

Korean contribution for EIC

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(Sejong University)

Korea-Japan Collaboration
Meeting
2021.07.15



Overview of Korean groups' contribution

- **Korean group's Interest on EIC**

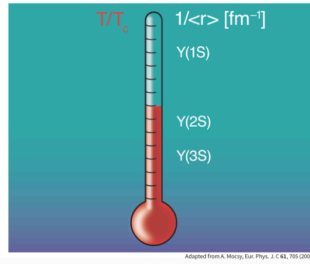
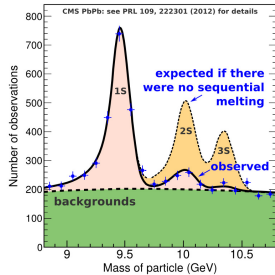
Group A (Forward Cal)	R&D of forward calorimeters, including neutron detectors at the very forward region.
Group B (Pixel Tracker)	Development, test, and production of silicon pixel detector
Group C (Dual-Readout)	single component calorimeter technique including entire functionalities of both electromagnetic and hadronic calorimeters

- **EOI** for EIC was submitted last November
- **Group A (Forward)** is inspired by the physics interest of the heavy ion groups involved in CMS, PHENX, and RHICf
 - Byungsik Hong, Jung KeuK Ahn, Yongsun Kim, Dongho Moon
- **Group B (Tracker)** is organized by the ALPIDE taskforce
 - Eun-Joo Kim, Sanghoon Lim, Youngil Kwon, Minjung Kweon
- **Group C (DRC)** is dedicated to the R&D of dual-readout calorimeters for generic use
 - Hyon-Suk Jo, Sehwook Lee, Jason Lee, Hwidong Yoo

Physics interest by Korean groups (1/2)

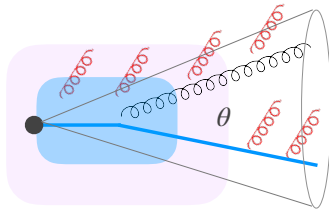
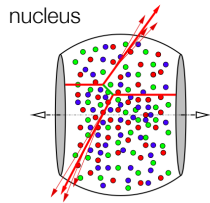
Hard Probes

Quarkonia modification



Quarkonia suppression as the signature of cold/hot medium effects

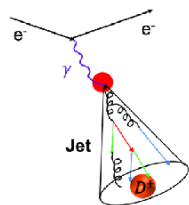
Jet stopping



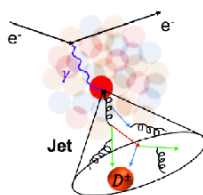
Energy loss and modification of constituent of jet by cold nuclear matter

Heavy flavor

$$e^- + p \rightarrow e^- + jet(D^\pm) + X$$



$$e^- + Au \rightarrow e^- + jet(D^\pm) + X$$



Mass/flavour dependence of quark and nucleus interaction

Physics interest by Korean groups (2/2)

Electromagnetic probing on nucleus

Photo-production

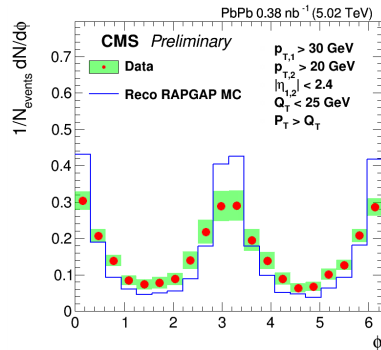
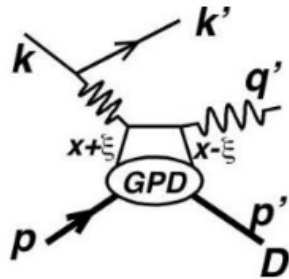


Photo-production of di-jet and vector meson

Electron scattering



Precision measurement of GPD

Dual-readout calorimetry

• Basic concept

- The major difficulty in measurement of hadronic shower comes from EM fraction (f_{em})
- f_{em} can be precisely measured by implementing two channels with different h/e response in a same module

$$S = E[f_{em} + \frac{1}{(e/h)_s}(1-f_{em})],$$

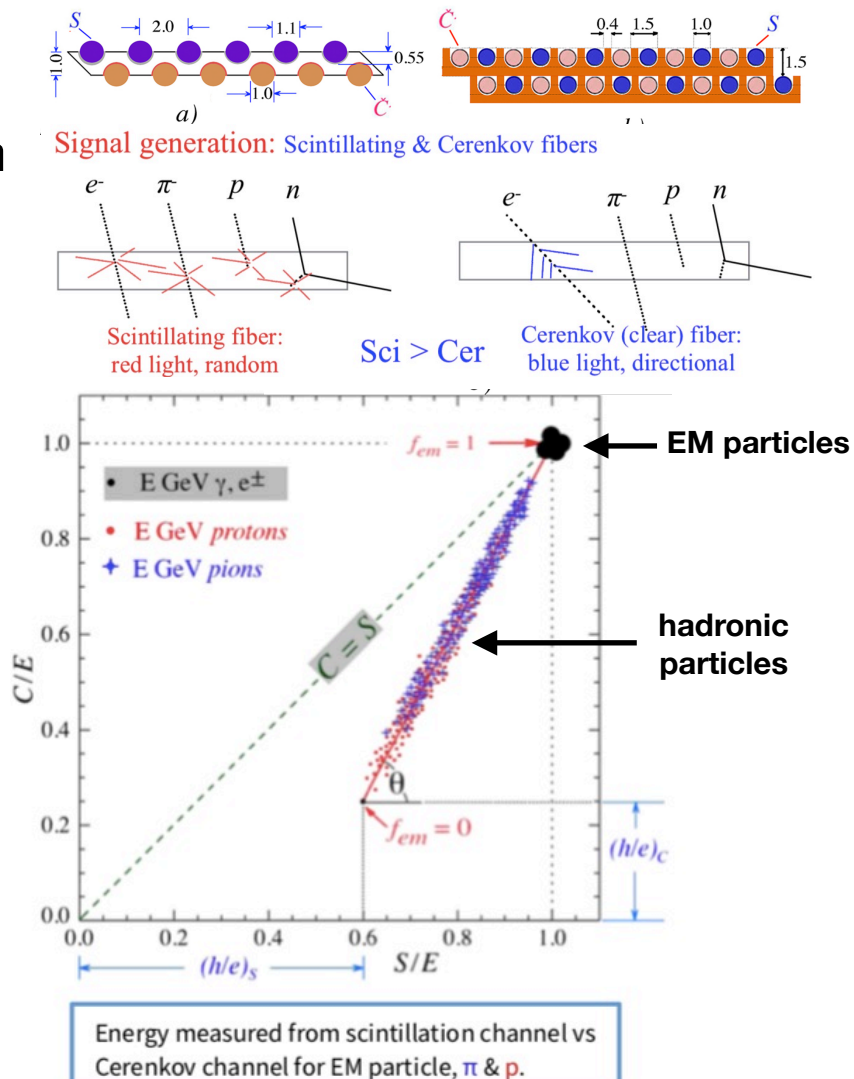
$$C = E[f_{em} + \frac{1}{(e/h)_c}(1-f_{em})].$$

$$f_{em} = \frac{(h/e)_c - (C/S)(h/e)_s}{(C/S)[1 - (h/e)_s] - [1 - (h/e)_c]}$$

$$\cot \theta = \frac{1 - (h/e)_s}{1 - (h/e)_c} \equiv \chi,$$

$$E = \frac{S - \chi C}{1 - \chi}.$$

- Can offer high-quality energy resolution for both EM and hadrons
- Demonstrate engineering aspects for full geometry detector
- 20+ years R&D: CERN RD52 experiment



See R. Ferrari's talk yesterday for detail

R&D of dual readout in Korea

- Group C, as participants of IDEA dual-readout collaboration, build a **prototype detector for CEPC and FCC-ee experiments**
 - 5 year R&D funding supported by Korea NRF: total \$2M for 2020 - 2025
 - To build a prototype that can almost fully (97.5%) cover the hadron shower
 - Optimize the performance of the detector
- **Secondary goal is to design the DRC for the EIC experiment**
 - Interested in both forward and central calorimeters
- **Korean DRC R&D group**
 - 5 institutes, 5 faculties, 20+ members



Sejong
Univ.



Kyungpook
Natl. Univ.



Seoul
Natl. Univ.



Univ. of
Seoul



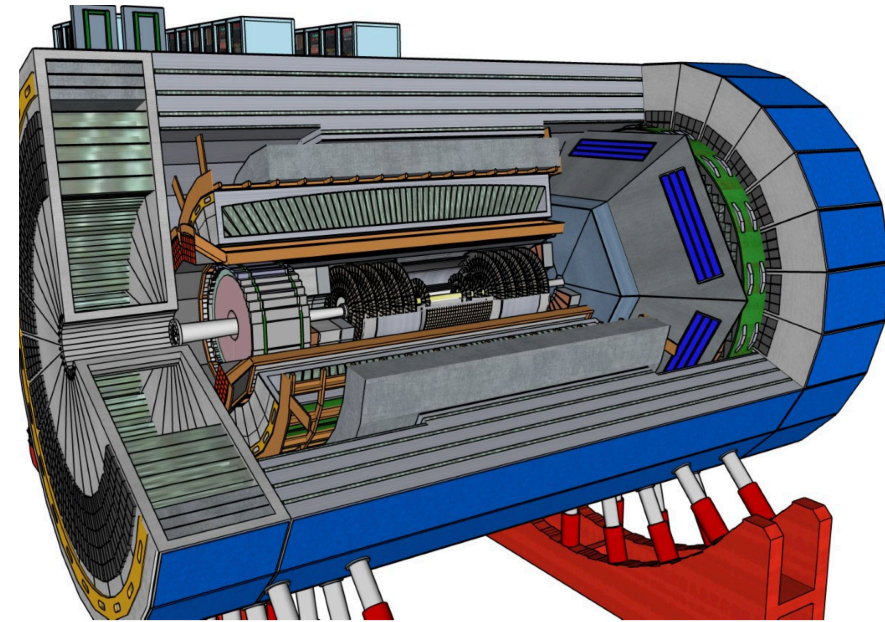
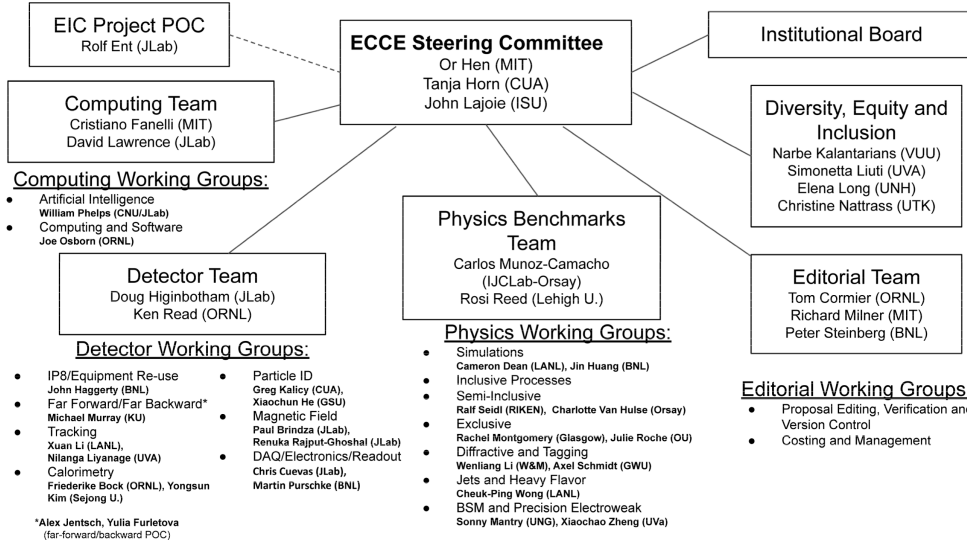
Yonsei
Univ.

Supported by



Contribution in ECCE

ECCE Consortium

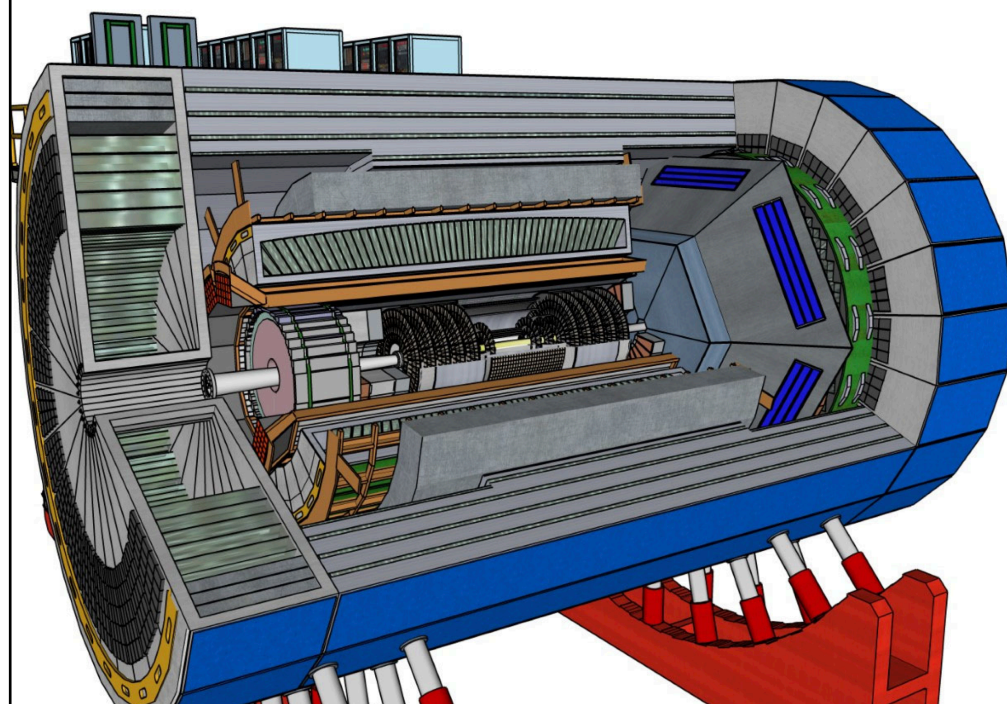


5/10/2021

ECCE 4th IB Meeting

- <https://www.ecce-eic.org>
- The EIC Collider Experiment (ECCE) pre-collaboration w/ ~40 institutions
- Based on 1.5 solenoid magnet (BaBar)
- Idea of building on the foundation of existing infrastructure available at RHIC IP8 and experimental equipment available there and JLab and RHIC

ECCE Detector (W.I.P.)



ELECTRON ENDCAP

Tracking: Large area μ RWELL

Electron Detection:

- Inner: PbWO4 crystals (reuse some)
- Outer: SciGlass (backup PbGI)

h-PID: mRICH & AC-LGAD

HCAL: Fe/Sc (STAR re-use)

CENTRAL BARREL

Tracking: MAPS Si for vertexing and endcaps
(design to be optimized)

Electron PID: SciGlass (alt: PbGI or W(Pb)/Sc shashlik)
(plus instrumented frame)

h-PID: hpDIRC & AC-LGAD

HCAL: Fe/Sc (sPHENIX re-use)

HADRON ENDCAP

Tracking: Large area μ RWELL

PID: dual-RICH & AC-LGAD

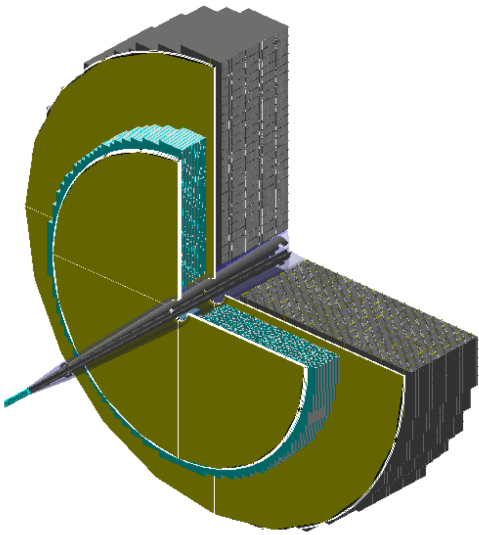
Calorimetry: (option A)
standard Pb/ScFi shashlik (PHENIX re-use)
long. sep. HCAL
(other options under study)

6/21/2021

ECCE 7th IB Meeting

7

DRC as a forward calorimeter option

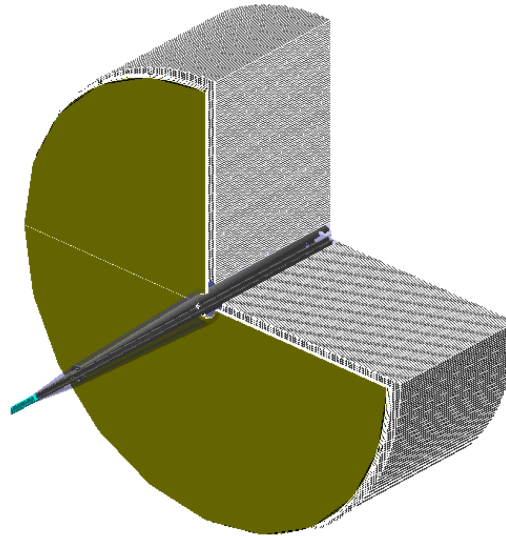


Options for E-Cal:

- Re-use PHENIX Shalick-E-Cal
- Other re-use or new E-Cal
- Dual read-out

Interested Groups:

ORNL, Sejong U., KNU, Yonsei U., PNU

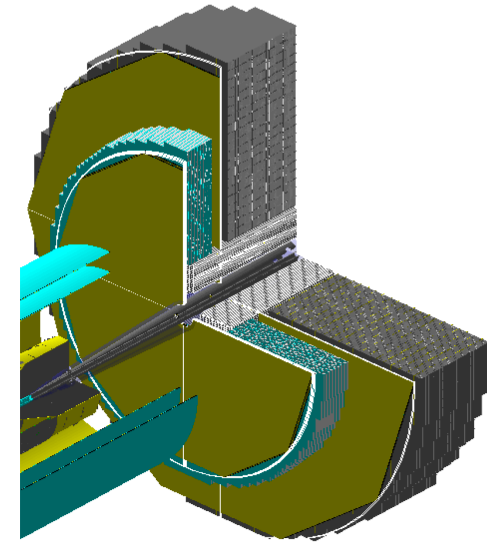


Options for H-Cal:

- Re-use STAR forward HCal
- new PSD (SHINE) like - HCal (longitudinal separation)
- Dual read-out
- Hybrid Dual read-out & re-use

Interested Groups:

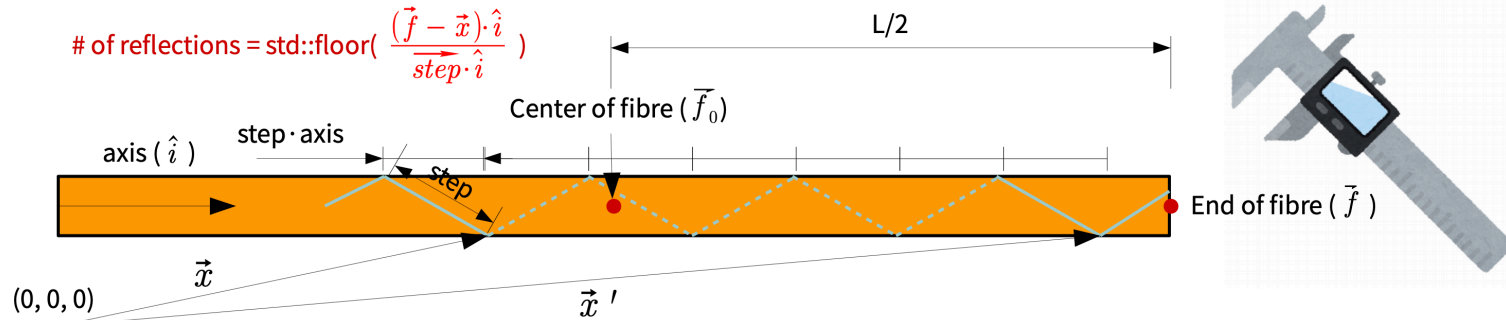
ORNL, WSU, Sejong U., KNU, Yonsei U., PNU



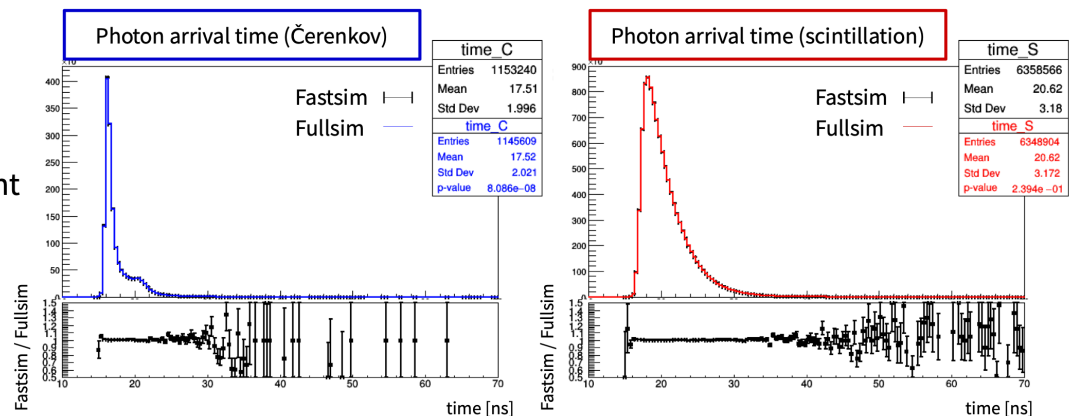
Implementation of dual-readout in full simulation

Developing fast simulation for optical photon tracking

- Simulating photon propagation is necessary, but dominates CPU consumption
- Yet, propagation of optical photons in fibres can be estimated, skipping full tracking
 - Developing a fast simulation module presented at GEANT4 R&D meeting [\[link\]](#)



- Preliminary Fastsim model shows excellent agreement with Fullsim
- Takes ~ 4 mins to simulate an event of 20 GeV e-
 - more efforts for further improvement on-going



- Developed by Hwidong Yoo and Sanghyun Ko
- To be implemented to Fun4All - Full ECCE Geant4 simulation

Summary

- Korean groups are interested in participating in building EIC calorimeters and silicon pixel trackers.
- Group A and group C focus on forward calorimeters for EIC
 - In 2021,
 - Precision measurement for hadron, γ , and jets in forward region
 - The utility of Dual readout calorimetry is one of major detector project in the Korean particle physics community
- Group B focus on pixel tracker development
 - Currently working for ALPID and FoCal
 - The experience will be very useful for the R&D in EIC

BACKUP