HiLumi HL-LHC PROJECT

Flux Jumps Signals in Power Converters

Michele Martino and Samer Yammine

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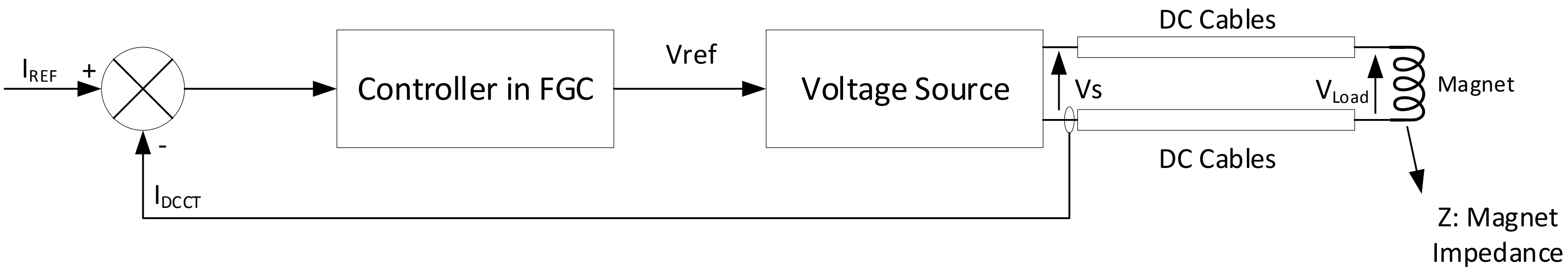
Power Converter Control Loop

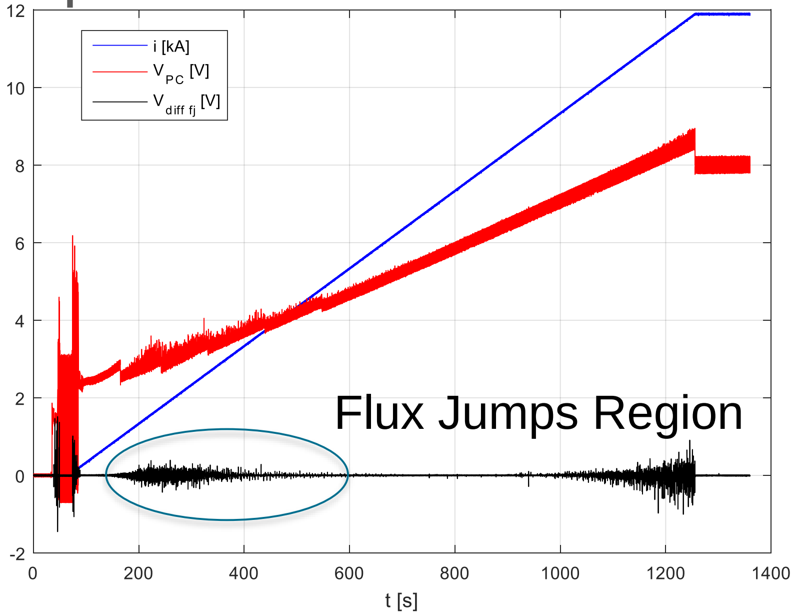
- Simplified representation of the PC current control loop



- Impedance of the magnet contributes highly to the control performance
- Impedance of the magnet varies (for instance due to saturation)
- Flux Jumps are believed to contribute as well to the impedance variation
- Load voltage is the relevant voltage for the power converter

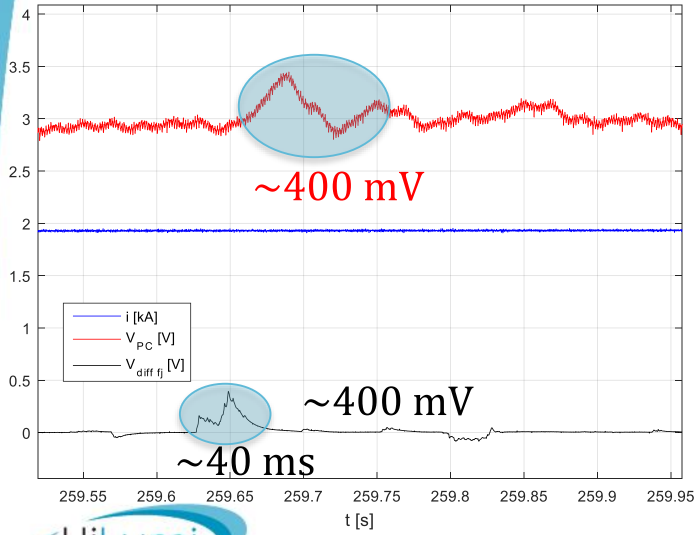
Power Converter Signals during Flux Jumps

- Signals for Fresca-2 test with cluster G power converter during ramp-up at 10 A/s



Power Converter Signals during Flux Jumps

- Flux jump could occur during ~100ms and an impedance variation occurs spontaneously (leading to a pc voltage response to regulate the current)



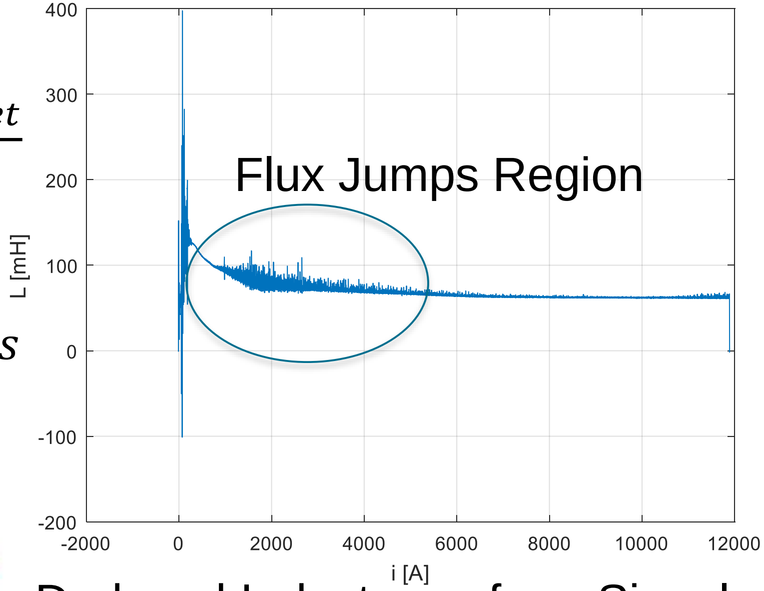
- Variations on current cannot be distinguished due to measurement noise on these plots → Minor impact on the current as the current loop is not “much” perturbed by flux jumps (at this coarse level of precision)
- More analysis is needed for Class0 requirements for HL-LHC (sub-ppm level of precision)

Power Converter Signals during Flux Jumps

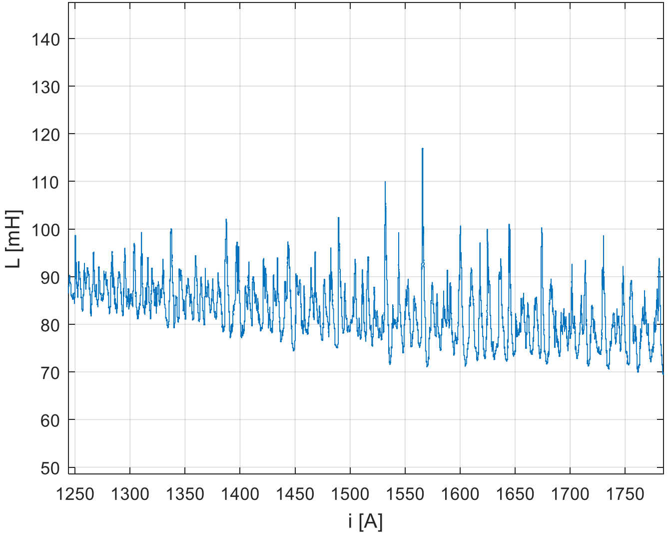
- Estimated inductance "seen by the power converter" during operation

$$\hat{L} = \frac{v_{magnet}}{rr}$$

$$rr = 10\ A/s$$



Deduced Inductance from Signals



"Inductance change" (ΔL) seems to reach 30-40 mH
To be confirmed…

Conclusion

- First results on Fresca-2 are hinting towards an “inductance fluctuation” model of the flux jumps; these fluctuations are rejected by the on the current loop
  - amplitude and time dynamics of the fluctuations depend on the magnet
  - EPC needs to quantify how much rejection (depends both on RST and time dynamics)
- Results of 11T and on MQXF prototype have to be studied to have an HL-LHC case study
- Simulations base on gathered results to be performed in the 11T trim/RB circuit control model and the inner triplet control model (with the decoupling matrix) to study the impact of flux jumps at the circuit level