Project tools and Loop Calculations with DIANA and aITALC

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DESY Zeuthen

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I. Motivation

Motivation: writing up

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. . . then you don't need to be a hacker to write decent software

Both are scientist's responsabilities

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In particle physics, where is quite frequent to rely on non-commercial programs, the software should

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- ℹ provide the *'Hello world'* examples

Public free codes $\not\Rightarrow$ Not-working codes

Let's make the effort because every piece of code matters!

II. Project Tools

Project Tools: overview

To handle software projects we'd better be organized. Some UNIX tools extremely facilitate the management of complicated tasks.

I would like to mention some GNU/LINUX tools in

① Version management

② Installation

③ Inter-operability

✓ Enhance the quality of your software and the efficiency of team-work!

Project Tools: Bad version management

John and Mary compute π. Is this directory structure familiar to you?

```
mary@linux:~ > ls -l
total 32
-rw-rw-r-- 1 mary users 108 2005-02-01 16:02 pi_2.f
-rw-rw-r-- 1 john users 141 2005-02-01 18:02 pi_2.old.f
-rw-rw-r-- 1 mary users 132 2005-02-01 18:05 pi_2.old.f~
-rw-rw-r-- 1 mary users 156 2005-04-05 16:03 pi_4.f
-rw-rw-r-- 1 mary users  89 2005-01-18 11:47 pi.f
-rw-rw-r-- 1 john users 171 2005-04-05 16:04 pi.new.f
-rw-rw-r-- 1 john users 108 2005-03-01 16:05 pi-works_I_think.f
```

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```

Will Mary and John progress much further in this mess?

They need **urgently** something like CVS

Project Tools: Version management CVS

CVS helps you managing your project versions

- keeps clean and visible current developing source files

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mary@linux:˜ > ls -l
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No magic: Requires a bit of discipline and the right policy

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Getting used to Makefile is always a good idea!, you just

- Establish ‘targets’ which are your final goals
- Specify the ‘requisites’ on which your targets rely (recompilation)
- Give generic or specific ‘rules’ for compilation (commands)
- Easy handle the file names and script functions
- Delete unnecesary (intermediate) objects: `make clean`

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```
FF= g77                                                #Variable for choosing compiler
FFLAGS= -O0 -Wunused                                   #Variable to use compiler flags
OBJS= acos.o                                           #Intermediate objects
                                                       #
all:  pi.out                                           #All we have to do
                                                       #
 pi.out :   pi.f   $(OBJS)                             #Requisites in 1st line
        $(FF)   $(FFLAGS)  -o  $@   $(OBJS)   $<       #Commands next lines with TAB
                                                       #
%.o:  %.f                                              #Generic requisites for .o files
        $(FF) $(FFLAGS) -c $<                          #Commands
                                                       #
clean:                                                 #No requisites for cleaning
        rm -f *.o                                      #How to delete rubbish
```

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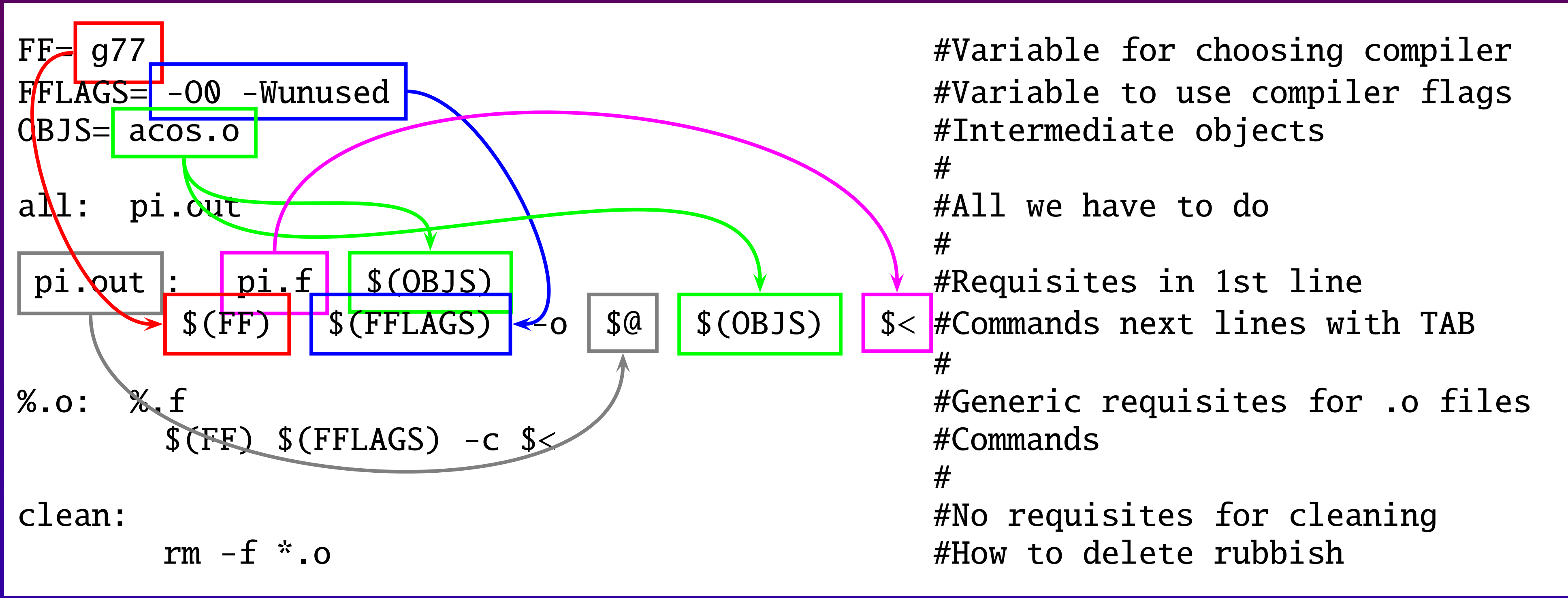

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Looks difficult but you just have to practice!

Project Tools: Inter-operability with Autoconf

Do you usually get errors when installing other's codes? (Yes/No)

Typical avoidable errors:

- `Library 'libwhatever.a' not found`
- `invalid option -- X, Try --help for more information`
- `Version X.Y does not allow such operation`

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With AUTOCONF you have a chance of reducing configuration errors by checking which libraries are needed, optimal flags, minimal version

↑ Ideal if you work in C or C++

↓ Adaptation tests require a bit of shell scripting

Hint: Have a look to a 'unorthodox' `configure.in` coming with *a*ÎTALC

III. DIANA and *a*ITALC

Diana: Feynman Diagram Analizer

Developed at U.Bielefeld 1997-2004 (Fleischer and Tentyukov)

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- C program, based on Nogueira's FORTRAN generator QGRAF2
- Command line: requires a driver file and model file
- High portability, running in many UNIX systems
- Front-end topology editor (tedi) included for GNU/LINUX

`http://www.physik.uni-bielefeld.de/~tentukov/diana.html`

Diana: Feynman Diagram Analizer

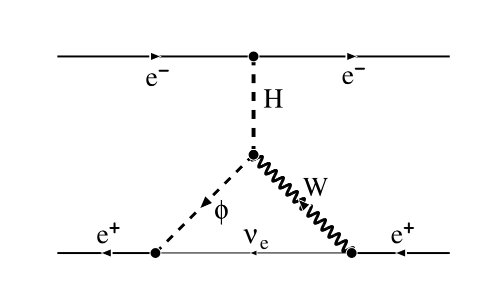
Developed at U.Bielefeld 1997-2004 (Fleischer and Tentyukov)

What do we ask?

```
SET _processname = Bhabha
\Begin(model,EWSM.model)
\Begin(process)
ingoing le(;p1),Le(;p4);
outgoing le(;-p2),Le(;-p3);
loops = 1;
options = onshell,notadp;
*\excludevertex(Le,le,H)
SET MakeEps = "!"
...
```

What does Diana answer?

Bhabha626.eps



```
G Amplitude =
(-1)*F(1,1,1,0,0)*(-i_)*e/2/sw*Mle/MW*F(2,2,1,-1,0)*
(-i_)*e/2/sqrt2/sw*Mle/MW*FF(3,2,+q,Mne)*i_*
F(3,2,mu1,1,-1,1)*(+i_)*e/2/sqrt2/sw*SS(4,0)*i_*
SS(1,2)*i_*VV(2,mu2,mu1,-q-k2,2)*i_*
V(4,mu2,+p1+p2-(+q+k1),1)*(-i_)*e/2/sw;
```

```
#define COUNTER "626" #define LINE "4"
#define LOOPTYPE "c" ...
```

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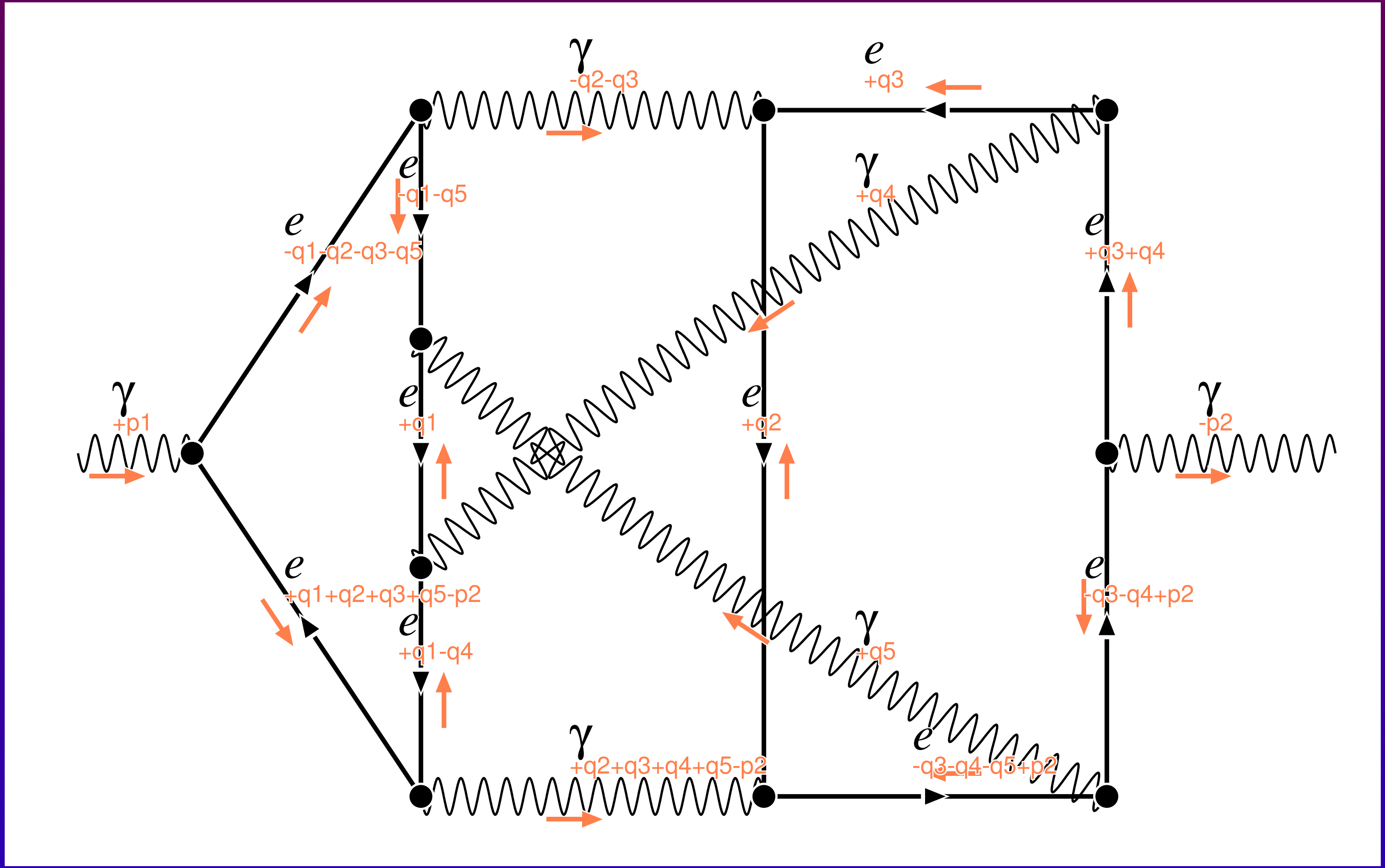
Do you imagine doing 5-loop QED calculations?



Computing: aITALC

an Integrated Tool for Automated Loop Calculations

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an Ịntegrated Tool for Automated Loop Calculations

- Restricted to automated 2 → 2 fermions (EWSM and QED)
- GNU/LINUX tool, GPL licensed, free available since 29.10.04
- `http://www-zeuthen.desy.de/theory/aitalc`
- Submitted to CPC: Lorca and Riemann. `hep-ph/0412047`

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Three structural blocks:

Diagram generation	Algebra simplification	Numerical evaluation
DIANA 2.35 (QGRAF)	FORM 3.1	FORTRAN 77 LOOPTOOLS (FF)

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Three structural blocks: all running under Make environment

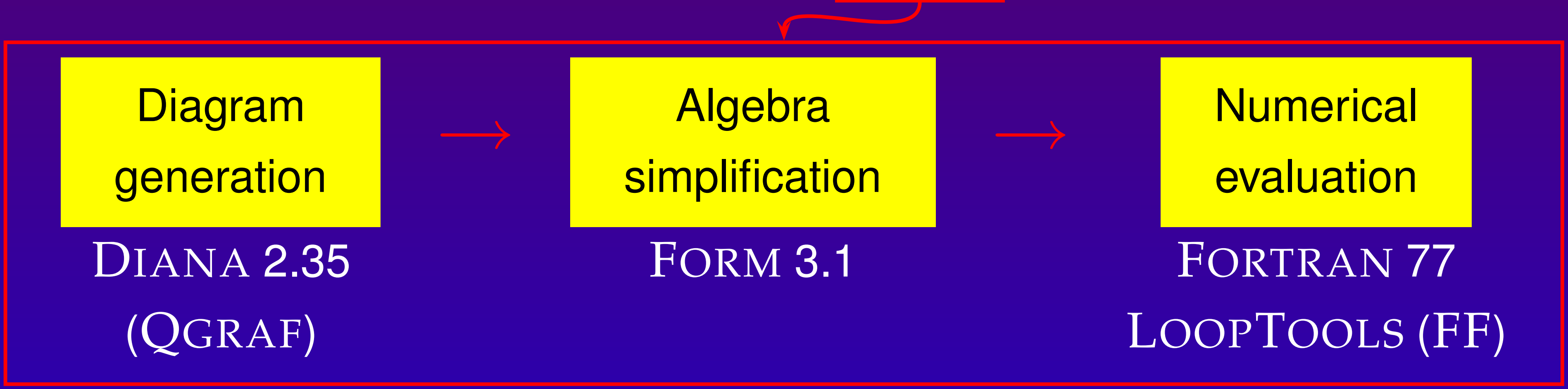

Diagram generation → Algebra simplification → Numerical evaluation

Diana 2.35 (Qgraf)

Form 3.1

Fortran 77 LoopTools (FF)

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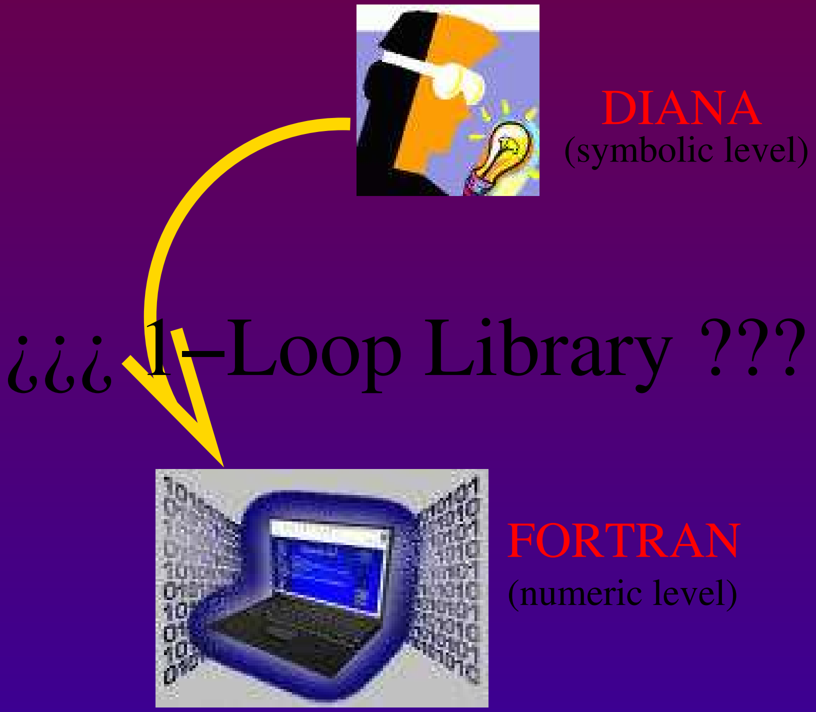

DIANA
(symbolic level)

¿¿¿ 1–Loop Library ???

FORTRAN
(numeric level)

Written in FORM

```
#call feynmanrules()
...
#call tracefermiloops()
#call integration()
#call chisholm()
#call dimensionfour()
#call gammaalgebra()
#call onshell()
#call diracequation()
#call massiveformfactors()
.end
```

These general procedures perform all algebra simplification

✓ Write automatically FORTRAN subroutines from DIANA output

Computing: aITALC numerical

For numerical evaluation language FORTRAN 77 is used

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The code is decomposed into different routines

- **Local**: Process-dependent automatically generated (`me, ff`)
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Executable file $\boxed{\texttt{main.out}}$

Input → parameter list, control flags.

Output ← tables for differential and integrated cross sections and forward-backward asymmetries

Tests ✔ ultraviolet and infrarred finiteness against parameter variation. Quadruple precision

Conclusions & Outlook

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  - Free, Documented, Installable, Automated, Run!
  - Limitation by now to 2 → 2 fermions in EWSM
  - Part of contributions required for precise collider predictions (hard photon, QCD, kin. cuts . . .)

IV. Play a bit!

`~alorca/public/capp_examples`