

Generic User Process Interface for Event Generators

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Abstract

Generic Fortran common blocks are presented for use by High Energy Physics event generators for the transfer of event configurations from parton level generators to showering and hadronization event generators.

Modularization of High Energy Particle Physics event generation is becoming increasingly useful as the complexity of Monte Carlo programs grows. To accommodate this trend, several authors of popular Monte Carlo and matrix element programs attending the *Physics at TeV Colliders Workshop* in Les Houches, 2001 have agreed on a generic format for the transfer of parton level event configurations from matrix element event generators (MEG) to showering and hadronization event generators (SHG).

CompHEP [1]		Herwig [6]
Grace [2]		Isajet [7]
MadGraph [3]	⇒	Pythia [8]
VecBos [4]		...
WbbGen [5]		...
...		

Events generated this way are customarily called user (or user-defined) processes, to distinguish them from the internal processes that come with the SHG. Specific solutions are already in use, including an interface of WbbGen with Herwig [9] and an interface of CompHEP with Pythia [10]—that experience is exploited here.

An implementation of the user process interface has been included in Pythia 6.2, described (with an example) in Ref. [11].

The user process interface discussed here is not intended as a replacement for HEPEVT [12], which is the standard Fortran common block for interface between generators and analysis/detector simulation. The user process common blocks address the communication between two event generators only, a MEG one and a SHG one, and not the communication of event generators with the outside world.

In the course of a normal event generation run, this communication occurs at two stages: (1) At initialization, to establish the basic parameters of the run as a whole. (2) For each new event that is to be transferred from the MEG to the SHG. Each of these two stages

here corresponds to its own Fortran common block.¹ These common blocks are described in detail in the next two sections, followed by some examples.

One can also foresee that each stage will be associated with its own subroutine, called from the SHG, where information is put in the respective common block, based on output from the MEG. The details of these subroutines are likely to be specific to a given MEG and may also be specific to a given SHG. The subroutine names `UPINIT` and `UPEVNT` (each with no arguments) were chosen for the Pythia 6.2 implementation. They are intended to be generic (the usual `PY` prefixes are omitted), and only dummy versions are packaged with the program. It is recommended that other SHG authors use the same dummy routine names (with zero arguments) such that for simple cases which do not require intervention ‘by hand’, MEG authors will be able to interface several SHGs with a single set of routines. Example routines are presented in the Pythia documentation [11].

In general, a user process run may consist of a number of subprocesses, each denoted by a unique integer identifier. If the user wishes to have the SHG unweight events using acceptance-rejection and/or mix together events from different processes, then the user process author will need to supply a subroutine that is able to return an event of the requested subprocess type to the SHG on demand. The author may choose to organize the subroutine to generate the event ‘on the fly’, or to read the event from a file stream (with a separate file stream for each subprocess). The SHG will also need information about the subprocess cross section and/or maximum event weight to select which process is generated next and for acceptance-rejection. This information will need to be known from the onset (and could, for example, be determined in advance from an initialization run). Alternatively, the user may already have a proper mixture of subprocesses from the MEG and only wish the SHG to process events in the order they are handed in. We therefore allow for several different event weight models.

If extra information is needed for a specific user implementation, then a implementation-specific common block should be created. The meaning of the user process common block elements should not be overloaded, as this would defeat the generic purpose.

The descriptions in this paper are intended for event generator authors and may appear complex—most of the details will be transparent to the casual user.

1 ‘User Process’ Run Information

The run common block contains information which pertains to a collection of events. In general this information is process dependent and it is impossible to include everything in a generic common block. Instead only the most general information is included here, and it is expected that users will have to intervene ‘by hand’ for many cases (i.e. a user may need to specify which cutoffs are used to avoid singularities, which jet clustering algorithm has been used to recombine partons in a next-to-leading-order calculation, the effective parton masses, ...).

¹An interface in C++ has been developed in Ref. [13] and contains similar information content as that discussed here.

```

integer      MAXPUP
parameter ( MAXPUP=100 )
integer      IDBMUP, PDFGUP, PDFSUP, IDWTUP, NPRUP, LPRUP
double precision EBMUP, XSECUP, XERRUP, XMAXUP
common /HEPRUP/ IDBMUP(2), EBMUP(2), PDFGUP(2), PDFSUP(2),
+              IDWTUP, NPRUP, XSECUP(MAXPUP), XERRUP(MAXPUP),
+              XMAXUP(MAXPUP), LPRUP(MAXPUP)

```

HEPRUP ‘USER PROCESS’ RUN COMMON BLOCK

- parameter MAXPUP=100 : *maximum number of different processes to be interfaced at one time*

Beam Information

Beam particle 1 (2) is defined as traveling along the +Z (-Z) direction.

- integer IDBMUP(2) : *ID of beam particle 1 and 2 according to the Particle Data Group convention [14]*
- double EBMUP(2) : *energy in GeV of beam particles 1 and 2*
- integer PDFGUP(2) : *the author group for beam 1 and 2, according to the Cernlib PDFlib [15] specification*
- integer PDFSUP(2) : *the PDF set ID for beam 1 and 2, according to the Cernlib PDFlib specification*

For e^+e^- or when the SHG defaults are to be used, PDFGUP=-1, PDFSUP=-1 should be specified.

The PDFlib enumeration of PDFs is sometimes out of date, but it is the only unique integer labels for PDFs available. In the case where a PDF not included in PDFlib is being used, this information will have to be passed ‘by hand’.

Process Information

- integer IDWTUP : *master switch dictating how the event weights (XWGTUP) are interpreted*

The user is expected to pick the most appropriate event weight model for a run, given the MEG input at hand and the desired output. Normally the SHG should be able to handle all of the models.

A summary of the IDWTUP switches is presented in Table 1.

- +1 Events are weighted on input and the SHG is asked to produce events with weight +1 as output. XSECUP and XERRUP need not be provided, but are calculated by the SHG. XWGTUP is a dimensional quantity, in pb, with a mean value converging to the cross section of the process. The SHG selects the next subprocess type to be generated, based on the relative size of the XMAXUP(i) values. The user-supplied interface routine must return an event of the requested type on demand from the SHG, and the maximum weight XMAXUP (or a reasonable approximation to it) must be known from the onset. A given event is accepted with a probability XWGTUP/XMAXUP(i). In case of rejection, a new event type and a new event are selected. If XMAXUP(i) is chosen too low, such that XWGTUP violates the XMAXUP(i), the SHG will issue a warning and update XMAXUP(i) with the new maximum weight value. If events of some types are already available unweighted, then a correct mixing of these processes is ensured by

- putting $XWGTUP = XMAXUP(i)$. In this option also the internal SHG processes are available, and can be mixed with the external ones. All weights are positive definite. k -factors may be included on an event by event basis by the user process interface by re-scaling the $XWGTUP$ for each event.
- 1 Same as above ($IDWTUP=+1$), but the event weights may be either positive or negative on input, and the SHG will produce events with weight $+1$ or -1 as output.² A given event would be accepted with a probability $|XWGTUP|/|XMAXUP(i)|$ and assigned weight $\text{sign}(1,XWGTUP)$, where the `sign` function transfers the sign of $XWGTUP$ onto 1. A physics process with alternating cross section sign must be split in two IDPRUP types,³ based on the sign of the cross section, such that all events of a particular IDPRUP have the same event weight sign. Also the $XMAXUP(i)$ values must be available for these two IDPRUP types separately, so that $|XMAXUP(i)|$ gives the relative mixing of event types, with event acceptance based on $|XWGTUP|/|XMAXUP(i)|$.
 - +2 Events are weighted on input and the SHG is asked to produce events with weight $+1$ as output. The SHG selects the next subprocess type to be generated, based on the relative size of the $XSECUP(i)$ values. The user-supplied interface routine must return an event of the requested type on demand from the SHG. The cross sections $XSECUP(i)$ must be known from the onset. A given event is accepted with a probability $XWGTUP/XMAXUP(i)$. In case of rejection, a new event of the same type would be requested. In this scenario only the ratio $XWGTUP/XMAXUP(i)$ is of significance. If events of some types are already available unweighted, then a correct mixing of these processes is ensured by putting $XWGTUP = XMAXUP(i)$. A k -factor can be applied to each process by re-scaling the respective $XSECUP(i)$ value at the beginning of the run, but cannot be given individually for each event. In this option also the internal SHG processes are available, and can be mixed with the user processes.
 - 2 Same as above ($IDWTUP=+2$), but the event weights may be either positive or negative on input, and the SHG will produce events with weight $+1$ or -1 as output. A physics process with alternating cross section sign must therefore be split in two IDPRUP types, based on the sign of the cross section, such that all events of a particular IDPRUP have the same event weight sign. Also the $XSECUP(i)$ and $XMAXUP(i)$ values must be available for these two IDPRUP types separately, so that $|XSECUP(i)|$ gives the relative mixing of event types, with event acceptance based on $|XWGTUP|/|XMAXUP(i)|$ and the total cross section of the two IDPRUP types combined given by $XSECUP(i)+XSECUP(j)$.
 - +3 Events are unweighted on input such that all events come with unit weight $XWGTUP=+1$. The SHG will only ask for the next event. If any mixing or unweighting is desired, it will have to be performed by the user process interface. The SHG will not reject any

²Negative-weight events may occur e.g. in next-to-leading-order calculations. They should cancel against positive-weight events in physical distributions. The details of this cancellation are rather subtle when considered in the context of showers and hadronization, however, and a proper treatment would require more information than discussed here. The negative-weight options should therefore be used with some caution, and the negative-weight events should be a reasonably small fraction of the total event sample.

³The motivation for this requirement is best understood with a simple example: imagine two subprocesses with the same cross section. The first process includes events with both positive and negative event weights such that two events out of three have weight $+1$ and the third -1 . All events from the second process have positive weight $+1$. In this scenario these two processes should be ‘mixed’ with proportions 3:1 to account for the cancellations that occur for the first process. The proportions for the mixing are communicated to the SHG by supplying the positive and negative contributions to the cross section separately.

events (unless it encounters other kinds of problems). If a k -factor is desired, it is the responsibility of the user process interface. When events are read sequentially from an already existing file, this would imply one common k -factor for all processes. In this option it is not possible to mix with internal SHG processes.

- 3 Same as above (IDWTUP=+3), but the event weights may be either +1 or -1 on input. A single process identifier (IDPRUP) may include events with both positive and negative event weights.
- +4 Same as (IDWTUP=+3), but events are weighted on input and the average of the event weights (XWGTUP) is the cross section in pb. When histogramming results on analyzed events, these weights would have to be used. The SHG will only ask for the next event and will not perform any mixing or unweighting. Neither XSECUP nor XMAXUP needs to be known or supplied. In this option it is not possible to mix with internal SHG processes.
- 4 Same as (IDWTUP=+4), but event weights may be either positive or negative on input and the average of the event weights (XWGTUP) is the cross section. A single process identifier (IDPRUP) may include events with both positive and negative event weights.

IDWTUP	event selection according to	control of mixing/unweighting	XWGTUP input	output
+1	XMAXUP	SHG	+ weighted	+1
-1	XMAXUP	SHG	\pm weighted	± 1
+2	XSECUP	SHG	+ weighted	+1
-2	XSECUP	SHG	\pm weighted	± 1
+3	—	user interface	+1	+1
-3	—	user interface	± 1	± 1
+4	—	user interface	+ weighted	+ weighted
-4	—	user interface	\pm weighted	\pm weighted

Table 1: Summary of the options available for the master weight switch IDWTUP.

- `integer NPRUP` : *the number of different user subprocesses*
i.e. LPRUP and other arrays will have NPRUP entries, LPRUP(1:NPRUP)
- `double XSECUP(J)` : *the cross section for process J in pb*
This entry is mandatory for IDWTUP= ± 2 .
- `double XERRUP(J)` : *the statistical error associated with the cross section of process J in pb*
It is not expected that this information will be used by the SHG, except perhaps for printouts.
- `double XMAXUP(J)` : *the maximum XWGTUP for process J*
For the case of weighted events (IDWTUP= $\pm 1, \pm 2$), this entry is mandatory—though it need not be specified to a high degree of accuracy. If too small a number is specified, the SHG will issue a warning and increase XMAXUP(J). This entry has no meaning for IDWTUP= $\pm 3, \pm 4$.
- `integer LPRUP(J)` : *a listing of all user process IDs that can appear in IDPRUP of HEPEUP for this run*

When communicating between the user process and SHG, the LPRUP code will be used. Example: if LPRUP(1)=1022, then the SHG will ask for an event of type 1022, not 1.

2 ‘User Process’ Event Information

```

integer MAXNUP
parameter ( MAXNUP=500 )
integer NUP, IDPRUP, IDUP, ISTUP, MOTHUP, ICOLUP
double precision XWGTUP, SCALUP, AQEDUP, AQCDUP,
+           PUP, VTIMUP, SPINUP
common /HEPEUP/ NUP, IDPRUP, XWGTUP, SCALUP, AQEDUP, AQCDUP,
+           IDUP(MAXNUP), ISTUP(MAXNUP), MOTHUP(2,MAXNUP),
+           ICOLUP(2,MAXNUP), PUP(5,MAXNUP), VTIMUP(MAXNUP),
+           SPINUP(MAXNUP)

```

HEPEUP ‘USER PROCESS’ EVENT COMMON BLOCK

- `parameter MAXNUP=500` : *maximum number of particle entries*
- `integer NUP` : *number of particle entries in this event*

An event with $NUP=0$ denotes the case where the user process is unable to provide an event of the type requested by the SHG (i.e. if the user process is providing events to the SHG by reading them sequentially from a file and the end of the file is reached).

- `integer IDPRUP` : *ID of the process for this event*

The process ID’s are not intended to be generic. The entry is a hook which the event generators can use to translate into their own scheme, or use in print statements (e.g. so that cross section information can be shown per process).

When $IDWTUP = \pm 1, \pm 2$ the next process to be generated is selected by the SHG, and so $IDPRUP$ is set by the SHG. For $IDWTUP = \pm 3, \pm 4$ the process is selected by the MEG, and $IDPRUP$ is set by the MEG.

- `double XWGTUP` : *event weight*

weighted events: if the user process supplies weighted events and the SHG is asked to produce unweighted events, this number will be compared against $XMAXUP$ in the run common block $HEPRUP$ for acceptance-rejection.

unweighted events: if the user process supplies events which have already been unweighted, this number should be set to +1 (-1 for negative weight events in e.g. a NLO calculation).

The precise definition of $XWGTUP$ depends on the master weight switch $IDWTUP$ in the run common block. More information is given there.

- `double SCALUP` : *scale of the event in GeV, as used for calculation of PDFs*

If the scale has not been defined, this should be denoted by setting the scale to -1.

- `double AQEDUP` : *the QED coupling α_{QED} used for this event (e.g. $\frac{1}{128}$)*
- `double AQCDUP` : *the QCD coupling α_{QCD} used for this event*

When α_{QED} and/or α_{QCD} is not relevant for the process, or in the case where the user process prefers to let the SHG use its defaults, $AQEDUP=-1$ and/or $AQCDUP=-1$ should be specified.

ID, Status, and Parent-Child History

- `integer IDUP(I)` : *particle ID according to Particle Data Group convention [14]*
undefined (and possibly non-physical) “particles” should be assigned $IDUP=0$ (i.e. the WZ particle in the example given in the $MOTHUP$ description below)

- integer `ISTUP(I)` : *status code*

- 1 Incoming particle
- +1 Outgoing final state particle
- 2 Intermediate space-like propagator defining an x and Q^2 which should be preserved
- +2 Intermediate resonance, Mass should be preserved
- +3 Intermediate resonance, for documentation only⁴
- 9 Incoming beam particles at time $t = -\infty$

The recoil from a parton shower (including photon emission) needs to be absorbed by particles in the event. Without special instructions, this can alter the mass of intermediate particles. The `ISTUP` flag +2 allows the user process to specify which intermediate states should have their masses preserved, i.e. for $e^+e^- \rightarrow Z^0 h^0 \rightarrow q\bar{q}b\bar{b}$, the Z^0 and h^0 would be flagged with `ISTUP=+2`.

The primary application of the `ISTUP=-2` status code is deep inelastic scattering (a negative number is chosen for this status code because the propagator in some sense can be thought of as incoming). See the example below.

The status code `ISTUP=-9` specifying incoming beams is not needed in most cases because the beam particle energy and identity is contained in the `HEPRUP` run information common block. The primary application of this status code will be non-collinear beams and/or runs for which the beam energy varies event by event (note that using the `-9` status code to vary the machine energy may produce problems if the SHG is asked to combine separate processes). The use of `ISTUP=-9` entries is optional, and is only necessary when the information in `HEPRUP` is insufficient. If entries with `ISTUP=-9` are specified, this information will override any information in `HEPRUP`.

- integer `MOTHUP(2,I)` : *index of first and last mother*

For decays, particles will normally have only one mother. In this case either `MOTHUP(2,I)=0` or `MOTHUP(2,I)=MOTHUP(1,I)`. Daughters of a $2 \rightarrow n$ process have 2 mothers. This scheme does not limit the number of mothers, but in practice there will likely never be more than 2 mothers per particle.

The history (intermediate particles) will be used by the SHGs to decipher which combinations of particles should have their masses fixed and which particle decays should be “dressed” by the parton shower. Example: for $q\bar{q}' \rightarrow W^- Z g \rightarrow l^- \nu l^+ l^- g$, intermediate “particles” WZ , W , and Z could be specified with `ISTUP=+2`. Here the WZ “particle” would have its own entry in the common block with `IDUP=0`. The showering generator would preserve the invariant masses of these “particles” when absorbing the recoil of the parton shower.

In a case like $e^+e^- \rightarrow \mu^+ \mu^- \gamma$ proceeding via a γ^*/Z^0 , where the matrix element contains an interference term between initial and final-state emission, this ambiguity in the parent-child history of the γ has to be resolved explicitly by the user process.

Color Flow

A specific choice of color flow for a particular event is often unphysical, due to interference effects. However, SHGs require a specific color state from which to begin the shower—it is the responsibility of the user process to provide a sensible choice for the color flow of a particular event.

⁴Treatment of `ISTUP(I)=+3` entries may be generator dependent (in particular see Ref. [11] for the special treatment in Pythia).

- `integer ICOLUP(1,I)` : *integer tag for the color flow line passing through the color of the particle*
- `integer ICOLUP(2,I)` : *integer tag for the color flow line passing through the anti-color of the particle*

The tags can be viewed as numbering the different color lines in the $N_C \rightarrow \infty$ limit. The color/anti-color of a particle are defined with respect to the physical time order of the process so as to allow a unique definition of color flow also through intermediate particles.

This scheme is chosen because it has the fewest ambiguities, and when used with the history information, it supports Baryon number violation (an example is given below).

To avoid confusion it is recommended that integer tags larger than MAXNUP (i.e. 500) are used. The actual value of the tag has no meaning beyond distinguishing the lines in a given process.

Momentum and Position

- `double PUP(5,I)` : *lab frame momentum (P_x, P_y, P_z, E, M) of particle in GeV*
The mass is the ‘generated mass’ for this particle, $M^2 = E^2 - |\vec{p}|^2$ (i.e. not necessarily equal to the on-shell mass). The mass may be negative, which denotes negative M^2 (i.e. $M = 2$ implies $M^2 = 4$ whereas $M = -2$ implies $M^2 = -4$).

Both E and M are needed for numerical reasons, the user should explicitly calculate and provide each one.

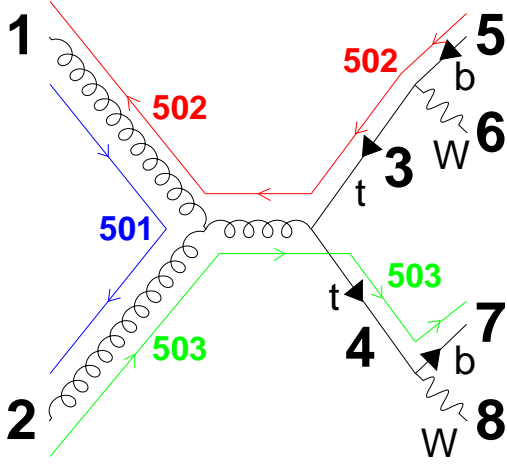
- `double VTIMUP(I)` : *invariant lifetime $c\tau$ (distance from production to decay) in mm*
Combined with the directional information from the momentum, this is enough to determine vertex locations. Note that this gives the distance of travel for the particle from birth to death, in this particular event, and not its distance from the origin.

Spin / Helicity

- `double SPINUP(I)` : *cosine of the angle between the spin-vector of particle I and the 3-momentum of the decaying particle, specified in the lab frame*

This scheme is neither general nor complete, but is chosen as the best compromise. The main foreseen application is τ ’s with a specific helicity. Typically a relativistic τ^- (τ^+) from a W^- (W^+) has helicity -1 ($+1$) (though this might be changed by the boost to the lab frame), so SPINUP(I)= -1 ($+1$). The use of a floating point number allows for the extension to the non-relativistic case. Unknown or unpolarized particles should be given SPINUP(I)=9. The lab frame is the frame in which the four-vectors are specified.

Example: hadronic $t\bar{t}$ production



I	ISTUP(I)	IDUP(I)	MOTHUP(1,I)	MOTHUP(2,I)	ICOLUP(1,I)	ICOLUP(2,I)
1	-1	21 (g)	0	0	501	502
2	-1	21 (g)	0	0	503	501
3	+2	-6 (\bar{t})	1	2	0	502
4	+2	6 (t)	1	2	503	0
5	+1	-5 (\bar{b})	3	3	0	502
6	+1	-24 (W^-)	3	3	0	0
7	+1	5 (b)	4	4	503	0
8	+1	24 (W^+)	4	4	0	0

The t and \bar{t} are given $ISTUP=+2$, which informs the SHG to preserve their invariant masses when showering and hadronizing the event. An intermediate s-channel gluon has been drawn in the diagram, but since this graph cannot be usefully distinguished from the one with a t-channel top exchange, an entry has not been included for it in the event record.

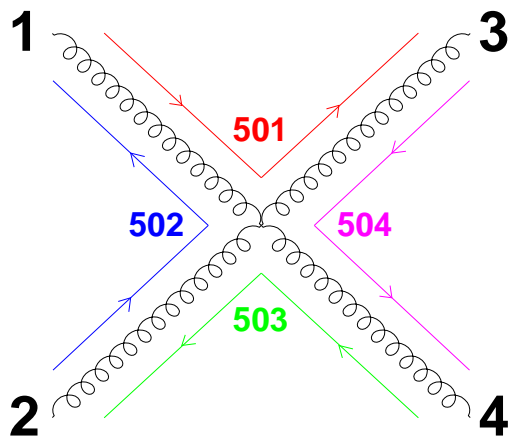
The definition of a line as ‘color’ or ‘anti-color’ depends on the orientation of the graph. This ambiguity is resolved by defining color and anti-color according to the physical time order. A quark will always have its color tag $ICOLUP(1,I)$ filled, but never its anti-color tag $ICOLUP(2,I)$. The reverse is true for an anti-quark, and a gluon will always have information in both $ICOLUP(1,I)$ and $ICOLUP(2,I)$ tags.

Note the difference in the treatment by the parton shower of the above example, and an identical final state, where the intermediate particles are not specified:

I	ISTUP(I)	IDUP(I)	MOTHUP(1,I)	MOTHUP(2,I)	ICOLUP(1,I)	ICOLUP(2,I)
1	-1	21 (g)	0	0	501	502
2	-1	21 (g)	0	0	503	501
3	+1	-5 (\bar{b})	1	2	0	502
4	+1	-24 (W^-)	1	2	0	0
5	+1	5 (b)	1	2	503	0
6	+1	24 (W^+)	1	2	0	0

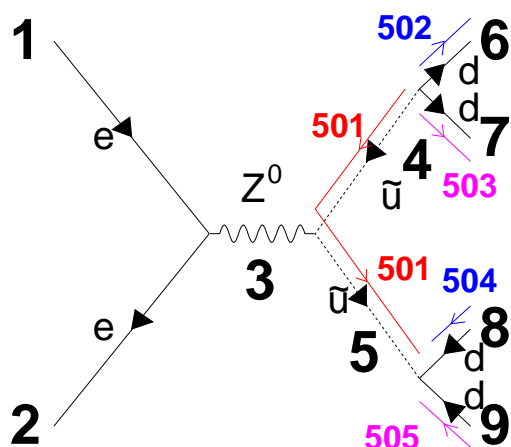
In this case the parton shower will evolve the b, \bar{b} without concern for the invariant mass of any pair of particles. Thus the parton shower may alter the invariant mass of the Wb system (which may be undesirable if the Wb was generated from a top decay).

Example: $gg \rightarrow gg$



I	ISTUP(I)	IDUP(I)	MOTHUP(1,I)	MOTHUP(2,I)	ICOLUP(1,I)	ICOLUP(2,I)
1	-1	21 (g)	0	0	501	502
2	-1	21 (g)	0	0	502	503
3	+1	21 (g)	1	2	501	504
4	+1	21 (g)	1	2	504	503

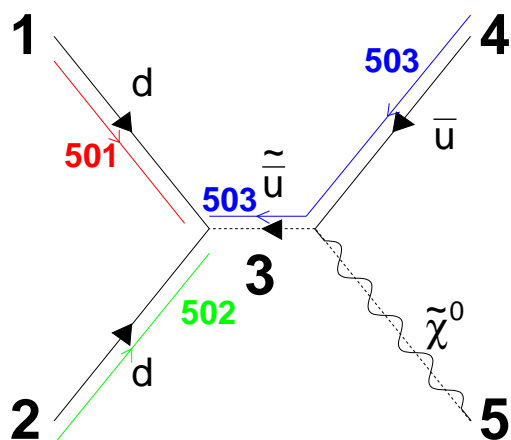
Example: Baryon number violation in decays



I	ISTUP(I)	IDUP(I)	MOTHUP(1,I)	MOTHUP(2,I)	ICOLUP(1,I)	ICOLUP(2,I)
1	-1	11 (e^-)	0	0	0	0
2	-1	-11 (e^+)	0	0	0	0
3	+2	23 (Z^0)	1	2	0	0
4	+2	-1000002 (\tilde{u})	3	3	0	501
5	+2	1000002 (\tilde{u})	3	3	501	0
6	+1	1 (d)	4	4	502	0
7	+1	1 (d)	4	4	503	0
8	+1	-1 (\bar{d})	5	5	0	504
9	+1	-1 (\bar{d})	5	5	0	505

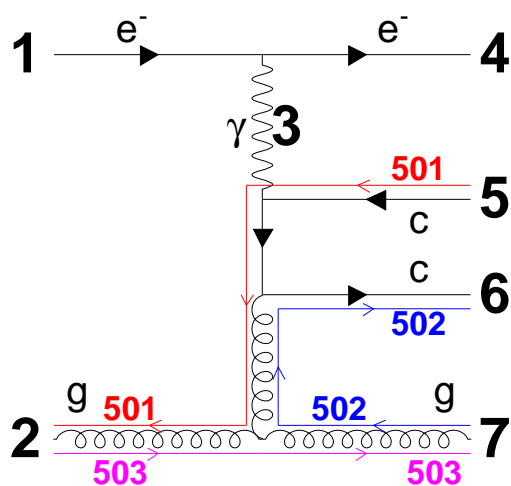
Three “dangling” color lines intersect at the vertex joining the \tilde{q}, q, q' (and $\tilde{q}, \bar{q}, \bar{q}'$), which corresponds to a Baryon number source (sink) of +1 (-1), and will be recognizable to the SHGs.

Example: Baryon number violation in production



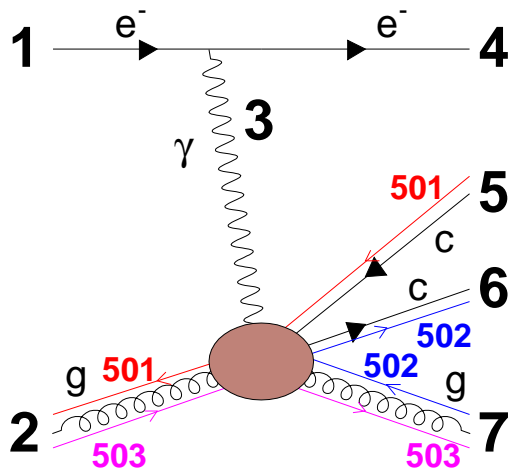
I	ISTUP(I)	IDUP(I)	MOTHUP(1,I)	MOTHUP(2,I)	ICOLUP(1,I)	ICOLUP(2,I)
1	-1	1 (d)	0	0	501	0
2	-1	1 (d)	0	0	502	0
3	+2	-1000002 (\tilde{u})	1	2	0	503
4	+1	-2 (\bar{u})	3	3	0	503
5	+1	1000022 ($\tilde{\chi}^0$)	3	3	0	0

Example: deep inelastic scattering



I	ISTUP(I)	IDUP(I)	MOTHUP(1,I)	MOTHUP(2,I)	ICOLUP(1,I)	ICOLUP(2,I)
1	-1	11 (e^-)	0	0	0	0
2	-1	21 (g)	0	0	503	501
3	-2	22 (γ)	1	0	0	0
4	+1	11 (e^-)	1	0	0	0
5	+1	-4 (\bar{c})	2	3	0	501
6	+1	4 (c)	2	3	502	0
7	+1	21 (g)	2	3	503	502

For DIS, the x and q^2 of the γ should not be altered by the parton shower, so the γ is given ISTUP=-2. We have not specified the internal quark and gluon lines which will be dressed by the parton shower, such that the partonic event configuration may be drawn as follows,



If information about the quark and gluon propagators is desired (i.e for human readability), then those entries may be included with status code ISTUP=+3.

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