LHC Machine Checkout & Dry Runs Strategy

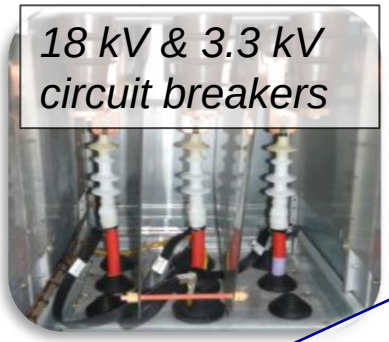
M. Albert LHC Beam Operation Workshop June 2014

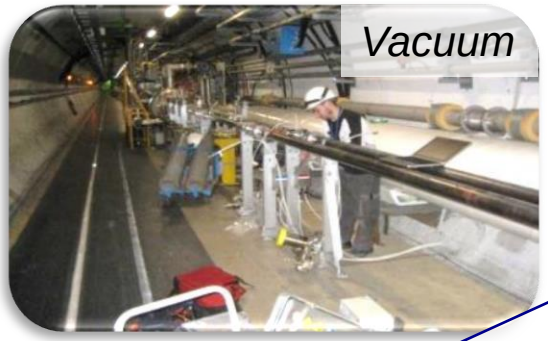
Acknowledgements: R.Alemany, R.Giachino

Outline

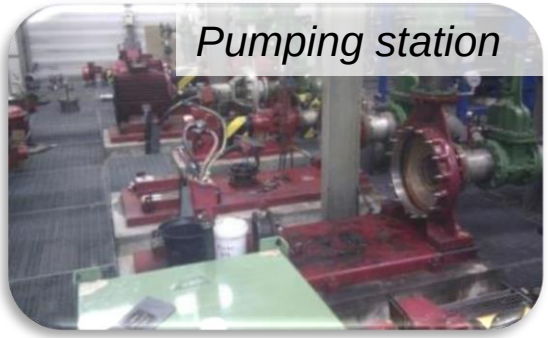
- Introduction
- Machine Checkout
- Dry Runs
- Conclusions

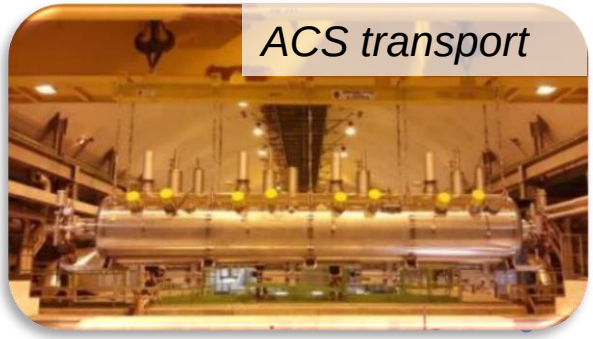
LS1 modifications





+ personnel changes, including OP/LHC !





The coordination team

Machine Checkout

Close collaboration to achieve common objectives

Dry Runs
Sector Test Preparation

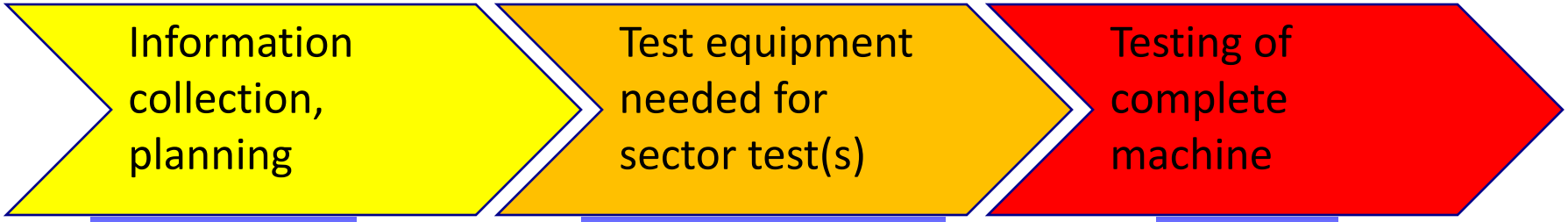
+ Delphine, Matteo

Machine Checkout

Definition:
Period between end of shutdown and start of beam commissioning during which all systems are tested by OP and equipment experts, in order to prepare the LHC for beam operation.

- Succeeds individual system test (IST) period
- Driven from the CCC (remote equipment control)
- Vital for a smooth transition from shutdown to beam commissioning
- 2014/2015 exercise:
  similar to start-up 2008 & restart 2009
  → early start & long preparation

Machine checkout - timeline



March – July

- Meetings with equipment experts (started in Q1/2014)
- Optimize test scheduling
- Preparation of MC planning
- Basis for following phases
- Start of Dry Runs

August - December

- Test & validation of equipment according to MC planning
- "sectorised" - machine checkout
- More Dry Runs
- 1st readiness deadline for most system

January

- Final tests of complete machine
- Run full LHC cycle
- Daily coordination & progress report meetings with close follow up

Machine checkout – current status

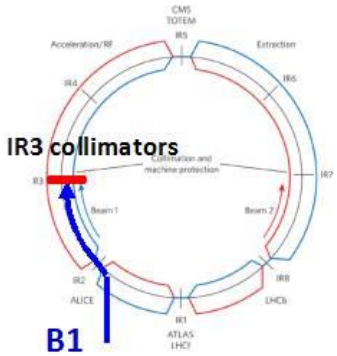
Information collection, planning

- Meetings with equipment group representatives to discuss:
  - Readiness
  - Test schedules
- Already covered:
  - Access system, BIS, Collimators, Cryogenics, General Services (EL, CV), LBDS, MKI, PC, PIC, RF, Vacuum, WIC
- Minutes:

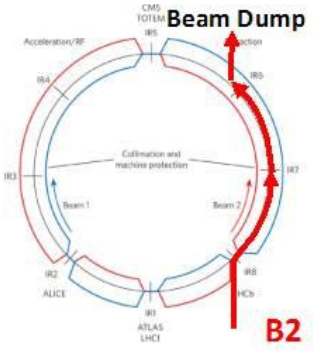
https://espace.cern.ch/LHCMachineCheckout

- Result: Machine Checkout test planning
  - Ready by end of July

Machine checkout – sector test



Test equipment needed for sector test(s)

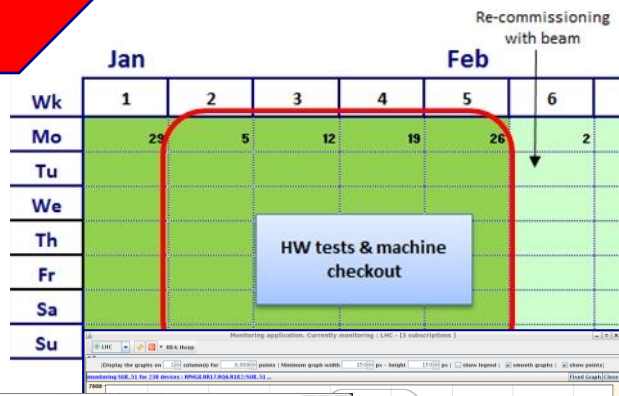


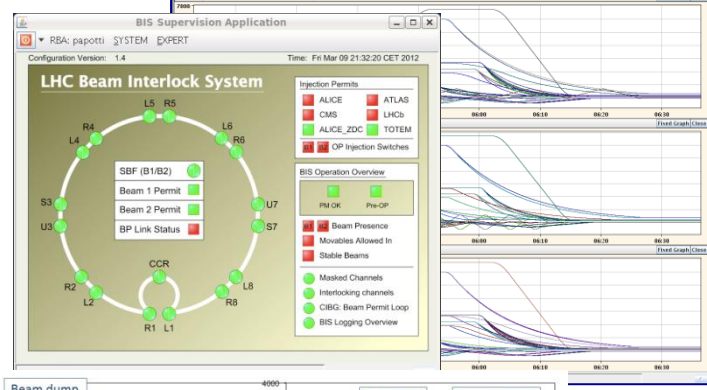
- 1st milestone with beam before full LHC commissioning
- Pre-conditions:
  - Full readiness of access system (4th/5th Oct)
  - Global DSO test: 11th/12th Oct
- Objective:
  - Test substantial subset of LHC equipment
  - Check-out all other systems as they become available
- **Dry runs** continue in parallel to HWC
- **Reduced BIS** configuration
- Powering group of circuits (**PGC**) of available sectors
- Software testing & debugging

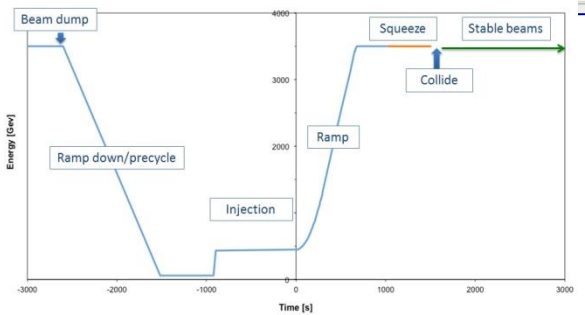
Machine checkout – the final

- Pre-condition:
  - Machine closed
  - All SC magnet circuits ready
  - PIC & QPS operational
  - Beam vacuum system operational
  - BIS operational
- Objectives:
  - Heat runs (warm magnets)
  - Test of full LHC cycle (injection, pre-cycle, ramp up/down)
  - Close beam permit loop with all BIS users connected
  - Final LBDS checks, energy tracking tests
  - MKI tests
  - Interlock tests without beam
  - Final machine protection tests (all BIS inputs)

Testing of complete machine





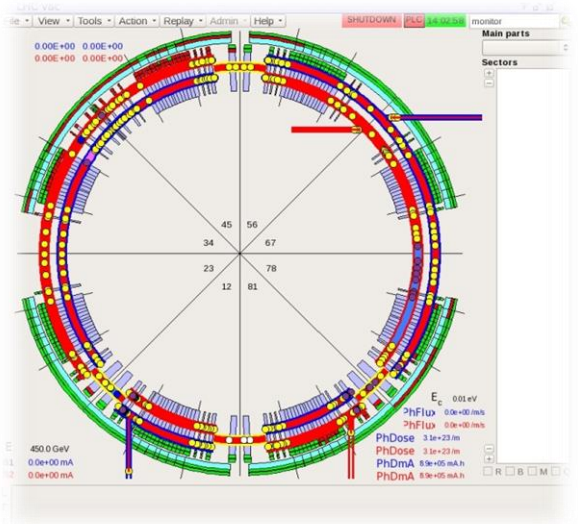


Daily 8:30 - meetings (access requests, test plan)

A typical MC test

vacuum valve interlock verification

- Pre-conditions:
  - IST on vacuum system done, valves in remote control
  - Straight section and adjacent sectors < 10^{-11}bar, $T_{cold\ mass}$ < 5K
  - BIC and supervision available
  - Logging of vacuum valve status
  - Valve alarms operational
  - NO powering tests in affected area



- Test sequence:
  - Simulation of vacuum problem to check correct valve behavior
  - Systematic individual valve closure/opening
  - With LHC ready to take beam: full verification of interlock logic

Dry Runs

Definition:
A **dry run** (or a **practice run**) is a testing process where the effects of a possible failure are intentionally mitigated. (wikipedia.org)

- Complementary preparation for sector tests and beam commissioning
- proven to be very efficient and useful tools in successfully qualifying the LHC for beam operation (start-up 2008, re-start 2009)
- 3 phases: preparation – execution – follow up
- Tight collaboration with equipment experts
- Involve complete controls chain (software debugging)

Dry Runs

- **Beam Dump:** local BIS loop + application, arming sequence, BETS simulator
- **Timing:** stress test
- **Beam Instrumentation + AC Dipole+ Tune/Aperture kicker + feedbacks:** sequencer tasks, applications, logging, concentrators
- **Injection:** timing, sequencer, MKI, applications, IQC (BI), synchronization/re-phasing
- **Hardware & Software Interlock System + Safe Machine Parameters (SMP):** sequences, flag generation SPS, forcing,…
- **Collimators + TCDQ + roman pots:** applications, settings, MPS tests, sequencer tasks, logging, roman pots (simulated energy and b*)
- **Damper + RF + Damper pickups:** sequencer tasks, settings, MCS checks
- **Experiments:** handshakes, beam modes, injection inhibits, interlocks,…
- **Power converters:** test “prepare circuits” sequence tasks,…
- **Postmortem (PM), Beam Dump External Post-Operational Checks (XPOC)**

Details & schedule: https://wikis.cern.ch/display/LHCOP/Dry+Runs+2014

2 Dry Duns so far …

Program	Comments/Issues
Dry run 1 (7-8 May) 1. Timing 2. TI 2 upstream BI 3. All BPM concentrators 4. Experiments beam modes and handshakes 5. Experiments frequency ramp 6. LHC RF re-synchronization (with experiment clocks)	• Test - hypercycle (2012 optics) • Old timing system (upgrade in autumn, but no change of interface nor functionality) • Mastership couldn't be taken (prevented some tests) • TI2 upstream BI not received at IQC (dynamic destinati… t available) • Some iss… synchronisation …, SPS part wasn't ready … equency ramp without ALICE no TI2 SETUP handshake with ALICE • no EXP data on DIP browser
Dry run 2 (21-22 May) 1. BIS-beam dump arming for B2 (local permit loop + two B2 BICs @ P6) 2. Revised arming sequence 3. Include arming of CIBDS (new BIS board)	• Only B2 tested (B1 at next occasion) • Some sequence modifications • Communication with XPOC and "Inject & Dump" not yet tested • Trigger from CIBDS not arriving on IPOC

No serious problems – very successful

Next Dry Runs

Date	Program
W24 - W29	**LBDS** reliability run B1 & B2, from CCC for several weeks
W25 / 18-19th Jun	LHC re-synchronisation (Linux FECs), LHC mastership (dynamic destination in test mode), TI2 – BI with IQC (possibly also TI8), SDDS, AC dipole, tune & aperture kicker, MCS checks, SMP for beta* and energy
W29 / 16-18th Jul	PM and XPOC
Parallel to HWC	Sequence to reset circuits, arm switches, LSA (trim, incorporation,…)
W33 / 12-14th Aug	Collimators (+ similar devices), RF beam control, ADT settings, injection cleaning, abort gap cleaning,…
W38 / 17-19th Sep	"old" implementation of feedbacks , BLM continuous, global permit loop + LBDS arming + XPOC, experiment interlocks & injection permits, BI sequencer tasks, ALICE frequency ramp, BQM, LHC BTVs, BRANs Start checking EVERY task in nominal sequence
W42, W44 Oct	Vacuum, BIS checks, BCTs, MKI, BLM triggered buffers, new timing system, sector test preparation (injection requests, inject & dump, set machine to injection…)
Until end of 2014	profile measurement systems (BSRT, WS), RF cavity control, ADT, new feedbacks

Conclusions

- LS1 = huge quantity of changes (LHC 2.0)
- Preparation for beam commissioning similar to start-up 2008/2009
- Sector tests as 1st major beam deadline to checkout most equipment
- General MC + DRs constitute a proven recipe to prepare the machine for beam commissioning