Beamtest results of high-density glass scintillator tiles

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On behalf of the CEPC calorimetry team, the CALICE collaboration and the Glass Scintillator Collaboration

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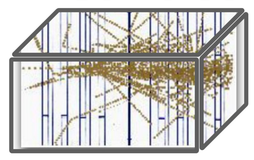
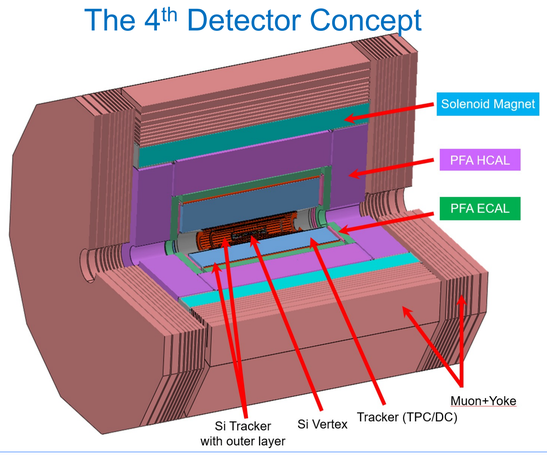


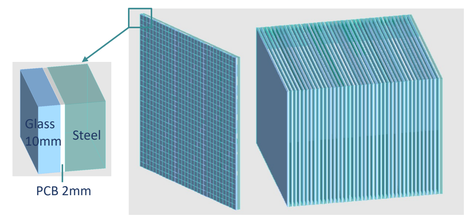
Introduction

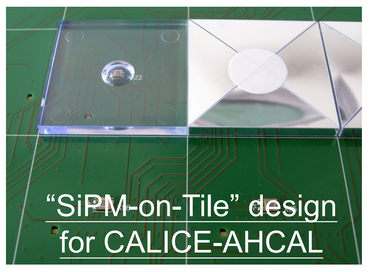
- PFA-oriented detector system: the CEPC 4th conceptual design
  - Hadronic calorimeter (HCAL) with glass scintillator tiles
  - Requires glass scintillator with dense, bright, cost efficient
  - Expect better hadronic energy resolution → better BMR
- R&D activities for glass scintillator HCAL
  - HCAL design, simulation studies and hardware developments
  - Glass scintillator tiles: testing with cosmics/sources/beams
    - Key requirement: MIP response ~100 p.e. in 10 mm thickness
  - PFA optimization and physics performance studies[1]

The 4th Detector Concept



Glass scintillator HCAL

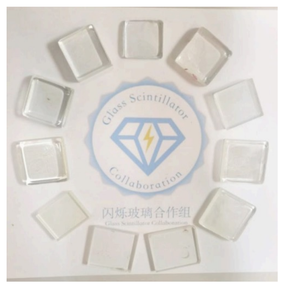




CERN Beamtest with muon

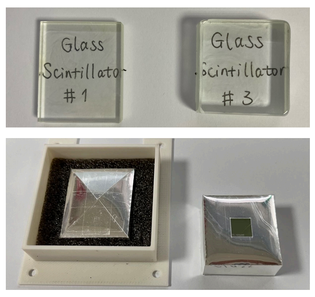
- **First batch of large-area glass scintillator tiles**
  - 11 tiles successfully tested at CERN PS-T9 in May 2023
  - Various tile dimensions: 25–40 mm in length, 5–10 mm in thickness

Glass tiles before wrapping

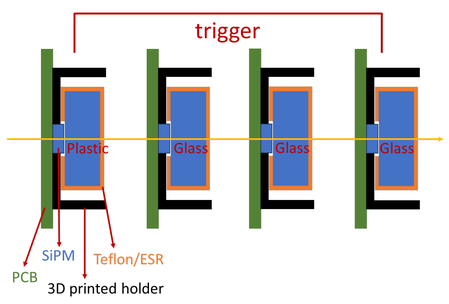


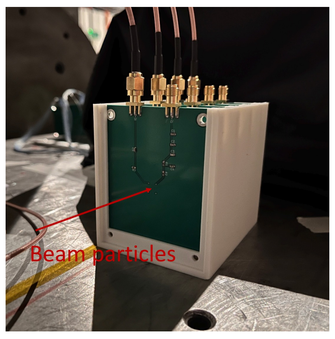
Glass tiles wrapped with Teflon and black tapes

Two glass tiles re-wrapped with ESR



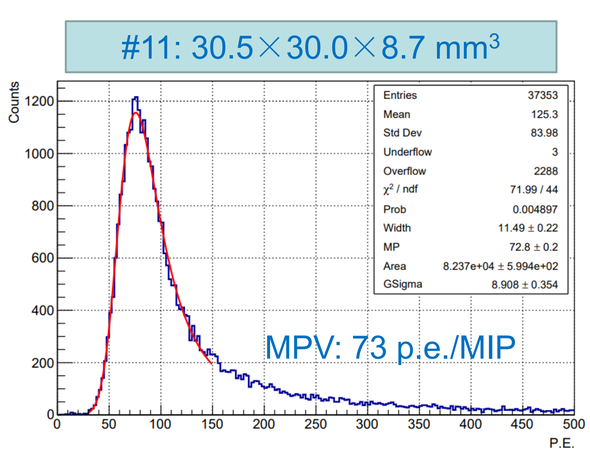
- **Beamtest setup**
  - 3 glass scintillator tiles and 1 plastic scintillator tile (as a reference) with individual SiPM readout
  - Used 10 GeV muon beam



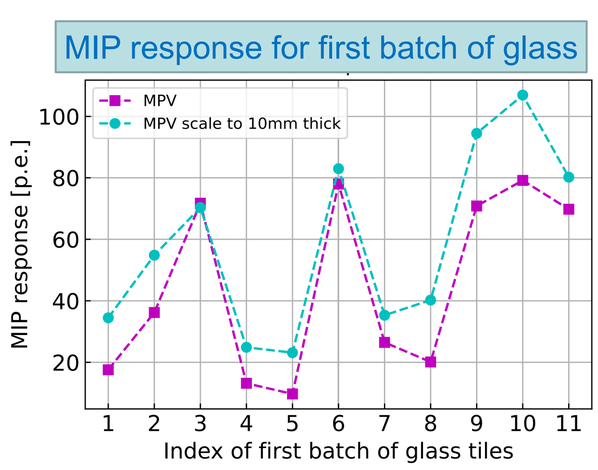


- **Beamtest results**[2]
  - Observed clear MIP signals in all 11 glass tiles
  - Fitting by Landau (MIP response) convoluted with Gaussian
  - MIP response range for all samples: 10–79 p.e./MIP

#11: 30.5×30.0×8.7 mm³



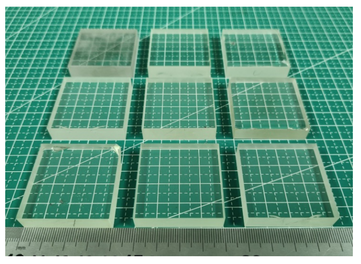
MIP response for first batch of glass



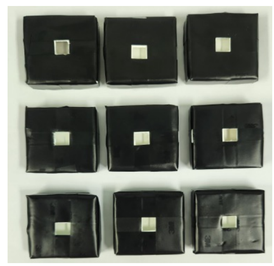
DESY Beamtest with electrons

- **Second batch of large-area glass scintillator tiles**
  - 9 new glass tiles with standard dimensions ($4\times4\times1\mathrm{cm}^3$) successfully tested at DESY in Oct. 2023 with 5 GeV e- beam
  - Also re-tested 4 glass scintillator tiles from the first batch
  - Response uniformity across the tile was scanned

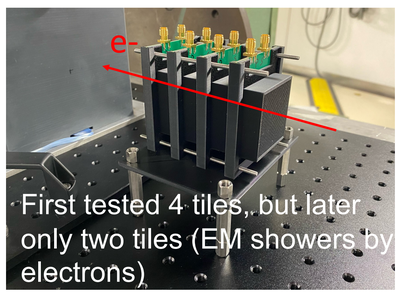
Glass tiles (standard size) before wrapping

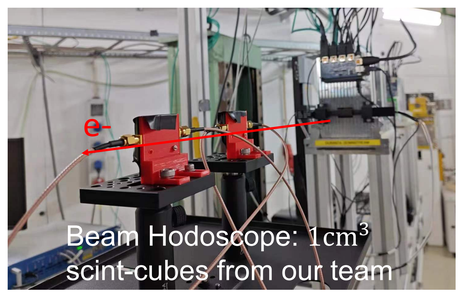


Glass tiles wrapped with Teflon and black tapes



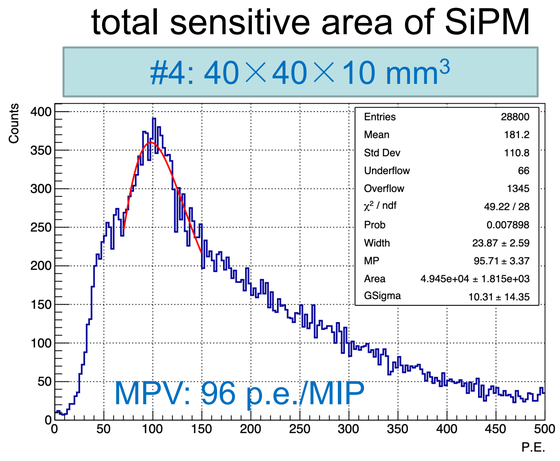
- **Beamtest setup**
  - 1 glass scintillator tiles (downstream) and 1 plastic scintillator tile (upstream) with individual SiPM readout
  - Used 5 GeV electrons beam: profile ~1cm² (determined by trigger)



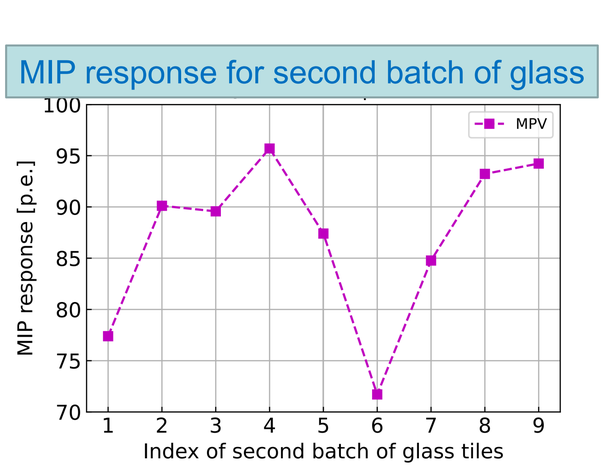


- **Beamtest results**
  - Observed clear (quasi-)MIP signals in all 13 glass samples
  - Typical MIP response: 71–96 p.e./MIP, showed generally relatively good uniformity with the same batch
  - 4 SiPMs can significantly improve tile uniformity with the same total sensitive area of SiPM

#4: 40×40×10 mm³



MIP response for second batch of glass



Conclusions

- Successful beamtests with the first batch of 11 glass scintillator tiles and second batch of 9 glass tiles in standard dimensions
- Promising results in the first batch of glass tiles, some samples expected to achieve the requirement of 100 p.e./MIP with thickness scaling
- For the second batch of tiles in standard dimensions, the Quasi-MIP response range of 71–96 p.e./MIP → promising to achieve the goal

Acknowledgements

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Reference

[1] "Performance studies of the GSHCAL based on the simulation" at CALOR 2024
[2] D. Du, Y. Liu, H. Cai, D. Chen, Z. Hua, J. Han et al., Muon beamtest results of high-density glass scintillator tiles, Journal of Instrumentation 19 (2024) P05039.