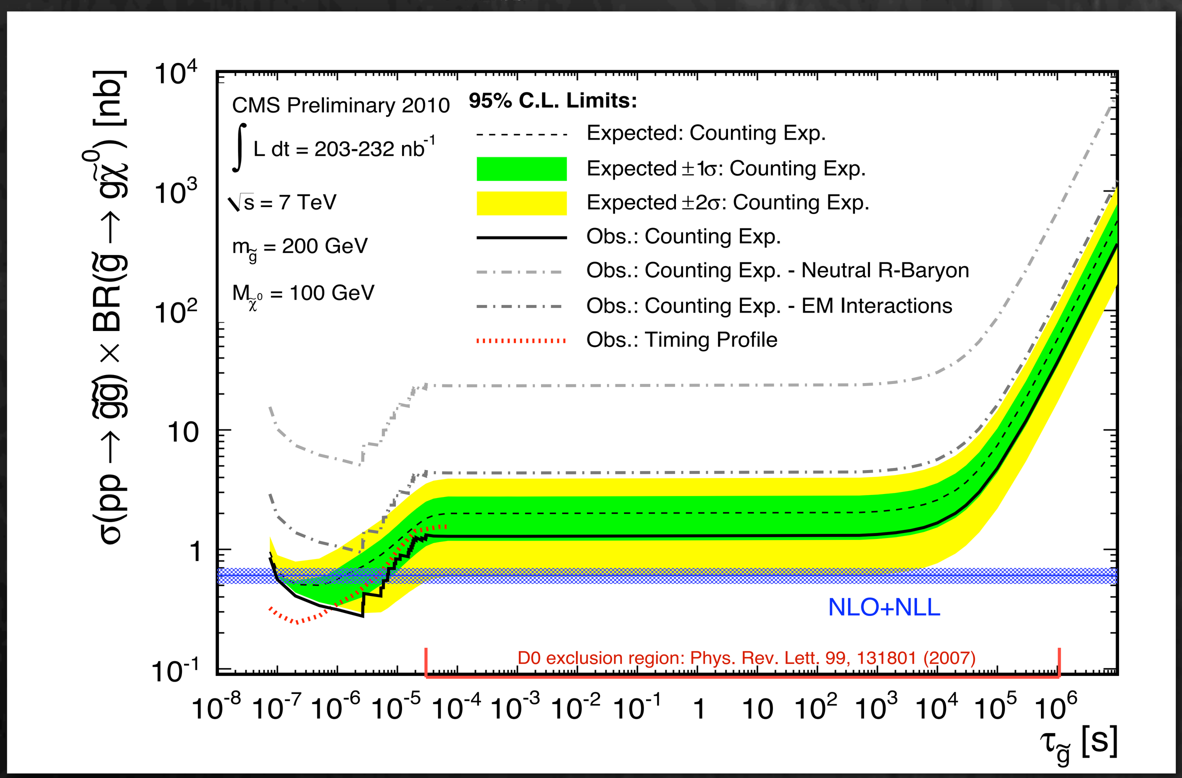
Quasy-Stable Gluino Stopping in the CMS Detector

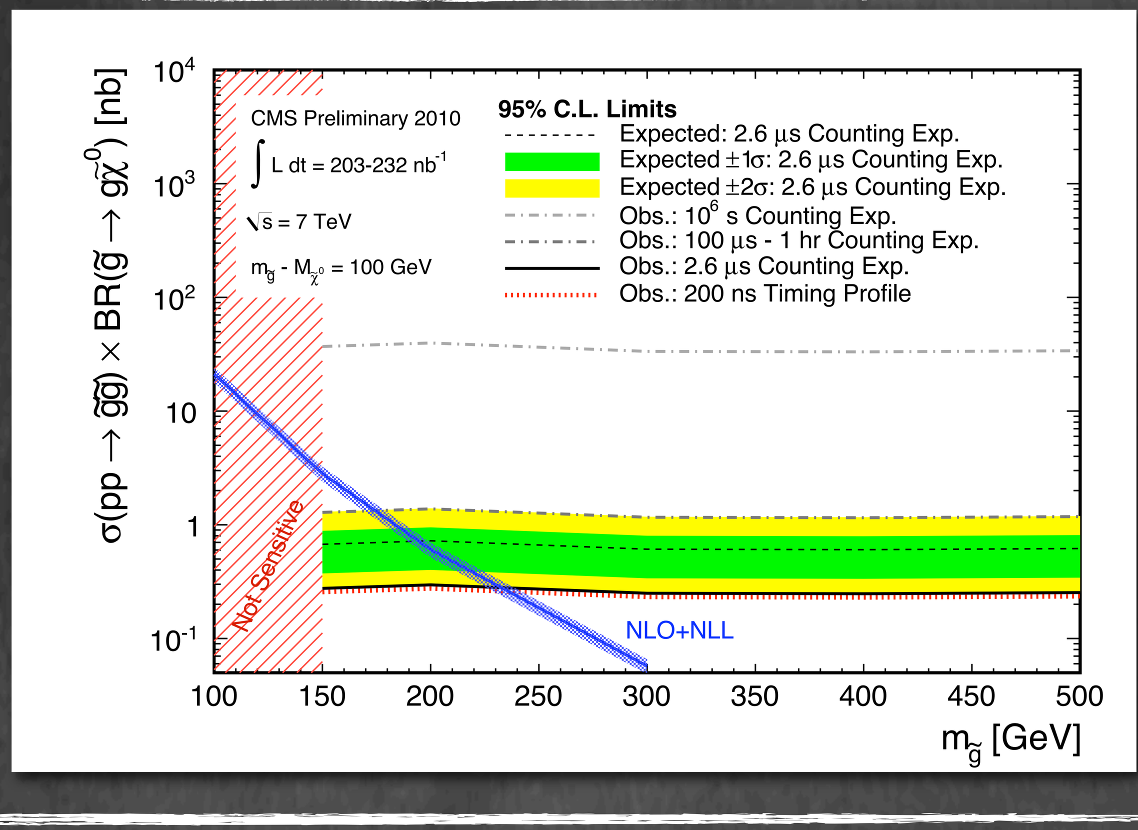
ONE OF THE FIRST LHC SEARCHES EXTENDING TEVATRON LIMITS!

Fedor.Ratnikov@KIT.edu
for the CMS Collaboration

Result for x-section exclusion



Result for gluino mass exclusion



- Results depend from R-Hadron interaction with material
  - Use "cloud" model as a baseline

Motivation

- Inspired by physics scenarios predicting long living heavy particles
  - some SUSY flavors predict long living gluino, stop, stau...
  - Hidden valley models, certain GUTs
  - Lifetimes $10^2..10^3$s of particular interest by cosmology
    - may explain ^{7}Li and ^{6}Li abundance discrepancy between measurement and conventional nucleosinthesis
- Strongly interacting particles form stable states with quarks/gluons – R-Hadrons
- Being charged, particles lose energy when traversing the detector
  - fraction of them eventually stop in the detector.
  - They will eventually decay: µs, minutes, hours,days, months after their production
- We will run a calorimeter trigger in periods when there are no collisions in the LHC, and look for energy released in these decays
- An observation of such a decay with no beam in the machine will be an unambiguous sign of physics beyond the SM

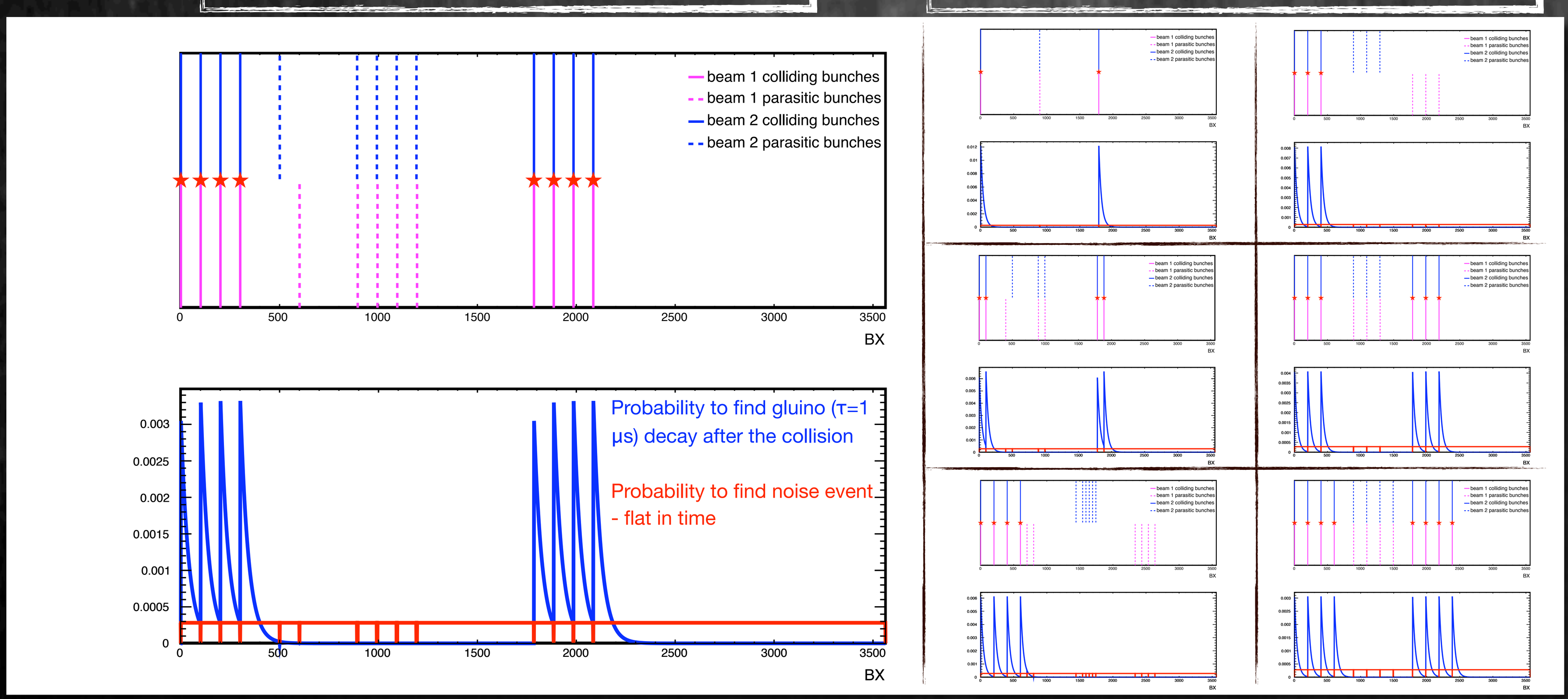
Summary

- Searched for particles stopped in CMS in 203-232nb^{-1} of data at $\sqrt{s}$=7TeV
  - For 120 ns < τ < 6 µs, exclude gluinos of mass up to 200 GeV/c^2
  - For lifetimes of 2.6 µs, exclude gluinos of mass up to 225 GeV/c^2
  - For lifetimes of 200 ns, exclude gluinos of mass up to 229 GeV/c^2
- Extend Tevatron limit for lifetimes below 30 µs
- More details in CMS public analysis summary CMS-PAS-EXO-10-003
  - http://cdsweb.cern.ch/record/1280689

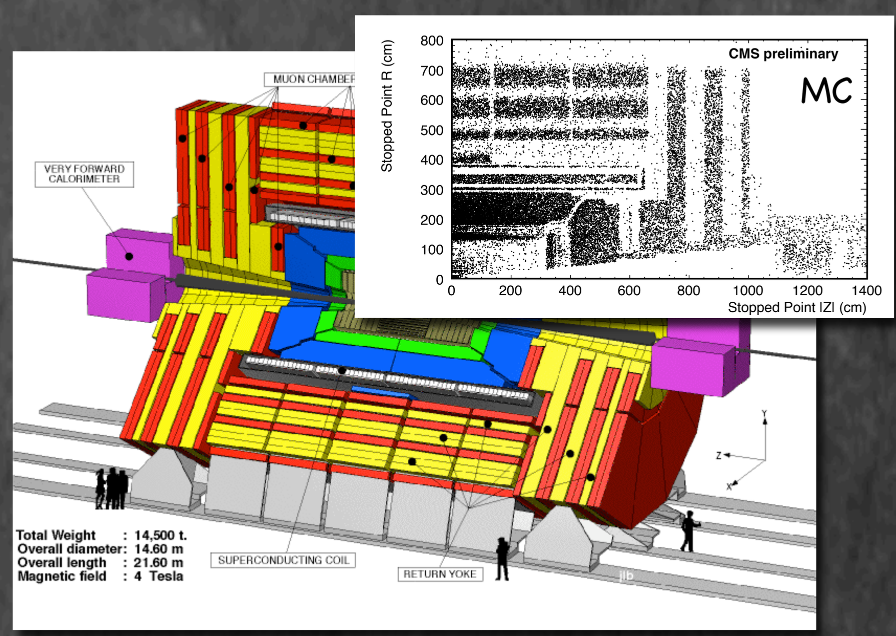
Ultimate Idea

- Run trigger during normal run but beyond filled bunch crossings
- Several different LHC bunch structures during early 2010 collisions

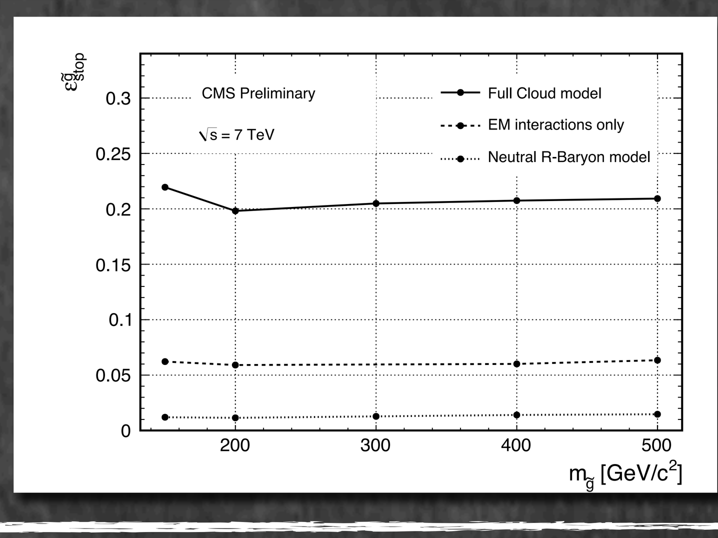
Single_13_8_8_8 LHC Fill Structure | Other Used LHC Fill Structure



Stopping Power



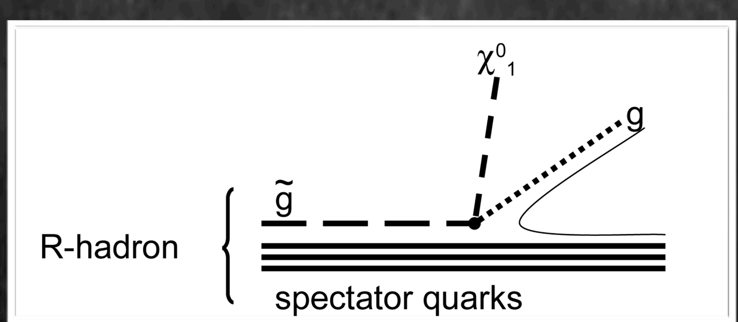
- Significant amount of all produced R-Hadrons stop in the calorimeter



- Stopping power essentially depends from details of interaction of the R-hadrons with detector material
  - It is the biggest uncertainty for the cross section measurement
    - Consider "cloud" model and two others for comparison

Signal Behaviors

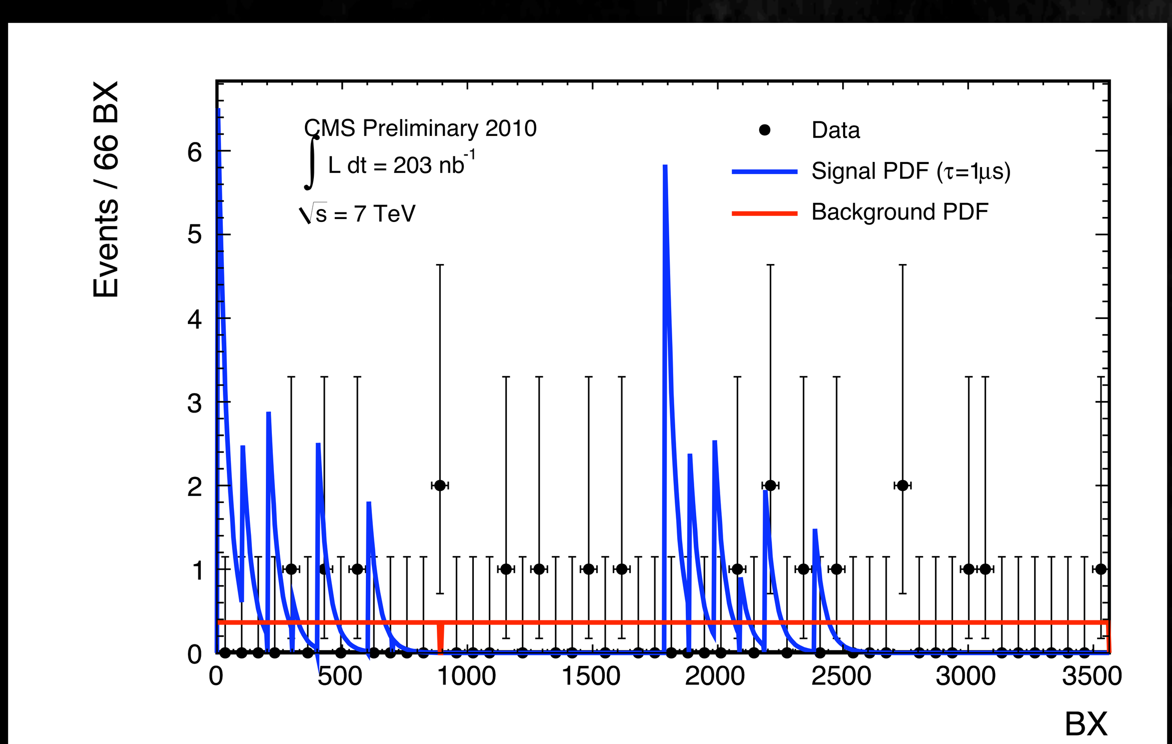
- Energy cluster in the calorimeter
  - Time profile of the signal is the same as for signals from interactions, but with arbitrary offset
  - Deposited energy mostly depends from the difference between gluino and neutralino masses
- No other activity in the detector
- Selection efficiency: 17% of all R-hadrons stopped in the detector



Backgrounds

- Cosmics interacting in the calorimeter
  - suppressed by veto events with track in muon system
- Instrumental noise
  - suppressed by sophisticated analysis of spatial and time profiles of the energy deposition
- Both cosmics contribution and instrumental noises were measured in 2008/2009 cosmics runs and confirmed in 2009/2010 collision runs
- Measured background rate: 6.9×10^{-5} Hz
- Beam related: early triggers, beam halo, beam-gas, parasitic bunches
  - suppress events within ±1 BX around collision/parasitic bunches

Observe 19 events in 203 nb^{-1} of data



Statistics Processing

- Counting Experiment
- Timing profile fit (τ<100 µs)

Systematic uncertainties

- Background – 30% (counting experiment only)
- Luminosity – 11%
- Jet energy scale and other efficiencies – 7%

Model independent result

- Production × stopping efficiency