TECHNOLOGICAL ISSUES OF WIRE COMPENSATORS

A collection of Ideas

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SLAC, LARP Mini-Workshop on Beam-Beam Compensation 2007

Outline

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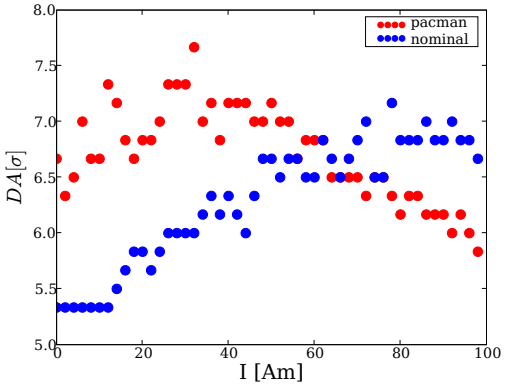
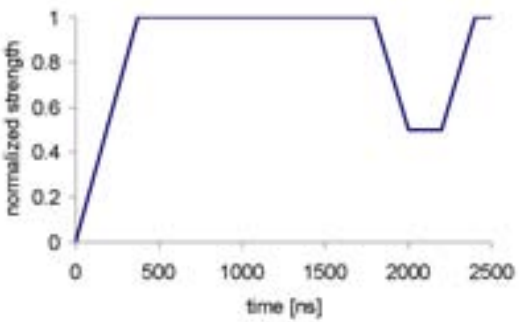
REQUIREMENTS I

- A DC compensation either optimizes normal or pacman bunches.
- An intermediate DC current level improves the nominal and does not harm the extreme (!) PACMAN bunches.
- A pulsed compensation must follow the bunch pattern:
  $\rightarrow$ max risetime: 374ns $\rightarrow$ average pulse frequency: 439 kHz.
- At these frequencies the wire acts like an inductivity of L=800nH.
- System must be flexible to adapt to different bunch patterns and to decreasing beam current during one store.

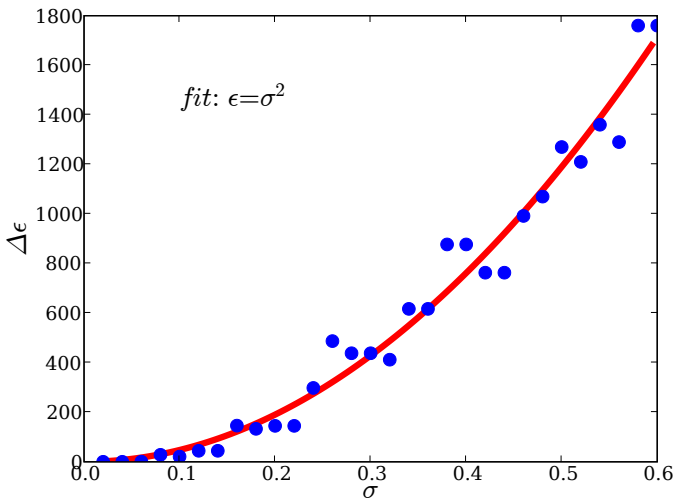




- Cooling: SPS: water, RHIC: heat sinks.

REQUIREMENTS II

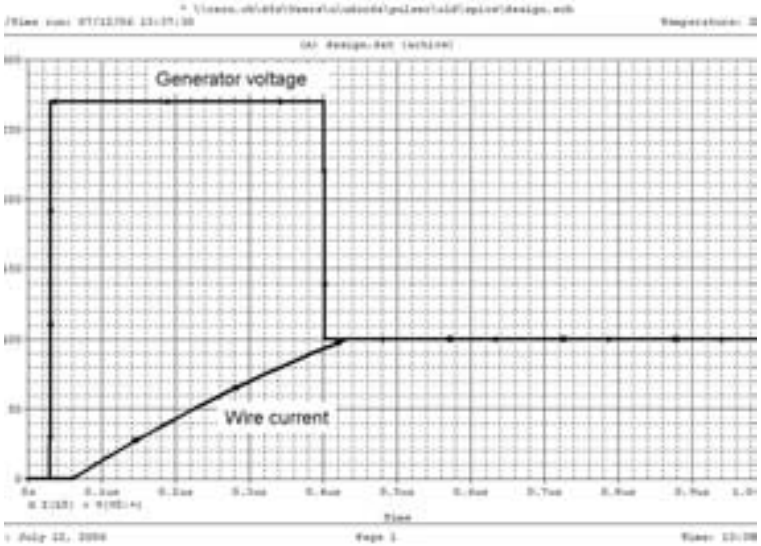
- Any turn to turn jitter causes emittance growth. (no growth from Low or high frequencies (compared to the synchrotron frequecy).
- Emittance growth for white gaussian noise.



- Therefore a turn-to turn-precision of $< 3mA$ ($\Delta\epsilon < 10\%$ in 20h)

IMPLEMENTATION GUIDLINE - IDEA 1 I

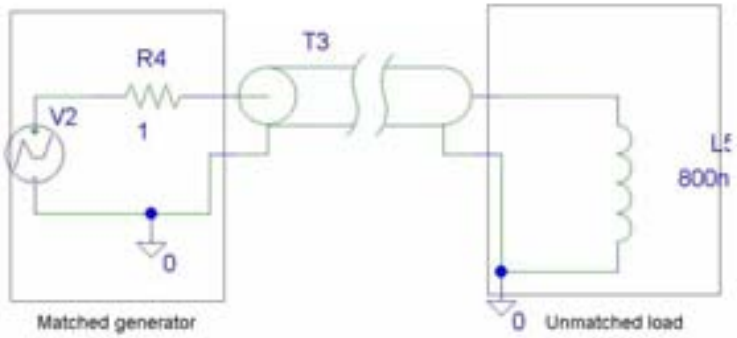
- Use low Ω cabeling (we want current, not power!)
- Use the inductivity: $\dot{I} = \frac{U}{L}$ to define the current slope and the cable's resisitvity to define the plateau:



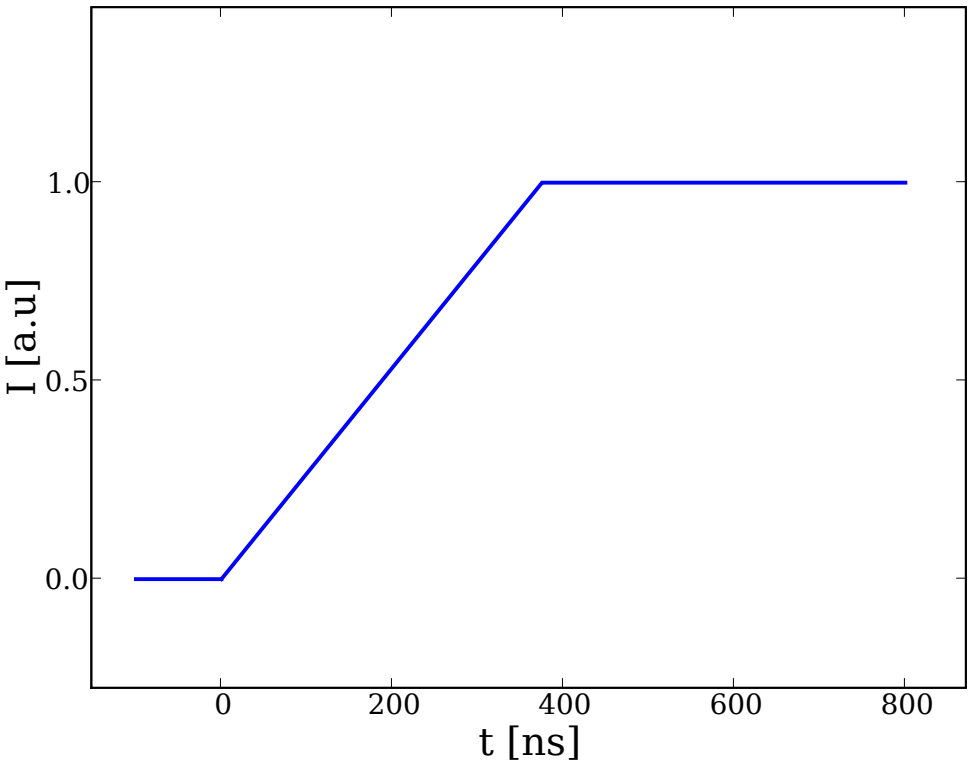
  - That doesn't really create a straight line, but that doesn't matter
  - required Voltage: 270V

IMPLEMENTATION GUIDLINES - IDEA 1 II

- This corresponds to a timing precision of 0.02ns.
- Take running times into account; Reflections disturb the pattern
  $\longrightarrow$ match on generator side (to have no reflections going back to the wire)
  $\longrightarrow$ Do not match on load side (would require high power).

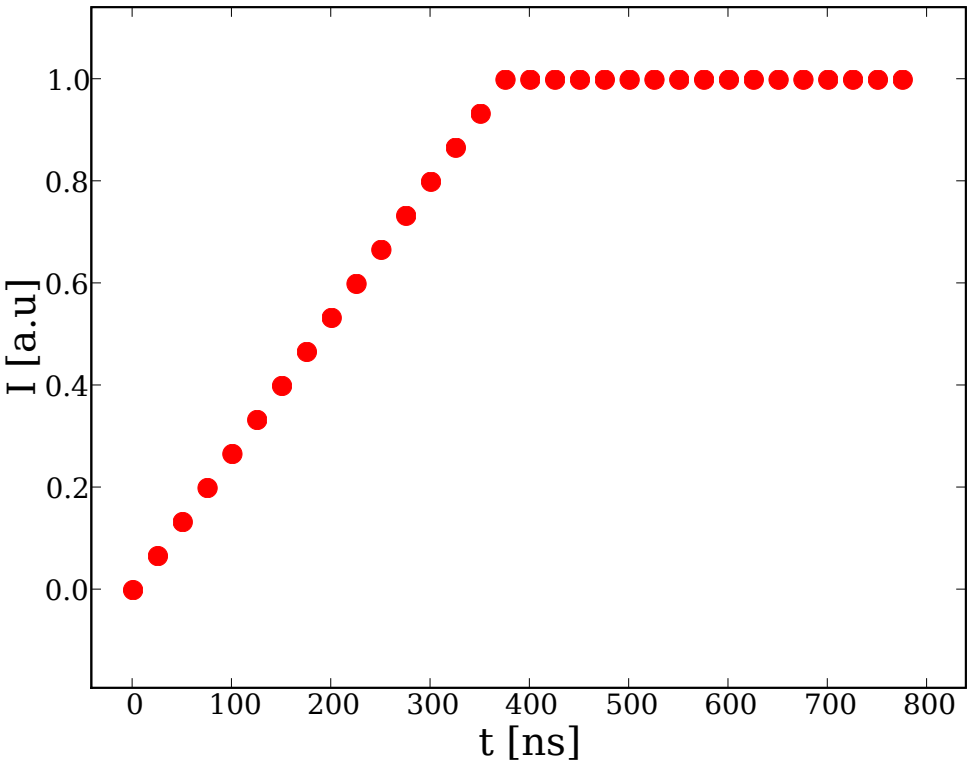


IMPLEMENTATION GUIDLINES - IDEA 2 I



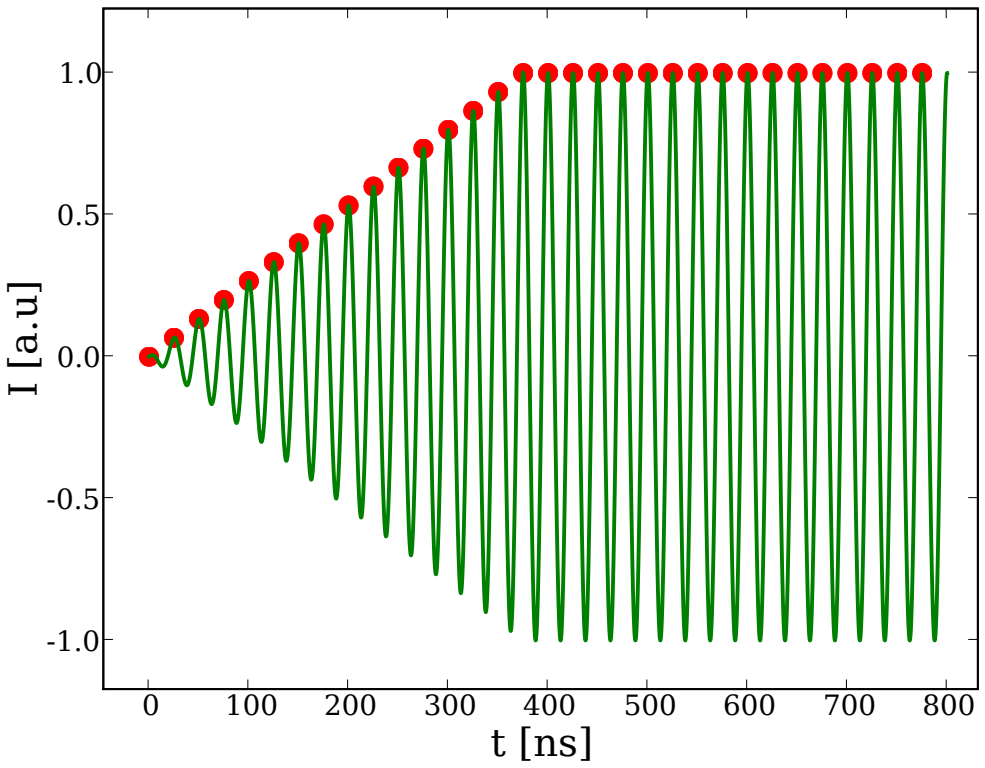
That's not what we need

IMPLEMENTATION GUIDLINES - IDEA 2 I

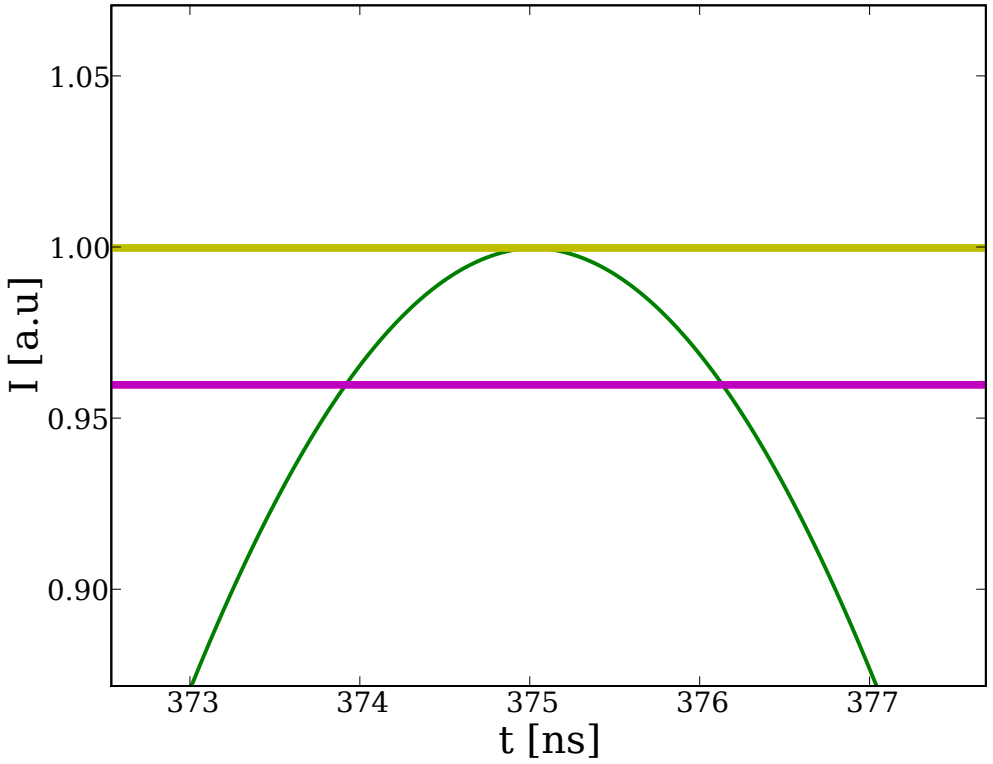


That's what we need

IMPLEMENTATION GUIDLINES - IDEA 2 I



40MHz sin shape



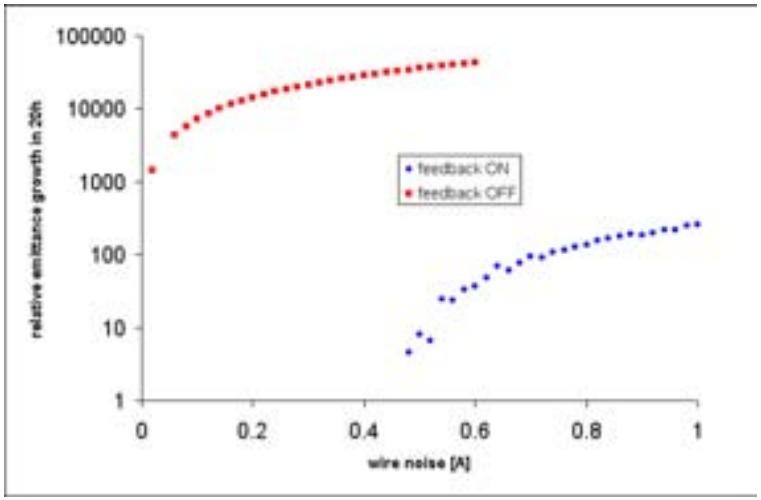
There is a difference between head/tail and center. This should not be a problem

IMPLEMENTATION GUIDLINES - IDEA 2 II

- Error of 3mA corresponds to a timing arror of 30ps. The ratio time/error is nonlinear and needs to be properly simulated.
- An amplitude modulated Sin shape is technological easier to implement/controll
- Phase noise measurement allows to measure the error
- Amplitude modulation prohibits a high Q resonator
- The pulser will be working on a standard 50 Ω cable and transformer (passiv) at the wire.

REMAINING NOISE

- Transverse Feedback might be needed anyway to cure other problems.



- J.P's 3-turn delay feedback: Measure the error on the wire and compensate for it $3 \cdot N$ turns later. Should be compatible with the RF approach.

CONCLUSIONS

- A pulsed wire is good, but make sure to keep a DC option as a fallback option.
- There is hope again with Fritz's RF idea.
- I like J.P's feedback.

Thanks to:
F. Caspers, T. Kroyer and J.P.K.