Higg's width: 10/17/18

- Higgs vs Z: Z decays faster bc of widths
- Why do we care about width? SM test ie does the Higgs couple to other things outside of the SM
- Lighter than Higgs dark sector particles decays
- Starting with direct search of Higgs width (mass measurement)
  - How do we directly measure width? First discussing signal modeling
  - Crystal ball function models detector response of mass spectrum
  - To measure width, convolve Breit-Wigner (NR) with detector resolution, usually crystal ball
  - Note crystal ball assumes Higgs has 0 width (bc Higgs width ~4 MeV is very small)
  - Are mass and width correlated? Yes, b/c for a certain Higgs mass, width is (theoretically) determined.
  - Best fit (profiling likelihood ratio)
    - Ratio of conditional fit (only width floats)/(width + mass floats)
    - For 4 lepton channel, note that difference in expected to observed widths are different b/c signal strength is different (mu = 1.66 in this channel)
  - How to improve? Increase detector resolution mainly (theoretical uncertainties actually small in direct measurement case)
- Lifetime Measurement
  - How far does it go?
  - Lifetime is defined based on width hbar/Gamma
  - Try and measure displacement of Higgs to 4l vertex
  - Detector resolution smears out Higgs decay position
  - Measured ct = 2mum -> limit at 95% CL of ct = 56mum
  - Modeled by taking Higgs samples with different lifetimes in steps of 10 microns, interpolating between points, and doing profile likelihood to get best fit
  - Know that detector modeling for width is nonlinear function here
  - This measurement is NOT sensitive to anomalous couplings b/c this does not depend on signal strength