Status of CompHEP

CompHEP Collaboration
Moscow State University

Introduction to CompHEP
Symbolical Part
Numerical Part
Interface to Pythia

CompHEP Applications for BSM Analysis (From Theory to Event Samples)

- MSSM
- MSUGRA
- Universal ED
- W-prime (D0 analysis is in progress)
- Gamma-prime
- Two Doublet Higgs Model
- FCNC (D0 analysis is in progress)
- Anomalous Wtb (D0 analysis is in progress)
- Leptoquarks

CompHEP Package

CompHEP is a package for evaluation of Feynman diagrams, integration over multi-particle phase space and event generation.

Calculations in HEP from Lagrangian to event flow for the different theoretical models

Decays 1->2,..., 1->5

Scattering 2->2,..., 2->6

CompHEP Collaboration:

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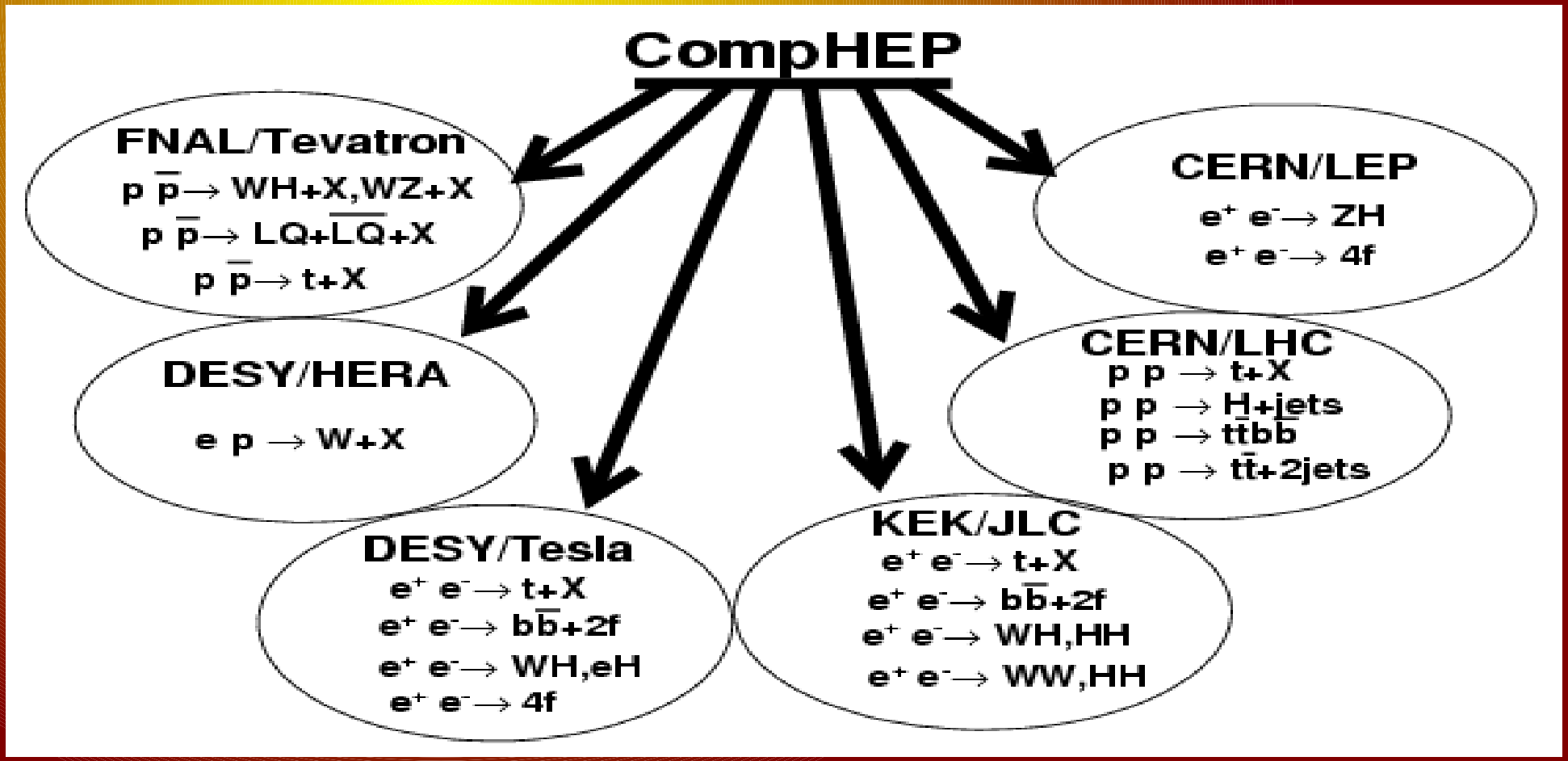
More Information:

hep-ph/0403113; hep-ph/0101232

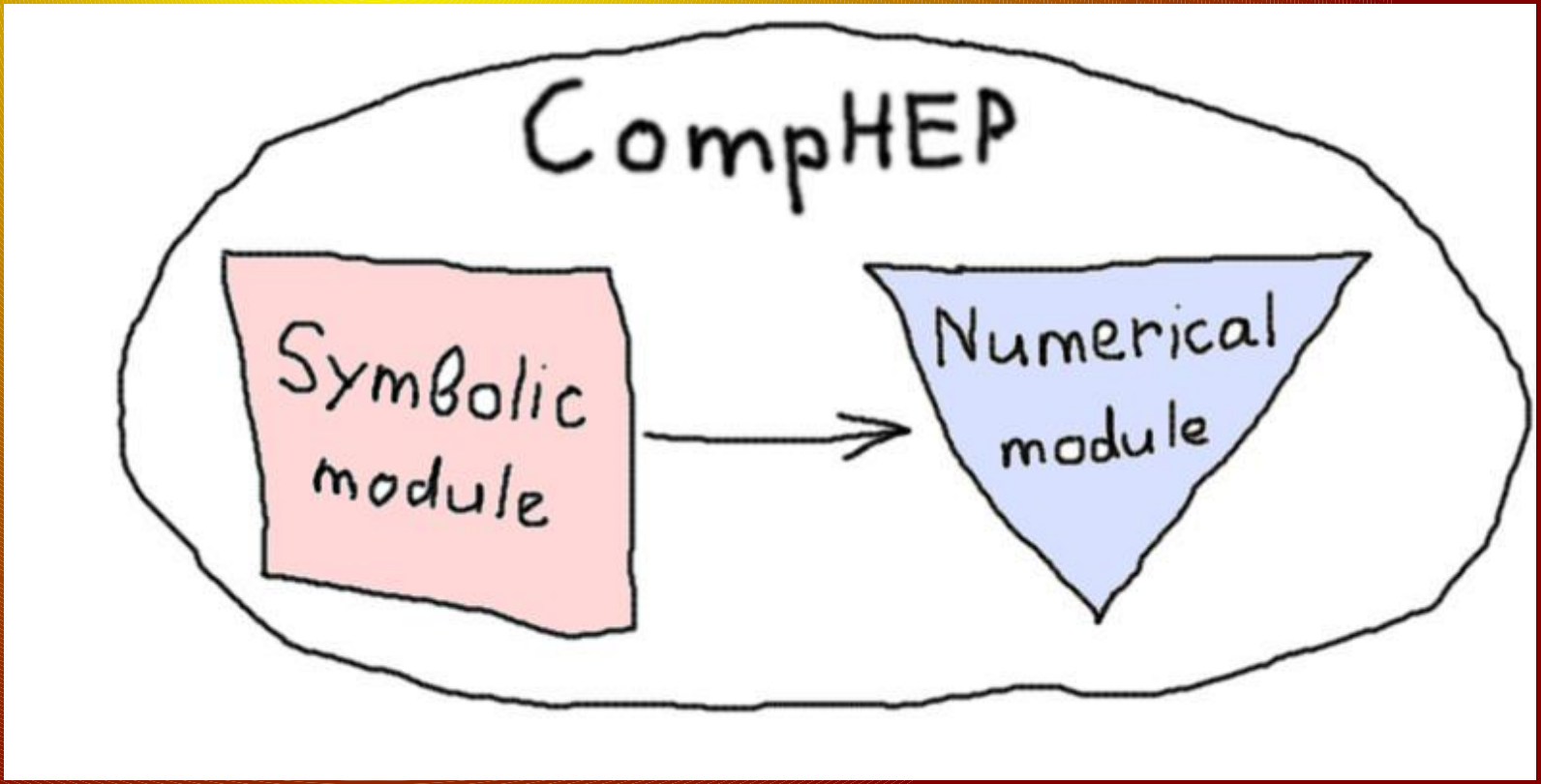
Nucl.Instrum.Meth. A534 (2004) 250-259

http://theory.sinp.msu.ru/comphep

Examples of Calculations with CompHEP



Structure of CompHEP

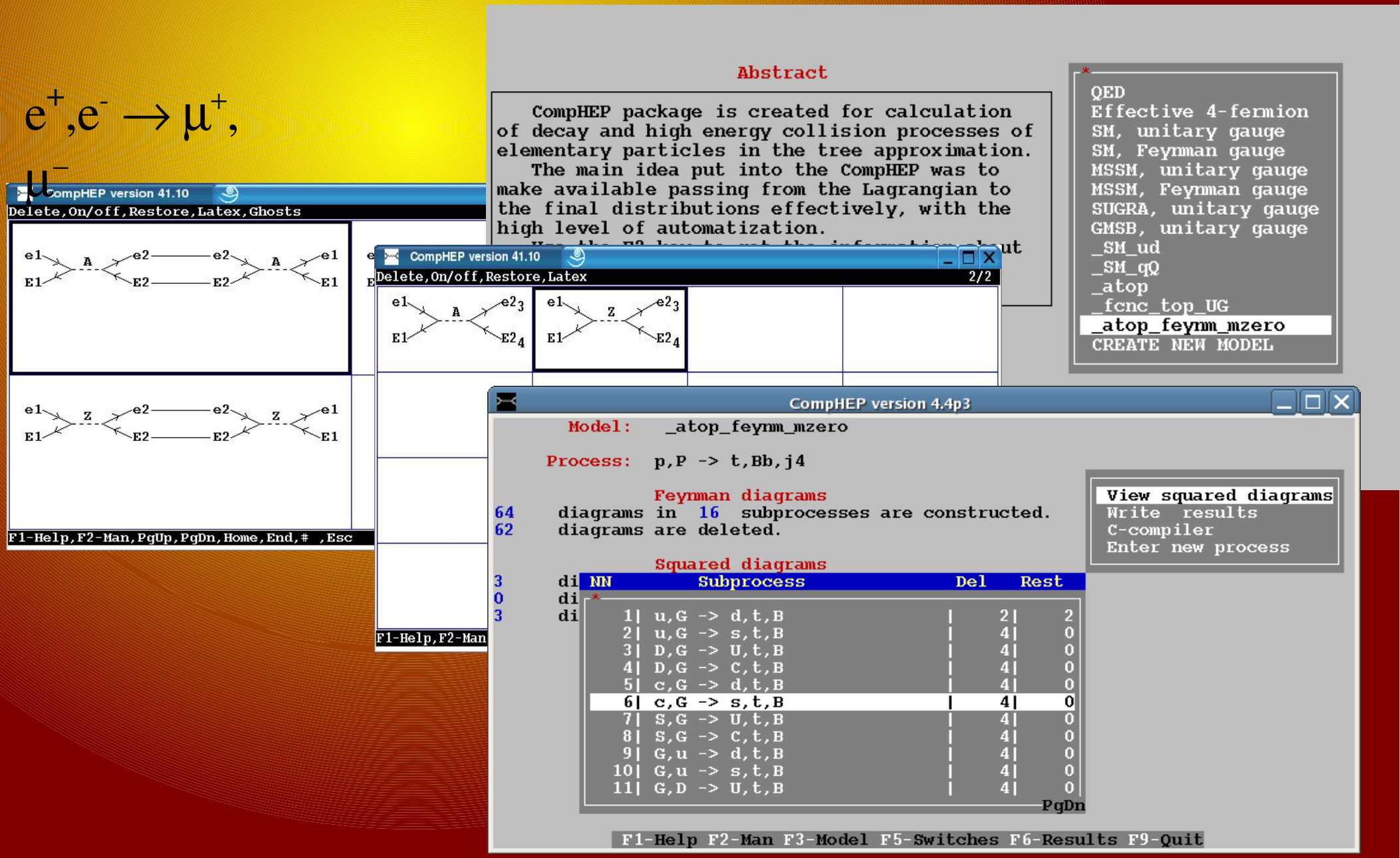


Symbolic Calculations

- Select theoretical model and process
- Generate Feynman diagrams (FD), display, etc.
- Exclude some diagrams (if necessary)
- Generate, display, exclude squared FD
- Calculate analytical expression of FD
- Save symbolic results in Mathematica, Reduce, FORM and C code
- Launch built-in numerical calculations

Example of Symbolic Part GUI

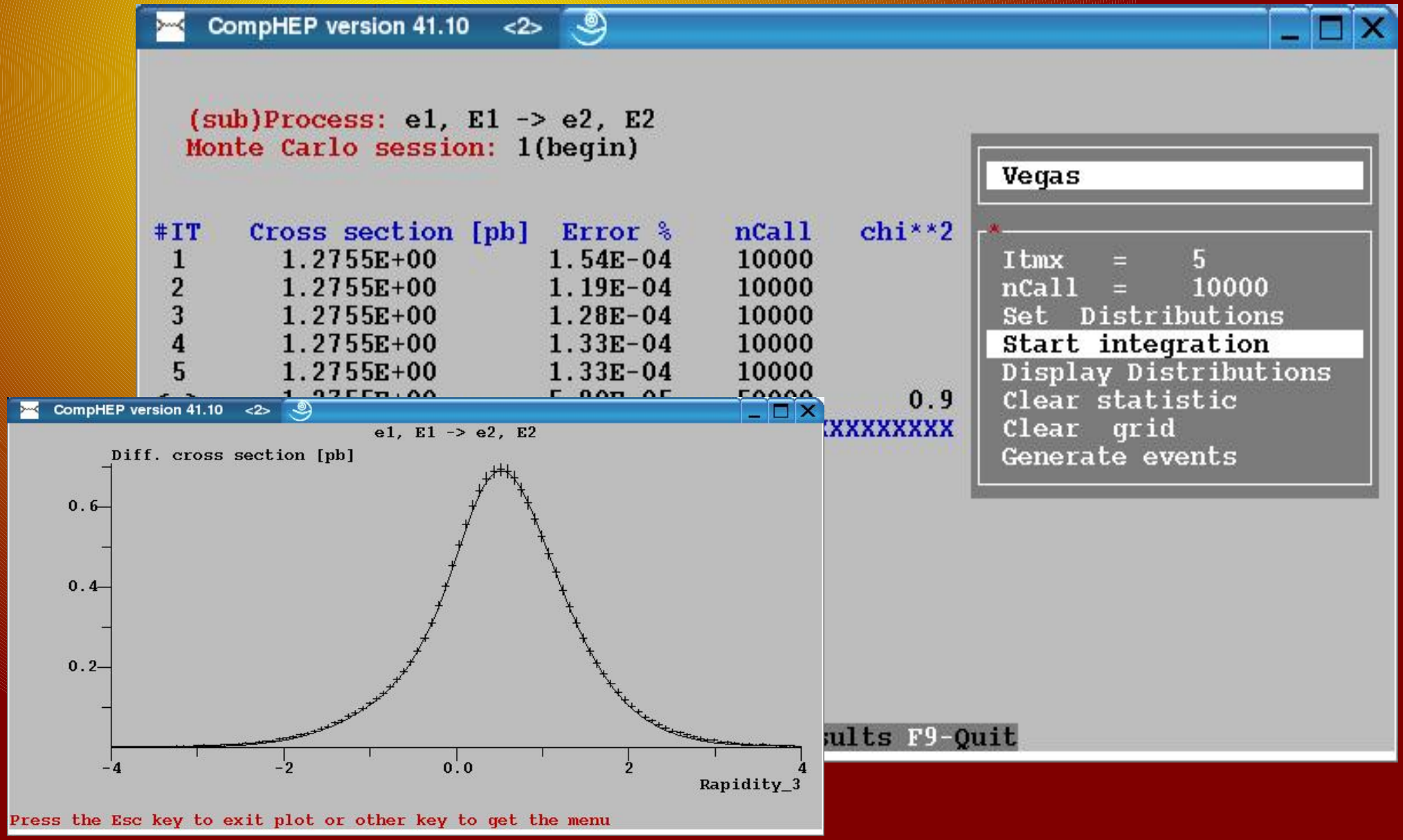
$e^+, e^- \rightarrow \mu^+, \mu^-$



Numerical Calculations

- Convolute FD with PDF, beam spectra, laser photons, Beamstrahlung spectra of electrons, etc.
- Modify physical parameters (masses, scale, ...)
- Introduce kinematic cuts and kinematic scheme
- Introduce a phase space mapping
- Perform a Monte-Carlo phase space integration
- Generate parton level events
- Display distributions of kinematic variables

Example of Numerical Part GUI



Batch Mode of CompHEP

Symbolic and Numeric calculations by perl scripts.

Useful in case of:

- Large scale calculations
- Calculations of many subprocesses
- Calculations on MC farms

Future Plans

- We plan to implement new algorithms to increase efficiency of symbolic calculations
- Perform calculations in theories with extra dimensions
- Introduce new complicated structures in the vertices (e.g. Form-factors)
- Use the dimensional regularization
- Perform polarized calculations by introducing the corresponding density matrices for external lines of squared diagrams.
- Include calculations with extension to 1-loop case
- Incorporate the gauge invariant classes of diagrams, etc.

CPYTH Package

- Interface of CompHEP parton level events to PYTHIA for further processing to the next levels of simulation (Shower, Hadronisation, FSR, ISR)
- Part of the CompHEP software, provides additional and necessary functionality

CPYTH Features

- Automatically read CompHEP events in PYTHIA as an external hard process
- Based on the Les Houches accord
- Pass necessary information about event (color chains, scale, ...)
- Mix different processes
- Randomize azimuthal angle

Structure of the CPYTH toolkit

Visualization (Root)

ME
(CompHEP)

Partonic events database

SH
(PYTHIA)

Data manipulation

(mixing, updating, cuts and etc.)

Running CompHEP in D0 RUN II Software

- Event generation with Standalone version of CompHEP
- Read the events with CPYTH, which is implemented in D0 Software (MCPythia.x)
- mc_runjob interface. Package called comphep (implemented by S.Desai, S.Brook and G.Brooijamans)

Required Setup Commands

- setup D0RunII p17.06.02
- newrel -t p17.06.02 new-release-area
- cd new-release-area
- d0setwa
- addpkg comphep
- addpkg mcpp_gen
- addpkg d0_mcpp_gen
- patch -p1 < patch //(to the new version of CPYTH)
- gmake all

Running CompHEP with mc_runjob

You must prepare a macro which is mostly the same as a macro for running Pythia but you need to add the following directives:

* cfg pythia define string UseComphep on

* cfg pythia define string CHProcessName <my process>

* cfg pythia define string CHInputFile full/path/to/event/file

Run Generation

- setup -d mc_runjob
- mc_runjob -macro=my_macro.py

New Patch:

- http://www-d0.fnal.gov/~dudko/cpyth_patch/

comphep_only_p17.06.02.patch (patch only CPYTH)

- http://www-d0.fnal.gov/~dudko/cpyth_patch/

comphep_p17.06.02.patch (add HBOOK ntuples filling)