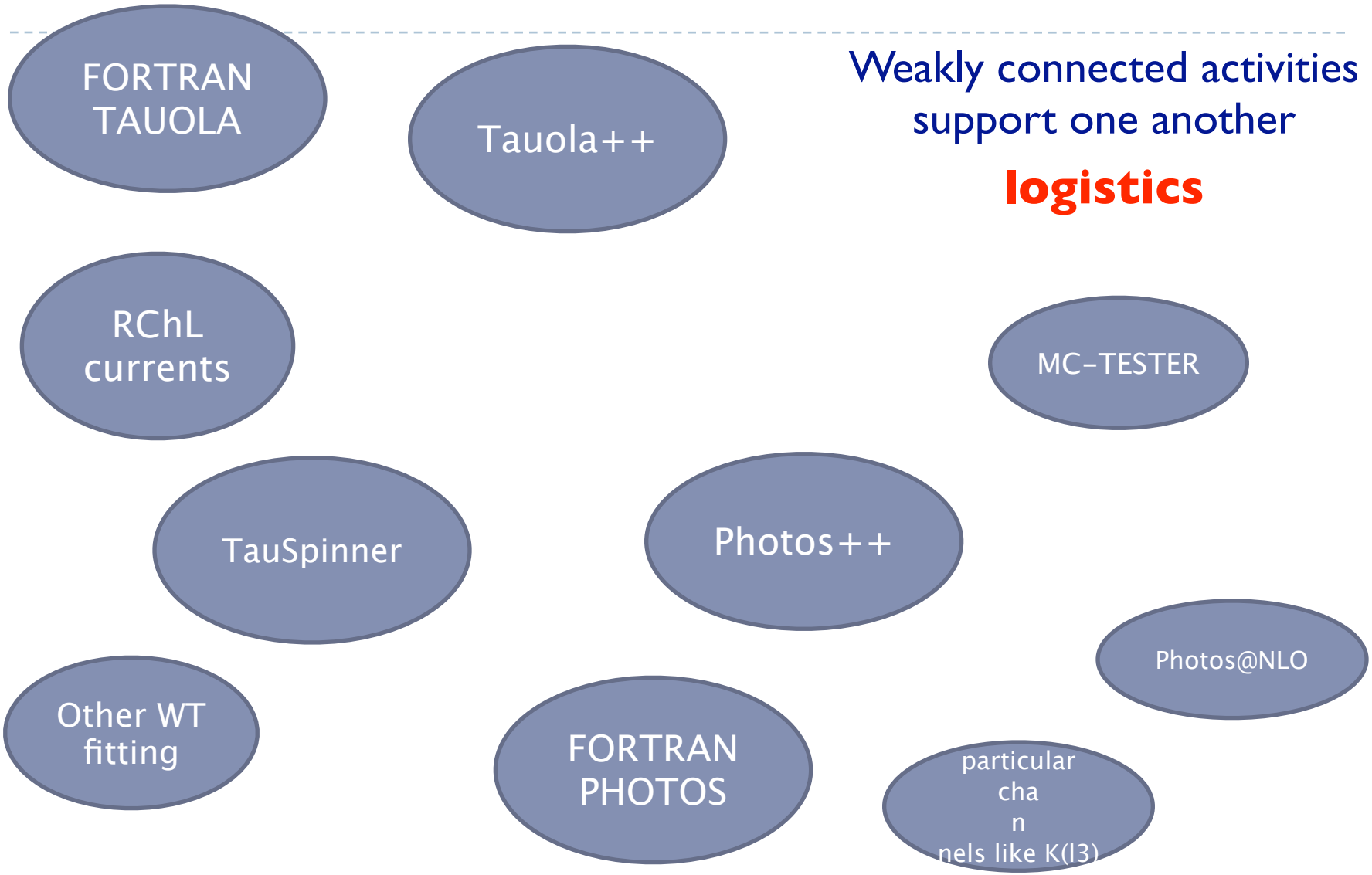
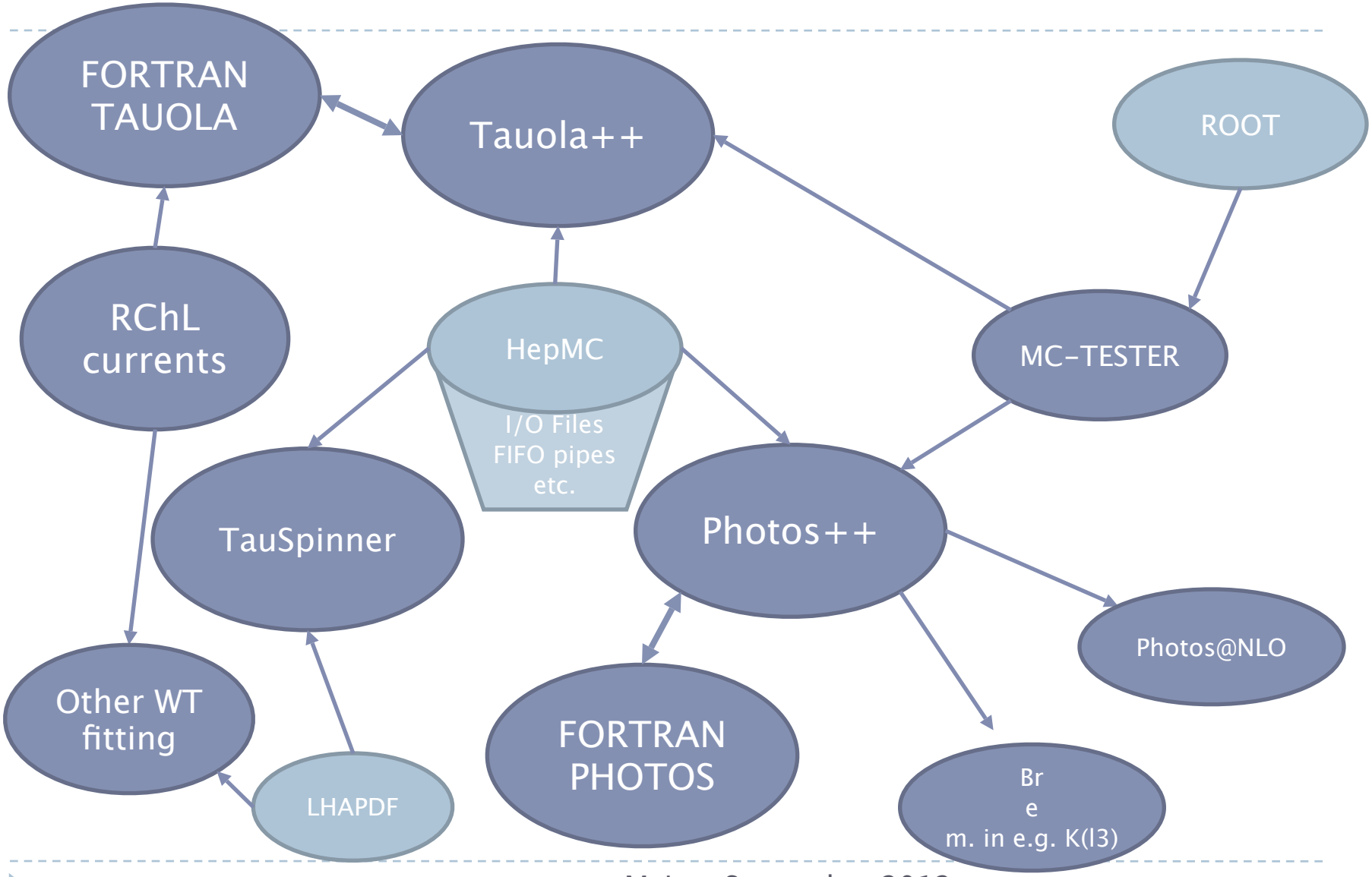
Status of TAUOLA and related projects

Zofia Czyczuła, Nadia Davidson, Gizo Nanava, Tomasz Przedziński, Elżbieta Richter-Wąs, Pablo Roig, Olga Shekhovtsova, Jakub Zaremba, Zbigniew Wąs, Quingjun Xu, …

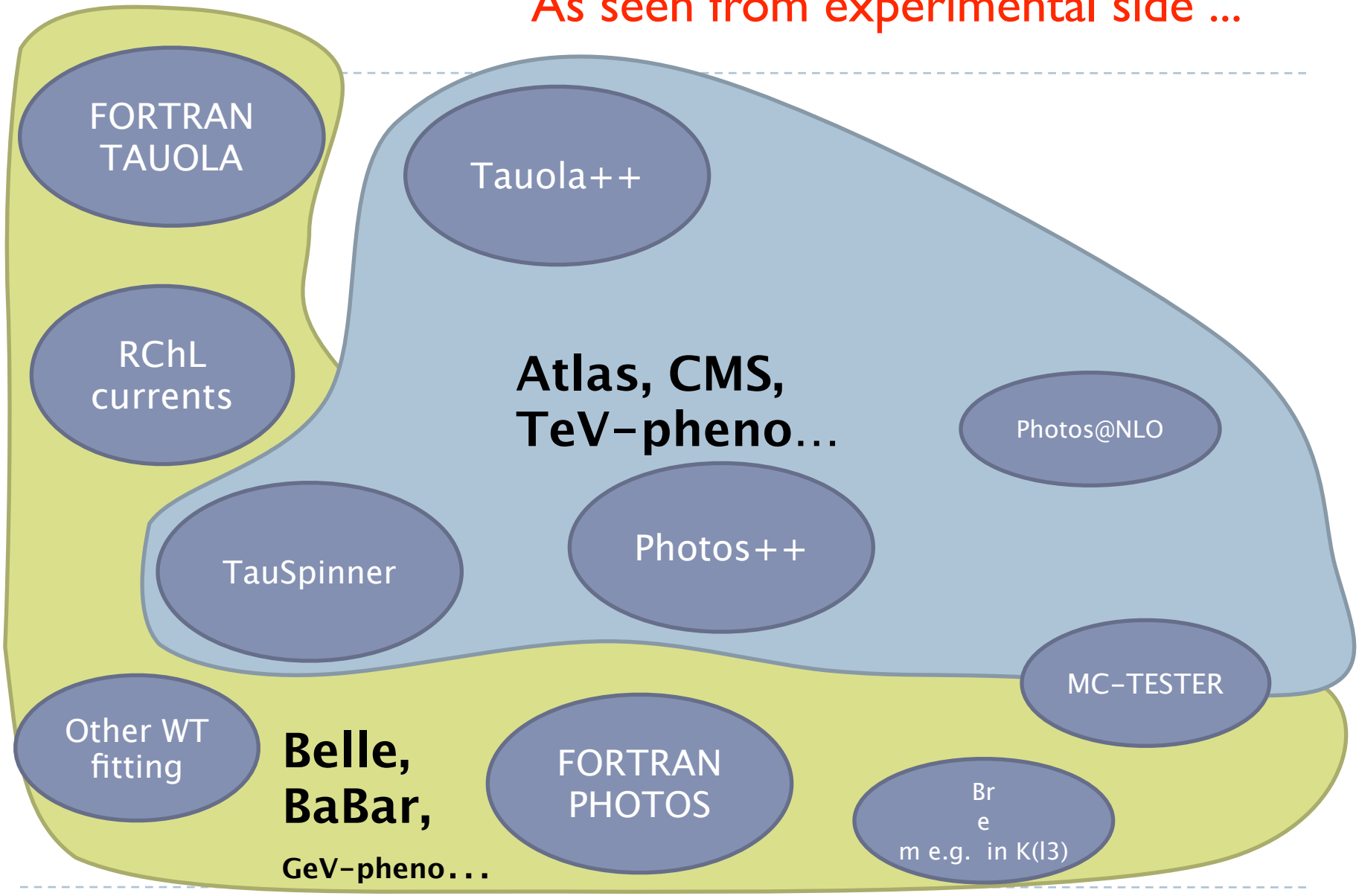
- Plan
- (I will supplement talks of Olga, Pablo, Ian and Zofia):
  - Tauola F77 and Photos F77 (theoretical errors general)
  - Photos @ NLO (theoretical errors for particular cases)
  - Tauola++ and Photos++ (new interfaces)
  - Tauola RChL currents
  - MC-TESTER
  - systematic errors for particular channels
  - Using new Tauola currents in LHC
  - TauSpinner
- Adapting projects for LHC Computing Grid


FORTRAN TAUOLA
Tauola++
Weakly connected activities support one another
logistics
RChL currents
MC-TESTER
TauSpinner
Photos++
Photos@NLO
Other WT fitting
FORTRAN PHOTOS
particular cha n nels like K(l3)

As seen from theoretical/software sides ...



As seen from experimental side ...



Authors and active users ...

I'm sorry, I have surely missed names

FORTRAN TAUOLA

S. Tsuno

Tauola++

E. Richter-Wąs
G. Nanava
N. Davidson

RChL currents

O. Shekhovtsova
P. Roig
V. Cherepanov

MC-TESTER

... J. Yarba, S. Lehti
I. M. Nugent ...

A. Buckley, J. Monk
I. M. Nugent, J. Kretzschmar

Z. Czyczuła,
S. Tsuno

TauSpinner

Photos++

R. Sadykov

Photos@NLO

P. Golonka, N. Davidson

Other WT fitting

T. Przedzinski, J. Zaremba

FORTRAN PHOTOS

Q. Xu

Bre
m
. e.g. in K(l3)

Tauola F77 and Photos F77

- Principles
  - All numerical algorithms of TAUOLA and PHOTOS rely on exact phase-space
  - Approximations are in matrix elements.
  - Path for improvements and tests is clear and unambiguous.
  - Each element requires technical tests.
  - Technical prec. must be factor of 3 better than required theoretical prec.
  - Theoretical precision should be factor of 3 better than experimental.
  - Otherwise it contributes to overall systematic of measurements.
  - Work on tests/matrix elements/model is essential.
  - From data object perspective it is simple.
  - That is why, calculation of ME is left in FORTRAN
  - It is for convenience of some (not all) of my collaborators too.
  - This brings little complications elsewhere.
  - Interfaces to event records benefit from C++
  - User access to event records offer nice algorithms.

Photos@NLO Tests and improvements

W, Z decays, systematic errors 0.5 % --> 0.2 % at LHC

From webpage ...

- **Test with KKMC** NLO; Z to e+e-
- **Test with KKMC** LO; Z to e+e-
- **Test with KKMC** NLO; Z to mu+mu-
- **Test with KKMC** LO; Z to mu+mu-

- **Comparisons PHOTOS LO with PHOTOS NLO**
  are published, see papers by P. Golonka and Z. Was for Z decays and by G. Nanava and Z. Was on W and H decays

- **Comparisons PHOTOS with ME**
  calculated from program of SANC group. The purpose is to prepare benchmarks where fixed first order QED is used by PHOTOS and SANC as well. It is necessary not only for tests of FSR QED but is essential first step for establishing prper matching with complete calculations. In particular complete weak corrections, hadronic/QCD contributions to vacuum

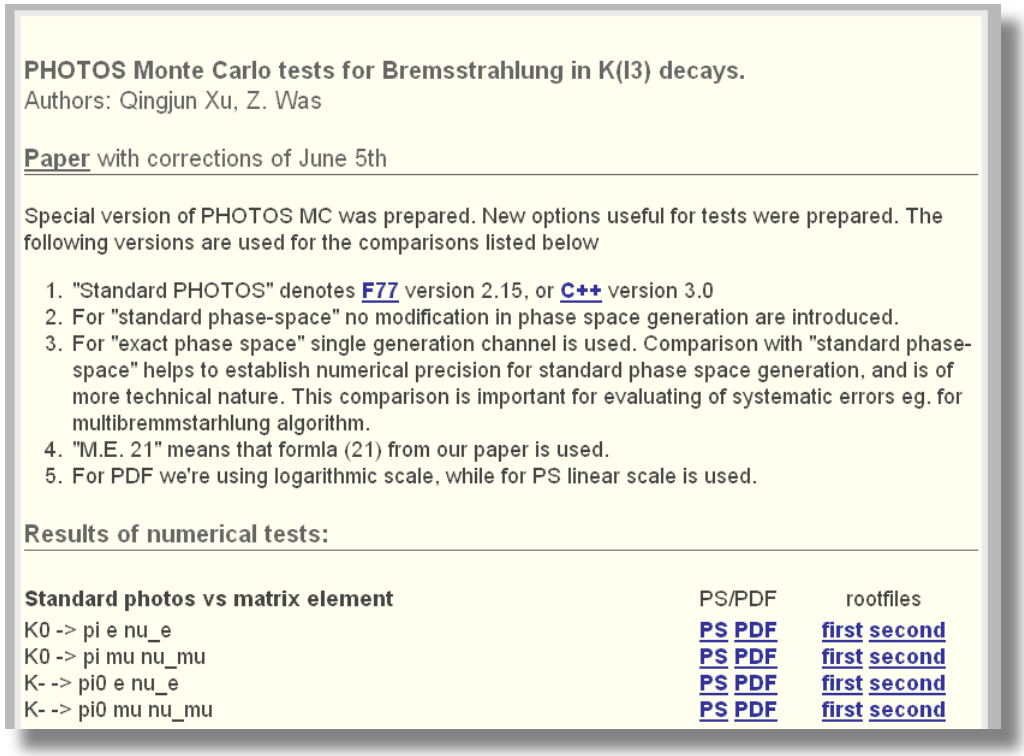
Webpage with tests and comparisons:

- LO vs NLO
- PHOTOS vs KKMC
- Comparison with SANC. Agreement at 0.01% level.
- Detector-oriented results
- discussion of missing effects
- 0.5 to 0.2 % precision for LHC

- http://annapurna.ifj.edu.pl/~wasm/photosNLOtest.html

Photos F77 low energy

- Examples of studies with matrix element
- Kl(3) decay channels
- Comparisons with matrix element calculations
  - paper with Q. Xu (EPJC in print)
  - web page with booklets
  - installation tests
  - algorithm tests
  - physics tests



PHOTOS Monte Carlo tests for Bremsstrahlung in K(l3) decays.
Authors: Qingjun Xu, Z. Was

Paper with corrections of June 5th

Special version of PHOTOS MC was prepared. New options useful for tests were prepared. The following versions are used for the comparisons listed below

1. "Standard PHOTOS" denotes **F77** version 2.15, or **C++** version 3.0
2. For "standard phase-space" no modification in phase space generation are introduced.
3. For "exact phase space" single generation channel is used. Comparison with "standard phase-space" helps to establish numerical precision for standard phase space generation, and is of more technical nature. This comparison is important for evaluating of systematic errors eg. for multibremmstarhlung algorithm.
4. "M.E. 21" means that formla (21) from our paper is used.
5. For PDF we're using logarithmic scale, while for PS linear scale is used.

Results of numerical tests:

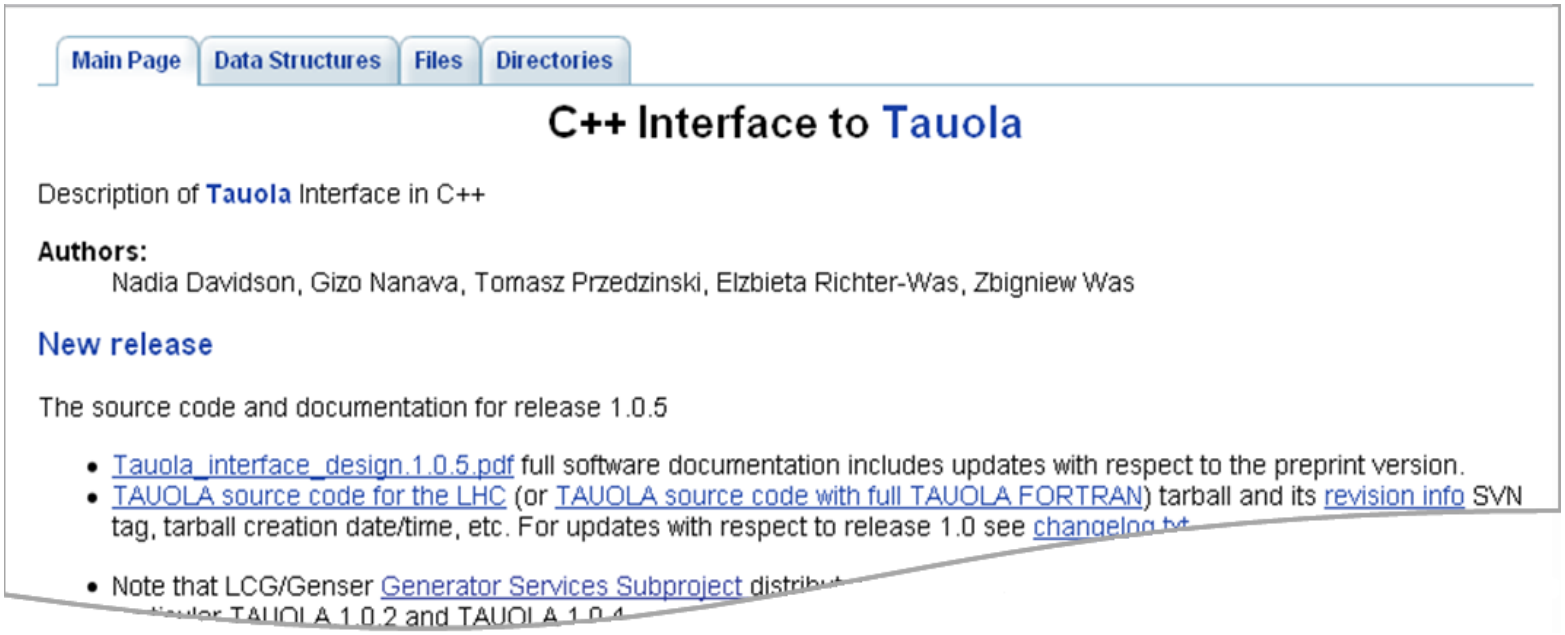
Standard photos vs matrix element	PS/PDF	rootfiles
K0 -> pi e nu_e	PS PDF	first second
K0 -> pi mu nu_mu	PS PDF	first second
K- -> pi0 e nu_e	PS PDF	first second
K- -> pi0 mu nu_mu	PS PDF	first second

http://hibiscus.if.uj.edu.pl/~przedzinski/Kl3/

Tauola++ and Photos++ Progress thanks to better control of event record content

Tauola++

- Tauola++ available for LHC: GENSER project (http://sftweb.cern.ch/generators/)
  - /afs/cern.ch/sw/lcg/external/MCGenerators/tauola++/
- Development version and stable releases available from:
  - http://www.ph.unimelb.edu.au/~ndavidson/tauola/doxygen/index.html
  - Doxygen documentation serves as quick reference for looking up functions and parameters



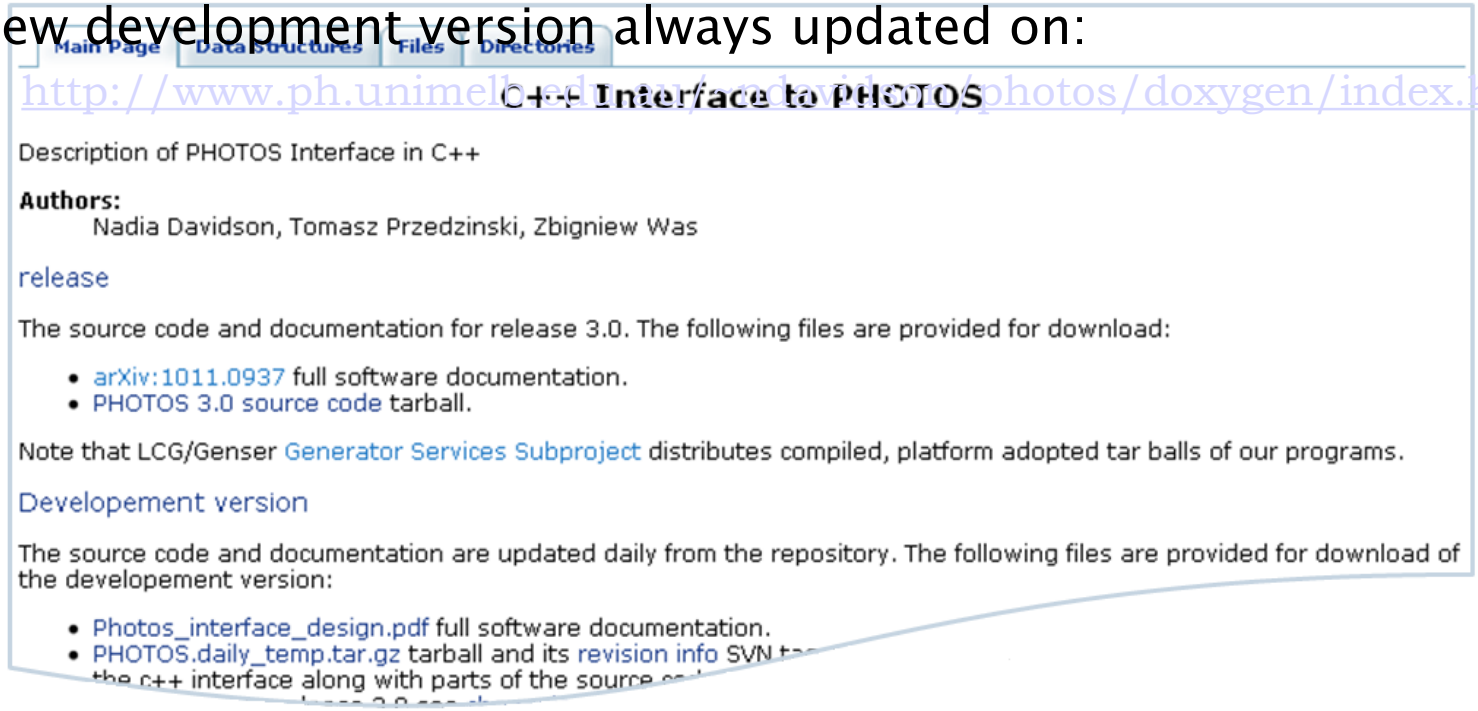
Tauola++

- All functionality of Fortran predecessor
- New physics
  - Transverse spin correlations
  - SANC electroweak corrections
- New options
  - Spin correlations on/off
  - Decay single
    t
    au (with / without polarization)
  - Redefine: modify event record before processing
  - Undecay: remove previous tau decays from event record

```
int main() {

  ...

  Tauola::initialize();

  Tauola::setSameParticleDecayMode(4);
  Tauola::setOppositeParticleDecayMode(4);

  // Begin event loop
  for(...)
  {
    if(!pythia.next()) continue;

    // Save pythia8 event in HepMC format
    GenEvent * HepMCEvt = new GenEvent();
    ToHepMC.fill_next_event(event, HepMCEvt);

    ...

    // Run Tauola on the event
    TauolaHepMCEvent evt(HepMCEvent);
    evt.decayTaus();

    ...

  }

  Tauola::summary();

  ...

}
```

Photos++

- Photos and Photos++
  a
  v
  ailable for LHC: GENSER project (http://sftweb.cern.ch/generators/)
  - /afs/cern.ch/sw/lcg/external/MCGenerators/photos/
  - /afs/cern.ch/sw/lcg/external/MCGenerators/photos++/
- New development version always updated on:
  - http://www.ph.unimelb.edu.au/~ndavidso/photos/doxygen/index.html



Photos++

- Options for controlling ME:
  - ME correction for W
  - ME correction for Z
  - ME correction for scalars
  - Downgraded kernel, same for Z and W
  - info on grandmothers for ME
- Options for event record
  - Process whole event
  - Suppress bremsst r ahlung in specified decays (branches)
  - Bremsstrahlung only in specified decays if present in event record
  - Bremsstrahlung in specific branching only

```
int main() {

  ...

  Photos::initialize();

  Photos::setMeCorrectionWtForW(true);
  Photos::setMeCorrectionWtForZ(true);

  Photos::setInterference      (true);

  // Begin event loop
  for(...)
  {
    if(!pythia.next()) continue;

    // Save pythia8 event in HepMC format
    GenEvent * HepMCEvt = new GenEvent();
    ToHepMC.fill_next_event(event, HepMCEvt);

    ...

    // Run PHOTOS on the event
    PhotosHepMCEvent evt(HepMCEvt);
    evt.process();

    ...

  }

  ...

}
```

Photos++ (... thanks to feedback from users)

- Photos++ v3.5 and v3.51
  - New options in v3.5 for correcting event record and adding history entries to the event record. History entries important for experimental studies at LHC.
  - New in v3.51: treatment of special cases provided by users, such as events with wrong mass information, vertices with three mothers, structures with loops within them
  - Photos v3.51 installed in GENSER as well

```
int main() {

  Photos::initialize();

  Photos::suppressBremForDecay (3,  15,  16,   11, -12);
  Photos::suppressBremForBranch(2,  15,  16, -213);
  Photos::forceBremForDecay    (2, -15, -16,  211);

  Photos::forceMassFrom4Vector(true);
  Photos::forceMassFromEventRecord(13);
  Photos::forceMassFromEventRecord(15);
  Photos::forceMass(11, 0.510998910);

  Photos::createHistoryEntries(true, 3);

  Photos::ignoreParticlesOfStatus  (60);
  Photos::deIgnoreParticlesOfStatus(60);
  Photos::setMomentumConservationThreshold(0.1);

  ...

}
```

Photos++ and Tauola++

- Modularity
  - Core left in Fortran
  - Interface to Fortran separated from other algorithms
  - Abstract interface to event records
  - plotting / logging / debugging classes separated
  - Photos++: random number generator separated. Can be replaced.
  - Tauola++: separate module for SANC electroweak corrections
- Event record implementations
- Multiple event records can be used in one project
- Interface for HepMC prepared and tested. NLO in F77
- Sample interface for HEPEVT included as well
- Software design allows to easily extend to any other event record, as needed

```
{
  ...

  TauolaHepMCEvent   *evt;
  TauolaHEPEVTEvent *evt2;

  PhotosHepMCEvent   *evt3;
  PhotosHEPEVTEvent *evt4;

  ...
}
```

Tauola RChL Currents

Sophisticated fits of new currents to Belle / BaBar data status of May 2012

- Our unpublished so far preprint CERN-PH-TH/2012-016 collects technical tests and detailed description of implementation for new currents.
- Analytic and MC results agree excellent.
- **Also branching fractions when compared with PDG data were not unreasonable, even before fits.**
- **We attracted some interest of experimental community ....**
- **We can now work with the fitting tools.**

Channel	Width, [GeV]		
	PDG	Equal masses	Phas with
$\pi^-\pi^0$	$(5.778 \pm 0.35\%) \cdot 10^{-13}$	$(5.2283 \pm 0.005\%) \cdot 10^{-13}$	$(5.2441 \pm 0$
$\pi^0 K^-$	$(9.72 \pm 3.5\%) \cdot 10^{-15}$	$(8.3981 \pm 0.005\%) \cdot 10^{-15}$	$(8.5810 \pm 0$
$\pi^-\bar{K}^0$	$(1.9 \pm 5\%) \cdot 10^{-14}$	$(1.6798 \pm 0.006\%) \cdot 10^{-14}$	$(1.6512 \pm 0$
K^-K^0	$(3.60 \pm 10\%) \cdot 10^{-15}$	$(2.0864 \pm 0.007\%) \cdot 10^{-15}$	$(2.0864 \pm 0$
$\pi^-\pi^-\pi^+$	$(2.11 \pm 0.8\%) \cdot 10^{-13}$	$(2.1013 \pm 0.016\%) \cdot 10^{-13}$	$(2.0800 \pm 0$
$\pi^0\pi^0\pi^-$	$(2.10 \pm 1.2\%) \cdot 10^{-13}$	$(2.1013 \pm 0.016\%) \cdot 10^{-13}$	$(2.1256 \pm 0$
$K^-\pi^-K^+$	$(3.17 \pm 4\%) \cdot 10^{-15}$	$(3.7379 \pm 0.024\%) \cdot 10^{-15}$	$(3.8460 \pm 0$
$K^0\pi^-\bar{K}^0$	$(3.9 \pm 24\%) \cdot 10^{-15}$	$(3.7385 \pm 0.024\%) \cdot 10^{-15}$	$(3.5917 \pm 0$
$K^-\pi^0K^0$	$(3.60 \pm 12.6\%) \cdot 10^{-15}$	$(2.7367 \pm 0.025\%) \cdot 10^{-15}$	$(2.7711 \pm 0$

Table 2: The τ decay partial widths. For each channel, the PDG value [23] is cor numerical results of Monte Carlo integration of our currents. The third colu results with isospin averaged masses, whereas for the last column physical r used. Comparison of the last two columns enumerates numerical effect of phys breaking the assumption of isospin symmetry in potentially uncontrolled wa results for individual decay channels are given in Subsections of Section 5.

5 Numerical results for two and three-pseud channels

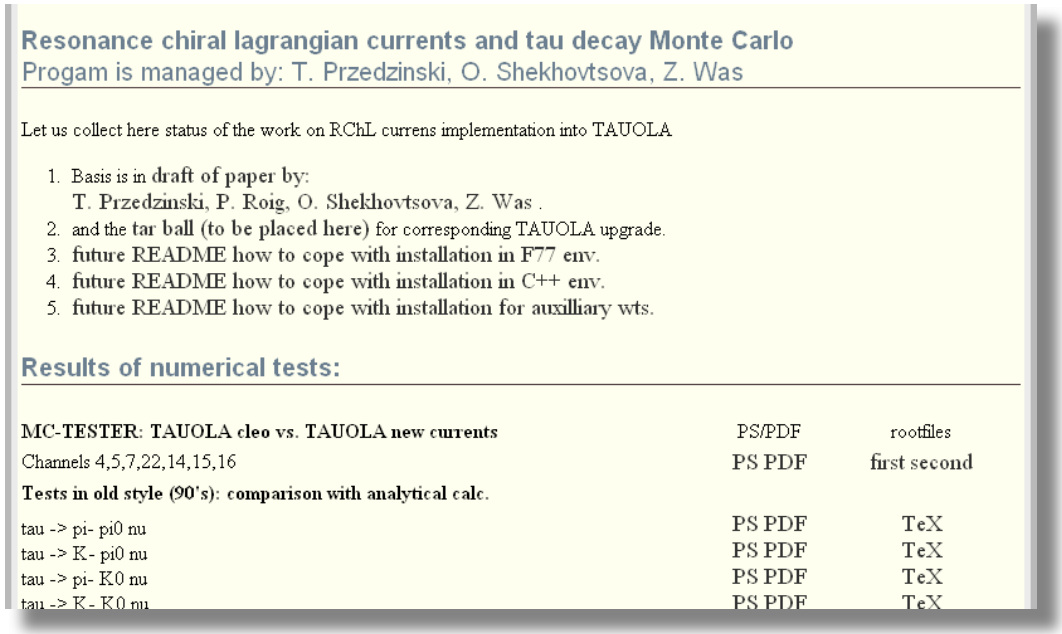
In the previous section we have presented examples of technical tests. Let u centrate on numerical results, corresponding to the most refined options of t included in our distribution tar-ball[20] which are of physics interest.

In the phase space generation, we will take into account the differences betw and charged pion and kaon masses, physical values will be taken. This has to

Tauola RChL currents --> see talks by Olga and Pablo

- Tauola CLEO core (as of year 2005) with easy to install modifications
- RChL-currents
  - Easy to install in old applications
  - Belle BaBar software
  - TAUOLA++

- cross-check
- compilation of several numerical and analytical tests, **techn. 0.01 %**
- reweighting alg. for fits.
- some details on next transparencies



Resonance chiral lagrangian currents and tau decay Monte Carlo

Progam is managed by: T. Przedzinski, O. Shekhovtsova, Z. Was

Let us collect here status of the work on RChL currens implementation into TAUOLA

1. Basis is in draft of paper by:
   T. Przedzinski, P. Roig, O. Shekhovtsova, Z. Was .
2. and the tar ball (to be placed here) for corresponding TAUOLA upgrade.
3. future README how to cope with installation in F77 env.
4. future README how to cope with installation in C++ env.
5. future README how to cope with installation for auxilliary wts.

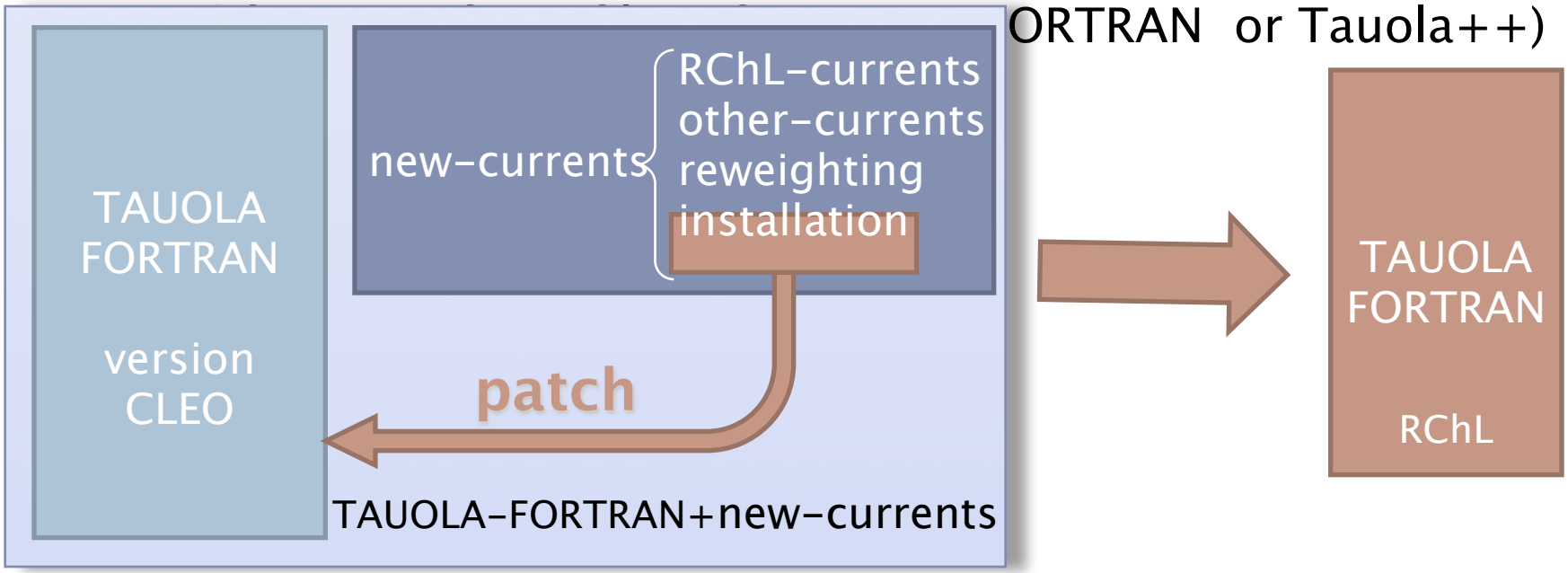
Results of numerical tests:

MC-TESTER: TAUOLA cleo vs. TAUOLA new currents	PS/PDF	rootfiles
Channels 4,5,7,22,14,15,16	PS PDF	first second
Tests in old style (90's): comparison with analytical calc.		
tau -> pi- pi0 nu	PS PDF	TeX
tau -> K- pi0 nu	PS PDF	TeX
tau -> pi- K0 nu	PS PDF	TeX
tau -> K- K0 nu	PS PDF	TeX

http://annapurna.ifj.edu.pl/~wasm/RChL/RChL.htm

Low energy application

- new-currents module compiled together with Tauola core
- Minimal number of changes to use new curren t



- Switch between old and new currents (RChL) useful for validation and reweighting

Sophisticated fits of new currents to Belle / BaBar data

- Method of recalculating weights for previously generated tau samples
- Example on how to do it with RChL currents
- **In this way, weights are attributed and any multi-dimensional distribution can be compared (including all detector effects)**
- **We use such methods already (on unfolded experimental 1-dim histograms).**

```
int main()
{
  ...

  // Initialize RChL currents
  inipcht_(1);

  // Initialize Tauola
  Tauola::Initialize();

  ...

  readParticlesFromFile(&tau, &tau_daughters);

  prepareKinematic(tau, tau_daughters);

  // Switch to TAUOLA CLEO currents
  inipcht_(0);

  // Determine decay channel and calculate weight
  double WT1 = calculateWeight(tau_pdgid, tau_daughters);

  // Switch to RChL currents
  inipcht_(1);

  // Determine decay channel and calculate weight
  double WT2 = calculateWeight(tau_pdgid, tau_daughters);

  // RChL / CLEO
  double WEIGHT = WT2/WT1;

  ...
}
```

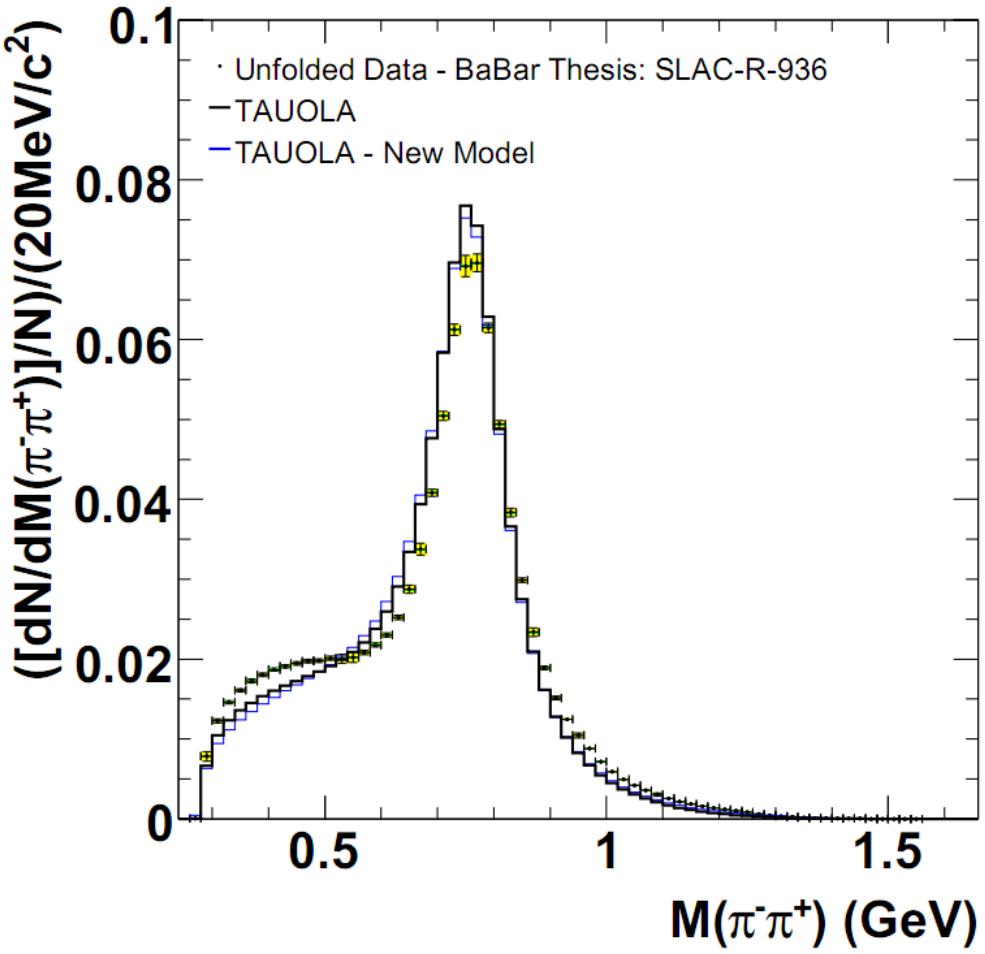
Sophisticated fits of new currents to Belle / BaBar data

- Input
  - 4-momenta and flavour of tau and its daughters
- Input from any source
  - MC generated with KKMC
  - ASCII files
  - Data files in HepMC::IO_GenEvent format
  - HepMC events stored in ROOT ntuples
  - Easy to adapt to any other format
  - Tau-tau spin correlations can be taken into account.

```
int main()
{
  ...

  // Initialize RChL currents
  inipcht_(1);

  // Initialize Tauola
  Tauola::Initialize();

  ...

  readParticlesFromFile(&tau, &tau_daughters);

  prepareKinematic(tau, tau_daughters);

  // Switch to TAUOLA CLEO currents
  inipcht_(0);

  // Determine decay channel and calculate weight
  double WT1 = calculateWeight(tau_pdgid, tau_daughters);

  // Switch to RChL currents
  inipcht_(1);

  // Determine decay channel and calculate weight
  double WT2 = calculateWeight(tau_pdgid, tau_daughters);

  // RChL / CLEO
  double WEIGHT = WT2/WT1;

  ...
}
```

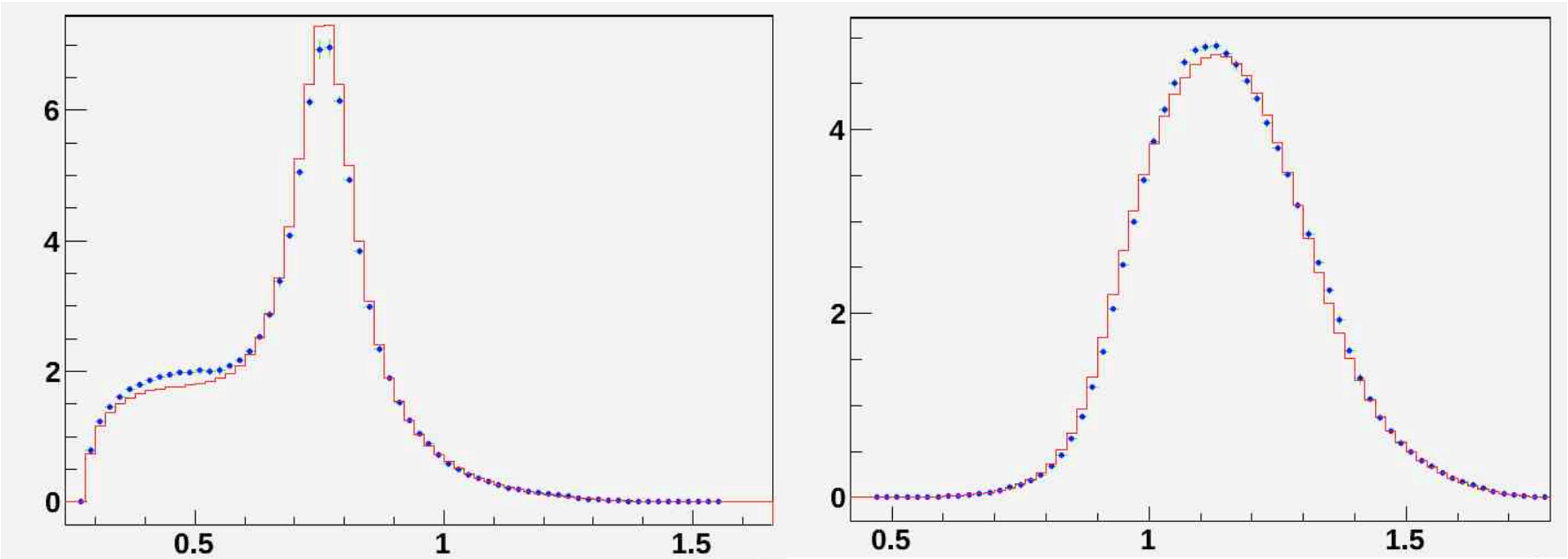
Sophisticated fits of new currents to Belle / BaBar data status of May 2012

- Can be used to test several different models simultaneously in comparison with Belle and BaBar data
- **How to perform such comparisons systematically and on multi-dimensional distributions as well**



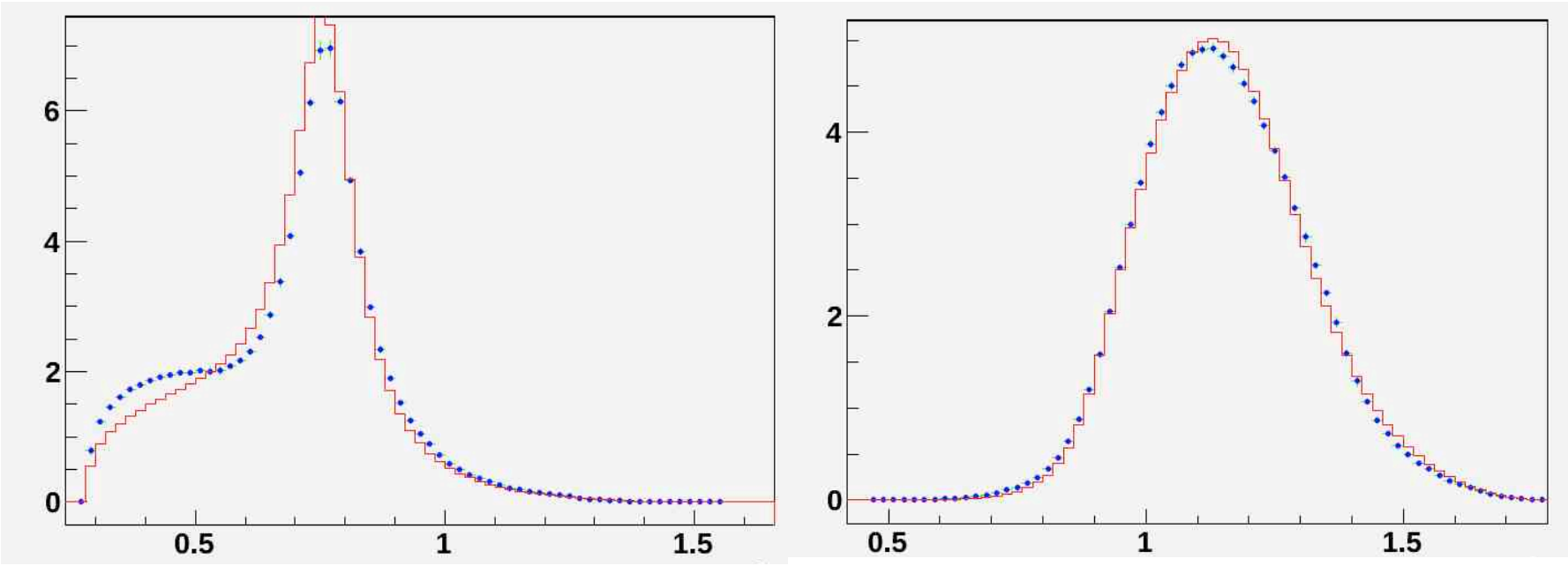
Fitting – 3pi channel (attempts)

- Results from 13.09.2012
- 20Mevents; gradient method
- Retabulization of a1 resonance width turned on
- Fitted parameters: mro, mrho1, grho1, mma1, fpi_rpt, fv_rpt, fa_rpt, beta_rho, gv_rpt
- Values after fitting: 0.7744, 1.45, 0.41, 1.22871, 0.092199, 0.120858, 0.139981, -0.185286, **1.06636/(fv_rpt/fpi_rpt^2)⬅ consistency check, rather poor**
- http://annapurna.ifj.edu.pl/~jzaremba/klocki/gradientyl2.html



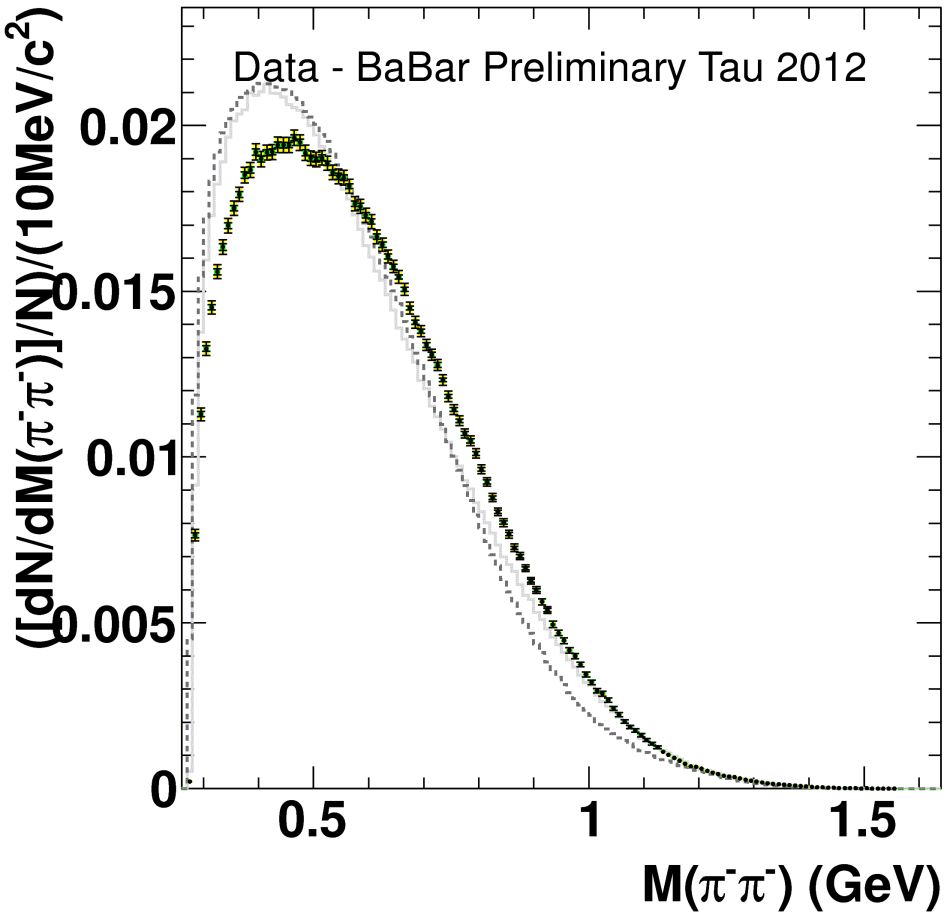
Fitting – 3pi channel (attempts)

- Results from 14.09.2012
- 20Mevents; Gradient-like chi2 test method
- Retabulization of a1 resonance width turned on
- Fitted parameters: mro, mrho1, grho1, mma1, fpi_rpt, fv_rpt, fa_rpt, beta_rho, gv_rpt
- Values after fitting: 0.7762, 1.414, 0.3, 1.12, 0.09258, 0.202, 0.18702, -0.3475, **$1.12/(fv\_rpt/fpi\_rpt^2)$ ⬅ consistency check which came out poorly**
- http://annapurna.ifj.edu.pl/~jzaremba/klocki/chi22.html



Cross check comparison.

- Our fits brought concerns for numerical values of some parameters, but ....
- Unfolded spectrum of p^-p^- mass (available since 3 days, Ian thanks a lot) does not get reproduced with RChL yet.
- Model as described in our preprint CERN-PH-TH/2012-016. was a great help for technical aspects but for physics require further effort.
- Weighted event techniques prepared for fits with acceptance and multidimensio-nal distributions.
- Combined effort: theorists and experimental physicisis necessary. We discuss already



Challenge: parametrizations should represent measurement and theory …

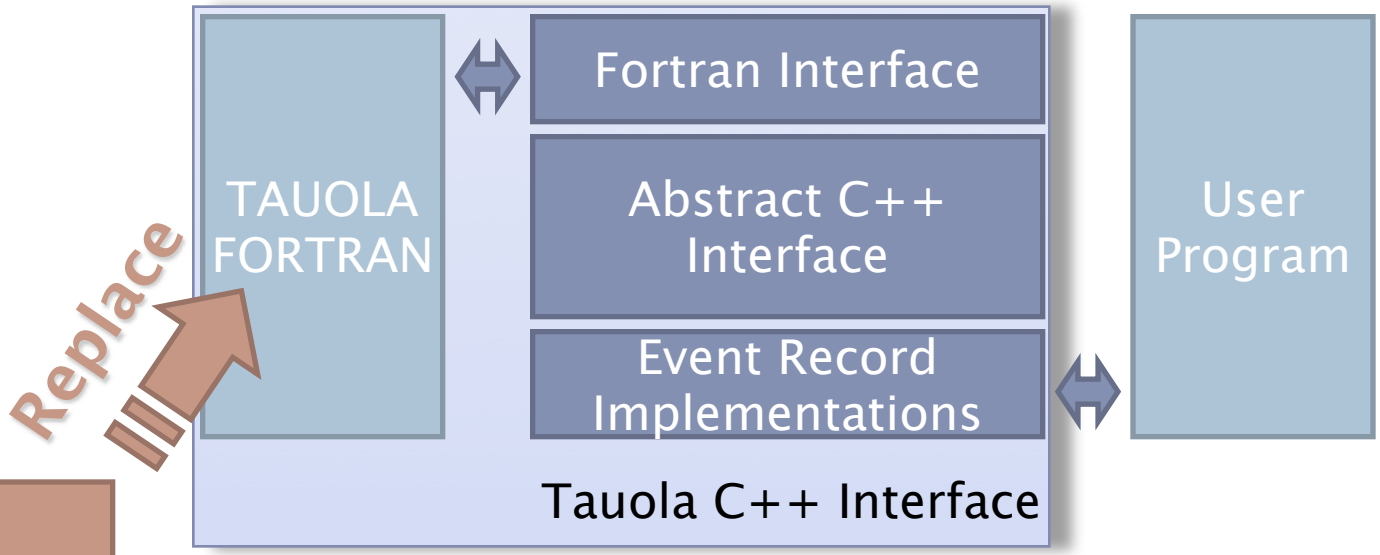
First results

- Better agreement than in spring, however …
- We investigate first of all features of fit method only.
- Nine parameter for currents originating from RChL
- uncertainty due to N_C=3
- Uncertainty due to *n* taken from observation, typically 3 …
- Statistical fluctuations of data and of MC sample used in fits
- Linearization of fitted function in every iteration step complicates too
- … especially if fitted function is not yet perfect.
- So far we have fitted two 1-dim histos only…
- … unfolded spectra, but important features missing.
- Cross-check, invariant mass of same sign pion mass is still poor
- multidimensional distributions will acceptance, cross-contamination, …
- … can be used in fits
- *How to avoid/minimize biases from theoretical and experimental sides?*
- *How to ensure steady progress?*

LHC applications

LHC application: Future use of Tauola currents in Tauola C++

- This feature is prepared and works semi-automatically, accordingly to short instruction



- Tests and validations

LHC application with weighted events
(Talk of Z. Czyczuła)

TauSpinner: tau spin reweight algorithm
Authors: Z. Czyczula, T. Przedzinski, Z. Was

PHYSICS PURPOSE:
For previously generated sample involving tau, its spin effects can be:

1. validated. Eg. if spin effects were taken into account when events were generated
2. calculate spin weght for previously generated events and stored on the tape.
   - In original sample spin effects could have been missing.

     Then spin weight will be in range $(0 , 2^n)$;
     n denotes number of taus in final state.
   - In original sample spin effects are eg for W+ and we would like to see how it would look if H+ was present instead.
3. reweight on flight such events with spin weight. Such unweighted events can be then monitored with MC-Tester for quick evaluation of spin effects

At present only nine main decay channels of tau have their spin effects used in algorithm.
These channels cover already now above 95% of total tau width.

For more information on agorithm use see **README**
(This README is included in distribution tarball as well)

- http://hibiscus.if.uj.edu.pl/~przedzinski/tau-reweight/

LHC application with weighted events:
example of TauSpinner in use

```
int main() {

  // Initialize Tauola
  Tauola::initialize();

  // Initialize TauSpinner
  initialize_spinner(Ipp, Ipol, CMSENE);

  // Begin event loop
  for(...) {

    // SimpleParticle consist of 4 momentum and PDGid
    SimpleParticle X, tau, tau2;
    vector<SimpleParticle> tau_daughters, tau_daughters2;

    // Read event from input_file
    readParticlesFromHepMC( ... );

    // Calculate weight
    if( abs(X.pdgid())==24 || abs(X.pdgid())==37 )
    {
      WT = calculateWeightFromParticlesWorHpn( ... );
    }
    else if( X.pdgid()==25 || X.pdgid()==36 ||
             X.pdgid()==22 || X.pdgid()==23 )
    {
      WT = calculateWeightFromParticlesH( ... );
    }
}
```

Highlighted function fills tau decay information from HepMC::IO_GenEvent data file.

Similar function can be written for any other source

Details on the webpage and in example distributed with the code.

Summary

- We have reviewed several tasks of TAUOLA related projects.
- I had to make it brief/incomplete.
- Fortunately some points were covered in other talks ...
- Thanks for valuable feed back and comments from
  Atlas, BaBar, Belle, CMS, CDF, D0, LHCb …
- Main references of the last 2 years:
- www.cern.ch/~wasm www.cern.ch/~wasm/newprojects.html

N. Davidson, P. Golonka, T. Przedzinski and Z. Was,
``MC-TESTER v. 1.23: A Universal tool for comparisons of Monte Carlo predictions for particle decays in high energy physics,''
Comput. Phys. Commun. 182, 779 (2011).

Summary

Main references of the last 2 years (cont):

G. Nanava, Q. Xu and Z. Was,
``Matching NLO parton shower matrix element with exact phase space: Case of W ---> l nu(gamma) and gamma* ---> pi+ pi -(gamma),''
Eur. Phys. J. C 70, 673 (2010).

N. Davidson, G. Nanava, T. Przedzinski, E. Richter-Was and Z. Was,
``Universal Interface of TAUOLA Technical and Physics Documentation,''
Comput. Phys. Commun. 183, 821 (2012).

N. Davidson, T. Przedzinski and Z. Was,
``PHOTOS Interface in C++: Technical and Physics Documentation,''
[arXiv:1011.0937 [hep-ph]].

Z. Czyczula, T. Przedzinski and Z. Was,
``TauSpinner Program for Studies on Spin Effect in tau Production at the LHC,''
Eur. Phys. J. C 72, 1988 (2012).

Q. Xu and Z. Was,
``Bremsstrahlung simulation in K to pi l^pm nu_l (gamma) decays,''
[arXiv:1201.0189 [hep-ph]]. (EPJC in print)

O. Shekhovtsova, T. Przedzinski, P. Roig and Z. Was,
``Resonance chiral Lagrangian currents and τ decay Monte Carlo,''
[arXiv:1203.3955 [hep-ph]].

Applications for LHC Computing Grid

- Code must work:
  - on multiple 32-bit and 64-bit platforms
  - with different sets of compilers
  - with several different configurations (ROOT, HepMC)
  - in several different experiments environments
- Autotools
- Separate configuration for specific cases
- Different configuration for individual users

MC-TESTER

- Useful for our work but also to validate installation
- Histograms are defined in automated way from information stored in event records.
- Automatic definition limits risk of mistakes.
- Solutions are generator independent (to large degree).

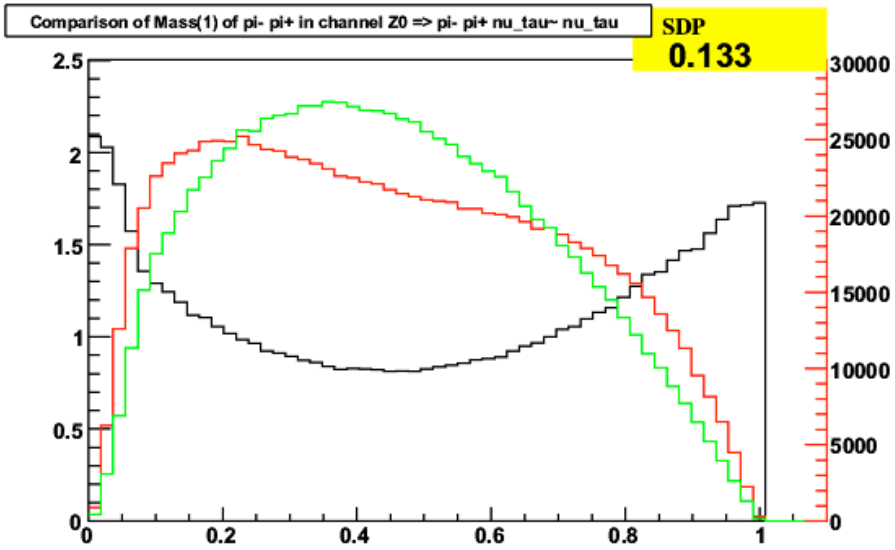
MC-TESTER

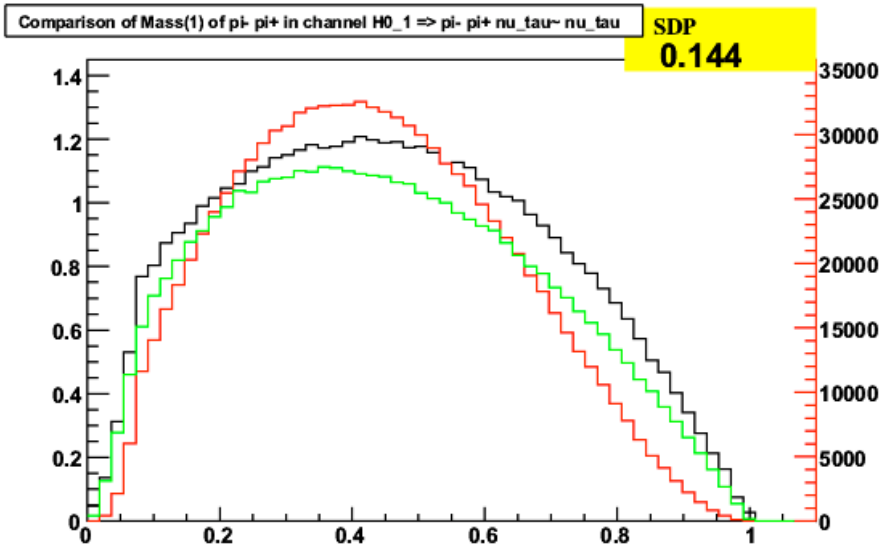
- Universal tool for comparison of different MC generators
- Generates .pdf booklet with reference table for all decay channels and detailed comparison for each channel

Decay channel	Branching Ratio ± Rough Errors		Max. shape dif. param.
	Generator #1	Generator #2	
$\tau^+ \to \pi^+\pi^0\widetilde{\nu}_\tau$	25.3029 ± 0.0159%	25.0750 ± 0.1584%	0.00000
$\tau^+ \to \widetilde{\nu}_\tau\nu_e e^+$	18.1201 ± 0.0135%	18.1030 ± 0.1345%	0.00000
$\tau^+ \to \widetilde{\nu}_\tau\nu_\mu \mu^+$	17.6046 ± 0.0133%	17.7180 ± 0.1331%	0.00000
$\tau^+ \to \pi^+\widetilde{\nu}_\tau$	11.1618 ± 0.0106%	11.2340 ± 0.1060%	0.00000
$\tau^+ \to \pi^+\pi^0\pi^0\widetilde{\nu}_\tau$	9.2787 ± 0.0096%	9.3770 ± 0.0968%	0.00029
$\tau^+ \to \pi^-\pi^+\pi^+\widetilde{\nu}_\tau$	8.7599 ± 0.0094%	8.6890 ± 0.0932%	0.00000
$\tau^+ \to \pi^-\pi^+\pi^+\pi^0\widetilde{\nu}_\tau$	4.5342 ± 0.0067%	4.5480 ± 0.0674%	0.00014

- All combinations of invariant masses ploted and compared separately for each channel
- Like Tauola++ and Photos++ works with HepMC and HEPEVT event record and can be easily adapted to others

MC-TESTER


Comparison of Mass(1) of pi- pi+ in channel Z0 => pi- pi+ nu_tau~ nu_tau
SDP
0.133
2.5
2
1.5
1
0.5
0
0.2
0.4
0.6
0.8
1
30000
25000
20000
15000
10000
5000
0


Comparison of Mass(1) of pi- pi+ in channel H0_1 => pi- pi+ nu_tau~ nu_tau
SDP
0.144
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0.2
0.4
0.6
0.8
1
35000
30000
25000
20000
15000
10000
5000
0

MC-TESTER

- Setup files storing analysis options
- Multitude of options
- Plotting
  - histogram binning
  - logarithmic scale
  - mass squared
  - scale X axis
- Generator description
- Attaching additional user histograms
- Different methods of SDP calculation; user can write new mehtods
- User analysis – attaching ROOT scripts to plot specific observables, compiled on-the-flight during analysis.

MC-TESTER

- Version 1.25.0 available from
  GE
  N
  SER project webpage (http://sftweb.cern.ch/generators/)
- Few new histogramming / booklet generation options
- Bugfixes and patch for ROOT memory corruption problem
- Recently installed into CMS

Tauola-BBB (2004)

- New decay channels for Tauola
- Need to be integrated to present version of the code
- When finished, result will be automatically available for Belle, Babar and LHC.
- Is it needed? Topic for private discussions.