The top hadronic trigger for Run II

- Physics goals
- Level 2/3 rates and efficiencies
- Dataset size

$\boxed{\textbf{Physics goals}}$

The main goal for this trigger is the selection of all-hadronic $t\bar{t}$ events.

In fact:

- this trigger has high efficiency for the selection of $t\bar{t}$ events when both W's decay into a jet pair

◦ since a typical analysis requires both a minimum number of jets (4 or 5) and a minimum total energy, the bias due to the trigger is mimimal

◦ since we do not require any specific b-tag we leave any possible tagging option open

◦ since there is no b-tag requirement we can use the dataset to infer the backgrounds (size and or shape)

$\Rightarrow$ *contact persons:* P. Azzi, A. Castro

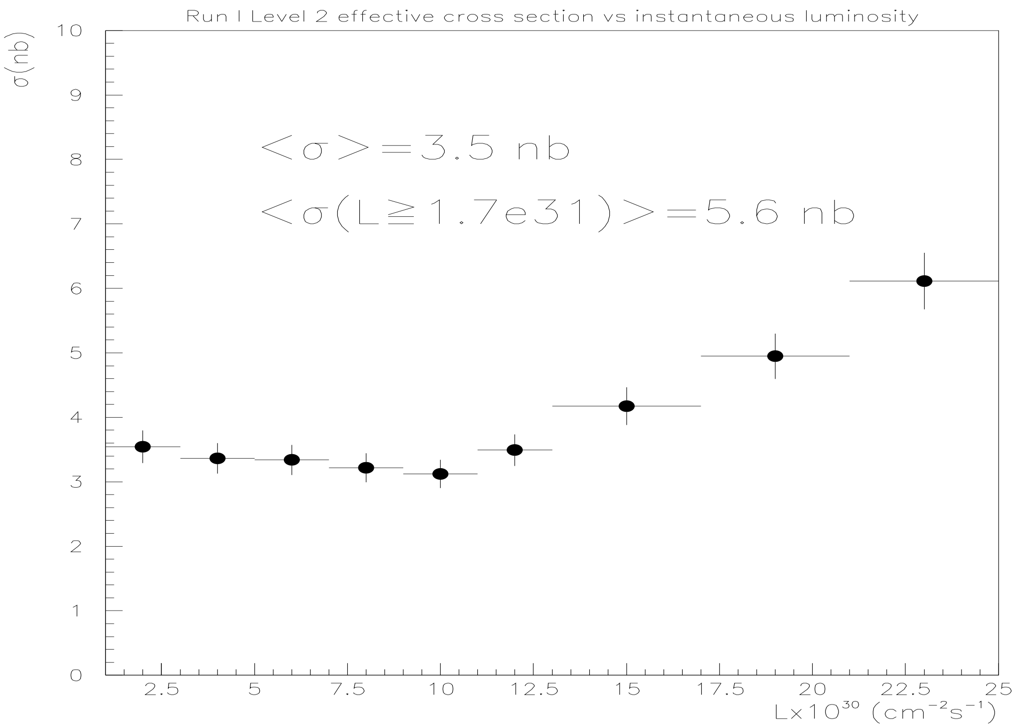
LEVEL2
TRIGGER TOTAL_ET_CL_125_4JETS_V1
SELECT TOTAL_ET_1 CUT TOTAL_ET >= 120. (GeV)
SELECT TOTAL_CLUSTER_ET_1 CUT TOTAL_ET >= 125. (GeV)
SELECT JET1
PARAMETER ET_THRESHOLD >= 15. (GeV)
CUT NUMBER_OF_JETS_1 >= 4

LEVEL3

```
TRIGGER QCDB_SUMET2_125_4JETS_V1
        SELECT PREREQ
        PARAMETER TALK_TO SETNAME PRMULJET
                PREREQUISITE TOTAL_ET_CL_125_4JETS_V1/LEVEL=2
                PREREQUISITE CLF_ANALOG_NOISE_MONITOR_V*/LEVEL=2
                RETURN
        END_TALK
        SELECT MJTFLT
                PARAMETER TALK_TO SETNAME TOPMJET1
                                CLUSTER_ET_MIN 10
                                THR_CLUSTER_ET 10
                                NUM_CLUSTER_MIN 4
                                EXIT
                END_TALK
TRIGGER QCDB_SUMET2_125_4JETS_C4
        SELECT PREREQ
                PARAMETER SETNAME PRMULJET
        EXECUTE JETCLU
                PARAMETER TALK_TO SETNAME CONE04
                                ALPHA_MAX .4
                                RETURN
                END_TALK
```

Run I: Level 2 σ vs instantaneous luminosity

The Run1 multijet trigger has a dependence on the $\mathcal{L}_{inst}$. The average Level 2 cross section for Run Ib: $<\sigma>= 3.5$ nb



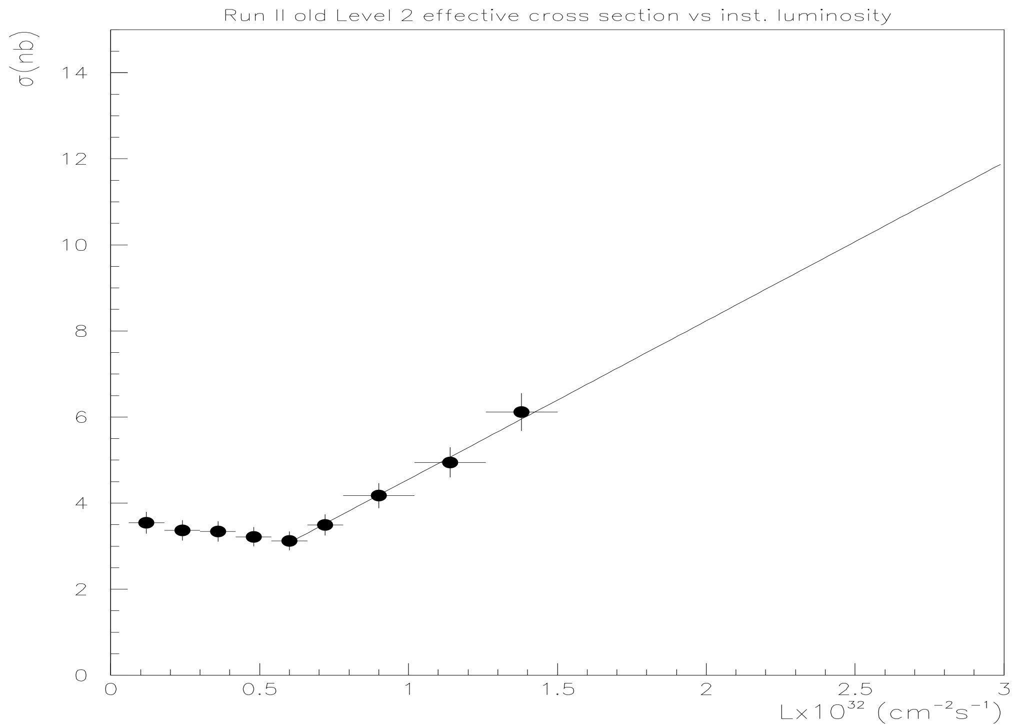
Extrapolation to Run II

We want to reproduce the situation of Run II $\mathcal{L}_{inst}$ in terms of multiple interaction rate:

- $1 \times 10^{32}\ cm^{-2}s^{-1}$ with 36 bunches corresponds to 2.8×10^{30} per bunch
- so a same Run I per bunch luminosity would have the same multiple interaction rate
- this translates to $2.8 \times 10^{30} \times 6 = 1.7 \times 10^{31}$ for Run I
- the average level 2 multijet cross section for $\mathcal{L} \geq 1.7 \times 10^{31}$ was 5.6 nb: we will use this number to infer Run II rates for the MJT sample

Run II: Level 2 σ vs instantaneous luminosity

Extrapolation of the Run1 Level2 cross section in the Run2 Level2 configuration as a function of instantaeous luminosity.



Data samples and tools

We estimate Level 1, 2 and 3 rates using Run I events:

- For Level 1 we will use minimum bias events (in progress)
- For Level 2 we use the JET20 sample (cross check with the multijet sample)
- For Level 3 we use the multijet sample itself (since now we want to have a trigger more restrictive)
- The signal: $t\bar{t}$ events (W's hadronic decay forced) generated at $\sqrt{s} = 2$ TeV (Pythia)

For the simulation of the Run2 variables we use the RUN2TRS package (we also share the analysis tools with the multijet higgs trigger people, Petar et al.)

RUN II Level 1 distribution

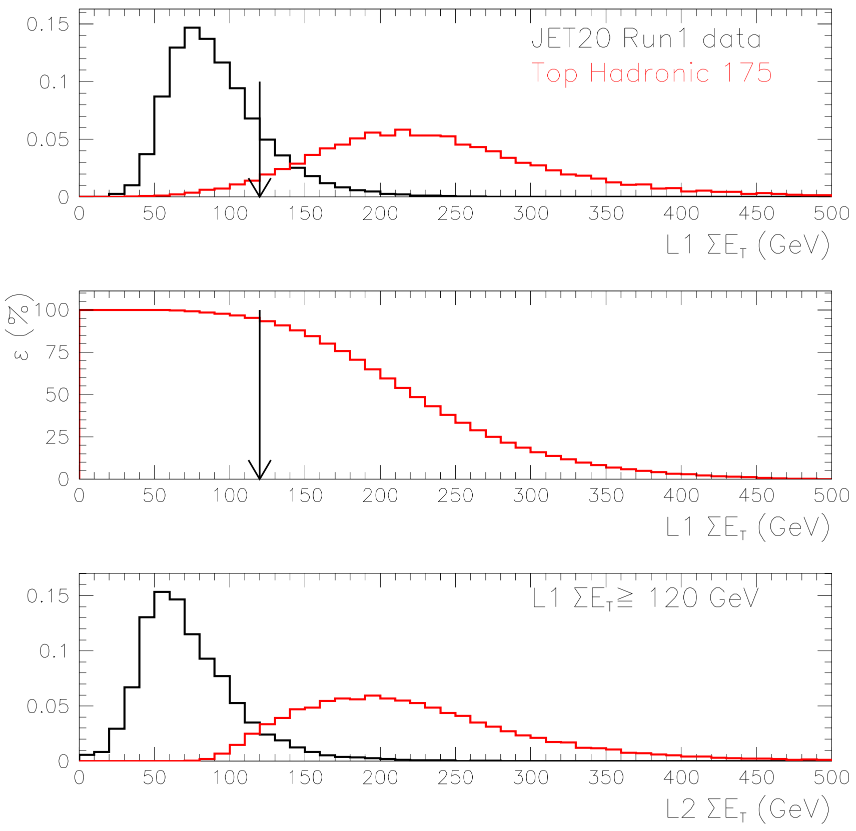


Figure 1: L1 and L2 sumet distribution forJet20 and $t\bar{t}$

RUN II Level 2 rates/eff for the 'Run1 MJT'

- Run 2 Level 2 rate extrapolated from Run 1 using JET20 sample: 750 Hz

1) Requiring $\sum E_T(L1) \geq 120\,\text{GeV}$: 120 Hz

2) Requiring $\sum E_T(L2) \geq 125\,\text{GeV}$: 9.3 Hz

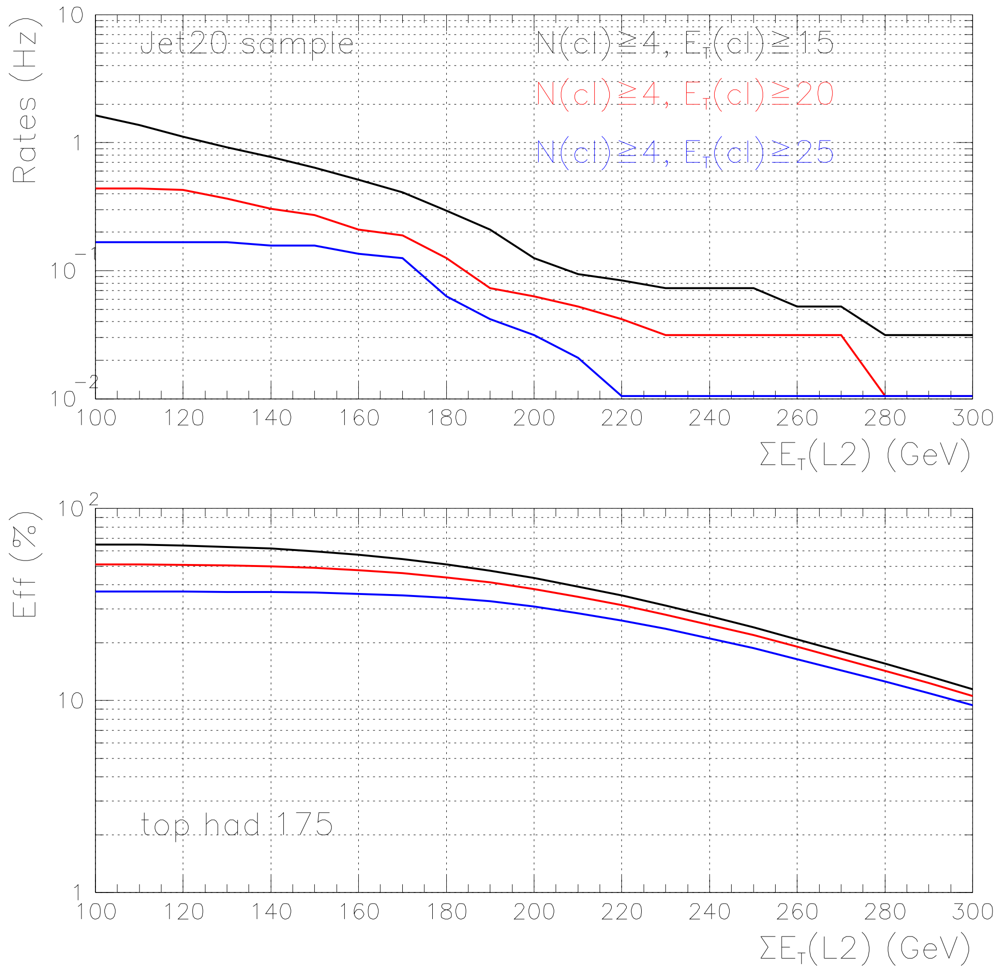
3) Requiring $N(L2clu) \geq 4$ where $E_T(L2clu) \geq 15\,\text{GeV}$: 1.1 Hz

- Step 3) is the L2 Run1 MJT trigger. The expected Run 2 rate from the MJT sample is about 0.43 Hz. (The uncertainty on the JET20 is large at this level of selection.)

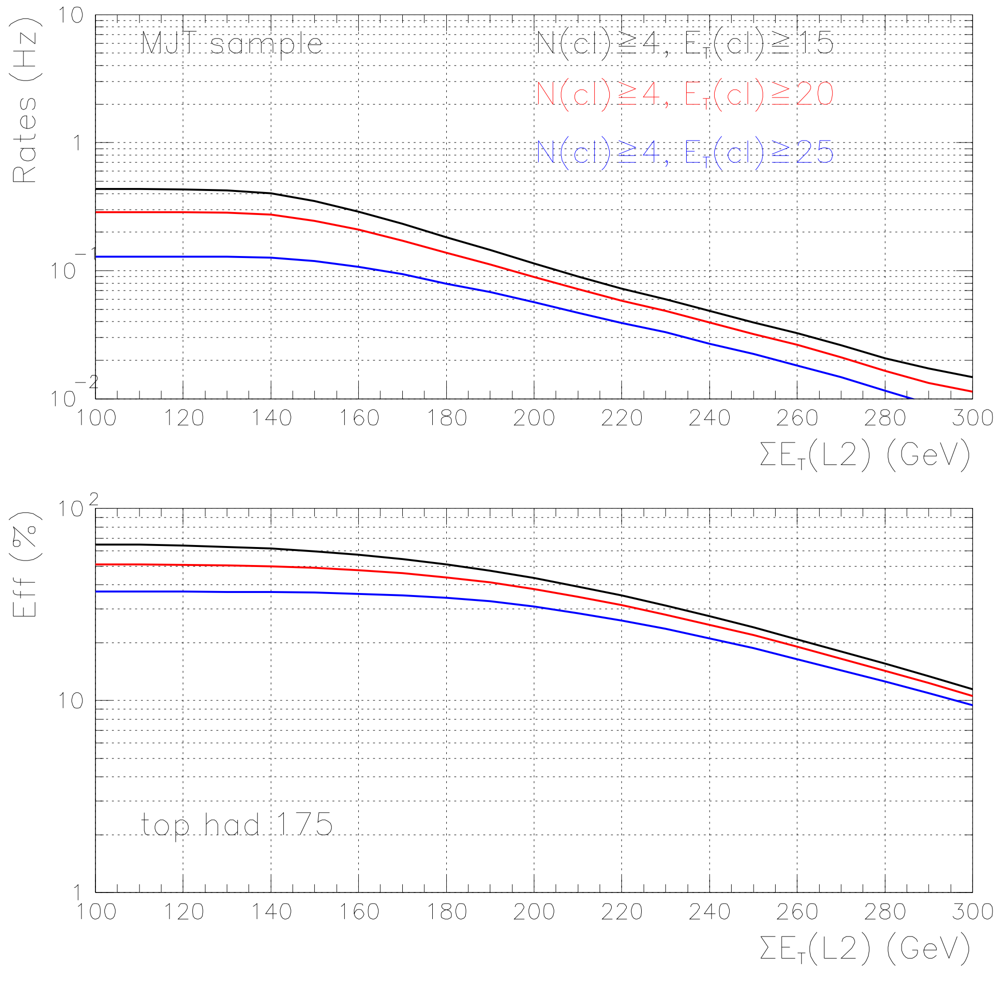
4) Increasing the threshold $E_T(L2clu) \geq 20\,\text{GeV}$ gives : 0.43 Hz for JET20 (only 39 events surviving) and 0.29 for MJT

4) Increasing the threshold $E_T(L2clu) \geq 25\,\text{GeV}$ gives : 0.13 Hz for MJT

RUN II Level 2 rates/eff - J20 sample

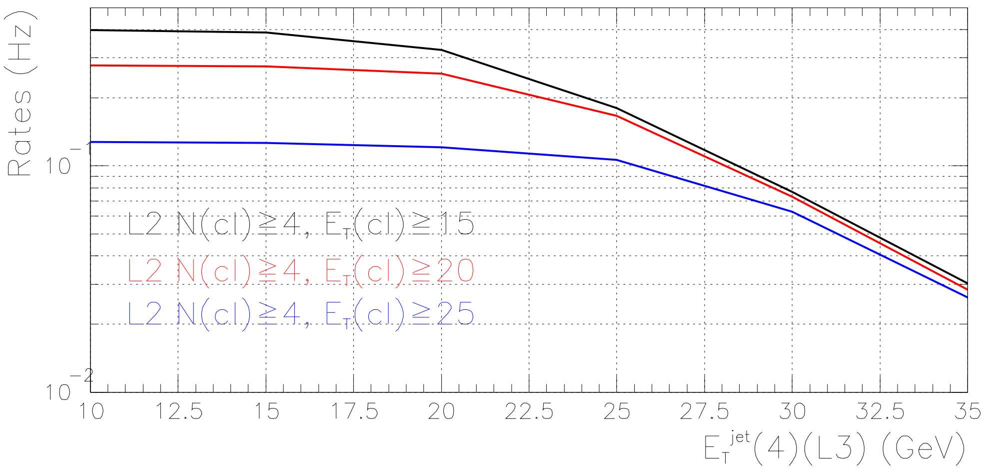


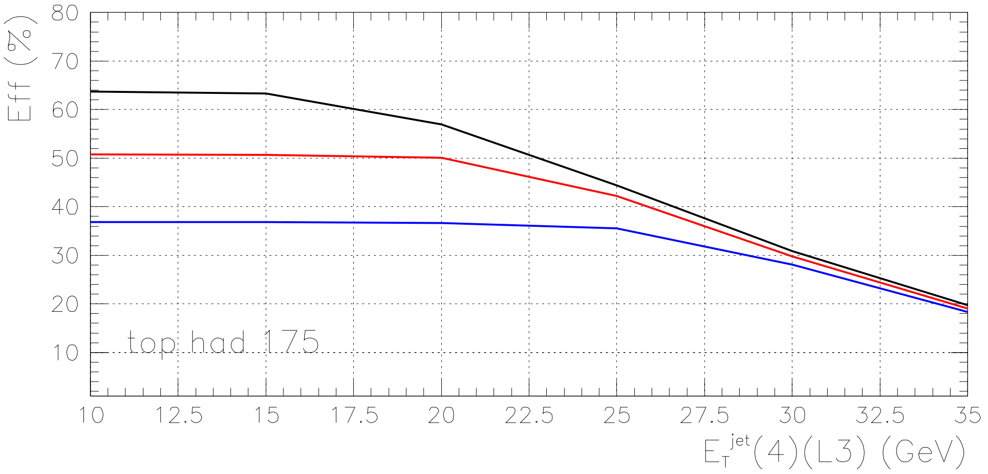
RUN II Level 2 rates/eff - MJT sample



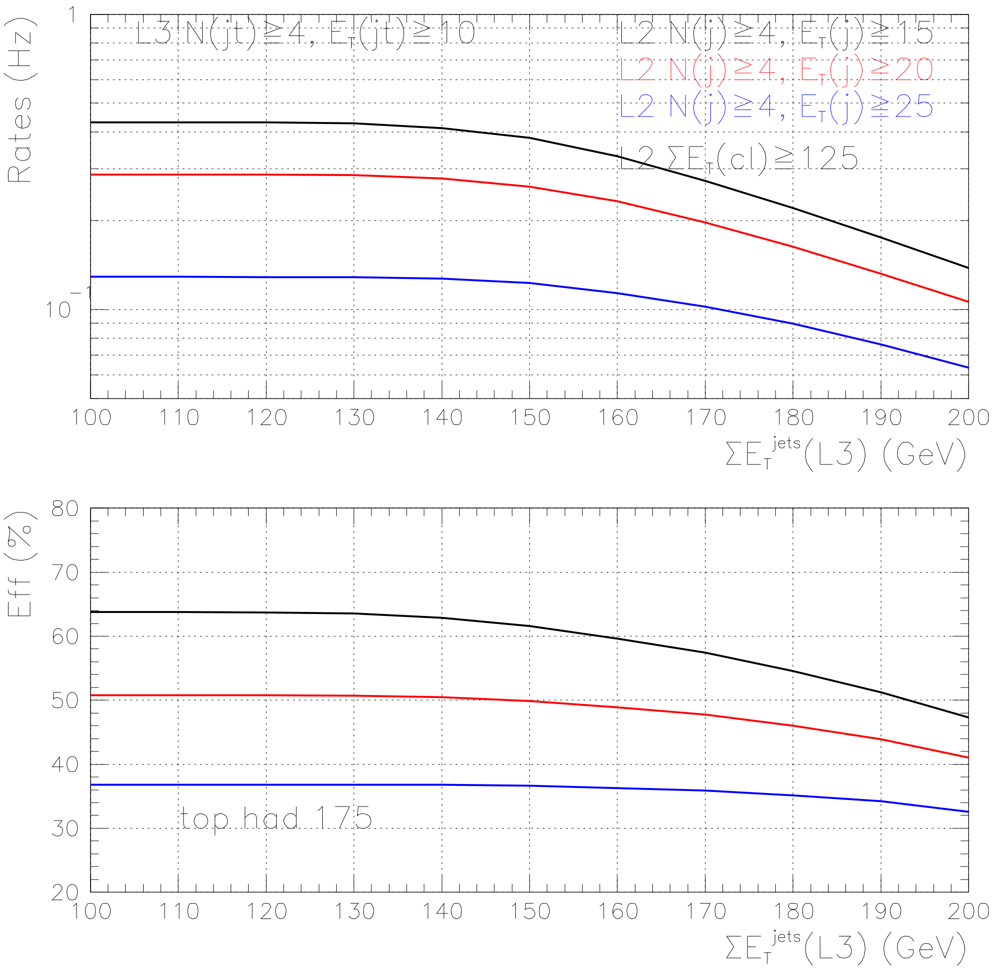
RUN II Level 3 rates and efficiency

At Level 3 require $N(jet) \geq 4$ where $E_T^{unc}(4) \geq [cut]$ GeV





RUN II Level 3 rates and efficiency - $\sum E_T(jets)$



Summary of Run2 rates and efficiencies

Selection	Rate^{J20}(Hz)	Rate^{MJT}(Hz)	ϵ(%)
$\sum E_T(L1) \geq 120\,\mathrm{GeV}$	120		95
$\sum E_T(L2) \geq 125\,\mathrm{GeV}$	10		90
$N(L2clu) \geq 4$ where			
a) $E_T(L2clu) \geq 15\,\mathrm{GeV}$	1.1	0.43	63.7
b) $E_T(L2clu) \geq 20\,\mathrm{GeV}$	0.43	0.28	50.8
c) $E_T(L2clu) \geq 25\,\mathrm{GeV}$	–	0.13	36.8
$N(L3jt) \geq 4$ and $E_T(4) \geq 10(15)\,\mathrm{GeV}$			
a)		0.40(0.39)	63.7(63.4)
b)		0.28(0.27)	50.8(50.7)
c)		0.13(0.13)	36.8(36.8)
$\sum E_T(L2) \geq 140\,\mathrm{GeV}$			
$N(L2clu) \geq 4$ where			
a) $E_T(L2clu) \geq 15\,\mathrm{GeV}$	–	0.40	61.8
b) $E_T(L2clu) \geq 20\,\mathrm{GeV}$	–	0.27	50.1
c) $E_T(L2clu) \geq 25\,\mathrm{GeV}$	–	0.13	36.7

Proposal for top hadronic trigger

We propose a very similar trigger as it was in Run1.

LEVEL1 $\sum E_T(total) \geq 120\,\mathrm{GeV}$

LEVEL2 $\sum E_T(cluster) \geq 125\,\mathrm{GeV}$

$N(cluster) \geq 4$ with $E_T(cluster) \geq 15\,\mathrm{GeV}$

LEVEL3 $N(jet) \geq 4$ with $E_T(jet) \geq 10\,\mathrm{GeV}$, cone 0.4 OR 0.7 (we have checked only the rate for the 0.4 cone)

For an instantaneous luminosity of $1 \times 10^3 2\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$ we have:

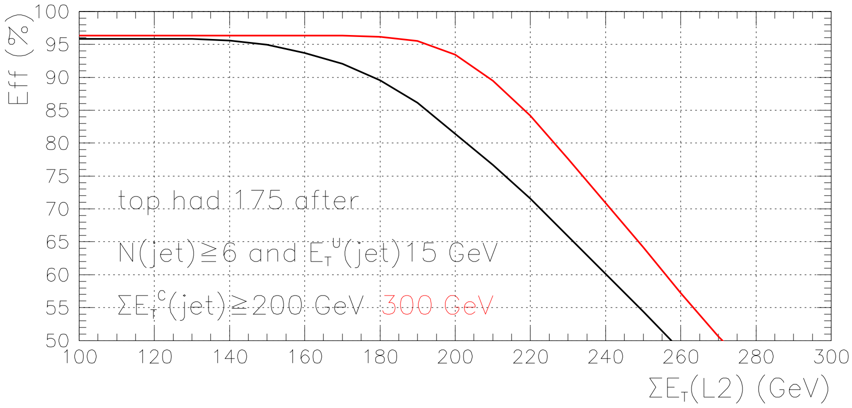
- Level 2 rate (extrapolated from Run 1): 0.43 Hz
- Level 3 efficiency: 63.7%
- Level 3 rate (extrapolated from Run I): 0.40 Hz
- Level 3 rate (including a factor 1.3 increase): 0.52 Hz
- Level 3 effective cross section (including a factor 1.3 increase): 5.2 nb

Efficiency for typical analysis cuts

Look at the efficiency for a typical selection for top hadronic:

- $N(jet) \geq 6$ with $E_T^{unc}(jet) \geq 15\,\mathrm{GeV}$
- $\sum E_T^{corr}(jet) \geq 200(300)\,\mathrm{GeV}$

as a function of the requirement on the Level2 $\sum E_T(cl)$. The L2 rate also does not drop for $\sum E_T(L2) < 140$: no advantage in cutting higher there.


Eff (%)
top had 175 after
N(jet)≥6 and E_T^u(jet)15 GeV
ΣE_T^c(jet)≥200 GeV 300 GeV
ΣE_T(L2) (GeV)

$\boxed{\textbf{Conclusions}}$

We have presented a study of the performances of a trigger for the top all hadronic channel in the Run 2 enviroment. Our extrapolations are based on:

- $\mathcal{L}_i nst = 1 \times 10^{32}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$
- old Run 1 multijet trigger philosophy
- RUN2TRS simulation package
- the signal has been generated at $\sqrt{s} = 2.0\,\mathrm{TeV}$

We find a rate (with the 1.3 scale factor) at Level2 = 0.52 Hz that corresponds to a cross section of 5.2 nb. We have also a preliminary extrapolation of the cross section versus instantanoues luminosity that can be used to infer the rates.