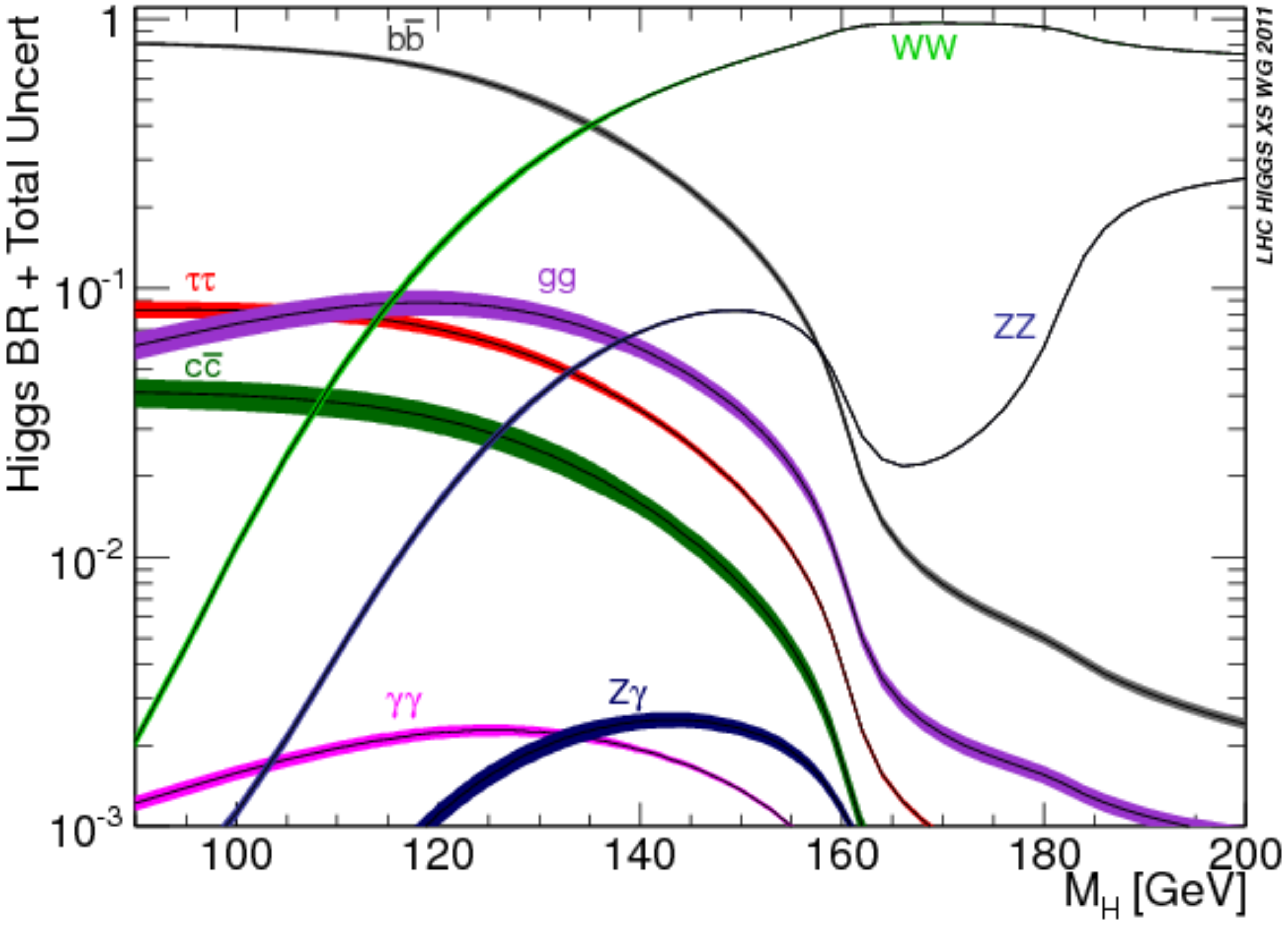
- More massive particles couple more strongly to the Higgs boson
- In other words: more massive particles are more likely to be created during H decay

(see next)

Higgs Branching Ratios

Branching ratio/fraction:

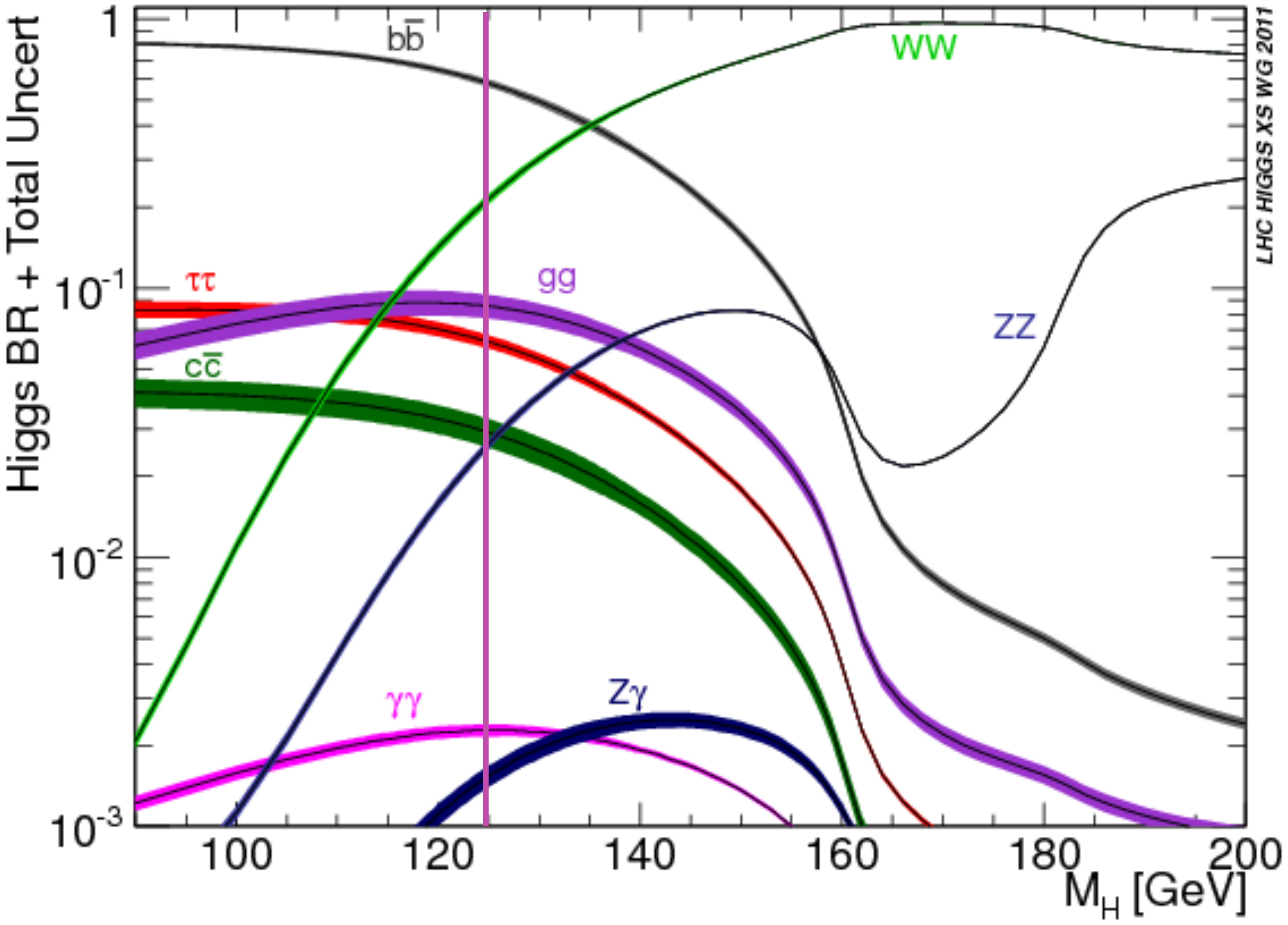
- Frequency with which a decay occurs (how probable it is)



Higgs Branching Ratios

Branching ratio/fraction:

- Frequency with which a decay occurs (how probable it is)



Higgs Branching Ratios

Branching ratio/fraction:

- Frequency with which a decay occurs (how probable it is)

- Larger branching ratio -> Stronger signal?
  - Yes, BUT:
- Background for most quark decays is large
  - Many collisions and decays can produce quarks
  - Finding a signal in such a large background can be very difficult
- Uncommon decays can sometimes be more practical
  - Ex: $h > \gamma\ \gamma$
- **Eliminating background while preserving signal is key in analyses**
  - Efficient data selection is important

Simulation Procedure: Event Generation

```
*************************************************************
*                                                           *
*                     W E L C O M E  to                     *
*              M A D G R A P H 5 _ a M C @ N L O            *
*                                                           *
*                                                           *
*                 *                       *                 *
*                   *        * *        *                   *
*                     * * * * 5 * * * *                     *
*                   *        * *        *                   *
*                 *                       *                 *
*                                                           *
*         VERSION 2.6.5                 2018-02-03          *
*                                                           *
*    The MadGraph5_aMC@NLO Development Team - Find us at    *
*    https://server06.fynu.ucl.ac.be/projects/madgraph      *
*                            and                            *
*            http://amcatnlo.web.cern.ch/amcatnlo/          *
*                                                           *
*               Type 'help' for in-line help.               *
*           Type 'tutorial' to learn how MG5 works          *
*    Type 'tutorial aMCatNLO' to learn how aMC@NLO works    *
*    Type 'tutorial MadLoop' to learn how MadLoop works     *
*                                                           *
*************************************************************
```

MadGraph5_aMC@NLO

- Collision simulation
- Generates specific processes
  - p p > z h, z > l+ l-, h > c c~
  - p p > w+ h, w+ > l+ vl, h > c c~
  - p p > w- h, w- > l- vl~, h > c c~
- Can modify input parameters, including:
  - Number of events
  - Particle masses
  - Parton Distribution Function (PDF)
- Collides fundamental particles (an issue)

Simulation Procedure: PYTHIA 8, Delphes

PYTHIA 8

- 'Hadronization'
  - Converts free partons in MG5 output to hadrons
  - Showering
    - Creates jets of energized particles
    - Think electrons dropping to lower energy level
- Data still doesn't look right…

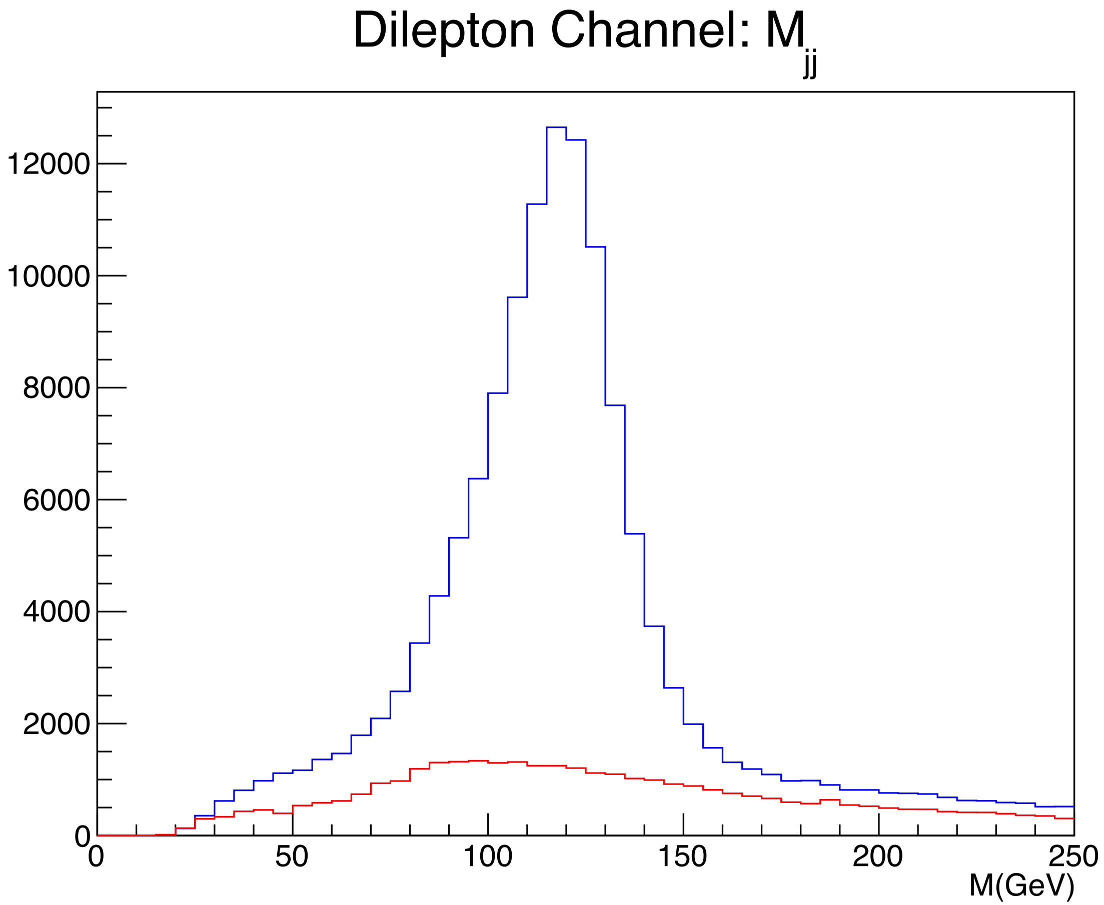
Delphes

- Detector Simulation
  - Detectors aren't perfect, accounts for this
    - Particles with low angles relative to the beam axis pass through undetected
    - Some particles misidentified outright
- Simulated collisions look more like actual data
- End result: ROOT file

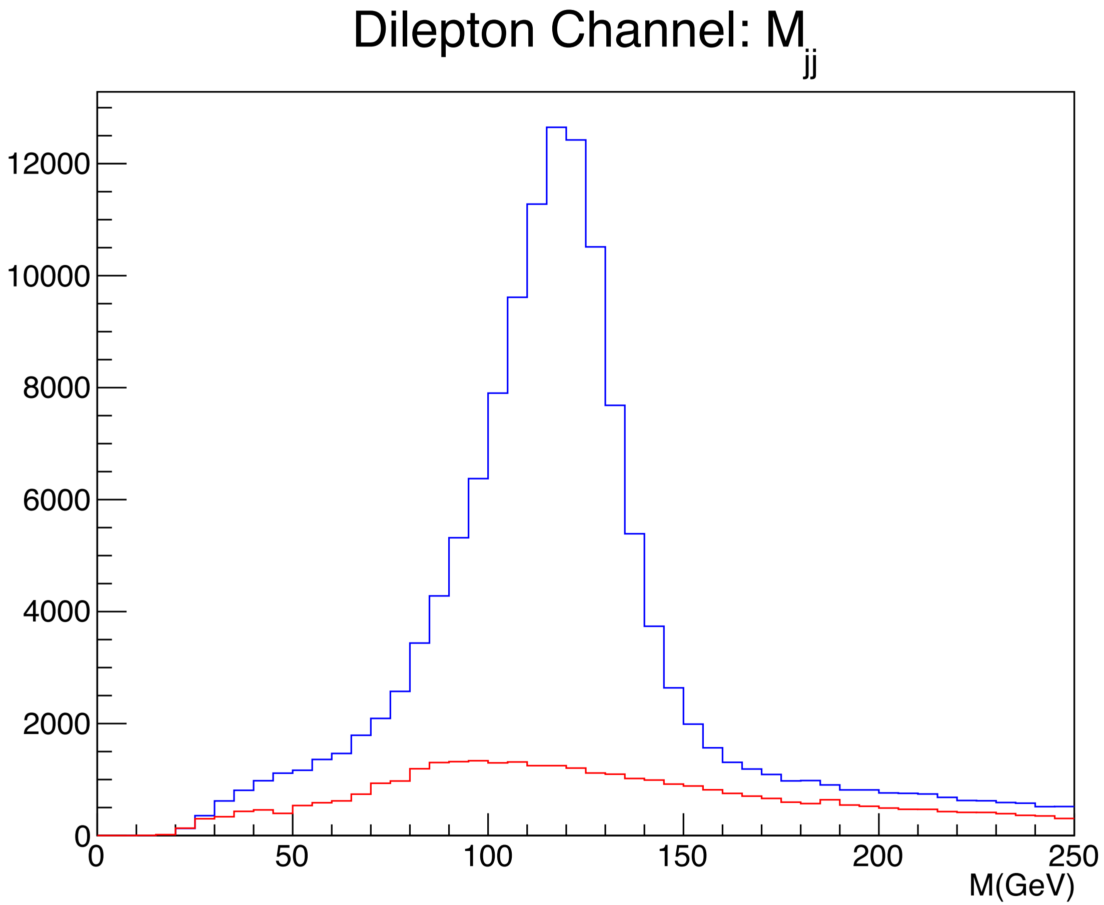
ROOT File Analysis

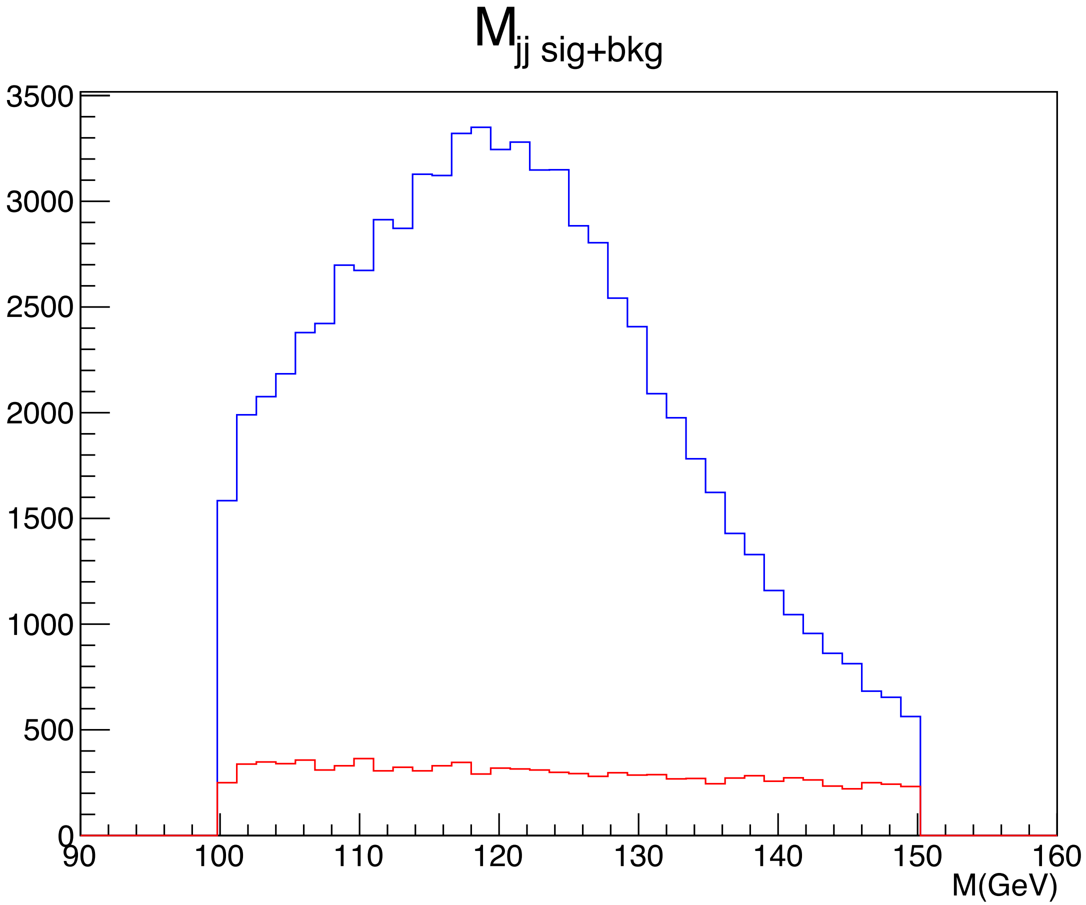
- ROOT files contain information ‘gathered’ from toy detector
- This data needs to be pared down (‘cut’)
- For H → c c~, cuts include (but not limited to):
  - Number of b-tagged jets
  - Invariant dilepton mass (ZH only)
  - Missing ET (WH only)
  - η and ΔR
- Add up all the events that qualify and plot histograms…

ROOT Analysis cont.



ROOT Analysis cont.





Questions?

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