Shashlik calorimeter option for EIC detector

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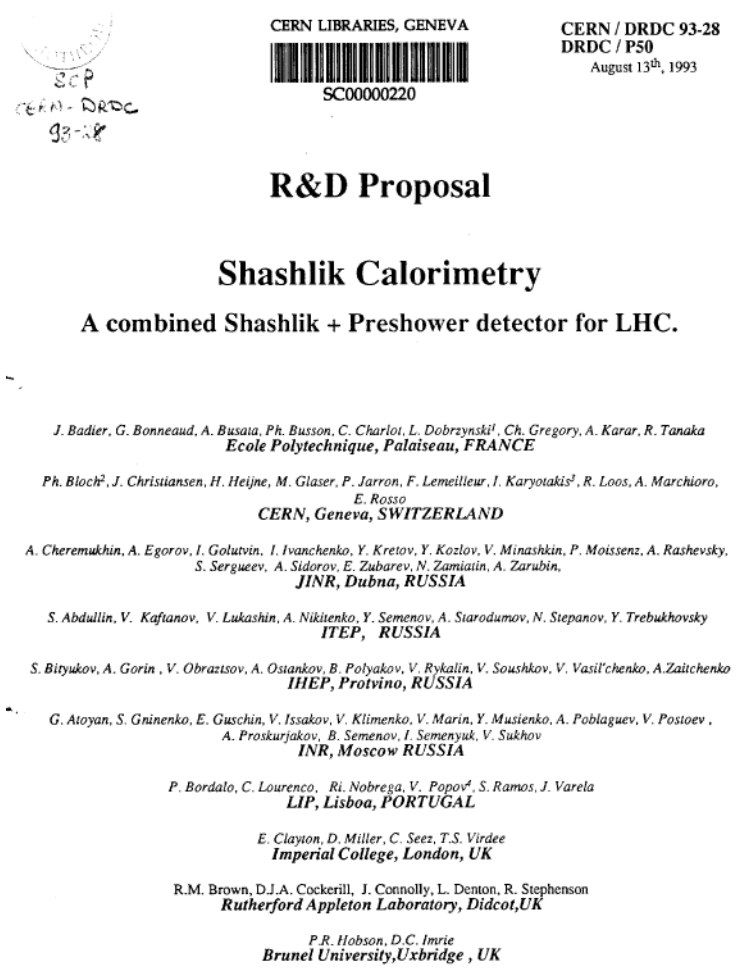
EIC Users Group Yellow Report
Working Group on Calorimetry

March 31, 2020

PbWO and shashlik calorimetry for LHC.

- CMS – PbWO
- ALICE- PbWO and shashlik
- LHCB-shashlik

Non LHC experiments:
NA-62 –shahslik
NA-64 – shashlik
NA-58/COMPASS –shashlik



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CERN / DRDC 93-28
DRDC / P50
August 13th, 1993

R&D Proposal

Shashlik Calorimetry

A combined Shashlik + Preshower detector for LHC.

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ITEP, RUSSIA

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G. Atoyan, S. Gninenko, E. Guschin, V. Issakov, V. Klimenko, V. Marin, Y. Musienko, A. Poblaguev, V. Postoev , A. Proskurjakov, B. Semenov, I. Semenyuk, V. Sukhov
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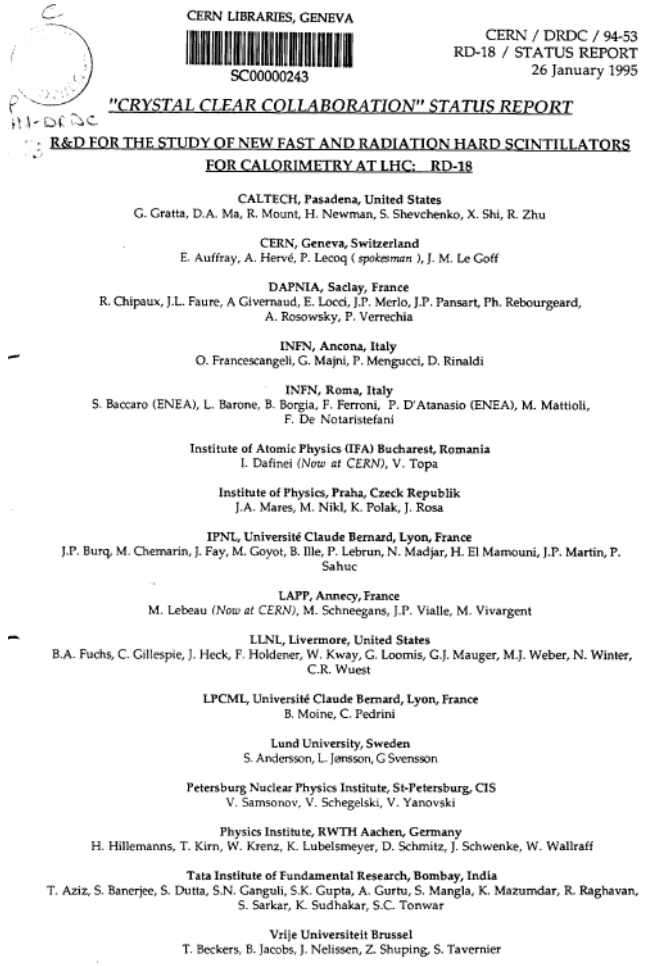
E. Clayton, D. Miller, C. Seez, T.S. Virdee
Imperial College, London, UK

R.M. Brown, D.J.A. Cockerill, J. Connolly, L. Denton, R. Stephenson
Rutherford Appleton Laboratory, Didcot,UK

P.R. Hobson, D.C. Imrie
Brunel University,Uxbridge , UK



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CERN / DRDC / 94-53
RD-18 / STATUS REPORT
26 January 1995

"CRYSTAL CLEAR COLLABORATION" STATUS REPORT

R&D FOR THE STUDY OF NEW FAST AND RADIATION HARD SCINTILLATORS FOR CALORIMETRY AT LHC: RD-18

CALTECH, Pasadena, United States
G. Gratta, D.A. Ma, R. Mount, H. Newman, S. Shevchenko, X. Shi, R. Zhu

CERN, Geneva, Switzerland
E. Auffray, A. Hervé, P. Lecoq (*spokesman*), J. M. Le Goff

DAPNIA, Saclay, France
R. Chipaux, J.L. Faure, A Givernaud, E. Locci, J.P. Merlo, J.P. Pansart, Ph. Rebourgeard, A. Rosowsky, P. Verrechia

INFN, Ancona, Italy
O. Francescangeli, G. Majni, P. Mengucci, D. Rinaldi

INFN, Roma, Italy
S. Baccaro (ENEA), L. Barone, B. Borgia, F. Ferroni, P. D'Atanasio (ENEA), M. Mattioli, F. De Notaristefani

Institute of Atomic Physics (IFA) Bucharest, Romania
I. Dafinei *(Now at CERN)*, V. Topa

Institute of Physics, Praha, Czeck Republik
J.A. Mares, M. Nikl, K. Polak, J. Rosa

IPNL, Université Claude Bernard, Lyon, France
J.P. Burq, M. Chemarin, J. Fay, M. Goyot, B. Ille, P. Lebrun, N. Madjar, H. El Mamouni, J.P. Martin, P. Sahuc

LAPP, Annecy, France
M. Lebeau *(Now at CERN)*, M. Schneegans, J.P. Vialle, M. Vivargent

LLNL, Livermore, United States
B.A. Fuchs, C. Gillespie, J. Heck, F. Holdener, W. Kway, G. Loomis, G.J. Mauger, M.J. Weber, N. Winter, C.R. Wuest

LPCML, Université Claude Bernard, Lyon, France
B. Moine, C. Pedrini

Lund University, Sweden
S. Andersson, L. Jønsson, G Svensson

Petersburg Nuclear Physics Institute, St-Petersburg, CIS
V. Samsonov, V. Schegelski, V. Yanovski

Physics Institute, RWTH Aachen, Germany
H. Hillemanns, T. Kirn, W. Krenz, K. Lubelsmeyer, D. Schmitz, J. Schwenke, W. Wallraff

Tata Institute of Fundamental Research, Bombay, India
T. Aziz, S. Banerjee, S. Dutta, S.N. Ganguli, S.K. Gupta, A. Gurtu, S. Mangla, K. Mazumdar, R. Raghavan, S. Sarkar, K. Sudhakar, S.C. Tonwar

Vrije Universiteit Brussel
T. Beckers, B. Jacobs, J. Nelissen, Z. Shuping, S. Tavernier

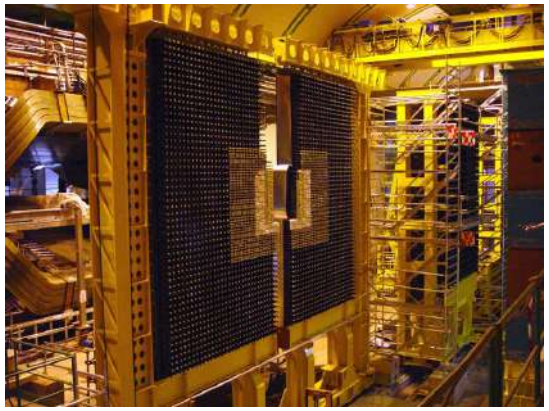
Why did CMS select PbWO?

- Space limitation with the magnet and the tracker.
- Only APD was a reasonable option of the photosensor with the strong magnetic field. APD required a temperature stabilization and was coplanar with PbWO
- ECAL endcaps were instrumented with photo triodes.
- The Crystal Clear Collaboration promised very radiation hard PbWO.
- PWO production was concentrated in one place with very tight control of CERN management.

LHCb shashlik calorimeter (was made with the experience of PHENIX and HERA-B)

Main parameters of the LHCb electromagnetic calorimeter.

	Inner section	Middle section	Outer section
Inner dimension, $x \times y$, cm^2	65×65	194×145	388×242
Outer dimension, $x \times y$, cm^2	194×145	388×242	776×630
Cell size, cm^2	4.04×4.04	6.06×6.06	12.12×12.12
# of modules	176	448	2688
# of channels	1536*	1792	2688
# of cells per module	9	4	1
# of fibres per module	144	144	64
Fibre density, cm^{-2}	0.98	0.98	0.44



Downstream view of the ECAL installed (but not completely closed) with the exception of some detector elements above the beam line.
Outer, middle and inner type ECAL modules (right).

$$\sigma_E/E = 10\%/\sqrt{E} \oplus 1\% \text{ (E in GeV)}$$

[16]TYVEK of type 1025D used, product of E.I. du Pont de Nemours and Company.
[17]Polystherene in pellets, Polystyrol 165H, [Cn Hn], product of BASF AG, Badische Anilin- & Soda Fabrik Aktienge-sellschaft, Carl-Bosch-Strasse 38, D-67056 Ludwigshafen, Germany, mailto:global.info@basf.com.
[18]PTP, p-Terphenyl, 1,4-Diphenylbenzene, [C6 H5 C6 H4 C6 H5], product of FLUKA(TM), Sigma-Aldrich Chemie GmbH, CH-9470, Buchs, Switzerland, mailto:fluka@sial.com.
[19]POPOP, 1,4-Bis(5-phenyl-2-oxazolyl)benzene, [C24 H16 N2 O2], product of FLUKA(TM), Sigma-Aldrich Chemie GmbH, CH-9470, Buchs, Switzerland, mailto:fluka@sial.com.

The light from the scintillator tiles is absorbed, re-emitted and transported by 1.2 mm diameter WLS Kuraray Y-11(250)MSJ fibrs, traversing the entire module.

Date: 6/18/18

EIC Detector R&D Progress Report

Project ID: eRD1
Project Name: EIC Calorimeter Development
Period Reported: from 1/1/18 to 6/30/18
Project Leaders: H.Z. Huang and C. Woody
Contact Person: T. Horn, H.Z. Huang, E. Kistenev, S. Kuleshov, O. Tasi, C. Woody

Collaborators

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(Spin and EIC Group, BNL Physics Department)

Y. Fisyak and W. Schmidke
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Thomas Jefferson National Accelerator Facility

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Indiana University

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University of California at Los Angeles

Y. Zhang, C. Li and Z. Tang
University of Science and Technology of China

S.Kuleshov
Detector Laboratory of UTFSM, Valparaiso, Chile

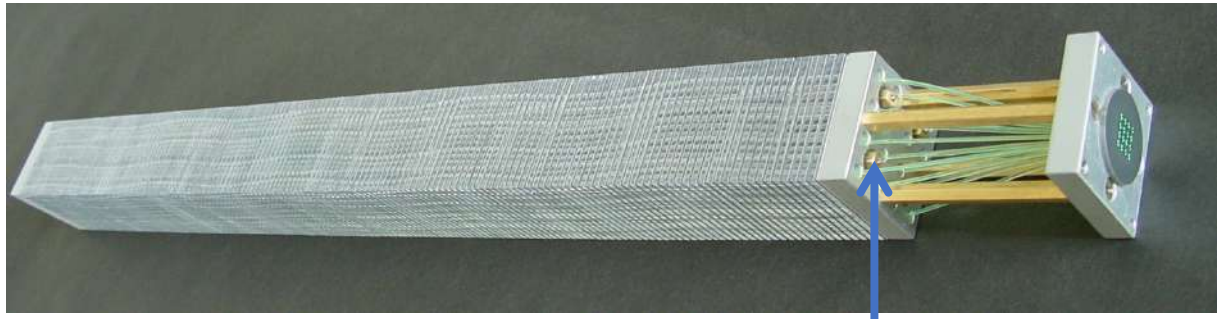
H. Mkrtychyan, V. Tadevosyan and A. Asaturyan
Yerevan Physics Institute

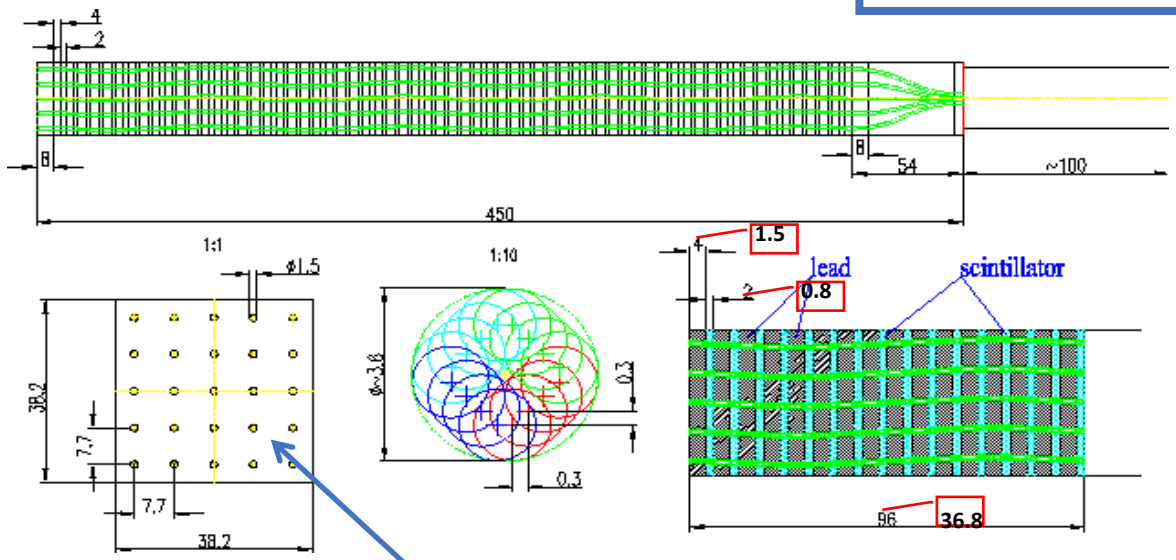
Sub Project: Development of a High Density, Fully Projective Shashlik Electromagnetic Calorimeter with Improved Energy, Position and Timing Resolution for EIC
Project Leaders: S. Kuleshov, E. Kistenev and C.Woody

Main goals:

- Optimize the shashlik calorimeter with SiPM read out.
- Update the shashlik calorimeter option for EIC detector.

Production of the prototype in UTFSM, Chile.



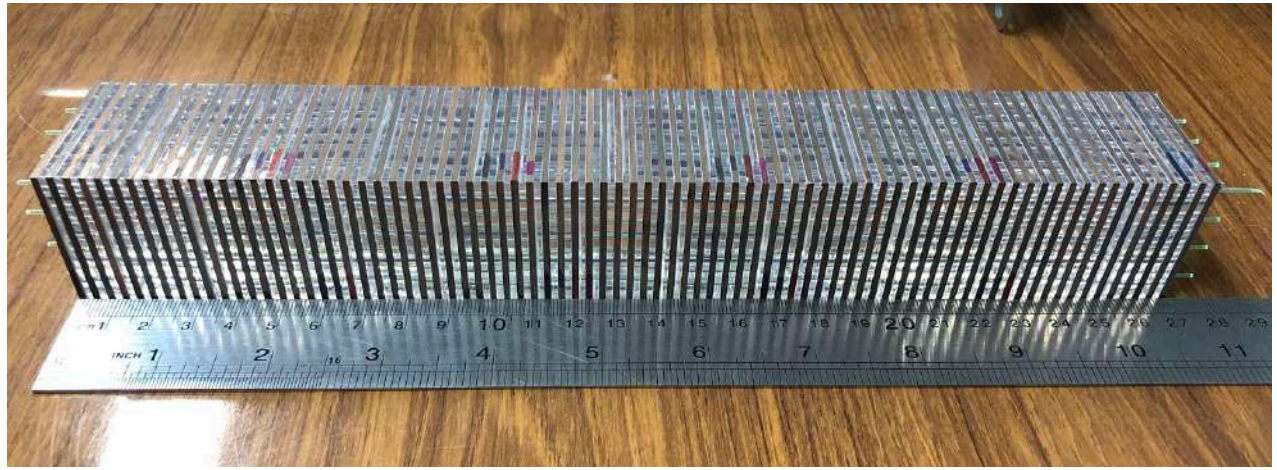


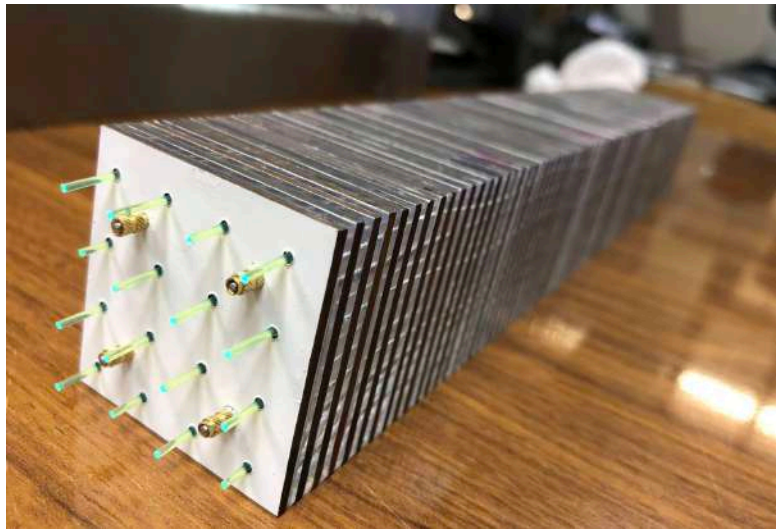
Must be a hole for double-end bolt.

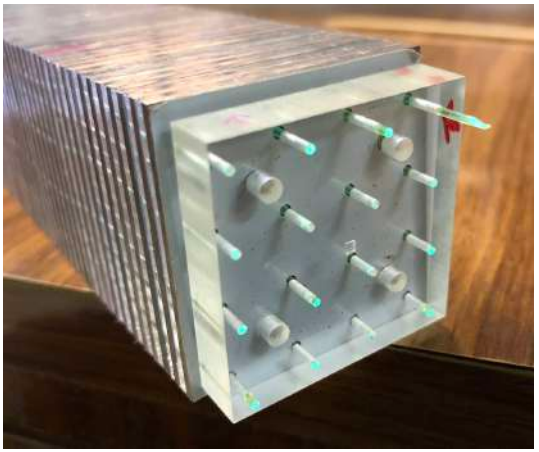
Radiation hard plastic scintillator for the Shashlik.

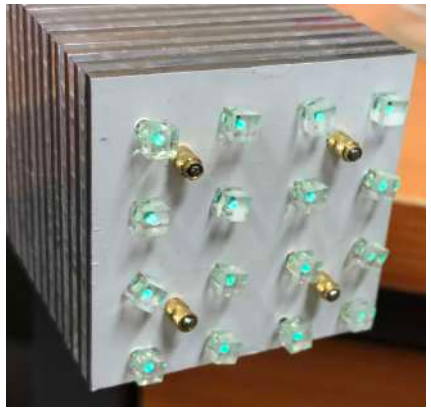
- Polystyrene DOW STYRON™ 637 **Polystyrene** (IUPAC **Poly(1-phenylethane-1,2-diyl)**), sometimes abbreviated **PS**, is an aromatic polymer made from the aromatic monomer styrene, a liquid hydrocarbon that is commercially manufactured from petroleum by the chemical industry. Polystyrene is one of the most widely used kinds of plastic.
- There are 2 solutes: 2%pTP(p-Terphenyl ($C_{18}H_{14}$)) and 0,02% POPOP ($C_{24}H_{16}N_2O$).
- This combination of the polystyrene and the solutes is complimentary to BCF-91A WLS fiber (Saint-Gobain).

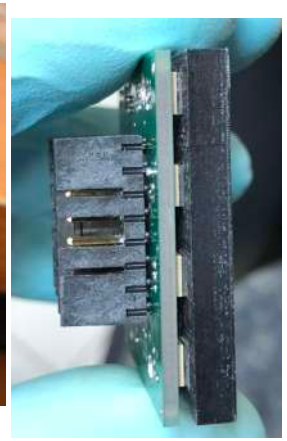
38 x 38 x 1.5 plastic and W80Cu20 plates (with polyvinyl film).

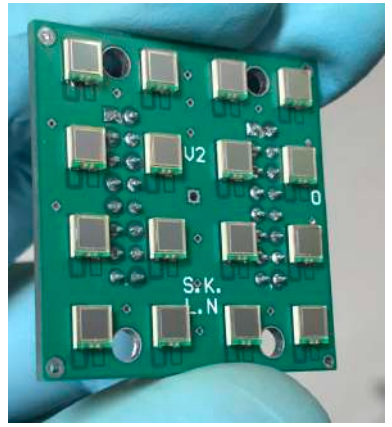


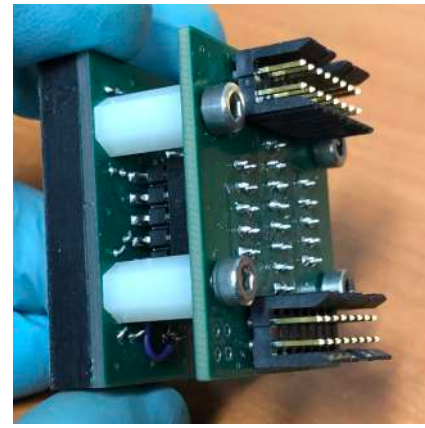










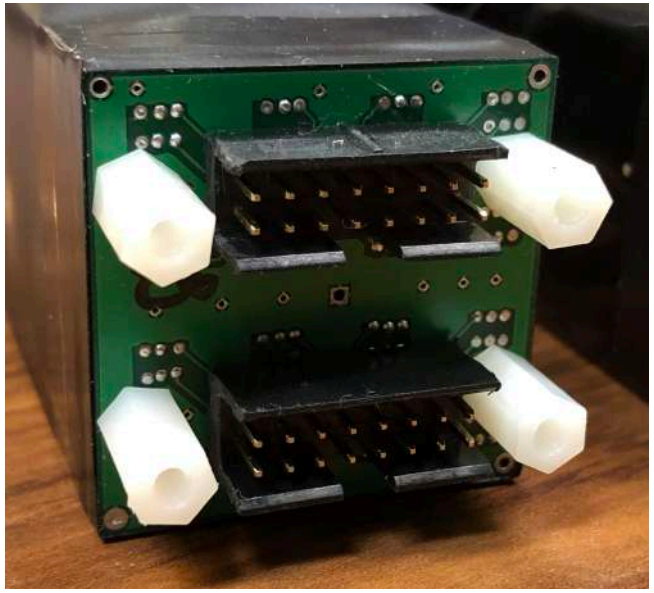


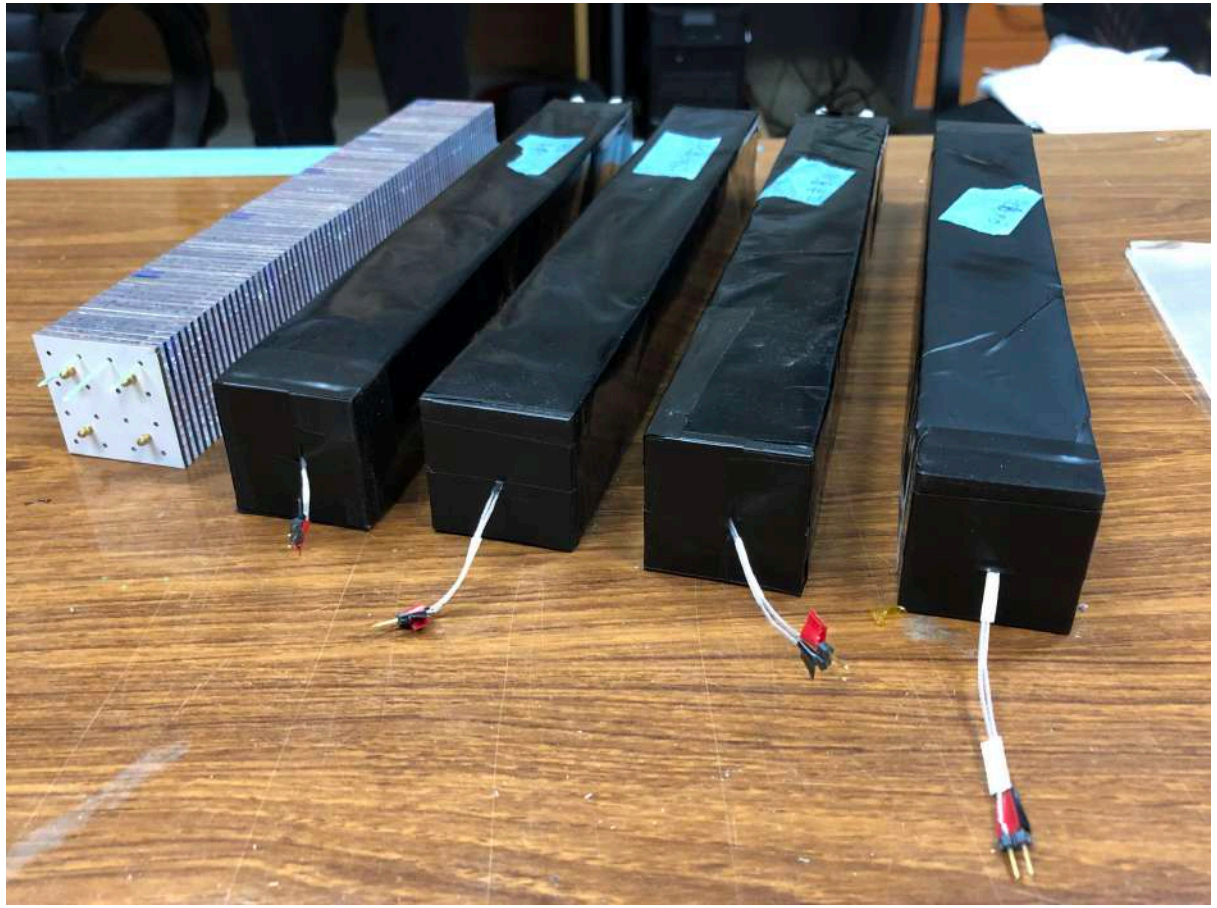
the front side with clear Plate for LED

The rear side with holders for light guides

Fibers with light guides

9 modules were assembled, tested and sent to BNL





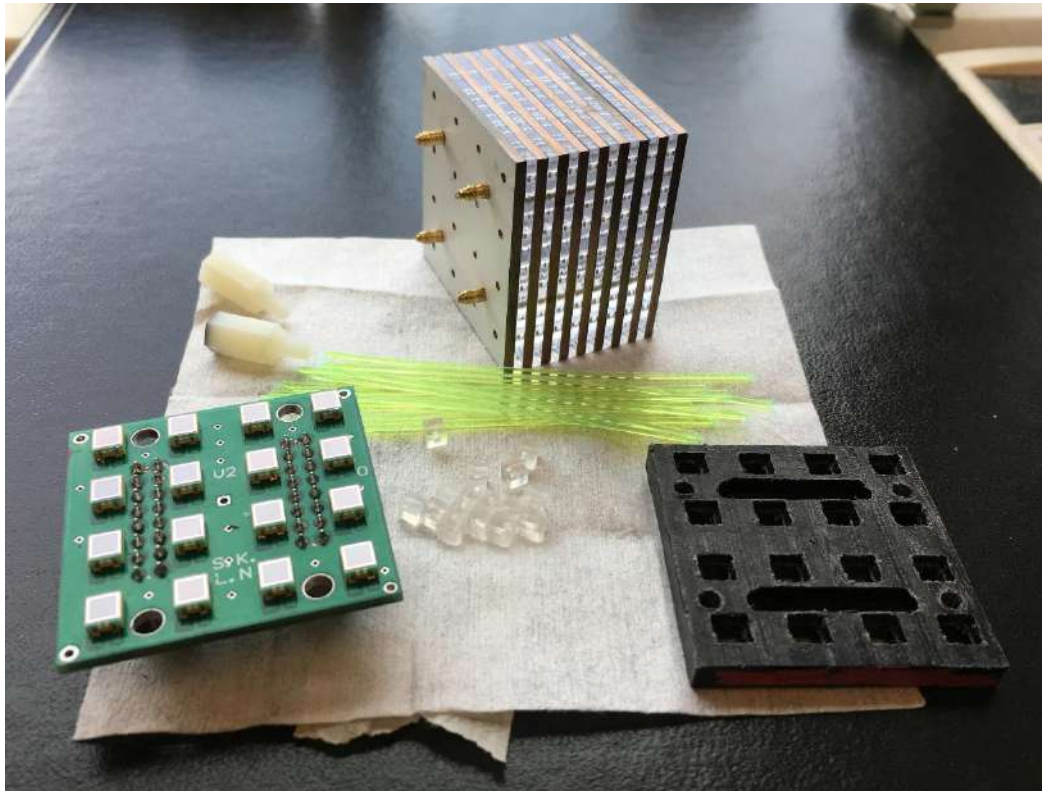

LeCroy
SAMSUNG

Additional Studies on Light Collection

A set of calorimeter components was sent to from UTFSM to BNL for additional studies on light collection.

These will be used to do detailed studies of the light collection within the absorber stack using lasers, LEDs and radioactive sources in the lab.

Will also test with new 3x3 mm^2 15 μm pixel SiPMs from Hamamatsu and KETEK.



- Short stack of absorber and scintillator plates
- WLS fibers
- Acrylic light mixers
- SiPM readout board and mounting plate