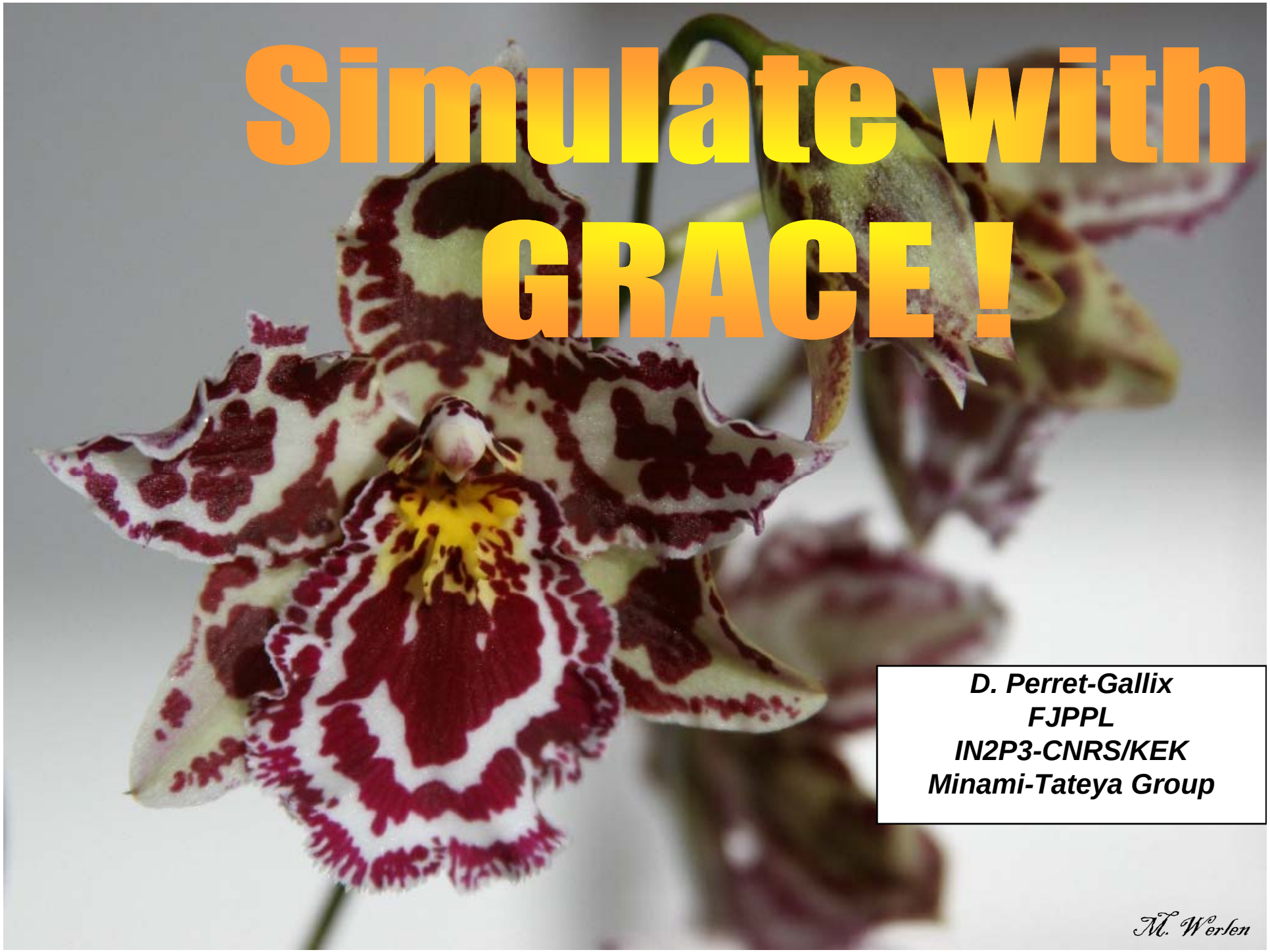
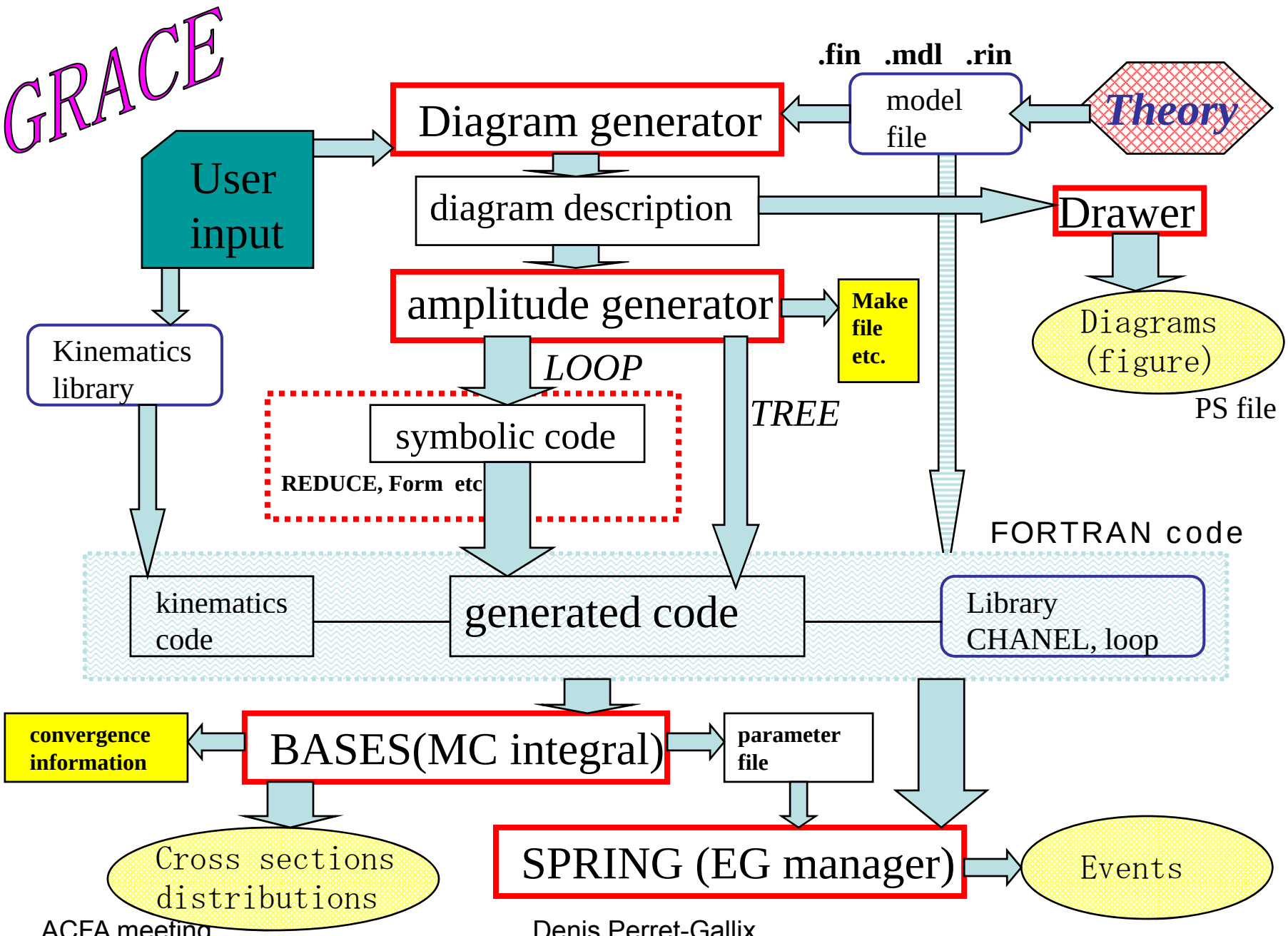

Simulate with
GRACE !
D. Perret-Gallix
FJPPL
IN2P3-CNRS/KEK
Minami-Tateya Group
M. Werlen

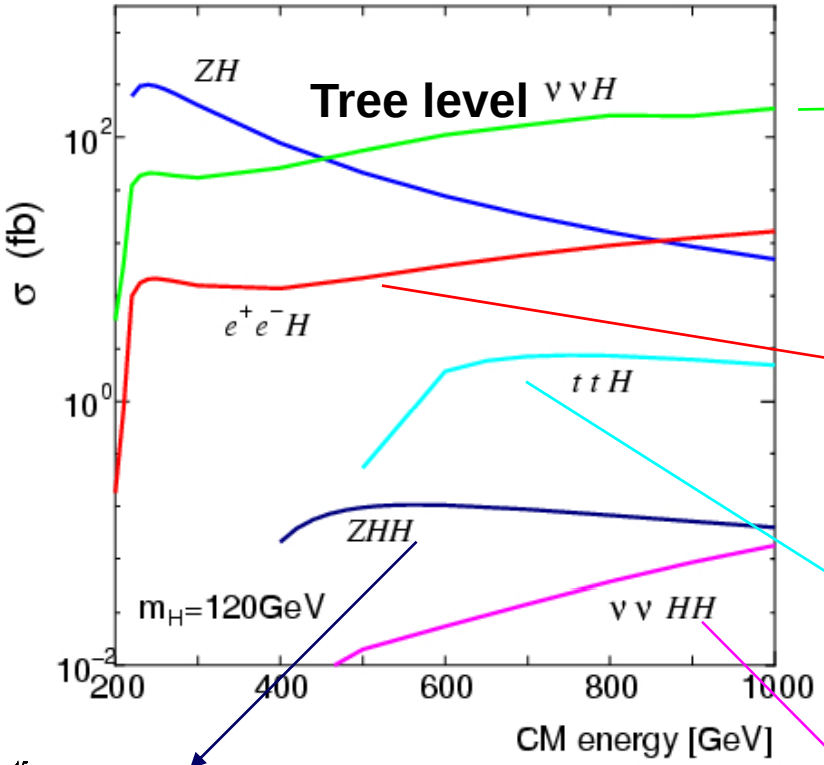
What is Grace ?

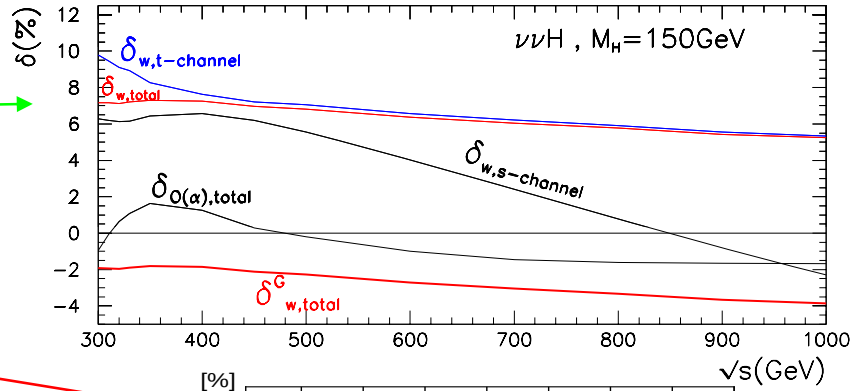
- Cross-section Automatic Computation System for:
  - Tree level
  - One-loop level
  - SM and MSSM
- Generator of “event generators”
  - Bases/Spring framework
- Used at LEP I, II and targeting LHC, ILC physics and astro-particle calculations

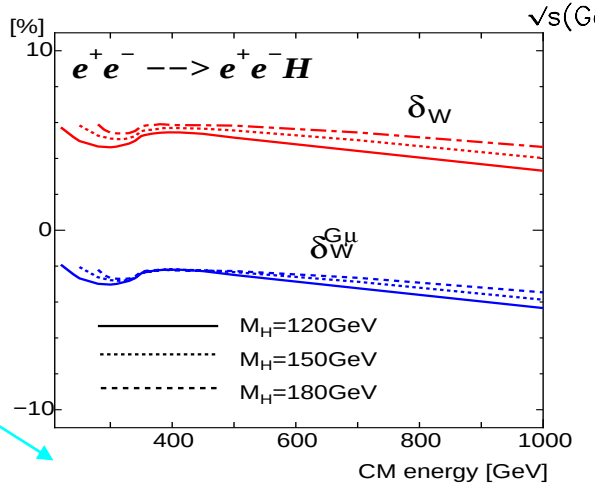
Developed by the Minami-Tateya Group (based in KEK)

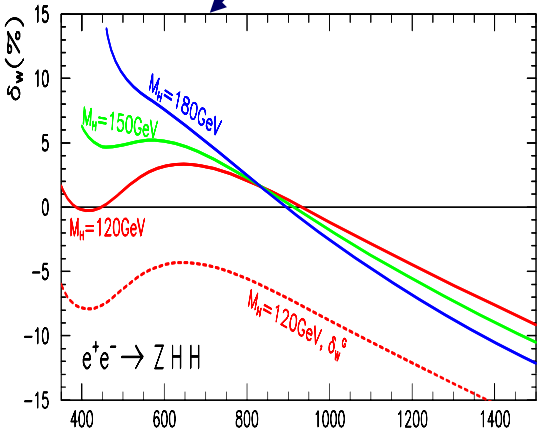


Systematic R.C. to the Higgs production in ILC w/ GRACE

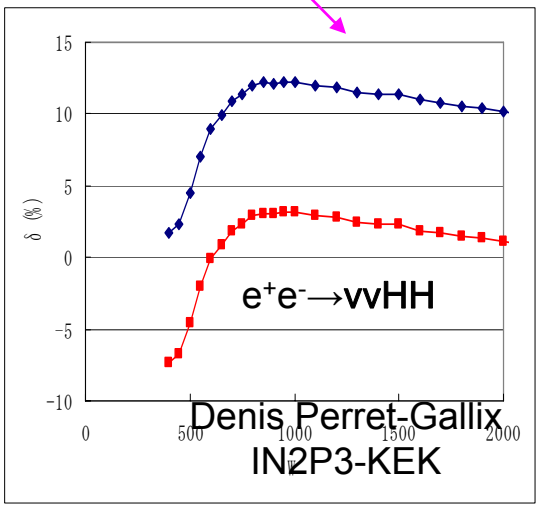




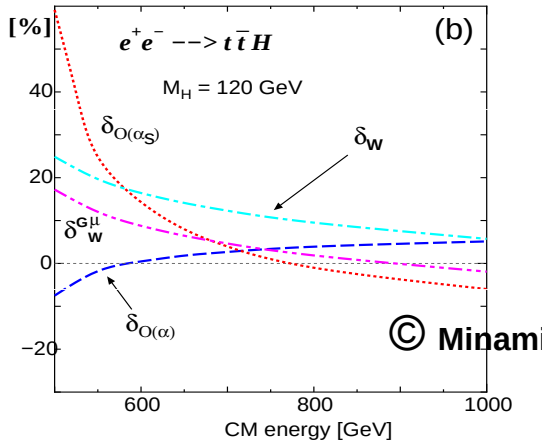




ACFA meeting,
Beijing Feb.4-7, 2007

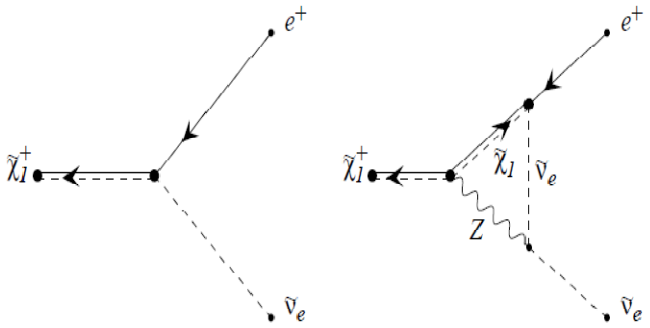


Denis Perret-Gallix
IN2P3-KEK



© Minami-Tateya (KEK)

GRACE/SUSY-loop project



- **Systematic calculation of R.C. to the two-body decay of charginos**
- Checked with the **non-linear gauge invariance**

Decay Channel	Γ_0(GeV)	$\delta^V\Gamma/\Gamma_0$	diagrams
$\tilde{\tau}_1\nu_\tau$	3.9×10^{-2}	−3.3%	56
$\tilde{\mu}_1\nu_\mu$	1.3×10^{-4}	−10.2%	56
$\tilde{\tau}\nu_\tau$	1.5×10^{-2}	0.1%	71
$\tilde{\mu}\nu_\mu$	1.1×10^{-2}	1.0%	71
$\tilde{e}\nu_e$	1.1×10^{-2}	1.0%	71
$W\tilde{\chi}_1^0$	9.7×10^{-4}	32.3%	193

hep/ph 0701200

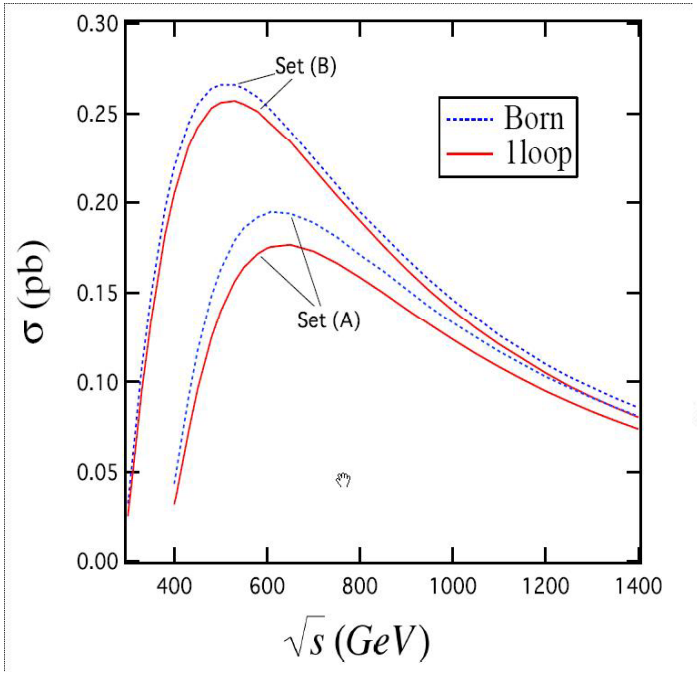
A)
Tanβ 10.
μ 400.
M_1 100.
M_2 197.
M_3 610.
M_{A0} 425.
~ SPA1a'

R.C. to the three-body decay of charginos
GRACE/SUSY-loop

Decay Channel	Γ_0(GeV)	$\delta\Gamma/\Gamma_0$	diagrams
$\tau\nu_\tau\tilde{\chi}_1^0$	6.5×10^{-6}	11.8%	1556
$\mu\nu_\mu\tilde{\chi}_1^0$	4.4×10^{-6}	9.4%	1556
$e\nu_e\tilde{\chi}_1^0$	4.4×10^{-6}	9.4%	1556
$ud\tilde{\chi}_1^0$ (ELWK)	3.4×10^{-6}	–0.2%	2227
$ud\tilde{\chi}_1^0$ (QCD)		6.3%	70
$cs\tilde{\chi}_1^0$ (ELWK)	3.3×10^{-6}	–0.2%	2227
$cs\tilde{\chi}_1^0$ (QCD)		6.3%	70

B)
Tanβ 10.
μ 400.
M_1 100.
M_2 157.
M_3 610.
M_{A0} 431.
~ SPA1a'

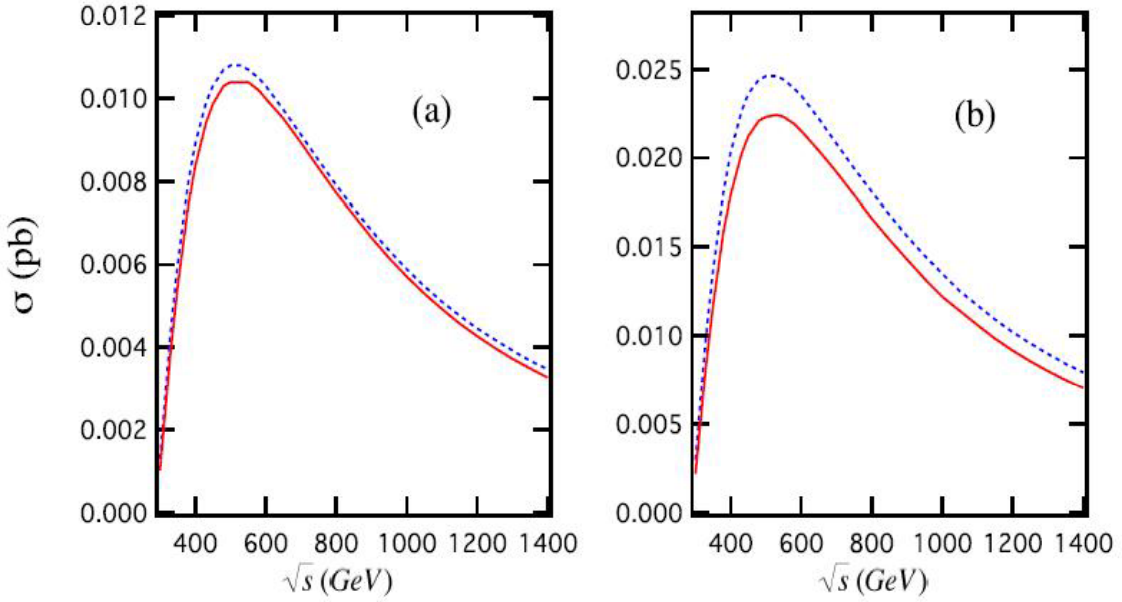
Chargino x-sections



$e^+e^- \to \tilde{\chi}_1^+\tilde{\chi}_1^-$

$e^+e^- \to \tilde{\chi}_1^+\tilde{\chi}_1^- \to (e^+\nu_e\tilde{\chi}_1^0)(e^-\bar{\nu}_e\tilde{\chi}_1^0)$

$e^+e^- \to \tilde{\chi}_1^+\tilde{\chi}_1^- \to (q\bar{q}'\tilde{\chi}_1^0)(q\bar{q}'\tilde{\chi}_1^0)$



Main issues

- Complex procedures, Many Interfaces to ext. programs
  - "GraceFUL" Project (Grace For U to Love)
- CPU/Memory performances
  - GRID, clusters, Supercomputers, Feynman@Home
- High Arithmetic accuracy (beyond Double Precision)
  - HAPPY (High Arithmetic Precision Processing Yoke)

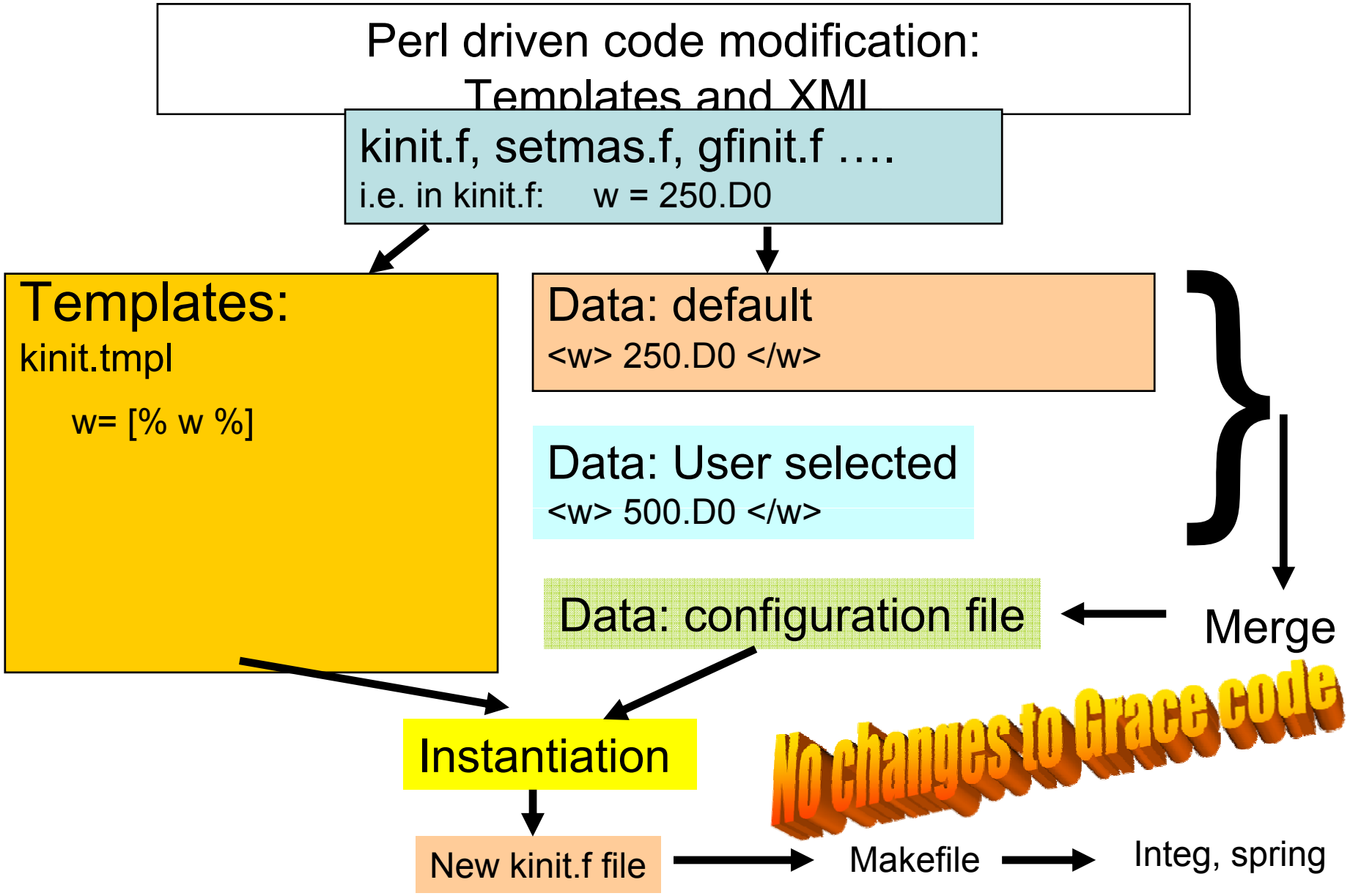
3 projects

GraceFUL

- Front-end package to Grace for:
  - Simple individual use
    - No GRACE code knowledge required to build integ/spring code
    - Cover all actions from process selection to parameter dependent cross-section and event generation
    - Interface to beamstrahlung and parton shower/hadronization
    - Gather all information on a single spreadsheet
  - System wide massive production system
    - Local or distributed, private or public computing system: Supercomputer, cluster, GRID, Feynman@Home
- For all Grace packages
  - SM, MSSM
  - Tree level, 1-loop
  - Generic processes (i.e. *e+-e-->lepton-lepton-H or pp->4 jets*)

Perl driven

- **Build and manage configuration and parameter files**
  - **Direct edition of XML files through XML editor/viewer (Amaya)**
- **Build and manage a directory tree for:**
  - **Codes**
  - **Configurations (sets of parameters)**
  - **Results**
- **Build the parameter dependent GRACE code**
  - **The "integ/spring" binaries No input file. Parameters hardwired (GRACE policy)**
- **Automates the Interface to Pythia, PDF, Circe (Beamstrahlung)**
  - **Output Spring-> Pythia records**
  - **Prepares the supporting Pythia (upinit and upevent code)**
- **Run and manage the Jobs**
  - **Local run on user PC**
  - **submit jobs to Supercomp, the GRID or Feynman@Home(PBS/LSF)**
- **Analyze/display the output, keep track of the results**
  - **Summary through SpreadSheet**
  - **Interface to Root: plots and ntuples for analysis**
- **Store all codes and results in a directory tree → a database**


Perl driven code modification:
Templates and XML
kinit.f, setmas.f, gfinit.f ….
i.e. in kinit.f: w = 250.D0
Templates:
kinit.tmpl
w= [% w %]
Data: default
<w> 250.D0 </w>
Data: User selected
<w> 500.D0 </w>
Merge
Data: configuration file
Instantiation
No changes to Grace code
New kinit.f file
Makefile
Integ, spring

Directory Tree for Code

```
Build  -- contains temporary files needed by grcfl
   |
Code --all physics processes code  |
   |SM   -- Standard Model processes
   |    |
   |    |1_to_2 --initial to final state particles nb
   |    |    |proc1  --name of the process
   |    |    |    |
   |    |    |    |channel1 --sub-process*
   |    |    |    |     |input  -- input files
   |    |    |    |     |fort -- fortran code
   |    |    |    |     |graph  -- graph files
   |    |    |    |     |log  -- installation log files
   |    |    |    |channel2
   |    |    |    | ...
   |    |    |    |templates  --templates for all channels
   |    |    |    |
   |    |    |proc2
   |    |    |...
   |    |1_to_3
   |    | ...
   |    |2_to_2
   |    |2_to_3
   |    |   ...
   |
   |MSSM Minimal SuperSymetry Model
```

Directory Tree for Running sets

```
Result --
    |SM   -- Standard Model processes
    |    |
    |    |1_to_2 --initial to final state particles nb
    |    |    |proc1  --name of the process
    |    |    |    |
    |    |    |    |set1 --setting of all parameters
    |    |    |    |    |chan1  -- channel 1
    |    |    |    |    |    |out  -- bases map,
    |    |    |    |    |    |    |out1
    |    |    |    |    |    |    |out2
    |    |    |    |    |    |    |...
    |    |    |    |    |    |log  -integ, spring
    |    |    |    |    |    |    |log1
    |    |    |    |    |    |    |log2
    |    |    |    |    |    |    |...
    |    |    |    |    |chan2
    |    |    |    |    |...
    |    |    |    |    |config : set1 modified sub and binaries
    |    |    |    |    |result
    |    |    |    |    |
    |    |    |    |set2
    |    |    |    |...
    |    |    |    |default
    |    |    |    |
    |    |    |proc2
    |    |    |
    |    |1_to_3
    |    |  ...
    |    |2_to_2
    |    |2_to_3
    |    |    ...
    |
    |MSSM Mininal SuperSymetry Model
Templates -- General templates
Temp Temporary used bu grcfl
history.txt -- last run
```

ACI
Beij

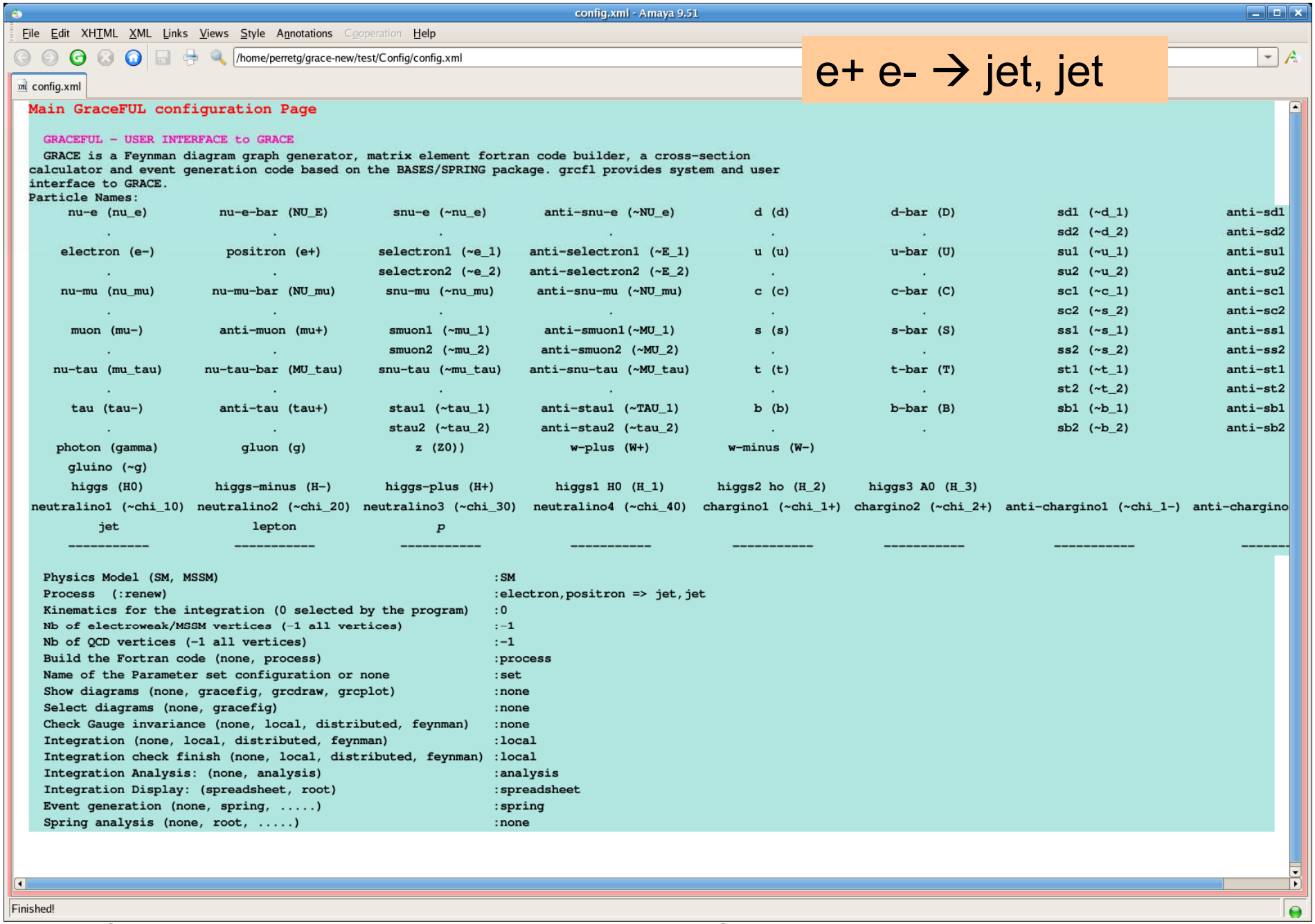
Parameters in XML format

- ***Single value***: <p1> x </p1>
  - x can be a number (or a Fortran expression using Grace variables (for expert only)
- ***Range***: <p1> xmin : xmax : step ; order </p1>
  - Order: 0…4 (0 inner loop)
- ***List:*** <p1> x1, x2, ….., x3 ; order </p1>

- Currently at most 5 (Range +List) parameters

Examples:

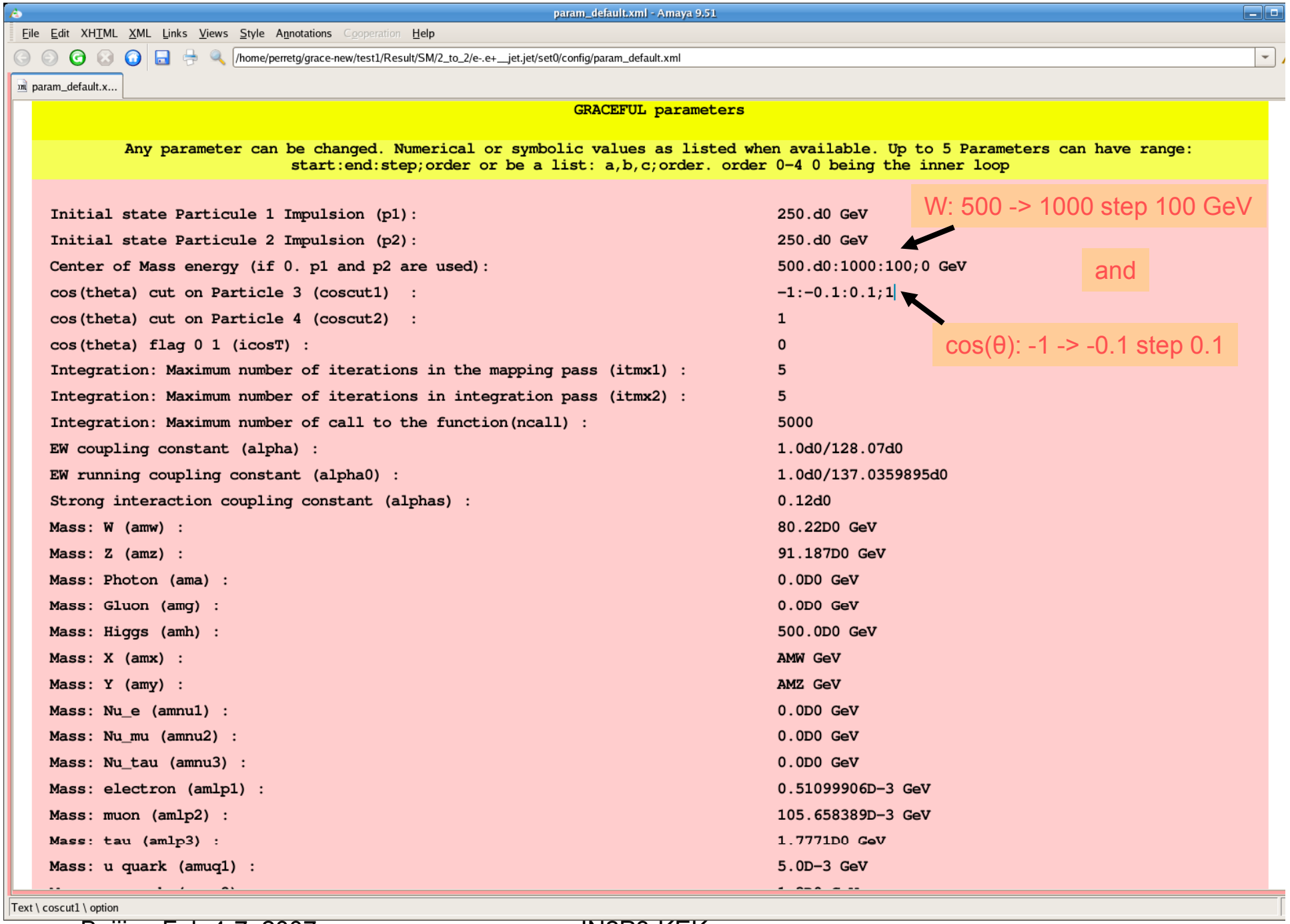
- <p1> 250.d0 </p1> Single value
- <p1> 250.:400.:10.;0 </p1> from 250. to 400. by step of 10.
- <p1> 250.,300.,1000.,2000.;1 </p1> list of values

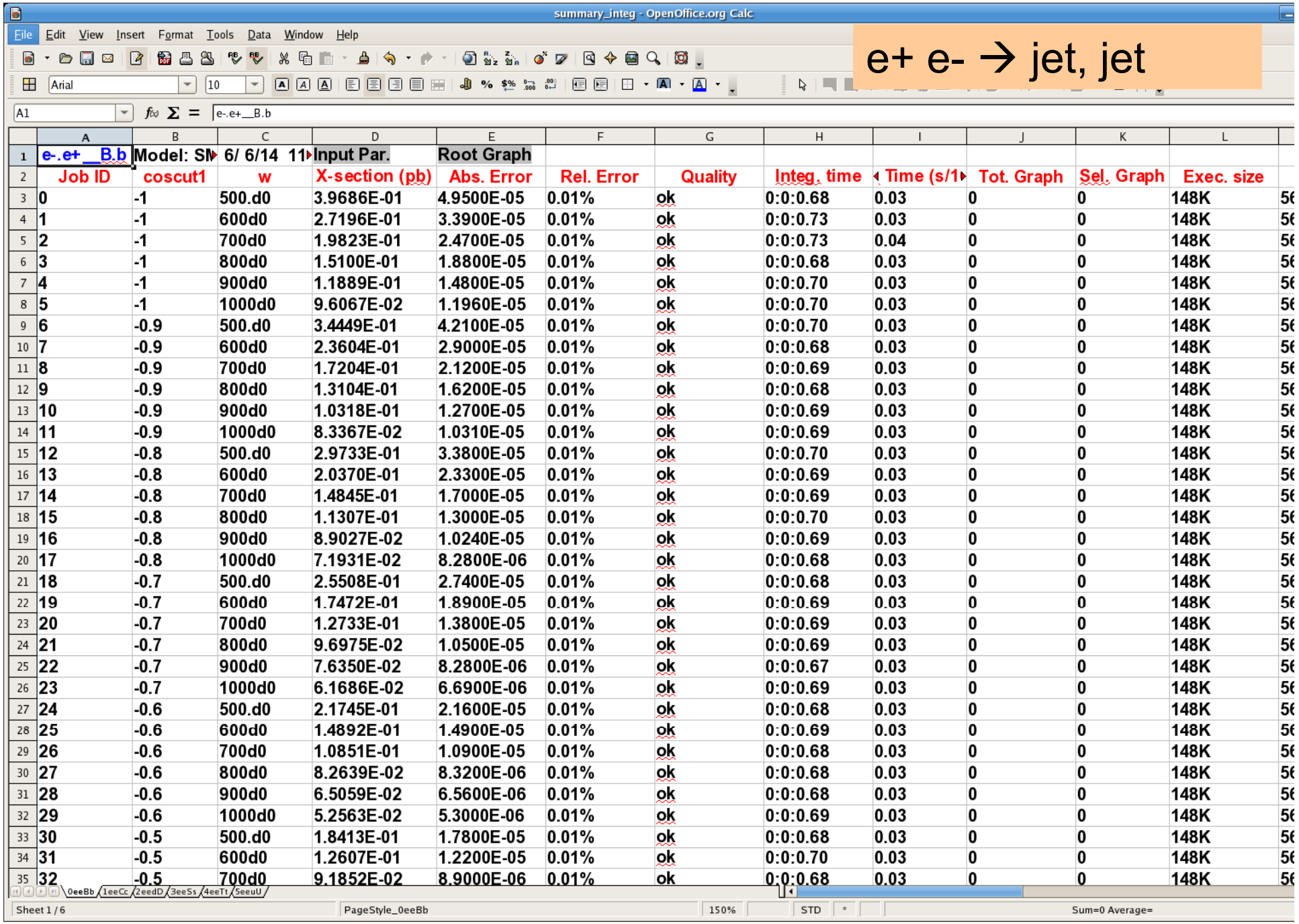

config.xml - Amaya 9.51
File Edit XHTML XML Links Views Style Annotations Cooperation Help
/home/perretg/grace-new/test/Config/config.xml
config.xml
e+ e- → jet, jet
Main GraceFUL configuration Page
GRACEFUL – USER INTERFACE to GRACE
GRACE is a Feynman diagram graph generator, matrix element fortran code builder, a cross-section calculator and event generation code based on the BASES/SPRING package. grcfl provides system and user interface to GRACE.
Particle Names:
nu-e (nu_e) nu-e-bar (NU_E) snu-e (~nu_e) anti-snu-e (~NU_e) d (d) d-bar (D) sd1 (~d_1) anti-sd1
sd2 (~d_2) anti-sd2
electron (e-) positron (e+) selectron1 (~e_1) anti-selectron1 (~E_1) u (u) u-bar (U) su1 (~u_1) anti-su1
selectron2 (~e_2) anti-selectron2 (~E_2) su2 (~u_2) anti-su2
nu-mu (nu_mu) nu-mu-bar (NU_mu) snu-mu (~nu_mu) anti-snu-mu (~NU_mu) c (c) c-bar (C) sc1 (~c_1) anti-sc1
sc2 (~s_2) anti-sc2
muon (mu-) anti-muon (mu+) smuon1 (~mu_1) anti-smuon1(~MU_1) s (s) s-bar (S) ss1 (~s_1) anti-ss1
smuon2 (~mu_2) anti-smuon2 (~MU_2) ss2 (~s_2) anti-ss2
nu-tau (mu_tau) nu-tau-bar (MU_tau) snu-tau (~mu_tau) anti-snu-tau (~MU_tau) t (t) t-bar (T) st1 (~t_1) anti-st1
st2 (~t_2) anti-st2
tau (tau-) anti-tau (tau+) stau1 (~tau_1) anti-stau1 (~TAU_1) b (b) b-bar (B) sb1 (~b_1) anti-sb1
stau2 (~tau_2) anti-stau2 (~tau_2) sb2 (~b_2) anti-sb2
photon (gamma) gluon (g) z (Z0)) w-plus (W+) w-minus (W-)
gluino (~g)
higgs (H0) higgs-minus (H-) higgs-plus (H+) higgs1 H0 (H_1) higgs2 ho (H_2) higgs3 A0 (H_3)
neutralino1 (~chi_10) neutralino2 (~chi_20) neutralino3 (~chi_30) neutralino4 (~chi_40) chargino1 (~chi_1+) chargino2 (~chi_2+) anti-chargino1 (~chi_1-) anti-chargino
jet lepton p
Physics Model (SM, MSSM) :SM
Process (:renew) :electron,positron => jet,jet
Kinematics for the integration (0 selected by the program) :0
Nb of electroweak/MSSM vertices (-1 all vertices) :-1
Nb of QCD vertices (-1 all vertices) :-1
Build the Fortran code (none, process) :process
Name of the Parameter set configuration or none :set
Show diagrams (none, gracefig, grcdraw, grcplot) :none
Select diagrams (none, gracefig) :none
Check Gauge invariance (none, local, distributed, feynman) :none
Integration (none, local, distributed, feynman) :local
Integration check finish (none, local, distributed, feynman) :local
Integration Analysis: (none, analysis) :analysis
Integration Display: (spreadsheet, root) :spreadsheet
Event generation (none, spring, ...) :spring
Spring analysis (none, root, ...) :none
Finished!

Sample XML default parameter file build by GraceFUL

```
<option>
<p1> 250.d0 </p1>
<p2> 250.d0 </p2>
<coscut1> -1 </coscut1>
<coscut2>  1 </coscut2>
<icost> 0 </icost>
<itmx1> 5 </itmx1>
<itmx2> 5 </itmx2>
<ncall> 5000 </ncall>
<pi> acos(- 1.0d0 ) </pi>
<pi2> pi * pi </pi2>
<rad> pi / 180.0d0 </rad>
<gevpb> 0.38937966d9 </gevpb>
<alpha> 1.0d0/128.07d0 </alpha>
<alpha0> 1.0d0/137.0359895d0 </alpha0>
<alphas> 0.12d0 </alphas>
<amw> 80.22D0 </amw>
<amz> 91.187D0 </amz>
<ama> 0.0D0 </ama>
```

```
…
<agz> 2.49D0 </agz>
<agh> 100.0D0 </agh>
<agx> AGW </agx>
<agy> AGZ </agy>
…
<jhs1> 0 </jhs1>
<jhe1> lextrn - 1 </jhe1>
<jhs2> 0 </jhs2>
<jhe2> lextrn - 1 </jhe2>
<jhs3> 0 </jhs3>
<jhe3> lepexa - 1 </jhe3>
<jhs4> 0 </jhs4>
<jhe4> lepexa - 1 </jhe4>
<jgluon > 1 </jgluon >
<jhiggs > 1 </jhiggs >
</option>
```


param_default.xml - Amaya 9.51
File Edit XHTML XML Links Views Style Annotations Cooperation Help
/home/perretg/grace-new/test1/Result/SM/2_to_2/e-.e+__jet.jet/set0/config/param_default.xml
param_default.x...
GRACEFUL parameters
Any parameter can be changed. Numerical or symbolic values as listed when available. Up to 5 Parameters can have range:
start:end:step;order or be a list: a,b,c;order. order 0-4 0 being the inner loop
Initial state Particule 1 Impulsion (p1): 250.d0 GeV
Initial state Particule 2 Impulsion (p2): 250.d0 GeV
Center of Mass energy (if 0. p1 and p2 are used): 500.d0:1000:100;0 GeV
cos(theta) cut on Particle 3 (coscut1) : -1:-0.1:0.1;1
cos(theta) cut on Particle 4 (coscut2) : 1
cos(theta) flag 0 1 (icosT) : 0
Integration: Maximum number of iterations in the mapping pass (itmx1) : 5
Integration: Maximum number of iterations in integration pass (itmx2) : 5
Integration: Maximum number of call to the function(ncall) : 5000
EW coupling constant (alpha) : 1.0d0/128.07d0
EW running coupling constant (alpha0) : 1.0d0/137.0359895d0
Strong interaction coupling constant (alphas) : 0.12d0
Mass: W (amw) : 80.22D0 GeV
Mass: Z (amz) : 91.187D0 GeV
Mass: Photon (ama) : 0.0D0 GeV
Mass: Gluon (amg) : 0.0D0 GeV
Mass: Higgs (amh) : 500.0D0 GeV
Mass: X (amx) : AMW GeV
Mass: Y (amy) : AMZ GeV
Mass: Nu_e (amnu1) : 0.0D0 GeV
Mass: Nu_mu (amnu2) : 0.0D0 GeV
Mass: Nu_tau (amnu3) : 0.0D0 GeV
Mass: electron (amlp1) : 0.51099906D-3 GeV
Mass: muon (amlp2) : 105.658389D-3 GeV
Mass: tau (amlp3) : 1.7771D0 GeV
Mass: u quark (amuq1) : 5.0D-3 GeV
Text \ coscut1 \ option
W: 500 -> 1000 step 100 GeV
and
cos(θ): -1 -> -0.1 step 0.1



	A	B	C	D	E	F	G	H	I	J	K	L
1	e-.e+__B.b	Model: SM	6/ 6/14 11	Input Par.	Root Graph							
2	Job ID	coscut1	w	X-section (pb)	Abs. Error	Rel. Error	Quality	Integ. time	Time (s/1	Tot. Graph	Sel. Graph	Exec. size
3	0	-1	500.d0	3.9686E-01	4.9500E-05	0.01%	ok	0:0:0.68	0.03	0	0	148K
4	1	-1	600d0	2.7196E-01	3.3900E-05	0.01%	ok	0:0:0.73	0.03	0	0	148K
5	2	-1	700d0	1.9823E-01	2.4700E-05	0.01%	ok	0:0:0.73	0.04	0	0	148K
6	3	-1	800d0	1.5100E-01	1.8800E-05	0.01%	ok	0:0:0.68	0.03	0	0	148K
7	4	-1	900d0	1.1889E-01	1.4800E-05	0.01%	ok	0:0:0.70	0.03	0	0	148K
8	5	-1	1000d0	9.6067E-02	1.1960E-05	0.01%	ok	0:0:0.70	0.03	0	0	148K
9	6	-0.9	500.d0	3.4449E-01	4.2100E-05	0.01%	ok	0:0:0.70	0.03	0	0	148K
10	7	-0.9	600d0	2.3604E-01	2.9000E-05	0.01%	ok	0:0:0.68	0.03	0	0	148K
11	8	-0.9	700d0	1.7204E-01	2.1200E-05	0.01%	ok	0:0:0.69	0.03	0	0	148K
12	9	-0.9	800d0	1.3104E-01	1.6200E-05	0.01%	ok	0:0:0.68	0.03	0	0	148K
13	10	-0.9	900d0	1.0318E-01	1.2700E-05	0.01%	ok	0:0:0.69	0.03	0	0	148K
14	11	-0.9	1000d0	8.3367E-02	1.0310E-05	0.01%	ok	0:0:0.69	0.03	0	0	148K
15	12	-0.8	500.d0	2.9733E-01	3.3800E-05	0.01%	ok	0:0:0.70	0.03	0	0	148K
16	13	-0.8	600d0	2.0370E-01	2.3300E-05	0.01%	ok	0:0:0.69	0.03	0	0	148K
17	14	-0.8	700d0	1.4845E-01	1.7000E-05	0.01%	ok	0:0:0.69	0.03	0	0	148K
18	15	-0.8	800d0	1.1307E-01	1.3000E-05	0.01%	ok	0:0:0.70	0.03	0	0	148K
19	16	-0.8	900d0	8.9027E-02	1.0240E-05	0.01%	ok	0:0:0.69	0.03	0	0	148K
20	17	-0.8	1000d0	7.1931E-02	8.2800E-06	0.01%	ok	0:0:0.68	0.03	0	0	148K
21	18	-0.7	500.d0	2.5508E-01	2.7400E-05	0.01%	ok	0:0:0.68	0.03	0	0	148K
22	19	-0.7	600d0	1.7472E-01	1.8900E-05	0.01%	ok	0:0:0.69	0.03	0	0	148K
23	20	-0.7	700d0	1.2733E-01	1.3800E-05	0.01%	ok	0:0:0.69	0.03	0	0	148K
24	21	-0.7	800d0	9.6975E-02	1.0500E-05	0.01%	ok	0:0:0.69	0.03	0	0	148K
25	22	-0.7	900d0	7.6350E-02	8.2800E-06	0.01%	ok	0:0:0.67	0.03	0	0	148K
26	23	-0.7	1000d0	6.1686E-02	6.6900E-06	0.01%	ok	0:0:0.69	0.03	0	0	148K
27	24	-0.6	500.d0	2.1745E-01	2.1600E-05	0.01%	ok	0:0:0.68	0.03	0	0	148K
28	25	-0.6	600d0	1.4892E-01	1.4900E-05	0.01%	ok	0:0:0.69	0.03	0	0	148K
29	26	-0.6	700d0	1.0851E-01	1.0900E-05	0.01%	ok	0:0:0.68	0.03	0	0	148K
30	27	-0.6	800d0	8.2639E-02	8.3200E-06	0.01%	ok	0:0:0.68	0.03	0	0	148K
31	28	-0.6	900d0	6.5059E-02	6.5600E-06	0.01%	ok	0:0:0.68	0.03	0	0	148K
32	29	-0.6	1000d0	5.2563E-02	5.3000E-06	0.01%	ok	0:0:0.69	0.03	0	0	148K
33	30	-0.5	500.d0	1.8413E-01	1.7800E-05	0.01%	ok	0:0:0.68	0.03	0	0	148K
34	31	-0.5	600d0	1.2607E-01	1.2200E-05	0.01%	ok	0:0:0.70	0.03	0	0	148K
35	32	-0.5	700d0	9.1852E-02	8.9000E-06	0.01%	ok	0:0:0.68	0.03	0	0	148K

Applications Places System

27 °C | Perl - param.css - Eclipse SDK | perretg@localhost:~/workspace1/G... | perretg@localhost:~/workspace1/G... | summary_integ - OpenOffice.org Calc | file:///home/perretg/grace-new/test/... | Starting Take Screenshot

summary_integ - OpenOffice.org Calc

File Edit View Insert Format Tools Data Window Help

Arial 10

A1 | e-.e+__B.b

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	e-.e+__B.b	Model: SI	6/ 6/14 11	Input Par.	Root Graph													
2	Job ID	coscut1	w	X-section (pb)	Abs. Error	Rel. Error	Quality	Integ. time	Time (s/1	Tot. Graph	Sel. Graph	Exec. size	DB size	Output file	Out_param			
3	0	-1	500.d0	3.9686E-01	4.9500E-05	0.01%	ok	0:0:0.68	0.03	0	0	148K	564816	Log	Out_Param			
4	1	-1	600d0	2.7196E-01	3.3900E-05	0.01%	ok	0:0:0.73	0.03	0	0	148K	564816	Log	Out_Param			
5	2	-1	700d0	1.9823E-01	2.4700E-05	0.01%	ok	0:0:0.73	0.04	0	0	148K	564816	Log	Out_Param			
6	3	-1	800d0	1.5100E-01	1.8800E-05	0.01%	ok	0:0:0.68	0.03	0	0	148K	564816	Log	Out_Param			
7	4	-1	900d0	1.1889E-01	1.4800E-05	0.01%	ok	0:0:0.70	0.03	0	0	148K	564816	Log	Out_Param			
8	5	-1	1000d0	9.6067E-02	1.1960E-05	0.01%	ok	0:0:0.70	0.03	0	0	148K	564816	Log	Out_Param			
9	6	-0.9	500.d0	3.4449E-01	4.2100E-05	0.01%	ok	0:0:0.70	0.03	0	0	148K	564816	Log	Out_Param			
10	7	-0.9	600d0	2.3604E-01	2.9000E-05	0.01%	ok	0:0:0.68	0.03									
11	8	-0.9	700d0	1.7204E-01	2.1200E-05	0.01%	ok	0:0:0.69	0.03									
12	9	-0.9	800d0	1.3104E-01	1.6200E-05	0.01%	ok	0:0:0.68	0.03									
13	10	-0.9	900d0	1.0318E-01	1.2700E-05	0.01%	ok	0:0:0.69	0.03									
14	11	-0.9	1000d0	8.3367E-02	1.0310E-05	0.01%	ok	0:0:0.69	0.03									
15	12	-0.8	500.d0	2.9733E-01	3.3800E-05	0.01%	ok	0:0:0.70	0.03									
16	13	-0.8	600d0	2.0370E-01	2.3300E-05	0.01%	ok	0:0:0.69	0.03									
17	14	-0.8	700d0	1.4845E-01	1.7000E-05	0.01%	ok	0:0:0.69	0.03									
18	15	-0.8	800d0	1.1307E-01	1.3000E-05	0.01%	ok	0:0:0.70	0.03									
19	16	-0.8	900d0	8.9027E-02	1.0240E-05	0.01%	ok	0:0:0.69	0.03									
20	17	-0.8	1000d0	7.1931E-02	8.2800E-06	0.01%	ok	0:0:0.68	0.03									
21	18	-0.7	500.d0	2.5508E-01	2.7400E-05	0.01%	ok	0:0:0.68	0.03									
22	19	-0.7	600d0	1.7472E-01	1.8900E-05	0.01%	ok	0:0:0.69	0.03									
23	20	-0.7	700d0	1.2733E-01	1.3800E-05	0.01%	ok	0:0:0.69	0.03									
24	21	-0.7	800d0	9.6975E-02	1.0500E-05	0.01%	ok	0:0:0.69	0.03									
25	22	-0.7	900d0	7.6350E-02	8.2800E-06	0.01%	ok	0:0:0.67	0.03									
26	23	-0.7	1000d0	6.1686E-02	6.6900E-06	0.01%	ok	0:0:0.69	0.03									
27	24	-0.6	500.d0	2.1745E-01	2.1600E-05	0.01%	ok	0:0:0.68	0.03									
28	25	-0.6	600d0	1.4892E-01	1.4900E-05	0.01%	ok	0:0:0.69	0.03									
29	26	-0.6	700d0	1.0851E-01	1.0900E-05	0.01%	ok	0:0:0.68	0.03									
30	27	-0.6	800d0	8.2639E-02	8.3200E-06	0.01%	ok	0:0:0.68	0.03									
31	28	-0.6	900d0	6.5059E-02	6.5600E-06	0.01%	ok	0:0:0.68	0.03									
32	29	-0.6	1000d0	5.2563E-02	5.3000E-06	0.01%	ok	0:0:0.69	0.03									
33	30	-0.5	500.d0	1.8413E-01	1.7800E-05	0.01%	ok	0:0:0.68	0.03									
34	31	-0.5	600d0	1.2607E-01	1.2200E-05	0.01%	ok	0:0:0.70	0.03									
35	32	-0.5	700d0	9.1852E-02	8.9000E-06	0.01%	ok	0:0:0.68	0.03									
36	33	-0.5	800d0	6.9946E-02	6.7800E-06	0.01%	ok	0:0:0.69	0.03									
37	34	-0.5	900d0	5.5063E-02	5.3400E-06	0.01%	ok	0:0:0.69	0.03									
38	35	-0.5	1000d0	4.4485E-02	4.3200E-06	0.01%	ok	0:0:0.68	0.03									
39	36	-0.4	500.d0	1.5483E-01	1.4900E-05	0.01%	ok	0:0:0.68	0.03									
40	37	-0.4	600d0	1.0598E-01	1.0200E-05	0.01%	ok	0:0:0.72	0.03									
41	38	-0.4	700d0	7.7203E-02	7.4100E-06	0.01%	ok	0:0:0.70	0.03									
42	39	-0.4	800d0	5.8785E-02	5.6500E-06	0.01%	ok	0:0:0.68	0.03									
43	40	-0.4	900d0	4.6274E-02	4.4500E-06	0.01%	ok	0:0:0.69	0.03									
44	41	-0.4	1000d0	3.7382E-02	3.5900E-06	0.01%	ok	0:0:0.68	0.03									
45	42	-0.3	500.d0	1.2925E-01	1.2600E-05	0.01%	ok	0:0:0.57	0.03									
46	43	-0.3	600d0	8.8445E-02	8.6900E-06	0.01%	ok	0:0:0.55	0.03									
47	44	-0.3	700d0	6.4415E-02	6.3500E-06	0.01%	ok	0:0:0.60	0.03									
48	45	-0.3	800d0	4.9042E-02	4.8500E-06	0.01%	ok	0:0:0.58	0.03									
49	46	-0.3	900d0	3.8602E-02	3.8200E-06	0.01%	ok	0:0:0.57	0.03									
50	47	-0.3	1000d0	3.1183E-02	3.0900E-06	0.01%	ok	0:0:0.57	0.03									
51	48	-0.2	500.d0	1.0710E-01	1.0500E-05	0.01%	ok	0:0:0.44	0.03									

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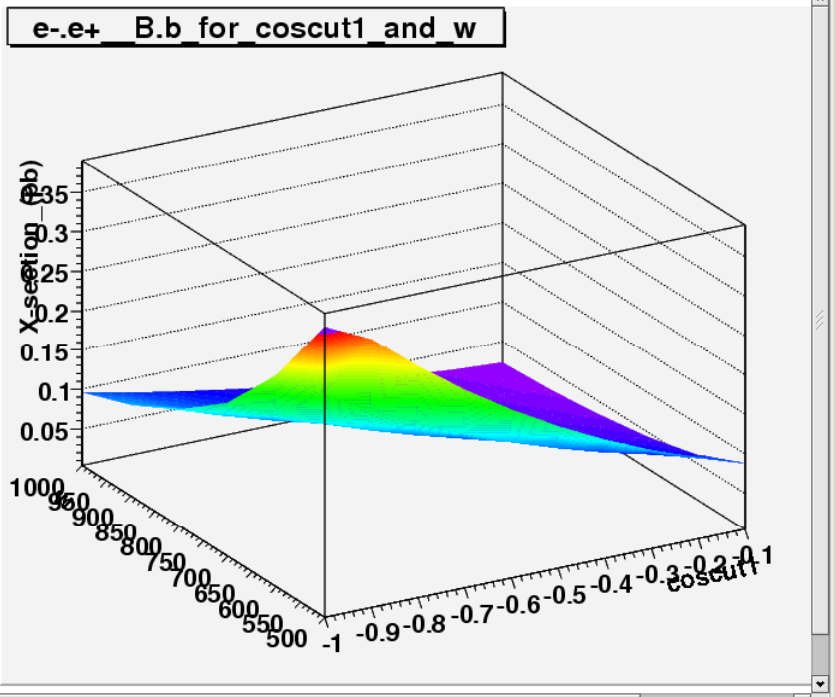

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dgraph.eps

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param.css 4 5/11/06 7:33 PM perretg

12option {font-weight: bold}
13option:before {display:block;text-align:center;height:30px}

In progress

- Interface to the “Les Houches Accords”
- Extension to other packages
  - Grcft, a new fast EW tree level Grace system
  - Grace 1-loop
- Objective-Perl ?
  - Already more than 5000 Perl lines

Feynman@home
Volonteer Computing For Particle Physics

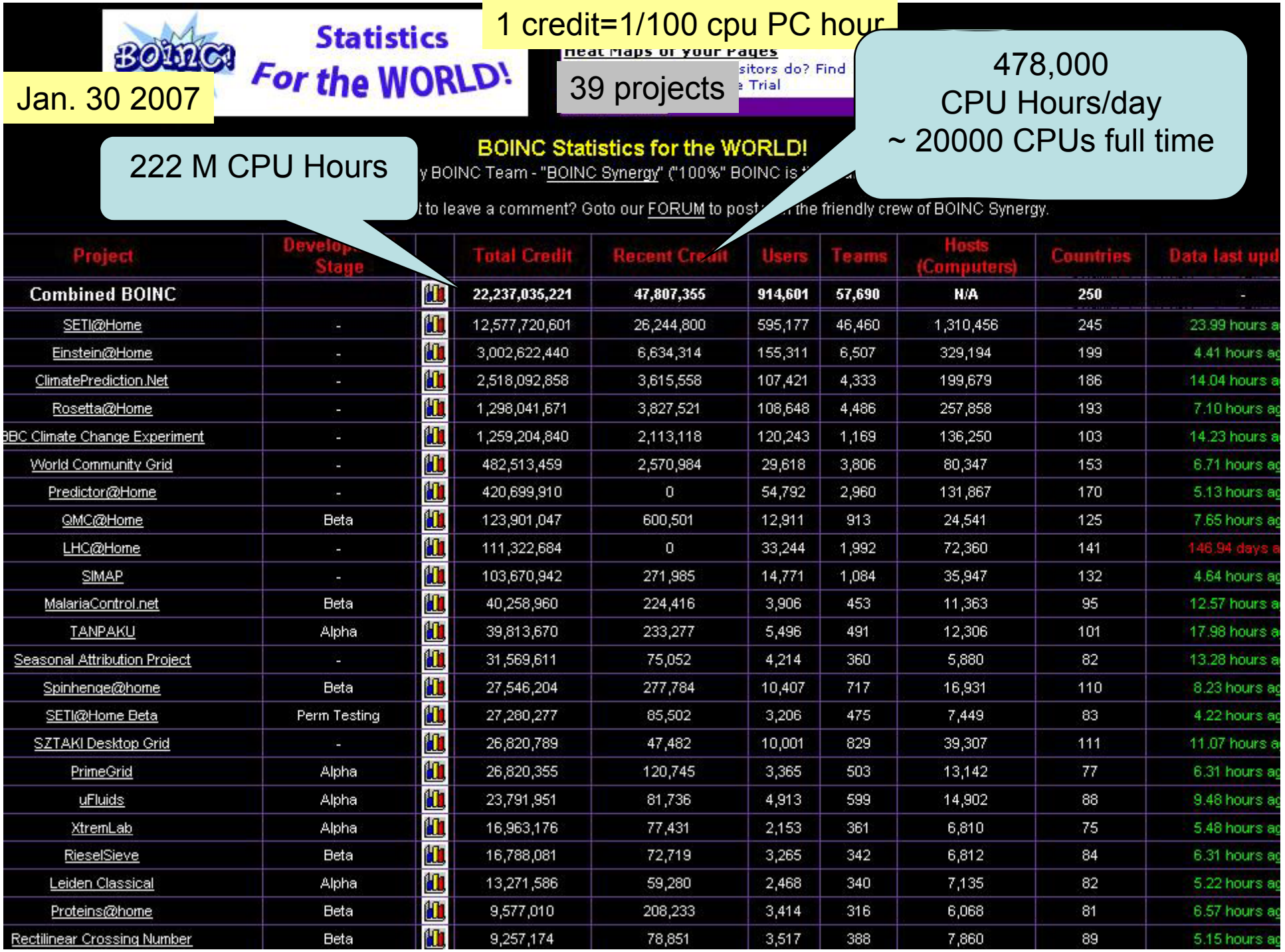
- BOINC Distributed Public Computing

Berkeley Open Infrastructure for Network Computing

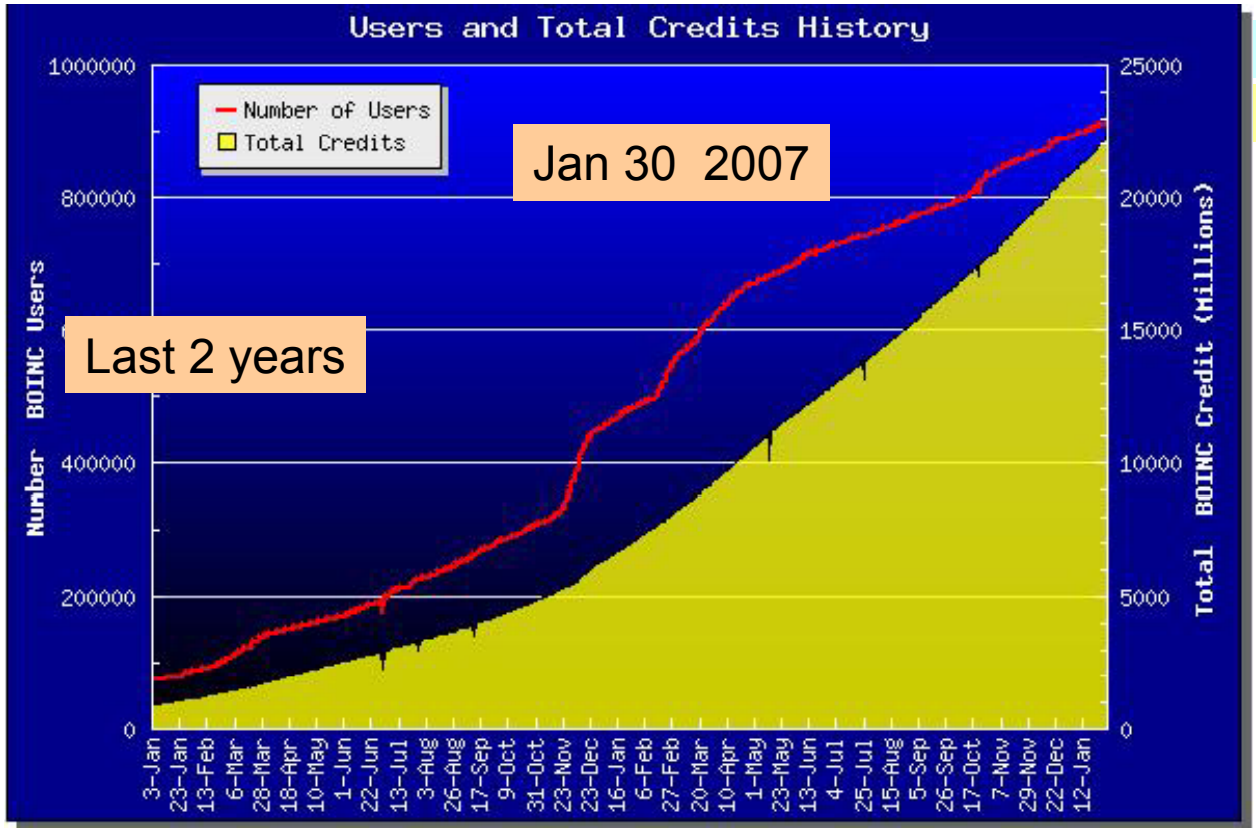
- http://boinc.berkeley.edu/

- Follow-up of SETI@HOME
  http://setiathome.berkeley.edu/

- Feynman@Home
  - **http://acpp.in2p3.fr/cgi-bin/twiki/bin/view/Feynman/WebHome**



Project	Develop Stage		Total Credit	Recent Credit	Users	Teams	Hosts (Computers)	Countries	Data last upd
Combined BOINC			**22,237,035,221**	**47,807,355**	**914,601**	**57,690**	**N/A**	**250**	-
SETI@Home	-		12,577,720,601	26,244,800	595,177	46,460	1,310,456	245	23.99 hours a
Einstein@Home	-		3,002,622,440	6,634,314	155,311	6,507	329,194	199	4.41 hours ag
ClimatePrediction.Net	-		2,518,092,858	3,615,558	107,421	4,333	199,679	186	14.04 hours a
Rosetta@Home	-		1,298,041,671	3,827,521	108,648	4,486	257,858	193	7.10 hours ag
BBC Climate Change Experiment	-		1,259,204,840	2,113,118	120,243	1,169	136,250	103	14.23 hours a
World Community Grid	-		482,513,459	2,570,984	29,618	3,806	80,347	153	6.71 hours ag
Predictor@Home	-		420,699,910	0	54,792	2,960	131,867	170	5.13 hours ag
QMC@Home	Beta		123,901,047	600,501	12,911	913	24,541	125	7.65 hours ag
LHC@Home	-		111,322,684	0	33,244	1,992	72,360	141	146.94 days a
SIMAP	-		103,670,942	271,985	14,771	1,084	35,947	132	4.64 hours ag
MalariaControl.net	Beta		40,258,960	224,416	3,906	453	11,363	95	12.57 hours a
TANPAKU	Alpha		39,813,670	233,277	5,496	491	12,306	101	17.98 hours a
Seasonal Attribution Project	-		31,569,611	75,052	4,214	360	5,880	82	13.28 hours a
Spinhenge@home	Beta		27,546,204	277,784	10,407	717	16,931	110	8.23 hours ag
SETI@Home Beta	Perm Testing		27,280,277	85,502	3,206	475	7,449	83	4.22 hours ag
SZTAKI Desktop Grid	-		26,820,789	47,482	10,001	829	39,307	111	11.07 hours a
PrimeGrid	Alpha		26,820,355	120,745	3,365	503	13,142	77	6.31 hours ag
uFluids	Alpha		23,791,951	81,736	4,913	599	14,902	88	9.48 hours ag
XtremLab	Alpha		16,963,176	77,431	2,153	361	6,810	75	5.48 hours ag
RieselSieve	Beta		16,788,081	72,719	3,265	342	6,812	84	6.31 hours ag
Leiden Classical	Alpha		13,271,586	59,280	2,468	340	7,135	82	5.22 hours ag
Proteins@home	Beta		9,577,010	208,233	3,414	316	6,068	81	6.57 hours ag
Rectilinear Crossing Number	Beta		9,257,174	78,851	3,517	388	7,860	89	5.15 hours ag



914 K users

222 M hours

Complementary to the GRID

- Large CPU power: 20,000 CPU and growing
- BUT
  - Low reliability: redundant computations
  - Not for time critical application

Feynman

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DenisPerretGallix
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Edit Attach Printable PDF/Latex PDF (testing)

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Scientific Goals of Feynman@Home

⚠ in preparation

For the **LHC** as well as for the linear collider program, the computation of higher precision and high multiplicity processes has become a must.

For QCD, next-to-leading order computations mitigate scale uncertainties, provide a first estimate of the observable normalization and include additional sub-processes that may change observable distribution shapes. Resummation techniques can be checked and improved.

But most importantly many QCD processes contribute to the background to Higgs or "new" physics searches; If the background is large, it has to be known precisely (st least better than signal/background ratio), otherwise extracting the signal will become intractable. Such a precision can only be obtained by incl NLO calculations.

An experimenter's wish list has been presented a few years ago, in the frameworks of the Tevatron Run II, it still apply to the LHC energy. One can see that multiplicity is quite high, from 6 to 8 still keeping the boson undecayed. Performing these calculations at tree level is already a substantial effort, at NLO it is challenge.

An experimenter's wishlist

Run II Monte Carlo Workshop

Single Boson	Diboson	Triboson	Heavy Flavour
$W+ \leq 5j$	$WW+ \leq 5j$	$WWW+ \leq 3j$	$t\bar{t}- \leq 3j$
$W \mid b\bar{b} \leq 3j$	$W \mid b\bar{b} \mid \leq 3j$	$WWW \quad b\bar{b} \mid \leq 3j$	$tt \mid \gamma \mid \leq 2j$
$W \mid c\bar{c} \leq 3j$	$W \mid c\bar{c} \mid \leq 3j$	$WWW \quad \gamma\gamma \mid \leq 3j$	$tt \mid W \quad \leq 2j$
$Z \mid \leq 5j$	$ZZ \mid \leq 5j$	$Z\gamma\gamma \quad \leq 3j$	$tt \mid Z \mid \leq 2j$
$Z + bb+ < 3j$	$Z + bb+ < 3j$	$ZZZ+ < 3j$	$t\bar{t} + H- < 2j$
$Z + c\bar{c}+ \leq 3j$	$ZZ + c\bar{c}+ \leq 3j$	$WZZ- \leq 3j$	$t\bar{b} \leq 2j$
$\gamma+ < 5j$	$\gamma\gamma+ < 5j$	$ZZZ+ < 3j$	$b\bar{b}+ < 3j$
$\gamma + b\bar{b} \leq 3j$	$\gamma\gamma + b\bar{b} \leq 3j$		
$\gamma + c\bar{c} \leq 3j$	$\gamma\gamma + c\bar{c} \leq 3j$		
	$WZ- \leq 5j$		
	$WZ + b\bar{b} \leq 3j$		
	$WZ + c\bar{c} \leq 3j$		

Feynman@Home

Exploratory stage

- Target and goal
  - Public or/and Organization (KEK, IHEP, … Companies…) deployment
  - Cross-section first then event generation
- Two applications:
  - Small executables i.e.: 2->2,3,4 (100-1000 diag.) 100-500 Mb
    - One set of processes/ many different parameters
      i.e. multi dimensional parameter phase space exploration (MSSM)
  - Huge executables i.e.: 2->5…8, 1-loop (5,000-100,000 diag.) 10-50 Gb
    - split the binaries into 100 small subsets each of 100-500 Mb.
    - Each subset run in // on client PC
    - The server run the integration algorithm
    - At each iteration generate a new set of phase space points
- Hybrid system: BOINC + cluster/GRID
  - Load balancing private cluster or the GRID

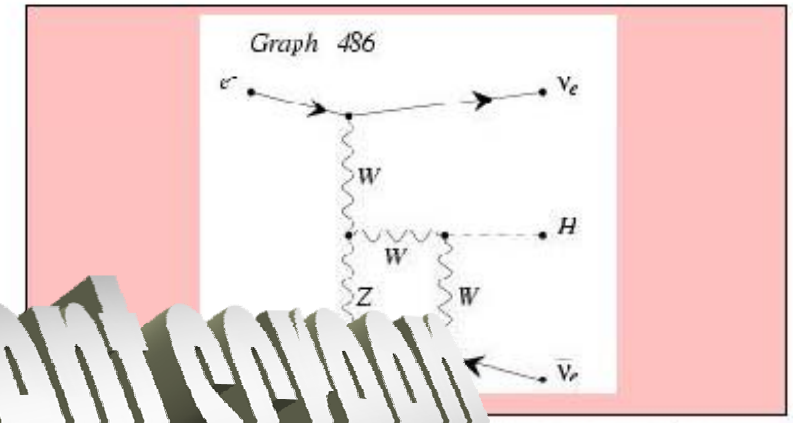
Feynman@Home

- International Collaboration
  - France, KEK, CERN, …
- Feynman@home server operational in KEK,
  - KEK intranet, no HEP application running yet
- Important Outreach for promoting LC and particle physics

Particle Physics and the Origin of the Universe

Running experiment LIVE event display
BELLE in KEK Japan

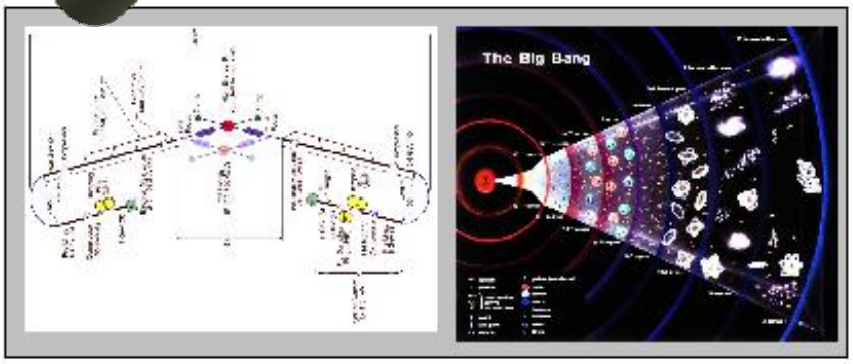
This computer is calculating this process

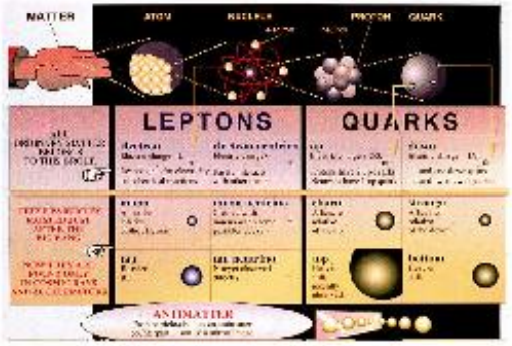


On each client screen

er are running
eriment)

Linear Collider project (ILC)





High precision Arithmetics

- BDP (Beyond Double Precision)
- Quadruple/octuple precision is needed.
  - Correct results.
  - Faster algorithms.

- But software implementations are too slow.

New hardware/software development needed.

Simple Example

by J. Fujimoto (KEK)

$$f = 333.75\, b^6 + a^2(11a^2b^2 - b^6 - 121b^4 - 2) + 5.5b^8 + a/2b$$

where a=77617.0, b=33096.0. (C. Hu, S. Xu and X. Yang)

Double Precision

f = 1.17260394005317863

Quadruple precision result

f = 1.172603940053178631858349045201801

Analytical result = - 54767/66192

f = - 0.827396059946821368141165095479813 70

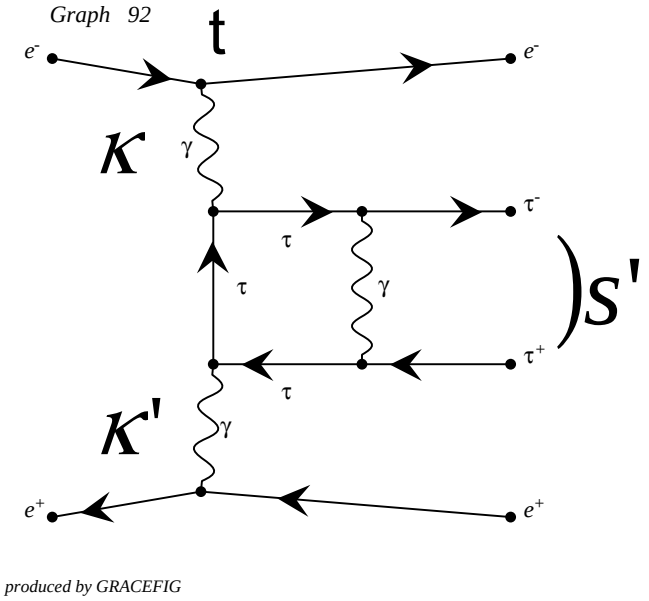
New Octuple precision library, H3Lib:

f = - 0.827396059946821368141165095479816

lost bits = 121

Actual application
By J. Fujimoto KEK

$$e^+e^- \to e^+e^-\tau^+\tau^-$$



Quadruple precision is required in some phase space points due to the Gram determinant ≈ 0

μ : **mass of** τ

λ : **mass of photon**

$\frac{0}{0}$ happens in the reduction algorithm.

Double precision

ReJ[1] = -1.49368718239238
ReJ[x] = - 6.86111482424926E-0002
ReJ[y] = - 6.86785270067264E-0002
ReJ[w] = - 1.39799775179174
ReJ[w2] = - 1.36472026946296**
ReJ[w*x] = - 2.708863236843683E-0002
ReJ[x*y] = - 3.048903558925384E-0002
…
ReJ[w3] = 93763.26727997246**
…

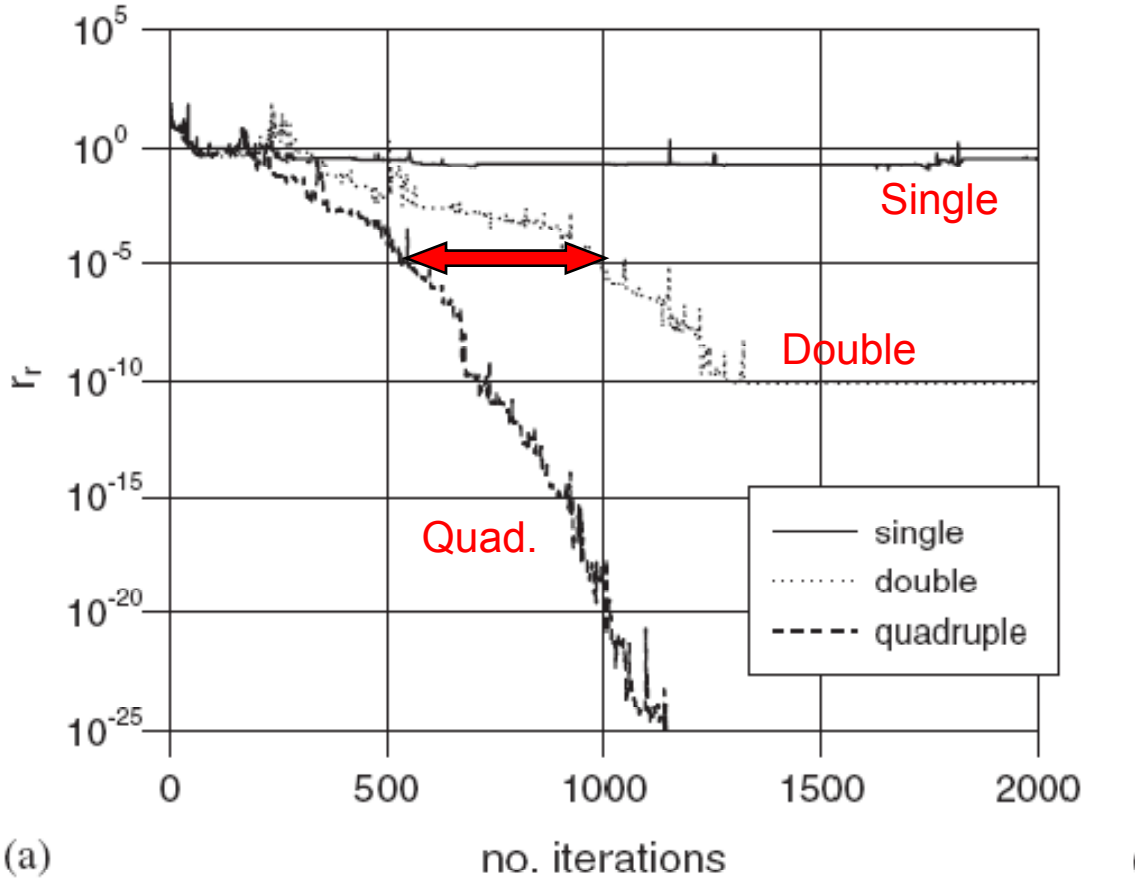
$$\mu = 1.6, \lambda = 10^{-20},$$
$$s' = 11.08527740873578,$$
$$t = -1.4631122650935 9,$$
$$\kappa = -2.007662965116379 \times 10^{-11}$$
$$\kappa' = -3.041076446800326 \times 10^{-2}$$

Blow up !!

Quadruple precision

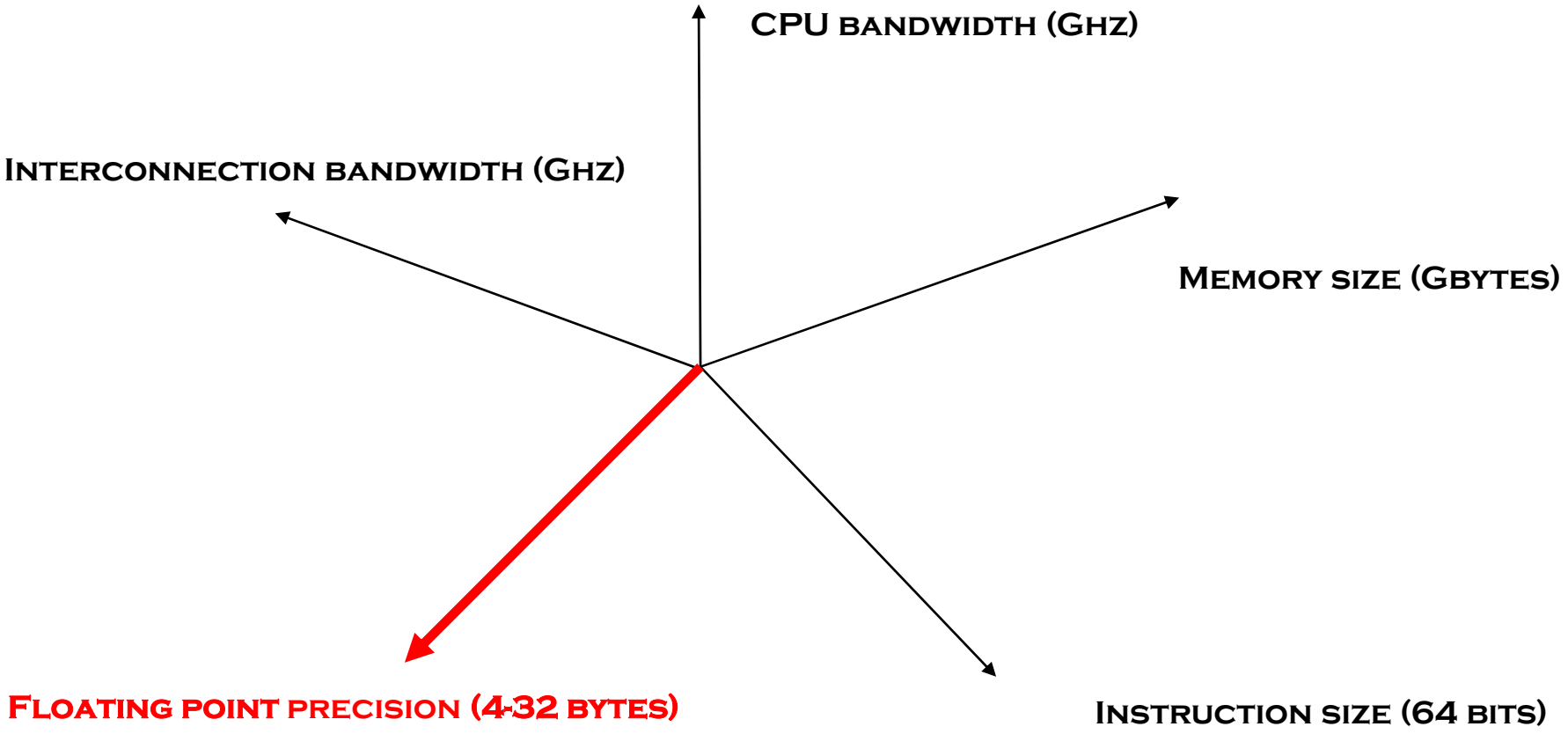
ReJ[1] = - 1.4936871823877751206230753988 2045
ReJ[x] = - 6.8611147088773892065533927899583 82E-0002
ReJ[y] = - 6.8678525856005751991716616427798 42E-0002
ReJ[w] = - 1.3979977549653604246428967415415 0
ReJ[w2] = - 1.3474634674219073562764119111912 8**
ReJ[w*x] = - 3.3347441188683933822808357197516 54E-0002
ReJ[x*y] = - 2.8223778264113378747899478237771 59E-0002
…
ReJ[w3] = - 1.6038937848214298648045488349187 8**
…

Minimization algorithms, …



Gambolatin et al.

A "new" dimension in system performance



Software approaches

- High precision libraries quadruple/octuple (Hitatchi)
- Double-double, quad-double (Arprec)
- Multi-precision lib. (1000 digits and more)
- Interval arithmetic
- Exact arithmetic (XR, iRRAM)

- Linpack double/quad: 30 times slower

Hardware development

- based on CELL processor (IBM,Sony,Toshiba) complex programing
- Investigating other possibilities

High precision Arithmetic Parallel Processor Yoke

HAPPY

Pulling heavy computations !!!

Grace Simulation Summary

- Grace *is producing tools for tree and one-loop SM and MSSM x-section calculations and event generation. (i.e. hep/ph 0701200)*
- 3 Projects *to overcome the computational and management difficulties of complex process calculations*
  - GraceFUL *Grace User Interface*
  - Feynman@Home *World-wide Public distributed computing for Feynman diag. calculations*
  - HAPPY *High Arithmetic Precision: beyond double-precision.*
- New collaborators welcome
- Perfect topics for international cooperations