How to simulate heavy stable particles in Atlas using Geant4

This page is intended as a simple manual to use the Athena package I have developed on some of the heavy stable hadrons that appear in extensions to the Standard Model such as R-hadrons and KK-gluons in hadrons.

Prerequisites

I will assume that you are acquainted with running single-particle simulations in Athena. If this is not the case a number of tutorials are available on the web covering the subject. You will need to have a runtime environment set up. The following examples assume that your username is *mackepr*, that you are running release 12.0.0 on a CERN machine, and that you have set up your release in */scratch/mackepr/cmtwork/12.0.0*.

You need to get the simulation package. Please download the latest version below:

- Particles-19-06-2006.tgz

Set up your installation directory:

```
cd /scratch/mackepr/cmtwork/12.0.0
mkdir Simulation
mkdir Simulation/G4Utilities
cd Simulation/G4Utilities
```

Unpack the archive in your G4Utilities directory and do the usual *cmt config / source setup.sh / make*

Now set up your rundir and runtime environment:

```
cd /scratch/mackepr/cmtwork/12.0.0
mkdir run
cd run
ln -s /afs/cern.ch/atlas/software/builds/AtlasOffline/12.0.0/AtlasOfflineRunTime/cmt/setup.sh set
. setup.sh
```

Next get all files from the share directory of the Particles package and look at them:

customparticles_full.txt

This file contains the particle definition data in the format

```
<PDG> <Mass (GeV)> # <Name>
```

Note that the heavy spectator *must* be the first particle in the list. The first few lines of the default file containing gluino hadron definitions are:

```
1000021    300.000    # ~g
1000993    300.700    # ~g_glueball
1009213    300.650    # ~g_rho+
1009313    300.825    # ~g_K*0
1009323    300.825    # ~g_K*+
1009113    300.650    # ~g_rho0
```

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RhadronProcessList.txt

This file contains the list of all possible processes for your custom particles. Processes are defined using particle names in the format:

```
<Incident> # <Target> # <Out1> # <Out2> (# <Out3>)
```

A couple of lines from the gluino hadron case:

```
~g_rho+ # neutron # ~g_Delta0 # pi+
~g_rho0 # neutron # ~g_Delta- # pi+
~g_rho+ # proton # ~g_rho+ # proton # pi0
~g_rho0 # proton # ~g_rho0 # proton # pi0
```

PhysicsConfiguration.txt

This file allows for setting some physics switches. These are:

- **Resonant** Enables / disables a cross section resonance
- **ResonanceEnergy** Determines at which lab-frame kinetic energy the resonance occurs
- **Gamma** The width of the resonance in CMS (A bit confusing, I know)
- **Amplitude** The height of the resonance in millibarn
- **ReggeSuppression** A charge suppression switch. 0 means no suppresion. 1 is full suppression.

Defaults are:

```
Resonant = 0.
ResonanceEnergy = 200.
Gamma = 0.1
Amplitude = 100.
ReggeSuppression = 0.
```

PDGTABLE.MeV

This file must be present for just about any Athena job to run. It needs to be modified to know the particles contained in customparticles_full.txt. The format is fairly self explanatory.

jo.py

This is a simple set of single particle joboptions. Note that they are set to use ATLAS-DC3-05 as default geometry tag in conformance with release 12.0.0

Running the simulation

Running *athena jo.py* will leave a sim-file named *test.root* in your rundir. This file may be passed on tho the digitization. Remember to pass along the PDGTABLE.MeV. It is needed at all stages in the chain.

Changing physics scenario

I have made a set of configuration files for running on stop hadrons. The usual arguments for stability applies, and any oscillation is disregarded

for now.

- StopFiles.tgz: Stop hadron configuration

Moving these files into your rundir and changing the PDG code in *jo.py* should be enough to have you running on stop hadron instead of gluino hadrons.

-- RasmusMackeprang - 19 Jun 2006

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