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on behalf of the Powering Test and Machine Check-out teams

With many kind inputs by a several people, in particular M. Bernardini, V. Montabonnet, H. Thiesen, R. Denz, B. Salvachua, G. Valentino, E. Carlier, E. Bravin, T. Lefevre, E. Piselli, C. Zamantzas, B. Puccio, J-C. Garnier
The schedule drivers: key dates

- DSO tests (machine in general mode before)
  - DSO tests on February 26 (and 27)
    - Both machine and experiments will be closed!
    - No activity can be planned on these dates!
  - March, 1 – start of UPS tests
  - March, 4 – LHC tunnel closed and start of powering tests
  - March, 16 – end of powering tests, experiments closed and (official) start of machine check-out
  - March, 21 – start of beam commissioning

It would be important to close the experiments already from Mon.14 during night time
EPC: impact on PT

See Session 3: V. Montabonnet, “Power converters”

- FGC CPLD & Software upgrade
- Current Calibration of
  - 13 kA circuits (main dipoles and quadrupoles, ITs)
  - RMSIs
- Additional intervention of maintenance / power module replacement
  - RB.A56, RQD-RQF.A56
    - Earth Fuse - Change from 1A to 200mA as discussed with TE-MPE for better localisation of an earth fault on the cold part
  - LHC4-6-8kA
    - Change of FWD fault (too sensitive) into warning
  - LHC120A-10V
    - Change of WATCHDOG fault (SEE sensitive) into warning
  - LHC600A
    - Over I – Current switch selector to be replaced by a PCB
  - Check the fans for RPHx, RPHGx 1Q converters

No major impact on re-commissioning (precise procedures and follow-up)
Required validation tests already in the baseline
MPE – QPS: Could strongly impact the commissioning time!!

- Installation (this week?) & commissioning (QPS-IST, interlock tests and powering tests) of radiation tolerant detection systems for 600 A circuits
  - Two 2 cases (causing beam dumps) were observed in 2015 (RR13 17/10/2015, RR57 31/10/2015)
  - Installation foreseen in RR13, 17, 53, 57, 73 and 77

- Upgrade of the firmware for the nQPS DAQ systems allowing easier recovery from local bus errors (436 units concerned)
  --> no more QH firing
  - Locations: 8 sectors (COMPLETED) Impact to be assessed

- Installation & commissioning of new detection systems for circuits RU.L4 and RU.R4 (‘undulator’).
  - New detection boards developed
  - Upgrade of the corresponding current sensors performed by EE team (replacement of LEMs by DCCTs)

  -> Might be able to ramp faster (ACCESS!), no more drift/dumps

All must be up and running for the UPS tests!
MPE - EE+ElQA: impact on PT

- A general and specific overhaul of the 32 installations of energy extraction in the LHC main dipole and quadrupole circuits is in progress
  - A 500 VDC voltage withstand test has been requested, involving the warm and cold part of the circuits; plus extraction at different current level

- All quench heater PS are switched off during the YETS; those with anomalies discovered in 2015 have been repaired or replaced
  - No global QH firing; only test of those affected by intervention
  - The QPS team foresees as well a test of the QPS interlocks

Additional verification to be done

- ELQA investigations of the earth fault on the circuit RCS.A78B2 (near DFB)
  - Decision taken by LMC to do the type test
  - Final test to be discussed later

Would require more extensive test!

- ELQA integrity verifications at the end of YETS
  - Depending on the temperature variations and the interventions on the circuits
  - Discussions have been started to assess the need for circuits hi-potting

The necessary validation tests have been included in the baseline Impact on re-commissioning depends on the list of ElQA tests

Organization

- We could test some circuits just before the UPS tests (February, 28-29) for debugging purpose (1 week to roll-back in case of issues…)
  - A 120 A test bench is being made available by EPC, but it would be important to test SW and HW modifications on all circuit types!

- From March 4, the machine will be closed (excluding urgent, spot interventions)

- Powering tests will be executed all around the clock
  - More than 7000 tests in 12 days (typically, interlock tests+ramp to training current)

- Tunnel accesses (exclusively related to powering) will be during the normal working hours

- Sequences and SW
  - Powering procedures have been updated by MP3 colleagues
  - Test sequences will be modified according to the latest needs
  - MTF campaign is being created
  - Acc_Testing campaign is being edited
Warm magnets

**EIS circuits**
No intervention on power part; powering (1 day per converter hors-chaine) and EIS interface
- RMSI Point 2 and 8
  - Installation of a new Control Crate for a better reliability and an optimisation of the spare card management
  - Rework at the level of the EIS for a better diagnostics
- RD34.LR7
  - Change of a DIVISOR MODULE card to solve a voltage measurement issue
- RD34.LR3
  - Change of the ACTUACTOR board; MCB Fault to be investigated

**Experiments**
- LHCB Dipole: 1 day for test
  - RPTI.SR8.RBLWH.R8
    - Installation of a new Control Crate to solve the issue of PC PERMIT bad contacts
  - RBXWSH.R8
    - Partial DC cable replacement (EN/EL)
- Alice Solenoid
  - PC flow-meter to replace the internal flowmeter which failed in Run2
  - Replacement of all water hoses of the thyristor cooling circuits
  - SX2 FGC Spare to put on WorldFip network

**Exchange of some coil retainers in point 3 and possibly point 7 on all MQW magnets**
- Foreseen from mid-February
- Verification by powering the circuits (ramp up and down)
- No cable disconnection → no polarity check needed
Machine check-out in a nutshell I

- Check all equipment control functionality
- Check the synchronization
- Check the beam instrumentation acquisition chain
- Drive all relevant systems, in a synchronized way, through the standard operational sequence
- Check the functionality of the control system from the control room high level applications
- Check machine protection and interlock systems
- During this phase many machine protection test without beam are accomplished
- All system have to be declared operational

➢ Test the readiness of the LHC to inject and accelerate a low intensity beam
Machine check-out in a nutshell II

- The beam can not be injected and circulate without closing the BIS loop
  - LBDS connected
  - All clients connected to the loop
  - LHC access key on beam mode
  - LHC vacuum valves open
  - Hardware commissioning finished; all circuits ON and no faults
  - No interlock from non-maskable clients

Interlocks will be tested by VSC and OP
LBDS

- Replace MKD generator side panels (full closure for improved dust protection)
- Replacement TSDS ELMA crates (redundant power supplies monitoring)
- Visual inspection MKD/MKB generators
- Replacement of 2/3 GTO switches (bad switch ratio)

- Full revalidation of the system needed during machine check-out
- **Full recalibration** at the end of the YETS
- Short reliability run in local

- UPS tests at the end of the YETS

- The different functionalities have to be checked
  - BETS
  - XPOC
  - Synchronization LBDS and RF
  - Full check-out tests needed with system fully connected
    - Energy tracking tests up to 6.5 TeV
    - Arming the system connected to BIS once beam permits are OK
    - Circulate and dump sequence
    - Machine protection tests with loop closed

TCDQ
- Calibration verification
Kickers

MKI
- Replace terminating resistors (MKI2 & MKI8)
- Deploy acquisition system for magnet capacitive pick-ups (precise location of HV breakdown inside the magnet)
- Upgrade thyatron heating system
- Implement fast vacuum acquisition of MKI interconnects
- Surveillance low voltage power supply in timing system
- Replacement fine delay V850 module by SVEC-FD module
- General software maintenance

MKQAc
- Upgrade from RIO3/LynxOS to MEN-A20/SLC6
- Verification HV contacts in AC-Dipole generators
- General software maintenance
Collimators

- Hardware and FESA should be tested with systematic ramps
- **Machine protection tests** to check position, energy and beta-star interlocks
- Injection protection tests (to check also the interlock chain)
- Additional tests will be done without beam, using a simulator to optimize the BLM alignment
  - during 3-4 hours without beam with as many collimators, to move them in parallel

27/01/2016
Beam instrumentation

- **BLM**
  - Test of the successful transition of USER_PERMIT [T→F] (5’x8 sectors) and the signal arrival at the BIC
  - Test the change of the threshold values according to the beam energy signal received (1h)
    - Sectors 45, 56, 67 and 78 ramped to 6.5 TeV or in a simulation energy ramp (timing system fully operational)
    - Check of the correct detection and propagation to the SIS for requesting a beam dump due to missing HV power supply on the system's detectors (1h)

- **BPM**
  - Will do BPM Fibre connectivity tests and software checks as much as they can to validate the new FESA3 server (BPMD class and BPMLHC class)
  - Intensive check of FW and SW:
    - Calibration, logging process, Post-Mortem buffers

- **WS** (mostly qualified with beam)
  - Check of the movements
  - Check of the FESA class
  - Check of the new functionalities of the FESA class

- Standard checks on BTV images/movements, applications get data, sequences work etc.
Must have 4 weeks available for RF conditioning and commissioning,
- Major controls validation on the new FESA3 software with some conditioned cavities
- For the LLRF, **2 weeks (without beam) to complete the setting-up of the loops after some cavities are conditioned**

**Additional time is requested for conditioning the klystron with higher cathode current**
- At present the power is sufficient because the voltage is reduced to 10 MV in physics (we used 12 MV during run 1 and the LHC design assumed 16 MV!)
- To increase the voltage above 12 MV, the 250 kW saturation will not be sufficient and we will need the design 300 kW.
Controls

From V. Baggioni:

- **Smooth upgrades are proceeding as planned:**
  - Major Controls upgrades (OS, Middleware, RBAC, Databases, Timing, LSA/InCA, etc) done successfully
  - Other upgrades (FESA classes, FGCs, PLC code, Firmware, etc) are ongoing
  - No problems anticipated for re-commissioning

- Up-to-date information here
  [https://wikis.cern.ch/display/SUWG/YETS+2015-16+Follow-up](https://wikis.cern.ch/display/SUWG/YETS+2015-16+Follow-up)

We’ll have to test extensively before beam! We’ll profit from the experience (and debugging) of the injectors!

27/01/2016
Concluding remarks

- The boundary conditions for the YETS are well defined; however
  - Few critical activities could have an impact
  - 7000 tests have to be done in 12 days

- As usual, the good coordination between PT and machine check-out will be fundamental for a smooth transition to the operational mode
  - A lot of tests and verifications to be done
  - All the systems finally connected together

- All experts are already working on their systems to get ready for beam; machine check-out coordination will kick in starting from mid-February

- Ways can be studied to reduce the time for commissioning, but this has to be done without forgetting the priorities (S-Q-P), since the rigorosity of the process is the key for a safe and successful operation of the machine throughout the year
Thank you for the attention!

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Temperature drifts during YETS...
Activities that could impact the PT

**Prerequisites:**
- Cryogenics – CS/CM should be there at the beginning
- Services (CV, EL,…)
  - Electricity, water, ventilation
  - The UPS tests will have to be (successfully) completed in the sectors under powering

- Power converter
- MPE
  - QPS
  - EE
  - EIQA
- PIC
  - No intervention foreseen during YETS
- EN/EL
  - Visual inspection on warm bus-bars should be conducted by EN/EL to avoid surprises when restarting (consolidation already done during 2015 TSs)

27/01/2016
RQ4.L/R1 modification

- ALFA project: adding one more WCC per RQ on Q4 circuit around point 1

For RR17, the installation is already completed and the tests are on-going
- Electrical insulation test “à sec”, PC connection and interlock test, water reconnection and insulation test are done
- 24h heat run on-going

For RR13, the tests will be around mid-February

Short-circuit test + 24h heat run to be done during the YETS
Complete re-commissioning of the 2 circuit during powering
List of powering tests to be done

- 60A
- 80-120A
- 600A
- IPQs
- IPDs
- ITs
- RQs
- RBs

Almost 7000 tests!!!

Update!!!

27/01/2016
MPE critical changes

- Normal checks before beam

- BIS – no additional tests needed
  - Displacement of many socket-outlet blocks (reglettes)
    - in all cases these units prevent the access to the VME redundant power supplies (namely ‘Wiener’ P.S.) (to be coordinated with EN-EL)
    - Locations: all UAs, US15, UJ33, USC55, TZ76, SR2 and SR8

- WIC
  - WIC upgrade to new generic code base: remote download followed by (partial) re-commissioning of the system – max half a day / point....

- SMP – only SW change, no HW – no additional tests
  - Replacement of the VME-bus master module family: ‘RIO3’ type replaced by ‘MenA20’ type (this depends on successful lab tests still to be confirmed)
  - Location: CCR

- Misc
  - Various SW upgrades (e.g. FMCM FESA class, QPS Swiss Tool, ACCTESTING,...) – time certainly needed to deploy and test!
  - All issues should be cleaned before start of powering tests