CNPEM
Brazilian Center for Research
in Energy and Materials

Brazilian Synchrotron
Light Laboratory

Status of MicroTCA.4 Technology at Sirius

MTCA Workshop 2020 – Hamburg (Virtual)

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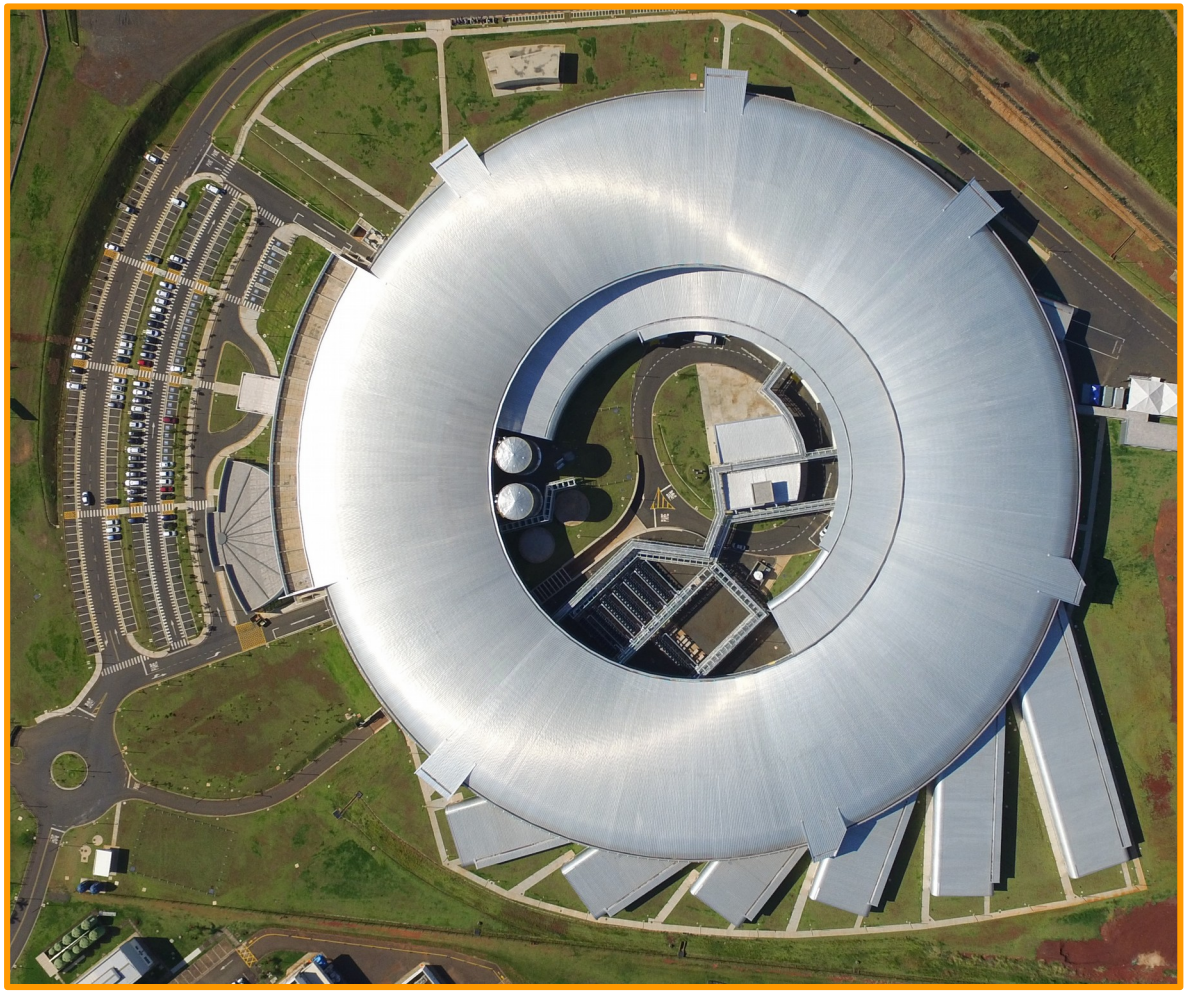
December 1st, 2020

Sirius – the 4th generation light source in Brazil

Outline

- MicroTCA.4 at Sirius
- AMC FMC Carrier
- New Developments and Highlights
- openMMC
- Integration to Control System
- Operations Experience
- Conclusion



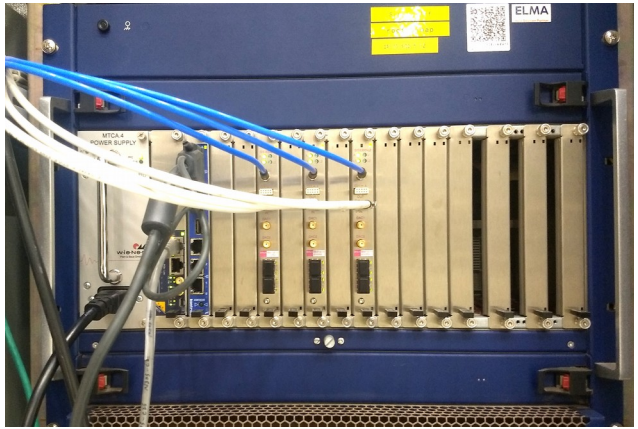
Sirius

- 4th generation synchrotron light source
- Natural emittance 0.25 nm.rad at 3 GeV
- Diffraction-limited for 10 keV photons

MicroTCA.4 at Sirius

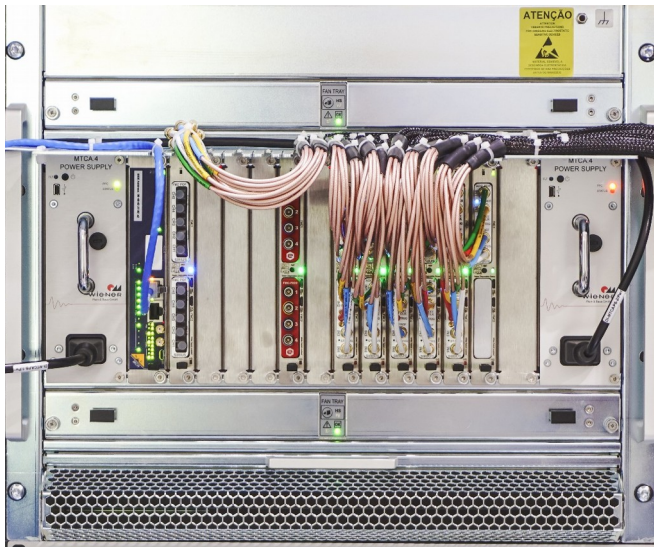
- **LINAC LLRF Crate – provided by SINAP**
  - 3x Struck SIS8300-L2
  - 3x Struck DRTM-DWC8VM1
  - FPGA gateware and software provided by SINAP

Linac LLRF
1 crate



- **BPM Electronics and Orbit Feedback Crate**
  - Pentair/Schroff 12-slot Crate with JSM
  - N.A.T. PHYS80 MCH + µRTM COMex CPU
  - Wiener Low Noise 1 kW Power Supply (redundant)
  - CAENels FMC-Pico-1M4
  - CAENels FMC-4SFP+
  - **Open Hardware AMC FMC Carrier (AFC)**
  - **Open Hardware FMC ADC 16-bit 250 MS/s**
  - **Open Hardware FMC POF (plastic optical fiber)**
  - **Open Hardware µRTM 8-SFP**
  - **Open Hardware RTM Fast Orbit Corrector Power Supply**
  - **Open source MMC firmware (openMMC)**
  - **Open source gateware and software for controls and data acquisition**

BPM and FOFB
21 crates

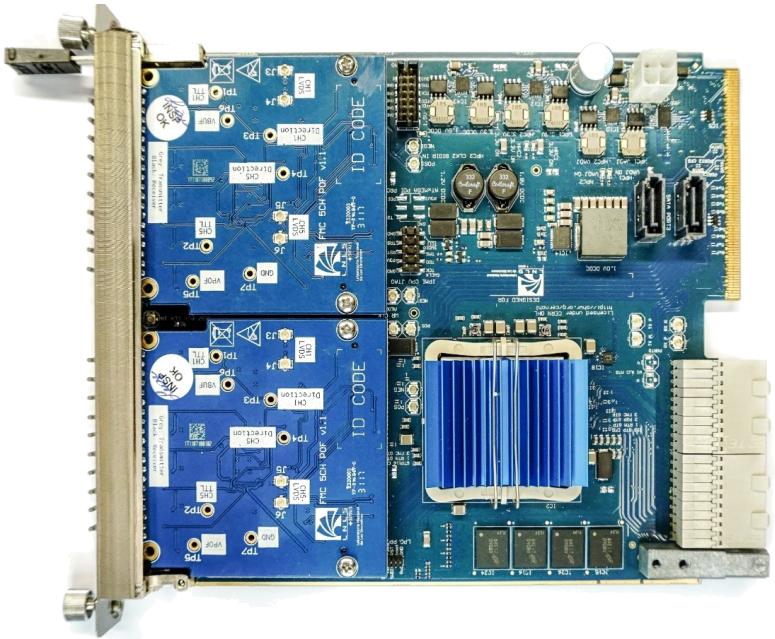


From AFC v3.1 to AFC v4

- **AMC FMC Carrier (AFC)**
  - Cheap: based on Xilinx Artix-7 200T (< 200 USD)
  - Versatile: 2x HPC FMC slots, RTM D1.3 slot, flexible clocking scheme, 2 GB DDR3 memory
  - Open Hardware design available at: https://www.ohwr.org/project/afc

- **AFC v3.1**
  - Needed design improvements
  - Recent evaluation from MTCA TechLab orded by GSI

- **AFC v4**
  - **The project is led by WUT (Mikolaj Sowinski, Tomasz Przywózki and Grzegorz Kasprowicz)**
  - Clean up and other improvements on schematics
  - Replace the JTAG switch (SCANSTA111) with a simpler mechanism to allow access to FMC JTAGs
  - Simplification of I^2C bus
  - Replace ADN4604 (16x inputs, 16x outputs) clock crossbar by IDT 8V54816A (16x bidirectional input/outputs)
  - Reduce board thickness
  - Provide alternative assembly option:
    - Option 1: 2x HPC FMC slots + partially pin assigned RTM
    - Option 2: 1x HPC FMC slot + 1x LPC FMC slot + fully pin assigned RTM slot
  - M-LVDS circuit improvement: higher speed, lower skew



GSI AFC PCIe issue investigation

B. Issues found on AFC Board

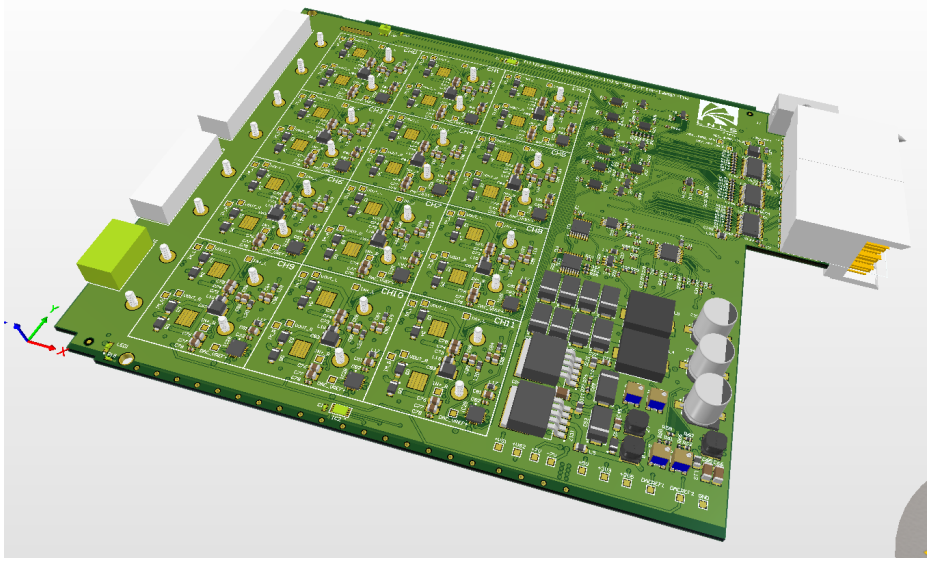
During the measurement/investigation session, many issues of the AFC board were identified that lead to reduced board performance.

Issue	Effect
Wrong termination voltage on clock multiplexer	wrong duty cycle/excessive jitter (not obeserved)
Clock distribution via passive unmatched Y-branch	reflections and marginal signal integrity on clock line (observed)
Connection between chassis and logic ground	violation of the standard, return currents via front panel
Inadequate filtering on `MGTAVTT` power rail (described before)	excessive noise on transceiver power (observed)
Inadequate layout for `MGTAVTT` power rail: single via (described before)	insufficient transient load regulation (not observed)
Shared power rail of `MGTAVCC` and FPGA core power (described before)	excessive noise on transceiver power (observed)
Board thickness violation	violation of the standard
Wrong pull-up resistors for Si570	Si570 can not be programmed
Current leaking between 3V3MP and 12VPP	startup issues of components (not observed)

Courtesy Tobias Hoffmann (GSI)

Fast Orbit Corrector Power Supply - RTM-LAMP

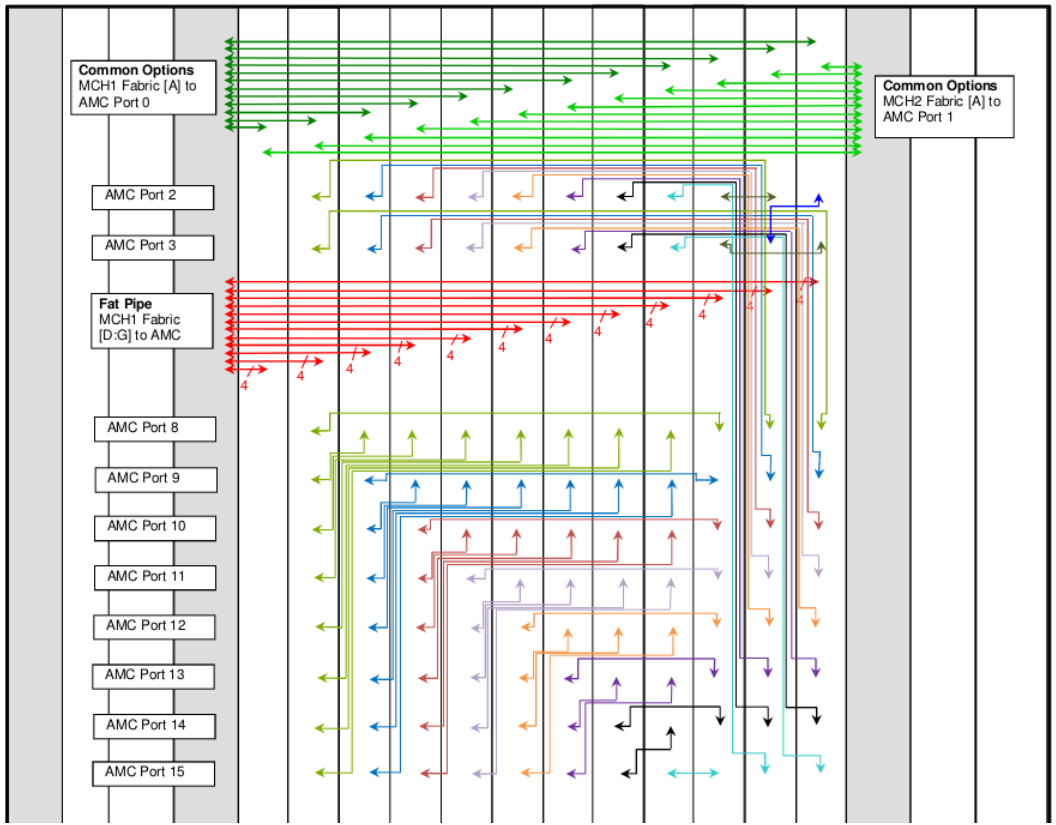
- **Specifications:**
  - 12 channels
  - +- 1 A per channel
  - 10 kHz small signal bandwidth
  - Nominal Load: 1 Ω, 3.5 mH
  - Designed to comply with the MicroTCA RTM specification
  - High efficiency DCDC converter (> 92%)
  - Supports an external 12V power for applications that require more than 36W
  - Can be assembled with a heat sink if necessary
  - First prototype boards expected to arrive at the end of January 2021



- Open Hardware design available at:
  - Hardware: https://github.com/lnls-dig/rtm-lamp-hw
  - Gateware: https://github.com/lnls-dig/rtm-lamp-gw

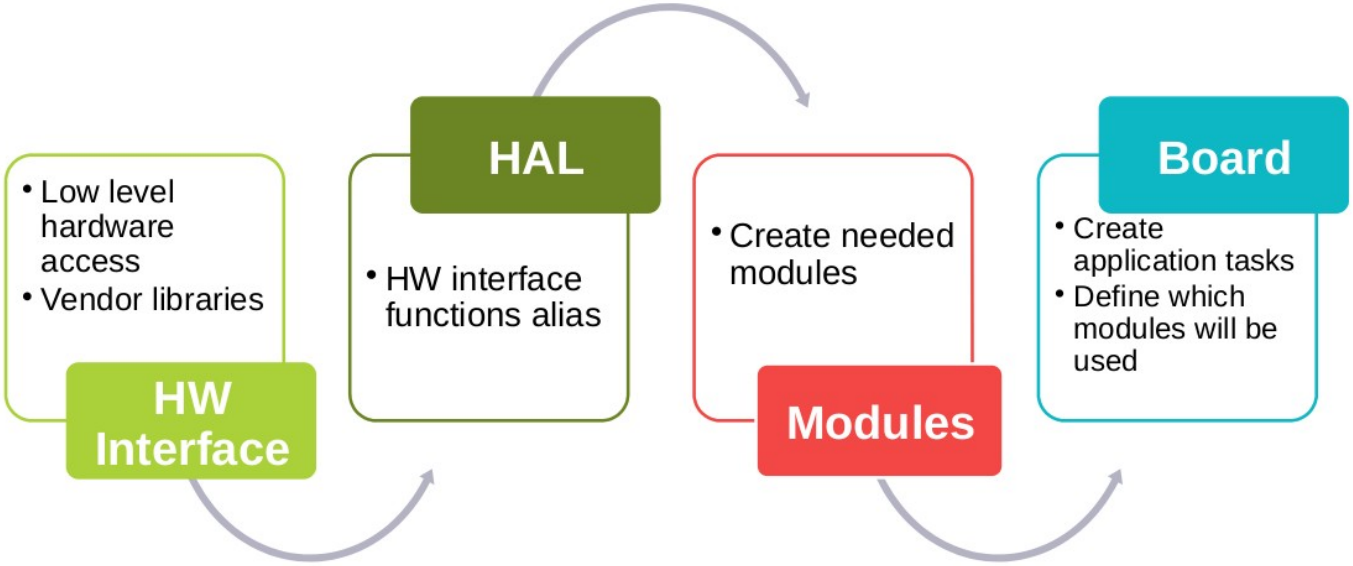
Custom Backplane

- **11-slot full mesh on AMC ports 2-3 and 8-15**



Courtesy Schroff

openMMC

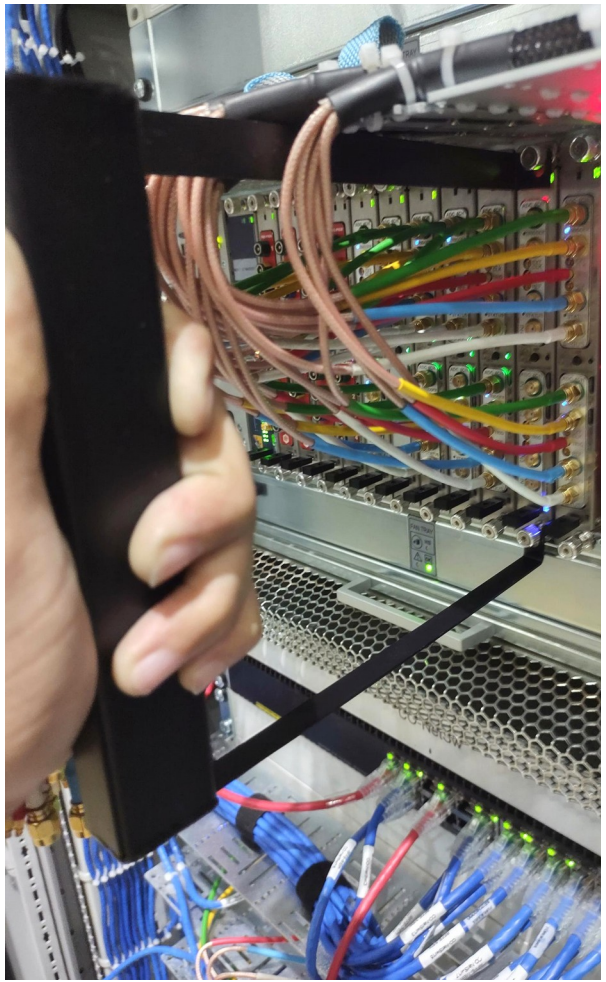


- **openMMC has been adopted by other facilities**
  - openMMC is built on top of FreeRTOS
  - Adopted by Sirius and CERN – collaborative development
  - GPL code available at: https://github.com/lnls-dig/openMMC

Mechanical removal of modules

- Tool for removing AMC modules

Gustavo Bruno
Fernando Cambaúva
Ricardo Fujihira



EPICS Management Interface

- **Heidelberg University's epics-ipmitool [1]:**
  - Depends on external ipmitool
  - Template EPICS database created via iocsh command `ipmiDumpDatabase`
  - Seems unmaintaned

- **SLAC's ipmiComm [2]:**
  - No external dependencies (only the typical asyn)
  - Predictable EPICS database templates already in place
  - Little support at the time (2018-2019)
  - Maintained by SLAC and other partners

- **FRIB's mtca-ipmi [3]**
  - Depends on external ipmitool (breaks compatibility with each version)
  - EPICS database templates already in place
  - Maintained by FRIB
  - Easiest to setup and use (with example GUI for 12-slot crate)

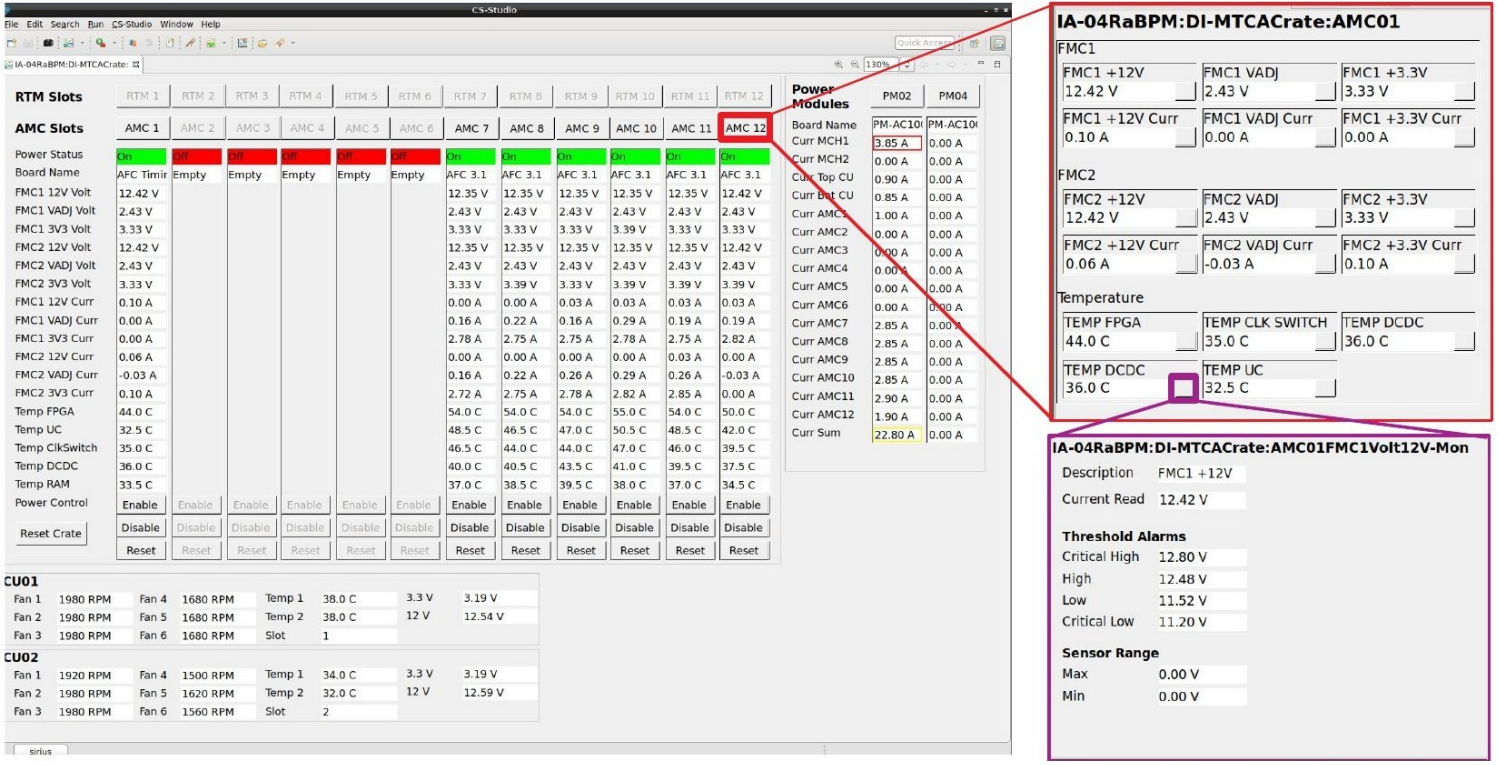
[1] https://github.com/sus-ziti-uni-hd/epics-ipmitool

[2] https://github.com/slac-epics-modules/ipmiComm

[3] https://github.com/frib-bim/mtca_ipmi

EPICS Management Interface

- **FRIB's mtca-ipmi was selected to use at Sirius:**
  - But still searching for a module non-dependant of ipmitool
  - SLAC module (and others) could be revisited in the future



Operations Experience

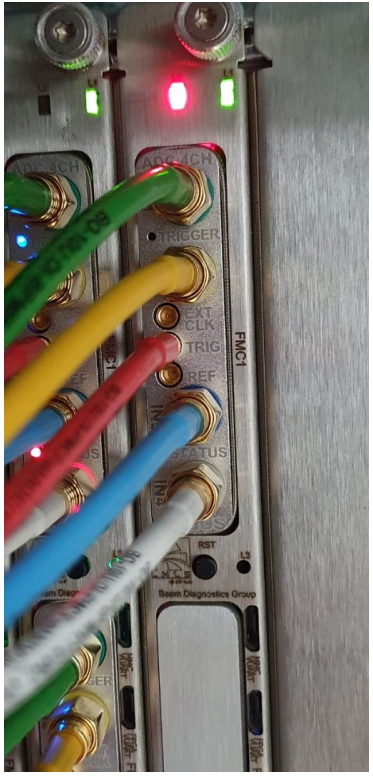
- **µRTM COMex CPU gets stuck from time to time**
  - No entries in syslog and persistent logs in systemd-journald
  - No crash dump when using kdump
  - MCH notices no failure – all sensors are good
  - No ping response, no display port nor USB ports activity

- **MCH gets stuck from time to time**
  - ssh, telnet and web interface is unresponsive
  - Only restored after power cycle

- **AFC spontaneous resets**
  - Sporadic power cycle
  - Reconfigures FPGA
  - PCIe link goes down and up

- **AFC loses communication with MCH**
  - Only recoverable by **hard_reset** command

- **One of a kind mysterious event**
  - AFCs from 3 distant crates (different machine sectors) simultaneously fail
  - MCH reports overcurrent when trying to power cycle the boards – **hard_reset** doesn't help
  - Only recovered when redundant Power Module was manually powered on – remote commands have no effect



Conclusion

- **MTCA.4 crates are routinely used in operations of all Sirius machines**
  - Linac: LLRF
  - Transfer lines, booster and storage ring: electron and photon BPMs, Fast Orbit Feedback, energy ramp power supplies' timing
- **Standardized hardware platform allowed system evolution by mixing open hardware and COTS modules**
- **Open source MMC code (openMMC) was key to improve system reliability**
- **Special 11-mesh backplane for low latency feedbacks**
- **New developments:**
  - RTM Fast Orbit Corrector Power Supply – RTM-LAMP
  - Module mechanical extractor
  - AFC v4 (led by WUT)
- **Many open issues to be tackled – machine operations are significantly impacted by MTCA.4 crates failures**

Thank you!

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