

MTCA workshop for accelerator and physics in Japan 2021 (Virtual)

Survey on MTCA in Japanese accelerators

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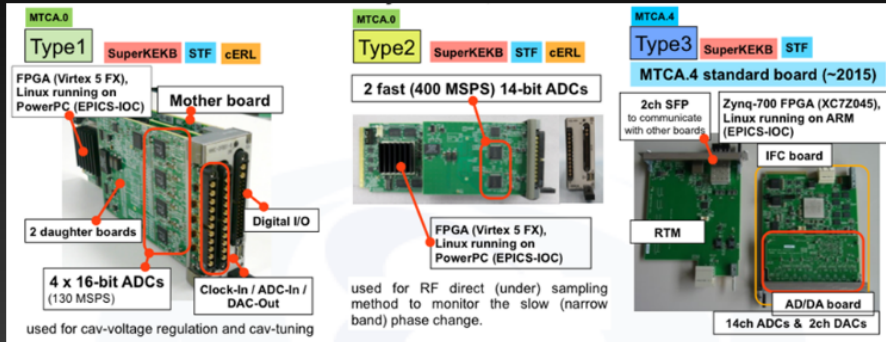
J-PARC Center

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Contents

1. Introduction
2. Survey on MTCA in Japanese accelerators
3. Barriers to the spread of MTCA in Japan
4. Summary

Introduction



Application of MTCA for accelerators was pioneered by Prof. Shin Michizono (KEK) in 2008.

Since then, MTCA is spreading to Japanese accelerators



However, it seems slow. Why? → Survey!

I was inspired by...

Comprehensive survey for MTCA users of accelerators in the world by Daniel Tavares (LNLS), IBIC2019:

<https://doi.org/10.18429/JACoW-IBIC2019-WE002>



CNPEM
Brazilian Center for Research
in Energy and Materials



Brazilian Synchrotron
Light Laboratory

MicroTCA.4 at Sirius and a closer look into the community

IBIC 2019 - Malmö

Daniel Tavares
LNLS Beam Diagnostics Group

September 11, 2019

8th Int. Beam Instrum. Conf.
ISBN: 978-3-95430-204-2

IBIC2019, Malmö, Sweden
ISBN: 2673-5350

JACoW Publishing
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Table 1: MTCA.4 projects on accelerator facilities (non-exhaustive list). a) LLRF, b) BPM Electronics, c) BAM Electronics, d) Beam Diagnostics (other than BPM and BAM Electronics), e) Synchronization/Timing, f) Machine Protection, g) Feedback Control, h) Image Processing, i) Experiment Control, j) Massive Data Processing.

Facility	Location	a	b	c	d	e	f	g	h	i	j	Number of Crates
DESY (E-XFEL, FLASH) [39]	Germany	x	x	x	x	x	x	x	x	x	x	200+
ESS [40, 41]	Sweden	x	x	-	x	x	x	-	-	-	-	101-200
ORNL (SNS) [42]	USA	x	-	-	-	x	x	-	-	-	x	101-200
GSI (FAIR) [43]	Germany	x	x	-	x	x	-	x	x	-	-	51-100
Spring-8/SACLA [44, 45]	Japan	x	x	-	x	x	-	x	-	-	-	51-100
CERN (SPS) [46]	Switzerland	x	-	-	x	-	-	x	x	-	-	21-50
FRIB [47]	USA	-	x	-	x	x	-	-	-	-	-	21-50
LNLS (Sirius) [20]	Brazil	x	x	-	x	-	x	-	-	-	-	21-50
APS-U [48]	USA	x	-	x	-	-	x	-	-	-	-	21-50
IHEP (HEPS)	China	x	-	-	-	x	x	-	-	-	-	21-50
ELI Beamlines [49]	Czech Republic	-	-	-	x	-	-	-	x	-	-	21-50
PAL (PAL-XFEL)	South Korea	-	x	-	-	-	-	-	-	-	-	21-50
CSNS (IHEP)	China	x	-	-	-	-	-	-	-	-	-	11-20
Diamond [50]	UK	x	-	-	x	-	-	x	-	-	-	6-10
KEK (SuperKEKB, STF-2) [51]	Japan	x	x	-	-	-	-	-	-	-	-	6-10
SINAP (SXFEL, SHINE) [52]	China	x	-	-	-	-	-	-	-	-	-	6-10
KIT (FLUTE) [53]	Germany	x	x	-	x	x	-	x	-	x	-	1-5
CANDLE [54]	Armenia	x	-	-	x	x	-	-	-	-	-	1-5
Soleil	France	x	-	-	-	-	-	-	x	x	-	1-5
USTC (HE-S-II)	China	x	x	-	-	-	-	-	-	-	-	1-5
HZDR (ELBE) [55]	Germany	x	-	-	x	-	-	-	-	-	-	1-5
ANSTO (AS) [56]	Australia	-	-	-	-	-	x	-	-	-	-	1-5
Elettra	Italy	-	-	-	-	-	-	x	-	-	-	1-5
ESRF	France	-	-	-	-	-	-	x	-	-	-	1-5
IMPACAS (ADS) [57]	China	x	-	-	-	-	-	-	-	-	-	1-5
J-PARC [58]	Japan	x	-	-	-	-	-	-	-	-	-	1-5
JGU (MESA) [59]	Germany	x	-	-	-	-	-	-	-	-	-	1-5

TRENDS FOR BEAM DIAGNOSTICS

BPM Electronics

MicroTCA.4 was born targeting a wide range of frequencies for analog signals processing and digitizing, from DC to a few GHz. With the extension of an auxiliary backplane in the MicroTCA.4.1 revision, clean LO and reference clock signals as required in analog down- and upconversion were made available. All of these building blocks make it possible to implement BPM electronics in a very compact crate setup.

Different design approaches were taken across the community. For instance, PAL-XFEL designed a custom RTM BPM in partnership with SLAC [60], used in conjunction with Struck SIS8300 AMC digitizer. A similar approach was followed by DESY for FLASH low charge BPMs, for which a custom RTM BPM electronics was designed [61]. Spring-8 and HEPS have adopted the same architecture using analog AMCs, but having designed in-house both AMIC

At Sirius (LNLS) [20] and CRYRING (GSI) [43] a third approach was taken: instead of RTM analog front-ends or digitizers such as the typical use case of MicroTCA.4, FMC ADC boards were used in AMC FMC carriers. Signal conditioning electronics resides outside the crate, in dedicated enclosures.

ESS BPM electronics design employed both COTS AMC digitizer and RTM down-conversion electronics. All BPM-specific analog signal conditioning is done in a separate electronics outside the crate [62].

Libera Brilliance+ (J-Tech) uses a distinct approach from all others by placing all analog and FPGA digital processing for one BPM in one single AMC. The AMC module is MicroTCA.0-compliant only, since the hardware architecture was decided before the release of MicroTCA.4. Customization to make a MTCA.4 AMC module would be possible but so far no request has been made by clients [63].

1. Introduction

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3. Barriers to the spread of MTCA in Japan

4. Summary

The survey form



The screenshot shows a Google Forms interface in a web browser. The title of the form is "MicroTCA (MTCA) に関するアンケート". The introductory text reads: "MicroTCA (MTCA) についてのアンケートです。使用状況を教えていただくとともに、印象、意見などお聞かせください。回答については2020年加速器学会の田村の発表（「加速器における MTCA 普及に向けて」）で使います。メールで追加の質問をすることもありません。" Below this, there are two required fields: "メールアドレス*" (Email address) and "お名前*" (Name). Each field has a red asterisk indicating it is mandatory. The "メールアドレス*" field has a placeholder text "メールアドレス". The "お名前*" field has a placeholder text "回答を入力". A small red asterisk is also visible next to the introductory text. The browser's address bar shows the URL "https://docs.google.com/forms/d/e/1FAIpQLSfDAUkrV6tGQ9YQKJ00Dnqj...".

Thanks to Google forms, it took only a few hours to prepare a small survey. The survey was performed in Summer 2020.

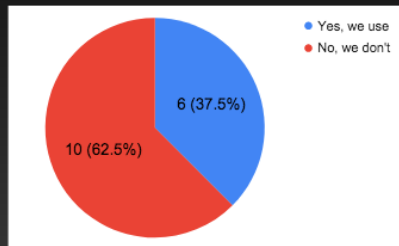
Disclaimer

The survey was answered by people working for LLRF, beam monitor, and control system of KEK and J-PARC.

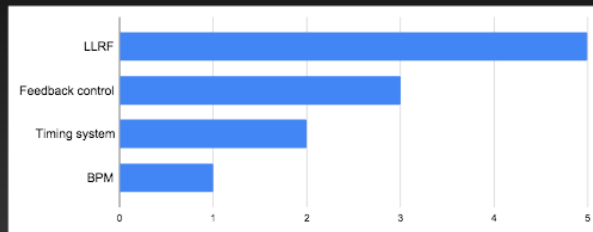
- The scope of the survey is limited to my related people, so it is not an accurate reflection of the actual situation in Japan
- Therefore, the results of the survey are not suitable for statistical treatment
- Analysis can be biased

Survey results

Q: Do you use MTCA?



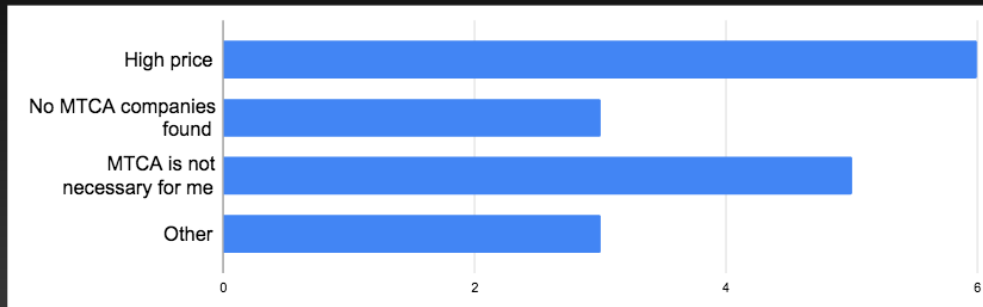
Q: What is your MTCA application?



- Most of Yes answers came from LLRF people
- Main application is LLRF, similar to the institutes in the world
 - Others: feedback control, timing system, and BPM

Survey results

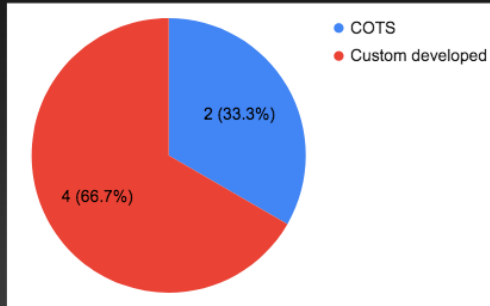
Q: If you do not use MTCA, what is the reason?



- Main reasons: High price and less need
- Cannot find the companies that can develop MTCA systems
- Other: no community to share knowhow of MTCA, and high initial barrier to start MTCA development

Survey results

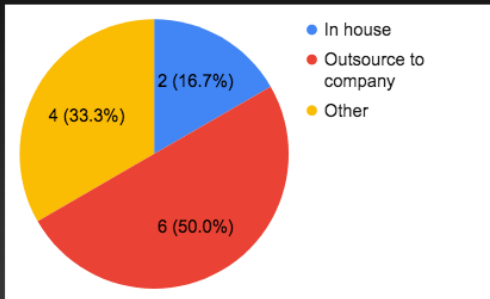
Q: Do you develop your custom MTCA modules or buy COTS modules?



- COTS vs custom development = 2:4

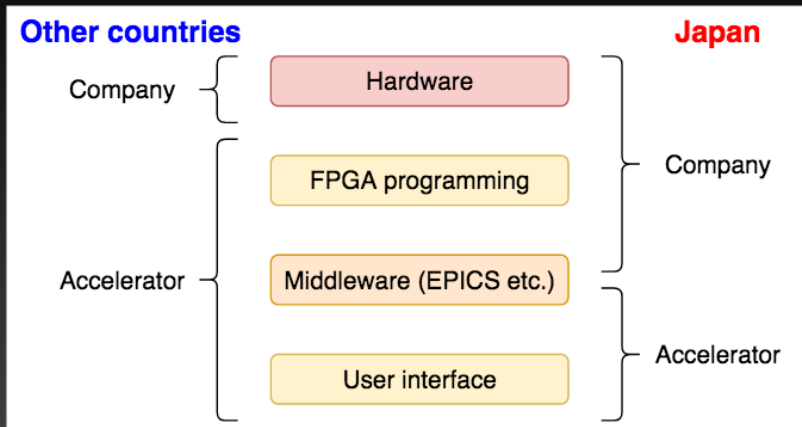
Survey results

Q: How do you develop FPGA logic or DSP programs?



- Only few answers of In house
- Other contains:
 - Prototyping is done in house but implementation to real machine is by company
 - Functionality is designed by institute and implementation is by company
- In most cases it is outsourced to companies

Difference of development style



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

Survey results

Q: What are the pros and cons of MTCA in your opinion?



Pros:

- High-performance AMCs and high speed backplane are available
- Module management, hot-swap, redundancy
- Promising future
- (About MTCA.4) AMC/RTM configuration allows separation of analog and digital circuits

Survey results

Q: What are the pros and cons of MTCA in your opinion?



Cons:

- High price. There are not many companies that can develop MTCA in Japan (Many same answers)
- Fewer COTS products
- Difficult module design due to the need to equip an MMC (Module Management Controller) for module management
- Interoperability. Each manufacturer of MCHs has its own compatibility with MMCs, and the system needs to be checked to see if it works in each configuration
- There is no data sharing mechanism for all AMC's, like VME bus or PLC shared memory

Survey results

Q: What do you consider to be necessary for MTCA to become popular in Japan?

- Increase in the number of companies that can develop modules in Japan
- Lower price
- More promotion

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Although the survey was conducted within a narrow scope, the results highlight barriers to the spread of MTCA in Japan.

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Barriers to the spread of MTCA in Japan

(1) High price:

- Common issue in the world
- MTCA shelf vendors seem to be making effort against the issue
 - Smaller shelves with MCH and/or CPU
- Japanese development style (FPGA program outsourced)
 - Buying COTS AMC and programming in house may reduce cost; hire / grow young staff
- High performance (in most cases) requires high cost
 - Example: J-PARC new LLRF is expensive but has wonderful performance
 - Management needs to change its mindset. Control system is as important as big power supply or klystron



Barriers to the spread of MTCA in Japan

(2) There are only a few companies in Japan that can manufacture MTCA modules:

- MTCA is complicated. Module management requires implementation of micro controller on the modules
 - Hopefully DMMC-stamp will help
- Japanese companies, which made high-quality VME or cPCI modules, should be able to develop MTCA modules as well
 - If they get enough information

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It is necessary to establish MTCA community in Japan to share information and know-how in order to promote the spread of MTCA in Japan.

Summary

A small survey on MTCA in Japanese accelerators, KEK and J-PARC, was conducted.

Indeed, the motivation to organize this workshop is presented here.

- We should establish MTCA community in Japan to share information and know-how in order to promote the spread of MTCA in Japan

Thank you for your attention!



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