



Recent Status of STF-2 Accelerator

Y. Yamamoto (KEK) on behalf of STF Group

STF Group incl. beam operation Gr.

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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**

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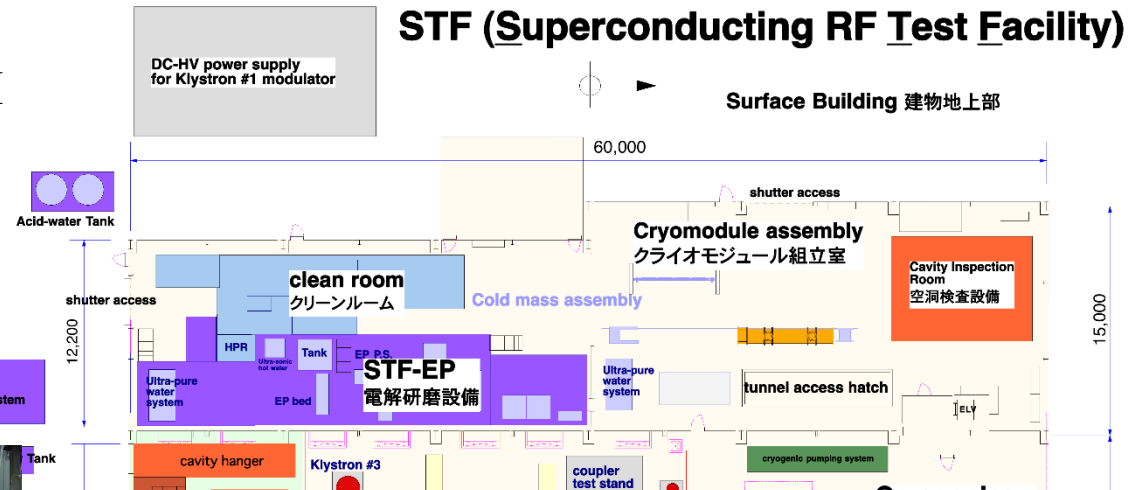
Superconducting RF Test Facility (STF) in KEK



STF-1 (4 cavities) in 2008

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

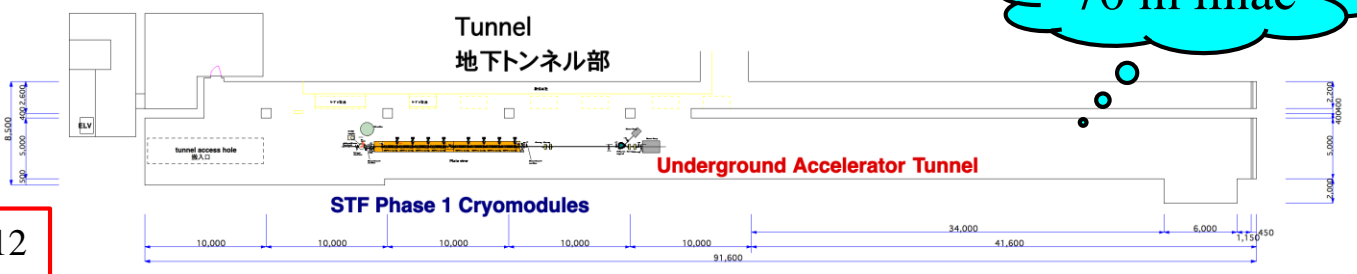
S1-Global (4+4 cavities) in 2010



Purpose: Technology demonstration of superconducting cavity/cryomodule for ILC

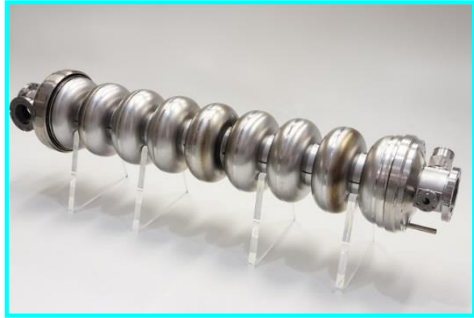


Quantum Beam (2 cavities) in 2012
Capture CM in STF-2 accelerator

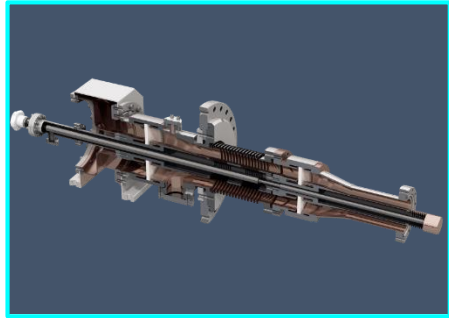


STF-2 project and STF-2 accelerator

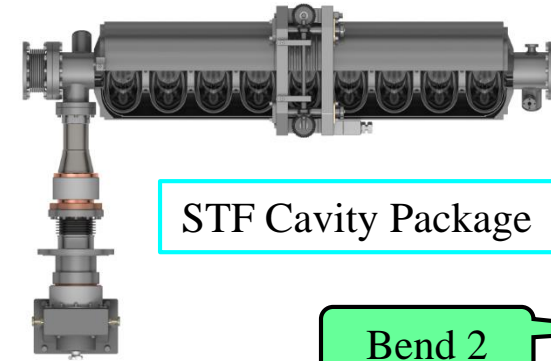
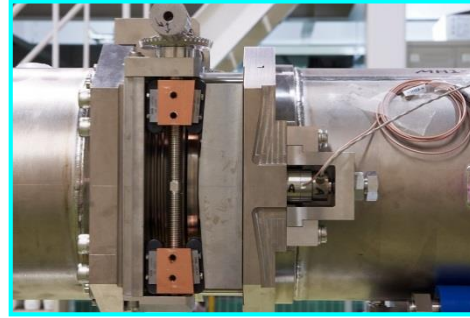
STF Cavity



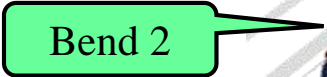
STF-II power coupler



Slide-jack tuner



STF Cavity Package



Bend 2



Dump 2

Cooldown	Date	Content
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Purpose: Beam operation fulfilling ILC specification

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

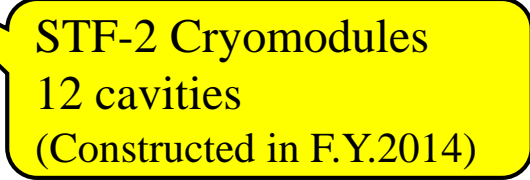
- ◆ RF: 1.65 msec/5 Hz (ILC/TDR)
- ◆ Temperature: 2K in liq. Helium
- ◆ As max. E_{acc} as possible for STF-2 CM



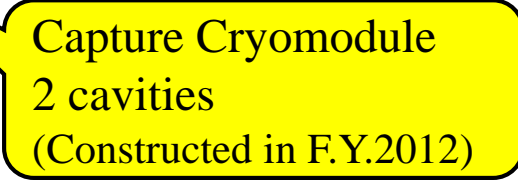
Bend 1



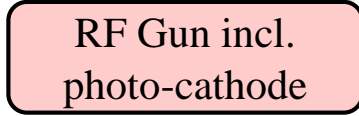
Dump 1



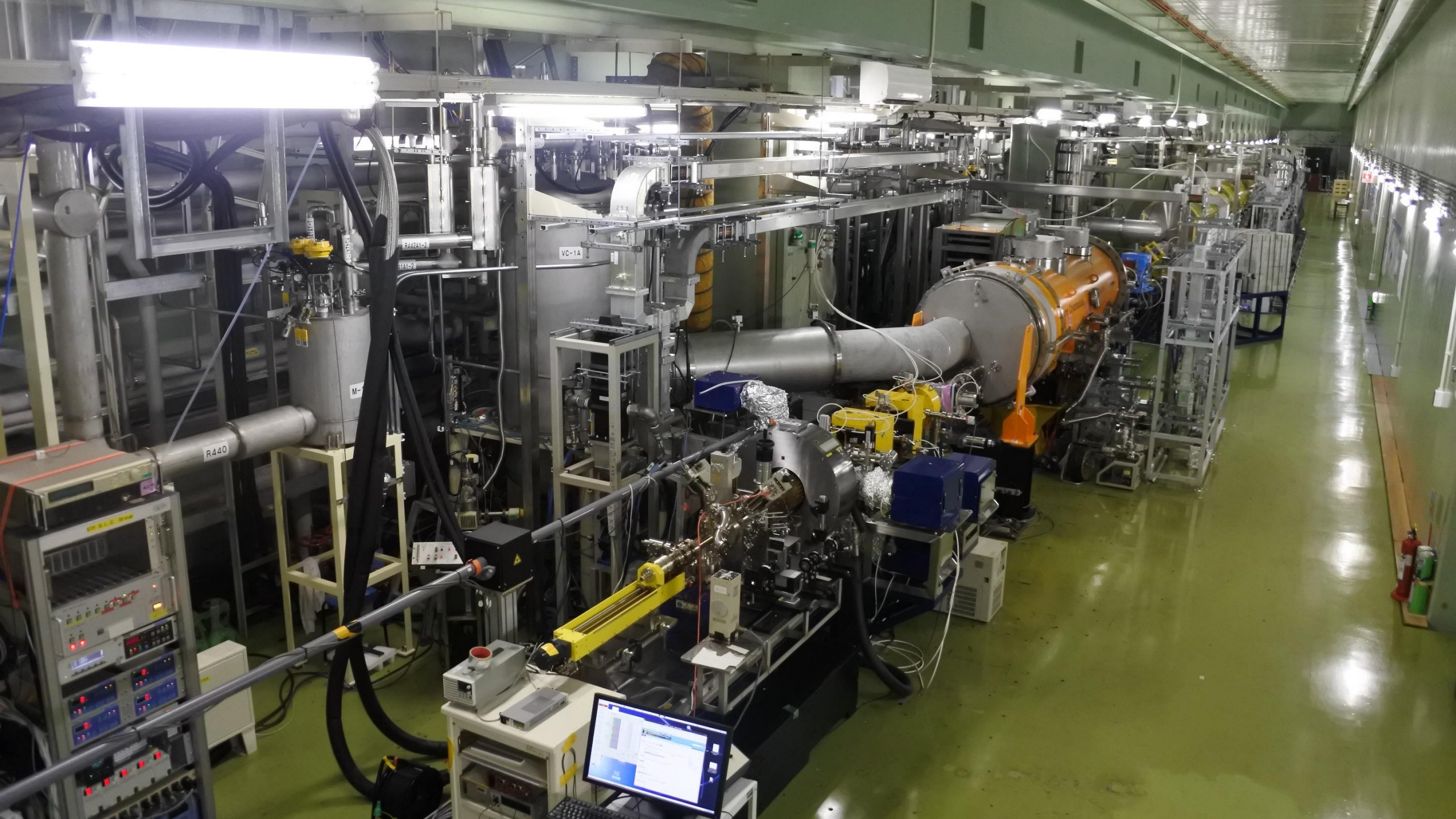
STF-2 Cryomodules
12 cavities
(Constructed in F.Y.2014)



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



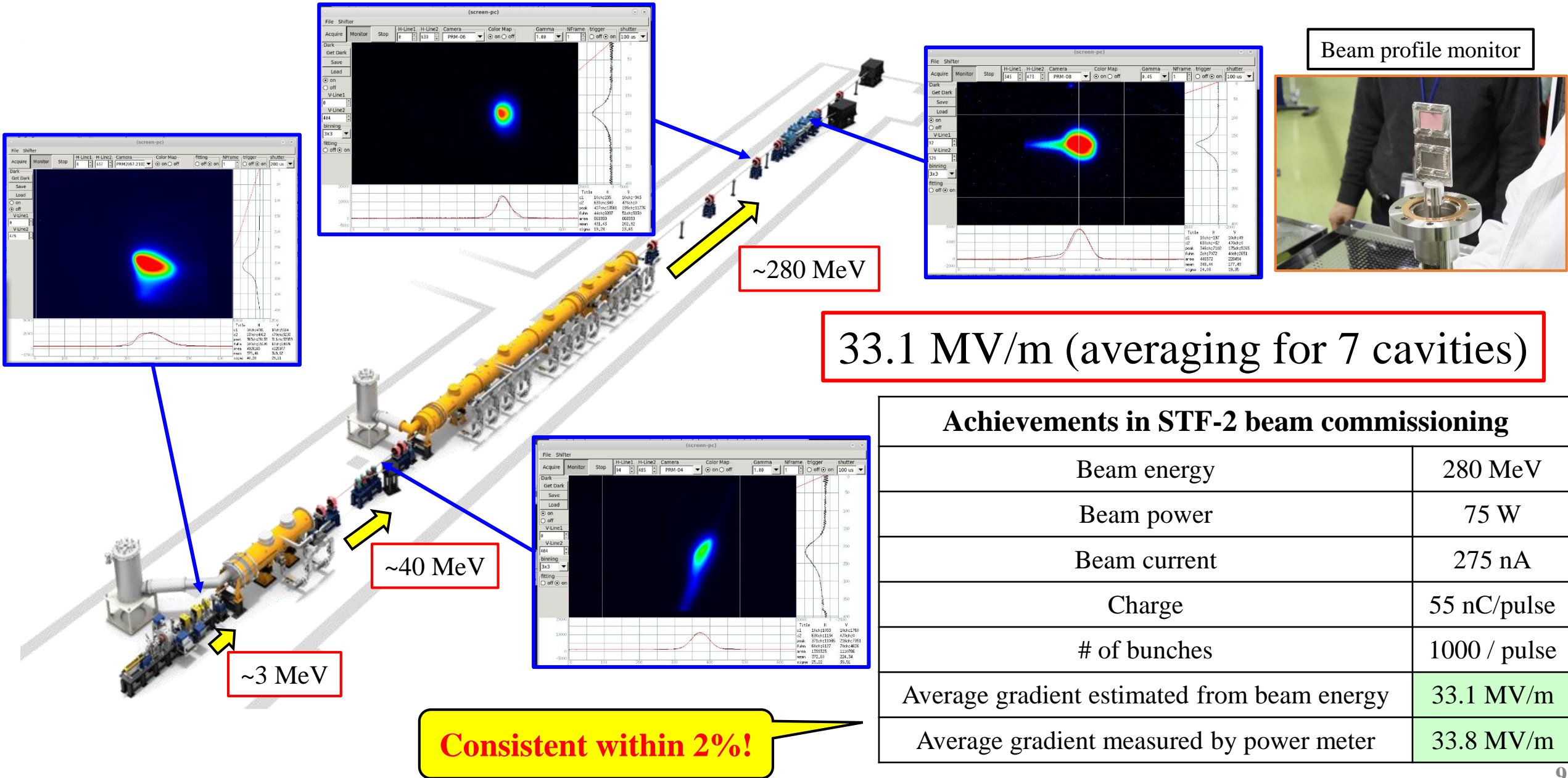
RF Gun incl.
photo-cathode



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Accelerating gradient estimated from beam energy



Beam profile monitor

~280 MeV

33.1 MV/m (averaging for 7 cavities)

~40 MeV

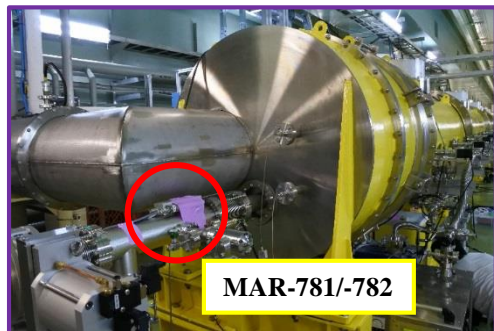
~3 MeV

Consistent within 2%!

Achievements in STF-2 beam commissioning	
Beam energy	280 MeV
Beam power	75 W
Beam current	275 nA
Charge	55 nC/pulse
# of bunches	1000 / pulse
Average gradient estimated from beam energy	33.1 MV/m
Average gradient measured by power meter	33.8 MV/m

Change of radiation level

GV opened in each step

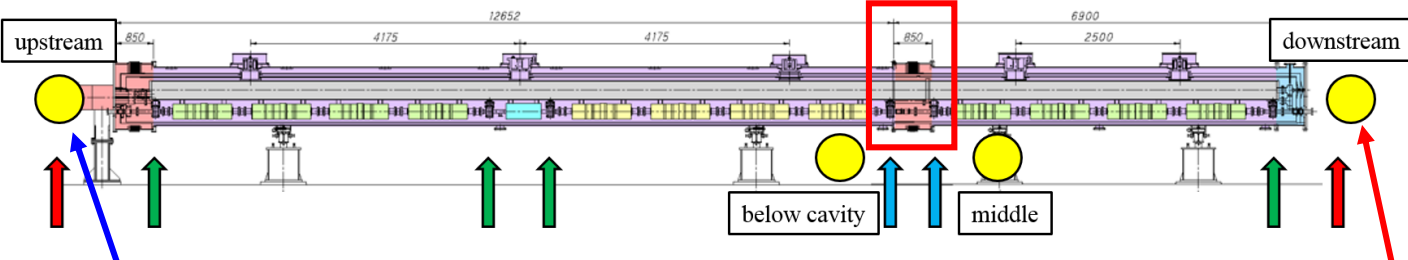


Gate Valve (GV) for cavity string

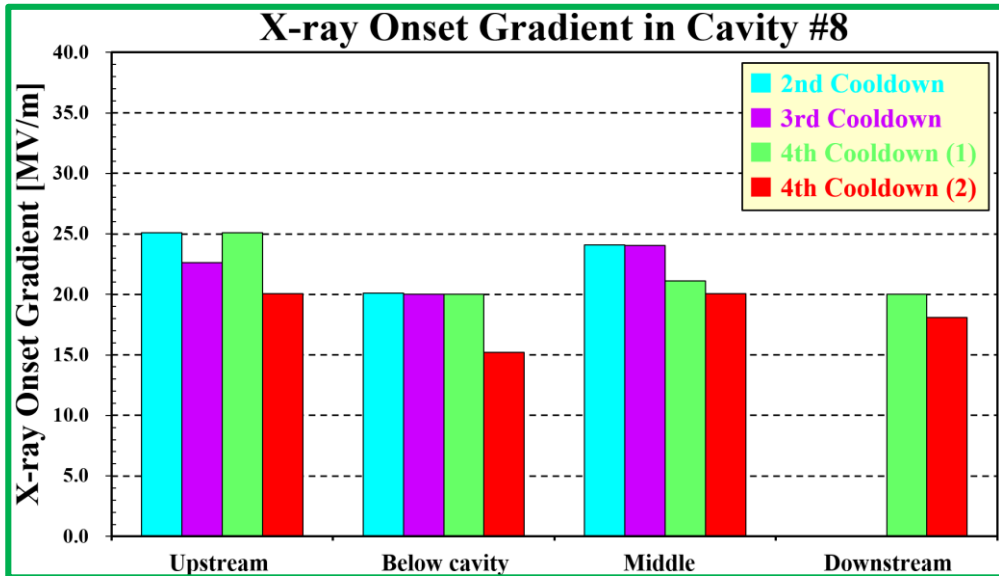
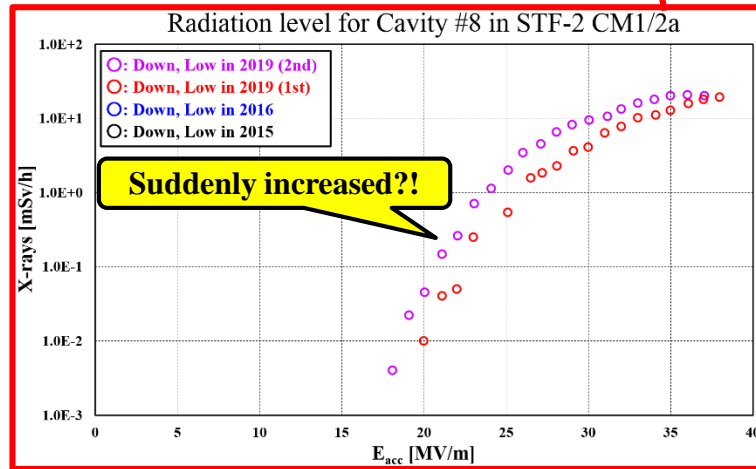
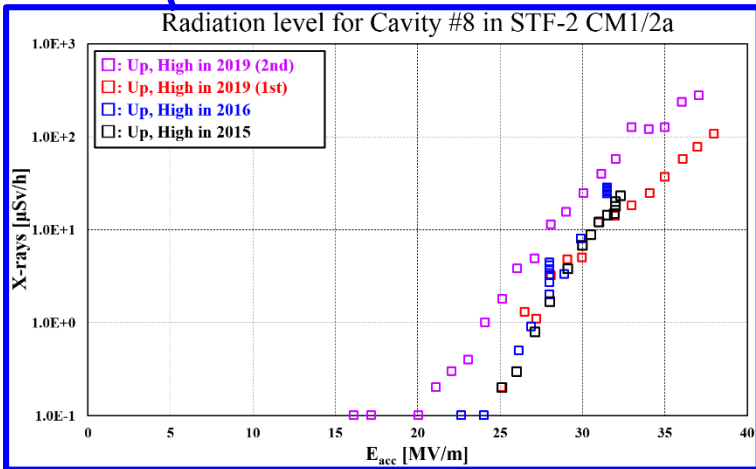


Beampipe reconnected

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



Radiation history of Cavity#8

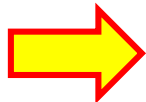


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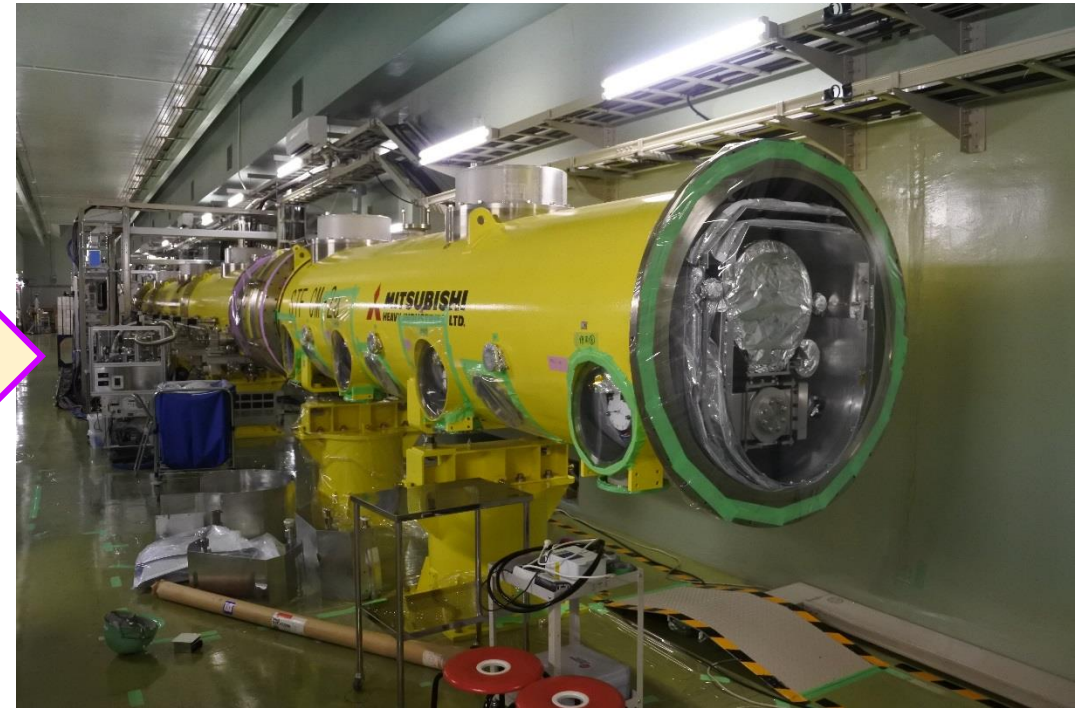
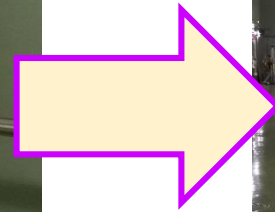
Brief history of STF-2 project

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



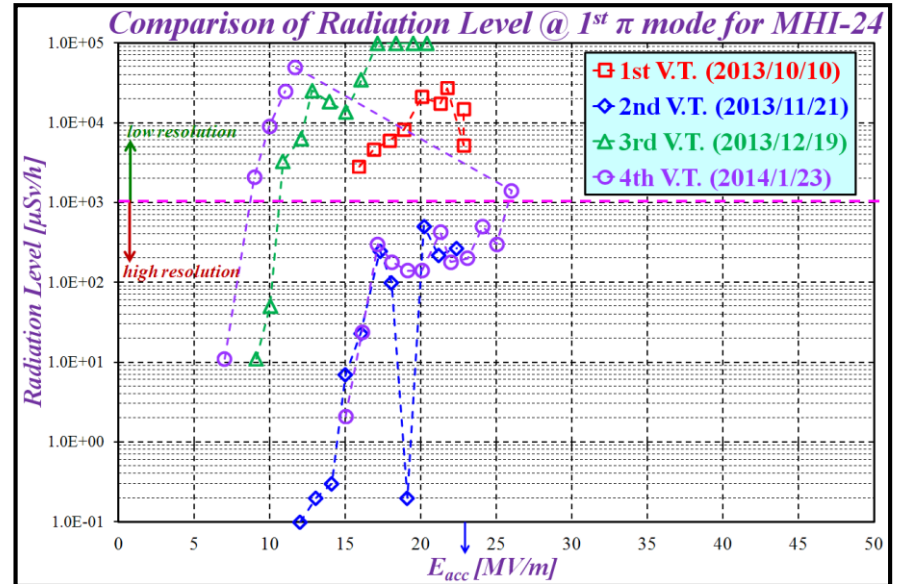
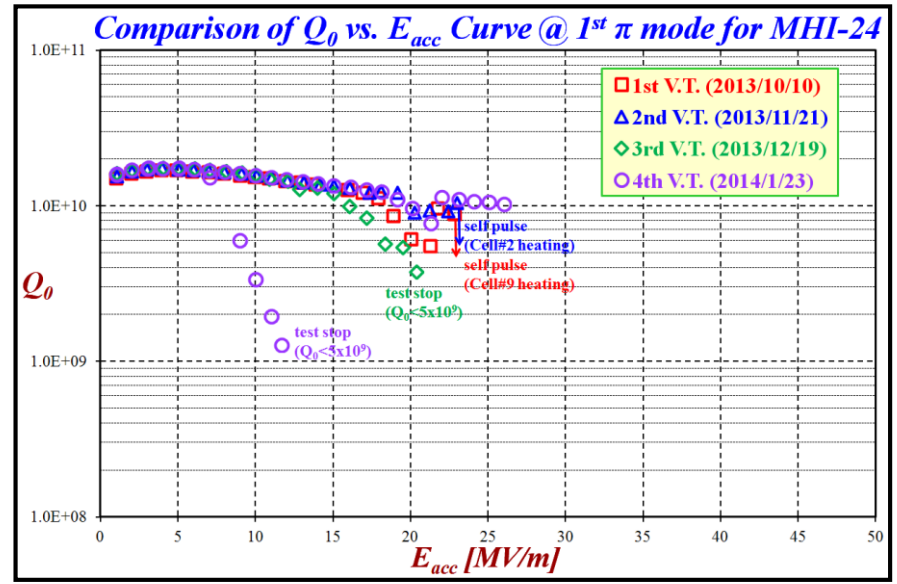
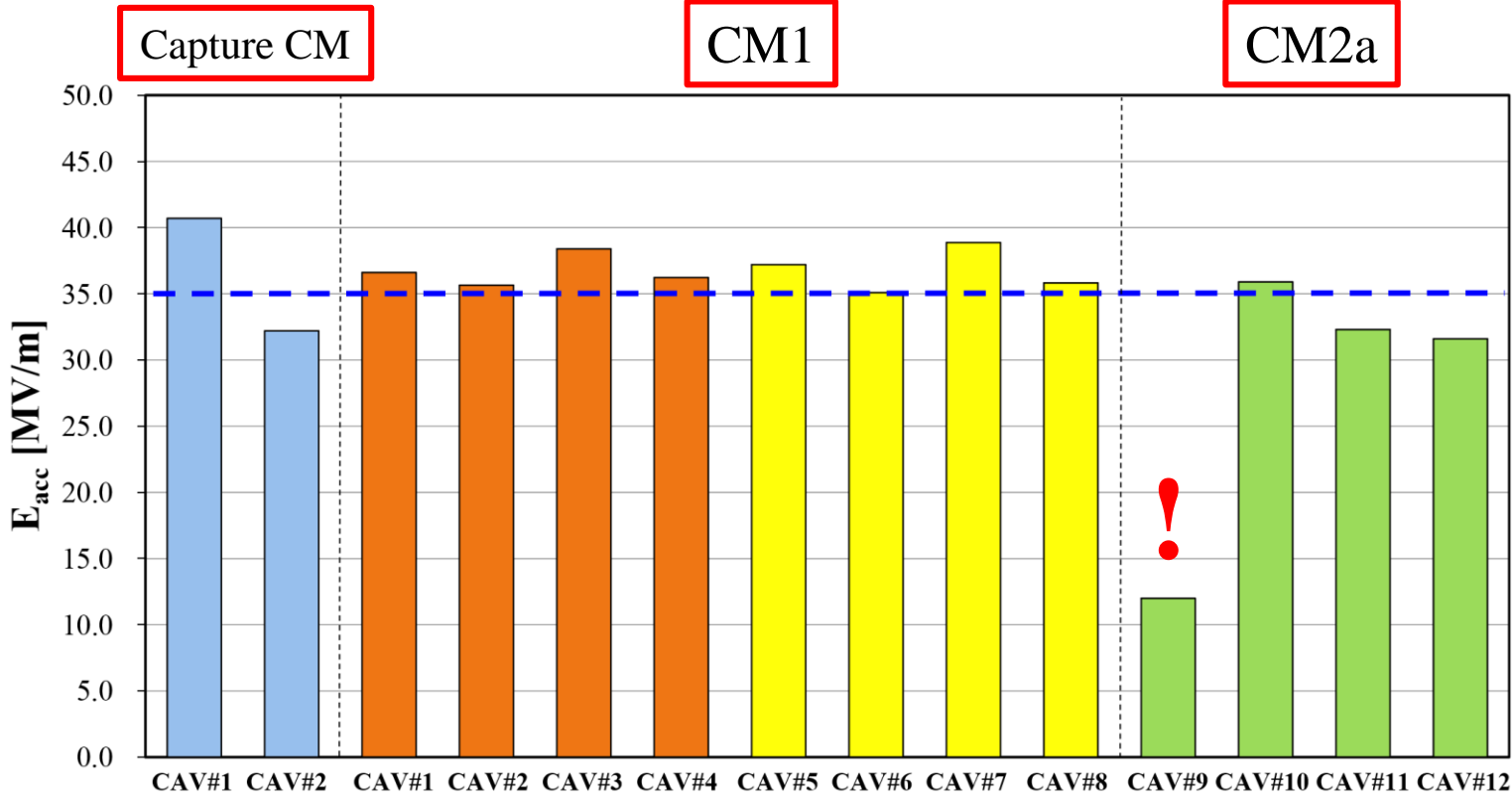
Cavity/Beamline exchange work (on the way...)

- ◆ 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

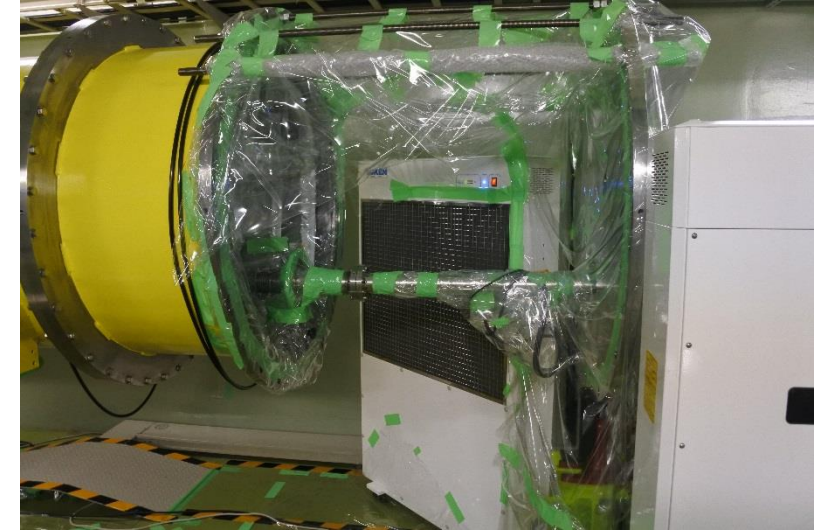
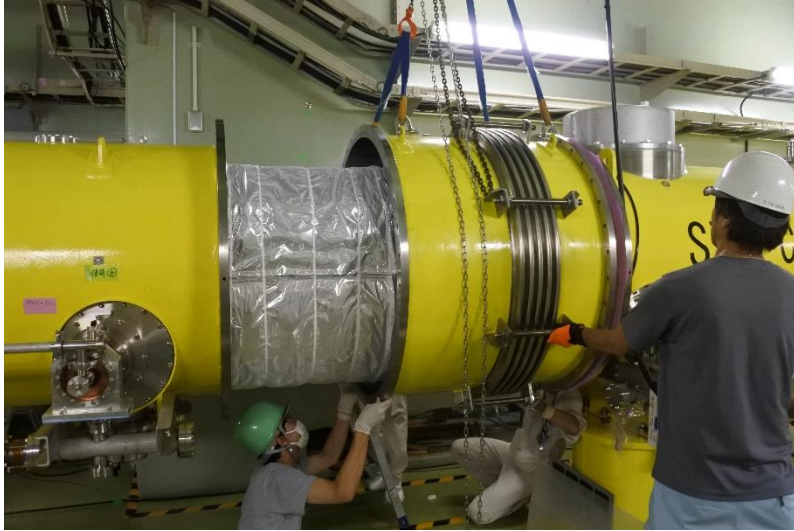


Only one goat in many sheep

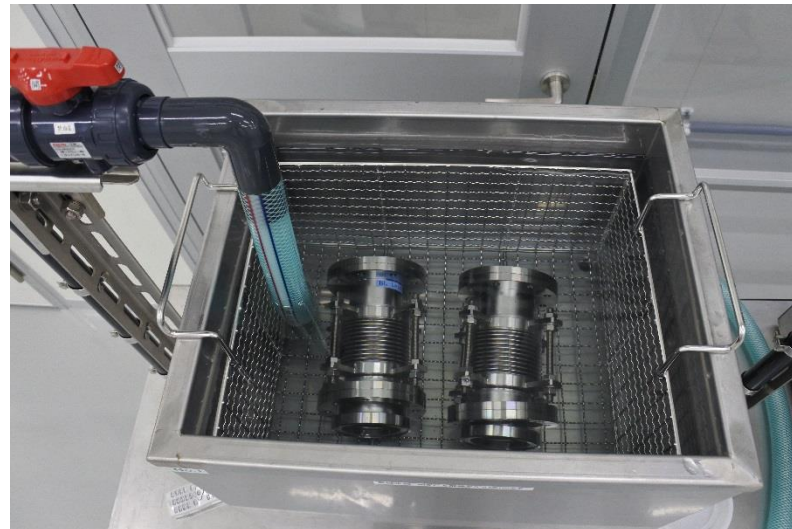
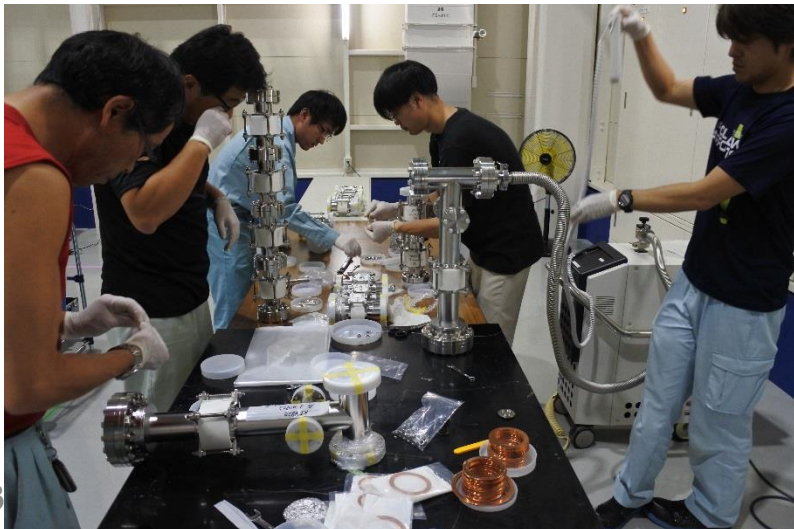


Work progress after summer in 2019

CM2a disassembly



Beampipe exchanged/Beamline reconstructed



Outline

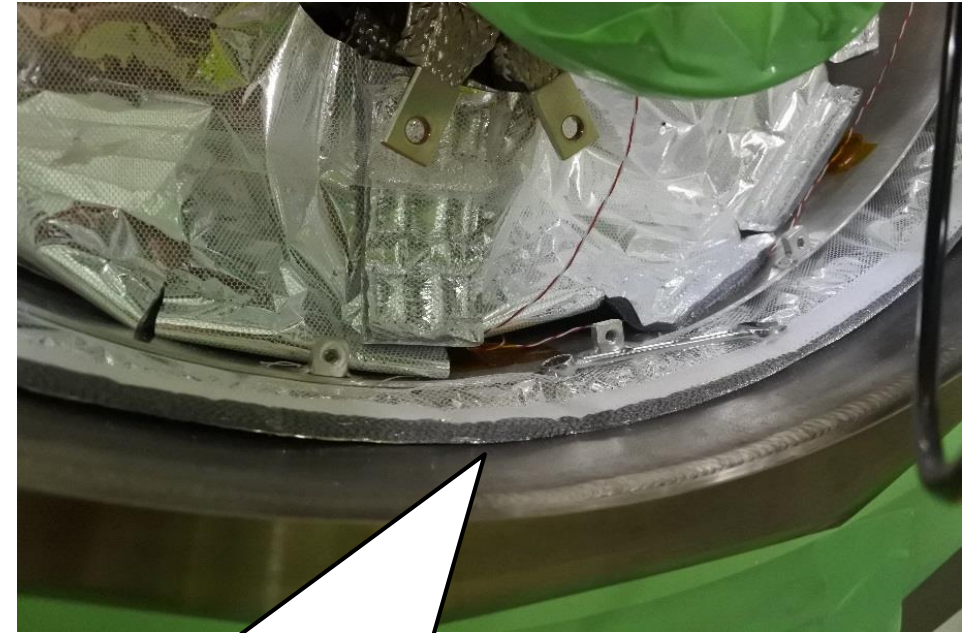
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Cause for enormous static heat load?

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.

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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!

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- ◆ **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!



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