Hadronic calorimeter (HCAL) design: reminder

- CEPC CDR baseline: Scintillator-Steel AHCAL
 - 40 sampling layers
 - Plastic scintillator (sensitive): 3 mm thick
 - Steel (absorber): 20 mm thick
 - Tile size: $30 \times 30 \ mm^2$
- Scintillating glass HCAL
 - Replace plastic scintillator with scintillating glass
 - Glass tile design: ongoing optimization



Single layer of CEPC AHCAL prototype

CEPC AHCAL prototype schematics



"SiPM-on-Tile" design





Note: Next study used a ideal geometry (semi-infinite) to avoid energy leakage

Performance of HCAL with scintillating glass



Incident particle: K_L^0 (1-100 GeV) Component: $B_2O_3 - SiO_2 -$ $Al_2O_3 - Gd_2O_3 - Ce_2O_3$ Density: 4.94 g/cm^3 (goal: $> 6 g/cm^{3}$)



- Performance potentials: comparison
 - Followed by detailed studies (next pages)
- Scintillating glass: better hadronic energy resolution in low energy region, especially in low energy resolution
 - Most hadrons at CEPC are with low energy



Impact of thickness to hadronic energy resolution



Orange curve corresponds to the homogeneous HCAL



- Varying thickness: glass and steel
 - Each layer fixed with $\sim 0.12\lambda_I$
 - Nuclear interaction length λ_I
 - Glass = 22.4 cm, steel = 16.8 cm
- Lower threshold would always be desirable for better resolution
- Better stochastic term with thicker scintillating glass
- The increase of glass thickness dose not significantly impact the constant term



MIP response of detector unit





• MIP response in experiment: 277 p.e./MIP





- Detected Photon Langau h3 Entries 10000 1200 302.6 Mean Std Dev 84.09 χ^2 / ndf 183.1 / 61 1000 Prob 3.908e-14 Width 11.97 ±0.28 MP 256.7 ±0.4 800 Area $1.112e+05 \pm 1.124e+03$ GSigma 18.22 ±0.52 600 400 200 100 200 300 400 500 600 700 800 900 1000
- Simulation setup
 - Scintillating glass (4.5×4.5×3.5mm³)
 - $6 \times 6 mm^2$ SiPM
 - Small air bubbles are included
- Perpendicular incidence
- 1 GeV mu- (regard as MIP particle)
- MIP response in simulation: 257 p.e./MIP
- Simulation validated by measurements
 - Reasonable consistency achieved



Projected performance of detector unit



- Considering response and uniformity, the optimal thickness is ~10mm
- Uniformity can be further optimized with new glass tile designs

