Positions and times of the produced hadrons

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Let's first compute positions and times of hadrons produced by the recombination of partons. We calculate a coordinate of center of mass of partons forming a hadron in their center-of-mass frame and it is given by

$$\mathbf{r}' = \frac{\sum_i m_i \mathbf{r}'_i}{\sum_j m_j} \tag{1}$$

where $\mathbf{r}'_i$ are coordinates of the partons in the center-of-mass frame (the hadron rest frame). When the time of the latest born parton is t'_f in the center-of-mass frame and speed of the center-of-mass of the partons in the lab frame is $\mathbf{v} = \mathbf{P}/E$, taking the Lorentz boost with speed $-\mathbf{v}$ to the four-coordinate $(\mathbf{r}', t'_f)$, we have the position and time of the recombined hadron in the lab frame.

Prior to find the space-time information of the hadrons produced of the string fragmentation of partons, we obtain the center of mass of a string $\mathbf{r}_s$ and the time of the latest born remnant parton t_s. Then, the formation time of a hadron is given by

$$t_f = E/m_T^2, \tag{2}$$

where E is the energy of the hadron and m_T is the transverse mass of the hadron defined by $m_T = \sqrt{m^2 + p_T^2}$. The position and time of each hadron produced from the string fragmentation are written by

$$t_H = t_s + t_f$$
$$\mathbf{r}_H = \mathbf{r}_s + \mathbf{v} t_f \tag{3}$$