Triggering in high eta using RPC PAC

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on behalf Warsaw Trigger Group

Outline:

- Upgrades during LS1
- Summary of simulations for the RPC PAC trigger in the high eta region

Logic of RPC PAC
(PAttern Comparator)

RPC hits are compared with predefined set of patters

Patterns:

- correspond to muons tracks of defined p_T
- are defined inside **Logic Cones** ("geometrical units" of the PAC segmentation)
- **Muon candidate is created in a Logic Cone when :**

– Barrel:

- **3 out of 4 inner chamber layers are fired**

  (to accept low pTmuons not reaching the outer stations)
- **4 out of 6 (5) chamber layers are fired (high pTmuons)**

– Endcap

- **3 out of 3 chamber layers are fired**

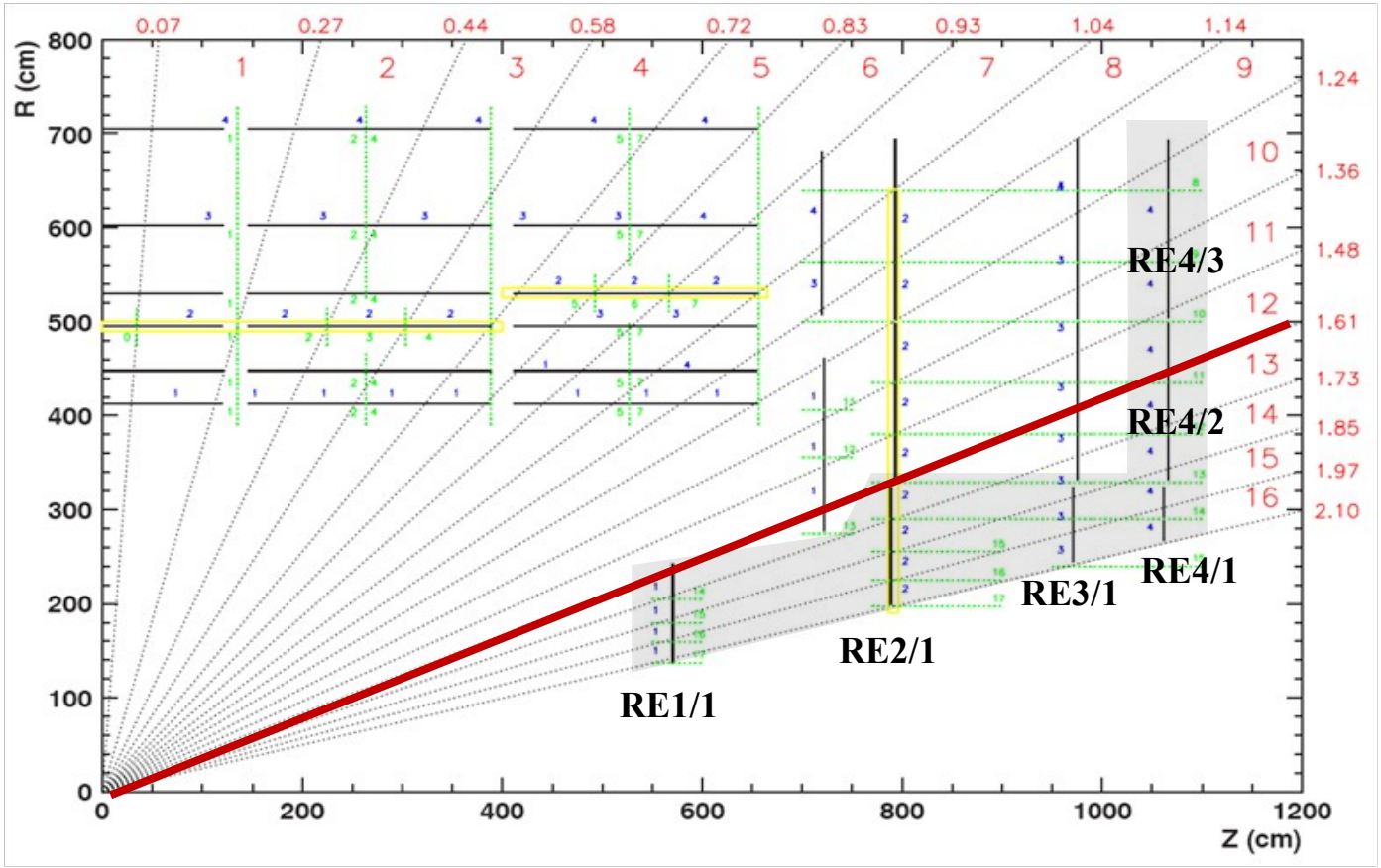
Trigerrable Muon

hits fit to at least one pattern and if hits are in the same BX

Triggering with PAC trigger

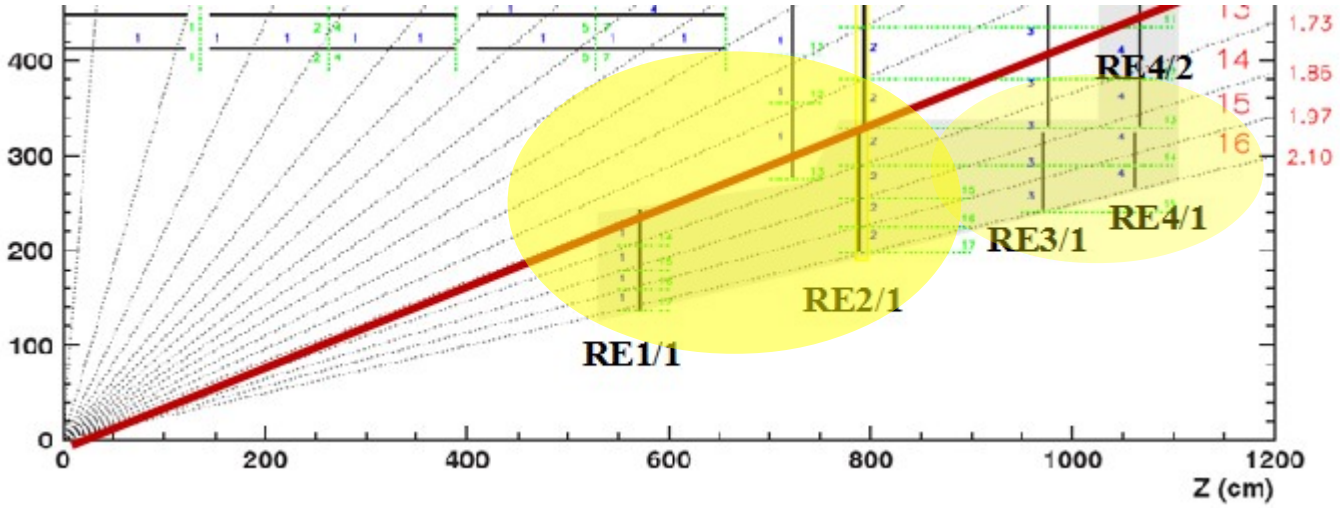
- Signal collected in BX (25ns) windows
  - Synchronization at the level of Link Boards (where to one LB is connected to one roll of the barrel or one chamber of endcaps)
- PAC trigger can store up to 7 BX, presently 6 BX (to avoid dead time with high rates)

New detectors in high eta region



- Presently, the RPC PAC trigger reaches |η|< 1.61
- RPC chambers will installed in RE4/2 and RE4/3 during the LS1 => "3 of 4" logic (now, "3 of 3")

New detectors in high eta region

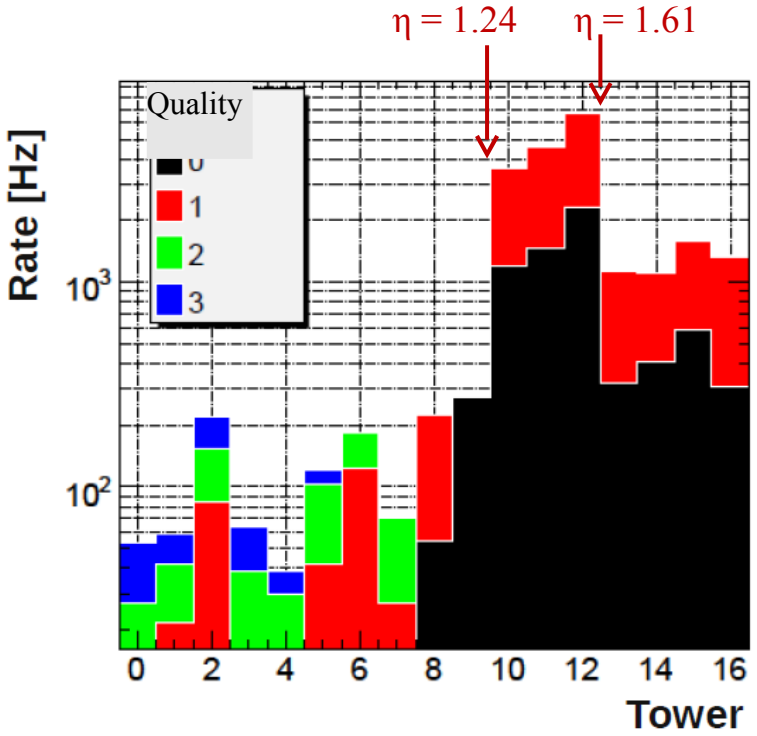


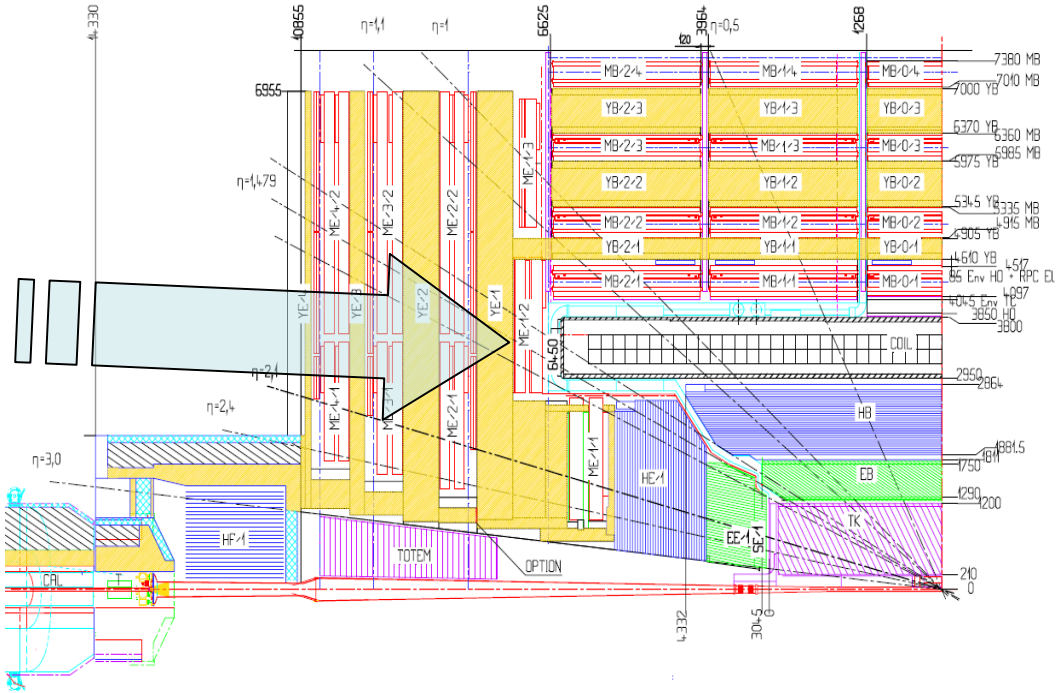
1st proposal was to install GEM detectors in RE1/1 and RE2/1 (and RE3/1, RE4/1)

- GEM chambers in the RE1/1 would have the same size and segmentation as planed for the RPCs:
  - 10° trapezoid chambers, ~1.2 m long

PAC desired improvments

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





- An additional measurement could lead to important improvement
- **New detectors in first station (preferably doubled, to measure the local delta:phi) can help to reduce the rate**

Trigger in high eta

- **Nothing has been decided yet →**
  it is not clear if new RPCs or GEM or GRCP
  will be installed and when (LS1 or LS2)

- Triggering may benefit from:
  - significantly better spatial and time resolution

Summary of the 1st PAC optimisation

- Done for the GEM [Technical Proposal]
- Results show 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
- Details on next slides

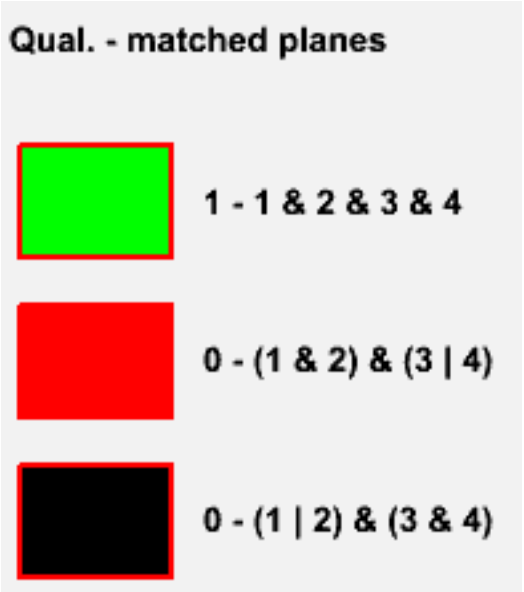
PAC Optimisation

- **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

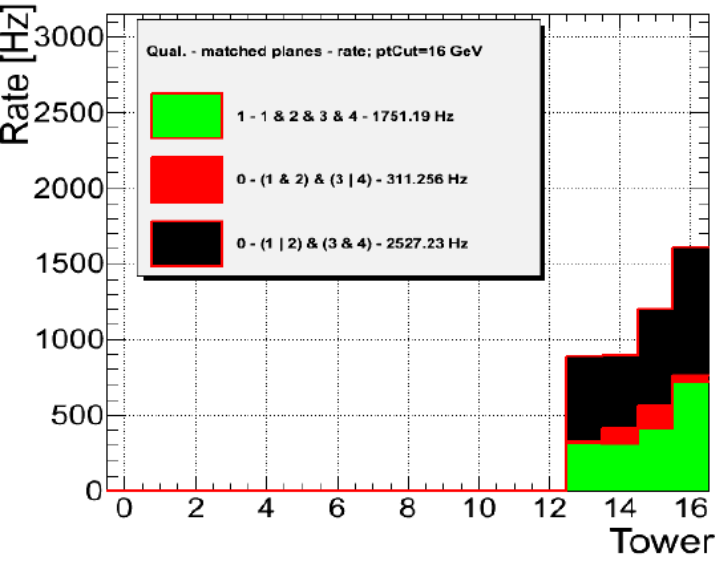
- Optimizations in PAC logic (patterns) to fully utilize GEMs:
- Prefered patterns are patters with first two planes fired (region of highest B field, GEM planes):

- 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)

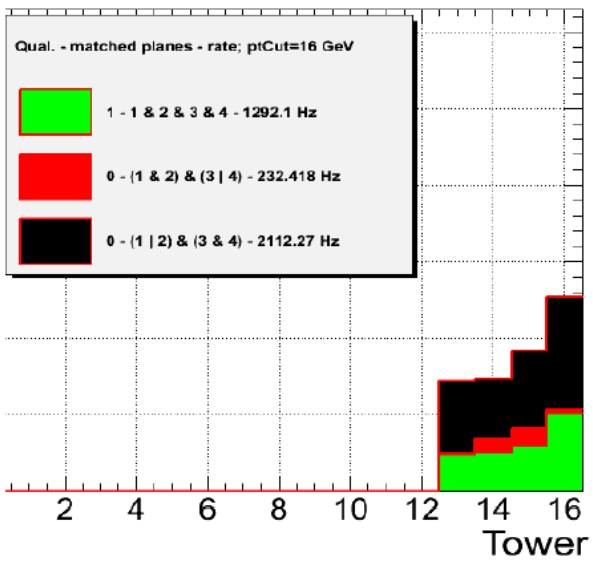


Ideal model, ptCut > 16 GeV

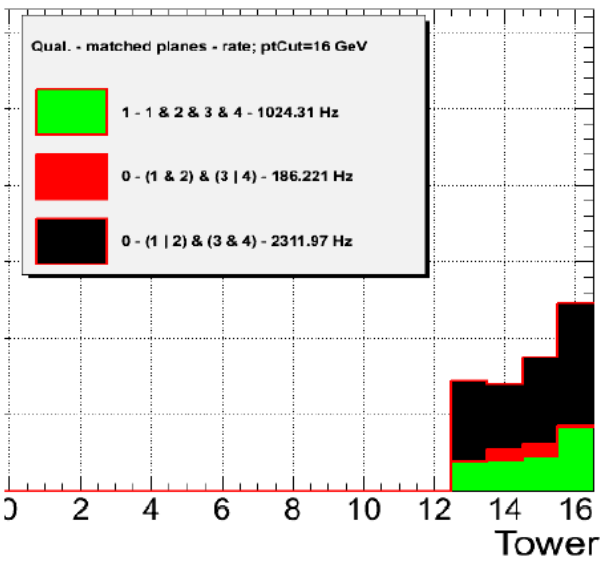
Base



2x



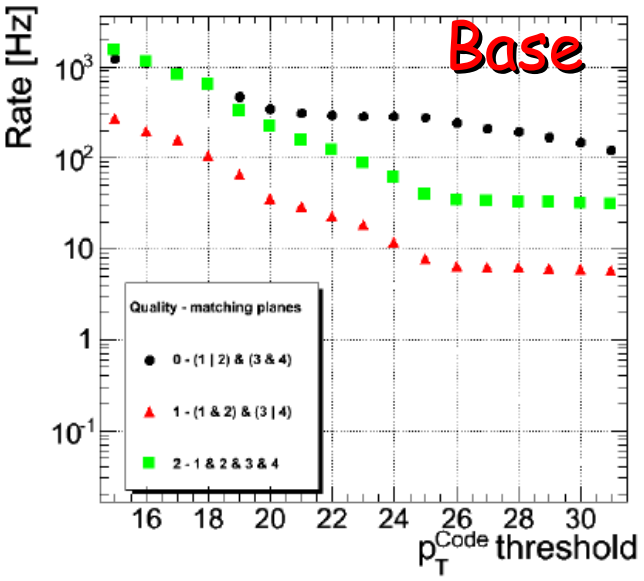
8x

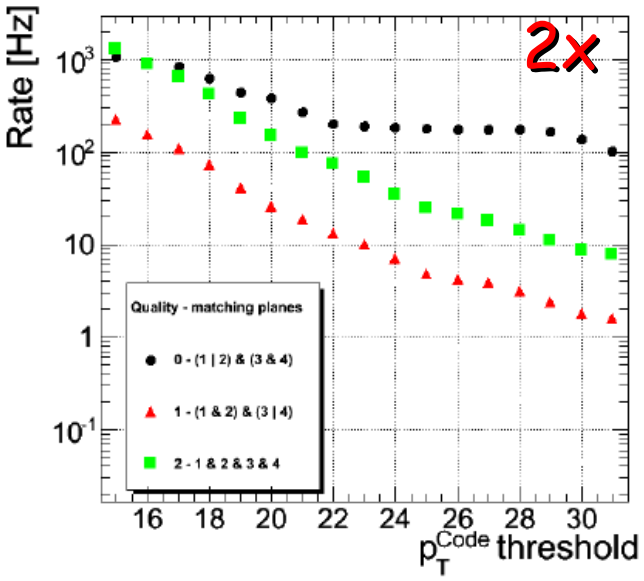


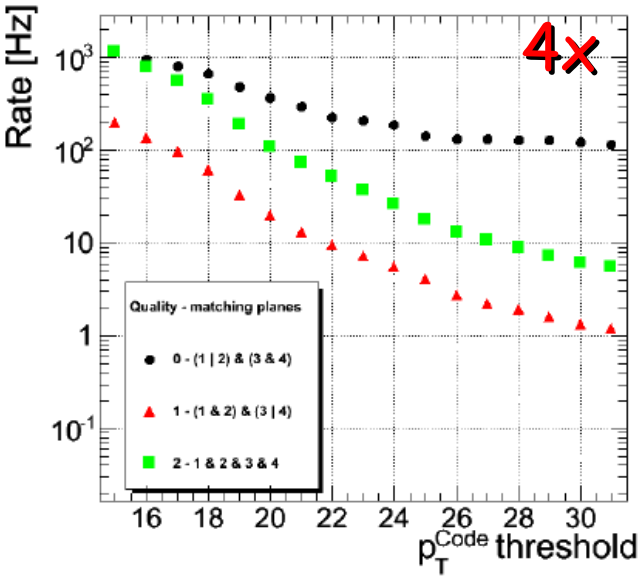
- Simulation for towers: 13,14,16
- Largest rate contribution for quality 0 "black"
- For ptCut > 16 GeV:

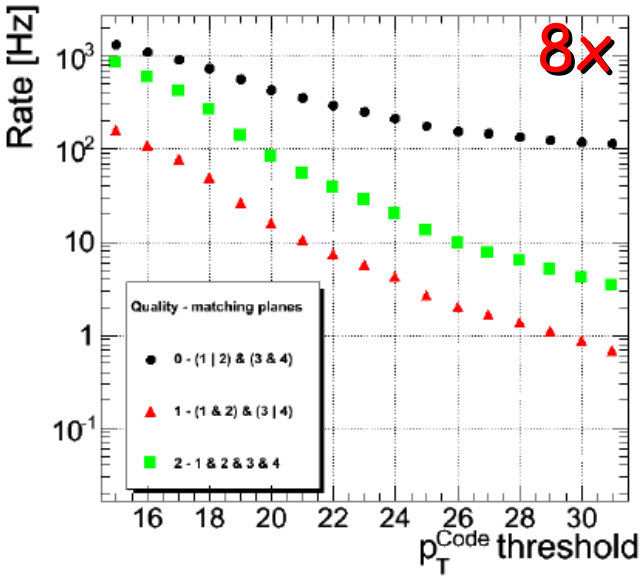
  green/red rates from Base → 2x → 4x drop slightly

Ideal model, Rate (ptCut)



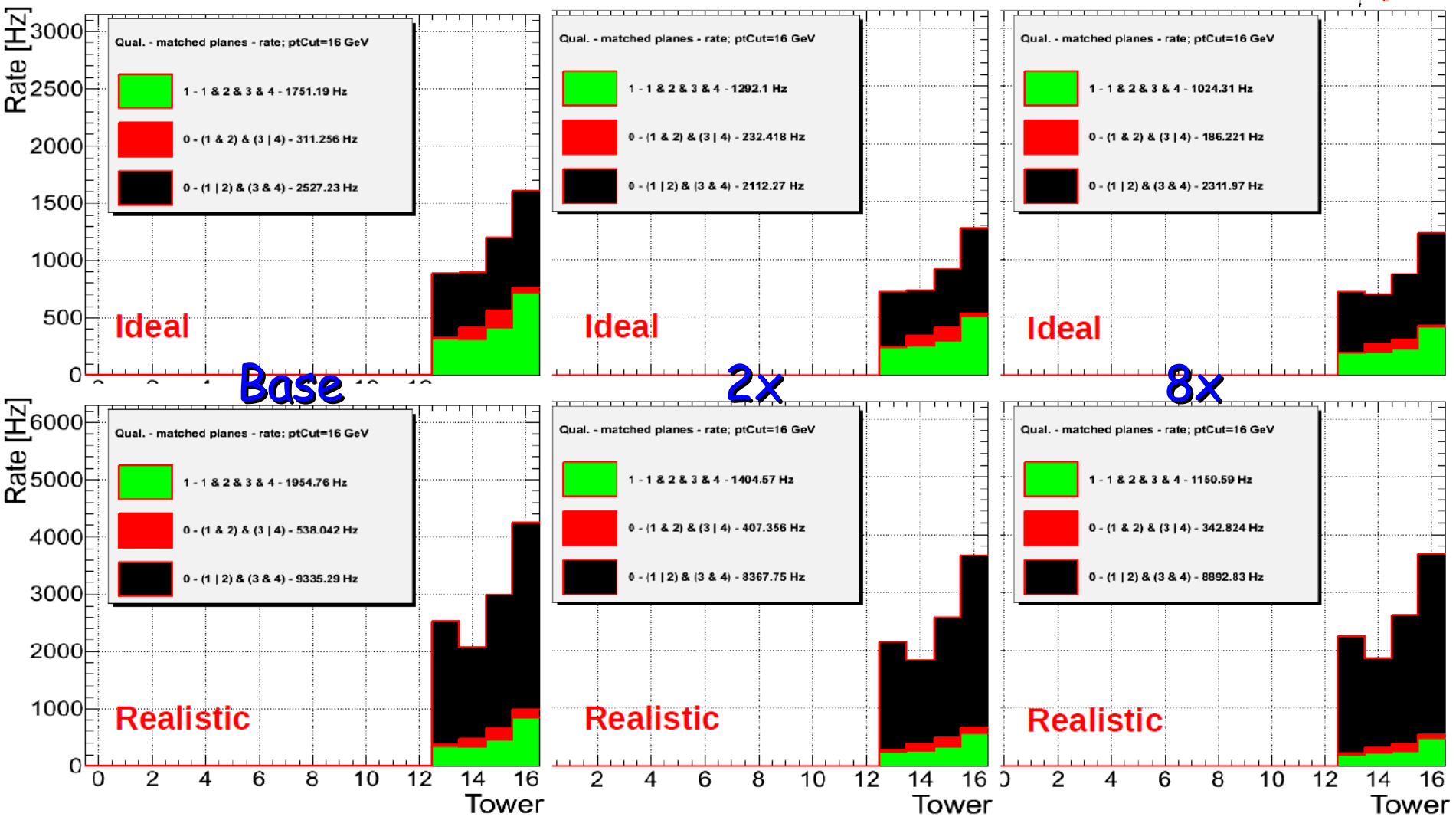






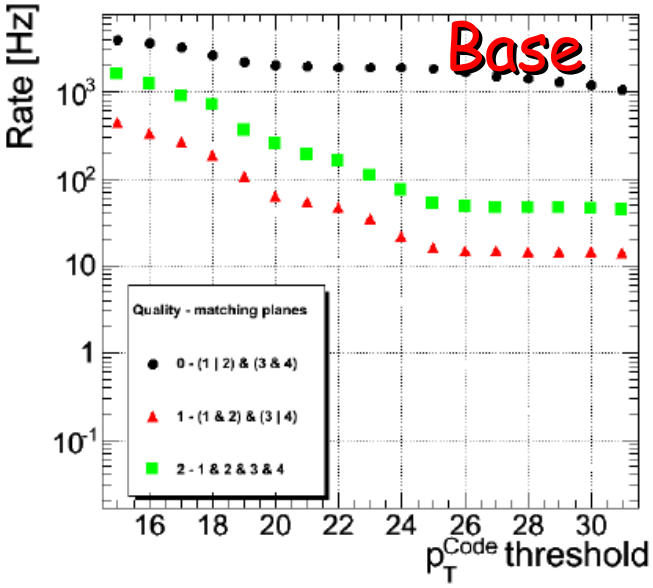
- Meaningful drop of rates between Base and 2x
- No significant influence for rates of cases with larger number of strips 2x - 8x

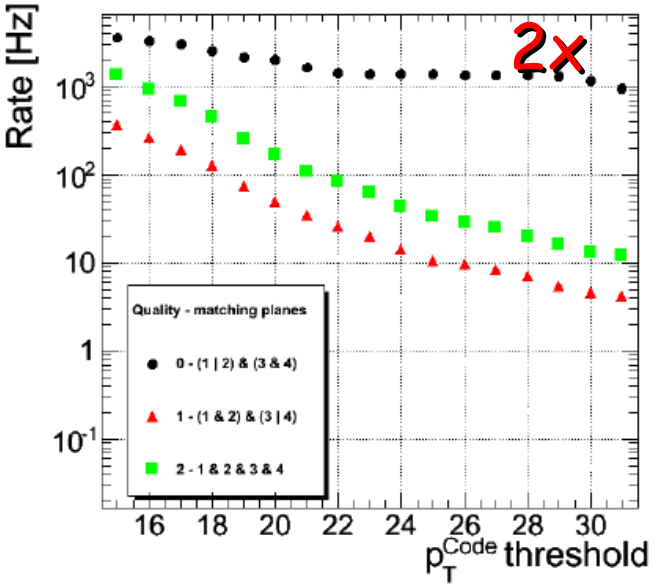
Realistic model, ptCut > 16 GeV

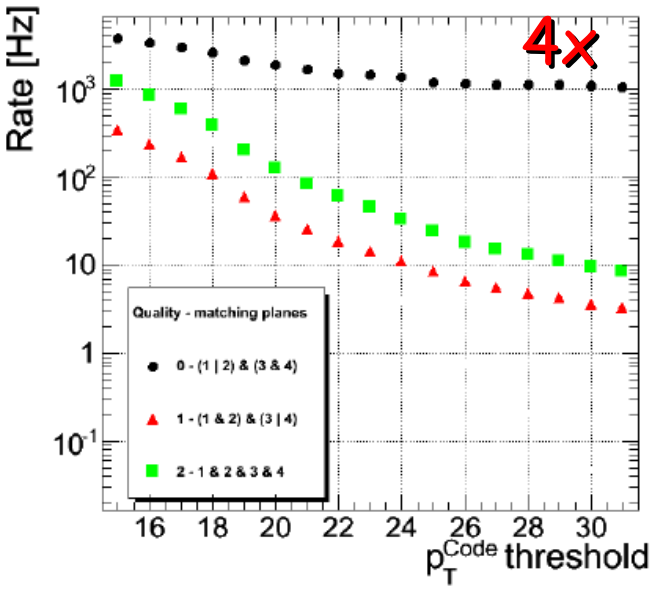


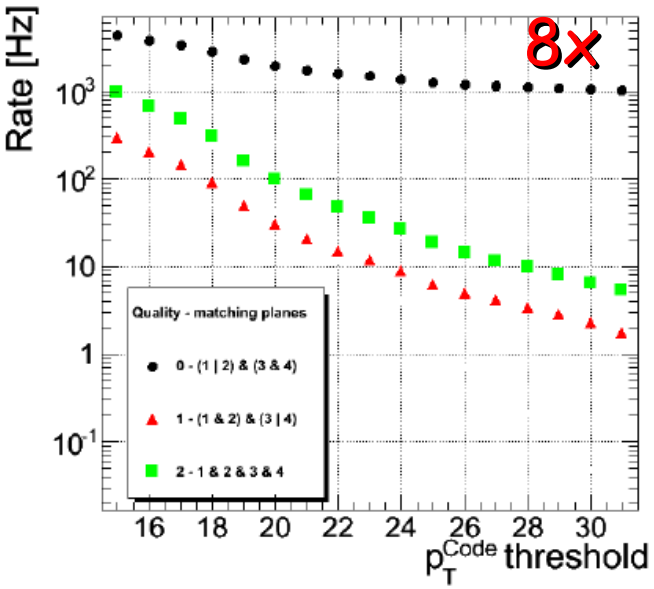
- Significant difference between ideal and realistic models

Realistic model, Rate (ptCut)



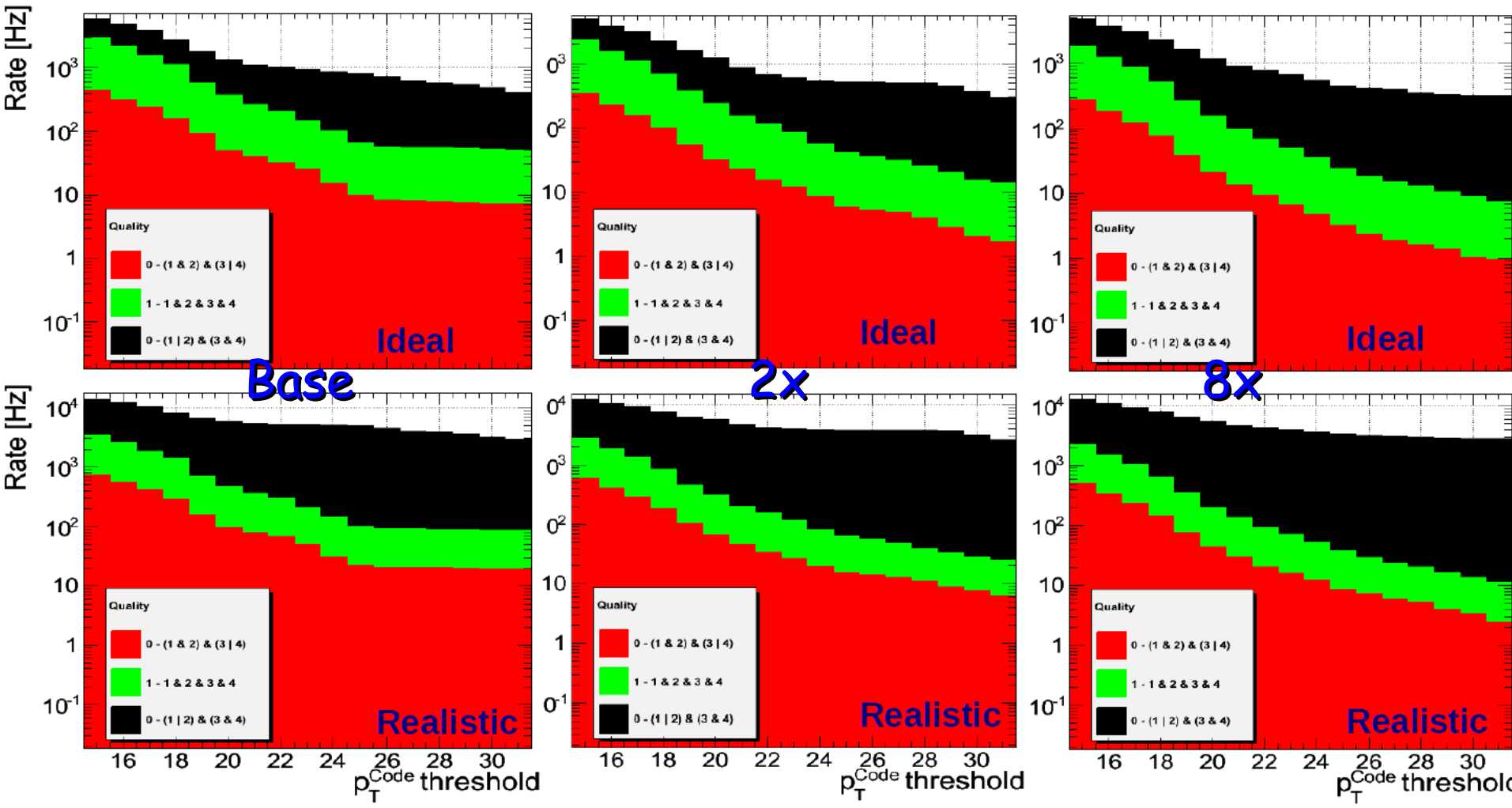






- The same conclusion as for the ideal model:
- Meaningful drop of rates between Base and 2x
- No significant influence for rates of cases with larger number of strips 2x - 8x
- BUT (next slide)

Rates for ideal and realistic model

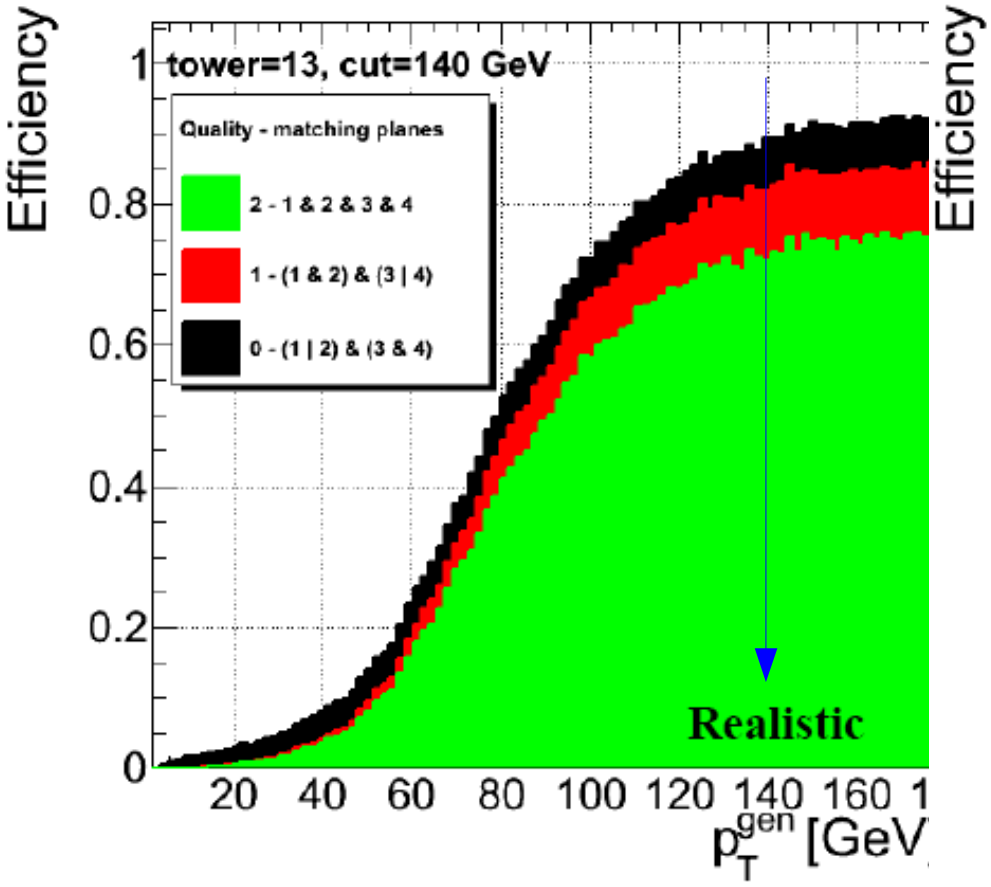


- Realistic model (w/clustering) induces visibly lower rate reduction

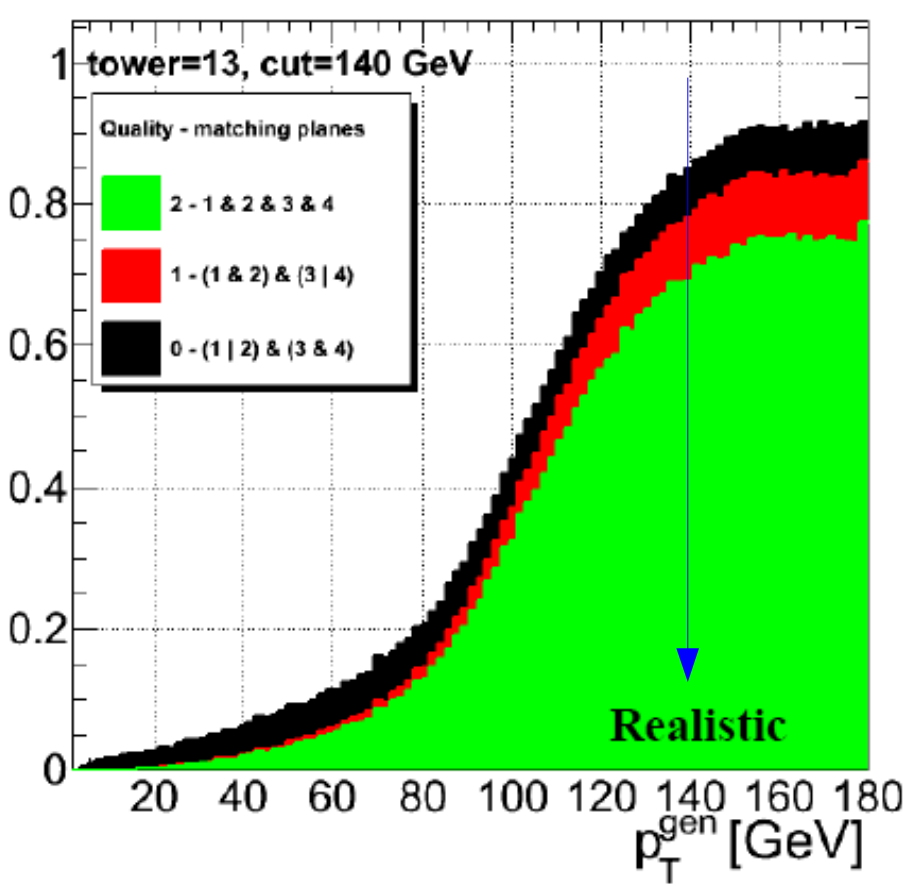
Efficiency turn-on curves

PtCut > 140 GeV

Base



8x



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

Summary

Triggering in high eta:

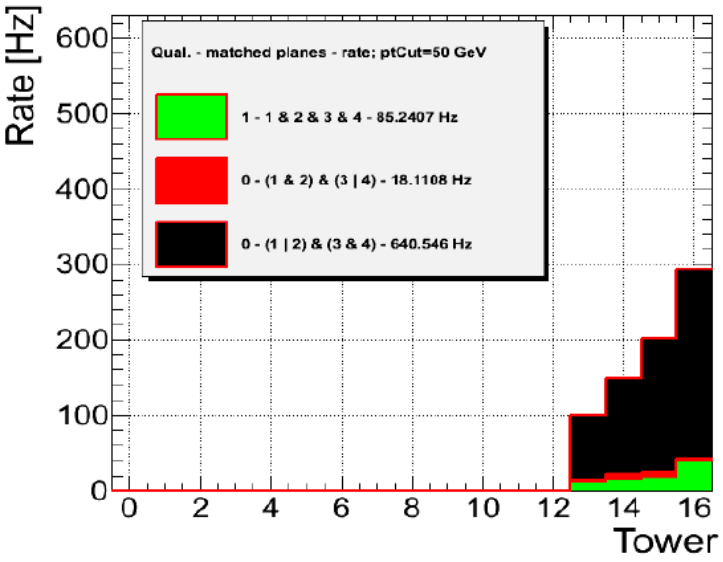
- Results show good improvements for triggering with GEMs
- The best results, when both inner planes used for measurement
- Benefits visible from better granularity and no clusters

- Similar results are expected for GRPCs

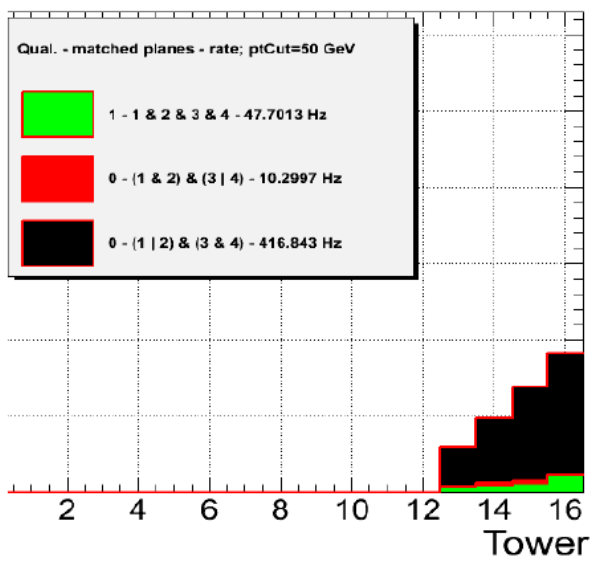
Backup slides

Ideal model, ptCut > 50 GeV

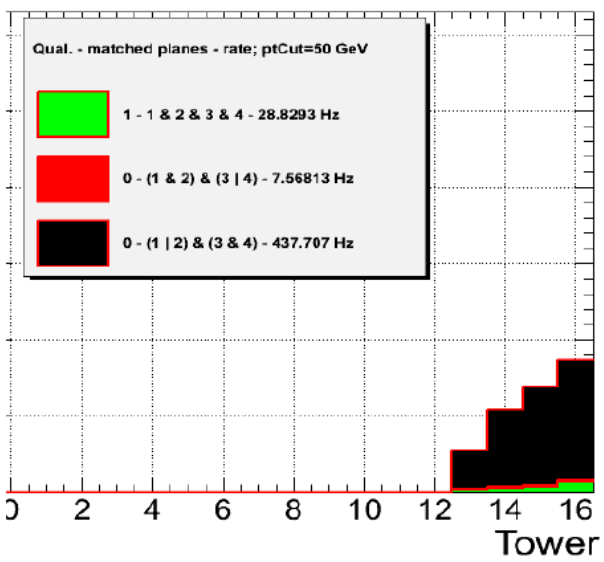
Base



2x



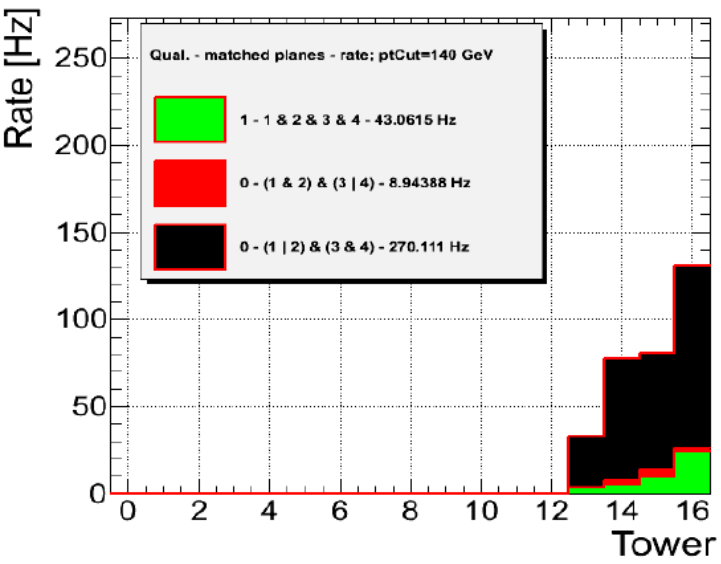
8x



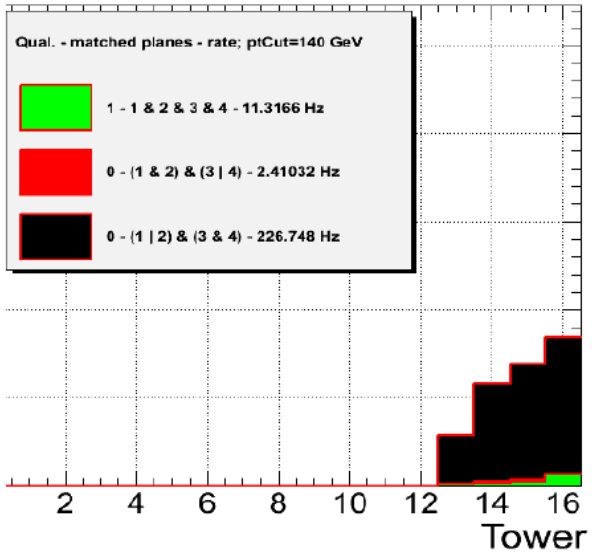
- For ptCut > 50 GeV:
  green/red rates from Base → 2x → 4x
  drop be a factor less than 2

Ideal model, ptCut > 140 GeV

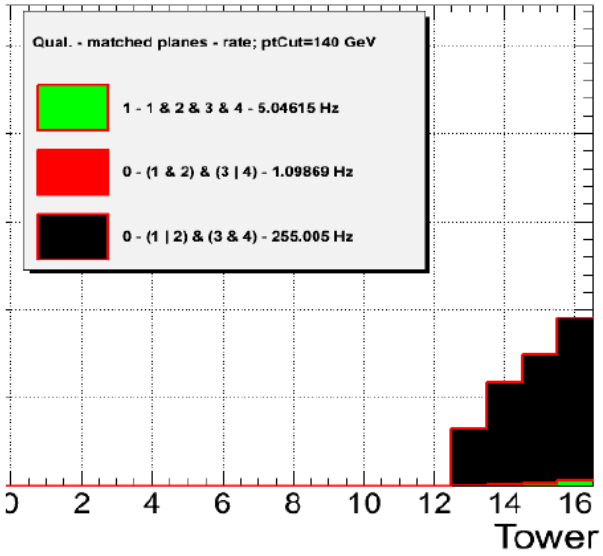
Base



2x



8x

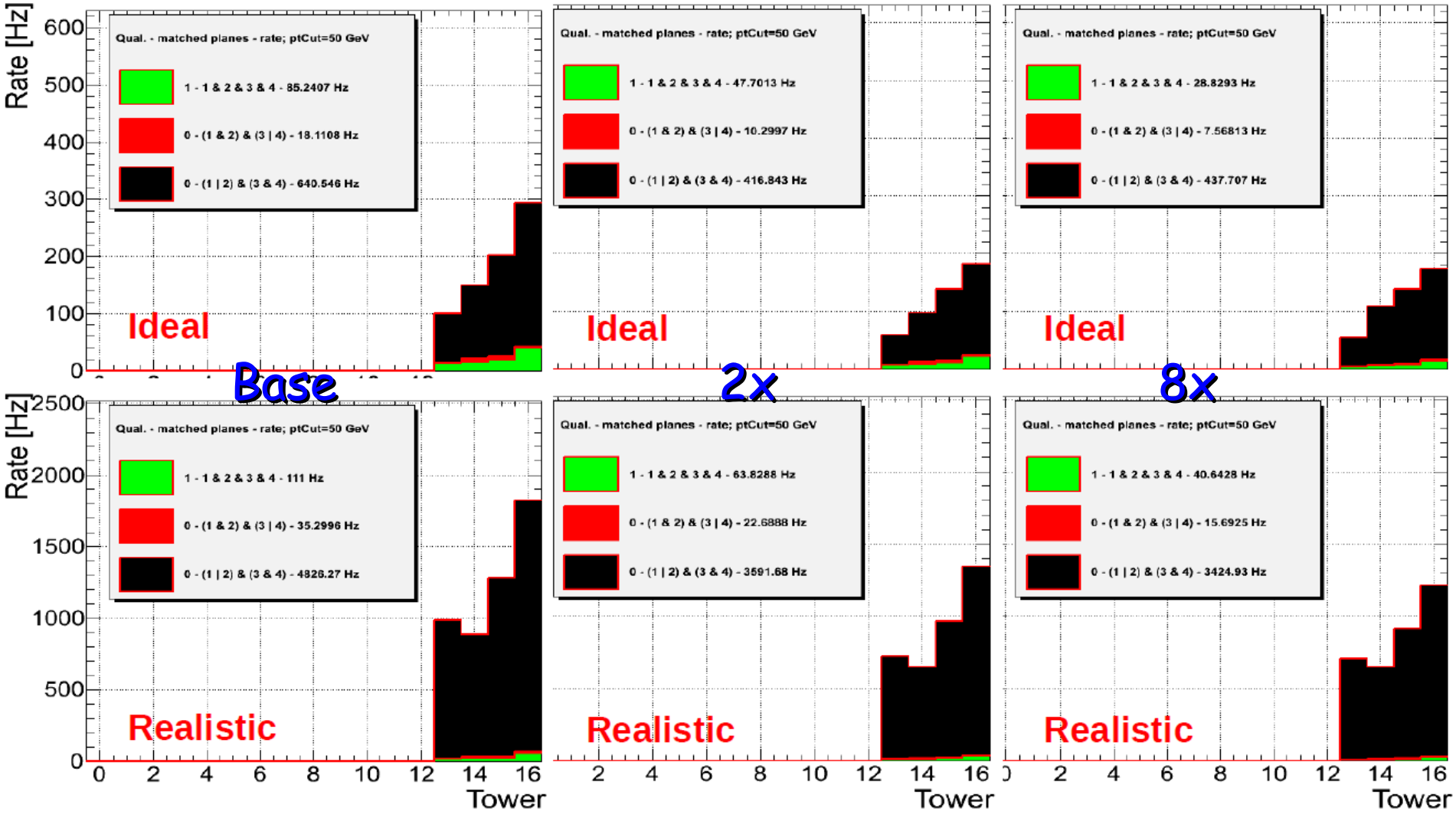


- For ptCut > 140 GeV:

  green/red rates: Base → 2x drop by a factor ~4

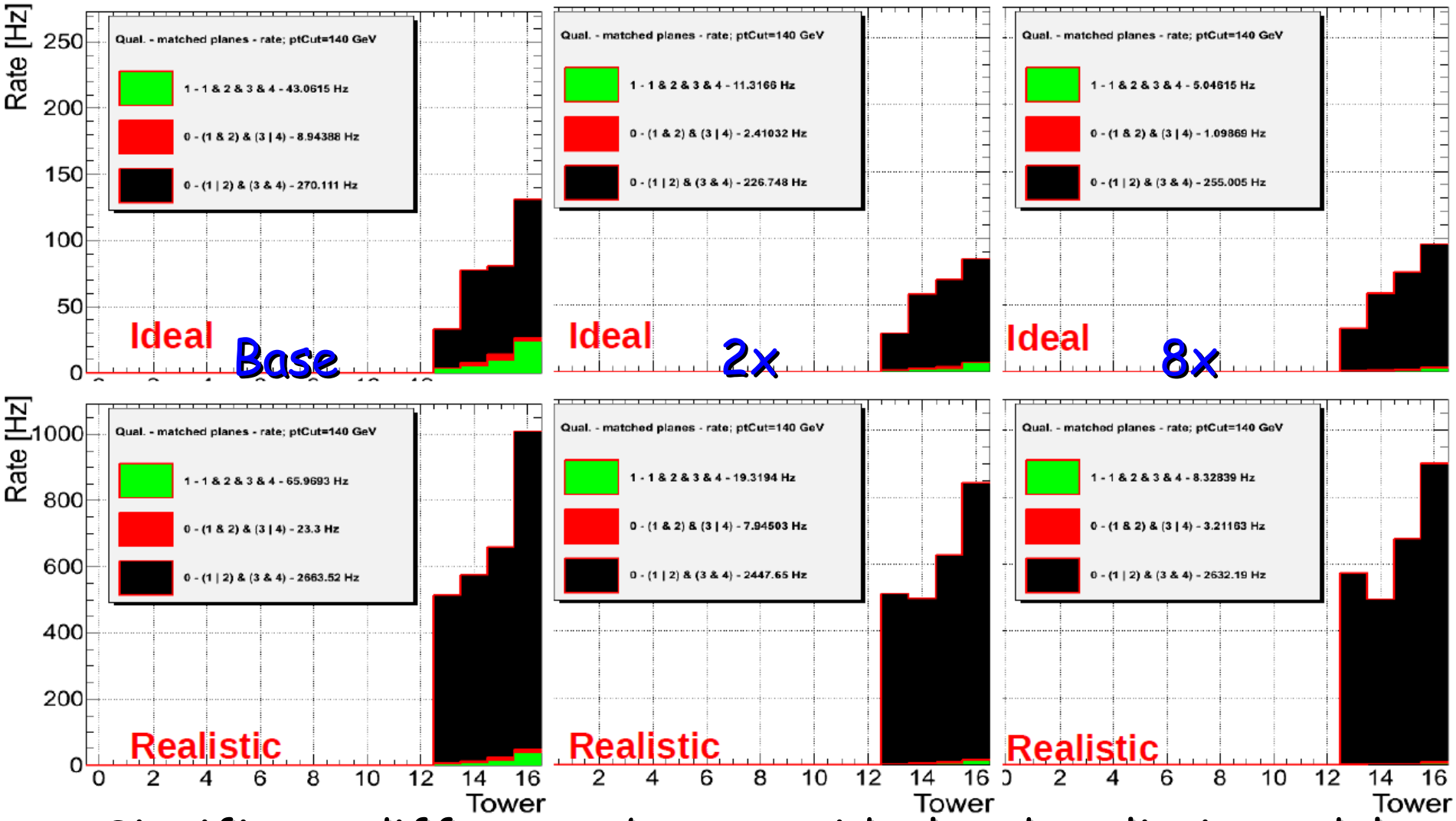
  2x → 8x drop by a factor ~2

Realistic model, ptCut > 50 GeV



- Significant difference between ideal and realistic models

Realistic model, ptCut > 140 GeV



- Significant difference between ideal and realistic models

Realistic model

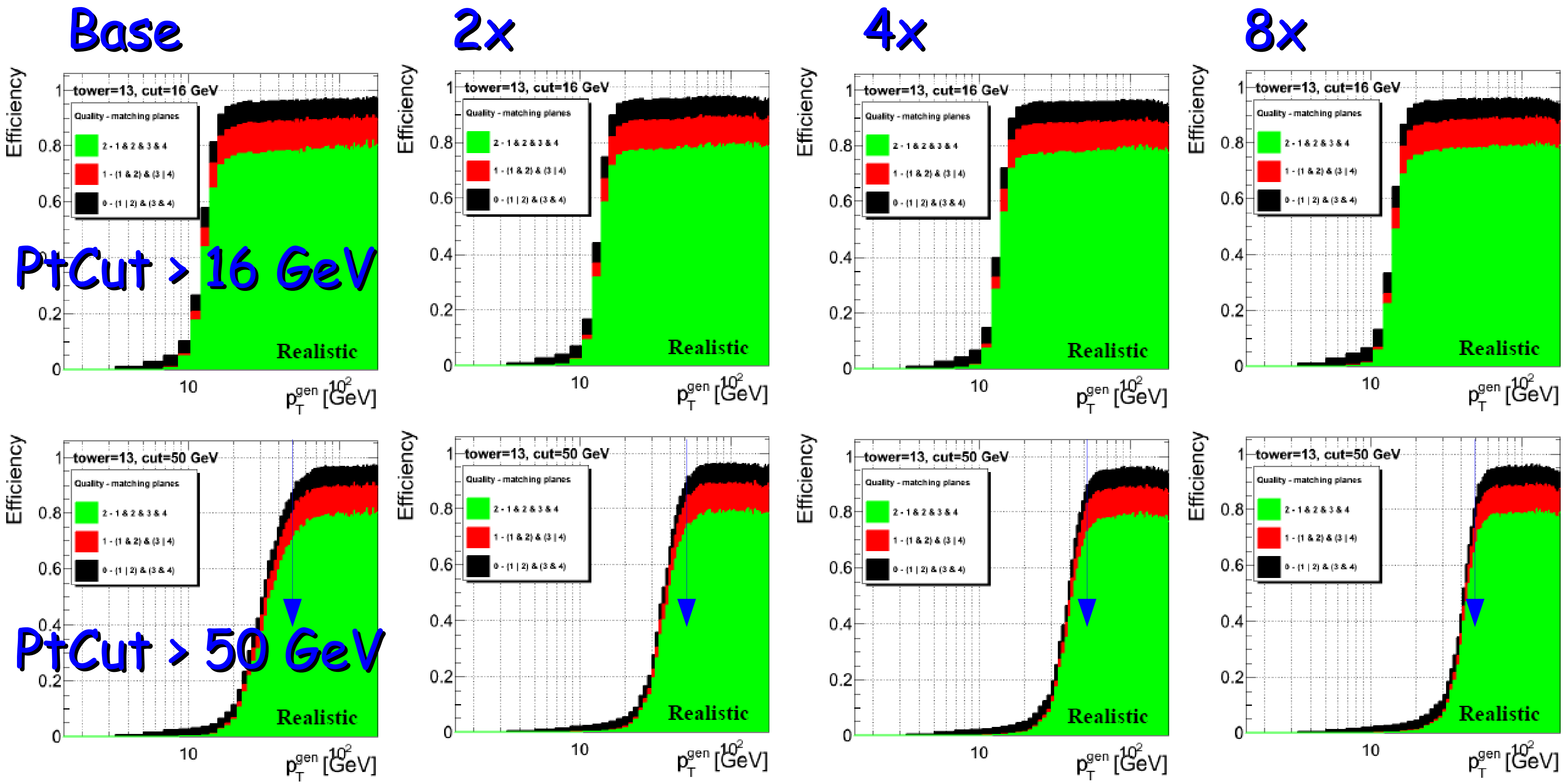
For ptCut > 140 GeV

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

For realistic model:

- green/red rates: Base → 2x rate goes down by factor ~3
- 2x → 8x - rate goes down by factor ~2 .5

Efficiency turn-on curves



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