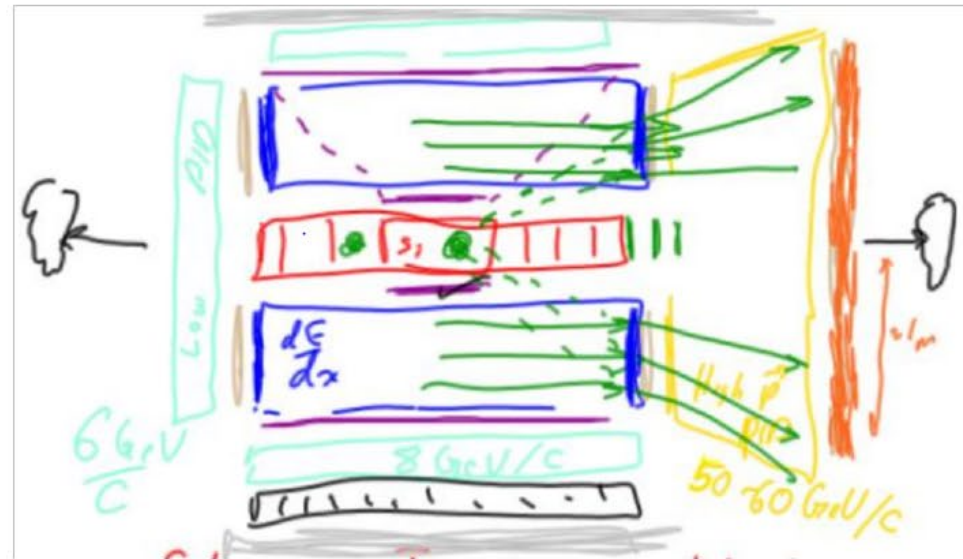


Global Design & Integration (GD/I)

Status and Plans



eRD6 Group Meeting

Silvia Dalla Torre, Jin Huang, Richard Milner, Thomas Ullrich

Reminder: Charge (4/26/2022)



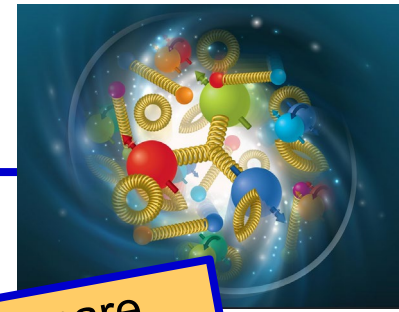
[...]

Your working group is fundamentally quite different from the joint detector and physics working groups that have been recently formed, in that we are asking your working group to take a broad view of the EIC project detector as it evolves to a technical design. The **global charge to your WG is as follows:**

- Work with the project and the joint working group to develop a detailed, integrated technical design of the project detector. This includes the integration of various detector systems, the necessary supports and services, and the requirements imposed by the ability to service the detector between EIC running periods.
- Work with the detector and physics working groups, as well as project management, to ensure that the integrated project detector remains capable of the full science program outlined in the EIC Whitepaper and NAS report. Where compromises need to be made in the integration of the project detector, ensure that the proper simulations studies are completed to ensure they do not unduly compromise the EIC science program.

[...]

Reminder: Charge (4/26/2022)



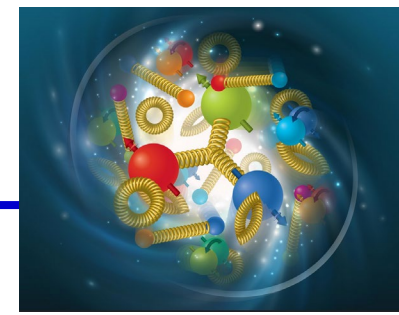
[...]

Your working group is fundamentally quite different from the working groups that have been recently formed. It is your group to take a broad view of the detector design with particular care design. The GD/I WG has to contribute to the detector design with particular care

- Therefore, GD/I WG has to be dedicated to:
 - Realistic integration aspects
 - Global performance (holistic view)
- Working groups, as well as project management, must ensure that the integrated project detector remains capable of the full program outlined in the EIC Whitepaper and NAS report. Where compromises need to be made in the integration of the project detector, ensure that the proper simulations studies are completed to ensure they do not unduly compromise the EIC science program.

[...]

OVERVIEW



Detector Design Process, goal:

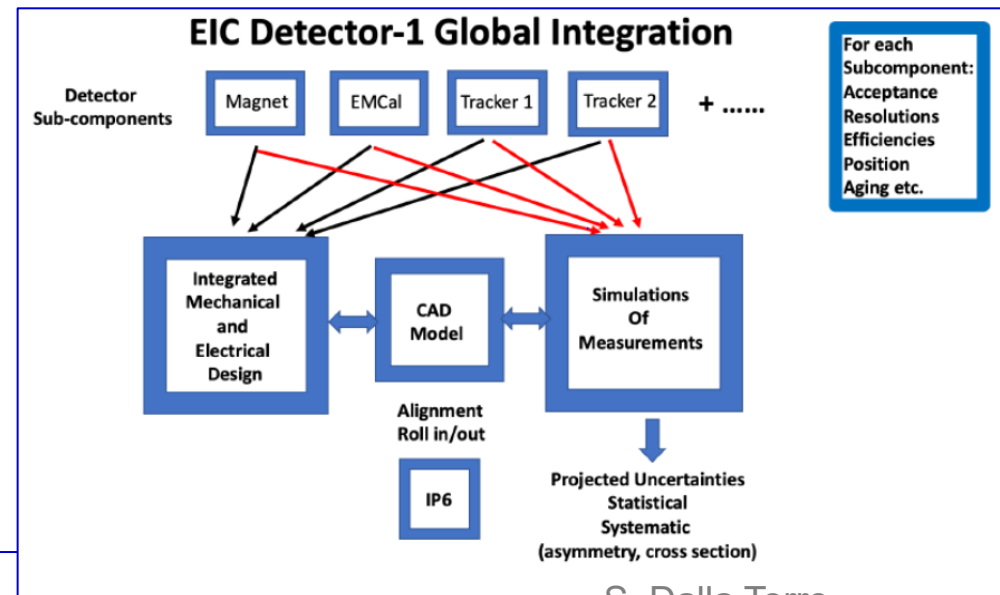
- Starting from the reference detector, consolidate (technology choices) and optimize (layout exercises) the EPIC detector toward a baseline

Detector Design Process, guiding elements:

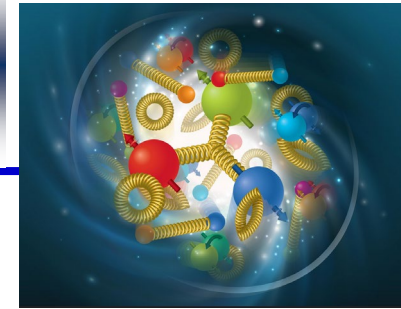
- **Performance, requirements** (YR and further updates from PWGs)
- **Detector performance and feasibility** (R&D, DWGs)
- **Available expertise** (DWGs and the groups in the Collaboration)
- **Integration** (engineering, space)
- **Cost** (project)

GD/I WG works with :

- Detector WGs
- Physics WGs
- Project
- Engineers

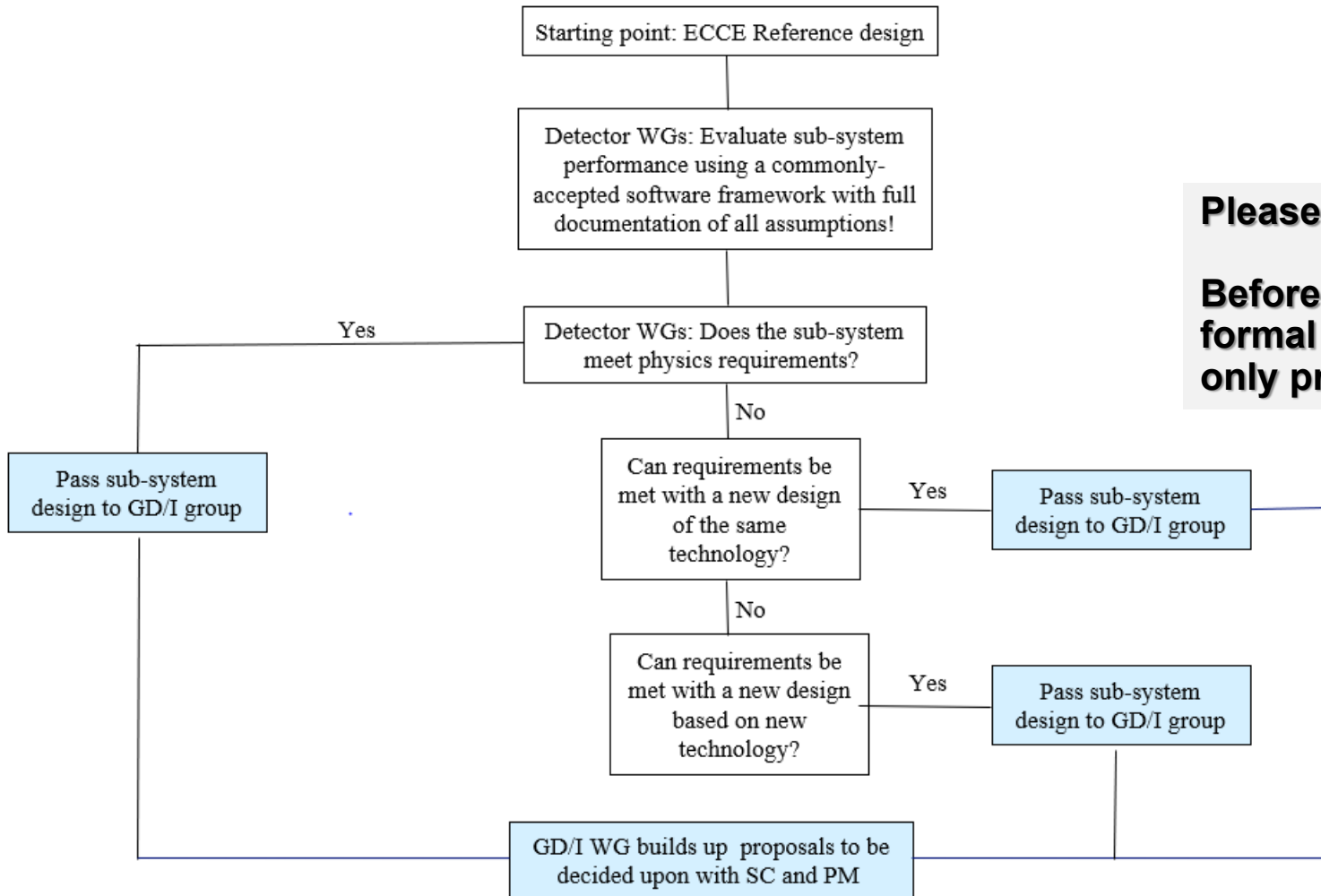


CONSOLIDATION ROADMAP



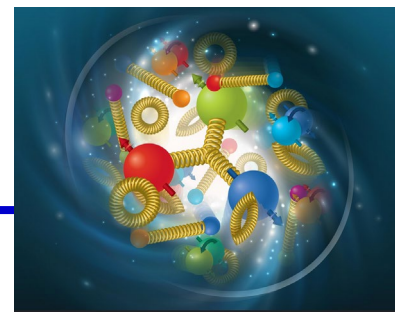
Please, note:

Before establishing a formal Collaboration, only preliminary decisions



CONSOLIDATION ROADMAP

A concrete example (the only one, so far)



- At the 6/3 Convener meeting, Calorimetry WG anticipated potential recommendations for forward calorimetry
- 6/11 e-mail from GD/I WG conveners to Calorimetry WG conveners:
 - Inviting Calorimeter WG to a GD/I meeting, together with specific charge for this meeting
- GD/I WG dedicated meeting on 6/27 (<https://indico.bnl.gov/event/16210/>)
- GD/I analysis summarized in an e-mail on 6/28

CONSOLIDATION ROADMAP

A concrete example (the only one, so far)



- 6/11 e-mail from GD/I WG conveners to Calorimetry WG conveners:

... We would like to **invite you to report** at our June 27th GD/I WG meeting (<https://indico.bnl.gov/event/16210/>) and we request from you some specific points of information:

- **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.
- 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.
- 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? What is the **assumption of performance and material distribution** of other subsystems that were relevant for your study? Do you see any potential challenges integrating your recommended solution within the global detector?
- Further, we would like to see **simulations that validate the performance of the proposed configuration**. ...

CONSOLIDATION ROADMAP



A concrete example (the only one, so far)

- GD/I analysis (e-mail on 6/28)

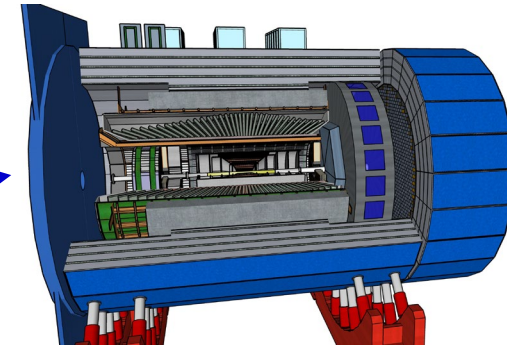
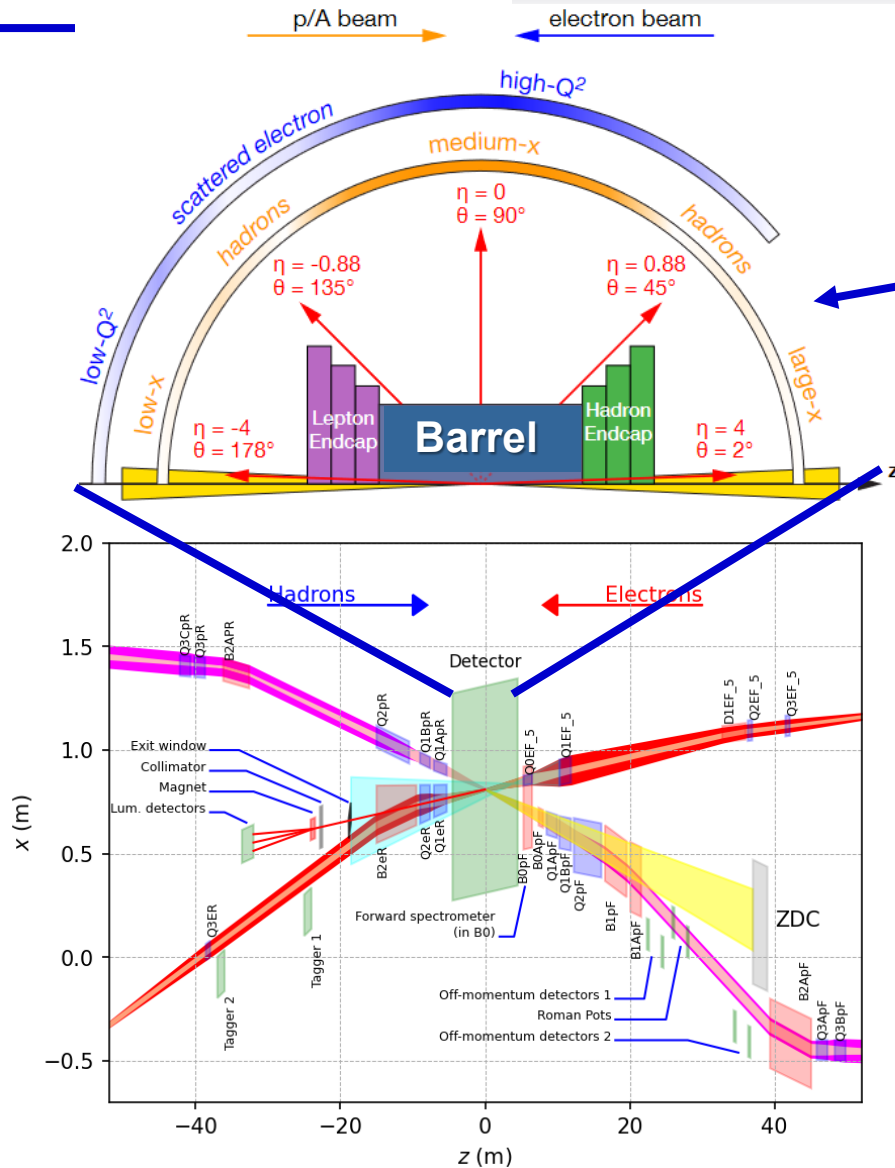
After discussion, the GD/I group agrees with your selection and recommends to the SC the system of LFHCal and WSciFi EMCAL as the systems of choice to the Det-1 SC and the EIC detector project management.

We were also impressed by the progress of detail of planning of the backward ECal where the choice of technology (PbWO4 + SiPM) was rather obvious from the start. We thank the people working on both all systems for their detailed answers to our questions.

As the most urgent next steps to take we recommend:

- 1) detailed implementation of fwd and bkws calorimeter systems in the simulation framework chosen by the SW group, including infrastructure. We realize that the current simulations have large uncertainties that need to be reduced. This needs to be followed by full simulation to determine the critical parameters such as resolution (all terms), e/h, photon separation etc. Where needed, refine the software simulation of the calorimeters, in view of more realistic performance results.
- 2) work closely with project engineers to settle on the details of the mechanical installation, magnet field interaction, and services. Now that the subsystem technologies are settled the need for input from our project engineers is needed.
- 3) R&D for the fwd calorimetry was postponed as at the time of proposal selection the choice of technology was not made. It is now time to work on a well thought out R&D plan that then would lead to an R&D proposal.
- 4) continue, detail, and report about studies of temperature evolution within the calorimeters (backward ECal, where it has been started and the others), in particular in relation to the use of SiPMs.

THE COMPLETE DETECTOR



Central Detector (CD)

Total size detector: ~75m

Central detector: ~10m

Backward electron detection: ~35m

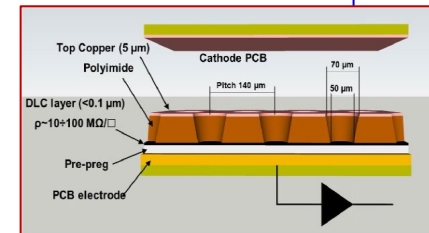
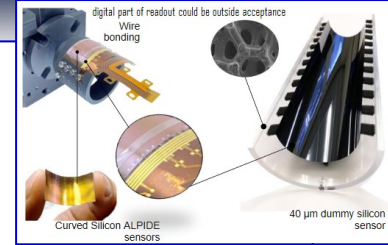
Forward hadron spectrometer: ~40m

Auxiliary detectors needed to tag particles with very small scattering angles both in the **outgoing lepton** and **hadron beam** direction (B0-Taggers, Off-momentum taggers, Roman Pots, Zero-degree Calorimeter and low Q^2 -tagger).

TECHNOLOGIES & OPEN QUESTIONS

TRACKING

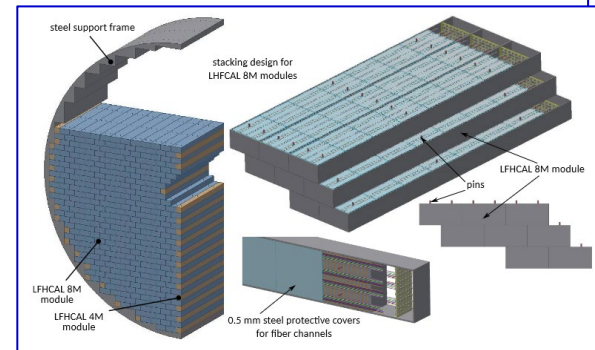
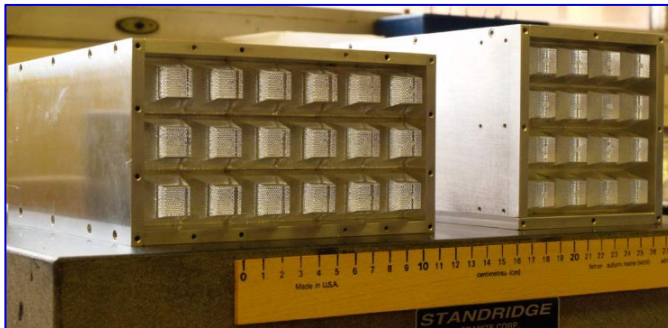
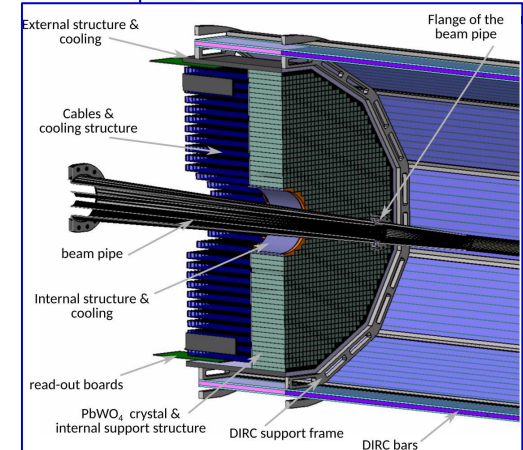
- **Vertex:** well-defined technology, layout to be defined
- **Barrel:** well-defined sensor, different implementation options (also requiring R&D) with implication on the geometry
- **For/backward:** Si-disks are well defined, are they too few ?
- **AC-LGAD layers:** when used (*PID implications*) they are tracking elements → implication on the overall design of the tracking system
- **MPGD layers:** the community favors a mixed technology approach (MM & μ RWELL) with R&D needs (cylindrical μ RWELL) and overall R&D to consolidate 2-D readout
- **At least 2 overall major needs to progress in the design:**
 - confirmation/modification of YR requirements (absolute reference?)
 - Urgency of validation by simulations including background and tracking pattern recognition



TECHNOLOGIES & OPEN QUESTIONS

CALORIMETRY 1 / 2

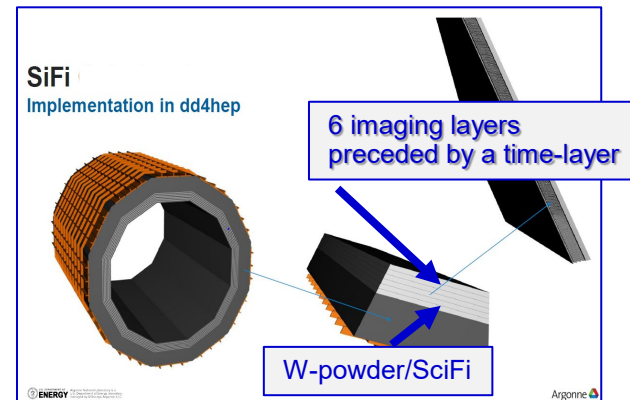
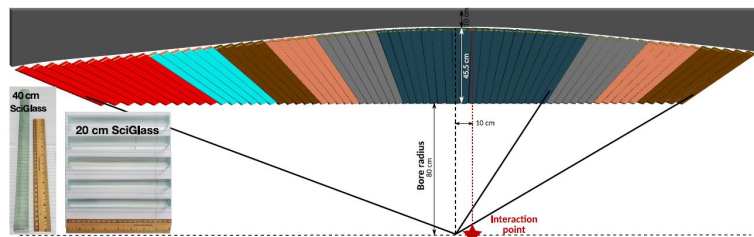
- **Backward ECAL**: well-defined technology, advanced integration
- **Backward HCAL** : physics justification?
- **Forward ECAL & HCAL**:
 - The first recommendation from a WG, confirmed by GD/ WG, provided that the further steps are completed (among them: simulation and integration) WSciFi + LFHCal



TECHNOLOGIES & OPEN QUESTIONS

CALORIMETRY 2/2

- **Barrel ECAL:** two options with different impact on physics domains and on implementation aspects

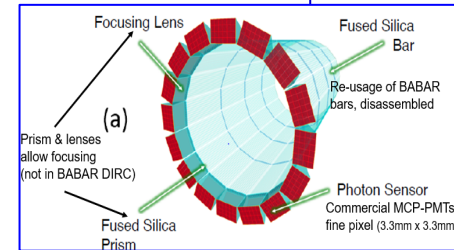


- **Barrel HCAL, inner:** to complement SciGlass ECAL, enough space?
- **Barrel HCAL, outer:** consensus towards the re-use of sPhenix HCAL
- **A major questions to progress in the design of all calorimetry:**
 - Urgency of validation by simulations and reconstruction together with tracking

TECHNOLOGIES & OPEN QUESTIONS

CHERENKOV PID

- **Barrel:** hpDIRC, integration being defined, further integrated simulation need; better understanding of threshold options



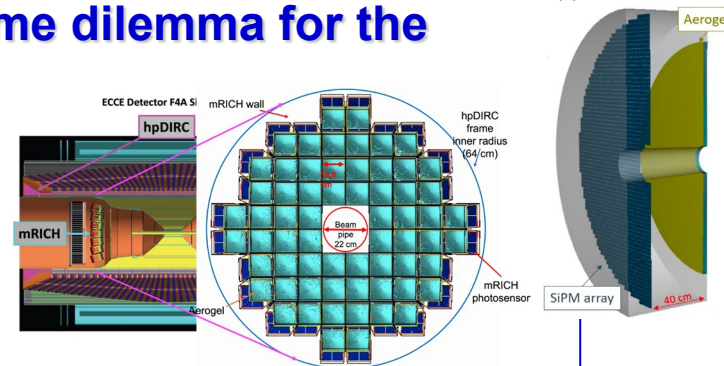
- **Forward:** dRICH, requested envelope to be ensured, simulations still in a preliminary status with partial reconstruction only; SiPM sensors to be confirmed (robust R&D ongoing); threshold options ?

- **Backward:** 2 options based on the same radiator; same dilemma for the sensors which are sitting in the acceptance

(SiPM cooling system is bulky / resistive or pixelized LAPPD at prototype level / LAPPDs can also provide ToF)

- **Major needs to progress:**

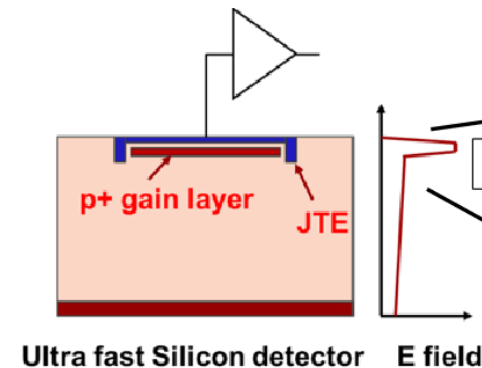
- Urgency of advancing in simulation (dRICH in particular)
- Integrating simulation and reconstruction in the Global Detector
- Advancing in photosensor R&D



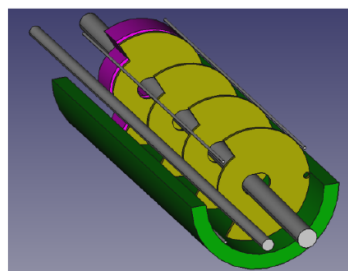
TECHNOLOGIES & OPEN QUESTIONS

TOF PID

- **Proposed technology:** AC-LGAD for barrel, for/backward
- **Challenges:** R&D, ASIC FEE, X/X0, integration (liquid cooling, services), cost
 - tracking needs optimization (add layers?) and space is scarce
 - might be a good technology for future upgrades?
 - How much can RICH achieve in threshold/veto mode?
 - Follow up on July-7 GD/I meeting – in barrel, $p > 250 \text{ MeV}/c$ π/κ separation possible
-- in forward, $p > 1 \text{ GeV}/c$ π/κ separation possible
 - physics case & requirement for low momentum PID to be defined
- **Major needs to progress:**
 - Clarify the status and R&D perspectives
 - Realistic evaluation of integration needs
 - Guidance from physics via the PWGs



FAR FOR/BACKWARD



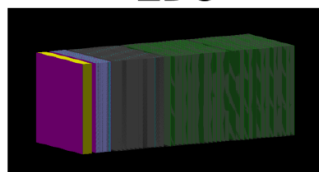
Roman Pots

Hadron Beam after IP



ZDC

Off Momentum



ZDC

Far Forward

- Instrumentation in the B0 magnet
- Roman Pots and Off Momentum detectors
- Zero degree Calorimeter

TECHNOLOGIES (including alternatives)

- PbWO_4 Cal
- W/Si sensors
- AC-LGADs
- MAPS
- W/SciFi
- Pb/Sci

Figure: Luminosity detector

side view:

brems. γ 's
exit window/
converter

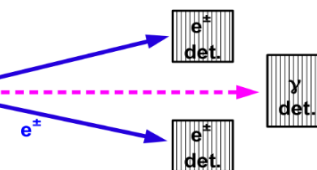
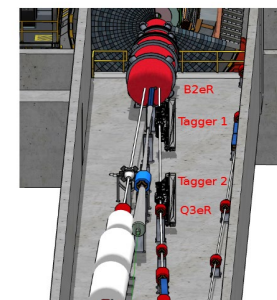


Figure: Low- Q^2 taggers



Far
Forward

Far
Backward

Far Backward

- Low- Q^2 tagger
- Luminosity monitor (electron-ion bremsstrahlung)

TECHNOLOGIES (including alternatives)

- AC-LGAD
- PbWO_4 Cal
- Spaghetti W-calorimeter with radiation-hard scintillating fiber, read out with fast PMTs
- Cherenkov-radiating quartz fibers read out by SiPMs

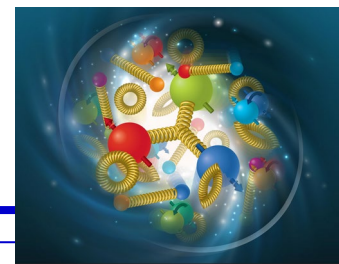
NEEDS for FAST DETECTOR BASELINE



A GD/I conveners' analysis

- **Consolidation and progress in the simulation field**
 - Of course, we fully understand that also this domain requires time for mature decisions and to merge communities; the progress, also announced at this meeting, is greatly appreciated
- **Global simulations \leftrightarrow holistic view of the detector**
- **Revisiting and confirming/modifying the key requirements of the YR**
 - Input from the PWGs
 - These requirements should be a guidance for the WG
 - Are, some of them too demanding and , therefore misleading and confusing?
 - What can the complementary by different subdetectors bring to the performance picture?
- **Move together with the DWG towards realistic detectors (integration, electronics)**
- **The progress in the formation of a structured collaboration to make difficult choices possible**

GD/I WG AGENDA



- **MAY 9** **KICK-OFF meeting: Touch base with the DWG conveners**
- **MAY 16** **Review global design consideration in both proposals**
- **MAY 23** **Review Babar magnet's features**
 first feedback from project engineers
- **JUNE 6** **Tracking update**
 Physics case for ToF
- **JUNE 13** **dRICH envelop**
 the 2 options for the backward RICH
- **JUNE 27** **Forward calorimetry**
- **JULY 7** **RICHes in threshold mode, 2 talks: DIRC, HERMES RICH**
 update about dRICH envelop
- **JULY 11** **background studies/integration into simulations & past experience**
 Release of the global EIC Geometry Management System
- **JULY 18** **studies for muon detection in ECCE and ATHENA**
- **AUG 15** **Tracking**
- **AUG 22** **Tracking**

GD/I WG LOGISTICS

- Indico: <https://indico.bnl.gov/event/15540/>
- Mailing List: eic-projdet-globalint-1@lists.bnl.gov
- Wiki: <https://wiki.bnl.gov/eic-project-detector/index.php/GDI>
- Conveners: Jin Huang (BNL), Richard Milner (MIT), Silvia Dalla Torre (Trieste), Thomas Ullrich (BNL)
- Meetings typically Monday's 9:00 EST/EDT
 - ▶ if Monday is holiday \Rightarrow Thursday 12:30 EST/EDT

Please sign up to our mailing lists (avoids sending to too many lists) :
<https://lists.bnl.gov/mailman/listinfo/eic-projdet-globalint-1>

THANK YOU