U.S. DEPARTMENT OF ENERGY

SciDAC PI Meeting 2014 High Energy Physics Introduction

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High Energy Physics

- **What's new?**
- **The U.S. particle physics community has just updated its vision for the future**
- **The P5** (Particle Physics Project Prioritization Panel) **report presents a strategy for the next decade and beyond that enables discovery and maintains our position as a global leader**
- **Science Drivers**
- **Experiment- Theory- Computing**
- **Technology**

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**

Computing and P5

- [Recommendation 29]
- ***Strengthen the global cooperation among laboratories and universities to address computing and scientific software needs, and provide efficient training in next-generation hardware and data-science software relevant to particle physics.***
  - **HEP Response: Set up Forum for Computational Excellence to work with HEP to address this Recommendation**
  - **A Pilot Forum has been set up by DOE led by Rob Roser (FNAL) and Salman Habib (ANL) to follow up on these issues among other topics**

Other HEP Reports Of Relevance

Report of Topical Panel on HEP Computing

Paul Avery and Salman Habib – Co Chairs
Held Bethesda, MD December 2013

Talks by Steve Binkley/Barb Helland from ASCR

Participation by SciDAC projects and ASCR Communities

http://science.energy.gov/hep/news-and-resources/reports/

Tools, Techniques, and Technology Connections of Particle Physics

Marcel Demarteau & Katie Yurkewicz - Co Chairs

HEP-ASCR SciDAC Projects

HEP-ASCR SciDAC -3 Projects

- Searching for Physics Beyond the Standard Model: Strongly Coupled Field Theories at the Intensity and Energy Frontiers
- Computation-driven Discovery for the Dark Universe
- Community Project for Accelerator Science and Simulation (ComPASS-2) Accelerator Science Modeling & Simulation

All projects are making important contributions and we will hear from them at this meeting.

Additional: HEP-ASCR SciDAC Pilot Project:

Transforming GEANT 4 for the Future – Rob Roser and R. Lucas

GEANT 4 is a critical HEP Simulation Tool that is widely used across HEP (and Beyond). The pilot project has made key advances in developing a prototype that is being tested. (Poster at this Meeting)

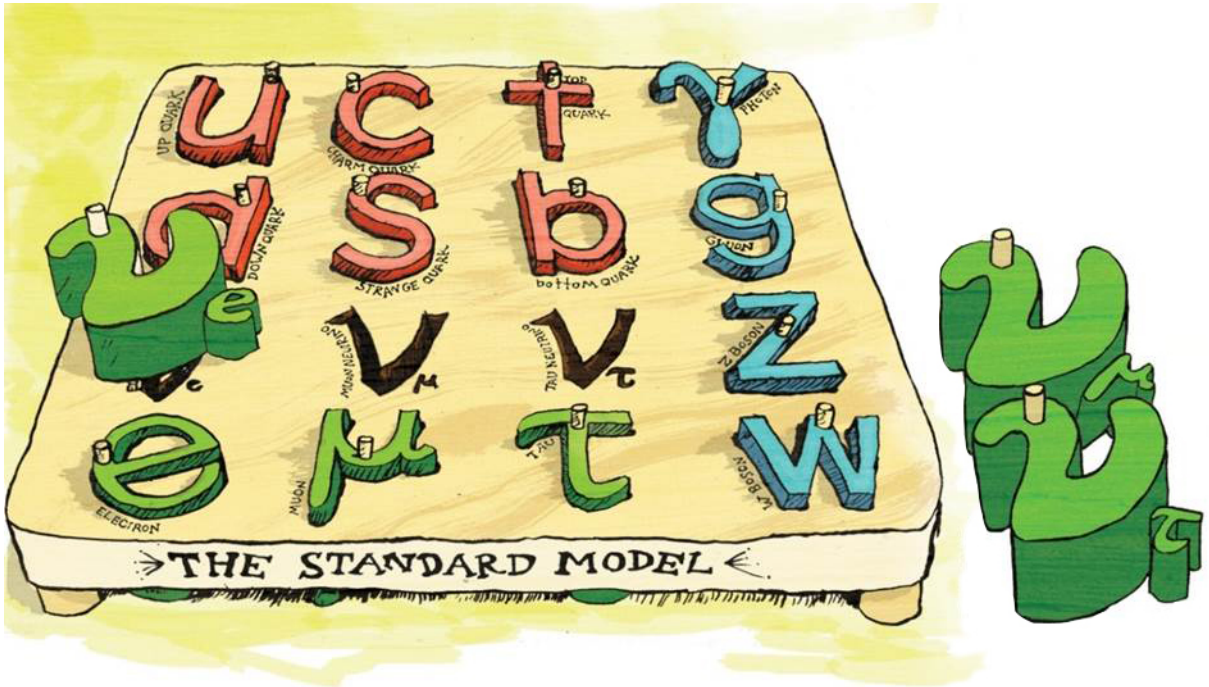
I will close with a few highlights from the SciDAC – 3 projects.

SciDAC 3 project: Searching for Physics Beyond the Standard Model

- **One mode to study Beyond-the-standard-model effects is the Kaon to Pion decay at high precision.**
- **The SciDAC project contributed to reducing the uncertainty the relevant form factors to 0.4%.**
- **This improved precision has unearthed a 2.5% discrepancy from what is expected in the standard model and is awaiting further testing to see if it leads to evidence for beyond-the-standard-model physics.**
- **This calculation was made possible by SciDAC work making structural improvements in the code that made it easy to generate the variety of three-point and two-point functions and interpolating operators required by the project.**
- **PI: Paul Mackenzie**

The Standard Model

The Standard Model (SM) describes the elementary particles that make up ordinary matter and the forces that govern them with very high precision.



With the discovery of the Higgs, we have all the nominal pieces of the SM in place. ***But they don't all fit perfectly…***

So we must keep searching…..increasing precision is one way

Computation-driven Discovery for the Dark Universe

- **Dark Energy and Dark Matter are strongly emphasized in the P5 report and present some of the most fundamental questions before us.**
- **Simulating the universe and developing mock catalogues and related predictions are essential and integral to our experimental cosmic frontier probes.**
- **The "Dark Universe" SciDAC 3 project recently completed the world's largest high-resolution cosmological simulation on Titan at OLCF, covering more than 60 times the volume of previous runs.**

  Galaxy distribution predictions from this run will enable dark energy investigations using current and future sky surveys -- DES, DESI, and LSST, as well as WFIRST-AFTA.
- **PI: Salman Habib**

SciDAC -3 Project: ComPASS 2 – Accelerator Science Modeling & Simulation

- **Particle Accelerators are critical for HEP research to probe the universe via controlled experiments at highest energies as well as at high intensities. Modeling and Simulation are naturally a very important part of this enterprise.**
- **Synergia multi-bunch studies and calculations using GPU have yielded results that are important for the design of the Proton Improvement Plan (PIP) and Simulations for the Mu2e experiment – both major HEP initiatives.**
- **Large scale Warp 3-D simulations validate a new concept for laser driven plasma accelerators – our possible routes to higher energies.**

PI: Panagiotis Spentzouris

Moving Forward-
Science Drivers and Frontiers

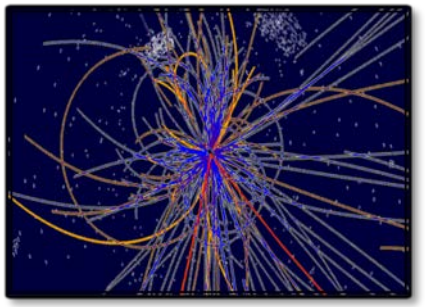
Higgs

Neutrinos

Dark Matter

Dark Energy / CMB

New particles



Energy Frontier

Intensity Frontier

Cosmic Frontier