**Objectives**

- **Milestone**
  - Implement application-specific visualization and/or analysis operators needed for in-situ use by LCF science codes
  - Use PISTON to take advantage of multi-core and many-core technologies

- **Target Application**
  - The Hardware/Hybrid Accelerated Cosmology Code (HACC) simulates the distribution of dark matter in the universe over time
  - An important and time-consuming analysis function within this code is finding halos (high density regions) and the centers of those halos

**Impact**

- **VTK-m framework**
  - The PISTON component of VTK-m focuses on developing data-parallel algorithms that are portable across multi-core and many-core architectures for use by LCF codes of interest
  - PISTON consists of a library of visualization and analysis algorithms implemented using Thrust, and our extensions to Thrust

- **Halo and Center Finders**
  - Data-parallel algorithms for halo and center finding implemented using VTK-m (PISTON) allow the code to take advantage of parallelism on accelerators such as GPUs
  - Can be used for post-processing or in-situ, with in-situ integration directly into HACC or via the CosmoTools library

**Accomplishments**

- **Performance Improvements**
  - On Moonlight with $1024^3$ particles on 128 nodes with 16 processes per node, PISTON 4.9x faster for halo + most bound particle center finding
  - On Titan with $1024^3$ particles on 32 nodes with 1 process per node, PISTON 11x faster for halo + most bound particle center finding
  - Prototyped grid-based most bound particle center finder that performs O(nlogn) total work instead of O(n^2)

- **Science Impact**
  - These performance improvements allow exact center finding to be used (instead of approximations) frequently in very large runs

- **Publications**
  - In preparation: “Utilizing Many-Core Accelerators for Halo and Center Finding within a Cosmology Simulation”
  - “The SDAV Software Frameworks …” Ultrascale Vis ‘12.