Status and use of truth tools : `MCParticle`, `RecoMCTruthLinker` and `TrueJet`

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Physics ⇒ Whizard ⇒ Parton shower ⇒ hadronisation ⇒ decays ⇒ Geant ⇒ MarlinReco ⇒ Pandora ⇒ Jet clustering ⇒YOU

The `TrueJet` and `RecoMcTruthLinker` processors tries to connect YOU with the Physics using the true information about the event. Ie. `McParticles` with `PandoraPFO`.

- The connection from Geant to You is done by the `RecoMCTruthLinker` processor, linking PFOs (and jets) to MCParticles.
- `TrueJet` takes care of the rest: How does the MCParticles connect to the hard event.

Note: The LHC experiments have no tools like this !

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RecoMCTruthLinker: DBD

`RecoMCTruthLinker` has been around in iLCSoft for a long time. In the DBD version:

- RecoMCTruthLink is uni-directional in the definition of the weight.
- It has no info about what true particles contribute to the cluster of a charged PFO.
- For neutrals, it only contains the link to the true particle that contributes the most to a cluster.
- ClusterMCTruthLink is also uni-directional, but does link all contributing true particles, and does so independently of the charge of the PFO that the cluster is attached to. However, it was not created in the mass-production for the DBD (?)
- TrackMCTruthLink and MCTruthTrackLink is bi-directional in the weight definition.

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> The aim is that the linking should be complete in both directions, ie. not just right in 98 % of the cases, but always !

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From MCParticles to Physics: `TrueJet`

- To link further back, `TrueJet` joins hadrons from the final colour neutrals to di-jets.
- The di-jet is split into two jets, connected to the final quarks.
- It follows the decay-chain of the primary hadrons, and assigns each of them to the jet of it's parent.
- The process continues from generated to simulated particles.
- Then the final quark is followed back through the parton-shower.
- Ultimately, the initial colour neutral is found.

The initial colour singlet is the closest one gets to the initial physics (W,Z,h,...).

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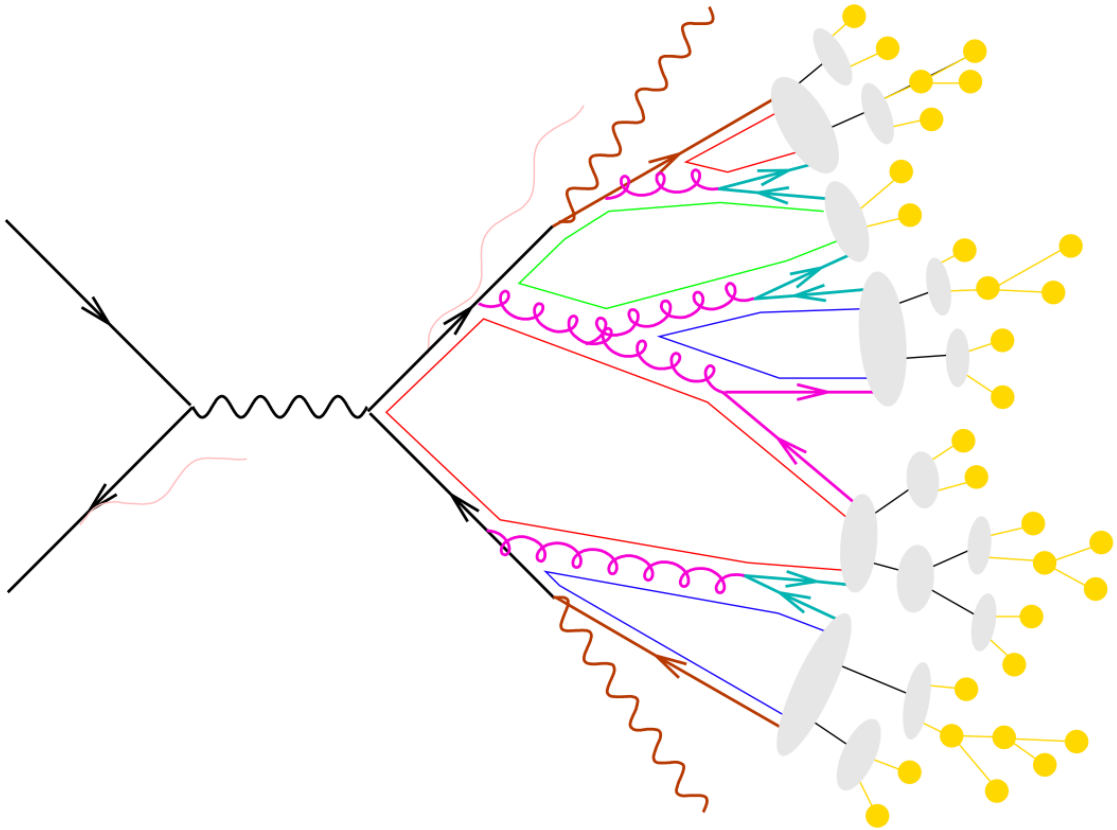
Pictorially:



- hard scattering
- (QED) initial/final state radiation
- partonic decays, e.g. $t \longrightarrow bW$
- parton shower evolution
- nonperturbative gluon splitting
- colour singlets
- colourless clusters
- cluster fission
- cluster $\longrightarrow$ hadrons
- hadronic decays

TrueJet: Assigning jets

- Find hard leptons, if any and assign each one, and their decay-products and any FSR, to a jet.
- Assign the ISR photons to one jet each.
- Find strings (and/or "clusters") - easy. Their descendants are hadrons, their first and last parents are final quarks.
- For clusters and strings: back-track to the initial hard system.
  - Following the quarks - ignore the gluons.
  - If a final quark comes from a gluon-splitting $\Rightarrow$ backtrack the gluon, but stop assigning the parents to jets. Note jet which jet radiated the gluon.
- During the back-tracking, note if inner beamstrahlung occurred.
  - Add this photon to the jet that its parent quark gives rise to.

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TrueJet: Assigning jets

- For clusters and strings, assign the first generation hadrons to a jet induced by the final quark to which it is closest to in angle, ie. not very sophisticated.
  - There is always two, and only two, quarks as immediate parents.
- Follow the decay-chain of each hadron, assigning any product to the same jet.
  - NB: Done to the end of the MCParticle parent-child chain. $\Rightarrow$ Both generator and simulator particles assigned to jets.
- All particles (post-PS) that are leftover are from overlaid events, and are grouped together in a single jet.

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TrueJet: Output Info

- True Jets and the colour-neutrals.
- Navigators from/to reconstructed objects and true particles to true jets, true jets to colour-neutrals, quarks/leptons to colour-neutrals.
- Helper-class to answer specific questions exists. Use it!
- NB: The actual true jets not so important: It's the di-jets we are mostly interested in!!!

TrueJet: Example of what one can do

(From J. Beyer)

- Take the correct jet assignment of true particles.
- Compare jet energy ...
  - from seen energy of these particles.
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- Ie. the pure detector and PID effects.
- Does it depend on flavour of the originator of the jet?

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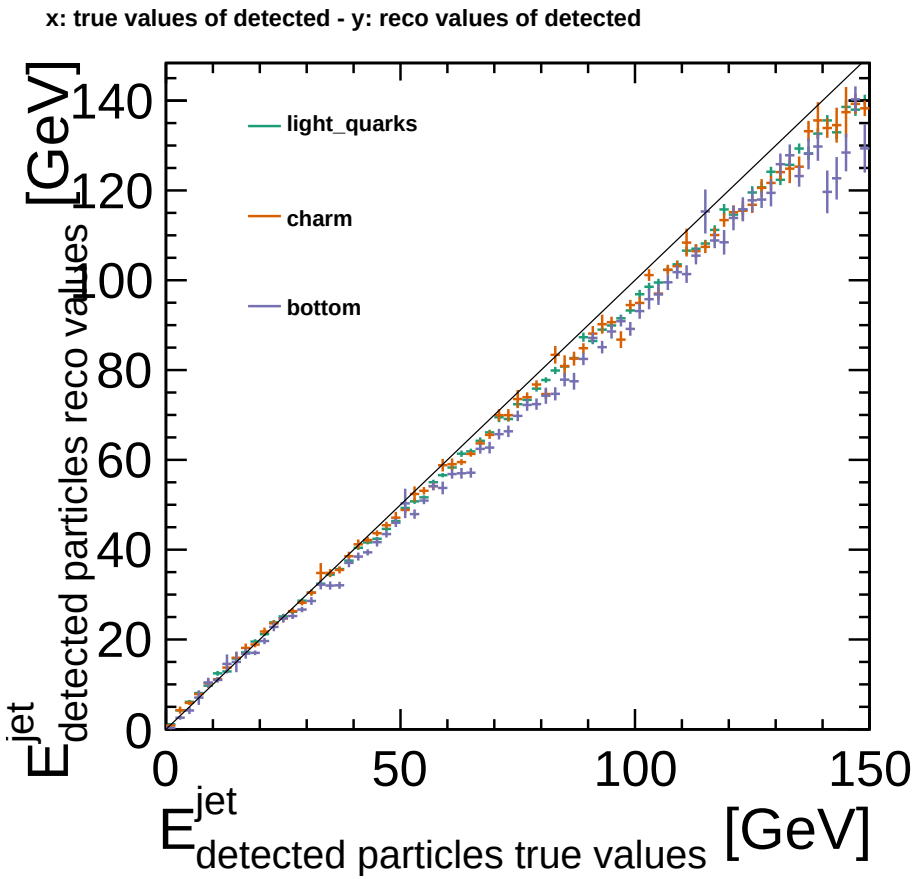

Conclusions and Outlook

- `RecoMCTruthLinker` and `TrueJet` are in `MarlinReco/Analysis`
- `.RecoMCTruthLinker` is run in standard production, while `TrueJet`, which only needs DST-input, is not.
- `TrueJet` is useful for disentangling effects of jet clustering from particle flow, from combinatorics, from detector effects.
- It is also useful for testing and developing overlay-removal and jet-clustering methods.
- Status:
  - All Whizard generated event-types have been tested and works - except $\gamma\gamma$ (which has, however been successfully tested at the generator output level)
  - Right now, it does not work for 8-fermion samples from Physim - all Whizard generated event-types have been tested and works.
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