

41st Meeting of SRF Group in IDT/WG2

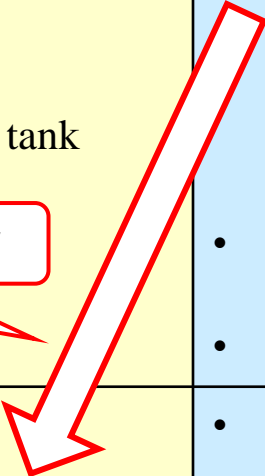
- ✓ Recent progress of SRF 5-year plan at KEK and global collaboration for ITN (Kirk)
- ✓ Preparation for LCWS2024 @Tokyo (Kirk)
- ✓ Others (if any)

Attendees: A. Yamamoto, K. Umemori, H. Sakai, E. Cenni, L. Monaco, D. Delikaris, S. Belometnykh, B. Rimmer, R. Ruber, P. Burrows, Kirk

<https://agenda.linearcollider.org/category/256/>

MEXT-ATD (Accelerator element Technology Development) (done by KEK as domestic program for 5 years)		ITN (as Time-critical work packages) (done by global collaboration for ILC for 4 years)	
Cavity	<ul style="list-style-type: none"> Nb material preparation Production HPGS Establishment of surface treatment Clean assembly VT Equipment of helium tank 	<ul style="list-style-type: none"> 1-cell cavity: fundamental research 9-cell cavity <ul style="list-style-type: none"> HPGS Purchasing SC material Industrial production with globally shared contracts VT and further effort Clean room work procedure (robotics) Quality control/assurance 	<p>Necessary Nb material sent from KEK</p> <p>WPP-1 (Cavity Industrial-Production Readiness)</p>
Cryomodule incl. ancillaries	<ul style="list-style-type: none"> Production HPGS Clean assembly/Installation Cold test at CM bunker 	<ul style="list-style-type: none"> Finalization of envelope drawing including tuner, coupler, SCQ HPGS 	<p>WPP-2 (Cryomodule design)</p>
Infrastructure	<ul style="list-style-type: none"> Cryogenics CM test bunker Cold mass hanger Rail system for cavity string 		
Crab cavity		<ul style="list-style-type: none"> Prototype production VT Design of CM 	<p>WPP-3 (Crab cavity)</p>

Two cavities sent from oversea before CY2027



Achievement in FY2023

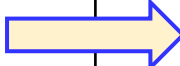
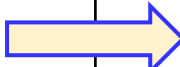
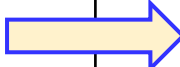
Component	Items
Infrastructure	<ul style="list-style-type: none"> • New EBW machine → installed • TIG welding area → constructed • Cold evaporator/Additional pressure vessel → installed • Preparation for cold mass hanger → improved
High pressure gas safety act	<ul style="list-style-type: none"> • Negotiation with KHK/Local government → continued • Document preparation → continued • Sample test → done • Simulation → done
Cavity	<ul style="list-style-type: none"> • Cavity fabrication (satisfying HPGS) → produced
Surface treatment/Vertical test	<ul style="list-style-type: none"> • 2-steps baking using new clean oven → continued • High-Q/High-G R&D (continued since 2017) → continued
Power coupler	<ul style="list-style-type: none"> • Drawing work/Detailed design → continued • Production of sample ceramic → continued
Frequency tuner	<ul style="list-style-type: none"> • Drawing → continued • Tuner test incl. piezo at room temperature → continued
Magnetic shield/Demagnetization	<ul style="list-style-type: none"> • Demagnetization test → continued • Drawing → continued
SCQ magnet	<ul style="list-style-type: none"> • Detailed design with vendors → continued
Cryomodule	<ul style="list-style-type: none"> • Drawing work → continued

Reduced numbers of cavities/ancillaries for production

We had to change number of production for each component including cavities due to inflation after last review. Currently, cavity has **no spare**, and power coupler/SCQ-magnet has **no prototype/no spare!** One or two cavities are expected to be sent from oversea (Asia/EU/US).

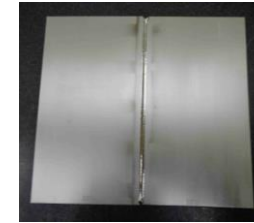
Our schedule is never changed!

※Prototype means “available for CM”, but training means “not available for CM”.

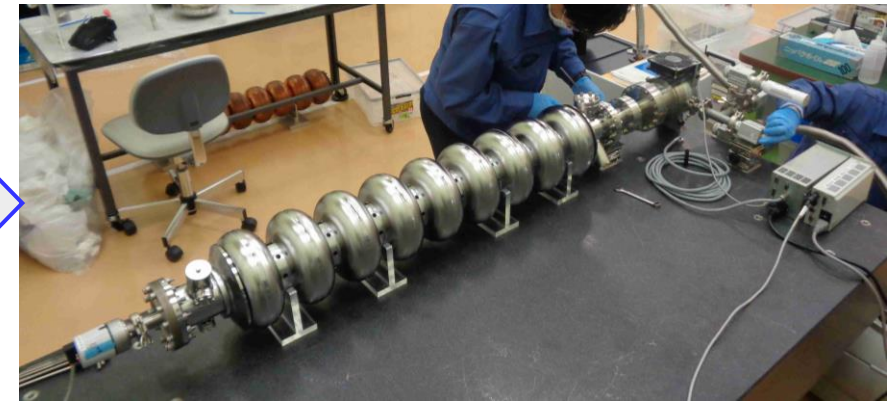
Component	Oct/2023	Mar/2024
9-cell Cavity (FG, domestic)	8 (one prototype incl.) 	4 (one prototype incl.)
9-cell Cavity (MG, domestic)	2 + 1 (training)	2 + 1 (training)
9-cell Cavity (MG, oversea)	2	2
Power coupler	8 + 2 (prototype) 	8
Frequency tuner	8 + 1 (prototype)	8 + 1 (prototype)
Magnetic shield	8 + 1 (prototype)	8 + 1 (prototype)
SCQ magnet	1 + 1 (prototype) 	1
Cryomodule	1	1

1st 9-cell cavity (w/ HPGS) produced

CFF group at KEK completed the production of 1st 9-cell (FG) cavity for this program. This cavity completely follows the high pressure gas safety (HPGS) act in Japan. After passing leak check, they measured all dimensions of this cavity by coordinate measuring machine. In FY2024, surface treatment, pre-tuning, pressure inspection for HPGS, and VT will be done.



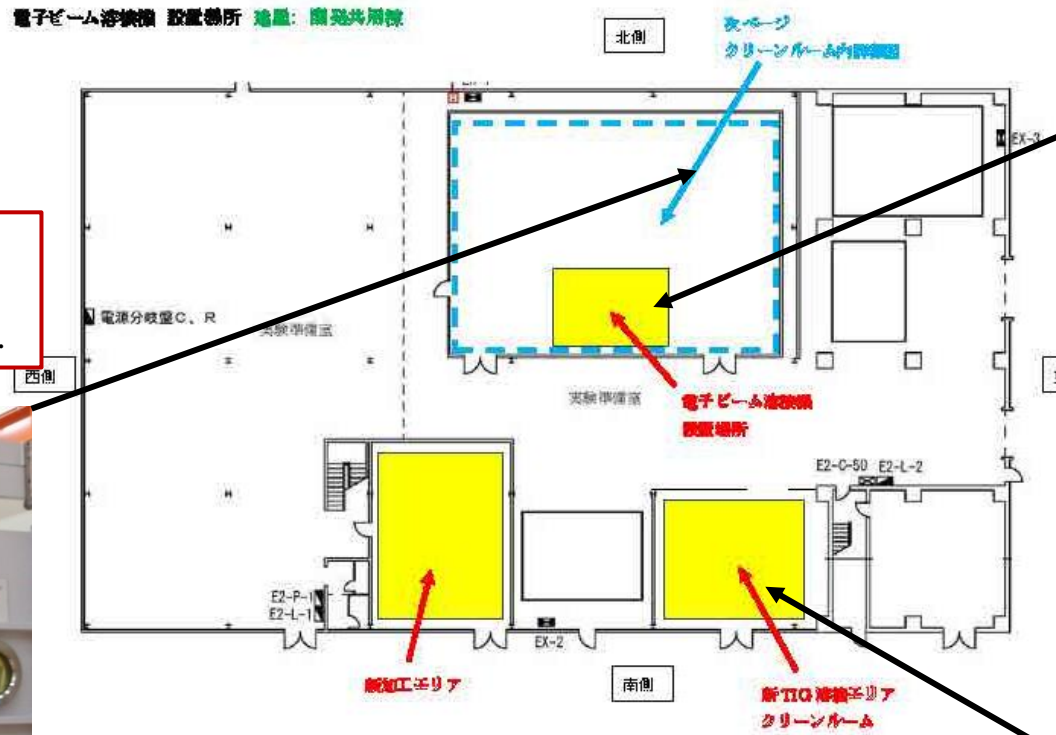
EBW test for HPGS
(should be done before production)



Dimension measurement

Infrastructure update at CFF

EBW machine #1 (installed in 2012)
Cryo-pump will be replaced in FY2024.
Control system will be upgraded in FY2027.



EBW machine #2
(newly installed in FY2023)



New TIG welding area for helium tank prepared in FY2023



Surface treatment being proposed by KEK

EP-1 (150 μm)



Heat treatment
(900°C, 3h)



EP-2
(cold EP, 20 μm)



HPR
Clean (dry) Assembly



2-step Baking
(75°C, 4h
+
120°C, 48h)

KEK's proposal is to apply **2-step baking** to realize high performance, higher-Q and higher gradient, of the cavities.

We will change not only baking parameter, but the others.

Cold EP



Clean Oven
(inside clean room)

Vacuum Furnace

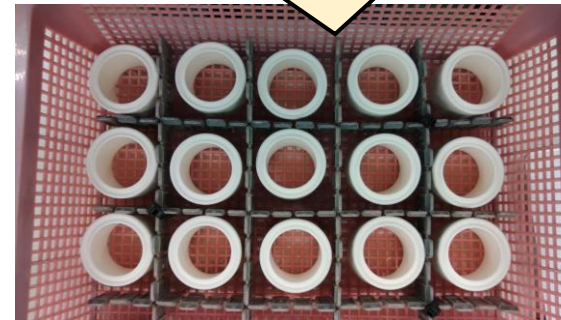


Power coupler in FY2023

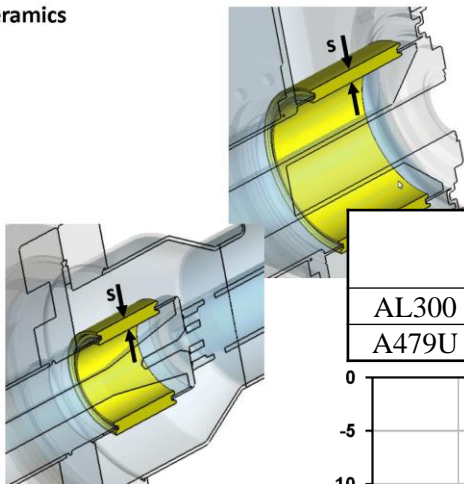
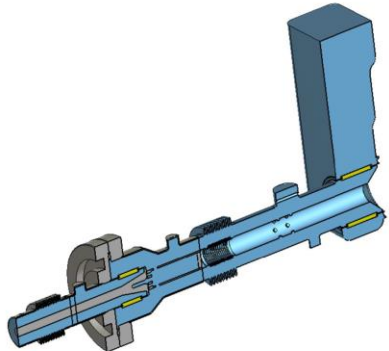
- RF simulation using new type ceramic by FNAL/KEK
- Drawing work/Detailed design
- Ceramic production for brazing test/Tensile test/TiN coating test

Ceramic samples were produced to test brazing, TiN coating, tensile stress

Fit check



Whole coupler with Kyocera ceramics

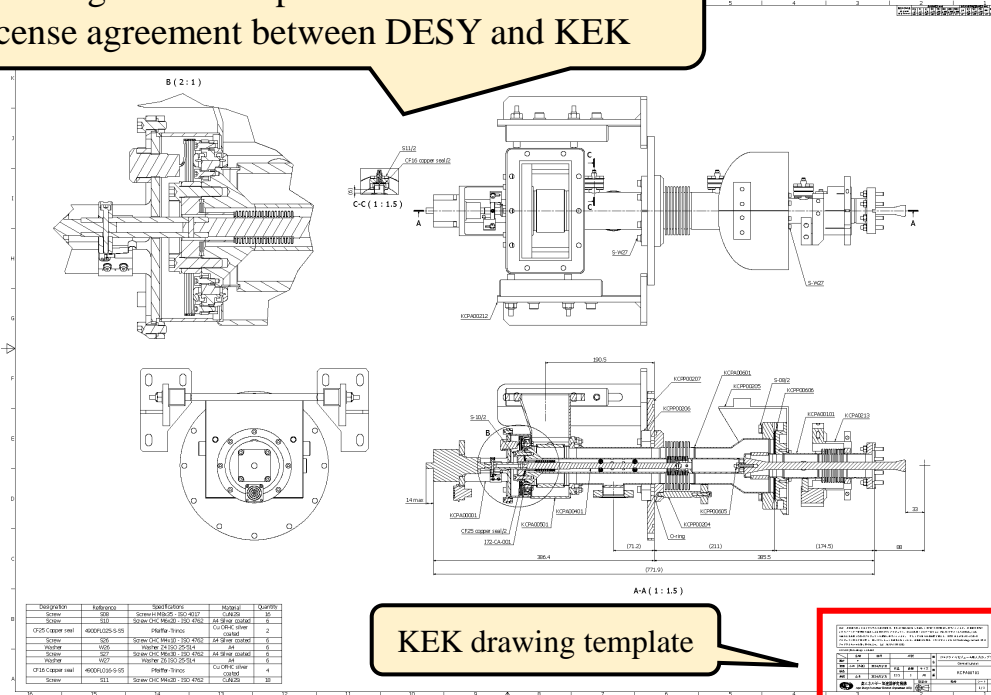
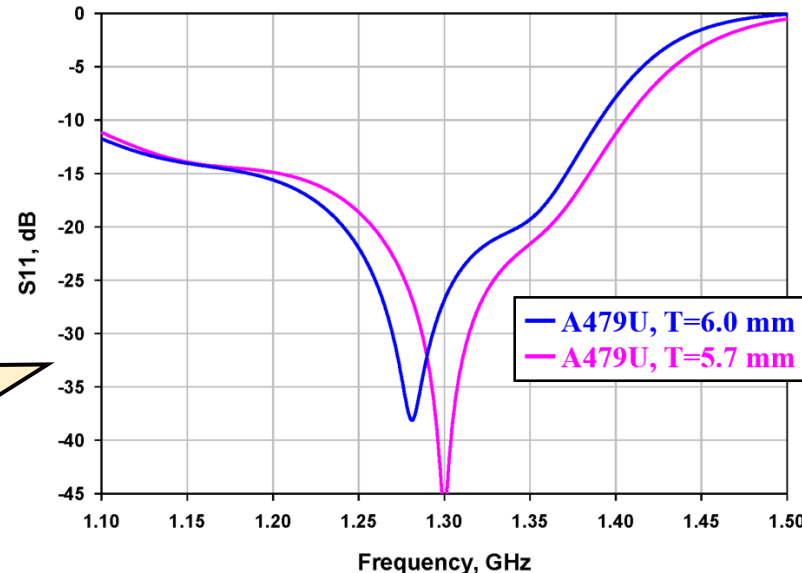


The inner and outer diameters were reduced by 0.15 mm

	Purity [%]	ϵ	$\tan\delta$	Optimum thickness of ceramics [mm]
AL300	97.6	9.29	2.57E-04	6.0
A479U	99.8	9.64	2.19E-05	5.7

All drawings were completed as the KEK version by license agreement between DESY and KEK

KEK changed ceramic material from AL300 (WESGO) to A479U (KYOCERA). For better RF matching, thinner ceramic is used.

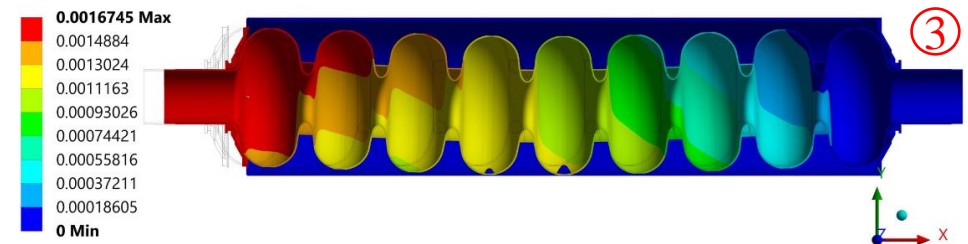
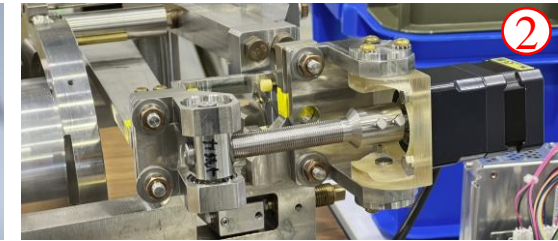
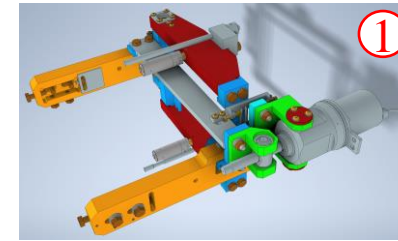


KEK drawing template

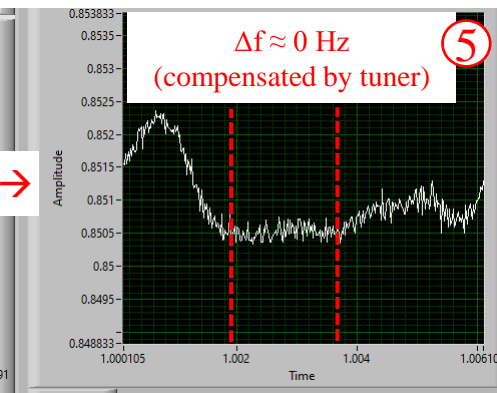
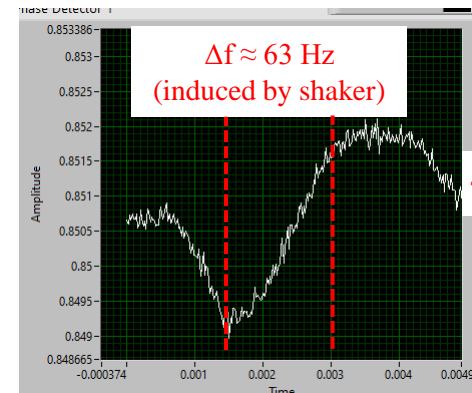


Frequency tuner in FY2023

- Development of tuner for ILC prototype CM based on the LCLS-II tuner design ongoing
- Setup of tuner R&D area at KEK completed
- Studies of 3D model (①) completed
- Designed and manufactured an adapter to drive a from FNAL lend tuner with a Japanese stepper motor (②)
- Simulations using Ansys on cavity deformations due to Lorentz forces detuning (③)
- Received a jacketed LCLS-II cavity, a frequency tuner, and electrical equipment from FNAL (④)
- Successful compensation of simulated Lorentz force detuning induced by a shaker (⑤)



Two FNAL staffs visited to KEK to work the tuner test with KEK staffs in Feb-Mar.

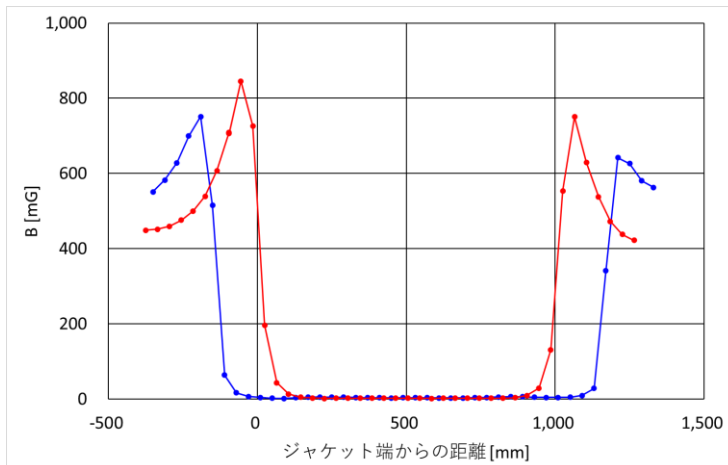
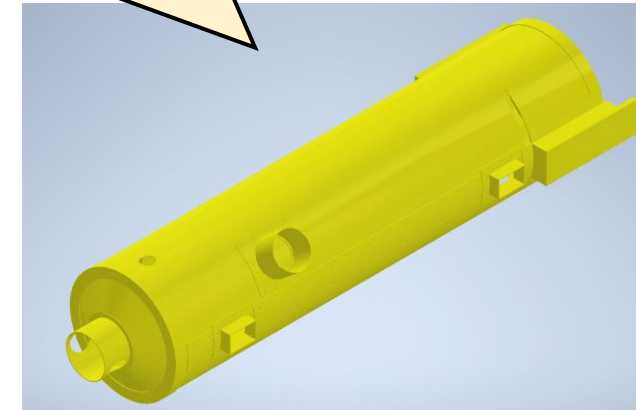


Magnetic shield/Demagnetization in FY2023

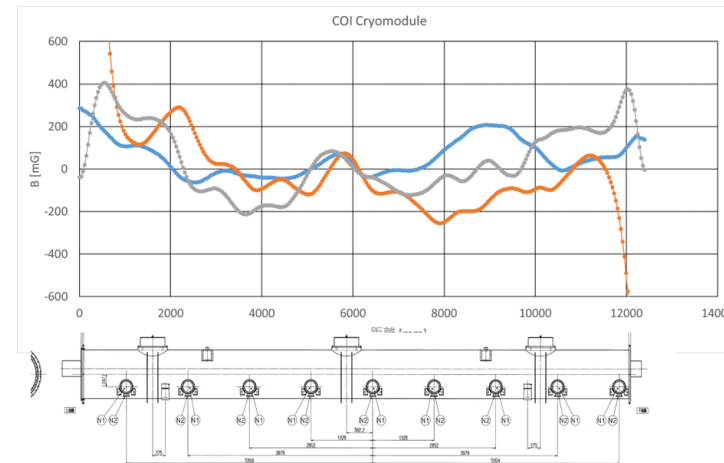
Progress status of magnetic shielding in 2023

- Magnetic shield
 - The first draft of the magnetic shield has been completed.
 - The performance comparison of inner and outer magnetic shield.
- Cryomodule demagnetization system
 - Auto measurement system of magnetic shield in cryomodule has been completed.
 - Preparations for demagnetization tests using 2m modules are complete.
 - Tests for determination of demagnetization conditions are being conducted.
- Magnetic field monitor system
 - Construction of test bench for calibration of magnetic field sensor is underway.

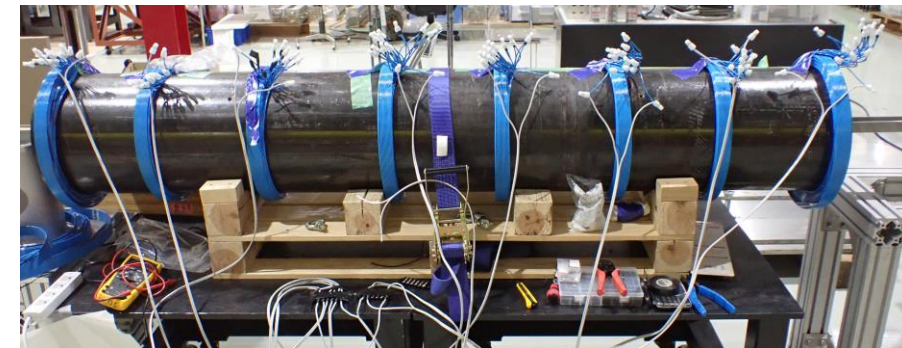
The design is under consideration



Comparison of inner and outer shield



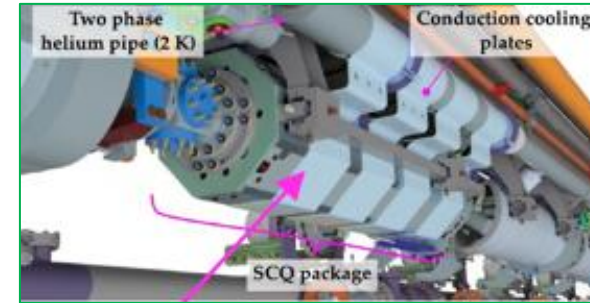
Auto measurement



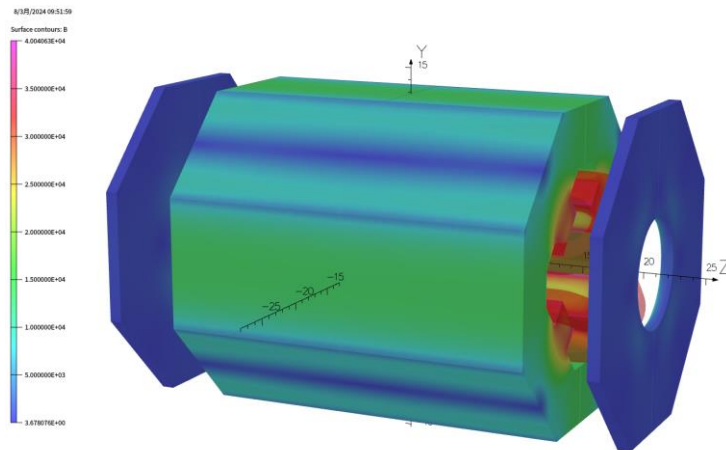
Demagnetization test using small cryo-vessel

SC Q-magnet in FY2023

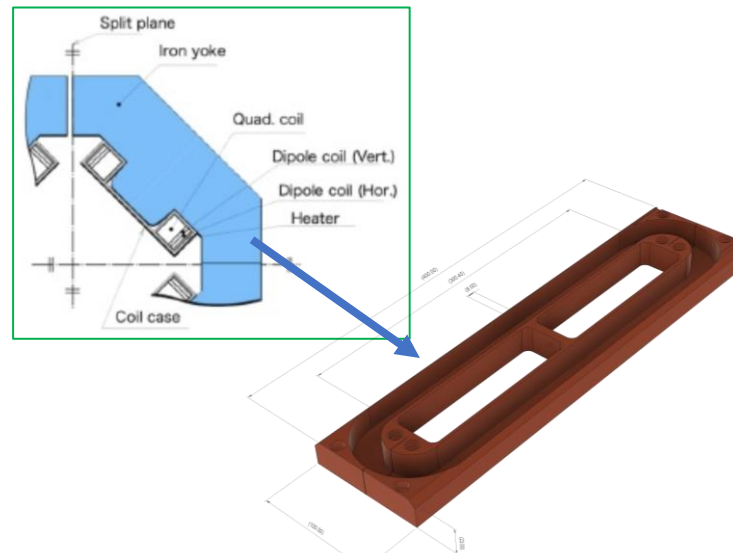
- Field calculation of magnet
- Design study for quench protection system
- Design of coil case and fabrication of one coil case
- Conceptual engineering design of magnet
- Design of test cryostat



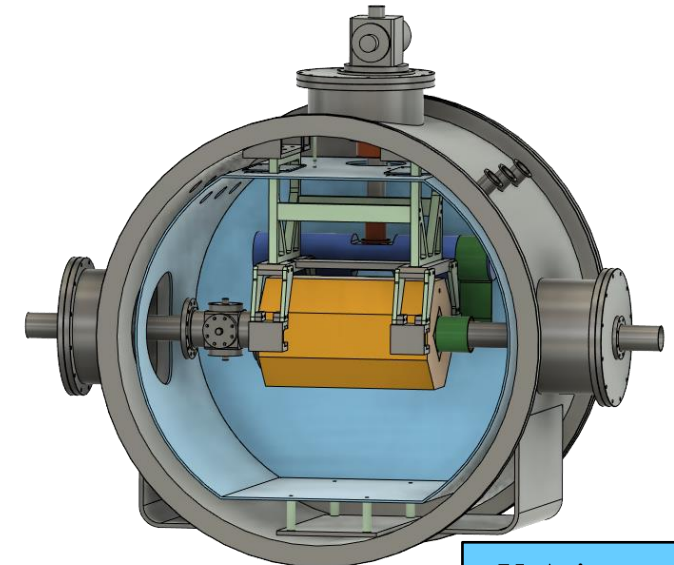
3D analysis model of the magnet



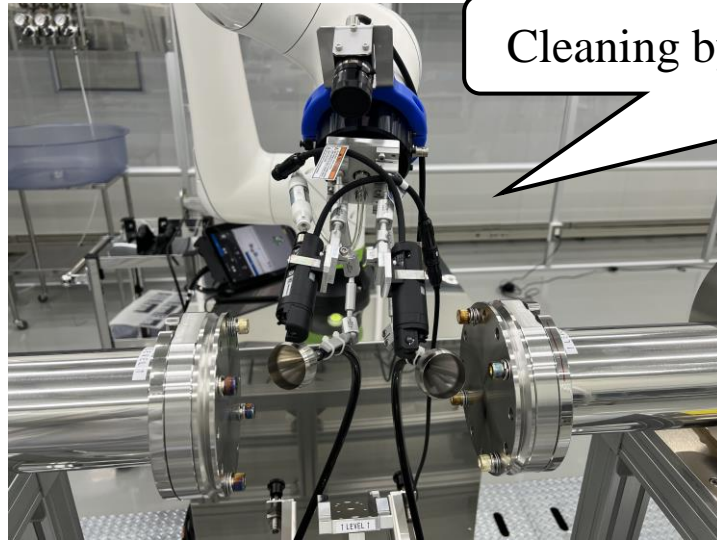
Coil case design



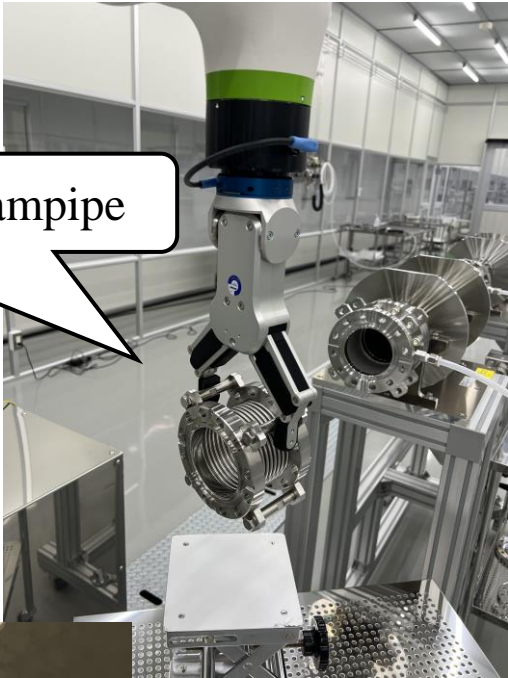
Test cryostat design (conduction cooling)



Robotics in FY2023



Cleaning by multi-ionized guns for the both flanges



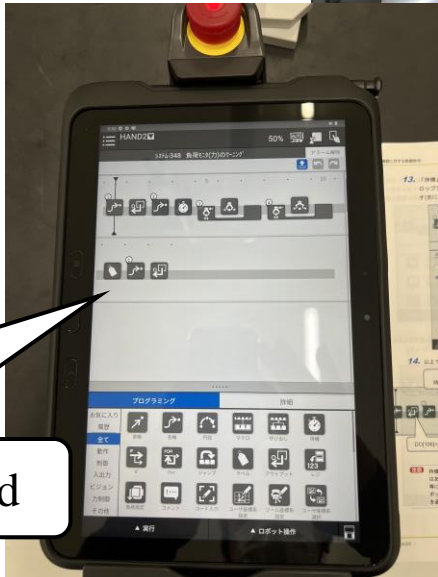
Attachment of bellows beampipe



Attachment of blank flange

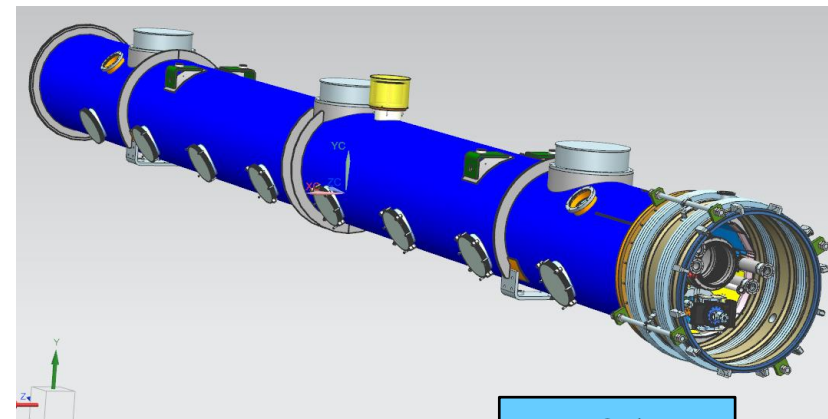
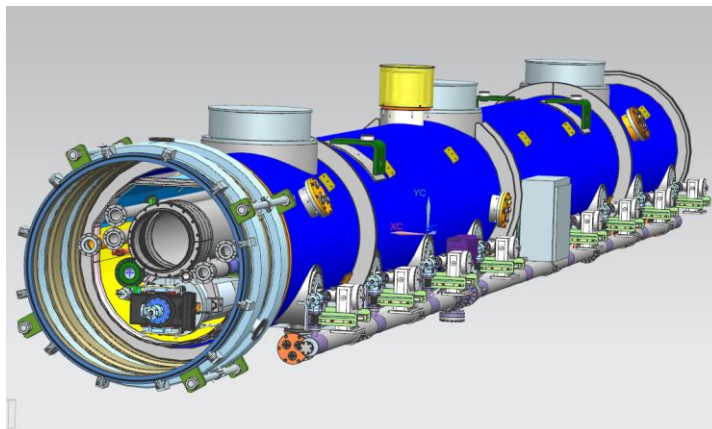
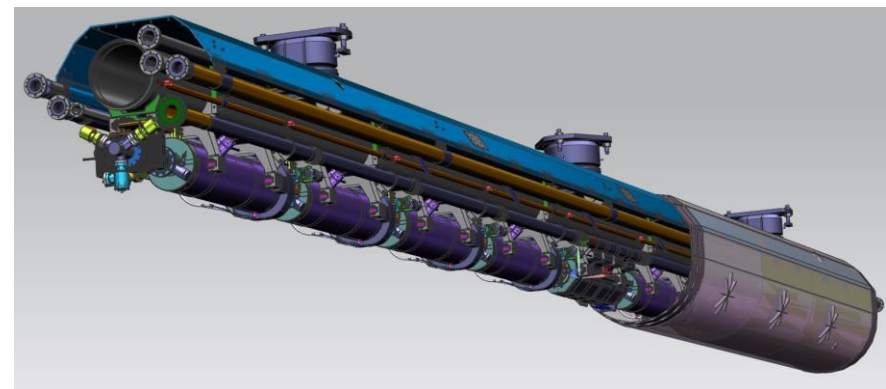
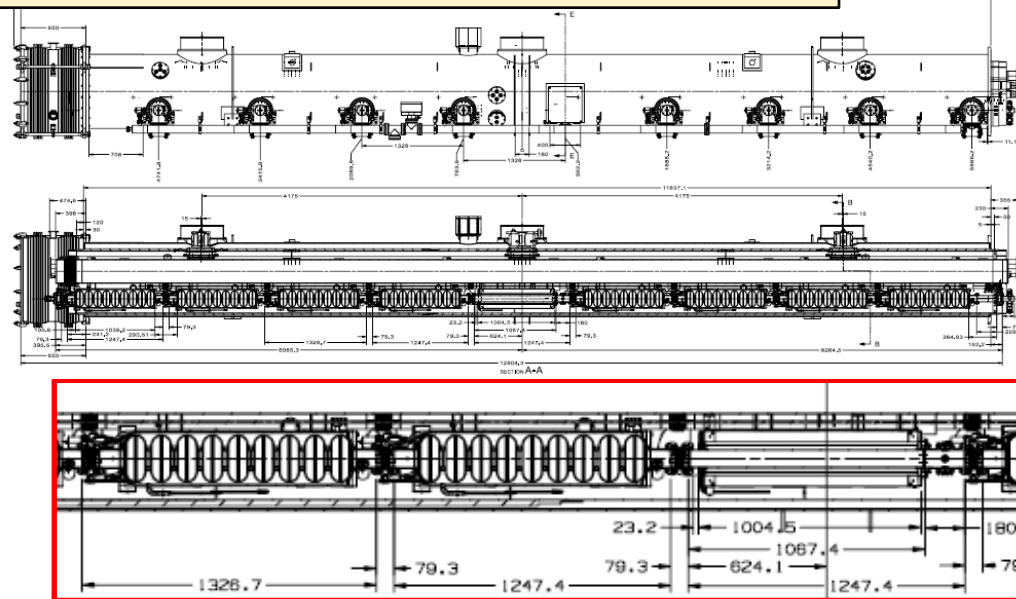
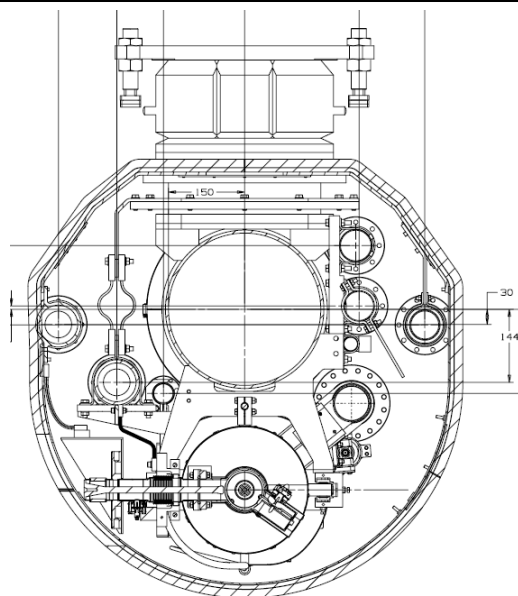
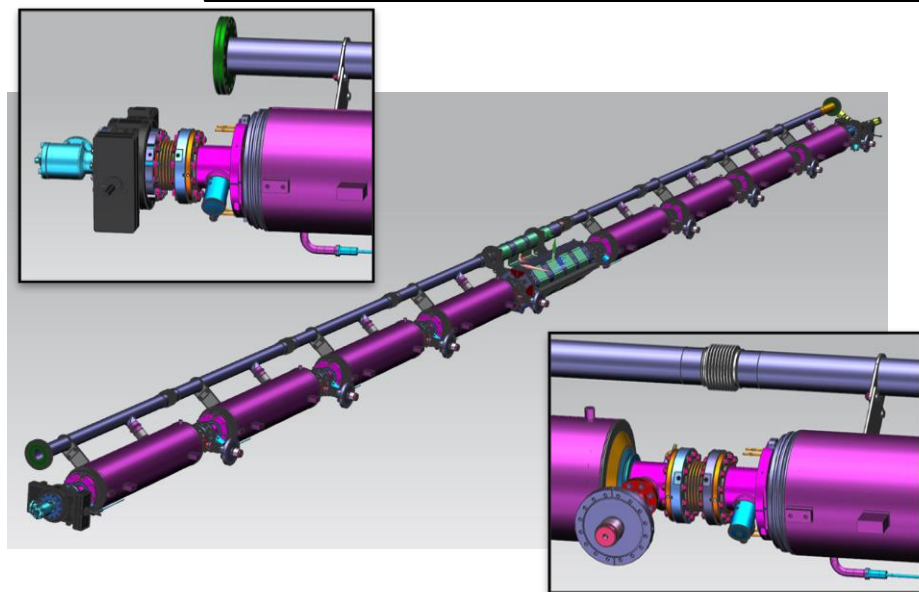


Development of icon-type program on touch-pad



“Tentative” Cryomodule (CM) design

We found T4CM ver.29 (stored in EDMS at DESY) is the latest version developed in the GDE era. KEK will start from this version for our CM production, and update some parts including tuner/helium tank. Especially, we have to take care of “earthquake effect” discussed in LCWS2013.



COI infrastructures (updated)

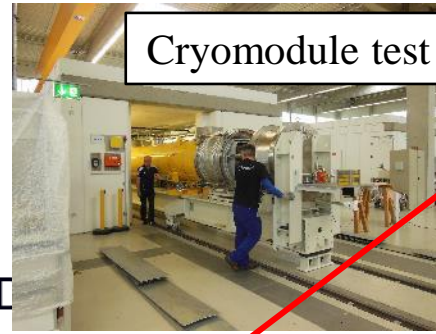
Rail system for cavity string



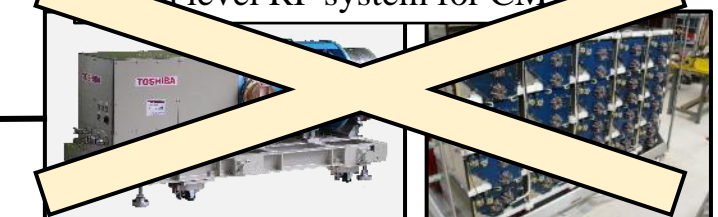
Robot arm for auto cleaning



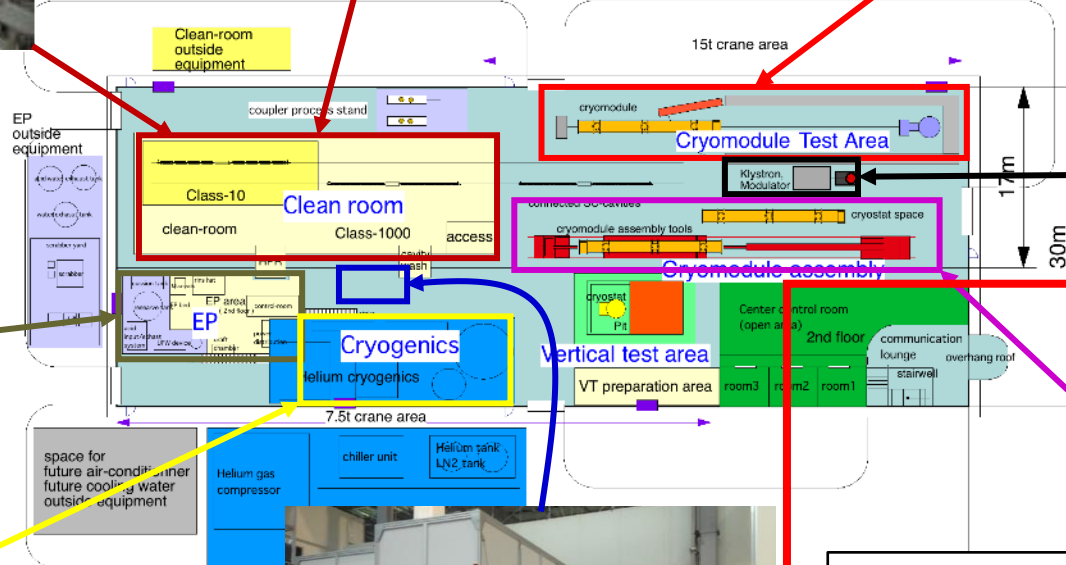
Cryomodule test bunker



High level RF system for CM test



Vertical EP



Cryogenics for CM test



Heating furnace



Hanger and rail system for CM construction



Yellow: operating, Gray: partly operating, White: not completed yet

Infrastructures in FY2023

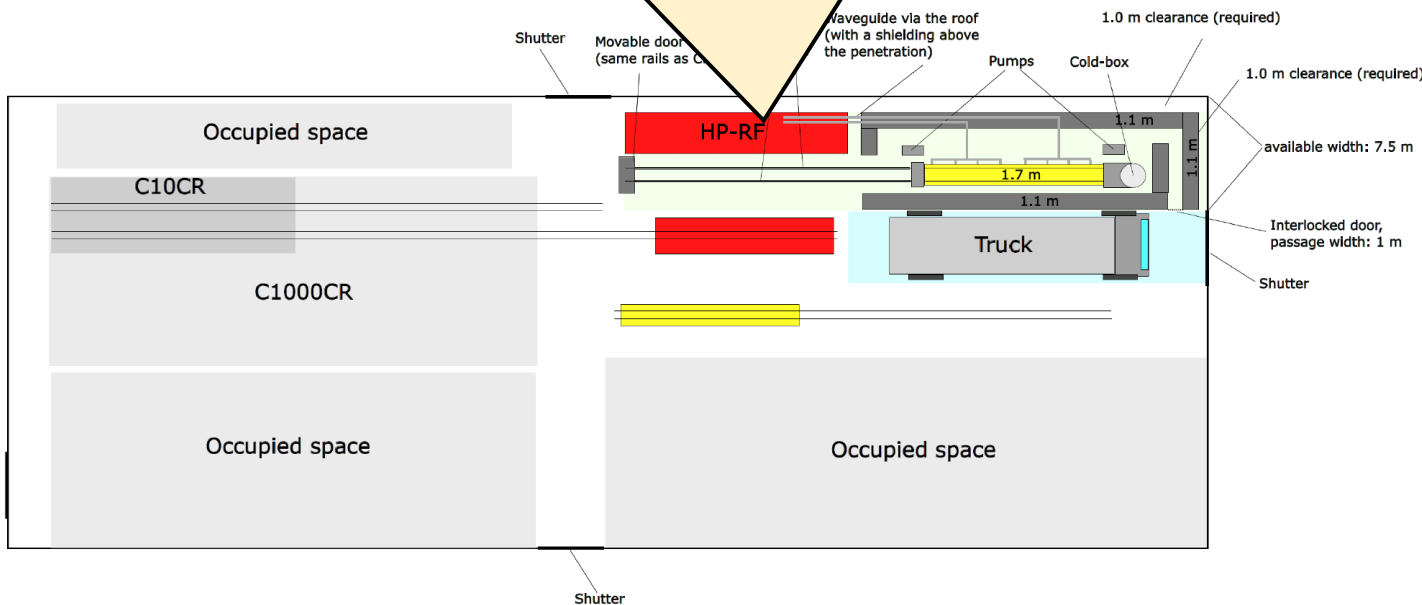
- Design of concrete shield
- Cost estimation on concrete shield
- Installation of pressure vessel and cold evaporator
- Improvement of hanger/carrier for cold mass
- Preparation of rail system for cavity string

Cold evaporator newly installed

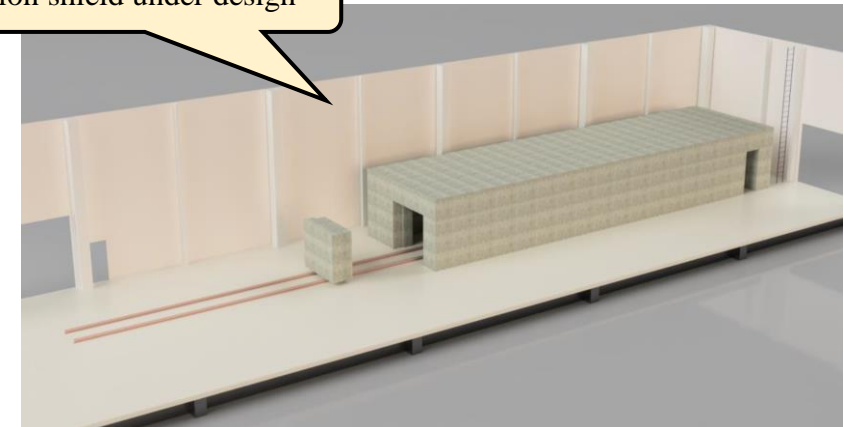
Cold mass hanger improved

He buffer tank installed

We have given up on trying to implement newly HLRF system.

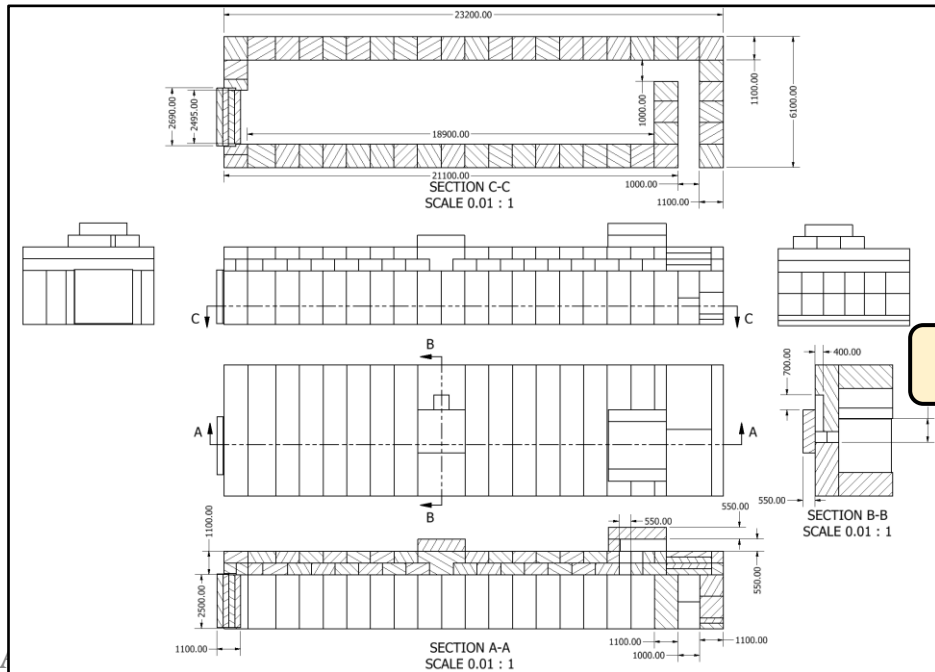
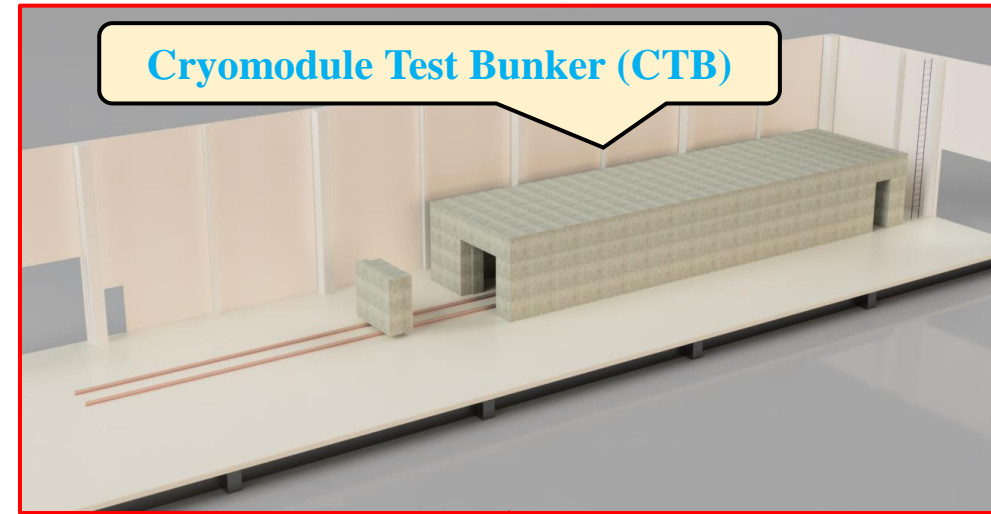


Radiation shield under design

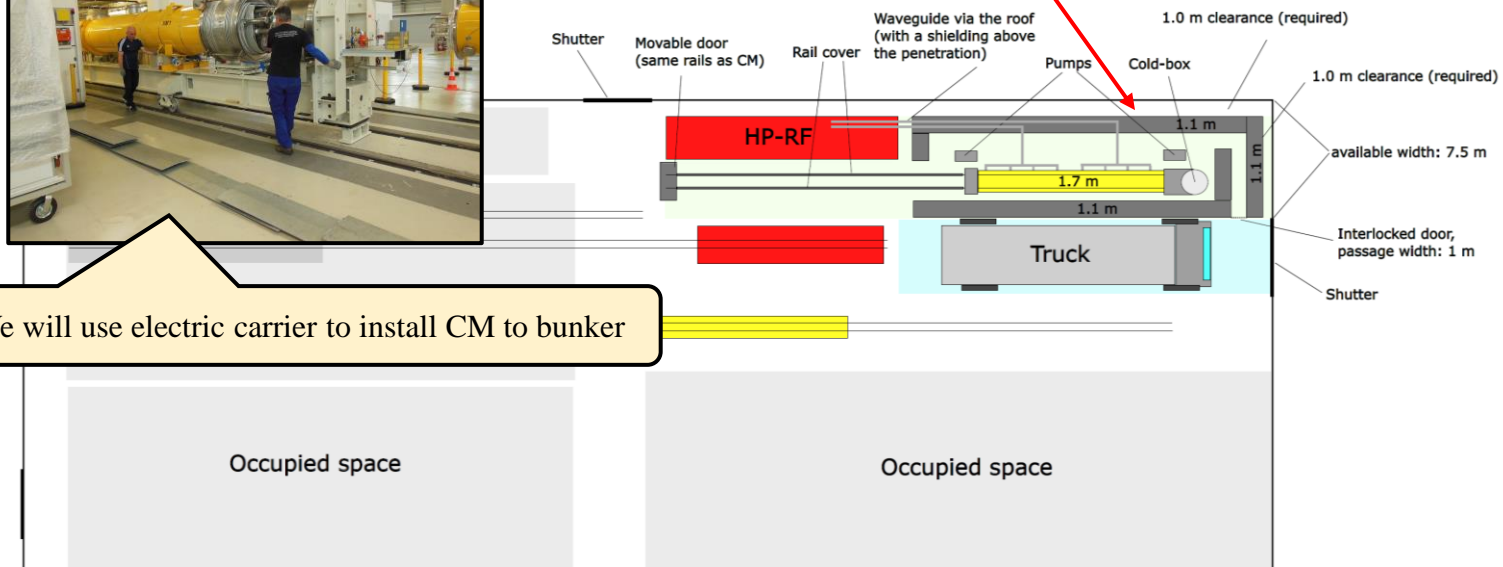


Radiation shield at COI

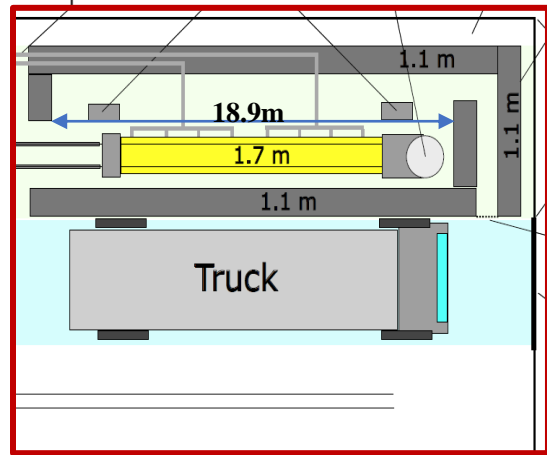
- Estimation on thickness of concrete wall (1.1 m) by radiation group
- Estimation on number of concrete blocks to be produced
- Discussion on radiation leakage from some holes to outside of COI
 - Transfer line of helium
 - RF Waveguide
 - Cables
- CM installation carrier and interlock system are under discussion



We will use electric carrier to install CM to bunker

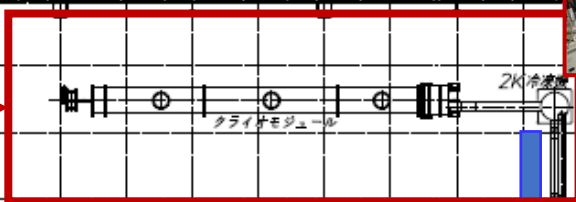


Cryogenic system at COI building

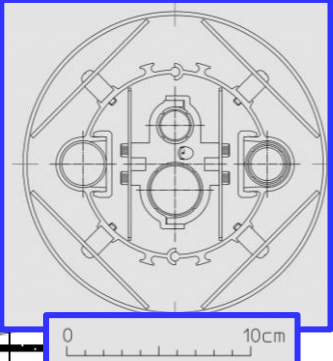
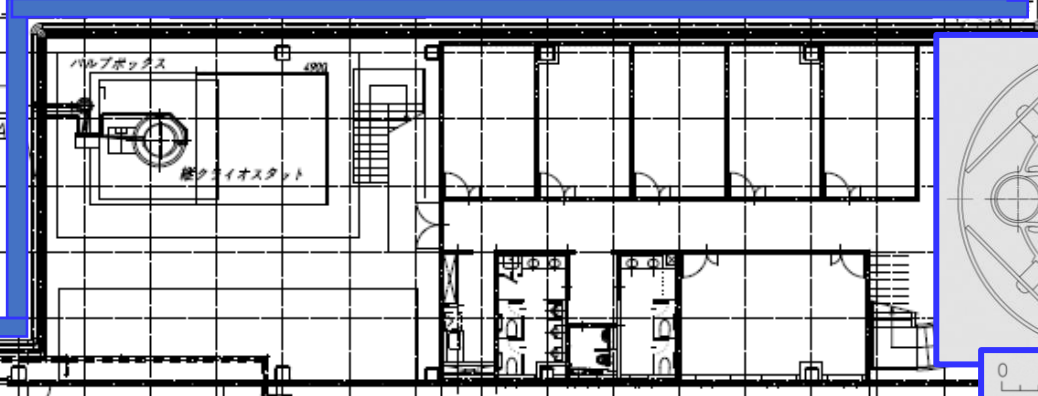


Height of the bunker is 2.5m

④ 2K refrigerator (FY2025-2026)



③ Liquid helium transfer line (~100m) (FY2025-2026)



① Control system for liquefier and 2K refrigerator (FY2024)

② Helium refrigerator in FY2024



⑤ Pumping system for 4K-to-2K (FY2023, 2027)



Negotiation with local government is steadily under progress!

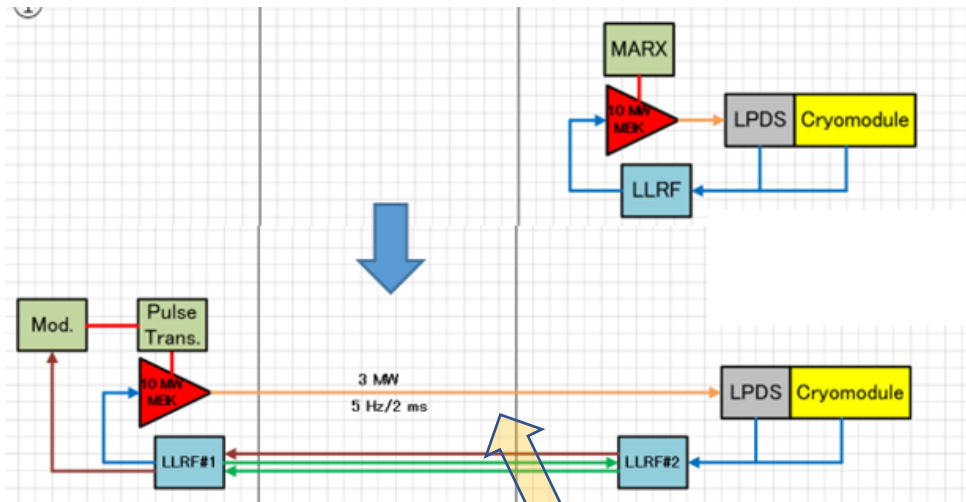
K. Nakanishi

RF system in FY2023

- Cost Reduction Proposal for High Power Test Stands

STF building

COI building



Straight waveguide

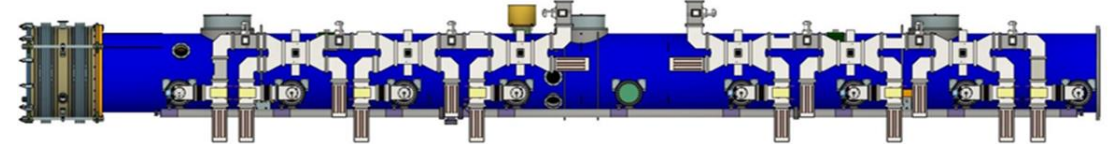
with total distance of **approx. 200 m**

- Power transmission ratio at 200 m waveguide is evaluated as; 72 % (WR650, Aluminum)
→ 3 MW RF output from MBK is enough
- In discussion with KEK Facilities Dept. to reduce its costs by using existing trenches, etc.

- Design of the Local Power Distribution System (LPDS)

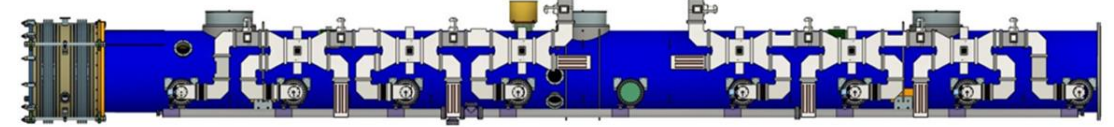
• Model 1

1. ILC: Eight cavity cryomodule (High Field Emission)



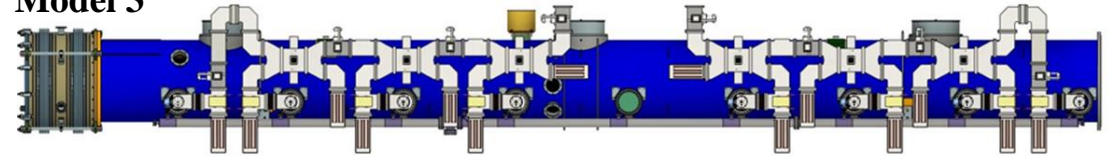
• Model 2

2. High Field Emission (Circulator-less model)



• Model 3

3. Low Field Emission



Three LPDS models are designed.

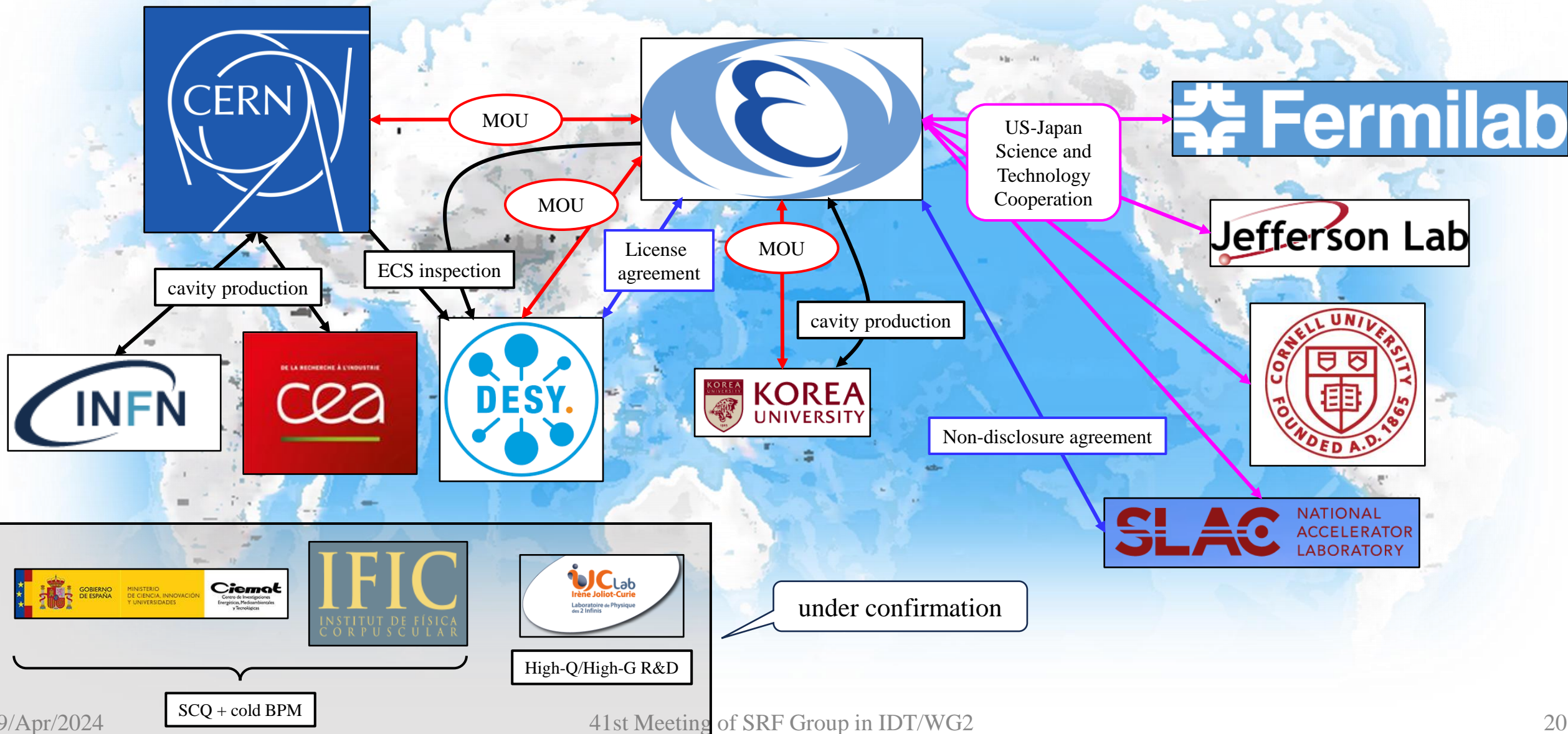
- **Model 1:**

This model satisfies ILC's requirement.

- **Model 2: - Circulator-less model –**
Cost reduction model

- **Model 3: - COI test-stand model –**
Low Field Emission is expected.

Global collaboration on SRF for MEXT-ATD/ITN

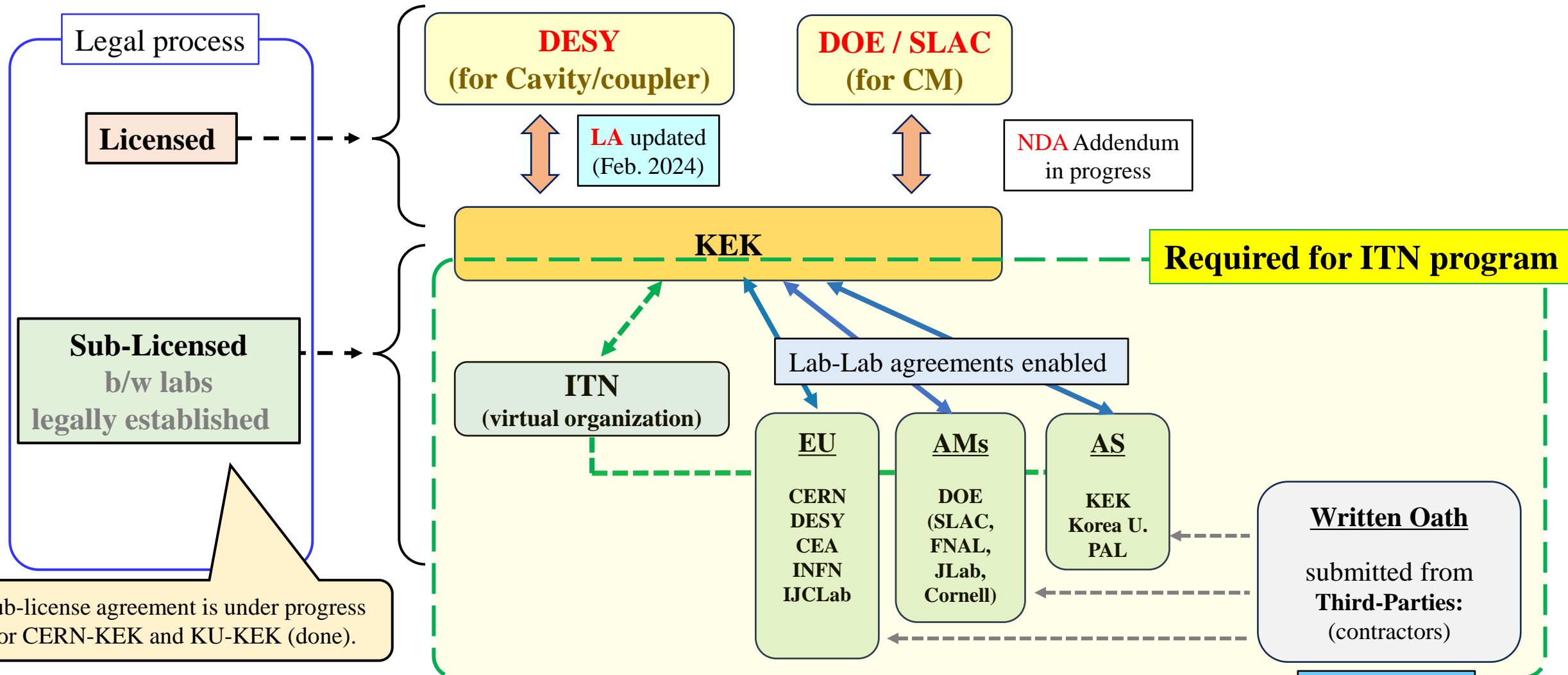


Recent progress for global collaboration in FY2023

- Asia
 - Discussion with **Korea University (KU)** on 1-cell cavity production/material preparation
- EU
 - Discussion with **CERN/CEA/INFN** on 1-cell/9-cell cavity production/material preparation
 - License agreement between **DESY** and **KEK** on E-XFEL cavity/power coupler has contracted
 - One staff from **CEA** has stayed for one month last summer to discuss cavity production in-person
 - Each staffs from **CEA** and **INFN** will stay at **KEK** this summer to discuss in-person
 - Discussion on robotics for auto-cleaning/assembly with **CEA**
- US
 - Not start yet as the ITN, but some items started under the US-Japan science and technology cooperation
 - License agreement on LCLS-II design between **SLAC/DOE** and **KEK** is under progress
 - Study on frequency tuner
 - Rental of a LCLS-II cavity w/ helium tank and tuner from **FNAL**
 - Instruction on LCLS-II tuner system by **FNAL** staffs (they stayed at **KEK** for 1.5 weeks)
 - quasi-LFD demonstration done at room temperature in **KEK/COI**
 - Study on power coupler
 - RF simulation by **FNAL** for new ceramic based on E-XFEL type power coupler
 - Discussion on magnetic shield for cavity and demagnetization for cryo-vessel with **FNAL**
 - Discussion on robotics for auto-cleaning/assembly with **FNAL**

Image of License Agreement (LA) and NDA updates for ITN

(based on the License Agreement between DESY and KEK, and NDA between SLAC and KEK)



Plan in FY2024 (from this April)

Component	Items	Comment
Infrastructure	<ul style="list-style-type: none"> New EBW machine (continued) New cryo-pump for existing EBW to be replaced Production of waveguide system for CM Cooling water system for HLRF Control system for cryogenics Rail system for cavity string 	
High pressure gas safety act	<ul style="list-style-type: none"> Negotiation with KHK/Local government Pressure/Leak-tightness test for cavity Helium tank with TIG welding 	
Cavity	<ul style="list-style-type: none"> Cavity fabrication (satisfying HPGS) (continued) 	
Surface treatment/Vertical test	<ul style="list-style-type: none"> High-Q/High-G R&D (continued since 2017) Establishment of final surface treatment recipe 	
Power coupler	<ul style="list-style-type: none"> Brazing test with new ceramic Design/Production of power couplers 	
Frequency tuner	<ul style="list-style-type: none"> Tuner test incl. piezo at cold temperature Design/Production of prototype tuner system 	waiting for cost estimation
Magnetic shield/Demagnetization	<ul style="list-style-type: none"> Design/Production of prototype magnetic shield Preparation for demagnetization of real cryo-vessel 	waiting for cost estimation
SCQ magnet	<ul style="list-style-type: none"> Design/Production of SCQ-magnet/vertical test cryostat 	waiting for cost estimation
Cryomodule	<ul style="list-style-type: none"> Drawing work (continued) Specification document 	waiting for cost estimation

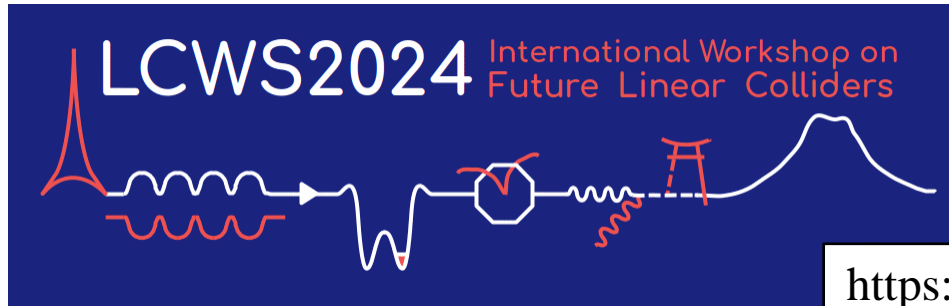
Announcement on LCWS2024 (8~11/Jul/2024)

SRF conveners

Superconducting RF

Enrico Cenni (CEA)
 Yasuchika Yamamoto (KEK)
 Marc Wenskat (DESY)
 Sergey Belomestnykh (FNAL)
 Daniele Sertore (INFN LASA)
 Dimitri Delikaris (CERN)

Enrico, Laura and Daniele will stay at KEK in this summer.



Please make your registration!
 The remote presentation is available.

<https://agenda.linearcollider.org/event/10134/>

	Mon 8	Tue 9	Wed 10	Thu 11	Fri 12
am1	plenary	parallels	parallels	ECR forum	
am2	plenary	parallels	parallels	acc plenary phys.det plenary	satellite meetings
pm1	acc plenary phys.det plenary	industry det.phys parallels	parallels	plenary	
pm2	grand vision for a Linear Collider facility	sustainability (+parallels if needed)	parallels	plenary	
evening	reception / poster		dinner		

Meeting/Conference schedule

Meeting #	Date	Contents
41	9/Apr	Recent progress of SRF 5-year plan and global collaboration for ITN, Preparation for LCWS2024
	8~11/Jul	LCWS2024 @Tokyo, Japan
	12/Jul	2 nd ITN meeting @Tokyo? (successively 1 st meeting @CERN)
	12~15/Nov	TTC Meeting 2024 @Lund, Sweden