CP3 Lunch Seminar

Search for Standard Model Higgs boson with WH, H→WW channel using two same sign leptons

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- Introduction:

- Leptons identifications:
  - Electrons
  - Muons

- Events selection:
  - Online and leptons selection
  - Jets selection
  - Results

- Uncertainties:
  - Statistical uncertainties
  - Systematic uncertainties

- Significance

Simulation chain

MC Generator — PYTHIA, COMPHEP, MADGRAPH, ...

MC Data

CMSSW (Geant) — Detector simulator — OSCAR (Geant)

Hits

CMSSW — Detector response (digitalization) — ORCA

Digi's

CMSSW — Reconstruction — ORCA

RecObject

CMSSW — Analysis — ExRootAnalysis
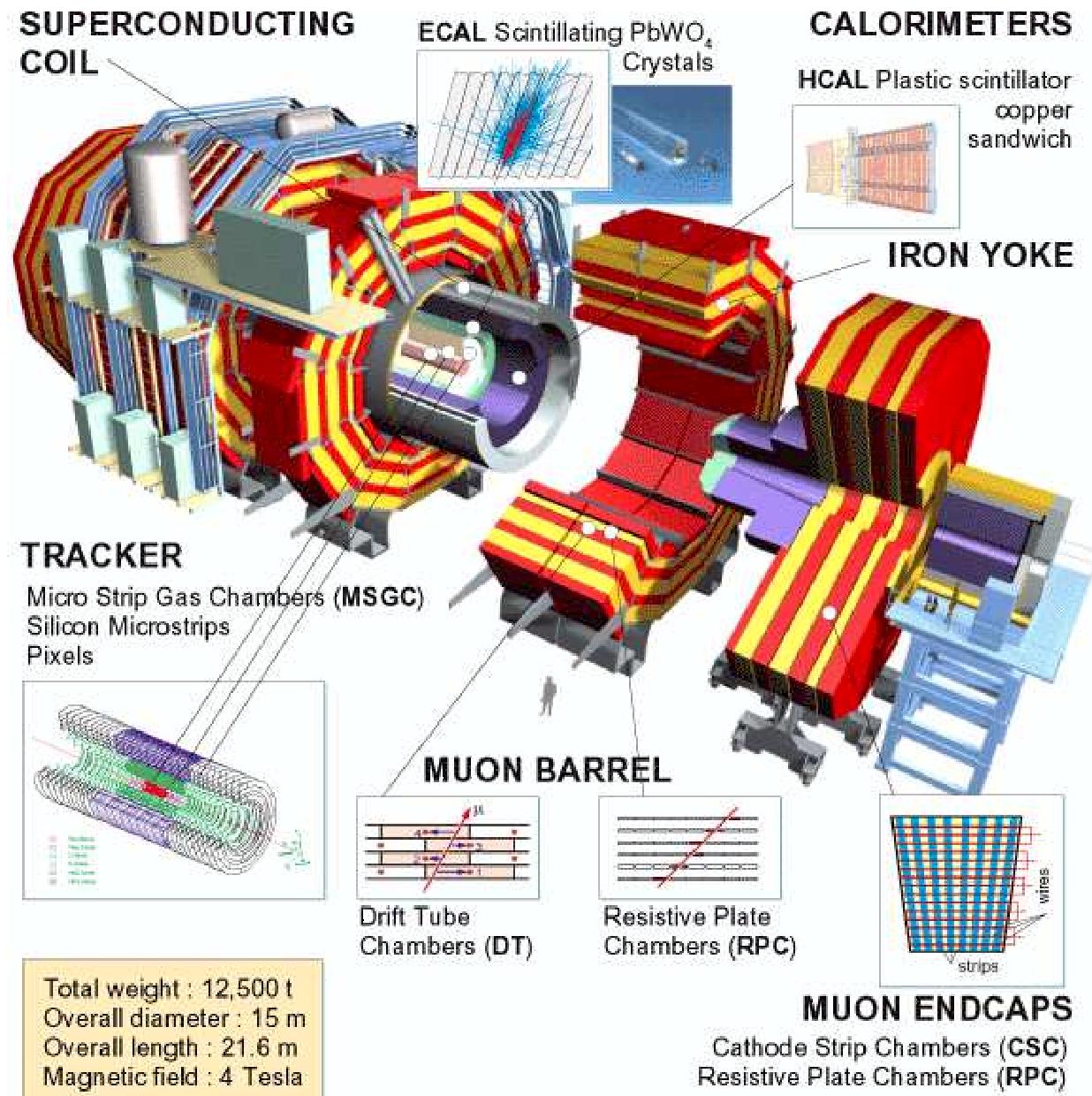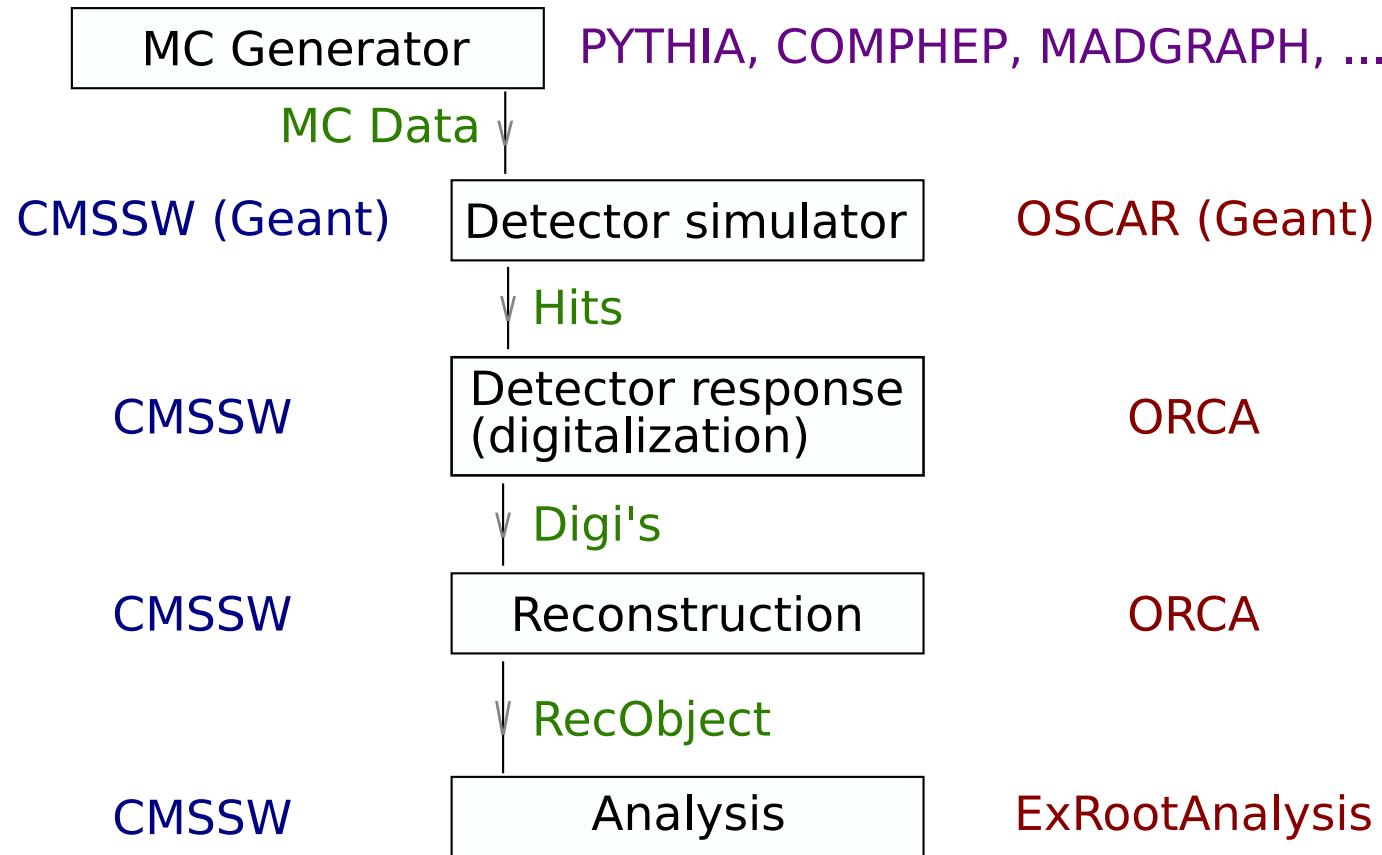
Signal

$WH, H \rightarrow WW, 2s.s.l.$

$m_H = 140$ GeV/c$^2 \rightarrow 180$ GeV/c^2

$\sigma(pp \rightarrow WH) \simeq 1060$ fb

$B_{H \rightarrow W^+W^-} \simeq 0.5$

$\rightarrow \sigma \simeq 36$ fb
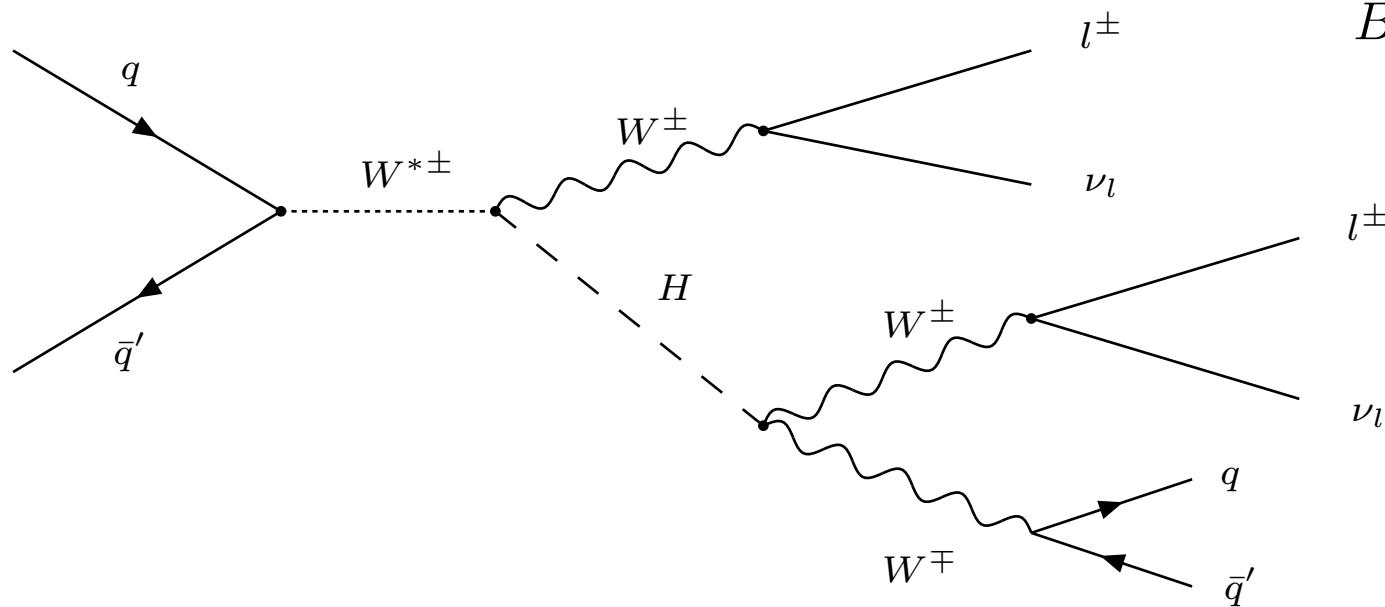
◆ $3l$

◆ 2 same sign l + $2j$

◆ 2 opposite sign l + $2j$, 1l+4j, 6j

C. Delaere

D. Teyssier and J.C.

$S/\sqrt{B}$ too small

◆ This process contains only g_{HWW} couplings, making measures easier.

◆ This process is allowed in a fermiophobic Higgs boson model.

◆ This process could maybe increase the Christophe's results.

◆ This process is free of large cross-section irreducible backgrounds.

Processus	Cross section	Generator	Number of events
signal $m_H =$140	35.9 fb	Pythia	9 594
signal $m_H =$150	40.2 fb	Pythia	9 586
signal $m_H =$160	42.8 fb	Pythia	8 849
signal $m_H =$170	37.3 fb	Pythia	8 894
signal $m_H =$180	29.6 fb	Pythia	9 011

Backgrounds

- ◆ same final state $\qquad$ $WWW, W^{\pm}W^{\pm}, WZ$
- ◆ missing lepton(s) $\qquad$ $WZ, ZZ, W\gamma$
- ◆ fake lepton(s) $\qquad$ $W+j, Z+j$
- ◆ lepton coming from B $\qquad$ $t\bar{t}, Wbb, st, Wt$

Processus	Cross section	Generator	Number of events
$W + j\ (l^{\pm}j)$	~ 40 nb	Pythia	1 114 000
$Z + j\ (l^{\pm}j)$	~ 7 nb	Pythia	840 000
$Wbb\ (l + bb)$	106.59 pb	TopRex	588 000
$t\bar{t}\ (l^+l^-b\bar{b})$	86.02 pb	Pythia and TopRex	1 086 000
$st\ t$-channel $(l + b\bar{b})$	83.97 pb	TopRex	92 000
$W\gamma\ (l + e^+e^-)$	12.65 pb	MadGraph	19 000
$Wt\ (l^+l^-b)$	5.56 pb	TopRex	80 000
$WZ\ (3l^{\pm})$	1.71 pb	Pythia	43 000
$ZZ\ (4l^{\pm})$	171 fb	Pythia	46 000
$W^{\pm}\,W^{\pm}\ (l^{\pm}l^{\pm}) + jj$	43 fb	MadGraph	19 000
$WWW\ (l^{\pm}l^{\pm}jj)$	10.9 fb	Pythia	4 847

1)

Cluster E
Cluster position

$\vec{B}$

Predict a track

Nominal vertex (0,0,0)

2)

Propagate to the pixel layers and look for compatible hits

3)

If a hit is found, estimate z vertex

4)

Pixel hit *Predict a new track and propagate*

Estimated vertex (0,0,z)

search $-N_{step}$

seed crystal

sub-cluster

ϕ

η
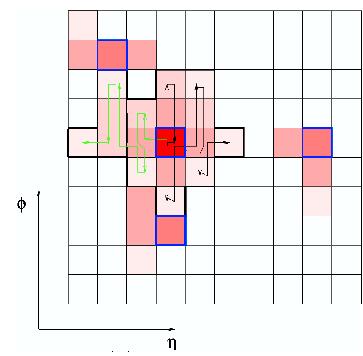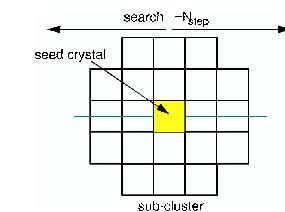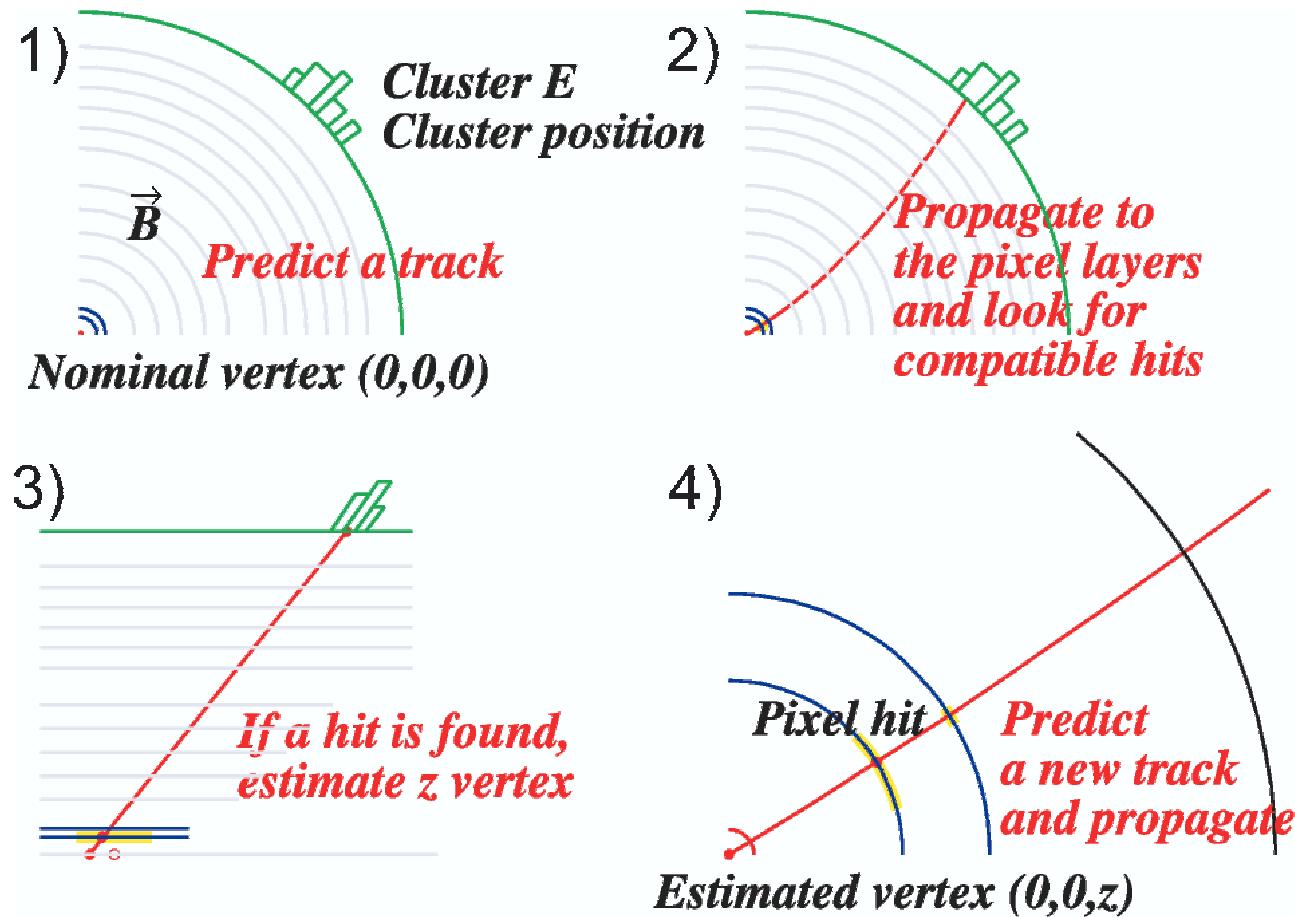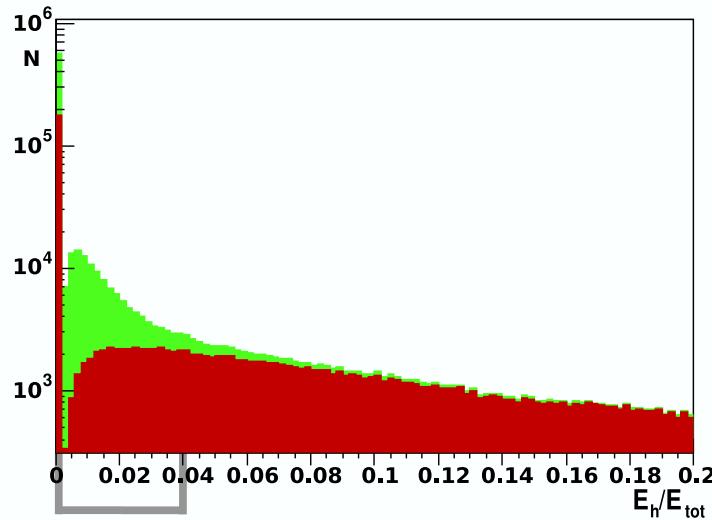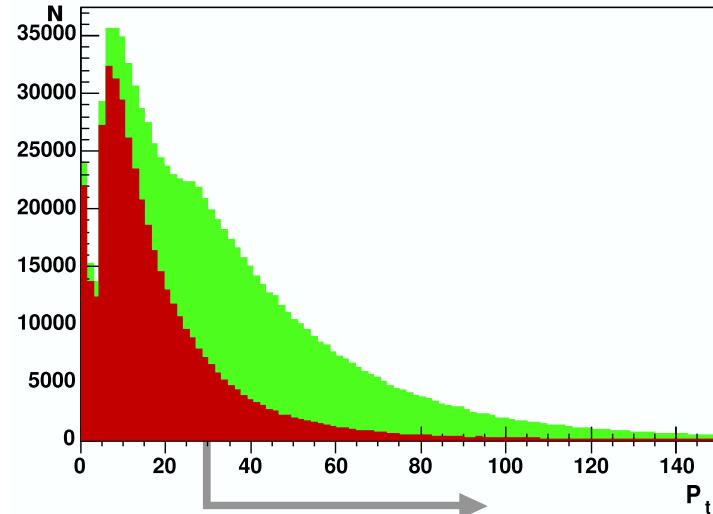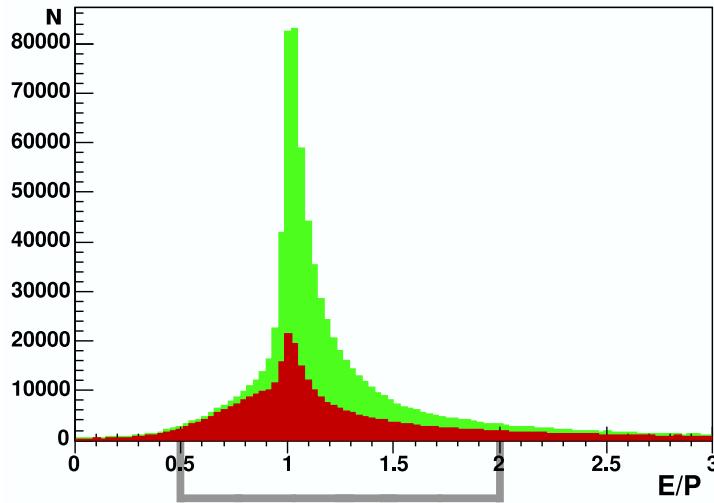
- $0.5 < E/P < 2$
- $E_{had}/E_{tot} < 0.04$
- $P_t > 30$ GeV/c
- $|\eta| < 2.5$ and $|\eta| \in]1.4442, 1.5660[$
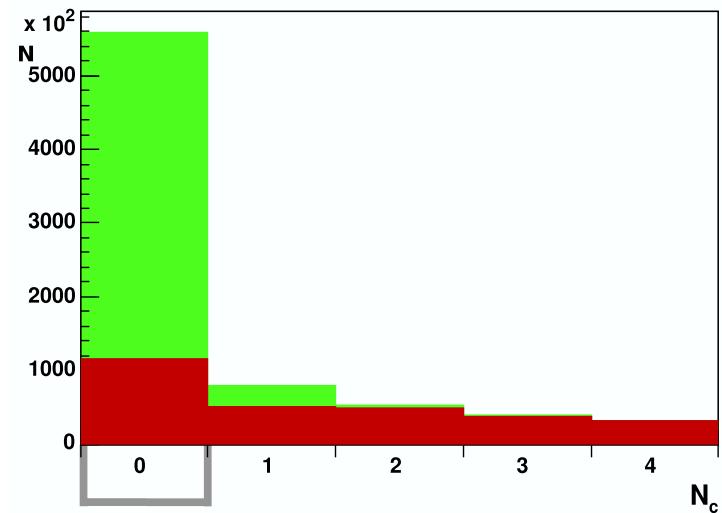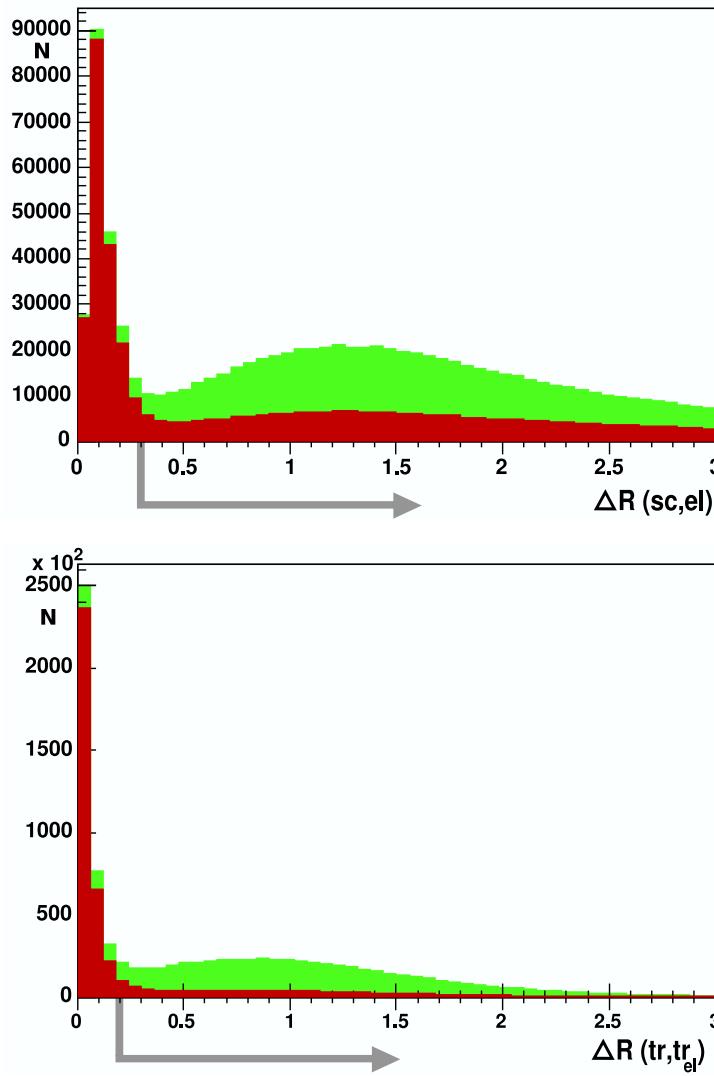
- $\Delta R(sc, el) \geq 0.3 \ (E > 3 \ \text{GeV})$
- $\Delta R(tr, tr_{el}) \geq 0.2 \ (P_t > 3 \ \text{GeV/c})$
- $N_c = 0$ in a 0.1 cone $(P_t > 1 \ \text{GeV/c})$

$t\bar{t}$: 1 086 000 events

335 538 isolated coming from W electrons

650 sign mis-identification electrons

$\rightarrow$ 0.19%   ($\rightarrow \sigma_{t\bar{t}} \sim 5 \times \sigma_{sig}$)

Cuts	All candidates		Bad candidates	
	Number	Percent	Number	Percent
none	335538	100	650	100
$\Delta R_{tr} < 0.0015$	309499	92.2	103	15.8
$h > 6$	310874	92.6	426	65.5
$d < 0.006$	298403	88.9	91	14.0
$q\Delta\phi > 0.005$	319079	95.1	28	4.3
all	251725	75.0	1	0.15

$\rightarrow 4 \times 10^{-4}$%   (no more $t\bar{t}$)

Electrons: Charge
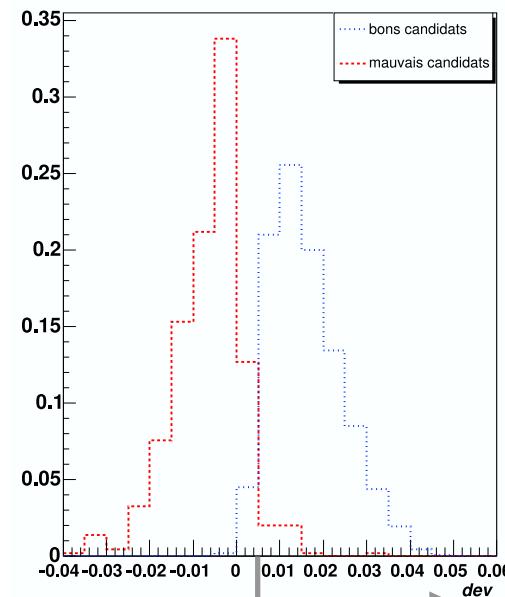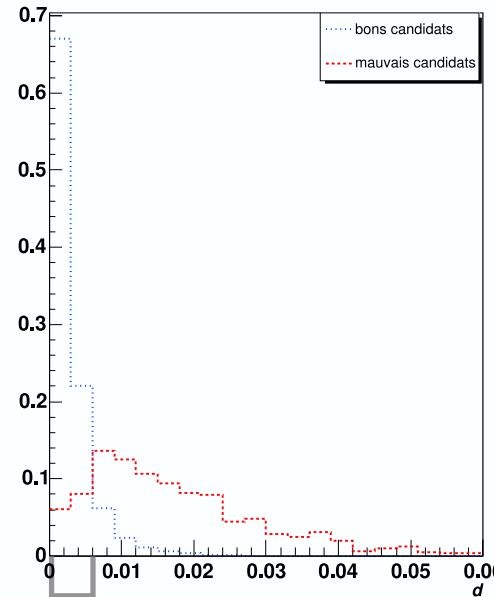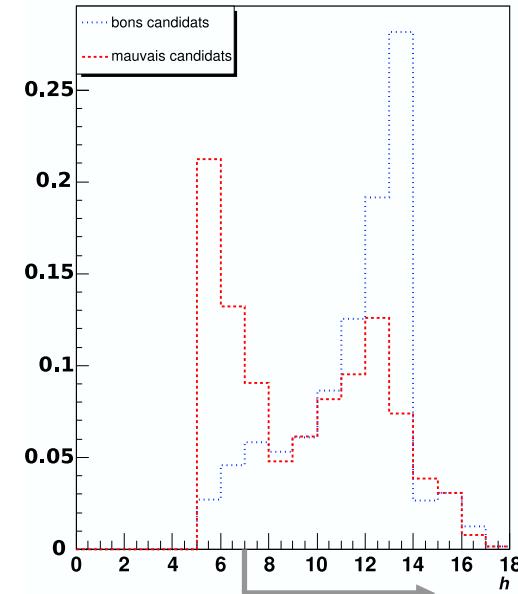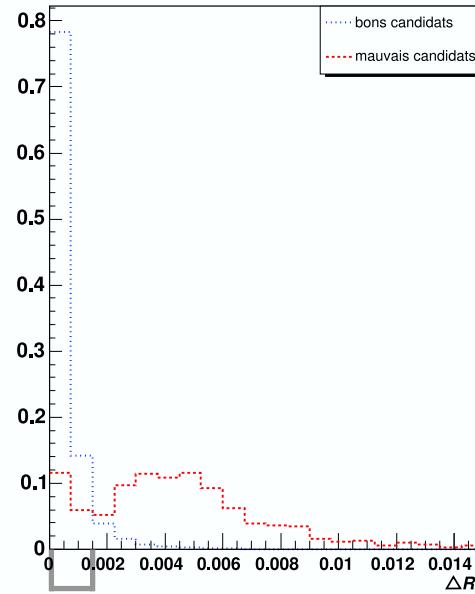
Muons
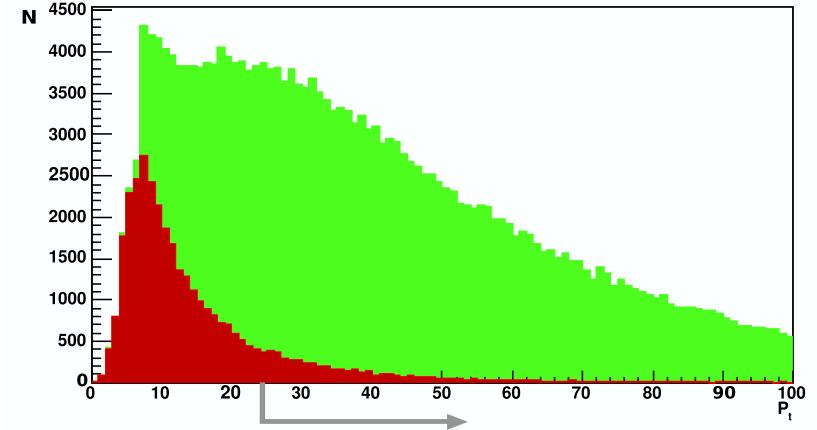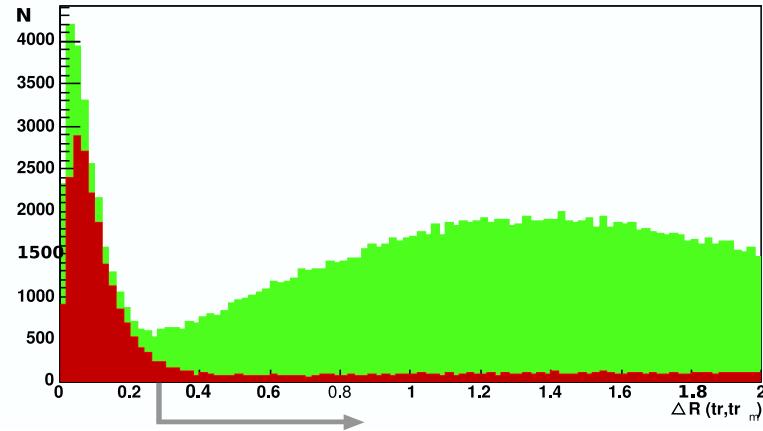
- $\Delta R(cl, \mu) > 0.25$
- $P_t > 25$ GeV/c

Online selection: HLT + 3 streams:

◆ e-e: dielectrons subtrigger

◆ μ-μ: dielectrons subtrigger

◆ e-μ: single electron subtrigger or single muon subtrigger

Leptons selection: depends on the channel:

◆ e-e:

   ◆ Only 2 same sign reconstructed electrons.
   ◆ These two electrons satisfy former conditions (quality, isolation, charge).
   ◆ No reconstructed muons with $P_t > 16$ GeV/c.

◆ μ-μ:

   ◆ Only 2 same sign reconstructed muons.
   ◆ These two muons satisfy former conditions (isolation, P_t).
   ◆ No reconstructed electrons with $P_t > 16$ GeV/c.

◆ e-μ:

   ◆ Only 2 same sign reconstructed electron and muon.
   ◆ This electron satisfies former conditions.
   ◆ This muon satisfies former conditions.

Jets selection:

◆ $\tau-$jet rejection:
For each tracks with $P_t > 8$ GeV/c, if there is at least one track with $P_t > 3$ GeV/c in a 0.2 cone, the event is conserved.

◆ jets P_t:
For the two first jets sorted by P_t,
the first must have a P_t between 30 and 120 GeV/c.
the second must have a P_t between 22 and 70 GeV/c.

◆ btag:
The two first jets must be not b-tagged.

◆ dijet mass:
The reconstructed dijet mass from the two jets must be between 50 and 130 GeV/c^2.

Results

e-e channel

	none	HLT	subtrigger	2ssl	τ-jet	P_t jets	b-tag	dijet mass	
s170	37.2	24.184	2.5848	0.2635	0.1924	0.1548	0.1422	0.1129	27
wbb	106594	29152	168.4113	0	0	0	0	0	0
ttbar	86016	63927	7960.3447	0.1584	0.1584	0	0	0	0
st	83971	36304	1222.1431	0	0	0	0	0	0
wγ	12646	8246.2818	507.3642	0	0	0	0	0	0
wt	5562	5562	596.1689	0	0	0	0	0	0
wz	1714	1167	279.4989	1.8309	1.1297	0.2143	0.2143	0.0584	3
zz	171	118.7	38.415	0.0886	0.0517	0.0222	0.0222	0.0074	2
ww	43.1	34.93	9.827	0.0775	0.073	0.0355	0.0322	0.0115	6
www	10.9	7.102	0.695	0.036	0.0315	0.0135	0.009	0.0067	3
wjets	413 10^5	11246617	952823	0	0	0	0	0	0
zjets	71.8 10^5	2329237	519510	0	0	0	0	0	0
ttbar incl.	955733	437786	24599	0	0	0	0	0	0
dy $\mu\mu$	15.8 10^5	1514935	24.433	0	0	0	0	0	0

$S/\sqrt{B} \simeq 3$ for 60 fb^{-1}

Results

μ-μ **channel**

	none	HLT	subtrigger	2ssl	τ-jet	P_t jets	b-tag	dijet mass	
s170	37.2	24.184	2.38	0.548	0.435	0.3221	0.2886	0.2133	51
wbb	106594	29152	153.91	0.3626	0.1813	0	0	0	0
ttbar	86016	63928	9144	1.109	0.7921	0.4752	0.1584	0.0792	1
st	83971	36304	209.0	0	0	0	0	0	0
wγ	12646	8246	5.088	0	0	0	0	0	0
wt	5562	5562	684.802	0	0	0	0	0	0
wz	1714	1169	354.35	7.518	4.986	0.838	0.779	0.429	22
zz	171	118.69	47.678	0.225	0.118	0.0665	0.0628	0.0148	4
ww	43.1	34.9	2.897	0.447	0.407	0.21	0.1918	0.0648	27
www	10.9	7.102	0.681	0.220	0.205	0.1124	0.0967	0.0697	31
wjets	413 10^5	11246617	1407003	0	0	0	0	0	0
zjets	71.8 10^5	2329237	752375	34.116	8.0556	4.0278	4.0278	0	0
ttbar incl.	955733	437786	16485	0	0	0	0	0	0
dy $\mu\mu$	15.8 10^5	1514935	1270955	40.722	24.433	0	0	0	0

$S/\sqrt{B} \simeq 2$ for 60 fb^{-1}

Results

e-μ **channel**

	none	HLT	subtrigger	2ssl	τ-jet	P_t jets	b-tag	dijet mass	
s170	37.2	24.184	20.28	0.937	0.778	0.552	0.510	0.3764	90
wbb	106594	29152	28142.9914	0.3626	0.1813	0	0	0	0
ttbar	86016	63928	54763.3698	1.6634	1.3465	0.5545	0.3168	0.0792	1
st	83971	36304	29723.9085	0.9127	0.9127	0	0	0	0
wγ	12646	8246	4845.9437	0.6252	0.6252	0.6252	0.6252	0	0
wt	5562	5562	4690.6353	0	0	0	0	0	0
wz	1714	1169	1080.3459	9.2517	5.9211	1.714	1.6166	0.4675	24
zz	171	118.69	105.287	0.3729	0.2474	0.1809	0.1809	0.0665	18
ww	43.1	34.9	24.7571	0.4453	0.4121	0.2328	0.2225	0.0833	37
www	10.9	7.102	5.9504	0.1934	0.1687	0.0967	0.0742	0.0562	25
wjets	$413\ 10^5$	11246617	10443156	50.676	50.676	0	0	0	0
zjets	$71.8\ 10^5$	2329237	2101077	44.2229	14.1196	6.0491	6.0491	0	0
ttbar incl.	955733	437786	114060	10.215	8.172	8.172	2.043	0	0
dy $\mu\mu$	$15.8\ 10^5$	1514935	1474401	0	0	0	0	0	0

$$S/\sqrt{B} \simeq 3.4 \text{ for } 60 \text{ fb}^{-1}$$