



LHC Commissioning Organization

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BE & TE Departments

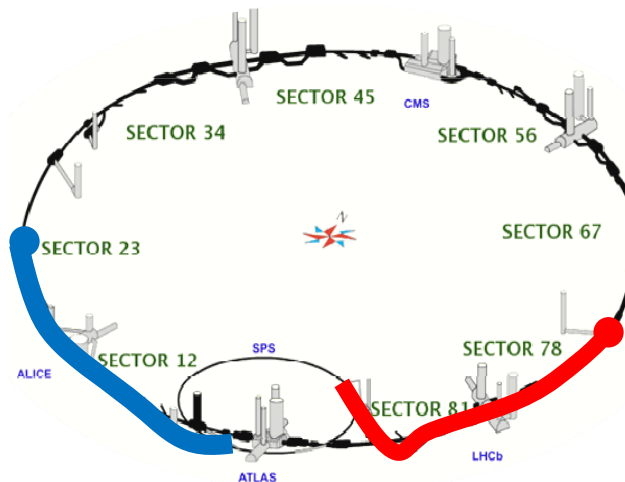
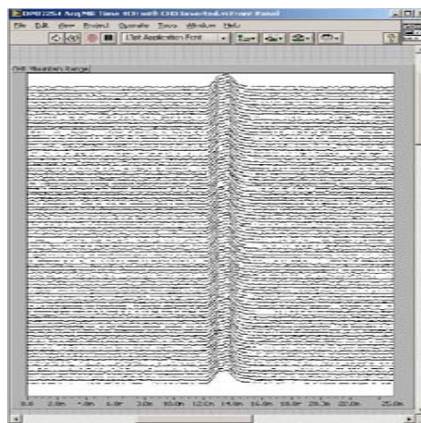
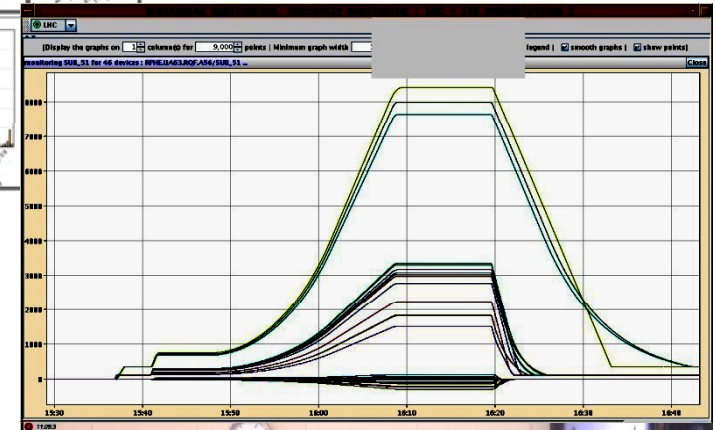
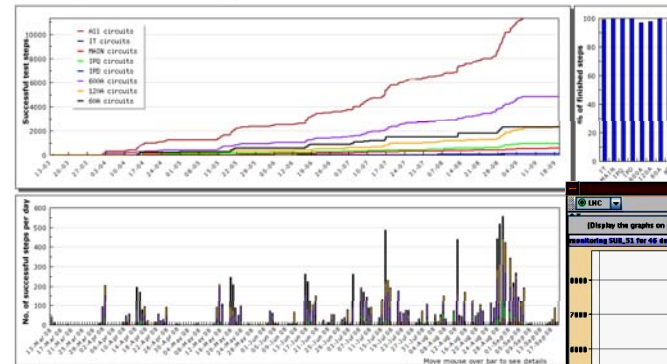
Outline

Organization in 2008

- HW Commissioning
- Dry Runs
- Machine Check-Out
- Injection Tests
- Beam Commissioning

- Lessons learned
- What is going to change?
- What could be improved?

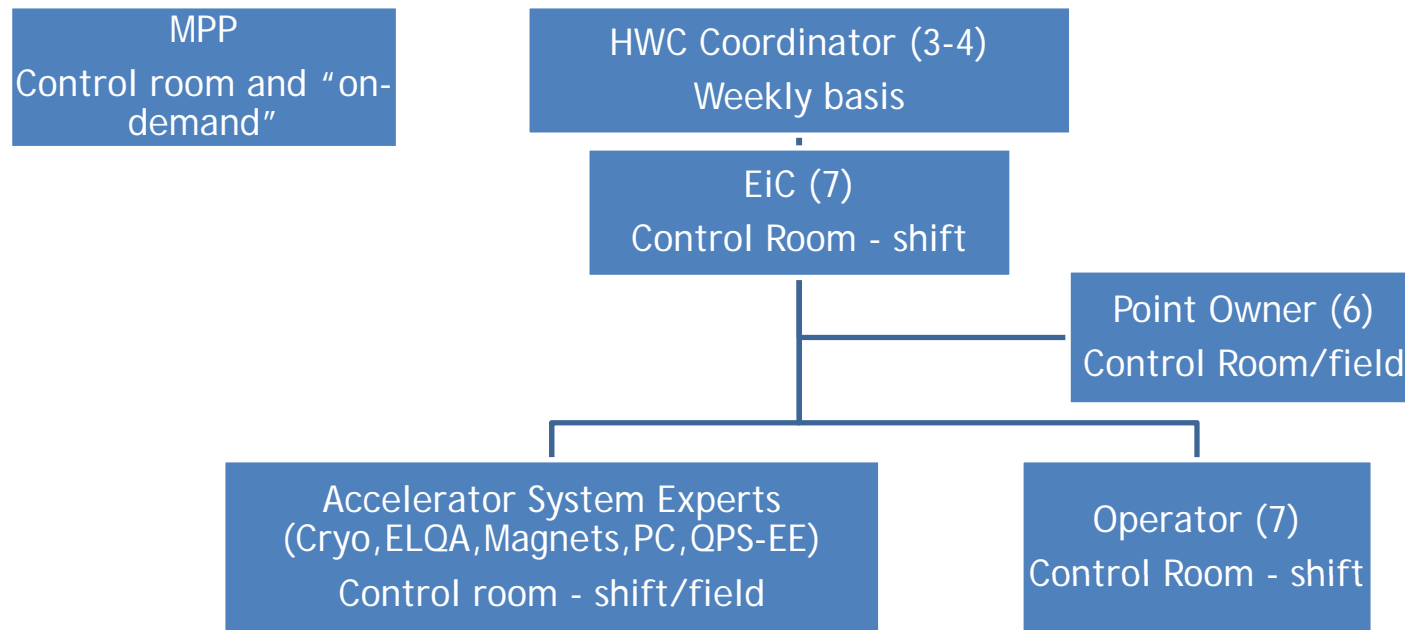
Summary of executed test steps in all sectors



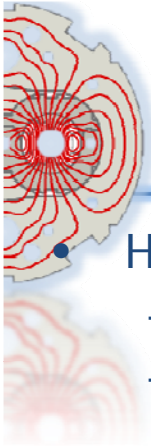
2008 - HW Commissioning



- In 2008 HWC focussed on the **Powering Tests** (including powering interlock verification) of the magnet circuits after qualification for operation the individual systems of a sector (vacuum, cryogenics, quench protection, interlocks, powering, etc.)
- Impressive organization and amount of work done (see M. Pojer - Session 1).



2008 - HW Commissioning



- HWC Coordinator:
 - Engineer/physicist with experience in SC circuits
 - Prepares the conditions for the commissioning: procedures, safety, environment, Infrastructure, Quality Assurance assisted by Point Owners
 - Defines the commissioning programme and procedures with System Experts
 - Reports progress and problems to the Project Management and wider community

- Point Owner:
 - Engineer/physicist with the knowledge of the “field” (2 sectors at least)
 - Assists the HWC Coordinator in the preparation of the commissioning
 - Assists the HWC Coordinator/EiC in the definition of the plan contributing to identifying/solving potential conflicts (e.g. access/safety/installation)

- EiC on shift:
 - Accelerator Engineer/Physicist (~2 year experience)
 - Responsible for the safety during the shift
 - Makes sure that the plan is executed and contributes to its execution
 - Documents the tests and the progress
 - Coordinates the access in collaboration with the Point Owner

2008 - HW Commissioning



- Operator on shift:
 - Experienced accelerator technician (injectors, magnet test facility)
 - Executes the test plan
 - Assists the EiC in handling the accesses
- System Expert:
 - Engineer, Physicist, Technician with experience in the system
 - Executes the steps required for the preparation of the HW Commissioning on the field (ELQA, QPS-EE preparation, Cryogenics tuning) or in CCC on shift
 - Monitors, analyses and manages the performance of his system during the HWC
- Main Ring Magnet Performance Panel (MPP) as “control” body:
 - Team of SC magnet, magnet protection, cryogenics experts
 - Define/revise the procedures for the tests
 - Monitor, analyze and manage all aspects of magnet performance
 - Detect, diagnose, correct or mitigate problems on magnets and SC circuits
 - Finally defining the operational envelope for a circuit
 - Both on-line (experts in CCC on shift) and off-line activity



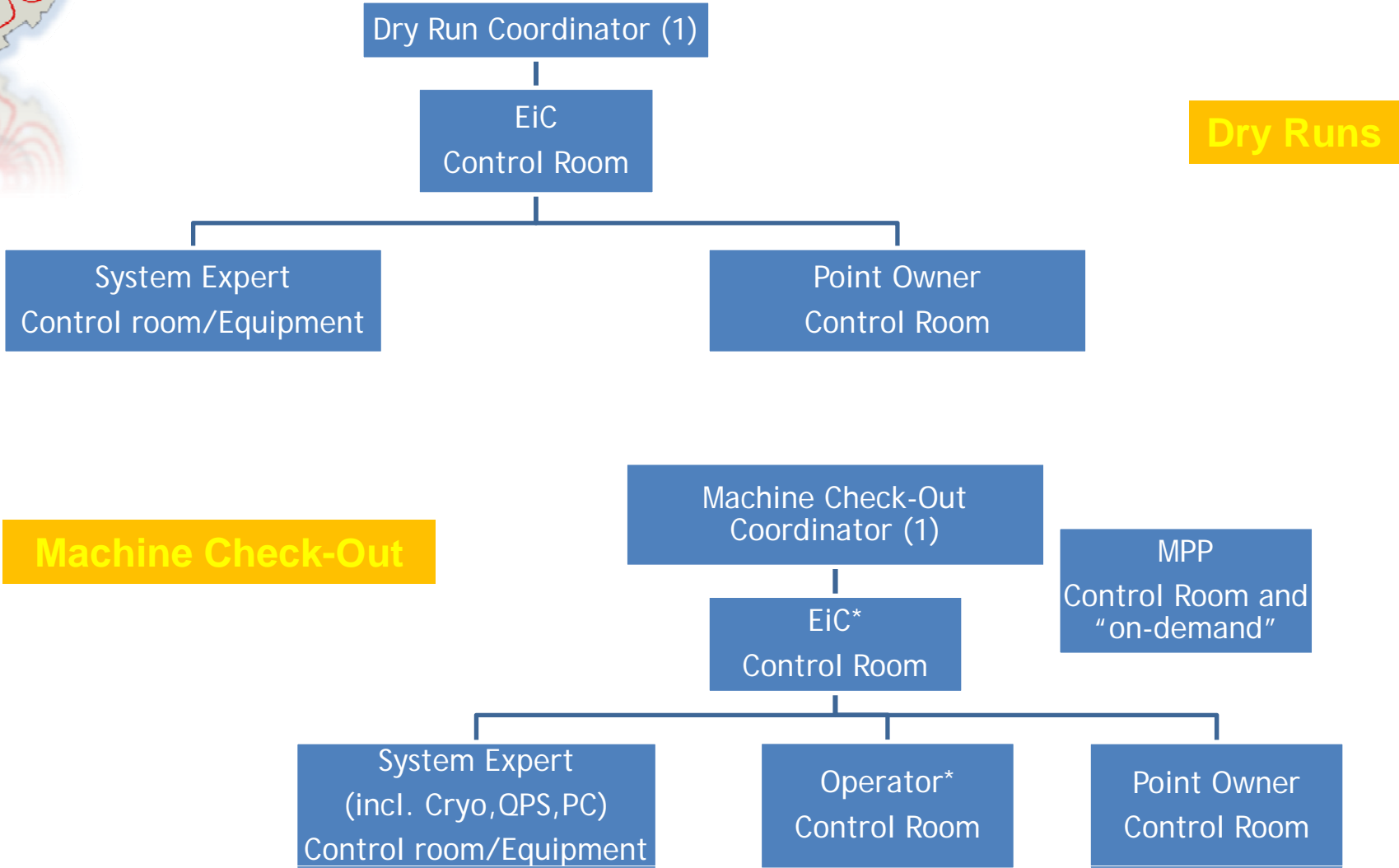
2008 - Machine Preparation for Beam

Organized in the form of Dry runs & Machine check-out tests aiming at verifying the operation of several systems mimicking different operational phases (e.g. Injection, ramp, squeeze, beam dump, interlocks tests, etc.)

- Dry runs (e.g. Injection System, Beam Abort System):
 - Started in 2003 (injection lines)
 - after individual system tests conducted by the equipment groups
 - Blocks of few days spaced by few weeks for analysis and correction of the problems
 - In CCC using **operational software**
 - Driven by System Experts, System Commissioners and EiCs
- Machine check-out (e.g. tracking among circuits and systems, beam interlock & alarm verification):
 - Test of the different circuits/sectors in unison and in operational conditions (ramp rates, acceleration rates, settings) once released by HWC
 - Integration of the various accelerator systems (injection, beam dump, RF, collimators, **beam interlocks, alarms,** etc.) once debugged in Dry Runs.
 - In CCC using **operational software**
 - Driven by the “users” (EiCs, Operators)



2008 - Machine Preparation for Beam



*On shift approximately one month before beam commissioning start



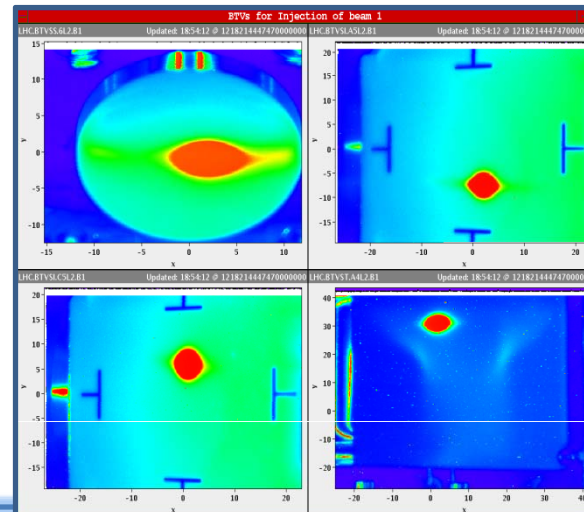
2008 - Machine Preparation for Beam

- Dry Run (resp., Machine Check-Out) Coordinator:
 - Experienced accelerator physicist
 - Defines the test programme with the Accelerator System Experts and Commissioners taking into account the constraints imposed by parallel activities (HWC, installation)
 - Makes sure that tests procedures exist, are updated and available
 - Reports on progress and issues to the Management and wider community
- EiC (often shared with HWC)/Operator:
 - EiC is responsible for safety when on shift
 - Assists the Commissioner/Expert in executing the tests
 - Updates procedures and sequences
 - Documents the tests
- System Commissioner/Expert
 - Not necessarily the “provider” of the system (can be also an experienced accelerator physicist)
 - Makes sure that the system under his/her responsibility is ready for beam commissioning.
 - Defines test procedures and implement them in coordination with the Coordinators and EiCs
 - Documents of the results of the tests
- Point Owner:
 - Assists the Coordinator/EiC in identifying/solving potential conflicts in the HWC/Machine Preparation activities in particular with respect to powering/access/safety

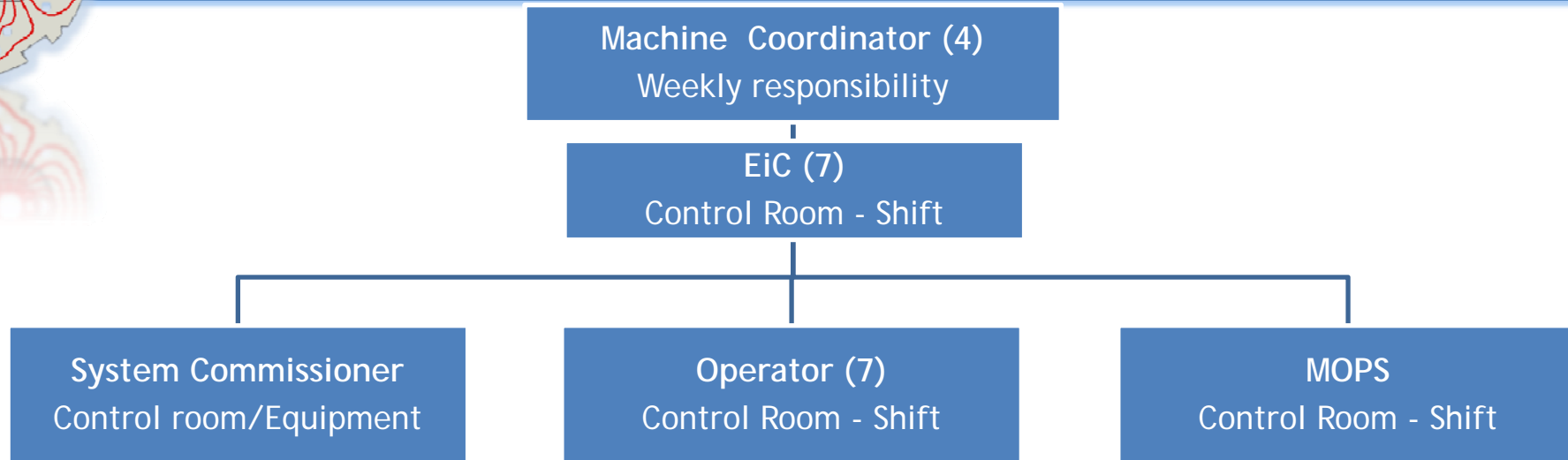
2008 - Beam Commissioning

LHC Commissioning with beam has been preceded by injection tests occurring in the last part of the HWC and Machine Check-Out Phase as soon as the sectors were made available after HW Commissioning

- Injection Tests proved to be invaluable to (see V. Kain - Session 7):
 - Debug fine timing and synchronization
 - Debug instrumentation with beam for the first time
 - Final check for machine configuration (polarities, settings)
 - Test tools for threading and optics measurements
 - Speed-up the commissioning with circulating beam by correcting all the issues found during the injection test



2008 - Beam Commissioning



- Machine Coordinator is an experienced accelerator physicist with the overall responsibility for the LHC machine on a weekly basis:
 - implements the LHC commissioning program according to the procedures established in 2006-2007
 - supervises and directing the shift crews
 - ensures the necessary follow up is done
 - reports progress and problems to the wider community
 - coordinates the contribution of the Commissioner/Experts in the different phases of the Commissioning



2008 - Beam Commissioning

- System Commissioner:

- Defines and conduct the necessary beam measurements and implement corrections in collaboration with the EICs according to his expertise in an accelerator or accelerator physics system
- Hands-on work on the machine
- Passes on information to EICs for incorporation into routine operation

- EiC on shift:

- under the direction of the Machine Coordinator
- takes overall responsibility for the LHC during an 8 hour shift
- drives the machine through the operational cycle
- establishes procedures for future operation
- assists the Commissioner in his job

- Operator on shift:

- assists the EiC and Commissioner in their job



2008 - Beam Commissioning

- MOPS (Magnet Operation and Performance Support) Expert:

- Engineer or Physicist with experience in SC magnet and magnet protection
- Monitor, analyse and manage aspects of SC circuits performance (including the electrical feed and protection systems) in relation to their impact on machine availability and performance
- Authorize powering of the magnets integrating all relevant conditions, including quench protection, cryogenics and vacuum
- Contribute to the understanding and refinement of the LHC magnetic model (e.g. FiDeL)



2008 - Experience

The success of the beam commissioning in 2008 is to a large extent the result of the careful preparation through HW Commissioning, system integration tests & dry runs, piece-wise machine check-out and injection tests.

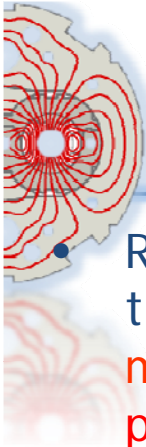
- **Cohabitation** among Installation, HWC and Machine Check-Out has been the key to that. It worked thanks to the good will of all the parties involved but it was not always easy:
 - Interferences in the last part of the commissioning with the increasing number of fronts opened both for HW Commissioning and Machine Check-Out
 - “Sharing” of resources (EiCs, Point Owners, operators, HW, MPP, QPS Experts)
 - ...and the access system did not make it easy....
- Machine Check-Out squeezed between HW Commissioning and Beam Commissioning. Machine protection tested in its minimal configuration, only sufficient to allow operation at pilot intensity and injection energy (e.g. Beam dump tracking could not be tested thoroughly - see B. Goddard - Session 6):
 - Postponing part of the machine protection tests in the Beam Commissioning phase
 - Definition of an envelope (intensity, energy, emittance) for safe operation of the machine (see J. Wenninger - Session 8)



2008 - Experience

- Contribution from the early phases of the commissioning is important to achieve a proper training of all the actors participating to the Beam Commissioning and Operation phase. This should be encouraged in order to:
 - ➔ have a sufficient number of people to avoid “burn-out”
 - ➔ Increase further their effectiveness during beam commissioning
- Contribution of the System Commissioners to the preparation for beam has been concentrated in most cases (there were exceptions) during the Injection Tests and Beam Commissioning
 - ➔ Need to extend it to the Dry Run and Machine Check-Out Phases.
- EiCs and operators have been actively participating to the Machine Preparation for beam. Proven to be a good training for the operation of the various machine systems and their controls
 - ➔ Need to complement it with training sessions during the shut-down (there is not much time left!).

What is going to change?



- Realistically the same overlap among the different phases and components of the commissioning is to be expected. **Dedicated periods of a few days with machine closed and all systems available are needed to test machine protection** either during machine check-out or during the VERY EARLY phase of the beam commissioning.
- Important modifications are taking place with respect to the original design of the magnet protection → **need new tests/procedures with the contribution of the magnet and magnet protection experts (see A. Vergara - Session 8)**
- Expect tighter constraints (**need to know**) on the access in the tunnel and **experimental caverns** during powering → tighter coordination SD/HWC/Machine Check-Out/**Experiments** is needed
- Some of the coordinators, equipment experts, point owners have left. → Need reinforcement of the team in charge of the HW Commissioning and of the preparation for beam
- Point Owners and EiCs are in OP → Larger synergy



What can be improved?

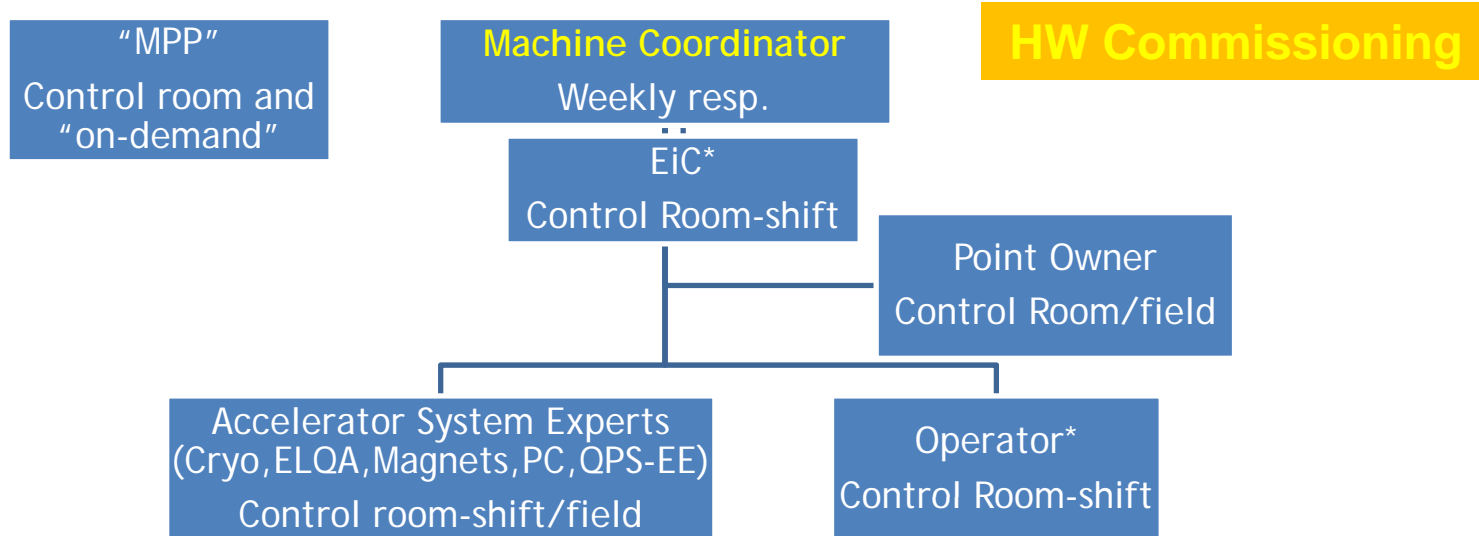
- The creation of a team of Machine Coordinators (at least 4) responsible of the coordination of the Commissioning in its different phases from HWC to Beam Commissioning would help in:
 - Reinforcing the HW Commissioning team
 - Making more transparent the line of command for all the actors involved
 - Minimizing conflicts in the assignment of resources for the different phases
 - Providing a clear interface for the experiments, management and wider community
 - Overall planning of concurrent commissioning activities
 - The larger spectrum of activities that the Machine Coordinator is requested to cover is likely compensated by the experience gained in 2008 and by the availability of procedures (although some of them might need to be modified)

- Involvement of all the System Commissioners and EiCs is essential from the beginning of the commissioning

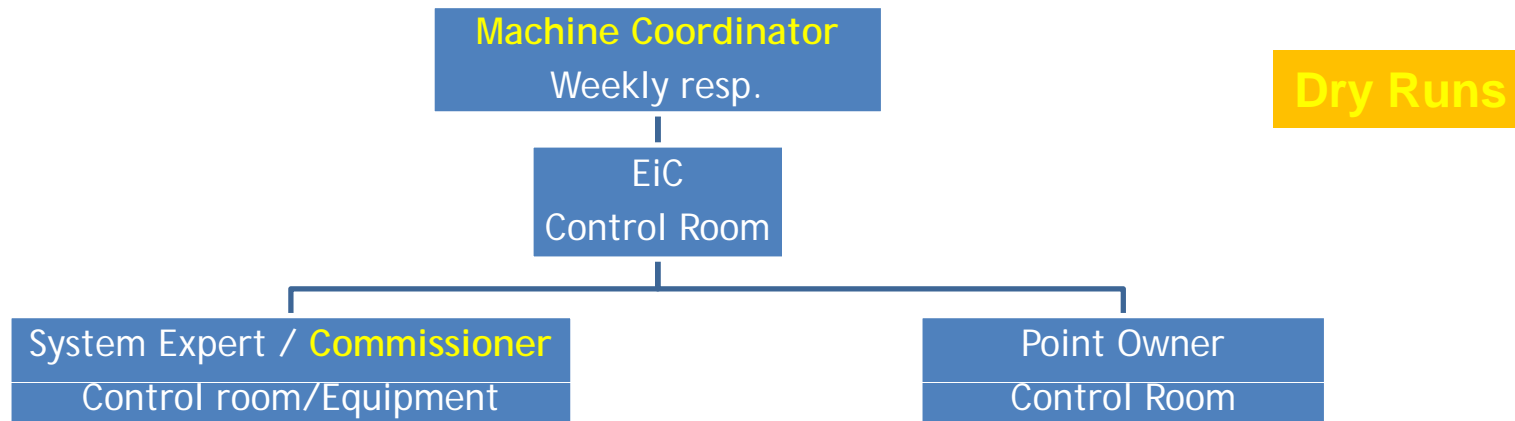
- The exact structure would then adapt to the different phases but with some “fixed-points” (e.g. Machine Coordinators, EiCs)



What can be improved?

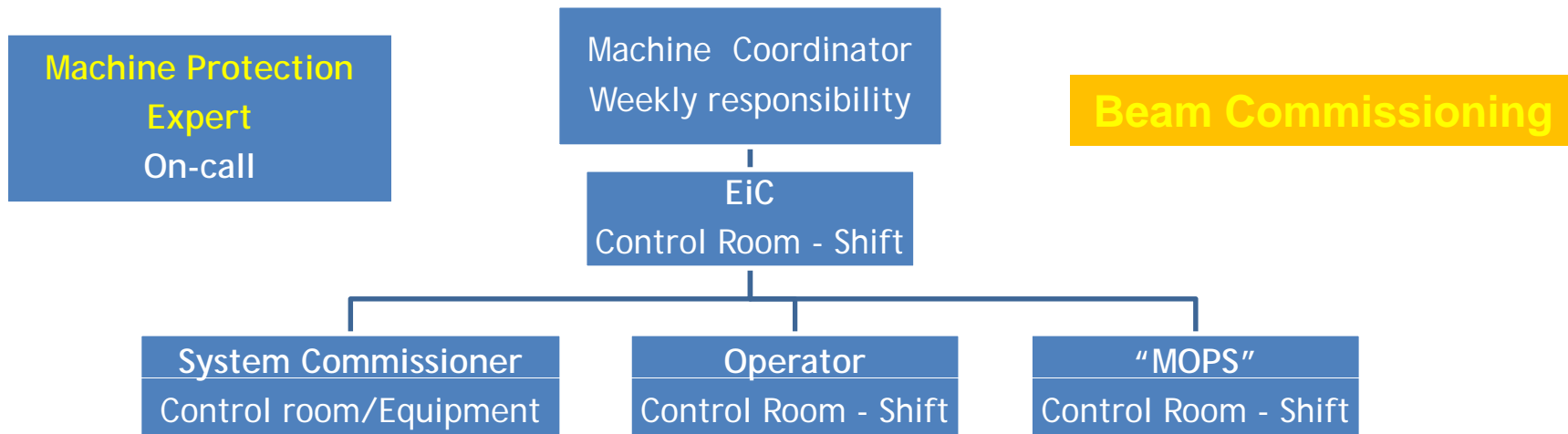
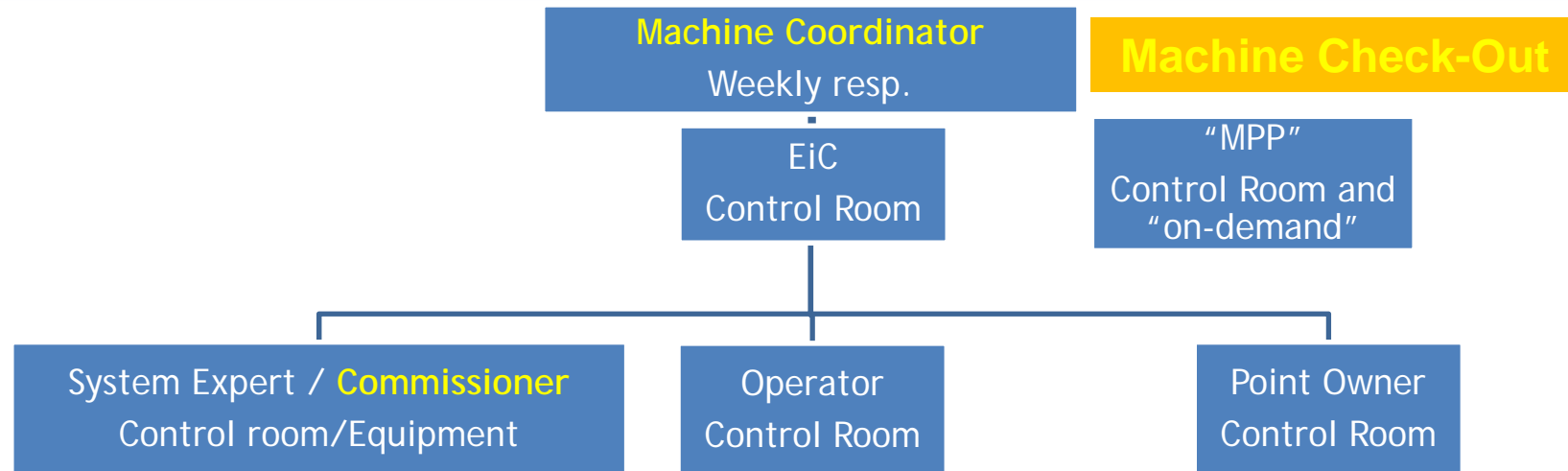


*On shift approximately one month before beam commissioning start





What can be improved?





What can be improved?

- The availability of **Machine Protection Experts** will be important from the early phases of the commissioning (see J. Wenninger - Session 8):
 - Help in defining the conditions for safe operation of the LHC within the envelope of the Machine Protection System during the staged commissioning (intensity and energy increase)
 - Provide support to the Machine Coordinator and the EiC in defining the mode of operation of the machine in case of abnormal operation of any element of the Machine Protection System
- Equally important will be presence of magnet and magnet protection experts in the control room in particular in the Commissioning and Early Physics phases.
- The expert coverage (shift vs. on-call) should be reviewed and might vary according to the phases:
 - E.g. need of a PC expert on shift?



Summary and Conclusions

- The organization and the structure put in place for the piece-wise machine commissioning (HW Commissioning, system integration tests & dry runs over the last 3 years, machine check-out, injection tests) and for the beam commissioning have been instrumental for the rapid progress.
- The overall strategy for the commissioning and its phase will remain mostly unchanged. The proposed modifications to the organization are mainly aimed at:
 - Distributing the load of the commissioning and (potentially long) operation over a larger team from the early phases of the commissioning
 - Simplifying the line of command and minimizing the potential conflicts
 - Favour training of the actors contributing to the commissioning of the machine at an early stage



Thank you!!!



We need your help!!!