Calorimeter cell time in ATLAS topological clustering

Margherita Spalla, on behalf of the ATLAS Collaboration

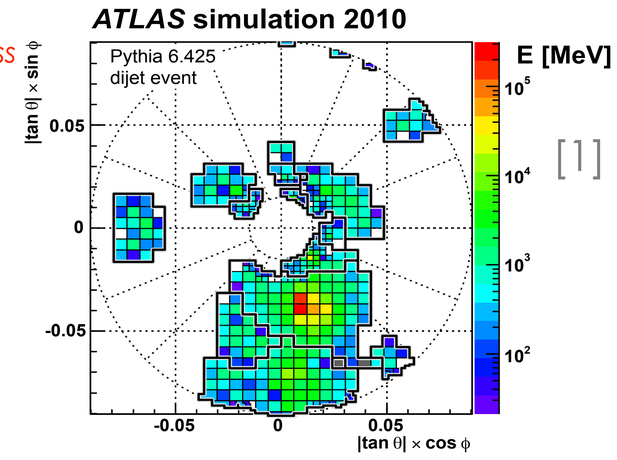
MAX-PLANCK-INSTITUT FÜR PHYSIK

Calorimeter topo-clusters: starting point to reconstruction of jets (through p-flow), e, γ, τ, p_T^{miss}

Building algorithm uses energy significance:

1. cluster seed: cell with large E significance
2. iteratively collects neighbouring cells based on their E significance

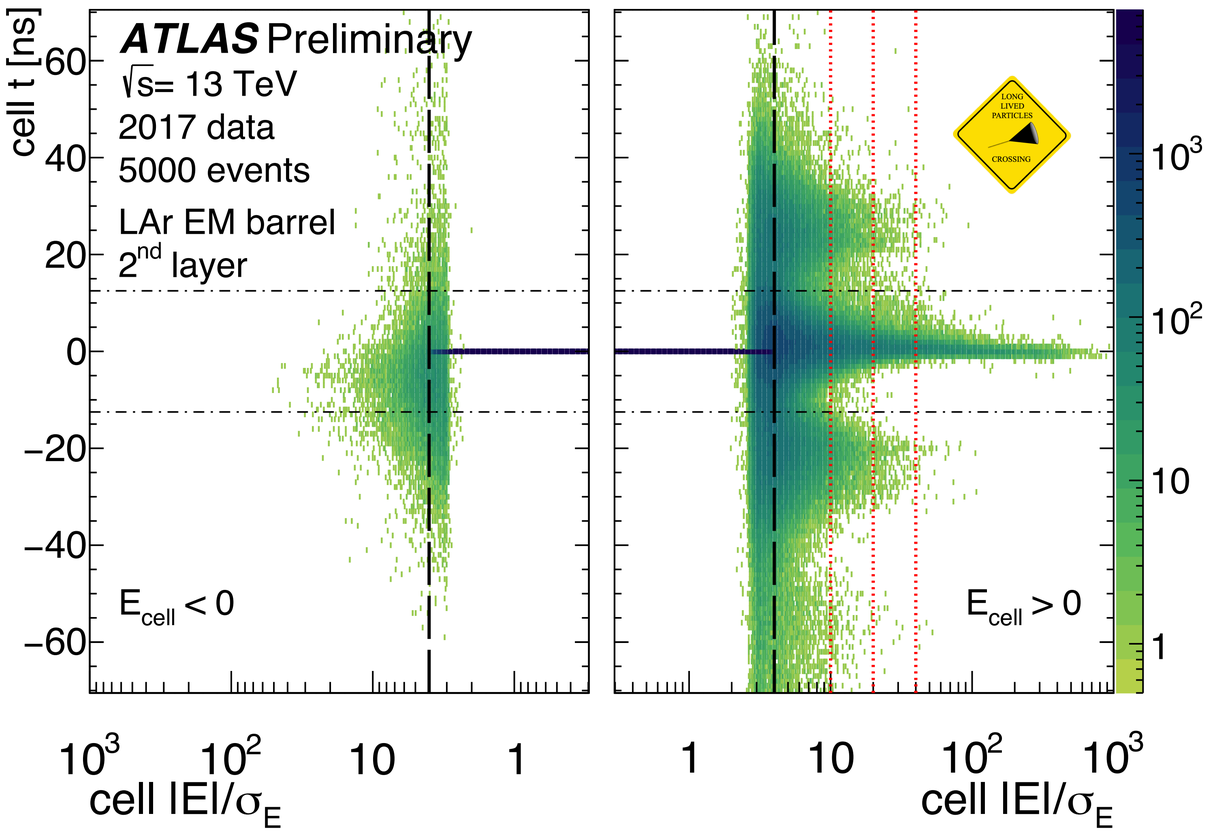
$$\frac{|E|}{\sigma_E} > 4$$



[1]

ATLAS calorimeters (Tile and LAr) also measure time

✓ a selection on time is feasible at large E significance



▶ Calorimeter time vs energy significance in LAr EM barrel [2].

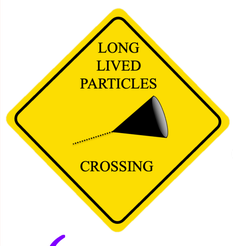
THE TIME CUT

MULTIPLE CONSIDERED:

- New cluster seed requirement

$$\begin{cases} |E|/\sigma_E > 4 \\ |t_{\text{cell}}| \leq 12.5 \text{ ns} \end{cases}$$

- What if $|E|/\sigma_E > 4$ but $|t| > 12.5$ ns ?
  - → Can be clustered as neighbour → *Seed cut*
  - → Vetoed from the cluster → *Seed Extended cut*



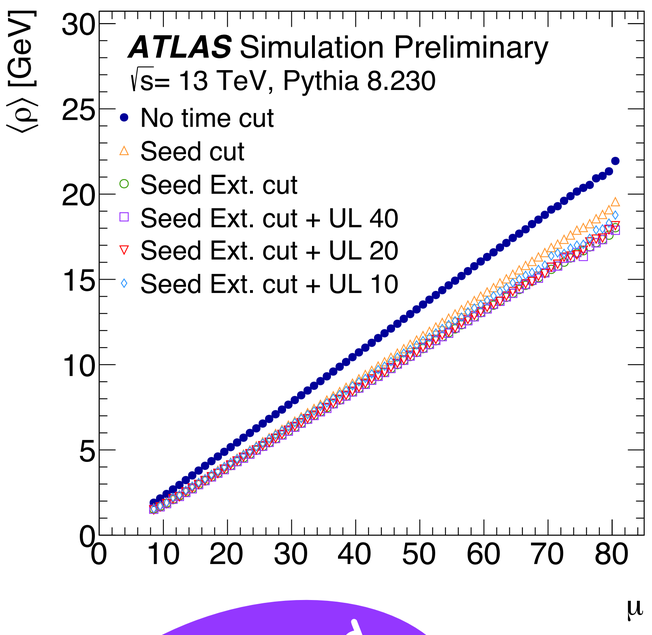
- Avoid rejecting phase space sensitive to new physics (Long-Lived-Particle): *Upper Limit*

$$\begin{cases} |E|/\sigma_E > 4 \\ |t_{\text{cell}}| \leq 12.5 \text{ ns} \end{cases} \quad \text{OR} \quad E/\sigma_E > X_{\text{UL}}$$

x_{UL} = 10, 20, 40

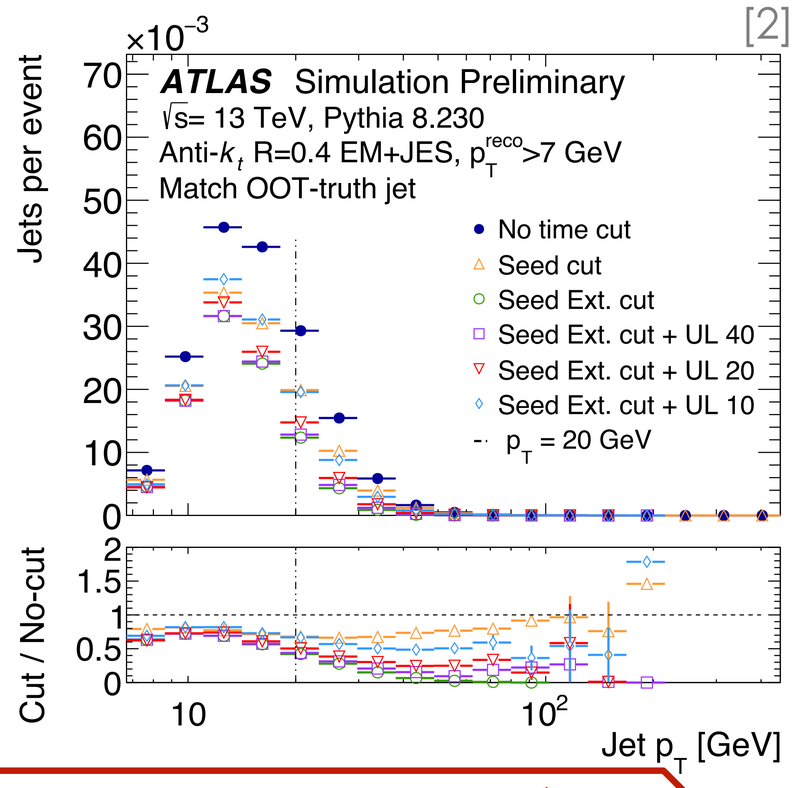
Pile-up suppression (MC)

✓ Suppress jets consistent with originating from out-of-time pile-up, without hindering the signal

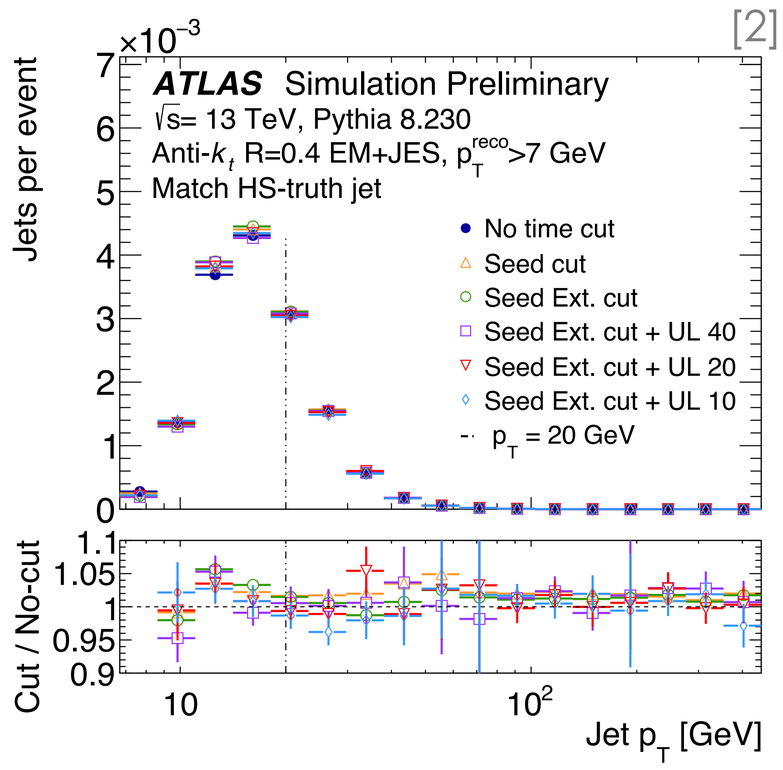


[2]

Event p_T density (ρ) less pile-up dependen



[2]

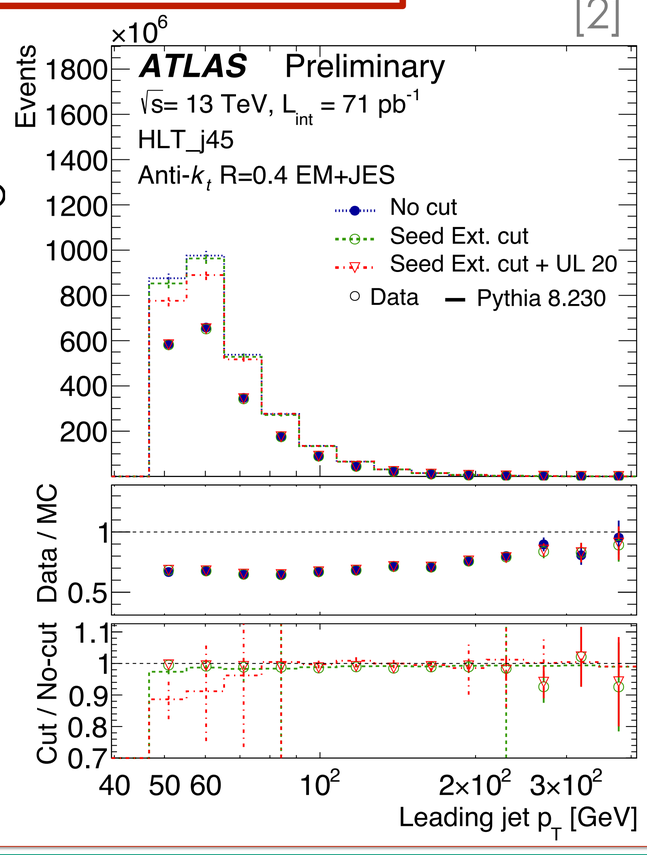


[2]

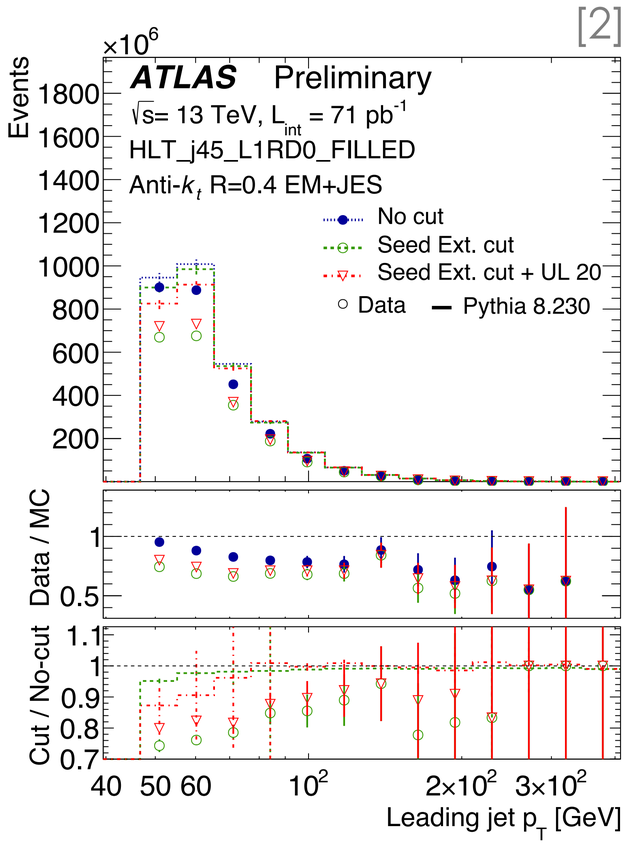
Seed Extended + x_{UL}=20 chosen for Run 3 (offline only)

Test with Run 2 data

Larger impact on trigger with more out-of-time pile-up (random L1 seed)



[2]



[2]

Disk size reduction

[2]

Sice variation	Data	MC
ATLAS event	-6.1%	-7.1%
Topo-clusters	-17%	-17%
Particle-flow objects	-18%	-18%
τ-leptons	-8.2%	-6.8%
Electrons / Photons	-7.8%	-8.6%

[1] Eur. Phys. J. C 77 (2017) 490
[2] ATLAS-CONF-2023-042

M. Spalla, Max Planck Institut für Physik, München
margherita.spalla@cern.ch