X-Cutting & Systems Integration Group

IF Snowmass meeting June 19, 2020

Jim Fast, Maurice Garcia-Sciveres, Ian Shipsey

IF9: Cross Cutting and Systems Integration

co-Conveners:

Name	Institution	email
Jim Fast	JLAB	jfast[at]jlab.org
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Description

This group will facilitate the identification of synergies among the Instrumentation Frontier sub-groups as well as with other Frontiers and research areas outside of HEP. The Cross Cutting and Systems Integration group covers topics related to integrating large, complex detectors into one system. In addition, the group will discuss needs and plans for necessary testbeam and irradiation facilities in the country in conjunction with the Accelerator/Technology Frontier group.

Leverage Basic Research Needs study on HEP Detector R&D

Charge: I request that you organize and carry out a Basic Research Needs (BRN) study to assess the present status of the HEP technology landscape, and to identify strategic technology areas, aligned with the strengths of the US community, that future long-term research and development (R&D) efforts should focus on in pursuit of the HEP science drivers identified in the P5 report. For each of these areas, the study should articulate and justify a set of Priority Research Directions (PRDs) to push the technology well beyond the current state of the art, potentially leading to transformative advances with broad-ranging applicability in HEP and beyond. Furthermore, the study should identify a small set of high-impact instrumentation "Key Challenges" where technological breakthroughs could lead to game-changing experimental capabilities in pursuit of HEP science goals.

Chaired by Bonnie Fleming and Ian Shipsey

- Charged in July 2019
- Working groups started in October 2019
- Main workshop held December 11-14, 2019
- Report is in final editing and review now
- It will be public after the presentation by the Chairs at HEPAP on July 10, 2020

- 5 physics and 7 detector thrusts areas & X-cut group
- Xcut group members
  - Marcel Demarteau (ORNL)
  - Abe Seiden (UCSC)
  - Young-Kee Kim (U. Chicago)
  - Sunil Golwala (Caltech)
  - Jim Fast (PNNL/JLab)

Main contributions of cross cutting group

- Ensuring technology working groups were sufficiently forward leaning (30-year vision)
- Identifying and highlighting linkages between thrust areas
- Ensuring Priority Research Directions (PRD) were clear and “actionable” by OHEP
- Developing the Grand (Key) Challenges that cross-cut many of the PRDs
- Looking at facilities needs, workforce needs and workforce development
- Identifying and documenting interplay within the field, to other Office of Science programs (e.g. NP, BES), to the broader S&T community (e.g. DOE-NNSA, DOD, NASA), and benefits to society

"Synergy and Interdisciplinarity "

In response to: *This group will facilitate the identification of synergies among the Instrumentation Frontier sub-groups as well as with other Frontiers and research areas outside of HEP*

We will host a series of interdisciplinary virtual workshops. The first will be hosted by Berkeley on September 30-October 2 (2.5 hours talks & 1 hour panel each day) bringing together HEP community members who have genuinely interdisciplinary aspects to their work HEP + chemistry HEP + materials science, HEP + mechanical engineering etc. https://indico.physics.lbl.gov/event/1217

MultiHEP 2020

30 September 2020 to 2 October 2020
US/Pacific timezone

- Overview
- Scientific Programme
- Timetable
- Participant List
- Organization

Snowmass virtual pre-meeting called by the detector R&D Cross-Cutting group and hosted by the Berkeley Experimental Particle Physics Center (bepp.berkeley.edu).
Intended to collect experience on successes, challenges, and lessons about multi-disciplinary collaborations to further or spin-off High Energy Physics R&D.
Presentations and panel discussions are by invitation.

Likely format:

1.5 hours of presentations

break

Panel discussion (~1 hours) related to presentation topics

repeat all 3 days

Local Organizing Committee:

Maurice Garcia-Sciveres, LBNL
Heather Gray, UC Berkeley
Carl Haber, LBNL
Simone Pagan Griso, LBNL
Haichen Wang, UC Berkeley

Scientific Committee

Karen Byrum, ANL
Gabriela Carini, BNL
Jim Fast, JLAB
Jeter Hall, SNOLAB
Klaus Honscheid, OSU
Yuan Mei, LBNL
Petra Merkel, FNAL
Kimberly Palladino, UW-Madison
Mark Palmer, BNL
Ian Shipsey, Oxford U.
...

“Synergy and Interdisciplinarity ”

In response to: *This group will facilitate the identification of synergies among the Instrumentation Frontier sub-groups as well as with other Frontiers and research areas outside of HEP*

Example: We suggest an interdisciplinary session be included in HEPIC workshop (see ASIC group talk)

Other workshops will be determined by the community

We will develop a narrative for cross-cutting research directions. Examples might be

- **Manipulate detector media to enhance physics reach**
- **Advance material purification and assay methods to increase sensitivity**
- **Addressing challenges in scaling technologies**

⇒ the community will identify actual cross-cutting research directions throughout the Snowmass process

"Integration"

In response to: *The Cross Cutting and Systems Integration group covers topics related to integrating large, complex detectors into one system.*

Some preliminary thoughts:

- *Engineering support is critical and is largely at the national labs, however the community has benefited immensely from university contributions and these foster education and linkages to communities outside HEP*
- *Support of CAD software (ME as well as EE), document controls etc. are crucial and again live primarily at the national labs. Integration across institutions is often difficult.*
- *There are always issues with transition from benchtop R&D to production for large experiments. These are typically either integration or technology maturity issues that fall under the purview of systems engineering. Systems engineering approaches tailored to one-off systems like HEP experiments may be worth considering. Tailoring of Technology Readiness Levels (TRL) to HEP detector development and construction.*
- *Cabling, connectors, and on-board data processing are recurring themes in integration. How do we get large amounts of data out without taking up any space, causing any scattering and with no power? This would touch on everything from radiation hard fiber readout components to alternatives like wireless or free-space optical communications. Very precise timing over distributed sensor arrays from LHC-like experiments (10's of meters) to telescope arrays (km) are adding yet another level of complexity.*

“Facilities/Capabilities in support of HEP”

In response to: *the group will discuss needs and plans for necessary testbeam and irradiation facilities in the country in conjunction with the Accelerator/Technology Frontier group.*

A multitude of unique facilities and capabilities underpin the advanced detector R&D program.
We believe this should include but be broader than testbeams and irradiation facilities and intend to broaden the scope to address other facilities needs.

In the near term we propose to:

- Design and seek input on the content of a survey or several surveys to understand community needs for infrastructure and facilities and then issue the survey(s) over the summer.

This summer we will:

- Catalog the existing facilities and capabilities and gauge their usage by the community.
- Make the case that it is critical that these core facilities continue to be supported

As the Snowmass process unfolds we will:

- Identify the new capabilities required for testing and evaluation of detectors for future experiments
- Make the case for these new facilities to be created.

"Example Facilities/Capabilities in support of HEP"

The availability of dedicated, specialized facilities and capabilities has contributed immensely to the success of HEP. Such facilities and capabilities will continue to be critical for future instrumentation research and development.

Some have been modeled as national user facilities and some are more captive requiring personal relationships to access. Some are "free" to users and others full cost recovery.

Examples (domestic only):

- **SiDET - The Silicon DETector center at FNAL; + capabilities at LBNL, BNL, Universities**
- **ASIC design - BNL, FNAL, LBNL, SLAC, Universities**
- **NLDF - The Noble Liquid Development Facility at FNAL**
- **Low background assay capabilities - PNNL, SURF, Universities**
- **MSL - The Micro-Systems Laboratory at LBNL**
- **FTBF - The Fermilab Test Beam Facility**
- **ESTB - End Station (A) Test Beam at SLAC**
    - **Decommissioned - a replacement electron beam is probably needed now**

“Facilities needs in support of HEP”

To support an advanced detector R&D program to execute the next generation of particle physics experiments, the following facility needs are likely:

- Traditional test facilities
  - Irradiation and Post-Irradiation Evaluation Facilities
  - Test Beams
  - Ultra-low temperature test stands
  - Specialized calibration facilities
  - Shallow underground sites
- Materials science and chemistry - R&D and program/project support
  - Low background materials and assay
  - Ultra-light composites
  - Novel detector and microelectronics materials
- Microelectronics design, simulation and test capability and foundry access
  - Extreme environment integrated circuits (ASICs) (Rad hard, cryo, high reliability…)
  - Novel CCD development and manufacturing
  - Superconducting detectors and devices
- Simulation Frameworks (GEANT, MCNP, FLUKA, etc.)

⇒ the community will identify actual needs both in the survey & throughout the Snowmass process

Input Needed

- *We need your input!*
- *In each WG overlaps will arise with items being covered in other IF groups, and outside IF.*
- *Please send us info on those overlaps (just email is fine)*
- *We will collect and try to coordinate, for example with sessions at upcoming workshops, joint meetings, etc.*