

Summary of my research work @ RIKEN

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29/Nov./2022 RBRC monthly meeting

Introduction

1/Apr/2021 Joining RBRC exp. group

- JSPS RPD research fellow (学術振興会 RPD 特別研究員)
RPD = Restart Postdoctoral Fellowship:
Support for researchers who interrupt research activities for a childbirth or a child-care
- 研究課題：「EIC計画へ向けた測定精度の研究と検出器開発」
Study of measurement prediction and development of detectors for Electron Ion Collider

30/Nov/2022 Leaving RBRC exp. group

- KEK INPS assistant professor (KEK 素核研 助教)
- Energy frontier group
 - ATLAS experiment @ LHC

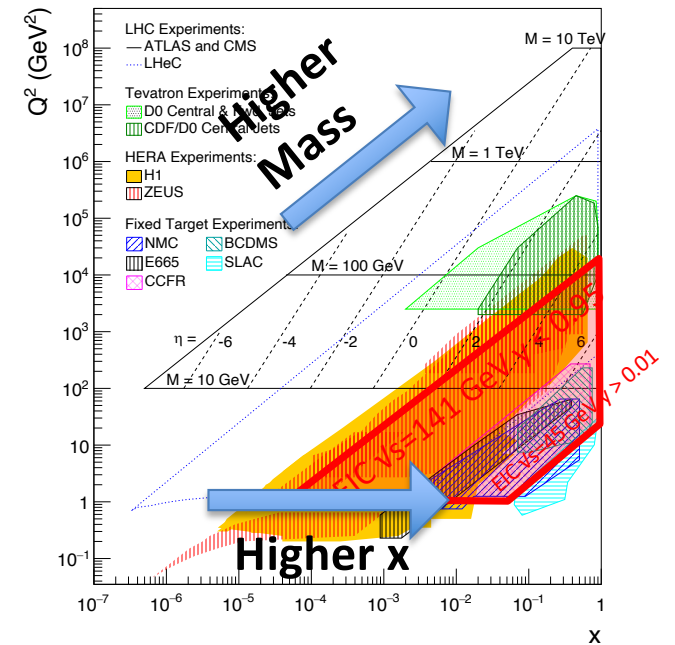
Summary of my research work

Studies for EIC

- ◆ Simulation study of the *ep* charged current deep inelastic scattering cross section measurement.
- ◆ Development and simulation study of the Zero Degree Calorimeter (ZDC) geometry.
 - Establish the first version of the ZDC design.
 - Implementation to the ECCE/EPIC simulation codes.
 - Simulation study with single particles.
 - Neutron irradiation test at RANS
 - Calculation/estimation of the number of neutrons.

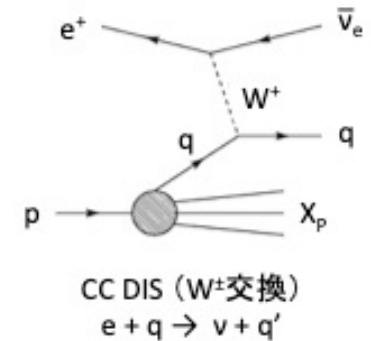
Charged Current DIS

- ◆ Motivation: LHC really needs **validation of the current proton PDFs**, especially at high- x .
 - HERA data is still essential, but old.
 - LHC data increases its precision, but any bias from new physics?



- ◆ Charged Current DIS

- Charge selective process: $\tilde{\sigma}(e^-p) \propto [(u + c) + (1 - y)^2(\bar{d} + \bar{s})]$
- Neutrino at the final state
- Requires the measurement of all the particle from the struck quark.



- ◆ Full simulation study (ECCE)

- Faced several issues of calorimeters.
- Checked that the EIC can go higher x values than HERA.

→ **ECCE physics technical note**
JPS talk @ 2022 autumn

e^-p CC DIS	ECCE	HERA
Q ² range	170 GeV ² -- 8000 GeV ²	300 GeV ² -- 30000 GeV ²
Highest x point	$x = 0.8$	$x = 0.65$
Stat. error@ Highest x point	1.5~4 %	30 ~ 50 %

ZDC design

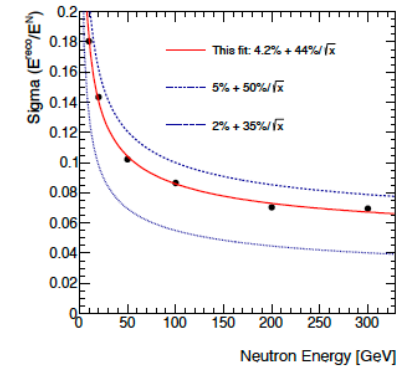
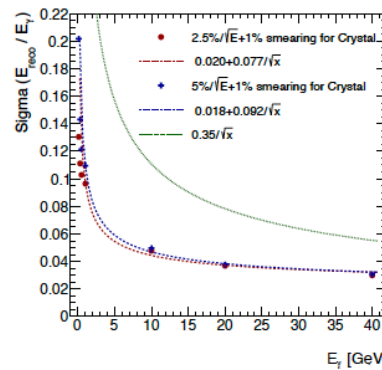
- ◆ Design = complex of calorimeters

Targets: O(100) MeV photons, GeV photons, and neutrons up to 275 GeV.

→ a crystal calorimeter and 3 types of sampling calorimeter.

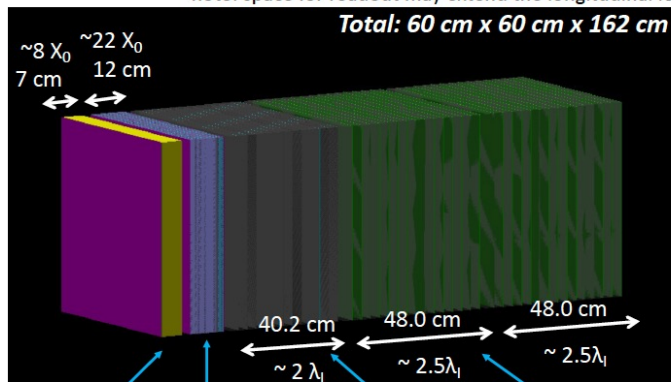
- ◆ Single particle simulation

Required resolution is obtained.

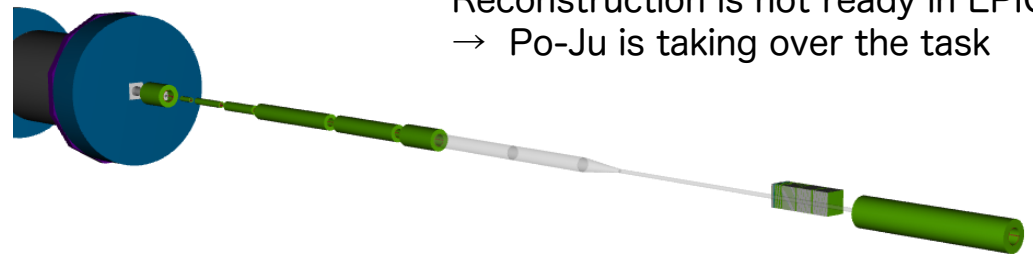


- ◆ Implemented in ECCE and EPIC simulation software

*note: space for readout may extend the longitudinal length.



Crystal (PbWO_4) + Silicon Pixel layer
 W/Si calo. 3 Pixel layers are inserted.
 Pb/Si calo. Pb/Sci. calo.

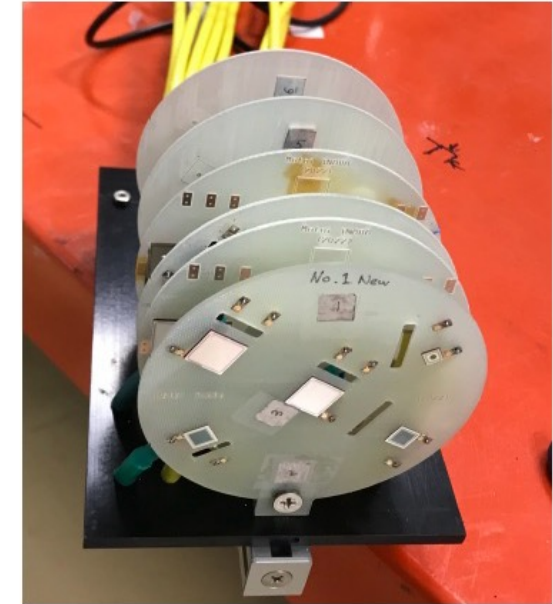


Reconstruction is not ready in EPIC
 → Po-Ju is taking over the task

→ ECCE proposal & tech. note
 JPS talk @ 2022 spring

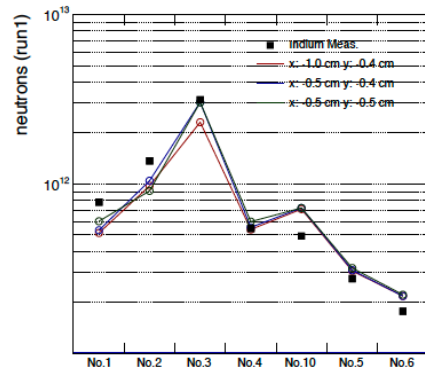
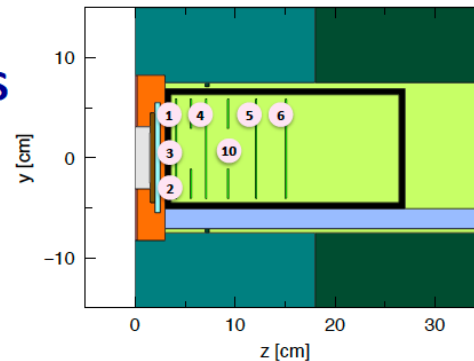
RANS test in March 2022

- ◆ ZDC should resist 10^{14} neutrons.
- ◆ Silicon sensors (FoCal) and APDs are irradiated by neutrons at RANS, RIKEN.
- ◆ Estimation of the neutron flux:
 - Estimated from indium foil measurements
 - PHITS calculation is also performed.

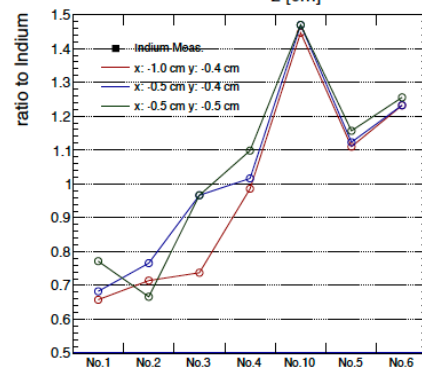


PHITS calculation for RANS

- ◆ y dependence is well reproduced with $\Delta(x, y) = (-1.0 \text{ cm}, -0.4 \text{ cm})$ shifts on the 1st plane.
- ◆ PHITS provides more neutrons than the indium estimation as z increases.

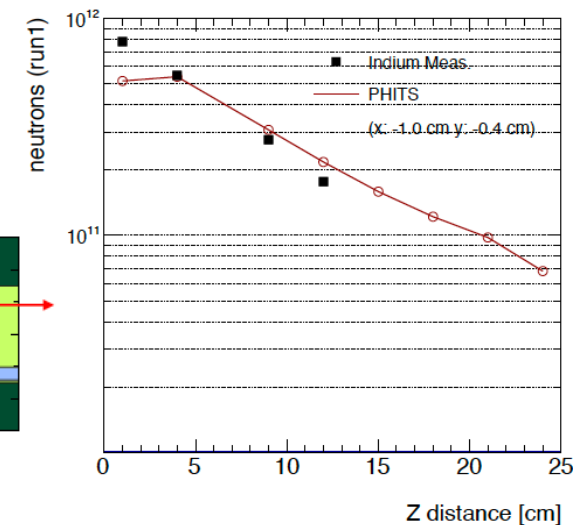
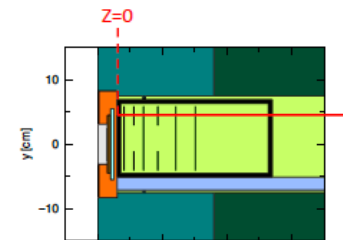


Foil ID



Foil ID

For future irradiation test:



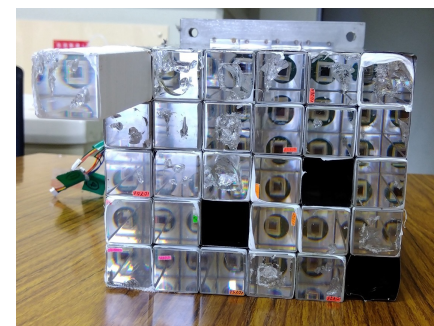
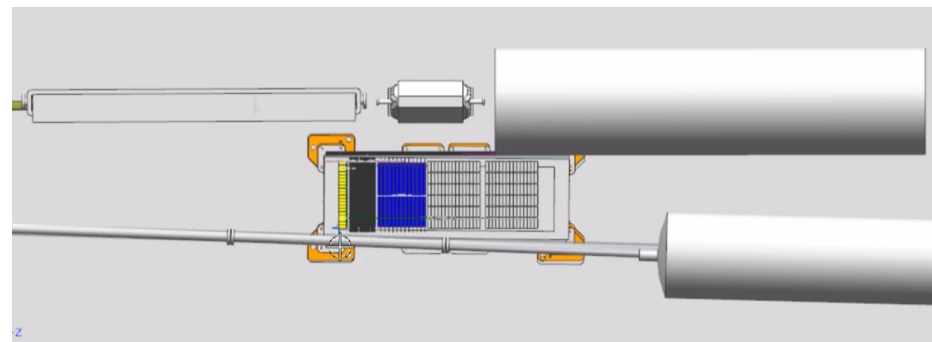
Further (future? remaining?) ZDC-related tasks

- ◆ ZDC in EPIC simulation
 - Taking over to Po-Ju from Taiwan.
 - Reconstruction codes
 - Shower shape study, etc.
- ◆ ZDC for pre-TDR
 - Discussed a lot about readout and their placement.
 - Should be continued.
 - CAD figures are prepared by JLab experts.
- ◆ Proto-type production of the crystal calorimeter
 - ALICE PHOS remnants @ Hiroshima-U
 - Will be sent to RIKEN → ??

Thanks Po-Ju for his stay in RIKEN!

We've checked:

- ✓ Geometry on viewer
- ✓ Simulation → Hit information and will check:
Event reconstruction codes



Last remarks

- ◆ Thank you for accepting me in this group!
 - It was a trial time for me to see whether I can continue my research activity or not.
- ◆ JSPS RPD fellowship is a nice program.
 - Opportunity comes every year.
 - Flexibility in working time.
 - (but first you need to have a baby or to give birth.)
- ◆ Children grow.
 - Situation changes quickly.



I'll work for LHC and I'm still looking forward to seeing new results on the proton structure from EIC, 10 years later.



Thank you!