High-Level Reconstruction: Where did we get?

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10.7.2015

HLRecoWS 2015
6-10 July 2015, Hamburg, Germany

Towards a new reconstruction

DBD Reconstruction - Overview

```
<marlin>
  <execute>
<!-- =========  overlay gamma gamma background ========== -->
    <processor name="BgOverlay" />
<!-- ========== track digitization and tracking  === -->
    ......
    <!-- ========== the new C++ tracking ========== -->
    <processor name="MyClupatraProcessor" />
     <processor name="MySiliconTracking_MarlinTrk"/>
    <processor name="MyForwardTracking"/>
    <processor name="MyTrackSubsetProcessor" />
    <processor name="MyFullLDCTracking_MarlinTrk"/>

<!-- ========== the post tracking patrec ========== -->
    <processor name="MyV0Finder"/>
    <processor name="MyKinkFinder"/>
....
```

Fix average number

yy->hadron overlay

Minivector VTX tracking

TPC, Si, Fwd tracking, combined track fit in FullLDCTracking

????? Status?

V0 & Kink finding: input to Pandora

DBD Reconstruction - Overview

```
<!-- ===== calorimeter digitization and PFA ========== -->
  ....
<processor name="MyMarlinPandora"/>
<processor name="MyBCalReco"/>

<!-- ========== particle ID ==================== -->
<!--processor name="MyPFOID" / →

<!-- ========== full and DST output ============== -->
<processor name="MyRecoMCTruthLinker"/>

<!-- ========== vertex finder ==================== -->
<processor name="VertexFinder"/>

<processor name="MyLCIOOutputProcessor"/>
<processor name="DSTOutput"/>
</execute>
```

PFO covariance matrix

Update Pandora & Calib Garlic?

PFO creation: PandoraPFANew BeamCal (pair bkg)

New BeamCalReco

PARTICLE ID!

NO PARTICLE ID

Updated version, truth vertices

Link PFOs with MCTruth

track recovery, updates

VertexFinder from LCFIPlus

are we happy with DBD DST format?

REC & DST output

New Reco: Structure

1. new standard reconstruction:
   SIM -> REC, DST: digitization, full reconstruction
2. re-dsting:
   REC -> DST:
   add new features on DBD REC files which require HITS
   dE/dx, cluster shapes, PID
   this becomes possible since it is now allowed to
   write out updated collections!
3. post-dsting:
   DST -> postDST: collect steering examples for running
   high-level reconstruction which is analysis-dependent:
   isolated leptons, overlay removal, jet finding, tau finding,
   pi0 finding, flavour tag

New Reconstruction

- Background Overlay [optionally]
  - gammagamma->hadrons (unchanged)
  - pairs (to be added)
- Digitisation
  - all as is, apart from
  - VXD: 3 options for DBD, fastDBD, **challenge** (done)
- Tracking
  - all as is, apart from
  - SiTracking: 3 options DBD, **mini-vec**, FPCCD (done)
  - dEdx (done) [improve error estimate]
  - V0/Kinks [fill all data members, medium term: improve!]
- Garlic [optionally] (done)

New Reconstruction (cont'd)

- Pandora
  - 3 options: new standard, **improved photons**, Garlic (done)
  - MarlinPandora/PFOCreator: fill all data members of LCIO:Clusters and ReconstructedParticles
- BeamCal
  - for now as in DBD
  - new version from Andre Sailer / Andrey Sapronov: needs formatting of pair background input and tuning to ILD – unclear
- VertexFinding
  - include adaptive vertex finding [to do]
- Truth
  - RecoMCTruthLink [to be updated]
  - TrueJet [to be updated]

Re-DSTing

- need to set
  <parameter name="AllowToModifyEvent" value="true" />
- dE/dx (done) [improve error estimate]
- ClusterShapes (done)
- ParticleID (done) [add special low pt stuff]
  - “basic” (ECal/ HCal ratio etc)
  - dE/dx based
  - cluster based
  - combined

Post-DST

- TauFinding
  - TaJet (taus in jet environment) (done)
  - DelphiTau (taus in low multiplicity) [to be added]
- pi0 (eta, eta') finding [under way]
- Isolated Lepton Finding (done)
- Jet Finding
- Flavour Tag
- .....

Content of Clusters and ReconstructedParticles

Content of EVENT::Cluster - TODO

getType:

should be bits from calos contributing energy

not used now -> do we need it ? – to leave unused

getEnergy: Pandora improved energies - todo

getEnergyError:

if pdg != 22/11: 60%/ sqrt(getEnergy) +3%

if pdg = 11/22: 17%/sqrt(getEnergy) + 1% ,
as used in Pandora's track-cluster matching - todo

get SubdetectorEnergies:

raw hit sums

split between barrel / endcaps -> todo

getHitContributions = if hit belongs to several clusters! - not used by Pandora

Content of EVENT::Cluster - TODO

getPosition: center-of-gravity as default - ok

for photons: via cluster shape (Graham & John todo: verify implementation in Pandora and transfer information out to LCIO for Cluster)

getITheta/IPhi: direction of cluster main axis

getPositionError, getITheta/IPhiError: rms of cog/main axis, to be calcuated in the same place: ClusterShapes.cc - TODO (->Mikael)

all properties will be set in MarlinPandora/.../PfoCreator.cc

routines for actual calculations:

-> eventually to MarlinUtil/ClusterShapes

-> for development: MarlinReco/Analysis/

Content of EVENT::ReconstructedParticle - TODO

currently filled in PFOCreator.cc

getType: particle “ID” by Pandora

isCompound: revise logic
- add “is not used in compound particle” = isConstituent
- todo!

momentum / energy: from track or cluster depending on charge

getMass: set independently!

getCharge: as is

getCovariance:

charged PFOs: implemented by Tino – todo: put in MarlinUtil/ (MarlinReco/ Analysis) and use in PfoCreator.cc - Tino

neutral PFOs: from cluster uncertainties – todo

getReferencePoint (todo?):

charged PFOs: z0 and (x0,y0) from (d0, phi0)

neutral PFOs: cluster position (cog or improved from shower shape)

Content of EVENT::ReconstructedParticle - TODO

getParticlesIDs: as discussed

getParticles: if compound...

getTracks, getClusters: ...

getStartVertex, getEndVertex (todo):

- should be filled by Pandora for V0s, Kinks etc
- should be filled by vertexing for the rest
  - -> needs to be able to update PFO!
- setStartVertex, no data member for EndVertex -> derived from getStartVertex of daughter particles on the fly, NULL else

Tau ID

two main approaches on the market:

TauJet: taus in hadronic events

Delphi: taus in low multiplicity events (up to ~10-15 PFOs)

plan:

release Taikan's TauJet in MarlinReco/Analysis - DONE

Taikan & Mikael go through details of both finders

how to combine?

wrap Delphi finder in SatoruJetFinder

lepton ID: improve by MVA, dE/dx, cluster shape

Vertexing

Vertexing is run on PandoraPFOs only

never tried on MarlinTrkTracks

need MarlinTrkTrack quality

suggestion to test:

- make basic track quality selection
- create a “TrackPFO” collection
- test vertexing on that
- Taikan comits Track2PFO converter into MarlinReco/Analysis
- if promissing: require Pandora to keep the relevant SOT tracks
- => work in progress by Sviatoslav / Roman /Yorgos

LCFIPlus

short-term:

adaptive vertex finding

soft lepton tagger using PID: put p_l in MVA

middle-term:

BNess tagger: add “CNess”? -> after WS

vertex mass: Graham or own pi0 reco? ->

for testing: use samples as in DBD!

enable vertex fit to read track collection directly ?

check if V0 PandoraPFO has end/start vertex correctly - has NOT

Truth Algorithms

TrueJets

- in v01-17-07
- needs: fixes for Higgs in final state, ttH physsim, gammagamma-> hadrons from Pythia

RecoMCTruthLink [to be updated]

- found various missing hit-MCP relations
- IMPORTANT: BeamCal hits by accident included in PandoraPFOs in DBD production ???
- fix-up will be provided

TrueShower – would it be useful? YES

Relation / Interplay with TruthVertices ???

Pair background

have file with MCParticles which go
directly through tracking volume without
backscattering ?

include pair overlay as option in stdreco?

BeamCal

not part of MarlinReco anymore, but in
new package FCalClusterer

use parametrised method

Frank will talk to Andre Sailer to understand preparation of
"TaggingEfficiency.root" input file for parametrised method

no simple fast sim parametrisation available ?

here the path to a usable update for ILD is still unclear

ILDPerformance

ILDPerformance Package

- Prototype by Yorgos, cf. presentation in Wednesday meeting
- add receipe to obtain standard performance plots
- more details than the hand-full of plots in DBD
- for software validation
- for performance comparison

Event-based

- FlavourTag (Taikan & Masakazu):
  - Efficiency vs rejection rate, Z->qq, ZZZ->qqqqqq, jet-based
    - B vs light, b vs c
    - C vs light, c vs b
  - Maybe ttbar?
- VertexFinding (Sviatoslav & Roman):
  - Efficiency to find B / D vertex as function of
    - Number of charged particles
    - Distance from IP
  - Number of correctly assigned tracks
  - „2D colour matrix“

Event-based

- Tracking (Yorgos, Tino)
  - Efficiency and bad track rate in ttbar, mumu vs p, theta
  - With >= 4 Si hits ? Or >= 4 in VXD ? In innermost
- Particle ID in jets (Masakazu)
  - same sample as flavour tag
  - Efficiency / fake rate vs momentum, theta, …
  - Same as single particle PID benchmarks
- Jets (Bono & Cambride group, Lan)
  - Invariant mass of uds dijets
  - Jet energy scale
  - Residual between
    - True and reco photon energy
    - True and reco neutral hadron energy
    - True and reco charged PFO energy
    - „PFO finding efficiency / fake rate“: but based on PFOs

Single particle based

- Photons: (Daniel?, Graham)
  - Efficiency / purity vs energy, theta
  - Energy resolution, x,y,z resolution of cluster position, intrinsic cluster direction
  - Number of reco photons per true photon,
- Pi0: Graham
  - „same as photons“
  - Mass resolution
- Taus ???: (Hieu, Taikan, Mikael)
  - „same as photons“
  - Decay mode separation
- V0, Conversions, J/Psi (Graham?)
  - Same as photon
  - Mass resolution

Single Particle based

- Particle ID: (Masakazu)
  - separately for dE/dx based, cluster-based, total
  - particles: e, mu, pi, p, K,
  - 1d histograms / matrix with probability to identify true type i as reco type j for fixed momentum: 0.5 GeV, 1 GeV, 2 GeV, … 10 GeV
  - e/pi separation vs p etc
- Tracking (Yorgos & Tino)
  - Single mu: resolution(d0, pt) vs momentum, theta
  - Single mu efficiency vs p, theta, d0
  - Pulls for dEdx
  - FWD Tracking: included
- BeamCal
- LumiCal
- Muon system ;-)

Conclusions

Further Plan

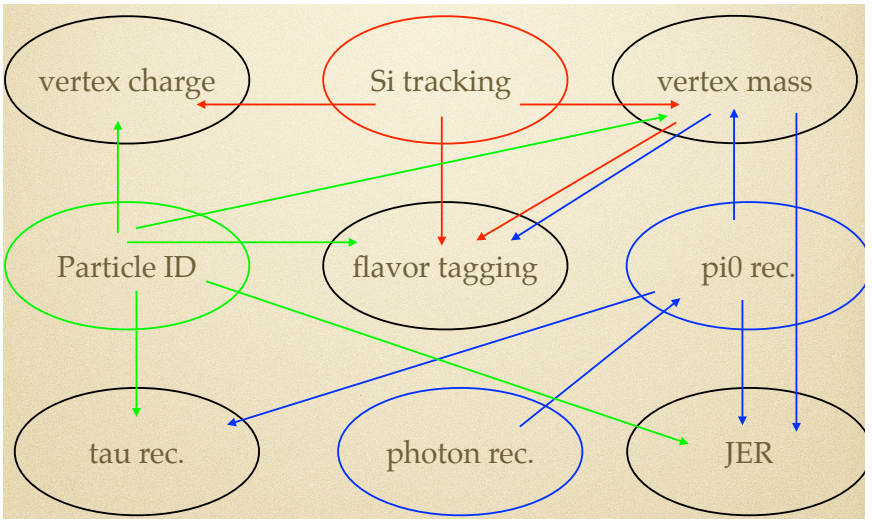
patch release v01-17-07.p02 TODAY

developers release v01-17-08 : next week
(before summer break)

Mokka-compatible
legacy release v01-18 (?): September ?

Conclusions – personal view

- we were *really* productive this week
- huge progress in integrated all the existing developments
- but also: significantly improved understanding of long existing stuff



- of course there remain several things to do
  -> but we have a clear path to proceed!

a big THANK YOU to all who contributed to this intense workshop – at DESY and remotely!