UCLA Experimental Group EIC Plan 2023

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For the UCLA Experimental Group

Major Tasks

1) eRD106 -- Forward pECal R&D Project

2) Work with IU group on eRD109 for pECal readout

3) pECal detector validation/simulations in DD4HEP (Zhongling's talk)

4) Forward Jet simulations in DD4HEP framework ?

eRD106 Status and Plan

1) **Proposal is fully funded once pECal technology is agreed upon**

2) **Build 4 pECal big blocks (4x4 towers):**
   one block at UCLA by UC EIC consortium groups
   three blocks at Fudan by Chinese EIC Cal Consortium

Goals:

Validate block construction technology with improved light collection uniformity

Optimize light guide to enhance light collection efficiency

Beam test run at FNAL

ePIC pECal CD2/3A Preparation

- **Mechanical integration of pECal into ePIC (at BNL)**
- **Structural tests (sheer and compressions) (at BNL)**
- **Comparison of Saint Gobain and Kuraray fibers (UCLA)**
- **Optical/mechanical/electrical integration of readout (with eRD109)**

pECal Software Plan (Zhongling)

Implementation of pECal in DD4HEP

Validation of the DD4HEP simulation results

Physics simulations of pECal performance (pi0, photons, electrons)

For Jet Measurements we will need
Tracking + pECal and pHCal

Future Integration in DD4HEP
and Beam Test of pECal+pHCal

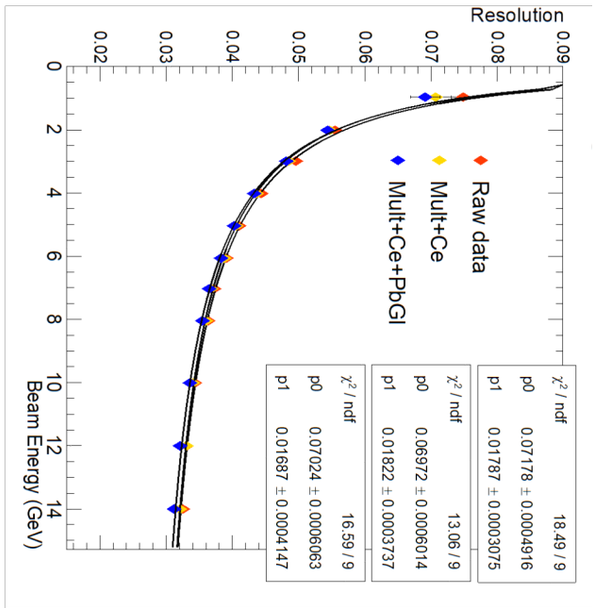
Update for ePIC fECal. Related R&D programs in FY23.

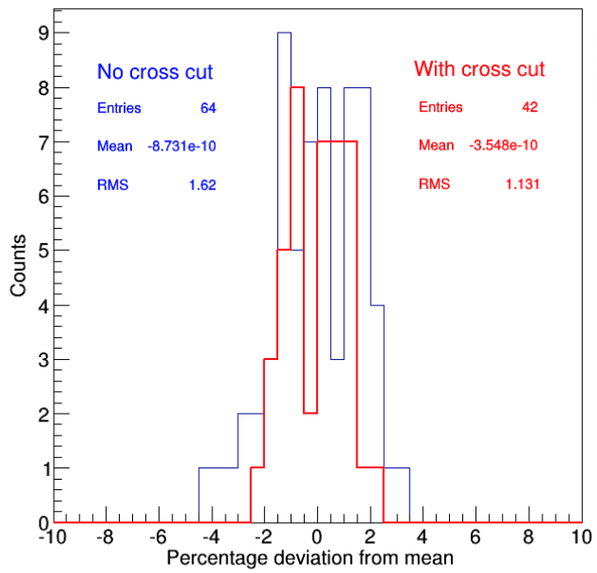
- eRD106 – forward ECal is funded. Contract with BNL still being workedout.
- eRD109 – electronics for forward ECal funded (Indiana University).
- EIC Project Detector Calorimetry Review Dec 6-7. Minor comments regarding forward ECal. Will be addressed via simulations (reviewers concerned about material coming from electronics in front of the Emcal).

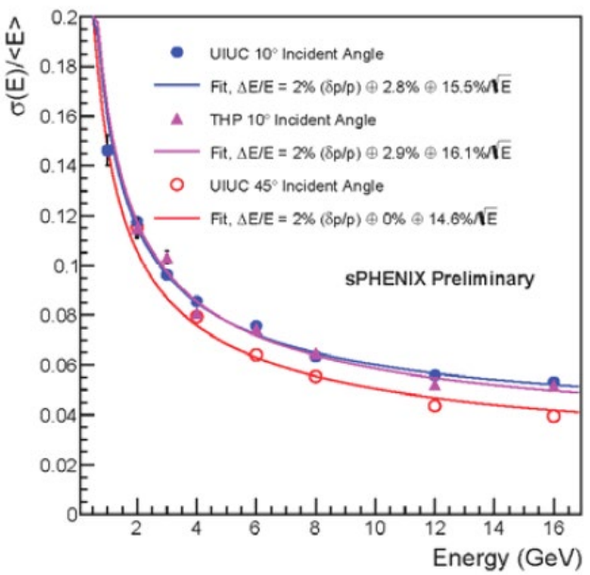
eRD1, Results 2016

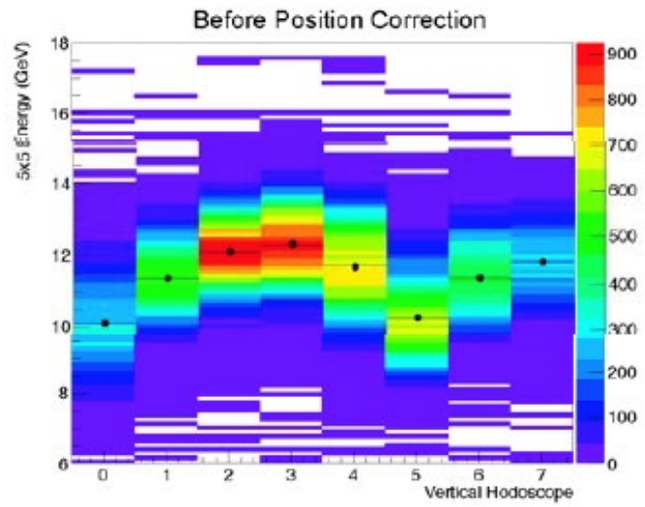
eRD106. There are two remaining technical questions for W/ScFi technology from the generic R&D program that we intend to address in eRD106:

1. Uniformity of light collection –> constant term ~2% in energy resolution in YR. Affects only very forward Ecal blocks, i.e. the one which are close to be projective.
2. Efficiency of light collection - > YR requirement on min. energy ~ 5 MeV.









'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

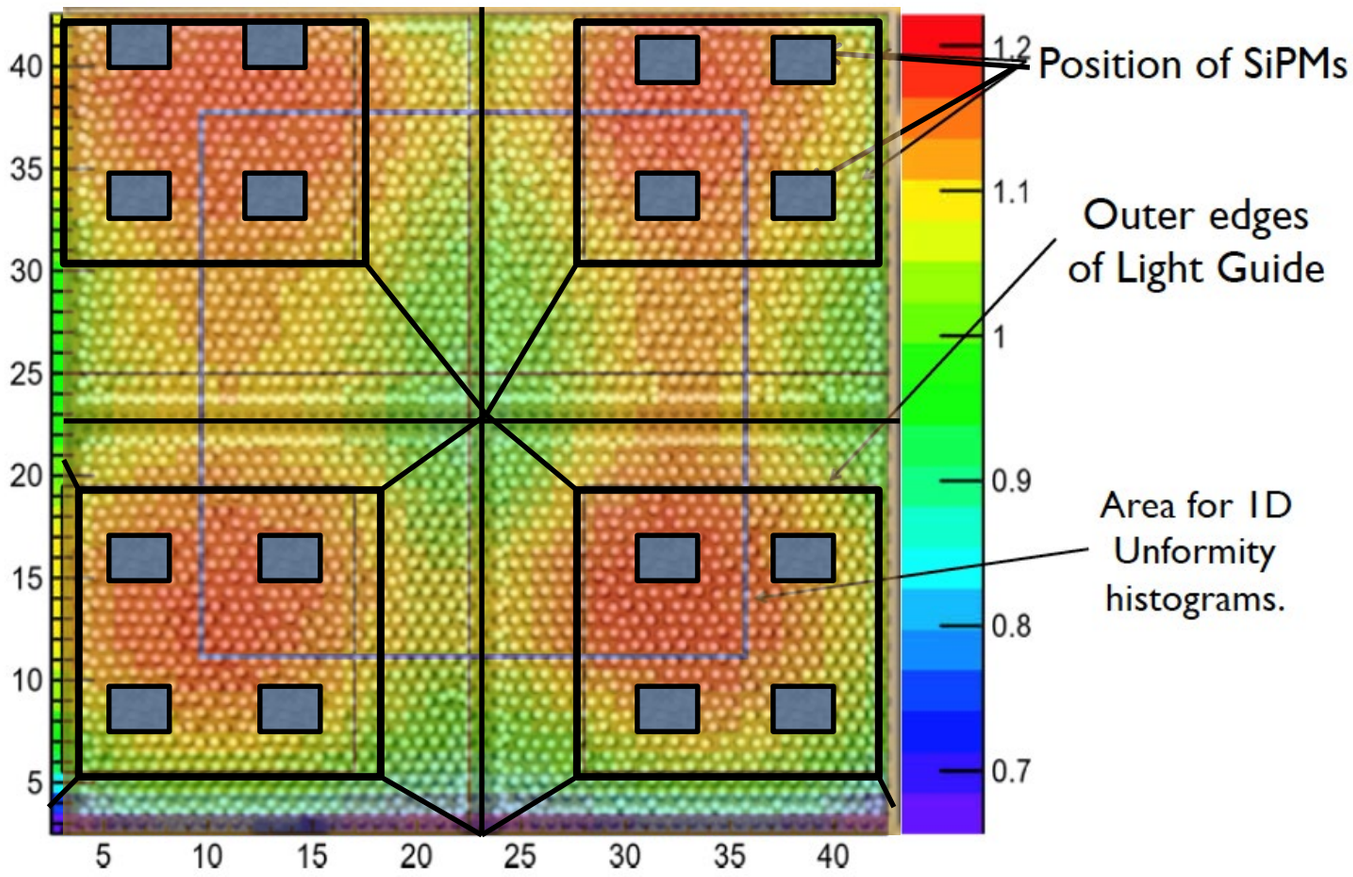
Compact scheme (short light guide with 4 SiPMs, which only partially covering output area of light guide) especially prone to be non-uniform.

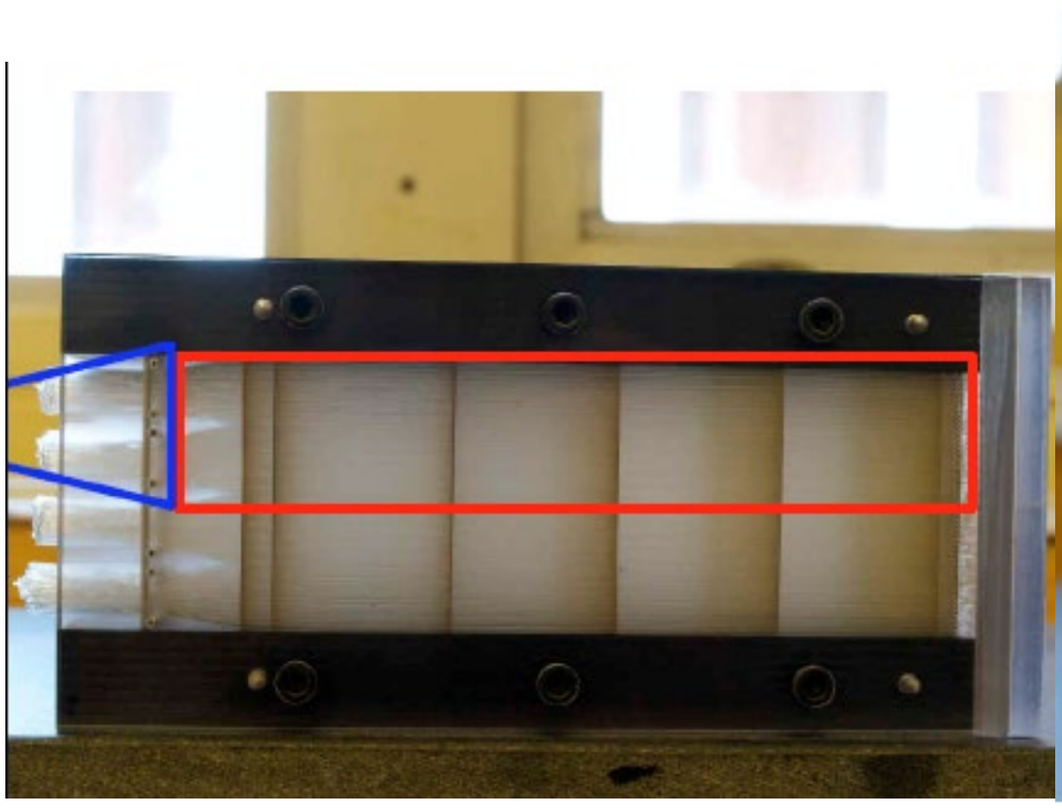
Solutions we tried in the past:

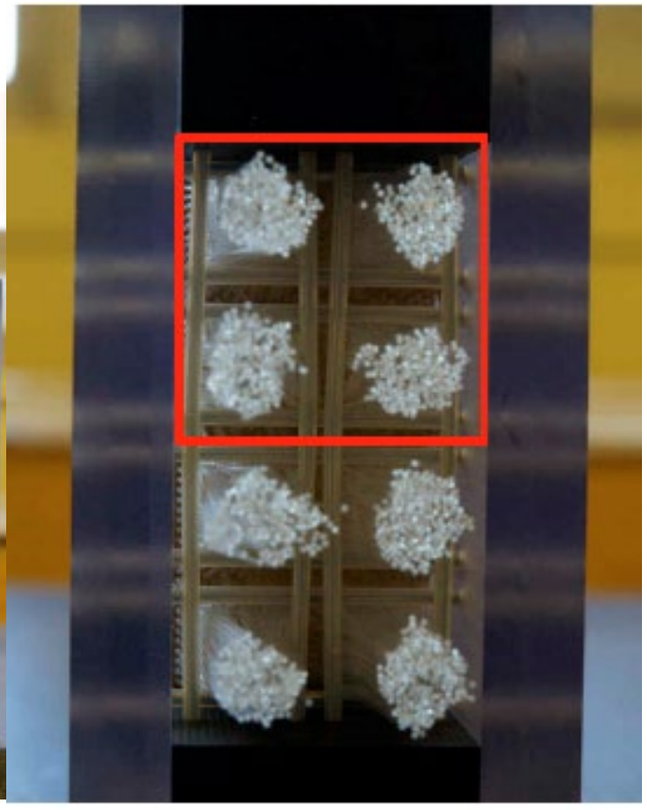
1. Compensation Filter between fibers and light guide. Loss about 30% of light (test run 2015). Will not be acceptable for ePIC ECal.

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.





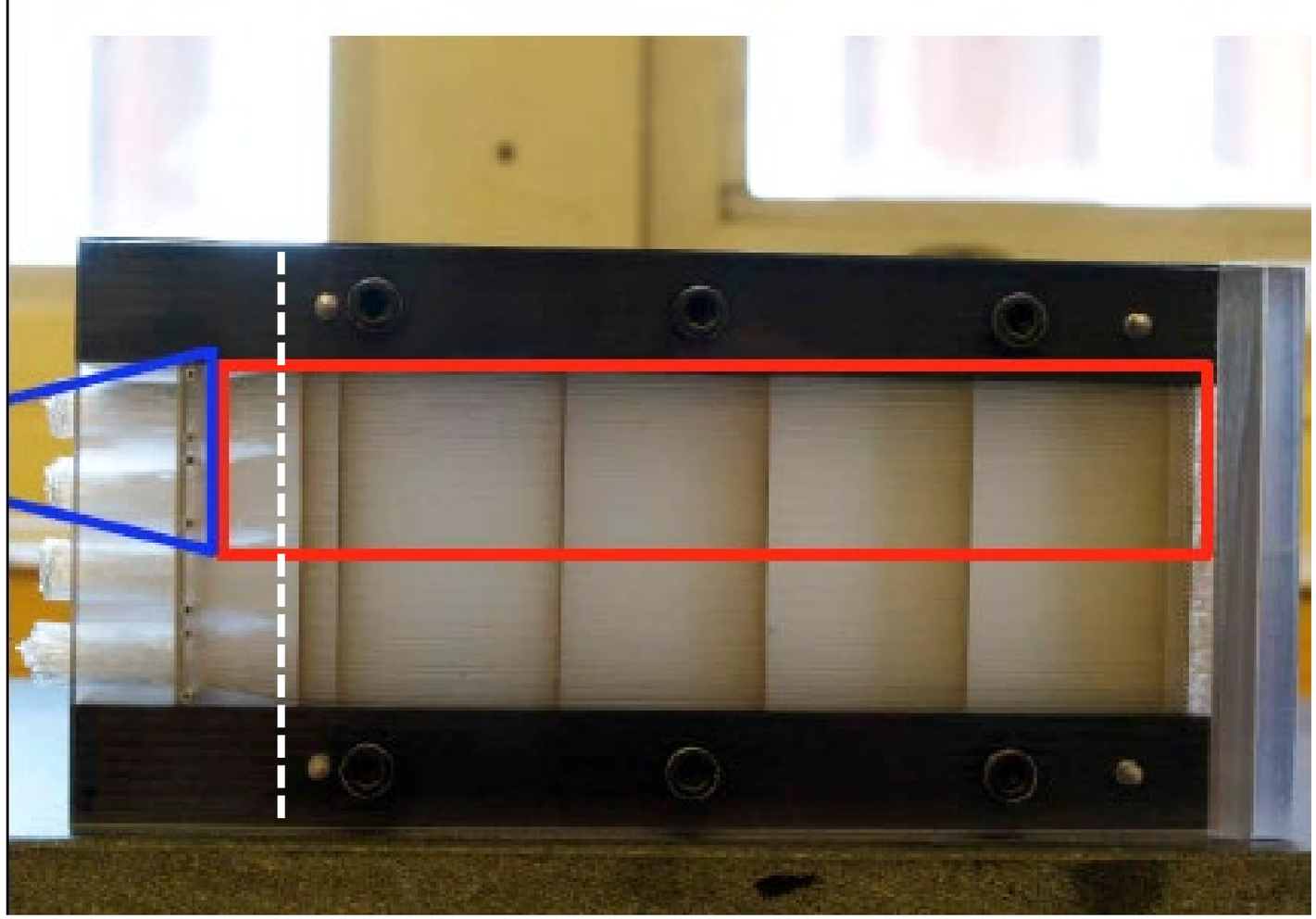


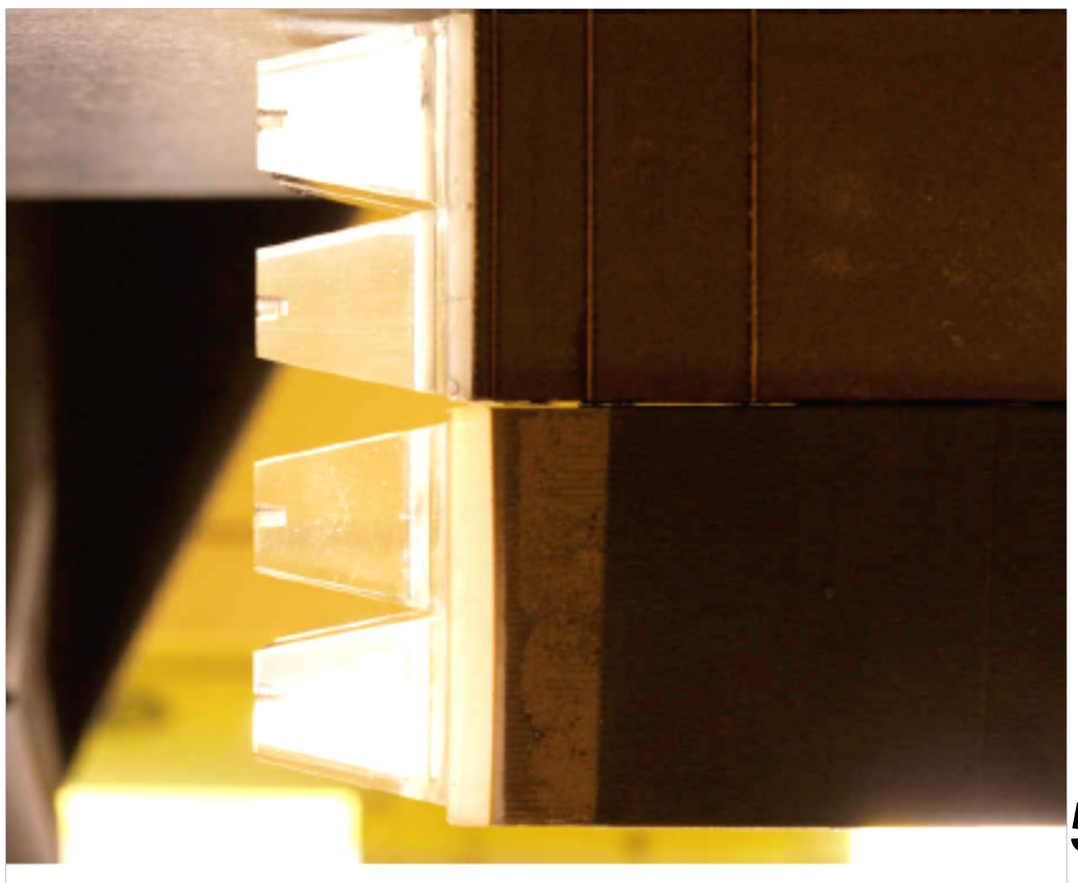
In 2014 we dropped development of ‘bunched fiber’ configuration for two reasons:

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

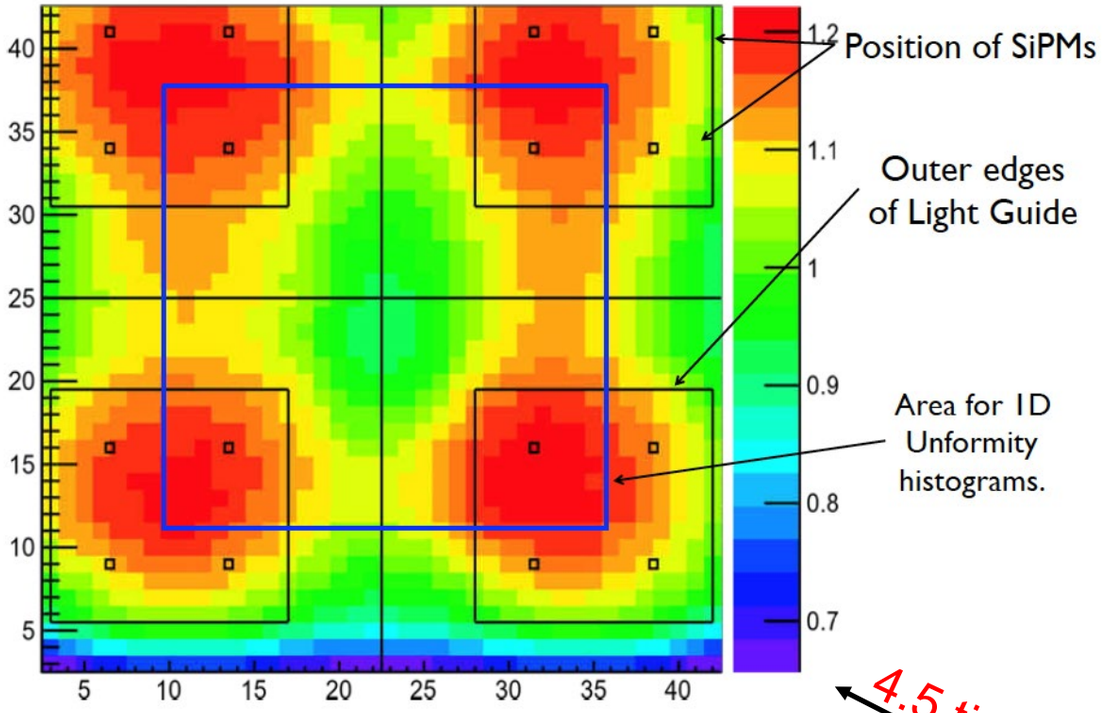
However, if we change angles of fibers only, then cut can be done close to the last mesh and the same single light guide can be used as in the previous design.

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



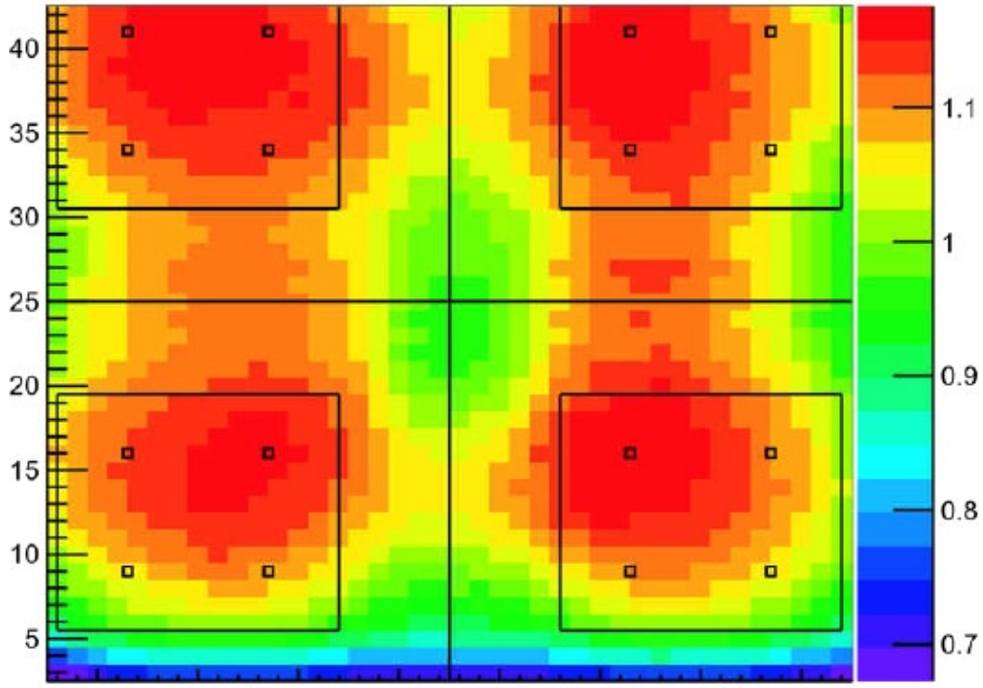


Optimization of light collection:



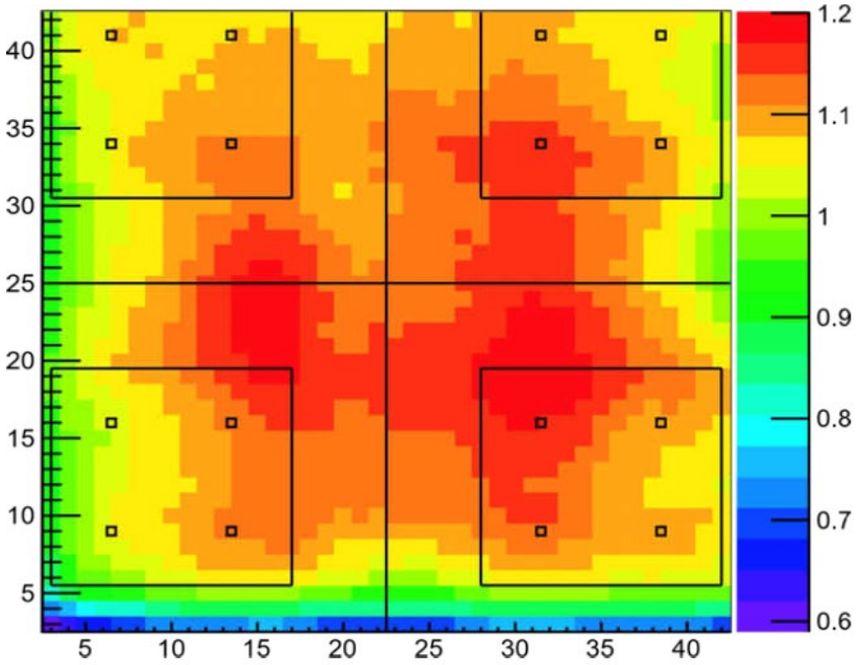
Old BEMC, Sylgard 184, 3mm

BEMC Superblocks, UV LED Map

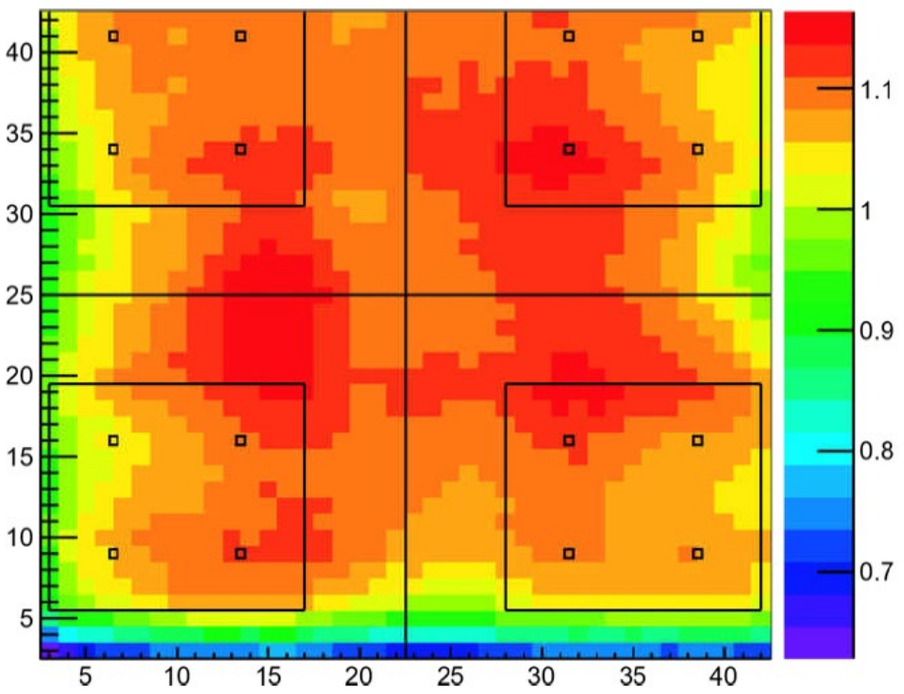


Old BEMC, BC-630, coupling is important

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 4 ECal installation blocks (installation block has 16 towers).
- Made one installation block using method developed by eRD116 at UCLA
- Three other in Fudan. (these are blocks for rapidities < 2, don't need to be 23 X0, exact length will be optimized by Zongling).
- Optimize light guides.
- Test detector at FNAL.

Moving toward CD2/3A:

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

Preview of FY24, FY25

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

FY 22 Detailed Schedule. (Already shifted, contract with BNL still being worked out)

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.