SciDAC PI Meeting 2015
High Energy Physics Overview

Lali Chatterjee
Program Manager
High Energy Physics (HEP)
HEP Science Drivers (P5) and Computing

Science Pursued Via Frontiers, Experiments, Projects & Technology

Cross Cut & Global Solutions Increasingly Important:
Address the Facts of Technology Changes
Optimize Resources, Share innovation, Avoid Duplication,
Maximize External Resources and Partnerships
Strengthen Computing Within The Vertical Towers
HEP-ASCR Connections

• **SciDAC**
  (SciDAC I, SciDAC II, **SciDAC III**, SciDAC III-2)

  • *Off cycle SciDAC: Geant -4 Pilot Project*  
    (Cross cut toolkit critical for HEP....and also used in medicine etc)

• **Software-Data- Networks Eco System**  
  (near term & far term)
  * HEP Forum for Computational Excellence (**FCE**)  
  * ASCR Facilities  
  * Data Demos for SC14  
  * Exascale Requirements Review (June 2015)
SciDAC III - 2

• Re-competed soon after the HEP P5 report
• Focused on P5 Science Drivers
• FOA closed Jan 2015
• Two year projects to bring us in Phase
• Four Proposals Recommended for funding
• Three of these are same areas as current projects and same PI
• New project on data movement simulation
## SciDAC III-2 2015-2017

<table>
<thead>
<tr>
<th>Collaboration Title (abbreviated)</th>
<th>Lead Lab</th>
<th>PI (lead)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computing the Sky: Simulation and Analysis for Cosmological Surveys</td>
<td>ANL</td>
<td>Habib, Salman</td>
</tr>
<tr>
<td>Community Project for Accelerator Science and Simulation-3</td>
<td>FNAL</td>
<td>Spentzouris, Panagiotis</td>
</tr>
<tr>
<td>Optimizing HEP Data Management and Analysis Capabilities</td>
<td>FNAL</td>
<td>Lyon, Adam</td>
</tr>
<tr>
<td>Exascale algorithms and software for lattice field theory</td>
<td>FNAL</td>
<td>Mackenzie, Paul</td>
</tr>
</tbody>
</table>
Computation-Driven Discovery for the Dark Universe (SciDAC3)

Project Director: S. Habib (ANL)   Institutional PIs: K. Heitmann (ANL), A. Slozar (BNL), N. Gnedin (FNAL), P. Nugent (LBNL), J. Ahrens (LANL), R. Wechsler (SLAC)

• Science Targets: “Dark Universe” physics as probed by cosmological surveys — nature of dark energy and dark matter, neutrino sector, nature of primordial fluctuations

• Computational Program:
  * Develop new cosmic probes and discovery channels
  * Extraction and optimization of cosmological survey science

• SciDAC Institutes: FastMATH, QUEST, SDAV
  * Adaptive mesh refinement methods  * Advanced statistical techniques  * Large-scale analytics and visualization

• Major Results:
  • World’s largest high-resolution N-body simulations with HACC
  • World’s largest hydro simulations for Ly-α forest studies with Nyx
ComPASS3: Community Project for Accelerator Science and Simulation

- Collaborating Institutions: Fermilab, Argonne, LBNL, RPI, SLAC, UCLA, U Oregon
- Accelerator applications: FNAL PIP-II, et al, LHC upgrades, laser- and plasma-based acceleration
- Computing topics: PIC on new architectures, performance and parameter optimization, scalable meshes and solvers
- HEP partnership with SciDAC Institutes:
  - FASTMath, SDAV, and SUPER
Lattice QCD - new techniques & precision

• Created new methods for calculating the decay of a kaon into two pions. (RBC)
  • This pioneered the still little-explored territory of calculating multi-particle decays with lattice QCD.

• Gauge configurations generated with SciDAC software were used to pioneer new methods for determining quark masses several times more precise than ever before. (HPQCD).
  • Quark masses this precise will be needed to analyze Higgs decays to ultra-high precision and for many other purposes.

• Calculated many corrections needed to obtain the CKM quark mixing matrix elements from the leptonic and semileptonic decays of mesons. (Fermilab/MILC, HPQCD, RBC).
  • These allowed much more stringent tests in the search for new physics in these decays.

• In software, a new library, QUDA (“kyoo-da”), was developed to allow convenient porting of QCD code to GPUs.
SciDAC III – 2 Data Simulation Project

• Prototype an end-to-end simulation of data facilities that support extreme scale computing
  – Study and simulate Fermilab’s HEP scientific data facility
  – Validate against actual data facility logging information

• Deliverables
  – Publish results of simulation under different HEP workflow scenarios
  – Publish simulation prototype code
  – Publish data facility logging information

• Validated simulation will be crucial for refinement of current HPC systems and design of future exascale facilities

• Joint HEP/ASCR, ANL/FNAL project

Pl’s: Adam Lyon (lyon@fnal.gov) & Rob Ross (rross@mcs.anl.gov)
The Science Drivers of Particle Physics

- Use the Higgs boson as a new tool for discovery
- Pursue the physics associated with neutrino mass
- Identify the new physics of dark matter
- Understand cosmic acceleration: dark energy and inflation
- Explore the unknown: new particles, interactions, and physical principles

Closely LINKED to SciDAC and the computing-data eco system.