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KORALB – An upgrade to version 2.4

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ABSTRACT

An upgrade of the Monte Carlo program for τ pair production including τ mass, spin and QED $O(\alpha)$ effects is presented. Its main feature is the interface to the new τ decay Monte Carlo library TAUOLA, new coding of the final states and implementation of the Z exchange at the Born level.

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NEW VERSION SUMMARY

Title of the program: KORALB, version: 2.4

Reference to original program: Comput. Phys. Commun. **36** (1985) 191.

Authors of original program: S. Jadach and Z. Wąs

Computer: HP 715

Operating system: UNIX

Programming language used: FORTRAN 77

High speed storage required: < 1MB

No. of bits in a word: 32

Peripherals used: Line printer

No. of lines in combined program and test deck including TAUOLA and PHOTOS libraries: about 12615.

Keywords: radiative corrections, heavy lepton τ , Monte Carlo simulation, quantum electrodynamics, spin polarization, electroweak effects

Comparison with the previous version, and reasons for the new version: The τ decay library [2] is now updated. The physics content of the τ production part of the program is enriched. Convenient for certain tests, the possibility to use the program at the Born level including Z exchange is introduced.

Typical running time: 1 to 300 events per (HP 715/33) sec, depending on the τ decay modes chosen and no beam polarization.

Unusual features of the manual: This is not an independent document. Only the differences with Ref. [1] are documented.

References:

[1] S. Jadach and Z. Wąs, Comput. Phys. Commun. **36** (1985) 191., *ibid.* **64** (1991) 261

[2] R. Decker, S. Jadach, M. Jezabek, J. H. Kühn and Z. Wąs, Comput. Phys. Commun. **64** (1991) 275, *ibid.* **70** (1992) 69, *ibid.* **76** (1993) 361.

1 Introduction

Since the original version of the KORALB program was published [1], no major improvements has been introduced to the code generating τ -pair production and spin effects. However, it is still the most complete and sophisticated Monte Carlo generator for the τ -pair production process at low energies, $\sqrt{s} < 30$ GeV. Its use is now quite widespread and, as the low-energy e^+e^- experiments are still collecting τ -pair data (CLEO) and the new high-luminosity experiments are planned (on τ -charm or b factories), there is therefore an urgent need to develop KORALB as well as to study its uncertainties.

In this paper we present the new version of KORALB. All the physical content of the program (treatment of QED, Z exchange, spin) remains very similar. The main improvement is the inclusion of possibility of switching off transverse spin correlations and running the program at the peak of the Z (with the Born level Z exchange spin amplitude in the small τ -mass approximation). Modifications to the program include automatized choice of the maximal spin weight allowing easy implementation of the extra amplitudes (such as Z exchange). We include in the program the updated version of the τ -decay library TAUOLA [2] with new QED bremsstrahlung corrections in the τ decays where in the semileptonic τ -decays approximate algorithm of the PHOTOS [3] is now used.

In the last five years we have developed another τ Monte Carlo program KORALZ [4], suitable for higher energies (LEP). With the increasing experimental precision it is becoming important to provide a platform in which results of the two programs can be easily compared. With the present update of KORALB the two programs KORALB and KORALZ can be used to study [6] the systematic errors related to certain terms missing in their matrix elements¹. On one hand, we are now able to estimate easily how missing transverse spin effects in KORALZ and on the other hand we can check how important are missing higher order QED effects in KORALB. The main principle of these tests/improvements in the predictions consists of calculating the numerical size of the corrections missing in one of the program with the help of the other one. This hybrid Monte Carlo tool enables calculation of above effects in the presence of the detector acceptance, with various choices of cuts etc. We have already successfully applied such a method in our high-precision calculation of the luminosity cross section at LEP [7].

In the following, we shall describe how to run the program, and we list the most important modifications to the code.

¹Similar comparisons can be performed with the results of a program [5] constructed specially for the study of non-standard couplings of the Z to τ .

2 How to use the program

A Monte Carlo event, i.e. a complete set of final state momenta and flavors, is generated by a single call to the routine KORALB. For example a complete sequence of calls, which generates 1000 Monte Carlo events may look like

```
REAL*4 PB1(4),PB2(4),E1(3),E2(3),XPR(40)
INTEGER*4 NPR(40)
CALL KORALB(-1,KFB,PB1,E1,-KFB,PB2,E2,XPR,NPR)
DO 300 IEV=1,1000
  CALL KORALB(0,KFB,PB1,E1,-KFB,PB2,E2,XPR,NPR)
300  filling histograms
CALL KORALB(1,KFB,PB1,E1,-KFB,PB2,E2,XPR,NPR)
```

Here, the first obligatory call on KORALB defines $e^\pm$ beam momenta and transfers other input parameters (so far no event generation). The other calls on KORALB in the loop generate M.C. events, and the final optional call terminates the generation by printing some useful output. The final output includes the total cross section, the widths in τ decays from TAUOLA, etc. Generally, the input parameters are transferred as KORALB parameters and the output results (momenta, flavours) are encoded in common blocks documented, if necessary, later in this Section.

Let us explain now in more detail the parameters of KORALB. As is obvious from the above example the first parameter `MODE` in `KORALB(MODE,...)` is defining whether KORALB is called in initialization mode (`MODE=-1`), generation mode (`MODE=0`), or post-generation mode (`MODE=1`).

3 Initialization mode

In the initialization mode (MODE=-1) the meaning of the parameters in KORALB(MODE,KFB,PB1,E1,-KFB,PB2,E2,XPR,NPR) is the following: REAL*4 PB1(4), PB2(4) are four-momenta of the first and second beam (where PB1(4) and PB2(4) are energies). Both momenta are necessarily along a third axis in the laboratory system and PB1 is required to have a positive third component. Having in mind asymmetric b -factories we have introduced a possibility of asymmetric beam energies, and the laboratory system is thus not necessarily identical to the center of mass system (CMS). The two are related by a simple boost along the third axis at the end of the kinematics chain. INTEGER*4 KFB is a flavor identifier of the first beam (i.e. associated with PB1). KFB=11, -11 denotes electron and positron, respectively, in the notation of [8]. Two four-vectors REAL*4 E1(4), E2(4) are spin polarization vectors of the first and second beam in the $e^\pm$ rest frames. For the first beam (PB1,E1), the corresponding rest frame used to define its spin polarization vector E1 has its third axis directed along its line of flight, i.e. it is a standard helicity axis. For E2, the direction of the corresponding third axis is opposite to its line of flight, i.e. opposite to its helicity axis. For example KFB=-11, E1=(0.0,0.0,1.0), E2=(0.0,0.0,1.0), means that the user asks for the first beam to be a right-handed positron and the second a left-handed electron. Transverse and partial polarizations are allowed, e.g. E2=(0.0,0.0,0.5) would represent a 50% polarized second beam. The other input parameters are transferred through matrices REAL*4 XPR(40) and INTEGER NPR(40).

In this table, we give a short summary of all input parameters.

Parameter	Meaning
KFB	Flavor identifier of the first beam, KFB= 11, -11 denotes electron and positron respectively (PDG notation).
PB1	Four-momentum of the first beam. PB1(3)>0 is required.
E1	Spin polarization vector of the first beam. E1(3)=helicity.
PB2	Four-momentum of the second beam.
E2	Spin polarization vector of the second beam. E2(3)=-helicity.
NPR(1)=ISPIN	Switch for spin effects in τ decay. The user normally sets ISPIN=1 to have all spin effects included and may set ISPIN=0 to neglect them.
NPR(2)=INRAN	Integer constant, INRAN $\geq$ 1, is used to initialize a random number generator in the τ pair production part of M.C.
NPR(3)=KEYGSW	Implementation level of the GSW standard electroweak model. For KEYGSW=0 there is no Z exchange at all. For KEYGSW=1 the interference between γ and Z exchange is included.
NPR(4)=KEYRAD	Switch for the QED bremsstrahlung. KEYRAD=0 means no QED bremsstrahlung. KEYRAD=1 denotes single bremsstrahlung.
NPR(5)=JAK1	The variable JAK1=1,2,3,... defines the decay channel of τ^+ as being $\nu e^+ \nu$, $\bar{\nu} \mu^+ \nu$, $\bar{\nu} \pi^+$, ... according to the order defined in TAUOLA. Furthermore, setting JAK1=0 causes the τ^+ to decay into all channels inclusively according to predefined branching ratios (see routine JAKER), and setting JAK1=-1 inhibits the decay completely.
NPR(6)=JAK2	The assignments of JAK2, for τ^- , are the same as those of JAK1.

4 Generation/production mode

In this mode all parameters of KORALB, except for $\text{MODE}=0$, are ignored. The produced Monte Carlo event is stored in the common block

```
C-- HEPEVT      Standard high-energy physics (HEP)
C--              common definitions

      INTEGER NMXHEP
      PARAMETER (NMXHEP=2000)
      INTEGER IDHEP, ISTHEP, JDAHEP, JMOHEP, NEVHEP, NHEP
      REAL PHEP, VHEP
      COMMON/HEPEVT/NEVHEP, NHEP, ISTHEP (NMXHEP), IDHEP (NMXHEP),
      1 JMOHEP (2, NMXHEP), JDAHEP (2, NMXHEP), PHEP (5, NMXHEP), VHEP (4, NMXHEP)
```

The common block HEPEVT contains a complete set of all initial and final state flavors and four-momenta encoded in the standard conventions [8]. This common block contains information on the e^+ beams, on the τ^+ , τ^- , γ , and finally on all the $\tau^\pm$ decay products including neutrinos. Conservation of total energy and momentum is explicitly obeyed. Intermediate particles like $W^\pm$ and $\rho^\pm$ are kept in the record, wherever possible.

In addition the final state momenta for the production process may be found in **COMMON** / UTIL4 / QP(4), QM(4), PH(4) where **REAL*4** QP, QM are four-momenta of τ^+ , and τ^- respectively, and **REAL*4** PH is the momentum of the bremsstrahlung photon (in GeV units).

5 Postgeneration mode

A call on KORALB in this mode ($\text{MODE}=1$) may be optionally used in order to obtain information on the value of the integrated cross section and the list of the partial τ decay widths. They are obtained with a finite statistical error depending on the number of generated M.C. events and they correspond strictly to the production and decay matrix elements used in the actual M.C. generation². All this information is printed in the output, and some of it is also provided to the user through parameter matrices **XPR** and **NPR**, as in the following table.

Parameter	Meaning
NPR(10)	Number of generated τ pairs.
XPR(10)	Total cross section in cm^2 .

²For the generation, however, the probabilities of various decay modes are determined using values of the branching ratios from the common block **TAUBRA**. They have to be initialized by the user, see Long-Write-Up of TAUOLA.

Parameter	Meaning
NPR(7)=ITFIN	This switch key allows the generation of final state fermion pairs other than τ pairs. The τ pairs are produced with $\text{ITFIN}=1$, μ pairs with $\text{ITFIN}=2$. The mass of τ and μ is taken from the common block of TAUOLA. A quark pair may be produced with $\text{ITFIN}=501-506$. In this case the quark mass is defined through XPR(14) (see below). For $\text{ITFIN} > 1$ the τ decay is automatically suppressed.
NPR(8)=ITDKRC	Switch for bremsstrahlung in the τ decay.
NPR(9)=ITRANS	Switch for transverse spin correlations.
NPR(11)=IFZET	Switch for full implementation of Z . At present it can be used only for KEYRAD=0 .
XPR(1)=AMZ	Mass of the Z .
XPR(1)=GAMZ	Width of the Z .
XPR(4)=GV	Vector coupling constant g_V and
XPR(5)=AV	axial coupling constant g_A of the τ to the W in the τ decay. Note that $g_V = 1$, $g_A = -1$ represent the standard $V-A$ assignment.
XPR(6)=SINW2	$\sin^2 \theta_W$. It has to be assigned for KEYGSW=1 .
XPR(8)=AMNUTA	Mass of the ν_τ . To avoid rounding machine errors it has to be assigned a non-zero value.
XPR(11)=XK0	k_0 , soft/hard photon cut-off for the QED bremsstrahlung. The recommended value is $k_0 \simeq 0.005$.
XPR(14)=AMFIN	Mass of the final state quarks. Dummy parameter for $\text{ITFIN}=1$ or $\text{ITFIN}=2$.
XPR(13)=XKMAX	Maximum photon energy to be generated (in $\sqrt{S}/4$ units).
XPR(1), NPR(1)	All other entries in the XPR and NPR matrices are dummy.

6 The most important modifications to the program

1. The τ decay library TAUOLA is updated.
2. The algorithm for QED radiative corrections of PHOTOS in the τ decay simulation is introduced.
3. Transverse spin correlation can be switched on and off with the help of NPR(9)=ITRANS.
4. Z exchange can be switched on, NPR(11)=IFZET. Its mass, width and $\sin^2 \theta_W$ are transmitted in through XPR(1), XPR(2) and XPR(6) respectively. The meaning of these parameters is exactly the same as in KORALZ [4]. At present this option is limited to the case of the Born level.
5. The energies of e^+e^- beams can be different; however, the beam energy spread is not yet introduced. Beam momenta have to be back to back.
6. Certain bugs were removed. The most important one is discussed in the Appendix; fortunately it is numerically insignificant.

The following three new common blocks were introduced:

1. COMMON / NEWZET/ IFZET, ITRANS
2. common / znovy / amz, gamz
3. COMMON / CMSLAB/ CAMLAB

As can be seen, there is still a lot of improvement in the program to be done. The present version of the program, together with KORALZ, forms a definite platform to decide whether a multi-photon Monte Carlo including complete spin treatment is needed or whether the hybrid solution KORALB+KORALZ presented here is still sufficient.

Acknowledgements

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References

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- [2] S. Jadach, J.H. Kühn and Z. Was, Comput. Phys. Commun. **64** (1991) 275; S. Jadach, M. Jezabek, J.H. Kühn and Z. Was, Comput. Phys. Commun. **70** (1992) 69; R. Decker, S. Jadach, J.H. Kühn and Z. Was, Comput. Phys. Commun. **76** (1993) 361.

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APPENDIX

In our paper [9] and in all calculations of spin amplitudes we used a different (opposite sign) choice of the scattering angle θ in the part of cross section Born+virtual ($k < k_0$) from that for the real-photon-emission part ($k > k_0$). The above choice is not the problem in itself but for some unknown reasons (blind optimization during the final clean-up before publication?) this fact was not properly reflected in the TRALOR routine, already in the first published version [1] of KORALB.

Corrections to our papers. All spin amplitudes expressions for correlation tensors R_{abcd} , numerical results, etc., in Refs. [9, 1] and any other are NOT affected. The bug is present in the long-write-up [1]; In eq. (2.28) in the definition of $L_0(\tau^\pm)$ rotation matrix $R_1(-\theta)$ should be replaced with $R_1(\theta)$. The same change should be made in Fig. 1a. The same change propagates to eqs. (2.2), (3.5) and Fig. 2a in Ref. [10] and to Fig. 1a in Ref. [11]. Note that the TIPTOP program and related papers are not affected because this program, although derived from KORALB, has a different TRALOR routine. The same is true for the KORALZ program.

Apologies and remarks on tests of KORALB. We are really very sorry for any inconveniences and/or any other possible consequences of the above bug. We would like to stress (as usual) that the user of any Monte Carlo program should test its basic properties relevant to her/his specific needs. Although it is always our aim that the Monte Carlo program is 100% free of bugs, the user should NEVER assume that this is true. *How well is KORALB tested?* Its basic tests are in Ref. [9] and we strongly recommend any user

to repeat them before he applies results of the program³. We expressed on many occasions our feelings that with present statistics of millions τ 's these old tests are NOT sufficient and there is an urgent need for more sophisticated tests – in addition to a repetition of old ones. Note that tests in Ref. [12] are performed on distributions, which are in principle insensitive to the bug; however, numerical size of the effect is small – it is respectively 1% and 3% for the distribution L of Ref. [12] calculated at 10 and 4 GeV center of CMS energy. Such a small effect could not be seen with the tests performed in this paper.

We would like to encourage anybody who finds observables more sensitive to the bug to contact us as soon as possible. The bug can be re-introduced with the flag `IBLAD=1` in routine `TRALOR`. We will immediately redistribute this information to other users of `KORALB`. So far, we can hope that the bug did not affect any experimental analysis.

Acknowledgement. We would like to thank Dr. Holger Thurn for reporting the bug and for helping us to localize it. His dedicated effort (including one day off his private visit in the Geneva area during Easter 93) was also very helpful in understanding the numerical effects of the bug. We would also like to thank Prof. Charles Nelson for calculating the sensitivity of his plots on the artificial introduction in his formulae a term equivalent to the bug we had in KORALB.

TEST RUN OUTPUT

DEMONSTRATION PROGRAM
THE MONTE CARLO PROGRAM
KORALB- VERSION 2.4
PREPRINT CEAN-TH 7272, MAY 1984
NEVTES= 2000 NO. OF REQUESTED EVENTS
ENE = 5.00 BEAM ENERGY

³In fact the statement in Ref. [9] p. 1155: “spin of the τ -s try to align both in the same direction along the beam axis” cannot be reproduced with a published version of KORALB – this may indicate that bug was introduced just before the submission of the program for publication in Ref. [1].

```

*****
*****-KORALB VERSION 2.4 INPUT PARAMETERS*****
*****MAY 1994*****
*****
*****-11 KF1 = FIRST BEAM IDENTIFIER*****
*****11 KF2 = SECOND BEAM IDENTIFIER*****
*****
*****PB1(3) = FOUR MOMENTA OF THE BEAMS =*****
*****PB1(4) = FIRST BEAM, 3-AD COMPONENT*****
*****PB2(3) = O-TH COMPONENT*****
*****PB2(4) = SECOND BEAM, 3-AD COMPONENT*****
*****PB2(4) = O-TH COMPONENT*****
*****
*****SPIN VECTORS OF THE BEAMS*****
*****E1(1) = FIRST BEAM, 1-ST COMPONENT*****
*****E1(2) = 2-ND COMPONENT*****
*****E1(3) = 3-AD COMPONENT*****
*****E2(1) = SECOND BEAM 1-ST COMPONENT*****
*****E2(2) = 2-ND COMPONENT*****
*****E2(3) = 3-AD COMPONENT*****
*****
*****INPUT PARAMS IN NPAR*****
*****
*****1 IFFIN = TYPE OF THE FINAL STATE*****
*****1 ISPIN = SPIN EFFECTS SWITCH*****
*****17 IRRAN = RANDOM NUMB. INITIALIZATION*****
*****1 KEYOSW = GSW IMPLEMENTATION LEVEL*****
*****1 KEYRAD = BREMSSTRAHLUNG SWITCH*****
*****0 JAK1 = DECAY TYPE TAU+*****
*****0 JAK2 = DECAY TYPE TAU-*****
*****1 ITRKRC = BREM. IN DECAY SWITCH*****
*****1 ITRANS = TRANSVERSE SPIN CORR. SWITCH*****
*****0 IFZET = NEW IMPLEMENT. OF Z SWITCH*****
*****
*****INPUT PARAMS IN APAR*****
*****
*****91.1999964948 ANZ = MASS OF ZO BOSON*****
*****2.6000000000 GAWZ = WIDTH OF ZO BOSON*****
*****.2300000004 SINW2 = SIN**2(THETAWENBERG)*****
*****1.0000000000 GV = VECTOR COUPLING CONST. IN DECAY*****
*****-1.0000000000 GA = AXIAL COUPLING CONST. IN DECAY*****
*****0.1000000000 AMNTTA = MASS OF TAU-NEUTRINO IN DECAY*****
*****0.1000000000 XGO = SQU/HAARD PHOTON CUT OFF*****
*****
*****
*****PHOTOS, Version: 2.0*****
*****Released at: 16/11/93*****
*****
*****PHOTOS QED Corrections in Particle Decays*****
*****
*****Monte Carlo Program - by E. Barberio, B. van Eijk and Z. Was*****
*****From version 2.0 on - by E.B. and Z.W.*****
*****
*****
*****Internal input parameters:*****
*****
*****INTERF= T ISEC= T IFTOP= T*****
*****ALPHA_QED= .00730 ALPHAQED= .01000*****
*****
*****option with interference is active*****
*****option with double photons is active*****
*****emission in t tbar production is active*****
*****
*****==KORALB-INITIALIZATION THROUGH TAULA==*****
*****1.784199693 AMFIN = MASS OF FINAL STATE FERMION*****
*****
*****

```

START PARAMETERS ARE ... ENERGY 6.1237 GEV
SIN2 .2300
INRAN 17
MASS OF ELECTRON/KAON BOSON Z0 IS (GEV) 91.2000
COUPLING CONSTANTS: CVC, CAC - .0475 - .5941
CVC, CAF - .0476 - .5941
CONTRIBUTIONS TO SOFT CROSS SECT. ARE...
BORN + SOFT PHOTON + VERTEX CORR. INIT. .6953
TOTAL CROSS SECTION - APPROXIMATE 1.2678

ALL ABOVE CROSS SECTIONS ARE GIVEN IN
UNITS OF THE LOWEST ORDER (POINTLIKE)
ONE PHOTON CROSS-SECTION SUGO WHICH IS
EQUAL TO .67904E-33 CM**2

*****TAUOLA LIBRARY: VERSION 2.5 *****
*****DECEMBER 1993*****
AUTHORS: S.JADACH, Z.WAS***
R. DECKER, M. JEZABEK, J.R.KUEN***
AVAILABLE FROM: VASW AT CERN***
*****PUBLISHED IN COMP. PHYS. COMM.*****
*****CERN-TH-6196 SEPTEMBER 1991*****
*****CERN-TH-6793 NOVEMBER 1992*****
*****DECAY ROUTINE: FINAL REPORT*****
NEV1 = NO. OF TAU+ DECS. ACCEPTED
NEV2 = NO. OF TAU- DECS. ACCEPTED
NEVTOT = SUM

NOEVENTS PART.WIDTH ERROR ROUTINE DECAY MODE
185 .9877298 .0231463 DADMELE ELECTRON
196 .9888754 .0234156 DADMMU MUON
178 .6058310 .0000000 DADMP1 PION
171 1.3090163 .0155149 DADMRD RHO (->2P1)
184 .7080593 .0158654 DADMAA A1 (->3P1)
199 .0397533 .0000000 DADMKX KAON
196 .0704854 .0131909 DADMKX K*
162 .0838137 .0202910 TAU- -> 2P1-, P10, P1+
198 .0168806 .0192922 TAU- -> 3P10, P1-
185 .0624964 .0254668 TAU- -> 2P1-, P1+, 2P10
187 .0295622 .0253486 TAU- -> 3P1-, 2P1+,
186 .0042098 .0282325 TAU- -> 3P1-, 2P1+, P10
171 .0042849 .0300143 TAU- -> 2P1-, P1+, 3P10
180 .0059910 .0214980 TAU- -> K-, P1-, K+
177 .0058121 .0227650 TAU- -> K0, P1-, K0B
195 .0006070 .0202096 TAU- -> K-, K0, P10
180 .0062184 .0151180 TAU- -> P10, P10, K-
138 .0309523 .0212613 TAU- -> K-, P1-, P1+
178 .0313717 .0209280 TAU- -> P1-, K0B, P10
193 .0110985 .0236187 TAU- -> ETA, P1-, P10
174 .0031587 .0174919 TAU- -> P1-, P10, GAM
186 .0188184 .0228925 TAU- -> K-, K0

THE ERROR IS RELATIVE AND PART.WIDTH
IN UNITS OF MEV**2/MASS**5/192/P1**3

*****KORALB VERSION 2.4 FINAL REPORT*****
*****MAY 1994*****
2000 NUMBER OF THE GENERATED EVENTS
.6907E-33 TOTAL CROSS SECTION CM**2
.004873007 RELATIVE ERROR

FINISH
sum charge: .00 sum mom. and inv. mass: .00000 2.50000 12.50000 12.24745

*****TAUOLA LIBRARY: VERSION 2.5 *****
*****DECEMBER 1993*****
AUTHORS: S.JADACH, Z.WAS***
R. DECKER, M. JEZABEK, J.R.KUEN***
AVAILABLE FROM: VASW AT CERN***
*****PUBLISHED IN COMP. PHYS. COMM.*****
*****CERN-TH-6196 SEPTEMBER 1991*****
*****CERN-TH-6793 NOVEMBER 1992*****
*****DECAY ROUTINE: FINAL REPORT*****
NEV1 = NO. OF TAU+ DECS. ACCEPTED
NEV2 = NO. OF TAU- DECS. ACCEPTED
NEVTOT = SUM

NOEVENTS PART.WIDTH ERROR ROUTINE DECAY MODE
185 .9877298 .0231463 DADMELE ELECTRON
196 .9888754 .0234156 DADMMU MUON
178 .6058310 .0000000 DADMP1 PION
171 1.3090163 .0155149 DADMRD RHO (->2P1)
184 .7080593 .0158654 DADMAA A1 (->3P1)
199 .0397533 .0000000 DADMKX KAON
196 .0704854 .0131909 DADMKX K*
162 .0838137 .0202910 TAU- -> 2P1-, P10, P1+
198 .0168806 .0192922 TAU- -> 3P10, P1-
185 .0624964 .0254668 TAU- -> 2P1-, P1+, 2P10
187 .0295622 .0253486 TAU- -> 3P1-, 2P1+,
186 .0042098 .0282325 TAU- -> 3P1-, 2P1+, P10
171 .0042849 .0300143 TAU- -> 2P1-, P1+, 3P10
180 .0059910 .0214980 TAU- -> K-, P1-, K+
177 .0058121 .0227650 TAU- -> K0, P1-, K0B
195 .0006070 .0202096 TAU- -> K-, K0, P10
180 .0062184 .0151180 TAU- -> P10, P10, K-
138 .0309523 .0212613 TAU- -> K-, P1-, P1+
178 .0313717 .0209280 TAU- -> P1-, K0B, P10
193 .0110985 .0236187 TAU- -> ETA, P1-, P10
174 .0031587 .0174919 TAU- -> P1-, P10, GAM
186 .0188184 .0228925 TAU- -> K-, K0

THE ERROR IS RELATIVE AND PART.WIDTH
IN UNITS OF MEV**2/MASS**5/192/P1**3

*****KORALB VERSION 2.4 FINAL REPORT*****
*****MAY 1994*****
2000 NUMBER OF THE GENERATED EVENTS
.6907E-33 TOTAL CROSS SECTION CM**2
.004873007 RELATIVE ERROR

FINISH
sum charge: .00 sum mom. and inv. mass: .00000 2.50000 12.50000 12.24745

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*****DECEMBER 1993*****
AUTHORS: S.JADACH, Z.WAS***
R. DECKER, M. JEZABEK, J.R.KUEN***
AVAILABLE FROM: VASW AT CERN***
*****PUBLISHED IN COMP. PHYS. COMM.*****
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*****CERN-TH-6793 NOVEMBER 1992*****
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NEV2 = NO. OF TAU- DECS. ACCEPTED
NEVTOT = SUM

NOEVENTS PART.WIDTH ERROR ROUTINE DECAY MODE
185 .9877298 .0231463 DADMELE ELECTRON
196 .9888754 .0234156 DADMMU MUON
178 .6058310 .0000000 DADMP1 PION
171 1.3090163 .0155149 DADMRD RHO (->2P1)
184 .7080593 .0158654 DADMAA A1 (->3P1)
199 .0397533 .0000000 DADMKX KAON
196 .0704854 .0131909 DADMKX K*
162 .0838137 .0202910 TAU- -> 2P1-, P10, P1+
198 .0168806 .0192922 TAU- -> 3P10, P1-
185 .0624964 .0254668 TAU- -> 2P1-, P1+, 2P10
187 .0295622 .0253486 TAU- -> 3P1-, 2P1+,
186 .0042098 .0282325 TAU- -> 3P1-, 2P1+, P10
171 .0042849 .0300143 TAU- -> 2P1-, P1+, 3P10
180 .0059910 .0214980 TAU- -> K-, P1-, K+
177 .0058121 .0227650 TAU- -> K0, P1-, K0B
195 .0006070 .0202096 TAU- -> K-, K0, P10
180 .0062184 .0151180 TAU- -> P10, P10, K-
138 .0309523 .0212613 TAU- -> K-, P1-, P1+
178 .0313717 .0209280 TAU- -> P1-, K0B, P10
193 .0110985 .0236187 TAU- -> ETA, P1-, P10
174 .0031587 .0174919 TAU- -> P1-, P10, GAM
186 .0188184 .0228925 TAU- -> K-, K0

THE ERROR IS RELATIVE AND PART.WIDTH
IN UNITS OF MEV**2/MASS**5/192/P1**3

*****KORALB VERSION 2.4 FINAL REPORT*****
*****MAY 1994*****
2000 NUMBER OF THE GENERATED EVENTS
.6907E-33 TOTAL CROSS SECTION CM**2
.004873007 RELATIVE ERROR

START PARAMETERS ARE ... ENERGY 6.1237 GEV
SIN2 .2300
INRAN 17
MASS OF ELECTRON/KAON BOSON Z0 IS (GEV) 91.2000
COUPLING CONSTANTS: CVC, CAC - .0475 - .5941
CVC, CAF - .0476 - .5941
CONTRIBUTIONS TO SOFT CROSS SECT. ARE...
BORN + SOFT PHOTON + VERTEX CORR. INIT. .6953
TOTAL CROSS SECTION - APPROXIMATE 1.2678

ALL ABOVE CROSS SECTIONS ARE GIVEN IN
UNITS OF THE LOWEST ORDER (POINTLIKE)
ONE PHOTON CROSS-SECTION SUGO WHICH IS
EQUAL TO .67904E-33 CM**2

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171 .0042849 .0300143 TAU- -> 2P1-, P1+, 3P10
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