# Introduction to CalcHEP 

Dhong Yeon Cheong ${ }^{1}$, Sungmook Lee ${ }^{1}$, and Tae Geun Kim ${ }^{1}$
${ }^{1}$ Yonsei University
January 22, 2018


#### Abstract

In this manual, we calculate $e^{-} e^{+} \rightarrow \mu^{-} \mu^{+}$process symbolically using CalcHep, and partially Mathematica. CalcHep could be useful when you just want quick result but would not be appropriate for complicated processes, such as loop level processes.


## Initializing CalcHep

1) Go to your CalcHEP folder(the directory of this folder may vary among computers).


Figure 1: This is a caption
2) Type
[] $/ \mathrm{mkWORK}$ dir test
Then you can find new 'test' directory generated.

| bin | calchep_batch | CITE | fileMap.txt | FlagsForSh | help | INSTALLATION | License.txt mkNORKdir palables | test | work |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| calchep calchep.ini | c_source | FlagsForMake | getFlags | include | lib |  | Makefile | models | sbin | utile |

Figure 2: This is a caption
3) Go in to the 'test' directory, and type
[] ./calchep
Then, a GUI screen will pop up in the following form.


Figure 3: This is a caption

## $e^{-} e^{+} \rightarrow \mu^{-} \mu^{+}$Calculation using CalcHep

4) Enter 'Standard Model' -> 'Enter Process'
(You may use or modify other options, but CalcHep is usually not appropriate to calculate such a complicated processes)


Figure 4: This is a caption
5) Type the process in which you want to calculate in the black line. (Capital letters mean anti-particle). You do not need to type anything in 'Exclude diagrams with' line.
6) Enter 'View Diagram'

Now, we only want to calculate QED processes, so we will exclude the second diagram, which is a Z-boson mediated process.


Figure 5: This is a caption

D : Exclude all diagrams, O : Exclude a selected diagram. (for others, use F1)
7) Back to previous menu, (click ESC) and enter 'Square diagrams'->'Symbolic Calculations'->'MATHEMATICA code'

When you enter 'MATHEMATICA code', it seems nothing happens, but don't worry. It really generated m-file script in your folder.
8) Escape from CalcHep GUI.

## Symbolic Calculation through Mathematica

9) Go to 'results' directory in your 'test' directory. You can find 'symb1.m' file generated.
[] cd results
10) Open 'symb1.m’
[] vi symb1.m
Now, you can change and copy this m-files script.


Figure 6: This is a caption

| batch_results | calchep | calchep.ini results |
| :--- | :--- | :--- | :--- |
| bin |  |  |

Figure 7: This is a caption

## aux symbl.m.

Figure 8: This is a caption
11) Copy the script and paste to the Mathematica terminal.
11) Close the m-files. (Esc->q->Enter or Esc $+:->q->$ Enter)
12) Go to 'utile' in 'calchep_3.6.30'

| alpha.c | batch_file | batch_file_3 | cmp.red | cycle_cmp | main_22_1hapdf.c | README | sum_cd.m | sum_int.red |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| alpha.h | batch_file_1 | checkpdt.c | cteq2pdt.c | lha5pdt.c | main_22.root | sum_22.m | sum_cd.red sum_num.red |  |
| axodraw.sty | batch_file_2 | check.red | cycle_check | main_22.c | mrst2pdt.c | sum_22.red sum_int.m | usrFF.c |  |

Figure 9: This is a caption
13) Open 'sum_int.m'.
[] vi $\operatorname{sum}_{i} n t . m$
14) Copy the script and paste to the Mathematica terminal. (above the previous symb1.m script!!!)
15) Run the scripts.
16) The final result is :
[] res $=$ totFactor*numerator/denominator res/.\{Mm-¿0\}//Simplify


Figure 10: This is a caption

