The Implementation of a Extensible PhysicsListFactory

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Geant4 Collaboration Mtg 2016-09-12 Parallel 1A

Factory Design Pattern

- Goal: supply a means for users to easily configure their applications at run-time
  - extensible: users need to be able to add their own classes without having to edit (or fork/duplicate) base system factory
  - provide this without disrupting existing user code base

- "Factory" design pattern:
  - constructor method for variants of a base class is registered with central class (usually a singleton object)
    - user code no longer references (via include headers) for particular physics lists
  - users ask for instance of an object of type X via a string
  - object returned via a pointer to base class

A Tale of Two Factories

- Physics Lists
- Physics Constructors

- Nomenclature of Geant4 implementations is a bit confusing
  - for a variety of (mostly historical) reasons
- Central repository of each is implemented as a “Registry”
  - `g4alt::G4PhysListFactory` acts a a facade (by redirecting requests) to `G4PhysListRegistry` in order to maintain backward compatibility with existing user code base

- what about the `G4GenericPhysicsList` ?
  - uses physics constructor registry to populate “list”
  - can be “ordered up” from the physics list registry/factory like any ordinary list

New PhysicsList Factory

- g4alt::G4PhysListFactory mimics and expands on the G4PhysListFactory class
  - drop in compatibility (sans g4alt namespace)
    - include different header + using namespace g4alt
  - only run-time difference for existing uses is a bit in the G4cout output
  - provides additional features
    - expandability for user classes
    - generalize EM options facility
      - ReplacePhysics ("_") vs. RegisterPhysics ("+")

Status

- Now fully working/tested on Windows
  - struggled w/ issue for static builds
    - (no load whole archive option — need to initialize static variables to register classes)
- test38 integrated into CDash / ctest system

- Report of problem when building user applications using GNUmakefile system
  - not clear to be in exactly what circumstances
  - when I tried it some months ago, problems seem to be unrelated to physics list factory work
  - tried, just before this meeting, to reproduce but didn't get far enough to explore possibilities (100GB build space limit).
- Last set of commits / tags were rejected based on this

Moving Forward

- Resolve GNUmakefile build issue (if it is an issue).
- Exchange the g4alt vs. current versions — or just replace?
- I have a start on documentation in Fermilab Redmine that could be transferred elsewhere
- Thanks to all who have contributed to effort in this area of user configurability

Backup Material

- Mostly last year's talk

Usage (old)

- Examples of use in examples/tests
  - two forms: given a string or from the $PHYSLIST env variable
  - new factory is "drop in" compatible (currently in g4alt namespace)

```
const char* plname = 0;
if ( argc > 2 ) { //Physics List via command line
    G4cout<<argv[2]<<G4endl;
    plname = argv[2];
}
else { //Search physics list via env.variable
    plname = getenv("PHYSLIST");
    if ( !plname ) plname = "local";//No command line and no env.
}
if ( strcmp(plname,"local")==0 ) {
    runManager->SetUserInitialization(new BeamTestPhysicsList);
}
else {
  G4PhysListFactory factory;
  runManager->SetUserInitialization( factory.GetReferencePhysList(plname) );
}
```

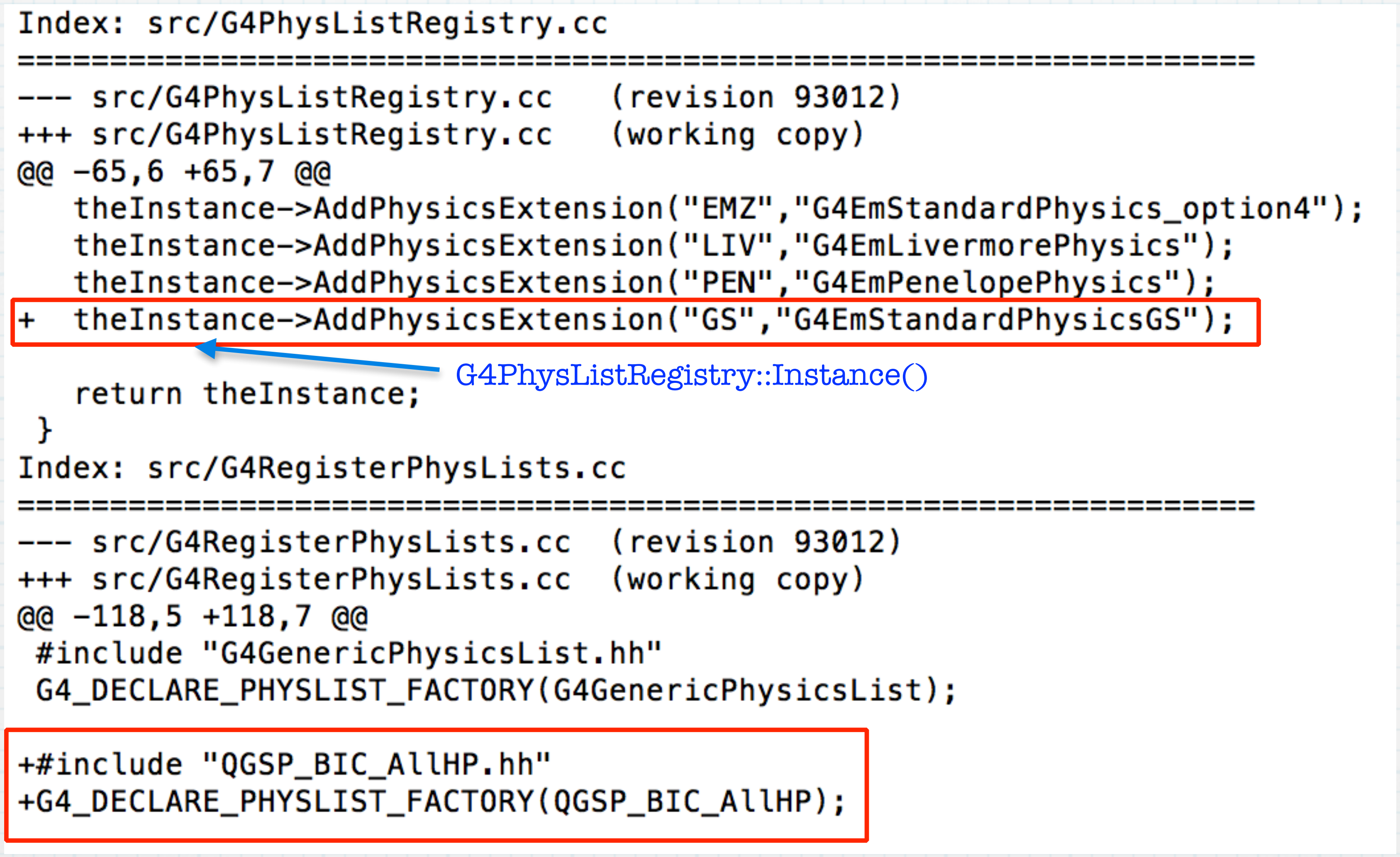
```
// return FTFP_BERT unless $PHYSLIST env set
// no means of local choice of default
G4PhysListFactory factory;
runManager->SetUserInitialization(factory.ReferencePhysList());
```

Involved Classes

- G4PhysListFactoryAlt [.hh | .cc]
  - defines g4alt::G4PhysListFactory
  - implements extended version of existing G4PhysListFactory
  - factory just acts as a dispatcher to G4PhysListRegistry
- G4PhysListRegistry [.hh | .cc]
  - singleton holding strings and their mapping to G4PhysListStamper
    - no internal pre-defined list; external code can self register
  - also hold extension mapping (e.g. _EMX etc)
- G4PhysListStamper.hh
  - PhysList equivalent of G4PhysicsConstructorFactory
  - clash of terminology "factory" as individual builder or collection
- G4RegisterPhysLists.cc
  - register all G4 supplied lists
    - special handling for physics lists because they're templated; no .cc
    - user physics lists can similarly register themselves with the factory

How to Extend

- Examples of new lists and new EM extension
  - for supplied standards make changes to these files
  - for user extensions, they can do it in code compiled into their own library



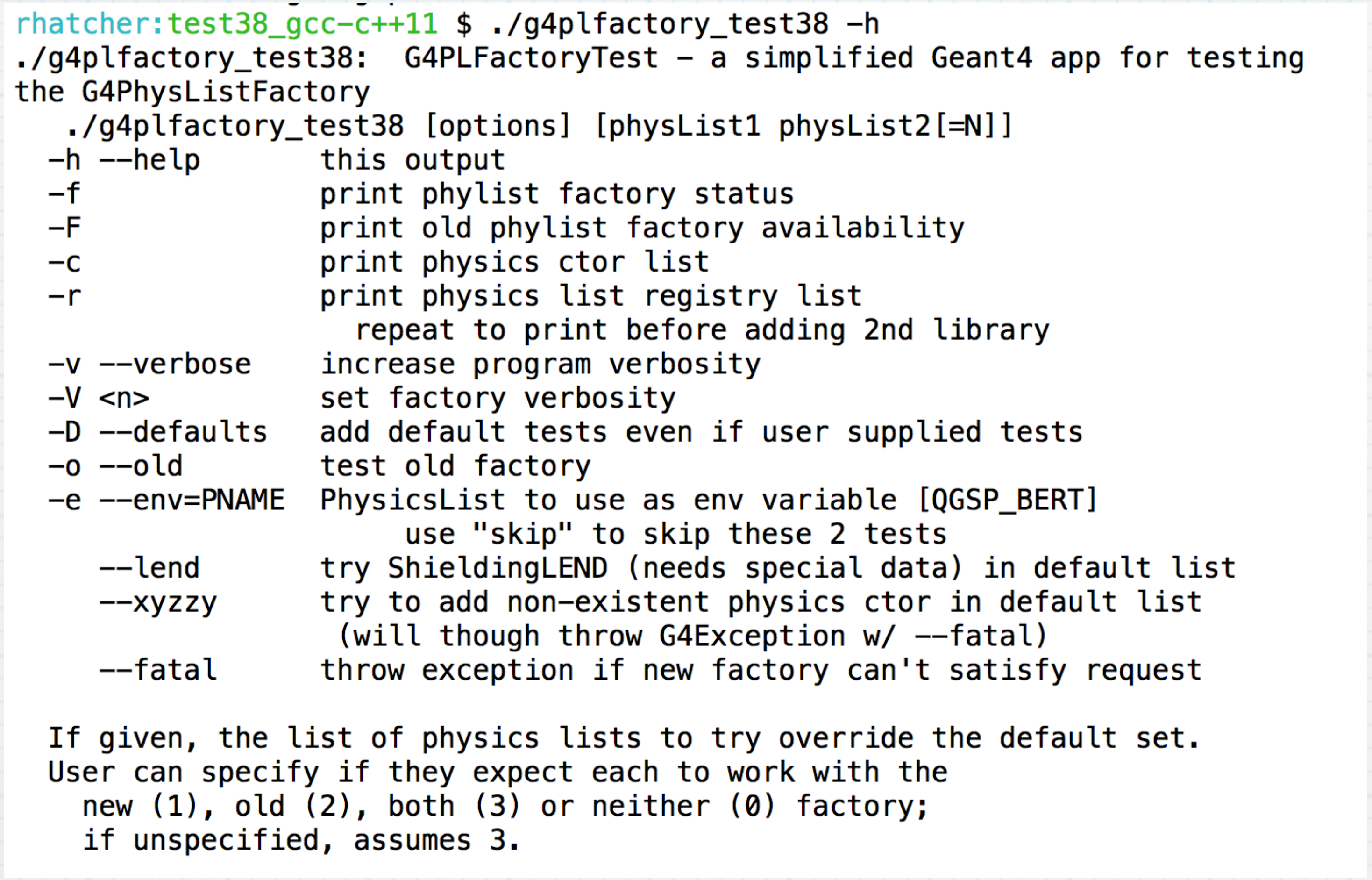
```
Index: src/G4PhysListRegistry.cc
===================================================================
--- src/G4PhysListRegistry.cc   (revision 93012)
+++ src/G4PhysListRegistry.cc   (working copy)
@@ -65,6 +65,7 @@
   theInstance->AddPhysicsExtension("EMZ","G4EmStandardPhysics_option4");
   theInstance->AddPhysicsExtension("LIV","G4EmLivermorePhysics");
   theInstance->AddPhysicsExtension("PEN","G4EmPenelopePhysics");
+  theInstance->AddPhysicsExtension("GS","G4EmStandardPhysicsGS");

   return theInstance;
 }
Index: src/G4RegisterPhysLists.cc
===================================================================
--- src/G4RegisterPhysLists.cc  (revision 93012)
+++ src/G4RegisterPhysLists.cc  (working copy)
@@ -118,5 +118,7 @@
 #include "G4GenericPhysicsList.hh"
 G4_DECLARE_PHYSLIST_FACTORY(G4GenericPhysicsList);

+#include "QGSP_BIC_AllHP.hh"
+G4_DECLARE_PHYSLIST_FACTORY(QGSP_BIC_AllHP);
```

g4plfactory_test38

- Implemented a stand-alone “test38”
  - ~~not~~ now integrated into full ctest chain
  - exercise the interfaces
    - provides optional cross check with old implementation



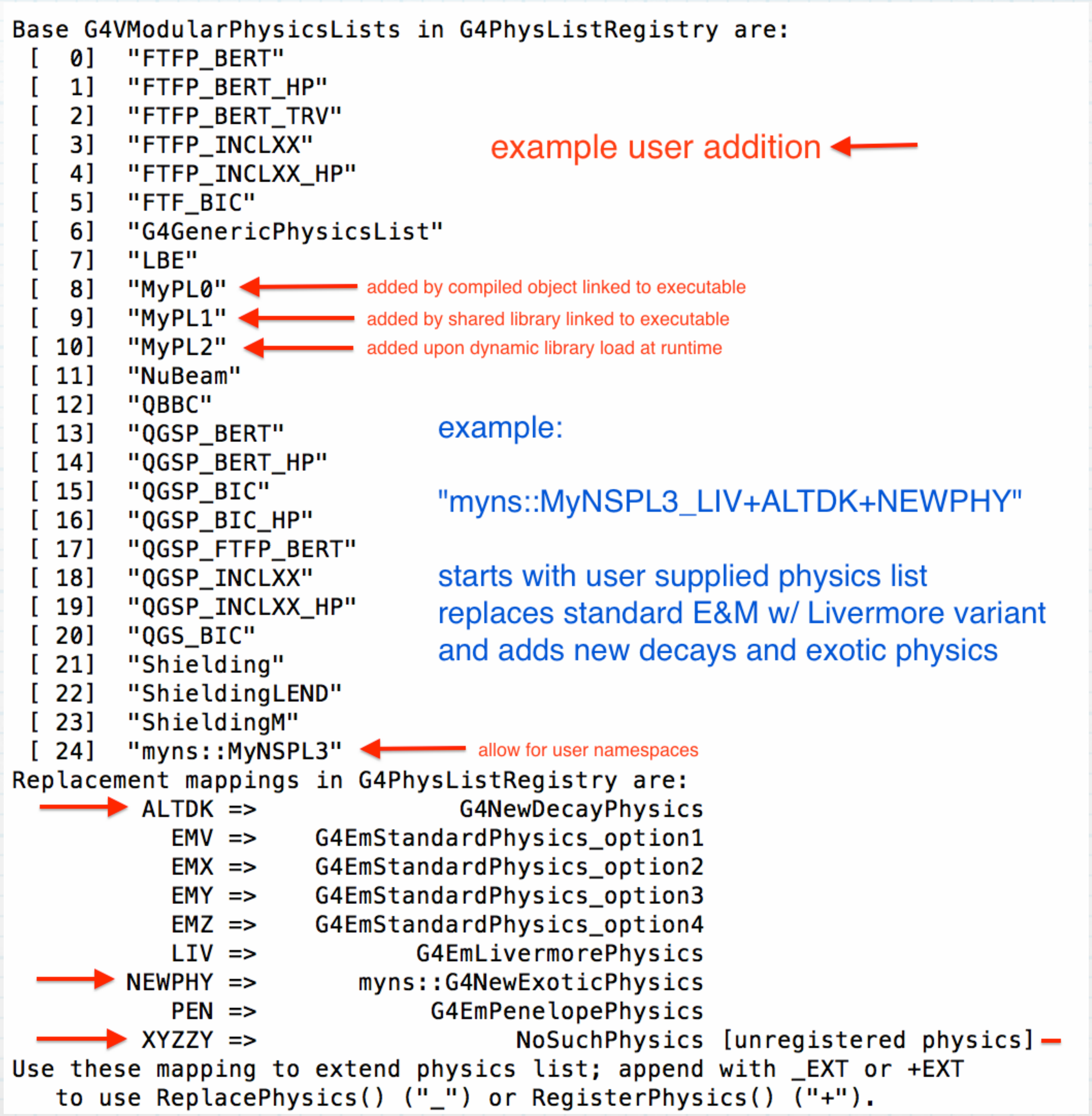
```
rhatcher:test38_gcc-c++11 $ ./g4plfactory_test38 -h
./g4plfactory_test38:  G4PLFactoryTest - a simplified Geant4 app for testing
the G4PhysListFactory
   ./g4plfactory_test38 [options] [physList1 physList2[=N]]
  -h --help       this output
  -f              print phylist factory status
  -F              print old phylist factory availability
  -c              print physics ctor list
  -r              print physics list registry list
                    repeat to print before adding 2nd library
  -v --verbose    increase program verbosity
  -V <n>          set factory verbosity
  -D --defaults   add default tests even if user supplied tests
  -o --old        test old factory
  -e --env=PNAME  PhysicsList to use as env variable [QGSP_BERT]
                       use "skip" to skip these 2 tests
     --lend       try ShieldingLEND (needs special data) in default list
     --xyzzy      try to add non-existent physics ctor in default list
                   (will though throw G4Exception w/ --fatal)
     --fatal      throw exception if new factory can't satisfy request

  If given, the list of physics lists to try override the default set.
  User can specify if they expect each to work with the
    new (1), old (2), both (3) or neither (0) factory;
    if unspecified, assumes 3.
```

g4plfactory_test38

- -f = factory status
- recommend to print this if user requests non-existent combination
- simply call:

```
PrintAvailablePhysLists()
```



```
Base G4VModularPhysicsLists in G4PhysListRegistry are:
 [  0]  "FTFP_BERT"
 [  1]  "FTFP_BERT_HP"
 [  2]  "FTFP_BERT_TRV"
 [  3]  "FTFP_INCLXX"
 [  4]  "FTFP_INCLXX_HP"
 [  5]  "FTF_BIC"
 [  6]  "G4GenericPhysicsList"
 [  7]  "LBE"
 [  8]  "MyPL0"
 [  9]  "MyPL1"
 [ 10]  "MyPL2"
 [ 11]  "NuBeam"
 [ 12]  "QBBC"
 [ 13]  "QGSP_BERT"
 [ 14]  "QGSP_BERT_HP"
 [ 15]  "QGSP_BIC"
 [ 16]  "QGSP_BIC_HP"
 [ 17]  "QGSP_FTFP_BERT"
 [ 18]  "QGSP_INCLXX"
 [ 19]  "QGSP_INCLXX_HP"
 [ 20]  "QGS_BIC"
 [ 21]  "Shielding"
 [ 22]  "ShieldingLEND"
 [ 23]  "ShieldingM"
 [ 24]  "myns::MyNSPL3"
Replacement mappings in G4PhysListRegistry are:
         ALTDK =>             G4NewDecayPhysics
           EMV =>     G4EmStandardPhysics_option1
           EMX =>     G4EmStandardPhysics_option2
           EMY =>     G4EmStandardPhysics_option3
           EMZ =>     G4EmStandardPhysics_option4
           LIV =>           G4EmLivermorePhysics
        NEWPHY =>      myns::G4NewExoticPhysics
           PEN =>            G4EmPenelopePhysics
         XYZZY =>                 NoSuchPhysics [unregistered physics]
Use these mapping to extend physics list; append with _EXT or +EXT
   to use ReplacePhysics() ("_") or RegisterPhysics() ("+").
```

example user addition

added by compiled object linked to executable

added by shared library linked to executable

added upon dynamic library load at runtime

allow for user namespaces

example:

"myns::MyNSPL3_LIV+ALTDK+NEWPHY"

starts with user supplied physics list
replaces standard E&M w/ Livermore variant
and adds new decays and exotic physics

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