

COLLISIONS ANALYZER

This module is used to analyze particle-particle or particle-wall collisions and export results as file in text format. User can obtain information about the following parameters of collisions (*Fig. 1 - Property*):

- *Coordinate*: analysis of collisions according to place where collision (first contact) between objects occur;
- *Distance*: collisions according to the distance to specified point or line. Their coordinates can be defined in Distance section (see below);
- *Duration*: duration of collision – interval between time point when contact appears and time point when contact between accorded partners disappears. Collisions which have not been finished before the simulation has been stopped will not be considered;
- *Energy*: energy of collision at the time of impact. Is calculated as $E = 0.5mv^2$, where v – total impact velocity, m – average mass of contact partners (for particle-particle collision) or mass of a particle (for particle-wall collision). This analysis can be done only if correct material database is loaded.
- *Force normal*: maximum of normal component of force acting in collision. Collisions which have not been finished before the simulation has been stopped will not be considered;
- *Force tangential*: maximum tangential component of force acting in collision. Collisions which have not been finished before the simulation has been stopped will not be considered;
- *Force total*: maximum force (normal + tangential) acting in collision. Collisions which have not been finished before the simulation has been stopped will not be considered;
- *Number*: total number of collisions;
- *Velocity normal*: normal component of relative velocity of objects when contact appears;
- *Velocity tangential*: tangential component of relative velocity of objects when contact appears;
- *Velocity total*: total relative velocity (normal + tangential) of objects when contact appears.

Four following results types can be selected (*Fig. 1 – Results type*):

- *Distribution*: distribution of selected parameter by specified number of classes on specific time interval (list of time points, see below). In this case the results will be generated as a table where each row represents a time point and each column corresponds to the specified property interval. Each cell of the table contains number of collisions which have property value within the given interval;
- *Average*: the result is an arithmetic average value of selected property for each time point. Additionally the information about number of considered collisions and deviation for each time point/interval will be provided in results;
- *Maximum*: maximum value of selected property for each time point;

- *Minimum*: minimum value of selected property for each time point.

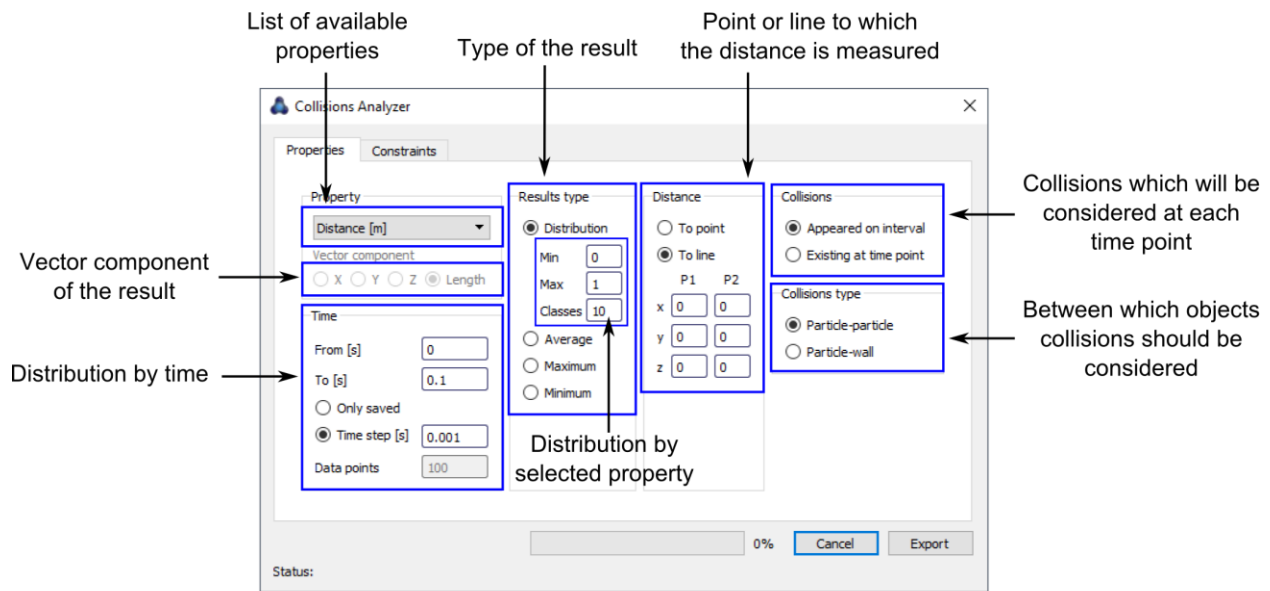


Figure 1. Main dialog of the Collisions Analyzer.

If selected property is *Distance*, user can additionally specify point or line, for which the distance is to be measured (Fig. 1 - Distance).

For all properties except *Distance*, *Duration*, *Energy* and *Number* besides the magnitude (*Length*) a specific component of resulting vector (*X*, *Y*, *Z*) can be determined (Fig. 1 – Vector component).

As collisions are continuous processes, there is a possibility to choose how the collisions will be considered at each time point or time interval (Fig. 1 – Collisions):

- *Appeared*: only collisions which **appear** on time interval (see below) will be taken into account. Each collision will be considered only once on time interval, where it appears. Forces and velocities of collisions will be assigned to this time interval;
- *Existing*: collisions which exist on time points between time classes (see below) will be considered. The same collision will be considered on each analyzed time point, if it continues on this time point. Forces and velocities of collisions will be assigned to each of these time intervals.

Collisions type (Fig. 1 – Collisions type) allows to distinguish between particle-particle and particle-wall collisions. List of available constraints depends on the chosen option (Fig. 2, Fig. 3).

Each property can be obtained for specific time interval, divided into classes (Fig. 1 - Time). Meaning of this parameter depends on parameter that is chosen in *Collisions* block:

- If consideration of *Appeared* collisions is chosen, values will be calculated for each time class from the whole interval. For example for initial data $T_{FROM} = 0$ s, $T_{TO} = 2$ s, $\Delta T = 1$ s, in the first time interval will be considered collisions, which have been started between 0 and 1 s; in second – collisions with start between 1 and 2 s;
- If consideration of *Existing* collisions is chosen, values will be exported for each time point from interval $[T_{FROM}; T_{TO}]$ starting from T_{FROM} with specified time step ΔT . For example for initial data $T_{FROM} = 0$ s, $T_{TO} = 5$ s, $\Delta T = 1$ s, the results will be generated for time points 0, 1, 2, 3, 4, 5 s. To get values for only one specific time point T specify $T_{FROM} = T_{TO} = T$. There is also a possibility to obtain results only for those time points, which were saved during the simulation (thereby avoiding the interpolated results).

If one wants to get distribution of some property (*Results type: Distribution* is chosen), there is a possibility to specify range of values for selected property and number of classes on which this interval will be divided (Fig. 1). Collisions whose properties do not fall within this range **will not be considered**. The result for each class at a specific time point is a number of collisions whose properties fall within this class. If the value is on the boundary between intervals, it will be assigned to a greater interval.

User can additionally specify a list of constraints (Fig. 2, Fig. 3), which will be applied to the list of collisions. Available constraints depend on the chosen *Collision type*.

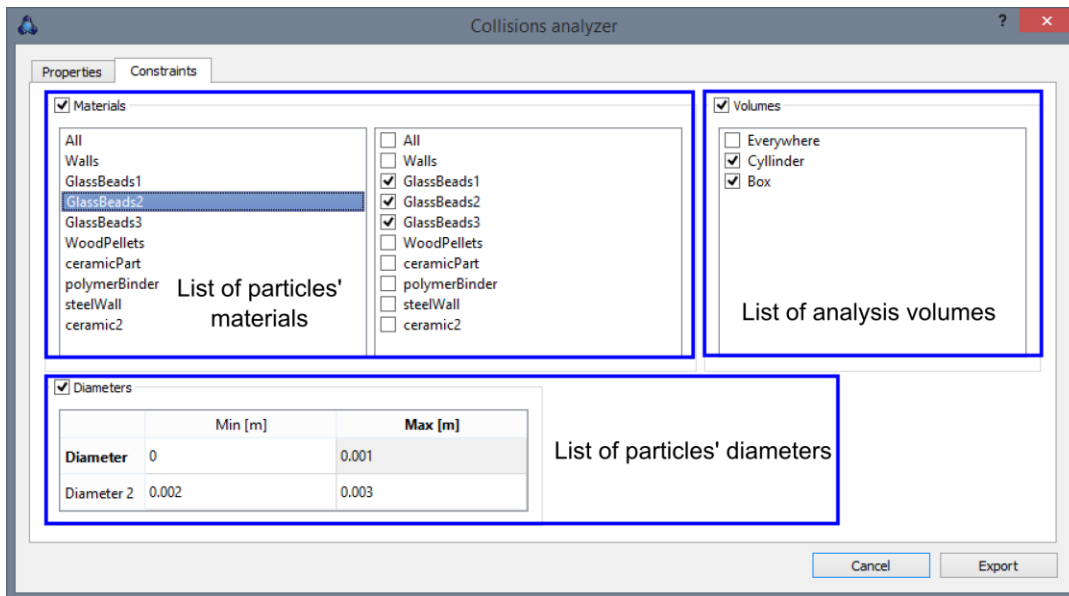


Figure 2. Constraints specification for the Collisions Analyzer in case of particle-particle collisions.

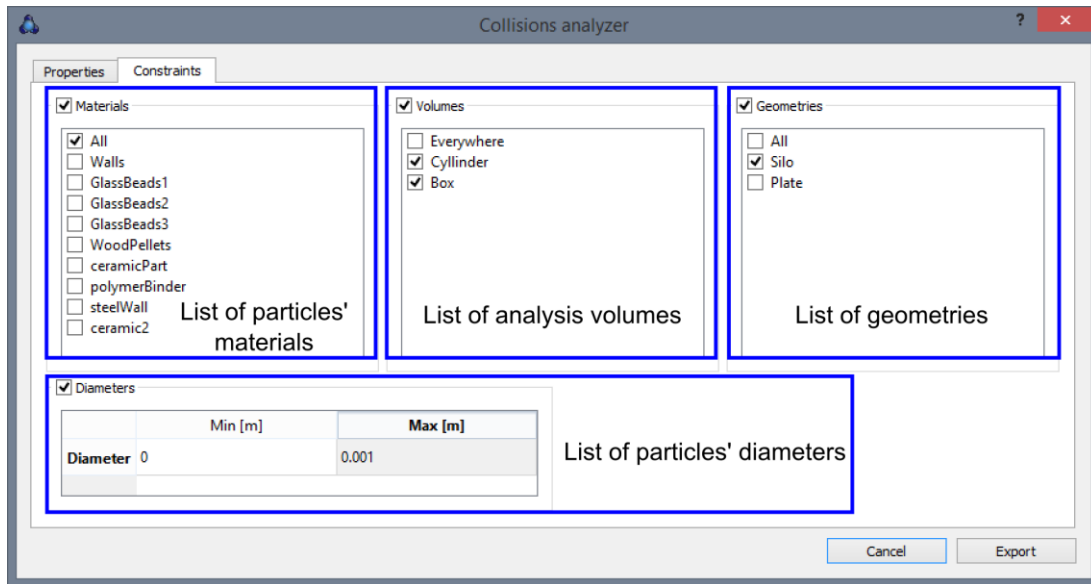


Figure 3. Constraints specification for the Collisions Analyzer in case of particle-wall collisions.

Several constraints are available in Collisions Analyzer in the case of particle-particle collisions (*Fig. 2*) (turning on filters can slightly reduce performance of the analysis):

- **Materials:** only collisions between particles of selected materials will be taken into account during the analysis. It is possible to specify a list of materials, which should be considered with selected material: one selects material from the left list and then assigns one or several materials from the right list. If first particle falls into the left list and second particle falls into the right list, such collision will be considered.
- **Volumes:** collision will be taken into account only if the first contact between partners occurred in one of the specified analysis volumes.
- **Diameters:** collision will be taken into account only if one of colliding particles has diameter from the first interval, and another particle has diameter from the second interval.

Several constraints available in Collisions Analyzer in the case of particle-wall collisions (*Fig. 3*) (turning on filters can slightly reduce performance of the analysis):

- **Materials:** only collisions with particles of selected materials will be taken into account during the analysis. Materials of walls are not considered.
- **Volumes:** collision will be taken into account only if the first contact between partners occurred in one of the specified analysis volumes.
- **Geometries:** collision will be taken into account only if particle collide with one of the specified geometrical objects.
- **Diameters:** collision will be taken into account only if diameter of colliding particle lies within the specified interval.