JEWEL

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What is JEWEL?

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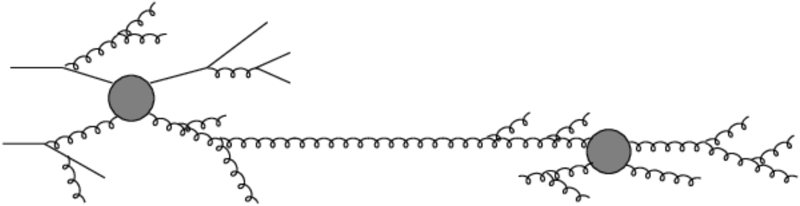
It accomplishes this by use of a perturbative approach, combining regular parton shower with successive scatterings:



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Event Generations

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- First, PYTHIA is called to calculate the initial scatterings of the partons inside the nuclei;
- The scattered partons are then propagated through the medium with JEWEL, where the medium is seen by the parton as a collection of scattering centres;
- Once all of the partons have reached the minimum of virtuality, given by an infrared regulator, they are given back to PYTHIA for hadronization;

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Physics of JEWEL

The use of perturbative approach is dealt with by making use of a probabilistic interpretation of the Sudakov form factor:

$$S_a(t_h, t_c) = \exp\left\{ -\int_{t_c}^{t_h} \frac{dt}{t} \int_{z_{min}}^{z_{max}} dz \sum_b \frac{\alpha(k_\perp^2)}{2\pi} \hat{P}_{ab}(z) \right\} \qquad (1)$$

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Wich means we can take it as the probability that a parton a emites no resolvable radiation between the scales t_c and t_h.

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The Sudakov form factor is used to perform the evolution by enforcing radiation until the parton reaches the t_c *cut-off*.
Besides that, the medium, seen as a collection of scattering centers by the parton, also has the probability of interaction.
This probability is given by the regular cross-section of a $2 \rightarrow 2$ process,given by:

$$\sigma_i(E,T) = \int_0^{|\hat{t}|_{max}(E,T)} d|\hat{t}| \int_{x_{min}(|\hat{t}|)}^{x_{max}(|\hat{t}|)} dx \sum_{j\in\{q,\bar{q},g\}} f_j^i(x,\hat{t}) \frac{\mathrm{d}\sigma}{\mathrm{d}\hat{t}}(x\hat{s},|\hat{t}|) \tag{2}$$

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Initial Conditions

The model employed by JEWEL is a variant of Bjorken model that approachs the initial contitions by the definition of the nuclear thickness function:

$$T(x, y) = \int dz \rho(x, y, z) \tag{3}$$

Initial Conditions

The nuclear thickness functions are then used to define a reduced thickness by:

$$
\begin{aligned}
n(b,x,y) = {} & T_A(x-\frac{b}{2},y)\left(1-\exp\left(\sigma_{NN}T_B(x+\frac{b}{2},y)\right)\right) \\
& + T_B(x+\frac{b}{2},y)\left(1-\exp\left(\sigma_{NN}T_A(x-\frac{b}{2},y)\right)\right)
\end{aligned}
\tag{4}
$$

Where σ_{NN} is the nuclear cross-section and b is the impact parameter.

Initial Conditions

This reduced thickness is then applied to take a map of the initial energy density:

$$\epsilon(x, y, b, \tau_i) = \epsilon_i \frac{n_{part}(x, y, b)}{< n_{part} > (b = 0)} \tag{5}$$

Where $< n_{part} > (b = 0) \approx \frac{2A}{\pi R_A}$.

Initial Conditions

The value of ϵ_i is determined by an initial temperature given as a parameter to JEWEL. This translation is made through the use of the relation $\epsilon_i \propto T_i^4$.

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Medium Evolution

The medium evolution is performed analytically by use of:

$$\epsilon(x, y, b, \tau) = \epsilon_i(x, y, b, \tau_i) \left(\frac{\tau}{\tau_i}\right)^{-\frac{4}{3}} \tag{6}$$

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This that the temperature evolves according to:

$$T(x, y, b, \tau) \propto \epsilon(x, y, b, \tau_i)^{1/4} \left(\frac{\tau}{\tau_i} \right)^{-\frac{4}{3}} \tag{7}$$

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Jet Algorithms

Today, the main type of algorithm to cluster particles from a given event into jets, thus defining a jet, are the sequential recombination algorithms. They define a distance functions between particles:

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$$d_{ij} = \min(p_{ti}^{2p}, p_{tj}^{2p}) \frac{\Delta R_{ij}^2}{R^2} \tag{8}$$

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$$d_{ij} = \min(p_{ti}^{2p}, p_{tj}^{2p})\frac{\Delta R_{ij}^2}{R^2} \tag{8}$$

Then a process of iteration is realized, where the particles with minimum d_{ij} are combined to form the given jets.

Jet Algorithms

Once the jets are found, one class of the possible observables are the jet shape observables.

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These reflect mush of the evolution that occurs in the jet formation, as well as the process of hadronization.

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The SoftDrop condition is:

$$\frac{\min(p_{T1}, p_{T2})}{p_{T1} + p_{T2}} > z_{cut} \left(\frac{\Delta R_{12}}{R_0} \right)^{\beta} \tag{9}$$

SoftDrop Procedure

Once the condition has been applied, the quantity:

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Reflects an observable that is usually related to the first splitting of the parent parton.

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This can be seen in the results of the fact that they follow the Altarelli-Parisi splitting functions.

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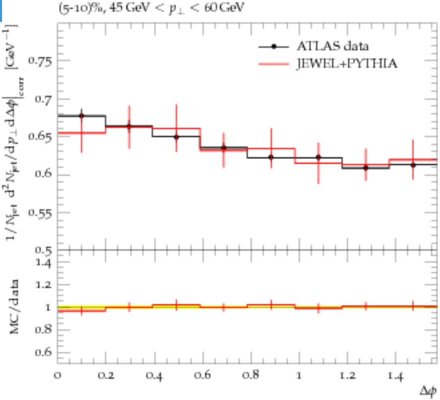
JEWEL Validation

The validation of JEWEL has been performed by comparing with exe-priments such as:



Centrality dependence of the angular distribution of single inclusive jets in Pb+Pb collisions at $\sqrt{s_{NN}} = 2.76\mathrm{TeV}$ for a jet radius $R = 0.2$ and $|\eta_{jet}| < 2.1$ in the range $45\mathrm{GeV} < p_t < 60\mathrm{GeV}$.

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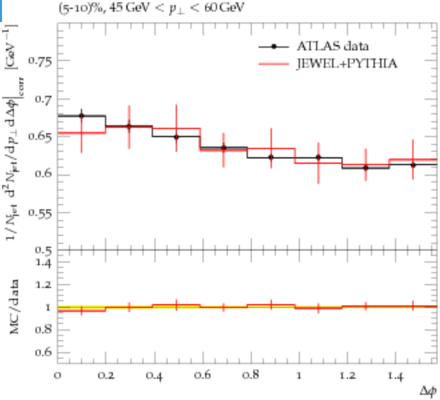

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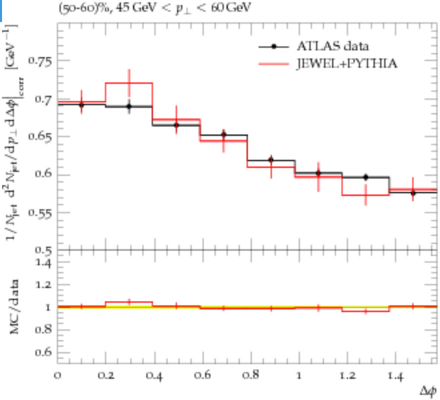

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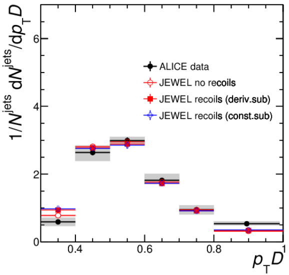

Jet shape distributions in 0 ∽ 10 central PbPb collisions at $\sqrt{s_{NN}} = 2.76\mathrm{TeV}$ for $R = 0.2$ in range of jet p_{chT},jet of 40 ∽ $60\mathrm{GeV}/c$ compared to JEWEL with and without recoils with different subtraction methods. The coloured boxes represent the experimental uncertainty on the jet shapes.

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- Prepare a code to read external medium files(currently running);
- Couple it with a different model of initial conditions(currently running with TRENTO);
- Couple it with a more realistic hydro;
- Talk to JEWEL developers to adapt it to run with haevy partons;