# AbstractID: 9396 Title: Towards Real-Time Radiation Therapy: Superposition/Convolution at 4fps

**Purpose:**
To enable novel radiation therapy workflows by providing superposition/convolution dose calculation at interactive rates.

**Method and Materials:**
The Superposition/Convolution (S/C) dose computation algorithm utilizes ray-tracing techniques extensively and is well suited to acceleration using consumer graphics processing units (GPU). The standard S/C algorithm was parallelized and implemented using NVIDIA's CUDA GPU programming environment.

The basic S/C method generates incident fluence, using a source model, and transports it from the radiation source, using ray-tracing, to deposit a TERMA grid. Then superposition spreads the dose deposition kernel out by ray-tracing from each point in the TERMA grid. There are several issues with parallelizing this algorithm.

Calculation of the TERMA grid suffers from read-write conflicts. We solve this by running groups of spatially separated divergent rays. The forward S/C kernel also suffers from read-write conflicts, but the inverse kernel does not. We reduced memory bandwidth by using a variable step ray-tracer, independently attenuating each spectral energy bin and caching lookup-tables. We explored the concept of using volumetric mip-maps to approximate the ray as a true solid angle.

**Results:**
We compared our implementation to Pinnacle$^3$ for low (64x64x64 cube with 4 mm voxels) and high resolution (128x128x128 cube with 2mm voxels) water phantoms using as similar settings as possible. Pinnacle$^3$ (Philips - Madison, WI) was run on a SunFire v250 machine with times of 30.961s and 365.944s respectively. We performed our calculations on a single NVIDIA GeForce 8800 GTX with times of 0.217s and 2.197s respectively. Preliminary experiments using volumetric mip-maps showed additional performance improvements with minor accuracy loss.

**Conclusion:**
We have completed a GPU accelerated superposition/convolution dose engine, providing a substantial performance gain over CPU based implementations - indicating that real time dose computation is feasible with the accuracy levels of the S/C algorithm.

**Conflict of Interest (only if applicable):**