

227th Meeting of the Machine Protection Panel

Injectors topics

July 1st, 2022, via Zoom

Participants:

G. Bellodi (BE-ABP), Y. Dutheil (SY-ABT), L. Esposito (SY-STI), C. Hernalsteens (TE-MPE), J. Lallement (BE-ABP), A. Lombardi (BE-ABP), C. Martin (TE-MPE), B. Mikulec (BE-OP), A. Radeva Poncet (BE-CSS), F. Roncarolo (SY-BI), M. Saccani (SY-BI), E. Sargsyan (BE-ABP), B. Schofield (BE-ICS), R. Scrivens (BE-ABP), P. Skowronski (BE-OP), J. Uythoven (TE-MPE), C. Wiesner (TE-MPE), D. Wollmann (TE-MPE).

The slides of all presentations can be found on the [website of the Machine Protection Panel](#) and on [Indico \(227th meeting\)](#).

Minutes and actions from the 219th (Injectors topics)

The minutes of the 219th meeting have been circulated and are approved. No action was identified.

Experience of Linac4 source test and proposal for 2023 source operation (A. Lombardi)

The IS03 and IS04 sources have identical plasma generators but have different extractions and electron dumping schemes. IS04 has a simplified design with only plasma, puller, and ground electrodes. The Einzel lens, causing emittance growth, has been removed. IS04 is 6cm shorter, 45 keV electrons (compared to 10 keV for IS03) are co-extracted on a dedicated dump.

IS04 provided better quality beams during the 20-week run on the test stand in 2021. This would reduce the losses at the RFQ. This has been confirmed during the November 2021 test at Linac4. The transmission is increased compared to IS03 for currents above 40mA.

A reliability run took place at the test stand in 2022, with a 50 mA current to stress the system. This allowed mainly to test the electron dump reliability with 45 keV electrons. No spark was observed in the extraction region and the source had no missing pulses. It showed an excellent shot-to-shot stability.

Daniel asked what the damage limit for the electron dump would be. Alessandra replied that for the currents that the source can deliver, no issue is expected.

All modifications to be performed in the tunnel are backward compatible. It would take 1 to 2 days to revert to IS03 if needed, a similar timescale as changing a source with its spare.

The Einzel Lens must be removed from the BIS inputs and the polarity of the solenoids must be reversed.

C. Martin asked about the CIBU input that needs to be removed. Alessandra clarified that the CIBU will remain in place. If we take out the CIBU then it would be more difficult to revert to IS03. C. Martin commented that now the signals from 3 power supplies are used on a single CIBU input. Alessandra replied that we need to stop monitoring only the Einzel lens and that EPC needs to reconfigure their system. There will be no change on the CIBU side and no need to re-test the user inputs.

Daniel asked how the rf limit is implemented and what is done to limit the current. The source is regulated by the “auto pilot” that sets the rf power in the source to reach the requested current. The autopilot can vary the power up to a certain limit and after a new source is installed, this limit is changed so that excessive currents cannot be reached. Piotr added that the BCT watchdog also serves as protection, with, in addition, the BLM interlock.

Daniel asked about the spare situation for IS03 in 2023. Alessandra replied that 3 IS03 units are available (1 running and 2 spares). A total of 3 IS04 units will be available for a total of six sources. The suggestion is to run in 2023 with IS04 and to reduce the number of available spares for IS03 as we gain experience.

In conclusion, it is proposed to use IS04 as operational source starting January 2023. It would not increase the operational risk for Linac4 and reverting to IS03 would be possible at any time.

Daniel concluded that the proposal is endorsed by the MPP without any objection. A review should be organized before retiring the spare IS03 units.

Risk assessment for change of Linac4 source BIC actuator (J.-B. Lallement)

The discussion concerns the two possibilities to interlock and stop the source (no particle propagating through the LEBT). The source is currently interlocked via the rf. The extraction voltages focus the H- beam, ensuring the extraction from the plasma and making sure that the electron beam is dumped at the right place. If there is no high voltage, no particle goes out of the plasma chamber. This is the second proposed interlocking option.

The source current stability depends on the stability of the parameters for the plasma generation (Cs, rf, temperature in the Faraday cage, etc.). In the absence of rf power, the source cools down and the stability may be impacted. The recovery time depends on the duration of the rf stop and stop frequency.

Interlocking with the extraction voltage would keep the plasma running. However, the HV still needs to be ramped-up to nominal level and should stay in interlock. Incorrect HV level means that the beam will be lost in the first part of the RFQ and inside the extraction region. Additionally, the electrons will be dumped at the wrong place. In case the HV is interlocked, it will need approximately 500 us to ramp-down, creating losses. At the moment, the rf is switched on only when the high voltage is reached and stable.

A kind of “avalanche” effect could happen if the HV is itself interlocked, generating instabilities on the HV, in turn triggering the interlock. This would lead to difficult restarts. These arguments might even be more problematic with IS04 as the electrons are dumped at 45 keV.

Whenever a long stop due to interlocks happens, the operators will insert the beam stoppers, clearing the source interlock and restarting the rf. The source is never left abandoned for more than five minutes. During the restart, the source is in “start-up” mode (expert mode), in a safe state. The HV levels are essential for the source integrity and should remain in the interlock equation. Having a HV ramp-down with rf on would have a severe impact on the source reliability and lifetime.

In conclusion, it is proposed to keep the interlock strategy as implemented until now.

Jan commented that it had been discussed that the beam stopper insertion could be automated. Jean-Baptiste commented that they are not meant to be manipulated too often. Piotr added that this had been vetoed by ABT. This is not directly needed if there is a clear instruction to restart the source as soon as possible during operation.

Daniel concluded that the MPP supports that the rf interlock is kept unchanged.

Summary of actions

No action has been identified.