

Volume 1.1 April, 2008 Editor Lars E. Olson

From the Editor

This is the inaugural edition of our newsletter! Its intent is to share all of the exciting research that high performance computing is allowing MU researchers to perform. All the work that many people have been putting into this effort is starting to reap real, fruitful results.

Not least of which has been Scott Goldsborough, PhD, Assistant Professor of Mechanical Engineering, whose spearheading our successful effort in obtaining NSF funding to get our computing cluster. Thanks go out to him and to all the investigators who contributed to that effort.

Also, Craig Struble, PhD, Assistant Professor in Mathematics, Statistics, and Computer Science, should be especially acknowledged For his leadership in organizing high performance computing in Southeast Wisconsin (see <http://www.sewhip.org>) and his technical guidance in making the cluster go. Also, he has developed our weekly HPC seminar at Marquette in which investigators share their cutting edge research and get howto's from Craig.

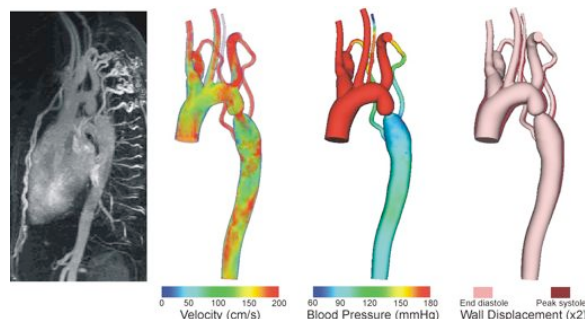
At present, we do much of the computing management ourselves. One advantage of this situation is that we are learning a lot about HPC and details about how to make it go. Taly Gilat-Schmidt, PhD, John LaDisa, PhD, and I, all in Biomedical Engineering, and Dr. Goldsborough have discovered nuances related to PBS scripting and job management. I have been a repository of this kind of information. If you need help, just contact me.

Aaron Ward is a graduate student in Mechanical Engineering working with John Borg, PhD, Assistant Professor of Mechanical Engineering. Aaron has worked in an HPC environment before coming to MU and has graciously agreed to work part-time to help manage the cluster. Thanks, Aaron and thank you to John Borg for allowing some of Aarons' FLOP's to be used on this community effort.

LEO lars.olson@mu.edu

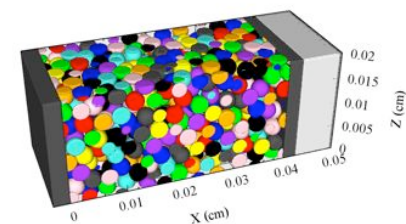
LaDisa Models a Pediatric Aortic Abnormality

Aortic coarctation is a pediatric cardiovascular disease affecting 5,000–8,000 births annually in the U.S. Unfortunately a child's life expectancy is diminished and the potential for long-term problems is increased despite treatment by any means. There is evidence to suggest that altered fluid dynamics may correlate with long-term issues in these children. John LaDisa, PhD, Assistant Professor of Biomedical Engineering, and graduate students Dave Wendell, Ronak Dholakia and Paul Larsen from the Laboratory for Translational, Experimental and Computational Cardiovascular Research are working with collaborators at the Children's Hospital of Wisconsin and Lucile Packard Children's Hospital at Stanford University to create computational fluid dynamics representations of the aorta from medical imaging data. The results are being interpreted as surrogates of the potential for long-term problems in children with aortic coarctation. The figure shows a mean intensity projection obtained from magnetic resonance angiography imaging data (left) and volume rendering of the peak systolic velocity, systolic blood pressure and wall displacement obtained from the simulation of a 10-year-old girl with severe (80% reduction in area) aortic coarctation.

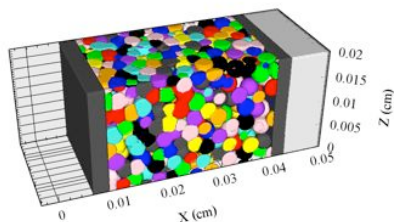


John Borg Studies Shock Physics of Powders

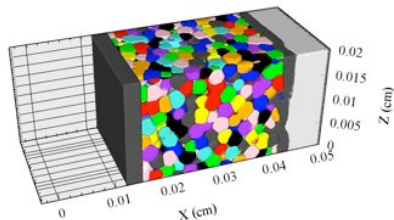
Understanding the behavior of granular systems has a wide range of applications from powder metallurgy to pharmaceutical preparations to geophysics phenomena such as understanding the motions of tectonic plates. The following is a series of images of a granular material being compacted at a rate of 300 m/s. From these calculations the bulk dynamic response of the powder can be numerically predicted. From these numeric predictions the bulk equation of state of the powder can be estimated. Thus far numeric simulations predict a slightly stiffer response than measured by experimentation. Through a rigorous parametric study it is hoped that a better understanding of the physical phenomena as well as the short comings of this numerical method can be better understood. Ultimately the hope is to numerically derive Hugoniot response curves for any powder configuration, to better understand the role of grain level phenomenology such as grain-on-grain contact heating, morphological effects, plastic deformation and void collapse in order to develop a better understanding of the bulk response without the use of costly experimentation.



$t = 0\mu\text{s}$



$t = 0.3\mu\text{s}$

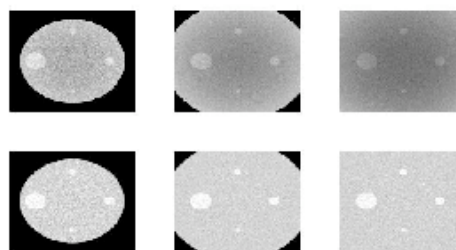


$t = 0.5\mu\text{s}$

Taly Gilat-Schmidt Studies Improved Breast Computed Tomography Systems

Monte Carlo simulation is a powerful tool for modeling the stochastic nature of computed tomography (CT) imaging. Unlike simulation methods that calculate the net attenuated x-ray beam, Monte Carlo methods model the physics of x-ray transport and track the trajectory of x-ray photons through the imaged object. Monte Carlo simulations are useful for studying effects that depend on the individual photon interactions, for example scattered radiation and radiation dose deposition. Monte Carlo simulations facilitate the study of system feasibility, optimization, and factors that are difficult to isolate experimentally. We are using the GEANT4 Monte Carlo simulation toolkit on the high performance computing cluster to study a variety of questions related to CT scatter and dose.

Dedicated breast CT systems have been recently proposed to overcome the sensitivity and specificity limitations of mammography. We propose a dedicated breast CT system with a unique geometry, known as the inverse geometry, to provide improved image quality and dose efficiency compared to conventional approaches. We have performed a simulation study on the cluster to compare the effects of scatter for inverse-geometry and cone-beam breast CT systems.



Reconstructed cone-beam and inverse-geometry images of breast phantoms of 10–18 cm diameter (left to right) with spherical interductal carcinoma tumors of 0.1–2.0 cm diameter. Top panels show cone-beam reconstruction and bottom panels show the improved, inverse-geometry images. The inverse-geometry may improve differentiation between the breast tissue and tumor.