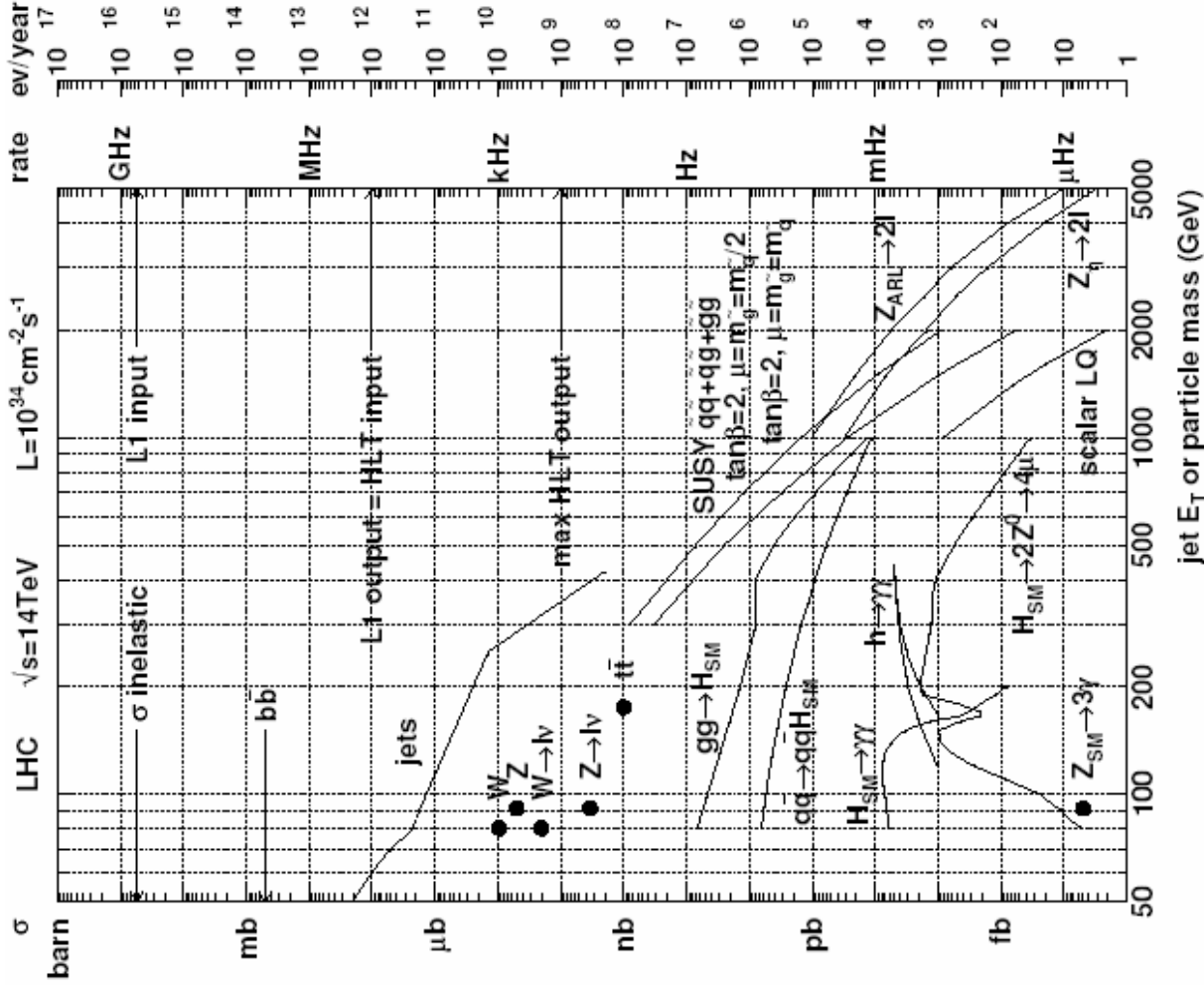


Strategie di trigger per eventi SUSY a LHC

**Simone Gennai
INFN Sez. di Pisa**

I.F.A.E. 2004

Sezioni d'urto di vari processi a LHC ²

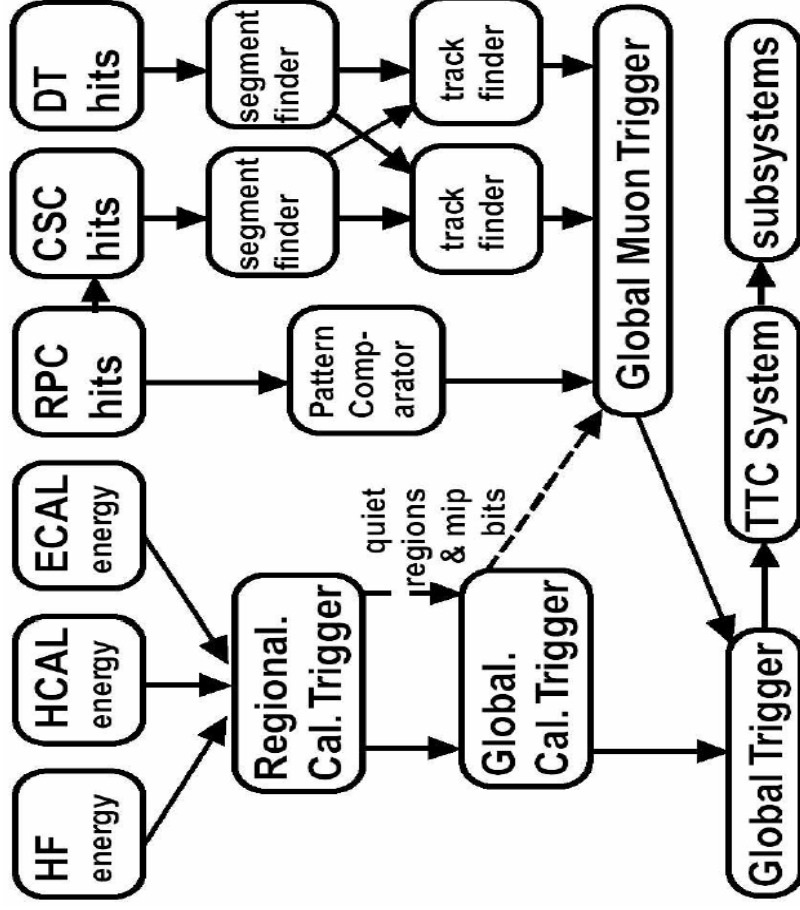


I processi di QCD rappresentano un fondo preoccupante per molti canali di fisica, a causa della loro alta sezione d'urto.

Escogitare le giuste strategie di trigger è fondamentale per riuscire a estrarre il segnale dai vari fondi.

Sistema di trigger di CMS

3



Il trigger di CMS si divide in 3 livelli:

L1: hardware, con soglie programmabili (->100 kHz).

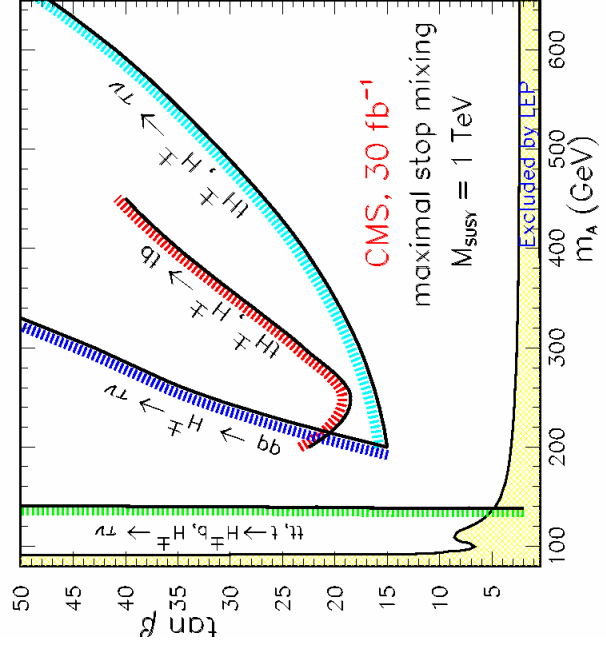
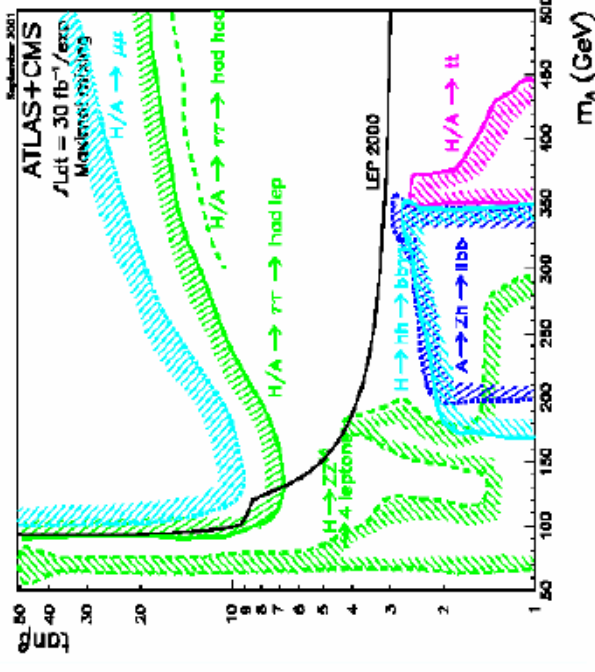
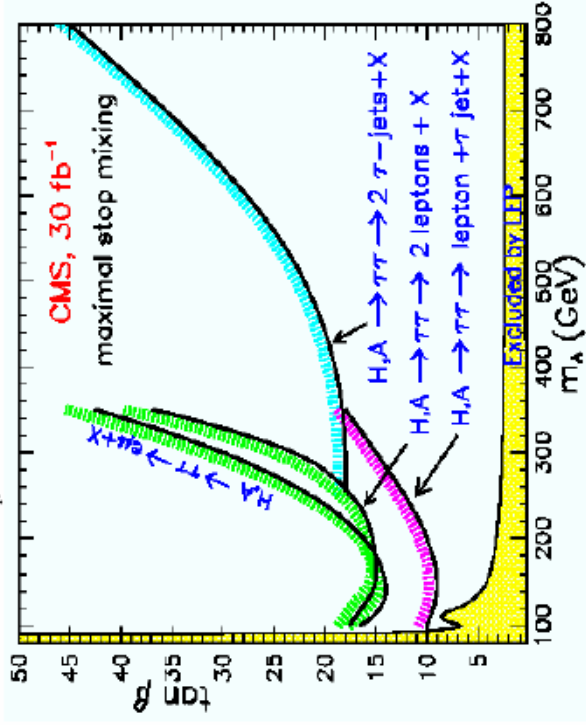
L2, L2.5, L3 (HLT): software, prendono come input il Livello 1 e applicano tagli in energia e isolamento dei vari oggetti fisici ricostruiti (->100 Hz).

Trigger di Livello 1: soglie e rate

4

Trigger	Threshold (GeV or GeV/c)	Rate (kHz)	Cumulative Rate (kHz)
Isolated e/γ	29	3.3	3.3
Di- e/γ	17	1.3	4.3
Isolated muon	14	2.7	7.0
Di-muon	3	0.9	7.9
Single tau-jet	86	2.2	10.1
Di-tau-jet	59	1.0	10.9
1-jet, 3-jet, 4-jet	177, 86, 70	3.0	12.5
Jet* $E_{T\text{miss}}$	88*46	2.3	14.3
Electron*jet	21*45	0.8	15.1
Min-bias		0.9	16.0
TOTAL			16.0

MSSM Higgs



Fundamentale per ricerche
MSSM ad alti tanβ

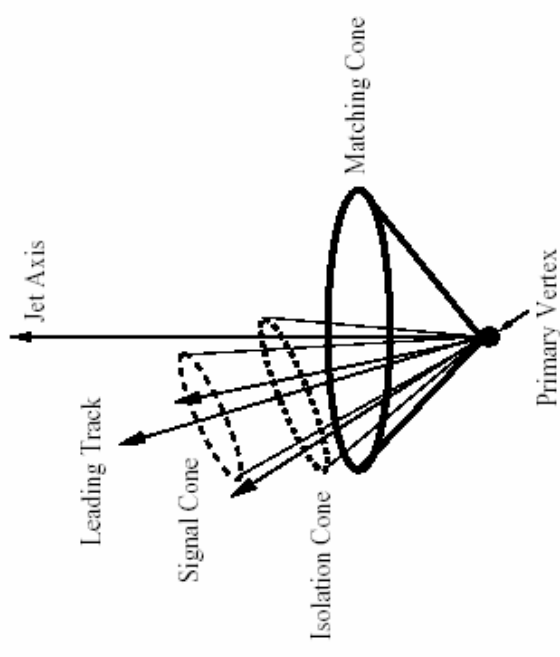
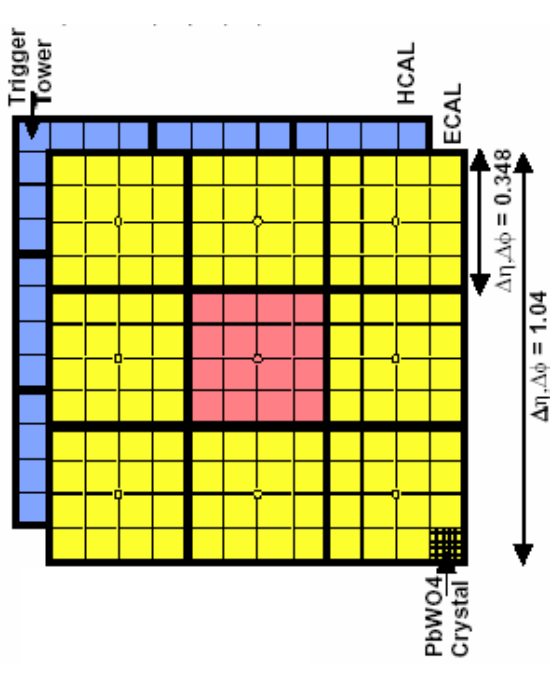
Calorimeter

- ✘ Energy released in few cells: narrow jets
- ✘ "Isolated energy deposit"

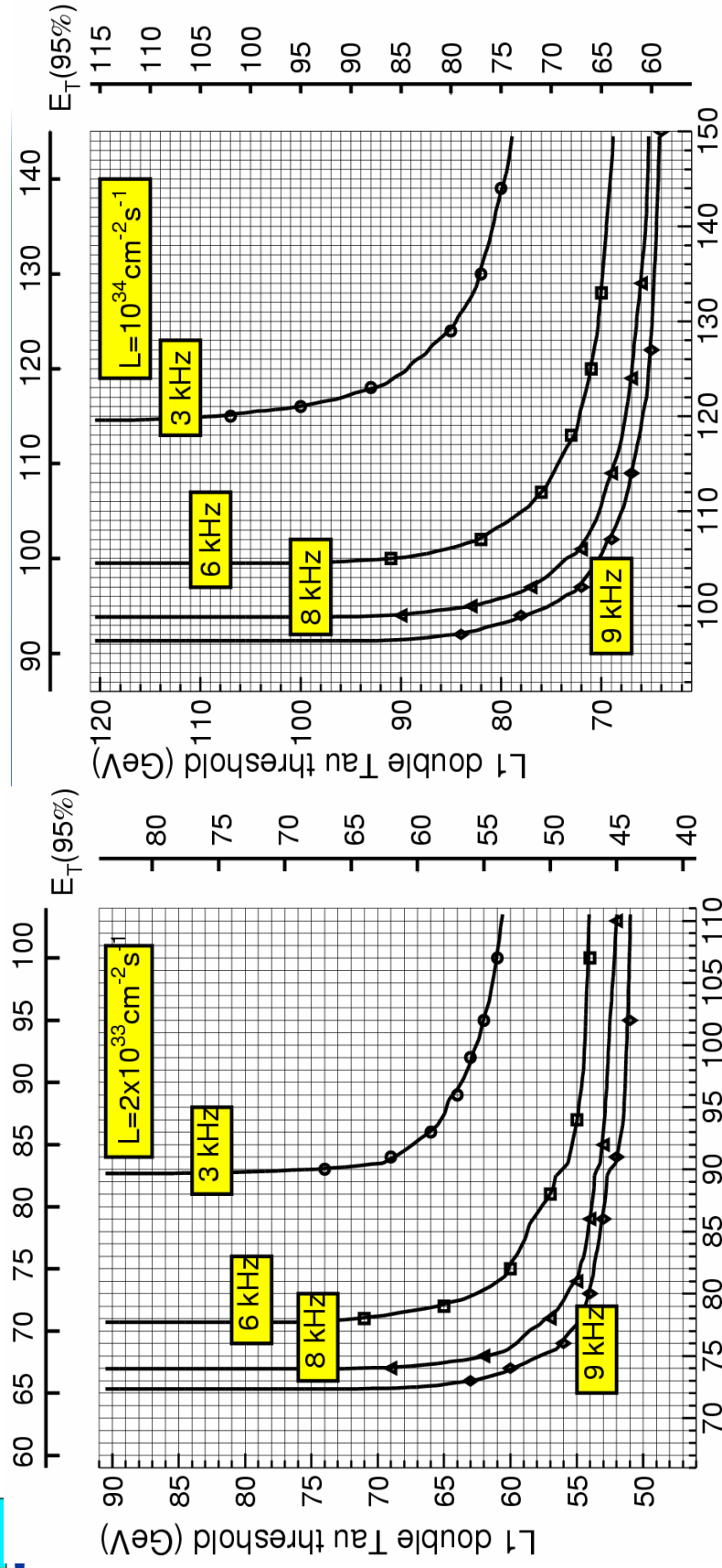
Tracker

- ✘ Isolation made with reconstructed tracks

Main background QCD 2jet events



Soglie di L1 del tau trigger



L1 single Tau threshold (GeV)

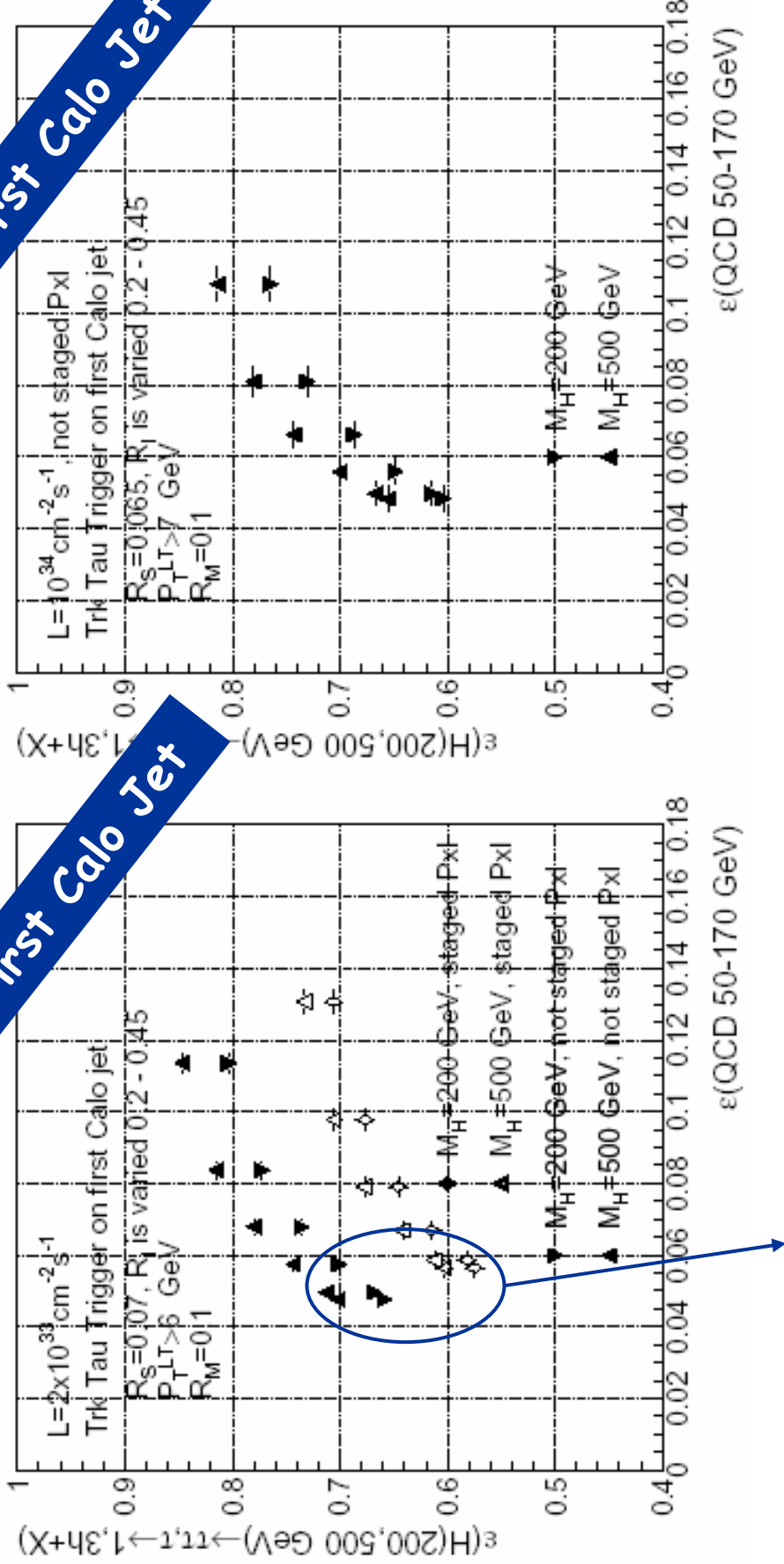
L1 single Tau threshold (GeV)

Luminosity	rate, kHz	1 Tau threshold (95%), GeV	2 Tau threshold (95%), GeV	$\epsilon(H \rightarrow 2\tau)$ $M_H = 200 \text{ GeV}$	$\epsilon(H^+ \rightarrow \tau\nu)$ $M_H = 200 \text{ GeV}$
Low	3	93 (86)	66 (59)	0.78	0.81
High	8	106 (101)	72 (67)	0.62	0.76

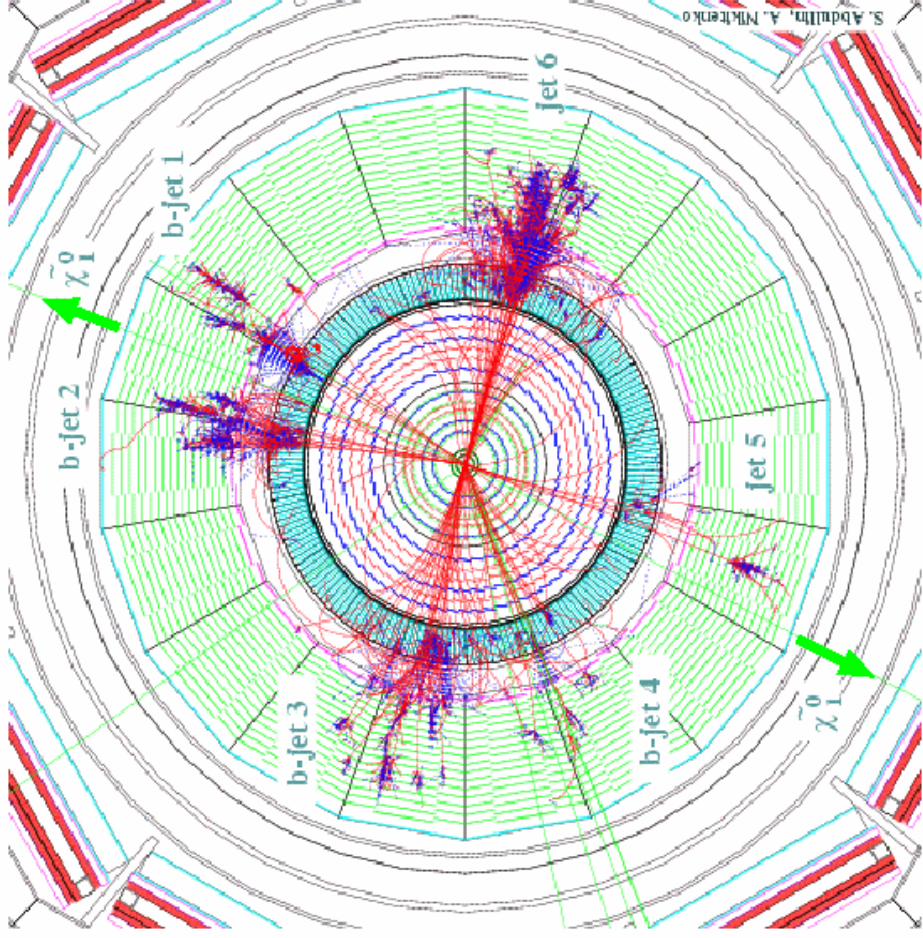
Isolamento tracker a L2

First Calo Jet

First Calo Jet



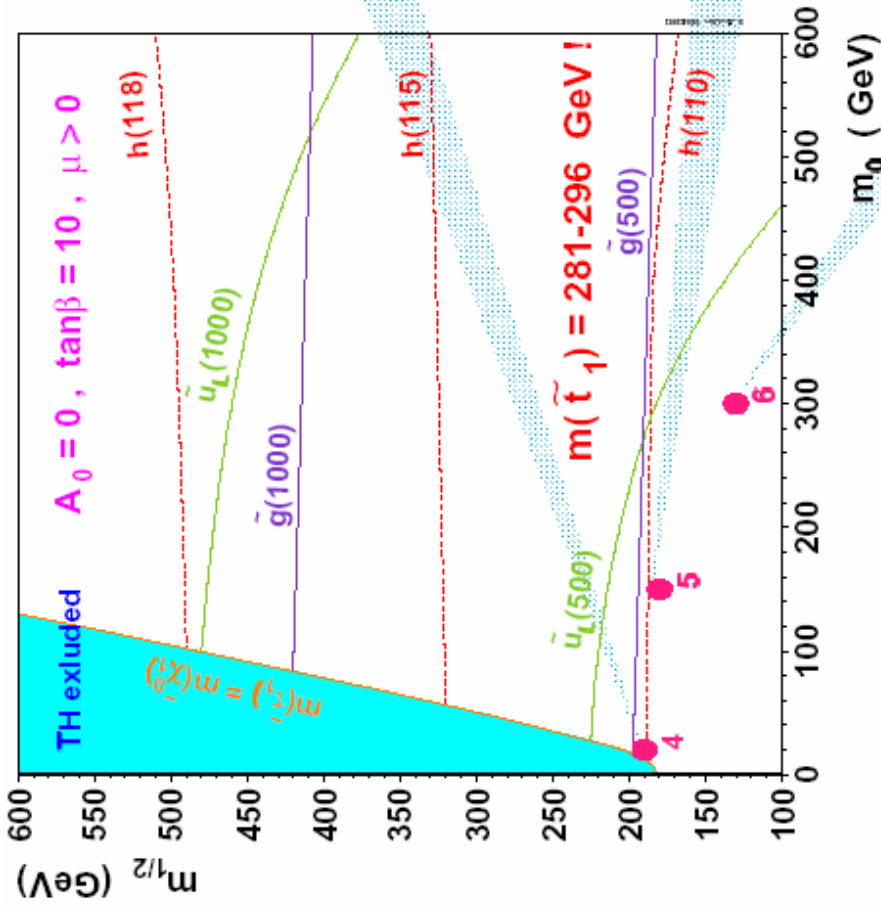
It is clear the gain in signal efficiency with the standard scenario, wrt the staged one



Principalmente gli eventi SUSY sono caratterizzati da una alta molteplicità di jet (o leptoni) e da grande energia trasversa mancante (E_T^{miss}).

Nel caso di violazione di R-parità, la quantità di E_T^{miss} è minore, ma la molteplicità di jet aumenta.

Benchmark points



$m(\tilde{\chi}_1^0) = 70 \text{ GeV}$ $m(h) = 110 \text{ GeV}$
 $m(\tilde{g}) = 466 \text{ GeV}$ $m(\tilde{u}_L) = 410 \text{ GeV}$
 $\sigma \sim 181 \text{ pb}$ tau-enriched,
4 **20,190** quite enough sleptons

$m(\tilde{\chi}_1^0) = 66 \text{ GeV}$ $m(h) = 110 \text{ GeV}$
 $m(\tilde{g}) = 447 \text{ GeV}$ $m(\tilde{u}_L) = 415 \text{ GeV}$
 $\sigma \sim 213 \text{ pb}$ nothing special
5 **150,180**

$m(\tilde{\chi}_1^0) = 45 \text{ GeV}$ $m(h) = 106 \text{ GeV}$
 $m(\tilde{g}) = 349 \text{ GeV}$ $m(\tilde{u}_L) = 406 \text{ GeV}$
 $\sigma \sim 500 \text{ pb}$ $\tilde{q} \rightarrow \tilde{q} + X, \tilde{g} \rightarrow 3 \text{ body,}$
6 **300,130** more jets, less MET

Require $\int L dt < 10 \text{ pb}^{-1}$
 (low luminosity LHC run)

Benchmark points (II)

11

Gli stessi tre punti sono stati considerati nel caso di R-parità violata

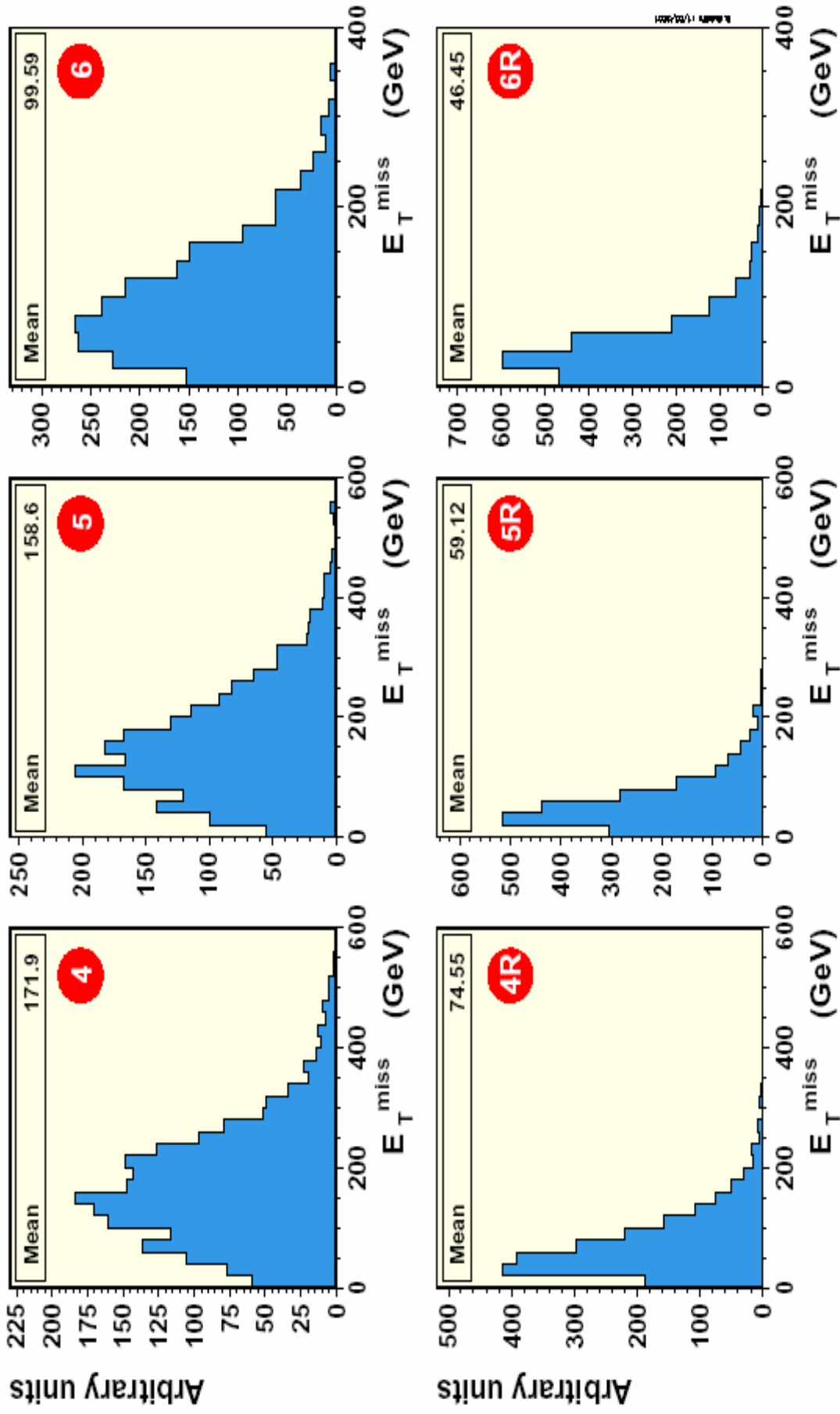
R

- Emiss diminuisce (ma non troppo):
Decadimenti in leptoni tau e W
Aumenta la produzioni di b jet

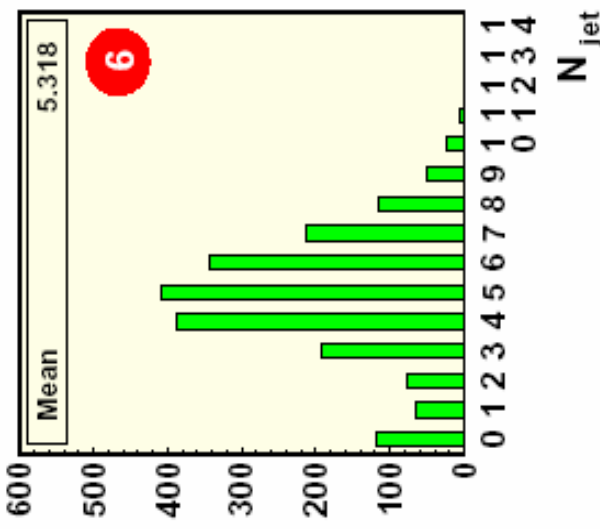
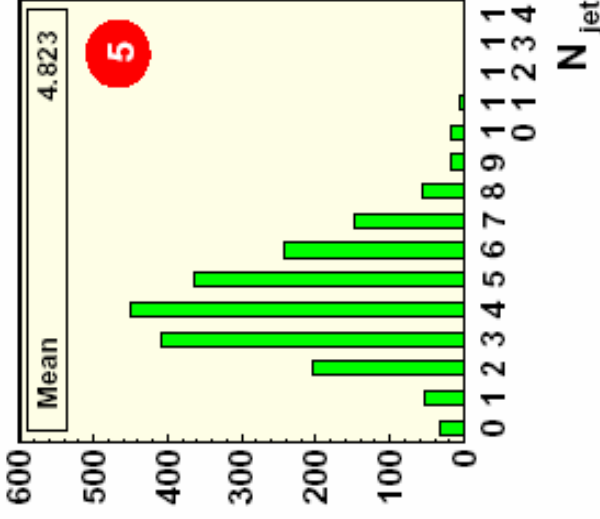
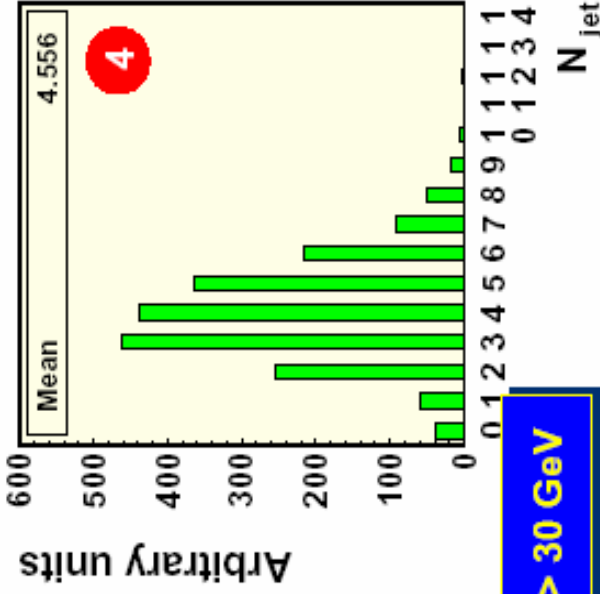
- Presenza di jet addizionali, ma "soffici"

$$M(\chi^0_1) = 45 - 70 \text{ GeV}$$

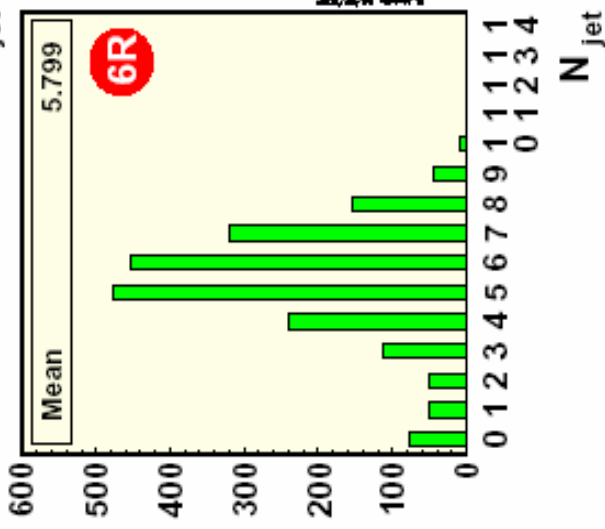
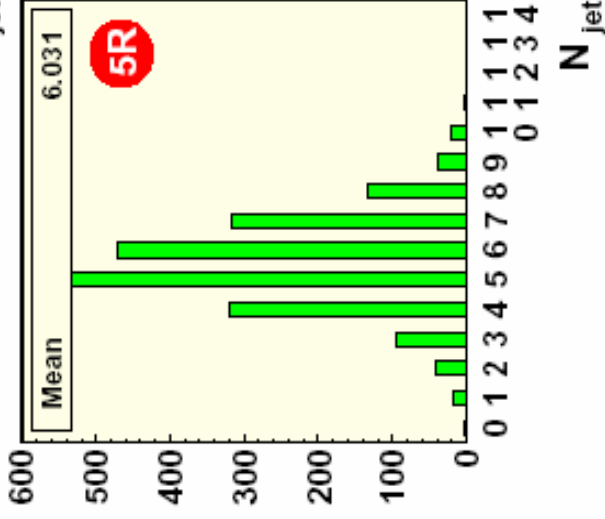
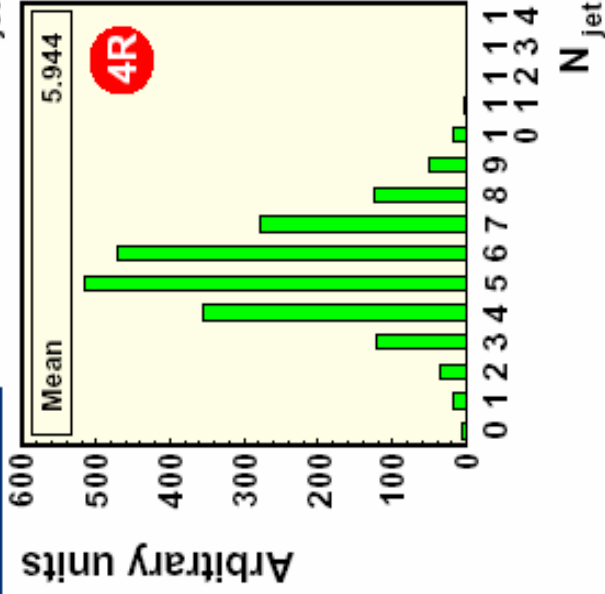
E_T^{miss} @ Livello 2 di trigger



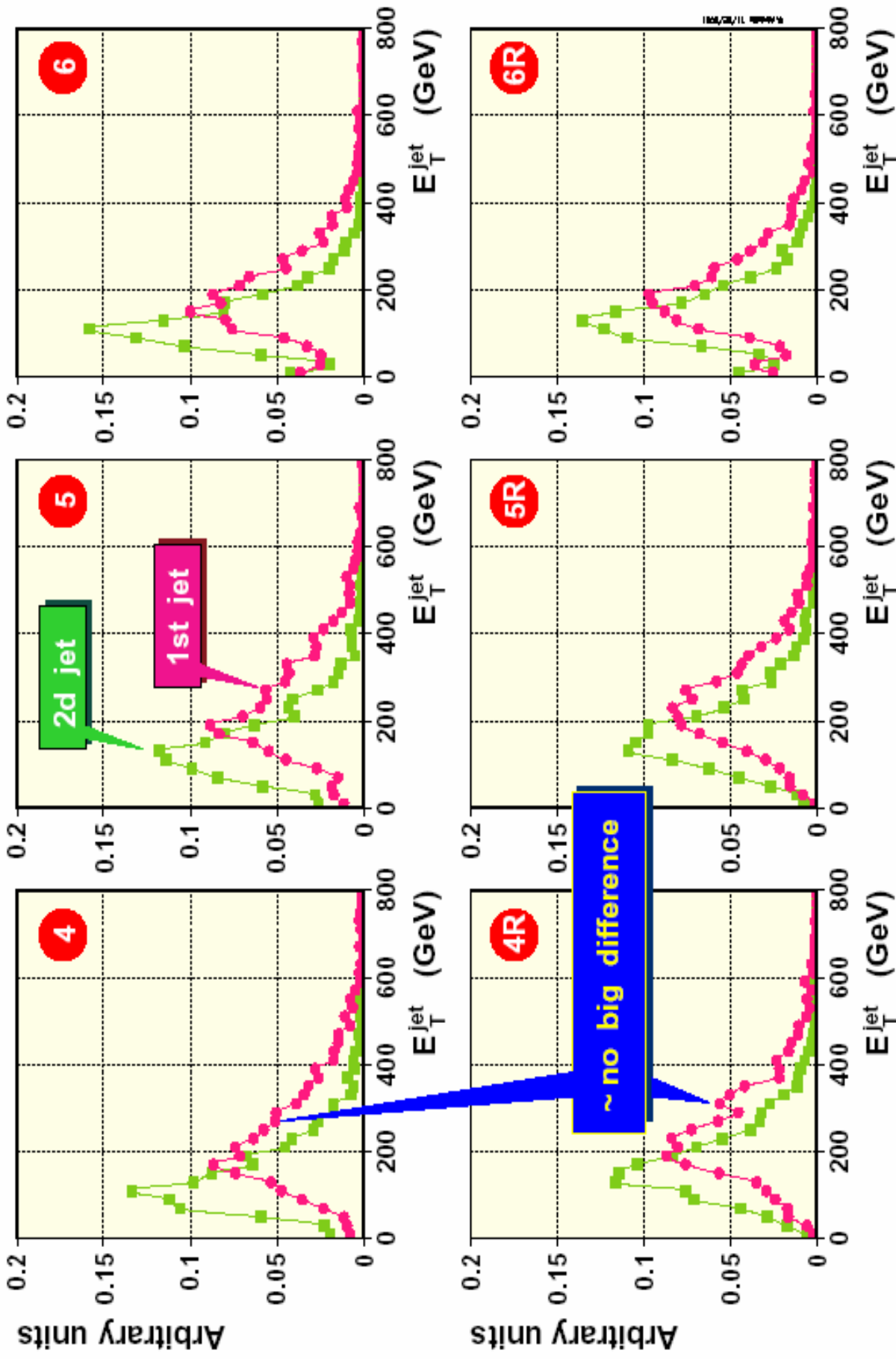
di jet @ Livello 2 di trigger



$E_T^{jet} > 30 \text{ GeV}$



E_T^{jet} @ Livello 2 di trigger



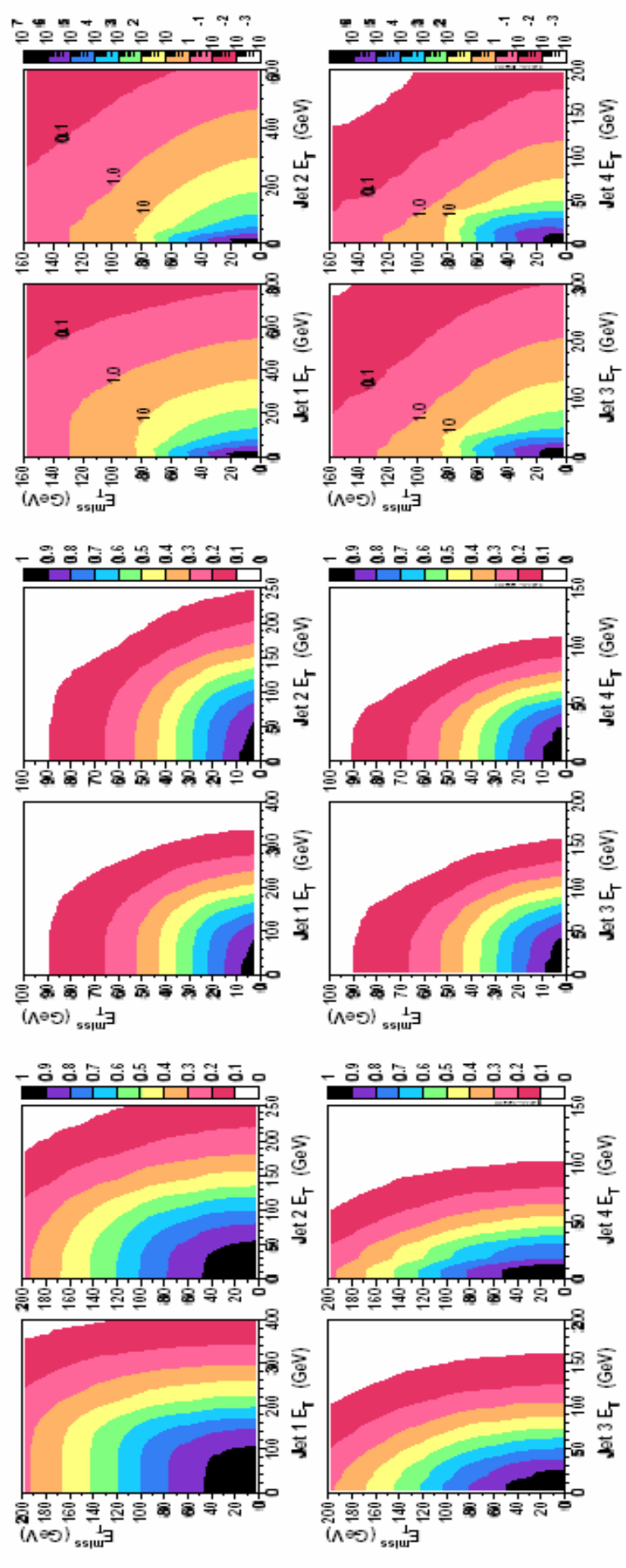
Efficienze di trigger

5

Signal efficiency

6R

QCD rate (Hz)



Soglie ottimizzate a L1

Cuts (GeV) →	J1	J3	J1 + MET
Point 4	79 (79)	87 (60)	93 (83)
Point 5	81 (81)	88 (65)	92 (83)
Point 6	66 (66)	80 (68)	84 (62)
Point 4R	88 (88)	94 (89)	94 (54)
Point 5R	87 (87)	95 (90)	95 (44)
Point 6R	71 (71)	88 (84)	88 (32)
QCD	0.78 (0.78)	1.63 (1.06)	2.05 (0.54)
t \bar{t}	} irrelevant !		
Wj (ν)			

signal efficiency (%)

Background rate (KHz)

Sono stati ottimizzati i tagli sulle energie dei Jet e della missing energy.

Il trigger combinato jet+E_{miss} permette di abbassare ulteriormente le soglie.

Il fondo principale sono gli eventi di QCD

Soglie ottimizzate a L2

$\Delta\phi(J1,J2) < 160^\circ$

Cuts (GeV) →	MET	J3 & MET	J4 & MET	MET	J2 & MET	J4 & MET	L2 rate (Hz)
	170	80 + 110	100 + 40	110	90 + 100	60 + 80	
Point 4	50 (50)	61 (33)	62 (9)	76 (65)	78 (51)	79 (19)	0.26
Point 5	43 (43)	56 (34)	59 (10)	72 (60)	74 (52)	76 (23)	0.30
Point 6	17 (17)	32 (24)	38 (12)	48 (35)	51 (31)	54 (21)	0.46
Point 4R	6 (6)	18 (17)	28 (16)	31 (15)	33 (16)	36 (16)	0.12
Point 5R	3 (3)	10 (10)	23 (16)	25 (9)	25 (9)	28 (12)	0.11
Point 6R	2 (2)	6 (5)	13 (10)	14 (4)	15 (5)	17 (7)	0.15
QCD	0.29 (0.29)	0.73 (0.51)	1.79 (1.12)	2.0 (0.44)	2.14 (0.41)	2.37 (0.50)	+
t \bar{t}						0.12	
Wj(ν)						0.17	
						Σ 2.67	

signal efficiency w.r.t. L1 (%)

Background rate (Hz)