Heavy stable particles in CMS

Marco Meneghelli
Bologna University
INFN Bologna
I-40126 Bologna, ITALY

1 HSCP: theoretical predictions

Several models of physics beyond the Standard Model (SM), including some versions of Supersymmetry (SUSY), predict the existence of new long-lived charged particles with masses of the order of several hundreds GeV/c^2 (Heavy Stable Charged Particles HSCP), with characteristics dependent on the model.

The Minimal Supersymmetric extension of the Standard Model (MSSM) poses the stop $\tilde{t}$, partner of the top quark, as electrical and color charged HSCP (cross section up to $\sim 10\ pb$).

The SplitSUSY scenario sees the gluino $\tilde{g}$ as a color charged HSCP; cross sections up to a nb are expected for low masses.

2 Search for HSCPs at CMS

At LHC, HSCPs can be produced directly in pairs or as consequence of the decay of heavier exotic particles. Colored ones, like the gluino and the stop, hadronize combining to quarks or gluons to form the so-called R-hadrons. There are free parameters of the hadronization model: depending on these, the particles can reach the external muon system or stop in the detector before decaying.

The unique signature of HSCPs is $\beta = v/c < 1$ even at large momenta: simultaneous measurements of β and momentum permit to evaluate the mass of the particle: $m = p\ \sqrt{\frac{1}{\beta^2} - 1}$

At the Compact Muon Solenoid experiment (CMS), β can be measured in the inner tracker, from specific ionization. HSCPs are expected to produce higher ionization with respect to a minimum ionizing particle in the silicon strips of the tracker.

3 First search for HSCPs with 3.1 pb^{-1}

The first 3.1 pb^{-1} of CMS data were used to search for HSCPs, during 2010 [1]. A counting experiment was set-up, the discrimination signal-background relied on the p_T of tracks and their associated specific ionization.

No events were observed with an expected background of less than 0.1 events. 95% confidence-level upper limits on the production cross sections for gluino and stop were computed (depending on the model assumed for R-hadron interaction with matter). Intersecting the theoretical cross section with the experimental limits, lower limits on masses of gluino and stop were put (see Table).

4 Search for stopped gluinos with 10 $\mathbf{pb}^{-1}$

Searches for long-lived gluinos were done using an integrated luminosity of 10 pb^{-1} [2]. Depending on the modeling interaction in matter, a significant fraction of gluinos is expected to rest inside the detector after production; the gluino can decay later resulting in a jet-like deposit in the calorimeters.

A counting experiment was performed, with a dedicated trigger to search for decays of particles outside collisions, considering gluino lifetimes from 75 ns to 106 seconds. No significant excess above background was observed.

Limits at the 95% CL on gluino pair production over 13 orders of magnitude of lifetime were set. For a mass difference between the gluino and the neutralino of 100 GeV a lower limit of 370 GeV on the gluino mass was put.

References

[1] V. Khachatryan *et al.* [CMS Collaboration], JHEP **1103**, 024 (2011). [arXiv:1101.1645 [hep-ex]].

[2] V. Khachatryan *et al.* [CMS Collaboration], Phys. Rev. Lett. **106**, 011801 (2011). [arXiv:1011.5861 [hep-ex]].

Particle	Lower limit on mass
Gluino	357 GeV/c^2
Stop	202 GeV/c^2