Extending EMSolve, an Electromagnetics Code

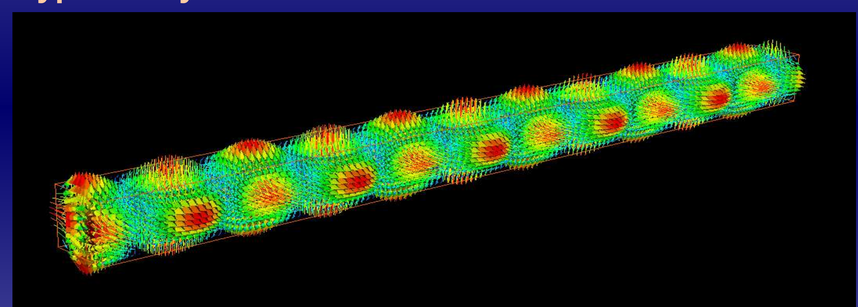
Jessica Schoen, University of Illinois, Urbana-Champaign

DSED/CADSE, Mark Stowell,
Lawrence Livermore National Laboratory

In order to solve a wider range of problems, the Defense Sciences Engineering Division's Computational Engineering Group needed the ability to solve linear systems with complex numbers in their EMSolve code. We responded to this need by incorporating the SuperLU library into their code.

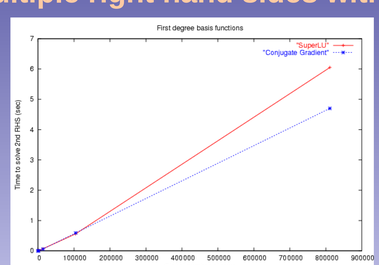
Introduction:

- Complex numbers would allow the group to solve frequency domain problems
- SuperLU is a library that performs LU factorization of sparse matrices
- We needed to verify that SuperLU was a viable choice for the types of systems we solve

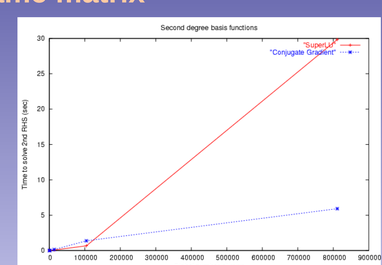


Results:

- We discovered that SuperLU is currently limited to solving systems which fit on a single processor
- In many cases, CG was faster than SuperLU even when solving multiple right hand sides with the same matrix



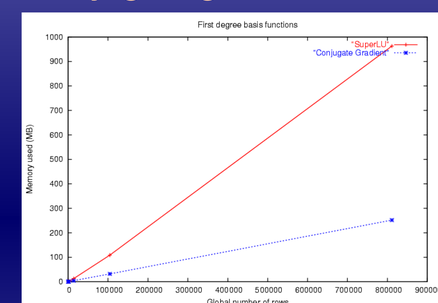
Time to solve 2nd RHS with 1st degree basis functions



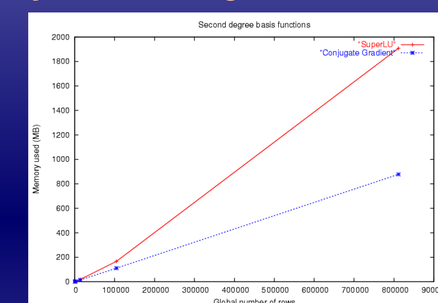
Time to solve 2nd RHS with 2nd degree basis functions

Methods:

Because our existing solvers do not handle complex numbers, we compared the performance of SuperLU and a conjugate gradient solver on real systems using MCR



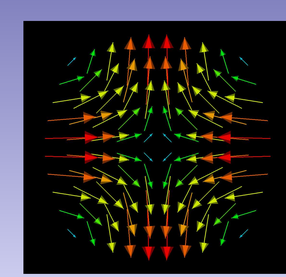
Memory usage with 1st degree basis functions



Memory usage with 2nd degree basis functions

Discussion:

- Although SuperLU used more memory and was often slower than existing methods for real systems, its complex number capabilities will still allow the group to solve many new problems.
- SuperLU is also more appropriate for certain real-valued problems such as eigenvalue and eigenmode computations.



The two color pictures are from frequency domain simulations of a TE_{11} mode in an electromagnetic waveguide. Producing the corresponding images in the time domain would be much more computationally expensive.

This work was performed under the auspices of the U.S. Department of Energy by University of California Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.