



Fermilab

Scintillator R&D Review

October 6, 2009

Committee Charge

R&D for HEP experiments in the US will have high priority for the next 5-10 years as we work to define the next generations of experiments that will push the boundaries of our knowledge in the energy, intensity, and cosmic frontiers. To that end, Fermilab needs to have a well-focused program of detector R&D so that the directions taken are appropriate, understood, and supported. PPD in collaboration with CD is organizing a series of mini-review/workshops to review the status, progress, and prospects for all known R&D efforts in the division.

Over the past 20 years, Fermilab has led development in a number of areas of scintillation detectors from scintillating fiber to extruded scintillator. However this development has slowed over the past few years due to loss of funding. In FY10, it is proposed that generic scintillator R&D resume starting with investigation of the feasibility of extruding scintillator around WLS fiber. We would like the review committee to evaluate the plans for this R&D. We would also like to start planning for longer term R&D in areas of solid and liquid scintillator. Since the plans for the long term are not yet well defined, we would like to engage the reviewers and others attending this meeting to participate in a discussion of what direction that research should take.

For the short term R&D, we would like to have of talks covering:

- What is the planned R&D and why should it be supported?
- What are the prospects for its use in future detectors?
- What is the specific plan for the next year?
- What is the level of financial and personnel resources needed for the next year or two?
- Where could this lead, on the »five year time scale, or in what experiment?
- At what point would this transition to detector specific or project work?

For the longer term planning discussion we would like to have a talk or talks to stimulate discussion about possible areas of investigation. These could include: neutron sensitive scintillator, water based liquid scintillator etc.

Our plan is to have a half-day mini-workshop whose outcome is a short report to the Division head covering the above questions. Please suggest an agenda with 2-3 hours of talks, including breaks, which address the above questions.

The workshop will be open to interested scientists at the lab and user community as well. Your research efforts are vital to the labs future, and we look forward to a very interesting and productive workshop.

The Committee

Giorgio Apollinari – FNAL/TD

Jerry Blazey - NIU/DOE

Ron Ray – FNAL/PPD

Richard Talaga - ANL

Findings

- Anna Pla presented the achievements of the FNAL-NICADD extrusion facility, also known as the Scintillator Detector Development Lab (SDDL). Anna described the time evolution of the facility, the production for existing projects (MINOS, T2K, Double-Chooz, etc.) and the various requests coming from possible experiments in the future (Mu2e, Frascati B Factory).
- The development of the extrusion facility has been a great success for Fermilab and is the acknowledged and preferred source of low-cost extruded scintillator for the HEP and nuclear communities. The technology of extruded scintillator bars clad in reflective material is truly a Fermilab product for which the laboratory should claim credit on the world scene.
- No major production runs are planned for the extrusion facility in the next two years. This provides an opportunity for a shift in emphasis from production back to R&D during this period.
- The extrusion facility lost key personnel (Victor Rykalin– detector physicist) and is on the verge of losing, through phased retirement, another major contributor to its success (Chuck Serritella – Mechanical Tech). In addition, Pla and Bross are both heavily engaged on other high-priority projects.
- Synergy and interplay with two die companies have been exploited and the die engineering effort has, appropriately, not been reproduced at Fermilab. The proposed R&D does not require scarce Fermilab engineering effort.
- An R&D program proposed for FY10 is to produce co-extruded scintillator and wavelength shifting fiber. The M&S cost has been estimated at \$80k. The new die (\$52k) and the fiber feeding system (\$15k) constitute most of the cost. Manpower needs were estimated at the level of 4 FTEs (2 Mech Techs, 1 QC Tech and 1 Eng Phys) for 3 months. Using average, burdened costs for these labor categories, the committee estimates that this amounts to approximately \$150k of labor.
- No timescale/schedule was presented beyond the desire to complete this work in FY10.
- Two additional R&D efforts were described; neutron sensitive scintillators (Li-loaded scintillator) and high-Z extruded scintillators (2% BaF₂). The customer base for these products is not as obvious as for the integrated scintillator/fiber package.

Comments

- The team led by Anna Pla is highly trained and qualified.
- The capabilities of the group are unique in the laboratory system and may be considered a component of Fermilab's core-competency in detector R&D and construction.
- The general extrusion scintillator R&D program could really benefit from a few Public Relations plots showing the performance (attenuation length, light yield, uniformity, etc.) and cost savings realized by the experiments that have built detectors using the facility. This will help to ensure that the value and reach of their efforts are fully appreciated when funding allocations are established.
- The scintillator extrusion program should be highlighted as unique rather than as a "standard production facility."
- The great success of this facility was made possible by R&D done nearly a decade ago. Little R&D has been done since that time due to the load placed on the group by production and the lack of R&D funds. The R&D that is now being proposed is necessary to seed production of the next generation of scintillation detectors that could benefit a wide array of future experiments.
- The lull in requests for production work in the next couple of years suggests that now is the time to consider new directions of the type that were presented.
- As part of the effort to make the R&D program at Fermilab more connected and coherent, and because it would result in a better final product, the scope of the R&D should be expanded to include incorporation of solid state optical detectors. This would bring together two significant R&D programs at Fermilab and increase the impact of both. The extruded scintillator/SiPM combination could become the new standard for scintillation based charged particle tracking and detection. This would require coordination with other PPD groups and facilities and would require support and guidance from PPD management.
- The absence of a detector physicist is clearly obvious. Studies of emission spectra, quantum efficiency curves, etc. are probably needed to make this a full- fledged R&D program. Such a person would be essential in order to expand the scope of the R&D to include incorporation of solid state detectors, mentioned earlier. It would also provide effort to optimize performance for various applications by looking at fiber size, dopant concentration, cladding, optical detector interface, etc.
- The total cost of the R&D program that was described to co-extrude scintillator and WLS fiber, including M&S, labor and overhead, is between \$200 - \$250k. This seems like a good investment given this group's track record and the

potential payoff.

Recommendations

- Independent of the R&D proposal, if the laboratory wishes to maintain the capabilities of the SDDL, a new lead technician should be identified to replace the existing technician who is in phased retirement. Some overlap between the two is essential.
- The laboratory should support the proposed co-extruded scintillator/WLS fiber project.
- The proposed R&D should be integrated into a wider laboratory effort to develop a standard charged tracking detector based on coextruded scintillator and SiPMs.
- An engineering physicist and a programmer should be identified to assist with the R&D.
- The proponents of this program should be asked to provide a more rigorous schedule and cost estimate - allowing for the nature of R&D as opposed to production.
- The proponents of this program should identify applications and customers for the neutron sensitive and high Z scintillator.
- Get credit for the outstanding work done so far. QA/QC results from the various detectors produced in the past should become part of every standard Lab 5 extrusion facility presentation.