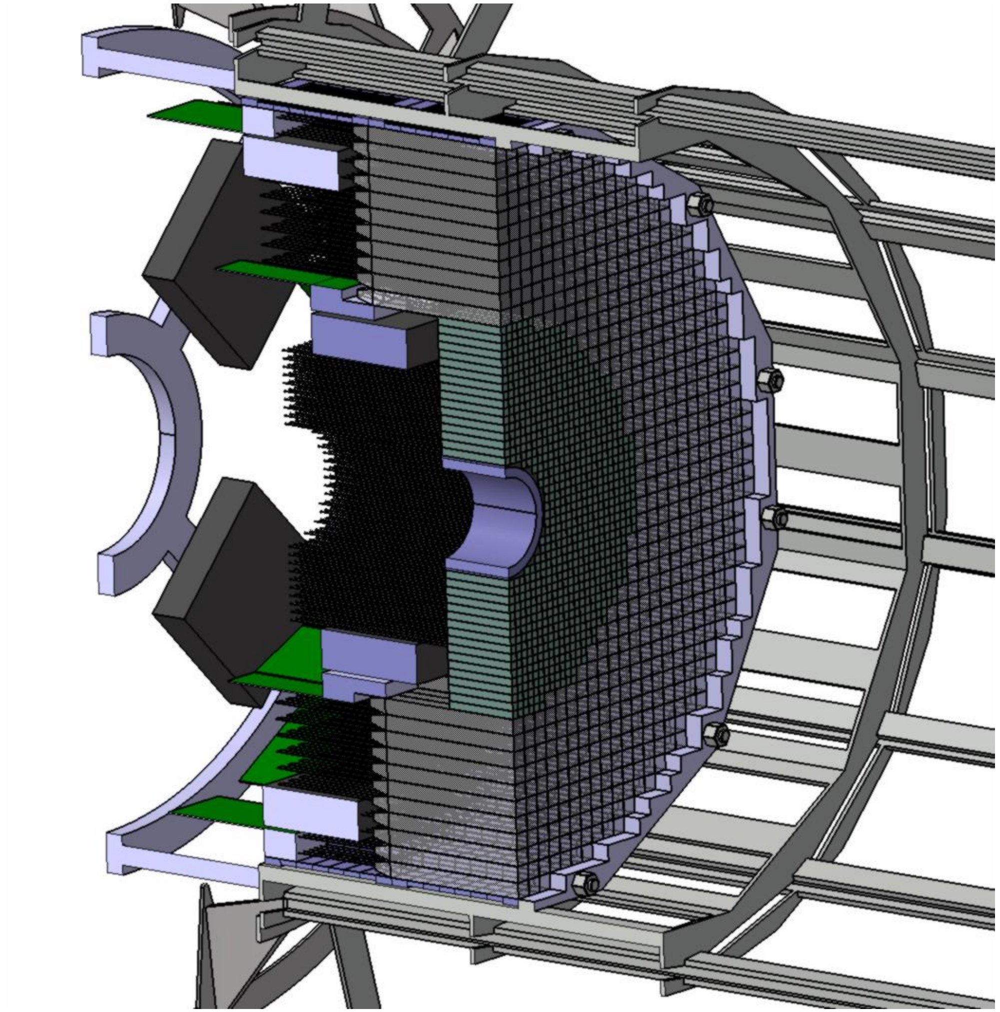


(electromagnetic) Backward calorimetry

Carlos Muñoz Camacho

IJCLab-Orsay, CRNS/IN2P3 (France)

for the EEEMCal consortium:

A. ALIKHANYAN National Laboratory

THE CATHOLIC UNIVERSITY OF AMERICA

IJCLab Irène Joliot-Curie Laboratoire de Physique des 2 Infinis

LEHIGH UNIVERSITY

MIT

LNS

UK

CHARLES UNIVERSITY

FIU FLORIDA INTERNATIONAL UNIVERSITY

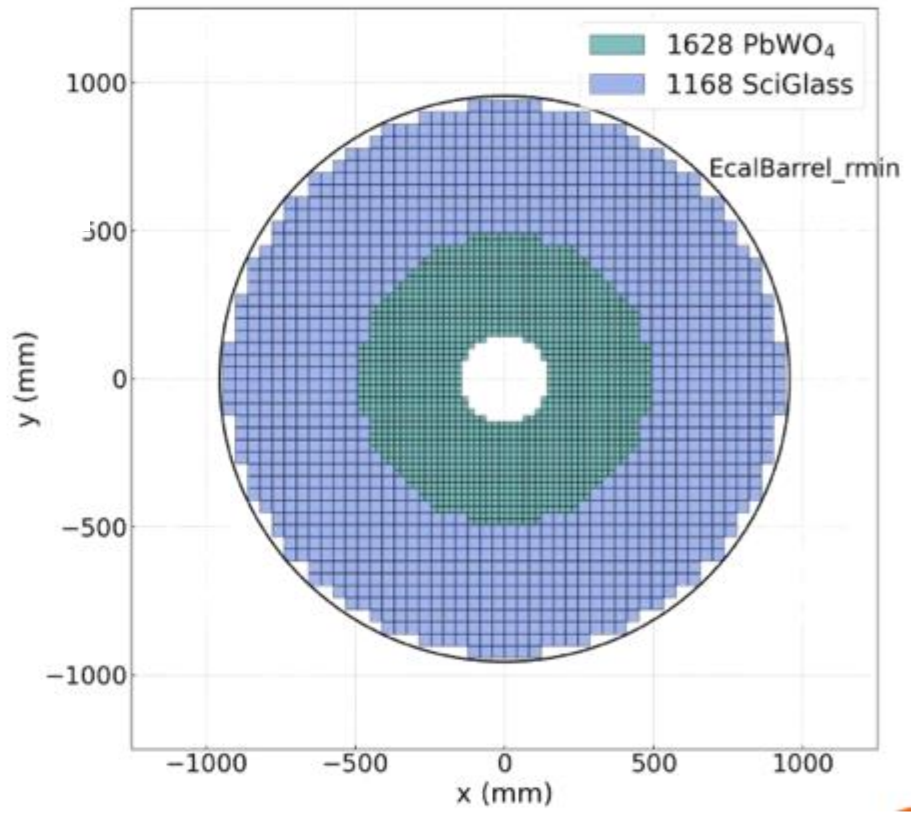
Introduction

➢ Design already common between ATHENA and ECCE (based on PWO)

➢ Only 2 differences:

❑ ATHENA, due to its larger size, include a ring of SciGlass at large angle

Not needed with the size of the BaBar magnet
→ all PWO



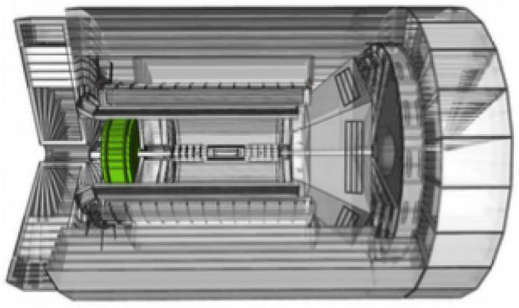
❑ HCAL in ATHENA and no HCAL in ECCE (*this will be the focus of a future meeting*)

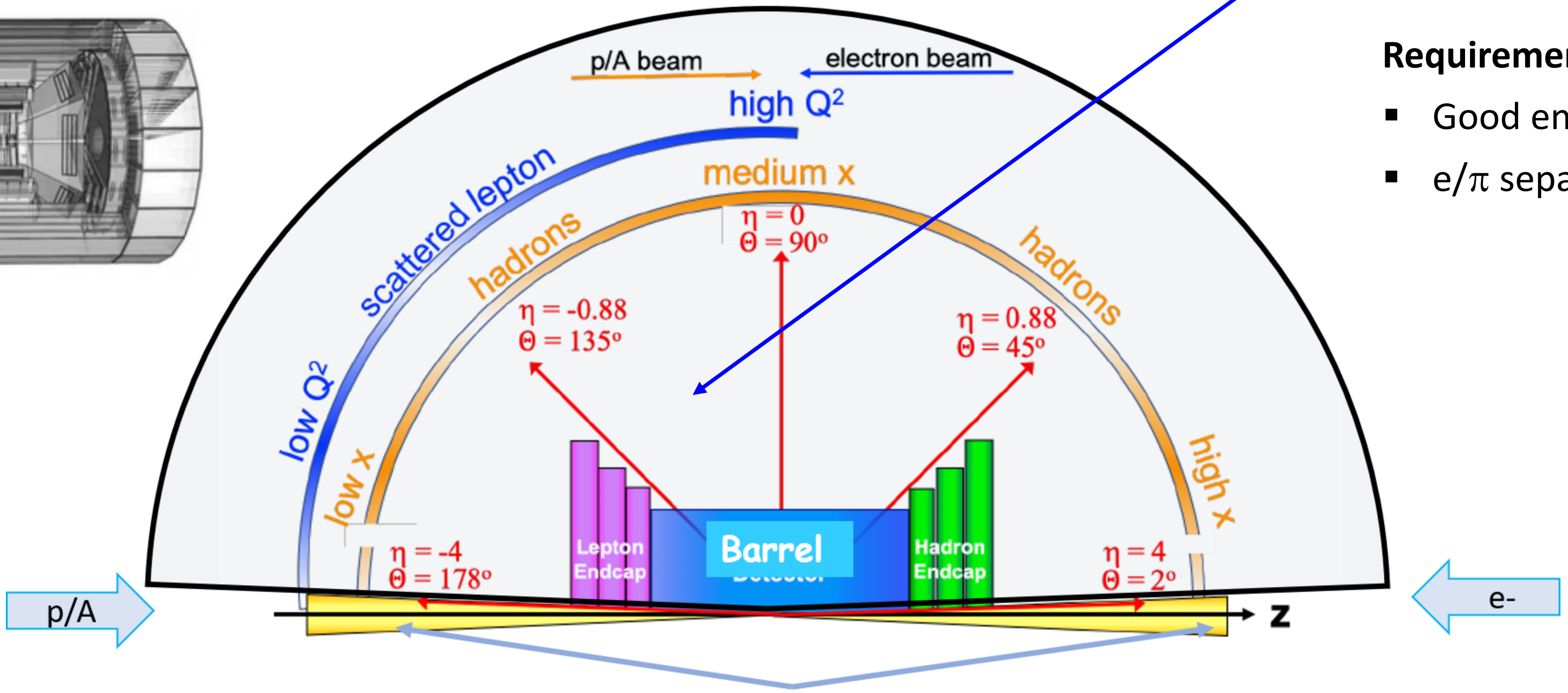
Scattered electrons – special detection requirements

Scattered electrons have to be detected in the Lepton Endcap (-3.5 < η < -1.0)

High resolution important in region -3.5 < η < -2

- Determines electron kinematics
- Physics requires (1-2%)/√E
- Particle E: ~0.02 – 18 GeV

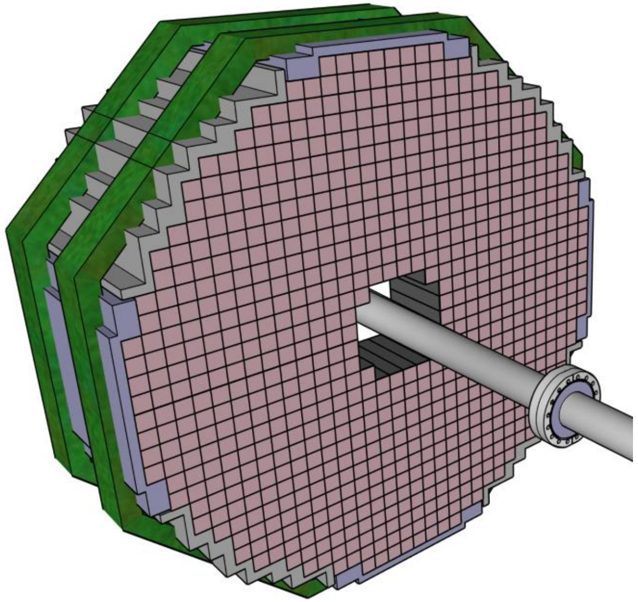




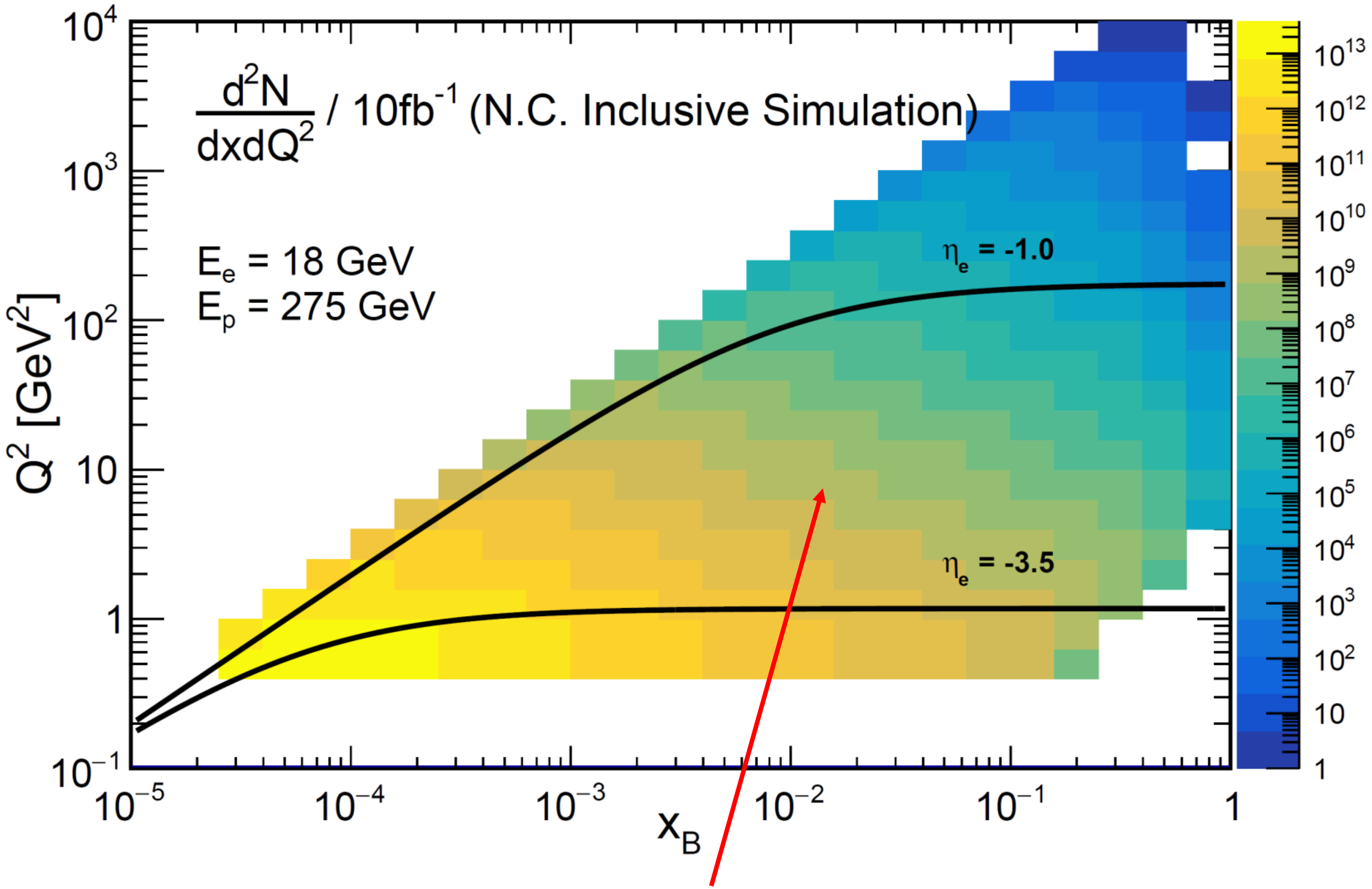
Requirements:

- Good energy resolution
- e/π separation up to 10^{-4}

Scattered electrons – kinematic coverage



Anticipated readout with SiPM



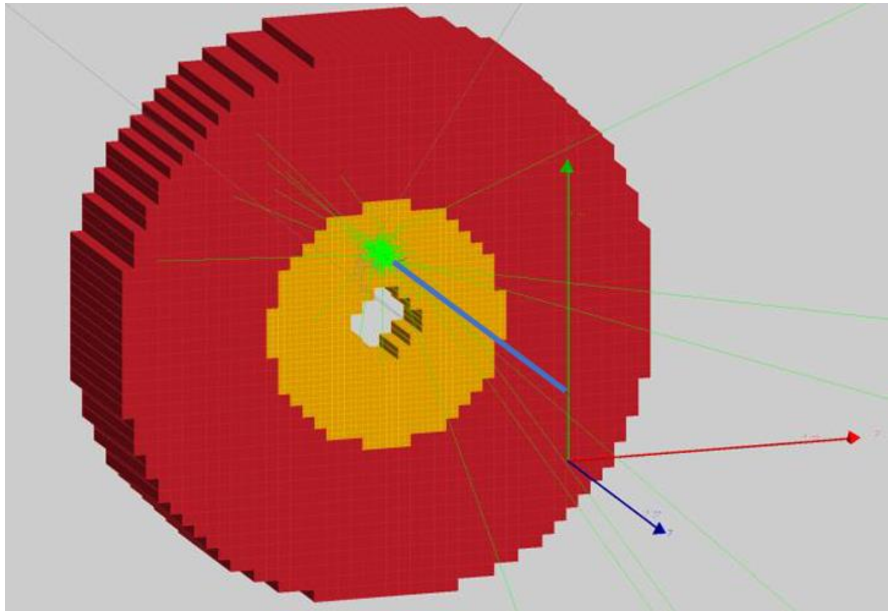
Region of physics enabled by the EEEMCal

Overview of EEMCal specifications

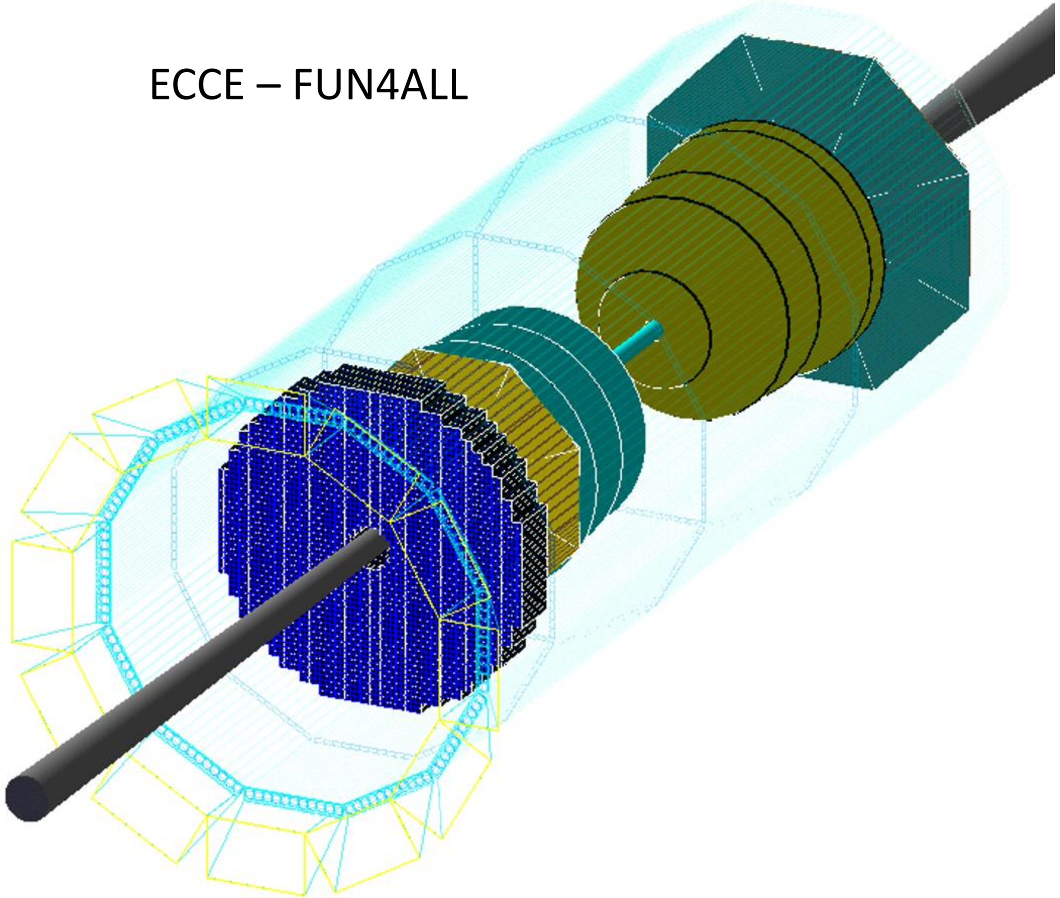
- Coverage: -3.5 < eta < -1
  - Inner: Rin=15cm, Rout=49cm
  - Outer: Rin=49cm, Rout=133cm
- Egamma:
  - Inner: 20 MeV – 20 GeV
  - Outer: 50 MeV – 20 GeV
- Energy Resolution:
  - Inner: 1%+2.5%/sqrtE+1%/E
  - Outer: 2%+4%/sqrtE+2%/E
- Spatial Resolution:
  - 1mm+3mm/sqrtE
- Maximum Annual Dose at top luminosity:
  - EM: ~3krad/year (30 Gy/year)
  - Hadron: 10^10 n/cm2
- Signal dynamics
  - 2 V dynamic range
  - ADC 12 bits
- Signal Rate: =<1 MHz/channel
- Digitization Gate: ~(100-200) ns
- Sampling Rate: 250 MHz
- Peaking Time: ~4ns
- Data sparsification/feature extraction
  - Peak
  - Integral
  - Time
  - Pedestal
  - Number samples
  - Pulse quality
  - Pileup detection and recovery

EEMCal in simulations

ATHENA – DD4HEP



ECCE – FUN4ALL



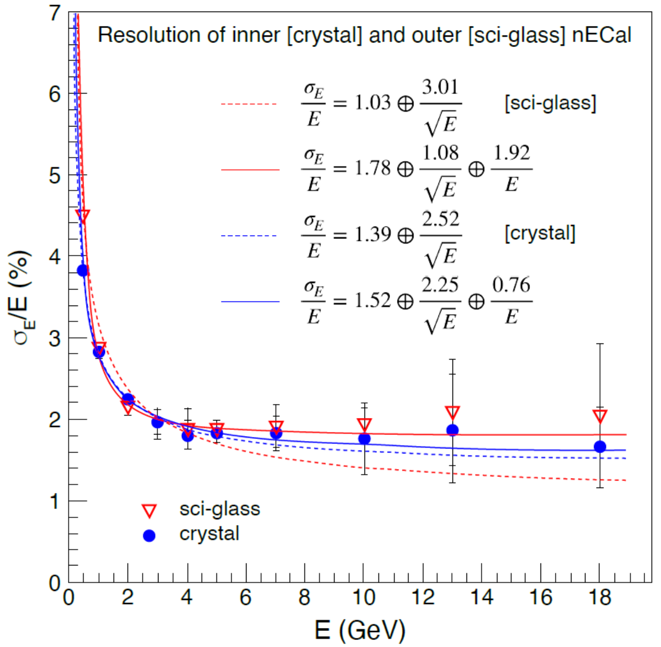
Physics performance studied in detailed during proposal process and within different software frameworks

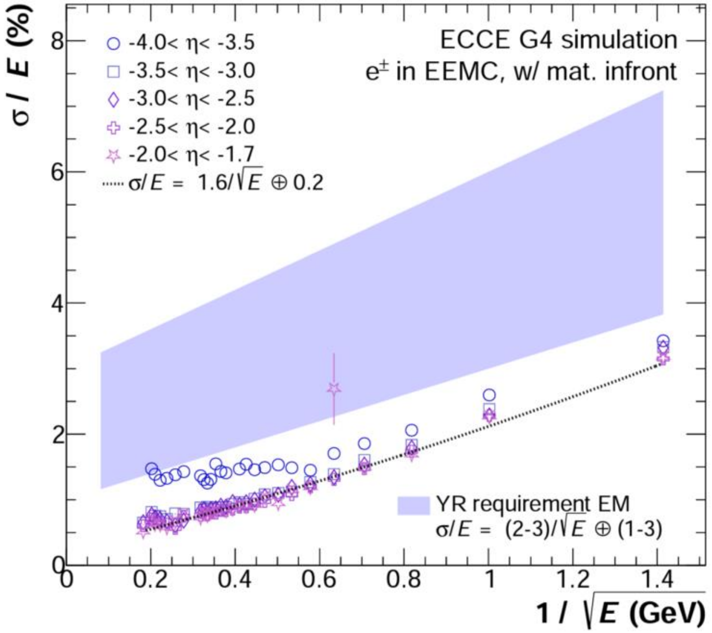
Physics performance

ATHENA

ECCE

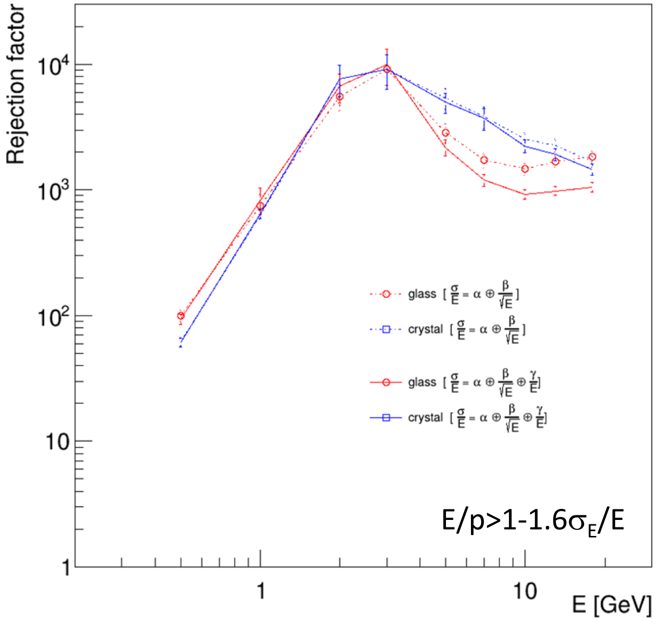
Energy resolution:

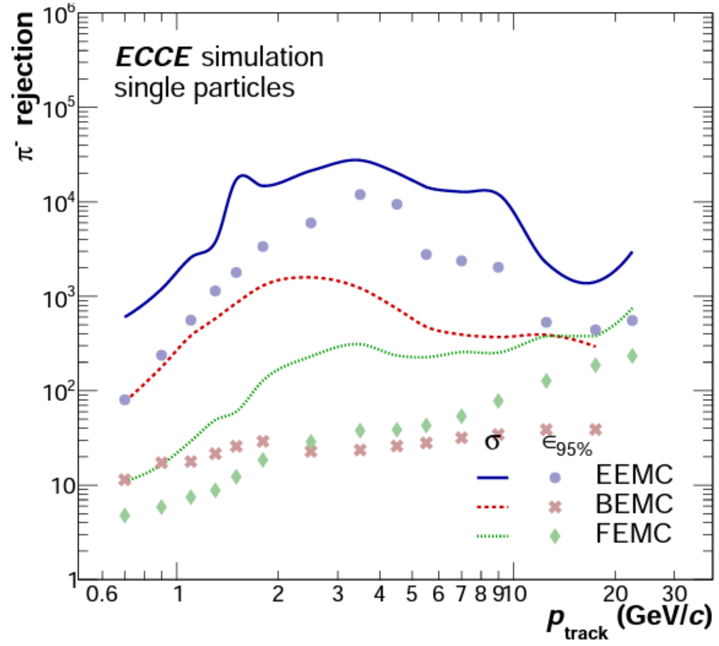




Performances well within YR requirements

Pion rejection:





The EEEMCal consortium

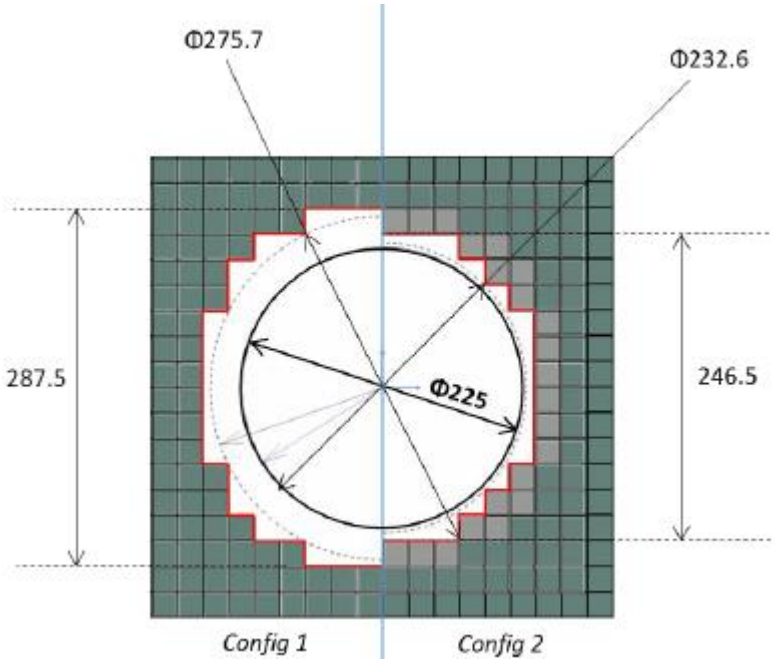
US

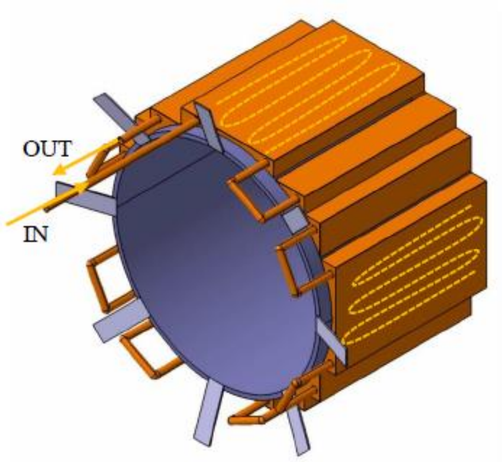
- The Catholic University of America (contact: Tanja Horn, hornt@cua.edu)
- Lehigh University (contact: Rosi Reed, rosijreed@lehigh.edu)
- University of Kentucky (contact: Renee Fatemi, renee.fatemi@uky.edu)
- MIT and MIT-Bates Research and Engineering Center (contact: Richard Milner, milner@mit.edu)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

International

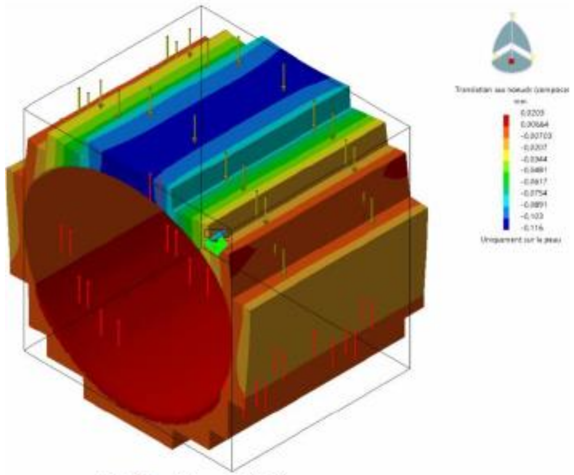
- AANL, Armenia (contact: Ani Aprahamian, aapraham@nd.edu)
- Charles University Prague, Czech Republic (contact: Miroslav Finger, Miroslav.finger@cern.ch)
- IJCLab-Orsay, France (contact: Carlos Munoz-Camacho, munoz@jlab.org)

Towards a preliminary technical design

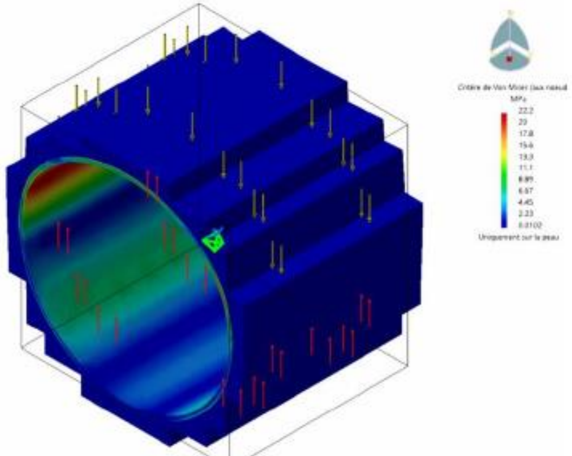




Cooling



Deflection < 0.1 mm

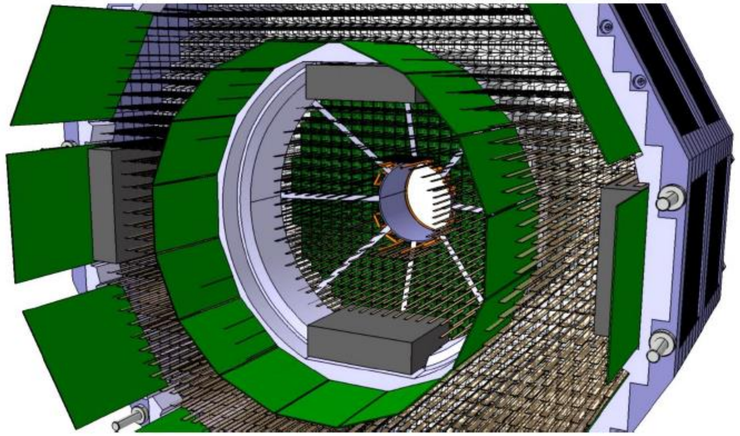


22.2 Mpa < Inox Yield Stress

EEEMCal

(Electron Ion Collider - EIC)

Mechanical design & Integration

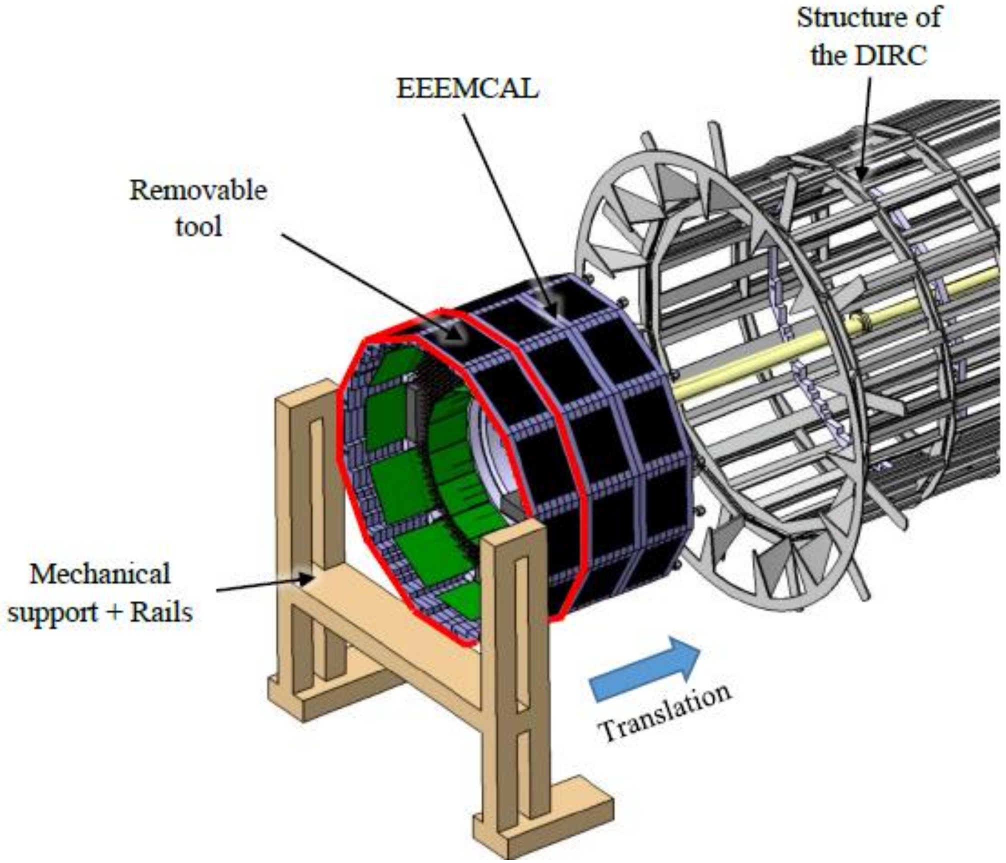


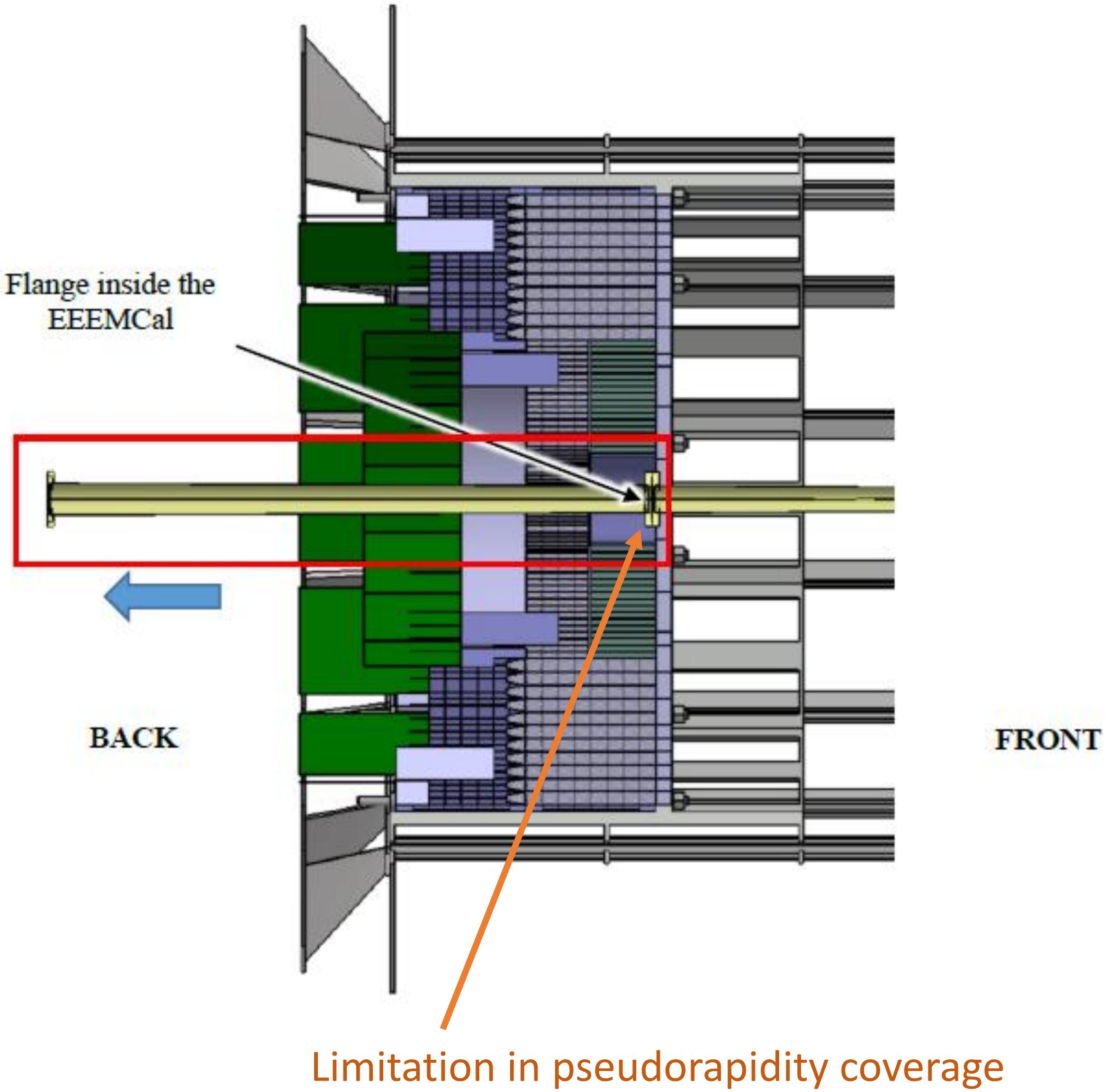
Date: 14/10/2021

Julien BETTANE
(IJCLab/Mechanical department)

Version: 1.2

EEMCal assembly



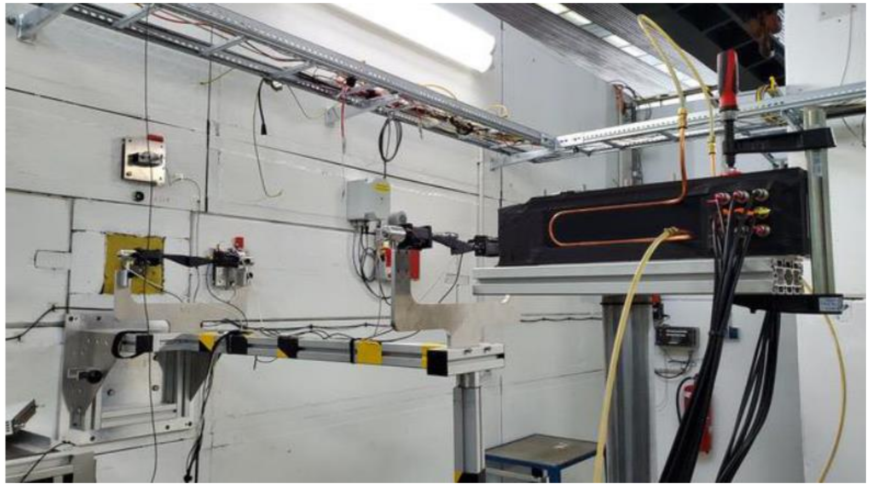


Ongoing efforts advancing the design
(flange optimization, inner calorimeter, etc)

EEMCal – ongoing tests

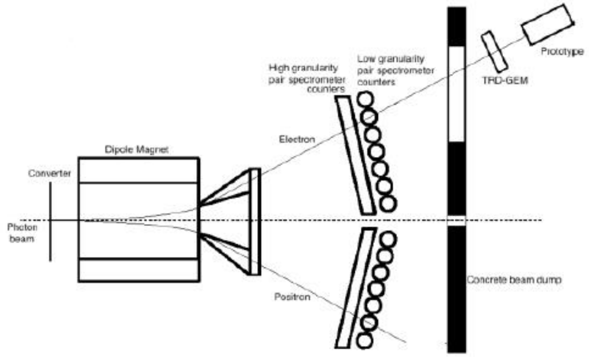
Goal:

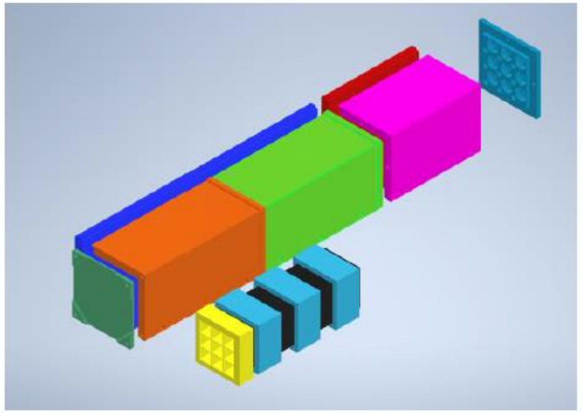
Tests of photosensor readout (SiPM) & triggerless DAQ

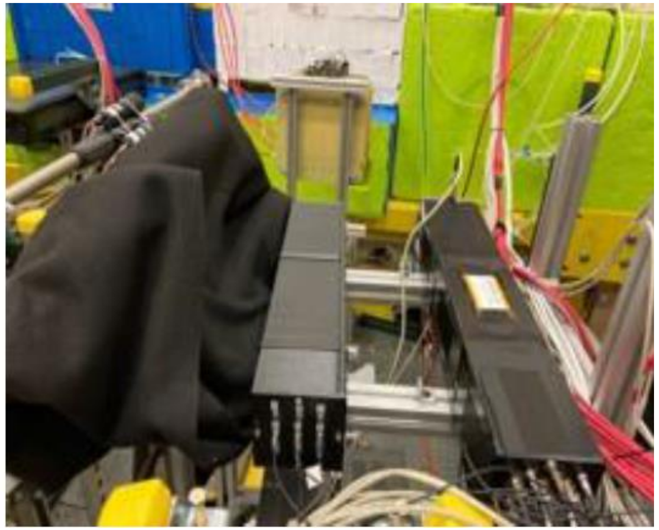


Prototype beam tests at DESY

Readout module for 1 crystal with 16 SiPM







Prototype beam tests in Hall D at JLab

Conclusion

- Backward calorimetry is crucial for reconstructing the DIS scattered electron
- Requirements include excellent energy resolution and high pion suppression
- Both ATHENA and ECCE came up with the same proposal based on PWO crystals
- The need of a hadron calorimeter in the backward direction needs to be discussed in upcoming meetings
- The EEEMCal consortium is leading the development, is actively working on advancing the design, and is eager to engage in the next steps towards a TDR and future construction