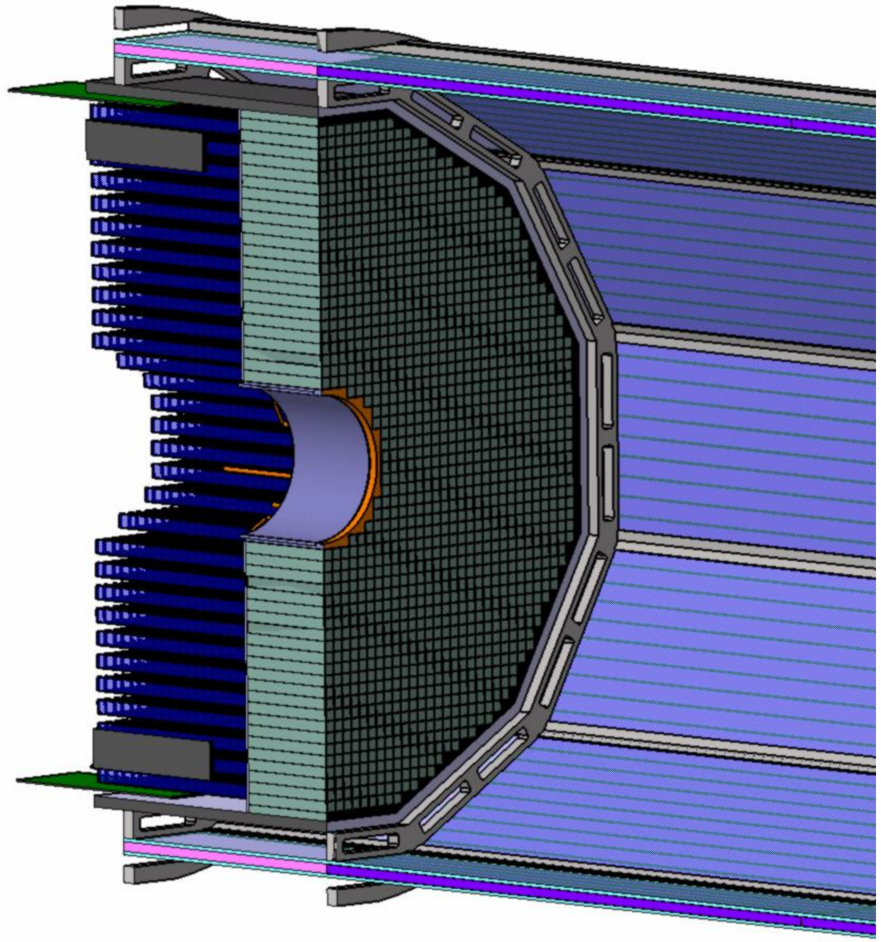


Update on the electron endcap calorimeters

Carlos Muñoz Camacho
IJCLab-Orsay, CNRS/IN2P3 (France)

Global design and integration WG meeting

June 27, 2022

ECAL: goals & requirements

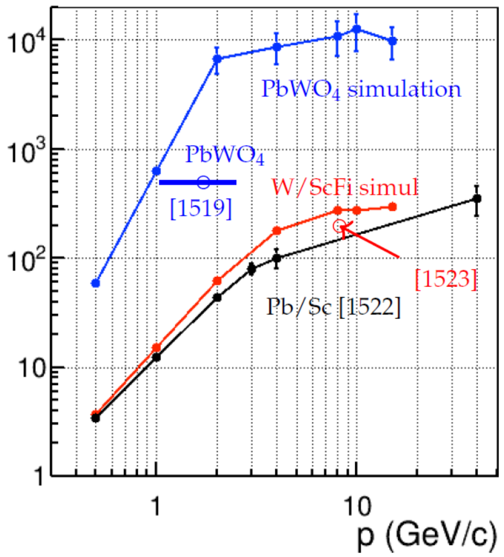
Goals:

- Electron/pion separation
- Improve electron resolution at large |η|
- Measure photons with good resolution
- Separate 2-γ from π^0 at high energy

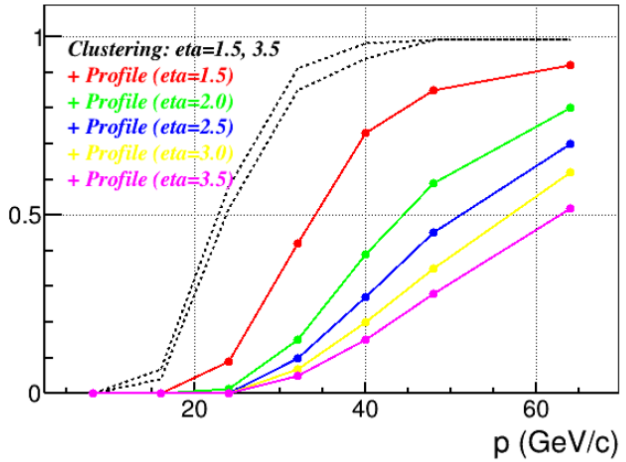
Requirements:

- Energy resolution: $2\%/\sqrt{E} + (1\text{-}3)\%$
- Pion suppression: $1:10^4$
- Minimum detection energy: > 50 MeV

π± rejection YR Fig. 11.48

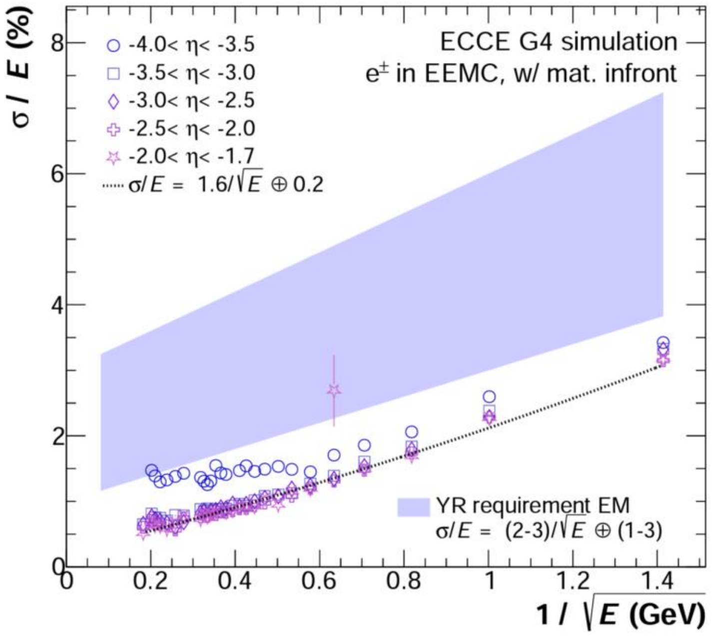


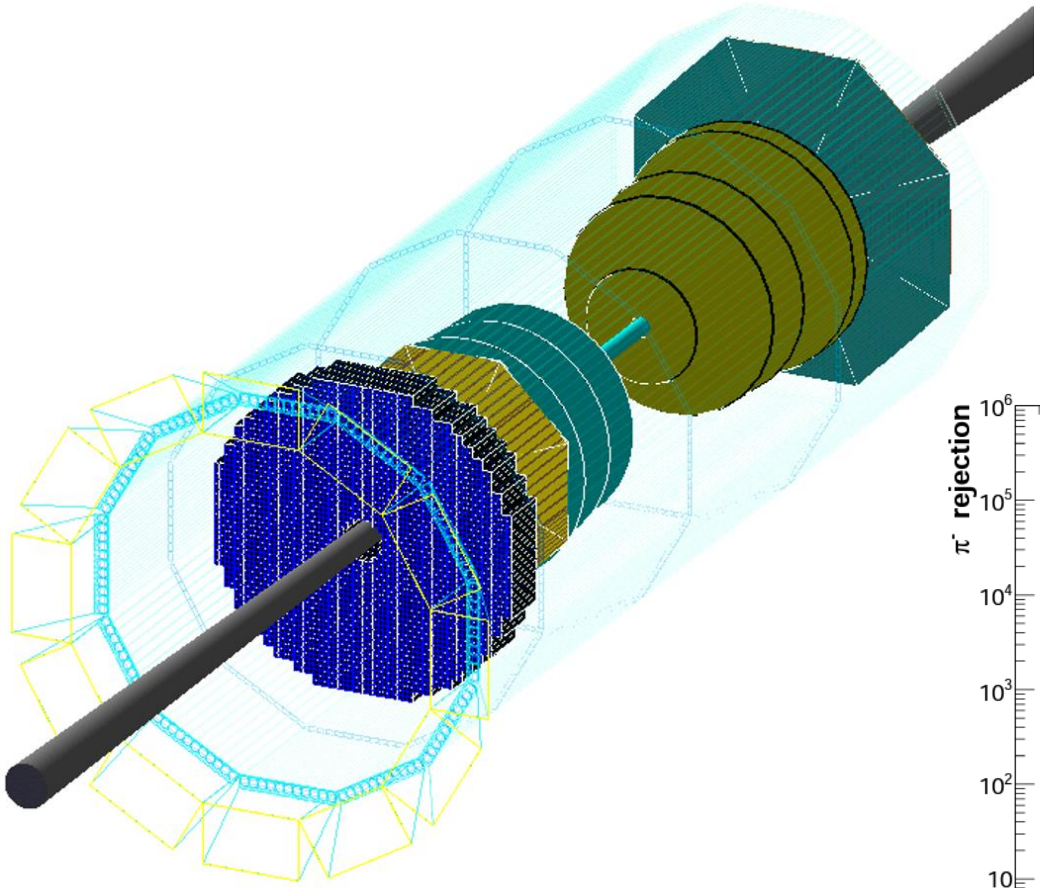
Pi0 merging prob vs p YR Fig. 11.46

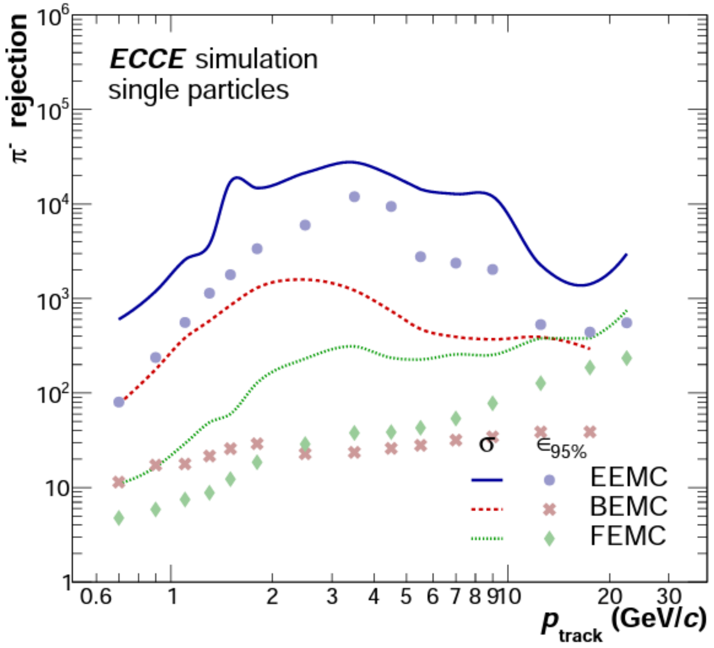


Yellow Report recommended PWO as technology choice for backward endcap
All proposals followed that recommendation in their detector design

ECAL implementation & performance

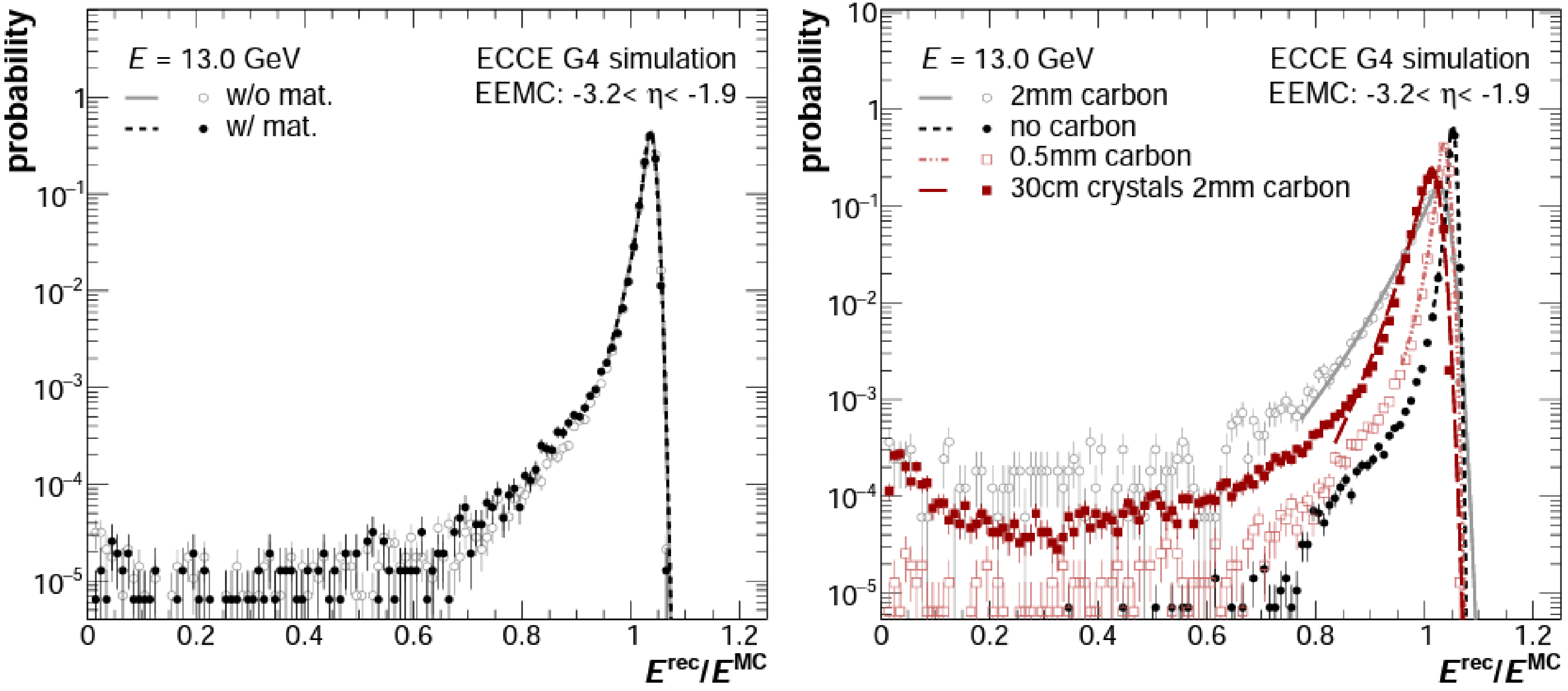






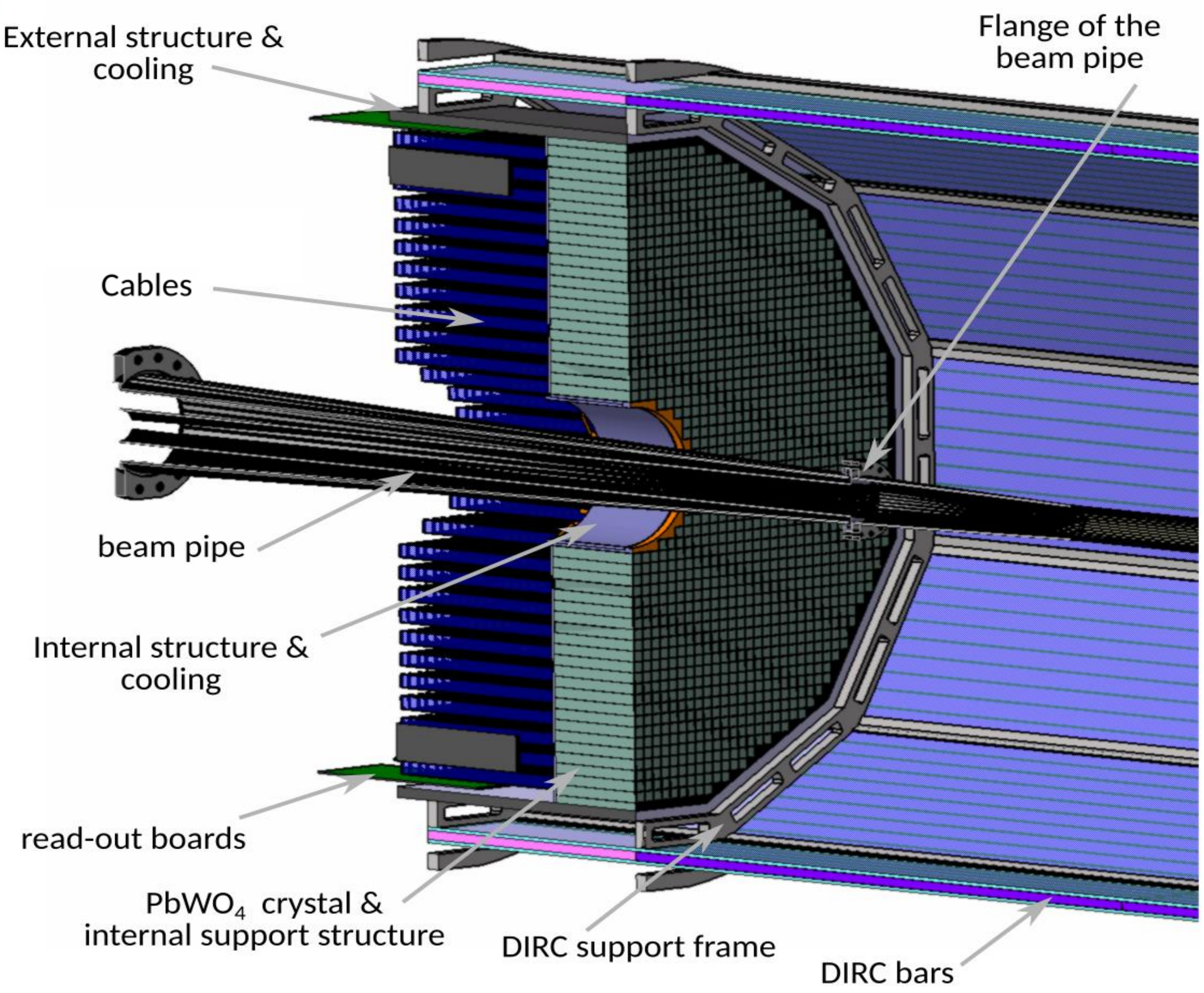
Simulations performed during proposals demonstrated that the YR requirements were met

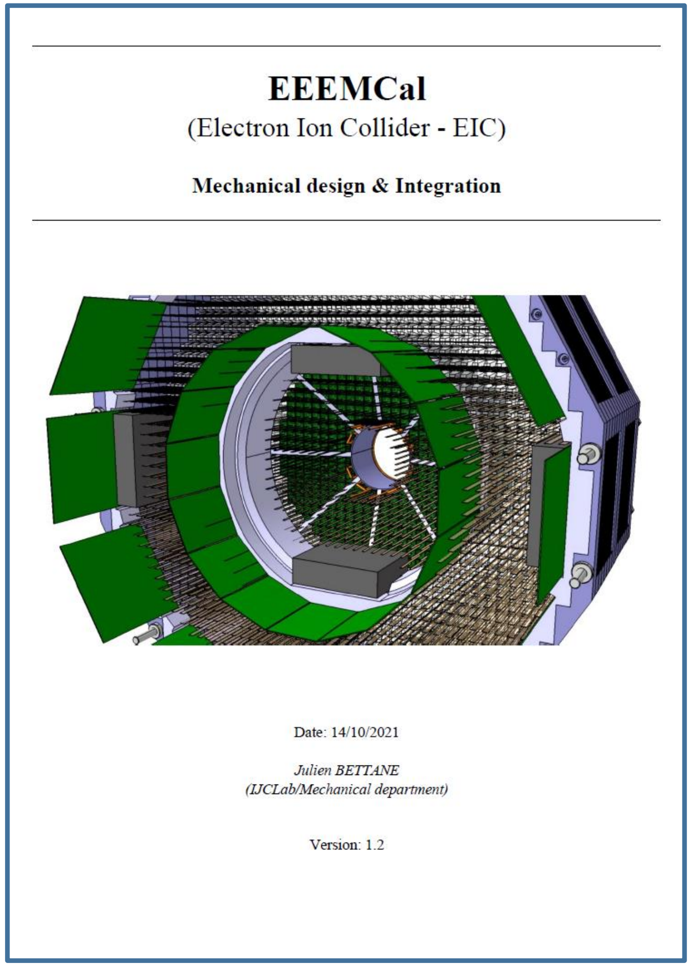
Physics performance: tails…



With geometry of the proposed detector,
tails were dominated by the material between towers rather than material in front

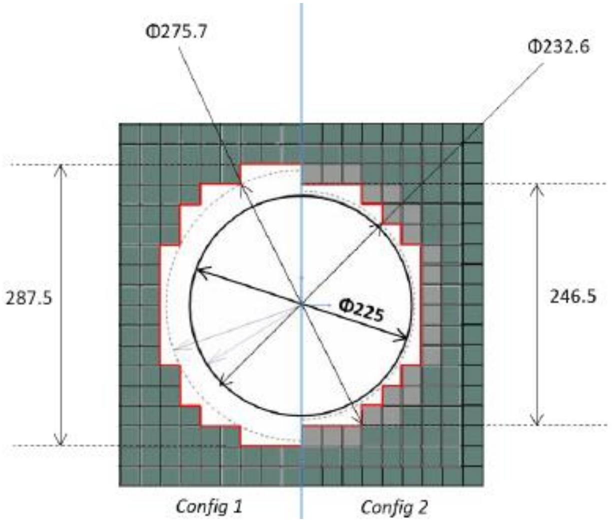
Towards a preliminary technical design

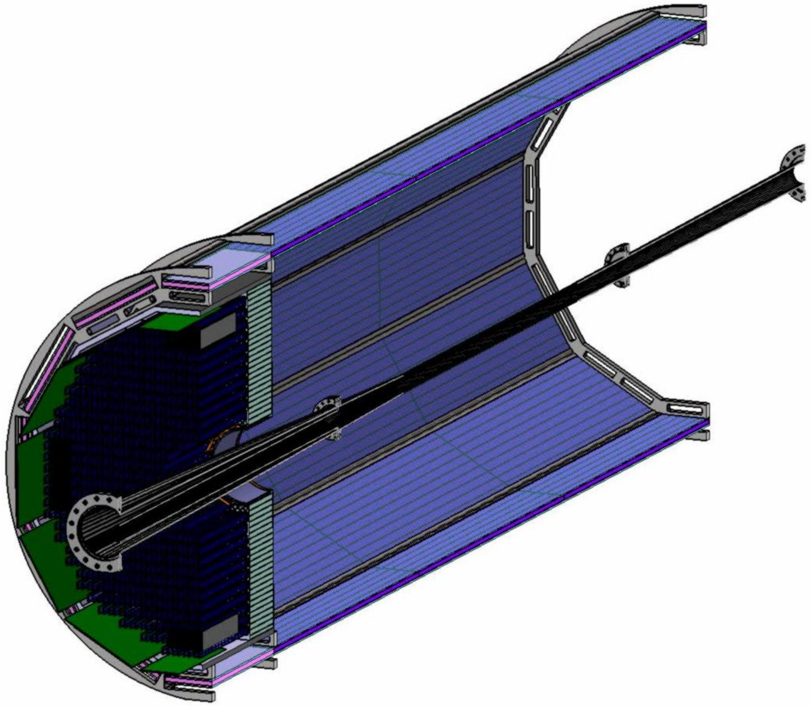


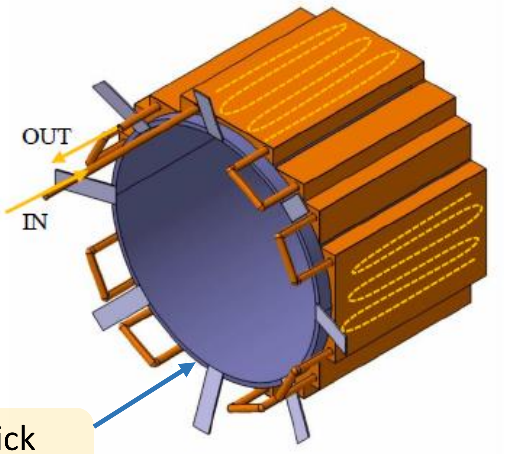


EEEMCal consortium pre-design

Limitation in η coverage

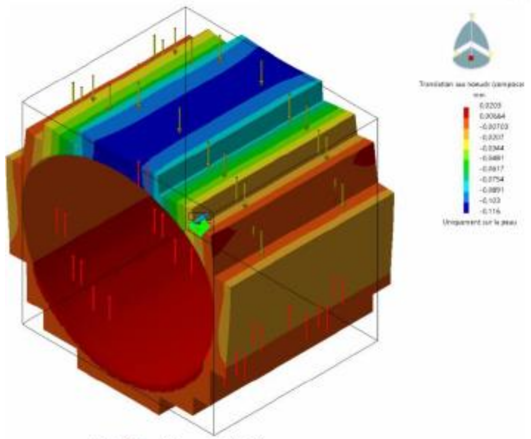




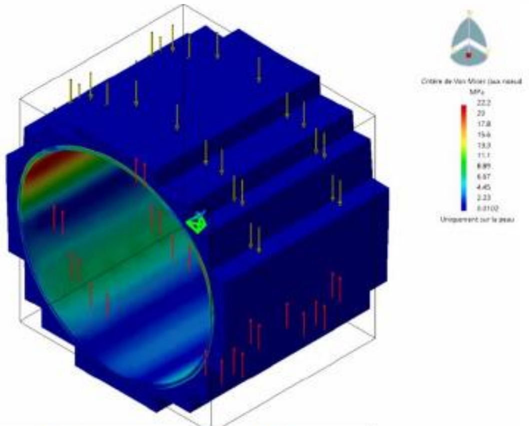


5-mm-thick Inox structure

Cooling

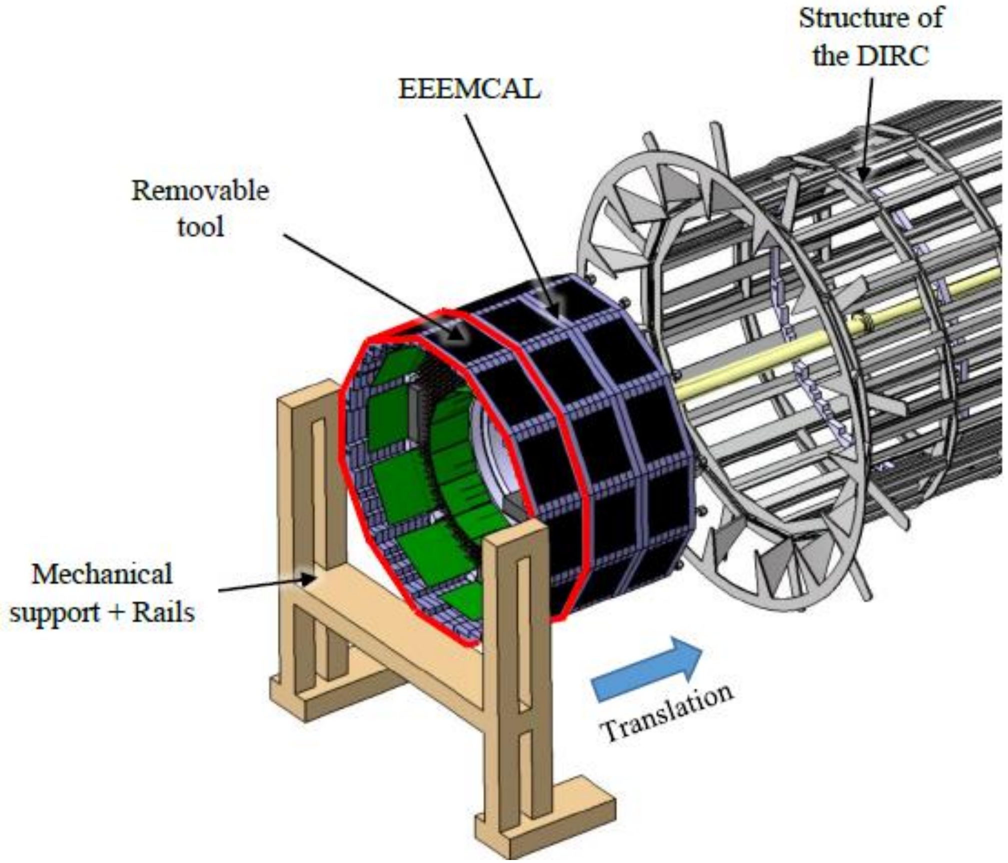


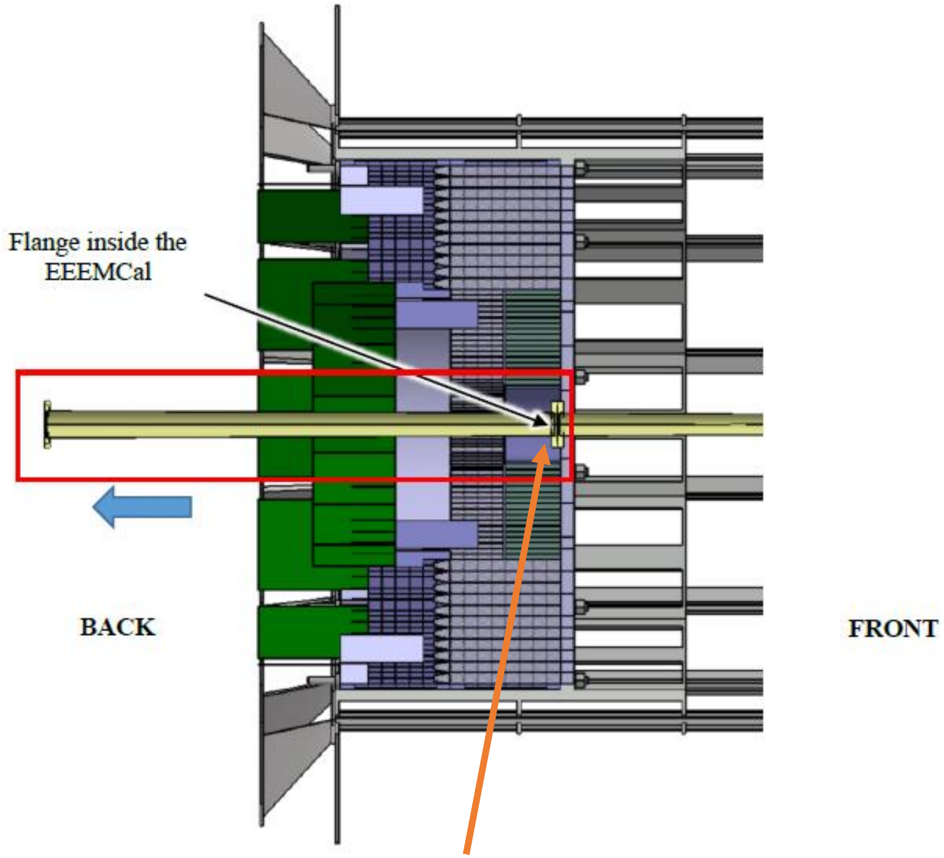
Deflection < 0.1 mm



22.2 Mpa < Inox Yield Stress

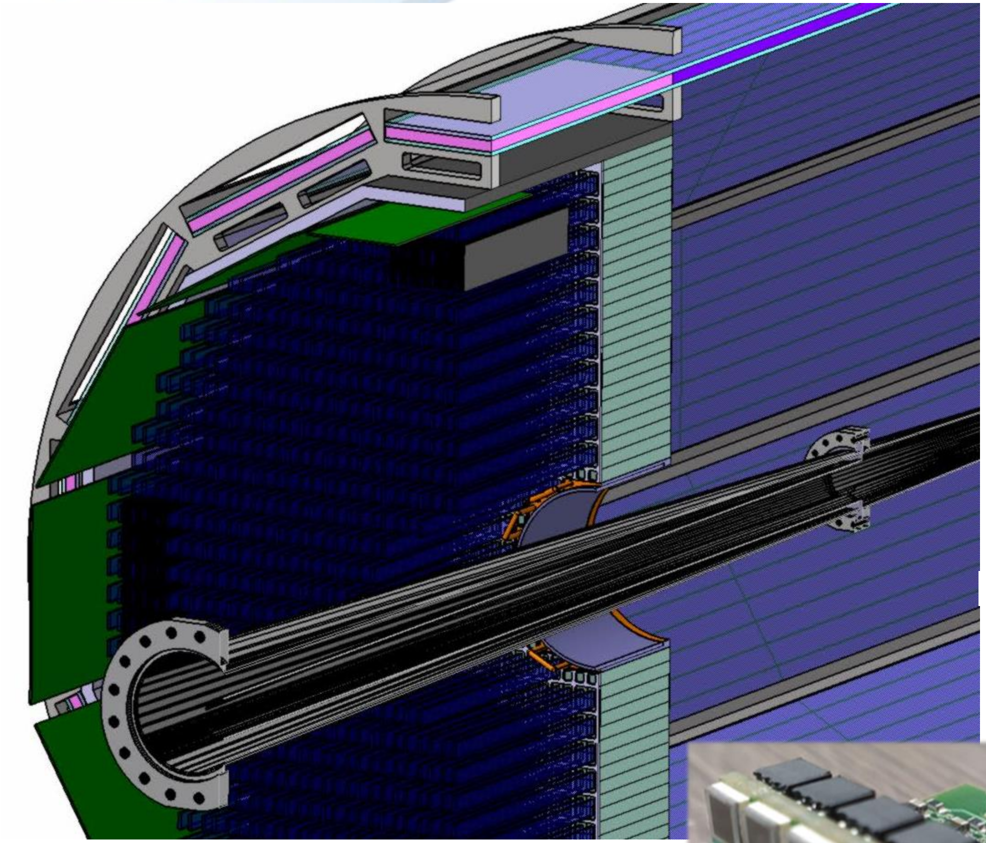
ECAL assembly

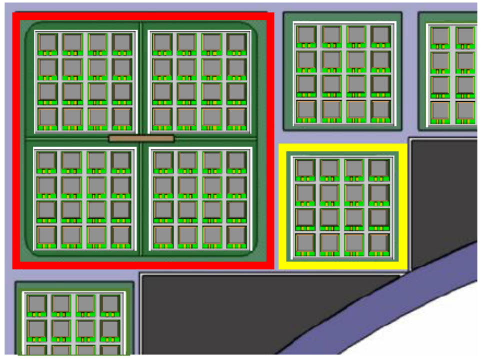




Limitation in pseudorapidity coverage

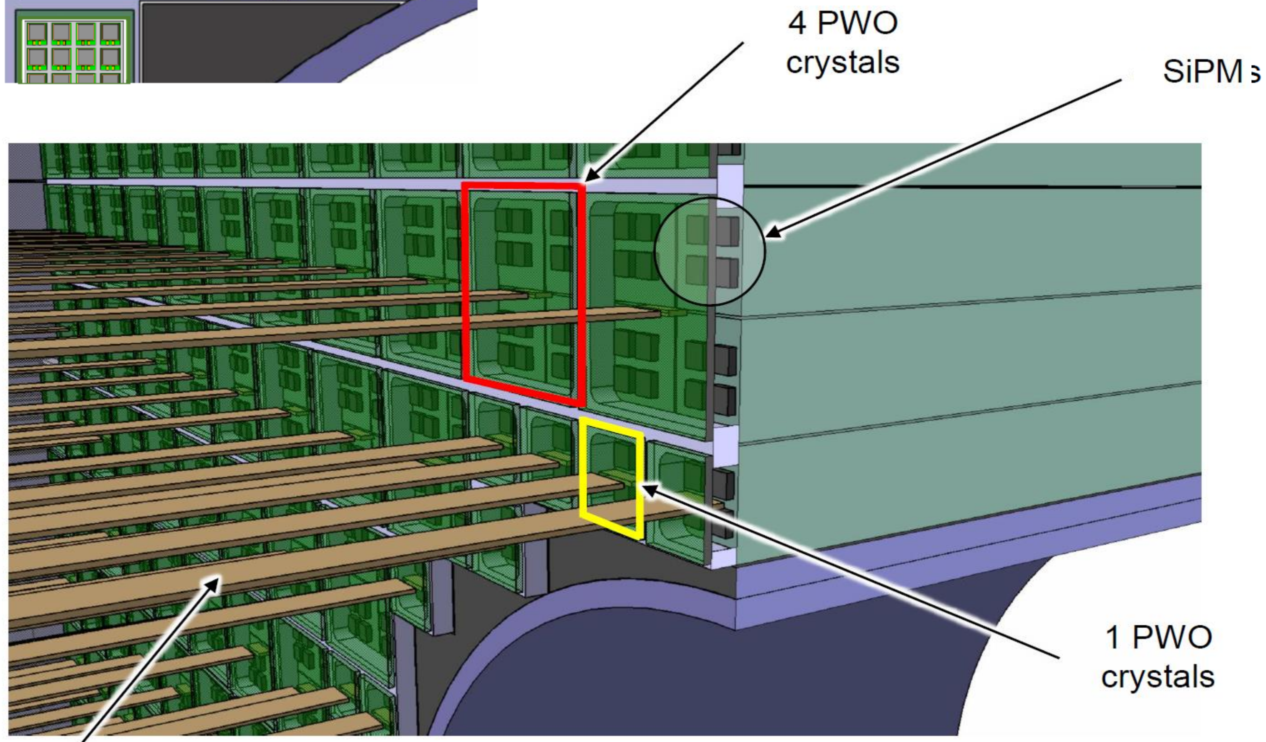
Ongoing efforts advancing the design
(flange optimization, inner calorimeter, etc)





Anticipated readout system:

16 SiPM per 2×2 cm^2 crystal



Readout module for
1 crystal with 16 SiPM

The EEEMCal consortium

US

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- Lehigh University (contact: Rosi Reed, rosijreed@lehigh.edu)
- University of Kentucky (contact: Renee Fatemi, renee.fatemi@uky.edu)
- MIT and MIT-Bates Research and Engineering Center (contact: Richard Milner, milner@mit.edu)
- Florida International University (contact: Lei Guo, leguo@fiu.edu)
- James Madison U. (contact: Gabriel Niculescu, gabriel@jlab.org)

International

- AANL, Armenia (contact: Ani Aprahamian, aapraham@nd.edu)
- Charles University Prague, Czech Republic (contact: Miroslav Finger, Miroslav.finger@cern.ch)
- IJCLab-Orsay, France (contact: Carlos Munoz-Camacho, munoz@jlab.org)

R&D plans

Year	Deliverable/Goal	Responsible Team
2021	Determine impact of calorimeter support structure on physics performance, e.g., energy resolution; define	AANL, CUA, IJCLab
2022	Concept design; Force calculations; thermal aspects; prototype tests	IJCLab, MIT
2023	100% design drawings, start of procurement, fabrication	IJCLab, MIT
2024	Procurement, fabrication	IJCLab, MIT
2025	Procurement, fabrication	IJCLab, MIT
2026	Assembly, installation, test	IJCLab, MIT
2027	Assembly, installation, test	IJCLab, MIT

Table 1: Mechanical

Year	Deliverable/Goal	Responsible Team
2021	Identify constraints; photodetector and microelectronics development; construct prototypes and initial commissioning	Charles U., IJCLab, MIT, Lehigh U., UKY
2022	Prototype and beam tests	AANL, Charles U., CUA, IJCLab, FIU, Lehigh U., MIT, UKY
2023	Production of photodetector and FEE; Q&A; labeling and selection	IJCLab, Lehigh U., UKY
2024	Production of photodetector and FEE; Q&A; labeling and selection	IJCLab, Lehigh U., UKY
2025	Production of photodetector and FEE; Q&A; labeling and selection	IJCLab, Lehigh U., UKY
2026	Assembly, installation, test	IJCLab, Lehigh U., UKY
2027	Assembly, installation, test	IJCLab, Lehigh U., UKY

Table 3: Readout

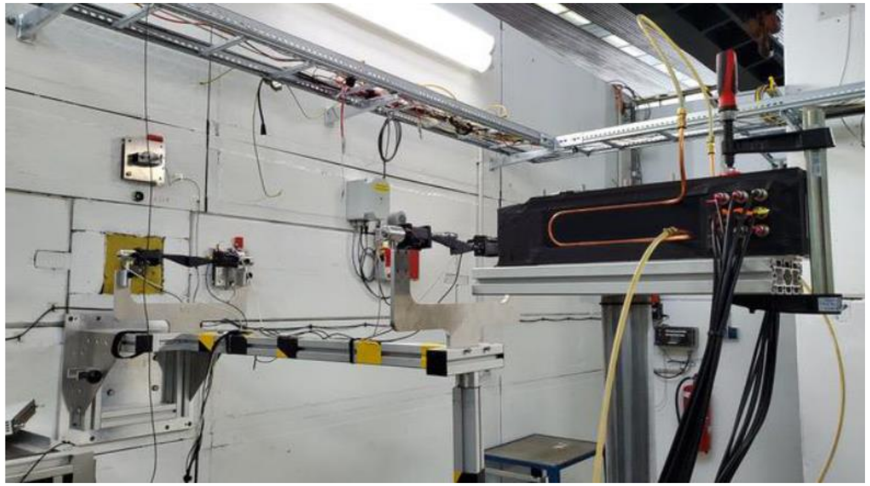
Year	Deliverable/Goal	Responsible Team
2021	Final formulation optimization and scale up SciGlass; characterize scintillator material; develop simulations and algorithms to optimize shared coverage; construction and initial commissioning of prototypes for beam test program	AANL, Charles U., CUA, FIU, MIT
2022	Prototype and beam tests; process design verification to scale up	AANL, Charles U., CUA, IJCLab, FIU, Lehigh U., MIT, UKY
2023	Production of scintillator material; Q&A; labeling and selection	AANL, Charles U., CUA, FIU
2024	Production of scintillator material; Q&A; labeling and selection	AANL, Charles U., CUA, FIU
2025	Production of scintillator material; Q&A; labeling and selection	AANL, Charles U., CUA, FIU
2026	Assembly, installation, test	AANL, Charles U., CUA, FIU
2027	Assembly, installation, test	AANL, Charles U., CUA, FIU

Table 2: Scintillator

Year	Deliverable/Goal	Responsible Team
2021	Development of simulations, reconstruction and analysis algorithms, artificial intelligence framework for optimization	AANL, FIU, MIT, Lehigh U., UKY
2022	Initial commissioning of simulations and algorithms	AANL, FIU, MIT, Lehigh U., UKY
2023	Testing and optimization of simulations and algorithms; concept	AANL, FIU, MIT, Lehigh U., UKY
2024	Testing and optimization of simulations and algorithms; concept	AANL, FIU, MIT, Lehigh U., UKY
2025	Testing and optimization of simulations and algorithms; concept	AANL, FIU, MIT, Lehigh U., UKY
2026	Installation, test	AANL, FIU, MIT, Lehigh U., UKY
2027	Installation, test	AANL, FIU, MIT, Lehigh U., UKY

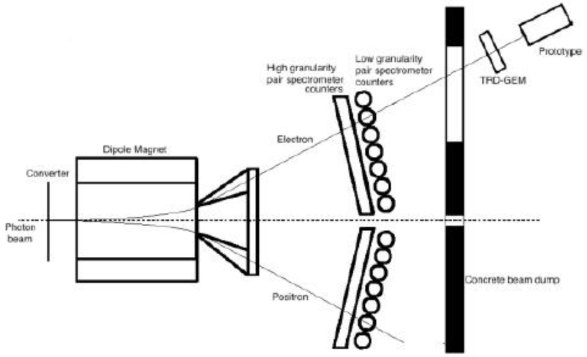
Table 4: Software

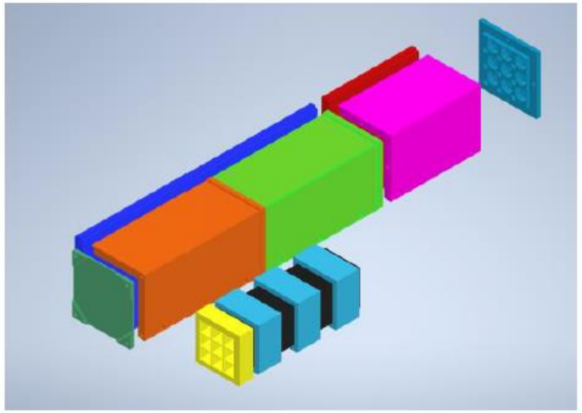
EEEMCal – ongoing tests

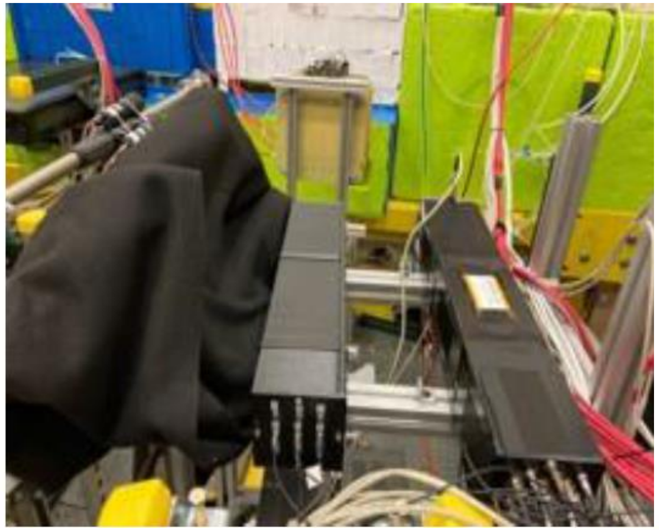


Prototype beam tests at DESY

Goal:
Tests of photosensor readout (SiPM) & triggerless DAQ





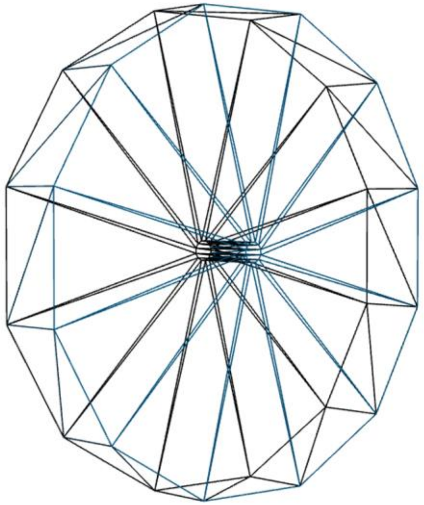


Prototype beam tests in Hall D at JLab

Backward HCAL

- No strong physics motivation was found during the YR
- The EIC science program (WP, NAS) can be delivered without a backward HCAL
- The strongest case for a backward HCAL is the potential for a neutral hadron veto which would allow for separate treatment/unfolding of jets with/without neutral

- Reference design contains no backward HCAL
- Some amount of steel is needed for flux return
- There seems to be a consensus within the calorimetry WG that the detector design should not preclude the possibility of adding an HCAL as an future upgrade



ATHENA endcap design with 41 layers of steel/scintillator arranged in 12 sectors

Title