Paul O’Connor

Dear Ian and Marcel,

Here is the input you requested on the Instrumentation Task Force topics. I have confined my comments to the instrumentation needs of High Energy Physics, although at a multipurpose lab like BNL we see quite significant overlap with other disciplines, particularly photon science and medical imaging.

1. National Instrumentation Board

It's unclear what authority this body could have. Perhaps a better model would be an advisory panel to the DOE and NSF or a sub-panel of HEPAP. Coordination with NP and BES programs may be more effective.

2. Targeted Resources at National Labs

I support the idea of dedicating a fraction of each labs' LDRD funding to leading-edge instrumentation development. In addition, Increased support for dedicated detector instrumentation groups at the labs is also needed. The more common model, engineering support organizations whose funding comes from charge-back to programs, makes it difficult to develop and sustain the talent and equipment resources needed to respond to next-generation instrumentation needs.

3. National Instrumentation fellowships

Few university physics departments promote talented students to follow instrumentation-related courses of study. There are some instances in which a MS in Instrumentation is offered to grad students who fail Ph.D. qualifying exams. The sense that instrumentation is a path for less-qualified students certainly does not promote the development of the next generation of talented instrumentalists. A suitably prestigious fellowship program could help reverse this trend, in conjunction with the Instrumentation schools.

4. Instrumentation schools

Of the topics listed for the task force this is one that I most strongly support. Every year the IEEE Nuclear Sciences Symposium short courses on instrumentation topics are well-attended by students from labs, universities, and industry. Mostly the one- or two-day format can only provide a shallow introduction to a given topic.

5. Interdisciplinary links

These are important and tend to arise spontaneously at the working level. The difficulty is finding ways for the organization to recognize and legitimize this type of activity -- it runs counter to the prevailing trend to bureaucratization and performance-based management. BNL has had a "seed grant" program with Stony Brook University for collaborations but it is underfunded and poorly promoted. The biannual Front End Electronics workshop has successfully expanded its charter from HEP applications to photon science, medical imaging, and related topics; the non-HEP areas have been flourishing; they provide an infusion of new ideas and energy to the field. Encouraging researchers from diverse communities to come together in similar workshops is beneficial.

6. APS prize for instrumentation

Good idea. Possibly overlaps existing prizes: APS Keithley Award for Advances in Measurement Science, and IEEE Radiation Instrumentation Outstanding Achievement Award. Could also sponsor "Best Paper", "Best Poster", and "Young Investigator" type of recognition at annual meetings.

General comments:

Increased coordination with industry and with NIST should be encouraged, for instance by exchange programs between DOE labs and industry research labs and targeted workshops. There is already considerable interaction in the fields of medical imaging and radiation detection for homeland security. A small group of companies are developing pixel detectors for protein crystallography. The new area of 3D integration is being investigated by several groups in close coordination with the semiconductor industry. Involvement of the related professional societies (IEEE, SPIE, Radiological Society of North America) may be helpful.

Bonnie Fleming

Dear Bonnie,

We are writing to invite you to serve as a national advisor to the newly created American Physical Society Division of Particles and Fields Taskforce on Instrumentation. As a physicist of exceptional experience and perspective your wisdom will greatly benefit the taskforce. The taskforce charge is here http://www.dpfnewsletter.org/?p=425.

The role of national advisors is several. First they provide US community context and perspective on the work of the taskforce. Second they provide specific information on activities the taskforce has identified arising from the charge.

As you well know, instrumentation is the great enabler of science both pure and applied. Instrumentation is critical to the mission of High Energy Physics, which is to explore the fundamental nature of energy, matter, space and time. Our field is embarking on a new golden age of discovery with the recent turn-on of the LHC, and with new experiments being planned at proposed new accelerators, deep underground, at the poles, and in space that together will reveal the origin of mass, explain the matter anti-mater asymmetry of the universe, search for extra spatial dimensions, determine the nature of dark matter and dark energy, and may probe the Planck scale. For the very first time we may come to know how our universe was born, how it will evolve and its ultimate fate.

However, we embark on this adventure of discovery with instrumentation that represents both a towering achievement, and, in some cases, a scaled up version of techniques used in the past. We have gargantuan accelerators equipped with gargantuan experiments that have gargantuan costs associated with them that are outstripping the internationally available public funding for particle physics. The result is accelerator projects with exceptionally long time scales for construction and completion, and major de-scoping of detectors and their capabilities to the detriment of physics reach to match costs. In addition the time scales for our experiments and our large collaborations may have insulated us from instrumentation advances and innovations in industry.

Instrumentation R&D has the power to transform this situation, from novel new acceleration techniques such as plasma wake-field, to novel new detectors that provide enhanced capabilities with significantly reduced cost. However, there has been a decline in DOE and NSF funding for instrumentation research and development during the last two decades at universities and national laboratories. If this funding trend is not reversed declining capabilities will surely lead to a dramatic change in how our field functions, and we will confront a different kind of future for HEP– the golden age of discovery will be stalled and its goals unfilled. Energy, matter, space, and time will remain enigmas.

The field of HEP would clearly benefit from the development of both evolutionary and transformative detector instrumentation that is coordinated across the national laboratories and with the university community and international partners and with other disciplines. Accordingly, at this unique moment for HEP it has never been more necessary to examine instrumentation research and development in its entirety. The DPF has decided to form a taskforce to this end.

The specific areas where we would like your advice are listed below. We are particularly interested in hearing your thoughts on a National Instrumentation Board, Targeted Resources at National Labs, National Instrumentation Fellowships and Instrumentation Schools. We would also be delighted to have your thoughts on any other topic you think we should be covering.

The first meeting of the taskforce will be in Anaheim, CA on May 3 at the APS "April " meeting. We are requesting information on the points above in brief written form by that time. Your input will be circulated to the taskforce. The taskforce expects to complete its work and produce a report by early autumn. We do hope you can advise the taskforce.

Sincerely,

Ian & Marcel

Ian Shipsey and Marcel Demarteau, co-Chairs DPF Task Force on Instrumentation

Taskforce membership:

Labs
Greg Bock FNAL
Marcel Demarteau (*) ANL
Gil Gilchriese LBNL
David Lissauer BNL
David MacFarlane SLAC
Harry Weerts ANL

Universities
Marina Artuso Syracuse
Ed Blucher Chicago
Bill Molzon Irvine
Gabrielle Sciolla MIT
Ian Shipsey (*) Purdue
Andy White UT, Arlington

Ex-officio
Chip Brock DPF MSU
Patty McBride DPF FNAL
Howard Nicholson, Mount Holyoke

(*) co-Chair

Proposed topics the taskforce will address and proposed method for proceeding. Additional topics may be added. Methods of proceeding may be adjusted by discussion of the taskforce at its first meeting on May 3.

Note: the important issue of generic and project specific research and the related issues of the LHC and next lepton collider research programs is not one of the six initial tasks but will be discussed at the first meeting where we will invite perspectives from both programs internationally and nationally. Subsequent to that meeting we will arrange for broad community input.

Task: A National Instrumentation Board.

What the taskforce will evaluate

Is there a need for a national body to evaluate and/or promote the national instrumentation R&D program? What are the processes for evaluating and promoting the national R&D program through a standing body? Please suggest under which auspices such a body might be organized and indicate possible reporting strategies. Please comment on the appropriate role for a standing panel in the instrumentation R&D programs for upgrades to existing projects and future projects. What are the advantages and disadvantages of creating a National Instrumentation Board?

There is absolutely a need for a National Instrumentation R&D board. At a minimum, a Board could serve to gather information on R&D in different fields to connect up researchers who would benefit from collaboration on instrumentation. This board should also oversee, advise, and promote funding support for instrumentation projects models for resource distribution in the field oversall (ie: lab vs university based work) and serve as a link between the national labs and university groups. This board should be comprised of lab and university scientists and should have some representation from the funding agencies that support R&D.

This board can also serve to promote some of the ideas presented later in this document such as an Instrumentation School.

I do not see any disadvantages of a National Instrumentation Board

Method of developing the discussion prior to the first meeting of the taskforce

The chairs will invite prominent members of the U.S. lab and university communities to give written input on the topic. The chars will invite prominent experts from Europe and Asia to provide a short written account of whether instrumentation boards exist on their continents and how they function. If they do not exist, has there been discussion in the past about creating such bodies? This information will be relayed to the taskforce at the first meeting.

How the taskforce will proceed

At the first meeting the chairs will summarize the information gathered. In addition all responses will be made available to the taskforce. A subgroup of taskforce members and consultants will be formed to develop a proposal. Taskforce members may volunteer for this task before our first meeting. We will make subgroup assignments prior to the meeting. Members from industry will be added to this task after it has been relatively well---developed. The subgroup will begin its work after the first meeting of the taskforce.

Task: The creation of targeted resources at national labs for detector R&D, and the scale of those resources up to fully---fledged detector R&D center(s) at National Labs.

What the taskforce will evaluate

Might targeted resources be established at each of the five national laboratories in order to specifically support particular instrumentation R&D needs of individual researchers at the universities and the laboratories? This will be in several forms: engineering design time and specific resources for small---scale collaboration among and between university and laboratory scientists. How might such a program be administered and funded?

This idea is already partly in practice at Fermilab. As a university scientist collaborating with Fermilab on an R&D activity, I have access to materials from PREP at Fermilab to work on this collaborative research in our lab at the university. To gain this access, I have a "sponsor" at Fermilab, the sponsor and I write up a collaborative agreement, which is kept on file at PREP. When I need something from PREP (power supply, NIM bin, etc) I just go online and "order it" and PREP ships it to me. This collaborative agreement is re-assessed every year. This concept is great and has worked well in our lab in practice. It would be good if this could be the policy at other national labs too.

One drawback in this model is that you must be collaborating with a Fermilab scientist to be able to arrange for the above. A scientist working on an HEP project, but not one that Fermilab is involved with, could not have access to equipment. This should not be the case. There should be access to anyone in the community from at least one of the labs perhaps organized around funding. For example, a university scientist with DOE HEP funding could arrange for equipment loan from FNAL, while a university scientist with DOE NP funding could arrange for equipment loan from BNL.

A model to arrange for engineering resources for university scientists would also be great. As the agencies fund fewer and fewer engineers at universities, there must be a way that university people can access engineering resources through the labs. Access to these resources should also be independent of collaboration with laboratory sciences.

Method of developing the discussion prior to the first meeting of the taskforce

Each taskforce lab representative will arrange for a brief written description to be provided of what currently exists at the labs to support instrumentation including LDRD funding and how it might evolve in the next five years.

The chairs will invite prominent members of the U.S. lab and university communities to give written input on the topic. The chars will invite prominent experts from Asia and Europe to provide an account of what National Labs on their continents make available for instrumentation R&D and who has access to those resources.

How the taskforce will proceed

At the first meeting the chairs will summarize the responses. In addition all responses will be made available to the taskforce. A subgroup of taskforce members and consultants will be formed to consider the input and develop a model that could range from modest targeted resources up to an R&D center for detector development. Taskforce members may volunteer for this task before our first meeting. We will make subgroup assignments prior to the meeting. The subgroup will begin its work after the first meeting of the taskforce.

Task: A national instrumentation fellowship program.

Rationale: support training of young scientists in instrumentation

What the taskforce will evaluate

Please comment on the suggestion that a national instrumentation fellowship program be created by the NSF and DOE and Industry for Ph.D. students and postdoctoral scholars to encourage and support research in instrumentation. How should industry be involved and what industries should be targeted?

A possible model: create high---stipend fellowships with travel budgets to be tenable at National labs and universities. Competitive proposals would determine where the fellowships were located. The successful institutes will then be responsible for filling the fellowship through an advertisement. Some fellowships might be sponsored by Industry in reciprocation for access to instrumentation schools (see below). Already at the March HEPAP meeting DOE and NSF officials indicated interest in the idea of national instrumentation fellowships.

Method of developing the discussion prior to the first meeting of the taskforce

The chairs will invite prominent members of the U.S. lab and university communities to give written input on the topic. The chars will invite prominent experts from Asia and Europe to provide an account of fellowships and other instrumentation opportunities on their continents as may exist.

How the taskforce will proceed

At the first meeting the chairs will summarize the information gathered. A subgroup of taskforce members and consultants will be formed to develop a proposal. Taskforce members may volunteer for this task before our first meeting. We will make assignments prior to the meeting. The subgroup will begin its work after the first meeting of the taskforce.

I am a little confused by this suggestion, is this a fellow that would then only focus on instrumentation? This would, in my mind, make the fellow less attractive for tenure track university labs if their PD has focused only on instrumentation rather than on a combination of instrumentation and analysis. If it is not, if it is in fact a fellowship for work in someone's group on data and analysis, then I think it sounds good but perhaps could have a different name.

Task: Instrumentation school

What the taskforce will evaluate

The accelerator community has a dedicated accelerator school with academic credits. The recent EDIT school for instrumentation and technology at CERN was a great success where academia and industry sent members of their staff to attend. What are the thoughts of the committee members on establishing an EDIT style instrumentation school at the US labs (possibly rotating between them), possibly with academic credits. How would the school be organized?

Idea: EDIT school has attendance by a few members from industry. EDIT offers a far higher level of product than the National Instruments Labview Courses Industry for example is willing to pay for. Advertise the school to industry. Two options

(a) Ask industrial partners to pay to attend the school. Use proceeds to partially support national fellowships in instrumentation named after the donor company.

(b) Or, probably more effective at generating goodwill and support (and independent voices for our field in Washington), offer the school free but subsequently when the national fellowship program from DOE and NSF is put into effect, ask companies who have benefitted from the school to sponsor some fellowships with their company name being attached to the fellowship.

Method of developing the discussion prior to the first meeting of the task force

The chairs will appoint taskforce consultants from the leadership of EDIT (they have already informally agreed to serve) and from elsewhere. The consultants will provide a brief description of EDIT ahead of the meeting and will address the committee on their vision for how the school should evolve at the first meeting.

The chairs will invite prominent members of the U.S. lab and university communities to give written input on the topic. The chars will invite prominent experts from Asia and Europe to provide perspectives on instrumentation schools on their continents in written form before the meeting to supplement the information from EDIT.

How the taskforce will proceed

A subgroup will be formed of taskforce members and consultants to develop a proposal. Consultants will include the EDIT leadership and folks from industry and other disciplines. Taskforce members may volunteer for this task before our first meeting. We will make subgroup assignments prior to the meeting. The subgroup will begin its work after the first meeting of the taskforce.

An Instrumentation school is a great idea. Working to find funding through industry would also be great but if not possible, this should not hold the school back. I would happily send my students to an Instrumentation school, however would note that I don't see how this could take the place or solve the problem of lack of hardware experience for HEP students, particularly those on the colliders. While you can learn a lot in two weeks, you do not gain the day to day experience of things working, and not on a real hardware project.

Task: Interdisciplinary

What the taskforce will evaluate

Please comment on the relative importance of developing strategic links to, for example, nuclear physics, materials science, condensed matter physics, and electrical and computer engineering both in academia and in industry to the future of HEP instrumentation as the complexity of our experiments increases. How might these links be developed and sustained?

Method of developing the discussion prior to the first meeting

The co-chairs will solicit the perspective of the multi---use labs (including FNAL) from the lab reps on the taskforce. The chairs will invite prominent members of the U.S. lab and university communities to give written input on the topic.
The chairs will invite prominent experts from Asia and Europe to provide perspectives on interdisciplinary links and the relations with industry on their continents in written form before the meeting.

How the taskforce will proceed

The chairs will summarize the input received at the first meeting. A subgroup of taskforce members and consultants will be formed to develop a proposal. Taskforce members may volunteer for this task before our first meeting. We will make subgroup assignments prior to the meeting. Members from industry will be added to this task after it has been relatively well developed. The subgroup will begin its work after the first meeting of the taskforce.

Task: A national prize

What the taskforce will evaluate

The APS has the annual Sakurai prize for theoretical particle physics and the annual Panofsky prize for experimental particle physics. What are the committee's thoughts on the establishment of a named prize for instrumentation in experimental high energy physics? Is there a benefit to having a medal versus a prize? To guide the discussion see the APS webpage on prizes and medals:
http://www.aps.org/programs/honors/taskforce/index.cfm
Note: the Panofsky Prize has been awarded for the development of instrumentation several times.

Method of developing the discussion prior to the meeting

Invite Alan Chodos or other APS officials to provide their thoughts on the topic. Get input from the Asia Team and Europe Team on whether such prizes exist (in written form before the meeting.)

The chairs will invite prominent members of the U.S. lab and university communities to give written input on the topic.
The chairs will invite prominent experts from Asia and Europe to provide perspectives on national prizes in their continents in written form before the meeting.

How the taskforce will proceed

The chairs will summarize the input received at the first meeting. A subgroup of taskforce members and consultants will be formed to develop a proposal. Taskforce members may volunteer for this task before our first meeting. We will make subgroup assignments prior to the meeting. The subgroup will begin its work after the first meeting of the taskforce. If a recommendation is made to create a prize it will be important that a plan for funding the prize also be included. One possibility to consider is industrial sponsorship.

Minfang Yeh

Minfang Yeh, draft-1

Re: responses to the charge of advisory

Task: A National Instrumentation Board.

What the taskforce will evaluate

Is there a need for a national body to evaluate and/or promote the national instrumentation R&D program? What are the processes for evaluating and promoting the national R&D program through a standing body? Please suggest under which auspices such a body might be organized and indicate possible reporting strategies. Please comment on the appropriate role for a standing panel in the instrumentation R&D programs for upgrades to existing projects and future projects. What are the advantages and disadvantages of creating a National Instrumentation Board?

At last HEPAP, the program manager (given by Glen for Howard) has identified few areas of prioroties on (1) R&D of particle detectors, (2) pre-CD0 work on large projects, and (3) future upgrades for LHC/LIC. However the complication of moving LIC into the detector R&D pie is not clear yet. It seems that having a national board to advise the priorities of R&D programs will be a very helpful mechanism to aid the process. Only drawback is that instrumentation is a rather large area overlapped with different aspects and could draw confusions from different fields. How to define the goal is the key and needs further discussion (such as, focusing on the HEP experiments and applications only? Will this loss the links between different fields: nuclear physics, condensed matter physics, homeland security, etc.?).

The current model of representatives from national labs and universities; plus committee is a good start.

Will DOE alone or DOE/NSF sponsor this activity?

Task: The creation of targeted resources at national labs for detector R&D, and the scale of those resources up to fully--- fledged detector R&D center(s) at National Labs.

Might targeted resources be established at each of the five national laboratories in order to specifically support particular instrumentation R&D needs of individual researchers at the universities and the laboratories? This will be in several forms: engineering design time and specific resources for small--- scale collaboration among and between university and laboratory scientists. How might such a program be administered and funded?

Likely will be difficult for each lab to specify an individual resource for instrumentation, due to (1) existence of LDRD (BNL at $150k top) is open for all field competitions; (2) fairness of science that other programs might ask lab to provide the similar resources. One possible solution is to identify certain % LDRD to this mission; however this will still run into the situation (2).

Task: A national instrumentation fellowship program.

Rationale: support training of young scientists in instrumentation

What the taskforce will evaluate

Please comment on the suggestion that a national instrumentation fellowship program be created by the NSF and DOE and Industry for Ph.D. students and postdoctoral scholars to encourage and support research in instrumentation. How should industry be involved and what industries should be targeted?

A possible model: create high--- stipend fellowships with travel budgets to be tenable at National labs and universities. Competitive proposals would determine where the fellowships were located. The successful institutes will then be responsible for filling the fellowship through an advertisement. Some fellowships might be sponsored by Industry in reciprocation for access to instrumentation schools (see below). Already at the March HEPAP meeting DOE and NSF officials indicated interest in the idea of national instrumentation fellowships.

Task: Instrumentation school

What the taskforce will evaluate

The accelerator community has a dedicated accelerator school with academic credits. The recent EDIT school for instrumentation and technology at CERN was a great success where academia and industry sent members of their staff to attend. What are the thoughts of the committee members on establishing an EDIT style instrumentation school at the US labs (possibly rotating between them), possibly with academic credits. How would the school be organized?

The instrumentation fellowship and school could be combined together. An instrumentation (summer) school is a useful tool to emphasize the importance of detector R&D (but somehow there might be several topics that will be overlapped with others summer schools). For instance, the Nuclear Summer School supported by ONP. It's operated every summer at BNL (east) and at San Jose State Univ (west) taking 12 students each. It's very competitive due to (1) stipend of $4,000, (2) credits granted by participated universities. The universities and labs also provide lodgings. There is a national committee of selection.

The instrumentation summer school should can follow the mode; but not be limited to students only. We should extend to postdocs as well. The national fellowship program can then be added to this summer school by selecting the 1~2 candidates from the participated students/postdocs. The reward could be a sponsored trip to its following APS national meeting. The key will be to get DOE/NSF to sponsor.

Task: Interdisciplinary

What the taskforce will evaluate

Please comment on the relative importance of developing strategic links to, for example, nuclear physics, materials science, condensed matter physics, and electrical and computer engineering both in academia and in industry to the future of HEP instrumentation as the complexity of our experiments increases. How might these links be developed and sustained?

The current detector R&D is somehow linked to other fields already including nuclear physics, instrumentation, etc. Our last workshop had some participatants from these fields and some R&D funding to support the researchers from these fields. A yearly workshop invited the ONP persons to co-organize will help. The main issue could be will this dilute the resources if only OHEP provides the R&D funding? Unless the ONP or other offices are willing to combine their resources or there are new funding, this invitation will be risky.

Task: A national prize

What the taskforce will evaluate

The APS has the annual Sakurai prize for theoretical particle physics and the annual Panofsky prize for experimental particle physics. What are the committee's thoughts on the establishment of a named prize for instrumentation in experimental high energy physics? Is there a benefit to having a medal versus a prize? To guide the discussion see the APS webpage on prizes and medals:

http://www.aps.org/programs/honors/taskforce/index.cfm
Note: the Panofsky Prize has been awarded for the development of instrumentation several times.

It might be an idea to encourage participation; but could be overlap with other prizes. If we specify, will that make the Panofsky prize, which is well-established already, exclusive to our instrumentation members?

Ron Lipton

Dear Ian and Marcel,

Thank you for soliciting my input for the Instrumentation Task Force. Even more than most other fields of science Experimental Particle Physics has always been driven by its instrumentation. In contrast to other fields, we have also always had a significant role in developing and deploying that instrumentation. Particle Physics has evolved on many ways over the past 20-30 years, and instrumentation is no exception. We have to deal with larger scale experiments, declining university infrastructure, costlier development, and very long time intervals between experiments. The latter problem is very serious for instrumentation development. Whereas in the past a new idea could be conceived, developed, and deployed in experiments in a few years (proportional chambers, liquid argon calorimeters…) this is no longer the case. Laboratories (especially Fermilab) had in the past focused their development efforts on specific experiments with less effort devoted to detector R&D. With the long interval between experiments technology development as a specific focus and enabler of new physics has become even more important. An environment that fosters and rewards this work has to be developed.

The teams that built the large scale collider detectors had a unique blend of experience, scientific and technical judgement, and a range of skills that spanned the mechanical, electronics, and sensor realms. The HEP community has unique expertise in electronics, sensors, and their mechanical integration. We will only be successful in the future if that mix is sustained. It is critical that a core of the next generation of physicists are as familiar with an oscilloscope or stress modeling or trapping centers in semiconductors as they are with C++.

The only way to really understand a technology is to apply it to experiments. Given the interval between applications in HEP, work outside of the field will be increasingly important. This includes applications to x-ray imaging, medical applications, and focal plane arrays. The opportunity to apply new technologies developed in HEP to these areas is important, not only because of the intrinsic merit of the work, but because we need to keep the teams needed to build the next generation of detectors coherent and active.

Addressing more specific Issues:

Targeted Resources at National Labs

I have felt for some time that the interface between the national labs, Fermilab in particular, and universities or other laboratories for detector R&D has not been optimal. Historically collaboration has been focused on specific experiments. Attempts to engage laboratory resources for university-initiated detector R&D had no clear model, and in several cases has failed. Issues in forming such collaborations include access to engineering resources, outside vs inside priorities, interface between engineers, technicians, and outside scientists and, of course, funding.

I had suggested several years ago, that a "Detector and Electronics" center be established at Fermilab. Such a center would serve as a focus and point of contact for groups wishing to use Fermilab resources to develop new detectors, electronics, and mechanical systems for HEP. The center would provide a "point of contact" where external researchers could request laboratory resources for R&D projects. Such a center would have a budget specifically targeted towards funding effort for engineers and technicians engaged in externally initiated R&D. The center would also be a focus for external scientists to form collaborations with laboratory staff. Some externally funded efforts, such as specific chip development or silicon detector fabrication would also go through this center. Management of the center would be charged with allocating effort among applying projects, setting priorities, and insuring that there is good contact between the technical effort and the scientists. Of particular concern is the ability to maintain priority of these projects with competing internal efforts.

This center could also be a point of contact outward. For example Fermilab has no internal semiconductor fabrication facilities. However many universities and national laboratories have sophisticated nanofabrication facilities which could be used in joint R&D projects.

National Instrumentation Board

A National Instrumentation Board, on its face, seems to have some appeal, but I have some concerns about a national board overseeing all HEP instrumentation research. There are many conflicting interests in instrumentation. The LHC experiments are a large portion of the national effort and house many innovative efforts, they will certainly have a strong voice and need to have some autonomy. Most national labs (with the exception of Fermilab) have their own internal LDRD funds which are internally directed. Laboratories will promote areas of R&D for specific parts of their programs (neutrino detectors, high intensity experiments …). These interests have to be balanced with smaller R&D efforts. Do we expect a board with sufficient power and authority to maintain a reasonable balance? Does this further diminish the power of the laboratories to define their own programs? How would the board interface with the funding agencies? I suspect the board would have little effect unless empanelled by the funding agencies.

A board advisory to the DOE/NSF which is charged with reporting on the state of R&D and recommending priorities may make sense in the short term. Such a board would not directly allocate funds, but could advise the agencies on imbalances and suggest priorities. A more formal role could evolve if the agencies and the field as a whole finds the advice useful.

A national instrumentation fellowship program.

I think this is a very good idea. National recognition of the importance of instrumentation and development of young talent are both worthy goals. The fellowships need to be accompanied by appropriate funding. I suspect significant industrial support will be difficult to obtain.

Instrumentation school

The recent CERN EDIT school was a significant success. It also took a substantial effort which will be hard to duplicate at the Fermilab school next year. The best school for HEP instrumentation is the test beam. Emphasis should be place on supporting students to participate in test beam studies and, where possible continue their work at Fermilab and SLAC test beams. A set of "generic" studies, such as the measurement of radiation lengths of new composite materials or assemblies to be placed into experiments using either scattering or conversions could both be used by students to gain experience, and provide real data for reference for future experiments.

Thanks again for soliciting my opinion, and best of luck in your work.

regards,

Ron

Steve Holand

Input to APS Taskforce on Instrumentation: Steve Holland, Lawrence Berkeley National Lab, 26April2011

1) National Instrumentation Board

Is there a need for a national body to evaluate and/or promote the national instrumentation R&D program? What are the processes for evaluating and promoting the national R&D program through a standing body? Please suggest under which auspices such a body might be organized and indicate possible reporting strategies. Please comment on the appropriate role for a standing panel in the instrumentation R&D programs for upgrades to existing projects and future projects. What are the advantages and disadvantages of creating a National Instrumentation Board.

I think there is a need for a national board to promote some of the other items that are under consideration, such as the fellowship program and the instrumentation school. I would think this board would be a part of HEPAP given the expressed interest in expanding University and National Laboratory collaborations. I'm not so clear if the same board should be evaluating the program. It seems that the program evaluation should the direct responsibility of the funding agency.

2) Targeted Resources at National Labs

Might targeted resources be established at each of the five national laboratories in order to specifically support particular instrumentation R&D needs of individual researchers at the universities and the laboratories? This will be in several forms: engineering design time and specific resources for small-scale collaboration among and between university and laboratory scientists. How might such a program be administered and funded?

This seems somewhat challenging to implement in practice. The resources at the National Labs are scarce to begin with, and small-scale collaboration might not receive much support. I suppose the Labs could recognize their particular specialties and develop formal centers of excellence for a particular detector niche that then could attract good ideas and the necessary funding to implement them.

3) National Instrumentation Fellowships

Please comment on the suggestion that a national instrumentation fellowship program be created by the NSF and DOE and Industry for Ph.D. students and postdoctoral scholars to encourage and support research in instrumentation. How should industry be involved and what industries should be targeted?

I would support the idea of fellowships to encourage students to be involved in detector R&D. A formal, competitive program with stable funding could generate more interest from National Laboratory groups to bring in students. I have some questions on how appealing it would be for a doctoral candidate to completely specialize in detectors, or if it makes more sense to have the fellowship be a of a 6 month to 1 year duration at a National Lab where the student performs detector R&D while maintaining some effort on the HEP topic of the dissertation. We have had post-doctoral scholars spend time in our detector R&D group while also working in a science area, and I believe that has worked fairly well.

I'm not sure how to get U.S. industry involved. I am aware of a university-based center in the UK to promote electronic imaging with e2v being the industrial sponsor. See

http://www.e2v.com/news/the-open-university-and-e2v-announce-the-opening-of-the-e2v-centre-for-electronic-imaging-/

There is also a similar Canadian effort I'm aware of. See

http://www.dalsa.com/semi/technology/researchcenter.aspx

Perhaps these could serve as models for a means to get industry involvement.

4) Instrumentation schools

The accelerator community has a dedicated accelerator school with academic credits. The recent school for instrumentation and technology at CERN was a great success where academia and industry sent members of their staff to attend. What are the thoughts of the committee members on establishing an instrumentation school at the US labs (possibly rotating between them), possibly with academic credits. How would the school be organized?

An instrumentation school could be an effective way to expose more HEP students to detector R&D. I would think given the HEP emphasis here the school could be organized in terms of topics by the major components of a HEP detector (tracker, calorimetry, etc) with additional emphasis on common areas such as analog signal processing. Other areas of interest such as astrophysics and homeland security should also be considered. There has been an effort in this area with emphasis on nuclear physics. See

http://ssrdm.berkeley.edu/Flyer_SSRDM.pdf

Geoff Taylor

Task: A National Instrumentation Board.

What the taskforce will evaluate

Is there a need for a national body to evaluate and promote the national instrumentation R&D program? What is the need, merit and process for evaluating and promoting the national R&D program through a standing body. Please indicate possible reporting strategies and suggest the auspices under which such a body might be organized. Please comment on the appropriate role for a standing panel on Instrumentation in the instrumentation R&D programs for upgrades to existing projects and future projects.

> With the long cycle-time for new experiments, and the need for large experiments to have multiple upgrades throughout their life-cycle, a supported instrumentation program attached to experiments would have merit. The experiments could provide assessments of the work (along with independent assessors). Proposals might need to require the experiments to participate in some essential way.
>
> It is important for the participants to see the fruits of their labours being closely reviewed by the experiments, so that their work has a chance of being taken up in an upgrade process. Thus close interaction with the experiment collaborations would be quite important.
>
> There are smaller or shorter term experiments as well of course, but I focus on the dual problem that large experiments face: long time-scale, large, expensive upgrade technology development cycle; and the ability to maintain hardware expertise and facilities when the emphasis is on data-taking and analysis.
>
> Another aspect of an instrumentation program is "blue-sky" techniques and technologies being developed without a specific application or targeted experiment. I assume that this is dealt with in a more general way with various existing funding agencies and programs?

Expert advice

Experts from Europe and Asia provide a short written account of whether instrumentation boards exist on their continents and how they function. If they do not exist, has there been discussion in the past about creating such bodies? This information will be relayed to the taskforce at the first meeting.

> There is no such board in Australia. A broader instrumentation board, going beyond particle physics could be appropriate with the relatively small HEP community here.

How the taskforce will proceed

Form a subgroup of taskforce members and consultants to develop a proposal. Taskforce members may volunteer for this task before our first meeting. We will make assignments prior to the meeting. Members from industry will be added to this task after it has been relatively well---developed. The subgroup will begin its work after the first meeting of the taskforce.

Task: The creation of targeted resources at national labs for detector R&D, and the scale of those resources up to fully---fledged detector R&D center(s) at National Labs.

What the taskforce will evaluate

Might targeted resources be established at each of the five national laboratories in order to specifically support particular needs of individual researchers at the universities and the laboratories? This will be in several forms: engineering design time and specific resources for small---scale collaboration among and between university and laboratory scientists. How might such a program be administered and funded?

> Engineering support is essential for getting beyond a proof of principle. For a technology to be tested for real applicability and usefulness, all the required services, and full environment/operation testing needs to be carried out. This part of the development is what is often beyond the capability of small university groups. Having targeted support to carry out these aspects at a national laboratory (especially with cooperation of potential target experiments) would be essential if the program was to have useful outcomes.

Method of developing the discussion prior to the meeting

Each lab representative will arrange for a brief written description to be provided of what currently exists at the labs to support instrumentation including LDRD funding and how it might evolve in the next five years.

The chairs will ask some rank and file lab and university folks to write down their thoughts on the topic. They will also be given the taskforce charge and a copy of this memorandum and asked to comment on any other area of the work of the taskforce, or areas not covered that should be. The members we will ask include:

Expert advice

Experts from Asia and Europe provide an account of what National Labs on their continents provide for instrumentation R&D and who has access to those resources.

> In Australia, much of significantly funded instrumentation development is directly associated with approved and funded scientific projects. Other such funded developments are often aiming at a commercial outcome and supported within one of our research centres. The national "laboratory", CSIRO, has some generic instrumentation development programs but most projects are allied with specific programs requiring specific tools. Thus the resources being applied to instrumentation development are generally not made widely available to the broad research community. There is a move to develop more shared national research facilities in Australia, but these do not impact much on support of new instrumentation development.

How the taskforce will proceed

At the meeting the chairs will summarize the responses. In addition all responses will be made available to the taskforce. A subgroup of taskforce members and consultants will be formed to consider the input and develop a model that could range from modest targeted resources up to an R&D center for detector development. Taskforce members may volunteer for this task before our first meeting. We will make assignments prior to the meeting. Consultants for this task are likely to be drawn from the list above. The subgroup will begin its work after the first meeting of the taskforce.

Task: A national instrumentation fellowship program.

Rationale: support training of young scientists in instrumentation

What the taskforce will evaluate

Please comment on the suggestion that a national instrumentation fellowship program be created by the NSF and DOE and Industry for Ph.D. students and postdoctoral scholars to encourage and support research in instrumentation. How should industry be involved and what industries should be targeted?

> Again, it is essential for the future of (most) such fellowship recipients (at least from NSF and DOE), who are looking for a career in particle physics, to be recognized through experiment collaborations that are evaluating or applying the technologies and instrumentation being developed. Moving within the HEP community and between instrumentation development and data analysis would be essential for young people to stay in the field.
>
> Industry based fellowships will presumably have a more targeted set of objectives relevant to the supporting industry, and capable of make a commercial return for the company, either directly or through the skills developed that can be more generally utilized in industry. A program of this sort will attract a different group of people than the particle physics based proposed fellowships. The programs should reflect this difference.

A possible model: create high---stipend fellowships with travel budgets to be tenable at National labs and universities. Competitive proposals would determine where the fellowships were located. The successful institutes will then be responsible for filling the fellowship through an advertisement. Some fellowships might be sponsored by Industry in reciprocation for access to instrumentation schools (see below).

Expert advice

Experts from Asia and Europe provide an account of fellowships and other instrumentation opportunities on their continents as may exist.

> In Australia, no specific instrumentation fellowships exist. However, many post-docs on federally funded research fellowships participate in instrumentation development as part or all of their work. This usually occurs as part of a project aimed at developing instrumentation for a specific scientific, medical or commercial outcome, rather than for instrumentation development in its own right. There are industry-based research fellowships (not specifically in instrumentation, but often including some such developments), partially supported by companies. These are often associated with a program within a research centre. Industry thus gets access to the larger expertise of the centre, not just to the instrumentation or technique being developed within the fellowship. This makes the industry more amenable to carrying part of the fellowship costs.

How the taskforce will proceed

Form a subgroup of taskforce members and consultants to develop a proposal. Taskforce members may volunteer for this task before our first meeting. We will make assignments prior to the meeting. The subgroup will begin its work after the first meeting of the taskforce. Already at the March HEPAP meeting DOE and NSF indicated interest in the idea. The subgroup will begin its work after the first meeting of the taskforce.

Task: Instrumentation school

What the taskforce will evaluate

The accelerator community has a dedicated accelerator school with academic credits. The recent EDIT school for instrumentation and technology at CERN was a great success where academia and industry sent members of their staff to attend. What are the thoughts of the committee members on establishing an EDIT style instrumentation school at the US labs (possibly rotating between them), possibly with academic credits. How would the school be organized?

Idea: EDIT school has attendance by a few members from industry. EDIT offers a far higher level of product than the National Instruments Labview Courses Industry for example is willing to pay for. Advertise the school to industry. Two options

(a) Ask industrial partners to pay to attend the school. Use proceeds to partially support national fellowships in instrumentation named after the donor company.

(b) Or, probably more effective at generating goodwill and support (and independent voices for our field in Washington), offer the school free but subsequently when the national fellowship program from DOE and NSF is put into effect, ask companies who have benefitted from the school to sponsor some fellowships with their company name being attached to the fellowship.

Method of developing the discussion prior to the meeting

We will appoint consultants, we are hopeful Ariella Cattai and Adam Para will agree to serve. We will request that they provide a brief description of EDIT ahead of the meeting and to address the committee on their vision for how the school should evolve at the first meeting.

Expert advice

Experts from Asia and Europe provide perspectives on instrumentation schools on their continents in written form before the meeting to supplement the information from EDIT.

> Through IUPAP-C11 we are following the development of EDIT. I think a program of schools even for PhD students and early career post-docs who are working on analysis in existing experiments, is a good idea. In fact, Ariella proposed EDIT in part because HEP experimentalists joining LHC experiments now, most often only "see" the hardware from the control room monitors, orin trying to understand calibrations or systematic errors. The schools broaden the education of these people who, through no fault of their own, might go through many years, even a whole career, as experimentalists who have never really worked on instrumentation. This is again due to the very long time-scales involved, and no doubt forms part of the reason for pushing for a taskforce.

How the taskforce will proceed

At the first meeting form a subgroup working with the consultants to develop a proposal. Consultants will include Ariella Cattai and Adam Para and William Trischuk, and folks from industry and other disciplines. Taskforce members may volunteer for this task before our first meeting. We will make assignments prior to the meeting. The subgroup will begin its work after the first meeting of the taskforce.

Task: Interdisciplinary

What the taskforce will evaluate

Please comment on the relative importance of developing strategic links to, for example, nuclear physics, materials science, condensed matter physics, and electrical and computer engineering both in academia and in industry to the future of HEP instrumentation as the complexity of our experiments increases. How might these links be developed and sustained?

Method of developing the discussion prior to the meeting

The co-chairs will solicit the perspective of the multi---use labs (including FNAL) from the lab reps on the committee.

Expert advice

Experts from Asia and Europe provide perspectives on interdisciplinary links and the relations with industry on their continents in written form before the meeting.

> It is very hard to foster substantial links with other fields based on generic ideas for instrumentation. Better to follow the path of necessity as it arises.
>
> However, exposure to techniques and technologies, through conferences, schools, visits and exchanges is quite important to broaden the knowledge base within particle physics.

How the taskforce will proceed

Form a subgroup of taskforce members and consultants to develop a proposal. Taskforce members may volunteer for this task before our first meeting. We will make assignments prior to the meeting. Members from industry will be added to this task after it has been relatively well developed. The subgroup will begin its work after the first meeting of the taskforce.

Task: A national prize

What the taskforce will evaluate

The APS has the annual Sakurai prize for theoretical particle physics and the annual Panofsky prize for experimental particle physics. What are the committee's thoughts on the establishment of a named prize for instrumentation in experimental high energy physics? Is there a benefit to having a medal versus a prize? To guide the discussion see the APS webpage on prizes and medals:
http://www.aps.org/programs/honors/taskforce/index.cfm
Note: the Panofsky Prize has been awarded for the development of instrumentation several times.

Method of developing the discussion prior to the meeting

Invite Alan Chodos or other APS officials to provide their thoughts on the topic. Get input from the Asia Team and Europe Team on whether such prizes exist (in written form before the meeting.)

Expert advice

Experts from Asia and Europe provide perspectives on national prizes in their continents in written form before the meeting.

How the taskforce will proceed

At the first meeting form a subgroup of taskforce members and consultants to develop a proposal. Taskforce members may volunteer for this task before our first meeting. We will make assignments prior to the meeting. The subgroup will begin its work after the first meeting of the taskforce. If a recommendation is made to create a prize it will be important that a plan for funding the prize also be included. One possibility to consider is industrial sponsorship.

Tatsuya Nakada

Lausanne, 1 May 2011

Input for APS/DPF Instrumentation Taskforce

T. Nakada, ECFA Chair

Instrumentation Board and National resources

For the LHC project, DRDC, a dedicated review committee for the detector R&D was set up by CERN first, well before the proposals for the experiments. It dealt with R&D proposals in a wide area needed to design detectors capable of taking data in the very high luminosity environment of LHC. Funding of the approved R&D proposals was done in the same way as normal CERN experiments, where all the participating institutes requested support to their national funding agencies. A similar evolution is expected for the detector upgrades for the SLHC, where the LHCC at CERN will review and monitor the R&D activities.

For detector R&D needed for other large facilities under consideration, such as high energy e^+e^- linear colliders and high intensity neutrino beams, there are no host laboratories that could naturally establish such a committee. For the case of the International Linear Collider, DESY Programme Review Committee agreed to receive reports regularly from the groups working on the various detector R&D activities including those without any involvement from a DESY group, responding to the wish by the ICL experimental community. However, there was a general feeling that a European review body for those detector R&D activities would be needed.

The European Committee for Future Accelerators (ECFA), established in 1963, is a particle physics community organization composed of delegates from the every CERN member countries. In November 1010, it has decided to set up an ECFA panel to review detector R&D proposals. It will receive proposals from groups working for detector R&D projects, in voluntary bases, review them, and make recommendations. The proponents can then use the recommendations for their funding negotiation with their national funding agencies. If proposals were funded, the panel would follow the progress by receiving reports regularly. Since ECFA has no funds, it will function as an advisory body to the national funding agencies, and keeps track of various R&D activities in Europe. It does not intend to steer the direction of R&D. ECFA is now in the process of appointing the panel chair and members so that it could become operational by the autumn 2011.

Fellowship programme

At CERN, "doctoral student" and "applied fellow" programmes are dedicated for the technical area of works such as instrumentation, accelerator, computing, and neither for experimental nor theoretical particle physics works. For the doctoral student programme, supervisions are given jointly by the CERN physicists and academic members of the universities where the doctoral degrees are awarded.

Instrumentation school

Europe has been actively contributing to the ICFA Instrumentation School. Since 2009, Instrumentation Working Group of the EIROforum, consists of 8 European laboratories (CERN, EFDA-JET, EMBL, ESA, ESO, ESRF, European XFEL, and ILL), has been organising one week long biennial EIROforum School on Instrumentation.

Wesley Smith

Dear Ian and Marcel:

I appreciate the opportunity to as a national advisor to the American Physical Society Division of Particles and Fields Taskforce on Instrumentation. I provide my comments below on the topics provided in your letter.

Best regards,
Wesley

Task: A National Instrumentation Board.

It is not clear that this is needed. Instrumentation should be driven by the mission and program needs and not operate as an independent program. Instrumentation and detector R&D should be integrated in the planning and funding of the DOE HEP experiments and facilities. Funding for instrumentation and detector R&D should be restored to University groups with an interest and track record in working in these areas. In comparison, the labs have sufficient resources in house with some redirection to satisfy instrumentation and detector R&D needs.

Task: The creation of targeted resources at national labs for detector R&D, and the scale of those resources up to fully---fledged detector R&D center(s) at National Labs.

Substitution of resources centralized at Labs for University resources does not work for many reasons and should not be done. First, the source of much of the creativity and advance in detector R&D and instrumentation is centered at the Universities. The engine that drives the most creative programs is the daily partnership between a University Faculty member and his/her team of scientists, postdocs and students and an engineering staff in a well-instrumented University lab. Centering the engineering resources in the national labs breaks this partnership. Substituting paid Lab staff supervision of an engineer for a University supported faculty member is not cost effective. Supporting engineers and facilities for R&D at a National Lab is also not as cost effective as at a University, particularly since the cost of the engineer and the lab equipment is often partially paid by University funds and almost the entire infrastructure is. If Universities are forced to seek engineering and R&D resources at national labs, they are "second class citizens" in competing for these resources with national lab personnel, usually not having access to the best engineers nor facilities, only those available after lab personnel needs were satisfied. This was documented in many cases of testimony to the HEPAP University Grants Program Subpanel[1].

If a partnership is sought between Universities, then the shared resource is much better distributed among then or better placed at one of the Universities. Finally, one of the major portals into a career of scientific research is the opportunity for undergraduates to work in labs of University researchers and Faculty at the same place as they take their classes and often with the same people who teach them. Programs supporting undergraduates for summer research or other visits at National Labs are useful but are no substitute in terms of access nor influence for having an active research program in a lab on campus. All of these points are documented in the HEPAP University Grants Program Subpanel Report.

[1] http://science.energy.gov/~/media/hep/pdf/files/pdfs/ugpsreportfinaljuly22_2007.pdf

In specific cases where the R&D or prototyping is beyond the capabilities available at collaborating universities, then having the R&D centralized at a national lab is appropriate and effective. However these cases are not the most common.

The internal lab programs using LDRD funds are generally good and effective within the labs and should be encouraged as a way of supporting research within the labs. Just asking for input from lab personnel is not going to provide a correct picture of the role of centralized lab R&D resources applicable to Universities. Asking for input from European Labs, where in some cases, the Universities have been made completely subservient and dependent on the Labs, even for funding, is not going to yield an appropriate perspective for U.S. Universities.

Task: A national instrumentation fellowship program.

This is an excellent idea. There should be a program with stipends to support University postdocs and students who are working 50% of their time on instrumentation with additional support to attend instrumentation conferences and schools. In order for their careers to successfully progress, postdocs and students should be spending time on physics analysis, so requiring full-time work on instrumentation is unrealistic. However, providing the encouragement of a fellowship that requires 50% effort on instrumentation would be effective in promoting expertise in instrumentation among physicists who have prospects for a successful career. Some of these fellowships could be awarded to postdocs at national labs, but these are less needed due to the presence of much instrumentation infrastructure and personnel at the labs. A truly interested postdoc or student resident at a national lab has plenty of personnel, instrumentation talks and facilities available.

Task: Instrumentation school

This is a good idea. Having instrumentation and detector R&D schools sponsored by the national labs will provide an important opportunity to train students and young postdocs. One should be careful about embracing and focusing too narrowly on specific technologies that may not be applicable in the future. The emphasis should be on producing technically savvy postdocs and students who are able to take advantage of the latest technology advances over the scope of their career and not generating expertise in a narrow area. Therefore the focus should be less on industry than on general particle physics technologies that will be important for the future because they have a roadmap for development that shows benefits for future particle physics instrumentation as well as being useful at present.

Task: Interdisciplinary

It is very important to develop and nurture strategic interdisciplinary links. Fortunately, University researchers have these links already within their physics departments and there are many incentives to submit interdisciplinary research proposals across departments and schools on University campuses. The best way to improve strategic alliances is to support and encourage University researchers to strengthen these ties and to partner with national lab personnel in multi-disciplinary programs. The traditionally multi-purpose labs such as Argonne and Brookhaven also provide extensive opportunities for interdisciplinary research. The most profitable way to nurture interdisciplinary links is to devise projects that offer compelling research for both parties,

for example, where students from each discipline can perform thesis research in their own area while collaborating. Examples of this are found in grid computing, radiation hard silicon sensors and electronics, field programmable gate array designs and radiation hard scintillators.

Task: A national prize

This is an excellent idea. The existence of a prize and the attention surrounding it will elevate the perception of working on instrumentation. Awarding this prize will point out experimental results that would not have happened without the instrumentation work leading up to them. It will share the credit for important results beyond the final physics analysis. It will send the message to young physicists working on instrumentation that the significance of their work is recognized and appreciated. The explicit focus on instrumentation will have a more salubrious result on the field of instrumentation than the occasional awarding of the Panofsky Prize for development of instrumentation, even though such awards have certainly been most helpful.

Su Dong

Hi Ian, Marcel,
Here are my inputs to the task force.

First of all I'd very much like to support the establishment of this task force and express some general opinions although I suspect they are pretty much known to everyone. It is very worrisome that the >opportunities and access for young people in our field to detector instrumentation is in the decline while we are facing the challenge of building increasingly complex detectors with very long time cycles. It is still more worrisome that while at least in Europe doing instrumentation theses are a common practice while it's harder in the US to define a coherent career path to prominence for young people >interested in instrumentation. I must admit that because of that difficulty, I also avoided encouraging students/postdocs to embark on extensive detector R&D efforts myself because of the career path difficulty. My impression of the tendency of US funding for detector R&D also noe have much more emphasis in support of short term construction with perhaps insufficient recognition that our competitiveness in engaging in such short term detector construction/design has taken a great deal of benefits from the blue sky long term R&D from some time ago that we must also continue to support strongly to assure our competitiveness in the future.

I will comment on the various specific tasks below:

a) National Instrumentation Board: Not sure how to weigh the pros and cons for this. Such a board can clearly promote the prominence of detector instrumentation and can potentially provide coordination for more effective use of resources. However, this can also potentially be another layer of bureaucracy. The effective management can be quite complex and hopefully will not impede raw grass root new ideas.

b) Targeted R&D resources at national labs: this is an interesting idea and I also know real examples where this can make great sense. A strong group of people with closely related expertise can produce a positive snowball effect that they attract more demand of their service, sometimes outside HEP, so that they typically can serve many experiments simultaneously by applying the combination of skills in the group efficiently with effective communication and organization that is harder to replicate with scattered resources at the same efficiency. The breadth and fast turnaround of projects covered by such as large group also nurture the skill and knowledge buildup of everyone in the group in a faster pace. However, heavily relying on the concentration of a particular area in one location would also put more serious demand on very effective management to ensure the success as the opposite could cause also a boarder negative impact. To mitigate the risk, some preservation of quality R&D resources for a given area in a few places may be desirable to keep up the standard with some external cross check and allow more chances of new ideas to emerge while there can be clearly targeted concentration in one place.

c) National instrumentation fellowship: this is perhaps long overdue and can significantly help the prominence of the detector instrumentation effort among young people which is the most serious general concern I emphasized in my general remarks. However, this alone I am afraid is insufficient. There is a much larger scale issue of a coherent career path. If we encouraged a bright young person into this fellowship with a near term glory, but his/her peers concentrated their effort on physics analyses ended up with faculty jobs, what would be the next natural level for a young instrumentation specialist? National labs can perhaps host such positions, but it needs a way to establish the prestige of such position and commitment from DOE to strongly recognize such positions with priority with associated independent funding.

d) Instrumentation school: This is again a good idea, but the scope of the school and the teaching structure can be quite tricky to establish to achieve the desired effectiveness. I knew a recently started trigger & DAQ school in Europe which had issues in serving the interests of all the attendants at the same time as the students had very different skill levels. It is also an issue whether the school can really cover all areas each year or better to go by themes to rotate through different areas each year.

e) Interdisciplinary: This is probably all about the balance of mutual benefits. I know the concrete example of instrumentation resources shared with photon science at SLAC. It is great to see that the traditional HEP instrumentation experience lent powerful help in establishing experiments at LCLS in a new regime which photon science community is not familiar with, which is more like small experiments in HEP.

However, the opportunities to apply modern technologies for photon science is beneficial for the experience of the work force to take that experience back to HEP. The impact of the HEP instrumentation experience applied to a broader range of disciplines helps the spin-off side of justification for the HEP mission in any case. While it is helpful that most non-HEP applications have the advantage of faster turn-around compared to large HEP projects for exercising new technology from R&D, there is always the danger that the same people shared between those projects and large HEP projects with longer time cycles, can easily be more impressed by the urgency of other needs on a faster pace to make it more challenging to maintain the attention and priority for the HEP projects.