

# History and Motivation of LAPPD Project

Howard Nicholson  
December 18, 2012

In 2008, HEP DOE Associate Director Dennis Kovar decided that the KA1503 budget category (Detector Development) should become a managed program with a DOE program manager. At that time I was an IPA at DOE and was asked to take over the KA1503 budget and to try to develop a coherent Detector R&D program.

In 2009 about \$25M was associated with this budget category with about \$20M going to the National Laboratories.

Some of the principles for the Detector R&D program that I developed developed were based on Energy Secretary Steven Chu's comments taken from Pat Dehmer's February 24, 2009 HEPAP talk.

**Priority: Science and Discovery**  
*Invest in science to achieve transformational discoveries*

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- **▪ Focus on transformational science**
  - • Connect basic and applied sciences
  - • Re-energize the national labs as centers of great science and innovation
  - • Double the Office of Science budget
  - • Embrace a degree of risk-taking in research
  - • Create an effective mechanism to integrate national laboratory, university, and industry activities

There were several DOE experiments which made use of large numbers of large area photomultiplier tubes to cover large areas (eg. Super-Kamiokande, Sudbury Neutrino Observatory), and one option for the Long Baseline Neutrino Experiment (LBNE) Detector at that time was a water Cerenkov detector with photomultiplier readout.

The following is from an email from me to Henry Frisch regarding the cost estimate of phototubes for a 300 kiloton water Cerenkov detector:

Email from H. Nicholson to H. Frisch, February 2009

Hi Henry,

Gina Rameika gave a talk at DoE several months ago and tried to cost out phototubes on a large detector. She used 10 inch phototubes. Per \$100 kiloton modules with about 20% coverage, she estimated 60,000 tubes at roughly \$1250/tube in November, 2008. This is \$75M/100 kilotons in FY08. People were talking about 300 kilotons minimum (\$225M FY08) with an ultimate goal of \$1M ton (\$750M FY08 dollars). This does not include installation costs, and one needs to include inflation. When you include them you get the higher number of about \$300M minimum for a 300 kiloton water Cerenkov detector. A factor of 3 in cost makes a BIG difference.

## Given:

- 1) the very large cost of photomultipliers to cover large detectors,
- 2) the fact that almost all photomultipliers are provided by a single manufacturer (Hamamatsu) so there is very little control over pricing, and
- 3) despite the importance of photomultipliers to many High Energy Physics experiments there is very little technical expertise about them in the United States High Energy Physics community,

it seemed that the development of a large area, cost effective photomultiplier would be an appropriate investment of KA1503 funds for DOE and would fit well into Steven Chu's focus on transformational science vision.

In addition, in 2009 there were ARRA funds which became available to fund new projects which could have significant impact on the future DOE – HEP program.

# DOE Detector R&D Program - March 2009

## ■ **Goals:**

- **Provide support for *planned future detectors and detector system development* within the existing or future HEP program (Microsystem Lab at LBNL- CCDs for Dark Energy, Large LAr Calorimeter R&D at BNL and Fermilab and Large Water Cerenkov detector development at BNL for DUSEL large detector, ASIC design at Fermilab and U. Penn for data acquisition, DUSEL R&D for small experiments, ILC Detector R&D to keep lepton collider detector R&D going.)**
- **Provide support for *unique and important capabilities* in the University/Laboratory system. (Test Beam at Fermilab, Microsystem Lab at LBNL, Mechanical Engineering and Electronics Design and Development throughout the Lab/University system.)**
- **Identify *new initiatives* which address existing problems or large future expenses. (ADR, Large photodetector development, possible water based liquid scintillator R&D, power and cable minimization for detector subsystems.)**

## Re: Large area photodetector workshop

Henry J. Frisch [frisch@hep.uchicago.edu]

You replied on 1/8/2009 5:16 PM.

Extra line breaks in this message were removed.

Sent: Thu 1/8/2009 5:13 PM

To: Nicholson, Howard

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Dear Howard,

We've got a draft agenda and list of speakers, and are just now (literally) getting the invitations out. We had hoped to get you an invitation at the beginning of this week, but are running a little behind.

The workshop will be Feb 26 and 27 at ANL, in conjunction with a (separate) 1-day workshop on PET at UC on the 28th (this has a separate organizing committee and will have a separate goal). We had originally planned it for mid-March, but have moved it up to accomodate your schedule.

Our organization of the agenda and clientele is very much in line with your charge. We're in the process of learning enough to make a credible schedule- my goal would be to have a commercial product within 5 years, meaning that we have proto-types and proof-of principle appreciably earlier. I think it's important to have the goal of commercialization built in from the start so that design and fabrication considerations are matched to the requirement of scaling from the start. We've already been in contact with companies interested in the `back-end' of the development- i.e. the commercialization. So, no need for a charge - unless you want to- we understand your need for a credible well-founded plan and schedule!

I'm really looking forward to this- we've identified a lot of expertise, and this workshop is focused on the device itself. The last one (6th in our series) was focused on the electronics, and I think by the end of it we convinced ourselves we understood the path to a solution. Hopefully this one will do a similar thing for the device, although we are much further behind in knowledge in this domain than we were in the electronics at the equivalent stage. There still is work to be done before we have confidence in the right path.

Best regards,  
Henry

Clearly, this was a **high risk, high reward** project. Reviewers were not convinced that the program would be successful without a much longer timeline, but there were no technical show stoppers that were identified.

There was expertise in three critical areas within the collaboration: Ossy Sigmund had considerable expertise in photocathode development, Argonne had considerable expertise in atomic layer deposition (ALD) which would be necessary in producing microchannel plate activation, and Henry Frisch and Gary Varner provided considerable expertise in readout electronics.

The proposed detector would be expected to have mm spatial resolution and time resolutions of order picoseconds. The good time resolution should be sufficient to provide reasonably good optical particle tracking in large detector systems and could be used to distinguish scintillation light from Cerenkov radiation.

Because of the potentially transformational characteristics of this detector both in cost and in technical characteristics, DOE decided to provide funding for three years.

Sentences from email from H. Frisch to H. Nicholson Feb. 2009

Requested

However, I hope I'm not publically put on the spot to make technical evaluations (i.e. cost and schedule) beyond the statements of process and good management, and the 3-year project and fixed budget. We have not done a budgeting process yet, and so I don't have a good sense of the risk/cost/speed curves (remember the old engineering adage, 'Faster, Better, Cheaper- pick any two'). From my visits and interactions with industry and the labs, I strongly believe that we can do this in 3 years within 3M\$/year, as we expressed in the LOI, and am willing to put my name to that. And after one year we will have a much reduced risk, as most of the uncertainty is in the first year and the start of the second, and if it doesn't look good then we can be shut off.

Note that the \$3M per year was assumed to be AFTER overhead.

- Large area photodetector R&D (~\$8M)
- Funding profile of photodetector

Funded

\$ in millions	FY09	FY10	FY11
Total	3.0	3.0	2.0
Base	1	1	1
Stimulus	2	2	1

Base funding here refers to DOE KA1503 base funding, not institutional base funding.

Henry J. Frisch [frisch@hep.uchicago.edu]

Extra line breaks in this message were removed.

Sent: Sat 8/8/2009 7:36 AM

To: Seiwright, Jennifer

Cc: Howard, Matt (ANL); Byrum, Karen; Pellin, Michael J.; McGregor, Stephen D.; Weerts, Hendrik Joseph; Guirguis, Nahed; Don Levy; Dalton, Roberta; Nicholson, Howard

Message |  1226\_001.pdf (197 KB) |  1225\_001.pdf (42 KB)

Dear Pecuniary People,

Tom Foley called yesterday evening to say that the paperwork was all done at the DOE office at ANL, and everything had been transmitted to the site office. He said that the funds should be in the accounts now or certainly by Monday.

He has been most helpful, and explained the process (to some extent), and tracked down our paperwork. I had no idea that the DOE office here was so big- the ANL site office (us) was just one of 600 contracts he is dealing with, including BNL, Fermilab, SLAC, etc. (he said a total of 4.7B\$).

Nahed- thanks for pointing me to him. He was the right one to ask.

Best regards,  
Henry

Because of administrative delays, initial funding did not arrive to the collaboration until mid August, 2009.