ADT- Update on most critical failures and interlocking ideas

Part 1: Overview

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Reminder and aim

- ADT can excite beam oscillations very rapidly when things go wrong
- has been looked at by MPP review in 2005
  http://indico.cern.ch/getFile.py/access?contribId=8&sessionId=2&resId=&materialId=slides&confId=a055

  - aim here: re-visit ADT as implemented and operated
  - list of critical failures related to ADT
  - mitigation measures in place
  - future options for further measures and interlocking
  - status of abort gap cleaning (Daniel)
  - diagnostics and post mortem (Daniel)
  - plans for settings protection (Daniel)

Maximum achievable performance

LHCADT performance in LHC optics version 6.5xxx compared to original assumptions (at 450 GeV/c), assuming 7.5 kV maximum kick voltage (parameters slightly changed with respect to 2005 MPP review)

	β=100 performance	Optics 6.4 performance
	Kick per turn in σ	Kick per turn in σ @ β in m
ADTH beam 1	0.2 σ	0.277 σ at β=193 m
ADTH beam 2	0.2 σ	0.273 σ at β=187 m
ADTV beam 1	0.2 σ	0.309 σ at β=239 m
ADTV beam 2	0.2 σ	0.316 σ at β=250 m

MPP relevant cases that happened

commissioning work: lost beam while setting-up:
normal, protected by BLMs / position interlock, pilot or safe beam (2009-2011)

test of kick strength, voluntarily kicked to excite oscillations
programmed to stop after n turns (2009)

excessive noise: slow losses→ bad lifetime (2009)
also on BI input

damper not on, lost beam → human error (2010, 2011)
BLMs protected, now driven by sequencer

loss of one damper module (half kick strength), survived (2011)

wrong gain, error running sequences → wrong damping time, survived (2011)

wrong settings, configuration due to software/reboot → lost beam (2011)

Lost crate CPU or process → FPGA continues, beam not lost,
but control and logging affected (2011)

Damper failures and protection (1)

- in case of a damper failure there is no danger for the damper system itself
- damper failure with loss of kick strength: example: loss of one damper module due to high voltage power supply trip or due to overload → survived, but shall we inhibit injection in this case ?
- test signal / checks with pilot, not done, is it worth ?
- loss of revolution frequency or clock frequency for digital processing: will lead to malfunctioning of the system, if detected, system can shut itself down to avoid unwanted action on beam; abort gap cleaning must be stopped in this case → check for AGC position complicated by new injection cleaning; signal processing by 40 MHz, 80 MHz clocks, needs work to detect failures, foreseen, details to be worked out, never happened yet → see some details in Daniel's talk
- there is no check foreseen to protect against unwanted signals injected on the excitation input. This input is provided for AB-BDI protection by attenuator in place limiting BI capabilities to 10% of nominal kick strength

Damper failures and protection (2)
worst case scenarios

- abort gap cleaning not aligned with abort gap due to bad revolution frequency phase → protection maybe possible, but not in place
- large amplitude signal injected on external input provided to BDI group → protection in place (attenuator)
- badly injected beam outside capabilities of damper: system will saturate not so good damping but not catastrophic, make a test ?
  note that collimation in transfer line at 5 σ will not help here as damper system will saturate earlier
- partial or complete loss of clock frequency will lead to erratic kicks
  → protection can be put in place, will not cover all cases easily, to be studied
- bad settings or (tune, damper phase setting, delay setting) can lead to anti-damping → effort needed for settings management, in work

Damper failures and protection (3)
Worst case protection

- Must rely on position interlock by external system to detect oscillating beam – only this can guarantee protection against "catastrophic" damper failures
- BLM system must react fast to provide protection
- Inside the damper system a few checks can be provided to prevent continuation of the mission when there is a risk that this will lead to unusable physics beam
- a *procedure* needs to be established to decide whether to take into account the damper interlocks for a particular mission. The beam safe-flag is a good concept, but my feeling is that the complexity calls for more than two levels

Conclusions

- Transverse damper system must be very powerful for efficient injection damping and to minimize emittance blow-up
- A high degree of flexibility is demanded from the damper systems: use as beam exciters, abort gap cleaning etc.
- Worst case scenario (1 σ amplitude excitation reached in 4 turns …) cannot be excluded
- External protection by BLM system and position interlock required
- Procedures must be established in order to define which of the possible damper interlocks should be taken into account for a particular mission to improve operational efficiency