論文の内容の要旨

Search for top squarks in events with one lepton in *pp* collisions at $\sqrt{s}$ = 13 TeV

（重心系エネルギー13 TeV の陽子・陽子衝突における 1 レプトン事象を用いたトップ・スクォークの探索）

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This thesis presents the results of a search for the top squark (stop), the supersymmetric partner of the top quark, in events with one lepton. The search uses the datasets of the 2015 and 2016 LHC *pp* collisions at $\sqrt{s}$ = 13 TeV recorded by the ATLAS detector, which amount to an integrated luminosity of 28.0 fb^{-1}.

The analysis targets a direct pair production of stops where each stop decays into the top quark and the lightest neutralino ($\tilde{t}_1 \rightarrow t\tilde{\chi}_1^0$), the *W* boson from one of the two top quarks decays into an electron or muon, and the *W* boson from the other top quark decays hadronically (see Figure 1).

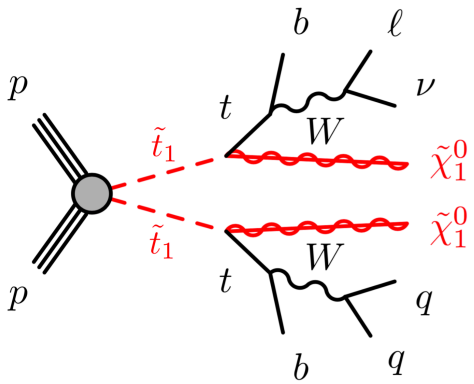

Figure 1 : Feynman diagram of the direct pair production of stops and their decay. The search aims at events include one lepton, two b-quarks, two light-flavor quarks, and two lightest neutralinos.

Since the signal event topology highly depends on the mass difference between the stop and the lightest neutralino, three analyses are performed which are optimized to *Boosted*, *Resolved*, and *Diagonal* topologies illustrated in Figure 2.

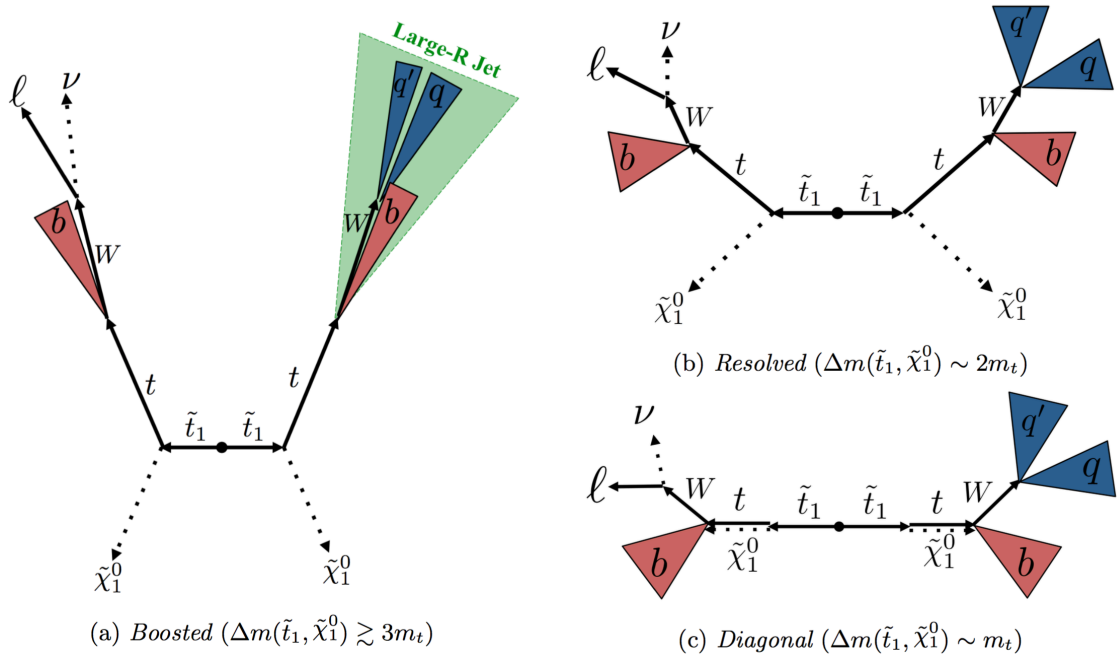

Figure 2 : Illustration of three types of the signal kinematic topologies, *Boosted* (a), *Resolved* (b), and *Diagonal* (c), categorized by $\Delta m(\tilde{t}_1, \tilde{\chi}_1^0) \equiv m_{\tilde{t}_1} - m_{\tilde{\chi}_1^0}$. The dashed lines indicate particles completely invisible to the ATLAS detector.

In *Boosted* topology ($\Delta m(\tilde{t}_1, \tilde{\chi}_1^0) \gtrsim 3m_t$), the three quarks from the hadronic top decay forms one large-radius jet (large-R jet). In *Resolved* topology ($\Delta m(\tilde{t}_1, \tilde{\chi}_1^0) \sim 2m_t$), the three quarks from the hadronic top decay are not merged but resolved. In *Diagonal* topology ($\Delta m(\tilde{t}_1, \tilde{\chi}_1^0) \sim m_t$)), the lightest neutralino and the top quark from the stop decay are nearly collinear with respect to the stop momentum. The detector signature of the signal events is similar to that of a top quark pair produced in association with large missing transverse momentum, which is highly suppressed by dedicated variables in *Boosted* and *Resolved* analyses or precisely estimated by a 2-dimensional shape fit in *Diagonal* analysis.

No significant excess from the Standard Model background-only hypothesis is observed, and exclusion limits on a plane of stop and lightest neutralino masses are set at 95% confidence level. Figure 3 shows the combined limits of *Resolved*, *Boosted*, and *Diagonal* results and indicates that the results presented by this thesis (red line) extend the ATLAS and CMS exclusion limits for stop pair production model obtained with data of 13.2 fb^{-1}.

The *Resolved* result doesn't newly exclude but enlarges the expected CL_s contour up to $(m_{\tilde{t}_1}, m_{\tilde{\chi}_1^0}) \sim (700 - 800, 400)$ GeV. The *Boosted* result newly excludes the $\tilde{t}_1 \rightarrow t\tilde{\chi}_1^0$ model with the $m_{\tilde{t}_1} \lesssim 980$ GeV for $m_{\tilde{\chi}_1^0} \lesssim 300$ GeV and $(m_{\tilde{t}_1}, m_{\tilde{\chi}_1^0}) = (900, 350)$ GeV. The *Diagonal* result is also reinterpreted to set exclusion limits on the model where stop decays to bottom quark, *W*-boson, and lightest neutralino ($\tilde{t}_1 \rightarrow bW\tilde{\chi}_1^0$), and newly excludes the $\tilde{t}_1 \rightarrow t\tilde{\chi}_1^0$ and $\tilde{t}_1 \rightarrow bW\tilde{\chi}_1^0$ models with 200 GeV < $m_{\tilde{\chi}_1^0}$ < 240 GeV and $(m_{\tilde{t}_1}, m_{\tilde{\chi}_1^0}) \sim (430, 250)$ GeV near a *Diagonal* line of $m_{\tilde{t}_1} = m_t + m_{\tilde{\chi}_1^0}$.

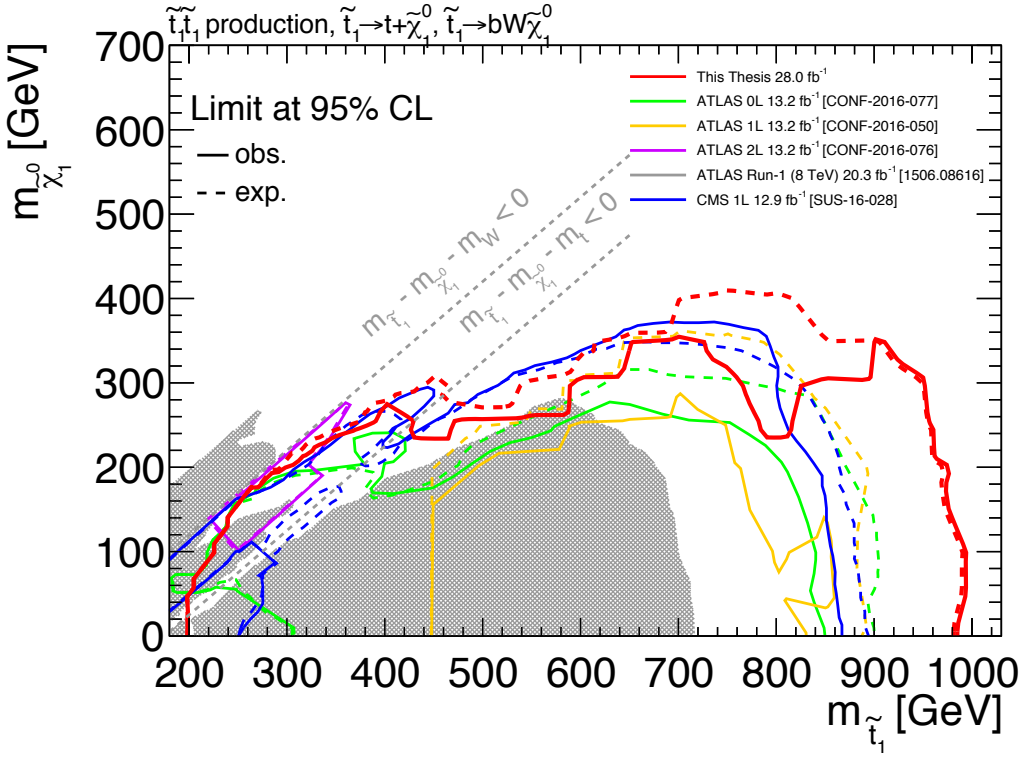

Figure 3: Comparison of the combined results of *Resolved*, *B*oosted, and *D*iagonal (red) to the ATLAS searches for top squark (stop) pair production based on 13.2 fb^{-1} of *pp* collision data taken at $\sqrt{s}$ =13 TeV using events with no lepton (green), one lepton (orange), and two leptons (violet) and the CMS search with 12.9 fb^{-1} using events with one lepton (blue). The observed limit obtained by the ATLAS Run-1 search with 20.3 fb^{-1} at $\sqrt{s}$ =8 TeV is also indicated by the gray region. Exclusion limits at 95% CL are shown in the $(m_{\tilde{t}_1}, m_{\tilde{\chi}_1^0})$ plane. The dashed and solid lines show the expected and observed limits, respectively, including all uncertainties except the theoretical signal cross section uncertainty.