

<http://www.geant4.org>

ProcessLevel test-suite update

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Outlook

Introduction: what is this application?

Recent activities: comparison with data, cross-sections, integration in docker and Azure

Initial presentation with details made at FNAL collaboration meeting:
<https://goo.gl/i6kPBw>

Introduction



What ProcessLevel is

A general purpose testing application that can simulate any G4Process **single interactions** specifying

- primary type and energy
- target material or isotope
- process type and sub-type

Everything is configured via macro-commands

- goal: reduce at minimum coding
- includes **run-time definition of output** (histograms, ntuples)
- more complex analysis algos can be added via a simple plugin mechanism

Example: study Bertini interactions of 1 GeV protons on Lead

Start application using FTFP_BERT physics lists using the following macro file:

```
##Primary name in standard G4 naming scheme
```

```
/processTest/primaryName pi-
```

```
##Energy of the primary
```

```
/processTest/primaryEnergy 1 GeV
```

```
##Target material from NIST database
```

```
/processTest/targetMaterial G4_Pb
```

```
#Process type. See G4ProcessType and Sub-type (4=Hadronic, 121=Inelastic)
```

```
/processTest/processType 4
```

```
/processTest/processSubType 121
```

```
/run/initialize
```

Example: study Bertini interactions of 1 GeV protons on Lead

Define histograms/ntuples with quantities extracted from secondaries

```
##Specify libraries to be load containing analysis algorithms
```

```
/processTest/analysis/library libAnalysisDefault.so
```

```
## Book an histogram Id = 0
```

```
/analysis/h1/create nSpectraLeading EnergyNeutronLeading 100 0.001 1 GeV
```

```
/analysis/h1/setXaxis 0 "Ekin [GeV]"
```

```
/analysis/h1/setYaxis 0 "dXS/dE"
```

```
## fill histogram with id 0 with the kinetic energy of the leading neutron and normalize histogram (XS)
```

```
/processTest/analysis/histo1D 0 Ekin 0 neutron true
```

```
/run/beamOn 1000
```

Complete documentation for all commands is available

Status of analysis libraries

More than 100 algorithms are available:

1. some are trivial quantities: kinetic energy of particles (spectra)
2. some may involve more than one particle: aperture angle between two leading secondaries
3. finally other are complex quantities: double differential lorentz-invariant cross-sections

Status



New since FNAL coll. meeting

Integrated with docker to run on Azure: histograms for 10.{1,2,3} are available

About 78000 regression testing macros are available for majority of processes and many energy points (macros are generated by cmake)

By default the data for total cross-section as a function of energy of a given process are created

Add possibility to specify isotope/isomer as target instead of material

Add possibility to specify range of reaction energies and not single fixed energy

New since FNAL coll. meeting

Simple GUI to manipulate configuration macro: currently on hold (lower priority)

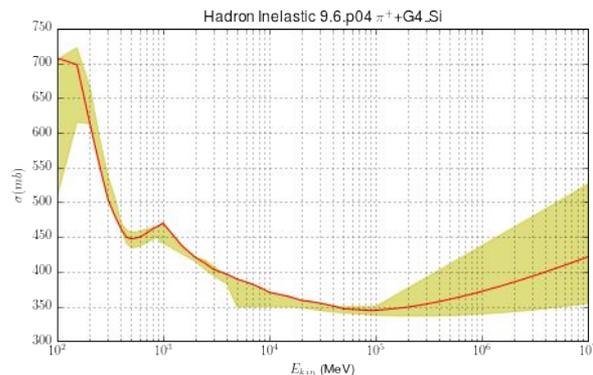
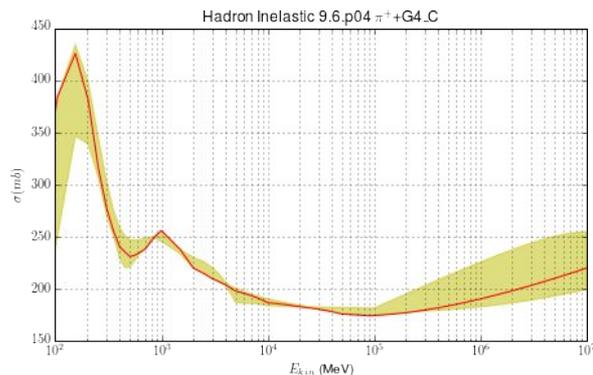
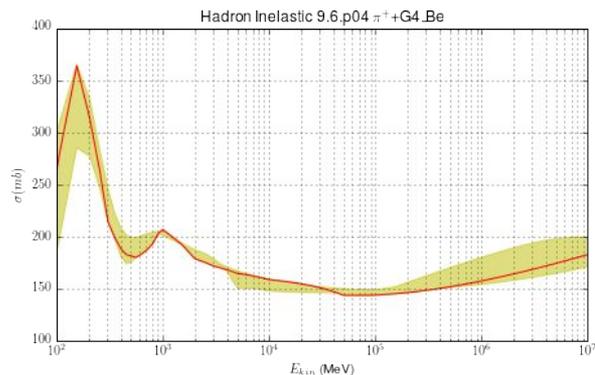
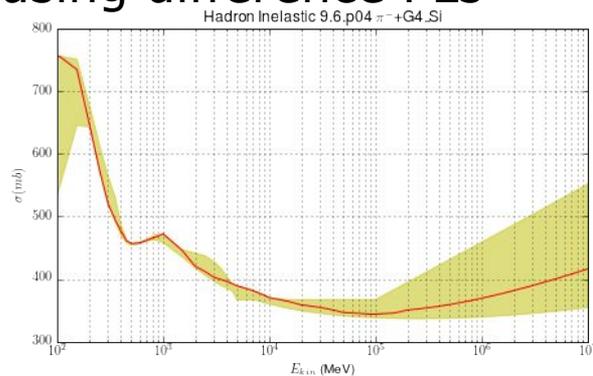
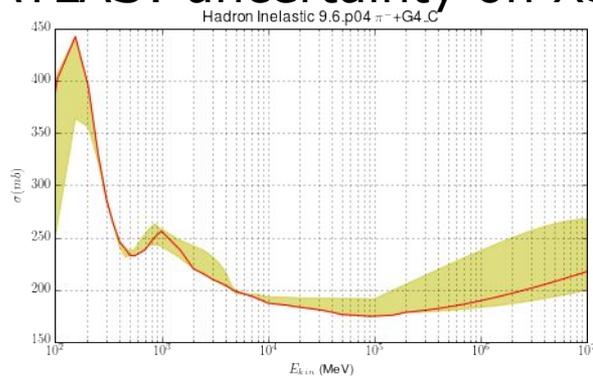
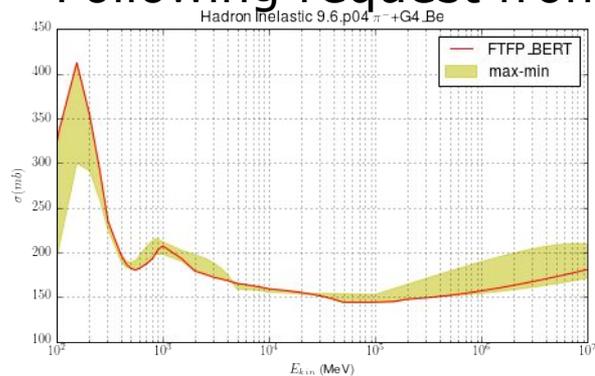
Optional use of local physics-list to change at run-time the models overlap region

Some old Geant4 validations being re-implemented with data comparison. Data and plotting macros are available

In the following showing examples of what is possible to obtain from application (only a showcase, not validation!)

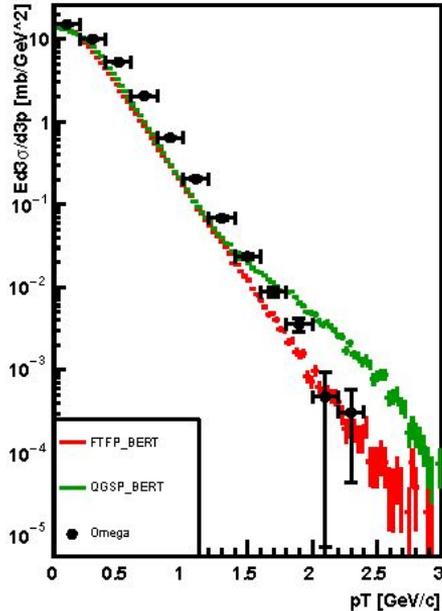
Total had inelastic cross-sections studies

Following request from ATLAS: uncertainty on XS using difference PLs

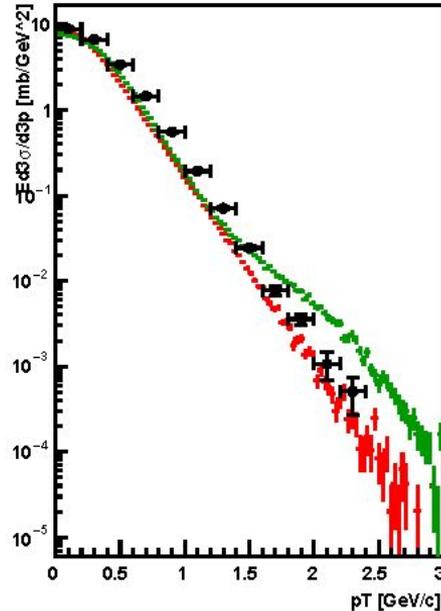


Forward π^0 production: Omega experiment

Inclusive π^0 invariant σ ($0.1 < x_F \leq 0.2$)



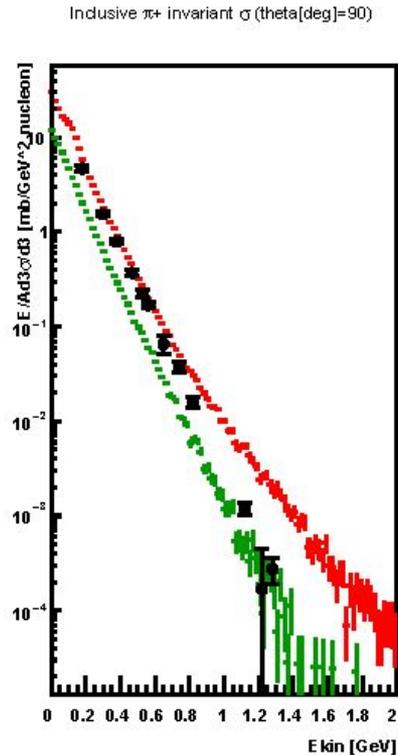
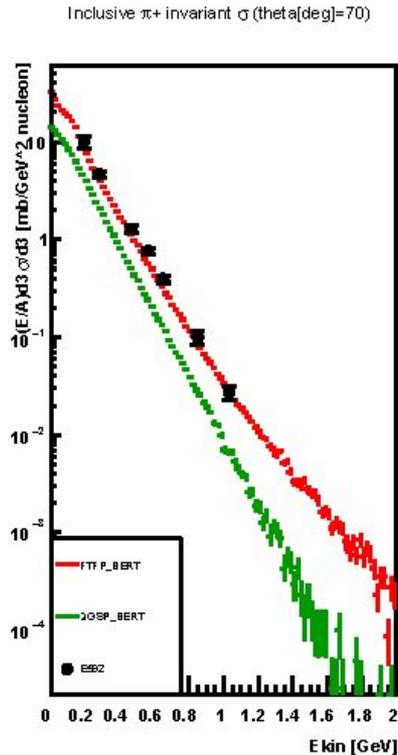
Inclusive π^0 invariant σ ($0.2 < x_F \leq 0.3$)



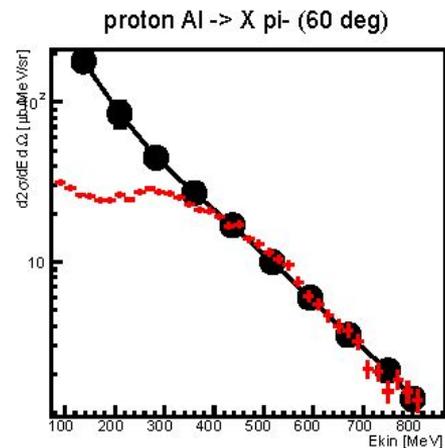
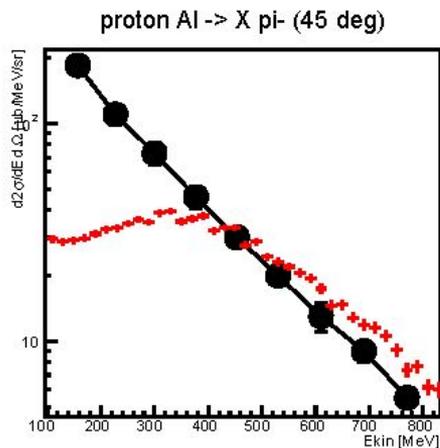
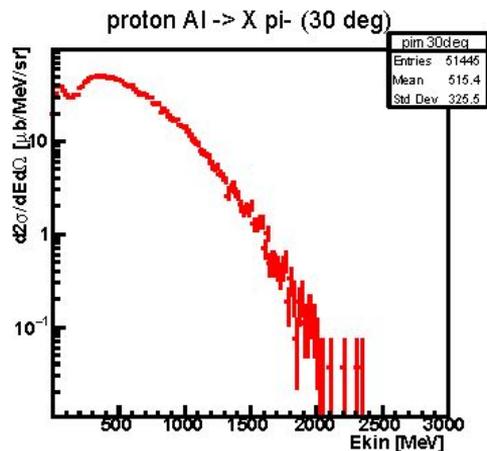
Lorentz-Invariant
differential XS in bins of X_f

Inclusive charged pion production: E592 experiment

Lorentz-Invariant differential
XS in bins of theta



Bertini validation test-suite

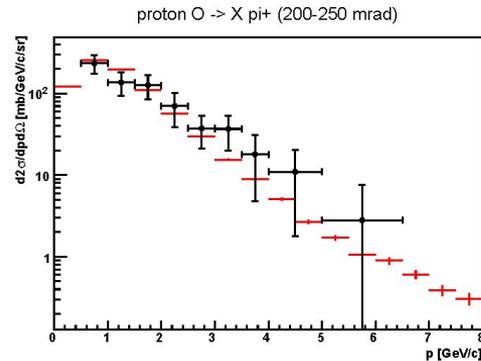
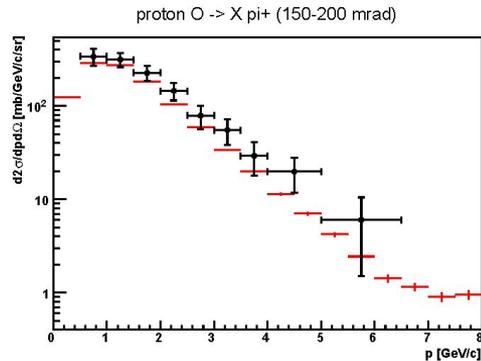
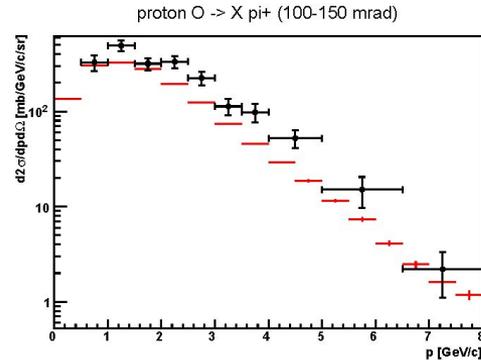
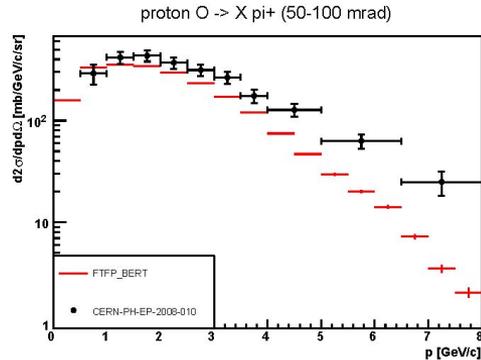


Double-differential cross-sections

Note that some plots are always created even when no data are available: to compare models

pion production: HARP data

Double differential cross-sections



Work in progress

Goal is to add all old validations from hadronic webpages:

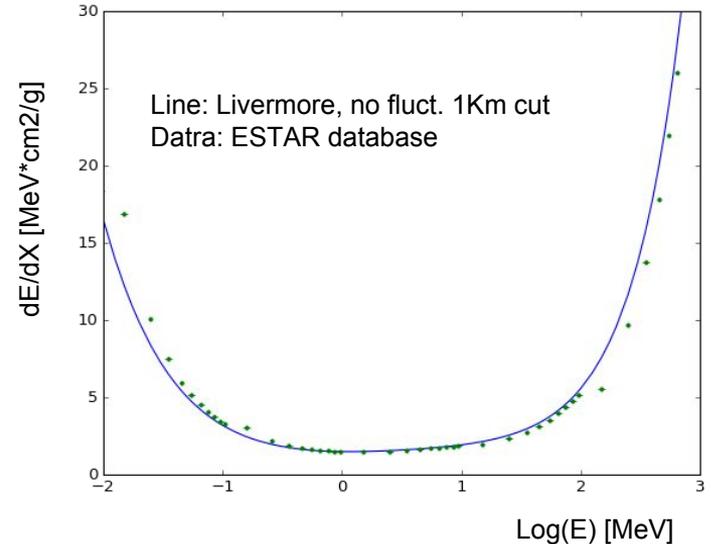
http://www.geant4.org/geant4/results/validation_plots.htm

Some are not updated since Geant4 Version 9.x

Convert all relevant plots for DoSSiER

- Done for cross-sections
- Being done for Omega results

Integrate some "AlongStep" processes



Todo

Integration with automatic statistical testing StatTest

Automatic translation to DoSSiER format of regression testing plots

Add more comparison with data (including EM testing whenever possible)

Revive configuration GUI (maybe transform it to a jupyter notebook?)

Anybody interested to help out? I'm searching a developer, not a user :-)

Conclusions

ProcessLevel application can produce thin-target (single interaction) plots:

- Simple regression testing plots (less physics oriented, towards automatization)
- Physics observables for validation (comparison with experimental data)

Integrated with docker and Azure for fast and reproducible productions

Integration with DoSSiER ongoing. Question: what is more relevant to store (full test-suite produces $O(100k)$ histos)?

Good progress made since FNAL meeting

- It is only a small fraction of my work-time, proceeds relatively slowly

Backup

Adding a new algorithm

```
#include "Analysis.hh"
#include "Plugin.hh"
using namespace Analysis;

struct cosTheta : public VAnalysis {
    G4double Analyse(const Particle& p ) { return p.fourMom.cosTheta(); }
    DECLARENAM("cosTheta"); //Name used in macro files
    DECLAREDOC("Calculate cos(theta) of input");//Help documentation
};
//Library manifest
PLUGIN(cosTheta);
BEGINLIB()
    ADDPLUGIN(cosTheta);
ENDLIB()
```