# Abort gap cleaning: status at 450 GeV and issues/plans at 3.5 TeV

W. Höfle, D. Valuch
Thanks to D. Jacquet, V. Kain et al.

Abort gap & Injection gap cleaning

- Cleaning mode – ADT excites the beam which then hits the collimators

- Excitation:

  – in a defined time window (abort gap, next injection slot)

  – by a synthesized signal (currently sinusoidal (various modulations available), noise is being studied)
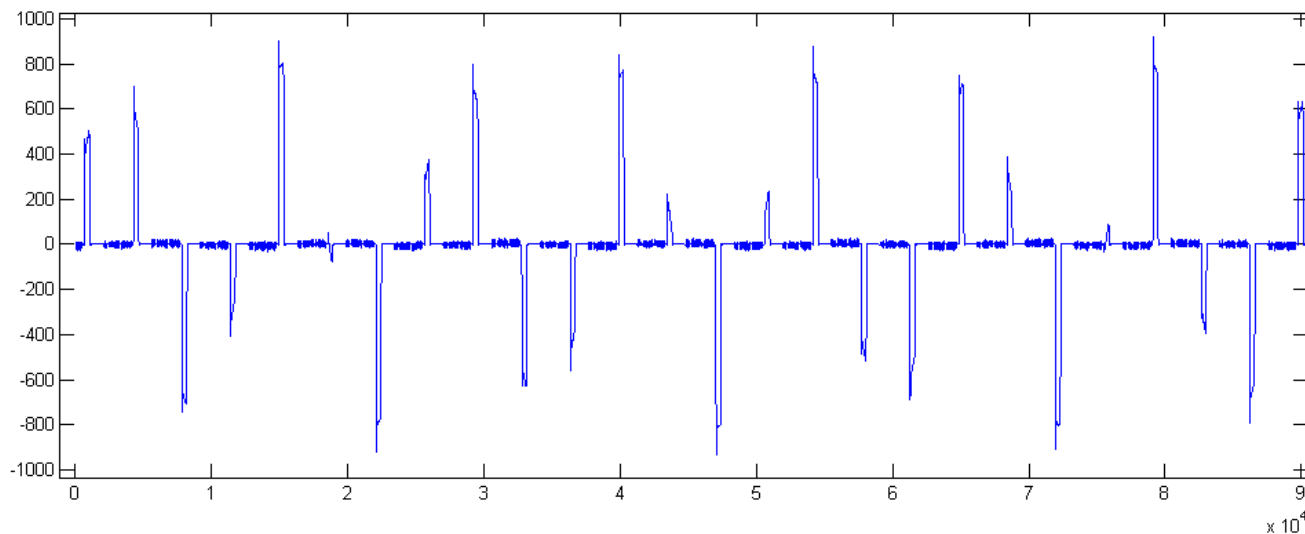
Signals acquired during injection of the fill #1867

ADT performance

- Excitation amplitude currently at 10% of the available kick strength (scales with the damper electronic gain)

LHC ADT performance in LHC optics version 6.5xxx compared to original assumptions (at 450 GeV/c), assuming 7.5 kV maximum kick voltage

|	β=100 performance	Optics 6.4 performance		New Optics
	Kick per turn in σ	Kick per turn in σ @ β in m		
ADTH beam 1	0.2 σ	0.277 σ at β=193 m	0.317 s	252 m
ADTH beam 2	0.2 σ	0.273 σ at β=187 m	0.253 s	160 m
ADTV beam 1	0.2 σ	0.309 σ at β=239 m	0.285 s	203 m
ADTV beam 2	0.2 σ	0.316 σ at β=250 m	0.386 s	305 m

ADT performance

Beam 2, Q9 vertical Abort Gap Cleaning tests 30. 4. 2010
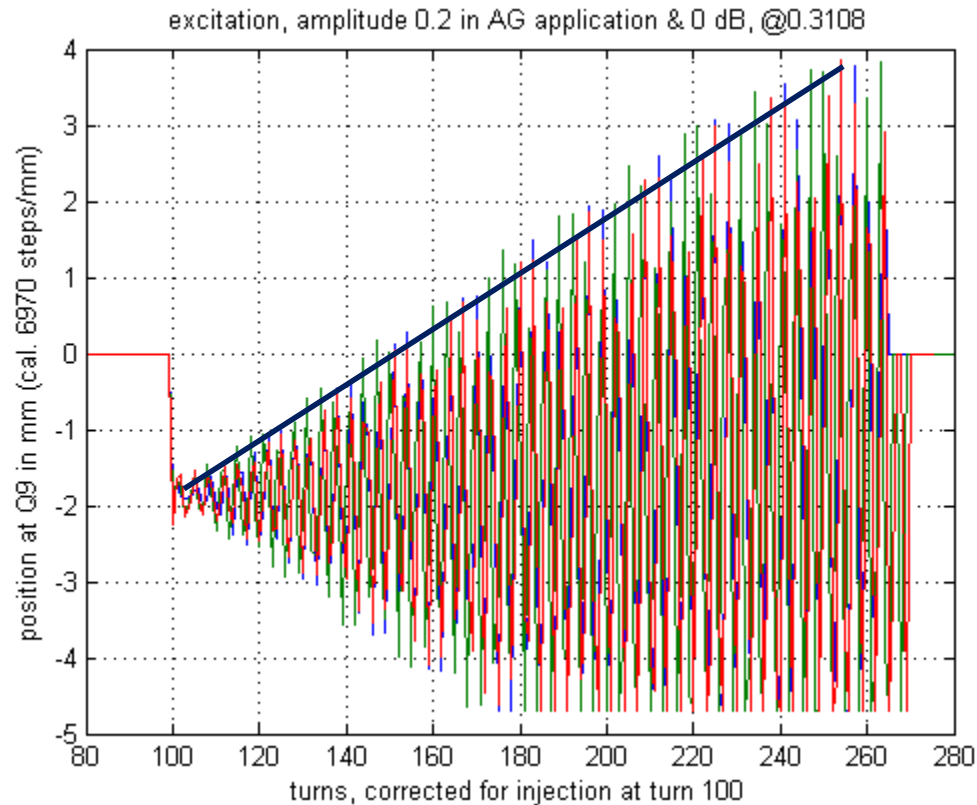
slope: 0.0387 mm/turn @1/10 of strength
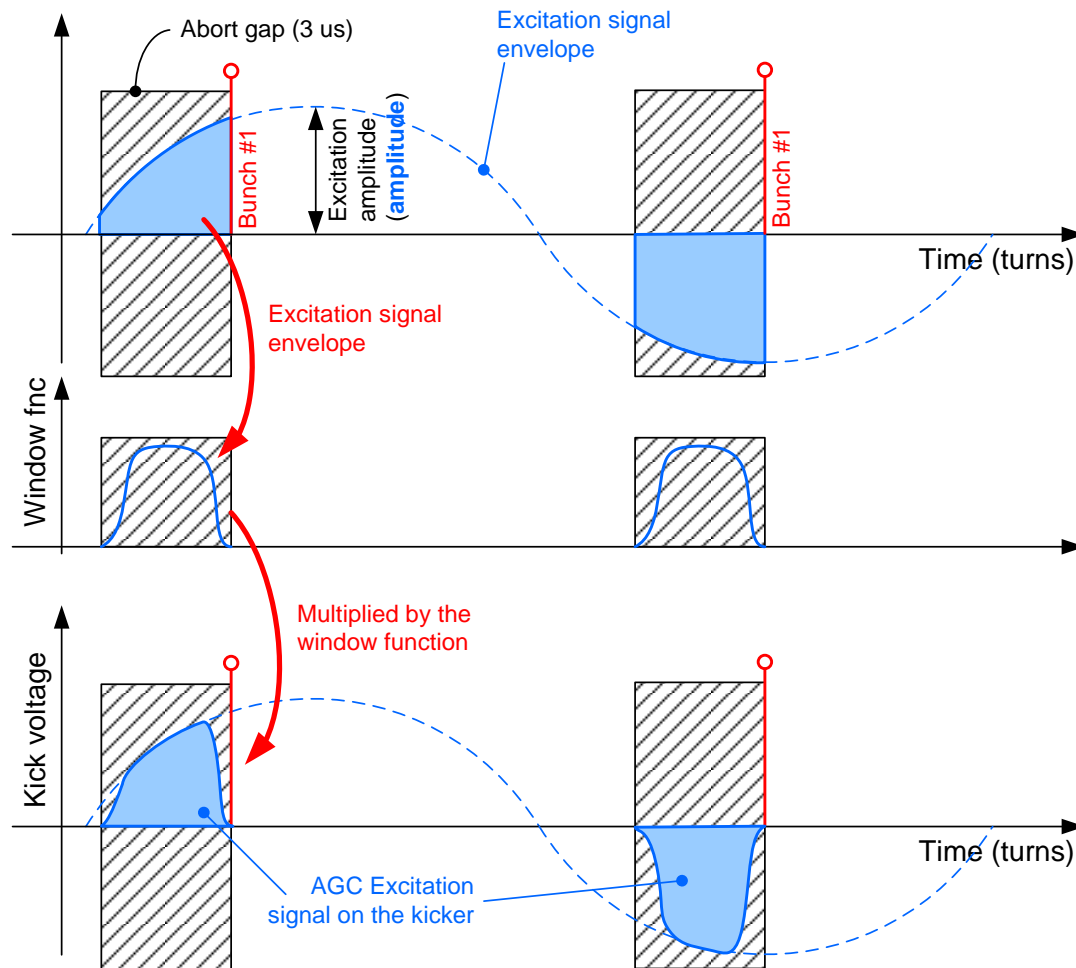(6 mm from turn 95 to 250)
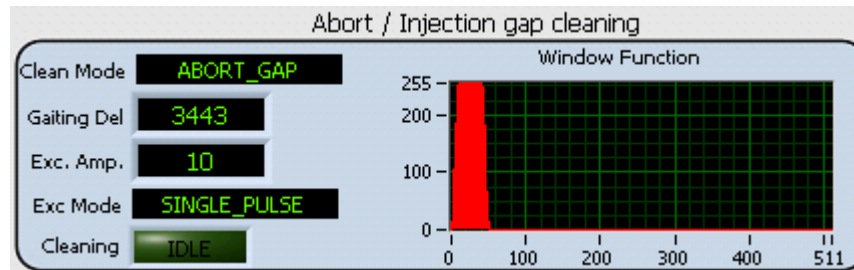
Cleaning signal generation

- Excitation within the turn
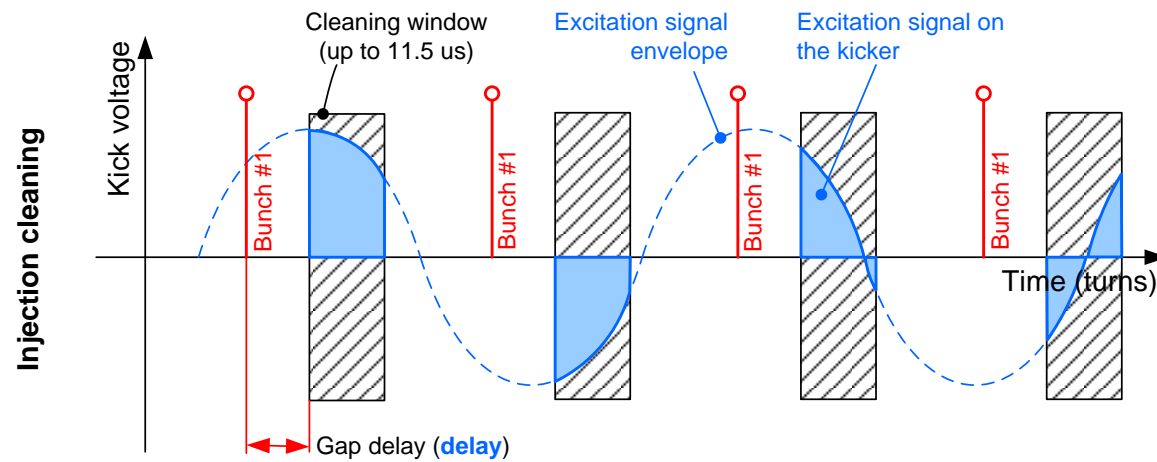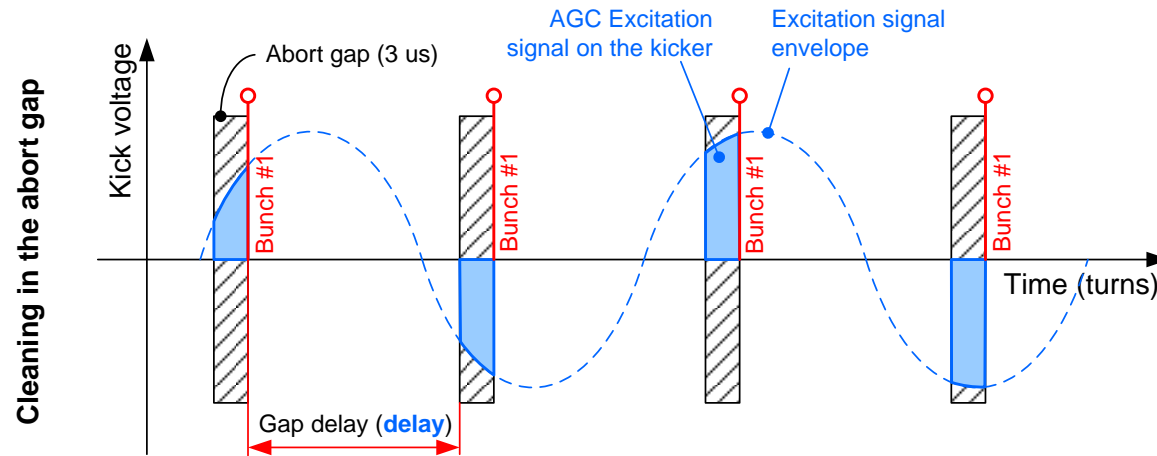
Cleaning signal generation

- Window function

Abort gap cleaning

- **Abort gap cleaning sequence**

  - Coherent excitation at $Q_{VER} \pm 0.01$ in 15 steps (750 turns/step)

  - Triggered by the 1000 ms timing

  - Sequence stops automatically after 11240 turns
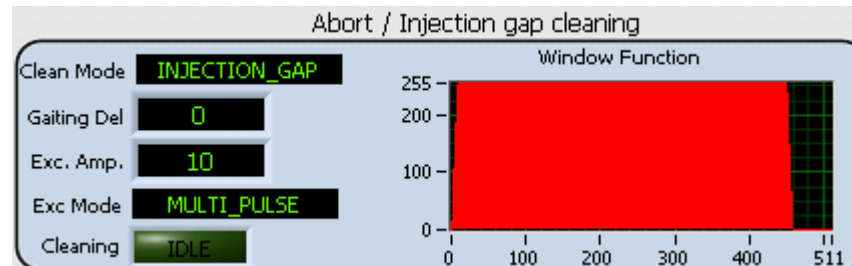
Abort gap cleaning

- **Operation**

  1. **Sequencer sets the cleaning parameters** for flat bottom. Drive all non critical, check all critical.

  2. **Inject pilot**

  3. **AGC activated** by task enabling the timing before injecting first nominal

  4. **Injecting physics beam**. Cleaning sequence is retriggered by timing every second

  5. **AGC deactivated** in the sequence prepare for ramp by disabling the timing (+ setting key parameters to zero)

Injection gap cleaning

- **Injection gap cleaning sequence**

  – Cleaning bucket programmed on-the-fly by the injection sequencer

  – Triggered by software (injection sequencer, could be protected by RBAC)

  – Coherent excitation at $Q_{HOR} \pm 0.01$ in 15 steps (750 turns/step)

  – One sub-sequence is 11240 turns long

  – Sub-sequence repeats up to 20 times

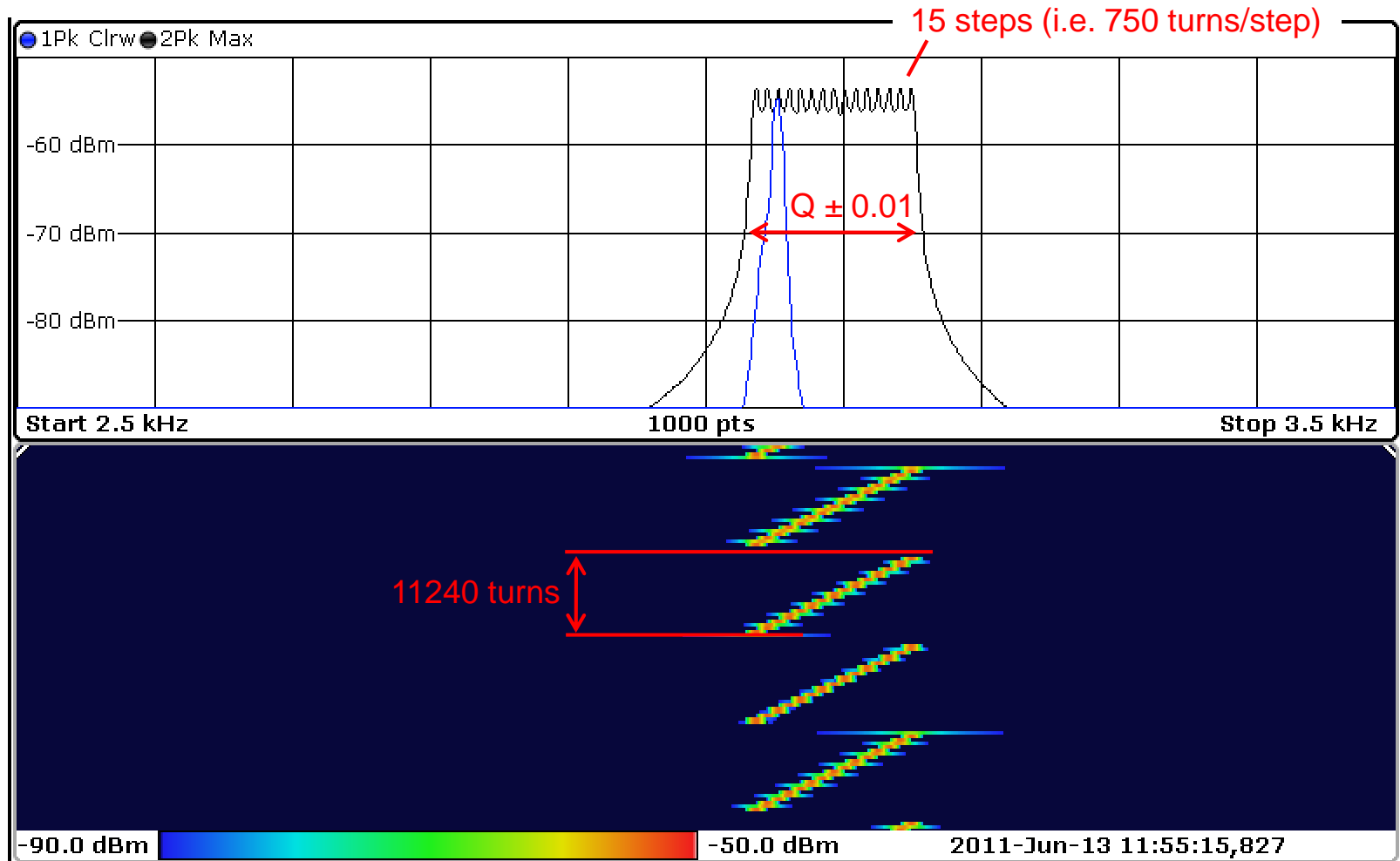 – Cleaning sequence redundantly stopped by two timings and software

Injection gap cleaning
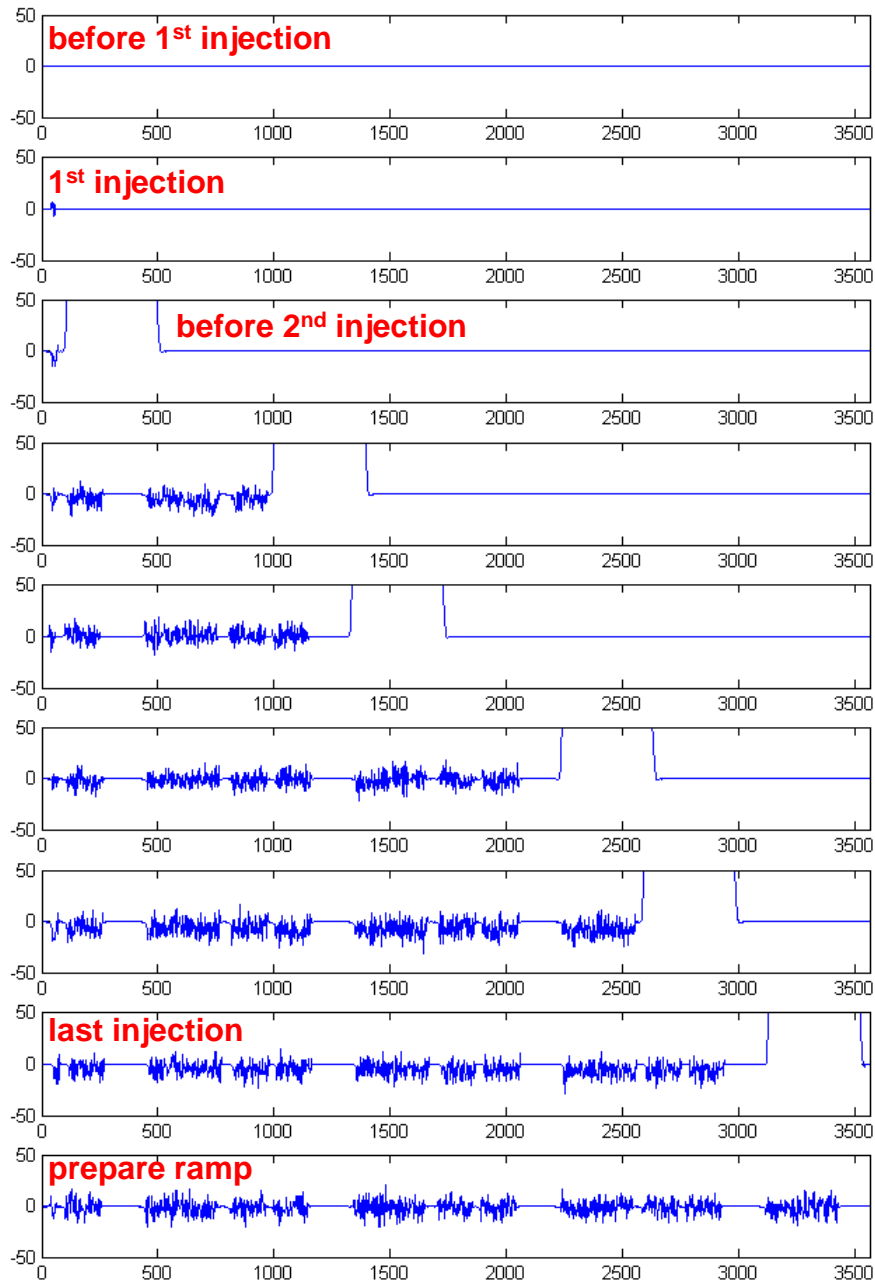
- **Operation**

  1. **Sequencer sets/checks the cleaning parameters**

  2. **Inject pilot**

  3. After inj. the **Injection sequencer checks the next injection bucket** and programs the next cleaning bucket

  4. **Injection sequencer starts the cleaning** as soon as the CBCM has accepted the injection request (typ. one SPS cycle)

  5. **Cleaning sequence is running**

  6. **Cleaning is stopped** 3 ms before the injection **by Injection forewarning timing** and redundantly 2 turns before injection by the BeamIn trigger

  7. **Cleaning stopped by the Injection sequencer** after injection (even empty inj.)

  8. **Cleaning times out in hardware** after 20 sequences (20 x 1s) had been played

  9. **Go to step 2**

  10. **Sequencer disables cleaning** by setting key parameters to zero **at Prepare ramp**
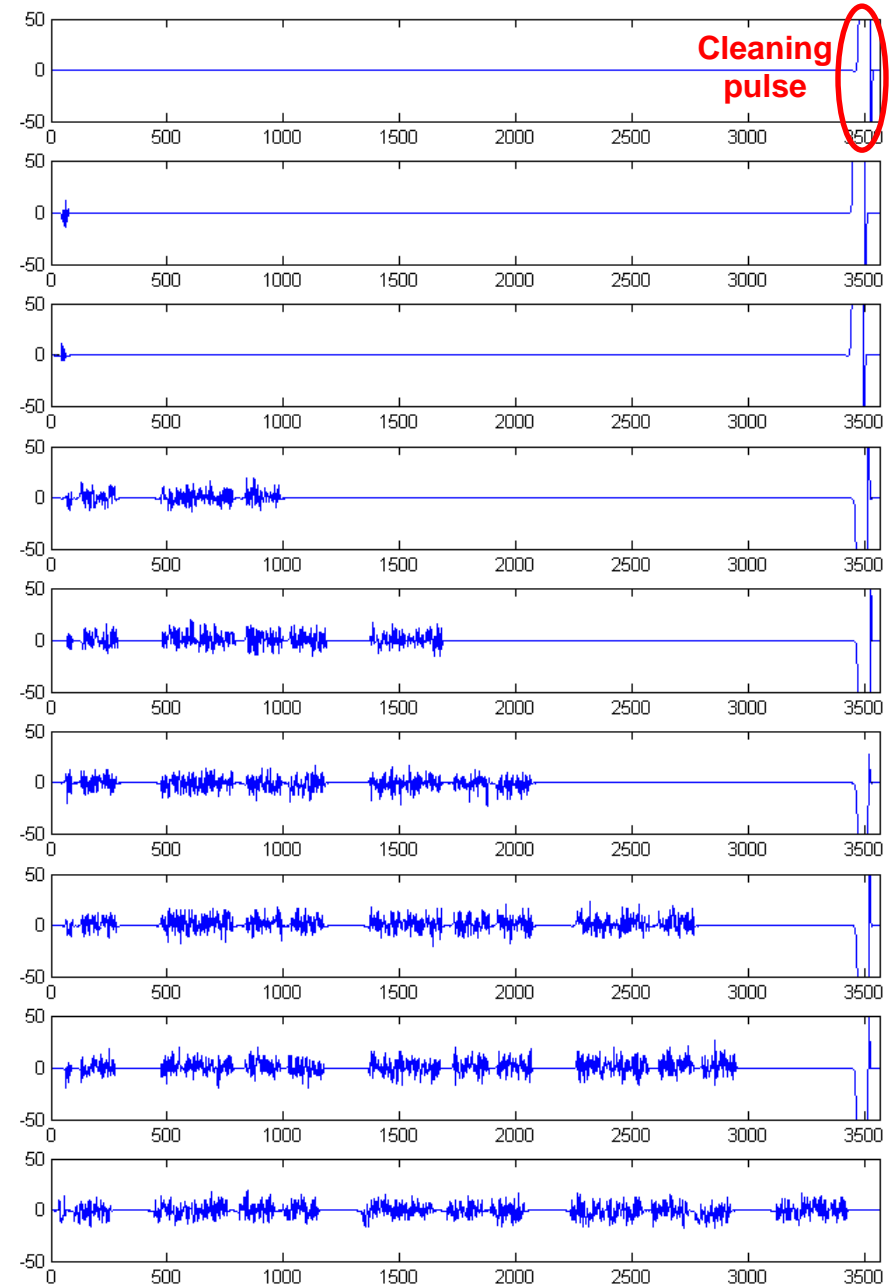
Cleaning sequence

- Abort gap cleaning sequence

Injection gap cleaning (hor. plane)

Abort gap cleaning (ver. plane)

before 1st injection

Cleaning pulse

1st injection

before 2nd injection

last injection

prepare ramp

Signals acquired during injection of the fill #1867

Current status

- Sequencer drives the settings at injection

- All cleaning settings are static:

  – Set of regular LSA settings (frequency, exc. mode, amplitude etc.)

  – Critical settings (Gating, Gating offset, Gating delay, Clean mode)

- Some settings will be different for 3.5 TeV operation

  – Tune values

  – Excitation mode, amplitude, cleaning sequence

  – Window function (?)

- Critical settings are identical for injection and flat top

- **Cleaning is not compatible with the tune measurement**

To do (for the next technical stop)

- Delphine already created different users for AGC

  - LHC.INJ_ADT (settings for injection)

  - LHC.FT_ADT (settings for flat top)

- The actual parameter settings are not user dependent

- The AGC control application needs to be updated

- The sequencer needs to be updated

To do…

- Agreement on the cleaning strategy at flat top with 70+ MJ in the machine

    - When and how to start the cleaning

    - What type of excitation to use

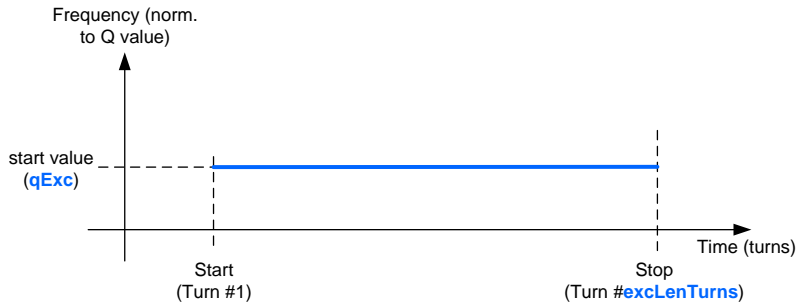   - Must avoid sudden high losses when we start to clean (beam dump)

Summary

- Abort gap / Injection gap cleaning routinely used at injection

- No technical issues to run the cleaning at flat top

- A set of multiplexed settings was already created to program the parameters for injection/flat top

- **Need to agree on cleaning strategy at flat top**
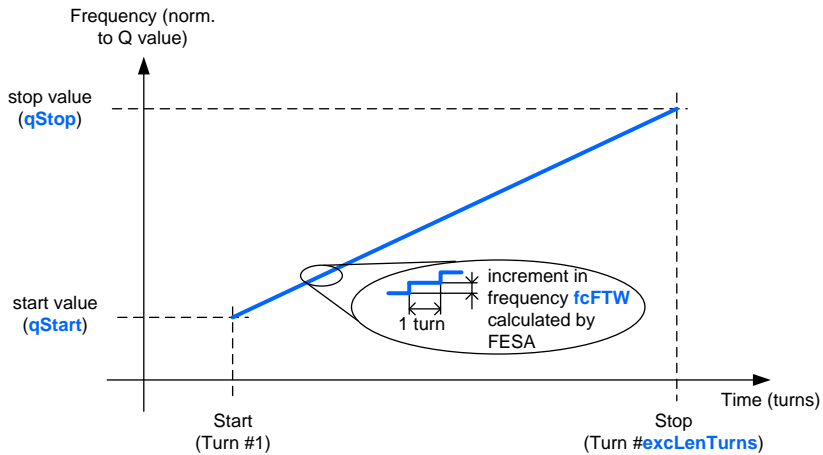
- **Input from the machine protection!**
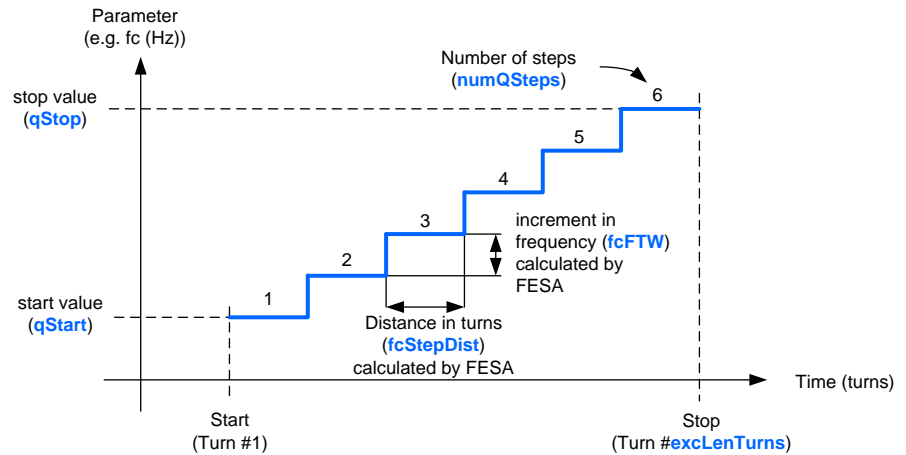
Abort gap & Injection gap cleaning

Fixed frequency excitation mode

Frequency (norm. to Q value)
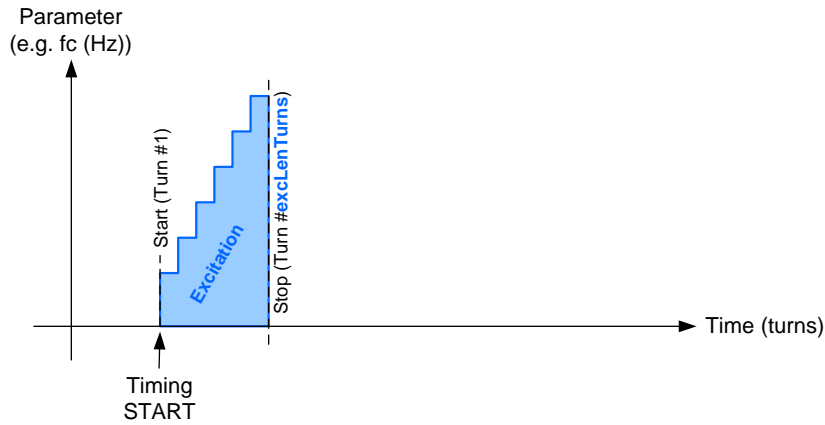
start value (**qExc**)

Start (Turn #1)

Stop (Turn #**excLenTurns**)

Time (turns)

Continuous frequency excitation mode

Frequency (norm. to Q value)

stop value (**qStop**)

start value (**qStart**)

increment in frequency **fcFTW** calculated by FESA

1 turn

Start (Turn #1)

Stop (Turn #**excLenTurns**)

Time (turns)

Stepped frequency excitation mode

Parameter (e.g. fc (Hz))

Number of steps (**numQSteps**)

stop value (**qStop**)

start value (**qStart**)

1 2 3 4 5 6

increment in frequency (**fcFTW**) calculated by FESA

Distance in turns (**fcStepDist**) calculated by FESA

Start (Turn #1)

Stop (Turn #**excLenTurns**)

Time (turns)
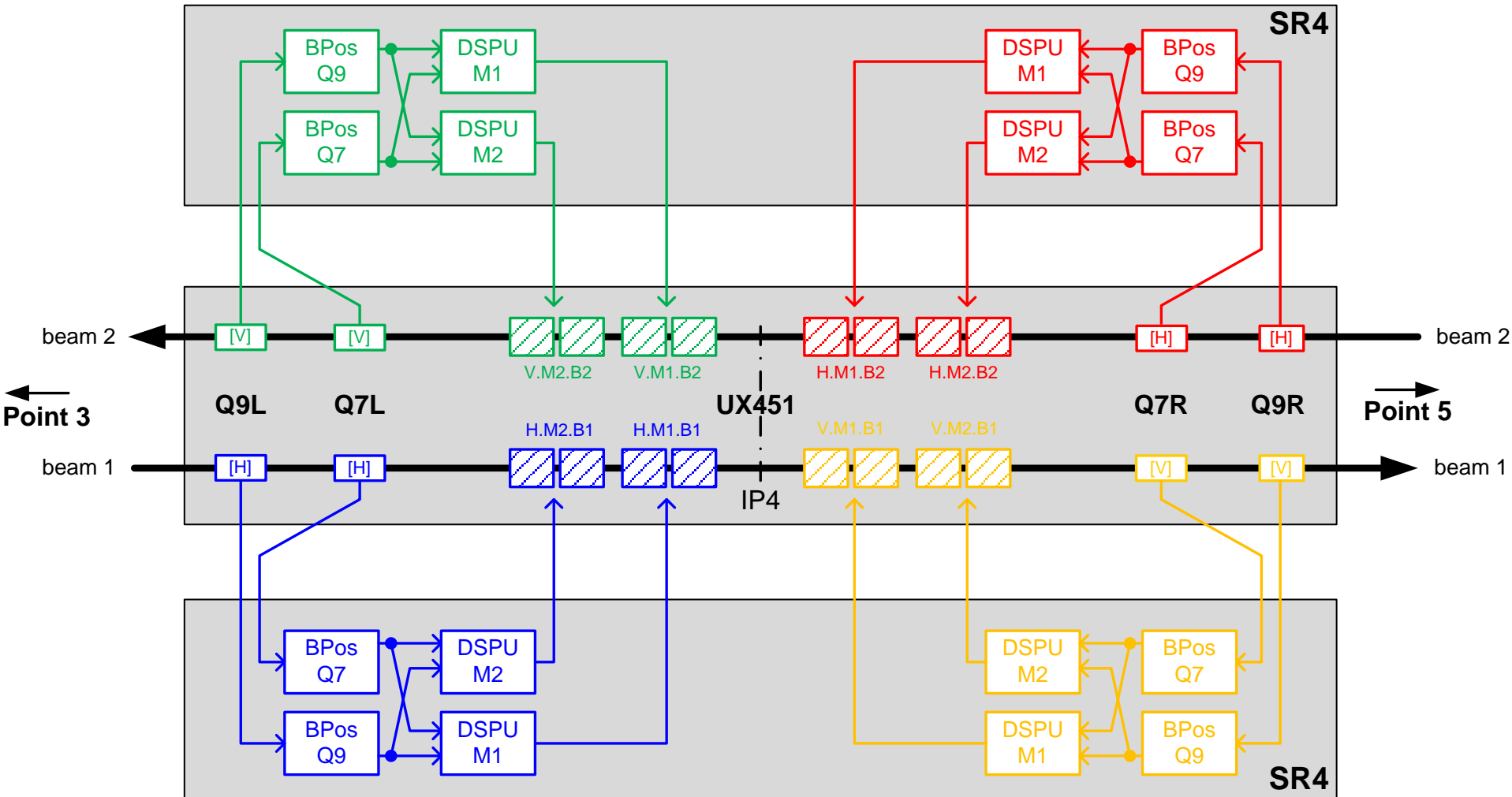
Cleaning sequence
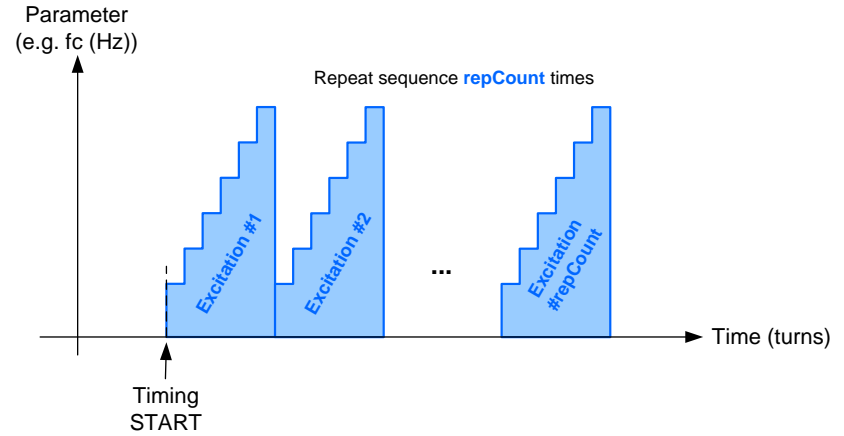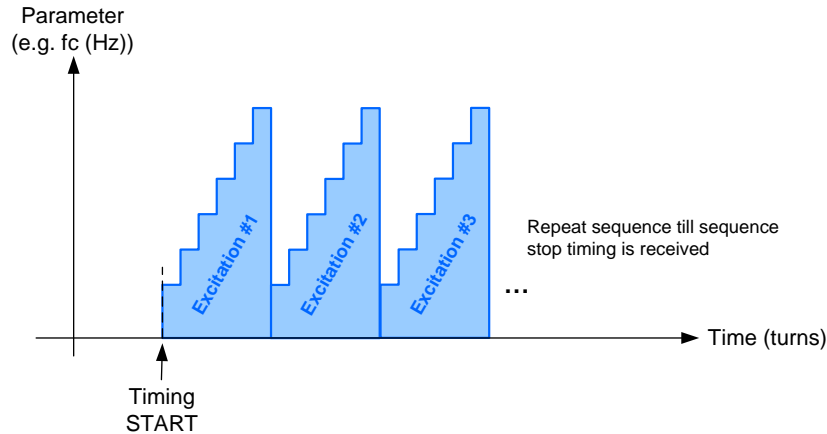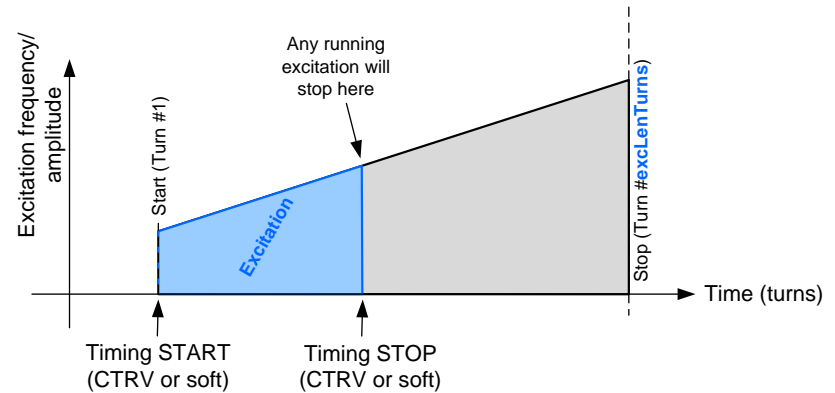
ADT layout in the machine

Bpos – Beam Position Module
DSPU – Digital Signal Processing Unit