Validation of invisible HZ $\rightarrow \chi\chi ll$ analysis for central MC production

- Analysis outline
- Effect of the PtmissPlusLeptonFilter
- MC samples needed
- Plans for HZ$\rightarrow \chi\chi ll$
- News on other invisible Higgs activities

Preliminary comments

- 99% of software development done on full reconstruction chain
- Large number of analyses still done with ATLFAST. Why?
- Impossible to fully reconstruct large MC samples for all backgrounds
- But ATLFAST has not been validated yet…
- Only possible solution: Add a filter
- Move to fully reconstructed AOD asap….

$Z^0H^0 \rightarrow l^+l^-$ invisible initial analysis strategy (Fortran-based ATLFAST, ATL-PHYS-PUB-2005-011)

Trigger: 1 or 2 prompt leptons

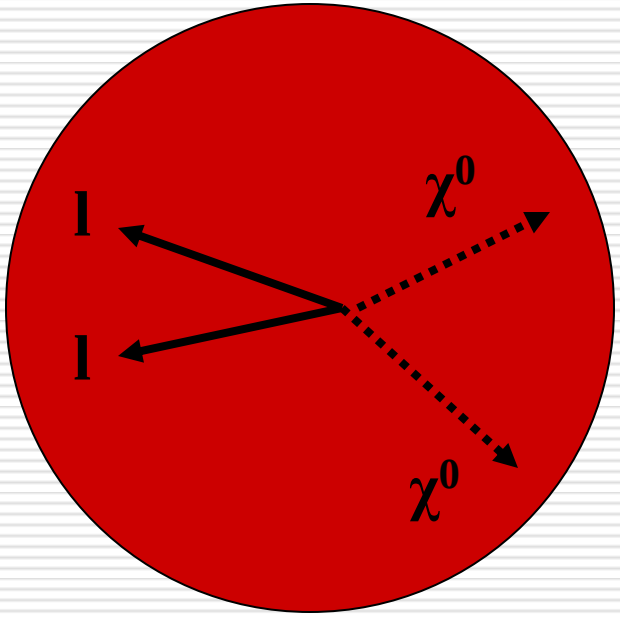
Preselection:

- large missing p_T
- 2 leptons of opposite sign and same flavour
- loose cut on Z mass

Final selection:

Use 8 discriminative variables in a likelihood analysis to extract signal

ZH: $H \longrightarrow \chi^0 \chi^0$, $Z \longrightarrow l^+l^-$



Invisible Higgs decay in HZ channel

Signal: $H \to \chi\chi$ and $Z \to l\,l$:

- Large missing p_T
- Two prompt leptons forming a Z

Main backgrounds:

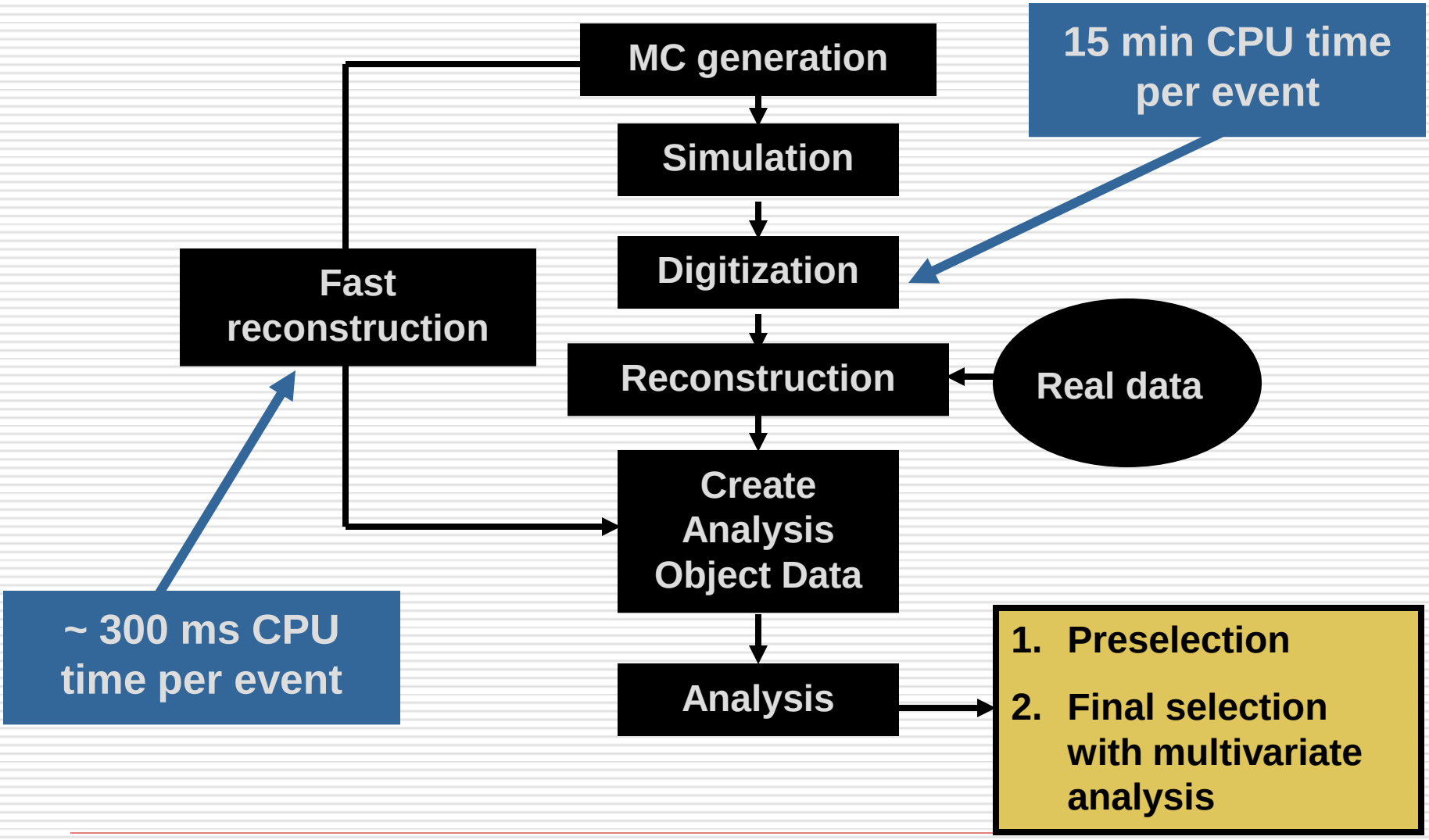
- $ZZ \to l\,l\,\nu\nu$
- Z inclusive with $Z \to l\,l$ missed jets
- $tt \to b\,l\,\nu\,b\,l\,\nu$ with missed bb jets
- $W\,W \to l\,\nu\,l\,\nu$
- $W\,Z \to l\,\nu\,l\,l$ with one missed lepton
- $ZZ \to l\,l\,\tau\tau$

Most background were rejected at preselection level in ATL-PHYS-PUB-2005-011

channel	$Z^0H^0 \rightarrow$ l^+l^- invisible	$Z^0Z^0 \rightarrow$ l^+l^- $\nu\nu$	Z^0 incl. $\rightarrow$ l^+l^-	$t\bar{t} \rightarrow$ $bl^+\nu$ $\bar{b}l^-\bar{\nu}$
σ * BR (pb)	0.043	0.300	2804	125.1
# events @10 fb^{-1}	426	3000	28.04 M	1.251 M
preselection	62.0	183.3	14.6	170.4
$\mathcal{L}$ selection	54.6	151.8	3.3	6.2

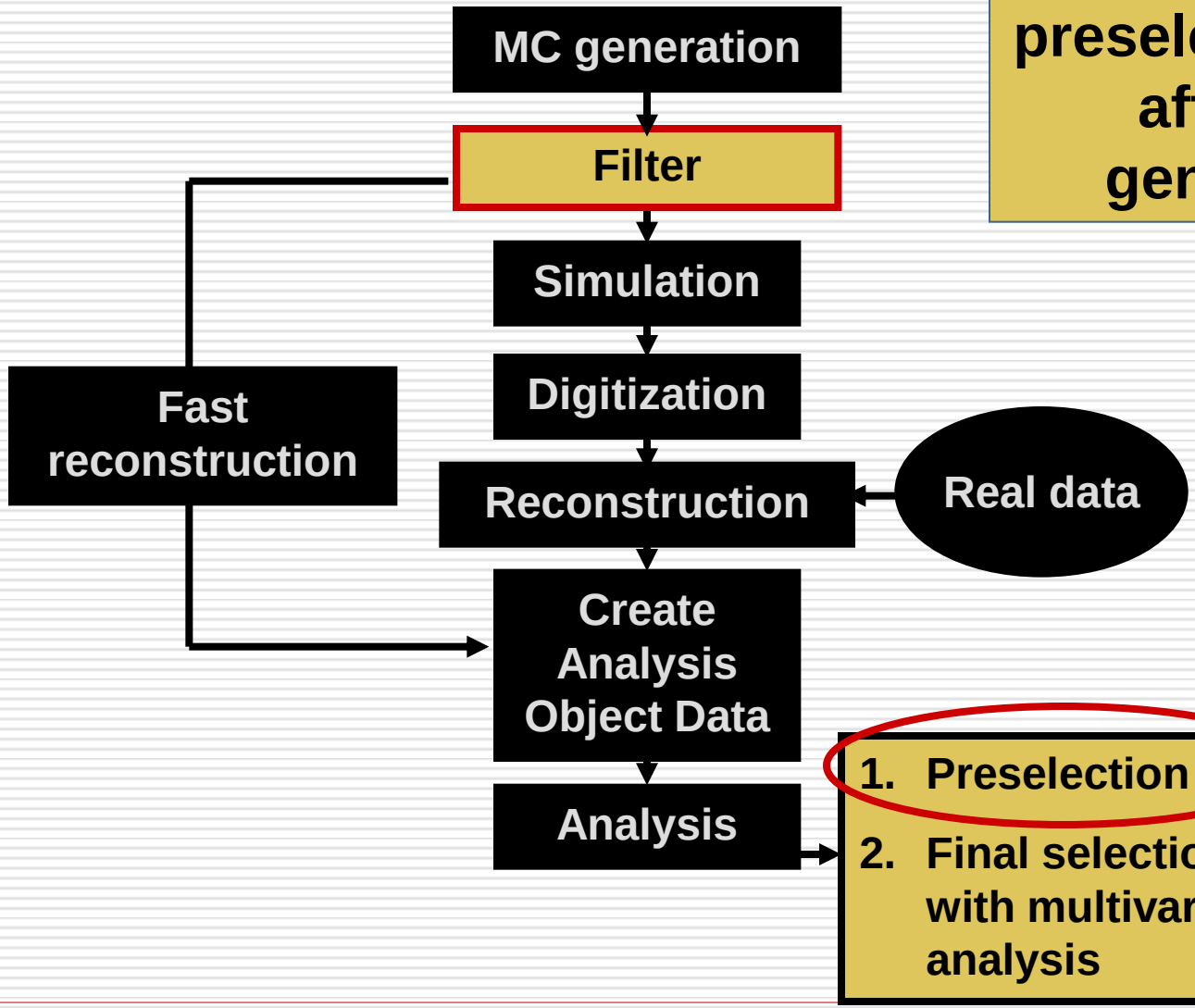
But no one can afford to fully reconstruct millions of events just to throw them away

ATLAS reconstruction chain



Solution: add a filter

Filter goal:
emulate preselection cuts after MC generation



Filter performance

- Filter must be inclusive:
  - All events selected at AOD level must be accepted by the filter
- Filter must substantially reduce the sizes of samples to be fully reconstructed
- The PtmissPlusLeptonsFilter does both
- All details in Monte Carlo group meeting:
  http://agenda.cern.ch/fullAgenda.php?ida=a061576

Filter versus preselection cuts

Filter cuts: looser cuts

- 2 leptons with $\eta <$ 2.7
- Trigger requirements:
  - 1 e with p_T > 18 GeV or
  - 2 e with p_T > 23 GeV or
  - 1 μ with p_T > 8 GeV or
  - 2 μ with p_T > 13 GeV
- Missing p_T > 50 GeV
- m_Z 25 GeV

Preselection cuts

- 2 leptons with $\eta <$ 2.5
- Trigger requirements:
  - 1 e with p_T > 20 GeV or
  - 2 e with p_T > 25 GeV or
  - 1 μ with p_T > 10 GeV or
  - 2 μ with p_T > 15 GeV
- Missing p_T > 90 GeV
- m_Z 20 GeV

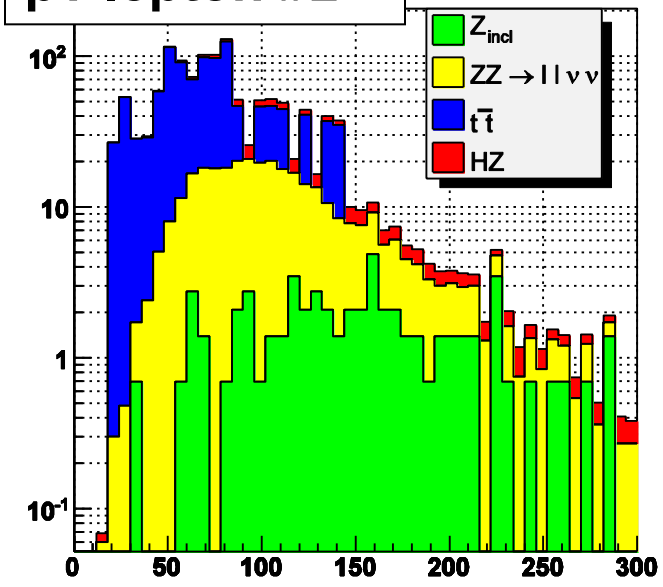
All preselected events at AOD level (both ATLFAST and full reconstruction) were retained by filter for signal and background

Cut flow on ATLFAST AOD after filter

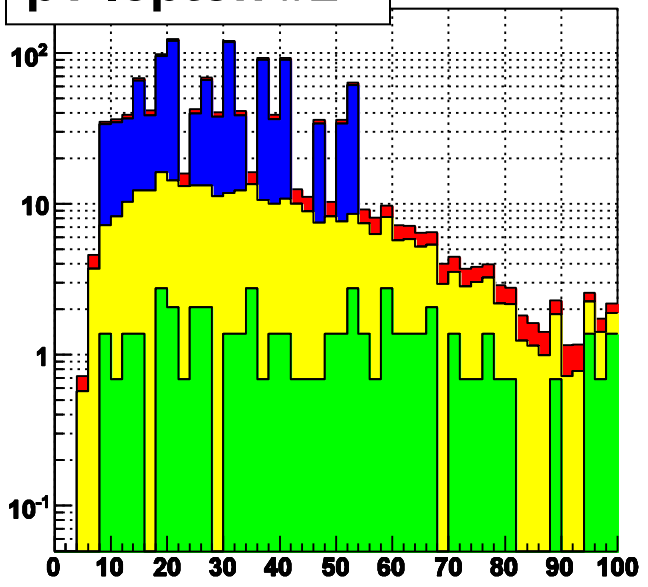
final filter sauf HZ and ZZ	HZ		ZZ -> llnunu		Z incl.		ttbar	
# of generated events	100 K		100 K		40.726 M		47270	
event weight	0.0043		0.03		0.689		26.47	
Events at 10 fb-1	430	100%	3000	100%	28.04 M	100%	1.251 M	100%
Events after filter	213	49.6%	890	29.7%	1224	0.0044%	21767	1.74%
Events after ptmiss cut @ 90 GeV	117	27.3%	362	12.1%	146	0.0005%	9758	0.78%
Events after # lepton cut	103	24.0%	298	9.9%	116	0.0004%	5254	0.42%
Events after full trigger	103	24.0%	298	9.9%	116	0.0004%	5254	0.42%
Events after mZll cut @ +/- 50 GeV	103	24.0%	297	9.9%	116	0.0004%	4128	0.33%
Events after btag	100	23.2%	288	9.6%	59	0.0002%	876	0.07%
old ATLFAST analysis	62	14.4%	183.3	6.1%	14.6	0.0001%	170.4	0.01%

Discriminating variables after preselection (ATLFAST AOD)

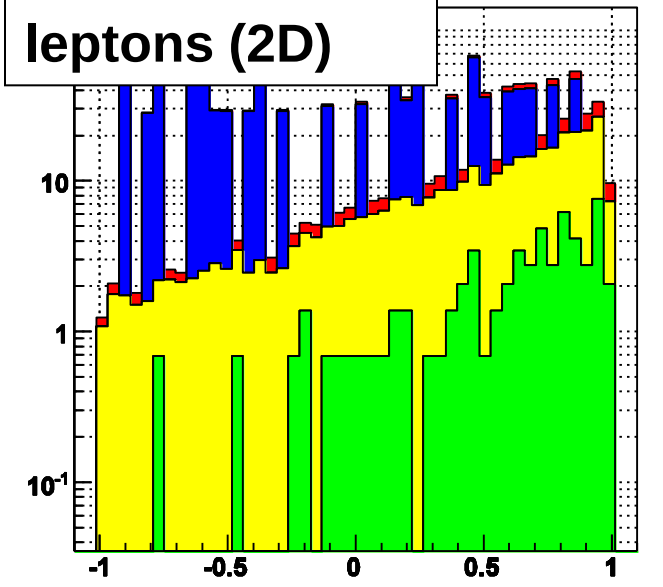
pT lepton #1



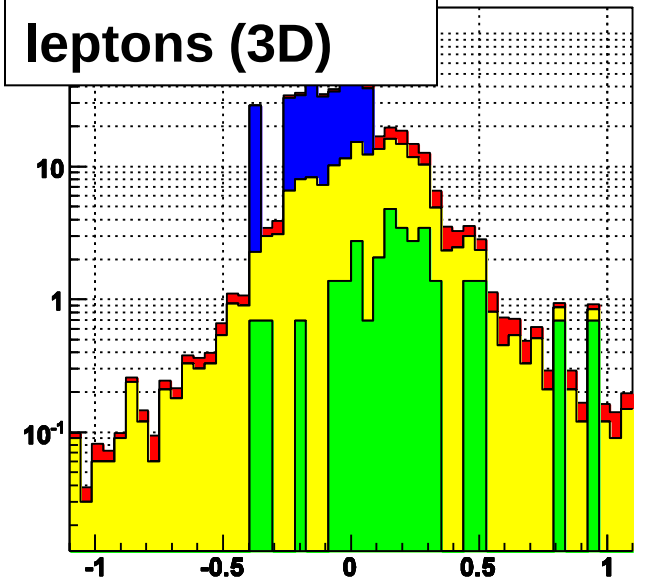
pT lepton #2



Cos between leptons (2D)

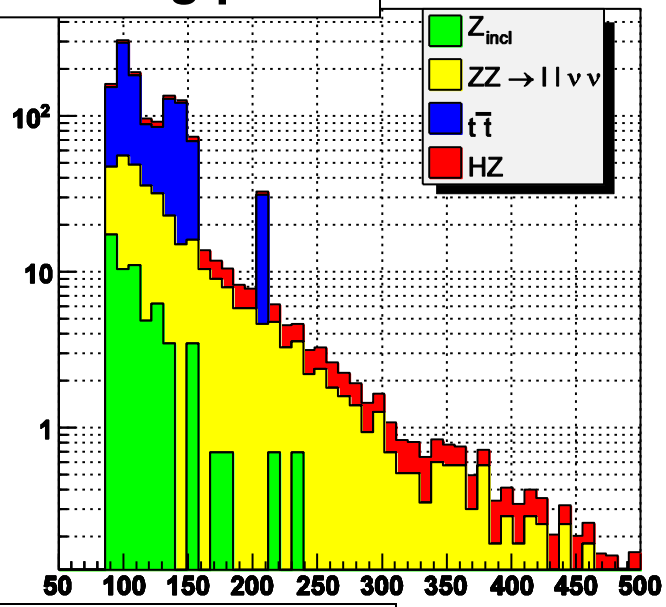


Cos between leptons (3D)

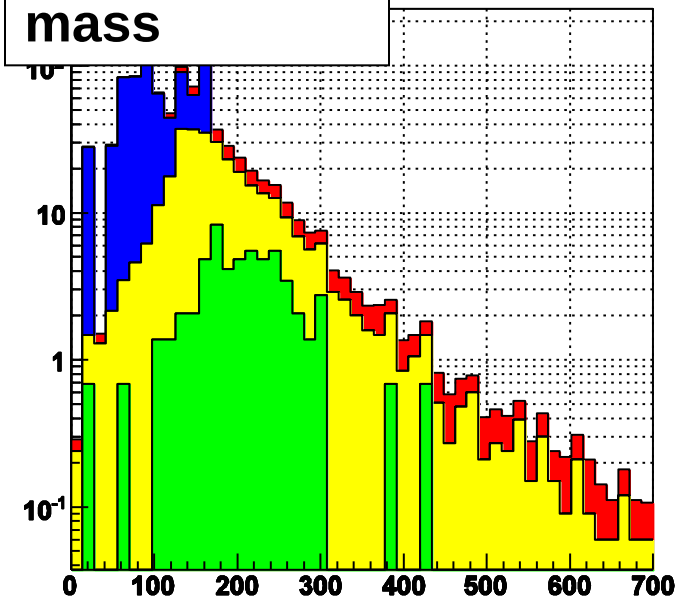


Discriminating variables after preselection (ATLFAST AOD)

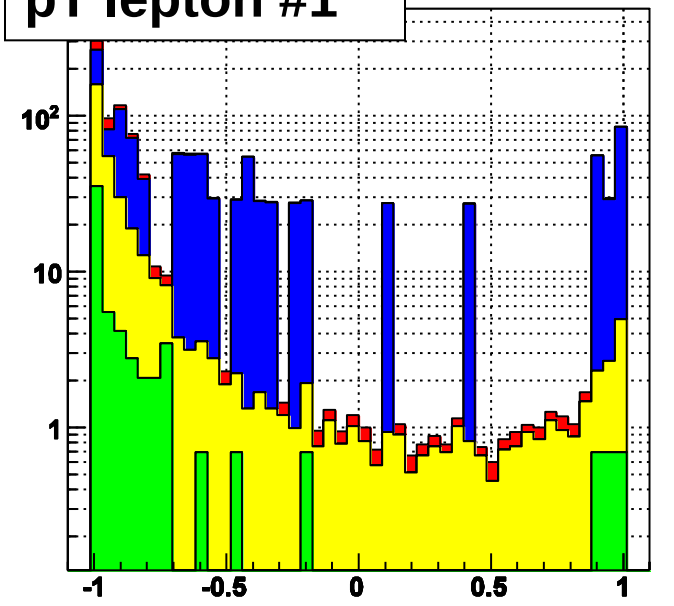
missing pT



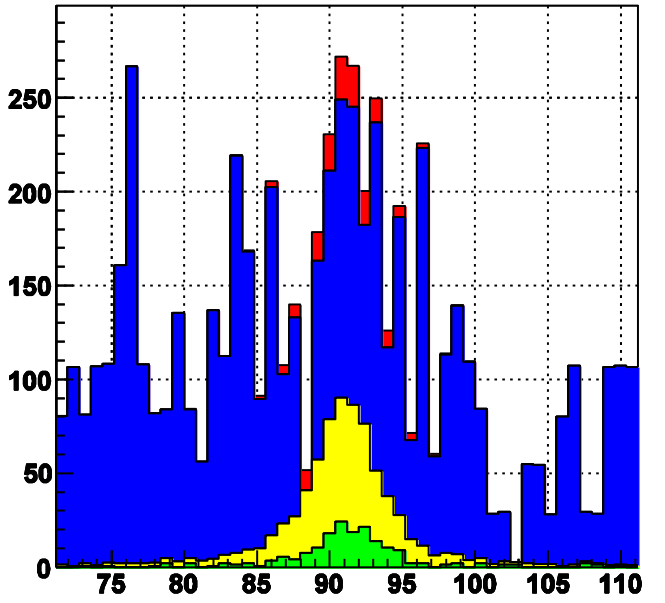
transverse mass



Cos pTmiss-pT lepton #1



m_Z



Request for MC samples to central production

for 100 fb^{-1}	$Z^0H^0 \rightarrow \chi\chi\ l^+l^-$	$Z^0Z^0 \rightarrow l^+l^-\ \nu\nu$	Z^0 incl. $\rightarrow l^+l^-$	$t\bar{t} \rightarrow bl^+\nu\ bl^-\nu$
Unfiltered	4260	30000	280.4 M	12.5 M
Filter retention	49.5%	29.7%	0.004%	0.4%
To be fully reconstructed	2130	8910	12200	217500

From 8360 CPU years down to 7 CPU years...

Filter has been included in release 11.5.0

Plans for HZ with $Z \rightarrow ll$ channel

- Test other backgrounds with filter:
  - WW, ZW, ZZ $\rightarrow ll\tau\tau$
- We have provided jobOptions files for ZH, ZZ, Z incl. but we will use official ttbar jobOptions file with our filter added
- Add new requests for central production:
  - Provide jobOptions and reference plots for all new backgrounds (WW, ZW, ZZ $\rightarrow ll\tau\tau$)
- Move to fully reconstructed AOD analysis
- Pursue studies on different multivariate analysis techniques to extract the signal
- Filter has been included in release 11.5.0

ATLAS invisible Higgs activities

Meeting held on March 9 to coordinate activities (Bonn, IU, Carleton, CERN)

- HZ channel:
  - $Z \rightarrow ll$ channel:
    - Freiburg (Frank Meisel) now working on more realistic SUSY scenario
    - Indiana (S. Subramania, P. Gagnon): full reconstruction in ATHENA
  - $Z \rightarrow bb$ channel: Siva Subramania started investigating
- VBF channel: interest revived to resolve trigger issues:
  - Carleton: Malachi Schram and Gerald Okham
  - CERN: Beniamino di Girolamo
  - Bonn: Markus Schumacher and Guilherem Hanninger
  - Toronto: Rachid Manzani
- ttH channel:
  - Freiburg: Dietrich Schroff (see talk in April 2004) reported a marginal discovery potential. Note in preparation. (not at meeting)
  - Additional studies on interpretation of phion models
  - P.Teixeira-Dias, R.Goncalo (Royal Holloway Univ. of London) (not at meeting)
- Gluon fusion channel: Freiburg team declared it hopeless