A Soft Electron Tag – based trigger for $\mathbf{H^0 + V}$

- ◇ Motivations
- ◇ Dataset
- ◇ Level 2/3 rates and efficiencies
- ◇ Work to do

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Motivations

RUNII simulations suggest that:

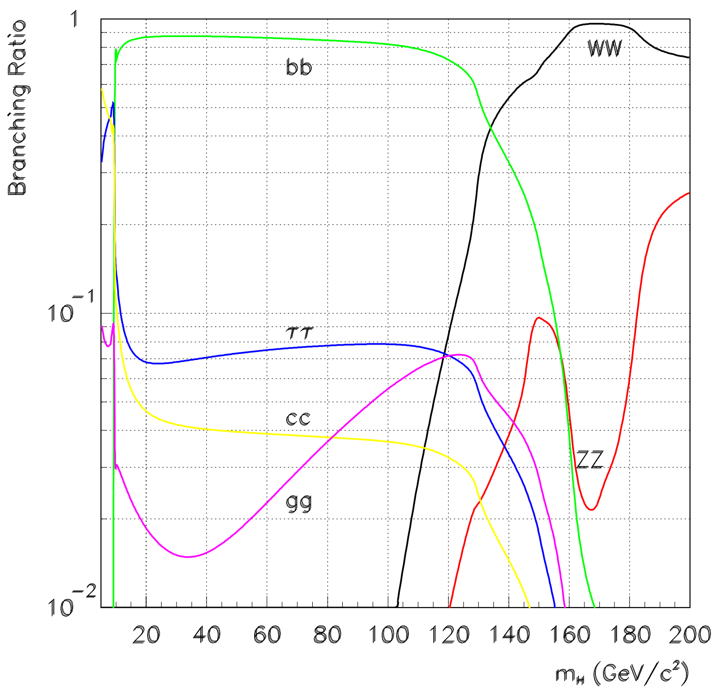
H^0 discovery (3σ) for $m_H \lesssim 130\,\mathrm{GeV/c^2}$.

H^0 exclusion (95% C.L.) for $m_H \lesssim 190\,\mathrm{GeV/c^2}$

are at reach if $\int \mathcal{L} \sim 10\,\mathrm{fb}^{-1}$ (CDF & D0).

H^0 Production: *gluon fusion* ($\sigma \sim 1\,\mathrm{pb}$) and *associated production* with Z^0, W ($\sigma \sim 0.1 \div 1\,\mathrm{pb}$).

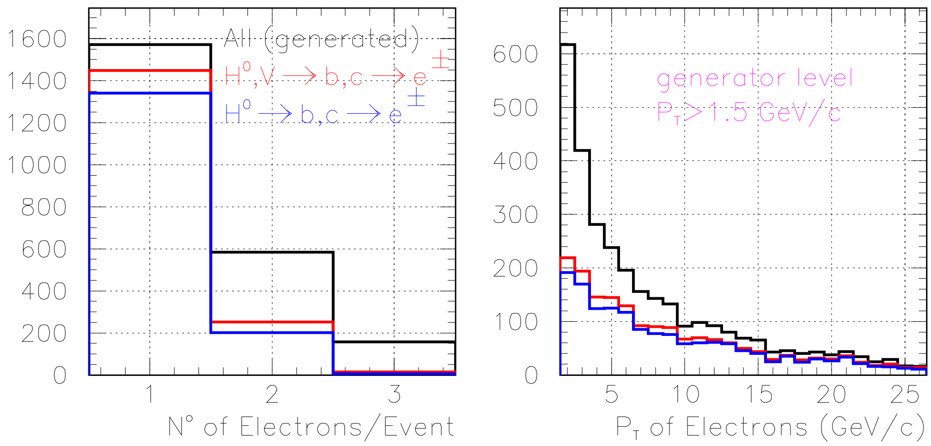
H^0 Decay: $H^0 \to b\bar{b}$ (b.r.$\sim$80% for $m_H \lesssim 130\,\mathrm{GeV/c^2}$):



$\Rightarrow$ b-enriched sample needed!

Physics goal

- The main goal of this trigger is the selection of H+Z/W events via a tagging of the electrons produced in the semileptonic decays of primary quarks (b or c).
- Such electrons have a soft P_T spectrum:



$\Rightarrow$ soft tagging procedure needed!

- This approach is complementary to the requirement of displaced SVT track at Level2, however...
- ...since the lepton comes from a b semileptonic decay, additional request of displacement of the electron track can be exploited (SVT).

Datasets size

Signal: sample of $\sim$ 5000 events generated with Pythia (H^0+Z^0/W$\rightarrow b\bar{b} + q'\bar{q}$ at $\sqrt{s} = 2\,\mathrm{TeV}$ with $m_{\mathrm{H}} = 120\,\mathrm{GeV/c^2}$) and simulated through QFL; $\sim$ 2000 of these contain at least 1 electron from semileptonic decay of H^0,V.

Data: sample of *minimum bias* events for Level 1 rates (in progress) and samples of $\sim$ 25000 JET20 and $\sim$ 13000 MJT events for Level 2 & 3 rates

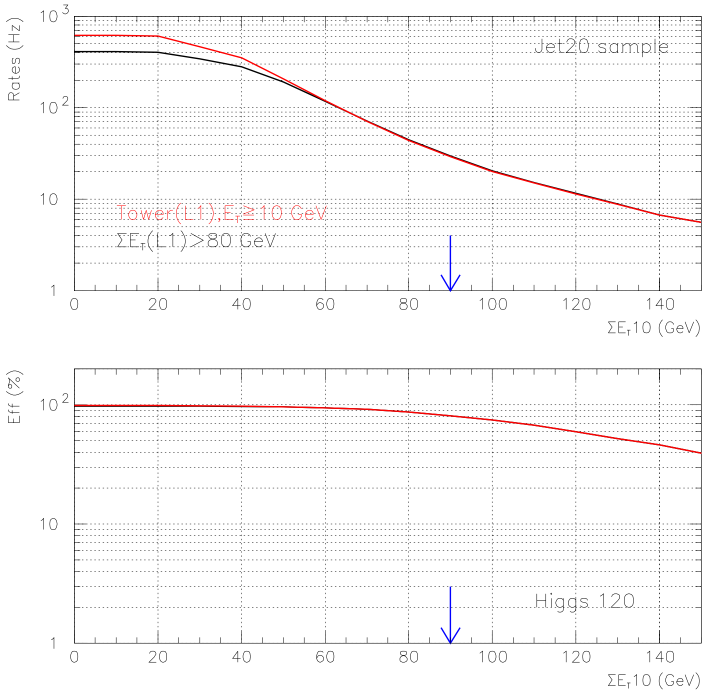
For the simulation of RUNII variables, the RUN2TRS package has been used (part of the analysis tools are shared with the multijet trigger group, Petar M.).

$\boxed{\textbf{RUNII Level 2 } vs \textbf{ Level 1 cut}}$

Cuts on L1 variables:

- $\diamond$ $\Sigma E_T(L1) > 80\,\mathrm{GeV}$
- $\diamond$ $N_{tow}(E_{tow} \geq 10\,\mathrm{GeV}) \geq 1$

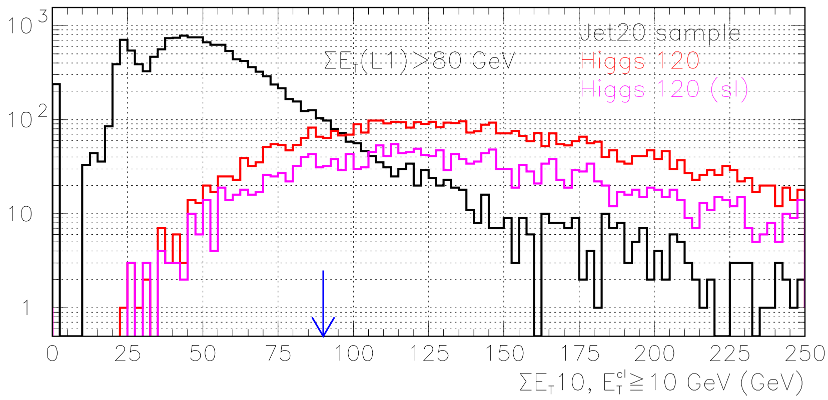
have been checked upon $\Sigma E_T 10(L2)$ distribution:

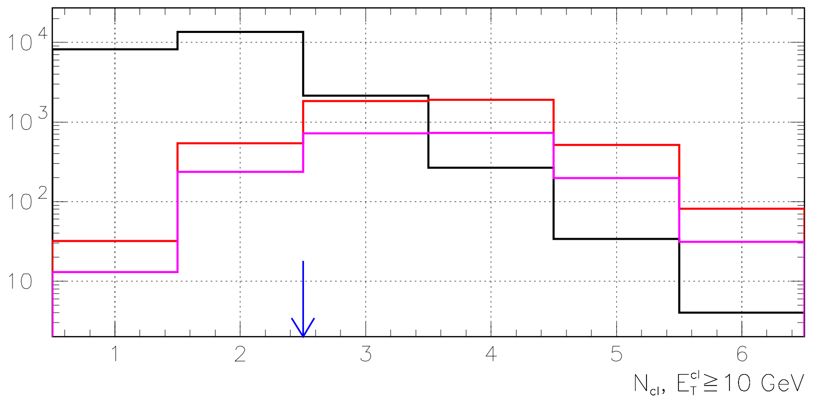


While using the JET20 sample for computing rates, the Level 1 cut $\Sigma E_T(L1) > 80\,\mathrm{GeV}$ has been used; this will be substituted further on by the requirement $N_{tow}(E_{tow} \geq 10\,\mathrm{GeV}) \geq 1$ (independent on $\mathcal{L}_{inst}$).

RUNII Level 2 distributions

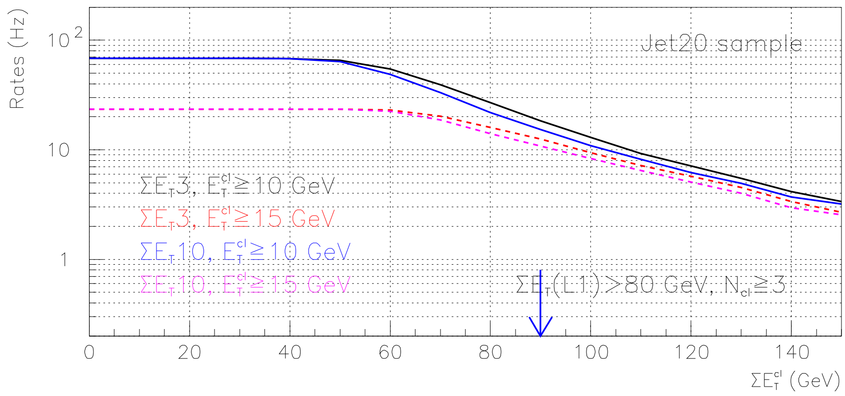
(Calorimetry)

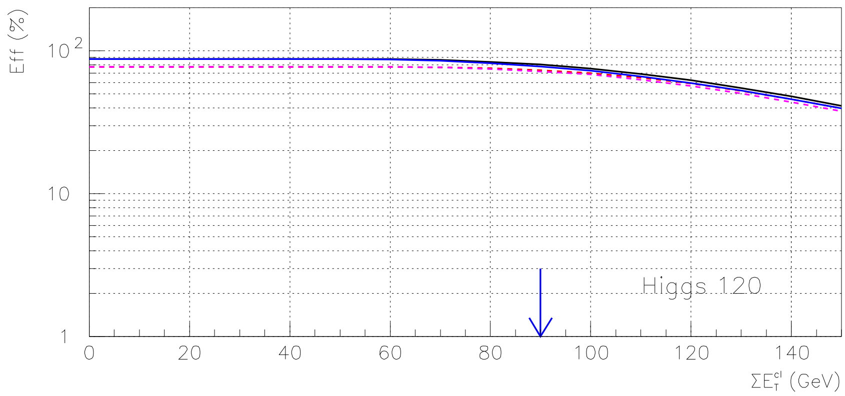




RUNII Level 2 efficiency & rate

(Calorimetry)





$N_{cl} \geq 3$	Efficiency	Rate
$\Sigma E_T 3 > 90$ GeV, $E_T^{cl} \geq 10$ GeV	80.2%	18.4 Hz
$\Sigma E_T 3 > 90$ GeV, $E_T^{cl} \geq 15$ GeV	73.3%	12.6 Hz
$\Sigma E_T 10 > 90$ GeV, $E_T^{cl} \geq 10$ GeV	77.8%	15.3 Hz
$\Sigma E_T 10 > 90$ GeV, $E_T^{cl} \geq 15$ GeV	71.9%	10.8 Hz

RUNII Level 2 rate & efficiency

(XCES)

- At least one XFT track per event is requested to match in ϕ a XCES bit whose pulse height E_{ph} (expressed in terms of CES ADC-counts) has to fulfill the requirement:

  $E_{ph} > 500 \times (P_T - 0.5)$,

  where P_T is the track momentum expressed in GeV/c.

- This cut has been measured in RUNI to be 90% efficient on electrons.

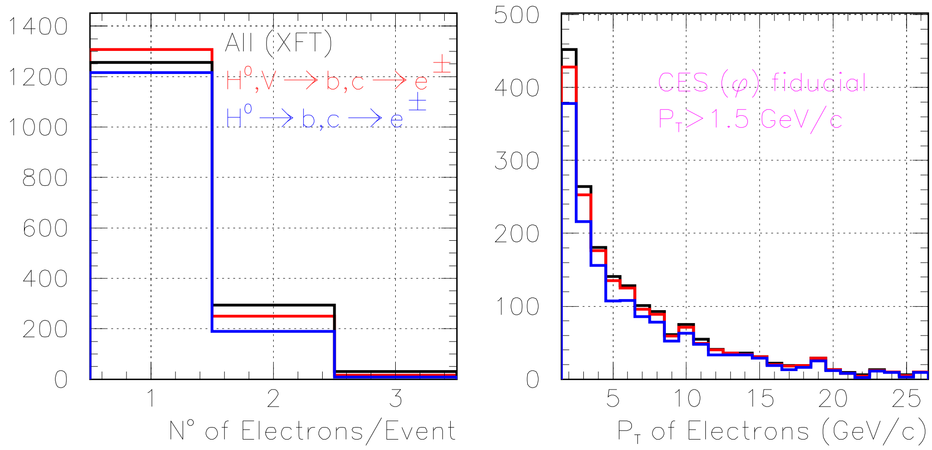
- Due to poor CES simulation, a 90% weight has been applied to each generated electron with $P_T > 1.5\,\mathrm{GeV/c}$ and within CES acceptance;

- The efficiencies are calculated wrt the number of events containing at least 1 electron from H^0,V semileptonic decay, and not on the full event (i.e. the fake rate on non-electron tracks present in the signal event is not considered).

RUNII Level 2 rates & efficiencies

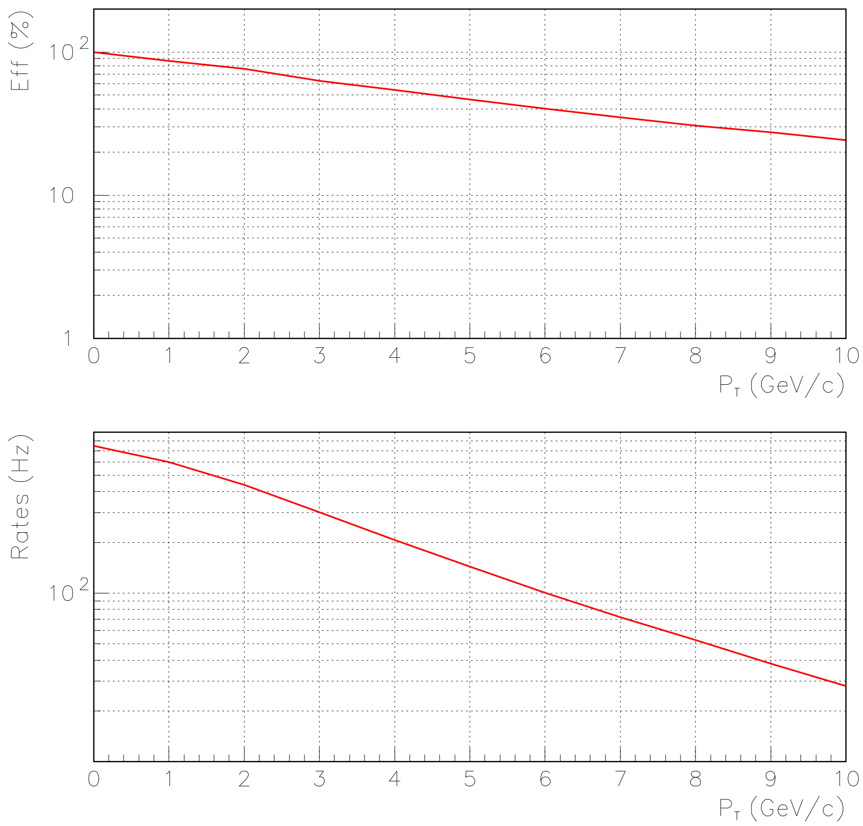
(XCES)

Number of fiducial signal electrons per event and P_T spectrum is reported:



RUNII Level 2 rates & efficiencies (XCES)

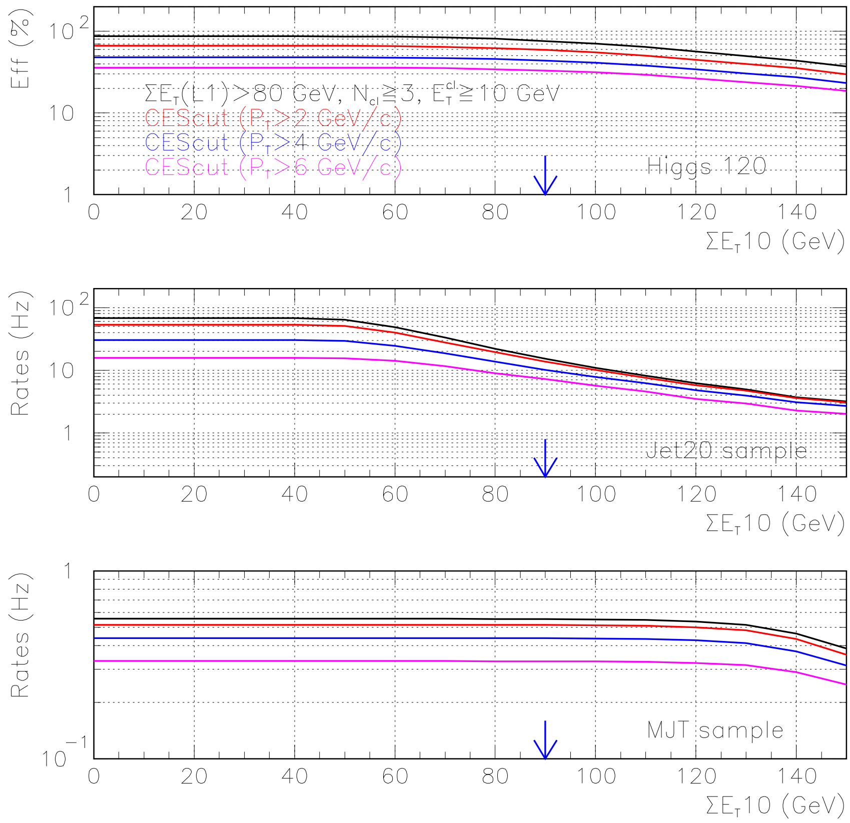
Expected factor $1.5 \div 2$ reduction on rate from CEScut can be observed before calorimetry requirements are applied:



No calorimetry cuts	Efficiency	Rate (JET20)
No CEScut	100%	750 Hz
CEScut $P_T > 2$GeV/c	76.6%	440 Hz
CEScut $P_T > 4$GeV/c	54.3%	207 Hz
CEScut $P_T > 6$GeV/c	40.3%	101 Hz

RUNII Level 2 rates & efficiencies

(XCES)



Calorimetry cut	Efficiency	Rate (JET20)	Rate (MJT)
No CEScut	75.9%	15.3 Hz	0.55 Hz
$P_T > 2$ GeV/c, $E_{ph} > 750$	59.0%	13.8 Hz	0.52 Hz
$P_T > 4$ GeV/c, $E_{ph} > 1750$	43.8%	10.2 Hz	0.44 Hz
$P_T > 6$ GeV/c, $E_{ph} > 2750$	33.1%	7.2 Hz	0.33 Hz

RUNII Level 3 rates & efficiencies

(SLT)

At least 1 Soft Electron Tag (RUNI algorythm) per event with $P_T \geq 2\,\mathrm{GeV/c}$:

Calorimeter	$0.7 < E/P < 1.5$
	$E_{had}/E_{em} < 0.1$
CES	$E_{strip} > 0.24 + 0.03 \times P$
	$E_{wire} > 0.24 + 0.03 \times P$
	$\lvert\Delta z\rvert < 2.0\mathrm{cm}$
	$\lvert\Delta x\rvert < 1.82 - 0.1867 \times P\mathrm{cm}$
	$\chi^2_{strip} < 16.0$
	$\chi^2_{wire} < 16.0$
CPR	$E_{CPR} < 4474 - (P/P_T) \times 11592+$
	$+7921 \times (P/P_T)^2$

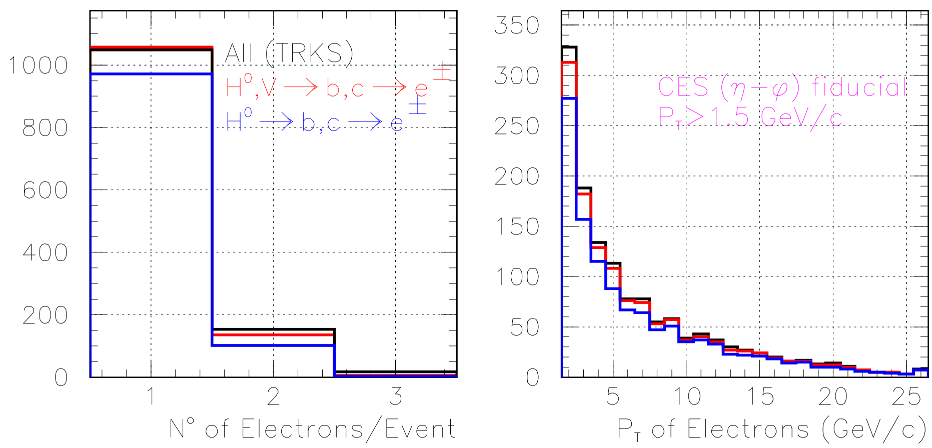
(energies and momenta expressed in GeV and GeV/c)

Conversion electrons are removed.

RUNII Level 3 rates & efficiencies

(SLT)

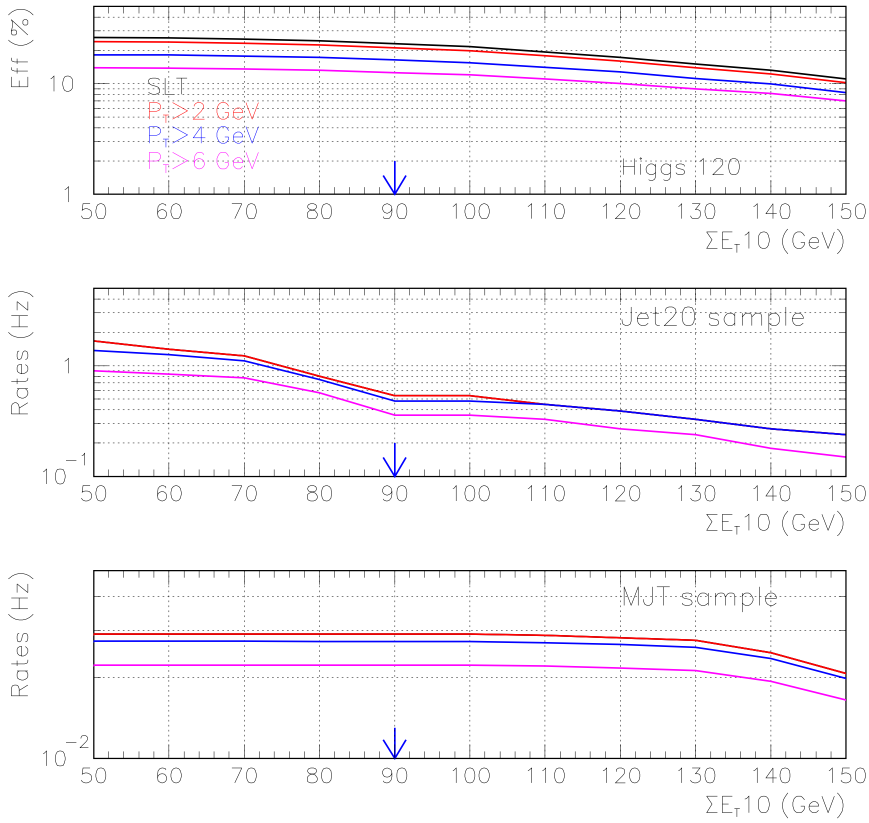
Number of fiducial signal electrons per event and P_T spectrum are reported:



Soft Lepton Tag – algorithms have been used to compute signal efficiency (from RUNI efficiency tables) and convoluted to the Level 2 efficiency on real electron tracks only.

RUNII Level 3 rates & efficiencies (SLT)

Level 3 rates & efficiencies are computed for different P_T values for CEScut:



Calorimetry cut	Efficiency	Rate (JET20)	Rate (MJT)
SLT	22.9% (9.0%)	0.54 Hz	0.029 Hz
L2 $P_T > 2$GeV/c	21.1% (8.3%)	0.54 Hz	0.029 Hz
L2 $P_T > 4$GeV/c	16.4% (6.4%)	0.48 Hz	0.027 Hz
L2 $P_T > 6$GeV/c	12.5% (4.9%)	0.36 Hz	0.022 Hz

Efficiencies on $H^0 + V \rightarrow$ had are indicated in parenthesis.

Conclusions

Lot of work to do! First tasks on our list:

- L2 clustering pass optimized for non isolated electrons;
- SVT requirement on the L2 electron track;
- Dependence of fake rate on event density (the JET20 sample is not the most appropriate, parametrize behaviour from MJT sample);
- Addition of muons: in progress (another student working on it Luca Scodellaro).