Purpose: Advanced model-based dose calculation algorithms such as Monte Carlo and others rely heavily on the accurate representation of the simulation geometry and the associated material composition. The lower the photon energy, the more critical is this step. Nowadays, manufacturers all use Computer Aided Design (CAD) in their fabrication process. In this work, a method is presented that allows arbitrary hardware to be incorporated in a Monte Carlo simulation code from its CAD descriptions.

Methods: Brachytherapy source and applicator parts were exported from CAD software to the STEP format. FASTRAD (TRAD, Toulouse, France) is used to import the CAD and set parameters related to the simulation. This information is then exported in a GEANT4 compatible format through the GDML Module. This process takes only a few minutes. Simulations were conducted to compare the CAD description of the Nucletron V2 HDR source to a simpler model, obtained after labour-intensive trials and error modelling, previously validated by our group against TG43.

Results: Using this process, all geometries were successfully imported in GEANT4. All properties were kept accurate and consistent through the process. Most solids were defined as polygon meshes which enable precise reproduction of the most complex brachytherapy applicator parts. We were also able to reproduce the TG43 parameters using the microSelectronV2 (Nucletron, Veenendaal, the Netherlands) STEP file.

Conclusions: This study demonstrates the use of a complete CAD description in a GEANT4 simulation for medical application. This allows to take explicitly into account the intricate designs of certain objects such as applicators and sources for which the accurate representation will have a clinical impact on the final dose distribution, in particular at low photon energy. Given the standard nature of the STEP file format, it could be hoped that such import feature be extended to other dosimetry tools.