Top studies : curing WW

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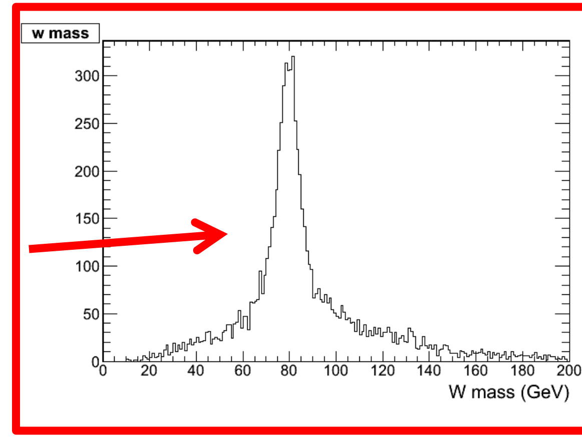
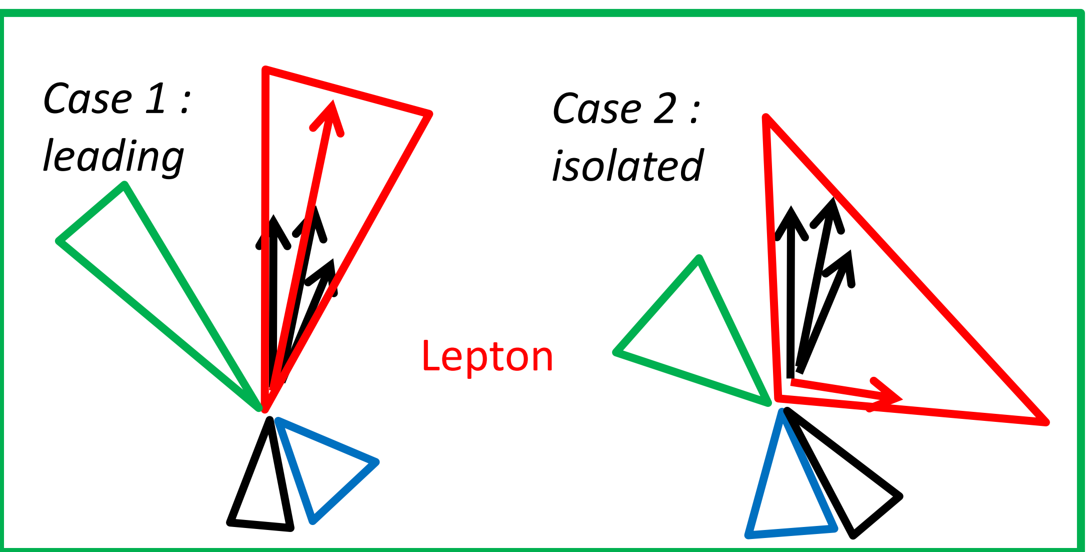
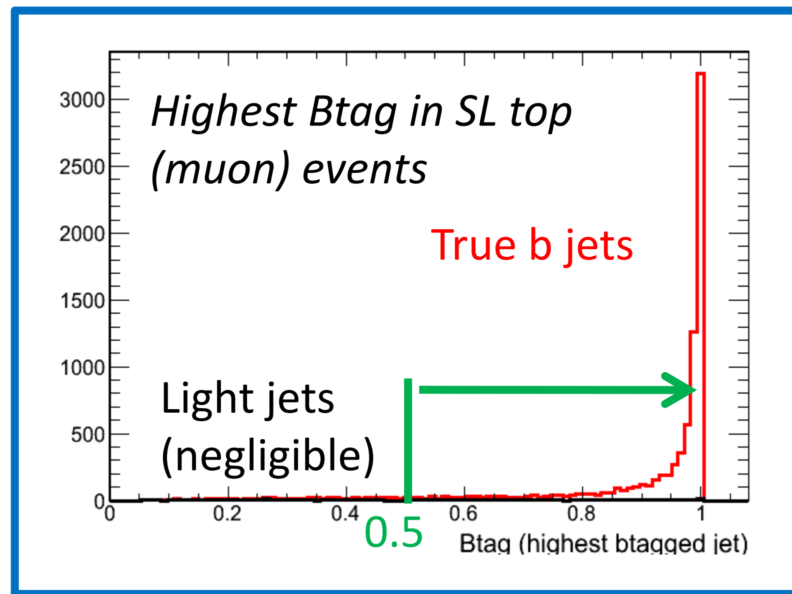
LABORATOIRE DE L'ACCÉLÉRATEUR LINÉAIRE

Introduction

- We focus on top pair production, semileptonic channel tt→(bW)(bW)→(blν)(bqq)
  - Observables : σ(tt), A_{LR}, A_{FB}, lepton angular distribution
  - Topology : 1 lepton + 4 jets (2b + 2 light jets)
  - Needs : 1 isolated lepton, 1 well Btagged jet
  - Use of LOI DSTs







Signal and background (as of last month)

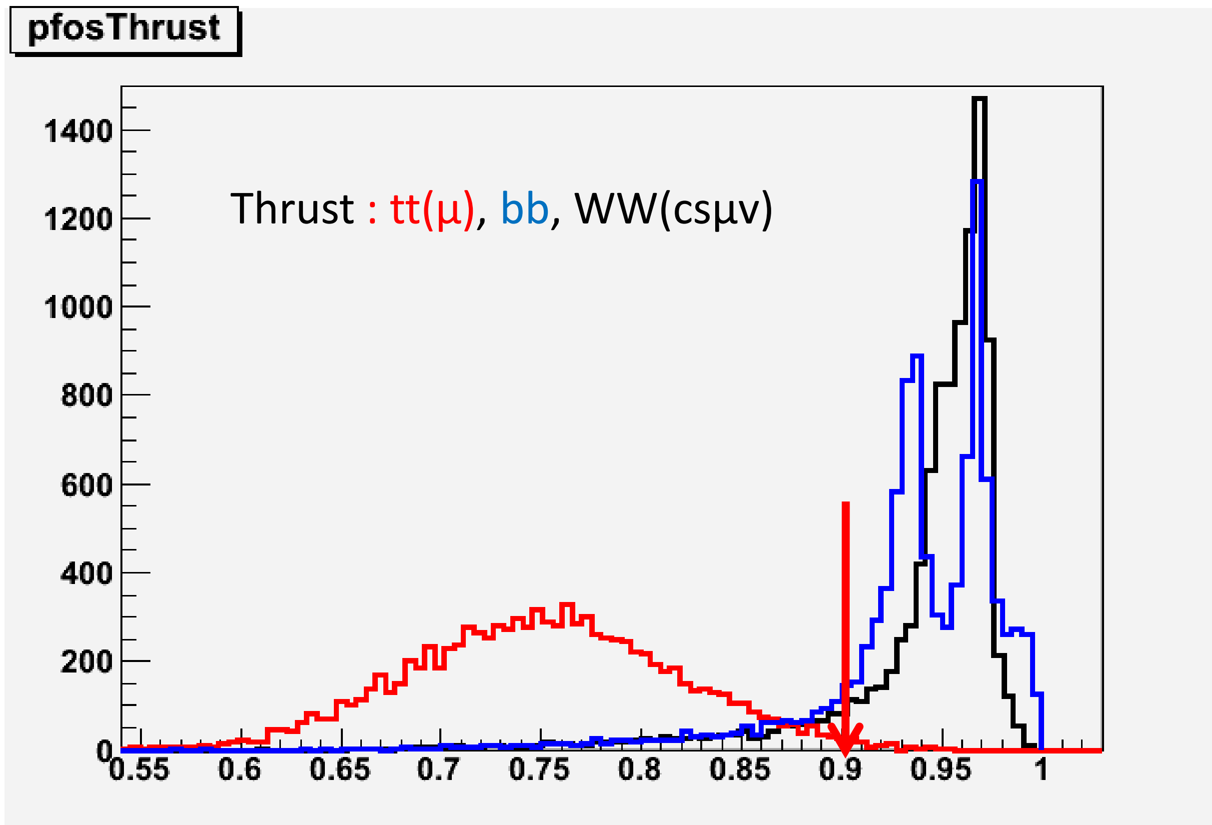
Process	Efficiency after Nlep = 1	Efficiency after highest btag > 0.5
tt → SL (e,μ)	85.3% , 81.7%	78.5% , 75.3%
tt → SL (τ)	20.6%	19.3%
tt → hadronic	1.7%	1.4%
bb	9.0%	6.0%
WW → qqlv	53.1%	4.4%

Remarks :

- tau decay mode adds statistics
- hadronic mode cured (no isolated lepton)
- some bb left (different topology)
- WW_{sl} left (bad lepton efficiency, bad btag purity)

1. To cure bb background (and most WW), use « thrust » as a precut (next slide)
2. Something is wrong with WW → First step towards WW studies
3. Some problems with 2 fermions cross-sections in Whizard :
   $\sigma(bb)_{unpol}$ = 2473 fb (Whizard) – 370 fb expected at tree level
   4 and 6 fermions seem correct

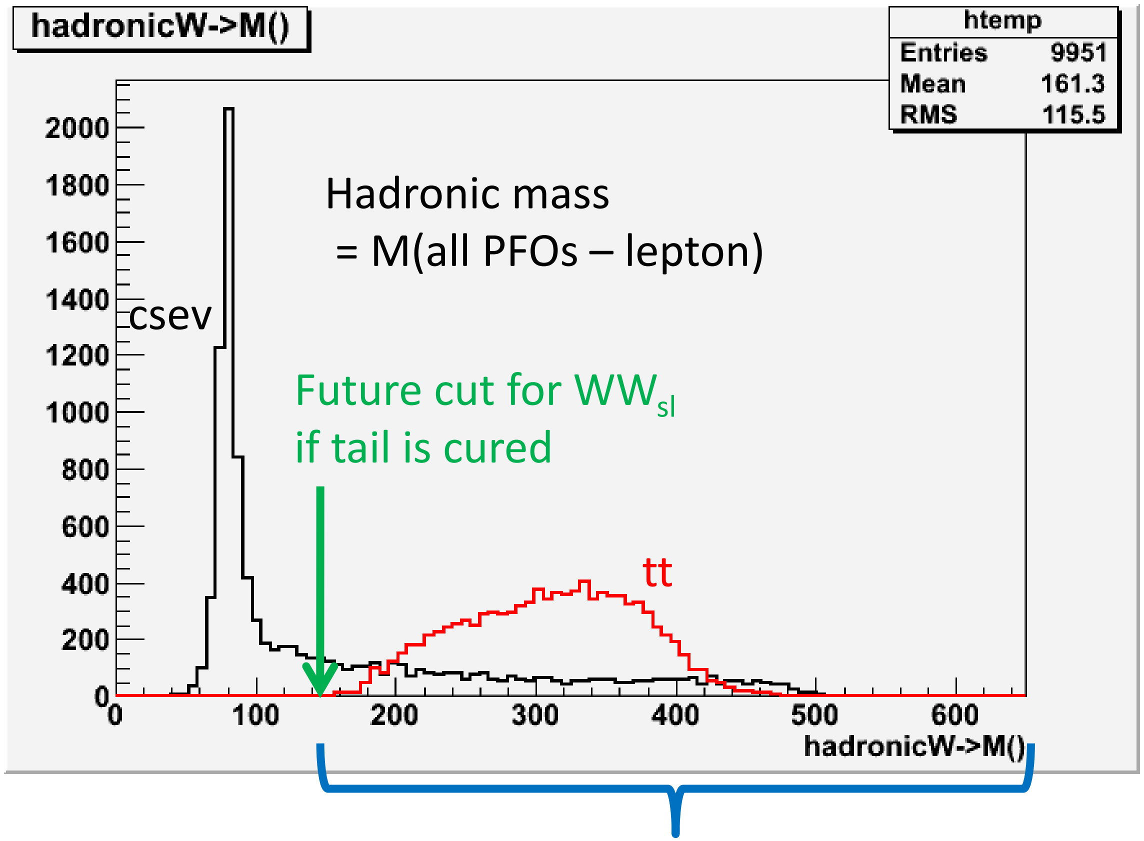
Precut on thrust



- Process well separated
- 2 peaks for bb (smallest thrust when one jet is lost E≈250 GeV, highest when E≈500 GeV)

Process	Fraction left after Thrust > 0.9
tt → bbcsμν	99.0 %
bb	12.6 %
WW → csμν	10.7 %

Semileptonic WW issue : hadronic mass



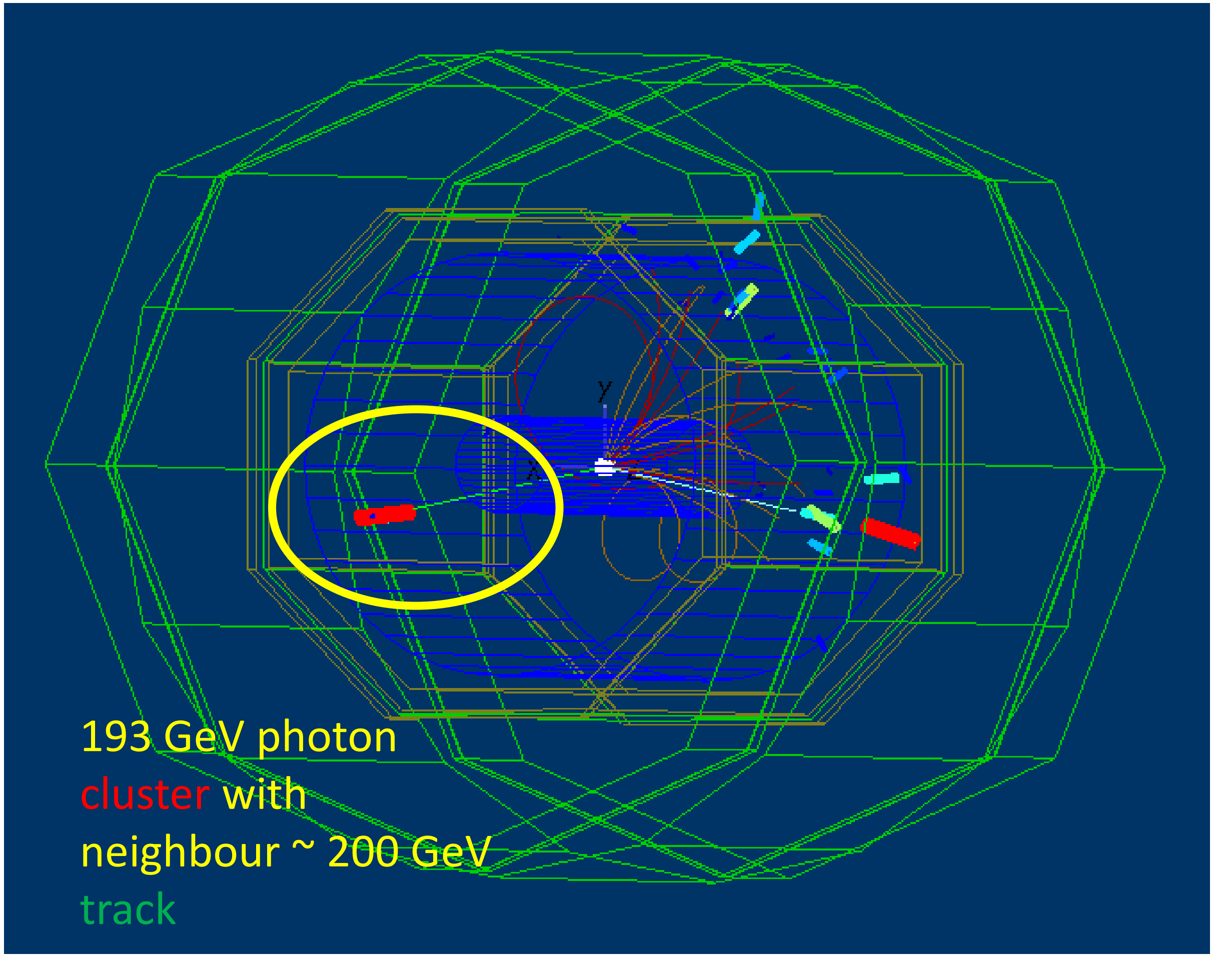
In WW_{sl} events :
WW/Wev→csev
After finding an isolated lepton, look at M(rest) = M(W)
→ Interesting cut but
→ Rather large tail

We investigated these WW events to understand where the lepton was lost → leads to better WW understanding and lepton selection

Non associated tracks

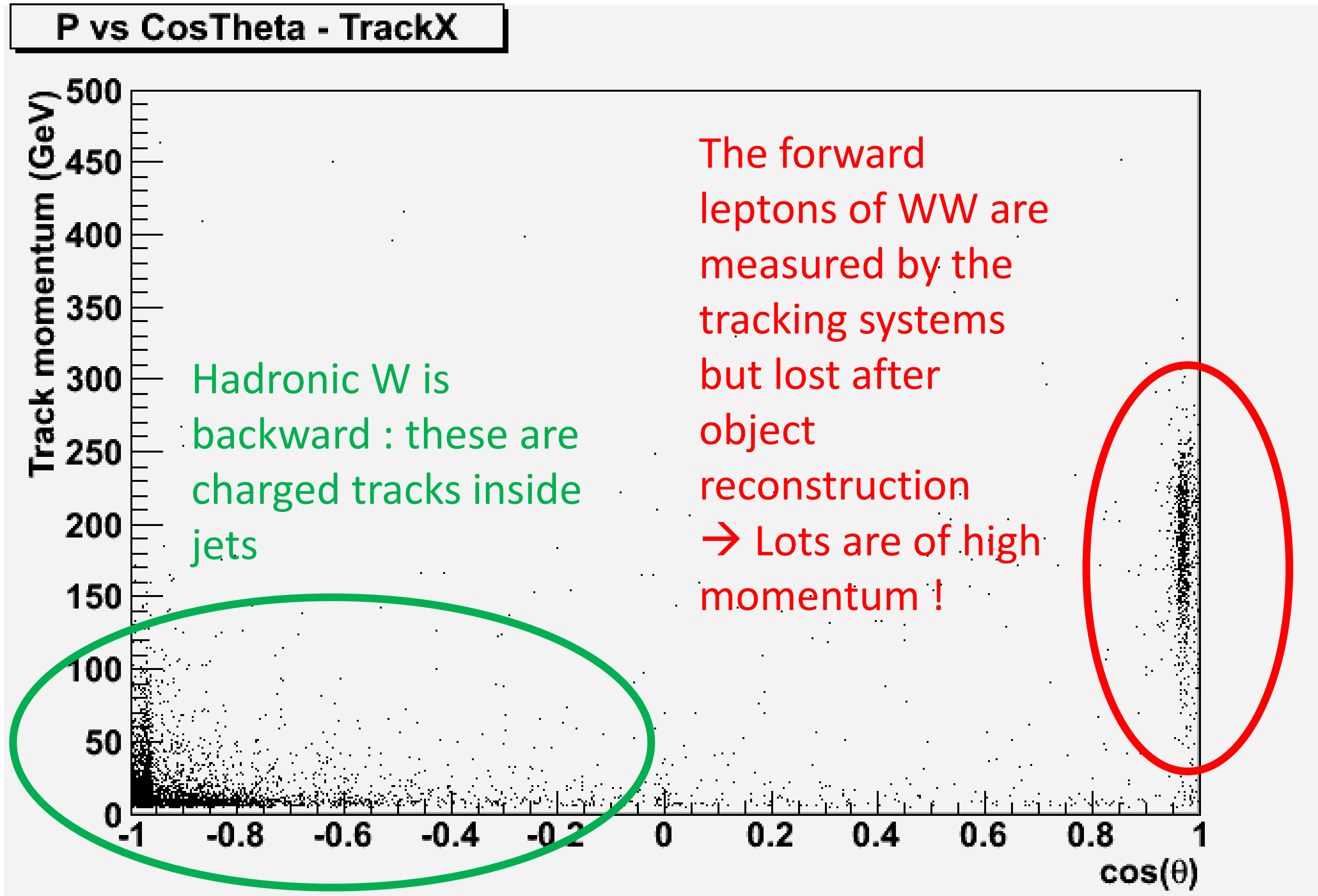
- We find some non-associated tracks in the forward (and central) regions
- Well measured (small Δp) and large p

- For electrons : a photon cluster with ~ same energy is closeby but not associated
→Energy is not lost but leads to wrong PID
- For muons : energy is lost !



Event display of a csev event : one track is not associated to its cluster while momenta and positions are very close.

Proof : non associated tracks



P vs cos(θ) of non associated tracks in csμν events (μ^- only)

≈ 40 % of WW_{sl} and tt_{sl} events contain non associated tracks
→ Major problem for leptons in WW but minor in tt

Getting the leptons back

After discussions with Mark Thomson :

- Maybe PandoraPFANew can cure the problem (no answer yet) but need to run on REC files
- We apply a simple recovery patch using a cone around the non associated track ($\cos(\theta)_{cone} = 0.95$)
  - Electron : if leading photon in cone ($E_y/E_{cone} > 70\%$) and energies match $|E_y - P_{track}|/P_{track} < 30\%$ then promote track+photon to electron
  - Muon : if $E_{cone}/P_{track} < 50\%$ then promote track to muon

Recovered leptons

Process	Efficiency to identify a lepton among non associated tracks	Purity of the identification
WW (μ)	15.3 %	96.7 %
WW (e)	16.3 %	93.6 %
tt (μ)	2.6 %	82.4 %
tt (e)	6.4 %	83.9 %

- Efficiency is small (a lot of non associated tracks come from charged hadrons) but very good purity
- Efficiency and purity are different for WW and tt : patch made for forward tracks in WW, tt has more particles and is « spherical »
- Efficiency is the same for e/μ in WW but different for e/μ in tt ! (not yet understood)

New figures

Process	Thrust > 0.9	+ Nb Lepton = 1 [contamination]	+ Mhad > 150	+ Highest Btag > 0.5
bbcsμν bbcseν bbcsτν	99 % 99 % 98.6 %	87.2 % [0.3 %] 86.5 % [0.4 %] 22.5 %	87.1 % 86.4 % 22.4 %	79.6 % 79.0 % 21.0 %
bb	12.6 %	1.3 %	0.5 %	0.4 %
csμν	10.7 %	10.0 %	4.9 %	0.5 %
cseν	30.7 %	22.2 %	5.8 %	0.5 %

Need to have a look at ZZ background

Further step : top reconstruction for A_{FB}

Efficiency – Contamination estimation :

- Signal is tt → bbqq(e,μ)ν : ε = 79.3 % « + taus »
- Background here is bb and WW → qqlν : Cut on m_W-m_{top} not yet added (should gain factor > 6 in purity) P_{top} ≈ 99% expected

Our purity = « finding the good lepton from SL tops» = $Cont._{top}$ + $Cont._{lep}$

Conclusions

- Semileptonic top study with ILD
  - Efficiency close to 80 % with ~ 99 % purity of good lepton expected
  - Room for improvements : lepton finding and Btagging
- To do :
  - Check minor backgrounds like ZZ
  - Combine results together to get σ(tt), A_{LR}, A_{FB} + systematics