
CERN

Machine Learning applied to CERN Industrial Control Systems

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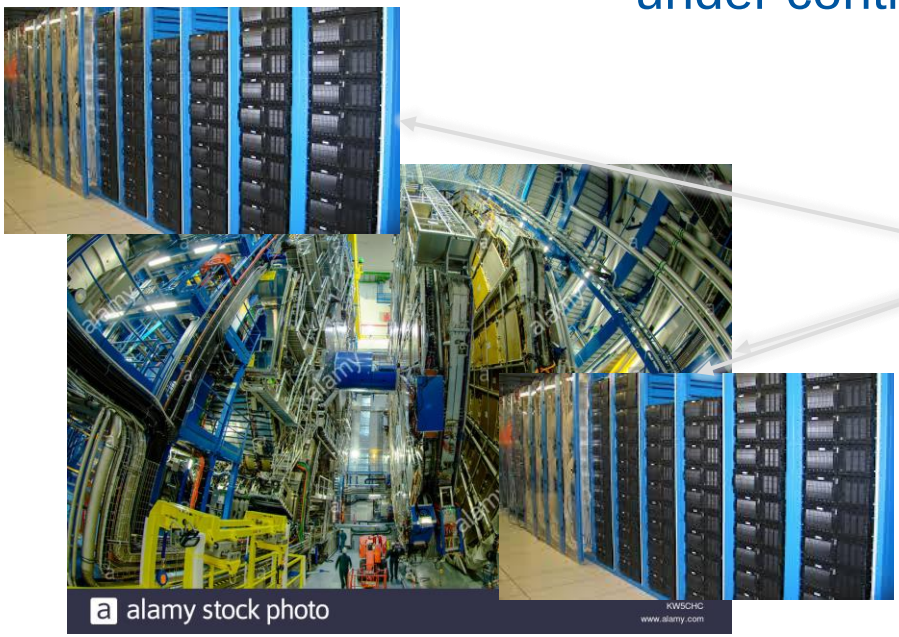
Industrial Control systems

Must ensure the safe and coherent operation of all part of the system under control, e.g. ATLAS



10 M IO to be monitored

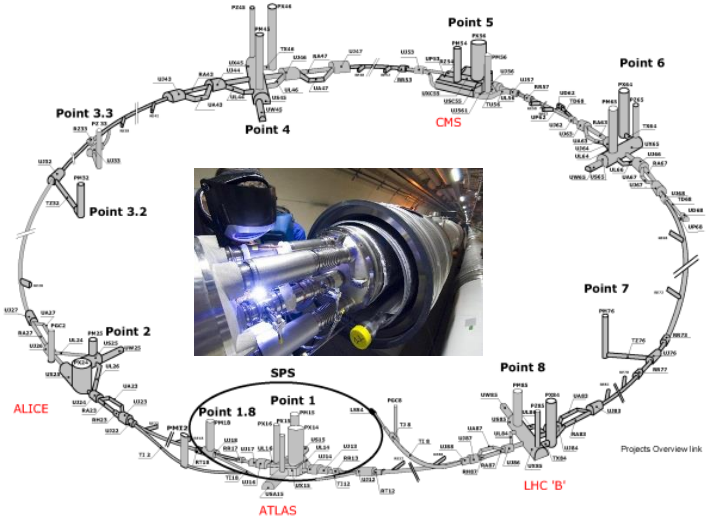
Control System

Various TB per day



LHC Cryogenics Controls

- Keep magnets under superconductivity condition
  - electric current passes almost without resistance
  - temperature dependency
  - Cooling power much cheaper than the Joule effect !!!
- Liquid helium bathing the LHC's magnets cooled down to 1.9K
- Over 34000 physical instrumentations and channels
  - 12136 AI, 4856 AO,4536 DI,1568 DO
  - 8000 spare and virtual channels
  - 4000 analogical control loops
- More than 120 PLCs
  - Siemens S7-416-2DP
  - 30000 conceptual objects/parameters



Anomaly detection

A number of anomalies cannot be detected by the control systems!

Possible causes:

- hardware failures/degradations
- wrong tuning/structure
- false measurements…

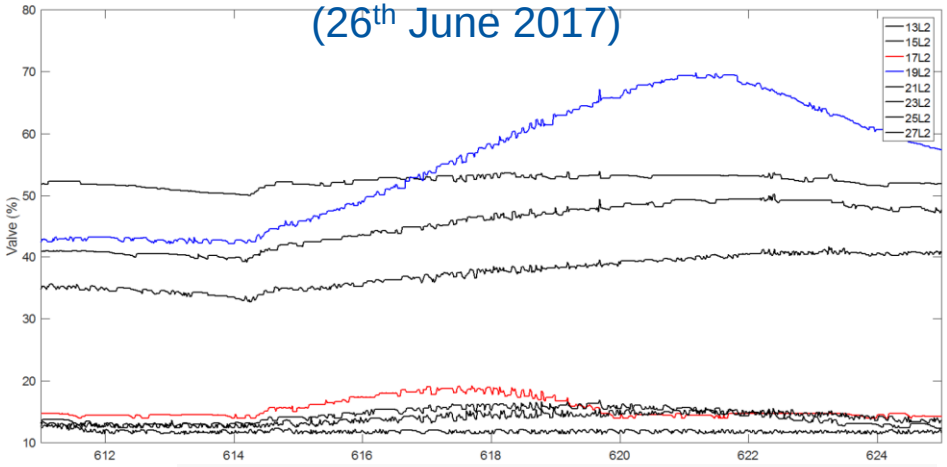
Impact

- Process stability and safety
- Maintenance (overuse of valves)
- Performance and downtime

Why data analytics?

- Too complex to embed calculations into the control systems
- Learn from historical data the group of signals with similar behaviour

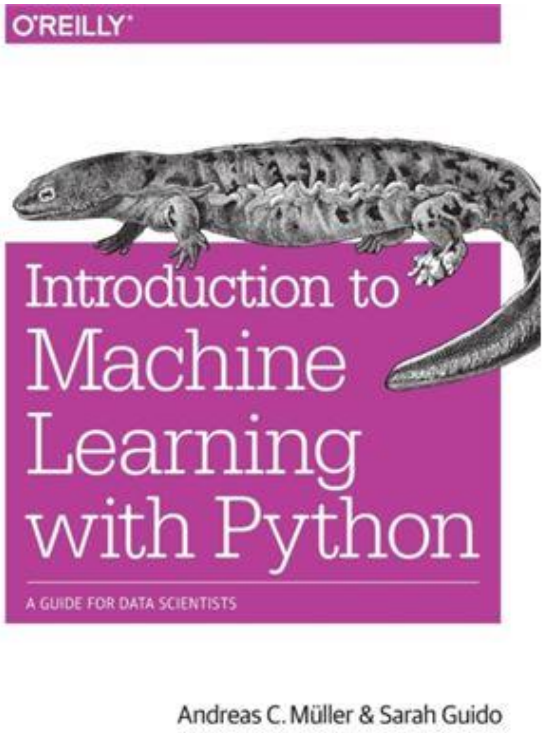
Valves CV910 openings in L2 (26th June 2017)



Direct impact on the operational cost!!!

Learning Objectives

- What are Industrial Control Systems?
- What they are made of?
- How can we exploit their archive data to render them “smart”?
  - A first exposition to Python and Machine Learning techniques



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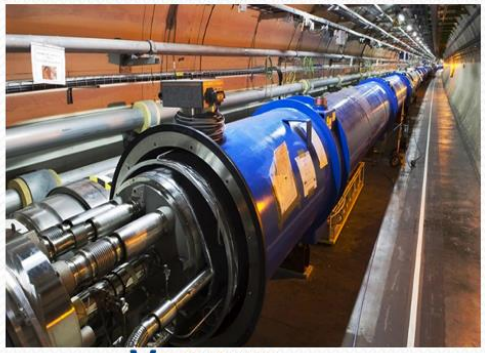
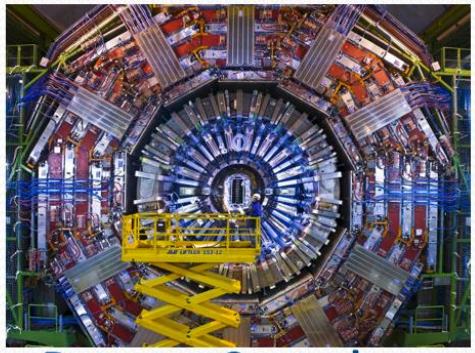
BACK UP SLIDES

Industrial Controls at CERN

Cooling & Ventilation



Vacuum



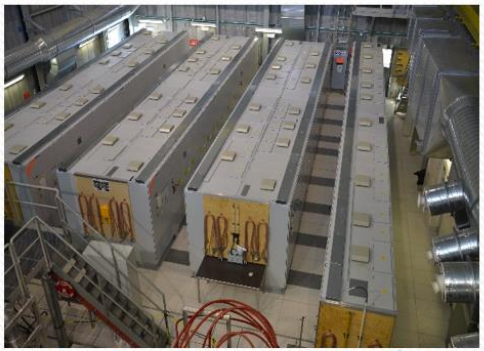
Detector Controls

Cryogenics

Gas Distribution

Environment & Radiation

Electric Grid



Interlocks and Safety

..and many others

Industrial Controls Architecture