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High Voltage Solid Switch (HiVoSS)

Context:

Over the last 40 years, short pulse (flash) x-ray sources have been continuously improved to remain an important diagnostic for the evaluation of hydrodynamic phenomena. Future flash radiographic machines will be able to deliver multiple radiographic images (2 or more) along a single axis in a short time scale. Based on a LIA (Linear Induction Accelerator) architecture, these future drivers shall implement induction cells in order to:

1. Generate high voltage to supply an electron injector (inductive voltage adder),
2. Accelerate the electron beam along with its propagation in the vacuum section.

The x-ray spot quality strongly depends on the high energy electron beam quality when interacting with the x-converter target. For a multi-pulse mode, the reproducibility of the successive high-quality electron beams at a MHz repetition rate is a main challenge. Then, efforts must be made on voltage pulse quality applied to the induction cells either for the emission of the electron bunches or their acceleration.

Discussions and main research axis:

From a global view, it is quite easy to achieve high quality requirements for the first pulse delivered by a dual pulse power generator. However, it is a much more difficult for the second one because its shape is modified by the multiple bounces (oscillations) due to the first voltage wave going back and forth between generator and induction cells. To maintain a high-quality voltage plateau on second and next pulses, four ways will be investigated:

1. Solid-state technology could be a relevant option to:
    a. Correct and adjust the plateau of the high voltage pulse (a few percent of several hundred kilovolts) for successive pulses produced by classical technology generator (pulse forming water lines and spark-gap switches),
    b. Produce, at the correct multi-pulse scale (number of pulses and rep-rate), reduced voltage pulses (20-30kV) which will be added in a selected architecture (LTD, IVA) to feed the induction cells.
2. Designing new long dispersive lines for:
    a. Temporarily isolate these successive pulses by the design of specific long transport lines from the generator to the induction cells. These lines must be compact, able to transport 500kV pulses without attenuation and distortion and ensure a 2µs isolation.
    b. Attenuate these voltage bounces. This could be made by dispersive lines (semiconductor loaded coaxial cables) with an attenuation rate in the right high-frequency band so that bounces are minimized but pulses shape (especially rise and fall edges) is not disturbed.