New filter for large missing p_T

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- New filter developed for the invisible Higgs search in the HZ channel.
- Can be useful to many other analyses requiring large missing p_T such as $H \rightarrow \tau\tau$
- Analysis based on previous work done with Fortran-based ATLFAST **(ATL-PHYS-PUB-2005-011)**
- Analysis based on Athena, release 10.5.0

$Z^0H^0 \rightarrow l^+l^-$ invisible analysis strategy

Trigger: 1 or 2 prompt leptons

Preselection:

- Select events with large missing p_T
- Select events with 2 leptons of opposite sign and same flavour
- Loose cut on Z mass

Final selection:

Use 10 discriminative variables in a likelihood function to select signal

Why a filter?

1) Background is overwhelming
2) 15 mins CPU per event!

From ATL-PHYS-PUB-2005-011	$Z^0H^0 \rightarrow \chi\chi\ l^+l^-$	$Z^0Z^0 \rightarrow l^+l^-\ \nu\nu$	Z^0 incl. $\rightarrow l^+l^-$	$tt \rightarrow bl^+\nu\ bl^-\nu$
σ * BR (pb)	0.043	0.300	2804	125.1
# events @10 fb^{-1}	426	2999	62.1 M	22.3 M
preselection (~ ptmiss + nlep)	62.0	183.3	14.6	170.4
$\mathcal{L}$ selection	54.6	151.8	3.3	6.2

Filter purpose: emulate preselection cuts after MC generation but be more inclusive than the AOD selection

Ptmiss calculation at AOD level

Ptmiss = - Σ visible transverse energies for:

- Isolated photons, electrons and muons
- Jets, b-jets and c-jets
- Clusters not accepted as jets
- Non-isolated muons not added to a jet
- Transverse energies in cells not used elsewhere

Ptmiss calculation at generator level

Vectorial sum of transverse momenta for

- Invisible particles (invisible Higgs, neutrinos)
- Lost particles: those falling outside the calorimeter acceptance region: $|\eta| > 5.0$

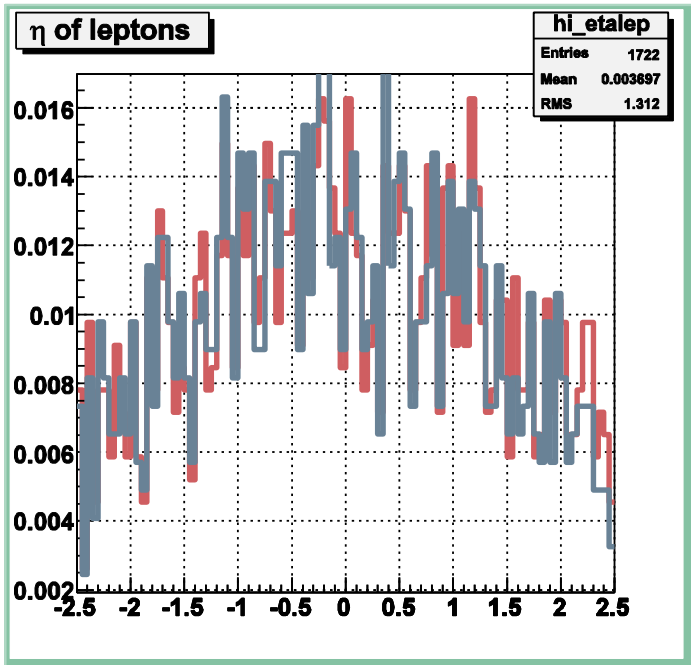
Ptmiss calculated differently in filter and in AOD (ATLFAST or full reconstruction)

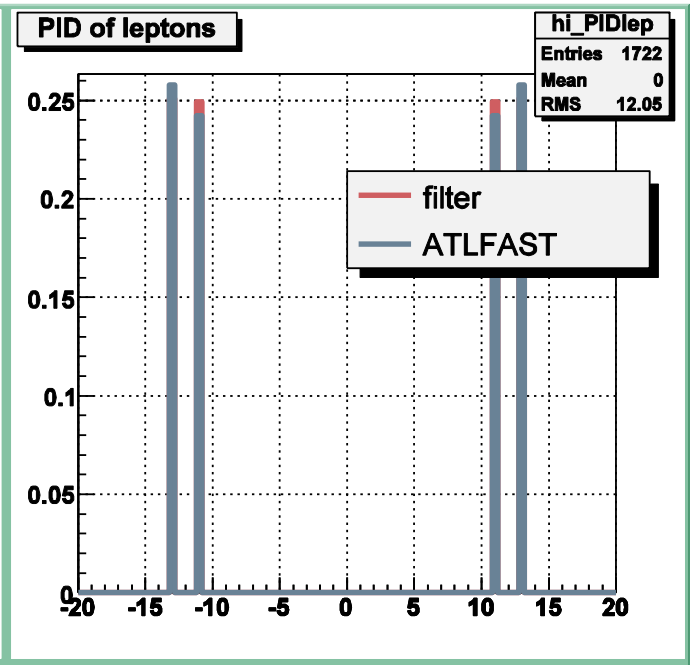
So we are not comparing the same object

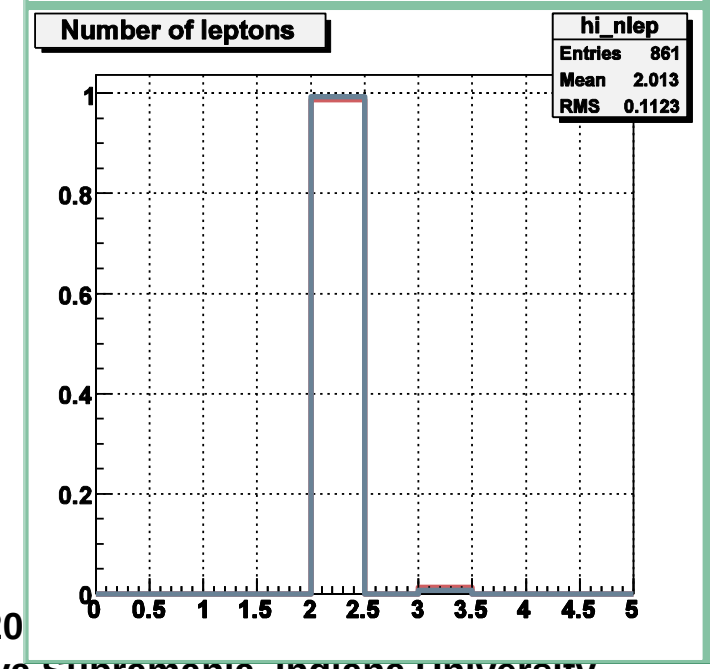
Second handle in filter: leptons

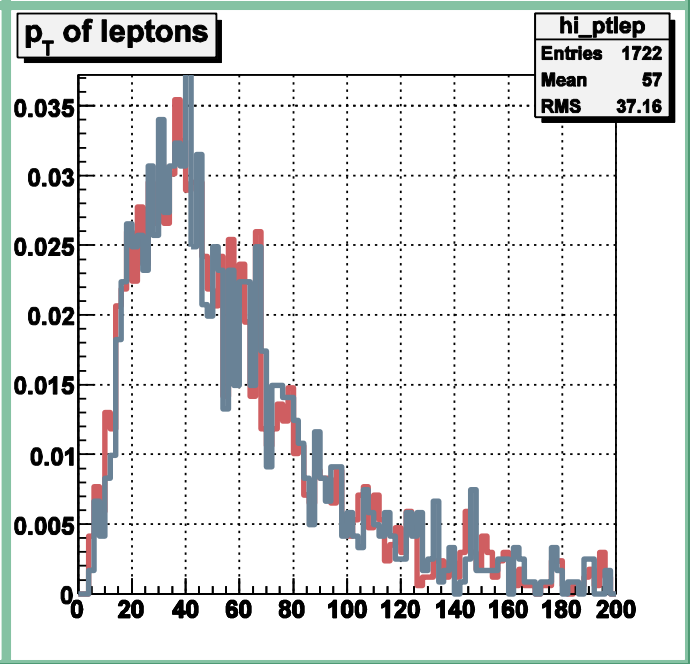
- To pass the filter, the event must contain at least 2 leptons in the acceptance region
  - tracking acceptance region: $|\eta| < 2.5$
  - we set it to $|\eta| < 3.2$ for smearing
- The leptons must have $p_T > 5$ GeV
- Trigger requirements: $p_T > 10$ GeV for di-muons
  $p_T > 15$ GeV for di-electrons

Comparison between lepton variables at generator level before filter and ATLFAST AOD for signal: $H^0Z^0 \rightarrow \chi\chi l^+l^-$

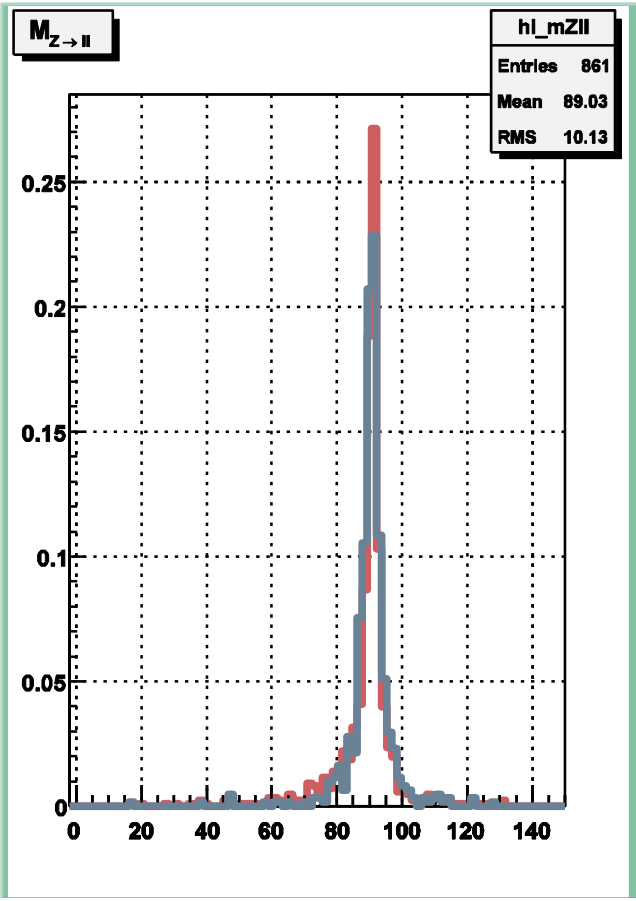


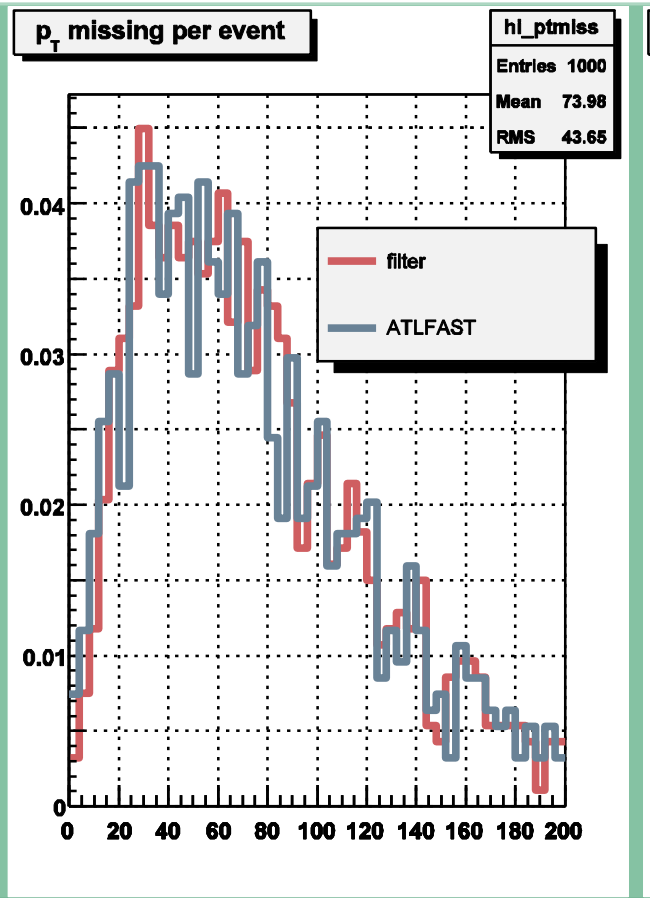


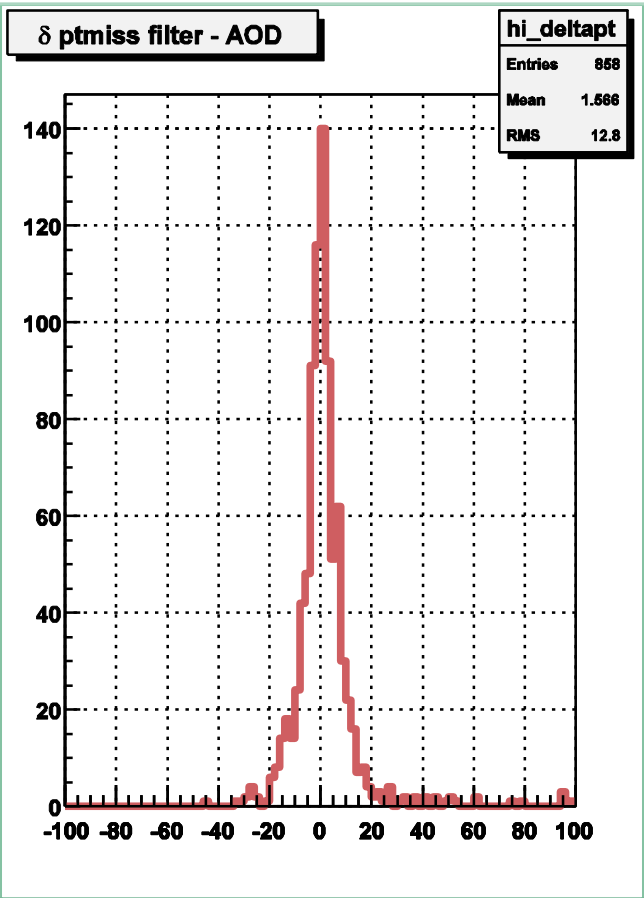




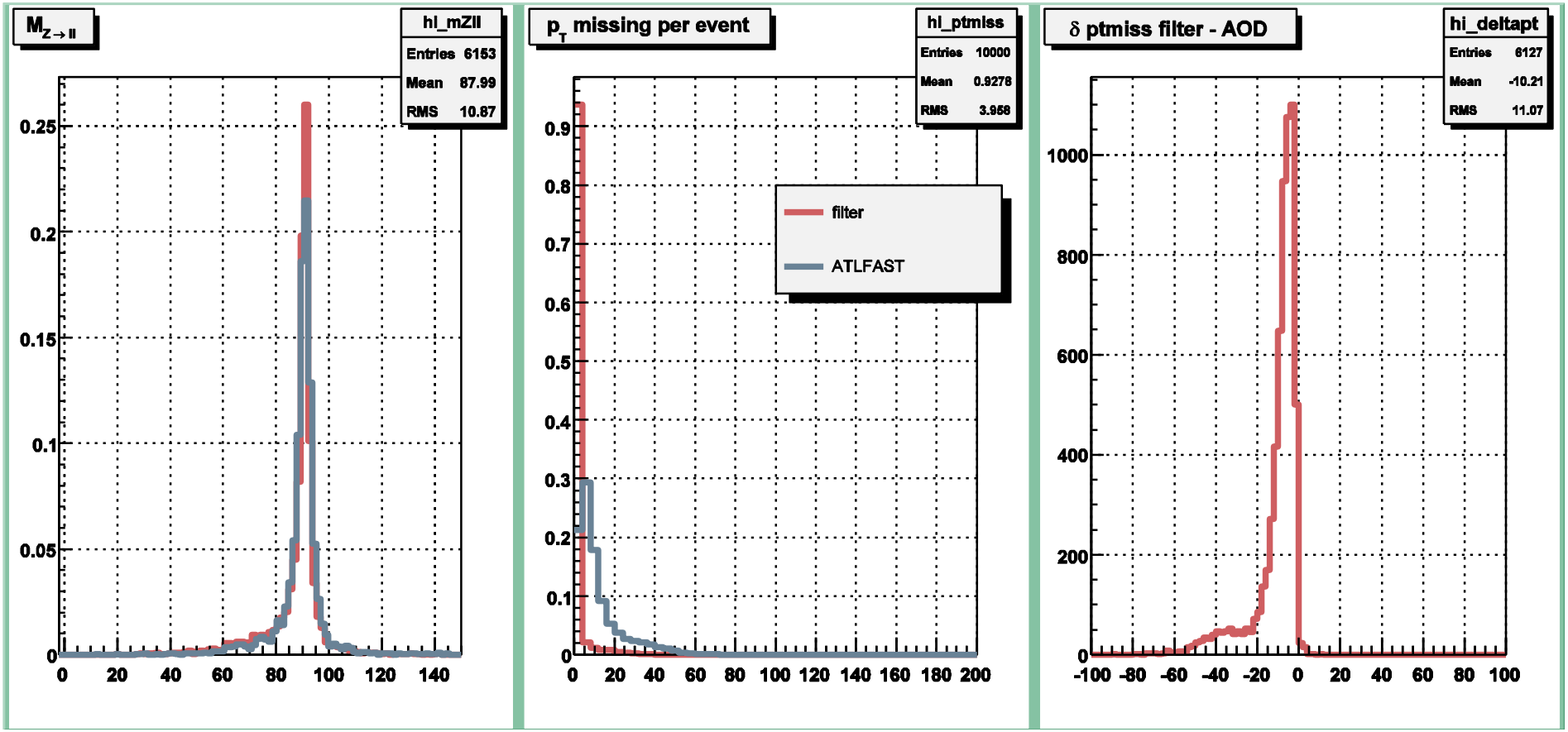
Comparison of global variables at generator level before filter and ATLFAST for signal: $H^0Z^0 \rightarrow \chi\chi l^+l^-$







Comparison between filter and ATLFAST for Z^0 incl.



Accepted events

Filter	ATLFAST AOD
ptmiss > 50 GeV	ptmiss > 90 GeV
$\|\eta\|$ lost > 5.0	$\|\eta\|$ lost > 5.0
$\|\eta\|$ lepton < 3.2	$\|\eta\|$ lepton < 2.5

	$H^0Z^0 \rightarrow \chi\chi l^+l^-$ Weight = 0.0043		$Z^0Z^0 \rightarrow l^+l^- \nu\nu$ Weight = 0.0300		Z incl. Weight = 280.4	
	Filter	AOD	Filter	AOD	Filter	AOD
Generated	99034	99034	100000	100000	100000	100000
Selected	60342	23369	38296	10480	2	0
Unmatched	36973	0	27818	2	2	0

CPU time savings when simulating 100 fb^{-1}

	$Z^0H^0 \rightarrow \chi\chi\ l^+l^-$	$Z^0Z^0 \rightarrow l^+l^-\ \nu\nu$	Z^0 incl. $\rightarrow l^+l^-$	$tt \rightarrow bl^+\nu\ bl^-\nu$
σ * BR (pb)	0.043	0.300	2804	125.1
100 fb^{-1}	4260	30000	621 M	223 M
filtered	2594	11490	12420	~1.1M

From 24 000 CPU years down to 32 CPU years…

Still more time saving is possible

Use Elzbieta Richter-Was' trick:

- Generate events and filter them
- Reconstruct filtered events with ATLFAST
- Apply final selection
- Feed back the selected events to the full simulation chain!
- Repeat analysis on handful of fully reconstructed events

Plans

- Complete comparison studies between filter and AOD for fully reconstructed events using 0.5 M ttbar (T1) sample
- Make this filter public in GeneratorFilters package as soon as possible
  - See /afs/cern.ch/user/p/pgagnon/public/PtmissFilter
- Apply the filter to large signal and background samples and fully reconstruct them on the Grid
- Redo the analysis with full simulation as in ATL-PHYS-PUB-2005-011. Improvements planned:
  - use NN for final selection
  - use $ZZ \rightarrow l^+l^- l^+l^-$ with second Z "invisible" as done by Freiburg group to improve cross-section determination for main background $ZZ \rightarrow l^+l^- \nu\nu$