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DOE HEP Program Perspective

HEP/NERSC Workshop

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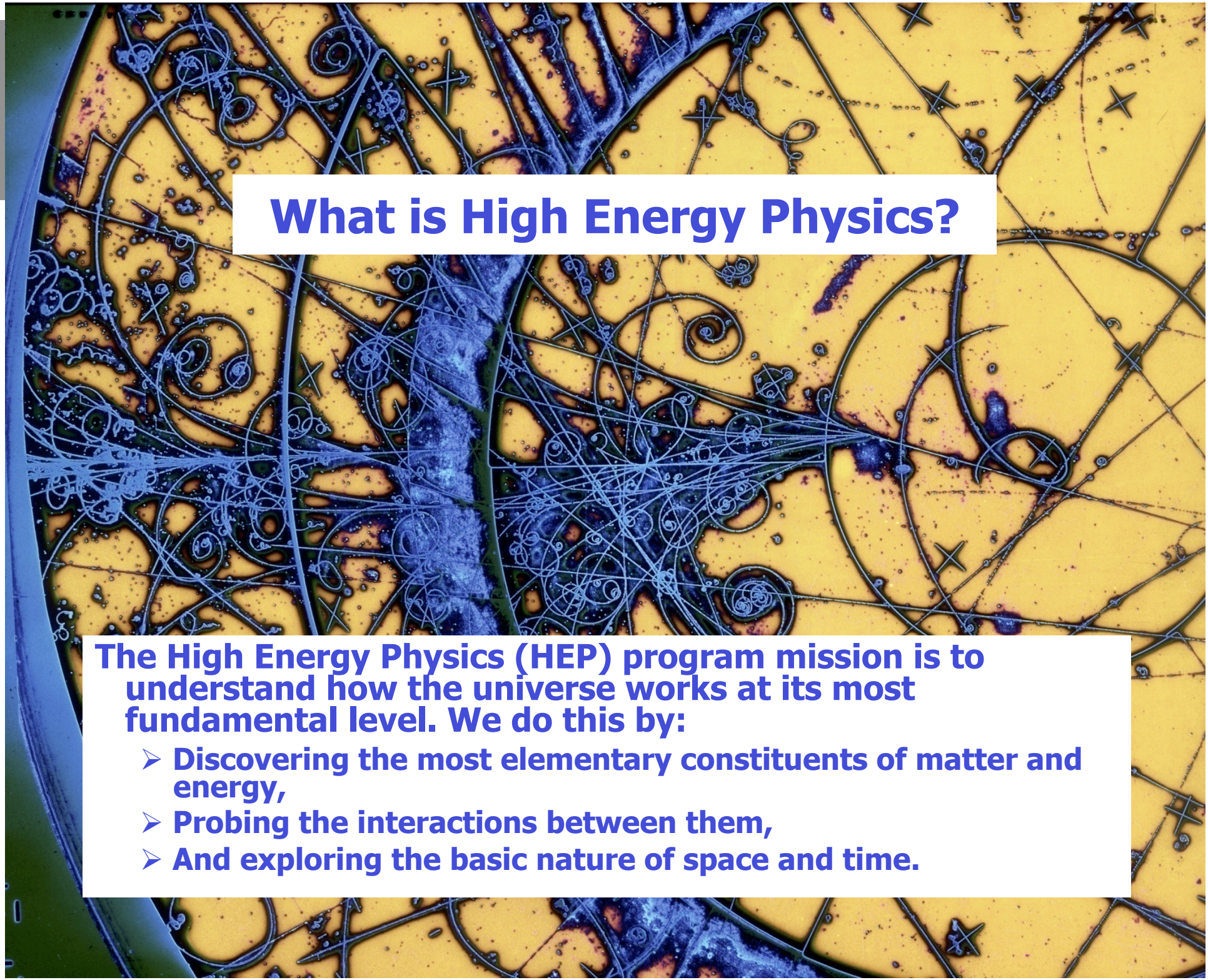

What is High Energy Physics?

The High Energy Physics (HEP) program mission is to understand how the universe works at its most fundamental level. We do this by:

- **Discovering the most elementary constituents of matter and energy,**
- **Probing the interactions between them,**
- **And exploring the basic nature of space and time.**

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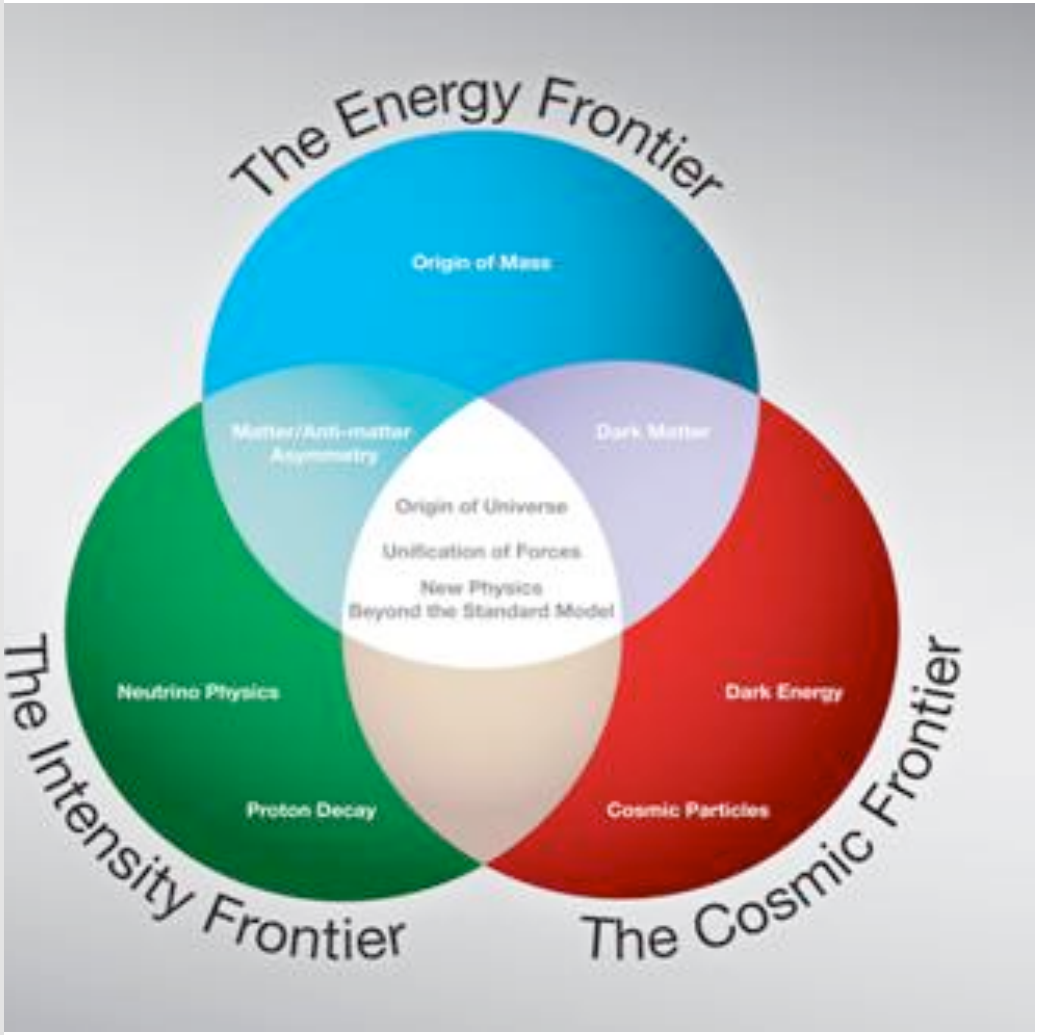
The Three Frontiers of HEP

- ***At the Energy Frontier,*** **powerful accelerators are used to create new particles;**
- ***At the Intensity Frontier,*** **intense particle beams and highly sensitive detectors study events that occur rarely in nature; and**
- ***At the Cosmic Frontier,*** **ground and space-based experiments and telescopes offer new insight and information about the nature of dark matter and dark energy, and discover new phenomena.**



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HEP Program at a Glance

The Office of High Energy Physics is the federal steward of HEP research providing over 90% of federal support to

- **Design, construct and operate the research facilities needed to advance our knowledge**
- **Support the researchers at universities and laboratories to carry out the research**
- **Develop advanced technologies and next generation scientific and technical workforce**

Five Subprograms

Budget Categories	($M) FY 2009
Proton Accelerator-Based Physics	402.5
Electron Accelerator-Based Physics	31.0
Non-Accelerator Physics	100.9
Theoretical Physics	64.8
Advanced Technology R&D	196.6
HEP Total	795.7

Demographics

Research Statistics	FY 2009 estimate
# University Grants	200
# Laboratory Groups	45
# Permanent Ph.D.'s (FTEs)	1,135
# Postdoctoral Assoc (FTEs)	550
# Graduate Students (FTEs)	595
# Ph.D.'s awarded	110

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HEP Approach to Computing

- **Scientific Mission: Experiments for HEP accelerator and non-accelerator science can be data and compute intensive. Theory is typically compute intensive.**
  - **We recognize that computing infrastructure and facilities are essential to fulfill our research mission**
    - **Data storage and compute facilities at national laboratories to support the experimental and theoretical programs**
      - **BABAR, CDF/DO, Intensity Program**
      - **LHC Tier 1 facilities for ATLAS (BNL) and CMS(FNAL)**
      - **Facilities for astrophysics experiments and theory**
      - **LQCD at BNL, FNAL.**
    - **Hardware for analysis and other program support at universities and laboratories**
      - **LHC Tier3**
      - **PDSF at LBNL**
    - **Specialized or custom-built software and computing**
  - **We collaborate with partners in Office of Science and NSF**
    - **Open Science Grid, LHCNet**
  - **We rely on High Performance Computing facilities**
    - **NERSC**
    - **INCITE**

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HEP Computing at NERSC

- **Five broad categories reflect computing in support of the HEP mission.**
  - **Accelerator Modeling**
  - **Computational Astrophysics**
  - **LQCD and other standard model theory calculations**
  - **HEP experiment simulations and data analysis**
  - **Experimental Astrophysics**
- ***All of these categories are vital to the HEP mission***
- **Reflected in current HEP NERSC usage**
  - **~35 users**
  - **Within these categories, priorities are determined as the programs evolve.**
- **Allocations and usage will be covered in more detail**

This planning exercise is essential: Computing cycles at NERSC has and will continue to enable these vital activities

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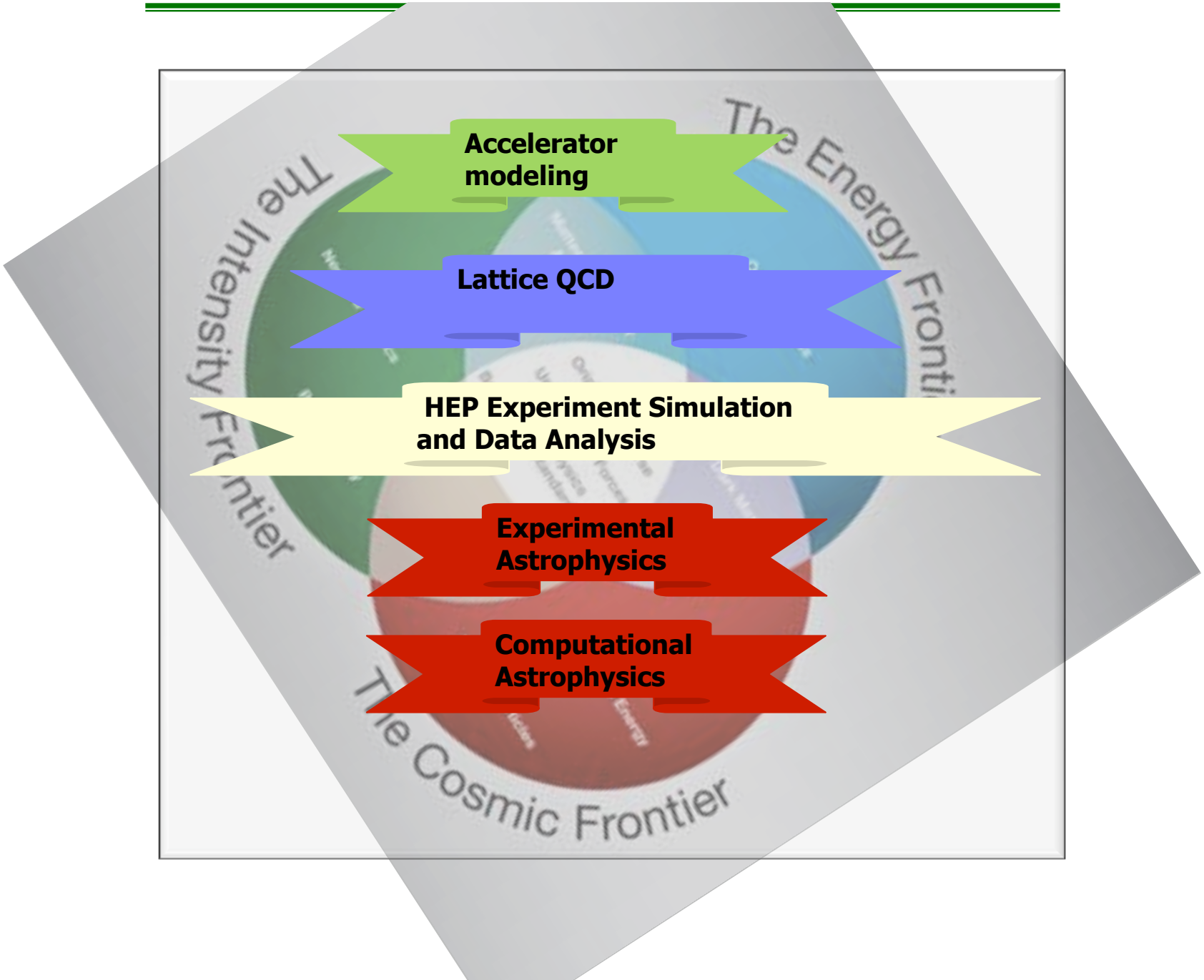
Computing at the Frontiers



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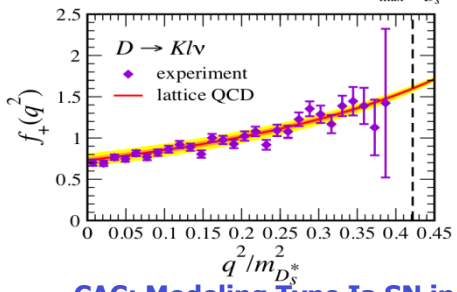
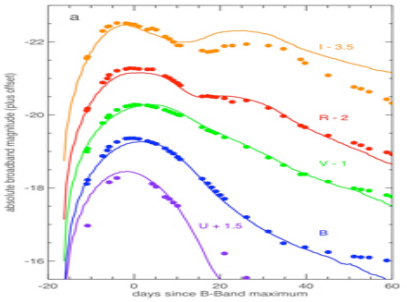
Scientific Discovery Through Advanced Computing

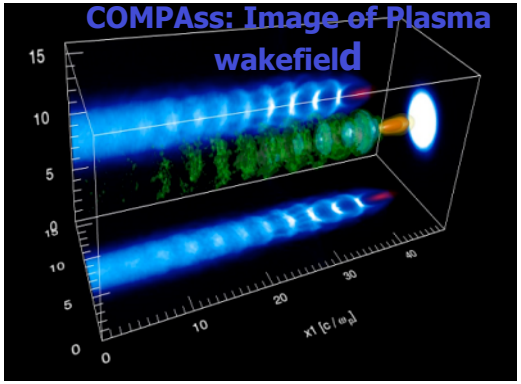
- **Lattice QCD**
  - Large scale numerical models to make precise predictions of Standard Model Physics to compare to experimental results
    - Calculations in progress include mixing, decay amplitudes in the B sector
  - Calculation of the masses of strongly interacting particles
  - Partners: NP, ASCR
- **Computational Astrophysics Consortium**
  - Modeling the properties of exploding stars and understanding the implications for supernova surveys and dark energy observatories
    - Type 1a supernova, nucleosynthesis, radiation transport, gamma ray burst.
  - Partners: NP, NNSA, ASCR
- **Community Petascale Project for Accelerator Science and Simulation**
  - Working to develop tools for accelerator scientists to study the behavior of charged particles traversing accelerating structures.
    - Highly parallel codes for Beam Dynamics, Electomagnetics and Advanced acceleration techniques
    - Full lifecycle from conceptual R&D-> accelerator design -> commissioning and operations
  - Partners: NP, BER, ASCR

LQCD:Form factor for D decay



CAC: Modeling Type Ia SN in 2d





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Summary

- **HEP has five areas with long term computing needs at NERSC**
  - **Accelerator Modeling**
  - **Computational Astrophysics**
  - **LQCD and other standard model theory calculations**
  - **HEP experiment simulations and data analysis**
  - **Experimental Astrophysics**
- **Thanks to NERSC and ASCR for arranging this opportunity to state the needs for HEP computing at NERSC**
- **Thanks to the participants**