

# Korea Future Collider Activities

Hwidong Yoo (Yonsei Univ.)

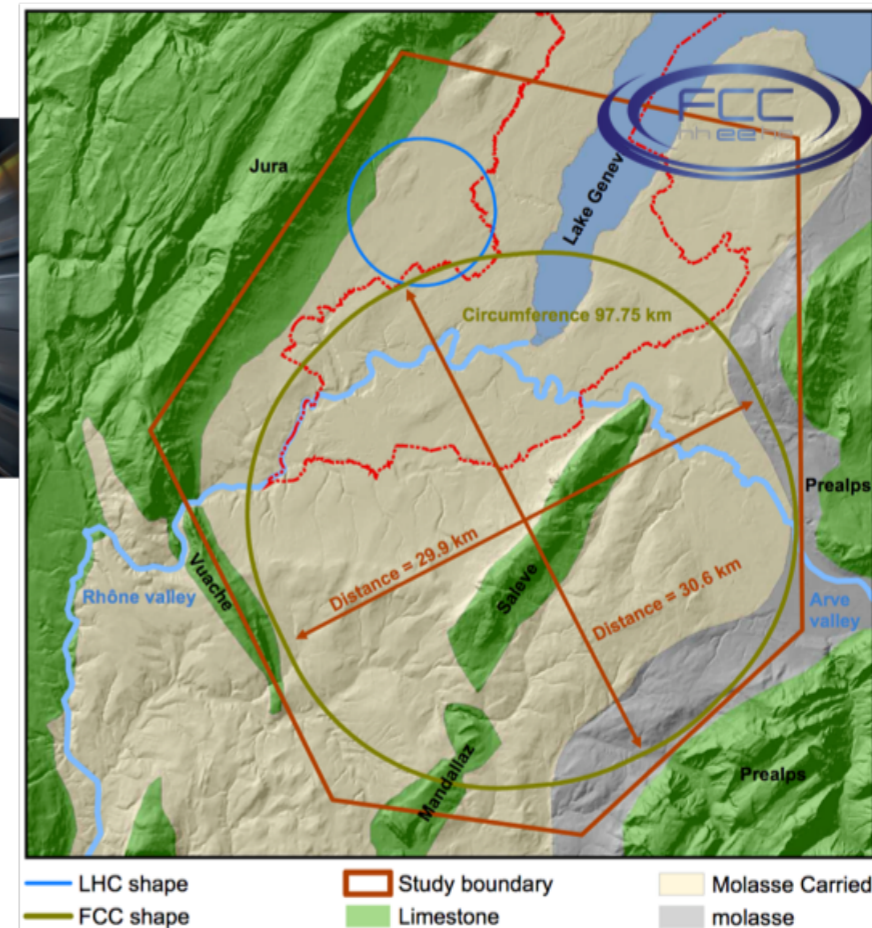
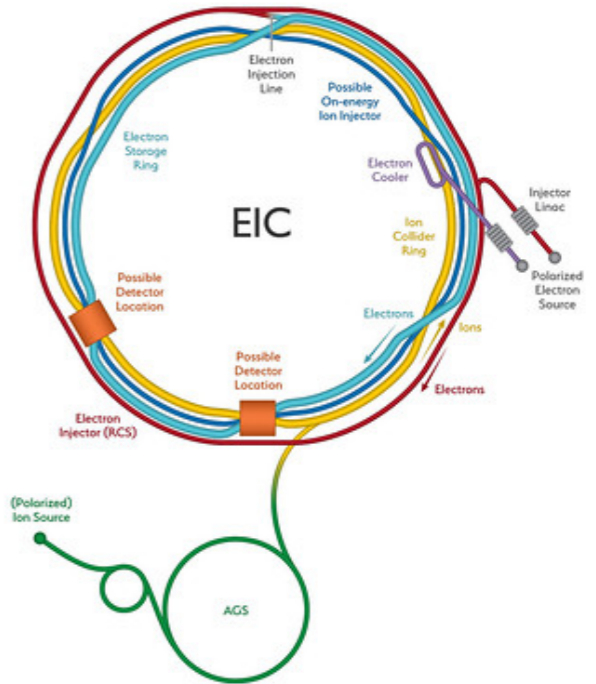
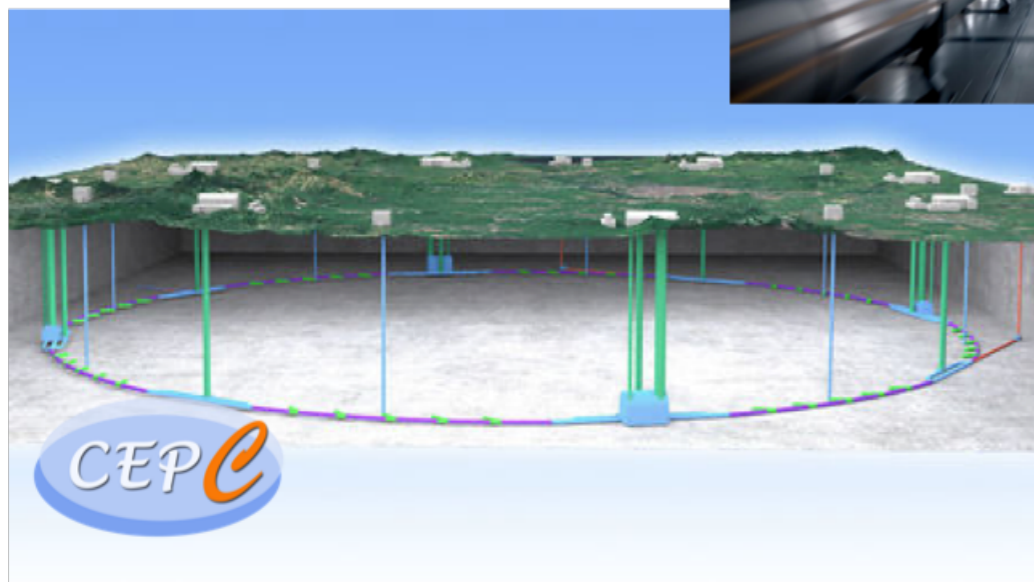
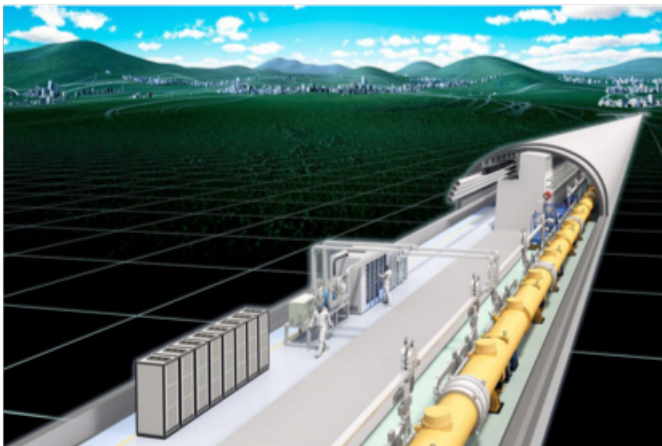
On behalf of  
the Korea Future Collider Consortium

**Korea Future Collider Workshop 2021 (summer)**  
**Aug. 26, 2021**



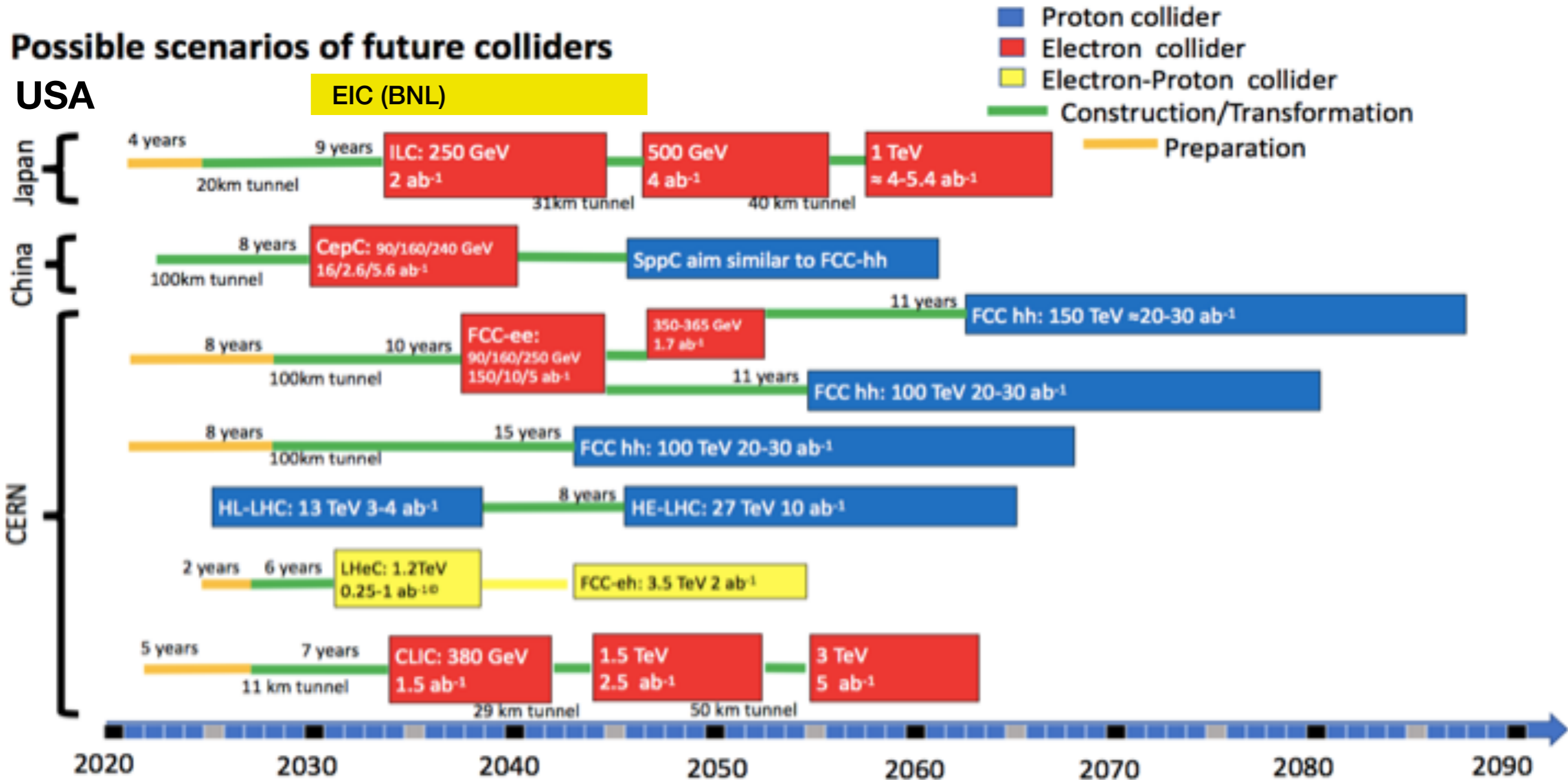
# Future Collider Projects in HEP

- Many next generation experiments are under discussion
  - Linear colliders: ILC (Japan), CLIC (CERN)
  - Circular colliders: FCC-ee/eh/hh (CERN), CEPC/SPPC (China)
  - HI colliders: EIC (US)



# Roadmap of FC Projects

- Time flies very fast!



# Updated Roadmap for FCC



## The PED Pillar Objectives in 2025



- Mostly defined by the general (tight) timeline of the FCC project

Infrastructure and accelerator

Physics, Experiments, and Detectors

Milestone / activity	Target date	Possible timeline
First e <sup>+</sup> e <sup>-</sup> collisions in FCC-ee	Early 2040's	FCC-ee detector commissioning
Start machine installation	2037	Start FCC-ee detector installation
Tunnel completion	2035/36	
Start tunnel construction	2030	Start FCC-ee detector construction
Project approval	2028/29	FCC-ee Detector TDR's and approvals
Next European Strategy Update	2026/27	Next European Strategy Update (ESU)
Key prototypes (feasibility proof)	2026	FCC-ee Proto-collaborations and EoI's
FSR <sup>(*)</sup> (feasibility proof)	End 2025	PED FSR, includes enough common material and knowledge for FCC-ee proto-collaborations

(\*) FSR = Feasibility Study Report

Adapted from schedule in M. Benedikt's presentation

# Korea Future Collider Consortium

- A workshop with small participants who have an interesting for FCC project at last October
- Agreed to form an organization for future collider activities
- Had a call for national contact from FCC organization
  - Prof. Pyungwon Ko (national contact), myself (deputy) to serve as the national contacts

Welcome to join anyone! (Contact to [hdyoo@cern.ch](mailto:hdyoo@cern.ch))

**Joint Seorak Workshop on FCC**  
16 Oct 2020, 11:30 → 17 Oct 2020, 15:00 Asia/Seoul  
컨싱턴 호텔 설악  
Minho Son (Korea Advanced Institute of Science and Technology (KR)), Tae Jeong Kim (Hanyang University (KR))

**Description** Join Zoom Meeting  
[ZOOM link](#)  
Passcode: 2020  
숙박장소 : 컨싱턴 설악 호텔 (주소 : 강원도 속초시 설악동 설악산로 998)  
20201022\_123317... IMG\_20201016\_11... Proceedings\_1st\_S...

**Registration** You are registered for this event. [Modify registration](#)

**Participants** Hwi Dong Yoo, Jae Hyeok Yoo, Minho SON, Patrick Janot, Pyungwon Ko, Seung J. Lee, Su Yong Choi, Sunghoon Jung, Tae Jeong Kim, Un-Ki Yang

**FRIDAY, 16 OCTOBER**

- 11:30 → 13:00 Pre-discussion over lunch (1h 30m)
- 13:00 → 18:00 Presentation: Topics for Future Circular Collider  
Convener: Minho Son (Korea Advanced Institute of Science and Technology (KR))
  - 13:00 Some thoughts on precision physics and rare processes @ FCC-ee (30m)  
Speaker: Seung J. Lee (Korea University)
  - 13:30 Jets at the e+e- / hh collider (30m)  
Speakers: Su Yong Choi (Korea University (KR)), Suyong Choi (Korea University)  
Jets in FutureCollid...
  - 14:00 Top FCNC at FCNC (30m)  
Speaker: Tae Jeong Kim (Hanyang University (KR))  
seorak2020\_TJ.pdf
  - 14:30 coffee break (30m)
  - 15:00 Precision of flavor physics involving b or top quark at the future collider (30m)  
Speaker: Minho Son (Korea Advanced Institute of Science and Technology (KR))
  - 15:30 Search for long-lived particle using timing information (30m)  
Speaker: Jae Hyeok Yoo (Korea University (KR))  
20201016\_Jae\_LL...
  - 16:00 Status of dual-readout calorimeter R&D (30m)  
Speaker: Hwi Dong Yoo (Yonsei University (KR))  
HDY00\_Seorak\_10...
  - 16:30 coffee break (30m)
  - 17:00 Question & Answers chatting with Patrick Janot for FCC (1h)  
Speaker: Patrick Janot (CERN)  
SK\_MiniWorkshop...

# Korea Future Collider Consortium

Korea-FC Consortium

## Future Circular Collider (FCC)

Circumference: 90 - 100 km  
Energy: 100 TeV (pp) 90-350 GeV ( $e^+e^-$ )

## Large Hadron Collider (LHC)

## Large Electron-Positron Collider (LEP)

Circumference: 27 km  
Energy: 14 TeV (pp) 209 GeV ( $e^+e^-$ )

## Tevatron

Circumference: 6.2 km  
Energy: 2 TeV ( $p\bar{p}$ )

# Korea Future Collider Consortium

The Standard Model in particle physics has successfully explained all the experimental data up to now. Nevertheless, our minds do not rest in satisfaction because of the baffling questions such as the naturalness problem, the origin of CP violation, the baryogenesis, the non-zero neutrino masses, and the identity of dark matter. We should carry on our journey to the final theory. One essential measure for one step forward is studying future colliders, pushing the energy and intensity frontiers of particle colliders. In this regard, we put our minds together and launch the **Korea Future Collider Consortium**.

**Goal: collaborate scientific activities for future collider projects in Korea such as theoretical approaches, detector R&D, accelerator R&D, communication etc.**

**Welcome to join anyone! (Contact to [hdyoo@cern.ch](mailto:hdyoo@cern.ch))**

# Korea Future Collider Consortium

- Homepage: <https://sites.google.com/yonsei.ac.kr/korea-fc-consortium>
- Activities
  - Regular workshop: winter, summer, fall
    - Kick-off workshop (Feb. 25): <https://indico.cern.ch/event/1003237/>
  - Topical meetings
    - Muon g-2 (Apr. 16): <https://indico.cern.ch/event/1029989/>
  - Attend FCC national contact meeting and present activities in Korean
  - Communication and collaboration between TH and EXP

Welcome to join anyone! (Contact to [hdyoo@cern.ch](mailto:hdyoo@cern.ch))

# Things to Discuss Future Activities

- Long-term organization: research plan, workshop organization, collaboration plan, etc.

- Organization and responsibility may need

- Regular (working) meeting?

- Once a month?



- Design KFCC logo

- Join KFCC program to Korea-CERN program

- Dedicate discussion on tomorrow at 4:30 pm

- Collaboration with other community

- Nuclear, Accelerator (and Civil Engineering?)

- CERN associate membership?

- Korean industries can bid and participate in 10B CHF FCC construction

## Tomorrow afternoon sessions

16:30 → 19:00	Session: Preparation of FCC Lol for Korea-CERN program ¶
16:30	Introduction Speaker: Hwi Dong Yoo (Yonsei University (KR))
17:00	Roundtable discussion

14:00 → 16:00	Session: Accelerator
14:00	Overview of Accelerator R&D for future collider projects Speaker: Moses Chung
15:00	Roundtable discussion

Welcome to join anyone! (Contact to [hdyoo@cern.ch](mailto:hdyoo@cern.ch))



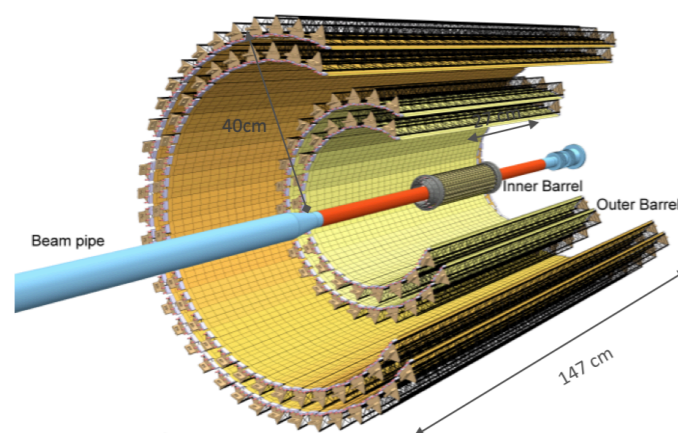
# Inter-Experiment Collaboration

- Example: Korean groups of the **ALICE**, **BELLE**, **CMS** experiments have contributed lots of major detector systems

- **ABC detector collaboration** for future collider projects

## KoALICE group

### ITS Upgrade



## K-BELLE group



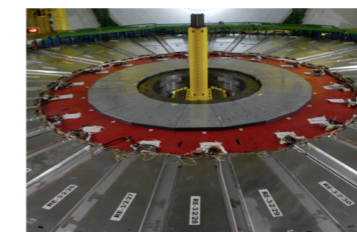
## KCMS group

- **LS1 : RPC (2013-2014)**
  - RPC Gap & Chamber
  - Phase-1 RE4/2 installed
- **LS2 : GE11, iRPC (2019-2022)**
  - GE11 construction (complete)
  - iRPC gap production
- **LS3 : GE21, ME0 (2024-2026)**
  - GE21, ME0 foil production



CERN-LHCC-XXXX-XXX  
CMS-TDR-YYY  
12 September 2020

The Phase-2 Upgrade of the  
CMS Data Acquisition and High Level Trigger  
Technical Design Report  
CMS Collaboration



## Triggers

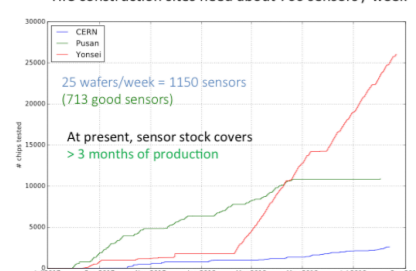
A Large Ion Collider Experiment

### Pixel chip (ALPIDE) production and test flow

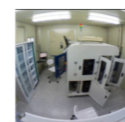


HIC construction sites need about 700 sensors / week

Yonsei



- 100- $\mu$ m chip testing: **running**
- Working schedule: 24/7
- Test rate: 26 wafers/week
- Smooth operation



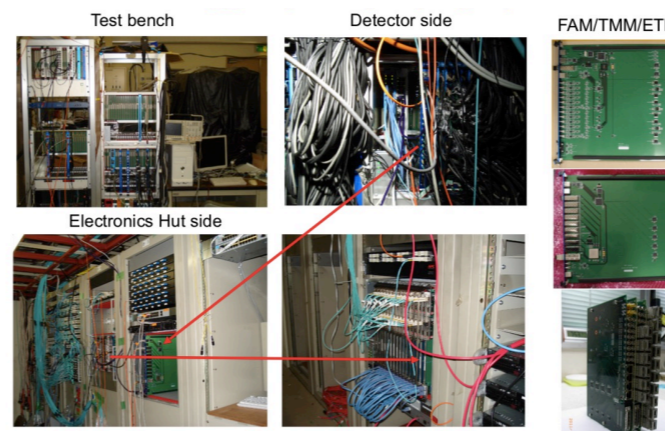
Pusan/Inha

- 100- $\mu$ m chip testing: **done** (end-April)
- (switchover to HIC constr.)
- Backup site

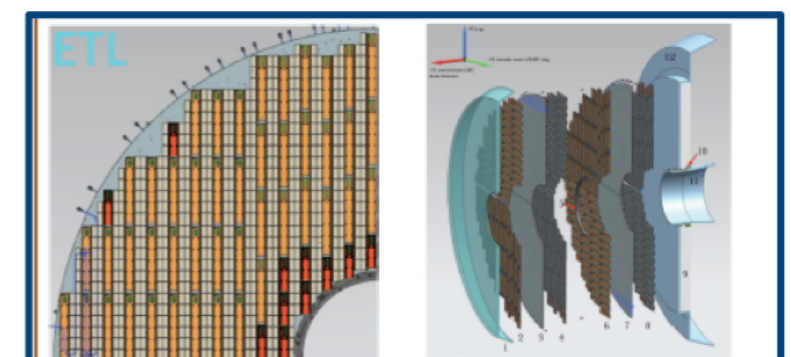


CERN

- 50- $\mu$ m chip testing: **running**
- wafer testing: **done**



### ETL:LGAD+ASIC



# Sister Consortium: EIC

- Formed a combined collaboration in last Oct.: submitted single EOI to EIC organization
- Prof. Yongsun Kim (Sejong Univ.): ECCE calorimeter group co-convenor
- Feasibility simulation study is on-going very actively

## Expression of Interest (EOI) Questionnaire

(Use this template for your document. The document can be at most 10 pages long, in this style, font and font size, but you can have appendices and do not have to include the tables in the page count. There is no prescribed format of the document, but you are asked to address the questions below. This document will be viewable by password to all who submit. You can also submit a separate document with certain information you would only like to be viewable by the EIC Project. DEADLINE FOR SUBMISSION: NOVEMBER 1.)

**Please indicate the name of the contact person for this submission:**  
we ask for one main contact person per submission. You can as needed provide further contacts, but there should be one primary contact)

Primary contact: Oh, Yongseok (Kyungpook National University), yohphy@knu.ac.kr

Deputy contacts:

- Kim, Yongsun (Sejong University), yongsun@sejong.ac.kr
- Lim, Sanghoon (Pusan National University), shlim@pusan.ac.kr
- Jo, Hyon-Suk (Kyungpook National University), hyonsuk@knu.ac.kr

All institutions are located in South Korea.

**Please indicate all institutions collectively involved in this submission of interest:**  
(even if institutions can submit on their own, it is highly encouraged to form groups to work together within their country, their geographical region, or as a general consortium)

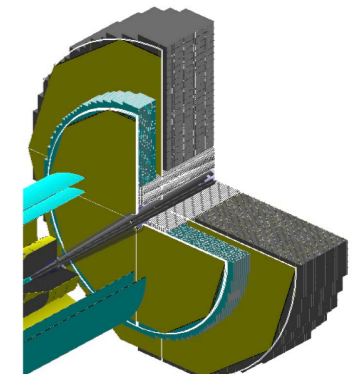
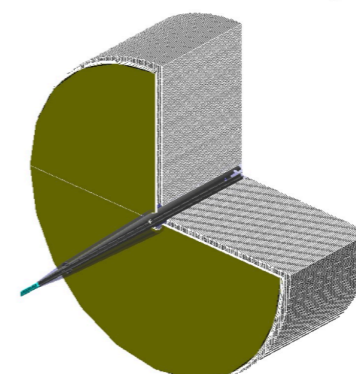
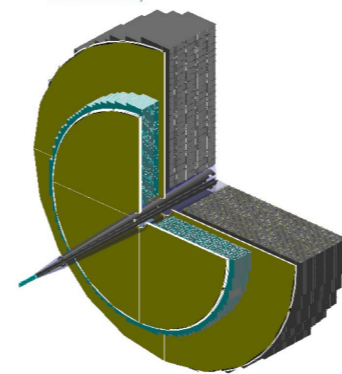
Group	Devoted to	Institutions	Faculties
A	Forward Calorimeter	Korea University	<u>Byungsik Hong</u> <u>Jung Keun Ahn</u>
		Sejong University	<u>Yongsun Kim</u>
		Chonnam National University	<u>Dongho Moon</u>
B	Pixel Tracker	<u>Jeonbuk National University</u>	<u>Eun-Joo Kim</u>
		<u>Pusan National University</u>	<u>Sanghoon Lim</u>
		<u>Yonsei University</u>	<u>Youngil Kwon</u>
		<u>Inha University</u>	<u>Minjung Kweon</u>
C	Dual-Readout Calorimeter	Kyungpook National University	<u>Hyon-Suk Jo</u> <u>Schwook Lee</u>
		University of Seoul	<u>Jason Lee</u>
		Yonsei University	<u>Hwidong Yoo</u>

(indicate experimental equipment components, including those integrated in the interaction regions, each separately)

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



## Forward calorimetry options

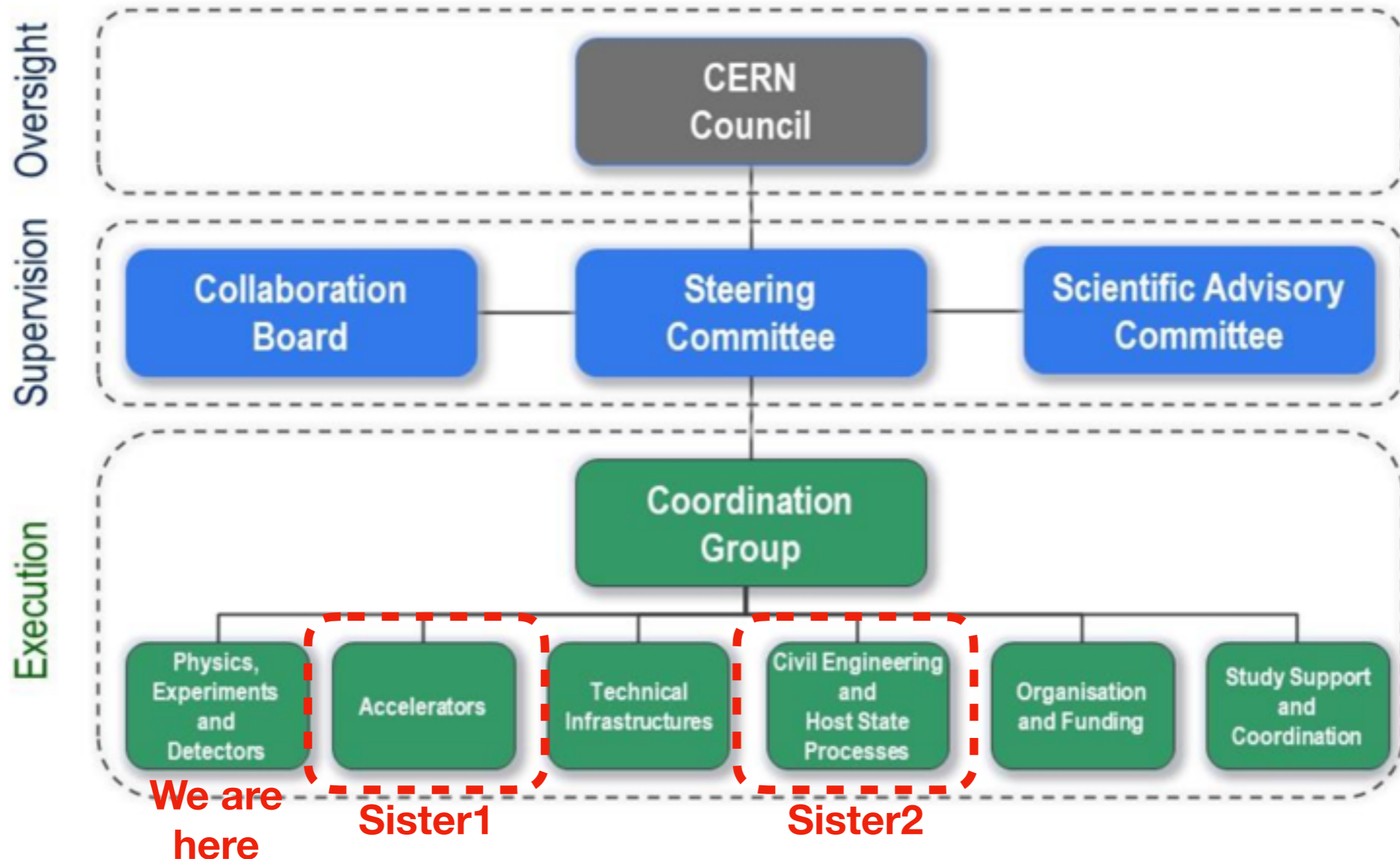


detector	z [m]	depth [cm]	radial coverage [cm]	pseudorapidity	tower size [cm]
ECAL:					
PHENIX/ALICE reuse	z = 2.9	37.5	20 < r < 183	1.24 < η < 3.50	5x5 (6x6)
HCAL:					
LHCAL	z < 3.5	100	20 < r < 262	1.11 < η < 3.47	5x5
DRCALO : (full)	3.0 < z < 4.5	150	20 < r < 220	1.11 < η < 3.47	0.3x0.3
(inlay)	3.0 < z < 4.5	150	20 < r < 50	2.70 < η < 3.70	0.3x0.3

# Extension of Collaboration

- Accelerator, civil engineering

## CERN FCC Organization



# Informal Meeting with CERN

- Sep. 3rd (next Friday) <https://indico.cern.ch/event/1065948/>
- Please register and participate the discussion with CERN FCC management team!

The screenshot shows the Indico event page for the 'Korea-CERN FCC management informal meeting'. The event is scheduled for Friday, 3 Sep 2021, from 16:30 to 19:30 in Asia/Seoul. It is a Zoom videoconference titled 'Future Collider Monthly Meeting'. The user is registered for the event. One participant, Hwi Dong Yoo, is listed. The agenda includes:

Time	Topic	Duration
16:30 → 17:00	Introduction to the FCC Feasibility Study	30m
17:00 → 17:30	Presentation on FCC Physics, Experiment and Detector	30m
17:30 → 18:00	Presentation on FCC Accelerator Science and Technology	30m
18:00 → 18:30	Presentation(s) from the Korean Scientific Community	30m
18:30 → 19:00	The FCC Feasibility Study Global Collaboration and Next Steps	30m
19:00 → 19:30	Discussion	30m

# Remarkable Comments

- Future Collider project will be a game changer
  - Opportunity that Korea HEP community be a major player in the scene
  - It is a time to imagine
- Most of important things (physics motivation, accelerator and detector design, etc.) will be decided by 2025-6
  - Not much time remains
- TH and EXP (even ACC, HI, etc.) collaboration is essential
  - Chance to be realized for your dream or any crazy idea (ex. AI Physicist?)
  - Experiment (accelerator, detector) should be designed to study non-conventional approach (constructed experiment like CMS is limited)
  - Target a big physics question and major efforts in Korean community (TH, EXP) can focus on
- As an experimentalist, knowhow and experience for the detector design/construction/maintenance should be kept and inherited
  - We need a successor for them after HL-LHC upgrade
  - Such expertise can not be obtained in short-time if we lost

