June 26, 2018 Minutes

Search for metastable heavy charged particles with large ionization energy loss in pp collisions at √s=13 TeV using the ATLAS experiment

Chaired by Greg.
Supervised by Laura

-These are high mass particles.
>>Mark: How high are their mass?
>>Greg: “100 GeV or higher?”
>>Laura: “search sensitive to \beta, not mass necessarily. Pretty much higher than 100 GeV. Requirements: heavy, interacts electromagnetically, lives long enough to travel though ID, little bit of MET in event” “calibration is done to protons”

>>Laura: ”Assume charge = 1. If it was charge 2, we’d get the mass wrong.”

>>Brad Axen’s thesis is useful. Different models are discussed there. In principle, any SM mechanism that results in a long-lived particle can be extended to BSM.

>>Cesar: “So SUSY can be a solution of the hierarchy problem?”
>>Greg: “yes, and some SUSY models give long lived particles”
>>C: “are long-livedness and hierarchy related?”
>>All: “no”

>>Laura: “who wants to talk about R-Parity?”
>>C: “I thought this was a response to something in the SM?”
>>L: “No, R-parity is in there to preserve proton decay (it keeps proton from decaying when you add in all other SUSY particles)”

>>L: “colored SUSY particles want to hadronize, but since eg gluinos are heavy, it’s different from regular hadronization, and this can lead to interesting effects in the detector”

>>G: “note stable vs meta-stable: ms decays inside detector”

>>L: “what constraints could there be on the lifetime of a charged heavy particle (beyond what is known from ATLAS)? Experimental measurements that aren’t direct detection”
>>G: “cosmological stuff?”
>>L: “We don’t see them in cosmic rays and stuff, so they’re not being shot out across the universe or anything. Also big bang nucleosynthesis sets limit at about 1 sec (having a heavy charged particle that was longer lived would mess up other things). Not really a hard rule, but you have to do some song and dance to evade that for longer lived stuff.”

THE MAIN TAKEAWAY OF THE DAY: SPEED OF LIGHT IS ABOUT 1 FOOT PER NANOSECOND

>>At speed of light, particle of lifetime 41ns would pass through detector
>>So there are like 8-9 orders of magnitude of lifetime

>>L: "Future question: what other searches would be sensitive to this signal?"

On to part 2
>>G: "why do you take out highest ionization measurement? To get average. Highest amount of ionization is like in the tail of a distribution"

>>L: "Someone needs to draw dE/dx (as fcn of $\beta \gamma$)"
>>Cesar got stuck with this job. He drew the mean energy loss diagram from PDG
>>L: "What's the problem with mean distribution? What's the distribution type?"
>>Mark: "it's Landau"
>>L: "right, so in a Gaussian, mean is most probable value, but in landau that's not the case. Why is there a tail in dE/dx? Rare events in which you lose a lot of energy give you that long tail. Mean in landau is not a well defined experimental quantity due to long tail. It'd be a long discussion."
>>C: "so is median more robust?"
>>L: "different experiments do different things, but yeah. We're only sample dE/dx four times per particle, so that's why we throw away the highest value."

>>L: "What's another way we could try to estimate the most probable value?"
>>G: "just fitting the data?"
>>L: "yeah and just find a template"

>>L: "oh yeah, the part of the dE/dx that corresponds to MIP, what pT does that correspond to?"
>>C: "pions?"
>>Patrick: "about a Gev-ish?"
>>L: "yeah"

>>L: "for a 200 GeV R-hadron with q=1, that would probably not be a MIP any more, but its not waaay out of the MIP range. Who knows how dE/dx depends on q? I think it goes as q^2"

>>L: "it's important to note that the SCT does not have charge readout, that's why we're not using it. What about the TRT? Let's talk about the TRT."
>>M: describes the TRT… tubes with different dielectric constants which reduce transition radiation yada yada

>>L: “this helps distinguish between pions and electrons. They do read out charge information though. You could use it for dE/dx, but that’s not normally done; someone would have to go through a bunch of studies and calibration and such.”
>>L: “pixel detectors suffer from radiation damage, so you have to calibrate it vs time.”
>>M: “isn’t that done with charge injection?”
>>L: “yes, but I’m talking about damage to sensors”

>>L: “you can actually do a bad dE/dx with SCT. SCT is read out in 3 bunch crosses. Small charges can leak into different bunch crosses. So by messing around with how you trigger readout based on which bunch crossings record a hit, you can almost have 2 bit charge information…”

>>L: “what about IBL?! See figure 1. Even with only 4 bits of TOT information (which is worse than other layers), it improves tails by 50%. It was only 4 bits because of data rate; high occupancy so close to beam line.”

>>L: “Why is there a $\beta \gamma$ limit of .3?”
>>G: “is that a mass limit thing?”
>>L: “There you’re depositing more charge. Very big signal takes a long time to dissipate. If that’s longer than latency, FEI3 does not read out hit! Overflow flag was added for FEI4.”