Status of the New EvtGen

- Upgraded EvtGen available in development release since 10/12/2005
- Updated CDF EvtGen User Guide (CDF note 7917, successor of note 5618)
- New EvtGen web page at http://fcdfhome.fnal.gov/usr/beringer/evtgen
- Alerting users to availability of new EvtGen and asking for user testing
  - Presentation at High Pt B Tag meeting 10/26/05
  - Presentation at Joint Physics meeting tomorrow
- This talk:
  - Changes in how EvtGen decides whether to decay a given particle
  - Decay of Ks, Lambda, and other particles traveling “finite” distances
  - Consistency of particle properties between different generators
  - PHOTOS cutoff

Exactly Which Particles Will EvtGen Decay?

- Particles passed to EvtGen are decayed if all of following conditions are met:
  1) Corresponding tcl parameter in module EvtGen is true (e.g. DecayBMeson)
  2) Particle's “PDG” code is included in EvtGenInterface::ListDecayParticles()
  3) A corresponding decay is defined in decay file(s)
- Particles generated by EvtGen are always decayed as specified by decay file
- In the old EvtGen:
  - 2) is only true for a few select particles
  - if 1) and 2) are met, any existing daughters are removed independently of 3)
  - if 3) is false, EvtGen leaves particle undecayed without warning
  - As a result, particles may simply disappear without warning (e.g. $\eta_c(2S)$)
  - Due to a bug in EvtGenInterface, EvtGen used “EvtGen particle codes” as input and wrote “PDG codes” as its output (had probably no significant effect when using the standard EvtGen setup)

Exactly Which Particles Will EvtGen Decay?

- In the new EvtGen:
  - PDG codes used as input and output
  - EvtGenInterface::ListDecayParticles() knows about all relevant PDG codes
  - If no decays are defined in DECAY.DEC for a given particle, it is not touched
    - But a warning is issued (once per job for each particle type)
    - If it was decayed previously, those decay products are left in HEPG bank
    - If it was not decayed previously, it remains undecayed
      - at least the user was warned
  - Example:

    EvtGenInterface:WARNING: You are asking EvtGen to decay a Sigma_b*0 (PDG code = 5214, EvtGen code = 5214), but no decays are defined in DECAY.DEC.

    EvtGenInterface:WARNING: Will not (re)decay this particle - please check your DECAY.DEC file. Will not repeat this warning for Sigma_b*0.

Who Decays Ks, Lambda, ...?

- Weakly decaying strange particles travel "finite" distances (K_s, Λ, Σ, Ξ, Ω) and can interact with the detector material
  - generally better to decay them by Geant and not by generator or EvtGen
- Current status wrt EvtGen (currently same as for "old" EvtGen):
  - EvtGen does not decay any such particles that were produced by the generator
    - Pythia and Herwig both do not decay Ks and Lambda (not checked for others)
  - But if such particles are produced by EvtGen as decay daughters, they will be decayed if any decay channels are listed in decay files
    - This has been the case for the default DECAY.DEC (K_L is not decayed)
    - Can easily be overridden through user decay file
- Proposal:
  - Check that all of the above particles are indeed decayed by Geant
  - Remove all such decays from the default EvtGen DECAY.DEC

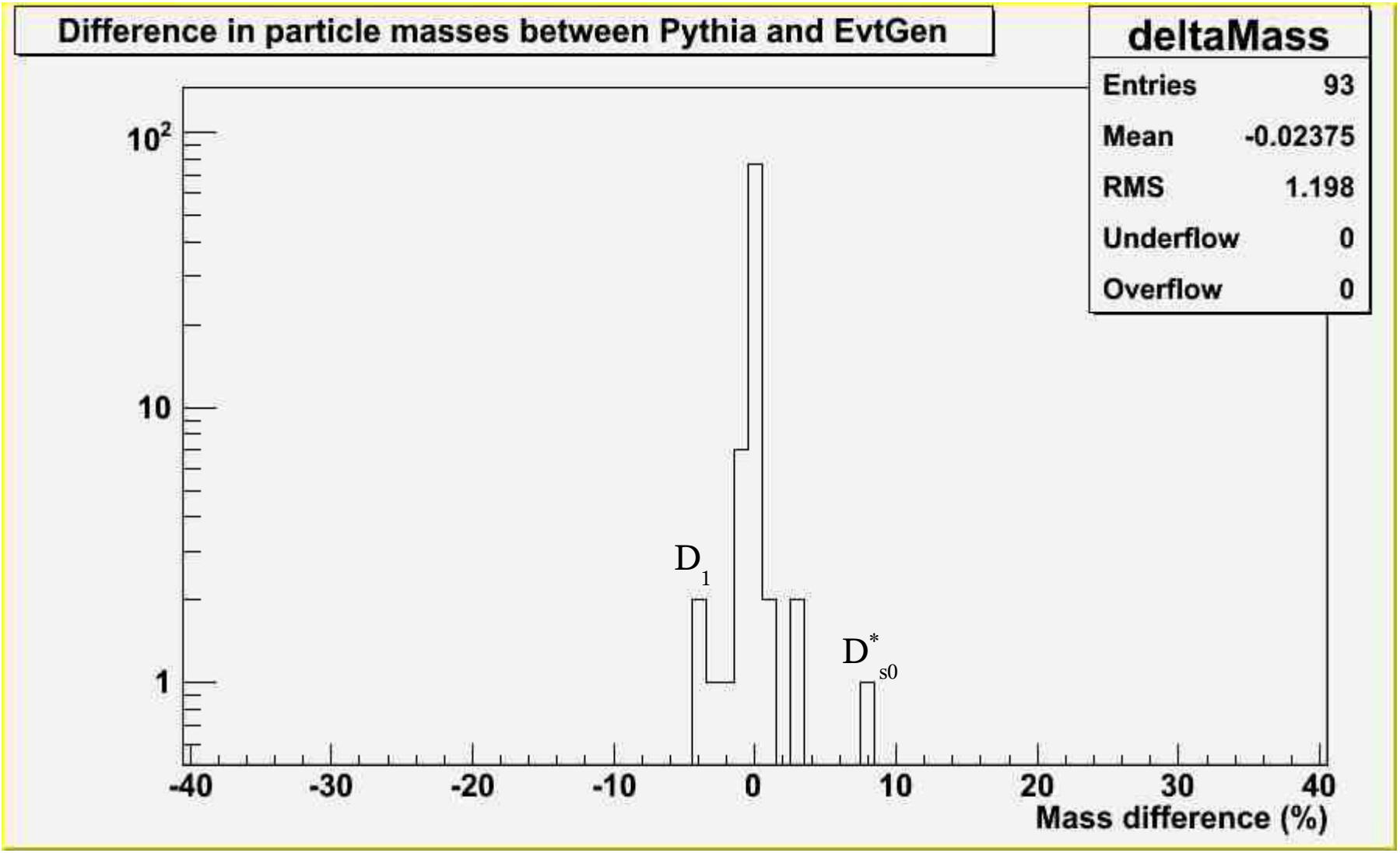
Consistency of Particle Properties in CDF

- A long-standing problem in CDF: no central definition of particle properties
  - Differences in particle masses used by different generators
  - Use of different "PDG" codes for the same particle
- Can (in principle) lead to many severe effects including:
  - Danger of mistaking the identity of a particle at the interface between different pieces of code
    - EvtGenInterface uses its own hard-coded translation routines
  - Reinterpreting E, p in terms of a different mass
    - Lots of checks for sqrt of negative numbers
  - Distorted or cut off distributions due to wrong "maximum probability" in MC sampling algorithms
    - Fixed explicitly in case of the SLN model (scalar -> Dirac neutrino decays) but makes EvtGen less efficient
    - There may be other cases

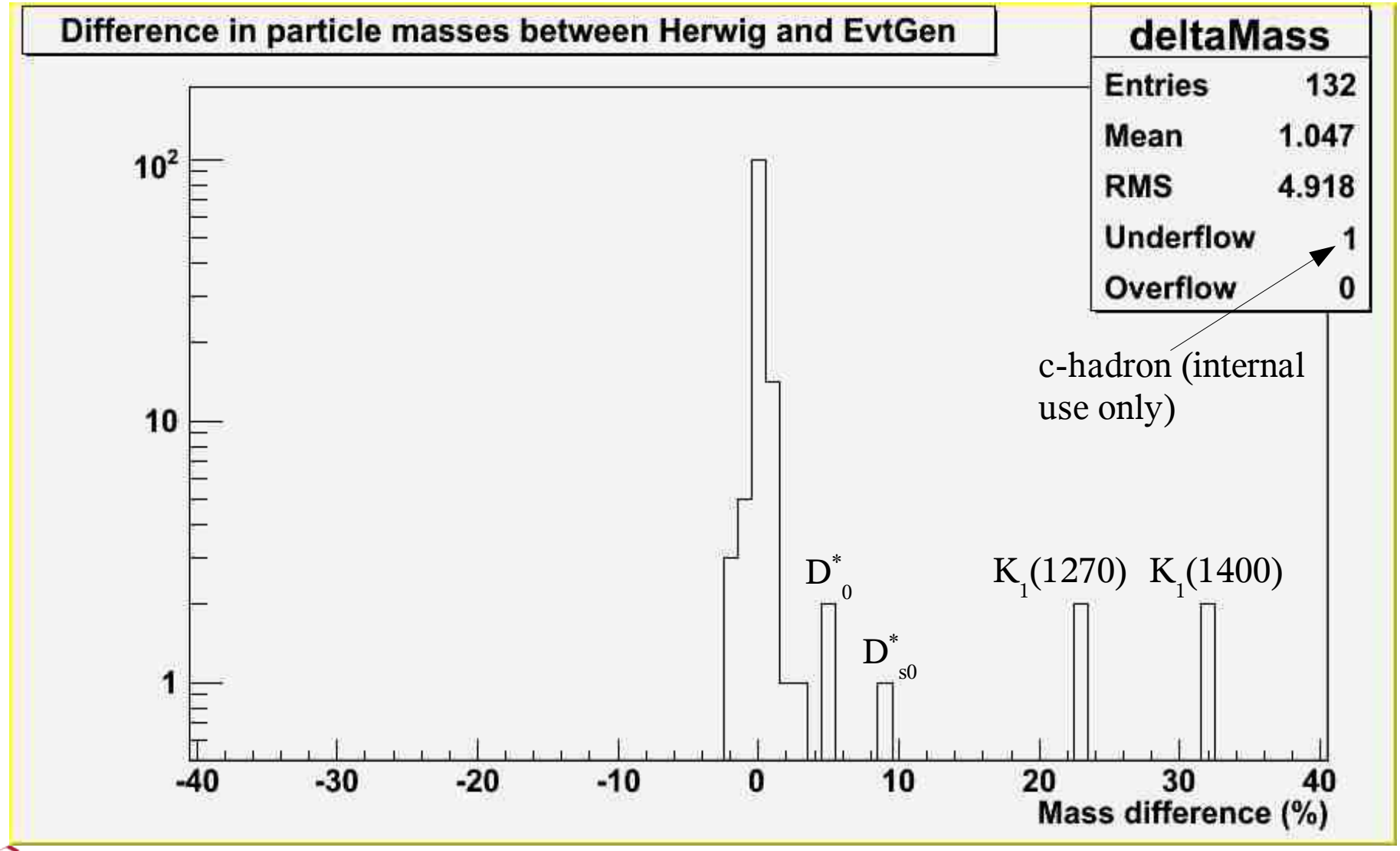
Are There Any Significant Differences?

- How large are mass differences really (6.1.0 and new EvtGen)?
  - Check after updating masses in EvtGen tables
- Test procedure:
  - Run generator (Pythia, Herwig, ...) without EvtGen over 10k events
  - Scan HEPG bank and, for each particle type, calculate average (and standard deviation of) mass for all instances of this particle
    - Need averaging for resonances (where mass in HEPG bank is $\sqrt{(E^2-p^2)}$)
  - Look for “large” differences with values from EvtGen's pdt.table

Differences Between EvtGen and Pythia

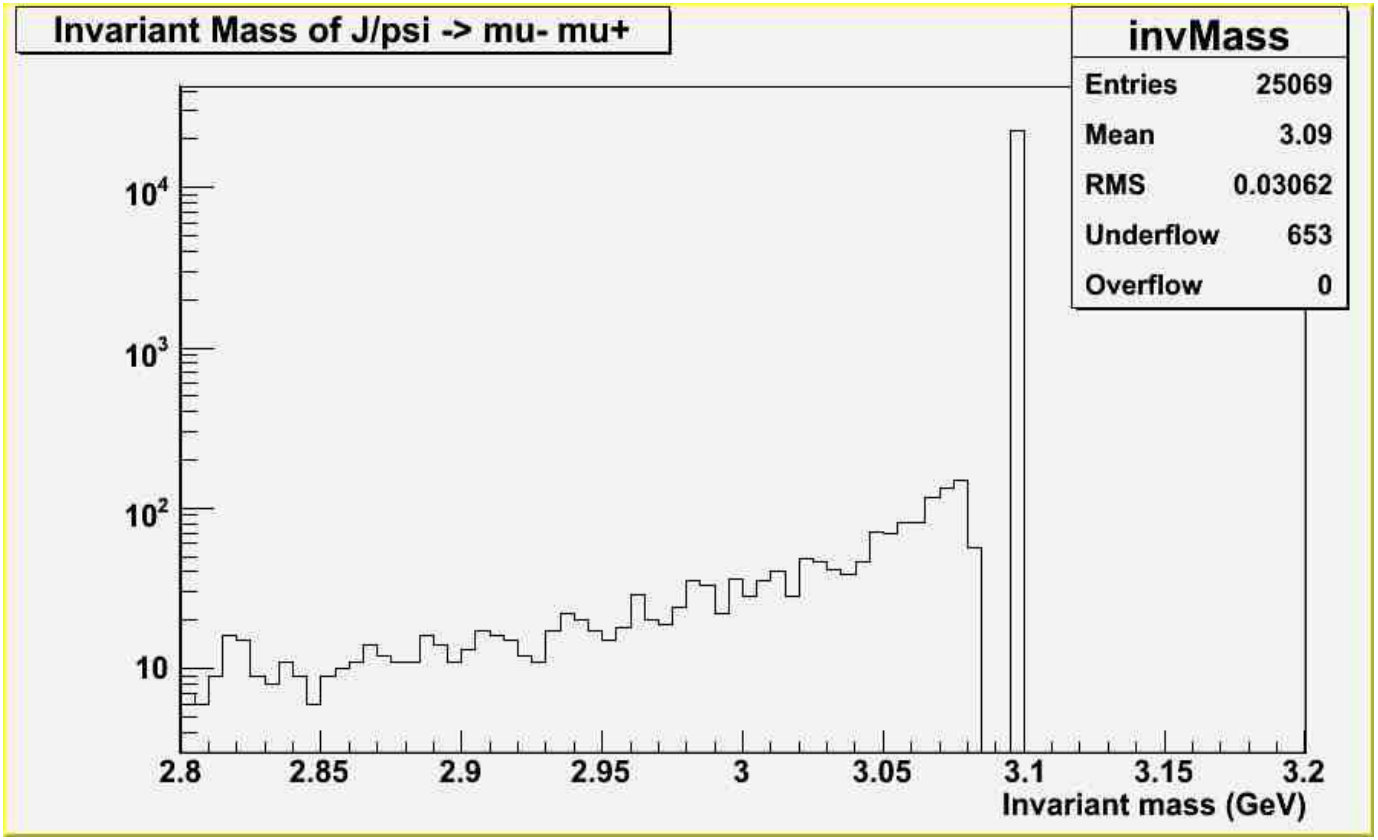


Differences Between EvtGen and Herwig



PHOTOS Bremsstrahlung Cutoff

- EvtGen uses PHOTOS to handle final state radiation
- Infrared cutoff parameter XPHCUT currently set to 10 MeV
  - Setting this to lower values (e.g. 1MeV) will require later PHOTOS version



Summary

- Improved algorithm selecting particles decayed by EvtGen in order to
  - better avoid unexpected behaviour by users
  - print warnings if a particle cannot be decayed by EvtGen
- Propose to change default EvtGen decay file so that particles such as Ks that travel “finite” distances get never decayed by EvtGen
- Particle masses agree (with a few exceptions) at the percent level
  - A few particle masses to be updated in Pythia and Herwig
- PHOTOS bremsstrahlung cutoff cannot be lowered significantly without update to later version of PHOTOS
  - Is a cutoff value of 10 MeV adequate for CDF?