



Recent Status of STF-2 Accelerator

Y. Yamamoto (KEK) on behalf of STF Group

STF Group incl. beam operation Gr.

Y. Yamamoto[#], E. Kako, T. Shishido, K. Umemori, H. Sakai, T. Saeki, T. Konomi, T. Matsumoto, S. Michizono, M. Egi, M. Akemoto, D. Arakawa, H. Katagiri, M. Kawamura, F. Qiu, H. Nakajima, T. Miura, H. Hayano, M. Fukuda, Y. Honda, N. Nakamura, T. Miyajima, T. Obina, M. Shimada, A. Aryshev, M. Kuriki, S. Matsuba, S. Notsu, K. Sakaue, H. Nakai, Y. Kojima, K. Hara, T. Honma, K. Nakanishi, H. Shimizu, Y. Kondou, A. Yamamoto, N. Kimura, S. Araki, Y. Morikawa, T. Sanami, T. Oyama, S. Takahara

KEK, Hiroshima Univ., Univ. of Tokyo



東京大学
THE UNIVERSITY OF TOKYO



LCWS2019 @Sendai



Outline

- ◆ **STF and STF-2 project**
- ◆ **Beam commissioning and change of radiation level**
- ◆ **Recent status of CM2a/beamline in STF-2**
- ◆ **Static heat load**
- ◆ **Future prospect**
- ◆ **Summary**

Outline

- ◆ **STF and STF-2 project**
- ◆ **Beam commissioning and change of radiation level**
- ◆ **Recent status of CM2a/beamline in STF-2**
- ◆ **Static heat load**
- ◆ **Future prospect**
- ◆ **Summary**

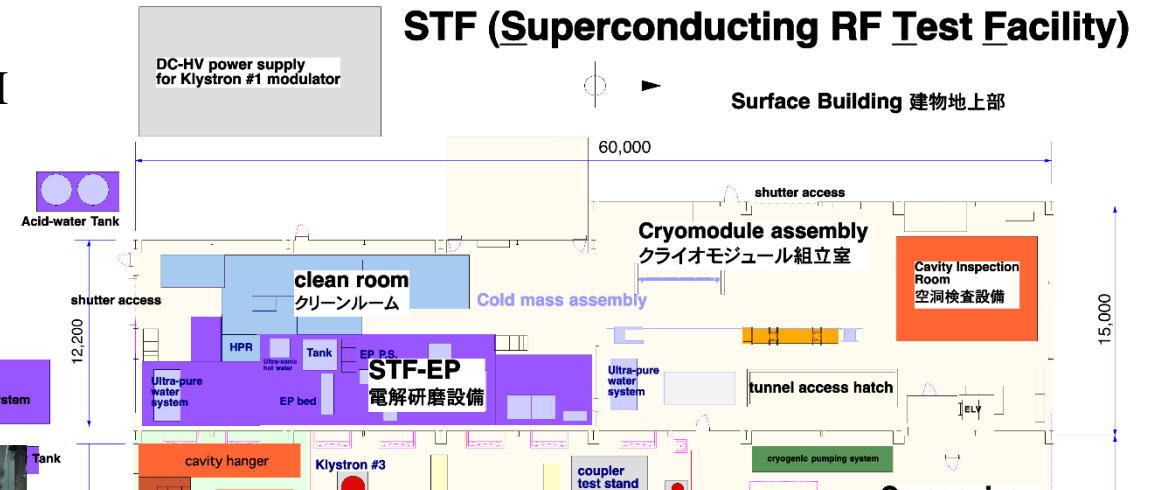
Superconducting RF Test Facility (STF) in KEK



STF-1 (4 cavities) in 2008

- ◆ Started from 2006
- ◆ Available for half size of CM
- ◆ Multi-beam klystron
- ◆ Cryogenics system
- ◆ EP system
- ◆ VT system

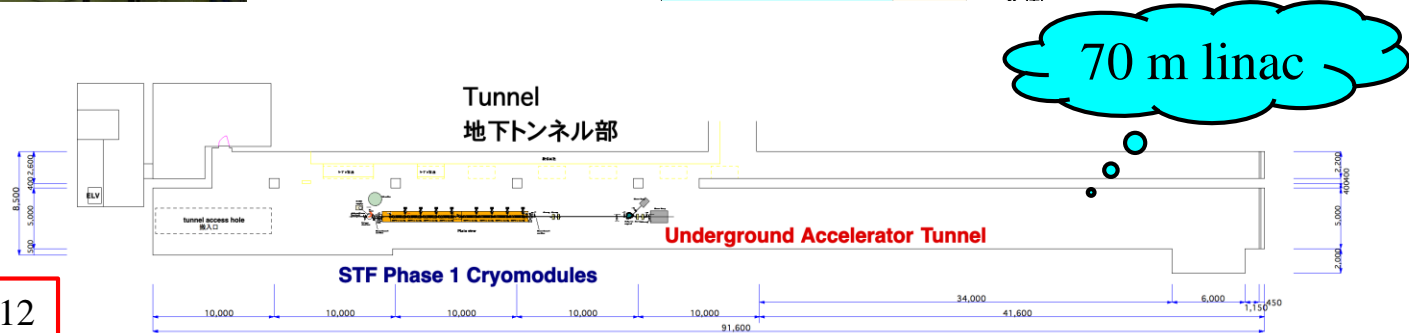
S1-Global (4+4 cavities) in 2010



Purpose: Technology demonstration of superconducting cavity/cryomodule for ILC



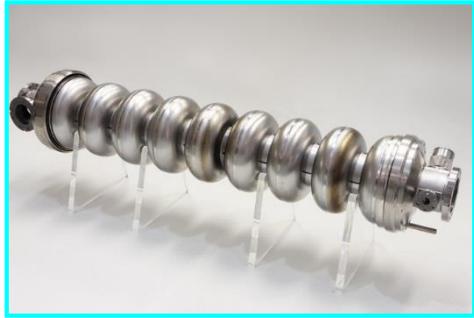
Quantum Beam (2 cavities) in 2012
Capture CM in STF-2 accelerator



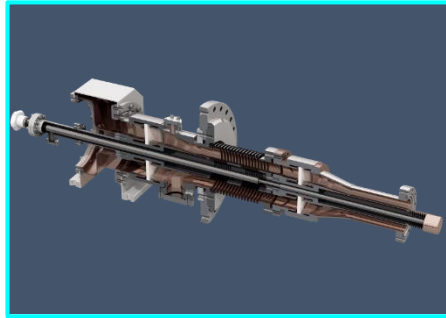
70 m linac

STF-2 project and STF-2 accelerator

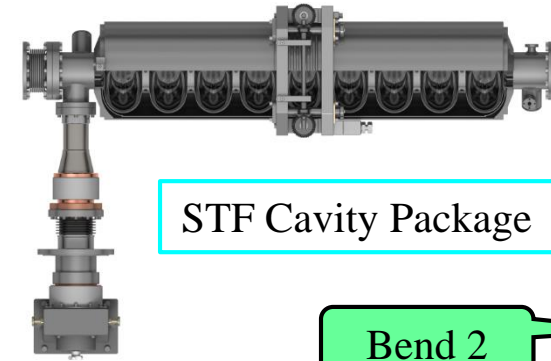
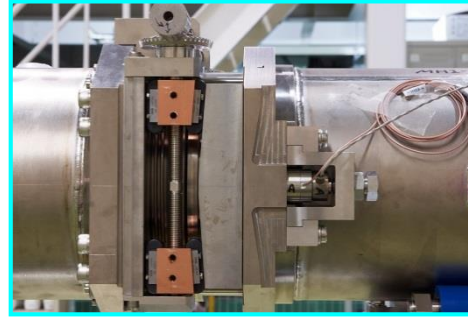
STF Cavity



STF-II power coupler



Slide-jack tuner



STF Cavity Package

Bend 2

Dump 2

Purpose: Beam operation fulfilling ILC specification

Cooldown	Date	Content
2	Oct/2015 ~ Dec/2015	Single cavity operation, performance check
3	Sep/2016 ~ Nov/2016	Eight cavities operation, LFD and heat load meas., LLRF study
4	Jan/2019 ~ Mar/2019	Beam commissioning, Machine study

Operational condition

- ◆ RF: 1.65 msec/5 Hz (ILC/TDR)
- ◆ Temperature: 2K in liq. Helium
- ◆ As max. E_{acc} as possible for STF-2 CM

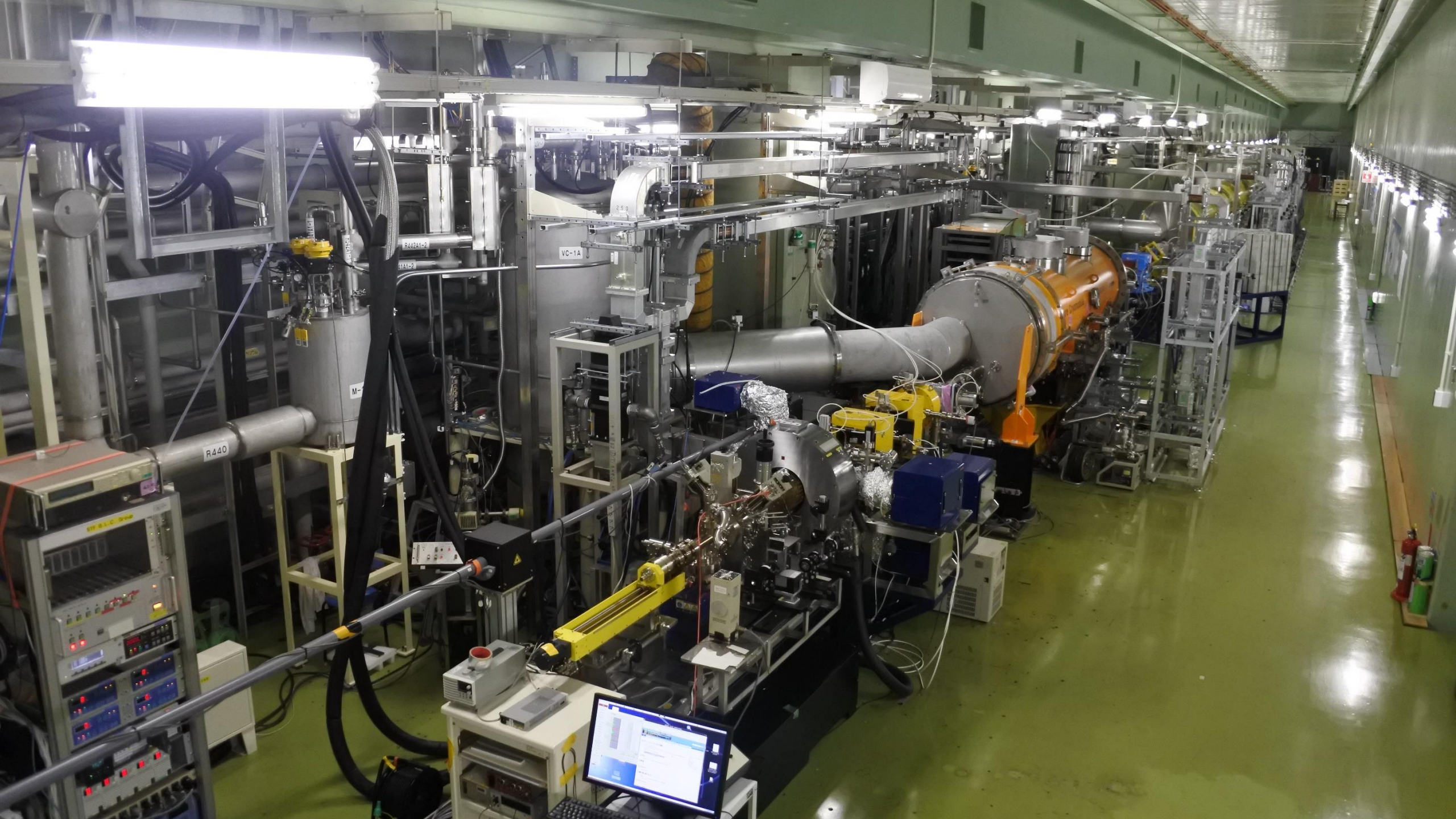
Bend 1

Dump 1

STF-2 Cryomodules
12 cavities
(Constructed in F.Y.2014)

Capture Cryomodule
2 cavities
(Constructed in F.Y.2012)

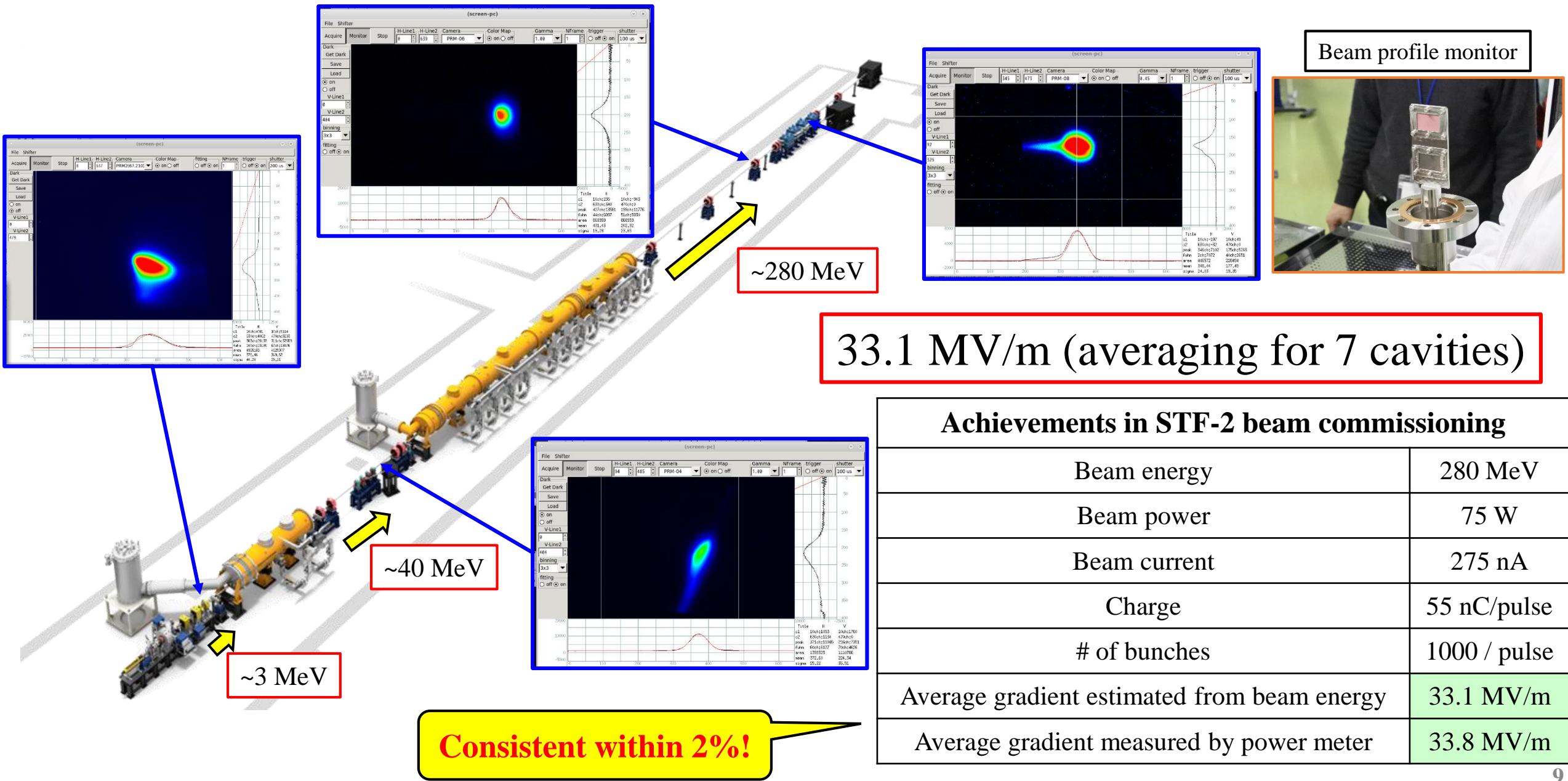
RF Gun incl.
photo-cathode



Outline

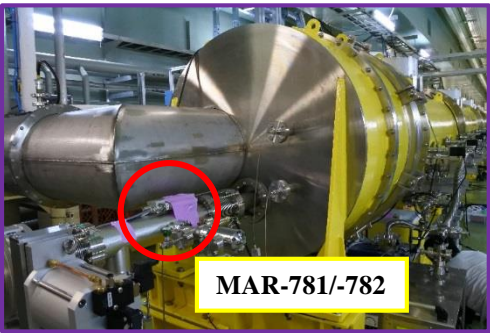
- ◆ STF and STF-2 project
- ◆ **Beam commissioning and change of radiation level**
- ◆ Recent status of CM2a/beamline in STF-2
- ◆ Static heat load
- ◆ Future prospect
- ◆ Summary

Accelerating gradient estimated from beam energy

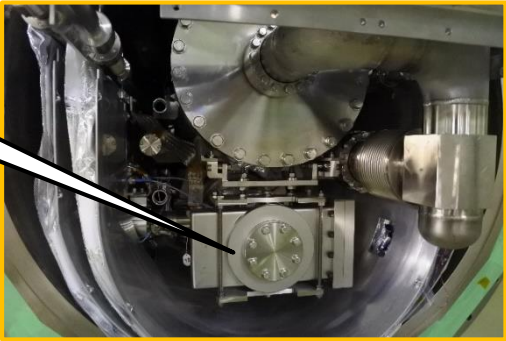


Change of radiation level

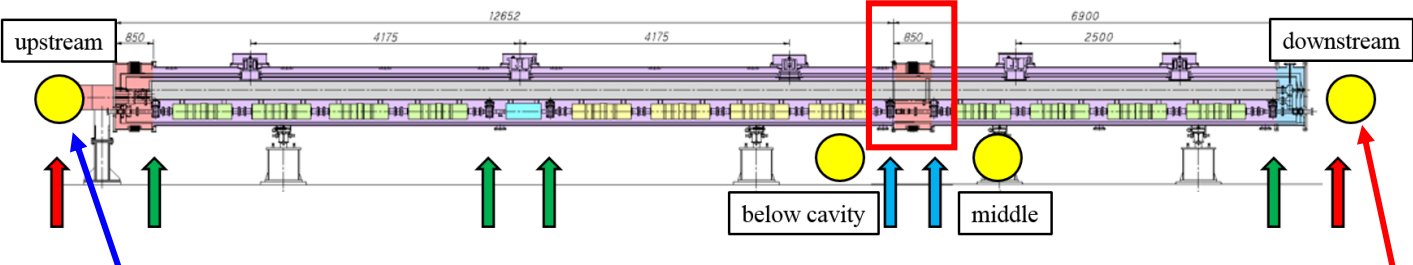
GV opened in each step



Gate Valve (GV)
for cavity string

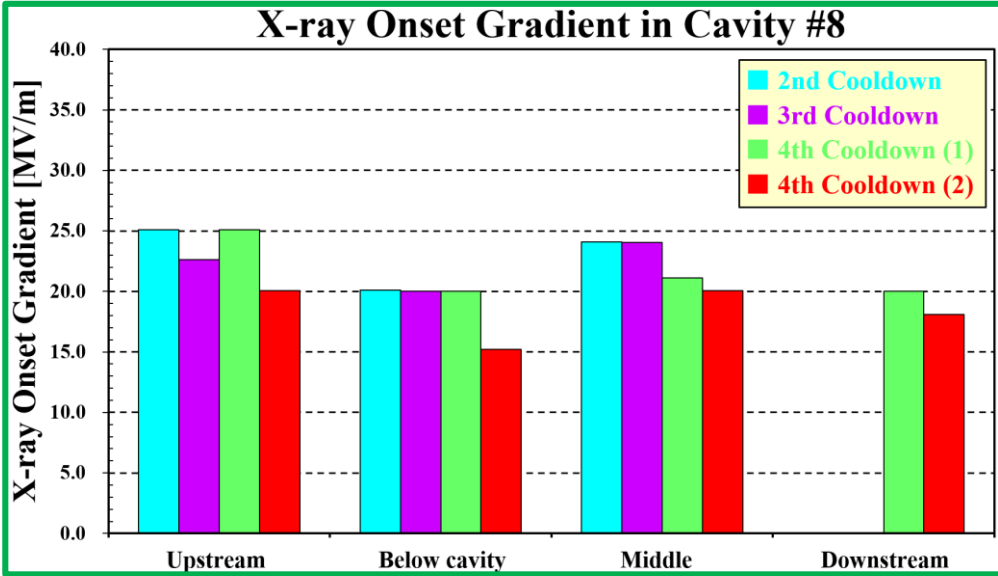
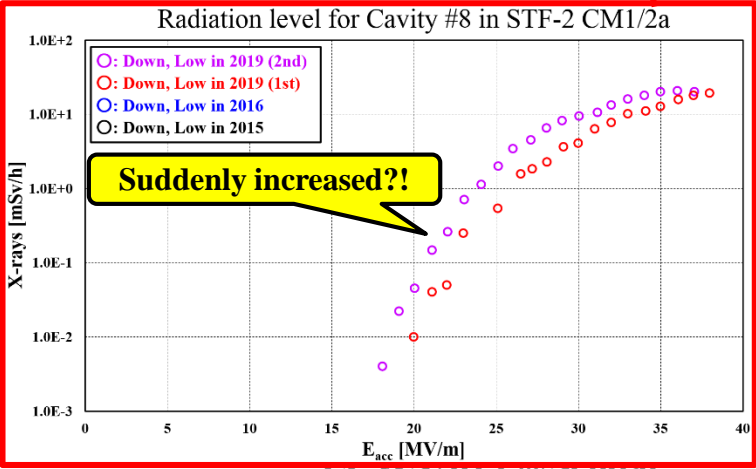
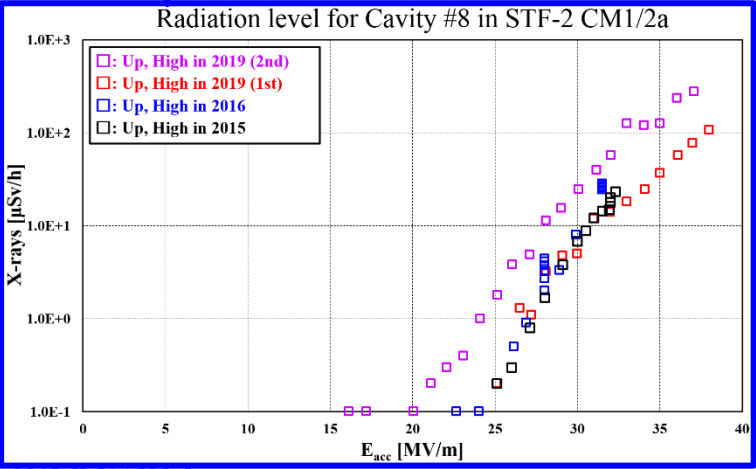


Beampipe reconnected



Radiation history of Cavity#8

History of radiation level for Cavity #8		
	Upstream	Downstream
2014	→ opened	
2015		Not observed
2016	Not changed	Not observed
2018	→ opened	
2019, 1 st	Not changed	Observed suddenly
2019	→ opened	
2019, 2 nd	Increased	Increased

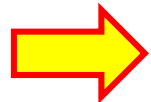


Outline

- ◆ STF and STF-2 project
- ◆ Beam commissioning and change of radiation level
- ◆ **Recent status of CM2a/beamline in STF-2**
- ◆ Static heat load
- ◆ Future prospect
- ◆ Summary

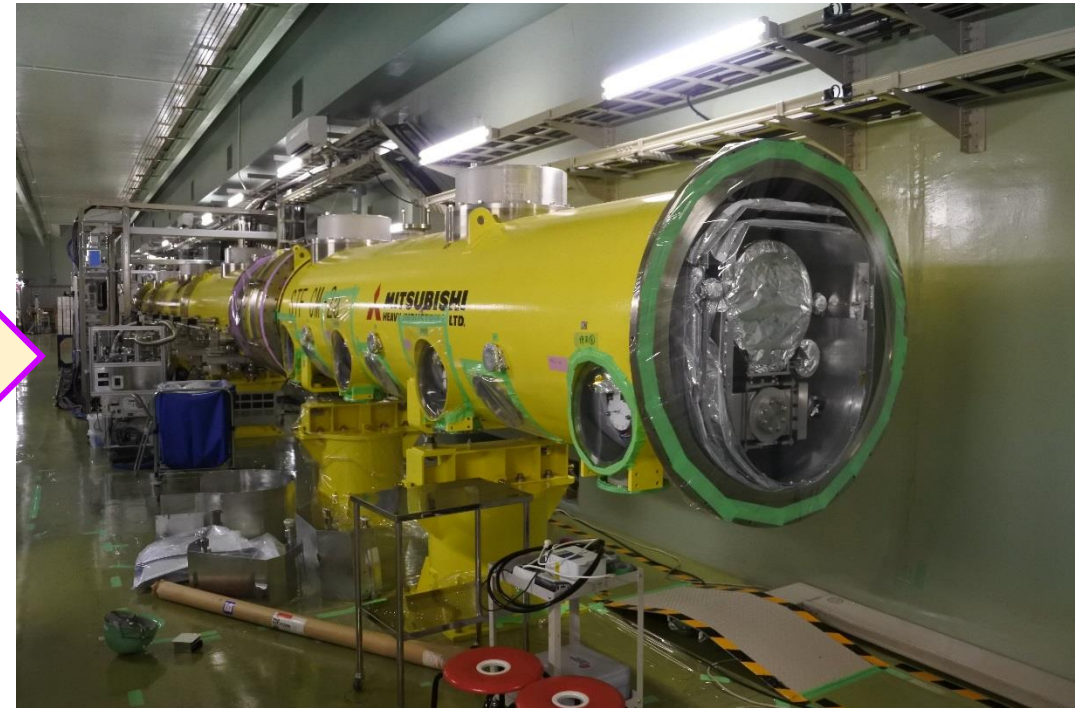
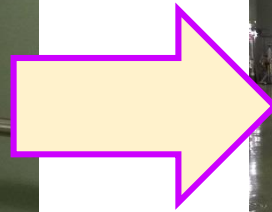
Brief history of STF-2 project

Date	Content
2010	Fabrication of cavities / power couplers
2011 ~ 2013	V.T. for 12 cavities / RF conditioning for 12 power couplers
Jun/2013	Cleaning up STF tunnel
Jul/2013 ~ Apr/2014	Cavity string assembly (three times)
Oct/2013 ~ Jun/2014	Module assembly (CM1/CM2a)
Jul/2014	Complete certification for High pressure Gas Code
Oct/2014 ~ Dec/2014	1 st cool-down; low power test
Apr/2015 ~ Jul/2015	5MW Klystron / Single waveguide system completed
Jul/2015 ~ Sep/2015	Power coupler conditioning at room temperature
Oct/2015 ~ Dec/2015	2 nd cool-down; high power test (single cavity operation, performance check)
Jan/2016 ~ Jul/2016	Multi-beam Klystron & Waveguide system completed (selection of 8 cavities)
Jul/2016 ~ Sep/2016	Power coupler conditioning at room temperature
Sep/2016 ~ Nov/2016	3 rd cool-down; LFD, Q ₀ measurement, 8 Cavities Operation & LLRF study
Aug/2018 ~ Dec/2018	Beamline construction
Jan/2019 ~ Mar/2019	4 th cool-down; Beam commissioning, Maximizing beam energy, Machine study
Aug/2019~	CM2a disassembly/Beamline reconstruction
Mar/2020	CM2a reconstruction (incl. one cavity exchanged)/reinstallation into tunnel



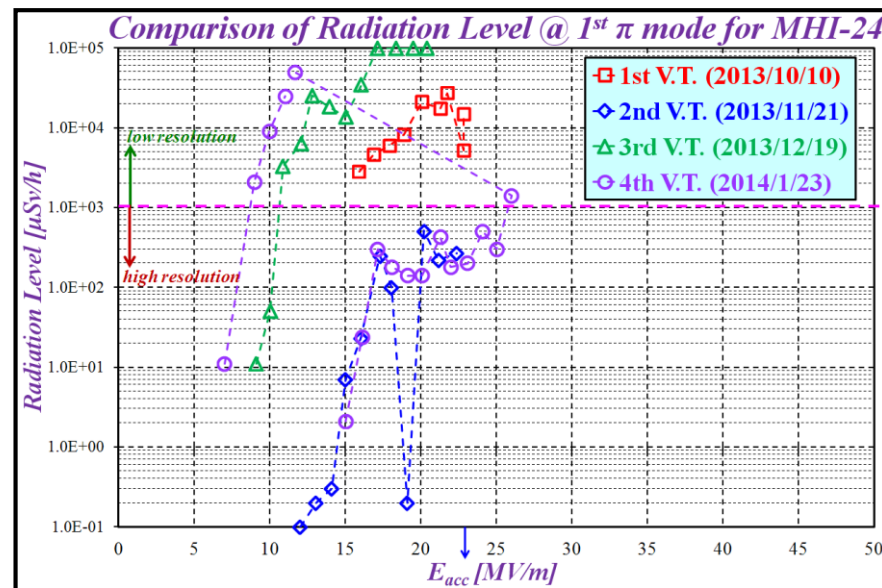
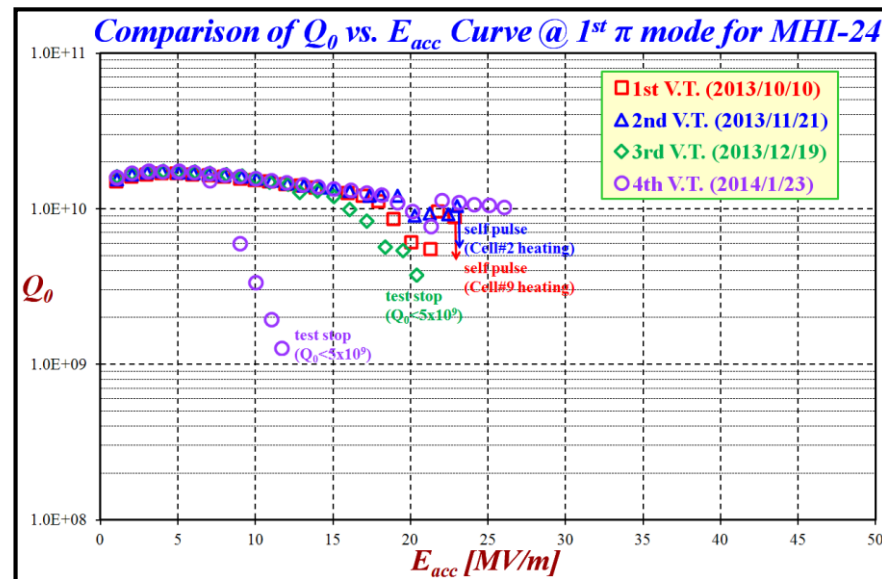
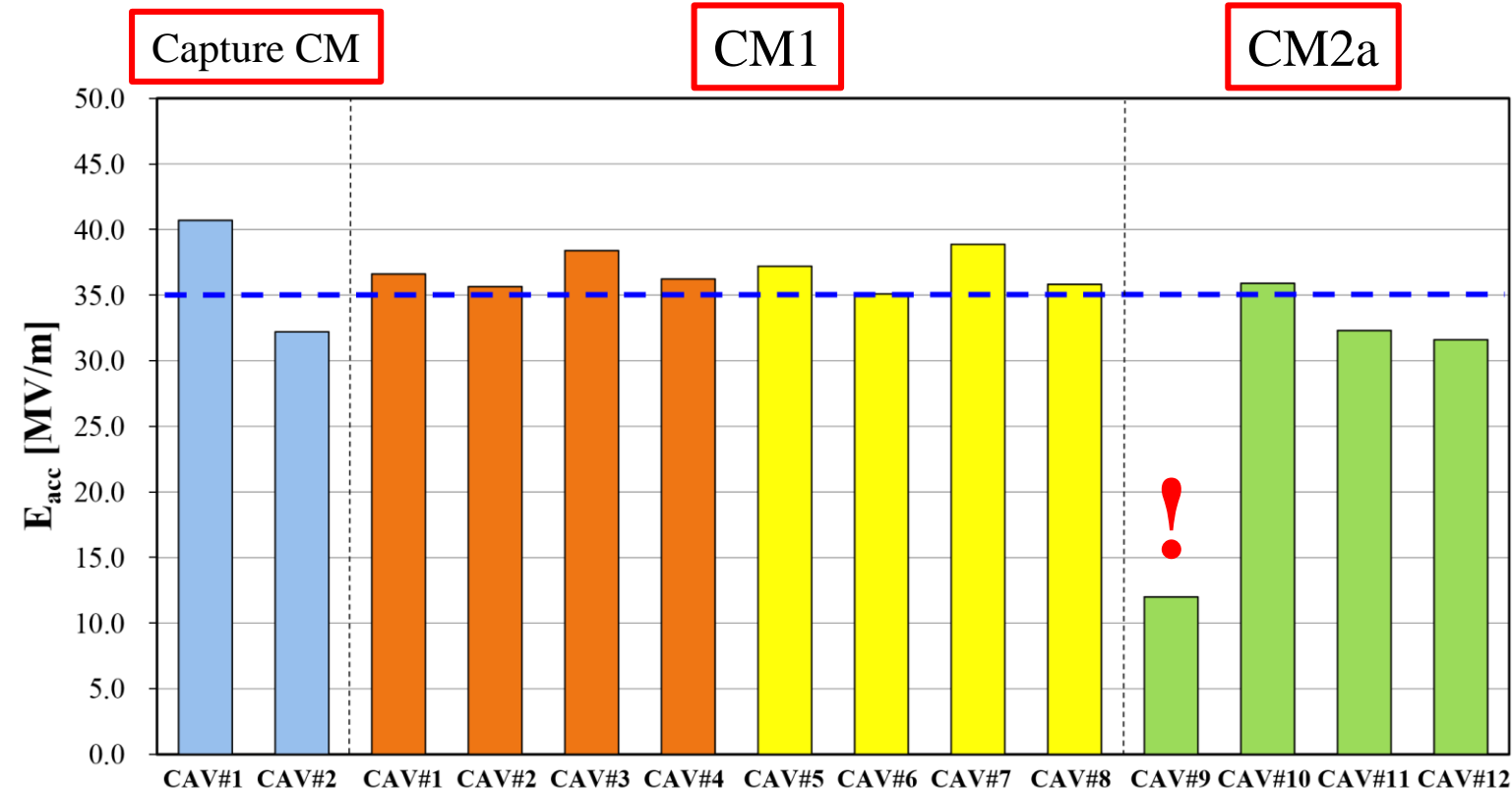
Cavity/Beamline exchange work (on the way...)

- ◆ Cavity #9 should be exchanged due to **too bad** performance
 - ◆ Ready for transportation of CM2a to ground floor
- ◆ All beampipes should be exchanged due to risk of vacuum leakage
 - ◆ Almost completed ☺



Cavity performance in last VT

VT performance of Cavity #9

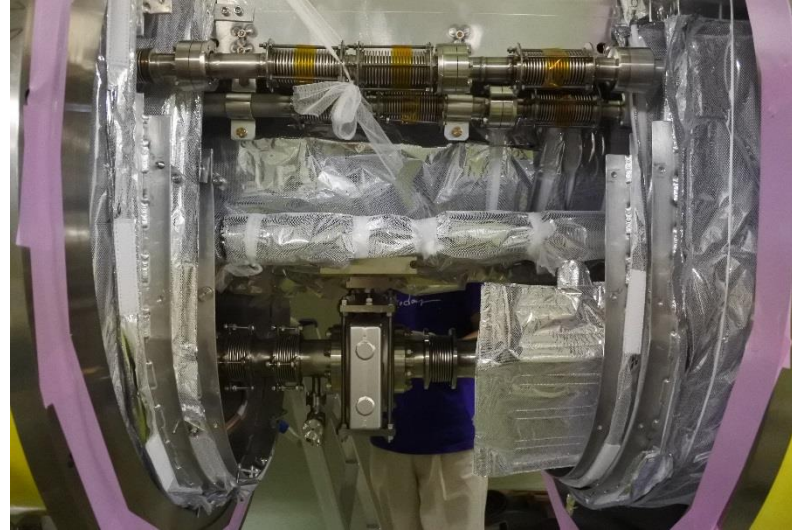
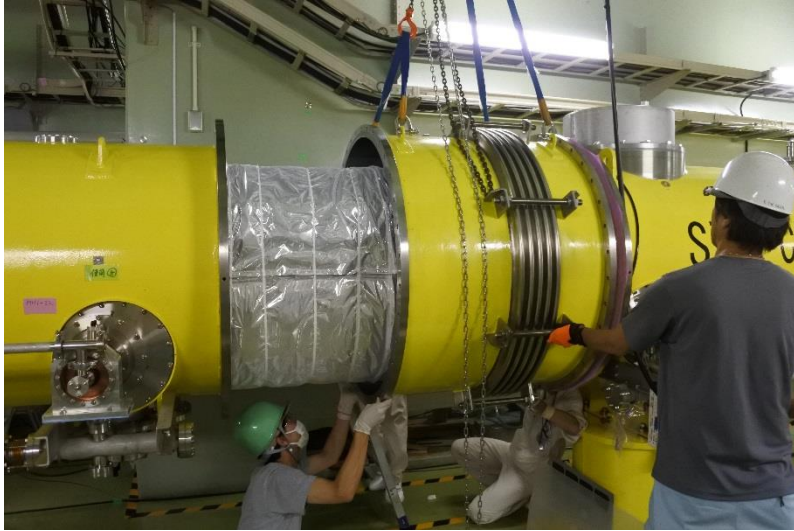


Only one goat in many sheep

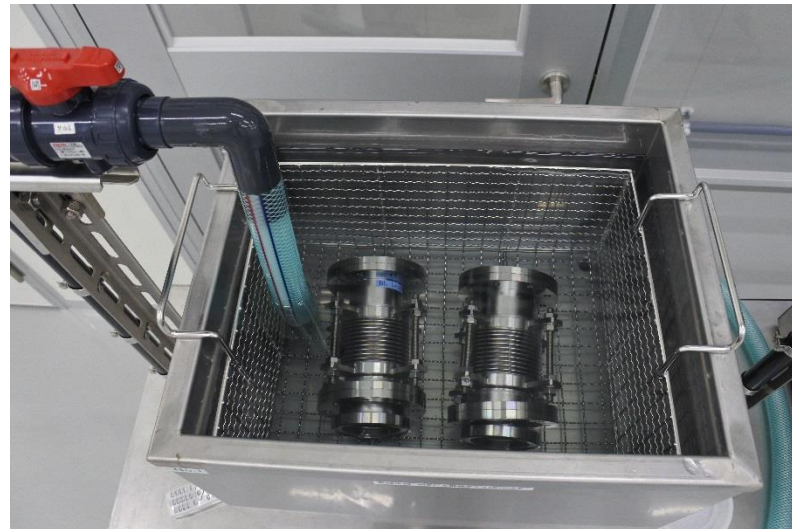
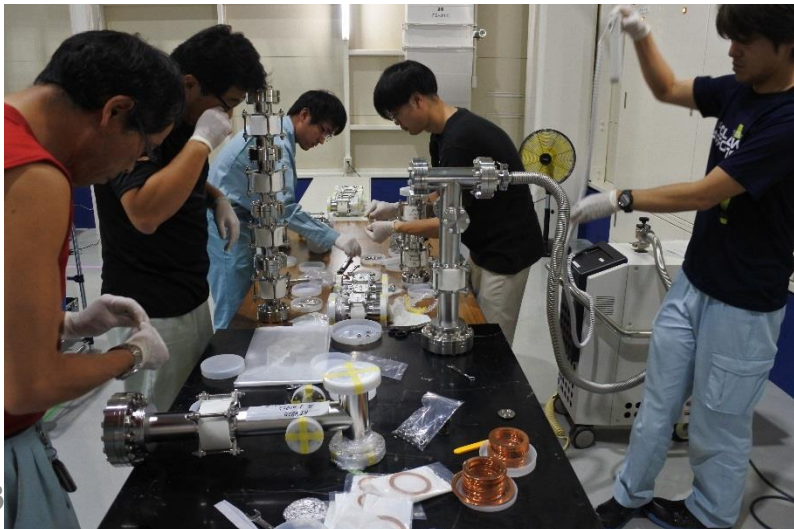


Work progress after summer in 2019

CM2a disassembly



Beampipe exchanged/Beamline reconstructed



Outline

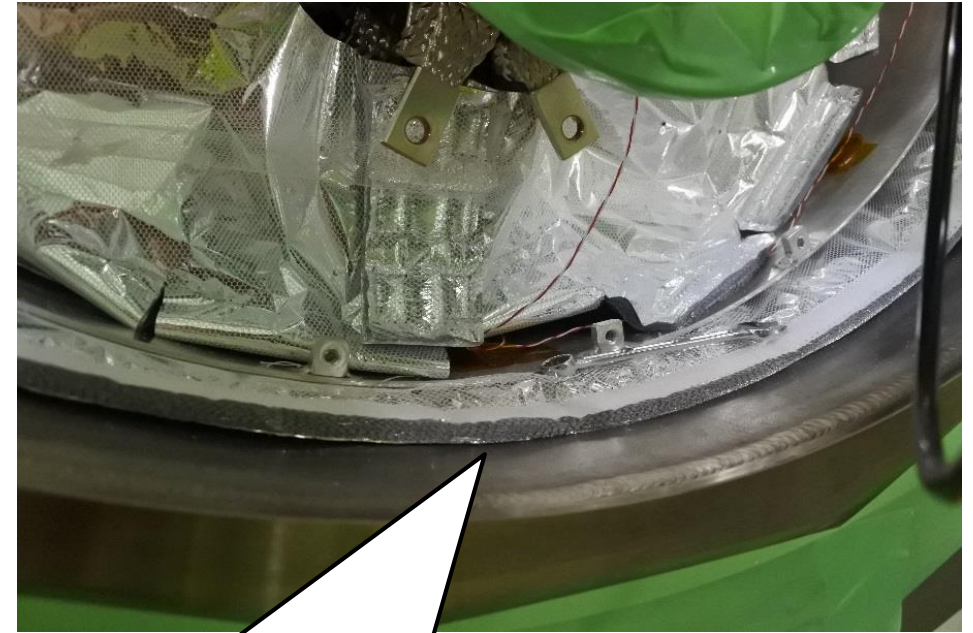
- ◆ **STF and STF-2 project**
- ◆ **Beam commissioning and change of radiation level**
- ◆ **Recent status of CM2a/beamline in STF-2**
- ◆ **Static heat load**
- ◆ **Future prospect**
- ◆ **Summary**

Cause for enormous static heat load?

Static heat load of CM1/2a was **23 W**! (it's enormous compared to E-XFEL CM)

	STF-2 CM	E-XFEL CM
# of support post	5	3
# of power coupler	12	8
# of Q-magnet incl. current leads	1	1
Static heat load [W]	23	5.6*

There may not be only one cause of this enormous heat load.



“Superinsulation” contacted with cryovessel!
And, also with thermal shield of 80K/5K!!

* B. Petersen *et al.*, “Serial testing of XFEL cryomodules”, CEC/ICMC2017, Madison, WI, U.S.

Outline

- ◆ **STF and STF-2 project**
- ◆ **Beam commissioning and change of radiation level**
- ◆ **Recent status of CM2a/beamline in STF-2**
- ◆ **Static heat load**
- ◆ **Future prospect**
- ◆ **Summary**

Future prospect

- ❑ Disassembly work of CM2a will be completed within 2019
- ❑ Reassembly work will start from February in 2020
 - ❑ This schedule depends on delivery date of MHI-31 after welding helium tank
 - ❑ MHI-31 will be exchanged as “New” Cavity #9
- ❑ Reassembly work will be finished until end of March (hopefully)
- ❑ 5th cooldown test may start from mid. of May
- ❑ Beam commissioning may start from September

We will complete disassembly/reassembly work of CM2a by ourselves!

Outline

- ◆ **STF and STF-2 project**
- ◆ **Beam commissioning and change of radiation level**
- ◆ **Recent status of CM2a/beamline in STF-2**
- ◆ **Static heat load**
- ◆ **Future prospect**
- ◆ **Summary**

Summary

- ◆ **Beam commissioning of STF-2 accelerator was successfully done**
- ◆ **Radiation level became higher after opening GVs**
- ◆ **Disassembly work of CM2a started from Aug/2019**
- ◆ **Exchange of Cavity#9 will be done in Feb/2020**
- ◆ **Cause for enormous static heat load can be superinsulation contacted with cryovessel**
- ◆ **Beamline reconstruction work was done**

Thank you very much for your attention!



Acknowledgement: K. Harada, M. Tawada, M. Masuzawa, S. Nagahashi, M. Asano, S. Imada, H. Yamada, T. Tainaka, S. Ishihara, K. Ishimoto, N. Numata, K. Tsutsumi, T. Okada, M. Iitake, A. Hayakawa, R. Terajima