Triggering on diffractive Higgs

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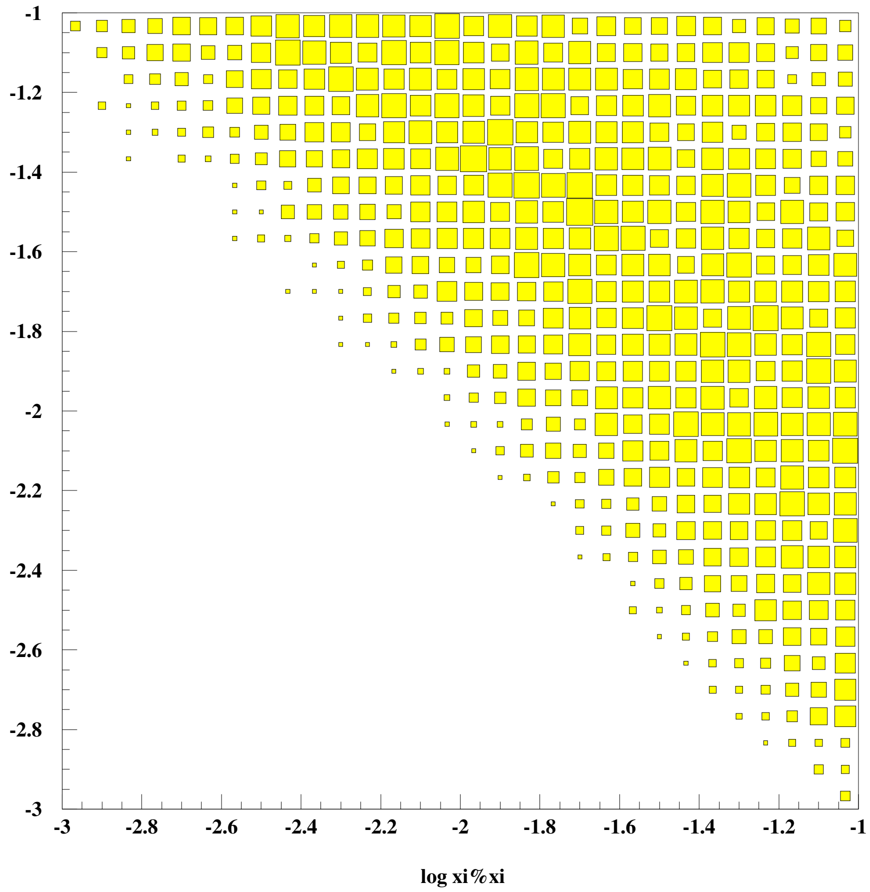
Contents:

- Inclusive Higgs production
- Exclusive Higgs production
- Higgs mass reconstruction at LHC using roman pots

Microstation detectors

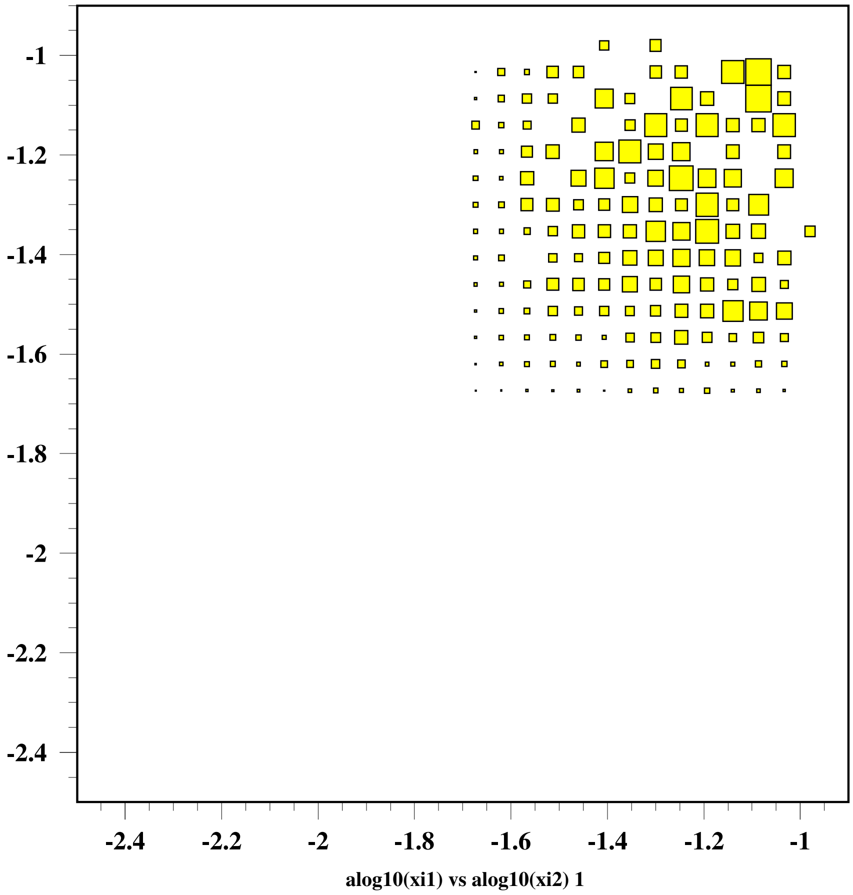
- TOTEM: $|t| \leq 1.5$ GeV^2, $\xi \geq 0.06$, linear acceptance between 0 and 1 between $0.02 \leq \xi \leq 0.06$
- Pots at 215 m: $|t| \leq 2$ GeV^2, $0.02 \leq \xi \leq 0.2$
- Pots at 308-336 m $|t| \leq 2$ GeV^2, $0.003 \leq \xi \leq 0.024$
- Pots at 420 m $|t| \leq 2$ GeV^2, $0.002 \leq \xi \leq 0.016$
- Resolution and acceptance: obtained after a full simulation of the beam line (Helsinki group)

ξ_1 vs ξ_2 for inclusive events



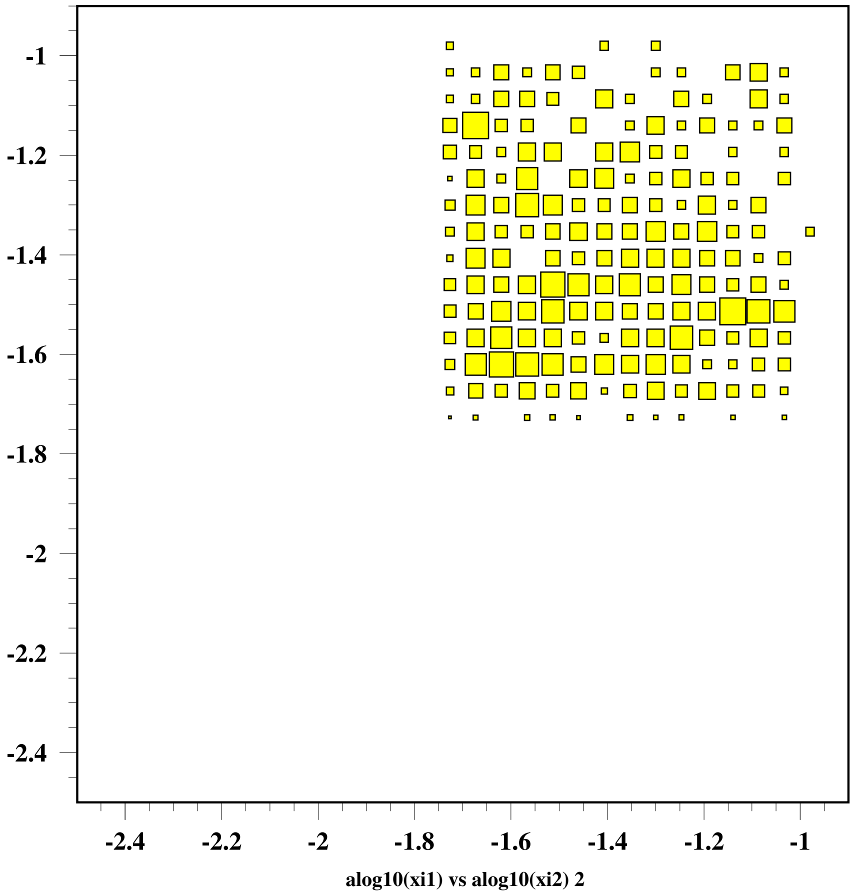
Conclusion: we can tag the inclusive events in the 215 m region at L1

ξ_1 vs ξ_2 for inclusive events (TOTEM)



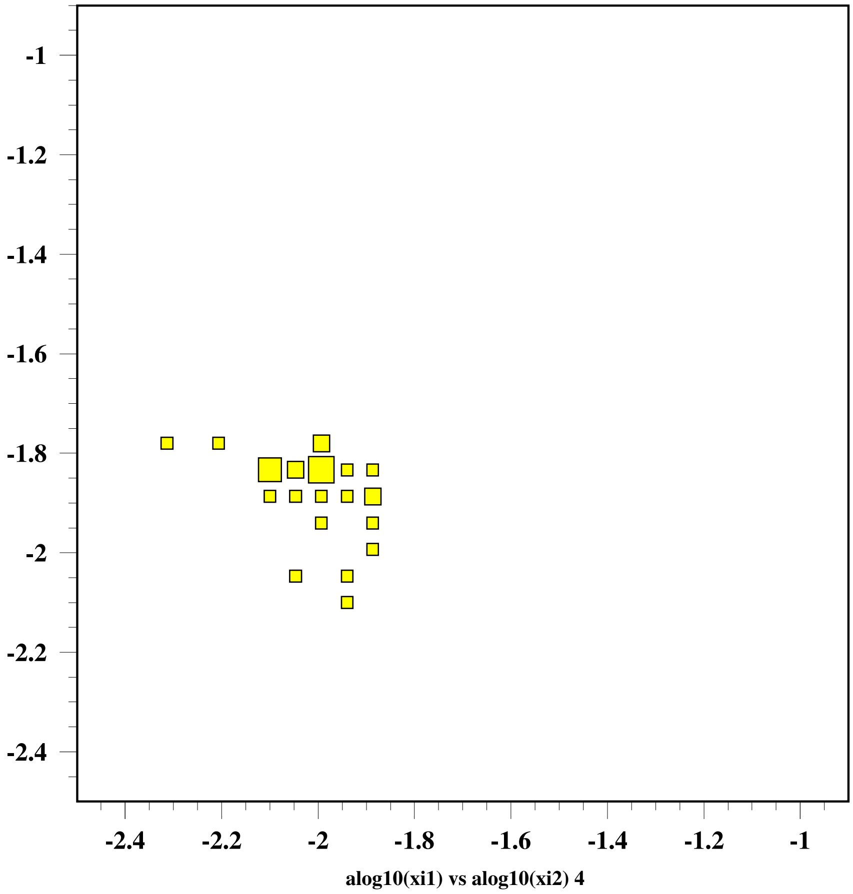
Conclusion: we can cut on TOTEM

ξ_1 vs ξ_2 for inclusive events (215 m)



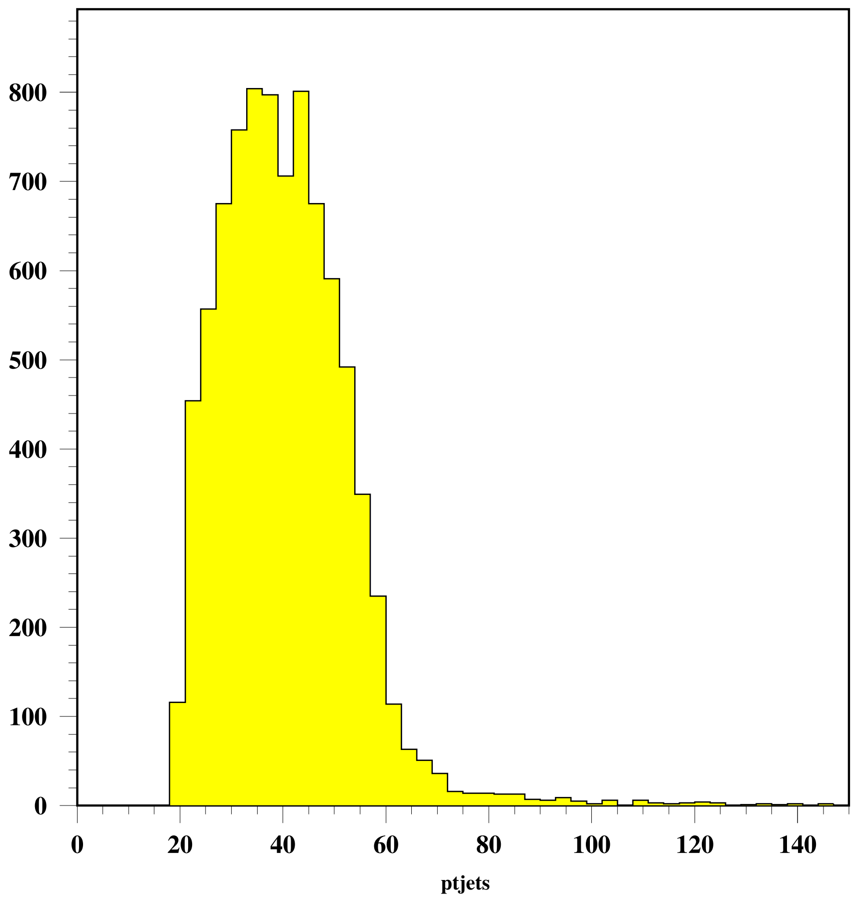
Conclusion: we can tag the inclusive events at 215 m, at least one one side

ξ_1 vs ξ_2 for inclusive events (420m)

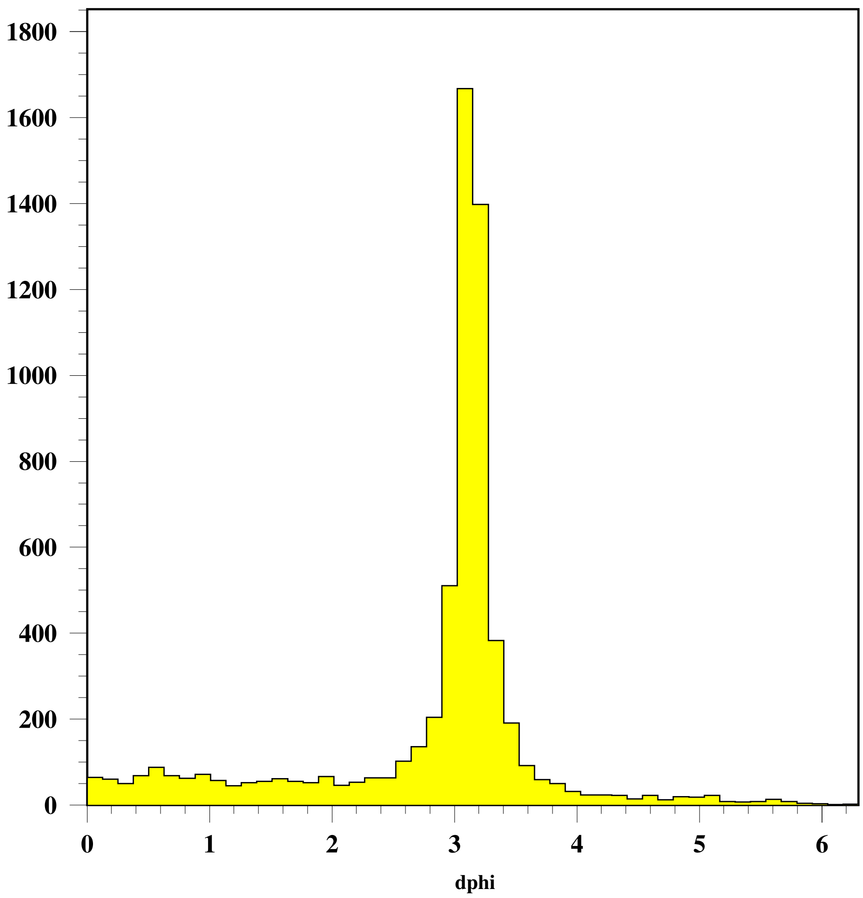


Conclusion: quasi-exclusive events

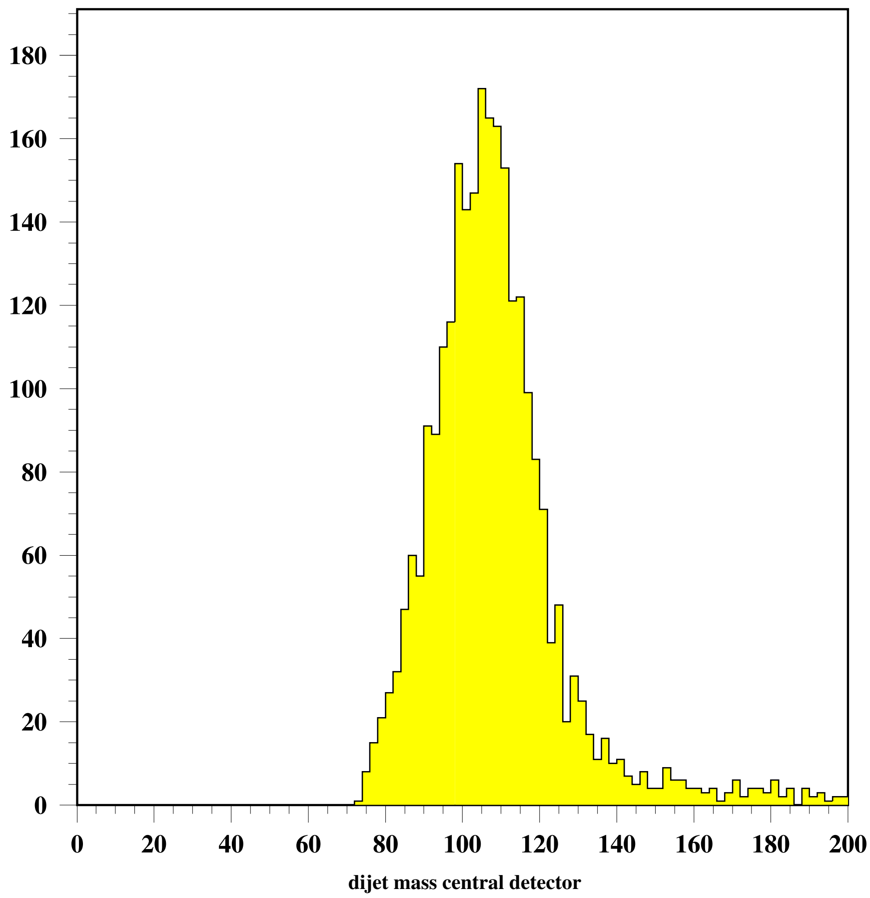
Leading jet p_T



$\Delta\Phi$ between jets

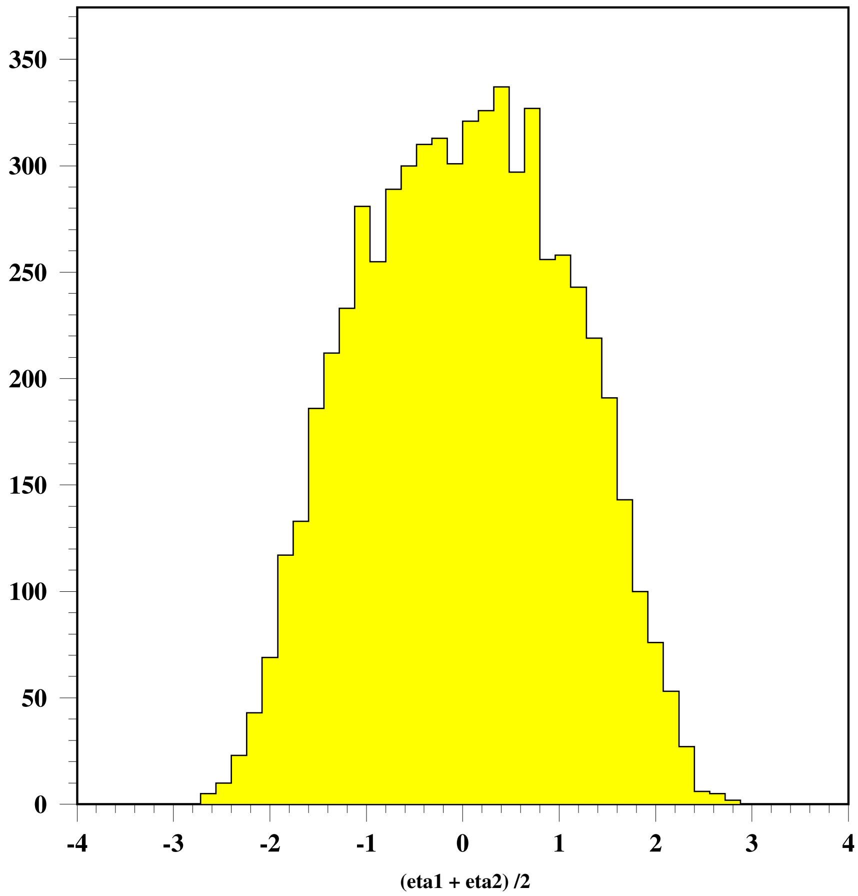


Dijet mass



180
160
140
120
100
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
200
dijet mass central detector

$(\eta_1 + \eta_2)/2$ distribution



Cuts to trigger on inclusive events

- At Level 1, in $b\bar{b}$ channel
  - cut on events triggered in Totem
  - ask at least one tag at trigger level at 215 m, and require $\xi \leq 0.07$
  - ask two jets with $p_T > 40$, 30 GeV, back to back
  - cut on dijet mass between $90 \leq M_{JJ} \leq 160$ GeV
- At Level 2: Cut on dijet mass fraction (> 0.5), and on presence of tags in pots at 308-336 m or 420m
- Background considered: Dijet double diffractive production
- Level 1: Trigger on $\tau\tau$ events (use the usual trigger for Atlas/CMS), no gap required, confirmation of tags in pots at L2
- NB: (low lumi: $210^{33} cm^{-2} s^{-1}$, high lumi: $10^{34} cm^{-2} s^{-1}$)

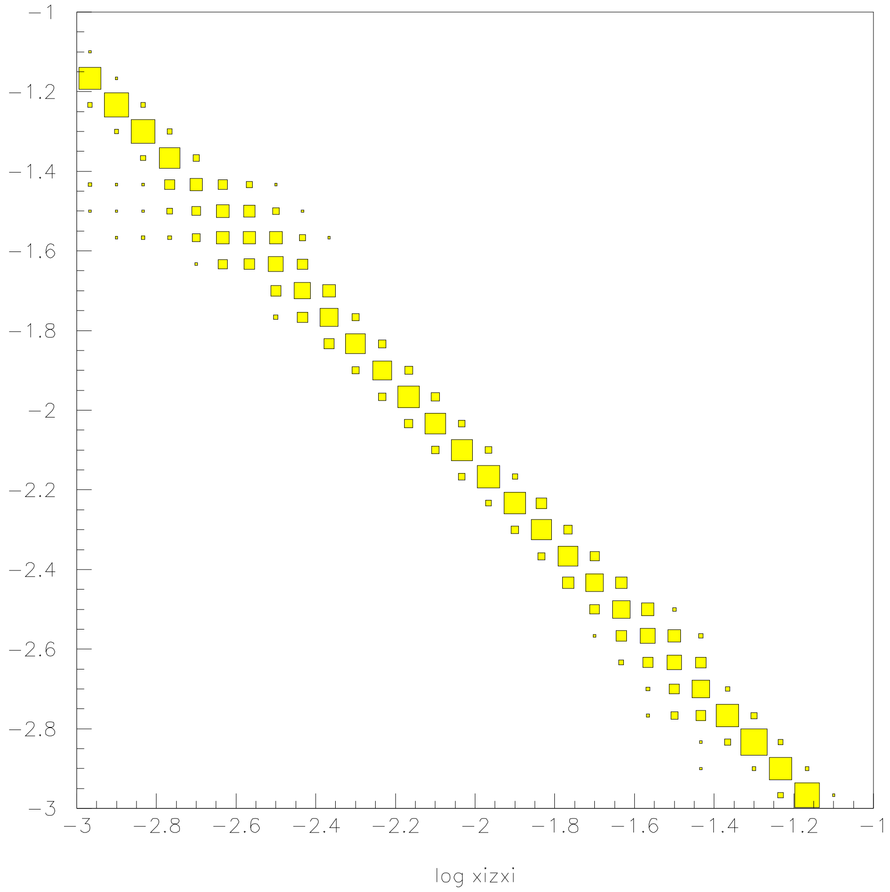
Cuts to trigger on inclusive events at low lumi

cut	Higgs eff.	excl.	Back. eff. (Trigger rate)
no cut	100 %	100%	100% (2260)
125 m tag TOTEM veto $\xi \leq 0.07$	92% 46%	67% 51%	91% (2057) 42% (949)
jet $p_T 1 > 40$	24%	23%	3% (63)
jet $p_T 2 > 30$	18% (26)	17%	2% (47)
jet ΔPhi jet $\|\eta_1 + \eta_2\| ge 0.3$	15% (22)	17%	1.5% (34)
Dijet mass	12% (18)	17%	1% (23)

NB: cut on $170 \leq \Delta\Phi \leq 190$, $90 \leq M_{JJ} \leq 160$ GeV

Numbers of exclusive events quite high but most of them outside acceptance of pots in cold region

ξ_1 vs ξ_2 for exclusive events



Conclusion: we need to tag the exclusive events in the cold region (308-338/420 m)

Cuts to trigger on exclusive events

- At Level 1, in $b\bar{b}$ channel
  - cut on events triggered either in Totem or at 215 m (one tag is enough to cut those events)
  - ask two rapidity gaps in the forward region
  - ask two jets with $p_T > 40$, 30 GeV, back to back
  - cut on dijet mass between $90 \leq M_{JJ} \leq 160$ GeV
- At Level 2: Cut on dijet mass fraction (> 0.85), and on presence of tags in pots at 308-336 m or 420m
- Background considered: Dijet double diffractive production

Cuts to trigger on exclusive events (cont.)

- NB: We need to remove the cut on rapidity gap at high lumi, but needs to study non diffractive background (low lumi: $210^{33} cm^{-2} s^{-1}$, high lumi: $10^{34} cm^{-2} s^{-1}$)
- Level 1: Trigger on $\tau\tau$ events (use the usual trigger for Atlas/CMS), no gap required, confirmation of tags in pots at L2

Cuts to trigger on exclusive events at low lumi

cut	Higgs eff.	Back. eff. (Trigger rate)
no cut	100 %	100% (2260)
125 m veto TOTEM veto	31%	4.9% (111)
jet $p_T 1 > 40$	15% (22)	0.69% (16)
jet $p_T 2 > 30$	10% (15)	0.37% (8)
jet ΔPhi	10% (15)	0.37% (8)
Dijet mass	7% (10)	0.13% (3)

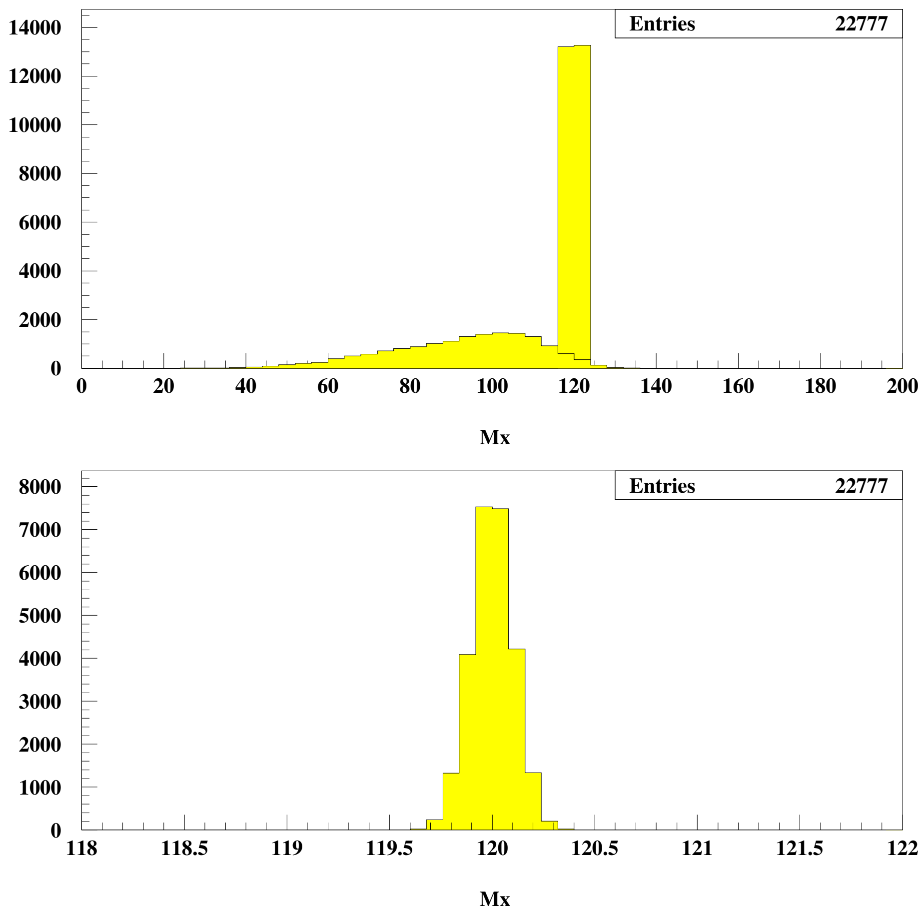
Advantage of diffractive events?

H mass reconstruction (missing mass method)

(M.Albrow, A.Rostovtsev, hep-ph/0009336)

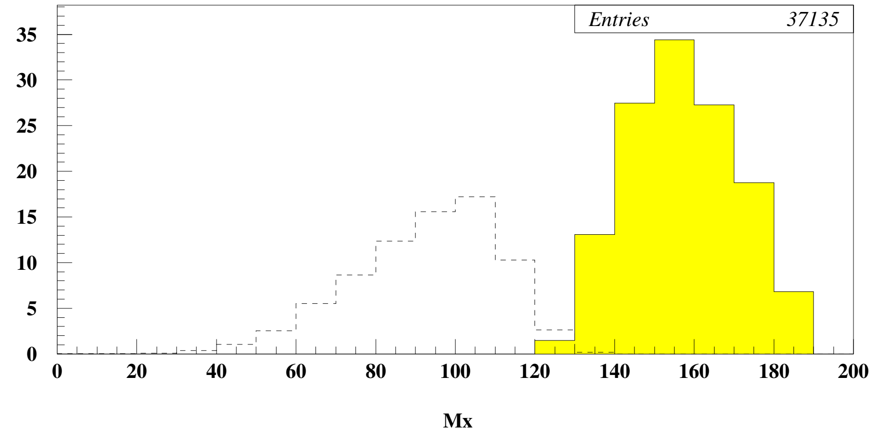
For events without radiation ($p\bar{p} \to p\bar{p}H$,

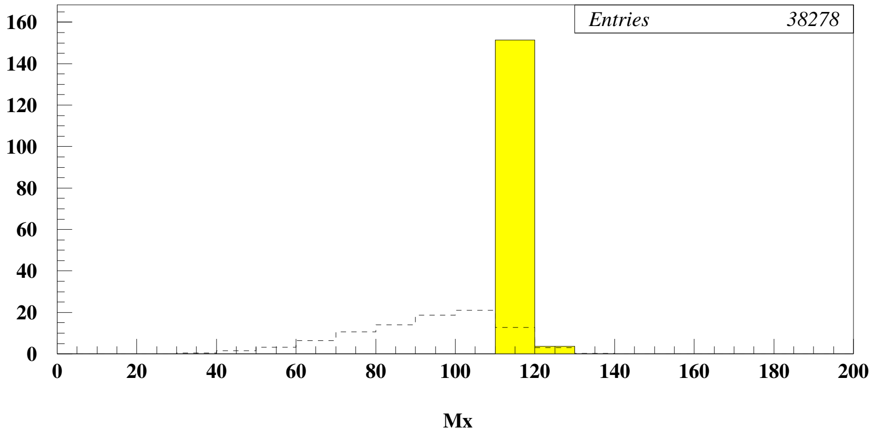
$M_H = \sqrt{\xi_p \xi_{\bar{p}} S}$, perfect reconstruction of the Higgs mass.



Advantage of diffractive events?

What about QCD radiation? The missing mass method does not work so nicely, since the total energy is used to produce the Higgs as before, but some of it is lost because of radiation ("pomeron remant")





Pomeron remnant tagging possibility

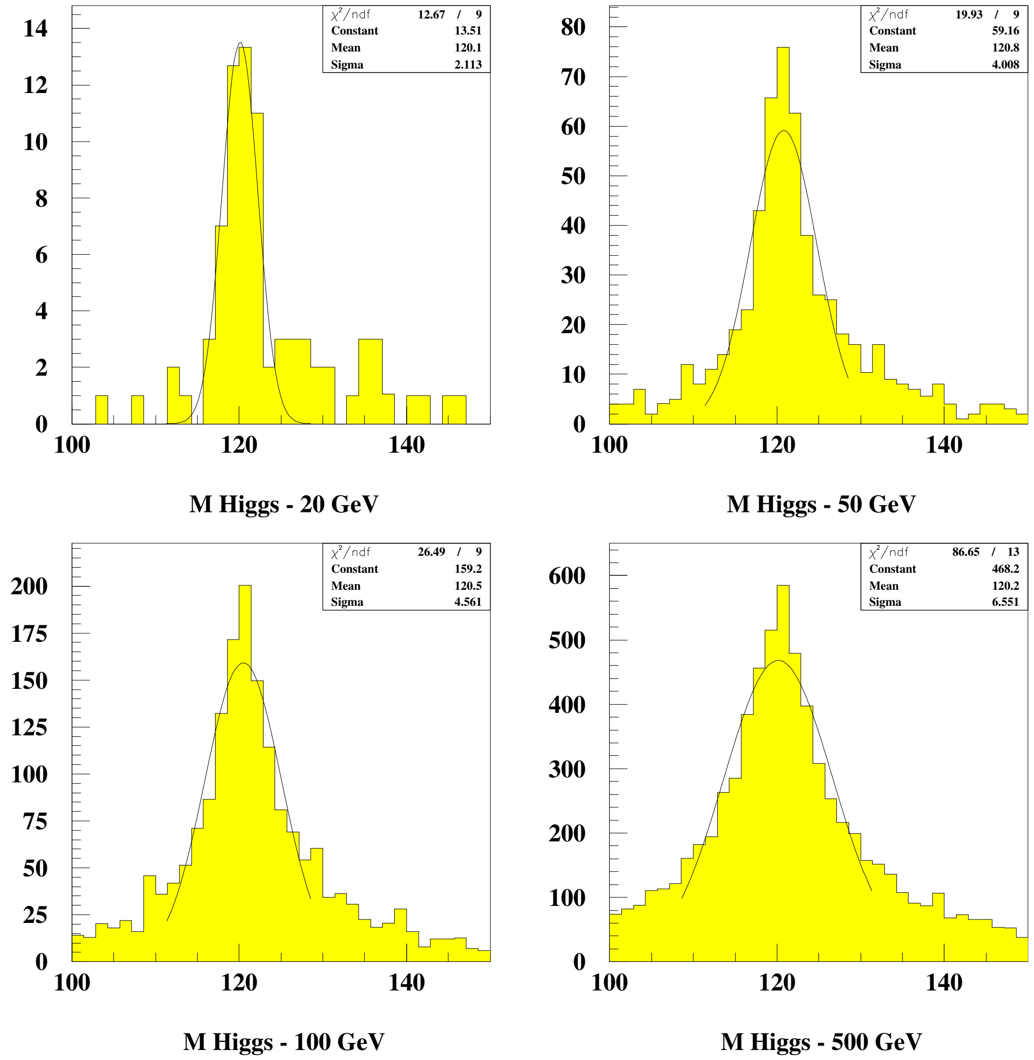
- Higgs mass reconstruction: $M_{Higgs} = \sqrt{\xi_1 \xi_2 S}$ nice method to reconstruct Higgs mass provided radiation is not too big. We just saw that the resolution is much worse without the possibility of measuring the pomeron remnants.

- Question: Where are the pomeron remnants going in pseudorapidity? Is it possible to tag them? New taggers at high η: CMS will have the possibility to install such taggers up to $\eta = 7.5$. In the simulated plots, we assume a resolution of $100\%/\sqrt{E}$ for the taggers

- Microstations/roman pot detectors in the cold region of the LHC: $|t| < 2$ GeV^2, $\xi > 0.002$

Resolution on Higgs mass

$M_{Higgs} = 120$ GeV at LHC at simulation level
(assumed resolution of taggers $\sim 100\%/\sqrt{E}$)



Conclusion

- Possibility to trigger on exclusive events in the 420m pot acceptance at low lumi in $b\bar{b}$ channel, and at low and high lumi in $\tau\tau$ channel
- Possibility to trigger on inclusive events in both decay channels at low and high lumi
- Higgs mass reconstruction with a good resolution if one is able to tag pomeron remnants (CASTOR in CMS?)

η distribution