Backward Hadronic Calorimeter

TDR planning

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Outline

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Introduction and organization

Webpage set up - see for up to date info

`https://wiki.bnl.gov/EPIC/index.php?title=Backward_Hcal`

Mailing list

`epic-backward-hcal-l@lists.bnl.gov`

Mattermost channel

`https://chat.epic-eic.org/main/channels/det-hcal-backward`

Institutions

OSU, CTU in Prague, UNH, BNL (help)

Work planning towards TDR

Detector design and technology choice:

- Few ideas to present and discuss soon:
  - LFHCAL style with larger tiles (may be costly)
    - Option to use thicker tiles and put SiPM on the side (to be tested with simulation): **0.5 FTE for 1-2 months**
  - Belle-II KLM long scintillator planks with WLS fibers: **0.5 FTE for 1-3 months**
    - $\sim 2\ \mathrm{m}$ length might be an issue due to light attenuation
    - May need different FEB from HGCROC to get the position from the timing
    - HGCROC provides 100 ps timing resolution (3 cm spatial - good!)
  - Tiles with WLS fibers
- TBD based on the results of:
  - Position resolution study
    - CTU in Prague working on that (1-2 months to complete)
    - May need more time and manpower to test different detector configurations: **1.0 FTE 2-4 months**
    - Clustering seems to be good enough, though splitting may need some work (1 month to complete in coordination with splitting task-force) - **may need extra 0.5 FTE for 1 month to complete**
  - Neutron detection study (both RECO hits and ML reco with GNN)
    - Student at OSU looking at RECO hits (1-2 months to complete)
    - Student at OSU working with ML (to present update soon, a few weeks to complete, need more manpower to test different configurations): **1.0 FTE 2-4 months**
    - UNH group working on PID with GNN and possible optimization of geometry based on ML response
    - Update coming soon, but more work may be needed
    - Need more help and coordination with LFHCAL group (still waiting for some answers)
  - Jets with neutron reconstruction
    - Help from Brian, started work and results are coming soon
    - Every adjustment of geometry needs a new simulation campaign or full event simulation (updates month by month)
    - May need more help and manpower here: **0.5 FTE for 2-4 months**

Tile tests and beam tests

- Tile tests with cosmic rays at OSU
  - Preparing test station with SiPMs and tiles (a few weeks to complete)
- Fermilab can provide more tile samples, need to establish contact through LFHCAL group

Beam tests:

- To be planned once the design is finalized
- Need engineering design
  - We should get mechanical engineer at OSU to work with BNL engineers (up to OSU leadership): **0.5 FTE for 2-4 months**
- We may need beams for prototype tests in 2025-2026 and first article in 2026-2027:
  - protons: $0.3 - 20\ \mathrm{GeV}$
  - pions: $0.3 - 20\ \mathrm{GeV}$
  - electrons: $0.3 - 20\ \mathrm{GeV}$
  - Spallation neutrons - unmoderated? $\sim 1\ \mathrm{GeV}$ to test low energy neutron performance
  - **0.5 FTE for 1-2 months** for beam tests

Electronics and calibration

- Electronics coordinate with the LFHCAL group - HGCROC
  - Long scintillator planks with WLS may require alternative solution
- Once design is determined we will provide connection topology to Norbert
- Sparsely placed temperature sensors for temperature monitoring
- LEDs 1/channel to calibrate the response with single photon spectra
- In principle can be taken care of quickly, but it would be good to have a dedicated person: **0.5 FTE for 1-2 months**

VM reconstruction performance with dimuons

- Not a priority right now
- Study with single muons should not be a problem
- Need manpower for that: **0.5 FTE for 1-3 months**
- May need a dedicated simulation with VM in realistic events for TDR
- Simple study with standalone VM simulation also possible

nHCal TDR planning

- Detector design
  - Overview
  - Detector requirements **CRUCIAL: In principle can be completed by 2024.11.1**
  - Radiation requirements
  - Test beam results (planned next year)
- Performance
  - Single particle studies **In principle can be completed by 2024.9.1**
  - Clustering (basically ok) **Some work needed in coordination with splitting TF by 2024.9.1**
  - Neutral jet reconstruction (coordinate with Brian) **CRUCIAL part to be completed by 2024.10.1**
  - Vector meson reconstruction with dimuons **No manpower, need 0.5-1.5 FTE months**
- Mechanics (TBD by the design) **No manpower - need help to meet deadlines by end of 2024**
  - Module structure
  - Assembly
  - Support structures
  - Seismic and load deformation studies (coordinate with other subsystems)
  - Scintillator performance
- Readout (waiting for design - to be coordinated with Norbert) **CRUCIAL to follow after Neutral jet performance studies**
  - SiPM boards
  - FEB design
  - Connection topology
- Cooling **No manpower, not crucial**
  - Heat load simulation (coordinate with other subsystems)
  - NO cooling needed
- Calibration (waiting for design - to be coordinated with Norbert) **CRUCIAL to follow after Neutral jet performance studies**
  - LED system
  - Temperature monitoring
- Integration

- from previous work
- ready to write up
- partially to write up
- lots of work required

Crucial topics for TDR

Each step depends on each other (assumptions are very optimistic):

1. Position resolution study **In principle can be completed by 2024.7.1** - seems taken care of and on track to completion
2. Neutron reconstruction with machine learning **In progress by UNH, but slow, need 2-4 FTE months and better collaboration with LFHCAL**
3. Neutral jet reconstruction performance study **CRUCIAL part to be completed by 2024.10.1, may need 1-2 FTE months, up to a few months according to experts**
4. Detector requirements **CRUCIAL: In principle can be completed by 2024.11.1**
5. Tile design and detector design **CRUCIAL: In principle can be completed by 2024.11.1, but may need extra 1-2.5 FTE months**
6. Mechanics (TBD by the design) **No manpower - need 1-2 FTE months to meet deadlines by end of 2024 (work may be underestimated)**
7. Electronics and calibration (TBD by the design) **In principle help by Norbert and LFHCAL - need 0.5-1 FTE months to meet deadlines by end of 2024**
8. Integration (TBD by the design) **Hard to estimate, but may need a few FTE months to complete by end of 2024**

Assuming almost no buffer time in case of delays, to make it work.

Manpower shortage and task summary

I have no prior experience writing TDRs - may need help/advice (just good communication, not an extra dedicated person). **This will absorb a lot of time on my side as the leader, so delegating tasks becomes even more important!**

Task	FTE	duration lo [months]	duration hi [months]	FTE*duration lo	FTE*duration hi
Optical simulation of tile performance for SiPM on tile arrangement	0,5	1	2	0,5	1
Belle-II KLM long planks investigation and implementation	0,5	1	3	0,5	1,5
Position resolution study	1	2	4	2	4
Clustering	0,5	2	2	1	1
Shower reconstruction with ML	1	2	4	2	4
Performance of neutral jets reconstruction	0,5	2	4	1	2
Mechanical design	0,5	2	4	1	2
Beam tests - needed later	0,5	1	2	0,5	1
Electronics and calibration	0,5	1	2	0,5	1
Performance of VM reco	0,5	1	3	0,5	1,5
Benchmarks development needed for TDR?	0,5	2	4	1	2
			Sum min and max =	10,5	19

- Extra 10.5-19 FTE-months required before June
- These estimates are mostly to meet TDR requirements at the end of 2024

Summary

- Clear plan towards TDR
- Lots of work required to finalize the design, but we are on the right path
- Minimal required manpower seems available, but need more help with detailed studies
  - **Extra 10.5-19 FTE-months needed**
- A lot depends on the simulation campaign cycle (month by month)
  - Need to complete various steps to be ready for each simulation campaign (risk for the timeline)
  - Make sure the tasks are completed on time

BACKUP