MTCA/ATCA Workshop 2019

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Keynote

Open Standard Solutions for High Energy Physics

Open Standard
Unlimited Possibilities
Sources of Information

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Open standards for High Availability Applications

High Energy Physics particle accelerators, 5G base-stations, mission deployed RADAR, High-precision measurement have all in common:

MTCA.4 with 4,400W power supply

"Reproduced with Permission, Courtesy of Keysight Technologies, Inc."

MTCA.3 licensed to fly system

THEY CAN'T AFFORD TO FAIL

Scalability

The VPX and XTCA are modular architectures like VME, cPCI and others. While there is a standard mechanical, environmental, or electrical specifications, the function of the module is flexible (DSP, FPGA, IO, Power, switch, …).

The level of potential scalability is mainly defined by the enclosure and the expansion Inputs/Outputs.

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Interoperability

Both the users in Defense and other industries are mandating improved implementation of open standards and interoperability. VME, VPX (VITA) and CPCI, XTCA (PICMG) specifications have been focused at the board level, and system-level requirements to improve interoperability and reduce customization, testing, cost, and risk.

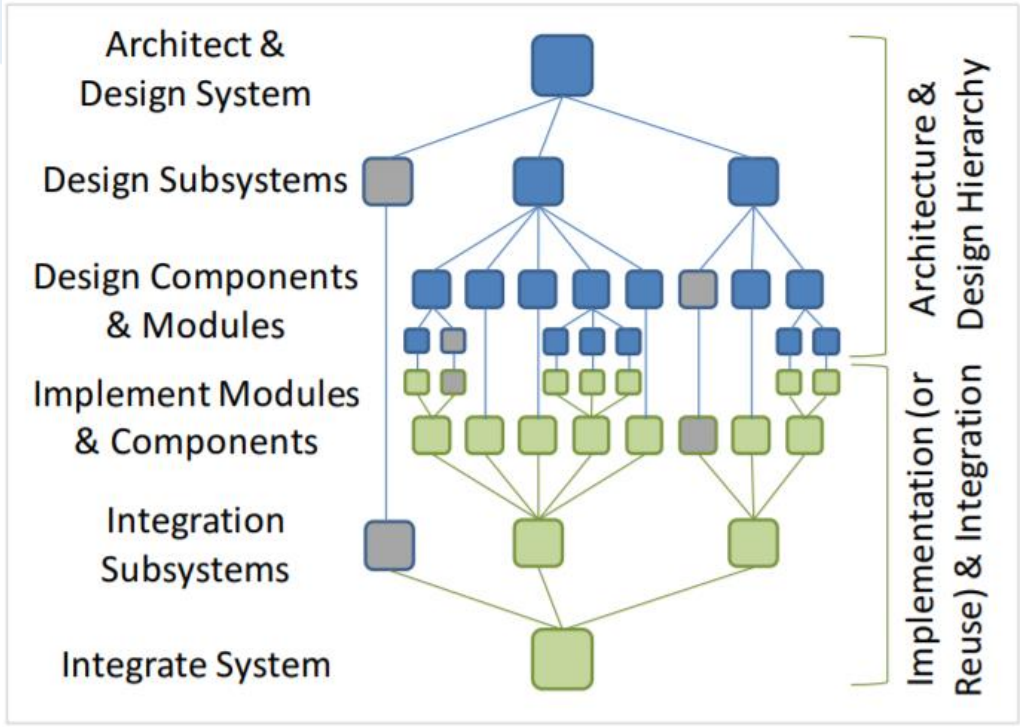
Open standards such as VME, CPCI, OpenVPX and XTCA aims at defining interoperability points. Open standards are developed by standards organizations that have hundreds of members with an extremely diverse technical talent base interfaces, they are completely documented and accessible within the community of interest, and can be implemented by different organizations without royalties.

Affordability

Why a complex integrated system built on non-open standard system has higher chances to be much more costly?

Over budget and exceeded schedules due for example to:

- Architecture is manual and informal
- Element specifications can be misinterpreted by teams
- Element and interface specs have ambiguities, errors, or inconsistencies, and acceptance criteria are not "executable"
- Engineers interact better in small groups
- Micro-cultures form, and diverge
- Our languages are imprecise
- Understanding is the projection of the truth onto each individual's "basis set" of pre-dispositions, talents, and experience
- Engineers look for a technical solution



MOSA by SwRI

There are more solutions based on open-standard deployed out there than what you would think…

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Muon g-2

Fermilab Muon g-2

The Muon g-2 experiment, located at the U.S. Department of Energy's (DOE) Fermi National Accelerator Laboratory, has begun its quest for phantom particles. According to BNL, "On May 31 2017, the 50-foot-wide superconducting electromagnet at the center of the experiment saw its first beam of muon particles from Fermilab's accelerators, kicking off a three-year effort to measure just what happens to those particles when placed in a stunningly precise magnetic field. The answer could rewrite scientists' picture of the universe and how it works".

Credit: Fermilab

Transport of the Muon g-2 rings from Brookhaven National Laboratory in New York *over* land and sea to Fermi National Accelerator Laboratory in Illinois.

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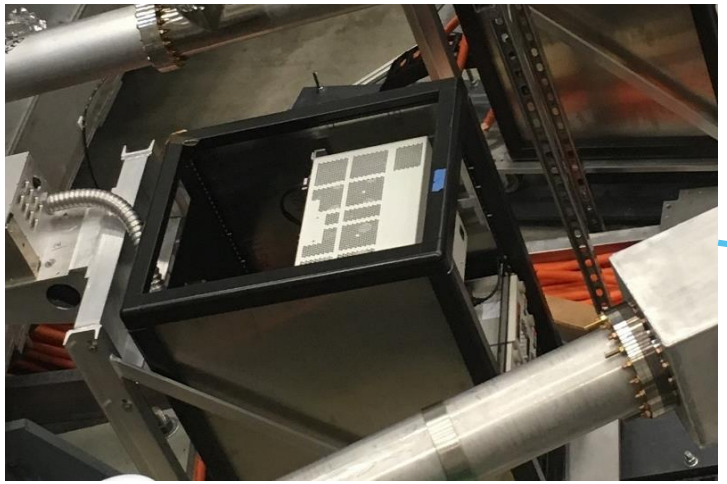
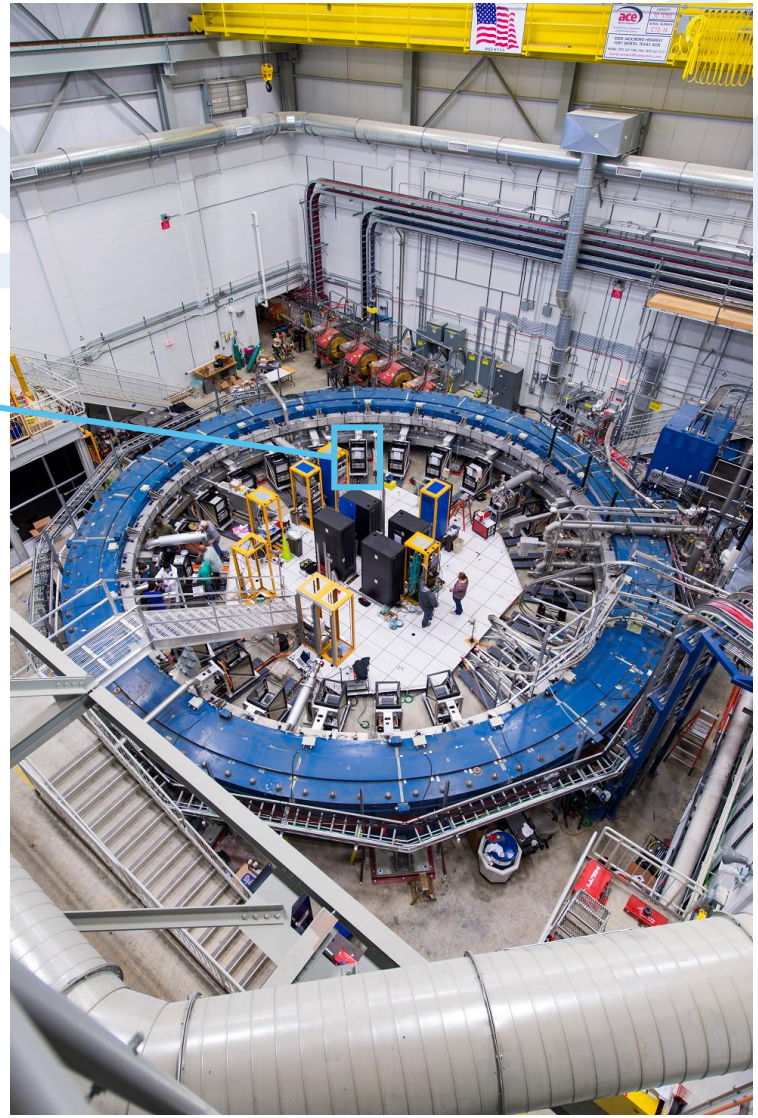
Standard MTCA at Fermilab Muon g-2





MicroTCA VadaTech 19” 7U chassis are turned inward and installed in each rack inside the circumference of the Muon g-2 ring. VadaTech supplied also some modules installed in these chassis in 2017.

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EPICS

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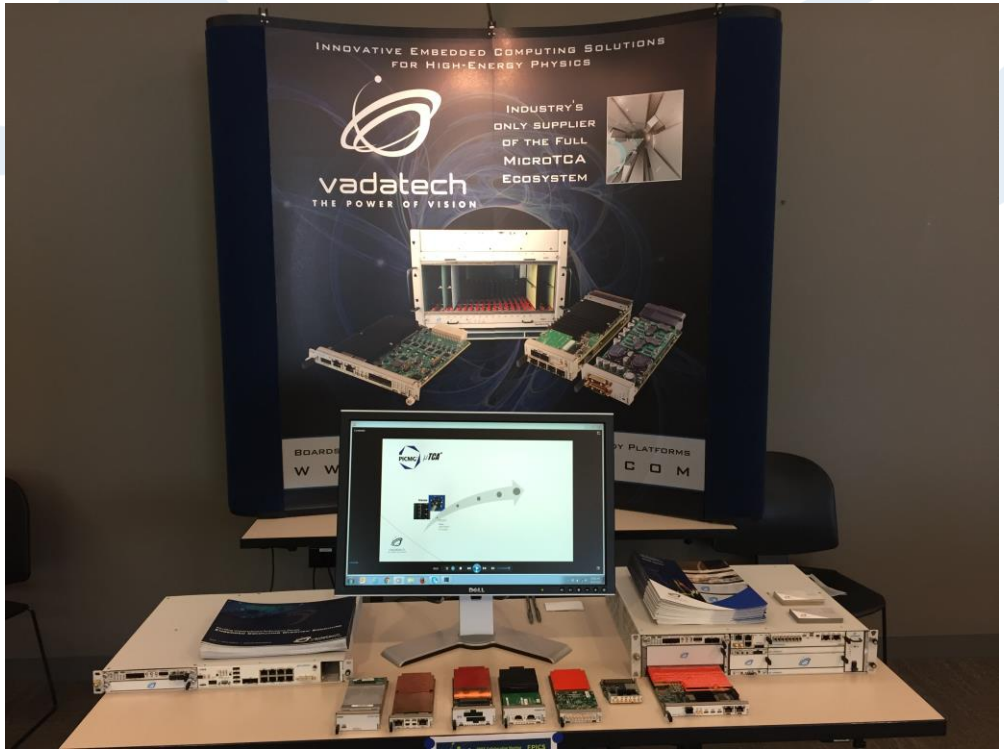
Standard MTCA and standard EPICS – EPICS Summit 2018 at Argonne Lab

We were very impressed with the DAQ523 system when it arrived with EPICS support. Within a day or so we were compiling all of the source files and had the EPICS IOC running acquiring data from the Analog Devices AD9653 ADC's.

We were able to capture some very nice data on the last studies day before the accelerator was shutdown for one of our scheduled maintenance periods.

[Argonne Lab, 2018]



VadaTech booth at the 2018 EPICS summit

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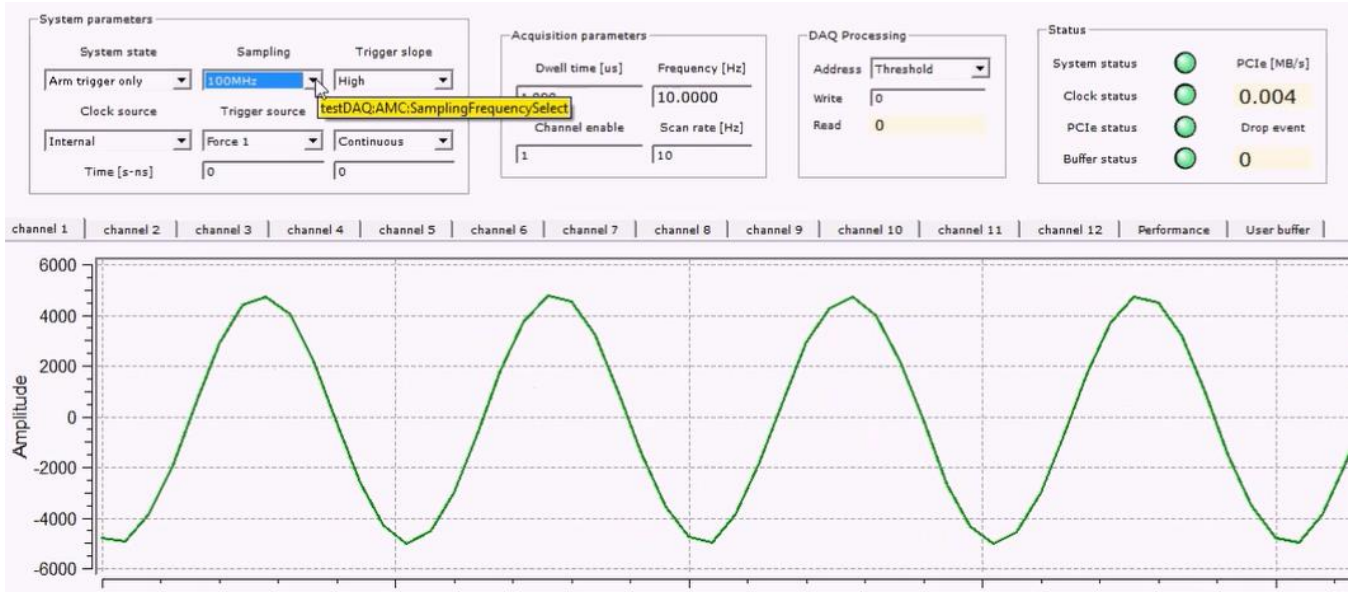
EPICS IOC – Open-Source SW on Open-Standard HW

EPICS is a set of Open Source software tools, libraries and applications developed collaboratively and used worldwide to create distributed soft real-time control systems for scientific instruments such as a particle accelerators, telescopes and other large scientific experiments.

VadaTech developed and supports EPICS IOC drivers on their digitizer and converter. Scientific Linux is also supported.



Spallation Neutron Source
MPS

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Oak Ridge National Laboratory – Spallation Neutron Source

The Spallation Neutron Source (SNS) provides one of the most intense pulsed neutron beams in the world for scientific research and industrial development.

The Machine Protection System (MPS) consists of multiple field “nodes” distributed throughout the accelerator facility. The primary function of each node is to interface with a group of sensors. If a sensor indicates an error, the node immediately reports the fault information to the master controller.

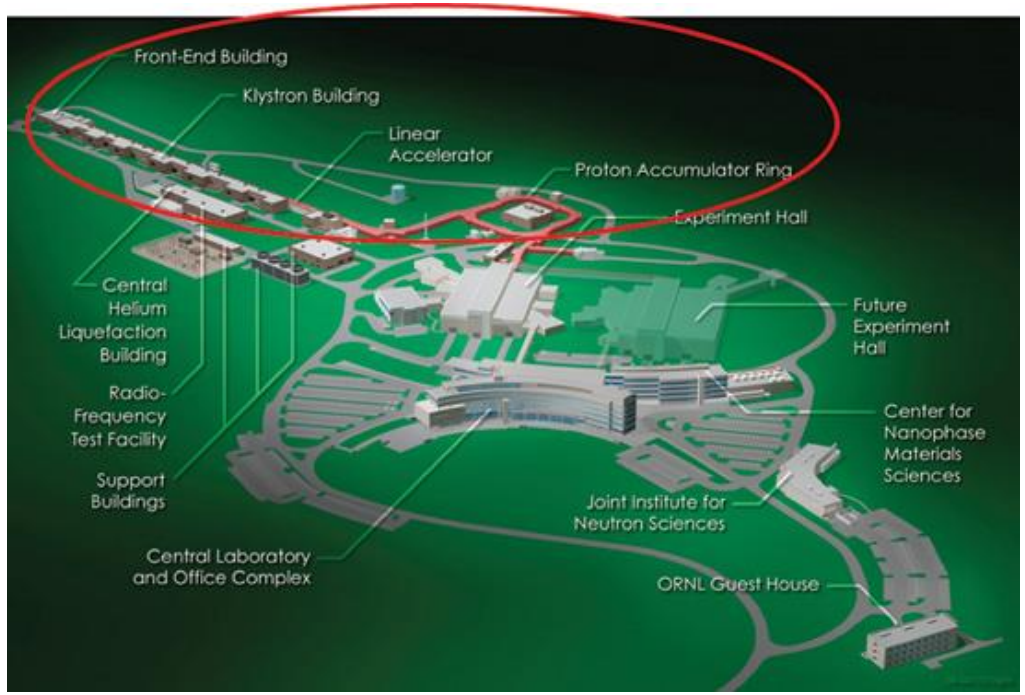

Figure 1: Oak Ridge National Laboratory’s Spallation Neutron Source Uses a Linear Accelerator and Accumulator Ring to Generate a 1.4MW pulsed proton beam.

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Oak Ridge National Laboratory – Spallation Neutron Source

Any one of the Node Processor (NP) blades must communicate a “terminate-beam” message to the BC blade immediately upon receipt of a fault packet from a down-stream field node. Using the crossbar has demonstrated consistent 640 ns transfers between blades using a 16-byte UFC message.

VadaTech designed and supplied in 2017 the unique configurable crossbar switch solution for deterministic, low-latency inter-blade communications.

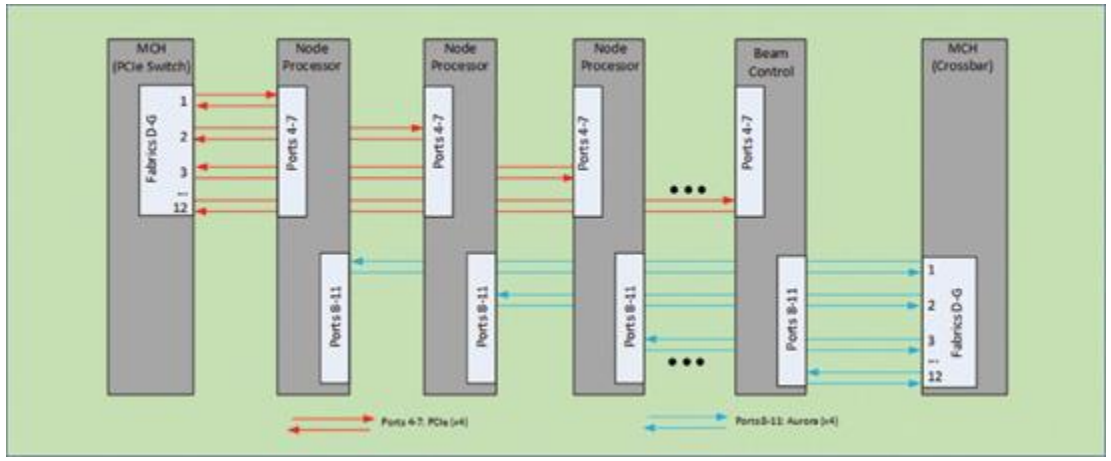

Figure 2: MPS Master Controller’s Utilization of the MicroTCA Backplane and VadaTech MCH with CrossBar Switch

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KSTAR

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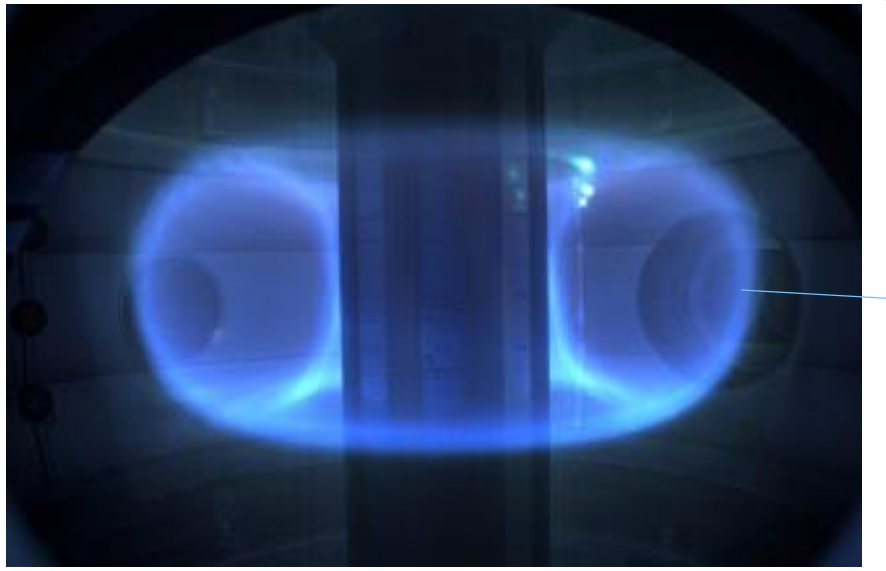
NFRI- KSTAR power generator control system

KSTAR is the world-class superconducting tokamak developed and constructed by Korean domestic technology. In January 2019 Korea announced that KSTAR magnetic fusion reactor Reaches Ion Temperature of 100 Million Degrees for First Time.



http://www.businesskorea.co.kr/news/articleView.html?idxno=29116

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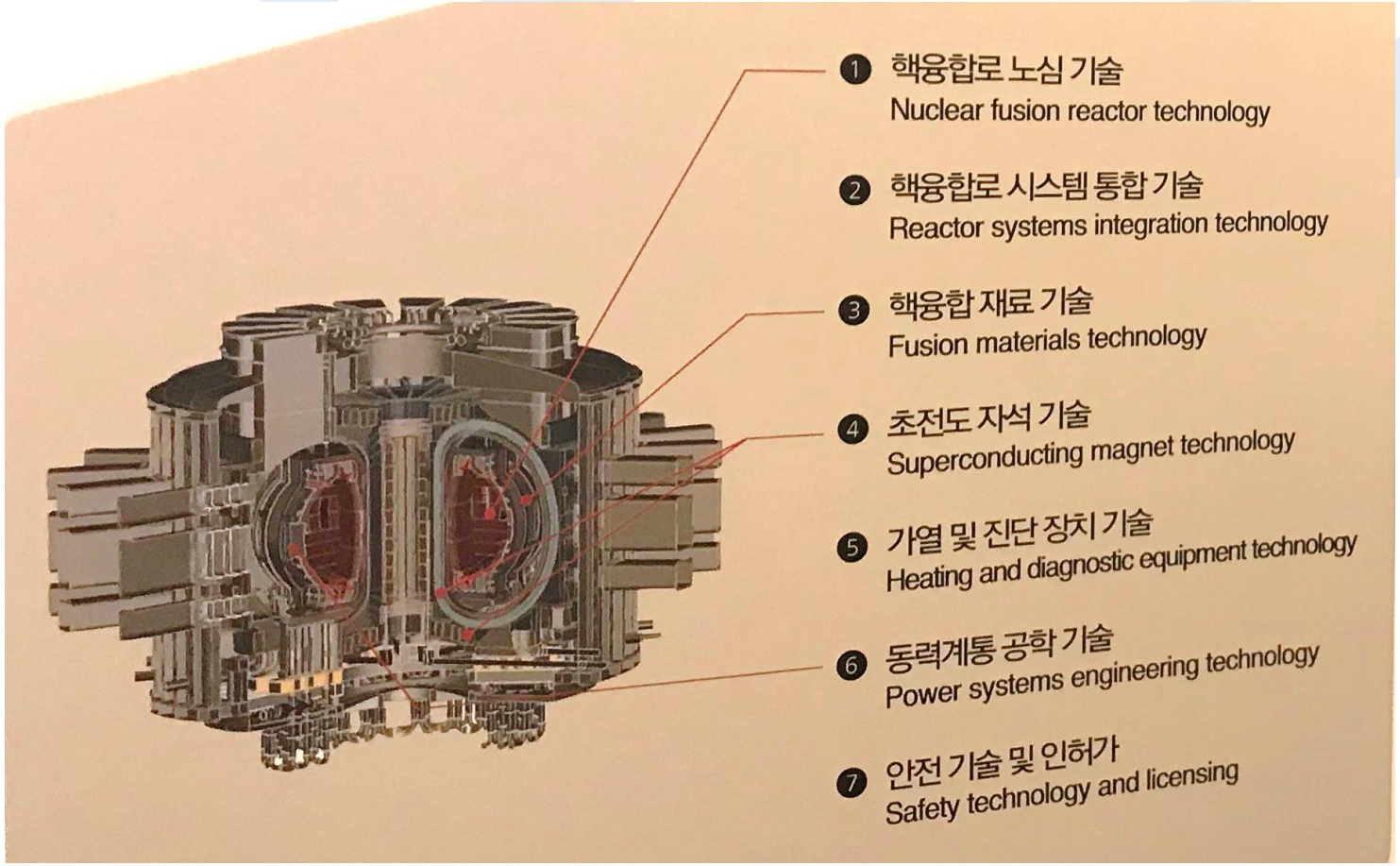
NFRI- KSTAR power generator control system

The Superconducting Magnet system consists of 16 TF(Toroidal Field) coils and 14PF(Poloidal Field) coils.

The power supplied to the magnet indirectly defines the position of the plasma.

VadaTech supplies and supports the manufacturer of the system which control the power allocation to the magnet.



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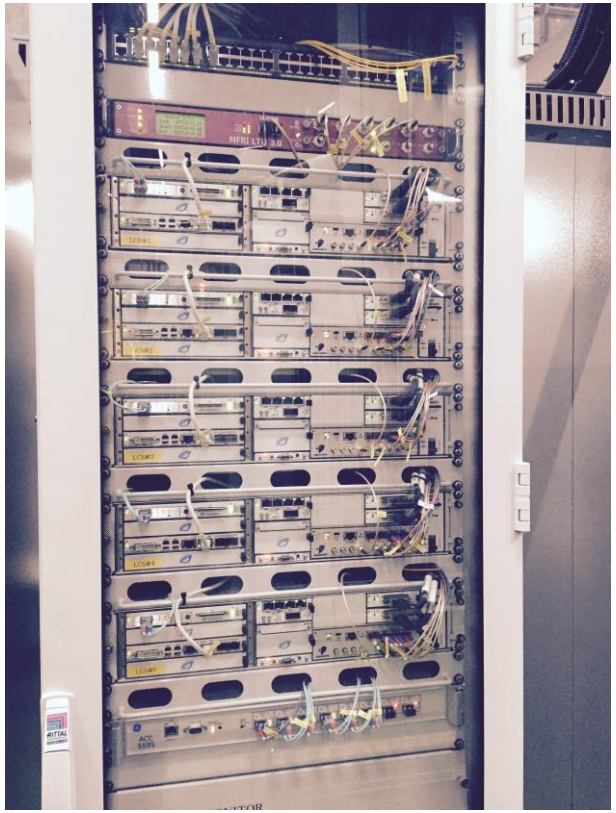
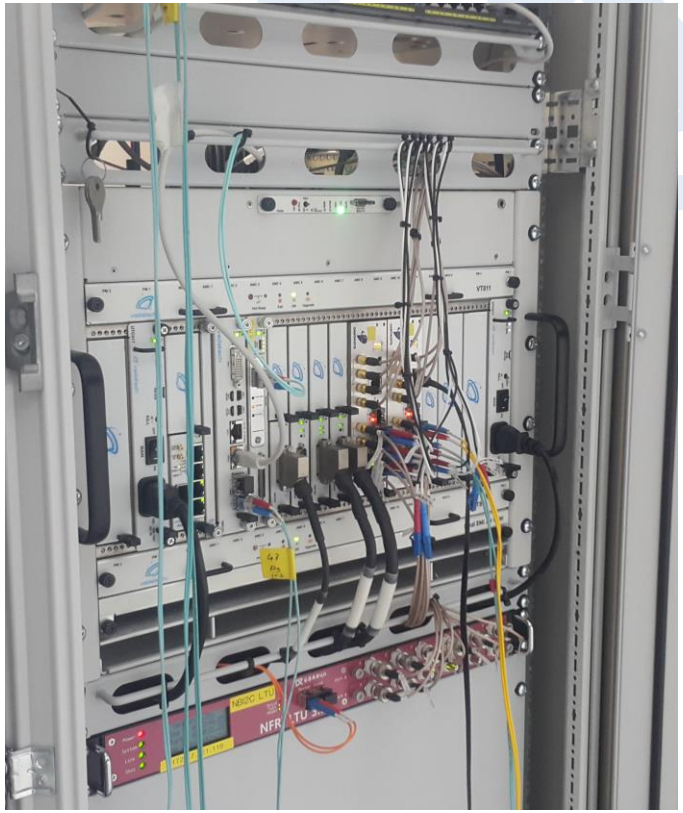
NFRI - KSTAR NBI-1 and NBI-2





MTCA based loop controller of the plasma position via allocation of the power to the Superconducting Magnet

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Possible Sources of Information: Users, Integrators, Vendors, Manufacturers

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Cross-check information between Integrators/Users and Vendors/Manufacturers

Platform Selection: ATCA vs uTCA

SLAC

- ATCA and uTCA both have many variants
  - We are comparing SLAC's common platform ATCA and uTCA as used in DESY
  - uTCA assumes PCIe backplane
  - ATCA assumes Ethernet backplane
  - ATCA assumes AMC carrier with JESD interface to FPGA
- ATCA is a mature standard with industry acceptance and support
  - Many sources for crates, power supplies, switch cards and shelf managers
  - Strong competition lowers cost and increases availability
- uTCA.4 is a new standard in a niche market
  - uTCA is a later offshoot standard from ATCA
  - uTCA.4 is a variant on uTCA
  - Many leading xTCA vendors have abandoned both uTCA and uTCA.4
  - Risk for longer term availability after DESY construction bubble dissipates
- Interconnects have consequences to the system architecture
  - PCI-Express in uTCA tightly couples the processor to the payload card
    - Geographic limitations
    - Processor hardware must be informed when cards come and go
  - Ethernet in ATCA decouples the processor and the payload card
    - Geographically unlimited
    - Message based communication
    - NAD like architecture with the advantage of clean mechanical packaging

uTCA is not fixed to PCIe. It can be PCIe, ETH and others

Restriction inherent to the protocol such as PCIe or ETH. No restriction inherent to the form-factor such as ATCA, uTCA or custom

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Cross-check information between Integrators/Users and Vendors/Manufacturers

Platform Selection: ATCA vs uTCA

SLAC

- Timing delivery is important
  - Encoded timing streams with bit rates ~4Gbps are common in modern systems
  - In uTCA the MCH serves as both the switch and the timing hub
    - Typically you want a commercial switch but a custom timing hub
    - Commercial MCH designs did not support the bit rates required
    - Would require a custom MCH, but PCI-Express vendors have difficult NDA requirements
- Crate based processors are not cost effective
  - Chassis vendors charge a premium for processor blades
  - uTCA requires the processor to be in the crate
  - ATCA allows an external cost effective processor
    - Can be the same model as used in non-crate based portions of the control system
    - Crate based processor is still an option, but not a necessity
- uTCA.4 has limited power capacity
  - AMC connector and RTM use signal pins for power
  - 12V based distribution, vs redundant 48V in ATCA
- ATCA crates support DC power input
  - Useful in very low noise applications
- ATCA main board size allows more flexibility in analog/digital divide
  - uTCA.4 assumes 50/50 space allocation, forcing ADCs onto digital board
  - SLAC's AMC carrier design allows the ADCs and DACs to be closely matched to analog section
  - Small digital section allows independent analog and digital upgrade paths
  - Allows independent analog and digital development
  - ATCA AMC provides better shielding and more space

Timing requirements are extremely critical to MIL radar and EW applications we support with both uTCA and ATCA.

Absolutely incorrect. The Processor Host can be remote, outside the crate.

If 4.4kW is not enough let me know

uTCA too

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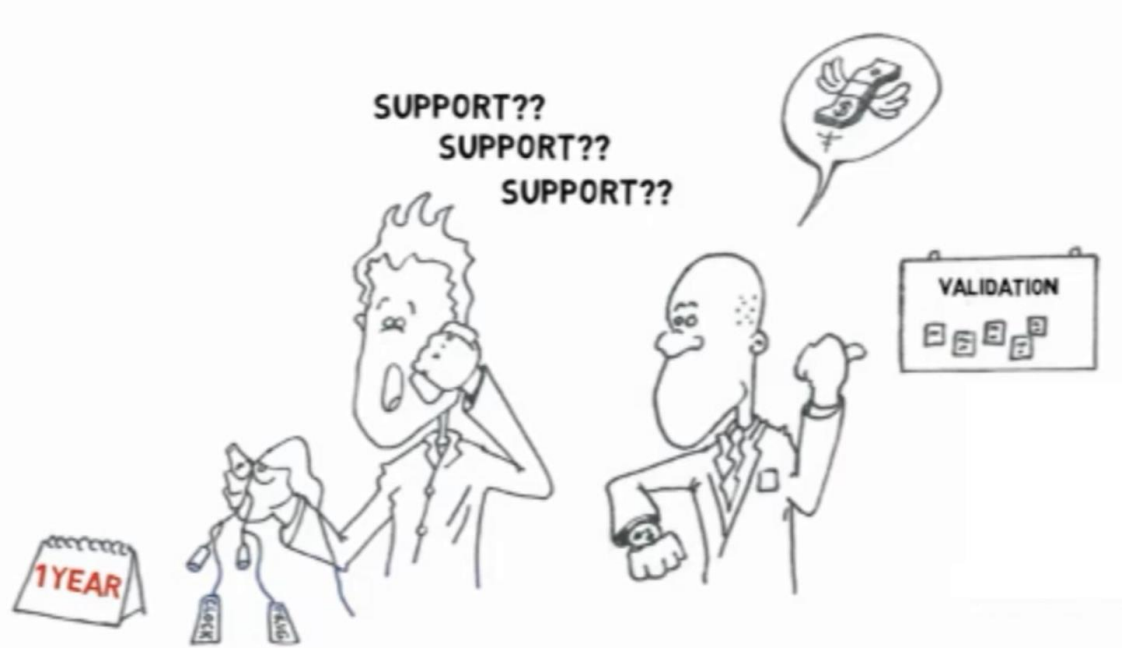
Getting the correct information allows making the right choice



Starting with the wrong information

Closing based on initially confirmed information

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Questions

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