

Latest developments for SGV

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Outline

- 1 **SGV**
 - Tracker simulation
 - Comparison with fullsim
 - Calorimeter simulation
 - Comparison with fullsim
- 2 **LCIO DST mass-production**
- 3 **Installing SGV**
- 4 **Summary**

Features of “la Simulation à Grande Vitesse”

- Typical generation+simulation+reconstruction time $\mathcal{O}(10)$ ms.
- Fully configurable discs 'n' cylinders geometry.
- Event generation: Callable PYTHIA, Whizard or input from PYJETS or stdhep.
- Output of generated event to PYJETS or stdhep.
- samples subdirectory with steering and code for:
 - Particle-flow parametrisation.
 - SUSY with PYTHIA
 - Whizard integration.
 - output LCIO DST
 - NEW : Beam-spectrum for PYTHIA.
 - NEW : BeamCal simulation including effects of pair-background.
 - Tools and examples.
- Written in Fortran 95.
- Some CERNLIB dependence.
- Managed in SVN. Install script included.
- Timing verified to be faster (by 15%) than the f77 version.

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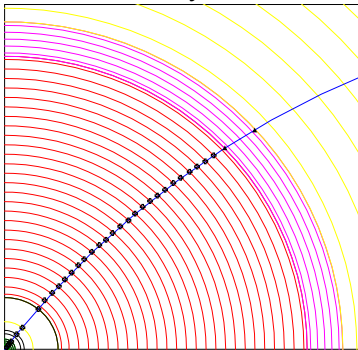
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SGV: How tracking works

SGV is a machine to calculate covariance matrices

Follow track-helix through
the detector-layers



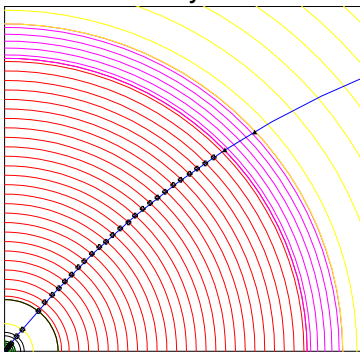
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EM-interactions in detector
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- Calculate cov. mat. at perigee, including material, measurement errors and extrapolation.
- Smear perigee parameters (Choleski decomposition: takes all correlations into account)
- Helix *parameters* exactly calculated, *errors* with one approximation: helix moved to (0,0,0) for this.
- Other stuff:
 - Plug-ins for particle identification, track-finding efficiencies,...
 - Information on hits accessible to analysis.

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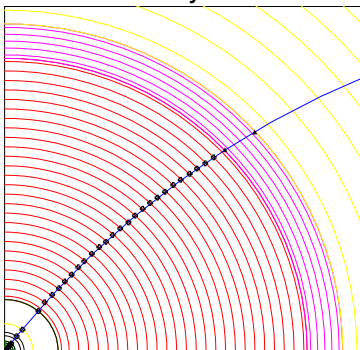
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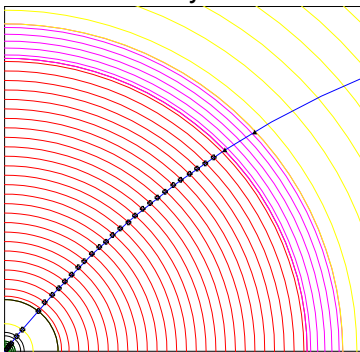
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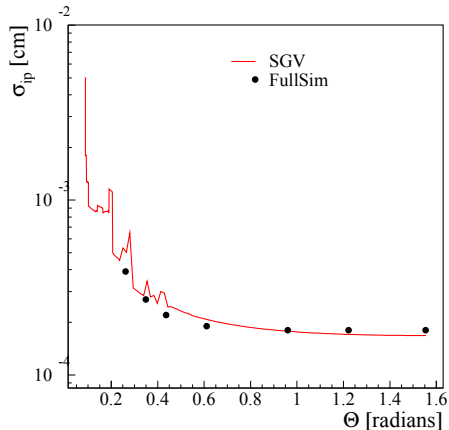
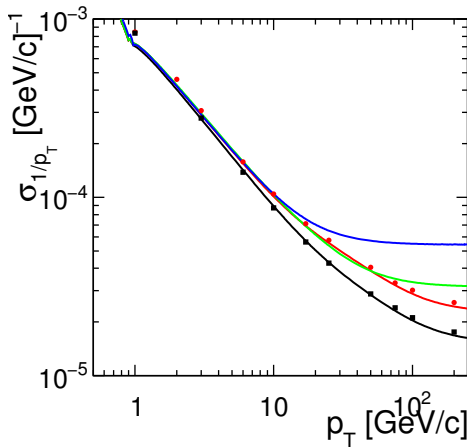
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SGV and FullSim: P_T and D_0 resolution



Lines: SGV, dots: Mokka+Marlin

Calorimeter simulation

The issues:

- Clearly: Random E, shower position, shower shape. Controlled by the geometry-file.
- But also association errors:
 - Clusters might merge.
 - Clusters might split.
 - Clusters might get wrongly associated to tracks.
- Will depend on Energy, on distance to neighbour, on EM or hadronic, on Barrel or forward, ...
- Consequences:
 - If a (part of) a neutral cluster associated to track → **Energy is lost.**
 - If a (part of) a charged cluster **not** associated to any track → **Energy is double-counted.**
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Study and Parametrisation of PFA

Look at how PFA on FullSim has **associated tracks and clusters**:

- From **LCIO** : MCParticles, Tracks, CalorimeterHits, Clusters, PFO's.
- Use **RecoMCTruthLinker**, with all switches on: Full relations.
- Create **true clusters**:
 - Each MCParticle is connected to a set of clusters made of CalorimeterHits **created by this true particle only**.
 - Each of these clusters **contribute to only one** Pandora cluster.

With this info:

- Identify, factorise and parametrise:
 - Probability to split
 - If split, probability to split off/merge the entire cluster.
 - If split, but not 100 %: Form of the p.d.f. of the fraction split off.
- All cases (EM/had - split/merge - Barrel/endcap) can be described by the **same functional shapes**.
- Functions are combinations of **exponentials and lines**.
- **28 parameters** $\times$ 4 cases (em/had $\times$ double-counting/loss)

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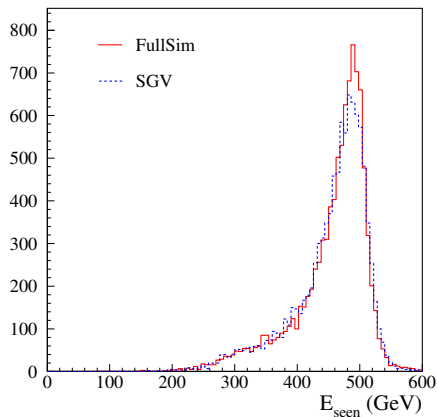
Feed **exactly the same** physics events through FullSim or SGV.

- Overall:
 - Total seen energy
- $e^+e^- \rightarrow ZZ \rightarrow$ four jets:
 - Make "True Jets":
 - Reconstructed M_Z at different stages in FullSim.
 - Seen Reconstructed M_Z , FullSim and SGV.
 - Jet-Energy resolution
- Zhh at 1 TeV:
 - Visible E
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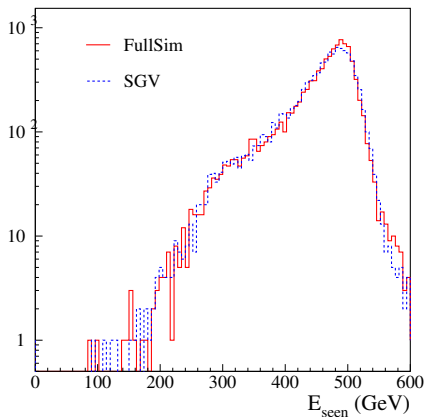
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"True jets"

- Find initial hadrons from each colour-singlet (string).
- Find the quarks at each end of the string.
- Group hadrons to jets by which quark they are closest to.
- Follow the decay-chains and assign all particles in the event to the jet of their respective ancestor hadron.

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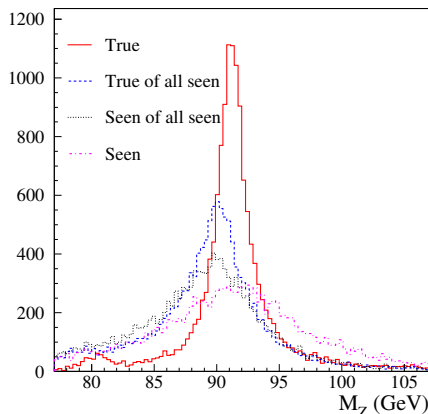
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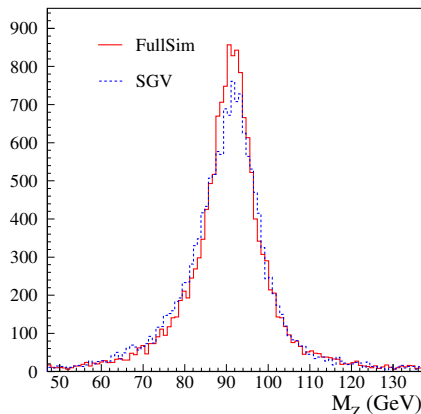
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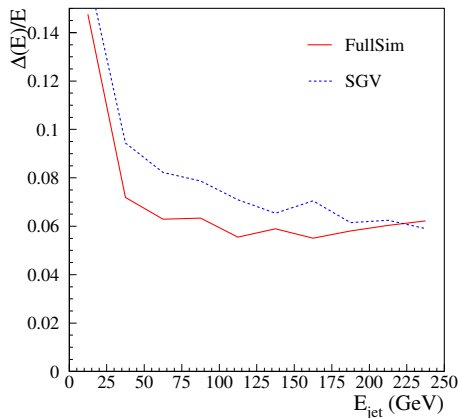
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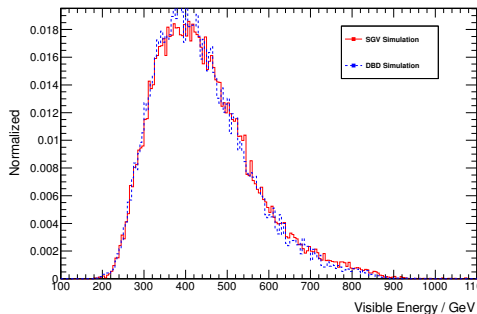
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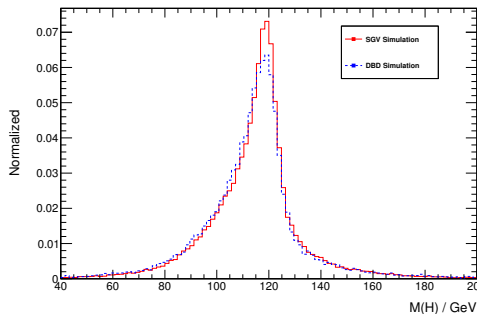
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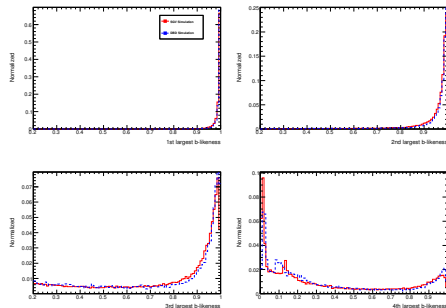
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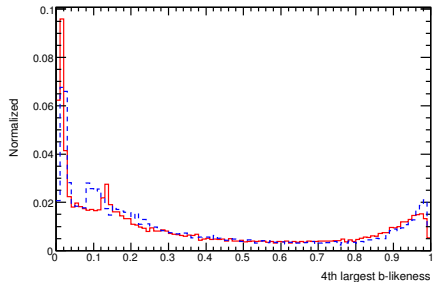
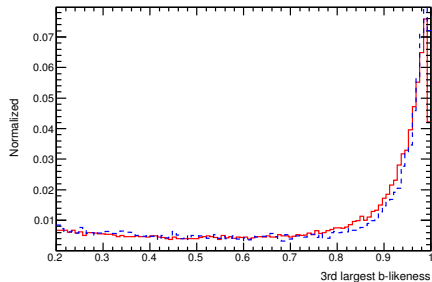
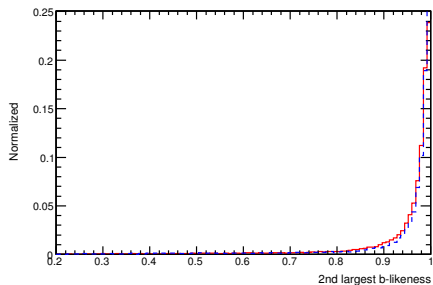
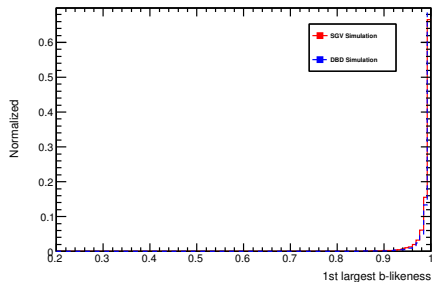
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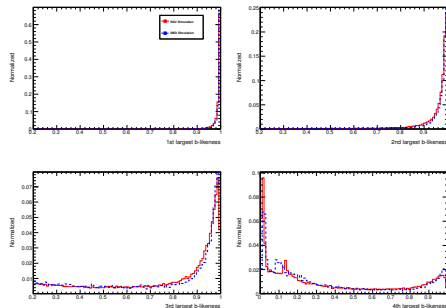
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LCIO DST mass-production

SGV has been used to produce ILD LCIO DST:s for the full DBD benchmarks- **several times**.

- 43 Mevents.
- ~ 1 hour of wall-clock time (first submit to last completed) on the German NAF.
- **NEW**: Also added $\gamma\gamma \rightarrow f\bar{f}$ at 500 GeV. Another **167 Mevents** (0.5 TB of DSTs ...). Took **30 minutes** on the NAF.
- On the grid under:
 - `lfn:/grid/lc/users/berggren/mc-dbd/sgv-dst_y/zzz/xxx`
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Installing SGV

Do

```
svn co https://svnsrv.desy.de/public/sgv/trunk/ sgv/
```

Then

```
cd sgv ; . ./install
```

This will take you about **30 seconds** ...

- Study README do get the first test **job done** (another **30 seconds**)
- Look README in the **samples** sub-directory, to enhance the capabilities, eg.:
 - Get **STDHEP** installed.
 - Get **CERNLIB** installed in native 64bit.
 - Get **Whizard** (basic or **ILC-tuned**) installed.
 - Activate **PFlow** parametrisation.
 - Get the **LCIO-DST** writer set up
 - ...

Summary

- The main features of the **SGV** FastSim program was presented.
- The method to emulate the performance of FullReco **particle-flow** (PandoraPFO) was explained.
- Comparisons to FullSim (Mokka/Marlin) was shown to be **quite good**.
- Recently added features:
 - Beam-spectrum for PYTHIA.
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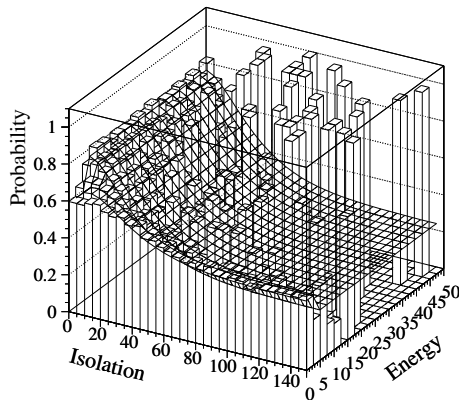
Thank You !

Backup

BACKUP SLIDES

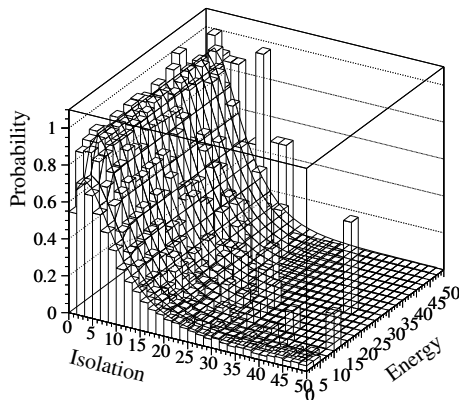
Observed distributions

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- ... and vs E
- Fit of the **Distribution** of the fraction
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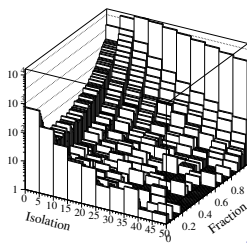
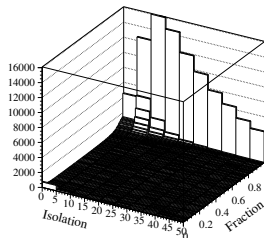
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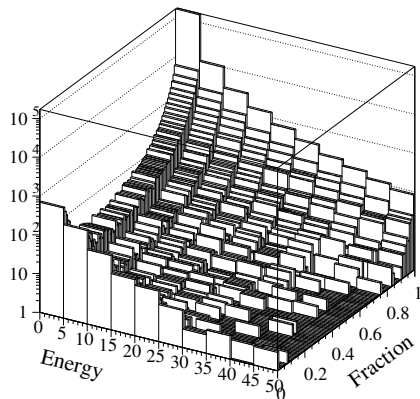
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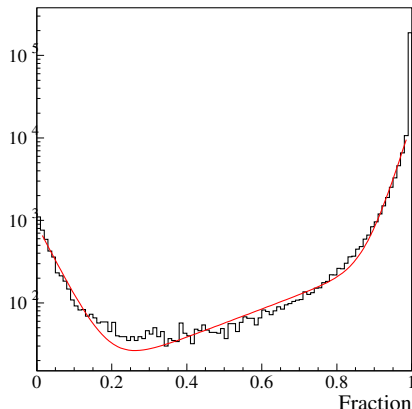
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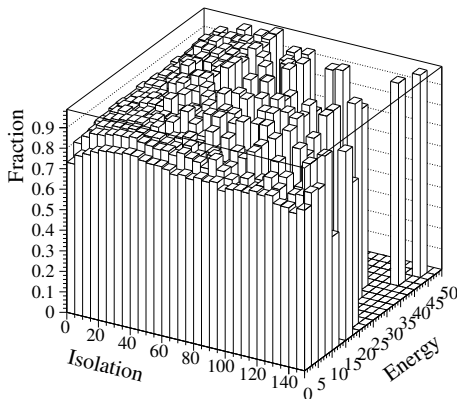
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Total cross-section for $e^+e^- \rightarrow \gamma\gamma e^+e^- \rightarrow q\bar{q}e^+e^-$: **35 nb** (PYTHIA)

- $\int \mathcal{L} dt = 500 \text{ fb}^{-1} \rightarrow 18 \times 10^9$ events are expected.
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SUSY parameter scans

Simple example:

- MSUGRA: 4 parameters + sign of μ
- Scan each in eg. 20 steps
- Eg. 5000 events per point (modest requirement: in sps1a' almost 1 million SUSY events are expected for 500 fb^{-1} !)
- $= 20^4 \times 2 \times 5000 = 1.6 \times 10^9$ events to generate...

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Use-cases at the ILC

- Used for **fastsim physics studies**, eg. arXiv:hep-ph/0510088, arXiv:hep-ph/0508247, arXiv:hep-ph/0406010, arXiv:hep-ph/9911345 and arXiv:hep-ph/9911344.
- Used for **flavour-tagging training**.
- Used for overall **detector optimisation**, see Eg. Vienna ECFA WS (2007), See Ilcagenda > Conference and Workshops > 2005 > ECFA Vienna Tracking
- **GLD/LDC merging and LOI**, see eg. Ilcagenda > Detector Design & Physics Studies > Detector Design Concepts > ILD > ILD Workshop > ILD Meeting, Cambridge > Agenda > Sub-detector Optimisation I

The latter two: Use the Covariance machine to get **analytical expressions** for performance (ie. *not* simulation)

White paper

- Written in Fortran 95.
- CERNLIB dependence. Much reduced wrt. old F77 version, mostly by using Fortran 95's built-in matrix algebra.
- Managed in SVN. Install script included.
- Features:
 - Callable PYTHIA, Whizard.
 - Input from PYJETS or stdhep.
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 - samples subdirectory with steering and code for eg. scan single particles, create hbook ntuple with "all" information (can be converted to ROOT w/ h2root). And: output LCIO DST.
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Study README, and README in the [samples](#) sub-directory, to eg.:

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Calorimeter simulation: SGV strategy

- Concentrate on what really matters:
 - True charged particles **splitting off** (a part of) their shower: **double-counting**.
 - True neutral particles **merging** (a part of) their shower with charged particles: **energy loss**.
- Don't care about neutral-neutral or charged-charged merging.
- Nor about multiple splitting/merging.
- Then: identify the **most relevant variables** available in fast simulation:
 - Cluster energy.
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Collections

- Added sensible values to all collections that will (probably) be there on the DST from the fullSim production.

- BuildUpVertex
- BuildUpVertex_RP
- MarlinTrkTracks
- PandoraClusters
- PandoraPFOs
- PrimaryVertex
- RecoMCTruthLink

- MCParticlesSkimmed
- V0Vertices
- V0RecoParticles
- BCALParticles
- BCALClusters
- BCALMCTruthLink
- PrimaryVertex_RP

- Also added more relation links:

- MCTruthRecoLink
- ClusterMCTruthLink
- MCTruthClusterLink

- MCTruthTrackLink
- TrackMCTruthLink
- MCTruthBcalLink

Comments

Secondary vertices (as before):

- Use **true information** to find all secondary vertices.
- For all vertices with ≥ 2 seen charged tracks: do vertex fit.
- Consequence:
 - Vertex *finding* is too good.
 - Vertex *quality* should be comparable to FullSim.

In addition: Decide from **parent pdg-code** if it goes into BuildUpVertex or V0Vertices !

MCParticle :

- There might be some issues with history codes in the earlier part of the event (initial beam-particles, 94-objects, ...)

Comments

Clusters:

- Are done with the Pandora **confusion** parametrisation on.
- Expect $\sim$ correct dispersion of jet energy, but a **few % to high central value**.
- See my talk three weeks ago.
- **Warning:** Clusters are always **only in one detector** , so don't use E_{had}/E_{EM} for e/π : It will be $\equiv 100$ % efficient !

Navigators

- **All the navigators** that the TruthLinker processor makes when all flags are switched on are created:
 - Both Seen to True and True to Seen (**weights are different** !)
 - Seen is both PFOs, tracks and clusters.
 - The standard RecoMCTruthLink collection is as it would be from FullSim ie. weights between 0 and 1.

Outlook

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