Search for $\tilde{\chi}_1^{\pm}\ \tilde{\chi}_2^0 \to 1\ \ell^{\pm} + h(b\bar{b}) + \not{E}_T$ with ATLAS at LHC Run2

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Origines, Constituants et EVolution de l'Univers

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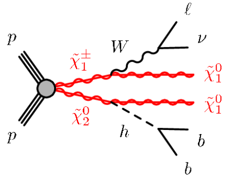
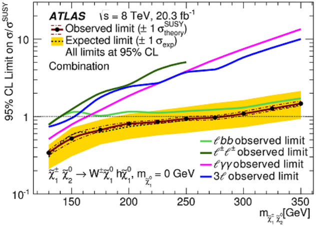
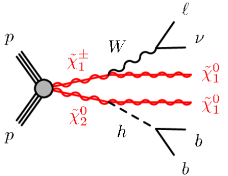


- Past: Run1 ($\sqrt{s}$=8TeV, L= 20 fb^{-1}):
  - 1st analyses using the Higgs boson to search for SUSY.
  - Exclusion limit at 95% C.L. $m_{\tilde{\chi}_1^{\pm},\tilde{\chi}_2^0} > 250$ GeV, $m_{\tilde{\chi}_1^0}$=0 GeV, Ref



- Near future: Run2 ($\sqrt{s}$=13 TeV, L= 100 fb^{-1}):
  - Enhance the search sensitivity.

- Looking for $\tilde{\chi}_1^{\pm}\ \tilde{\chi}_2^0 \longrightarrow 1\ \ell^{\pm} + h(b\bar{b}) + \not{E}_T$ at LHC Run2 with ATLAS.



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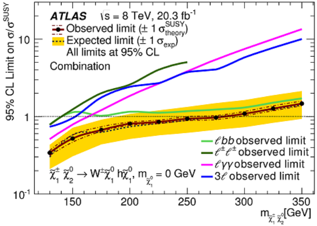


- Near future: Run2 ($\sqrt{s}$=13 TeV, L= 100 fb^{-1}):
  - Enhance the search sensitivity.

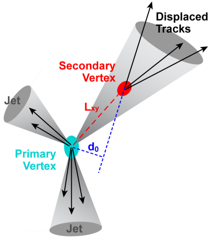
- Timing: Starting: Sep 2016

  Goal: Preliminary results conf winter 2017,

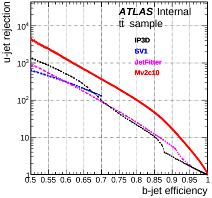
  Publication after summer 2017 conf

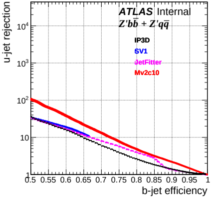
- b-tagging plays crucial role because of the 2 b-jets in the final state.

- b-taggers distinguish b jet from light and c jets
  - Rely on B-hadron properties (lifetime, mass)
  - Based on jets associated tracks properties. More details



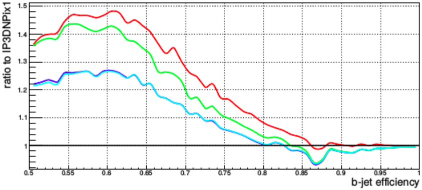
- The baseline run 2 b-tagging performance for $t\bar{t}$ (b-jet p_T mean: 66.7 GeV) and Z'($b\bar{b}$)+Z'($q\bar{q}$) samples (b-jets p_T mean: 550 GeV) for Z' produced with masses 1, 2 and 5 TeV.





Task1: V_0-trk reconstruction in jets

- V_0 (i.e $K_s^0 \to \pi^+\pi^-$) have lifetime similar to B-hadron.
- We're studying the impact of using the neutral parent V_0 track instead of the daughters on IP3D b-tagging performance.
- However, among the truth K_s^0 we reconstructed only 15 %.



IP3D 'SV1 Bad Tracks' are used
IP3D with rejecting Bad Tracks
IP3D with the reco- K_s^0-track using actual version of SV1
IP3D with rejecting truth $\pi^{\pm}$ trks from K_s^0
IP3D with the truth- K_s^0-track shows the highest improvement

Impact of Pixel dead modules on b-tagging

- I produced several scenarios with different % of inactive modules in pixel layers (IBL, L0, L1, L2).
- I studied the role of the IBL against the Multi Scattering and Pattern recognition issues

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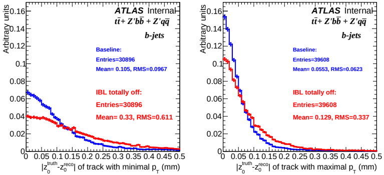

- The degradation in performance is decreasing with increasing track p_T.

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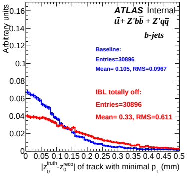

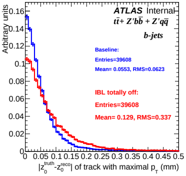

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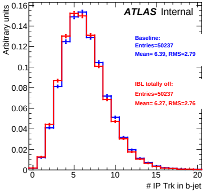
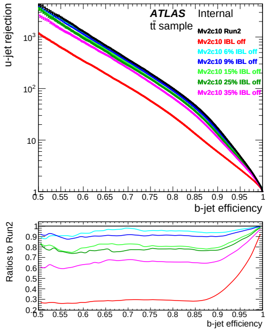
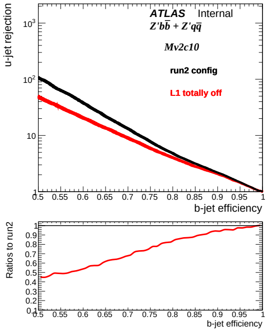


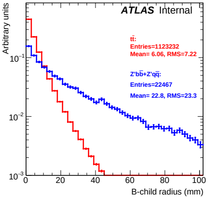
- Jets loosing tracks are boosted jets containing large number of tracks.

- For $t\bar{t}$ scenarios in IBL show the highest degradation in perf while it is L1 for Z' samples



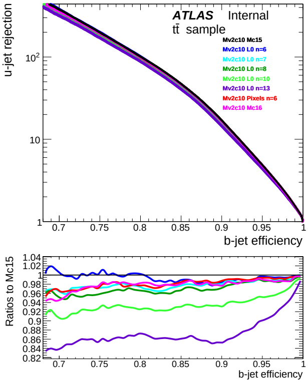


- This is because B-hadrons go beyond the IBL for Z' samples.



Impact of pixel ToT threshold changes on b-tagging

- At high Luminosity the number of collision and particles produced will increase and L0 will suffers from high occupency.
- One of the possible solution is to increase the pixel ToT threshold cut from 4 in to 6.



- No visible impact on b-tagging perf.
- It was decided to increase ToT cut to 6.
- Both studies on pixels will be documented in ATLAS internal notes by end of october.

- Add the 125 GeV Higgs boson mass as input to Suspect 3
  - Suspect3 is a SUSY spectrum calculator
  - In the present version this mass is calculated as output

- Benefit for all SUSY analyses:
  - Facilates pMSSM scans by avoiding large number of incompatible models.

- Task: Look for free parameters in the Higgs and stop sectors (i.e.: μ, A_t, tanβ) computable for a **known Higgs boson mass**.

Suspect3

- Authors: - Fortran: A. Djouadi, J-L Kneur, G. Moultaka.
  - C++: Michael Ughetto, Dirk Zerwas.
- Aim:
  - Computes pMSSM spectrum for SUSY breaking models mSUGRA, AMSB and GMSB.
  - Implements the radiative corrections at full one loop for the masses and the dominant **two loops for the Higgs**

  .
- Input: SLHA file containing
  - SM inputs (M_Z, M_{top}^{pole}, $\alpha(M_Z)$, $\alpha_s(M_Z)$,...)
  - Boundary conditions of the SUSY breaking model.

- Reminder of the simple approximation for the Higgs mass radiative corrections (RC)

$$m_h^2 = m_h^{2,tree} + \frac{3g_2^2 m_t^4}{8\pi^2 m_w^2 sin^2(\beta)} [ln(\frac{m_{\tilde{t}_1} m_{\tilde{t}_2}}{m_t^2}) + \frac{X_t^2}{2M_s^2} - \frac{X_t^4}{12M_s^4}]$$

With $X_t = A_t - \mu cot(\beta)$

$M_s^2 = \sqrt{m_Q^2 m_{t_R}^2 + m_t^2(m_Q^2 + m_{t_R}^2) + m_t^4}$

$m_{\tilde{t}_1} m_{\tilde{t}_2} = \sqrt{M_s^4 - 4m_t^2 X_t^2}$

- Possible inversions:

125 Higgs boson mass $\xrightarrow{1} A_t$

$\xrightarrow{2} \mu$

$\xrightarrow{3} tan\beta$

$\xrightarrow{4} m_{H_u}^2, m_{H_d}^2$

- Example: A_t computation:
  - Input: $\tan(\beta)$, μ, $m^2_{H_u}$, $m^2_{H_d}$
  - Procedure: $m_A \rightarrow\ m_H^{tree} \rightarrow$ RC, Quadratic equation in X_t^2
    $\rightarrow$ multiple A_t solutions
- Technical difficulties:
  - Multiple solutions: Need Constraints to reject unwanted solutions
  - Convergence of the iterative procedure
- Status: First code version with the 4 inversions working well and in validation.
- Future work: Replace RC with the full one loop for the masses and the dominant **two loops for the Higgs** relation.

- We computed $m^2_{H_u}$ and $m^2_{H_d}$ using inversion 4 for A_t= -2000.

Input	Output
type of inversion= 1	A_t
m_H exp= 125 GeV	m_A^{tree}= 65 GeV
m_{top}= 173 GeV	m_H^{tree}= 62.5 GeV
m_W= 80.1 GeV	RC= 11719.3 GeV^2
m_Z= 90.1 GeV	
m_{t_R}= 2000 GeV	A_{t_1}= -2004.48 correct value,
m_Q= 2000 GeV	relative deviation=0.24%
g_c= 0.64	
$\tan(\beta)$= 10	A_{t_2}= 2204.48 unwanted value
μ= 1000	
sign of μ= +1	
$m^2_{H_u}$= -984135 GeV	
$m^2_{H_d}$= -1.01164e+06 GeV	

Thank you for your attention!

Basics of b-tagging

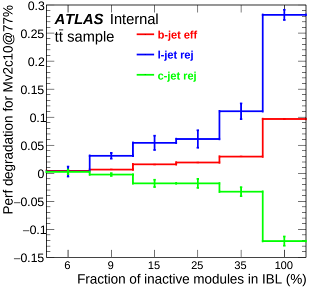
- The **B-hadron properties** utilised by spatial b-taggers (i.e.: IP3D, SV):
  - Hard fragmentation of b quarks ($x_B \sim 70\%$)
  - long lifetime($\sim$ 1.5ps) leading to a flight length (few mm)

  $\Rightarrow$ displaced secondary vertex
- Tracks from B−hadron decay at the SV are characterised by large impact parameters (IP)
- The IP (d_0, z_0) is the distance from the point of closest approach of the track to the PV.
- Other ATLAS b-taggers: the multivariate Mv2c10
  - It combines the output of the simple taggers (IP3D, SV, ..)

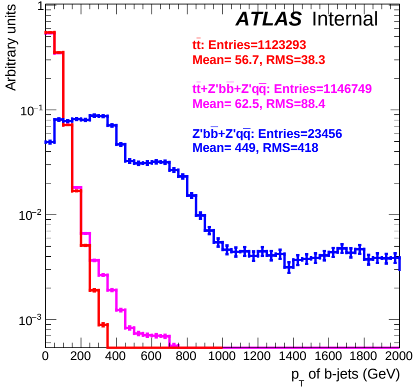
- The Pixel detector measure the Time-over-Threshold (ToT):
  - the time in which the signal is abovethreshold.
  - In units of bunch crossings (BC), i.e. 25 ns
- ToT is proportional to the deposited charge.

$$ToT = A\frac{Q+E}{Q+C}$$

- A, E and C are calibrated for each FE.
- RUN1 calibration ToT@mip30 =19000e
- The threshold represents the efficency to have a hit from charged particle
  - it corresponds to 3500e $\Rightarrow$ hits with time $<$ threshold is not read.



- We looked for the degradation in perf for fixed cut on jet-w.


ATLAS Internal
tt̄: Entries=1123293
Mean= 56.7, RMS=38.3
tt̄+Z'bb̄+Z'qq̄: Entries=1146749
Mean= 62.5, RMS=88.4
Z'bb̄+Z'qq̄: Entries=23456
Mean= 449, RMS=418
Arbitrary units
p_T of b-jets (GeV)
1
10^-1
10^-2
10^-3
0 200 400 600 800 1000 1200 1400 1600 1800 2000

- Tracks from V0 decay in l-jets look like tracks from B-hadron
- They are flagged as SV1 Bad Tracks
- In this preliminary study, using the truth we are estimating the highest improvement we can expect.
- We reconstruct Ks vertex if we find in the same jet two SV1 bad track with opposite charges forming a vertex with ks mass
- We are drawing a linear neutral track for the reco Ks in jet using reco Ks vertex and position x,y,z and Ks momentum Vector.
- Similarly we are drawing a linear neutral track for the truth