

Search for SUSY with low MET, all-hadronic signature

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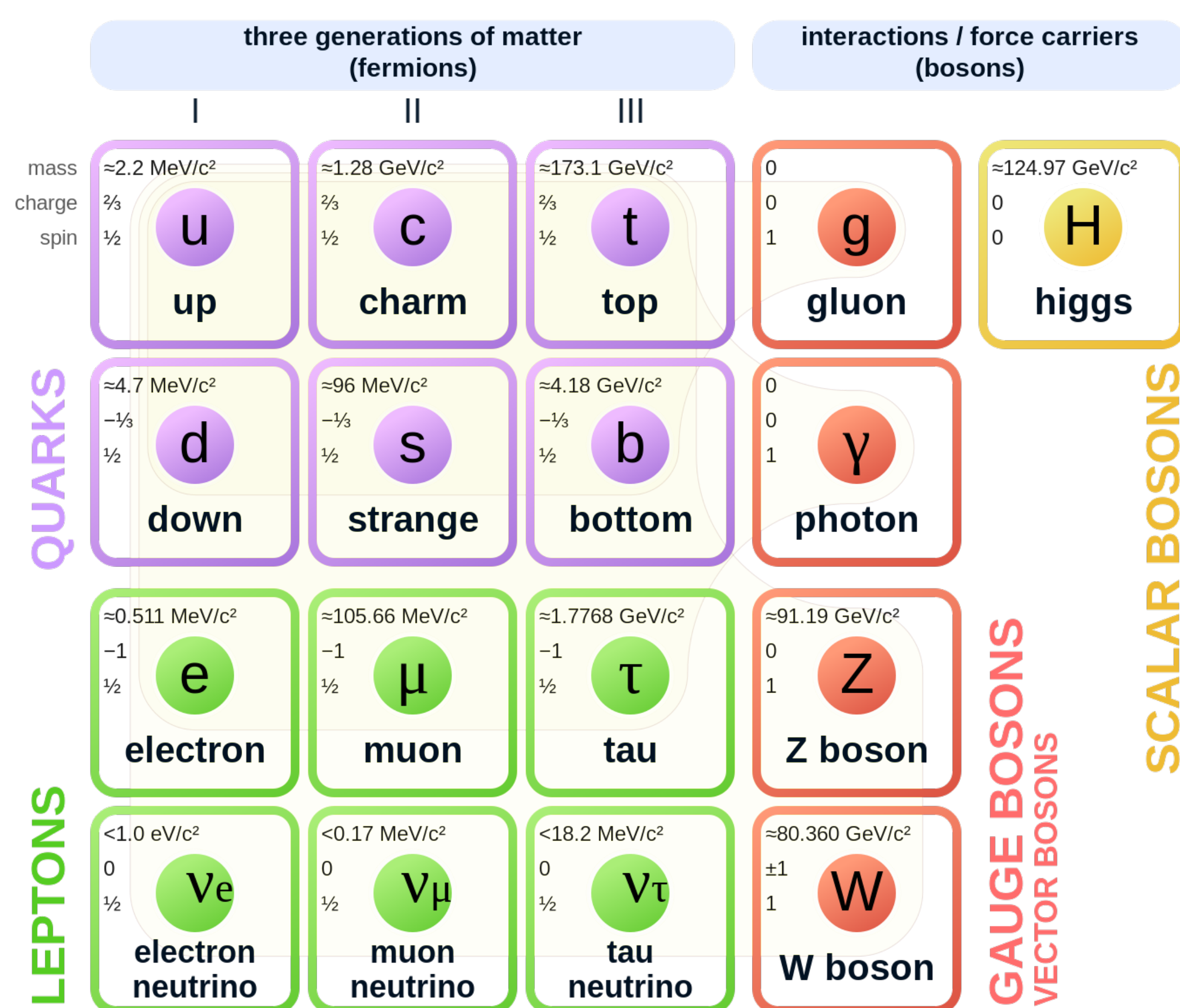
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Standard model of particles

The standard model of particle physics has been successful in explaining decades of experimental observations. It is able to explain three of the four fundamental forces observed in nature. The theory postulates 6 quarks, 6 leptons, 4 gauge bosons and a Higgs boson. The discovery of Higgs boson at the LHC verified one of the key predictions of the theory while opening doors to new questions. The mass of the Higgs boson was expected to have large, divergent quantum corrections, yet the latest measurements revealed the Higgs boson mass with $\sim 0.1\%$ uncertainty [1]. This paradox is commonly referred to as the hierarchy problem.

Standard Model of Elementary Particles



What is SUSY, why is it needed?

- Supersymmetry (SUSY) predicts the existence of superpartners for each of the known standard model particles.
- A symmetry would naturally dictate the superpartners to have masses close to their SM partners.
- If the masses of the superpartners are light enough, SUSY can naturally explain the hierarchy problem
- SUSY has large number of free parameters (>100). This number can be reduced with reasonable assumptions, and is called Minimally Supersymmetric model (MSSM)

Motivation for low-MET electroweak SUSY

- MET: -ve Vector sum of transverse momenta of all observed collision products in a p-p collision.
- Typical SUSY searches in the past decade targeted high-MET events, placing strong constraints on sparticle production.
- certain models of SUSY predict low-MET signatures while still providing a natural solution to the hierarchy problem.
- These models completely evade experimental bounds from high-MET searches.
- Current experimental bounds on low-MET searches focus largely on squark and gluinos, leaving very loose bounds on electroweak superpartners, of which, the higgsinos are central to understanding the hierarchy problem.

Jet Tagging using Deep Neural Networks

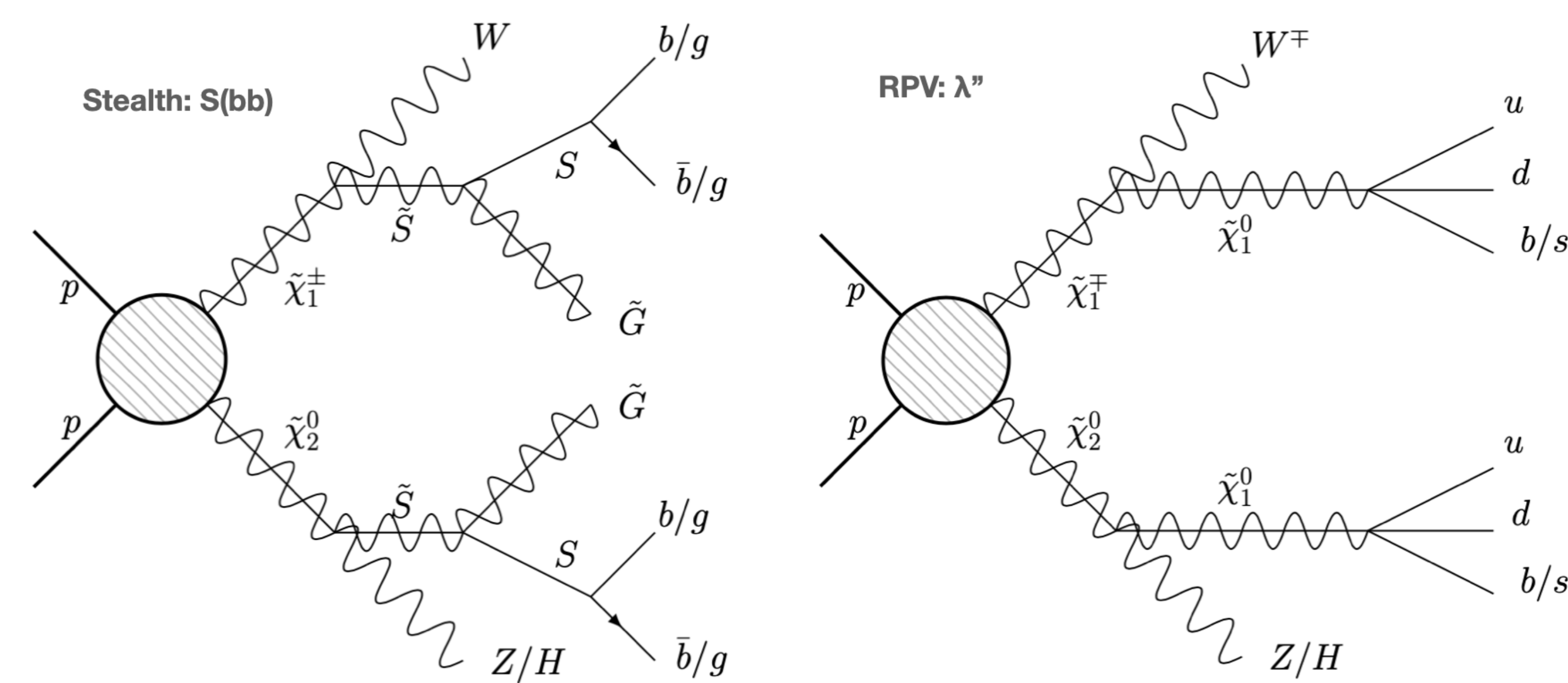
- DeepAK8 taggers: Individual particle information is processed by two CNNs parallelly followed by a fully connected neural net
- Jets are tagged according to t/W/Z/H with and without mass correlation.
- A combination of W,Z,H,t taggers used to study signal events

Current status and future work

- Signal and background events were sorted into different categories depending on the presence of different jet tags.
- Higgs combine tool was used to put theoretical limit on the cross-section. (Refer to figure below)
- Mass decorrelated t tagger will be explored to tag RPV neutralino jets.

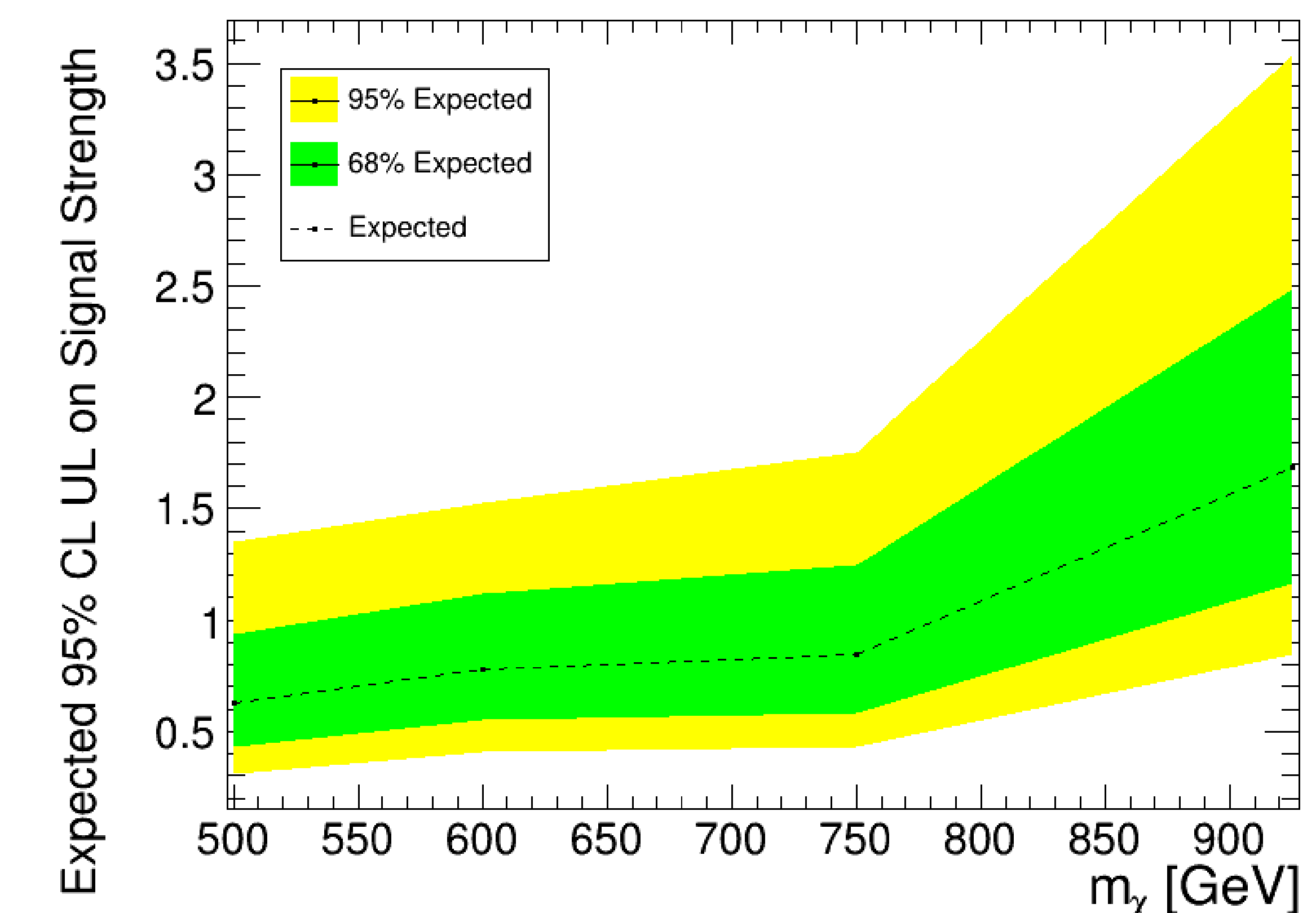
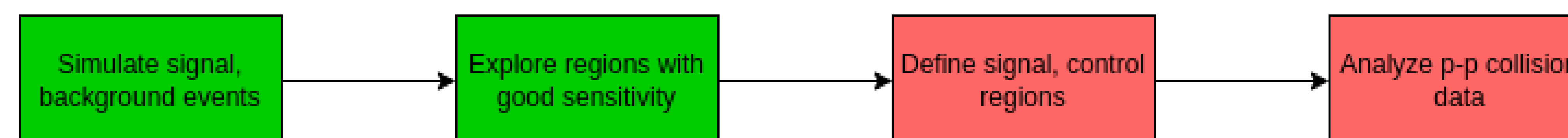
Signal models

Stealth SUSY	RPV SUSY
<ul style="list-style-type: none"> Assumes extension of SM Higgs sector, with a neutral singlet and its superpartner singlino Chargino/neutralinos decay to singlino and W/Z/H Singlet can either decay to bb or gluons Chargino/neutralino masses are about 0.5-1TeV 	<ul style="list-style-type: none"> R-parity violation allows neutralino to decay. R-parity is violated by decaying neutralino to 3 quarks. Lightest neutralino has mass around 100-200GeV Heavier chargino/neutralinos have same mass as of stealth



Search strategy

- Event selection: $HT > 1\text{TeV}$, lepton veto, at least 2 high P_T AK8 jets
- Major backgrounds: ttbar, QCD, W+jets, t+jets, diboson, triboson



References

- [1] CERN-EP-2023-156
- [2] Owen Colegrove et.al., "DEEPAK8: Multi-class Boosted Jet Tagger", CMS Heavy Flavour Tagging Workshop