論文 / 著書情報
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題目(和文)	LHC-ATLAS実験における多数の粒子飛跡を伴い衝突点から離れた崩壊点を用いた長寿命超対称性粒子の探索
Title(English)	Search for long-lived supersymmetry particle by signature of a high track-multiplicity displaced vertex using the LHC-ATLAS Experiment
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
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論 文 要 旨

THESIS SUMMARY

専攻： Department of	基礎物理学　専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of　（　理学　）
学生氏名： Student's Name	Pettersson Nora Emilia	指導教員（主）： Academic Advisor(main)	陣内　修
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

This thesis treats the experimental search for new physics conducted at the LHC-ATLAS Experiment. The analysis described within looks to reconstruct displaced vertices (DVs) arising from long-lived particles (LLPs) postulated by supersymmetry (SUSY), decaying within the tracking volume of the ATLAS detector. Several charged daughter particles are expected from LLP decay, yielding reconstructable tracks from which a vertex is fit. A new *DV+jets* channel has been developed, where 20.3 fb^{-1} data collected at a centre of mass energy of 8 TeV in 2012 are scrutinised for events containing a DV and at least four high transverse momentum (p_T) jets. Solely requiring jets and a DV present in an event provides a generic and model independent search strategy. The results can therefore be interpreted on any model yielding a fairly massive LLP decaying within the given fiducial volume. In this thesis, R-Parity violating (RPV) scenario of SUSY is put under the test. The targeted signal production process from the proton-proton collision is the following; pair production of prompt decaying gluinos, where the gluino decays to a quark and a long-lived neutralino. After a given lifetime, the neutralino decays through the RPV $L_iQ_jD_k$-coupling to a lepton or lepton-neutrino and a pair of quarks. The indices i, j, and k correspond to the generations of the lepton (L) and the quarks (Q and D) in the decay of the neutralino (values of 1, 2 or 3). In total, nine different combinations of the generators are considered. One RPV coupling is set to non-zero values, all the rest of the SUSY couplings are set to decay promptly. The value of the RPV coupling must remains relatively small to suppress the neutralino decay, giving it a significant lifetime.

The displaced vertex analysis is from an experimental view-point quite unique. Mostly owning to the fact that secondary decays, or displaced decays, are not favoured by the detector design. This introduces difficulties and typically low reconstruction efficiencies, and in turn low signal efficiencies for LLP searches. Specially modified version of the track reconstruction is used to counter-act this inherited inertia and low performance for non-promptly decaying particles.

Moreover, no standard model (SM) background is to be expected, looking for a high track-multiplicity displaced vertex. There are no known massive particles that could produce the targeted signature. Instead, what is expected is down to detector inefficiencies. For instances, say a long-lived Kaon (497 MeV) get crossed by a particle track originating from an independent source, perhaps a nuclear interaction, if this additional track gets fit to the Kaon vertex. The vertex mass could then potentially become high enough to imitate the signal of a LLP and would become a source of background vertices. A major part of the thesis has been dedicated into developing a new and significantly improved technique to estimate the background down to detector effects and mis-reconstructions. The systematic uncertainty has been reduced from 100% down to 14%, using the new method compared to what has been used in the past. Yielding an invaluable improvement of the analysis as the new *DV+jets* channel is more likely to have a larger background due to the generic selection criteria; giving the channel a background 100 times larger than for the older channels of *DV+muon* (which is not a part of this thesis).

In the absence of any signal events, upper limits on the production cross-sections are set. Both in a model independent way through limits on the visible cross-section and in a model dependent way. The model dependent limits are set on the decays through one of the nine RPV scenarios of SUSY. Here the upper limits on the cross-sections are evaluated for a range of proper decay length ($c\tau$) of the LLP, going from 1 mm to 1000 mm. The limit on the visible cross-section is set to 0.14 fb given the full 20.3 fb^{-1} of data, resulting in an improvement from earlier reported exclusions of 5.4 fb. Along with a range of values dependent on proper decay lengths, in the best case for one RPV coupling with ijk = 211, where the neutralino decays to a muon and light quarks (up and down) the exclusions are made for 4 mm < $c\tau$ < 100 mm at 0.5 fb while the interval outside $c\tau$ > 100 mm and $c\tau$ < 4 mm are less restricted with exclusion down to 100 fb.

An second analysis is included in the thesis and has been performed, dealing with the performance of the ATLAS tracking, attempting to quantify the amount of material in the inner detector to reduce the uncertainties related to the material descriptions for track reconstruction.

The thesis is structured in two parts, Part I and Part II. The first part of the thesis includes a review of the theoretical background related and necessary to understand the displaced vertex analysis. As well as an overview of the LHC accelerator and the ATLAS Experiment. The second part includes every element of the displaced vertex analysis; event selection criteria, physics object reconstruction, background estimation and the results and limits. This part also contains a chapter dedicated to the material study - the hadronic interaction analysis.