中国科学院高能物理研究所
Institute of High Energy Physics, Chinese Academy of Sciences

Experimental Characterization and Optical Simulation of Scintillating Glass for the AGORA Calorimeter

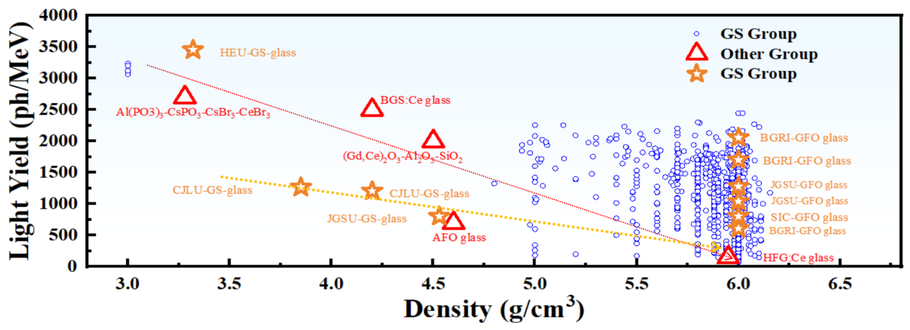
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on behalf of the AGORA-calorimetry team

Institute of High Energy Physics, Chinese Academy of Sciences

01 Background

AGORA: one of the detector concepts proposed for FCC-ee

- Material cost of crystal ECAL motivates a glass alternative.
- Improved GFO glass motivates extending scintillating glass to ECAL.
- ECAL material-cost savings allow a larger sensitive volume in HCAL.



Design requirements

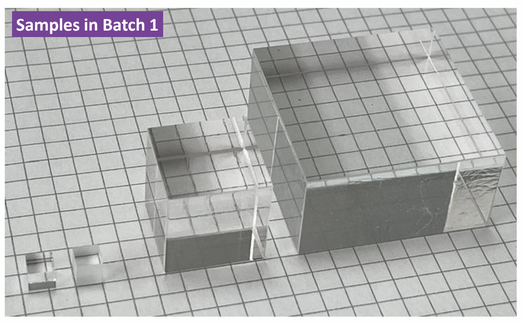
Property	ECAL	HCAL
Density (g/cm³)	6.0	6.0
Light yield (ph/MeV)	2000	≥1000
Attenuation length (cm)	≥10	≥10
Scintillation time (ns)	~500	~500

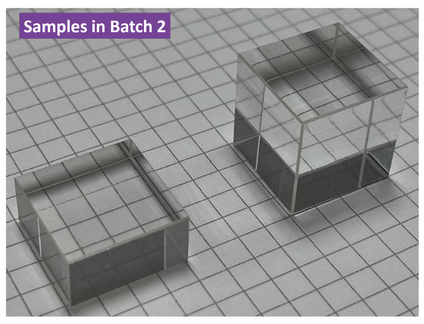
Section	CEPC Reference detector	AGORA concept
ECAL	BGO crystal bars	Finely segmented GFO glass cells
HCAL	Glass + steel sampling ~30% sampling fraction	Glass replaces steel absorber High active material fraction

02 Laboratory Cosmic-Ray Test of Scintillating Glass Samples

ScintGlass samples from BGRI:

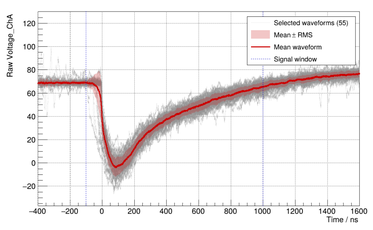
- Batch 1: 5×5×5 mm³ cube × 2, **20×20×20 mm³ cube**, 40×40×20 mm³ brick
- Batch 2: **20×20×10 mm³ tile, 20×20×20 mm³ cube**



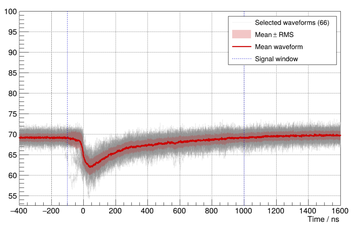


Typical cosmic-ray waveforms of ScintGlass with different SiPMs:

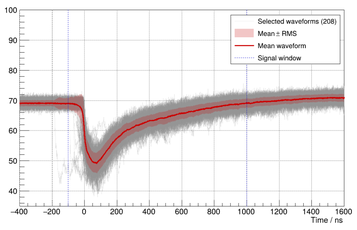
S13360-6025PE



S14160-3010PS

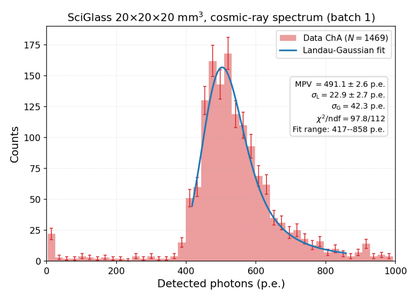


S14160-3015PS

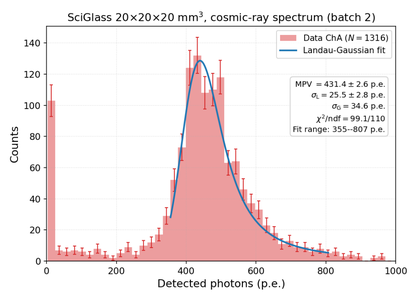


MIP response results from cosmic-ray test:

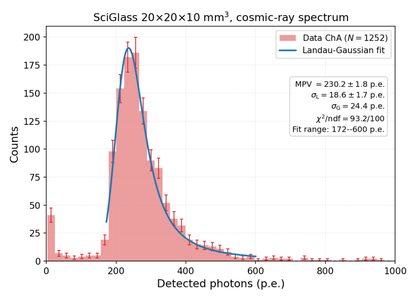
- 3 different samples with 6×6 mm² SiPM (Hamamatsu S13360-6025PE)



MPV: 491.1 ± 2.6 p.e.

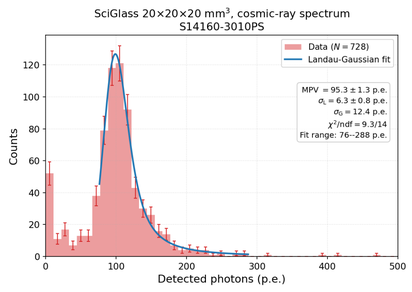


MPV: 431.4 ± 2.6 p.e.

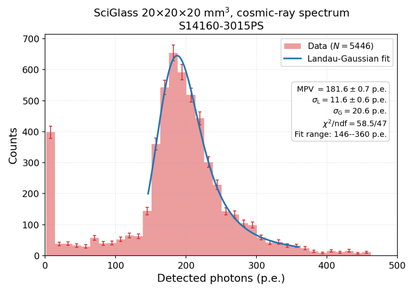


MPV: 230.2 ± 1.8 p.e.

- 1 sample with different 3×3 mm² SiPM (Hamamatsu S14160-3010PS, S14160-3015PS)



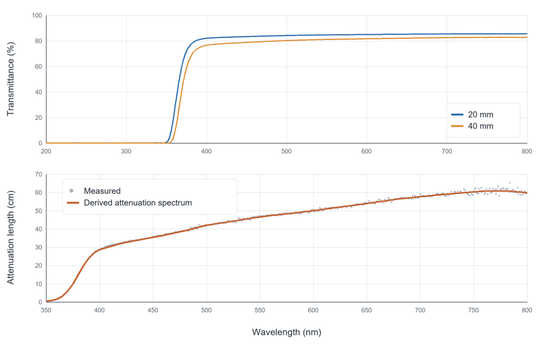
MPV: 95.3 ± 1.3 p.e.

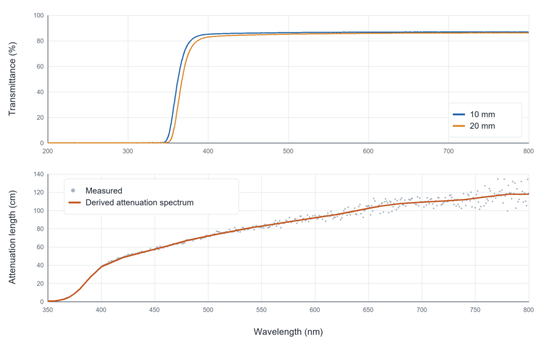


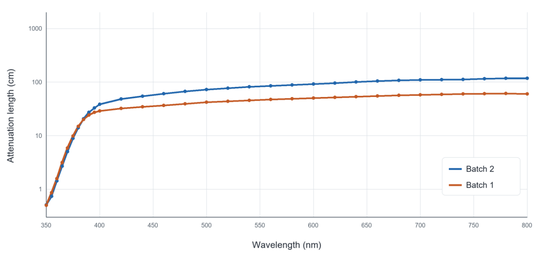
MPV: 181.6 ± 0.7 p.e.

03 Transmittance and Attenuation Length

- Measurements of transmittance(T) by Agilent Cary 60 UV-Vis spectrophotometer
- Culculation of the attenuation length: AL = (L1-L2)/ln(T2/T1)





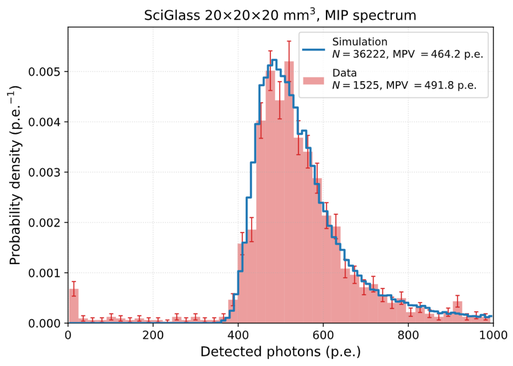


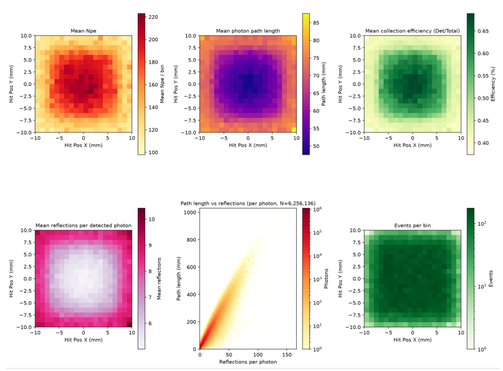
Attenuation length of tens of centimeters, indicates improved light output uniformity, thereby allowing improved energy resolution to be achieved.

04 Optical Simulation

Developing a Geant4 optical model to describe and understand the optical properties of ScintGlass

- The established model has been initially validated against a specific set of experimental data, providing a basis for further refinement.
- To identify the best model, the next step is to tune parameters such as light yield and attenuation length and to introduce scattering, so that the simulation agrees with all measured data.





Conclusions

- Light output of 95–491 p.e./MIP, providing promising photon statistics for ECAL
- Wavelength-dependent attenuation length on the order of tens of centimeters
- Providing encouraging reference results for future R&D

Outlook

- Position-dependent light output uniformity scan
- More rigorous calculation of attenuation length
- Further optimization of the Geant4 optical model

[1] CEPC Reference Detector TDR, arXiv:2510.05260 (2025).