Case studies at LPNHE

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- ## 2 case studies (Snowmass LoIs)

  - Perspectives for high-precision $\alpha_S(m_Z^2)$ determinations from future e +e− measurements at FCC-ee

  - High-precision $\alpha_S(m_Z^2)$ determinations from future FCC-ee e +e− → hadrons data **below the Z peak**

- ## People involved

  - B. Malaescu, LP

  - Sukyung KIM: M2 Internship March-June on FCC

    - Postulate for PhD: 2/3 ATLAS, 1/3 FCC   Today not funded

α_S evaluation from *hadronic Z decays*

- ## Theoretical prediction available at N³LO

  - Better convergence of perturbative series & less non-perturbative corrections wrt precise determination at lower scales (eg τ decays)

  Used for "reference value"
  Determinations at other energies evolved @ m_Z scale & then compared to test the RGE from QCD

- $\rightarrow$ Need to study acceptance & reconstruction efficiency etc. -> *optimize detector design*
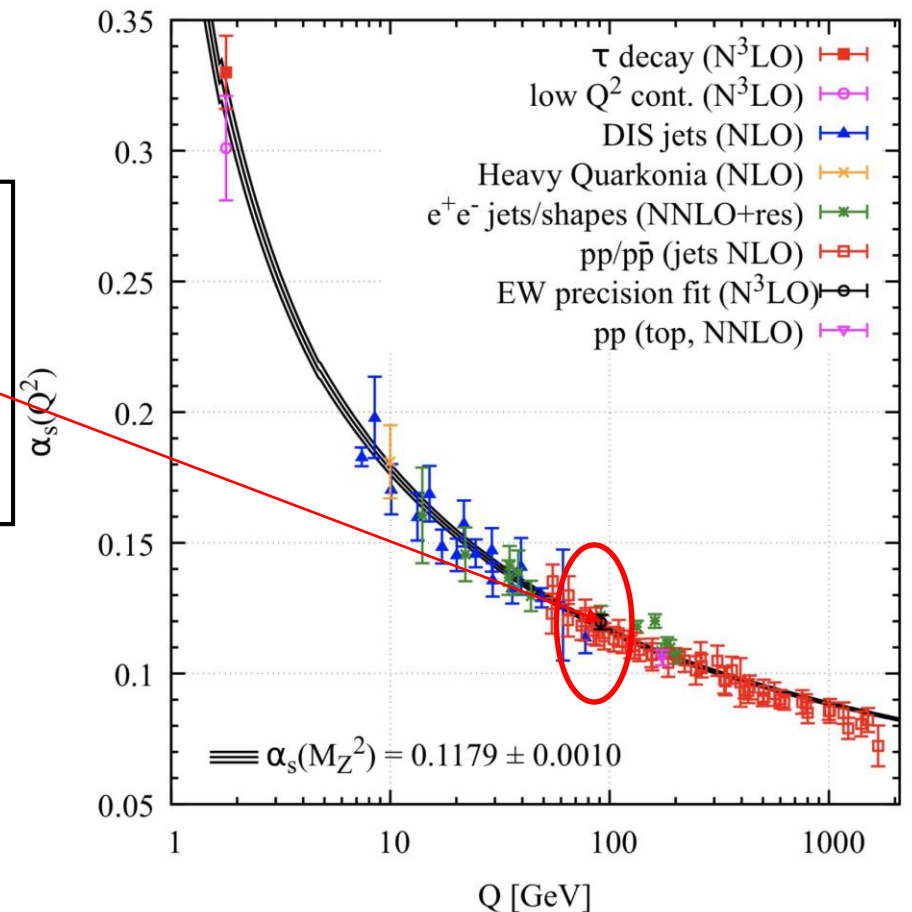
α$_S$ evaluation from *(ISR) jet production*

- ## Sensitivity to α$_S$
  - eg from 3/2 jet ratios
  - Or jet rates wrt total hadronic Xsec
- ## High luminosity -> large evts samples with collinear/large angle ISR γ
  - allows to scan √s' with same detector & collider conditions
- ## Need to study
  - Jet and photon energy calibration and resolution
  - Acceptance & recons. efficiency -> *optimizing detector design*
  - Should be able to target δα$_S$ / α$_S$ < 1%

N3LO + NNLL
(arXiv:1902.08158)

N2LO + NLLA
(arXiv:1205.3714)
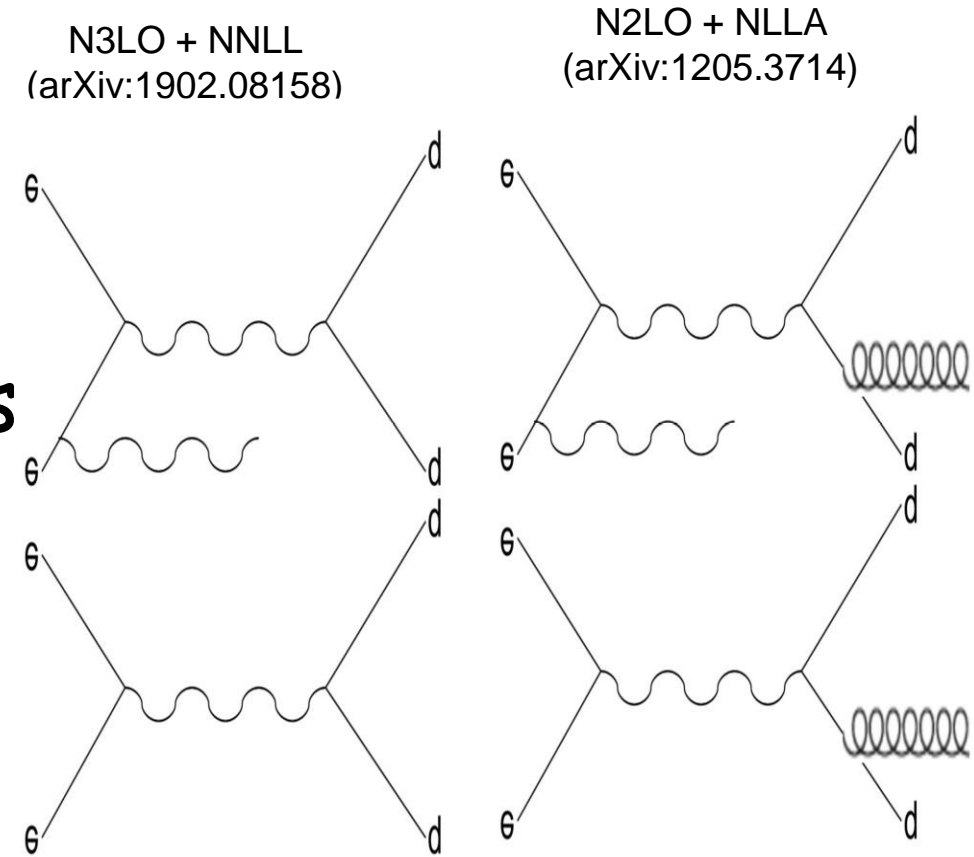
Jet substructure opportunities

- Algos/methods developed -> study jet substructure at LHC
  - Important for understanding QCD effects inside jets, jet tagging (e.g. boosted top, H→bb), NP searches
- Precision studies possible also in clean FCC-ee environment
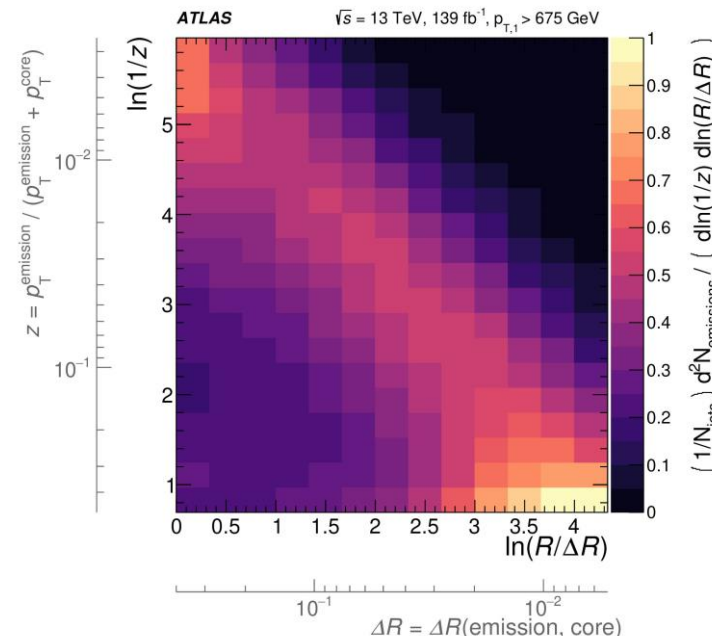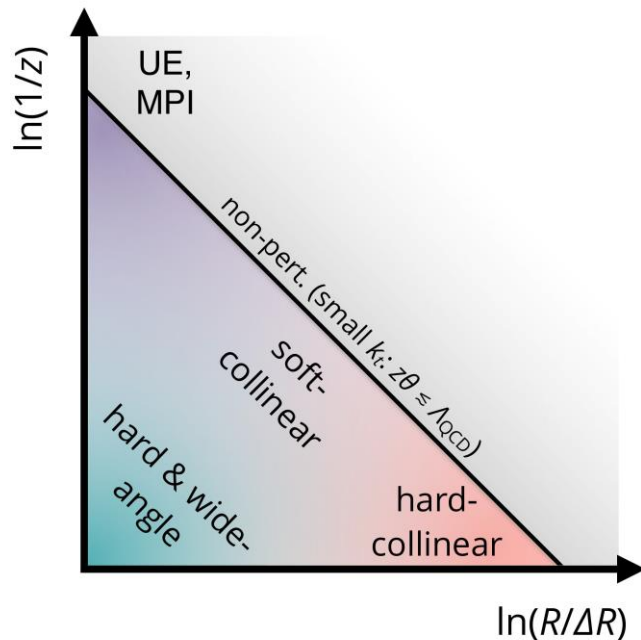
arXiv:2004.03540

ANR deposited (ATLAS, FCC)
- 1 PostDoc requested
- Positive feedback from 2nd round

Framework

Studies performed in official FCCSW framework

- Generation
  - Pythia e+e- -> Z -> qq at $s^{1/2}$ = m_Z

  (Pythia was the only generator fully integrated in EDM for FCC)
  - **Mimic Higher order & α_S values via FSR**
- Fast simulation
  - Delphes with IDEA simulation
- Analysis
  - Official python code (developed for top studies)
  - Integrates various jets reconstruction algorithms
  - Ad-hoc C++ code on .root files

First results

Observable: #evts w/ at least **3jets** / #evts w/ at least **2 jets**
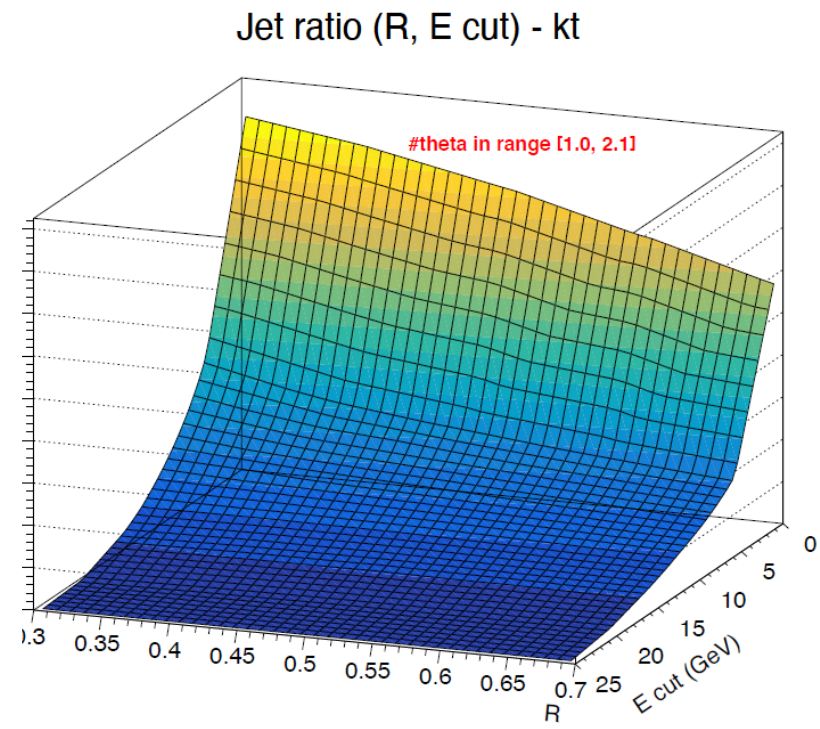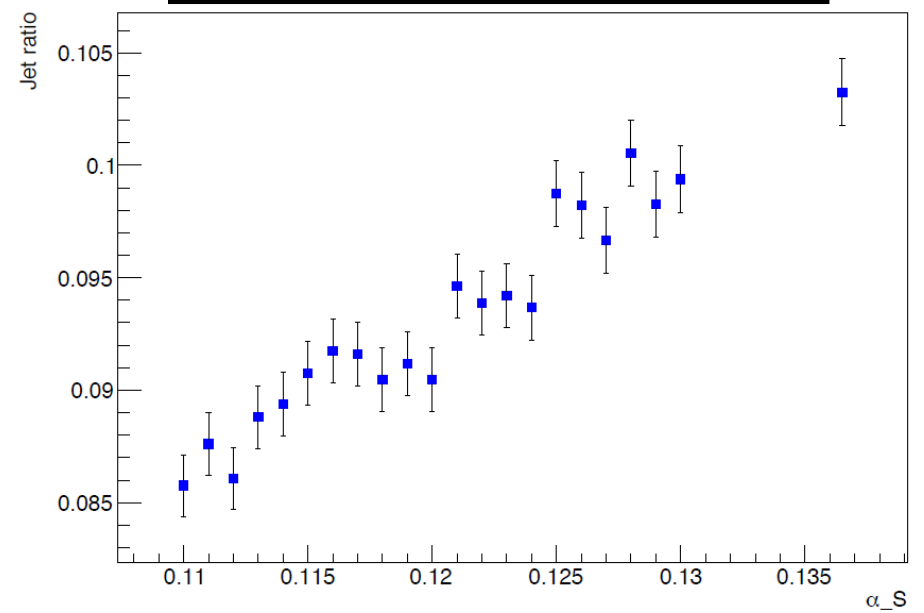- Directly sensitive to α_S

#jets

Jet ratio wrt α_S

Jet ratio sensitivity wrt jet E cut, jet algo type, algo param
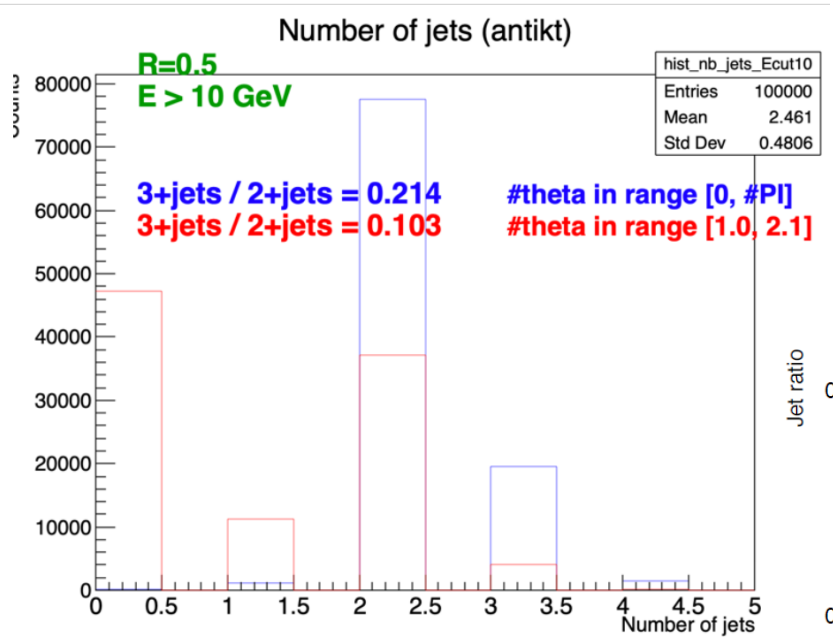
Next

- Jet ratio 3/2
  - Redo study with Higher orders generators
    - Herwig not running in FCCSW (today)
    - Sherpa OK but interface to FCCSW not working (today) - Madgraph
  - Quantify effects of parameters
    - Jet energy cut, jet algorithm used (type & parameters)
  - Evaluate detector parameters on α_S precision extraction
    - Granularity, energy resolution
- Running α_S with ISR
  - Studies with Pythia ongoing
  - Just started to use KKMCee
    - Implementation in FCCSW OK -Ongoing