
arXiv:hep-ph/9908288v2 11 Feb 2000

CompHEP- a package for evaluation of Feynman diagrams and integration over multi-particle phase space

A.Pukhov* E.Boos M.Dubinin V.Edneral V.Ilyin D.Kovalenko A.Kryukov V.Savrin

Skobeltsyn Institute of Nuclear Physics, Moscow State University

S.Shichanin

Institute for High Energy Physics, Protvino, Russia

A.Semenov

Joint Institute for Nuclear Research, Dubna, Russia

User's manual for version 33

Preprint INP-MSU 98-41/542

*contact persons: Alexander Pukhov: pukhov@theory.npi.msu.su and Viacheslav Ilyin: ilyin@theory.npi.msu.su

1

File Name: comphep manual.pdf
Size: 1719 KB
Type: PDF, ePub, eBook
Category: Book
Uploaded: 5 May 2019, 22:45 PM
Rating: 4.6/5 from 689 votes.

Book Descriptions:

We have made it easy for you to find a PDF Ebooks without any digging. And by having access to our ebooks online or by storing it on your computer, you have convenient answers with comphep manual . To get started finding comphep manual , you are right to find our website which has a comprehensive collection of manuals listed.
Our library is the biggest of these that have literally hundreds of thousands of different products represented.

Book Descriptions:

comphep manual

On acquiring the program the Party agrees to be bound by terms of this agreement.See the necessary references on the WWW page or on Persons interested in a forprofit use should contact the Authors. Thus, if you have another OS on the computer, please adjust this installation procedure according requirements of your OS.But for convenient. Users manual for version 33 August 1999 Source arXiv Project High energy physycs Authors A. Pukhov E. Boos M. Dubinin V.F. Edneral 18.79 Lomonosov Moscow State University Show all 10 authors Hide Download fulltext PDF Read fulltext Download fulltext PDF Read fulltext Download citation Copy link Link copied Read fulltext Download citation Copy link Link copied Citations 399 References 50 Figures 2 Abstract and Figures CompHEP is a package for automatic calculations of elementary particle decay and collision properties in the lowest order of perturbation theory the tree approximation. The main idea prescribed into the CompHEP is to make available passing on from the Lagrangian to the final distributions effectively with a high level of automation. Download fulltext PDF The main idea prescrib ed into the CompHE P is to mak e a v ailable passing on from the Lagra ngian to the nal distribu tions eectiv ely with a high lev el o f automation. CompHEP is a menudriv en system with the conte xt help. The notations used in CompHEP are ve ry similar to those used in part icle ph ysics. The presen t v ersion has 4 builtin ph ysical mo dels. Tw o of them are the ve rsions of the Standard Mo del SU3xSU2xU1 in the unitary and t'Ho oft F eynman gauges. The user can c hange particle interaction and mo del parameters. It is also possible to create new mo dels of particle inte r action. In the presen t v ersion p olarizations are no t t a k en into accoun t. Av eraging o v er initial and summing o v er nal p o larizations are p erformed automatically. The CompHEP pack age consists of t w o parts sym b olic and nu merical.http://ledseoul.com/userData/board/7-cities-of-gold-manual.xml

- **comphep manual.**

The sym b olic part is written in the C programming language. It pro duces F ortr an and C co des for a squared matrix elemen t, a nd they ar e used in the n umerical calculation later on. There are t wo v ersions of the n umerical part one is written in F ortr an and another one is done in C. The facilities of b oth v ersions are almost equal. The C ve rsion has more comfortable in terface but it do es not po ssess an option to gene ra te ev ents and do es not p erform calculations with a quadruple precision.The primary form ulation of ph ysical problems for the pro ject was do ne b y E. Bo os, Mikhail Dubinin, and D mitri Sla vno v. The rst softw are w orking group w as organized and manag ed by V. Ilyin. The main author of the CompHEP softw are is Alexande r Pukhov. He has dev elop ed almost all algorithms and datarepresen tation structures o f the pac k age. Namely, the structure of ph ysical mo del database, the algorithm for generation of F eynman diagrams, the algorithm for ev aluation of squared matrix elemen ts, the structure of output co des for dieren t programming languages, the algorithm for optimization of n umerical co des, the alg orithm for phasespace in tegration with smo othing of propagator p eaks. He also has created the sp ecialized sym b olic manipulation pac k age for CompHEP. It was written in the T urb o Pasc al programming lang uag e for the MSDOS op eration system. The program pro duced a code for calculation of squared diagrams, written in the R e d uc e sym b o lic manipulation language. Routines for ev aluation of the color factors w ere written by Alexander Kryuk o v. The R e d uc e co de generation ro utines w ere written by Alexander T arano v and A. Pukho v. The authors of CompHEP w ere b eing lead b y an idea to create a user friendly softw are. So they paid a sp ecial attention to the interface and data represen tation facilities. The general part of graphical in terfa ce was designed b y A. Pukho v.http://gurolmumcu.com/userfiles/7-cities-of-gold-game-manual.xml

The routines for graphic r epresen tation of diagrams w ere writ ten b y Victor Edneral. The c o ntextse nsitiv e help facilit y was designed b y 8 The main problem remaining in this v ersion w as the phasespace in te gration. CompHEP created the F ortr an co de fo r squared matrix elemen ts with a high leve l of automation. Generally the matrix eleme nts hav e a lot of singularities caused b y the propaga tors of virtual particles. In order to succee d in the Mon te Carlo phasespace integration of singular matrix ele men ts the user w as forced ev ery time to mo dify the program of phasespace parameterization. F or automation of this op eration step A. Pukho v propo sed a general ap 9 Later on the structure function pack a g e w as impro v ed b y A. Pu khov to include the regularization of integration ov er F eynman parameters. As a result we get a v ersion whic h pro vides the user with a p ossibilit y of automatic ev aluation starting fr o m the input of Lagrangian and nishing with distributions in ph ysical parameters. The correspo nding service for a histogram lling also w as done b y A. Pukho v. The list of needed distributions was compiled by E. Bo os. During this work it w as realized that the F ortr an programming language is not con v enien t for the future dev elopmen t of the n umerical part of Com pHEP. In 1997 the C co de output f o r the n umerical calculation w a s designed and the F o rtr an progra m for the num erical ev aluation w as rewritten in C as w ell. The dev elopmen t of CompHEP w as b eing under a con tin uous pressure of ph ysicists' r equests. The work s of E. Bo os, M. Dubinin, V. Ilyin, V. Sa vrin and S. Shic hanin, who rst used CompHEP for ph ysical calculations, at the same time w ere dening a direction of the pack age dev elopmen t. They also con tribute to and are resp onsible for debugging the pack age.During a long time the CompHE P group had not got a p ossibilit y to dev elop the pro ject on UNIX w orkstations in Russia.

The adaptation of the pac k age for dieren t UNIX platforms was done during the visits of the group mem b ers to v arious univ ersities and scien tic cen ters of the world. W e v ery m uc h appreciate this supp ort a nd a r e g ra teful for co op eration to our foreign colleagues Y. Shimizu, KEK, Japan, H.S. Song Seoul National Univ ersit y, Korea, O. Eb oli Univ ersit y of Sao P aulo, Brazil, H. J. Sc hreib er DESY, German y. W e ac know ledge b enecial discussions with F. Cuyp ers, I. Ginzburg, F. Gutbro d, B. Mele, M. Sac hwitz, W. v on Sc hlippe, P. Osland, and mem b ers of MinamiT ateya g roup KEK, and their b enev olen t attitude to our pro ject during many y ears. In this con text we are esp ecially grateful to D. Pe rret Gallix. W e also ex press our gratitude to our colleagues A. T arano v, P. Baik ov, H. Ec k, L. Gladilin, P. Silaev, S. Ostap che nko who contribut ed to the dev el opmen t of CompHEP soft w are as w ell as to A. Dav ydyc hev, A. Ro diono v and D. Slav nov for some helpful ideas. W e thank S. Amb ro sanio and A. Bely aev fo r their n umerous rep orts on CompHEP bugs. 11 P ersons in terested in a forprot use should con tact the Authors. 5. The Authors of CompHEP do not guarante e that the program is free of errors or meets its specication and cannot b e held responsible for loss or consequen tial damage as a r esult of using it. 12 This directory con tains source co des of the CompHEP pack age for UNIX platforms. After compilation of these co des the CompHEP binary exe cutable les app ear in t he same direc to ry. W e shall refer to it b elo w as a CompHEP ro o t directory. 2.4 Compilatio n pro c edu r e In order to compile the CompHEP source co de you need a C compiler with the X11 graphics library. If y ou w ould like to use F ortr an for n umer ical ev aluation y ou nee d also a F ortr an compiler.It pro vides us with a p ossibilit y to ha v e one CompHEP ro ot directory for sev eral users.

If this le exists, the C compiler name and its o ptions are read from this le. Otherwise, a s w e usually ha v e at the rst start of cr e ate c, this le is created and contains default parameters. After that t he cr e a te c program tests the necess ary compiler options. F or this goal it generates v arious programs with the same name test.c and tries to compile and link them. If compilation is not satisfactory, the cr e ate c command nishes with the corresp onding error message a nd asks you to rewrite the command le CC in order to t the require ment. The curren t test le test.c is sa v ed. So in t he case of suc h an error y ou could up date y our CC le and start cr e ate c ag ain.Starting CompHEP source code compilat ion. If your UNIX platform is one of the listed Linux, IRIX, IRIX64, HPUX, AIX, OSF1, the necess ar y options a re kno wn from the beginning except of the path to X11. An yw ay, in the case of some problem on this step y ou can send a request for help to the CompHEP authors. A correction of the CC and F77 les could b e used to tune compiler options according to your UNIX platform. In this case y ou should create CC or F77 by starting makeCC or m akeF77, p erform tunings in the CC or F77 les and launc h cr e ate c or cr e ate f af ter that. F or example, you could switc h on an optimization ag. C c ompiler tuning There are t w o mac r o denitions for the C co de, whic h could b e useful to tune The rst one is STRSIZ. This is a maxim um size of strings in the Com pHEP mo dels. The second macr o denes a t yp e of in teger n um b ers whic h are use d in sym b olic calculations b y CompHEP. By default CompHEP uses the ’long’ t yp e. DNUM LONG LONG forces the compiler to use ’long long’. This ty p e is not the ANSI standard and, p erhaps, it is not supp orted in y our case. Dieren t realizations of the ’lo ng long’ t yp e use dieren t formats for reading and writing suc h n um b ers. The user may specify this format dening the ’NUM STR’.

http://inspired2write4him.com/images/calibration-of-manual-polarimeter.pdf

By default CompHEP uses 15 A few w orking directories may b e created for v arious tasks and b y dieren t users. In order to pro vide the progra ms with an access to the CompHEP les and commands the en vironmen t v ariable COMPHEP should con tain the cor respo nding path. W e recomm end to de ne the COMPHEP v ariable in the user startup le. The name of the startup le and the syn ta x of the assign men t instruc tio n dep ends on the command in terpreter.The directory tmp is created for tempora l les. The directory r es ults is assigned for a CompHEP output.The user should use the ”Numerical in ter preter” option to get numeri cal results. The installation le bNNi.zip where NN denotes a num b er of the re lease is a v ailable to cop y from the CompHEP W ebpage. The installation pro cedure is the following 1 create an installation directory and cop y the distributiv e bNNi.zip to this directory; 2 unpac k the distributiv e le bNNi.zip by the command unzip bNNi.z ip As a result a set of les and sub directories should b e created. This set corresp onds to the user w orking directory in the UNIX release see section 2.5. Executable and other les corresponding to those in the CompHEP ro ot directory of the UNIX v ersion see section 2.3 are stored in the sub directory bin. T o start a CompHEP session the user should launc h the command comphep.The sym b olic part is done in C. The n umerical one w as written in F ortr an but later on w as conv erted to C. How ev er b ot h ve rsions of num erical part are no w av ailable. So in the latter case the service is more ugly. 3.1.1 Graphical interfa c e There are the follo wing elemen ts of the user in terface in the CompHEP pac k age On line Help, Menu, Messag e, String Editor, T able Editor, Diagr am Viewer and Plot Viewer. If the screen heigh t is not enough to display the full help message, y ou will see the PgDn mark in the righ tb ottom corner of the help windo w.

https://judo-allier.com/images/calibration-manual-keratometer.pdf

T o get the next page of the message press the PgDn k ey or clic k the mark. T o close the help windo w press the Esc k ey or clic k the asterisk in the topleft corner of the help b order. 2. Men u. The menu program displa ys a list of men u functions. O ne of them is highlighte d. See a typi cal example of men u in Fig.1. Use the arrow k eys o r a mouse clic k to highligh t a desire d function.In order to get back to the previous men u lev el press the Esc k ey or click the asterisk in the topleft corner of the menu b order. The men u prog r a m is also sensitiv e to the functional ke ys F1, F 2,.,F9. The list of activ e functional k eys dep ends on the program p oin t and is dis pla y ed on the b otto m line of the scree n. Generally the f unctional k eys a cti v ate the follow ing programs F1 Help displa ys a help message ab o ut the highligh ted men u function; F2 Man ual displa ys an information ab out service facilities. F3 Mo dels displa ys con ten ts of the curren t model of particle interactions. F4 Diagrams bro wses the generated F eynman diagrams. F6 Results views and deletes CompHEP output les. F9 Quit quits the CompHEP session. T o call one of these programs just press the functional k ey o r clic k on the correspo nding sym b ol on the b ottom line of the scree n. The digit ke ys act as the functional k eys. F or example, ’3’ acts a s F3. 3. Message. CompHEP writes info rmativ e and dialog ue messages during the session. The informative messages nish with the ”Pr e ss any key” string. Y ou can contin ue y our w ork either follo wing this instruction or clic king the mouse on the message area. As a rule, previous information a b out this item is a v ailable and the k ept string is displa y ed. Otherwise, if the st input c haracter is a prin ting sym b o l, the original string will b e deleted. The Delete k ey works a s the Backsp ac e k ey and remo ve s a c haracter left to the cursor.

T o terminate t he input y ou can press Enter to accept the resulting string or the Esc k ey to cancel it. 19 F or all these cases an y unit displa y ed as a table line consists of sev eral elds table columns. The program T able Editor is in ve nted to pro vide the user a p ossibilit y to view and change the table conten ts. In some progra m p oin ts the T able Editor is used to brow se a table con ten ts without a p ermission to c hange data. T able is displa y ed on the scree n as it follow s see Fig.3. The top line of the windo w con tains a title of the table. Belo w there a re table column s surrounded b y a fra me b o x. The columns are separated by v ertical lines. The rst horizon tal line con ta ins column names. One cell a line column in tersection is highlighte d. If the table is op en fo r c hanges, the highlighted cell con tains the curs o r. The ordering n um b er of the corres p o nding line is displa y ed in the topright corner of the window. T o c hange p osition o f the cursor a nd the highligh ted cell one can use the arro w k eys, the T ab key and the mouse clic k. If one t yp es any prin ting sym b ol it will be inserted in to the table at the cursor p osition. The PgUp, PgDn k eys are used to scroll the table. The F1 and F2 functional key s pro vide information ab out the meaning of ta ble elds and ab out facilities of the T able Editor. T o exit the table one has t o press the Es c k ey. There are some auxiliary c o mmands whic h help the user to op erate the tables. These commands can b e realized b y means of Con tr ol sym b o ls or b y mouse clic k on the command lab el displa y ed on the table b order T op . T mov es the cursor highligh ted cell to the top line of the table. Bottom B mo v es the cursor highligh ted cell to the b ottom line of the table. GoT o G mo v es the cursor to the line directed b y the user. Find F searc hes the string directed by the user. Find ag a in A rep eats previous command Find.

In this case CompHEP opens a special windo w and the eld text wraps this windo w. T o terminate the Zo om mo de one has either to press Enter to accept c hanges or Esc to forget them. ErrMess E redispla ys an error message concerning the con ten ts of one of the tables whic h has b een previously generated by CompHEP. The ab o ve commands are a v ailable in b oth modes of the T able Editor. The lab els of these commands a re disp osed on the b ottom b order of the table. The following commands are av ailable only if the table is op en for c hanges 20 R es t R restores the con ten ts of the curren t eld whic h existed b efore last enterin g t he corresp onding cell. Del D cuts the curren t line from the table and put it in to the buer. New N creates a new line and ll it with the buer con ten ts. Also y ou can press the Enter ke y to create a new line. The lab els of these commands are disp osed on the top b o r der of the windo w. 6. Diagram Viewer. This program w a s designed to displa y sev eral F eyn man diagrams o n the screen. The View er splits the screen in to rectangle cells and puts the diagram images in thes e cells one b y one. One cell is mark ed b y surrounding b ox frame. The total n um b er of diagrams and the o rdinal n um b er o f the marked o ne are displa y ed in the righttop corner of the screen. See an example in Fig.4. The n um b er of diagrams whic h can b e displa y ed sim ultaneously dep ends on the windo w size. If y ou would lik e to see more diagrams on one screen, increase the windo w using the windo w manager. Y ou can mov e the p osition of the surrounding b ox by the A rr ows k eys or b y the mous e clic k. T o nis h w ork with the D iagram View er press the Esc k ey. The lab els for the abov e commands are displa y ed on the b ottom b order of the windo w and you ma y use the mouse clic k to activ ate one of them. The Diagram View er may ha v e some optional functions whic h depend on the conte xt.

The lab els for these functions are show n on the top b o rder of the windo w. One of them generates a le with graphical diagram image in the L A T E X f o rmat. Press the F1 k ey to get an information abo ut these commands. Y o u ma y use the mouse clic k on the lab el or its rst sym b ol to activ ate the function. 21 If some other k ey is pressed then the user gets a menu whic h you can see in Fig.7. This menu allow s to c hange the limits of v ertical axis and its scale. Note that the logarithmic scale is av ailable only if the lo w er limit is p ositiv e and the ratio of upp er and lo w er limits is more then ten. T o redispla y the plot ch o ose the 'R e dr aw p l o t' option. The menu also pro vides the user with a p ossibilit y to sa v e a graphical plot image as a L A T E X le and as a nume rical table. Y ou can see in Fig.2 ho w this men u lo oks lik e on the displa y. 2. T ables. T ables are used to en ter and change information ab out ph ysical cuts and a phase space regularization. When you use t his program a nu mer ated list of elemen ts is displa y ed. Elemen ts whic h hav e a num b er older than 22 N is used to insert a new table line. The subsequen t input dep ends on the table. D is used to delete records en umerated in. F o r example, D13A will delete the rst, t hird and ten th records. C a llo ws y ou to c hange con tents o f the th item. It oers you an option to select a mo del of elemen tary particle in teraction for subseq uent w ork. There are four mo dels built in CompHEP quan tum electro dynamics, the mo del of electro w eak fourfermion in teraction, and tw o v ersions of the Standard Mo del. The Q ED mo del is included as an example o f r ealization of the simples t particle in teraction sc heme in CompHEP. The four fermion in teraction model give s an example of realization of the fourfermion in ter action in the CompHEP notations. The Standard Mo del is presen ted in tw o gauges the unitary one and the t'Ho oftF eynman one.

W e rec ommend to c ho ose the latter for calculations b ecause the ultraviolet cancellations b e t w een diagrams caused b y gauge inv ariance are absen t in this case. See the 23 The b ottom me nu function pro vides y ou with a p ossibilit y to include a new mo del into the CompHEP list. New mo del is created as a cop y o f one of ex isting mo dels. On the next men u lev el you can c hange this copy. If y ou c ho ose the "New Mo del" men u function y ou will b e prompted fo r a new mo del name and a template source. CompHEP adds the underscore sym b ol ' ' in fron t of the name of new mo del. It serv es to distinguish user's mo dels from the builtin ones. T o c ho ose a template the list of existing mo dels app ears. Men u 2. The rst function of this men u lets y ou en ter the phy sical pro cess whic h y ou wish to deal with. A format of pro cess sp ecication is explaine d b elo w. Y ou can also use the con text help facility pressing the F1 k ey on any step of the input. Before en tering a pro cess you ma y also edit the mo del con ten ts by means of the Edit Mo del men u. Lat er on y ou will b e able only to bro wse the mo del con ten ts by pressing F3 , but not to c hange it. If the curren tly used mo del is a usercreated one, the men u function Delete mo del remo v es this mo del and CompHEP returns to Menu 1. In the case of a builtin mo del Delete mo del restores the default v ersion of mo del instead. Before the deletion or restoration the corresponding warni ng app ears and y ou can cancel the op eration. Men u 3. Information ab out a mo del is stored in four tables. Generally they are text les whic h are disp osed in user's mo dels directory and may b e corrected b y an ordinary text edi to r. But w e strongly recomm end to use CompHEP facilities to edit these les b ecause in this case CompHEP can con trol p ossible mistak es of the user input. CompHEP displa ys a men u o f mo del tables.

By c ho osing a p osition of this men u y ou can edit the corresp onding part of the mo del. The Par ameters, Constr aints, Particles and V ertic es men u functions let y ou bro wse and edit corresp ondingly 1. independen t parameters of the c hosen mo del; 2. parameters dep ending on the basic ones; 3. list o f particles and t heir prop erties; 24 See Section 4.1 for the format of thes e tables and also Section 3.1.1 for the explanation of facilities of the table editor. CompHEP v eries the mo del when y ou try to leav e this men u after some c hanges made in one of the tables. If some error is detected the corresp onding message app ears and no exit from the men u o ccurs. This message con tains the diagnostics, the table name, and the n umber of line where the error has b een detected. Y ou can recall this message later on within the table editor b y pressing the Ctrl E k ey. The c hec k stops when the rst error is detected. Y ou can x the error and t ry to lea ve the Edit Mo del men u once more. When y ou en ter the Edit Mo del me nu the curren t ve rsion of the model is sa v ed and y ou hav e a p ossibilit y to return to this v ersion forgetting y our corrections. Just answ er N the question Sa v e correction. See Section 4.1 for a full list of requiremen ts on the mo del. 25 The notation of anti particle is sho wn in parenth eses after that of particle. In the case of the Standard Mo del the corresp onding screen is sho wn in Fig.6. If the list is to o long one ma y use the PgUp and PgDn buttons to scroll it. In the b ottom part of the scre en the prompt ' Enter pr o c es s ' app ears. The particles inside of eac h set are separated by commas.One can also construct inclusiv e pro cesses.If the program nds an unkno wn name among the inparticles it will try to consider it as a name of comp o site particle and will ask y ou ab out its parton conte nts. If y ou ch o ose 'Y' y ou will b e prompted to sp ecify the parton structure of 'p'.

A p ossible input is 'p' consists of u, U, d, D, G If one en ters a collision pro cess, the information on total energy of collid ing particles in the cen terofmass system is demanded Enter SqrtS in GeV 300 CompHEP generates only those c hannels where the to tal mass of in coming particles and the total mass of outgoing particles are smaller than SqrtS. On the next step of input y ou are prompted t o exclud e diagrams with sp ecied virtual particles. The input should b e 26 Suc h an input means that diagrams where t he n um b er of virtual particles P i is more than n i will not b e constructed. Sev eral restrictions separated b y commas are allo we d. If one ha s a restric tion fo r a particle, the restriction for the corresp onding an tiparticle is not needed. This option may b e used to exclude diagrams whic h are suppress ed due to a large virtual particle mass, or a small coupling constan t, o r for some other reasons. Use the empt y input to g et a full set of diagrams. Use the Esc k ey to return to the previous lev el of input and the F1 k ey to get the online help. After the input is completed CompHEP starts the F eynman diagram generation. If the n um b er of generated diagrams is zero the corresp onding w arning app ears and y ou return to the b eginning of pro cess input, otherwise the next men u app ears. 3.2.3 Squaring of diagram s and sym b olic calculation Men u 5. This menu a pp ears on the screen just after construction of F eyn man diagrams and together with the informatio n ab out n umbers of diagrams and subpro cesses generated. The rst function of this men u Squaring is the instruction for Com pHEP t o create sq uared diagrams. CompHEP uses the squared diagra m tec hnique fo r ev aluation of sq uared matrix elemen ts. See Section B fo r de tails.

The View diagr am s function giv es y ou a to ol to view a graphic represen tation of generated F eynman diagra ms, to remo ve some diagrams b efore the squaring and to create the L A T E X output for undeleted diagrams. If a few subpro cesses hav e b een generated then the subpro cess men u app ears after an activ ation of the View diagr ams men u function. There is a p ossibilit y to remo v e all diagrams in the highligh ted subprocess b y press ing the F7 button. In its turn the F8 k ey restores all diagrams of the highligh ted 27 When y ou c ho ose a subprocess the diagram graphic view er is launc hed. See Section 3.1.1 for details or use the F 1 and F 2 f unctional k eys for online help. Virtual particles are lab eled b y t heir names at the midline. Suc h diagrams are restored on the step of squared di agram ev aluation. Any ghost has a real particle a s a prototype se e 3 In the following text we use Gol dstone ghost instead o f co mmonly used Gold st one b oson. F or our conv enience we name b oth of these tw o kinds of elds and the auxiliary tensor eld as ghosts. 28 During the calcula tion of these par ent diagrams the con tributions of the corresp onding ghost diagra ms are also calculated and added to the con tribution of the parent one see Section B. There exist some exceptions from this rule. F or example, the Standard Mo del con tains the verte x with four Goldstone b osons asso ciated with the Z b oson, how ev er the Z 4 v ertex is abse nt in the theory. See Sections 6, 4.1.5, 4.2 for further explanations. Men u 6. T he View squar e d diag r am s function is similar to the View dia gr a m one of the previous men u but is applied to the set of squared diagrams. Eac h squared diagram is a graphic represen tation of AB.Instead, for simplicit y, CompHEP calculates 2.T o see the ghost squared diagrams f o r eac h displa ye d one just press the

’G’ k ey.

If y ou brows e the squared diagrams after usage o f the Symb olic c a lculation function you will see that eac h of the squared diagrams is mark ed by one of the following lab els C ALC, ZERO, Out of memory, Del. They mean that the diagram has been s uccessfully calculated; giv es a zero con tribution; cannot b e calculated; or has b een deleted, corresp ondingly. The Symb olic c alculation function starts sym b olic ev aluation of the gener ated squared diagrams. This ev aluation is p erformed by the builtin sym b olic calculator created sp ecially in the fr a mew ork of the CompHEP pro j ect. These co des are not used for the further CompHEP pro cessing, but th ey can b e useful fo r crossc hec king t he CompHEP soft w are. On one hand, one can in v estigate the R e duc e co de to get con viction that it correctly calc ulates a con tribution of the squared diag ra m. On the other hand, y ou may compare the result of the R e duc e ev aluation of diagram co de with the result of built in sym b olic calculator. There are some too ls created f or t his purpose. See Section A for details. General purp ose of a pac k age lik e CompHEP is to create the corresp ond ing C or F ortr an source co de for further nume rical pro cessing and compile this co de using the corresp onding system f acilities. User’s con trol is not necess ar y for this step as w ell as fo r the step of sym b olic calculations. Com pHEP pro vides the user with a p o ssibilit y to p erform the ab ov e ste ps in a nonin teractiv e mo de. T o start the nonin teractiv e session o ne could acti v ate the Make n c omphep c or Make n c omphep f men u function. Then the curren t in teractive session ends and a new batc h pro cess starts. See Section 3.2.5 fo r details of the non in teractiv e calculations in CompHEP. As the outcome, the executable le n c omphep c or n c omphep f is created for the f urther numeric al precessing. Y ou ma y nd it in the r esults directory.