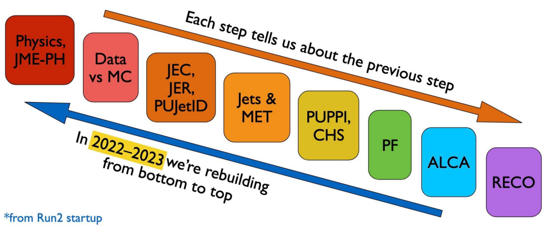
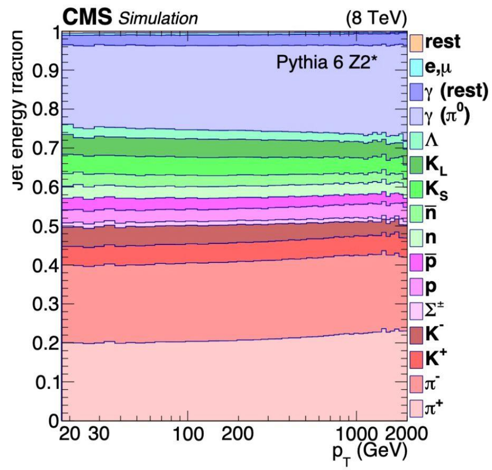
- many many particles ($\pi^0 \rightarrow \gamma\gamma$, π^+, π^-, K^0_L, n, p etc.) from many many vertices
- Particle Flow (**PF**) reconstructs 3 types: charged hadrons, neutral hadrons, photons
- Charge Hadron Subtraction (**CHS**) and Pile Up Per Particle Id (**PUPPI**) remove pileup

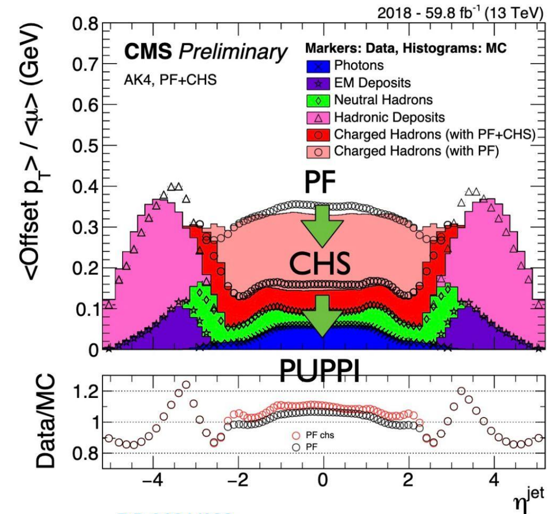
CMS



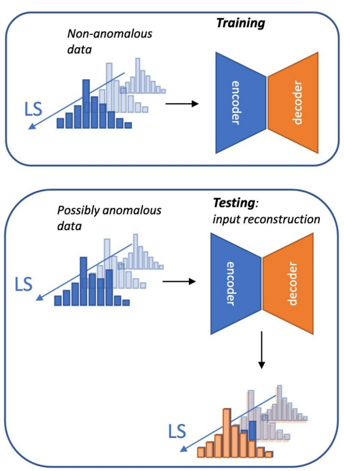
*from Run2 startup



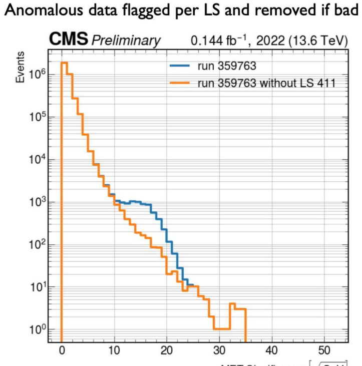
JME-13-004



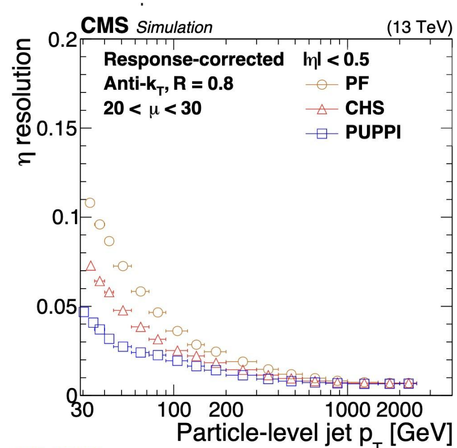
DP-2021/033



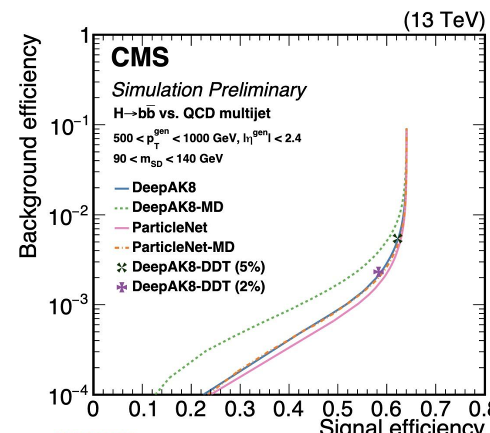
- Data quality management (DQM) with Machine Learning (ML) improves overall efficiency:
  - AutoEncoder trained on good luminosity sections (LS ~ 23s) of data to learn normal behaviour
  - Anomalous data flagged per LS and removed if bad



CMS-DP-23/010



JME-18-001

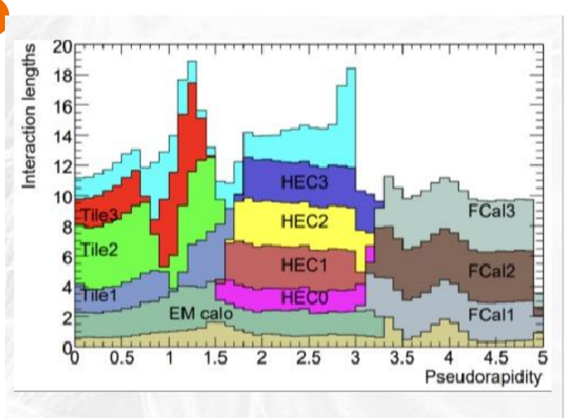


DP-20/002

A lot of novelties, long mileage covered since Run1

ATLAS

New ideas, that make our life easier



2 parts: Bias HS object energy, add PU jets to event!

PU removal at every level:

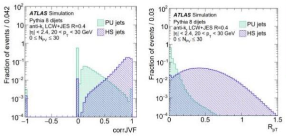
3. On jets
   - Jet Area subtraction
   - Grooming (trimming, softDrop) (backup)
   - Forward Jet Vertex Tagger (fJVT)
   - **Jet Vertex Tagger** (JVT)

$$R_{\mathrm{pT}} = \frac{\sum_k p_{\mathrm{T},k}^{\mathrm{track}}(\mathrm{PV}_0)}{p_{\mathrm{T}}^{\mathrm{jet}}}$$

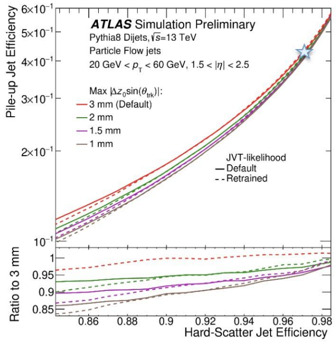
$$\mathrm{corrJVF} = \frac{\sum_m p_{\mathrm{T},m}^{\mathrm{track}}(\mathrm{PV}_0)}{\sum_l p_{\mathrm{T},l}^{\mathrm{track}}(\mathrm{PV}_0) + \frac{\sum_{n\geq 1}\sum_l p_{\mathrm{T},l}^{\mathrm{track}}(\mathrm{PV}_n)}{(k\cdot n_{\mathrm{track}}^{\mathrm{PU}})}}$$

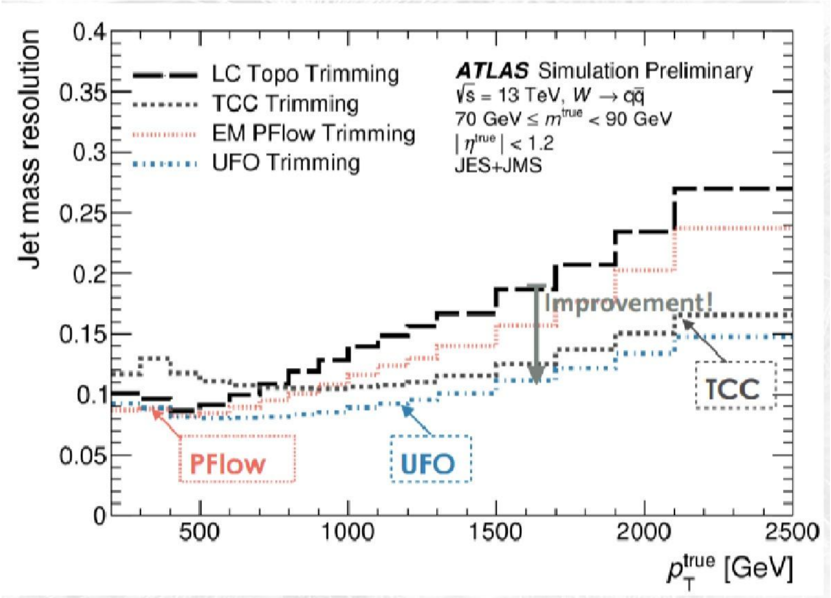
kNN Likelihood
- Trained on MC dijets
- Truth-tag HS/PU jets

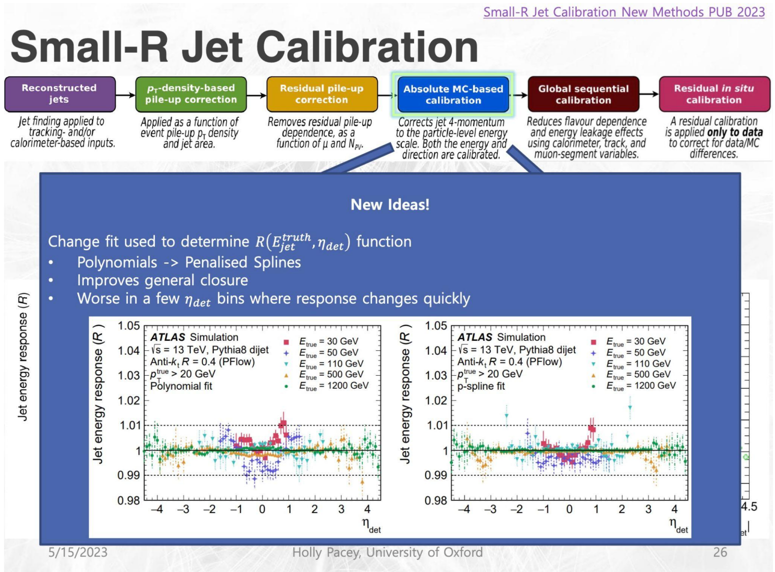
JVT discriminant



Aiming to upgrade to a NN using more info

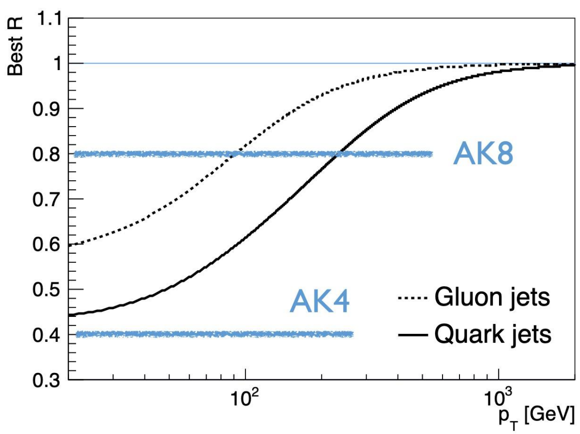






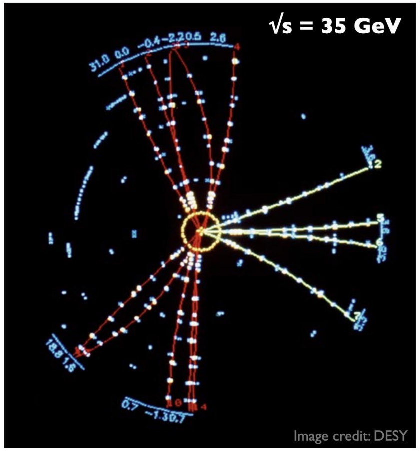
Jets clustering

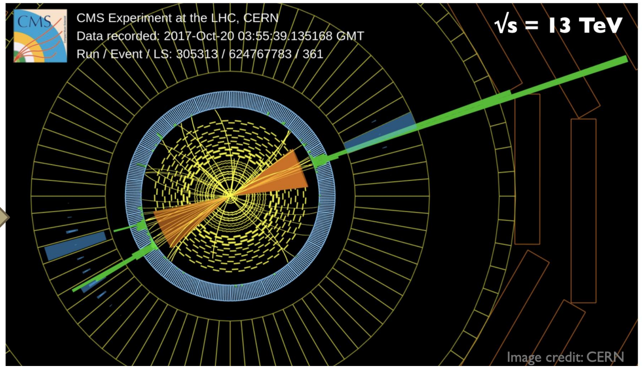
Is there an optimal R?



It depends…
… on p_T and flavour

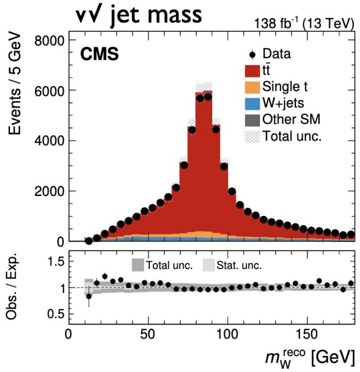
TASSO at PETRA, 1979

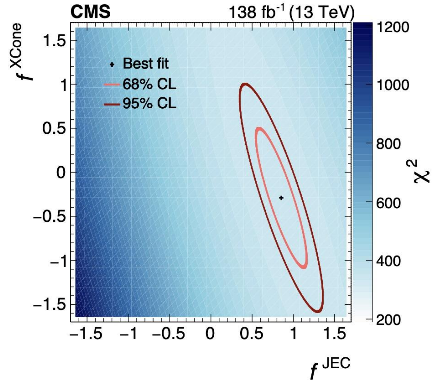




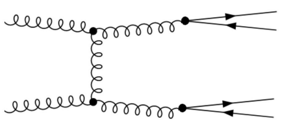
Measuring with XCone

√√ jet mass





Defining Quark and Gluon Jets



Obviously two gluon jets…

… or not?!?

- Parton flavour (from hard matrix element) is intrinsically flawed
- Physically meaningful definitions (not exhaustive)
  - N-Subjettiness [Larkoski, Metodiev, EPJC 10, 014 (2019)]
    - Possibility to unambiguously define quark jets ($\tau_N \to 0$)
    - Gluon jets always contaminated by quark jets, $(C_F/C_A)^{N\text{emissions}}$
  - Flavour-k_T [Banfi, Salam, Zanderighi, EPJC 47, 113 (2006)]
  - Jet topics [Komiske, Metodiev, Thaler, JHEP 11 059 (2018)]
  - Fragmentation approach (WTA axis) [Caletti et al., JHEP 10 158 (2022)]

Heavy Object Tagger with Variable R

[Lapsien, Haller, RK, EPJC 76, 600 (2016)]

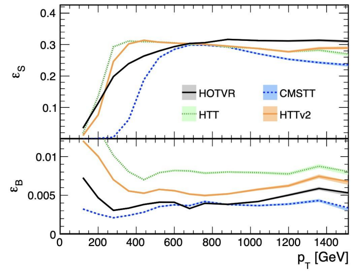
One-pass clustering with integrated subjet finding

- Jet distance measures (with variable R)

$$d_{ij} = \min[p_{T,i}^{2n}, p_{T,j}^{2n}]\Delta R_{ij}^2$$

$$d_{iB} = p_{T,i}^{2n} R_{\text{eff}}^2 \qquad R_{\text{eff}} = \frac{\rho}{p_T}$$

- Clustering veto at each step
  - mass jump veto
- Store objects i and j as subjets
- Used in tW resonance search [CMS, JHEP 04, 048 (2022)]
- Works beautifully, but can be improved



[RK, STMP 284 (2021)]

Random

Clearly, a lot of new interesting ideas (ParticleNet, ML in DataCertification etc)

Common grounds for ATLAS/CM ? Room for improvement and collaboration / x-talking?

Clear intersection with theory, pheno + ML etc

Jet clustering : are we using/studying the new ideas/models in CMS/ATLAS?

.-we certainly do in some cases, like XCone)

.-What are we missing?