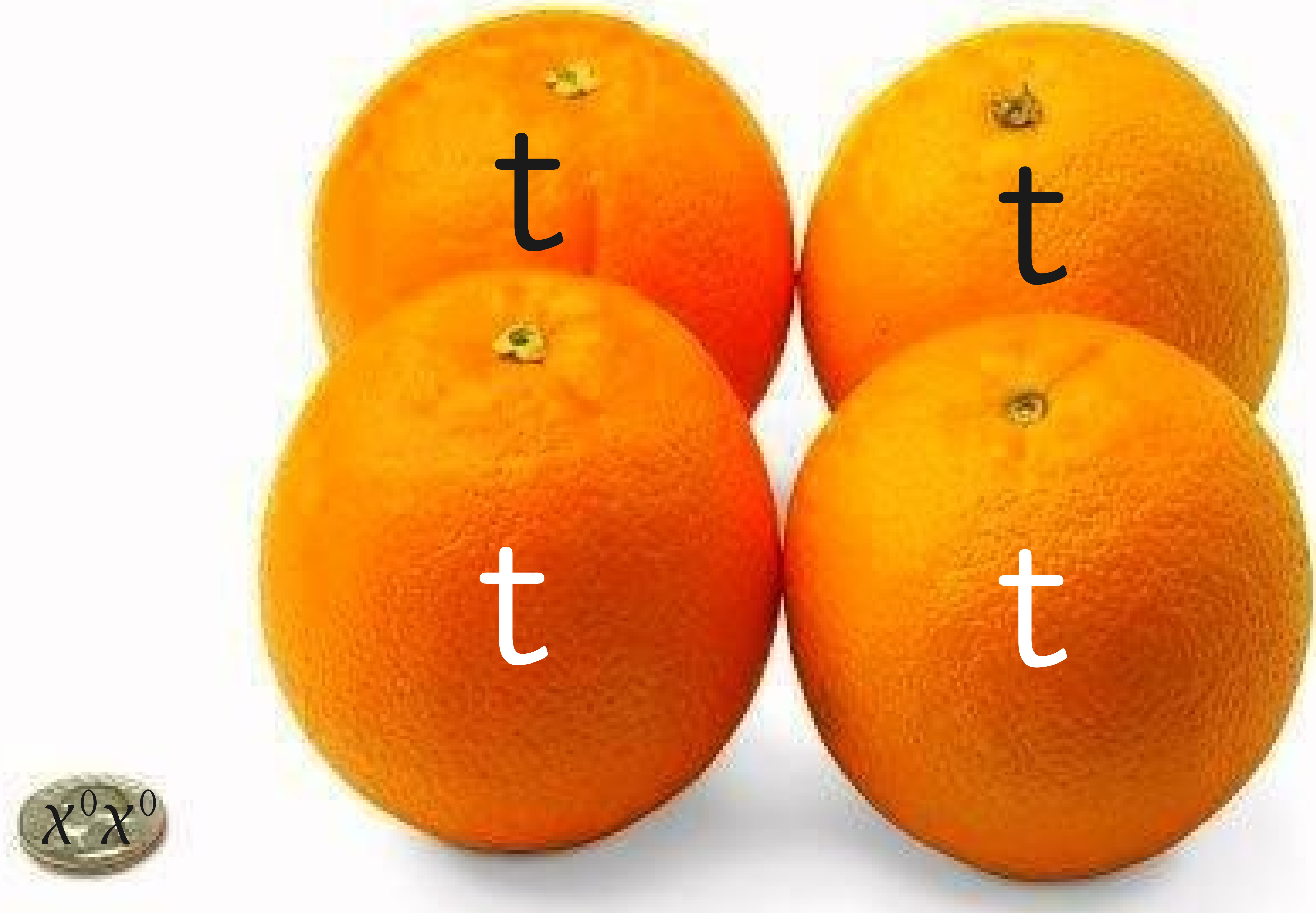

t
t
t
t
$\chi^0\chi^0$

Is this four top scenario as laughable as it seems?

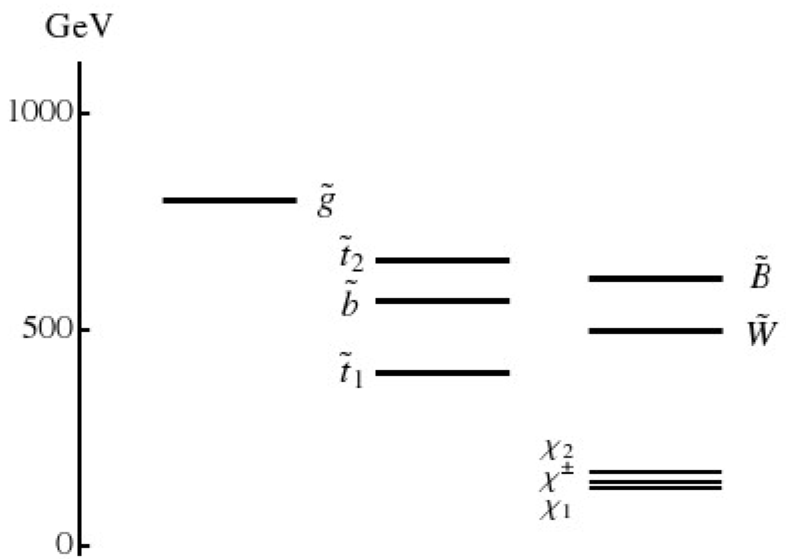
Rather rethorical...

But let me answer with a few more questions

SCIENCE IS ALL ABOUT FINDING THE RIGHT QUESTIONS

- Why SUSY? Or how I have started searching.
- Is it worth looking for?
- What is the real final state?
- What is the spirit with which this analysis is performed?

WHY SUSY?



- A template for all the MMSSMs
- Naturally leads to 4tops+2 neutralinos final states.
- Favoured by flavour and naturalness considerations
  - Without assuming anything on the very high energy dinamics (unlike mSUGRA and “aligned” friends).

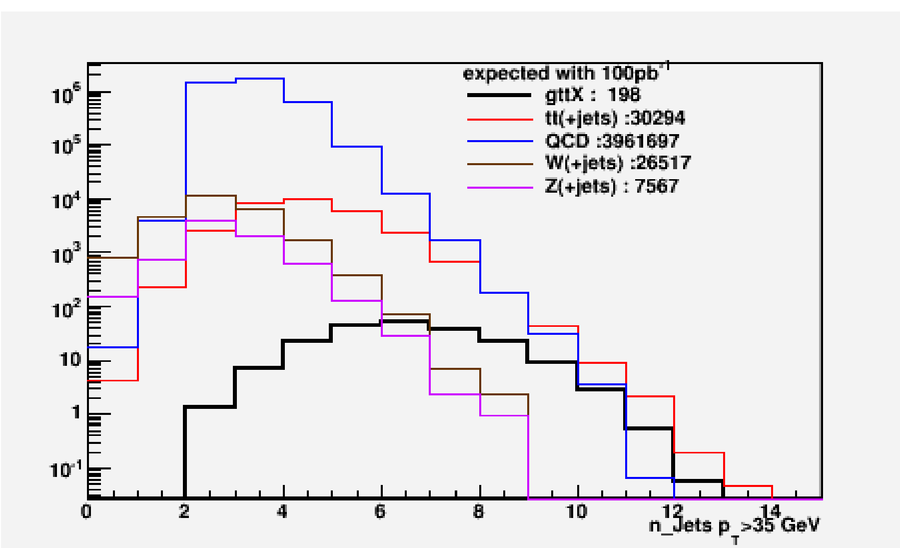
R.Barbieri, D. Pappadopulo: JHEP 0910:061, 2009.
R.Barbieri, E.Bertuzzo, M.Farina, P.Lodone, D.Pappadopulo: JHEP 1008:024, 2010.

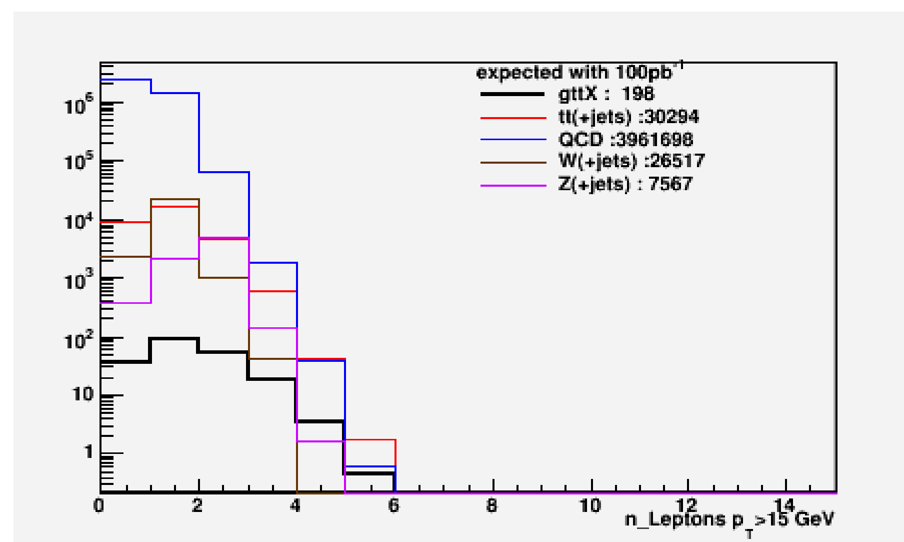
IS IT WORTH LOOKING FOR?

- ...
- But no one is looking for this specific model.
- We are just taking inspiration for
  - A model independent search on the tails of the SM jet multiplicity.
  - A model independent search of rare topologies (2b-jets+ 2SS Leptons +MET, just to mention one).
  - A "precision" measurement (the SM cross section for this final state is < 1fb).

WHAT IS THE REAL FINAL STATE?

- Let us focus on the SUSY spectrum for simplicity.
- $\tilde{g}\tilde{g} \rightarrow t\bar{t}t\bar{t}\chi_0\chi_0$
- The possibile signatures are endless. At the moment we are studying the region with high jet multiplicity.
- It would also be interesting to look in the tails of the b-jets multiplicity and leptons multiplicity.





DISCLAIMER
(OR THE NATURE OF THE ANALYSIS)

- The final state is very rich and most of these searches are already being performed in CMS.
- What is new is to ask $N_{jets} \geq 8$
- At the same time we will treat the SUSY scenario as a simplified model and we will scan the three dimensional parameter space: $\{ m_{\tilde{t}}, m_{\tilde{g}}, m_{\chi^0} \}$

ALICE IN JETLAND

SAMPLES

- DATA (for the Muon boxes)
  - RunB 2010
  - HLT_Mu9 Runs ≤ 147119, HLT_Mu11 [148068, 147146], HLT_Mu15 ≥ 148108.
- MC samples
  - TTJets_TuneZ2_7TeV-madgraph-tauola
  - WJetsToLNu_TuneZ2_7TeV-madgraph-tauola
  - ZJetsToLNu_TuneZ2_7TeV-madgraph-tauola
  - TtoBLNu_TuneZ2_*-Channel_7TeV-madgraph (*=s,t,tW).
  - QCD*Jets_Pt*to*_TuneZ2_7TeV-alpgen
  - Signal: PYTHIA8+FASTSIM
    - 600 benchmark points from m_g=200 GeV to m_g=500 GeV

SCUOLA NORMALE SUPERIORE PISA

EVENT SELECTION

JET TAILS ANALYSIS

- Five exclusive “boxes”: μ, $\mu\mu$, e, ee, eμ
- 4 AntiKtR0.5 PFJets with p_T > 30 GeV (and $|\eta|<2.4$) for the baseline selection
- 4 additional AntiKtR0.5 PFJets with p_T > 30 GeV (and $|\eta|<2.4$) for the full analysis
- One central jet $|\eta|<2.1$
- Fake Jets subtraction (see next slide)

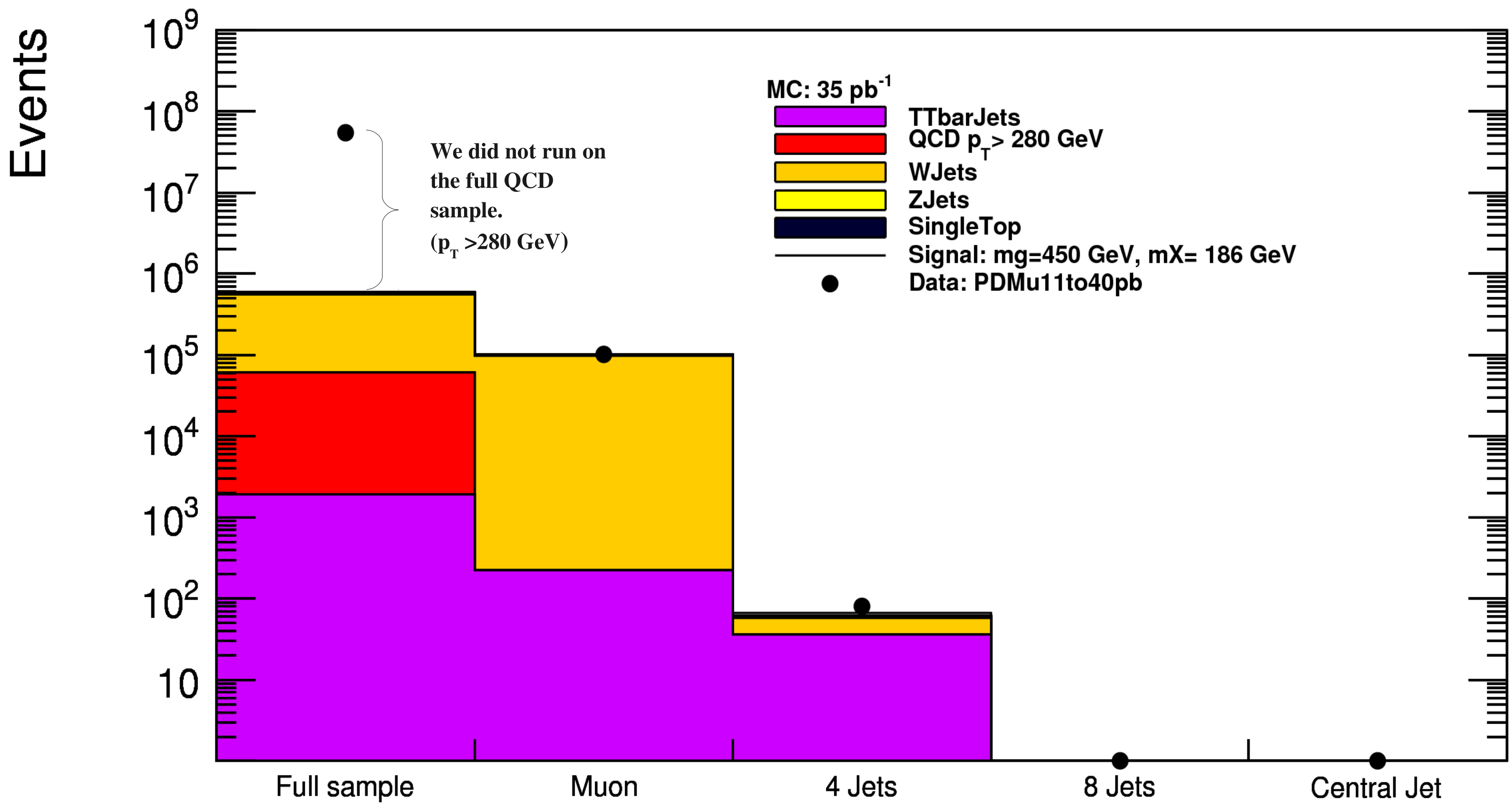
SUSY ORIENTED

- Jet tails analysis
- If there is an excess in the 8 Jets bin:
  - Go back to the baseline selection
  - Look at the shape of a kinematic variable on which we have not cut (M_R, H_T, ME_T, M_T, S_T, ...).

LEPTONS

- VBTF selection
- PFJets with a reco (loose) muon or (80)electron within $\Delta R=0.5$ of their axis are not counted as Jets.
- For the muon box we select events with
  - One tight muon p_T>18 GeV
    - The muon must be identified as both global muon and tracker muon
    - Number of pixel hits > 0
    - Number of hits in the tracker > 10
    - Transverse impact parameter of the muon with respect to the beam spot < 2 mm
    - Chi2/ndof of the global muon fit < 10
    - Number of valid hits in the muon chambers used in the global muon fit > 0
    - Number of muon stations > 1
    - $|\eta|<2.1$
    - (IsoTrk+IsoECAL+IsoHCAL)/p_T < 0.15

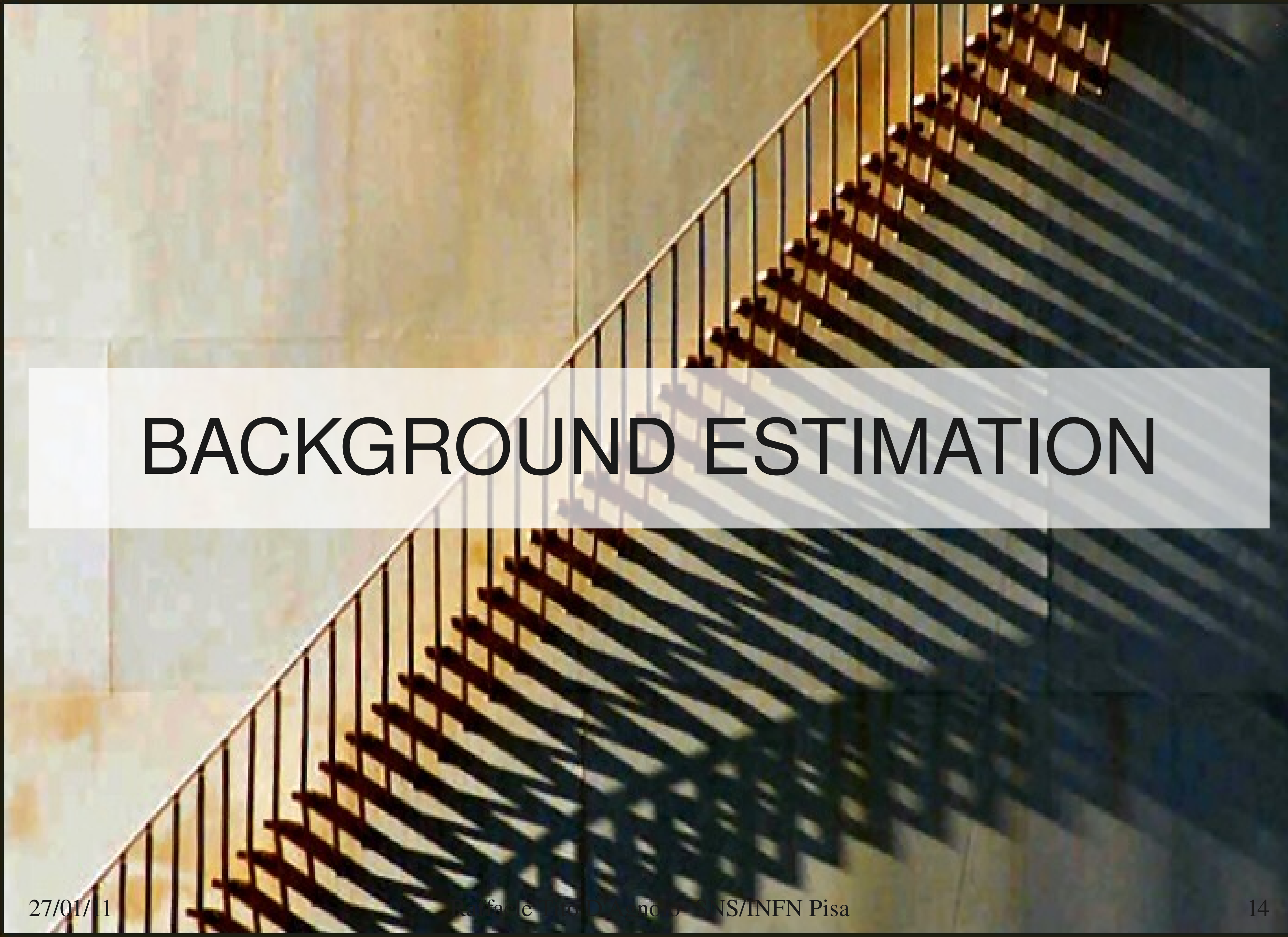
ANALYSIS CUTFLOW



SCUOLA NORMALE SUPERIORE PISA

ANALYSIS CUTFLOW (II)

	N events (expected with 1 fb-1)	One tight muon	4 Jets	8 Jets	1 Central Jet
TTbarJets	55125	6406	1038	4	4
Wjets	14091300	2754822	608	2	2
ZJets	1341120	161278	56	0	0
QCD (p_T >280 GeV)	1687692	34	0	0	0
Signal (mg=450 GeV, mX=186 GeV)	2200	162	134	11	11



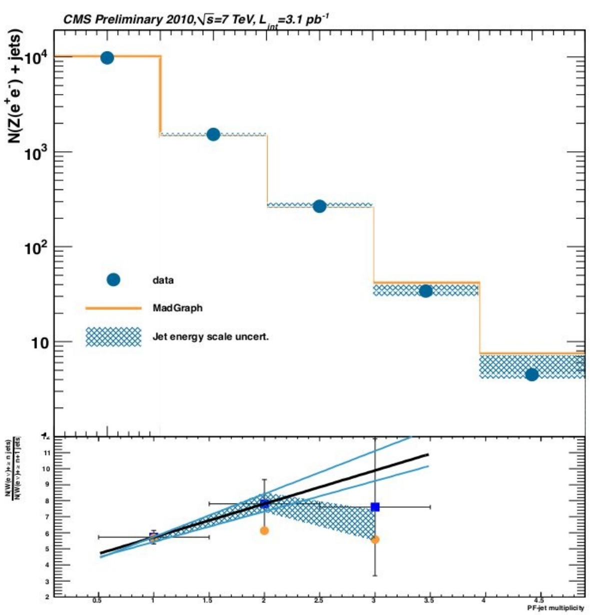
BACKGROUND ESTIMATION

OUR BOX IS NOT SO EMPTY

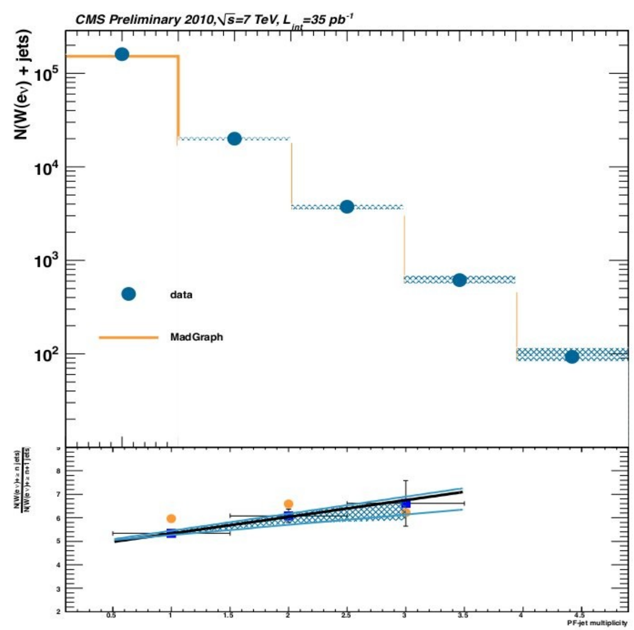
- Not trusting the MC in that region of phase space (8 Jets), we need a data-driven strategy to estimate the background
- EW background:
  - Measure it in bins of “low” jet multiplicity
  - Exploit the Berends-Giele scaling (AN-2010/425)
- QCD: Is not really our main concern (see previous slide), but we can separate it from EW bkgs using lepton anti-isolation

SCALING

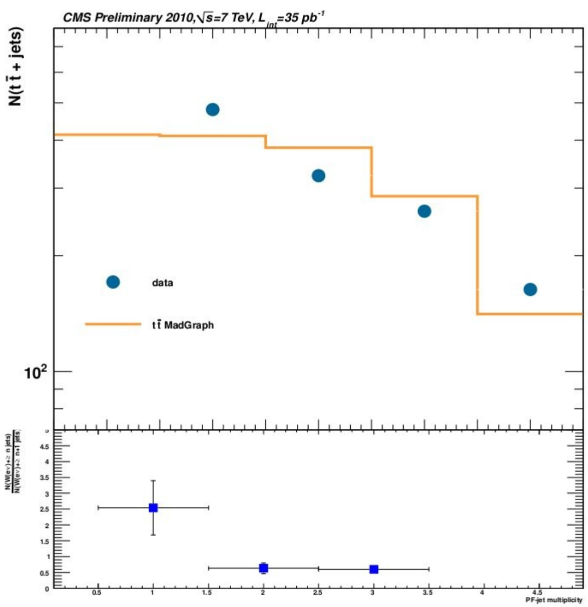
Z



W



TTbar



$$C_n = \frac{N_n}{N_{n+1}}$$

$$C_n = \alpha + \beta \cdot N$$

35 pb^{-1}

$$\alpha(W) = 4.89 \pm 0.10(stat) \pm 0.48(syst)$$ JES

$$\alpha(Z) = 4.59 \pm 1.09(stat) \pm 0.38(syst)$$

$$\beta(W) = 0.66 \pm 0.09(stat) \pm 0.54(syst)$$

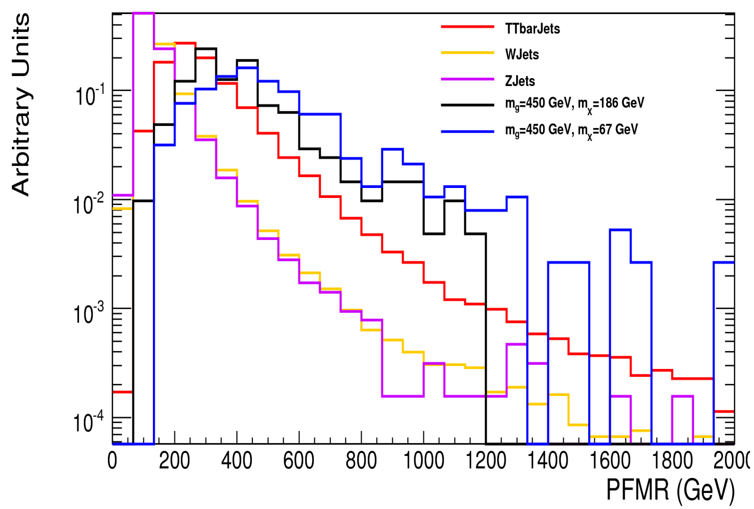
$$\beta(Z) = 1.11 \pm 0.94(stat) \pm 0.70(syst)$$

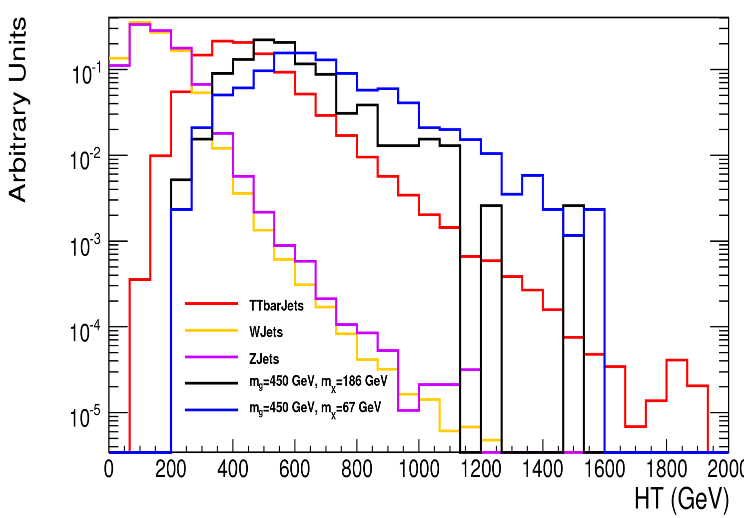
AN-2010/425

LOOKING IN THE MUON BOX

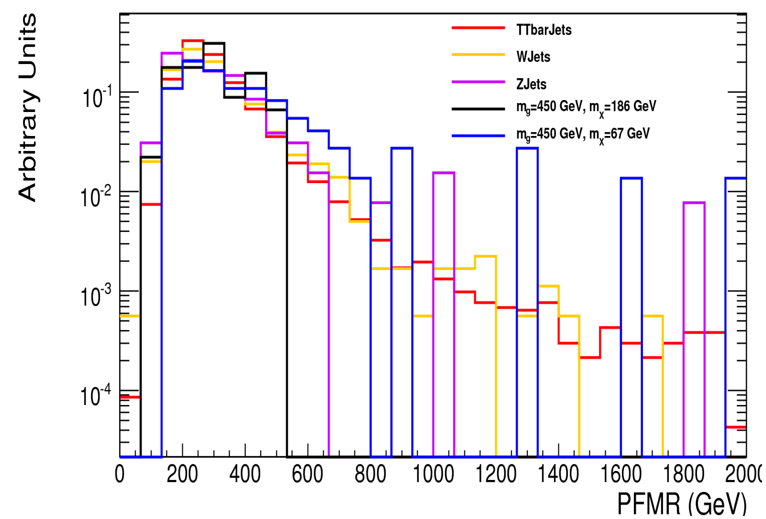
SCUOLA NORMALE SUPERIORE PISA

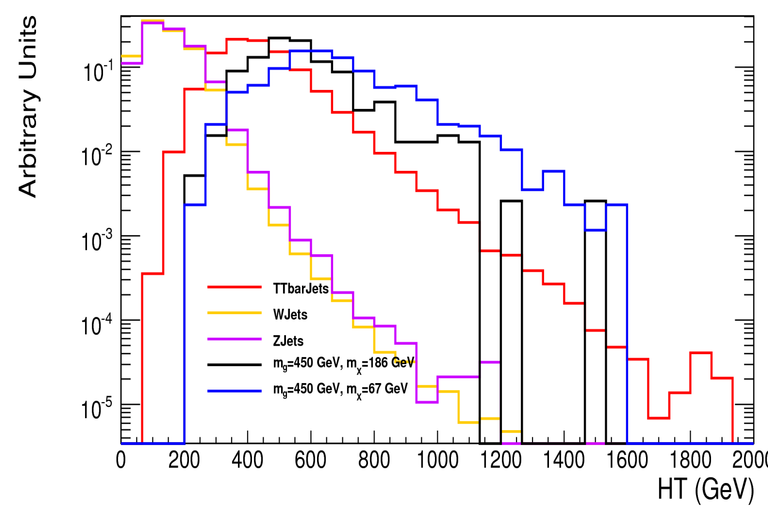
ALL JETS





≥4 JETS





CONCLUSION

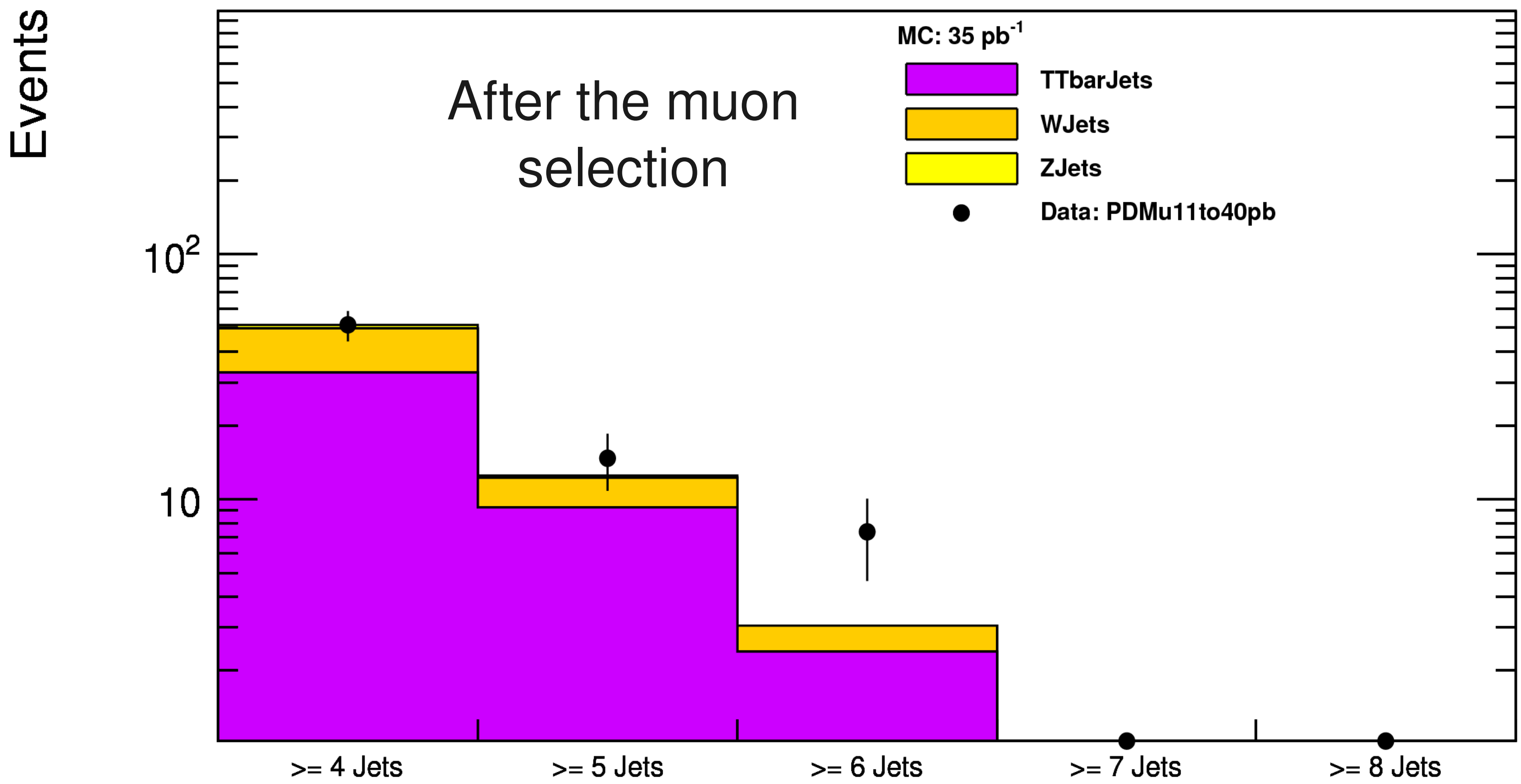
- We have shown that looking in the high jet multiplicity tails of the SM is possible and interesting:
  - We are sensitive to a wide range of gluino masses (up to 500 GeV) with one fb^{-1} of data.
  - We have a data driven method to estimate the background which is interesting in itself.
- We have not shown
  - The full procedure to estimate the QCD background (that we are refining).
  - The statistical framework to set limits on sparticles masses which is already in place, but it is not the main issue at this stage of the analysis.
- This is just a good start and to complete the analysis there is still a lot of work to do:
  - Assess the systematics
  - Understand how to better characterize the signal

BACKUP

ANALYSIS CUTFLOW(III)

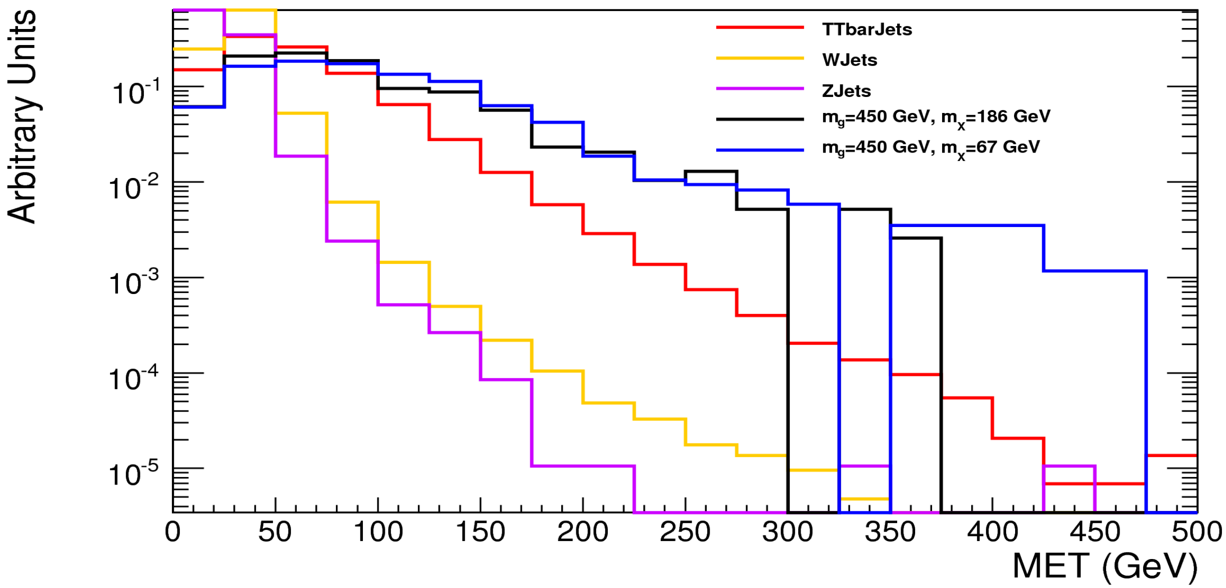
	N events (expected with 1 fb-1)	One tight muon	4 Jets	8 Jets	1 Central Jet
Signal (mg=450 GeV, mX=67 GeV)	2200	256	220	62	57
Signal (mg=450 GeV, mX=186 GeV)	2200	162	134	11	11

JETS CUTFLOW

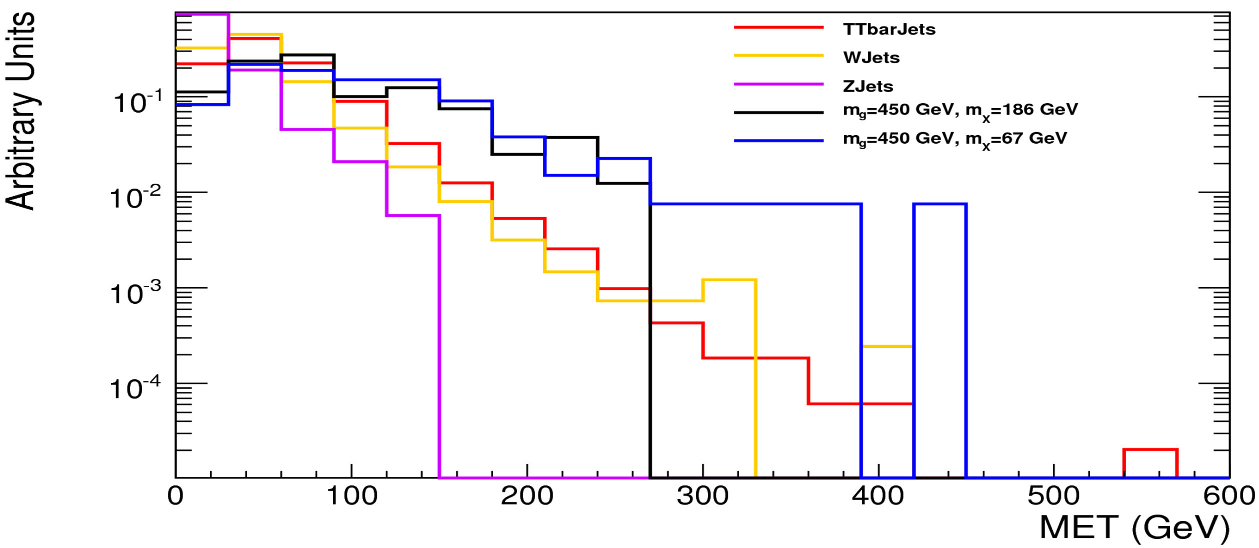


MET

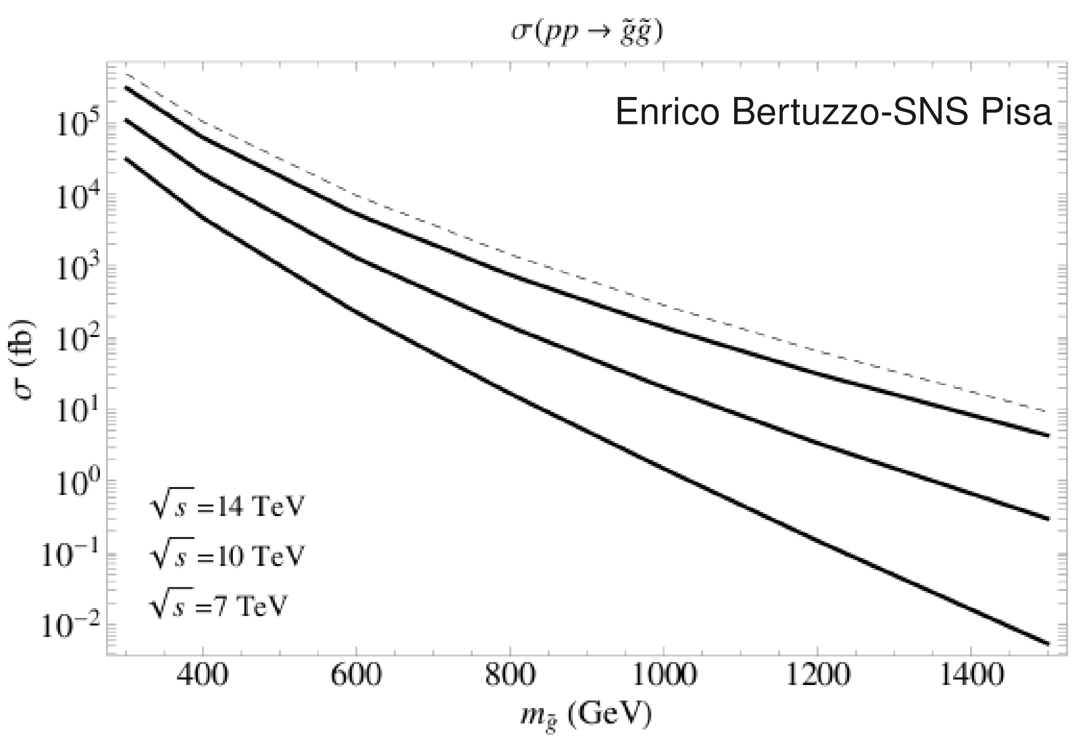
ALL JETS



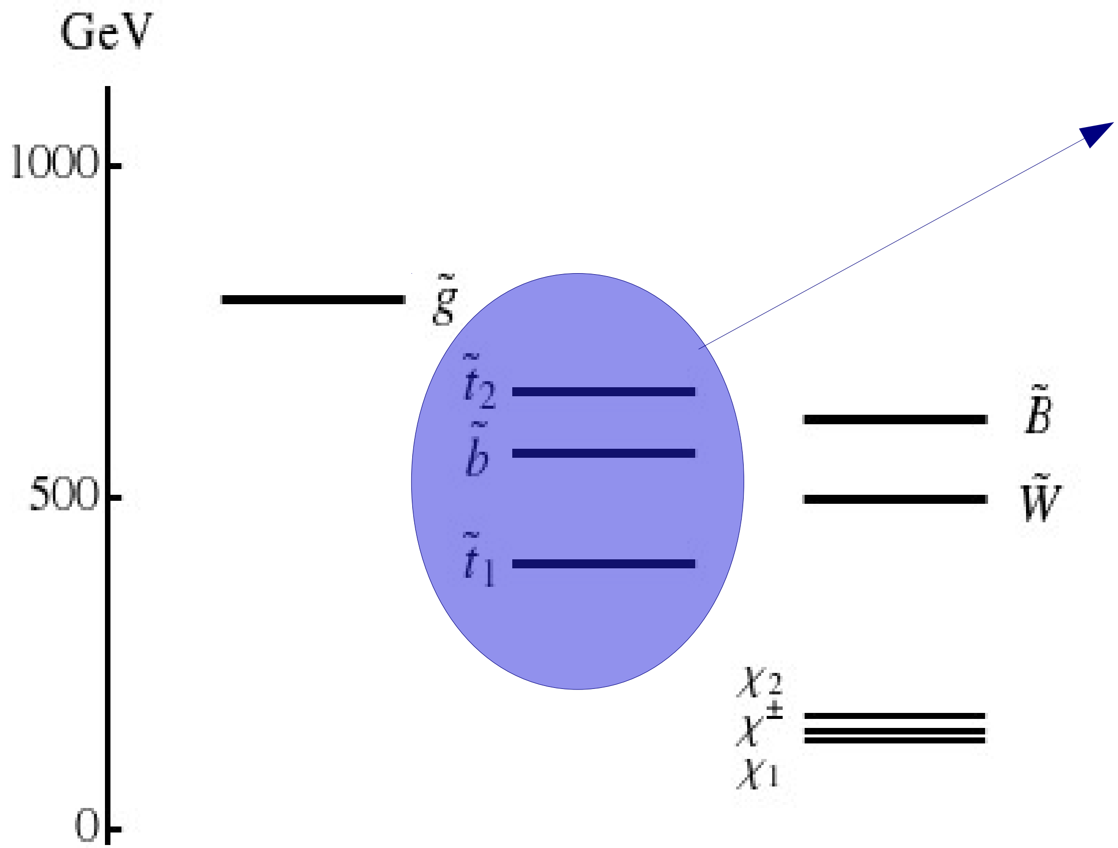
≥4 JETS



GLUINO PRODUCTION



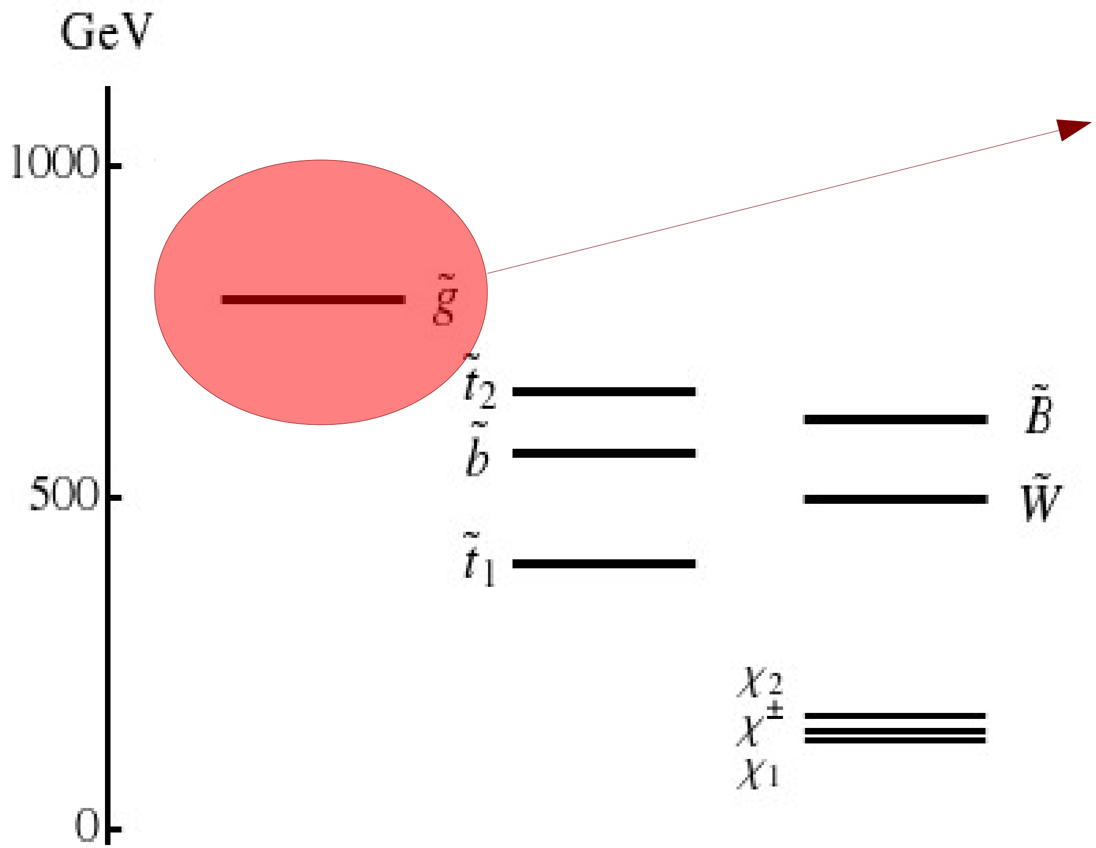
SPECTRUM



Heavy enough to evade the LEP2 bound on the Higgs mass, but light enough to ensure naturalness of the Fermi scale.

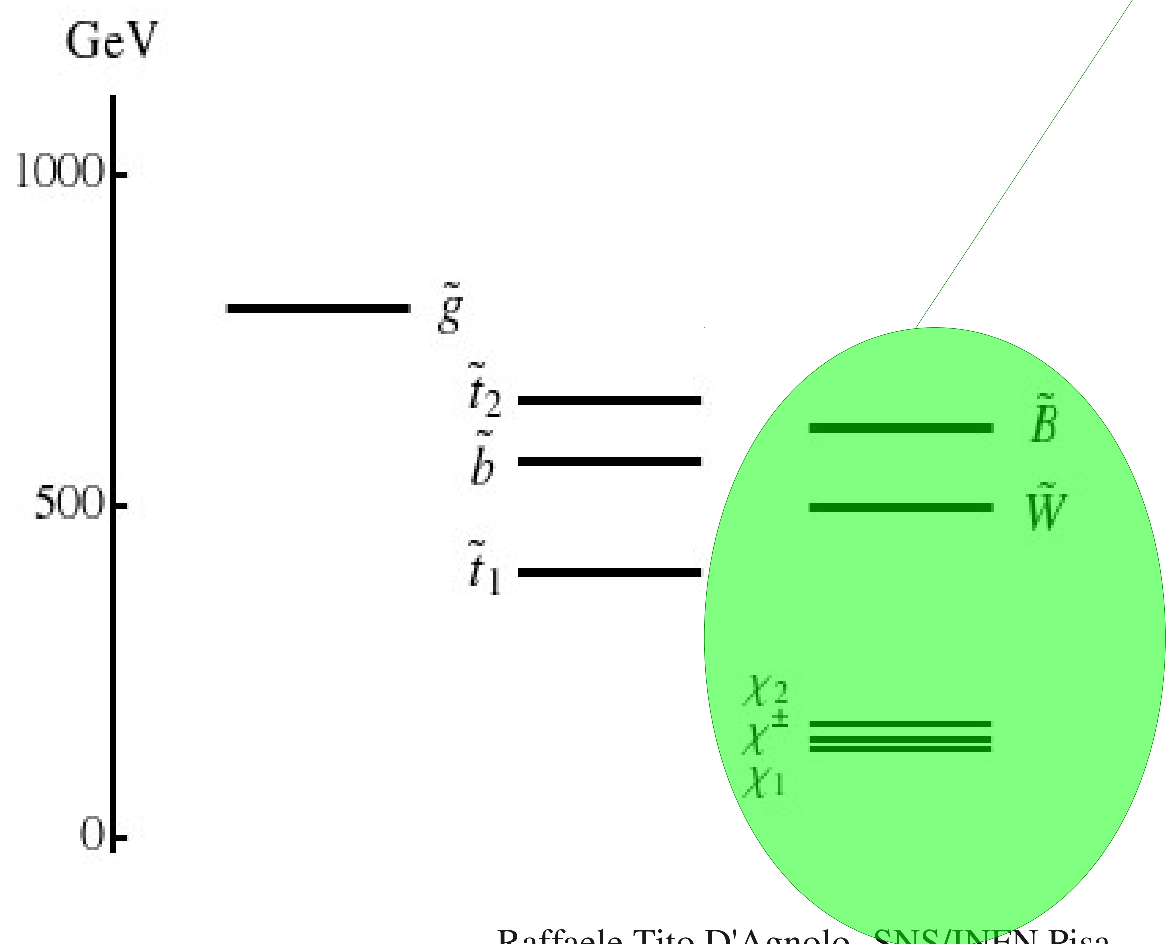
The first two generations squarks can be as heavy as 2-3 TeV without endangering naturalness. Thus playing no significant role in the early LHC phenomenology.

SPECTRUM (II)



On the one hand the running of the squark masses favours a light gluino.
On the other FCNC constraints (gluino-sbottom exchanges) point to a heavier range for its mass.

SPECTRUM (III)



The lightest sfermions are higgsino-like, with masses in the neighbour of μ, that we take between 100 and 200 GeV, to be consistent with LEP bounds.

A modified scenario with a lighter Bino would lead to a more realistic dark matter abundance (assuming the only DM component is our lightest neutralino), but would not change much the LHC expected signals.