Status of physics Tools in Marlin

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Outline

Topics

Topics that will be discussed:

- What is the specific needs for physics analysis ?
- What exists as analysis tools in Marlin ?
- What else exists in people's cupboards ?
- What is their status - support, LDC/GLD $\rightarrow$ ILD , ...
- What would be useful to add ?
- Are our procedures the good ones to efficiently catch the developments done and make them available for the collaboration?

Requirements for a Physics Analysis Tool

In an ideal world, a Physics analysis tool should:

- Have a low threshold for the novice Marlin user.
- Have a documentation with
  - Example processor and steering-file.
  - Physics and mathematics explained.
  - Reference to the original publication of the method.
  - Technical implementation details are less important.
  - Ie. rather an "User's Guide",than a "Reference Manual" !
- Be usable on the most compact data-source, presently the DST.
- Have support.
- Be flexible.

Such a tool will be used !

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Requirements for a Physics Analysis Tool

While we have a solid tool for simulation and reconstruction, both for ILD and for test-beams, do we have what is needed to as smoothly as possible also do physics analysis of what we produce?

- Is the "end-user" (ie. physicist doing physics analysis with the ILD) well served ?
- Is the DST-format adequate for $>$ 90 % of the needs ?
- Do we all the tools needed to do standard physics analysis ?
- Does these tools have support ?
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Analysis $\Leftrightarrow$ Reconstruction

I will be talking about analysis tools, meaning that the border will be somewhere after the core-MarlinReco functionality. There are some ambiguities:

- Is jet-finding analysis or reconstruction ?
- Flavour tagging ?
- PFA ?

Traditionally, flavour tagging and PFA is considered as reconstruction in ILD, because the complexity of these tasks.

In physics analysis, the aim should be that the DST contains sufficient information to do the job.

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However, any given analysis has different requirements:

- Is the worst error to claim that an event has a property that it in reality has not, or to claim that it hasn't a property that it in reality has?
- Ie. is it type I or type II errors that should be. avoided ?
- NB. you can't get high significance and high power at the same time ...
- What is the null hypothesis H_0, and what is the alternative one H_1? Eg. "Particle is a hadron" vs. "particle is a muon", is not the same test as to "Particle in not a muon" vs. "Particle is a muon".

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LCFI and Pandora

LCFI and, to some extent, Pandora, are physics analysis tools rather than reconstruction:

- Flavour tagging exhibits the Type I/Type II dilemma: what is worst: to call a jet a b-jet if it isn't, or not to call it a b-jet if it is ? This clearly depends on the physics.
- Flavour tagging also has the H_0/H_1 problem: Is the question "b or not b", or "hf or not hf", or "b or c", or ... ?
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Tools in ILCSoft

The existing tools can mostly be found under MarlinReco/vxxx/Analysis/:

- EventShapes
  - Fox: Calculates Fox-Wolfram moments (P.Krstonosic)
  - Sphere: Calculates aplanarity, sphericity, ...(P.Krstonosic)
  - ThrustReconstruction: Calculates thrust and axes (?)
  - YThresh: Calculates Y-cut value for transition from N to N+1 jets (Durham) (B. Hooberman)
- SatoruJetFinder: Multi algorithm Jet finder. (S. Yamashita, T. Kuhl, J. Samson)
- RecoMCTruthLink
  - MCTruthJetEnergy: Calculate true jet energy (M.Beckmann, F.Gaede)
  - (RecoMCTruthLinker: MC to reconstructed link for skimmed MC collection (F.Gaede))

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- MarlinKinfit: Kinematic fitting (B. List, J.List, M. Beckmann)
- BCalTagEfficiency: Gives probability to see a high energy electron or photon above the pair-background in the BeamCal (M. Montull, J. List, M.B.)
- ZFinder: Recover brems-strahlung photons from electrons in the detector (M. Thomson)

NB.: All of these are Marlin processors, which might be inefficient: Eg. suppose you want to use all EventShapes for a NN training. You will then loop all ReconstructedParticle:s in the relevant collection for each variable ...

$\Rightarrow$ Consider packages, rather than Processors !

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Some other tools

There are also many other tools around. A few examples that I'm aware of, mostly from DESY:

- Beam_Spectrum_Weighter : Calculates event-weight to get a different beam-spectrum than what was generated (M.B).
- RootTreeWriter : Takes care of all the difficult stuff when creating and filling RootTrees in a Marlin Job (O. Samson)
- A parametric approach to dE/dx particle identification (P. Schade)
- LCIOToRoot: Create and fill a RootTree with "all" DST information (M.B.)
- tsttav: DELPHI tau finder for new physics (M.B.)

There are also many other procedures used in various analyses presented in the LOI and elsewhere (jet-pairing procedures, tau-decay channel identifiers, lepton-id procedures, determination of SUSY masses, ...), that has remained private.

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Tools on the border-line

There are also tools that are on the border between reconstruction and analysis. Typically they either are quite time-consuming, difficult to master and/or need more information than what is on the DST to run:

- KinkFinder and V0finder (under MarlinReco/vxxx/Tracking): find kinks or decays in the tracker (M. Thomson)
- PFOid (under MarlinReco/vxxx/PFOID): Particle identification (M. Ohlerich, A. Raspereza)
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Support level

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Useful tools missing for DST analysis

A few items on my personal list:

- dE/dx particle id.
- Vertex fitting.
- Impact parameters wrt. fitted vertex/beam spot.
- Different H_0 and H_1 in flavour tag.
- Truth↔Seen disentangler.

Many of these exist at reconstruction-level, but can't be run with at DST-level, which is what we want for physics analysis.

Problems

- Why are there so few central tools, mainly from “the usual suspects”?
- Did all the students doing analyses just run Marlin once to create Root-files and never touch it again ? So that all the smart analysis ideas only were done in Root macros ?
- Or did they get intimidated by the way we manage the software ?
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- Exercise:
- 1. Find the energy in LumiCal for a ReconstructedParticle.
- 2. Find and interpret the result of LCFI on the DST.
- Only allowed help is the documentation linked to ILCSoft portal.

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- Some examples of missing tools was also given.
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- A survey of existing tools was given.
- Some examples of missing tools was also given.
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