HepMCAnalysis Tool.
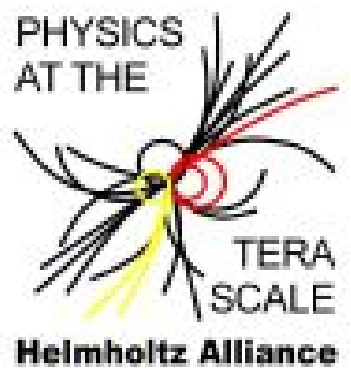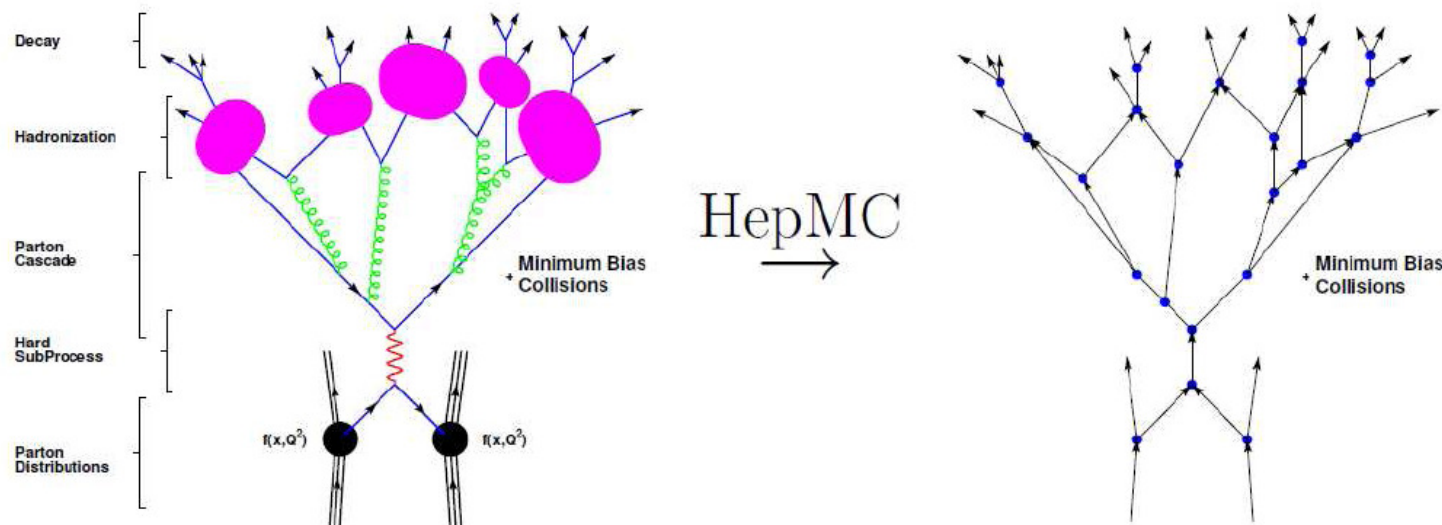
Sebastian Johnert
MC School 2011
Hamburg, 14.03. – 18.03.2011

overview

> introduction

> HepMCAnalysis Tool

- components and structure

- class structure

- user analysis class

> installation

> Genser (GENerator SERvice)

> application and examples

> summary

introduction

> many different generators → many different formats

> one unified format independent of generator: HepMC

> possible to study output of different generators independent from generator format → decision to create HepMCAnalysis Tool

HepMCAnalysis Tool

> framework for MC generator validation and comparison with standard processes

> was originally developed for MC schools and small scale MC related studies

> covers many aspects from event generation: hard process, parton shower, UE, …

> covers many physics processes: pp→ttbar, pp→Z→$\tau\tau$, pp→Dijets, pp→W/Z+Jets, …

> provide examples to run full chain including generator steering for process generation and different tunes (up to analysis)

> provide scripts for web interfaces

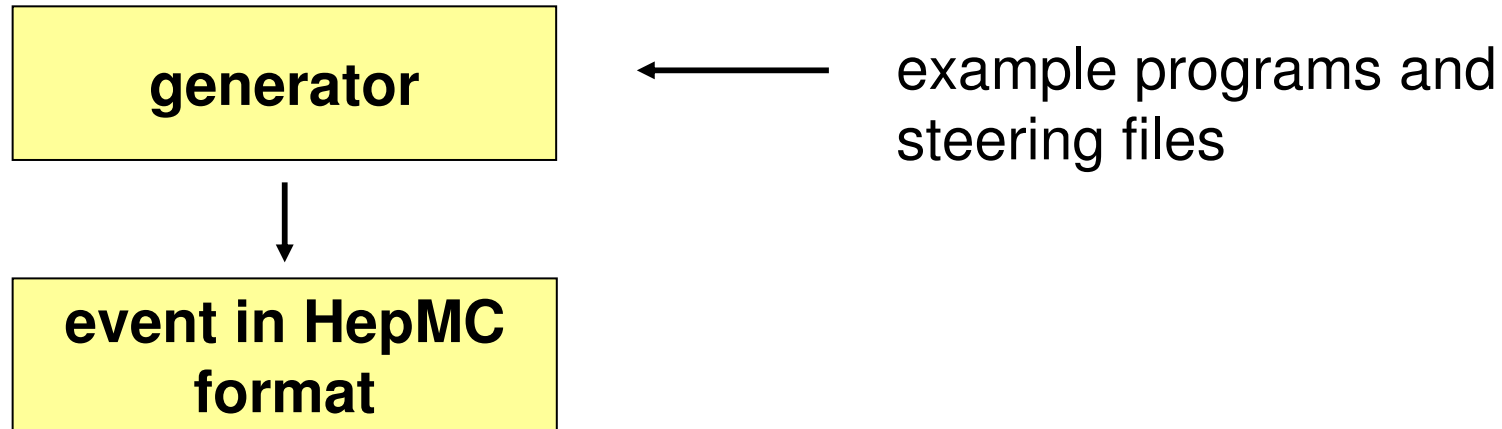> regular releases; latest release 3.4

HepMCAnalysis Tool

> technical goals:

  ▪ robust: small dependence from other software packages, minimal framework

  ▪ easy: easy understandable code (written in C++)

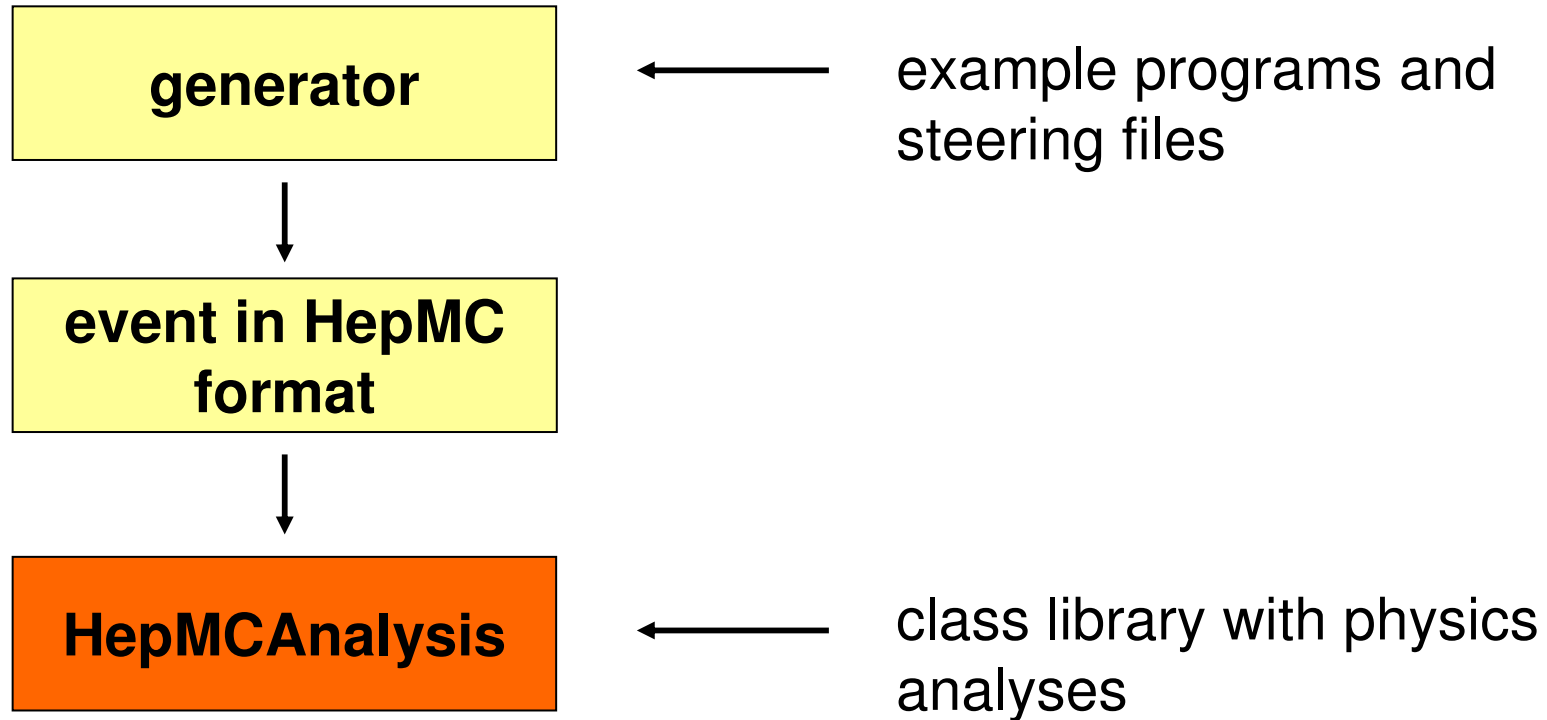 ▪ scalable: easy extensible for private analyses or other applications

> differences to Rivet

  ▪ no comparisons to measurements implemented

  ▪ smaller package than Rivet, less dependencies from other packages → easier to install

  ▪ provide root output

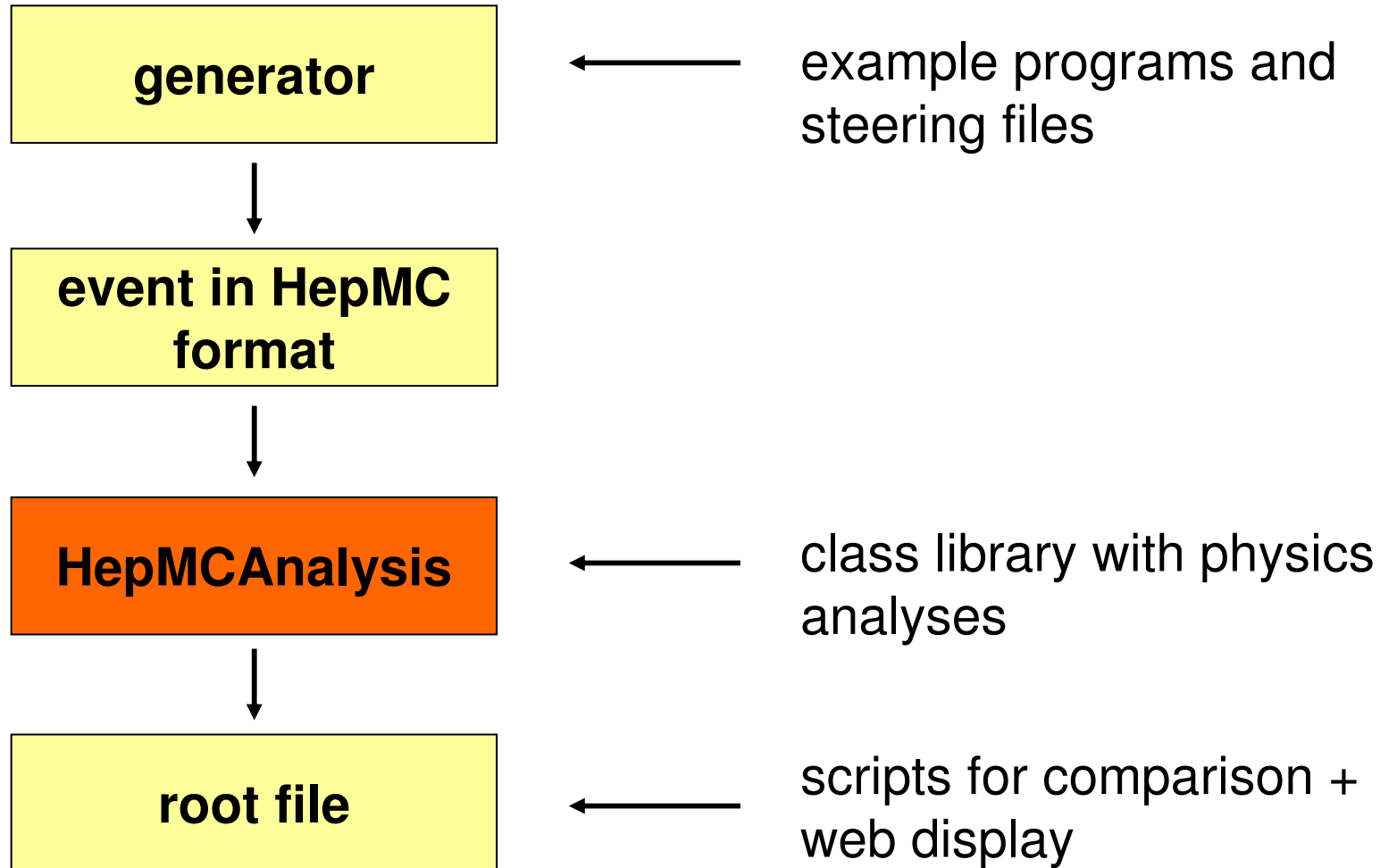 ▪ links to pre-installed generator versions → no compilation of generators code needed
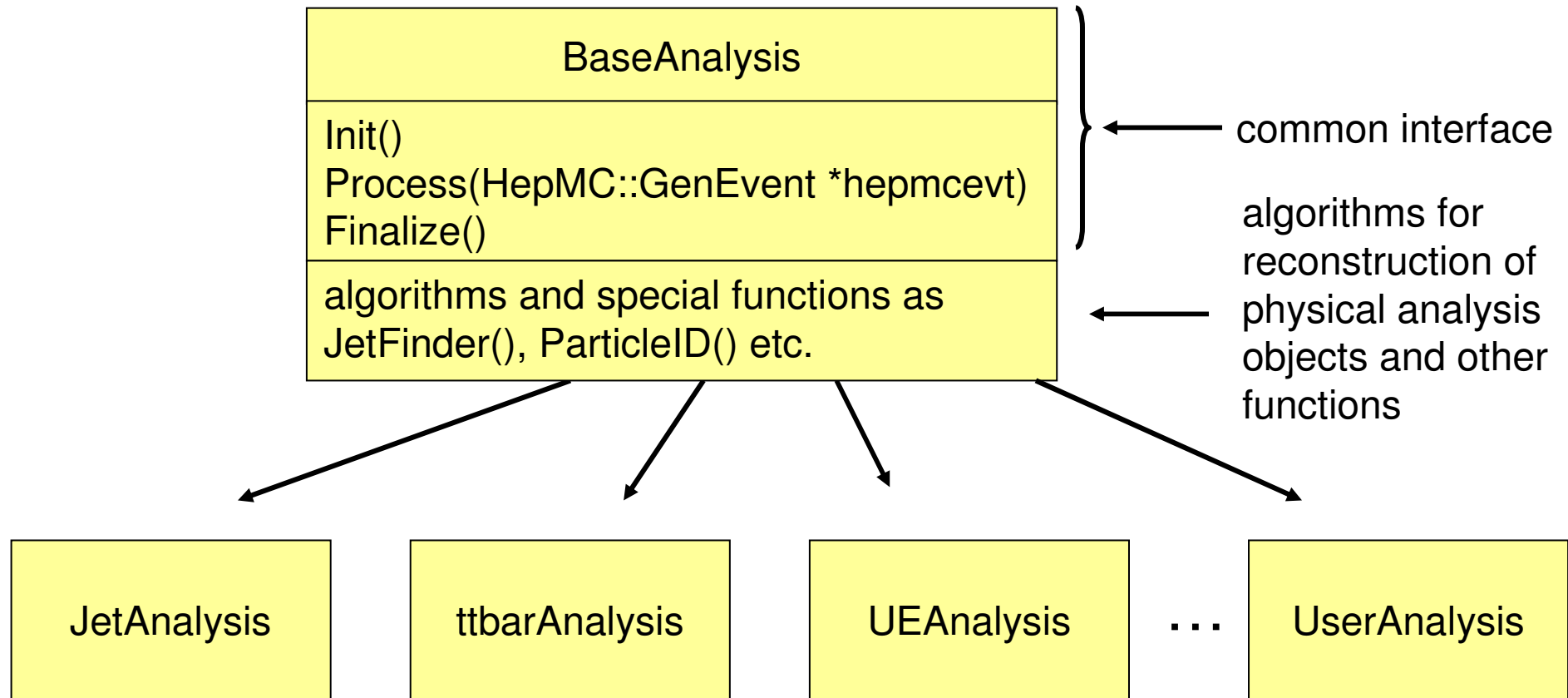
components and structure

generator ← example programs and steering files

generator → event in HepMC format

components and structure

```
┌─────────────────┐
│    generator    │  ◄─────────  example programs and
└─────────────────┘              steering files
         │
         ▼
┌─────────────────┐
│  event in HepMC │
│     format      │
└─────────────────┘
         │
         ▼
┌─────────────────┐
│  HepMCAnalysis  │  ◄─────────  class library with physics
└─────────────────┘              analyses
```

components and structure

```
┌─────────────────────┐
│      generator      │  ◄─────  example programs and
└─────────────────────┘          steering files
           │
           ▼
┌─────────────────────┐
│   event in HepMC    │
│       format        │
└─────────────────────┘
           │
           ▼
┌─────────────────────┐
│    HepMCAnalysis    │  ◄─────  class library with physics
└─────────────────────┘          analyses
           │
           ▼
┌─────────────────────┐
│      root file      │  ◄─────  scripts for comparison +
└─────────────────────┘          web display
```

class structure

BaseAnalysis

Init()
Process(HepMC::GenEvent *hepmcevt)
Finalize()

algorithms and special functions as JetFinder(), ParticleID() etc.

common interface

algorithms for reconstruction of physical analysis objects and other functions

JetAnalysis

ttbarAnalysis

UEAnalysis

...

UserAnalysis

list of available analyses

- jet analysis

- ttbar analysis

- bbbar analysis

- W (plus Jet) analysis

- Z analysis

- $Z\tau\tau$ analysis

- $W\tau\nu$ analysis

- underlying event analysis

- elastic scattering analysis

- missing E_T analysis

- **user analysis**

UserAnalysis

> running own analysis

- add own analysis by modifying UserAnalysis.h and UserAnalysis.cc

- recompile package

> all functions from baseAnalysis allowed to be used

> no need to create own UserAnalysis; example UserAnalysis can be used

> new analysis can always be integrated in the core package by sending us the code

show how to run the tool

HepMCAnalysis tool installation

> available via hepmcanalysistool.desy.de as .tar and .tar.gz file

> library also in LCG/Genser (GENerator SERvice project) on-hand and preinstalled

> runs on all LCG supported platforms

> linking to all generator libraries from Genser

- no local installation of MC generators necessary

- automatic configuration at CERN/DESY environment

- use of local installed MC generators also possible by modifying configuration and setup scripts

Genser project

> Genser = GENerator SERvice project; part of LHC computing grid project (LCG)

> provides at CERN and DESY large number of MC generators as libraries and source code in afs file system

> before MC generators tested adequately

> used by ATLAS, CMS and LHCb for generator software

generators from Genser

link to homepage of MC generator

application

> in Genser for histogram based validation

- generation of O(100k) events per process and generator version

- linking of histogram based validation to validation webpage of Genser

- histograms in root file available

> in Genser for nightly regression tests

> in ATLAS software framework Athena for generator validation

- comparison of Genser results with ATLAS settings

- validation of official datasets

- regression test with Athena interface (also in nightly tests)

> in LHCb software framework (planned)

> in generator studies of private physics analyses

show webpage and webinterface

example: pdf study

> private study: comparison of two pdf sets CTEQ6L1 (LO) and mLOMRST (modLO) with Pythia6 and ATLAS tune

  - control of many different processes and distributions to check general use of modLO pdfs

> idea modLO-pdfs: special developed pdfs for LO MC generators to reach as close as possible to NLO distribution
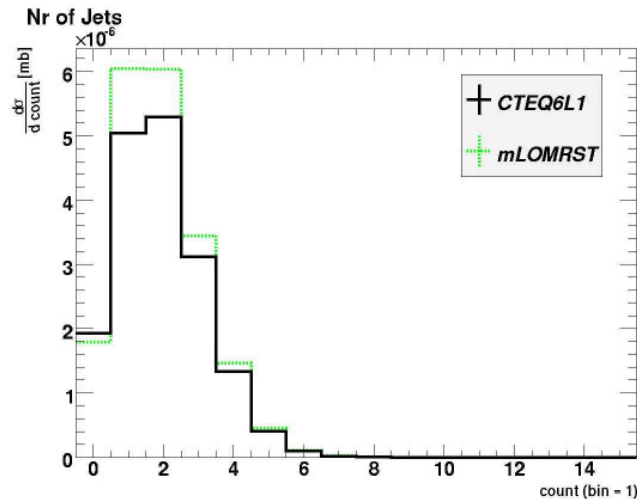
> 100000 events with pp→W→µν with HepMCAnalysis Tool
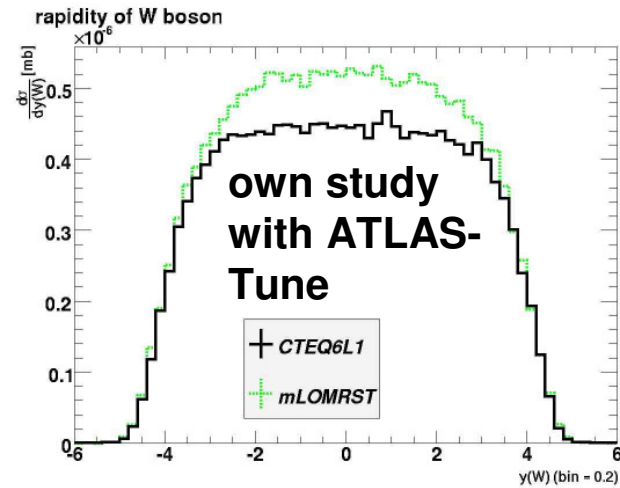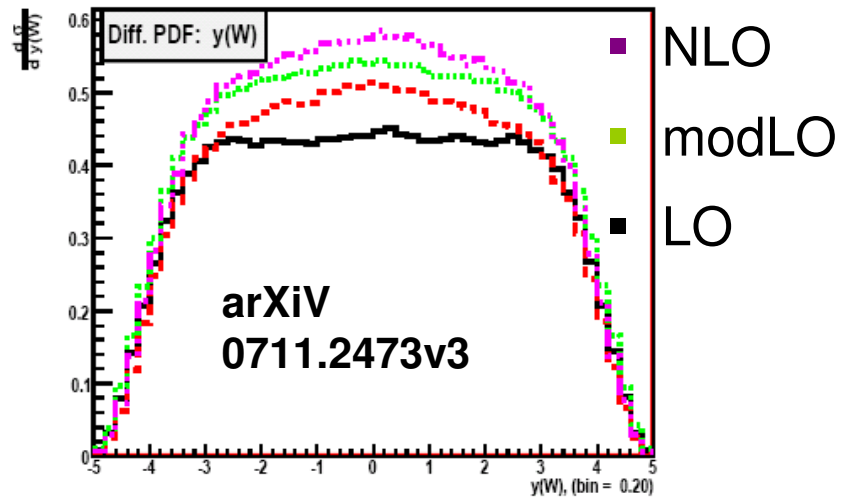
Rapidity of W boson

$\Rightarrow$ verification of rapidity distribution

parton shower

number of jets per event   **transversal momentum of jets**
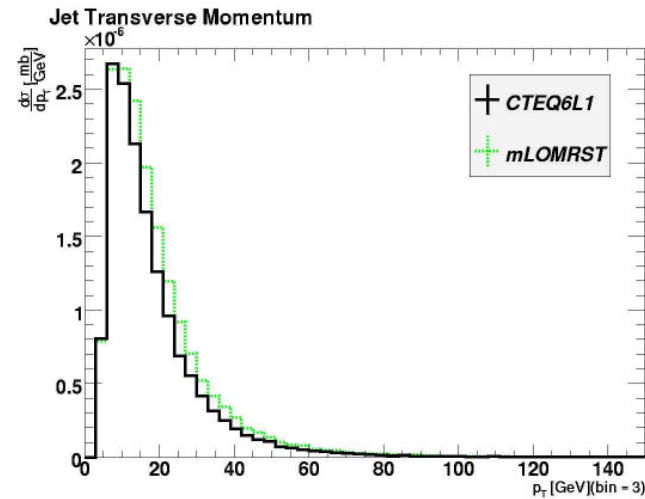
> additional observed (distributions not in arXiV 0711.2473v3): jets from parton shower

> produced by gluon radiation before hard scattering (ISR) and multiparton interaction (MI)

$\Rightarrow$ generation of more jets at higher p_T for modLO generated events

example: characteristics on pp→W→τν_τ decays

> production of W→τν_τ processes with σ x BR = $1.7 \cdot 10^4$ pb (LO) at ECMS = 14 TeV (see "Expected Performance of the ATLAS Experiment – Detector, Trigger, Physics", The ATLAS Collaboration, December 2008)

> for comparison: σ x BR = $10.5 \cdot 10^3$ pb (NNLO) at E_{CMS} = 7 TeV

> dominated by events with low pT W bosons → soft τ leptons with low $E_{T,Miss}$

> right plots: done with HepMCAnalysis Tool, process pp→W→τν_τ (only signal)
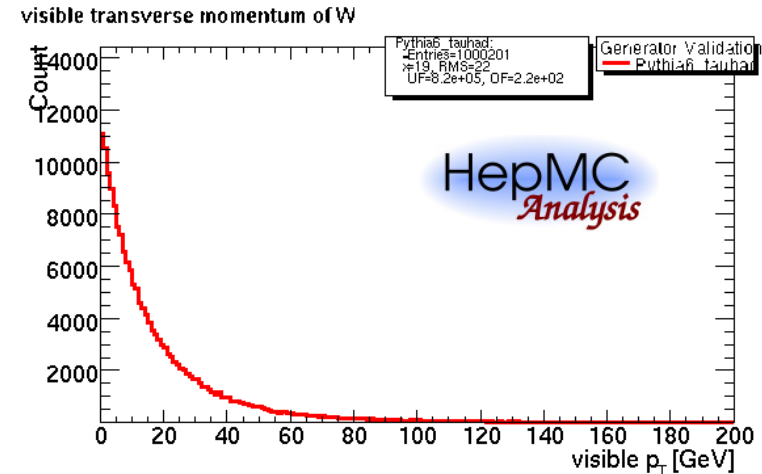
visible p_T of W
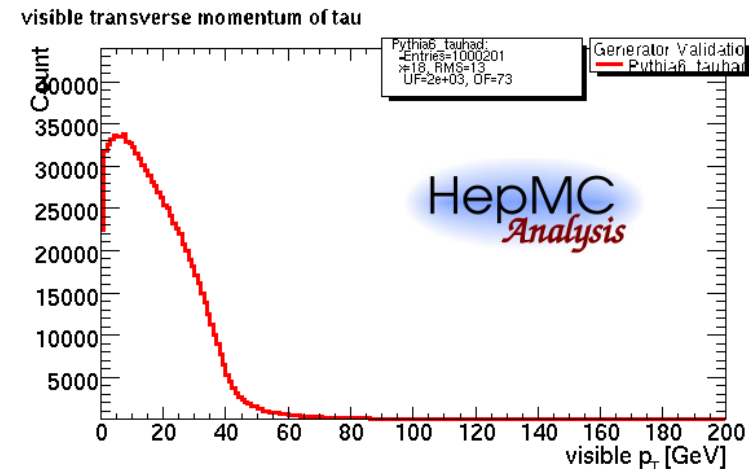
visible p_T of τ

Illustration plots for typical variables of Wτν
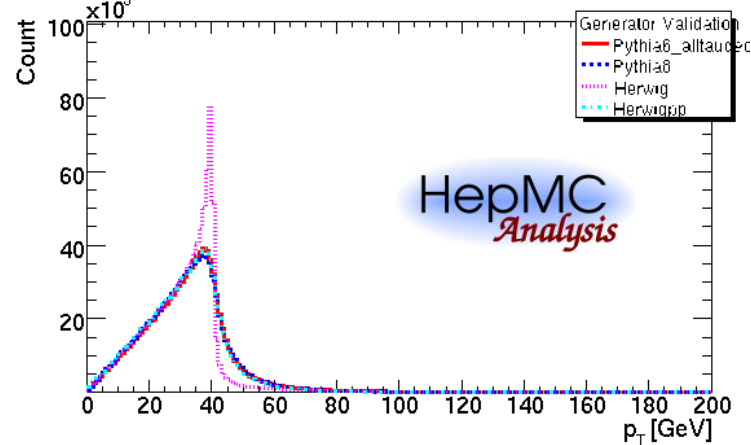
Pythia6 Pythia8

Herwig Herwigpp

p_T of W

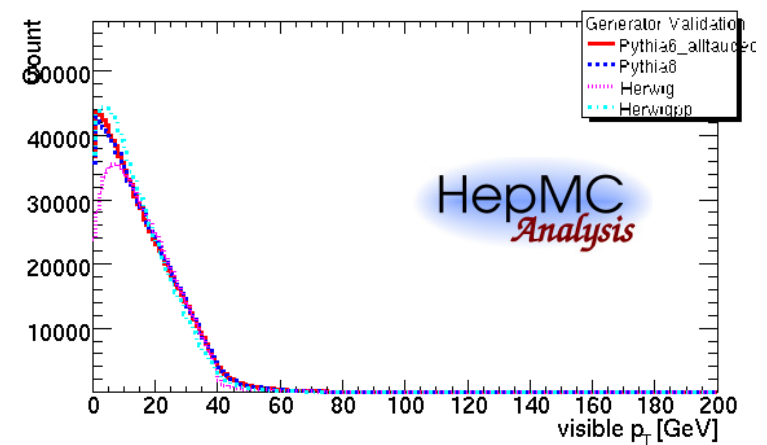**visible p_T of W**

p_T of τ

visible p_T of τ

Illustration plots for typical variables of Wτν

Pythia6 Pythia8
Herwig Herwigpp

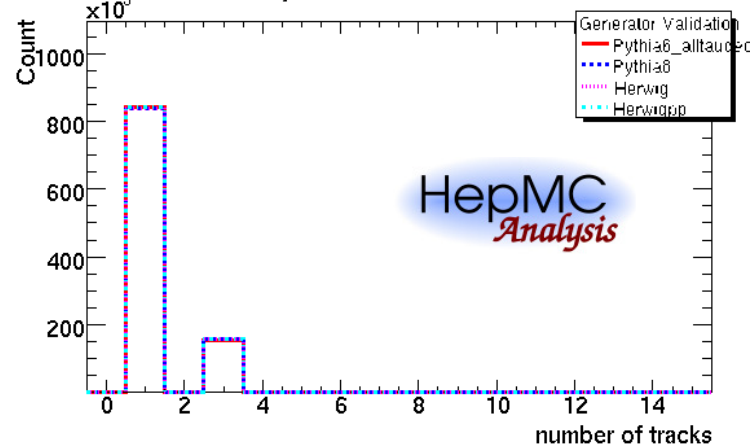η of τ

Φ of τ
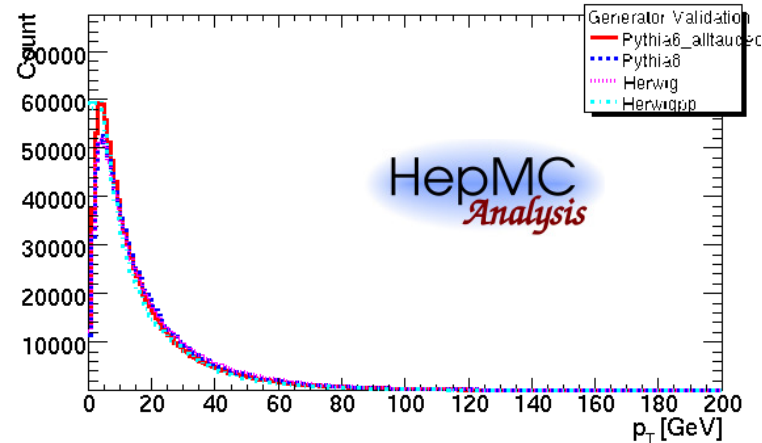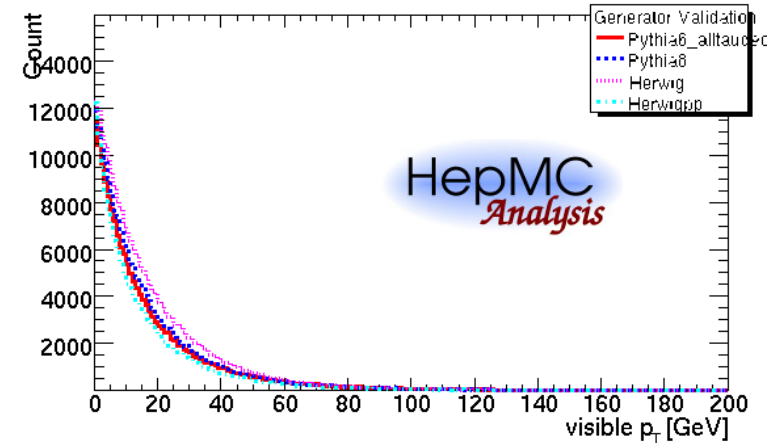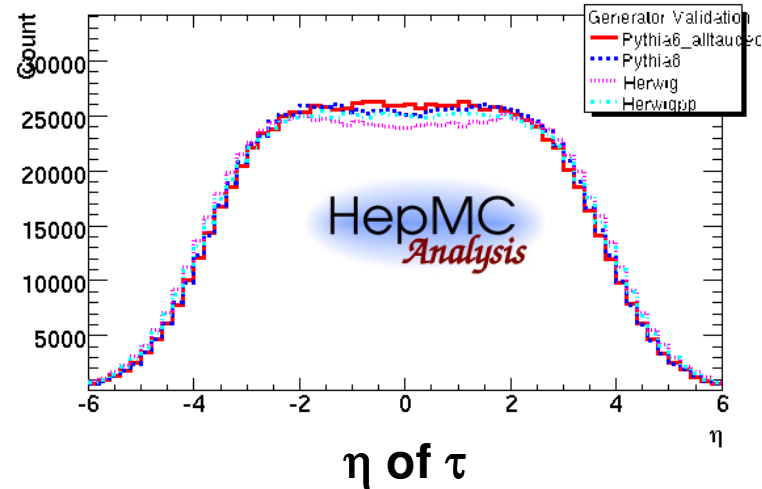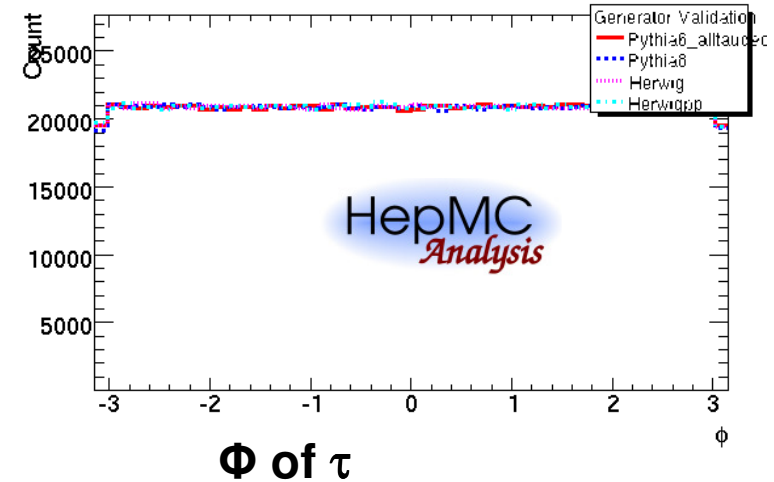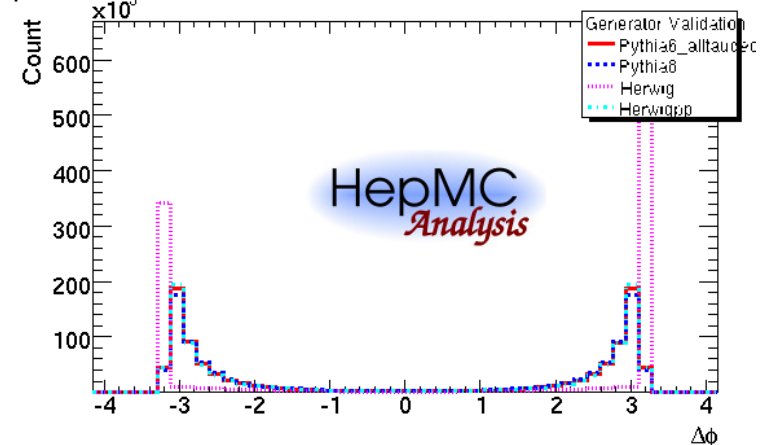
number of tracks of τ decay

ΔΦ between τ and ν_τ

summary

> HepMCAnalysis Tool as framework for generator validation and comparisons in HepMC format presented

> available via hepmcanalysistool.desy.de

> actual version: release 3.4

> widespread use: Genser, ATLAS software framework ATHENA, LHCb (planned), private studies, …

> extension on other analysis classes (minimum bias, SUSY, …) and other generators (Sherpa, …) easy possible $\rightarrow$ send us your code

> tutorial on ATLAS interface of HepMCAnalysis Tool after official MC School

Backup