

Interfacing Herwig++ and EvtGen

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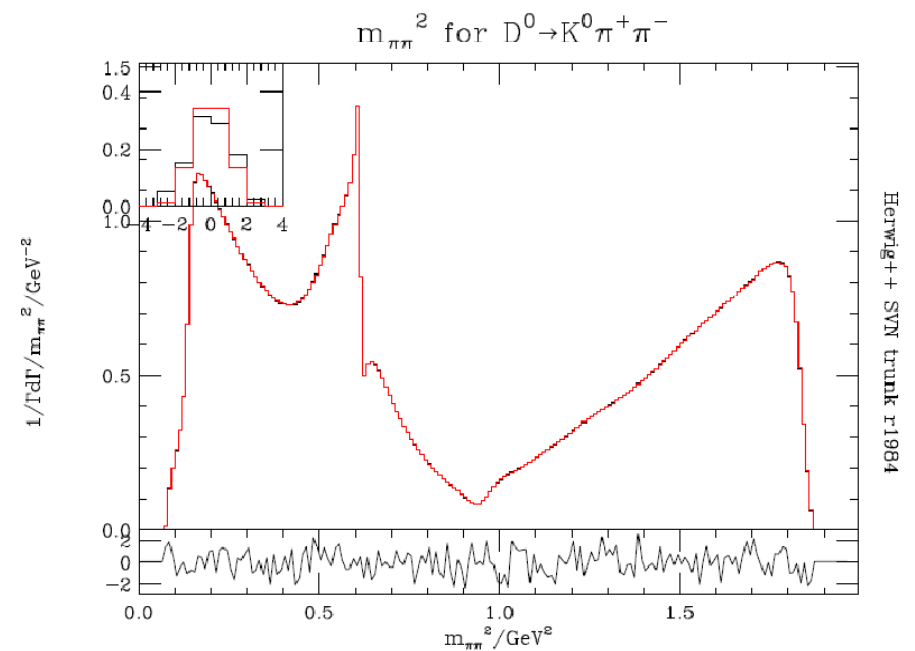
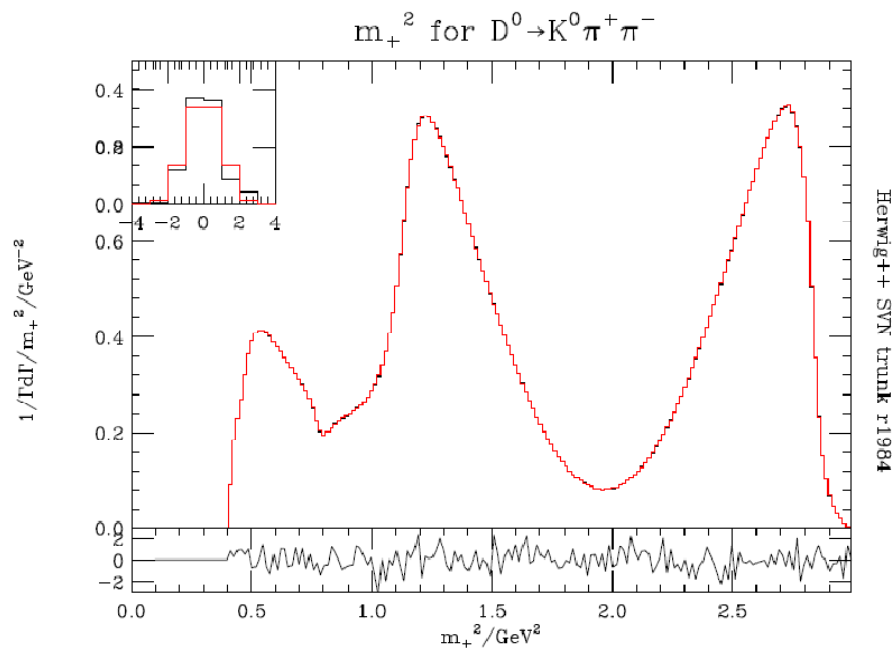
Outline

- Introduction
- Changes needed To EvtGen
- Conclusions

Herwig++

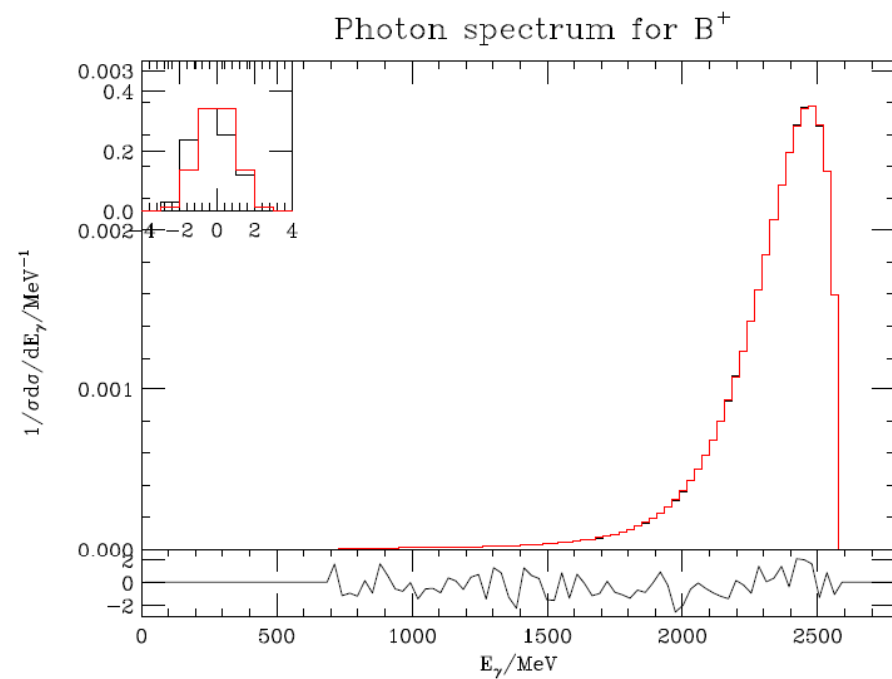
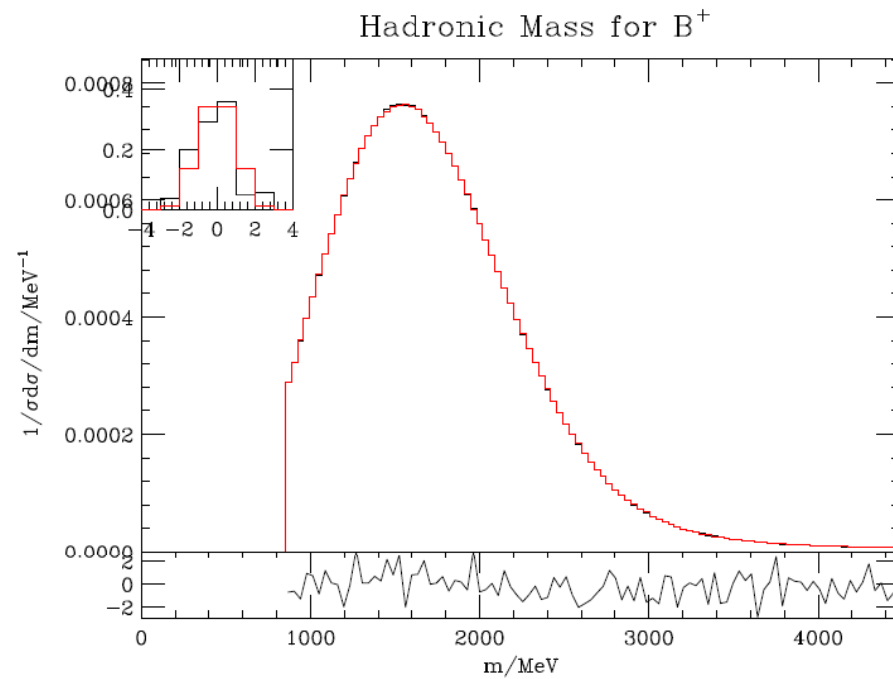
- In Herwig++ we now use the same algorithm we used in the FORTRAN program for the decay of fundamental particles for both fundamental and hadron decays.
- Herwig++ includes sophisticated modelling of the decays of fundamental particles, both SM and in BSM models, tau leptons, mesons and baryons.
- The algorithm is the same as that in EvtGen, although the implementation is different.

$D \rightarrow K \pi \pi$



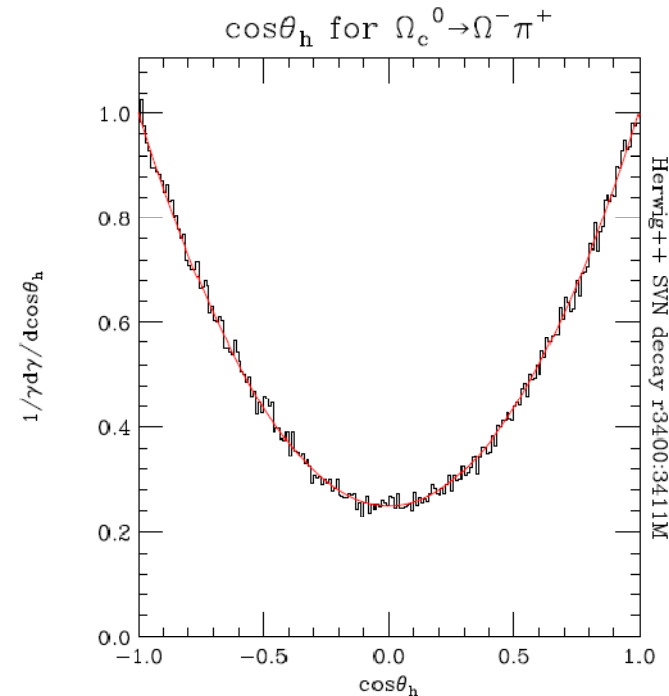
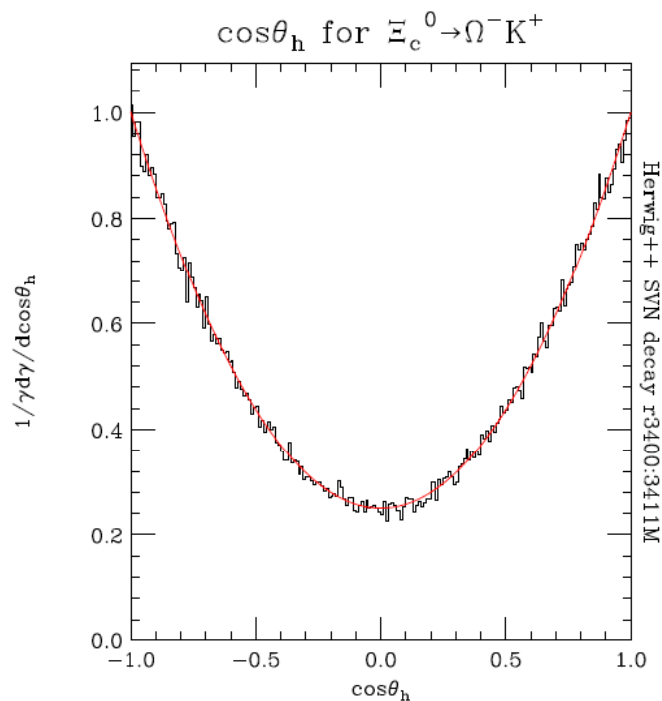
Comparison of Herwig++ and EvtGen implementations of the fit of Phys. Rev. D63 (2001) 092001 (CLEO).

$B \rightarrow s\gamma$



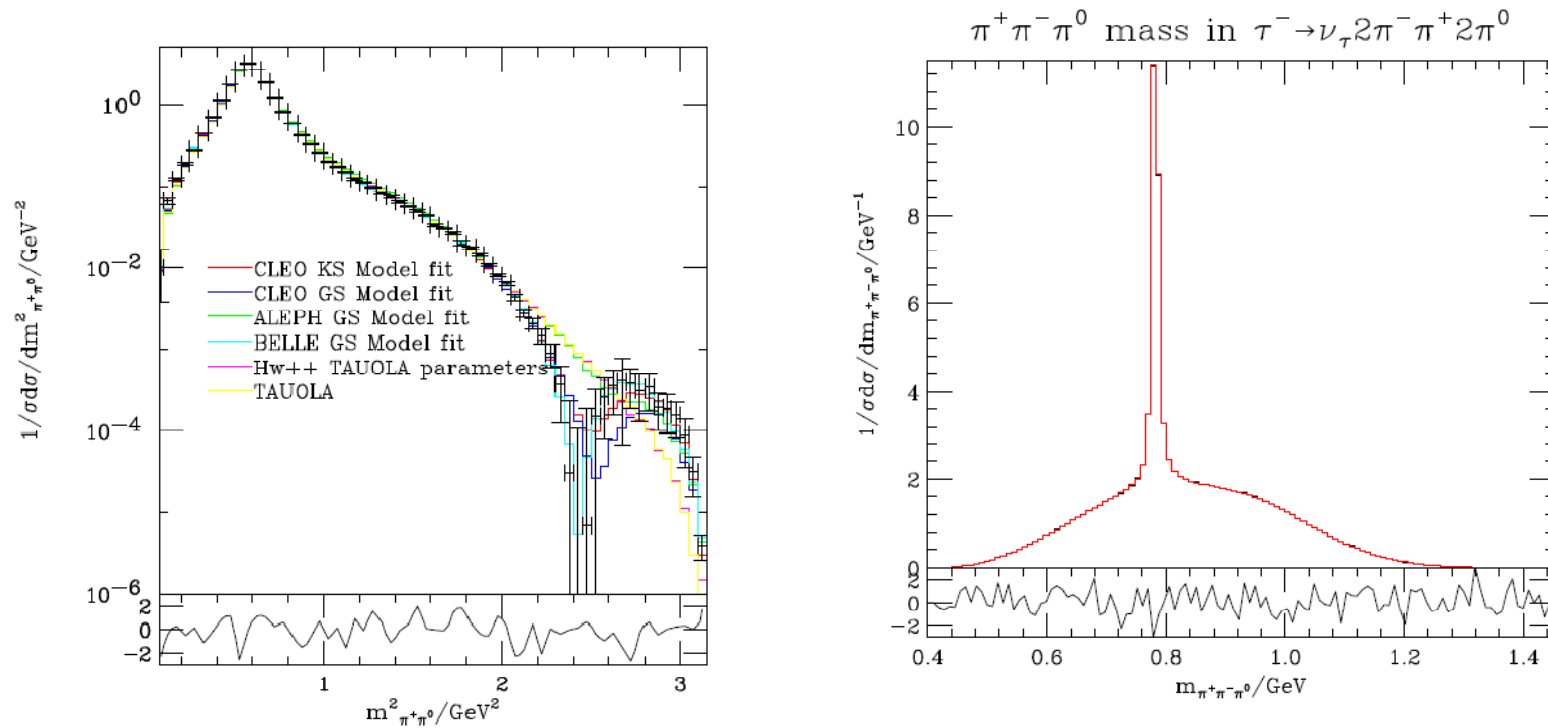
Comparison of EvtGen and Herwig++ for the model of hep-ph/9805303

Baryon Decays



Angle of the Λ produced in the Ω decay with respect to the Ω direction in its rest frame compared to the theoretical result. Using the calculation of Z.Phys.C55,659 (1992) for the charm baryon decays and hep-ph/9905398 for the Ω decays.

Tau Decays



Mass spectrum of $\pi\pi$ in $\tau \rightarrow \pi\pi\nu_\tau$ for various models and example of mass distribution in $\tau \rightarrow 5\pi\nu_\tau$ comparing Herwig++ and TAUOLA.

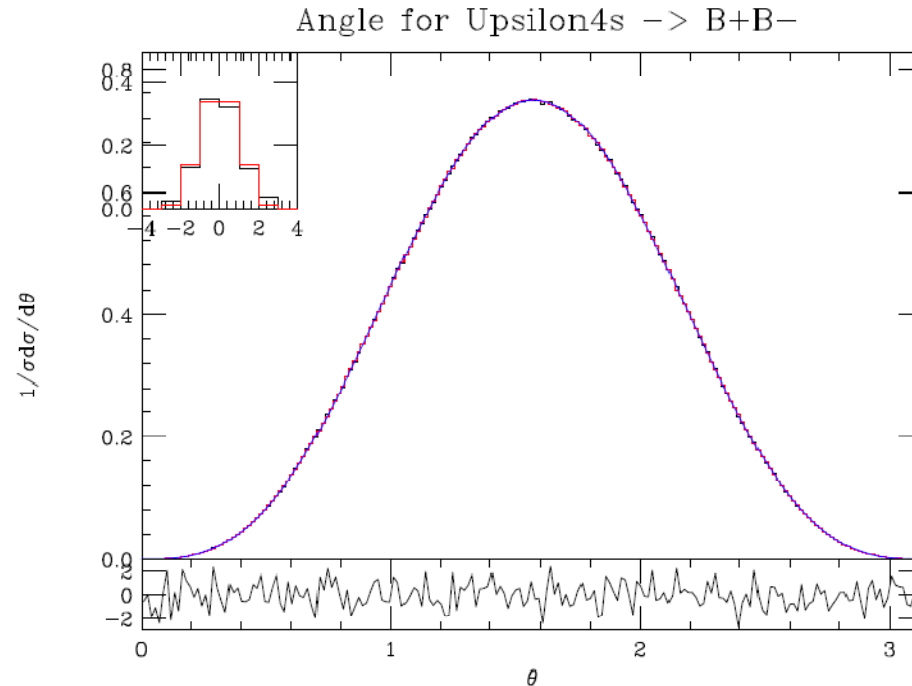
Herwig++

- Modelling in Herwig++ at the same level of sophistication for light meson decays, more models for baryon decays.
- Tau decays comparable to TAUOLA.
- Still weaker for the B decays as hard to tune given lack of published data.
- As Herwig++ and EvtGen use the same algorithm for spin correlations can interface them include correlation effects.

Introduction

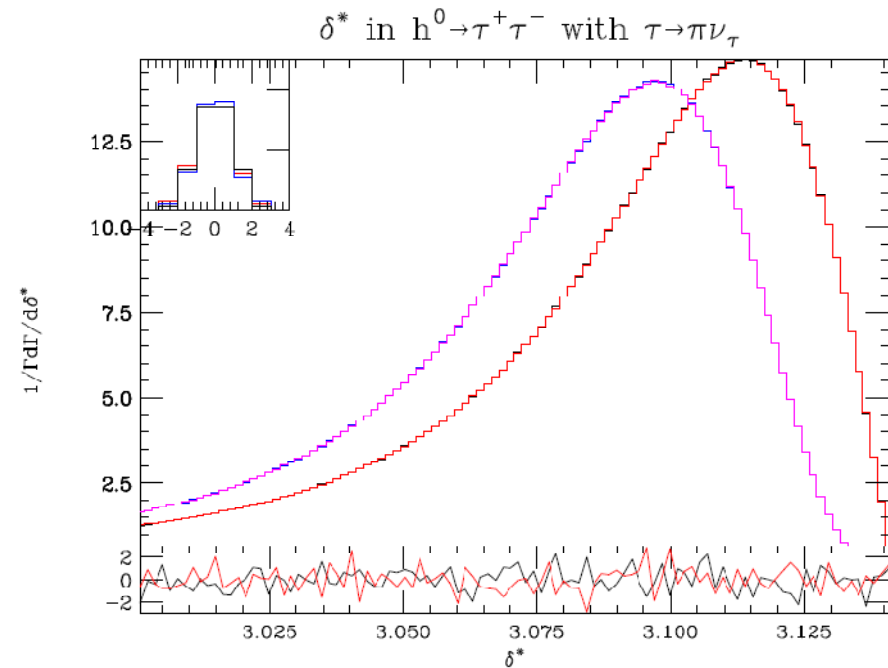
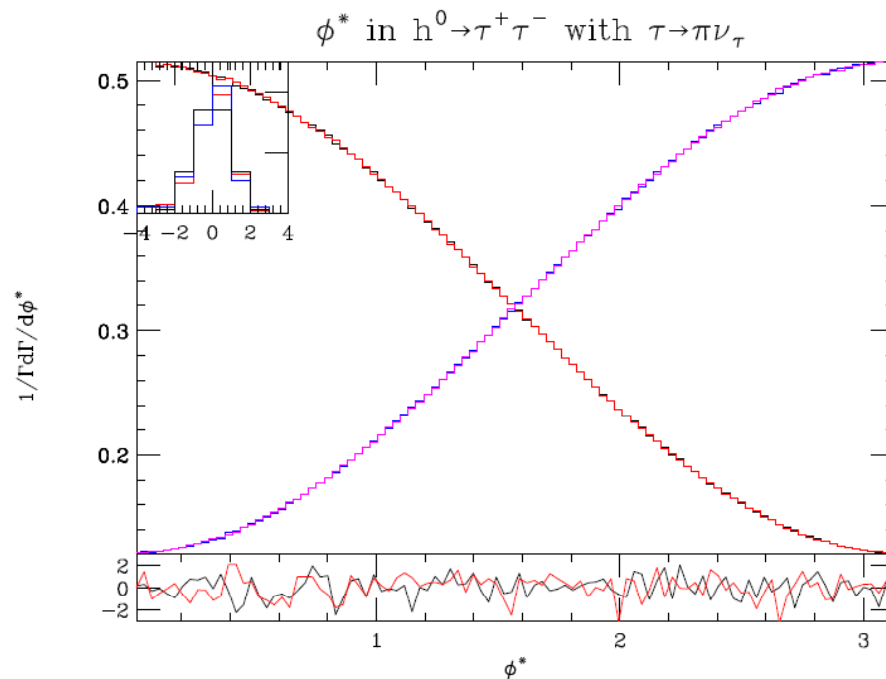
- When interfacing Herwig++ and EvtGen need to pass more information than just the momenta of the decaying particle.
- However passing the information to get the spin correlations is more complicated and error prone than just passing the momenta.
- Doing this will require some modifications to EvtGen.
- So first some examples to show it works comparing the internal Herwig++ modelling and Herwig++ interfaced to EvtGen for some decays.

$$e^+e^- \rightarrow Y(4s) \rightarrow B^+B^-$$



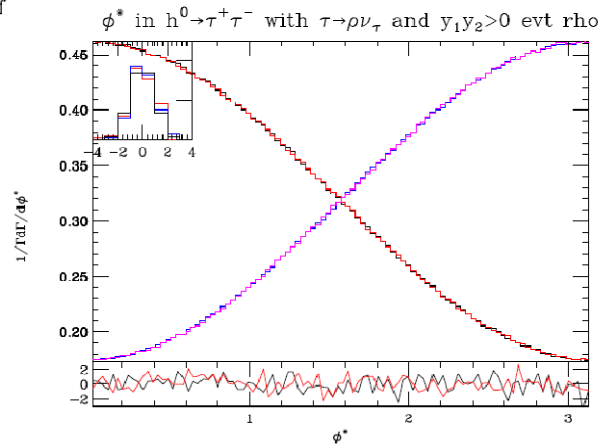
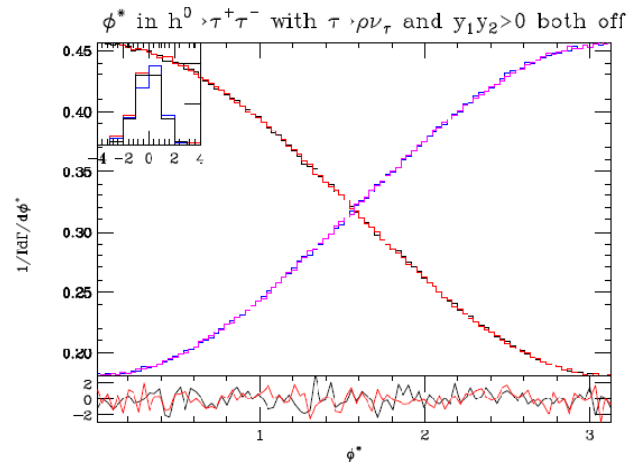
- Angle of B $^+$ meson with respect to the beam with the Y(4s) decay performed by either Herwig++ or EvtGen.
- Tests the conversion of spin-1 particles, amplitudes and spin density matrices.

$$h^0/A \rightarrow \tau^+ \tau^- \rightarrow \pi^+ \pi^- \nu_\tau \nu_\tau$$

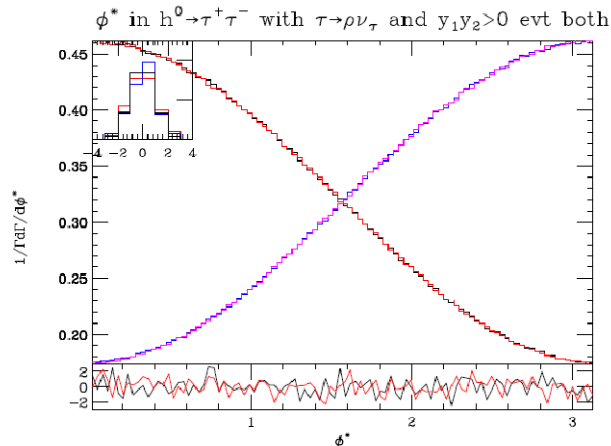
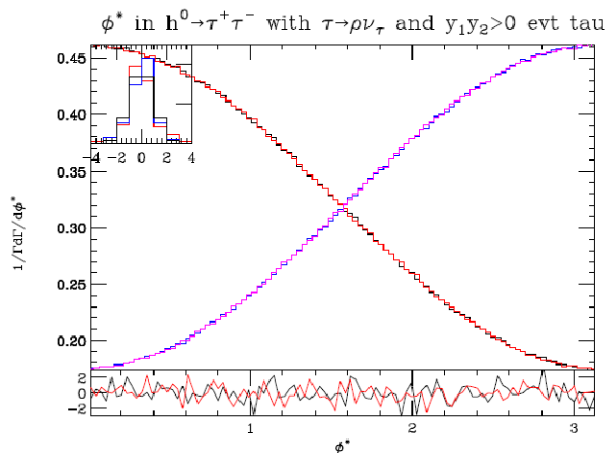


- Angle between τ decay planes and between pions with τ decay performed by Herwig++ or EvtGen.
- Tests the conversion of spin-1/2 particles, amplitudes and spin density matrices

$$h^0/A \rightarrow \tau^+ \tau^- \rightarrow \rho^+ \rho^- \nu_\tau \nu_\tau$$



- Angle between the ρ decay planes for scalar and pseudoscalar Higgs decays.



- Uses different combinations of Herwig++ and EvtGen for the τ and ρ decays.

- Tests the spinors/polarization vectors are calculated in the right frames for long decay chains

Changes

- In order to interface we need some changes to EvtGen in order to:
 - get access to some additional information;
 - set some variables which are currently private.
- None of them will effect the current behaviour of EvtGen and hopefully they can be agreed.
- I've attached a full diff file for the latest GENSER release to the talk

Changes

- Some of the changes are fairly minor:
 - Accessors for the Rarita-Schwinger spinors in EvtParticle, as for other basis states;
 - Access to the EvtId object for a given member of the particle list in EvtPDL;
 - Access to the amplitude in EvtDecayAmp.
- Some are more significant but don't change current code:
 - New Init() members in EvtDiracParticle, EvtVectorParticle, EvtRaritaSchwingerParticle and EvtTensorParticle which set the basis states.

Changes

- We would like the option of getting EvtGen to perform only the decay of a particle and not the subsequent decays of its decay products.
- This needs
 - addition of a flag recursive to the makeDecay members in EvtDecayBase, EvtDecayAmp, EvtDecayIncoherent, EvtDecayProb and small changes to implementation.
 - Would default to true so no change to current behaviour and only minor changes to the code.

Conclusions

- Herwig++ has its own sophisticated hadron decay package.
- As it is using the same algorithm as EvtGen we have been able to write an interface which gets the correlation effects right.
- Will need some fairly minor changes to EvtGen to work.
- Hopefully we can agree on these or something which will allow the same functionality for the next version of EvtGen.