SIDIS requirements for backward hadronic calorimeter construction

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Outline

1. SIDIS measurements with backward HCal
2. Introduction
3. Geometry implementation in dd4hep

SIDIS measurements with backward HCal

Purpose:

- The point of this presentation is to get feedback from SIDIS PWG about:
  - Which SIDIS measurements could benefit from backward HCal(nHCal)
    - Extended acceptance, charged/neutral hadron identification and measurement
  - What parameters are most relevant?
    - Efficiency, acceptance, granularity/position resolution
  - How can we translate the acceptance into coverage in x, Q^2 plane

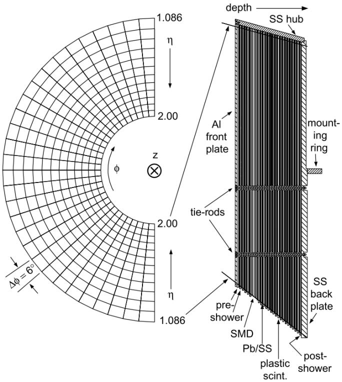
Simulations of physics processes including backward HCal:

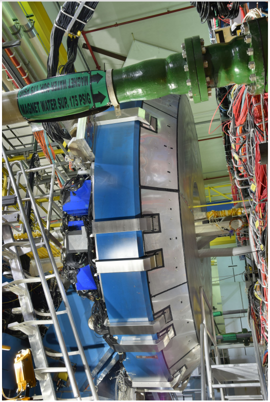
- Track-cluster association should work (not tested for nHCal)
- Basic reco clusters available - further tests needed
- Truth clusters can also be used

Introduction - backward HCal

Requirements: `https://eic.jlab.org/Requirements/`

A future backward HCal shall provide functionality of a tail catcher for the high resolution e/m calorimeter in electron identification, as well as for jet kinematics measurement at small Bjorken x

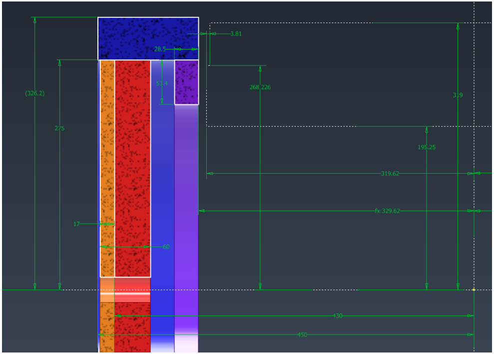




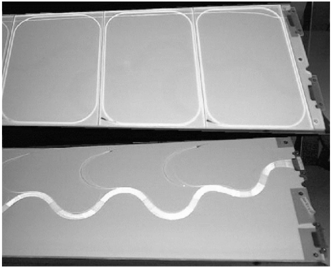
- Design considerations:
  - High efficiency for neutron detection
  - Good spatial resolution to distinguish neutral/charged hadrons
- Reuse STAR EEMC scintillator megatiles (expected to have lost only $\sim 5\%$ of light yield): `https://doi.org/10.1016/S0168-9002(02)01971-X`

Design

- Sampling calorimeter with 10 alternating layers, $2.4\lambda^0$ (red), similar to Belle-II KLM:
  - stainless steel 4 cm
  - plastic scintillator 4 mm Kuraray SCSN-81
- Scintillator light guided by 0.83 mm WLS (Kuraray Y11-doped 200 ppm fiber)
- Light collection by SiPM:
  - Candidate (to verify): S14160-1315PS `https://www.hamamatsu.com/eu/en/product/optical-sensors/mppc/mppc_mppc-array/S14160-1315PS.html`
- Electronics to follow solutions of other calorimetry systems (HGCROCv3 or EICROC)

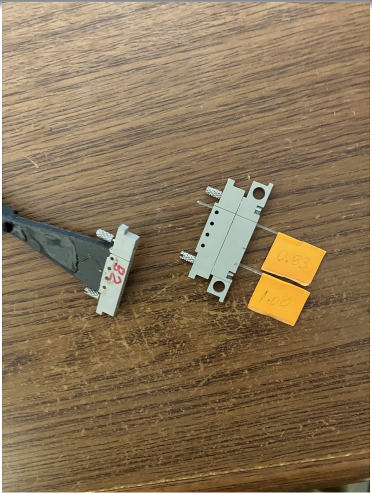


STAR EEMC 6° megatile - 12 tiles in η direction (radial) each



- nHCal decoupled from the magnetic steel $\Rightarrow$ more flexibility

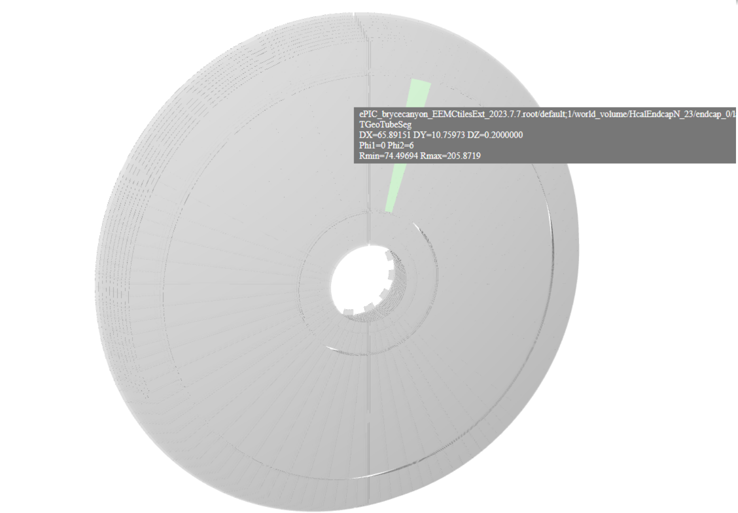
STAR EEMC megatile and connectors



Pictures thanks to Will Jacobs

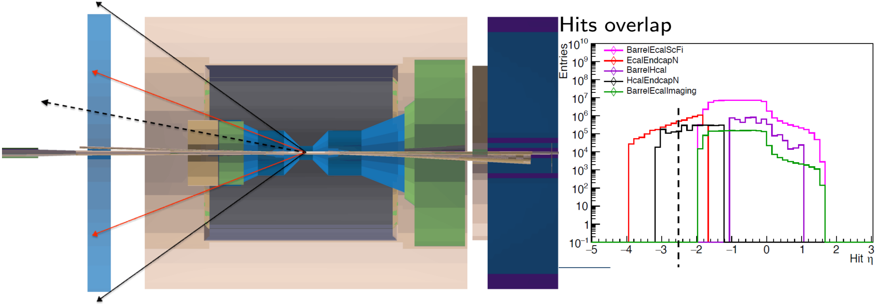
- 12° megatile shown (2 rows of 12 tiles in η)
- 0.83 mm diameter WLS fiber contained in σ-shaped grooves
- New, modified connectors need to be made, coupling light to an array of 12 SiPMs each (1 fiber/SiPM, but multiple fibers/SiPM to be considered)
- May need to remain wrapped after disassembly of STAR

Geometry implementation in dd4hep

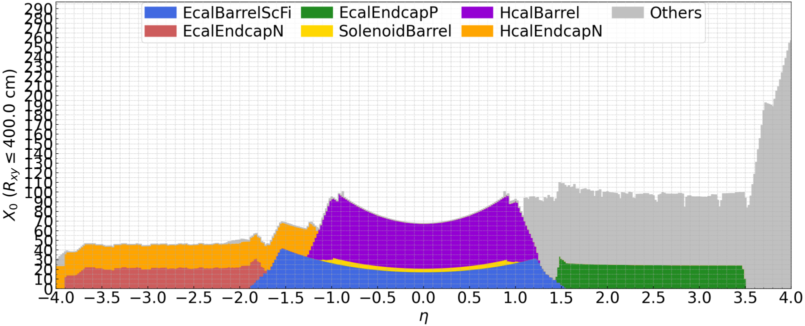


- Exact tile geometry implemented with absorber (no support structures)
- Added extrapolated inner and outer parts with a gap for connectors
- A simplified version already present in the main ePIC branch and included in the simulation campaigns

Acceptance

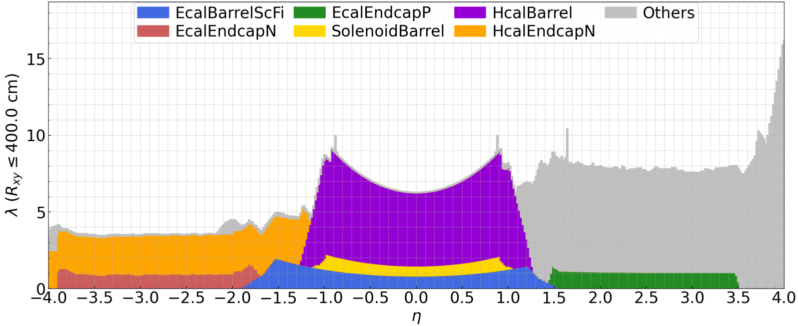


- Acceptance $-3.5 < \eta < -1.27$ - can still be extended to match the stainless steel absorber volume
- Overlaps with backward and barrel EMcals



- $\sim 24 X_0$ for backward HCal
- Scintillator tiles do not cover the same volume as steel absorber yet

Interaction length - brycecanyon geometry



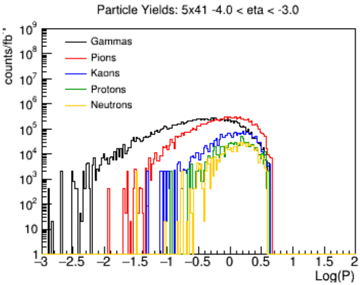
- $\sim 2.4\lambda_0$ for backward HCal
- Scintillator tiles do not cover the same volume as steel absorber yet

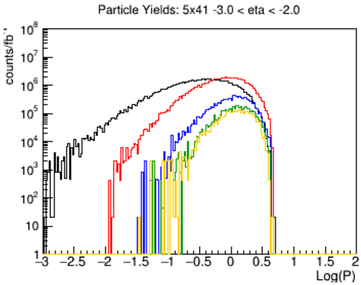
Conclusions

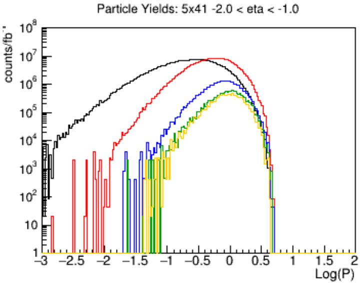
- Presented basic concept for backward HCal for ePIC
- Realistic geometry implemented in dd4hepp, simplified already in simulation campaign
- Tiles can be further extrapolated towards the beam - need guidance from physics
- Starting point for a discussion/coordination between PWG(effects on physics) and detector design

BACKUP

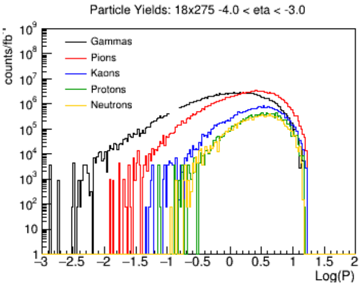
Jet particle distributions

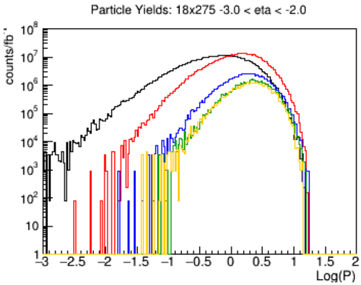


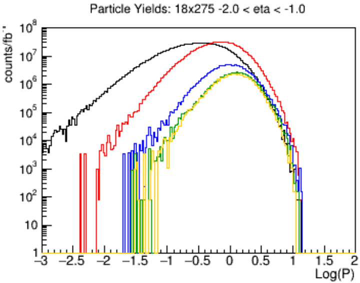




- Pythia simulation by Brian Page







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