Abort Gap Cleaning Tests

Malika Meddahi, for the AG cleaning collaboration:, Stephane Bart Pedersen, Andrea Boccardi, Andy Butterworth, Alan S. Fisher, Eliana Gianfelice-Wendt, Brennan Goddard, Georges-Henry Hemelsoet, Wolfgang Höfle, Delphine Jacquet, Michael Jaussi, Verena Kain, Thibault Lefevre, Elena Shaposhnikova, Jan Uythoven, Daniel Valuch

Tests performed on December 15-16, 2009

1- Results from the cleaning trials and To-Do list

2- Observations with the BSRA and To-Do list

3- Proposal for the interlock strategy

Abort Gap Cleaning Tests

Test 1: Cleaning of a bunched beam

Conditions 1: Used a fix frequency (1-Qv) and various damper kick amplitudes

Result 1: Beam lost in few minutes with smallest amplitude

Conditions 2: Using a variable frequency, around (1-Qv), 10 steps, each for 100 turns, and various damper kick amplitudes

Result 2: Idem : Beam lost in few minutes with smallest amplitude

-> To Do: Calibrate the kick amplitude to check cleaning time with model (Wolfgang & team + simulations of Eliana)

Abort Gap Cleaning Tests

Test 2: Cleaning of a 3 μs gap localised between 2 bunches

Test of the "trailing edge" effect

Conditions: injected 2 bunches 3 μs apart (abort gap length) and timed the dampers to cover the gap between the 2 bunches.

Results:

- Kicking at Qv with large kick amplitude: large losses of the downstream bunch
- Kicking with both reduced kick duration and amplitude to determine possible operational window: with the damper window width reduced to 0.75ms and small amplitude, the surrounding bunch lifetime was better, but still affected by the "cleaning"

-> To-Do: AG cleaning: optimization of cleaning pulse in order not to affect beam outside abort gap is necessary (Wolfgang and Team)

Abort Gap Cleaning Tests

Cleaning of debunched beam:

Conditions: 4 bunches of 2.5e10 left debunched for 5 mn before starting the AG cleaning with the "variable frequency mode".

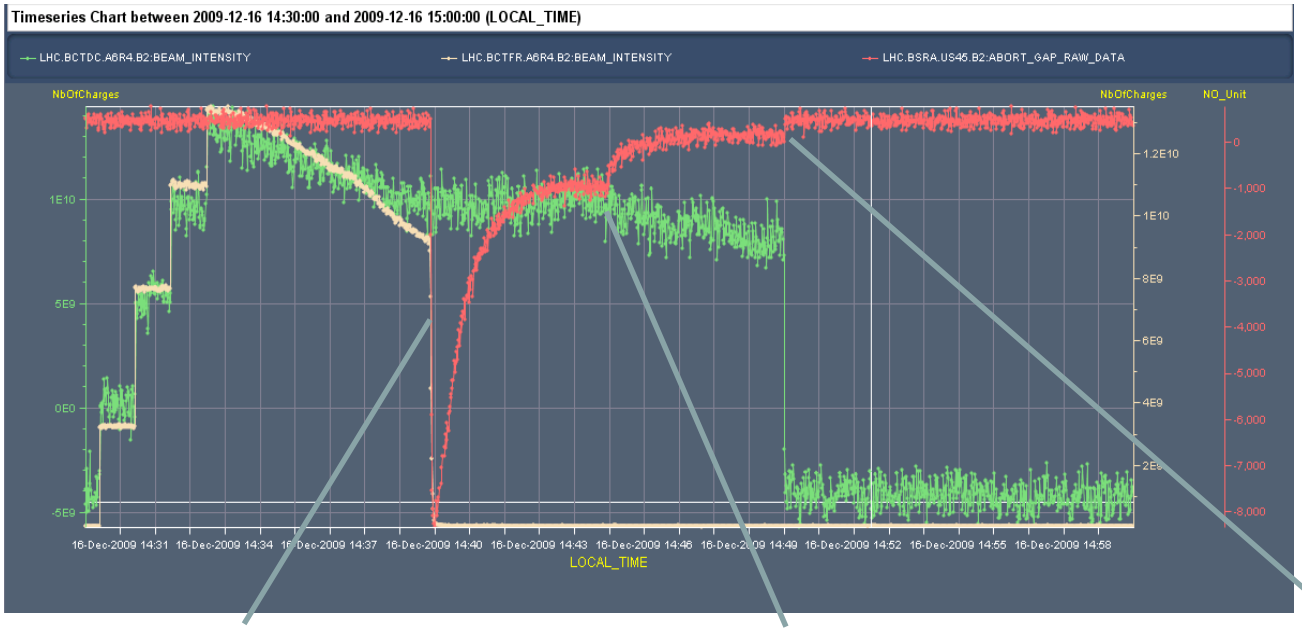
Results:

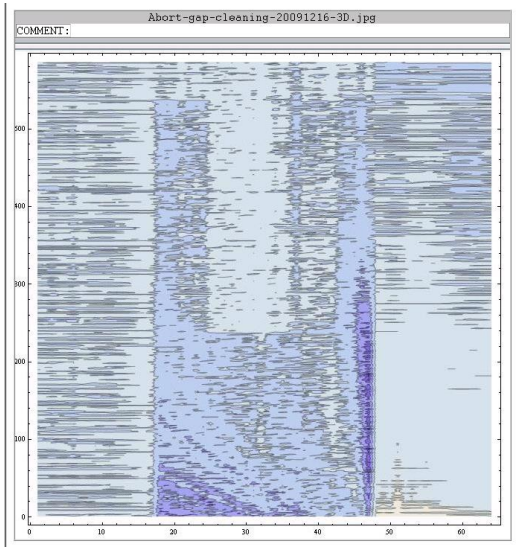
When cleaning started, the synchrotron light production decreases proportionally to the gap population and targeted portion of the gap was quickly emptied .
At the moment of the beam dump, the gap was not fully empty (equilibrium between cleaning and repopulation process) and the synchrotron light production was still decreasing.

-> To Check: Cleaning efficiency may be improved by enlarging the kick width and/or increasing the kick amplitude

Abort Gap Cleaning Tests

BSRA data show gap partially cleaned





RF-Off:
BCTFR signal to 0
BCTDC signal flat
BSRA signal pops up and reduces when beam disperses

Cleaning on:
BCTDC signal shows losses = cleaning
BSRA signal decreases from previous equilibrium to new equilibrium

Beam Dumped:
BCTDC to 0
BSRA to 0

Losses at BLMs at TCDQ / TCDS, at moment of dump, are reduced to about 10 – 12 % relative to no cleaning!

Abort Gap monitor: BSRA

From Thibault Lefevre at Evian WS

- NEED the undulators ON for both beams for low beam energies, i.e. below 1.2 TeV, then D3 can take over
- Undulator useless after 1.3 TeV. At Evian: nevertheless, proposed to leave it on
- TO DO: Check calibration of BSRA signal with proton intensity - at 450 GeV and higher E
- To DO: Build confidence in BSRA reading: which level of particle population can be trusted?
- TO DO : Operation with predefined and checked calibration tables in order to monitor the AG population and send a signal when needed
- TO DO: if population is higher than the limit, would have to feedback on the PMT high voltage to avoid saturation and continue to provide useful data during the cleaning.

Interlock strategy: proposal

- Get continuously the abort gap population from BSRA
- Perform continuous cleaning of the abort gap population
- Send software interlock to dump the beam if population gets nevertheless beyond the threshold
- If BSRA not functioning: continue standard cleaning procedure, do not dump the beam, rely on TCDQ to protect from losses of un-captured particles
- Operation with beam will allow us to tune this strategy accordingly with observation

Summary : Abort Gap cleaning tests

- All systems working as needed (thanks to the equipment and Dry Run teams);
- Functionally of the abort gap cleaning demonstrated;
- Undulator and BSRA commissioned for beam 2;
- Undulator needed for beam 1 as well : to be commissioned (incl.BSRA);
- Work on going to establish / understand the best cleaning parameters to be used to clean the full 3 μs while limiting the losses outside the abort gap (kick amplitude, damper window…)
- Concerning Machine Protection we will need to commission the **Abort Gap Monitoring Interlock**
- Interlock values to be found and tested with beam

Reminders:

- Abort gap is 3 μs long –abort kicker rise time- and always in front of the first injected beam

- With RF OFF: Time to fill the abort gap from both sides: ~5s at 450 GeV, 20 s at 7 TeV

- Time necessary for un-captured particles to fill the abort gap are about 2-3 times less at injection than on flat top

- Time scales for this process with RF OFF and RF ON are very similar

source: Elena Shaposhnikova

- BSRA:
  - synchroton light based monitor
  - detect line density of ~2e5 p/m,
  - 0.1 μs resolution, 30 bins (within the 3 μs gap), measured at 10Hz, but updated at 1Hz.
  - Unit: proton/bin
  - Monitor designed to run continuously – calibration needed each ~year

Reminders:

- Quench limit and cleaning level

	Quench limit p/m	Cleaning level p/m
450 GeV	2×10^8	2×10^7
7 TeV	2×10^6	2×10^5