# The development of a highly granular scintillator-steel hadron calorimeter for the CEPC

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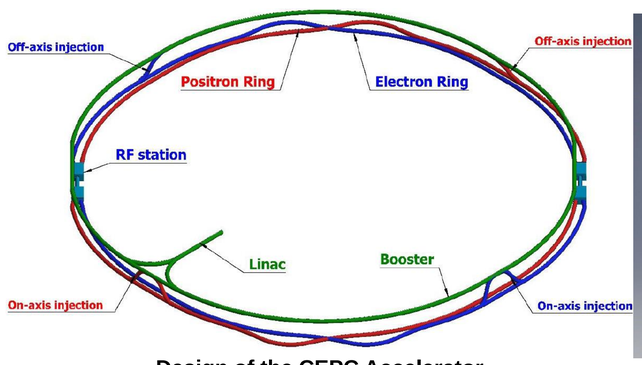
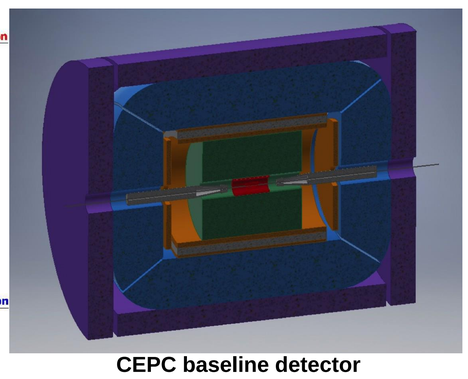
**Abstract:** Based on the particle-flow algorithm, a highly granular sampling hadron calorimeter (HCAL) with scintillator tiles as active layers and stainless steel as absorber is proposed to achieve an unprecedented jet energy resolution to address major challenges of precision measurements at future lepton colliders, including the Circular Electron Positron Collider (CEPC). A wide range of R&D efforts are being carried on with a major aim to construct a scalable HCAL prototype for the CEPC. This talk will present the latest progress of the prototype development, with highlights from optimization studies of the HCAL design based on the evolving CEPC Particle Flow Algorithm "Arbor", mass production of scintillator tiles, automated foil wrapping, as well as dedicated test stands for the quality control of scintillator tiles.

## Introduction

The Circular Electron Positron Collider(CEPC) is a future Higgs or Z factory. In order to conduct precision measurements on Higgs and Z bosons, the detector system is guided by the particle flow algorithm(PFA). The PFA can reach a good jet energy resolution by using the optimal detector to detect different components in a jet. the key point to realize PFA is to separate the different components in a jet, so the high granularity AHCAL would play an important role in the PFA reconstruction

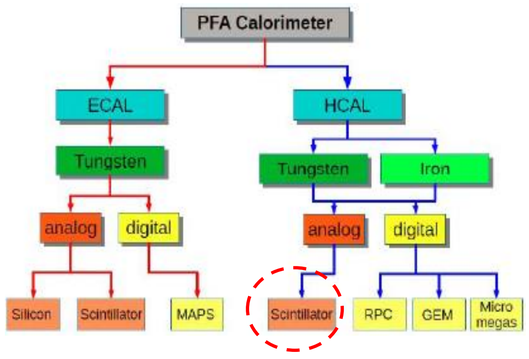



Design of the CEPC Accelerator



CEPC baseline detector

## CEPC AHCAL

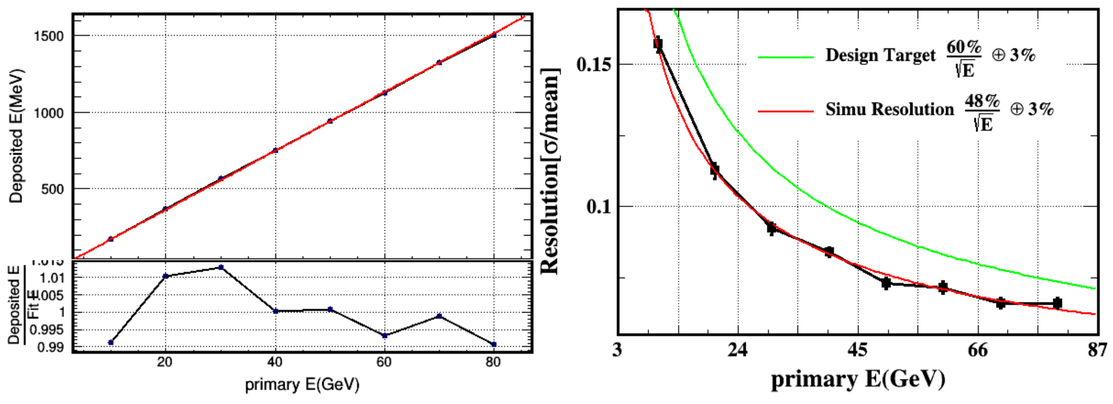



- 40 sampling layers
  - –20 mm Steel
  - –3 mm plastic scintillator
  - –2 mm PCB
  - –40 mm Cell Size
- SiPM+SPIROC readout

## Optimization

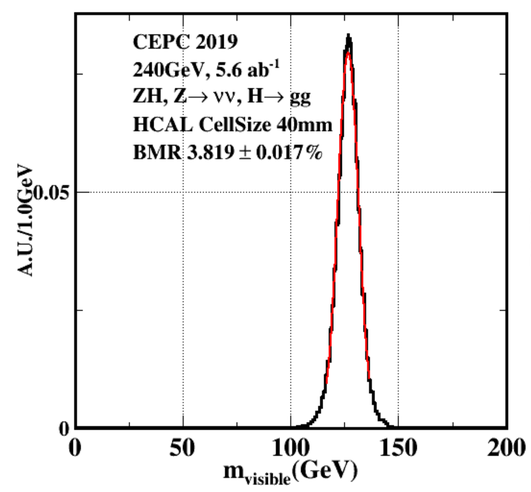
The optimization focuses on the balance of the calorimeter resolution, the CEPC physics performance and the detector cost. the scanning of key detector parameters such as: absorber thickness, sampling layers, scintillator thickness, cell size, has been done to optimize the calorimeter design

- AHCAL prototype simulation: A $72 \times 72 cm^2$ prototype was built based on geant4. The Klong performance of this prototype has been studied, then the prototype design parameters have been optimized in terms of Klong energy resolution

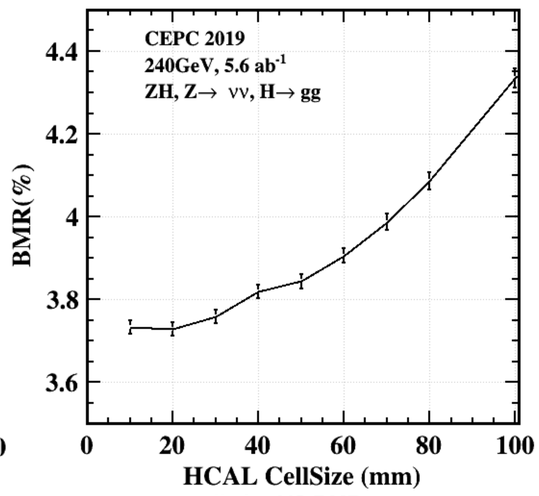



Prototype linearity and resolution

- CEPC AHCAL simulation: The scintillator-steel AHCAL is implemented into the CEPC detector geometry. A particle flow algorithm named arbor is used to reconstruct the H-gg events. The Higgs boson mass resolution(BMR) is required to be less than 4% for the benefit of CEPC physics. Detector parameters like: absorber thickness, sampling layers, scintillator thickness and cell size, have been scanned to optimize the BMR. The results is found to be consistent with the prototype design



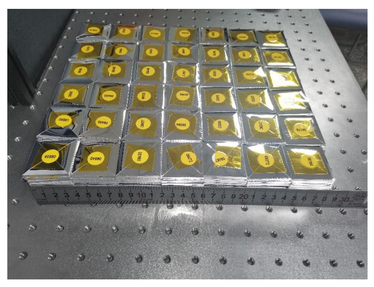

BMR at 40mm cell size



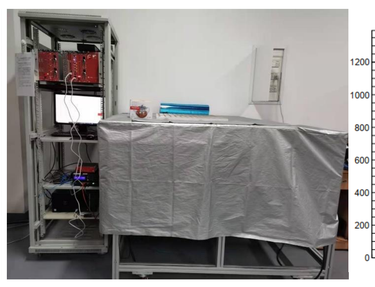

cell size VS BMR

## Progress of the AHCAL prototype

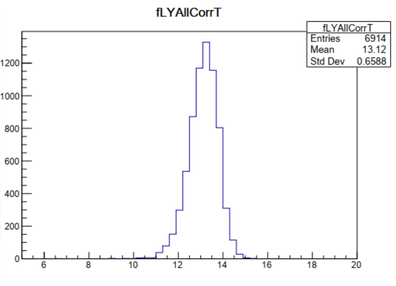
- The scintillator is produced using the injection molding technique. The wrapping and labelling procedure is then done by machines. 11000 scintillators have been made, wrapped and labeled, 5000 scintillators will be finished before the end of summer
- A batch test system is developed to ensure the uniformity of scintillator's light yield. A motor loaded with Sr90 serves as the MIP source. The results in SJTU shows that 95% of the 6914 scintillators have a light yield within mean ±10% which are qualified.



scintillators



Batch test system




Light yield

## Summary and outlook

☐The optimization for the prototype has been done both with a stand alone geometry and CEPC geometry, key detector parameters have been settled.

☐The scintillators have been produced and test. Other work like SiPM test, design and production of HCAL layers will be finished this year. A prototype will be constructed in the middle of next year, the beam test is then expected

## Acknowledgement

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