MCTester – summary and outcome of workshop discussions

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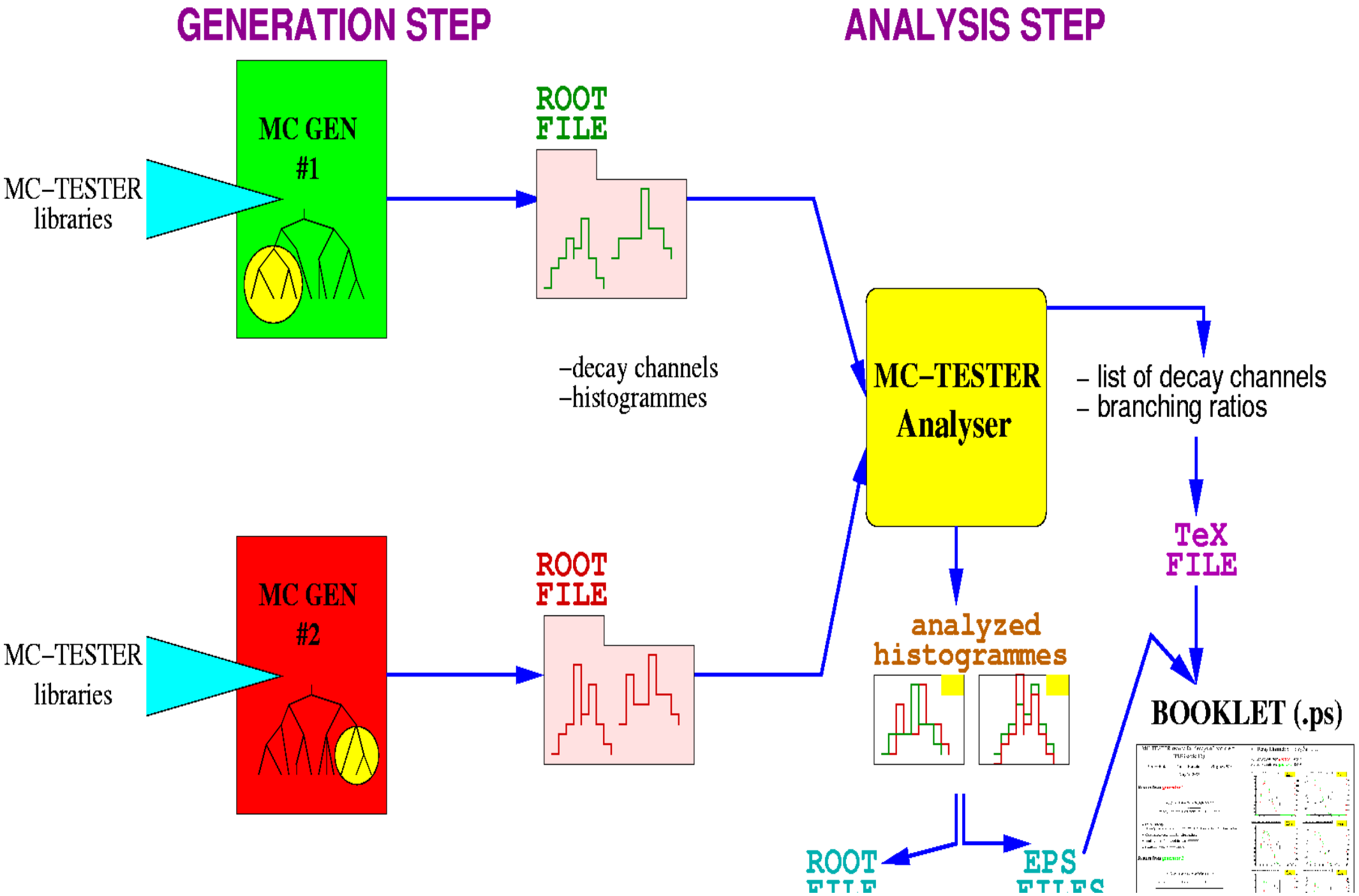
http://cern.ch/Piotr.Golonka/MC/MC-TESTER

MC-TESTER:
a universal tool for comparisons of Monte Carlo predictions for particle decays in high energy physics

- ***For more details, please refer to MC-Tester webpage: http://cern.ch/Piotr.Golonka/MC/MC-TESTER***

- ***The tool has already been introduced in the talks on "Decay Packages" session (July 24) and "ME" session (July 9)***

MC-TESTER analysis:



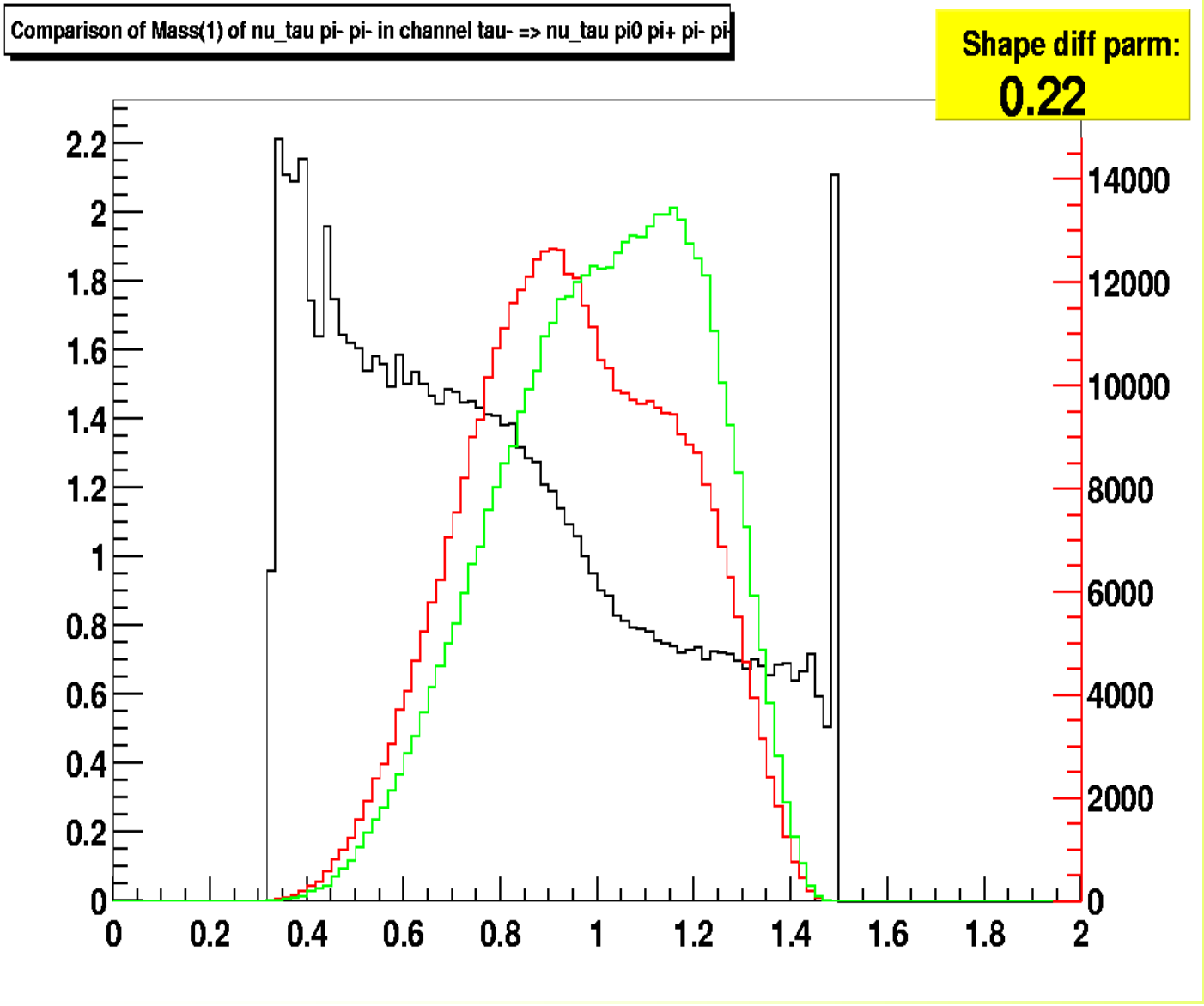
Found decay modes:

Decay channel	Branching Ratio ± Rough Errors Generator #1	Generator #2	Max. shape dif. param.
$\tau^- \to \nu_\tau \pi^0 \pi^-$	25.3683 ± 0.0159%	25.3085 ± 0.0159%	0.04375
$\tau^- \to e^- \widetilde{\nu}_e \nu_\tau$	17.8479 ± 0.0134%	18.1093 ± 0.0135%	0.00000
$\tau^- \to \mu^- \widetilde{\nu}_\mu \nu_\tau$	17.3866 ± 0.0132%	17.6326 ± 0.0133%	0.00000
$\tau^- \to \nu_\tau \pi^-$	11.0768 ± 0.0105%	11.1765 ± 0.0106%	0.00000
$\tau^- \to \nu_\tau \pi^0 \pi^0 \pi^-$	9.1865 ± 0.0096%	9.1171 ± 0.0095%	0.09413
$\tau^- \to \nu_\tau \pi^+ \pi^- \pi^-$	8.9837 ± 0.0095%	8.8828 ± 0.0094%	0.09368
$\tau^- \to \nu_\tau \pi^0 \pi^+ \pi^- \pi^-$	4.2973 ± 0.0066%	4.5319 ± 0.0067%	0.30310
$\tau^- \to \nu_\tau \pi^0 \pi^0 \pi^0 \pi^-$	1.0765 ± 0.0033%	1.0090 ± 0.0032%	0.00724
$\tau^- \to \nu_\tau K^-$	0.7202 ± 0.0027%	0.7138 ± 0.0027%	0.00000
$\tau^- \to \nu_\tau \pi^0 \pi^0 \pi^+ \pi^- \pi^-$	0.4990 ± 0.0022%	0.0897 ± 0.0009%	0.00000
$\tau^- \to \nu_\tau \pi^0 K^-$	0.4785 ± 0.0022%	0.4617 ± 0.0021%	0.00000
$\tau^- \to \nu_\tau K_L^0 \pi^-$	0.4624 ± 0.0022%	0.4444 ± 0.0021%	0.00000
$\tau^- \to \nu_\tau \pi^- K_S^0$	0.4610 ± 0.0021%	0.4449 ± 0.0021%	0.00000
$\tau^- \to \nu_\tau \pi^+ \pi^- K^-$	0.3902 ± 0.0020%	0.5051 ± 0.0022%	0.52330
$\tau^- \to \nu_\tau \pi^0 \pi^- \eta$	0.1707 ± 0.0013%	0.1696 ± 0.0013%	0.00000
$\tau^- \to \nu_\tau \pi^- K^+ K^-$	0.1704 ± 0.0013%	0.1309 ± 0.0012%	0.07360
$\tau^- \to \nu_\tau \pi^0 K_L^0 \pi^-$	0.1605 ± 0.0013%	0.2745 ± 0.0017%	0.92850
$\tau^- \to \nu_\tau \pi^0 \pi^- K_S^0$	0.1592 ± 0.0013%	0.2734 ± 0.0017%	0.93657
$\tau^- \to \nu_\tau \gamma \pi^0 \pi^-$	0.1559 ± 0.0012%	0.1303 ± 0.0011%	0.00000
$\tau^- \to \nu_\tau K_L^0 \pi^- K_S^0$	0.1510 ± 0.0012%	0.0763 ± 0.0009%	0.00270
$\tau^- \to \nu_\tau K_L^0 K^-$	0.1289 ± 0.0011%	0.0508 ± 0.0007%	0.00000
$\tau^- \to \nu_\tau K_S^0 K^-$	0.1287 ± 0.0011%	0.0507 ± 0.0007%	0.00000
$\tau^- \to \nu_\tau \pi^0 \pi^0 \pi^0 \pi^+ \pi^- \pi^-$	0.1094 ± 0.0010%	0.0506 ± 0.0007%	0.00000
$\tau^- \to \nu_\tau \pi^+ \pi^+ \pi^- \pi^- \pi^-$	0.0803 ± 0.0009%	0.0401 ± 0.0006%	0.00000
$\tau^- \to \nu_\tau \pi^0 \pi^0 K^-$	0.0792 ± 0.0009%	0.0504 ± 0.0007%	0.29190
$\tau^- \to \nu_\tau K_L^0 K_L^0 \pi^-$	0.0760 ± 0.0009%	0.0372 ± 0.0006%	0.00854
$\tau^- \to \nu_\tau \pi^- K_S^0 K_S^0$	0.0756 ± 0.0009%	0.0378 ± 0.0006%	0.01189
$\tau^- \to \nu_\tau \pi^0 K_L^0 K^-$	0.0507 ± 0.0007%	0.0763 ± 0.0009%	0.85321
$\tau^- \to \nu_\tau \pi^0 K_S^0 K^-$	0.0498 ± 0.0007%	0.0746 ± 0.0009%	0.87506
$\tau^- \to \nu_\tau \pi^0 \pi^+ \pi^+ \pi^- \pi^- \pi^-$	0.0186 ± 0.0004%	0.0293 ± 0.0005%	0.00000

Table of decay modes:

- Decay channel
- Branching ratio for generator #1 and #2
- Rough statistical errors of branching ratios
- Maximal “Shape Difference Parameter”
- Similarity Coefficients (combined for all decay modes)

Example of histogrammes:



- Histogrammes of invariant mass from generator #1 and #2
- Ratio of the two histogrammes
- ***Shape Difference Parameter*** value

MCTester: areas of use (1)

- Analysis of decays of particles in event records
- Written in C++, supports F77 (and F90) *by design*
- *Support for various event-record standards (future C++)*
- *“user fiendly” - easy integration with user's code*
- Comparison of particle decay event generators
- Testing of large installations (e.g. ATLAS)
- Porting of MC event generators from F77 (to C++)

Areas of use (2)

- Comparisons of parton-level generators (2 n)
- Exists as an extension of MC-Tester
- Already found useful by Linear Collider community
- Event record search routine not particularly used in that case – it's ready for the next step:
  - At some stage, generators of “full” event will be written (in C++?), comparisons of decays will also be needed.

User's feedback:

- In course of the current workshop we had a lot of interaction with users
- Thanks to:
  - Fabio Maltoni (MADGRAPH)
  - Yoshimasa Kurihara (GRACE)
  - Torbjorn Sjöstrand (PYTHIA)
  - Frank Krauss (AMEGIC++)
  - Krzysztof Kołodziej (eett6f)
  - Borut Kersevan (HERWIG, Atlas software)

Suggestions of extensions:

- Support for weighted events
- Interface "*Les Houches*" format
- Direct support of 2 n process
  (rather than crossing through 1 n)
- Distribution of other variables (not only invariant mass)
- Improvements for channels with big multiplicities
- Support for HepMC (C++ event record)
- Support for channels with multiple, e.g. photons, in final state

Extensions: weighted events (1)

- *"poor-man's unweighting"*
  - *algorithm already exists (`workshop.f`)*
  - *Based on calculation of average weight*
  - *Often sufficient for many users*
  - *A tool for debuging of phase-space inefficiencies*
  - *Comparisons of results from weighted and*

Extensions: weighted events (2)

- Full support for weighted events requested

  Histogramming with weights – trivial to implement

  – The whole statistical analysis needs to be rewritten!

  – (e.g: calculation of weight dispersion, SDP algorithms)

  Timescale: a few weeks, depending on priority

We need more input from users to determine the priority of this task on "to do" list

Extensions: large multiplicities

- For decay channels with more than a few particles, the number of histogrammes explodes:

N-Body decay	Total histos		2-body	3-body	4-body	5-body	6-body	7-body	8-body	9-body	10-body	11-body	12-body
2	1		1										
3	4		3	1									
4	11		6	4	1								
5	26		10	10	5	1							
6	57		15	20	15	6	1						
7	120		21	35	35	21	7	1					
8	247		28	56	70	56	28	8	1				
9	502		36	84	126	126	84	36	9	1			
10	1013		45	120	210	252	210	120	45	10	1		
11	2036		55	165	330	462	462	330	165	55	11	1	
12	4083		66	220	495	792	924	792	495	220	66	12	1

Extensions: Large multiplicities(2)

- For particle decay Monte Carlos:
  - One may suppress the decay of certain particles in MC-Tester (e.g. ^{0})
- For ME Monte Carlos:
  - Reduction of depth of analyzed cascade (to be implemented soon)
- For large multiplicities:
  - Create only histogrammes for 2, 3, (n-1), (n-2), (n-3) particles

Extensions:multi-photon states

- Special treatment of distribution with multiple photons in final state : S.Jadach, W. Płaczek,
  e.g. $e^+ e^- \rightarrow \; ^+ \; ^- + n$ ***photons***
  (to be discussed – contact W. Płaczek)

Extensions: other variables

- Three cathegories of variables
  a) Based on existing invariants and constants
  b) Based on 4-vectors, invariants and external constants and 4-vector (coordinate systems)
  c) Based on Levi-Civita tensors
- The ME users expressed particular interest in (b):
  (variables like p_t, , defined in LAB frame)
- Timescale: a few weeks/months – may require significant changes in the MC-TESTER structure!
  – Stability(?), user-friendly(?)

Summary:

.We have gathered a lot of suggestions and requests for improvements.

.MC-Tester was succesfully used with various MC generators, showing that little effort is needed to adapt it, it is stable.

.We need yet more input from users to decide on priorities of extensions to be implemented,

. but we want to preserve stability ...