Top pair production

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Motivations for top studies

- Top = heaviest known fermion, strongly connected to EWSB *(our theoretical framework is a composite scenario dual of an extradimensional model)*
- Need to measure Ztt couplings (for t_R and t_L)
- Observables of interest :
  - σ(tt), A_{LR}, A_{FB}

$$A_{LR} = \frac{N_{top}(e_L^-) - N_{top}(e_R^-)}{N_{top}(e_L^-) + N_{top}(e_R^-)}$$ (e^- polar. flip)

Error, $\Delta A = \sqrt{\frac{1 - A_{FB(LR)}^2}{N}}$

$$A_{FB} = \frac{N_{top}(\cos\theta_t > 0) - N_{top}(\cos\theta_t < 0)}{N_{top}(\cos\theta_t > 0) + N_{top}(\cos\theta_t < 0)}$$ (top direction)

Topology studied : semileptonic top

- We study semileptonic top decays, i.e. tt→(bW)(bW)→(bqq)(blv)
  - 1 lepton (→ top charge) + 4 jets (2 b jets + 2 light jets = W)
  - Combinatorics reduced : (b_1W) or (b_2W) only
  - Lepton angular distribution gives hints on CPV
- We need :
  - Excellent lepton ID + selection
  - Excellent B tagging for 1 jet (b jets come in pairs)
- *The data samples used are those of the LOI (full simulation + reconstruction)*

Lepton identification

Particle	Momentum cut	Identification	Efficiency
Muon	$P_{track} > 5$ GeV	$E_{calo}/P_{track} < 0.5$	99.4%
Electron	$P_{track} > 5$ GeV	$E_{calo}/P_{track} > 0.8$ $E_{ecal}/E_{calo} > 0.9$	97.9%

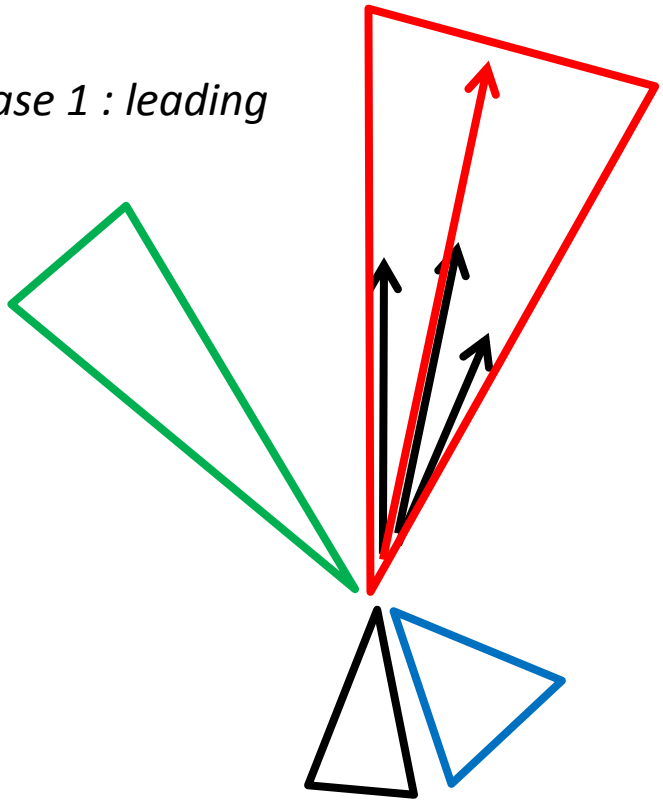
Rather loose cuts but :

- A muon may pick a small pion cluster in the calorimeter (also with electron / photon)
- We kill other candidates with an isolation method (see next slides)

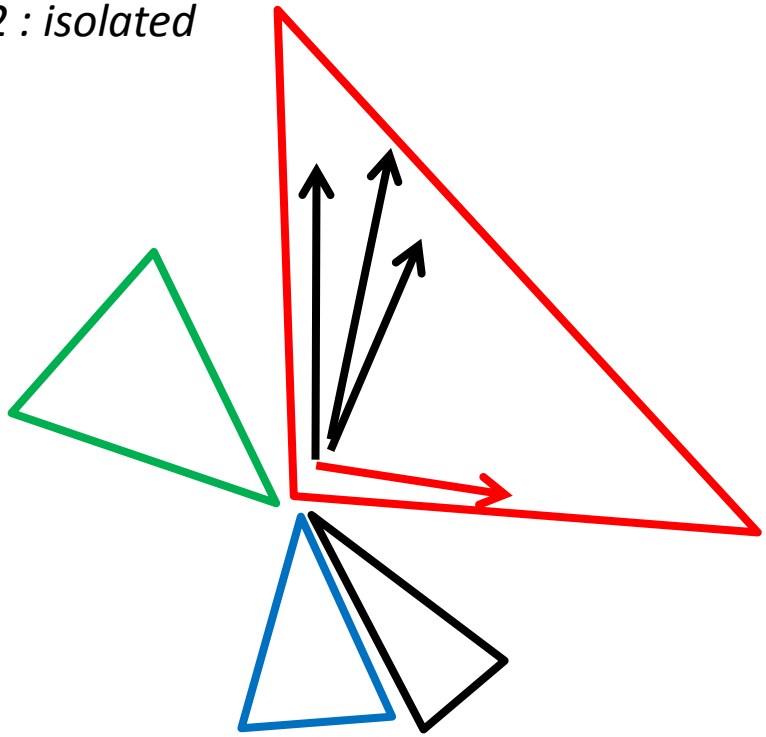
Isolation method

- Force 4 jets topology → lepton embedded into a jet
- The lepton from W decay must be « leading » or « isolated »
  - Kills pions faking muons (always inside a jet)
  - Kills leptonic b decays (neither leading, nor isolated)

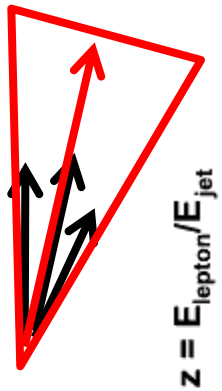
Case 1 : leading



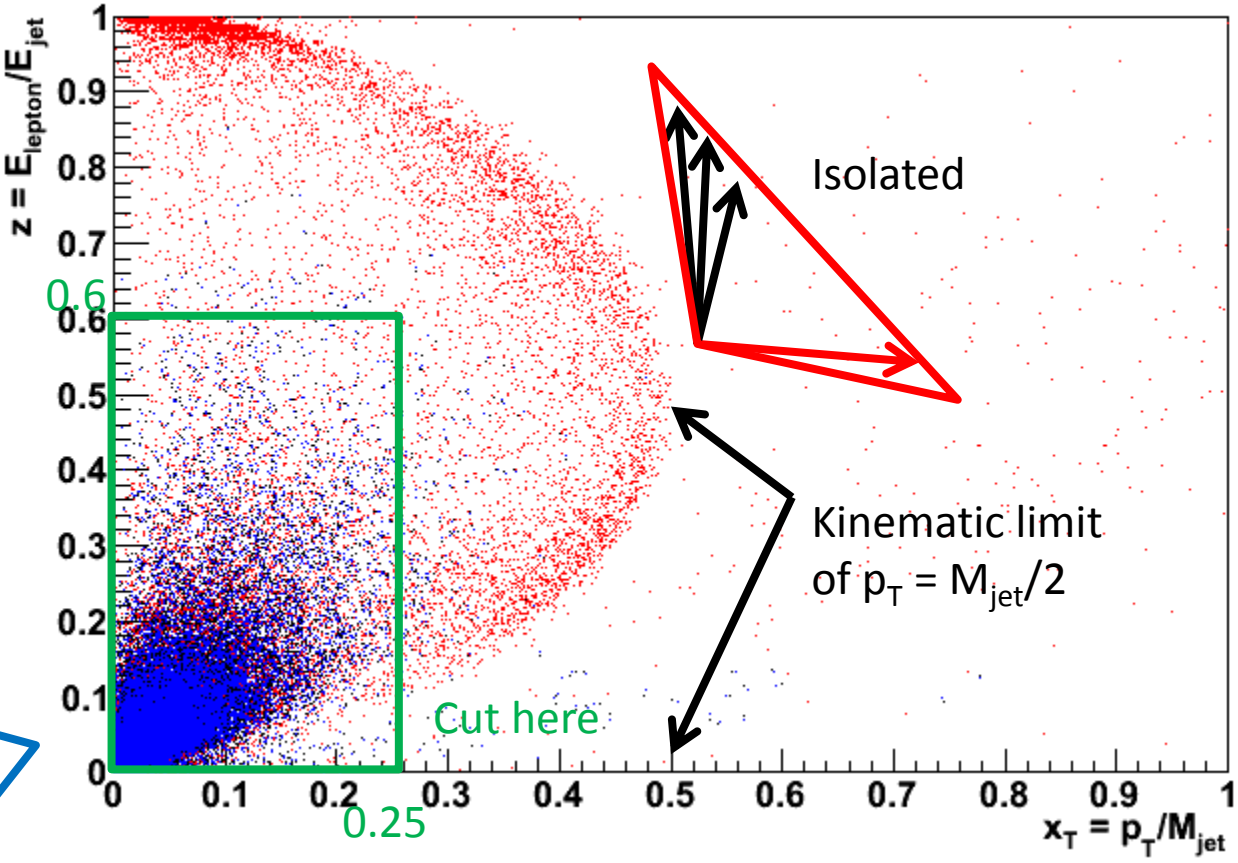
Case 2 : isolated

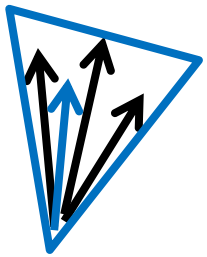


Isolation cuts



Leading





Not isolated
(lepton from b)

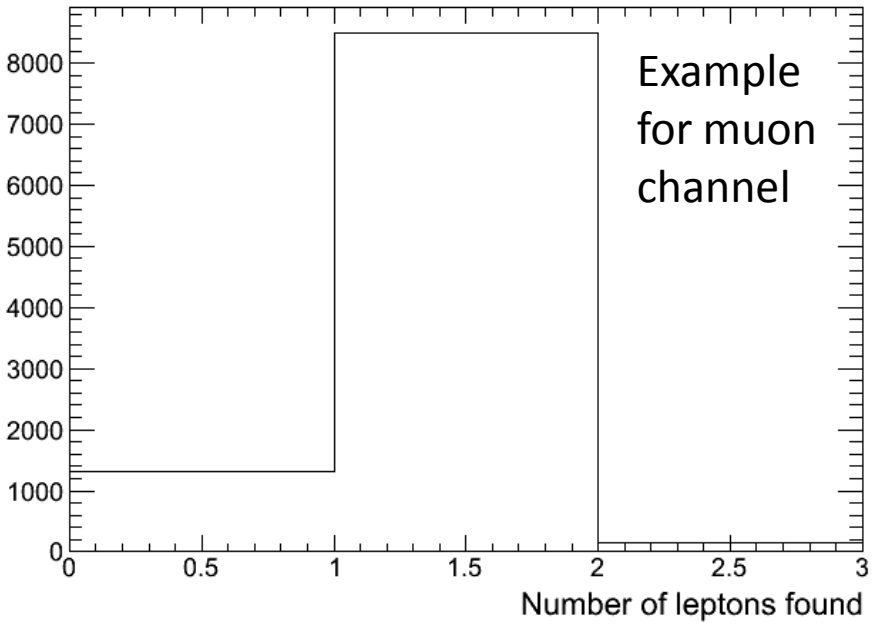
Red = leptons in semileptonic top events

Blue = leptons in full hadronic top events = leptons from b

Results with isolation

Lepton	P « good » W→lν	P « bad » (mis-id)	Efficiency	Contamination (1-purity)
Muon	86.7%	1.8%	85.3%	0.24%
Electron	82.7%	1.6%	81.7%	0.28%

- Efficiency rather good (strong isolation constraints)
- Excellent purity to deal with full hadronic top background
- Will force $N_{leptons} = 1$ (rejects ZZ→bbll background)
- tau → lνν channel gives a 20% contribution to add



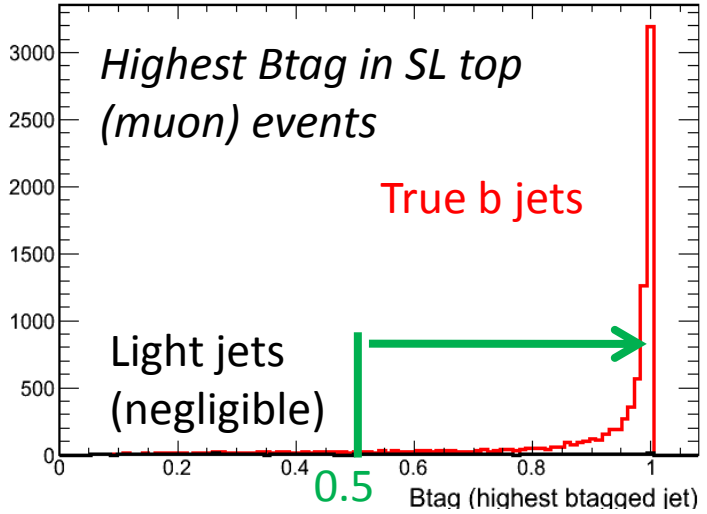
B tagging

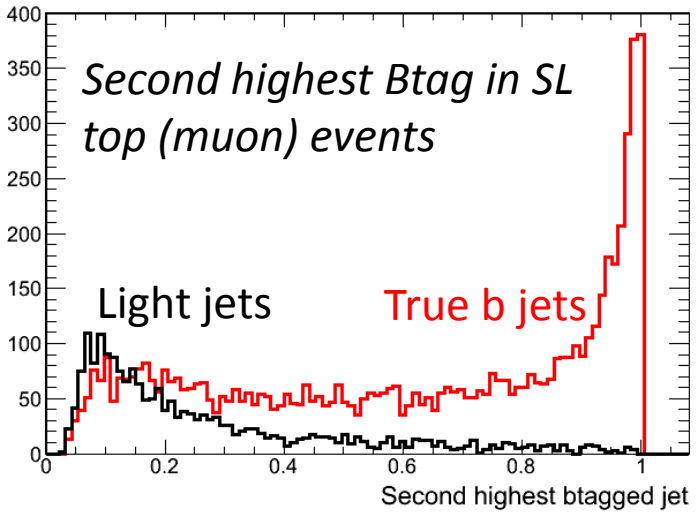
- 1 well tagged b jet is enough (1 b jet comes with another)

Btag > 0.5
- Efficiency = 90.2%
- Purity = 98.2%

→ Good for highest btagged jet

→ Second highest is more problematic (not used here)
- Efficiency = 48.8%
- Purity = 96.2%
- Discussed a while ago (maybe decay length and problems in jet clustering)



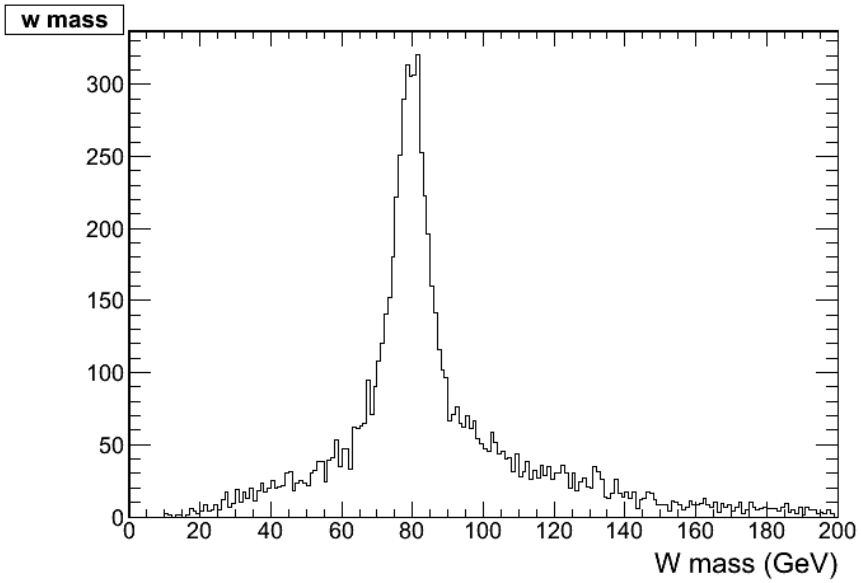


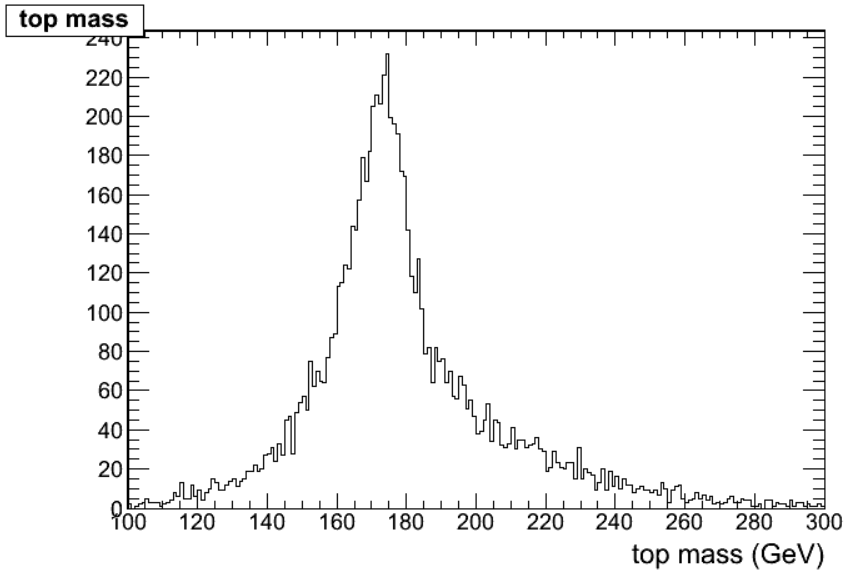
Pairing b and W

- We use the constraints on the top energy and mass : E_{top} = 250 GeV, M_{top} = 174 GeV

- Minimise $$d_{1,2} = \left(E(b_{1,2}W) - 250\right)^2 + \left(M(b_{1,2}W) - 174\right)^2$$

Preliminary results of m_W and m_{top} (signal only)
→ Good reconstruction without effort !





Signal and background left

Process	Efficiency after Nlep = 1	Efficiency after highest btag > 0.5	Relative cross-sections	Fraction left w.r.t SL signal
tt → SL (e,μ)	85.3% , 81.7%	78.5% , 75.3%	1	77%
tt → SL (τ)	20.6%	19.3%	~ 0.5	9%
tt → hadronic	1.7%	1.4%	~ 3	4%
bb	9.0%	6.0%	~ 14	84%
WW → qqlv	53.1%	4.4%	~ 34	150%

WW → qqlv often b-tagged !

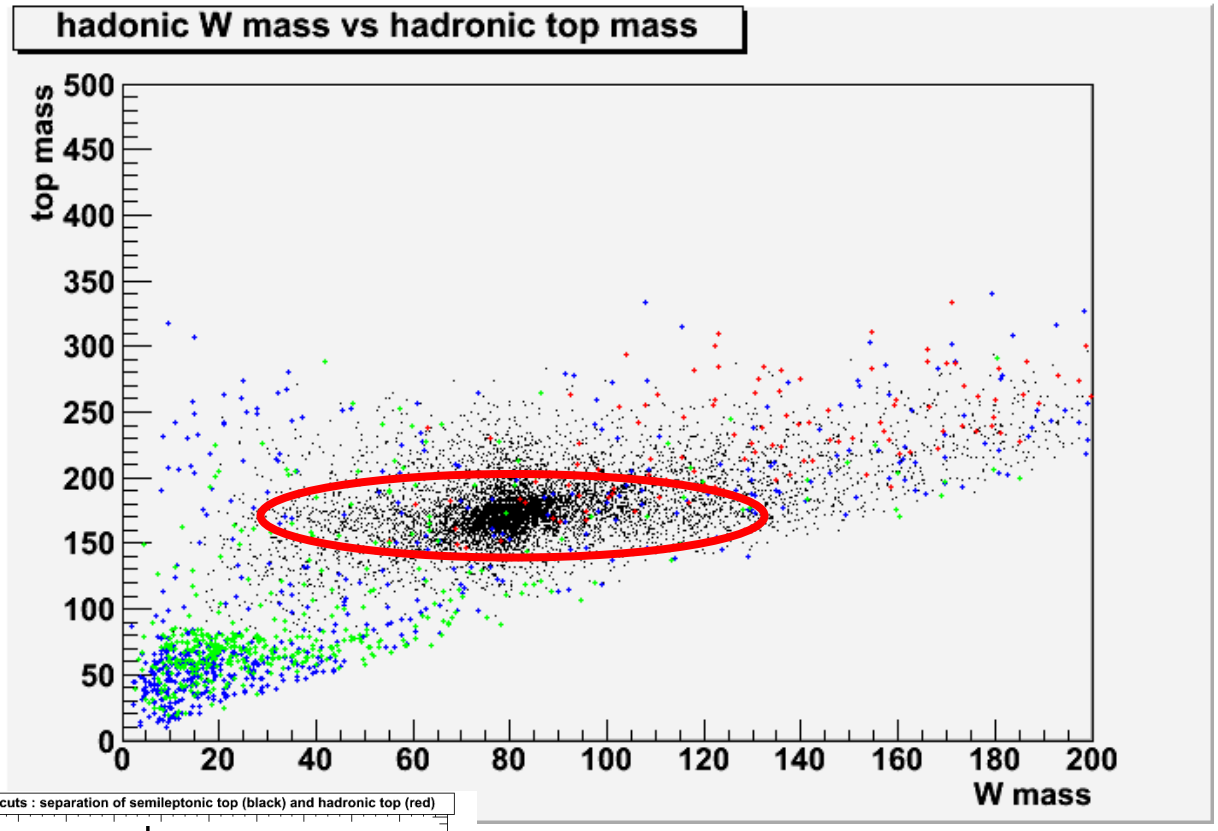
More work on these backgrounds is needed

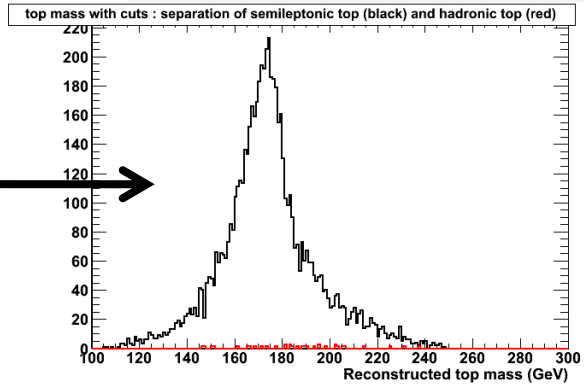
Cut on m_W/m_{top}

- Black = SL top
- Red = had top
- Blue = bb
- Green = WW_{sl}

This final cut should remove almost all remaining backgrounds

Need to work on it





Reconstructed semileptonic top mass and hadronic top background (still preliminary)

Conclusions and outlook

- Top pair production is studied to measure σ(tt), A_{LR} and A_{FB} + CPV from lepton → < 1% precision expected
  - Need to find 1 isolated lepton :
    - > 80% efficiency and > 99.5% purity
  - Need 1 well b-tagged jet (btag > 0.5) :
    - > 90% efficiency and > 98% purity
- Major backgrounds are being checked :
  - Full hadronic tt is killed by isolated lepton
  - Still bb and WW_{sl} left (large cross-sections)
    - Work on it – maybe use m_W/m_{top} cut
- Derive sensitivites on observables and Ztt couplings