# Cryring BPM

Development of MicroTCA.4 bunch position measurement system for Cryring@ESR

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## **Agenda**

- Motivation
- Base platform
- MMC firmware
- Beam Position Monitor
- Tools
- Summary



#### **Motivation**

Experimental storage ring with new bunch position monitor \_\_\_

system (8X + 8Y)

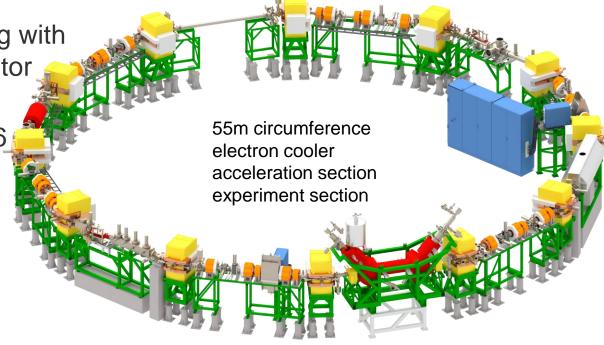
Commissioning mid 2016

AMC/MicroTCA.4

ANSI/VITA FMC

WhiteRabbit timing

Front-end software architecture (FESA)



CRYRING@ESR
the heavy ion storage ring
formerly located at
Stockholm University,
Swedish in-kind contribution to FAIR



#### **Base platform**

2013-01-28

Platform ordered

2013-02-28

Expected hardware delivery

2014-12-10

Arrived to GSI

2015-03-02

Position calculation algorithm tests with hardware

2015-06-15

 Tests and design verification finished



- 8U MicroTCA.4 chassis (VT811)
- 500W power supply (UTC017)
- MCH Vadatech (UTC002)
- CPU Concurrent (AM 902/411)
- 6x AFCv2
- 9x FMC ADC 250M 16b 4cha
- 1x FMC DIO32



#### **Work Order**

- MMC (Module Management Controller)
- 2. HDL design improvements
  - ADC initialization
  - DDR3 memory
  - PCI Express

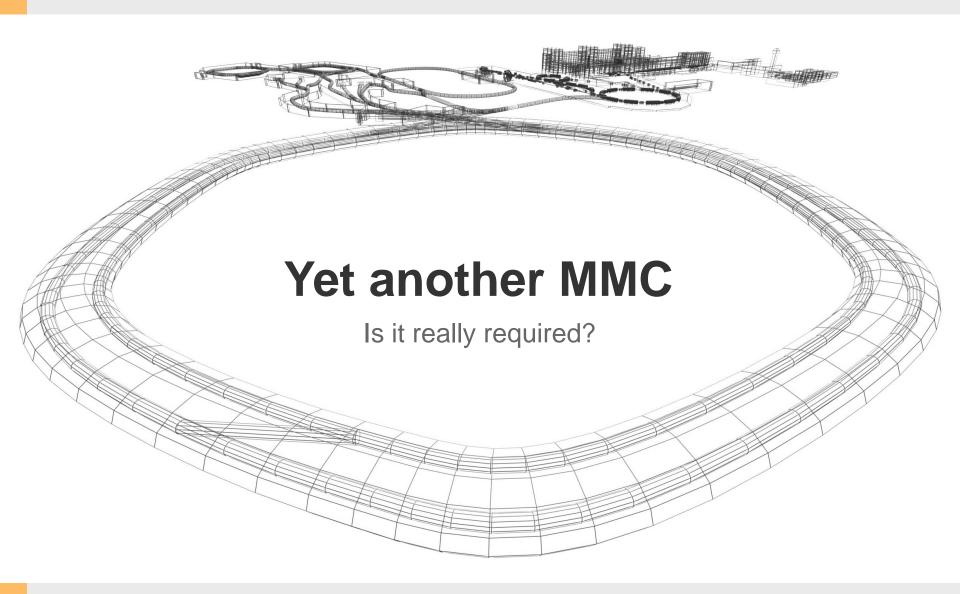


"There's only one way to do the job, the right way. My way\*"

Gus

\*Includes collaboration







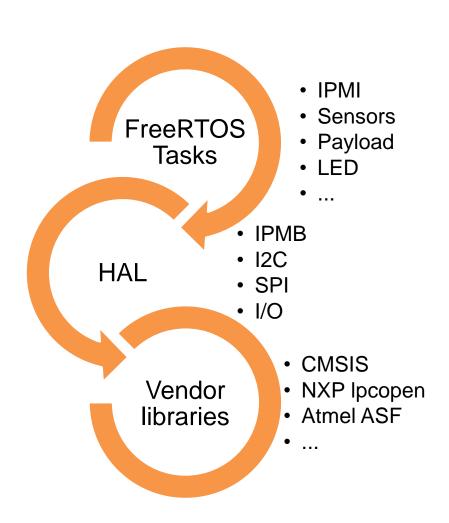
#### **MMC - Existing implementations**

- Original AFCv2 firmware (LPC1764)
- CoreIPM (LPC2368, MSP430)
- University of Wisconsin (UC3A1512)
- DESY (ATxmega128A1)
- DESY/CERN (ATmega128)
- Vadatech (32bit RISC ???)
- N.A.T. (ATxmega128A4U)
- Kontron (LPC2136)
- •



## **MMC** - firmware requirements

- Reliable
- Portable
- RTOS based
- Extendible
  - sensors and drivers
  - New OEM commands without any modification to MMC core
  - Additional user task
- Community based development model
  - GSI (Germany)
  - Creotech (Poland)
  - Warsaw University of Technology
  - LNLS (Brazil)
- IPMI debug channel to Wireshark





## MMC – architecture comparison

	Cortex-M3	AVRxmega
Architecture	32bit	8bit
Bit Band regions	1MB + 1MB	Partial
Internal RAM	Up to 512MB	Up to 56KB
External RAM	Up to 1GB	Up to 16MB
Memory space	Unified	Two (Flash/Data)
Multiple stacks	Yes (MSP/PSP)	No
SVC/PendSV	Yes	No
System Timer	Yes	No
Memory Protection Unit	Optional	No
Bootloader protection	No	Yes
Used by	Advantech	N.A.T., DESY, CERN(AVRMega)

<sup>\*</sup>ARM7 is used by denx-cs, CoreIPM, kontron, and many other

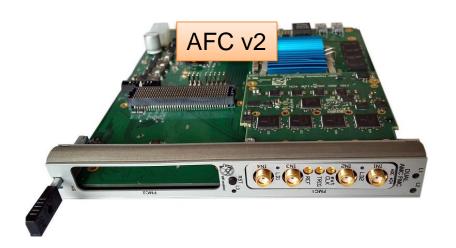


#### MMC - added features

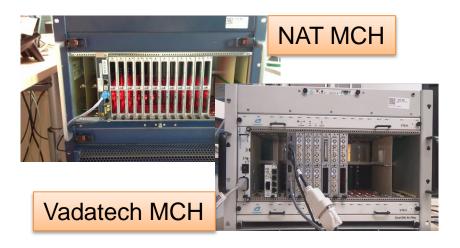
- IPMI
  - requests triggers handlers with well known API
  - stored as table of pointers (created during linking stage)
- Sensors
  - array of sensors with pointers to callbacks
- FRU
  - stored as array of chars
  - created with external tool
  - replace without recompilation
- Payload
  - power sequence different for each board
- Replaceable User Tasks and IPMI



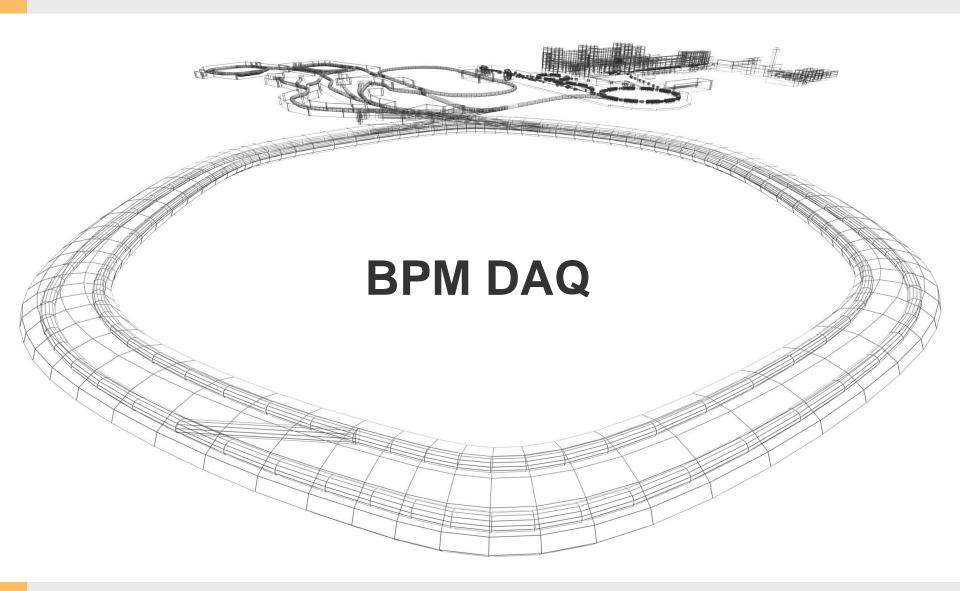
## **MMC** - supported boards





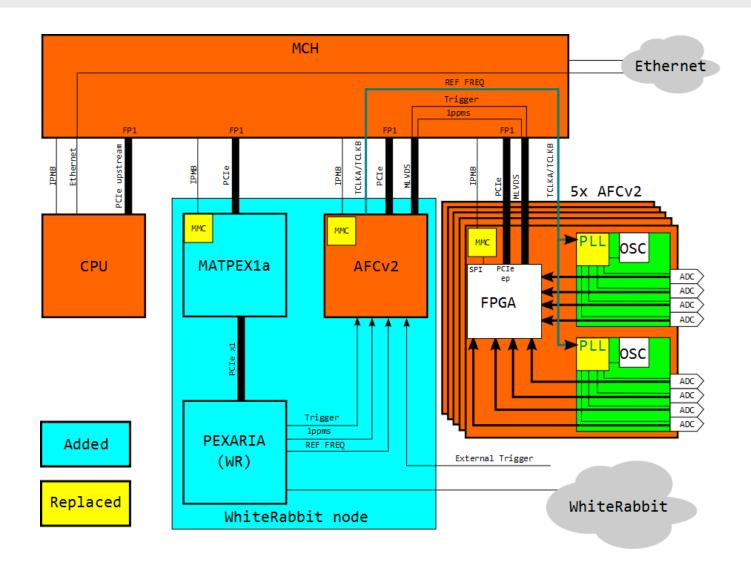








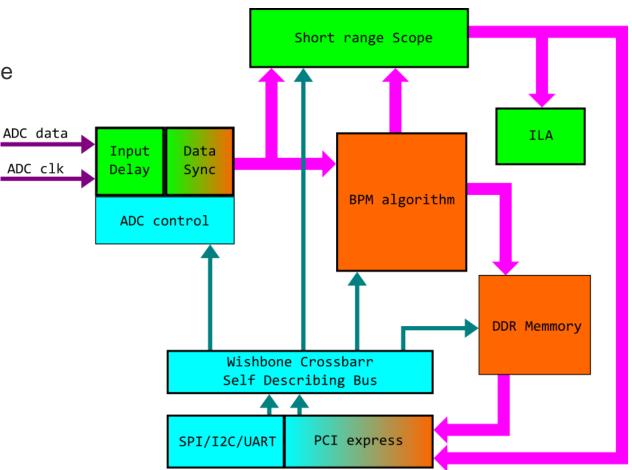
#### **BPM DAQ - crate setup**



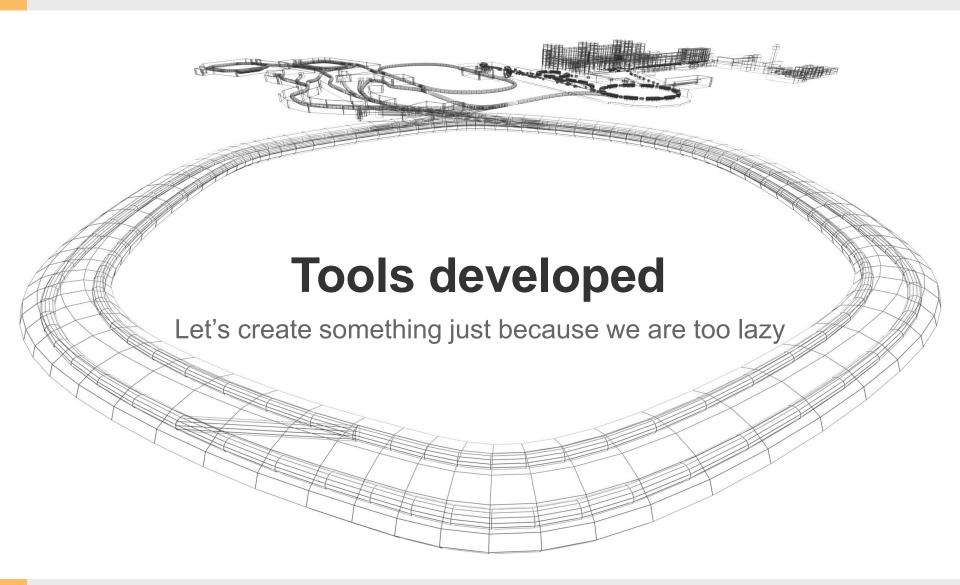


## **BPM DAQ – HDL block design**

- AMC/MicroTCA.4 features:
  - TCLK: ADC reference frequency
  - MLVDS: Trigger / Interlock
- Wishbone + SDB
- Two masters
  - UART
    - SPI
    - I2C
    - PCI-Express
- Separate path for processing data
- Short range scope mode







# Tools developed IPMI and I2C sniffer

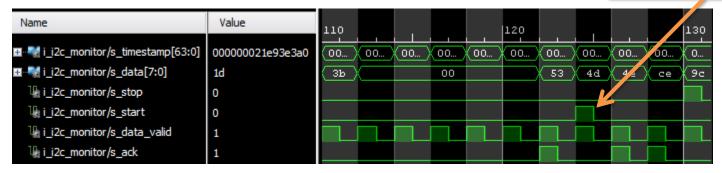


- RedPitaya based standalone sniffer for arbitrary
- IPMI logs channel over UART
- Operation modes:
  - Logic analyzer
  - Wireshark



RedPitaya board

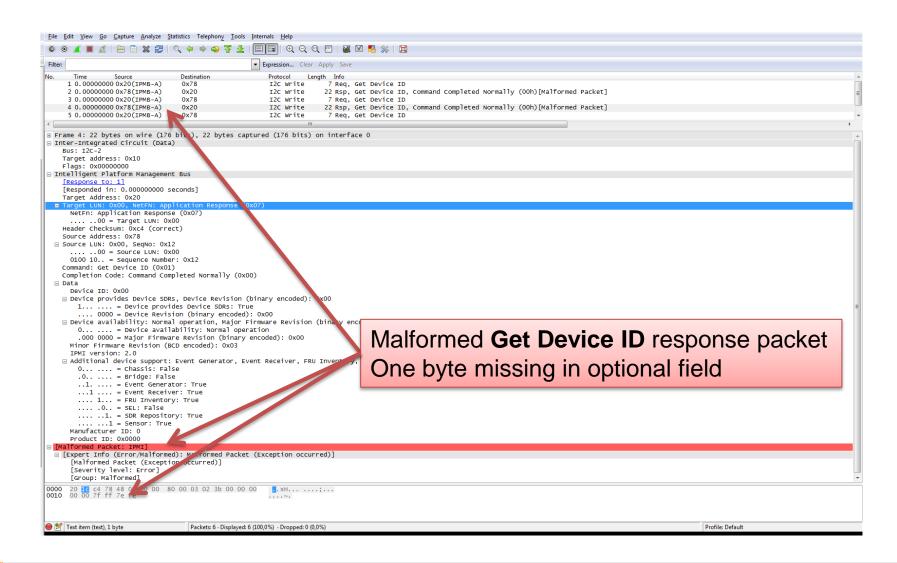
Reapeated start



Logic analyser view

# Tools developed IPMI and I2C sniffer – Wireshark mode

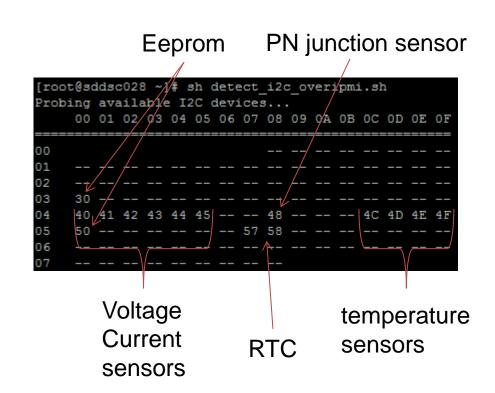




# Tools developed ipmitool wrappers



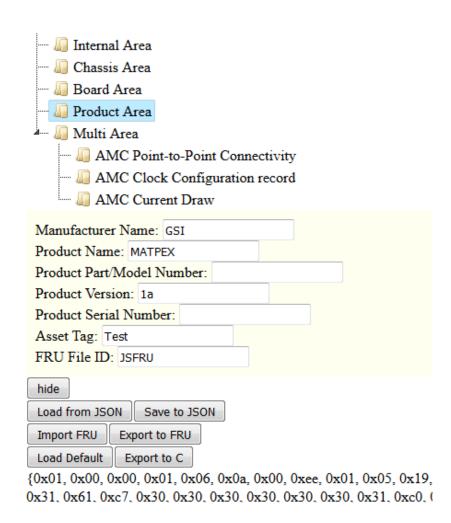
- I2C
  - i2c transfer
  - i2c detect
- SPI
  - SPI/Flash reader/writer
  - Wishbone access
  - DPRAM access
- IO
  - MMC IO state view and change
- clock resources configurator
- ADC board initialize



# Tools developed FRU editor



- HTML5 and JavaScript based
- Data import/export
  - binary
  - JSON
  - C array (export only)
- Allows to define:
  - Internal Area
  - Chassis Area
  - Board Area
  - Product Area
  - AMC Current Draw
  - AMC Point-to-Point connectivity
  - AMC Clock Configuration record
- FMC and RTM FRU support planned





#### **Project summary**

#### Finished:

- MMC IPMI
- System hardware delivered
- AFC Master board firmware
- WhiteRabbit timing node prototype

#### TODO:

- AFC ADC boards firmware (FPGA)
- DDR3 memory IP Core (FPGA)
- PCI Express IP Core (FPGA)
- Safe firmware upgrade (MMC)
- Flexible build system (MMC)
- FESA class and data acquisition software

