Φ^{++} phenomenology discussion

Model

- The model is designed to explain neutrino masses through a scalar triplet
- This means there are three components:
  - Φ^{++}, Φ^{+}, Φ^{0}
- So far most experiments have only searched for the doubly charged component
- CMS has used the singly charged in associated production

Production

- Drell-Yan pair-production the most common
  - Production of $\Phi^{++}\,\Phi^{--}$, cross section model independent and well known (M. Spira et al have computed @ NLO)
  - Synchronized for 7 TeV between CMS and ATLAS
  - Need to re-sync for 8 TeV and later for 13/14 TeV

- Associated production
  - pp -> W* -> $\Phi^{++}\,\Phi^{-}$
  - Cross section at LHC ~2x higher than pair-production
  - No common cross section calculation, CMS estimated from LO CalcHEP with pair-production k-factor as an approximation, need precise calculation

- Pair-production of singly charged component
  - Very likely 0.25x of pair-production of doubly charged components due to charge difference, but need to compute

- VBF channel pp -> $W^{+}W^{+}$ +jets -> Φ^{++} +jets
  - Tough to see as requires high vev value and tension, but possibly of interest

Decays

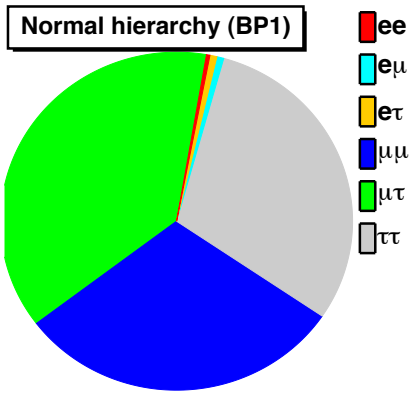
- Decay predominated by mass relation:
  - $M_{ij} = Y_{ij} \langle v \rangle$ where M_{ij} is $O(10^{-10})$ GeV
  - Either <v> is tiny or Yukawa's are

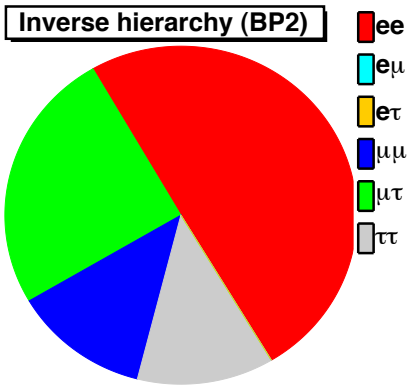
- If $\langle v \rangle > 10^{-5}$ GeV, then main decay to bosons ($\Phi^{++} \rightarrow W^+W^+$, $\Phi^+ \rightarrow W^+Z^0$…)
- If $\langle v \rangle < 10^{-5}$ GeV, then main decay to leptons (flavor violation allowed)
- <v> upper bound from ρ is $\langle v \rangle < 1$ GeV

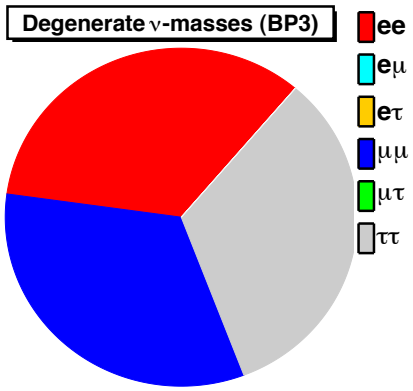
- Looking at just 100% decays to one channel reduces searched parameter space considerably (very improbable to get 100% to one channel from neutrino physics)
- Possibility of cascade decays ($\Phi{+}{+} \rightarrow \Phi^+ \Phi^+$ / $\Phi^+ W^+ \rightarrow \Phi^0$ … or other way around) if triplet is not degenerate however that has strong implications on precision physics

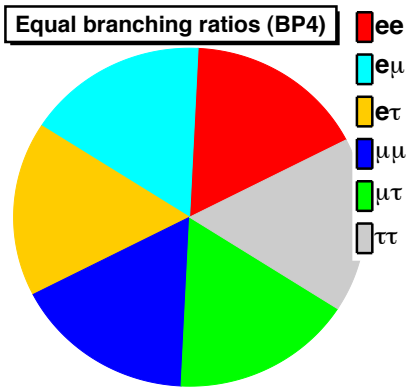
Benchmark points

- CMS has defined 4 benchmark points:
  - BP1 describes the neutrino sector with normal mass hierarchy and a massless lightest neutrino, $m_1 = 0$ eV.
  - BP2 describes the same but with the inverse mass hierarchy
  - BP3 represents a degenerate neutrino mass spectrum with $m_1 = 0.2$ eV
  - BP4 represents the degenerate case in which all Φ^{++} branching fractions are equal.









What is needed

- Common cross sections for various production mechanisms
- Common benchmark points for leptonic decays to try to cover a wide range of final state hypotheses
- Of course that assumes both experiments are interested in expanding the scope of this search