

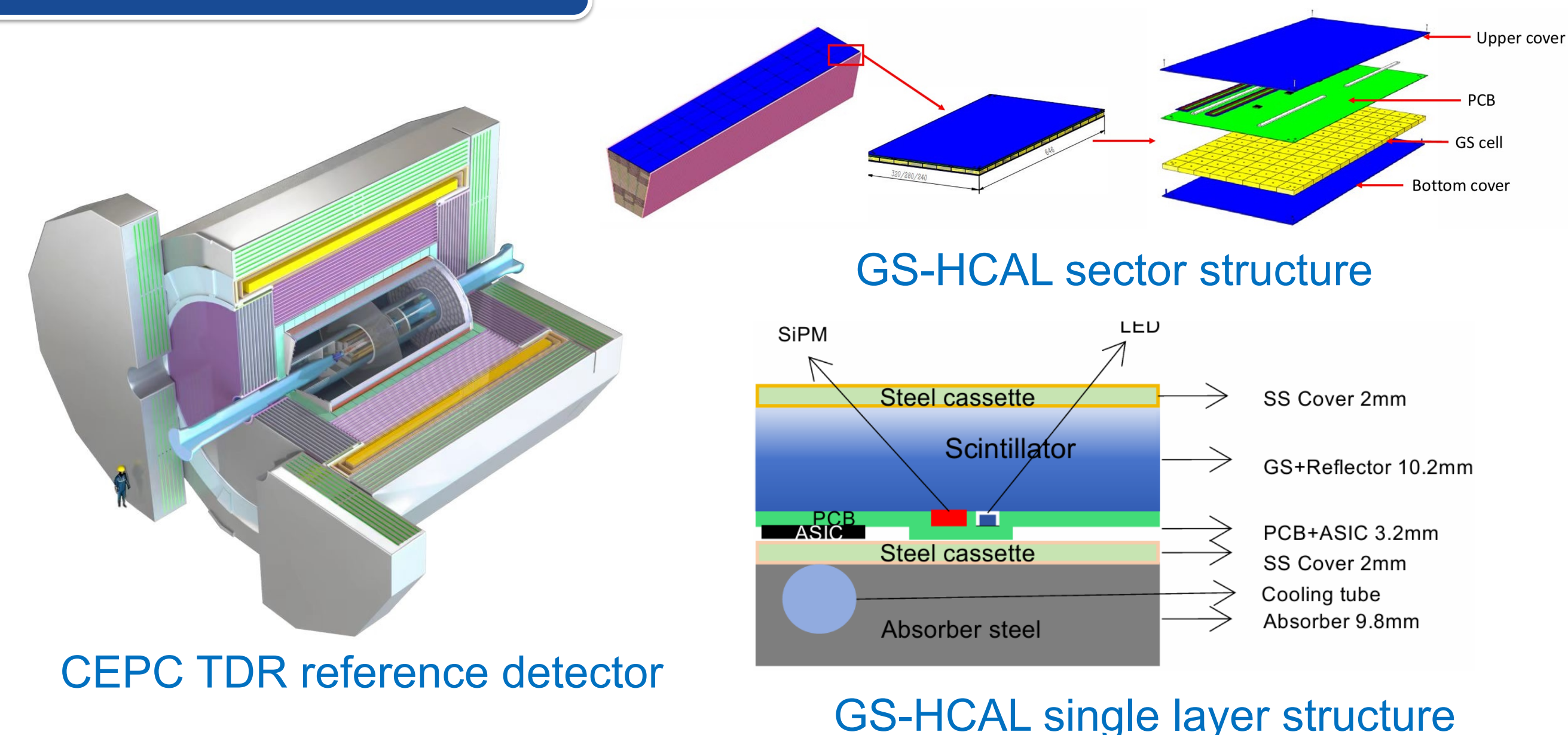
Introduction

➤ PFA-oriented calorimeter system: CEPC ref-TDR detector design

- Hadronic calorimeter (HCAL) with glass scintillator tiles
- Expect better hadronic energy resolution than the plastic scintillator option
- Requires glass scintillator to be dense, bright, cost efficient

➤ 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 60-100 p.e. in 10 mm thickness



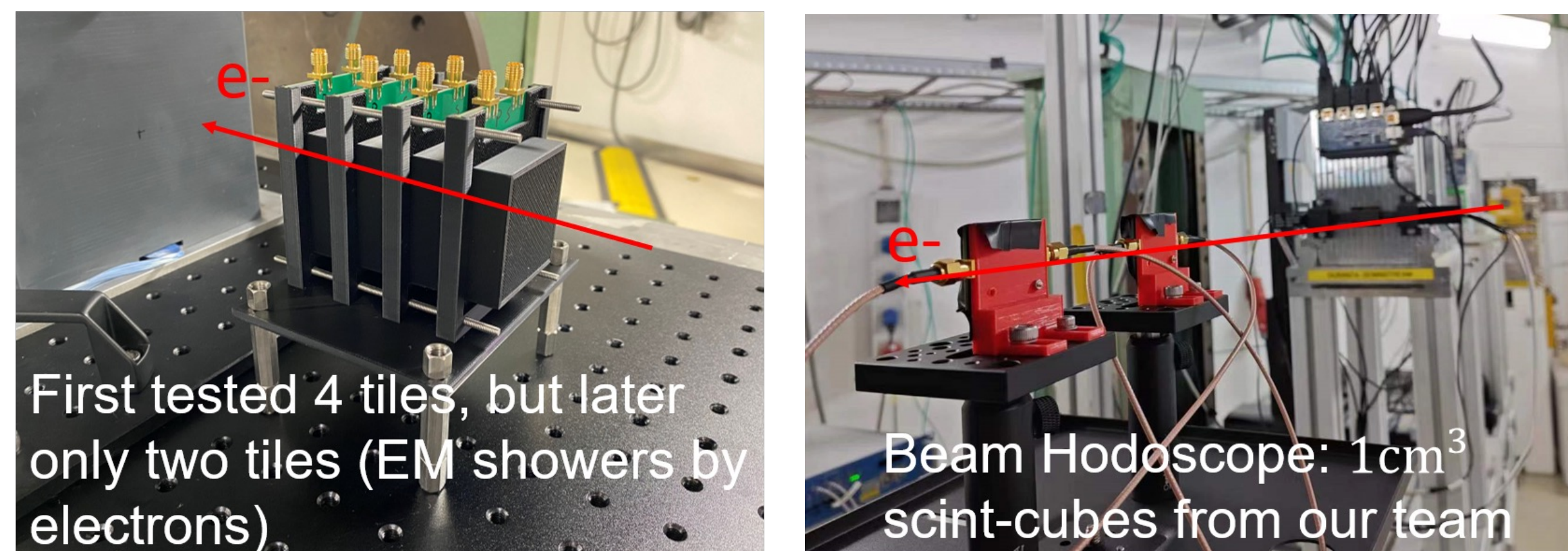
Beam test results

➤ Beam test for glass scintillator tiles

- 9 glass tiles with standard dimensions ($4 \times 4 \times 1 \text{ cm}^3$)
- Each glass tile coupled with one SiPM ($6 \times 6 \text{ mm}^2$) at the center for readout
- Successfully tested at DESY in Oct. 2023 with 5 GeV e^- beam

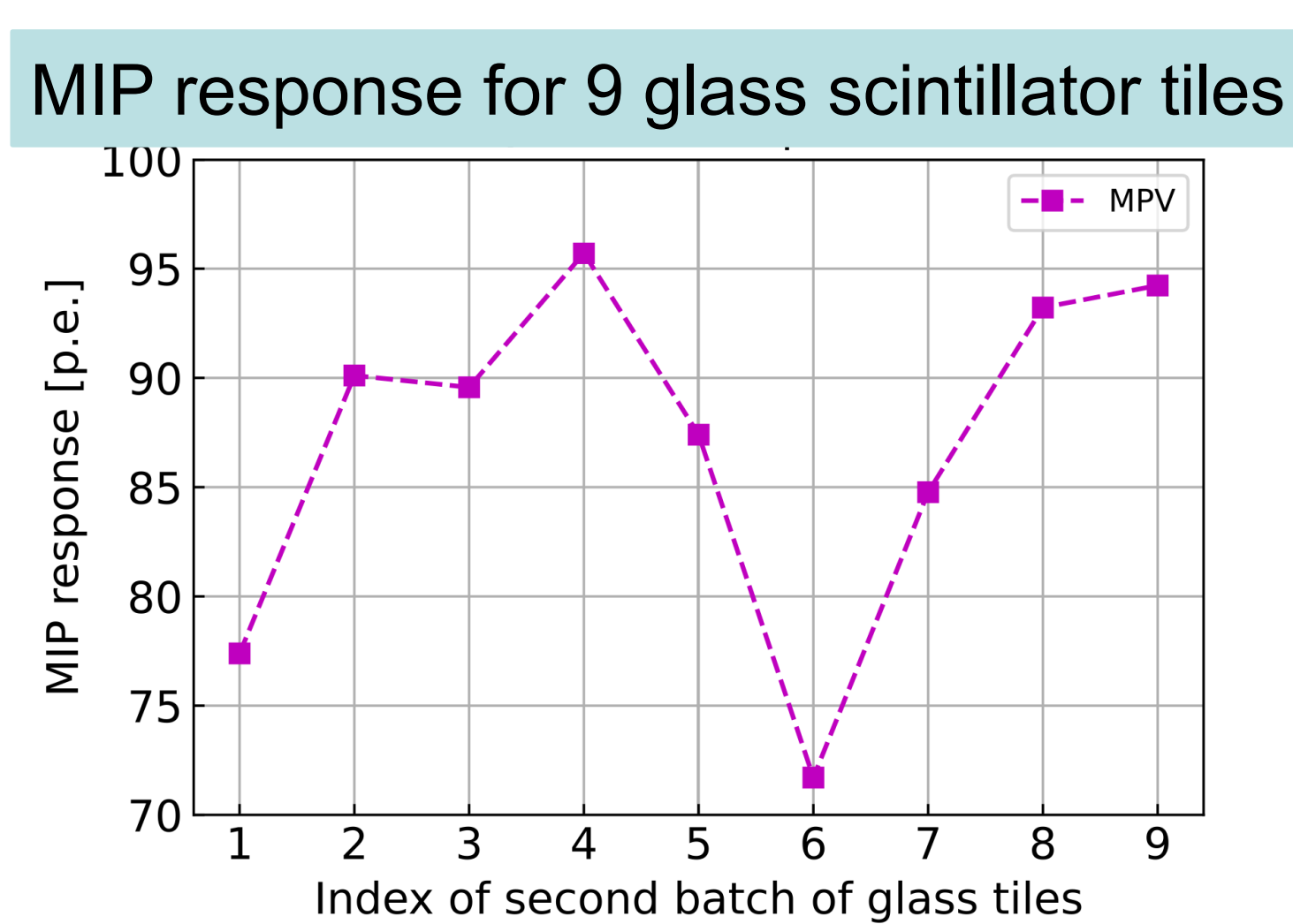
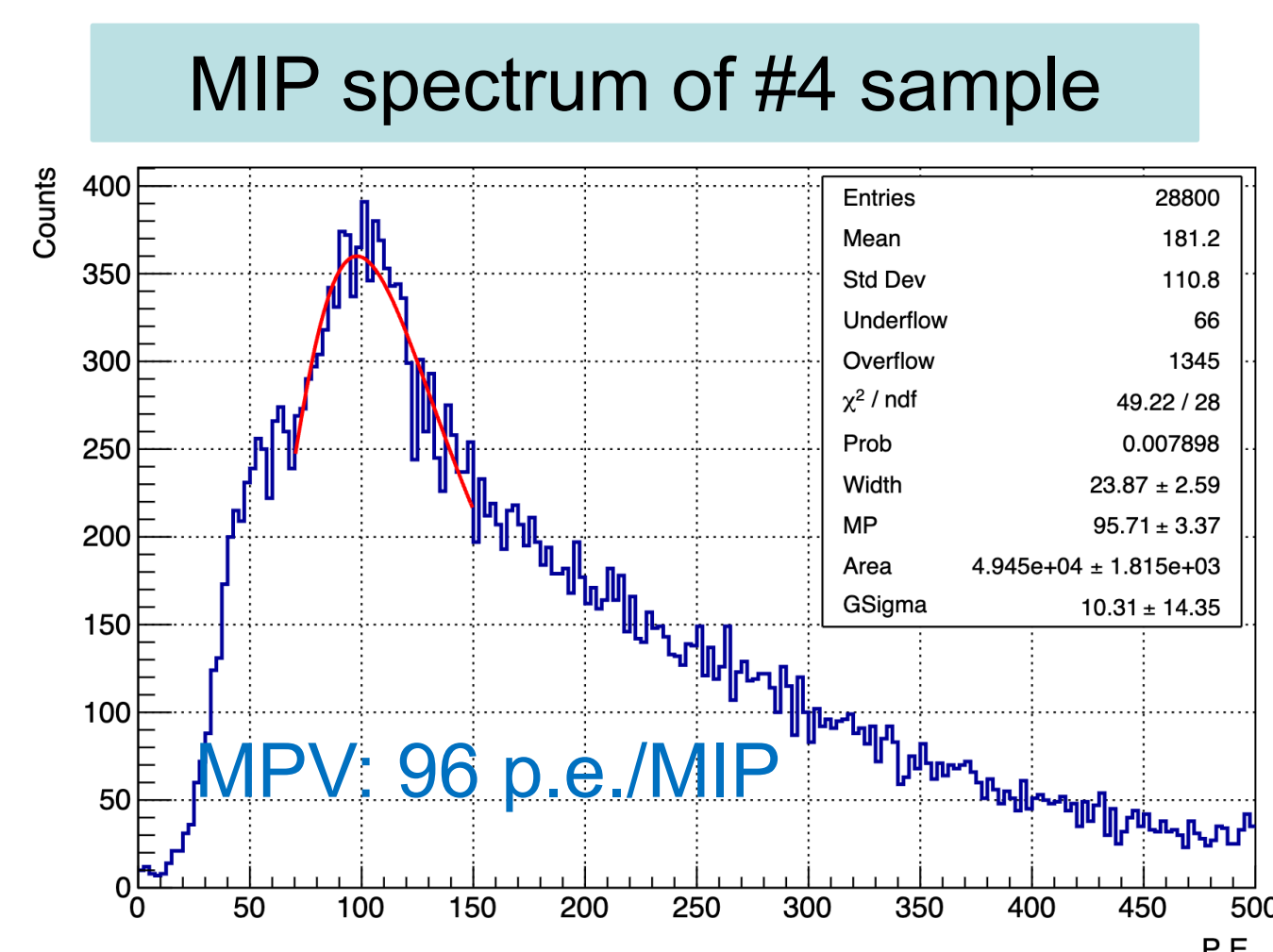


Beam test setup at DESY TB-22



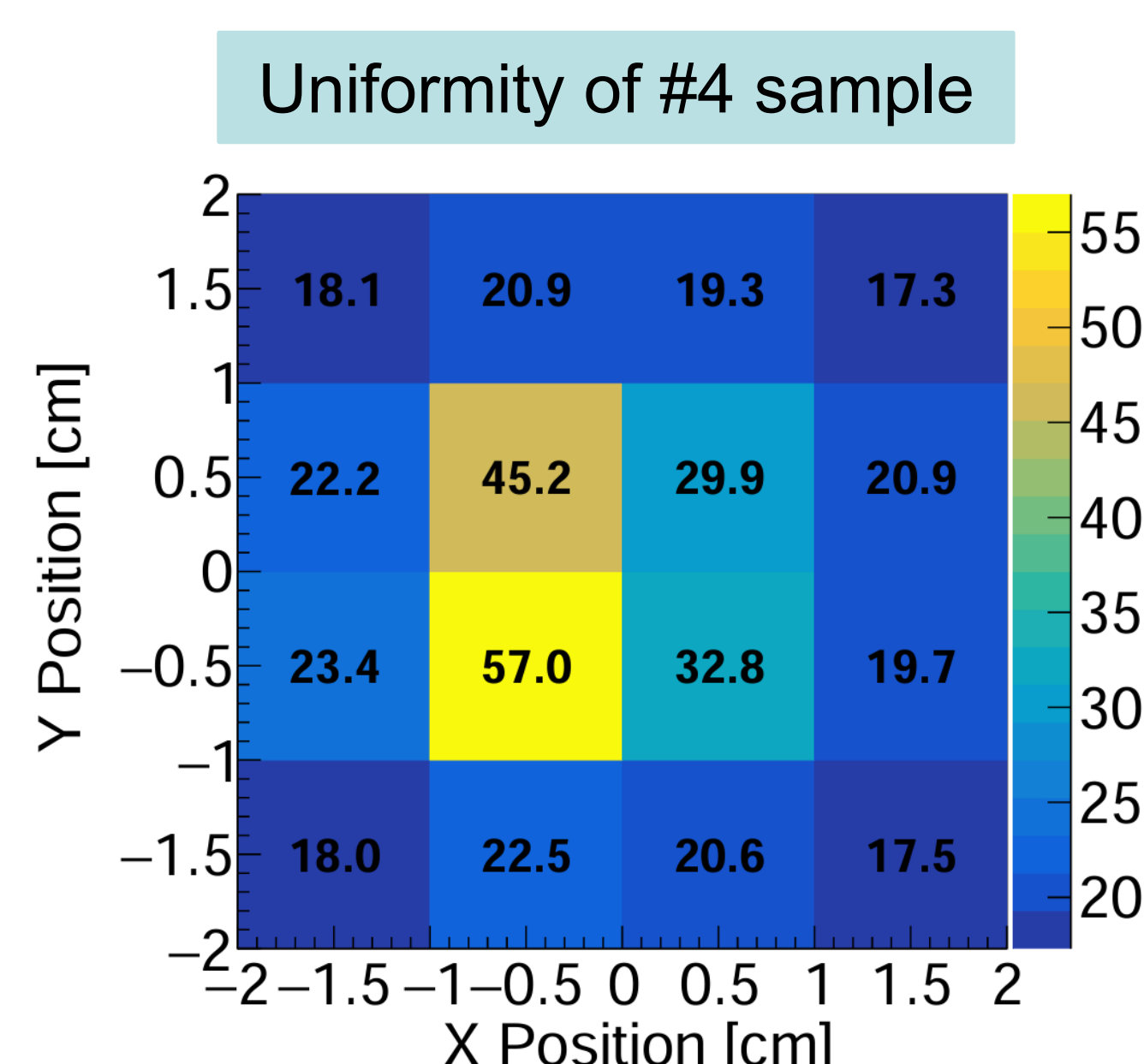
➤ MIP response

- Observed clear (quasi-)MIP signals in all 9 glass tiles
- The patterns in energy spectrum is largely due to tile response non-uniformity
- Typical MIP response: **71–96 p.e./MIP**, showed generally relatively good uniformity with the same batch



➤ Uniformity of individual glass tile

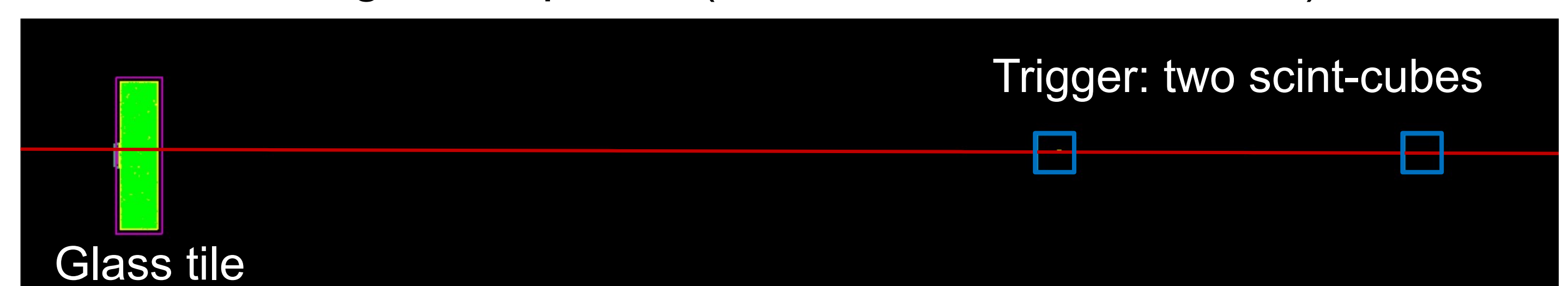
- Vary beam incident position (1 cm step limited by trigger)
- Non-uniformity ($\frac{\max - \min}{\text{ave}}$) is very large $\sim 200\%$
- Improve it by optimizing **tile design** and glass material properties



Optical simulation studies

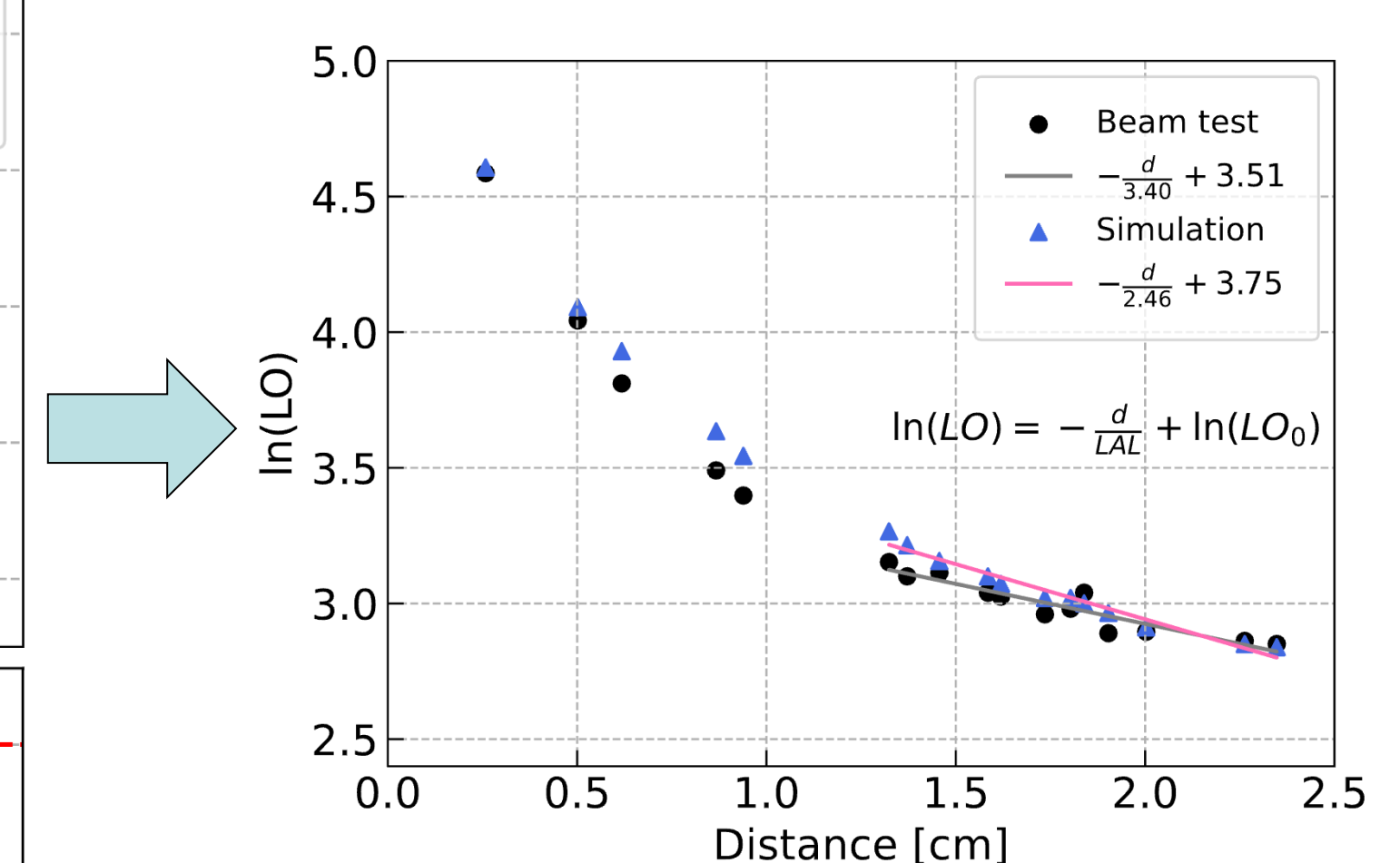
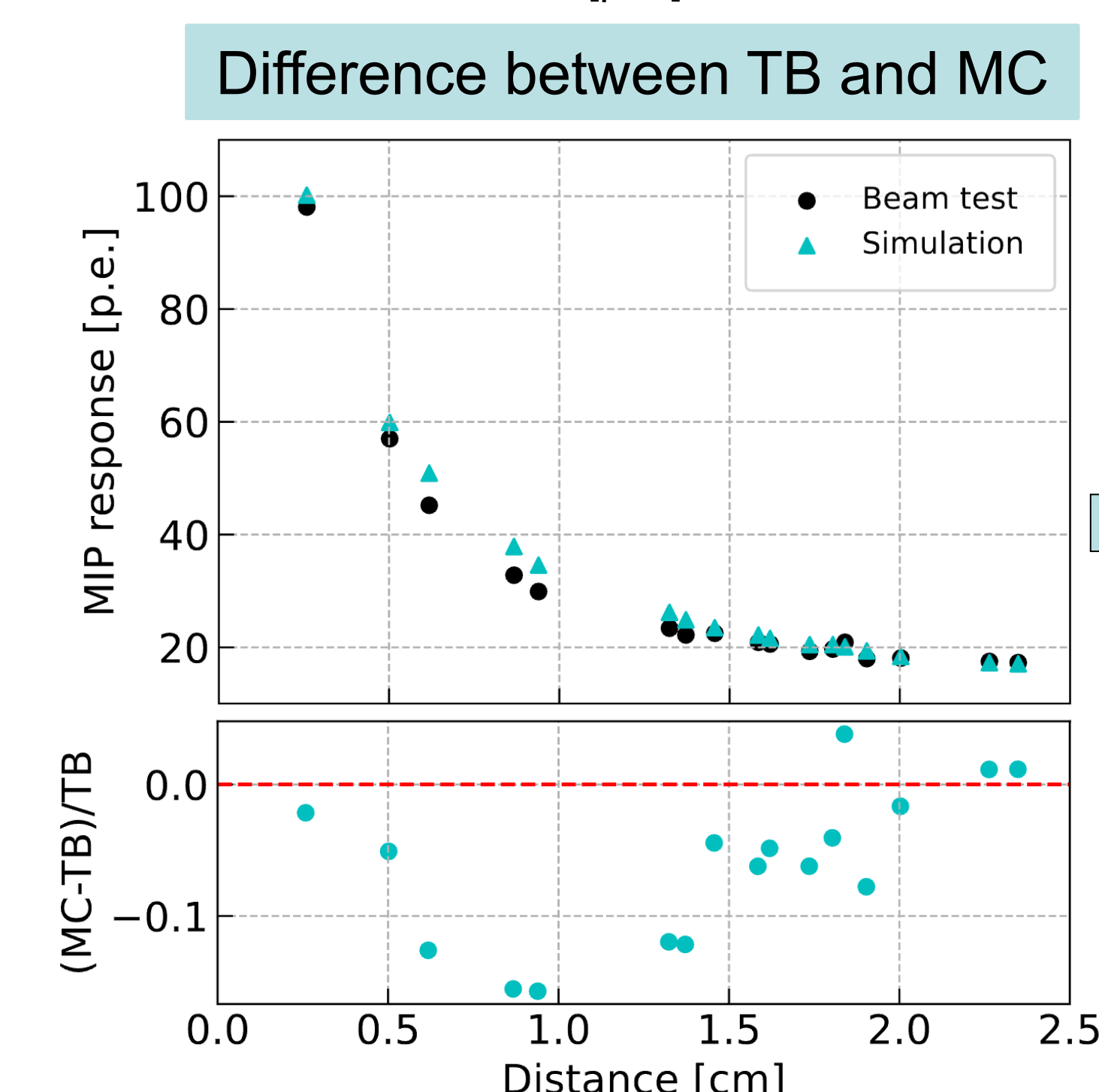
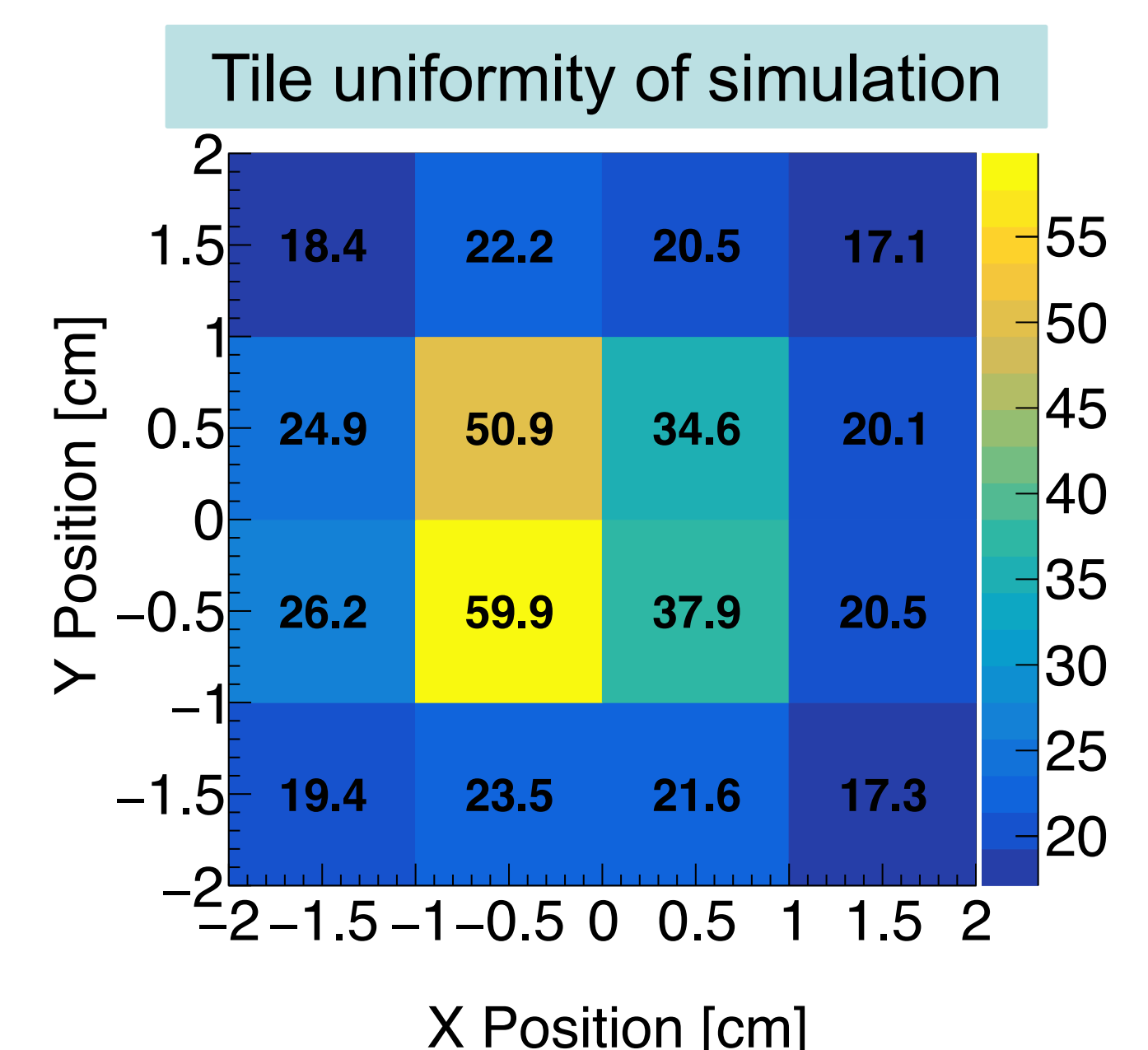
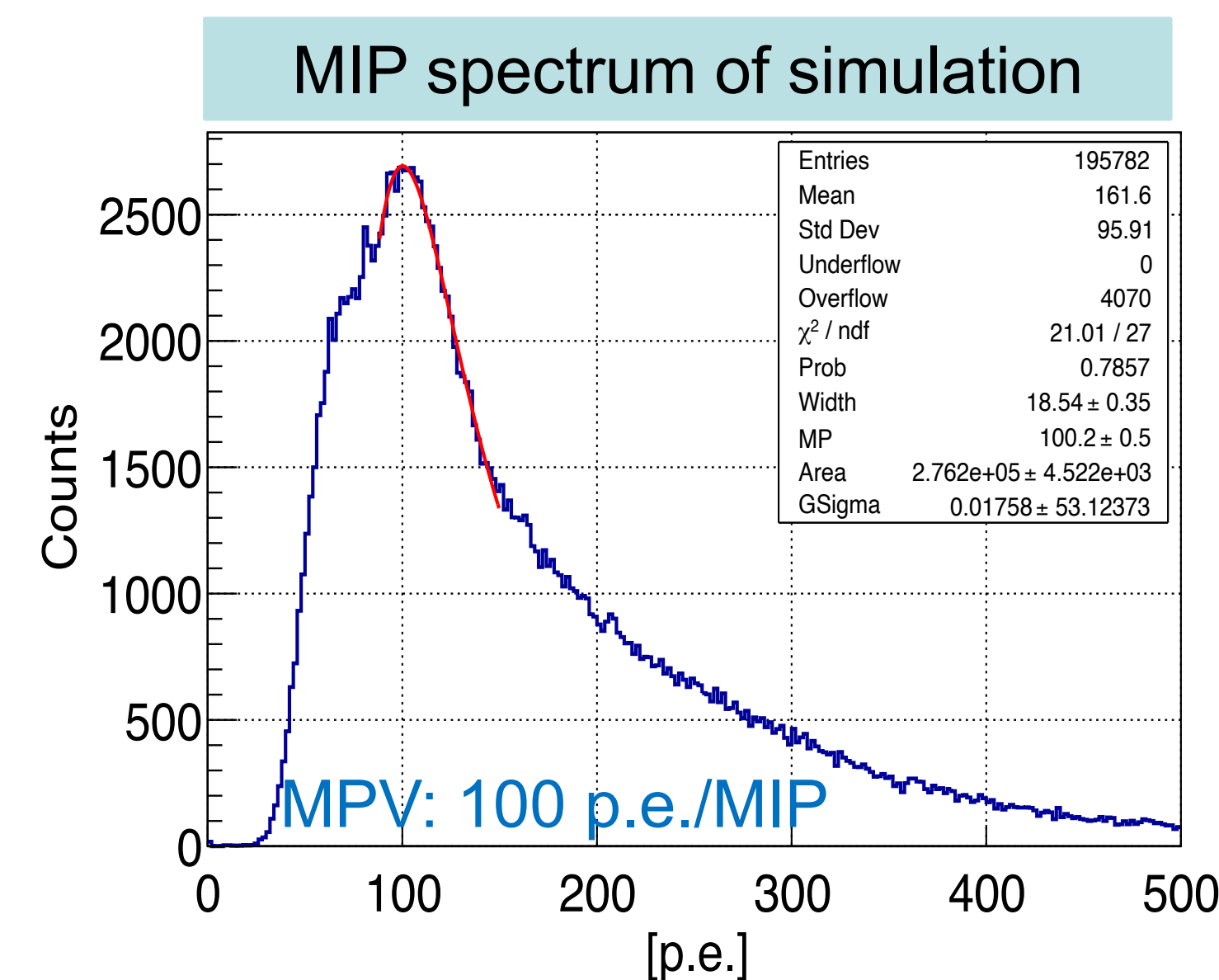
➤ Simulation Setup

- Including detailed geometry and optical processes
- Properties of the glass tile extracted from measurements
- Considering beam profile (2-D Gaussian distribution)



➤ Simulation results

- For #4 glass tile, the discrepancy between test and simulation is smaller than 15%
- The scattering effect cannot be ignored in glass scintillators, and the influence of scattering needs to be further considered in the simulation



Summary

- Successful beam test with 9 glass tiles in standard dimensions, and results show the target of $\sim 100 \text{ p.e./MIP}$ in 10 mm thickness is very promising
- Ongoing efforts to improve TB/MC consistency through optimizing the optical simulation setup, and to improve tile uniformity by optimizing glass tile design

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