eRD106. Forward ECal. Proposal for FY23

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BNL, Chinese EIC ECal Consortium (Fudan, Shandong, Tsinghua and South China Normal Universities), Indiana University, UC EIC Consortium (University of California at Los Angeles, University of California Riverside)

EIC Project R&D – DAC Meeting, 10/20 2022

eRD106 was postponed in FY22, due to different technology choices for forward ECal by ECCE (Pb/Sc Shashlyk) and ATHENA (W/ScFi).

- Consolidation/optimization process described by S. Dalla Torre talk on 10/19.
- For forward ECal process was finished by mid Summer.
- Dedicated meeting. https://indico.bnl.gov/event/16210/ with answers to six specific charges by ePIC GD/I WG to Calorimetry WG.

a) Introductory meeting. Overview of forward calorimeter system for ECCE and ATHENA https://indico.bnl.gov/event/15493/
b) Dedicated meeting for forward ECal https://indico.bnl.gov/event/15686/
c) Follow up discussions between proponents (ORNL, UC_EIC, Chinese Consortium)

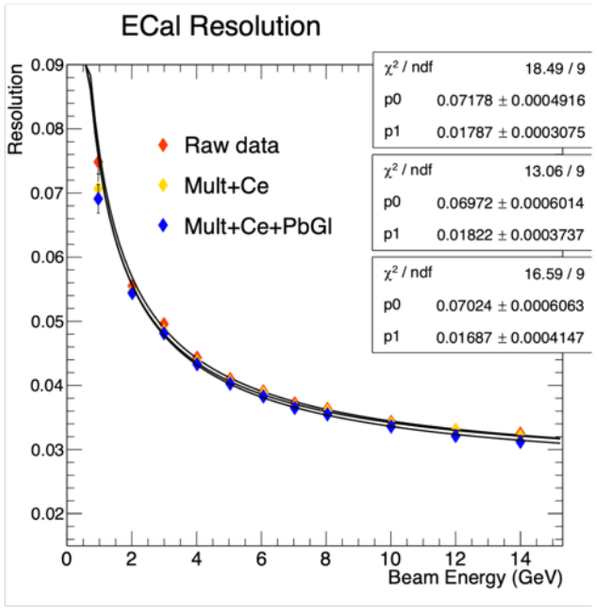
Details (b):
Minireview of technology details, including performance studies, assumptions used for simulations in proposal, integration and cost. Cost numbers were updated for ECCE and overall costs were reviewed by A. Bazilevsky. Detailed questions and technical information were discussion.

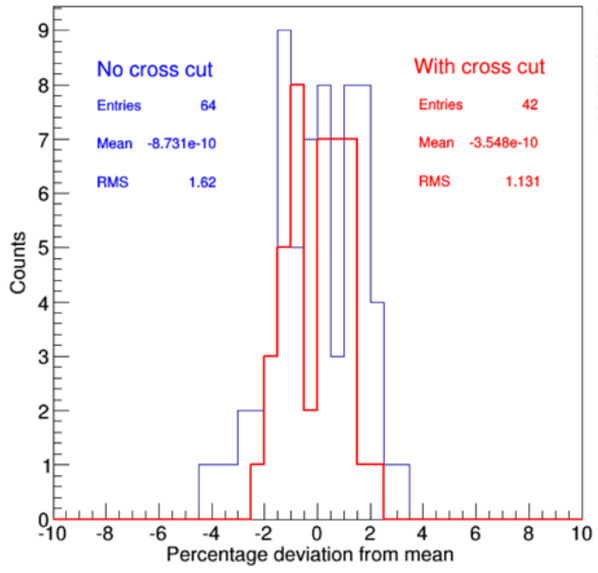
W/ScFi technology developed during generic EIC R&D program was chosen for ePIC forward ECal.

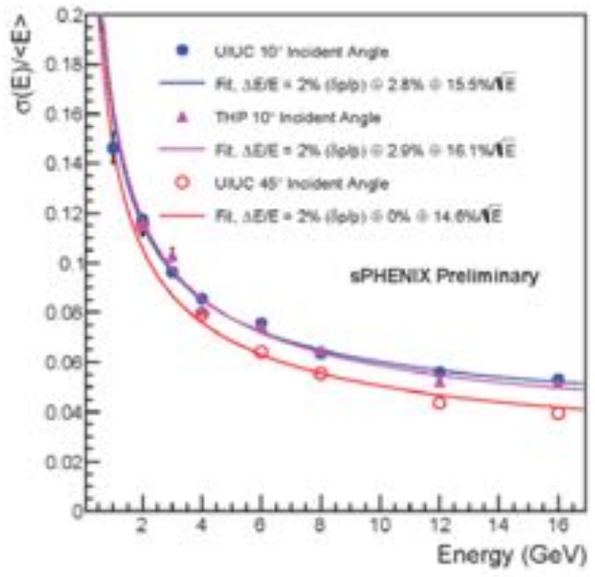
eRD106. There are two remaining technical questions for W/ScFi technology from the generic R&D program that we intend to address in eRD106:

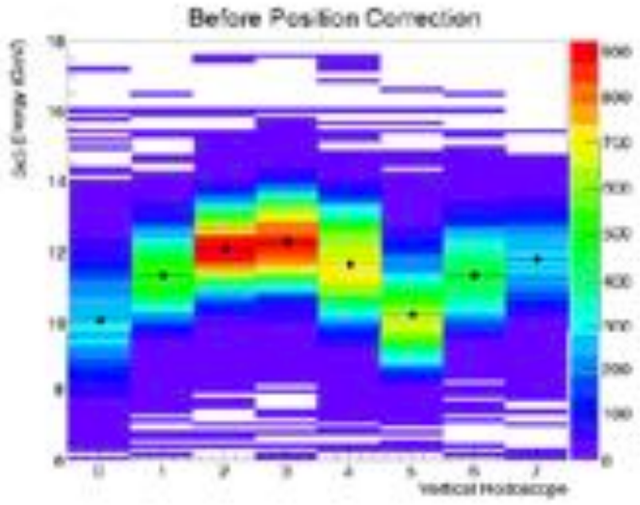
1. Uniformity of light collection -> constant term ~2% in energy resolution in YR.
2. Efficiency of light collection - > YR requirement on min. energy ~ 5 MeV.

eRD1, Results 2016









'Ideal Light Collection' PMT+ long light guide
Constant term 1.7%

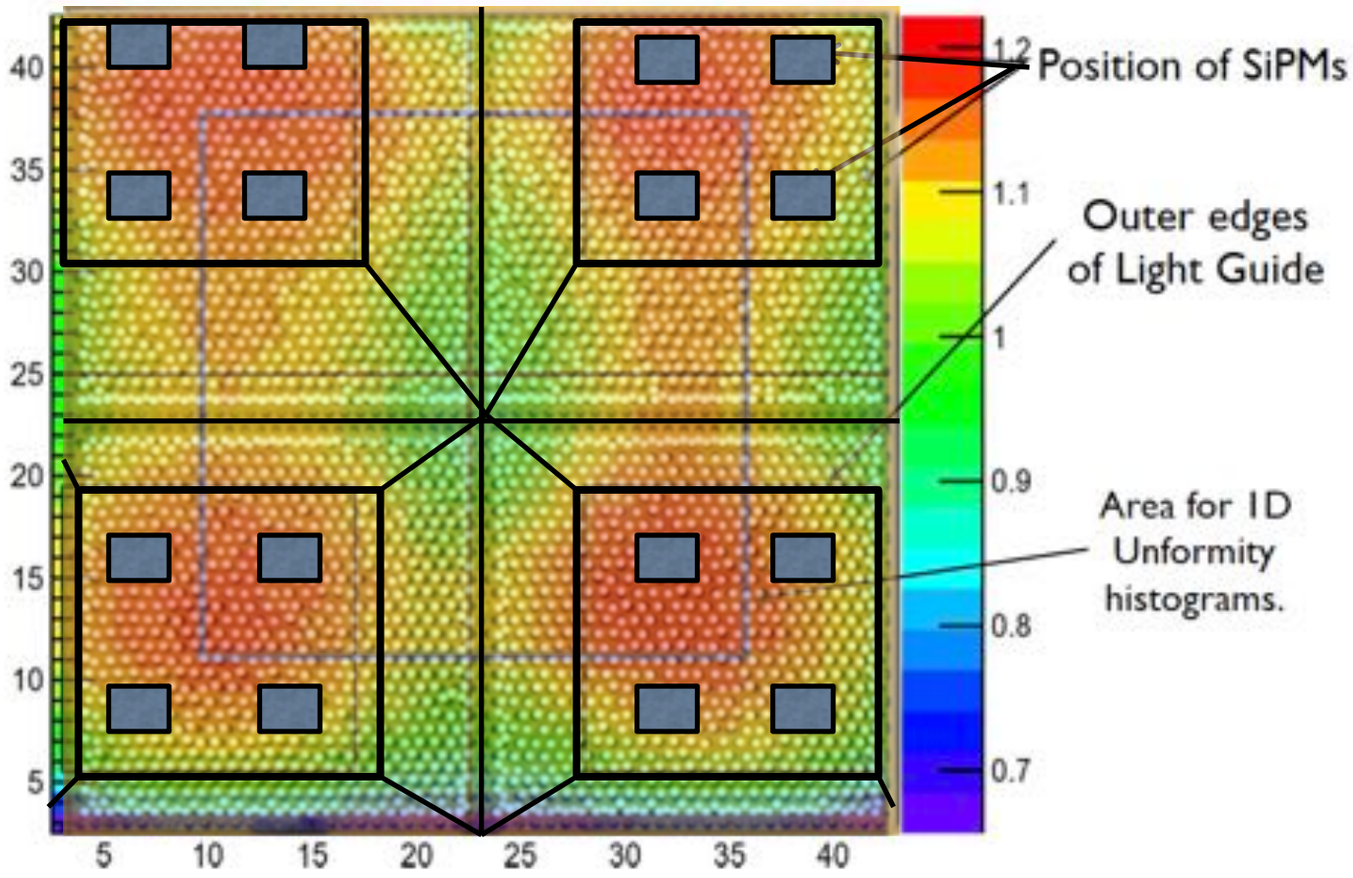
Short Light Guides, SiPMs
Constant term ~5% (sPHENIX latest numbers)
Light Yield was about 390 p.e. / GeV

Optimization of light collection (2016): BEMC Superblock 2 x 2 towers, 4 SiPMs / tower, UV LED Map

Compact scheme (short light guide with 4 SiPMs, which only partially covering output area of light guide) especially prone to be non-uniform.

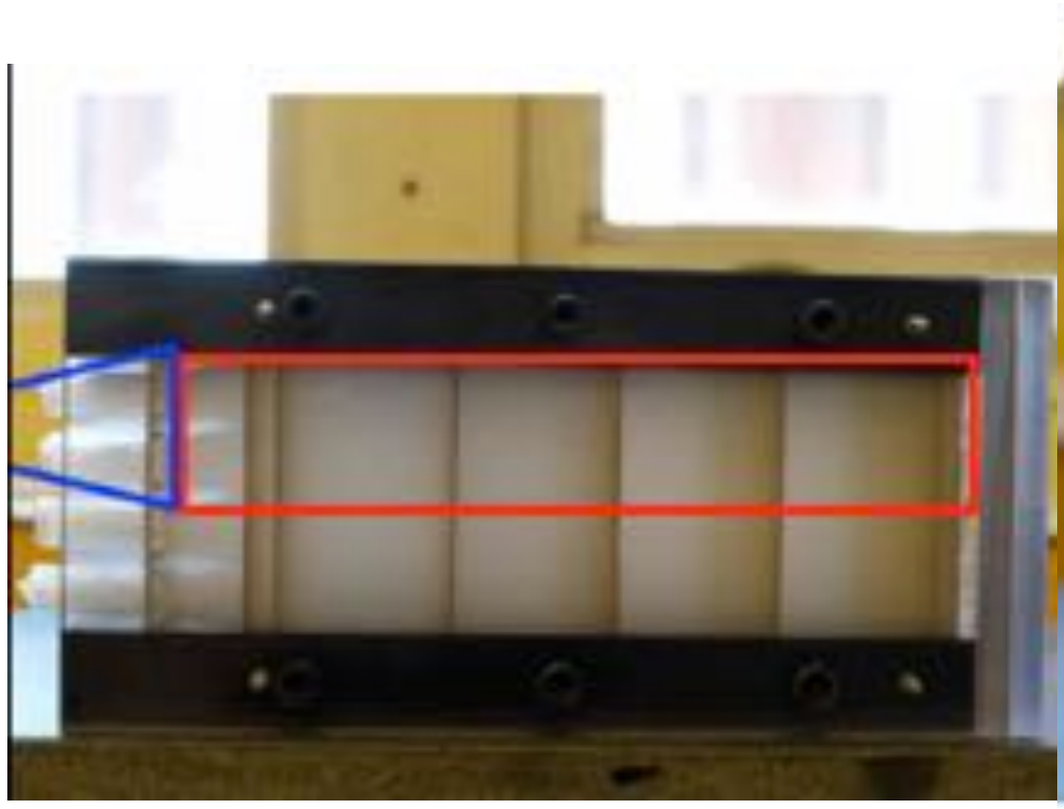
Solutions we tried in the past:

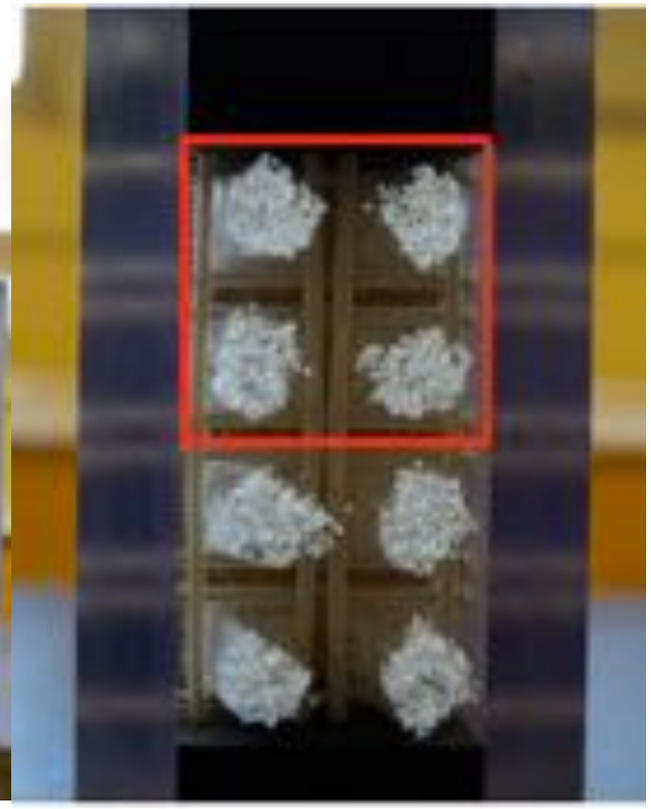
1. Compensation Filter between fibers and light guide. Loss about 30% of light (test run 2015). Will not be acceptable for ePIC ECal.



2. Compensation with gradient reflector from the back side of the superblock. Practicality issues.

New Approach. Introduce controlled angular arrangement in fibers within tower, so that fibers in the corners and in the middle of the tower generate the same LY.



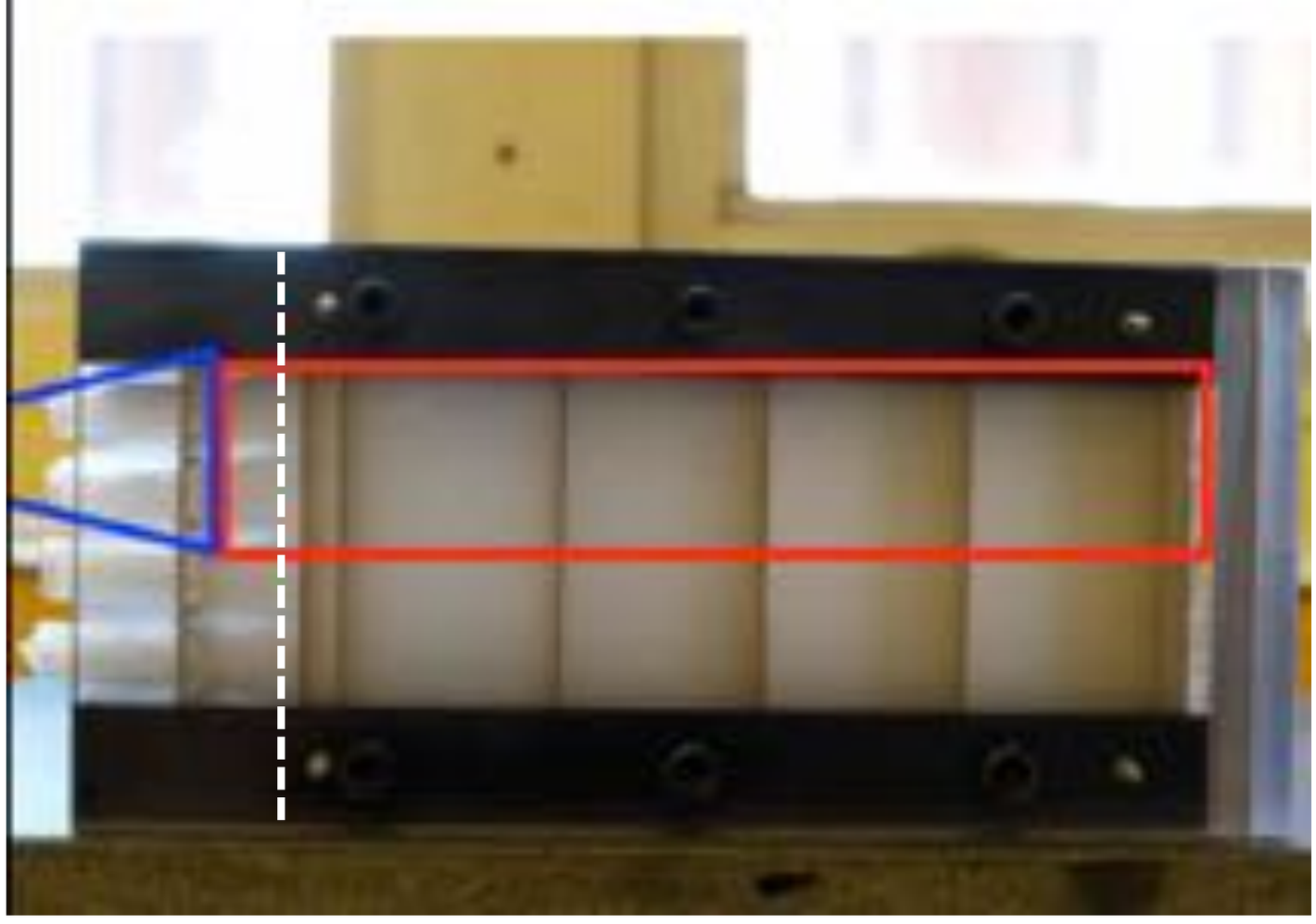


In 2014 we dropped development of 'bunched fiber' configuration for two reasons:

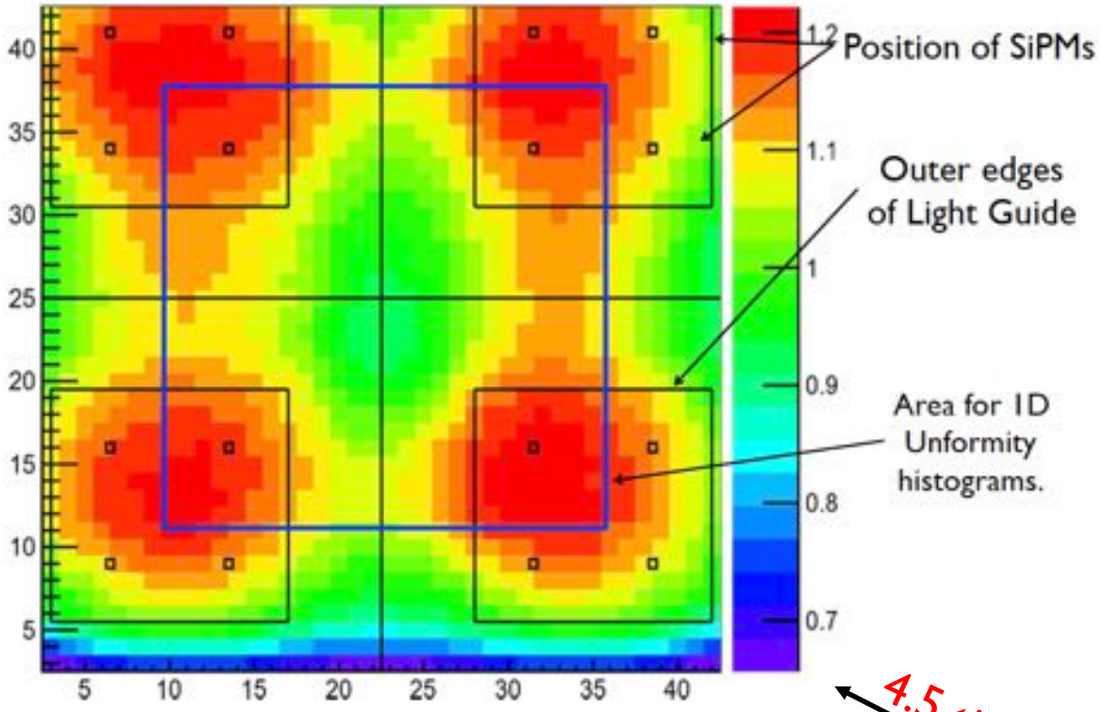
1. Undesired small volume in tower with 100% sampling fraction.
2. Practical issues; four independent light guides, mechanical mounting of FEEs to towers.

However, if we change angles of fibers only, then cut can be done close to the last mesh and the same single light guide can be used as in the previous design.

The last mesh has larger diameter holes to allow bending of fibers.

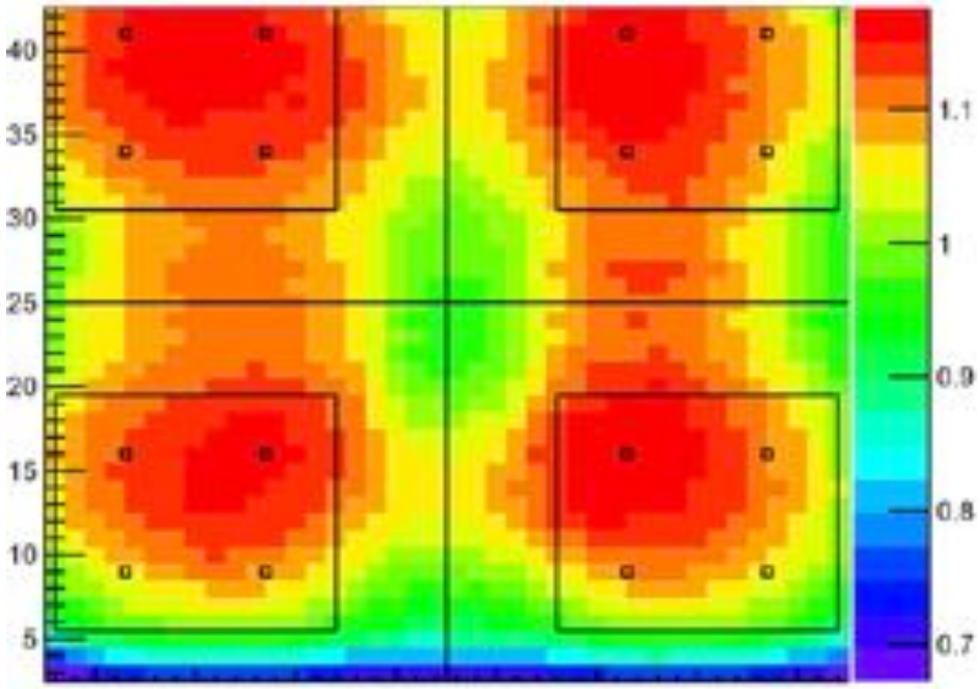


Optimization of light collection:



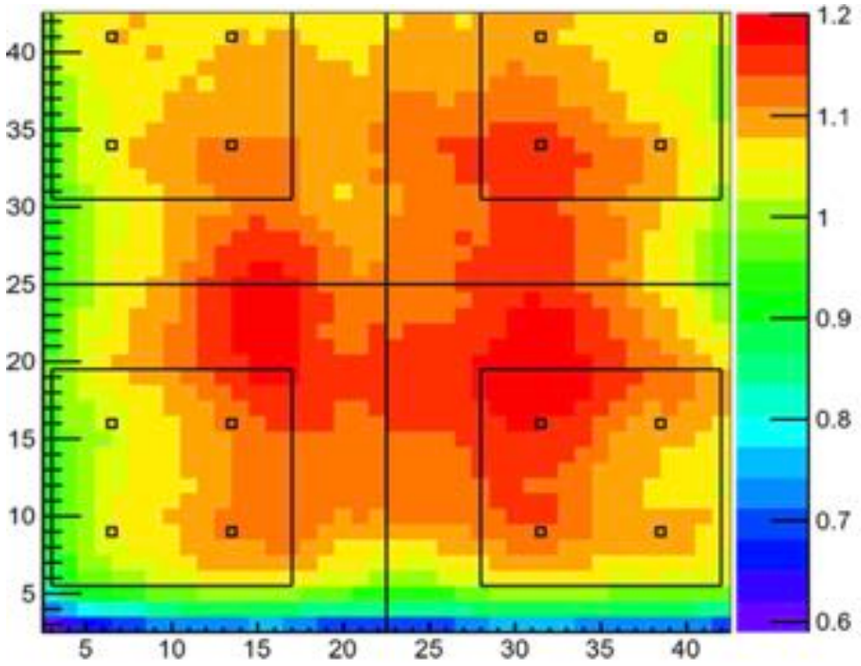
Old BEMC, Sylgard 184, 3mm

BEMC Superblocks, UV LED Map

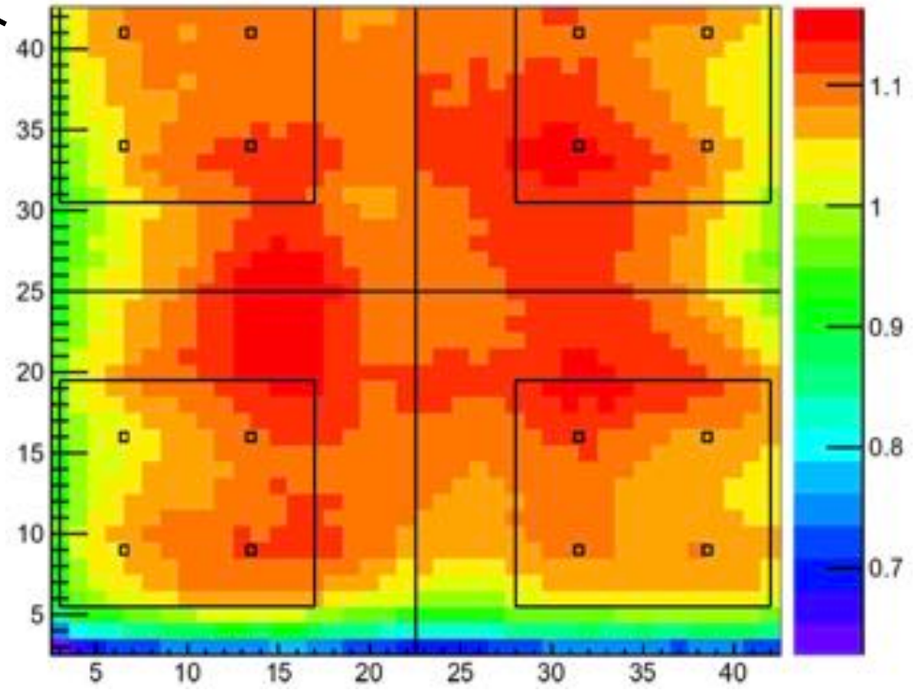


Old BEMC, BC-630, coupling is important

4.5 times better



New BEMC, BC-630.
New arrangement of fibers works quite well.



New BEMC, Lumisil 591
Better fiber arrangement and better coupling.

Milestones for FY23:

To address the remaining technological questions:

- Construct 64 channel ECal prototype, using latest method developed by eRD1.
- Optimize light guides.
- Test detector at FNAL.

Moving toward CD2/3A:

- Mechanical integration of ECal into ePIC.
- Structural tests (sheer and compressions).
- Comparison of 'EIC specs' Saint Gobain and Kuraray fibers.
- Optical/mechanical/electrical integration of readout (with eRD109)
- SiPM testing (with eRD110)

Preview of FY24, FY25

- Produce more blocks for joint test run with Forward HCal
- Joint test run with HCal with final readout electronics

Thanks!

Backup Slides.

FY 22 Detailed Schedule.

1. Transfering know-how, old production mold/methods and tooling from UCLA to Fudan. 12/31/22
2. Comparison of new Bicron BCF-12 Fibers with Kuraray SCSF-78. 1/15/23
3. Assembly of one production block in China from leftover materials 1/31/23.
4. Shear tests complete 3/30/23
5. Acquire Sc. Fibers (all fibers delivered to Fudan) 02/27/23
6. Acquire W Powder (all powder delivered to Fudan) 02/27/23
7. Acquire production meshes and tooling (all meshes and some tooling in Fudan) 02/27/23
8. Iteration on production methods and molding forms finished 03/30/23
9. Start production of blocks for test beam prototype 04/01/23
10. Deliver two production blocks to US for inspections 05/01/23
11. QA first production blocks 05/15/23
12. Perform UV scan to check uniformity LY 05/30/23
13. Deliver all production blocks to US 06/30/23
14. QA Production all blocks done 07/15/23
15. Compression tests complete 7/30/23
16. Mechanical/optical/electrical integration with readout complete 8/15/23
17. Light guides for prototype produced 8/30/23
18. 64 channel prototype ready for integrating readout. 09/30/23
19. Readout electronics for test run, software, MC complete 10/30/23
20. Test Run at FNAL complete 12/15/23.

Budget

Items	Total Cost	Institution	Comments
Blocks Production	$25.5K	Chinese EIC Consortium	PO from UCLA for 64+32 towers
Light Guides Optimization	$20K	UC EIC and Chinese EIC consortiums.	PO from UCLA to Chinese consortium
Test Run Electronics	$10k	UCLA	UCLA electronics shop. with input from G. Visser
SiPMs	$6K	UCR	SiPMs for test beam prototype
Students Support	$12.6K	UC EIC Consortium	UCLA/UCR 50/50
Travel	$15K	UCLA	Mostly test run.
Structural Tests	$10K	BNL	
Total	$99.1K		