LHCb software performance regression testing

From SW commissioning to testing and validation

Dmitry Popov (UCAS)

CLHCP 2021, Nanjing, China, 25-28.11.2021

Outline

Introduction

SW development and testing in LHCb

Performance and regression testing

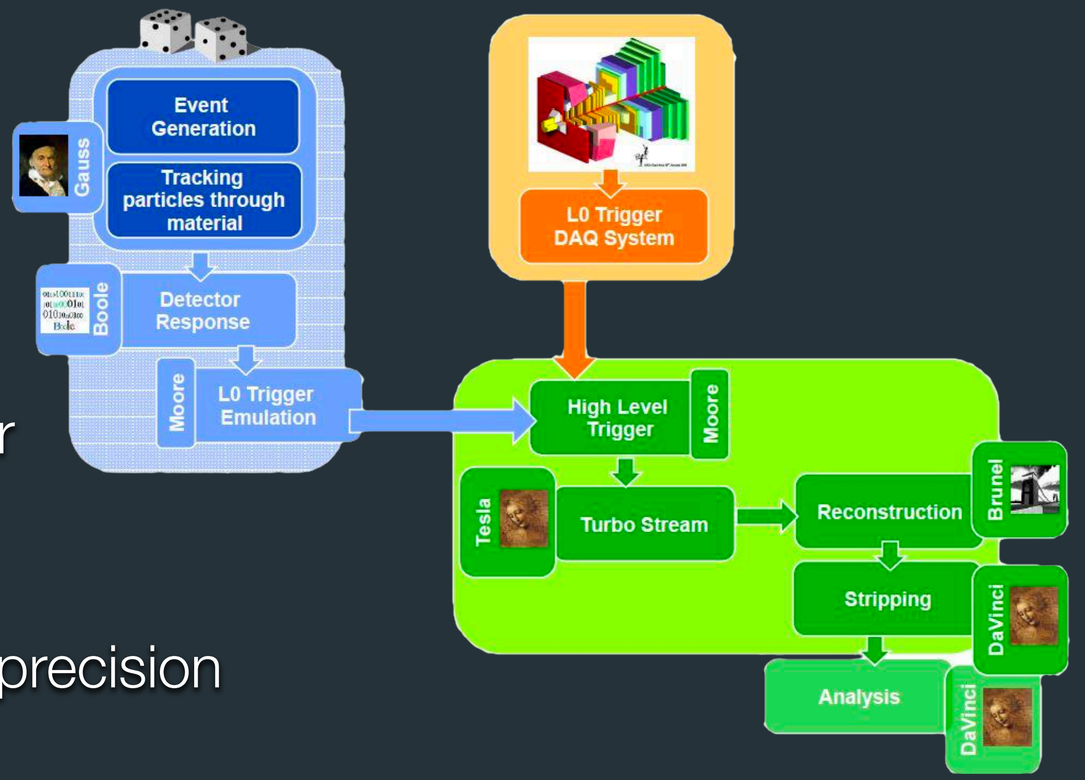
LHCbPR in a nutshell and its workflow

Some examples of LHCbPR results

Summary

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



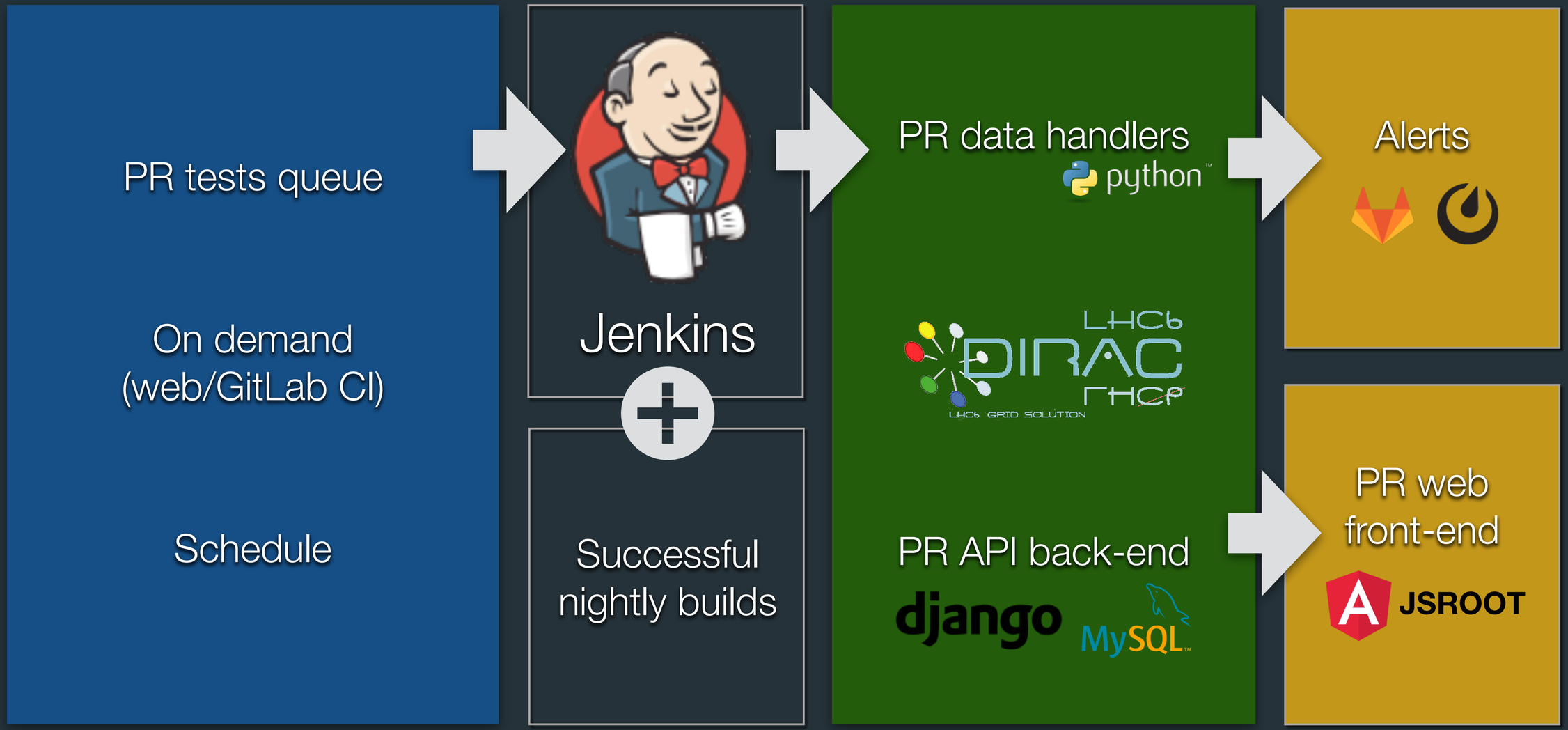
LHCb SW development

- Projects hosted on CERN GitLab, nightly builds (Jenkins)
- Main development relies on unit-/QM-/PR tests
  - Major changes to applications, frameworks, building tools
  - Simple, quick tests *O*(1 evtent), project builds/runs
- Continuous code polishing
  - PR tests longer/more sophisticated/physics observables *O*(1K events)
- Some projects validated in production/data quality monitoring *O*(1M events)

LHCb Performance and Regression tests

- Run LHCb applications, various configurations
  - MC generators, LHC beam conditions, detector geometry
- Typical monitoring properties:
  - Application behaviour: timings, memory footprint
  - Physics: 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



Adoption within LHCb

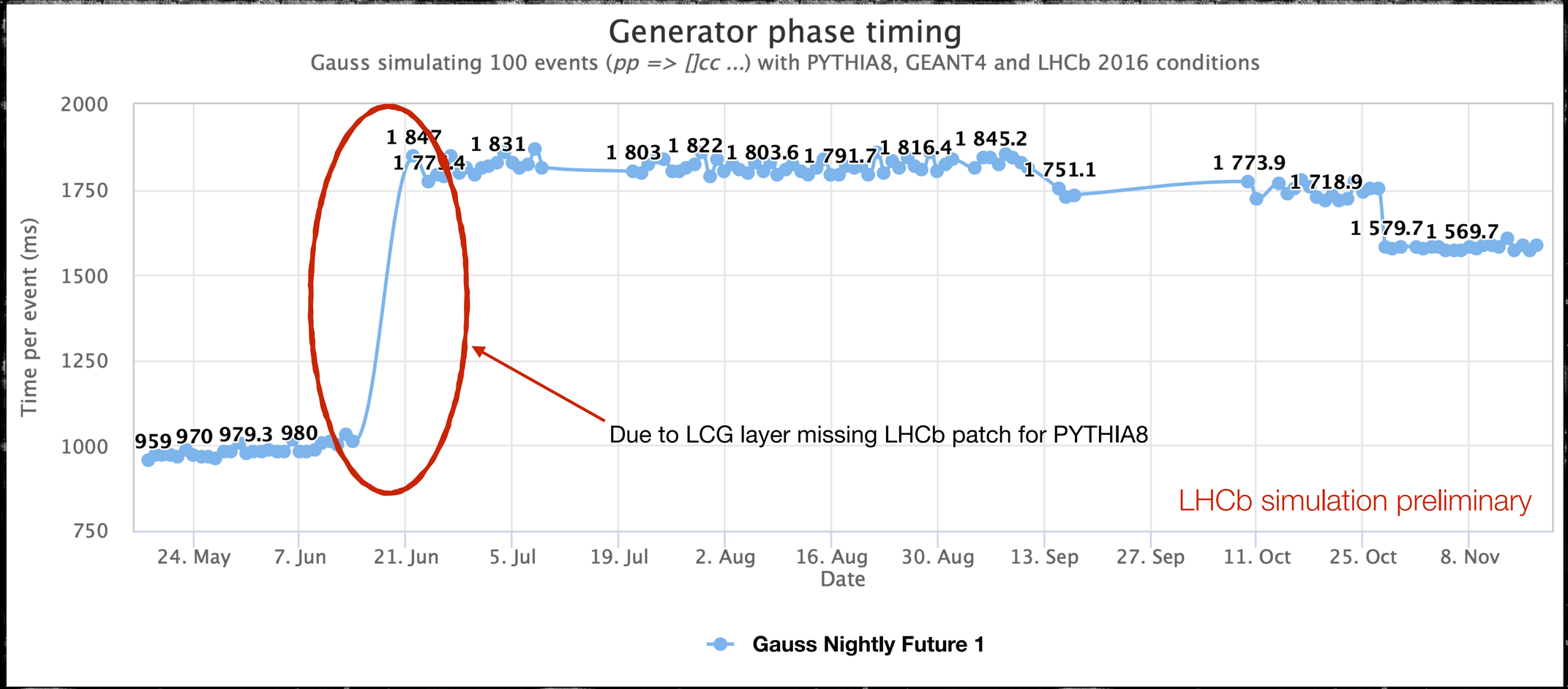
- LHCbPR was initially developed for LHCb simulation
  - Tests cover everything from GEANT4 to MC generators
  - Became a go-to tool for simulation checks
    - Validation of LHCb simulation stack releases
- Since then used by other LHCb projects (digitisation, reconstruction)
- A valuable tool for upgrade detector SW development
  - Now coupled with CERN GitLab CI
    - Test separate MRs, compare to references, issue alerts, link results

Example of LCHbPR simulation tests

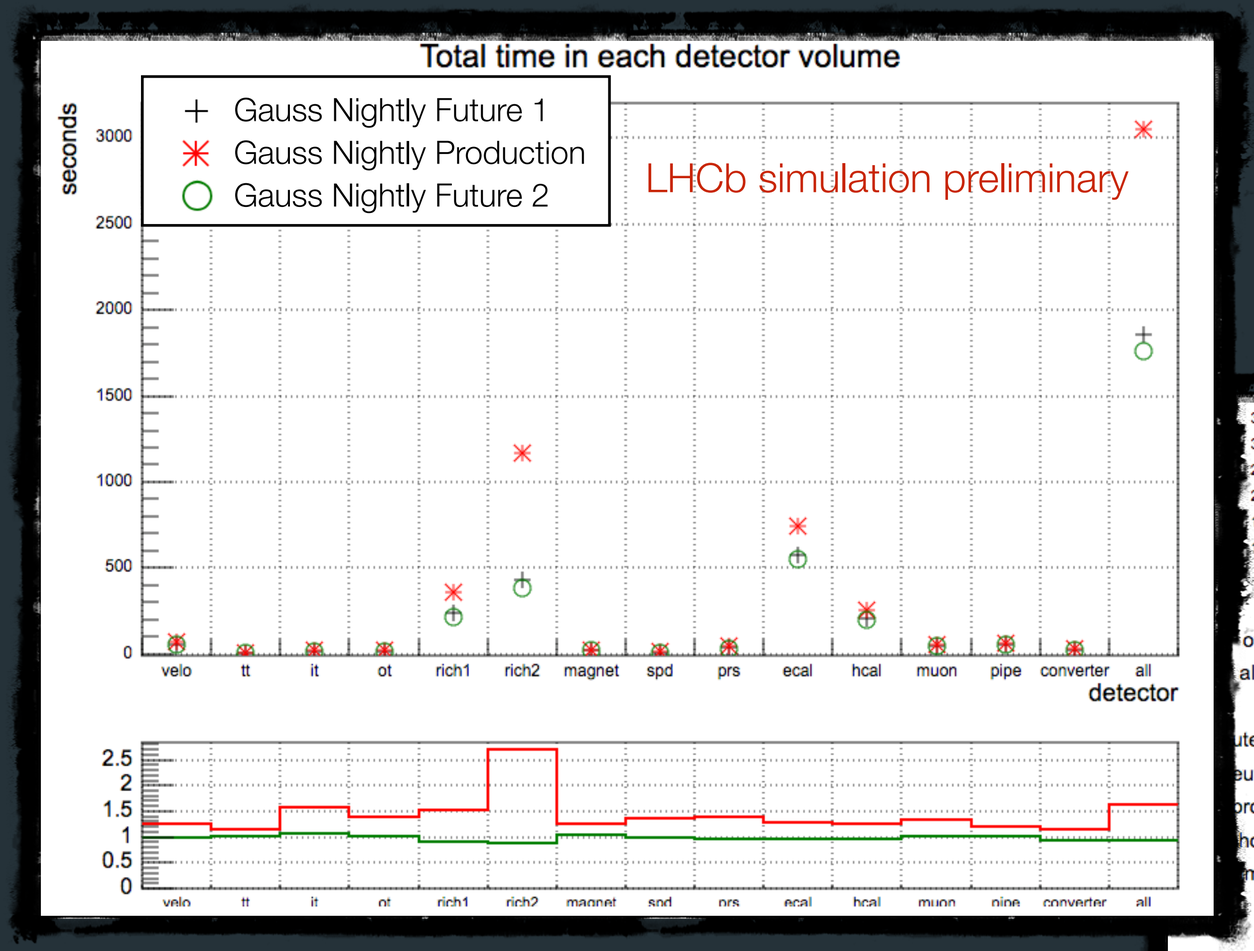
GEANT4 tests
Hadronic X-section
Calorimeter
Multiple Scattering
Simplified RICH Simulation

Gauss tests	
Hadronic Multiplicities	Radiation Length and Absorption Map
Muon Multiple Scattering	dE/dx in Thin Layer
VELO Energy Deposits	Detailed Timing in Detector Volumes
Bremsstrahlung	CPU & Memory Consumption
Simulation Validation	

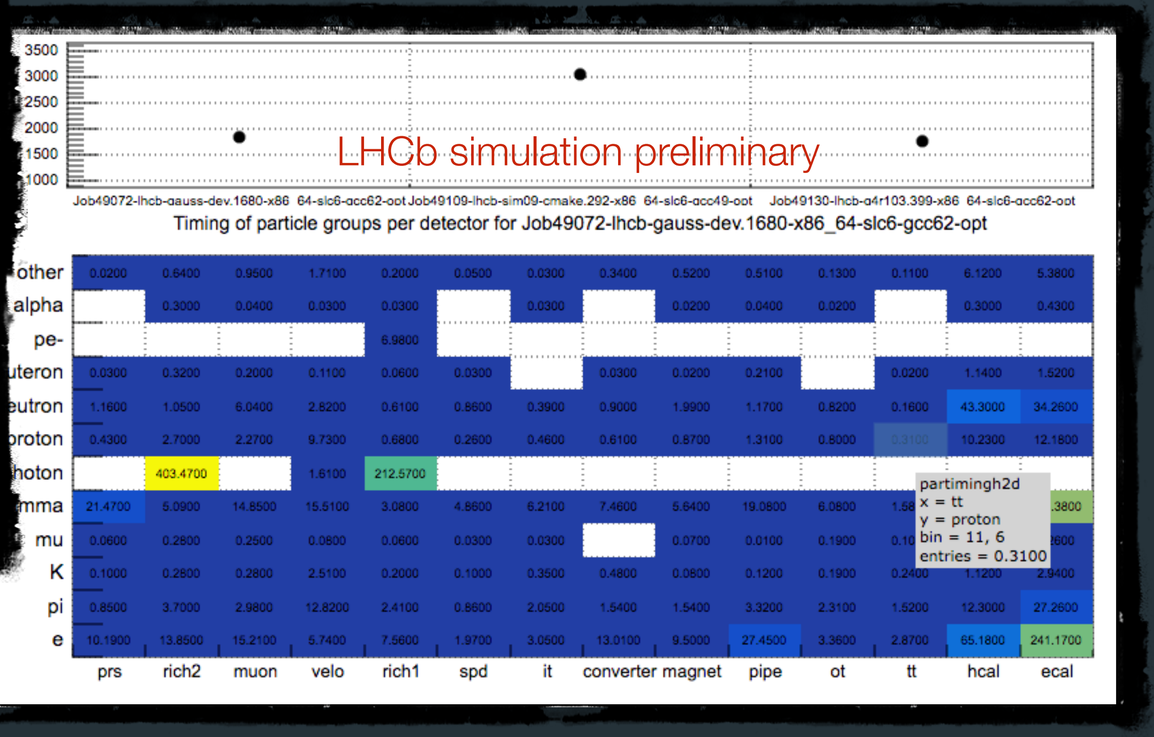
Examples of LHCbPR visualising results



Examples of LHCbPR visualising results

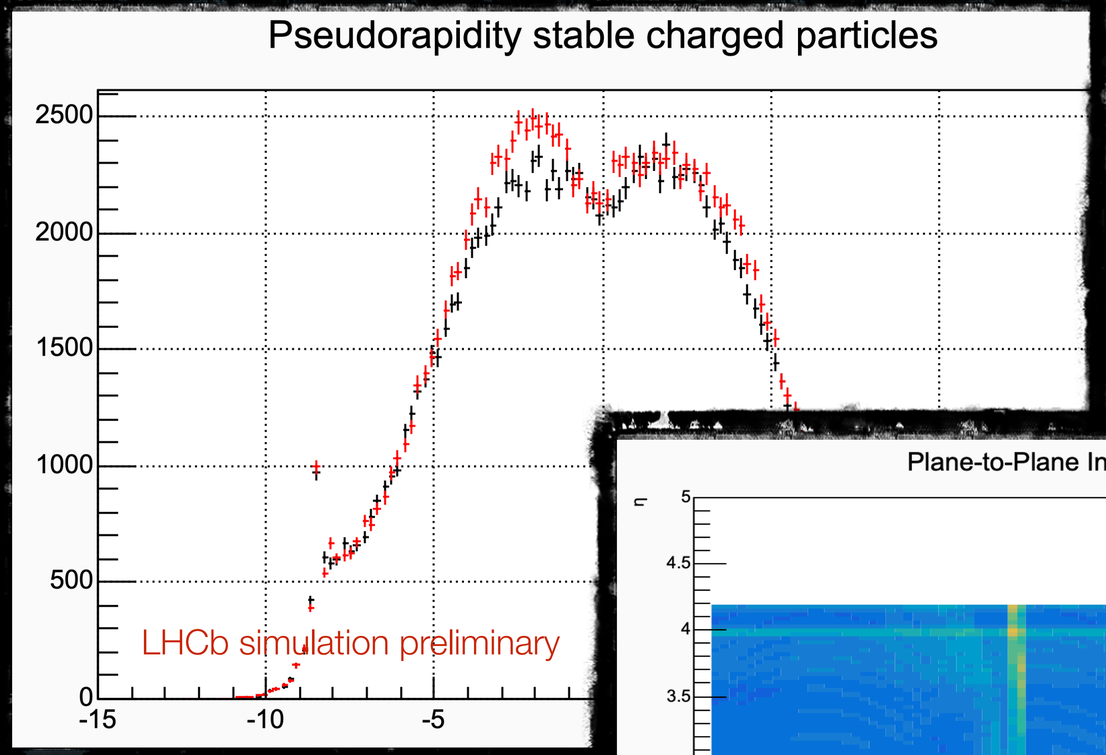


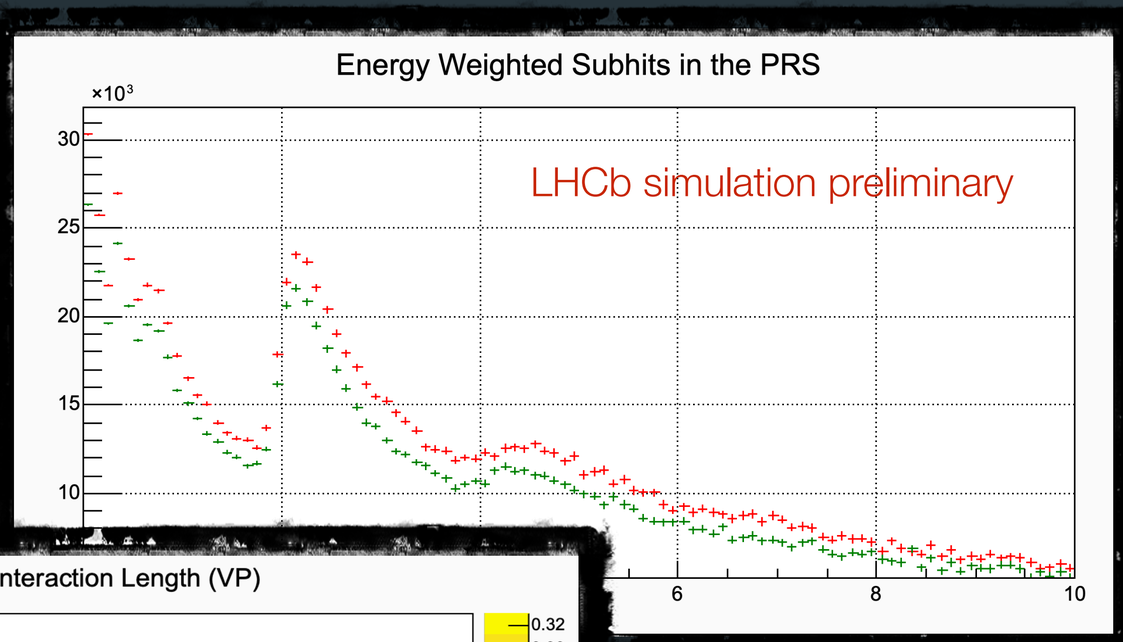
"Detailed timing in G4 volumes" results comparison in PR

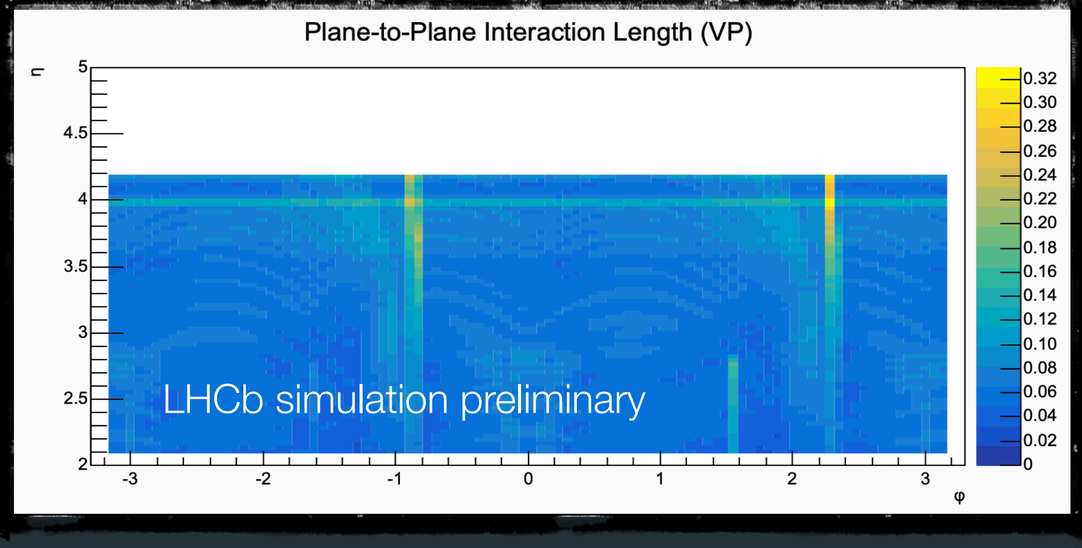


Examples of LHCbPR visualising results

Generator phase







Detailed simulation

Summary

- Delivering reliable SW tools for physics analysis is a complicated task
- LHCb has adopted a multilevel verification approach
  - ✓ Simple, not time consuming nightly tests
    - ✓ More complex LHCbPR checks
      - ✓ Validation in small productions for some projects
- LHCbPR is now used by other projects in LHCb
  - Proved to be a valuable asset in development
    - Work on modernised back-end is ongoing
- Together these steps help to spot the majority of potential problems

Thank you for your attention!