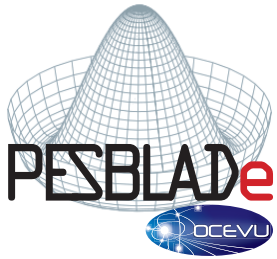


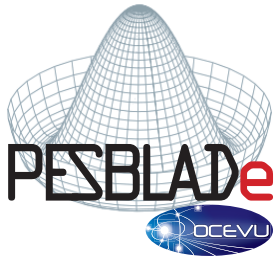
# PESBLAD<sup>e</sup> report





# How it started

- Project started with a series of meetings between L2C-LUPM and ATLAS-CPPM groups:
  - ATLAS-CPPM SM top-quark, vector boson pairs production, SM Higgs, SUSY, and 4<sup>th</sup> generation quark searches in top-like events.
  - L2C-LUPM: phenomenology of minimal and extended SUSY models, Higgs physics, composite Higgs models and their implications on Beyond SM (BSM) collider phenomenology and particle dark matter.
- 10 days of meetings in 2013 to discuss point of interest and convergence between the two groups
  - Higgs couplings: we discussed how to constraint couplings to have generic info both on SUSY and composite Higgs models
  - SUSY: stop pair production and associated stop pair Higgs production:
  - Composite higgs: (1) single production of a heavy top partner (T), (2) single T production via  $Wb$  or  $Zt$  or  $Wt$  fusions and (3) single T production via heavy gluon (G) decay:  $G \rightarrow T t$ .



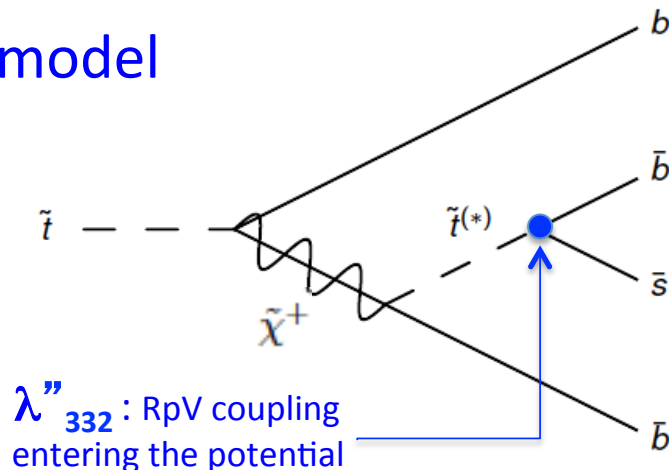
# How it works

- Signatures for SUperSYmmetric (SUSY) models with R-parity violation through the hadronic multi-b-jet decays of a light stop
  - Motivated by naturalness of the Higgs potential, which would favor light third-generation squarks, and the stringent LHC bounds on RPC signatures
  - Final states with multi-heavy flavored jets under study by ATLAS CPPM group
  - L. Feligioni, G. Moultaqa + postdoc position starting January 2014 (Sara Diglio) and an M1 stage (2 months) Damien Minenna (12-5-2014/22-07-2014).
- So far 37 days of meetings between Marseille and Montpellier in 2014
  - generated the Trilinear RpV SUSY model using the SARAH code SARAH
    - Mathematica package to build SUSY supported by the MadGraph5 events generator
  - Calculated several SUSY spectra for the above Trilinear RpV SUSY model using SPheno (Supersymmetric Phenomenology)
    - bottom-bottom approach [master stage Damien Minenna]
- New physics beyond the SM driven by dynamical EWSB, which potentially could give rise to new signatures in di-boson events, in particular for multi-lepton final states. [G. Moultaqa, S. Diglio, C. Diaconou] + 1 PhD Venugopal Ellajosyula [started Oct 2014, currently doing qualification task in ATLAS on electron identification]
  - Visiting Scientists: Y. Liu (USTC), S. Davidson (IPNL)

# Search for new physics with high b-jet multiplicity

- Tri-Linear R-parity Violation (RpV) SUSY model

- Stop pair production:  $p p \rightarrow t\tilde{t}$
- Stop decay:  $t\tilde{t} \rightarrow b\chi^+, \chi^+ \rightarrow b t\tilde{t}, t\tilde{t} \rightarrow b s$
- **Experimental signature:**
  - At least 8 jets, of which at least 6 b-jets
  - No missing energy



- Motivation for RpV

- Strong experimental constraints for many RpC models, not many RpV studies
- RpV is a “signature generator”: many couplings  $\rightarrow$  freedom in spectra
  - Possible final states without missing energy (differently from RpC)

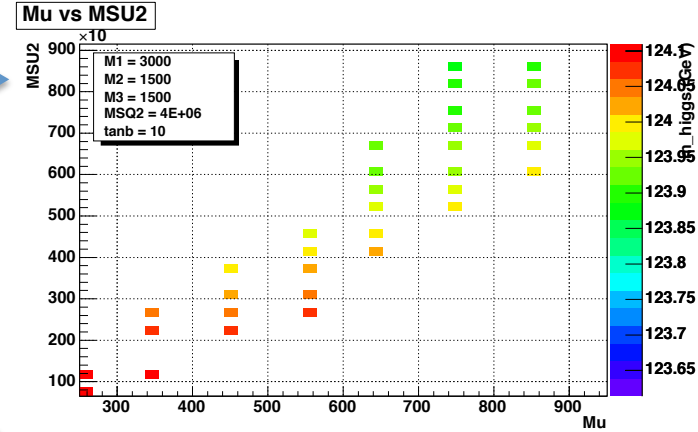
- Motivation for this channel

- Expected cleaner signature wrt 4 jets final states due to the high (b-) jets multiplicity  $\leftarrow$  reduced QCD bkg
  - Dominant over direct 4 jets final states in some regions of the SUSY parameter space
- Sensitive to small stop masses ( $300 \text{ GeV} < m_{t\tilde{t}} < 1 \text{ TeV}$ ) and  $\lambda''_{332}$  coupling

# Status of the art and ongoing work

- Study of the RpV SUSY spectrum as a function of low scale SUSY parameters ( $M1, M2, M3, TU, MSU2, MSQ2, \mu, \tan\beta, \lambda''_{332}$ )

- Study of the spectra to find the **avored region for the process of interest**



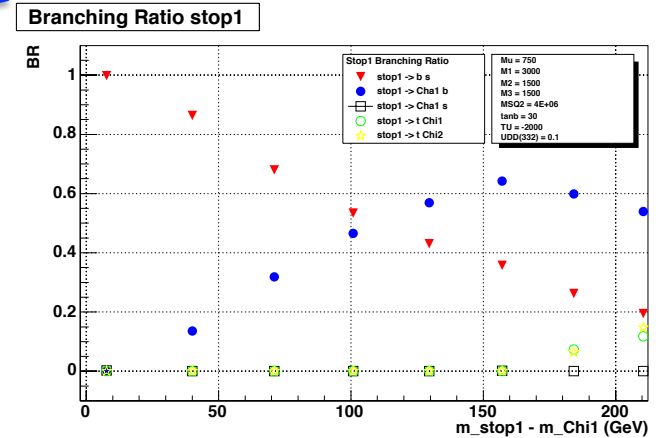
- $\tilde{t}_R$  is the lightest sfermion
- $m_{\tilde{t}^-} - m_{\chi_0^0} < m_t$  and  $m_{\tilde{t}^-} - m_{\chi_+^0} < m_b$ 
  - Suppressed phase space for  $\tilde{t}^- \rightarrow \chi_0^0 t$
- Higgsinos nearly degenerate
- Chargino mostly Higgsino-like

- Check spectra compatibility with experimental constraints (Higgs mass, flavor sector measurements, ...)

- Analytical and numerical computations of cross sections, widths and BR of the interesting process wrt other RpC and RpV processes as a function of:

- RpV coupling :  $\lambda''_{332}$
- Stop and neutralino masses
- Mass difference:  $m_{\tilde{t}^-} - m_{\chi_0^0}$

- Choose benchmark points to perform a full analysis with signal and background MC events



	$\lambda''(332) = 0.01$	$\lambda''(332) = 0.05$	$\lambda''(332) = 0.1$
8 jets xsec (pb)	0.003605 +- 1.4e-05	0.003262 +- 1.1e-05	0.00223 +- 8.4e-06
4 jets xsec (pb)	2.18e-07 +- 4.3e-10	0.000136 +- 2.4e-07	0.00106 +- 2.8e-06
Ratio (8/4 jets)	<b>~1.66E+04</b>	<b>~ 2.4E+01</b>	<b>~ 2.1</b>
BR ( $\tilde{t}^- \rightarrow b s$ )	3.19073428E-03	7.76874188E-02	2.30765624E-01
BR ( $\tilde{t}^- \rightarrow \chi^+ b$ )	9.95093709E-01	9.20724937E-01	7.67910810E-01

Spectrum	
$m_{\tilde{t}^-}$	~ 600 GeV
$m_{\chi^+}$	~ 450 GeV
$m_{\chi_0^0}$	~ 450 GeV
$m_h$	~ 125 GeV
$m_{\tilde{g}}$	~ 1900 GeV

# Actions foreseen in 2015

- Steps towards publication of multi-b-jets RPV analysis
  - Simulated data analysis using Run 2 LHC scenario
    - Emphasis on simulation of relevant backgrounds [multi-b-jets] using multi-legs MC generators
    - Identification of event variables to discriminate multi resonant SUSY production from SM background
  - Mixed experimental-phenomenology Workshop on RPV Run 2 sensitivity
- Study of the R-parity conserving supersymmetry, on the search for chargino and neutralino production in final states with 1 lepton, 2 b-jets compatible with a Higgs boson and missing transverse energy [S. Muanza, J.-L. Kneur].
  - This subject extends the SUSY studies and used a mix of experimental signatures, thereby enhancing the potential for discoveries.
  - A new PhD position will be allocated starting from September 2015.
  - 1 visiting scientist: X. Zhuang (IHEP)
    - Originally interested on expanding this search on tau final states. Her focus shifted on strong (not EW) SUSY production.