**Quick Guide to identify the (most likely) faults in an FMCM**

**PREAMBLE**

It has to be said that so far no FMCM has yet experienced a critical failure of any HW component yet. The most frequent problem is a failure of the communication, which is however a non-critical failure (and often not noticed by operations) as the RS422 communication mainly serves diagnostics purposes and does not at all affect the critical path.

Most calls of operation are related to an increased rate of inhibited extractions due to FMCM interlocks appearing on extraction septa magnets, which so far in all cases could be correlated with a degradation of the power converter performance or e.g. changes on the electrical distribution network such as VAR Compensators, etc…

**WHATEVER THE FAULT, THRESHOLDS SET ON THE FMCMs ARE SAFETY CRITICAL AND MUST NEVER BE RELAXED WITHOUT PRIOR CROSS-CHECK WITH MARKUS Z. OR JORG W.**

**QUICK menu to identify and resolve failures**

1. What is the type of failure?
   1. No Beam Permit for LHC/TL devices when it should be there (ie magnets pulsing normally in TL or being ON at nominal current in the LHC -> Proceed to step 5
   2. Spurious/increased number of interlocks during flat top -> Proceed to step 4
   3. No communication and/or no PM data from the device -> Proceed to step 2
2. Open the FMCM GUI <http://slwww.cern.ch/~pcrops/releaseinfo/pcropsdist/lhc/lhc-app-fmcm/PRO/FMCM-Control-GUI.jnlp> and find the device in question. Double click on it and verify whether the device is still online (ie values are updated and that the magnet voltage is non-zero when the magnet should be switched ON). In a transfer line device one should approximately recognize the extraction cycles, and LHC device is typically showing constant voltages (if not ramping up/down). In both cases the max signal for **U\_MAG should be in the order of 5-10V**.
3. In case the communication is not working, check that the FESA class is running properly (see device list for the corresponding FE), eventually reboot the FESA class (non-critical, is NOT going to have an influence on the HW interlocks).
4. **LHC Device:** In case of spurious interlocks in the LHC the reason is most likely to be found in the Isolation amplifier of the voltage divider. In the LHC the thresholds are set well below the normal current ripple of the power converter, unless the current stability of the converter is clearly degraded wrt to normal operation (check with EPC) the isolation amplifier might be the cause. Check the stability of the U\_MAG signal at the front-panel of the FMCM device and compare with the V\_MEAS of the power converter. If there is a clear difference (increased noise) -> Exchange the Isolation amplifier (black box of around 5x5x10cm with green LED on top). In the LHC the amplifier is installed in the BIC rack.

**TL Device:** Check as well a possible degradation of the isolation amplifier, if the device in question is a septa magnet (MSE,MSI,MST,..) the more likely case is however the tight detection threshold. On these converters the voltage ripple during nominal operation is already very close to the thresholds (due to the tight requirements). Check with SPS operation whether any changes have been made to the electrical distribution network of the building, eventually check with EPC the power converter signals during the cycle and compare to previous days/weeks where operation was more stable. Request EPC regulation if no clear malfunctioning of the FMCM is detected.

1. The absence of Beam Permit might be due to the connected CIBU or due to the FMCM itself. Check first that the U\_MAG signal is properly received by the FMCM when cycling (see as well point 4 for a possible fault of the isolation amplifier). Verify the presence of the interlock at the level of the FMCM (front-panel lemo TRIG\_OUT). Run self-check of CIBU.

If the U\_MAG signal is properly present (I the range of 5-10V), but the Beam Permit is not properly provided by the FMCM, **exchange the FMCM, making sure to reconnect all cables and to put the same DUMP and WARNING THRESHOLDS as well as selecting the same operational mode TL/LHC as on the presently installed device.** No other settings are required to tailor an FMCM to a given location.