PHOTOS
recent developments.

TeV4LHC

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Web pages for transparencies and progam(s):

http://wasm.home.cern.ch/wasm/goodies.html

http://cern.ch/Piotr.Golonka/MC/PHOTOS-MCTESTER/

Motivation (2004/2005)

- Recent interest in use of PHOTOS for precision measurements in B-factories
- Impact of the radiative correction comes through efficiency (ϵ): it is around 5%. If we want to measure with precision of 1% then shape corrections due to bremsstrahlung have to be known with precision (0.3%) for related systematics to be negligible.
- Physics of these resonances, will be of some interest at LHC as well.
- For similar purposes radiative corrections need to be included in case of simulations for measurements of W mass and couplings in TEVATRON/LHC experiments;
- Main interest: decays of W' and Z's, but also t, H
- Algirithmitc side: Iterative solution like in parton shower

Motivation

- PHOTOS (by E.Barberio, B. van Eijk, Z. W., P.Golonka) is used to calculate the effect of radiatiative corrections
- but we need to discuss its systematic error
- PHOTOS has not been tested for B, K decays. No works on matrix elements.
- See our transparencies for CKM workshop in La Jolla CA,
- However a lot was done recently in context of Z and W decays, precision of 0.1% was established!
- Technical and algorithmic developments as well: multiple photon mode, plays at different level of crude distr .
- The purpose of my talk is nonetheless mainly presentation of 'numerical proofs'.

PHOTOS recent changes

E. Barberio, B. van Eijk, Z. Was, Comput. Phys. Commun.(1991) ibid. (1994)

See also: P. Golonka et al. hep-ph/0312240

- Until 2002 option for single- and double- photon emissions were available, no precision tests were performed, no work with W decays matrix elements, no related weights in PHOTOS!
- Year 2003: improvements in W decays, for 30 MeV-precision in Tevatron.
- Summer 2004: precision tests for W and Z decays, hundreds of histograms and benchmark numbers available at cern.ch/Piotr.Golonka/MC/PHOTOS-MCTESTER
- Summer 2004: new options for triple, quatric and multiple-photon emission
- January 2005: thanks to input from NA48 improvements in meson decays. Precision improved from about factor of two to 20% for decays like $K \to l^{\pm}\nu\pi^{\mp}$. Middle of the work!
- I assume here that there is no need for presentation of PHOTOS. It is a Monte Carlo of "after-burner" type which reads in event record for decay chains without radiative corrections and, sometimes, adds bremsstrahlung photons. It is weight=1 algorithm, very convenient for use with full detector acceptance simulations.

PHOTOS may work in three regimes:

1. as a universal crude tool in decays of ”any” particle
2. as a precision tool in dedicated channels: Z and W decays - precision better than per-mile level, this was never assured for B, K, etc decays!
3. with explicit process-dependent ME included (never needed so far)

In B meson decays (like always) PHOTOS was expected to be used at LL precision level, that is for the purpose acceptance-simulations only and NOT for shape corrections. Precision was supposed to come from other programs.
PHOTOS was for easy use. Just add photons here and there in HEPEVT – favorite event record of 90’s.

Technical developments:

- **PART 1: Rounding error traps**
  - classified and those found removed
  - HEPEVT living object. Action of PHOTOS depends on its content
  - Increased physics sophistication brought additional numerical pressure
- **PART 2: Single photon emission**
  - Plays with intereference and underlying crude for angular singularities around each charge !!!
  - From 4-vectors to angular parametrization of phase space and back! Shwinger-Dyson type relations
- **PART 3: Iteration**
  - double, triple, quatric, multiple-photon emission. Reshuffling
- **I am just listing elements in game, they may give hints for QCD.**

Main lines of development and underlying tests:

- **PART 1: W and Z decays: field theory input available in full**
  - correction weights for W decays
  - universal test
  - results of comparison with ME Monte Carlo and (indirectly) LEP data
- **PART 2: Semileptonic B decays**
  - some Monte Carlo (weighted events) and semi-analytical energy spectra available for tests
  - comparisons with data also useful and partly performed
- **PART 3: Non-leptonic B decays**
  - only comparisons with data are possible
- **Motto: Guilty until proven otherwise.**

PART 1:

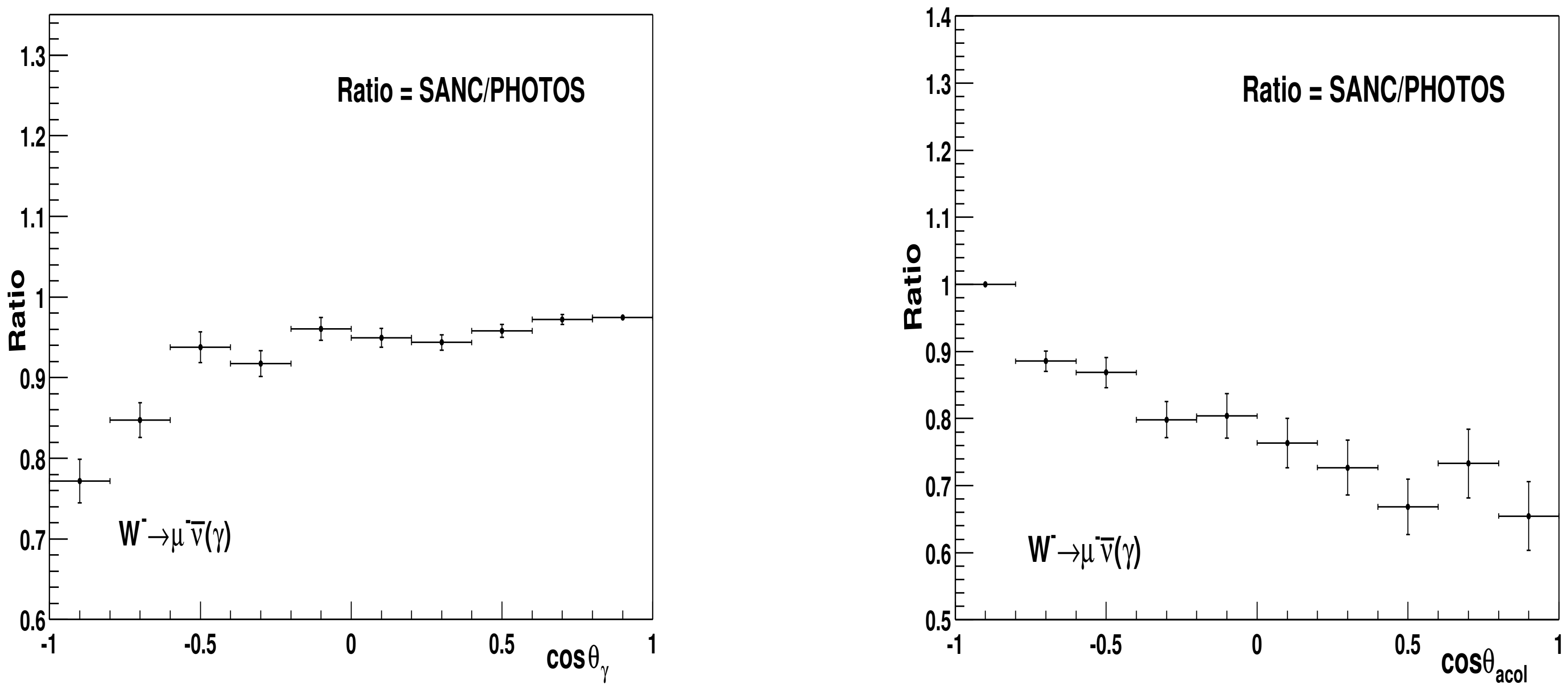
Completed scenario for improvements in W and Z decays.

project performed for Tevatron and LHC applications

(measurement of the W mass)

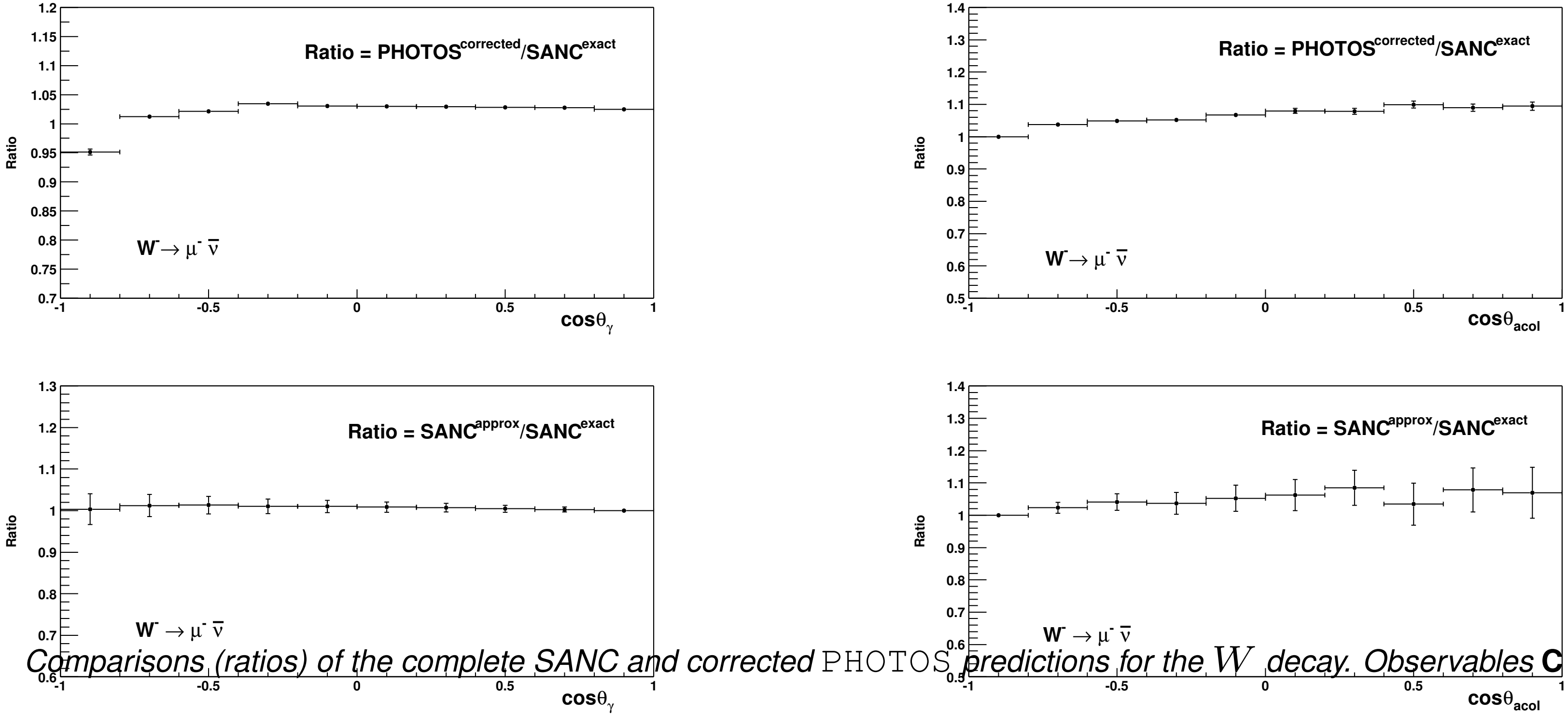
Will serve as example of the work which is done (nearly).

$W \to l\nu$ PHOTOS vs. ME, interference terms missing:



Status as of 2002/2003 (from paper by D. Bardin at al.), program works as expected but not good enough for Tevatron 2004.

$W \to l\nu$ PHOTOS with correcting weight vs. ME, 2003



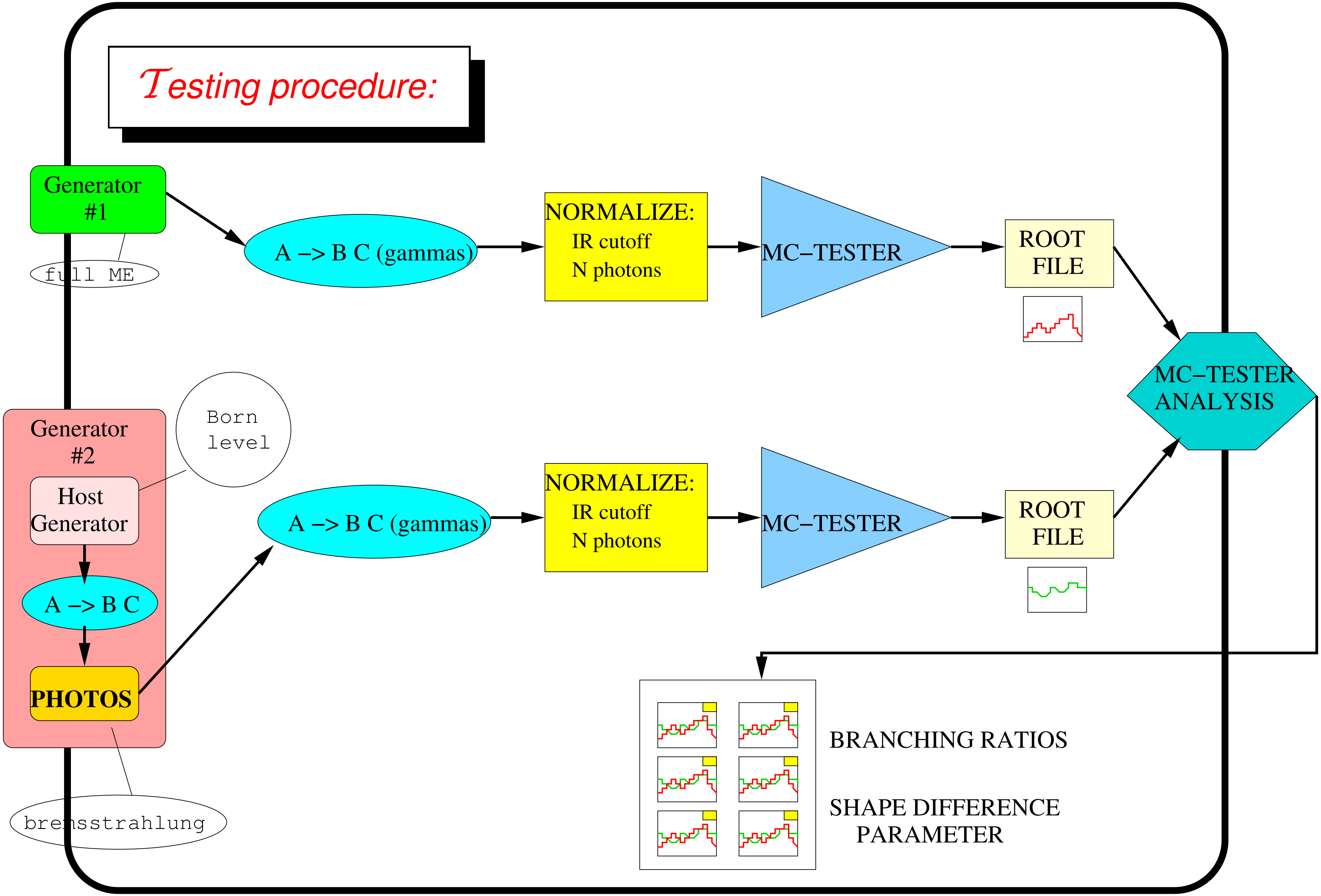
Comparisons (ratios) of the complete SANC and corrected PHOTOS *predictions for the W decay. Observables* **C** *and* **D***: ratios of the photon angle with respect to μ^- (left-hand side) and $\mu^-\bar{\nu}$ acollinearity (right-hand side) distributions from the two programs. The dominant contribution is of infrared non-leading-log nature for the left-hand side plot, and non-infrared non-leading-log nature for the right-hand side one. In the lower part of the plots similar comparisons for the complete and truncated–corrected with δ predictions are given. From paper by G. Nanawa and Z. Was.*

Testing procedure: comparsions of predictions of two Monte Carlo runs

- Numerical comparison tests: we heavily rely on other generators (KKMC, KORALZ, MUSTRAAL, WINHAC, TAUOLA) and work of other people:

  E. Baberio, F. Berends, R.Decker, B. van Eijk, S.Jadach, M.Jezabek, J. Kuhn, R. Kleiss, W. Placzek, B. Ward

  and, indirectly, on LEP data. No miracles: precision need work with matrix elements and/or data (on top of defining algorithm).
- Testing procedure need to be infrared-safe, see http://cern.ch/Piotr.Golonka/MC/PHOTOS-MCTESTER for details.
- Test parameter: E_{test} threshold for soft photons
- Test parameter: maximum number of photons (1 or 2);
- The softer photons' momenta added to fermions momenta (number of photons reduced to 1 or 2)
- We use MC-TESTER to perform systematic study of large number of distributions of invariant masses of decay products


Testing procedure:
Generator #1
full ME
A –> B C (gammas)
NORMALIZE:
IR cutoff
N photons
MC–TESTER
ROOT FILE
MC–TESTER ANALYSIS
Generator #2
Born level
Host Generator
A –> B C
PHOTOS
bremsstrahlung
A –> B C (gammas)
NORMALIZE:
IR cutoff
N photons
MC–TESTER
ROOT FILE
BRANCHING RATIOS
SHAPE DIFFERENCE PARAMETER

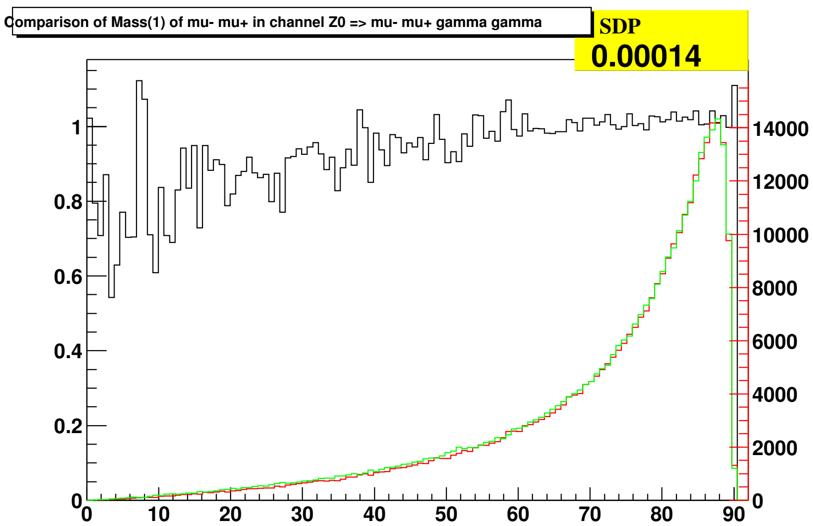
A lot of tests for W and Z decays with radiative corrrections are available at:

http://cern.ch/Piotr.Golonka/MC/PHOTOS-MCTESTER

Hard bremsstrahlung in KK and PHOTOS - results

Comparison of KK and PHOTOS.
in Z->mu mu + bremsstrahlung process at Z mass

GENERATOR	Branching ratio					Maximum SDP					T1		T2		Booklet	
	test1		test2			test1		test2			test1	test2	test1	test2	test1	test2
(n photons) ->	0	1	0	1	2	0	1	0	1	2						
E_test=1.0																
KK	83.918	16.082	83.918	14.816	1.266											
KORAL-Z	83.984	16.016	83.984	14.771	1.244	0	0.00208	0	0.00123	0.00124	0.133	0.133	0.033	0.019		
KORAL-Z O(1)	82.514	17.486				0	0.037				2.807		0.621			
PHOTOS O(1)	82.362	17.638				0	0.0314				3.111		0.528			
PHOTOS O(2)	83.925	16.075	83.925	14.630	1.445	0	0.0067	0	0.0035	0.0122	0.016	0.373	0.107	0.065		
PHOTOS O(3)	83.832	16.168	83.832	14.889	1.280	0	0.0038	0	0.0025	0.0080	0.172	0.172	0.061	0.046		
PHOTOS O(4)	83.836	16.164	83.836	14.871	1.293	0	0.0040	0	0.0027	0.0058	0.163	0.163	0.0635	0.045		
PHOTOS EXP	83.837	16.163	83.837	14.868	1.295	0	0.0041	0	0.0023	0.0092	0.161	0.161	0.066	0.044		
This is to be compared with WINHAC tests:																
KoralZ ME O(1)Exp			83.931	14.899	1.170			0	0.0009	0.0678		0.191		0.086		



A summary table points to booklets with thousands of detailed plots.

This one presents the invariant of largest (SDP$<$0.1% !) discrepancy between PHOTOS EXP and KKMC in Z decays. Events are referred to as 0, 1 or 2 photon configurations, when 0 1 or at least 2 photons with energy above E_{test} are present.

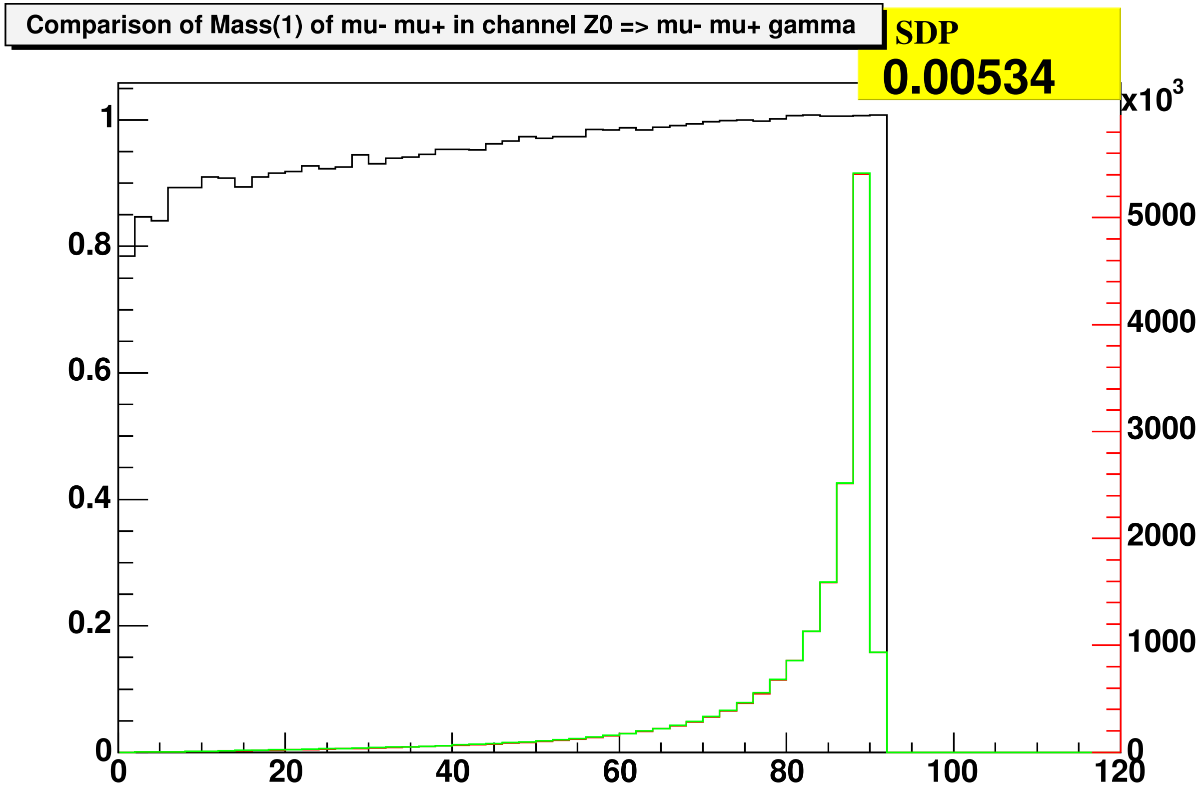
Further tests

Numerical comparison tests of the single photon emission kernel have been peformed for:

- Z^0 leptonic decays (comparisons with KORALZ and KKMC) good agreement, options for PHOTOS: single-, double-, triple-, quatric- and multiple-photon emission
  options for KKMC: $O(\alpha^2)$ exponentiated,$O(\alpha)$ exponentiated
  options for KoralZ $O(\alpha^2)$ exponentiated,$O(\alpha)$ exponentiated and fixed first-order (no exp).
- W leptonic decays:
  WINHAC: first-order, SANC first-order and WINHAC exponentiated,
  PHOTOS: first order and exponentiated

$Z \to \mu^+\mu^-$ PHOTOS vs KORALZ, fixed first-order

Plot of largest difference (quantifies approx. in PHOTOS necessary to iterate)

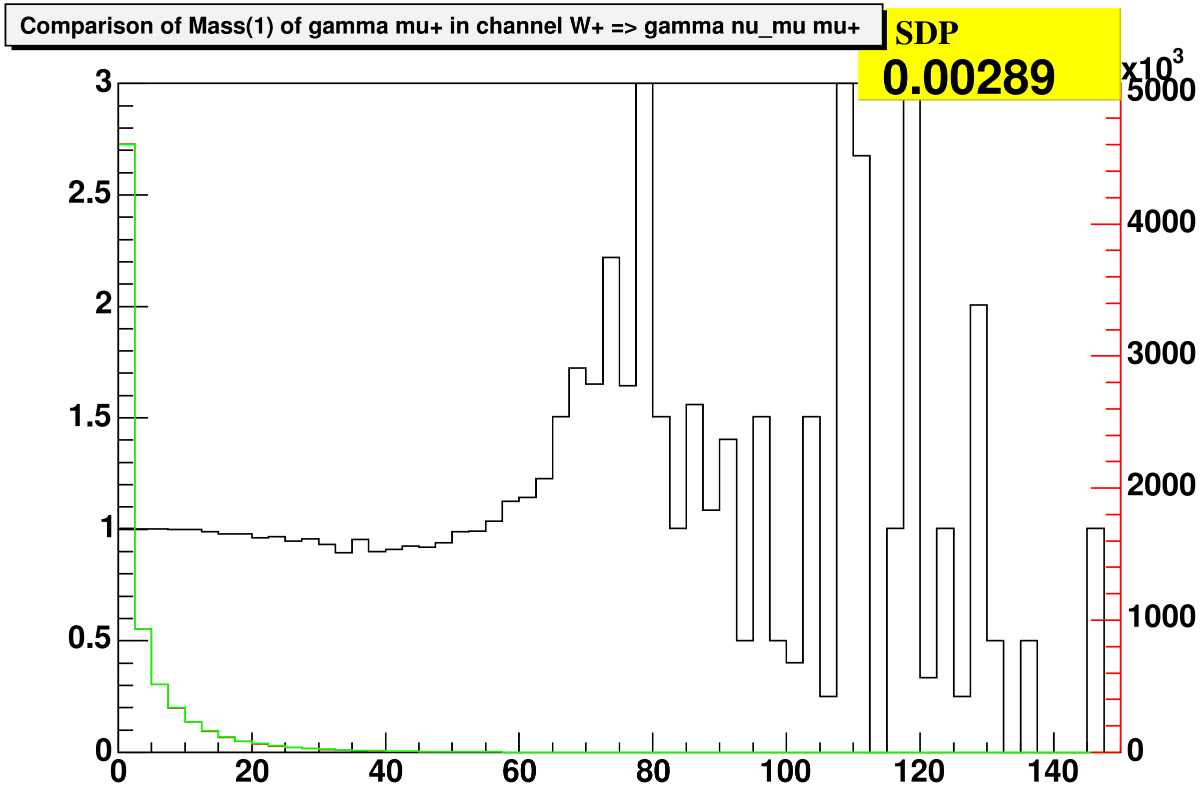


The difference in branching ratios are at fraction of permile level; BR * SDP$<$0.1%.

The differences due to approximations in PHOTOS kernel (restorable with process dep. wt. if needed).

$W \to l\nu$ PHOTOS vs. WINHAC, fixed first order

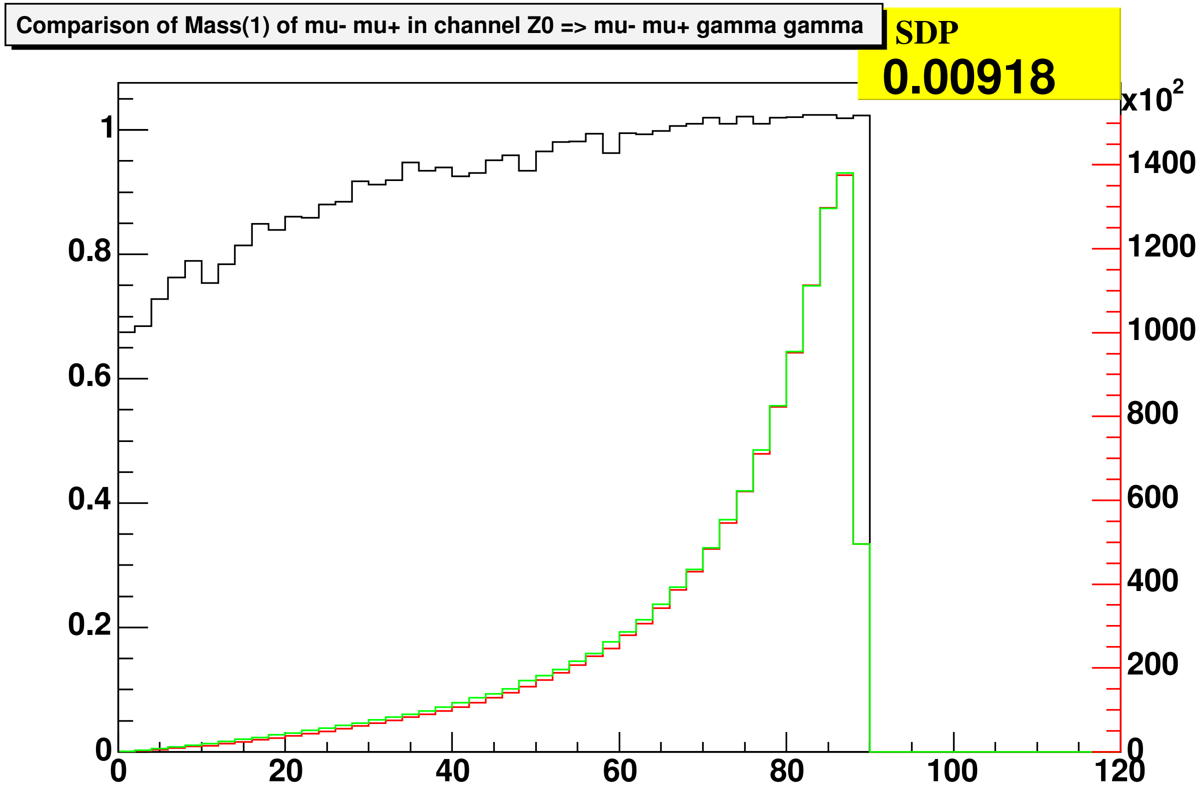
Plot of largest difference:



The difference in branching ratios are at fraction of permile level, also BR * SDP $<$0.1%.

$Z \to \mu^+\mu^-$ PHOTOS (EXP) vs. KKMC $O(\alpha^2)$

Plot of largest difference:

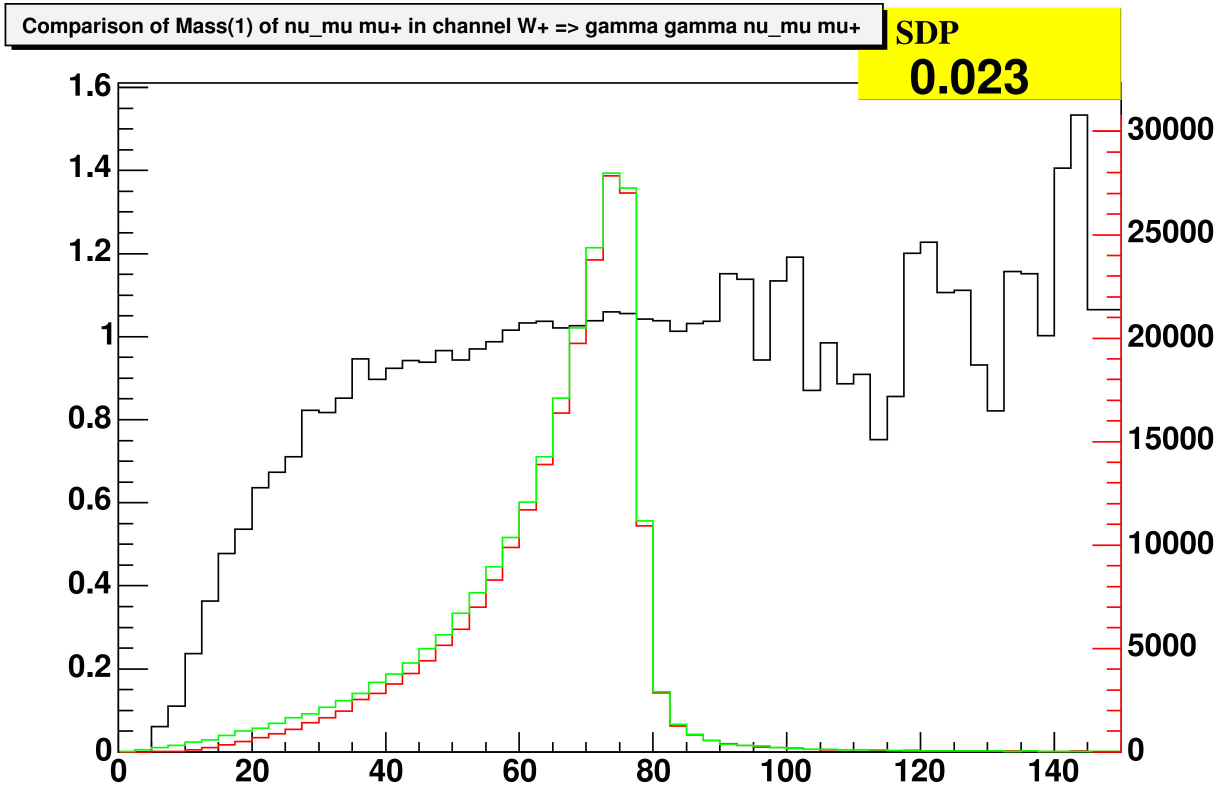


The difference in branching ratios are at permile level and BR * SDP$<$0.1%.

The agreement was good only if complete $O(\alpha^2)$ ME used in KKMC!

$W \rightarrow l\nu$ PHOTOS (EXP) vs. WINHAC $O(\alpha)$ exp

Plot of largest difference:



The difference in branching ratios are at permile level and BR * SDP $<$0.1%.

The source of residual difference not investigated; too small to bother.

WINHAC is full $O(\alpha)$ ME only; PHOTOS single-emission kernel not perfect as well

PART 2:
Semileptonic and leptonic decays

some theoretical predictions available:

Ginsberg, Marciano, Richter-Was, Andre, FFS (NA48)

We need to test single-emission kernel.

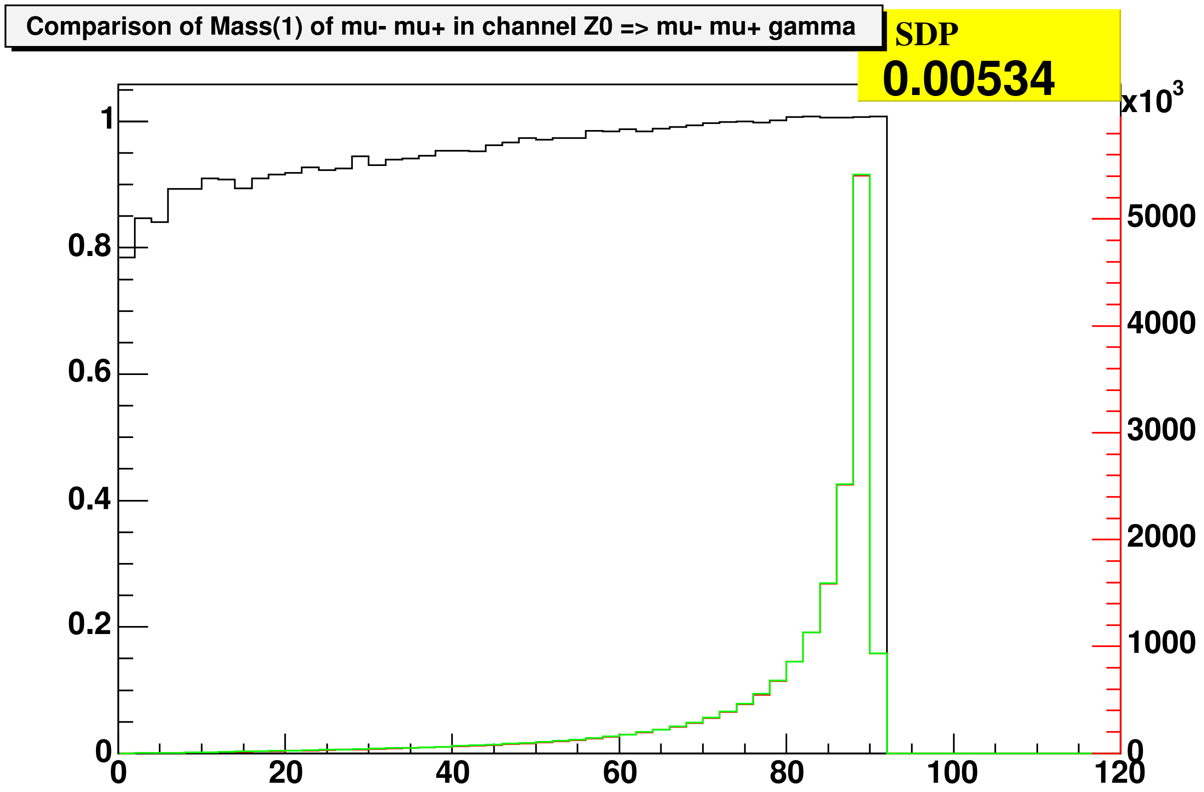
General properties of algorithm for higher-orders have been checked before.

We will profit from Z, W tests in B-decays as well.

Work in progress

$Z \rightarrow \mu^+\mu^-$ PHOTOS vs KORALZ, fixed first-order

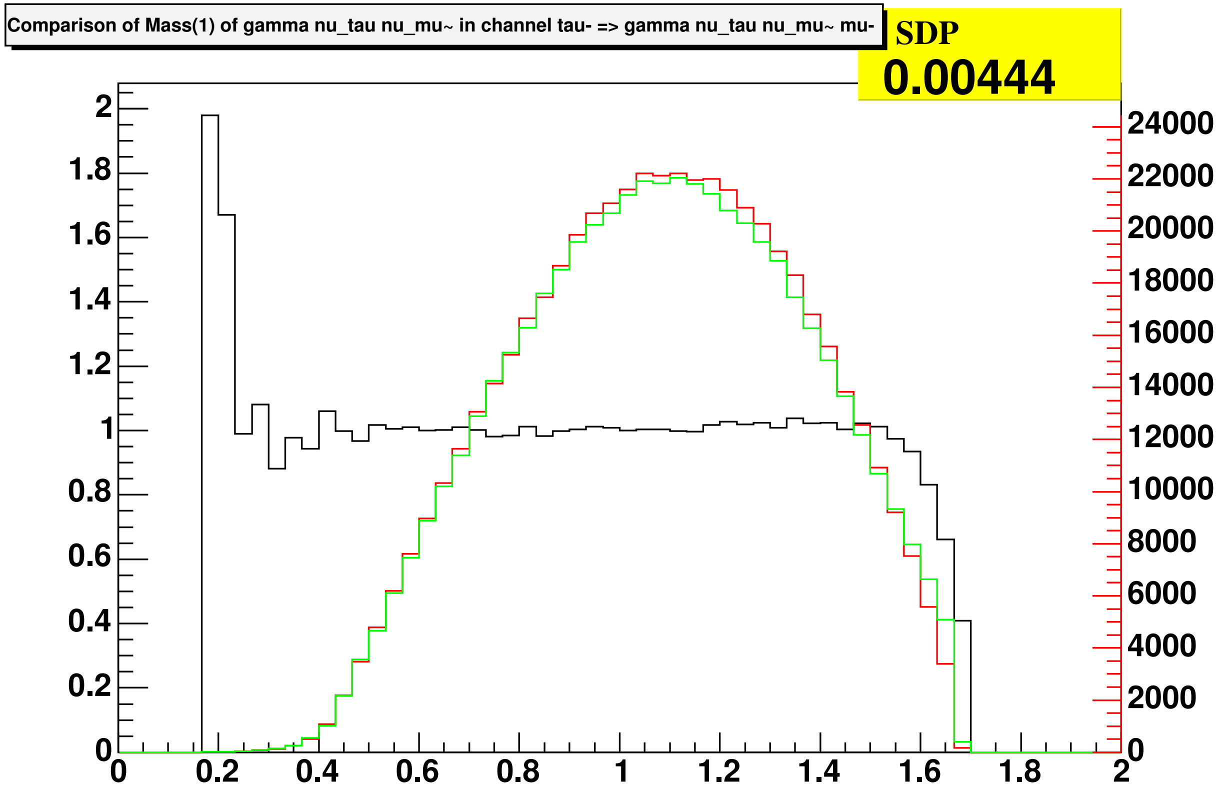
Plot of largest difference (quantifies approx. in PHOTOS necessary to iterate)



We need to find a counterpart for this result, but in case of B, K decays.

$\tau \rightarrow l\nu\bar{\nu}$ PHOTOS vs TAUOLA

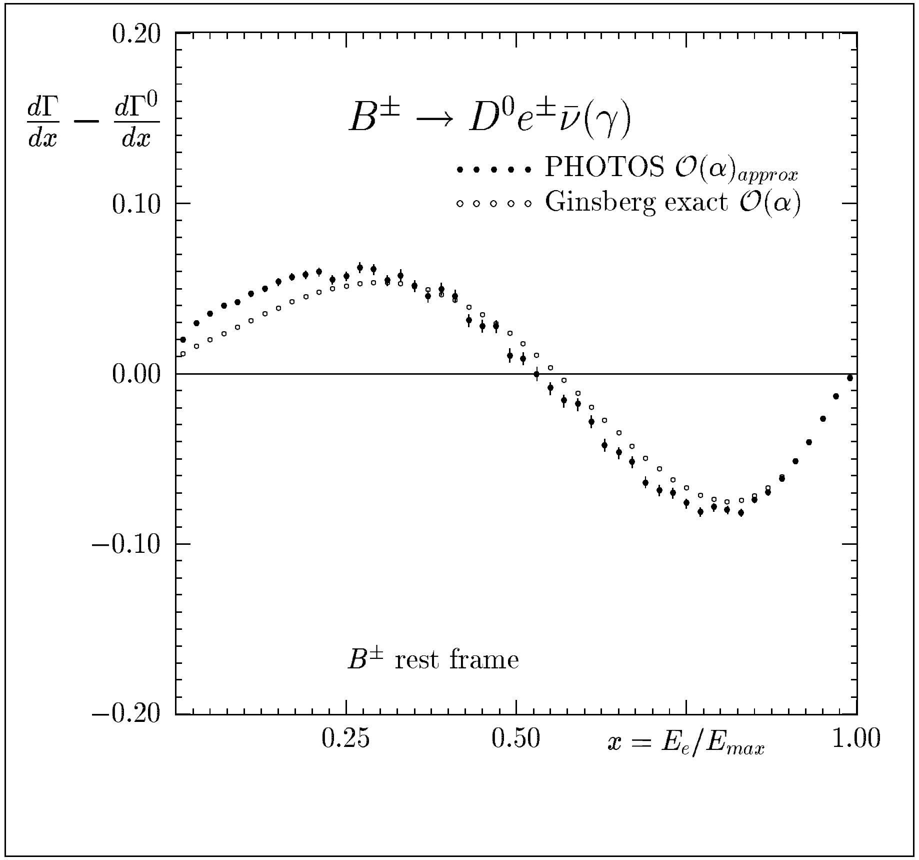
Plot of largest difference:



The difference in branching ratios are at fraction of permile level.

These are still leptonic decays, field-theory prediction available, PHOTOS works excellently.

Phys. Lett, B 303 (1993) 163-169

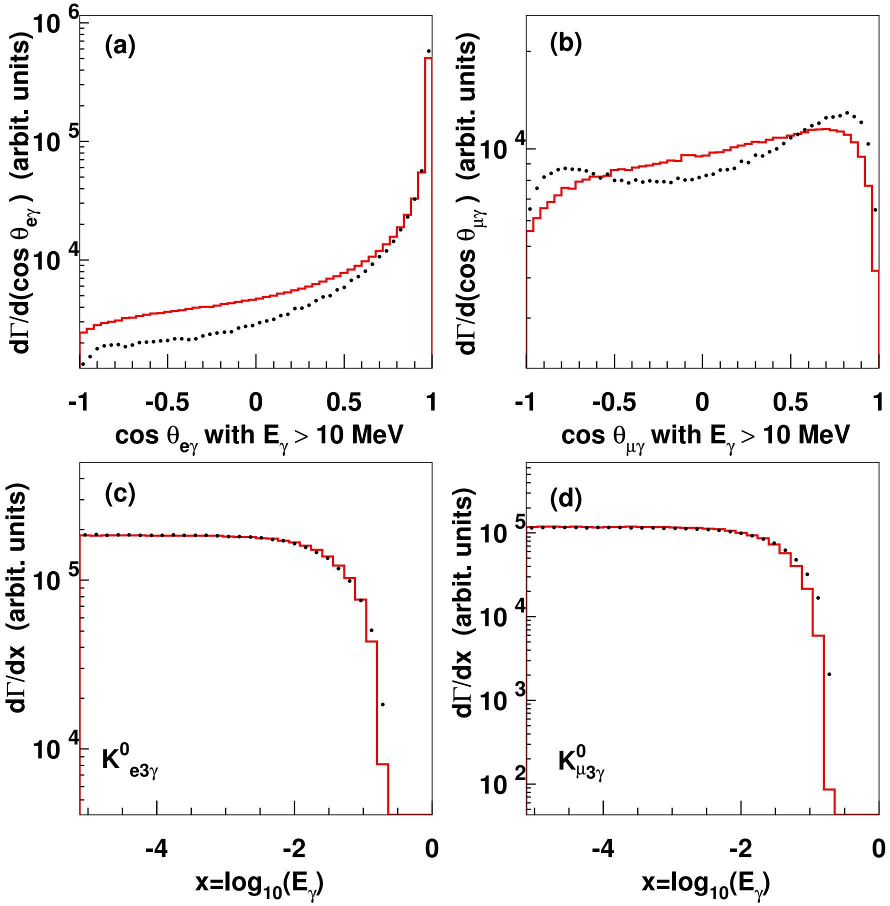


Radiative correction to the decay rate $(d\Gamma/dx - d\Gamma^0/dx)$ for $B^\pm \to D^0 e^\pm \bar{\nu}(\gamma)$ in the $B^\pm$ rest frame. Open circles are from the exact analytical formula [2], points with the marked statistical errors from PHOTOS applied to JETSET 7.3. A total of 10^7 events have been generated. The results are given in units of $(G_\mu^2 m_B^5/32\pi^3) N_\eta |V_{cb}|^2 |f_+^D|^2$, where $N_\eta = \eta^5 \int_0^1 x^2(1-x)^2/(1-\eta x)dx$ and $\eta = 1 - m_D^2/m_B^2$.

- *"QED bremsstrahlung in semileptonic B and leptonic τ decays"* by E. Richter-Was.
- agreement up to 1%
- disagreement in the low-x region due to missing sub-leading terms
- study performed in 1993 - PHOTOS 1.06

$K \to \pi l \nu$ in KLOR and PHOTOS: hep-ph:0406006

only on 28 December 2004 we realized that PHOTOS is used for K decays and precision is not sufficient. Even though, program works not worse than expected.



(a) $\cos(\Theta_{\gamma,l})$ $K_{\mu 3}$

(b) $\cos(\Theta_{\gamma,l})$ K_{e3}

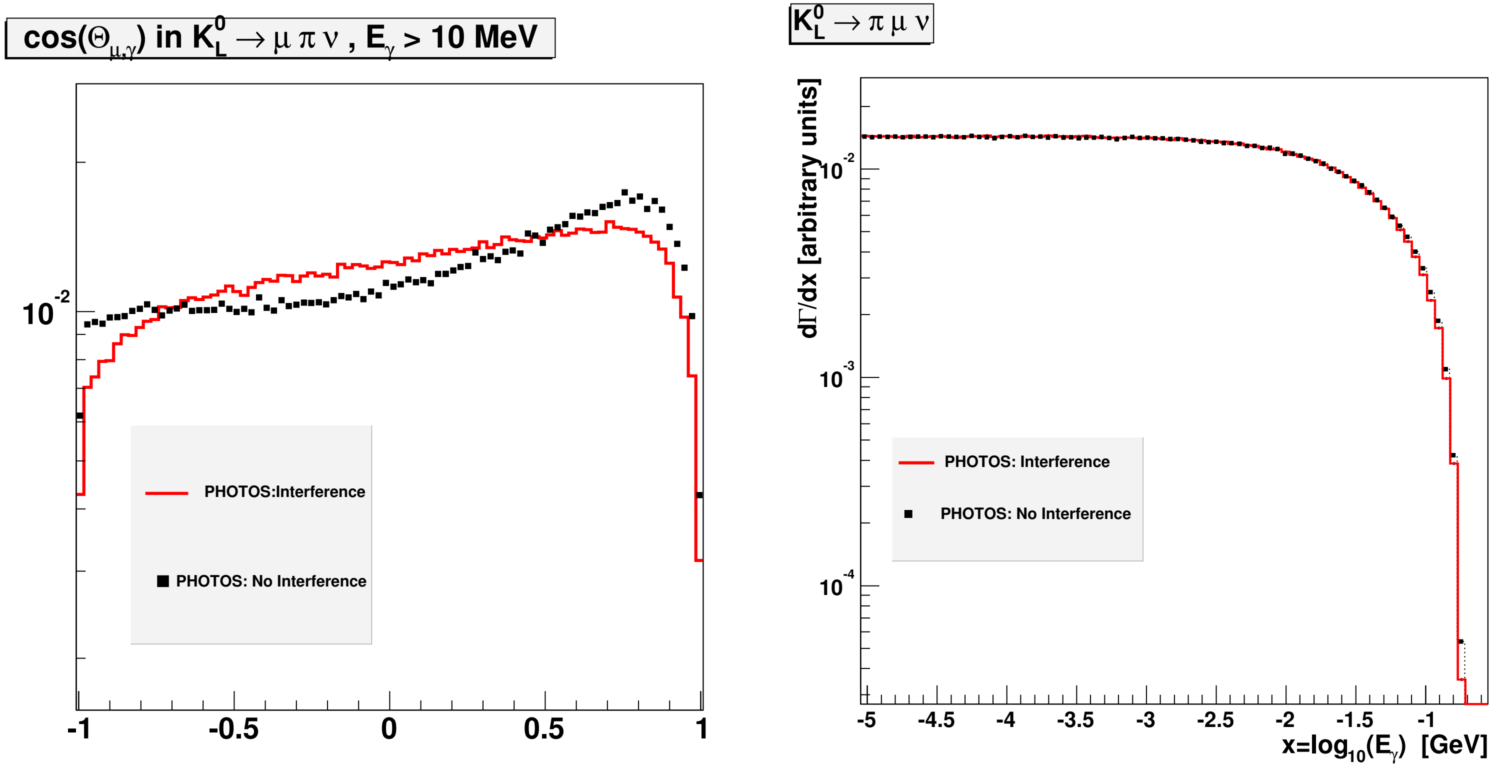
(c) $\log_{10}(E_\gamma)$ $K_{\mu 3}$

(d) $\log_{10}(E_\gamma)$ K_{e3}

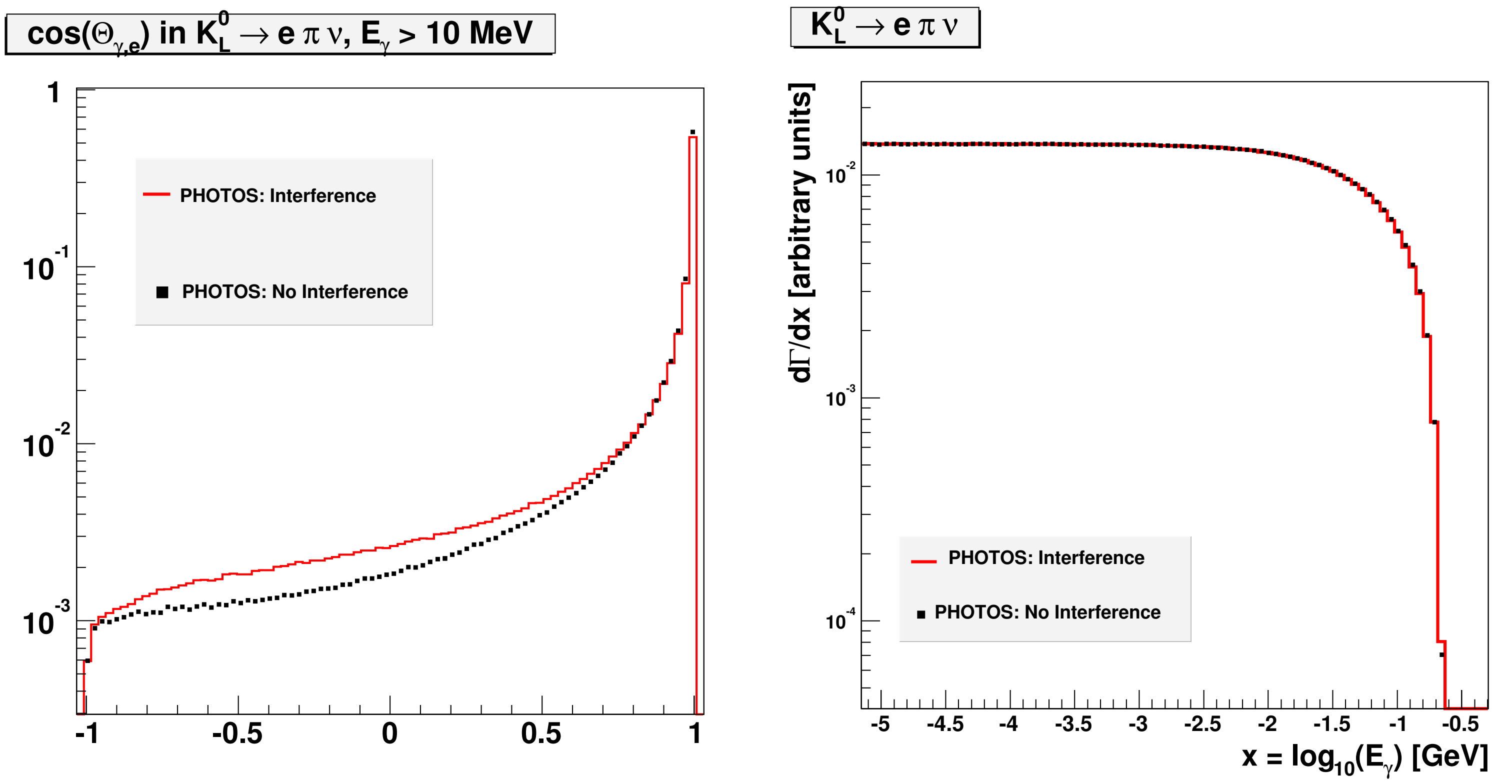
in KLOR

and PHOTOS

$K \to \pi\mu\nu$ + PHOTOS bremsstrahlung, interference on/off



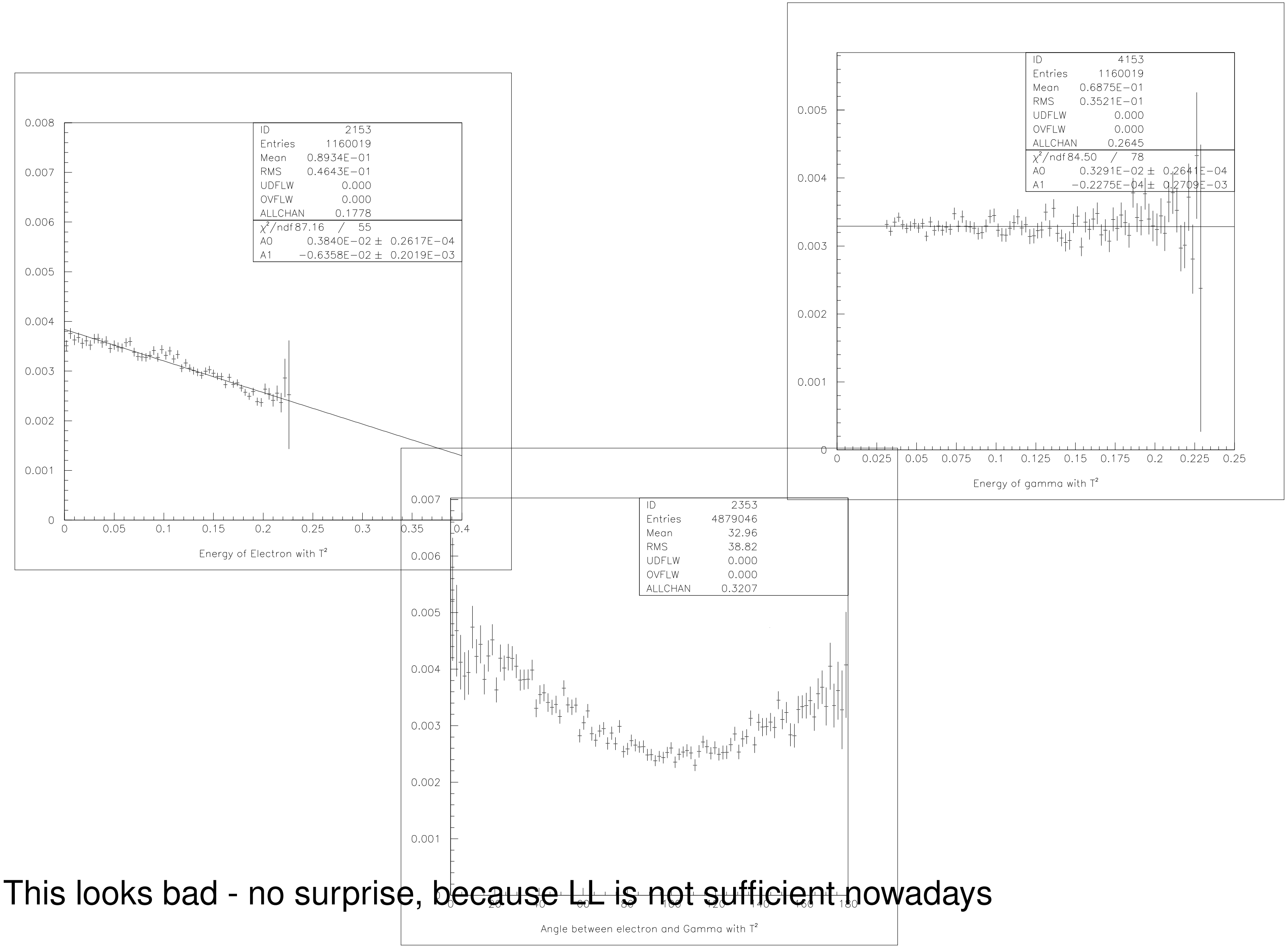
$K \rightarrow \pi e \nu$ + PHOTOS bremsstrahlung, interference on/off



Seems that the interference weight removed the difference to a large degree, but still some inconsistencies at $\cos\Theta \simeq -1$

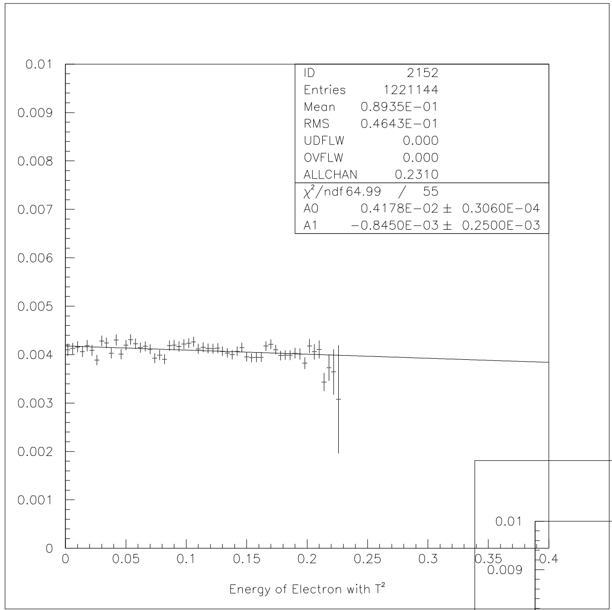
- We used published results which indicated improvements in PHOTOS were urgent.
- Fortunately thanks to work for W it was trivial to do.
- After initial success we need to worry about smaller, also possibly technical problems.
- Thanks to NA48 (L. Litov, et al) we proceed with further comparisons with Matrx-Element generators.
- channel $K \to \pi^{\pm} e^{\mp} \nu$
- channel $K \to \pi^{\pm} \mu^{\mp} \nu$

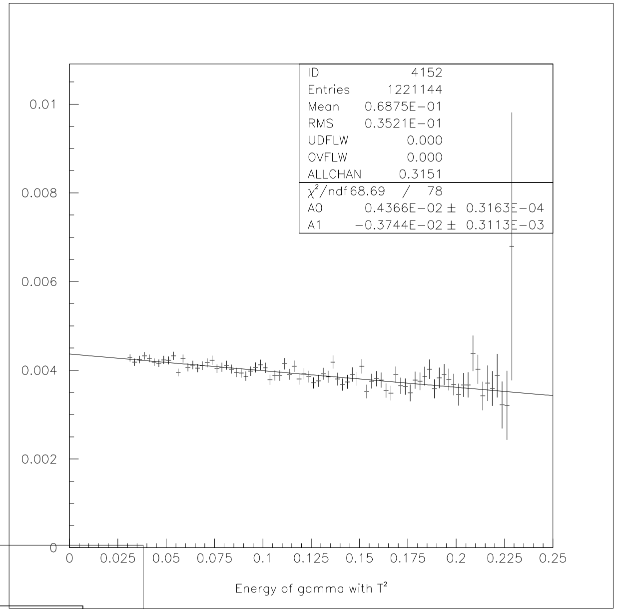
$K \to \pi e \nu(\gamma)$ PHOTOS (A.D. 2004) vs Gasser

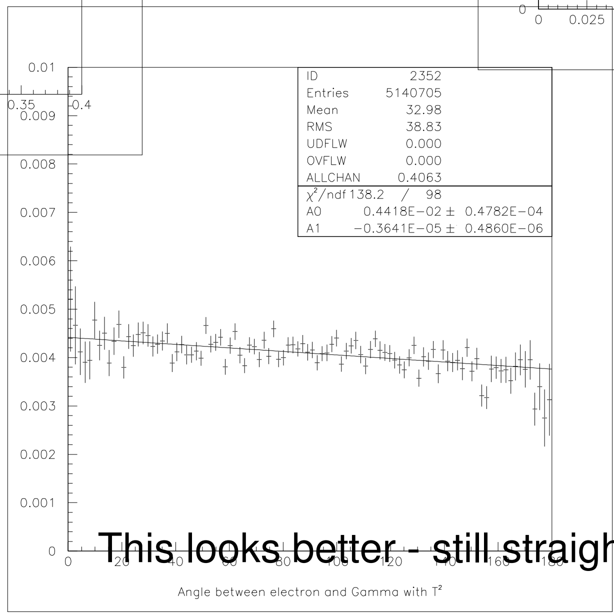


This looks bad - no surprise, because LL is not sufficient nowadays

$K \rightarrow \pi e \nu(\gamma)$ PHOTOS w/Interf vs Gasser







This looks better - still straightforward improvements possible

Events with and without photon:

$R = \frac{\Gamma_{K_{e3\gamma}}}{\Gamma_{K_{e3}}}$	PHOTOS interf	GASSER
$5 < E_\gamma < 15\, MeV$	2.38	2.42
$15 < E_\gamma < 45\, MeV$	2.03	2.07
$\Theta_{e,\gamma} > 20$	0.876	0.96

This table may indicate that residual discrepancy between new PHOTOS and KLOR for e-channel may be not real problem ...

New PHOTOS (beta version 2.13) is available (as a special patch) from http://cern.ch/wasm/goodies.html

PART 3:
Non-leptonic decays

- **Motto: Guilty until proven otherwise.**

Testbed

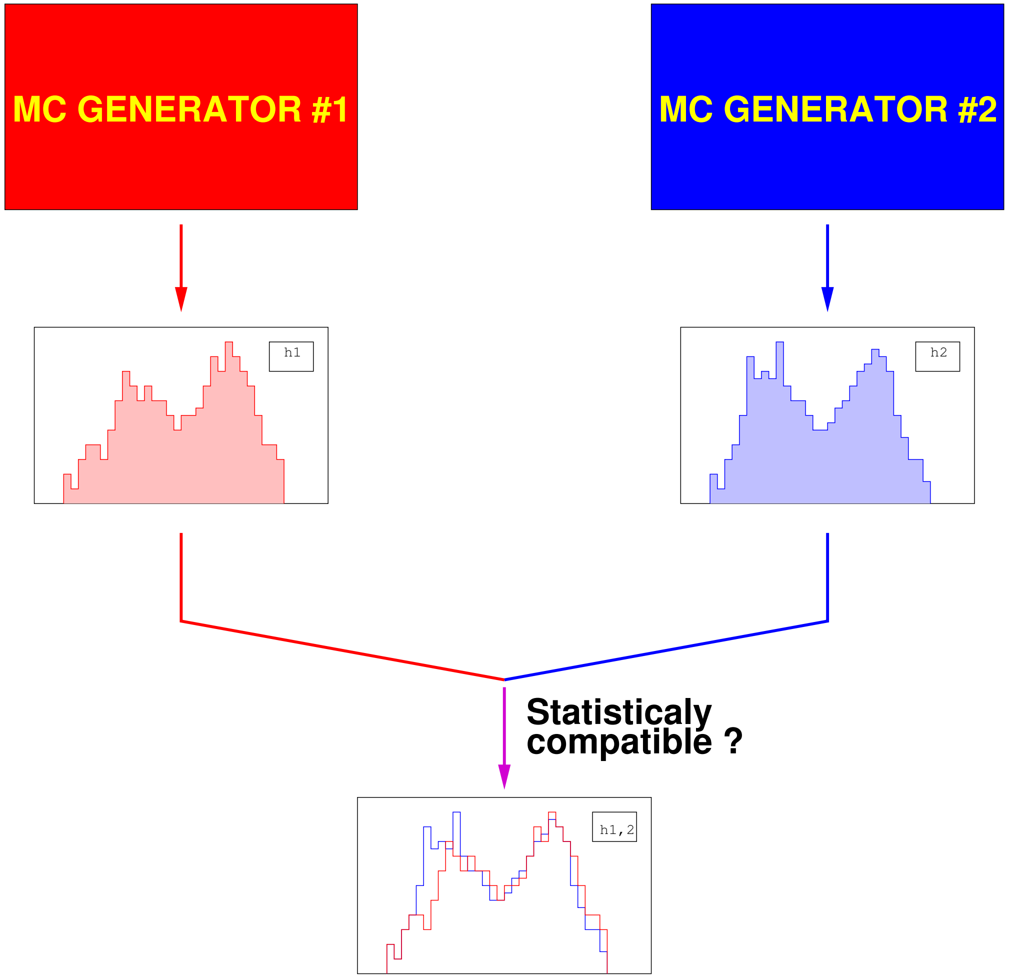
- no good field-theory predictions as in Z and W decays, also ...
- no semianalytical formulas, no Monte Carlo (neither weighted nor unweighted events)
- fortunately there is a possibility to compare with data
- collaboration effort is critically needed

Summary:

- B-physics requirements were not satisfied with PHOTOS version available in 2004.
- we improved significantly, but probably we are still half-way through only...
- Present version of PHOTOS assures precision for W and Z decays, also H.
- PHOTOS is on a way from general purpose facility to precison tool in places where tests are completed.
- PHOTOS provides also interesting testbed for some parton shower-like iterative solutions.

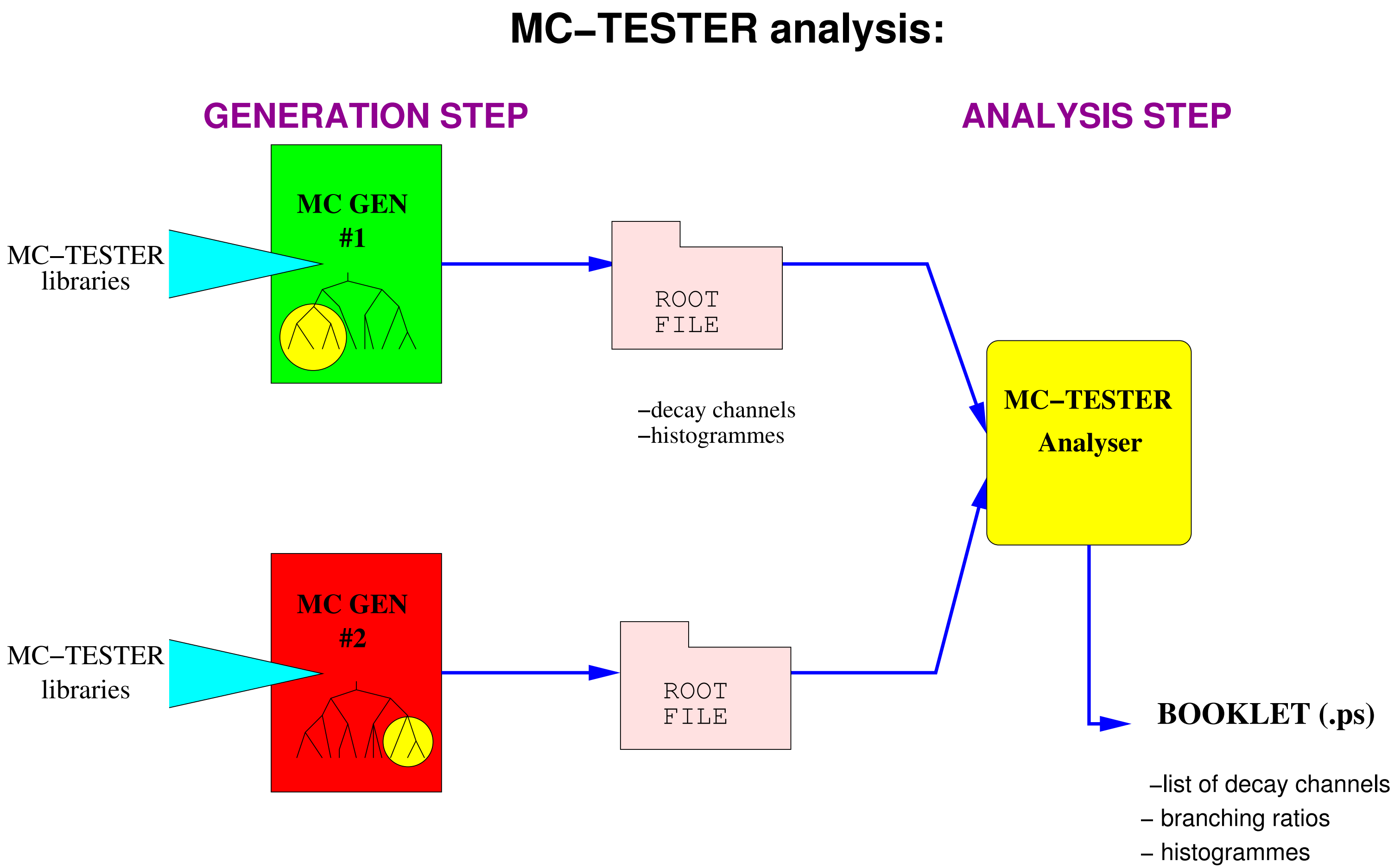
APPENDIX

MC-TESTER: motivation



$\mathcal{M}$C-TESTER

- universal tool for semi-automatic comparison tests of HEP Monte Carlo generators
- based on ROOT package (C++) with F77 support
- gathers all possible distributions of invariant mass of decay products
- produces a “comparison booklet”: visual verification of discrepancies
- quantifies the differences using “Shape Difference Parameter” (various algorithms available)
- documented in Comput. Phys. Commun. 157 (2004), 39-62
- available from http://cern.ch/Piotr.Golonka/MC/MC-TESTER


MC–TESTER analysis:
GENERATION STEP
ANALYSIS STEP
MC–TESTER
libraries
MC GEN
#1
ROOT
FILE
–decay channels
–histogrammes
MC–TESTER
Analyser
MC–TESTER
libraries
MC GEN
#2
ROOT
FILE
BOOKLET (.ps)
–list of decay channels
– branching ratios
– histogrammes

MC-TESTER results for decays of particle τ^- (PDG code 15).

Piotr Golonka   Tomasz Pierzchala   Zbigniew Was

May 22, 2004

Results from generator 1.

tauola-cleo starting point no modifications in any case `May 19 2004.`

- From directory:
  `/home/wasm/y2004/TAUOLA-all/nowa-tauola/TAUOLA/tauola-old/demo-standalone/prod`
- Total number of analyzed decays: 5000000
- Number of decay channels found: 32

Results from generator 2.

tauola-cleo new version new channels installed, brs=*0.001 `May 22 2004.`

- From directory:
  `/home/wasm/y2004/TAUOLA-all/nowa-tauola/TAUOLA/tauola-new/demo-standalone/prod`
- Total number of analyzed decays: 5000000
- Number of decay channels found: 32 + 8

1

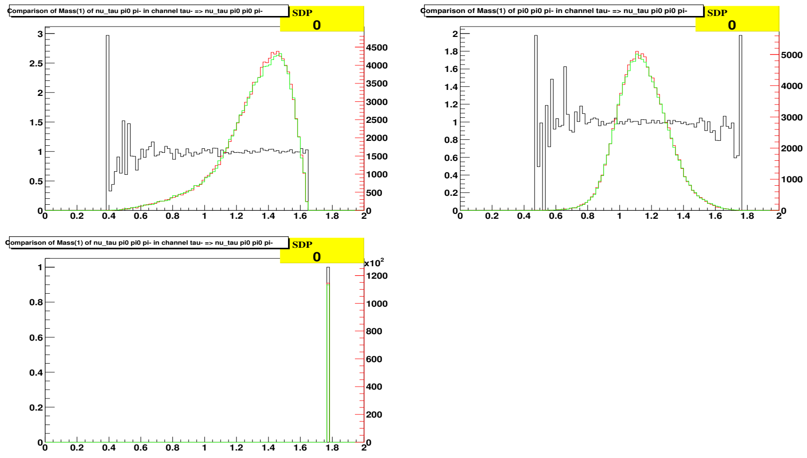
MC-TESTER booklet: Page 1

Found decay modes:

Decay channel	Branching Ratio ± Rough Errors Generator #1	Generator #2	Max. shape dif. param.
$\tau^- \to \nu_\tau K^-$	4.5460 ± 0.0095%	4.5500 ± 0.0095%	0.00000
$\tau^- \to \nu_\tau \pi^0 \pi^0 \pi^+ \pi^- \pi^-$	4.5460 ± 0.0095%	4.5425 ± 0.0095%	0.00000
$\tau^- \to \nu_\tau \pi^+ \pi^+ \pi^- \pi^- \pi^-$	4.5457 ± 0.0095%	4.5303 ± 0.0095%	0.00000
$\tau^- \to \nu_\tau \pi^0 \pi^0 \pi^0 \pi^+ \pi^- \pi^-$	4.5449 ± 0.0095%	4.5271 ± 0.0095%	0.00000
$\tau^- \to \nu_\tau \pi^0 \pi^0 \pi^0 \pi^-$	4.5416 ± 0.0095%	4.5366 ± 0.0095%	0.00000
$\tau^- \to \nu_\tau \pi^0 \pi^+ \pi^- \pi^-$	4.5392 ± 0.0095%	4.5371 ± 0.0095%	0.00000
$\tau^- \to \nu_\tau \gamma \pi^0 \pi^-$	4.5368 ± 0.0095%	4.5160 ± 0.0095%	0.00000
$\tau^- \to \nu_\tau \pi^0 \pi^0 K^-$	4.5268 ± 0.0095%	4.5468 ± 0.0095%	0.00000
$\tau^- \to \nu_\tau \pi^0 \pi^- \eta$	4.5236 ± 0.0095%	4.5154 ± 0.0095%	0.00000
$\tau^- \to \mu^- \tilde{\nu}_\mu \nu_\tau$	4.3942 ± 0.0094%	4.3919 ± 0.0094%	0.00000
$\tau^- \to e^- \tilde{\nu}_e \nu_\tau$	3.8276 ± 0.0087%	3.8245 ± 0.0087%	0.00000
$\tau^- \to \nu_\tau \pi^0 \pi^0 \pi^-$	2.2907 ± 0.0068%	2.2669 ± 0.0067%	0.00000
$\tau^- \to \nu_\tau K^0_S K^-$	2.2832 ± 0.0068%	2.2582 ± 0.0067%	0.00000
$\tau^- \to \nu_\tau \pi^0 K^0_L K^-$	2.2825 ± 0.0068%	2.2698 ± 0.0067%	0.00000
$\tau^- \to \nu_\tau K^0_L K^-$	2.2795 ± 0.0068%	2.2725 ± 0.0067%	0.00000
$\tau^- \to \nu_\tau \pi^0 K^0_L \pi^-$	2.2756 ± 0.0067%	2.2680 ± 0.0067%	0.00000
$\tau^- \to \nu_\tau K^0_L \pi^- K^0_S$	2.2756 ± 0.0067%	2.2667 ± 0.0067%	0.00000
$\tau^- \to \nu_\tau \pi^0 K^0_S K^-$	2.2717 ± 0.0067%	2.2606 ± 0.0067%	0.00000
$\tau^- \to \nu_\tau \pi^0 \pi^- K^0_S$	2.2582 ± 0.0067%	2.2663 ± 0.0067%	0.00000
$\tau^- \to \nu_\tau \pi^+ \pi^- \pi^-$	2.2449 ± 0.0067%	2.2822 ± 0.0068%	0.00000
$\tau^- \to \nu_\tau \pi^0 K^-$	1.5545 ± 0.0056%	1.5441 ± 0.0056%	0.00000
$\tau^- \to \nu_\tau \pi^- K^0_S$	1.5047 ± 0.0055%	1.4819 ± 0.0054%	0.00000
$\tau^- \to \nu_\tau K^0_L \pi^-$	1.5019 ± 0.0055%	1.4915 ± 0.0055%	0.00000
$\tau^- \to \nu_\tau \pi^- K^+ K^-$	4.5561 ± 0.0095%	4.5349 ± 0.0095%	0.00000
$\tau^- \to \nu_\tau \pi^-$	4.5501 ± 0.0095%	4.5291 ± 0.0095%	0.00000
$\tau^- \to \nu_\tau \pi^+ \pi^- K^-$	4.5465 ± 0.0095%	4.5461 ± 0.0095%	0.00000
$\tau^- \to \nu_\tau \pi^0 \pi^-$	4.5528 ± 0.0095%	4.5405 ± 0.0095%	0.00000
$\tau^- \to \nu_\tau K^0_L K^0_L \pi^-$	1.1407 ± 0.0048%	1.1324 ± 0.0048%	0.00000
$\tau^- \to \nu_\tau \pi^0 \pi^+ \pi^+ \pi^- \pi^- \pi^-$	4.5557 ± 0.0095%	4.5381 ± 0.0095%	0.00000
$\tau^- \to \nu_\tau \pi^- K^0_S K^0_S$	1.1340 ± 0.0048%	1.1404 ± 0.0048%	0.00000
$\tau^- \to e^- \tilde{\nu}_e \nu_\tau \gamma$	0.7181 ± 0.0038%	0.7164 ± 0.0038%	0.00000
$\tau^- \to \mu^- \tilde{\nu}_\mu \nu_\tau \gamma$	0.1507 ± 0.0017%	0.1489 ± 0.0017%	0.00000

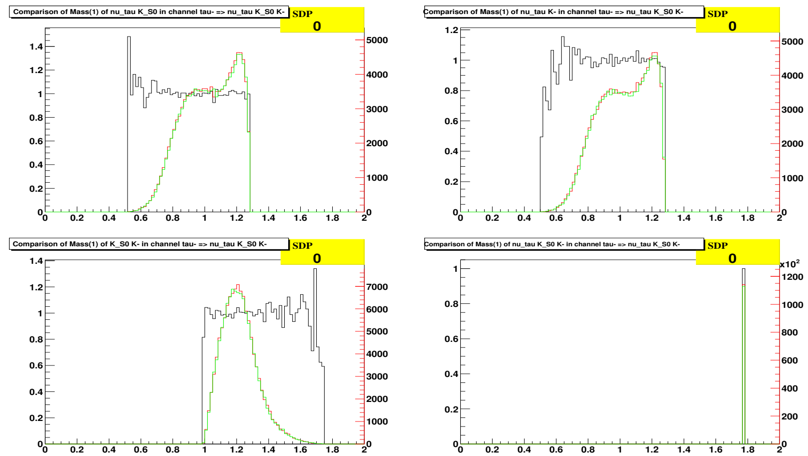
2

MC-TESTER booklet: Page 2



13 Decay Channel: $\tau^- \to \nu_\tau K^0_S K^-$

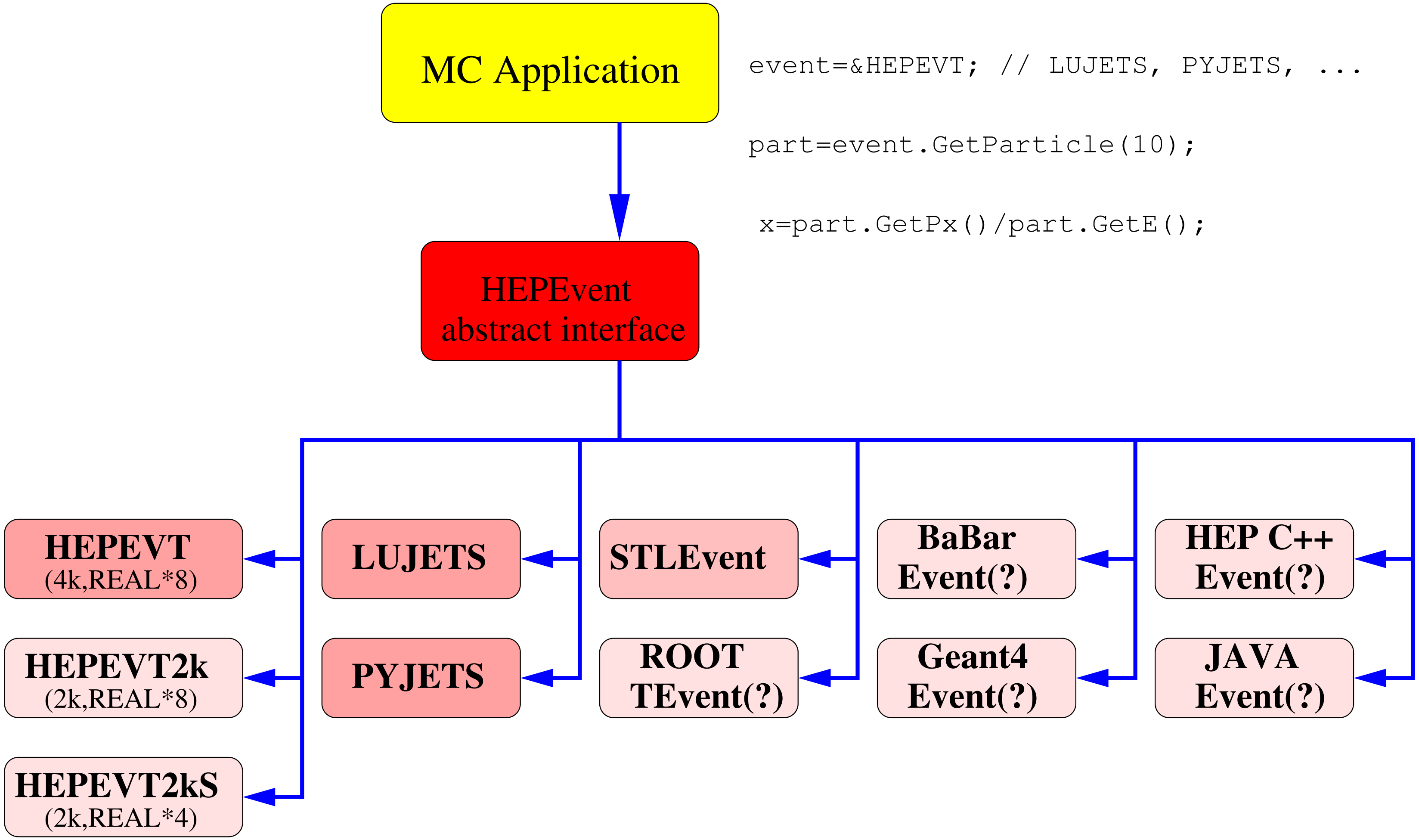
Number of events from generator 1: 114161
Number of events from generator 2: 112908



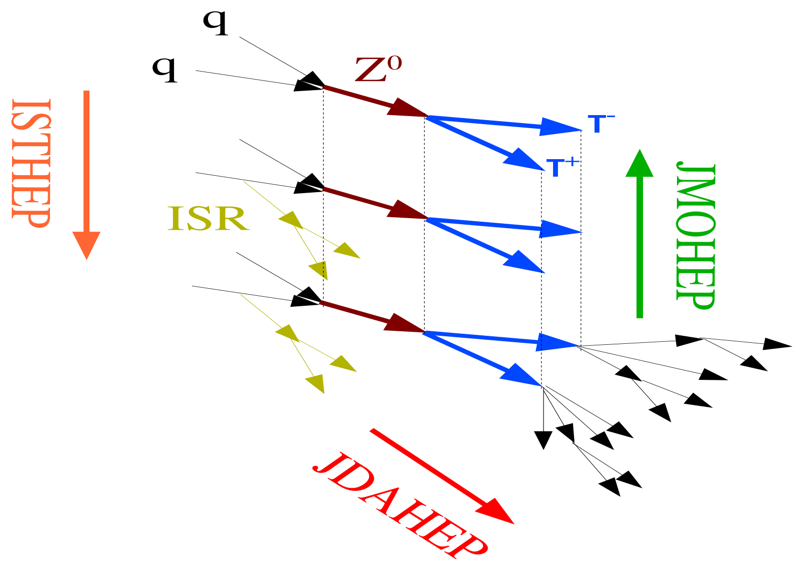
49

MC-TESTER booklet: Page 49

This tool can be used for any MC storing events in standard common blocks: HEPEVT, PYJETS, ... It may also be extended to adopt new event-record data-structures (i.e. in C++).



Problems With Event Record



1. Hard process
2. with shower
3. after hadronization
4. Event record overloaded with physics beyond design $\longrightarrow$ gramar problems.
5. Here we have basically LL phenomenology only.

This Is Physics Not F77!

Similar problems are in any use of full scale Monte Carlos, lots of complaints at MC4LHC workshop, `HEPEVTrepair` utility (C. Biscarat and ZW) being probed in D0.

Design of event structure WITH some grammar requirements AND WITHOUT neglecting possible physics is needed NOW to avoid large problems later.

HEPEventLib

- PHOTOS was always connected to attempts on software engineering, data structures transformations etc. Originally in FORTRAN and for Eloisatron software. Necessity to interact with many people and architectures.
- Motto: **“this is physics, not FORTRAN (or C++)”**
- Variety of event record event structures: HEPEVT, PYJETS, HepMC, ThePEG, LesHouches, ...
- Data structures often ”overloaded” to encode more data in structures that were not designed for this purpose, e.g. status code and mother-daughter pointers re-used to encode color, spin or tree-layer navigation.
- Various ”gramatics” of **standard** event records; consistent, but not compatible with each other and with the standard! (3 versions of PYTHIA gramatics, HERWIG gramatics, ...)
- Ultimate data structure for future C++ generators still not established

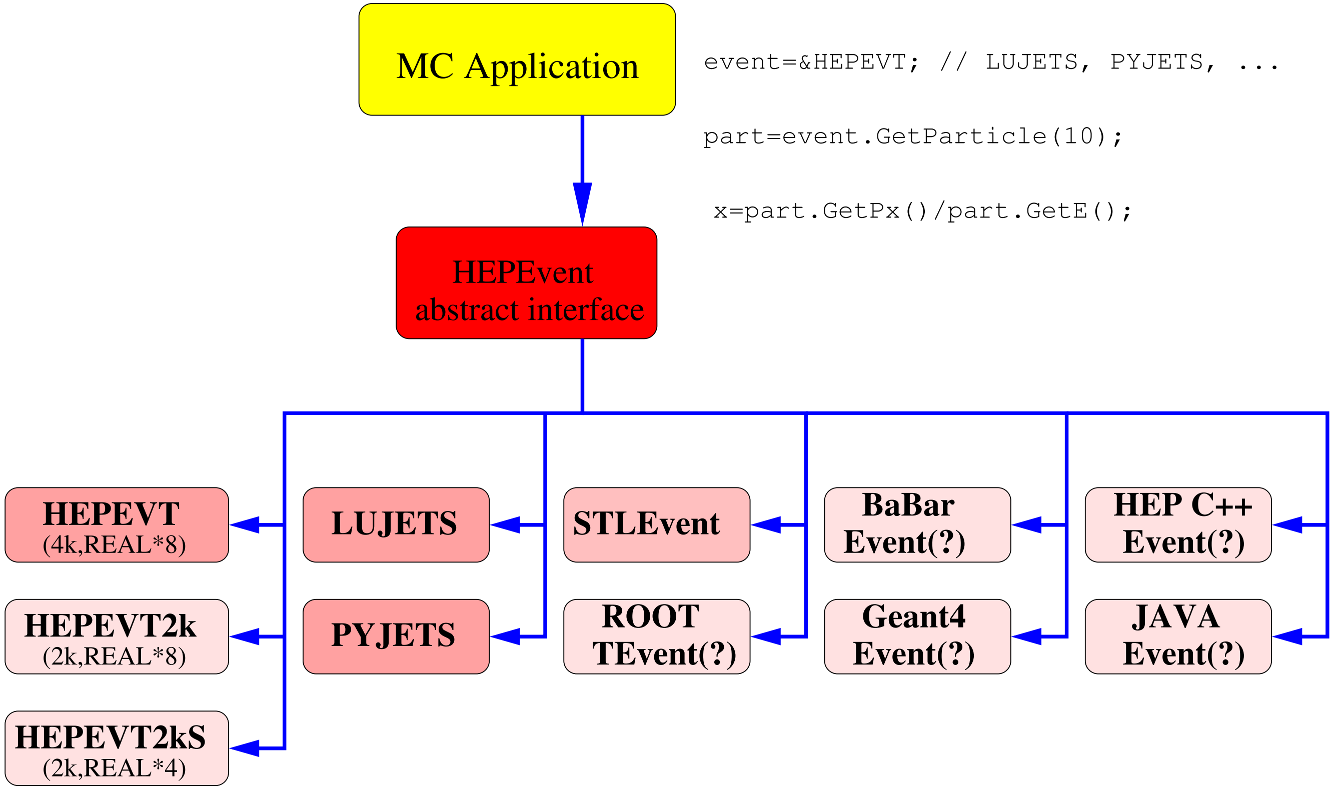
- How to extract the data we need from various, entangled data structures ?
- How to navigate through the tree structure?
- Most common solutions: try to rely on standards and “hack” the code to make it inter-operable with non-standard gramatics (i.e. PHOTOS/HERWIG integration); or: have an internal data structure and a set of input-output routines

HEPEventLib: aims

- Provide a common way ("interface") to extract physical information from various event-record data-structures
- centralize all the gramatics-dependencies, technicalities and complexity in a single library
- present the data to the user in a consistent way, by means of a set of well-defined, simple C++ methods ("functions")
- "lightweight": very few, relatively simple classes, like Event, Particle, 4Vector, ParticleList, ListIterator
- no particular, specialized functions (object persistency, ME libraries, complicated algebra, etc); every programmer has his own method of doing this
- "conservative C++" - maintain ease of use and clarity
- no dependencies on other libraries (optional support for ROOT, some experiments with simple STL)

A common interface to event records

Regardless of the actual event-record being used, the data may be obtained in a uniform way.



Yet another event record standard ?

NO!

- A common way to get information from existing (and future) event records
- A way to gain independence of underlying data structures
- A way to write code now, regardless of what C++ event structure will become standard in future
- A common way to navigate through the tree structures
- Provides direct access to the data that is interesting to physicist (i.e. decay vertex with an easy-to-process list of decay prodcucts, rather than a complicated C++ tree data structure)

Status and availability

- HEPEventLib : first incarnation in 1999 for Photos+; not published
- used (succesfully) in MC-TESTER, and (work in progress) new C++ prototype of PHOTOS
- works (currently) with : HEPEVT, Herwig variant of HEPEVT, LUJETS, PYJETS
- work in progress to support tree-based structures (HepMC, ThePEG)
- Help and feedback would be very appreciated
- PHOTOS as toy-like prototyping platform?
- Please, contact *Piotr.Golonka@CERN.CH* if interested