Signature $l^+l^- + E_{\mathrm{T}}^{\mathrm{miss}}$ at CMS near $H^0 \to Z^0Z^0 \to l^+l^-\nu\tilde{\nu}$ Decay Threshold

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- One of the **purposes of our activities** is searching for physics suggesting that CMS endcap calorimetry may be of a major importance

- Our **previous results** (6-th Annual RDMS CMS Collaboration Meeting, MSU, Moscow, December 19-21, 2001):

  "irreducible" background (IB) due to nonresonant ZZ/ZW production can be eliminated in case of Higgs masses close to $H^0 \to Z^0Z^0 \to l^+l^-\nu\tilde{\nu}$ decay threshold via a cut set upon $\widehat{\vec{P}_{\mathrm{T}}^{ll}\vec{P}_{\mathrm{T}}^{\mathrm{miss}}}$;

  events with high-p_{T} jets turn out to be selected

- **Goals of this study**

  $gg \to gH^0$ & $qg \to qH^0$ vs. $gg \to H^0$;

  search for ways of suppressing '$t\bar{t}$ & Z+jets' background

- **Simulation tools**

  PYTHIA_6.158 & CMSJET_4.703

- **Kinematical cuts**

  A i) $E_{\mathrm{T}}^{\mathrm{miss}} \geq 40$ GeV, $|\eta| \leq 2.4$, $p_{\mathrm{T}}^{l} \geq 20$ GeV/c, $P_{\mathrm{T}}^{ll} \geq 40$ GeV/c, $|M_{\mathrm{Z}} - M_{ll}| \leq 5$ GeV, the number of high-p_{T} leptons $\equiv 2$;

  ii) $\widehat{\vec{P}_{\mathrm{T}}^{ll}\vec{P}_{\mathrm{T}}^{\mathrm{miss}}} \leq 90°$, $\widehat{\vec{P}_{\mathrm{T}}^{ll}\vec{P}_{\mathrm{T}}^{\mathrm{jets}}} \geq 120°$, $\widehat{\vec{P}_{\mathrm{T}}^{\mathrm{miss}}\vec{P}_{\mathrm{T}}^{\mathrm{jets}}} \geq 120°$ (these wash out "irreducible" $(ZW,\ ZZ)$ component of background);

  iii) no "b-tagged" jets with $E_{\mathrm{T}} \geq 40$ GeV;

  B $\widehat{\vec{p}^{\,l1}\vec{p}^{\,l2}} \geq 60°$, $\widehat{\vec{p}_{\mathrm{T}}^{\,l1}\vec{p}_{\mathrm{T}}^{\,l2}} \geq 90°$;

  C single-jet ($p_{\mathrm{T}}^{\mathrm{jet}} \geq 40$ GeV/c) events with $1.0 \leq |\eta^{\mathrm{jet}}| \leq 4.5$

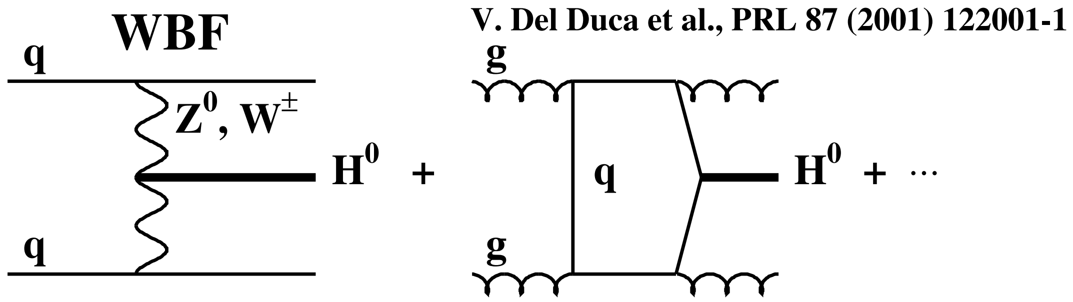
- **Results**

Channel (pp, $\sqrt{s}$ =14 TeV)	event rates / 10^5 pb^{-1}		
	A	B	C
$H \to ZZ \to ll\nu\bar{\nu}$, $M_{\mathrm{H}} = 200$ GeV/c^2	541	256	108
$H \to ZZ \to ll\nu\bar{\nu}$, $M_{\mathrm{H}} = 225$ GeV/c^2	274	103	53
$H \to ZZ \to ll\nu\bar{\nu}$, $M_{\mathrm{H}} = 250$ GeV/c^2	163	54	32
$Z + \text{jets} \to ll + \text{jets}$	5390	921	469
$t\bar{t} \to WW + \text{jets} \to l\nu l\bar{\nu} + \text{jets}$	2118	1230	368
Total background	7508	2151	837

• Concluding remarks

— A considerable suppression of the '$t\bar{t}$ & Z+jets' background can be reached with extra cuts "B" and "C", though $S/\sqrt{B}$ is still too small to observe Higgs;

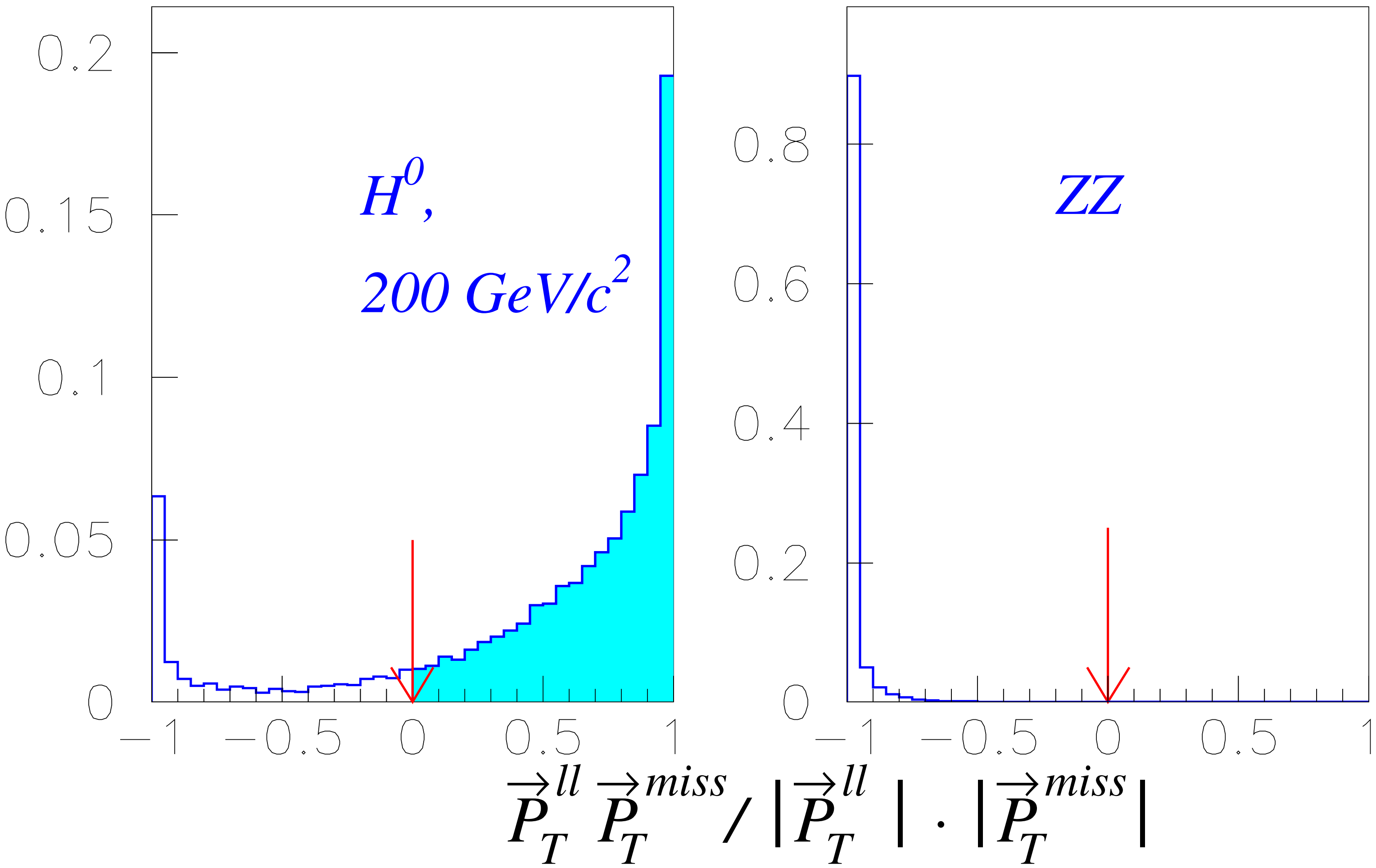
— Tuning the cuts to select also the two-jet events

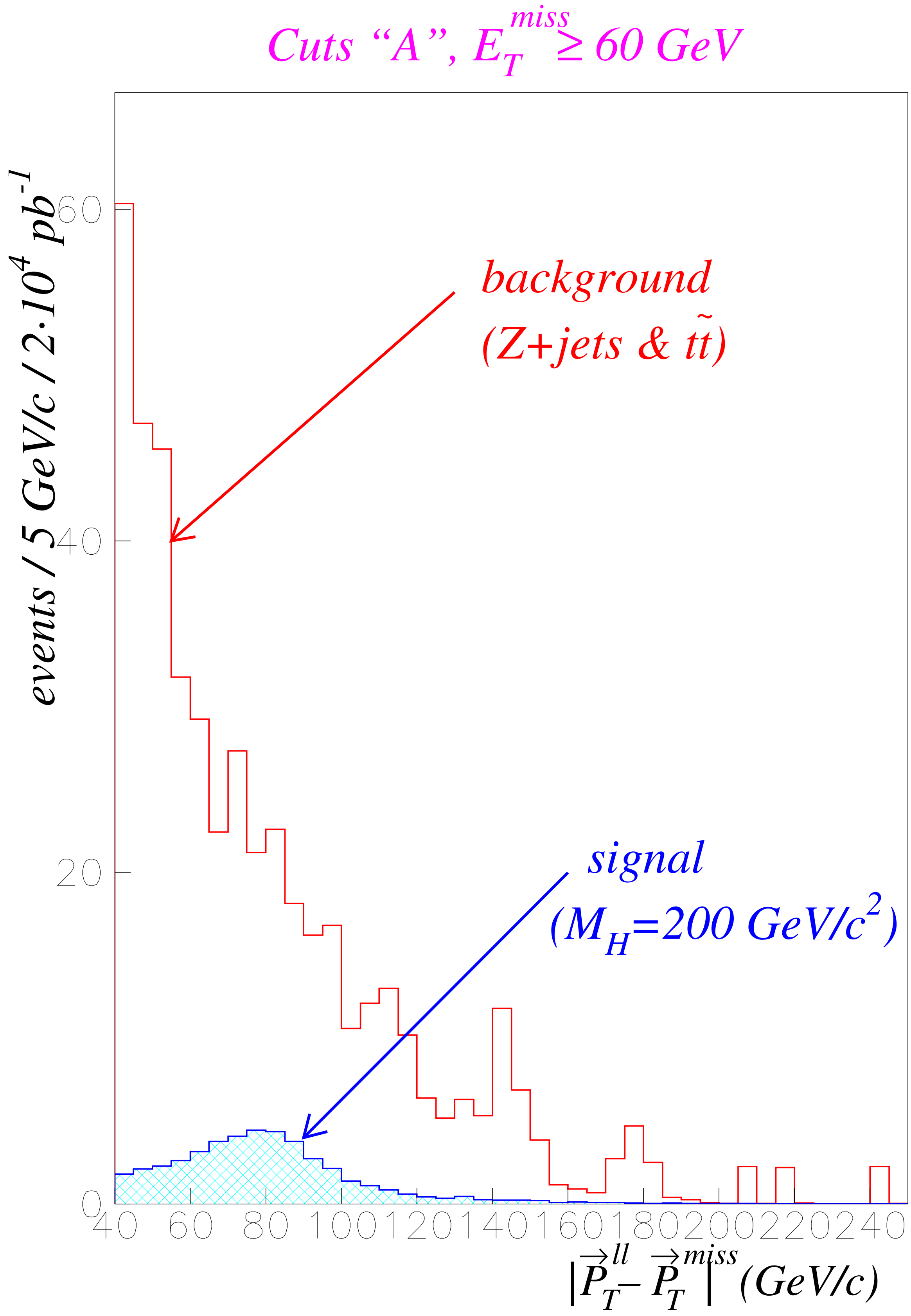


may increase $S/\sqrt{B}$;

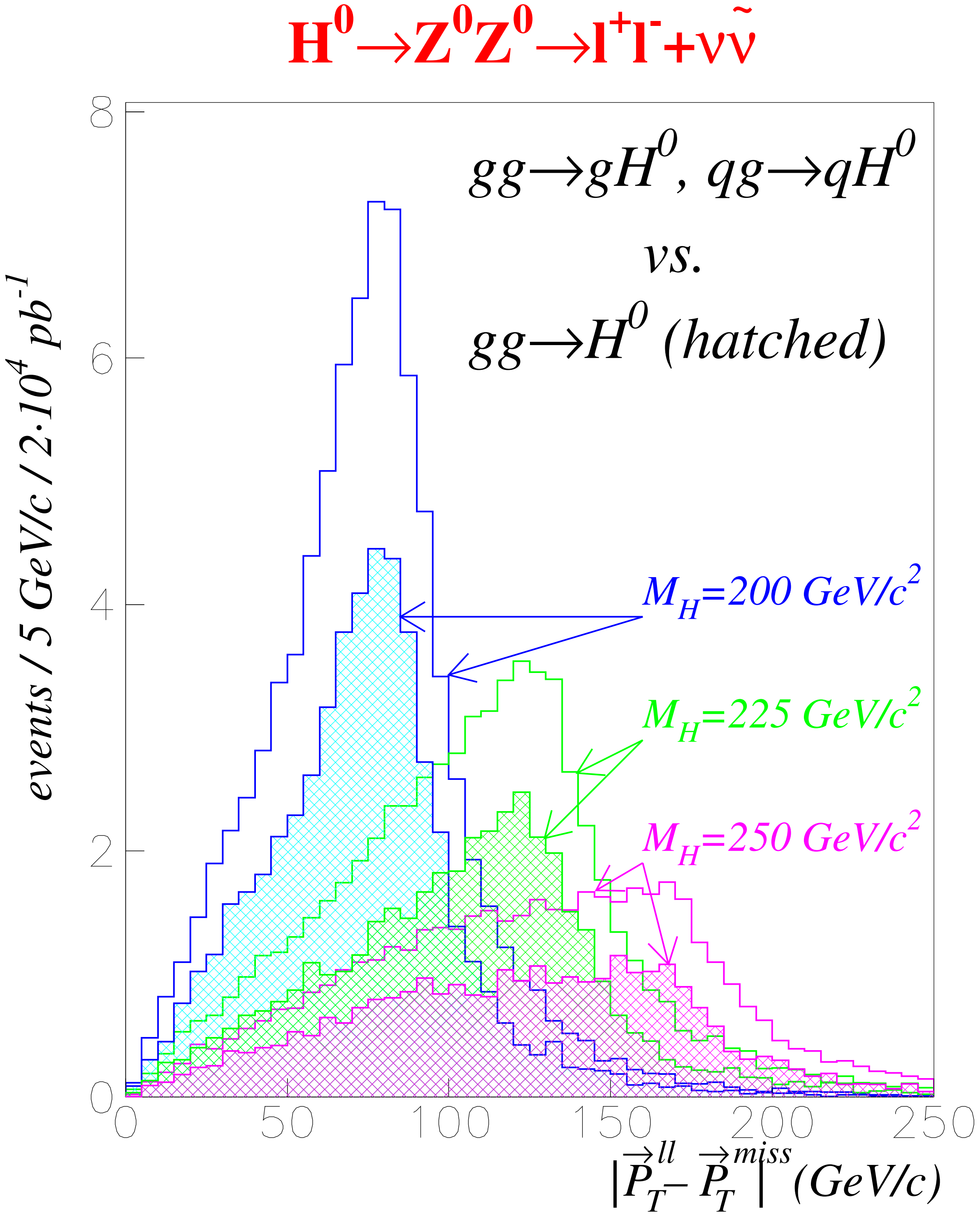
— 5 000 000 '$t\bar{t}$' and 20 000 000 'Z+jets' events have been generated at the **NSC KIPT CMS Linux cluster**; it would be difficult to obtain a convincing statistics via the "detailed" (CMSIM/ORCA) simulation

suppression of "irreducible" background



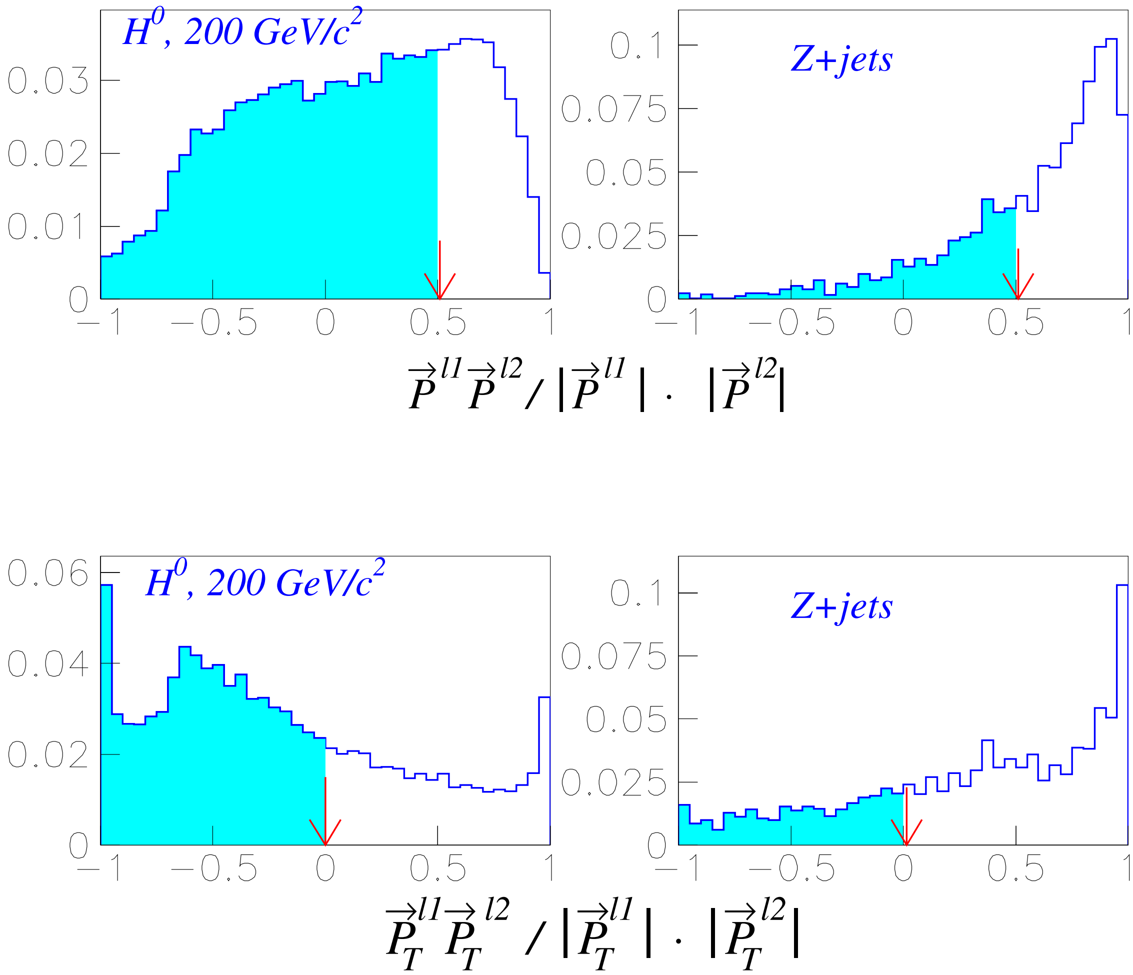


Cuts "A", $E_T^{miss} \geq 60$ GeV
events / 5 GeV/c / $2 \cdot 10^4$ pb^{-1}
background
(Z+jets & $\tilde{t}t$)
signal
(M_H=200 GeV/c^2)
0
20
40
60
40
60
80
100
120
140
160
180
200
220
240
$|\vec{P}_T^{ll} - \vec{P}_T^{miss}|$ (GeV/c)

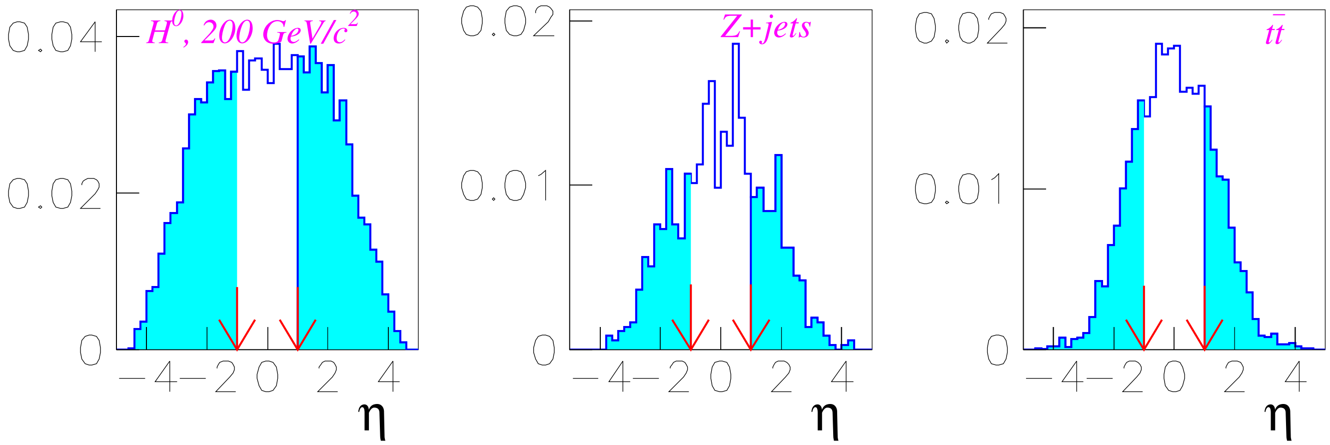


$H^0 \to Z^0 Z^0 \to l^+ l^- + \nu\tilde{\nu}$
$gg \to gH^0$, $qg \to qH^0$
vs.
$gg \to H^0$ (hatched)
M_H=200 GeV/c^2
M_H=225 GeV/c^2
M_H=250 GeV/c^2
events / 5 GeV/c / $2\cdot10^4$ pb^{-1}
$|\vec{P}_T^{ll} - \vec{P}_T^{miss}|$ (GeV/c)
0
2
4
6
8
0
50
100
150
200
250

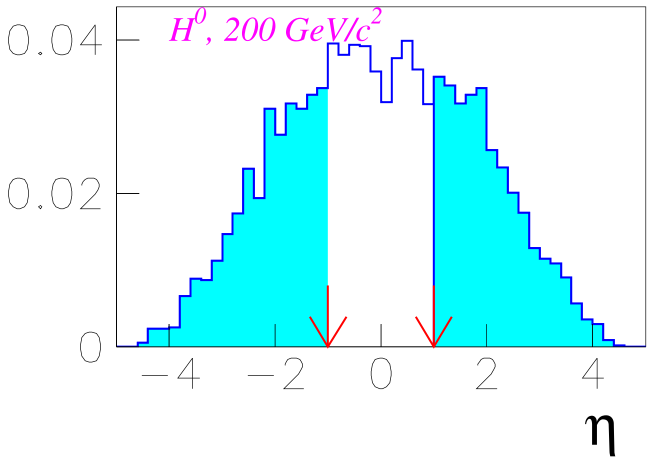
cuts on angles between momenta of leptons



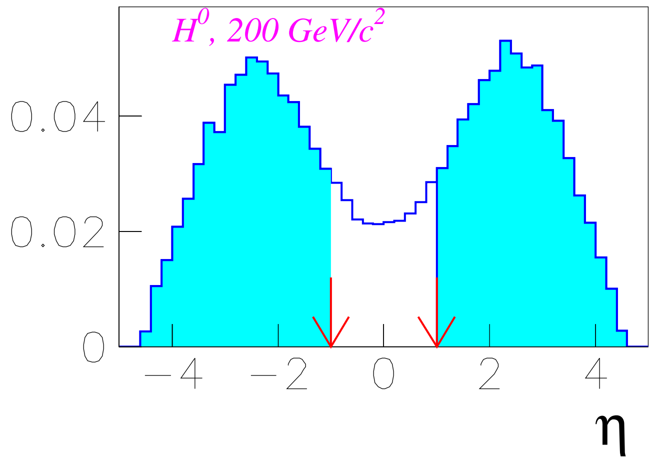
selection of events using differencies in pseudorapidity distributions

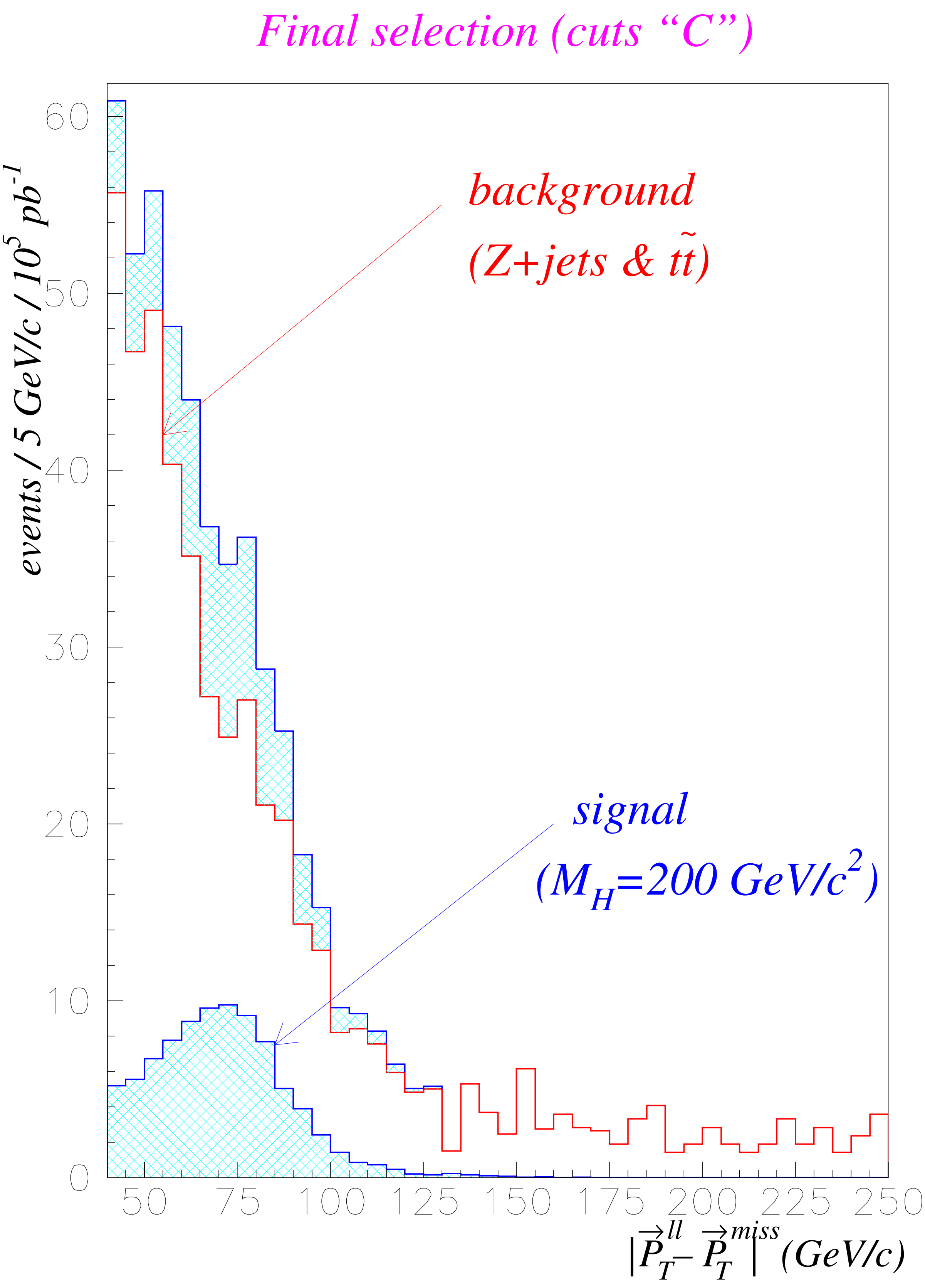


$gg \to gH^0$, $qg \to qH^0$



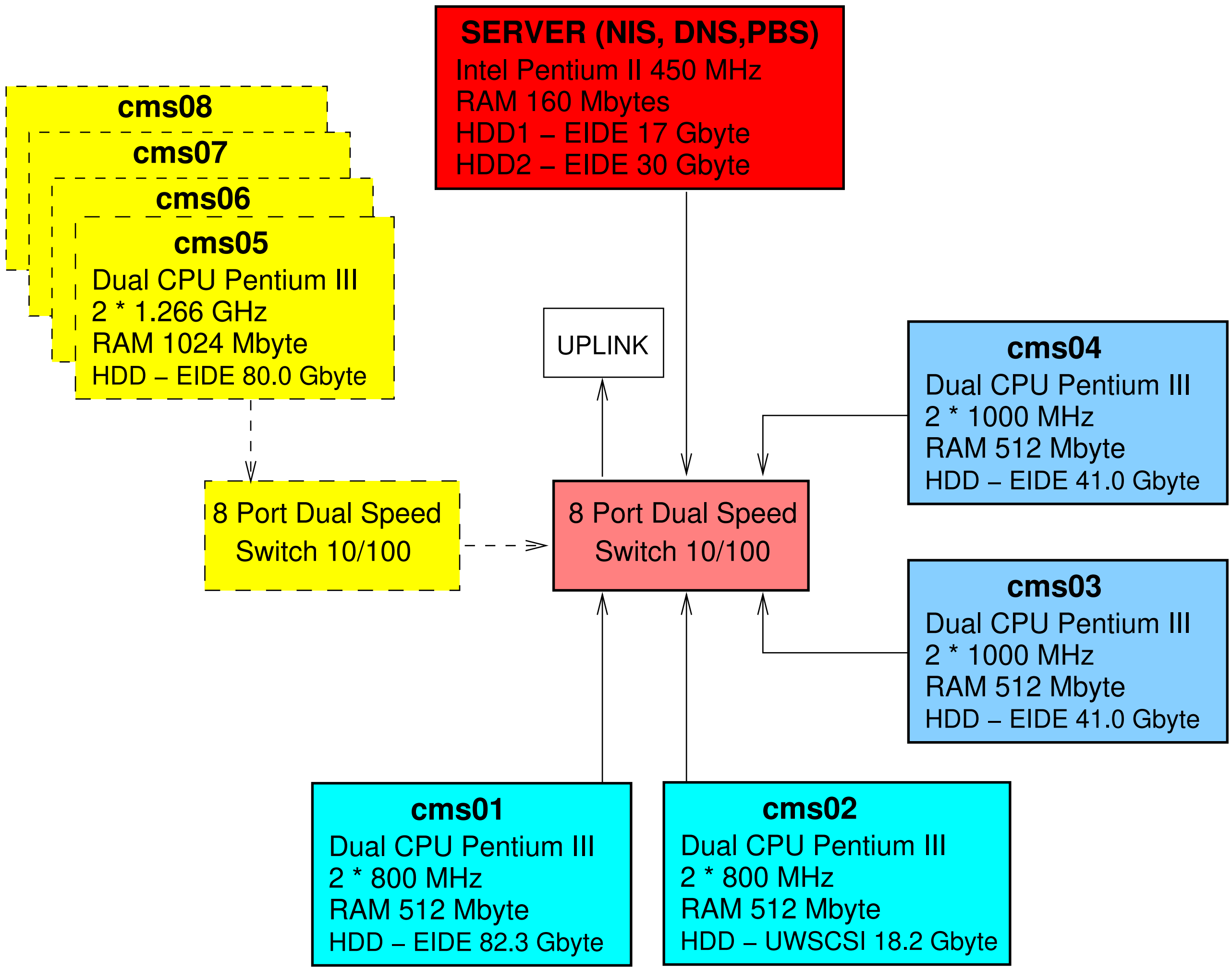
$qq \to qqH^0$ (“Weak Boson Fusion”)





Final selection (cuts "C")
events / 5 GeV/c / 10^5 pb^-1
background
(Z+jets & t̃t)
signal
(M_H=200 GeV/c^2)
0
10
20
30
40
50
60
50
75
100
125
150
175
200
225
250
|P_T^ll − P_T^miss| (GeV/c)

NSC KIPT CMS Linux Cluster



Cluster performances

311.36 SPECfpt95/361.36 SPECint95 ($\times$2.4 by the end of year 2002
HDD: 230 GB (550 GB by the end of year 2002)

Participation in CMS Events Production:

6000 events generated in the Summer_02 Production Run