PB TMDs with CASCADE – Exercises 3

- Why $\Delta\phi$ in high p_T dijets ?
- Part 3
  - Effects of TMD and parton shower
  - Uncertainties in calculation
  - On-shell or off-shell matrix elements for hard process
  - Comparison with other approaches: Pythia8 parton shower

  - merging

Goals

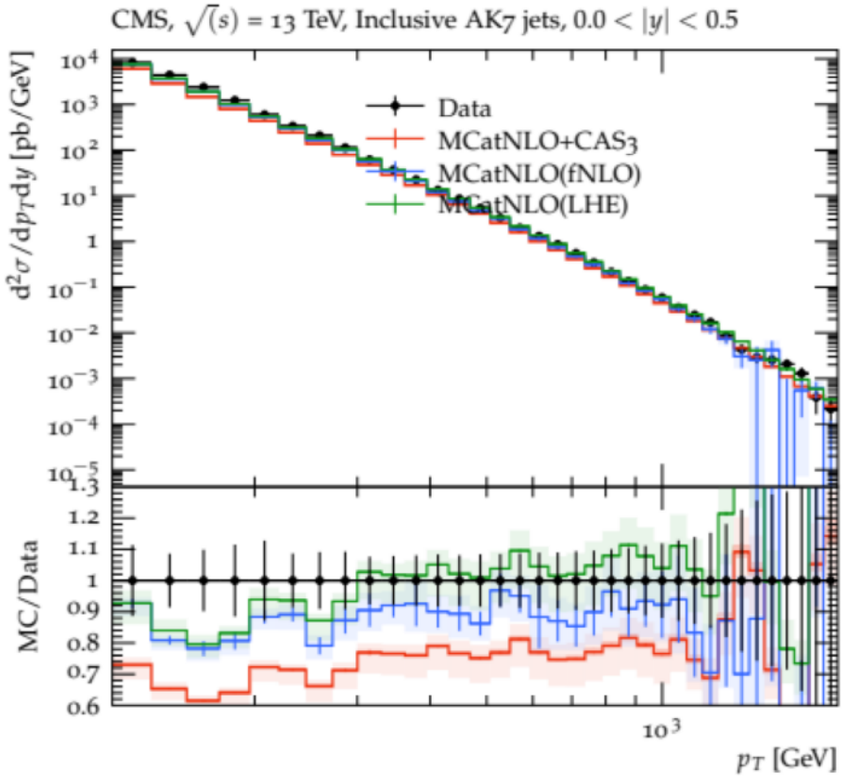
- we will have a presentation of the results of this MC school at the REF 2021 workshop next week:

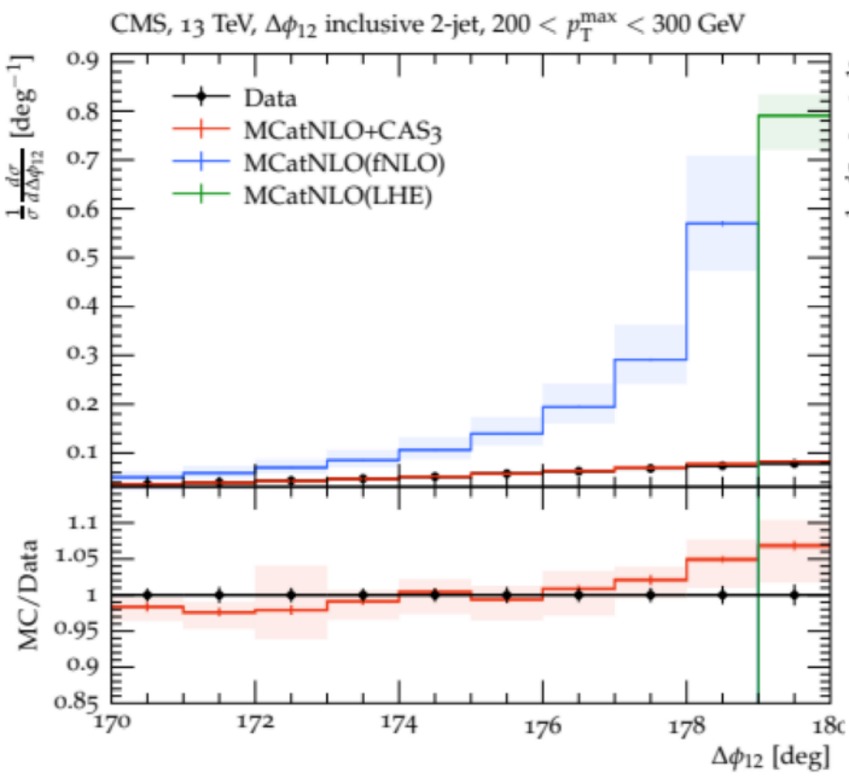
  - **Thursday 18. Nov at 17:00**: Azimuthal correlations in high pt dijet events with PB TMDs
    - Armando will give the summary.

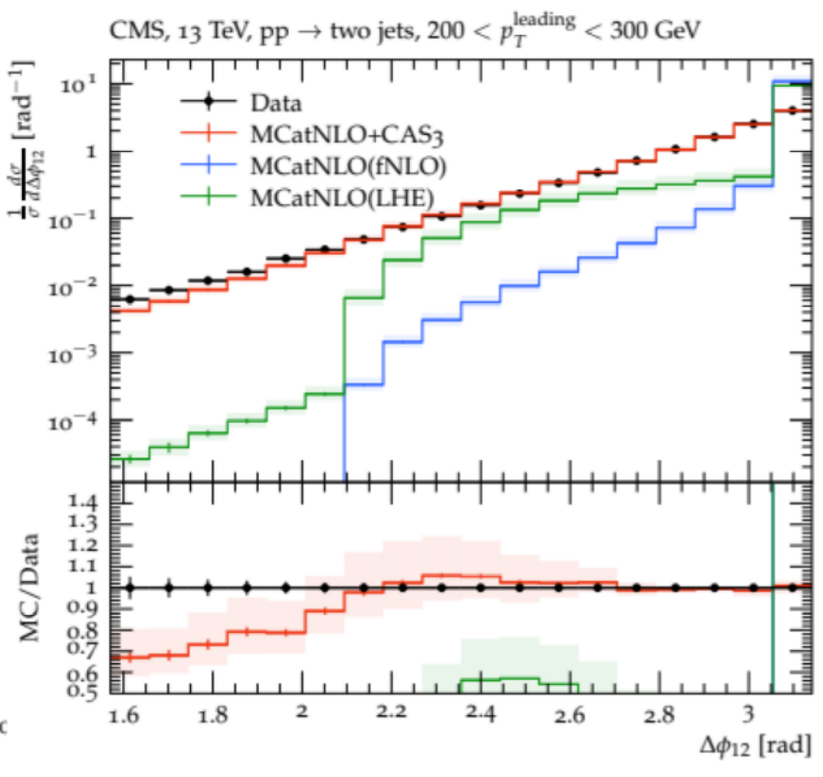
  - with the results of this presentation, we will prepare a **journal publication**, with co-authors everyone from the MC school, who is interested.
    - time scale: 4 weeks (at least before end of 2021)

Analysis Program - dijets at high pt

- Measurement of the inclusive jet cross-section at13TeV (CMS_2016_I1459051)
- Azimuthal separation in nearly back-to-back jet topologies in inclusive 2- and 3-jet events in pp collisions at 13 TeV (CMS_2019_I1719955)
- Azimuthal correlations for inclusive 2-jet, 3-jet, and 4-jet events in pp collisions at 13 TeV (CMS_2018_I1643640)

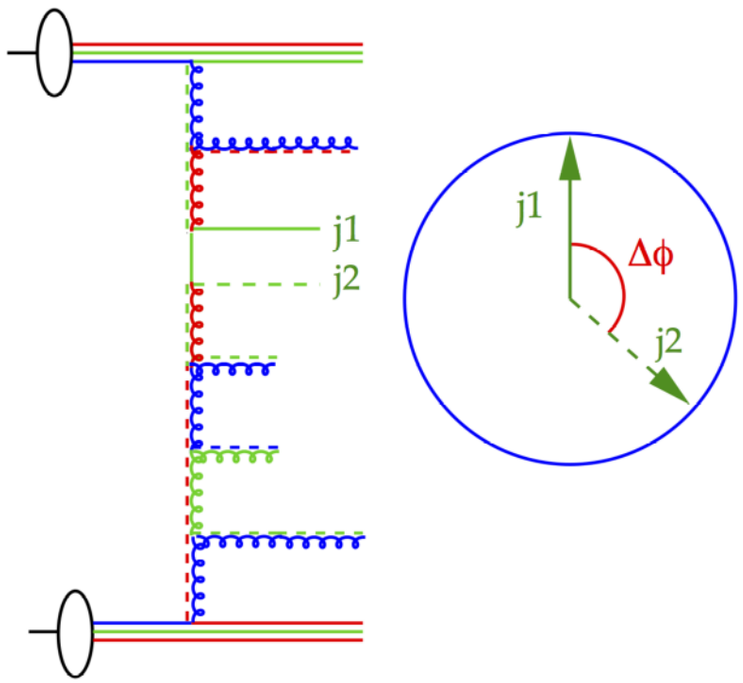


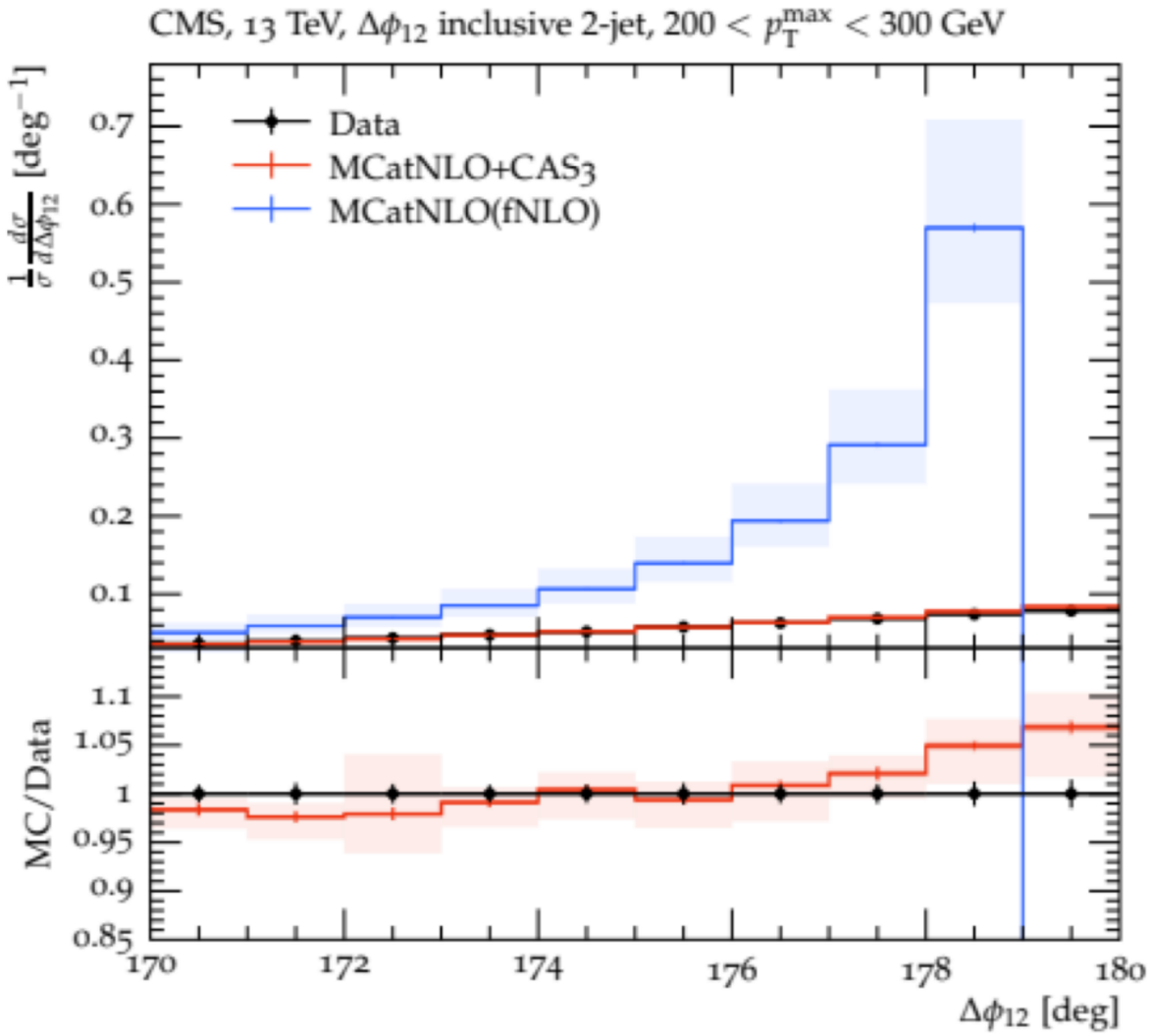




Why di-jets at high p_T - why TMDs ?

- Measurements with $p_T > 200$ GeV
  - at least 2 jets

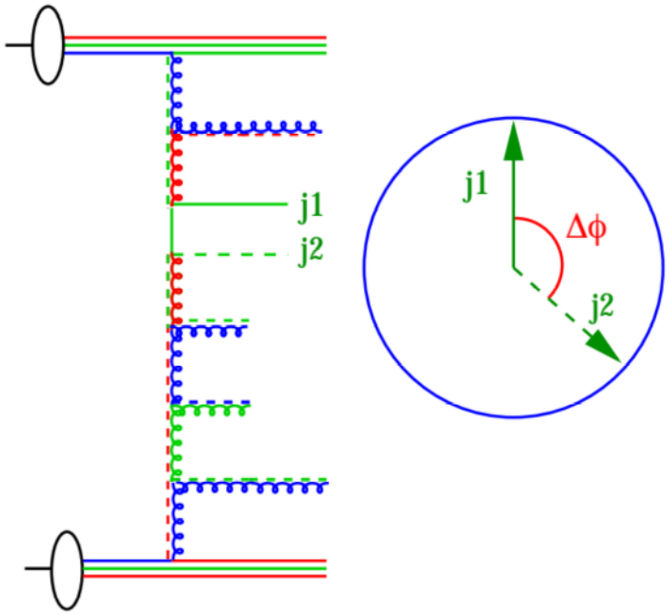




- MCatNLO-dijet + TMD + TMD shower gives a goos description of large $\Delta\phi$
- MCatNLO (fNLO)-dijet is not appropriate for this observable

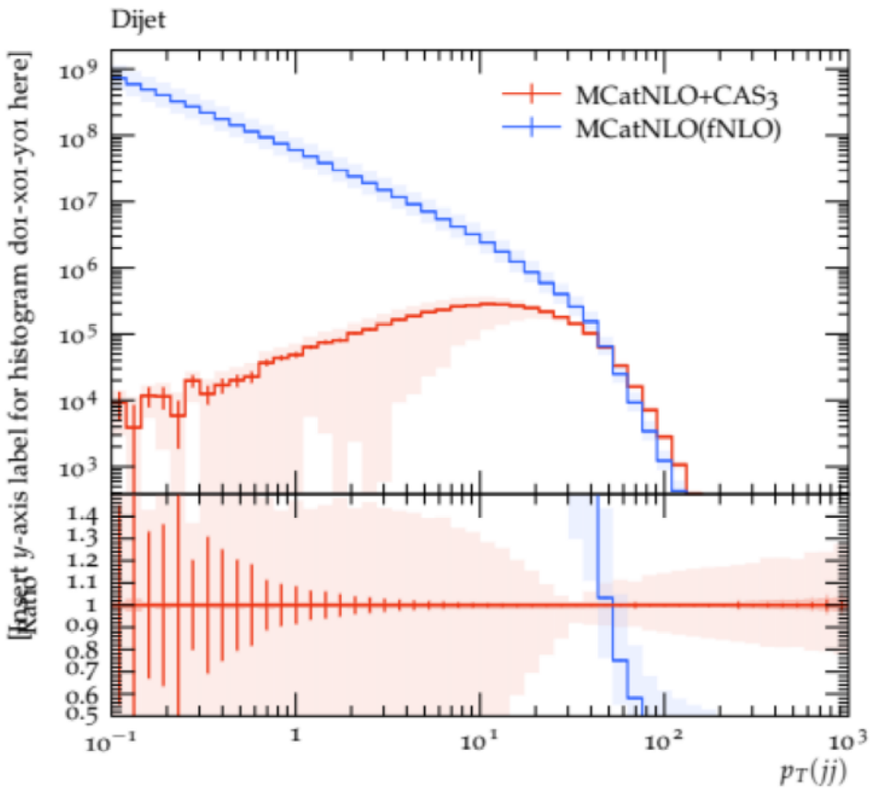
Why back-to-back region is important ?

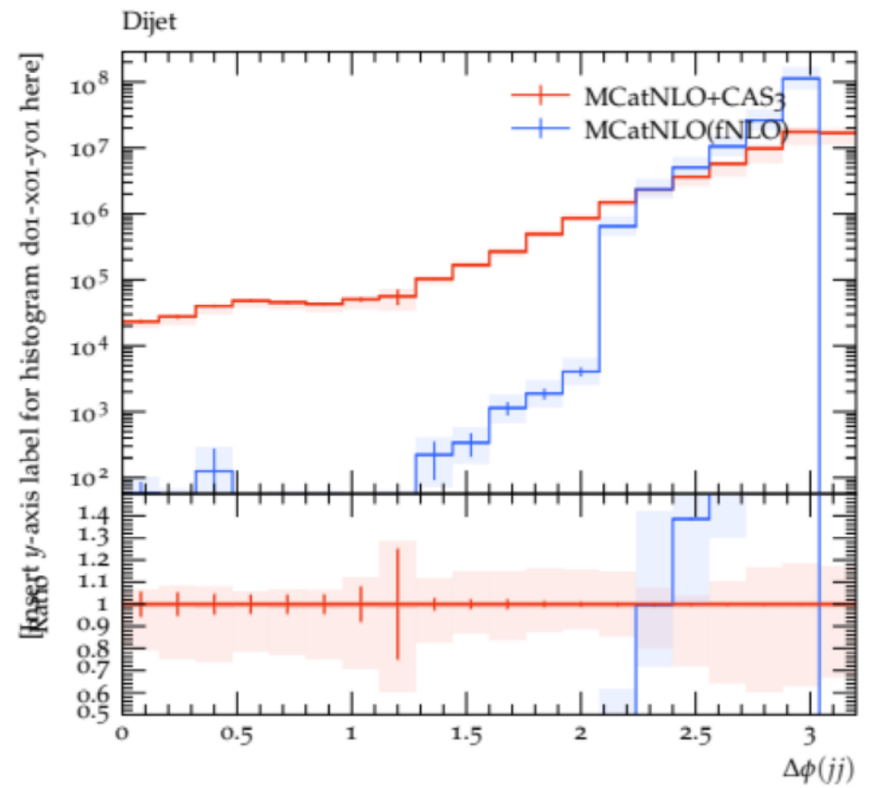
- Look at p_T of di-jet system:



- Experimentally p_T is more difficult:
  - interesting effect at p_T < 10 GeV
  - easier is $\Delta\phi$

- in QCD, there are always soft gluons:
  - probability to have no soft gluon: → 0
  - x-section for $\Delta\phi \rightarrow \pi$ (or p_T(jj) → 0) vanishes



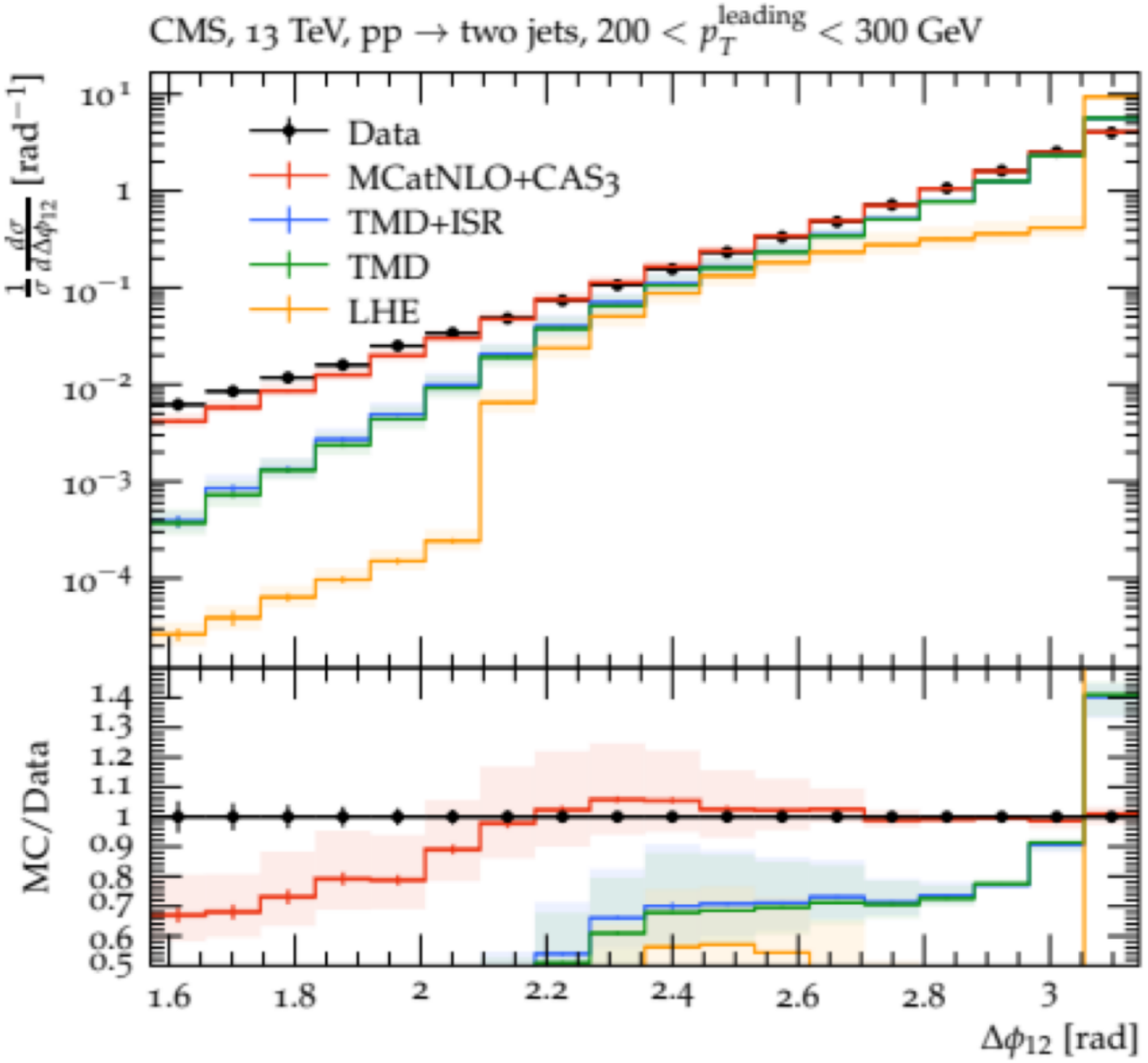


Program for today – the global picture

- Effects of TMD and parton shower
- Uncertainties in calculation
- On-shell or off-shell matrix elements for hard process
- Comparison with other approaches: Pythia8 parton shower
- multijet merging

Effects of TMD and parton shower

- Study effect of
  - TMD,
  - initial state TMD shower
  - final state parton shower



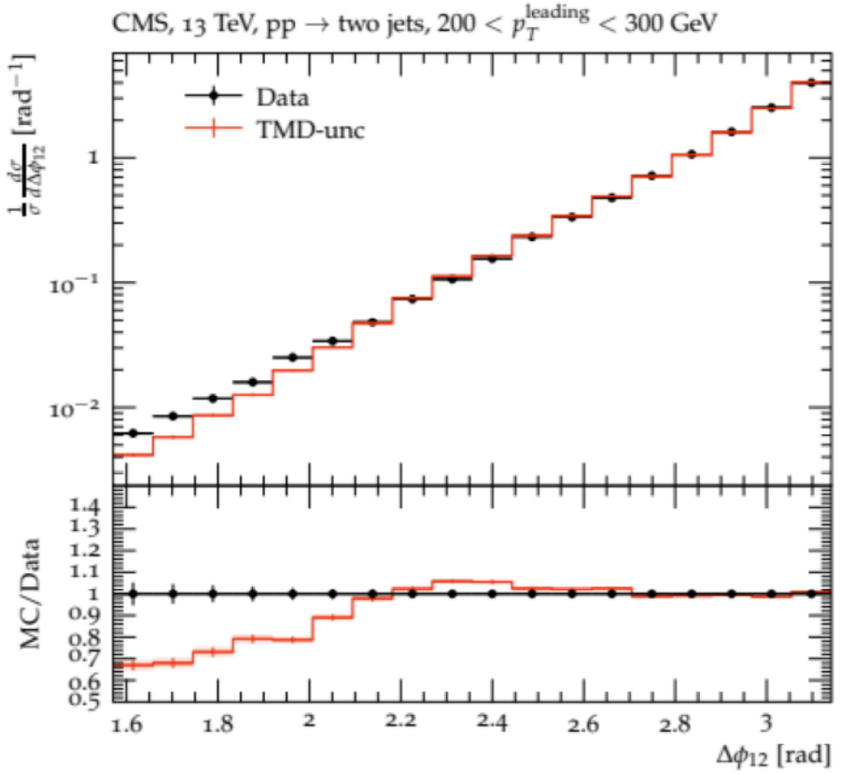
- switch parameters in submission script:

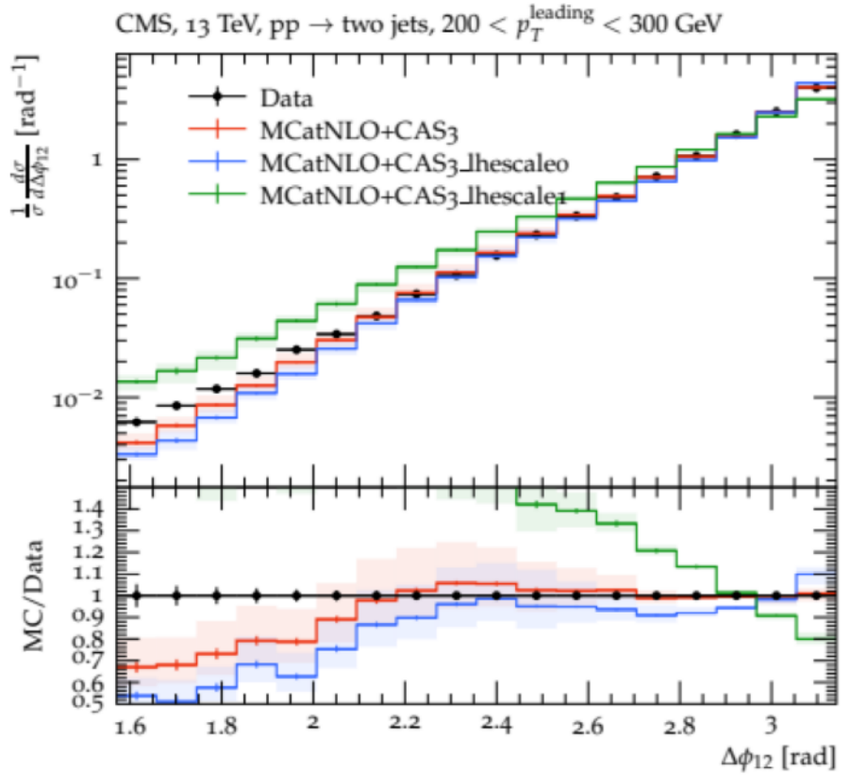
```
SpaceShower = 0/1
TimeShower = 0/1
lheHasOnShellPartons = 0/1
```

- TMD is very important in back-to-back region as well as in small $\Delta\phi$
- ISR does not play a bit role → why ?
- FSR plays a role at small $\Delta\phi$

Uncertainties in calculation

- Scale variation by default: μ_R , μ_F varied by factor of 2 up and down within aMCatNLO LHE calculation
- TMD uncertainty estimated by running CASCADE (look at README-TMDunc)
- further uncertainty from scale in TMD: $x\,A(z,k_T,\mu)$ where scale μ_F is defined as:
  - `lhescale=0`: SCALUP
  - `lhescale=1`: s_hat
  - `lhescale=2(default)`: $H_T = 1/2 \sum p_{Ti}$
- BUT note, H_T is used in LHE calc, so it should be consistently used also for $x\,A(z,k_T,\mu)$



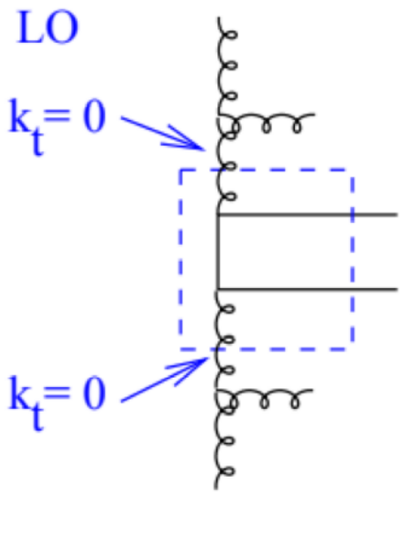


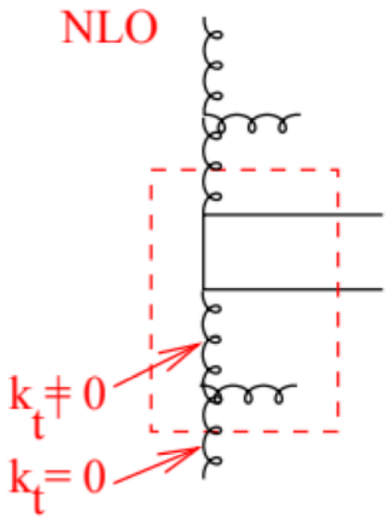
On-shell or off-shell matrix elements for hard process

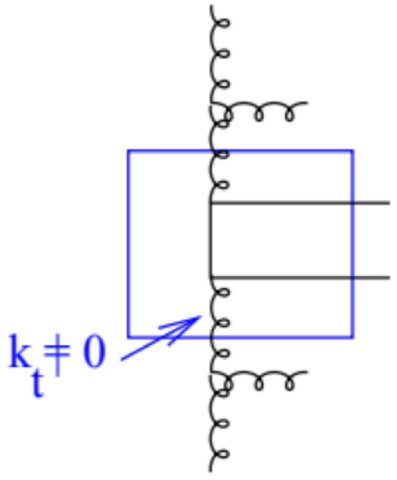
- Is there a difference using collinear NLO or off-shell LO matrix elements

  `lheHasOnShellPartons = 0`

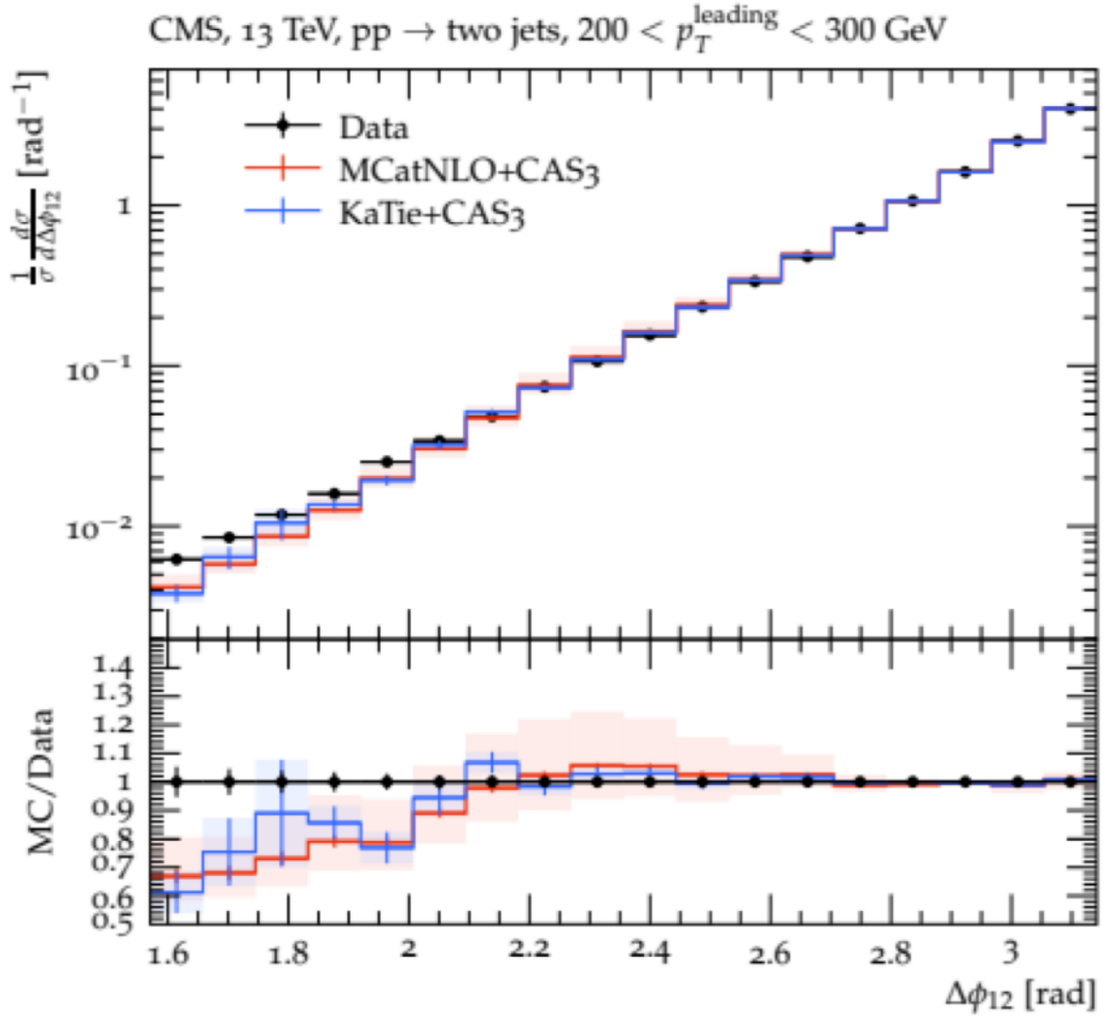
  - KaTie is used to generate LHE files







high energy factorization

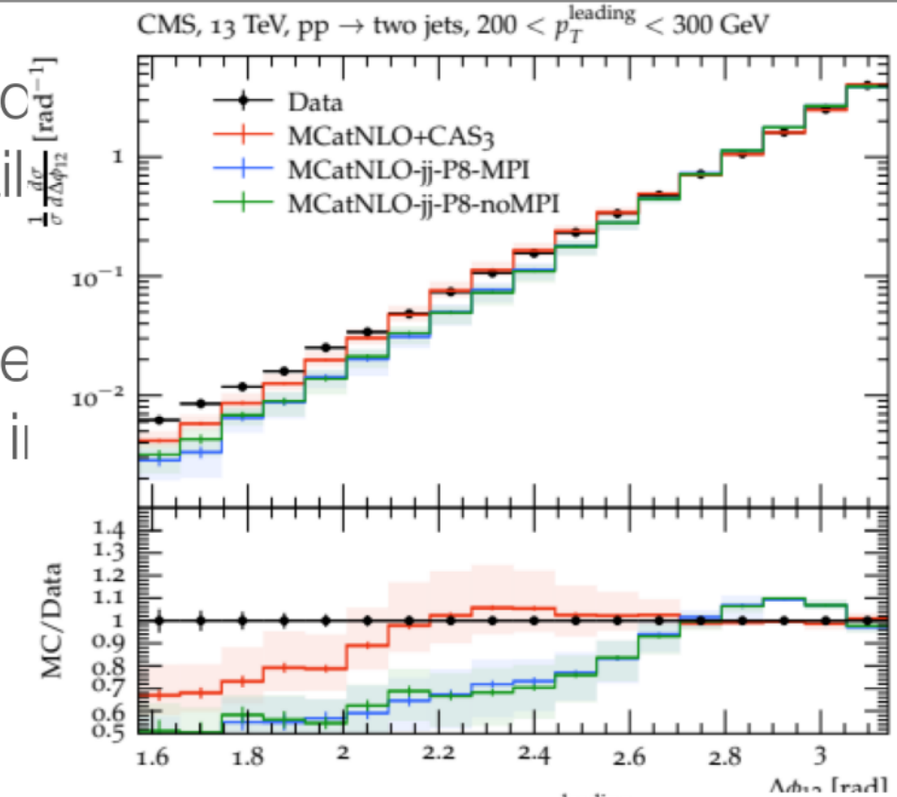


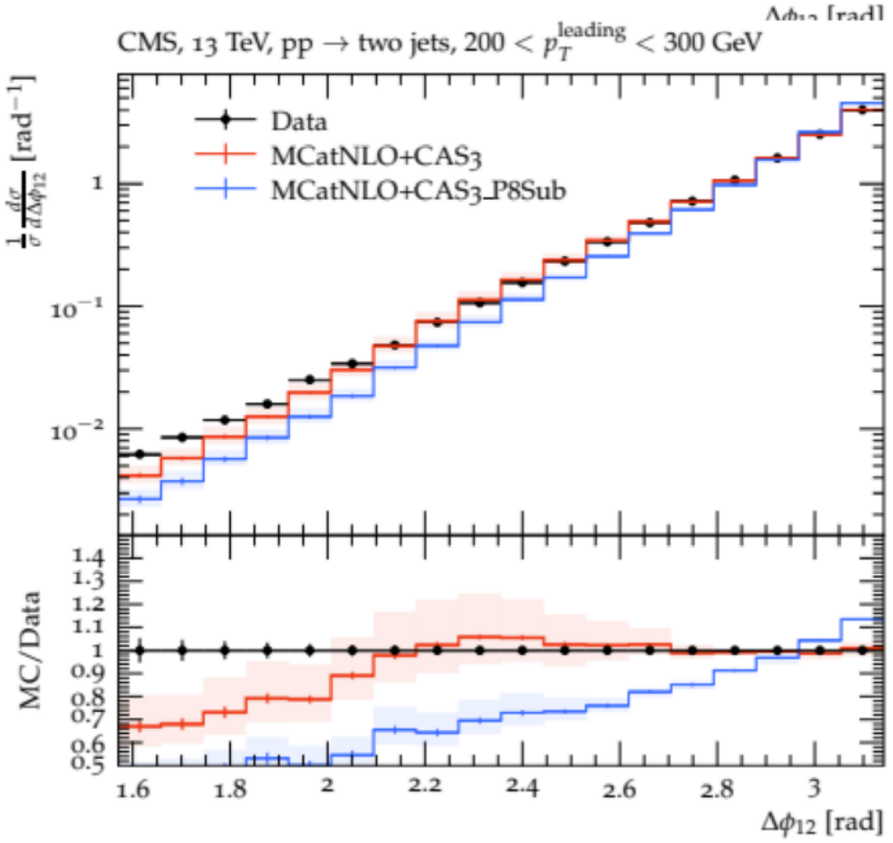
- Very good agreement between NLO and off-shell ME + TMD + shower

Comparison with other approaches: P8 parton shower

- Investigate different parton shower and MPI from Pythia8
- use:
  `/afs/desy.de/user/j/jung/public/mcschool2021/pythia8`
  - the yoda file is correct, only the lhe file uploaded was with the wrong pdf

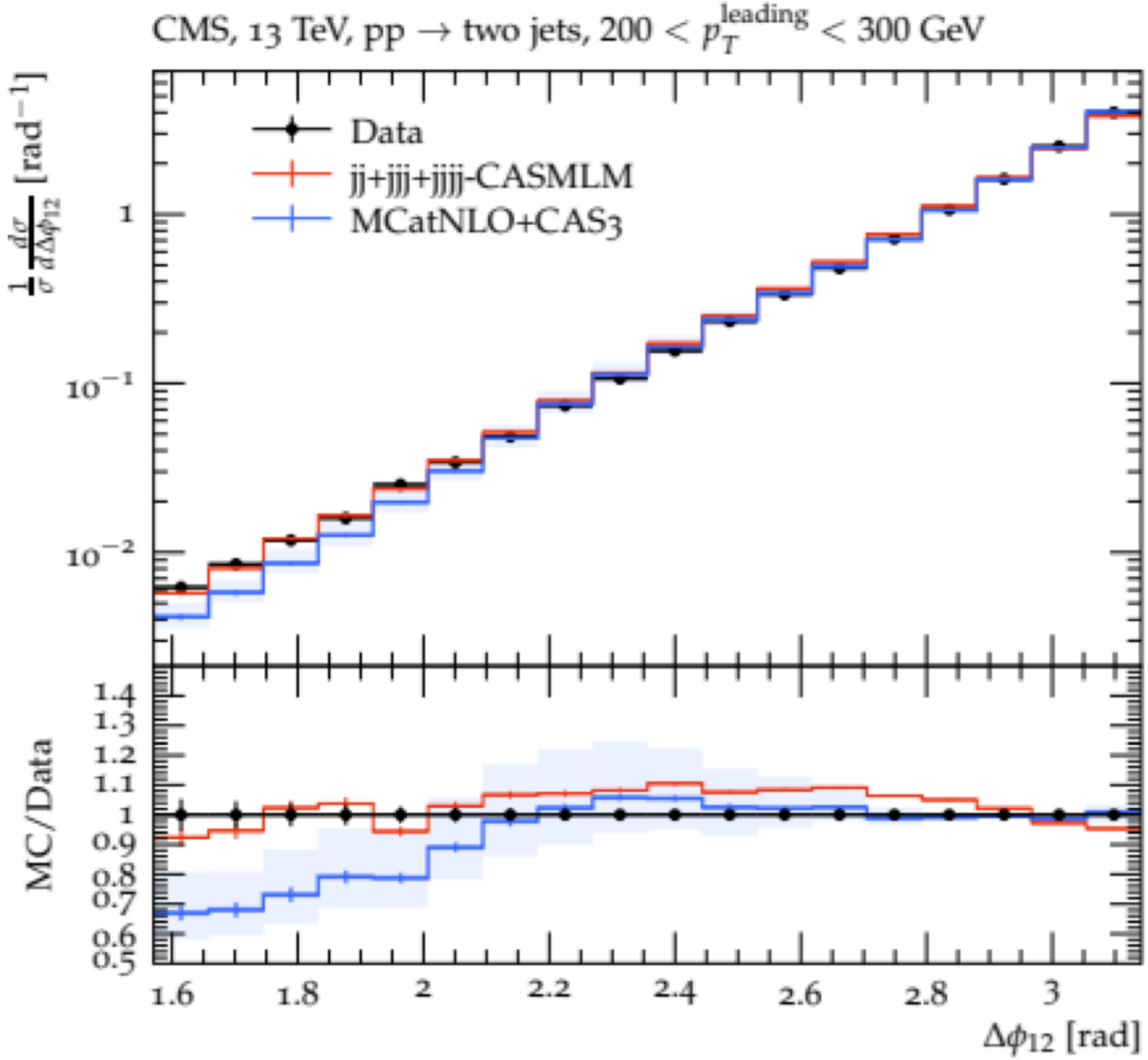
- $\Delta\phi$ c… e detail…
- Corre… very i…





Multijet merging

- merging of LO jj+jjj+jjjj
- will be discussed in a separate session today



What is our global picture ?