Calorimeter Working Group - Recommendations

June 27, 2022

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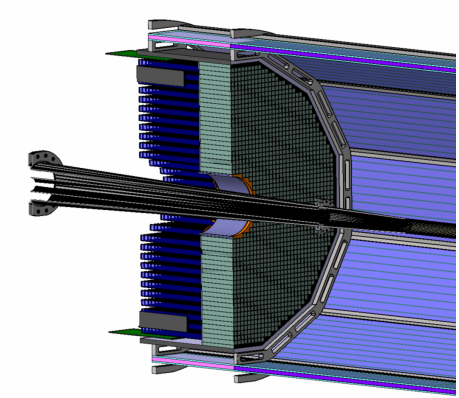
Electron-Endcap Calorimeters



EMCal

- Non-projective $PbWO_4$ - crystal calorimeter as proposed by EEEMC-Consortium
- Increased coverage in η through inlay around beam pipe - exact details to be worked out
- Detailed mechanical design in the works

→ **Details in presentation by Carlos**

HCal

- Preparing stronger physics case and infra-structure for possible upgrade path

→ **Will come back at later date**

Barrel Calorimeters

ECal

- Very complementary concepts ECCE SciGlass calorimeter & ATHENA imaging calorimeter
- Main concerns for SciGlass calorimeter
  - Possible R&D delays for SciGlass
  - Possible need for more space for tracker
  - Realismn of performance studies with final geometry, shower containment
- Main concerns for imaging calorimeter
  - Shower separation in PbSciFi along same ϕ & matching with Si-layers
  - Cooling & data flow management in silicon layers
  - Realismn of performance studies with final geometry & reconstruction limitations
- Exploring possibility of additional review of different concepts regarding cost, risk & performance after conclusion of additional studies

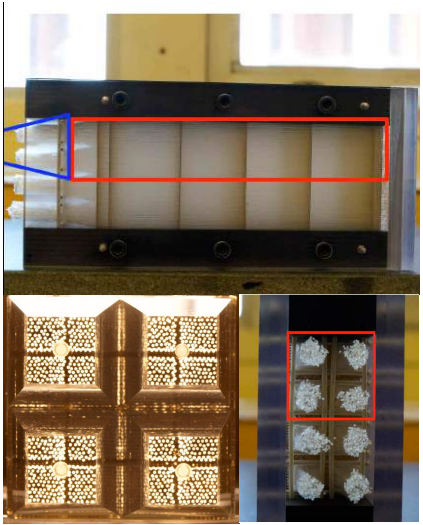
→ **Will come back at later date**

HCal

- Re-use & Refurbishment of sPHENIX outer HCal
- Necessity and feasibility of inner HCal still to be determined, strongly depends on choice of ECal

→ **Will come back at later date**

Hadron-Endcap Calorimeters -EMCal



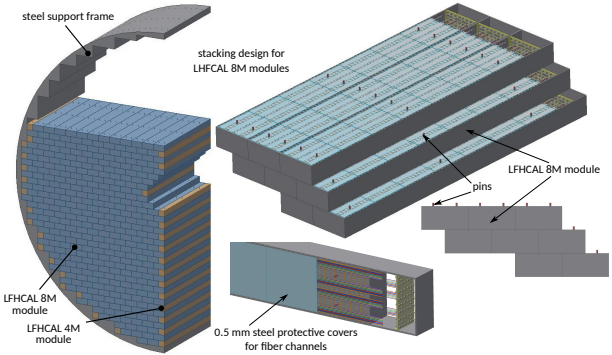
- Two mature EMCal concepts proposed:
  ECCE Pb-Scint-Shashlik vs. ATHENA WSciFi
- Using below R_M tower sizes which can vary as function of R
- Significantly easier construction for WSciFi calorimeter
- Less space needed for WSciFi calorimeter & higher EM-shower containment
- Cost comparable after adjustment for Uniplast unvailabilty & calorimeter dimensions

$\Rightarrow$ Consensus within WG to recommend ATHENA WSciFi for implementation & construction and to adapt plans for eRD106 accordingly

$\Rightarrow$ Exploring higher granularily & density inlay around beam pipe mathing beam pipe cut out shape

$\rightarrow$ **Details in presentation by Oleg**

Hadron-Endcap Calorimeters -HCal



- Both detector concepts using longitudinally separated Steel-Scintilator HCal
- ECCE LFHCal with additional W-layers offers larger shower containment
- Cost increase due to Sci-plate main vendor unavailabilty under investigation
- Construction method allows to vary tower sizes as function of R to possibly reduce cost

$\Rightarrow$ Consensus within WG to recommend ECCE LFHCal for implementation & construction and change plans for eRD107 accordingly

$\Rightarrow$ Exploring highly granular/pixelized inlay around beam pipe similar to W-CALICE design

$\rightarrow$ **Details on main part of HCAL in rest of presentation**

Forward HCal Recommendation: Longitudinally separated Forward HCal (LFHCal)

June 27, 2022

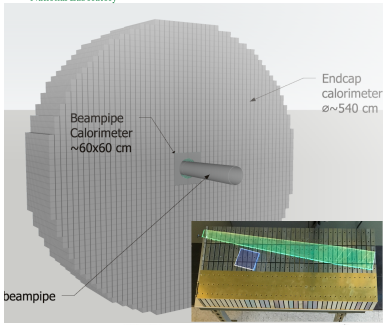
Friederike Bock (ORNL)

F. Bock, M. Demarteau, M. Fasel, E. Glimos, O. Hartbrich, H. Hassan, F. Jonas, C. Loizides, J. Osborn, M. Poghosyan, K. Read, A. Russu, J. Schambach, N. Schmidt

Questions by GDI

1. Details on the work done to provide the necessary input for your decision making process. This includes both collection of existing information and any new studies your WG initiated to establish the expected system performance.
2. The full pro/con list that was used to inform your recommendations. This should include any and all considerations that helped the WG form your recommendations. A presentation of your recommendations and reasoning for them based on the information presented in the points above.
3. Your view of how these recommendations fit with the global detector. e.g. Did you ensure the system fits within the geometrical constraints. Have you considered how service routing might work?
4. What is the assumption of performance and material distribution of other subsystems that were relevant for your study?
5. Do you see any potential challenges integrating your recommended solution within the global detector?
6. We would like to see simulations that validate the performance of the proposed configuration.

Accumulation of material on forward HCals



Different meetings

- Introductory overview meeting for all calorimeters May 5^{th}
- Dedicated session on HCals May 18^{th}
  - Mini technical review of technology choice (ATHENA & ECCE)
  - Evaluation of simulation setups & constraints
  - Performance evaluation in respective detector system
  - Mini Costing review
- Follow up discussions with ORNL, UC-EIC & other interested parties

Recommendation

⇒ Consensus within WG to recommend ECCE LFHCal for implementation & construction and change plans for eRD107 accordingly

Pro/Con arguments

General considerations

- Both concepts follow similar general idea: highly segmented HCal in $x - y$ & z
- Current simulations don't entirely reflect reality (Steel-HCal response too good) $\Rightarrow$ expecting $1.5 - 2x$ worse resolution in reality with same reco-algorithms
- SiPM-Readout & integration with ECal can be done in similar way for both

pHCAL

Pros

- Easy construction, tight tolerance assembly, solid mechanical structure
- Good understanding of general cost & risk (STAR FCS)

Cons

- Max. 4 long segments & effi loss due to signal splitting using time response
- Once installed segmentation is fixed
- Needs assembly at IP6

LFHCAL

Pros

- Larger shower containment
- Somewhat flexible segmentation in x-y & z, better performance using ML possible
- Possibility for distributed module assembly & testing

Cons

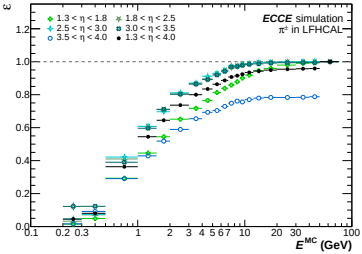
- More complex assembly & integrating (fiber routing)
- No test beam yet
- Higher cost

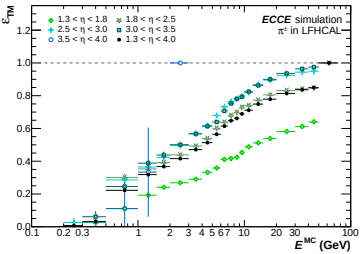
Detector integration

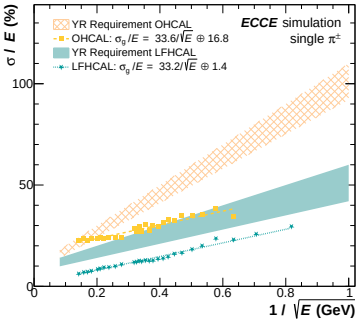
3. Did you ensure the system fits within the geometrical constraints. Have you considered how service routing might work?
   - Outer dimensions: $Z = 140 + 10$ cm, $R = 262$ cm , ECCE Position: $Z = 350$ cm
   - LFHCAL has 1^{st} CAD model (need adaptation to take out ECal part)
   - Shifted beam pipe hole off center in x to optimize acceptance
   - Shorter ECal (pECAL) will ease integration even further (42.5 cm ECCE, 30 cm ATHENA)
   - Basic service routing envisioned at back of HCal
4. What is the assumption of performance and material distribution of other subsystems that were relevant for your study?
   - Most of preformance studies for LFHCAL for acceptance/efficiency done with full ECCE setup, resolution in standalone due to missing cross calibration with ECal in simulations so far

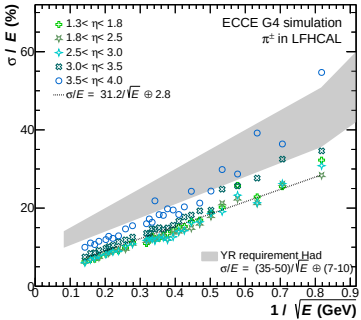
   $\rightarrow$ Final studies will need ot be done including new ECal
5. Do you see any potential challenges integrating your recommended solution within the global detector?
   - Readout design still under scrutiny (which parts on/off detector)
   - Will need mechanical & electrical engineering studies

LFHCAL Performance









- Cluster finding and track matching efficiencies good in center of LFHCAL, losses towards edges
- Meeting YR energy resolution requirements even without ML based clusterizer optimization
- Small η dependence for energy resolution
- Studies to improve clusterization further using ML started