Searches for Evidence of Natural SUSY with the ATLAS Detector at the LHC Run 2

S. Muanza CPPM CNRS-IN2P3 & AMU
J.-L. Kneur L2C CNRS-INP & UM2

OCEVU Particle Physics Group

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Introduction

- For the next Call for Proposals in early july 2014
- We'll submit a request aimed at starting a new axis of cooperation between CPPM Marseille and L2C Montpellier
- The new project is called in short SENSUAL:
  "Searches for Evidence of Natural SUsy with the Atlas detector at the Lhc run 2"
- The goal is to maintain and to strenghten the following activities
  - Experiment: main stream SUSY analyses in ATLAS
  - Phenomenology: developments of the recent C++ version of Suspect
  - Plus expected (yet undetermined) cross-fertilizing ideas
- Two convenors to represent each these activities:
  - Experiment: S. Muanza, CPPM Marseille
  - Phenomenology: J.-L. Kneur, L2C Montpellier

Physics Context

- All of the above mentioned activities are very high profiles ones in the context of the LHC Run 2
- Indeed, despites negative results of SUSY searches at LHC Run 1; SUSY still thought of as the main hope for BSM Physics
- Natural SUSY implies relatively light $\tilde{t}_1$, $\tilde{b}_1$, $\tilde{\chi}_1^0$, $\tilde{\chi}_1^{\pm}$, $\tilde{\chi}_2^0$
- Also $M_{\tilde{g}} < O(1.5 - 2\,TeV)$, other sparticles (esp. $\tilde{q}$) could have multi-TeV masses
- Hence productions of $\tilde{g} + \tilde{g}$ and $\tilde{\chi}_1^{\pm} + \tilde{\chi}_2^0$, $\tilde{\chi}_1^{\pm} + \tilde{\chi}_1^{\mp}$ best hope for discovering Natural SUSY at the LHC Run 2 (except for direct stop and sbottom productions)

Past Experience

- CPPM & L2C can build upon very solid grounds in these activities
- C++ Suspect v3, , [A. Djouadi (LPTHE Orsay), J.-L. Kneur, G. Moultaka, M. Ughetto, D. Zerwas (LAL Orsay)]
  - The UM2 PhD thesis of M. Ughetto co-tutored between L2C-CPPM (2011-2014)
  - Tutors: J.-L. Kneur, G. Moultaka, S. Muanza, L. Vacavant
- ATLAS Search for $p + p \to \tilde{\chi}_1^{\pm} + \tilde{\chi}_2^0 \to W^{\pm}(\to \ell^{\pm}\nu) + h(\to b\bar{b}) + 2\tilde{\chi}_1^0$
  - ATLAS-CONF-2013-093 [S. Muanza, M. Ughetto], paper in preparation
- ATLAS Search for $p + p \to \tilde{\chi}_1^{\pm} + \tilde{\chi}_1^{\mp} \to W^{\pm}(\to \ell^{\pm}\nu) + W^{\mp}(\to \ell^{\mp}\nu) + 2\tilde{\chi}_1^0$
  - JHEP 1405 (2014) 071 [T. Serre, P. Pralavorio, S. Muanza]
- ATLAS Search for $p + p \to \tilde{g} + \tilde{g} \to \ell^{\pm}\ell^{\pm} + jets + \not{E}_T$
  - arXiv:1404.2500 [hep-ex] [J. Maurer, P. Pralavorio, F. Hubaut]
- Notes:
  - P. Pralavorio based at CERN, former convenor of the ATLAS SUSY group
  - J. Maurer got an ATLAS award for his PhD thesis
  - S. Muanza & R. Grimm (CPT Marseille) lecturing on SUSY, doctoral school of AMU
- Therefore, SENSUAL is not an opportunistic request to OCEVU
- On top of this, none of these activities are covered by any other OCEVU Particle Physics projects

Physics Project

- ATLAS:
  - Prepare & perform $p + p \rightarrow \tilde{\chi}_1^{\pm} + \tilde{\chi}_2^0 \rightarrow W^{\pm}(\rightarrow \ell^{\pm}\nu) + h(\rightarrow b\bar{b}) + 2\tilde{\chi}_1^0$ Run 2 analysis
  - Prepare & perform $\tilde{g} + \tilde{g} \rightarrow \ell^{\pm}\ell^{\pm} + jets + \not{E}_T$ Run 2 analysis
- PHENO:
  - Developments of non-minimal SUSY models in Suspect v3
  - Others?
- Crossing Points:
  - pMSSM interpretations of ATLAS Run 2 analyses
  - Ideas of new SUSY analyses by the end of Run 2
  - Interpretations of SUSY analyses into non-SUSY models

People Involved

- CPPM: F. Hubaut, E. Monnier, S. Muanza, P. Pralavorio
- L2C: J.-L. Kneur, G. Moultaka, C. Hugonie?, M. Frigerio?
- Extension: Cooperation in with the group of Prof. Xuai Zhuang from IHEP Beijing ATLAS group
  - 1 Prof., 1-3 months stay at CPPM starting in september
  - Possible PhD students (co-tutoring), possible post-docs
  - Extension of strong production analysis: $\tilde{g} + \tilde{g} \rightarrow \tau^{\pm}\tau^{\pm} + jets + \not{E}_T$
  - Extension of EW production analysis: $\tilde{\chi}_1^{\pm} + \tilde{\chi}_2^0 \rightarrow W^{\pm}(\rightarrow \tau^{\pm}\nu) + h(\rightarrow b\bar{b}) + 2\tilde{\chi}_1^0$
  - Common work on non-leptonic aspects of both analyses

Actual Requests

1. 1 PhD position, CPPM, ATLAS EW-SUSY Search (late 2014 ?)
2. 1 post-doc, L2C, developments of SUSY models in Suspect v3 (2015)
3. 1 PhD position, CPPM, ATLAS Strong-SUSY Search (TBD)
4. Travel money: Montpellier, Marseille, CERN, Terascale-GDR meetings, small workshops