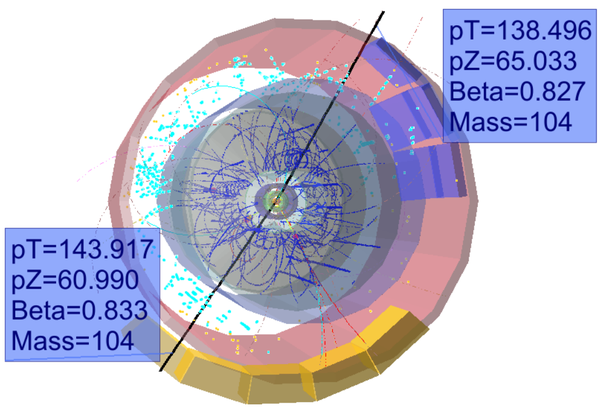
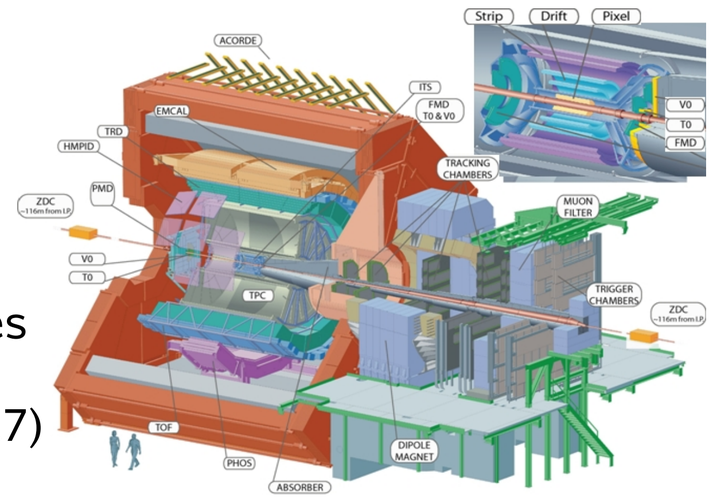
Searches for Heavy Stable Hadrons with ALICE in pp Collisions

A. Dobrin, for the ALICE Collaboration

Heavy Stable Charged Hadrons



Predicted by some theories for new physics: SUSY, UED
Not observed at Fermilab and LEP
Coloured = ”large” cross sections
So long lived that they make it through the detector
Ionization different from ”normal” high momentum particles
TOF could give clean signal
Could be difficult to trigger on for ATLAS and CMS ($\beta > 0.7$)



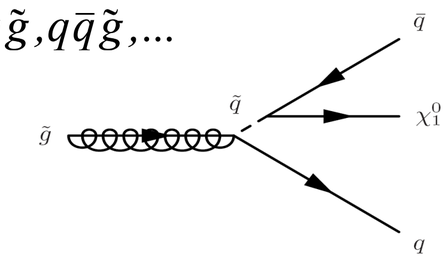
R-hadron

SUSY: R-hadrons consist of a heavy gluino/squark and quarks (ignore glueballs): $qqq\tilde{g}, q\bar{q}\tilde{g}, \ldots$

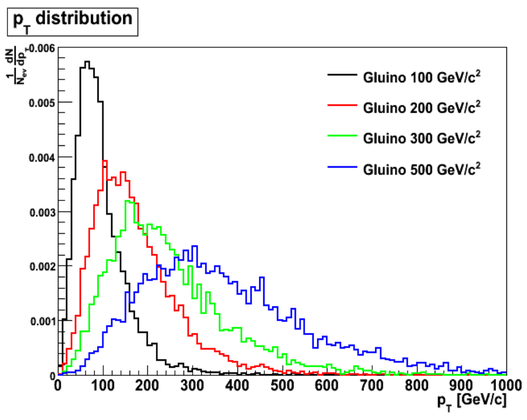
- Quark system interacts
- Gluino is ”just” a reservoir of kinetic energy

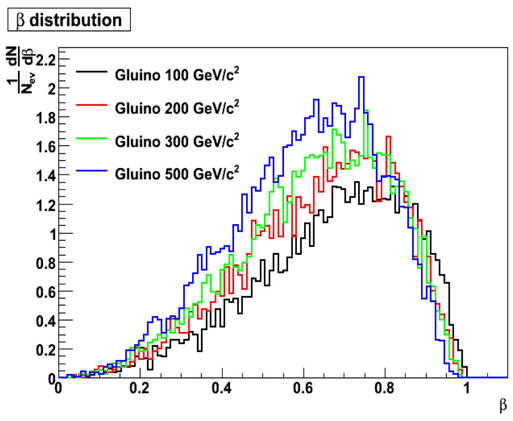
Split-SUSY: gluino is light, squark is very heavy (stable if R-parity is considered)

- Because squark is heavy, the R-hadron decay to neutralino is suppressed



PYTHIA results



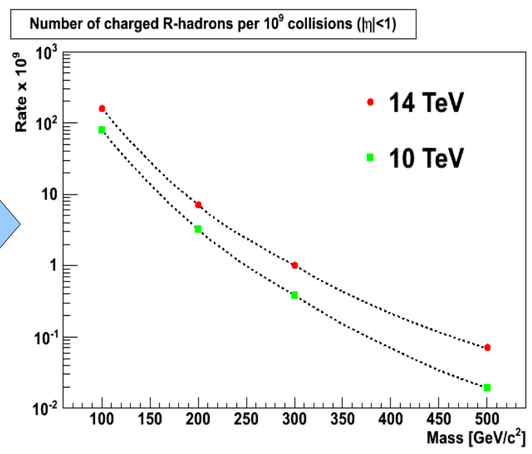


Kinematic properties of the R-hadrons for different values of gluino mass in the ALICE acceptance ($|\eta|<1$): p_T distribution (left) and β distribution (right)

R-hadrons are pair-produced approximately back-to-back
The probability for a R-hadron to be charged is ~50%

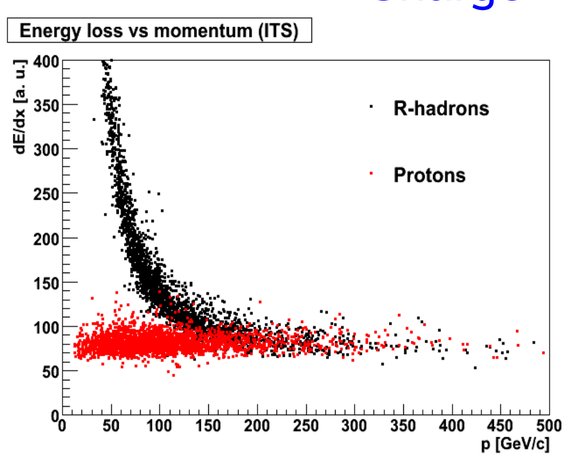
- 99% R-mesons and 1% R-baryons

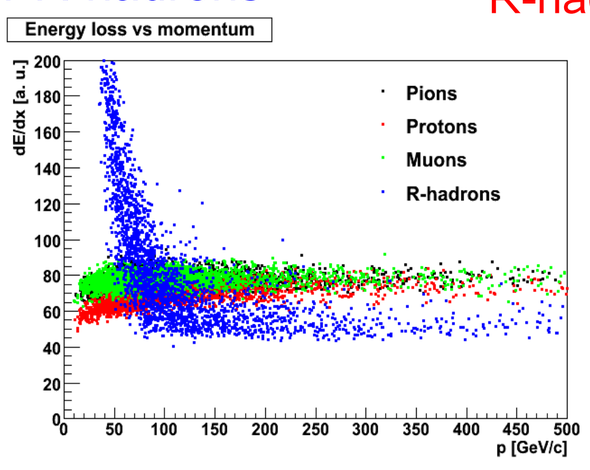
Charged R-hadron tracks inside ALICE acceptance per 10^9 MB events as a function of gluino mass

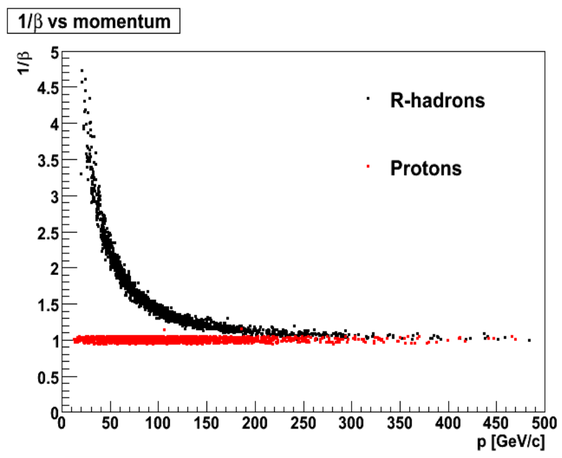


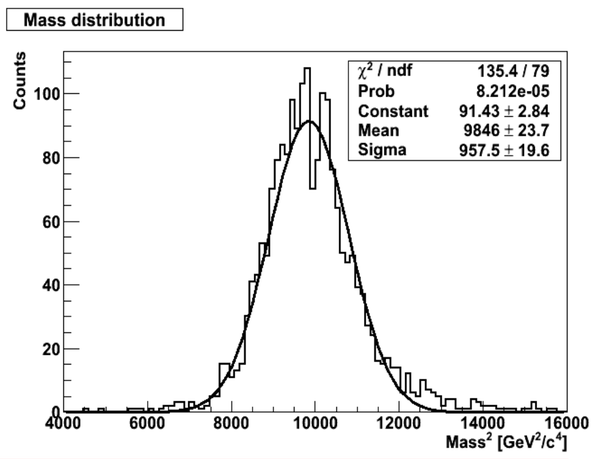
Detector response simulation results

Charge +1 R-hadrons







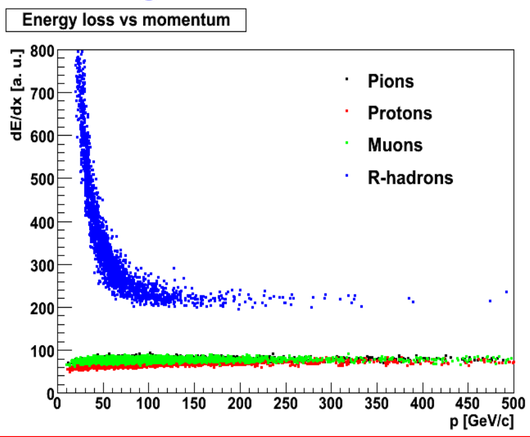


Detector responses for charge +1 R-hadrons, pions, protons, and muons

R-hadrons (gluino mass 100 GeV/c²) are simulated and reconstructed

- dE/dx for R-hadrons is in the region of $1/\beta^2$ (the same as for low momentum SM particles)
- dE/dx for pions, muons, protons is on the relativistic plateau
- ~30% of the R-hadrons can be identified by the large dE/dx
- TOF allows separation for 99% of the R-hadrons
- The mass can be determined from the measurement of the momentum and TOF

Charge +2 R-hadrons



- Models: a small fraction (1%) of R-hadrons have charge +2
- Very clean signal: Complete separation of R-hadrons with charge +2

TPC PID for charge +2 R-hadrons, pions, protons, and muons

Conclusions

Even though ALICE can only record 10^9 pp collisions per year, so a relatively large cross section for physics beyond the Standard Model is required, as the ALICE trigger and detector system are optimized for PID of slow charged particles, heavy stable charged hadrons provide good candidates for ALICE searches