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Monte Carlo Programs and Other Utilities for High Energy Physics

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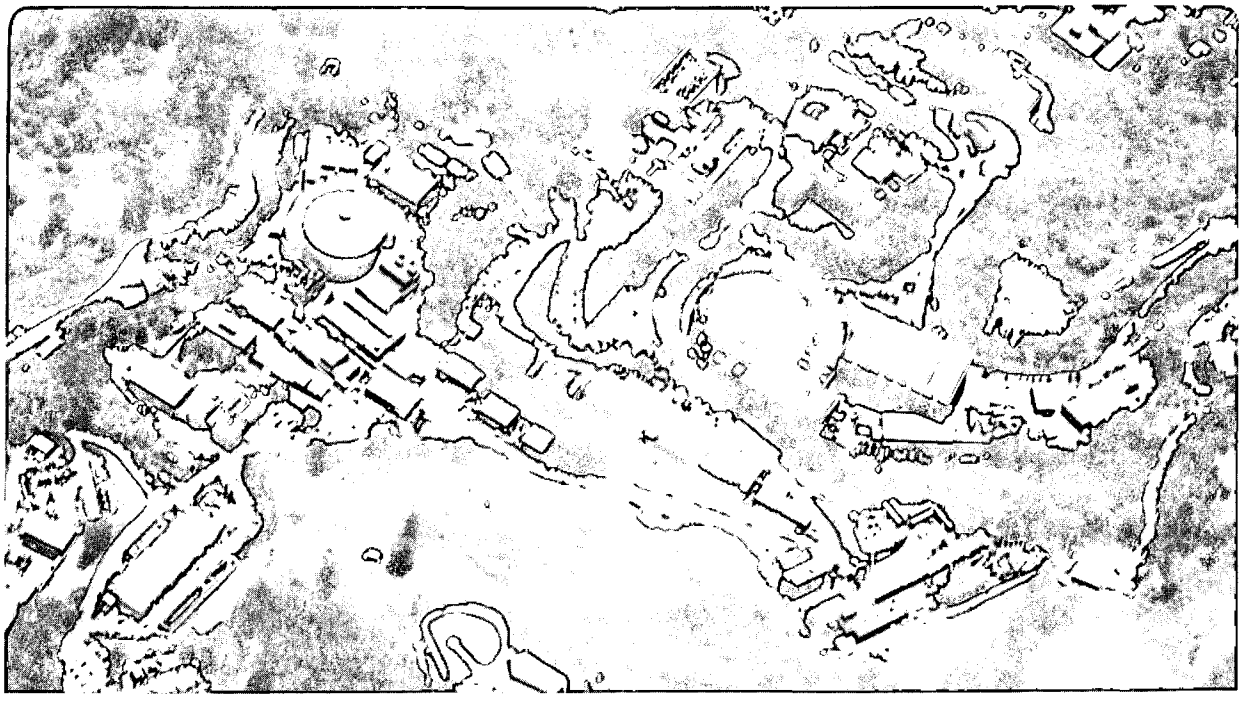

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The Software Standards and Documentation Group of the Workshop on Physics and Detector Simulation for SSC Experiments has compiled a list of physics generators, detector simulations, and related programs. This is not meant to be an exhaustive compilation, nor is any judgement made about program quality; it is a starting point for a more complete bibliography. Where possible we have included an author and source for the code. References for most programs are in the final section.

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Event Generators

Program	*Author(s)*	*Contact*	*Description*
ARIADNE	U. Pettersson and L. Lönnblad	KITTEL @CERNVM	A program for QCD cascades in the color dipole formulation.
BABAMC	F. Berends et al.	CERN	Stand-alone first order generator for $e^+e^- \rightarrow e^+e^-(\gamma)$.
BHLUMI	S. Jadach and B. F. L. Ward	CERN	Uses the YFS method to simulate multiple photon effects in $e^+e^- \rightarrow e^+e^-n(\gamma)$ at low angles, on an event by event basis.
CALASY	Z. Was	WASM @CERNVM	A semianalytical program for the calculation of basic observables of τ decay products such as σ_{tot}, A_{FB}, and $cos(\theta)$*energy distributions at LEP energies.
CALTECH-II	T.D. Gottschalk (Cal Tech)	CalTech	An e^+e^- event generator based on parton showers and a hybrid of cluster (*à la* Webber) and string (*à la* Lund) hadronization.

Program	*Author(s)*	*Contact*	*Description*
COJETS	R. Odorico (Bologna)	CERN	Simulation for $\bar{p}$-p and p-p collisions.
DPSJET	W. Ochs	WWO @DM0MPI11	A statistical model of jet evolution.
DTUJET	J. Ranft	CERN	A *p-nucleus* event generation program for minimum bias and minijets only.
DYMU2	J. Campagne R. Zitoun	CERN	Models Drell-Yan process and *parton-parton* scattering in *hadron-hadron* collisions.
EPOCS	K. Kato and T. Munehisa	KEK	An e^+e^- event generator, including production and hadronization of top quarks and quarkonium, for Tristan, LEP and SLC energies.
EPOS	G. Valenti et al.	GIANNI @VXCERN	Models e^+e^- annihilation using the fire-string model.
EURODEC	A. Ali and B. van Eijk	CERN	A Monte Carlo program package for the fragmentation of partons and decays of particles.
EXPOSTAR	D. Kennedy et al.	SLAC	A simple simulation for calculating electroweak quantities at LEP/SLC energies, including initial state radiative effects by exponentiation, but no final state radiation.
FPAIR	F. Berends et al.	CERN	An e^+e^- simulation which aims at a precise description of events with one or more bremsstrahlung photons.
HERWIG	G. Marchesini and B. Webber	CERN	A general purpose event generator: parton shower and local color singlet cluster for hadronization. Hadron Emission Reactions With Interfering Gluons.
HOWLEEG		CERN	An $e^+e^- \rightarrow e^+e^-\gamma$ generator which includes QED and an ad-hoc exponentiation.
ISAJET	F. Paige and S. Protopopescu	BNL PAIGE@BNL	A hadron-hadron event generator which includes most hard scattering processes with the independent fragmentation model.
JETSET	T. Sjöstrand et al.	CERN	The Lund Monte Carlo for event generation. Includes e^+e^- generation and LUND string fragmentation.
KORALB	Z. Was	WASM @CERNVM	A Monte Carlo program for τ pair production at low energies.
KORALZ	Z. Was	WASM @CERNVM	A Monte Carlo program for fermion pair (μ, τ, ν, u, d, c, s, (b)) production at LEP energies.
MMGE92	J. P. Alexander et al.	CERN	An extension of MMG1/MUSTRAAL which includes second order effects for initial state radiation and exponentiation.
MOE	G. Bonvicini et al.	CERN	Simulates multiphoton production in initial state radiation for the reaction $e^+e^- \rightarrow f\bar{f}n(\gamma)$.

Program	*Author(s)*	*Contact*	*Description*
MULTJ	R. Odorico	Belfast	A program for QCD event simulation in e^+e^- annihilation at LEP energies.
MUONMC	F. Berends et al.	CERN	Sister program to BABAMC, simulates $e^+e^- \rightarrow \mu^+\mu^-(\gamma)$.
MUSTRAAL	F. Berends et al.	CERN	Simulation of radiative corrections to the processes $e^+e^- \rightarrow \mu^+\mu^-$ and $e^+e^- \rightarrow \overline{q}q$ in the Z^0 region.
NLLjet	K. Kato et al. (Japan)	KAMAE @JPNKEKVM	A QCD parton shower Monte Carlo based on the next-to-leading log approximation, uses JETSET for hadronization.
NUNUBGG	F. Berends et al.	CERN	Simulates and calculates the cross section for $e^+e^- \rightarrow \nu\overline{\nu}\gamma(\gamma)$.
OLDBAB	F. Berends and R. Kleiss	CERN	A Bhabha event generator developed for PEP and PETRA energies.
PAPAGENO	I. Hinchliffe (LBL)	THEORY@LBL	A partonic Monte Carlo program that uses exact QCD matrix elements for given processes.
PARJET	Fippel et al.	CERN	Implements the evolution of quark-antiquark jets as produced in e^+e^-.
PHOTOS	B. van Eijk and Z. Was	WASM @CERNVM	Models bremsstrahlung photons in decays.
PYTHIA	T. Sjöstrand and H.-U. Bengtsson	CERN	A general purpose hadron-hadron event generator that uses JETSET for hadronization.
RABHAT	K. Tobimatsu and Y. Shimizu	KEK	An e^+e^- event generator with a missing final e^+ and/or e^-.
SAGE	R. Chaffee	SLAC	A simple and fast parton phase space Monte Carlo.
TEEGG	D. Karlen	SLAC	Simulates radiative Bhabha scattering up to $O(\alpha^2)$ for configurations when one or both electrons scatter at small angles.
TIPTOP	S. Jadach and J. Kühn	JXK @DM0MPI11	Models heavy fermion production and decay in e^+e^- annihilation, incorporating initial state radiation, longitudinal beam polarization, and the effects of the polarizations of the produced heavy fermions.
UCLA	C. Buchanan and S. Chun	UCLA UCLA::CDBP04	An adaptation of JETSET which uses the Lund parton shower structure, but replaces the Lund fragmentation description with a small number of hadron level parameters.
VENUS	K. Werner	CERN	A heavy ion event generator.

Electromagnetic or Hadronic Interactions

AEGIS	A. Van Ginneken	FNAL	Simulates electromagnetic interactions with matter.

Program	*Author(s)*	*Contact*	*Description*
CASIM	A. Van Ginneken	FNAL	Models hadronic production in ***hadron-nucleus*** collisions via a modification of the Hagedorn-Ranft thermodynamic model.
COG	T. P. Wilcox and E. M. Lent	LLNL	A ***neutron-photon*** transport code designed to solve the Boltzman equation for deep penetration (shielding) problems.
EGS4	W. R. Nelson et al.	SLAC	Simulates electromagnetic interactions with matter.
FLUKA	A. Aarnio et al.	CERN	Simulates hadronic cascades, with an interface to EGS4 for electromagnetic interactions. The core event generator EVENTQ is also used in HETC.
GHEISHA	H. Fesefeldt	Aachen	Simulates hadronic interactions, with an interface to EGS4 for electromagnetic interactions.
HADRIN	K. Hanssgen and J. Ranft	CERN	Simulates ***hadron-nucleon*** interactions up to about 5 GeV.
HETC	R. G. Alsmiller, et al.	ORNL	Simulates hadronic interactions with matter.
LAHET	R. E. Prael and H. Lichtenstein	LANL	A union of the HETC code and MCNP with a common geometry and a few enhancements to HETC.
MARS	N. V. Mokhov and J. D. Cossairt	FNAL	Simulates hadronic and electromagnetic cascades and μ transport.
MCNP		LANL LEE@LAMPF	LANL's continuous energy ***neutron-proton*** transport code. Simulates hadronic interactions below about 20 MeV.
MORSE	M. B. Emmett	ORNL	Simulates low energy hadronic interactions.
NUCRIN	K. Hanssgen and J. Ranft	CERN	Simulates low energy ***hadron-nucleus*** interactions.

Simulation packages and Frameworks

ANLSIM	H.-J. Trost	ANLHEP::TROST	A GEANT framework for SSC simulation.
CALOR89	T. Gabriel et al.	ORNL	A general simulation package for hadronic interactions; encompasses HETC and lower energy codes.
GARF	R. Veenhof	CERN	A program for the detailed simulation of 2-D wire chambers consisting of thin wires and equipotential planes.
GEANT3	R. Brun et al.	CERN	A general detector simulation package.
GEANE	M. Maire, E. Nagy et al.	CERN	Calculates average trajectories of particles and calculates the transport matrix and error covariance matrix. Integrated into GEANT.

Program	*Author(s)*	*Contact*	*Description*
GFLASH	G. Grindhammer et al.	DESY (F36GGG @DHHDESY3)	A package to add parametrised showers into GEANT.
GVerify	S. Youssef	SCRI::YOUSSEF	Detects errors in GEANT geometries.
HERMES	D. Filges	KFA Jülich REW089@JUKF11	A general simulation package with emphasis on neutrons, based on a low energy version of HETC.
MC4	S. Youssef	SCRI::YOUSSEF	Has vectorised EM interactions in simple geometries.
POISSON	R. Holsinger C. Iselin	CERN	A collection of programs for calculating magnetostatic and electrostatic fields for magnet design calculations.
QFL	J. Freeman et al.	FNAL	A simple detector simulation.
SPICE		SPICE@CAD .BERKELEY.EDU	A general purpose circuit simulation program.
SSCANA	E. Wang and A. Bay	LBL (EMWP04@LBL)	An integrated simulation package.
SSCSIM	S. Linn	SCRI::LINN	A GEANT framework for SSC Simulation.

Data Managers and Data Structure Packages

ADAMO	P. Palazzi et al.	PALAZZI @VXCERN	A data system for scientific programming based on the Entity-Relationship model.
BOS	V. Blobel	DESY	A data structure manager.
CHEETAH	P. Kunz and G. Word	WORD @SLACVM	A data management package for C programs, portable between VM, VMS, and UNIX.
DUCS	A. S. Johnson et al.	TONYJ @SLACVM	Automated code and documentation distribution system for IBM and VMS.
JAZELLE	A. S. Johnson et al.	TONYJ @SLACVM	A symbolic data management system for HEP data from data acquisition to DST.
TYPES	S. Youssef	SCRI::YOUSSEF	A data abstraction package for FORTRAN.
UFMULTI	P. Avery et al.	U of Florida	A framework for HEP farm processing on VMS or UNIX.
YBOS	D. Quarrie	CDF, CEBAF	A data structure manager.
ZEBRA	R. Brun et al.	CERN	A data structure manager.

Display, Fitting, and Analysis Programs; Interactive Interfaces

BWGNEW	W. S. Lockman	UCSC BILLY@SLACVM	A package which performs log likelihood fits to Breit-Wigner and gaussian distributions using the minimization routine MINUIT.
Clustering Toolbox	S. Youssef	SCRI::YOUSSEF	This is a toolbox for exploring clustering algorithms.

Program	*Author(s)*	*Contact*	*Description*
DISPLAY	H. L. Videau, B. Gabioud et al.	KOELLNER @LBL	An interactive package for the display and manipulation of HBOOK histograms.
GBOOK	T. Sjöstrand	LUND	An HBOOK-compatible histogramming package in standard FORTRAN.
GEP	E.Bassler et al.	R02BAS @DHHDESY3	A batch and interactive package for generation, display, and manipulation of histograms, scatter plots, and n-tuples.
HANDYC	B. Mours	PFKEB @SLACVM	A general purpose histogramming and plotting package for C programs.
HANDYPAK	A. Boyarski	SLAC	A general purpose histogramming and plotting package.
HBOOK	R. Brun and D. Lienart	CERN	A histogramming and plotting package.
HIGZ	R. Bock et al.	CERN	An interactive graphics interface based on ZEBRA.
HPLOT	R. Brun and N. Cremel Somon	CERN	A FORTRAN-callable facility for producing HBOOK output on graphic devices other than a line printer.
IDA	T. H. Burnett	SLAC	An interactive data analysis package.
KUIP	R. Brun and P. Zanarini	CERN	An interactive user interface frequently used in CERN products.
MINUIT	F. James and H. Roos	CERN VXCRNA::JAMES	A tool to find the minimum value of a multi-parameter function and analyse the shape of the function around the minimum.
MUDIFI	R. Brun et al.	CERN	**Multidimensional Fit** program: allows user to approximate a linear combination of polynomials.
PAW	R. Brun et al.	CERN	An interactive package for data analysis.
PYKUIP	S. Linn	SCRI::LINN	PYKUIP is a KUIP interface to PYTHIA.
REASON	W. B. Atwood et al.	PFKEB@ SLACVM	A graphical physics analysis package for use in the NextStep computing environment.
TOPDRAWER	R. Chaffee (SLAC)	many versions CLEMENT @RICE has a nice interactive interface	Creates and manipulates good quality histograms and plots.
UGS	R. Beach	SLAC	**U**nified **G**raphics **S**ystem, a collection of FORTRAN subroutines which is designed to run on a number of computers and control almost any line drawing graphic device.

Program	*Author(s)*	*Contact*	*Description*
Programming Aides, Source Code Managers, Databases, and Other Essentials			
ASPIRIN	A. S. Johnson	SLAC	Provides partial translation from VAX FORTRAN to FORTRAN77 (see also FORSE).
CMZ	M. Brun et al.	CERN	Code management using ZEBRA, compatible with PATCHY.
COMIS	V. Berezhnoi et al.	CERN	Compilation and Interpretation System.
EXPAND	K. Chadwick	FNAL	The CDF version of VAX FORTRAN to IBM or ACP FORTRAN.
FORSE	S. Youssef	SCRI::YOUSSEF	Provides partial VAX FORTRAN to FORTRAN77 (complementary to ASPIRIN).
FORTRIX			Translates FORTRAN to C.
PATCHY	R. Brun et al.	CERN	A system for source code management. Being replaced by CMZ.
QSPIRES		SLAC	A facility for using BITNET to search the SLAC high energy physics database or a variety of other databases with information such as names, phone numbers, and computer accounting information for people associated with SLAC.
SPIRES		installed at SLAC and elsewhere	A general database for high energy physics, including preprints, papers, books, and conferences.
VMSREXX	A. S. Johnson et al.	TONYJ @SLACVM	A REXX interpreter for VAX/VMS.
Toolpack	L. J. Osterweil et al.	Numerical Algorithms Group (312)971-2337	An integrated set of tools to support FORTRAN software development.
WHO		CERN and elsewhere	WHO is an interactive utility to find userids, nodes, and addresses of high energy physicists.

References

For a general overview of e^+e^- generators, see

G. Altarelli, R. Kleiss and C. Verzegnassi, eds., "Z Physics at LEP1, Vol. 3: Event Generators and Software," CERN 89-08, Vol. 3, 1989, which includes

R. Kleiss (convener), D. Bardin, R. Barlow, A. Blondel, W. De Boer, G. Bonneaud, H. Burkhardt, J.E. Campagne, M. Dam, S. Jadach, D. Karlen, E.M. Locci, J. Ludwig, S. Van Der Marck, A.D. Schaile, V. Shchegelskii, L. Vertogradov, B.F.L. Ward, Z. Was, and R. Zitoun, "Monte Carlos for Electroweak Physics," and

T. Sjöstrand (convener), B.Bambah, J. Chrin, W. de Boer, J. Fuster, J. W. Gary, M. Hahn, V. Khoze, W. Kittel, B. Lampe, P. Mättig, T. Sjöstrand, H. Stone and B. van Eijk, "QCD generators," also published as "QCD Generators for LEP," CERN-TH.5466/89 (1989).

AEGIS, A. Van Ginneken, "AEGIS: A Program to Calculate the Average Behavior of Electromagnetic Showers," Fermilab Report FN-309 (1978); see also A. Van Ginneken, "Calculation of the Average Properties of Electromagnetic Cascades at High Energies (AEGIS)," Erice 1978, Proceedings, Computer Techniques In Radiation Transport and Dosimetry, (1978) 211-222.

ARIADNE, Leif Lönnblad, "ARIADNE: A Monte Carlo for QCD Cascades in the Color Dipole Formulation," LU-TP-88-5 (1988); see also Leif Lönnblad and Ulf Pettersson, "ARIADNE: A Monte Carlo for QCD Cascades in the Color Dipole Formulation, an Update," LU-TP-88-15 (1988); Leif Lönnblad, "A Manual for ARIADNE Version 3," LU-TP-89-10 (1989); and CERN Yellow Report 89-08, vol. 3 (1989) p. 199.

BABAMC, F.A. Berends, R. Kleiss, and W. Hollik, "Radiative Corrections to Bhabha Scattering at High Energies. 2: Hard Photon Corrections and Monte Carlo Treatment," DESY Report 87/094 (1987), published in Nucl. Phys. **B304** (1988) 712; see also M. Bohm, A. Denner, and W. Hollik, "Radiative Corrections to Bhabha Scattering at High Energies. 1. Virtual and Soft Photon Corrections," DESY Report 86/165 (1986), published in Nucl. Phys. **B304** (1988) 687; and CERN Yellow Report 89-08, vol. 3 (1989) p. 88.

BHLUMI, Stanislaw Jadach and B.F.L. Ward, "Multi-Photon Monte Carlo for Bhabha Scattering at Low Angles," University of Tennessee Report UTHEP-88-11-01 (1988), published in Phys. Rev. **40** (1989) 3582; see also CERN Yellow Report 89-08, vol. 3 (1989) p. 92.

BOS, V. Blobel, "The BOS System. Dynamic Memory Management," DESY Internal Report Number R1-88-01 (1988); see also V. Blobel, "The BOS System. Dynamic Memory Management. FORTRAN77 Version," DESY Internal Report Number F14-86-02 (1986).

BWGNEW, W. S. Lockman, "BWGNEW 2.1 User's Guide," Santa Cruz Institute for Particle Physics Report SCIPP 89/08 (1990).

CALASY, see CERN Yellow Report 89-08, vol. 3 (1989) p. 58.

CALOR89, T. A. Gabriel, J. E. Brau and B. L. Bishop, "The Physics of Compensating Calorimetry and the New CALOR89 Code System," Oak Ridge National Laboratory Report ORNL/TM-11060 (1989).

CALTECH-II, T. D. Gottschalk and D. A. Morris, "A New Model for Hadronization and e^+e^- Annihilation," Nucl. Phys. **B288** (1987) 729; see also T. D. Gottschalk, "A Simple Phenomenological Model for Hadron Production from Low Mass Clusters," Nucl. Phys. **B239** (1984) 325; and T. D. Gottschalk, "An Improved Description of Hadronization in the QCD Cluster Model for e^+e^- Annihilation," Nucl. Phys. **B239** (1984) 349; see also CERN Yellow Report 89-08, vol. 3 (1989) p. 208.

CASIM, A. Van Ginneken, "CASIM: Program to Simulate Transport of Hadronic Cascades in Bulk Matter," Fermilab Report FN-272 (1975); see also A. Van Ginneken, "Calculation of the Average Properties of Hadronic Cascades at High Energies (CASIM)," Erice 1978, Proceedings, Computer Techniques In Radiation Transport and Dosimetry, (1978) 323.

CMZ, M. Brun, R. Brun and F. Rademakers, "CMZ - Code Management using ZEBRA," Proceedings of the Conference on Computing in High Energy Physics, Oxford, April 1989 (1989).

COG, T. P. Wilcox, Jr. and E. M. Lent, "COG: A Particle Transport Code Designed to Solve the Boltzman Equation for Deep-Penetration (Shielding) Problems—Volume I, Users Manual," Lawrence Livermore National Laboratory Report M-221-1.

COJETS, R. Odorico, "COJETS: A Monte Carlo Simulation Program for $\bar{p}$-p and p-p Collisions," Bologna University Report DFUB-88-27 (1989); see also R. Odorico, "COJETS: A Monte Carlo Program Simulating QCD in Hadronic Production of Jets and Heavy Flavors with Inclusion of Initial QCD Bremsstrahlung," Comp. Phys. Comm. **32** (1984) 139; and CERN Yellow Report 89-08, vol. 3 (1989) p. 215.

COMIS, V. Berezhnoi, R. Brun, S. Nitikin, Y. Petrovykh and V. Sikolenko, "COMIS, Compilation and Interpretation System," CERN Program Library L210 (1988).

DPSJET, see CERN Yellow Report 89-08, vol. 3 (1989) p. 218.

DUCS, A. S. Johnson, B. Saitta, O. Gervasi, G. Bower, A. Rothenberg and A. Waite, "DUCS: A Fully Automated Code and Documentation Distribution System," SLAC-PUB-5230 (1990), Presented at Computing in High Energy Physics Conf., Santa Fe, NM, Apr 9-13, 1990.

DYMU2, J. E. Campagne and R. Zitoun, "Electromagnetic Radiative Corrections at LEP-SLC Energies for Experimentalists," LPNHEP-88-08 (1988), published in Z. Phys. **C43** (1989) 469.

EGS4, W. R. Nelson, H. Hirayama and D. W. O. Rogers, "The EGS4 Code System," Stanford Linear Accelerator Center Report SLAC-265 (1975); see also W. R. Nelson and Y. Namito, "The EGS4 Code System: Solution of Gamma Ray and Electron Transport Problems," SLAC-PUB-5193 (1990).

EPOCS, K. Kato and T. Munehisa, "e^+e^- Event Generator EPOCS User's Manual" KEK Report 87-5 (1987).

EPOS, see CERN Yellow Report 89-08, vol. 3 (1989) p. 220.

EURODEC, B. van Eijk, "EURODEC User Manual," DELPHI Report 89-39 PHYS 41 PROG 136; see also B. van Eijk, "EURODEC Reference Manual," CERN DD Report in preparation; and CERN Yellow Report 89-08, vol. 3 (1989) p. 226.

EXPOSTAR, D. Kennedy, B.W. Lynn, C.J.C. Im and R.G.Stuart, "Electroweak Cross Sections and Asymmetries at the Z^0," SLAC-PUB-4128 (1988), published in Nucl. Phys. **B321** (1989) 83; see also CERN Yellow Report 89-08, vol. 3 (1989) p. 53.

FLUKA, P. A. Aarnio, A. Fassò, J. Lindgren, J. Ranft and G. R. Stevenson, "Enhancements to the FLUKA86 Program (FLUKA87)," CERN TIS-RP/190 (1987); see also P. A. Aarnio, A. Fassò, H-J. Möhring, J. Ranft and G. R. Stevenson, "FLUKA86 User's Guide," CERN TIS-RP/168 (1986); see also J. Ranft, H.J. Möhring, T.M. Jenkins, W.R. Nelson, "The Hadron Cascade Code, FLUKA82: Setup and Coupling with EGS4 at SLAC," SLAC-TN-86-3 (1986).

FPAIR, see CERN Yellow Report 89-08, vol. 3 (1989) p. 81.

GEANT3, R. Brun, F. Bruyant, M. Maire, A. C. McPherson and P. Zanarini, "GEANT3," CERN Data Handling Division, DD/EE/84-1 (1987).

GEP, E. Bassler, "The Graphical Editor Program: GEP," Comput. Phys. Comm. **45** (1987) 201; see also E. Bassler, "GEP - Graphical Editor Program for Presenting Physical Data, Version 1.0," DESY Internal Report DESY R02-81/02, revised version (1981).

GHEISHA, H. Fesefeldt, "The Simulation of Hadronic Showers: Physics and Applications," Aachen Tech. Hochsch., III Phys. Inst. Report PITHA-85/02 (1985).

HADRIN, K. Hangssen and J. Ranft, "The Monte Carlo Code HADRIN to Simulate Inelastic Hadron Nucleon Interactions at Laboratory Energies Below 5 GeV," Comput. Phys. Comm. **39** (1986).

NLLjet, K.Kato, T. Munehisa, T. Kamae, A. Shirahashi, " Next-to-LL Parton Shower Generator for e^+e^- Hadronic Annihilation - Description of the Program NLLjet," Note for NLLjet Version 0.1 March 31, 1989, Tokyo University Preprint Number UT-HE-89/01 (1989); see also Kiyoshi Kato and Tomo Munehisa, "QCD Parton Shower in e^+e^- Annihilation," KUDP-88/02 (1988), published in "Perspectives on Part. Phys.". Edited by S. Matsuda et al., World Scientific (1988); and CERN Yellow Report 89-08, vol. 3 (1989) p. 287.

NUCRIN, K. Hanssgen and J. Ranft, "The Monte Carlo Code NUCRIN to Simulate Inelastic Hadron-Nucleus Interactions at Laboratory Energies Below 5 GeV," Comput. Phys. Comm. **39** (1986) 53; see also K. Hanssgen, R. Kirschner, J. Ranft and H. Wetzig, "Monte Carlo Simulation of Inelastic Hadron-Nucleus Reactions: Description of the Model and of the Computer Code NUCRIN," Karl Marx University Report KMU-HEP-80-07 (1980).

NUNUBGG, F.A. Berends, G.J.H. Burgers, C. Mana, M. Martinez and W.L. van Neerven, "Radiative Corrections to the Process $e^+e^- \to \nu\bar{\nu}\gamma$," CERN-TH-4865/87 (1987), published in Nucl. Phys. **B301** (1988) 583; see also A. Barroso, W. Beenakker, F.A. Berends, W. Blum, F. Boudjema, G.J. Burgers, H.H. Burkhardt, M. Caffo, J.P. Cole, N. Dombey, F. Dydak, J. Fleischer, E. Gonzales, W. Hollik, S. Jadach, F. Jegerlehner, R. Kleiss, L. Lanceri, B.W. Lynn, C. Mana, M. Martinez, E. Neugebauer, D. Perret-Gallix, R. Ragazzon, P. Ratoff, J.C. Romao, J. Salicio, A. Shapira, E. Simopoulou, R.G. Stuart, W.L. van Neerven, C. Verzegnassi, H. Wachsmuth and Z. Was, "Electroweak Radiative Corrections at LEP Energies," CERN-EP/87-70 (1987), published in Aachen ECFA Workshop 1986:157; C. Mana, M. Martinez and F. Cornet, "Hard Photon Corrections to the Process $e^+e^- \to \nu\bar{\nu}\gamma$," DESY Report 86/114 (1986); C. Mana and M. Martinez "On the Radiative Bhabha Scattering for the single Photon Configuration," DESY Report 86/062 (1986), published in Nucl. Phys. **B287** (1987) 601; and CERN Yellow Report 89-08, vol. 3 (1989) p. 83.

OLDBAB, F.A. Berends and R. Kleiss, "Distributions in the Process $e^+e^- \to e^+e^-(\gamma)$," Leiden University Preprint 83-0779 (1983), published in Nucl. Phys. **B228** (9183) 537; see also CERN Yellow Report 89-08, vol. 3 (1989) p. 86.

PARJET, S. Ritter, "Monte Carlo Code PARJET to simulate e^+e^- Annihilation Events via QCD Jets," Karl Marx University Report KMU-HEP-83-03 (1983), published in Comput. Phys. Comm. **31** (1984) 401; see also CERN Yellow Report 89-08, vol. 3 (1989) p. 291.

PATCHY, H. J. Klein and J. Zoll, "PATCHY Reference Manual," CERN Program Library L400 (1988).

PAW, R. Brun, O. Couet, C. Vandoni and P. Zanarini, "PAW - Physics Analysis Workstation," CERN Program Library Q121 (1989); see also R. Brun, O. Couet, C. E. Vandoni and P. Zanarini "PAW: A General Purpose Portable Software Tool for Data Analysis and Presentation," CERN Data Handling Division Report CERN-DD/89/17 (1989) and Proceedings of the Conference on Computing in High Energy Physics, Oxford, April 1989 (1989); H. Johnstad, "PAW at Fermilab: Core Based Graphics Implementation of HIGZ," FERMILAB-CONF-89/142 (1989) and Proceedings of the Conference on Computing in High Energy Physics, Oxford, April 1989 (1989); R. Bock, R. Brun, O. Couet, J.C. Marin, R. Nierhaus, L. Pape, N. Saumon, C. Vandoni and P. Zanarini "PAW: Towards a Physics Analysis Workstation," CERN-DD/87/5 (1987), Published in Asilomar Computing H. E. Phys. 1987:181.

PYTHIA, H.-U. Bengtsson and T. Sjöstrand, "The LUND Monte Carlo for Hadronic Processes: PYTHIA Version 4.8," Lund University Report LU-TP-87-3 (1987), Published in Comput. Phys. Comm. **46** (1987) 43; see also H.-U. Bengtsson and T. Sjöstrand, "PYTHIA: The LUND Monte Carlo for Hadronic Processes," Lund University Report LU-TP-86-17, Published in UCLA SSC Workshop 1986:228 and also in Snowmass Summer Study 1986:311.

RABHAT, K. Tobimatsu, Y. Shimizu, "Radiative Bhabha Scattering in Special Configurations with Missing Final e^+ and/or e^-," KEK-Preprint-89-9 (1989), submitted to Comp. Phys. Commun.

REASON, "The REASON Project," W.B. Atwood, R. Blankenbecler, P. F. Kunz, B. Mours, A. Weir and G. Word, SLAC-PUB-5242 (1990).

SAGE, R. Chaffee, "A User's Guide for SAGE: A General System for Monte Carlo Event Generation with Preferred Phase Space Density Distributions," SLAC Report CGTM-195 (1979).

SIGMA, C. Vandoni, "SIGMA - System for Interactive Graphical Mathematical Applications," CERN Program Library Q122 (1988).

SPIRES, A. Rittenberg, F.E. Armstrong, B.S. Levine, T.G. Trippe, C.G. Wohl and G.P. Yost, "A User's Guide to Particle Physics Computer Searchable Data Bases on The SLAC SPIRES System," Lawrence Berkeley Laboratory Report LBL-19173 (1986); see also L. Addis, "SPIRES I Online Search Guide," SLAC Report SLAC-TN-75-015 (1975).

TEEGG, D. Karlen, "Radiative Bhabha Scattering for Singly Tagged and Untagged Configurations," SLAC-PUB-4121-Rev. (1987), published in Nucl. Phys. **B289** (1987) 23; see also CERN Yellow Report 89-08, vol. 3 (1989) p. 95.

TIPTOP, S. Jadach and J. Kühn, "The Monte Carlo Program TIPTOP for Heavy Fermion Production and Decay at LEP and SLC," Max Planck Institute Report MPI-PAE/PTh-86/64 (1986); see also S. Jadach and J. H. Kühn, "Asymmetries in Heavy Fermion Production and Decay," Max Planck Institute Report MPI-PAE/PTh 79/86 (1986), published in Phys. Lett. **191B** (1987) 313; and CERN Yellow Report 89-08, vol. 3 (1989) p. 293.

TOOLPACK, W. R. Cowell, "User's Guide to TOOLPACK/1 Tools for Data Dependency Analysis and Program Transformation," Argonne National Laboratory Report ANL-88-17 (1988); see also W. R. Cowell, S.J. Hague and R.M.J. Iles "TOOLPACK/1 Release 2: Introductory Guide, Second Edition October 1986," Argonne National Laboratory Report ANL-86-43 (1987).

TYPES, S. Youssef, "The TYPES Users Guide: A Data Abstraction Package in FORTRAN: Version 1.0," Florida State University Supercomputer Computations Research Institute Report FSU-SCRI-90T-03 (1990).

UCLA, see, for example, C. D. Buchanan and S. Chun, "Evidence Indicating that Meson and Baryon Formation are Controlled by Phase Space and a Linear Confining Quark Potential," UCLA-HEP-89-003 (1989).

UGS, R. C. Beach, "The Unified Graphics System for FORTRAN 77: Internal Operation and Maintenance Manual, Revised Version," SLAC Report CGTM-205 (1988); see also R. C. Beach, "The Unified Graphics System for FORTRAN 77: Graphic Algorithms Manual, Revised version," SLAC Report CGTM-204-Rev.3 (1988); R. C. Beach, "The Unified Graphics System for FORTRAN 77: Programming Manual, Revised version," SLAC Report CGTM-203-Rev.3 (1988); R. C. Beach, "Converting from the FORTRAN-66 Version of the Unified Graphics System to the FORTRAN-77 Version," SLAC Report CGTM-211 (1984); R. C. Beach, "A Version of the SLAC Unified Graphics System Coded Almost Entirely in FORTRAN," SLAC Report CGTM-191 (1978); and R. C. Beach, "An Introduction to the SLAC Unified Graphics System," SLAC Report CGTM-166 (1975).

VENUS, see, for example, K. Werner, "A New String Model (VENUS 2) for Hadronic Collisions Based on Color Exchange Between Quarks and Anti-Quarks," Brookhaven National Laboratory Report BNL-42932 (1989), Published in Moriond 1989: Hadronic:515; K. Werner, "Energy and Particle Densities In Ultrarelativistic Heavy Ion Collisions from the String Model VENUS," Brookhaven National Laboratory Report BNL-42162 (1988), Published in Phys. Lett. **B219** (1989) 111; K. Werner,"Multiparticle Production in *p-p*, *p-Ar* and *p-Xe* Collisions at 200 GeV by the Multistring Model VENUS," Brookhaven National Laboratory Report BNL-41500 (1988), Published in Phys. Rev. **D39** (1989) 780; K. Werner, "Analysis of Energy Flow in O^{16}-*nucleus* Collisions at 60 GeV and 200 GeV by the Multistring Model VENUS," Brookhaven National Laboratory Report BNL-41501 (1988), Published in Z. Phys. **C42** (1989) 85; and K. Werner, "Analysis of *p-nucleus* and *nucleus-nucleus* Scattering at 200 GeV by the Multistring Model VENUS," Brookhaven National Laboratory Report BNL-40981 (1988), published in Phys. Lett. **208B** (1988) 520.

YFS2, S. Jadach and B.F.L. Ward, "Exclusive Exponentiation in the Monte Carlo Yennie-Frautschi-Suura Approach," Krakow University Preprint TPJU-89-19 and University of Tennessee Preprint UTHEP-89-0703 (1989); see also Stanislaw Jadach and B.F.L. Ward "The Exclusive Exponentiation in the Monte Carlo: The Case of the Initial State Bremsstrahlung," CERN-TH-5399/89 (1989); and Stanislaw Jadach, "Yennie-Frautschi-Suura Soft Photons in Monte Carlo Event Generators," MPI-PAE/PTh 6/87 (1987).

ZEBRA, R. Brun and J. Zoll, "ZEBRA - Data Structure Management System," CERN Program Library Q100 (1989).

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