

EUROPEAN SPALLATION SOURCE



Deployment and Development of MicroTCA at ESS

European Spallation Source

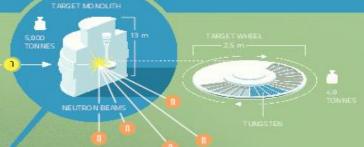


The European Spallation Source (ESS) is a multi-disciplinary research centre based on the world's most powerful neutron source. ESS will give scientists new possibilities in a broad range of research, from life science to engineering materials, from heritage conservation to magnetism. ESS is a pan-European project, with Sweden and Denmarkserving 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 is the rotating tungsten ranget wheel spellation 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 moderattors and neutron guides to the scientific instruments where they are used for experiments. The Target monoith consists of the Target wheel moderators, cooling systems and site king and weekls amorosines in 5 fill to me.



ACCEL ERATOR



IONSOURCE

PROTONS GENERATES

In the zon source protons are game rated and goulded into the line of accelerator the Linar. The first part of the linar is used to focus the proton beam while it accelerates. PROTON BEAM
MAGNETIC FIELD

CAVITIES ACCELERAT

Electromagnetic fields are used to accelerate the protons to approximate 95% of the speed of light. The second part of the accelerator consists of superconducting cactles which are couled to -27% "Eusing liquid helium. After traveling 6025 in the protons has the target wheel.

VALUE OF THE PROPERTY OF THE P

EXPERIMENTAL HALL 3

IFIC IMENT UNIQUE CAPAR

TOTAL BUILDING AREAGS 000 m

The Exist facility will be approximately said metres in total length. The target building will be 125 metres, long, and about 30 metres high. The 537 meter targets lead to turned is build underground and will be cavered with said.

PILES TO AVOID MOVEMENTS

The heavy Target building and experime stal halls are resting on a total of 6,400 pless of different types, in order to avoid unwarted movements in the structure.

ARGET MONOLITH

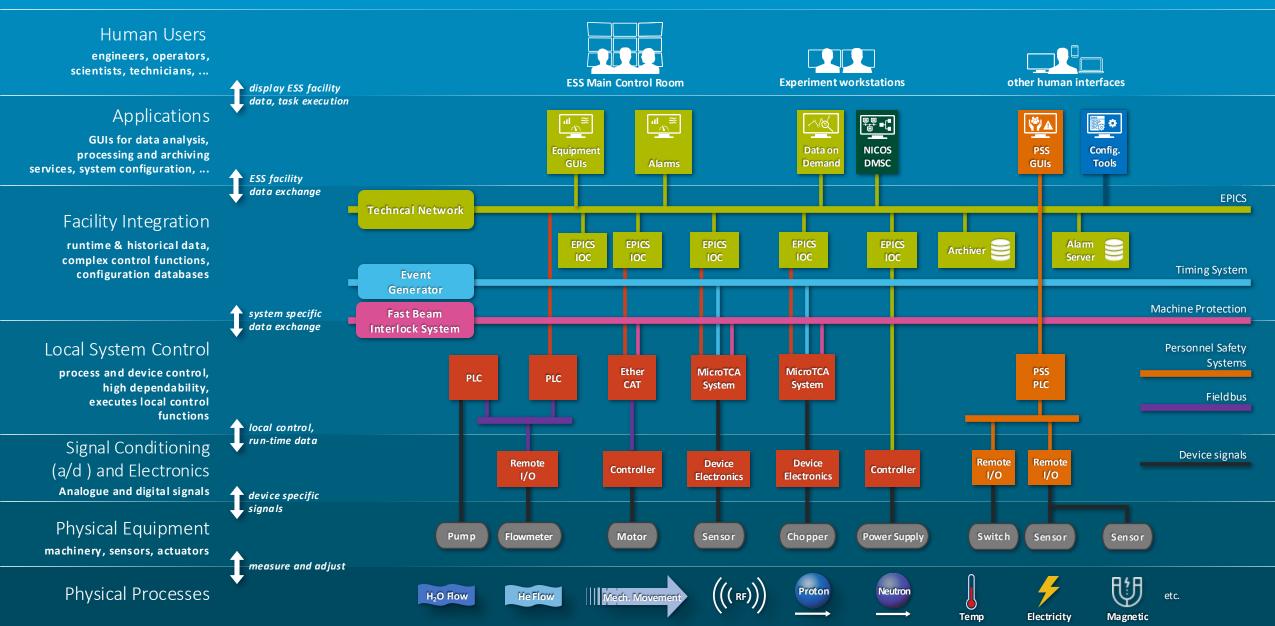
UNIQUE CAPABILITIES OF ESS

ESG will have 22 taker-made matriarishts located in three experimental halfs. Neutrons are excellent for probing materials on an atomic and indicated level — everything from rectors and medicine, to plastics and proteins. The neutrons had the sample and detectors register the neutron cattering, giving medicine information about the material's structure and dynamics.

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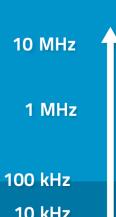
Layer Architecture of ESS Control Systems





Control Systems deployed at ESS





Digital Controls Platform

MicroTCA® is a modular, open standard for building high performance switched fabric computer systems in a small form factor. Because of its modularity and flexibility, MicroTCA is well-suited for industrial control and automation systems. MicroTCA defines fully redundant redundant system configurations including power budgeting, hot-swap, complete component and system management that allows failure detection and isolation. This greatly improves system reliability and availability.

10 kHz

1 kHz

100 Hz

10 Hz

1 Hz

0,1 Hz



EtherCAT

EtherCAT is a modern high-speed industrial automation system standard which enables faster data interchange with deterministic timing and higher processing power than traditional industrial automation systems. EtherCAT systems at ESS are connected to the EPICS control layer.

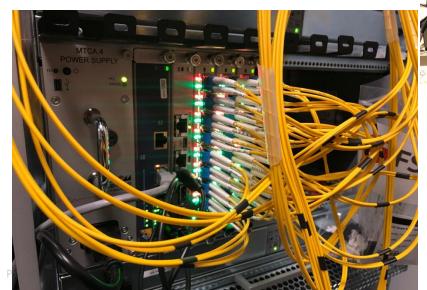


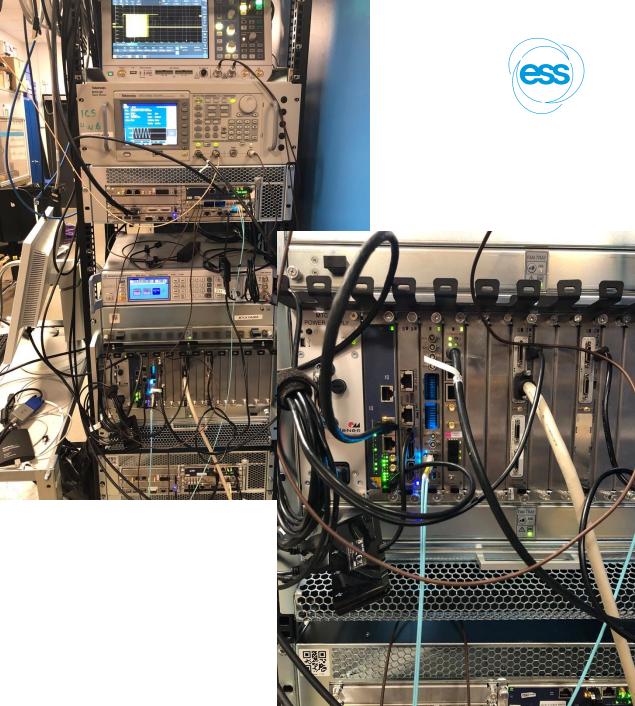
Industrial automation (PLC)

Slower signals are handled by industrial automation (PLC) for reliability and cost reasons. The standardized platform for ESS applications comes from Siemens.

MTCA at ESS

- Have ≅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





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EVIT Marrie	Type	Institut	Link Status Valid			Time	EVE Multi-OPT			
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A 4200FC RFS EVR 101	4171.3-E178-300	0		0	0	•	NIST	War, 15 Sep. 2015 30 04-6	110000	OF
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+ 1400FC/RFS 6V8-103	w/TCS.EV# 500	0	0	0	0	•	AURE	Way, 25 Sep 2428 10 D4-6	1+0000	OF
101-008-END-1008-8-	WITCH EVE DOD	0	0	0	0	•	40%	Mark 13 Sep 2523 10-04-6	1+0000	OF
A 450RFC/RFS-EVM-101-	H420F54E383	0		0	0		4700	Wars, 15 Sept 2103-1004-6	110000	OF
8-100FCRF6-EVR-201	#/TOLEVE 383	0			0	•	4707	Wars, US Sep 2105 10 04 K	1+0000	CR
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- HORFCRIS-EVA.101	W/TCN-EVR-360	0	0	0	0	0	4000	Mars, 15 Sep J125 10 D4 4	1+6000	00
A HORICATS DA LOL	9/TCA-EX9-383	0	•	0	0	•	4106	War, 15 Sep 2(03 30 Det 4)	1+0000	- 08
A ADMICARY-EVE 202	#17CF-E19E-3003	0		0	0	•	4703	Wars, 15-Sep 2025 50:04:40	10000	OF
4 490RFC/RFS-EVM-101	HTCA-EVR SES	0	0	0	0	0	4134	Mark 13-54p-2525-30-04-6	140200	OF
4 4000TC 00TS EVE 202-	HTCA-EVE-SSS	0	0	0	0	•	4723	May, 15 Sep 2513 10:04-6	+0000	OF
A HIGHTCHIS EVE LOL	WTCH-899-366	0	0	0	0	•	4584	Mark, 10 Sep 2103 10:04-6	1+6000	08
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A-110RFC/RFS-898-2012	+1CA-EY# 393	0	0	0	0	0	4000	Mary 15 Sep 3125 10:04-6	+00to	OF
# 1308FCRFS 8V9-101	#1131EV#383	0	0	0	0	0	4100	Mars. 15 Sep. 2525 10:04-6	1+0000	OF
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ph-1308FCRFS-EVE-101:	WTCA-EVE-380	0		0	0		HONT	Mary 15 Sep 2025 10 04 4	1+0000	OF
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NEL OTORPORPE PER ARCH HTCLEUM 300 O O O O SHOT New 125 Sep 2002 12 0 4 42 42 000 OP NEL OROMPORPE PER ARCH HTCLEUM 300 O O O O O O O O O O O O O O O O O O	ны отписаться акт	WTOERWESS	00000	346 West 10	Sep.2001 10 Sep.2001 1001 1001
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NEL-ONDEPCRESERVE-MELL NTCA-CUM-200 O O O O O SHAR Non-25 Sep-2005 10 0-4 01 -000 ON	MIN. COURSE STR. 2011	WTCAESM-380	00000	369 Hos.1	750 HOR-DARK 2001 2001
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HBL-GIMPCRPS-EVE-283	WTC4-EW-300	00000	546 Port 25 Sept	2025 10:04 42 +0 208 094	
HILLOHITCH'S EXPANS	m7(3+6)(0.300)	00000	Se40 Non, 15 Sept	2025 (0:00:42 4)208	
HILLOHITCETS DIR HIL	WTCA-EVE-300	00000	5647 Hon, 25-Sep.	2025 3 0 0 4 2 + 2 20 4 4 7 1	
HILLSHIPCES-EN-SEL	entroveres ado	00000	5365 Hor, 23 Sep.	2025 10104 42 49208 984	
HBL-0208FC-BPS-EIRE-283	WYCA-EVR-500	00000	5993 Hon. 25 Sep-	202510-0442+0208	
HEL-GERFCEPS ENGIN	e104895300	00000	5294 Hon, 23 Sep.	2023 20 04 42 40 200 0 009	
HBL GORRECOPS EVE-443	#17CA-EVM 300	00000	1070 Flory, 25-5ep	2023.10:00:42:42.00 095	
HIR ESIMPLATS EVA SIG-	HTCREVE.DO	00000	5768 Hee, 21 Sept.	100 1004-12-000 DP	
HIR. 4398/TEMPS-009-300:	HTTP://EVE-200	00000	\$746 Hun, 25 Sep.2	2005 200 9-42 + 0000 DPK	
HR.458FCRF5-8W-303	WITER-BYR.500	00000	\$195 Park, 25 Sept	1000 10164-42+0100 OPA	
HR. 4388FC/875-698-802	HTCLEVE300	00000	5747 Hun, 23 Sep. 2	2020 20 64-42 + 2020 094	
HILL CHINICATE CHE LOC.	HTCA-CVI-000	00000	\$713 9600, 32 Sept.	200 10 0 4 40 + 600 OPR	
HBL 44807EXPS-EV4-203-	HYDAEVE.RO	00000	5/13 Hun, 13 Sep. 2	2020 10-94-42 + 0.010 GPR	
HIL 4400FCRFS-6V9-BILL	HATCH EVEN NO	00000	\$714 Mon, \$15 kep.)	PE 1110+2-9111 200	
H9L4408FC0F5-EV8-403	HTDLEVESO.	00000	3738 Phw. 23 Sep 2	2005 20104-02+0000 - 0095	
HOL-ESSRECIRES EVE-201.	W109-608-300	00000	5407 Hun, 23 Sep. 2	2005 10:04:42:40200 00%	
HIL-45MFCRF5-8M-302	HTC4-EV6-300	00000	5109 Myrr, 35 Sep 2	2025 38-94-42+9289 (399	
HIL-1500FC:075-079-301.	m1046V9-300	00000	\$700 Hun, 25 Sep. 2	2005 20-04-42+0000 DPB	
HB. 4500FC6F5-EVB-4C1	WTCKEVE DO	00000	5998 Nov. 15.54p.	100 DESCRIPTION OF	



Alarm Service







TD Alarm Tree X TD ▼ TD ▶ TD-D11 ▶ TD-D12

- ▶ TD-PE2
- ▶ TD-PE3 ▶ TD-D24 ▶ TD-PE5

▶ TD-D21

▶ TD-D22

▶ TD-D23

▶ TD-D210

▶ TD-D211

▶ TD-D212

▶ TD-D213

▶ TD-D214

▶ TD-D217

▶ TD-D220

▶ TD-D221

- ▶ TD-D25 ▶ TD-PE7 ▶ TD-D26 ▶ TD-PE9
- ▶ TD-D27 ▶ TD-PN1
- ▶ TD-D28 ▶ TD-PN3 ▶ TD-D29
 - ▶ TD-PN5
 - ▶ TD-PN7
 - ▶ TD-PS1
 - ▶ TD-PS2
 - ▶ TD-PS3 ▶ TD-PS4
- ▶ TD-D215 ▶ TD-PS5 ▶ TD-D216
 - ▶ TD-PW1 ▶ TD-PW2
- ▶ TD-D218 ▶ TD-PW3
- ▶ TD-D219 ▶ TD-PW4
 - ▶ TD-PW5
 - ▶ TD-PW6
- ▶ TD-D222 ▶ TD-PW7
- ▶ TD-D223 ▶ TD-PW8
- ▶ TD-M ▶ 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:PII-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

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

▼ 1 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



11

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