Jets in ATLAS

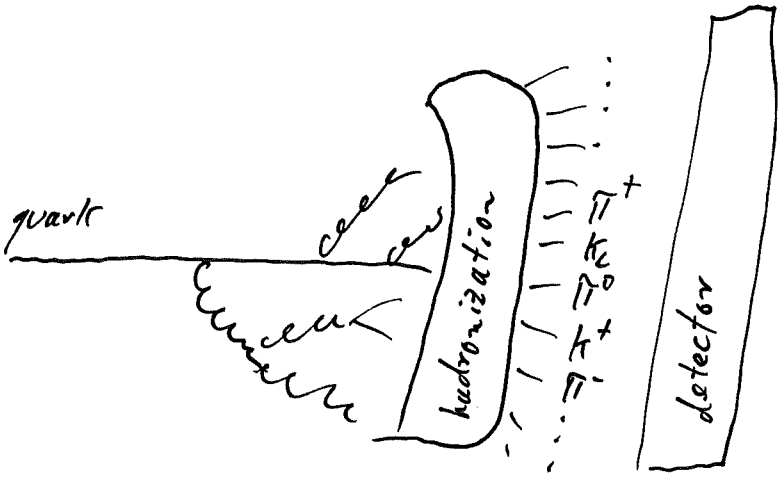
Motivation

- Used a lot in searches and measurements
- Collimated spray of particles
- Jet reconstruction: detector objects → partons
- Large mass range in e.g. $t\bar{t}$ resonance search

Outline

1. Lecture: Jet reconstruction at hadron collider
2. Lecture: Boosted object tagging – pileup
3. Lecture: Top tagging + $t\bar{t}$ resonance search

Parton fragmentation



Gluon emission

$$\int \alpha_s \frac{dE}{E} \frac{d\theta}{\theta} \gg 1$$

partons particles detector objects

Reconstructing Jets

$\{p_i\}$ —jet definition→ $\{j_k\}$

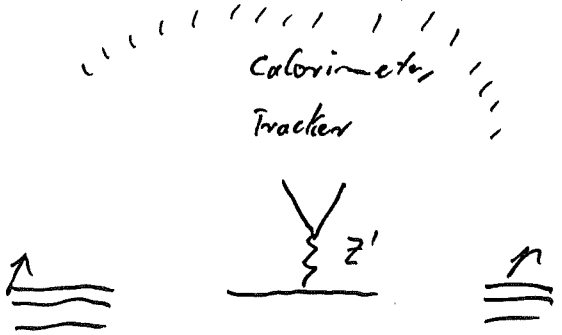
particles
calorimeter towers
4-momenta

jets

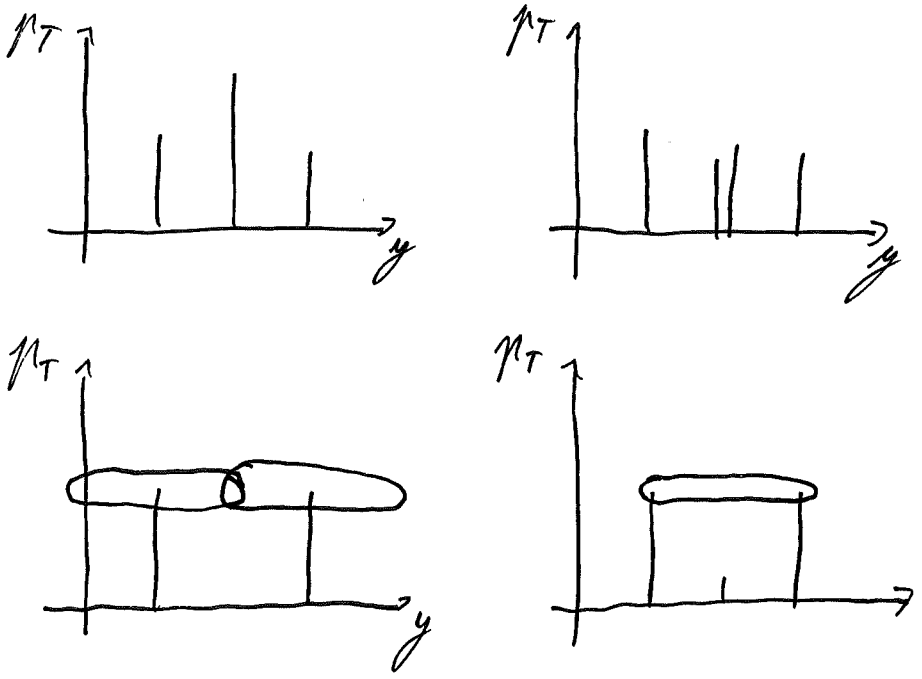
Which particles to group in a jet?

How to combine the momenta?

$\mathcal{O}(1000)$ particles in an event



Collinear/infrared safety



Sequential Recombination

particles $i = 1 \dots N$ $\quad d_{ij}$ distance between i and j

hadron collider

$E \sim p_T \qquad \Delta R_{ij} = \Delta \eta_{ij}^2 + \Delta \varphi_{ij}^2 \sim \theta_{ij}$

proton remnants at pp collider

→ „beam distance" $\quad d_{iB} = p_{T_i}^{2n}$

$$d_{ij} = \min\left(p_{T_i}^{2n}, p_{T_j}^{2n}\right) \Delta R_{ij}^2 / R^2$$

1. Find smallest d_{ij}, d_{iB}
2. If $d_{ij}^{\min} < d_{iB}^{\min}$: recombine i and j

$$p_{(ij)}^{\mu} = p_i^{\mu} + p_j^{\mu} \quad (E\text{-scheme})$$

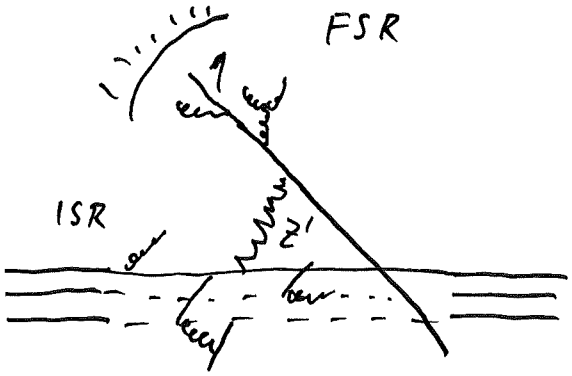
3. If $d_{iB}^{\min} < d_{ij}^{\min}$: call i a jet and remove it
4. Repeat from 1 until no particles left
5. Only use jets with $p_T > p_T^{\min}$

$n = 1$ $\quad k_T$ algorithm

$n = 0$ $\quad$ Cambridge – Aachen

$n = -1$ $\quad$ anti – k_T

Hadronic activity in pp event



$\equiv$ x 30 PU pileup

FSR $p_T \leq \frac{M}{2}$

ISR $p_T \leq \frac{M}{2}$

MPI $p_T \sim$ few GeV

PV $p_T \sim n_{PV} \times \frac{1}{2}$ GeV

Where does energy "grow" in the event ?

What is the optimal R parameter ?