CREMLINplus Task 5.3
Development of software @ BINP

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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
  usable in analysis
- ✓ Full detector geometry
  at least basic description for all detector elements, several options for
  some subsystems
- ✓ Full simulation
- ✓ Digitization
  to be presented really soon
- ✓ 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 (TODO)
- 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
- 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 is going to be released in February,
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

Would be great to establish futher release milesones and schedule.

Task 5.3 Deliverables

Month 18 Status report on the software for the SCT detector
          Also the release of SCT software
Month 44 Final report on the software for the SCT detector

We are going to announce the Aurora release at vCHEP 2021.