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Linac4 'Critical' Settings

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with input from

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Interlock-Related Settings

From last meeting...

- ▶ **BLMs:** along Linac4 and all transfer lines (~20)
 - ▶ Running sums: 2 μ s, 400 μ s, 1 ms, beam presence, ambient, cycle
 - ▶ HW threshold x 6
 - ▶ SW threshold x 6
 - ▶ Should we only set the thresholds for beam presence and maybe cycle?
- ▶ **Watchdog:** 4 watchdogs for LBE line run (8 more to add with PSB)
 - ▶ High-loss threshold [mA]: 1
 - ▶ Low-loss threshold [%] + max. no. of bad pulses
- ▶ What is the **damage threshold**?? (how to define the high-loss thresholds?)
- ▶ How to deal with **beam profile measurements**? → lead to losses
 - ▶ Have to map losses once commissioning is finished
 - ▶ Low-loss thresholds to be modified with SIS when inserting BI equipment or more relaxed threshold settings?
- ▶ Settings cannot be provided from the start – still in **commissioning phase**
- ▶ **Roles** to set thresholds – who?
- ▶ How to follow **threshold changes**?

Approach

- ▶ For Linac4 we have identified 3 groups of 'critical' settings:
 - ▶ **4 watchdogs** measuring transmission between 2 BCTs (see picture + LBE watchdog) x 3 interlock settings → protection from damaging losses plus machine activation considerations

BCTwD	2nd BCT	1st BCT
L4L.BCTwD	L4L.BCT.3113	L4L.BCT.1137
L4L.BCTwD.Dump	L4Z.BCT.0273	L4L.BCT.4013
L4L.BCTwD.L4T	LT.BCT30	L4L.BCT.4013

- ▶ High-loss threshold [mA], Low-loss threshold [%] + max. no. of bad pulses
 - ▶ **BLMs** along the linac and transfer lines: threshold interlock settings for 2x6 running sums (HW and SW thresholds) → protection from damaging losses plus machine activation considerations
 - ▶ **Window/threshold equipment settings for certain critical power converters:** source HV, 3 MEBT quads (optics to assure good beam chopping efficiency) and all bending magnets along the transfer lines
- ▶ Different options available in the controls system, and we should consider
 - ▶ Desired protection level
 - ▶ Operational flexibility
 - ▶ Definition of roles

Watchdogs and BLMs

- ▶ Remark machine damage potential
 - ▶ Certain risk of producing a hole in the beam pipe/bellows, in particular at low energy, but damage threshold at different energies unknown (very few FLUKA simulations available)
- ▶ **Proposed implementation of threshold settings:**
 - ▶ **Create virtual parameters for all 'critical' settings in LSA (no 'Machine Critical Settings'=MCS)**
 - ▶ For each cycle, **SIS will compare the setting of the 'real' parameters with the 'virtual' parameters**
 - ▶ Action: if the CCV exceeds the setting of the virtual parameter, the **beam will be inhibited** (BAD SIS user_input to corresponding BIC; correct geographical mapping of equipment to BICs required); message will show which threshold has triggered the inhibit
 - ▶ Check is also valid when re-mapping old cycles (thresholds might have changed in the meantime...)
 - ▶ **Implement RBAC roles**
 - ▶ To modify virtual parameter settings (Linac4 supervisors, J-F. Comblin, G.P. Di Giovanni)
 - ▶ To be able to mask the SIS processes (Linac4 supervisors, G.P. Di Giovanni and CPS shift leaders); masking will sometimes be needed in case of special operational conditions or setup (like cavity re-phasing)

Special Considerations for Watchdogs and BLMs

- ▶ The possibility to reset watchdogs and BLMs remains
- ▶ Low-energy high-loss threshold will for moment be disabled (see <https://indico.cern.ch/event/768188/>); triggered by sudden RFQ voltage drops (beam losses, RFQ spikes); decided to increase instead the low-loss transmission threshold and decrease the no. of allowed bad pulses)
- ▶ BLMs:
 - ▶ Loss inventory during LBE run (once stable operational conditions) to propose **high-loss HW thresholds**
 - ▶ Plan to actively use only **'beam presence' running sum SW threshold** (SW thresholds for other RSs at high levels for the moment)
- ▶ **Increased losses will happen during:**
 - ▶ **Cavity re-phasing** → plan to temporarily disable corresponding SIS
 - ▶ **Insertion of devices into beam:** BTV, wire scanners, Semgrids, BSM wires, stripping foil
 - ▶ Loss inventory during LBE run (including different measurement optics) with longest possible beam pulse
 - ▶ Should **temporarily increase corresponding watchdog and BLM thresholds** when inserting the measurement device
 - ▶ Investigating possibility to use **sequencer tasks** when starting and stopping these measurements

Power Converter Critical Settings

- ▶ Proposed implementation 'à la SPS FEI'
 - ▶ **Through OP application set voltage/current thresholds or window threshold settings**
 - ▶ Difference compared to SPS: BIS card settings can be set non-ppm (BIS.PPM property set to 'disabled'); need only to set up non-ppm MCS (in non-multiplexed cycle context)
 - ▶ Implement RBAC and MCS protection to be able to change (Linac4 supervisors, J-F. Comblin, G.P. Di Giovanni, EPC experts tbd)
 - ▶ Try to have application ready for LBE line run (L. Kolbeck)

Conclusions

- ▶ A plan concerning the handling of 'critical' settings for Linac4 is now available
- ▶ Implementation of Power Converter MCS hopefully for LBE line run; of 'critical' settings for BLMs and watchdogs for 2020 restart after systematic study of loss levels at different operational scenarios
- ▶ Modifications of 'critical' settings through RBAC/MCS roles and traceable through LSA
- ▶ Reminders for active SIS masks should be sent every shift → elogbook?