



MTCA.4 at FRIB

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U.S. DEPARTMENT OF
ENERGY

Office of
Science

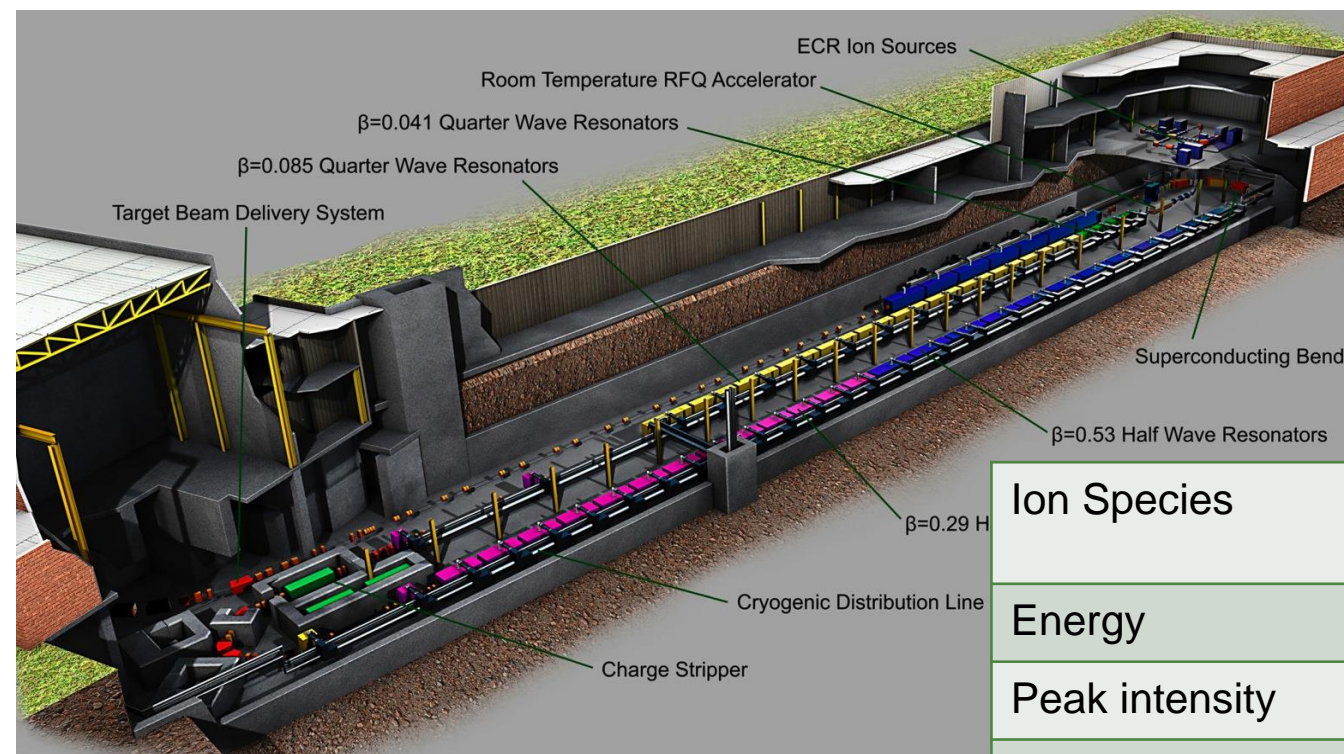
Outline

- Facility for Rare Isotope Beams
- MTCA.4 Hardware at FRIB
- Generating FRU EEPROM Images

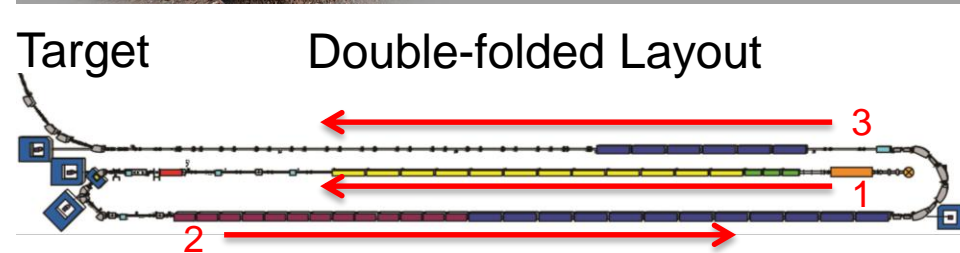


Facility for Rare Isotope Beams
U.S. Department of Energy Office of Science
Michigan State University

Layout and Design Parameters for FRIB Driver Linac



Ion Species	All stable ions up to uranium
Energy	200 MeV/u
Peak intensity	0.7 emA
Duty	0-99.5%
Average beam power	400 kW
Cavity type	SC QWR, SC HWR
Frequency	80.5/322 MHz



FRIB Construction Site



Facility for Rare Isotope Beams
U.S. Department of Energy Office of Science
Michigan State University

M. Konrad, December 2015 MicroTCA Workshop, Slide 4

FRIB General Purpose Digital Board I

40-pair RTM connector
(can also be populated with
30-pair connector)
66 differential pairs, 2 clocks,
2 MGTs

AMC Connector
(PCIe x1, GbE,
Clocks and
Triggers)

Spartan 6 FPGA
XC6SLX150-
2FGG900C

Low-speed GPIO
(15 differential pairs)

3 SFP Cages
3.125 Gb/s

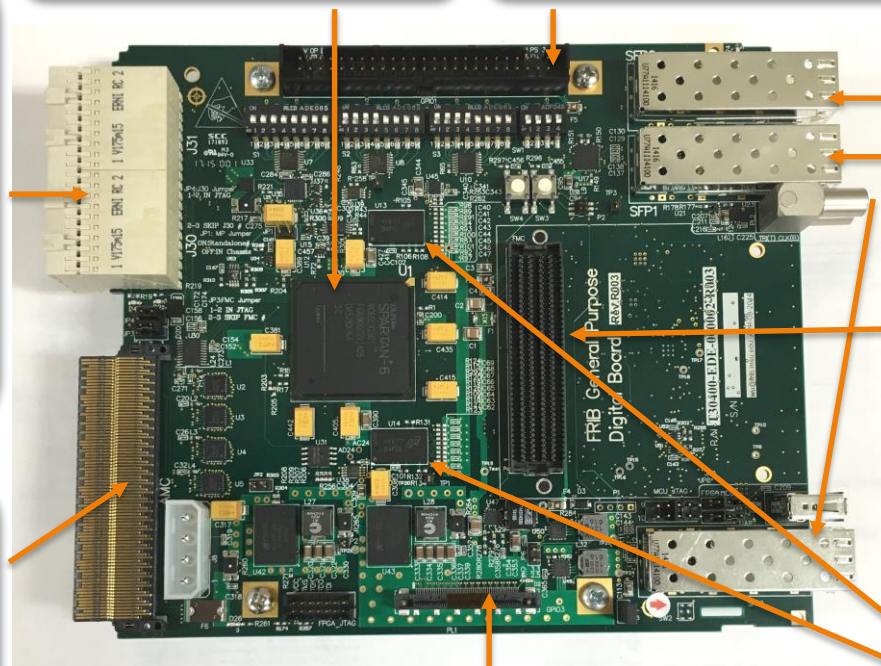
FMC Connector
2.5 V/3.3 V

MMC Firmware
based on
DESY MMC1.0

PLLs and Clock
Distribution

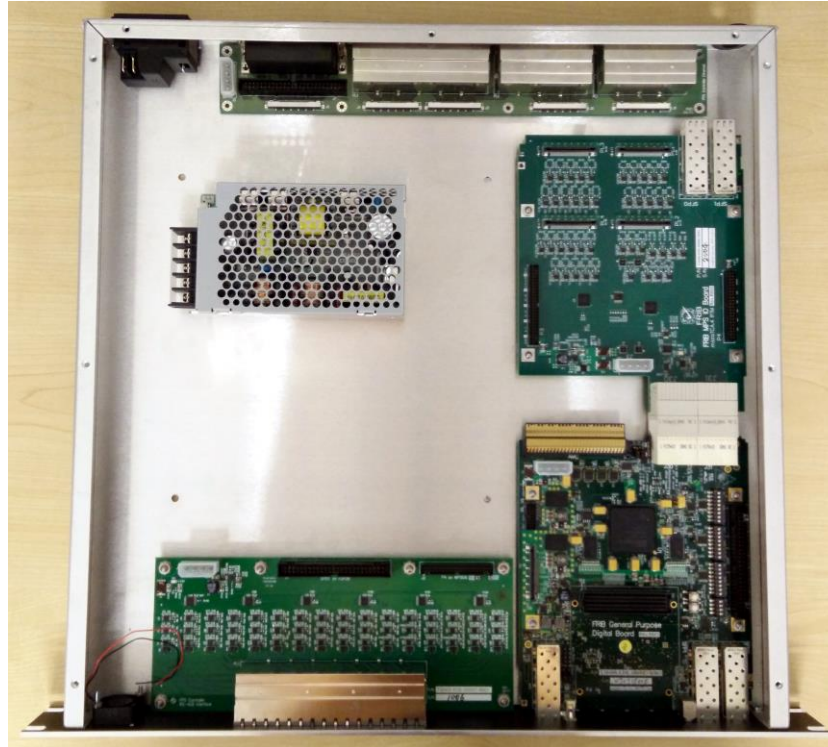
High-speed GPIO
(17 differential pairs)

4 Gbit DDR3
RAM



FRIB General Purpose Digital Board II

- Board is designed for MTCA.4 as well as stand-alone operation

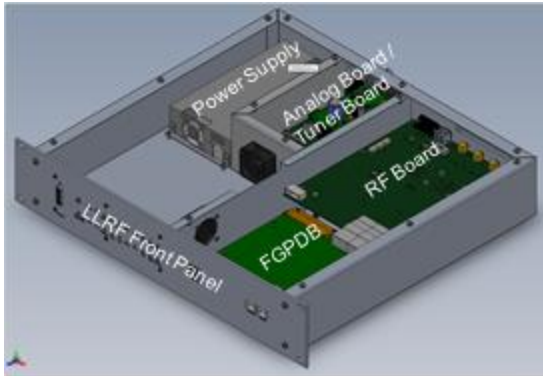


- Monitoring in stand-alone mode
 - MMC monitors sensors, sends sensor data to FPGA with a rate of 1 Hz
 - FPGA passes this data on to the control system (Ethernet)

MTCA.4 Hardware at FRIB I

■ Low-level RF Controllers

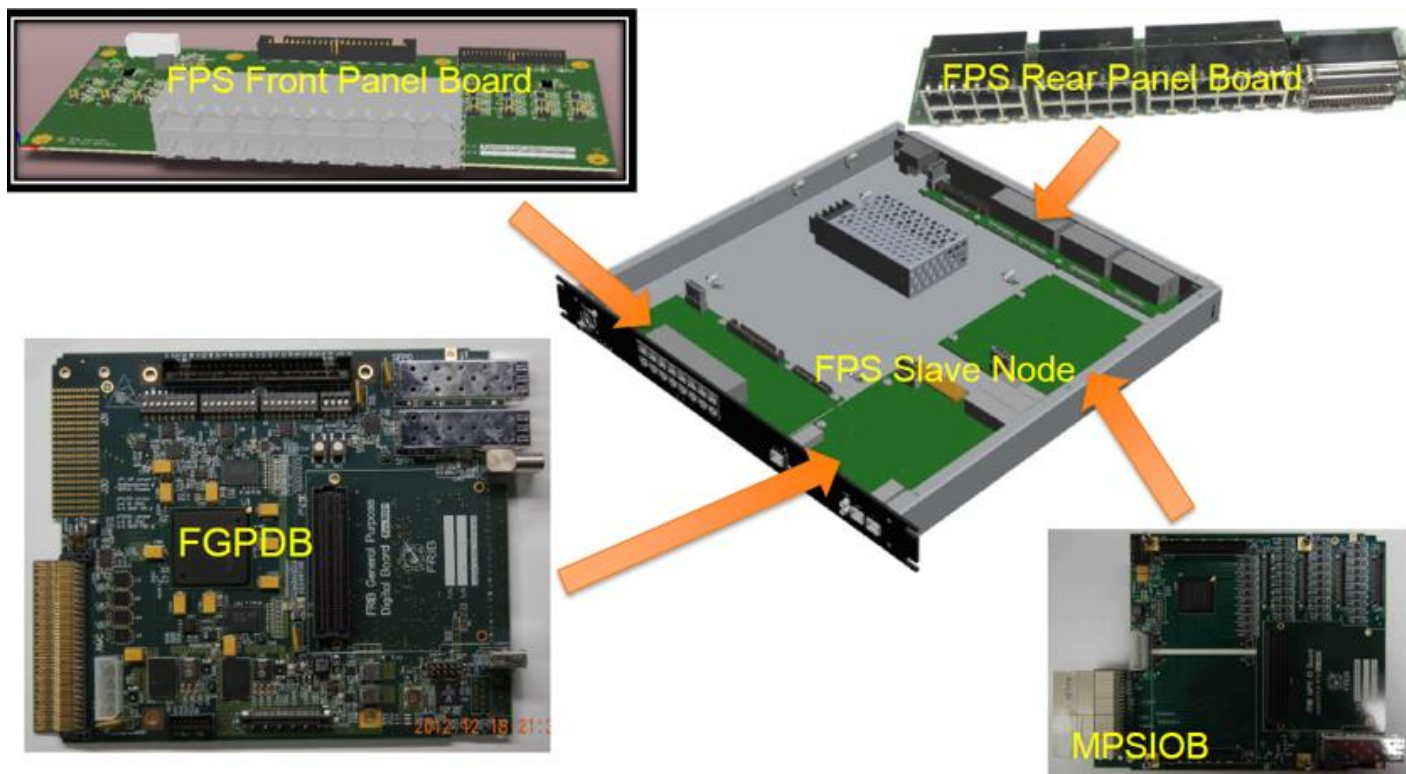
- FRIB General Purpose Digital Board (347 cards)
- LLRF “RTM”
 - » PCB is larger than MTCA.4 to improve signal quality
 - » 40 pair RTM connector
 - » Not following DESY’s RTM recommendation
- Designed for pizza boxes



MTCA.4 Hardware at FRIB II

■ Machine Protection System

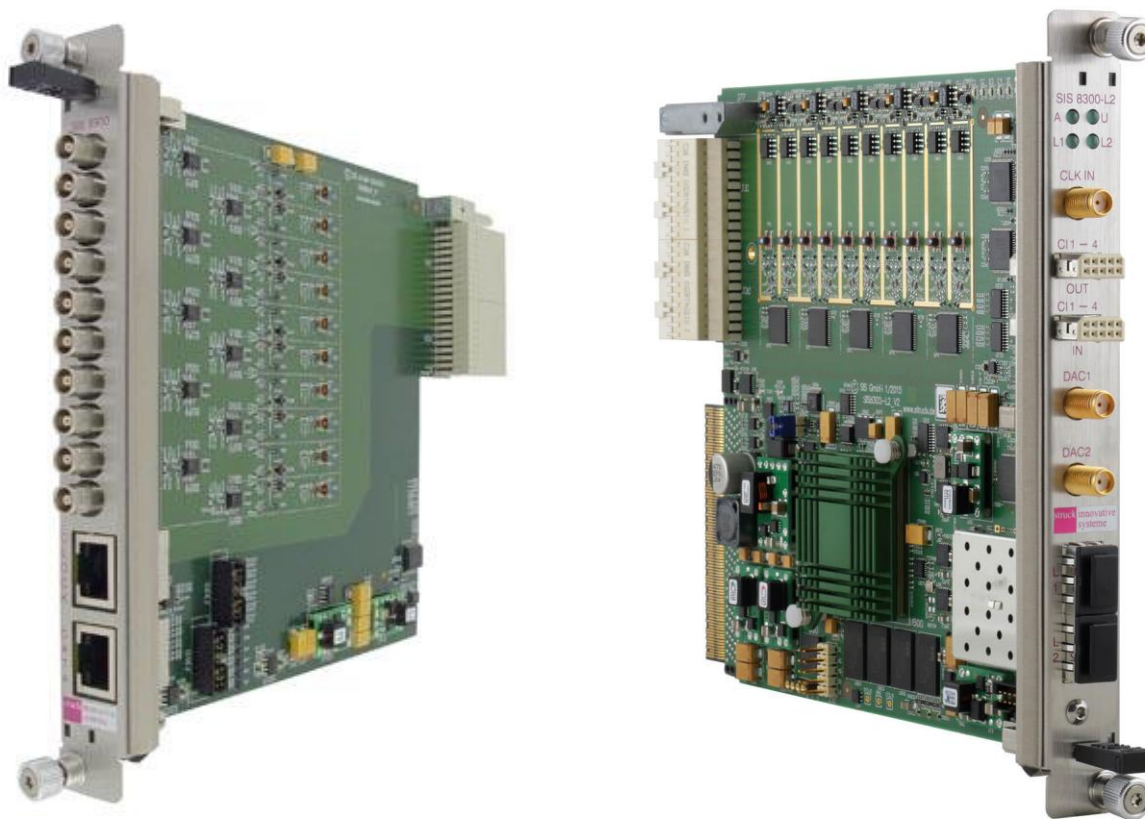
- AMC: FRIB General Purpose Digital Board (53 cards)
- RTM: MPS I/O Board (53 cards)
- Up to 132 I/O channels for 44 devices in 1 U



MTCA.4 Hardware at FRIB III

■ Beam Current Monitors

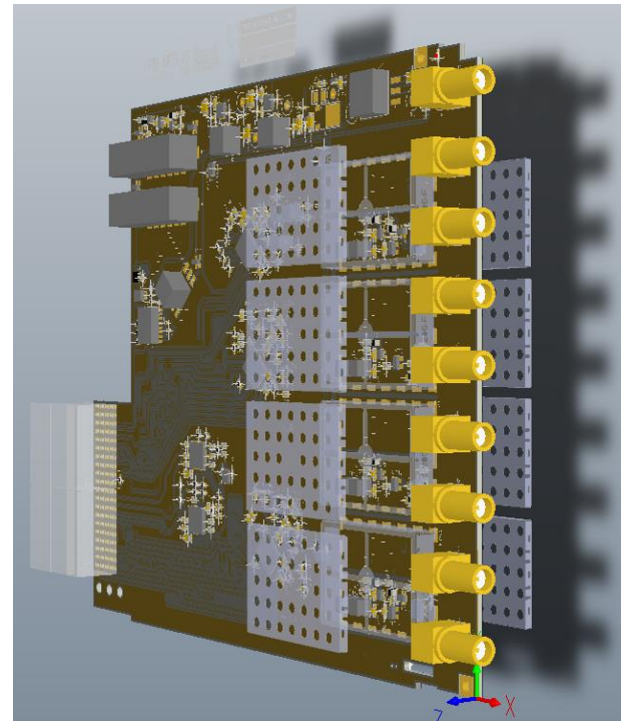
- AMC: Struck SIS8300-L2 (3 cards)
- RTM: Struck SIS8900 (3 cards)



MTCA.4 Hardware at FRIB IV

■ Beam Position Monitors

- AMC: FRIB General Purpose Digital Board (~75 cards)
- RTM: based on FRIB LLRF “RTM” (~75 cards)
 - » 9 channels (2 BPMs + RF reference)



MTCA.4 Hardware at FRIB V

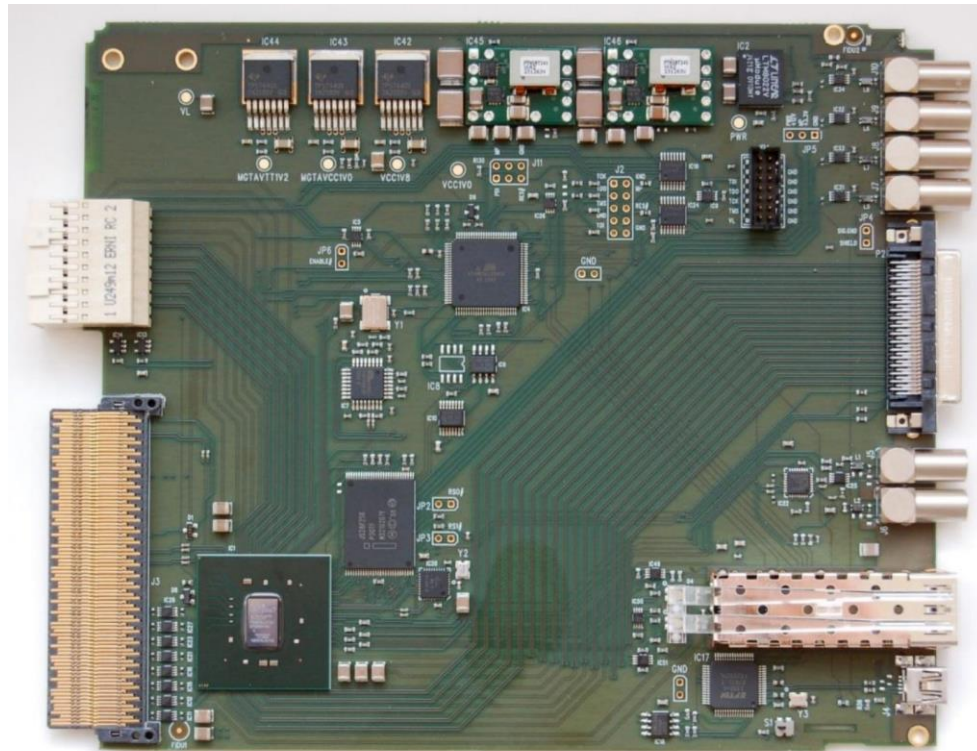
- Beam Loss Monitors/Faraday Cups/Profile Monitors
 - AMC/FMC: Testing CAENels AMC-PICO-8 picoammeter (~50/100 cards)
 - Analog bandwidth has been improved to 50-70 kHz
 - Working with CAENels to develop a 1 kV variant of the card (so far ≤ 300 V)
 - » 1 MS/s, up to 1 mA



MTCA.4 Hardware at FRIB VI

■ Timing

- We are considering the new Micro Research Finland AMC as an event receiver for our diagnostics MTCA.4 chassis
- FGPDB might be an alternative



Generating FRU EEPROM Images

- We need to generate binary images for the FRU EEPROMs on our AMCs/RTMs
- Problem:
 - We want to use Continuous Integration which rules out most tools on the market
 - We want to avoid signing an NDA/paying license fees/vendor lock in
- We did not find a tool out there that met our requirements so we developed our own

GenerateFRUStorage

■ Highlights

- Support for AMCs/RTMs
- Runs from command line (easy to automate)
- Translates a JSON input file into binary
- Support for E-Keying
 - » Ethernet
 - » PCIe
 - » Clocks (!)
- C++, object oriented, modular, easy to extend
- Very good unit test coverage
- Support for building Debian packages
- Open Source (patches welcome!)

■ Downsides

- Needs to be compiled before it can be used

■ <https://stash.nscl.msu.edu/projects/MTCA/repos/generatefrustorage>

Summary

- FRIB will use MTCA.4 hardware for some sub-systems
 - Mix of COTS and in-house developed hardware
- In-house developed hardware
 - FRIB General Purpose Digital Board
 - Machine Protection System RTM
 - Beam Position Monitor RTM
 - Beam Loss Monitor and Picoammeter Analog Board (under development with CAENels)
- For cost reasons some systems will use MTCA.4-compatible boards in pizza boxes
- GenerateFRUStorage generates FRU EEPROM images for AMCs/RTMs