

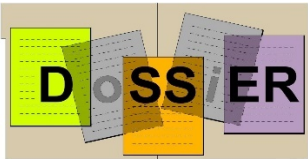
# Database of Scientific Simulation and Experimental Results: Status

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Witold Pokorski, Federico Carminati, Dmitri Konstantinov, Alberto Ribon, Gunter Folger (CERN)  
Andrea Dotti (SLAC)

## Outline:

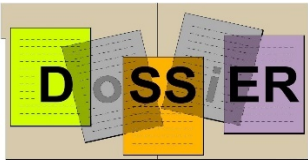
- Motivation
- Requirements
- What's new?
- DoSSiER
  - Components
  - Ancillary Tools
  - Meta Data
- Status of the project
  - Prototype: G4WebAppNG
  - Status of DoSSiER: web application and web service
- Accommodating Neutrino Generators (Genie)
- Summary, Conclusions and Plans





# Motivation

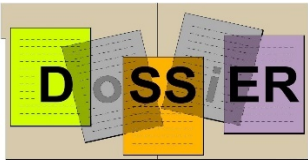
- Provide guidance to experimenters and answers to questions like:
  - What data is used to validate the physics of Geant4/GeantV/GENIE/... ?
  - How well does the Geant4/GeantV/GENIE/... simulation describe the data of interest for the experiment?
  - Which model provided by Geant4/GeantV/GENIE best 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

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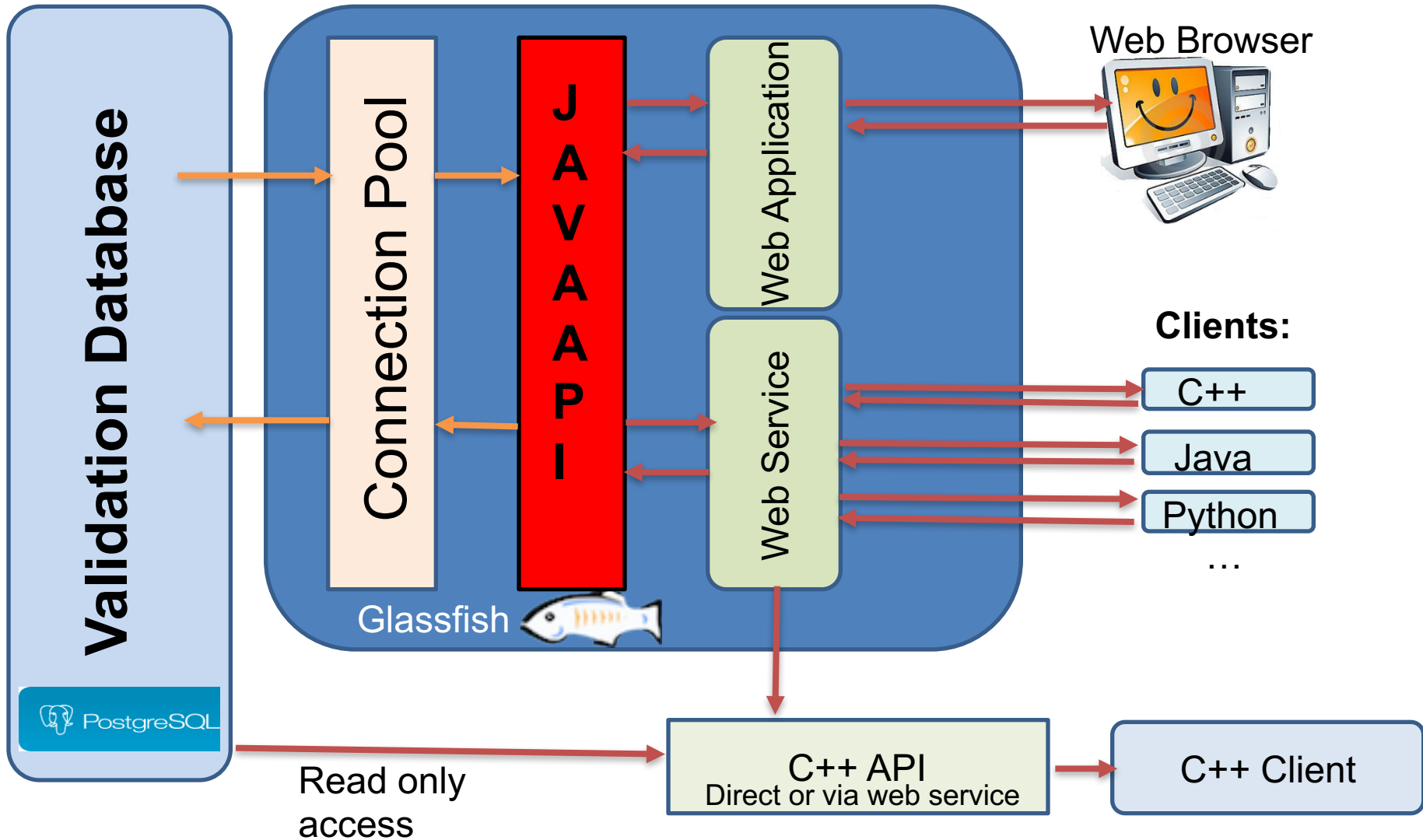
- Provide repository:
  - to store experimental validation data as raw data,
  - to store simulation results as raw data and as static plots.
- Provide display web-application which:
  - allows to select and overlay compatible tests,
  - allows to overlay experimental data,
  - allows automatic upload 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.
  - Allows automatic upload
- Modern look, meaningful search, easy to navigate menus.
- Based on modern internet technology and industry standards.
- Secure!

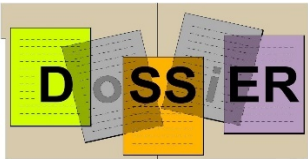


# What's new?

- 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.
- 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 → see Andrea's presentation and Demo.
  - 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:

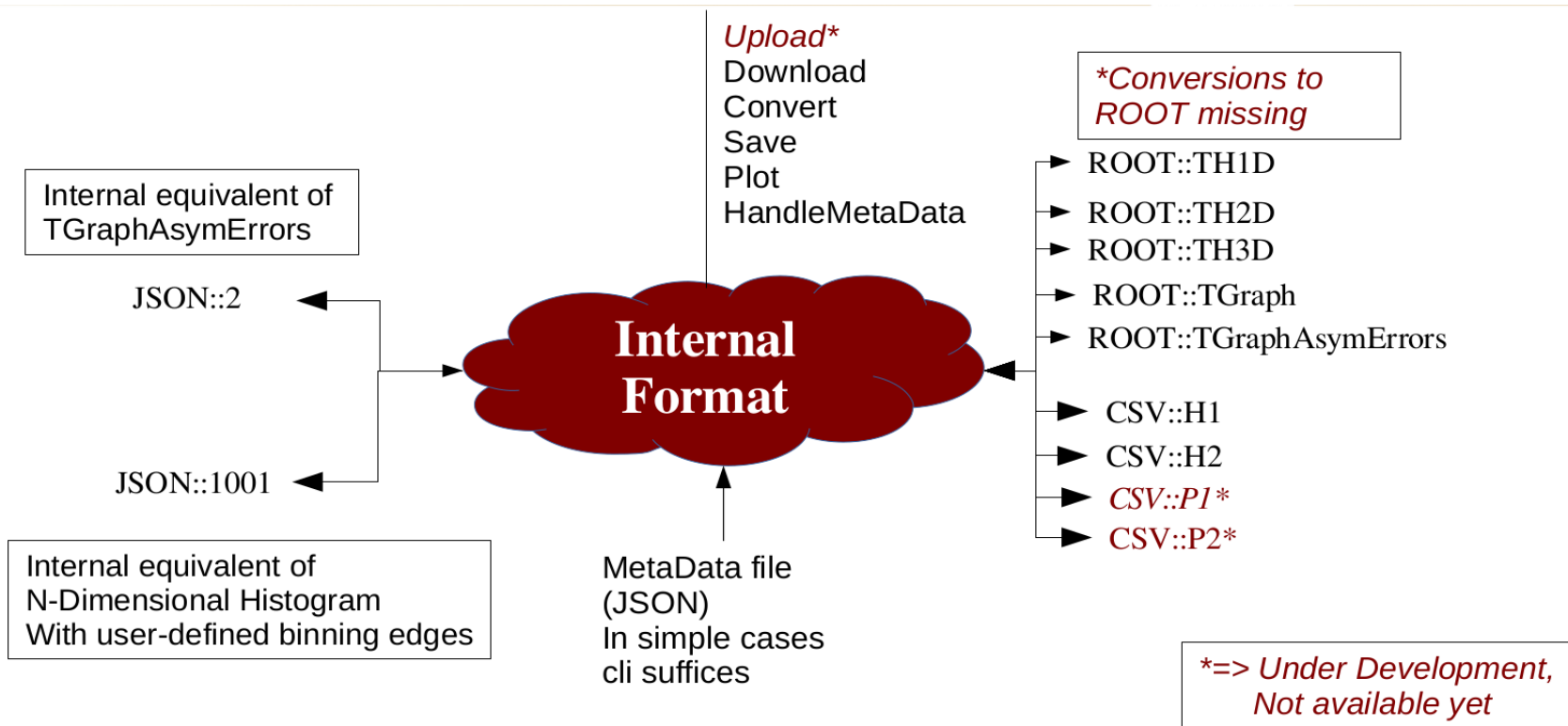




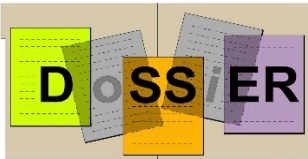
# Ancillary Tools: Conversion Tool

## Python program

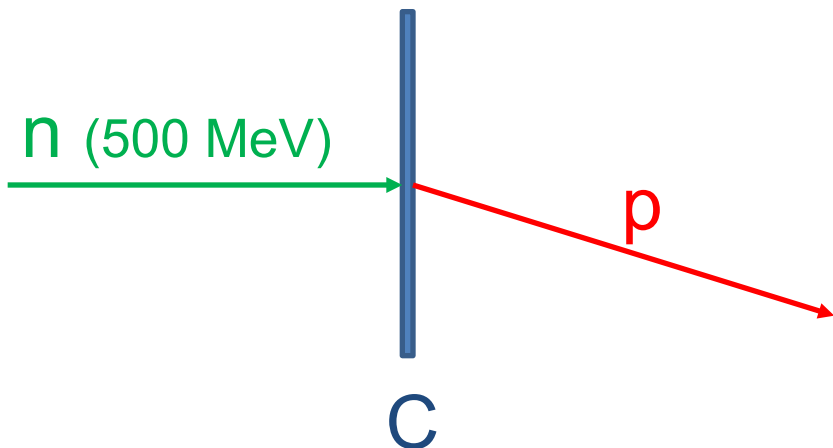
- to read and convert histograms from/to different formats: ROOT, ASCII (CSV), JSON
- Download from and upload to DoSSiER
- Inspect and interact with histograms (*matplotlib*)
- CLI (script integration) or API (integration in python programs) are available



For more see Andrea's presentation 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

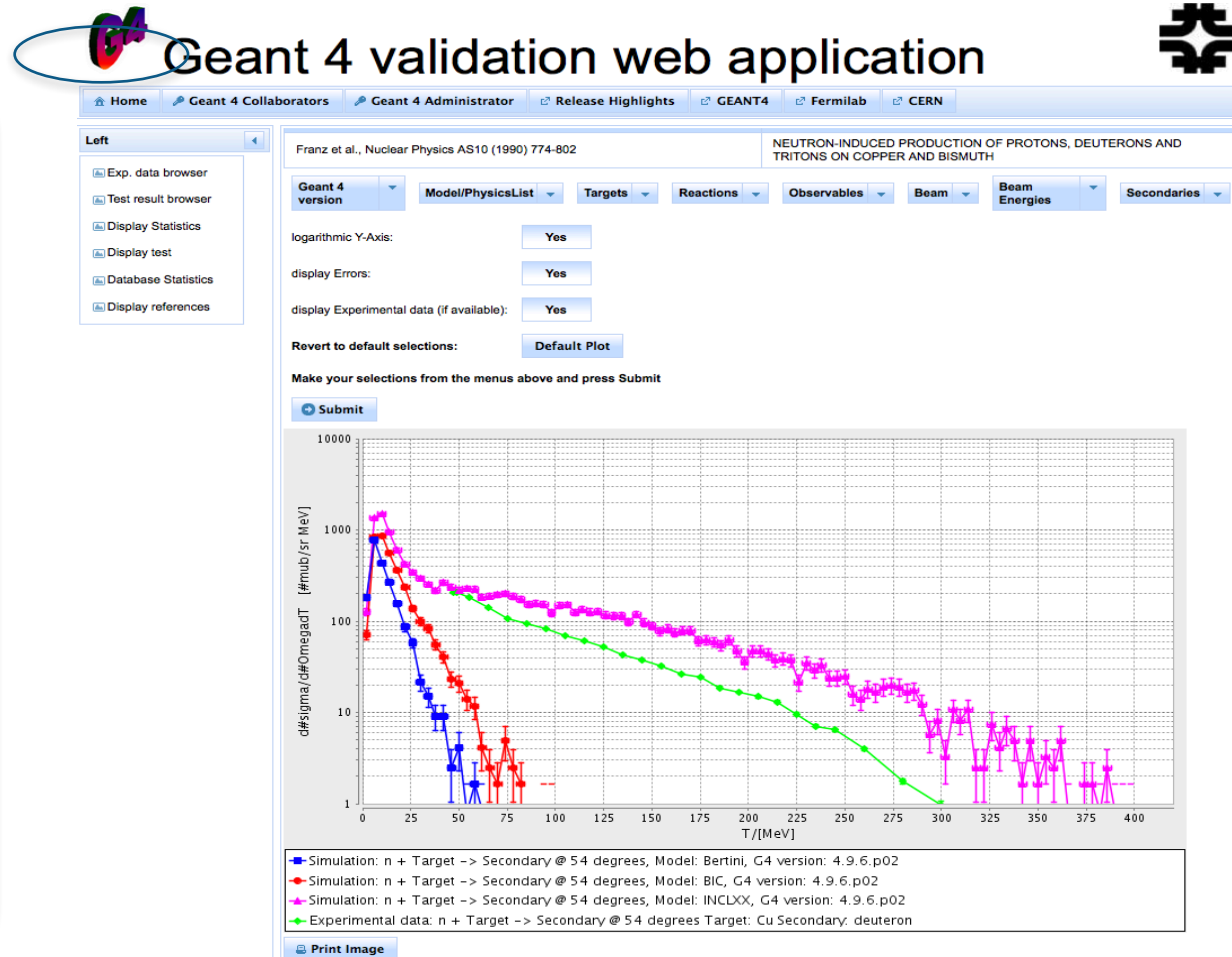
Based on prototype schema and API. Can be found at the following URL:

<http://g4validation.fnal.gov:8080/G4WebAppNG/> → in the process of porting to DoSSiER!!!!

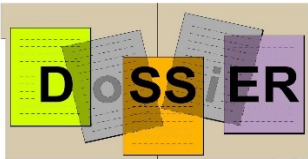
This allows to select Geant4 simulation results of interest, and to compare them to the experimental data as applicable. Shown on the right is neutron induced deuteron (default selection).

Different Models:

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

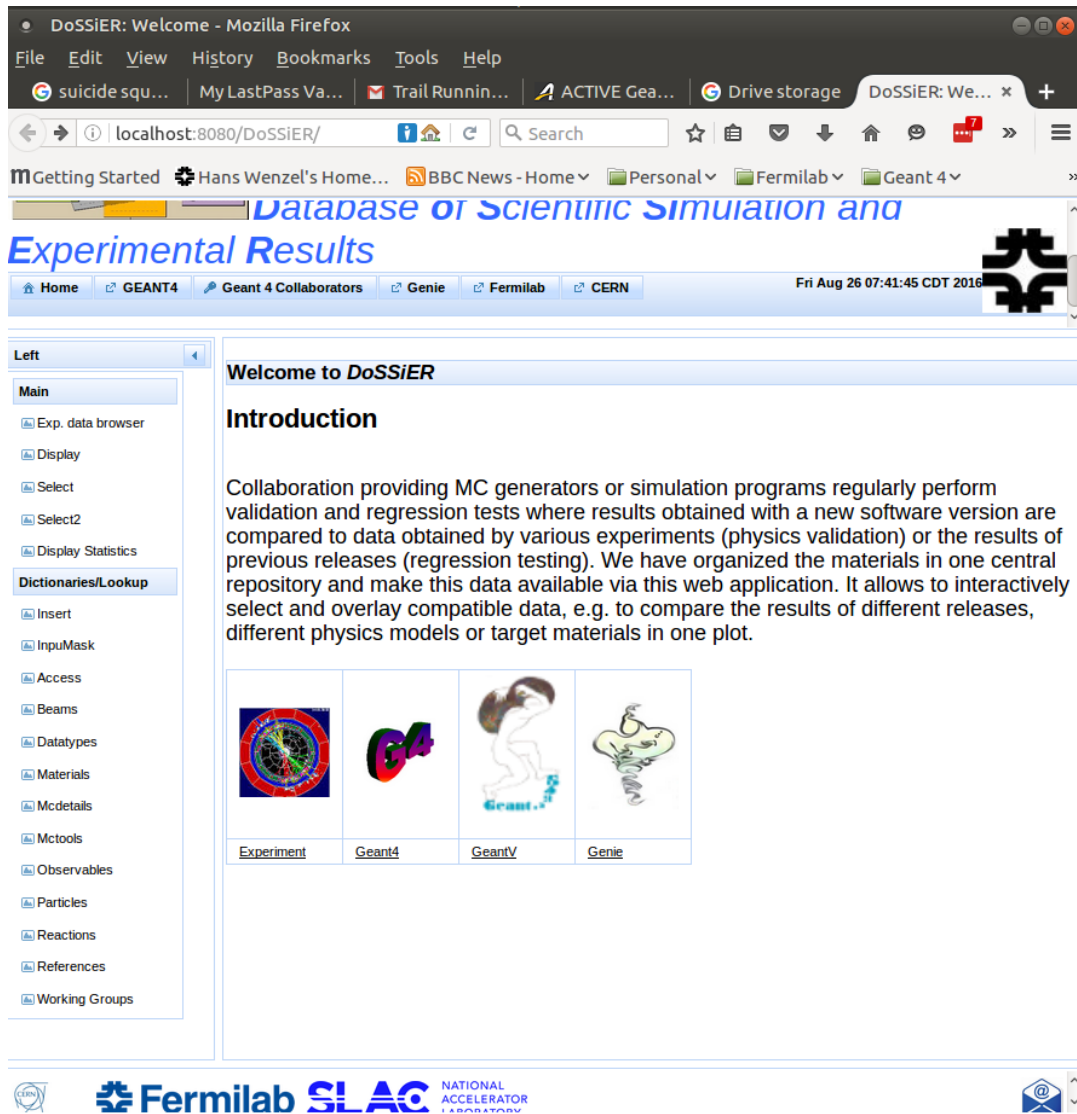


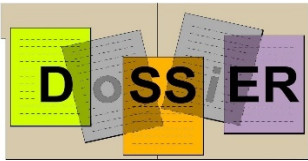




Currently:

- Based on new JAVA API and database schema.
  - Can display exp. /simulated 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



## 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	<a href="#">link</a>

Target: Secondary: theta outgoing particle

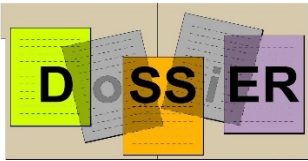
Submit

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

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





# Experimental statistics



G4 Database statistics - Mozilla Firefox

file Edit View History Bookmarks Tools Help

My LastP... | Peopl... | Y Forme... | Shamr... | deleti... | Kronos W... | 6 Event... | C Chica... | C Chica... | C Subsc... | G4 Dat... | doc/gi... | add.js... | SSH K... | Error- /D... | DisplayS > +

g4level.fnal.gov:8080/DoSSiER/DisplayStatistics.xhtml?sessionId=F3a1d0849b118b0ee61747c4343b

Q crud

Getting Started | Hans Wenzel's Home... | BBC News - Home... | Personal | Fermilab | Geant 4 | G4Validation | Iariat | CERN | art | Ubuntu - news, usn | Most Visited | Grid

**DoSSiER** Database of Scientific Simulation and Experimental Results

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

**INSPIRE or exp. website**

### 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

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 (1965) , p. 116-121	543	<a href="#">link</a>
4	A comparison of pi+ and pi- total cross-sections of light nuclei near the 3-3 resonance	Nucl.Phys.62 (1973) , p. 61-85	12	<a href="#">link</a>
20	Neutron Induced Production of Protons, Deuterons and Tritons on Copper and Bismuth	Nucl.Phys.A510 (1990) , p. 774-802	180	<a href="#">link</a>
52	Proton-nuclei cross sections at 20 GeV	Nucl.Phys.79 (1966) , p. 609-624	9	<a href="#">link</a>
5	Pion reaction cross-sections and nuclear sizes	Nucl.Phys.A209 (1973) , p. 1-51	18	<a href="#">link</a>
6	Pion-Nucleus Total Cross-Sections from 88-MeV to 960-MeV	Nucl.Phys.B76 (1974) , p. 15-28	10	<a href="#">link</a>
56	An Investigation of Quark and Diquark Fragmentation in Neutrino SpS and Anti-neutrino SpS Charged Current Interactions in (BEBC)	Nucl.Phys.B214 (1983) , p. 369	2	<a href="#">link</a>
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	<a href="#">link</a>
12	NEUTRONS FROM NUCLEAR CAPTURE OF NEGATIVE PIONS	Phys.Rev.C25 (1982) , p. 3050-3067	7	<a href="#">link</a>
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	<a href="#">link</a>
45	Large-angle production of charged pions with incident pion beams on nuclear targets	Phys.Rev.C80 (2009) , p. 065207	864	<a href="#">link</a>
46	Forward production of charged pions with incident protons on nuclear targets at the CERN PS	Phys.Rev.C80 (2009) , p. 035208	200	<a href="#">link</a>

Number of datasets by Experiment

Number of datasets by Experiment

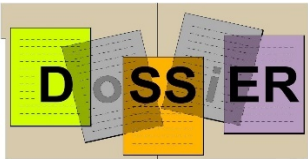
Left sidebar menu:

- Main
  - Exp. data browser
  - Exp. data table browser
  - Display
  - Select
  - Select2
  - Display Statistics
- Dictionaries/lookup
  - Access
  - Beams
  - Datatypes
  - Materials
  - Modelats
  - Mctools
  - Observables
  - Particles
  - Reactions
  - References
  - Working Groups

Footer: Fermilab | NATIONAL ACCELERATOR





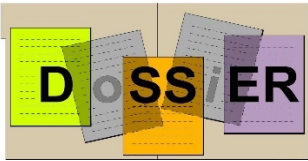


## Accommodating the GENIE generator

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- 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/dashboard summarizing relevant data/highlights for each GENIE release.





# Summary and Conclusions

- DoSSiER: **D**atabase **o**f **S**cientific **S**imulation 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).
- 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

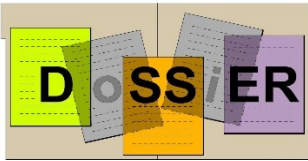
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- Port all functionality from G4WebAppNG, then ask for user feedback for additional functionality.
- Import more tests and experimental data. On-board other groups like GENIE, GeantV...
- Move to FNAL/CERN SSO (single sign on) (saml/shibboleth) for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



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# Backup





# Choice of technologies

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

# Ancillary Tools

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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



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

Targets: [v] Reactions: [v] Beam: [v] Beam Energies: [v] Secondaries: [v] d#sigma/d#Omega dT [#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]

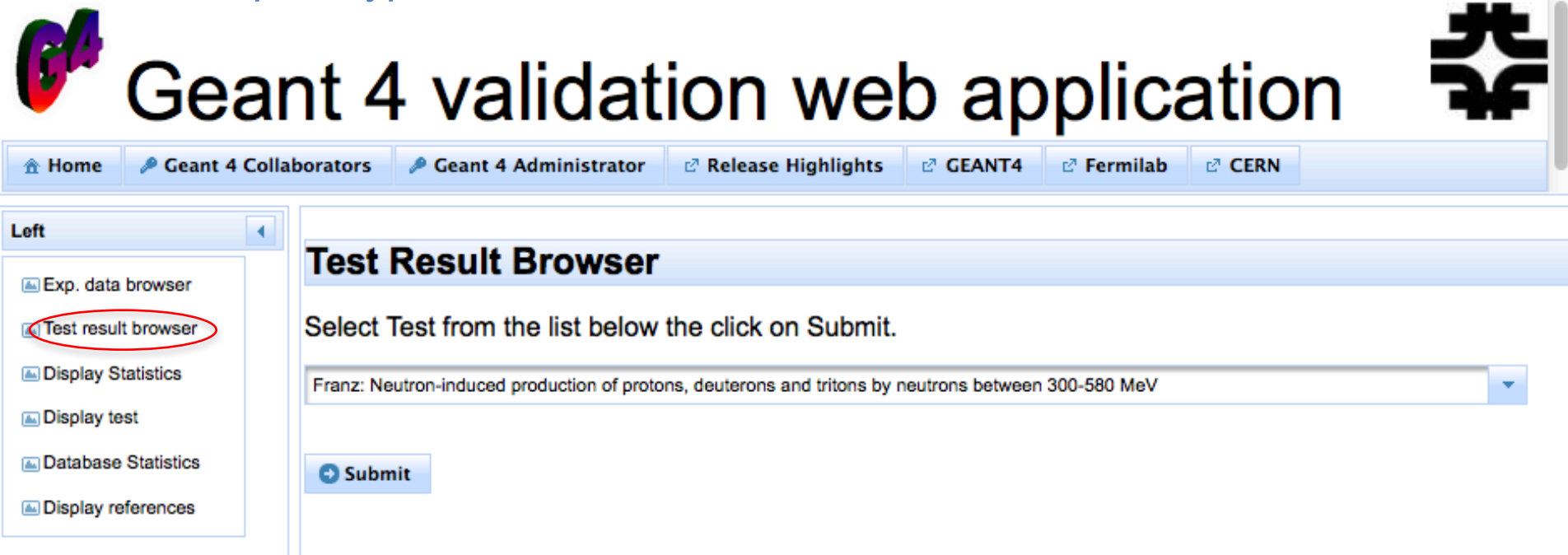
Decription	Data Table			
Reaction: n + Target -> Secondary @ 54 degrees Target: Cu Beam: neutron Beam Energy: 425 MeV Secondary: proton	T/[MeV]	Error	d#sigma/d#Omega dT [#mub/sr MeV]	Error
	35.0	0.0	914.7	30.63
	37.0	0.0	754.7	26.43
	39.0	0.0	687.4	24.57
	45.0	0.0	680.2	15.99
	55.0	0.0	570.8	13.69
	65.0	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	2.251	

# Status: G4WebAppNG (predecessor of DoSSiER)

Can be found at the following URL:

<http://g4validation.fnal.gov:8080/G4WebAppNG/>

Based on prototype schema and API



The screenshot shows the web application interface for Geant 4 validation. At the top left is the G4 logo, and at the top right is the Fermilab logo. The main heading is "Geant 4 validation web application". Below this is a navigation bar with links: Home, Geant 4 Collaborators, Geant 4 Administrator, Release Highlights, GEANT4, Fermilab, and CERN. On the left side, there is a "Left" sidebar with a list of menu items: Exp. data browser, Test result browser (circled in red), Display Statistics, Display test, Database Statistics, and Display references. The main content area is titled "Test Result Browser" and contains the instruction "Select Test from the list below the click on Submit." Below this is a dropdown menu with the selected text "Franz: Neutron-induced production of protons, deuterons and tritons by neutrons between 300-580 MeV". At the bottom of the main content area is a "Submit" button.