

AC-Dipole Upgrades

LHC Optics Measurement and Corrections review
17-19 June 2013 - CERN

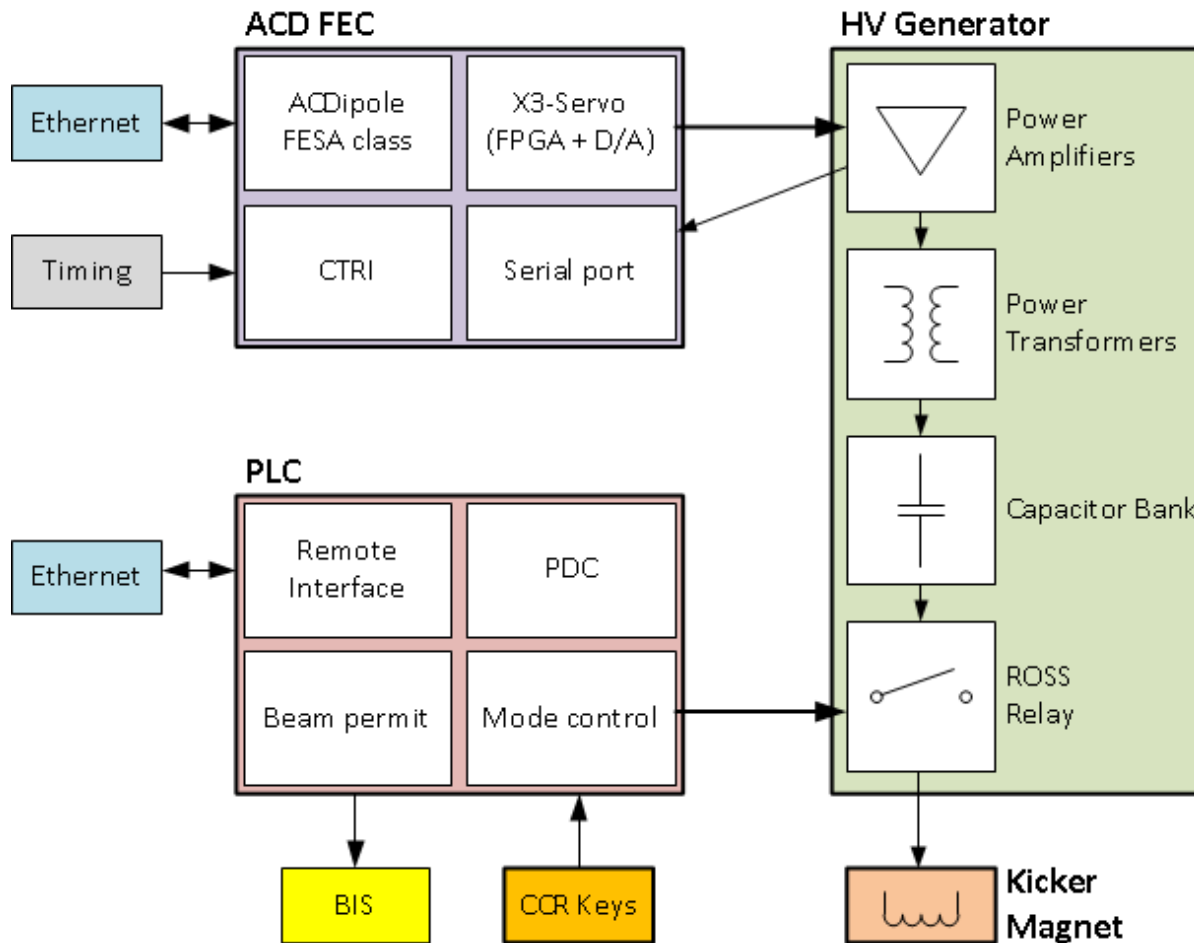
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Thanks to E.Carlier, R.A.Barlow, J.Uythoven

Plan

- AC-Dipole overview
- Changes already done in 2012
- Upgrades already planned for LS1
- Improvements requested
- Other improvements ?

AC-Dipole overview

Simplified block diagram



ACD FEC :

- ACDipole FESA class for settings/state control
- Timing event for trigger
- X3-Servo card to generate the waveforms
- Serial port to check power amplifiers configuration

PLC :

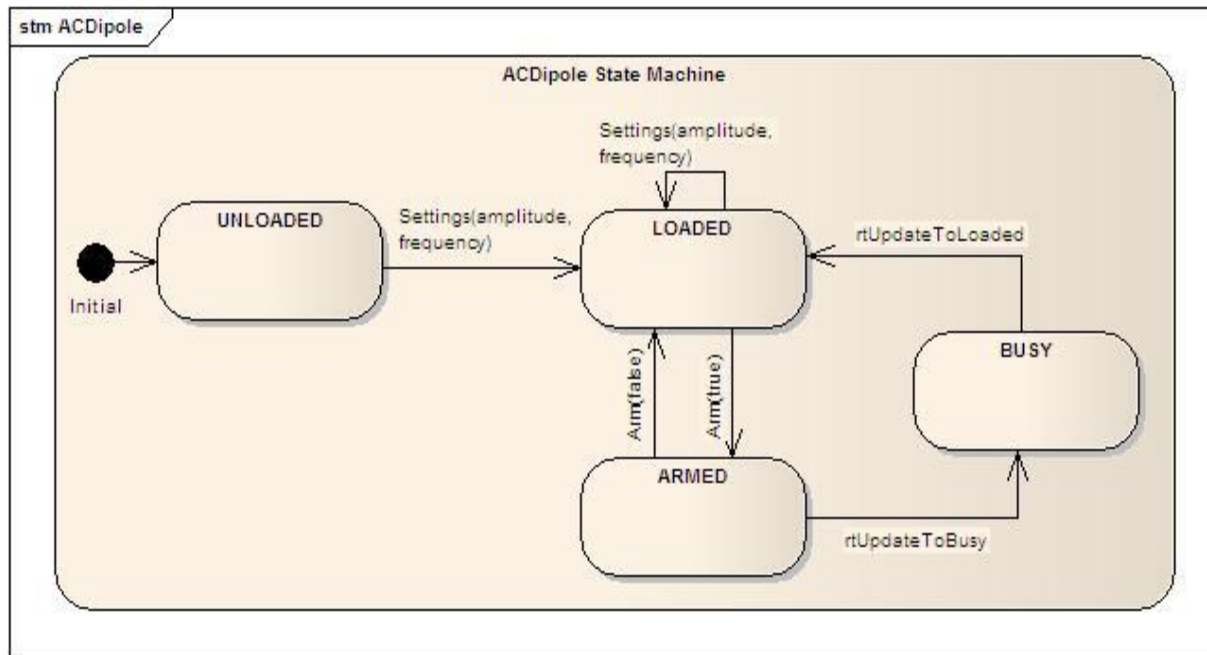
- Mode control (CCR keys)
- Beam permit control (BIS)
- ROSS relay control
- Power distribution control

To operate AC-Dipole :

- CCR keys on mode 'AC'
- 'Safe beam' flag present

AC-Dipole overview

ACDipole FESA class states



Courtesy: I. Kozsar

Operational sequence :

- 1) **Load** the settings (Amplitude, Frequency)
- 2) **Arm** the system
- 3) **Trigger** the system (ACD timing event)
- 4) **Wait for 1min**
- 5) Load new settings or Arm again...

The system is **blocked** in 'BUSY' state **for 1 minute**

=> Not possible to pulse the AC-Dipole more that 1p/min

AC-Dipole overview

Some pictures... (before LS1)



AC-Dipole installation at point 4 (UA43)



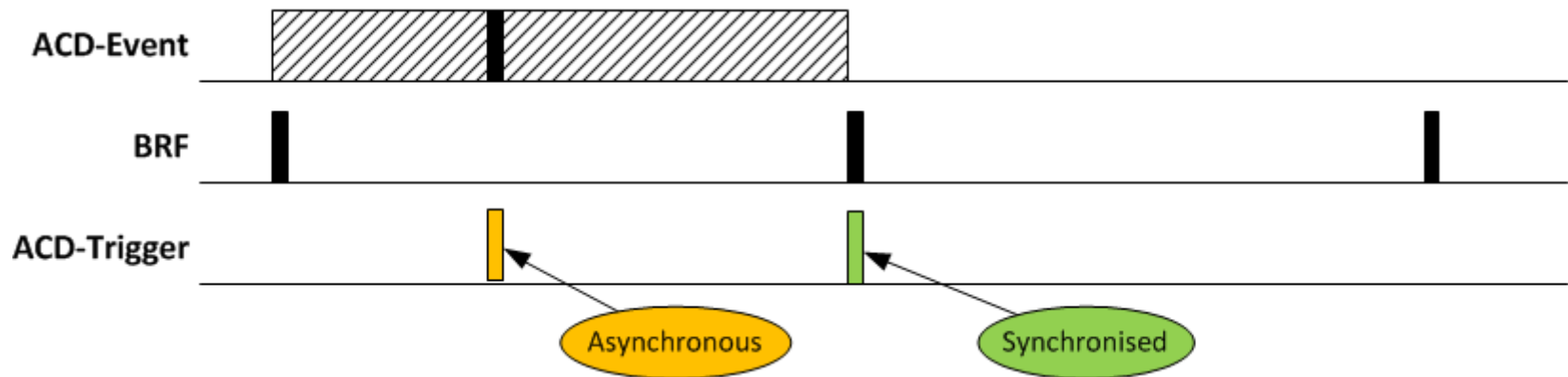
Mode control keys in CCR



ACD FEC located **inside** HV generator

Changes already done in 2012

Synchronisation with BRF



Problem: ACD timing events are asynchronous w.r.t. beam.

=> **Impossible to average consecutive BPMs acquisitions**

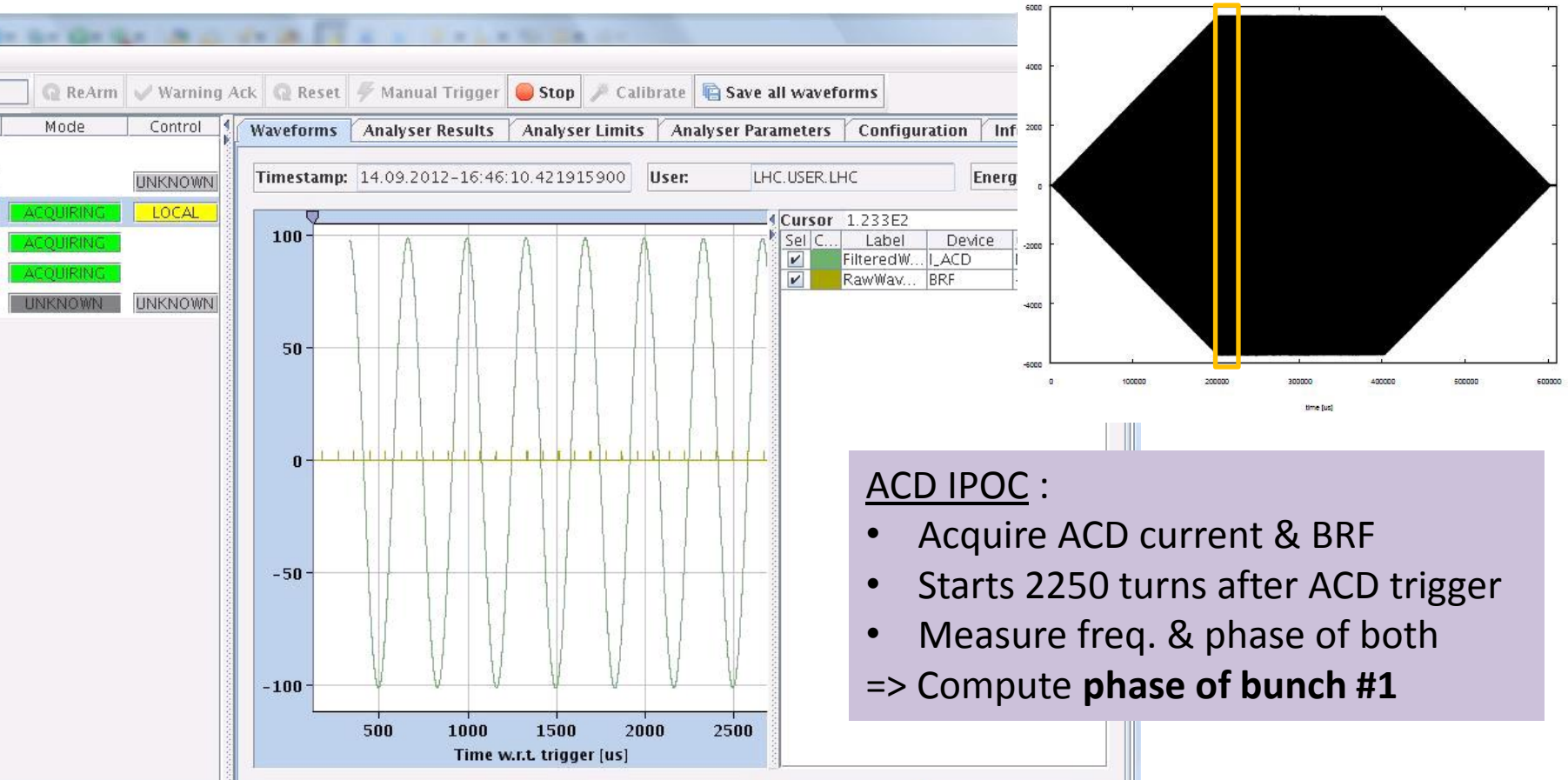
Solution: ACD trigger is generated on first BRF pulse following AC-Dipole timing event.

=> BPMs measurements show that now **the phase is constant** from one acquisition to another: **Average is possible.**

BUT: Still problem of synchronisation w.r.t BPMs (1 turn shift sometimes)

Changes already done in 2012

ACD IPOC system to measure the phase



ACD IPOC :

- Acquire ACD current & BRF
 - Starts 2250 turns after ACD trigger
 - Measure freq. & phase of both
- => Compute **phase of bunch #1**

Still some test/improvements to do but phase measurement should be **available after LS1**

Upgrades already planned for LS1

- ACD FEC moved outside the HV generator and normalised:
 - ⇒ ACD FEC will be a 'standard' BE/CO FEC, and away from high power devices.
- New IEPLC communication between PLC and ACD FEC:
 - ⇒ We can pulse in LOCAL without having to call CCC to insert the AC-Dipole keys and send the timing events.

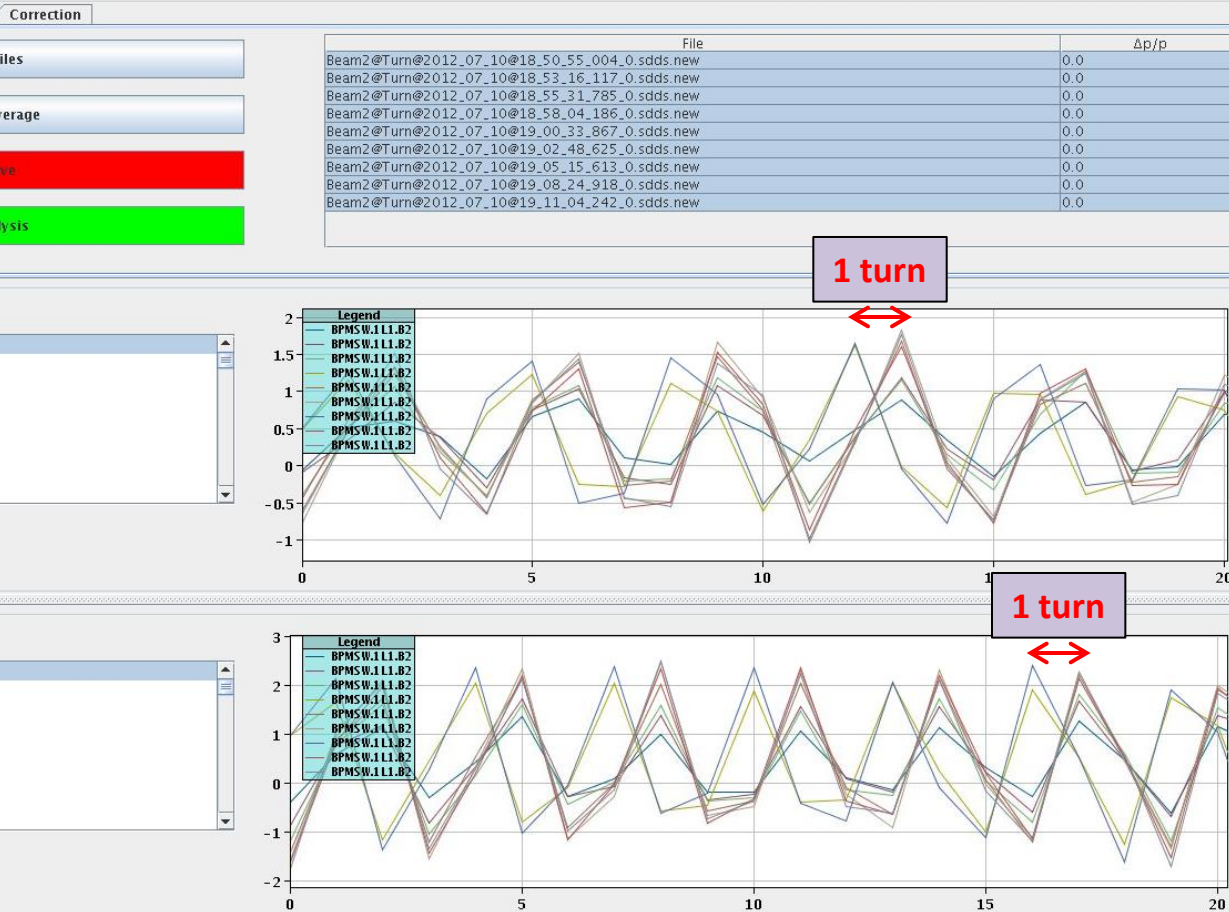
=> No functional changes impacting on operation.

Improvements requested

Problem of synchronisation with BPMs

Model selected : test1

LHCb2 Memory used: 281 Mb / 1067 Mb



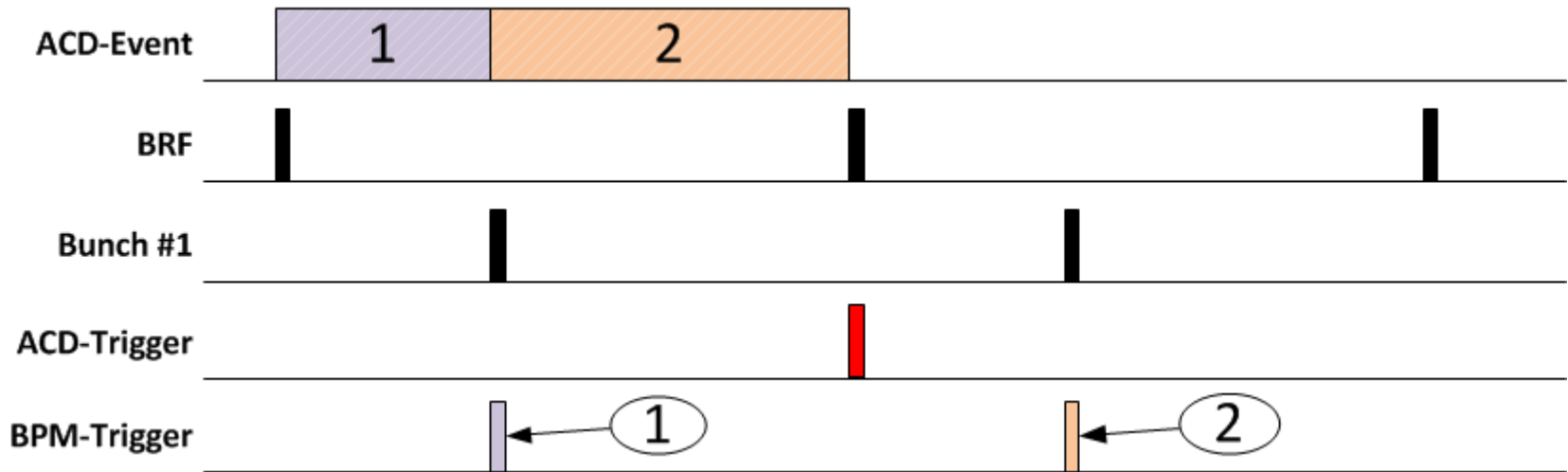
Consecutive acquisitions are **synchronised...**

BUT:

Sometimes **1 turn shift** seen on BPMs.

Improvements requested

Problem of synchronisation with BPMs (2)



Possible explanation : **BRF in point 4** is not aligned with passage of **bunch #1**

=> **2 cases**: ACD-Event comes **before / after** passage of bunch #1

=> **1 turn shift** between these two cases

Possible solution : Delay BRF in point 4, so it is aligned with passage of **bunch #1**

Improvements requested

Problem of synchronisation with BPMs (3)

If this explanation is correct, statistics should confirm it:

Delay BRF – Bunch #1 in point 4:

- Beam 1: **X us** => **aa %** of case 1 vs case 2
- Beam 2: **Y us** => **bb %** of case 1 vs case 2

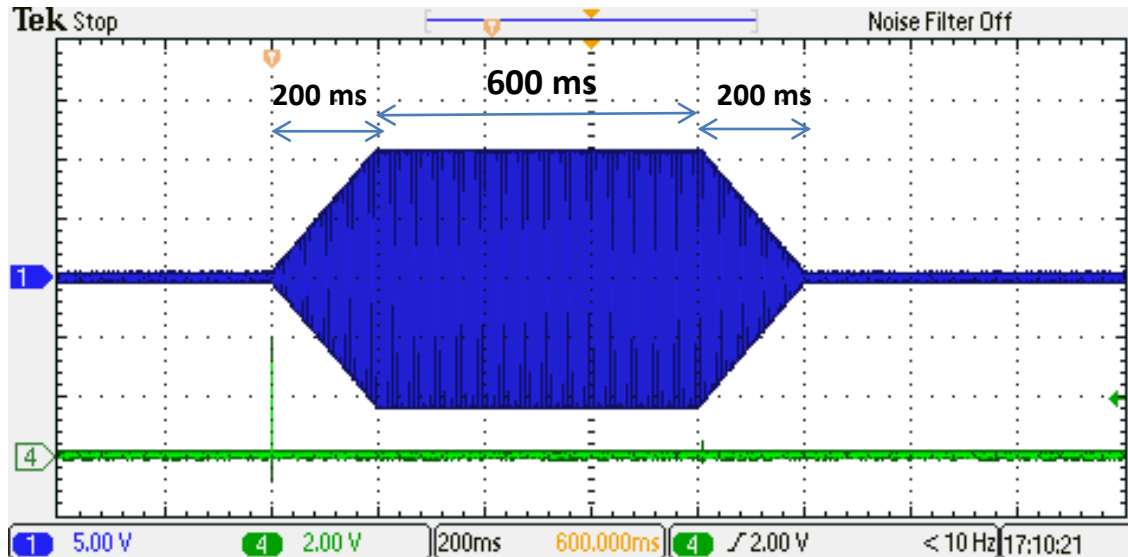
Questions:

- How BPMs are triggered ?
- BPMs analysis software should detect/correct this case ?

=> Needs more studies to properly understand this problem...

Improvements requested

Increase the flat top length to >400ms



Waveform tested :
Up to **600ms** Flat-Top
(Maximum **1s** overall)

To be validated: The heat dissipation with longer pulse ?

Only software library to release => **Could be done during LS1**

Improvements requested

Pulse at higher rate than 1p/min

Problem :

- Potential heating problems in high power components (relays, transformers,...).

Actual solution :

- Pulse rate limited to 1 pulse/min (**based on worst case** power dissipation)

Better solutions ? :

- No pulse rate limit but Interlock on temperature measurement
- Pulse rate depending on settings (strength/length)
- More ideas ?

Hardware (X3-Servo) limited to 1 pulse/min => Needs **Firmware & Software updates.**

Needs more studies + lots of changes => **Probably not during LS1**

Other improvements ?

- 50Hz component measured on BPMs :
 - Is it coming from AC-Dipole ?
=> We will perform measurements magnet current.
- Amplitude settings in **kA** instead of **% of full-scale** :
 - Kicker current would not depend on frequency
=> Is it interesting for operation ?
- **ACD IPOC interlocks** if measured kicker current magnitude or phase w.r.t. beam is not as expected :
 - Malfunctioning of AC-Dipole should be detected by TE/ABT control system, not by BE/ABP measurements...
- Any more requests ? 😊
 - Let's discuss them...

Summary

Upgrades already planned for LS1:

⇒ **No impact on REMOTE operation**

Requested improvements:

1) Synchronisation with BPMs:

⇒ Needs more studies but **we must find a solution during LS1...**

2) Extension of Flat-Top to >400ms

⇒ Needs more tests/validation, but should be **possible during LS1**

3) Increase pulse rate:

⇒ Needs studies, lots of changes, **probably not possible during LS1**