

# 81<sup>st</sup> Meeting of the Machine Protection Panel

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Participants: W. Bartmann, C. Bracco, V. Chetvertkova, B. Dehning, A. Di Mauro, L. Ducimetiere, W. Hoefle, A. Lechner, S. Mazzoni, S. Bart Pedersen F. Roncarolo, V. Senaj, G. Steele, J. Uythoven, D. Valuch, A. Verweij, A. Vidal, S. Wenig, J. Wenninger, D. Wollmann

## 1 Presentations

The slides of all presentations can be found on the website of the LHC and SPS Machine Protection Panel:

<http://lhc-mpwg.web.cern.ch/lhc-mpwg/>

### 1.1 BSRA / abort gap monitoring: changes planned during LS1 – (S. Mazzoni)

- Beam Synchrotron Radiation Abort Gap (BSRA) monitors the intensity of synchrotron light measured in the 3 $\mu$ s of the abort gap. It is based on a gated MCP-photo multiplier.
- The synchrotron radiation for the instrument is generated by the undulator in the LHC beam for energies below 1.5TeV and by the D3 for higher energies. The BSRA is using the same optical port as the BSRT.
- The data from the abort gap monitor are published at 1Hz.
- Planned modifications:
  - HW- Changes in BSRT optical line and components:
    - New extraction mirror with reduced RF-heating either by using a metallic holder and a longer mirror without protruding parts, or by replacing the metallic parts by ceramics.
  - Bernd comments that for the BSRA in general one doesn't depend so much on the quality of the light (i.e. good mirror) but only on the integral of the intensity over time. Stefano answers that the mirror also serves the BSRT, which requires a high quality of the imaging, besides not constant light introduces uncertainties.

- The BSRA and BSRT lines will be decoupled directly after the steering mirror (much earlier than currently).
- The photo multiplier will probably stay the same. The amplifier may be changed. The current amplifier has a high bandwidth, which is not really necessary, with a high noise level. Thus the amplifier will probably be changed to one with a lower bandwidth and lower noise.
- The installations will be improved: grounding, cable shielding, power supplies. The cables might be replaced.
  - Bernd: How long are the cables? Enrico: between PMT and the amplifier very short (on the same table). From the rest the cables have the same length as the ones from the wire-scanners, i.e. several 10s of meters.
- SW - better calibration procedures and new managements of alarms:
  - The quench limit estimates for the Q4 and Q5 were derived from FLUKA (G. Steele, A. Lechner) and QP3 simulations (A. Verweij, B. Auchmann) and have been documented in an EDMS note.
  - For automatic actions based on the BSRA readings the following thresholds were proposed:
    - Warning: 0.1x quench limit ( $\sim 1e9$  p in the abort gap). From this level the cleaning shall be started.
    - Dump: The beam will be dumped at 2x the quench limit.
    - No dump: If the intensity in the abort gap is more than 20x the quench limit it was decided not to dump.
  - Jan comments that these limits are clearly a bit philosophical. The warning levels depend on the resolution/ noise level of the instrument. For the no dump level the FLUKA

and QP3 simulations show that the Q4/Q5 cannot be damaged if the TCDQ and TCSG are positioned correctly. However a massive quench would happen.

- Joerg ask how the dump will be initiated. Stefano and Jan respond that the BSRA will have a flag, which will be published to the SIS. The beam dump will then be initiated by the SIS.
- Stefano adds that the abort gap cleaning will probably be switched on and off directly from the FESA server. S. Bart Pedersen comments that it would be better to do the switching on and off also via the SIS (or a dedicated server process) rather than from the FESA server.
- Wolfgang points out that the cleaning depends on the tune. This needs to be taken into account, when it is decided in which beam modes cleaning shall be operated.
  - **Action:** Define the final levels for warning, dump and no dump. Define the procedure how to switch the abort gap cleaning on and off and how to initiate the beam dump (Via SIS?) (J. Wenninger, S. Bart-Petersen, J. Uythoven, S. Mazzoni).
- Software and Interlocks: setting flags for cleaning on/off, dump, etc.
  - Minimum detectable intensity at 3.5TeV was 1e8p.
  - The Calibration with a photo diode shall be performed during setup or ramp down. This will be triggered by the sequencer.
  - An additional calibration will be performed with pilot beam with respect to the FBCT signal.

- The calibration of the system shall be performed in regular intervals to guarantee the integrity of the system.
  - Actions in case of problems have to still be discussed in detail.
- Eng. Specs will be finalized soon and circulated for comments. The hardware in the optical line of the BSRT will be changed in the first half of 2014. Software changes will be performed in the second half of 2014. The system will be ready for testing during commissioning end of 2014.

#### Discussion:

- S. Bart Pedersen: asks if the abort gap cleaning will only be switched on during stable beams or also during ramp/squeeze?
  - Joerg says it could be done during flat-top and squeeze, i.e. at constant energy. Jan adds that it is not needed during the ramp, as un-bunched beam is lost constantly during the ramp.
- S. Bart Pedersen states that the calibration should be done in a dedicated server and not directly in the FESA server. The calibration with the FBCT requires a certain state of the machine to make sure that this test can be performed successfully.
- Jan comments that the calibration will be definitely an improvement from 2012, when the system had to be recalibrated especially after technical stops etc. manually.
- Wolfgang asks how the gating is performed in the BSRA. Stefan responds that the gating is done directly in the device.

#### 1.2 Vacuum incident on the MKB dilution kickers (A. Vidal)

- History of the vacuum incident on the MKB dilution kickers:
  - Before lowering into the tunnel the 5th MKB tank has been pre-pumped at the surface. The turbo pump was then removed from the port and the port was provisionary covered with aluminum foil.
  - The 5th tank was then connected to the other tanks and a pump was installed at the first MKB tank without noticing the missing turbo pump at the port of tank 5.

- After a bit more than half an hour of pumping the aluminum foil was torn apart and pieces of aluminum were sucked through the five MKB tanks.
- After this incident an EDMS document ([1296474](#)) with the detailed cleaning steps for the MKB tanks was created.
- Before the cleaning, visual inspections have been performed to systematically map the position of the debris in the MKB tanks. Alexis shows example photos from the visual inspection.
- During the endoscopic inspection of the ion pumps, aluminum debris was detected in the ion pumps of tank 5, 4 and 3. Therefore all 10 ion pumps of the MKB were replaced by freshly reconditioned ones.
- The cleaning of the aluminum particles has been performed with the help of pincers and a Hoover. The debris was then inventoried and stored in small plastic bags.
- Afterwards the tanks were flushed with Nitrogen and the debris was cleaned away with the help of a Hoover.
- The cleaning was finished with an automatic ventilation of several hours (~4h).
- After the cleaning a visual inspection of the 5 tanks and an endoscopic inspection of the connecting ports has been performed. All the pictures are available on DFS ([\\cern.ch\dfs\Departements\TE\Groups\VSC\LBV](#)).
- After first electric tests endoscopic inspections have been performed, during which no debris was found in the tanks.
- Alexis showed pictures of the perforated aluminum foil and the debris from the tanks.
- For the future rigid aluminum plugs will be used instead of aluminum foil and the checks before switching on the vacuum pumps will be reinforced.
- For the moment the pressure in the MKB is in the order of 1e-6mbar.

#### Discussion:

- Jan comments that during a visit in the tunnel after the incident it was agreed to weigh the gathered aluminum pieces to compare it to the

original weight of the Aluminum foil. Alexis responds that this has not been done, yet, but all the pieces are stored and therefore available for weighing them. Jan points out that it would be good to do this, to avoid any doubts if vacuum or HV problems around the MKBs would appear in 2015.

- **Action:** Weigh the recuperated aluminum pieces and estimate the surface size of the missing parts (A. Vidal).

### 1.3 Implication on HV performance and tests foreseen – (V. Senaj)

- Viliam shows a photo of an MKB tank and explains that it houses two magnets: either two horizontal or two vertical ones. 2 sputtering pumps are connected to the tank and in the middle a turbo pump is installed. The MKB magnets are powered with up to 29kV and 24kA.
- Inside of the MKB there is a copper coil in short circuit, which is insulated and its surface is painted with conductive paint. The surface is grounded. Thus, there is no danger due to an aluminum piece at the coil.
- Critical parts are the:
  - Tank HV feed-through.
  - The coil contact on the HV side.
  - HV conductor spacer.
- All these three places have been visually inspected, with limitations, as the conducting paint should not be damaged.
- The conditioning of the coil should be performed by carefully pulsing the magnet with slowly increasing voltage. At the same time the vacuum activity needs to be carefully monitored to identify potential onset of sparking. The vacuum quality should be as good as possible ( $<1\text{e-6mbar}$ ) as this reduces the risk for sparking.
- The reading of the vacuum gauge is currently not included in the VAC application. A request to add this gauge has been sent. Should this be also interlocked?

**Discussion:**

- Jorg: When are the tests going to start? Jan responds that the conditioning will start in November and the reliability test will be performed in the beginning of 2014.

**1.4 Fluka simulation of Energy deposition in MQY.4R6 due to proton interactions with Al foil in the MKBs (G. Steele)**

- FLUKA simulations have been performed to estimate the consequences for the nearby MQY.4R6, due to beam impacting on a part of the aluminum foil.
- The particle distribution (7 TeV, 2808b,  $1.15 \times 10^{11}$  p/bunch, Emittance:  $2 \mu\text{m}$ ) was provided by Brennan. The maximum particle density was  $2.3 \times 10^{16}$  p/cm<sup>2</sup>.
- The foil was simulated as pure Al (melting point 933K) with a thickness of  $20 \mu\text{m}$ . The peak energy density in the foil is on average  $\sim 5.8 \text{ J/cm}^3$  ( $= 2.1 \text{ J/g}$ ) per nominal bunch. Therefore, 300 bunches would be sufficient to melt the Al foil.
- The peak energy density can be found in the upper most outer coils for B1 ( $0.5 \text{ mJ/cm}^3$ ). For this it was assumed that all the 2808 bunches impact on the aluminum, thus, a worst case assumption. Therefore, there is most probably no risk to quench the Q4 due to such an event.