Higgs working meeting, Nov 12, 2021

- Long time since our last working meetings
  - A few emails sent over the summer were unanswered, apologies especially to Ang and to Jan

- More people have expressed interest to contribute – welcome to Roy and Nikos

- Physics Performance structure: this informal group will soon become an “official” working group
  - Timeline: < end of the year

- Had not created an informal mailing list in view of the to-come WG – but may be useful to create an e-group anyway, even if its lifetime is short ?

Summary of issues / caveats in the current samples

- Several issues reported – and understood to a large extent – at the last two physics performance meetings.

- The problems were in the Delphes card – i.e. private samples, made with the default card, are affected as well.

- Short summary :
  - Inefficiencies for very low momentum tracks (affects flavour analyses)
  - Inefficiencies for electrons
    - Initially believed to be due to isolation (cf Nicolas in July)
      - Problem was actually elsewhere – although the isolation may still need to be studied further
      - See news slides of the last Phys Perf meeting (or backup)
  - Severe issues with the jets that are produced with the current Delphes settings
    - Looked into only recently – little studies on jets so far, and these studies, as recommended, were re-running the jet clustering anyway, since the default algo (antikT) is no good for ee

Issues with the jets in the Delphes card

```
#####################################################
# Find uniquely identified photons/electrons/tau/jets
#####################################################

module UniqueObjectFinder UniqueObjectFinder {
# earlier arrays take precedence over later ones
# add InputArray InputArray OutputArray
  add InputArray PhotonIsolation/photons photons
  add InputArray ElectronIsolation/electrons electrons
  add InputArray MuonIsolation/muons muons
  add InputArray JetEnergyScale/jets jets
}
```

Overlap removal procedure: if an “isolated photon” is among the jet components, the jet is removed from the list (it is said to be a photon)

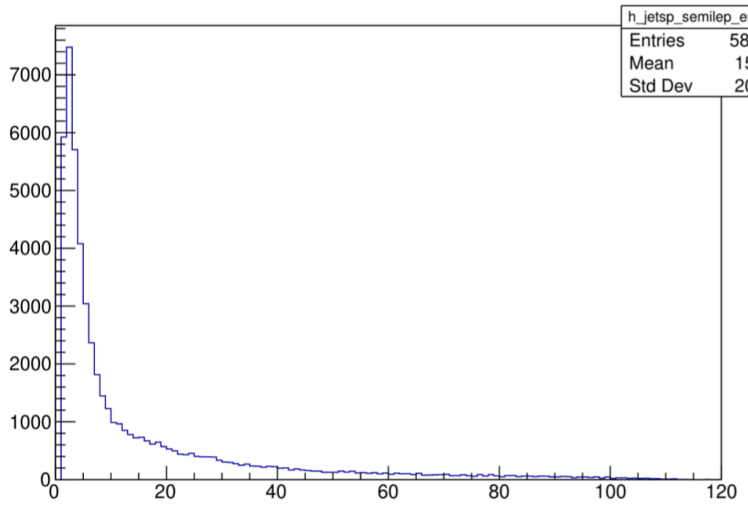
Problem: the ‘PhotonIsolation” module actually applies no isolation cut at all.
The overlap removal basically kills jets if there was a pi0 in the shower..

```
module Isolation PhotonIsolation {
  set CandidateInputArray PhotonEfficiency/photons
  set IsolationInputArray EFlowMerger/eflow

  set OutputArray photons

  set DeltaRMax 0.5

  set PTMin 0.5

  set PTRatioMax 999.
}
```

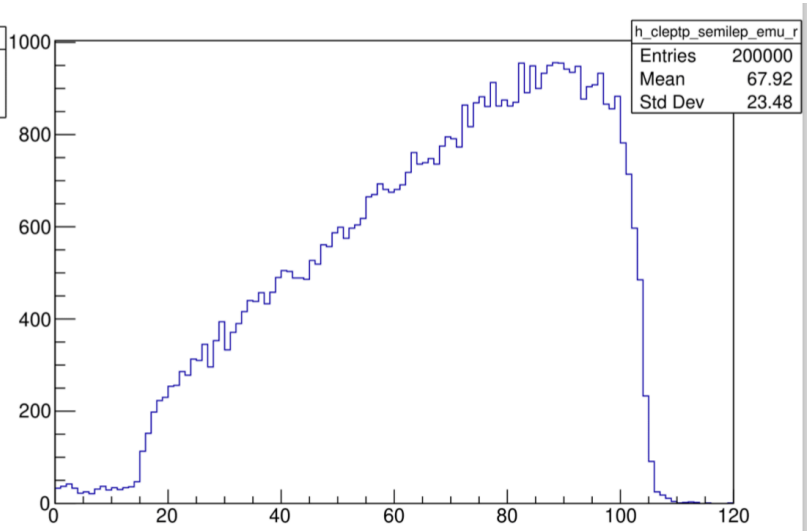
Issues with the jets in the Delphes card

- Next version of the delphes card will fix that – cf Michele's talk on Monday (overlap removal will be left to the users).

- Problem was realised and understood in the context of Jean-Loup analysis of WW events, see September meeting where this was shown and (orally) explained. https://indico.cern.ch/event/1076058/



Highest jet momentum in the Jet collection



Highest charged lepton momentum

Jets in the File are too soft

- Probably explains also other weird things seen with default jets, poor resolutions

To get the jets right

What you should do is re-cluster the jets, as explained here:
https://github.com/HEP-FCC/FCCeePhysicsPerformance/tree/master/General#example-analyses
(5th bullet).

Look at the example here:
https://github.com/HEP-FCC/FCCAnalyses/blob/master/examples/FCCee/top/hadronic/analysis.py
that shows how to re-do the jets (using JetClusteringUtils) (and how to 'tag" them (see JetTaggingUtils), if you are interested in that part).

That should be quite straightforward, but let me know in case of any problem.
This re-clustering was set up by Julie, there is some information in her talk in our September meeting.

Agenda for today

- Update from Andy / Nikos on Higgs to invisible
- Discussion on plans and next steps for the ZH analysis (measurement of the ZH cross section and of mH)
- Round-table, plans for other analyses
  - What can we target for the workshop in Liverpool in early February ?
  - Papers for Snowmass ? (deadline Mar 15)

Backup

Proposed structure for Physics Performance

- Have working groups that "mirror" the WGs of Physics Programme
  - Higgs / Flavours / Precision EW / Top / BSM / QCD
- Expect "working meetings" of these WGs where the details of the analyses are discussed.
- The monthly Physics Performance meetings would consist of :
  - regular status reports from these WGs
  - Detailed presentations of "case studies" when they are (close to) final or when there has been significant progress.
  - Reports on "transverse" activities – for example algorithms for b / c / g / s tagging, or packages for kinematic fits.
- Considering 1 junior + 1 more senior person as "conveners".

Starting to think of conveners. Please contact us if you have suggestions.
Timeline: goal is to have the first WGs in place by the end of the year.

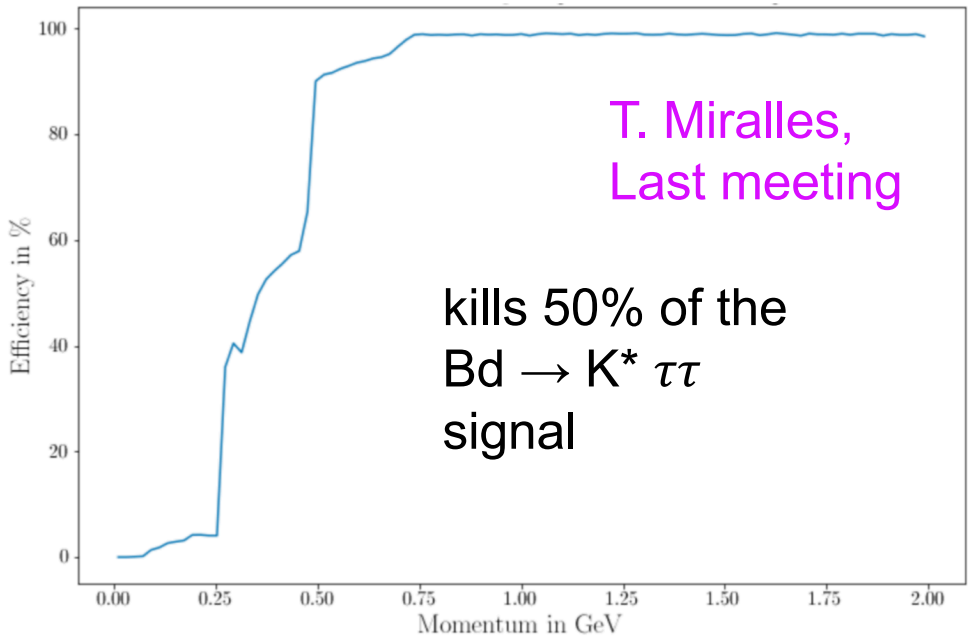
Follow-ups from the last meeting

Delphes-based analyses reported last time spotted two issues :

- Low efficiency for low pT tracks

Now understood :

- Trivial: the efficiency formula plugged in in the “efficiency module” was over-pessimistic
- Less trivial: fixing the formula was not enough.. Understood (Michele Selvaggi, Franco Bedeschi, E.P.)

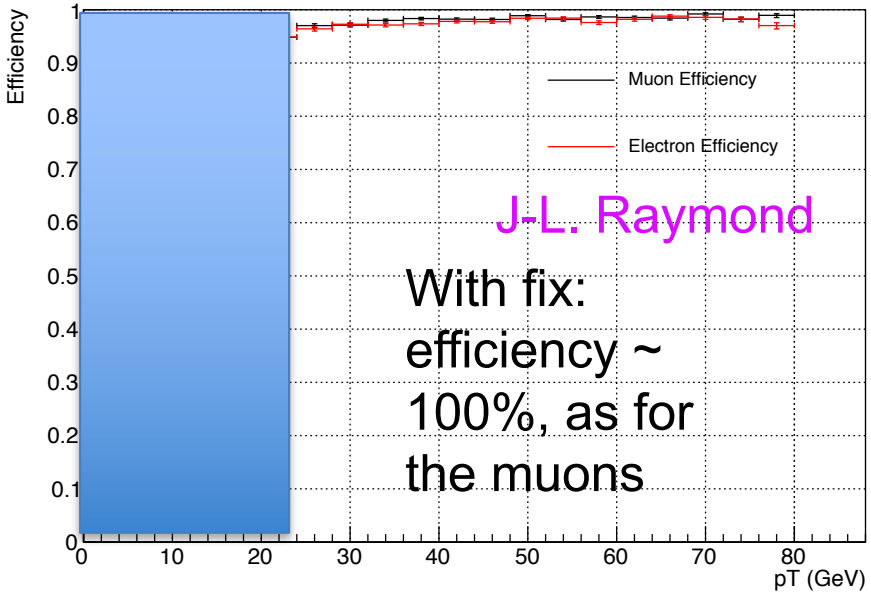


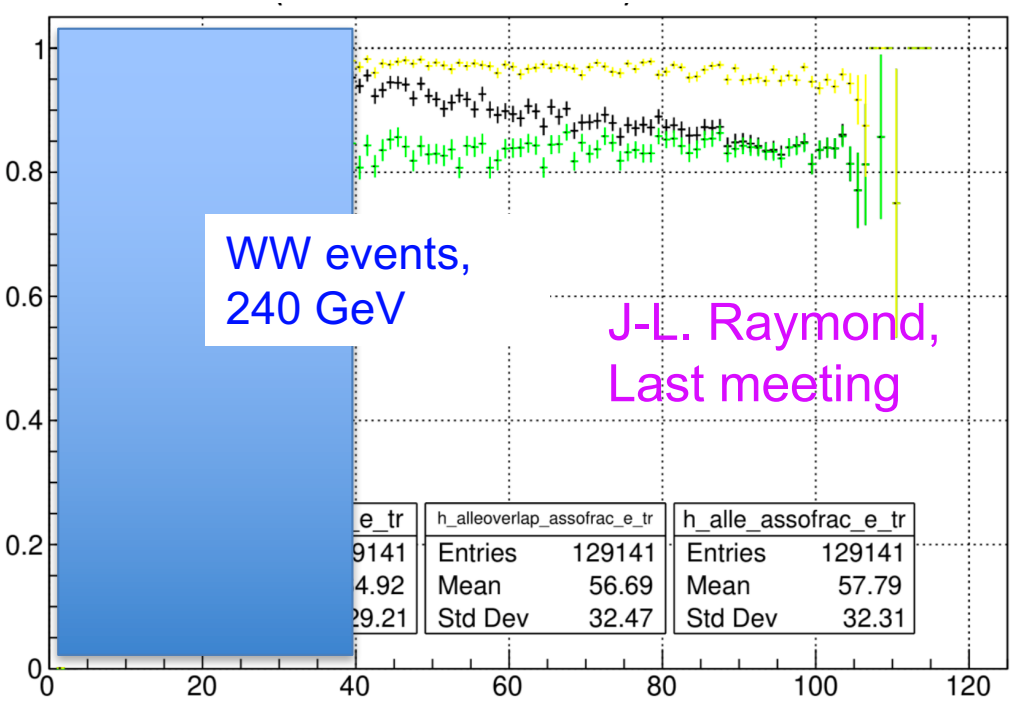
Fixes will be made in the next version of the Delphes card. Recovers full efficiency down to 100 MeV.

Follow-ups from the last meeting (2)

❑ Inefficiencies for high pT electrons

- Initially believed to be due to isolation (cut in Delphes is a bit tight, cf N.Morange, July meeting)
- But actually induced by the “overlap removal” between electrons and photons
- Cause understood, technical – “photons” created by the particle-flow module





Ways out were checked to recover the efficiency (Jean-Loup Raymond, Lucia di Ciaccio, Michele S, E.P.).

Will be fixed in the next version of the samples.