

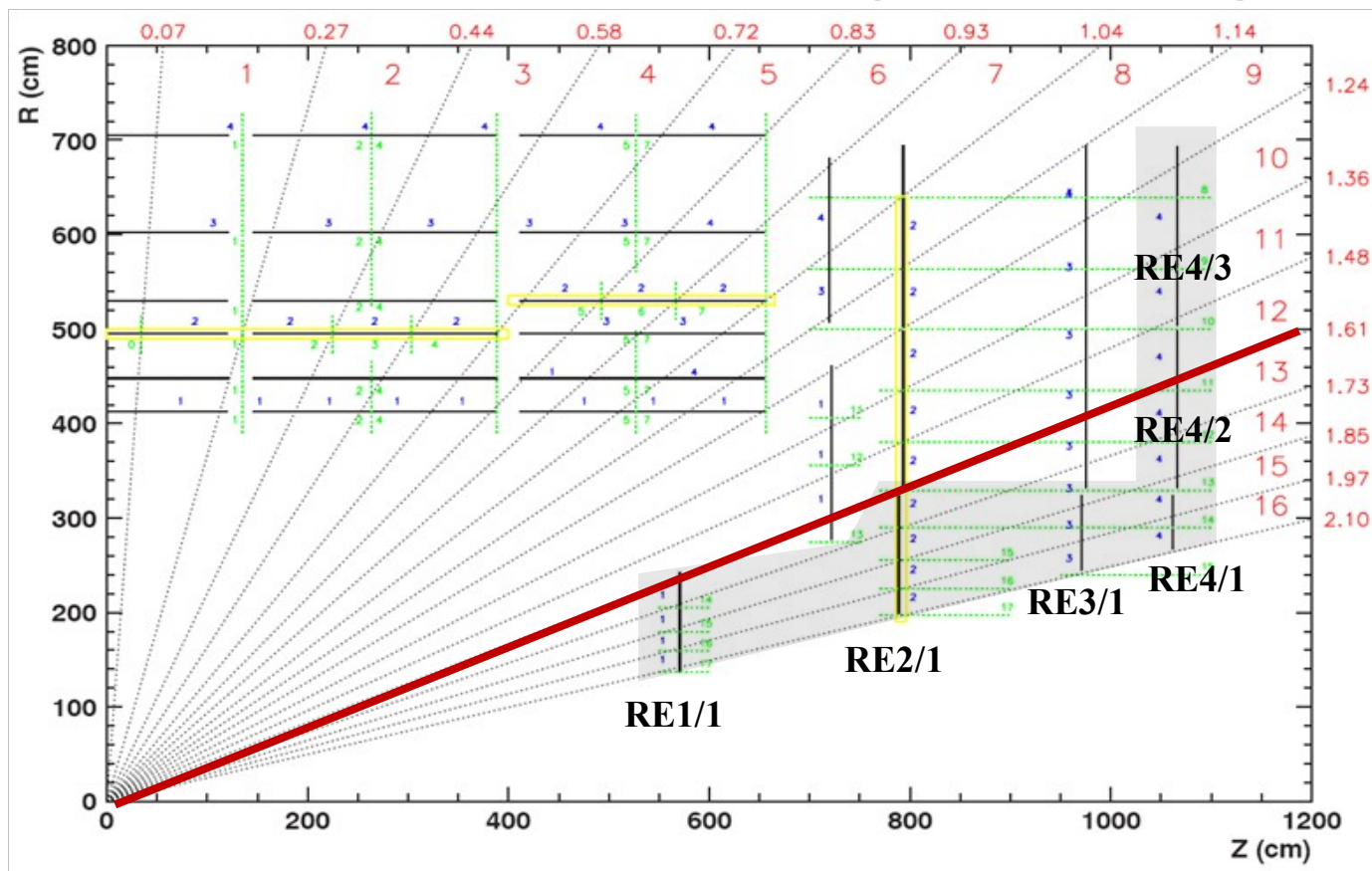
Extension of RPC trigger with GEMs

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on behalf
Warsaw Trigger Group

PLAN:

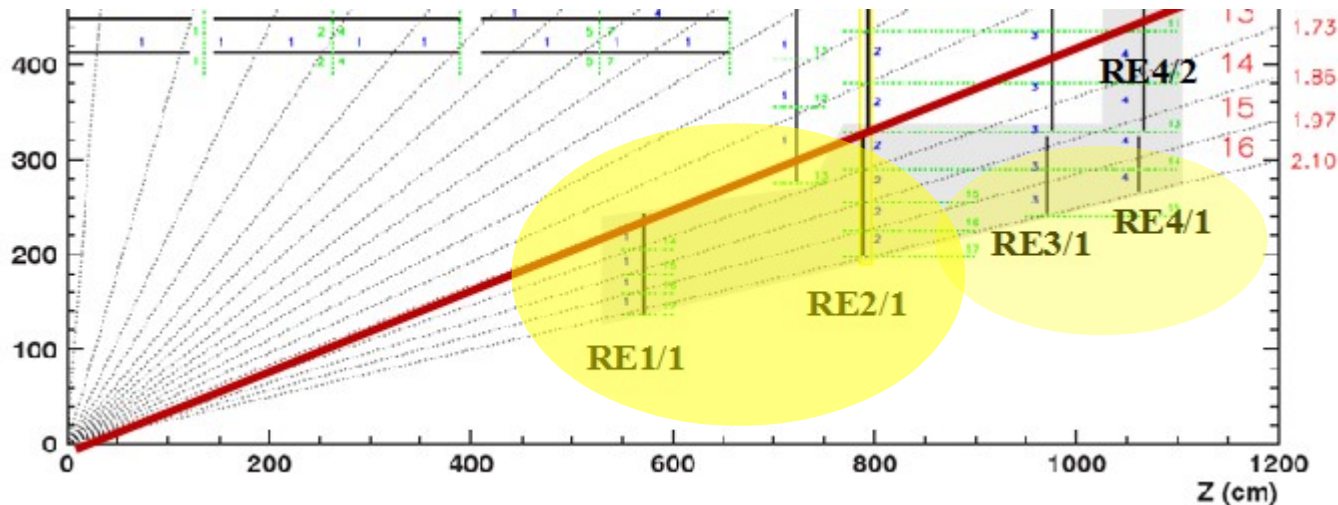
- Simplified simulation of the L1 PAC trigger performance for RPC+GEM detectors

New detectors in high eta region



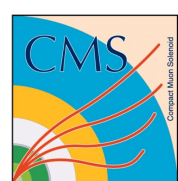
- Presently, the RPC PAC trigger reaches $|\eta| < 1.61$
- RPC chambers are planned to be installed in RE4/2 and RE4/3 during the LS1
=> "3 of 4" logic

GEM detectors in high eta region



Proposition: to install GEM detectors in RE1/1 and RE2/1 (and RE3/1, RE4/1)

- GEM chambers in the RE1/1 will have the same size and segmentation as planned for the RPCs:
 - ◆ 10° trapezoid chambers, ~1.2 m long
- GEMs in the RE2/1 can be longer than the RPCs (i.e. range higher eta)
- GEM readout strips segmentation:
 - Strips are radial (as in case of the endcap RPCs), but with much finer granularity, both in the phi and eta, e.g.: 8-10 eta partitions, 384 strips in each eta partition => one strip = $0.026^\circ = \sim 1\text{mm}$
 - RPC chamber suppose to have 4 eta partitions with 36 strips each



PAC Optimisation






- **1st CASE: GEM in RE1/1 RE2/1**
- Geometry of RE1/1 and RE2/1 modified to increase number of strips in phi (eta segmentation as for the RPC case). RE3/1 and RE4/1 treated as for the RPC
- **4 different geometry variants** tested:
 - base RPC geometry - baseline TDR geometry
 - 2x - geometry with **two times higher number of strips** in GEMs
 - 4x
 - 8x
- **Ideal** chamber model: chamber **eff 100%, no noise, no clustering**
- **Realistic** chamber model: chamber **eff 95%**, average **cluster size 2** was used **for RPC** chambers, while for GEMs clustering was disabled

PAC Optimisation

- Optimizations in PAC logic (patterns) to fully utilize GEMs:
- Preferred patterns are patterns with first two planes fired (region of highest B field, GEM planes):

- **Quality 1 - all 4 planes fired**
- **Quality 0, matches first two planes and any of last two (matches 3 planes total)**
- Quality 0, matches last two planes and any of first two (matches 3 planes total)

Qual. - matched planes

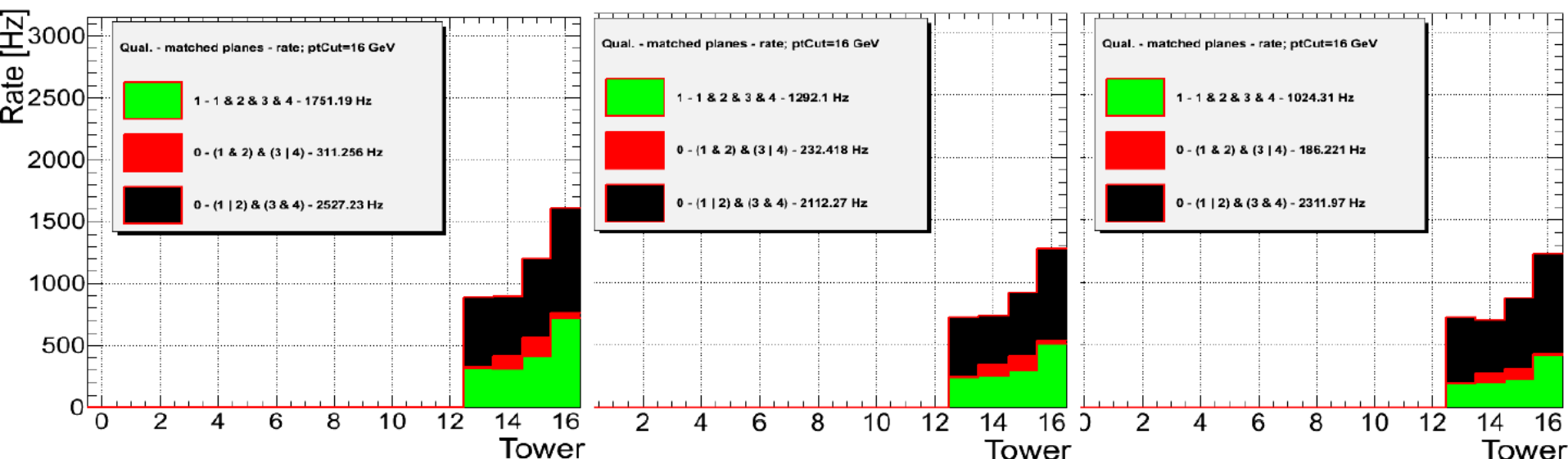
	1 - 1 & 2 & 3 & 4
	0 - (1 & 2) & (3 4)
	0 - (1 2) & (3 & 4)

Ideal model, $pt_{Cut} > 16 \text{ GeV}$

Base

2x

8x



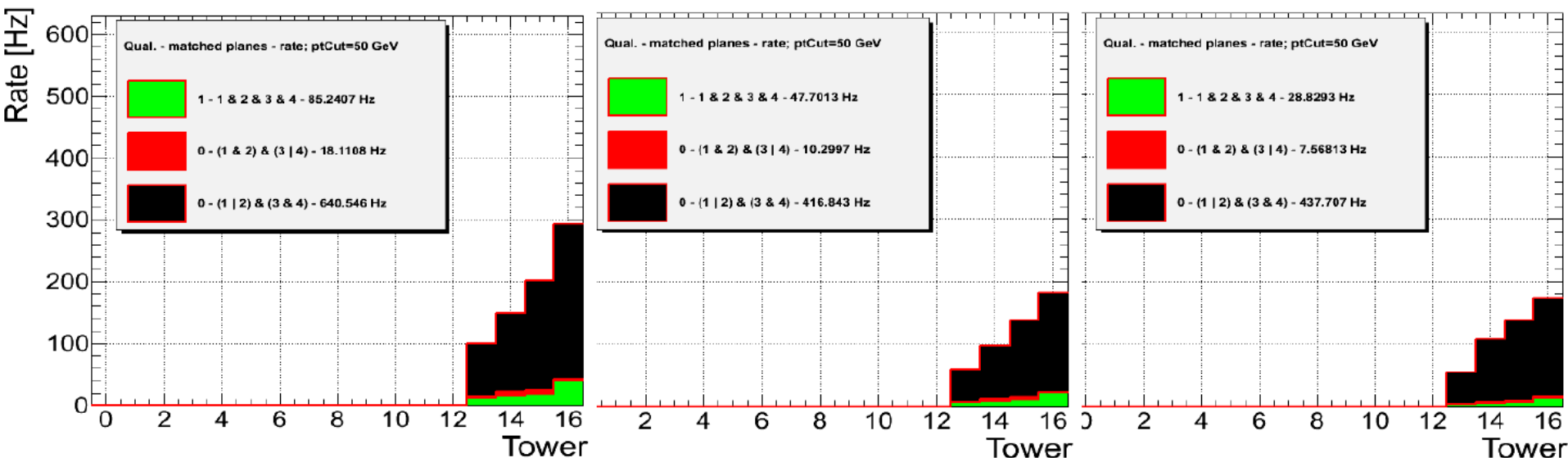
- Simulation for towers: 13,14,16
- Largest rate contribution for quality 0 "black"
- For $pt_{Cut} > 16 \text{ GeV}$:
green/red rates from Base \rightarrow 2x \rightarrow 4x drop slightly

Ideal model, $ptCut > 50 \text{ GeV}$

Base

2x

8x



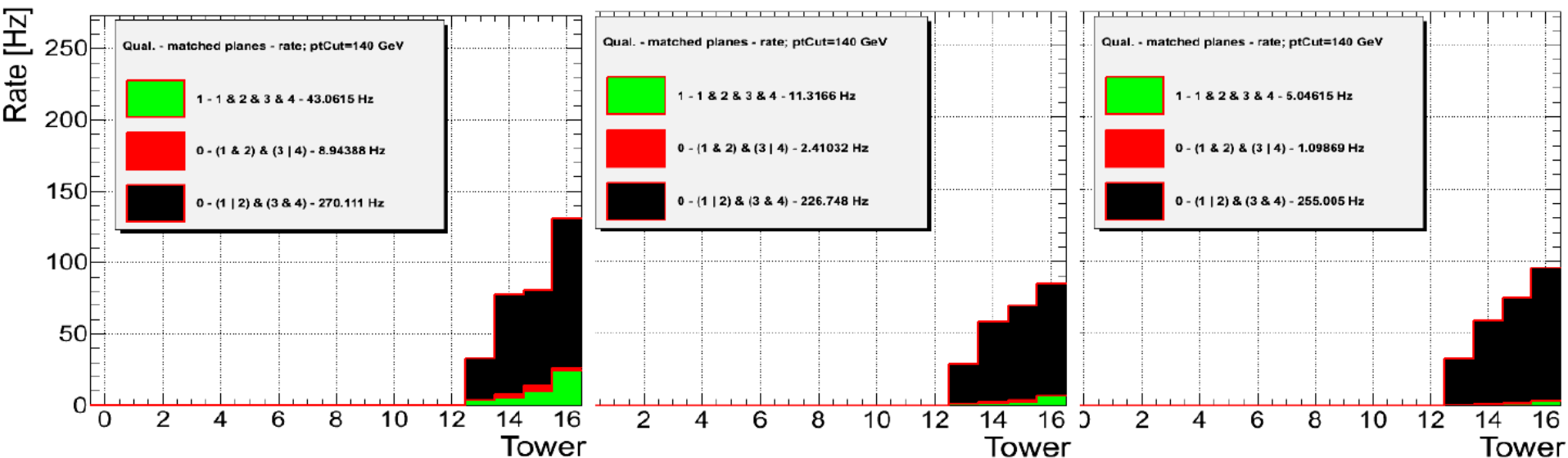
- For $ptCut > 50 \text{ GeV}$:
green/red rates from Base \rightarrow 2x \rightarrow 4x
 drop be a factor less than 2

Ideal model, $pt_{Cut} > 140 \text{ GeV}$

Base

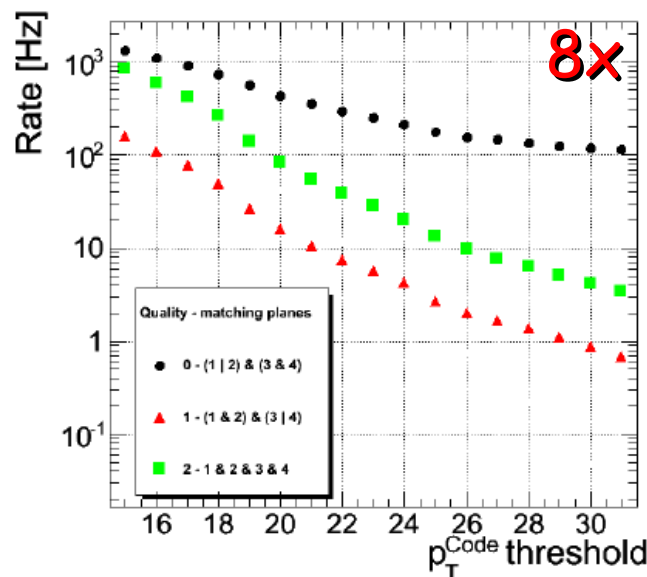
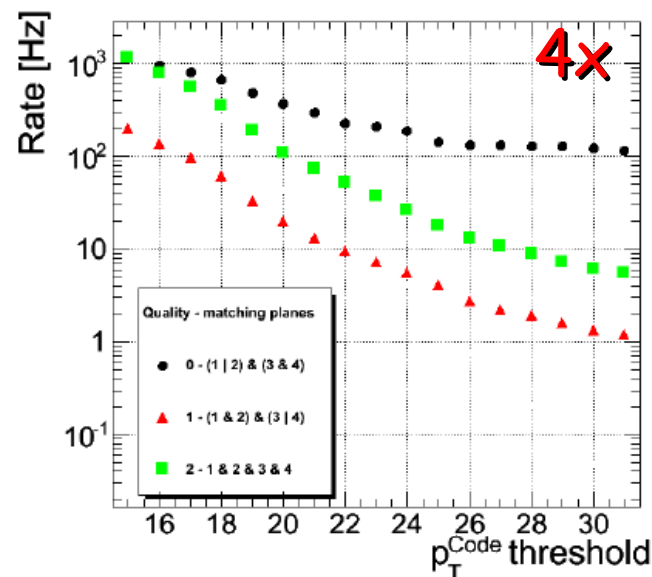
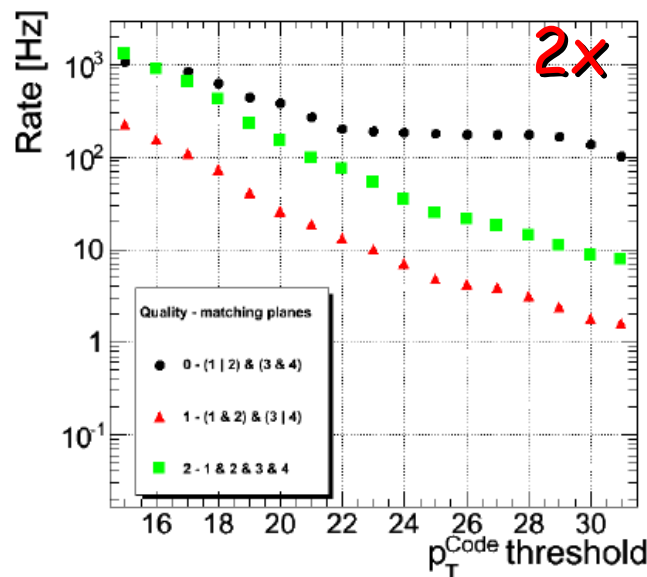
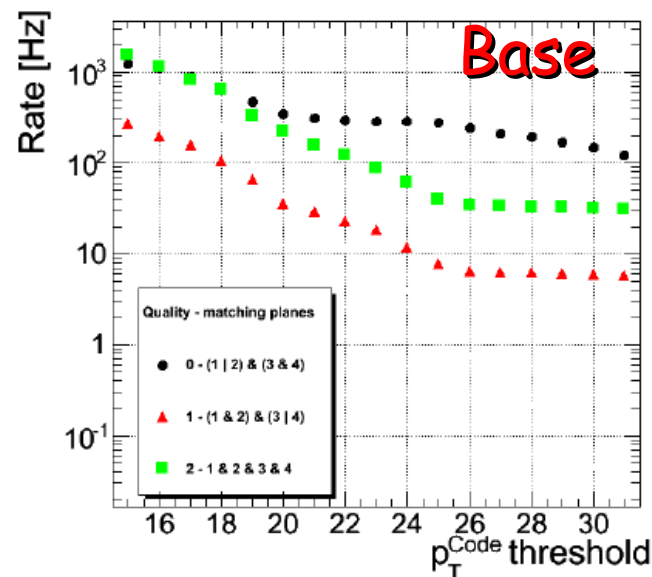
2x

8x



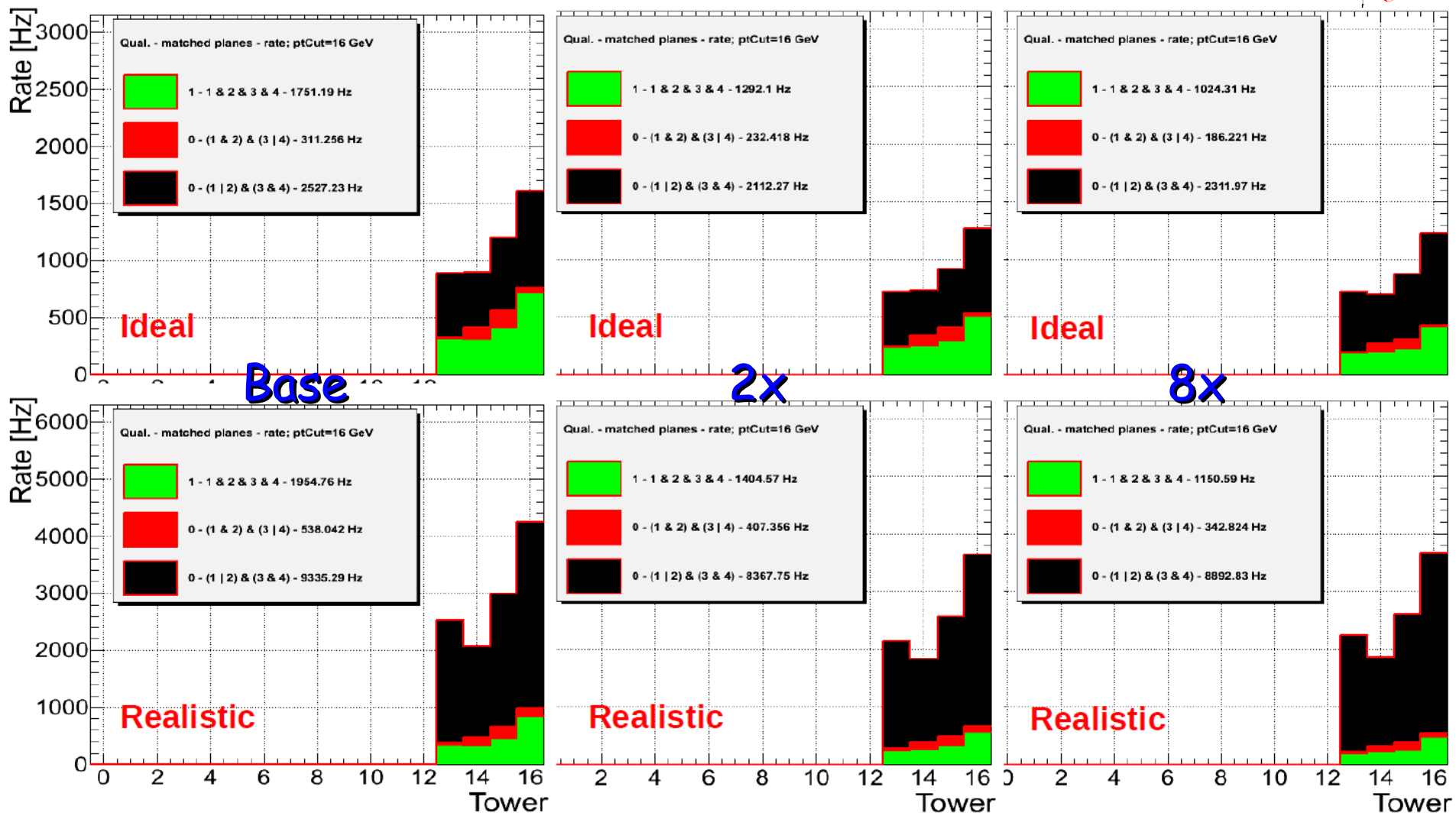
- For $pt_{Cut} > 140 \text{ GeV}$:
 - green/red rates: Base \rightarrow 2x drop by a factor ~ 4
 - 2x \rightarrow 8x drop by a factor ~ 2

Ideal model, Rate (ptCut)



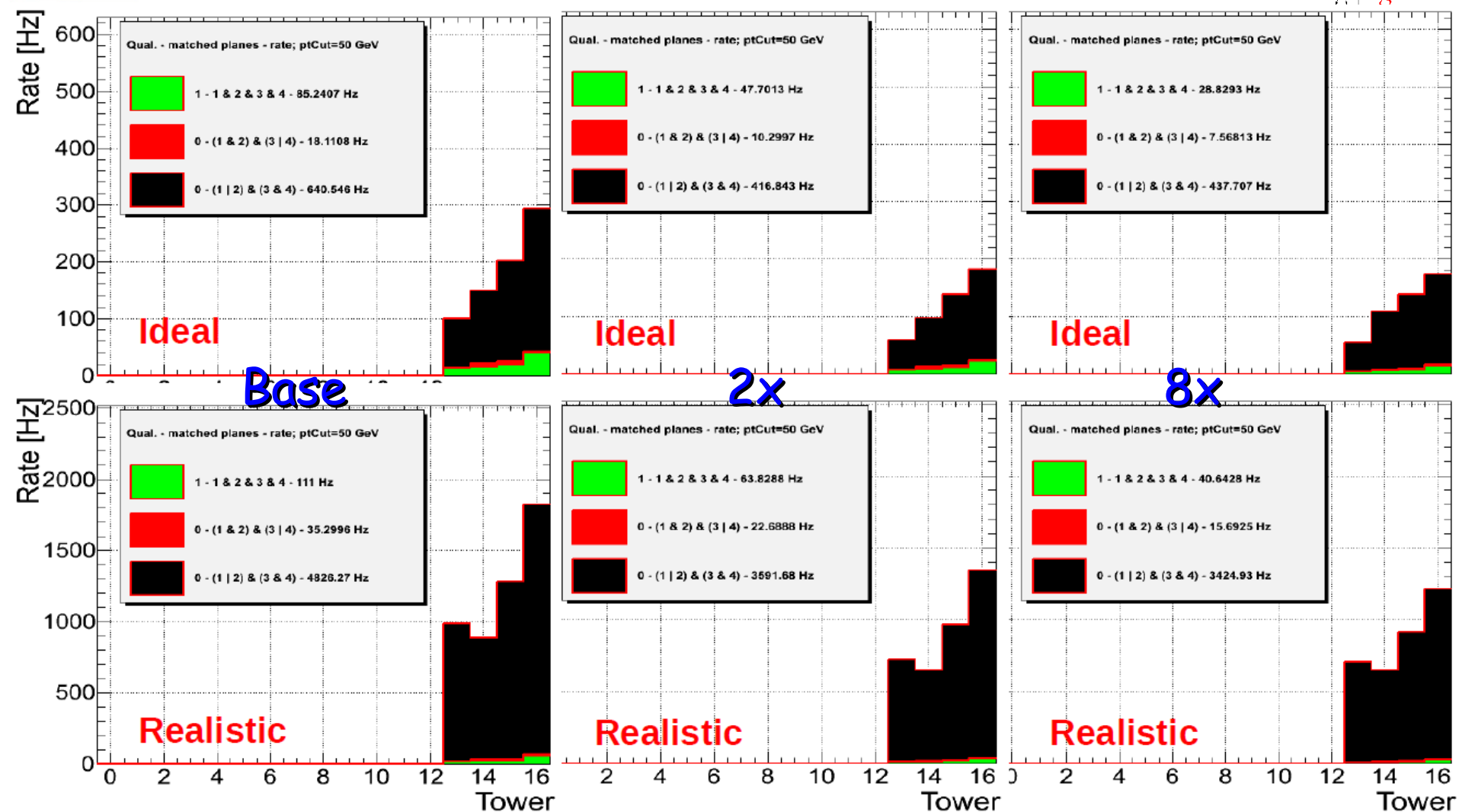
- Meaningful drop of rates between Base and 2x
- No significant influence for rates of cases with larger number of strips 2x - 8x

Realistic model, $ptCut > 16 \text{ GeV}$



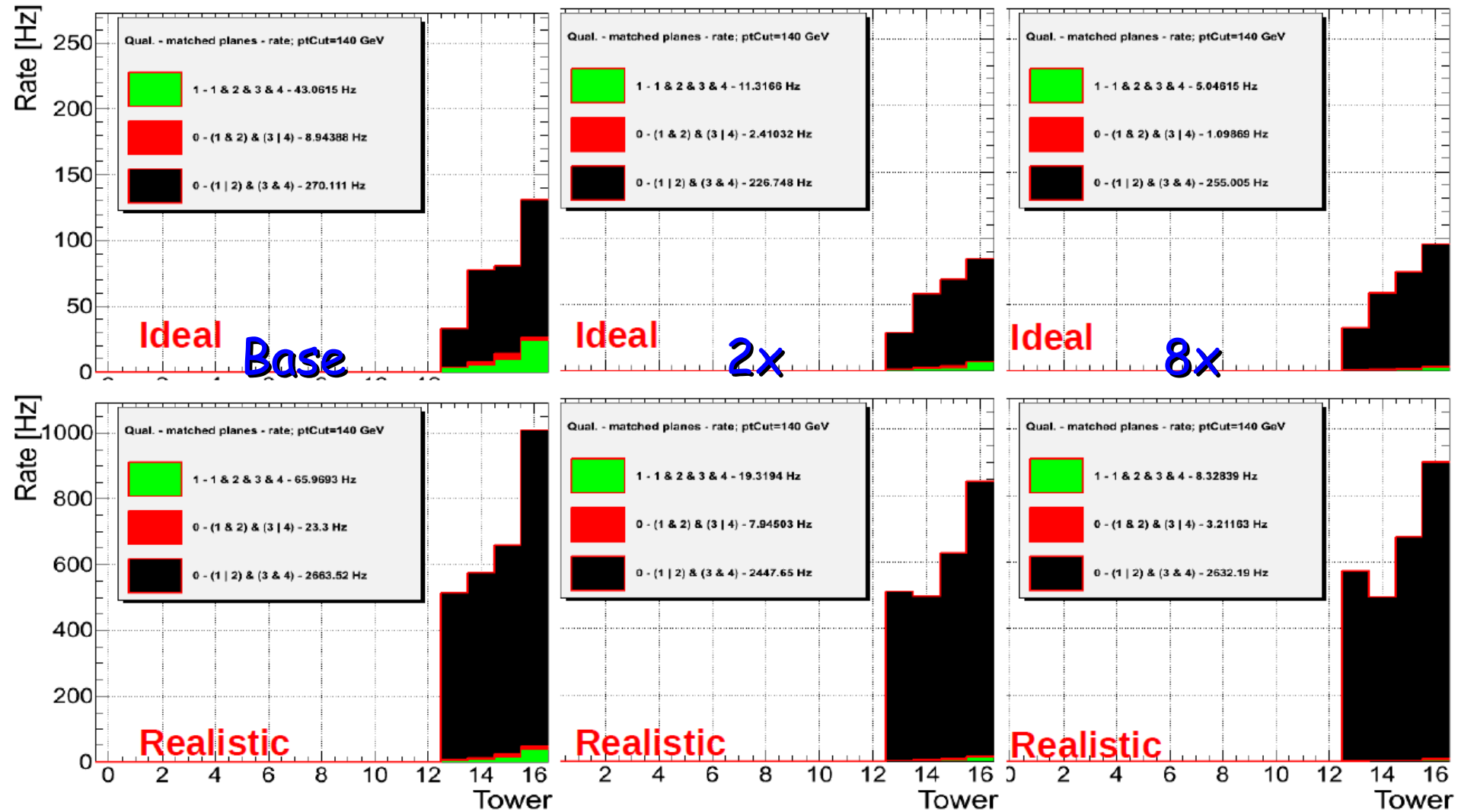
• Significant difference between ideal and realistic models

Realistic model, $ptCut > 50 \text{ GeV}$



• Significant difference between ideal and realistic models

Realistic model, $pt_{Cut} > 140 \text{ GeV}$



• Significant difference between ideal and realistic models

Realistic model

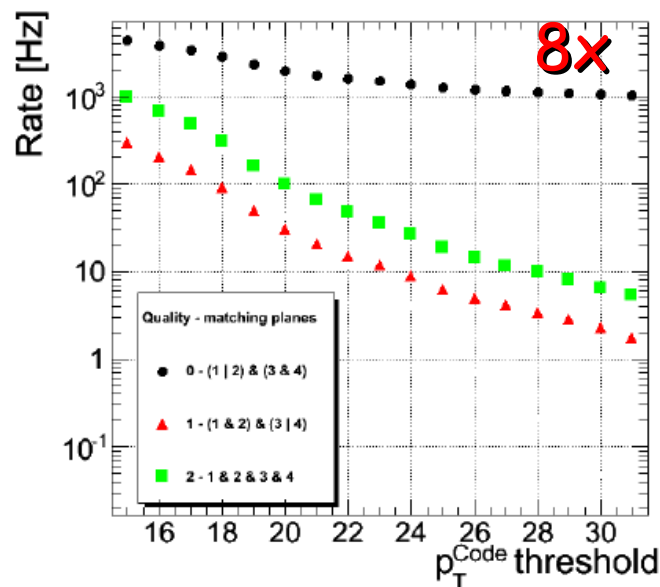
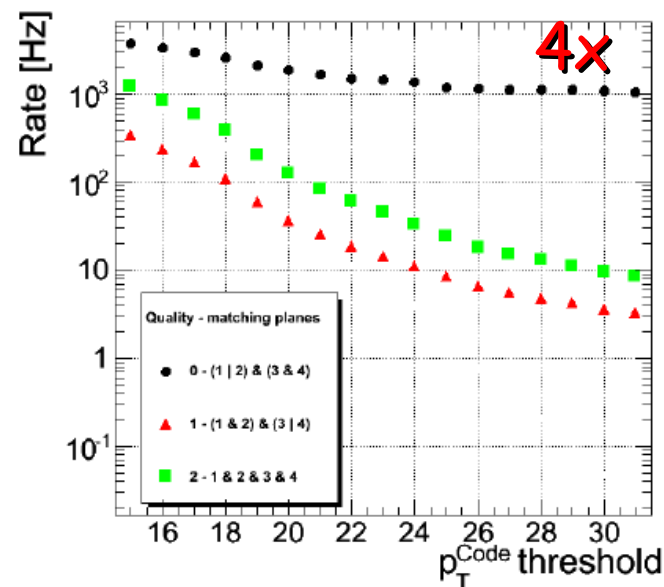
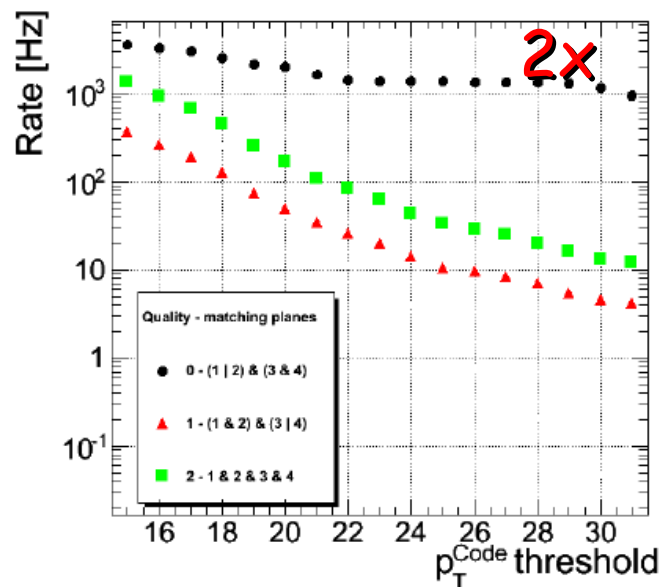
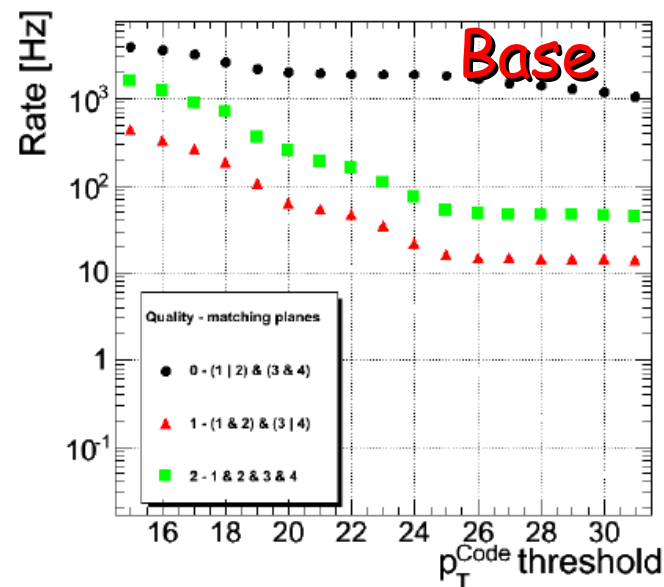
For $pt_{Cut} > 140 \text{ GeV}$

- Rate again dominated by quality 0 - "black"
- Contribution from qualities "red" and "green" $\sim 2x$ bigger rate for realistic model (when clusters for RPC enabled)
- Contribution from quality "black" $\sim 10x$ bigger rate for realistic model (when clusters for RPC enabled)

For realistic model:

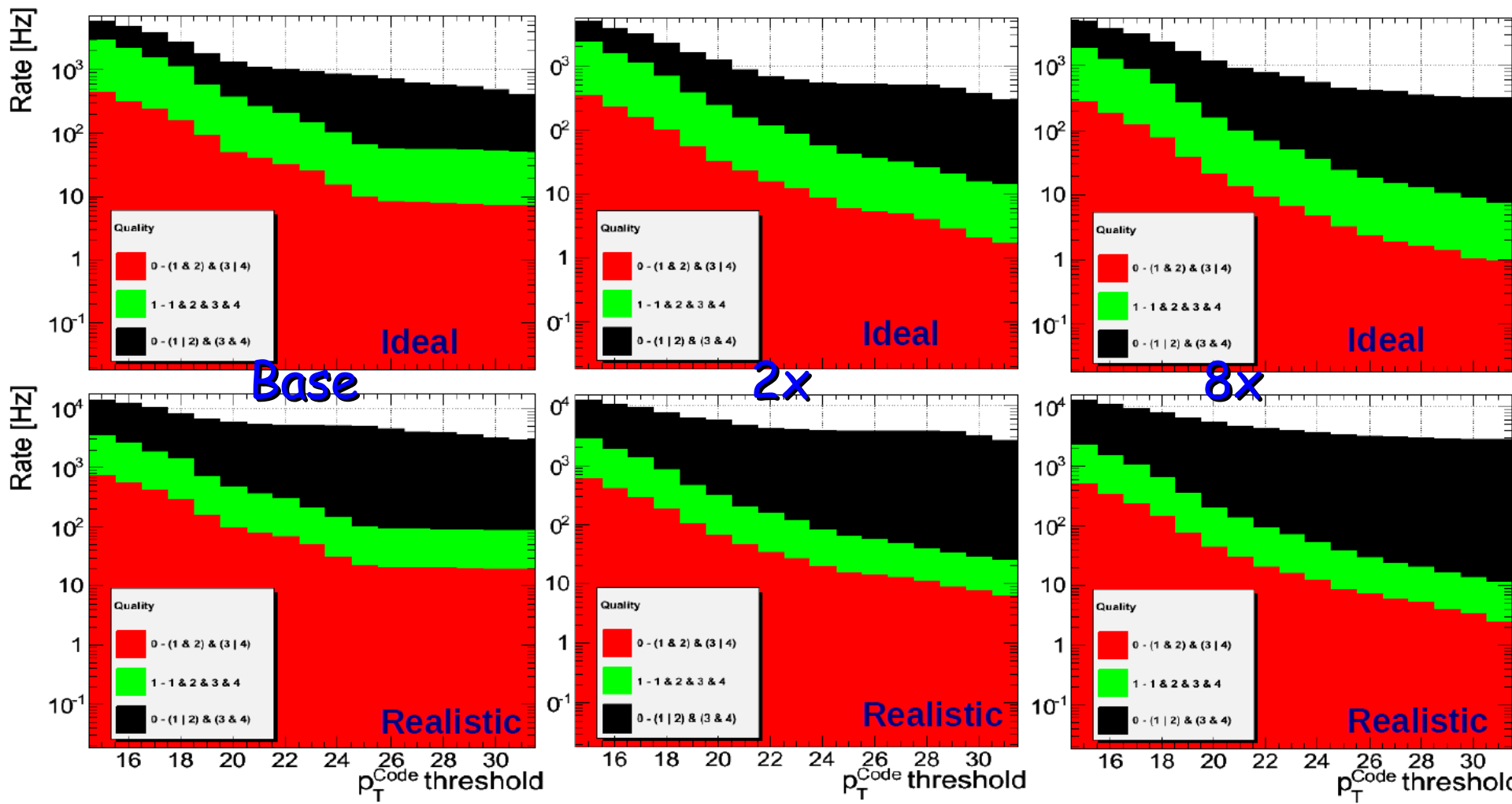
- **green/red** rates: Base $\rightarrow 2x$ rate goes down by factor ~ 3
- $2x \rightarrow 8x$ - rate goes down by factor ~ 2.5

Realistic model, Rate (ptCut)



- The same conclusion as for the ideal model:
- Meaningful drop of rates between Base and 2x
- No significant influence for rates of cases with larger number of strips 2x - 8x
- BUT (next slide)

Rates for ideal and realistic model



Realistic model (w/clustering) induces visibly lower rate reduction

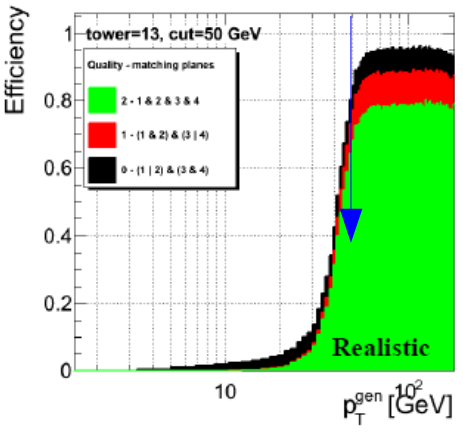
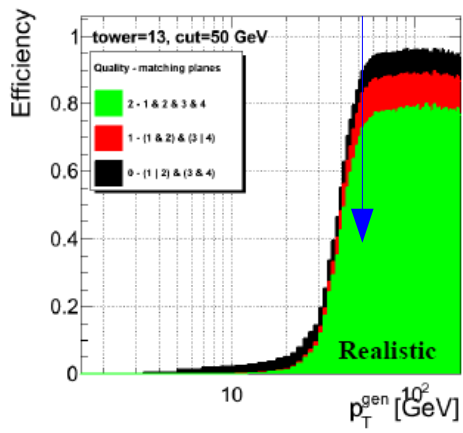
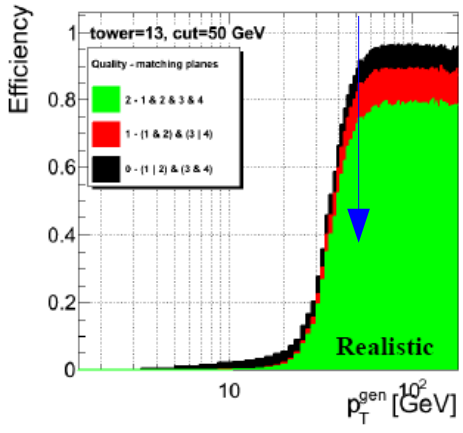
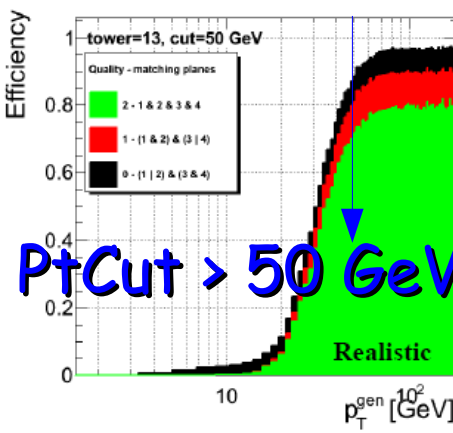
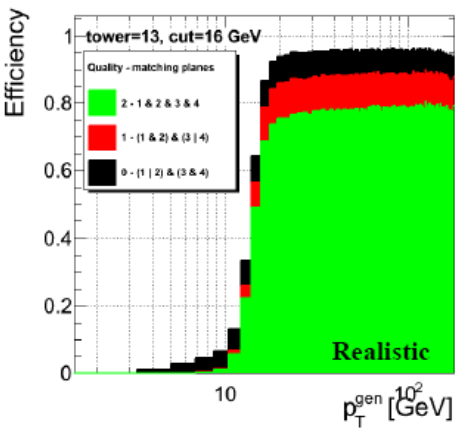
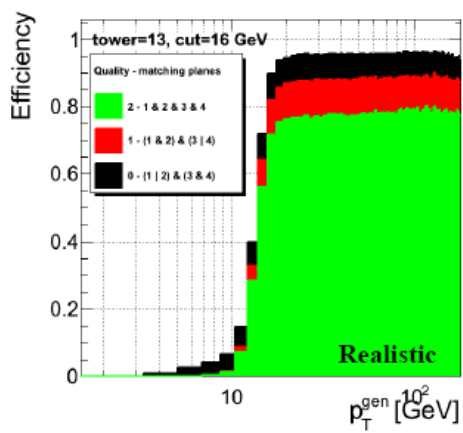
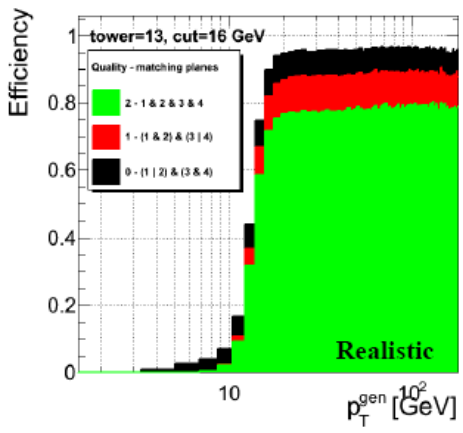
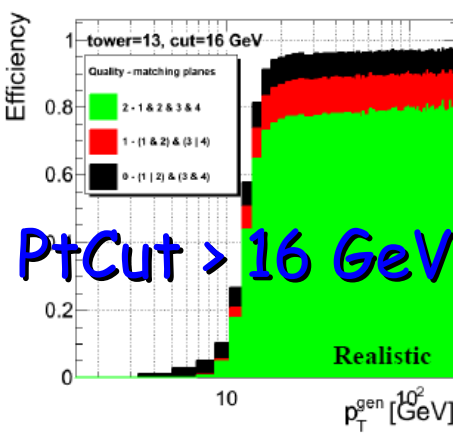
Efficiency turn-on curves

Base

2x

4x

8x



Eff. curves get better (steeper slope) when GEM granularity increases

Efficiency turn-on curves

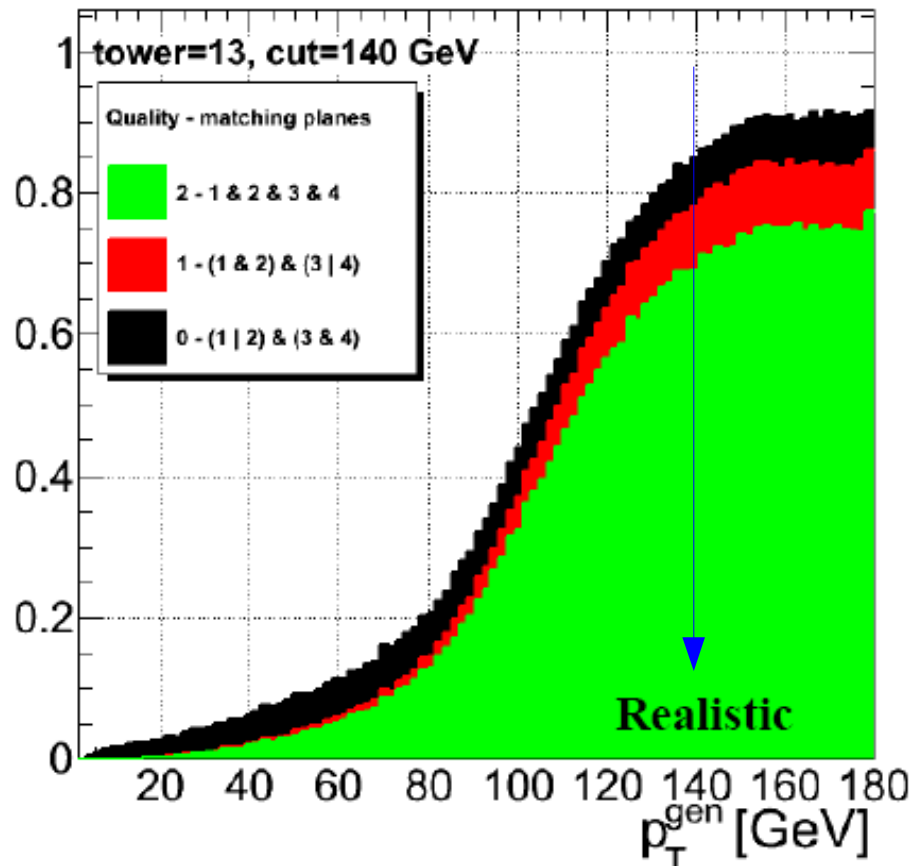
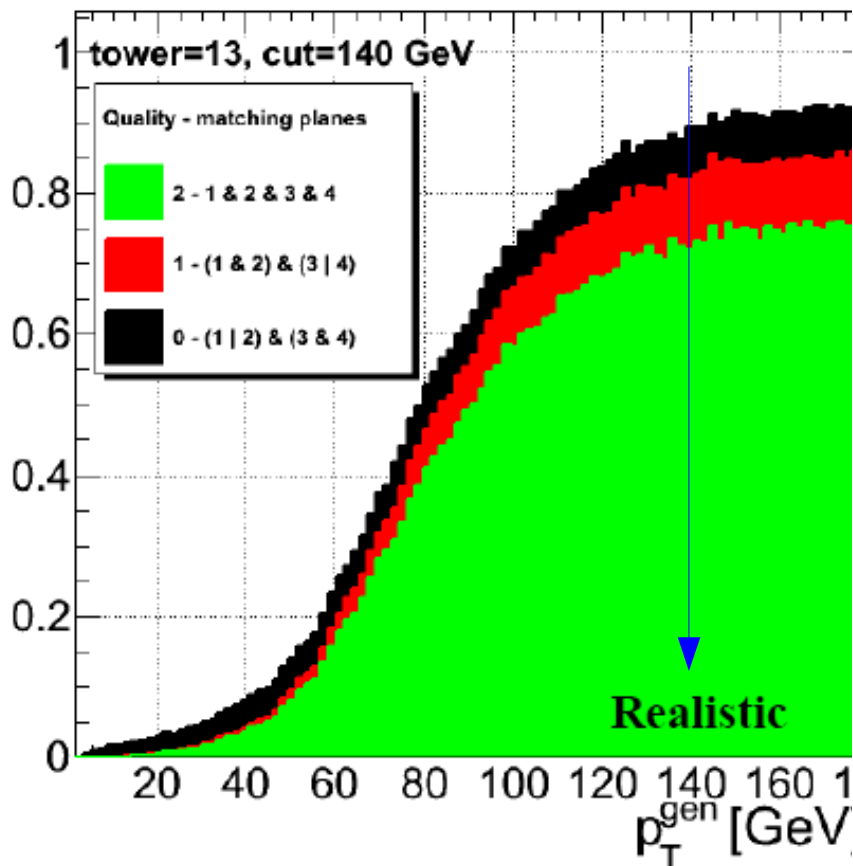
PtCut > 140 GeV

Base

8x

Efficiency

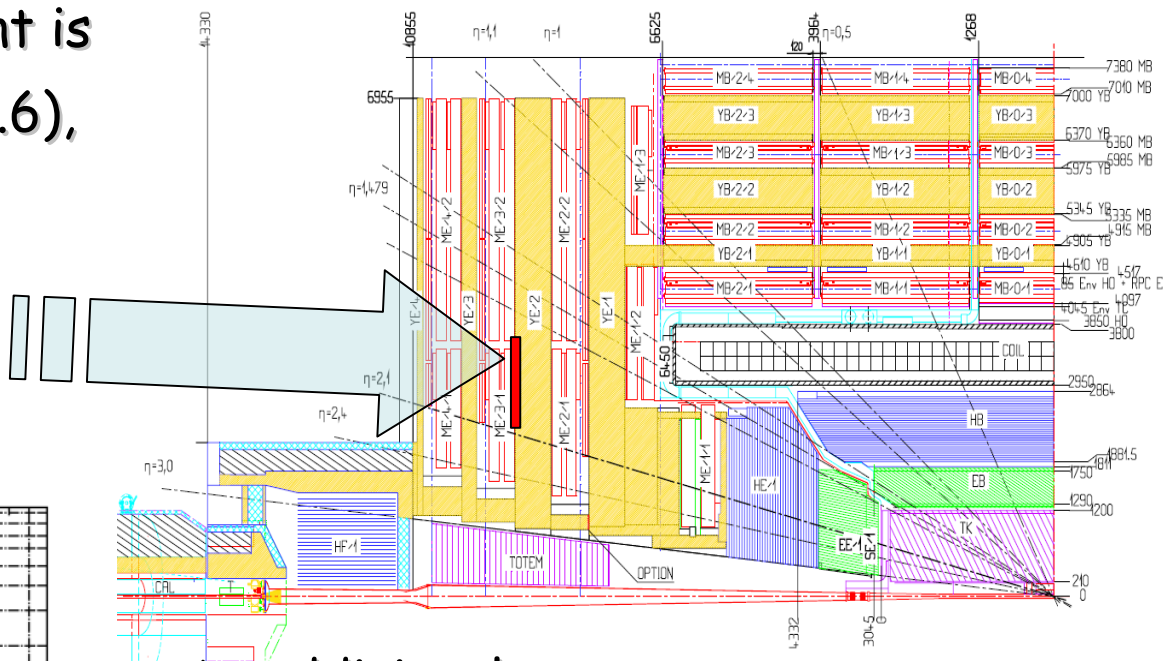
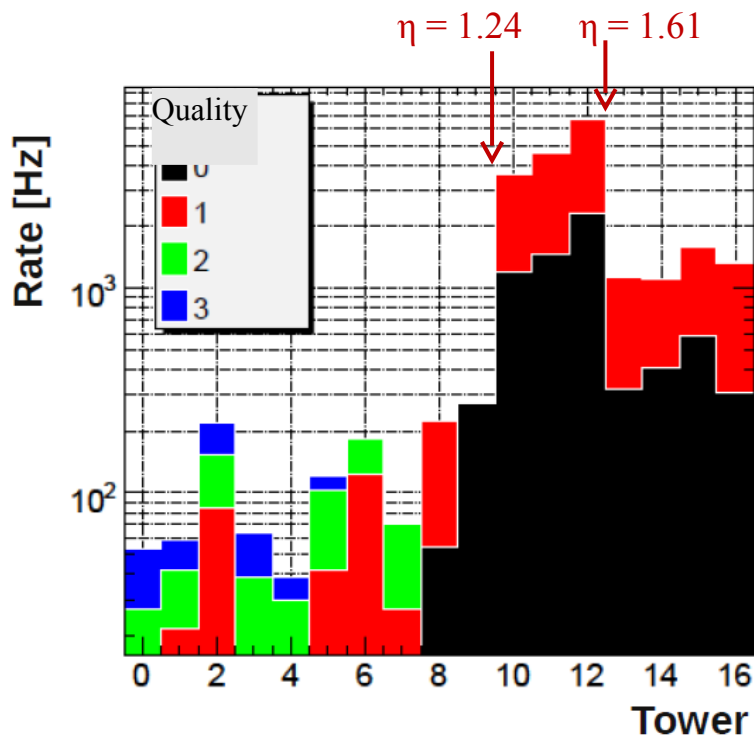
Efficiency



- Eff. curves get better (steeper slope) when GEM granularity increases

L1 Desired improvements with GEM

- The worst pt measurement is in towers 10-12 (η 1.2-1.6), as there is very small bending between the 1st and 2nd station



- An additional measurement could lead to important improvement
- GEM detector in first station (preferably doubled, to measure the local $\Delta\phi$) can help to reduce the rate



Summary and plans



- Results for two configuration models shows good improvements for triggering with GEMs
- The best results, when both inner planes used for measurement
- Benefits visible from better granularity and no clusters
- Doubling spatial resolution gives 3~4x rate drop (when two first station used for measurement). Going further (increasing spatial resolution 8x) gives 8~9x rate reduction
- Further studies are planned with different variation of GEM geometry and more specific definition of quality of candidates