Software Aspects of the Geant4 Validation Repository

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Abstract

The Geant4 collaboration regularly performs validation and regression tests where results obtained with a new Geant4 version are compared to data obtained by various HEP experiments (validation) or the results of previous releases (regression). As the number of regularly performed validation tests increases and the collection of results grows, storing them and making them available to the collaborators and users community becomes a challenge. We decided to organize the materials in one central repository and to make this data easily available via a web application. The DoSSiER (**D**atabase **o**f **S**cientific **Si**mulation and **E**xperimental **R**esults) project is not unique to Geant4. GENIE and GeantV are examples where DoSSiER will be used.

Requirements

- Provide repository:
  - to store experimental validation data as raw data,
  - to store simulation results as raw data and as static plots.
- Provide display web-applications which:
  - allows to select and overlay compatible tests,
  - allows to overlay experimental data,
  - allows automatic upload into repository,
  - allows to display static images,
  - provides search functions and easy navigation.
- Provide web service:
  - to access programmatically the data,
  - with a modern look, meaningful search, easy to navigate menus.
- Provide a secure authenticated system.
- Based on modern internet technology and industry standards to simplify maintenance

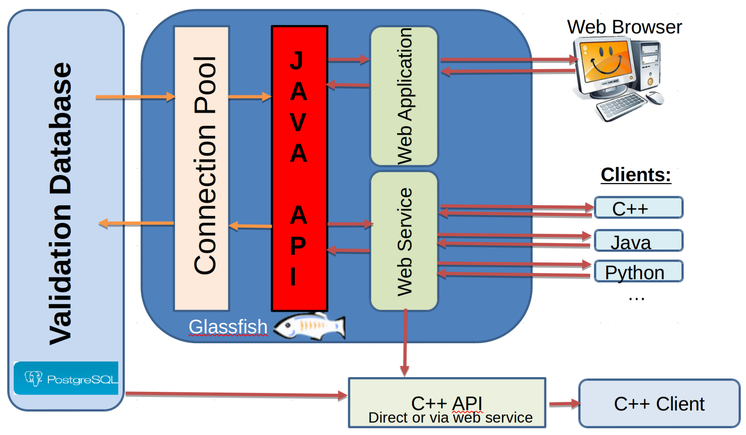

Figure 1. General design of the system

Choice of technology

PostgreSQL	Open source relational data base, hosted by Fermilab data base group.
	Glassfish: Web Application server hosted on fermicloud
PRIMEFACES	Primefaces JSF (Java Server Faces) based framework to create modern looking web pages and easy to navigate menus.
NetBeans	Integrated Development Environment
	Java programming language, JAVAEE, JAX-RS
Google Charts	JavaScript library used to create interactive graphs

Software Components

Figure 1:

- **PostgresSQL relational database:** stores both simulated and experimental data in form of raw data points or images with associated meta-data. The meta data describes the test describing the condition of the test (e.g. beam particle, target material, etc.) and lists the references from which the compared-to experimental data was obtained.
- **Java API:** based on the data access object (DAO) design pattern and provides an abstract interface to the database.
- **Web Application:** based on Java Platform, Enterprise Edition (Java EE) is deployed on a GlassFish Application server. The web application allows interactive selection and overlay of compatible data. The web application also provides security and authentication to grant access to groups of functions and data that are internal to the Geant4 collaboration, e.g. viewing results from development releases, upload of new tests and/or modification of selected tests.

Figures 2-4 show different views provided by the Web Application.

Meta-data

Meta-data are associated to results. These additional data can be used to search the data-base and contain information such as type of the beam, target material, simulation software version. In the simplest case the data are in the form of key-value pairs and are stored in dictionaries that can be referenced by unique ID. However complex data structures are supported, such as neutrino flux files used by GENIE software.
The meta-data are also used to group together results and provide a comparison of similar results (for example displaying superimposed the Geant4 calculations from different versions)

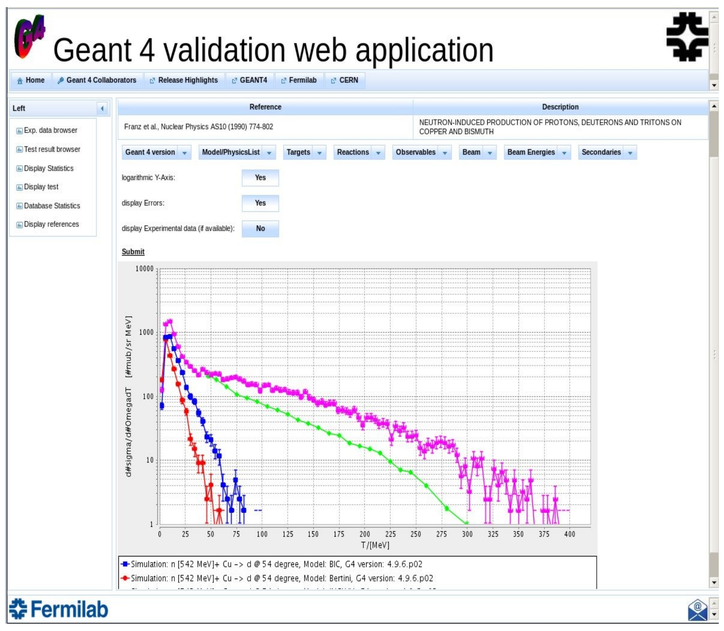

Figure 2. Comparison of experimental data (green) with different Geant4 models

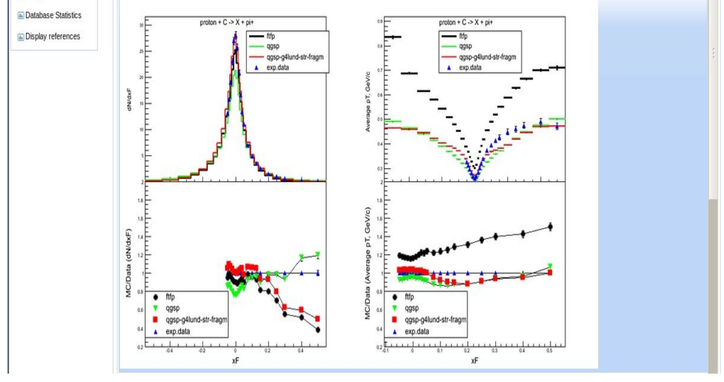

Figure 3. Display of static images with metadata. DoSSiER supports the handling of images

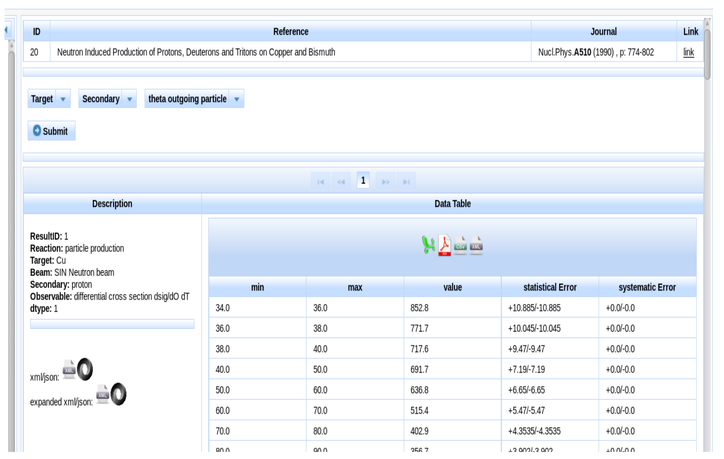

Figure 4. Data can also be presented as data-table which can be exported in a number of formats (Excel, PDF, CSV, JSON)

Additional Tools

Additional tools have been created to programatically interact with DoSSiER from applications. In particular a python program (**Figure 5**) has been created to convert histograms from different formats to JSON-based files suitable to be uploaded to DoSSiER via a web application (a direct upload via REST API is under development). The tool accepts ROOT or CSV formats as input files and allows to convert and manipulate meta-data.
A C++ library is also being developed to download and upload histograms from a ROOT-based program.

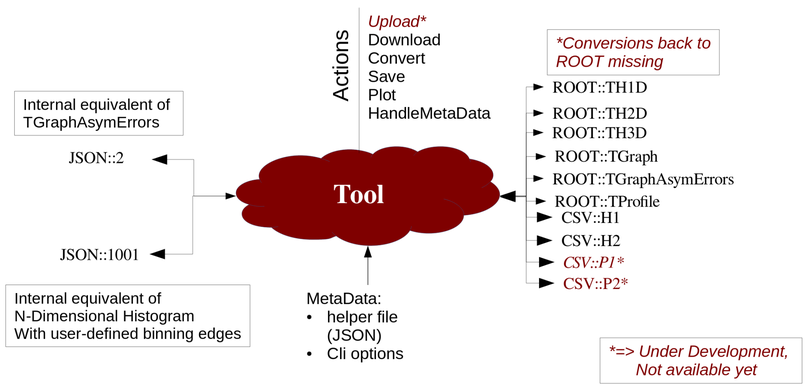

Figure 5. External tool for conversion and manipulation of histograms

Conclusions

We have created a repository to collect and organize Geant4 validation and regression test data as well as the experimental data used for validation. A Web Application allows easy access to the data other communities have expressed interest in using the same system (GENIE, GeantV). A web service allows programmatic access to the data from user-code.

Contact

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