



Prerequisites for the Validation of Experiment and Theory



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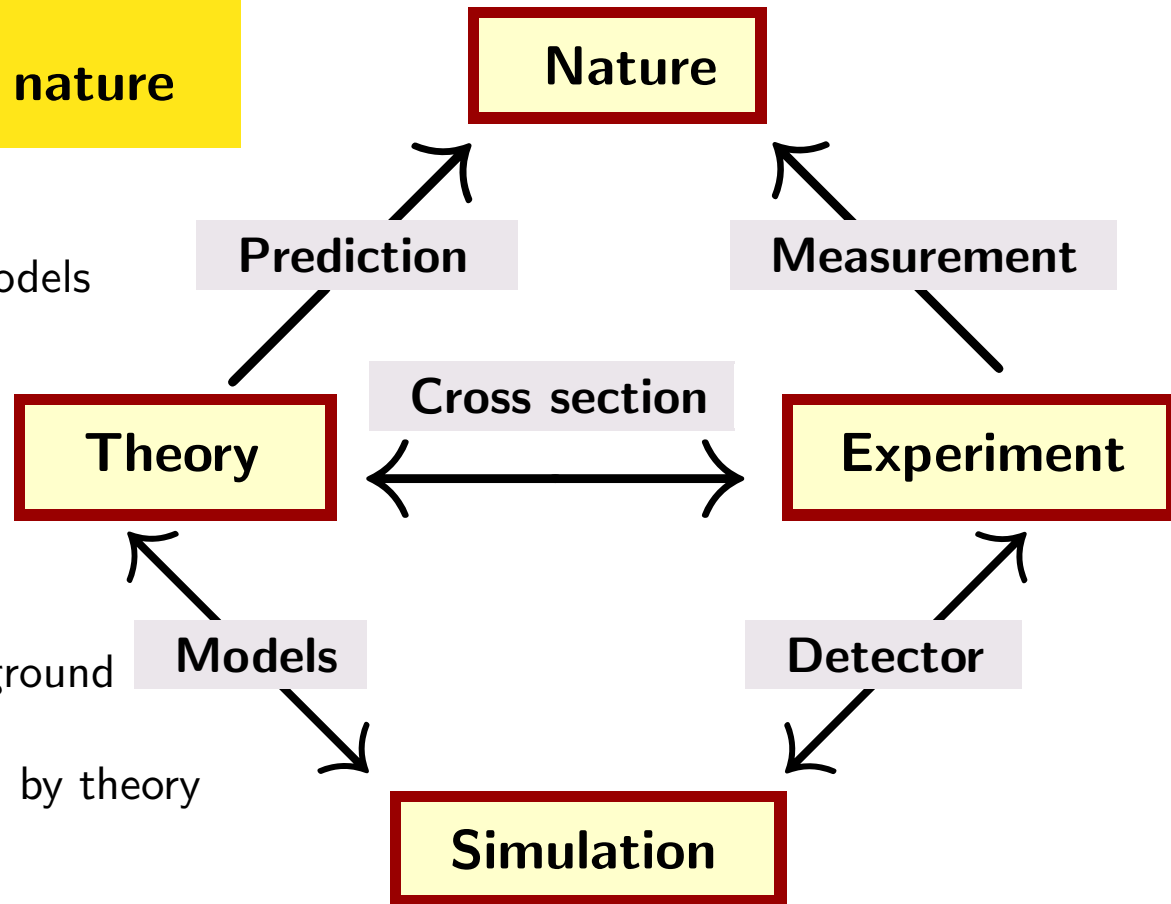
- Introduction
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Introduction

The ultimate goal:
A better understanding of nature



- Theory needs input from experiment
 - Verification/Falsification of concurrent models
 - Description of nature being probed by experiment
- Experiment needs input from theory
 - Predictions for observables
 - Understanding of processes and rates
 - Discriminating instrumental effects/background from (new) physics
 - Improved understanding of nature, guided by theory
- Improving description of nature
 - Recursive interplay between experiment and theory
 - Focussing in this talk on the need for corrected data and the reproducibility of analyses

Understanding (verification/validation/optimization/improvement) of **Monte Carlo** event generation/**Simulation** is crucial!

Recursive interplay between experiment and theory

Sir Arthur Eddington : It is a good rule not to put overmuch confidence in a theory until it has been confirmed by observation. I hope I shall not shock the experimental physicists too much if I add that it is also a good rule not to put overmuch confidence in the observational results that are put forward *until they have been confirmed by theory.*

Need for Validation of
Experiment and Theory



28.12.1882 - 22.11.1944

MC Event Generator Parameters

- Theory makes predictions to very few fixed orders (LO, NLO) plus resummation of radiation
- More or less phenomenological models are needed for comparison with measurements
- **Models** are implemented in MC event generators, they **contain phenomenological parameters**:
- Parton shower termination parameters: $p_{\perp\min}$, m_{\min}
- Hadronisation: Lund string and cluster fragmentation parameters: string function parameters, mass
- Underlying event: Primordial k_{\perp} , Color reconnection parameters
- Parton Distribution Functions (PDF's)
- Models need to be **validated**/adjusted **using real data!**

Real Data: HepData Database

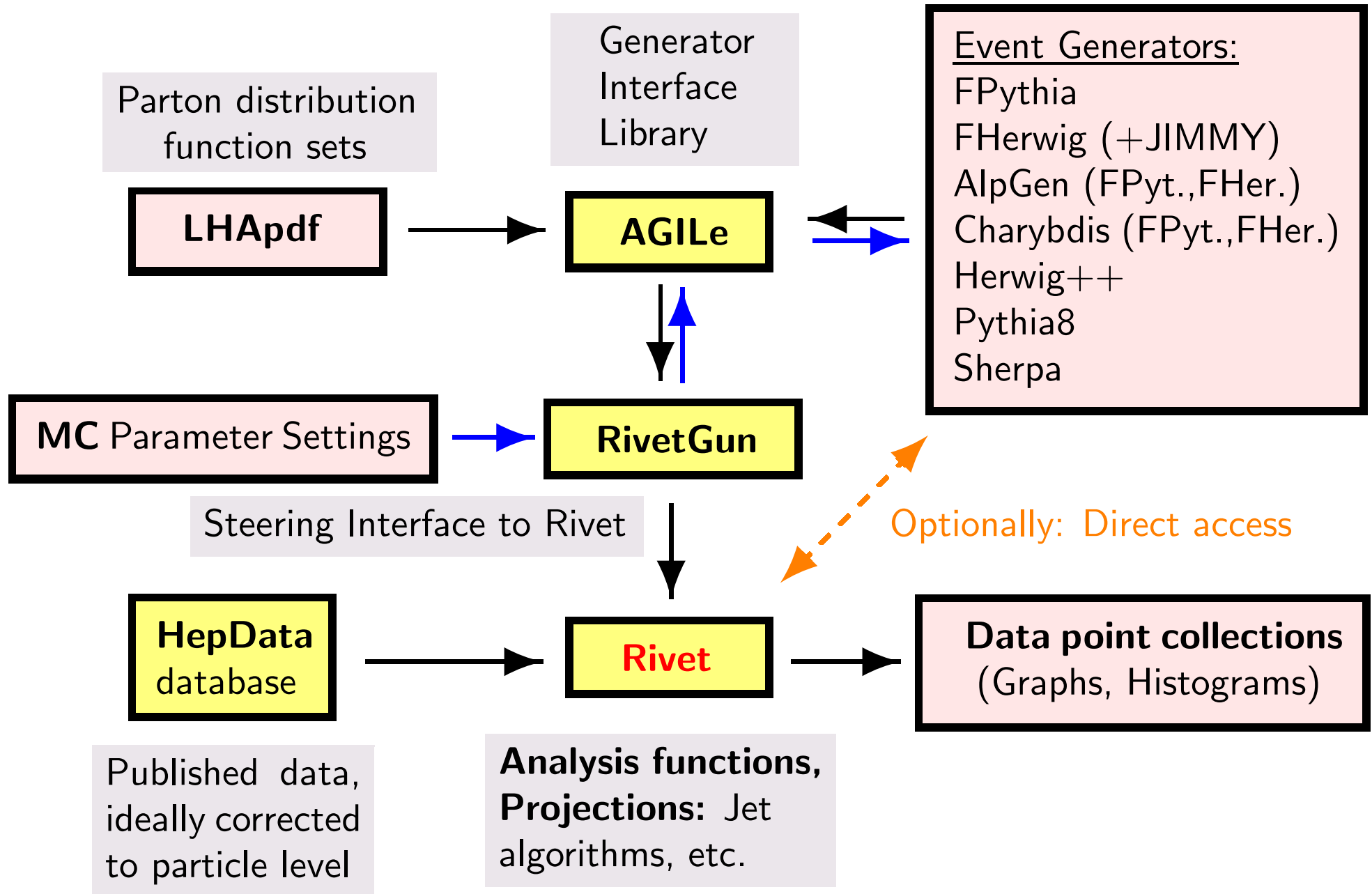
- Archive of published HEP data from the last 30 years
 - Almost exclusively data which is corrected for detector effects
- Focus on cross sections and similar distributions
 - Complementary to PDG
- Available at <http://projects.hepforge.org/hepdata>

- If you are publishing author of a measurement, please **do** remember to **send** your **corrected data to** the **HepData** database.
- **If** your measurement is **corrected** for detector effects it will be **useful for ever!**

Reproducibility of published data analyses

- **Before comparison of simulation/models to data:**
Implemented analyses have to match publications exactly
- Phenomenologists spend an enormous amount of time to reproduce published data analyses in all details:
 - Jet algorithm details/how exactly applied
 - Publication might seem unambiguous at the time of writing, not so later on ...
- **Solution:** The validation tool **Rivet**; containing analysis code
(see <http://projects.hepforge.org/rivet>)
- ⇒ Authors of published (corrected) analyses should implement their analysis **into Rivet at time of publication**
 - Only in this way exact reproduction is guaranteed!

Validation of experiment and theory with Rivet



Important for experimental measurements

- **Authors of analyses: Correct your data for detector effects (acceptance /efficiency/instrumental background) particle level/hadronic final state not further! (to prevent introduction of model dependencies)**
- **If corrected in this way it can be always compared to event generators**
- **Else your analysis will be obsolete sooner or later (typically rather soon)**
- **Present and past collider Centre of Mass Energies provide unique points of operation**
- **Event generator authors (Herwig++, Pythia8, Sherpa, ...) appreciate very much corrected LEP analyses. Hadronisation corrections are larger than detector corrections \Rightarrow Constraining fragmentation models. The most important LEP analyses are already in Rivet.**
- **Matrix of correlated errors are typically only provided by analyses of QCD groups. This information can not be recovered from published plots and is therefore extremely important to be documented, too!**
- **Constraints are needed for further generator development. The more the better. You will benefit from it in the next iteration!**

Summary

- Publish only data corrected for detector effects
⇒ it will be useful for ever
- Provide also Covariance matrix of errors, if not diagonal
- Send your publication results to the [HepData](#) database
- Implement your analysis into the validation framework [Rivet](#)