



EUROPEAN
SPALLATION
SOURCE



Deployment and Development of MicroTCA at ESS

PRESENTED BY FAYE CHICKEN

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European Spallation Source

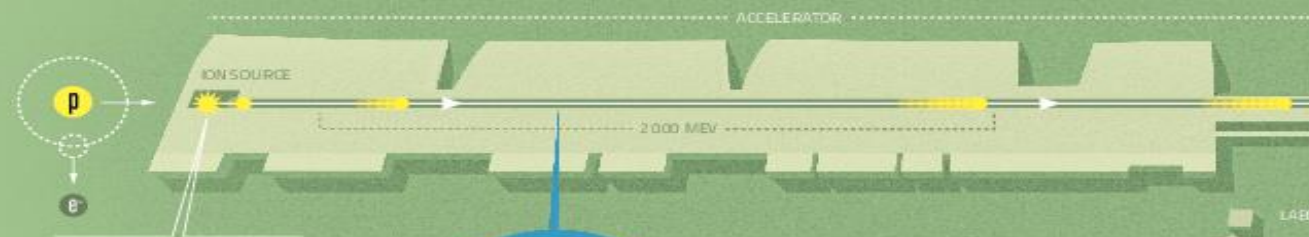
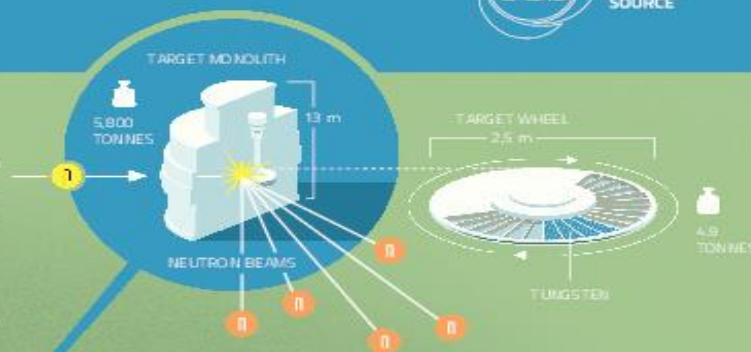


The European Spallation Source (ESS) is a multi-disciplinary research centre based on the world's most powerful neutron source. ESS will give scientists new possibilities in a broad range of research, from life science to engineering materials, from heritage conservation to magnetism. ESS is a pan-European project, with Sweden and Denmark serving as host countries. The main research facility is being built in Lund, Sweden, and the Data Management and Software Centre (DMSO) is located in Copenhagen, Denmark.



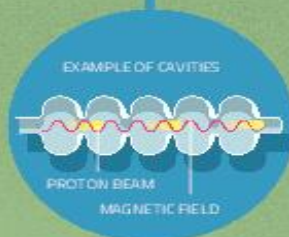
THE TARGET IS THE NEUTRON SOURCE

When the accelerated protons hit the rotating tungsten target wheel, spallation occurs and neutrons are scattered from the tungsten nucleus. The more neutrons produced and collected in the target, the "brighter" the neutron source. The neutrons are directed through moderators and neutron guides to the scientific instruments where they are used for experiments. The Target monolith consists of the Target wheel, moderators, cooling systems and shielding and weighs approximately 5,800 tonnes.



PROTONS GENERATED IN ION SOURCE

In the ion source protons are generated and guided into the linear accelerator. The first part of the linac is used to focus the proton beam while it accelerates.



CAVITIES ACCELERATE THE PROTONS

Electromagnetic fields are used to accelerate the protons to approximately 96% of the speed of light. The second part of the accelerator consists of superconducting cavities which are cooled to -271°C using liquid helium. After traveling 602.5 m the protons hit the target wheel.

TOTAL BUILDING AREAS 600 m²

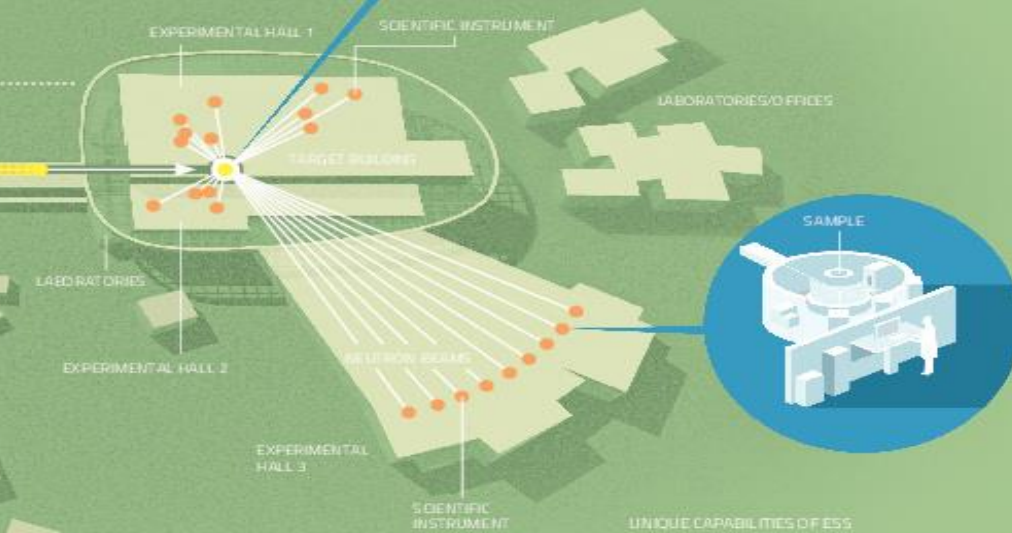
The ESS facility will be approximately 650 metres in total length. The target building will be 125 metres long, and about 30 metres high. The 537-metre-long accelerator tunnel is built underground and will be covered with soil.

Concrete	50 000 m ³
Rebar	6 000 tonnes
Pipes	40 km
Cables	2 000 km
Total volume	400 000 m ³

602.5 m

PILES TO AVOID MOVEMENTS

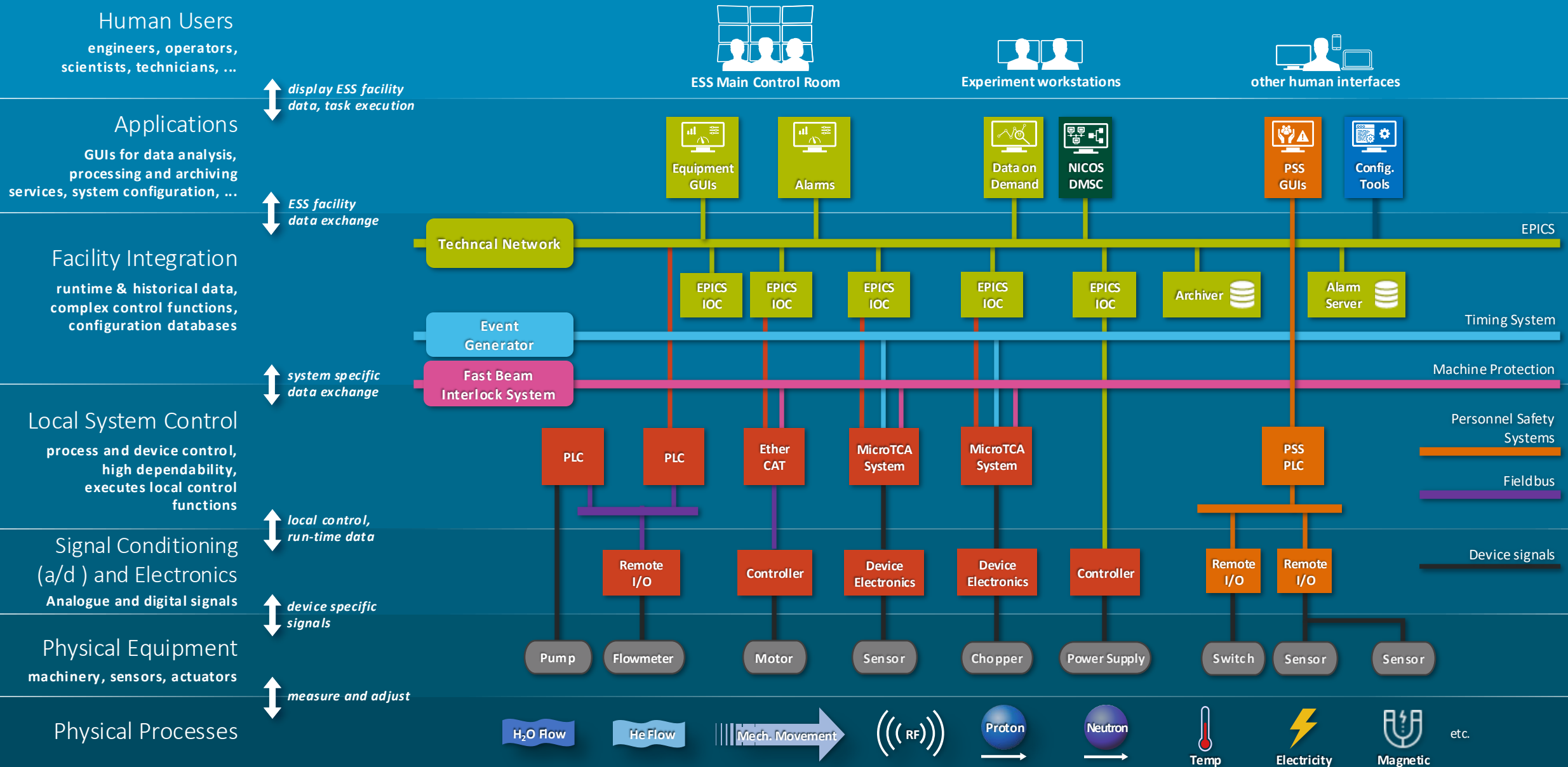
The heavy Target building and experimental halls are resting on a total of 6 400 piles of different types, in order to avoid unwanted movements in the structure.



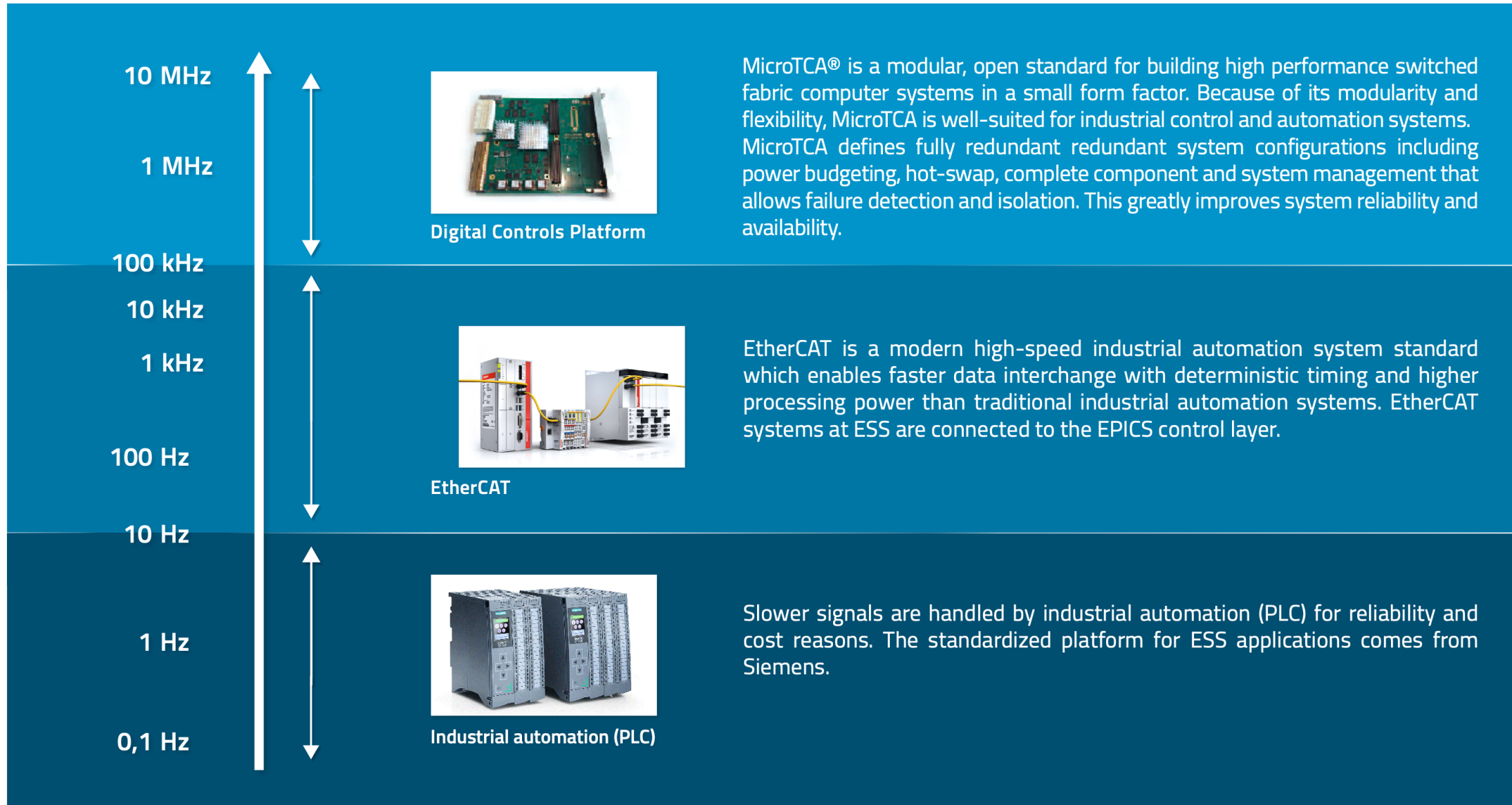
UNIQUE CAPABILITIES OF ESS

ESS will have 22 tailor-made instruments located in three experimental halls. Neutrons are excellent for probing materials on an atomic and molecular level – everything from motors and medicine, to plastics and proteins. The neutrons hit the sample and detectors register the neutron scattering, giving precise information about the material's structure and dynamics.

Layer Architecture of ESS Control Systems

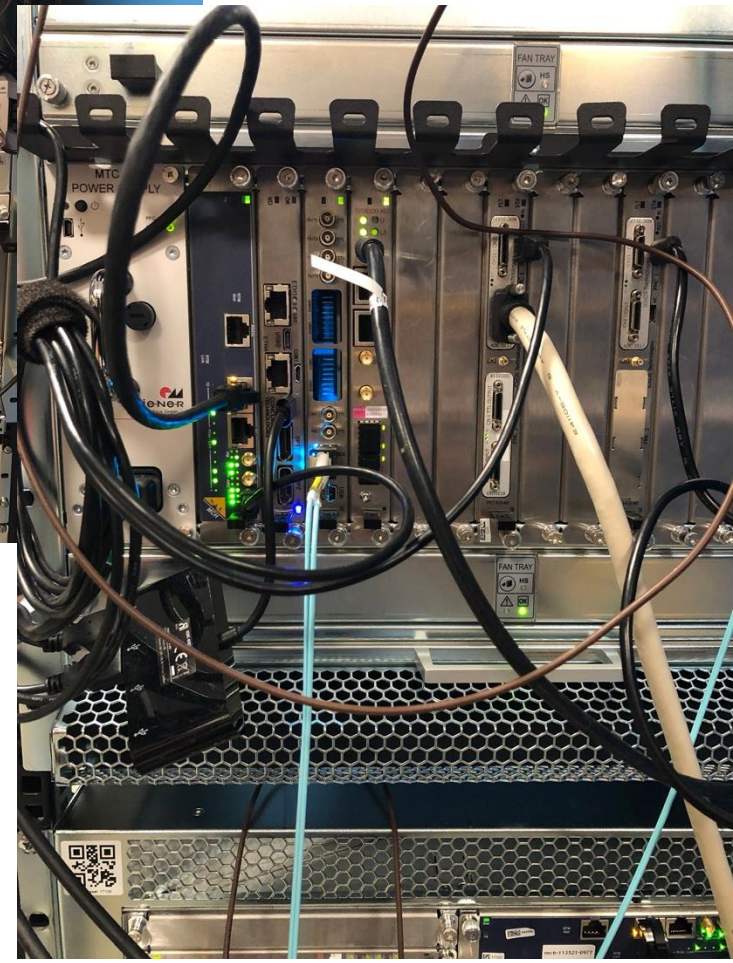
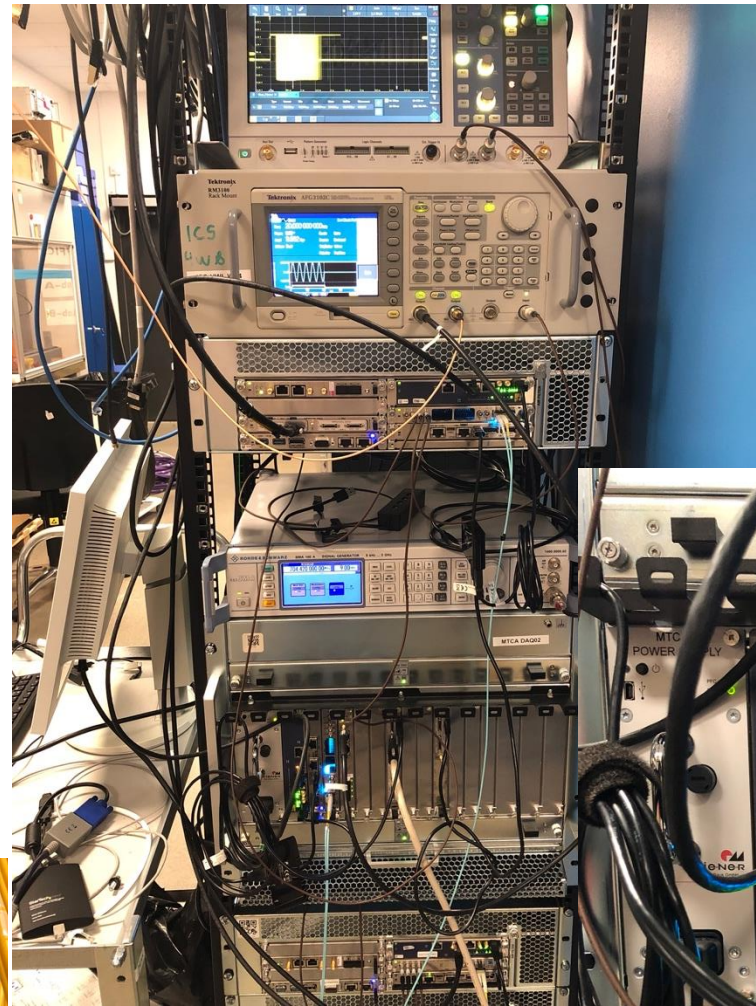


Control Systems deployed at ESS



MTCA at ESS

- Have $\cong 250$ MTCA systems in production
- Supporting Timing Distribution, LLRF, Beam Instrumentation and Fast Beam Interlock for Machine Protection.
- Many systems are now mature and running for significant time without issue
- >70% migrated to ESS Linux OS



ENV Name	Type	Enabled	Link Status	Value	Time	ENV Match GPU	
HBL-0308FC-BPS-ENV-500	nvTCA-ENV-500				5425	Mon, 25 Sep 2023 10:04:42 +0300	OFF
HBL-0308FC-BPS-ENV-500	nvTCA-ENV-500				5446	Mon, 25 Sep 2023 10:04:42 +0300	OFF
HBL-0308FC-BPS-ENV-500	nvTCA-ENV-500				5446	Mon, 25 Sep 2023 10:04:42 +0300	OFF
HBL-0308FC-BPS-ENV-400	nvTCA-ENV-500				5447	Mon, 25 Sep 2023 10:04:42 +0300	OFF
HBL-0308FC-BPS-ENV-600	nvTCA-ENV-500				5395	Mon, 25 Sep 2023 10:04:42 +0300	OFF
HBL-0308FC-BPS-ENV-200	nvTCA-ENV-500				5393	Mon, 25 Sep 2023 10:04:42 +0300	OFF
HBL-0308FC-BPS-ENV-300	nvTCA-ENV-500				5394	Mon, 25 Sep 2023 10:04:42 +0300	OFF
HBL-0308FC-BPS-ENV-400	nvTCA-ENV-500				5396	Mon, 25 Sep 2023 10:04:42 +0300	OFF
HBL-0308FC-BPS-ENV-500	nvTCA-ENV-500				5348	Mon, 25 Sep 2023 10:04:42 +0300	OFF

NIL-4380FCRFS-EVR-303	rsTCA-EVR-300	     	5.745	Mon, 23 Sep 2020 10:04:42 +0000	OFF
NIL-4380FCRFS-EVR-403	rsTCA-EVR-300	     	5.747	Mon, 23 Sep 2020 10:04:42 +0000	OFF
NIL-4480FCRFS-EVR-503	rsTCA-EVR-300	     	5.713	Mon, 23 Sep 2020 10:04:42 +0000	OFF
NIL-4480FCRFS-EVR-203	rsTCA-EVR-300	     	5.713	Mon, 23 Sep 2020 10:04:42 +0000	OFF
NIL-4480FCRFS-EVR-303	rsTCA-EVR-300	     	5.714	Mon, 23 Sep 2020 10:04:42 +0000	OFF
NIL-4480FCRFS-EVR-403	rsTCA-EVR-300	     	5.718	Mon, 23 Sep 2020 10:04:42 +0000	OFF
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NIL-4580FCRFS-EVR-203	rsTCA-EVR-300	     	5.699	Mon, 23 Sep 2020 10:04:42 +0000	OFF
NIL-4580FCRFS-EVR-303	rsTCA-EVR-300	     	5.700	Mon, 23 Sep 2020 10:04:42 +0000	OFF
NIL-4580FCRFS-EVR-403	rsTCA-EVR-300	     	5.698	Mon, 23 Sep 2020 10:04:42 +0000	OFF



Alarm Service

TD

TD Alarm Tree X

TD

▼ TD

▶ TD-D11

▶ TD-D12

▶ TD-D21

▶ TD-D22

▶ TD-D23

▶ TD-D24

▶ TD-D25

▶ TD-D26

▶ TD-D27

▶ TD-D28

▶ TD-D29

▶ TD-D210

▶ TD-D211

▶ TD-D212

▶ TD-D213

▶ TD-D214

▶ TD-D215

▶ TD-D216

▶ TD-D217

▶ TD-D218

▶ TD-D219

▶ TD-D220

▶ TD-D221

▶ TD-D222

▶ TD-D223

▶ TD-M

- ▶ TD-PE2
- ▶ TD-PE3
- ▶ TD-PE5
- ▶ TD-PE7
- ▶ TD-PE9
- ▶ TD-PN1
- ▶ TD-PN3
- ▶ TD-PN5
- ▶ TD-PN7
- ▶ TD-PS1
- ▶ TD-PS2
- ▶ TD-PS3
- ▶ TD-PS4
- ▶ TD-PS5
- ▶ TD-PW1
- ▶ TD-PW2
- ▶ TD-PW3
- ▶ TD-PW4
- ▶ TD-PW5
- ▶ TD-PW6
- ▶ TD-PW7
- ▶ TD-PW8
- ▶ TD-PW11

- ▼ TD-D21

▼ TD-D21:Ctrl-EVM-1

PV: TD-D21:Ctrl-EVM-1:Enable-RB

PV: TD-D21:Ctrl-EVM-1:EvtClkPll-Sts

PV: TD-D21:Ctrl-EVM-1:EvtClkSource-RB

PV: TD-D21:Ctrl-EVM-1:FCTLink8-Sts

PV: TD-D21:Ctrl-EVM-1:SFP8PwrRX-I

PV: TD-D21:Ctrl-EVM-1:SFP8PwrTX-I
- ▼ ? TD-EVR

▼ A2T-010Row:Ctrl-EVR-101

PV: A2T-010Row:Ctrl-EVR-101:DCEna-RB

PV: A2T-010Row:Ctrl-EVR-101:DCLck-Sts

PV: A2T-010Row:Ctrl-EVR-101:DCLckDat-Sts

PV: A2T-010Row:Ctrl-EVR-101:Link-Sts

PV: A2T-010Row:Ctrl-EVR-101:Pll-Sts

PV: A2T-010Row:Ctrl-EVR-101:SFPPwrRX-I

PV: A2T-010Row:Ctrl-EVR-101:SFPPwrTX-I

PV: A2T-010Row:Ctrl-EVR-101:TimeValid-Sts

TD Alarm Tree X

TD

▶ TD

▶ ? TD-EVR

▶ TD-EVR-TS

▶ ! TD-HEALTH

BIFROST

- ▼ TD-PW4

▼ TD-PW4:Ctrl-EVM-1

PV: TD-PW4:Ctrl-EVM-1:Enable-RB

PV: TD-PW4:Ctrl-EVM-1:EvtClkPll-Sts

PV: TD-PW4:Ctrl-EVM-1:EvtClkSource-RB

PV: TD-PW4:Ctrl-EVM-1:FCTLink8-Sts

PV: TD-PW4:Ctrl-EVM-1:SFP8PwrRX-I

PV: TD-PW4:Ctrl-EVM-1:SFP8PwrTX-I

▶ TD-PW4:Ctrl-EVM-2
- ▼ ! TD-HEALTH

▶ TD-DE1

▶ TD-DN1

▶ TD-DS1

▼ TD-DW1

▶ TD-DW1:Ctrl-CPU-1

▶ TD-DW1:Ctrl-CPU-2

▶ TD-DW1:Ctrl-CU-1

▶ TD-DW1:Ctrl-CU-2

▶ TD-DW1:Ctrl-MCH-1

▶ TD-DW1:Ctrl-MCH-2

▶ TD-DW1:Ctrl-PM-1

▶ TD-DW1:Ctrl-PM-2

Replacement of Arc Detector Controls



Analog readout of the arc detectors on the RF distribution chain.

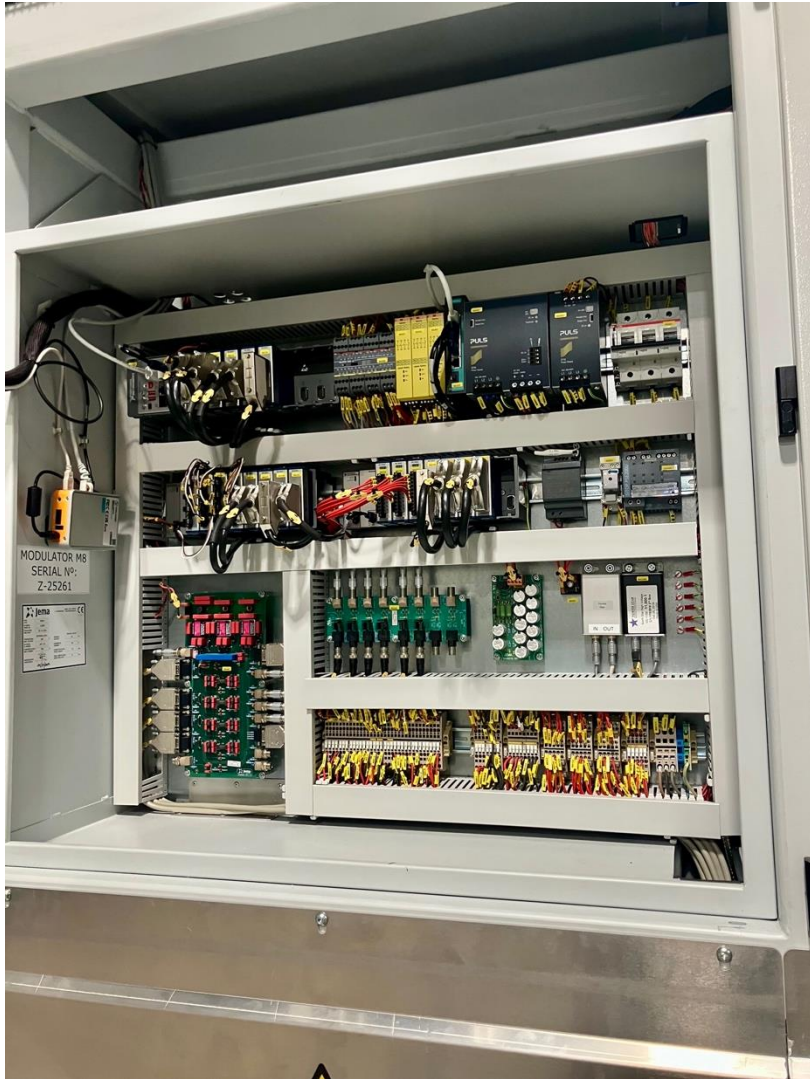
Whenever there is an arc inside cavities, they want to be able to correlate with LLRF data. Need the classic "scope" application to properly acquire these signals. Currently one oscilloscope in each RF station to digitize the signals and integrate to EPICS



Migration to MTCA based system to use hw from IOxOS

- IFC_1420 (modified for DC)
- RAA_1471 RTM

Replacement of Modulator Controls System



Currently running on NI CompactRIO HW

Change to use:

- nVent 5U (baby) Chassis
- NAT-PM-AC600D
- NAT-MCH-PHYS80
- IOxOS IFC_1412
 - ADC_3117
 - DIO_3118





Next Steps for 2026

BOD2 and BOT and production of first neutrons

Complete migration of MTCA systems to ESS Linux OS (Yocto)

Development of Arc-Detector system using IOxOS IFC and new RTM

Conversion of Modulator controls from CompactRIO to MTCA

Conclusions and lessons

- Knowledge sharing is key; avoid brain drain and costly roadbumps
- Collaboration is important; EPICs community has shown how impactful
- Make full use of deployment tools from other groups/facilities
- Good relationships with suppliers is critical; for questions/information but also product development

“If I had asked people what they wanted, they would have said faster horses.”

- Henry Ford



End