The Simulation Library of the Belle II Software

ACAT 2017
21-25 August 2017
University of Washington, Seattle

The Belle II Simulation Group

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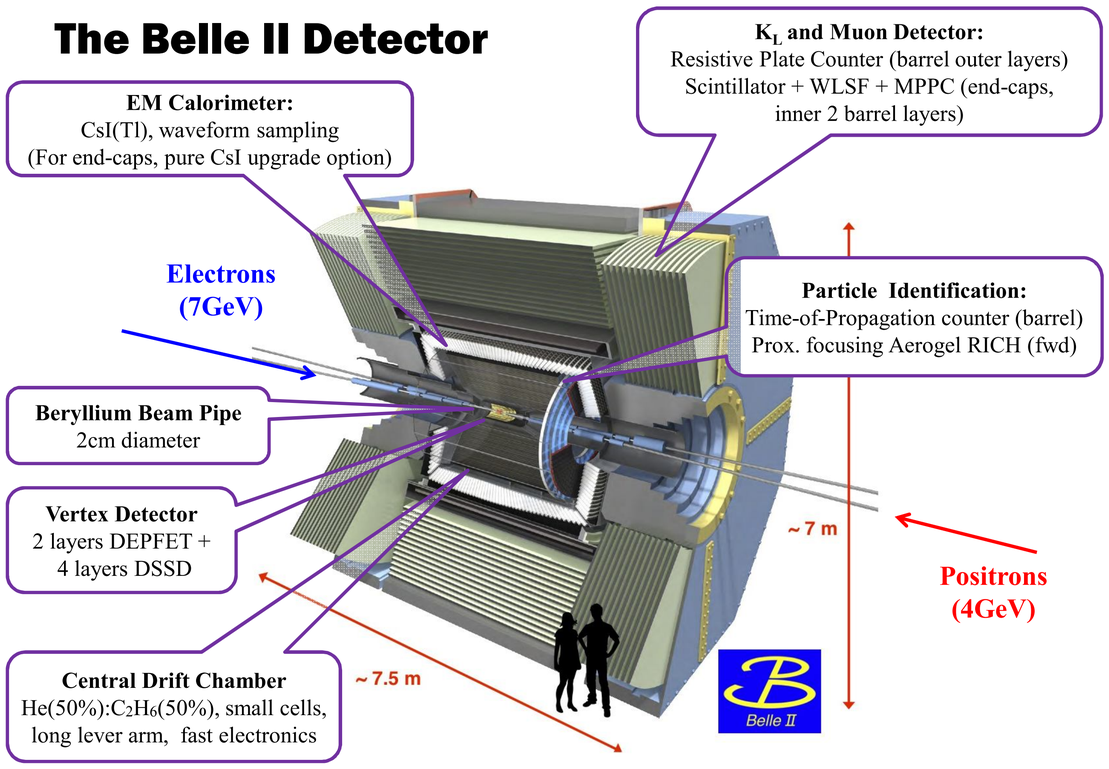
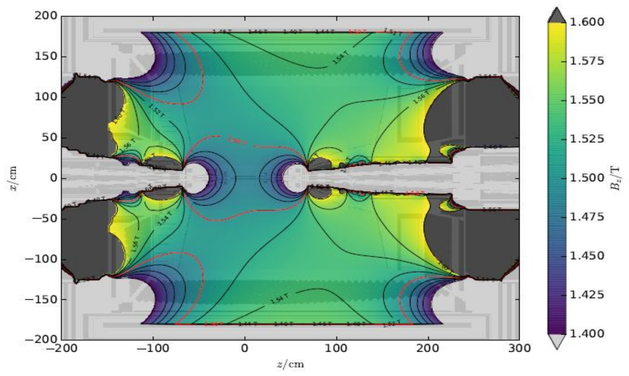
The Belle II Detector



3-D Magnetic Field in basf2



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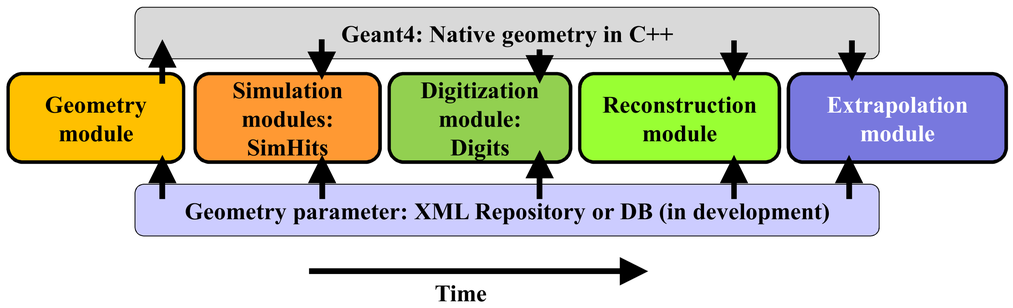
- **Belle II magnet** = 1.5T Solenoid + Beam focusing system + Iron yokes in KLM + Non-linearity from quadruple shields/yokes.
- **Simulation of B field:**
  - Opera3D/Tosca for modeling
  - In-situ measurements in September 2015 and more in 2017.
  - Aiming to improve the precision up to 0.1 %.

The Basic Structure of basf2 (The Belle II Software System)

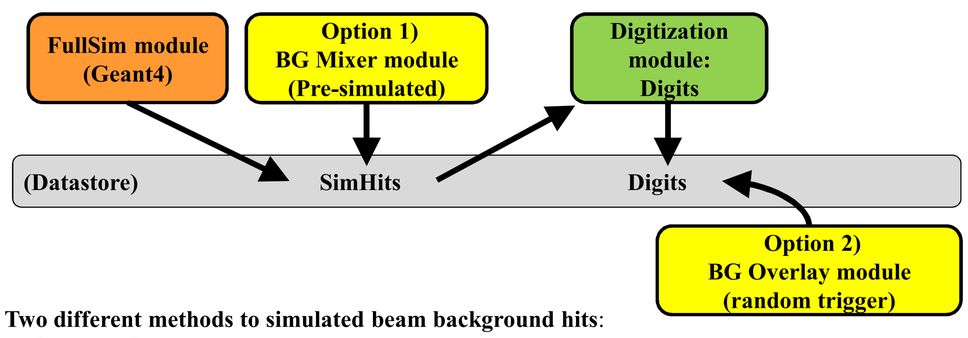
The Belle II software is written in C++ mostly. The job scripts are handled by Python.

- A basf2 event is created by a user defined chain of modules on a path.
- The core simulation module is an interface to Geant4 v 10.1.2. For B physics, FTFP_BERT is used as the physics list.

Example: Order of basf2 Modules per Event



Mixing of Beam Background Hits

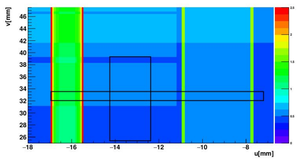


Two different methods to simulated beam background hits:

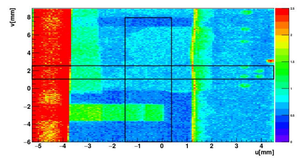
- Option 1) Pre-simulated beam background hits:
  Radiative Bhabha, Touschek scattering, beam-gas interactions, two-photon QED.
- Option 2) The background overlay scheme using random trigger events.

Validation Tools
Example: Material Budget Study of SVD Ladder

Default Geant4 simulation



Radiation length image from test beam



Results: Updated geometry

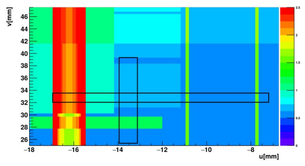
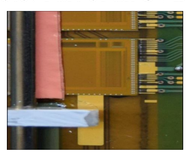


Photo: Part of an SVD ladder



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- Radiation lengths of the vertex detector is obtained by scattering angles of traversing particles.
- This test beam result is compared to the Geant4 simulation.

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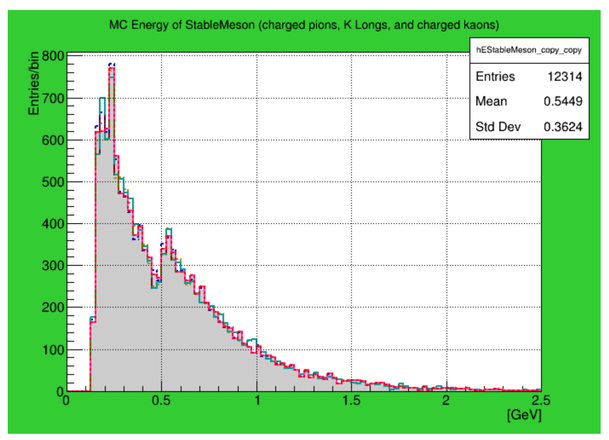
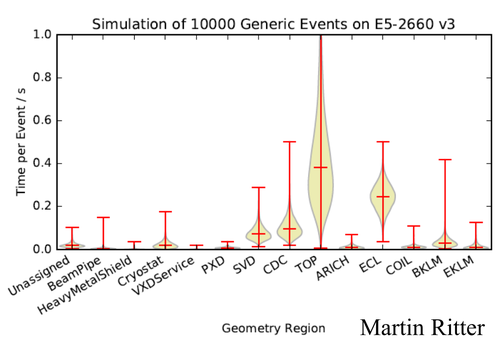
Example: Daily Comparison of Basic Histograms



Summary and Future Plan

- Nominal geometry has been implemented. Most of the displacement geometry is also implemented, which is the difference between the design values and the actual construction.
- Geant4 is the core of the FullSim module.
- Various tools are in development to validate the simulation.
- We will use the 2017 – 2018 data sets to fine-tune the simulation library.



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Acknowledgments

Doris Y Kim is supported by the National Research Foundation of Korea (NRF) Grant No. 2016R1D1A1 B02012900 and No. 2016K1A3A7A0900560. This author also thanks Korea Institute of Science and Technology Information (KISTI) for the resources and technical support.