OAK RIDGE National Laboratory

ePIC

Calo eRD Summary:

https://indico.bnl.gov/event/17159/

October 27, 2022

Friederike Bock

eRD105: SciGlass

October 20, 2022

T. Horn (CUA)
for the eRD105 consortium

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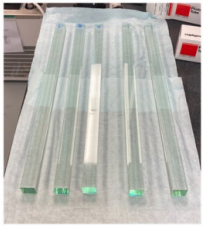
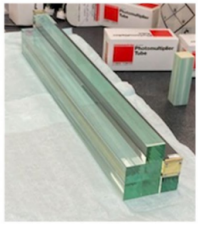
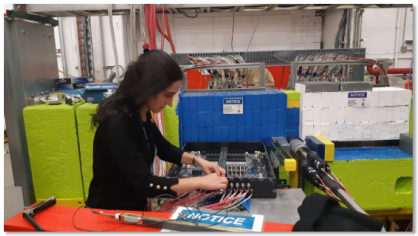
SciGlass R&D







- Demonstrate that SciGlass viable cost-effective solution as EIC calorimeter technology
- R&D effort benefits from a separately funded DOE SBIR/STTR Phase 2 providing facilities and resources for the glass fabrication and scale-up production (Scintilex)
- Food progress in FY22 towards completion – albeit delays due to Covid19 and start of R&D funding
- Remaining R&D in FY23:
  - optimizing the readout matched to glass
  - comparison of different glass geometry shapes with prototypes and beam tests

Participating institutes/consortia:

- A.I. Alikhanyan National Science Laboratory/Yerevan, Catholic University of America, The Vitreous State Laboratory, IJCLab-Orsay/France, INFN-GE, Jefferson Laboratory, U of Kansas

eRD105 - Plans & Milestones

Plans for FY23

1. Focused on the full block optimized for the calorimeter
2. Characterization of the transverse shower development
3. Optimization of the readout (SiPM matrix and services)
4. Measurement of the ratio of fast and slow components of the scintillating glass – an important input for the electronics optimization
5. Implementation of the process production and performance comparison of different glass geometry shapes.

Milestones for FY23

1. FY23: Scale-up to 40 cm complete
2. Receive 25 test samples
3. Beam test with 3x3 (5x5) prototype with 40+ cm. (CUA, AANL, JLab)
   - HallD Jlab beam test logistic: installation, safety, DAQ etc. (JLab)
   - Beam test preparation and data analysis (CUA, AANL)
4. Develop and implement a SiPM-based readout (INFN-GE)
5. Design and test an optimized streaming RO chain (INFN-GE)
6. Sciglass blocks characterization, including Irradiation (IJCLab-Orsay, Kansas U.)
7. Implement process for different geometries (CUA)

Close-out remarks: eRD105 – SciGlass

- Important production of 40cm blocks, progress in manufacturing process
- Characterization of longitudinal light transmission, radiation tolerance
- Successful beam tests with 20cm and 40cm block test counter
- Recommend study of details of uniformity of density/index/scintillation along/across blocks using eg transverse transmission
- Recommend study of transverse position resolution (simulation and measurement)
- Recommend of study of optimization of block size relative to Moliere radius
- Recommend study of production times both for uniformly shaped blocks and those with projective geometry shapes.
- Important to understand impact of using external foundry for production

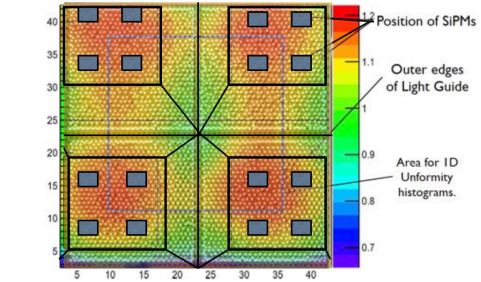
eRD106: Forward ECal

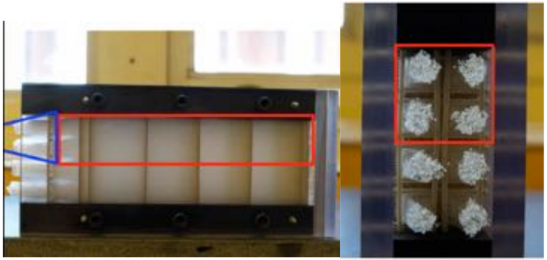
October 20, 2022

O. Tsai (UCLA)
for the eRD106 consortium

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)

The General Idea





Concept:

- eRD106 was postponed in FY22, due to different technology choices for forward ECal by ECCE (Pb/Sc Shashlyk) and ATHENA (W/ScFi).
- Remaining technical questions for W/ScFi technology from the generic R&D program that
  - Uniformity of light collection $\rightarrow$ constant term $\sim$ 2% in energy resolution in YR.
  - Efficiency of light collection $\rightarrow$ YR requirement on min. energy $\sim$ 5 MeV.

Participating institutes/consortia:

- BNL, Chinese EIC ECal Consortium, Indiana University, UC EIC Consortium

eRD106 - Plans & Milestones

Milestones for FY23

1. **To address the remaining technological questions:**
   - Construct 64 channel ECal prototype, using latest method developed by eRD1.
   - Optimize light guides.
   - Test detector at FNAL.
2. **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)
3. **Preview of FY24, FY25**
   - Produce more blocks for joint test run with Forward HCal
   - Joint test run with HCal with final readout electronics

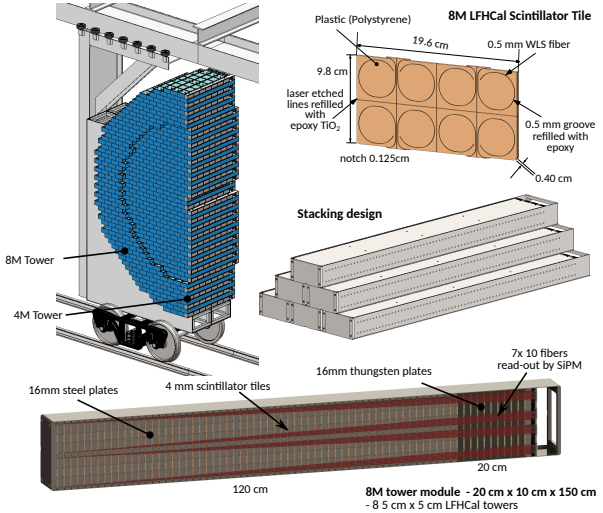
eRD107: Longitudinally separated Forward HCal (LFHCal)

October 20, 2022

Friederike Bock (ORNL)
for the eRD107 consortium

M. Arratia (UCR), F. Bock (ORNL), H. Caines (Yale), M. Connors (GSU), J. Freeman (FNAL), A. Gibson (Valpo), O. Hartbrich (ORNL), J.Lajoie (ISU), C. Loizides (ORNL), C. Nattrass (UTK), N. Novitzky (ORNL), B. Page (BNL), K. Read (ORNL/UTK), N. Schmidt (ORNL), P. Steinberg (BNL), C. Woody (BNL)

The General Idea



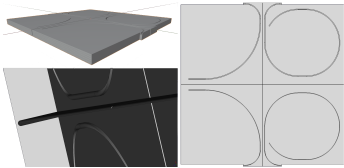
Concept:

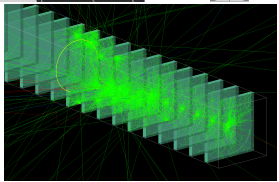
- PSD [link TDR] inspired inspired Fe/W-Scint calorimeter
  60 layers of Steel (160 mm)-Sci plates (4mm) +
  10 layers of W (160 mm)-Sci plates (4mm)
- Multiple towers combined in one module to reduce dead areas, increase granularity
- Read-out:
  - 7 signals per tower (signals combined from 10 Sci-plates)
  - readout position: after full HCal
- Modules of different sizes (8M, 4M, 2M, 1M) to maximize coverage & assembly efficiency

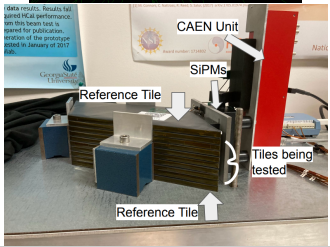
Participating institutes:

- ORNL, BNL, FNAL, ISU, GSU, Yale, UCR, UTK, Valpo

eRD107 - Plans & Milestones







1. **Prototype tile production using machining & injection molding (04/23)**
   - Assembled prototype tiles using machined scintillator plates
   - Assembled prototype tiles using injection molded scintillator tiles
   - Documentation of procedures for manual assembly of tiles & WLS fibers
2. **Reconstruction optimization (09/23)**
   - Write-up of optimization results from simulations
3. **Sensor board development (07/23)**
   - First prototype of sensor board for Si-PM readout (together with eRD109)
4. **Small test module assembly (07/23)**
   - First prototype of single segment of 8M module
5. **First automated scintillator tile assembly (08/23)**
   - Assembled prototype tiles
   - Documentation and Evaluation of procedures for automated assembly of tiles & WLS fibers
6. **Tile Characterization (08/23)**
   - Write-up of test bench & test beam measurement for all assembled tile-prototypes

Close-out remarks: eRD106/eRD107 – Forward Calorime

- ePIC choice of WSciFi for EM cal
- Focus on optimization of sensor/fiber connection to increase uniformity and efficiency
- In addition to study of proposed scheme, recommend study of possibly simpler alternatives
- Development of Hadron Cal modules especially production
- Good collaboration with CALICE
- Testing of injection molding tiles
- Recommend study with prototype and incorporation of performance parameters in ePIC simulation
- Some of tasks are more project engineering than R&D

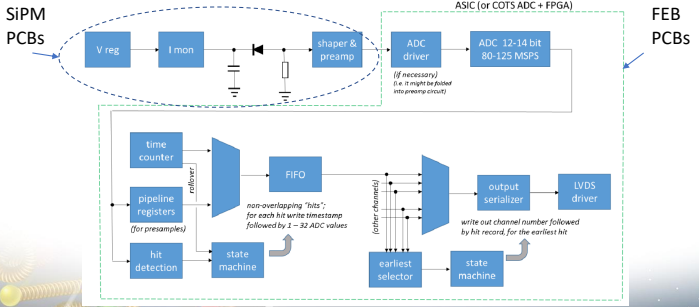
eRD109

F. Barbosa (JLab)
for the eRD109 consortium

https://indico.bnl.gov/event/17159/

Proposal A – Calorimeters, SiPMs – Discrete/COTS/ASIC

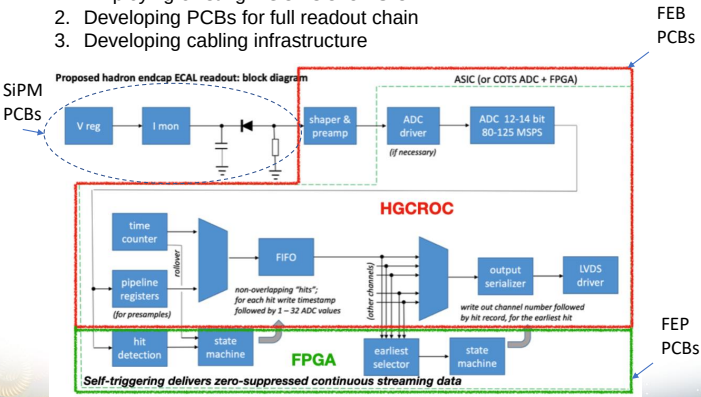
- Develop a readout solution for the calorimeters with SiPMs by:
  1. Employing discrete, COTS devices
  2. Developing PCBs for full readout chain
  3. Developing cabling, controls, power and cooling infrastructure
  4. Making it adaptable to implementations that may benefit from the availability of ASICs.



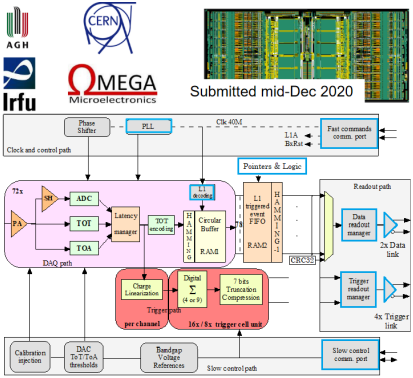
- Based on STAR FCS.

Proposal B – Calorimeters, SiPMs – HGCROCv3

- Develop a readout solution for the calorimeters with SiPMs by:
  1. Employing existing HGCROCv3 ASIC
  2. Developing PCBs for full readout chain
  3. Developing cabling infrastructure



eRD109 - Slides



- SiPM version.
- Large dynamic range.
- Low noise.
- Charge: ADC+TOT (22 bits).
- Time: TOA (25 ps).
- 512 DRAM buffer.
- 2x 1.28 Gbps links.
- I2C controls.
- 40 MHz operation.
- 20 mW/Ch.
- Radiation tolerant.

- Developed for CMS.

eRD109 – Proposals: Cost & Timeline

- Budget requests for each of the five (5) proposals:

	File	Authors	FY23 ($k)	FY24 ($k)	FY25 ($k)	FY26 ($k)
A	eRD109_pECAL_readout_prototype_FINAL	G. Visser (IU), et al.	79.7	31 - 41	31 - 41	Not provided
B	eRD109CalorimeterReadout	N. Novitzky (ORNL), et al.	39	34	26	Not provided
C	eRD109-alcor	M. Ruspa (INFN), et al.	60	60	60	Not provided
D	ACLGAD_ASIC_Electronics_FY23	Z. Ye (UIC), et al.	267 (Note 1)	220	700	100
E	eRD109_SALSA_proposal_vfinal1	D. Neyret (CEA), et al.	197	Not provided	Not provided	Not provided

- Note 1: Details of AC-LGAD development costs:

	ACLGAD_ASIC_Electronics_FY23	FY23 ($k)
1	EICROC ASIC	75
2	FCFD ASIC	40
3	Third party ASIC Evaluation	33
4	Frontend Electronics	119

- Mostly labor for development of associated flexible PCBs, prototype of readout PCBs and service hybrids.

Close-out remarks: eRD109 & General

eRD 109 remarks:

- Active program for many detector sensor/systems
- All require compatible with streaming read out
- Important for collaboration to focus on details of full readout system (i.e. detector to electronics hut)
- Overlapping efforts should mitigate risk and lead to synergy in R&D
- Recommend careful attention to ASIC development cycles with vendors to keep to project timeline, possibly too optimistic. Historically development time has been significantly under-estimated.

General Recommendations:

- Again, congratulations to all on enormous progress in short time!
- Continue workshops to have good communication between overlapping development efforts
- Many projects are at test beam stage; overall coordination might be very useful
- At next review important to hear how R&D is being used in development of final design, especially critical design choices
- Aggressive effort needed to keep to project timeline
- Important to move from R&D activites to detector specific design
- Important to expand manpower as soon as possible to keep on track
- Recommend more direction of effort towards final detector development for CD2/3a