

**Snowmass White Paper in support of
Training in System Design and Electronics
Design & Verification Tools,
Access to ASIC Fabs,
Multi-Institutional Agreements
for
HEP Detector Instrumentation**

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Training & Organization of Design Efforts

- HEP detector design has undergone a huge transformation with the advent of IC design and the development of several new sensor types
 - Systems with thousands to millions of independent sensor readouts have inspired the development of highly sophisticated architectures.
 - Timeframes have been extended from years to a decade or more for recent systems
 - Next generation systems will rely heavily on past experience especially at the system level where development times can be significantly decreased by co-design from the early stages instead of serialized development starting with the front end and mapped into independently designed back ends.

Specialized Instrumentation Training

- Design & Development of Next Gen detector systems will largely be in the hands of new and somewhat inexperienced engineers and physicists considering the human time scale of current system development.
- HEP Instrumentation specific training will be crucial for Engineers, Physicists, Post Docs and Grad Students design, development and review

Training in ASIC Design & Verification

- Next Generation HEP detector mounted electronics will operate in extreme temperatures and radiation environments unlike most all commercial devices.
 - Designers will need to deeply understand the properties of semi-conductors and passive components in these environments as well as how to exploit the increasingly sophisticated tools of dense analog and digital circuits including design flows synthesis of digital circuits power analysis and verification.
- Last year DOE announced and awarded funding for HEP focused training programs at both the Lab and University level. We should encourage evaluation and further funding of these kinds of programs as well as encourage our students to participate in them to maintain a high level of expertise in our field.

Access to ASIC fabrication

- While there have been many important developments in electronics, Detector mounted ASIC readouts have been the driver that stimulates the use of the state of the art Trigger, DAQ and related Readout systems in current day detector systems.
 - Extreme Operational environments and combined sensor and readouts such as MAPS will likely require access to several different ASIC technologies as well as Design Kits and models either from the manufacturer or developed by internally.
- It will be helpful to point this out to our DOE supporters.
- There is a strong Office of Science interest in fostering participation ASIC programs that cross boundaries to strengthen us expertise in the development of ASICs and provide industry with a source of trained experts in design,

Multi-Institutional Agreements

- Our on detector Electronics has moved from multiple special function chips on boards whose payload is simply data to Systems on a chip with multiple data types including prompt trigger information. In the future this may lead to chips that can be reconfigured in situ for different types of physics investigations or optimize their performance using machine learning or artificial intelligence techniques.
- This kind of technology will require experts spread across multiple institutions for successful implementation with a realistic schedule.
 - While this has proven difficult for individual labs and universities to achieve we should express the need for a DOE, perhaps Office of Science negotiated contract that allows ASIC designs to be shared among Universities and Labs working on the same ASIC to better match needs with the HEP labor pool.

Discussion

- We will be best able to use the Snowmass process to argue for improvements in access to training and technology by expanding on these and other areas.
- So we are looking for help in stimulating ideas, organizing and editing contributions and helping out with our executive statement about the needs in Electronics and ASICs for the development of next generation detector systems.
- The IF Cross-Cutting team has started to look into foundries-related issues.
- The Community Engagement Frontier had started discussion and organized meetings with various design tools companies to gauge their interest in helping out HEP instrumentation efforts.
- The HEPIC is one of the awarded HEP traineeship programs and a traditional venue/forum for the community.

We should include those in our white paper.