CalcHEP

Neil D. Christensen
University of Wisconsin - Madison

Outline

- Graphical User Interface
- Batch Mode
- New Numerical Session
- Choose Resonant Diagrams

Download & Installation

- Download
  - http://theory.sinp.msu.ru/~pukhov/calchep.html
- Setup CalcHEP directory:
  - mkdir physics/CalcHEP
  - cp Downloads/calchep_2.5.6.tar.gz physics/CalcHEP/calchep_2.5.6.tar.gz
- Compile CalcHEP
  - cd physics/CalcHEP
  - tar xvzf calchep_2.5.6.tar.gz
  - cd calchep_2.5.6
  - make
- Start CalcHEP
  - ./mkUsrDir ../ch_2.5.6
  - cd ../ch_2.5.6
  - ./calchep &

CalcHEP - a package for calculation of Feynman diagrams and integration over multi-particle phase space.

Authors - Alexander Pukhov, Alexander Belyaev, Neil Christensen

The main idea in CalcHEP was to enable one to go directly from the Lagrangian to the cross sections and distributions effectively, with the high level of automation. The package can be compiled on any Unix platform.

General information
Main facilities , Old Versions , Acknowledgments News&Bugs

Manual
calchep_man_2.3.5(ps.gz) (137 pages, 445KB, March 18, 2005)
HEP computer tools (Lecture by Alexander Belyaev)
See also: Dan Green, High Pt physics at hadron colliders (Cambrige University Press)

Codes download.
Licence Installation References&Contributions
CalcHEP code for UNIX: version 2.5.6 (May 27 , 2010)

Models:
MSSM(04.08.2006) NMSSM NMSSM23(based on MSMMStools 2.3.1 for CaclHEP >=2.5.6)
CPVMSSM(04.08.2006) LeptoQuarks
Universal Extra Dimension Models: 5DSM 6DSM SUSY models for CompHEP By A.Semenov

---

Relative packages on Web:
Packages for model generation: LanHEP FeynRules
RGE and spectrum calculation: SuSpect Isajet SoftSUSY SPheno CPsuperH NMHDecay
Particle widths in MSSM: SDECAY HDECAY
Parton showers: PYTHIA

Email contact: **calchep@googlegroups.com**
Main Page

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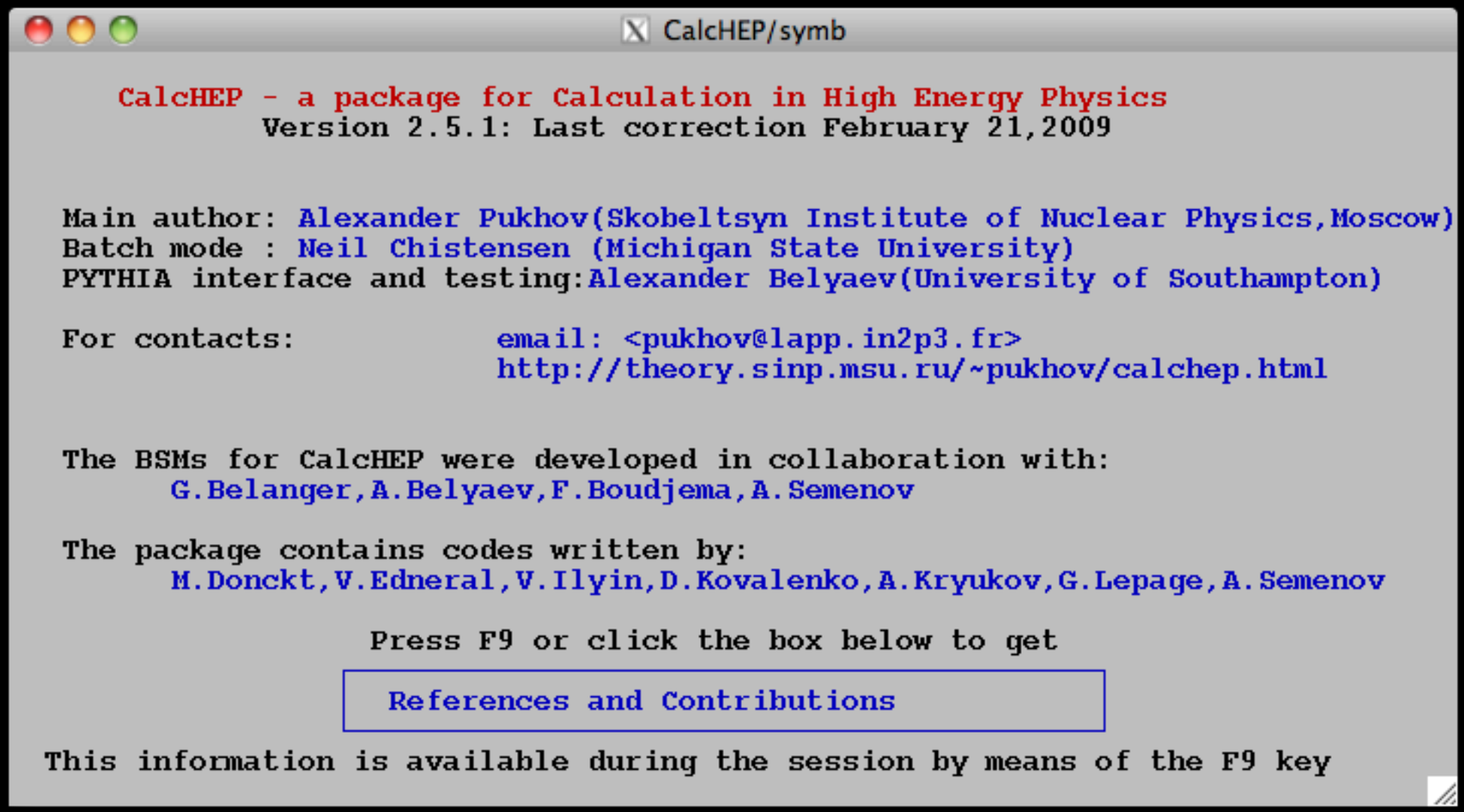
Main Page

Edit Model

- Parameters:
  - Add/remove independent parameters.
  - Change numerical values of independent parameters.
- Constraints:
  - Add/remove dependent parameters.
  - Change expressions for dependent parameters.
- Particles:
  - Add/remove particles.
  - Change properties of particles.
- Vertices:
  - Add/remove vertices.
  - Change coefficient of vertices.
  - Change Lorentz structure of vertices.
- Libraries:
  - Add/remove external code.

Terminal — bash — 69×22

```
ip-101-210:ch_2.5.6 neil$ ./calchep &
```


CalcHEP/symb
CalcHEP - a package for Calculation in High Energy Physics
Version 2.5.1: Last correction February 21,2009
Main author: Alexander Pukhov(Skobeltsyn Institute of Nuclear Physics,Moscow)
Batch mode : Neil Chistensen (Michigan State University)
PYTHIA interface and testing:Alexander Belyaev(University of Southampton)
For contacts: email: <pukhov@lapp.in2p3.fr>
http://theory.sinp.msu.ru/~pukhov/calchep.html
The BSMs for CalcHEP were developed in collaboration with:
G.Belanger,A.Belyaev,F.Boudjema,A.Semenov
The package contains codes written by:
M.Donckt,V.Edneral,V.Ilyin,D.Kovalenko,A.Kryukov,G.Lepage,A.Semenov
Press F9 or click the box below to get
References and Contributions
This information is available during the session by means of the F9 key

CalcHEP/symb

Abstract

CalcHEP package is created for calculation of decay and high energy collision processes of elementary particles in the lowest order (tree) approximation. The main idea put into the CalcHEP was to make available passing from the lagrangian to the final distributions effectively with the high level of automatization.

Use F2 key to get information about interface facilities and F1 - as online help.

<

Standard Model(CKM=1)
Standard Model
IMPORT OF MODELS

F1-Help F2-Man F5-Switches F6-Results F9-Ref F10-Quit

CalcHEP/symb

Model: Standard Model(CKM=1)

Abstract

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Use F2 key to get information about interface facilities and F1 - as online help.

<

Enter Process
Force Unit.Gauge OFF
Edit model
Delete model

F1-Help F2-Man F5-Switches F6-Results F9-Ref F10-Quit

CalcHEP/symb

Model: Standard Model(CKM=1)

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Edit model

<

Parameters
Constraints
Particles
Vertices
Libraries
RENAME
CHECK MODEL

F1-Help F2-Man F5-Switches F6-Results F9-Ref F10-Quit

CalcHEP/symb

Parameters 3

Clr-Del-Size-Read-ErrMes

Name	Value	> Comment	
EE	0.31223	Electroweak coupling. EE=0.31223 corresponds to alpha=EE	
GG	1.238	Strong coupling. Value will be changed automaticaly in n	
alfSMZ	0.1172	MS-BAR Srtong coupling at MZ	
SW	0.481	MS-BAR sine of the electroweak mixing angle	
Mm	0.1057	muon mass	
Ml	1.777	tau-lepton mass	
Q	100	QCD scale	
McMc	1.2	Mc(Mc) MS-BAR	
MbMb	4.23	Mb(Mb) MS-BAR	
Mtp	175	t-quark pole mass	
MZ	91.1884	Z-boson mass	
Mh	100	higgs mass	
wt	1.59	t-quark width	(tree level 1->2x)
wZ	2.49444	Z-boson width	(tree level 1->2x)
wW	2.08895	W-boson width	(tree level 1->2x)

F1-F2-Xgoto-Ygoto-Find-Write

CalcHEP/symb

Parameters 3

Clr-Del-Size-Read-ErrMes

Name	Value	> Comment	
EE	0.31223	Electroweak coupling. EE=0.31223 corresponds to alpha=EE	
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CalcHEP/symb

Model: Standard Model(CKM=1)

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Edit model

<

Parameters
Constraints
Particles
Vertices
Libraries
RENAME
CHECK MODEL

F1-Help F2-Man F5-Switches F6-Results F9-Ref F10-Quit

CalcHEP/symb

Constraints 2

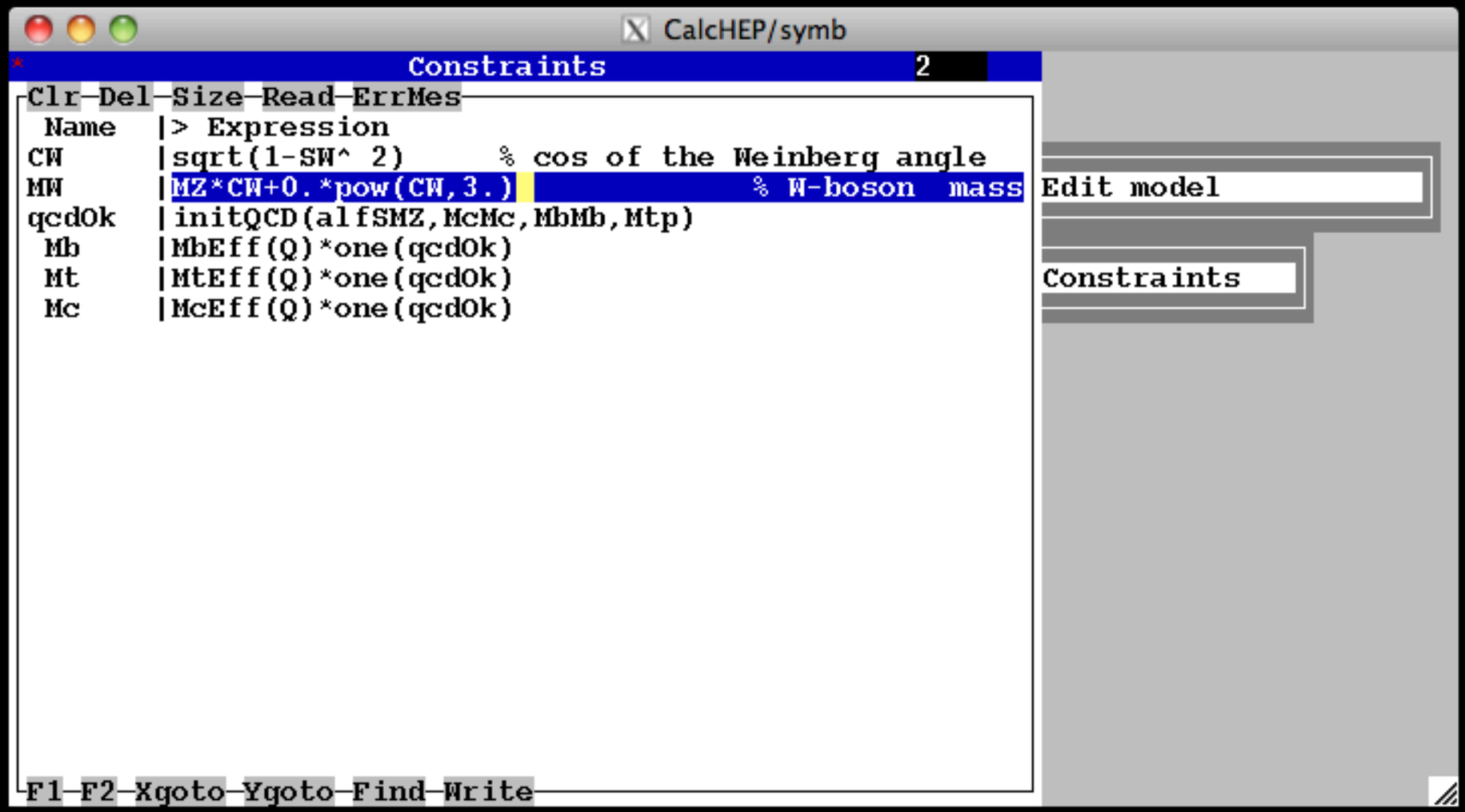
Clr-Del-Size-Read-ErrMes

Name	> Expression <
CW	sqrt(1-SW^ 2) % cos of the Weinberg angle
MW	MZ*CW % W-boson mass
qcdOk	initQCD(alfSMZ,McMc,MbMb,Mtp)
Mb	MbEff(Q)*one(qcdOk)
Mt	MtEff(Q)*one(qcdOk)
Mc	McEff(Q)*one(qcdOk)

Edit model

Constraints

F1-F2-Xgoto-Ygoto-Find-Write


CalcHEP/symb
Constraints 2
Clr Del Size Read ErrMes
Name |> Expression
CW |sqrt(1-SW^ 2) % cos of the Weinberg angle
MW |MZ*CW+0.*pow(CW,3.) % W-boson mass
qcdOk |initQCD(alfSMZ,McMc,MbMb,Mtp)
Mb |MbEff(Q)*one(qcdOk)
Mt |MtEff(Q)*one(qcdOk)
Mc |McEff(Q)*one(qcdOk)
Edit model
Constraints
F1 F2 Xgoto Ygoto Find Write

CalcHEP/symb

Model: Standard Model(CKM=1)

Abstract

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Edit model

<

Parameters
Constraints
Particles
Vertices
Libraries
RENAME
CHECK MODEL

F1-Help F2-Man F5-Switches F6-Results F9-Ref F10-Quit

CalcHEP/symb

Particles 1

Clr-Del-Size-Read-ErrMes

Full name	A	A+	number	2*spin	mass	width	color	aux	>LaTex(A)<	>LaTe
gluon	G	G	21	2	0	0	8	G	g	g
photon	A	A	22	2	0	0	1	G	\gamma	\gamm
Z-boson	Z	Z	23	2	MZ	wZ	1	G	Z	Z
W-boson	W+	W-	24	2	MW	wW	1	G	W^+	W^-
Higgs	h	h	25	0	Mh	!wh	1		h	h
electron	e	E	11	1	0	0	1		e	\bar{
e-neutrino	ne	Ne	12	1	0	0	1	L	\nu_e	\bar{
muon	m	M	13	1	Mm	0	1		\mu	\bar{
m-neutrino	nm	Nm	14	1	0	0	1	L	\nu_\mu	\bar{
tau-lepton	l	L	15	1	Ml	0	1		\tau	\bar{
t-neutrino	nl	Nl	16	1	0	0	1	L	\nu_\tau	\bar{
d-quark	d	D	81	1	0	0	3		d	\bar{
u-quark	u	U	2	1	0	0	3		u	\bar{
s-quark	s	S	83	1	0	0	3		s	\bar{
c-quark	c	C	4	1	Mc	0	3		c	\bar{
b-quark	b	B	5	1	Mb	0	3		b	\bar{
t-quark	t	T	6	1	Mt	wt	3		t	\bar{

F1-F2-Xgoto-Ygoto-Find-Write

CalcHEP/symb

Particles 1

Clr-Del-Size-Read-ErrMes

Full name	A	A+	number	2*spin	mass	width	color	aux	>LaTex(A)<	>LaTe
gluon	G	G	21	2	0	0	8	G	g	g
photon	A	A	22	2	0	0	1	G	\gamma	\gamm
Z-boson	Z	Z	23	2	MZ	wZ	1	G	Z	Z
W-boson	W+	W-	24	2	MW	wW	1	G	W^+	W^-
Higgs	h	h	25	0	Mh	!wh	1		h	h
electron	e	E	11	1	0	0	1		e	\bar{
e-neutrino	ne	Ne	12	1	0	0	1	L	\nu_e	\bar{
muon	m	M	13	1	Mm	0	1		\mu	\bar{
m-neutrino	nm	Nm	14	1	0	0	1	L	\nu_\mu	\bar{
tau-lepton	l	L	15	1	Ml	0	1		\tau	\bar{
t-neutrino	nl	Nl	16	1	0	0	1	L	\nu_\tau	\bar{
d-quark	d	D	81	1	0	0	3		d	\bar{
u-quark	u	U	2	1	0	0	3		u	\bar{
s-quark	s	S	83	1	0	0	3		s	\bar{
c-quark	c	C	4	1	Mc	0	3		c	\bar{
b-quark	b	B	5	1	Mb	0	3		b	\bar{
t-quark	t	T	6	1	Mt	wt	3		t	\bar{

F1-F2-Xgoto-Ygoto-Find-Write

CalcHEP/symb

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Edit model

<

Parameters
Constraints
Particles
Vertices
Libraries
RENAME
CHECK MODEL

F1-Help F2-Man F5-Switches F6-Results F9-Ref F10-Quit

CalcHEP/symb

Vertices

Clr	Del	Size	Read	ErrMes	> Factor <	> Lorentz part
A1	A2	A3	A4			
G	G	G			GG	m1.m2*(p1-p2).m3+m2.m3*(p2-p3).m1+m3.m1*(p3-p1).m2
G	G	G.t			GG/Sqrt2	m1.M3*m2.m3-m1.m3*m2.M3
W+	W-	A			-EE	m1.m2*(p1-p2).m3+m2.m3*(p2-p3).m1+m3.m1*(p3-p1).m2
W+	W-	Z			-EE*CW/SW	m1.m2*(p1-p2).m3+m2.m3*(p2-p3).m1+m3.m1*(p3-p1).m2
W+	W-	Z	Z		-(EE*CW/SW)^ 2	2*m1.m2*m3.m4-m1.m3*m2.m4-m1.m4*m2.m3
W+	W+	W-	W-		(EE/SW)^ 2	2*m1.m2*m3.m4-m1.m3*m2.m4-m1.m4*m2.m3
W+	W-	A	Z		-EE^ 2*CW/SW	2*m1.m2*m3.m4-m1.m3*m2.m4-m1.m4*m2.m3
W+	W-	A	A		-EE^ 2	2*m1.m2*m3.m4-m1.m3*m2.m4-m1.m4*m2.m3
h	W+	W-			EE*MW/SW	m2.m3
h	Z	Z			EE/(SW*CW^ 2)*MW	m2.m3
h	h	h			-(3/2)*EE*Mh^ 2/(MW*SW)	1
h	h	h	h		(-3/4)*(EE*Mh/(MW*SW))^ 2	1
h	h	Z	Z		(1/2)*(EE/(SW*CW))^ 2	m3.m4
h	h	W+	W-		(1/2)*(EE/SW)^ 2	m3.m4
M	m	h			-EE*Mm/(2*MW*SW)	1
L	l	h			-EE*Ml /(2*MW*SW)	1
C	c	h			-EE*Mc/(2*MW*SW)	1
B	b	h			-EE*Mb/(2*MW*SW)	1
T	t	h			-EE*Mt /(2*MW*SW)	1
E	e	A			-EE	G(m3)
M	m	A			-EE	G(m3)
L	l	A			-EE	G(m3)
Ne	e	W+			EE/(2*Sqrt2*SW)	G(m3)*(1-G5)
Nm	m	W+			EE/(2*Sqrt2*SW)	G(m3)*(1-G5)
Nl	l	W+			EE/(2*Sqrt2*SW)	G(m3)*(1-G5)
E	ne	W-			EE/(2*Sqrt2*SW)	G(m3)*(1-G5)
M	nm	W-			EE/(2*Sqrt2*SW)	G(m3)*(1-G5)
L	nl	W-			EE/(2*Sqrt2*SW)	G(m3)*(1-G5)
E	e	Z			-EE/(4*SW*CW)	G(m3)*(1-G5)-4*(SW^ 2)*G(m3)
M	m	Z			-EE/(4*SW*CW)	G(m3)*(1-G5)-4*(SW^ 2)*G(m3)
L	l	Z			-EE/(4*SW*CW)	G(m3)*(1-G5)-4*(SW^ 2)*G(m3)
Ne	ne	Z			EE/(4*SW*CW)	G(m3)*(1-G5)
Nm	nm	Z			EE/(4*SW*CW)	G(m3)*(1-G5)
Nl	nl	Z			EE/(4*SW*CW)	G(m3)*(1-G5)

F1 F2 Xgoto Ygoto Find Write

CalcHEP/symb

Model: Standard Model(CKM=1)

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Edit model

<
Parameters
Constraints
Particles
Vertices
Libraries
RENAME
CHECK MODEL

F1-Help F2-Man F5-Switches F6-Results F9-Ref F10-Quit

Batch Mode

- Batch File:
  - Define processes, parameters, energies, cuts, etc. of run.
- Production + Decay:
  - Production and decay are connected.
  - (Cuts are only applied to production modes.)
  - Final output is in an lhe file.
- Parallelization:
  - Dynamically splits subprocesses and runs them concurrently.
  - Also works with clusters.
- HTML Status:
  - Dynamically writes HTML showing current state.

pp-WPZ

```
########################################
# Model Info
########################################
Model                          :       HLS (Final)
Model changed                  :       False
Gauge                          :       Feynman
```

-:--- **pp-WPZ** Top (18,0) (Fundamental)

Wrote /Users/neil/physics/CalcHEP/ch_2.5.6/pp-WPZ

pp-WPZ

```
Model                          :        HLS (Final)
Model changed                  :        False
Gauge                          :        Feynman

########################################
# Process Info
########################################
Process                :        p,p->~W,Z
Decay                  :        ~W->W,Z
Decay                  :        W->j,j
Decay                  :        Z->l,l
Composite              :        p=u1,U1,d1,D1,G
Composite              :        j=u1,U1,d1,D1,G
Composite              :        ~W=~W+,~W-
Composite              :        W=W+,W-
Composite              :        l=e1,E1,e2,E2
```

-:--- **pp-WPZ** 7% (18,0) (Fundamental)

Wrote /Users/neil/physics/CalcHEP/ch_2.5.6/pp-WPZ

pp-WPZ

```
Composite       :       ~W=~W+,~W-
Composite       :       W=W+,W-
Composite       :       l=e1,E1,e2,E2

########################################
# PDF Info
########################################
pdf1            :       cteq6l (proton)
pdf2            :       cteq6l (proton)

########################################
# Momentum Info
########################################
p1              :       7000
p2              :       7000
```

-:--- **pp-WPZ** Bot (32,0) (Fundamental)

Wrote /Users/neil/physics/CalcHEP/ch_2.5.6/pp-WPZ

pp-WPZ

```
# Momentum Info
#######################################
p1                :       7000
p2                :       7000

#######################################
# Parameter Info
#######################################
Parameter         :       MF=4000
```

-:--- **pp-WPZ** Bot (37,0) (Fundamental)

Wrote /Users/neil/physics/CalcHEP/ch_2.5.6/pp-WPZ

pp-WPZ

```
########################################
Run parameter   :       MWP
Run begin       :       400
Run step size   :       100
Run n steps     :       9

########################################
# Event Info
########################################
Number of events        :       1000
Filename                :       pp-WPZ
```

-:**- pp-WPZ Bot (52,0) (Fundamental)

pp-WPZ

```
# Event Info
########################################
Number of events        :       1000
Filename                :       pp-WPZ

########################################
# Parallelization Info
########################################
Parallelization method  :       local
Max number of cpus      :       2
sleep time              :       3
```

-:--- pp-WPZ Bot (57,24) (Fundamental)

Wrote /Users/neil/physics/CalcHEP/ch_2.5.6/pp-WPZ

pp-WPZ

```
#######################################
Parallelization method  :       local
Max number of cpus      :       2
sleep time              :       3

#######################################
# Vegas Info
#######################################
nSess_1           :       5
nCalls_1          :       10000
nSess_2           :       5
nCalls_2          :       100000
```

-:--- **pp-WPZ** Bot (63,26) (Fundamental)

Terminal — bash — 80×24

```
ip-101-210:ch_2.5.6 neil$ ./calchep_batch pp-WPZ
```

Terminal — perl5.10.0 — 80×24

```
ip-101-210:ch_2.5.6 neil$ ./calchep_batch pp-WPZ


Processing batch:
Progress information can be found in the html directory.
Simply open the following link in your browser:
file:///Users/neil/physics/CalcHEP/ch_2.5.6/html/index.html
You can also view textual progress reports in /Users/neil/physics/CalcHEP/ch_2.5
.6/html/index.txt
        and the other .txt files in the html directory.
Events will be stored in the Events directory.
```

Home
Symbolic Results
Numerical Results
Events Library
Process Library
Help

Thank you for using CalcHEP!
Please cite
arXiv:0000.0000

Symbolic Sessions

HLS (Final)

Processes	Lib	PID	Time(hr)
u1,D1->Z,~W+	✓	13766	0.00
U1,d1->Z,~W-	✓	13768	0.00
d1,U1->Z,~W-	✓	14504	0.00
D1,u1->Z,~W+	✓	14506	0.00
~W+->Z,W+	✓	15242	0.00
~W-->Z,W-	✓	15244	0.00
W+->u1,D1	✓	15370	0.00
W-->U1,d1	✓	15372	0.00
Z->e1,E1	✓	15498	0.00
Z->e2,E2	✓	15500	0.00
Widths	✓	15626	0.01

Home
Symbolic Results
Numerical Results
Events Library
Process Library
Help

Thank you for using CalcHEP!
Please cite
arXiv:0000.0000

Numerical Sessions

HLS (Final)

Calculating Cross Sections

Runs	σ (fb)	Running	Finished	Time (hr)	N events
MWP=400	0	0/4	4/4	0.01	0
MWP=500	0	2/4	2/4	0.01	0
MWP=600	0	0/4	0/4	0.00	0
MWP=700	0	0/4	0/4	0.00	0
MWP=800	0	0/4	0/4	0.00	0
MWP=900	0	0/4	0/4	0.00	0
MWP=1000	0	0/4	0/4	0.00	0
MWP=1100	0	0/4	0/4	0.00	0
MWP=1200	0	0/4	0/4	0.00	0
				0.01	

Home
Symbolic Results
Numerical Results
Events Library
Process Library
Help

Thank you for using CalcHEP!
Please cite
arXiv:0000.0000

Numerical Sessions

HLS (Final)

Calculating Cross Sections

Processes	σ (fb)	PID	Time (hr)	Details	
u1,D1->Z,~W+	17.563	18000	0.00	prt_1	session.dat
U1,d1->Z,~W-	6.5531	18011	0.00	prt_1	session.dat
d1,U1->Z,~W-	0	18046	0.00	prt_1	session.dat
D1,u1->Z,~W+	0	18056	0.00	prt_1	session.dat
Total	24.116		0.01		

Distributions

Home
Symbolic Results
Numerical Results
Events Library
Process Library
Help

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Numerical Sessions

HLS (Final)

Calculating Cross Sections

Runs	σ (fb)	Running	Finished	Time (hr)	N events
MWP=400	0	0/4	4/4	0.01	0
MWP=500	0	0/4	4/4	0.01	0
MWP=600	0	0/4	4/4	0.01	0
MWP=700	0	0/4	4/4	0.01	0
MWP=800	0	0/4	4/4	0.01	0
MWP=900	0	0/4	4/4	0.01	0
MWP=1000	0	0/4	4/4	0.01	0
MWP=1100	0	0/4	4/4	0.01	0
MWP=1200	0	2/4	0/4	0.00	0
				0.06	

Home
Symbolic Results
Numerical Results
Events Library
Process Library
Help

Thank you for using CalcHEP!
Please cite
arXiv:0000.0000

Numerical Sessions

HLS (Final)

Generating Events

Runs	σ (fb)	Running	Finished	Time (hr)	N events
MWP=400	0	2/11	4/11	0.00	0
MWP=500	0	0/11	0/11	0.00	0
MWP=600	0	0/11	0/11	0.00	0
MWP=700	0	0/11	0/11	0.00	0
MWP=800	0	0/11	0/11	0.00	0
MWP=900	0	0/11	0/11	0.00	0
MWP=1000	0	0/11	0/11	0.00	0
MWP=1100	0	0/11	0/11	0.00	0
MWP=1200	0	0/11	0/11	0.00	0
				0.00	

Home
Symbolic Results
Numerical Results
Events Library
Process Library
Help

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Numerical Sessions

HLS (Final)

Generating Events

Processes	σ (fb)	PID	Time (hr)	N events	Details	
u1,D1->Z,~W+	118.01	19315	0.00	392/392	prt_1	session.dat
U1,d1->Z,~W-	47.412	19325	0.00	157/157	prt_1	session.dat
d1,U1->Z,~W-	47.438	19459	0.00	157/157	prt_1	session.dat
D1,u1->Z,~W+	117.97	19469	0.00	392/392	prt_1	session.dat
Total	330.83			1098/1098		

Decays	Γ (GeV)	PID	Time (hr)	N events	Details	
~W+->Z,W+	2.867	19610	0.00	5101/5100	prt_1	session.dat
~W-->Z,W-	2.867	19625	0.00	5101/5100	prt_1	session.dat
W+->u1,D1	0.70557	19802	0.00	5101/5100	prt_1	session.dat
W-->U1,d1	0.70557	19816	0.00	5101/5100	prt_1	session.dat
Z->e1,E1	0.086807	19994	0.00	5101/5100	prt_1	session.dat
Z->e2,E2	0.086806	20008	0.00	5101/5100	prt_1	session.dat

Widths		PID	Time (hr)		Details
Widths		20186	0.00		session.dat
Total	0		0.01		

Home
Symbolic Results
Numerical Results
Events Library
Process Library
Help

Thank you for using CalcHEP!
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Numerical Sessions

HLS (Final)

Generating Events

Runs	σ (fb)	Running	Finished	Time (hr)	N events
MWP=400	0.5216	0/11	11/11	0.01	1000
MWP=500	0.1831	0/11	11/11	0.01	1000
MWP=600	0	2/11	2/11	0.00	0
MWP=700	0	0/11	0/11	0.00	0
MWP=800	0	0/11	0/11	0.00	0
MWP=900	0	0/11	0/11	0.00	0
MWP=1000	0	0/11	0/11	0.00	0
MWP=1100	0	0/11	0/11	0.00	0
MWP=1200	0	0/11	0/11	0.00	0
				0.02	

Home
Symbolic Results
Numerical Results
Events Library
Process Library
Help

Thank you for using CalcHEP!
Please cite
arXiv:0000.0000

Numerical Sessions

HLS (Final)

Generating Events

Runs	σ (fb)	Running	Finished	Time (hr)	N events
MWP=400	0.5216	0/11	11/11	0.01	1000
MWP=500	0.1831	0/11	11/11	0.01	1000
MWP=600	0.07601	0/11	11/11	0.01	1000
MWP=700	0.03533	0/11	11/11	0.01	1000
MWP=800	0.01781	0/11	11/11	0.01	1000
MWP=900	0.009534	0/11	11/11	0.01	1000
MWP=1000	0	2/11	4/11	0.00	0
MWP=1100	0	0/11	0/11	0.00	0
MWP=1200	0	0/11	0/11	0.00	0
				0.06	

Home
Symbolic Results
Numerical Results
Events Library
Process Library
Help

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Numerical Sessions

HLS (Final)

Done!

Runs	σ (fb)	Running	Finished	Time (hr)	N events
MWP=400	0.5216	0/11	11/11	0.01	1000
MWP=500	0.1831	0/11	11/11	0.01	1000
MWP=600	0.07601	0/11	11/11	0.01	1000
MWP=700	0.03533	0/11	11/11	0.01	1000
MWP=800	0.01781	0/11	11/11	0.01	1000
MWP=900	0.009534	0/11	11/11	0.01	1000
MWP=1000	0.005353	0/11	11/11	0.01	1000
MWP=1100	0.003121	0/11	11/11	0.01	1000
MWP=1200	0.001876	0/11	11/11	0.01	1000
				0.08	

Terminal — s_calchep — 80×24

```
ip-101-210:ch_2.5.6 neil$ ls Events/
events.txt          pp-WPZ-MWP1200.lhe pp-WPZ-MWP600.lhe  pp-WPZ-MWP900.lhe
pp-WPZ-MWP1000.lhe pp-WPZ-MWP400.lhe  pp-WPZ-MWP700.lhe  tmp
pp-WPZ-MWP1100.lhe pp-WPZ-MWP500.lhe  pp-WPZ-MWP800.lhe
ip-101-210:ch_2.5.6 neil$
```

Terminal — less — 149×32

```
</event>
<event>
12    1   1.0000000E+00   9.0880000E+02  -1.0000000E+00  -1.0000000E+00
       2   -1    0    0  500    0  0.00000000000E+00  0.00000000000E+00  1.24919161230E+02  1.24919161230E+02  0.00000000000E+00  0.0000E+00  9.0
      -1   -1    0    0    0  500  0.00000000000E+00  0.00000000000E+00 -1.65296074880E+03  1.65296074880E+03  0.00000000000E+00  0.0000E+00  9.0
      23    2    1    2    0    0  1.96743249538E+00 -3.34962100188E+02 -3.68522676850E+02  5.06453095606E+02  9.11876000000E+01  6.6842E-14  9.0
 6000024    2    1    2    0    0 -2.12754895199E+00  3.32615923671E+02 -1.16009205556E+03  1.27192099650E+03  4.00000000000E+02  5.1309E-13  9.0
      11    1    3    3    0    0  4.01749762042E+01 -8.30894807808E+01 -8.81035497527E+01  1.27593597051E+02  0.00000000000E+00  0.0000E+00  9.0
     -11    1    3    3    0    0 -3.82075437089E+01 -2.51872619408E+02 -2.80419127097E+02  3.78859498555E+02  0.00000000000E+00  0.0000E+00  9.0
      23    2    4    4    0    0 -4.70434449331E+00 -6.41200418955E+01 -2.10518779002E+02  2.38866335566E+02  9.11876000000E+01  4.5742E-14  9.0
      24    2    4    4    0    0  2.73691199794E+00  3.99082142084E+02 -9.49000131668E+02  1.03256047881E+03  8.03980000000E+01  1.7452E-13  9.0
      13    1    7    7    0    0 -2.77243188511E+01 -8.01358688379E+01 -1.60444295351E+02  1.81473905599E+02  1.05700000000E-01  0.0000E+00  9.0
     -13    1    7    7    0    0  2.30199743578E+01  1.60158269424E+01 -5.00744836508E+01  5.73924299666E+01  1.05700000000E-01  0.0000E+00  9.0
       2    1    8    8  502    0  1.44275400844E-01  3.93357475279E+02 -9.47769820024E+02  1.02615678915E+03  0.00000000000E+00  0.0000E+00  9.0
      -1    1    8    8    0  502  2.59263659709E+00  5.72466680462E+00 -1.23031164409E+00  6.40368966223E+00  0.00000000000E+00  0.0000E+00  9.0
</event>
<event>
12    1   1.0000000E+00   2.1010000E+03  -1.0000000E+00  -1.0000000E+00
      -1   -1    0    0    0  500  0.00000000000E+00  0.00000000000E+00  3.95828447880E+02  3.95828447880E+02  0.00000000000E+00  0.0000E+00  9.0
       2   -1    0    0  500    0  0.00000000000E+00  0.00000000000E+00 -2.78778201450E+03  2.78778201450E+03  0.00000000000E+00  0.0000E+00  9.0
      23    2    1    2    0    0  3.98720351095E+02 -9.17245455795E+02 -9.53483143105E+02  1.38554245976E+03  9.11876000000E+01  1.6897E-15  9.0
 6000024    2    1    2    0    0 -3.98718386267E+02  9.17491192838E+02 -1.43871557147E+03  1.79825220411E+03  4.00000000000E+02  1.6194E-13  9.0
      13    1    3    3    0    0  3.29927460706E+02 -6.97248883794E+02 -6.84270543232E+02  1.03113254375E+03  1.05700000000E-01  0.0000E+00  9.0
     -13    1    3    3    0    0  6.87928903898E+01 -2.19996572001E+02 -2.69212599873E+02  3.54409916005E+02  1.05700000000E-01  0.0000E+00  9.0
      23    2    4    4    0    0 -2.75178944925E+01  3.20771359936E+02 -6.98020898007E+02  7.74236678561E+02  9.11876000000E+01  1.6327E-14  9.0
      24    2    4    4    0    0 -3.71202456603E+02  5.96474095859E+02 -7.40449525448E+02  1.02383132401E+03  8.03980000000E+01  1.7722E-15  9.0
      13    1    7    7    0    0 -5.91105304205E+01  2.53933594886E+02 -5.57604095217E+02  6.15547450318E+02  1.05700000000E-01  0.0000E+00  9.0
     -13    1    7    7    0    0  3.15926359280E+01  6.68377650497E+01 -1.40416802790E+02  1.58689228242E+02  1.05700000000E-01  0.0000E+00  9.0
       2    1    8    8  502    0 -3.50334928341E+02  5.56940940593E+02 -7.17750454935E+02  9.73695788676E+02  0.00000000000E+00  0.0000E+00  9.0
      -1    1    8    8    0  502 -2.08675282615E+01  3.95331552655E+01 -2.26990705125E+01  5.01355353330E+01  0.00000000000E+00  0.0000E+00  9.0
</event>
:
```

In Development

New Numerical Session

- "Composites" Table:
  - Define names for list of particles.
- Dynamical Processes and Decays:
  - Dynamically add processes and decays.
  - Code is dynamically generated and linked.
- Connects Productions and Decays:
  - Dynamically connects production and decay modes.
  - Cuts are applied to final states (after decay).
  - Optionally Breit-Wigner smear resonances.
  - Adds cross sections and distributions (after decay).
  - Works harder on processes with larger absolute errors.

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

- Composites
- Processes
- Decays
- IN state
- Model parameters
- Constraints
- QCD coupling
- Breit-Wigner
- Cuts
- Phase space mapping
- Vegas

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

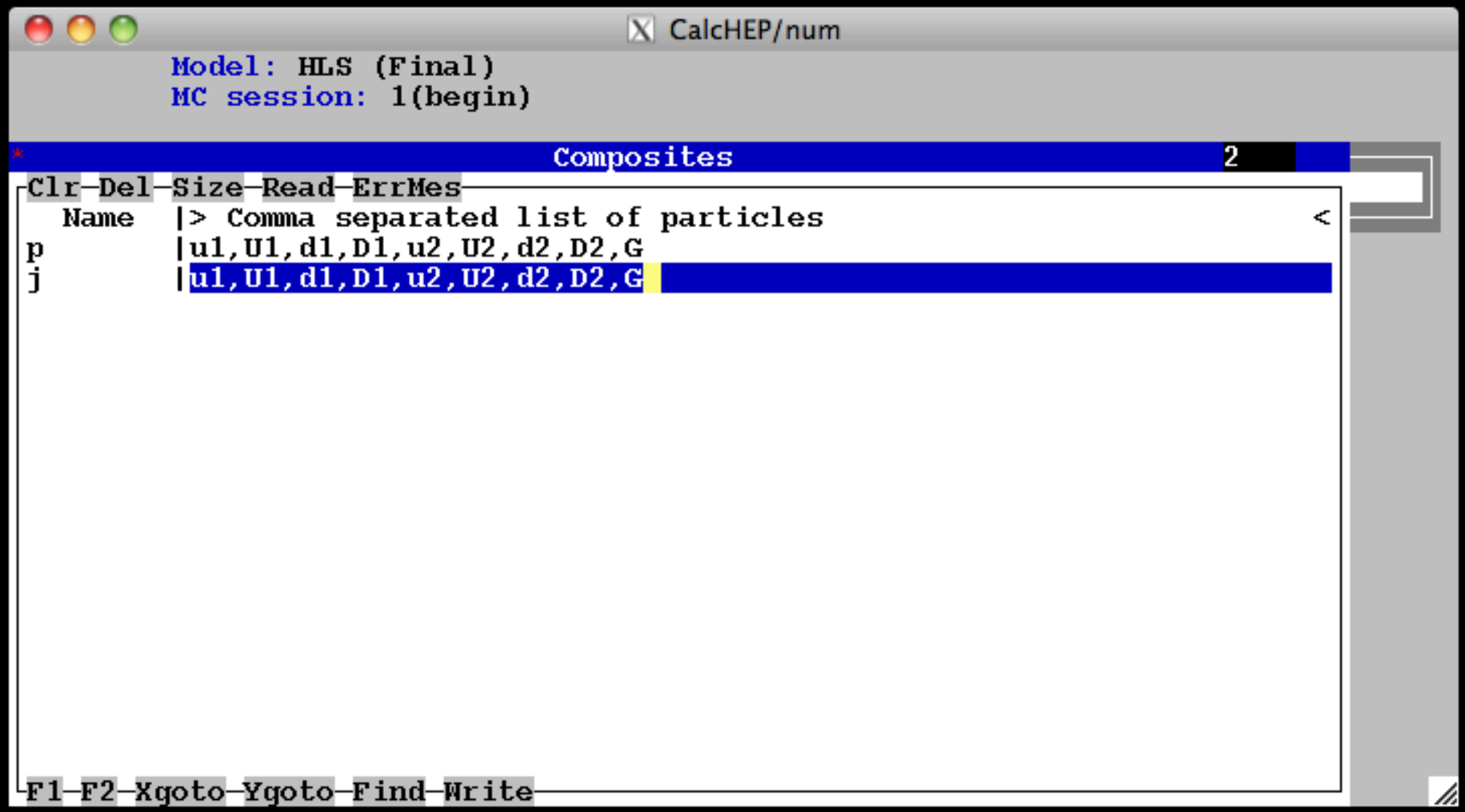
Model: HLS (Final)
MC session: 1(begin)

Composites

Clr Del Size Read ErrMes

Name |> Comma separated list of particles <

F1 F2 Xgoto Ygoto Find Write


CalcHEP/num
Model: HLS (Final)
MC session: 1(begin)
Composites
2
Clr Del Size Read ErrMes
Name |> Comma separated list of particles <
p |u1,U1,d1,D1,u2,U2,d2,D2,G
j |u1,U1,d1,D1,u2,U2,d2,D2,G
F1 F2 Xgoto Ygoto Find Write

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

Composites 5

Clr-Del-Size-Read-ErrMes

Name	> Comma separated list of particles <
p	u1,U1,d1,D1,u2,U2,d2,D2,G
j	u1,U1,d1,D1,u2,U2,d2,D2,G
l	e1,E1,e2,E2
l-	e1,e2
l+	E1,E2

F1-F2-Xgoto-Ygoto-Find-Write

CalcHEP/num

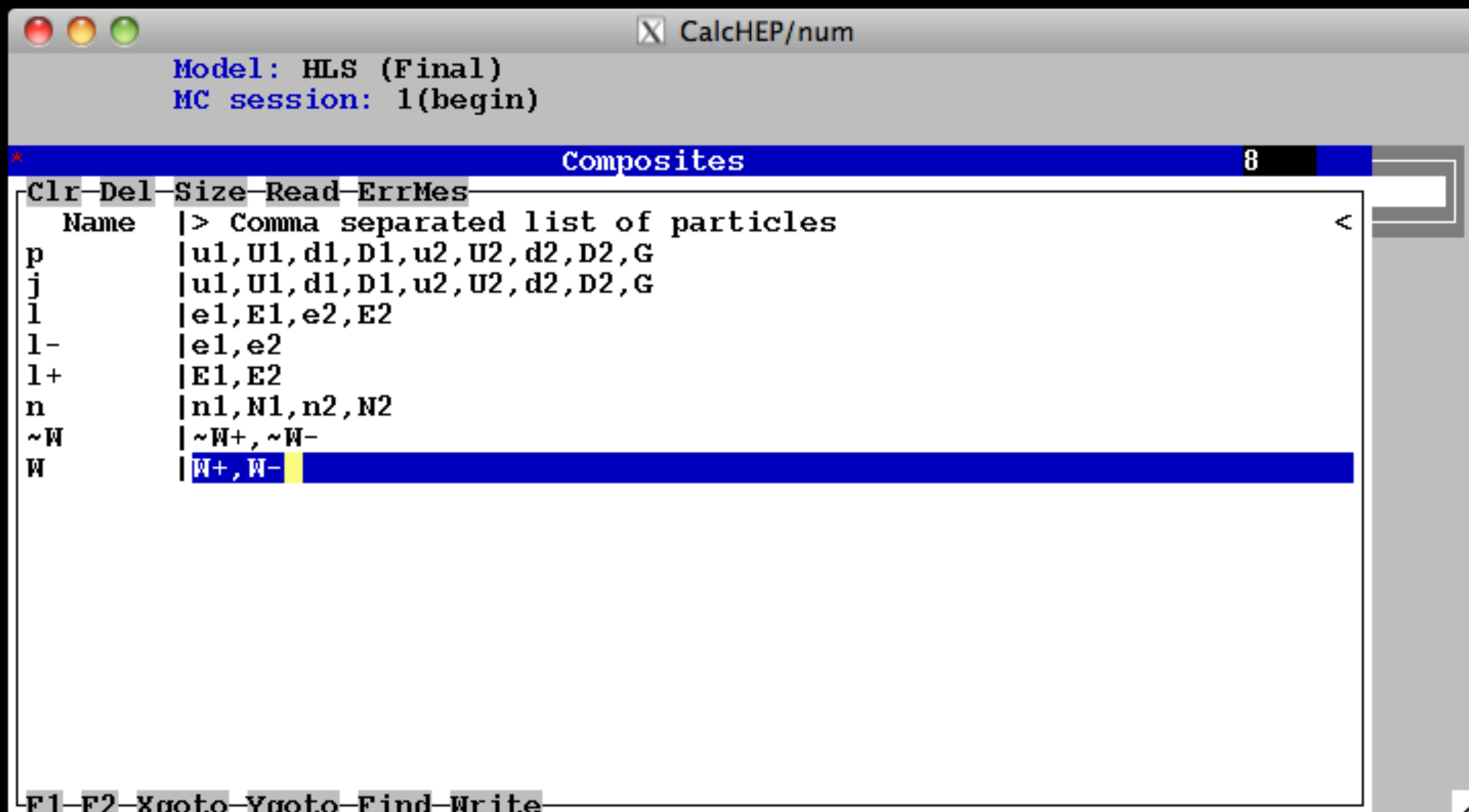
Model: HLS (Final)
MC session: 1(begin)

Composites 6

Clr Del Size Read ErrMes

Name	> Comma separated list of particles <
p	u1,U1,d1,D1,u2,U2,d2,D2,G
j	u1,U1,d1,D1,u2,U2,d2,D2,G
l	e1,E1,e2,E2
l-	e1,e2
l+	E1,E2
n	n1,N1,n2,N2

F1 F2 Xgoto Ygoto Find Write


CalcHEP/num
Model: HLS (Final)
MC session: 1(begin)
Composites
8
Clr-Del-Size-Read-ErrMes
Name |> Comma separated list of particles <
p |u1,U1,d1,D1,u2,U2,d2,D2,G
j |u1,U1,d1,D1,u2,U2,d2,D2,G
l |e1,E1,e2,E2
l- |e1,e2
l+ |E1,E2
n |n1,N1,n2,N2
~W |~W+,~W-
W |W+,W-
F1-F2-Xgoto-Ygoto-Find-Write

CalcHEP/num

```
Model: HLS (Final)
MC session: 1(begin)
```

```
<
Composites
Processes
Decays
IN state
Model parameters
Constraints
QCD coupling
Breit-Wigner
Cuts
Phase space mapping
Vegas
```

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

Proce Processes
Add process(es

F1-Help F2-Man F6-Results F8-Calc F9-Ref

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

Proce Processes

Add process(es

p,p->~W,Z

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

Processes

u1	D1	->	Z	~W+	On
U1	d1	->	Z	~W-	On
d1	U1	->	Z	~W-	On
D1	u1	->	Z	~W+	On
u2	D2	->	Z	~W+	On
U2	d2	->	Z	~W-	On
d2	U2	->	Z	~W-	On
D2	u2	->	Z	~W+	On

Add process(es)

F1-Help F2-Man F6-Results F8-Calc F9-Ref

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

Processes

u1	D1	->	Z	~W+	On
U1	d1	->	Z	~W-	On
d1	U1	->	Z	~W-	On
D1	u1	->	Z	~W+	On
u2	D2	->	Z	~W+	On
U2	d2	->	Z	~W-	On
d2	U2	->	Z	~W-	On
D2	u2	->	Z	~W+	On

Add process(es)

F1-Help F2-Man F6-Results F8-Calc F9-Ref

CalcHEP/num

```
Model: HLS (Final)
MC session: 1(begin)
```

```
<
Composites
Processes
Decays
IN state
Model parameters
Constraints
QCD coupling
Breit-Wigner
Cuts
Phase space mapping
Vegas
```

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

Decays | Decays

Add decay(s

F1-Help F2-Man F6-Results F8-Calc F9-Ref

CalcHEP/num

```
Model: HLS (Final)
MC session: 1(begin)
```

Decays | Decays

Add decay(s

```
~W->W,Z
```

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

Decays

~W+ -> Z W+ On
~W- -> Z W- On
Add decay(s)

F1-Help F2-Man F6-Results F8-Calc F9-Ref

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

Decays

Add decay(s)

W->j,j

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

Decays

~W+	->	Z	W+	On
~W-	->	Z	W-	On
W+	->	u1	D1	On
W+	->	u2	D2	On
W-	->	U1	d1	On
W-	->	U2	d2	On

Add decay(s)

F1-Help F2-Man F6-Results F8-Calc F9-Ref

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

Decays

Add decay(s)

Z->l,l

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

Decays

~W+	->	Z	W+	On
~W-	->	Z	W-	On
W+	->	u1	D1	On
W+	->	u2	D2	On
W-	->	U1	d1	On
W-	->	U2	d2	On
Z	->	e1	E1	On
Z	->	e2	E2	On

Add decay(s)

F1-Help F2-Man F6-Results F8-Calc F9-Ref

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

<
Composites
Processes
Decays
IN state
Model parameters
Constraints
QCD coupling
Breit-Wigner
Cuts
Phase space mapping
Vegas

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

```
Model: HLS (Final)
MC session: 1(begin)
```

IN state

```
S.F.1: OFF
S.F.2: OFF
First  particle momentum[GeV] = 7000
Second particle momentum[GeV] = 7000
First  particle unpolarized
Second particle unpolarized
```

F1-Help F2-Man F6-Results F7-Plot F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

IN state

S.F.1 OFF

PDT:

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

IN state

S.F.1: OFF

PDT:mrst2002nlo(anti-proton)
PDT:mrst2002nlo(proton)
PDT:mrst2002lo(anti-proton)
PDT:mrst2002lo(proton)
PDT:cteq6m(anti-proton)
PDT:cteq6m(proton)
PDT:cteq6l(anti-proton)
PDT:cteq6l(proton)
PDT:CTEQ5M(anti-proton)
PDT:CTEQ5M(proton)

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

```
Model: HLS (Final)
MC session: 1(begin)
```

IN state

```
S.F.1: PDT:cteq6l(proton)
S.F.2: OFF
First  particle momentum[GeV] = 7000
Second particle momentum[GeV] = 7000
First  particle unpolarized
Second particle unpolarized
```

F1-Help F2-Man F6-Results F7-Plot F8-Calc F9-Ref F10-Quit

CalcHEP/num

```
Model: HLS (Final)
MC session: 1(begin)
```

IN state

```
S.F.1: PDT:cteq6l(proton)
S.F.2: PDT:cteq6l(proton)
First  particle momentum[GeV] = 7000
Second particle momentum[GeV] = 7000
First  particle unpolarized
Second particle unpolarized
```

F1-Help F2-Man F6-Results F7-Plot F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

<
Composites
Processes
Decays
IN state
Model parameters
Constraints
QCD coupling
Breit-Wigner
Cuts
Phase space mapping
Vegas

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

Model parameters
Change parameter

<

aEWM1= 127.92
Gf= 1.1664e-05
aS= 0.1176
ZM= 91.188
MF= 4000
a= 1
SO= -0.010113
MZ= 91.188
MW= 80.398
MWP= 500
mmu= 0.1057
mta= 1.777
mch= 1.27
mto= 171.2
mst= 0.104

PgDn

F1-Help F2-Man F6-Results F8-Calc F9-Ref

CalcHEP/num

```
Model: HLS (Final)
MC session: 1(begin)
```

<
Composites
Processes
Decays
IN state
Model parameters
Constraints
QCD coupling
Breit-Wigner
Cuts
Phase space mapping
Vegas

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

Breit-Wigner

BreitWigner range	2.7
T-channel widths	OFF
GI in t-channel	OFF
GI in s-channel	OFF
BW smearing	ON

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

Cuts

Clr-Del-Size-Read-ErrMes
!| Parameter |> Min bound <|> Max bound <

F1-F2-Xgoto-Ygoto-Find-Write

Cuts

~W+ ->
~W- ->

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

Cuts 2

Clr-Del-Size-Read-ErrMes

	Parameter	> Min bound <	> Max bound <
	T(j)	20	
	T(1)	20	

F1-F2-Xgoto-Ygoto-Find-Write

Cuts

~W+ ->

~W- ->

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

Cuts 4

Clr-Del-Size-Read-ErrMes

!| Parameter	> Min bound <	> Max bound <
|T(j)	20	
|T(l)	20	
|N(j)	-4	4
|N(l)	-2.5	2.5

F1-F2-Xgoto-Ygoto-Find-Write

Cuts

~W+ ->
~W- ->

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

Cuts 6

Clr-Del-Size-Read-ErrMes

!	Parameter	> Min bound <	> Max bound <
	|T(j)	|20	|
	|T(l)	|20	|
	|N(j)	|-4	|4
	|N(l)	|-2.5	|2.5
	|J(j,j)	|0.4	|
	|J(j,l)	|0.4	|

F1-F2-Xgoto-Ygoto-Find-Write

Cuts

~W+ ->
~W- ->

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

- Composites
- Processes
- Decays
- IN state
- Model parameters
- Constraints
- QCD coupling
- Breit-Wigner
- Cuts
- Phase space mapping
- **Vegas**

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

```
Model: HLS (Final)
MC session: 1(begin)
```

```
 Vegas

 Accuracy goal = 1.00%
*Improve Grids
   nCalls    = 10000
*Integrate

 Set  Distributions
 Display Distributions

 Clear statistics
 Clear grid & statistics
```

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

---Improving Grids---

Process	cs(pb)/BR	%T Err	%C Err
u1,D1->Z,~W+	4.1963E-02	4.7E-01	4.7E-01
*U1,d1->Z,~W-	1.5466E-02	8.8E+00	8.8E+00
d1,U1->Z,~W-	1.6083E-02	8.4E+00	8.4E+00
D1,u1->Z,~W+	4.4540E-02	8.1E+00	8.1E+00
u2,D2->Z,~W+	8.5926E-04	1.3E+01	1.3E+01
U2,d2->Z,~W-	8.3154E-04	1.3E+01	1.3E+01
d2,U2->Z,~W-	9.1663E-04	1.1E+01	1.1E+01
D2,u2->Z,~W+	8.0164E-04	1.3E+01	1.3E+01
~W+->Z,W+	9.9998E-01	1.0E-04	1.0E-04
~W-->Z,W-	9.9998E-01	1.0E-04	1.0E-04
W+->u1,D1	3.3340E-01	1.0E-04	1.0E-04
W+->u2,D2	3.3328E-01	1.0E-04	1.0E-04
W-->U1,d1	3.3340E-01	1.0E-04	1.0E-04
W-->U2,d2	3.3328E-01	1.0E-04	1.0E-04
Z->e1,E1	3.4383E-02	1.0E-04	1.0E-04
Z->e2,E2	3.4383E-02	1.0E-04	1.0E-04

Vegas

*Improve Grids

XCalculation in progress. Calculation in progress.

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

---Improving Grids---

Process	cs(pb)/BR	%T Err	%C Err
u1,D1->Z,~W+	4.1995E-02	2.0E-01	2.1E-01
U1,d1->Z,~W-	1.6206E-02	2.1E-01	2.3E-01
d1,U1->Z,~W-	1.6216E-02	2.0E-01	2.2E-01
D1,u1->Z,~W+	4.1883E-02	2.0E-01	2.2E-01
u2,D2->Z,~W+	8.2493E-04	2.5E-01	2.6E-01
U2,d2->Z,~W-	8.2656E-04	2.4E-01	2.5E-01
d2,U2->Z,~W-	8.2349E-04	2.4E-01	2.5E-01
D2,u2->Z,~W+	8.2717E-04	2.3E-01	2.4E-01
~W+->Z,W+	9.9998E-01	5.8E-05	1.0E-04
*~W-->Z,W-	9.9998E-01	7.1E-05	1.0E-04
W+->u1,D1	3.3340E-01	7.1E-05	1.0E-04
W+->u2,D2	3.3328E-01	7.1E-05	1.0E-04
W-->U1,d1	3.3340E-01	7.1E-05	1.0E-04
W-->U2,d2	3.3328E-01	7.1E-05	1.0E-04
Z->e1,E1	3.4383E-02	7.1E-05	1.0E-04
Z->e2,E2	3.4383E-02	7.1E-05	1.0E-04

Vegas

*Improve Grids

XXXXXXXXXXXXXXXXXXgress. Calculation in progress.

CalcHEP/num

Model: HLS (Final)
MC session: 1(begin)

---Improving Grids---

Process	cs(pb)/BR	%T Err	%C Err
u1,D1->Z,~W+	4.2022E-02	1.4E-01	2.8E-01
U1,d1->Z,~W-	1.6178E-02	1.4E-01	2.9E-01
d1,U1->Z,~W-	1.6207E-02	1.3E-01	2.7E-01
D1,u1->Z,~W+	4.1818E-02	1.3E-01	2.3E-01
u2,D2->Z,~W+	8.2301E-04	1.6E-01	5.0E-01
U2,d2->Z,~W-	8.2404E-04	1.7E-01	3.0E-01
d2,U2->Z,~W-	8.2287E-04	1.6E-01	2.6E-01
D2,u2->Z,~W+	8.2661E-04	1.7E-01	3.0E-01
~W+->Z,W+	9.9998E-01	4.5E-05	1.0E-04
~W-->Z,W-	9.9998E-01	4.5E-05	1.0E-04
W+->u1,D1	3.3340E-01	4.5E-05	1.0E-04
W+->u2,D2	3.3328E-01	4.5E-05	1.0E-04
W-->U1,d1	3.3340E-01	4.5E-05	1.0E-04
W-->U2,d2	3.3328E-01	4.5E-05	1.0E-04
Z->e1,E1	3.4383E-02	4.5E-05	1.0E-04
Z->e2,E2	3.4383E-02	4.5E-05	1.0E-04

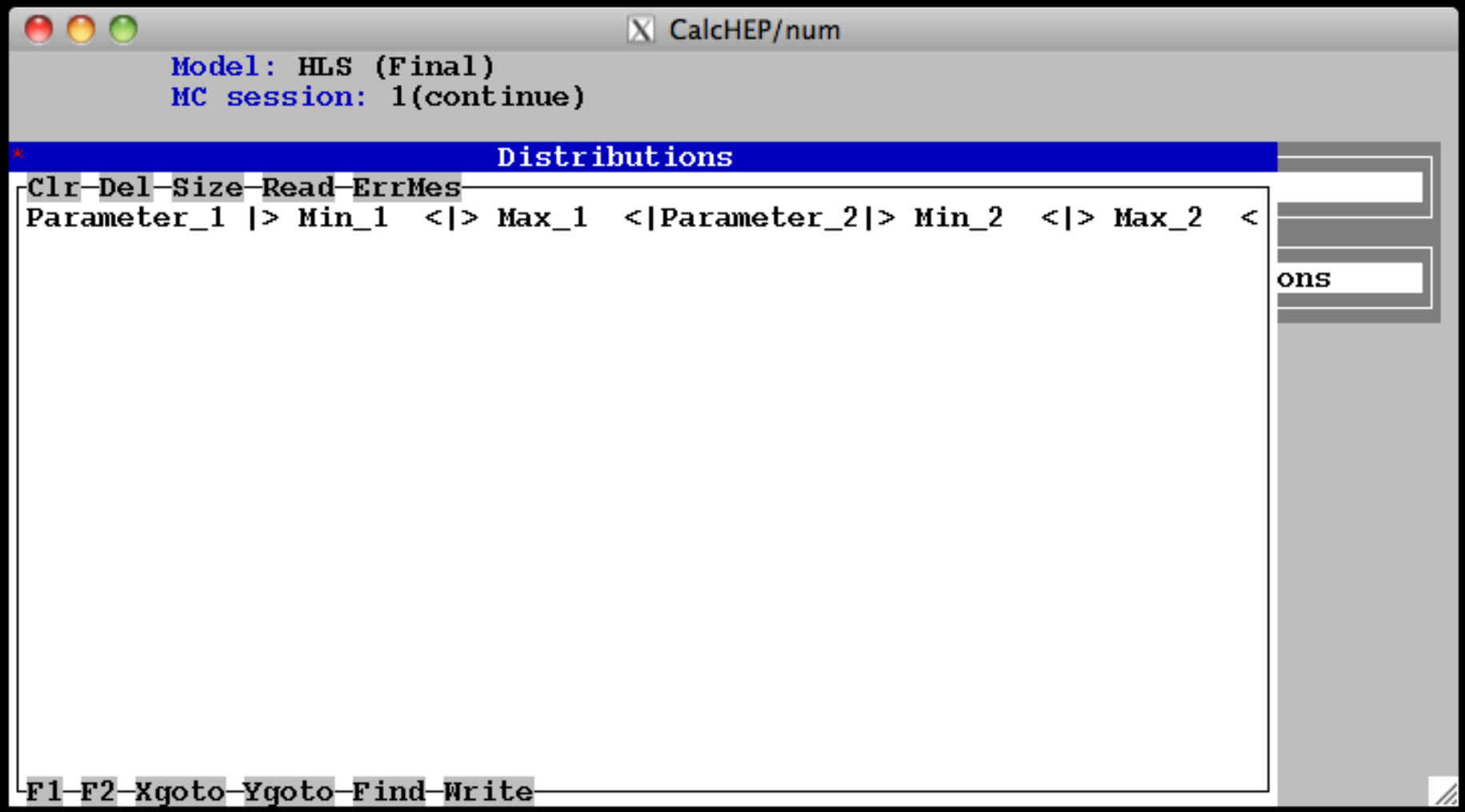
Vegas

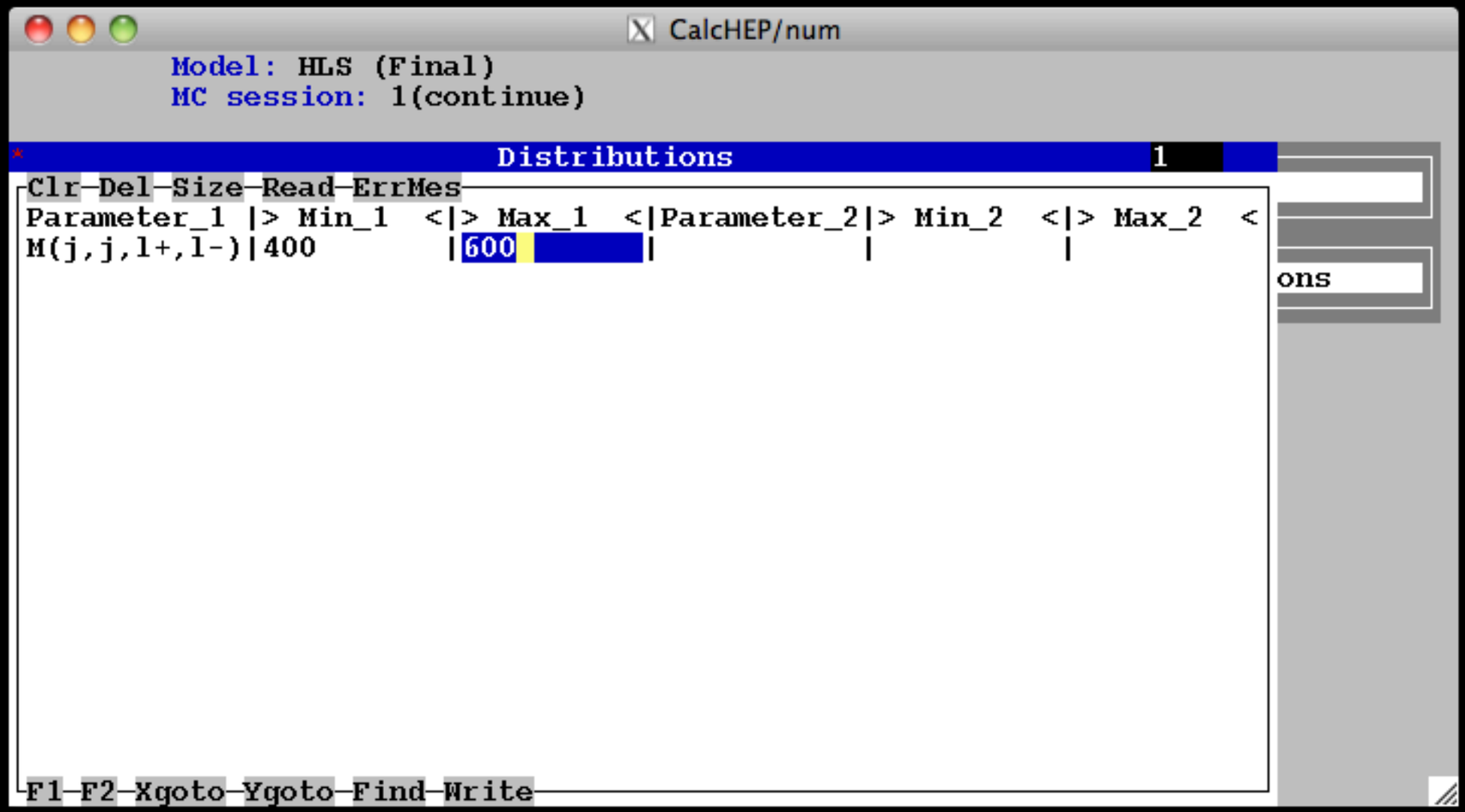
Accuracy goal = 1.00%
*Improve Grids
nCalls = 10000
*Integrate

Set Distributions
Display Distributions

Clear statistics
Clear grid & statistics

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit


CalcHEP/num
Model: HLS (Final)
MC session: 1(continue)
Distributions
Clr Del Size Read ErrMes
Parameter_1 |> Min_1 <|> Max_1 <|Parameter_2|> Min_2 <|> Max_2 <
ons
F1 F2 Xgoto Ygoto Find Write


CalcHEP/num
Model: HLS (Final)
MC session: 1(continue)
Distributions 1
Clr-Del-Size-Read-ErrMes
Parameter_1 |> Min_1 <|> Max_1 <|Parameter_2|> Min_2 <|> Max_2 <
M(j,j,1+,1-)|400 |600 | | |
ons
F1-F2-Xgoto-Ygoto-Find-Write

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Vegas

Accuracy goal = 1.00%
*Improve Grids
nCalls = 10000
*Integrate

Set Distributions
Display Distributions

Clear statistics
Clear grid & statistics

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
D1,u1->e2,E2,e1,E1,u1,D1	7.9393E-06	7.2E-07
D1,u1->e2,E2,e2,E2,u2,D2	7.3862E-06	6.5E-07
u1,D1->e2,E2,e2,E2,u2,D2	7.2914E-06	6.8E-07
D1,u1->e2,E2,e1,E1,u2,D2	6.9902E-06	6.8E-07
D1,u1->e1,E1,e1,E1,u2,D2	6.9218E-06	7.1E-07
u1,D1->e1,E1,e1,E1,u1,D1	6.5905E-06	6.7E-07
u1,D1->e1,E1,e1,E1,u2,D2	6.4786E-06	7.0E-07
D1,u1->e2,E2,e2,E2,u1,D1	6.4307E-06	6.4E-07
u1,D1->e1,E1,e2,E2,u1,D1	6.3256E-06	6.2E-07
u1,D1->e2,E2,e1,E1,u1,D1	6.3093E-06	6.6E-07
u1,D1->e2,E2,e2,E2,u1,D1	6.1824E-06	7.3E-07
u1,D1->e1,E1,e2,E2,u2,D2	6.0138E-06	6.5E-07
D1,u1->e1,E1,e2,E2,u1,D1	5.8774E-06	7.4E-07
D1,u1->e1,E1,e1,E1,u1,D1	5.8457E-06	6.3E-07
D1,u1->e1,E1,e2,E2,u2,D2	5.8199E-06	6.8E-07

PgDn

Total	cs(pb)	% Error
	1.5118E-04	1.9E+00

Vegas

*Integrate

XXXlculation in progress. Calculation in progress.

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
D1,u1->e2,E2,e1,E1,u1,D1	7.4272E-06	3.5E-07
D1,u1->e2,E2,e2,E2,u2,D2	7.2880E-06	3.5E-07
D1,u1->e1,E1,e1,E1,u2,D2	7.0239E-06	3.5E-07
u1,D1->e1,E1,e1,E1,u2,D2	6.9556E-06	3.5E-07
u1,D1->e2,E2,e2,E2,u2,D2	6.9145E-06	3.5E-07
D1,u1->e1,E1,e2,E2,u1,D1	6.8190E-06	3.5E-07
D1,u1->e2,E2,e1,E1,u2,D2	6.7971E-06	3.5E-07
u1,D1->e1,E1,e2,E2,u1,D1	6.7477E-06	3.5E-07
u1,D1->e1,E1,e2,E2,u2,D2	6.7157E-06	3.5E-07
u1,D1->e2,E2,e1,E1,u1,D1	6.6293E-06	3.5E-07
u1,D1->e2,E2,e1,E1,u2,D2	6.5961E-06	3.5E-07
u1,D1->e2,E2,e2,E2,u1,D1	6.4296E-06	3.5E-07
D1,u1->e2,E2,e2,E2,u1,D1	6.3773E-06	3.5E-07
u1,D1->e1,E1,e1,E1,u1,D1	6.2900E-06	3.5E-07
D1,u1->e1,E1,e2,E2,u2,D2	6.2375E-06	3.5E-07

PgDn

Total	cs(pb)	% Error
	1.5559E-04	1.0E+00

Vegas

Accuracy goal = 1.00%
*Improve Grids
nCalls = 10000
*Integrate

Set Distributions
Display Distributions

Clear statistics
Clear grid & statistics

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
D1,u1->e2,E2,e1,E1,u1,D1	7.4272E-06	3.5E-07
D1,u1->e2,E2,e2,E2,u2,D2	7.2880E-06	3.5E-07
D1,u1->e1,E1,e1,E1,u2,D2	7.0239E-06	3.5E-07
u1,D1->e1,E1,e1,E1,u2,D2	6.9556E-06	3.5E-07
u1,D1->e2,E2,e2,E2,u2,D2	6.9145E-06	3.5E-07
D1,u1->e1,E1,e2,E2,u1,D1	6.8190E-06	3.5E-07
D1,u1->e2,E2,e1,E1,u2,D2	6.7971E-06	3.5E-07
u1,D1->e1,E1,e2,E2,u1,D1	6.7477E-06	3.5E-07
u1,D1->e1,E1,e2,E2,u2,D2	6.7157E-06	3.5E-07
u1,D1->e2,E2,e1,E1,u1,D1	6.6293E-06	3.5E-07
u1,D1->e2,E2,e1,E1,u2,D2	6.5961E-06	3.5E-07
u1,D1->e2,E2,e2,E2,u1,D1	6.4296E-06	3.5E-07
D1,u1->e2,E2,e2,E2,u1,D1	6.3773E-06	3.5E-07
u1,D1->e1,E1,e1,E1,u1,D1	6.2900E-06	3.5E-07
D1,u1->e1,E1,e2,E2,u2,D2	6.2375E-06	3.5E-07

PgDn

Total	cs(pb)	% Error
	1.5559E-04	1.0E+00

Vegas

<
Accuracy goal = 1.00%
*Improve Grids
nCalls = 10000
*Integrate

Set Distributions
Display Distributions

Clear statistics
Clear grid & statistics

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
D1,u1->e2,E2,e1,E1,u1,D1	7.4272E-06	3.5E-07
D1,u1->e2,E2,e2,E2,u2,D2	7.2880E-06	3.5E-07
D1,u1->e1,E1,e1,E1,u2,D2	7.0239E-06	3.5E-07
u1,D1->e1,E1,e1,E1,u2,D2	6.9556E-06	3.5E-07
u1,D1->e2,E2,e2,E2,u2,D2	6.9145E-06	3.5E-07
D1,u1->e1,E1,e2,E2,u1,D1	6.8190E-06	3.5E-07
D1,u1->e2,E2,e1,E1,u2,D2	6.7971E-06	3.5E-07
u1,D1->e1,E1,e2,E2,u1,D1	6.7477E-06	3.5E-07
u1,D1->e1,E1,e2,E2,u2,D2	6.7157E-06	3.5E-07
u1,D1->e2,E2,e1,E1,u1,D1	6.6293E-06	3.5E-07
u1,D1->e2,E2,e1,E1,u2,D2	6.5961E-06	3.5E-07
u1,D1->e2,E2,e2,E2,u1,D1	6.4296E-06	3.5E-07
D1,u1->e2,E2,e2,E2,u1,D1	6.3773E-06	3.5E-07
u1,D1->e1,E1,e1,E1,u1,D1	6.2900E-06	3.5E-07
D1,u1->e1,E1,e2,E2,u2,D2	6.2375E-06	3.5E-07

PgDn

Total	cs(pb)	% Error
	1.5559E-04	1.0E+00

Vegas

Display Distributions

Distributions

<

M(j,j,l+,l-)

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
D1,u1->e2,E2,e1,E1,u1,D1	7.4272E-06	3.5E-07
D1,u1->e2,E2,e2,E2,u2,D2	7.2880E-06	3.5E-07
D1,u1->e1,E1,e1,E1,u2,D2	7.0239E-06	3.5E-07
u1,D1->e1,E1,e1,E1,u2,D2	6.9556E-06	3.5E-07
u1,D1->e2,E2,e2,E2,u2,D2	6.9145E-06	3.5E-07
D1,u1->e1,E1,e2,E2,u1,D1	6.8190E-06	3.5E-07
D1,u1->e2,E2,e1,E1,u2,D2	6.7971E-06	3.5E-07
u1,D1->e1,E1,e2,E2,u1,D1	6.7477E-06	3.5E-07
u1,D1->e1,E1,e2,E2,u2,D2	6.7157E-06	3.5E-07
u1,D1->e2,E2,e1,E1,u1,D1	6.6293E-06	3.5E-07
u1,D1->e2,E2,e1,E1,u2,D2	6.5961E-06	3.5E-07
u1,D1->e2,E2,e2,E2,u1,D1	6.4296E-06	3.5E-07
D1,u1->e2,E2,e2,E2,u1,D1	6.3773E-06	3.5E-07
u1,D1->e1,E1,e1,E1,u1,D1	6.2900E-06	3.5E-07
D1,u1->e1,E1,e2,E2,u2,D2	6.2375E-06	3.5E-07

PgDn

Total	cs(pb)	% Error
	1.5559E-04	1.0E+00

Vegas

Display Distributions

Distributions

M(j,j,l+,l-)

number of bins

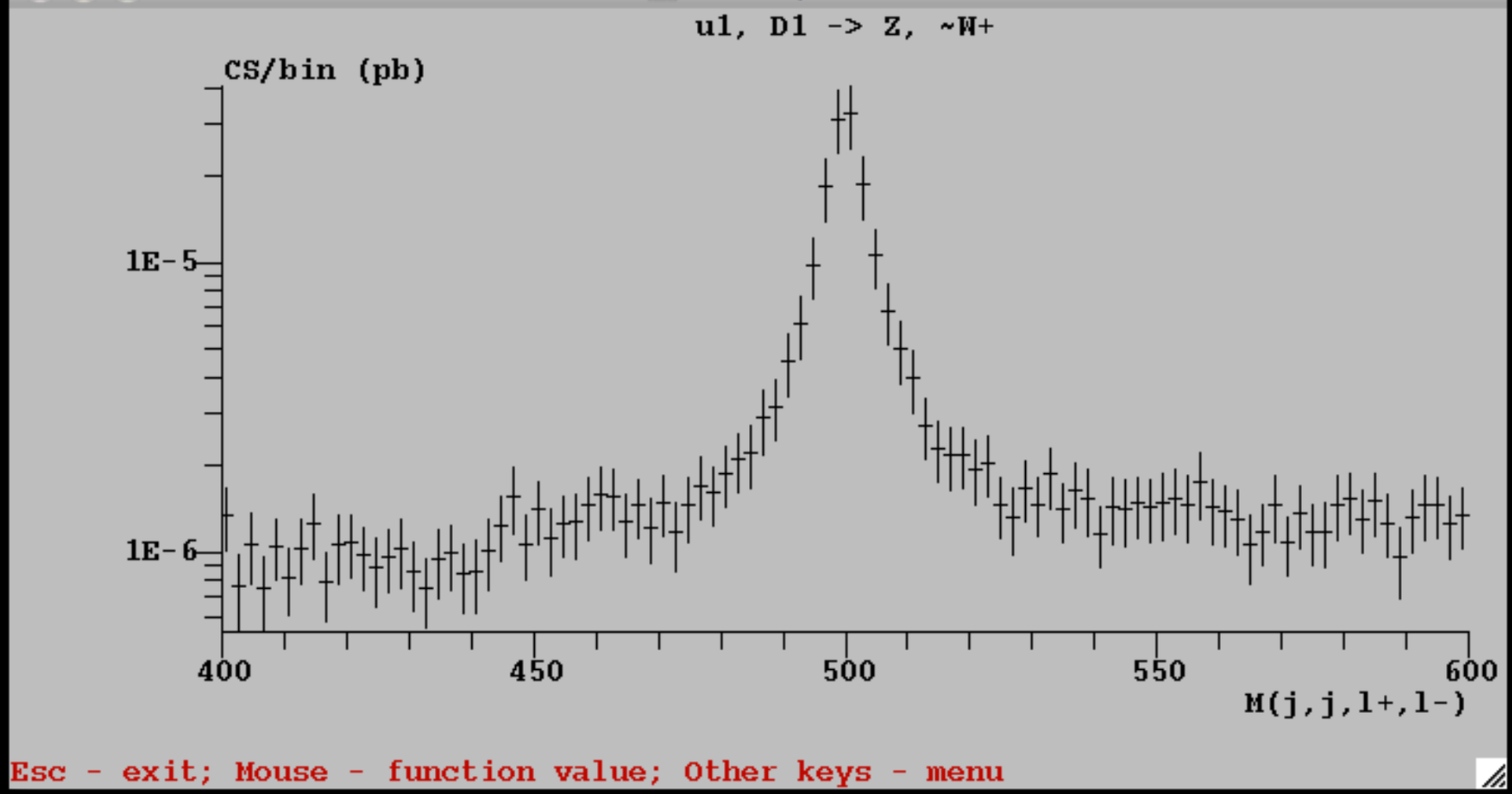
<

300
150
100
75
60
50
30
25

PgDn

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num



Esc - exit; Mouse - function value; Other keys - menu

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
D1,u1->e2,E2,e1,E1,u1,D1	7.4272E-06	3.5E-07
D1,u1->e2,E2,e2,E2,u2,D2	7.2880E-06	3.5E-07
D1,u1->e1,E1,e1,E1,u2,D2	7.0239E-06	3.5E-07
u1,D1->e1,E1,e1,E1,u2,D2	6.9556E-06	3.5E-07
u1,D1->e2,E2,e2,E2,u2,D2	6.9145E-06	3.5E-07
D1,u1->e1,E1,e2,E2,u1,D1	6.8190E-06	3.5E-07
D1,u1->e2,E2,e1,E1,u2,D2	6.7971E-06	3.5E-07
u1,D1->e1,E1,e2,E2,u1,D1	6.7477E-06	3.5E-07
u1,D1->e1,E1,e2,E2,u2,D2	6.7157E-06	3.5E-07
u1,D1->e2,E2,e1,E1,u1,D1	6.6293E-06	3.5E-07
u1,D1->e2,E2,e1,E1,u2,D2	6.5961E-06	3.5E-07
u1,D1->e2,E2,e2,E2,u1,D1	6.4296E-06	3.5E-07
D1,u1->e2,E2,e2,E2,u1,D1	6.3773E-06	3.5E-07
u1,D1->e1,E1,e1,E1,u1,D1	6.2900E-06	3.5E-07
D1,u1->e1,E1,e2,E2,u2,D2	6.2375E-06	3.5E-07

PgDn

Total	cs(pb)	% Error
	1.5559E-04	1.0E+00

Vegas

Accuracy goal = 1.00%
*Improve Grids
nCalls = 10000
*Integrate

Set Distributions
Display Distributions

Clear statistics
Clear grid & statistics

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
D1,u1->e2,E2,e1,E1,u1,D1	7.4272E-06	3.5E-07
D1,u1->e2,E2,e2,E2,u2,D2	7.2880E-06	3.5E-07
D1,u1->e1,E1,e1,E1,u2,D2	7.0239E-06	3.5E-07
u1,D1->e1,E1,e1,E1,u2,D2	6.9556E-06	3.5E-07
u1,D1->e2,E2,e2,E2,u2,D2	6.9145E-06	3.5E-07
D1,u1->e1,E1,e2,E2,u1,D1	6.8190E-06	3.5E-07
D1,u1->e2,E2,e1,E1,u2,D2	6.7971E-06	3.5E-
u1,D1->e1,E1,e2,E2,u1,D1	6.7477E-06	3.5E-07
u1,D1->e1,E1,e2,E2,u2,D2	6.7157E-06	3.5E-07
u1,D1->e2,E2,e1,E1,u1,D1	6.6293E-06	3.5E-07
u1,D1->e2,E2,e1,E1,u2,D2	6.5961E-06	3.5E-07
u1,D1->e2,E2,e2,E2,u1,D1	6.4296E-06	3.5E-07
D1,u1->e2,E2,e2,E2,u1,D1	6.3773E-06	3.5E-07
u1,D1->e1,E1,e1,E1,u1,D1	6.2900E-06	3.5E-07
D1,u1->e1,E1,e2,E2,u2,D2	6.2375E-06	3.5E-07

PgDn

Total	cs(pb)	% Error
	1.5559E-04	1.0E+00

Vegas

Accuracy goal = 1.00%

Enter new value 0.1

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
D1,u1->e2,E2,e1,E1,u1,D1	7.4272E-06	3.5E-07
D1,u1->e2,E2,e2,E2,u2,D2	7.2880E-06	3.5E-07
D1,u1->e1,E1,e1,E1,u2,D2	7.0239E-06	3.5E-07
u1,D1->e1,E1,e1,E1,u2,D2	6.9556E-06	3.5E-07
u1,D1->e2,E2,e2,E2,u2,D2	6.9145E-06	3.5E-07
D1,u1->e1,E1,e2,E2,u1,D1	6.8190E-06	3.5E-07
D1,u1->e2,E2,e1,E1,u2,D2	6.7971E-06	3.5E-07
u1,D1->e1,E1,e2,E2,u1,D1	6.7477E-06	3.5E-07
u1,D1->e1,E1,e2,E2,u2,D2	6.7157E-06	3.5E-07
u1,D1->e2,E2,e1,E1,u1,D1	6.6293E-06	3.5E-07
u1,D1->e2,E2,e1,E1,u2,D2	6.5961E-06	3.5E-07
u1,D1->e2,E2,e2,E2,u1,D1	6.4296E-06	3.5E-07
D1,u1->e2,E2,e2,E2,u1,D1	6.3773E-06	3.5E-07
u1,D1->e1,E1,e1,E1,u1,D1	6.2900E-06	3.5E-07
D1,u1->e1,E1,e2,E2,u2,D2	6.2375E-06	3.5E-07

PgDn

Total	cs(pb)	% Error
	1.5559E-04	1.0E+00

Vegas

<

Accuracy goal = 0.10%
*Improve Grids
nCalls = 10000
*Integrate

Set Distributions
Display Distributions

Clear statistics
Clear grid & statistics

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
D1,u1->e2,E2,e2,E2,u2,D2	7.3446E-06	3.1E-07
D1,u1->e2,E2,e1,E1,u1,D1	7.2790E-06	3.1E-07
u1,D1->e1,E1,e2,E2,u1,D1	7.0133E-06	3.1E-07
u1,D1->e1,E1,e1,E1,u2,D2	6.9985E-06	3.1E-07
u1,D1->e2,E2,e2,E2,u2,D2	6.9154E-06	3.1E-07
D1,u1->e1,E1,e1,E1,u2,D2	6.8539E-06	3.1E-07
D1,u1->e2,E2,e1,E1,u2,D2	6.8298E-06	3.1E-07
u1,D1->e1,E1,e2,E2,u2,D2	6.8224E-06	3.1E-07
D1,u1->e2,E2,e2,E2,u1,D1	6.7006E-06	3.1E-07
u1,D1->e2,E2,e2,E2,u1,D1	6.6753E-06	3.1E-07
D1,u1->e1,E1,e2,E2,u1,D1	6.6354E-06	3.1E-07
u1,D1->e2,E2,e1,E1,u1,D1	6.6149E-06	3.1E-07
u1,D1->e2,E2,e1,E1,u2,D2	6.6073E-06	3.1E-07
u1,D1->e1,E1,e1,E1,u1,D1	6.4818E-06	3.1E-07
D1,u1->e1,E1,e2,E2,u2,D2	6.1551E-06	3.1E-07

PgDn

Total	cs(pb)	% Error
	1.5626E-04	8.6E-01

Vegas

*Integrate

XXXXXXXation in progress. Calculation in progress.

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
D1,u1->e2,E2,e2,E2,u2,D2	7.2446E-06	2.0E-07
D1,u1->e2,E2,e1,E1,u1,D1	7.2028E-06	2.0E-07
D1,u1->e1,E1,e1,E1,u2,D2	7.1881E-06	2.0E-07
u1,D1->e2,E2,e2,E2,u1,D1	6.9927E-06	2.0E-07
u1,D1->e2,E2,e2,E2,u2,D2	6.9751E-06	2.0E-07
D1,u1->e2,E2,e1,E1,u2,D2	6.9587E-06	2.0E-07
u1,D1->e2,E2,e1,E1,u1,D1	6.9083E-06	2.0E-07
u1,D1->e2,E2,e1,E1,u2,D2	6.9079E-06	2.0E-07
u1,D1->e1,E1,e2,E2,u1,D1	6.9062E-06	2.0E-07
u1,D1->e1,E1,e1,E1,u2,D2	6.8111E-06	2.0E-07
u1,D1->e1,E1,e2,E2,u2,D2	6.7647E-06	2.0E-07
u1,D1->e1,E1,e1,E1,u1,D1	6.6639E-06	2.0E-07
D1,u1->e2,E2,e2,E2,u1,D1	6.6522E-06	2.0E-07
D1,u1->e1,E1,e2,E2,u1,D1	6.6486E-06	2.0E-07
D1,u1->e1,E1,e2,E2,u2,D2	6.6300E-06	2.0E-07

PgDn

Total	cs(pb)	% Error
	1.5805E-04	5.9E-01

Vegas

*Integrate

XXXXXXXXXXXXXXXXXXXXXss. Calculation in progress.

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
D1,u1->e2,E2,e2,E2,u2,D2	7.0456E-06	9.3E-08
u1,D1->e1,E1,e1,E1,u2,D2	6.9720E-06	9.3E-08
D1,u1->e1,E1,e1,E1,u2,D2	6.9719E-06	9.3E-08
D1,u1->e2,E2,e1,E1,u2,D2	6.9416E-06	9.3E-08
u1,D1->e1,E1,e2,E2,u1,D1	6.9290E-06	9.3E-08
u1,D1->e2,E2,e1,E1,u1,D1	6.9122E-06	9.3E-08
u1,D1->e2,E2,e2,E2,u1,D1	6.8993E-06	9.3E-08
u1,D1->e2,E2,e1,E1,u2,D2	6.8687E-06	9.3E-08
u1,D1->e1,E1,e1,E1,u1,D1	6.8625E-06	9.3E-08
u1,D1->e1,E1,e2,E2,u2,D2	6.8426E-06	9.3E-08
u1,D1->e2,E2,e2,E2,u2,D2	6.8134E-06	9.3E-08
D1,u1->e1,E1,e2,E2,u2,D2	6.7917E-06	9.3E-08
D1,u1->e2,E2,e1,E1,u1,D1	6.7767E-06	9.3E-08
D1,u1->e1,E1,e2,E2,u1,D1	6.7557E-06	9.3E-08
D1,u1->e2,E2,e2,E2,u1,D1	6.6859E-06	9.3E-08

PgDn

Total	cs(pb)	% Error
	1.5864E-04	3.3E-01

Vegas

*Integrate

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXrogress.

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
u1,D1->e1,E1,e1,E1,u2,D2	6.9948E-06	7.3E-08
D1,u1->e2,E2,e2,E2,u2,D2	6.9488E-06	7.3E-08
u1,D1->e2,E2,e1,E1,u2,D2	6.9231E-06	7.3E-08
D1,u1->e1,E1,e1,E1,u2,D2	6.9105E-06	7.3E-08
u1,D1->e2,E2,e1,E1,u1,D1	6.9039E-06	7.3E-08
u1,D1->e1,E1,e2,E2,u1,D1	6.8933E-06	7.3E-08
u1,D1->e2,E2,e2,E2,u1,D1	6.8828E-06	7.3E-08
D1,u1->e2,E2,e1,E1,u2,D2	6.8689E-06	7.3E-08
D1,u1->e1,E1,e2,E2,u2,D2	6.8607E-06	7.3E-08
u1,D1->e1,E1,e2,E2,u2,D2	6.8134E-06	7.3E-08
D1,u1->e2,E2,e1,E1,u1,D1	6.8134E-06	7.3E-08
u1,D1->e1,E1,e1,E1,u1,D1	6.7943E-06	7.3E-08
u1,D1->e2,E2,e2,E2,u2,D2	6.7922E-06	7.3E-08
D1,u1->e2,E2,e2,E2,u1,D1	6.7369E-06	7.3E-08
D1,u1->e1,E1,e1,E1,u1,D1	6.7088E-06	7.3E-08

PgDn

Total	cs(pb)	% Error
	1.5850E-04	2.6E-01

Vegas

<

Accuracy goal = 0.10%
*Improve Grids
nCalls = 10000
*Integrate

Set Distributions
Display Distributions

Clear statistics
Clear grid & statistics

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
u1,D1->e1,E1,e1,E1,u2,D2	6.9948E-06	7.3E-08
D1,u1->e2,E2,e2,E2,u2,D2	6.9488E-06	7.3E-08
u1,D1->e2,E2,e1,E1,u2,D2	6.9231E-06	7.3E-08
D1,u1->e1,E1,e1,E1,u2,D2	6.9105E-06	7.3E-08
u1,D1->e2,E2,e1,E1,u1,D1	6.9039E-06	7.3E-08
u1,D1->e1,E1,e2,E2,u1,D1	6.8933E-06	7.3E-08
u1,D1->e2,E2,e2,E2,u1,D1	6.8828E-06	7.3E-08
D1,u1->e2,E2,e1,E1,u2,D2	6.8689E-06	7.3E-08
D1,u1->e1,E1,e2,E2,u2,D2	6.8607E-06	7.3E-08
u1,D1->e1,E1,e2,E2,u2,D2	6.8134E-06	7.3E-08
D1,u1->e2,E2,e1,E1,u1,D1	6.8134E-06	7.3E-08
u1,D1->e1,E1,e1,E1,u1,D1	6.7943E-06	7.3E-08
u1,D1->e2,E2,e2,E2,u2,D2	6.7922E-06	7.3E-08
D1,u1->e2,E2,e2,E2,u1,D1	6.7369E-06	7.3E-08
D1,u1->e1,E1,e1,E1,u1,D1	6.7088E-06	7.3E-08

PgDn

Total	cs(pb)	% Error
	1.5850E-04	2.6E-01

Vegas

Display Distributions

Distributions

<

M(j,j,l+,l-)

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
u1,D1->e1,E1,e1,E1,u2,D2	6.9948E-06	7.3E-08
D1,u1->e2,E2,e2,E2,u2,D2	6.9488E-06	7.3E-08
u1,D1->e2,E2,e1,E1,u2,D2	6.9231E-06	7.3E-08
D1,u1->e1,E1,e1,E1,u2,D2	6.9105E-06	7.3E-08
u1,D1->e2,E2,e1,E1,u1,D1	6.9039E-06	7.3E-08
u1,D1->e1,E1,e2,E2,u1,D1	6.8933E-06	7.3E-08
u1,D1->e2,E2,e2,E2,u1,D1	6.8828E-06	7.3E-08
D1,u1->e2,E2,e1,E1,u2,D2	6.8689E-06	7.3E-08
D1,u1->e1,E1,e2,E2,u2,D2	6.8607E-06	7.3E-08
u1,D1->e1,E1,e2,E2,u2,D2	6.8134E-06	7.3E-08
D1,u1->e2,E2,e1,E1,u1,D1	6.8134E-06	7.3E-08
u1,D1->e1,E1,e1,E1,u1,D1	6.7943E-06	7.3E-08
u1,D1->e2,E2,e2,E2,u2,D2	6.7922E-06	7.3E-08
D1,u1->e2,E2,e2,E2,u1,D1	6.7369E-06	7.3E-08
D1,u1->e1,E1,e1,E1,u1,D1	6.7088E-06	7.3E-08

PgDn

Total	cs(pb)	% Error
	1.5850E-04	2.6E-01

Vegas

Display Distributions

Distributions

M(j,j,l+,l-)

number of bins

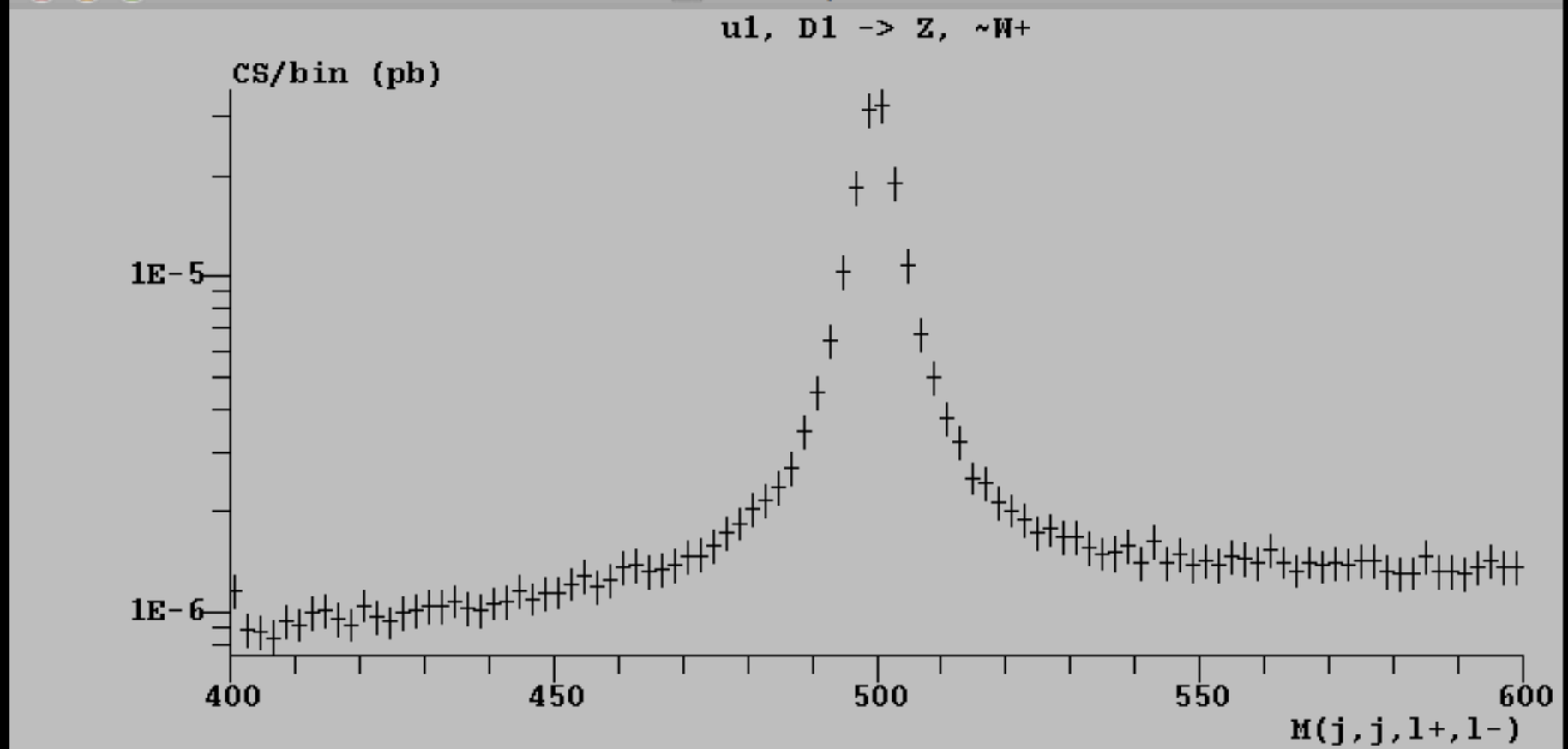
<

300
150
100
75
60
50
30
25

PgDn

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num



Esc - exit; Mouse - function value; Other keys - menu

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
u1,D1->e1,E1,e1,E1,u2,D2	6.9948E-06	7.3E-08
D1,u1->e2,E2,e2,E2,u2,D2	6.9488E-06	7.3E-08
u1,D1->e2,E2,e1,E1,u2,D2	6.9231E-06	7.3E-08
D1,u1->e1,E1,e1,E1,u2,D2	6.9105E-06	7.3E-08
u1,D1->e2,E2,e1,E1,u1,D1	6.9039E-06	7.3E-08
u1,D1->e1,E1,e2,E2,u1,D1	6.8933E-06	7.3E-08
u1,D1->e2,E2,e2,E2,u1,D1	6.8828E-06	7.3E-08
D1,u1->e2,E2,e1,E1,u2,D2	6.8689E-06	7.3E-08
D1,u1->e1,E1,e2,E2,u2,D2	6.8607E-06	7.3E-08
u1,D1->e1,E1,e2,E2,u2,D2	6.8134E-06	7.3E-08
D1,u1->e2,E2,e1,E1,u1,D1	6.8134E-06	7.3E-08
u1,D1->e1,E1,e1,E1,u1,D1	6.7943E-06	7.3E-08
u1,D1->e2,E2,e2,E2,u2,D2	6.7922E-06	7.3E-08
D1,u1->e2,E2,e2,E2,u1,D1	6.7369E-06	7.3E-08
D1,u1->e1,E1,e1,E1,u1,D1	6.7088E-06	7.3E-08

PgDn

Total	cs(pb)	% Error
	1.5850E-04	2.6E-01

Vegas

<

Accuracy goal = 0.10%
*Improve Grids
nCalls = 10000
*Integrate

Set Distributions
Display Distributions

Clear statistics
Clear grid & statistics

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
u1,D1->e1,E1,e1,E1,u2,D2	6.9948E-06	7.3E-08
D1,u1->e2,E2,e2,E2,u2,D2	6.9488E-06	7.3E-08
u1,D1->e2,E2,e1,E1,u2,D2	6.9231E-06	7.3E-08
D1,u1->e1,E1,e1,E1,u2,D2	6.9105E-06	7.3E-08
u1,D1->e2,E2,e1,E1,u1,D1	6.9039E-06	7.3E-08
u1,D1->e1,E1,e2,E2,u1,D1	6.8933E-06	7.3E-08
u1,D1->e2,E2,e2,E2,u1,D1	6.8828E-06	7.3E-08
D1,u1->e2,E2,e1,E1,u2,D2	6.8689E-06	7.3E-08
D1,u1->e1,E1,e2,E2,u2,D2	6.8607E-06	7.3E-08
u1,D1->e1,E1,	6.8134E-06	7.3E-08
D1,u1->e2,E2,	6.8134E-06	7.3E-08
u1,D1->e1,E1,	6.7943E-06	7.3E-08
u1,D1->e2,E2,e2,E2,u2,D2	6.7922E-06	7.3E-08
D1,u1->e2,E2,e2,E2,u1,D1	6.7369E-06	7.3E-08
D1,u1->e1,E1,e1,E1,u1,D1	6.7088E-06	7.3E-08

Quit session?
(Y / N ?)

PgDn

Total	cs(pb)	% Error
	1.5850E-04	2.6E-01

Vegas

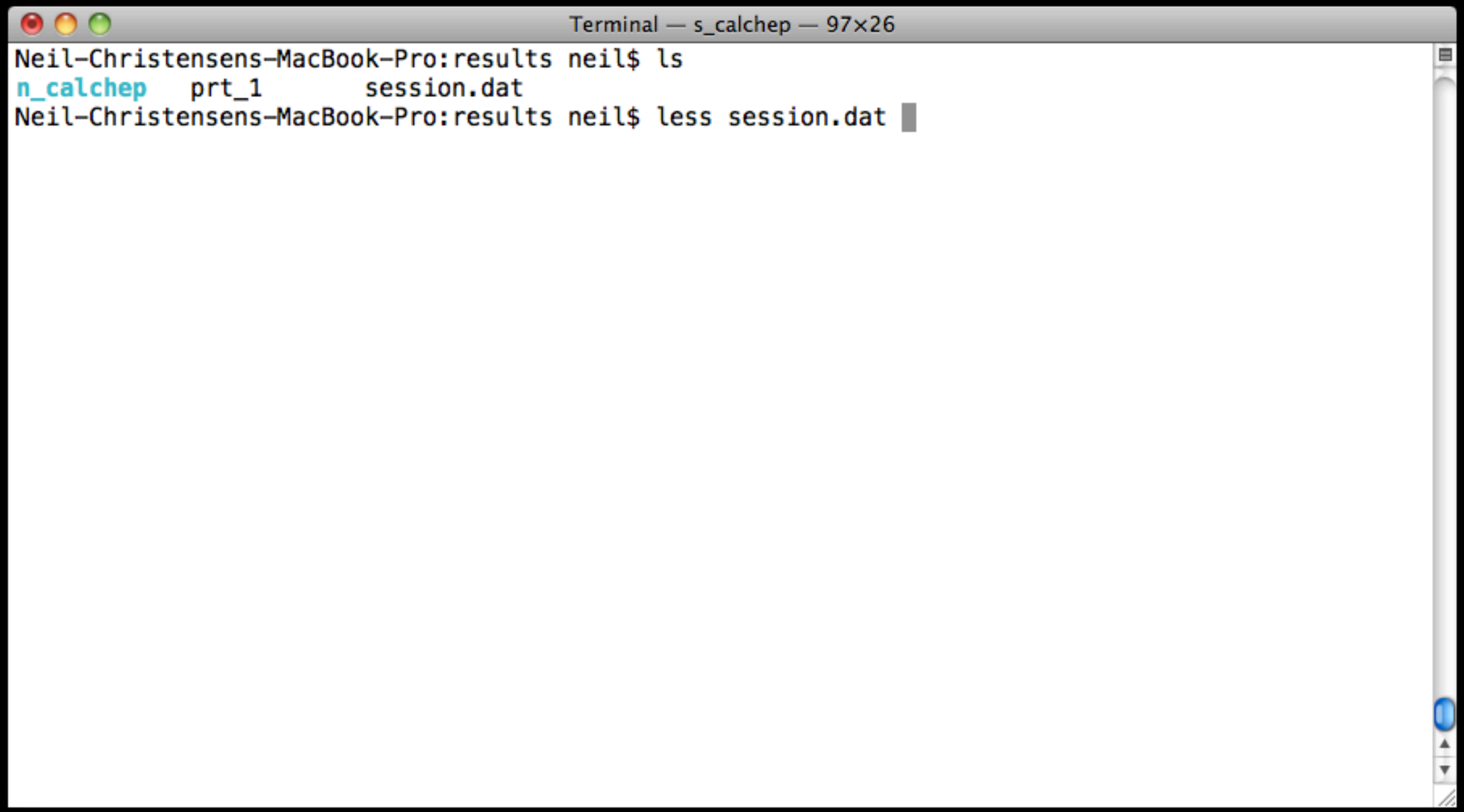
Accuracy goal = 0.10%
*Improve Grids
nCalls = 10000
*Integrate

Set Distributions
Display Distributions

Clear statistics
Clear grid & statistics

Terminal — s_calchep — 97×26

```
Neil-Christensens-MacBook-Pro:results neil$ ls
n_calchep   prt_1       session.dat
Neil-Christensens-MacBook-Pro:results neil$
```


Terminal — s_calchep — 97×26
Neil-Christensens-MacBook-Pro:results neil$ ls
n_calchep	prt_1	session.dat
Neil-Christensens-MacBook-Pro:results neil$ less session.dat

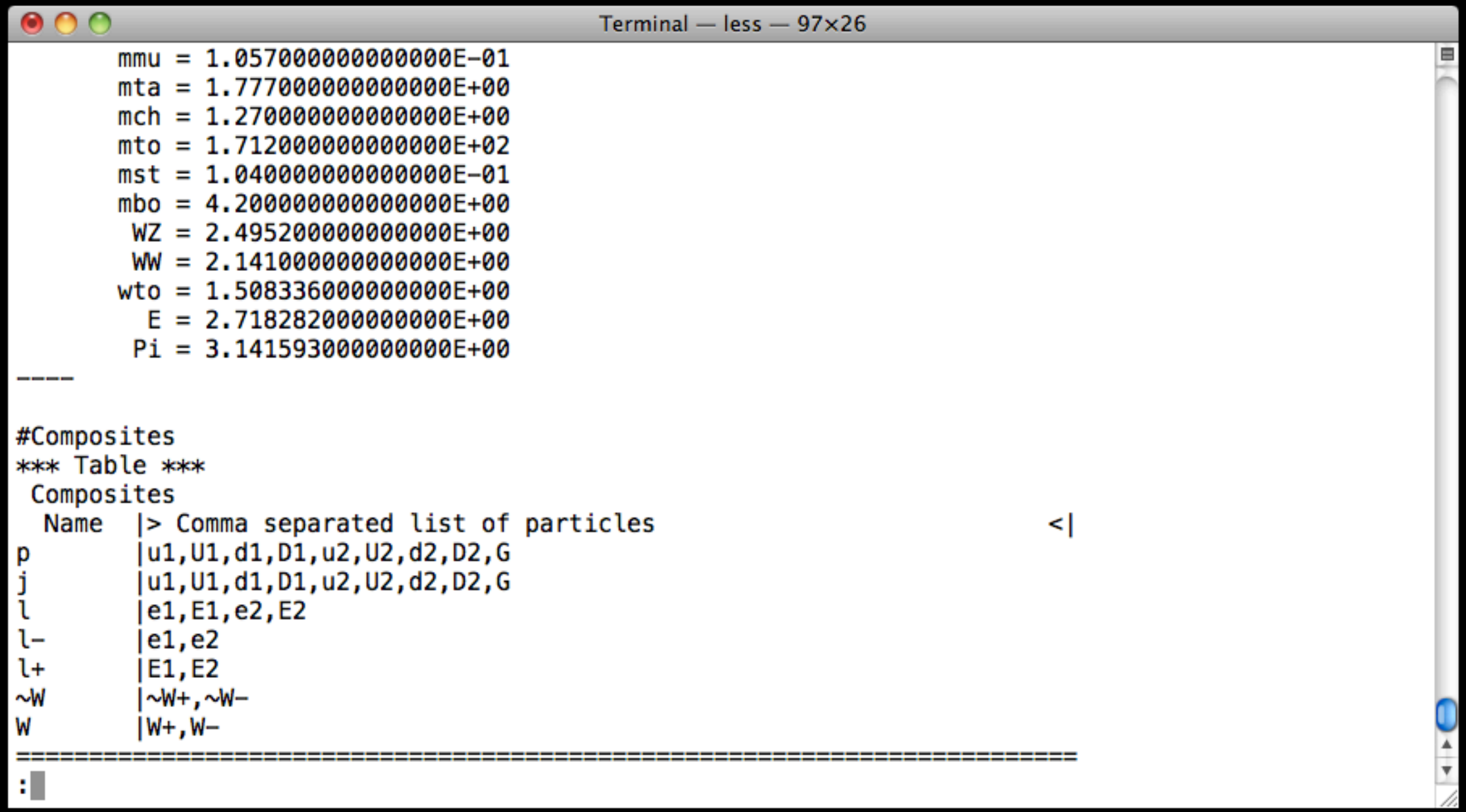
Terminal — less — 97×26

```
#Production_Decay :  N Productions=8   N Decays=8  N pde states=64
modelDir=/Users/neil/physics/CalcHEP/ch/models
modelNum=3  ForceUG=0

#Session_number 1
#Initial_state  inP1=7.000000E+03  inP2=7.000000E+03
 Polarizations= { 0.000000E+00  0.000000E+00 }
  StrFun1="PDT:cteq6l(proton)" 2212
  StrFun2="PDT:cteq6l(proton)" 2212

#Vegas_calls Acc Goal=0.100000  nCalls=10000
#Random 158757CFC31A

#Physical_Parameters
     aEWM1 = 1.27925000000000E+02
        Gf = 1.16637000000000E-05
        aS = 1.17600000000000E-01
        ZM = 9.11876000000000E+01
        MF = 4.00000000000000E+03
         a = 1.00000000000000E+00
        S0 = -1.01128000000000E-02
        MZ = 9.11876000000000E+01
        MW = 8.03980000000000E+01
       MWP = 5.00000000000000E+02
session.dat
```


Terminal — less — 97×26
mmu = 1.057000000000000E-01
mta = 1.777000000000000E+00
mch = 1.270000000000000E+00
mto = 1.712000000000000E+02
mst = 1.040000000000000E-01
mbo = 4.200000000000000E+00
WZ = 2.495200000000000E+00
WW = 2.141000000000000E+00
wto = 1.508336000000000E+00
E = 2.718282000000000E+00
Pi = 3.141593000000000E+00

#Composites
*** Table ***
Composites
Name |> Comma separated list of particles <|
p |u1,U1,d1,D1,u2,U2,d2,D2,G
j |u1,U1,d1,D1,u2,U2,d2,D2,G
l |e1,E1,e2,E2
l- |e1,e2
l+ |E1,E2
~W |~W+,~W-
W |W+,W-
:

Terminal — less — 97×26

```
#Cuts
*** Table ***
 Cuts
!|  Parameter  |> Min bound <|> Max bound <|
 |T(j)         |20           |
 |T(l)         |20           |
 |N(j)         |-4           |4
 |N(l)         |-2.5         |2.5
 |J(j,j)       |0.4          |
 |J(j,l)       |0.4          |
=========================================

#Distribution_Definitions
*** Table ***
Distributions
Parameter_1 |> Min_1  <|> Max_1  <|Parameter_2|> Min_2  <|> Max_2  <|
M(j,j,l+,l-)|400       |600       |            |           |           |
=============================================================================

#Breit-Wigner BW range    2.700000
t-channel widths 0
GI trick in s-  0
GI trick in t-  0
Smearing 1
:
```

Terminal — less — 97×26

```
#Breit-Wigner BW range    2.700000
t-channel widths 0
GI trick in s-  0
GI trick in t-  0
Smearing 1

#QCD alphaPDF=1 alpha(MZ)=1.176000E-01 NF=5 Order=2 MbMb=4.200000E+00 Mtp=1.712000E+02
#Subprocess ----------------------------( u1, D1 -> Z, ~W+ )-----------------------------
#Kinematical_scheme
12 -> 3 , 4

#Regularization
*** Table ***
 Regularization
 Momentum     |> Mass  <|> Width <| Power|
=========================================

#QCD_Scale Scale= M12
#Vegas_integral  0.000000000000000E+00 0.000000000000000E+00 0.000000000000000E+00 0 1 0 0
#VEGAS_Grid  Vegas_grid: dim=3  size=50
 0.000000000000000E+00 5.643891401397878E-04 9.462405138703724E-04 1.222629835697207E-03 1.461286
003011089E-03 1.699832332993916E-03 1.932934655165525E-03 2.159718628450779E-03 2.390306548401956
E-03 2.626309979298574E-03 2.867939728475883E-03 3.114742339470073E-03 3.363068866528844E-03 3.61
853609167789 6E-03 3.885397180367 68E-03 4.174065316032836E-03 4.468560484583802E-03 4.76844162866
7253E-03 5.078196815018447E-03 5.407646344480247E-03 5.745933604588682E-03 6.115000165224450E-03
:
```

Terminal — s_calchep — 97×26

```
Neil-Christensens-MacBook-Pro:results neil$ ls
n_calchep   prt_1       session.dat
Neil-Christensens-MacBook-Pro:results neil$ less session.dat
Neil-Christensens-MacBook-Pro:results neil$ ./n_calchep &
```

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
u1,D1->e1,E1,e1,E1,u2,D2	6.9948E-06	7.3E-08
D1,u1->e2,E2,e2,E2,u2,D2	6.9488E-06	7.3E-08
u1,D1->e2,E2,e1,E1,u2,D2	6.9231E-06	7.3E-08
D1,u1->e1,E1,e1,E1,u2,D2	6.9105E-06	7.3E-08
u1,D1->e2,E2,e1,E1,u1,D1	6.9039E-06	7.3E-08
u1,D1->e1,E1,e2,E2,u1,D1	6.8933E-06	7.3E-08
u1,D1->e2,E2,e2,E2,u1,D1	6.8828E-06	7.3E-08
D1,u1->e2,E2,e1,E1,u2,D2	6.8689E-06	7.3E-08
D1,u1->e1,E1,e2,E2,u2,D2	6.8607E-06	7.3E-08
u1,D1->e1,E1,e2,E2,u2,D2	6.8134E-06	7.3E-08
D1,u1->e2,E2,e1,E1,u1,D1	6.8134E-06	7.3E-08
u1,D1->e1,E1,e1,E1,u1,D1	6.7943E-06	7.3E-08
u1,D1->e2,E2,e2,E2,u2,D2	6.7922E-06	7.3E-08
D1,u1->e2,E2,e2,E2,u1,D1	6.7369E-06	7.3E-08
D1,u1->e1,E1,e1,E1,u1,D1	6.7088E-06	7.3E-08

PgDn

Total	cs(pb)	% Error
	1.5850E-04	2.6E-01

<
Composites
Processes
Decays
IN state
Model parameters
Constraints
QCD coupling
Breit-Wigner
Cuts
Phase space mapping
Vegas

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
u1,D1->e1,E1,e1,E1,u2,D2	6.9948E-06	7.3E-08
D1,u1->e2,E2,e2,E2,u2,D2	6.9488E-06	7.3E-08
u1,D1->e2,E2,e1,E1,u2,D2	6.9231E-06	7.3E-08
D1,u1->e1,E1,e1,E1,u2,D2	6.9105E-06	7.3E-08
u1,D1->e2,E2,e1,E1,u1,D1	6.9039E-06	7.3E-08
u1,D1->e1,E1,e2,E2,u1,D1	6.8933E-06	7.3E-08
u1,D1->e2,E2,e2,E2,u1,D1	6.8828E-06	7.3E-08
D1,u1->e2,E2,e1,E1,u2,D2	6.8689E-06	7.3E-08
D1,u1->e1,E1,e2,E2,u2,D2	6.8607E-06	7.3E-08
u1,D1->e1,E1,e2,E2,u2,D2	6.8134E-06	7.3E-08
D1,u1->e2,E2,e1,E1,u1,D1	6.8134E-06	7.3E-08
u1,D1->e1,E1,e1,E1,u1,D1	6.7943E-06	7.3E-08
u1,D1->e2,E2,e2,E2,u2,D2	6.7922E-06	7.3E-08
D1,u1->e2,E2,e2,E2,u1,D1	6.7369E-06	7.3E-08
D1,u1->e1,E1,e1,E1,u1,D1	6.7088E-06	7.3E-08

PgDn

Total	cs(pb)	% Error
	1.5850E-04	2.6E-01

<

Composites
Processes
Decays
IN state
Model parameters
Constraints
QCD coupling
Breit-Wigner
Cuts
Phase space mapping
Vegas

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
u1,D1->e1,E1,e1,E1,u2,D2	6.9948E-06	7.3E-08
D1,u1->e2,E2,e2,E2,u2,D2	6.9488E-06	7.3E-08
u1,D1->e2,E2,e1,E1,u2,D2	6.9231E-06	7.3E-08
D1,u1->e1,E1,e1,E1,u2,D2	6.9105E-06	7.3E-08
u1,D1->e2,E2,e1,E1,u1,D1	6.9039E-06	7.3E-08
u1,D1->e1,E1,e2,E2,u1,D1	6.8933E-06	7.3E-08
u1,D1->e2,E2,e2,E2,u1,D1	6.8828E-06	7.3E-08
D1,u1->e2,E2,e1,E1,u2,D2	6.8689E-06	7.3E-08
D1,u1->e1,E1,e2,E2,u2,D2	6.8607E-06	7.3E-08
u1,D1->e1,E1,e2,E2,u2,D2	6.8134E-06	7.3E-08
D1,u1->e2,E2,e1,E1,u1,D1	6.8134E-06	7.3E-08
u1,D1->e1,E1,e1,E1,u1,D1	6.7943E-06	7.3E-08
u1,D1->e2,E2,e2,E2,u2,D2	6.7922E-06	7.3E-08
D1,u1->e2,E2,e2,E2,u1,D1	6.7369E-06	7.3E-08
D1,u1->e1,E1,e1,E1,u1,D1	6.7088E-06	7.3E-08

PgDn

Total	cs(pb)	% Error
	1.5850E-04	2.6E-01

Vegas

<

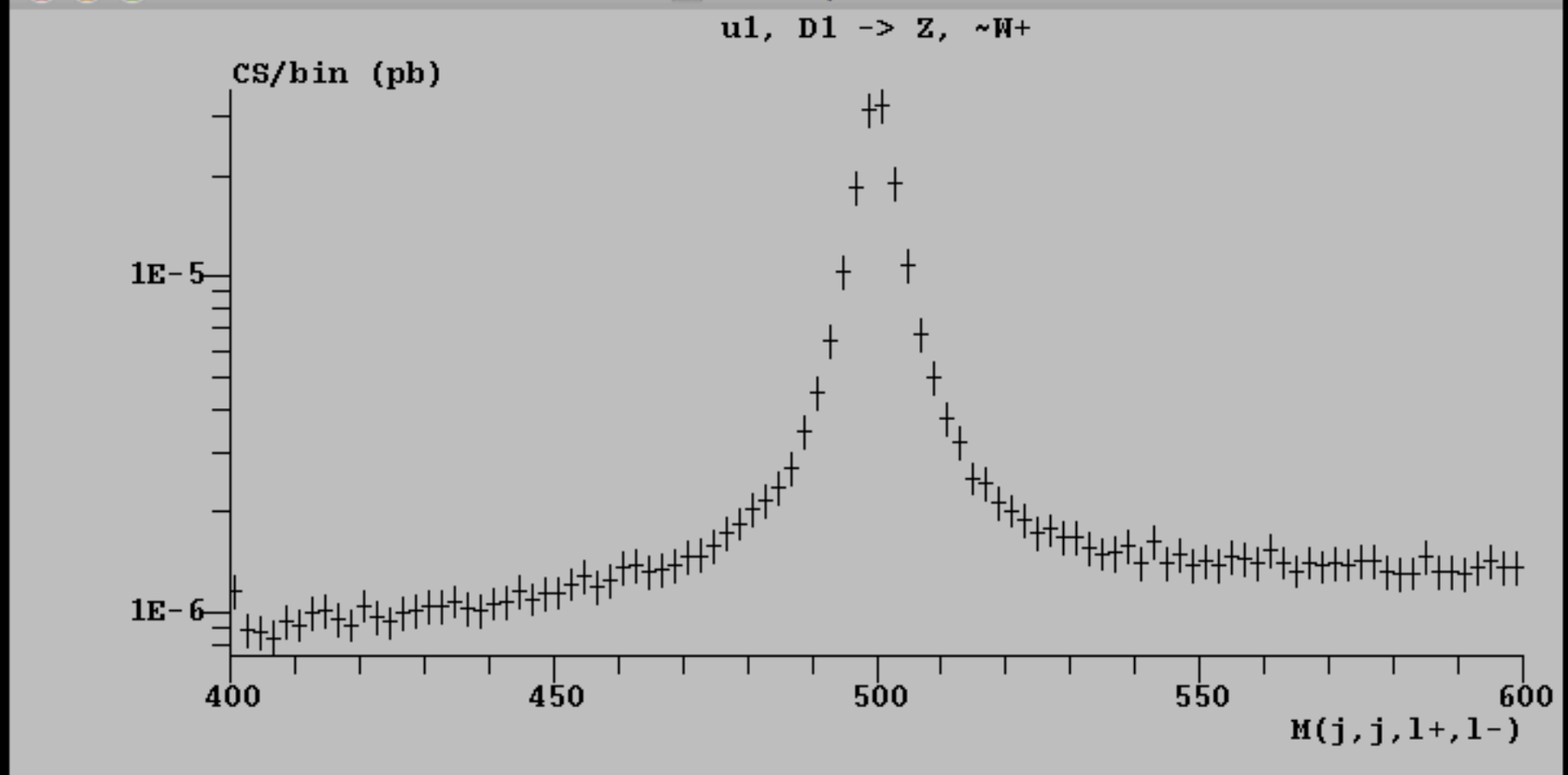
Accuracy goal = 0.10%
*Improve Grids
nCalls = 10000
*Integrate

Set Distributions
Display Distributions

Clear statistics
Clear grid & statistics

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num



Esc - exit; Mouse - function value; Other keys - menu

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
u1,D1->e1,E1,e1,E1,u2,D2	6.9948E-06	7.3E-08
D1,u1->e2,E2,e2,E2,u2,D2	6.9488E-06	7.3E-08
u1,D1->e2,E2,e1,E1,u2,D2	6.9231E-06	7.3E-08
D1,u1->e1,E1,e1,E1,u2,D2	6.9105E-06	7.3E-08
u1,D1->e2,E2,e1,E1,u1,D1	6.9039E-06	7.3E-08
u1,D1->e1,E1,e2,E2,u1,D1	6.8933E-06	7.3E-08
u1,D1->e2,E2,e2,E2,u1,D1	6.8828E-06	7.3E-08
D1,u1->e2,E2,e1,E1,u2,D2	6.8689E-06	7.3E-08
D1,u1->e1,E1,e2,E2,u2,D2	6.8607E-06	7.3E-08
u1,D1->e1,E1,e2,E2,u2,D2	6.8134E-06	7.3E-08
D1,u1->e2,E2,e1,E1,u1,D1	6.8134E-06	7.3E-08
u1,D1->e1,E1,e1,E1,u1,D1	6.7943E-06	7.3E-08
u1,D1->e2,E2,e2,E2,u2,D2	6.7922E-06	7.3E-08
D1,u1->e2,E2,e2,E2,u1,D1	6.7369E-06	7.3E-08
D1,u1->e1,E1,e1,E1,u1,D1	6.7088E-06	7.3E-08

PgDn

Total	cs(pb)	% Error
	1.5850E-04	2.6E-01

Vegas

Accuracy goal = 0.10%
*Improve Grids
nCalls = 10000
*Integrate

Set Distributions
Display Distributions

Clear statistics
Clear grid & statistics

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

Model: HLS (Final)
MC session: 1(continue)

Processes	cs(pb)	Error
u1,D1->e1,E1,e1,E1,u2,D2	6.9947E-06	5.8E-08
u1,D1->e2,E2,e1,E1,u1,D1	6.9061E-06	5.8E-08
D1,u1->e2,E2,e2,E2,u2,D2	6.9040E-06	5.8E-08
D1,u1->e2,E2,e1,E1,u2,D2	6.8752E-06	5.8E-08
D1,u1->e1,E1,e1,E1,u2,D2	6.8603E-06	5.8E-08
u1,D1->e2,E2,e2,E2,u1,D1	6.8393E-06	5.8E-08
u1,D1->e1,E1,e2,E2,u1,D1	6.8317E-06	5.8E-08
u1,D1->e2,E2,e1,E1,u2,D2	6.8171E-06	5.8E-08
D1,u1->e1,E1,e2,E2,u2,D2	6.8152E-06	5.8E-08
u1,D1->e2,E2,e2,E2,u2,D2	6.8135E-06	5.8E-08
D1,u1->e2,E2,e1,E1,u1,D1	6.8001E-06	5.8E-08
u1,D1->e1,E1,e1,E1,u1,D1	6.7945E-06	5.8E-08
D1,u1->e2,E2,e2,E2,u1,D1	6.7857E-06	5.8E-08
u1,D1->e1,E1,e2,E2,u2,D2	6.7704E-06	5.8E-08
D1,u1->e1,E1,e2,E2,u1,D1	6.7667E-06	5.8E-08

PgDn

Total	cs(pb)	% Error
	1.5817E-04	2.1E-01

Vegas

Accuracy goal = 0.10%
*Improve Grids
nCalls = 10000
*Integrate

Set Distributions
Display Distributions

Clear statistics
Clear grid & statistics

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

Resonant Diagrams

- Specify resonant diagrams:
  - p,p→(~W→(W→j,j),(Z→l,l)),Z→l,l

CalcHEP/symb

Model: HLS (Final)

Abstract

CalcHEP package is created for calculation of decay and high energy collision processes of elementary particles in the lowest order (tree) approximation. The main idea put into the CalcHEP was to make available passing from the lagrangian to the final distributions effectively with the high level of automatization.

Use F2 key to get information about interface facilities and F1 - as online help.

<

Enter Process
Force Unit.Gauge OFF
Create Prod+Dec code
Edit model
Delete model

F1-Help F2-Man F5-Switches F6-Results F9-Ref F10-Quit

CalcHEP/symb

Model: HLS (Final)

List of particles (antiparticles)

A(A)- Photon	Z(Z)- Z boson	W+(W-)- W boson
~Z(~Z)- Z' boson	~W+(~W-)- W' boson	G(G)- Gluon
n1(N1)- Electron-neut	n2(N2)- Mu-neutrino	n3(N3)- Tau-neutrino
e1(E1)- Electron	e2(E2)- Muon	e3(E3)- Tauon
u1(U1)- u-quark	u2(U2)- c-quark	u3(U3)- t-quark
d1(D1)- d-quark	d2(D2)- s-quark	d3(D3)- b-quark
~n1(~N1)- Heavy Electro	~n2(~N2)- Heavy Mu-neut	~n3(~N3)- Heavy Tau-ne
~e1(~E1)- Heavy Electro	~e2(~E2)- Heavy Muon	~e3(~E3)- Heavy Tauon
~u1(~U1)- Heavy u-quark	~u2(~U2)- Heavy c-quark	~u3(~U3)- Heavy t-quar
~d1(~D1)- Heavy d-quark	~d2(~D2)- Heavy s-quark	~d3(~D3)- Heavy b-quar

Enter process: u1,D1->u1,D1,e1,E1,e1,E1

CalcHEP/symb

Model: HLS (Final)

List of particles (antiparticles)

A(A)- Photon	Z(Z)- Z boson	W+(W-)- W boson
~Z(~Z)- Z' boson	~W+(~W-)- W' boson	G(G)- Gluon
n1(N1)- Electron-neut	n2(N2)- Mu-neutrino	n3(N3)- Tau-neutrino
e1(E1)- Electron	e2(E2)- Muon	e3(E3)- Tauon
u1(U1)- u-quark	u2(U2)- c-quark	u3(U3)- t-quark
d1(D1)- d-quark	d2(D2)- s-quark	d3(D3)- b-quark
~n1(~N1)- Heavy Electro	~n2(~N2)- Heavy Mu-neut	~n3(~N3)- Heavy Tau-ne
~e1(~E1)- Heavy Electro	~e2(~E2)- Heavy Muon	~e3(~E3)- Heavy Tauon
~u1(~U1)- Heavy u-quark	~u2(~U2)- Heavy c-quark	~u3(~U3)- Heavy t-quar
~d1(~D1)- Heavy d-quark	~d2(~D2)- Heavy s-quark	~d3(~D3)- Heavy b-quar

Enter process: u1,D1->u1,D1,e1,E1,e1,E1
Exclude diagrams with ~u1,~d1,~e1,~n1

CalcHEP/symb

```
      Model:  HLS (Final)

    Process:  u1,D1->u1,D1,e1,E1,e1,E1

              Feynman diagrams
1906  diagrams in  1   subprocesses  are constructed.
0     diagrams  are deleted.
```

F1-Help F2-Man F3-Model F5-Switches F6-Results F9-Ref F10-Quit

CalcHEP/symb

Model: HLS (Final)

Process: u1,D1->u1,D1,e1,E1,e1,E1

Feynman diagrams

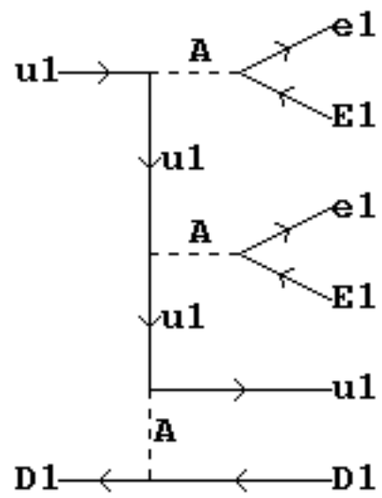
1906 diagrams in 1 subprocesses are constructed.
0 diagrams are deleted.

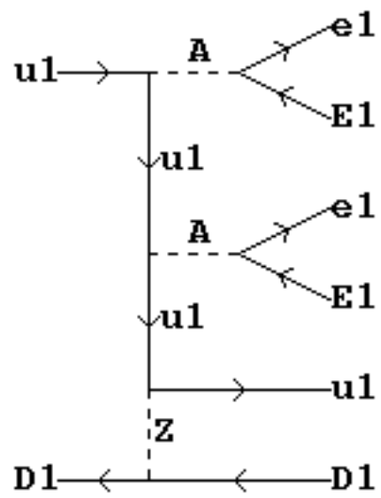
View diagrams
Squaring technique
Write down processes

F1-Help F2-Man F3-Model F5-Switches F6-Results F9-Ref F10-Quit

CalcHEP/symb

Delete,On/off,Restore,Latex 1/1906





F1-Help,F2-Man,PgUp,PgDn,Home,End,# ,Esc

CalcHEP/symb

Model: HLS (Final)

Abstract

CalcHEP package is created for calculation of decay and high energy collision processes of elementary particles in the lowest order (tree) approximation. The main idea put into the CalcHEP was to make available passing from the lagrangian to the final distributions effectively with the high level of automatization.

Use F2 key to get information about interface facilities and F1 - as online help.

<

Enter Process
Force Unit.Gauge OFF
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Edit model
Delete model

F1-Help F2-Man F5-Switches F6-Results F9-Ref F10-Quit

CalcHEP/symb

Model: HLS (Final)

List of particles (antiparticles)

A(A)- Photon	Z(Z)- Z boson	W+(W-)- W boson
~Z(~Z)- Z' boson	~W+(~W-)- W' boson	G(G)- Gluon
n1(N1)- Electron-neut	n2(N2)- Mu-neutrino	n3(N3)- Tau-neutrino
e1(E1)- Electron	e2(E2)- Muon	e3(E3)- Tauon
u1(U1)- u-quark	u2(U2)- c-quark	u3(U3)- t-quark
d1(D1)- d-quark	d2(D2)- s-quark	d3(D3)- b-quark
~n1(~N1)- Heavy Electro	~n2(~N2)- Heavy Mu-neut	~n3(~N3)- Heavy Tau-ne
~e1(~E1)- Heavy Electro	~e2(~E2)- Heavy Muon	~e3(~E3)- Heavy Tauon
~u1(~U1)- Heavy u-quark	~u2(~U2)- Heavy c-quark	~u3(~U3)- Heavy t-quar
~d1(~D1)- Heavy d-quark	~d2(~D2)- Heavy s-quark	~d3(~D3)- Heavy b-quar

Enter process: u1,D1->(~W+->(W+->u1,D1),(Z->e1,E1)),(Z->e1,E1)

CalcHEP/symb

```
      Model:  HLS (Final)

            List of particles (antiparticles)

 A(A    )- Photon          Z(Z    )- Z boson         W+(W-   )- W boson
 ~Z(~Z   )- Z' boson       ~W+(~W-  )- W' boson       G(G    )- Gluon
 n1(N1   )- Electron-neut  n2(N2   )- Mu-neutrino     n3(N3   )- Tau-neutrino
 e1(E1   )- Electron       e2(E2   )- Muon            e3(E3   )- Tauon
 u1(U1   )- u-quark        u2(U2   )- c-quark         u3(U3   )- t-quark
 d1(D1   )- d-quark        d2(D2   )- s-quark         d3(D3   )- b-quark
 ~n1(~N1  )- Heavy Electro ~n2(~N2  )- Heavy Mu-neut  ~n3(~N3  )- Heavy Tau-ne
 ~e1(~E1  )- Heavy Electro ~e2(~E2  )- Heavy Muon     ~e3(~E3  )- Heavy Tauon
 ~u1(~U1  )- Heavy u-quark ~u2(~U2  )- Heavy c-quark  ~u3(~U3  )- Heavy t-quar
 ~d1(~D1  )- Heavy d-quark ~d2(~D2  )- Heavy s-quark  ~d3(~D3  )- Heavy b-quar


Enter  process: u1,D1->(~W+->(W+->u1,D1),(Z->e1,E1)),(Z->e1,E1)
Exclude diagrams with ~u1,~d1,~e1,~n1
```

CalcHEP/symb

```
      Model:  HLS (Final)

    Process:  u1,D1->(~W+->(W+->u1,D1),(Z->e1,E1)),(Z->e1,E1)

              Feynman diagrams
4     diagrams in  1   subprocesses  are constructed.
0     diagrams  are deleted.
```

F1-Help F2-Man F3-Model F5-Switches F6-Results F9-Ref F10-Quit

CalcHEP/symb

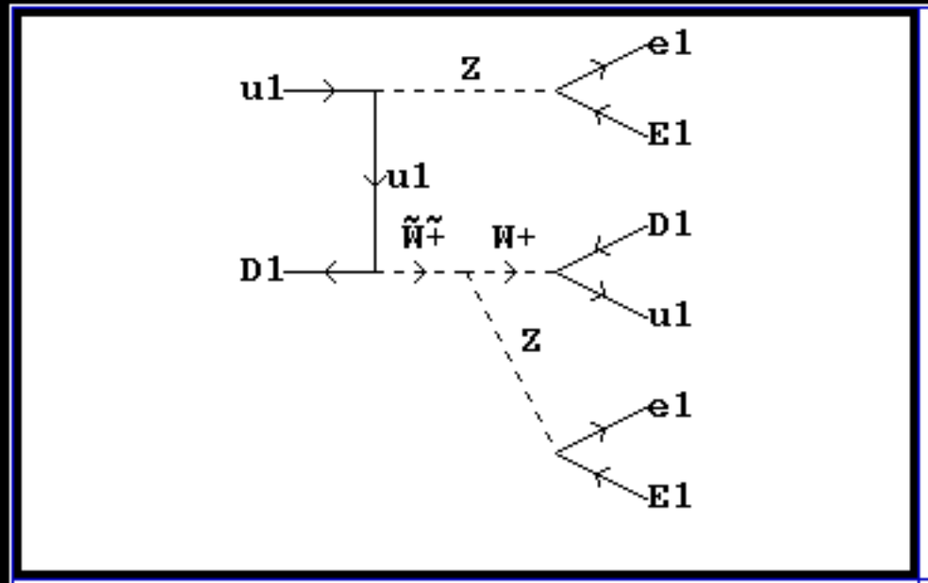
```
      Model:   HLS (Final)

    Process:   u1,D1->(~W+->(W+->u1,D1),(Z->e1,E1)),(Z->e1,E1)

               Feynman diagrams
 4     diagrams in  1   subprocesses  are constructed.
 0     diagrams  are deleted.
```

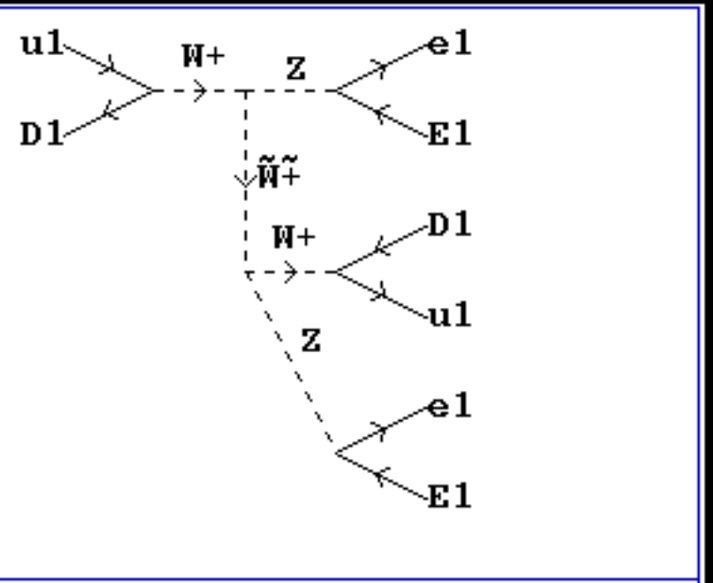
View diagrams
Squaring technique
Write down processes

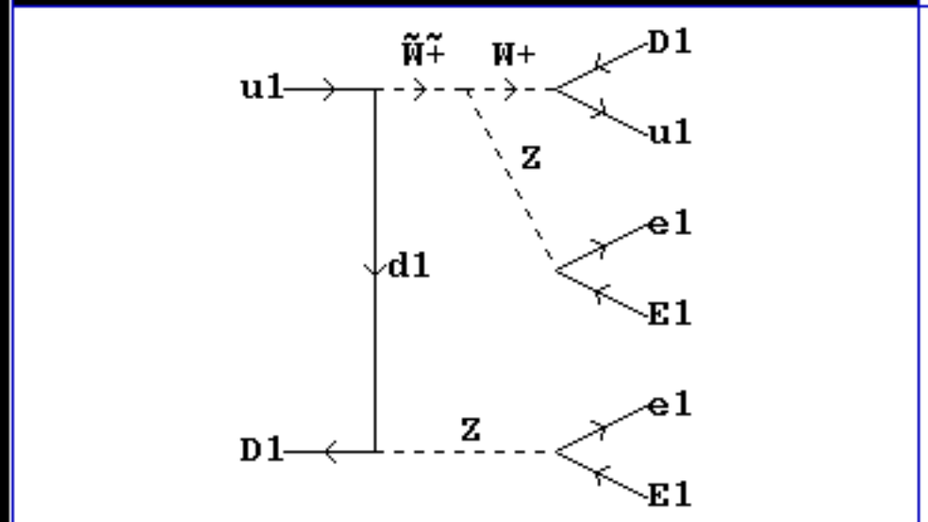
F1-Help F2-Man F3-Model F5-Switches F6-Results F9-Ref F10-Quit

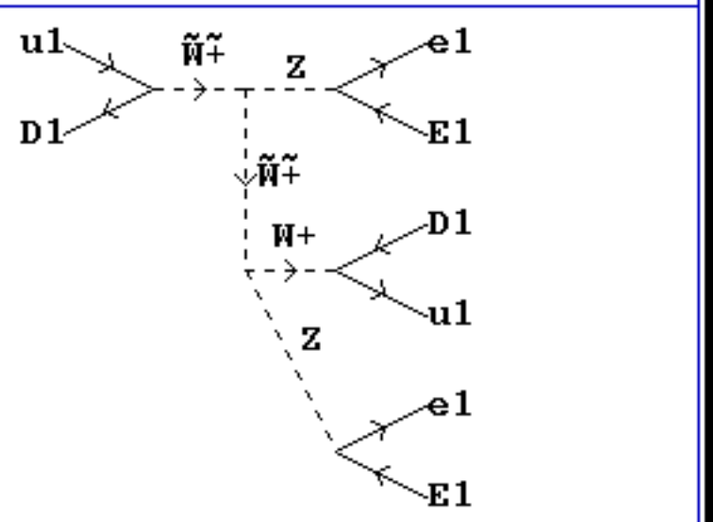
CalcHEP/symb

Delete,On/off,Restore,Latex 1/4









F1-Help,F2-Man,PgUp,PgDn,Home,End,# ,Esc

Future
New Numerical Session

- Better control of processes:
  - Allow user to remove particles from diagrams.
  - Allow resonant diagrams to be chosen.
- Event output:
  - Write weighted/unweighted events.
- New Batch Mode:
  - Use the strengths of this new numerical mode to make batch mode more efficient.
- Various other things:
  - Reduce the size of the numerical code.
  - Threading?

Appendix

Integration

- Generate Process:
  - Choose gauge.
  - Choose diagrams.
  - Symbolic calculation.
  - Generate numerical code.
- Integration:
  - Choose momentum/pdf of incoming states.
  - Change numerical value of independent parameters.
  - Set cuts.
  - Set regularization of resonances.
  - Set distributions.
  - Improve grids.
  - Integrate.
  - Generate unweighted events.

CalcHEP/symb

Model: Standard Model(CKM=1)

Abstract

CalcHEP package is created for calculation of decay and high energy collision processes of elementary particles in the lowest order (tree) approximation. The main idea put into the CalcHEP was to make available passing from the lagrangian to the final distributions effectively with the high level of automatization.

Use F2 key to get information about interface facilities and F1 - as online help.

<

Enter Process
Force Unit.Gauge OFF
Edit model
Delete model

F1-Help F2-Man F5-Switches F6-Results F9-Ref F10-Quit

CalcHEP/symb

Model: Standard Model(CKM=1)

Abstract

CalcHEP package is created for calculation of decay and high energy collision processes of elementary particles in the lowest order (tree) approximation. The main idea put into the CalcHEP was to make available passing from the lagrangian to the final distributions effectively with the high level of automatization.

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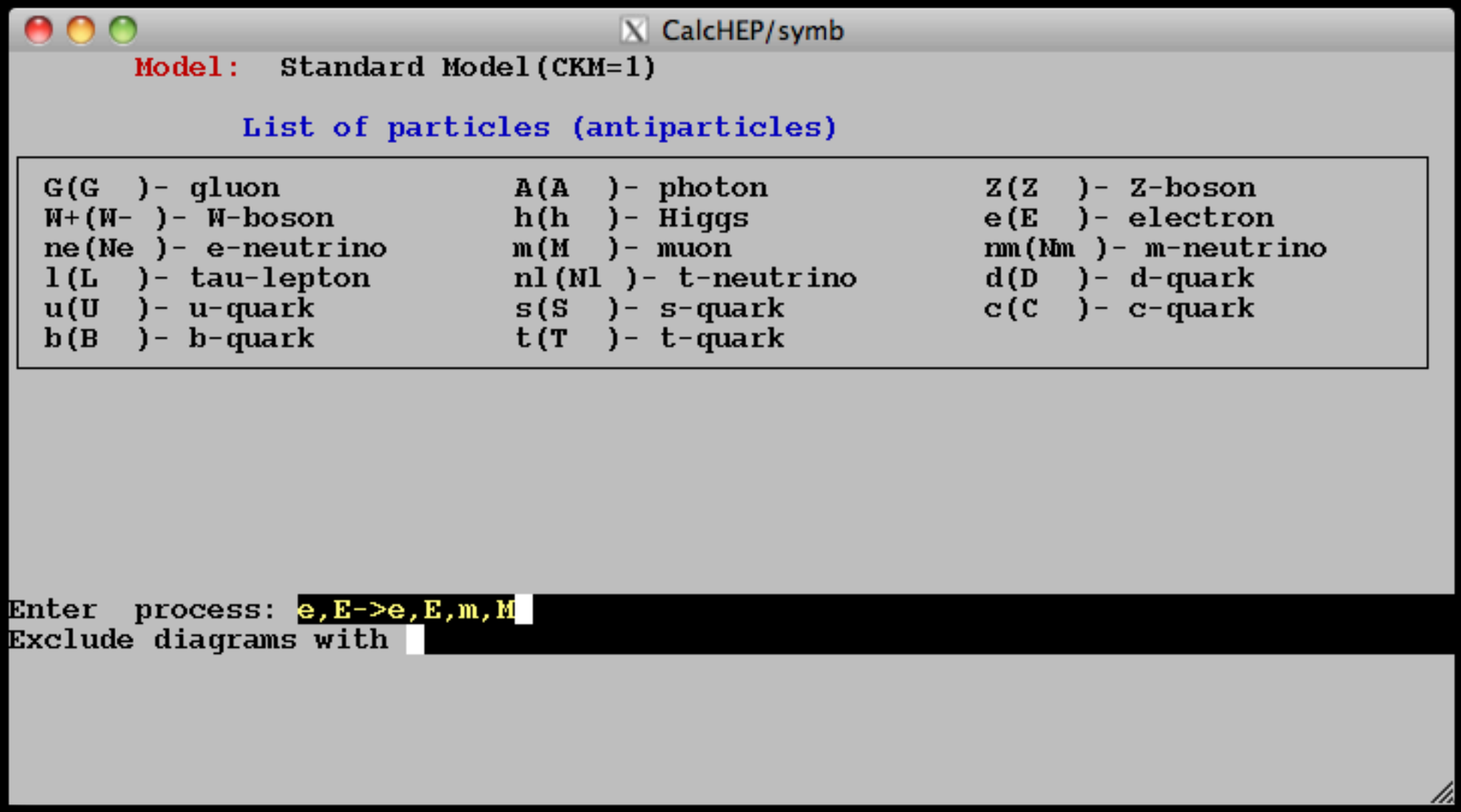
CalcHEP/symb

Model: Standard Model(CKM=1)

List of particles (antiparticles)

G(G)- gluon	A(A)- photon	Z(Z)- Z-boson
W+(W-)- W-boson	h(h)- Higgs	e(E)- electron
ne(Ne)- e-neutrino	m(M)- muon	nm(Nm)- m-neutrino
l(L)- tau-lepton	nl(Nl)- t-neutrino	d(D)- d-quark
u(U)- u-quark	s(S)- s-quark	c(C)- c-quark
b(B)- b-quark	t(T)- t-quark	

Enter process: e,E->e,E,m,M


CalcHEP/symb
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nm(Nm)- m-neutrino
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nl(Nl)- t-neutrino
d(D)- d-quark
u(U)- u-quark
s(S)- s-quark
c(C)- c-quark
b(B)- b-quark
t(T)- t-quark
Enter process: e,E->e,E,m,M
Exclude diagrams with

CalcHEP/symb

Model: Standard Model(CKM=1)

Process: e,E->e,E,m,M

Feynman diagrams

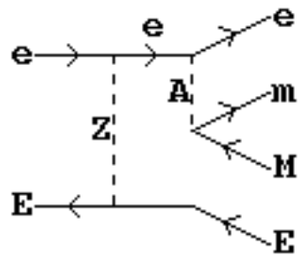
50 diagrams in 1 subprocesses are constructed.
0 diagrams are deleted.

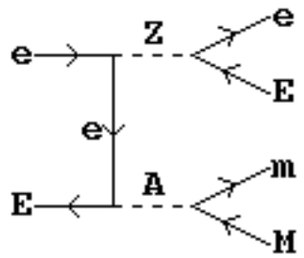
<
View diagrams
Squaring technique
Write down processes

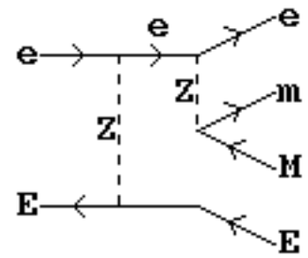
F1-Help F2-Man F3-Model F5-Switches F6-Results F9-Ref F10-Quit

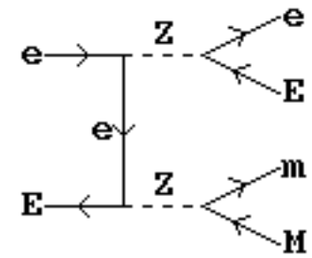
CalcHEP/symb

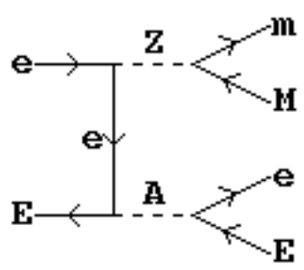
Delete,On/off,Restore,Latex 28/50

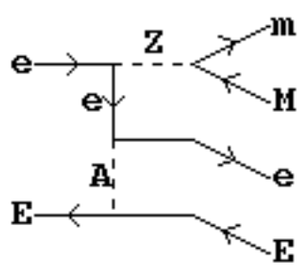


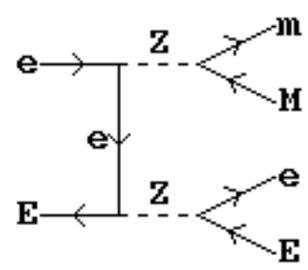


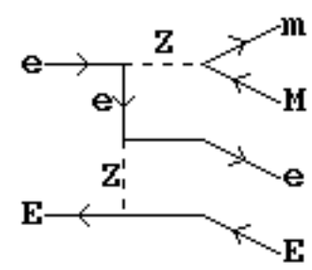








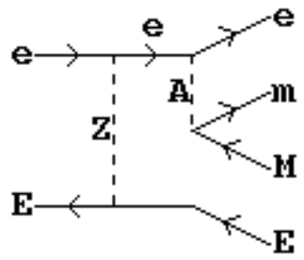




F1-Help,F2-Man,PgUp,PgDn,Home,End,# ,Esc

CalcHEP/symb

Delete,On/off,Restore,Latex 28/50



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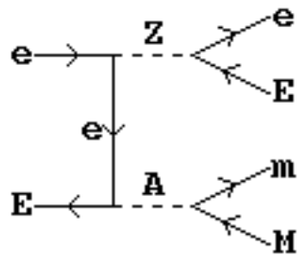

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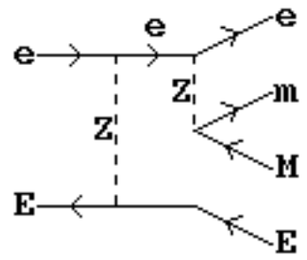

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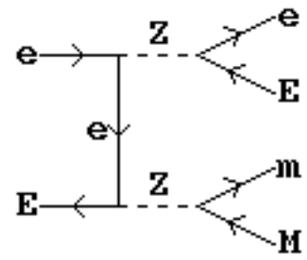

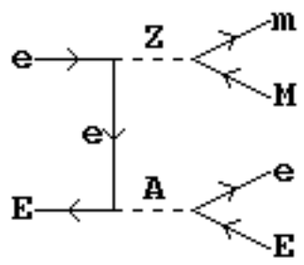

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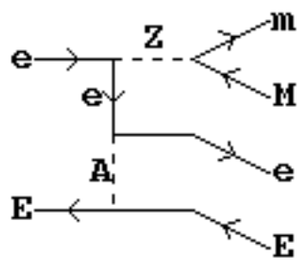

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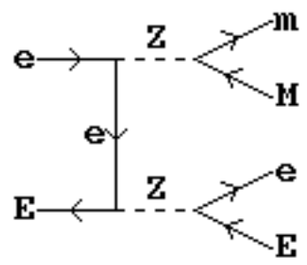

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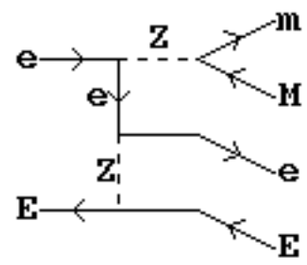
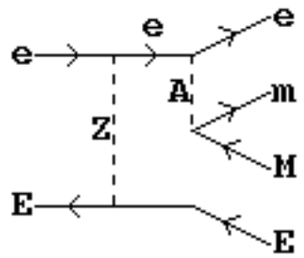


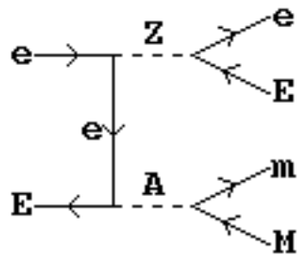
DEL

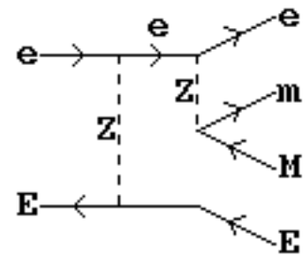
F1-Help,F2-Man,PgUp,PgDn,Home,End,# ,Esc

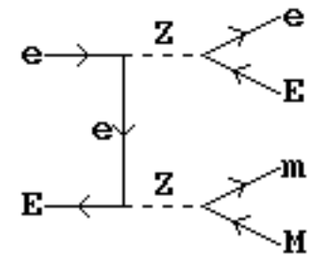
CalcHEP/symb

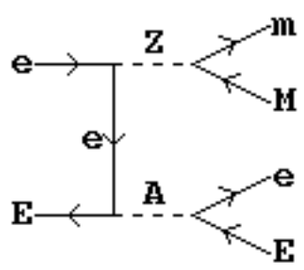
Delete,On/off,Restore,Latex 28/50

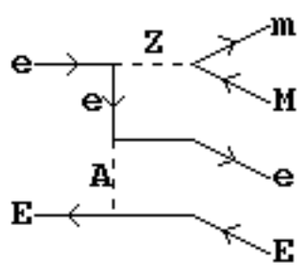


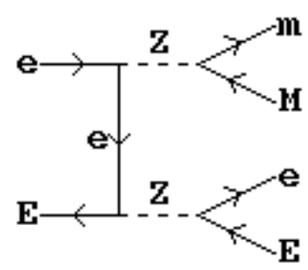


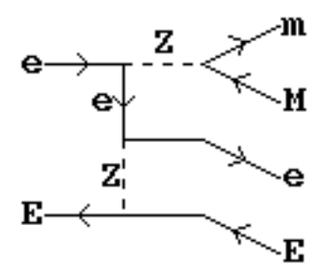












F1-Help,F2-Man,PgUp,PgDn,Home,End,# ,Esc

CalcHEP/symb

```
      Model:   Standard Model(CKM=1)

    Process:   e,E->e,E,m,M

               Feynman diagrams
50     diagrams in  1   subprocesses  are constructed.
0      diagrams  are deleted.
```

F1-Help F2-Man F3-Model F5-Switches F6-Results F9-Ref F10-Quit

CalcHEP/symb

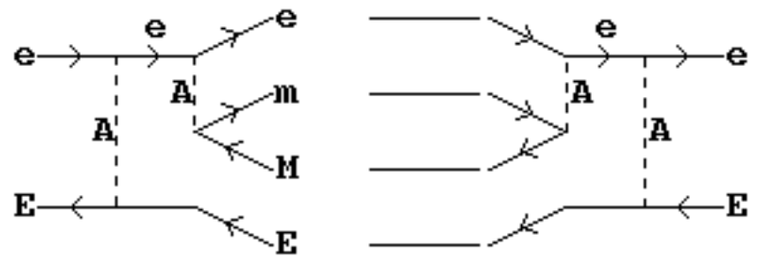
```
      Model:   Standard Model(CKM=1)

    Process:   e,E->e,E,m,M

               Feynman diagrams
50     diagrams in  1   subprocesses  are constructed.
0      diagrams  are deleted.

               Squared diagrams
1275   diagrams in  1   subprocesses  are constructed.
0      diagrams  are deleted.
0      diagrams  are calculated.
```

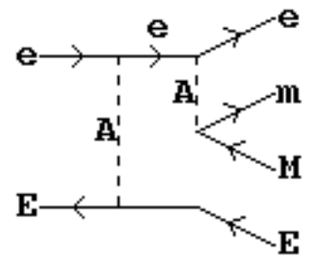
<
View squared diagrams
Symbolic calculations
Make&Launch n_calchep
Make n_calchep
REDUCE program

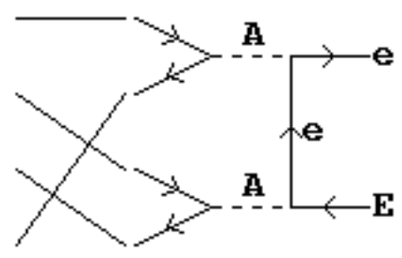
F1-Help F2-Man F3-Model F4-Diagrams F5-Switches F6-Results F9-Ref F10-Quit

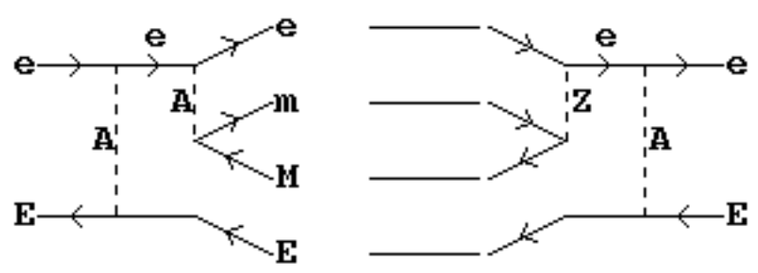
CalcHEP/symb

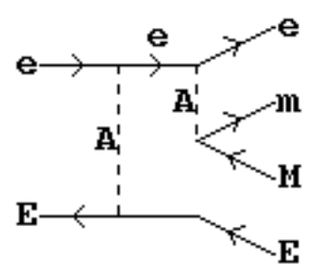
Delete,On/off,Restore,Latex,Ghosts 1/1275

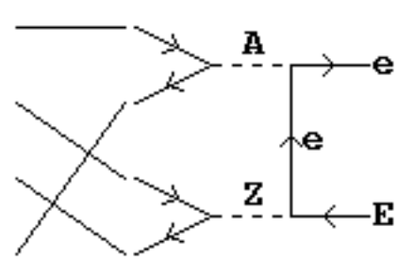








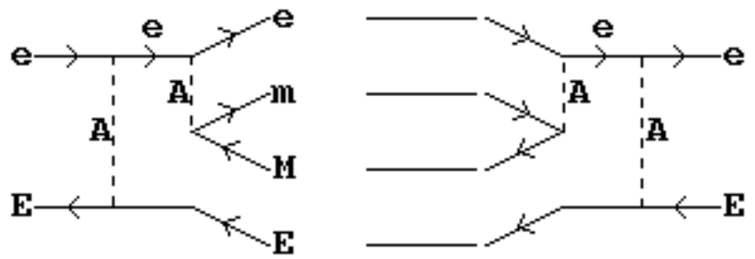


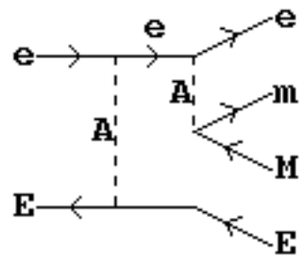


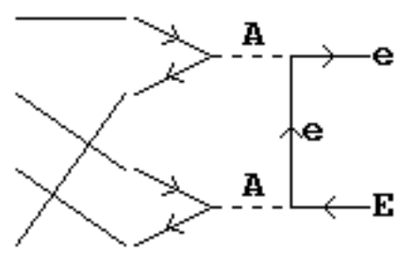
F1-Help,F2-Man,PgUp,PgDn,Home,End,# ,Esc

CalcHEP/symb

Delete,On/off,Restore,Latex,Ghosts 1/1275







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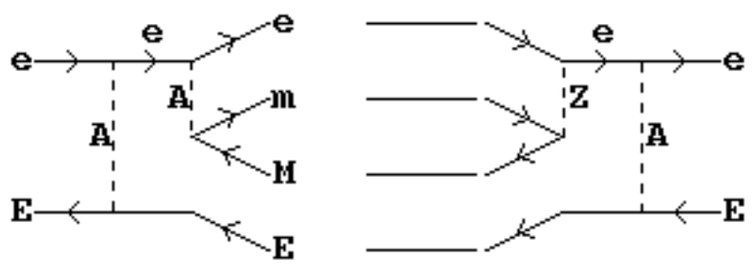

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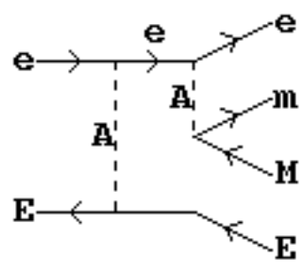
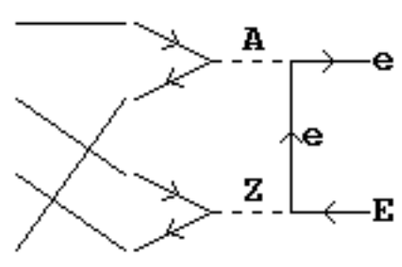


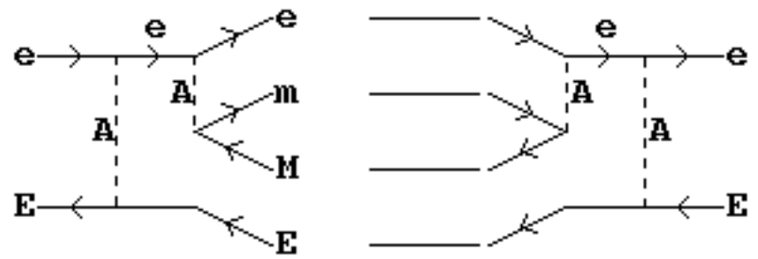


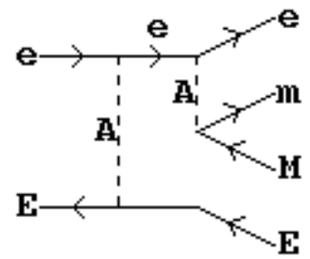
DEL

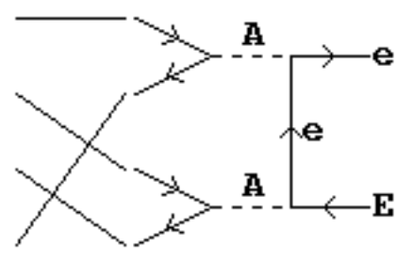
F1-Help,F2-Man,PgUp,PgDn,Home,End,# ,Esc

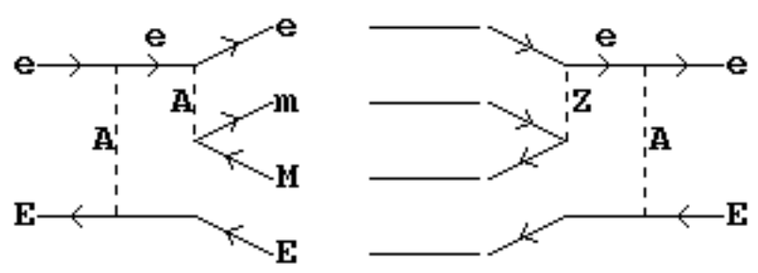
CalcHEP/symb

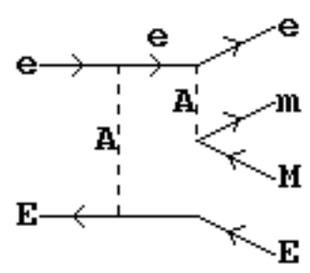
Delete,On/off,Restore,Latex,Ghosts 1/1275

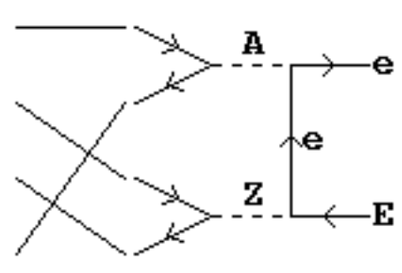












F1-Help,F2-Man,PgUp,PgDn,Home,End,# ,Esc

CalcHEP/symb

```
      Model:   Standard Model(CKM=1)

    Process:   e,E->e,E,m,M

               Feynman diagrams
50     diagrams in  1   subprocesses  are constructed.
0      diagrams  are deleted.

               Squared diagrams
1275   diagrams in  1   subprocesses  are constructed.
0      diagrams  are deleted.
0      diagrams  are calculated.
```

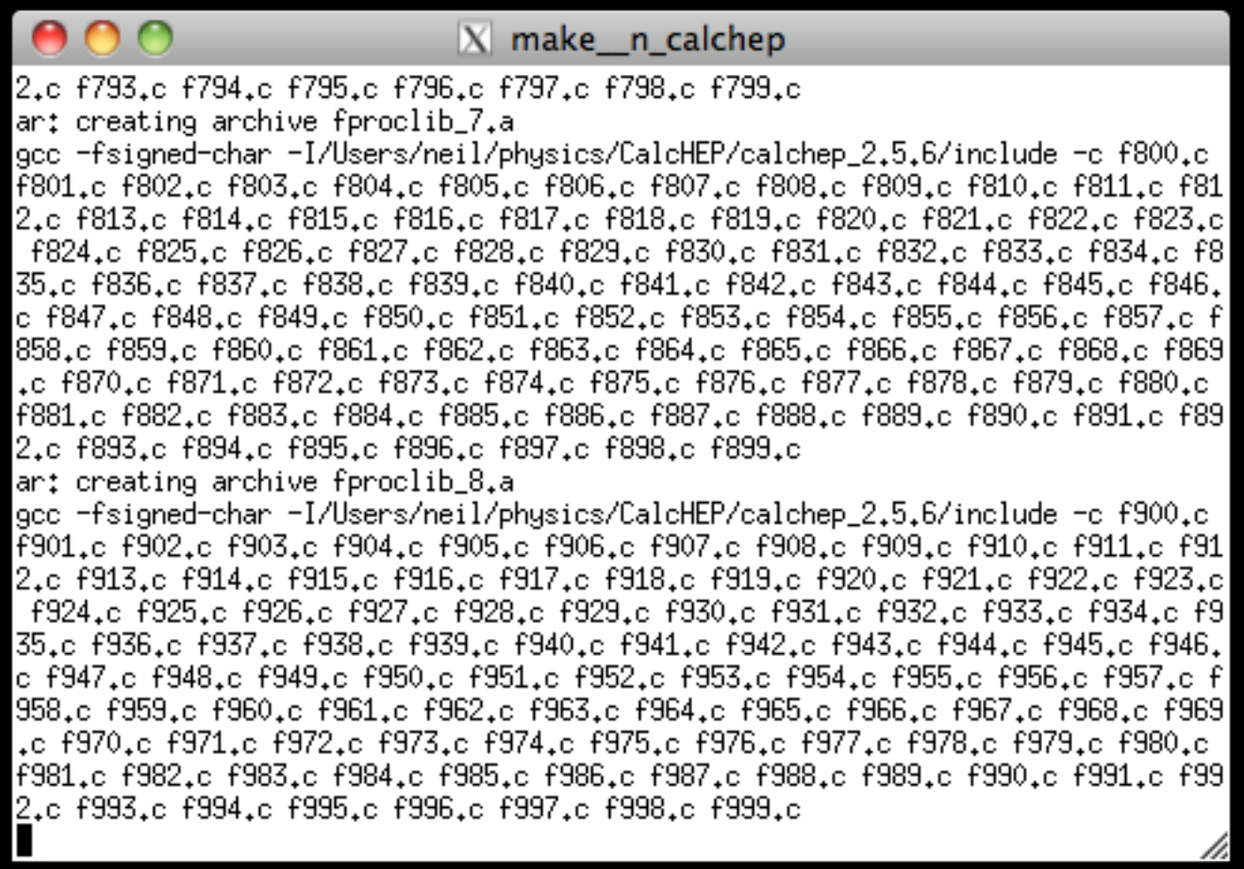
<
View squared diagrams
Symbolic calculations
Make&Launch n_calchep
Make n_calchep
REDUCE program

F1-Help F2-Man F3-Model F4-Diagrams F5-Switches F6-Results F9-Ref F10-Quit

CalcHEP/symb

```
      Model:   Standard Model(CKM=1)

    Process:   e,E->e,E,m,M

                Feynman diagrams
50     diagrams in  1   subprocesses  are constructed.
0      diagrams  are deleted.

                Squared diagrams
1275   diagrams in  1   subprocesses  are constructed.
0      diagrams  are deleted.
237    diagrams  are calculated.
0      Out of memory
current diagram  238      in (Sub)process e,E->e,E,m,M
Subdiagram  :1(of 1)
Used memory :488 Kb
Operation   :Total factor calculation

 Press Esc to halt calculations
```

Symbolic calculations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f901.c f902.c f903.c f904.c f905.c f906.c f907.c f908.c f909.c f910.c f911.c f91
2.c f913.c f914.c f915.c f916.c f917.c f918.c f919.c f920.c f921.c f922.c f923.c
f924.c f925.c f926.c f927.c f928.c f929.c f930.c f931.c f932.c f933.c f934.c f9
35.c f936.c f937.c f938.c f939.c f940.c f941.c f942.c f943.c f944.c f945.c f946.
c f947.c f948.c f949.c f950.c f951.c f952.c f953.c f954.c f955.c f956.c f957.c f
958.c f959.c f960.c f961.c f962.c f963.c f964.c f965.c f966.c f967.c f968.c f969
.c f970.c f971.c f972.c f973.c f974.c f975.c f976.c f977.c f978.c f979.c f980.c
f981.c f982.c f983.c f984.c f985.c f986.c f987.c f988.c f989.c f990.c f991.c f99
2.c f993.c f994.c f995.c f996.c f997.c f998.c f999.c

CalcHEP/num

(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 1(begin)

<
Subprocess
IN state
Model parameters
Constraints
QCD coupling
Breit-Wigner
Cuts
Phase space mapping
Vegas
Generate events

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

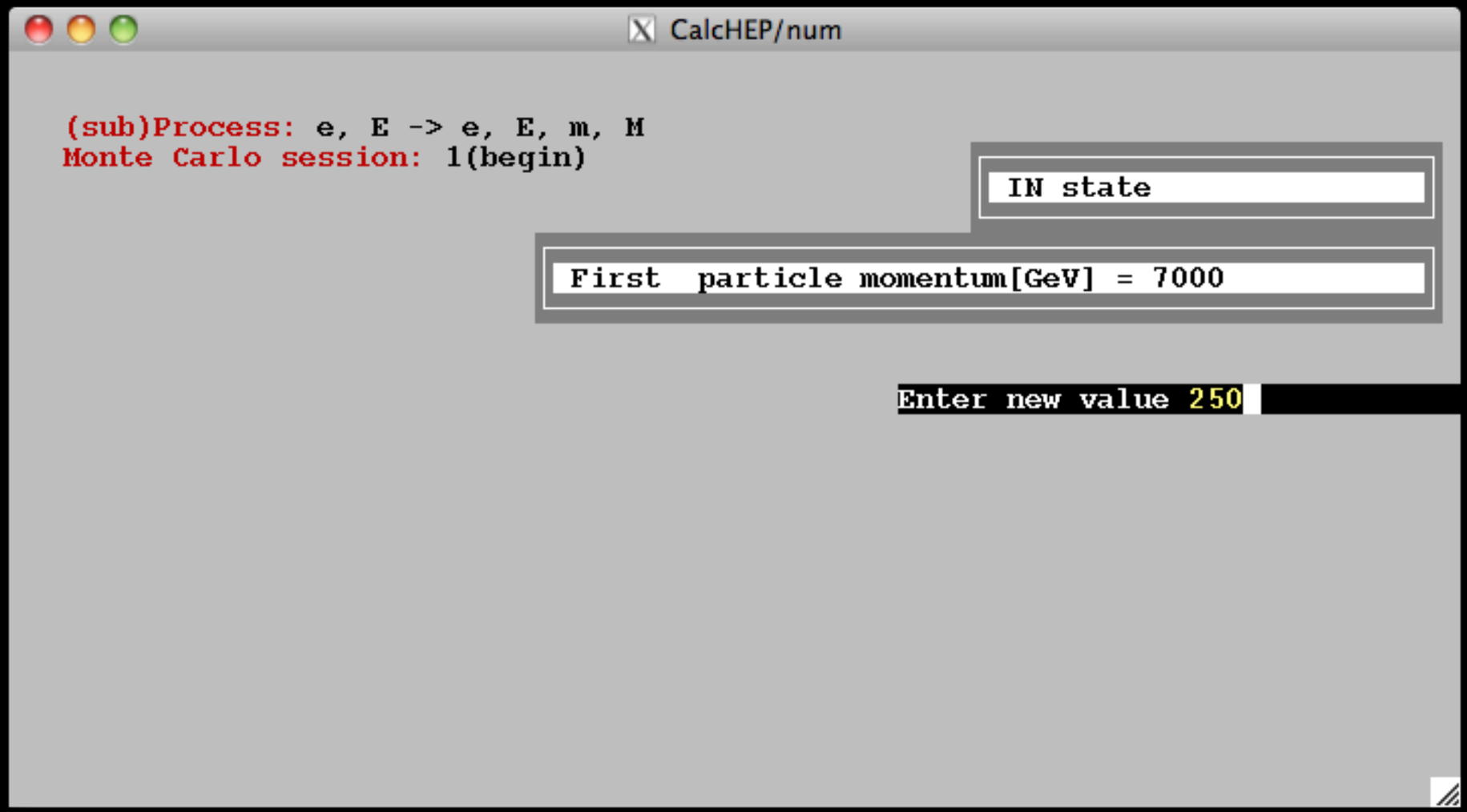
CalcHEP/num

```
(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 1(begin)
```

IN state

```
<
 S.F.1: OFF
 S.F.2: OFF
 First  particle momentum[GeV] = 7000
 Second particle momentum[GeV] = 7000
 First  particle unpolarized
 Second particle unpolarized
```

F1-Help F2-Man F6-Results F7-Plot F8-Calc F9-Ref


CalcHEP/num
(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 1(begin)
IN state
First particle momentum[GeV] = 7000
Enter new value 250

CalcHEP/num

(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 1(begin)

<
Subprocess
IN state
Model parameters
Constraints
QCD coupling
Breit-Wigner
Cuts
Phase space mapping
Vegas
Generate events

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 1(begin)

Model parameters
Change parameter

<

EE=	0.31223
alfSMZ=	0.1172
SW=	0.481
Mm=	0.1057
Ml=	1.777
Q=	100
McMc=	1.2
MbMb=	4.23
Mtp=	175
MZ=	91.188
Mh=	100
wZ=	2.4944

F1-Help F2-Man F6-Results F8-Calc F9-Ref

CalcHEP/num

(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 1(begin)

<
Subprocess
IN state
Model parameters
Constraints
QCD coupling
Breit-Wigner
Cuts
Phase space mapping
Vegas
Generate events

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

(sub)Process: e, E -> e, E, m, M

Cuts

Clr Del Size Read ErrMes

!| Parameter |> Min bound <|> Max bound <

F1 F2 Xgoto Ygoto Find Write

Cuts

CalcHEP/num

(sub)Process: e, E -> e, E, m, M

Cuts

Clr Del Size Read ErrMes

!| Parameter |> Min bound <|> Max bound <

Cuts

F1 F2 Xgoto Ygoto Find Write

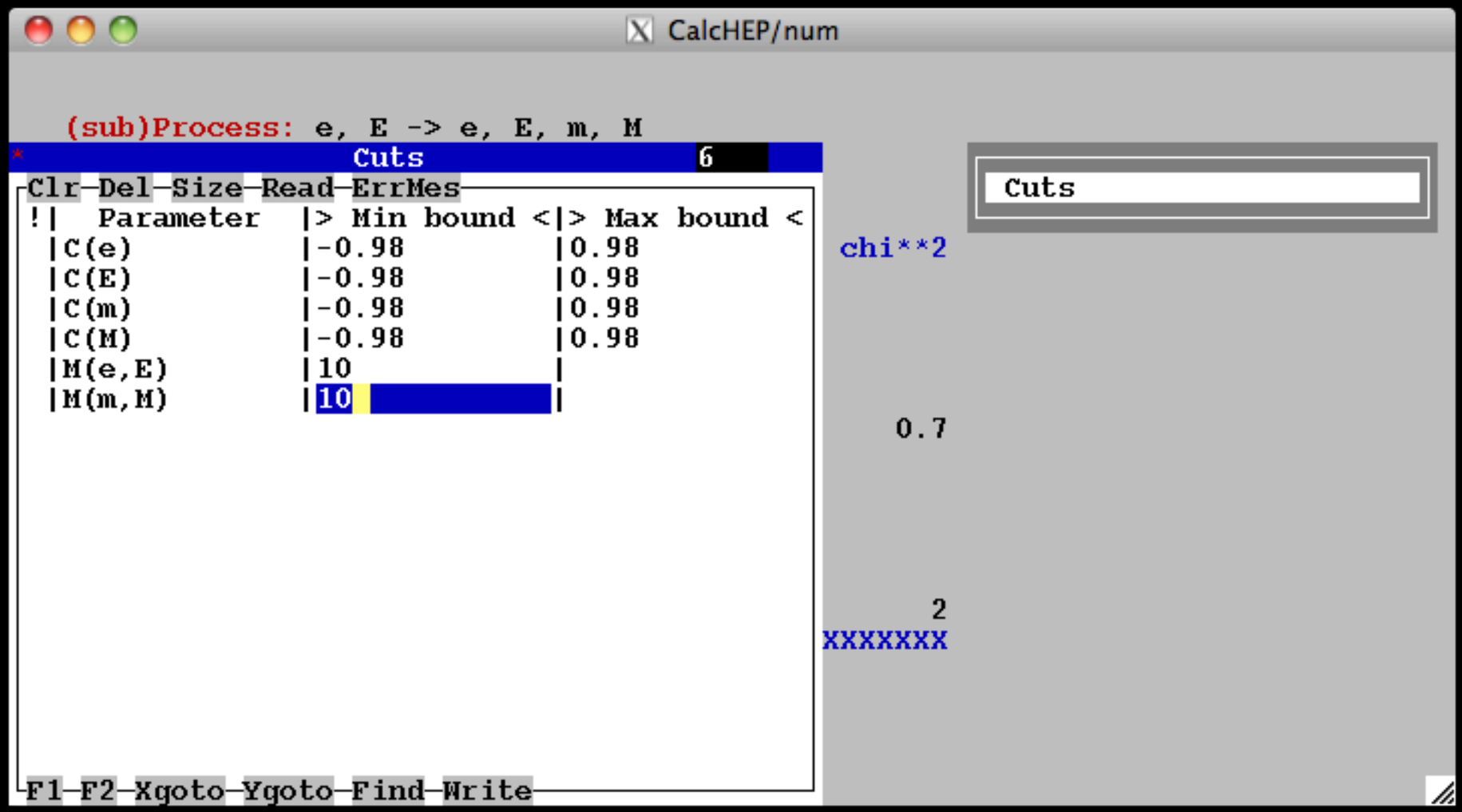
Cuts

n_cut

This table specifies cuts on the phase space. A phase space function
is described in the second column. Its limits are defined in the third
and the fourth columns. If one of these fields is empty then a one-side
cut is applied.
  The phase space function is defined by its name, which characterizes
the type of cut, and a particle list for which the cut is applied.
For example, "T(u)" means the transverse momentum of the 'u'-quark.
"T(u,D)" means the transverse momentum of the sum of the momenta of the
quark pair.
  The following cut functions are available:

A - Angle in degree units
C - Cosine of angle
J - Jet cone angle
E - Energy of the particle set
M - Mass of the particle set
P - Cosine of the angle between the first particle in the list and
     the direction of boosting of the particle set into the rest
     frame of the particles set
T - Transverse momentum (P_t) of the particle set
Y - Rapidity of the particle set
N - Pseudo-rapidity of the particle set

PgDn


CalcHEP/num
(sub)Process: e, E -> e, E, m, M
Cuts 6
Clr-Del-Size-Read-ErrMes
!| Parameter |> Min bound <|> Max bound <
|C(e) |-0.98 |0.98
|C(E) |-0.98 |0.98
|C(m) |-0.98 |0.98
|C(M) |-0.98 |0.98
|M(e,E) |10 |
|M(m,M) |10 |
F1-F2-Xgoto-Ygoto-Find-Write
Cuts
chi**2
0.7
2
XXXXXXX

CalcHEP/num

(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 1(begin)

<
Subprocess
IN state
Model parameters
Constraints
QCD coupling
Breit-Wigner
Cuts
Phase space mapping
Vegas
Generate events

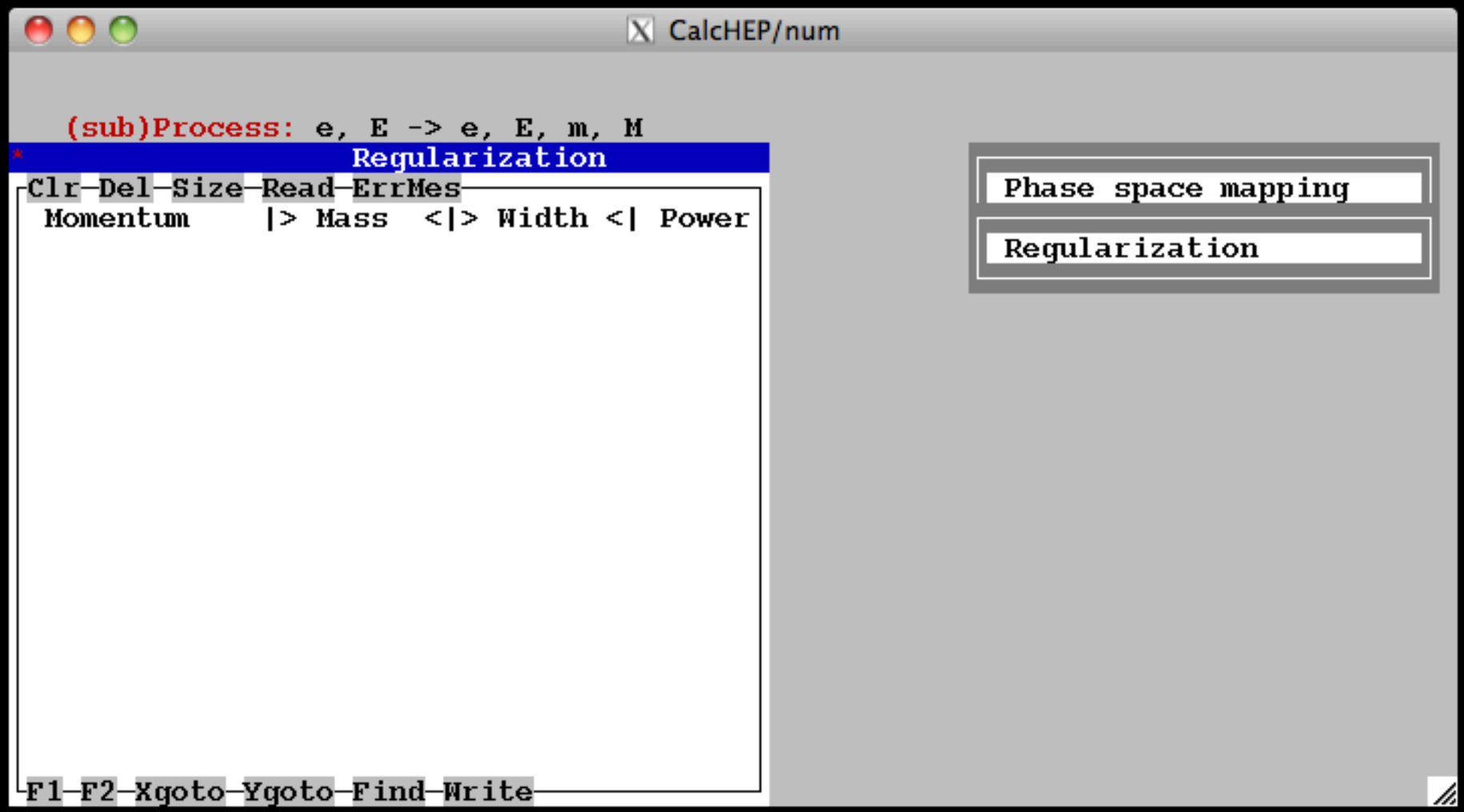
F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 1(begin)

Phase space mapping
<
Kinematics
Regularization

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit


CalcHEP/num
(sub)Process: e, E -> e, E, m, M
Regularization
Clr Del Size Read ErrMes
Momentum |> Mass <|> Width <| Power
F1 F2 Xgoto Ygoto Find Write
Phase space mapping
Regularization

CalcHEP/num

(sub)Process: e, E -> e, E, m, M

Regularization 2

Clr	Del	Size	Read	ErrMes
Momentum	|> Mass	<|> Width	<| Power	
34	|MZ	|wZ	|2	
56	|MZ	|wZ	|2	

F1 F2 Xgoto Ygoto Find Write

Phase space mapping

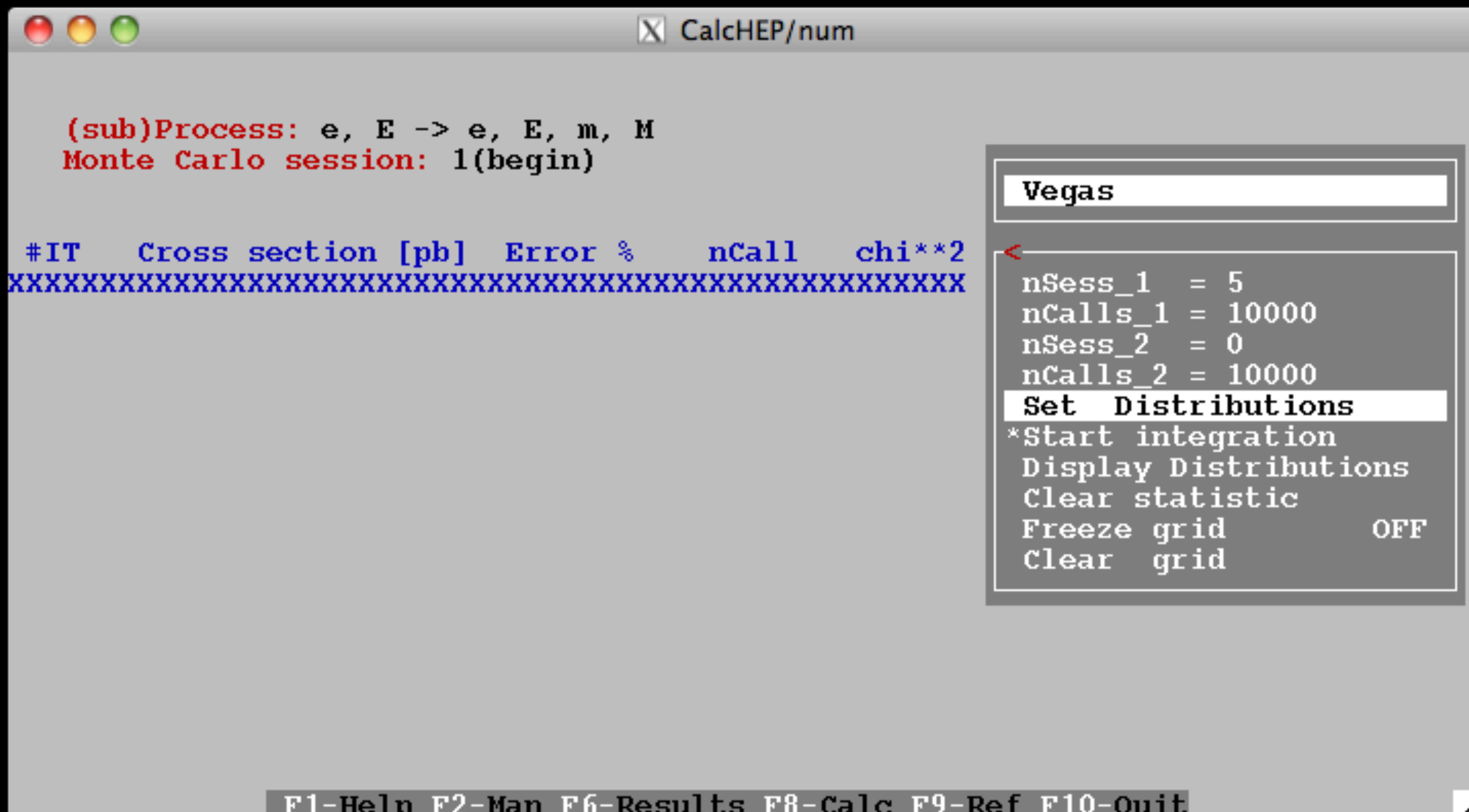
Regularization

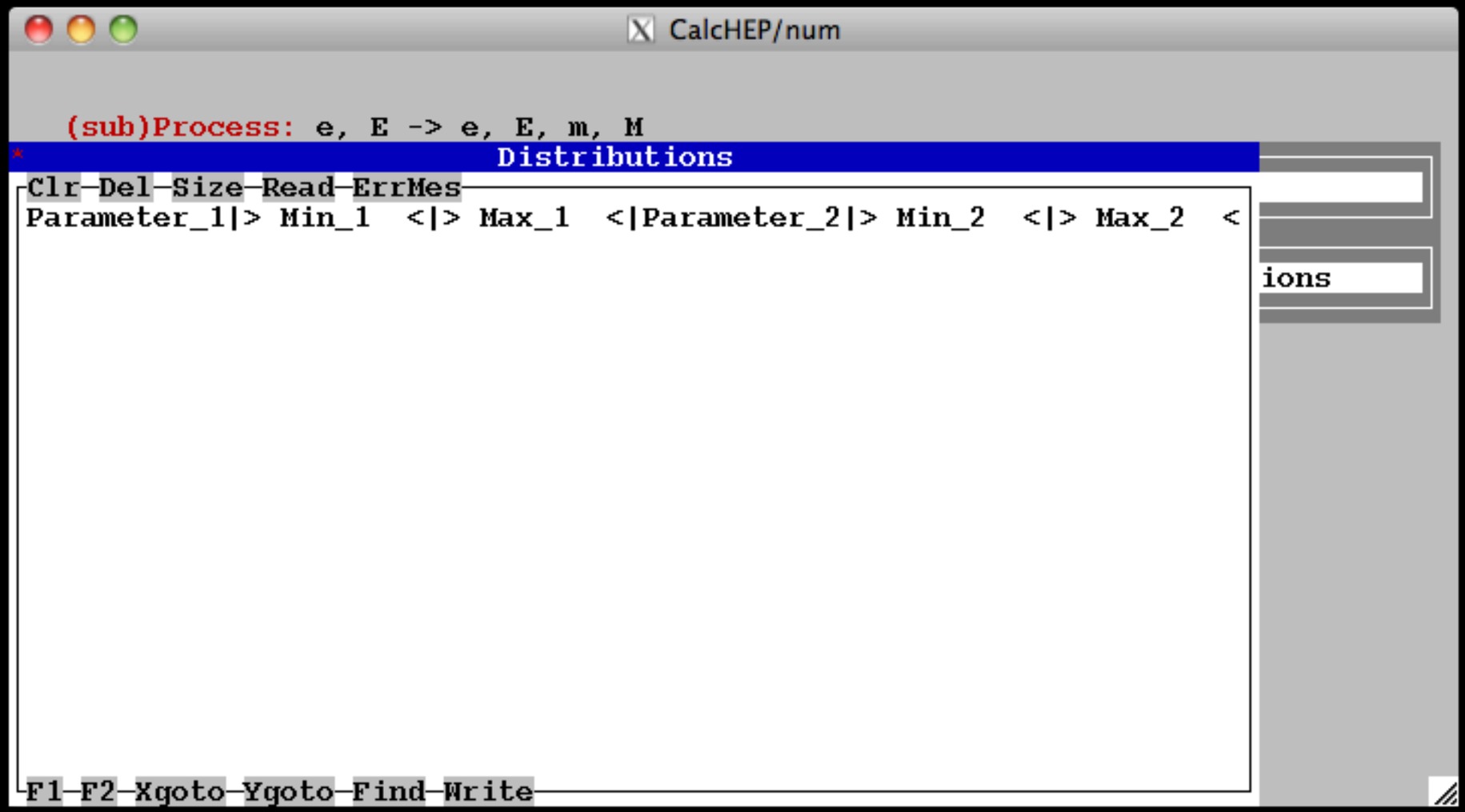
CalcHEP/num

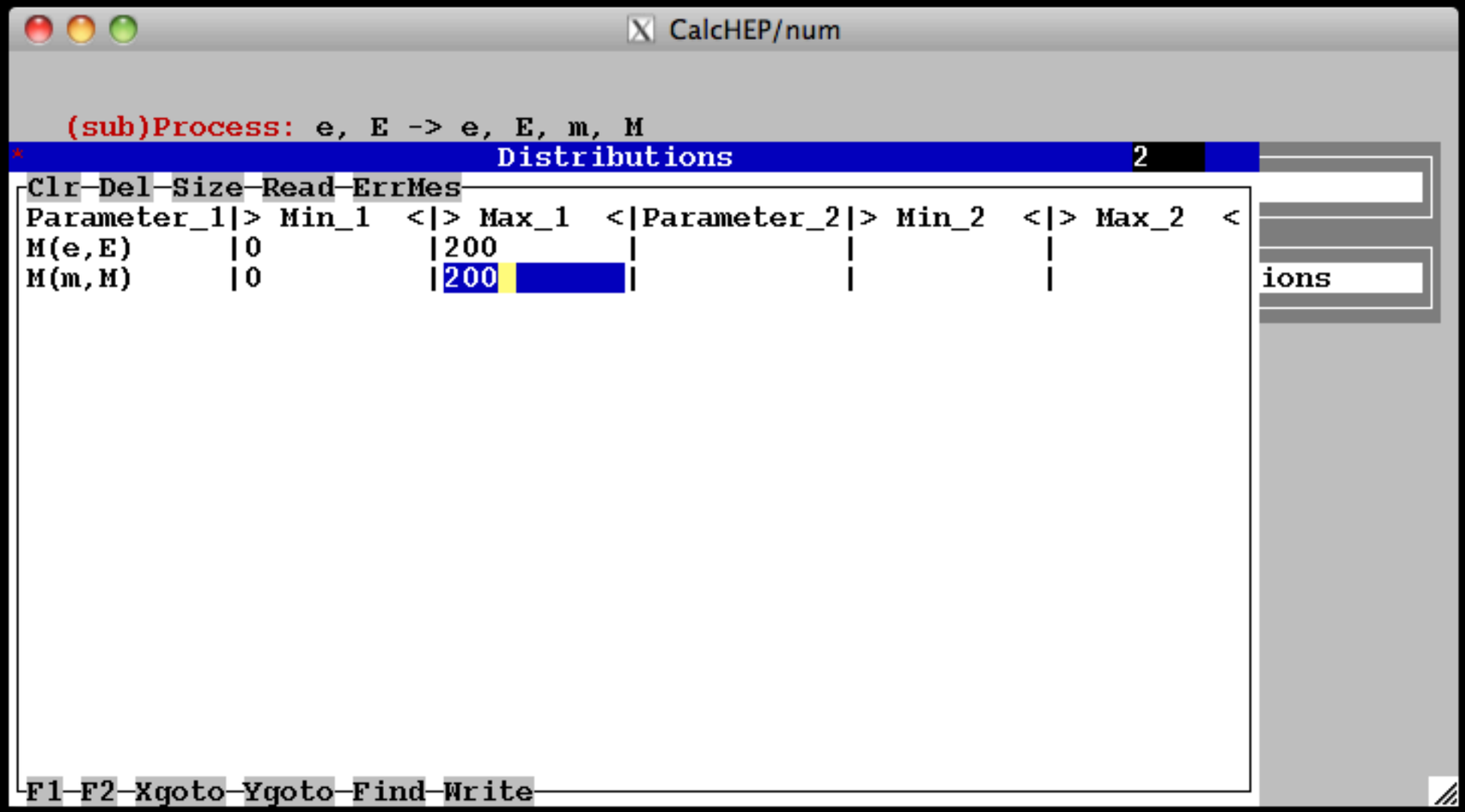
```
(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 1(begin)
```

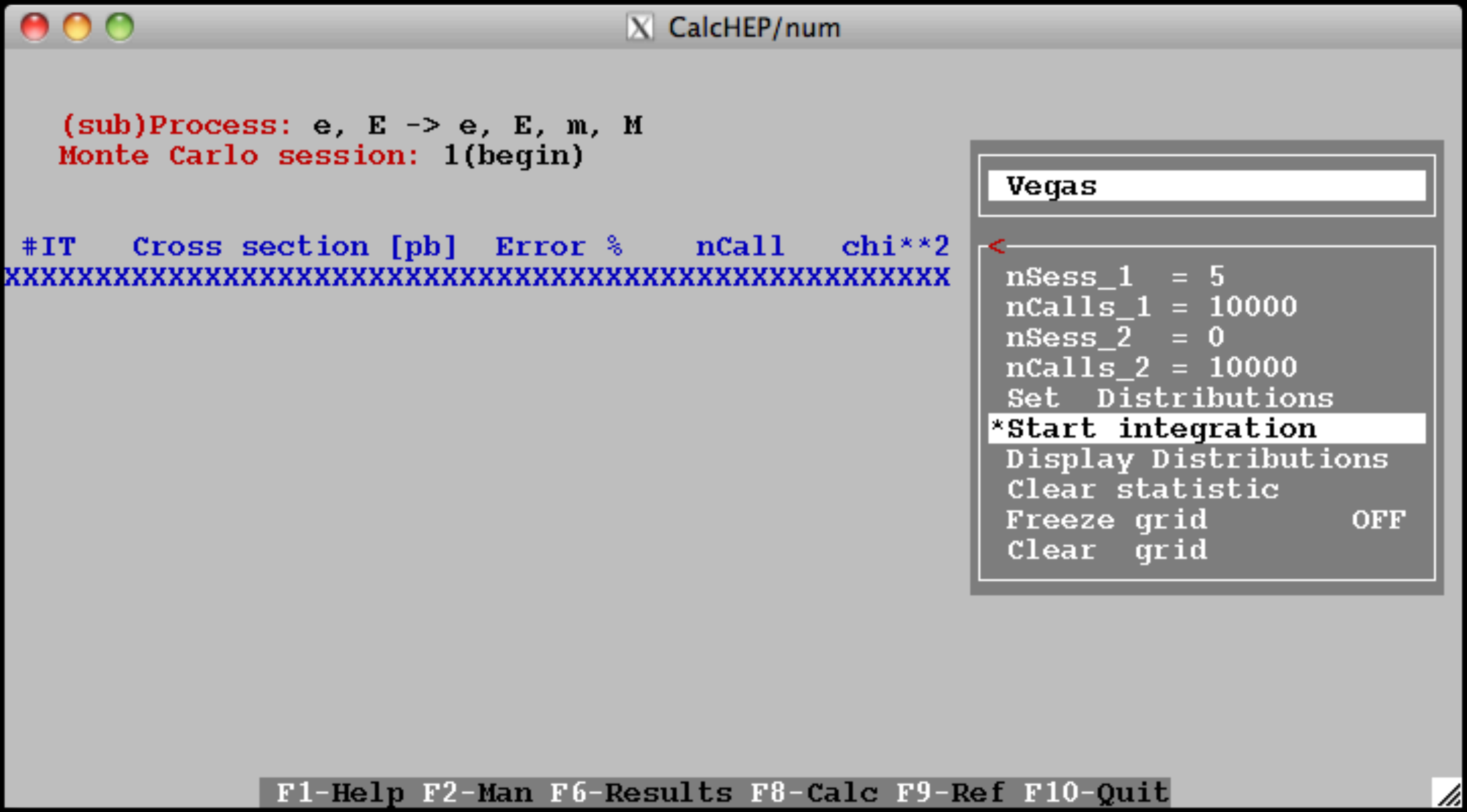
<
Subprocess
IN state
Model parameters
Constraints
QCD coupling
Breit-Wigner
Cuts
Phase space mapping
Vegas
Generate events

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit


CalcHEP/num
(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 1(begin)
#IT Cross section [pb] Error % nCall chi**2
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Vegas
nSess_1 = 5
nCalls_1 = 10000
nSess_2 = 0
nCalls_2 = 10000
Set Distributions
*Start integration
Display Distributions
Clear statistic
Freeze grid OFF
Clear grid
F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit


CalcHEP/num
(sub)Process: e, E -> e, E, m, M
Distributions
Clr Del Size Read ErrMes
Parameter_1|> Min_1 <|> Max_1 <|Parameter_2|> Min_2 <|> Max_2 <
ions
F1 F2 Xgoto Ygoto Find Write


CalcHEP/num
(sub)Process: e, E -> e, E, m, M
Distributions
2
Clr Del Size Read ErrMes
Parameter_1|> Min_1 <|> Max_1 <|Parameter_2|> Min_2 <|> Max_2 <
M(e,E) |0 |200 | | | |
M(m,M) |0 |200 | | | |
ions
F1 F2 Xgoto Ygoto Find Write


CalcHEP/num
(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 1(begin)
#IT Cross section [pb] Error % nCall chi**2
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Vegas
nSess_1 = 5
nCalls_1 = 10000
nSess_2 = 0
nCalls_2 = 10000
Set Distributions
*Start integration
Display Distributions
Clear statistic
Freeze grid OFF
Clear grid
F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

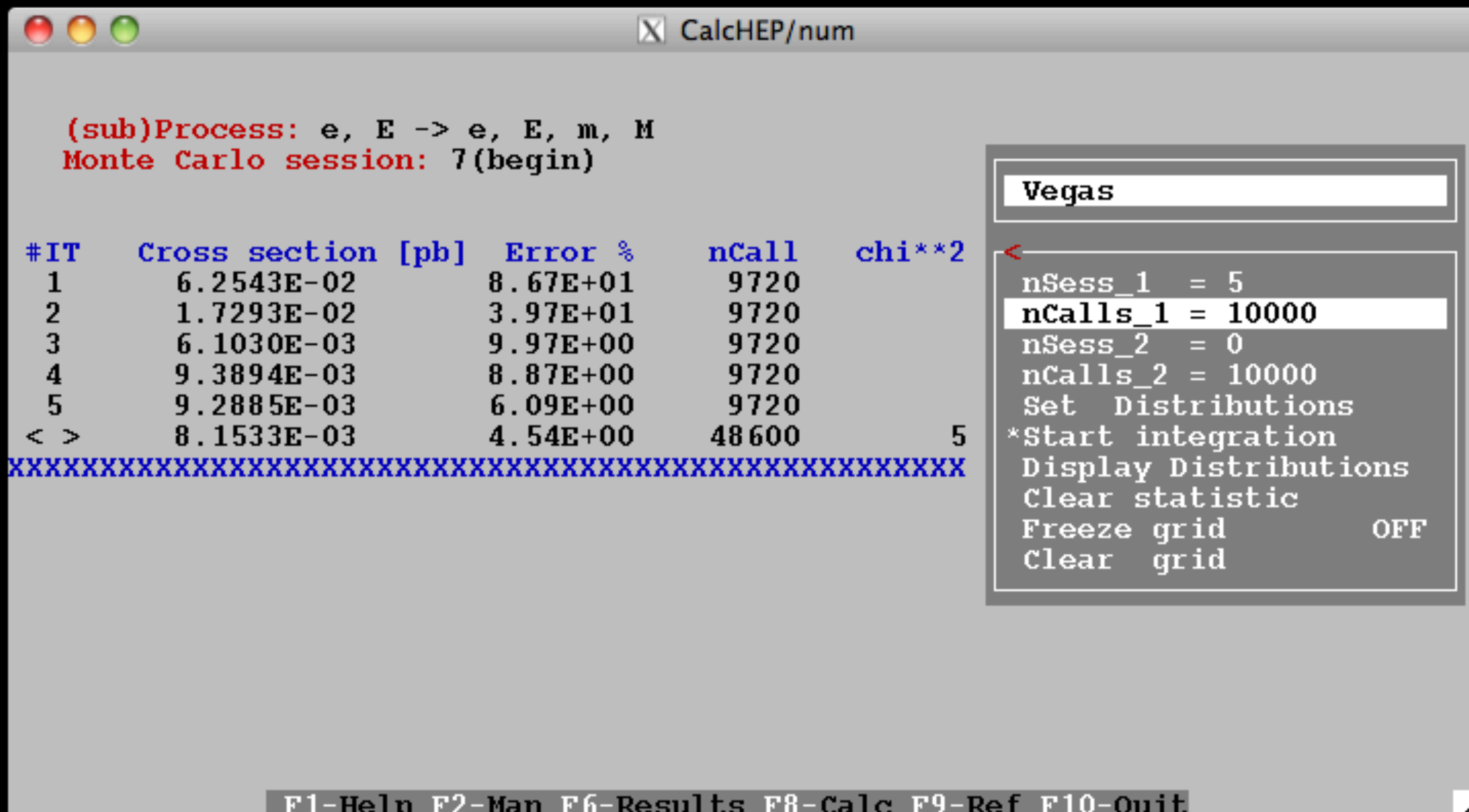
(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 7(begin)

#IT	Cross section [pb]	Error %	nCall	chi**2
1	6.2543E-02	8.67E+01	9720	
2	1.7293E-02	3.97E+01	9720	
3	6.1030E-03	9.97E+00	9720	
4	9.3894E-03	8.87E+00	9720	
5	9.2885E-03	6.09E+00	9720	
< >	8.1533E-03	4.54E+00	48600	5

Vegas

*Start integration

Integration is over
Press any key


CalcHEP/num
(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 7(begin)
#IT Cross section [pb] Error % nCall chi**2
1 6.2543E-02 8.67E+01 9720
2 1.7293E-02 3.97E+01 9720
3 6.1030E-03 9.97E+00 9720
4 9.3894E-03 8.87E+00 9720
5 9.2885E-03 6.09E+00 9720
< > 8.1533E-03 4.54E+00 48600 5
Vegas
nSess_1 = 5
nCalls_1 = 10000
nSess_2 = 0
nCalls_2 = 10000
Set Distributions
*Start integration
Display Distributions
Clear statistic
Freeze grid OFF
Clear grid
F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 7(begin)

#IT	Cross section [pb]	Error %	nCall	chi**2
1	6.2543E-02	8.67E+01	9720	
2	1.7293E-02	3.97E+01	9720	
3	6.1030E-03	9.97E+00	9720	
4	9.3894E-03	8.87E+00	9720	
5	9.2885E-03	6.09E+00	9720	
< >	8.1533E-03	4.54E+00	48600	5

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Vegas

nCalls_1 = 10000

Enter new value 100000

CalcHEP/num

```
 (sub)Process: e, E -> e, E, m, M
 Monte Carlo session: 7(begin)

#IT   Cross section [pb]  Error %    nCall    chi**2   <
 1      6.2543E-02        8.67E+01    9720             nSess_1   = 5
 2      1.7293E-02        3.97E+01    9720             nCalls_1 = 100000
 3      6.1030E-03        9.97E+00    9720             nSess_2   = 0
 4      9.3894E-03        8.87E+00    9720             nCalls_2 = 10000
 5      9.2885E-03        6.09E+00    9720             Set  Distributions
< >     8.1533E-03        4.54E+00   48600         5  *Start integration
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx   Display Distributions
                                                       Clear statistic
                                                       Freeze grid        OFF
                                                       Clear  grid

Vegas

   F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit
```

CalcHEP/num

(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 7(begin)

Vegas

*Start integration

#IT	Cross section [pb]	Error %	nCall	chi**2
1	6.2543E-02	8.67E+01	9720	
2	1.7293E-02	3.97E+01	9720	
3	6.1030E-03	9.97E+00	9720	
4	9.3894E-03	8.87E+00	9720	
5	9.2885E-03	6.09E+00	9720	
< >	8.1533E-03	4.54E+00	48600	5
6	9.1857E-03	2.12E+00	100000	
7	9.6025E-03	2.08E+00	100000	
8	9.1952E-03	1.53E+00	100000	
9	9.4139E-03	2.17E+00	100000	
10	9.2395E-03	1.93E+00	100000	
< >	9.2500E-03	8.43E-01	548600	4

Integration is over
Press any key

CalcHEP/num

(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 7(begin)

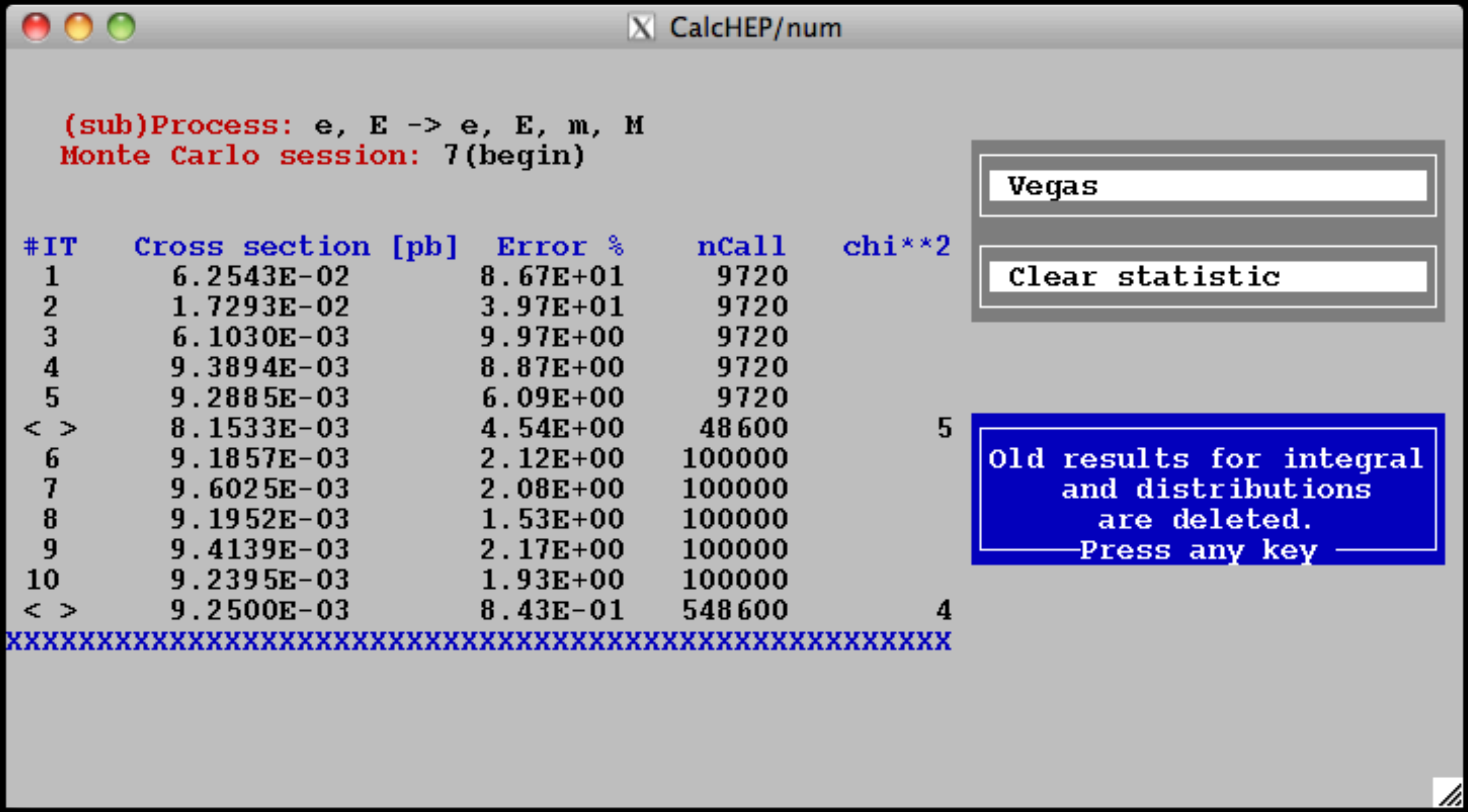
#IT	Cross section [pb]	Error %	nCall	chi**2
1	6.2543E-02	8.67E+01	9720	
2	1.7293E-02	3.97E+01	9720	
3	6.1030E-03	9.97E+00	9720	
4	9.3894E-03	8.87E+00	9720	
5	9.2885E-03	6.09E+00	9720	
< >	8.1533E-03	4.54E+00	48600	5
6	9.1857E-03	2.12E+00	100000	
7	9.6025E-03	2.08E+00	100000	
8	9.1952E-03	1.53E+00	100000	
9	9.4139E-03	2.17E+00	100000	
10	9.2395E-03	1.93E+00	100000	
< >	9.2500E-03	8.43E-01	548600	4

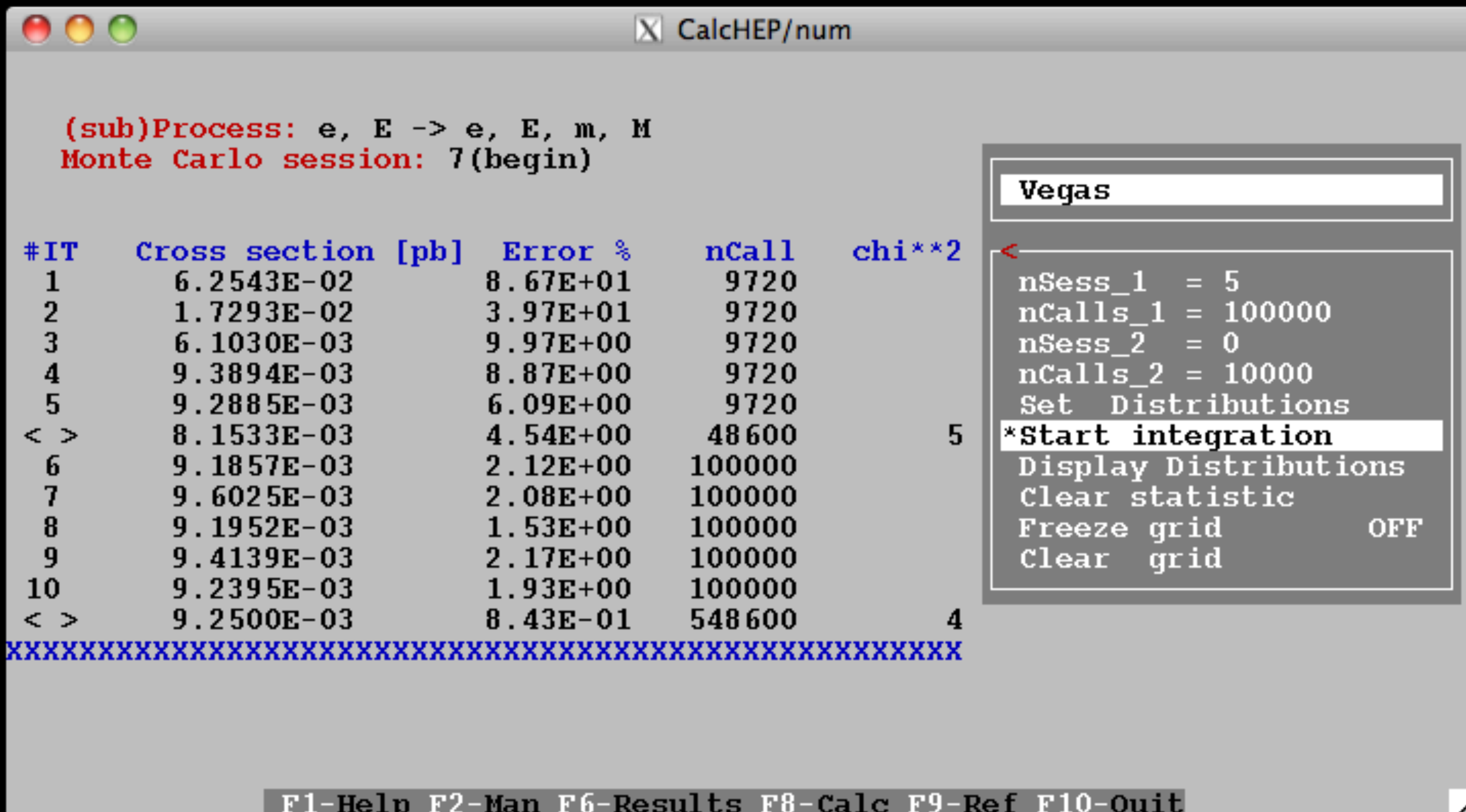
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Vegas

nSess_1 = 5
nCalls_1 = 100000
nSess_2 = 0
nCalls_2 = 10000
Set Distributions
*Start integration
Display Distributions
Clear statistic
Freeze grid OFF
Clear grid

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit


CalcHEP/num
(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 7(begin)
#IT Cross section [pb] Error % nCall chi**2
1 6.2543E-02 8.67E+01 9720
2 1.7293E-02 3.97E+01 9720
3 6.1030E-03 9.97E+00 9720
4 9.3894E-03 8.87E+00 9720
5 9.2885E-03 6.09E+00 9720
< > 8.1533E-03 4.54E+00 48600 5
6 9.1857E-03 2.12E+00 100000
7 9.6025E-03 2.08E+00 100000
8 9.1952E-03 1.53E+00 100000
9 9.4139E-03 2.17E+00 100000
10 9.2395E-03 1.93E+00 100000
< > 9.2500E-03 8.43E-01 548600 4
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
Vegas
Clear statistic
Old results for integral
and distributions
are deleted.
Press any key


CalcHEP/num
(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 7(begin)
#IT Cross section [pb] Error % nCall chi**2
1 6.2543E-02 8.67E+01 9720
2 1.7293E-02 3.97E+01 9720
3 6.1030E-03 9.97E+00 9720
4 9.3894E-03 8.87E+00 9720
5 9.2885E-03 6.09E+00 9720
< > 8.1533E-03 4.54E+00 48600 5
6 9.1857E-03 2.12E+00 100000
7 9.6025E-03 2.08E+00 100000
8 9.1952E-03 1.53E+00 100000
9 9.4139E-03 2.17E+00 100000
10 9.2395E-03 1.93E+00 100000
< > 9.2500E-03 8.43E-01 548600 4
Vegas
nSess_1 = 5
nCalls_1 = 100000
nSess_2 = 0
nCalls_2 = 10000
Set Distributions
*Start integration
Display Distributions
Clear statistic
Freeze grid OFF
Clear grid
F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

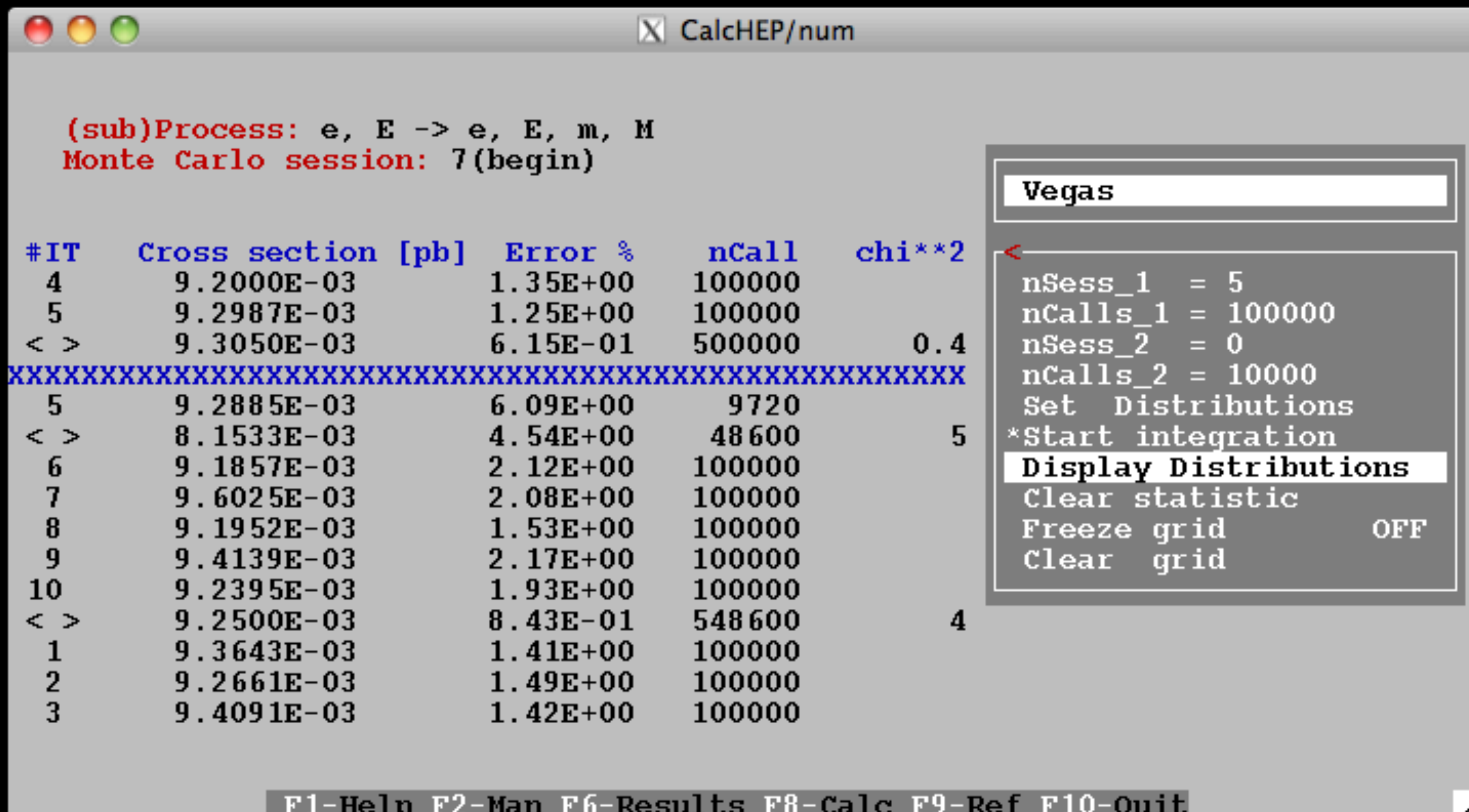
(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 7(begin)

#IT	Cross section [pb]	Error %	nCall	chi**2
4	9.2000E-03	1.35E+00	100000	
5	9.2987E-03	1.25E+00	100000	
< >	9.3050E-03	6.15E-01	500000	0.4
5	9.2885E-03	6.09E+00	9720	
< >	8.1533E-03	4.54E+00	48600	5
6	9.1857E-03	2.12E+00	100000	
7	9.6025E-03	2.08E+00	100000	
8	9.1952E-03	1.53E+00	100000	
9	9.4139E-03	2.17E+00	100000	
10	9.2395E-03	1.93E+00	100000	
< >	9.2500E-03	8.43E-01	548600	4
1	9.3643E-03	1.41E+00	100000	
2	9.2661E-03	1.49E+00	100000	
3	9.4091E-03	1.42E+00	100000	

Vegas

*Start integration

Integration is over
Press any key


CalcHEP/num
(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 7(begin)
#IT Cross section [pb] Error % nCall chi**2
4 9.2000E-03 1.35E+00 100000
5 9.2987E-03 1.25E+00 100000
< > 9.3050E-03 6.15E-01 500000 0.4
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
5 9.2885E-03 6.09E+00 9720
< > 8.1533E-03 4.54E+00 48600 5
6 9.1857E-03 2.12E+00 100000
7 9.6025E-03 2.08E+00 100000
8 9.1952E-03 1.53E+00 100000
9 9.4139E-03 2.17E+00 100000
10 9.2395E-03 1.93E+00 100000
< > 9.2500E-03 8.43E-01 548600 4
1 9.3643E-03 1.41E+00 100000
2 9.2661E-03 1.49E+00 100000
3 9.4091E-03 1.42E+00 100000
Vegas
nSess_1 = 5
nCalls_1 = 100000
nSess_2 = 0
nCalls_2 = 10000
Set Distributions
*Start integration
Display Distributions
Clear statistic
Freeze grid OFF
Clear grid
F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

CalcHEP/num

(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 7(begin)

#IT	Cross section [pb]	Error %	nCall	chi**2
4	9.2000E-03	1.35E+00	100000	
5	9.2987E-03	1.25E+00	100000	
< >	9.3050E-03	6.15E-01	500000	0.4
xxxxxxxxxxxx	xxxxxxxxxxxx	xxxxxxxxxxxx	xxxxxxxxxxxx	xxxxxxxxxxxx
5	9.2885E-03	6.09E+00	9720	
< >	8.1533E-03	4.54E+00	48600	5
6	9.1857E-03	2.12E+00	100000	
7	9.6025E-03	2.08E+00	100000	
8	9.1952E-03	1.53E+00	100000	
9	9.4139E-03	2.17E+00	100000	
10	9.2395E-03	1.93E+00	100000	
< >	9.2500E-03	8.43E-01	548600	4
1	9.3643E-03	1.41E+00	100000	
2	9.2661E-03	1.49E+00	100000	
3	9.4091E-03	1.42E+00	100000	

Vegas

Display Distributions

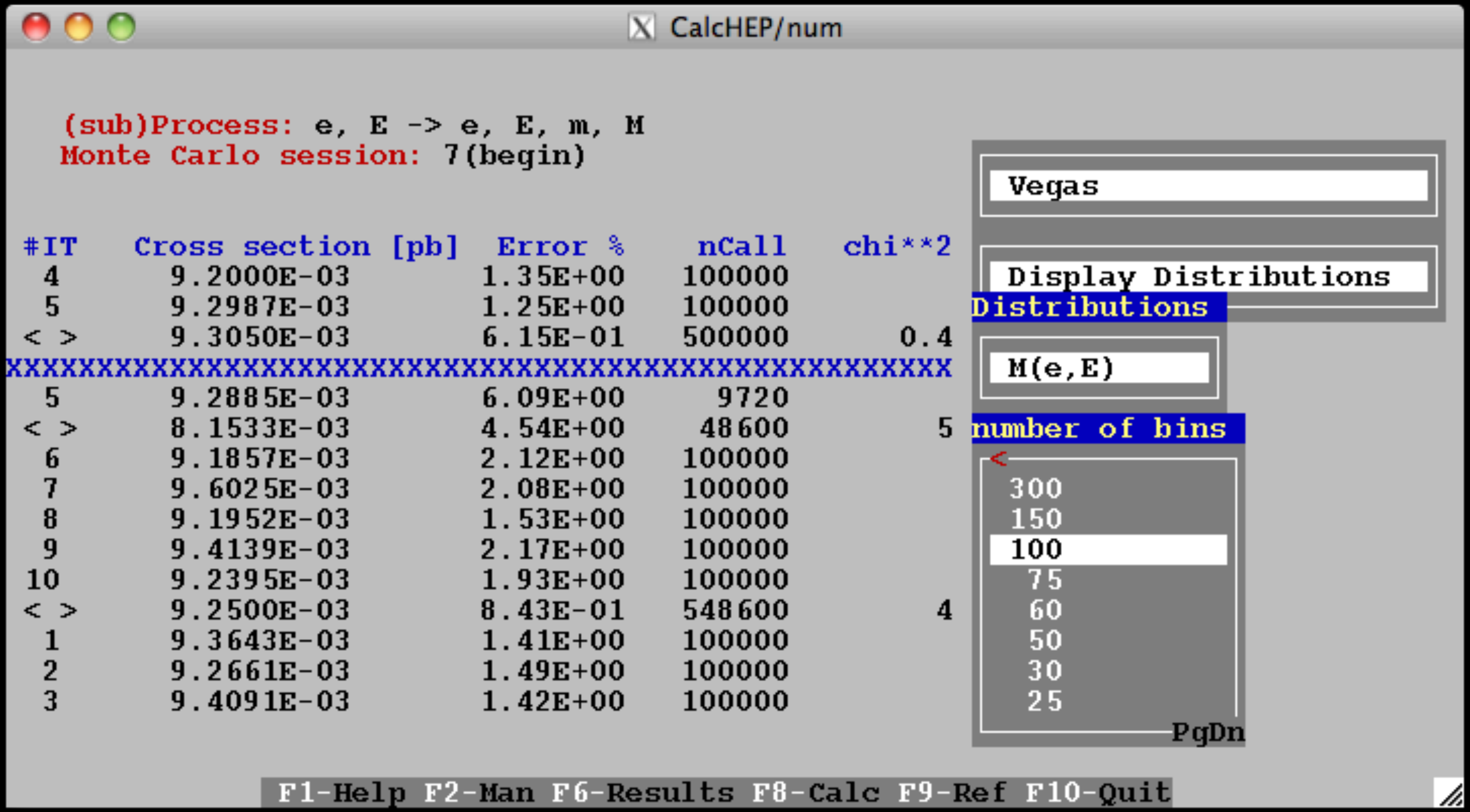
Distributions

<

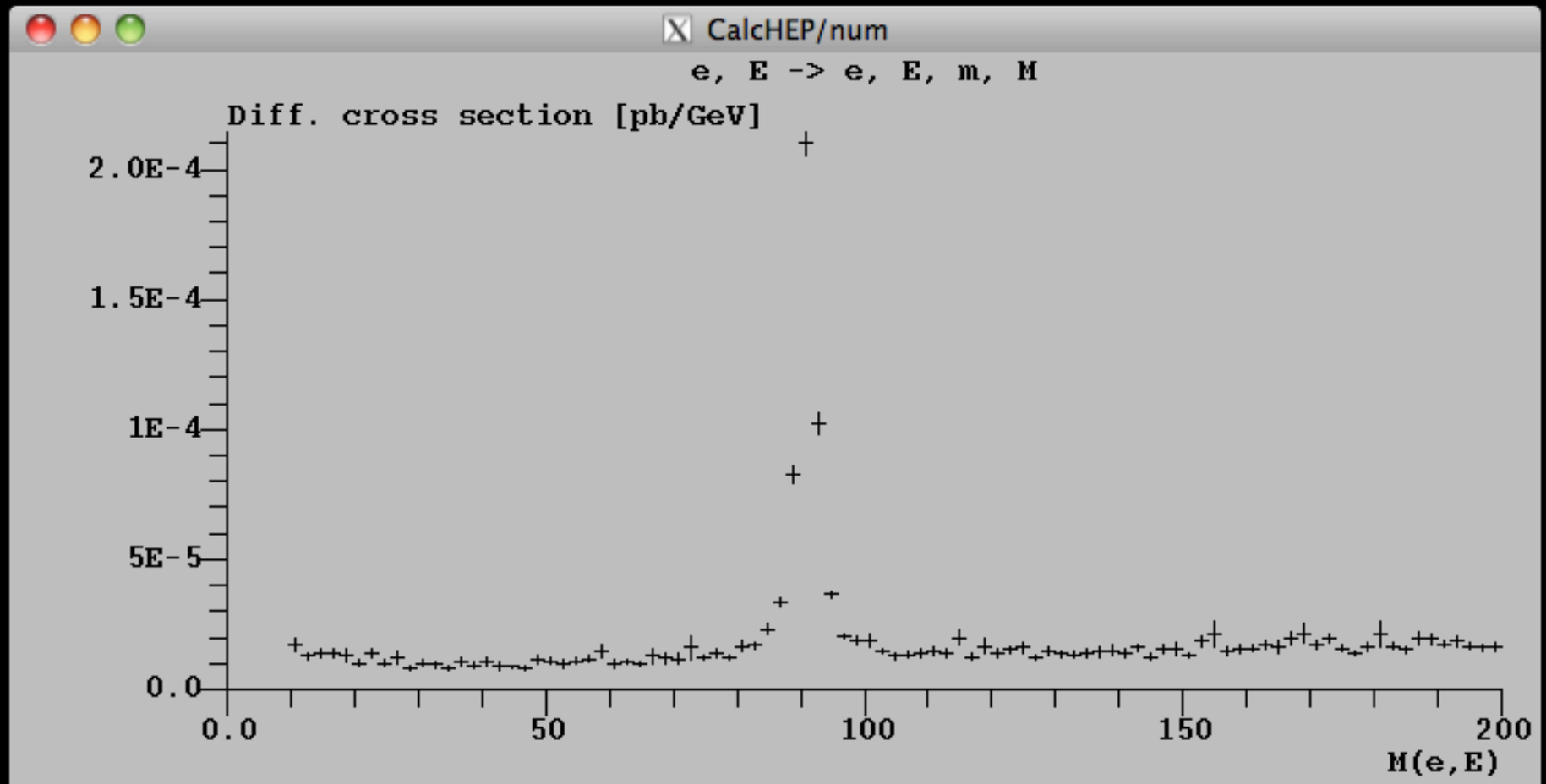
M(e,E)

M(m,M)

F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit


CalcHEP/num
(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 7(begin)
#IT Cross section [pb] Error % nCall chi**2
4 9.2000E-03 1.35E+00 100000
5 9.2987E-03 1.25E+00 100000
< > 9.3050E-03 6.15E-01 500000 0.4
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
5 9.2885E-03 6.09E+00 9720
< > 8.1533E-03 4.54E+00 48600 5
6 9.1857E-03 2.12E+00 100000
7 9.6025E-03 2.08E+00 100000
8 9.1952E-03 1.53E+00 100000
9 9.4139E-03 2.17E+00 100000
10 9.2395E-03 1.93E+00 100000
< > 9.2500E-03 8.43E-01 548600 4
1 9.3643E-03 1.41E+00 100000
2 9.2661E-03 1.49E+00 100000
3 9.4091E-03 1.42E+00 100000
Vegas
Display Distributions
Distributions
M(e,E)
number of bins
<
300
150
100
75
60
50
30
25
PgDn
F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit

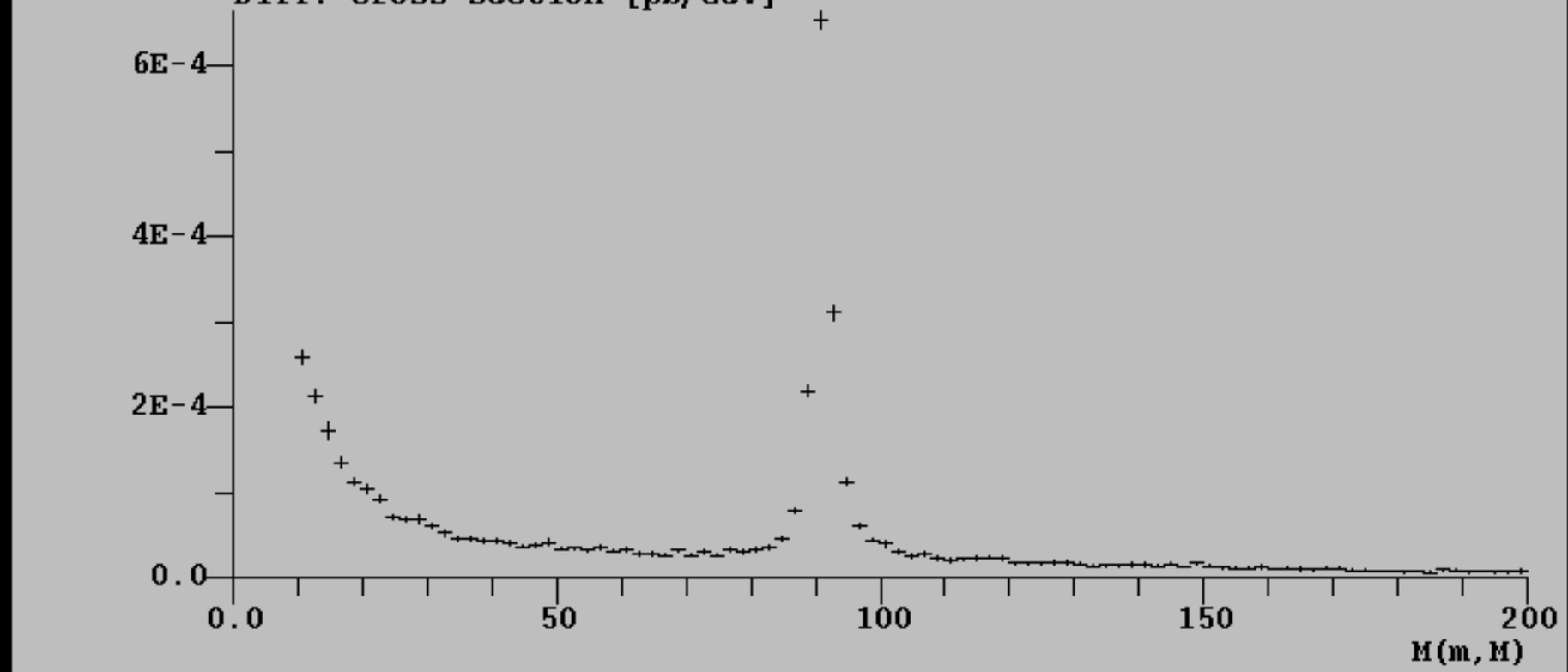
CalcHEP/num



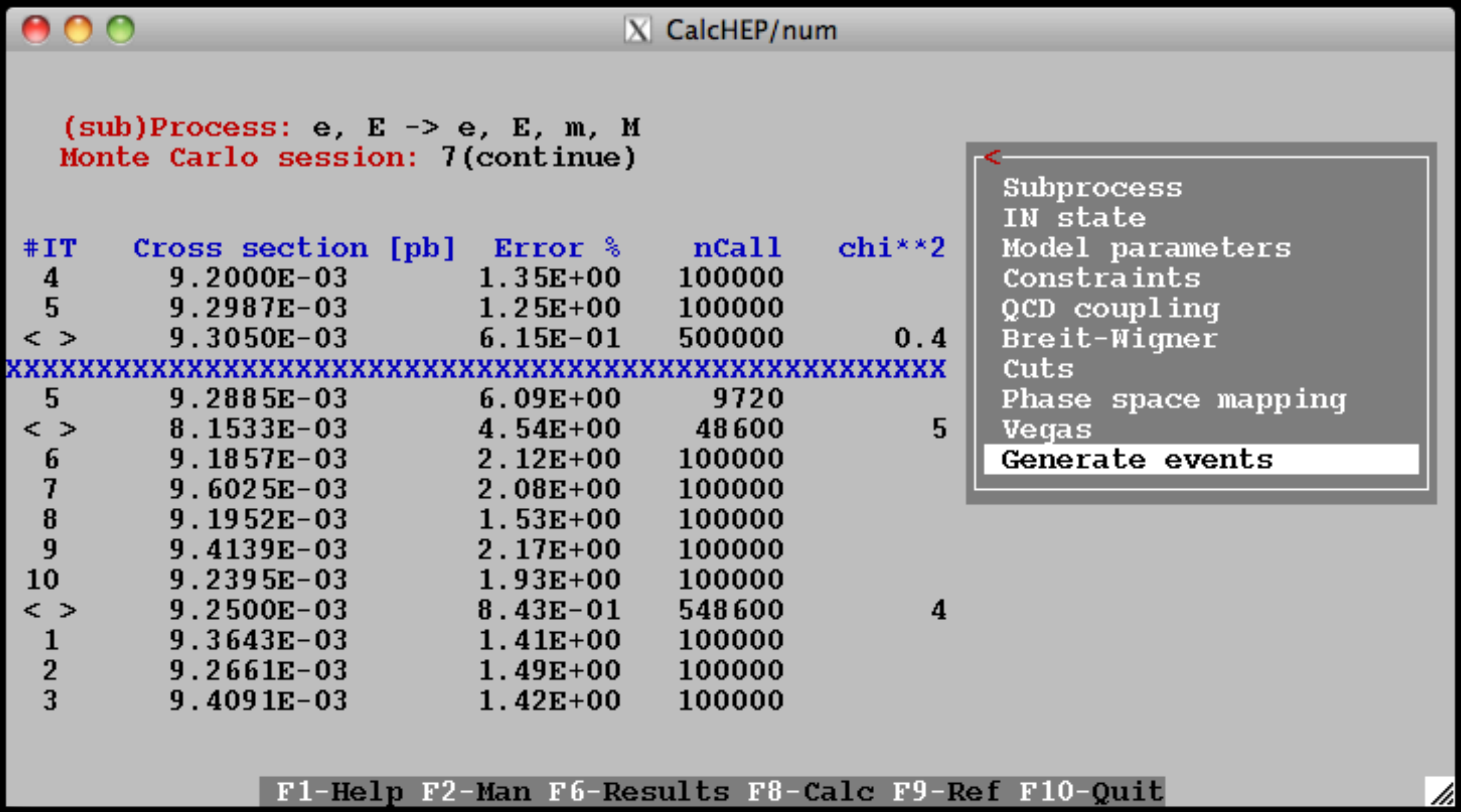
Esc - exit; Mouse - function value; Other keys - menu

CalcHEP/num

e, E -> e, E, m, M



Mouse Info: X=1.776E+02 F=6.46E-06+/-6.2E-07
Esc - exit; Mouse - function value; Other keys - menu


CalcHEP/num
(sub)Process: e, E -> e, E, m, M
Monte Carlo session: 7(continue)
#IT Cross section [pb] Error % nCall chi**2
4 9.2000E-03 1.35E+00 100000
5 9.2987E-03 1.25E+00 100000
< > 9.3050E-03 6.15E-01 500000 0.4
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
5 9.2885E-03 6.09E+00 9720
< > 8.1533E-03 4.54E+00 48600 5
6 9.1857E-03 2.12E+00 100000
7 9.6025E-03 2.08E+00 100000
8 9.1952E-03 1.53E+00 100000
9 9.4139E-03 2.17E+00 100000
10 9.2395E-03 1.93E+00 100000
< > 9.2500E-03 8.43E-01 548600 4
1 9.3643E-03 1.41E+00 100000
2 9.2661E-03 1.49E+00 100000
3 9.4091E-03 1.42E+00 100000
Subprocess
IN state
Model parameters
Constraints
QCD coupling
Breit-Wigner
Cuts
Phase space mapping
Vegas
Generate events
F1-Help F2-Man F6-Results F8-Calc F9-Ref F10-Quit