Effects of 40 MeV and higher timing thresholds

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Timing is one of the tools to spot overlapping hits in clusters. Whereas the "cluster time" is usually defined as the measured time in the highest energy towers, other towers in the cluster may have measured TOF as well (if their energy passes the timing threshold). If there is a large discrepancy between the measured times of any two towers within a cluster, it is a good indication that more than one particle contributed to the cluster energy.

These results presented here were obtained under the following conditions:

- 250 central Hijing events
- The timing threshold is 40 MeV for central_40 and 80 MeV for central_80
- A cluster must have at least 100 MeV in the highest E tower
- A tower has to have at least 20 MeV to be included in the cluster
- As always, **dom** refers to the dominant particle that **deposited** the highest energy in the cluster, irrespective of its momentum. **sec** is the second highest... **dom_frac, sec_frac** is the fraction of the total cluster energy deposited by dom, sec respectively. Sec_frac is by definition less than 0.5, dom_frac can actually be smaller than 0.5. (!!!)
- All three plots consider neutral clusters only (photons, neutrons and antineutrons), and only those that have a total energy larger than 500 MeV, have some overlap (at least 5% of the energy comes from a second particle).
- Whereas the **dominant** particle has to be neutral, the **secondary** can be anything in these plots (there is no charge veto).
- The total number of neutral showers with $E > 0.5$ GeV in this sample is 4756.
- In these plots I did not distinguish between vertex and non-vertex originated particles.

The top panel shows what fraction of energy comes from a second particle ("sec_frac"). There are 993 entries, i.e. 993/4756, 20% of the clusters have at least 5% overlap. In accordance with intuition 5-10% contamination is much more likely than 40-50%.

The bottom left panel shows **sec_frac** once the cut is applied that **all valid times of flight** for the towers in this cluster are within 0.5 ns, with a **TOF threshold of 40 MeV**. There are 174 entries in the histogram, *i.e.* (993-174)/993, 82% of the "significant overlaps" have been spotted by requiring consistent TOF within the cluster. Note, that the "sec_frac" distribution is now essentially flat. Alternately, contamination will remain unnoticed with this method in only 174 out of 4756, *i.e.* **only 3.6% of the neutral clusters** .

The bottom right panel has the same conditions as the bottom left, except that now the **timing threshold is 80 MeV**, therefore within a cluster **less** towers have a valid TOF. There are 257 entries, *i.e.* (993-257)/993, 74% of the "significant overlaps" are found using consistency check of TOF within the cluster. Contamination will remain unnoticed in only 257 out of 4756, *i.e.* **only 5.4% of the neutral clusters** . For **120 MeV** and **200 MeV** timing thresholds the results are shown on the next page.