REPORT ON RF RAMPING TESTS (WEEK 42)

-what was the aim?

-how was it set up?

-what was the program?

-what did we really do?

-what did we learn?

-why we want to do another one

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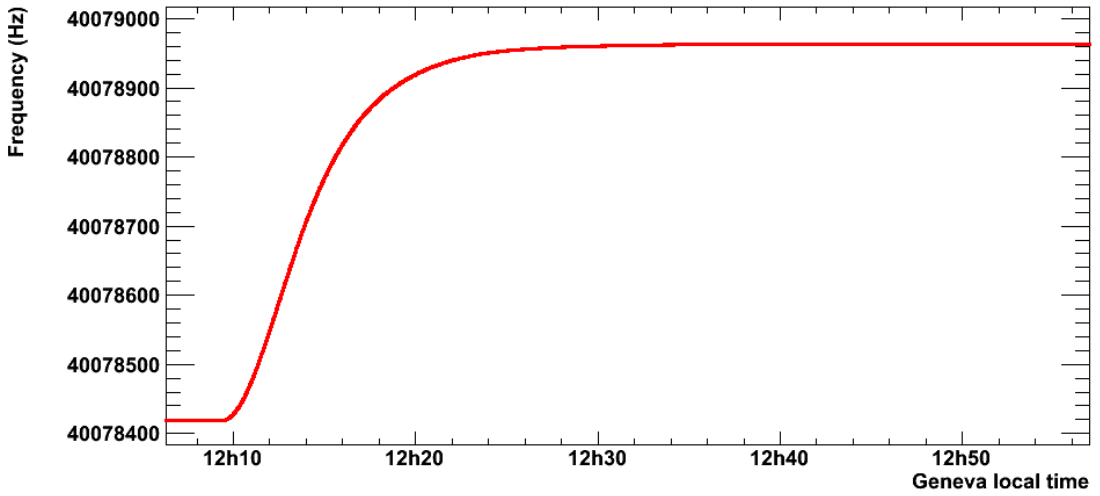
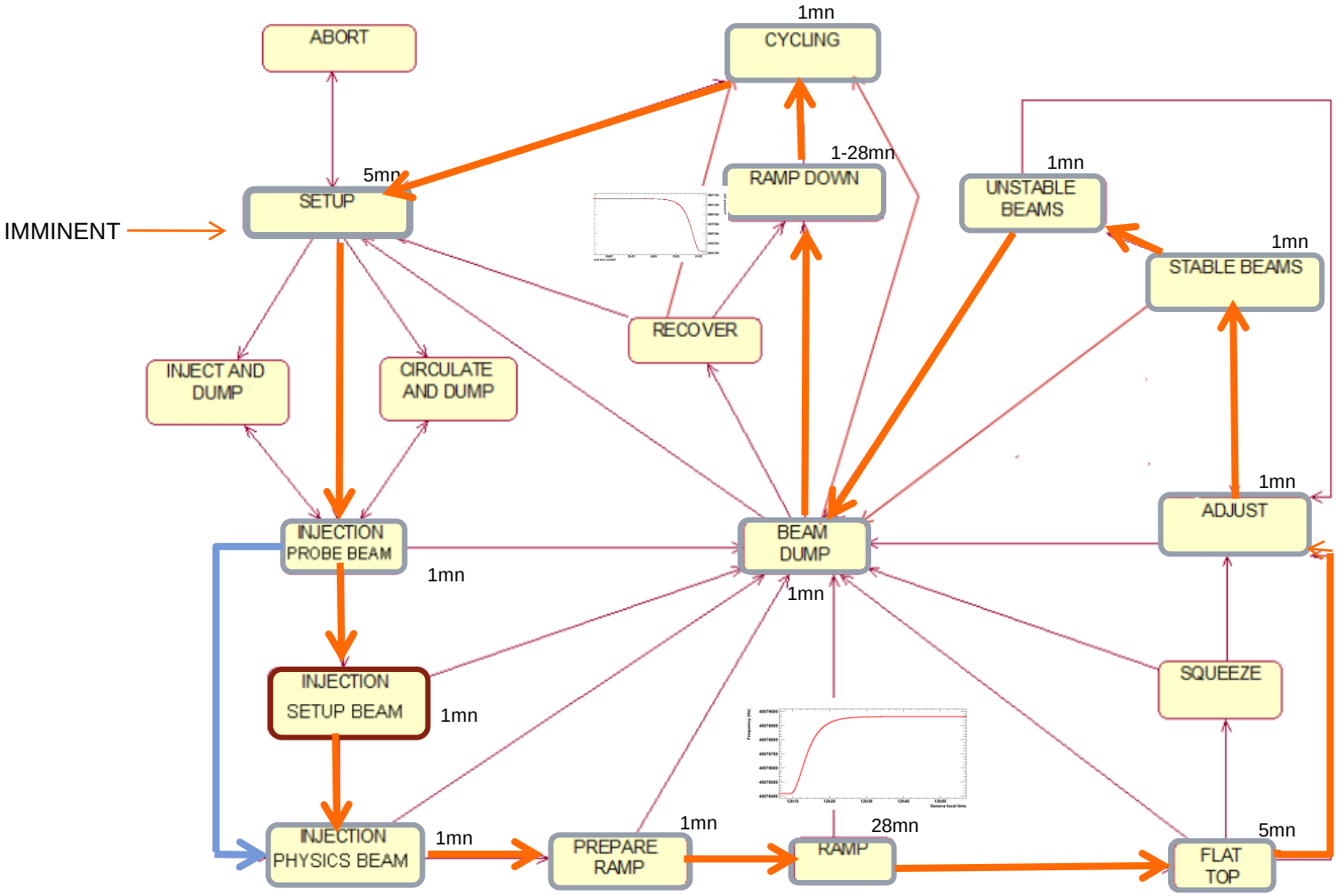
What is a ramping test?



- Realistic sequence of Beam Modes simulating a basic LHC hypercycle **focusing on the RF frequency**
- RAMP mode: Slowly increase the RF frequency to simulate beam acceleration from 450GeV to 7TeV
- RF frequency follows the '**frequency program**' controlled by operation and integrated in the sequencer
- Two separate frequency functions per particles type
  - RF ramp for **Protons: 864 Hz** (400.788790 MHz – 400.789654 MHz)
  - RF ramp for **Ions: 5441 Hz** (400.784187 MHz – 400.789628 MHz)
- The experiments receive the Bunch Clock = RF/10

RAMPING TEST HYPERCYCLE



Why is it useful? [1]

- RF:
  - test the hardware, firmware and software in real conditions (controlled by operation)
  - Validate latest firmware releases
- OP:
  - Use the frequency program in the framework of the sequencer
  - Better know the reaction of the RF system to the actions sent by operation via the sequencer
  - Progressive integration of handshakes and SMP to test the procedures
  - Adjust the shape of global frequency cycles (when and how to perform the ramp down and the resynchronisation)

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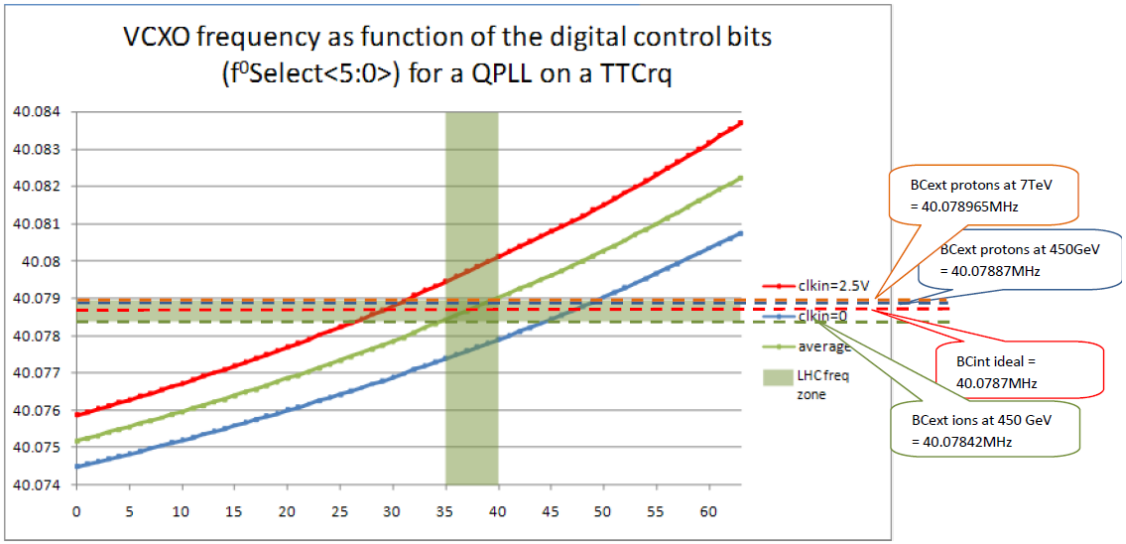
WHY IS IT USEFUL? [2]

Experiments:

- Run the detectors electronics with typical frequency cycles
  - Particular cases of QPLLs are watched (digital locking range of 7kHz, Analogue locking ranges of about 2kHz)



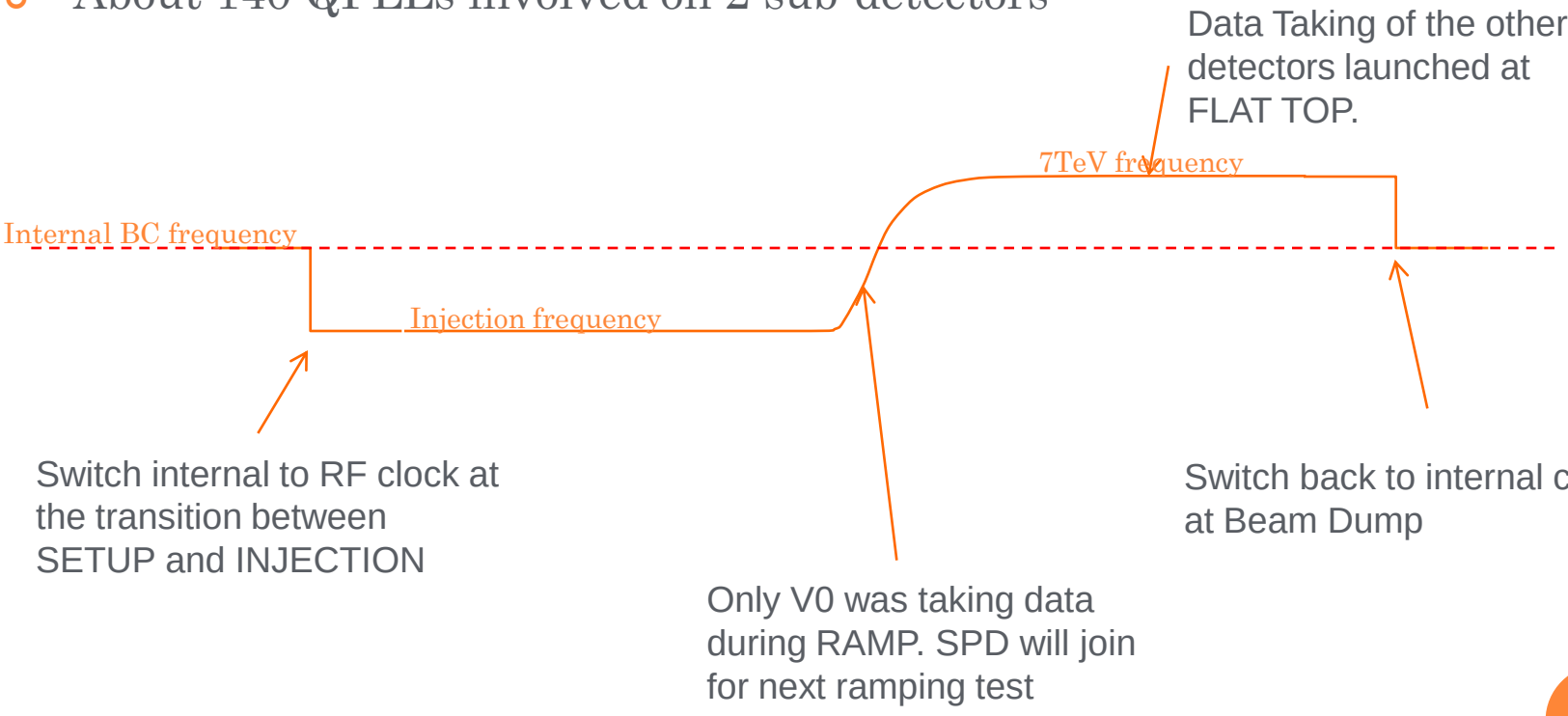
  - Understand the behaviour of detectors during clock changes (ramping, 'dump', resynchronisation)
  - Even if data taking during ramping will not be mandatory during stable runs, experiments will try to do it for the first beams if possible (especially as the Bcref is not available yet).
- Adjust their strategy in term of clock switching, start of data taking, QPLLs resetting procedures.

How was it set up?

- Home made hypercycles are prepared before the tests by operation including Beam Modes and frequency programs (Reyes, Delphine)
- The sequences are controlled by the operators at the CCC, with support from RF and TTC people. The RF is checked on site (SR4), the timing signals are monitored by the TTCpage1 tool (CCR) and followed by the 4 experiments.
- The experiments have the choice to run with internal Bunch Clock or with the RF Bunch Clock.

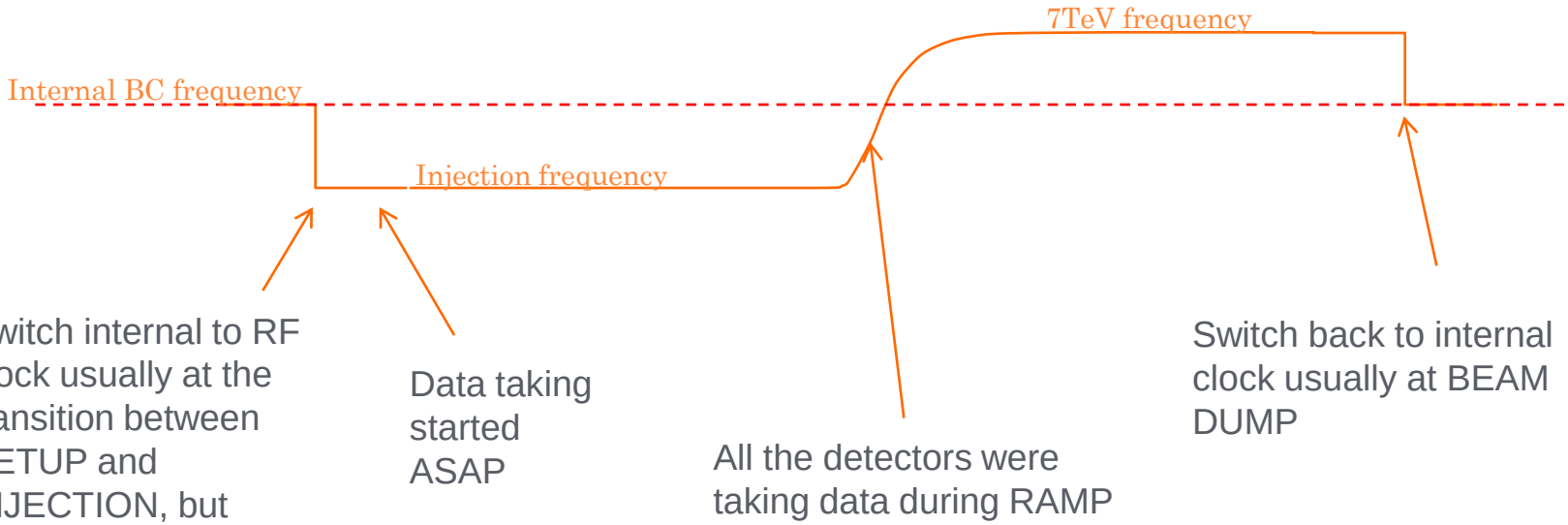
ALICE

- 7 sub detectors out of 17 present during the tests (ACORDE, PHOS, SPD, SSD, TPC, TRD, V0)
- About 140 QPLLs involved on 2 sub-detectors



ATLAS

- 95% of the detector in global run @ 30kHz
- New procedures for QPLL initialisation for TRT and Lar
- 1000s of QPLLs
- Careful check of data corruption
- Accurate frequency monitoring (GPS based) every second



CMS

- Detector still recovering, running on local clock
- However, the CMS clock monitoring system followed the RF clock

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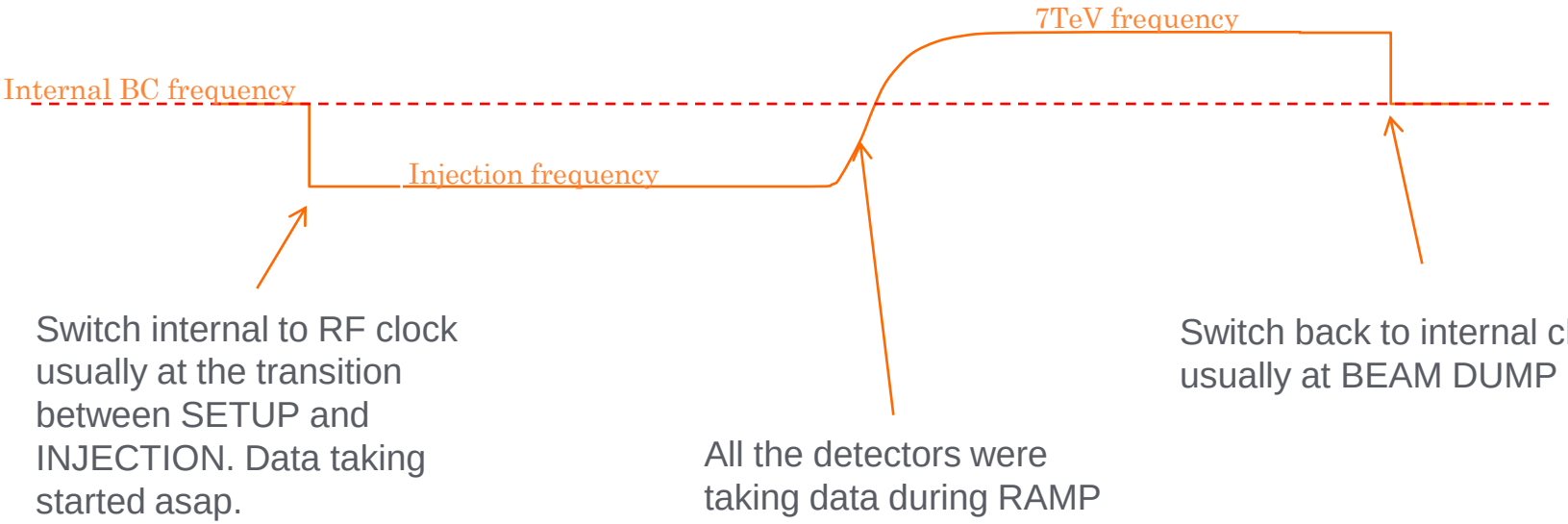
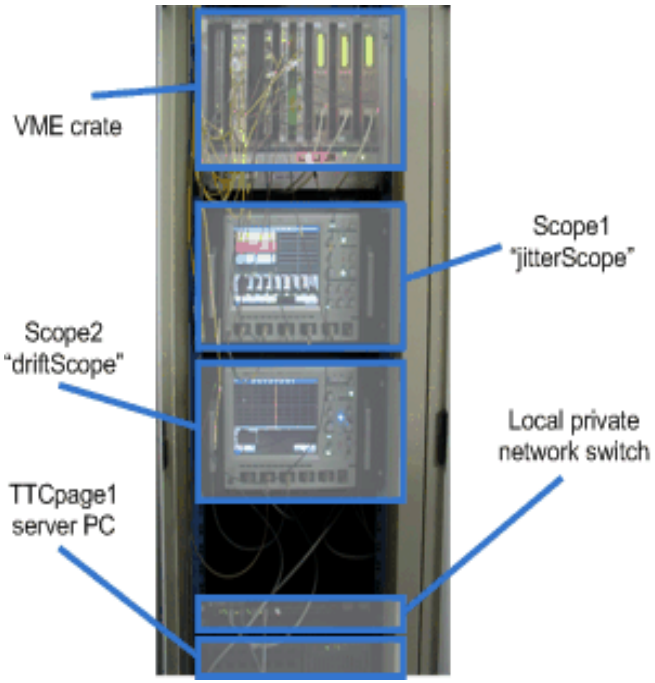
LHCb

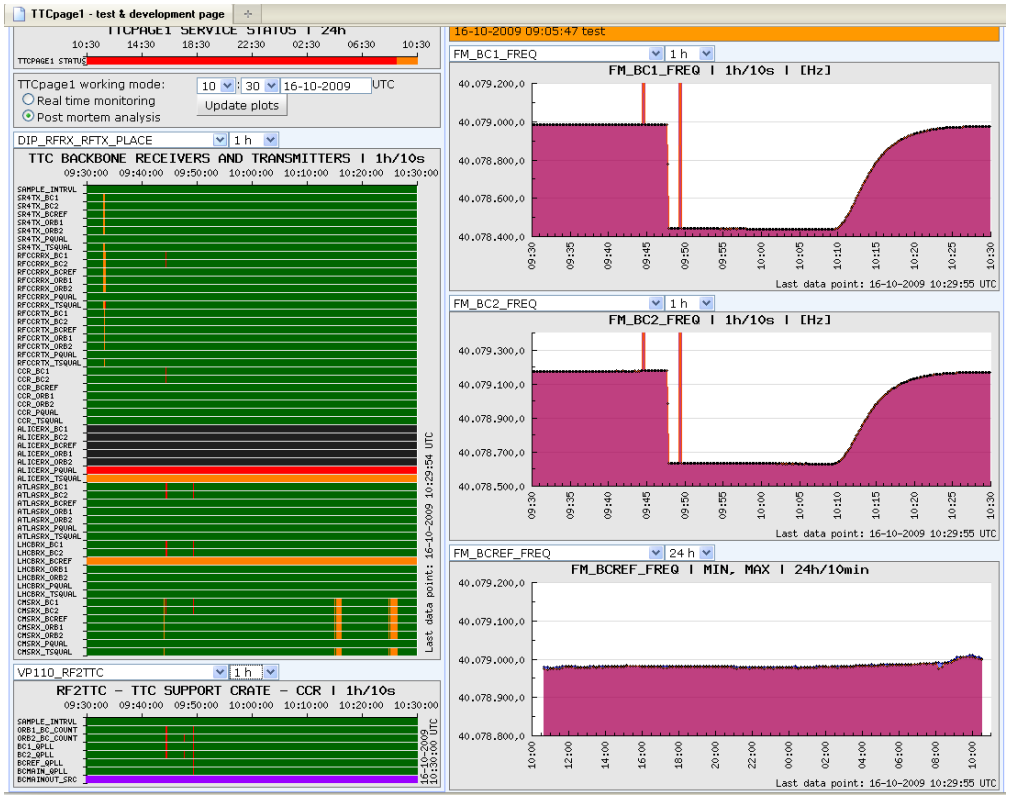
- Full detector was running in standalone on Thursday and global run on Friday
- More than 1000 QPLLs were following the ramps



TTCpage1 Monitoring System

- A monitoring system is installed in the CCR and publishes a status of the system every 10s on a webpage (http://cern.ch/ttcpage1)

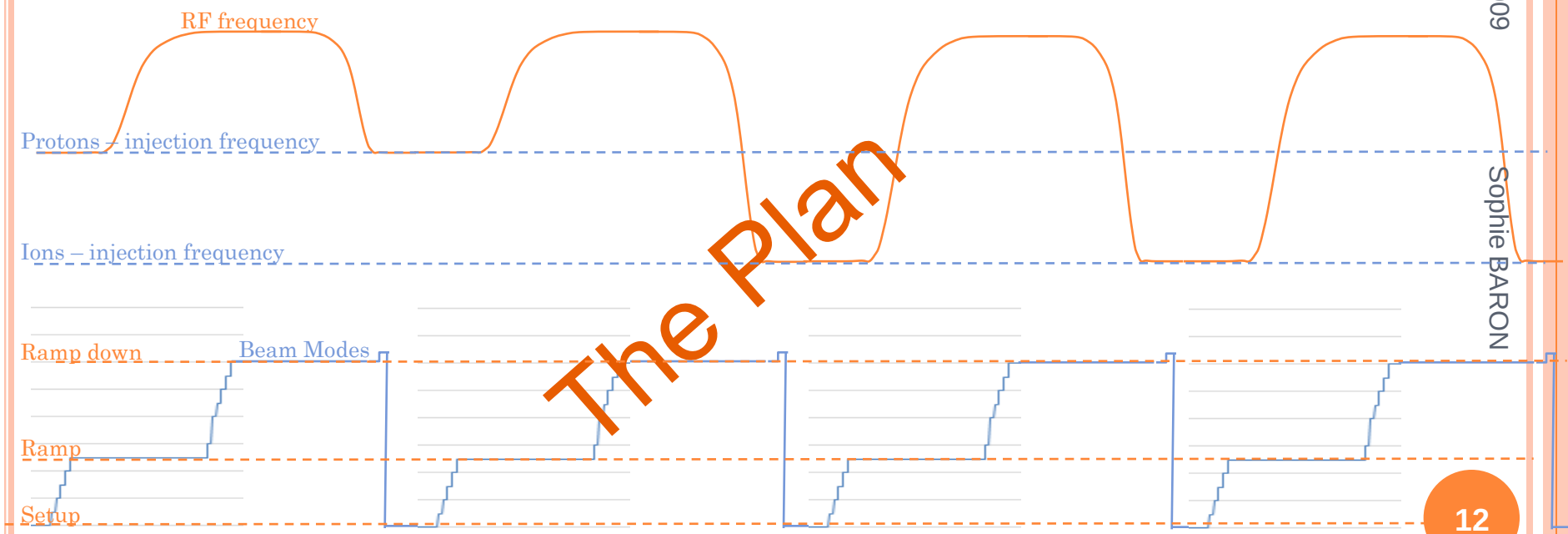




Program of week 42 – Thursday 15

Thursday 15th of October, 14:00 18:00: Simple RF ramping tests + Beam Modes (with no abrupt changes of the RF : **slow ramp down** and **no RF resynchronization to avoid bothering the experiments electronics**)

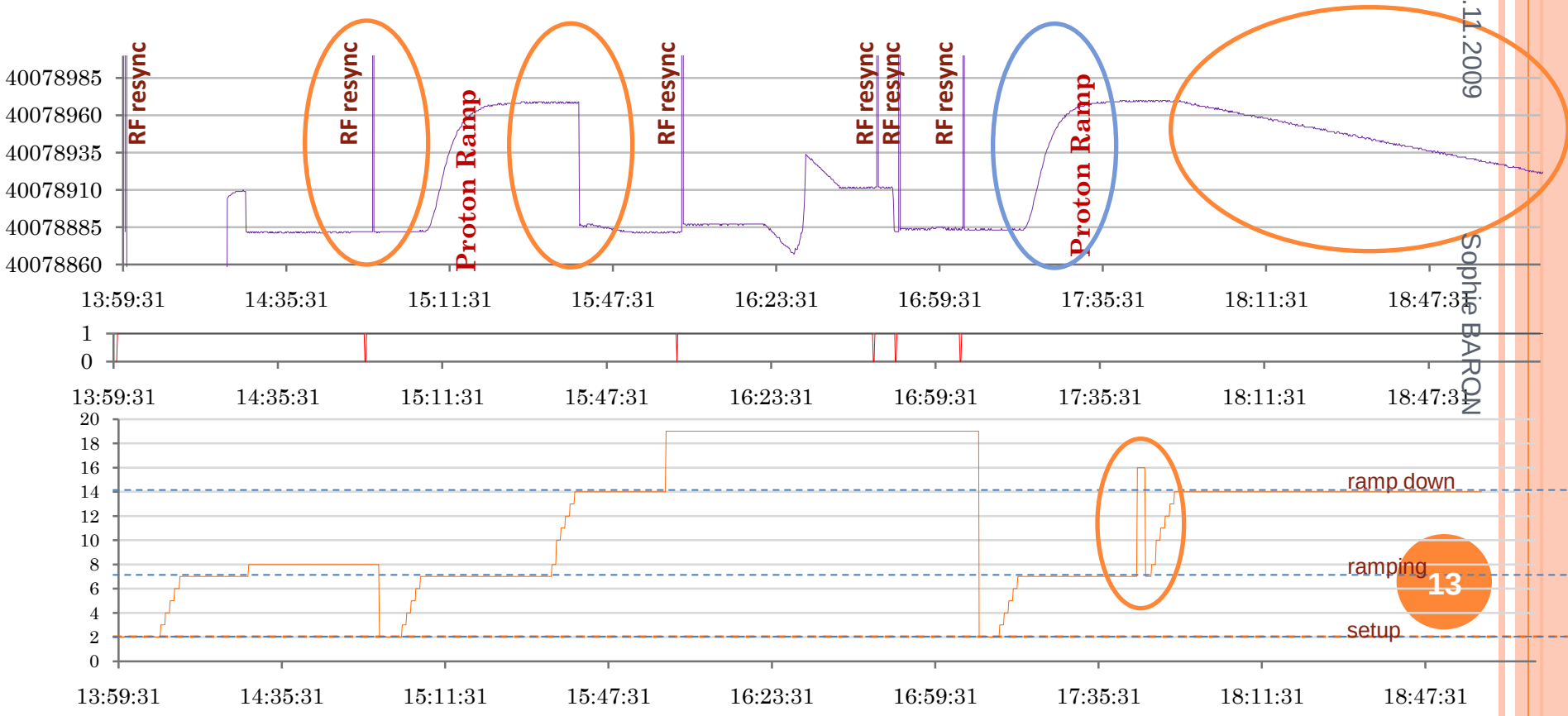
- 14 :00: Simple Ramp 7TeV Protons
- 15 :00: Simple Ramp 7TeV Protons
- 16 :00: Simple Ramp 7TeV Ions
- 17:00: Simple Ramp 7TeV Ions



Program of week 42 – Thursday 15

Thursday 15th of October, 14:00 18:00: Simple RF ramping tests + Beam Modes (with no abrupt changes of the RF : **slow ramp down** and **no RF resynchronization (sic)**)

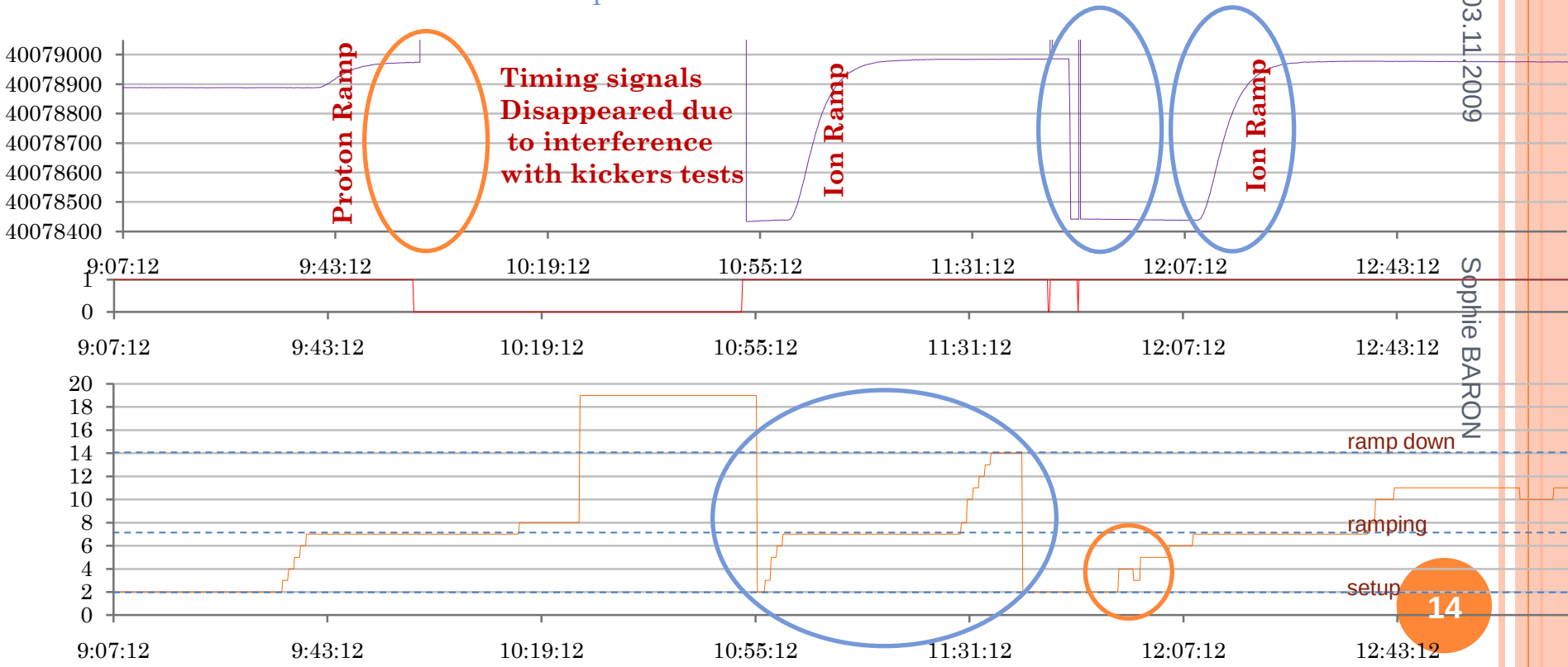
- 14 :00: Simple Ramp 7TeV Protons
- 15 :00: Simple Ramp 7TeV Protons
- 16 :00: Simple Ramp 7TeV Ions
- 17:00: Simple Ramp 7TeV Ions



Program of week 42 – Friday 16

Friday 16th October, 9:00 - 14:00 : Simple and combined RF ramps (without and with RF resynchronization)

- 9 :00: Simple Ramp 7TeV Protons
- 10 :00: Simple Ramp 7TeV Ions
- 11 :00: Combined Ramp 7TeV Protons
- 12 :10-13 :20 : Combined Ramp 7TeV Ions



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Data extracted from the TTCpage1 monitoring webpage

Lessons learned [1]

Most of the unexpected events happened due to the fact that the hypercycles were custom.

All of these expected and un-expected events taught us:

- A 'resync' (aka 1ms gap) indeed lasts ...9s. The RF was contacted about that and confirmed. This is due to the sequence of commands applied to the beam control system, which includes a stop of the Master40MHz.
- All the present experiments reported a very smooth behaviour of their electronics during both protons and ions ramps (even with Data Taking ON).
- Sudden events on clock are not so badly handled by experiments:
  - A resync or a clock switching is very well handled when the DAQ is OFF (<=10mn of recovery).
  - An unexpected brutal resync, change or loss of clock during data taking is not so problematic, even if it may induce data corruption (thanks to the unexpected events!)
- Ramping down the frequency was not very easy (it was not implemented on the sequencer and was done by setting frequency values asynchronously).

Lessons learned [2]

- In the future, we propose to keep the RF at the high energy value until we reach back the new SETUP mode. And we will gather all the 'dirty actions' on RF during SETUP following the procedure below:
  1. Application of 2 very different frequencies on BC1/Orb1 and BC2/Orb2 to identify BC1 from BC2 (request from the kickers)
  2. Set up of the new RF value for the next run
  3. Resync of the RF system
- The clock disappearing on Friday morning was due to an overlap of two tests. This underlined a very conservative procedure applied by the RF firmware, which is going to be moderated.
- Combined tests (including handshaking and SMP) were very appreciated both from experiments and operation point of view. It was not blocking the ramping tests, as it was manually controlled on the operation side, and could be skipped if required.
- On the TTC support point of view, it helped us a lot to build our knowledge on the behaviour of the full system and on how to analyze the results we get.

Future plans

A new RF ramping would be required within the next few weeks:

- From the RF to validate latest firmware releases
- From the OP to finalize the sequence (include all the actions on RF during setup)
- From the experiments to:
  - allow the missing detectors to join the test (in particular CMS and some ALICE detectors).
  - Gain expertise and accumulate statistics on QPLLs locking ranges and start-up procedures.
  - Get ready to take data as soon as there is beam, even during ramping if possible.
- It is scheduled for the 13th of November (Friday)

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Many thanks to:
OP: Reyes, Delphine, Eric, Verena,
RF: Andy, Philippe, Gregoire,
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ATLAS: Thilo,
CMS: Jan, Andre, Jeroen
LHCb: Richard