Quench Test Strategy Working Group

Date: 16th March 2012

Chairperson: Mariusz Sapinski

Scientific secretary: Agnieszka Priebe

Participants: T.Baer (BE-OP), M.Bednarek (TE-MPE), Ch.Bracco (TE-ABT), K.Brodzinski (TE-CRG), B.Dehning (BE-BI), W.Hofle (BE-RF), J.Jowett (BE-ABD), A.Lechner (EN-STI), E.Nebot (BE-BI), A.Priebe (BE-BI), S.Redaelli (BE-ABP), M.Sapinski (BE-BI), M.Schaumann (BE-ABP), E.Todesco (TE-MSC), D.Wollmann (TE-MPE), D.Valuch (BE-RF), A.Verweij (TE-MPE)

Presentations:

- Mariusz Sapinski "Quench Test strategy WG - Introduction"
- Wolfgang Hofle "ADT for quench tests"
- Agnieszka Priebe "Quench test with orbital bump"
- Daniel Wollmann "Dispersion Supresor tests"

Minutes:

- **Mariusz Sapinski "Quench Test strategy WG - Introduction".**

  M. Sapinski pointed out that there were at least three groups actively involved in quench the magnets: BLM, collimation and MPP. The cooperation between these groups is an efficient way to reach the goal which is a quench-safe operation of the LHC after the LS1. He has presented three types of losses - fast losses (10^{-4} s), UFO-like losses (10^{-3} - 10^{-2} s) and steady state losses (1 - 10^{1} s). Fast losses has been investigated by the Injection & Dump method when a beam interacts with a magnet only once. The next part was devoted to UFO studies which have been pointed as a critical issue during Chamonix 2012 meeting (number of UFOs is foreseen to grow with beam energy and they might be one of the main luminosity limitations). M. Sapinski proposed a repetition of a wire scanner test on MBRB magnet with a shorter loss duration and an orbital bump on the same magnet as well. Then results could be extrapolated for other magnets using the simulations made in Geant4 and/or FLUKA. The other option to study the UFOs would be based on a BLM threshold increase and quench anticipation (so-called UFO-fishing). The last presented way was to perform an orbital bump with a use of ADT in millisecond order timescale. The next part of presentation was devoted to the steady state losses which are still not well-known in terms of the LHC.

Final conclusions contained UFOs and steady state losses studies as priorities for 2012 tests. An application of ADT is crucial for all quench tests in 2012. Additional tools to be expected are: QPS scope and cryogenics measurements.

Discussion:
E.Todesco asked not to do anything with MBRB since this is a special magnet (4.5 K and it was constructed outside CERN). One spare magnet (although not fully functional) of this type is possessed but neither testing nor production lines are available in case of any damage. In this situation it would take about 4 years to provide a new MBRB.
T.Baer said that in the arcs, no significant losses apart from UFOs are observed (for proton operation).
It was noticed that steady state losses are crucial not only for proton but also for ion runs. J.Jowett added that ion team would be interested as well.
B.Dehning noted that the R2E (radiation to electronics) is important in terms of steady state losses, collimation studies, ion runs and development of the magnets.

Outcome:
For the UFO test it is crucial to perform a quench test with an orbital bump with additional ultrafast ADT excitation. The "UFO-fishing" in not enough and wire scanner test is disfavoured by the magnet group.
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- **Wolfgang Hofle "ADT for quench tests"**

W.Hofle presented a possible application of the LHC Transverse Dumper (ADT) to the quench tests. This method is based on a beam excitation and a beam blow-up. Tests performed in 2011 were related to the beam 2 and provided a loss duration up to 8 s. A comparison of damper loss maps with 3rd order resonance crossing (traditional procedure) maps has shown to produce similar loss patterns. One of the final conclusions was that the ADT blow-up tests went successfully in 2011. Although initially this method was invented for loss maps, now it could also be used for the quench tests. A calibration of the losses still must be done.

Discussion:

M.Sapinski asked if it was possible to feedback the ADT with BLM signal. D.Valuch claimed that theoretically yes, it's possible but with limited response (not extremely fast).
D.Valuch added that for the long losses an usage of noise would be better while for the slow losses the cleaning (single frequency excitation) would be preferable. This method excite on tune, one has to be far from the excitation point and be careful even with a pilot beam since kick strength is 0.2 sigma per turn.

- **Agnieszka Priebe "Quench test with orbital bump"**

A.Priebe has summarized 3-corrector orbital bump-based quench tests performed in 2010. A circulating proton beam was deflected in the horizontal plane in case of beam 1 and in the vertical plane for the beam 2. All these experiments were done aiming on the MQ in ARC half-cell C14R2. Three out of four tests were done for the beam 2. In all cases but one the MQ magnet was a quenching element. Only one MB

quench was observed for the beam 1 deflected in the horizontal direction. The longest loss duration was estimated to be around several seconds. A.Priebe stressed the fact that no MD time was given for this kind of tests in 2011. Based on results gained from 2010 tests, the BLM thresholds were lowered. The Geant4 simulation results a show good agreement with the BLM signals measured during the quench test. This brings confidence that the estimations of energy deposited inside the magnet superconducting coils are correct. The methodology of data analysis was briefly presented. The last part of her presentation was related to the lessons which have to be taken in 2012. She has pointed out that UFOs and steady state losses had to be well-understood for the higher LHC beam energies. Both of these cases could be studied with application of the 3-corrector orbital bump method based either on a BLM orbit feedback or on the ADT. The improvements of the experiment are foreseen – 7 additional BLMs would be installed to increase a resolution of data acquisition and new QPS scope would be used. Geant4 simulations are already prepared and a new safe cell (C17R5) has been chosen after discussion with Arjan Verwiej.

Discussion:

J.Jowett suggested a comparison of Geant4 and FLUKA simulations for this kind of experiments.
A.Lechner underlined the fact that loss patterns and details of magnet representation inside the Geant4/FLUKA code had very important impact onto the final results. He was concerned about a loss pattern input to the simulations.
B.Dehning stressed the importance of comparison of UFO and bump losses.

- **Daniel Wollmann "Dispersion Suppressor tests"**

D.Wollmann presented Quench Tests performed in the Dispersion Suppressor region with an use of protons and ions. Steps of MD were shown. The aim of these studies was to deposit a total particle energy of 500 kJ on the collimators and observe the losses in the downstream dispersion suppressor. These tests are done to support the decision to delay the collimation upgrade to after LS1. The collimator intensity limit has been estimated to be 30 times the nominal intensity (around $3 \cdot 10^{14}$ p) at 3.5 TeV and extrapolation to nominal energy of 7 TeV has shown that this value is sufficient. According to DS quench test with protons the peak loss rate was around $9.1 \cdot 10^{11}$ p/s and energy at Q8L7 was approximately 335 J. During the test with ions, the fast losses were observed but no quenching. The dumps occurred due to the high losses in running sums RS06 and RS07. The quench limit scales with a factor 4.5 and deposited energy with a factor of 2 which gives together factor of 9. An application of the ADT is foreseen in 2012 test to create losses in more controlled way. DS magnet is targeted to quench during long losses (order of 10 s). The idea is to perform this kind of tests on both sides of IR3 and IR7.

Discussion:

There might be some problems in IR3 and IR7 due to irradiation of electronics.

J.Jowett said that there were no 1 MW. They have smaller cleaning efficiency, therefore ratios between losses on collimators and losses on magnets are smaller but the losses on magnets can be larger indeed.

Presentations can be found on indico page:

https://indico.cern.ch/conferenceDisplay.py?confId=182393

Tentative agenda for the next meeting:

1. Tobias Baer “UFO observations” (to be confirmed)
2. Krzysztof Brodzinski “Energy estimations with cryogenics measurements”
3. Mariusz Sapinski “Planning of the ADT experiment”
4. MD detailed proposal

If you want to give a presentation, please let us know.

Next meeting will be held next month. The exact date and plan to be announced.