Generic Detector R&D at Argonne

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Disclaimer

I was not originally scheduled to talk at this retreat, but since Marcel was not able to be present and I have recently had a broad overview of the DOE Detector R&D program, I thought I might contribute my perspective of what an Argonne Detector program might become in the coming years.

The National Program

While Associate Director of DOE HEP, Dennis Kovar organized the DOE HEP program into three major frontiers – the energy frontier, the intensity frontier, and the cosmic frontier.

In the coming years, the energy frontier will largely be centered in Europe at the LHC. However the intensity frontier may well be located in the U.S. at DUSEL or elsewhere, and the ground based cosmic frontier is likely to have some large facilities in locations where a substantial U.S. contribution would be critical to project success.

The National Program (Cont.)

Dennis also added a Generic Detector R&D program to serve as an **enabler** of the HEP research program.

This program is one of the few places in HEP where it is possible to do high risk – high reward research.

Detector R&D is **NOT** subject to the DOE CD funding process.

Given the importance of the intensity and cosmic frontiers to the U.S. HEP program, Detector R&D which enables them should be a high priority for DOE HEP in the coming years.

Types of Detector R&D

In general I believe that Generic Detector R&D in HEP consists primarily of:

- Inventing new detector technologies driven by physics needs (ex: CDMS dark matter ionization and photon detectors)
- Improving the performance or characteristics of existing detectors driven by limitations of existing detectors (ex: Radiation hard pixel detectors for LHC)
- Developing technologies which can substantially reduce the cost of large detector systems (ex: Water based liquid scintillator; Large Area, High Speed Photodetector)

Types of Detector R&D (cont.)

I think the HEP physics community does a good job in inventing new detectors and improving existing detectors.

However, I think the community generally neglects the development of new technologies to reduce costs if existing technology (no matter how old) will do the job even with a substantial cost penalty. (ex: We buy photodetectors from what is now a sole foreign source, and we continue to wire up detectors even though it is time consuming and error prone.)

Detector R&D and National Laboratories

National Laboratories have the infrastructure to develop technologies which can substantially reduce the costs of future experiments.

The Argonne initiative to develop a major Detector R&D center has the potential to make Argonne a major enabler of future, large scale HEP experiments.

Detector Initiatives to Reduce Costs

At DOE, I became increasingly aware of the value of:

- Water based liquid scintillator. (The size of NOvA was being determined by the cost of oil.)
- Cheaper large area photodetectors. (Phototubes for a 100kton water Cerenkov detector were being estimated at $100M.)

Detector Initiatives to Reduce Costs (Cont.)

- Wireless readout systems. Cabling up major detector systems is time consuming, prone to errors, can be dangerous, and adds significantly to the overall detector expense. Wireless communications are becoming common in commercial applications, but the HEP community has only deployed wireless readout systems when forced by to do so (AUGER, space missions) where the technology has to be developed for each application.

Detector Initiatives to Reduce Cost (Cont.)

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- Isotopic separation. We buy our separated isotopes from Russia or France. The possibility of developing cheap ways of separating nobel gas isotopes, such as double beta decaying isotopes of Xenon from stable Xenon isotopes or separating radioactive Ar^{39} from Ar^{40} where it is important that the purified Ar^{40} not be subsequently re-exposed to cosmic radiation, might be possible using long vertical tubes in unused climb-out-ladder space of mine shafts.

Detector R&D at Argonne

I have a somewhat biased opinion, but I think the U. Chicago – Argonne large area photodetector development program is a model program for DOE Detector R&D support since success would have major positive impacts on the entire HEP program, several other areas of scientific research, and a number of commercial applications. But it is only one activity. The Generic Detector R&D program at Argonne needs to identify other Detector R&D efforts which are also particularly appropriate for Argonne.

Detector R&D at Argonne (Cont.)

Argonne has a number of strengths for Generic Detector R&D:

- It is a multidisciplinary laboratory with multiple funding sources, strong material science capabilities, and the APS.
- It is near Fermilab which can provide substantial integrated circuit design support and test beams.
- It has cooperative programs with the University of Chicago and other area Universities which can provide intellectual stimulation and student manpower.

Possible Major Components of a Detector R&D Program at Argonne

- A centerpiece of the current and near future Argonne Detector R&D program should be the continued development of the Large Area Photodetector.
- I would suggest that a second **major** Detector R&D activity which might be particularly appropriate at Argonne is the development and standardization of a wireless, generic DAQ system. This is essential in large area ground based detectors (AUGER, CTA) and would be generally useful, particularly in large underground detectors such as SNO+ and LBNE. (In a few years, Jose Repond's RPC detector might provide an excellent test for a wireless readout system in a Fermilab test beam.)

Strategies for Developing a Detector R&D Program

Get to know the Detector R&D laboratory and University community including talks and workshops at ANL. This has several benefits:

- It provides an overview of the National Detector R&D program currently funded by DOE.
- It identifies areas of community activity and expertise.
- It is likely to generate ideas for future activity at Argonne, particularly in the Mechanical and Electronics groups.
- It identifies Argonne as a center for Detector R&D.

Strategies for Developing an Detector R&D Program (Cont.)

Identify areas in the intensity and cosmic frontiers where novel technology would substantially reduce detector costs and where Argonne could easily become the lead institution.

Carry out Detector R&D in those areas in which the existing strengths of the laboratory provide the necessary resources and competitive advantages.

Strategies for Developing a Detector R&D Program (Cont.)

Use me and my knowledge of the U.S. Detector R&D community to identify people and activities which might be of interest to Argonne.

Look with particular interest on developing detectors which are motivated by the HEP program but which could have substantial value to other areas of science such as Nuclear Physics and Basic Energy Science and/or applications for National Security or Medical Diagnosis.

Conclusion

In general I think that Argonne has the resources and capabilities to become a major player in DOE's Generic Detector R&D program.

A Generic Detector R&D program has the advantage that it is not linked to a specific experiment, and the R&D remains useful and important even if the experiment which may have initially motivated the R&D is cancelled. Therefore, a major laboratory investment in this kind of work is much less risky than a major investment in future large scale experiments which may not be funded.