Study of Dual-readout Calorimeter for the EIC

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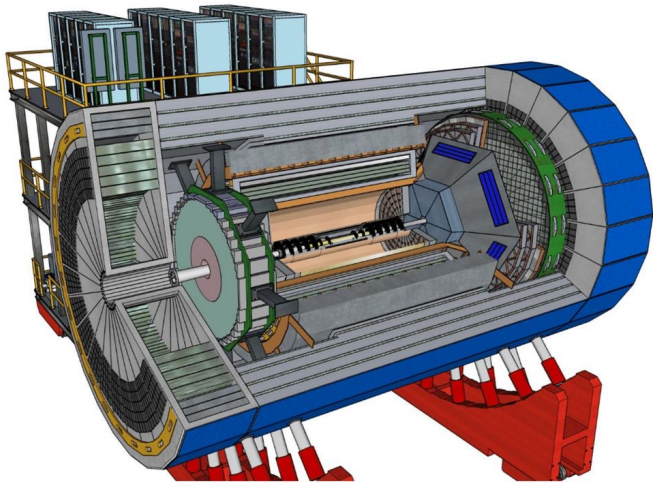
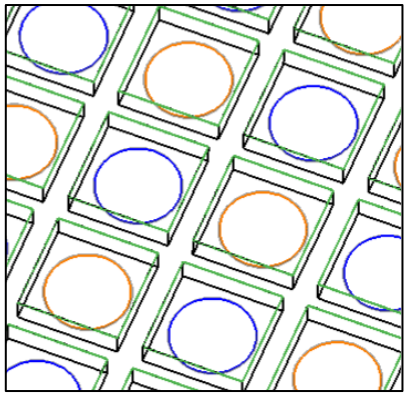
Introduction

- EIC :
  - To be constructed at BNL in the US
  - To study detailed structure of proton and nucleus
- ECCE :
  - Candidate experiment at EIC IP8
  - DRC is considered an upgrade option
  - Simulation framework
    - Include geometry of the DRC

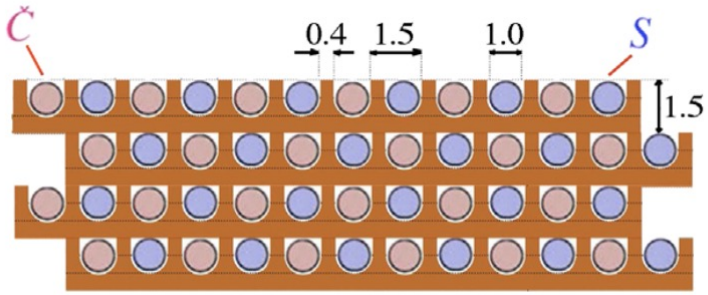


ECCE detectors

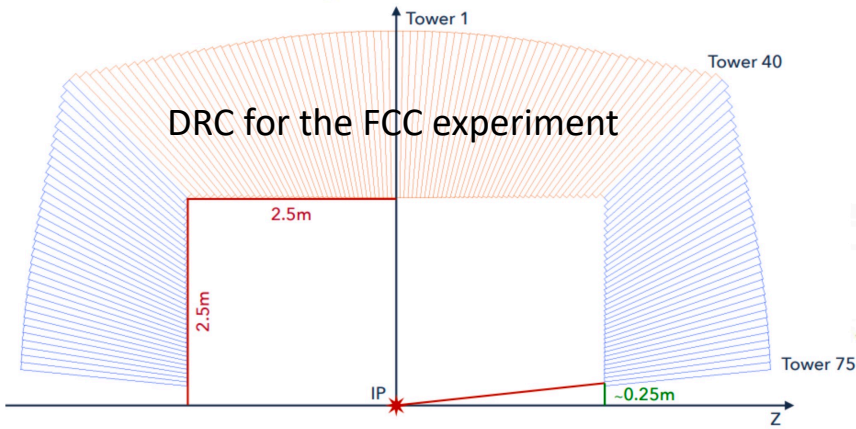
- Dual-readout Calorimeter(DRC) :
  - Consist of absorber and two optical fibers
    - Cherenkov fiber
    - Scintillation fiber
  - Considered to use as ECAL + HCAL in FCC-ee experiment
  - Geant4 Simulation framework was developed



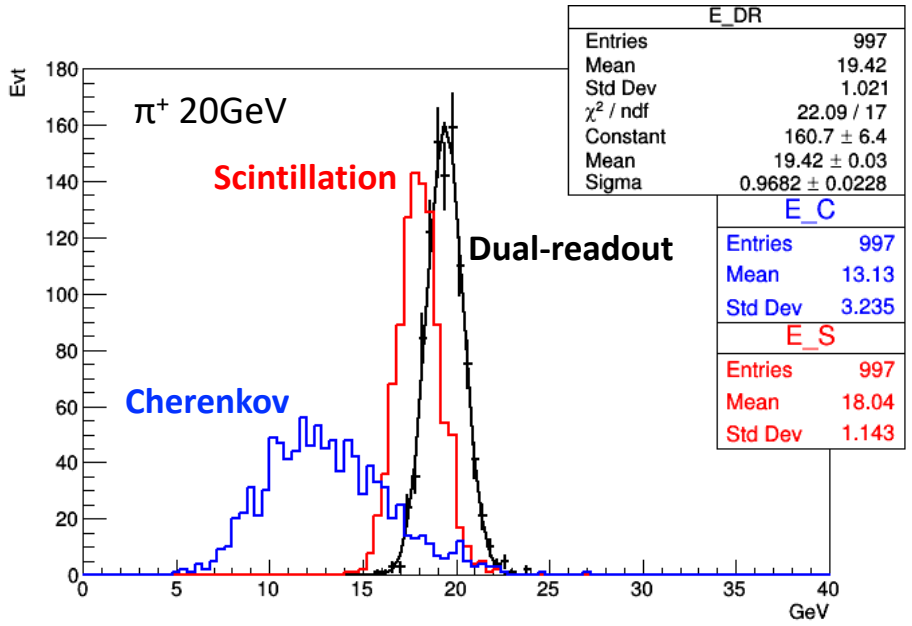
SiPM for detecting photon



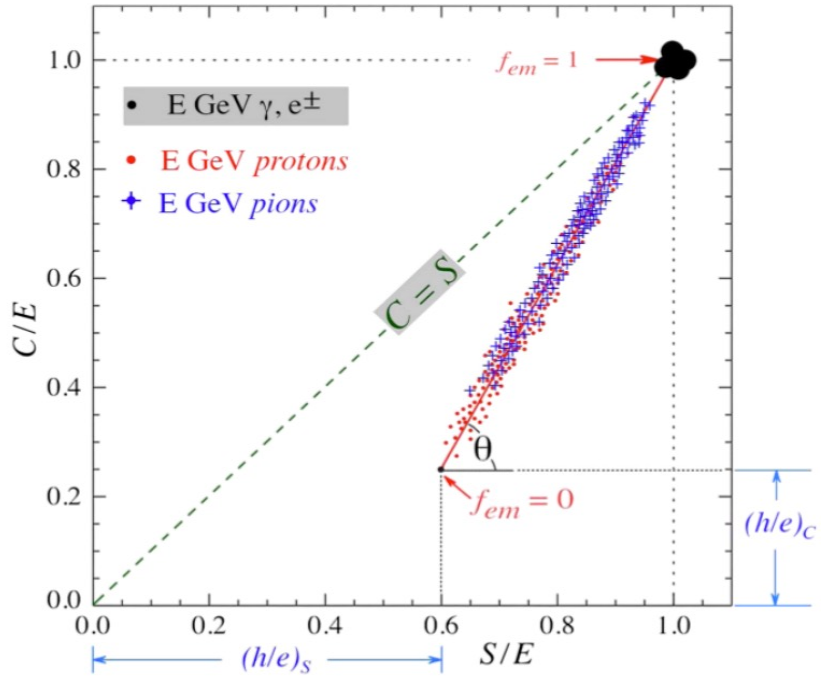
Fiber pattern RD52



DRC as Forward Hadron Calorimeter



2.5m Cu Dual-readout calorimeter



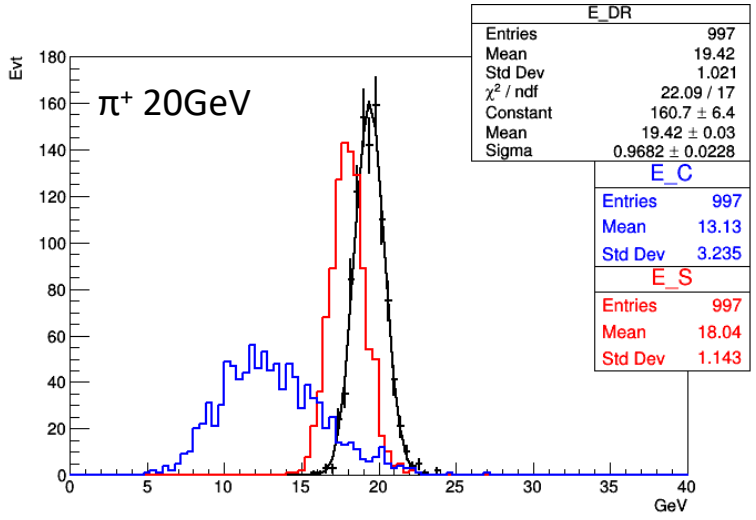
Ratio of measured energy and initial energy

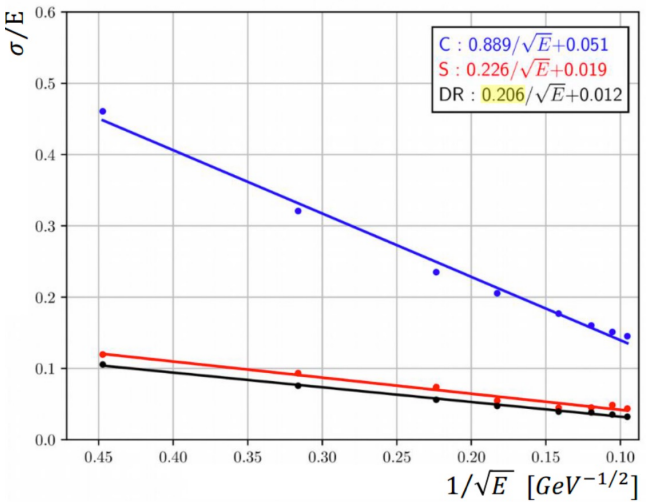
- Advantage of DRC
  - DRC can measure the fraction(f_{EM}) of EM components in hadron shower
  - High energy resolution can be achieved by correcting the f_{EM}
  - obtained from FCC-ee study : $\sim 11\%/\sqrt{E}$ for EM particles, $\sim 21\%/\sqrt{E}$ for hadron
- Dual-readout correction

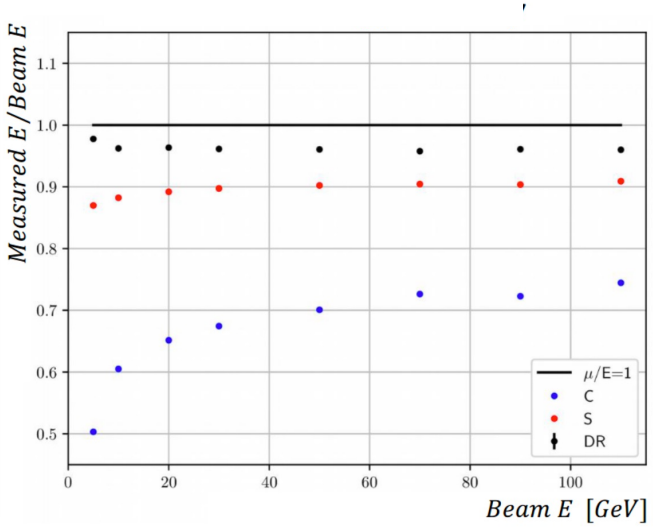
$$E = \frac{E_S - \chi E_C}{1 - \chi} \qquad \chi = cot(\theta) = 0.291$$ Obtained from experiment

DRC performance study

2.5m Cu

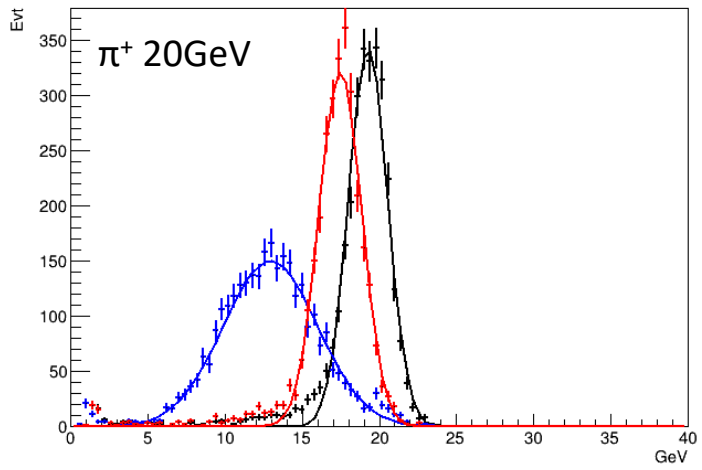


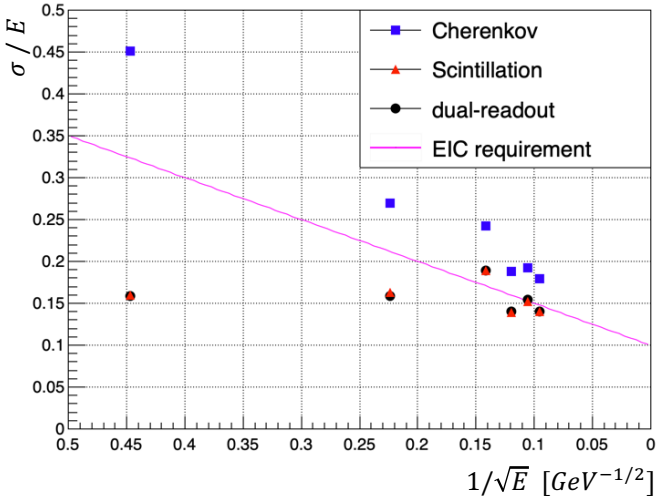


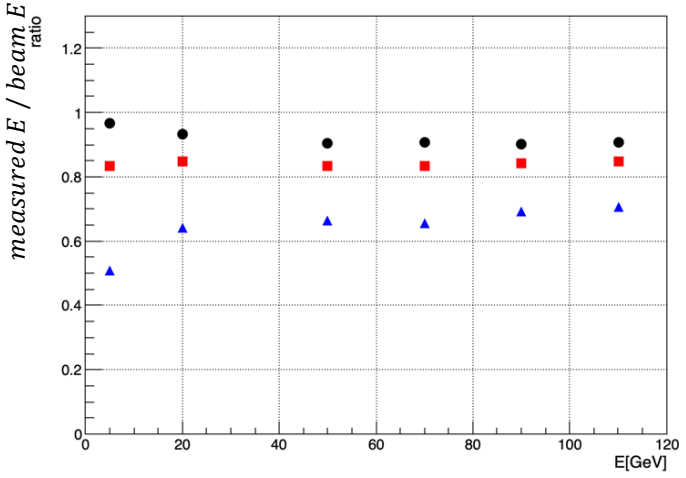


Similar response in two tower lengths

1.25m Cu EIC-DRC

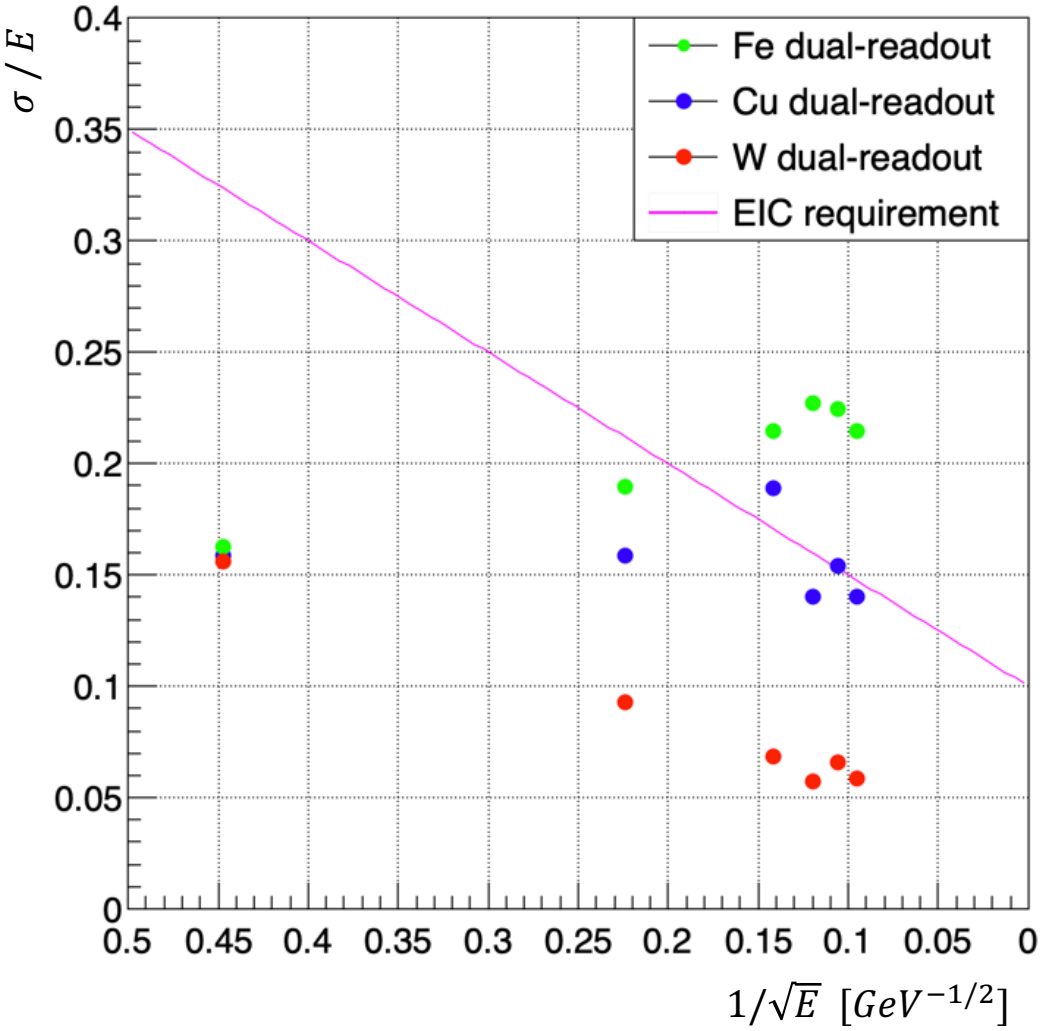






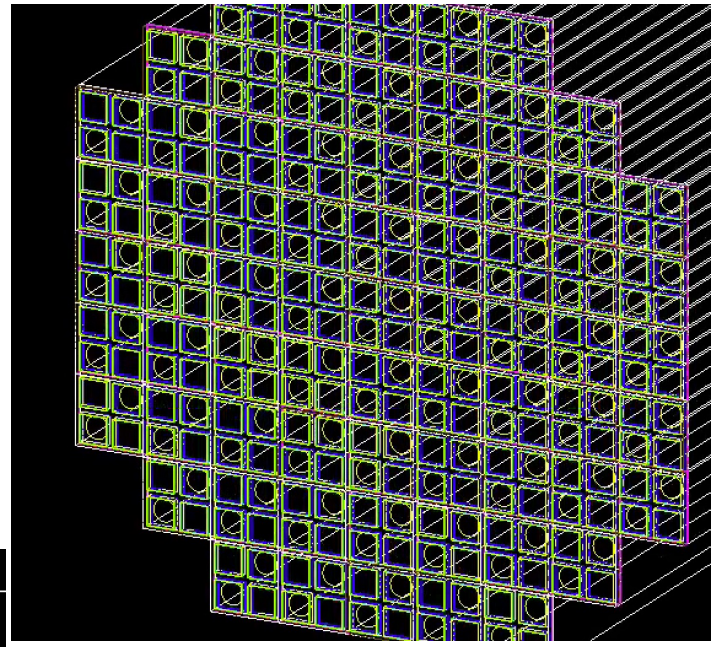
Performance of absorber material

- Single particle simulation
  - Particle species : π^+
  - Tower length : 1.25m (EIC-DRC)
  - For all materials, we used the same correction factor
    $\chi_{copper} = 0.291$
  - Absorber material :
    - Fe(EIC default material)
      Worse than the EIC requirement
    - Cu(DRC default)
      Nearly satisfies the EIC requirement
    - W(highest density)
      Best performance among 3 materials

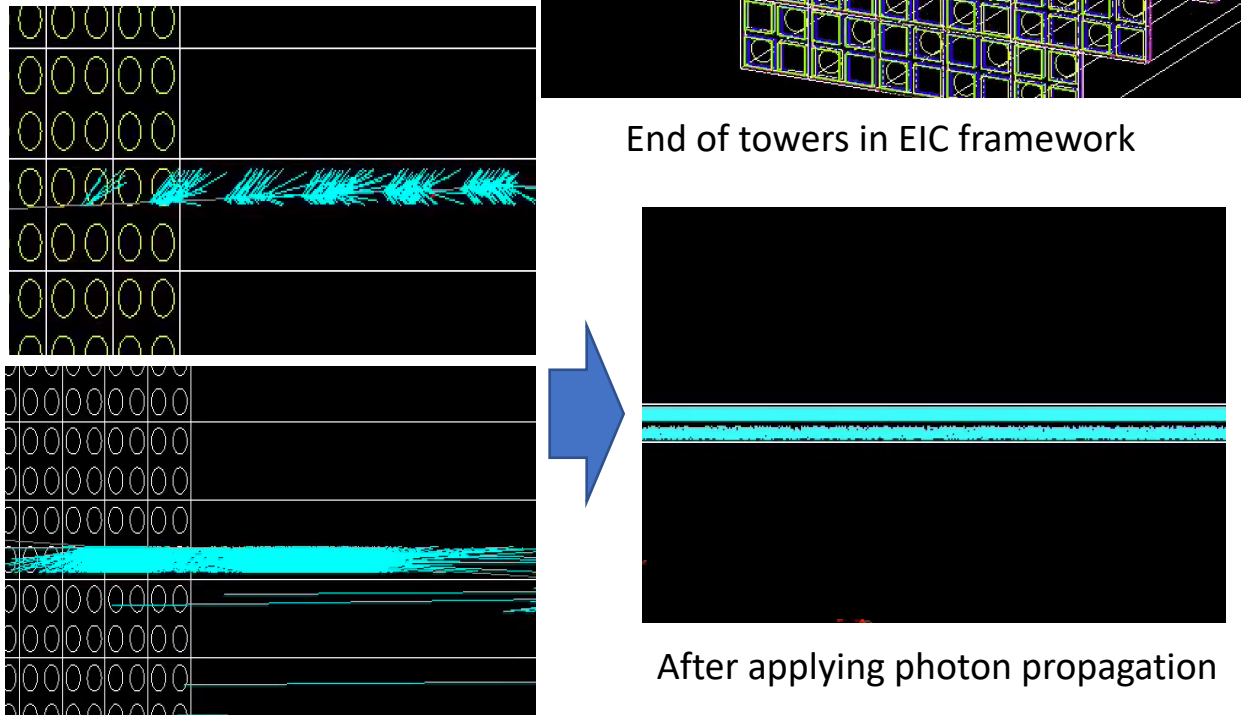


Summary & Plan

- Summary
  - Studies for EIC
    - Performance of absorber material
      - 1.25m Copper DRC nearly satisfies
      - 1.25m Tungsten DRC shows the best performance
      - 1.25m Iron DRC does not satisfy
- Plans
  - Migrated details of DRC to EIC framework
    - (SiPM, geometry and readout)
  - Plan to compare the performance of both frameworks after the migration
  - Study of jet and absorber material will be performed in the EIC simulation framework



End of towers in EIC framework



After applying photon propagation