J-PARC Contributions to LHC Injector Upgrade (LIU) Project

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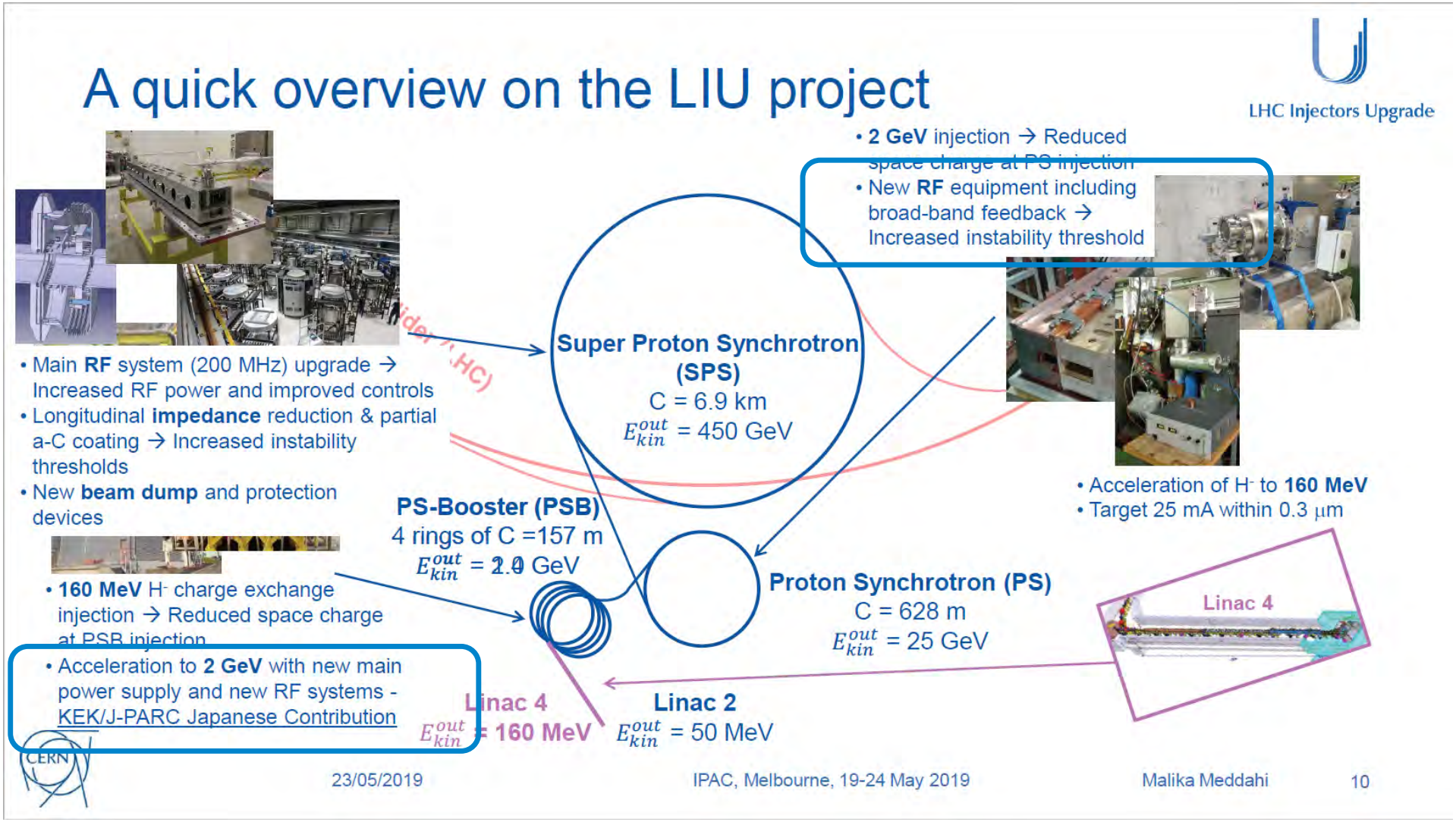
Collaboration history

- 2002: CERN Low Energy Ion Ring (LEIR) Cavities for Heavy Ion collision at LHC and Solid-state amplifiers for J-PARC RCS & MR

- 2010: Information of Low Power Loss Finemet, FT3L
- 2012: Collaboration restarted for LIU

Injectors(Linac4,PSBooster,PS,SPS)

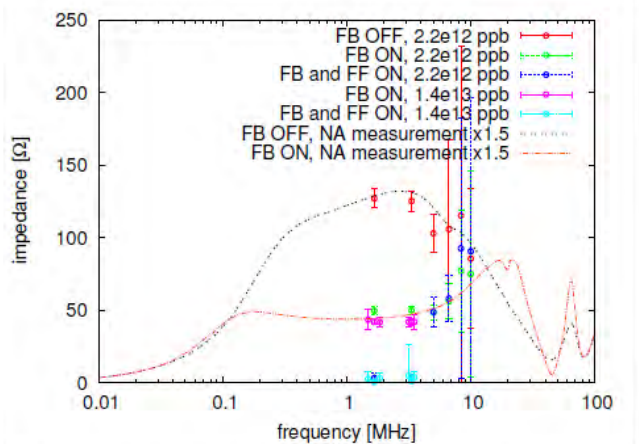


PS Booster New RF systems

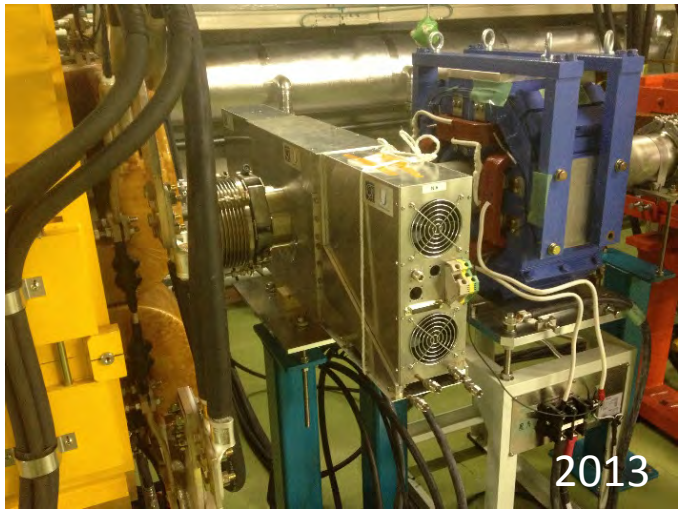
- Test of broadband RF system
  - At J-PARC (3GeV injection) in LS1

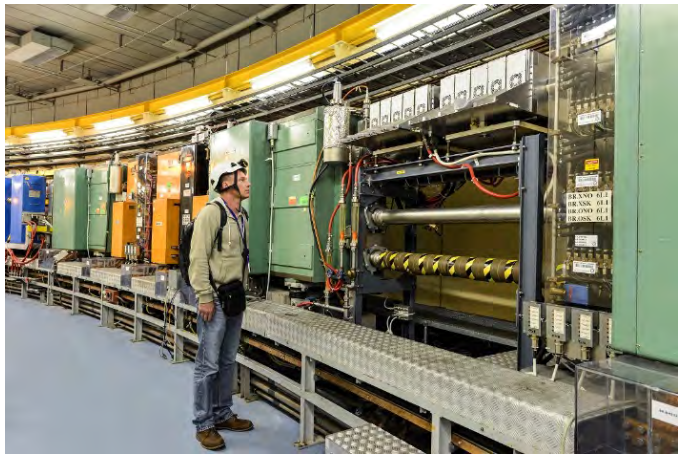
beam intensity 1.4 x 10^{13} ppb, 8 bunches

F. Tamura@Finemet Review

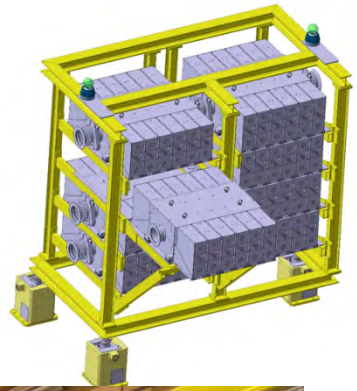


  - At PSB, beam test after LS1
    - Beam Loading
    - Reliability (>99%)
    - Multi-harmonic RF
  - Braodband system was approved!





PS Booster New RF systems



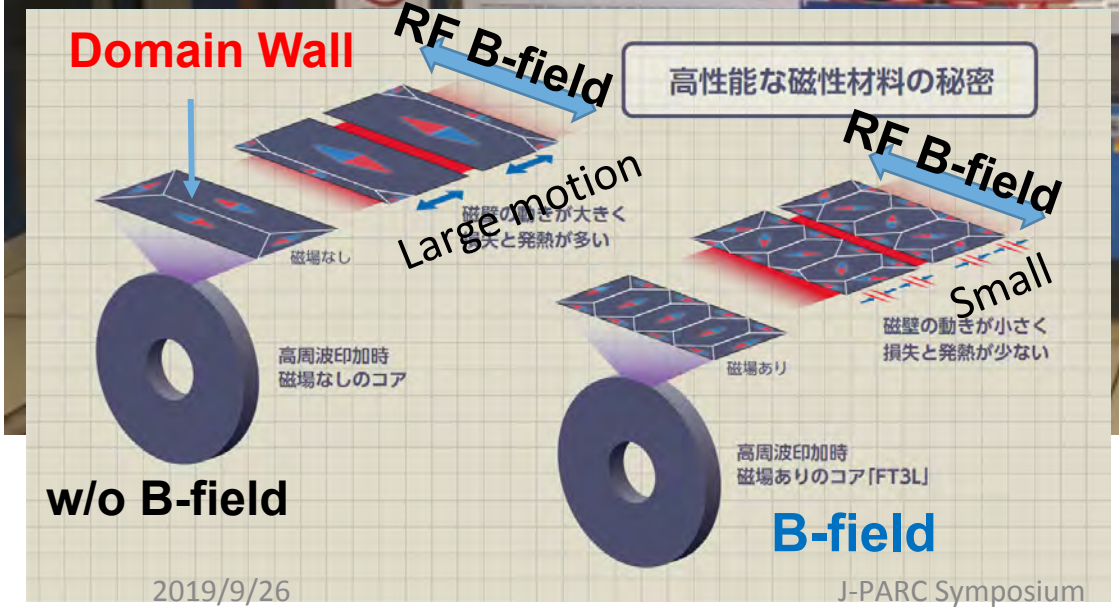
- New RF systems are under installation !

Please see cavity in OPEN DAYS video (~8min.)
https://www.youtube.com/watch?time_continue=4640&v=U3vutvLlo-8

PS Booster RF Systems @ OD2019

New Magnetic Alloy (Finemet FT3L)-loaded Cavity

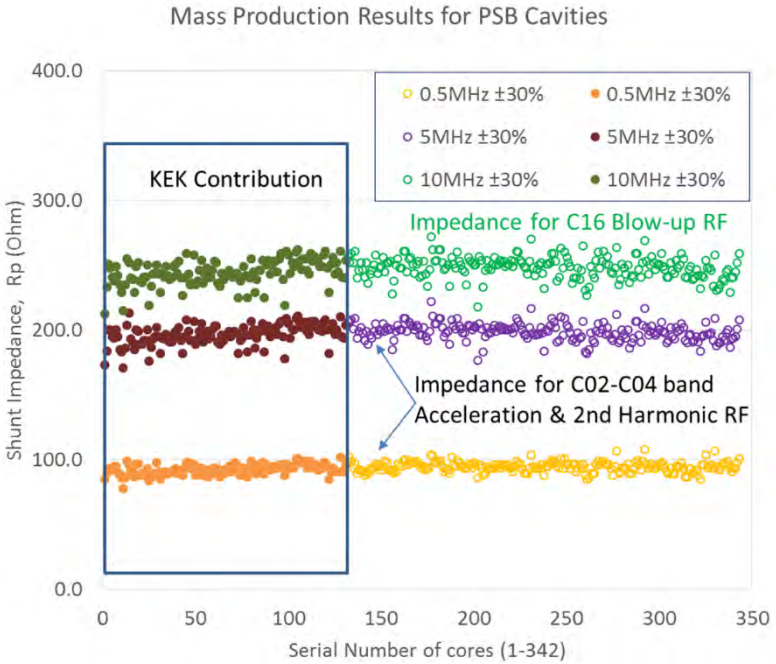
Old Ferrite-loaded Cavity system

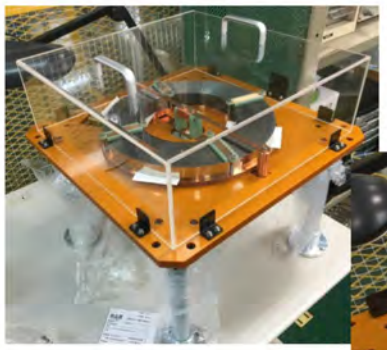


In J-PARC tour, MR FT3L cavities will be seen.

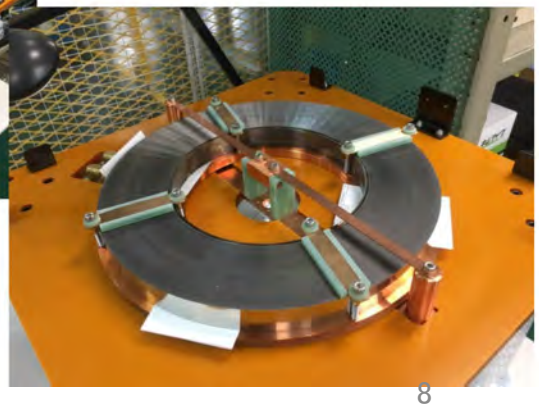
Contributions

- High impedance core by J-PARC-made Magnetic-annealing oven
- Contribution to mass production from ATLAS-Japan
- Quality check



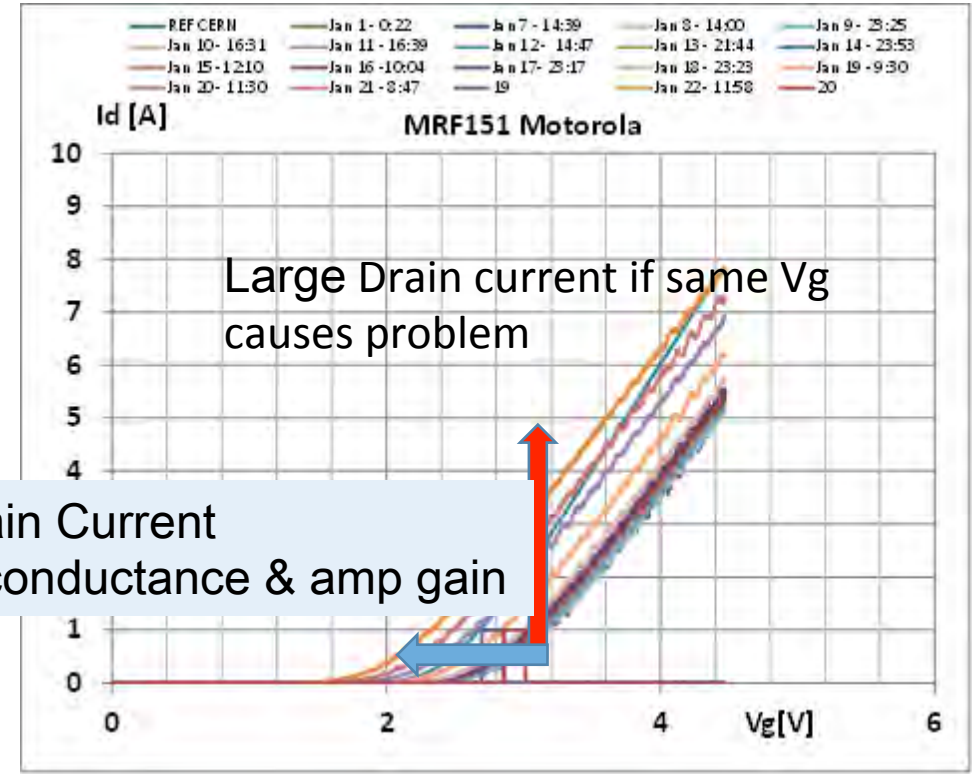


Power test of core at company



Rad-Hard Solid-State AMP

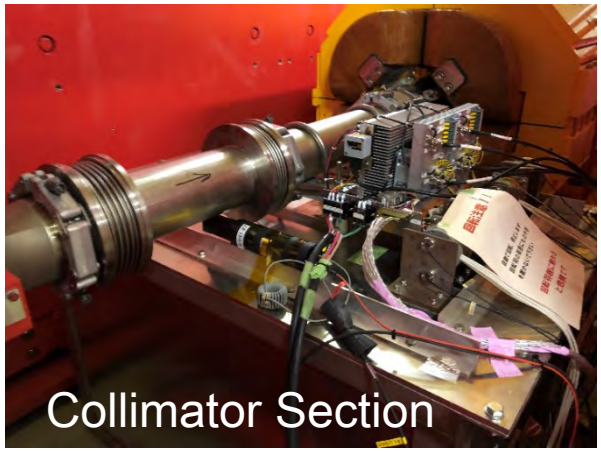
- Many Solid-State AMPs in PSB tunnel
  - Cause of problem is TID effect on bias point of MOSFET.

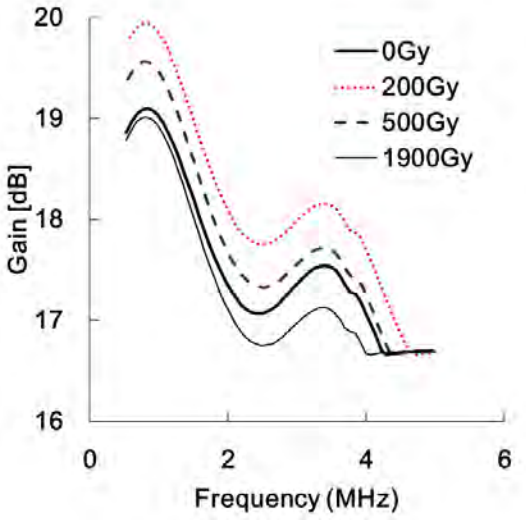


175Gy

Rad-Hard Solid-State AMP

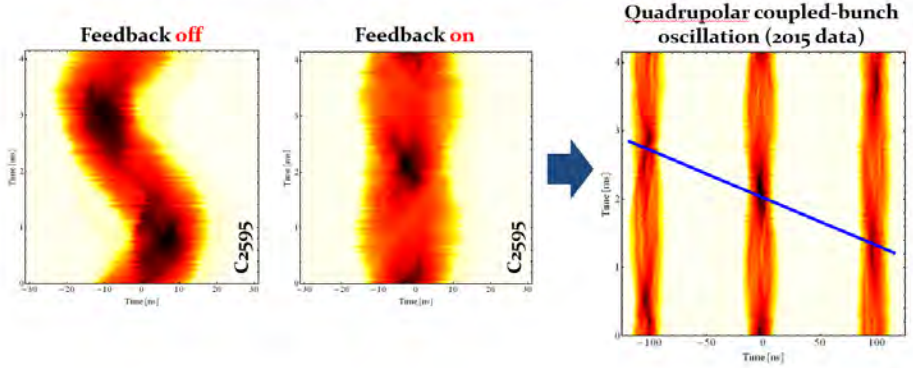
- **Mitigation of Radiation effects was applied.**
  - So far, gain variation is ~1 dB up to ~2 kGy in mixed field and 8.8 kGy by Co60 !
    - 2 kGy means 100 years in PSB RF areas !
    - Results are published in IEEE TNS in Sep. DOI:10.1109/tns.2019.2937603 "Development of Radiation-Hard Solid-State Amplifiers for Kilogray Environments Using COTS Components"
    - 10 kGy test in fall at J-PARC for PS feedback AMPs in 1k Gy/year environment



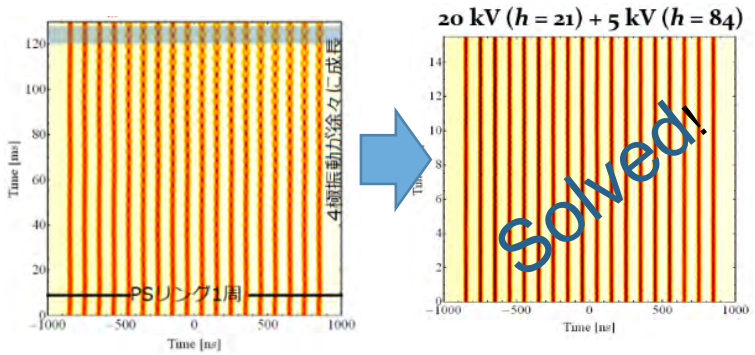


PS Damper system

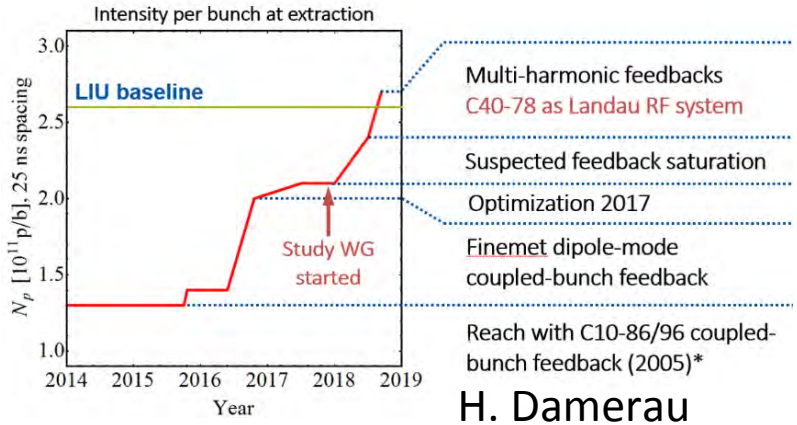
- Suffered by longitudinal coupled bunch instability.
- HL-LHC needs 2.6 x 10^{11} ppb



Damper Cavity

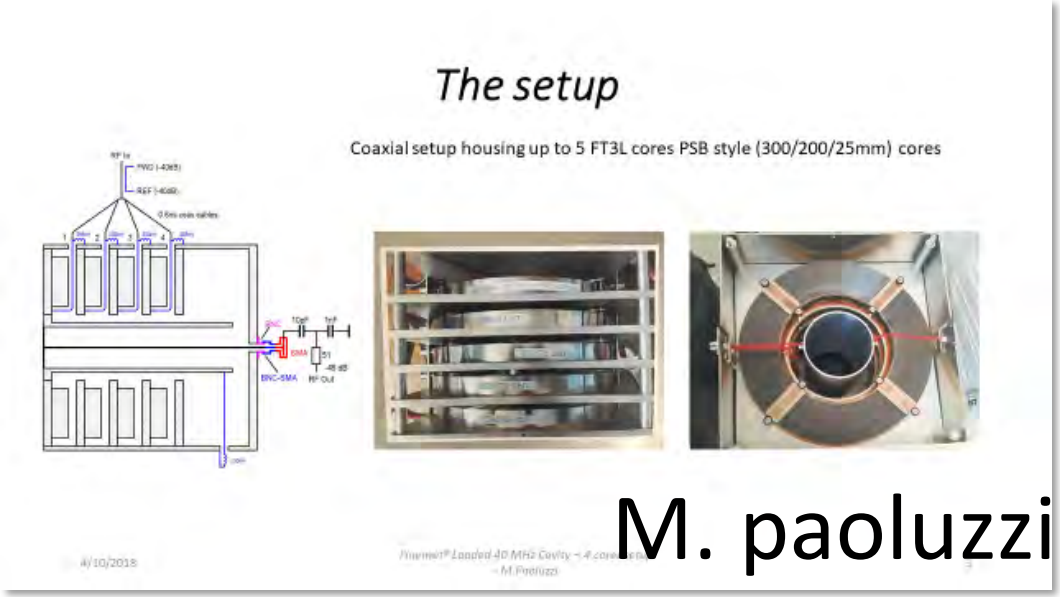


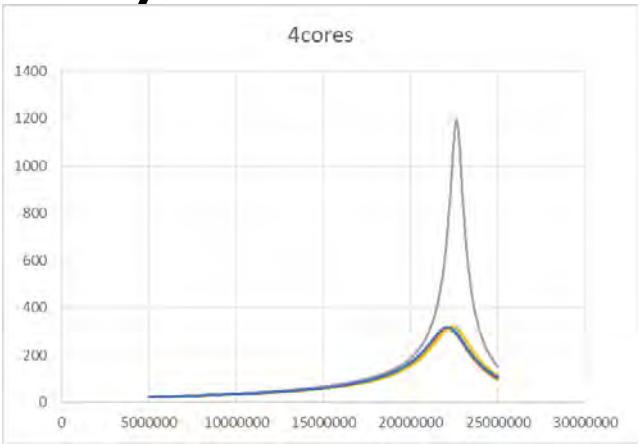
Damper& 40 MHz Landau Cavities



H. Damerau

40 MHz Wideband Cavity Technology
Finemet®-base Landau Cavity R&D





J-PARC cores (10μm thick) also gives a high impedance at 20 MHz !

However, instability was solved!

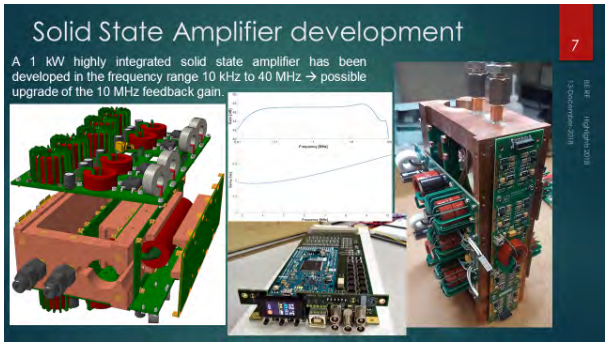
Test cavity is under testing at KEK/J-PARC with the **best** MA cores.

40 MHz Cavity R&D may be useful for future applications.

Material Research Collaboration using muon beam at MLF in J-PARC
MFL-IN-3: "Magnetic Field Dependence on Crystallization Process of FINEMET® Nano-crystalline Alloy Detected by μSR Method" by OHTA, Motoki (Hitachi Metals)

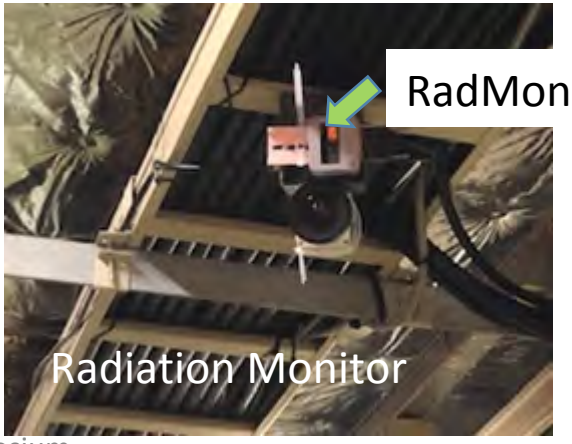
Benefits to J-PARC

- Solid-state AMP technology at CERN helped and will help J-PARC.
  - For 1 MW beam, feedback AMP will be helpful.



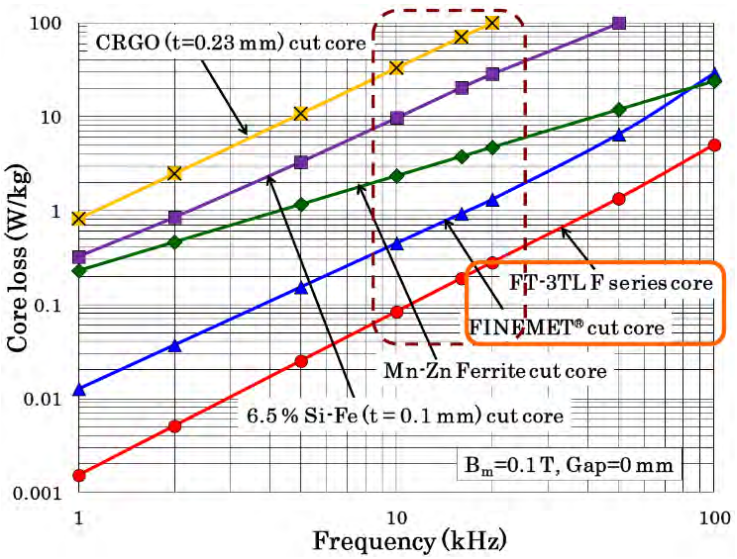
E. Jensen, BE-RF highlight 2018

- Beam Dump, RadMON



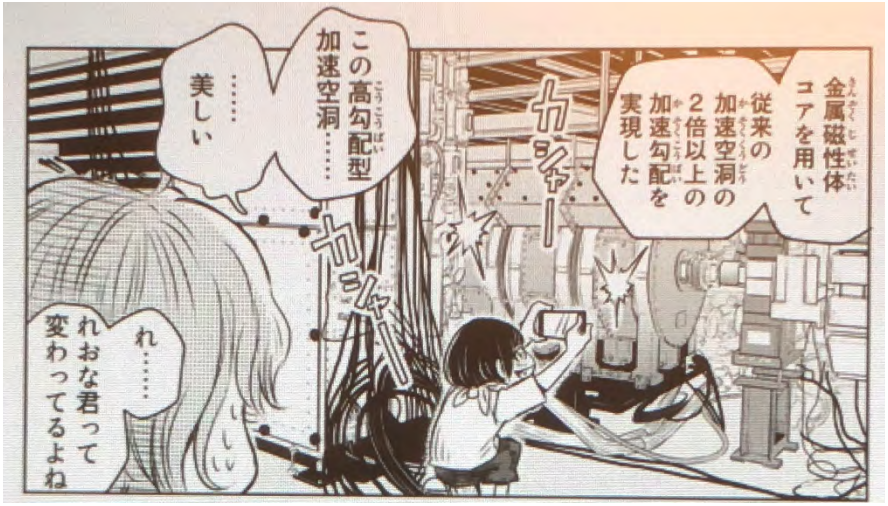
Technology Transfer and Contribution to Society

- J-PARC/KEK developed a large core production system- magnetic annealing oven in 2013.
- The oven may be used to produce transformer cores for power supplies of **transportation systems**. **KEK** and **Hitachi Metal Ltd.** agreed to use the system and R&D has been started in 2018.



Wideband Cavity Technology may contribute to downsize transformers, to reduce power consumption and to Conservation of the global environment.

Summary



J-PARC Cavity on Manga-"アルキメデスのお風呂"

"Using Magnetic Alloy cores, more than 2 times field gradient than before.This high-field gradient cavity is beautiful"

- J-PARC RF technology contributes CERN accelerators.
  - Wideband cavity is used in ELENA and, from 2020, AD for anti-proton deceleration.

- J-PARC and CERN have been collaborating for many years for ring RF.
- A lot of Benefits for both laboratories.

Special Thanks to R. Garoby and T. Roser for long-tem supports for J-PARC RF developments.

Back up