# Behind ATLAS measurements

## An example of systematics evaluation

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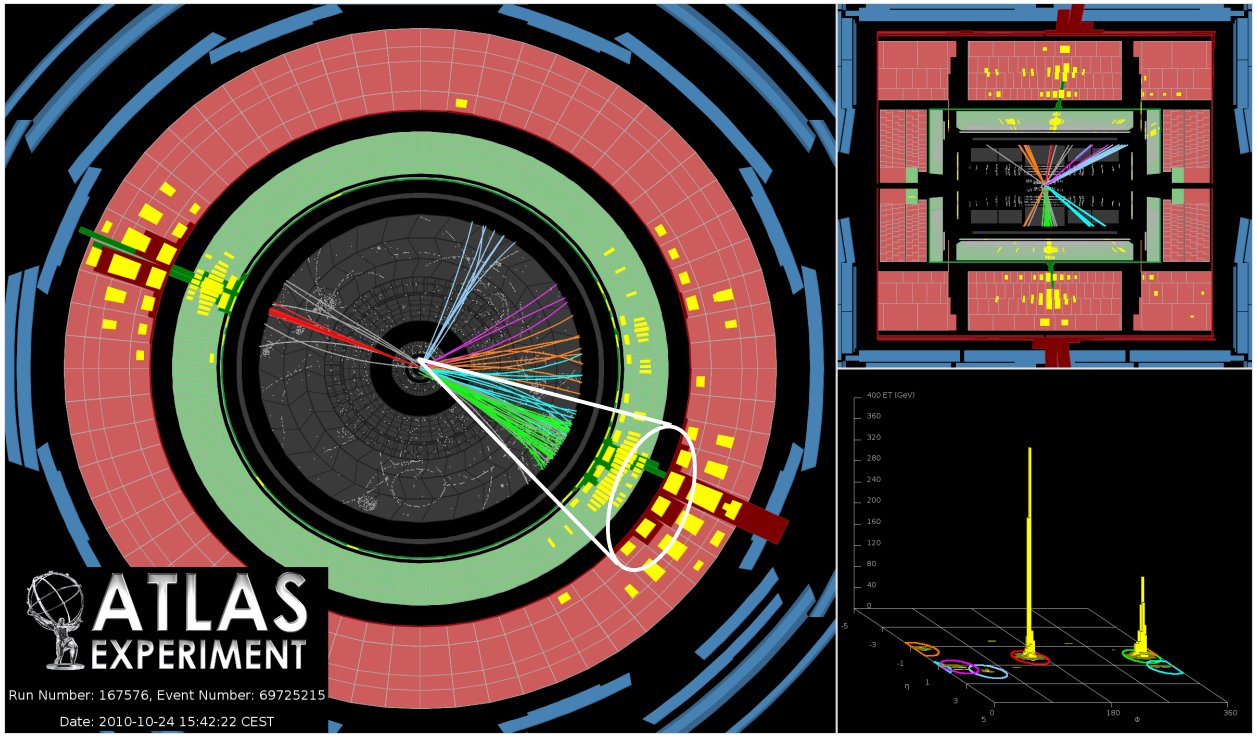
# Summay

- My thesis topic:  Search for MSSM bb h/A/H →ττ
- To improve the analysis trackjet (with b-tagging) are useful
- To be used trackjet needs Systematic evaluation

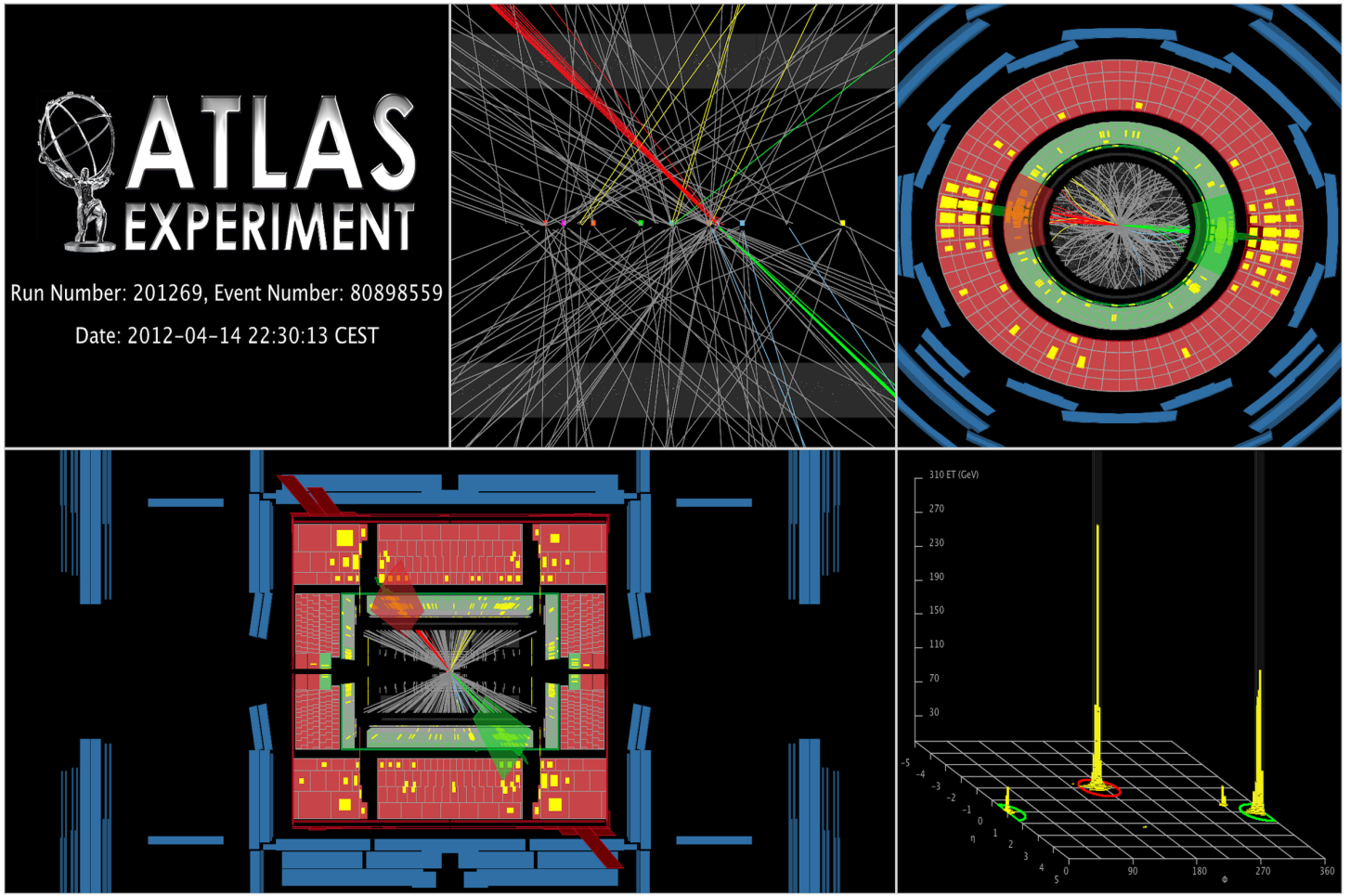
# Definition: Jet & Trackjet

- Jet definition should assure → collinear and infrared safety




- Jets are built merging 4-vector input in a cone of fixed size:
  - Calorimeter cell, Truth particle, Tracks → Trackjets

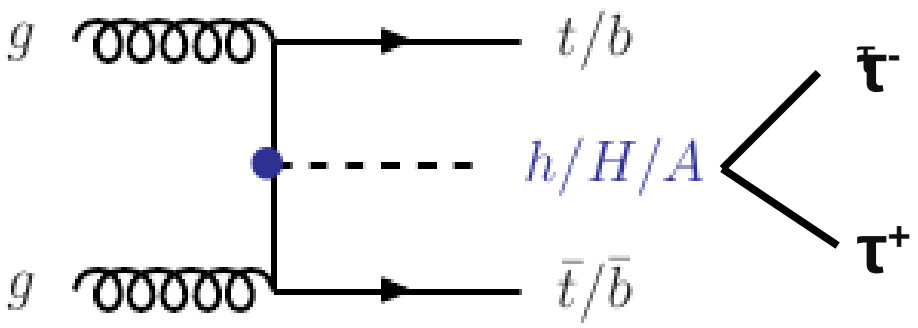
# Trackjets properties

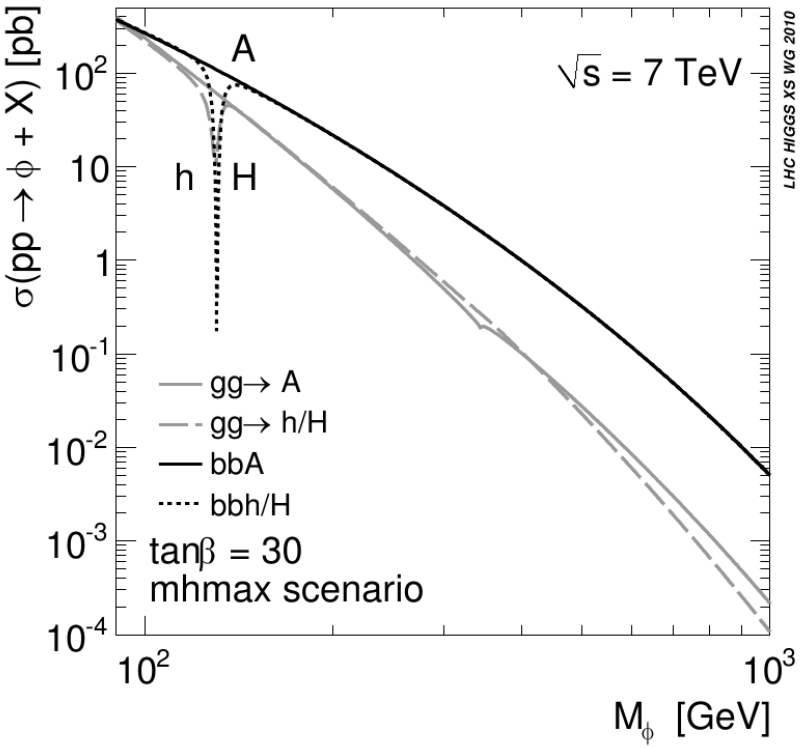



- Good: Trackjets are not affected from high pileup conditions
- Bad: loss of neutral part of the jet

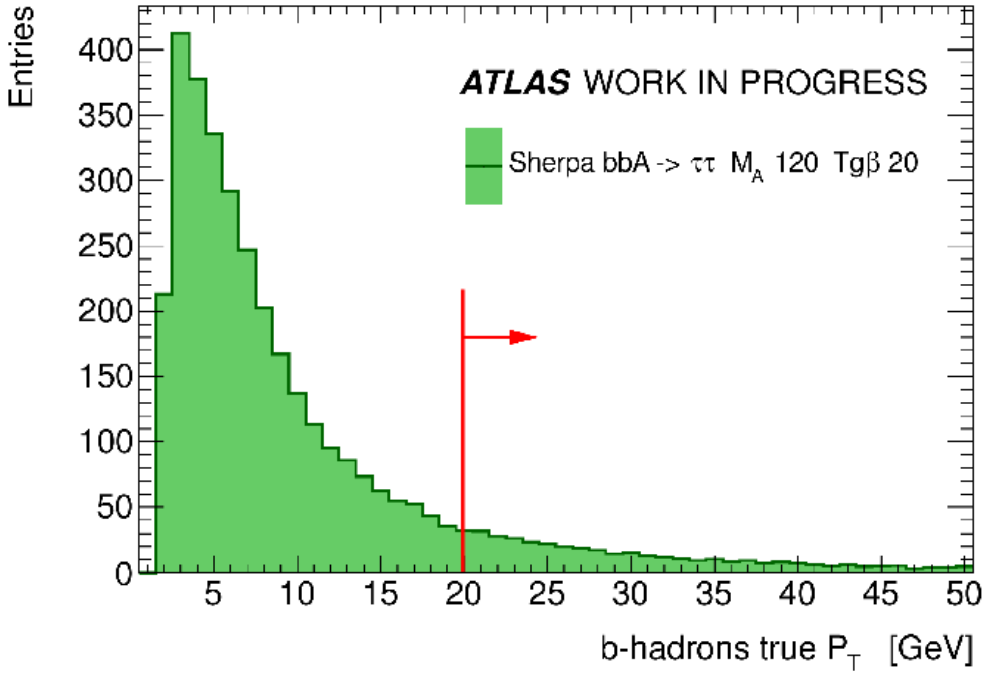
# Motivation for trackjet study: MSSM analysis

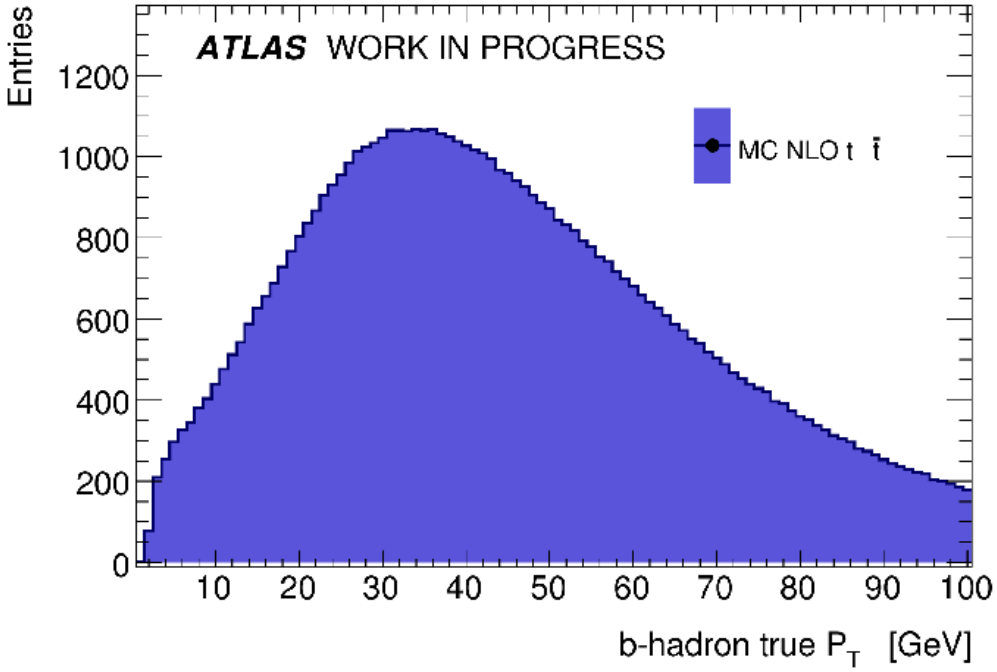
- Optimization of Neutral MSSM Higgs boson search in "associated b-quark production" channel
- Decay channel h/H/A → ττ
- Signature:
  - High energetic τ
  - Missing energy
  - b-jets



# Motivation for trackjet: analysis problem




- B-hadron in signal has low $P_T$ (transverse momentum)
- Calorimeter-Jet issue: due to ambient energy (pileup) → cut 20 GeV in $P_T$
- Trackjet → independent from pileup → can go lower in $P_T$ but.....

# Motivation: trackjets problems

- For Trackjets no systematic (Sys.) Uncertainty is provided
  - Cut on $P_T$ → Energy scale Sys. Is needed
- B-tagging @ low $P_T$ has low performance…

What actually experimentalist (ATLAS) means when they talk about Systematics Evaluation?

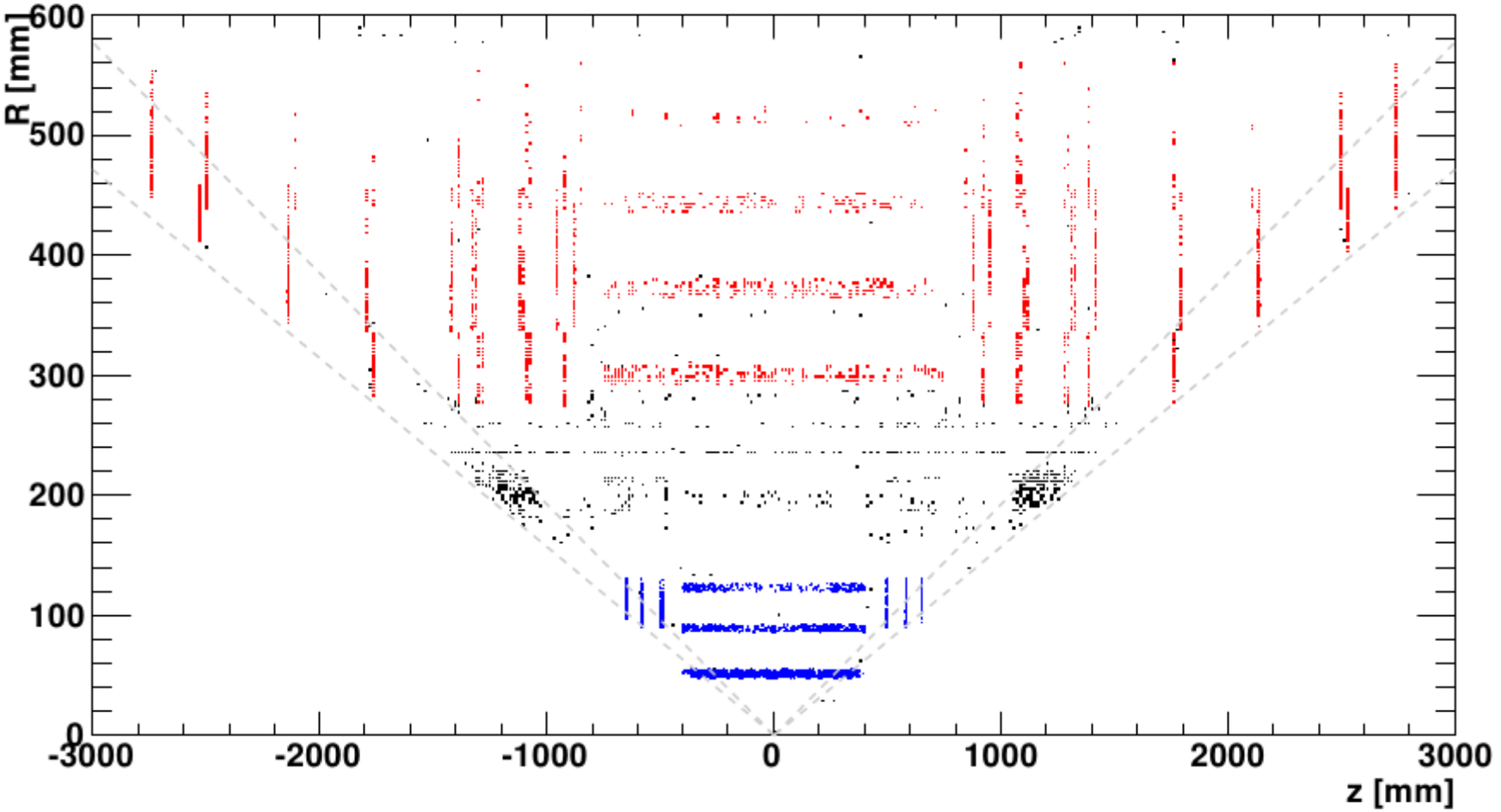
# Systematics evaluation

- ATLAS uses a very good MC simulation either at detector (GEANT) and generator level → simulation is heavily used
- Systematics = evaluation of data/MC discrepancy:
  - Detector mismodelling: wrong amount of material, alignment, ecc...
  - Physics model: PDF, underlying event, ecc...

# Concrete example: Trackjet energy scale Systematics

- MC physics model generator:
  - Details on fragmentation function, underlying event, color reconnection, Strange hadron probability
- Energy scale and resolution of single track (negligible)
- Tracking efficiency mismodelling: (dominant sys.)
  - Mainly due to material mismodeling
- Tracking in jet core: (maybe negligible)
  - Degradation of resolution because of hit overlap (well modeled)
  - Fake tracks, combining hits for several tracks (small effect)

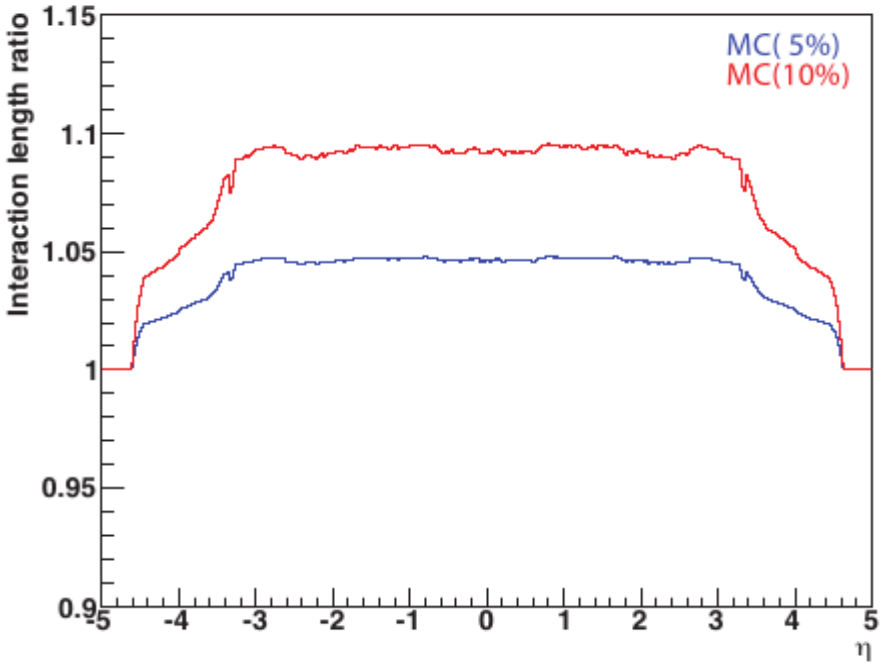
# Interaction with material

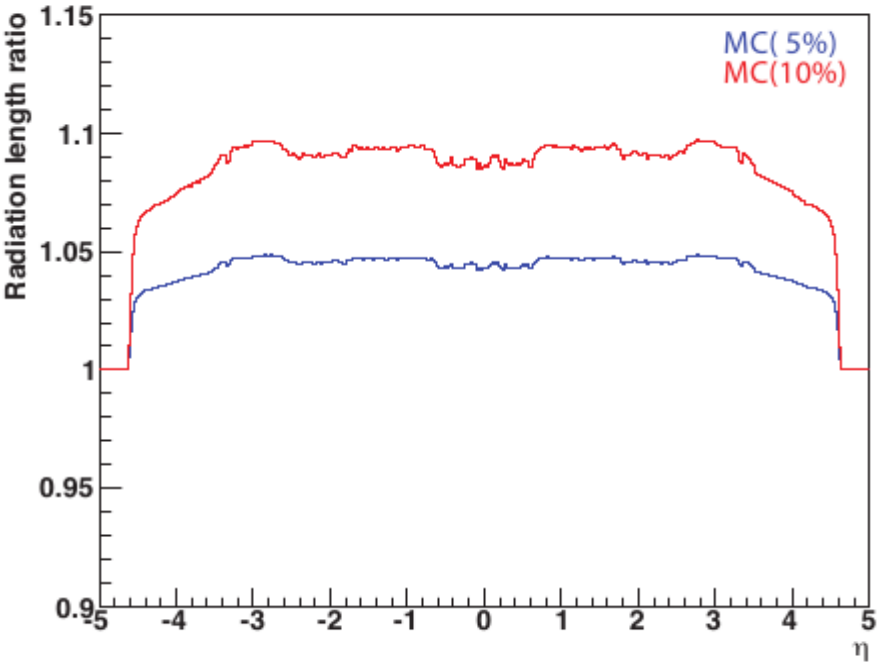



- Red = SCT hits; Blue = Pixel Hits; Black = particle interaction

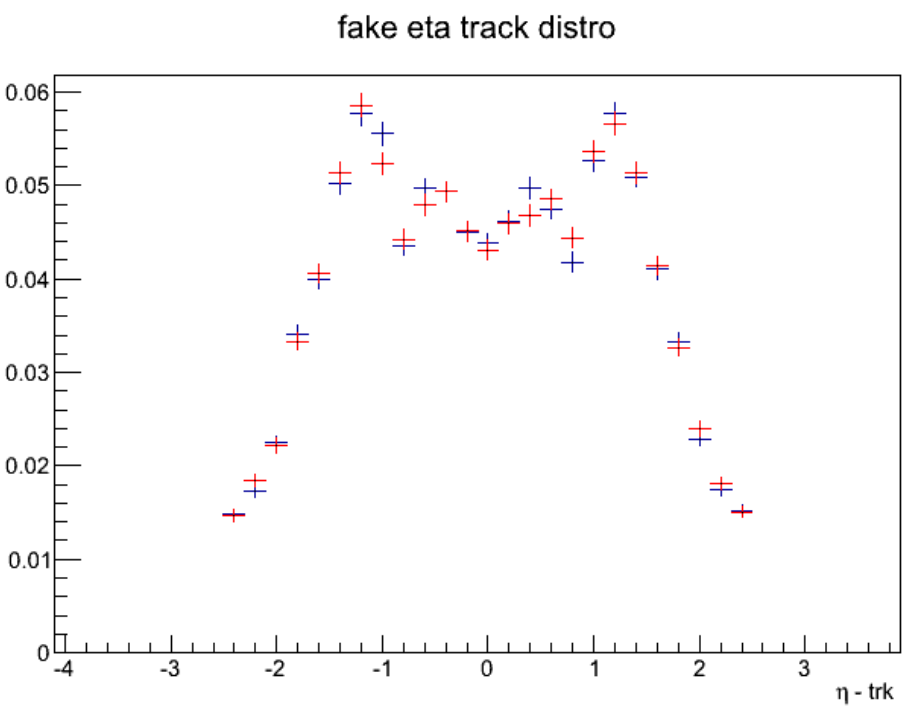
# Sys. Due to material mismodeling

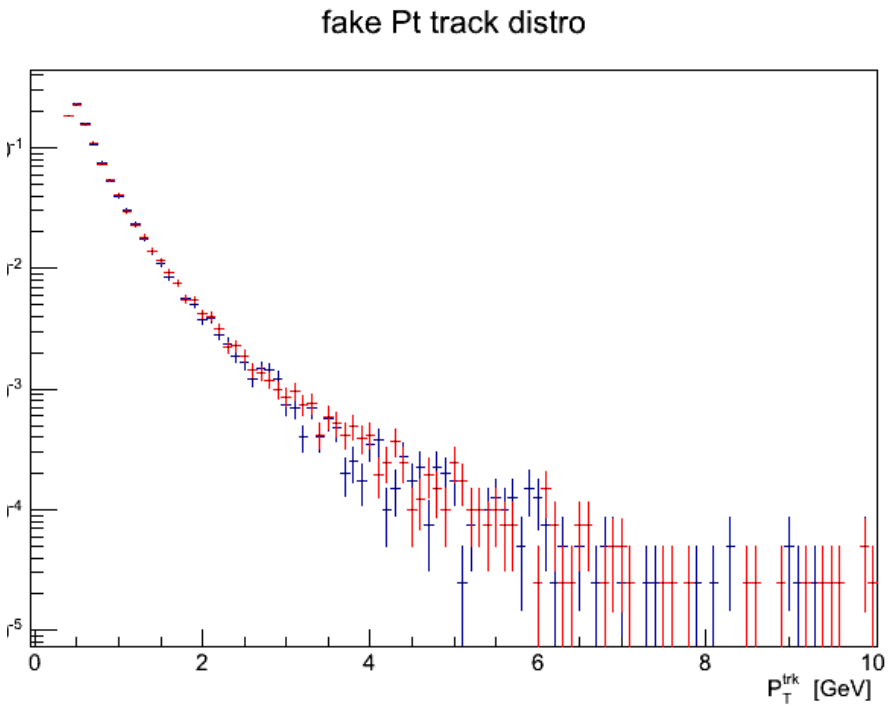
- Just take a MC sample with more/less material than the standard one
- Used sample with 10% more material



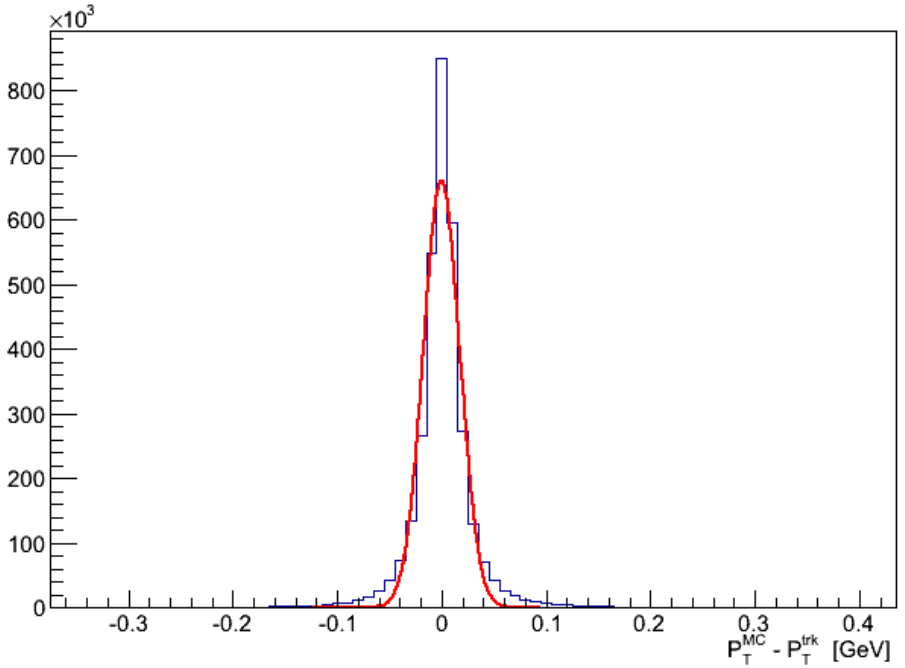
# Some kinematic comparison

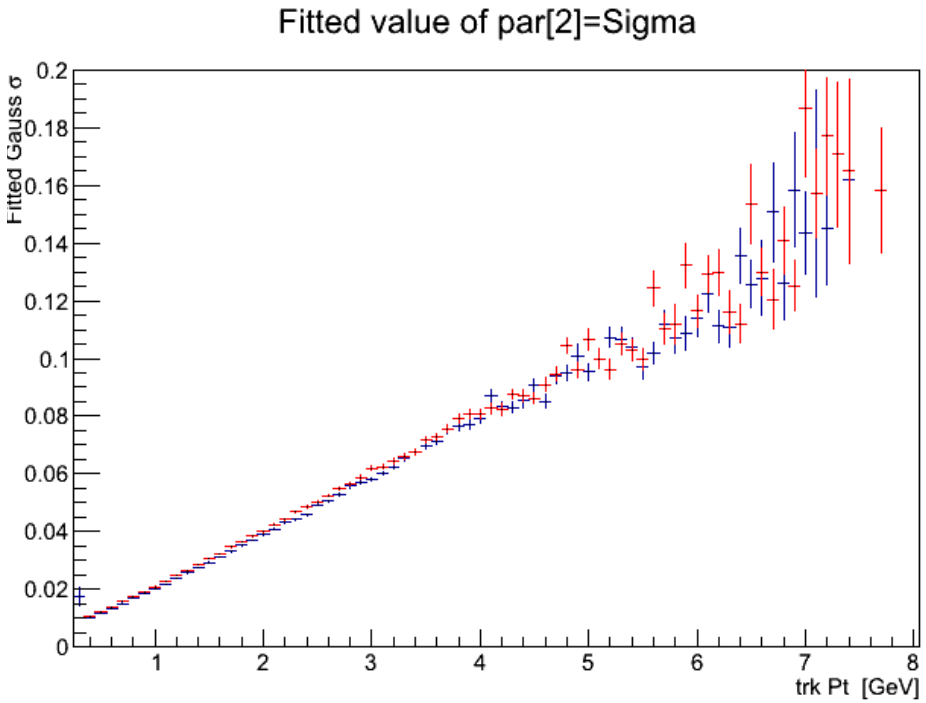



- Fake distributions for STD sample Blue and +10% sample red
- Nice agreement

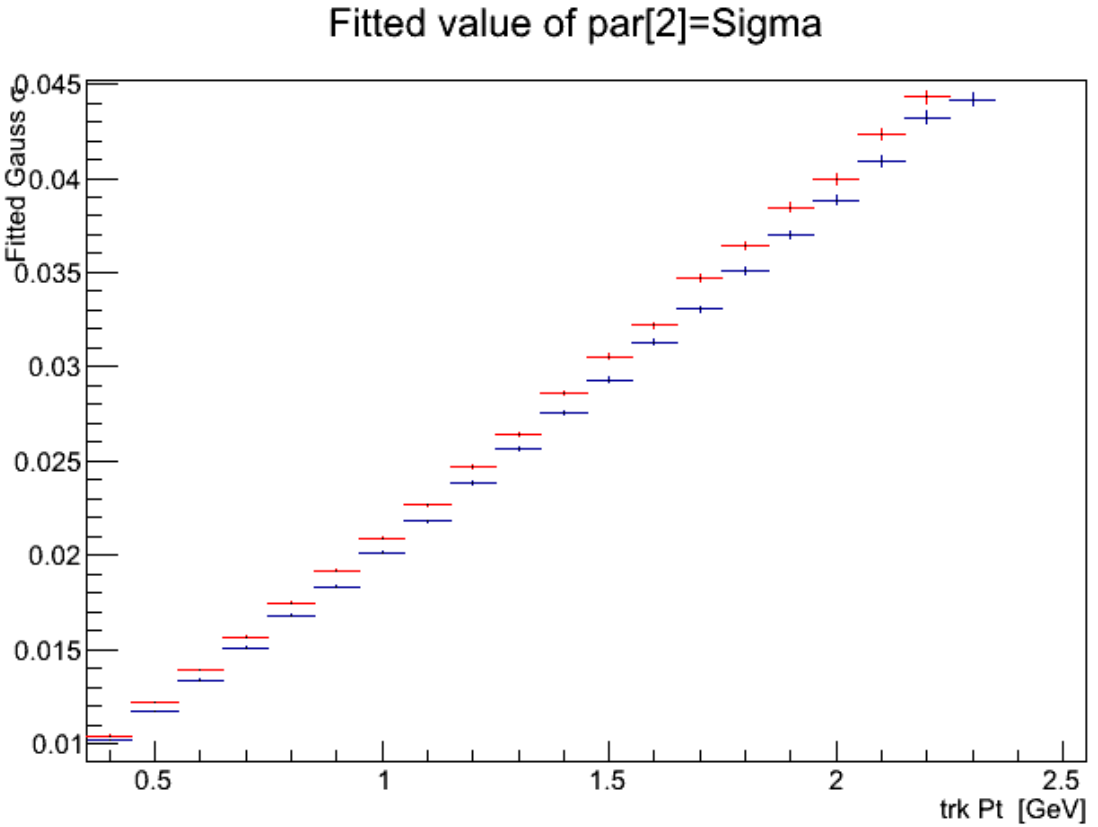
# Resolution comparison



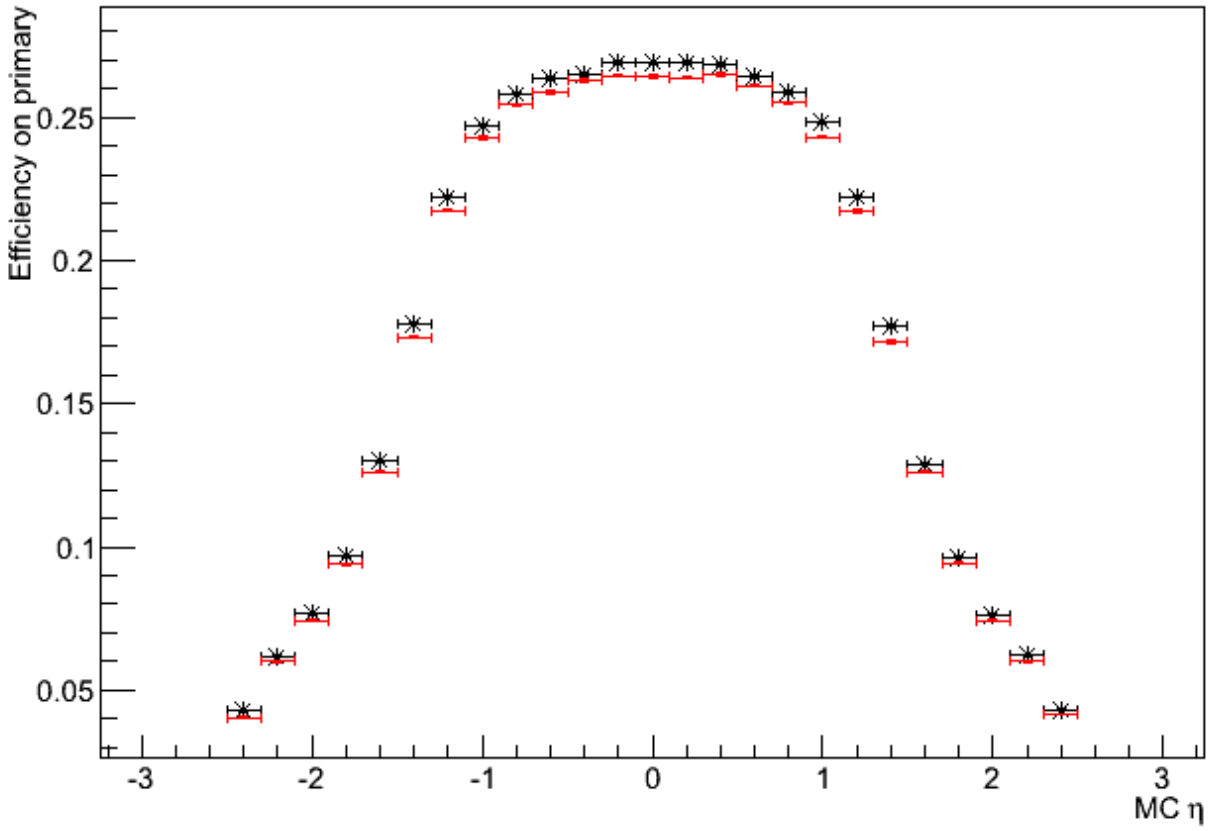

- Fitted Gauss (Pt_truth – Pt_trk) VS Pt_trk

# Resolution comparison



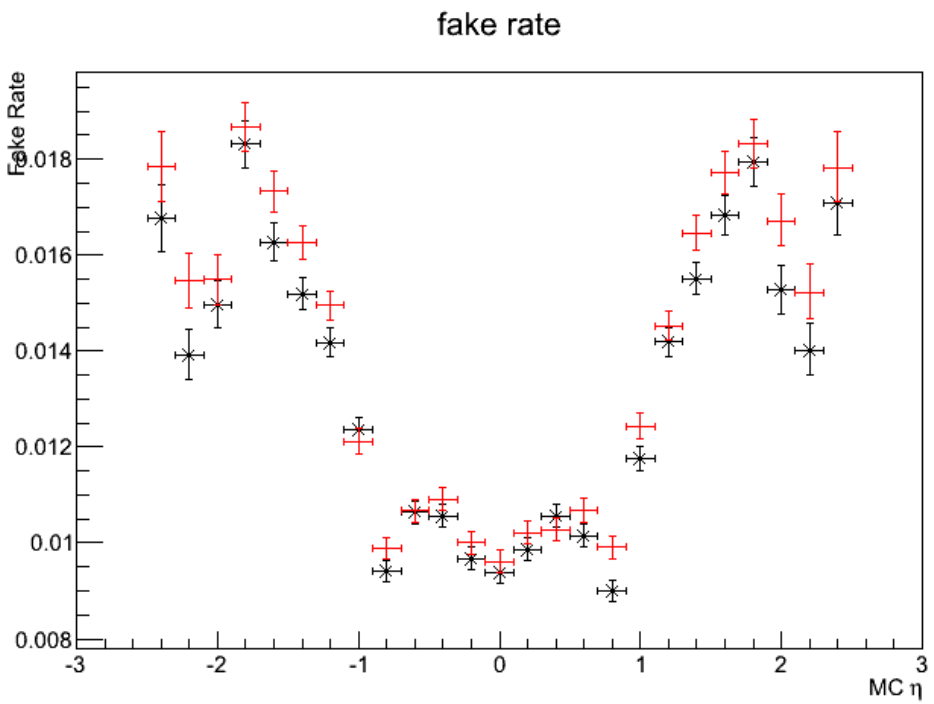

- If you zoom in +10% material sample tend to have higher sigma

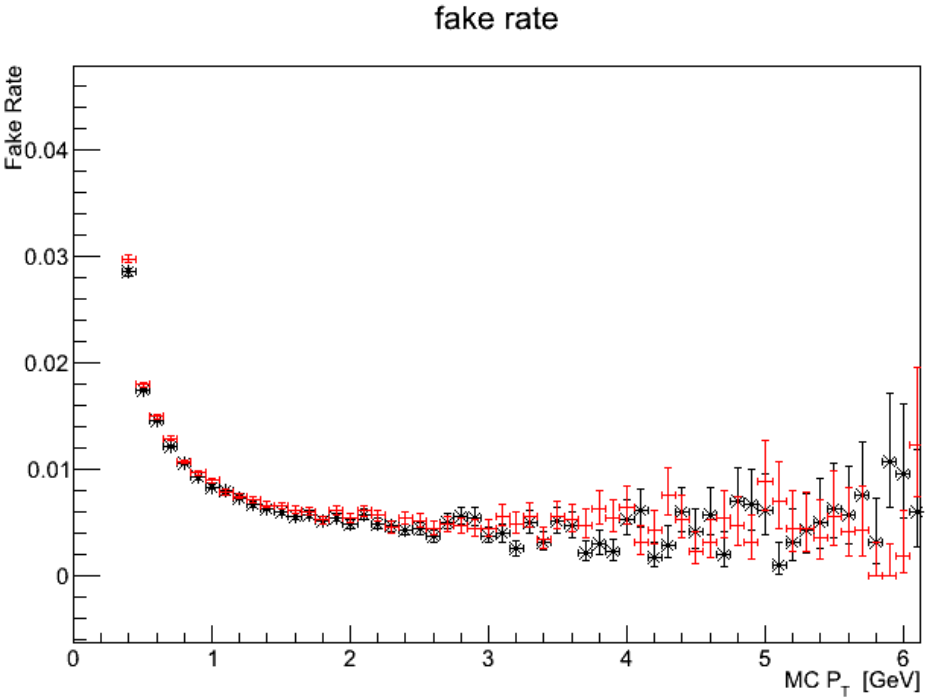
# Efficiency WRT primary




- STD has higher efficiency as expected

# Fake rate comparison



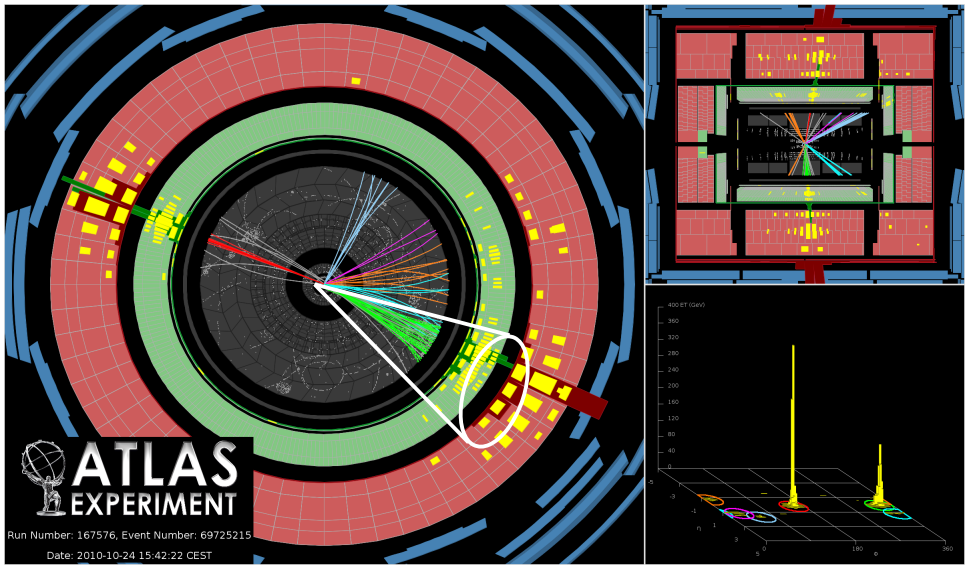




Black = STD

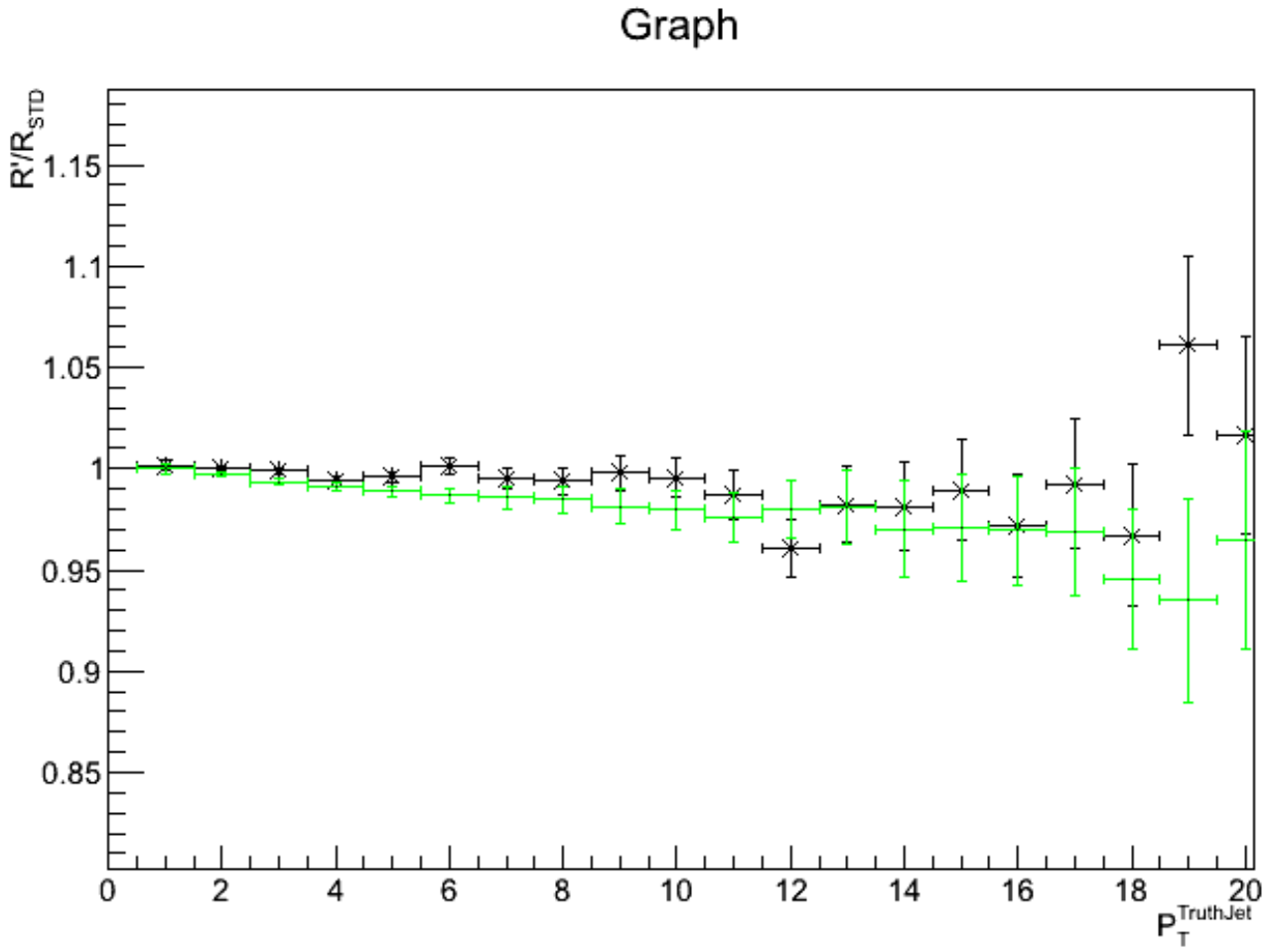
RED = 10% more material

# Sys. Due to material mismodeling

- Estimate ($P_T$ of $Jet_{+10\%}$ )/ ($P_T$ of $Jet_{standard}$) VS $P_T$
- For this you need an intermediate object → TruthJet
- Match with truthJet
- $R_i = P_T^{\,i} / P_T^{\,TruthJet}$
- $R_{+10\%} / R_{standard}$ → TruthJet independent

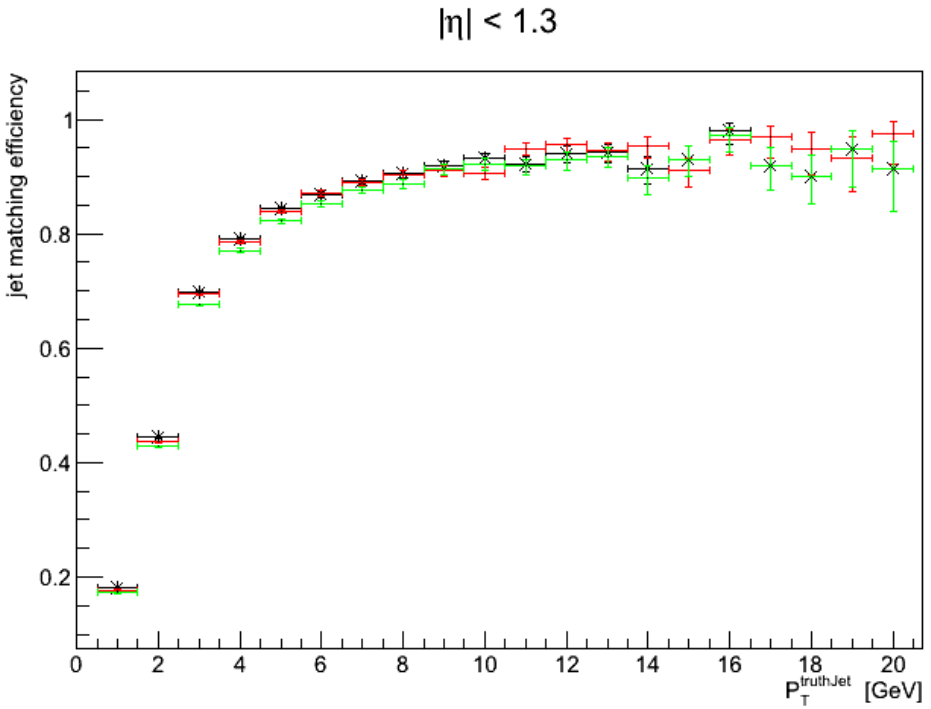


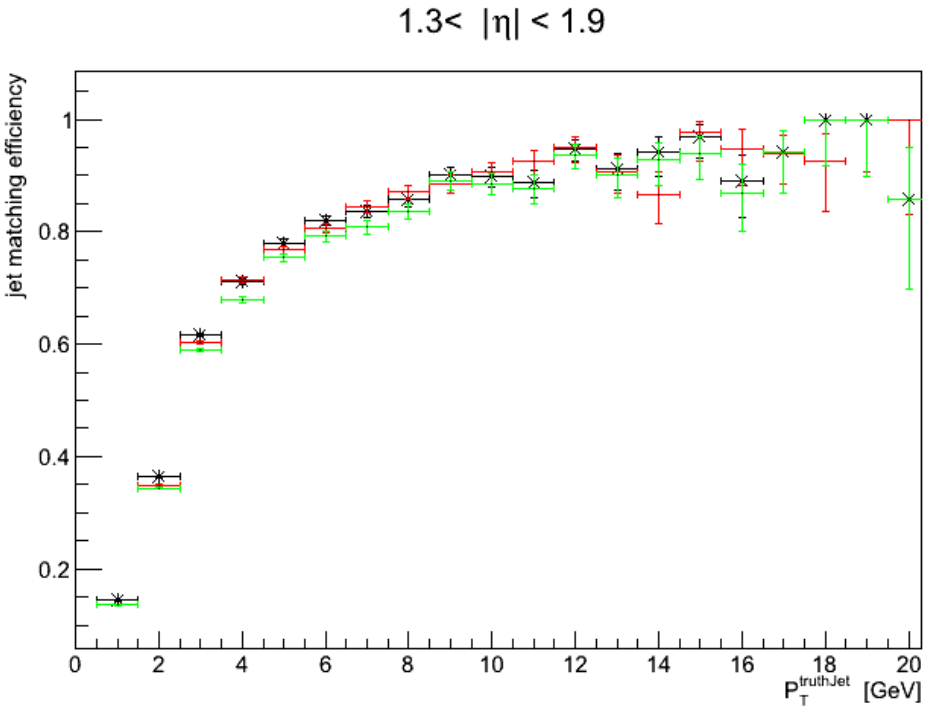
# Example of Sys. evaluation




- Look only at the black plot
- Little effect → track selections is very robust!

# Jet truth matching efficiency comparison



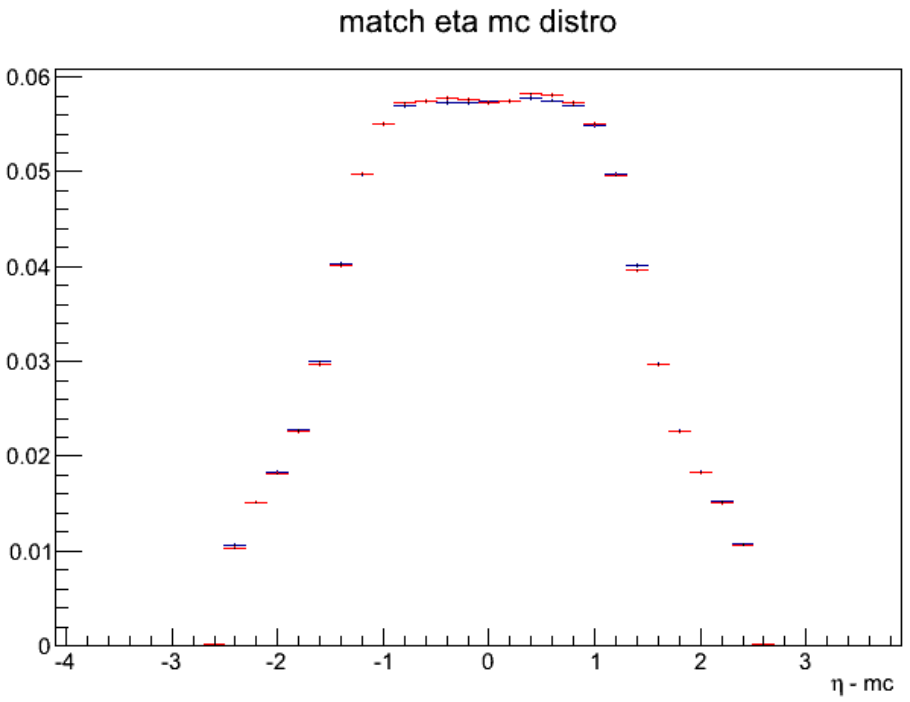

- Black: STD ; Red = +10%; Green = I'm not telling you

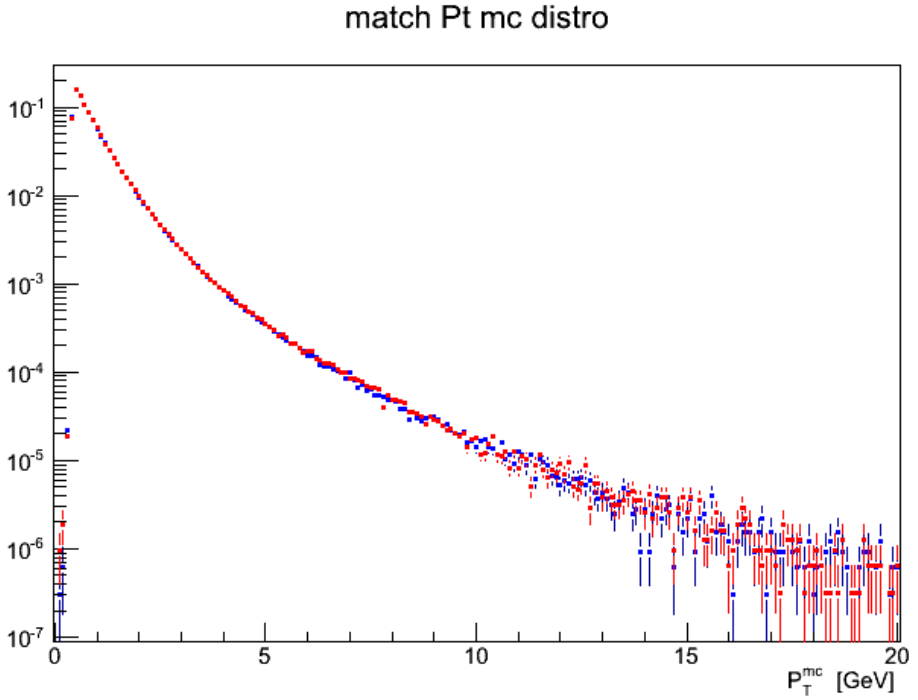
# Conclusion

- I presented a very simple example of systematic evaluation for trackjets (can't be used in practice...)
- Trackjets are very promising and could be used in many different analysis
- But the way is still long...

THANKS!

# Some kinematic comparison




- Matched distributions for STD sample Blue and +10% sample red
- Nice agreement

# backup