Search for Heavy Stable Charged Particles with dE/dx Measurements from the Tracker

Kolja Kaschube, April 8, 2010

Introduction

Heavy Stable Charged Particles (HSCPs) may emerge from several BSM theories

- GMSB: stau (NLSP)

- MSSM: long-lived gluino, stop, sbottom → hadronize to form R-hadrons

- Universal Extra Dimensions: Kaluza-Klein tau

- and a few others...

HSCP characteristics

- lepton-like (stau, KK-tau) or hadron-like (R-hadrons)

- cross entire CMS detector before decaying

- mass of order > 100 GeV

- highly ionizing, (very) little bremsstrahlung

- high momentum, often slow (v < c) due to high mass ($p = \beta\gamma c \cdot M_{HSCP}$)

- lepton-like HSCPs behave like muons, only distinguished by speed β

- R-hadrons may interact hadronically (via light partons), switching charge but "surviving"

- production cross sections range from 10^{-3} to 10^3 pb
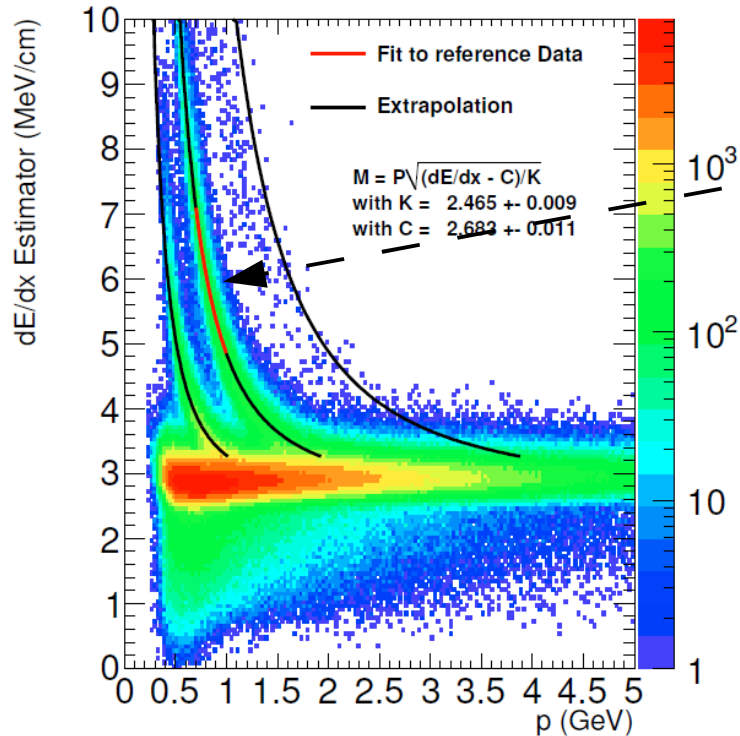
Detecting HSCPs

Measurement of β

- **Tracker**: estimate dE/dx of tracks → **$1/\beta = \mathrm{sqrt}(\, K \cdot dE/dx\,)$**

K: calibration factors obtained from data

(low-momentum protons)

Fit to reference Data

Extrapolation

$M = P\sqrt{(dE/dx - C)/K}$
with $K =$ 2.465 +- 0.009
with $C =$ 2.683 +- 0.011

900 GeV MinBias data (2009)

L. Quertenmont, A. Giammanco, G. Bruno (UCL)

- **Drift Tubes**: time-of-flight measurement → **$1/\beta = c \cdot \Delta x\,/\,d_{layer} \cdot v_{drift} + 1$**

Δx: distance of reconstructed to actual hit position due to delayed arrival of HSCP at DTs; determined in separate track fit
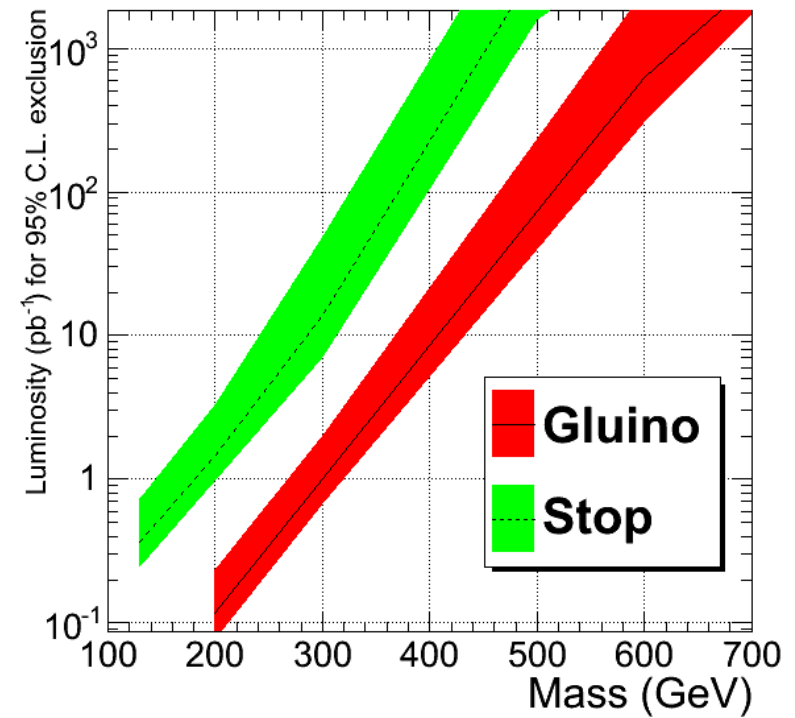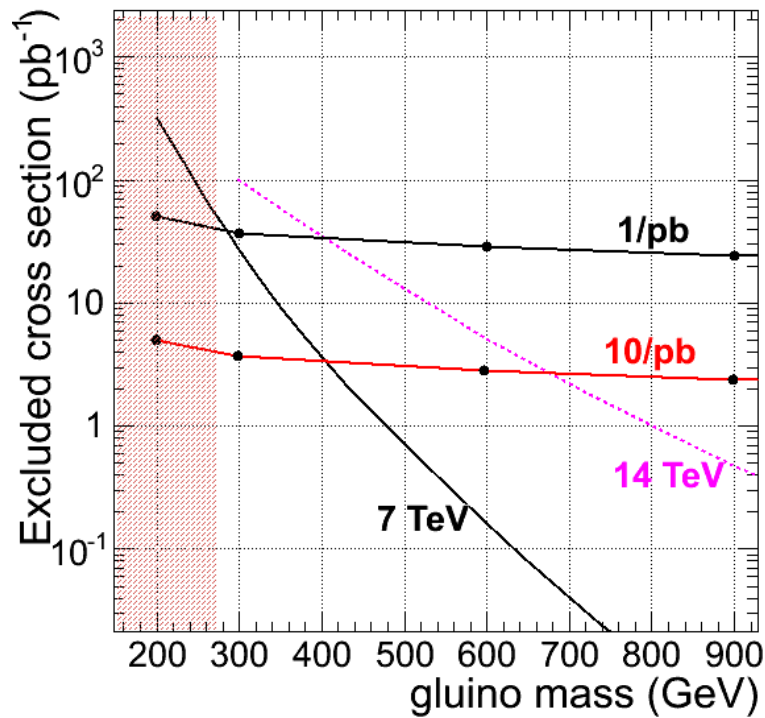
Detecting HSCPs

- Triggers: Muons, MET, Jets

- select high-p_T Tracks, calculate **dE/dx** (left plot, MC)

- reconstruct particle **mass** from β, p measurements (right plot, MC)

- backgrounds: QCD + μ, W→lv + jets, γ + Z→μμ, QCD

7 TeV MC 10 pb^{-1}

L. Quertenmont, A. Giammanco, G. Bruno (UCL)
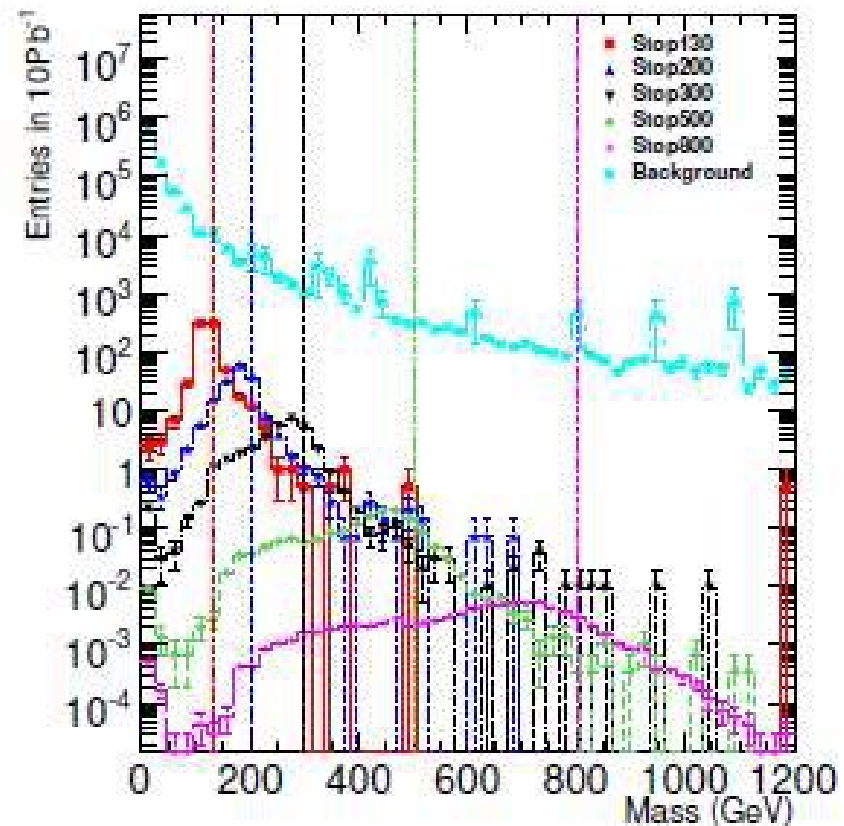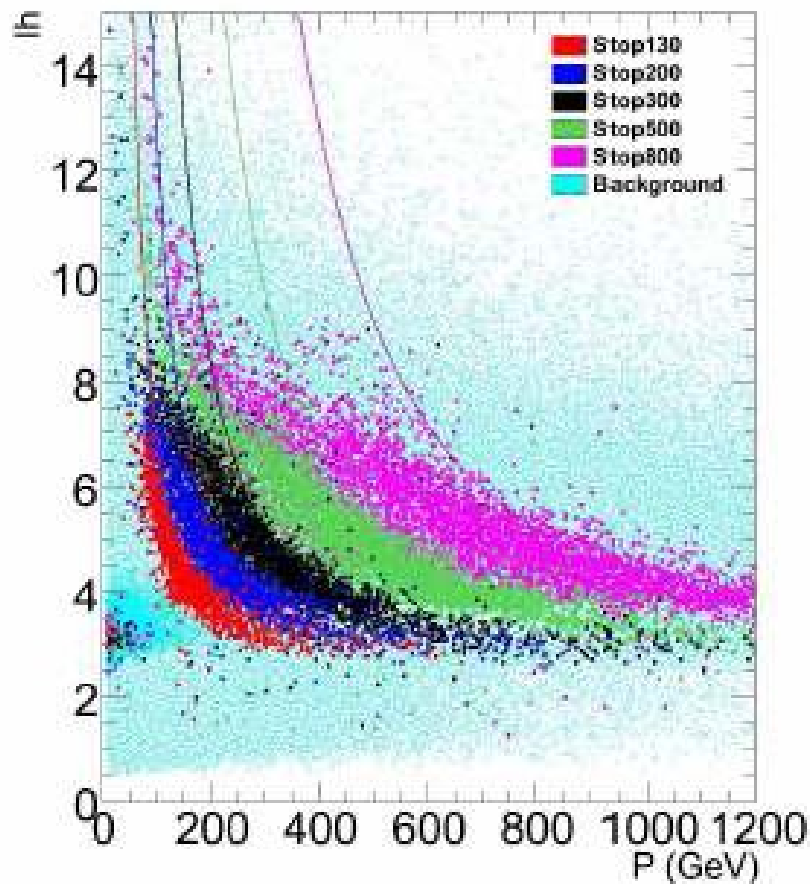
Detecting HSCPs

- exclusion reach in early data

A. Rizzi, HSCP group

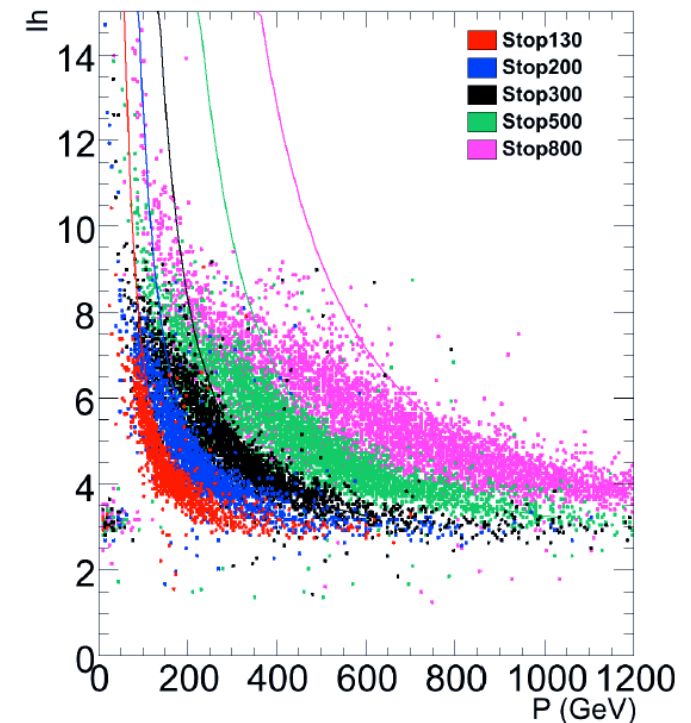- Tevatron exclusions reached with a few pb^{-1}

What's My Business in This?

Currently

- understand/test dE/dx measurement with Tracker

- saturation of strips gives bias in measurement (see plot)

     $\rightarrow$ look at energy deposit in single hits

- create signal MCs (currently stau-samples)

Later

- use dE/dx measurement in BSM search

    with first data (?)

Theory prediction (solid lines) and simulation (colored dots) of energy loss vs momentum for HSCP-stops of varying masses (*G. Bruno, UCL*)