

The Evolution of the Control System for the **Electromagnetic Calorimeter of the Compact Muon Solenoid Experiment at the Large Hadron Collider**

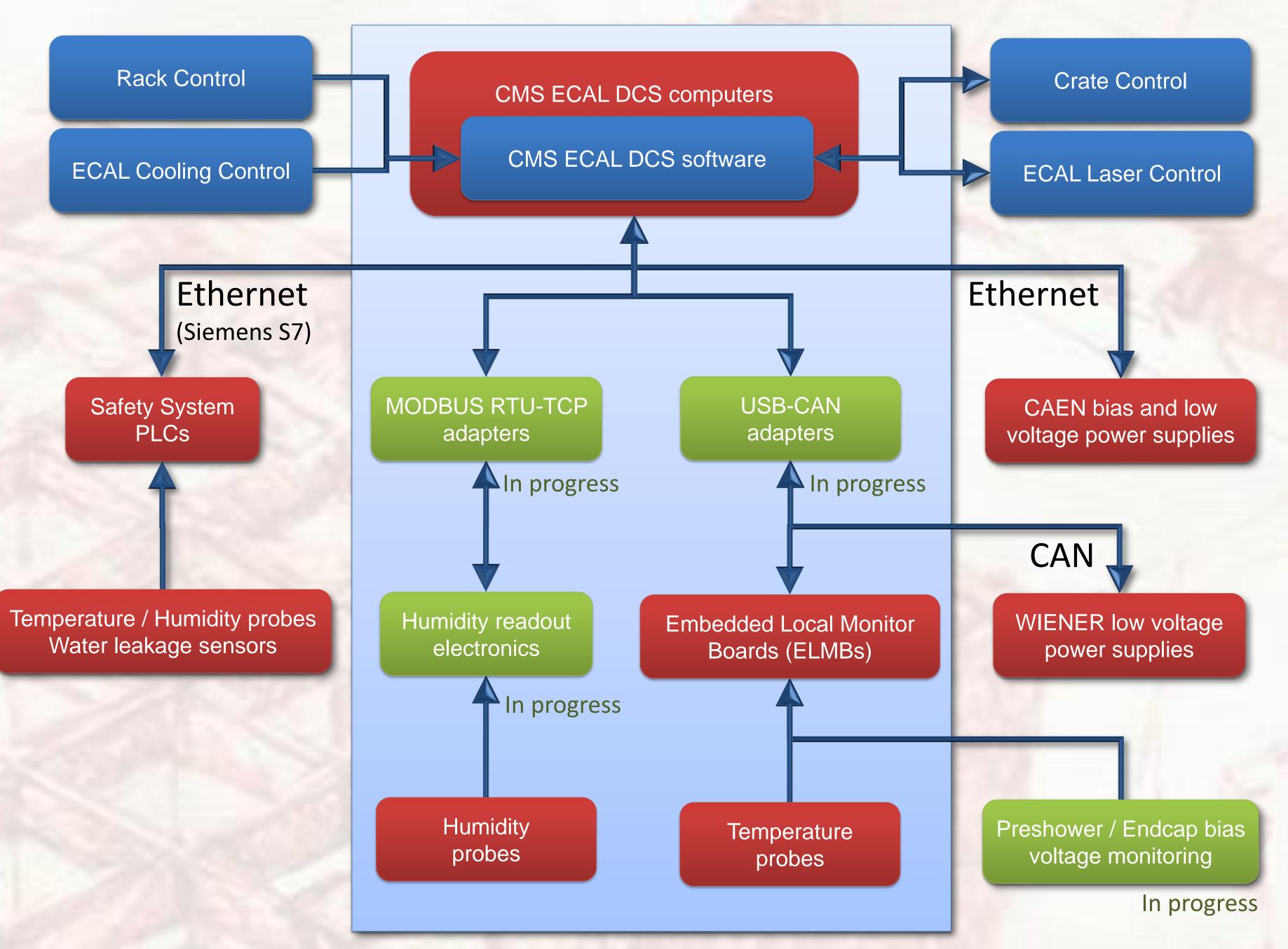
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On behalf of the CMS ECAL group

- **Compact Muon Solenoid (CMS) Electromagnetic Calorimeter (ECAL) Detector Control System (DCS)**
- Based on WinCC Open Architecture (formerly PVSS)
- Uses Joint COntrols Project (JCOP) Framework
- 24/7 two-level on-call service (operations / expert)
- Almost no ECAL down time associated with DCS

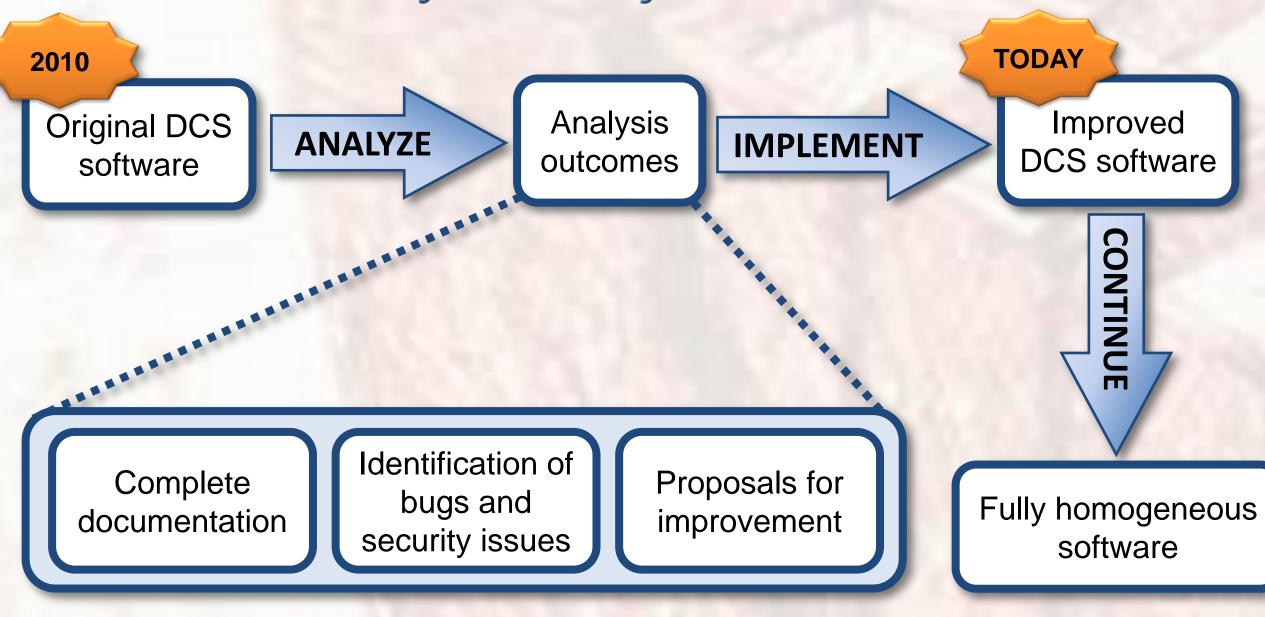
۵	DCS computers	14

Modified architecture and interfaces to external systems



Low voltage channels	>1000	
Bias voltage channels	>1400	
Temperature sensors	972	
Humidity sensors	180	
Water leakage detection sensors	40	

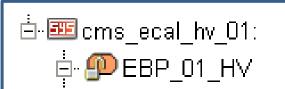
Software Analysis Project



- Reduction of long term maintenance effort

Unified CMS ECAL DCS Installation Mechanism

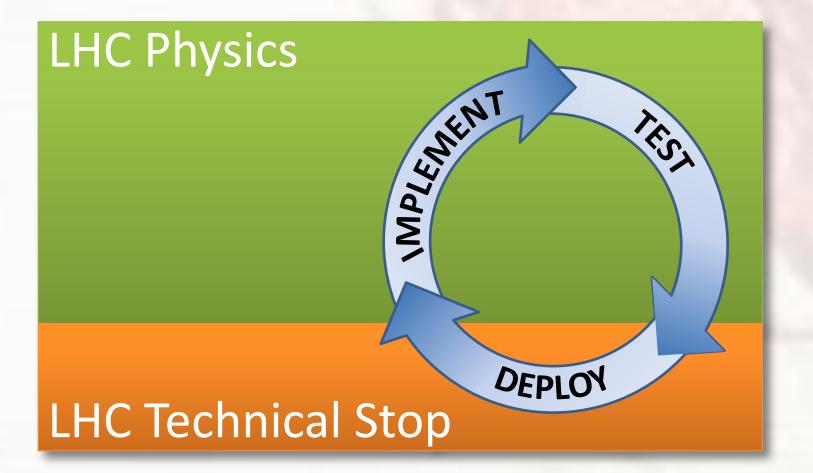
- Replaces individual mechanism for each DCS application
- Fully automated installation and upgrades
- Data-driven method

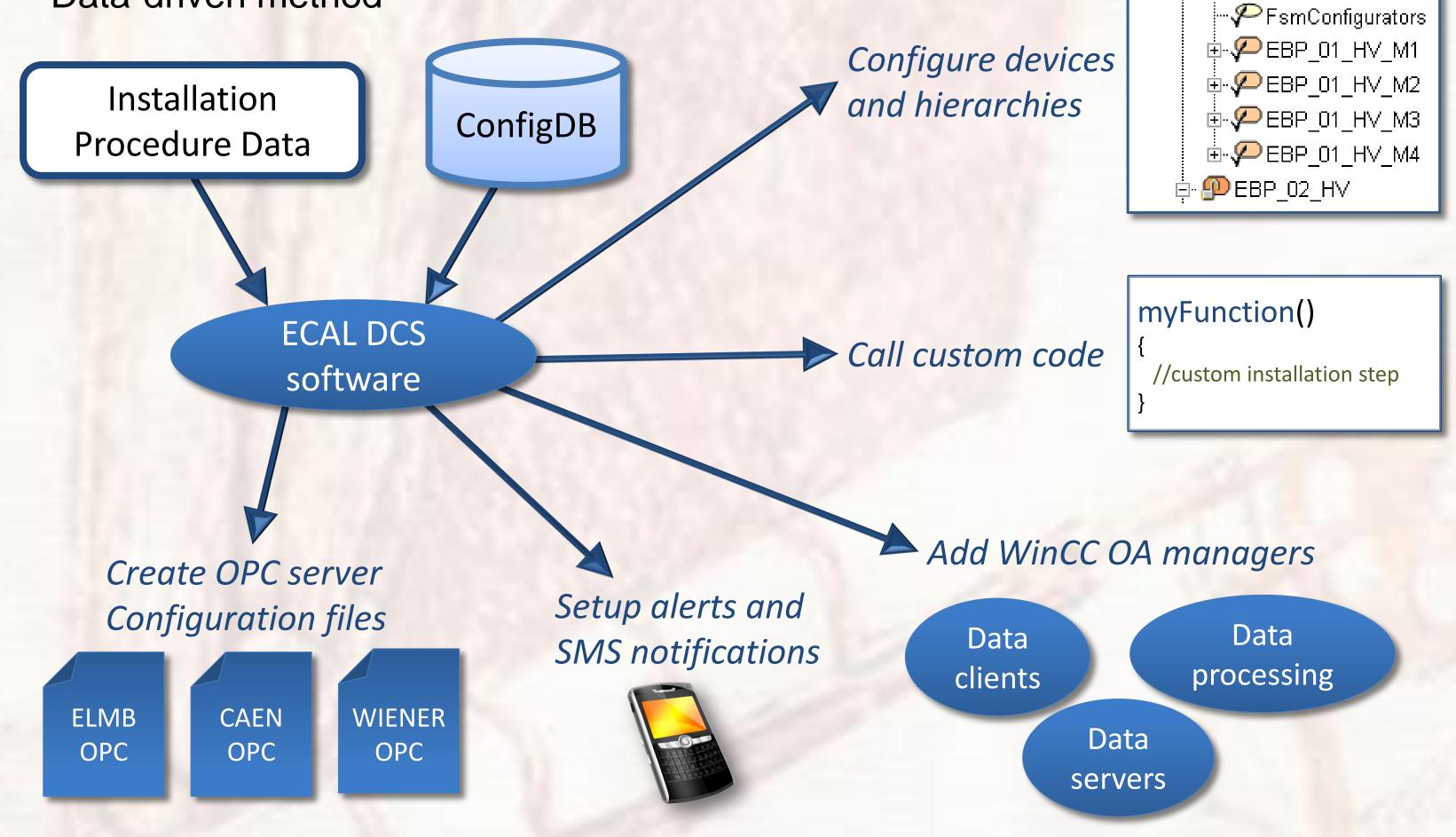


- Removal of duplicated feature implementation
- 20% reduction of control and data processing code

Software Re-Development Approach

- Create generic reusable components
- Piece-by-piece implementation minimizes risk of change
- Matching of development cycle to LHC technical stops





Use of Configuration Database (ConfigDB) Storing CMS ECAL DCS hardware and software configuration

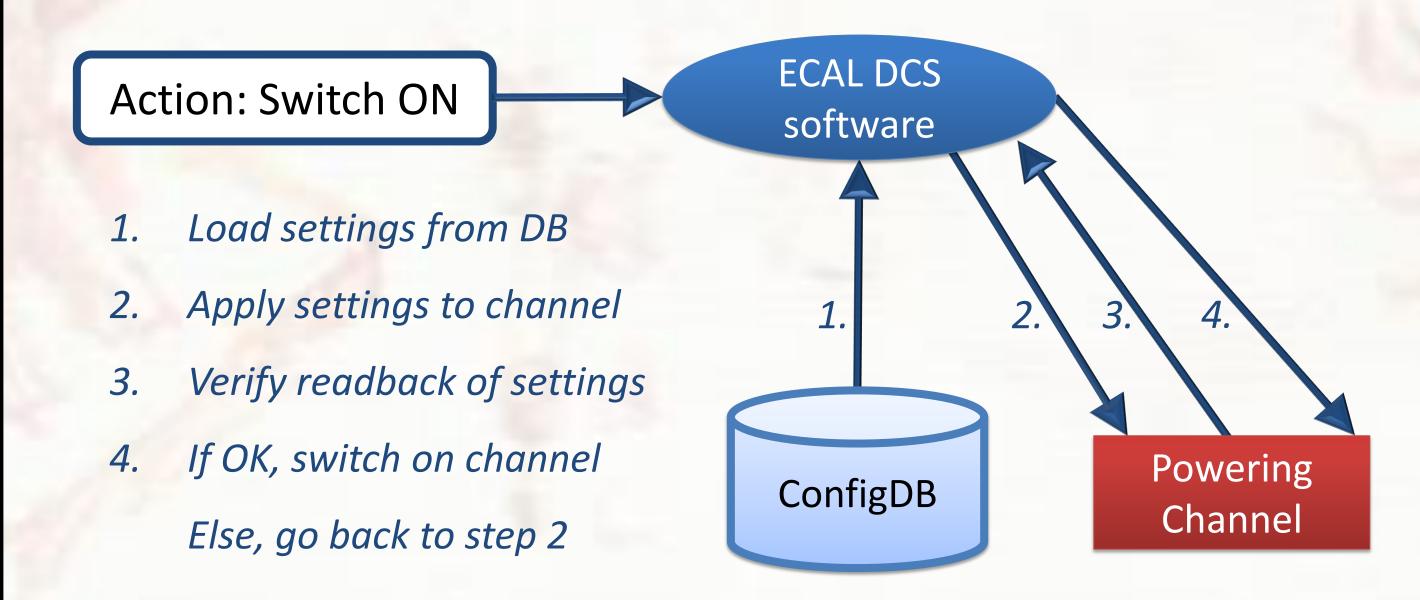
New Features Improve On-Call Efficiency

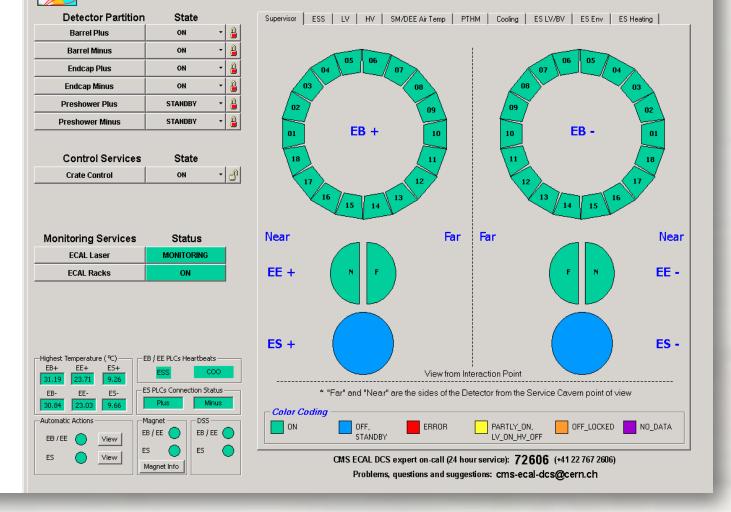


Storing bias and low voltage channel settings

1) ETH Zurich, Switzerland

- Channel settings applied and verified before switching on
- Periodic verification of hardware setting consistency





Extended alert and SMS notifications

Faster problem detection

LHC status and beam mode display

🔅 CMS ECAL Racks					-
		EB/EE Low Voltage	Crates & Racks 🔹		
RACK STATUS X3A01 ON Partitions Crate Status	RACK STATUS X3V01 ON Partitions Crate Status	NEAR	FAR	RACKSTATUSX3S01ONPartitionsCrate Status	RACK STATU: X3J01 ON Partitions Crate Sta
1 ON EBP_07 2 ON 3 ON 3	EBP_06 2 ON 3 ON		s	1 ON EBM_04 2 ON 3 ON 3	EBP_05 2 ON 3 ON
EBP_08 2 ON 3 ON	EBM_03 2 ON 3 ON	RACK S4F07	STATUS ON	EBM_05 2 0N 3 0N	EBP_04 2 ON 3 ON
EBP_09 1 ON 2 ON 3 ON	EBM_02 1 ON 2 ON 3 ON	OPFCs Barrel Mir RACK S4F06	STATUS	EBM_06 1 ON 2 ON 3 ON	EBP_03 1 ON 2 ON 3 ON
1 ON EBP_10 2 ON 3 ON	1 ON EBM_01 2 ON 3 ON	OPFCs Endcaps - RACK	STATUS	EBM_07 1 0N 2 0N 3 0N	EBP_02 1 ON 2 ON 3 ON
EBP_11 2 ON 3 ON	EBM_18 1 ON 2 ON 3 ON	S4F05		1 ON EBM_08 2 ON 3 ON	EBP_01 2 0N 3 0N
RACK STATUS X3J33 ON Partitions Crate Status	RACK STATUS X3V33 ON Partitions Crate Status	RACK STATUS X0U12 ON Partitions Crate Status	RACK STATUS X0R11 ON Partitions Crate Status	RACK STATUS X3A33 ON Partitions Crate Status	RACK STATU X3S33 ON Partitions Crate Sta
1 0N 2 0N 3 0N 4 0N 5 0N 6 0N	Partitions Clate status 1 ON 2 OON 3 ON 4 ON 5 ON 6 ON 7 ON	Failutions Clause Status 1 ON EBM_13 2 3 ON EBM_14 2 3 ON 3 ON BBM_14 2 ON 3 CON 3 CON 3 EBM_15 2	EBP_13 0N 3 0N 4 0N 2 0N 3 0N 2 0N 3 0N 2 0N 3 0N 2 0N 3 0N 3 0N 0 0N 0 0N	Partitions Clate status 1 ON 2 ON 3 ON 4 ON 5 ON 6 ON 7 ON	Partition Crate state 1 ON 2 ON 3 ON 5 ON 6 ON
RACK STATUS X2U01 ON Partitions Crate Status	RACKSTATUSX2U02ONPartitionsCrate Status	3 ON	3 <u>ON</u>	RACK STATUS X2R02 on Partitions Crate Status	RACK STATU X2R01 ON Partitions Crate Sta
EBP_18 1 ON 2 ON 3 ON	EBM_17 1 ON 2 ON 3 ON	RACK STATUS X0U11 ON Partitions Crate Status	RACK STATUS X0U11 ON Partitions Crate Status	EBM_09 1 ON 2 ON 3 ON	EBM_10 2 0N 3 0N
EBP_17 2 ON 3 ON	EBM_16 2 ON 3 ON	EBM_12 2 ON 3 ON	EBP_16	EBP_12 2 ON 3 ON	EBM_11 2 0N 3 0N

Combined rack and crate monitoring Faster problem resolution

Acknowledgements

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2) University of Wisconsin-Madison, U.S.A.