The SLAC Detector R&D Program

David MacFarlane

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Overview of detector R&D program

- KA15 detector R&D program includes
  - Core engineering and generic detector R&D capabilities
  - Sensor development R&D
  - Electronics and DAQ development R&D
  - Detector systems R&D
    - MDI studies, detector simulation toolkit, PFA studies & related hardware R&D, supported by test beams and facilities
- Selection criteria for projects
  - Connection to future physics opportunities
  - Potential impact on performance, physics reach and/or cost
  - Match between core capability or its evolution, and the R&D effort
  - Connections and synergy among projects

Core capabilities

- Expertise at the frontiers of detector technology
  - Leveraging connection to Stanford and Silicon Valley
- End-to-end electronics system architecture and design
  - High-reliability systems including space applications
  - Mechanical, thermal, electrical integration & electronics packaging
- High-performance DAQ system architecture and design
  - Next generation state-of-the-art hardware and software platforms
- Innovative mechanical design and integrated detector concept development including machine-detector interface
  - Developing expertise in underground low-radioactivity experiments
- Support from KA15 detector R&D is critical
  - Key engineers at ~50% level reflecting role as drivers for innovation
  - Small number of support personnel enhance functionality of core

Activities and plans for sensor R&D

- Push the performance boundaries of detector sensor attributes
  - Timing resolution: fast focusing DIRC and MCP-PMT TOF
  - Energy resolution: PolyChrome imager, spherical silicon geometries, and high-yield Germanium sensors
  - Radiation tolerance: 3D architecture silicon diodes and diamond sensors, gray-tone diffusions
  - High-occupancy: dual readout
  - Integration and system cost: double-metal strip detectors
- Builds on the extensive existing micro and nano-fabrication infrastructure on the Stanford campus
  - Location within Silicon Valley facilitates the use of services from a wide range of companies specializing in microtechnology
- Envision significant growth in the sensor development effort over the coming three years

Activities and plans for electronics/DAQ R&D

- Builds on established end-to-end electronics system design capability
  - SLD, BABAR, Fermi GST, EXO-200 and many other experiments
- Future emphasis of electronics effort:
  - System-on-a-chip approach to high-rate low-mass front-ends
  - ASIC design effort to complement sensor development work
  - Radioactive-free front-end modules for low-background experiments
  - Possible 3d multi-layer ASIC assemblies
- Multi-gigabit data transmission integrated inside detector system
- Development of a generic high-speed high-volume DAQ systems
  - Composed of modular building blocks to interface to the detector front-ends and provide low-cost high-bandwidth I/O with real-time DAQ software
- High-reliability systems for inaccessible ground-based, e.g., linear collider, or space-based, e.g., JDEM, applications

Activities and plans for detector systems R&D

- Developing and supporting a versatile simulation and reconstruction toolkit for detector system design and performance evaluation
  - Emphasis on applications to understanding and optimizing the Particle Flow Algorithm capability
  - Optimize jet energy resolution of precision experiments for the linear collider
- Development of hardware systems designed to meet PFA requirements
  - Concepts for high-density highly-segmented electromagnetic calorimetry, digital hadronic calorimetry, and low-mass silicon tracking
  - Efforts tie tightly to the sensor development with electronics and electronics system design capabilities
- Engaged in understanding machine-detector interface and detector integration issues
  - Critical for understanding the feasibility of future high-luminosity linear collider experiments

Connections among detector R&D projects

- Front-end and DAQ expertise closely tied to our ability to easily develop and then test new sensor technologies
- Front-end expertise also closely tied to creating new low-mass tracking or compact, highly-segmented calorimetry for PFA applications
- Flexible detector simulation toolkit is essential for understanding the potential performance impacts of integrated detector concepts
- Emphasis on mechanical & electronics/DAQ system architecture strongly grounds & connects generic R&D efforts in realistic setting
- Linkages further enhanced by common facilities, such as clean rooms and easy access to state-of-the-art facilities on the Stanford campus
- Restoration of a test beam capability will also greatly enhance the efficiency of the development and testing cycle for these programs
  - Provides the US community with a unique electron test beam capability for detector R&D and detector calibration purposes over the next decade.

Linkages to program R&D effort