# Analysis Update
# PYTHIA + FastJet

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# Outline

# Cuts

- Extraction of $p_T$ from jets in pp collisions at $\sqrt{s} = 13$ TeV within 2 different regions of $\hat{p}_T$.
    1. $\hat{p}_{T_{\text{mín}}} = 30$ GeV/c and $\hat{p}_{T_{\text{máx}}} = 40$ GeV/c.
    2. $\hat{p}_{T_{\text{mín}}} = 120$ GeV/c and $\hat{p}_{T_{\text{máx}}} = 140$ GeV.

- Classification algorithm for the jets clustering: sequential recombination longitudinally anti-$k_t$ algorithm with jet radius $R = 0.5$ and $p_{T_{\text{mín}}} = 5$ GeV/c.

- **Classification algorithm for the background subtraction: sequential recombination longitudinally $k_t$ algorotihm with jets radius $R_{\textbf{bkg}} = 0.4$.**

- The analysis was made for 5 cases.

  1. For all hard QCD processes using MPI: off, ISR :off and FSR: off.
  2. For gg $\longrightarrow$ gg using MPI: off, ISR: off and FSR: off.
  3. For gg $\longrightarrow$ gg using MPI: on, ISR: off and FSR: off.
  4. For gg $\longrightarrow$ gg using MPI: on, ISR: on and FSR: off.
  5. For gg $\longrightarrow$ gg using MPI: on, ISR: on and FSR: on.

- **The `Pythia`'s particles were selected at $|\eta| < 2.4$ and $|\eta| < 5.0$. Analogously for the particles from the Background Subtraction.**

- Results were obteined using `Pythia 8.244` and `FastJet 3.3.4`.

Background subtraction ✗

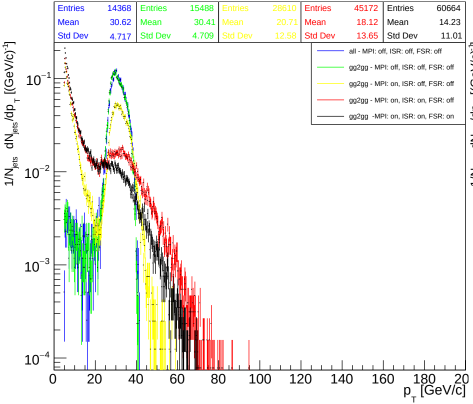


Figura: Jet $p_T$ distribution for pp collisions at $\sqrt{s} = 13$ TeV with $\hat{p}_{T_{\text{mín}}} = 30$ GeV/c and $\hat{p}_{T_{\text{máx}}} = 40$ GeV/c.

Background subtraction ✓

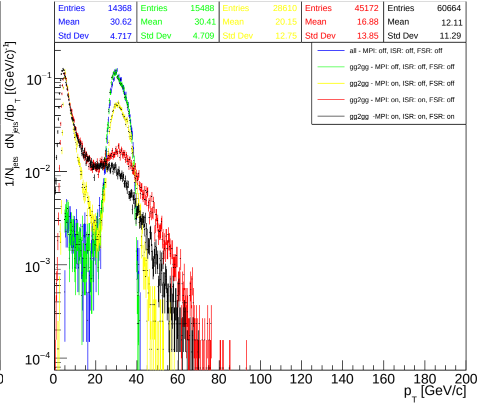


Figura: Jet $p_T$ distribution for pp collisions at $\sqrt{s} = 13$ TeV with $\hat{p}_{T_{\text{mín}}} = 30$ GeV/c and $\hat{p}_{T_{\text{máx}}} = 40$ GeV/c.

Background subtraction ✗

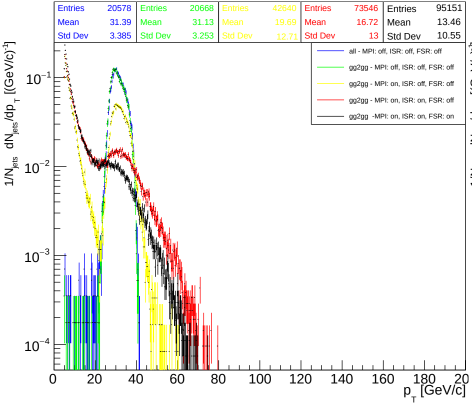


Figura: Jet $p_T$ distribution for pp collisions at $\sqrt{s} = 13$ TeV with $\hat{p}_{T_{\text{mín}}} = 120$ GeV/c and $\hat{p}_{T_{\text{máx}}} = 140$ GeV/c.

Background subtraction ✓

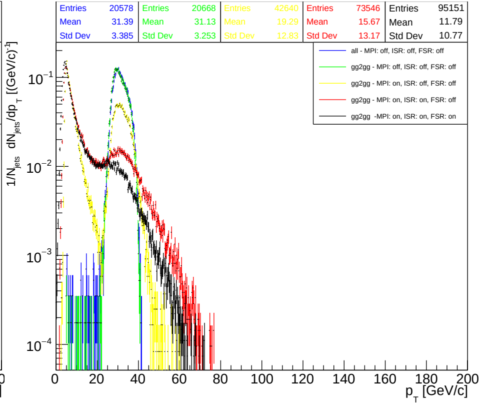


Figura: Jet $p_T$ distribution for pp collisions at $\sqrt{s} = 13$ TeV with $\hat{p}_{T_{\text{mín}}} = 120$ GeV/c and $\hat{p}_{T_{\text{máx}}} = 140$ GeV/c.

# Results using $|\eta| < 2.4$ for $120$ GeV/c $< \hat{p}_T < 140$ GeV/c

Background subtraction ✗

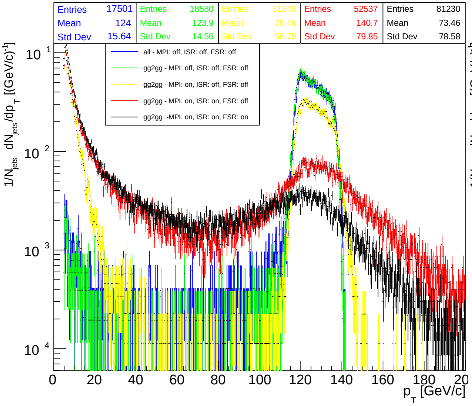


Figura: Jet $p_T$ distribution for pp collisions at $\sqrt{s} = 13$ TeV with $\hat{p}_{T_{\text{mín}}} = 120$ GeV/c and $\hat{p}_{T_{\text{máx}}} = 140$ GeV/c.

Background subtraction ✓

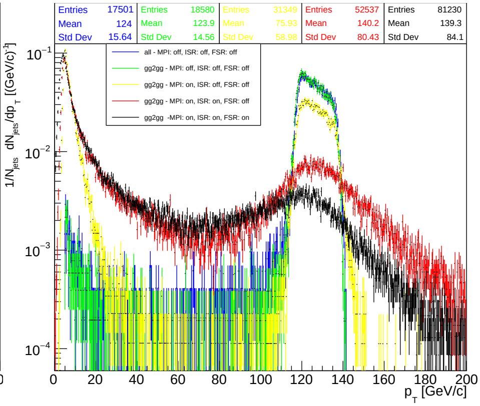


Figura: Jet $p_T$ distribution for pp collisions at $\sqrt{s} = 13$ TeV with $\hat{p}_{T_{\text{mín}}} = 120$ GeV/c and $\hat{p}_{T_{\text{máx}}} = 140$ GeV/c.

# Results using $|\eta| < 5.0$ for $120$ GeV/c $< \hat{p}_T < 140$ GeV/c

Background subtraction ✗

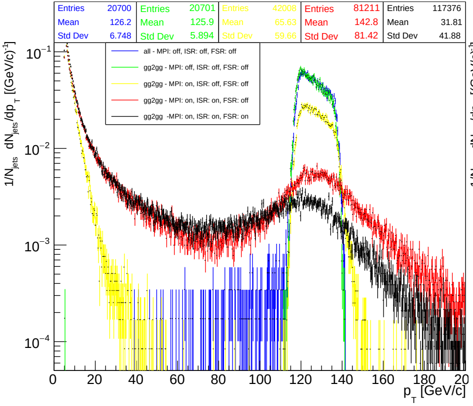


**Figura:** Jet $p_T$ distribution for pp collisions at $\sqrt{s} = 13$ TeV with $\hat{p}_{T_{\text{mín}}} = 120$ GeV/c and $\hat{p}_{T_{\text{máx}}} = 140$ GeV/c.

Background subtraction ✓

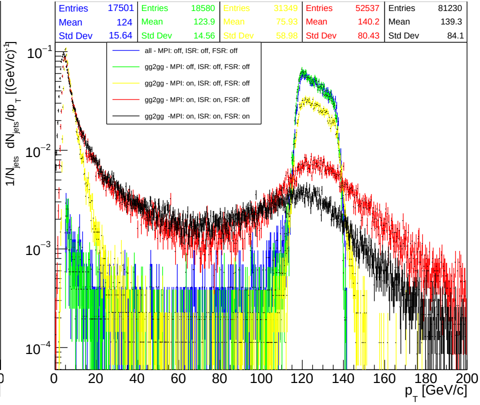


**Figura:** Jet $p_T$ distribution for pp collisions at $\sqrt{s} = 13$ TeV with $\hat{p}_{T_{\text{mín}}} = 120$ GeV/c and $\hat{p}_{T_{\text{máx}}} = 140$ GeV/c.

# On the way

- Exploring another clustering algorithms for the subtraction.
- Exploring another regions of $\eta$ for the selection.
- Checking how is the particle density from the brackground (the so called $\rho$ parameter given by the class `JetMedianBackgroundEstimator.hh`.)
- Reading about storing information using the `ROOT` class `TTrees.h`.

# Summary

1. Compilation of ROOT + Pythia8 + FastJet (Makefile issue solved). ✓
2. Phase space cuts and hard QCD processes conditions were correctly established in Pythia. ✓
3. Jet classification and $p_T$ extraction using FastJet clustering algorithms. ✓
4. Background subtraction using FastJet algorithm. ✓

# References


- FastJet 3.2.2 Online Manual.
  https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwj4or-dgNLuAhUEUKwKHdApAqkQFjAMegQIAxAC&url=http%3A%2F%2Ffastjet.fr%2Frepo%2Ffastjet-doc-3.2.2.pdf&usg=AOvVaw0UYAX7jNWy-OsbTw0yT1LR.

# BackUp: Background Subtraction Algorithm

- // State $R$, $R_{bkg}$, $\eta$, $p_{T_{\text{mín}}}$ and ghost_maxrap
- `// Create JetDef & AreaDef for the jet clustering`
- `JetDefinition jet_def(antikt_algorithm, R);`
- `GhostedAreaSpec area_spec(ghost_maxrap);`
- `AreaDefinition area_def(active_area, area_spec);`
- `// Create JetDef & AreaDef for the background clustering`
- `JetDefinition jet_def_bkgd(kt_algorithm, R_bkg);`
- `AreaDefinition area_def_bkgd(active_area_explicit_ghosts, GhostedAreaSpec(ghost_maxrap));`
- `// Create an estimator for the bkg sub`
- `Selector selector = SelectorAbsRapMax(ghost_maxrap);`
- `JetMedianBackgroundEstimator bkgd_estimator(selector, jet_def_bkgd, area_def_bkgd);`
- `Subtractor subtractor(&bkgd_estimator);`
- `for loop to investigate the pythia events`
- `vector<PseudoJet> particles;`
- `for loop to select particles in each pythia event (via` $\eta$`)`
- `// Run the clustering and apply the subtractor`
- `ClusterSequenceArea cs(particles, jet_def, area_def);`
- `vector<PseudoJet> jets = sorted_by_pt(cs.inclusive_jets( ptmin ));`
- `bkgd_estimator.set_particles(particles);`
- `vector<PseudoJet> subtracted_jets = subtractor(jets);`
- `// Fill the histograms and clear the vectors for the next iteration`