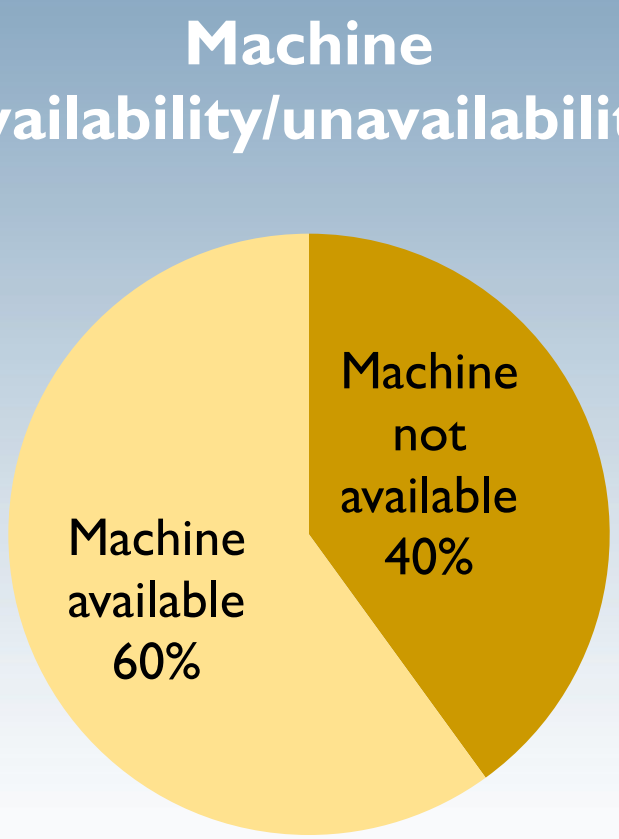
[R. Alemany]
[CERN AB/OP]
[Engineer In Charge of LHC]
Beam Commissioning Workshop, Evian Jan 2010

How to improve operational efficiency ?

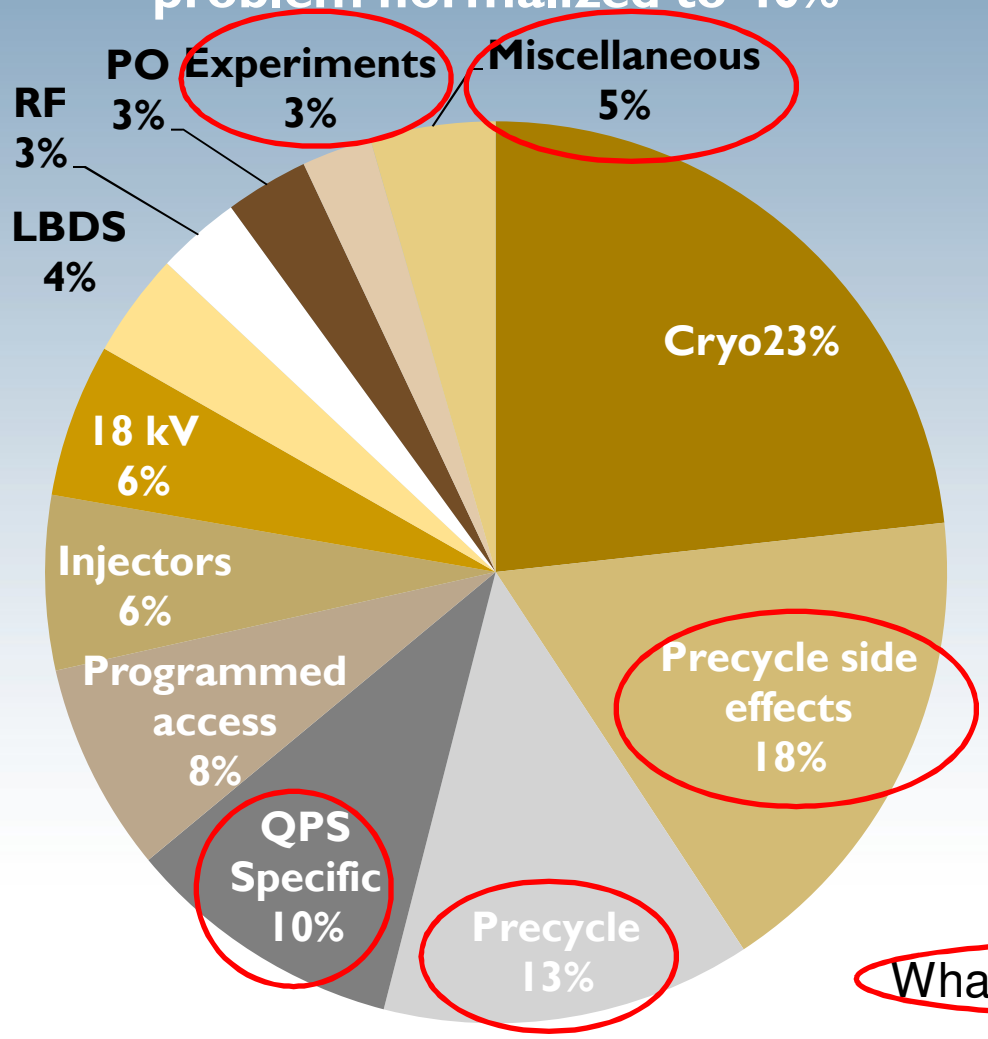
I. Machine availability/unavailability



Source: e-logbook from the 20th of November to 16th of December 2009

Machine not available 40%

Percentage of down time in the machine per problem normalized to 40%



What can be optimized

Machine not available 40%

- **Precycle side effects (18%):**
  - Non correct settings → Dry runs (but we need the full monty)
  - Power converter problems (some occasions access needed)
  - QPS problems:
    - Not possible to reset with power cycle ➔ intervention tunnel needed
    - Trips due to U_RES drifts up > 0 mV
    - Noise induced by RBHI in TI2 trips nQPS
  - RQTD, RQTF trips in the whole machine because Q-feedback left over.
  - Circuits mostly affected: 600 A

Machine not available 40%

- **Precycle side effects (18%):**
  - Non correct settings
  - Power conver… cess needed)
  - QPS problems:
    - Not possible to reset with power cycle ➔ intervention tunnel needed
    - Trips due to U_RES drifts up > 0 mV
    - Noise induced by RBHI in TI2 trips nQPS
  - RQTD, RQTF trips in the whole machi… because Q-feedback left over.
  - Circuits mostly affected: 600 A

Remote reset is available for all sectors but for some reasons not always works, why? Can it be fixed?

We need a PVSS method (Sequencer task) that resets U_RES drift once per day

Thresholds increased from 300 µV to 500 µV in S12, but is this enough? We systematically switch off TI2. Once wrong thresholds loaded

Status of QPS – 600 A

- 600 A circuits
  - Most of problems observed during 2009 run related to a hand full of controllers / circuits
    - Hardware failures (very few)
    - Communication problems ar
    - Trips during pre-cycle and operation
  - Analysis is ongoing
    - In some cases help by MP3 may be needed
    - Firmware updates
    - Field-bus controllers, inductance tables (in a few cases only)
    - Change of thresholds only where absolutely needed
  - Some hardware to be repaired exchanged
- PGC tests mandatory for final validation
  - Upgrades may be required afterwards

And I would like to repeat that the EMC problem between the RBHI in TI2 and the nQPS of S12 should not be forgotten.

Courtesy of Reiner

Machine not available 40%

- **Precycle side effects (18%):**
  - Non correct settings
  - Power con
    needed)
  - QPS proble
    - Not poss
      interven
    - Trips due to U_RES drifts > 0 mV
    - Noise induced by RBHI in 2 trips nQPS
  - RQTD, RQTF trips in the whole machine because Q-feedback left over.
  - Circuits mostly affected: 600 A

Avoid to left over Q-Feedback action after an unscheduled dump
→ Q/Q'-FB dependence on beam presence flag (BPF):
automatic FB 'on → off' if BPF 'on → off'
FB 'off → on' only if 'BPF == true'
(without forgetting that sometimes we may want to switch off the feedback when beam is in)

Machine not available 40%

- **QPS specific (10%), examples:**
  - Access to increase thresholds on global bus bar detection
  - Access to reset circuits that cannot be rested from CCC
  - Access to replace heater discharge power supply S34
- **Experiments (~ 3%):**
  - ATLAS lost patrol (2 hours)
  - ATLAS up to 20 minutes to analyze PM and give back injection permit SYSTEMATICALL
  - ALICE problems to give the injection permit (4 hours)

Systematic verification of heaters power supplies. Automatic tasks in the QPS system with corresponding alarms.

Procedure to recover pretty simple, but only one person new it ... Difficult to find in the middle of the night ➔ Better trained shifts crews in the experiments.

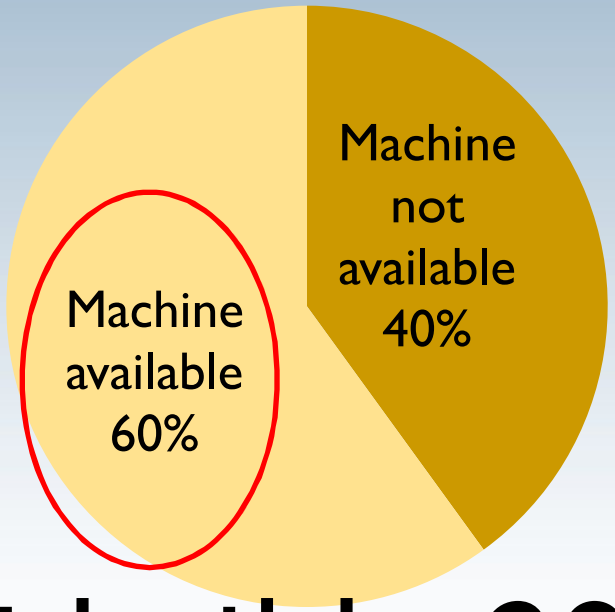
Unacceptable when beam dump not produced by ATLAS and safe beam. With unsafe beam we should discuss. Other experiments by far more fast.

Machine not available 40%

- **Miscellaneous (~ 5%):**
  - Emergency access
  - A combination of precycle problems + cryo lost + access needed
- One of the major down time reasons is related to having to remove the power permit to access the machine, even the UAs. Why? Because this implies switching off the PC and then having to recycle with all the unwanted side effects. This procedure is very expensive for operations. Can we do something about, like declaring PHASE I (injection current) for all the machine except the RB which will be OFF when accessing UAs? → CHAMONIX should answer

Machine available 60%

Machine availability/unavailability



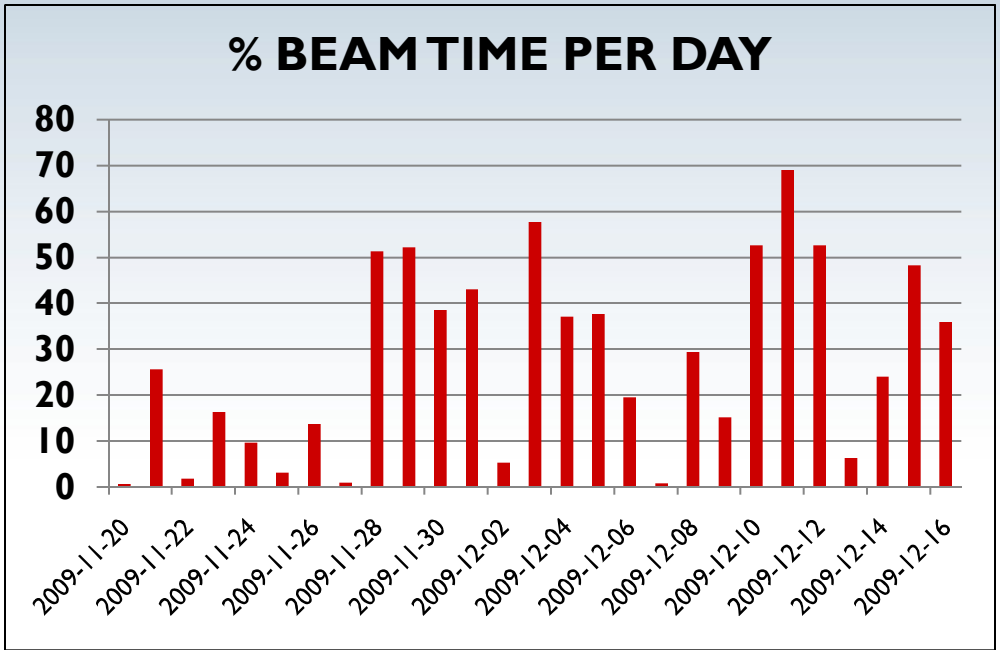
What is this 60%?

Source: e-logbook from the 20th of November to 16th of December 2009

Machine available 60%

- Out of the 60%, 50% beam in the machine, the other 50% was:
  - Preparation for injection: set up transfer lines, MKI soft start, handshakes, LBDS/BIC arming, etc
  - Solve problems (most of them mentioned in Brennan's talk)
  - Understand the dump (PM)

The first thing to do is to solve those problems



PERCENTAGE OF BEAM IN THE MACHINE DURING THE 26 DAYS ➔ **~30 %**

Thanks to Chris R.

Machine available 60%

- The big majority of problems are solved within few minutes. What is important in this case is the number of times the problem gets repeated.
- If the problem repeats systematically this is an indication of control tools not adequate, procedures not adequate, training insufficient.
- There are problems that we can afford to have them with safe beam, if they happen one or two times, but even at this low rate the may constitute an important issue when working with unsafe beam.
- There are problems that they are not problems by themselves but because of the collateral damage they produce: powering-access interlock → locks all PCs

Machine available 60%

- Most of the problems mentioned by Brennan have a rather easy and straight forward technical solution
  ➔ controls problems (FESA servers, proxies, etc) (Wojtek's talk)
  ➔

Experiment-machine interface

Rigorous use of mode, automatize actions as a function of beam mode changes (fill number changes, handshake, etc)

Communication with experiments and machine modes

- End-of-fill not signaled
- Machine mode changes forgotten
- Slow handshake (e.g. injection, before dumping beam, …)

Manual mode change, e.g. from 'stable' after dump

- Sometimes forgotten – needed by at least ATLAS to switch off

BG's talk

Machine available 60%

- **Sequencer**: a review took place the first week of Jan and a list of requirements with priorities exists. Within the requirement list emphasis is given to prepare the sequencer for unsafe beam operation.

Rec

ID	Request for the
1	Factorize sub_s subseq name, u
2	Give more visib tasks are visible
3	Show only oper mode (unless o
4	Visualize all ope
5	Use single click
6	Show the conte is executed
	Tooltips are ver

Requests S

ID	Request for the server part (if * r
1	Unskipable tasks*
2	Possibility to set a subsequence t single task inside
3	Checklist tasks*
4	New properties to monitor consta the Sequencer behaviour via the
5	Avoid simultaneous execution of (reservation mechanism)
6	Possibility to pass parameters fro inside
7	Calling applications/fixed displays
8	Long task execution more verbos
9	Encapsulate consolidated sub_se
11	Put in place a mechanism that wh sequencer can change the active

Requests Sum y Table

From Sequencer Review

ID	Request for the server part (if * means DB is affec	Priority
10	Check entry conditions/sanity checks before starting a cri • Should indicate time when the task was executed. • Should be possible to save it to see what happened, like active optics history. • Should be possible to insert them into the elogbook	1
11	User mode/expert mode: user mode can only execute a full sequence, cannot execute sub_sequences or tasks individually or jump or skip; expert mode is what we have now. Can be implemented at the level of the server and the GUI.	1
12	Create a LHCSuperUser user which has the role LHCSUPERUSER. If we are running unsafe beam equipment rules will be configured such: operational mode=OPERATIONAL, role=LHCSUPERUSER , location=the EIC console in the CCC. Therefore, only this role can access the lhc equipment. This role should only come from the sequencer. ➔ Or something similar.	1

1 Priority 1 in red fields means has to be ready for unsafe beam

Machine available 60%

Sequencer and state machines

- Sequencer and MP:
  - Once a standard sequence is established, the sequencer is useful for MP since it avoids (or reduced the number of) mistakes.
  - But using the sequencer to force integrity checks etc should be avoided.
    - I do not believe in the safety of 'unskippable' tasks and similar tricks.
- Servers implementing *state machines* should be used to enforce periodic checks, task order etc
  - Equipment access through state machine server (enforced by RBAC), for example for BICs, BLMs, LBDS.
  - State machine can block untimely commands, refuse rearm/reset without execution of operational check…

CO should invest into a state machine framework !

Jorg's talk

Machine available 60%

- BLMs issues found in 2009 being addressed/solved + lot of work on reliability/monitoring of the healthiness of the system + over-injection problem under study

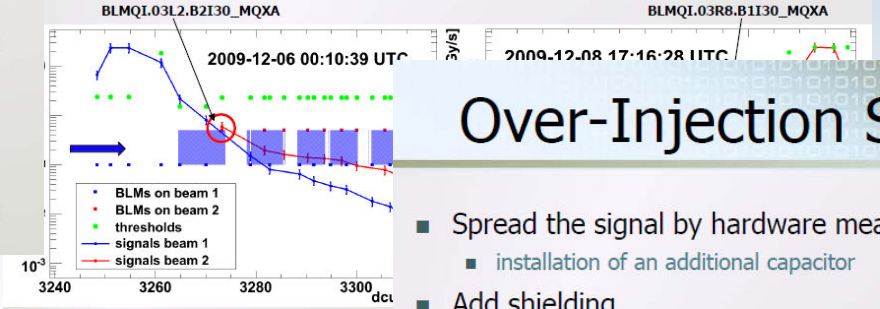
Automated checks

- MCS Online check — One minor bug pending
  - Verify consistency of parameters
- Connectivity (HV Modulation) check — Finalising
  - Verify monitor connections
- Internal Beam Permit check (BLETC -> BLECS) — Completed
  - Verify the ability of each card to trigger a dump

Will activate in the firmware the enforcing of the agreed periodic run of those checks by the Sequencer.

- External Beam Permit check (BLMS -> BIS) — Completed
  - Verify connection to BIS

Over-Injection problem



Problem consists of losses at the LH

- Some small difference betw
- Installation has been verifie

Over-Injection Solutions

- Spread the signal by hardware means
  - installation of an additional capacitor
- Add shielding
  - most favourable
  - needs simulations

➢ Last year's test with threshold values set over the maximum allowed limit is not a safe solution.

- Etc, etc

Christos' talk

Machine available 60%

- But there are other problems that require a careful thinking, mainly the ones which solution has to be in place before unsafe beam operation:
  - **Injection mechanism**: improve software tools to assure correct injection (IQC, injection sequencer, LHC sequencer), check entry conditions before injecting, clean-up the system after injection to be ready for next step, procedures/sequences + of course W. Bartmann's presentation

3.5 TeV? Higher intensity?

- NOT ready
- Injection protection needs to be fully operational for maximum intensity of 1e12 per injection
- Needs adequate setting-up time
- TCDQ system should be tested for different β* squeeze steps
- TCDQ system needs to be operational for stable beam

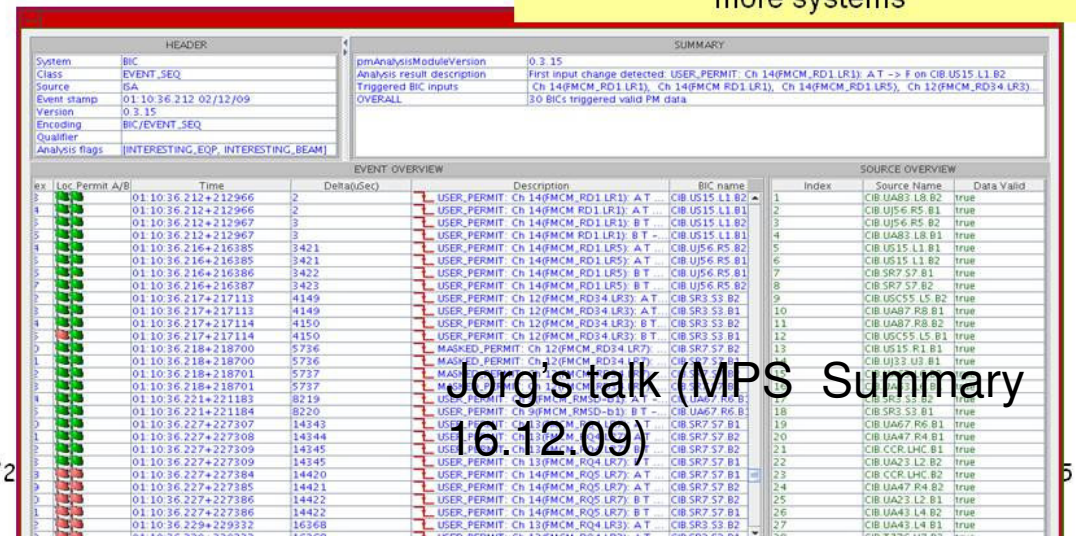
Machine available 60%

- **Beam dump analysis**:
  - XPOC still work to be done here, as well as
  - Post Mortem:

Post-mortem System

- Dump diagnostics with Post-mortem system is already a routine check in the CCC. The diagnostics is very good for:
  - BIS - who dumped and when (BIS Team)
  - BLMs (F. Folin)
  - BPMs (J. Wenninger)
  - PIC, FMCM (MI team)

Online diagnostics must be extended to more systems



Jorg's talk (MPS Summary 16.12.09)

Machine available 60%

- **System specific problems**: we have to make sure they are addressed and solved. This needs follow up: beam commissioning meeting, dry runs.
- **Procedural problems**: need a major debate, but what Brennan proposes is already a good start.
- **Operational discipline/training**

Conclusion

- If we manage to solve the solvable problems which make the machine unavailable we can recover 40-50 % of the down time.
- If we manage to solve the problems which prevents us of having beam in the machine when the machine is available, we can recover ~15% of down time.
- The means to do this exist.
- But when trying to maximize the beam availability time we should not compromise safety. Unsafe beam operation will imply less flexibility, more checks before injection takes place, more time to analyze the beam dumps ... Less beam presence in the machine