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M.Jonker

INTENSITY RAMPUP

AN INVITATION FOR DISCUSSION

Motivation

Post pulse analysis and next cycle permit are key concepts.

How to bootstrap the next cycle permit?

Safe operation: Do not allow potentially harmful beam in the machine

potentially harmful :: current state of the machine & brilliance of the beam.

The principle:

- '*Cold start-up*' (i.e. unknown machine): only beam that cannot cause structural damage to the installation is safe
- Once probed by safe pilot beam: increase charge density of the beam in steps (as long as allowed by the post cycle analysis of every previous step)

A (fast) intensity ramp up procedure is needed every time we lose the next cycle permit

- false beam interlock rate 5 minutes + 3 second ramp time = 1% dead time

Warning

The exact details of the intensity ramp for CLIC, shown in the following slides, are not too important for the discussion.

(Only the fact that there is an intensity ramp matters)

Drive Beam: 100 × Safe Beam

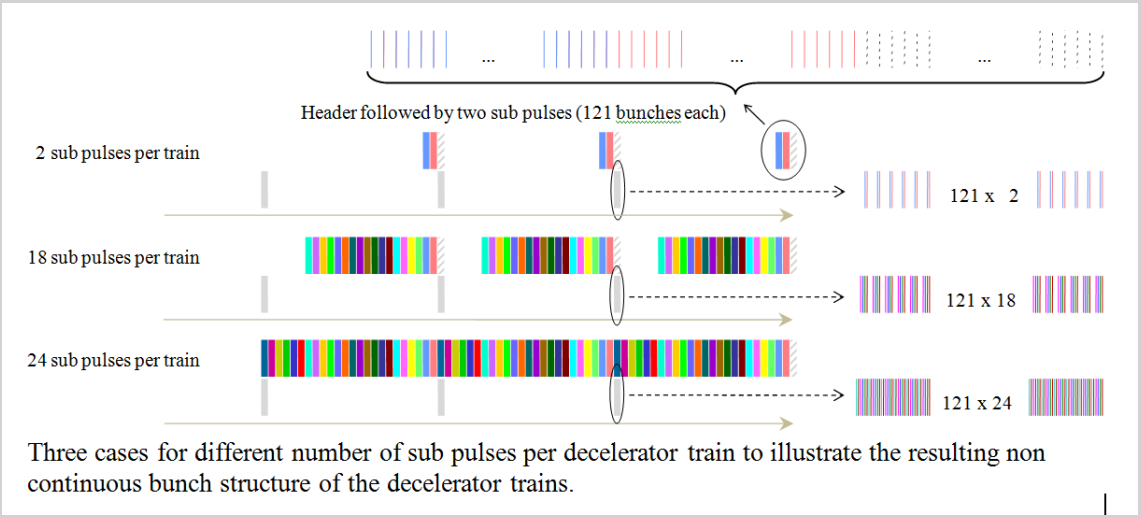
(for a single train out of 24)

One train = 24*121 bunches ⇒ safe beam is 30 Bunches.

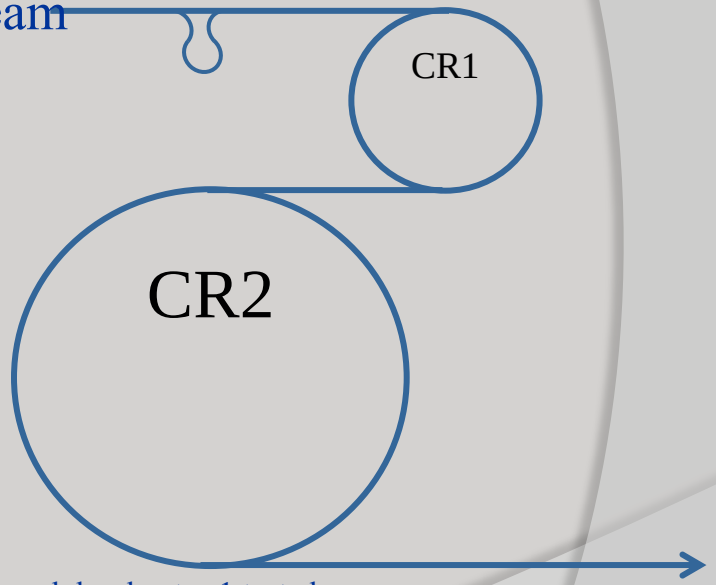
Full drive beam: 1+24x24 sub-pulses (1SP = 121b). Header is dumped, remaining 24x24 sub-pulses are arranged in combiner complex in 24 **"*trains*"**, of 24x121 bunches @ 12 GHz

Strategy to ramp intensity :

Gradually add bunches to the end of the full drive beam



Three cases for different number of sub pulses per decelerator train to illustrate the resulting non continuous bunch structure of the decelerator trains.



- 30b, 60b, 1SP, 2SP, 2SP+30b, … 24SP (48 steps) ⇒ Recombination complex and decelerator 1 tested
- 1T+ 30B, 1T+ 60B, 1T+ 1SP, 1T+2SP... (18? steps) ⇒ Decelerator 2 tested
- 2T+ above program for third train ⇒ Decelerator 3 tested
- Etc… **Total 48+23*18 =462 pulse combinations to test full circuit (10 seconds if all goes well).**

  need strategy to intensity ramp trains in parallel (1 second if all goes well)

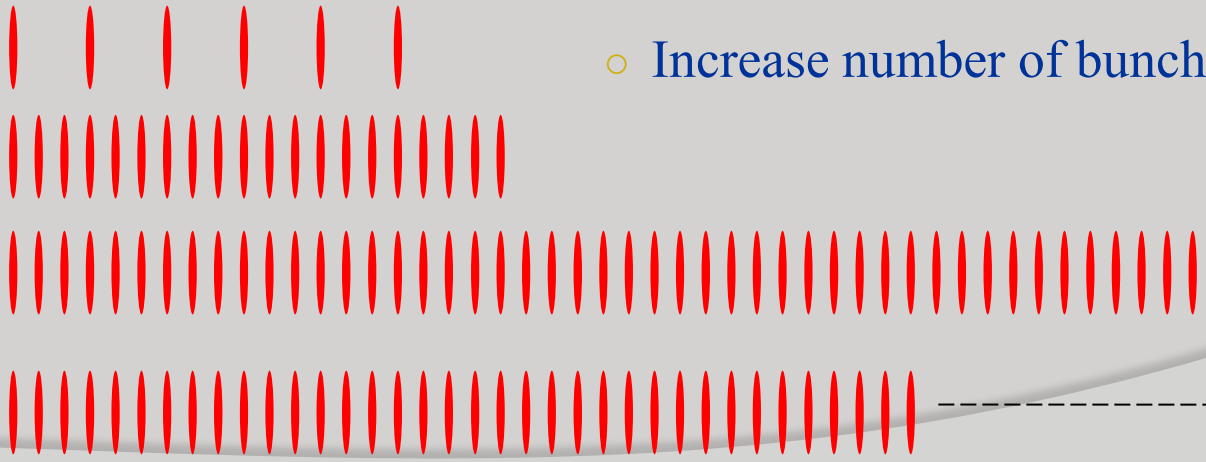
Main Beam: 10000 × Safe Beam

Reduced brilliance by 10^4 with respect to nominal (312 bunches in 152 ns).

- Reduce to 6 bunches in 10 ns (for Beam Position Monitors) ⇒ factor 50
- Reduce intensity / bunch ⇒ factor 3
- Reduce emittance in damping rings (ε_h: 1/3, ε_v: 1/20) ⇒ factor 60

Strategy to ramp to nominal values:

- Reduce emittance & increase bunch current
- Increase number of bunches



Decrease bunch spacing

Increase train length

The principle

- upon interlock, it shall not be required to step all the way back to the intensity level applicable to the completely unknown machine.
  - Those components that worked shall be kept up and running.
  - Failing components shall fall back to a safe intensity level.
- independent components shall ramp intensity in parallel
- if all works well (i.e. false beam interlock) the intensity ramp shall be fast

Implication in practice

Conditions to make it work

- the post pulse analysis shall have specific criteria for every intensity setting (to take into account beam loading effects). Hence, there are many machine modes.
- the beam feedback shall converge to these (machine mode dependent) values allowing the next step of intensity increase.
- the beam feedback shall successfully track energy drifts where needed for all modes
- the intensity ramp shall be fast enough that the temperature drift is insignificant during short revalidation ramps (and hence do not demand extra time).

- What more ... ?