Database of Scientific Simulation and Experimental Results: Overview and Status of the Project

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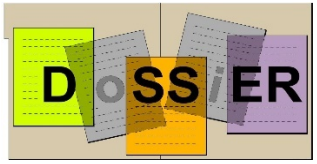
Andrea Dotti (SLAC)

Outline:

- Motivation
- Requirements
- What's new?
- DoSSiER
  - Components
  - Ancillary Tools
  - Meta Data
- Status of the project
  - Prototype: G4WebAppNG
  - Status of DoSSiER: web application and web service
- Accommodating Neutrino Generators (Genie)
- Summary, Conclusions and Plans



Motivation

- Provide guidance to experimenters and answers to questions like:
  - What data is used to validate the physics of Geant4/GeantV/GENIE/… ?
  - How well does the Geant4/GeantV/GENIE/… simulation describe the data of interest for the experiment?
  - Which model provided by Geant4/GeantV/GENIE best describes the data of interest for the experiment?
  - What are the benefits of switching to the latest version of Geant4/GeantV/GENIE/…? What changed?
  - What systematic uncertainties are involved?

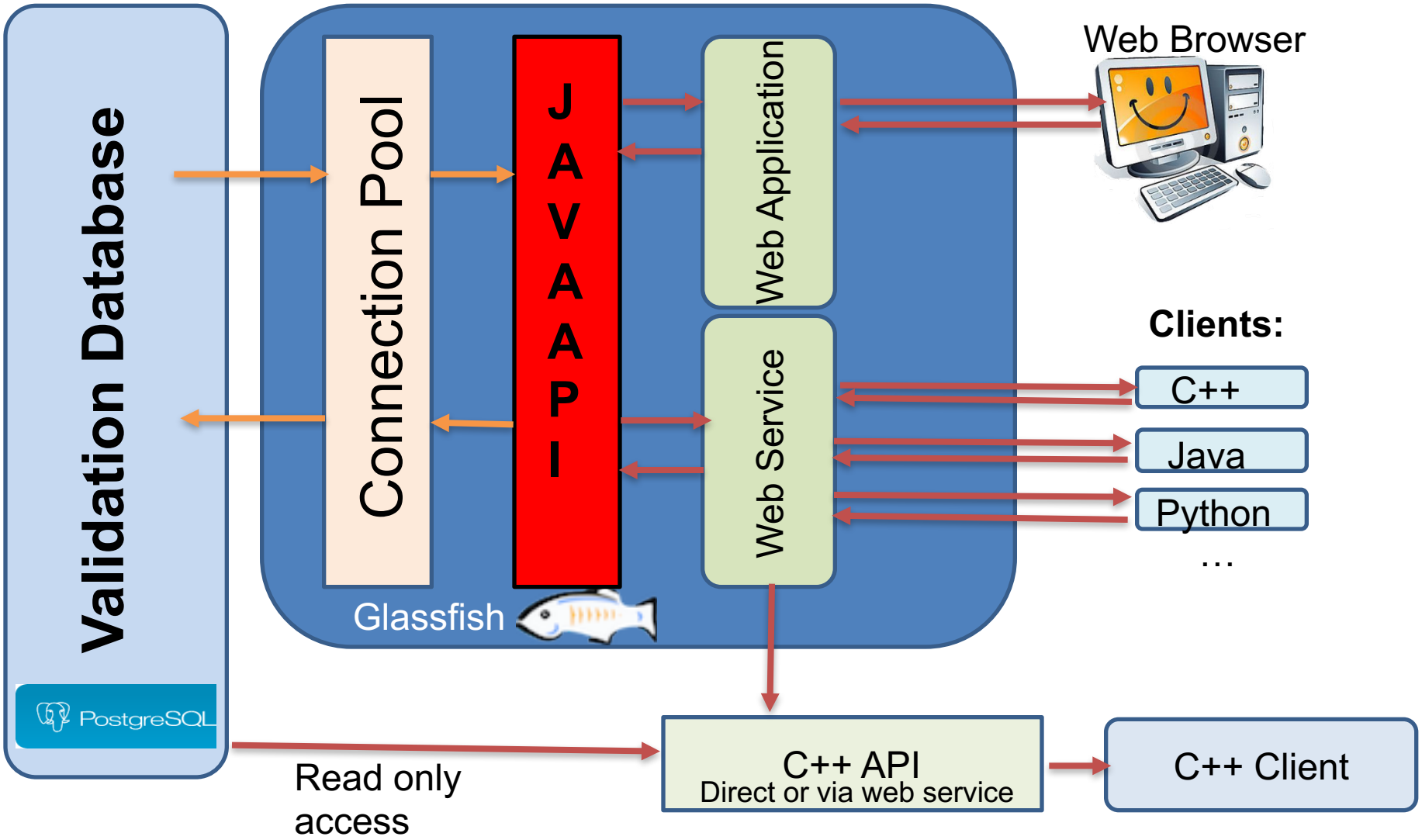
Requirements

- Provide repository:
  - to store experimental validation data as raw data,
  - to store simulation results as raw data and as static plots.
- Provide display web-application 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 REST-ful Web service which:
  - allows programmatic access to the data e.g to be accessed by C++ validation programs.
- Modern look, meaningful search, easy to navigate menus.
- Based on modern internet technology and industry standards.
- Secure!

What's new?

- We have new Database schema which:
  - Allows to serialize multidimensional histograms and data point sets.
  - Uses the same tables for experimental and simulated data.
  - Uses dictionaries for data like materials, particles ..
- We completed the full JAVA API (CRUD: create, read, update, delete) based on the DAO (Data Access Object) pattern and the new db schema.
- We now Provide a REST (representational state transfer)-ful Web service which:
  - allows programmatic access to the data e.g. by C++ validation programs → already used by validation jobs that Julia runs.
- We provide programmatic access from C++ application provided using DbReader by Dimitri → see his presentation in parallel 5A.
- The software is now packaged using maven (ValidationLib, web Application/Service)
- We provide
  - easy to use formats (json/xml) for data exchange and upload of results.
  - Tools to convert result from validation jobs (.root, .csv...) to json format that then can be uploaded.
  - Upload web application.
  - Documentation: https://twiki.cern.ch/twiki/bin/view/Geant4/ExtendingFnalDb
- We switched as much functionality as possible to external tools: e.g. Connection Pools, authentication, Inspire….

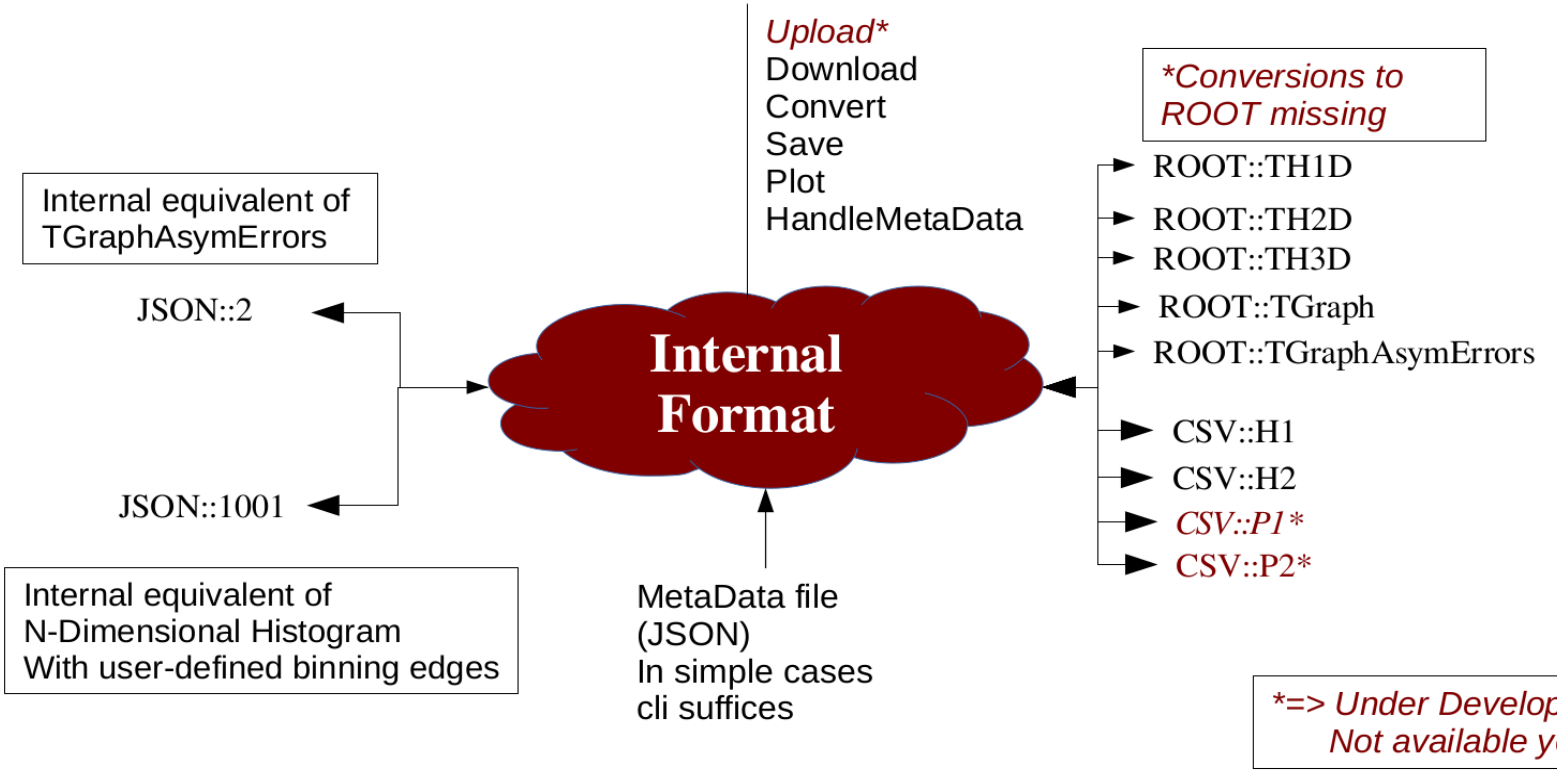
Components:


Validation Database
PostgreSQL
Connection Pool
JAVAAPI
Web Application
Web Service
Glassfish
Web Browser
Clients:
C++
Java
Python
...
Read only access
C++ API
Direct or via web service
C++ Client

Ancillary Tools: Conversion Tool

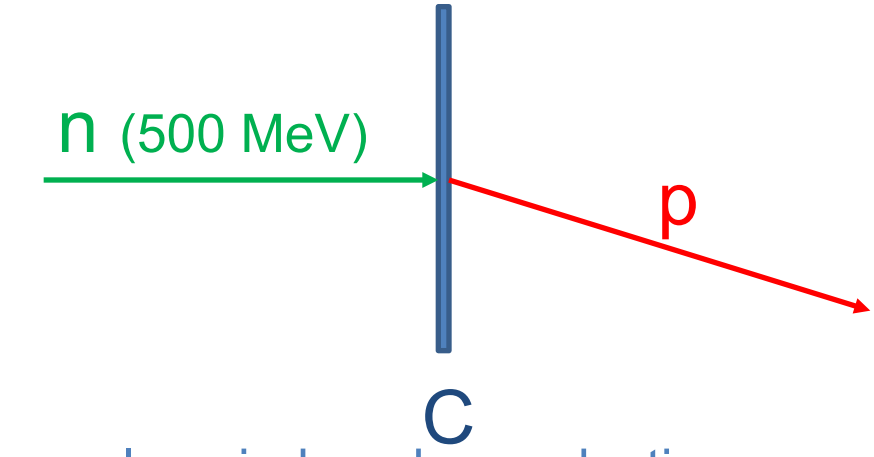
Python program

- to read and convert histograms from/to different formats: ROOT, ASCII (CSV), JSON
- Download from and upload to DoSSiER
- Inspect and interact with histograms (*matplotlib*)
- CLI (script integration) or API (integration in python programs) are available



For more details see Parallel 5A: talk by Andrea and Demo how to use.

Meta data to classify a result



Example: n induced p production

Beam: mono energetic neutrons
Target: Carbon.
Secondary: protons.
Observable: differential cross section
Reaction: particle production
MC detail: e.g. BIC, geant4.10.1.p02

In addition parnames/parvalue pairs can be added

Note:

- Values for metadata stored in dictionaries:
  (Beams, Materials, Particles, Observable, Reaction, MC details…).
- Meta data used to match experimental and simulated results.
- Complicated Beams (e.g. neutrino flux files, test beams consisting of many particles can be described by the schema).
- Ditto for Materials (e.g. Target test beam Calorimeter).
- Dictionaries can evolve as needed.

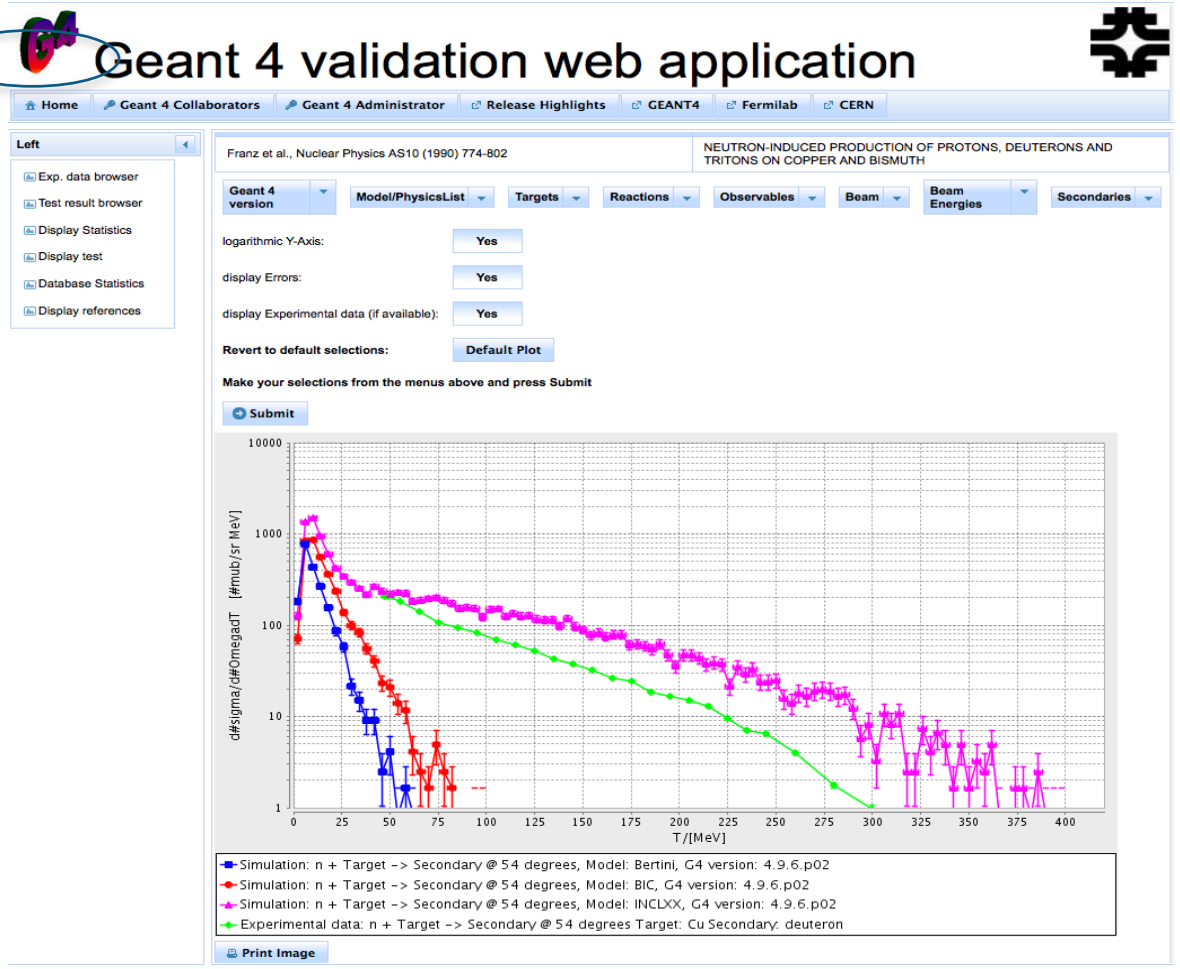
G4WebAppNG: Test Result Browser

Based on prototype schema and API. Can be found at the following URL:
http://g4validation.fnal.gov:8080/G4WebAppNG/ → in the process of porting to DoSSiER!!!!!

This allows to select Geant4 simulation results of interest, and to compare them to the experimental data as applicable. Shown on the right is neutron induced deuteron (default selection).

Different Models:

- BIC(blue),
- Bertini (red)
- INCL++(magenta)
- Experimental Data (green)

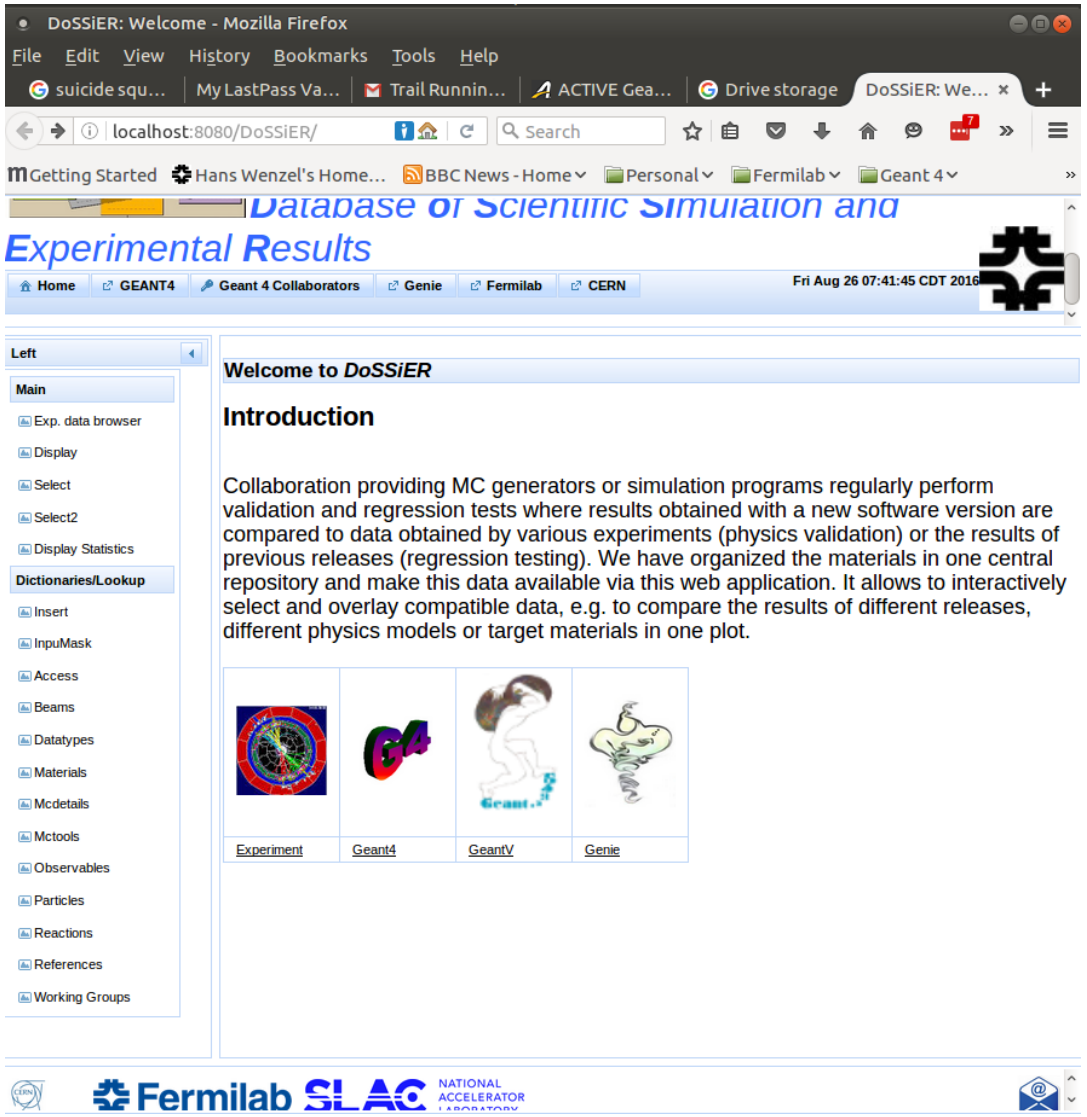


Web application: http://g4devel.fnal.gov:8080/DoSSiER/

Currently:

- Based on new JAVA API and database schema.
- Can display exp. Data. (graph and table)
- Displays dictionaries.
- Displays statistics.
- Allows uploads using json/xml file formats.

But many features still missing, need porting from prototype (G4WebAppNG).



Experimental data Browser

In addition to showing data as plots, one can select "Display data table", to extract the data in a tabulated form that is easy to cut and paste. Or can be retrieved as json/xml, or excel,pdf,csv,xml

Database of Scientific Simulation and Experimental Results

Geant 4 Collaborators | Genie | Fermilab | CERN

Thu Sep 08 14:26:38 CDT 2016

ID	Reference	Journal	Link
20	Neutron Induced Production of Protons, Deuterons and Tritons on Copper and Bismuth	Nucl.Phys.**A510** (1990) , p: 774-802	link

Target | Secondary | theta outgoing particle

Submit

1

Description

ResultID: 1
Reaction: particle production
Target: Cu
Beam: SIN Neutron beam
Secondary: proton
Observable: differential cross section dsig/dO dT
dtype: 1

xml/json:

expanded xml/json:

Data Table

min	max	value	statistical Error	systematic Error
34.0	36.0	852.8	+10.885/-10.885	+0.0/-0.0
36.0	38.0	771.7	+10.045/-10.045	+0.0/-0.0
38.0	40.0	717.6	+9.47/-9.47	+0.0/-0.0
40.0	50.0	691.7	+7.19/-7.19	+0.0/-0.0
50.0	60.0	636.8	+6.65/-6.65	+0.0/-0.0
60.0	70.0	515.4	+5.47/-5.47	+0.0/-0.0
70.0	80.0	402.9	+4.3535/-4.3535	+0.0/-0.0
80.0	90.0	356.7	+3.902/-3.902	+0.0/-0.0
90.0	100.0	343.7	+3.7915/-3.7915	+0.0/-0.0
100.0	110.0	342.5	+3.799/-3.799	+0.0/-0.0
110.0	120.0	299.8	+3.3915/-3.3915	+0.0/-0.0

Experimental statistics

G4 Database statistics - Mozilla Firefox

File Edit View History Bookmarks Tools Help

g4devel.fnal.gov:8080/DoSSiER/DisplayStatistics.xhtml;jsessionid=f3a1d0849b118b0ee61747c4343b

Database of Scientific Simulation and Experimental Results

INSPIRE or exp. website

Home | GEANT4 | Geant 4 Collaborators | Genie | Fermilab | CERN

Left

Main
- Exp. data browser
- Exp. data table browser
- Display
- Select
- Select2
- Display Statistics

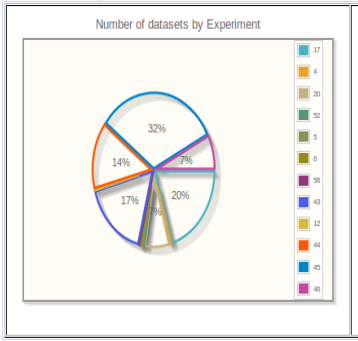
Dictionaries/Lookup
- Access
- Beams
- Datatypes
- Materials
- Mcdetails
- Mctools
- Observables
- Particles
- Reactions
- References
- Working Groups

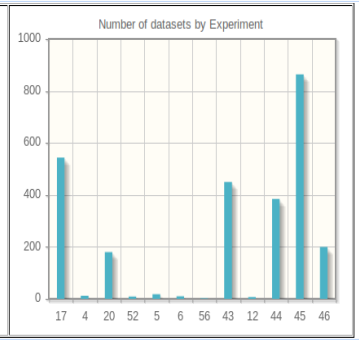
Experiments Statistics

As of Fri Sep 09 08:54:12 CDT 2016
Number of distinct experiments with results in database: 12
Number of data sets in database: 2679

Experimental data with Results in Database

ID	Title	Journal	Results	Link
17	ANGULAR DEPENDENCES OF INCLUSIVE NUCLEON PRODUCTION IN NUCLEAR REACTIONS AT HIGH-ENERGIES AND SEPARATION OF CONTRIBUTIONS FROM QUASIFREE AND DEE	Sov.J.Nucl.Phys.**42** (1985) , p: 116-121	543	link
4	A comparison of pi+ and pi- total cross-sections of light nuclei near the 3-3 resonance	Nucl.Phys.**B62** (1973) , p: 61-85	12	link
20	Neutron Induced Production of Protons, Deuterons and Tritons on Copper and Bismuth	Nucl.Phys.**A510** (1990) , p: 774-802	180	link
52	Proton-nuclei cross sections at 20 GeV	Nucl.Phys.**79** (1966) , p: 609-624	9	link
5	Pion reaction cross-sections and nuclear sizes	Nucl.Phys.**A209** (1973) , p: 1-51	18	link
6	Pion-Nucleus Total Cross-Sections from 88-MeV to 860-MeV	Nucl.Phys.**B76** (1974) , p: 15-28	10	link
56	An Investigation of Quark and Diquark Fragmentation in Neutrino p and Anti-neutrino p Charged Current Interactions in {BEBC}	Nucl.Phys.**B214** (1983) , p: 369	2	link
43	Large-angle production of charged pions with 3-12.9-GeV/c incident protons on nuclear targets	Phys.Rev.**C77** (2008) , p: 055207	450	link
12	NEUTRONS FROM NUCLEAR CAPTURE OF NEGATIVE PIONS	Phys.Rev.**C25** (1982) , p: 3050-3067	7	link
44	Forward production of charged pions with incident pi+- on nuclear targets measured at the CERN PS	Nucl.Phys.**A821** (2009) , p: 118-192	384	link
45	Large-angle production of charged pions with incident pion beams on nuclear targets	Phys.Rev.**C80** (2009) , p: 065207	864	link
46	Forward production of charged pions with incident protons on nuclear targets at the CERN PS	Phys.Rev.**C80** (2009) , p: 035208	200	link





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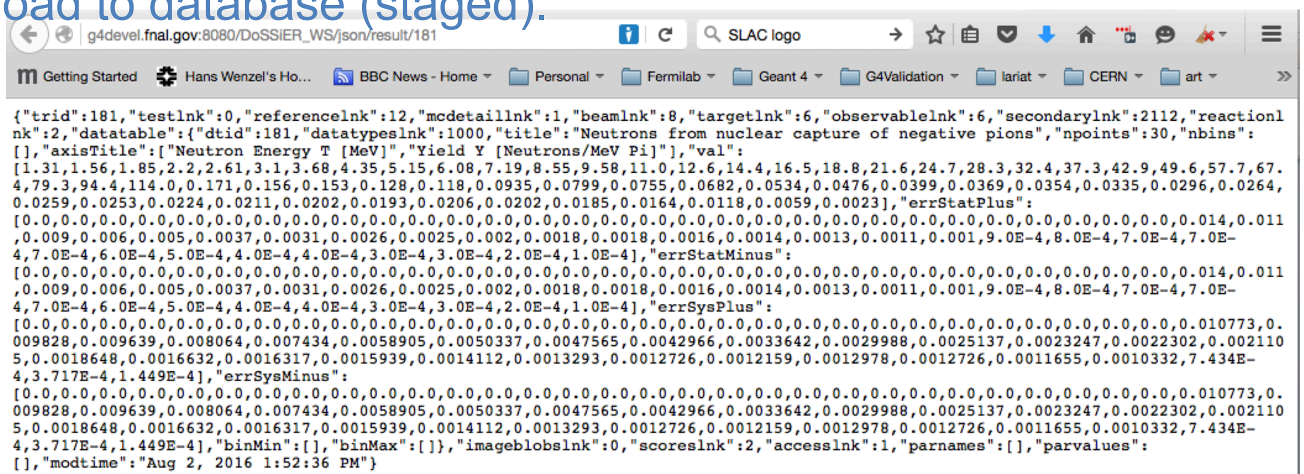
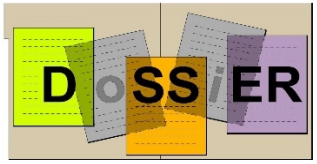
The Web service

- **Based on: Java API for REST - ful** (Representational State Transfer) **Services (JAX-RS)**
- Deployed on the development server: http://g4devel.fnal.gov:8080/DoSSiER_WS/json/result/181
- Allows programmatic retrieval of results in json or xml format (with dictionaries expanded or not) these are the same formats used for uploads!
- C++ clients already used by selected Geant4 validation jobs see Julia's presentation in session xx !
- Planned:
  - Search functions like in INSPIRE/SPIRES.
  - Programmatic upload to database (staged).



Accommodating the GENIE generator

- Reference for neutrino hadron production added to development Database.
- Beams for various neutrino fluxes added.
- Experimental data for neutrino hadron production added.
- Plan:
  - add Minerva GENIE simulations.
  - Provide slide shows/dashboards summarizing relevant data/highlights for each GENIE release.



Summary and Conclusions

- DoSSiER: **D**atabase **o**f **S**cientific **Si**mulation and **E**xperimental **R**esults is actively being developed with participation by Geant4 groups at CERN, Fermilab and SLAC.
- GENIE group is providing input and requirements.
- Experimental data and results from simulation (Geant4, GeantV?, GENIE(soon)) are stored in a relational database.
- Data can be imported and exported using json/xml formats. (scripts are provided to extract data from root files or ASCII tables and convert to json/xml.)
- Web application progressing quickly:
  - allows to select and search.
  - Will allow to overlay experimental and simulated data.
  - authentication is necessary to have access to internal data and functions (e.g. upload, edit, delete, insert).
- Web service: allows programmatic retrieval of data e.g. by validation jobs.
- Porting from prototype G4WebAppNG to DoSSiER well under way!!
- If you want more info or want to contribute (always welcome) visit our twiki: https://twiki.cern.ch/twiki/bin/view/Geant4/ExtendingFnalDb

Plans

- Port all functionality from G4WebAppNG, then ask for user feedback for additional functionality.
- Import more tests and experimental data. On-board other groups like GENIE, GeantV…
- Move to FNAL/CERN SSO (single sign on) for authentication.
- Provide programmatic upload tool via web service.
- Evaluate different tools (node.js) to provide all of DoSSiER's functionality → see presentation by Ioana Ifrim in session 5A.

Backup

Choice of technologies

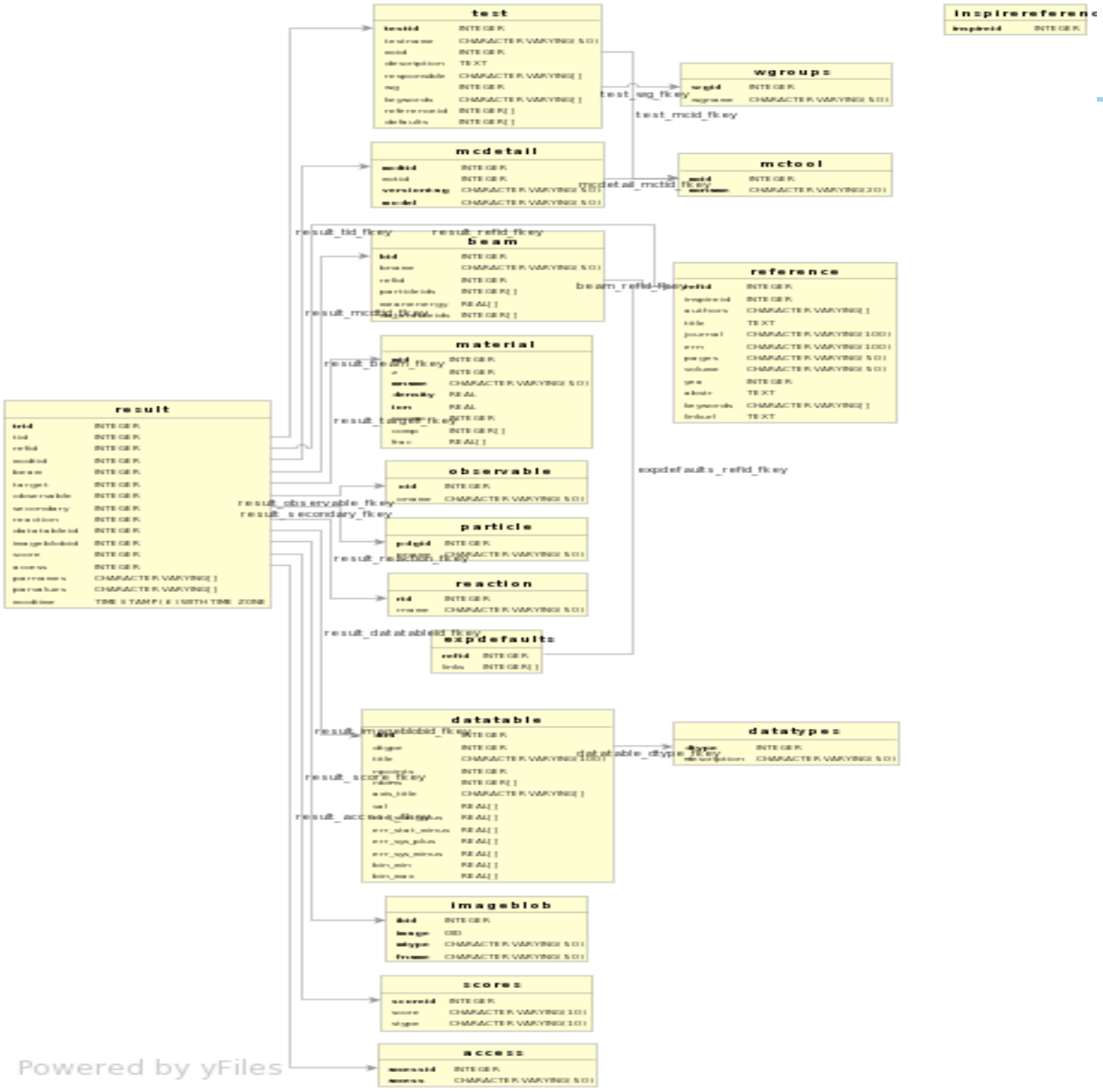
PostgreSQL	Open source relational data base, hosted by Fermilab data base group.
	Glassfish: Web Application server hosted on fermicloud
PRIME FACES	Primefaces JSF (Java Server Faces) based framework to create modern looking web pages and easy to navigate menus.
NetBeans	Integrated Development Environment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

Ancillary Tools

A set of stand-alone python based tools, integrated with DoSSiER are being developed to:

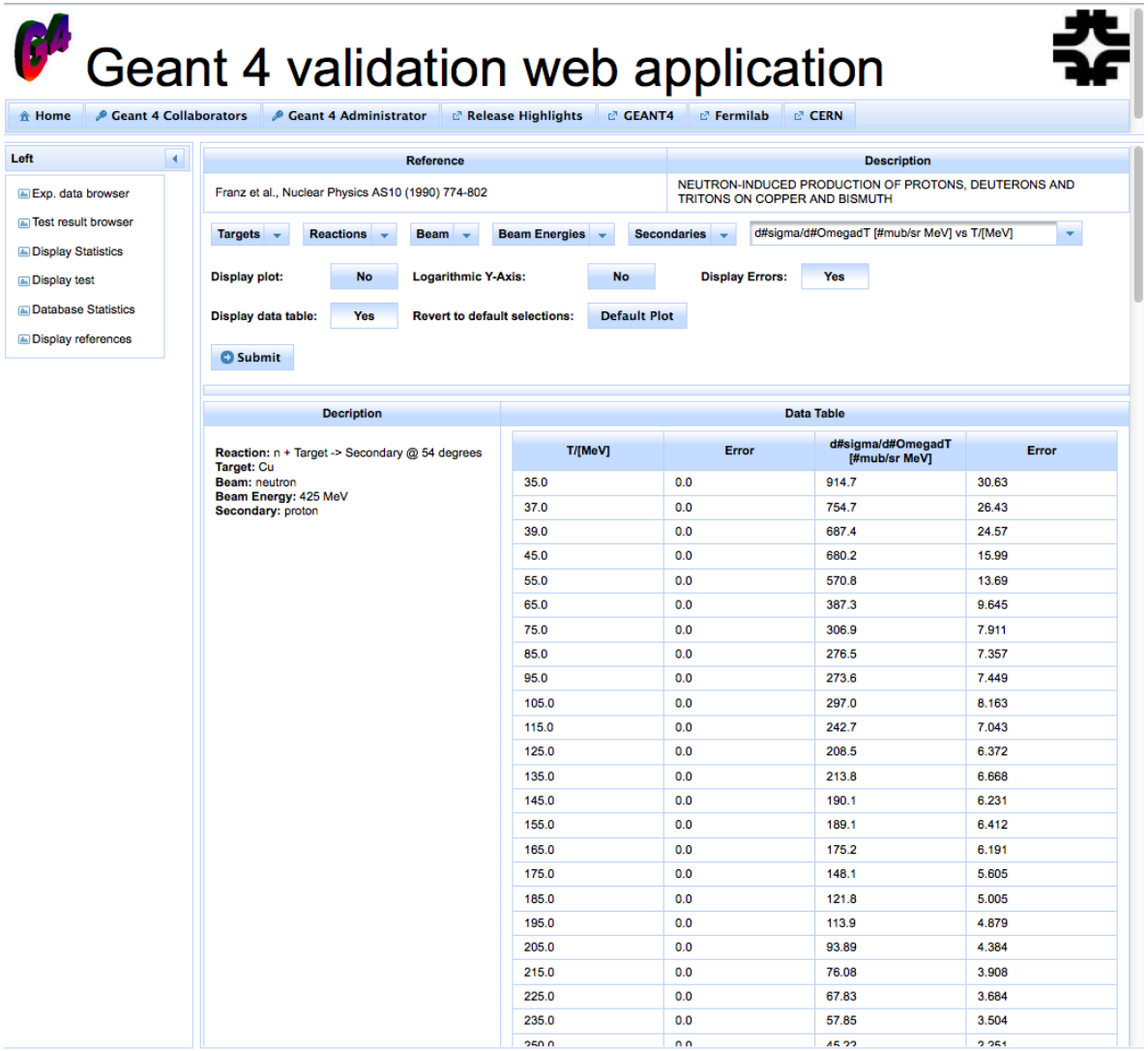
- allow for interaction from command-line or in applications with validation data.
- perform comparisons between results and simulations independently of web-application.
- integrate DoSSiER into Geant4 semi-automatic testing.

Focus is on simple and portable command line applications


test
wgroups
test_wg_fkey
test_rmcid_fkey
mcdetail
mctool
mcdetail_rmctid_fkey
result_tid_fkey
result_refid_fkey
beam
reference
material
result_beam_fkey
result_target_fkey
result
observable
result_observable_fkey
result_secondary_fkey
particle
result_reaction_fkey
reaction
result_datatableid_fkey
expdefaults
expdefaults_refid_fkey
datatable
datatypes
datatable_dtype_fkey
result_score_fkey
imageblob
scores
access
Powered by yFiles

G4WebAppNG: Experimental data Browser

In addition to showing data as plots, one can select "Display data table", to extract the data in a tabulated form that is easy to cut and paste.



Geant 4 validation web application

Home | Geant 4 Collaborators | Geant 4 Administrator | Release Highlights | GEANT4 | Fermilab | CERN

Left

- Exp. data browser
- Test result browser
- Display Statistics
- Display test
- Database Statistics
- Display references

Reference	Description
Franz et al., Nuclear Physics AS10 (1990) 774-802	NEUTRON-INDUCED PRODUCTION OF PROTONS, DEUTERONS AND TRITONS ON COPPER AND BISMUTH

Targets | Reactions | Beam | Beam Energies | Secondaries | d#sigma/d#OmegadT [#mub/sr MeV] vs T/[MeV]

Display plot: No | Logarithmic Y-Axis: No | Display Errors: Yes

Display data table: Yes | Revert to default selections: Default Plot

Submit

Decription

Reaction: n + Target -> Secondary @ 54 degrees
Target: Cu
Beam: neutron
Beam Energy: 425 MeV
Secondary: proton

Data Table

T/[MeV]	Error	d#sigma/d#OmegadT [#mub/sr MeV]	Error
35.0	0.0	914.7	30.63
37.0	0.0	754.7	26.43
39.0	0.0	687.4	24.57
45.0	0.0	680.2	15.99
55.0	0.0	570.8	13.69
65.0	0.0	387.3	9.645
75.0	0.0	306.9	7.911
85.0	0.0	276.5	7.357
95.0	0.0	273.6	7.449
105.0	0.0	297.0	8.163
115.0	0.0	242.7	7.043
125.0	0.0	208.5	6.372
135.0	0.0	213.8	6.668
145.0	0.0	190.1	6.231
155.0	0.0	189.1	6.412
165.0	0.0	175.2	6.191
175.0	0.0	148.1	5.605
185.0	0.0	121.8	5.005
195.0	0.0	113.9	4.879
205.0	0.0	93.89	4.384
215.0	0.0	76.08	3.908
225.0	0.0	67.83	3.684
235.0	0.0	57.85	3.504
250.0	0.0	45.22	3.251

Status: G4WebAppNG (predecessor of DoSSiER)

Can be found at the following URL:
http://g4validation.fnal.gov:8080/G4WebAppNG/
Based on prototype schema and API