CP angular correlations in mu-tau channel

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Introduction

Status updated

- Study CP angle ϕ_{CP}. Introduction: see presentation Andrea
  https://indico.desy.de/indico/event/21271/
- Purpose presentation: status update
  - Study ggH, SUSY, and DY for two decay modes
    - Generator level results: amplitude/baseline ratio
    - First RECO level results
  - Next steps

Please note

- Just a progress report
  - Certain things ambiguous and still under construction!

NTupler

- Used SynchNTupler_2017.cc to create NTuples
- Run with mu tau mode
  - Here *exclusively* focus on two muonic-hadronic decay modes:
    - $\mu^{\pm}$ and $\pi^{\mp}$
    - $\mu^{\pm}$ and $\pi^{\mp}\pi^0$
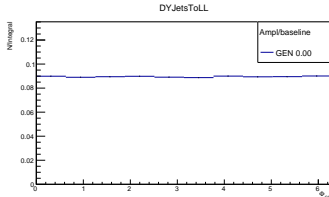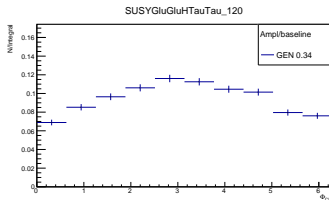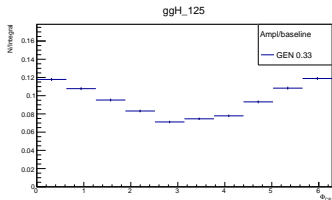- CP calculation genlevel (seemingly) working

Observables

- Spectrum ϕ_{CP}
- Ratio amplitude sinus over baseline
  - Some measure of resolving power

Decays to $\mu^{\pm}$ and $\pi^{\mp}$

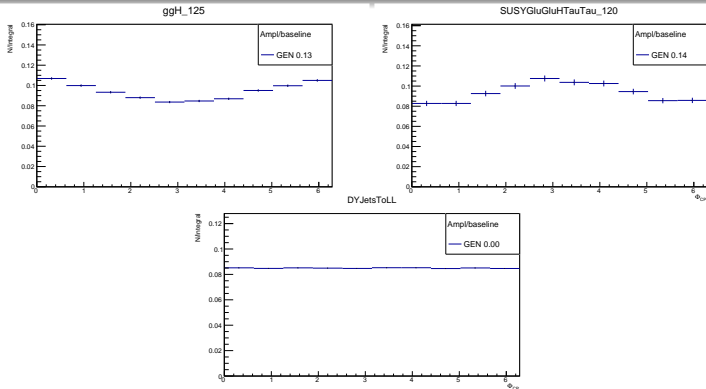## Decays to $\mu^{\pm}$ and $\pi^{\mp}$

- Left: ggH. Right: SUSY. Bottow: DY+Jets
  - ▸ Note phase difference CP1 and CP-1 (SUSY). Resolving power well comparable
  - ▸ DY bg flat
- Gen level distri's as expected.

Decays to $\mu^{\pm}$ and $\pi^{\mp}\pi^0$

Decays to $\mu^{\pm}$ and $\pi^{\mp}\pi^0$

- Left: ggH. Right: SUSY. Bottow: DY+Jets
    - Note phase difference CP1/CP-1. Resolving power comparable
    - Resolving power <half of decay without π^0
        - Consequence of τ analysing power
        - Note we can optimise spin analysing power with energy cuts
    - DY bg flat
- Gen level distri's as expected.
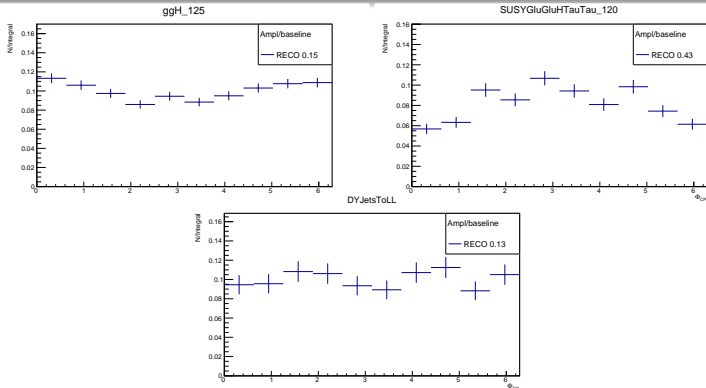
RECO level

NTupler

- 1 prong with neutral pion things seem to work..
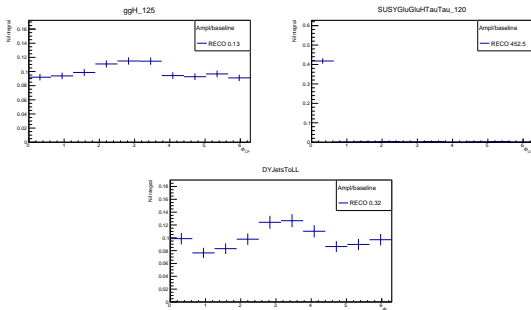- RECO level cuts in backup

RECO: $\mu^{\pm}$ and $\pi^{\mp}\pi^0$

- Left: ggH. Right: SUSY. Bottow: DY+Jets
  - Note expected phase difference CP1/CP-1
  - ggH sample comparable resolving power as gen level
  - SUSY sample *better* resolving power than ggH sample; likely statistical fluctuation
    - Intend to resolve by fitting..
  - DY bg flat *on average*
    - More statistics could be helpful
- RECO level more or less as expected

RECO: $\mu^{\pm}$ and $\pi^{\mp}$

RECO: $\mu^{\pm}$ and $\pi^{\mp}$

- Top left: ggH. Top right: SUSY. Bottow left: DY+Jets
  - ggH: out of phase with genlevel
  - SUSY: calculation appears erronous
  - DY bg problematic
- Perhaps issue with a switch in code..

Conclusions and next steps

CP calculations 1 prong mu-tau

- Gen level distri's appear in order
- RECO level: seems succesfully fixed for $\mu^{\pm}$ and $\pi^{\mp}\pi^0$
  - First results not disencouraging
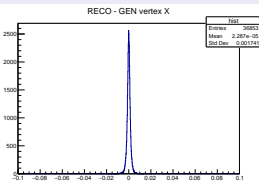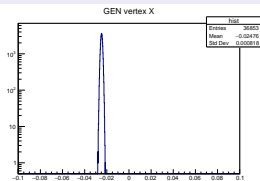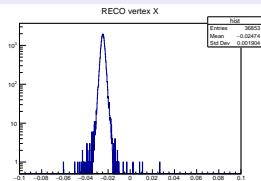- RECO level $\mu^{\pm}$ and $\pi^{\mp}$ not yet understood

Next step 1 prong mu-tau

- 1 prong mu-tau
  - Look into bad RECO results $\mu^{\pm}$ and $\pi^{\mp}$
  - More statistics could be useful at some point
  - Fit signal and bg for more stable amplitude/baseline ratio..
  - Decay to $\pi^{\mp}\pi^0$ may be optimised with energy cuts. Study gen level also!
- Further:
  - Andrea is working on mu-tau 3 prong implementation
  - Vinay and Diwakar working on vertex improvements by removing taus from vertex fitting algorithm

Some miscellaneous plots

Vertices

- For events that pass reco level cuts:
  - GEN vertex *x*
  - RECO vertex *x*
  - GEN-RECO
  - Suggest to pull changes to maintain storage in SynchNTupler_2017.cpp

RECO level cuts:

- Selection: `&&iso_1<0.15&&extraelec_veto<0.5&&extramuon_veto<0.5&&mva17_2>0.5&&mt_1<60&&againstMuonTight3_2>0.5&&againstElectronVLooseMVA6_2>0.5&&(singleLepTrigger>0.5||xTrigger>0.5)&&(os>0.5)`