CREMLINplus Task 5.3 Development of software @ BINP

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Connecting Russian and European Measures for Large-scale Research Infrastructures

Objectives

- A flexible software allowing to make motivated decisions about detector and its subsystems design, also being a good base for futher detector operation.
- Featuring all common (offline) software tasks: event generation, full detector simulation with digitization, reconstruction and analysis.
- Initially agreed to be based on
 - Gaudi (overall framework),
 - Geant4 (simulation),
 - ▶ ROOT (data analysis, statistical interpretation, data storage),
 - DD4hep (flexible detector geometry description toolkit).
- Going to utilize as much of external software as possible (various HEP and general software packages, Belle2 analysis tools...)

Software development

The Aurora framework

- Generally inspired by ATLAS Athena.
- Based on standard tools (Gaudi, ROOT, Geant4,...).
- Lots of adopted code (FCCSW, Belle2, ILC,...).
- Includes (or should include)
 - physical generators
 - parameterized simulation,
 - full simulation,
 - digitization,
 - reconstruction of simulated (and real) events,
 - analysis tools,
 - visualization tools,
 - ► etc.
- Also provides
 - a build system,
 - ► an external software repository.

Software development

People

- BINP base software development team
 - design & develop general framework
 - provide users with examples and basic package version
 - implement modules when subsystem experts are unavailable
 - prepare build, test, visualization etc tools
- Parameterized simulation team
- Subsystem experts
 - expected to prepare comprehensive parts of the code concerned with corresponding subsystem(s)
 - framework usage and feedback
- Physics & Analysis experts
 - event generation and analysis tools implementation
 - framework usage and feedback
- CERN software team

The Aurora framework organization

- The framework organized in packages, each package being responsible for a certain task.
- Concurrent variants of detector subsystems are implemented as separated packages which could be selected at runtime.
- A user is able to work with "pure" Aurora or add new packages or modify some of the existing ones.
- There is a set of wrapper packages to flawlessly incorporate external software into Aurora build system.
- The whole framework tree is hosted in the git repository, git being important part of the development workflow.

Aurora: the status

- ✓ Generators
- Parameterized simulation
- ✓ Full detector geometry at least basic description for all detector elements, several options for some subsystems
- Full simulation
- ✓ Digitization preliminary version is ready for several subsystems: Silicon Strip, Drift Chamber, Calorimeter, Moun system
- Reconstruction modules from basic to really advanced
- 🗸 Analysis tools
- Test and service tools

Aurora: the analysis tools

The Analysis module implements tools needed for:

- Access the reconstructed final-state-particles
- Reconstruction arbitrary decay trees
- Imposing selection criteria
- Applying kinematic fit to the decay tree (with mass constraint)
- Saving a flat ntuple to a ROOT TTree for further work

The AuroraMaster package contains python classes providing high level interfaces to the Aurora algorithms and tools.

- Read/write SCT EDM data
- Run primary event generators
- Parametric simulation
- Full simulation with DD4Hep and Geant4
- Event analysis and selection with the Analysis package

Aurora: ToDo

- General framework development
 - Visualization improvement
 - Software distribution via cvmfs
 - Migration to Python3
 - Improve optical photons handling in simulation
- Subsystem experts
 - routine work for each subsystem software development
- Physics&Analysis
 - improve and actually use analysis tools

Aurora: the release

Aurora v. 1.0.0 was released in March, the release highlights include:

- Unified Sensitive Detectors in full simulation
- Simplfied but somehow realistic magnetic field
- A working sample of Digitization module
- Improved analysis tools
- Resent versions of external software

Bugfix release Aurora v. 1.0.1 was released in July.

Task 5.3 Deliverables

- Month 18 Status report on the software for the SCT detector. Release of the SCT software.
- Month 44 Final report on the software for the SCT detector.

The Aurora release 1.0.0 was announced at vCHEP 2021.