# CAD based Monte Carlo Method

## Algorithms for geometric evaluation in support of Monte Carlo radiation transport calculation

By
**Mengkuo Wang**

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## Abstract

In particle transport computations, the Monte Carlo simulation method is a widely used algorithm. There are several Monte Carlo codes available that perform particle transport simulations. However the geometry packages and geometric modeling capability of Monte Carlo codes are limited as they can not handle complicated geometries made up of complex surfaces. Previous research exists that take advantage of the modeling capabilities of CAD software. The two major approaches are the Converter approach and the CAD engine based approach. By carefully analyzing the strategies and algorithms of these two approaches, the CAD engine based approach has been identified as the more promising approach. Though currently the performance of this approach is not satisfactory, there is room for improvement. The development and implementation of an improved CAD based approach is the focus of this thesis.

Algorithms to accelerate the CAD engine based approach are studied. The major acceleration algorithm is the Oriented Bounding Box algorithm, which is used in computer graphics. The difference in application between computer graphics and particle transport has been considered and the algorithm has been modified for particle transport.

The major work of this thesis has been the development of the MCNPX/CGM code and the testing, benchmarking and implementation of the acceleration algorithms. MCNPX is a Monte Carlo code and CGM is a CAD geometry engine. A facet representation of the geometry provided the least slowdown of the Monte Carlo code. The CAD model generates the facet representation. The Oriented Bounding Box algorithm was the fastest acceleration technique adopted for this work. The slowdown of the MCNPX/CGM to MCNPX was reduced to a factor of 3 when the facet model is used.

MCNPX/CGM has been successfully validated against test problems in medical physics and a fusion energy device. MCNPX/CGM gives exactly the same results as the standard MCNPX when an MCNPX geometry model is available. For the case of the complicated fusion device –

the stellerator, the MCNPX/CGM's results closely match a one-dimension model calculation performed by ARIES team.