The Scope of this Workshop

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Forum Focused on the WHIZARD Monte-Carlo Code

Monte-Carlo simulations of particle collisions are involved in nearly any study or analysis in HEP.

The interesting physical effects are complicated – analytical calculations rarely sufficient or feasible

- theory predictions

and, likewise, for

- data interpretation

MC tools are most successful and worth the effort if they are universally applicable:

- large set of processes
- all relevant effects
- interfaced to common representation of data
- convenient to use

$\Rightarrow$ Scope of WHIZARD

The Scope of WHIZARD

WHIZARD started as a theory tool: numerical evaluation of typical electroweak processes (1999)

but has become useful + could be further developed to cover a wide range of phenomena: ILC and LHC, others

Applications and development reflected in growing community of users and developers

$\Rightarrow$ WHIZARD forum

First WHIZARD forum: DESY 2013

Second WHIZARD forum: Würzburg 2015

WHIZARD is not specifically funded as a project. This workshop was made possible by you (the participants) and:

- Helmholtz alliance “Physics at the Terascale”
- SFB 676 “Particles, Strings, and the Early Universe”
- University of Würzburg

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- Balthasar Neumann

The Purpose of this Workshop

Going beyond regular exchange (e-mail, personal, conferences) between and within user and development teams:

International WHIZARD Forum

- Forum for common topics, gather experience and criticism
- Identify areas where WHIZARD is successful, to further focus and improve the software and its applications
- Identify important issues where the program is insufficient but can be enhanced
- Identify new topics that could also be covered by WHIZARD
- Discuss and set priorities for developers and users
- Get involved!

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WHIZARD is intended for a variety of collider-physics applications.

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- calculations complicated, no fool-proof algorithms
- independent algorithms, independent implementations
- different models and approximations
- user support and flexibility

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Conversely: WHIZARD as a framework/environment for dedicated codes and tools

WHIZARD: Core Layer

- Amplitudes (OMega): fast tree amplitudes for arbitrary $1 \to n$ and $2 \to n$ processes, arbitrary perturbative models
- WHIZARD core: multi-channel phase space parameterization and evaluation
- VAMP multichannel MC integration (VEGAS) over the unit hypercube (including event unweighting)

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With WHIZARD 2.2, the modules are represented as abstract entities and can be exchanged with alternative implementations.

WHIZARD: Mantle Layer

- Model definitions and interface to FeynRules or SARAH for BSM models
- Process definition, evaluation, steering, mixing
- Dedicated code for specific processes (tt and electroweak)
- Interfaces and built-in code for initial state structure: lepton and hadron colliders
- Interfaces and built-in code for final state structure: decays, shower, hadronization
- Event output formats

WHIZARD: Shell Layer

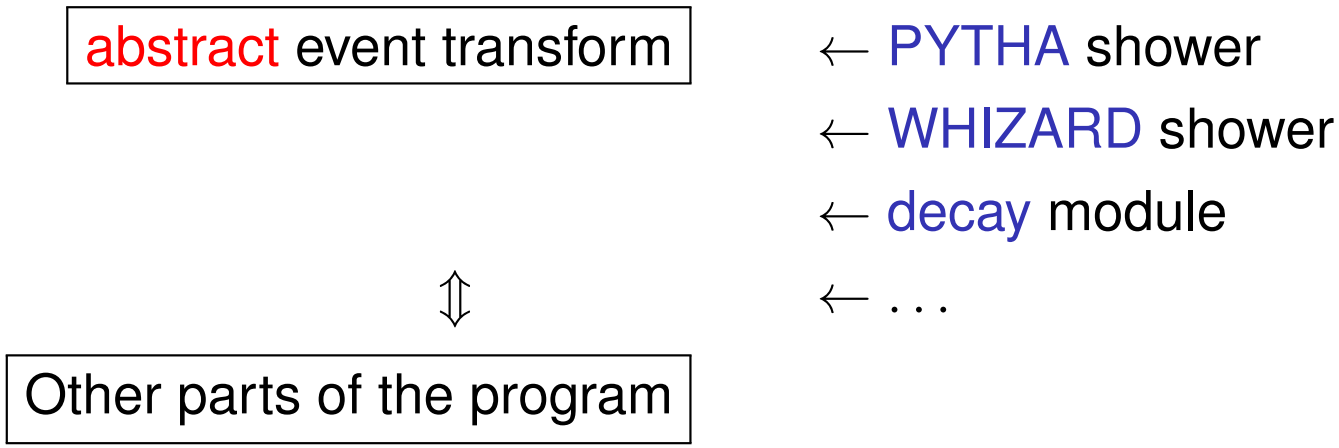
- Sindarin as a language for expressions (cuts, weights), simple analysis (plots, histograms) and steering (parameters, definitions, scans, I/O)
- Stand-alone program with options
- Library interface, callable from Fortran, C, C++, Python, ...

New & Current Developments

- GoSam interface for NLO and independent implementation of PowHEG algorithm (shower/NLO matching)
- Interface to NLO and NRQCD higher-order code for the $t\bar{t}$ threshold
- Unitary, generic simplified models for high-energy electroweak interactions (if they are not SM)
- Alternative, fast ME code: Omega Virtual Machine

WHIZARD: software design

Flexible program structure: object-oriented design patterns (parton shower, beam structure, event transform, event I/O, integrator, phase space, ...)



Realization straightforward in Fortran, but requires 2003 standard.

⇒ WHIZARD code structure (2.1+)

Project Issues

Universal MC generators are becoming full-scale software projects
(> 100k LOC, > 10 years life cycle, distributed development teams)

For WHIZARD, we had to learn and set up

- ⇒ Portable multi-platform configuration
- ⇒ Revision control and release tags
- ⇒ Automated test suite
- ⇒ Continuous integration
- ⇒ Bug tracker

Revised program design
⇒ facilitate new contributions and collaboration

Topics at this WS

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- Interfacing codes that provide calculations that WHIZARD doesn't support, or alternatives.

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- User Interface

WS Overview

Machines and Experiments

LHC resuming, ILC approaching realization, new multi-TeV projects

- $\Rightarrow$ precision in LHC analyses
- $\Rightarrow$ new, more detailed physics studies
- $\Rightarrow$ MC reference event samples
- $\Rightarrow$ ILC beam description
- $\Rightarrow$ Unitarity and modelling BSM

Beyond the Standard Model

No scenario is preferred.

- $\Rightarrow$ Automatic model evaluation for perturbative (Lagrangian) models
- $\Rightarrow$ Vector-Boson Scattering (within effective theory and beyond)
  $\Rightarrow$ new strong interactions

Beyond Tree Level

Accessing and incorporating NLO for realistic simulation.

- ⇒ Automatic NLO calculation in QCD
- ⇒ NLO QCD with external-code interface for WHIZARD
- ⇒ QCD at threshold and beyond for $t\bar{t}$ production
- ⇒ Status and prospects for NLO electroweak

Final State

Radiation, decays, hadrons

- ⇒ Shower modules and matching
- ⇒ Spin correlations
- ⇒ Hadronization interface

Efficiency

Fast evaluation and event generation

- ⇒ New algorithm for tree-level matrix elements (OVM)
- ⇒ Parallel computing (OpenMP, MPI, . . .)
- ⇒ Further ideas

Looking forward . . .

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. . . to a successful workshop!