Center for Particle Physics Siegen

UNIVERSITÄT SIEGEN

Technical Benchmarks

Alan Price on behalf of WG2
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STAR Sensing and Sensibility
Transcending Disciplines for a Responsible Future

Content

- Benchmark Aims
- How to Benchmark
- Future Plans and Outlook

Benchmark Aims

- Main goal is to provide a framework to perform ***technical*** test of MC generators for all possible future Higgs factories
- Identify possible deviations between generators
  - Lead to discussions with WG1 and generator authors
- e+e- study has a long lifetime and MC will through many changes
  - Need a benchmark or standard candle to compare to
- “Lessons learned from LEP2”

See F. Piccinini **Talk**

2nd Topical Meeting on Generators

Monte Carlo Tools

Process Specific

RacoonWWW

KKCM

YFSWW

TAUOLA

KoralW

BabaYaga@NLO

General Purpose MC

MadGraph5_aMC@NLO

SHERPA

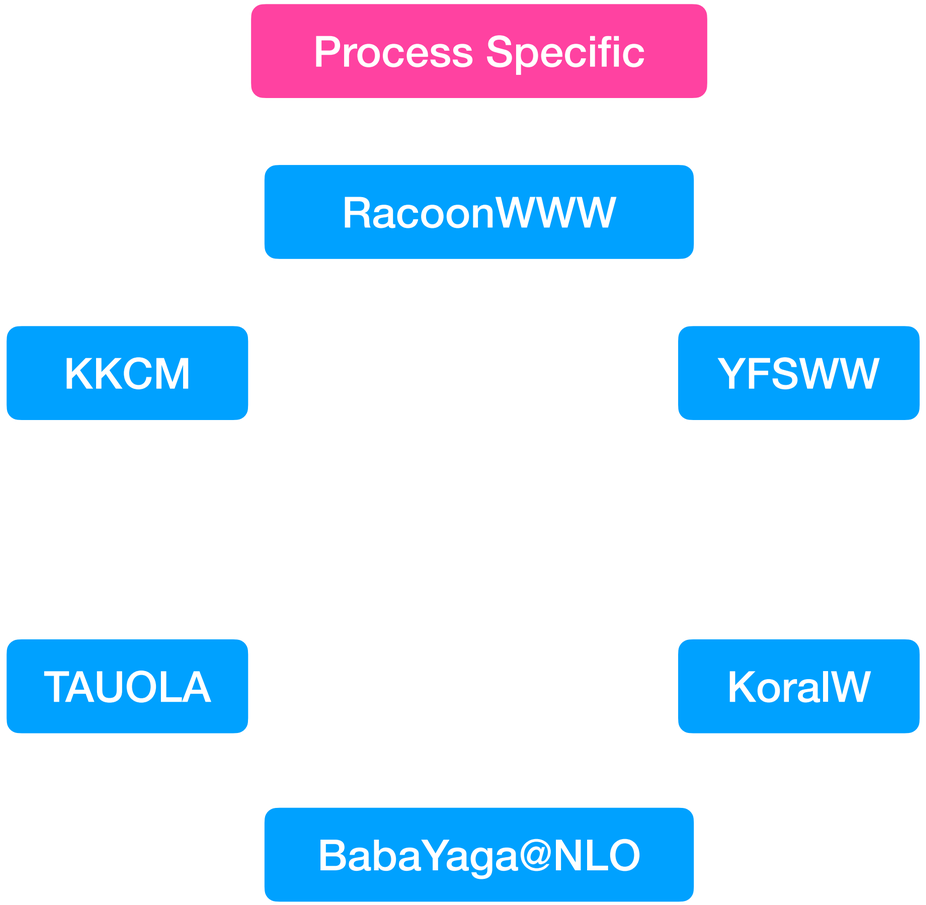
PYTHIA

HERWIG7

WHIZARD

See J. Reuter **Talk**

Monte Carlo Tools



- Well validated against e^+e^- data
- Most benchmarked for LEP
- New versions released

  ➡Benchmarked by authors
- Good Standard candles to compare against
- Some still state of the art

See J. Reuter **Talk**

Monte Carlo Tools

- Well validated in LHC environment
- Compared against LEP date e.g tuning
- Some detailed validatiation already done for e^+e^-
  - Whizard vs Madgraph Pia Bredt Thesis
  - Sherpa YFS vs LEP YFS AP Thesis

General Purpose MC

SHERPA

PYTHIA

HERWIG7

WHIZARD

MadGraph5_aMC@NLO

See J. Reuter **Talk**

MC Contacts

- **Herwig7**: Simon Plaetzer
- **Madgraph5_aMC@NLO**: Stefano Frixione
- **Pyhtia**: Ilkka Helenius
- **Sherpa**: Alan Price*
- **Tauola** et al: Zbigniew Was
- **Whizard**: Juergen Reuter
- **Powheg**: Emanuele Re
- **BabaYaga**: Carlo Carloni Calame
- **Geneva**: Simone Alioli
- **Guinea Pig**: Daniel Schulte
- **CIRCE**: Thorsten Ohl

- Point of first contact for the benchmark study
- Regular contact with authors outside of ECFA

How to Benchmark?

Reproducibility

Paper

Reproducible with some effort

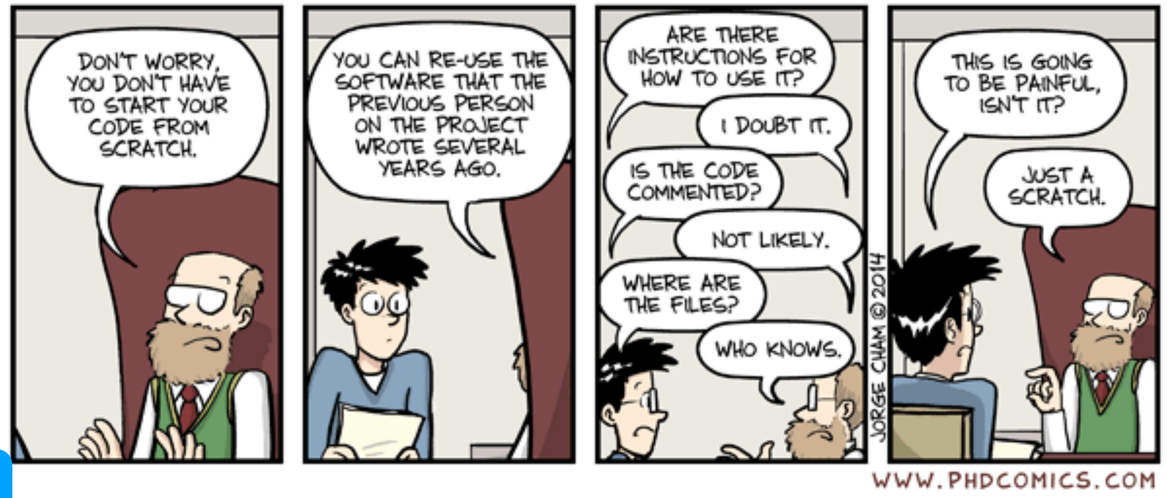
+ Run-card

Easily Reproduced

+ Analysis Files

Easily Reproduced

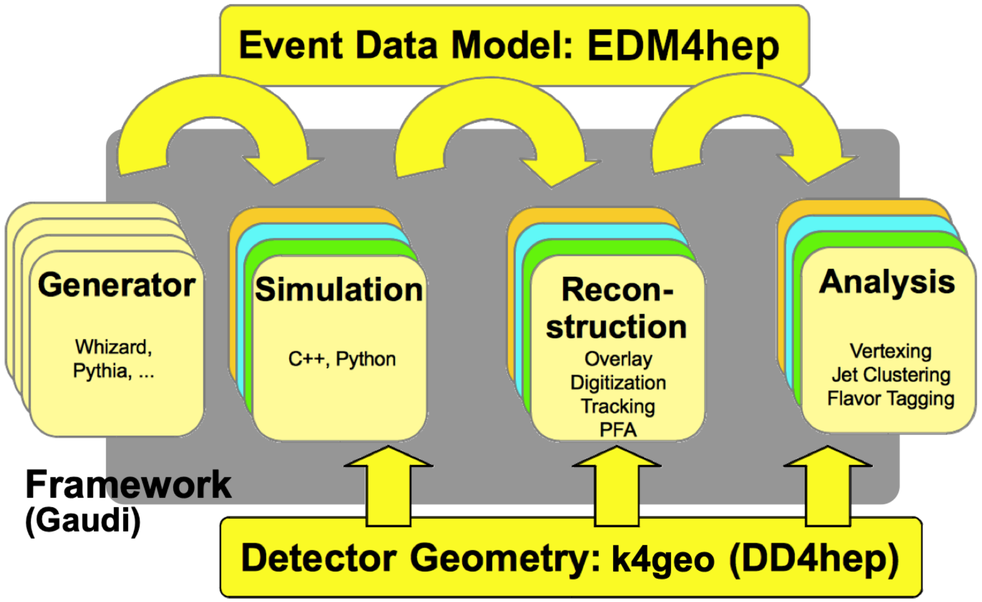
And trivially to validate



Reproducibility

We already have a sophisticated software system!

- Provide “**Add-on**” to Key4Hep framework
- Should be simple enough that:
  - New process can be easily added
  - MC authors can update interfaces if needed
- Keep some public event records
  - Juggle usefulness vs Storage
- More dedicate test for new generator releases



See J. Miguel Carceller **Talk**

Input

- Think about reproducibility!
  - With such a long timeline for lepton colliders results should be easily reproduced
- Develop in house tool that will automatically:
  - Run all MC from one input card, allows for easy setting of global parameter
  - Collect and compare final results e.g Cross-sections
  - Allow for easy comparison of differential distributions
  - Tricky but possible for technical checks

```
Processes:
  - 13 -13
  - 14 -14
  - 15 -15
  - 16 -16

Generators:
  - KKMC
  - Madgraph
  - Sherpa: {Version: "2.2.11"}
  - Whizard

Particles:
  23: {Mass: 91.1876}

Analysis:
  - CosTheta:
      Xmax: 1
      Xmin: -1
      Bins: 20
```

Output

- For all generators we should aim for a consistent output
  - At top-level, tables of cross-sections, differential distributions
- Store all outputs in a systematic way
  - Very helpful for debugging and
- Tricky but possible for technical checks
- Long term storage of event files

```
Processes:
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```

What to Benchmark?

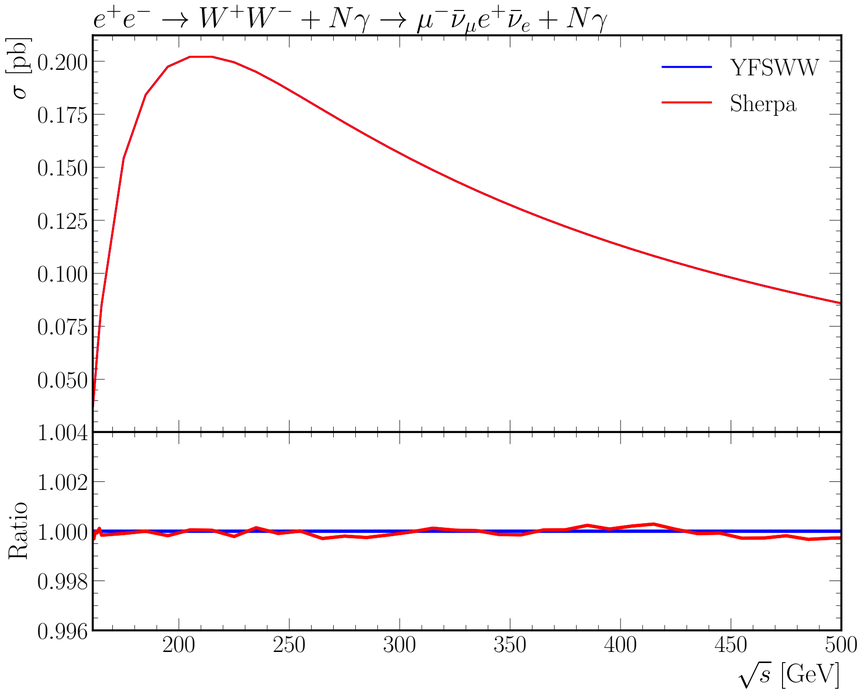
Processes

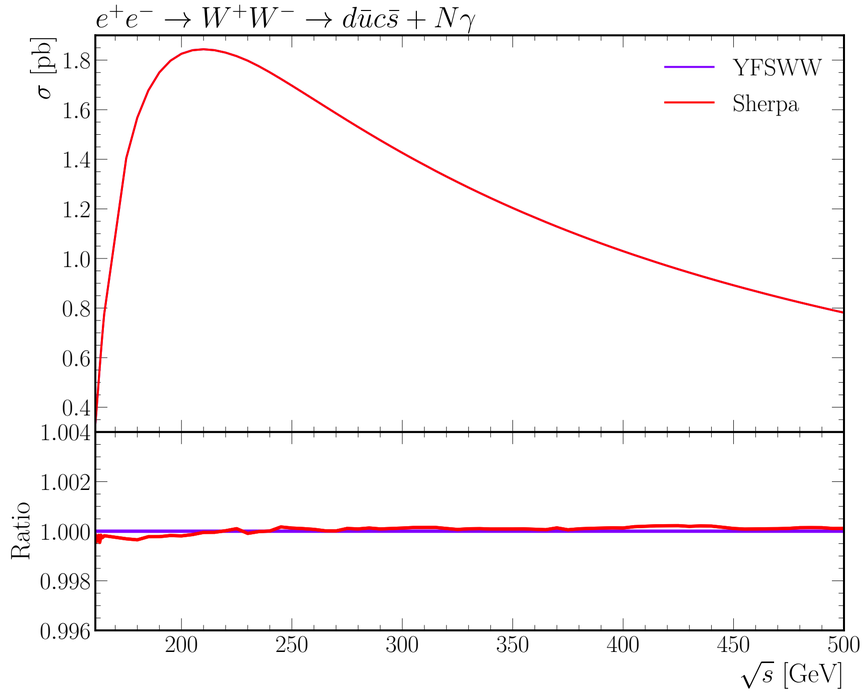
- We will consider all **process** of interest to all **colliders** at all relevant **energies**
- Add your favourite process to our living, evolving document **here**

Features

- If two or more MC support a feature it should be benchmarked
- E.g Coulomb correction in W+W- production. Not present in all generators

Example

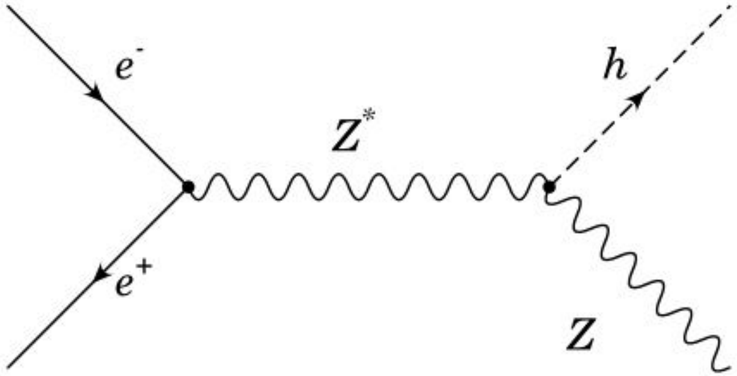


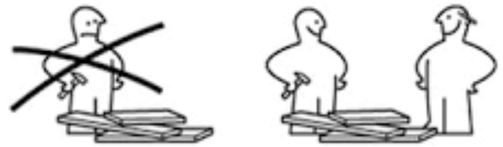


Since both Sherpa and YFSWW support YFS resummation for ISR,
a technical benchmark makes sense

Next Steps

- Implement and validate one process
  - Both locally and within Key4Hep “**Add-on**”
- Provide validation suit to “Volunteers”
  - Iterate feedback with both MC and Key4Hep authors
- Initially focus on “Matrix-element” validation first
- Volunteers welcome!





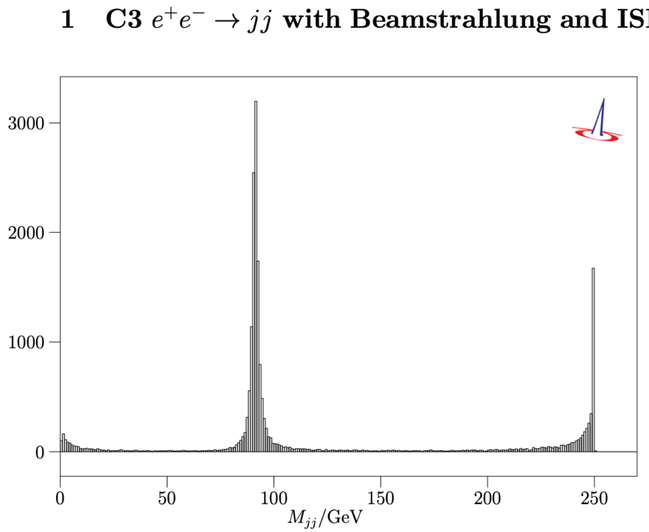
Beyond Generators

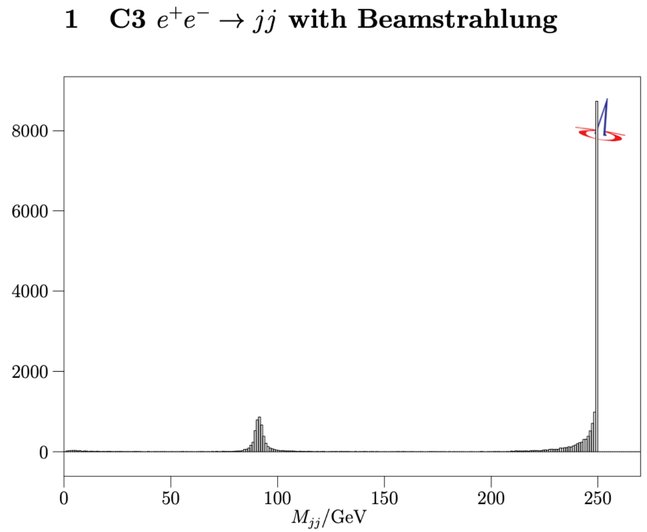
Another aspect to consider is beam-dynamics and there interface with generators

“Lindsey Gray and Elias Metter did everything by the book simulating C3 beamstrahlung”

See T. Ohl **Talk**

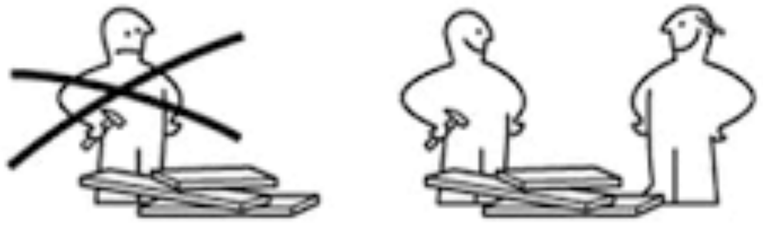
Could this have be found with benchmarks?

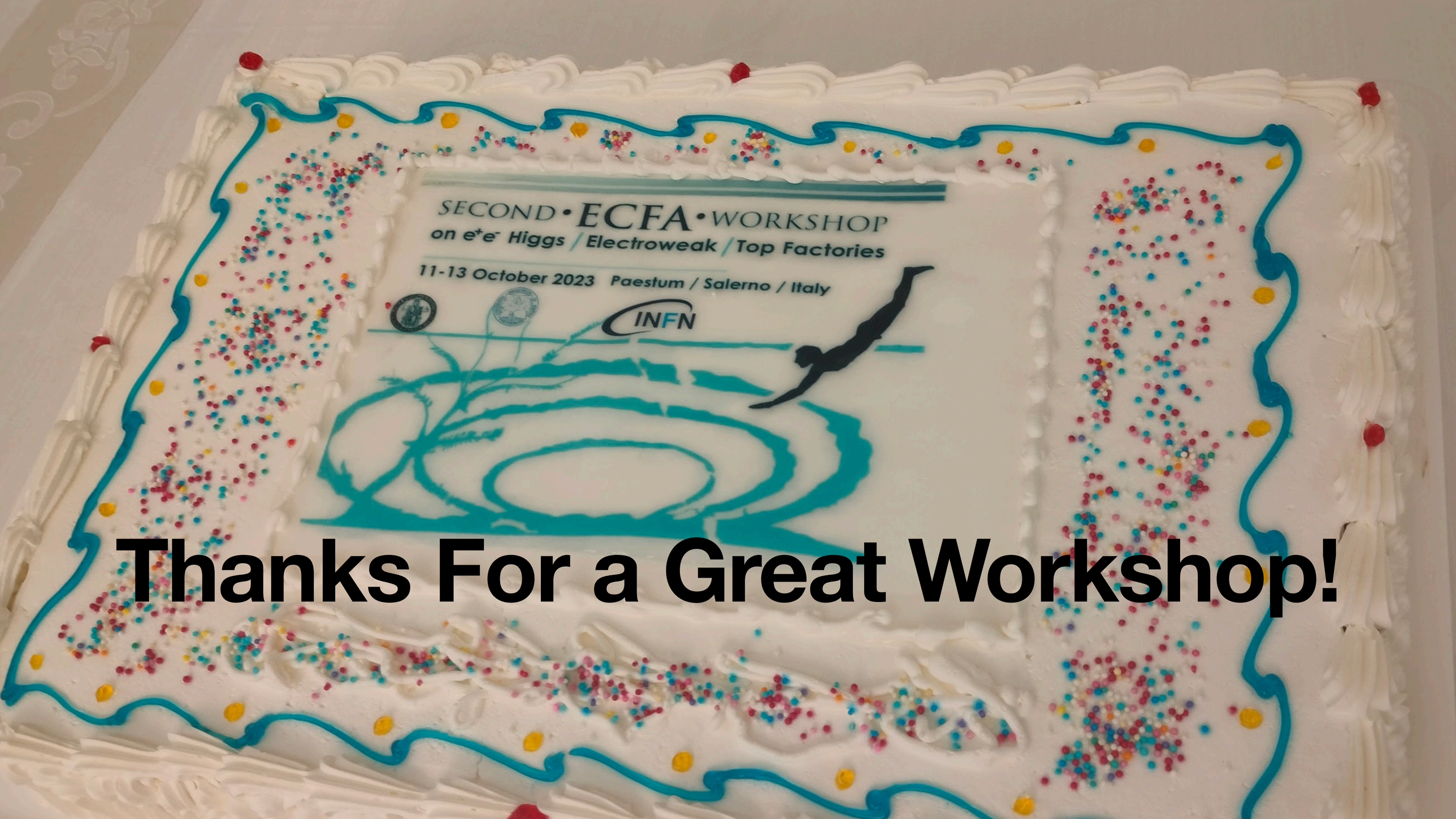




Outlook

- Technical benchmarks are of huge importance
  - **IF** there are issues, better to identify them sooner
- With a long programme for Higgs factory we need a robust framework to ensure consistent generator predictions





Thanks For a Great Workshop!