# HepPDT
# 1.00
## Particle Data Table Classes

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http://www-pat.fnal.gov/stdhep/heppdt.html

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# 1 Overview

For some time, there has been a need for a C++ class embodying the information contained in the Review of Particle Properties[1]. We have written HepPDT to fill this need. HepPDT allows access to particle name, particle ID, charge, nominal mass, total width, spin information, color information, constituent particles, and decay mode information. HepPDT is designed to be used by StdHepC++[2] or any Monte Carlo generated particle class. Generated particles will contain a pointer to the particle data information found in the HepPDT particle data table. HepPDT also has simple mechanisms to enable customized decay chains.

## 1.1 HepPDT Design

HepPDT has been designed to be used by any Monte Carlo particle generator or decay package. It contains only generic particle attributes. In principle, all information which can be found in the Review of Particle Properties[1] can be encapsulated in HepPDT. HepPDT contains particle information such as charge and nominal mass as well as decay mode information. This information is contained in a table which is accessed by a particle ID number. This ID number is defined according to the Particle Data Group's Monte Carlo numbering scheme[7].

HepPDT may be used alone or as part of the StdHepC++[2] package. StdHepC++ provides a standard generated particle class which can be used to communicate among various Monte Carlo generators and decay packages. A StdHep particle contains momentum information, generated mass, information about its generated decay, and a pointer to the appropriate HepPDT particle data.

Decay information is a crucial part of the particle data in HepPDT. Standard decay information is a list of allowed decay channels with associated branching fractions, decay model names and decay model code. There may also be extra information needed by the decay model (*e.g.*, helicity). A mechanism is provided so that the decay model code can be accessed using the decay data information instead of needing to use a series of if statements based on the decay model name. In addition, users often need the ability to "force" a particle to decay in a certain way. To do this, you must provide custom decay information. Often this information involves the entire decay chain (*e.g.*, $D^{*+} \to D^0\pi^+, D^0 \to K^-\pi^+$). The design allows the generated particle to have a pointer to a custom DecayData object. If this pointer is non-null,the pointed-to object overrides the DecayData associated with the generated particle's ParticleData. To customize the decay chain, the user may create particle aliases which use other special DecayData objects.

Methods are provided to create ParticleDataTable objects from Pythia, Herwig, Isajet, QQ, and EvtGen decay information. Methods are also provided to facilitate creation of custom particle and decay information. A ParticleDataTable object may be created from multiple information sources.

The design requires that ParticleDataTable objects must be fully created before they are used. Multiple data tables are allowed. Although potentially dangerous, we recognize that this is also a powerful option.

Figure 1 shows the interactions of the basic classes.

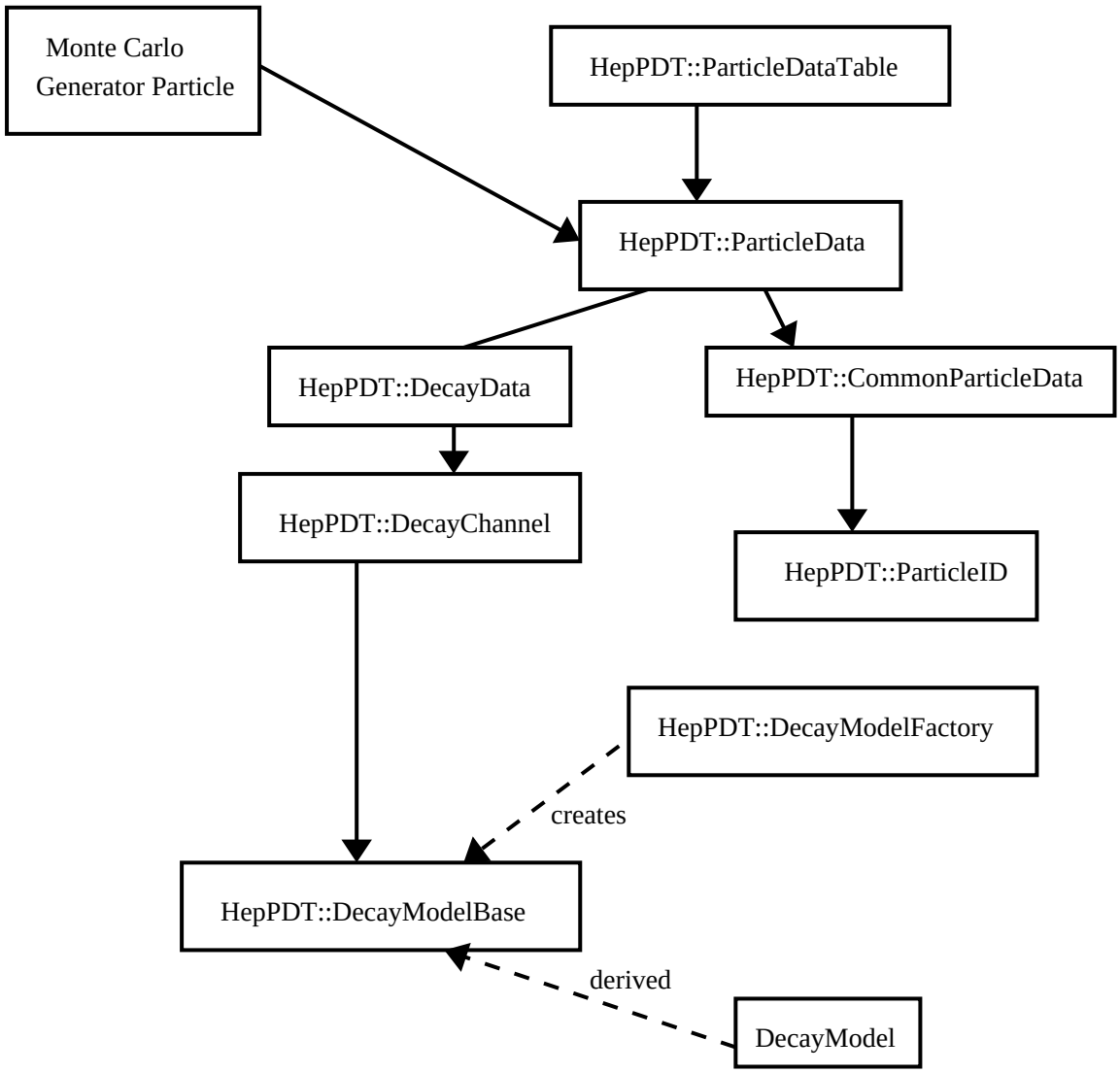


Figure 1: HepPDT Classes: Particle information is accessed by a pointer to ParticleData from any Monte Carlo generated particle. CommonParticleData contains particle information such as mass, charge, and total width. Decay information is found in DecayData. The ParticleDataTable contains a map of ParticleData objects, referenced by ParticleID, as well as lists of CommonParticleData and DecayData. ParticleData has indices to CommonParticleData and DecayData, as well as methods to access all relevant information. The DecayModelFactory is used to create DecayModelBase objects which are derived from user DecayModel classes.

### 1.2 HepPDT Classes

The ParticleDataTable class contains a map of ParticleData which is keyed on the ParticleID class. Particle ID aliases can be used to add custom DecayData. ParticleDataTable also contains lists of CommonParticleData and DecayData.

The ParticleID class can be used to retrieve all the information that is implied in the particle ID (*e.g.*, charge and quark content). Boolean methods (such as isMeson, isBaryon, hasBottom, and hasTop) are provided for ease of searching for various types of particles.

The ParticleData class has iterators into the lists of CommonParticleData and DecayData. CommonParticleData is extensible and includes particle name, particle ID, charge, mass, total width with cutoffs, spin information, color information, and constituent particles (*e.g.*, quark content). This class is not templated.

The DecayData class is a collection of DecayChannels. A generated particle may use the DecayData information from the ParticleDataTable entry or it may use a customized DecayData that allows, for instance, only a single DecayChannel. Users may add customized DecayData objects to the ParticleDataTable.

Each DecayChannel has a collection of decay channel products (which are pointers to ParticleData), a decay name, a branching fraction, an optional vector of extra decay model parameters, and a pointer to DecayModelBase. We recognize that other information, such as helicity, may be needed by a particular DecayChannel object. Because there are many options, this information is stored as a vector of doubles.

## 2 Particle Numbering Scheme

A basic particle numbering scheme was proposed by the Particle Data Group in 1988[5]. Practical application of this scheme exposed some limitations. After consultation[6], the scheme was revised to better match the practice of program authors. The revised scheme includes numbering states by orbital and radial quantum numbers to allow systematic inclusion of quark model states which are as yet undiscovered. The new scheme also includes numbering for hypothetical particles such as SUSY particles.

Because the old PDG convention allowed a fair amount of room for interpretation, the implementation tended to have minor variations among packages. With the new scheme, there is much less variation, but occasional differences remain.

The standard particle numbering scheme is explained in full detail in reference [7].

Quarks, leptons, guage bosons, Higgs, and similar particles are assigned numbers between 1 and 80. Numbers 81-100 are for generator specific use. Any particle with an ID of 100 or less is considered a "fundamental" particle. The list of fundamental particles is in Appendix B.1.

The PDG numbering algorithm for composite particles uses a signed 7 digit number for each particle: $\pm n n_r n_L n_{q_1} n_{q_2} n_{q_3} n_J$. $n_{q_{1-3}}$ are quark numbers used to specify the quark content. The rightmost digit, $n_J = 2\mathrm{J} + 1$, gives the total spin of the composite particle. The scheme does not cover particles of total spin $J > 4$. The fifth digit, $n_L$, is reserved to distinguish mesons of the same total ($J$) but different spin ($S$) and orbital ($L$) angular momentum quantum numbers. The sixth digit, $n_r$, is used to label mesons radially excited above the ground state. Many states appearing in the PDG meson listing do not yet have definite $q\bar{q}$ model assignments. For these states, $n_{q_{2-3}}$ and $n_J$ are assigned according to the state's most likely flavors and spin. Within

these groups $n_L = 0, 1, 2, \ldots$ is used to distinguish states of increasing mass. These states are flagged with $n = 9$. The numbering scheme does not extend to baryons with $n > 0$, $n_r > 0$, or $n_L > 0$. Digits $n_{q_2}$ and $n_{q_3}$ are used for mesons, with $n_{q_1} = 0$. Digits $n_{q_1}$, $n_{q_2}$, and $n_{q_3}$ are used for baryons. Digits $n_{q_1}$ and $n_{q_2}$ are used for diquarks, with $n_{q_3} = 0$. (A list of diquark states is in Appendix B.1.) A negative number indicates an antiparticle. The states are generally listed in order of increasing mass. $K_L^0$ and $K_S^0$ are exceptions. Their assigned identification numbers are 130 and 310, respectively.

SUSY particles are indicated with $n = 1$ for right-handed particles or $n = 2$ for left-handed particles. Technicolor states have $n = 3$. Excited (composite) quarks and leptons are identified by setting $n = 4$. Other exotic particles have $nn_r = 51$.

The new numbering scheme attemts to list all states needed by the Monte Carlo generators. Appendix B.2 contains a full list of meson states and their ID numbers, up through the top quark states.

The baryon $\Xi$ and $\Omega$ states for charmed and heavier quarks require special consideration. Three spin 1/2 states are recognized for cxy, bxy, etc., where x and y are lighter, non-identical quarks. The non-primed states are antisymmetric under interchange of the lighter quarks. and the primed states are symmetric. The numbering for these states is explicitly stated in the new numbering scheme. Appendix B.3 contains a full list of the baryon states.

HepPDT uses an ad-hoc numbering scheme for ions. Ion numbers are $FAAAZZZ00n_J$, where F = 1 and flags this as an ion. AAA, and ZZZ are the ion's A and Z respectively. The first digit, $n_J$, contains the total spin as $n_J$ = 2J + 1.

## 2.1 Generator Numbering Schemes

The Isajet particle identification algorithm uses a signed four digit number: ±MLKJ. M, L, and K are quarks and J is the spin. A negative number indicates the antiparticle, and is meant to associate with the lightest quark. For mesons, M = 0, and for diquarks, K = 0.

Pythia, Herwig, EvtGen, and QQ use the PDG algorithm in addition to internal compressed numbering schemes. Although the latest implementations of Pythia, Herwig, and QQ conform closely to the new numbering scheme, some differences remain.

Isajet, Herwig, and Pythia contain the possibility of defining fourth family states.

## 2.2 ParticleID

The HepPDT::ParticleID class provides methods to return all the information which can be extracted or inferred from the particle ID (PID). It is expected that any 7 digit number used as a PID will adhere to the rules of the Monte Carlo Particle Numbering Scheme published by the PDG.[1]

The ParticleID class considers any particle with an ID less than 100 a "fundamental" particle.

In most cases, a user can define particles not already in the Particle Data Table without needing to extend the numbering scheme. A previously unknown particle can be assigned a valid PID by following the rules in the "Review of Particle Physics".[1]

If the user wishes to force the decay chain $D^* \to D^0\pi^0, D^0 \to K^-\pi^+\pi^0\pi^0$, a user might define a special $D^0$ which only decays to $K^-\pi^+\pi^0\pi^0$, leaving any $D^0$ produced elsewhere to

decay normally. The PID for a normal $D^0$ is 421. The PID for the special $D^0$ might be 6000421. This new PID might be used in several different jobs for $D^0$ particles with different forced decay modes. (EvtGen defines these special particles as aliases in the decay table. The TableBuilder class handles the aliases appropriately without needing to create a new PID for the particle alias.)

```
                ParticleID( int pid = 0 );
                ParticleID( const ParticleID & orig );
                ParticleID & operator=( const ParticleID & );
void            swap( ParticleID & other );
bool            operator < ( ParticleID const & other ) const;
bool            operator == ( ParticleID const & other ) const;

int             pid( ) const;
int             abspid( ) const;

bool            isValid( ) const;
bool            isMeson( ) const;
bool            isBaryon( ) const;
bool            isDiQuark( ) const;
bool            isHadron( ) const;
bool            isLepton( ) const;
bool            isNucleus( ) const;

bool            hasUp( ) const;
bool            hasDown( ) const;
bool            hasStrange( ) const;
bool            hasCharm( ) const;
bool            hasBottom( ) const;
bool            hasTop( ) const;
```

**In practice, it is better to query the ParticleData class for quark content.**

```
int             jSpin( ) const;
int             sSpin( ) const;
int             lSpin( ) const;
int             fundamentalID( ) const;
Quarks          quarks( ) const;
int             threeCharge( ) const;
int             A( ) const;
int             Z( ) const;
unsigned short  digit(location) const;
```

## 2.3 Translating Particle ID's

The header ParticleID.hh defines a number of free functions which can be used to translate between generator and HepPDT numbering schemes.

```
int   translatePythiatoPDT( const int pythiaID );
int   translateIsajettoPDT( const int isajetID );
int   translateHerwigtoPDT( const int herwigID);
int   translateQQtoPDT( const int qqID);
int   translateGeanttoPDT( const int geantID);
int   translatePDGtabletoPDT( const int pdgID);
int   translateEvtGentoPDT( const int evtGenID );

int   translatePDTtoPythia( const int pid );
int   translatePDTtoIsajet( const int pid );
int   translatePDTtoHerwig( const int pid );
int   translatePDTtoQQ( const int pid );
int   translatePDTtoGeant( const int pid );
int   translatePDTtoPDGtable( const int pid );
int   translatePDTtoEvtGen( const int pid );
```

# 3 Particle Properties

Particle data information is stored in HepPDT::ParticleDataTable, which is a map of HepPDT::ParticleData objects that are referenced by HepPDT::ParticleID. The design envisions that generated particles will contain links to the relevant HepPDT::ParticleData object.

## 3.1 Reading Particle Data information

HepPDT can accept particle data information from a variety of sources. To fill HepPDT::ParticleDataTable, the user creates an empty ParticleDataTable object and then calls HepPDT::TableBuilder methods to read the information from an input stream. Information may be read from as many input streams as desired. In case of conflicts, previous information will be overwritten. All information is kept in temporary objects until the TableBuilder destructor is called. The TableBuilder destructor then creates the ParticleData objects owned by ParticleDataTable.

The following code fragment reads Pythia input from a flat file. Examples reading input from other sources are in Appendix A and also in the example subdirectory.

```
#include <fstream>

#include "HepPDT/TableBuilder.hh"
#include "HepPDT/ParticleDataTable.hh"
#include "HepPDT/TempParticleData.hh"

    const char infile[] = "data/pythia.tbl";
    // open input file
    std::ifstream pdfile( infile );
    if( !pdfile ) {
      std::cerr << "cannot open " << infile << std::endl;
      exit(-1);
```

```
    }
    // construct empty PDT
    HepPDT::ParticleDataTable datacol( "Pythia Table" );
    {
        // Construct table builder
        HepPDT::TableBuilder  tb(datacol);
// read the input - put as many here as you want
        if( !addPythiaParticles( pdfile, tb ) )
      { std::cout << "error reading pythia file " << std::endl; }
    } // the tb destructor fills datacol
```

The Particle Data Group provides a table of particle masses and widths for known particles. This table, pdg_mass.tbl, is distributed with the HepPDT package. This information is also available from specific generators, often as flat files. HepPDT contains

## 3.2 Accessing Particle Data information

The following code fragment accesses pion and muon information. Refer to the Appendices for a listing of particle ID numbers.

```
    std::ofstream wpdfile( outfile );
    HepPDT::ParticleDataTable db( "my Table" );
    ......
    HepPDT::ParticleData * pd = datacol.particle( HepPDT::ParticleID(111) );
    pd->write(wpdfile);
    double mumass = datacol.particle( HepPDT::ParticleID(13) )->mass();
```

In principle, all information in the PDG may be obtained from ParticleData access methods.

```
std::string const &          name() const;
ParticleID                   ID() const;
int                          pid( ) const;
double                       charge() const;
double                       color() const;
SpinState                    spin() const;
Measurement                  mass() const;
Measurement                  totalWidth() const;
Measurement                  lifetime() const;
int                          numConstituents() const;
Constituent                  constituent( int i ) const;
ParticleID                   constituentParticle( int i ) const;
ResonanceStructure const *   resonance() const;

bool                         isMeson( ) const;
bool                         isBaryon( ) const;
bool                         isDiQuark( ) const;
bool                         isHadron( ) const;
bool                         isLepton( ) const;
bool                         isNucleus( ) const;
bool                         hasUp() const;
bool                         hasDown() const;
bool                         hasStrange() const;
bool                         hasCharm() const;
bool                         hasBottom() const;
bool                         hasTop() const;

int                          numDecayChannels() const;
bool                         isStable() const;
DecayChannel                 channel( int i ) const;
DDID                         getDecayData() const;
CPDID                        getCommonParticleData() const;

void                         write( std::ostream & os ) const;
```

## 3.3 The Measurement Class

Some tables contain errors on mass and width values. To keep this error information available, we wrote a simple HepPDT::Measurement class which contains a double value and a double error on the value. If you reference it with a double, Measurement returns the value.

```
            Measurement( double value, double sigma );
            Measurement( const Measurement & orig );
            Measurement & operator=( const Measurement & );
void        swap( Measurement & other );
bool        operator < ( Measurement const & other ) const;
bool        operator == ( Measurement const & other ) const;
double      value() const;
double      sigma() const;
operator    double() const;
```

# 4 Use of Templates

Decay methods are, by definition, outside the scope of HepPDT. However, the user may wish to be able to call decay methods from DecayChannel.

DecayModelBase is the mechanism that allows the user to invoke an actual decay method from this class. Because the decay method must know what kind of generated particle will be created, DecayModelBase is a class *template*, parameterized on the type of particle to be generated. Because of the need to allow the user freedom of choice for this generated particle class, many related abstractions in this model are also class templates. In each case, a typedef is provided to allow users who do not need this degree of flexibility to ignore it. These typedefs also stand as an example for those groups who wish to standardize upon a common type for the generated particles.

# 5 Decay Model Factory

In order to allow users to "plug-in" new decay models (subclasses of DecayModelBase), without requiring recompilation of the entire library, we provide the class template DecayModelFactory, and a simple means by which user-written decay models will be automatically registered for creation, when requested by a DecayData object. This is done by the common technique of having each decay model register (at static initialization time) a function object that is used to create instances of that decay model.

# 6 Conclusions

HepPDT provides access to all useful particle data properties and is designed to be used with any generated particle. It also contains a factory to allow the user to directly access decay model code instead of needing to use a lookup table or series of if statements based on the decay model name. HepPDT will be part of the StdHepC++ package in CLHEP[4] and is available now at http://www-pat.fnal.gov/stdhep/c++/.

# References

[1] Particle Data Group: Groom, D.E. *et al.*, *The European Physical Journal* **C3**, (2000).

[2] StdHepC++: http://www-pat.fnal.gov/stdhep/c++/.

[3] Particle Data Group: Groom, D.E. *et al.*, *The European Physical Journal* **C3**, (2000) 205, http://www-pdg.lbl.gov/mc_particle_id_contents.html.

[4] CLHEP: http://wwwinfo.cern.ch/asd/lhc++/clhep/.

[5] Particle Data Group: G.P. Yost *et al.*, Phys. Lett. **B204**, 1 (1988).

[6] I. G. Knowles *et al.*, in "Physics at LEP2", CERN 96-01, vol. 2, p. 103.

[7] Particle Data Group: C. Caso *et al.*, The European Physical Journal **C3** (1998) 180.

# A Input Data Examples

## A.1 Read PDG Particle Data

```
// $Id: TestReadPDG.cc,v 1.2 2001/08/10 22:18:33 garren Exp $
// ----------------------------------------------------------------------
// TestReadPDG.cc
//
// read PDG table and write it out
//
// ----------------------------------------------------------------------

#include <fstream>

#include "HepPDT/TableBuilder.hh"
#include "HepPDT/ParticleDataTable.hh"
#include "HepPDT/DecayModel.hh"

int main()
{
    const char pdgfile[] = "../data/pdg_mass.tbl";
    const char outfile[] = "PDfile";
    // open input file
    std::ifstream pdfile( pdgfile );
    if( !pdfile ) {
      std::cerr << "cannot open " << pdgfile << std::endl;
      exit(-1);
    }
    // construct empty PDT
    HepPDT::ParticleDataTable datacol( "PDG Table" );
    {
        // Construct table builder
        HepPDT::TableBuilder  tb(datacol);
// read the input - put as many here as you want
if( !addPDGParticles( pdfile, tb ) ) { std::cout << "error reading PDG file " << std::en
    } // the tb destructor fills datacol
    std::ofstream wpdfile( outfile );
    if( !wpdfile ) {
      std::cerr << "cannot open " << outfile << std::endl;
      exit(-1);
    }
    datacol.writeParticleData(wpdfile);
}
```

## A.2 Read EvtGen Particle Data

```
// $Id: TestReadEvtGen.cc,v 1.1 2001/03/29 19:30:51 products Exp $
// ----------------------------------------------------------------------
// TestReadEvtGen.cc
//
// read EvtGen table and write it out
//
// ----------------------------------------------------------------------

#include <fstream>

#include "HepPDT/TableBuilder.hh"
#include "HepPDT/ParticleDataTable.hh"

int main()
{
    const char infile1[] = "data/pdt.table";
    const char infile2[] = "data/DECAY.EvtGen.DEC";
    const char outfile[] = "PDfile3";
    // open input files
    std::ifstream pdfile1( infile1 );
    if( !pdfile1 ) {
      std::cerr << "cannot open " << infile1 << std::endl;
      exit(-1);
    }
    // construct empty PDT
    std::ifstream pdfile2( infile2 );
    if( !pdfile2 ) {
      std::cerr << "cannot open " << infile2 << std::endl;
      exit(-1);
    }
    HepPDT::ParticleDataTable datacol( "EvtGen Table" );
    {
        // Construct table builder
        HepPDT::TableBuilder  tb(datacol);
// read the input - put as many here as you want
        if( !addEvtGenParticles( pdfile1, tb ) ) { std::cout << "error reading EvtGen pd
        if( !addEvtGenParticles( pdfile2, tb ) ) { std::cout << "error reading EvtGen de
    } // the tb destructor fills datacol
    std::ofstream wfile( outfile );
    if( !wfile ) {
      std::cerr << "cannot open " << outfile << std::endl;
      exit(-1);
    }
```

```
    datacol.writeParticleData(wfile);
}
```

## A.3 Read Pythia Particle Data

```
// $Id: TestReadPythia.cc,v 1.2 2001/08/02 22:02:15 garren Exp $
// ----------------------------------------------------------------------
// TestReadPythia.cc
//
// read Pythia table and write it out
//
// ----------------------------------------------------------------------

#include <fstream>

#include "HepPDT/TableBuilder.hh"
#include "HepPDT/ParticleDataTable.hh"
#include "HepPDT/TempParticleData.hh"

int main()
{
    const char infile[] = "data/pythia.tbl";
    const char outfile[] = "PDfile2";
    // open input file
    std::ifstream pdfile( infile );
    if( !pdfile ) {
      std::cerr << "cannot open " << infile << std::endl;
      exit(-1);
    }
    // construct empty PDT
    HepPDT::ParticleDataTable datacol( "Pythia Table" );
    {
        // Construct table builder
        HepPDT::TableBuilder  tb(datacol);
// read the input - put as many here as you want
        if( !addPythiaParticles( pdfile, tb ) )
      { std::cout << "error reading pythia file " << std::endl; }
    } // the tb destructor fills datacol
    std::ofstream wpdfile( outfile );
    if( !wpdfile ) {
      std::cerr << "cannot open " << outfile << std::endl;
      exit(-1);
    }
    datacol.writeParticleData(wpdfile);
}
```

## A.4 Read QQ Particle Data

```
// $Id: TestReadQQ.cc,v 1.4 2001/08/10 20:19:01 garren Exp $
// ----------------------------------------------------------------------
// TestReadQQ.cc
//
// read QQ table and write it out
//
// ----------------------------------------------------------------------

#include <fstream>

#include "HepPDT/QQDecayTable.hh"
#include "HepPDT/PDGtoQQTable.hh"
#include "HepPDT/TableBuilder.hh"
#include "HepPDT/ParticleDataTable.hh"
#include "HepPDT/TempParticleData.hh"

int main()
{
    const char infile[] = "data/decay.dec";
    const char outfile[] = "PDfileQQ";
    // open input file
    std::ifstream pdfile( infile );
    if( !pdfile ) {
      std::cerr << "cannot open " << infile << std::endl;
      exit(-1);
    }
    // read decay.dec
    HepPDT::QQDecayTable qdt( pdfile );
    // create the translation table
    HepPDT::PDGtoQQTable::instance()->buildTable( qdt );
    // construct empty PDT
    HepPDT::ParticleDataTable datacol( "QQ Table" );
    {
        // Construct table builder
        HepPDT::TableBuilder  tb(datacol);
// read the input - put as many here as you want
        if( !addQQParticles( qdt, tb ) )
     { std::cout << "error reading QQ table file " << std::endl; }
    } // the tb destructor fills the PDT
    std::ofstream wpdfile( outfile );
    if( !wpdfile ) {
      std::cerr << "cannot open " << outfile << std::endl;
      exit(-1);
```

```
    }
    // write the tranlations
    HepPDT::PDGtoQQTable::instance()->writeTranslations( wpdfile );
    // write the particle and decay info
    datacol.writeParticleData( wpdfile );
}
```

# B Particle Numbering

Numbers which have changed since PDG 1998 are in bold text.

## B.1 Elementary Particle Identification Code Listing

| Quarks and Leptons | | | | | | | |
|---|---|---|---|---|---|---|---|
| Particle | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $d$ | 2 | 1 | 1 | -2,-8 | 1 | 1 | 1 |
| $u$ | 1 | 2 | 2 | -1,-7 | 2 | 2 | 2 |
| $s$ | 3 | 3 | 3 | -3,-9 | 3 | 3 | 3 |
| $c$ | 4 | 4 | 4 | -4,-10 | 4 | 4 | 4 |
| $b$ | 5 | 5 | 5 | -5,-11 | 5 | 5 | 5 |
| $t$ | 6 | 6 | 6 | -6,-12 | 6 | 6 | 6 |
| $b'$ | 7 ($y$) | 7 | 7 ($v$ & $h$) | | 7 | 7 | 7 |
| $t'$ | 8 ($x$) | 8 | 8 ($a$ & $h'$) | | 8 | 8 | 8 |
| $e^-$ | 12 | 11 | 11 | 7,8 | 11 | 11 | 11 |
| $\nu_e$ | 11 | 12 | 12 | 9,10 | 12 | 12 | 12 |
| $\mu^-$ | 14 | 13 | 13 | 11,12 | 13 | 13 | 13 |
| $\nu_\mu$ | 13 | 14 | 14 | 13,14 | 14 | 14 | 14 |
| $\tau^-$ | 16 | 15 | 15 | 15,16 | 15 | 15 | 15 |
| $\nu_\tau$ | 15 | 16 | 16 | 17,18 | 16 | 16 | 16 |
| $\tau'^-$ | | 17 | | | 17 ($L^-$) | 17 | 17 |
| $\nu_{\tau'}$ | | 18 | | | 18 ($\nu_L$) | 18 | 18 |

| Gauge and Higgs Bosons | | | | | | | |
|---|---|---|---|---|---|---|---|
| Particle | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $g$ | 9 | 21 | 21 | -13 | 21 | 21 (9) | 21 (9) |
| $\gamma$ | 10 | 22 | 22 | 1 | 22 | 22 | 22 |
| $\gamma_{virtual}$ | | | | | 10022 | | 10022 |
| $Cerenkov$ | | | | | 20022 | | 20022 |
| $Z^0$ | 90 | 23 | 23 | 2 | 23 | 23 | 23 |
| $W^+$ | 80 | 24 | 24 | 3,4 | 24 | 24 | 24 |
| $h^0/H_1^0$ | 81 | 25 | 25 | | 25 | 25 | 25 |
| $Z'/Z_2^0$ | | 32 | 32 | | 32 | 32 | 32 |
| $Z''/Z_3^0$ | | 33 | | | 33 | 33 | 33 |
| $W'/W_2^+$ | | 34 | | | 34 | 34 | 34 |
| $H^0/H_2^0$ | 83 ($H_H^0$) | 35 | 35 | | 35 ($H'$) | 35 | 35 |
| $A^0/H_3^0$ | 84 ($H_A^0$) | 36 | 36 | | 36 | 36 | 36 |
| $H^+$ | 86 | 37 | 37 | | 37 | 37 | 37 |
| $H_1^{++}$ | 88 | | | | | | 52 |
| $H_2^+$ | 87 | | | | | | 53 |
| $H_2^{++}$ | 89 | | | | | | 54 |
| $H_4^0$ | 85 | | | | | | 55 |
| $H_5^0$ | | | | | | | |
| $H_L^{0\,NOTE}$ | 82 | | 26 | | | | 51 |
| Special Particles | | | | | | | |
| Particle | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $G$ (graviton) | 92 | | **39** | | | 39 | 39 |
| $R^0$ | | 40 | | | 40 | 41 | 41 |
| $LQ^c$ | | 39 | | | | 42 | 42 |
| $reggeon$ | | 28 | | | 28 | 110 | 110 |
| $pomeron$ | | 29 | | | 29 | 990 | 990 |
| $odderon$ | | | | | | 9990 | 9990 |
| $X_u^0$ | | | | | 41 | | 61 |
| $X_u^+$ | | | | | 42 | | 62 |
| internal code | | 81-99 | 91 | 82-93 | | 81-100 | 81-100 |
| NOTE: $H_L^0$ is redundant with $h^0/H_1^0$, but is given a different number in Isajet and Herwig. | | | | | | | |

| Supersymmetric Particles | | | | | | | |
|---|---|---|---|---|---|---|---|
| Particle | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $\tilde{d}_L$ | 22 | 1000001 | 1000001 | | | 1000001 | 1000001 |
| $\tilde{u}_L$ | 21 | 1000002 | 1000002 | | | 1000002 | 1000002 |
| $\tilde{s}_L$ | 23 | 1000003 | 1000003 | | | 1000003 | 1000003 |
| $\tilde{c}_L$ | 24 | 1000004 | 1000004 | | | 1000004 | 1000004 |
| $\tilde{b}_1/\tilde{b}_L$ | 25 | 1000005 | 1000005 | | | 1000005 | 1000005 |
| $\tilde{t}_1/\tilde{t}_L$ | 26 | 1000006 | 1000006 | | | 1000006 | 1000006 |
| $\tilde{e}_L^-$ | 32 | 1000011 | 1000011 | | | 1000011 | 1000011 |
| $\tilde{\nu}_{eL}$ | 31 | 1000012 | 1000012 | | | 1000012 | 1000012 |
| $\tilde{\mu}_L^-$ | 34 | 1000013 | 1000013 | | | 1000013 | 1000013 |
| $\tilde{\nu}_{\mu L}$ | 33 | 1000014 | 1000014 | | | 1000014 | 1000014 |
| $\tilde{\tau}_1^-/\tilde{\tau}_L^-$ | 36 | 1000015 | 1000015 | | | 1000015 | 1000015 |
| $\tilde{\nu}_{\tau L}$ | 35 | 1000016 | 1000016 | | | 1000016 | 1000016 |
| $\tilde{d}_R$ | 42 | 2000001 | 2000001 | | | 2000001 | 2000001 |
| $\tilde{u}_R$ | 41 | 2000002 | 2000002 | | | 2000002 | 2000002 |
| $\tilde{s}_R$ | 43 | 2000003 | 2000003 | | | 2000003 | 2000003 |
| $\tilde{c}_R$ | 44 | 2000004 | 2000004 | | | 2000004 | 2000004 |
| $\tilde{b}_2/\tilde{b}_R$ | 45 | 2000005 | 2000005 | | | 2000005 | 2000005 |
| $\tilde{t}_2/\tilde{t}_R$ | 46 | 2000006 | 2000006 | | | 2000006 | 2000006 |
| $\tilde{e}_R^-$ | 52 | 2000011 | 2000011 | | | 2000011 | 2000011 |
| $\tilde{\nu}_{eR}$ | 51 | 2000012 | 2000012 | | | | 2000012 |
| $\tilde{\mu}_R^-$ | 54 | 2000013 | 2000013 | | | 2000013 | 2000013 |
| $\tilde{\nu}_{\mu R}$ | 53 | 2000014 | 2000014 | | | | 2000014 |
| $\tilde{\tau}_2^-/\tilde{\tau}_R^-$ | 56 | 2000015 | 2000015 | | | 2000015 | 2000015 |
| $\tilde{\nu}_{\tau R}$ | 55 | 2000016 | 2000016 | | | | 2000016 |

| Supersymmetric Particles | | | | | | | |
|---|---|---|---|---|---|---|---|
| Particle | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $\tilde{g}$ | 29 | 1000021 | 1000021 | | | 1000021 | 1000021 |
| $\tilde{\chi}_1^0/\tilde{\gamma}$ | 30 ($Z_1^{ss}$) | 1000022 | 1000022 | | | 1000022 | 1000022 |
| $\tilde{\chi}_2^0/\tilde{Z}^0$ | 40 ($Z_2^{ss}$) | 1000023 | 1000023 | | | 1000023 | 1000023 |
| $\tilde{\chi}_1^+/\tilde{W}^+$ | 39 ($W_1^{+ss}$) | 1000024 | 1000024 | | | 1000024 | 1000024 |
| $\tilde{\chi}_3^0/\tilde{H}_1^0$ | 50 ($Z_3^{ss}$) | 1000025 | 1000025 | | | 1000025 | 1000025 |
| $\tilde{\chi}_4^0/\tilde{H}_2^0$ | 60 ($Z_4^{ss}$) | 1000035 | 1000035 | | | 1000035 | 1000035 |
| $\tilde{\chi}_2^+/\tilde{H}^+$ | 49 ($W_2^{+ss}$) | 1000037 | 1000037 | | | 1000037 | 1000037 |
| $\tilde{G}$ | 91 | 1000039 | 1000039 | | | 1000039 | 1000039 |
| Technicolor Particles | | | | | | | |
| Particle | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $\pi_{tech}^0$ | | 51 | | | | 3000111 | 3000111 |
| $\pi_{tech}^+$ | | 52 | | | | 3000211 | 3000211 |
| $\pi_{tech}^{\prime 0}$ | | 53 | | | | | 3100111 |
| $\eta_{tech}^0$ | | 38 | | | | 3000221 | 3000221 |
| $\rho_{tech}^0$ | | 54 | | | | 3000113 | 3000113 |
| $\rho_{tech}^+$ | | 55 | | | | 3000213 | 3000213 |
| $\omega_{tech}^0$ | | 56 | | | | 3000223 | 3000223 |
| Excited Particles | | | | | | | |
| Particle | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $d^*$ | | 4000001 | | | | 4000001 | 4000001 |
| $u^*$ | | 4000002 | | | | 4000002 | 4000002 |
| $e^*$ | | 4000011 | | | | 4000011 | 4000011 |
| $\nu_e^*$ | | 4000012 | | | | 4000012 | 4000012 |
| Other Exotics | | | | | | | |
| Particle | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $H_L^{++}$ | | 61 | | | | | 5100061 |
| $H_R^{++}$ | | 62 | | | | | 5100062 |
| $W_R^+$ | | 63 | | | | | 5100024 |
| $\nu_{Re}$ | | 64 | | | | | 5100012 |
| $\nu_{R\mu}$ | | 65 | | | | | 5100014 |
| $\nu_{R\tau}$ | | 66 | | | | | 5100016 |

| Diquarks | | | | | | | |
|---|---|---|---|---|---|---|---|
| Diquark | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $(dd)_0$ | | | | | 1101 | | |
| $(ud)_0$ | 1200 | 2101 | 2101 | | 2101 | 2101 | 2101 |
| $(uu)_0$ | | | | | 2201 | | |
| $(sd)_0$ | 2300 | 3101 | 3101 | | 3101 | 3101 | 3101 |
| $(su)_0$ | 1300 | 3201 | 3201 | | 3201 | 3201 | 3201 |
| $(ss)_0$ | | | | | 3301 | | |
| $(cd)_0$ | -2400 | 4101 | | | 4101 | 4101 | 4101 |
| $(cu)_0$ | -1400 | 4201 | | | 4201 | 4201 | 4201 |
| $(cs)_0$ | -3400 | 4301 | | | 4301 | 4301 | 4301 |
| $(cc)_0$ | | | | | 4401 | | |
| $(bd)_0$ | 2500 | 5101 | | | 5101 | 5101 | 5101 |
| $(bu)_0$ | 1500 | 5201 | | | 5201 | 5201 | 5201 |
| $(bs)_0$ | 3500 | 5301 | | | 5301 | 5301 | 5301 |
| $(bc)_0$ | 4500 | 5401 | | | 5401 | 5401 | 5401 |
| $(vv)_0$ | | | | | 5501 | | |
| $(dd)_1$ | 2200 | 1103 | 1103 | | 1103 | 1103 | 1103 |
| $(ud)_1$ | | 2103 | | | 2103 | 2103 | 2103 |
| $(uu)_1$ | 1100 | 2203 | 2203 | | 2203 | 2203 | 2203 |
| $(sd)_1$ | | 3103 | | | 3103 | 3103 | 3103 |
| $(su)_1$ | | 3203 | | | 3203 | 3203 | 3203 |
| $(ss)_1$ | 3300 | 3303 | 3303 | | 3303 | 3303 | 3303 |
| $(cd)_1$ | | 4103 | | | 4103 | 4103 | 4103 |
| $(cu)_1$ | | 4203 | | | 4203 | 4203 | 4203 |
| $(cs)_1$ | | 4303 | | | 4303 | 4303 | 4303 |
| $(cc)_1$ | 4400 | 4403 | | | 4403 | 4403 | 4403 |
| $(bd)_1$ | | 5103 | | | 5103 | 5103 | 5103 |
| $(bu)_1$ | | 5203 | | | 5203 | 5203 | 5203 |
| $(bs)_1$ | | 5303 | | | 5303 | 5303 | 5303 |
| $(bc)_1$ | | 5403 | | | 5403 | 5403 | 5403 |
| $(bb)_1$ | 5500 | 5503 | | | 5503 | 5503 | 5503 |

| Miscellaneous Particles | | | | | | | |
|---|---|---|---|---|---|---|---|
| Particle | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $\rho^0_{diffr}$ | | 110 | | | 110 | | 9910113 |
| $\pi^+_{diffr}$ | | 210 | | | 210 | | 9910211 |
| $\omega^0_{diffr}$ | | 220 | | | 220 | | 9910223 |
| $\phi^0_{diffr}$ | | 330 | | | 330 | | 9910333 |
| $J/\psi^0_{diffr}$ | | 440 | | | 440 | | 9910443 |
| $n^0_{diffr}$ | | 2110 | | | 2110 | | 9912112 |
| $p^+_{diffr}$ | | 2210 | | | 2210 | | 9912212 |
| remnant photon | | | 98 | | | | 9920022 |
| remnant nucleon | | | 99 | | | | 9922212 |
| deuterium | | | | | 1011 | | |
| tritium | | | | | 1021 | | |
| $He^3$ | | | | | 1012 | | |
| $\alpha$ | | | | | 1022 | | |
| geantino | | | | | 100 | | |

## B.2 Complete Meson Particle Identification Code Listing

| Light Mesons | | | | | | | |
|---|---|---|---|---|---|---|---|
| Meson | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $\pi^0$ | 110 | 111 | 111 | 51 | 111 | 111 | 111 |
| $\pi^+$ | 120 | 211 | 211 | 21,22 | 211 | 211 | 211 |
| $a_0^0(980)$ | | 10111 | 9000111 | 251 | 10111 | 9000111 | 9000111 |
| $a_0^+(980)$ | | 10211 | 9000211 | 252,253 | 10211 | 9000211 | 9000211 |
| $\pi^0(1300)$ | | | | | 20111 ($\pi(2S)$ | 100111 | 100111 |
| $\pi^+(1300)$ | | | | | 20211 ($\pi(2S)$ | 100211 | 100211 |
| $a_0^0(1450)$ | | | 10111 | | | 10111 | 10111 |
| $a_0^+(1450)$ | | | 10211 | | | 10211 | 10211 |
| $\pi^0(1800)$ | | | | | | 200111 | 200111 |
| $\pi^+(1800)$ | | | | | | 200211 | 200211 |
| $\rho^0(770)$ | 111 | 113 | 113 | 91 | 113 | 113 | 113 |
| $\rho^+(770)$ | 121 | 213 | 213 | 61,62 | 213 | 213 | 213 |
| $b_1^0(1235)$ | | 10113 | 10113 | 265 | 10113 | 10113 | 10113 |
| $b_1^+(1235)$ | | 10213 | 10213 | 266,267 | 10213 | 10213 | 10213 |
| $a_1^0(1260)$ | 10111 | 20113 | 20113 | 108 | 20113 | 20113 | 20113 |
| $a_1^+(1260)$ | 10121 | 20213 | 20213 | 107,109 | 20213 | 20213 | 20213 |
| $\pi_1^0(1400)^{NOTE}$ | | | | | | 9000113 | 9000113 |
| $\pi_1^+(1400)^{NOTE}$ | | | | | | 9000213 | 9000213 |
| $\rho^0(1450)$ | | | | | 30113 ($\rho(2S)$ | 100113 | 100113 |
| $\rho^+(1450)$ | | | | | 30213 ($\rho(2S)$ | 100213 | 100213 |
| $\pi_1^0(1600)$ | | | | | | **9010113** | **9010113** |
| $\pi_1^+(1600)$ | | | | | | **9010213** | **9010213** |
| $a_1^0(1640)$ | | | | | | **9020113** | **9020113** |
| $a_1^+(1640)$ | | | | | | **9020213** | **9020213** |
| $\rho^0(1700)/\rho^0(D)$ | | | 30113 | 106 | 40113 ($\rho(4S)$ | 30113 | 30113 |
| $\rho^+(1700)/\rho^+(D)$ | | | 30213 | 205,206 | 40213 ($\rho(4S)$ | 30213 | 30213 |
| $\rho^0(2150)$ | | | | | | **9030113** | **9030113** |
| $\rho^+(2150)$ | | | | | | **9030213** | **9030213** |
| NOTE: $\pi_1^0(1400)$ was $\hat{\rho}(1405)$ in PDG 1998. | | | | | | | |

| Light Mesons | | | | | | | |
|---|---|---|---|---|---|---|---|
| Meson | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $a_2^0(1320)$ | | 115 | 115 | 254 | 115 | 115 | 115 |
| $a_2^+(1320)$ | | 215 | 215 | 255,256 | 215 | 215 | 215 |
| $a_2^0(1660)$ | | | | | | **9000115** | **9000115** |
| $a_2^+(1660)$ | | | | | | **9000215** | **9000215** |
| $\pi_2^0(1670)$ | | | 10115 | | | 10115 | 10115 |
| $\pi_2^+(1670)$ | | | 10215 | | | 10215 | 10215 |
| $a_2^0(1750)$ | | | | | | **9010115** | **9010115** |
| $a_2^+(1750)$ | | | | | | **9010215** | **9010215** |
| $\pi_2^0(2100)$ | | | | | | **9020115** | **9020115** |
| $\pi_2^+(2100)$ | | | | | | **9020215** | **9020215** |
| $\rho_3^0(1690)$ | | | 117 | | | 117 | 117 |
| $\rho_3^+(1690)$ | | | 217 | | | 217 | 217 |
| $\rho_3^0(2250)$ | | | | | | 9000117 | 9000117 |
| $\rho_3^+(2250)$ | | | | | | 9000217 | 9000217 |
| $a_4^0(2040)$ | | | | | | 119 | 119 |
| $a_4^+(2040)$ | | | | | | 219 | 219 |

| $u\bar{u}$, $d\bar{d}$, and $s\bar{s}$ Meson admixtures | | | | | | | |
|---|---|---|---|---|---|---|---|
| Meson | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $\eta$ | 220 | 221 | 221 | 52 | 221 | 221 | 221 |
| $\eta'$ | 330 | 331 | 331 | 53 | 331 | 331 | 331 |
| $f_0(400-1200)$ | | | | | | 9000221 | 9000221 |
| $f_0(980)$ | 10110 | 10221 | 9010221 $f_0'$ | 257 | 10221 | 9010221 | 9010221 |
| $\eta(1295)$ | | | | | 20221 ($\eta(2S)$ | 100221 | 100221 |
| $f_0(1370)/f_0'$ | | 10331 | 10221 $f_0^0(H)$ | 258 | 10331 | 10221 | 10221 |
| $\eta(1440)$ | | | | | | 100331 | 100331 |
| $f_0(1500)$ | | | | | 50221 | 9020221 | 9020221 |
| $f_0(1710)^{NOTE}$ | | | | | | **10331** | **10331** |
| $\eta(1760)$ | | | | | | 200221 | 200221 |
| $f_0(2020)$ | | | | | | **9030221** | **9030221** |
| $f_0(2060)$ | | | | | | **9040221** | **9040221** |
| $f_0(2200)$ | | | | | | **9050221** | **9050221** |
| $\eta(2225)$ | | | | | | **9060221** | **9060221** |
| $X_{ss}^0$ | | | | | 30363 | | 9000331 |
| $\omega(782)$ | 221 | 223 | 223 | 92 | 223 | 223 | 223 |
| $\phi(1020)$ | 331 | 333 | 333 | 93 | 333 | 333 | 333 |
| $h_1(1170)$ | | 10223 | 10223 | 263 | 10223 | 10223 | 10223 |
| $f_1(1285)$ | | 20223 | 20223 | 259 | 20223 | 20223 | 20223 |
| $h_1(1380)/h_1'$ | | 10333 | 10333 | 264 | 10333 | 10333 | 10333 |
| $f_1(1420)/f_1'$ | | 20333 | 20333 $f_1(H)$ | 260 | 20333 | 20333 | 20333 |
| $\omega(1420)$ | | | | | 30223 | 100223 | 100223 |
| $f_1(1510)$ | | | | | | 9000223 | 9000223 |
| $\omega(1650)$ | | | 30223 | | | 30223 | 30223 |
| $\phi(1680)$ | | | | | | 100333 | 100333 |
| NOTE: $f_0(1710)$ was $f_J(1710)$ in PDG 1998. | | | | | | | |
| Also, Herwig's $f_1(H)$ had a mass of 1512 in Herwig 5.9 and a mass of 1426 as of Herwig 6.1. | | | | | | | |

| $u\bar{u}$, $d\bar{d}$, and $s\bar{s}$ Meson admixtures | | | | | | | |
|---|---|---|---|---|---|---|---|
| Meson | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $f_2(1270)$ | 112 | 225 | 225 | 261 | 225 | 225 | 225 |
| $f_2(1430)$ | | | | | | 9000225 | 9000225 |
| $f_2'(1525)$ | | 335 | 335 | 262 | 335 | 335 | 335 |
| $f_2(1565)$ | | | | | | 9010225 | 9010225 |
| $f_2(1640)$ | | | | | | 9020225 | 9020225 |
| $\eta_2(1645)$ | | | 10225 | | | 10225 | 10225 |
| $f_2(1810)$ | | | | | | 100225 | 100225 |
| $\eta_2(1870)$ | | | 10335 | | | 10335 | 10335 |
| $f_2(1950)$ | | | | | | 9030225 | 9030225 |
| $f_2(2010)$ | | | | | | 100335 | 100335 |
| $f_2(2150)$ | | | | | | 9040225 | 9040225 |
| $f_2(2300)$ | | | | | | 9050225 | 9050225 |
| $f_2(2340)$ | | | | | | 9060225 | 9060225 |
| $\omega_3(1670)$ | | | 227 | | | 227 | 227 |
| $\phi_3(1850)$ | | | 337 | | | 337 | 337 |
| $f_4(2050)$ | | | | | | 229 | 229 |
| $f_J(2220)$ | | | | | | 9000339 | 9000339 |
| $f_4(2300)$ | | | | | | 9000229 | 9000229 |

| Strange Mesons | | | | | | | |
|---|---|---|---|---|---|---|---|
| Meson | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $K_S^0$ | 20 | 310 | 310 | 57 | 310 | 310 | 310 |
| $K_L^0$ | -20 | 130 | 130 | 58 | 130 | 130 | 130 |
| $K^0$ | 230 | 311 | 311 | 25,26 | 311 | 311 | 311 |
| $K^+$ | 130 | 321 | 321 | 23,24 | 321 | 321 | 321 |
| $K_0^{*0}(1430)$ | | 10311 | 10311 | 268,269 | 10311 | 10311 | 10311 |
| $K_0^{*+}(1430)$ | | 10321 | 10321 | 270,271 | 10321 | 10321 | 10321 |
| $K^0(1460)$ | | | | | | 100311 | 100311 |
| $K^+(1460)$ | | | | | | 100321 | 100321 |
| $K^0(1830)$ | | | | | | 200311 | 200311 |
| $K^+(1830)$ | | | | | | 200321 | 200321 |
| $K_0^{*0}(1950)$ | | | | | | 9000311 | 9000311 |
| $K_0^{*+}(1950)$ | | | | | | 9000321 | 9000321 |
| $X_{sd}^0$ | | | | | 30343 | | 9010311 |
| $X_{su}^+$ | | | | | 30353 | | 9020321 |
| $K^{*0}(892)$ | 231 | 313 | 313 | 65,66 | 313 | 313 | 313 |
| $K^{*+}(892)$ | 131 | 323 | 323 | 63,64 | 323 | 323 | 323 |
| $K_1^0(1270)$ | 10231 | 10313 | 10313 ($K_1^0(L)$) | 59,60 | 10313 | 10313 | 10313 |
| $K_1^+(1270)$ | 10131 | 10323 | 10323 ($K_1^+(L)$) | 201,202 | 10323 | 10323 | 10323 |
| $K_1^0(1400)$ | | 20313 ($K_1^{*0}$) | 20313 ($K_1^0(H)$) | 19,20 | 20313 ($K_1^{\prime 0}$) | 20313 | 20313 |
| $K_1^+(1400)$ | | 20323 ($K_1^{*+}$) | 20323 ($K_1^+(H)$) | 203,204 | 20323 ($K_1^{\prime +}$) | 20323 | 20323 |
| $K^{*0}(1410)$ | 30231 | | | | 100313 ($K^{\prime *0}$) | 100313 | 100313 |
| $K^{*+}(1410)$ | 30131 | | | | 100323 ($K^{\prime *+}$) | 100323 | 100323 |
| $K_1^0(1650)$ | | | | | | 9000313 | 9000313 |
| $K_1^+(1650)$ | | | | | | 9000323 | 9000323 |
| $K^{*0}(1680)$ | | | 30313 | | 30313($K^{\prime\prime *0}$) | 30313 | 30313 |
| $K^{*+}(1680)$ | | | 30323 | | 30323($K^{\prime\prime *+}$) | 30323 | 30323 |
| In Herwig 6.2, $K_1^0(L)$ has mass 1570 and $K_1^0(H)$ has mass 1850. | | | | | | | |

| Strange Mesons | | | | | | | |
|---|---|---|---|---|---|---|---|
| Meson | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $K_2^{*0}(1430)$ | 232 | 315 | 315 | 272,273 | 315 | 315 | 315 |
| $K_2^{*+}(1430)$ | 132 | 325 | 325 | 274,275 | 325 | 325 | 325 |
| $K_2^0(1580)$ | | | | | | 9000315 | 9000315 |
| $K_2^+(1580)$ | | | | | | 9000325 | 9000325 |
| $K_2^0(1770)$ | | | 10315 | | | 10315 | 10315 |
| $K_2^+(1770)$ | | | 10325 | | | 10325 | 10325 |
| $K_2^0(1820)$ | | | 20315 | | | 20315 | 20315 |
| $K_2^+(1820)$ | | | 20325 | | | 20325 | 20325 |
| $K_2^{*0}(1980)$ | | | | | | 100315 | 100315 |
| $K_2^{*+}(1980)$ | | | | | | 100325 | 100325 |
| $K_2^0(2250)$ | | | | | | 9010315 | 9010315 |
| $K_2^+(2250)$ | | | | | | 9010325 | 9010325 |
| $K_3^{*0}(1780)$ | | | 317 | 278,279 | 317 | 317 | 317 |
| $K_3^{*+}(1780)$ | | | 327 | 280,281 | 327 | 327 | 327 |
| $K_3^0(2320)$ | | | | | | 9010317 | 9010317 |
| $K_3^+(2320)$ | | | | | | 9010327 | 9010327 |
| $K_4^{*0}(2045)$ | | | | | 319 | 319 | 319 |
| $K_4^{*+}(2045)$ | | | | | 329 | 329 | 329 |
| $K_4^0(2500)$ | | | | | | 9000319 | 9000319 |
| $K_4^+(2500)$ | | | | | | 9000329 | 9000329 |

| Charmed Mesons | | | | | | | |
|---|---|---|---|---|---|---|---|
| Meson | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | PDG 2000 | std 3.04 | HepPDT 1.00 |
| $D^+$ | -240 | 411 | 411 | 29,30 | 411 | 411 | 411 |
| $D^0$ | -140 | 421 | 421 | 27,28 | 421 | 421 | 421 |
| $D_0^{*+}$ | | 10411 | 10411 | 221,225 | 10411 | 10411 | 10411 |
| $D_0^{*0}$ | | 10421 | 10421 | 229,233 | 10421 | 10421 | 10421 |
| $D(2S)^+$ | | | | | 30411 | | 100411 |
| $D(2S)^0$ | | | | | 30421 | | 100421 |
| $D^{*+}(2010)$ | -241 | 413 | 413 | 69,70 | 413 | 413 | 413 |
| $D^{*0}(2007)$ | -141 | 423 | 423 | 67,68 | 423 | 423 | 423 |
| $D_1^+(2420)/D_1^+(L)$ | | 10413 | 10413 | 223,227 | 10413 | 10413 | 10413 |
| $D_1^0(2420)/D_1^0(L)$ | | 10423 | 10423 | 231,235 | 10423 | 10423 | 10423 |
| $D_1^+(H)/D_1^{*+}$ | | 20413 | 20413 | 222,226 | 20413 ($D_1^{\prime+}$) | 20413 | 20413 |
| $D_1^0(H)/D_1^{*0}$ | | 20423 | 20423 | 230,234 | 20423 ($D_1^{\prime 0}$) | 20423 | 20423 |
| $D(2S)^{*+}$ | | | | | 30413 | | 100413 |
| $D(2S)^{*0}$ | | | | | 30423 | | 100423 |
| $D_2^{*+}(2460)$ | | 415 | 415 | 224,228 | 415 | 415 | 415 |
| $D_2^{*0}(2460)$ | | 425 | 425 | 232,236 | 425 | 425 | 425 |
| $D_s^+$ | -340 ($F^+$) | 431 | 431 | 31,32 | 431 | 431 | 431 |
| $D_{s0}^{*+}$ | | 10431 | 10431 | 237,241 | 10431 | 10431 | 10431 |
| $D_s^{*+}$ | -341 ($F^{*+}$) | 433 | 433 | 71,72 | 433 | 433 | 433 |
| $D_{s1}^+(2536)/D_{s1}^+(L)$ | | 10433 | 10433 | 239,243 | 10433 | 10433 | 10433 |
| $D_{s1}^+(H)/D_{s1}^{*+}$ | | 20433 | 20433 | 238,242 | 20433 | 20433 | 20433 |
| $D_{s2}^{*+}$ | | 435 | 435 | 240,244 | 435 | 435 | 435 |

| $c\bar{c}$ Mesons | | | | | | | |
|---|---|---|---|---|---|---|---|
| Meson | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $\eta_c(1S)$ | 440 | 441 | 441 | 54 | 441 | 441 | 441 |
| $\chi_{c0}(1P)$ | 20440 | 10441 | 10441 ($\chi_{c1}$) | 110 | 10441 | 10441 | 10441 |
| $\eta_c(2S)$ | | | | | 20441 | 100441 | 100441 |
| $J/\psi(1S)$ | 441 | 443 | 443 | 94 | 443 | 443 | 443 |
| $h_c(1P)$ | | 10443 | 10443 | 215 | 10443 | 10443 | 10443 |
| $\chi_{c1}(1P)$ | 20441 | 20443 | 20443 ($\chi_{c0}$) | 111 | 20443 | 20443 | 20443 |
| $\psi(2S)/\psi'$ | 10441 | 100443 | 100443 | 219 | 30443 | 100443 | 100443 |
| $\psi(3770)$ | | | 30443 | 211 | 40443 | 30443 | 30443 |
| $\psi(4040)$ | | | | 212 | 50443 | 9000443 | 9000443 |
| $\psi(4160)$ | | | | 213 | 60443 | 9010443 | 9010443 |
| $\psi(4415)$ | | | | 214 | 70443 | 9020443 | 9020443 |
| $\chi_{c2}(1P)$ | 20442 | 445 | 445 | 112 | 445 | 445 | 445 |
| $\psi(3836)$ | | | | | | **9000445** | **9000445** |

| Bottom Mesons | | | | | | | |
|---|---|---|---|---|---|---|---|
| Meson | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $B^0$ | 250 | 511 | 511 | 36,35 | 511 | 511 | 511 |
| $B^+$ | 150 | 521 | 521 | 34,33 | 521 | 521 | 521 |
| $B_0^{*0}$ | | 10511 | 10511 | 479,483 | 10511 | 10511 | 10511 |
| $B_0^{*+}$ | | 10521 | 10521 | 471,475 | 10521 | 10521 | 10521 |
| $B^{*0}$ | 251 | 513 | 513 | 76,75 | 513 | 513 | 513 |
| $B^{*+}$ | 151 | 523 | 523 | 74,73 | 523 | 523 | 523 |
| $B_1^0(L)$ | | 10513 | 10513 | 481,485 | 10513 | 10513 | 10513 |
| $B_1^+(L)$ | | 10523 | 10523 | 473,477 | 10523 | 10523 | 10523 |
| $B_1^0(H)/B_1^{*0}$ | | 20513 | 20513 | 480,484 | 20513 ($B_1^{\prime 0}$) | 20513 | 20513 |
| $B_1^+(H)/B_1^{*+}$ | | 20523 | 20523 | 472,476 | 20523 ($B_1^{\prime +}$) | 20523 | 20523 |
| $B_2^{*0}$ | | 515 | 515 | 482,486 | 515 | 515 | 515 |
| $B_2^{*+}$ | | 525 | 525 | 474,478 | 525 | 525 | 525 |
| $B_s^0$ | 350 | 531 | 531 | 38,37 | 531 | 531 | 531 |
| $B_{s0}^{*0}$ | | 10531 | 10531 | 487,491 | 10531 | 10531 | 10531 |
| $B_s^{*0}$ | 351 | 533 | 533 | 78,77 | 533 | 533 | 533 |
| $B_{s1}^0(L)$ | | 10533 | 10533 | 489,493 | 10533 | 10533 | 10533 |
| $B_{s1}^0(H)/B_{s1}^{*0}$ | | 20533 | 20533 | 488,492 | 20533 ($B_{s1}^{\prime 0}$) | 20533 | 20533 |
| $B_{s2}^{*0}$ | | 535 | 535 | 490,494 | 535 | 535 | 535 |
| $B_c^+$ | 450 | 541 | 541 | 40,39 | 541 | 541 | 541 |
| $B_{c0}^{*+}$ | | 10541 | 10541 | | 10541 | 10541 | 10541 |
| $B_c^{*+}$ | 451 | 543 | 543 | 80,79 | 543 | 543 | 543 |
| $B_{c1}^+(L)$ | | 10543 | 10543 | | 10543 | 10543 | 10543 |
| $B_{c1}^+(H)/B_{c1}^{*+}$ | | 20543 | 20543 | | 20543 ($B_{c1}^{\prime +}$) | 20543 | 20543 |
| $B_{c2}^{*+}$ | | 545 | 545 | | 545 | 545 | 545 |

| $b\bar{b}$ Mesons | | | | | | | |
|---|---|---|---|---|---|---|---|
| Meson | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $\eta_b(1S)$ | 550 | 551 | 551 | 55 | 551 | 551 | 551 |
| $\chi_{b0}(1P)$ | | 10551 | 10551 | 100 | 10551 | 10551 | 10551 |
| $\eta_b(2S)$ | | | | | 20551 | 100551 | 100551 |
| $\chi_{b0}(2P)$ | | | 110551 | 103 | 30551 | 110551 | 110551 |
| $\eta_b(3S)$ | | | | | 40551 | 200551 | 200551 |
| $\chi_{b0}(3P)$ | | | | | 50551 | 210551 | 210551 |
| $\Upsilon(1S)$ | 551 | 553 | 553 | 95 | 553 | 553 | 553 |
| $h_b(1P)$ | | 10553 | 10553 | 218 | 10553 | 10553 | 10553 |
| $\chi_{b1}(1P)$ | | 20553 | 20553 | 101 | 20553 | 20553 | 20553 |
| $\Upsilon_1(1D)$ | | | | | 120553 | 30553 | 30553 |
| $\Upsilon(2S)/\Upsilon'$ | | 100553 | 100553 | 97 | 30553 | 100553 | 100553 |
| $h_b(2P)$ | | | | | 40553 | 110553 | 110553 |
| $\chi_{b1}(2P)$ | | | 120553 | 104 | 50553 | 120553 | 120553 |
| $\Upsilon_1(2D)$ | | | | | 130553 | 130553 | 130553 |
| $\Upsilon(3S)$ | | | 200553 | 98 | 60553 | 200553 | 200553 |
| $h_b(3P)$ | | | | | 100553 | 210553 | 210553 |
| $\chi_{b1}(3P)$ | | | | | 110553 | 220553 | 220553 |
| $\Upsilon(4S)$ | | | 300553 | 99 | 70553 | 300553 | 300553 |
| $\Upsilon(10860)$ | | | | 216 | 80553 | 9000553 | 9000553 |
| $\Upsilon(11020)$ | | | | 217 | | 9010553 | 9010553 |
| $\Upsilon(7S)$ | | | | 220 | | | 9020553 |
| $\chi_{b2}(1P)$ | | 555 | 555 | 102 | 555 | 555 | 555 |
| $\eta_{b2}(1D)$ | | | | | 40555 | 10555 | 10555 |
| $\Upsilon_2(1D)$ | | | | | 30555 | 20555 | 20555 |
| $\chi_{b2}(2P)$ | | | 100555 | 105 | 10555 | 100555 | 100555 |
| $\eta_{b2}(2D)$ | | | | | 60555 | 110555 | 110555 |
| $\Upsilon_2(2D)$ | | | | | 50555 | 120555 | 120555 |
| $\chi_{b2}(3P)$ | | | | | 20555 | 200555 | 200555 |
| $\Upsilon_3(1D)$ | | | | | 557 | 557 | 557 |
| $\Upsilon_3(2D)$ | | | | | 10557 | 100557 | 100557 |

| Top Mesons | | | | | | | |
|---|---|---|---|---|---|---|---|
| Meson | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $T^+$ | -260 | | 611 | 43,44 | | | 611 |
| $T^0$ | -160 | | 621 | 41,42 | | | 621 |
| $T^{*+}$ | -261 | | | 83,84 | | | 613 |
| $T^{*0}$ | -161 | | | 81,82 | | | 623 |
| $T_s^+$ | -360 | | 631 | 45,46 | | | 631 |
| $T_s^{*+}$ | -361 | | | 85,86 | | | 633 |
| $T_c^0$ | 460 | | 641 | 47,48 | | | 641 |
| $T_c^{*0}$ | 461 | | | 87,88 | | | 643 |
| $T_b^+$ | -560 | | 651 | 49,50 | | | 651 |
| $T_b^{*+}$ | -561 | | | 89,90 | | | 653 |
| $\eta_t$ | 660 | | | 56 | | | 661 |
| $\theta$ | 661 | | 663 | 96 ($\psi_t$) | | | 663 |

## B.3 List of baryon states

| Light Baryons | | | | | | | |
|---|---|---|---|---|---|---|---|
| Baryon | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $p$ | 1120 | 2212 | 2212 | 137,138 | 2212 | 2212 | 2212 |
| $n$ | 1220 | 2112 | 2112 | 143,144 | 2112 | 2112 | 2112 |
| $\Delta^{++}$ | 1111 | 2224 | 2224 | 193,194 | 2224 | 2224 | 2224 |
| $\Delta^{+}$ | 1121 | 2214 | 2214 | 169,170 | 2214 | 2214 | 2214 |
| $\Delta^{0}$ | 1221 | 2114 | 2114 | 175,176 | 2114 | 2114 | 2114 |
| $\Delta^{-}$ | 2221 | 1114 | 1114 | 195,196 | 1114 | 1114 | 1114 |

| Strange Baryons | | | | | | | |
|---|---|---|---|---|---|---|---|
| Baryon | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $\Lambda$ | 2130 | 3122 | 3122 | 121,122 | 3122 | 3122 | 3122 |
| $\Lambda(1405)$ | | | | | 13122 | | |
| $\Lambda(1600)$ | | | | | 23122 | | |
| $\Lambda(1670)$ | | | | | 33122 | | |
| $\Lambda(1800)$ | | | | | 43122 | | |
| $\Lambda(1810)$ | | | | | 53122 | | |
| $\Lambda(1520)$ | | | | | 3124 | | |
| $\Lambda(1690)$ | | | | | 13124 | | |
| $\Lambda(1820)$ | | | | | 3126 | | |
| $\Lambda(1830)$ | | | | | 13126 | | |
| $\Sigma^+$ | 1130 | 3222 | 3222 | 139,140 | 3222 | 3222 | 3222 |
| $\Sigma^0$ | 1230 | 3212 | 3212 | 129,130 | 3212 | 3212 | 3212 |
| $\Sigma(1660)^0$ | | | | | 13212 | | |
| $\Sigma(1750)^0$ | | | | | 23212 | | |
| $\Sigma(1670)^0$ | | | | | 13214 | | |
| $\Sigma(1775)^0$ | | | | | 3216 | | |
| $\Sigma^-$ | 2230 | 3112 | 3112 | 145,146 | 3112 | 3112 | 3112 |
| $\Sigma^{*+}/\Sigma(1385)^+$ | 1131 | 3224 | 3224 | 171,172 | 3224 | 3224 | 3224 |
| $\Sigma^{*0}/\Sigma(1385)^0$ | 1231 | 3214 | 3214 | 161,162 | 3214 | 3214 | 3214 |
| $\Sigma^{*-}/\Sigma(1385)^-$ | 2231 | 3114 | 3114 | 177,178 | 3114 | 3114 | 3114 |
| $\Xi^0$ | 1330 | 3322 | 3322 | 149,150 | 3322 | 3322 | 3322 |
| $\Xi^-$ | 2330 | 3312 | 3312 | 151,152 | 3312 | 3312 | 3312 |
| $\Xi^{*0}/\Xi(1530)^0$ | 1331 | 3324 | 3324 | 181,182 | 3324 | 3324 | 3324 |
| $\Xi^{*-}/\Xi(1530)^-$ | 2331 | 3314 | 3314 | 183,184 | 3314 | 3314 | 3314 |
| $\Omega^-$ | 3331 | 3334 | 3334 | 197,198 | 3334 | 3334 | 3334 |

| Charmed Baryons | | | | | | | |
|---|---|---|---|---|---|---|---|
| Baryon | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $\Lambda_c^+$ | 2140 | 4122 | 4122 | 123,124 | 4122 | 4122 | 4122 |
| $\Sigma_c^{++}$ | 1140 | 4222 | 4222 | 141,142 | 4222 | 4222 | 4222 |
| $\Sigma_c^+$ | 1240 | 4212 | 4212 | 131,132 | 4212 | 4212 | 4212 |
| $\Sigma_c^0$ | 2240 | 4112 | 4112 | 147,148 | 4112 | 4112 | 4112 |
| $\Sigma_c^{*++}$ | 1141 | 4224 | 4224 | 173,174 | 4224 | 4224 | 4224 |
| $\Sigma_c^{*+}$ | 1241 | 4214 | 4214 | 163,164 | 4214 | 4214 | 4214 |
| $\Sigma_c^{*0}$ | 2241 | 4114 | 4114 | 179,180 | 4114 | 4114 | 4114 |
| $\Xi_c^+$ | 3140 | 4232 | 4232 | 125,126 | 4232 | 4232 | 4232 |
| $\Xi_c^0$ | 3240 | 4132 | 4132 | 127,128 | 4132 | 4132 | 4132 |
| $\Xi_c^{\prime+}$ | 1340 | 4322 | 4322 | 133,134 | 4322 | 4322 | 4322 |
| $\Xi_c^{\prime0}$ | 2340 | 4312 | 4312 | 135,136 | 4312 | 4312 | 4312 |
| $\Xi_c^{*+}$ | 1341 | 4324 | 4324 | 165,166 | 4324 | 4324 | 4324 |
| $\Xi_c^{*0}$ | 2341 | 4314 | 4314 | 167,168 | 4314 | 4314 | 4314 |
| $\Omega_c^0$ | 3340 | 4332 | 4332 | 153,154 | 4332 | 4332 | 4332 |
| $\Omega_c^{*0}$ | 3341 | 4334 | 4334 | 185,186 | 4334 | 4334 | 4334 |
| $\Xi_{cc}^+$ | 2440 | 4412 | | 157,158 | | 4412 | 4412 |
| $\Xi_{cc}^{++}$ | 1440 | 4422 | | 155,156 | | 4422 | 4422 |
| $\Xi_{cc}^{*+}$ | 2441 | 4414 | | 189,190 | | 4414 | 4414 |
| $\Xi_{cc}^{*++}$ | 1441 | 4424 | | 187,188 | | 4424 | 4424 |
| $\Omega_{cc}^+$ | 3440 | 4432 | | 159,160 | | 4432 | 4432 |
| $\Omega_{cc}^{*+}$ | 3441 | 4434 | | 191,192 | | 4434 | 4434 |
| $\Omega_{ccc}^{*++}$ | 4441 | 4444 | | 199,200 | | 4444 | 4444 |

| Bottom Baryons | | | | | | | |
|---|---|---|---|---|---|---|---|
| Baryon | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $\Lambda_b^0$ | 2150 | 5122 | 5122 | 401,402 | 5122 | 5122 | 5122 |
| $\Sigma_b^-$ | 2250 | 5112 | 5112 | 427,428 | 5112 | 5112 | 5112 |
| $\Sigma_b^0$ | 1250 | 5212 | 5212 | 413,414 | 5212 | 5212 | 5212 |
| $\Sigma_b^+$ | 1150 | 5222 | 5222 | 425,426 | 5222 | 5222 | 5222 |
| $\Sigma_b^{*-}$ | 2251 | 5114 | 5114 | 455,456 | 5114 | 5114 | 5114 |
| $\Sigma_b^{*0}$ | 1251 | 5214 | 5214 | 441,442 | 5214 | 5214 | 5214 |
| $\Sigma_b^{*+}$ | 1151 | 5224 | 5224 | 453,454 | 5224 | 5224 | 5224 |
| $\Xi_b^-$ | 3250 | 5132 | 5132 | 405,406 | 5132 | 5132 | 5132 |
| $\Xi_b^0$ | 3150 | 5232 | 5232 | 403,404 | 5232 | 5232 | 5232 |
| $\Xi_b^{\prime-}$ | 2350 | 5312 | 5312 | 417,418 | 5312 | 5312 | 5312 |
| $\Xi_b^{\prime 0}$ | 1350 | 5322 | 5322 | 415,416 | 5322 | 5322 | 5322 |
| $\Xi_b^{*-}$ | 2351 | 5314 | 5314 | 445,446 | 5314 | 5314 | 5314 |
| $\Xi_b^{*0}$ | 1351 | 5324 | 5324 | 443,444 | 5324 | 5324 | 5324 |
| $\Omega_b^-$ | 3350 | 5332 | 5332 | 429,430 | 5332 | 5332 | 5332 |
| $\Omega_b^{*-}$ | 3351 | 5334 | 5334 | 457,458 | 5334 | 5334 | 5334 |
| $\Xi_{bc}^0$ | 4250 | 5142 | | 409,410 | | 5142 | 5142 |
| $\Xi_{bc}^+$ | 4150 | 5242 | | 407,408 | | 5242 | 5242 |
| $\Xi_{bc}^{\prime 0}$ | 2450 | 5412 | | 421,422 | | 5412 | 5412 |
| $\Xi_{bc}^{\prime +}$ | 1450 | 5422 | | 419,420 | | 5422 | 5422 |
| $\Xi_{bc}^{*0}$ | 2451 | 5414 | | 449,450 | | 5414 | 5414 |
| $\Xi_{bc}^{*+}$ | 1451 | 5424 | | 447,448 | | 5424 | 5424 |
| $\Omega_{bc}^0$ | 4350 | 5342 | | 411,412 | | 5342 | 5342 |
| $\Omega_{bc}^{\prime 0}$ | 3450 | 5432 | | 423,424 | | 5432 | 5432 |
| $\Omega_{bc}^{*0}$ | 3451 | 5434 | | 451,452 | | 5434 | 5434 |
| $\Omega_{bcc}^+$ | 4450 | 5442 | | 431,432 | | 5442 | 5442 |
| $\Omega_{bcc}^{*+}$ | 4451 | 5444 | | 459,460 | | 5444 | 5444 |

| Bottom Baryons | | | | | | | |
|---|---|---|---|---|---|---|---|
| Baryon | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $\Xi_{bb}^{-}$ | 2550 | 5512 | | 435,436 | | 5512 | 5512 |
| $\Xi_{bb}^{0}$ | 1550 | 5522 | | 433,434 | | 5522 | 5522 |
| $\Xi_{bb}^{*-}$ | 2551 | 5514 | | 463,464 | | 5514 | 5514 |
| $\Xi_{bb}^{*0}$ | 1551 | 5524 | | 461,462 | | 5524 | 5524 |
| $\Omega_{bb}^{-}$ | 3550 | 5532 | | 437,438 | | 5532 | 5532 |
| $\Omega_{bb}^{*-}$ | 3551 | 5534 | | 465,466 | | 5534 | 5534 |
| $\Omega_{bbc}^{0}$ | 4550 | 5542 | | 439,440 | | 5542 | 5542 |
| $\Omega_{bbc}^{*0}$ | 4551 | 5544 | | 467,468 | | 5544 | 5544 |
| $\Omega_{bbb}^{*-}$ | 5551 | 5554 | | 469,470 | | 5554 | 5554 |

| Top Baryons | | | | | | | |
|---|---|---|---|---|---|---|---|
| Baryon | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $\Lambda_t^+$ | 2160 | | 6122 | | | | 6122 |
| $\Sigma_t^0$ | 2260 | | 6112 | | | | 6112 |
| $\Sigma_t^+$ | 1260 | | | | | | 6212 |
| $\Sigma_t^{++}$ | 1160 | | 6222 | | | | 6222 |
| $\Sigma_t^{*0}$ | 2261 | | | | | | 6114 |
| $\Sigma_t^{*+}$ | 1261 | | | | | | 6214 |
| $\Sigma_t^{*++}$ | 1161 | | | | | | 6224 |
| $\Xi_t^0$ | 3260 | | 6132 | | | | 6132 |
| $\Xi_t^+$ | 3160 | | 6232 | | | | 6232 |
| $\Xi_t^{\prime 0}$ | 2360 | | | | | | 6312 |
| $\Xi_t^{\prime +}$ | 1360 | | | | | | 6322 |
| $\Xi_t^{*0}$ | 2361 | | | | | | 6314 |
| $\Xi_t^{*+}$ | 1361 | | | | | | 6324 |
| $\Omega_t^0$ | 3360 | | 6332 | | | | 6332 |
| $\Omega_t^{*0}$ | 3361 | | | | | | 6334 |
| $\Xi_{tc}^+$ | 4260 | | | | | | 6142 |
| $\Xi_{tc}^{++}$ | 4160 | | | | | | 6242 |
| $\Xi_{tc}^{\prime +}$ | 2460 | | | | | | 6412 |
| $\Xi_{tc}^{\prime ++}$ | 1460 | | | | | | 6422 |
| $\Xi_{tc}^{*+}$ | 2461 | | | | | | 6414 |
| $\Xi_{tc}^{*++}$ | 1461 | | | | | | 6424 |
| $\Omega_{tc}^+$ | 4360 | | | | | | 6342 |
| $\Omega_{tc}^{\prime +}$ | 3460 | | | | | | 6432 |
| $\Omega_{tc}^{*+}$ | 3461 | | | | | | 6434 |
| $\Omega_{tcc}^{++}$ | 4460 | | | | | | 6442 |
| $\Omega_{tcc}{*}^{++}$ | 4461 | | | | | | 6444 |

| Top Baryons | | | | | | | |
|---|---|---|---|---|---|---|---|
| Baryon | Isajet 7.51 | Pythia 6.155 | Herwig 6.2 | QQ 9.2b | EvtGen | PDG 2000 | HepPDT 1.00 |
| $\Xi_{tb}^{0}$ | 5260 | | | | | | 6152 |
| $\Xi_{tb}^{+}$ | 5160 | | | | | | 6252 |
| $\Xi_{tb}^{\prime 0}$ | 2560 | | | | | | 6512 |
| $\Xi_{tb}^{\prime +}$ | 1560 | | | | | | 6522 |
| $\Xi_{tb}^{*0}$ | 2561 | | | | | | 6514 |
| $\Xi_{tb}^{*+}$ | 1561 | | | | | | 6524 |
| $\Omega_{tb}^{0}$ | 5360 | | | | | | 6352 |
| $\Omega_{tb}^{\prime 0}$ | 3560 | | | | | | 6532 |
| $\Omega_{tb}^{*0}$ | 3561 | | | | | | 6534 |
| $\Omega_{tbc}^{+}$ | 5460 | | | | | | 6452 |
| $\Omega_{tbc}^{\prime +}$ | 4560 | | | | | | 6542 |
| $\Omega_{tbc}^{*+}$ | 4561 | | | | | | 6544 |
| $\Omega_{tbb}^{0}$ | 5560 | | | | | | 6552 |
| $\Omega_{tbb}^{*0}$ | 5561 | | | | | | 6554 |
| $\Xi_{tt}^{+}$ | 2660 | | | | | | 6612 |
| $\Xi_{tt}^{++}$ | 1660 | | | | | | 6622 |
| $\Xi_{tt}^{*+}$ | 2661 | | | | | | 6614 |
| $\Xi_{tt}^{*++}$ | 1661 | | | | | | 6624 |
| $\Omega_{tt}^{+}$ | 3660 | | | | | | 6632 |
| $\Omega_{tt}^{*+}$ | 3661 | | | | | | 6634 |
| $\Omega_{ttc}^{++}$ | 4660 | | | | | | 6642 |
| $\Omega_{ttc}^{*++}$ | 4661 | | | | | | 6644 |
| $\Omega_{ttb}^{+}$ | 5660 | | | | | | 6652 |
| $\Omega_{ttb}^{*+}$ | 5661 | | | | | | 6654 |
| $\Omega_{ttt}^{*++}$ | 6661 | | | | | | 6664 |