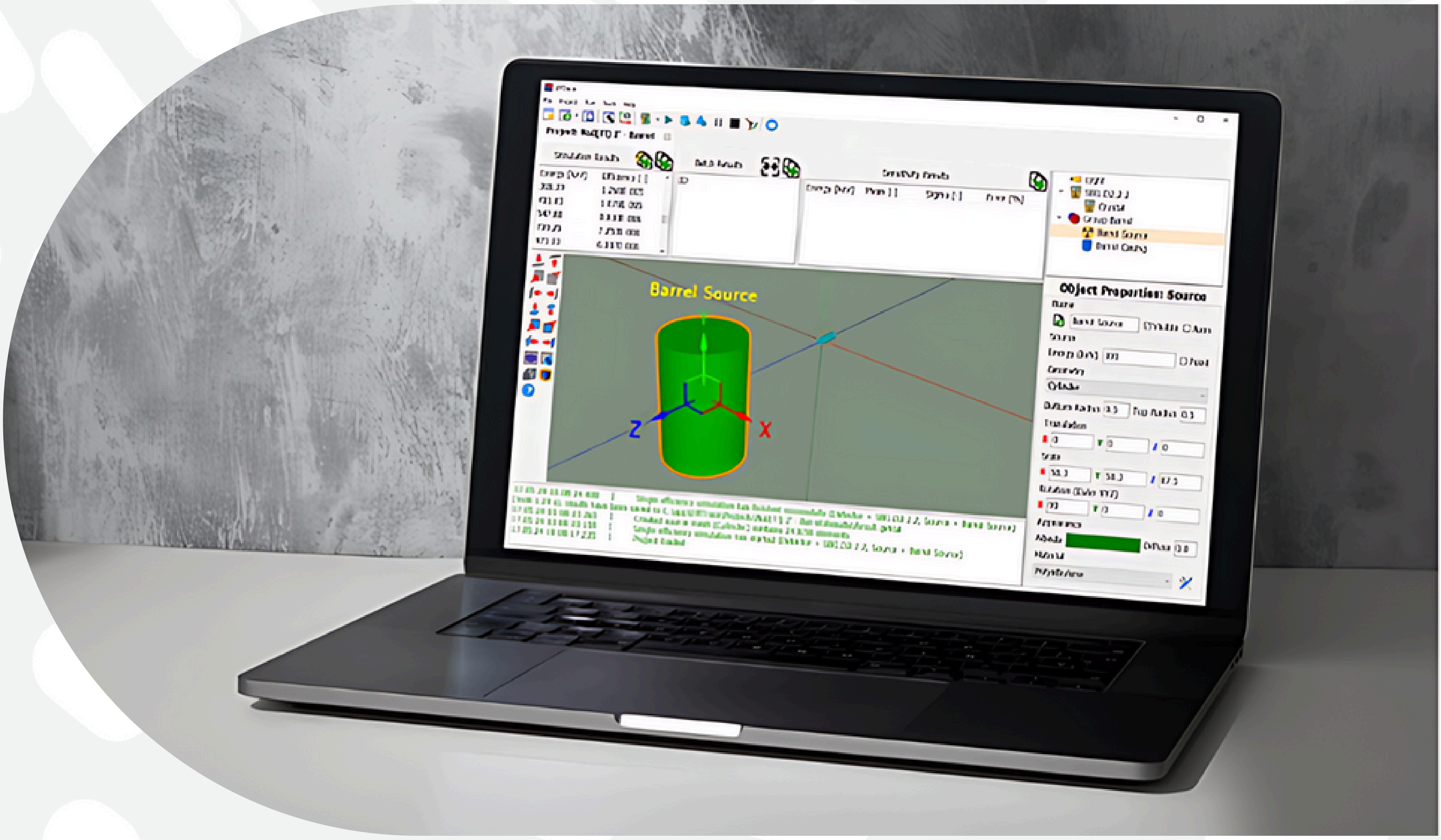
Specification

NuSOFT EffTrace



The NuSOFT EffTrace software is intended to be used for fast and accurate estimation of efficiency calibrations for arbitrary measured objects with gamma spectrometric detectors (both for scintillation and semiconductor HPGe). The calculation is based on analytical approach with calculation of solid angle between elementary source volume and the detector, corrected by attenuation effects of the source itself and all other entities in the 3D modelled geometry. For correct absorption effect in the detector, the efficiencies for various distances, angles and gamma energies have to be entered by user. This allows to use NuSOFT EffTrace with arbitrary detector. For collimators, the SW offers built-in Monte Carlo method, which can automatically estimate the effect of collimator for given detector without need to measure such effect experimentally.

Benefits

- Easy definition of complex 3D geometry using CSG
- Possibility to import STL 3D geometries
- User definition of detector and collimator
- Collimator's effect is calculated by built-in Monte Carlo method
- Rapid analytical approach to efficiency calculations
- Batch mode calculation allowing automatized modification of various parameters (with Batch calculation module)
- Sensitivity analysis to perform uncertainty study of input parameters to the simulations (with Sensitivity analysis module)

Project editor

All necessary definitions for efficiency calculations are tied into a project. The main component of a project window is a 3D scene, through which the measured geometry is modelled. The scene is equipped with all useful tools as various camera controls, dimension grid or gizmo operation modes. The editor is designed in simplistic manner in order for the user to get comfortable with the software as soon as possible. Entity operations are available through a popup menu (activated by right mouse button clicks) and they are easily edited via Object Properties panel.

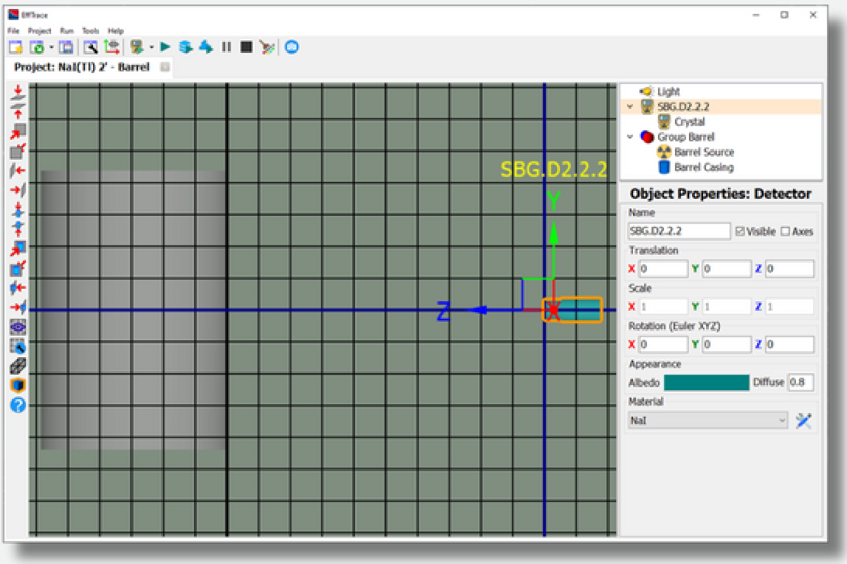
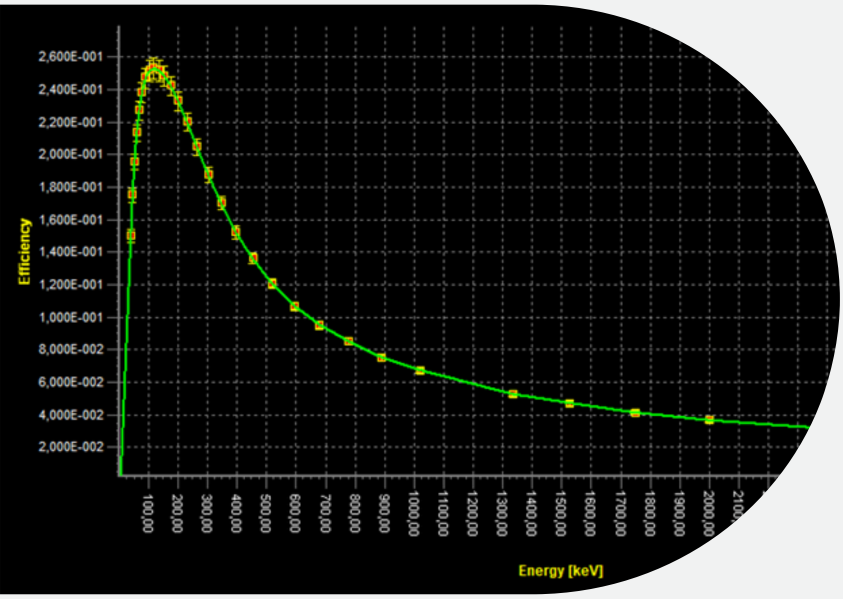


Figure 1: Project scene, orthographic camera mode – useful for interpreting and correcting entity dimensions



Definition of entities

All entities in the measured geometry can be created by methods of CSG (constructive solid geometry) with following basic entities:

- Cube
- Sphere
- Cylinder
- Cone
- Mesh – option to load an externally created mesh in STL file format.

This allows to easily create arbitrary complex shaped objects. Simple shapes can be directly defined as Sphere, Cube, Cylinder or Cone to lower the complexity of photon tracing during calculations. Furthermore, entities can be grouped together or a reference root for an entity can be defined, which gives the user freedom for abstract object definitions.

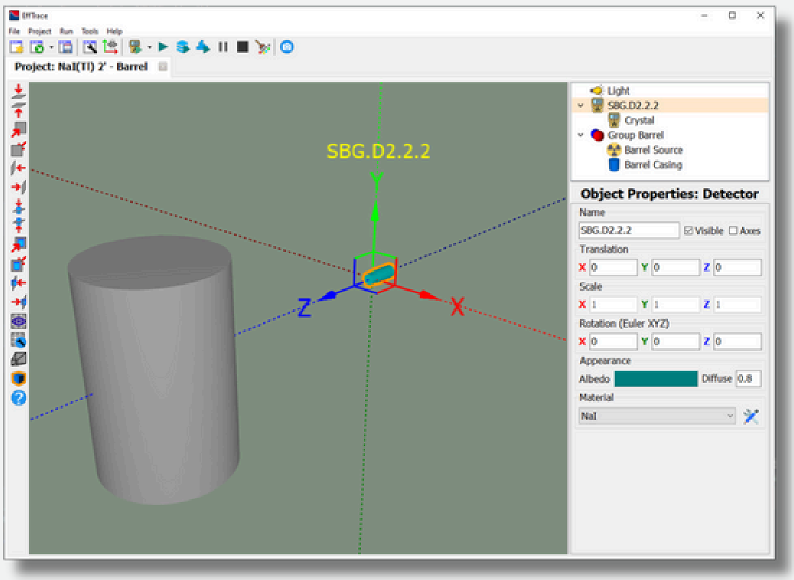


Figure 2: Project scene, perspective camera mode

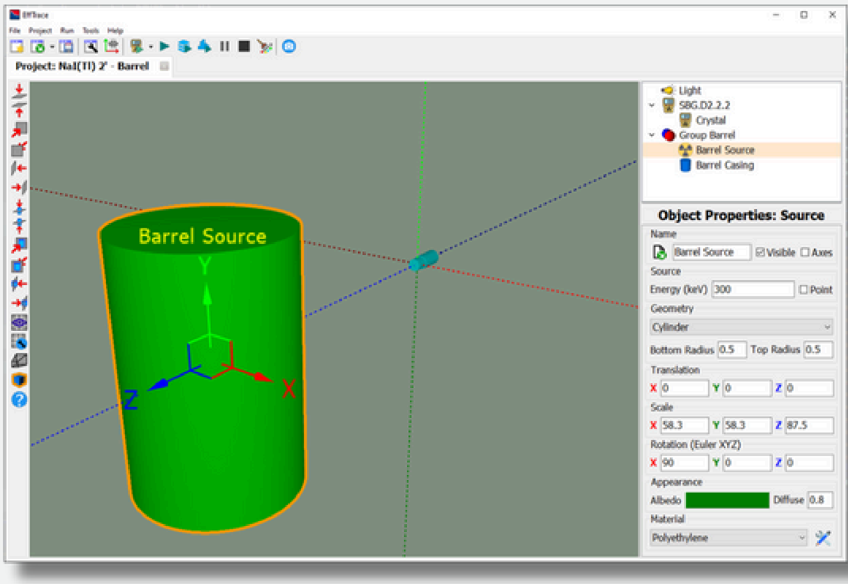


Figure 3: Cylinder entity as a source

Detector definition

The workflow with defining detectors is set up in the way of a catalogue. NuSOFT EffTrace contains a database of defined detectors and the user chooses a detector and adds it to a desired project. The detectors are uniquely identified by their name. The catalogue is composed of 3D preview, list of detectors and various tool buttons.

Detector definition is divided into two workflows: Geometry and Calibration. These are executed in the Detector Editor. Geometry is composed of 3 entities:

1. Detector body – the main frame of the detector, the physical reference of the measuring device.
2. Crystal – the scintillation crystal, which is the entity that is used in the calculations.
3. Collimator

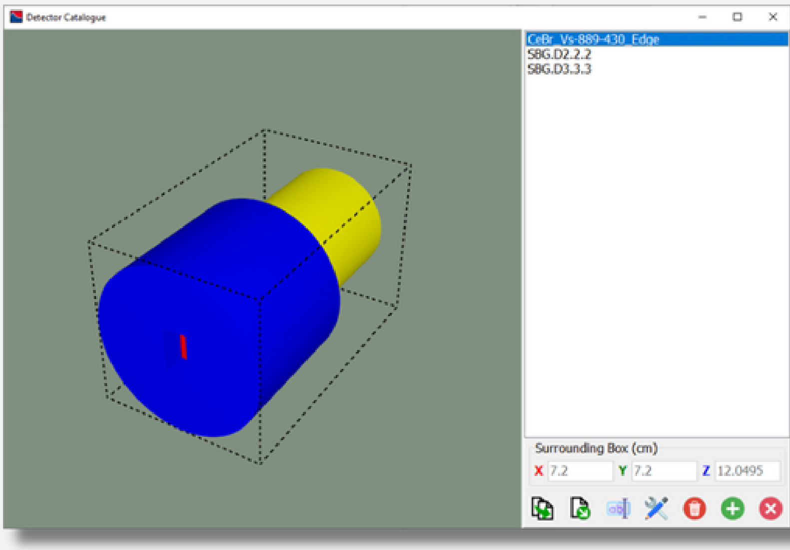


Figure 4: Detector catalogue

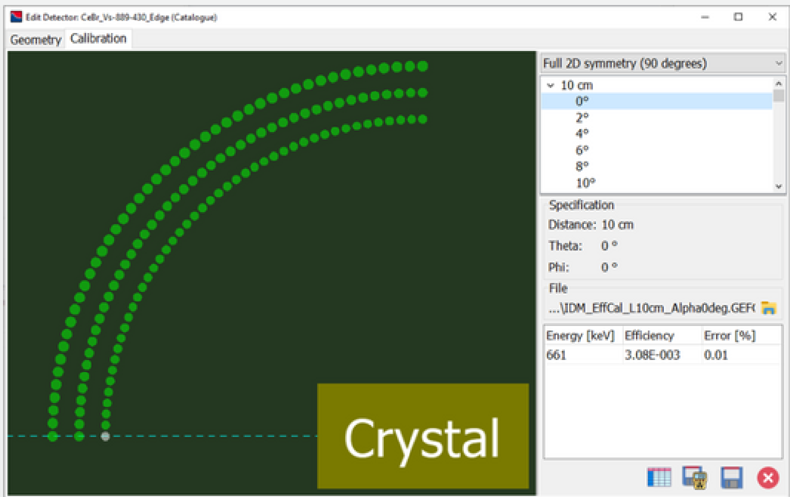


Figure 5: Detector editor

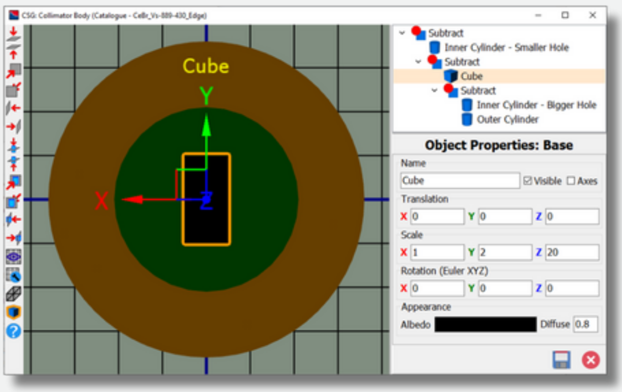


Figure 6: Defining collimator using CSG geometry

Configuring an efficiency calculation

NuSOFT EffTrace informs the user about all necessities to run a calculation by means of error messages. First of all, software detector efficiencies and collimator effects of chosen detector need to be precomputed. Then the setup defined in Project Settings is taken to configure the calculation and if all is performed successfully, the user is informed about the output.

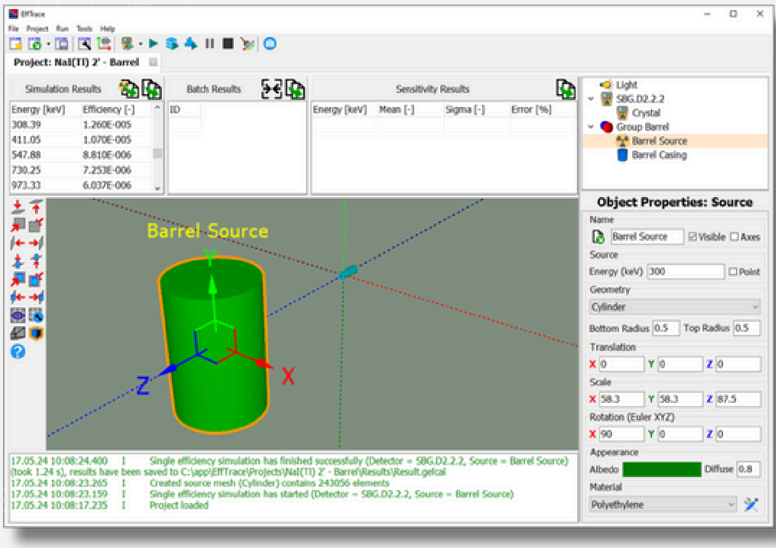


Figure 8: Efficiency calculation performed successfully

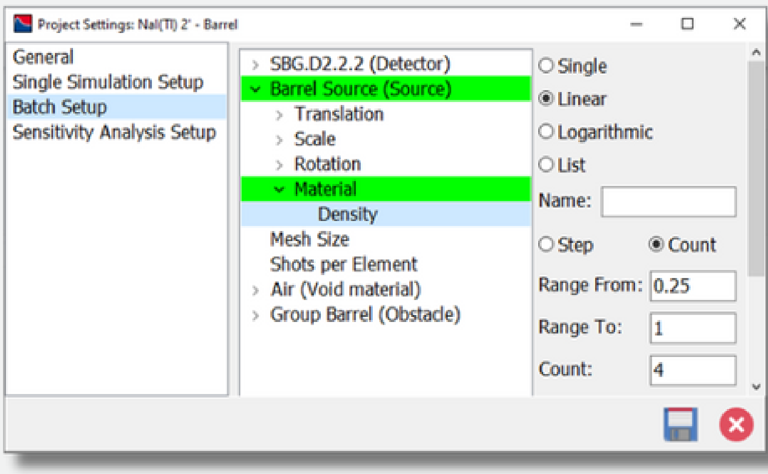


Figure 9: Project settings – configuring batch parameters

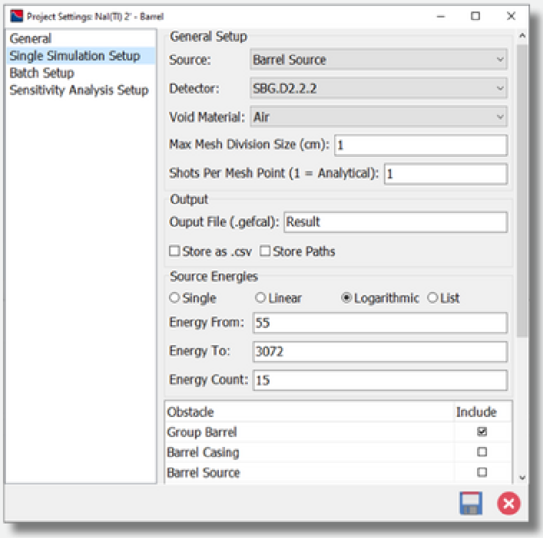


Figure 7: Project settings – configuring a simulation

Batch mode

In cases of parameter studies, or in general if many situations are to be evaluated, changing the scene and running only one simulation at once is inefficient. For such scenarios, when different simulation configurations can be described by meaningful parameters, it is possible to run multiple simulations at once. The supported parameters are:

- Material (from project's database) of any non-detector entity involved in simulation,
- Material density of any non-detector entity or of the void material,
- Translation and Rotation of any entity,
- Scale of any non-detector entity,
- Mesh size of the source,
- Number of Monte Carlo shots.

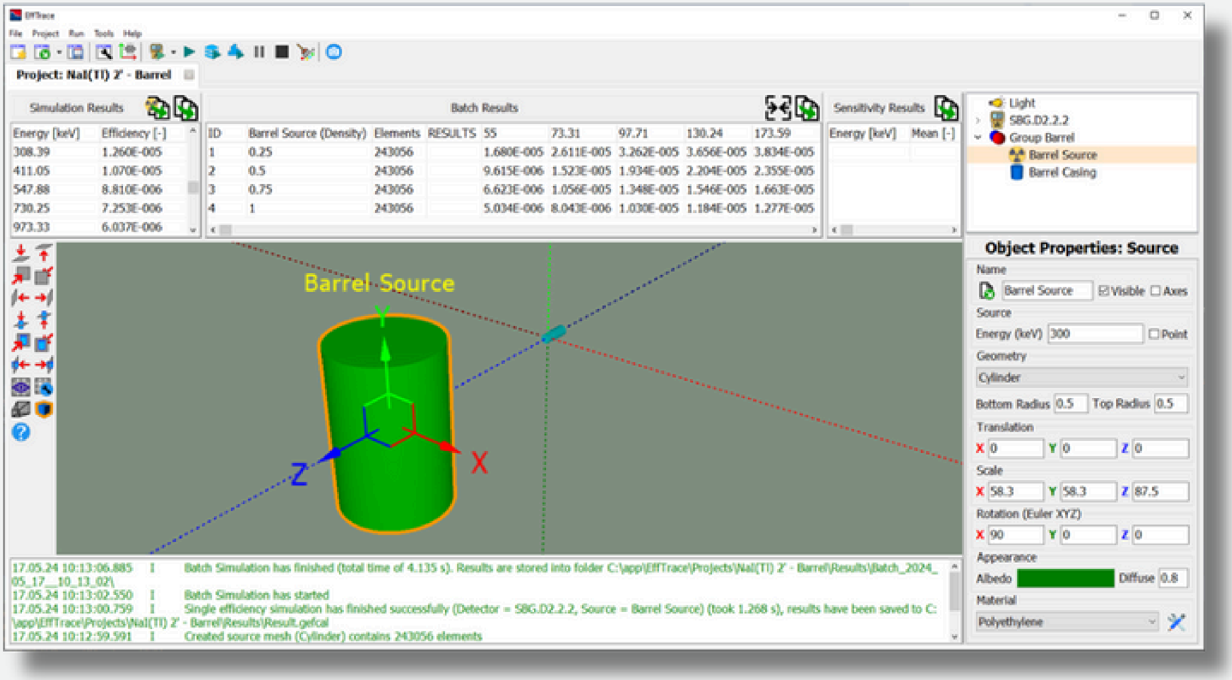


Figure 10: Batch calculations performed successfully

Sensitivity analysis

Similar to Batch mode, it is possible to evaluate the effect of uncertainty of input parameters such as material density. The parameters can be defined as uniform distribution with a specified range or as normal distribution with provided mean and standard deviation. The user also chooses the number of random samples (i.e., the number of independent simulations). The output of sensitivity analysis contains the mean efficiency, its standard deviation (sigma) and the error (sigma divided by mean) in percentage.

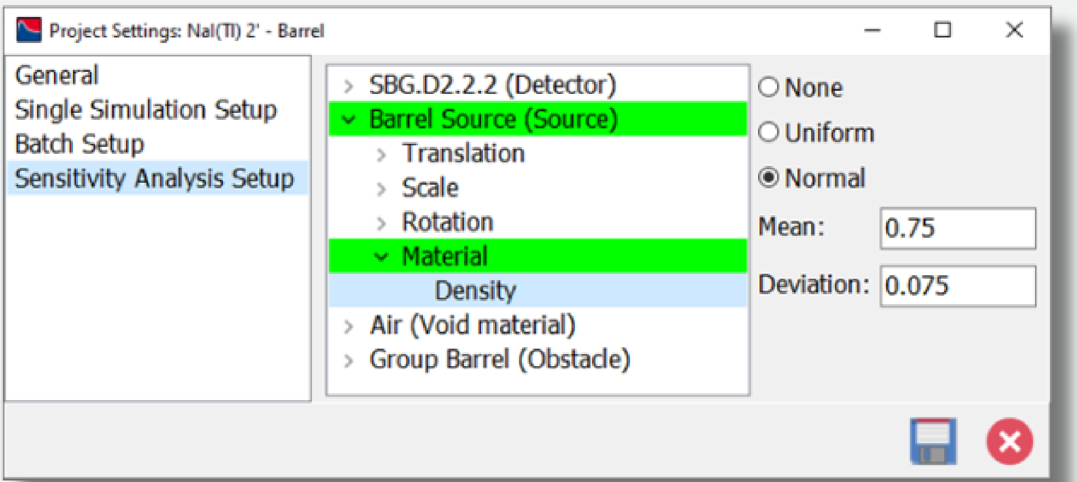


Figure 11: Project settings – configuring sensitivity parameters

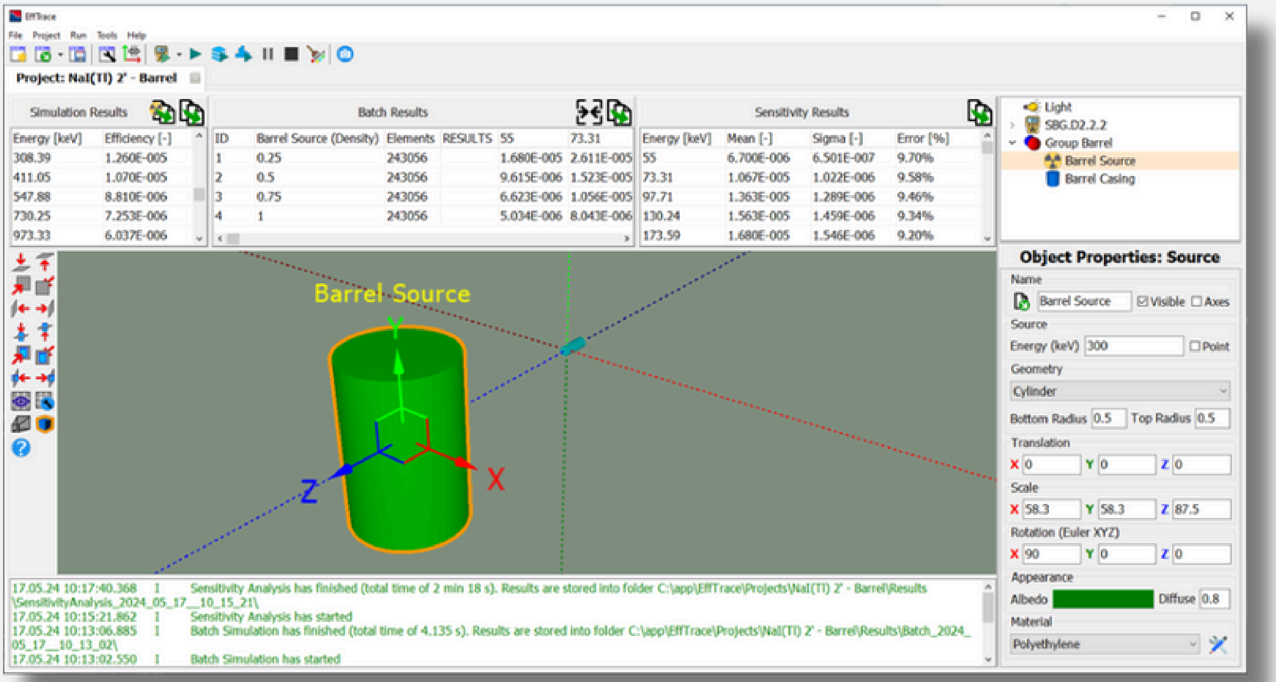


Figure 12: Sensitivity analysis performed successfully

NuSOFT EffTrace software package modules:

Main module

- Detector and collimator definition
- 3D geometry creation
- Material definition
- Source characterization
- Efficiency calculation
- Export to CSV or GAMWIN

Batch calculation module

- Automatized calculation of efficiencies with modifications of various parameters (e.g., various materials, densities, and positions of source)
- Wide range of parametrization possibilities
- Bulk export of efficiencies to CSV or multiple individual efficiency files
- Multithreaded support for estimating effect of collimator in independent geometry configurations

Sensitivity analysis module

- Uncertainty study of input parameters such as material density or filling ratio of a barrel

Monte Carlo module

- Allows to calculate efficiencies for source using simple Monte Carlo method (semi-analytical approach)
- Can be used for Marinelli beakers or samples at close geometries