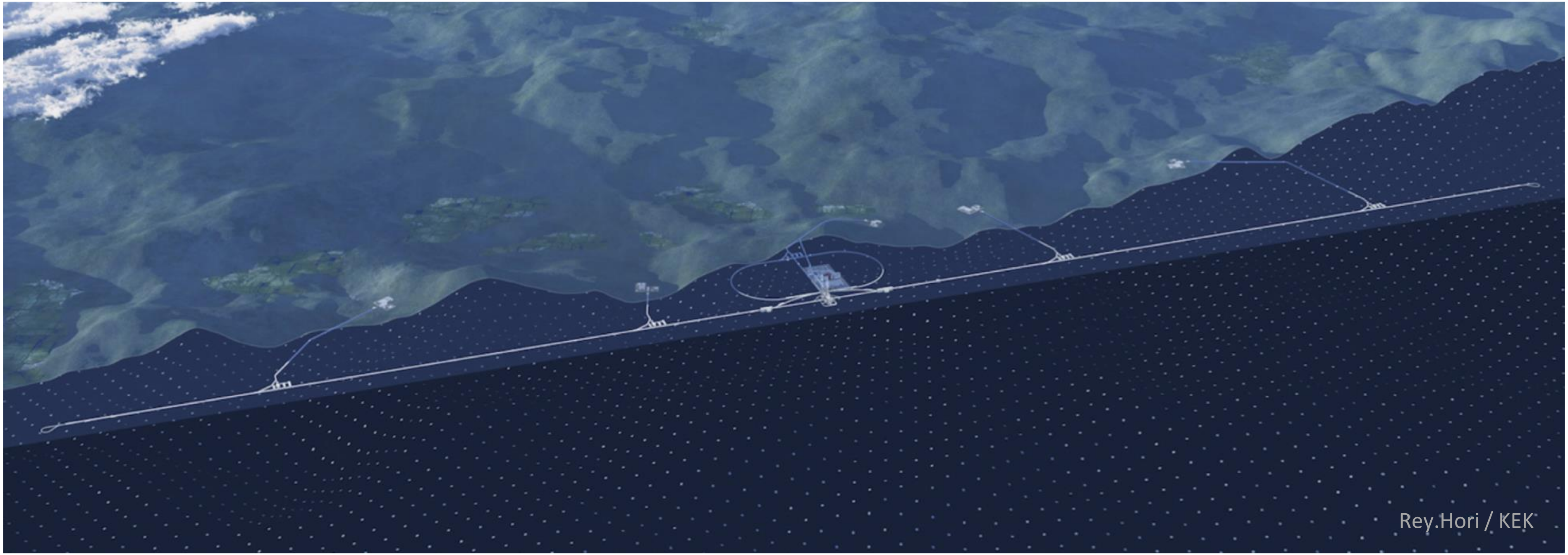


Civil Engineering Status

Nobuhiro Terunuma, KEK

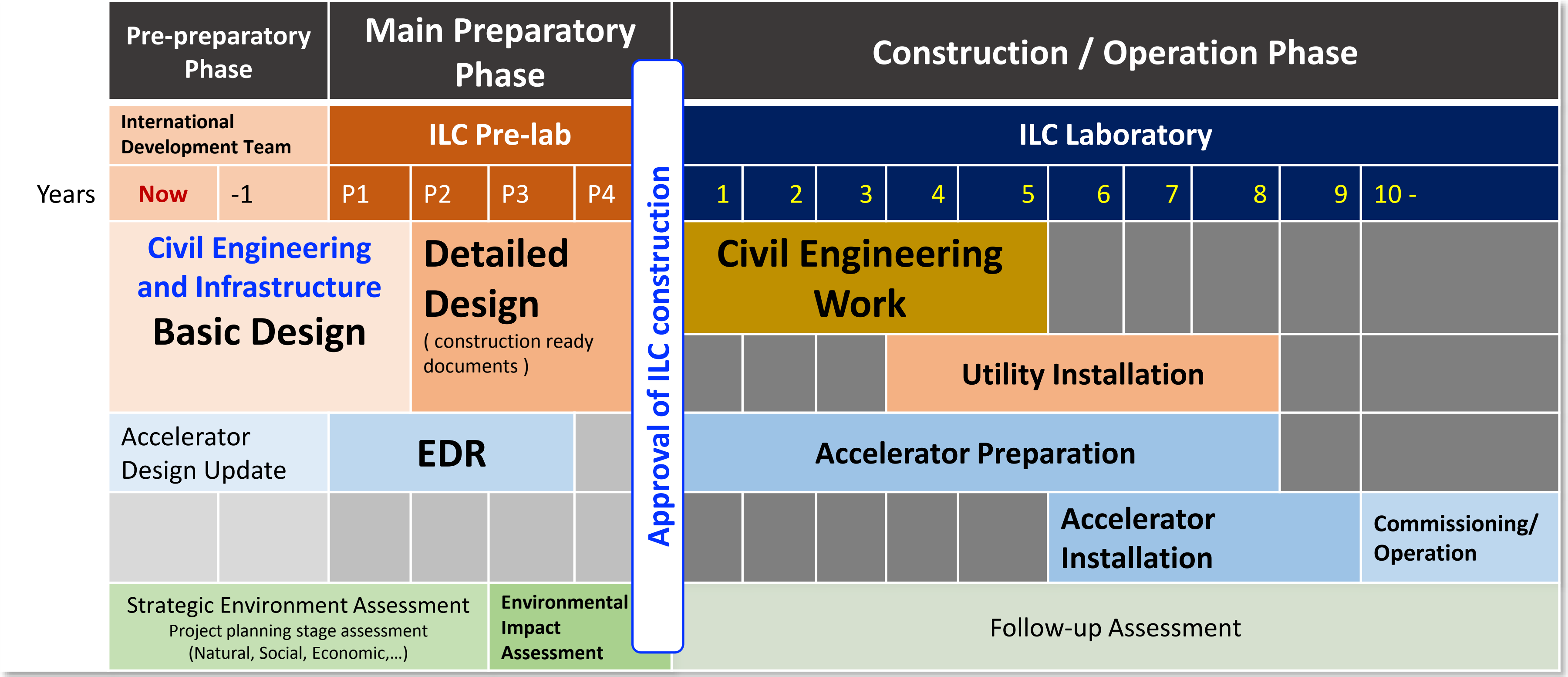
On behalf of the CFS group

AWLC2020, October 20, 2020

Contents

- Anticipated schedule
- Civil Engineering activity in Japan
- Overall of the civil engineering design of ILC
- Summary

Civil Engineering related Schedule for ILC-250GeV



References; (1) TDR, (2) Recommendations on ILC Project Implementation, 2019.

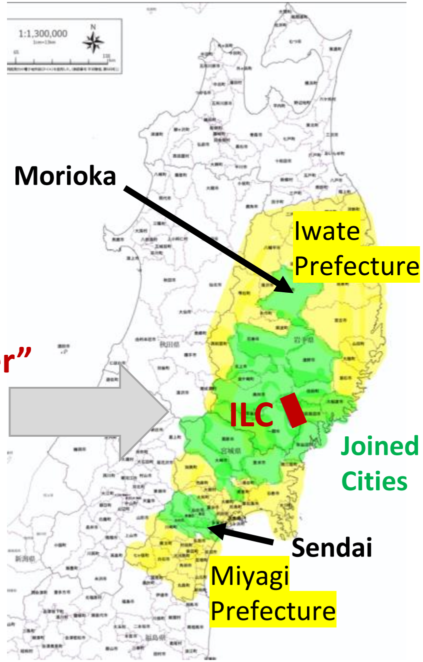
ILC Civil Engineering Activity in Japan

Premise:

- Civil works are the responsibility of the host country.
- Proceed the civil design using a model route in the Kitakami Mountains and examine the issues of civil works for the ILC.

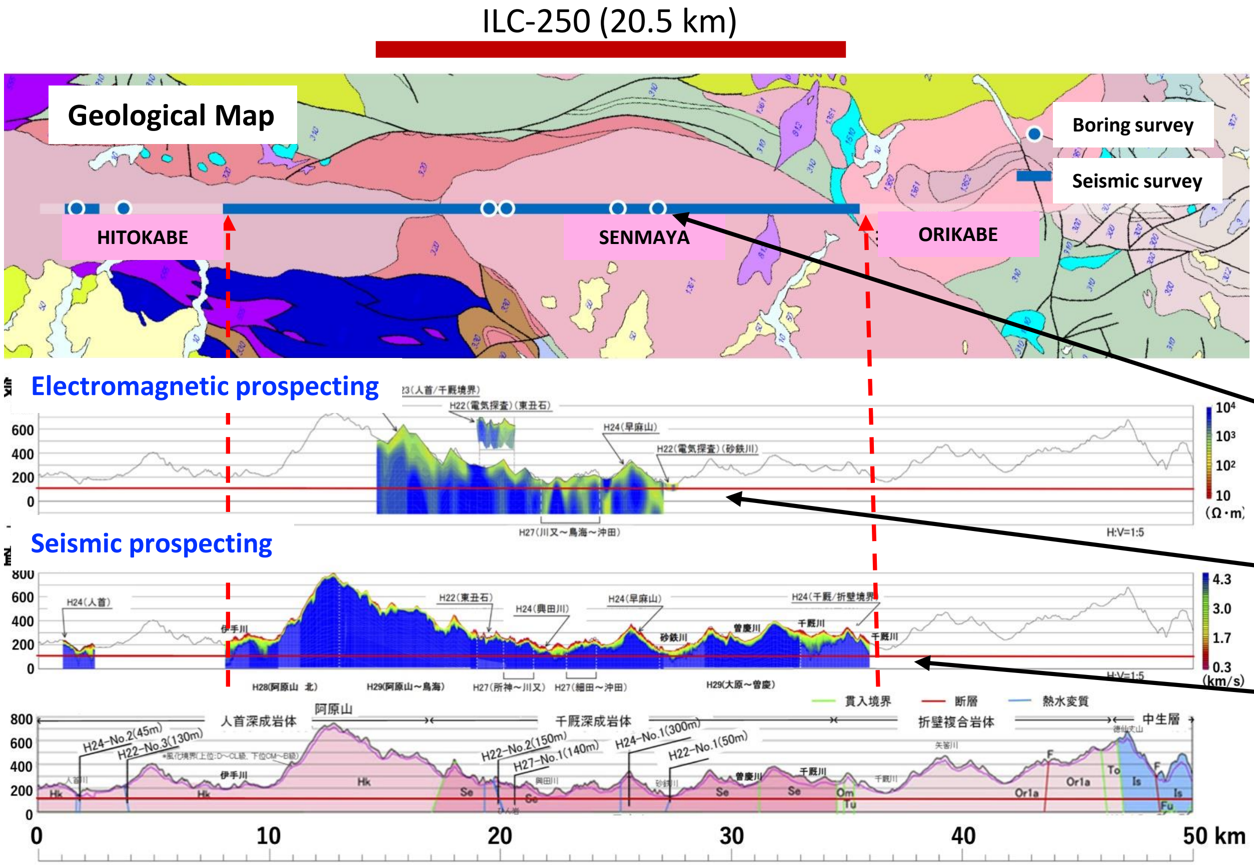
- **KEK and universities in Japan,** with oversea collaboration
- **Experts from Industry**
  - WG of AAA for underground issues; experts from civil engineering companies

    Advanced Accelerator Association (AAA); An organization of industrial sector to aim to make a leap in science and technology through the development of cutting-edge accelerators jointly by industry and academia.
- **Enhanced activity in the Tohoku region**
  - **Upgrade the promotion body in Aug. 2020, "Tohoku ILC project development center"**
    - consists of Local governments(18), universities(3) and Iwate ILC promotion council.
    - **Examination of issues that the region should address** in terms of environmental improvement and research facility construction around the ILC candidate site
    - Natural environment, Social and Economic impacts of ILC construction
    - System and town development for researchers and their families, ...



- **Validation of Civil Engineering Design at Kitakami Mountains**
  - 2019/7-2020/3 **by the Rock Mechanics Committee, the Japan Society of Civil Engineers**
  - It is the first validation by 3rd party based on the real candidate site and concluded that the "Civil Engineering Plan for ILC at Tohoku" is technically feasible.

Geological Surveys for ILC: Kitakami Mountains



- Continuous **granite region**

  HITOKABE, **SENMAYA** and **ORIKABE** bedrock

- **Have capability to extend the ILC up to 50 km in future**

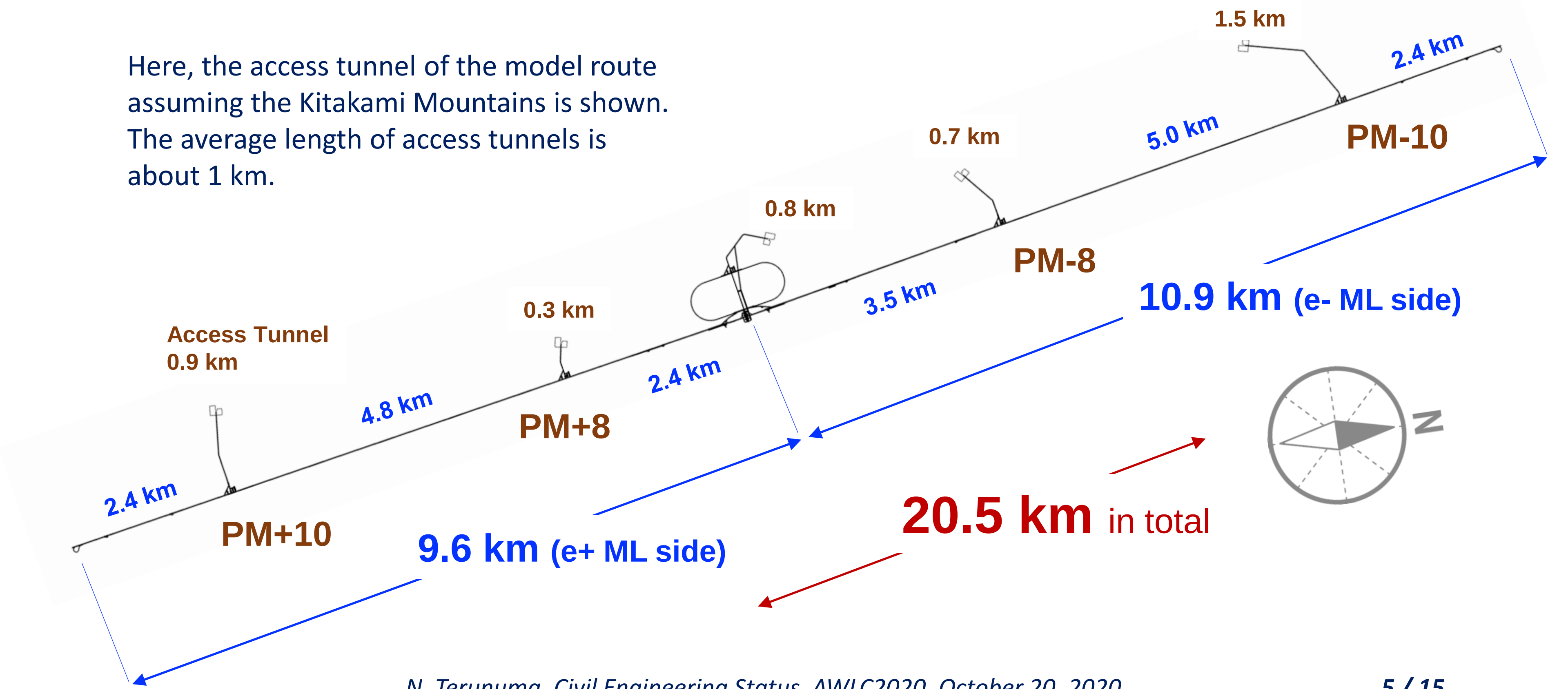
- **Boring geological survey**
  → Direct sampling down to the accelerator depth

- **Electromagnetic prospecting**
  → Cracks in the rock

- **Seismic prospecting**
  → Rock hardness

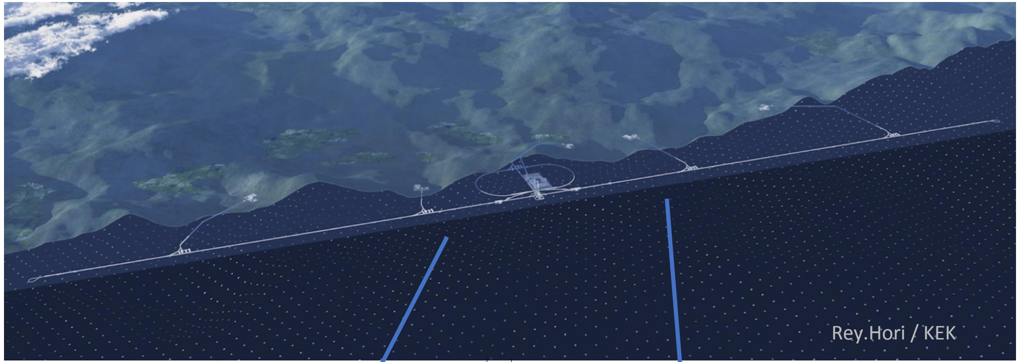
Scale of the ILC-250GeV

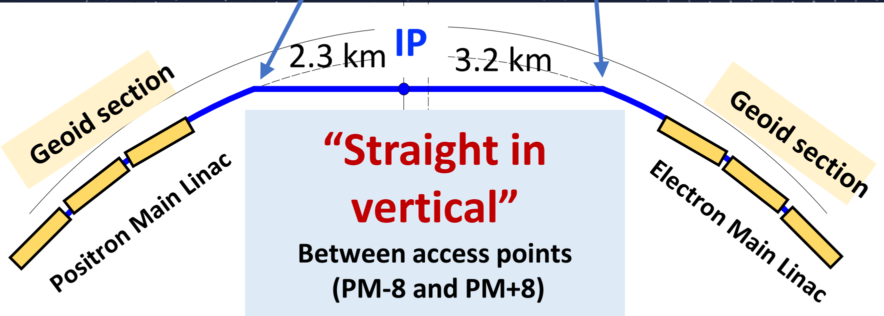
Here, the access tunnel of the model route assuming the Kitakami Mountains is shown. The average length of access tunnels is about 1 km.



Laser Straight Section

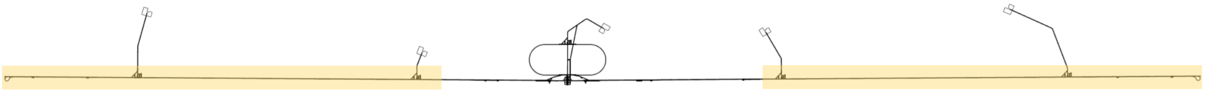
- BDS: “laser straight” in vertical
- ML: Cryomodule will be aligned to the geoid.

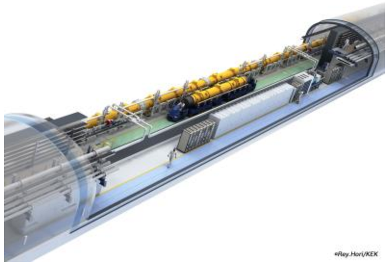




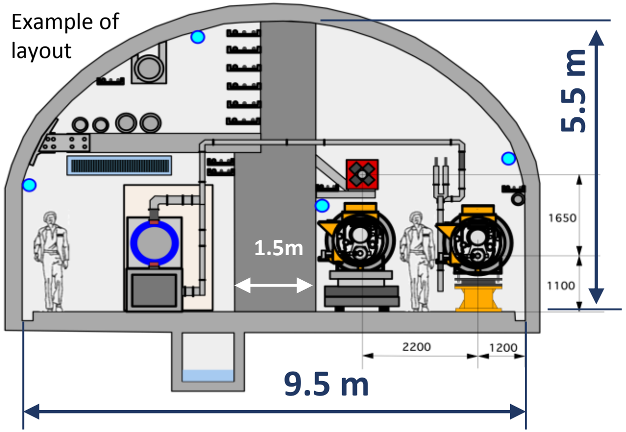
- ILC optics DECK has been updated to incorporate corrections for **geoid** and **straight sections** around the IP.
- Asymmetric straight sections
  - The e- side is longer to include undulator and dog-leg.
  - If e+ and e- MLs are at the same altitude, the IP is tilted by 0.1 mrad.
  - If e- ML is placed 0.6 m higher than e+, the IP has no tilt and BDSs are symmetrically sloped to the IP.

Main Linac (ML) tunnel



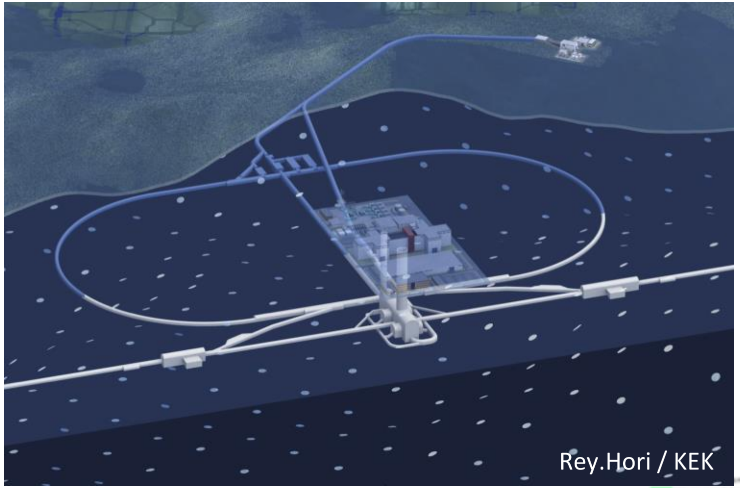


- 15 km in (e+e-) total
- follow the geoid in vertical
- **Kamaboko 9.5m X 5.5m**
- **1.5m central radiation shield**
- Further optimization will be done.



- **66 kV distribution cables**
- **Colling water pipes**
- Fan Coil Units
- Low power and signal cables
- **RF klystrons and modulators**
- **Electric Power Stations**

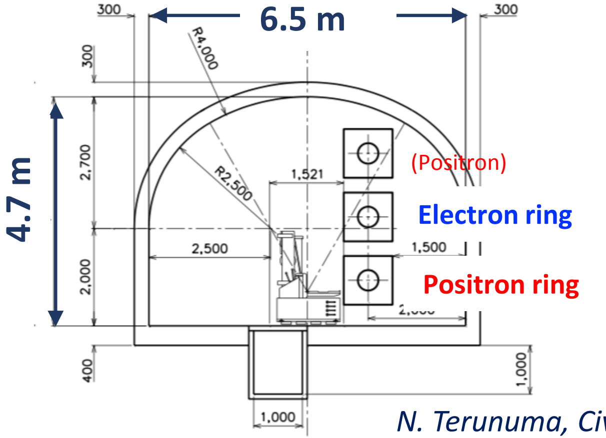
- **ML Cryomodules**
- **RTML**
- Low power and signal cables



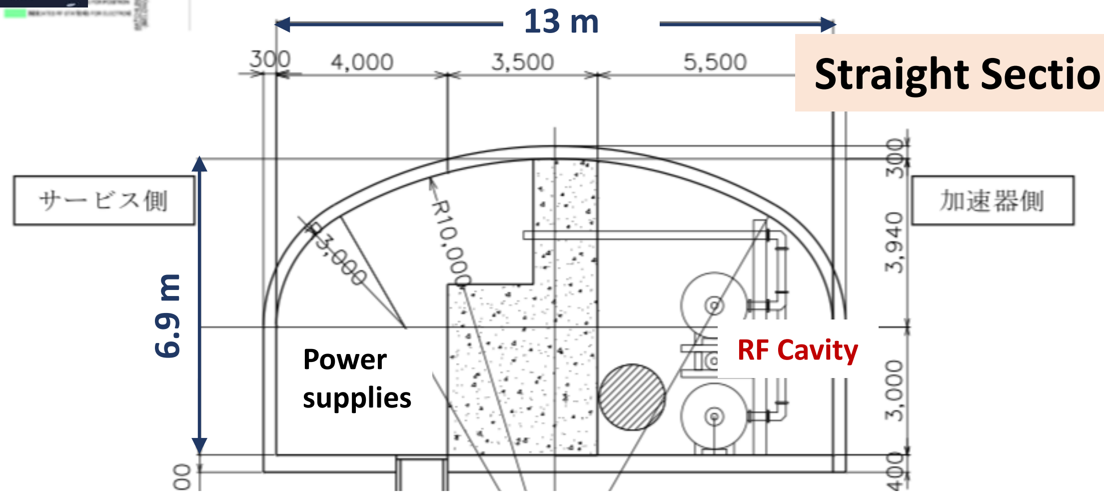
Damping Ring

- Circumference: 3.2km
- Start with two rings
- Arc section: **single tunnel, no central shield.**
- Straight section: **Kamaboko with a central shield** (3.5m in TDR).

Arc Section



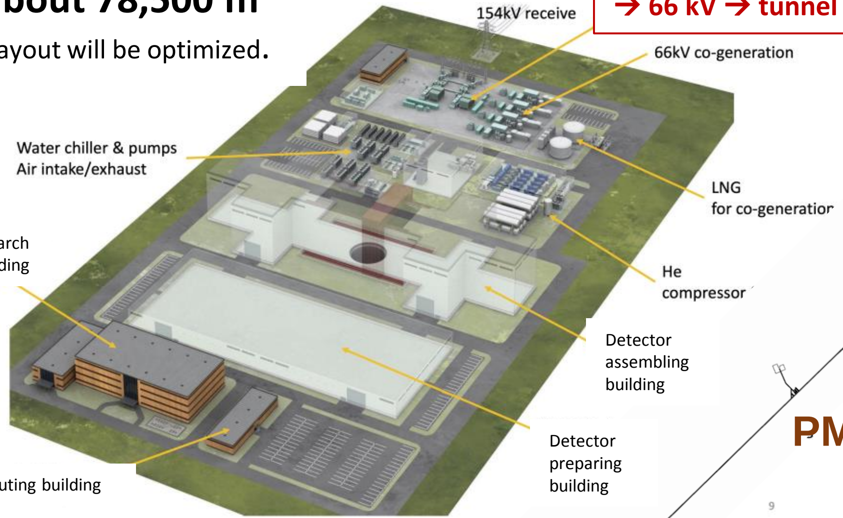
Straight Section



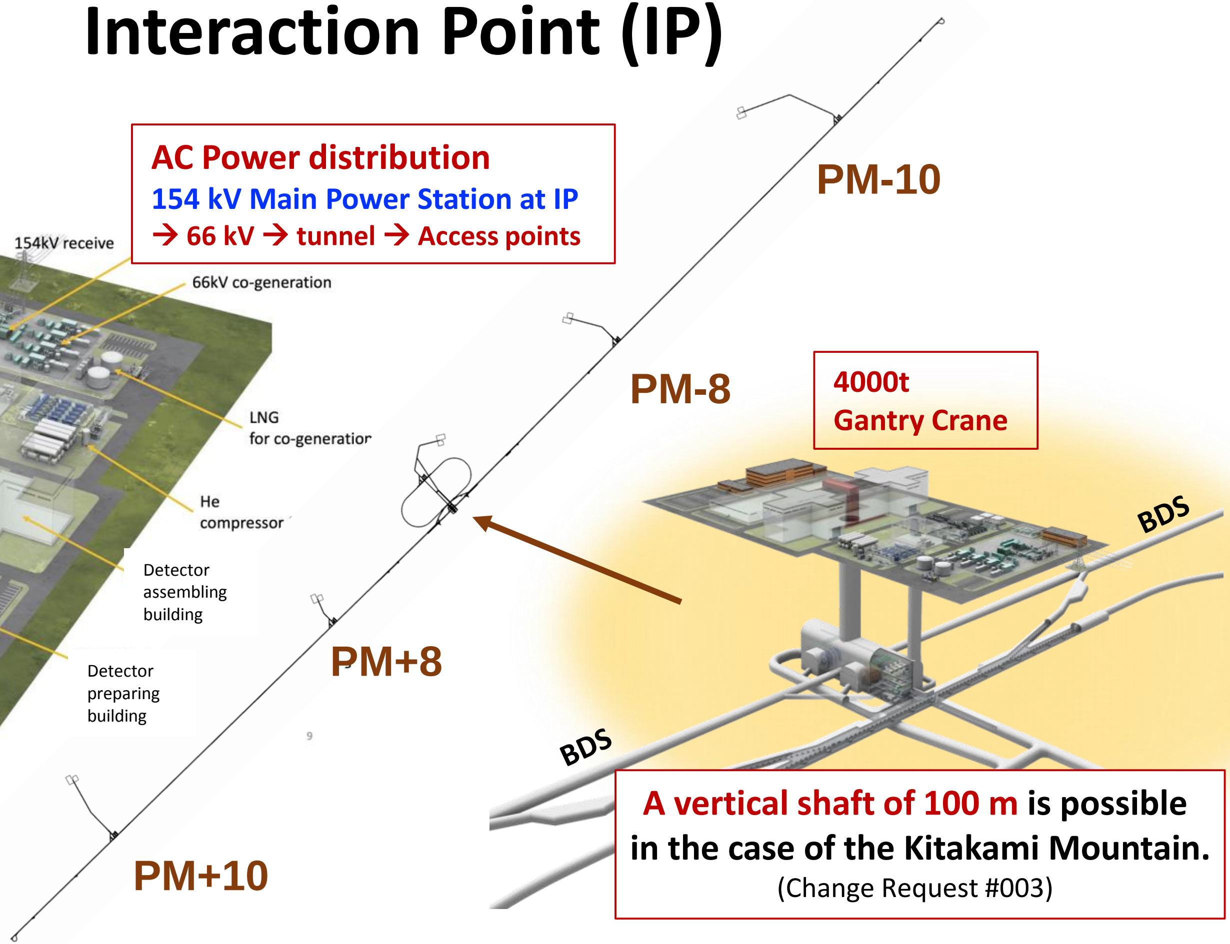
Interaction Point (IP)

IP surface area
about 78,500 m^2

Layout will be optimized.



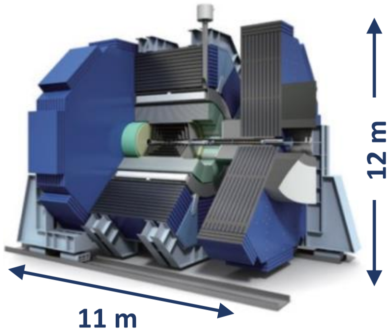
AC Power distribution
154 kV Main Power Station at IP
→ 66 kV → tunnel → Access points



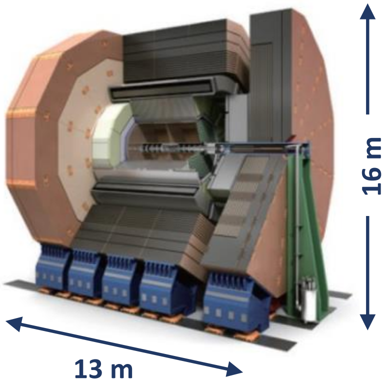
4000t
Gantry Crane

A vertical shaft of 100 m is possible in the case of the Kitakami Mountain.
(Change Request #003)

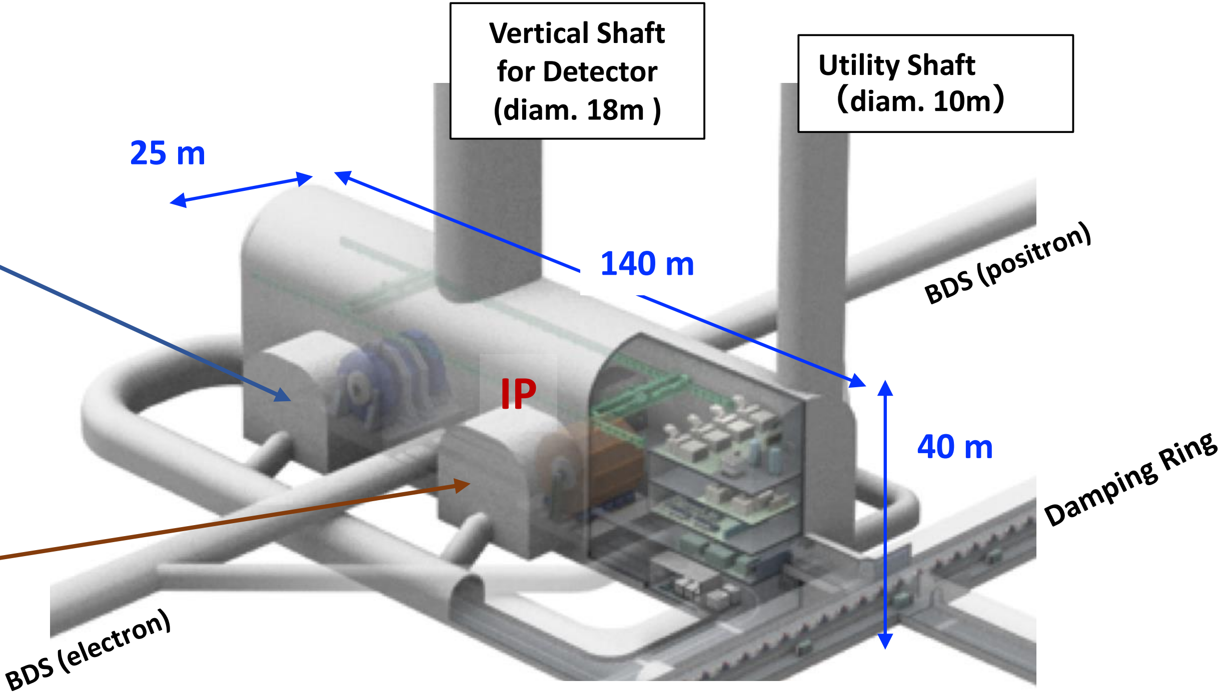
Detector Hall



SiD, 8,000 t



ILD, 15,000 t



Rey.Hori / KEK

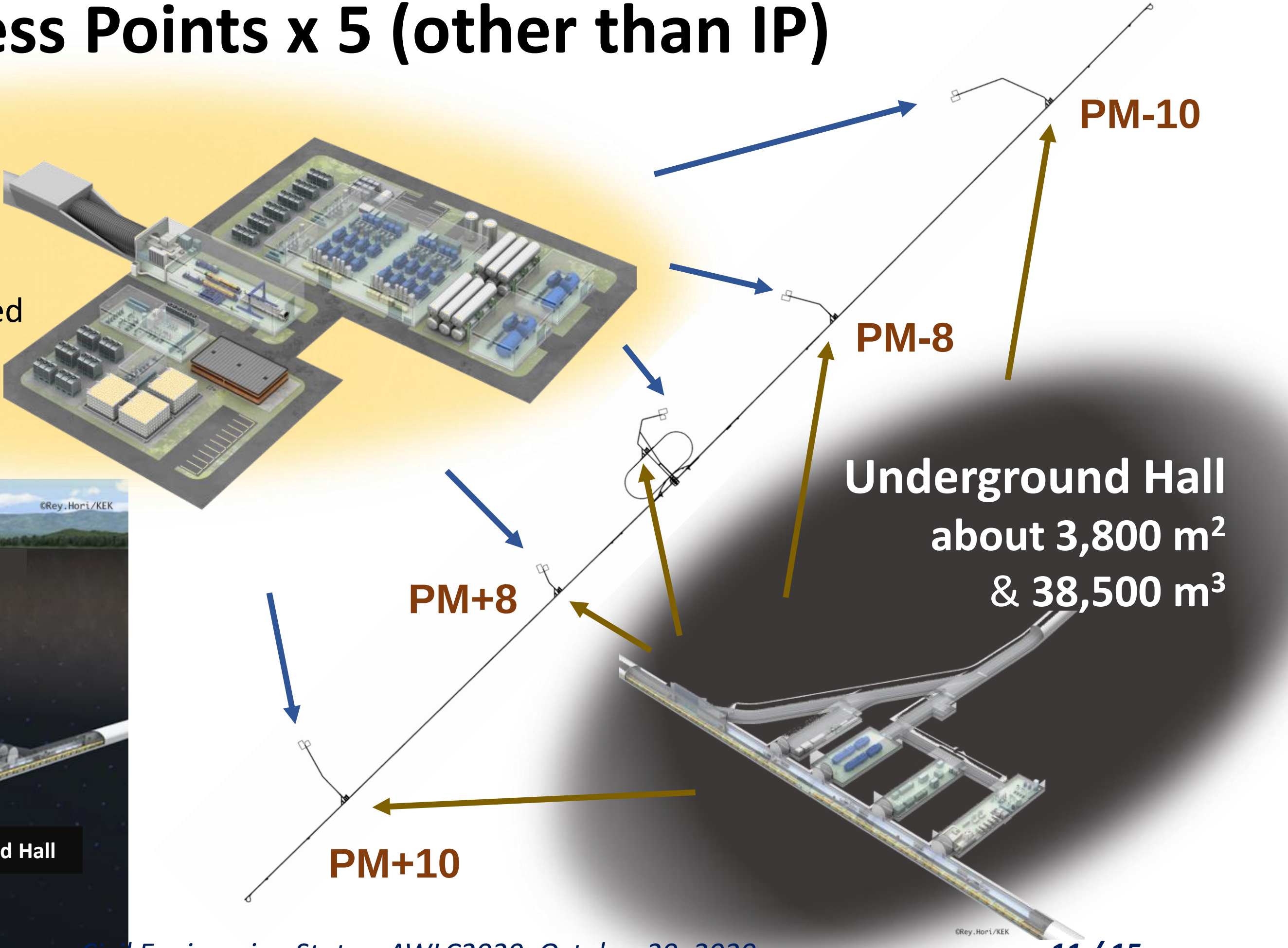
Layout of the detector hall and around will be optimized with detector groups.

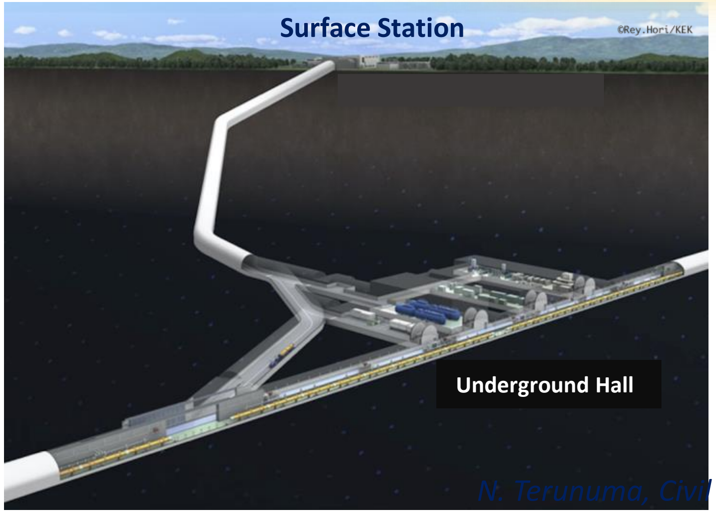
Access Points x 5 (other than IP)

Surface Station

about 16,600 m^2

The ground layout is optimized by the station.





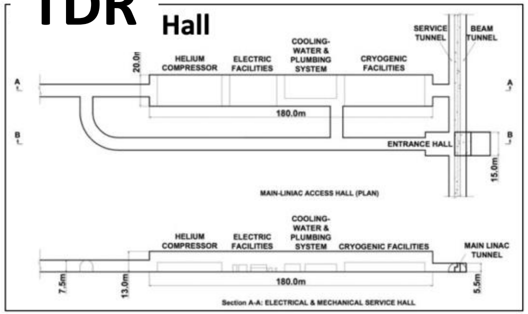
Underground Hall

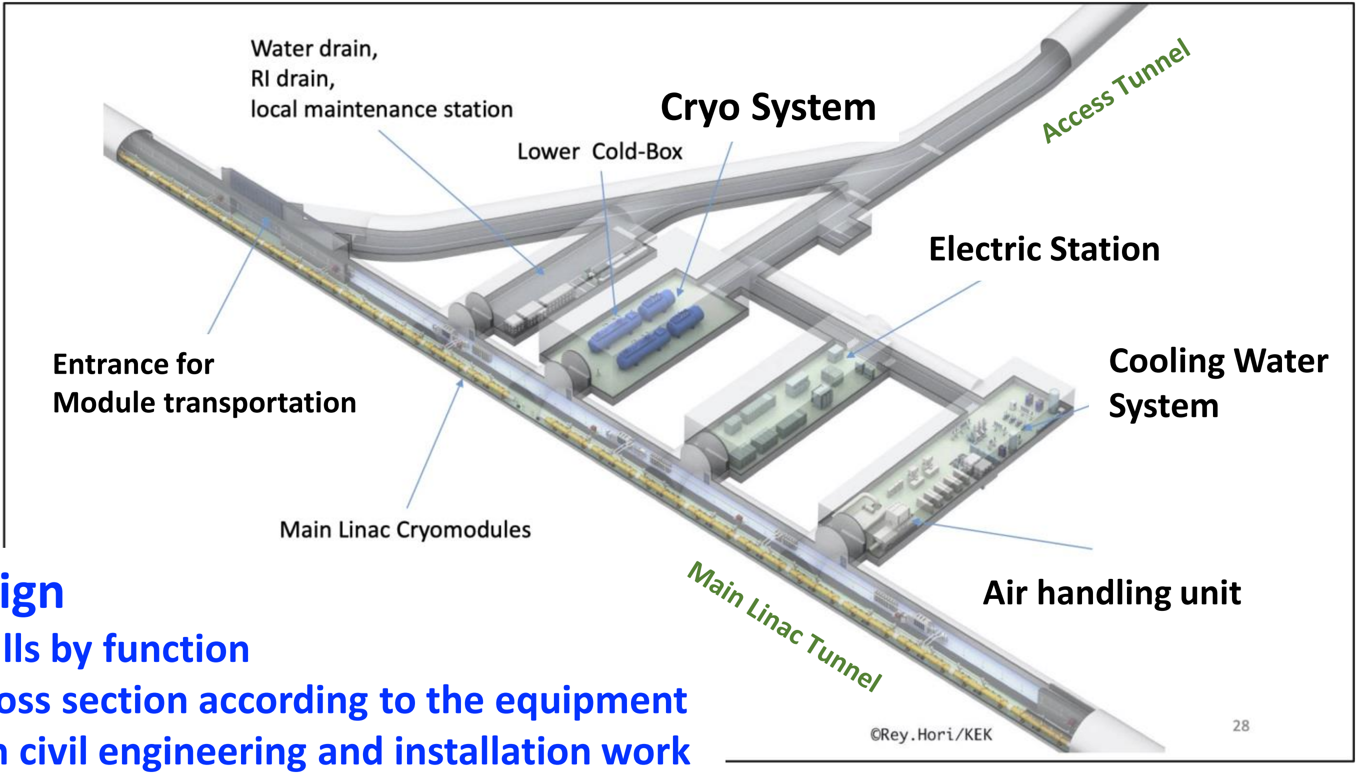
about 3,800 m^2

& 38,500 m^3

Underground Access/utility Halls

TDR

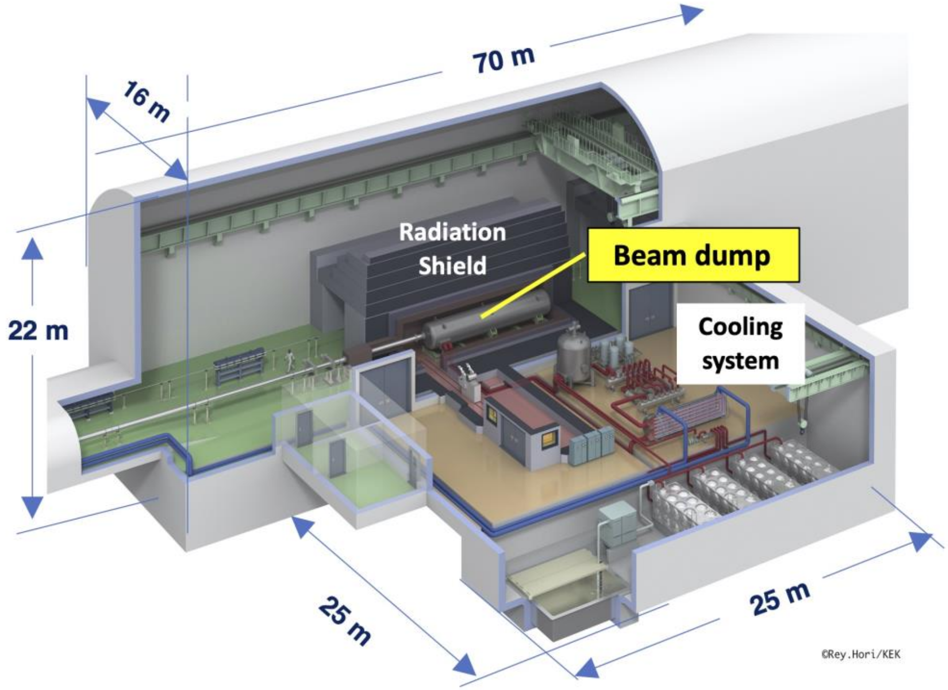




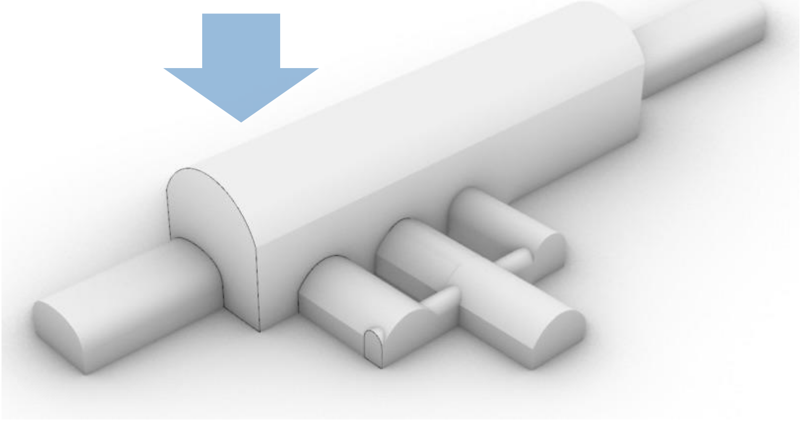
Updated Design

- Separated halls by function
- Optimized cross section according to the equipment
- advantage on civil engineering and installation work

Cavern for Main Beam Dump



- **Three big caverns**
  - Two main beam dumps
  - e- dump for undulator, low energy collision (5 x 5 Hz)
- The main beam dump has been designed for **1 TeV collisions.**
  - **5 m thick concrete shield in all directions**
  - **17 MW power cooling (wider utility hall)**
  - **¼ volume of detector hall**
- **The civil engineering design is updating with experts from Industry (AAA).**



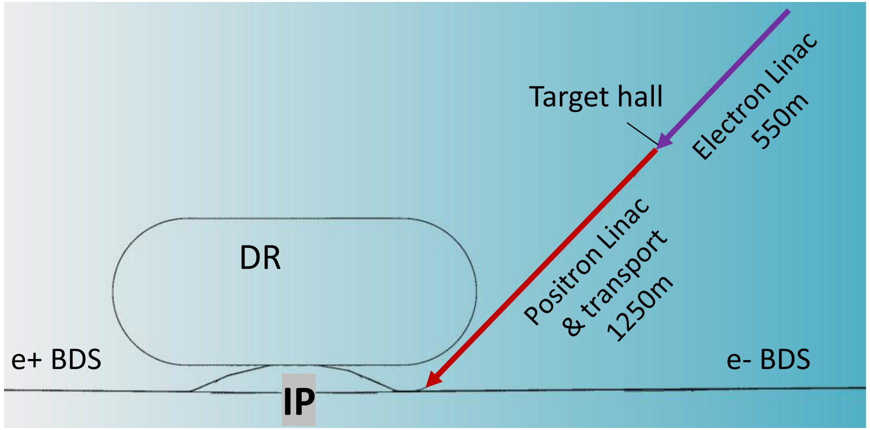
Civil Engineering Design for Positron Source

Since civil engineering (CE) work will start immediately after the preparation period, a lot of detailed design work is expected during the preparation period, so the CFS Group will proceed with the basic design of the CE for the positron source in advance.

- Have the CE design to **include the undulator scheme in any scenarios.**
  - **TDR based layout**
  - and have **Photon dump line** in the BDS tunnel
- **E-driven source** will be in **separated dedicated tunnel.**
  - **add on to the TDR based design**
  - From the CE view, sharing of BDS tunnel is not realistic.
  - e-driven study group is developing this design.
  - Access tunnel should be considered.

Design study for e-driven positron source

- Figure shows the length of the linac, taking into account the size and placement of devices.
- Positron injection into the DR uses RTL.
- Joint angle to the BDS tunnel will be optimized for local conditions.



Summary

- The CFS Group is proceeding with studies assuming that the ILC construction work will begin immediately after the ILC main preparatory phase.
- The civil engineering design of the ILC is being studied using a model route in the Kitakami Mountains. It examines local challenges in ILC construction.
- These efforts are being implemented in collaboration with KEK, universities in Tohoku, local governments, and industry.

appendix

Appendix

Major Changes related on Civil Engineering after the TDR

Change Request: approve process of the design change from the TDR

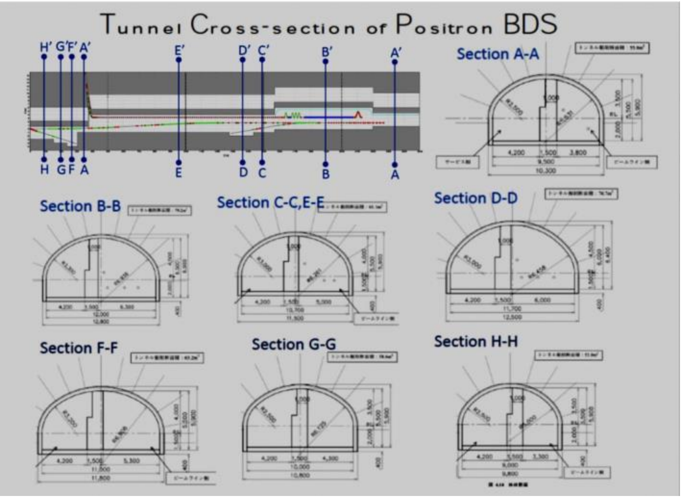
- CR-003: Detector hall with vertical shaft access
- CR-004: Extension of the ML tunnel
- CR-007: Adoption of the Asian design as sole baseline
- CR-009 and CR-014: Cryogenic Layout
- CR-012: Reduction of width of Linac Shield Wall and Tunnel Cross-Section
- CR-015: Kamaboko shaped positron BDS tunnel
- CR-017: Orientation of electron/positron linacs

BDS tunnel

TDR: Twin tunnel (accelerator and service)

2017: Single tunnel for e+ BDS

(Change Request CR-015:)



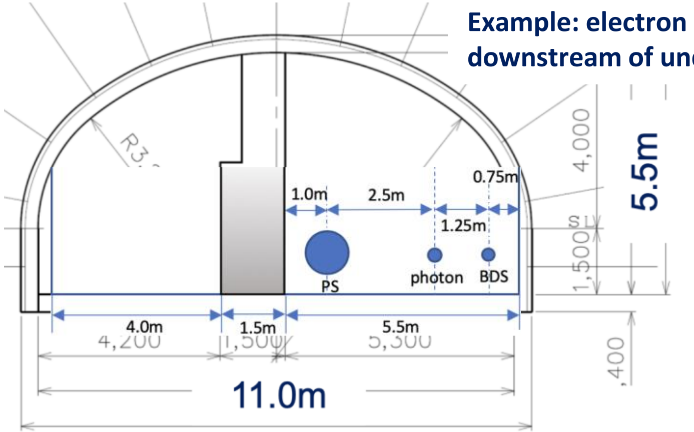
CR-015: Fig.5 tunnel cross-section model for cost estimation

2019:

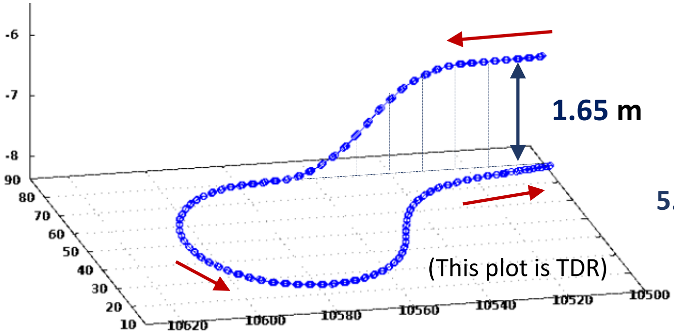
Unified tunnel cross-section along the BDS is proposed

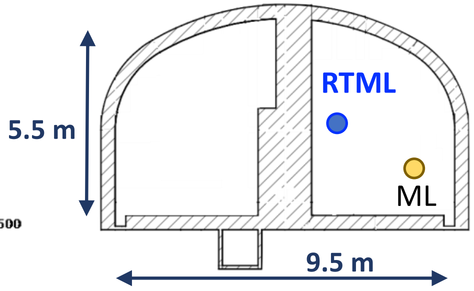
- Civil engineering point of view
- Avoid many change of the cross-section

The **11m-wide kamaboko tunnel along the BDS** will involve the undulator positron source, photon dump line and e- BDS.



Turn-around





- **For future ML extensions, the Kamaboko Tunnel should extend longer than the turnaround section.**
- This will allow for external extension work to be done even during the operational period of the ILC.
- The extension will also serve as an evacuation route for the turnaround section.
- Turnaround has been enlarged +10 m in radius by the update of optics, corrected gap between magnets.

ML tunnel prepared for future extension