Chombo's approach to solving PDE's

- **An AMR Software Framework**
  - Chombo is the public open-source library from ANAG.
  - Chombo supports a wide variety of applications that use AMR by means of a common software framework.
  - Mixed-language programming: C++ for high-level abstractions, Fortran for calculations on regular patches.
  - Reusable components, based on mapping of mathematical abstractions to classes.
  - Layered architecture that hides different levels of detail behind interfaces.
    - Layer 4: Complete parallel applications. AMRSelfGravity, AMRMHD, AMRINS, EBAMRINS, AMRCharm. 100K lines of code.
    - Layer 3: Solver libraries: geometric multigrid solvers on unions of rectangles and AMR hierarchies. Hyperbolic solvers. 70K lines of code.
    - Layer 2: Tools for managing interactions between different levels of refinement in an AMR calculation. These include interpolation operators, averaging operators, and coarse-fine boundary conditions. 50K lines of code.
    - Layer 1: Data and operations on unions of rectangles. This includes set calculus and a rectangular array library, data on unions of rectangles with SPMD parallelism implemented by distributing boxes to processors and load balancing tools. 80K lines of code.
  - Utility Layer: Code instrumentation, interoperability libraries. This also has an API for HDF5 I/O and performance and debugging tools. 20K lines of code.

- **Performance Tools**
  - Chombo Timers
    - Instrumented source code.
    - Parallel or serial profiling.
    - Hardware counters.
  - Memory tracking
    - Memory leak detection.
    - Memory usage.
  - Parallel debugging.
  - Event-based diagnostics.

- **Chombo Fortran**
  - Provides a less error-prone interface for mixed language programming.
  - Provides a dimension-independent syntax for Fortran.
    - 1, 2, and 3 dimensional simulations can call the same Fortran subroutines.
    - This eliminates the software maintenance nightmare of maintaining separate Fortran cores for each dimension.
  - Fortran 77 and the prototypes headers to call it are generated from Chombo Fortran files.
  - OpenMP hooks and other performance optimizations can be added automatically into Fortran subroutines.

- **Software Engineering practices**
  - Source code control
    - CVS (soon svn) repository.
    - Release branches
  - Nightly regression testing
    - 4 machines, 24/7 allocation.
    - Large configuration space.
  - Doxygen hypertext documentation
  - Chombo User's guide.
  - Easy to port and modify
    - Build based on just GNU make and perl.
    - Only one external library dependency (HDF5).
  - Visit integrated with GDB debugger.
  - Software design process
    - Design document
    - Example applications
    - Unit tests
  - Chombo coding standards
  - Chombo users mailing list
    - Bug reporting
    - Community input