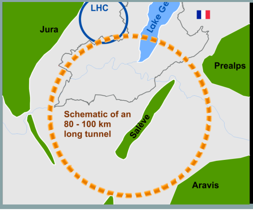
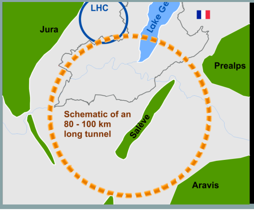


LEP legacy Monte Carlos for FCCee

Stanisław Jadach

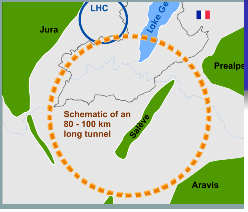
FCC Software Workshop, CERN **October 2-3, 2019**

*This work is partly supported by the Polish National Science Center grant 2016/23/B/ST2/03927 and the CERN FCC Design Study Programme.



OUTLINE

- KKMC/TAUOLA/PHOTOS
- BHLUMI
- KORALW/YFSWW



What is KKMC?

KKMC is the MC event generator for the process:

$$e^- e^+ \rightarrow f\bar{f} + n\gamma$$

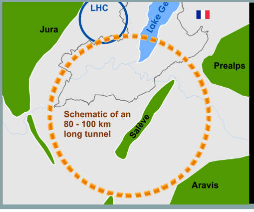
$f = \mu, \tau, \nu, u, d, s, c, b, \quad n = 0, 1, 2 \ldots \infty.$

Interfaced with TAUOLA+PHOTOS
and with electroweak library DIZET.
Published version 4.13 (to be cited):

- Comput.Phys.Commun. 130(2000) 360, hep-ph/9912214, F77 code description and user guide (manual).
- Phys. Rev. D63 (2001) 113009, hep-ph/0006359 physics content, CEEX exponentiation of QED corrs.

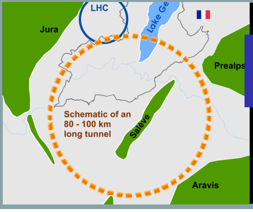
"Workhorse" in data analysis of all four LEP collaborations.

(Replacement of earlier MC's KORALZ and KORALB.)
(Not aplicable for $e^- e^+ \rightarrow e^- e^+$)



KKMC is special because:

- Resummed (exponentiated) multiphoton effects at the AMPLITUDE level (CEEX). $\sim$10 man-years of work in QED.
- QED rad. corrections up to third LO and NLO, both in the initial and final state plus (exponentiated) initial-final interference.
- Complete spin effects, including transverse correlations, for incoming beams and outgoing femions (needed for taus).



More KKMC versions available since 2000

https://twiki.cern.ch/twiki/bin/view/FCC/FccGenerators

http://192.245.169.66:8000/FCCeeMC/wiki/kkmc

KKMC for fermion pair production at electron-positron colliders

- Production Version 4.16, Oct. 2001, (KKMC-v.4.16d-export.tar.gz). Improved $\nu\bar{\nu}$ matrix elm. RRes module for $\gamma^* \rightarrow$ *narrow resonances* at LEP.
- Developement Version 4.19, Sept. 2002, (KKMC-v.4.19.b-export.tar.gz). With C++ wrappers. Improved $\nu\bar{\nu}$ matrix element and RRes for low energy colliders. ISR with complete NLO corrs, as in Phys.Rev. D65(2002) 073030 by S.J., M.Melles, B.F.L.Ward and S.A. Yost. Collinear beamstrahlung for NLC/ILC.
- Developement Version 4.22, June 2013, (KKMC_v4_22.tgz). Tested with $\mu^-\mu+$ and $q\bar{q}$ beams (instead of e^-e^+) at fixed energy. Optionally, collinear PDFs for $q\bar{q}$ beams instead of beamstrahlung, as a patch in the source code (temp. solution).

- First version [4.24] of the **KKMCee development branch**.

Beamstrahlung implementation for FCCee/ILC/CLIC is now improved, simplified and better debugged. Temporary insertions in the source code for quark beams are removed (kept and developed further in KKMChh branch, to be published).

More on KKMC version 4.22 (2013)
Technical points

next page

- Old benchmarks, Table III in Pys.Rev. D 63 (2001) and more, are reproduced under SLC5 and SLC6, after adjustments of flags in makefile's and minor corrections in f77 code.
- Unpublished (public) v.4.16,4.19 include varying subset of extra subdirectories, not included in v4.13. Also not in v.4.22.
- System of original interrelated custom *Makefile*'s is renamed *Makefile* → *KKMakefile* and preserved.
- *Atomake*/*Autotools* are introduced (*makefile.am* etc.). Hence KKMC is more platform independent and can be easily put under *kdevelop*3 or *eclipse*.
- Interface to C++ is provided. Main program (histogramming, etc) can be in C++, using optionally ROOT. (On request, or in v4.19)
- Scripts for running on PC-farms slightly upgraded and working.
- Old versions of PHOTOS and TAUOLA.

Version 4.24 (2017) tested/run under Centos7 and Ubuntu16

Table I in Phys.Rev. D88 (2013) no.11, 114022.

$v_{\max}$	$\mathcal{KK}$sem Refer.	$\mathcal{O}(\alpha^3)_{\rm EEX3}$	$\mathcal{O}(\alpha^2)_{\rm CEEX}$ intOFF	$\mathcal{O}(\alpha^2)_{\rm CEEX}$
	$\sigma(v_{\max})$ [pb]			
0.01	1.6712 ± 0.0000	1.6736 ± 0.0018	1.6738 ± 0.0018	1.7727 ± 0.0021
0.10	2.5198 ± 0.0000	2.5205 ± 0.0020	2.5210 ± 0.0020	2.6009 ± 0.0024
0.30	3.0616 ± 0.0000	3.0626 ± 0.0022	3.0634 ± 0.0022	3.1243 ± 0.0026
0.50	3.3747 ± 0.0000	3.3745 ± 0.0022	3.3761 ± 0.0022	3.4254 ± 0.0026
0.70	3.7223 ± 0.0000	3.7214 ± 0.0022	3.7249 ± 0.0022	3.7648 ± 0.0027
0.90	7.1430 ± 0.0000	7.1284 ± 0.0022	7.1530 ± 0.0022	7.1821 ± 0.0026
0.99	7.6136 ± 0.0000	7.5974 ± 0.0021	7.6278 ± 0.0021	7.6567 ± 0.0026
	$A_{\rm FB}(v_{\max})$			
0.01	0.5654 ± 0.0000	0.5661 ± 0.0012	0.5661 ± 0.0012	0.6121 ± 0.0014
0.10	0.5664 ± 0.0000	0.5667 ± 0.0009	0.5667 ± 0.0009	0.5931 ± 0.0011
0.30	0.5692 ± 0.0000	0.5694 ± 0.0008	0.5693 ± 0.0008	0.5864 ± 0.0010
0.50	0.5744 ± 0.0000	0.5744 ± 0.0008	0.5743 ± 0.0008	0.5870 ± 0.0009
0.70	0.5863 ± 0.0000	0.5858 ± 0.0007	0.5857 ± 0.0007	0.5953 ± 0.0008
0.90	0.3105 ± 0.0000	0.3107 ± 0.0004	0.3100 ± 0.0004	0.3176 ± 0.0004
0.99	0.2851 ± 0.0000	0.2856 ± 0.0003	0.2848 ± 0.0003	0.2918 ± 0.0004

TABLE I. Energy cut-off study of total cross section σ and charge asymmetry $A_{\rm FB}$ for annihilation process $e^-e^+ \to \mu^-\mu^+$, at $\sqrt{s}$ =189GeV. Energy cut: $v < v_{\max}$, $v = 1 - M^2_{f\bar{f}}/s$. Scattering angle for $A_{\rm FB}$ is $\theta^\bullet$(defined in Phys. Rev. **D41**, 1425 (1990)). No cut in $\theta^\bullet$. E-W corr. in $\mathcal{KK}$ according to DIZET 6.x. In addition to CEEX matrix element, results are also shown for $\mathcal{O}(\alpha^3)_{\rm LL}$ EEX3 matrix element without ISR⊗FSR interf. $\mathcal{KK}$sem is semianalytical program, part of $\mathcal{KK}$MC.

http://192.245.169.66:8000/FCCeeMC/wiki/kkmc

Unpacking:

```
   gtar -xczf KKMC_v4_24a.tgz
```

HOW TO compile and run simple examples. Main prog. in f77.

```
Under Linux (SLC6) proceed as below immediately:)
     ****************
     **   ffbench  **
     ****************
Main program in f77. System of custom KKMakefile's in all
subdirectories is first created running master makefile ffbench/KKMakefile:
    cd ./ffbench
    alias kmake='make -f KKMakefile'
    kmake makflag
    kmake makprod
If an adjustment of the fortran compilation options is needed,
then do it only in the master KKMakefile and repeat the above.

BASIC DEMO:
Inclusive, mu+tau+u+d+c+s+b, hadronization on, wt=1 events,
as for the detector simulation:
        cd  ./ffbench
        cp demo/demo.input.1k demo/demo.input
        kmake demo-start
        diff -b demo/demo.output.1k demo/demo.output | less
```

More examples in f77

```
Inclusive, mu+tau+u+d+c+s+b, hadronization off, tau decays off, wt=1 events:
        cp Inclusive/Inclusive.input.1k Inclusive/Inclusive.input
        kmake Inclusive-start
        diff -b Inclusive/pro.output.1k Inclusive/pro.output | less

Tau's, decays on, beam polarization on:
        cp Tau/Tau.input.1k Tau/Tau.input
        kmake Tau-start
        diff -b Tau/pro.output.1k Tau/pro.output | less

Muons only, v<0.99, wt=1 events:
        cp Mu/Mu.input.1k Mu/Mu.input
        kmake Mu-start
        diff -b Mu/pro.output.1k Mu/pro.output | less

Beamstrahlung at 500GeV (takes a few minutes):
        cp Beast/Foam500,1k.input Beast/Beast.input
        kmake Beast-start
        diff -b Beast/pro.output Beast/Foam500,1k.output.linux | less
```

http://192.245.169.66:8000/FCCeeMC/wiki/kkmc

Examples with main program in C++

```
     ****************
     **    MaMar   **
     ****************
Main program in C++. ROOT version 5 is involved.
Here autotools are recommended:
     cd KKMC_v4_24a
     make distclean       <== optionally, sometimes helps
     autoreconf -i --force
     ./configure
     make -k
Running example program:
     cd MaMar
     cp test0/test0_95GeV.input test0/test0.input
     make test0-start
     make test0-stop
Wait until program stops and
     make Plot1
See more information in MaMar/README:
```

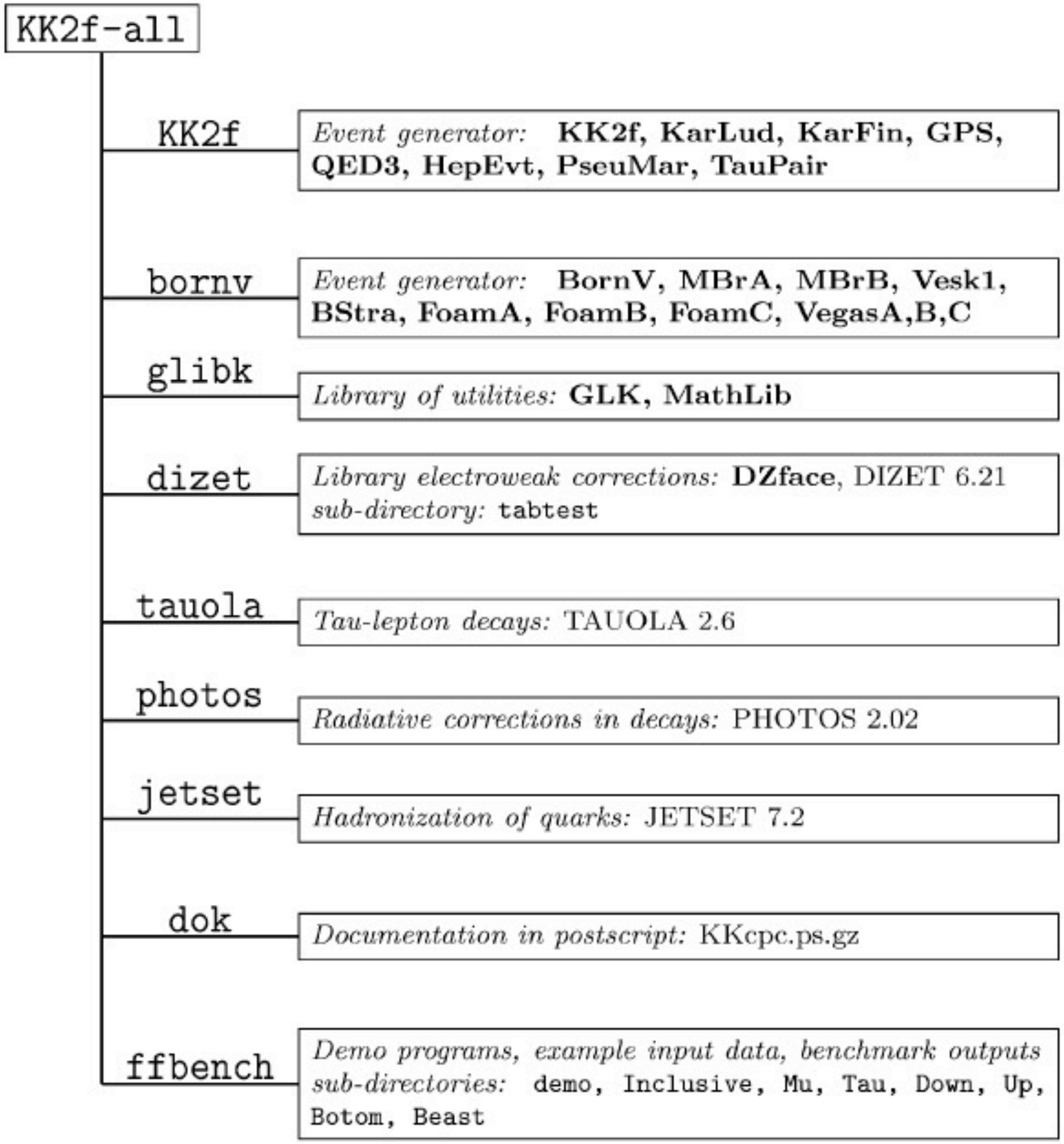


Fig. 1. Topography of the distribution directory.

Table 2
List of input parameters of the $\mathcal{KK}$ generator. General and related to QED radiation input parameters. Default values in brackets. User may change, with precautions, the starred items, while the doubly starred ones should never be changed

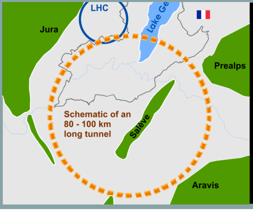
Input parameters

Parameter	Position and meaning
CMSene	xpar(1) (=100): $\sqrt{s}$, centre-of-mass (CMS) energy [GeV]
DelEne	xpar(2) (=0d0): Beam energy spread [GeV]
Ninp	xpar(3) (=5): Input unit number (unused)
Nout	xpar(4) (=16): Output unit number
LevPri	xpar(5) (=0): PrintOut Level 0, 1, 2
Ie1Pri	xpar(6) (=1): PrintOut Start point
Ie2Pri	xpar(7) (=1): PrintOut End point
IdYFS*	xpar(8) (=600): Pointer for internal histograms
WtMax*	xpar(9) (=1): Maximum weight for rejection
KeyWgt	xpar(10) (=0): Switch between constant $=0$ and variable $=1$ weight events
IdeWgt*	xpar(11) (=74): Ident of the EEX principal weight
KeyELW	xpar(12) (=1): Type of electroweak corrections, $=0$ only for tests, $=1$ default for DIZET
vvmin*	xpar(16) (=1D-5): Minimum real photon energy in units of beam energy
vvmax	xpar(17) (=1d0): Maximum value of $v=1-s'/s$-variable, where s' is mass squared of $f\bar{f}$ system including FSR photons! See more comments in the text.
DelFac*	xpar(18) (=1d-3): FSR cut eps = vvmin*DelFac
NphMax**	xpar(19) (=100): Hard-wired maximum photon multiplicity
KeyISR	xpar(20) (=1): Test switch, KeyISR $=0$ swithes off the ISR
KeyFSR	xpar(21) (=1): Test switch, KeyFSR $=0$ switches off the FSR
KeyPia**	xpar(22) (=1): Removal of FSR photons below Emin=Ene*Delta in CMS, for KeyPia $=0,1$ removal is OFF, ON
mltISR**	xpar(23) (=0): Special tests: fixed ISR multiplicity for mltISR>0
mltFSR**	xpar(24) (=0): Special tests: fixed FSR multiplicity for mltFSR>0
KeyFix	xpar(25) (=0): Type of ISR, for KeyFix $=0,1$ QED without beamstrahlung, for KeyFix $=2$ beamstrahlung is ON, see also KeyGrid
KeyWtm**	xpar(26) (=0): Special tests only: mass terms in "crude" MC photon distrib.
KeyINT	xpar(27) (=2): Switch of ISR-FSR Interference (IFI), for KeyINT $=0$ it is OFF, for KeyINT $=2$ it is ON, KeyINT $=1$ is only for special tests
KeyGPS	xpar(28) (=1): Level of new exponentiation CEEX, note vmaxGPS overrules KeyGPS for each type of final fermion
KeyQSR	xpar(29) (=1): Photon emission from the final quarks is ON, OFF for KeyQSR $=0,1$

Table 4
List of input parameters of the $\mathcal{KK}$ generator. Initial/final fermion properties and EW parameters. Default values in brackets. User may change, with precautions, the starred items, while the doubly starred ones should never be changed

Parameter	Position and meaning
`KFini`*	`xpar(400) (= 11)`: Beam flavour code
	jth fermion is included in MC generation if its Mask(j) = 1
`Mask( 1)`	`xpar(401) (=1)`: Mask variable for d quark
`Mask( 2)`	`xpar(402) (=1)`: Mask variable for u quark
`Mask( 3)`	`xpar(403) (=1)`: Mask variable for s quark
`Mask( 4)`	`xpar(404) (=1)`: Mask variable for c quark
`Mask( 5)`	`xpar(405) (=1)`: Mask variable for b quark
`Mask(13)`	`xpar(413) (=1)`: Mask variable for muon lepton
`Mask(15)`	`xpar415() (=1)`: Mask variable for tau lepton
	Basic electroweak input data
`MZ`	`xpar(502) (=91.187D0)`: Mass of Z-boson [GeV] (PDG 1996)
`SwSq`	`xpar(503) (=.22276773D0)`: $\sin^2(\theta_W)$ where θ_W is EW mixing angle
`GammZ`	`xpar(504) (= 2.50072032D0)`: Z width (from Dizet)
`MH`	`xpar(505) (=100D0)`: Higgs mass, input for Dizet
`Mtop`	`xpar(506) (=175D0)`: Top mass, input for Dizet
`MasPhot`*	`xpar(510) (= 1D-60)`: Photon mass used as IR regulator
	The data base record below is for d quark, $j = 1$
`KFferm(j)`*	`xpar(501+10*j) (= 1)`: Flavour code
`NCf(j)`*	`xpar(502+10*j) (= 3)`: Number of colours
`Qf(j)`*	`xpar(503+10*j) (=-1)`: 3×charge
`T3f(j)`*	`xpar(504+10*j) (=-1)`: 2×T3L = 2×Isospin for left component
`Helic(j)`*	`xpar(505+10*j) (= 1)`: 2×helicity, not used
`Mferm(j)`*	`xpar(506+10*j) (= 0.010d0)`: Mass [GeV] (PDG)
`MfCon(j)`*	`xpar(506+10*j) (= 0.100d0)`: Constituent mass, not used
`WtMax(j)`*	`xpar(507+10*j) (= 5.0d0)`: Maximum weight for rejection
`AuxPar(j)`*	`xpar(508+10*j) (= 0.99d0)`: below `vmaxGPS` CEEX, above EEX

Input parameters



Output MC event of KKMC

```
*--------------------------------------------------------------------
      INTEGER nmxhep          ! maximum number of particles
      PARAMETER (nmxhep=2000)
      DOUBLE PRECISION   phep, vhep
      INTEGER nevhep, nhep, isthep, idhep, jmohep, jdahep
      COMMON /d_HepEvt/
     $      nevhep,           ! serial number
     $      nhep,             ! number of particles
     $      isthep(nmxhep),   ! status code
     $      idhep(nmxhep),    ! particle ident KF
     $      jmohep(2,nmxhep), ! parent particles
     $      jdahep(2,nmxhep), ! childreen particles
     $      phep(5,nmxhep),   ! four-momentum, mass [GeV]
     $      vhep(4,nmxhep)    ! vertex [mm]
      SAVE  /d_hepevt/
*--------------------------------------------------------------------
```

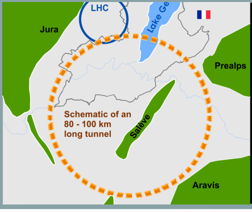
Table 6
The meaning of the weights in the WtSet

Parameter	Position and meaning
WtSet(71)	EEX $\mathcal{O}(\alpha^0)$
WtSet(72)	EEX $\mathcal{O}(\alpha^1)$
WtSet(73)	EEX $\mathcal{O}(\alpha^2)$
WtSet(74)	EEX $\mathcal{O}(\alpha^3)$
WtSet(201)	CEEX $\mathcal{O}(\alpha^0)$
WtSet(202)	CEEX $\mathcal{O}(\alpha^1)$
WtSet(203)	CEEX $\mathcal{O}(\alpha^2)$
WtSet(251)	CEEX $\mathcal{O}(\alpha^0)$ without ISR-FSR interference
WtSet(252)	CEEX $\mathcal{O}(\alpha^1)$ without ISR-FSR interference
WtSet(253)	CEEX $\mathcal{O}(\alpha^2)$ without ISR-FSR interference

```
*////////////////////////////////////////////////////////////////////////////////
*//        Fill standard HEP and/or LUND common blocks and HADRONIZE            //
*////////////////////////////////////////////////////////////////////////////////
      CALL KarLud_GetExe(Exe)
      CALL KK2f_ZBoostAll(  exe)
      CALL KarLud_ZBoostAll(exe)
      CALL KarFin_ZBoostAll(exe)
*
      IF( m_WtMain .NE. 0d0) CALL HepEvt_Fill
      IF( m_WtMain .NE. 0d0 .AND. m_KeyHad .EQ. 1 ) THEN
         CALL HepEvt_Hadronize(m_HadMin)   ! <-- PYexec and RRes (Photos)
      ENDIF
* ==========================================================================
* Tau decays using tauola, all spin effects implemented!
      IF(m_WtCrud .NE. 0d0) THEN
        IF( ABS(KFfin) .EQ. 15) THEN
          CALL TauPair_GetIsInitialized(TauIsInitialized)
          IF( TauIsInitialized .NE. 0) THEN
            IF(m_KeyGPS .EQ. 0 ) THEN
              WRITE(m_out,*) ' #### STOP in KK2f_Make: for tau decays GPS not activated !!!'
              WRITE(    *,*) ' #### STOP in KK2f_Make: for tau decays GPS not activated !!!'
              STOP
            ENDIF
            CALL TauPair_Make1          ! tau decay generation
            CALL TauPair_ImprintSpin    ! introduction of spin effects by rejection
            CALL TauPair_Make2          ! book-keeping, Photos, and pyhepc(2) HepEvt-->Pythia
          ENDIF
        ENDIF
      ENDIF
      END                 !!! end of KK2f_Make !!!
```

Getters and setters for interfacing with C++

- KK2f_GetPhotAll(Nphot,PhoAll) provides the user with the momenta of all photons: DOUBLE PRECISION PhoAll(100,4) and photon multiplicity INTEGER Nphot. Alternatively, Nphot is provided by KK2f_GetNphot (Nphot) and the ith photon momentum by KK2f_GetPhoton1(iPhot,Phot), with DOUBLE PRECISION Phot(4).
- KK2f_GetFermions(q1,q2) provides the user with the momenta of the final fermions DOUBLE PRECISION q1(4), q2(4).
- KK2f_GetBeams(p1,p2) provides the user with the momenta of the beams DOUBLE PRECISION p1(4), p2(4).
- KK2f_GetWtAll(WtMain,WtCrud,WtSet) can be used to get access to the main MC weight WtMain and the list of all alternative weights WtSet(1000). The weight for the crude differential cross section WtCrud is also provided. All of them are DOUBLE PRECISION type. Alternatively, the getter KK2f_GetWt(WtMain,WtCrud) may be more convenient.



TAUOLA is an important part of KKMC

https://twiki.cern.ch/twiki/bin/view/FCC/FccGenerators

arch
FCC All webs

StaszekJadach
Log Out
FCC

CommonTools
FccGenerators
Bhabha
Higgsline
Kkmc
Tauola

FCC web page
FCC-ee (TLEP) web page
FCC-hh (FHC) old twiki
FCC-eh (LHeC) web page

Web Left Bar

TWiki > FCC Web > CommonTools > FccGenerators (2017-05-03, MarcinChrzaszcz)

Edit Attach PDF

Welcome to LEP/TLEP/FCCee repository of the MC generators

Low Angle Bhabha BHLUMI (by S.Jadach, W.Placzek, E.Richter-Was, B.F.L.Ward and Z.Was)

source code, documentation, talks

Fermion pair production: KKMC (by S.Jadach, et. al)

source code, documentation, talks

Tau lepton decays: TAUOLA (by M.Chrzaszcz, T. Przedzinski, Z. Was, J. Zaremba)

source code, documentation, talks

TAUOLA source code:

* Source code of TAUOLA for FCCee TAUOLA-FORTRAN-03-05-2017.tar.gz

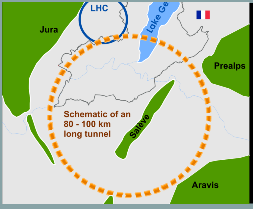
Documentation (papers):

- https://arxiv.org/abs/1609.04617

PHOTOS is inside

Attachments

I	Attachment	History	Action	Size	Date	Who
	TAUOLA-FORTRAN-03-05-2017.tar.gz	r1	manage	9914.1 K	2017-05-03 - 23:09	MarcinChrzaszcz



TAUOLA is an important part of KKMC and many other MC generators Most recent documentation:

arXiv.org > hep-ph > arXiv:1609.04617

Search...

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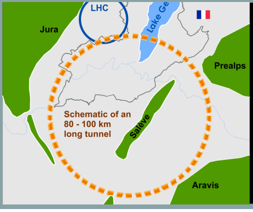
High Energy Physics – Phenomenology

TAUOLA of tau lepton decays-- framework for hadronic currens, matrix elements and anomalous decays

M. Chrzaszcz, T. Przedzinski, Z. Was, J. Zaremba

(Submitted on 15 Sep 2016 (v1), last revised 5 May 2017 (this version, v2))

We present an update of the Monte Carlo event generator TAUOLA for tau lepton decays, with substantially increased list of decay channels and new initialization options. The core of the program remains written in FORTRAN but necessary arrangements have been made to allow handling of the user-provided hadronic currents and matrix elements at the execution time. Such solution may simplify preparation of new hadronic currents and may be useful for fitting to the experimental data as well.
We have implemented as default for TAUOLA a set of hadronic currents, which is compatible with the default initialization used by BaBar collaboration. Options for currents available in previous releases are still stored in the code, sometimes left defunct or activated by internal flags only. The new version of the program, includes also implementation of Lepton Flavour Violating tau decays.
Finally, we present, as an example, a set of C++ methods for handling user-provided currents, matrix elements or complete new decay channels initialization which can be performed at the program execution time.



Recent studies using KKMC

arXiv:1801.08611

QED Interference in Charge Asymmetry Near the Z Resonance at Future Electron-Positron Colliders

Stanislaw Jadach, Scott Yost

(Submitted on 25 Jan 2018 (v1), last revised 16 Jul 2019 (this version, v4))

The measurement of the charge asymmetry $A_{FB}(e^-e^+ \to \mu^-\mu^+)$ will play an important role at the high-luminosity circular electron-positron collider FCCee considered for construction at CERN. In particular, near the Z resonance, $\sqrt{s} \simeq M_Z \pm 3.5$ GeV, A_{FB} will provide a very precise value of the pure electromagnetic coupling constant $\alpha_{QED}(M_Z)$, which is vitally important for overall tests of the Standard Model. For this purpose, A_{FB} will be measured at the FCCee with an experimental error better than $\delta A_{FB} \simeq 3 \cdot 10^{-5}$, at least a factor 100 more precisely than at past LEP experiments! The important question is whether the effect of interference between photon emission in the initial and final state can be removed from the A_{FB} data at the same precision level using

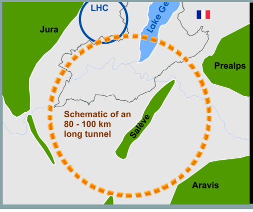
arXiv:1908.06338

Precision measurement of the Z boson to electron neutrino coupling at the future circular colliders

R. Aleksan, S. Jadach

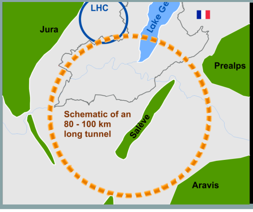
(Submitted on 17 Aug 2019)

At the high luminosity electron-positron circular colliders like FCC-ee in CERN and CEPC in China it will possible to measure very precisely $e^+e^- \to Z\gamma$ process with subsequent Z decay into particles invisible in the detector, that is into three neutrina of the Standard Model and possibly into other weakly coupled neutral particles. Apart from the measurement of the total invisible width (which is not the main subject of this work) this process may be used as a source of Z coupling to electron neutrino -- known very poorly. This is possible due to the presence of the t-channel W exchange in the $e^+e^- \to \nu_e\bar{\nu}_e\gamma$ channel which deforms slightly spectrum of the photon. We are going



Ongoing developments in KKMC

- Provisions for recalculating matrix element with modified EW parameters like $\alpha_{QED}(M_Z)$ for example. (For fitting SM parameters using MC.) Soon.
- Upgrade of DIZET electroweak library, hadronic VP routine, more steering parameters for manipulating EW corrections. Soon.
- Upgrade of TAUOLA library. To early?
- Cleanup and posting on the web next improved version, also with enriched C++ interface. Soon?



BHLUMI Monte Carlo

The same source code on two wiki webpages

http://192.245.169.66:8000/FCCeeMC/wiki/bhlumi

logged in as jadach | Logout | Preferences | Help/Guide

Wiki | Timeline | Roadmap | View Tickets | New Ticket | Search

wiki: bhlumi

Start Page | Ind

Last modified

BHLUMI 4.0x source code:

- Source code of the linux version: bhlp-4.x-linux.tar.gz (2.5MB)
- Original CPC version: bhlp-4.04-export.tar.gz WARNING! will not compile under modern systems

How to compile and run simple examples: HERE

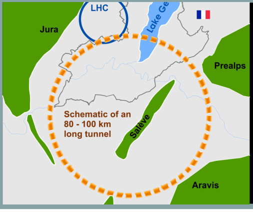
Documentation (papers):

- program description and user manual, Phys. Commun. 102 (1997)
- more papers in the attachments

Talks on low angle Bhabha and BHLUMI are HERE

▸ **Attachments**

https://twiki.cern.ch/twiki/bin/view/FCC/Bhabha



BHLUMI Monte Carlo

Instructions for the user

Unpacking:

```
> gtar -xvzf bhlp-4.x-linux.tar.gz
```

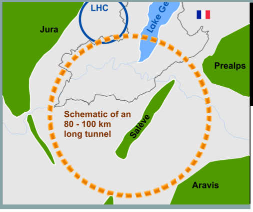
How to compile and run simple example

```
The simplest thing to do is the following:
   > cd Bhlumi-linux/4.x-cpc
   > make demo-start
You may need to correct manualy fortran compilator name and options.
Present version is tested under SLC linux.

Example of reanimated entry in the makefile (under SLC5):
   > cd Bhlumi-linux/4.x-cpc
   > make prod2-start
   > make prod2-stop
   > make prod2-ps
```

Bechmarks

- For other runs makefiles still have to be corrected.
- Instruction for reproducing at least one benchmark should be be given (to be done).



BHLUMI Monte Carlo

S. Jadach et al. / Computer Physics Communications 102 (1997) 229–251

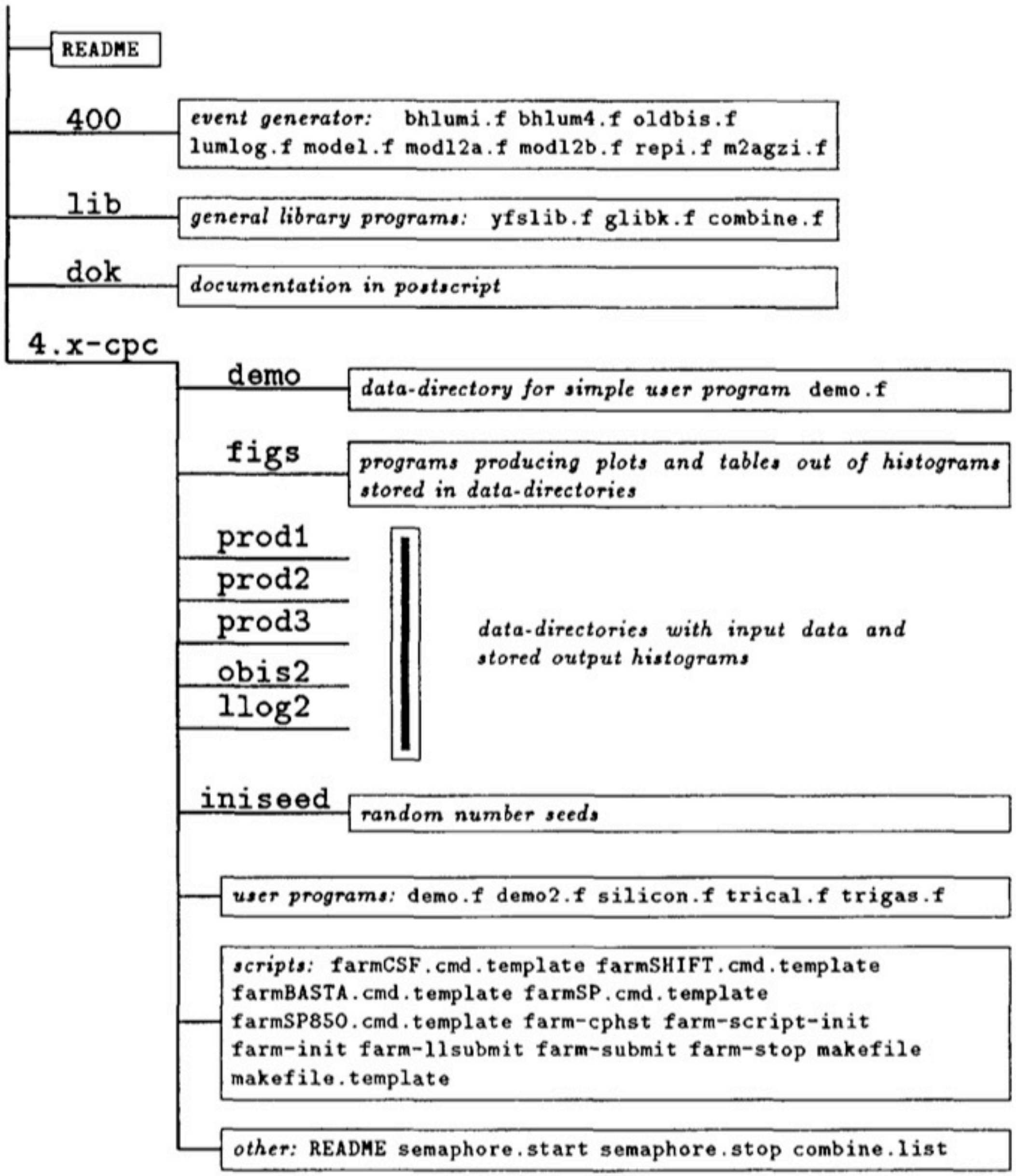
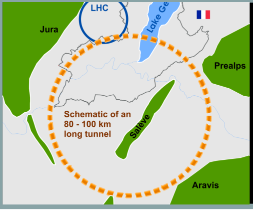
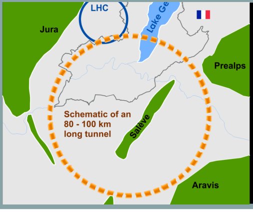


Fig. 2. Topography of the distribution directory.



BHLUMI Monte Carlo simple user program

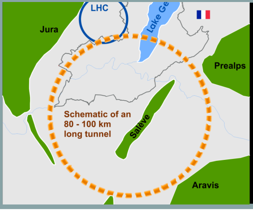
```
      PROGRAM main
      IMPLICIT DOUBLE PRECISION (a-h,o-z)
* Histograms in labeled common
      COMMON / cglib / b(50000)
* Common blocks with output events from bhlumi MC event generator
      COMMON / momset / p1(4),q1(4),p2(4),q2(4),phot(100,4),nphot
      COMMON / wgtall / wtmod,wtcru1,wtcru2,wtset(300)
* Input parameters
      DIMENSION xpar(100),npar(100)
* Initialization of histogramming package--
      CALL glimit(50000)
      (book histograms)
      CALL bhlumi(-1,xpar,npar)
      DO IEVENT=1,10000
         CALL bhlumi( 0,xpar,npar)
         (fill histograms)
      ENDDO
      CALL bhlumi( 2,xpar,npar)
      (print histograms)
      END
```



BHLUMI Monte Carlo input parameters

Table 2
List of input parameters of LUMLOG sub-generator

Parameter	Meaning
`Npar(1)=KeyOpt`	`=1000*KeyGen+10*KeyWgt+KeyRnd`, general option switch, where `KeyGen=2` for this (LUMLOG) sub-generator, `KeyRnd=1,2` implies use of the RANMAR or RANECU random number generator. Both `KeyWgt=1,2` options provide variable-weight (weighted) events. For `KeyWgt=2` weighted events down to zero angle (below `TminL`) are generated—with this option one may cover the complete phase space.
`Npar(2)=KeyRad`	`=100*KeyFin+10*KeyTes+KeyBlo`, option switch determining the type of QED matrix element used to calculate the principal total weight `WtMod`. The user may exploit weights other than `WtMod`, see common block `/WgtAll/`, described in Table 3. For `KeyFin=0,1`, the final state collinear radiation is OFF, ON. Normally `KeyTes=0` while `KeyTes=1` is for tests only— the QED electron structure functions replaced with (unrealistic) testing functions $(1-z)^{1/2}$. The `KeyBlo` switch controls the definition of the big logarithm L in the calculation: for the recommended choice `KeyBlo=3` we use $L=\ln(s'\xi^*/m_e^2)-1$ and for `KeyBlo=4` we have $L=\ln(s\xi_u/m_e^2)$ (cruder but legitimate choice).
`Xpar(1)=CMSene`	$\sqrt{s}$, centre-of-mass (CM) energy in GeV.
`Xpar(2)=TminL`	Minimum ϑ electron/positron scattering angle in units of degree.
`Xpar(3)=TmaxL`	Maximum ϑ electron/positron scattering angle in units of degree.
`Xpar(4)=xk0`	k_0, dimensionless infrared cut on the CM system energy of soft real photons, $E_{phot} > k_0\sqrt{s}/2$; for *non-exponentiated* versions of the calculation. Recommended range is $10^{-7} <_0 < 10^{-4}$.
`Xpar(5)=xkmax`	k_{max} determines the minimum effective mass s' of the final state electron and positron: $s' > s(1-k_{max})$. Note that $k_{max}=1$ is allowed but we recommend $k_{max} \leqslant 0.9999$.

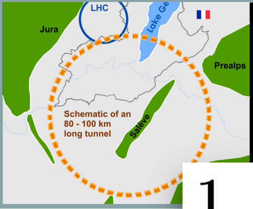


BHLUMI Monte Carlo auxiliary model weights

Table 3

Explanation of parallel weights in the `WtSet` list for the BHLUM4 sub-generator. The listed weights correspond to matrix element type (A). The entries for type (B) matrix element have the index shifted by 100. See Ref. [3] for the definitions of the matrix element. For example `WtSet(41)` corresponds to the $\mathcal{O}(\alpha^1)_{\rm exp}$ exponentiated matrix element type (A) and `WtSet(141)` corresponds to $\mathcal{O}(\alpha^1)_{\rm exp}$ type (B). The principal total weight `WtMod=WtSet(1)` corresponds to weight `WtSet(142)`. For nonzero `KeyPia` and/or `KeyZet` the weight `WtMod=WtSet(1)` is multiplied by a factor corresponding to photon vacuum polarization and the Z contribution is added. The other weights are not affected.

Entry	Type of cross section	Emission line
`WtSet(1)`	Principal weight `WtMod`; it depends on `KeyPia, KeyZet`	upper + lower
`WtSet(11)`	Z contribution *without* vacuum polarization	upper + lower
`WtSet(12)`	Z contribution *with* vacuum polarization	upper + lower
`WtSet(30,31,32)`	$\mathcal{O}(\alpha^0)_{\rm exp}$, $\mathcal{O}(\alpha^1)_{\rm exp}$ and $\mathcal{O}(\alpha^2)_{\rm exp}$ total	upper line only
`WtSet(35,36)`	$\mathcal{O}(\alpha^1)_{\rm exp}$ version of $\bar\beta_0$ and $\bar\beta_1$	upper line only
`WtSet(37,38,39)`	$\mathcal{O}(\alpha^2)_{\rm exp}$ version of $\bar\beta_0$, $\bar\beta_1$ and $\bar\beta_2$	upper line only
`WtSet(40,41,42)`	$\mathcal{O}(\alpha^0)_{\rm exp}$, $\mathcal{O}(\alpha^1)_{\rm exp}$ and $\mathcal{O}(\alpha^2)_{\rm exp}$ total	upper + lower
`WtSet(43,44)`	$\mathcal{O}(\alpha^1)_{\rm exp}$ version of $\bar\beta_0$ and $\bar\beta_1$	upper + lower
`WtSet(45,46)`	$\mathcal{O}(\alpha^1)_{\rm exp}$ $\bar\beta_1$ upper and lower contribution	upper + lower
`WtSet(47,48,49)`	$\mathcal{O}(\alpha^2)_{\rm exp}$ version of $\bar\beta_0$, $\bar\beta_1$ and $\bar\beta_2$	upper + lower
`WtSet(50,51)`	$\mathcal{O}(\alpha^2)_{\rm exp}$ $\bar\beta_1$ upper and lower contributions	upper + lower
`WtSet(52,53,54)`	$\mathcal{O}(\alpha^2)_{\rm exp}$ $\bar\beta_2$ upper $\times$ lower, upper and lower contributions	upper + lower
`WtSet(60,61,62)`	$\mathcal{O}(\alpha^0)$, $\mathcal{O}(\alpha^1)$ and $\mathcal{O}(\alpha^2)$ total	upper line only
`WtSet(70,71,72)`	$\mathcal{O}(\alpha^0)$, $\mathcal{O}(\alpha^1)$ and $\mathcal{O}(\alpha^2)$ total	upper + lower



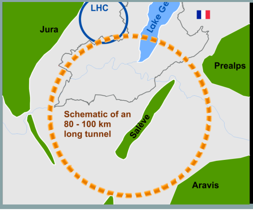
BHLUMI Monte Carlo
an example of reproducing the old benchmark

1 Baseline benchmark

WARNING: Tables are from machine produced LaTeX source.

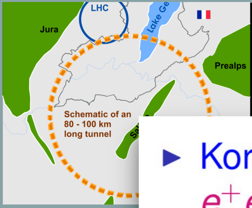
$1 - z_{\min}$	WW	NW	NN
	BARE1 $\sigma(z_{\min})$ [nb]		
0.10	142.6118 ± 0.0056	114.2880 ± 0.0036	113.2223 ± 0.0050
0.30	161.6587 ± 0.0059	130.5044 ± 0.0038	128.1726 ± 0.0053
0.50	168.7849 ± 0.0060	136.4534 ± 0.0038	133.4601 ± 0.0053
0.70	171.7381 ± 0.0061	138.8446 ± 0.0038	135.5760 ± 0.0054
0.90	173.3117 ± 0.0061	140.1594 ± 0.0038	136.7746 ± 0.0054
	CALO2 $\sigma(z_{\min})$ [nb]		
0.10	123.4192 ± 0.0052	92.0316 ± 0.0032	90.7872 ± 0.0044
0.30	132.9727 ± 0.0053	99.8417 ± 0.0033	97.2052 ± 0.0046
0.50	135.8402 ± 0.0054	101.8854 ± 0.0033	98.5796 ± 0.0046
0.70	136.5898 ± 0.0054	102.4246 ± 0.0033	98.9859 ± 0.0046
0.90	136.9899 ± 0.0054	102.7298 ± 0.0033	99.2189 ± 0.0046
	SICAL2 $\sigma(z_{\min})$ [nb]		
0.10	123.6495 ± 0.0052	92.1861 ± 0.0032	90.9518 ± 0.0044
0.30	133.7042 ± 0.0053	100.3967 ± 0.0033	97.7079 ± 0.0046
0.50	137.1478 ± 0.0054	102.9010 ± 0.0033	99.4586 ± 0.0046
0.70	137.7384 ± 0.0054	103.2823 ± 0.0033	99.7078 ± 0.0046
0.90	138.0116 ± 0.0054	103.4572 ± 0.0033	99.8158 ± 0.0046

Table 1: **Results from BHLUMI Monte Carlo for $e^+e^- \to e^+e^-$ at 92.3GeV.** Reproducing Tables 14 and 16 in Proc. of workshop 1996. Here VP and Z are switched ON. S. Eidelman, F. Jegerlehner, Z. Phys. C (1995) Energy cut on $z_{\min} = s'/s$ for BARE1 and $z_{\min} = 4E_1E_2/s$ for CALO2 and SICAL2. Statistics 3G events (1h run on 24 processors).



BHLUMI Monte Carlo
Ongoing development

- Adding two more routines, with more precise recent calculations of the hadronic vacuum polarisation.
- Upper level (main program and analysis) in C++, similarly as in KKMC with wrappers, ROOT histogramming etc.
- Programming event selection as in FCCee lumi detector.
- Preparing baseline for implementing new ***second order*** QED matrix element in the CEEX style in C++.
- NB. there are several versions of BHLUMI with beamstrahlung developed by within the ILC community.



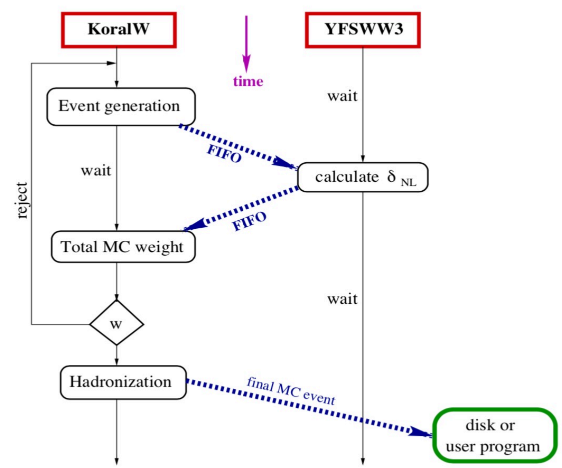
Monte Carlos for WW production

- KoralW Monte Carlo contains complete process $e^+e^- \to 4fermions$ at the Born level. Radiation: multiphoton ISR YFS-type
- YFSWW3 Monte Carlo generates signal process $e^+e^- \to W^+W^- \to 4fermions$ with up to $\mathcal{O}(\alpha)$ electroweak corrs. in production of W^+W^-. It includes multiphotonic radiation from the production part in the YFS framework.
- KandY = KoralW⊕YFSWW3 combined 4-fermion and $\mathcal{O}(\alpha)$ WW
- KandY: is precision 0.02% at FCCee feasible ????

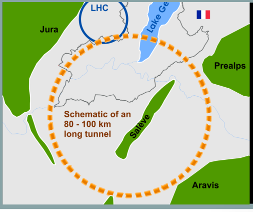
Merge of KoralW and YFSWW3 = KandY

Possible because the underlying photonic distribution is the same YFS-ISR in both codes. All other photonic effects are included as weights. So are the $\mathcal{O}(\alpha)$ EW corrs.

Concurent realization of $\sigma_{K/Y}$ with "named pipes"



Works effectively as a single MC event generator



Monte Carlos for WW production

http://placzek.web.cern.ch/placzek/

Homepage of **Wieslaw Placzek**

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Monte Carlo programs:

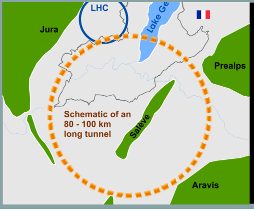
- **LESKO-E & FRANEQ**: For Deep Inelastic Neutral Current Scattering at HERA (not updated since January 1993).
- **BHWIDE**: For Large-Angle Bhabha Scattering.
- **KoralW**: For 4-Fermion Production in Electron-Positron Collisions.
- **YFSWW**: For W-Pair Production and Decay in Electron-Positron Collisions.
- **YFSZZ**: For Z-Pair Production and Decay in Electron-Positron Collisions.
- **WINHAC**: For Single W-Boson Production in Hadron Collisions.

KoralW – source code

Available from: **/afs/cern.ch/user/s/skrzypek/public/**

- koralw-1.51.3-export.tgz
  – last version published in CPC
- koralw-1.53.3-export.30sep02.tgz
  – last version, as used at LEP2, with *t*-channel ISR
- koralw-1.53.3-linux-export.tar.gz
  – last version, adapted for Linux
- koralw-1.53.3-QuadPrec-export.tar.gz
  – last version upgraded to quadruple precision i.e. stable in small angles for e^+e^- in final state

Instructions in README and RELEASE.NOTES files
Simple demo: goto demo.14x directory and execute:
make KWdemoCC03 or make KWdemoGRCall

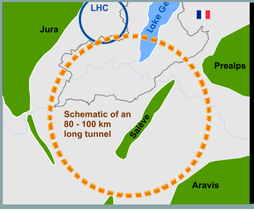


Summary

- LEP has seen development of the precision MC event generators tailored for just one scattering process.
- The legacy codes in written F77 are alive and can be still quite useful for FCCee related studies.
- Web pages of the source codes and extensive documentation are available.

- Much better MC generators for precision physics at FCCee will have to be developed in the future, starting from what we already have got.

*This work is partly supported by the Polish National Science Center grant 2016/23/B/ST2/03927 and the CERN FCC Design Study Programme.


LHC
Jura
Prealps
Schematic of an
80 - 100 km
long tunnel
Aravis

Reserve

At the FCC-ee exp. precisions present QED uncertainty is unacceptable!

Current QED precision vs. FCCee exp. error