231st Meeting of the Machine Protection Panel

LHC & injectors topics

November 25th, 2022, via Zoom

Participants:
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The slides of all presentations can be found on the website of the Machine Protection Panel and on Indico (231st meeting).

Minutes and actions from the 230th meeting (LHC topics)

The minutes of the 230th MPP meeting are available. The action concerns the reporting on the BCCM tests to minimize the bunch length dependence.

Joerg proposed a list of topics to be discussed at upcoming MPP meetings:

- Usage of beta* and energy limits for collimation
- BLM thresholds in IR3
- Review 2023 strategy for loss maps, async. Dumps and intensity ramp-up
- BCCM strategy for 2023

Hardware transmission of DC-BCT intensity to SMP SPS and LHC (T. Levens)

Tom summarized the issue with the SMP probe beam flag during the 2021 LHC pilot run. The probe beam flag was true even for nominal bunch intensity and allowed injection of a nominal beam into an empty LHC.

The SMP flags are generated from 3 SPS BCTs: the “low intensity” BCT4 and the “high intensity” BCT3/5. The BCT4 transmits data with a least significant bit (LSB) value of 1×10^8 charges. It is used for the probe beam flag. The BCT3/5 transmit data with a LSB value of 1×10^{10} charges. They are used for the setup and TED beam flags. A bug in FESA3 upgrade during LS2 meant that BCT4 was also encoding its data with a LSB=1×10^{10} charges. The interpretation by the SMP led to having the probe beam flag at true even for nominal bunches or higher intensities. This was quickly fixed but reminded of the weaknesses in the system.

Tom detailed the system architecture, as shown in Figure 1. The same FESA class is deployed for each of the 3 BCTS. BCT4 drives both A and B channels of the SMP without hardware redundancy. BCT3 and BCT4 are very old commercial systems.

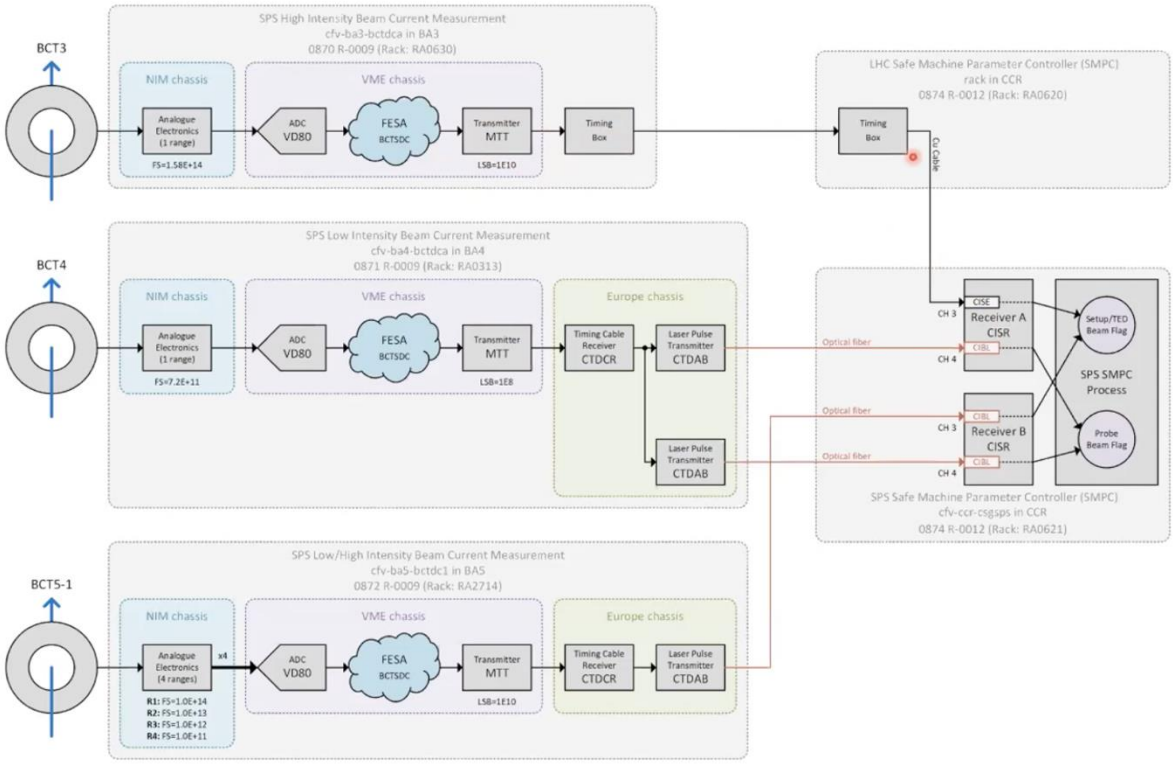

Figure 1 SPS BCT / SMP architecture schematics.

A new 24-bit acquisition system has been installed on BCT5 during LS2 for the dI/dt. The ADC is located on surface. This will allow to change the SMP logic without hardware development. The noise level for high-intensity beams with the 24-bit acquisition is significantly lower than with the old 16-bit acquisition. However, the signal is affected by magnetic interference at flat top. It results in an measured intensity increase of 1 x 10^9 charges.

The proposal is to keep BCT3 and BCT4 as they are. BCT3 will provide the high intensity channel 3A and BCT4 the low intensity channel 4A. The BCT5 connection will be modified to send SMP directly from VFC-HD. The range 1 will feed the high intensity channel 3B and the range 3 channel will feed the low intensity channel 4B. This requires modifications on the SMP side (see next presentation of this meeting). BCT 5, thus, provides diverse redundancy.

Tom then presented the architecture for the LHC. There is still no redundancy for the 24-bit system, any issue would impact both systems. The plan for the YETS is to move the VFC to the operational crates. The new firmware also has the direct SMP transmission logic implemented. No change on the SMP side is required, the same headers will be used.

In conclusion, a direct transmission of the SMP frames has been implemented in the firmware of both the SPS and LHC 24-bit DC-BCT systems. In the SPS it is proposed to connect the BCT5 to both high and low intensity channels for improved redundancy. In the LHC the new VFC-HD will be installed during YETS to remove the third FEC and improve the redundancy. Also, the direct transmission from the 24-bit system to the LHC-SMP is possible.

Jan commented on the long history of the issue and thanked the team for improving the system. Jan asked which option should be chosen for the LHC. Tom replied that he proposes to use the direct connection with the VFC. Jan commented that then we should do that from the start. Daniel agreed.

Daniel asked why the same solution is not chosen for the B channel. Tom replied that the B channel is still on the 16-bit acquisition system.

Daniel added that the proposal should be written in a ECR.

Action: Draft ECR on the proposed DC-BCT and SMP changes (T. Levens).
The ECR has since been prepared and approved. It is available in EDMS.

SMP modifications and their implications during YETS 2022-2023 (R. Secondo)

Raffaello presented the impact of the DC-BCT connection changes on the SMP system. The generation of the Probe Beam Flag will be performed using redundant sources. The VFC-HD transmitted headers are hard encoded, independent of FESA. The DCCT hardware is ready for the SMPv2 receivers.

The format of the data transmission to the SMP uses a 8-bit header and a 24-bit payload. The headers for BCT3 and BCT5-low intensity are not changed. The changes for BCT4, BCT5-high intensity have been implemented in the critical firmware of the SMP-SPS receivers (CISR, A and B). SMPv2 sources should later modify their header values to reflect their status and provide diagnostics of the source.

Raffaello pointed to the difficult re-programming a Xilinx Spartan 2 device with ISE 10.1. A very old computer is used to have access to it. The updated setup is being tested in the lab.

The logic of the generation of the probe beam flag is currently using the first valid input from the two inputs. The proposal is to modify the logic for the low intensity to now use the highest value, from the two now-redundant inputs.

Jan commented that the magnetic perturbation mentioned by Tom represents only 1% of the probe beam limit. Jorg added that any error below 1×10^{10} charges are acceptable.

Daniel asked if issues are expected from the challenging re-programming of the FPGA. Raffaello replied that it is complicated to perform the modifications, but that extensive testing will mitigate risks of errors. A full re-commissioning of the SMP system will be performed after the YETS.

Daniel concluded that the MPP endorses the two sets of changes.

Summary of actions

The actions from the meeting are:

- Hardware transmission of DC-BCT intensity to SMP SPS and LHC
    1. ~~Draft ECR on the proposed DC-BCT and SMP changes~~ (T. Leven, R. Secondo)