# LHCb PR testing

## Software quality assurance in LHCb

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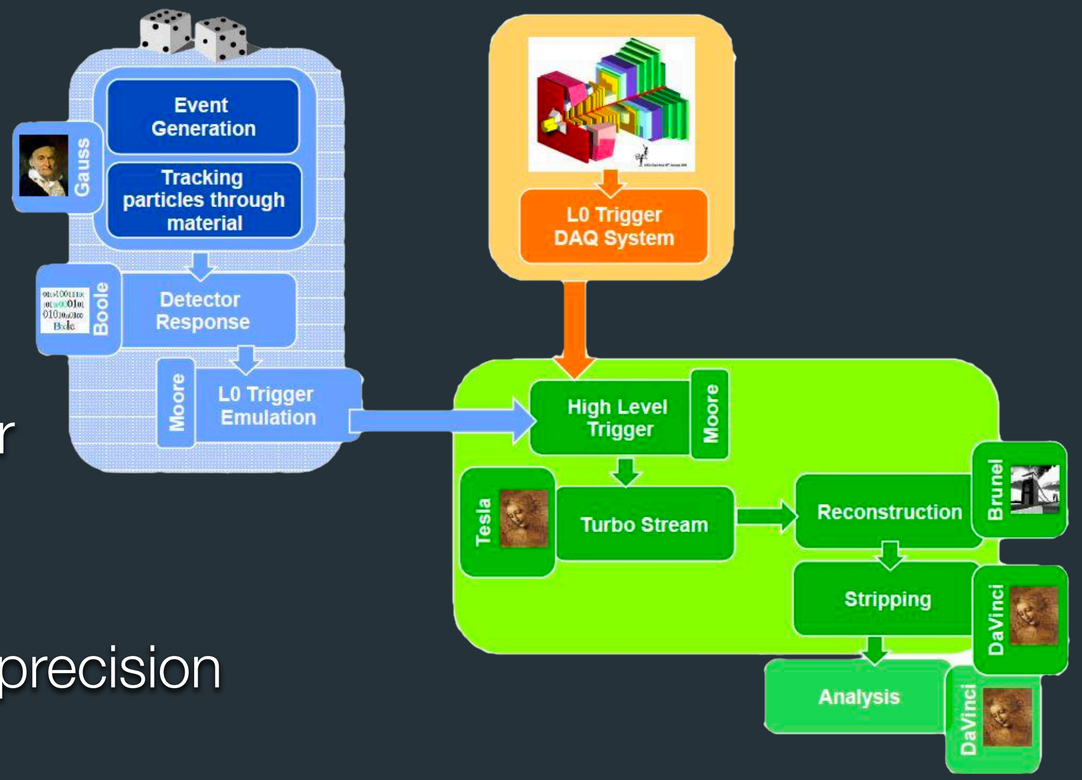
8th China LHC Physics Workshop, 23-27 November 2022, Nanjing, China

# Research relies on software tools

- LHCb software is a large code base
  - Data acquisition, simulation, reconstruction, etc.
  - Developed by the collaboration
  - External dependencies and tools
    - Compilers, MC generators, frameworks
  - Development for the LHCb upgrade detector
- Focus is results in physics
  - Quality of SW tools directly influence results precision
  - Increased data flows drive error cost



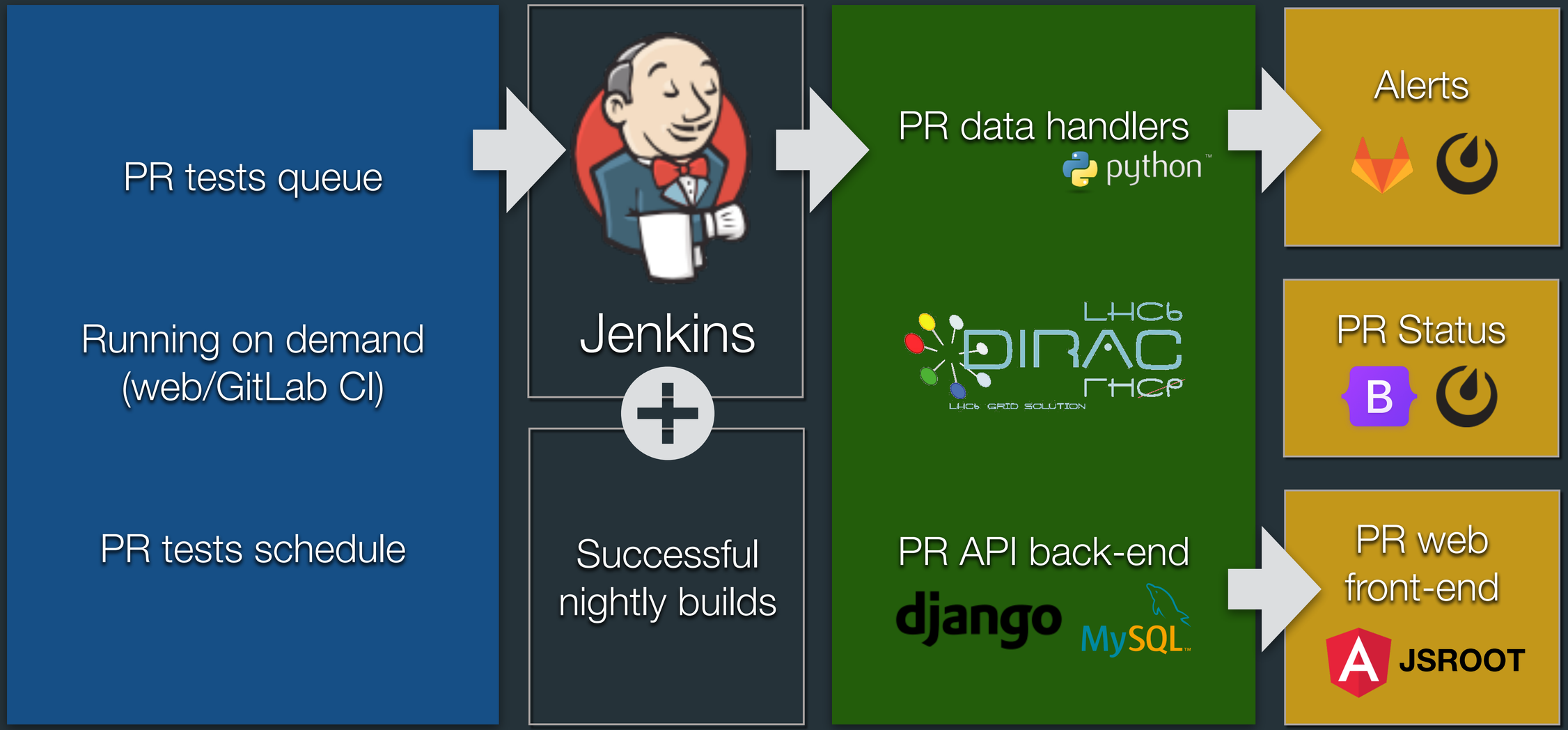
# LHCb SW development

- Projects hosted on CERN GitLab, built with LHCb nightly system (Jenkins)
- Active development relies on CI and nightly tests
  - Style compliance, syntax errors, static code analysis
  - Major changes to applications, frameworks, building tools
  - Quick tests *O*(1 event), project builds/runs
- Continuous code polishing and project evolution monitoring
  - PR tests: longer, sophisticated, physics analysis *O*(1K-100K events)
- Some projects are validated in large central productions *O*(1M events)

# LHCb Performance Regression tests

- Run LHCb applications, various configurations
  - MC generators, LHC conditions, detector geometry
- Typical monitoring properties:
  - Application behaviour
    - Timings, CPU/memory profiling, stack traces sampling
  - Physics analysis:
    - Numbers of tracks/vertices, momentum, energy deposits
- Size of data samples are a compromise between time and statistics
- Store results in various forms: basic types/JSON/files (e.g. ROOT)

# LHCbPR workflow



# LHCbPR adoption within LHCb

- LHCbPR was initially developed for LHCb simulation
  - Now used by other projects (digitisation, reconstruction)
- Wide coverage of analysed entities and aspects
  - MC generators, fast simulation, tracking efficiencies, throughput rates
- Became a go-to tool for development monitoring
  - Routine checks, validation of software releases
- A valuable tool for upgrade detector SW development

# Examples of LCHbPR tests

| GEANT4 |
| --- |
| Hadronic cross-section |
| Calorimeter |
| Multiple scattering |
| Simplified RICH simulation |
| Gamma di-lepton conversion |

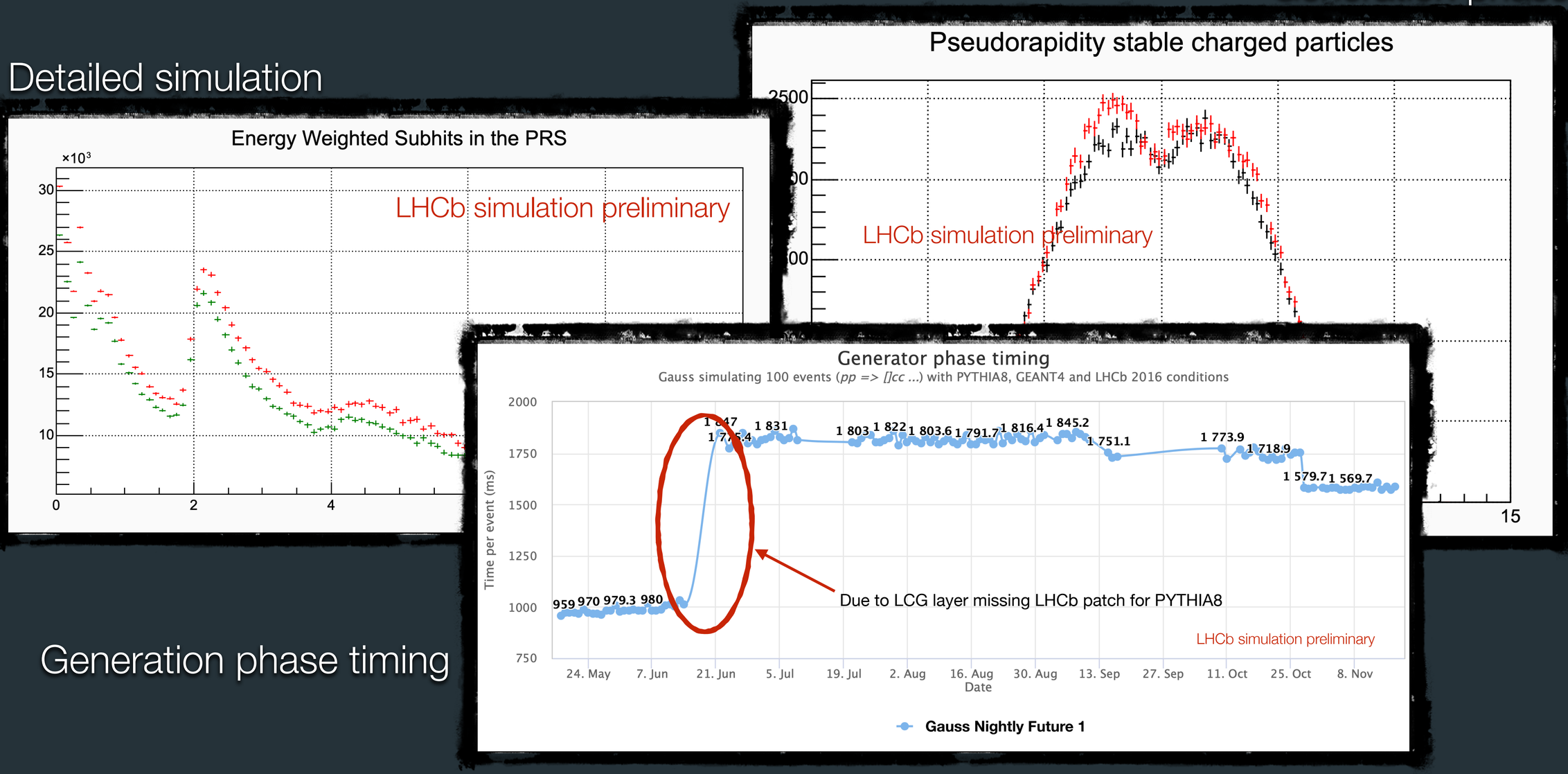
| Simulation | |
| --- | --- |
| Detailed and fast simulation validation | |
| Radiation length and absorption map | Detailed timing in detector volumes |
| CPU & memory profiling, stack traces sampling | |

| Reconstruction | |
| --- | --- |
| Trigger throughput profiling | Tracks monitoring |

# Examples of LHCbPR visualising results

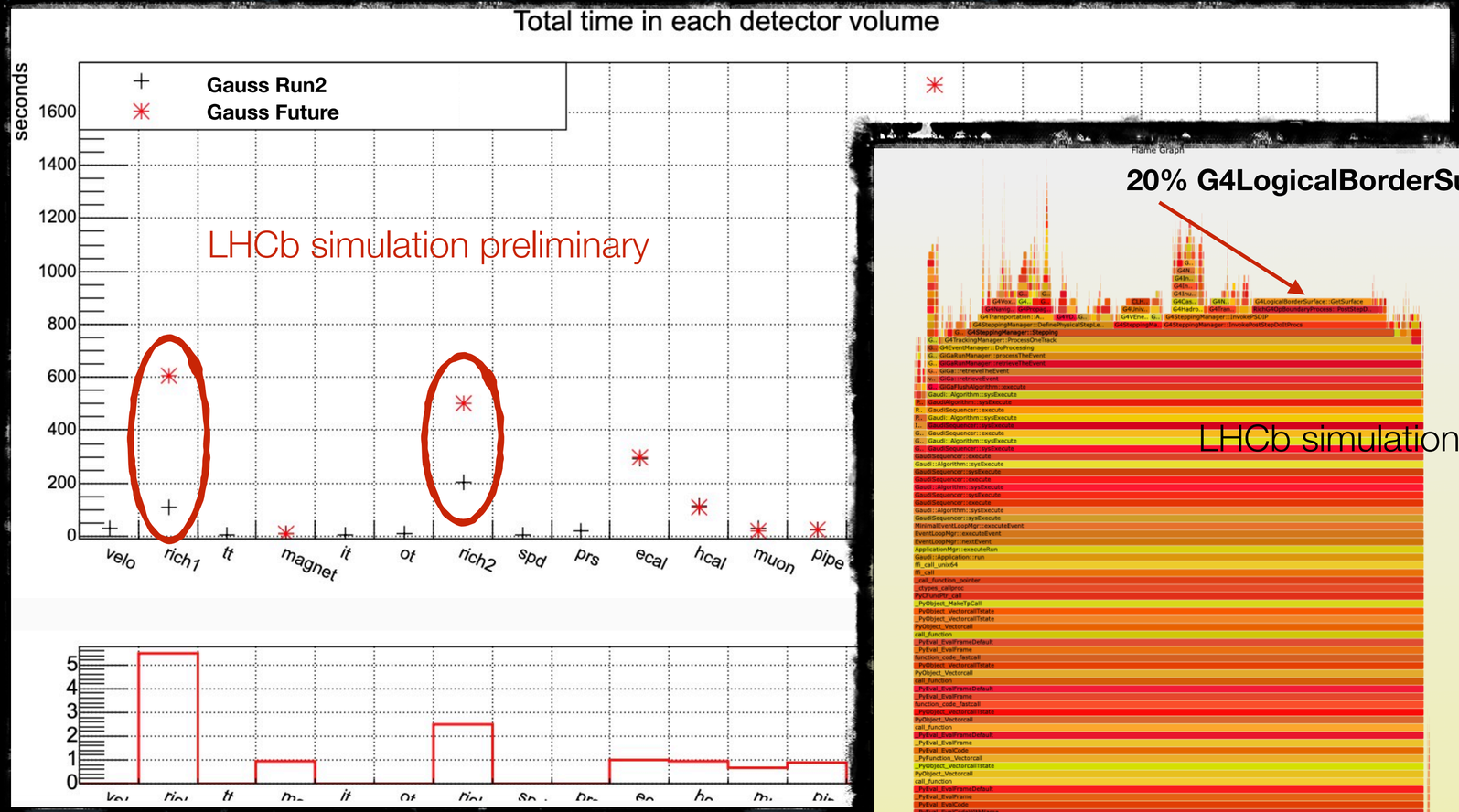
Generation phase

Detailed simulation



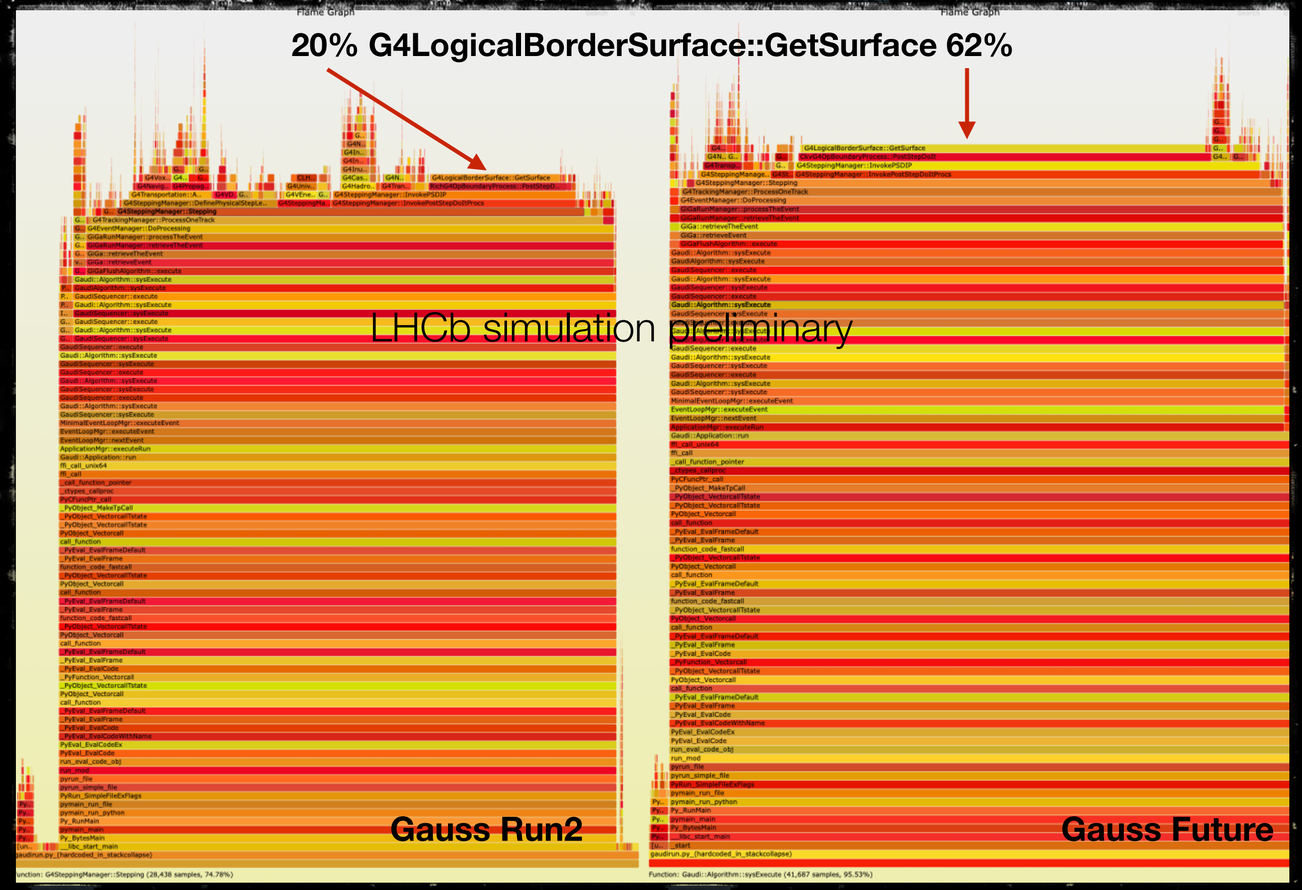

Generation phase timing

# Examples of LHCbPR visualising results




Detailed timing in Geant4

Gauss stack sampling



# Summary

- Delivering reliable SW tools for physics analysis is a complicated task
- LHCb has adopted a multilevel verification approach
  - ✓ Initial checks with quick CI and nightly tests
    - ✓ In-depth analysis with PR tests
- LHCbPR system is now used by other projects in LHCb
  - Used in routine development monitoring and validation of releases
  - Evolving web interface and growing library of PR tests
- LHCbPR proved to be a valuable asset in SW development

# Thank you for your attention!