CalcHEP PROGRAMI

İlkay TÜRK ÇAKIR

İstanbul Aydın Üniversitesi

İleri Araştırmalar Uygulama ve Araştırma Merkezi

Hızlandırıcı ve Parçacık Fiziği Bilgisayar Uygulamaları IV
Anadolu Üniversitesi, Eskişehir
1-8 Şubat, 2015

http://theory.sinp.msu.ru/~pukhov/calchep.html

Authors - Alexander Pukhov, Alexander Belyaev, Neil Christensen

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

General information

Main features , Acknowledgments News&Bugs Publications&Lectures Contributions

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Manual

calchep_man_3.3.6.pdf (manual for version 3.3.6, July 19, 2012)

HEP computer tools (Lecture by Alexander Belyaev)

See also: Dan Green, High Pt physics at hadron colliders (Cambrige University Press)

Code download.

Licence Installation Curent version 3.4.7 (27.05.2014) Old Versions ,

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Models:

MSSM(24.06.2011) NMSSM23(07.05.2011) CPVMSSM(11.06.2013) SUSY models By A.Semenov LeptoQuarks 5DSM 6DSM

Model database HEPMDB

Related packages on Web:

Packages for model generation: LanHEP FeynRules SARAH

RGE and spectrum calculation: SuSpect Isajet SoftSUSY SPheno CPsuperH NMSSMTools

Particle widths in MSSM: SUSY-HIT HDECAY

Parton showers: PYTHIA

Contacts

Email: calchep@googlegroups.com *Launchpad service:* *Ask a question* *File a bug*

Kurulum

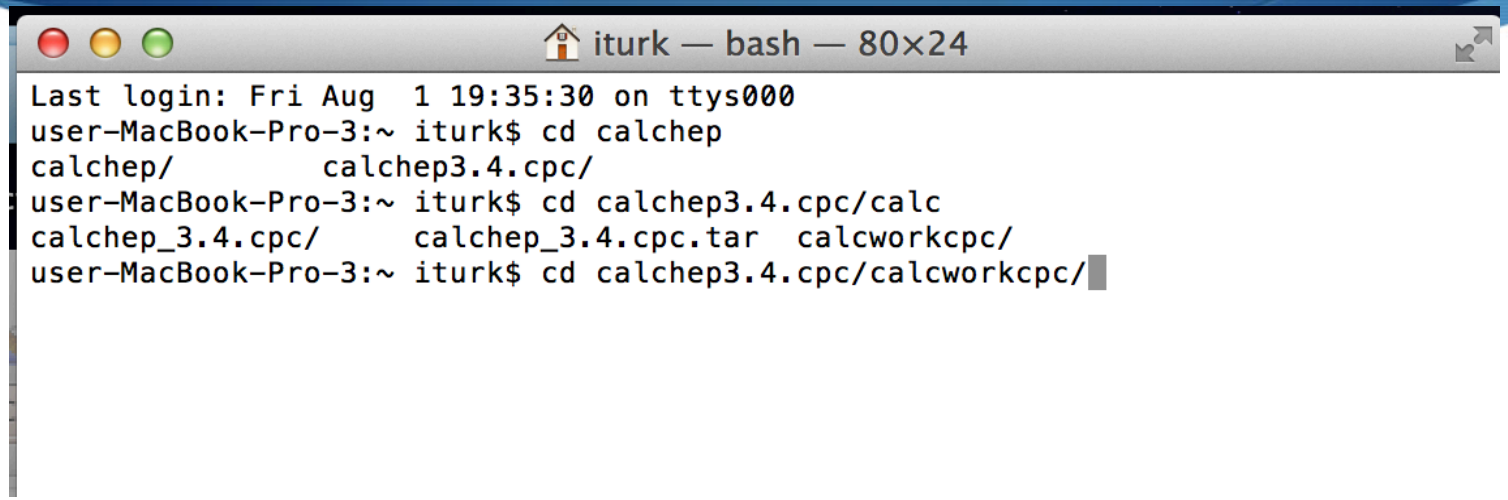
- tar zxvf calchep_3.4.x.tgz
- cd calchep_3.4.x
- make
- ./mkWORKdir ../calcworkcpc (istenilen bir isim verilebilir, bende calcworkcpc)
- cd ..
- cd calcworkcpc

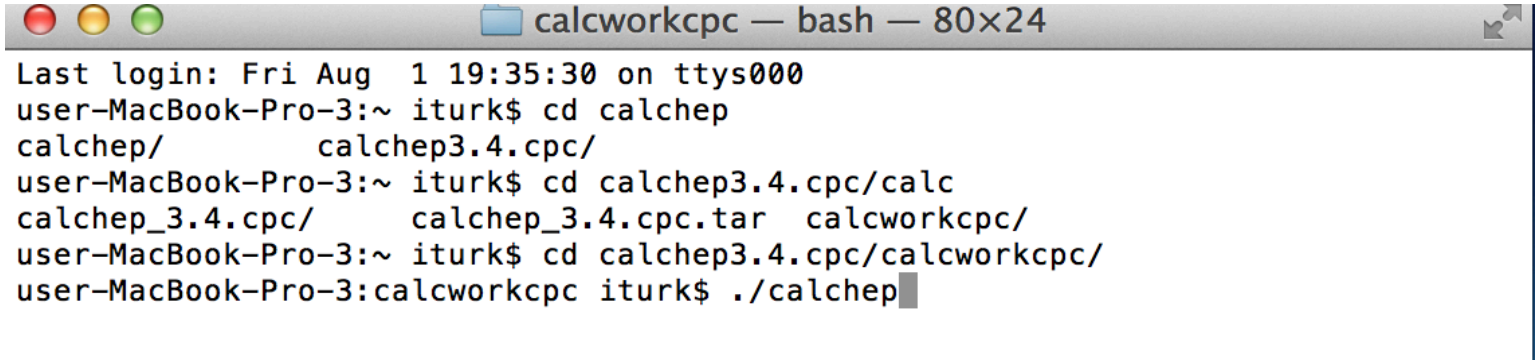
Bu program ile ne yapabiliriz?

Calculate High Energy Physics

- Dallanma Oranı Hesaplayabiliriz ☺
- Ağeç Seviyesinde Tesir Kesiti Hesaplayabiliriz ☺
- Feynman Çizimleri Yapabiliriz ☺
- Olay Üretimi ☺
- Yeni süreç girebiliriz ☺

Not: En çok kullanacağınız tuş: esc tuşu


iturk — bash — 80×24
Last login: Fri Aug 1 19:35:30 on ttys000
user-MacBook-Pro-3:~ iturk$ cd calchep
calchep/   calchep3.4.cpc/
user-MacBook-Pro-3:~ iturk$ cd calchep3.4.cpc/calc
calchep_3.4.cpc/   calchep_3.4.cpc.tar calcworkcpc/
user-MacBook-Pro-3:~ iturk$ cd calchep3.4.cpc/calcworkcpc/

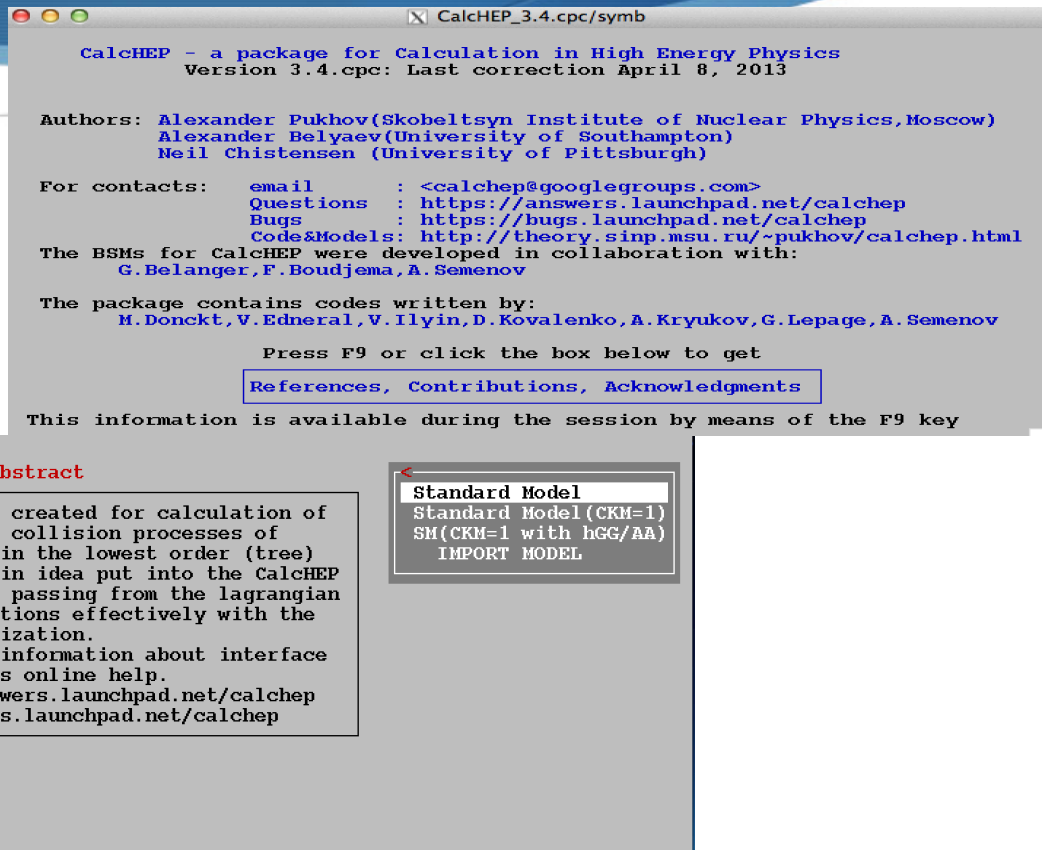

calcworkcpc — bash — 80×24
Last login: Fri Aug 1 19:35:30 on ttys000
user-MacBook-Pro-3:~ iturk$ cd calchep
calchep/   calchep3.4.cpc/
user-MacBook-Pro-3:~ iturk$ cd calchep3.4.cpc/calc
calchep_3.4.cpc/   calchep_3.4.cpc.tar calcworkcpc/
user-MacBook-Pro-3:~ iturk$ cd calchep3.4.cpc/calcworkcpc/
user-MacBook-Pro-3:calcworkcpc iturk$ ./calchep

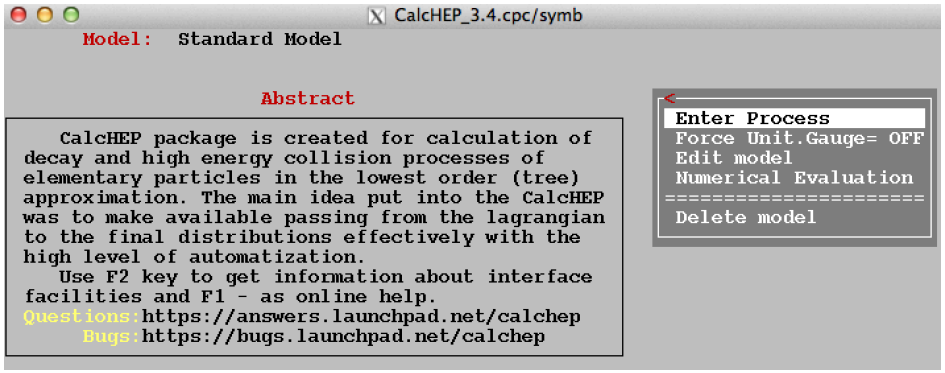
Çalışma Sırası – 1

1- Bir parçacık seçelim.

2- Bozunma genişliğini hesaplayalım.

3- Dallanma oranını hesaplayalım.





CalcHEP_3.4.cpc/symb

Model: Standard Model

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: t->2*x

CalcHEP_3.4.cpc/symb

Model: Standard Model

Process: t->2*x

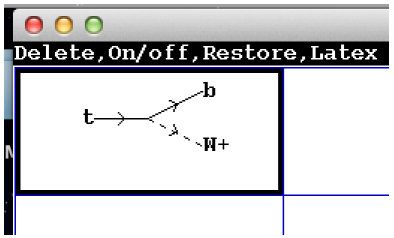
Feynman diagrams

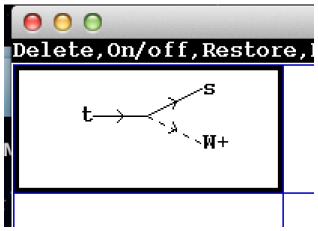
View diagrams

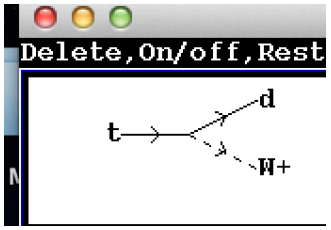
3 diagrams in 3 subprocesses are constructed.

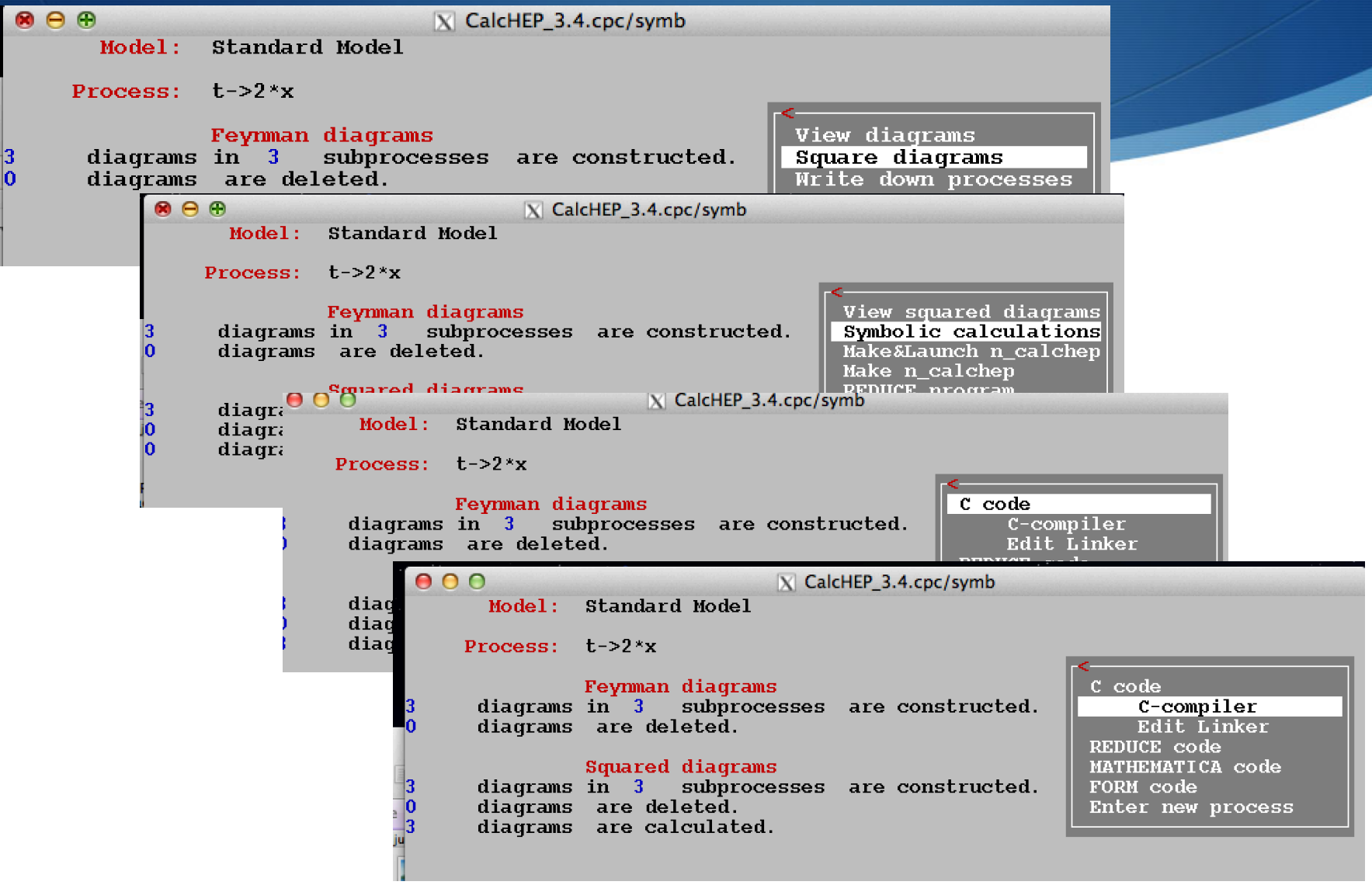
0 diagrams are deleted.

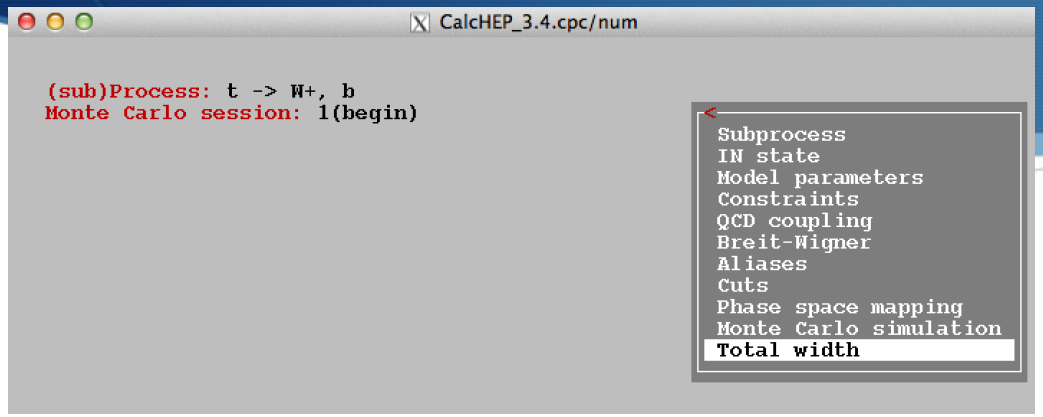
NN	Subprocess	Del	Rest
1	t -> W+,b	0	1
2	t -> W+,s	0	1
3	t -> W+,d	0	1





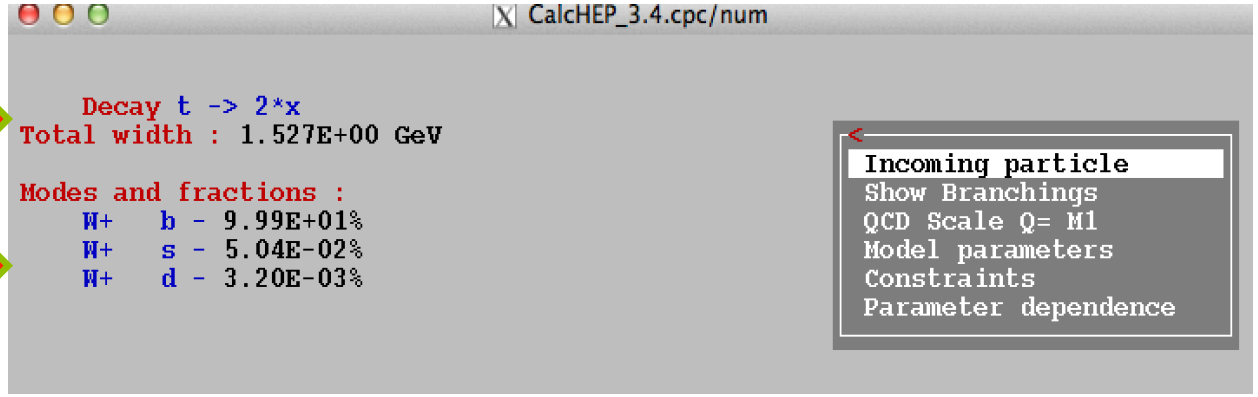



CalcHEP_3.4.cpc/symb
Model: Standard Model
Process: t->2*x
Feynman diagrams
3 diagrams in 3 subprocesses are constructed.
0 diagrams are deleted.
View diagrams
Square diagrams
Write down processes
CalcHEP_3.4.cpc/symb
Model: Standard Model
Process: t->2*x
Feynman diagrams
3 diagrams in 3 subprocesses are constructed.
0 diagrams are deleted.
View squared diagrams
Symbolic calculations
Make&Launch n_calchep
Make n_calchep
CalcHEP_3.4.cpc/symb
Model: Standard Model
Process: t->2*x
Feynman diagrams
diagrams in 3 subprocesses are constructed.
diagrams are deleted.
C code
C-compiler
Edit Linker
CalcHEP_3.4.cpc/symb
Model: Standard Model
Process: t->2*x
Feynman diagrams
3 diagrams in 3 subprocesses are constructed.
0 diagrams are deleted.
Squared diagrams
3 diagrams in 3 subprocesses are constructed.
0 diagrams are deleted.
3 diagrams are calculated.
C code
C-compiler
Edit Linker
REDUCE code
MATHEMATICA code
FORM code
Enter new process



Bozunma Genişliği

Dallanma Oranı



Çalışma Sırası – 2

1) Bir model seçelim.
Örneğin Standart Model seçilir.

2) Bir süreç seçelim.
İstenmeyen alt süreçler atılabilir.

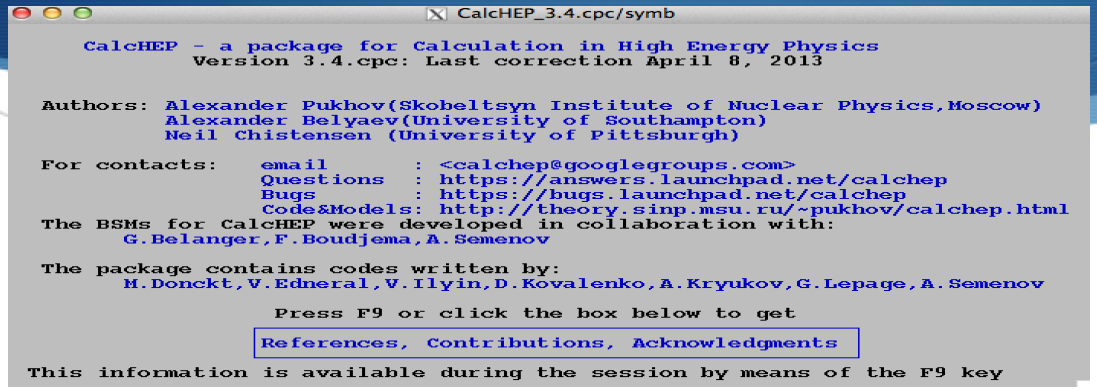
3) Feynman çizimlerinin karesini alıp sonucu "C" dilinde yazdıralım.
Çizimler mutlaka inceleyelelim.

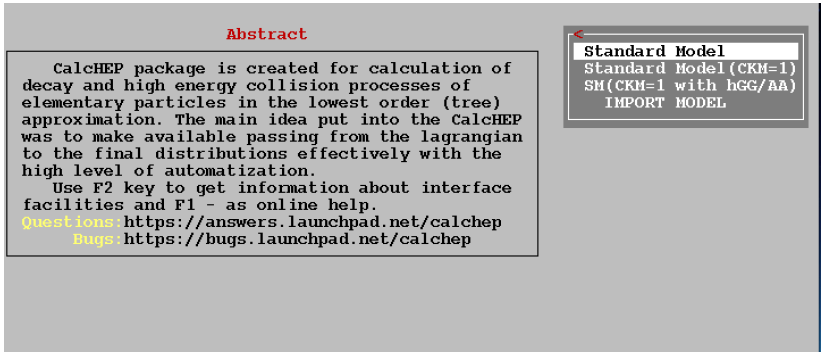
4) "C" programını derleyip sayısal inceleme yapalım.
Sonuçlar burada elde edebiliriz.

5) Hızlandırıcı da burada seçelim.

6) Tesir kesitlerini elde edelim.

a)ISR ve BS etkileri dahil olmadan b) dahil ederek

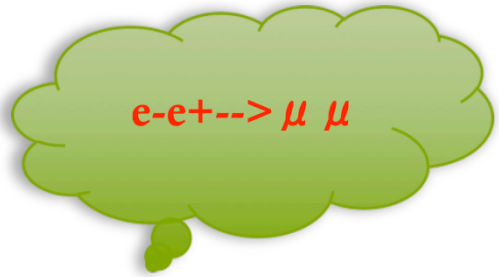




Model Seçimi

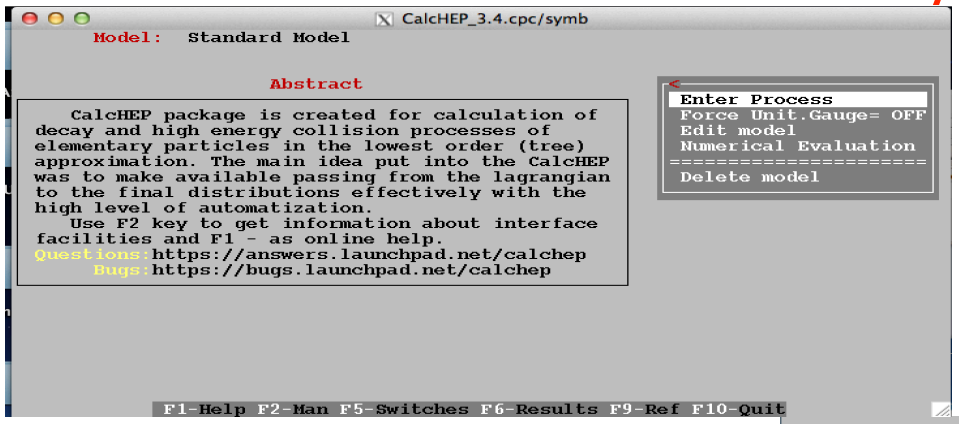
SUSY, SM, QED ile ilgili modelleri bulabilir.

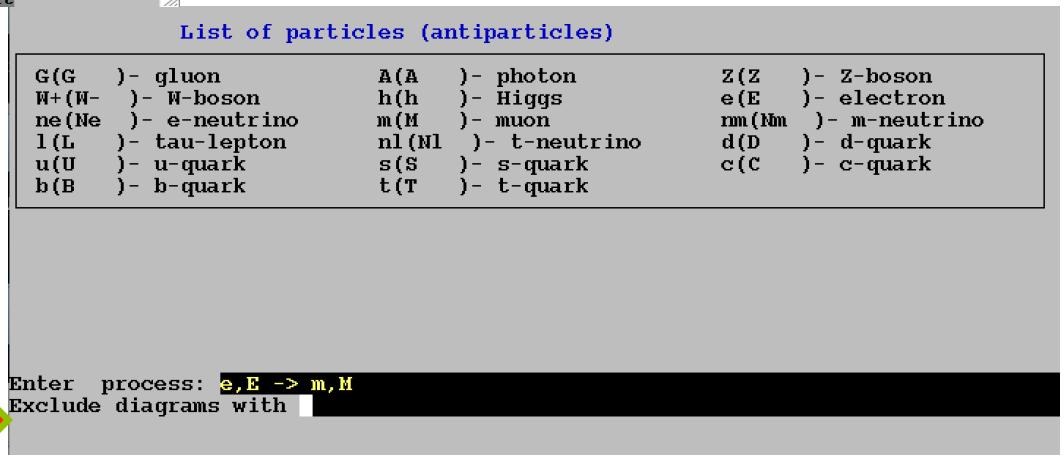
Temel Bir Süreç elektron+pozitron-->muon+antimüon



Temel Bir Süreç elektron+pozitron-->muon+antimüon

e-e+--> μ μ





İstemediğimiz altsüreç varsa ilgili parçacık yazılır. Örneğin: Z ara parçacıklı altsüreci istemiyorsak Z yazılır

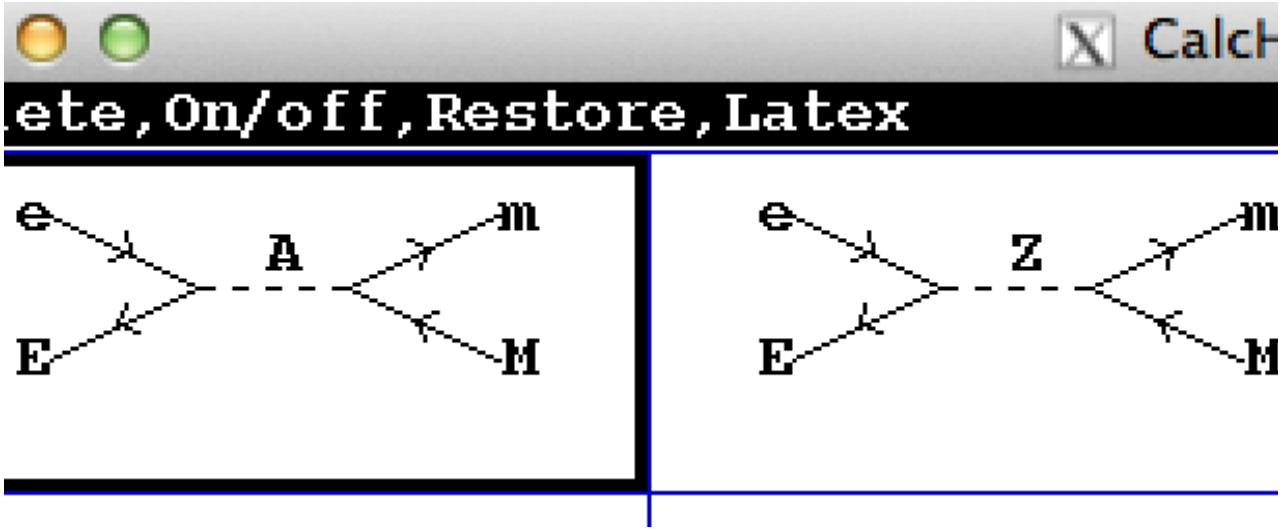
CalcHEP_3.4.cpc/symb

```
      Model:   Standard Model

    Process:   e,E -> m,M

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

View diagrams
Square diagrams
Write down processes



CalcHEP_3.4.cpc/symb

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      Model:   Standard Model

    Process:   e,E -> m,M

               Feynman diagrams
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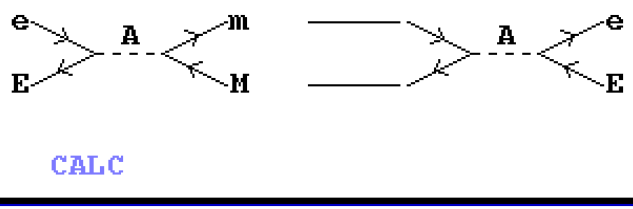
CalcHEP_3.4.cpc/symb

```
      Model:   Standard Model

    Process:   e,E -> m,M

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

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

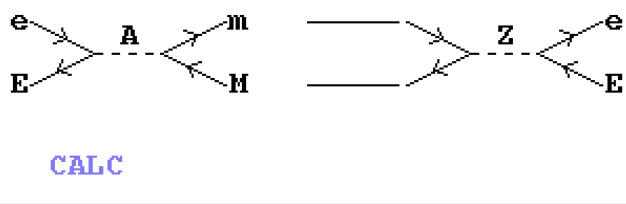
View squared diagrams
Symbolic calculations
Make&Launch n_calchep
Make n_calchep
REDUCE program

CalcHEP_3.4.cpc/symb

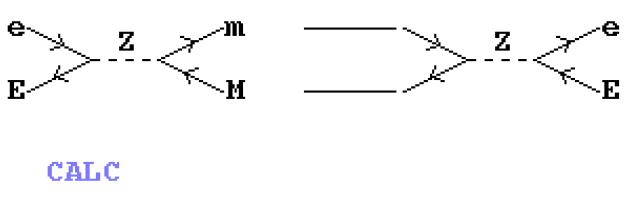
Delete,On/off,Restore,Latex,Ghosts 1/3



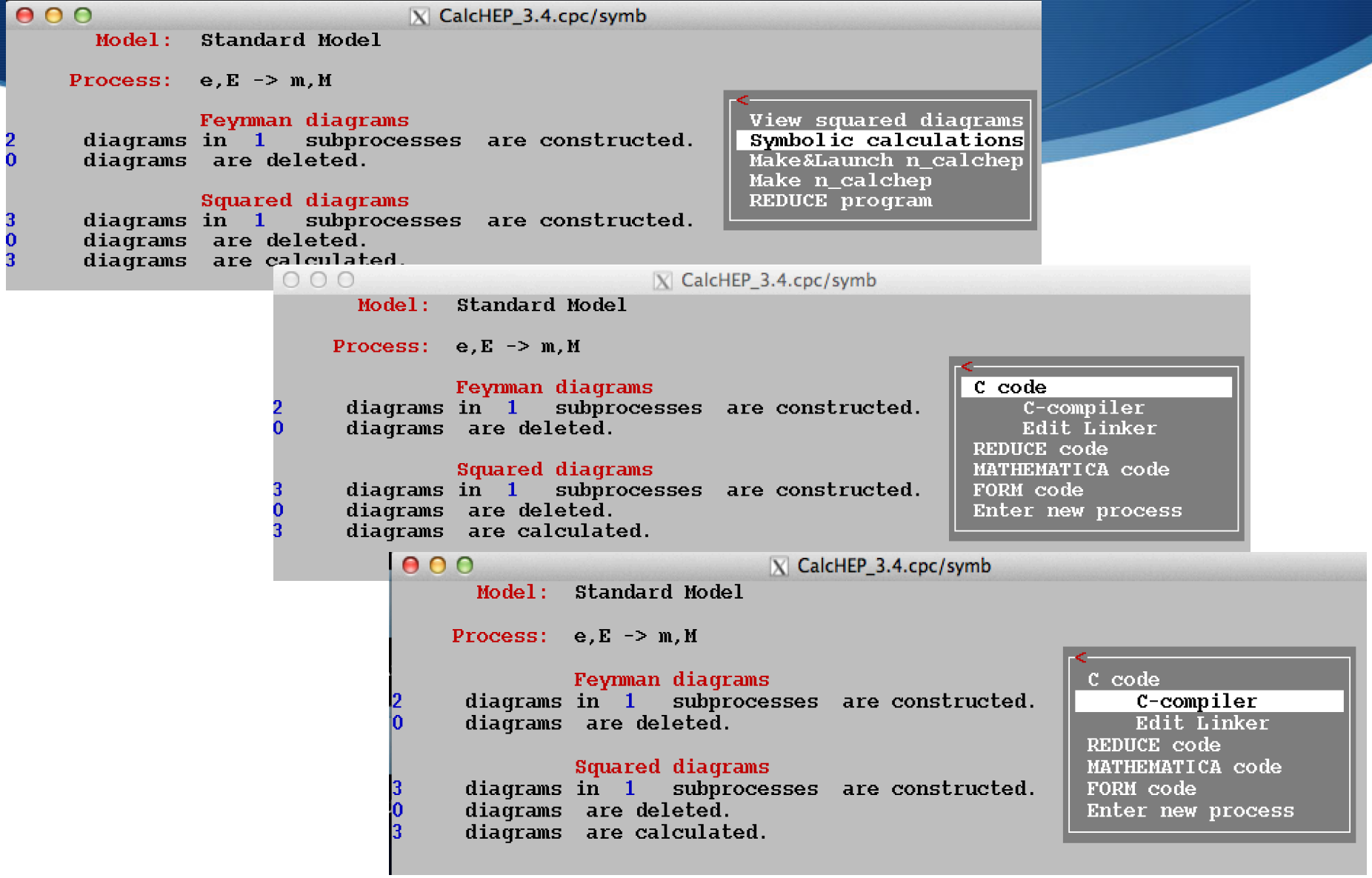
CALC

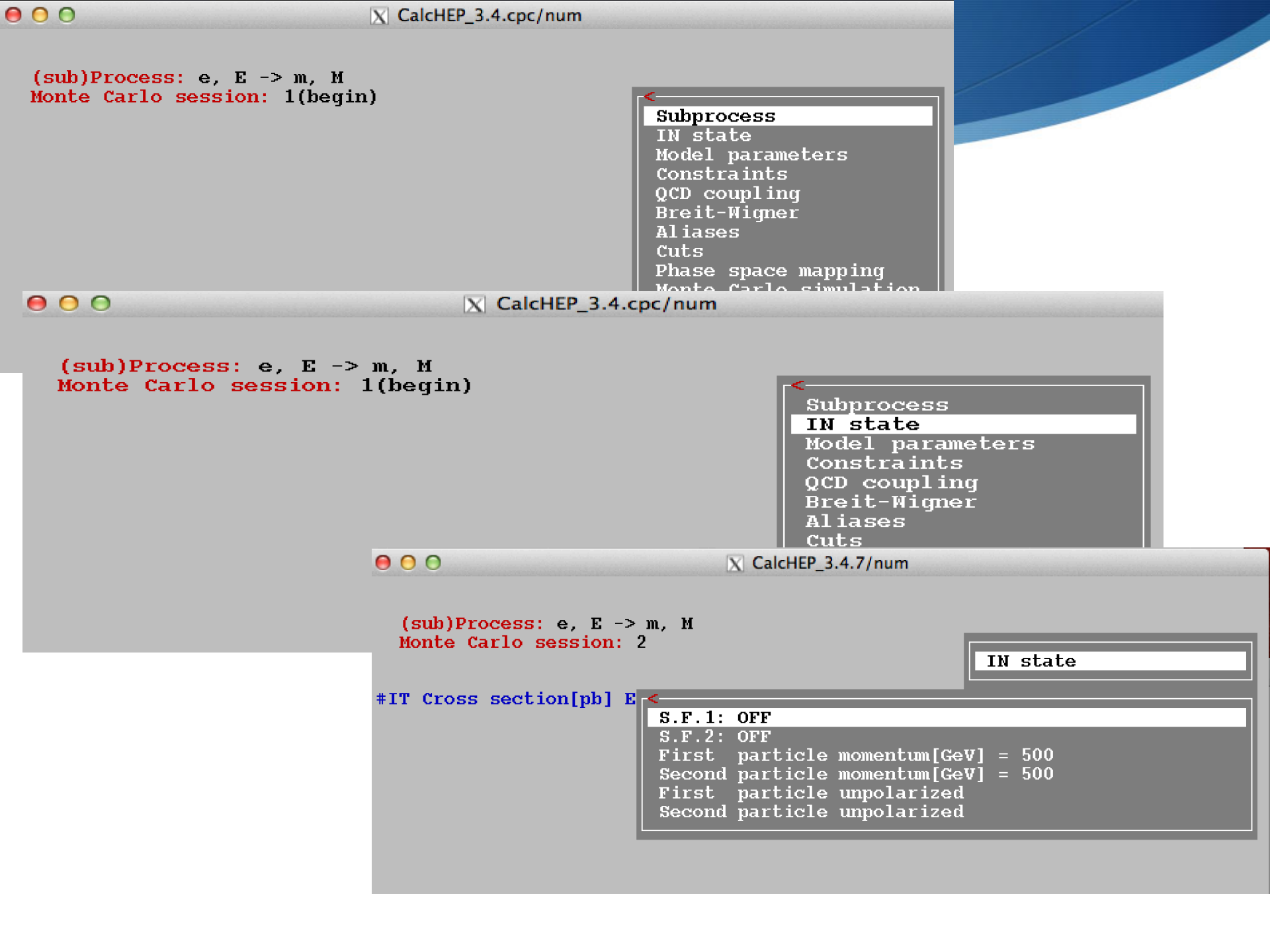


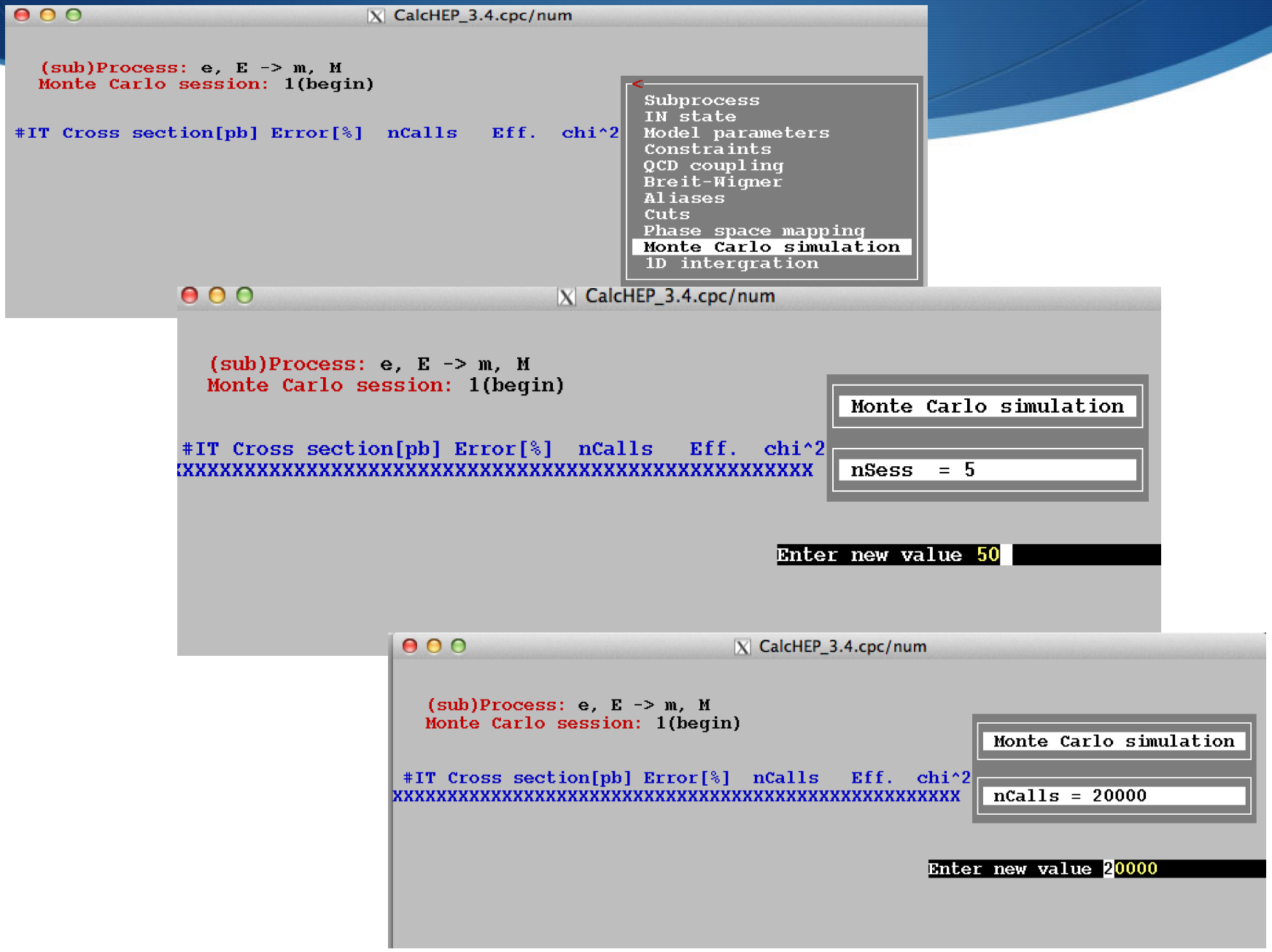
CALC

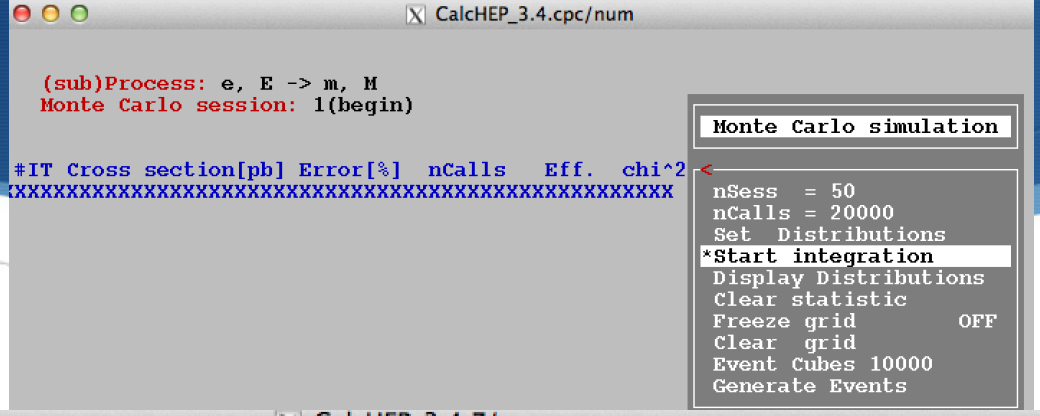


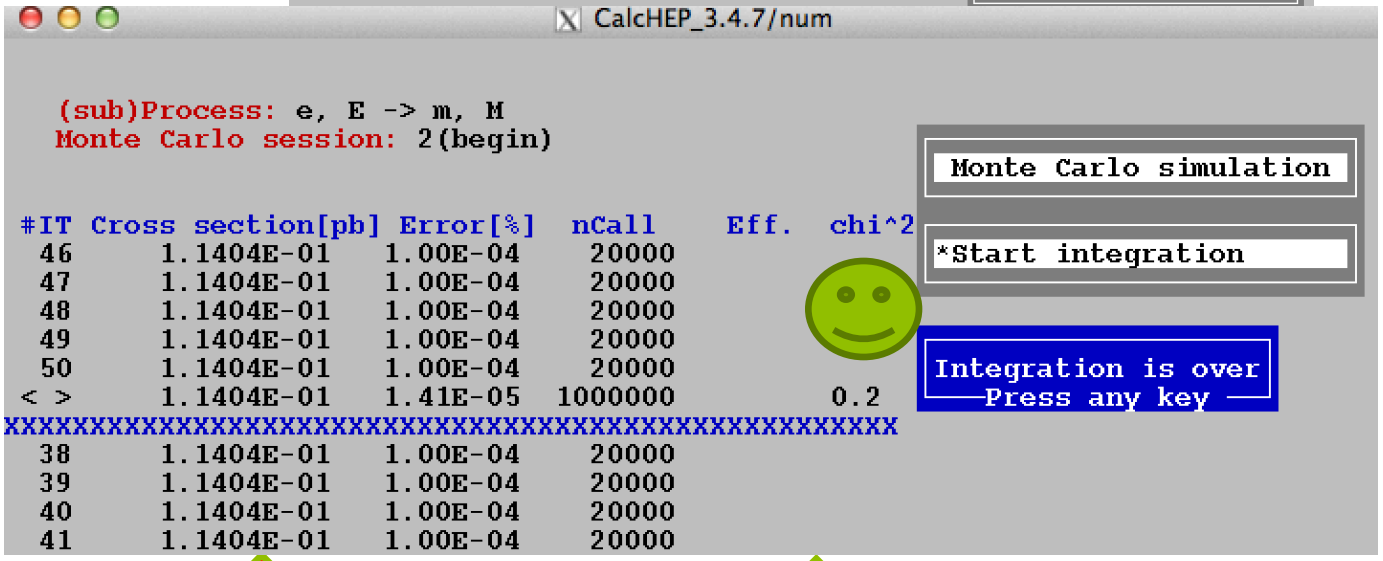
CALC


CalcHEP_3.4.cpc/symb
Model: Standard Model
Process: e,E -> m,M
Feynman diagrams
2 diagrams in 1 subprocesses are constructed.
0 diagrams are deleted.
Squared diagrams
3 diagrams in 1 subprocesses are constructed.
0 diagrams are deleted.
3 diagrams are calculated.
View squared diagrams
Symbolic calculations
Make&Launch n_calchep
Make n_calchep
REDUCE program
CalcHEP_3.4.cpc/symb
Model: Standard Model
Process: e,E -> m,M
Feynman diagrams
2 diagrams in 1 subprocesses are constructed.
0 diagrams are deleted.
Squared diagrams
3 diagrams in 1 subprocesses are constructed.
0 diagrams are deleted.
3 diagrams are calculated.
C code
C-compiler
Edit Linker
REDUCE code
MATHEMATICA code
FORM code
Enter new process
CalcHEP_3.4.cpc/symb
Model: Standard Model
Process: e,E -> m,M
Feynman diagrams
2 diagrams in 1 subprocesses are constructed.
0 diagrams are deleted.
Squared diagrams
3 diagrams in 1 subprocesses are constructed.
0 diagrams are deleted.
3 diagrams are calculated.
C code
C-compiler
Edit Linker
REDUCE code
MATHEMATICA code
FORM code
Enter new process


CalcHEP_3.4.cpc/num
(sub)Process: e, E -> m, M
Monte Carlo session: 1(begin)
Subprocess
IN state
Model parameters
Constraints
QCD coupling
Breit-Wigner
Aliases
Cuts
Phase space mapping
CalcHEP_3.4.cpc/num
(sub)Process: e, E -> m, M
Monte Carlo session: 1(begin)
Subprocess
IN state
Model parameters
Constraints
QCD coupling
Breit-Wigner
Aliases
Cuts
CalcHEP_3.4.7/num
(sub)Process: e, E -> m, M
Monte Carlo session: 2
IN state
#IT Cross section[pb] E
S.F.1: OFF
S.F.2: OFF
First particle momentum[GeV] = 500
Second particle momentum[GeV] = 500
First particle unpolarized
Second particle unpolarized


CalcHEP_3.4.cpc/num
(sub)Process: e, E -> m, M
Monte Carlo session: 1(begin)
#IT Cross section[pb] Error[%] nCalls Eff. chi^2
Subprocess
IN state
Model parameters
Constraints
QCD coupling
Breit-Wigner
Aliases
Cuts
Phase space mapping
Monte Carlo simulation
1D intergration
CalcHEP_3.4.cpc/num
(sub)Process: e, E -> m, M
Monte Carlo session: 1(begin)
#IT Cross section[pb] Error[%] nCalls Eff. chi^2
Monte Carlo simulation
nSess = 5
Enter new value 50
CalcHEP_3.4.cpc/num
(sub)Process: e, E -> m, M
Monte Carlo session: 1(begin)
#IT Cross section[pb] Error[%] nCalls Eff. chi^2
Monte Carlo simulation
nCalls = 20000
Enter new value 20000


CalcHEP_3.4.cpc/num
(sub)Process: e, E -> m, M
Monte Carlo session: 1(begin)
#IT Cross section[pb] Error[%] nCalls Eff. chi^2
Monte Carlo simulation
nSess = 50
nCalls = 20000
Set Distributions
*Start integration
Display Distributions
Clear statistic
Freeze grid OFF
Clear grid
Event Cubes 10000
Generate Events


CalcHEP_3.4.7/num
(sub)Process: e, E -> m, M
Monte Carlo session: 2(begin)
Monte Carlo simulation
*Start integration
Integration is over
Press any key
#IT Cross section[pb] Error[%] nCall Eff. chi^2
46 1.1404E-01 1.00E-04 20000
47 1.1404E-01 1.00E-04 20000
48 1.1404E-01 1.00E-04 20000
49 1.1404E-01 1.00E-04 20000
50 1.1404E-01 1.00E-04 20000
< > 1.1404E-01 1.41E-05 1000000 0.2
38 1.1404E-01 1.00E-04 20000
39 1.1404E-01 1.00E-04 20000
40 1.1404E-01 1.00E-04 20000
41 1.1404E-01 1.00E-04 20000

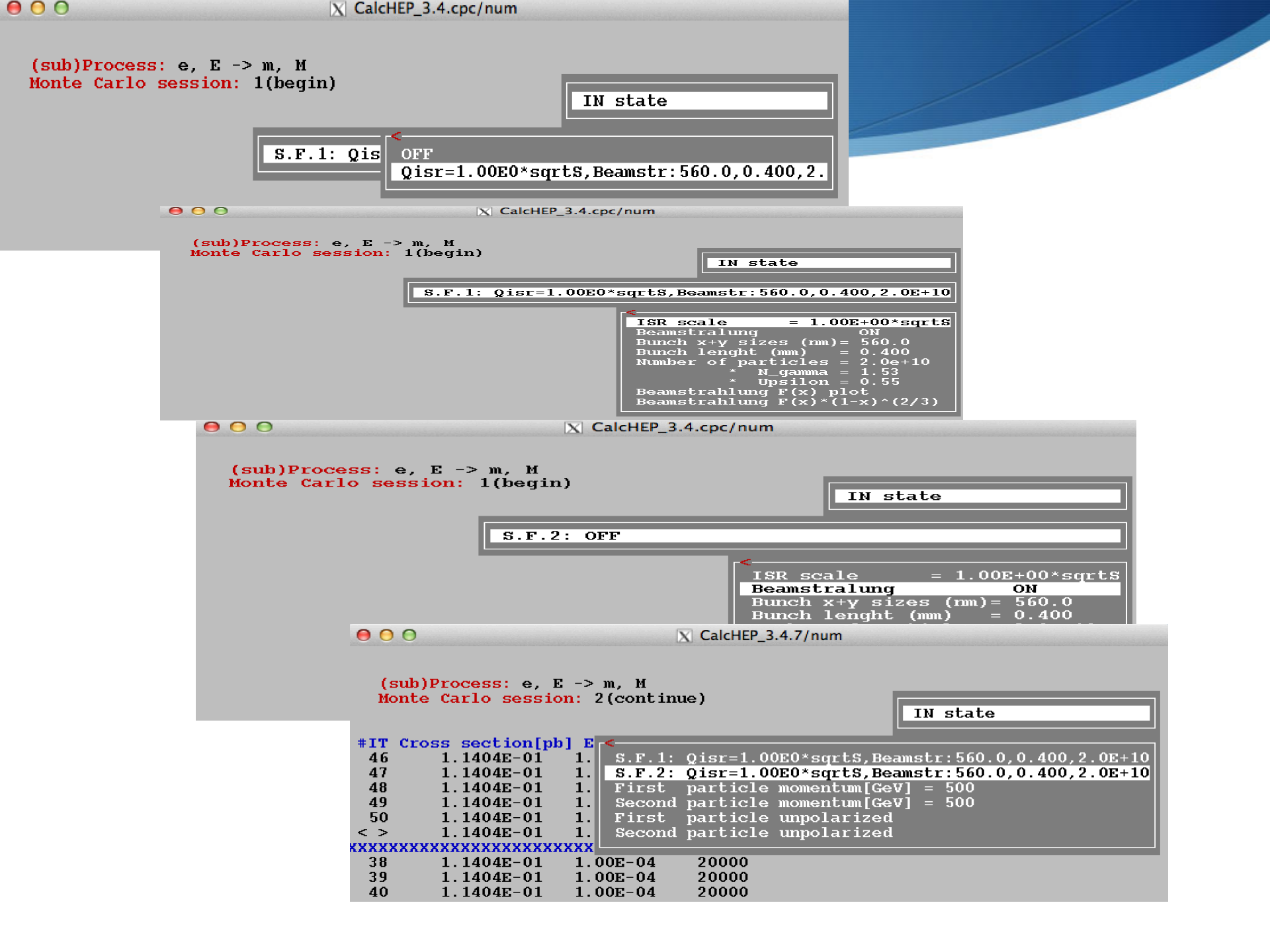

Tesir Kesiti

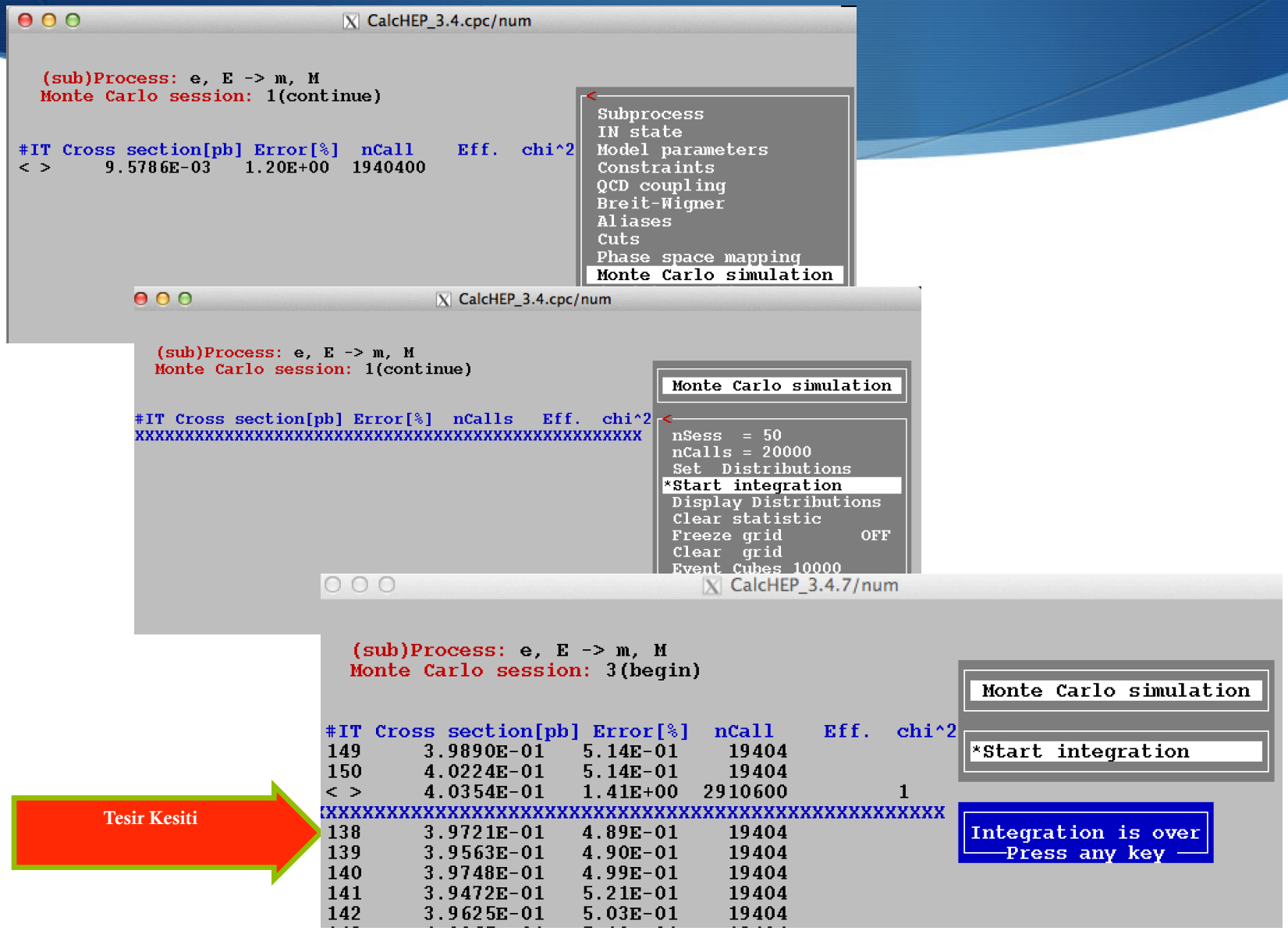

1 veya 1'den küçük olamsı
tercih edilir

ISR&BS Etkisini (Hızlandırıcımıza Uygun Olarak) Göz Önüne Alalım

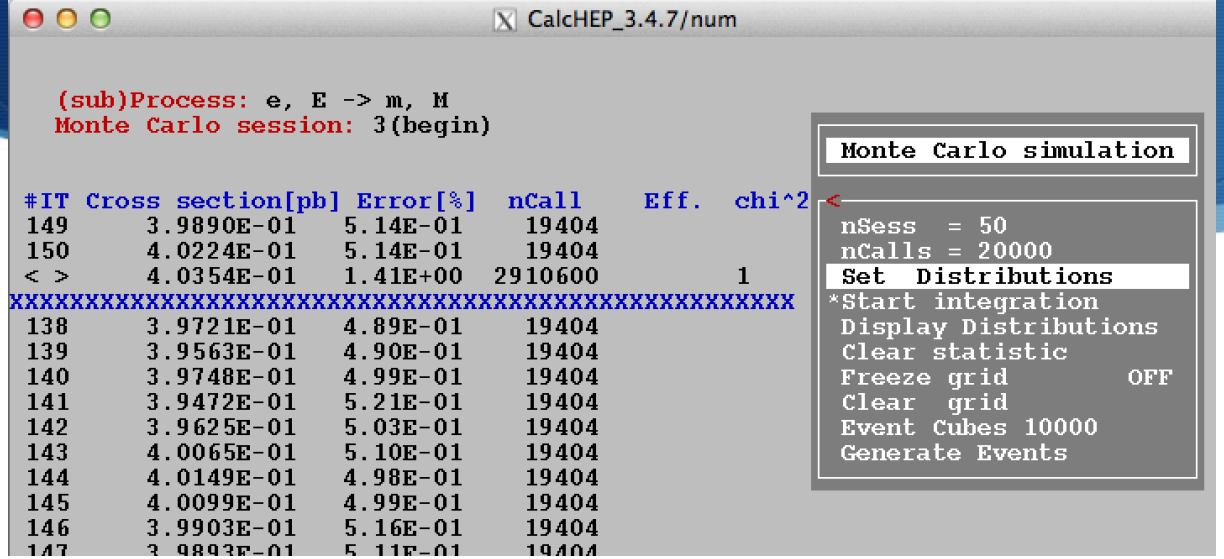
ISR: İlk ışımadan yayınlanan foton radyasyonu-KM enerjisini azaltabilir.

BS: Parçacıkların EM alanından dolayı enerji kaybediyor. Bu spektrum doğrusal çarpıştırcının geometrisine (bunch x+y sizes), demetin boyutlarına (bunch lenght), demetdeki parçacık sayısına (bunch of particles), demet enerjisine göre değişim göstermektedir.

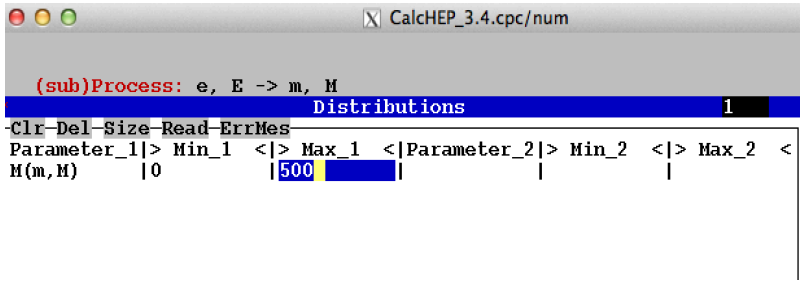

CalcHEP_3.4.cpc/num
(sub)Process: e, E -> m, M
Monte Carlo session: 1(begin)
IN state
S.F.1: Qis
OFF
Qisr=1.00E0*sqrtS,Beamstr:560.0,0.400,2.
CalcHEP_3.4.cpc/num
(sub)Process: e, E -> m, M
Monte Carlo session: 1(begin)
IN state
S.F.1: Qisr=1.00E0*sqrtS,Beamstr:560.0,0.400,2.0E+10
ISR scale = 1.00E+00*sqrtS
Beamstralung ON
Bunch x+y sizes (mm)= 560.0
Bunch lenght (mm) = 0.400
Number of particles = 2.0e+10
* N_gamma = 1.53
* Upsilon = 0.55
Beamstrahlung F(x) plot
Beamstrahlung F(x)*(1-x)^(2/3)
CalcHEP_3.4.cpc/num
(sub)Process: e, E -> m, M
Monte Carlo session: 1(begin)
IN state
S.F.2: OFF
ISR scale = 1.00E+00*sqrtS
Beamstralung ON
Bunch x+y sizes (mm)= 560.0
Bunch lenght (mm) = 0.400
CalcHEP_3.4.7/num
(sub)Process: e, E -> m, M
Monte Carlo session: 2(continue)
IN state
#IT Cross section[pb] E
S.F.1: Qisr=1.00E0*sqrtS,Beamstr:560.0,0.400,2.0E+10
S.F.2: Qisr=1.00E0*sqrtS,Beamstr:560.0,0.400,2.0E+10
First particle momentum[GeV] = 500
Second particle momentum[GeV] = 500
First particle unpolarized
Second particle unpolarized
46 1.1404E-01 1.
47 1.1404E-01 1.
48 1.1404E-01 1.
49 1.1404E-01 1.
50 1.1404E-01 1.
< > 1.1404E-01 1.
38 1.1404E-01 1.00E-04 20000
39 1.1404E-01 1.00E-04 20000
40 1.1404E-01 1.00E-04 20000

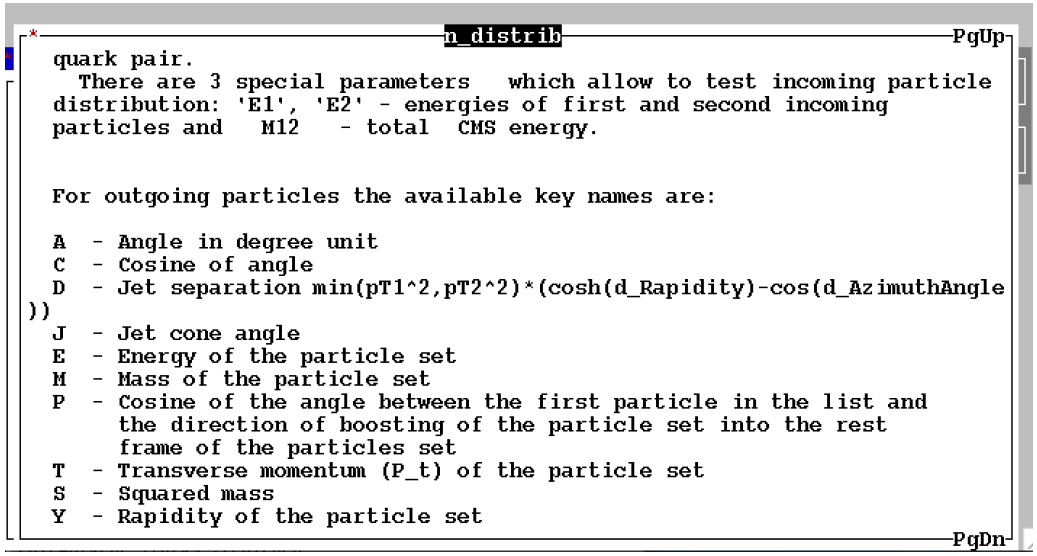


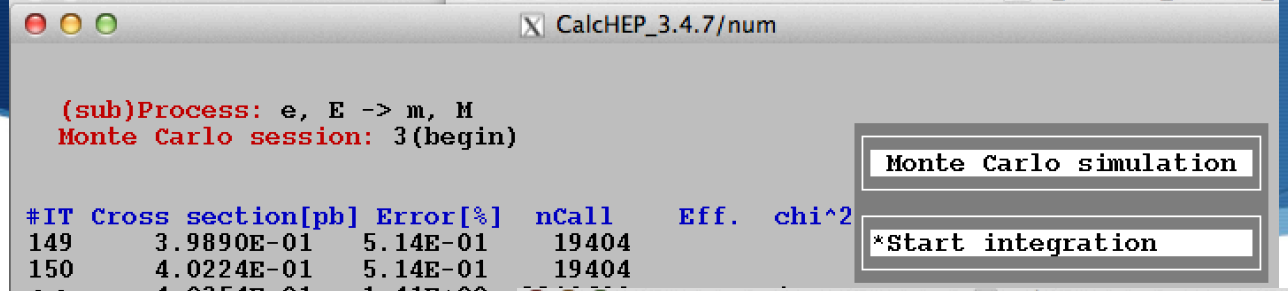
Önceki sonuçla karşılaştırıldığında sonucun değiştiğini görüyoruz yani hızlandırıcı parametrelerinin tesir kesiti üzerindeki etkisini görüyoruz.

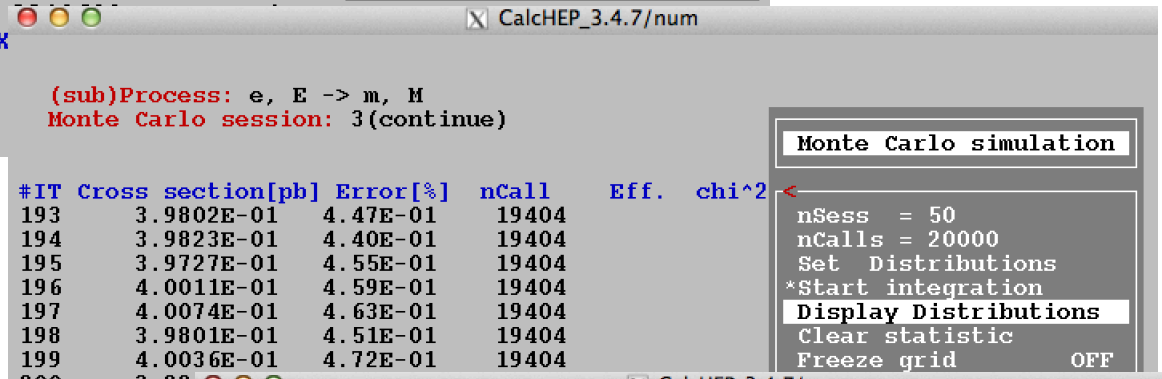


F1 komutuna basılır

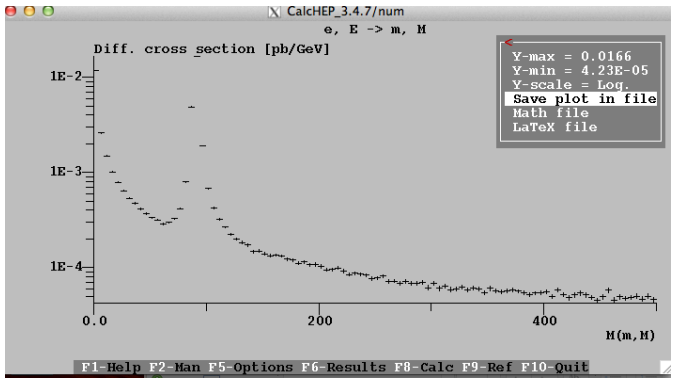


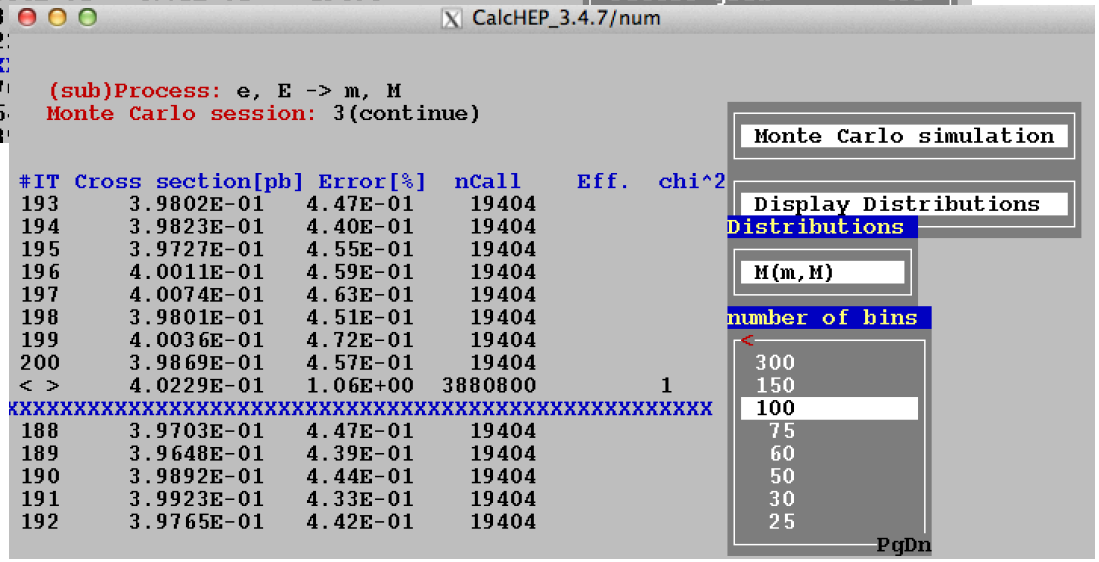






- Çift- mu değişmez (invaryant) kütle dağılımı
- latex&text çıktı alınabilir
- log&lineer Y ekseni kullanılabilir





Çalışma Sırası-3 – PROTONLARDA

Aynı yollardan tesir kesitlerini ama bu sefer kesmeler (cutlar) koyarak hesaplayalım. Sonra da bol bol olay üretimi yapalım. pp -> b B sürecini inceleyelim.

CalcHEP_3.4.cpc/symb

Model: Standard Model/Unitary Gauge/

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 high le
Use
facilit
Questic
Bu

Enter Process
Force Unit.Gauge= ON
Edit model
Numerical Evaluation
Delete model

CalcHEP_3.4.cpc/symb

Model: Standard Model/Unitary Gauge/

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: p,p->b,B
composite 'p' consists of: u,U,c,C,d,D,s,S,b,B,G

CalcHEP_3.4.cpc/symb

Model: Standard Model/Unitary Gauge/

Process: p,p->b,B

Feynman diagrams

View diagrams

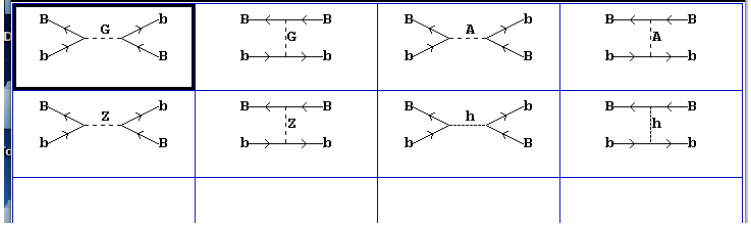
53 diagrams in 15 subprocesses are constructed.
0 diagrams are deleted.

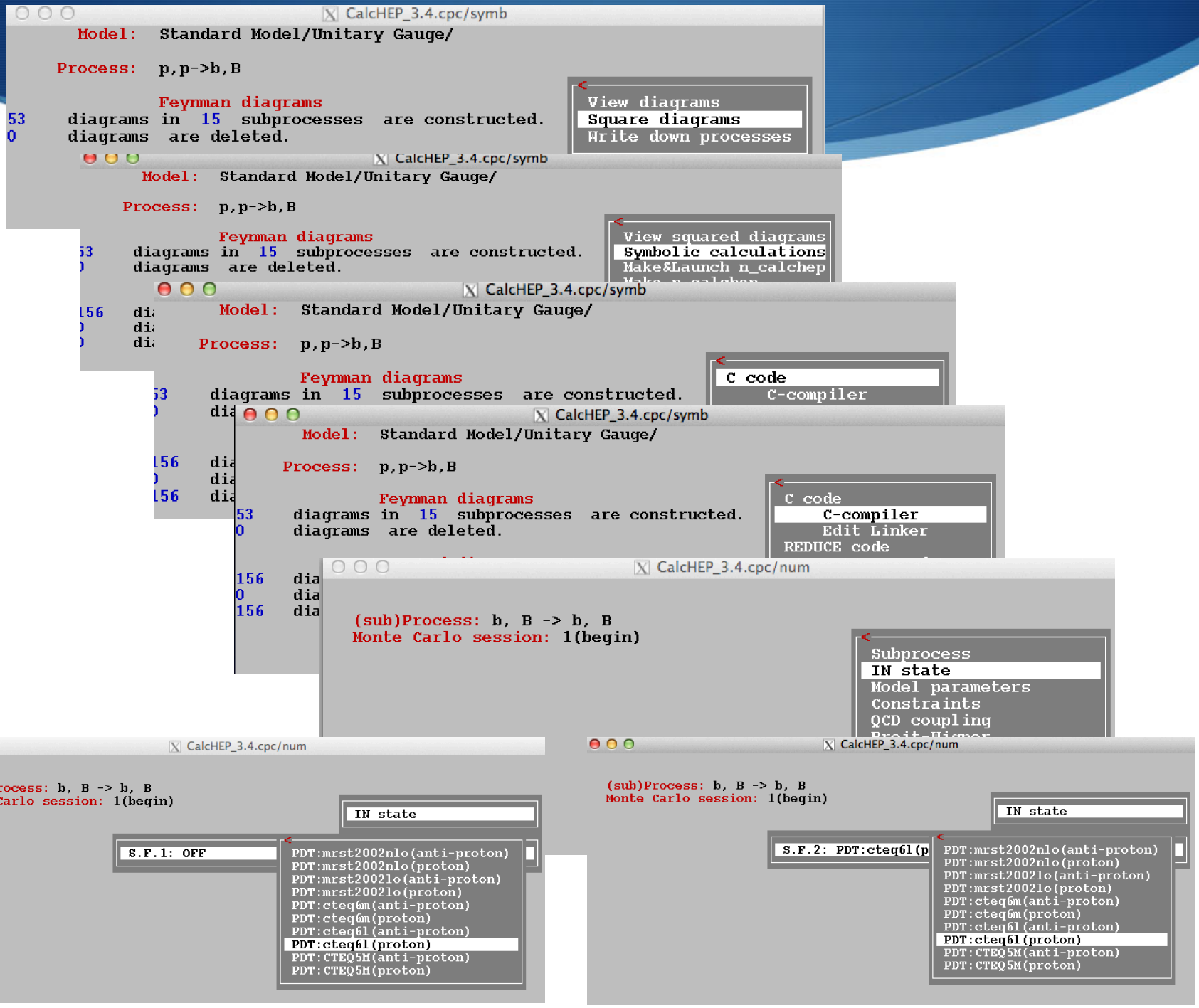
NN	Subprocess	Del	Rest
1	u,U -> b,B	0	4
2	u,C -> b,B	0	1
3	U,u -> b,B	0	4
4	U,c -> b,B	0	1
5	c,U -> b,B	0	1
6	c,C -> b,B	0	5
7	C,u -> b,B	0	1
8	C,c -> b,B	0	5
9	d,D -> b,B	0	3
10	D,d -> b,B	0	3
11	s,S -> b,B	0	3

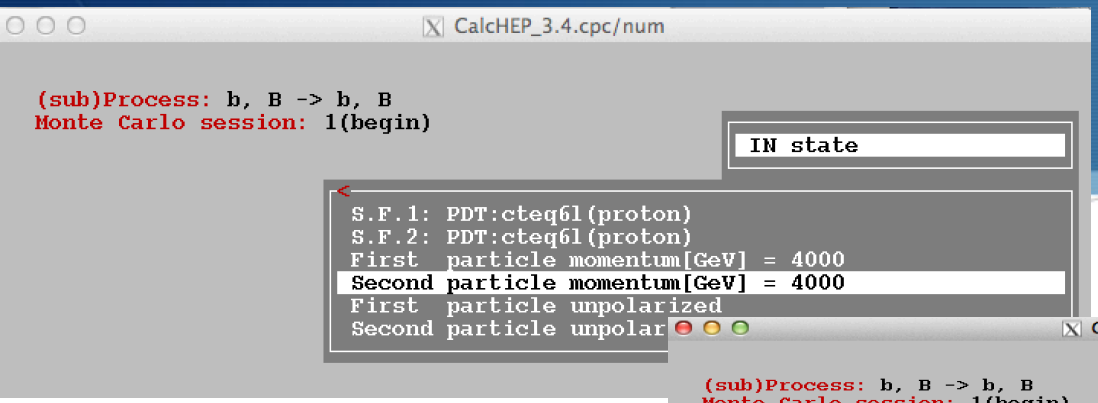
PgDn

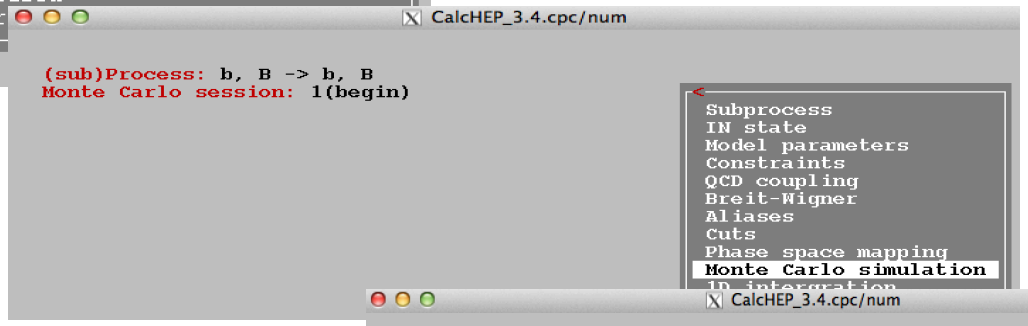
CalcHEP_3.4.cpc/symb

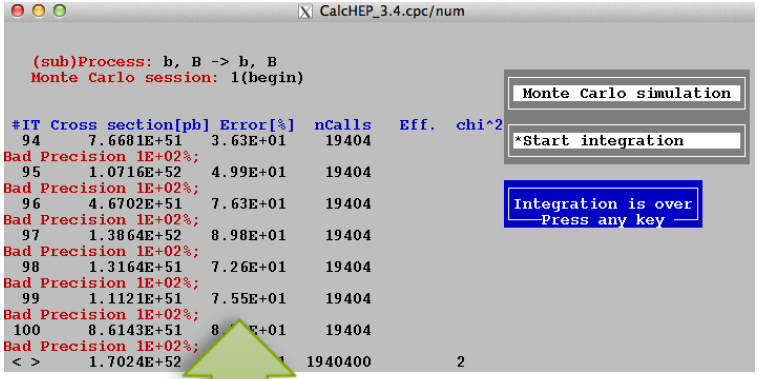
Delete,On/off,Restore,Latex 1/8

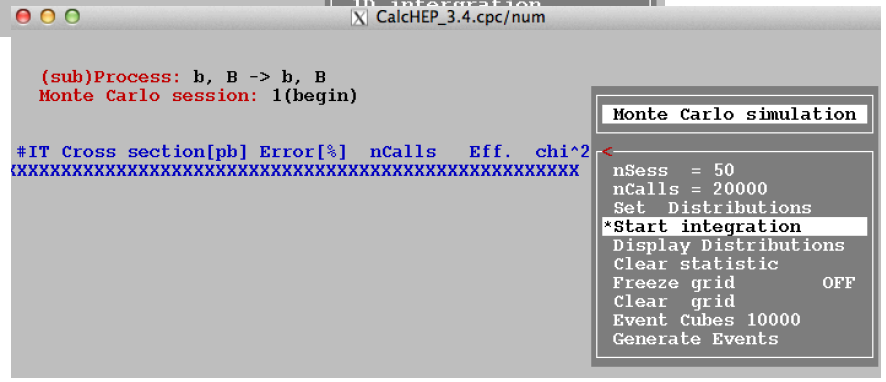



CalcHEP_3.4.cpc/symb
Model: Standard Model/Unitary Gauge/
Process: p,p->b,B
Feynman diagrams
53 diagrams in 15 subprocesses are constructed.
0 diagrams are deleted.
View diagrams
Square diagrams
Write down processes
CalcHEP_3.4.cpc/symb
Model: Standard Model/Unitary Gauge/
Process: p,p->b,B
Feynman diagrams
53 diagrams in 15 subprocesses are constructed.
View squared diagrams
Symbolic calculations
Make&Launch n_calchep
CalcHEP_3.4.cpc/symb
Model: Standard Model/Unitary Gauge/
Process: p,p->b,B
Feynman diagrams
53 diagrams in 15 subprocesses are constructed.
C code
C-compiler
CalcHEP_3.4.cpc/symb
Model: Standard Model/Unitary Gauge/
Process: p,p->b,B
Feynman diagrams
53 diagrams in 15 subprocesses are constructed.
0 diagrams are deleted.
156 dia
0 dia
156 dia
C code
C-compiler
Edit Linker
REDUCE code
CalcHEP_3.4.cpc/num
(sub)Process: b, B -> b, B
Monte Carlo session: 1(begin)
Subprocess
IN state
Model parameters
Constraints
QCD coupling
CalcHEP_3.4.cpc/num
(sub)Process: b, B -> b, B
Monte Carlo 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)
CalcHEP_3.4.cpc/num
(sub)Process: b, B -> b, B
Monte Carlo session: 1(begin)
IN state
S.F.2: PDT:cteq6l(p
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)









Sonuçlar iyi değil ☹

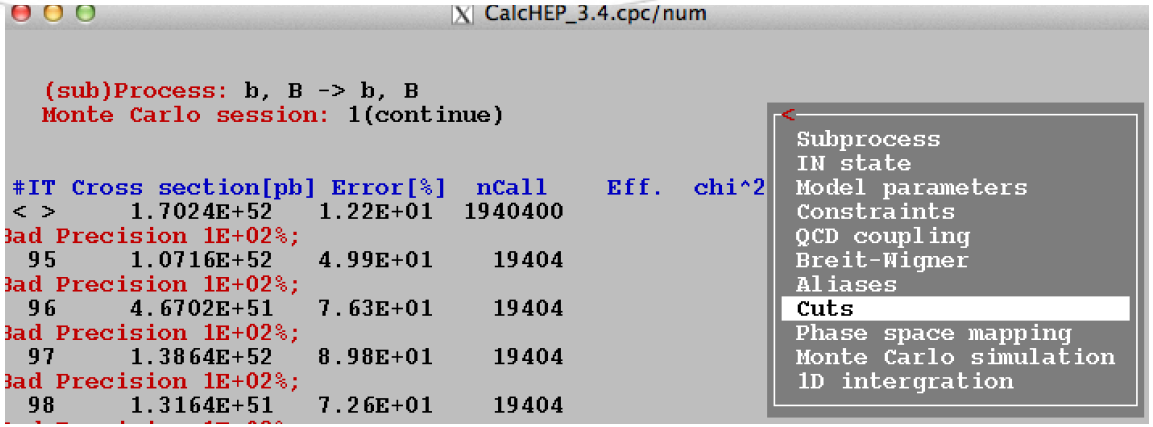
Ne yapmalı ??

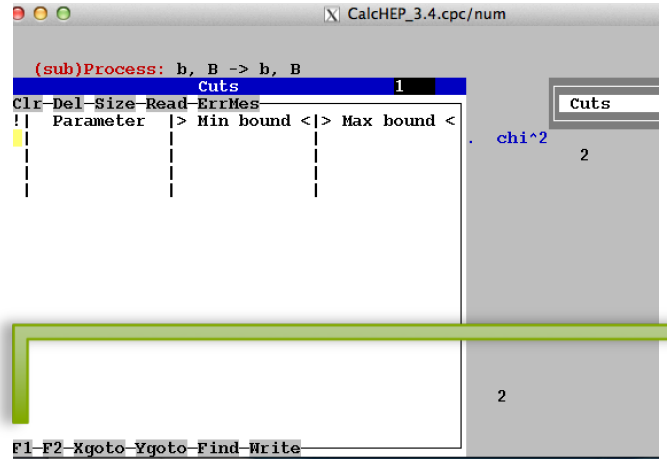
ÇÖZÜM: Kesmeler (Cut) Konmalı

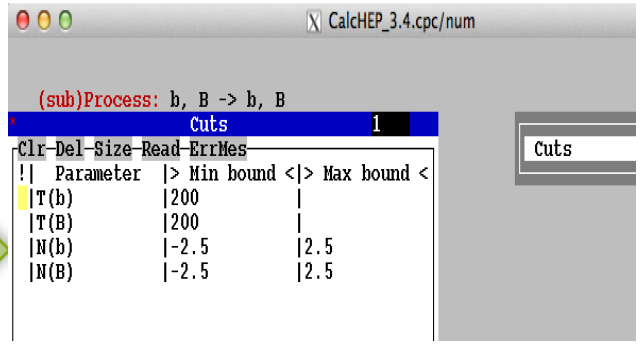
Cuts

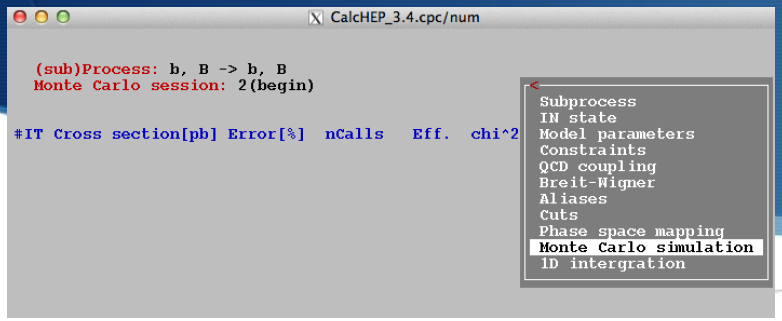
- T3
- T4
- N3
- N4 gibi

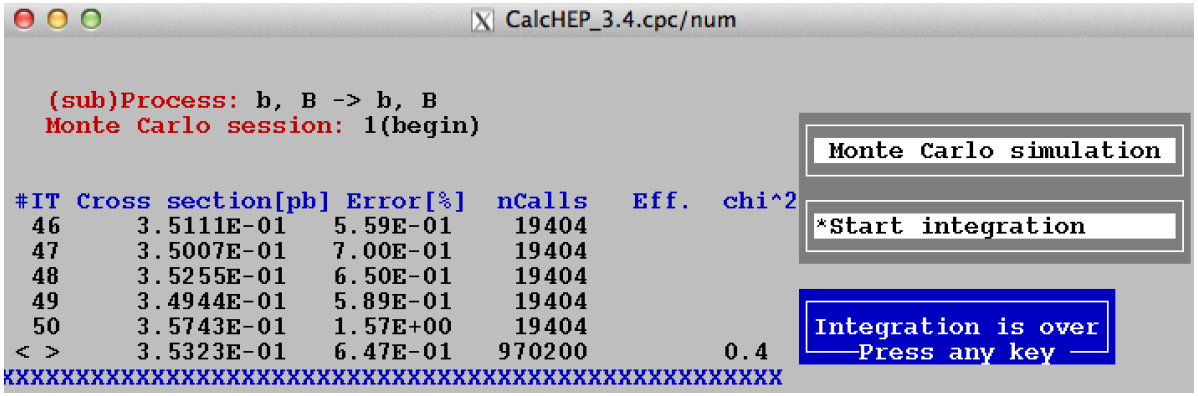
konulabilir...







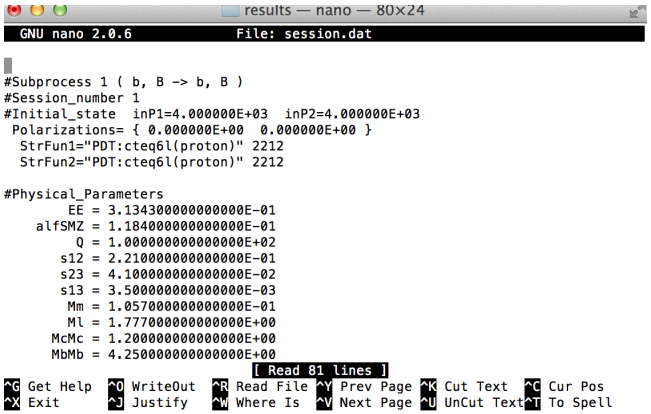




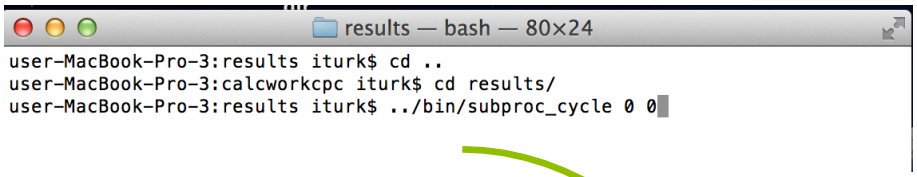
Sadece bir alt süreç hesapladık, hepsini yani toplam tesir kesitini hesaplamak CalcHEP'den geri çıkılır.

Başka bir pencere açalım ve results dizinine girilirek session.dat dosyasından parametreler kontrol edilebilir.

```
user-MacBook-Pro-3:results iturk$ nano session.dat
```



Yine results dizinine girilirek ../bin/subproc_cycle 0 0 komutu yazılır.



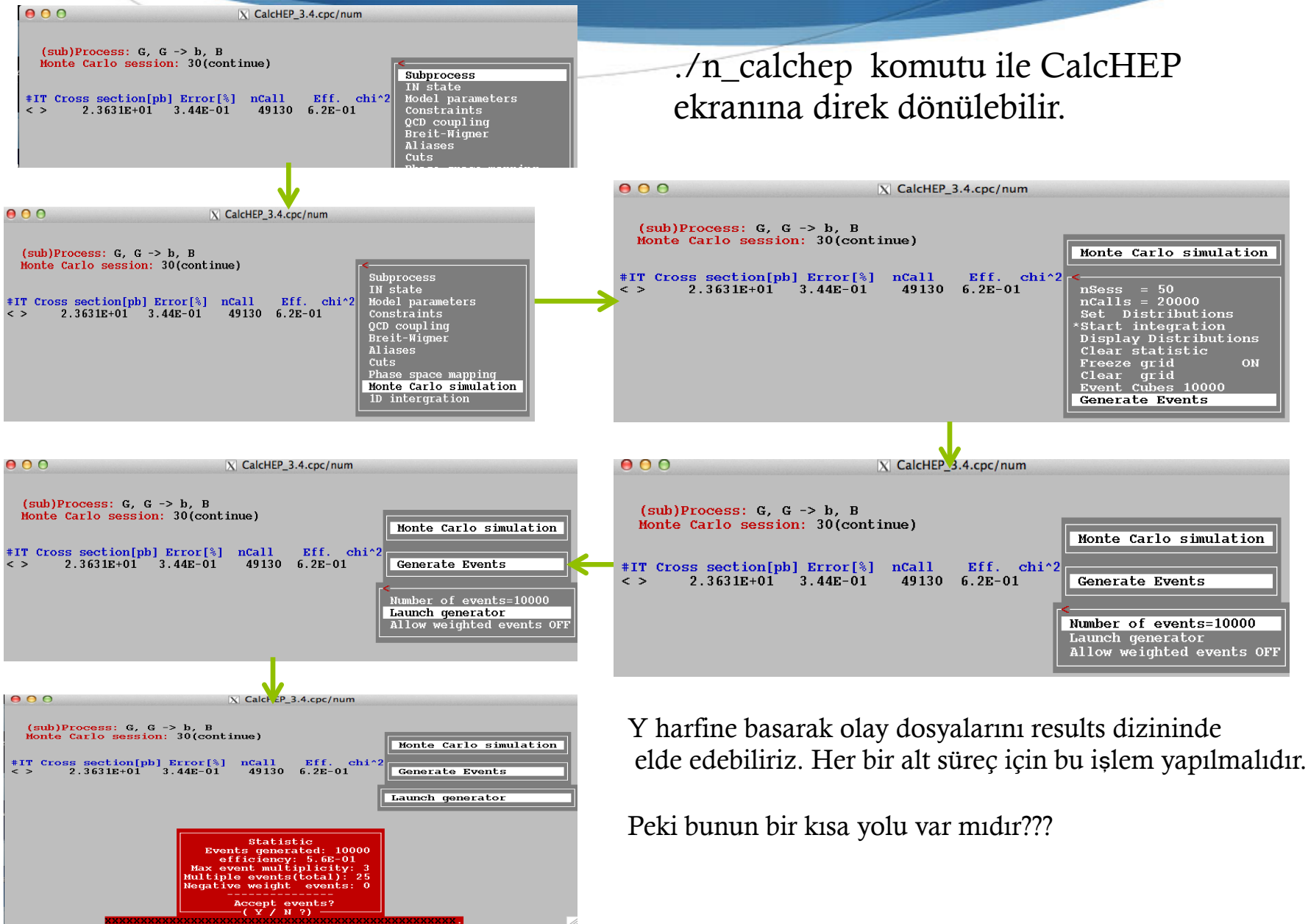

```
user-MacBook-Pro-3:results iturk$ ../bin/subproc_cycle 0 0
#Subprocess 1 ( b, B -> b, B ) Cross section = 3.5370E-01 , 0 events
#Subprocess 2 ( B, b -> b, B ) Cross section = 3.5337E-01 , 0 events
#Subprocess 3 ( u, U -> b, B ) Cross section = 2.1467E+00 , 0 events
#Subprocess 4 ( u, C -> b, B ) Cross section = 1.1989E-08 , 0 events
#Subprocess 5 ( U, u -> b, B ) Cross section = 2.1541E+00 , 0 events
#Subprocess 6 ( U, c -> b, B ) Cross section = 1.0024E-09 , 0 events
#Subprocess 7 ( c, U -> b, B ) Cross section = 1.0019E-09 , 0 events
#Subprocess 8 ( c, C -> b, B ) Cross section = 4.3243E-02 , 0 events
#Subprocess 9 ( C, u -> b, B ) Cross section = 1.1894E-08 , 0 events
#Subprocess 10 ( C, c -> b, B ) Cross section = 4.3275E-02 , 0 events
#Subprocess 11 ( d, D -> b, B ) Cross section = 1.2996E+00 , 0 events
#Subprocess 12 ( D, d -> b, B ) Cross section = 1.3003E+00 , 0 events
#Subprocess 13 ( s, S -> b, B ) Cross section = 1.2834E-01 , 0 events
#Subprocess 14 ( S, s -> b, B ) Cross section = 1.2796E-01 , 0 events
#Subprocess 15 ( G, G -> b, B ) Cross section = 2.3688E+01 , 0 events
Total Cross Section 31.63858803 [pb]
see details in prt_1 - prt_15 files
```

Tüm alt süreçlerin tesir kesitlerini hesaplamış olduk ☺

OLAY ÜRETİMİ

```
user-MacBook-Pro-3:results iturk$ ./n_calchep
```

./n_calchep komutu ile CalcHEP ekranına direk dönülebilir.



Y harfine basarak olay dosyalarını results dizininde elde edebiliriz. Her bir alt süreç için bu işlem yapılmalıdır.

Peki bunun bir kısa yolu var mıdır???

KISA YOL

```
user-MacBook-Pro-3:results iturk$ ../bin/subproc_cycle 100 1000
```

```
user-MacBook-Pro-3:results iturk$ ls
EXTLIBsh          events_27.txt   prt_13          prt_23          prt_6
VandP.cc          events_28.txt   prt_14          prt_24          prt_7
autoprot.h        events_29.txt   prt_15          prt_25          prt_8
aux               events_30.txt   prt_16          prt_26          prt_9
events_16.txt     n_calchep       prt_17          prt_27          scale.c
events_17.txt     n_calchep.dSYM  prt_18          prt_28          scale.so
events_18.txt     proclib_0.a     prt_19          prt_29          scale.so.dSYM
events_20.txt     prt_1           prt_2           prt_3           session.dat
events_23.txt     prt_10          prt_20          prt_30
events_25.txt     prt_11          prt_21          prt_4
user-MacBook-Pro-3:results iturk$ ../bin/subproc_cycle 100 1000+
```

Sonuçta olay dosyaları oluşur (alt süreç sayısı kadar oluşmadı) neden???

```
#Number_of_events       1000
#Events       P1_3 [Gev]        P2_3 [Gev]        P3_1 [Gev]        P3_2 [Gev]        P3_3 [Gev]        P4_1 [Gev]        P4_2 [Gev]        P4_3 [Gev]     Q_factor   alpha_QCD  Color chains
      1   3.2895054289E+02 -1.4273472973E+02  1.9629887833E+02  8.6897259478E+01  1.2521481368E+02 -1.9629887833E+02 -8.6897259478E+01  6.1000999474E+01| 4.334E+02  9.563E-02   (1 2)(4 3)
      1   8.8786555372E+01 -6.3873345889E+02  1.2634770740E+02  1.6409697244E+02 -4.5460894754E+02 -1.2634770740E+02 -1.6409697244E+02 -9.5337955974E+01| 4.764E+02  9.455E-02   (1 2)(4 3)
      1   1.9317462109E+02 -3.3253896668E+02 -2.0930947481E+02 -1.4211154184E+02 -8.5503843259E+01  2.0930947481E+02  1.4211154184E+02 -5.3860502327E+01| 5.069E+02  9.385E-02   (1 2)(4 3)
      1   2.9170277693E+02 -5.3210134311E+02 -2.4362108426E+02 -8.8182849265E+01  1.9010366506E+02  2.4362108426E+02  8.8182849265E+01 -4.3050223125E+02| 7.880E+02  8.918E-02   (1 2)(4 3)
      1   1.3891215695E+02 -8.2014563610E+02  1.3816447729E+01  2.1177937626E+02  3.2273061168E+01 -1.3816447729E+01 -2.1177937626E+02 -7.1350654031E+02| 6.751E+02  9.075E-02   (1 2)(4 3)
      1   3.3604721942E+02 -2.7312314228E+02  1.1902827653E+02  2.3251316233E+02  1.8575482353E+02 -1.1902827653E+02 -2.3251316233E+02 -1.2283074639E+02| 6.059E+02  9.189E-02   (1 2)(4 3)
      1   3.7581600984E+02 -1.5057375977E+02  7.0323322615E+01  1.9019263149E+02  2.5023943681E+02 -7.0323322615E+01 -1.9019263149E+02 -2.4997186738E+01| 4.758E+02  9.456E-02   (1 2)(4 3)
      1   3.0351583115E+02 -2.6369400137E+02  1.9235030154E+02 -2.0335734650E+02 -2.1208911670E+01 -1.9235030154E+02  2.0335734650E+02  6.1030741458E+01| 5.658E+02  9.263E-02   (1 2)(4 3)
      1   3.2915954153E+02 -3.0194635681E+02 -2.2015352121E+02  1.0100474125E+02  2.1558395739E+02  2.2015352121E+02 -1.0100474125E+02 -1.8837077266E+02| 6.306E+02  9.146E-02   (1 2)(4 3)
      1   6.4071160706E+02 -1.6146656323E+02  2.6628951195E+02  1.2641319173E+02  4.0013295783E+02 -2.6628951195E+02 -1.2641319173E+02  7.9112085999E+01| 6.433E+02  9.125E-02   (1 2)(4 3)
      1   2.3383605770E+02 -2.5899803135E+02  5.6033812326E+01  2.3402342884E+02  3.9026123563E+01 -5.6033812326E+01 -2.3402342884E+02 -6.4188097213E+01| 4.922E+02  9.418E-02   (1 2)(4 3)
      1   3.3660828956E+02 -2.1820069023E+02  6.9322348697E+01  2.6182235591E+02  6.9028475355E+01 -6.9322348697E+01 -2.6182235591E+02  4.9379123982E+01| 5.421E+02  9.310E-02   (1 2)(4 3)
      1   3.4449554994E+02 -1.3817903714E+02  1.7822332712E+02 -1.2381517783E+02  1.2815401541E+02 -1.7822332712E+02  1.2381517783E+02  7.8162497391E+01| 4.364E+02  9.555E-02   (1 3)(4 2)
      1   8.1755561785E+02 -6.1698506250E+01 -2.0281994024E+02  8.0532287079E+01  4.8240215295E+02  2.0281994024E+02 -8.0532287079E+01  2.7345495865E+02| 4.494E+02  9.522E-02   (1 2)(4 3)
      1   2.5790971576E+02 -1.9774384515E+02  1.0584692601E+01 -2.0528545734E+02  1.2442939890E+02 -1.0584692601E+01  2.0528545734E+02 -6.4263528289E+01| 4.517E+02  9.516E-02   (1 2)(4 3)
      1   4.8805542520E+02 -2.7685696558E+02 -5.3697574560E+01 -2.8947798424E+02  3.3459459955E+02  5.3697574560E+01  2.8947798424E+02 -1.2339613992E+02| 7.352E+02  8.988E-02   (1 2)(4 3)
      1   2.5437084137E+02 -1.8754336225E+02  1.8761745436E+01  2.1725850523E+02  2.0919066769E+01 -1.8761745436E+01 -2.1725850523E+02  4.5908412343E+01| 4.369E+02  9.554E-02   (1 2)(4 3)
      1   1.4290638553E+02 -8.5384698865E+02  2.2012136052E+02  1.4030266037E+02 -2.4272112111E+01 -2.2012136052E+02 -1.4030266037E+02 -6.8666849101E+02| 6.987E+02  9.040E-02   (1 2)(4 3)
      1   2.9138193985E+02 -5.7837403544E+02  2.1733916861E+02 -2.6209778066E+01  2.2439066019E+02 -2.1733916861E+02  2.6209778066E+01 -5.1138275577E+02| 8.211E+02  8.877E-02   (1 2)(4 3)
      1   2.6595042899E+02 -6.0562307507E+02 -4.0274686670E+01  2.4203169116E+02  1.7502364194E+02  4.0274686670E+01 -2.4203169116E+02 -5.1469628802E+02| 8.027E+02  8.900E-02   (1 2)(4 3)
      1   4.7435749712E+02 -1.1020114337E+02 -5.5126157291E+01 -2.0458987892E+02  2.9193172339E+02  5.5126157291E+01  2.0458987892E+02  7.2224630369E+01| 4.573E+02  9.501E-02   (1 2)(4 3)
```

Sonuçta olay dosyalarını birbirne harmanlayalım….

```
user-MacBook-Pro-3:results iturk$ ../bin/event_mixer
../bin/event_mixer needs arguments: Luminosity[1/fb]  nEvents event_directories ...
user-MacBook-Pro-3:results iturk$ ../bin/event_mixer 100 1000 .
```

Işınlık

Olay sayısı

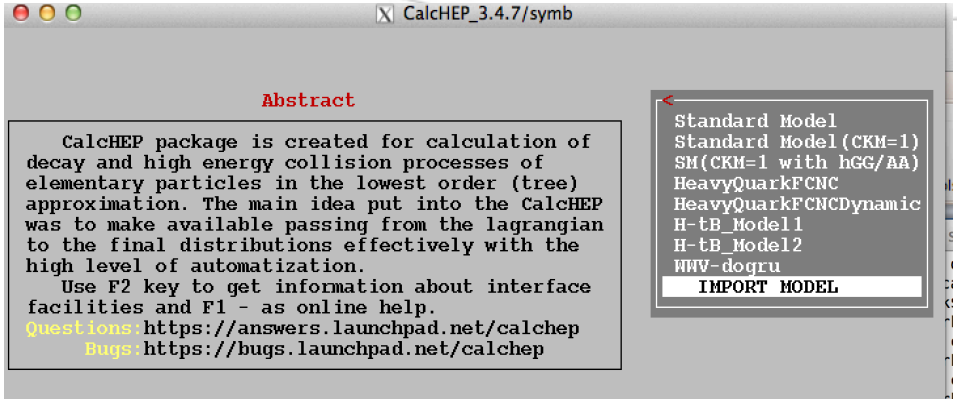
```
user-MacBook-Pro-3:results iturk$ nano event_mixer.lhe
```

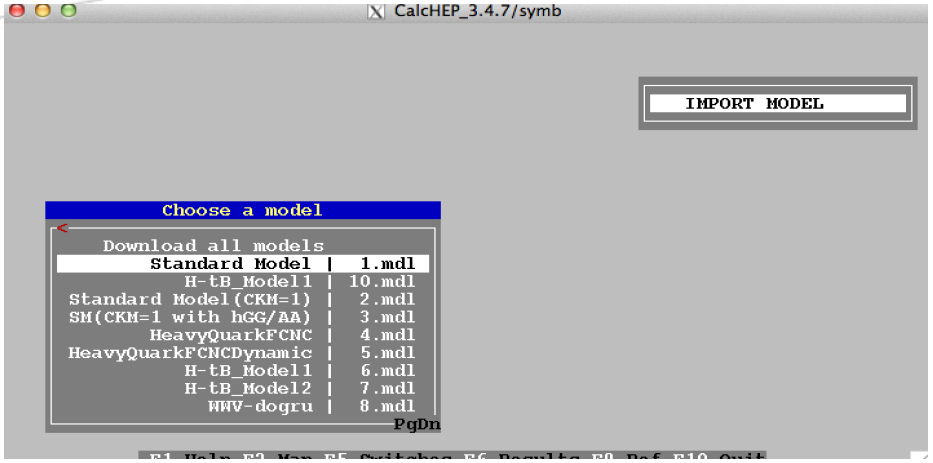
```
  GNU nano 2.0.6                      File: event_mixer.lhe

<LesHouchesEvents version="1.0">
<!--
File generated with CalcHEP-PYTHIA interface
-->
<header>
<hepml>
<samples xmlns="http://mcdb.cern.ch/hepml/0.2/"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://mcdb.cern.ch/hepml/0.2/ http://mcdb.cern.ch/hepml/0.2/hepml.xsd">
    <files>
        <file>
            <eventsNumber> 1000           </eventsNumber>
            <crossSection unit="pb">31.502904</crossSection>
            <fileSize> 682506           </fileSize>
            <comments></comments>
            <location>
              <path/>
            </location>
        </file>
```

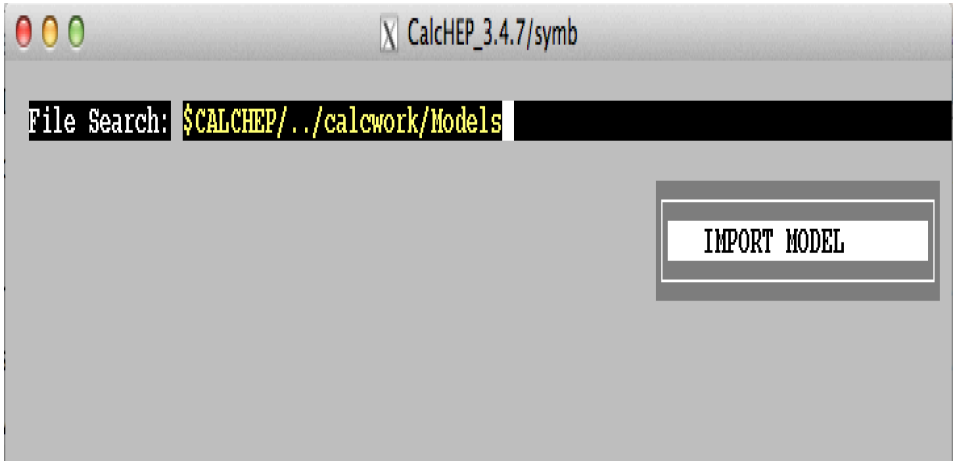
```
results — nano — 154×21
  GNU nano 2.0.6                                  File: event_mixer.lhe                                  Modified

      21   -1    0    0  500  502  0.00000000000E+00  0.00000000000E+00  4.04769194600E+02  4.04769194600E+02  0.00000000000E+00  0.0000E+00  9.0
      21   -1    0    0  501  500  0.00000000000E+00  0.00000000000E+00 -1.56808369860E+02  1.56808369860E+02  0.00000000000E+00  0.0000E+00  9.0
       5    1    1    2  501    0  1.44599812290E+02  1.60959034880E+02 -1.98058234680E+01  2.17300929661E+02  3.24141395780E+00  0.0000E+00  9.0
      -5    1    1    2    0  502 -1.44599812290E+02 -1.60959034880E+02  2.67766648210E+02  3.44276634818E+02  3.24141395780E+00  0.0000E+00  9.0
</event>
<event>
 4    1   1.0000000E+00   6.8090000E+02  -1.0000000E+00   9.0660000E-02
       1   -1    0    0  500    0  0.00000000000E+00  0.00000000000E+00  6.70265151070E+02  6.70265151070E+02  0.00000000000E+00  0.0000E+00  9.0
      -1   -1    0    0    0  501  0.00000000000E+00  0.00000000000E+00 -1.72916265410E+02  1.72916265410E+02  0.00000000000E+00  0.0000E+00  9.0
       5    1    1    2  500    0 -1.26624959070E+02  2.99387584110E+02  1.23467921570E+02  3.47737890084E+02  3.24141395780E+00  0.0000E+00  9.0
      -5    1    1    2    0  501  1.26624959070E+02 -2.99387584110E+02  3.73880964090E+02  4.95443526400E+02  3.24141395780E+00  0.0000E+00  9.0
</event>
<event>
 4    1   1.0000000E+00   4.7920000E+02  -1.0000000E+00   9.4480000E-02
      21   -1    0    0  500  501  0.00000000000E+00  0.00000000000E+00  2.91459881240E+02  2.91459881240E+02  0.00000000000E+00  0.0000E+00  9.0
      21   -1    0    0  501  502  0.00000000000E+00  0.00000000000E+00 -1.96975955610E+02  1.96975955610E+02  0.00000000000E+00  0.0000E+00  9.0

^G Get Help     ^O WriteOut     ^R Read File    ^Y Prev Page    ^K Cut Text     ^C Cur Pos
^X Exit         ^J Justify      ^W Where Is     ^V Next Page    ^U UnCut Text   ^T To Spell
```

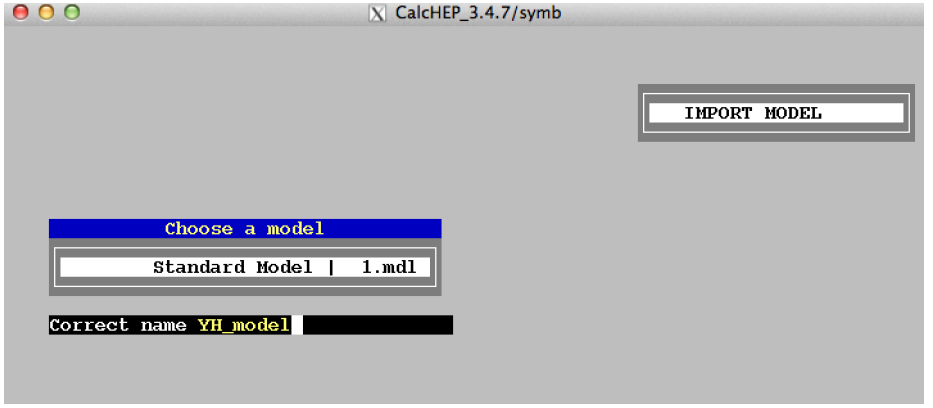
YENİ MODEL OLUŞTURMA

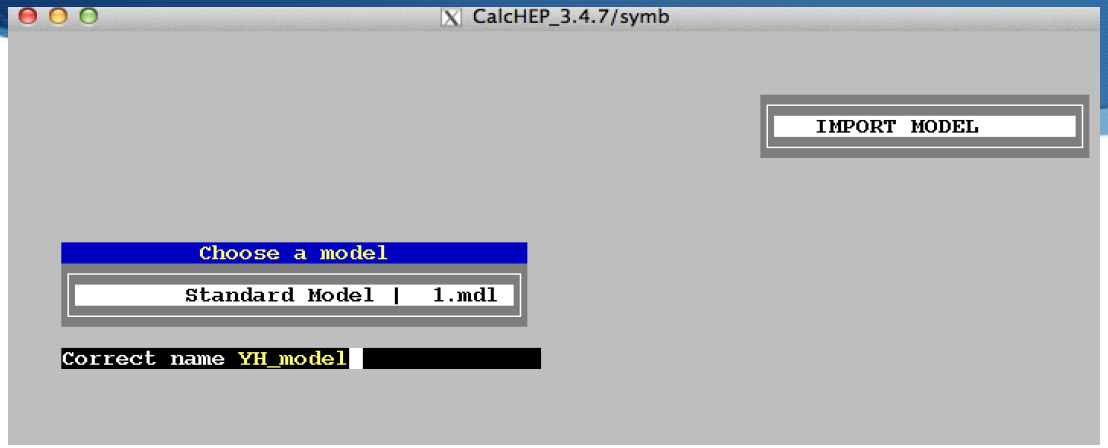
pp->H-t

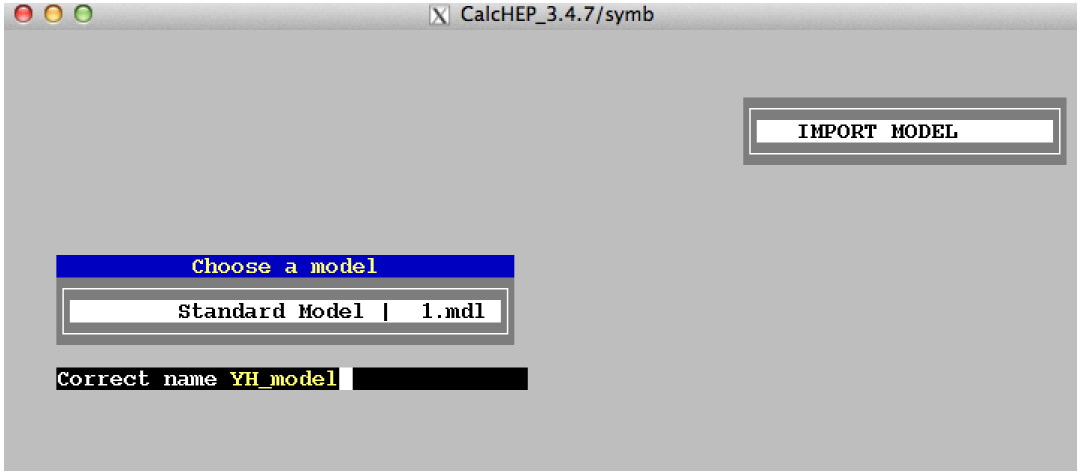






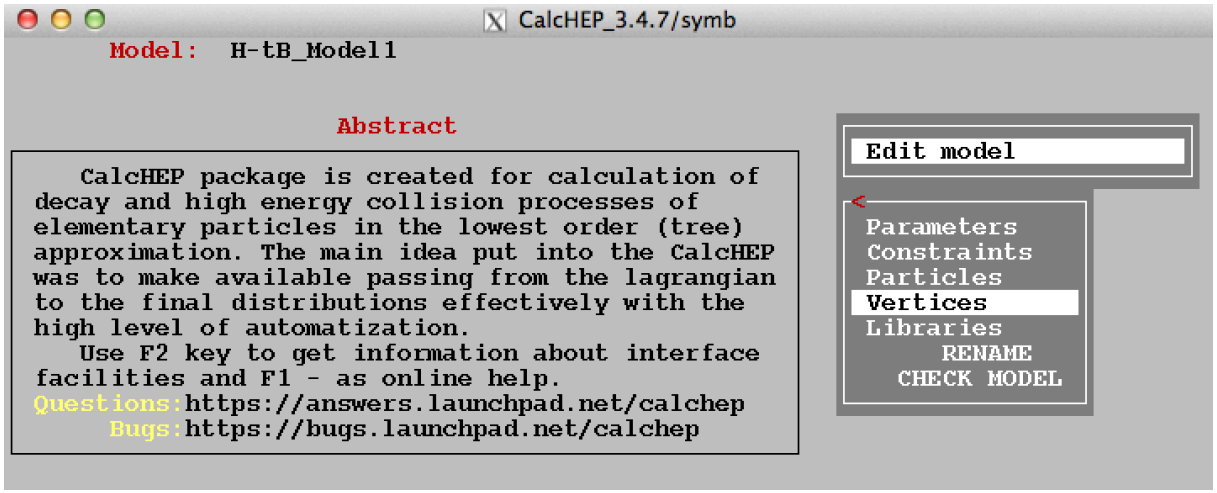



CalcHEP_3.4.7/symb
IMPORT MODEL
Choose a model
Standard Model | 1.mdl
Correct name YH_model


CalcHEP_3.4.7/symb
IMPORT MODEL
Choose a model
Standard Model | 1.mdl
Correct name YH_model

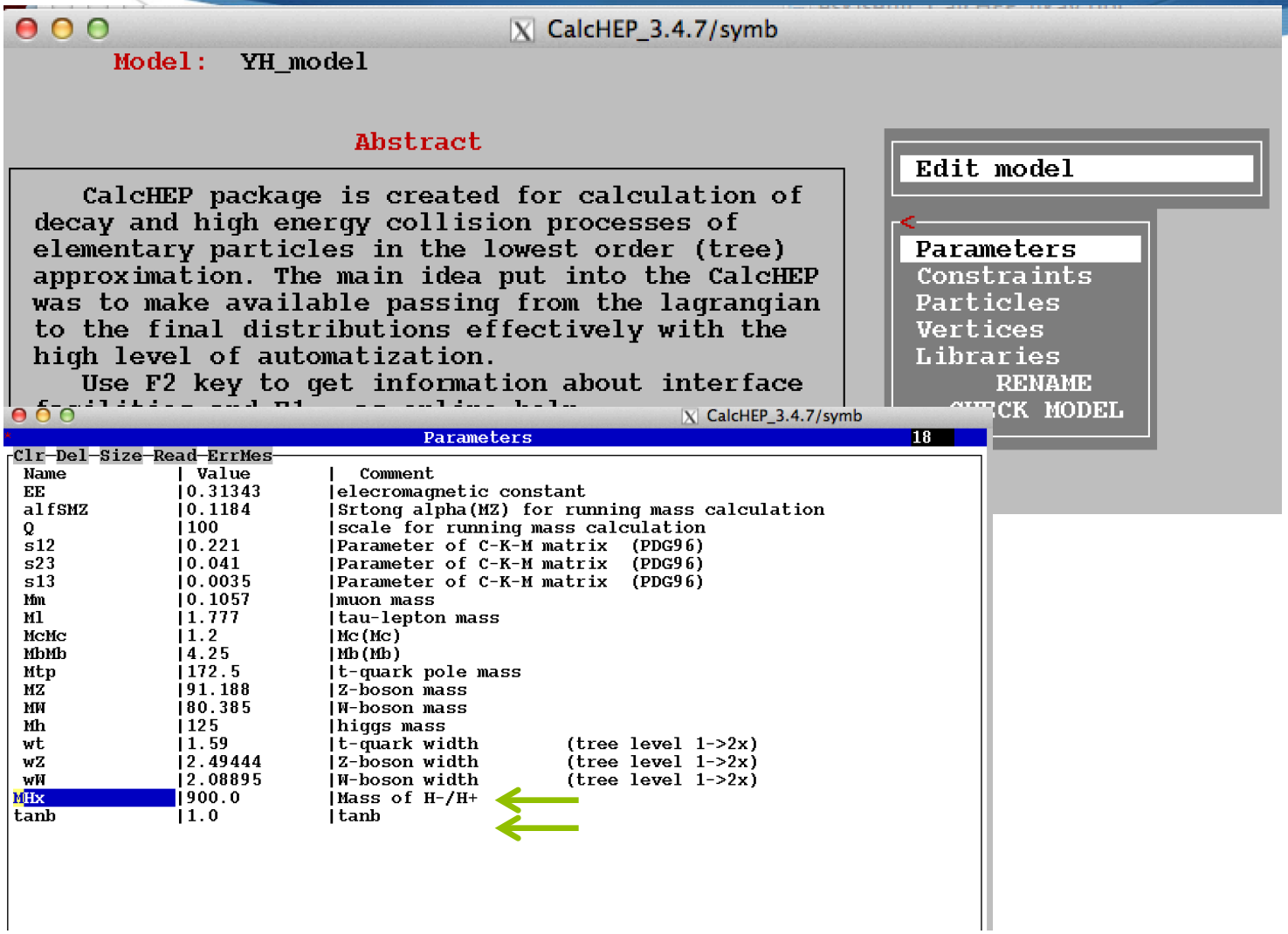
Değişiklik yapılacak yerler:

* Vertices
* Parameters
* Constraints
* Particles



$$g_{H^-t\bar{b}} = \frac{g}{2\sqrt{2}m_W}\left[m_t \cot\beta(1+\gamma_5) + m_b \tan\beta(1-\gamma_5)\right].$$

B	t	H-		-EE*Vtb/(2*Sqrt2*SW*MW)	Mt*cotb*(1+G5)+Mb*tanb*(1-G5)
T	b	H+		-EE*Vtb/(2*Sqrt2*SW*MW)	Mt*cotb*(1-G5)+Mb*tanb*(1+G5)


CalcHEP_3.4.7/symb
Model: YH_model
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
Edit model
Parameters
Constraints
Particles
Vertices
Libraries
RENAME
CHECK MODEL
CalcHEP_3.4.7/symb
Parameters
18
Clr Del Size Read ErrMes
Name | Value | Comment
EE |0.31343 |elecromagnetic constant
alfSMZ |0.1184 |Srtong alpha(MZ) for running mass calculation
Q |100 |scale for running mass calculation
s12 |0.221 |Parameter of C-K-M matrix (PDG96)
s23 |0.041 |Parameter of C-K-M matrix (PDG96)
s13 |0.0035 |Parameter of C-K-M matrix (PDG96)
Mm |0.1057 |muon mass
Ml |1.777 |tau-lepton mass
McMc |1.2 |Mc(Mc)
MbMb |4.25 |Mb(Mb)
Mtp |172.5 |t-quark pole mass
MZ |91.188 |Z-boson mass
MW |80.385 |W-boson mass
Mh |125 |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)
MHx |900.0 |Mass of H-/H+
tanb |1.0 |tanb

Model: YH_model

Abstract

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Use F2 key to get information about interface

Edit model

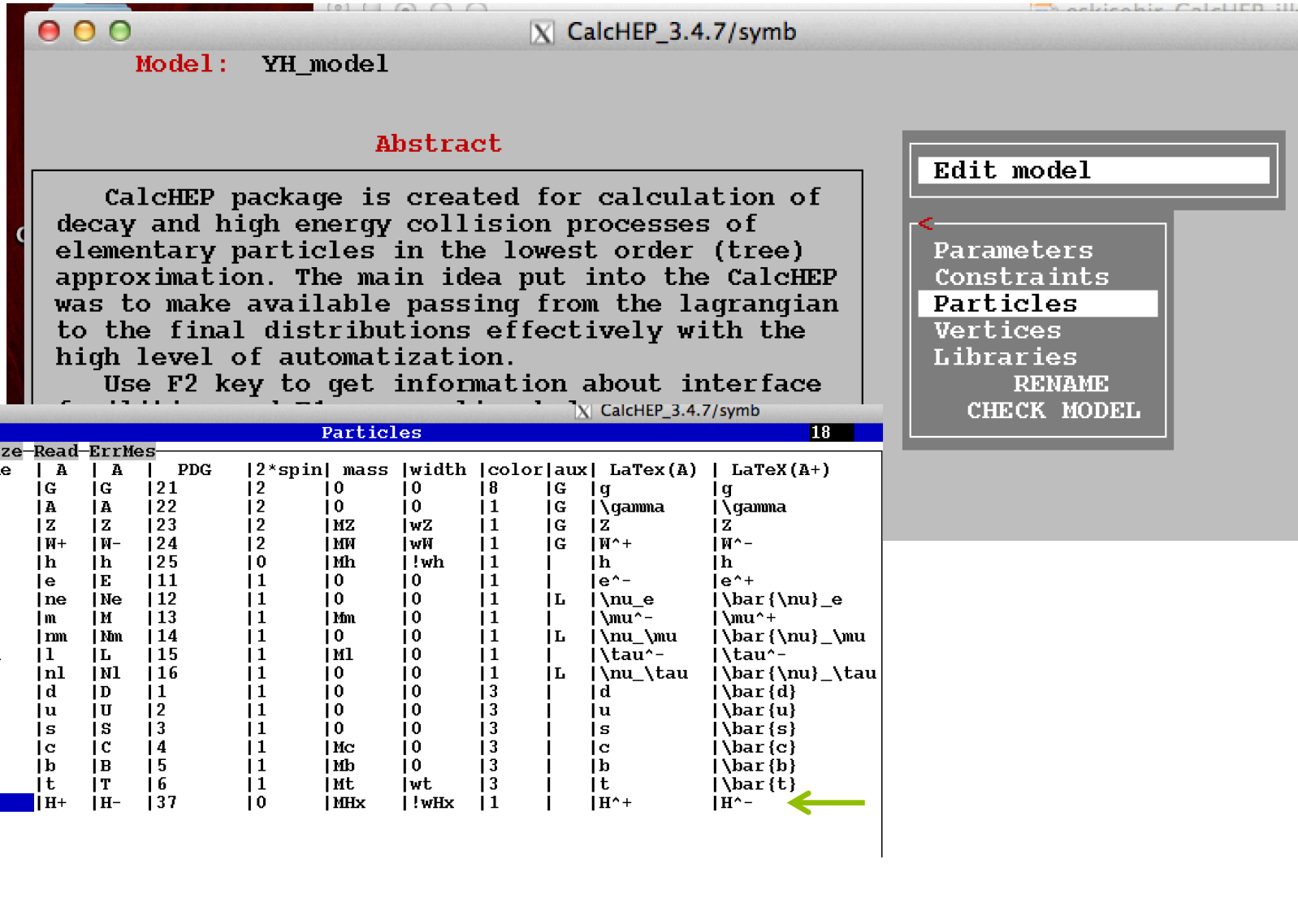
- Parameters
- Constraints
- Particles
- Vertices
- Libraries

RENAME

CalcHEP_3.4.7/sy

Constraints 20

Clr	Del	Size	Read	ErrMes	Name	Expression	
					CW	MW/MZ	% on-shell cos of the Weinberg angle
					SW	sqrt(1-CW^2)	% sin of the Weinberg angle
					GF	EE^2/(2*SW*MW)^2/Sqrt2	% Fermi constant (not used below)
					c12	sqrt(1-s12^ 2)	% parameter of C-K-M matrix
					c23	sqrt(1-s23^ 2)	% parameter of C-K-M matrix
					c13	sqrt(1-s13^ 2)	% parameter of C-K-M matrix
					Vud	c12*c13	% C-K-M matrix element
					Vus	s12*c13	% C-K-M matrix element
					Vub	s13	% C-K-M matrix element
					Vcd	-s12*c23-c12*s23*s13	% C-K-M matrix element
					Vcs	c12*c23-s12*s23*s13	% C-K-M matrix element
					Vcb	s23*c13	% C-K-M matrix element
					Vtd	s12*s23-c12*c23*s13	% C-K-M matrix element
					Vts	-c12*s23-s12*c23*s13	% C-K-M matrix element
					Vtb	c23*c13	% C-K-M matrix element
					LamQCD	initQCD5(alfSMZ,McMc,MbMb,Mtp)	
					Mb	MbEff(Q)	
					Mt	MtEff(Q)	
					Mc	McEff(Q)	
					cotb	1/tanb	


CalcHEP_3.4.7/symb
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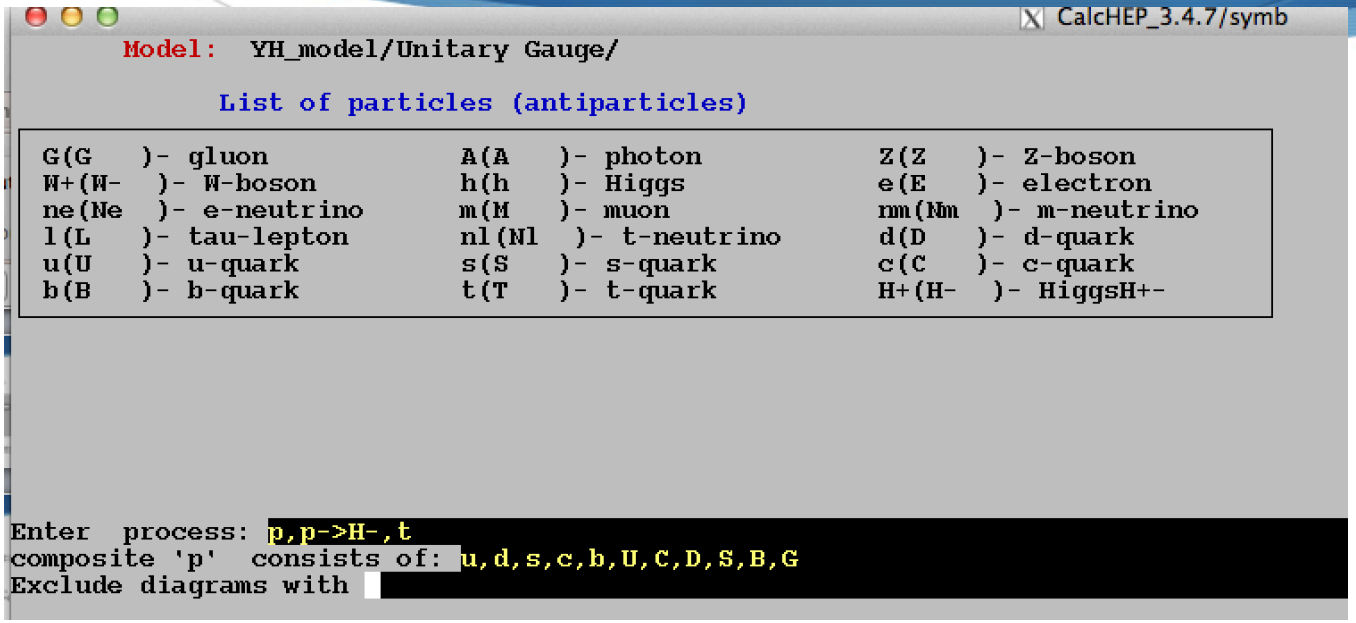
Use F2 key to get information about interface
Edit model
Parameters
Constraints
Particles
Vertices
Libraries
RENAME
CHECK MODEL
CalcHEP_3.4.7/symb
Particles 18
Clr Del Size Read ErrMes
Full name | A | A | PDG | 2*spin | mass | width | color | aux | LaTex(A) | LaTeX(A+)
gluon | G | G | 21 | 2 | 0 | 0 | 8 | G | g | g
photon | A | A | 22 | 2 | 0 | 0 | 1 | G | \gamma | \gamma
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^- | e^+
e-neutrino | ne | Ne | 12 | 1 | 0 | 0 | 1 | L | \nu_e | \bar{\nu}_e
muon | m | M | 13 | 1 | Mm | 0 | 1 | | \mu^- | \mu^+
m-neutrino | nm | Nm | 14 | 1 | 0 | 0 | 1 | L | \nu_\mu | \bar{\nu}_\mu
tau-lepton | l | L | 15 | 1 | Ml | 0 | 1 | | \tau^- | \tau^-
t-neutrino | nl | Nl | 16 | 1 | 0 | 0 | 1 | L | \nu_\tau | \bar{\nu}_\tau
d-quark | d | D | 1 | 1 | 0 | 0 | 3 | | d | \bar{d}
u-quark | u | U | 2 | 1 | 0 | 0 | 3 | | u | \bar{u}
s-quark | s | S | 3 | 1 | 0 | 0 | 3 | | s | \bar{s}
c-quark | c | C | 4 | 1 | Mc | 0 | 3 | | c | \bar{c}
b-quark | b | B | 5 | 1 | Mb | 0 | 3 | | b | \bar{b}
t-quark | t | T | 6 | 1 | Mt | wt | 3 | | t | \bar{t}
HiggsH+- | H+ | H- | 37 | 0 | MHx | !wHx | 1 | | H^+ | H^-



Süreç girilir ve önceki adımlar takip edilirse tesir kesiti elde edilir…

```
user-MacBook-Pro-3:results iturk$ ../bin/subproc_cycle 0 0
#Subprocess 1 ( b, G -> t, H- ) Cross section = 1.8399E-04 , 0 events
#Subprocess 2 ( G, b -> t, H- ) Cross section = 1.8421E-04 , 0 events
Total Cross Section 0.0003682 [pb]
see details in prt_1 - prt_2 files
user-MacBook-Pro-3:results iturk$
```

Kaynaklar

HPFBU Kars Kış Okulu notları (G. Ünel)

Program kılavuzu

CalcHEP-from model building down to collider phenomenology
(A. Belyaev)

ÖDEV

* p,p-> W+,b,bbar sürecini kütle merkezi enerjisi 14 TeV için toplam tesir kesitini hesaplayınız.