Life with MTCA at J-PARC

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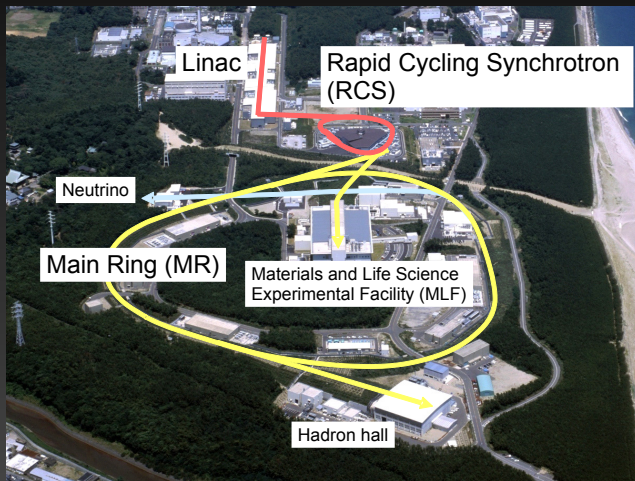2. Various ingenuity of Japanese companies
   EPICS IOC on Zynq SoC
   Lightweight MTCA shelf
   Reinforcement of front panel
   A small part for...

3. Conclusion

Japan Proton Accelerator Research Complex (J-PARC)

- Accelerators: 400 MeV linac, 3 GeV RCS, 30 GeV Main Ring (MR)
- Experimental facilities: MLF (n, μ), Hadron hall, Neutrino
- High intensity: 1 MW (RCS), 750 kW (MR)

MTCA at J-PARC:
- Linac: new LLRF modules
- RCS: Next-generation LLRF control system
- MR: Longitudinal damper, voltage control test system, new LLRF

MTCA is (slowly) growing at J-PARC.

# Next generation LLRF control system for RCS deployed in 2019

- Shelf with rf backplane
- 1x common function AMC/RTM
- 6x cavity driver AMC/RTM for 12 cavities
- Clock eRTM
- High speed serial communication module

- Signal transfer via backplane, no cables between modules
- Better maintainability

F. Tamura, et al., IEEE Transactions on Nuclear Science, vol. 66, no. 7, pp. 1242-1248 (2019)
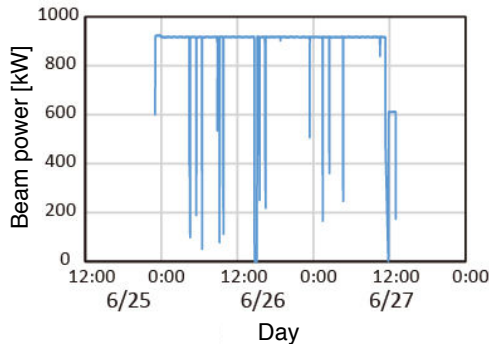
New LLRF works nicely
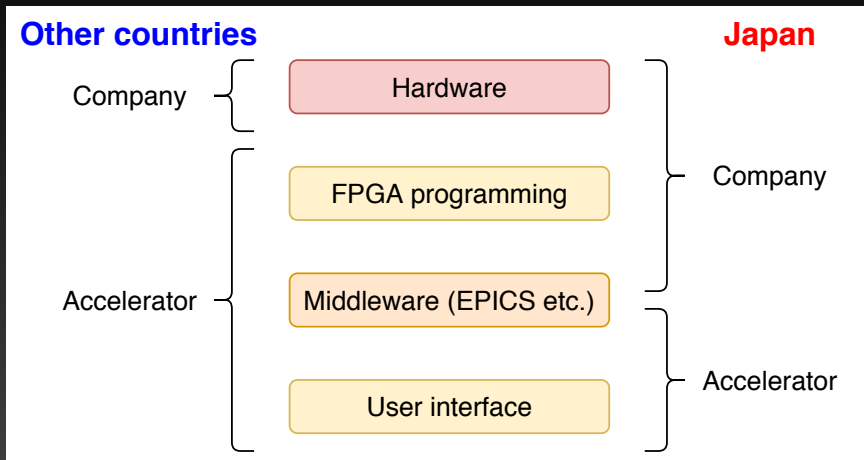
Improved beam loading compensation:
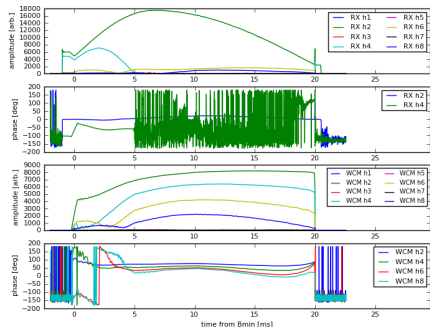
F.Tamura, et al., Phys. Rev. Accel. Beams 22, 092001

RCS 1 MW continuous operation demo:

36 hour demonstration successful.

Difference of development style

Other countries   **Japan**

Company ⎨   Hardware

              FPGA programming   Company

Accelerator ⎨   Middleware (EPICS etc.)

               User interface   Accelerator

- FPGA logic is usually outsourced in Japan
  - Less engineer/technician in institutes
- Role of companies is more than other countries

Behind our successful deployment...

Deployment of the next-generation LLRF control system was smooth and successful.

Behind our successful deployment...

Deployment of the next-generation LLRF control system was smooth and successful.

During the development, we have been supported by the various ingenuity of Japanese companies.

    etc...

We present the various ingenuity.

1. Introduction

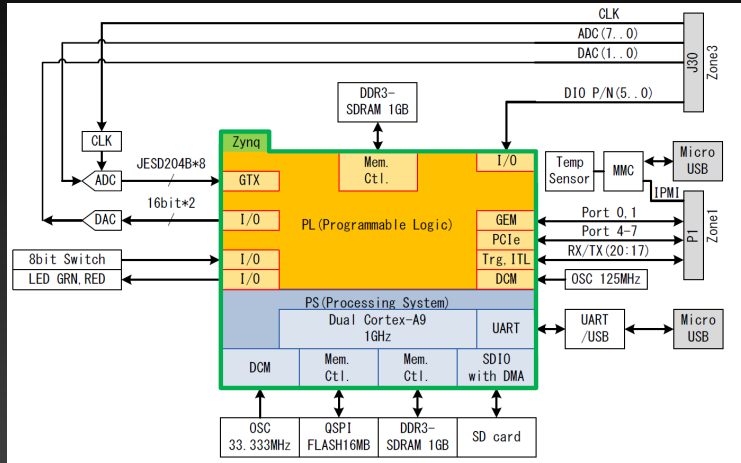2. Various ingenuity of Japanese companies
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9th MTCA workshop, F. Tamura   Life with MTCA at J-PARC   8

AMC by Mitsubishi TOKKI systems corporation

- FPGA Zynq XC7Z045
- 8x ADC, 2x DAC
- 1 GB SDRAM
- Linux / EPICS IOC on Zynq SoC is prepared by Mitsubishi Tokki

Their Development environment

Cross-development environment prepared for ARM (Cortex-A9) on Zynq FPGA.

Embedded linux	Xilinx Linux
Tool chain for kernel, device driver	PetaLinux
Tool chain for EPICS	Sourcery CodeBench Lite 2013.05-24 (gcc 4.7.3)

- According to reference design (XAPP1082), Mitsubishi Tokki realized SD card boot
- FPGA configuration file on SD card (BOOT.bin); remote update of logic via ethernet is possible
- FAT format SD card is ok
  - Linux file system on RAM disk and NFS

Boot-up configuration:
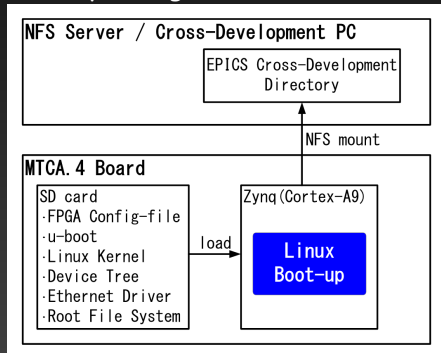
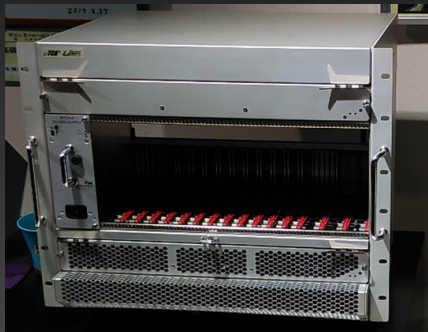# EPICS is ready at the beginning
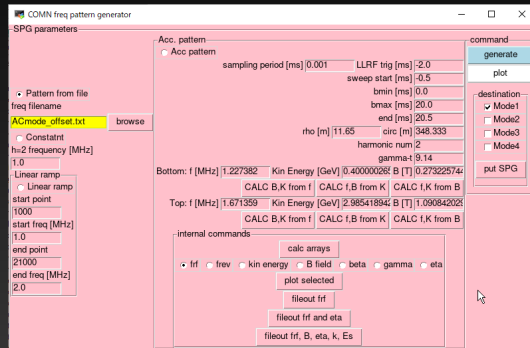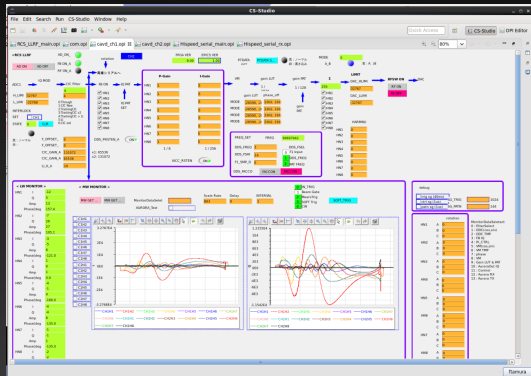
- Tests at company using EPICS
- Module delivered with EPICS / CSS OPI
- We can quickly prepare OPI using python, medm, CSS...

On board EPICS and SD card boot is very beneficial for us.

Lightweight MTCA shelf

https://www.uber-corp.co.jp/pg136.html

Our MTCA shelf is product of Uber, Japanese company.

- Full-featured 12 slot MTCA shelf with rf backplane
- Made of Aluminum
- Lightweight, 12.5 kg
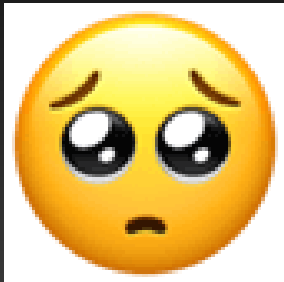 (Typical steel shelf is ∼20 kg)

Lightweight is justice

The lightweight shelf is easy to handle.

- Especially helpful during R&D phase
    - Sometimes we bring it lab to lab
- Installation to 19-inch rack was easy
    - done by me
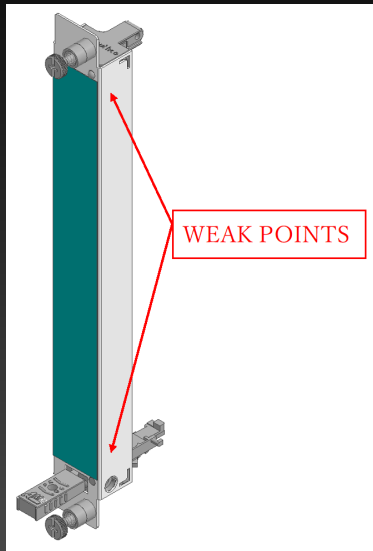- Worth to pay an extra cost

Smile!

Mechanical issue of AMC

Removal of MTCA.4 AMC is very hard.

- Strong force necessary
- MTCA.4 with card edge and Zone3 connectors
- How do you manage?

Mechanical issue of AMC

WEAK POINTS

We may bend the front panel when removal.

- Have you ever experienced?
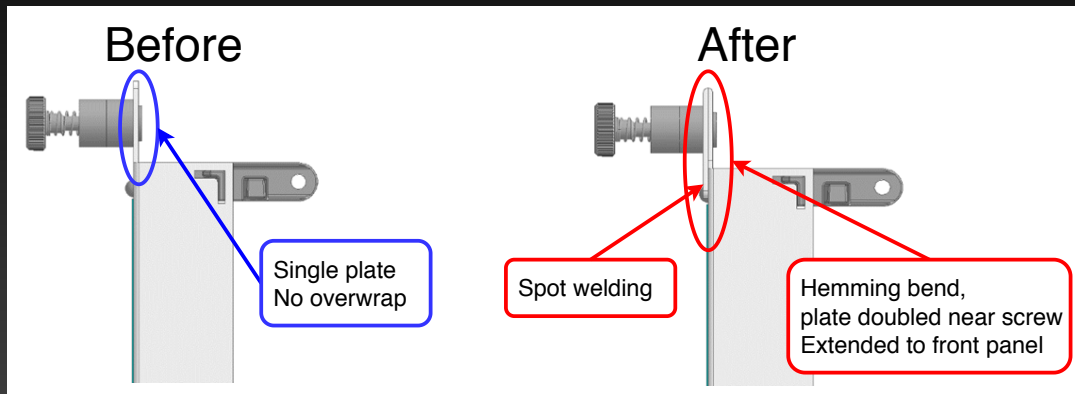

Contact XTech
NOW
for Details!

Helpful tool. (no longer available in market)

Still some force near the upper screw needed.

We asked Mitsubishi Tokki and Uber for reinforcement of front panel.

Reinforcement of front panel

Before

Single plate
No overwrap

After

Spot welding

Hemming bend,
plate doubled near screw
Extended to front panel

Reinforcement by Uber made it much more solid.

Reinforcement of front panel
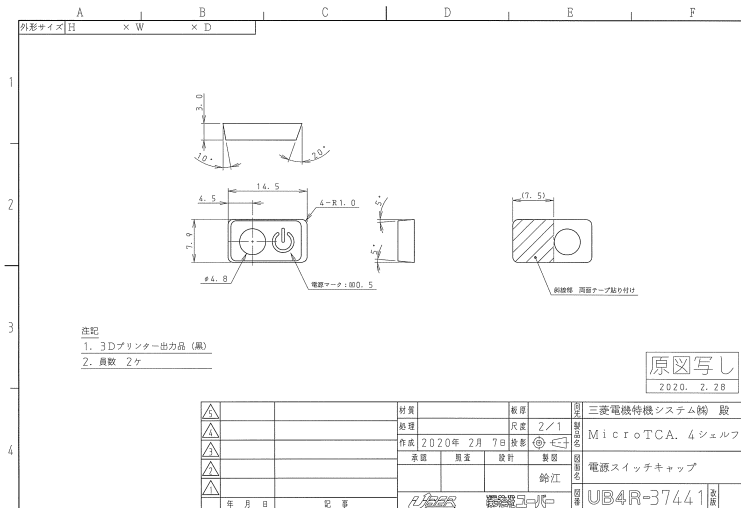

Possible to pull

Rigid
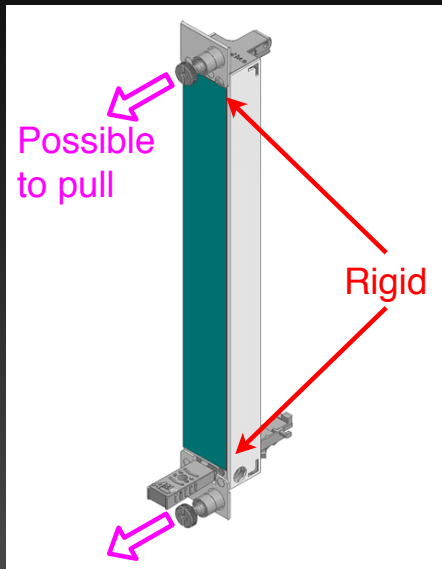
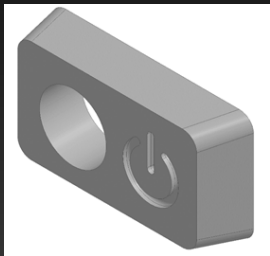With reinforced front panel, we can pull the screws for removal of AMC.

Comment here:
- MTCA standard should include guideline for mechanical design

What is this small part? (15 mm × 8 mm × 3 mm)

Small, but beneficial part

We like performance of Wiener PS, but the switch is too easy to push.

- Misoperation may happen

Uber designed and made a small switch cover using 3D printer.

- Attached as the photo
- Fingers cannot push the button, tools (ex. screw driver) necessary

Chance of misoperation greatly reduced.

Conclusion

Our happy life with MTCA at J-PARC is supported by the ingenuity of Japanese companies.

Announcement:

MTCA workshop in Japan, which was postponed due to COVID-19, will be held in September or October 2021.

- "Real" at KEK or "virtual" with Zoom

Thank you for your attention!

Questions? → **fumihiko.tamura@j-parc.jp**