

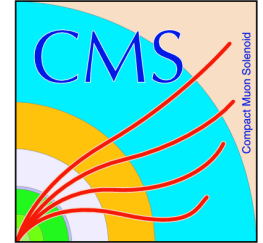
PCaPAC 2012

ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich



ETH Institute for
Particle Physics



Maintaining an effective and efficient control system for the Electromagnetic Calorimeter of the Compact Muon Solenoid experiment during long-term operations of CERN's Large Hadron Collider

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For the CMS collaboration

FNSNF

SWISS NATIONAL SCIENCE FOUNDATION

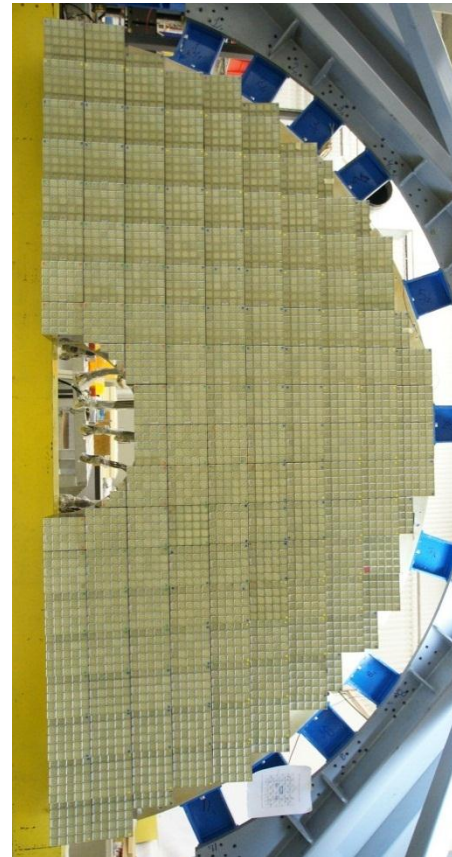
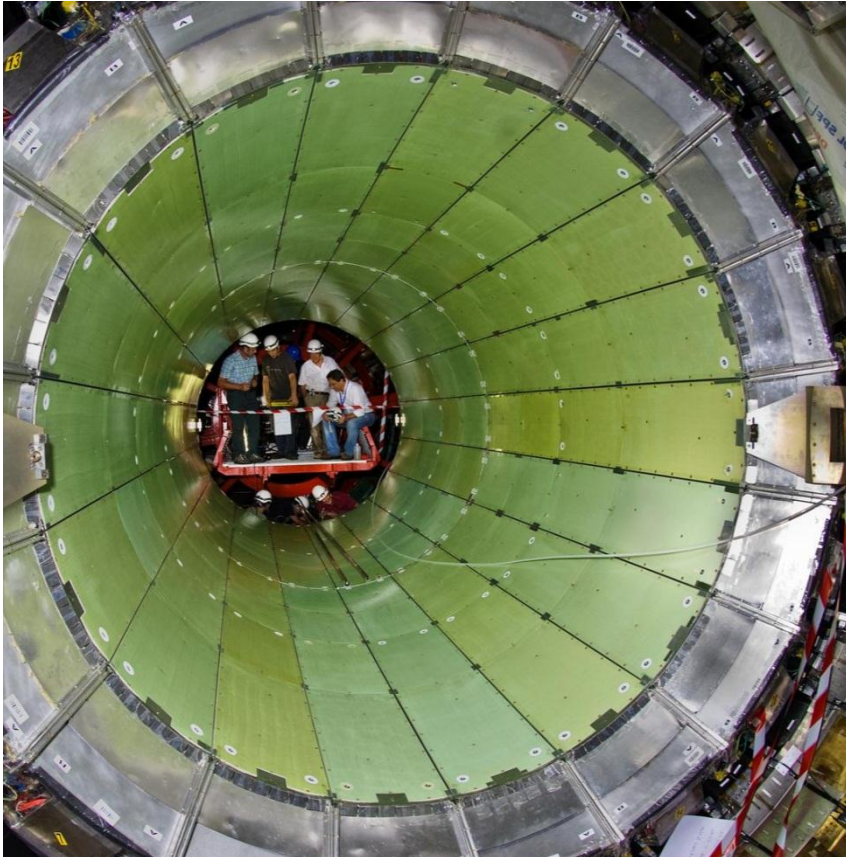
Overview

1. CMS Electromagnetic Calorimeter (ECAL)
2. Detector control system (DCS) architecture
3. Challenges
4. Approaches
5. Conclusions

CMS ECAL

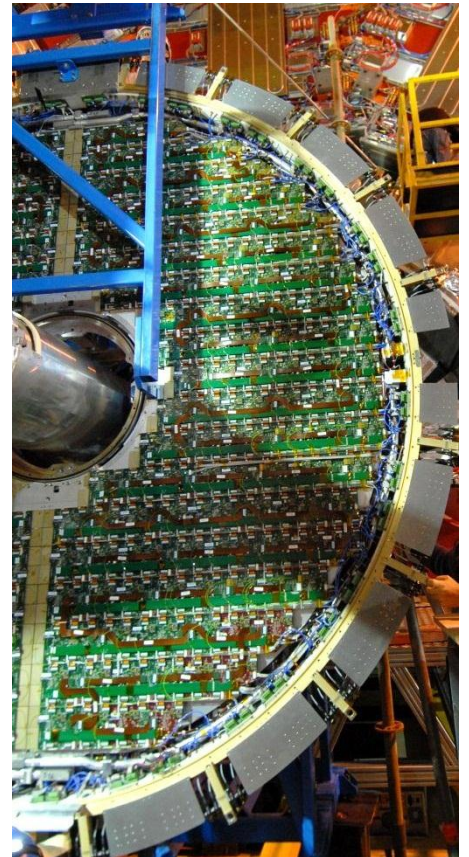
Barrel & Endcaps

Lead tungstate (PbWO_4) scintillating crystals
Photodiodes / phototriodes detect generated light



Preshower

Silicon strip sensors



Essential CMS ECAL DCS requirements

Monitoring

Temperature	972 probes
Humidity	180 probes
Cooling system monitoring	3 independent systems

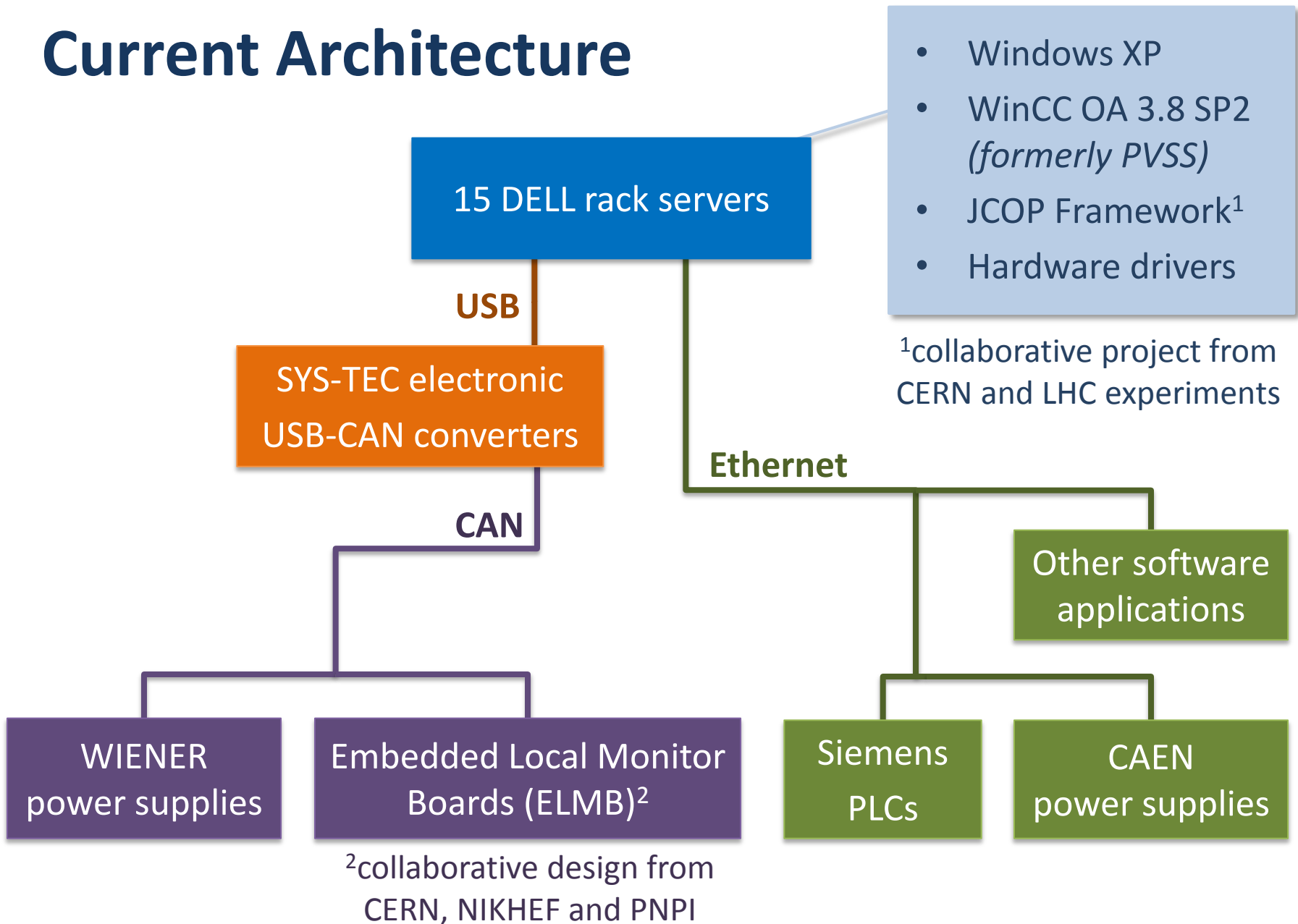
Control

Low voltage	1'060 channels Wiener & CAEN
Bias voltage	1'624 channels CAEN

Detector protection

- Software level protection actions
- Siemens PLC safety systems for interlocks

Current Architecture



Challenges for the CMS ECAL DCS

High software maintenance

- Diverse component design
- Reduced staff numbers
- Consolidation required

Technological developments

- Release & support cycles
- Interdependencies
- Benefits of new technology

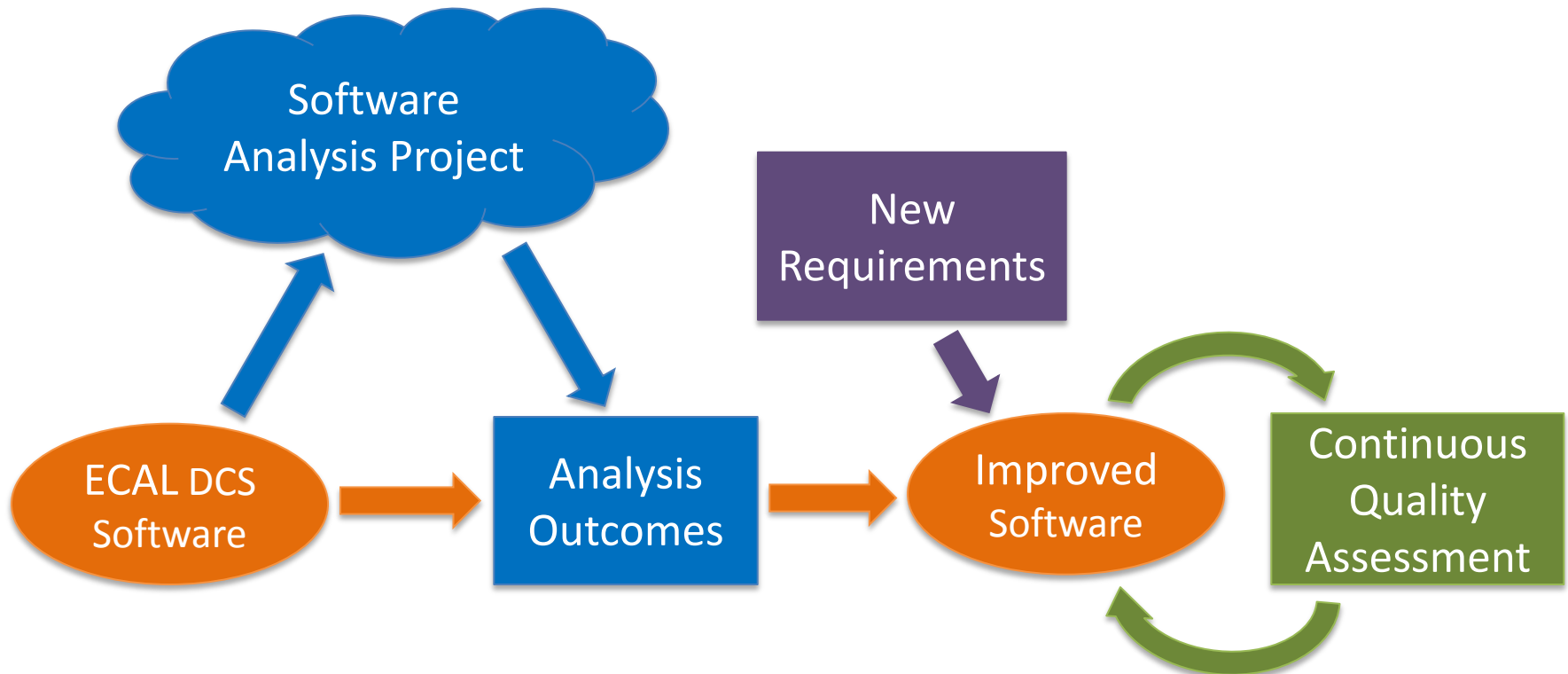
Extension of requirements

- Resulting from operational experience
- Need to avoid growing complexity
- Limit number of technologies

Software Consolidation

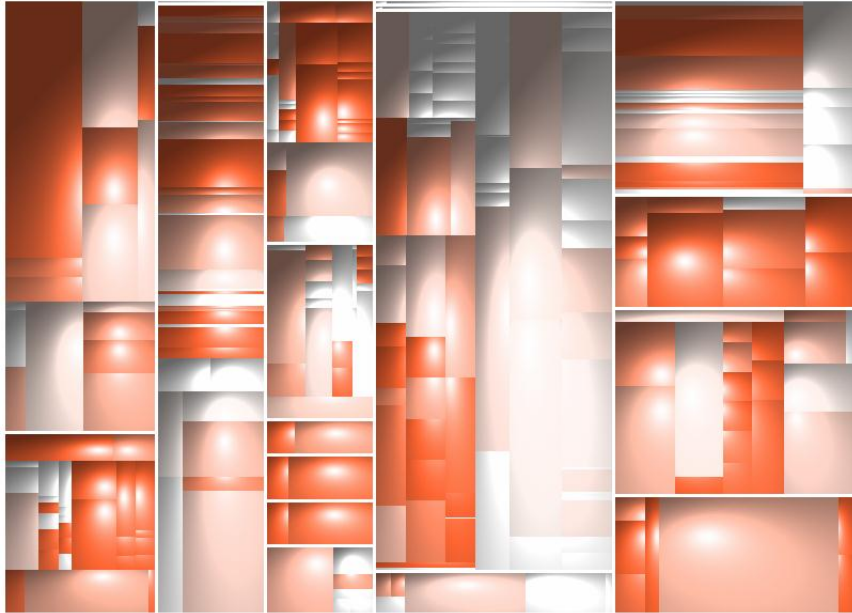
Software Analysis Project

- Factor out common functionality
- Homogenization
- Remove unneeded features



Software Analysis Project Impact

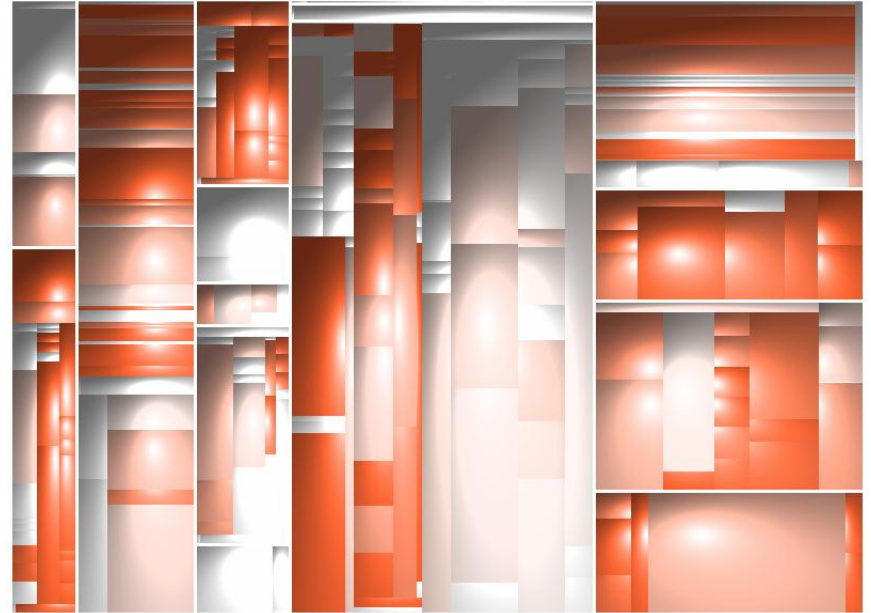
Before (January 2011)



Lines of code:
67'532

Duplicated code
marked in **RED**

After (October 2011)

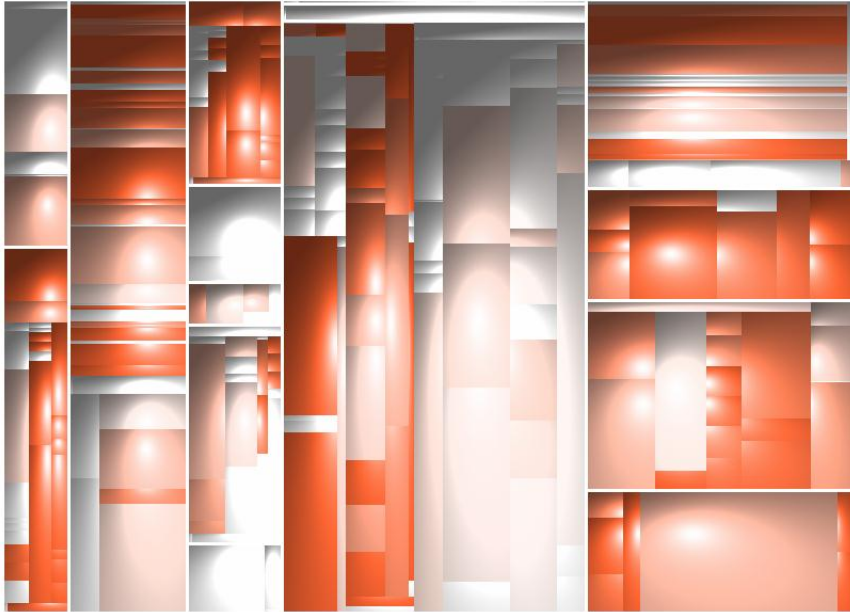


Lines of code:
59'655

Code reduced by
more than 10%

Continuous Quality Control Impact

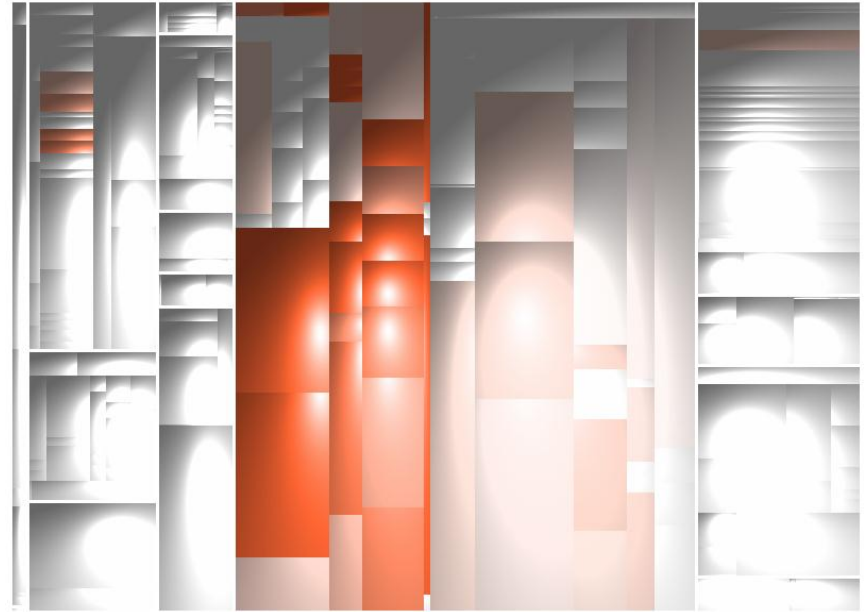
Without (October 2011)



Lines of code:
59'655

Duplication after
analysis project

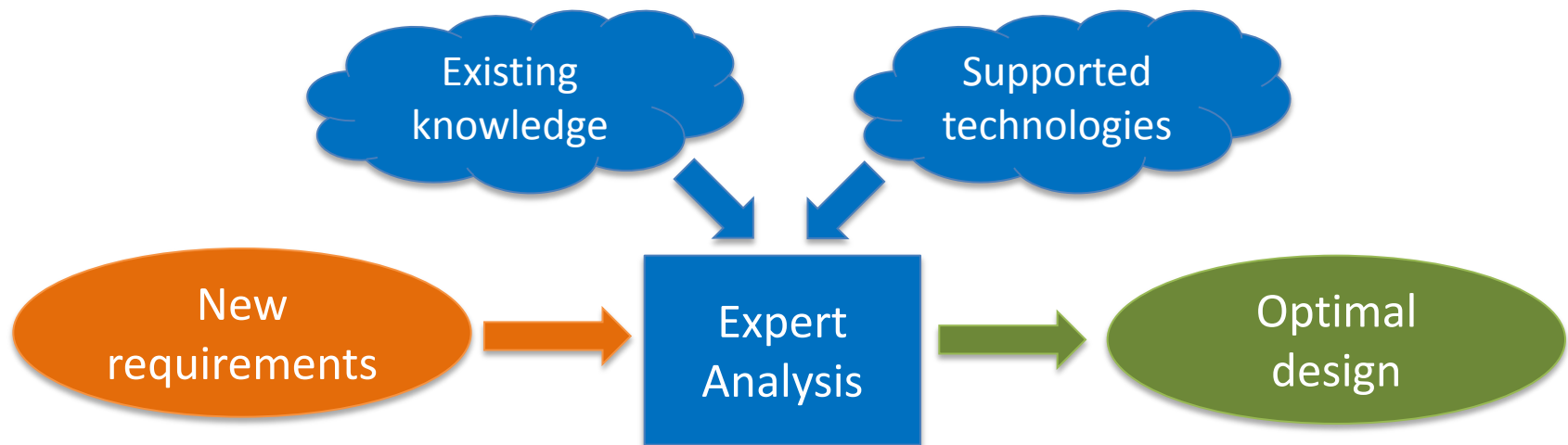
With (October 2012)



Lines of code:
37'124

Code reduced by
another 35%

Handling new requirements



Preshower bias voltage monitoring

- Based on existing ELMB design and experience

Improved humidity monitoring

- Custom electronics essential for existing probes
- Modbus chosen for readout due to WinCC OA support

Adopting new technologies

Smooth migration is essential

- Restrictive upgrade schedule

CMS ECAL DCS replica lab setup

- Research, development and validation
- Fewer problems seen during deployment

Upcoming migrations (2013-2014)

New DELL blade servers	✓ Validated
Windows 7	✓ Validated
CAN readout via Ethernet	In progress
WinCC OA 3.11	Pending
JCOP Framework 5.0	Pending

Conclusions

- Approaches have yielded benefits:

1. Consolidation and quality monitoring

- Code size reduced by 45%
- More consistency between components

2. Reusing existing technologies

- Rapid development of DCS extensions
- Complexity of system is controlled

3. New technology research and development

- Smooth migration to new technologies
- Benefit obtained from new features

Robustness maintained with extended functionality