CONTROLS FOR LHC CRYOGENICS

AT-ACR and AT-ECR

Outline

- Experiments cryogenic system overview
- Overview of the LHC machine cryogenic system
- The LHC cryogenic system status
- Requirements and expected AB/CO support:
  - 1st phase: hardware installation and software production
  - 2nd phase: commissioning
    - Commissioning of individual sub-systems
    - Global system commissioning, upgrades and consolidations
  - 3rd phase: operation and system upgrade / improvement
- Experiments cryogenics special needs
- What should be improved or does not work as expected

AT-ECR control equipments

AT/ECR equipment overview

ATLAS

* Helium external cryogenics (2 cryoplants, 2 OWS) – Operation
* Helium proximity cryogenics (barrel toroids, end-cap toroids and central solenoid, 2 OWS) – Commissioning

* Argon external cryogenics (1 cryoplant, 1 OWS)
* Argon proximity/internal cryogenics (barrel, end-cap A and end-cap C calorimeters, 2 OWS) – Commissioning

CMS

* Helium external cryogenics (1 cryoplant, 1 OWS)
* Helium proximity cryogenics (1 OWS) – Commissioning

NA48

* Krypton calorimeter – to be transferred to UNICOS end 06

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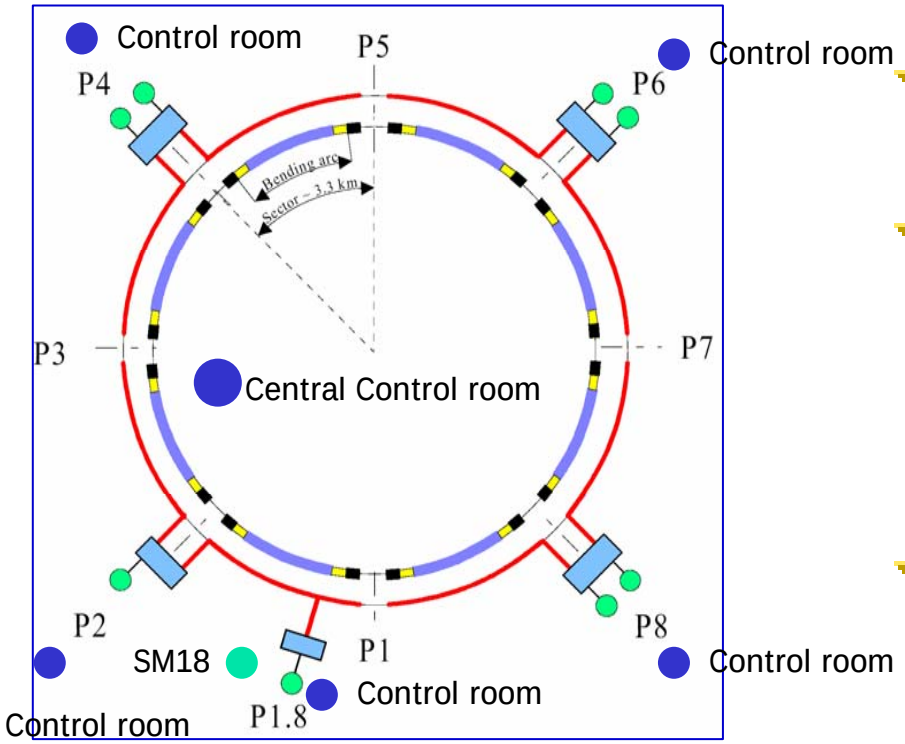
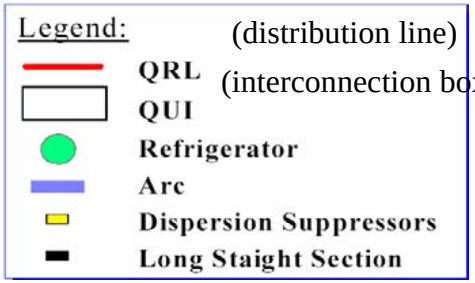
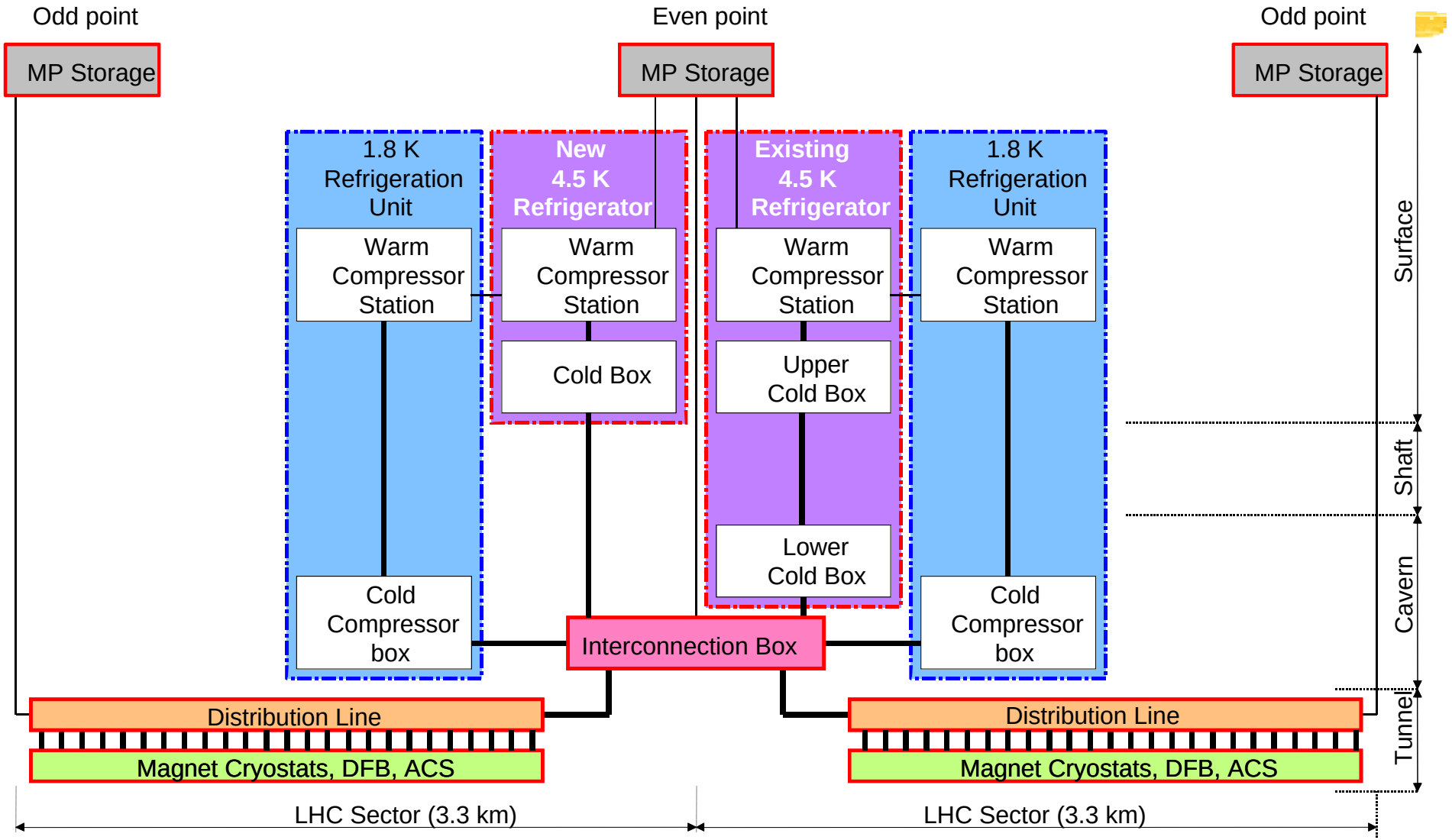
Cryogenic system layout 1/2

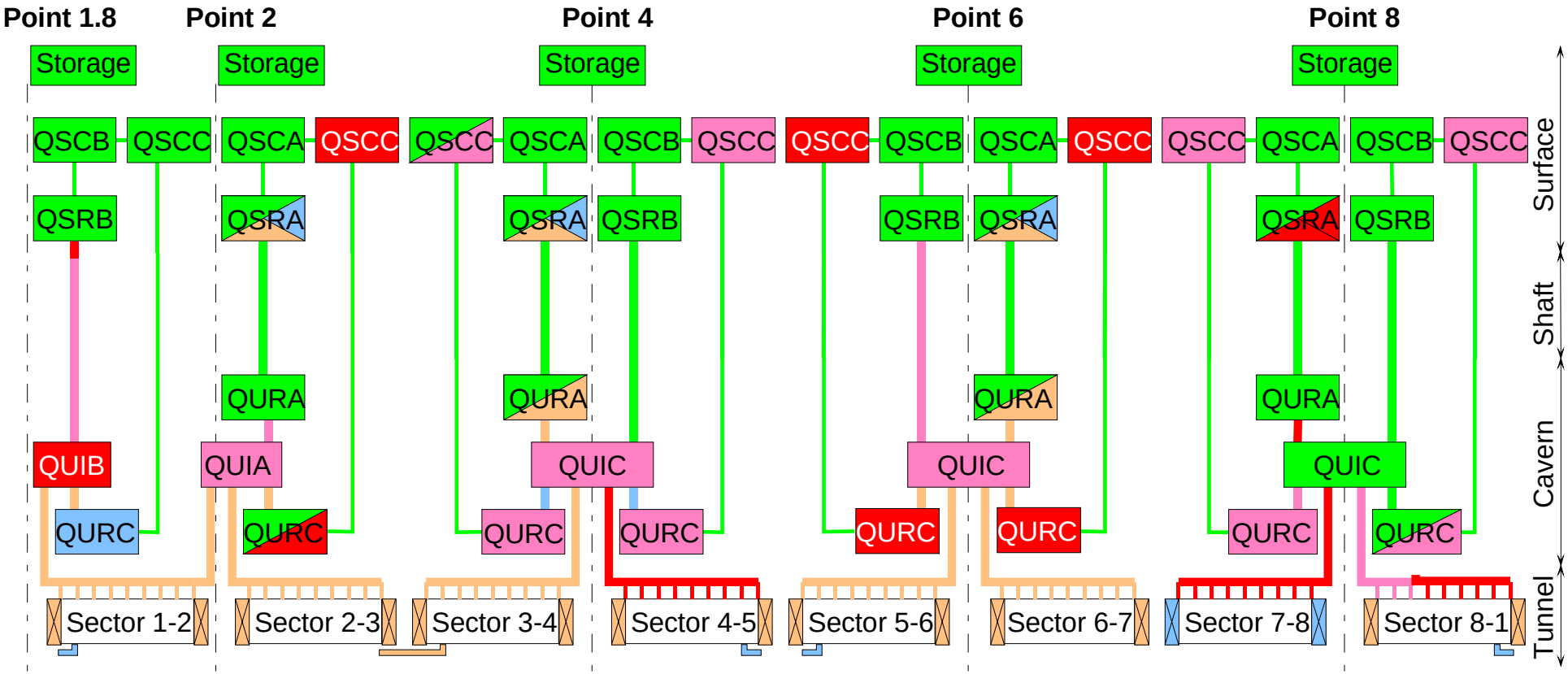




- 5 cryogenic islands
- 5 local and 1 central control room
- 8 refrigerators
  - 2 at P4, 6 and 8,
  - 1 at P2
  - 1 at P1.8
- 1 refrigerator serves 1 sector (18 kW @ 4.5 K, 600 kW precooler)
- possibility to couple two refrigerators via the interconnection box ➔ 2 refrigerators for 1 sector

Cryogenic system layout 2/2





Legend

Cryogenic Distribution Line

QSC_(A,B,C): Warm Compressor Station
QSR_(A,B): Surface 4.5 K Refrigerator Cold Box
QURA: Underground 4.5 K Refrigerator Cold Box
QURC: 1.8 K Refrigeration Unit Cold Box
QUI_(A,B,C): Cryogenic Interconnection Box

Electrical Feed Box

Superconducting Link

Commisionned & accepted

Delivered / Under installation

Ordered (Contract placed)

Under commissioning

Under fabrication

Under definition

1st phase HW and SW production

- First time (new controls):
  - All tunnel cryogenic system (ACR/IN with AB/CO support) – 2006-07
    - QRL sect. 8-1 – 4th quarter 2005
    - LSS8L – 4th quarter 2005
    - QRL and magnet systems 4-5 & 3-4 – 1st semester 2006
    - QRL and magnet systems all – 2nd semester 2006
  - SM 18 cryo infra and 6 kW Linde ABB -> UNICOS - 1st semester 07
  - Ex-LEP refrigerator upgrade to UNICOS (Pt. 4 and 6) – early 06
  - Precoolers and upgrade (all pts) – 4th quarter 05 – 1st semester 06
  - QURC Pt. 1.8, 2, 6 – end 05 – 1st quarter 06

- Already performed in other LHC points (duplication):
  - QUI Pt.1.8 but need upgrade for all points- 1st semester 06
  - Pt. 1.8 18 kW refr. ABB -> UNICOS – SD 06-07
  - Dryers pt 2, 4, 6, 8 - end 2005 – beginning 06

- SW production verification and debugging prior to cold commissioning !

- Participation to the CFAWG to define the cryogenic system functional analysis and write the engineering specifications for the controls of the overall system

2nd phase commissioning

- Commissioning of individual sub-systems
  - Tunnel cryogenics, ex-LEP refrigerators, QUI, QURC's, dryers, pre-coolers, SM18 infra and refr.
  - All on critical path for hardware commissioning
  - Requires presence of AB-CO software specialist at start-up (no on-call support) to shorten, optimize and make safe and reliable tests (first few days are sufficient)
  - SW verification prior to cooldown to minimize on-line modifications during runs
  - Maintain and ensure SW modification consistency and up-to-date version
- Global system commissioning, upgrades and consolidations
  - Require presence of AB-CO software specialist at start-up
  - Software verification prior to cooldown
  - QA and logging of SW modifications
  - Participation of AB-CO to the commissioning activities to optimize collective behavior of sub-systems and optimize general process during the tests at least during first sectors and systems testing
  - Cryogenics and HC will work on 2x8 shift; any stop will delay the HC and disrupt the work of up to 10 persons / day -> it requires fast troubleshooting -> on-call service 24h/24h
- Participate to Monday morning ACR commissioning meeting in order to review commissioning activities and set priorities
- Participation to the CFAWG to revise and improve the controls of the overall system

3rd operation and consolidation

- 24 h/ 24h on-call support for installation in operation (ABB installations prior to transfer to UNICOS ?)
- Ensure control system improvements and modifications are correctly tracked and updated in default SW version
- Support for GTPM applications necessary for fast re-start after major stop
- Support for supervision screens and fixed displays production, maintenance and upgrade
- Availability of AB-CO specialist for controls improvement and upgrade during the first years of operation

Recovery time to nominal operation after a failure

- Controls :
  - ? Complete new control system
  - ? Ethernet dependent (control loops, PLC communication)
- Required performances, reliability and robustness of the control system is not "yet" up to requirements

The cryogenic recovery acts as a **time amplifier**
- utility stop: rec. time=6 hours + 3 x "utility stop length"
- bad insulation vacuum or leaking QRV: rec. time = 15 x "utility stop length"

AT-ECR control equipments

Special needs for AT/ECR cryogenic installations:

- PLC and Data Server shall be running (almost) non-stop for argon calorimeters
- Only short « Shut Down » period for ATLAS and CMS magnets

Consequence for control system:

- 2nd line control support (ECR/CE 1st line support)
- Network performance
- Centralized data server (including support)

365 j/365 j (24h/24h)

Starting Dec 05

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What should be improved or does not work as expected
(and NEED to be solved before HC!)

- Resources:
  - No sufficient support from AB-CO to cover the commissioning of more than 1 – 2 subsystems at the time
    - -> 4 sectors in parallel -> ?
  - No on-call support during non-working hours for urgent troubleshooting of controls
  - Mainly "call centre" type technical support (we need AB-CO support in the control room during machines start-up) to improve efficiency, share of responsibility and achievements, better understanding of problems, team work !

What should be improved or does not work as expected
(and NEED to be solved before HC!)

- Hardware/Software:
  - Ethernet and communication problems (loss of time, data, configuration) –how safe and reliable ?
  - Quality control on software and modifications
    - Update of version without loss of configuration and parameters, …
    - Checks before hand-over for commissioning
  - Slow response and "load" of the control system
  - Continuous evolution of HW/SW versions
    - The change is not transparent as it should be
  - User interfaces
    - Trends: still progress needs to be made
    - Data logging: data extraction without formatting and ready to analyse
    - Data logging: continuous change of naming in DB makes difficult the creation of automatic routines for data collection and analysis
    - Diagnostics info: not always available or difficult to implement
    - PVSSIII: on-line modification not possible