LHC Fast Timing Commissioning

P. Baudrenghien AB/RF

S. Baron PH/ESE

- Reminder
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Reminder

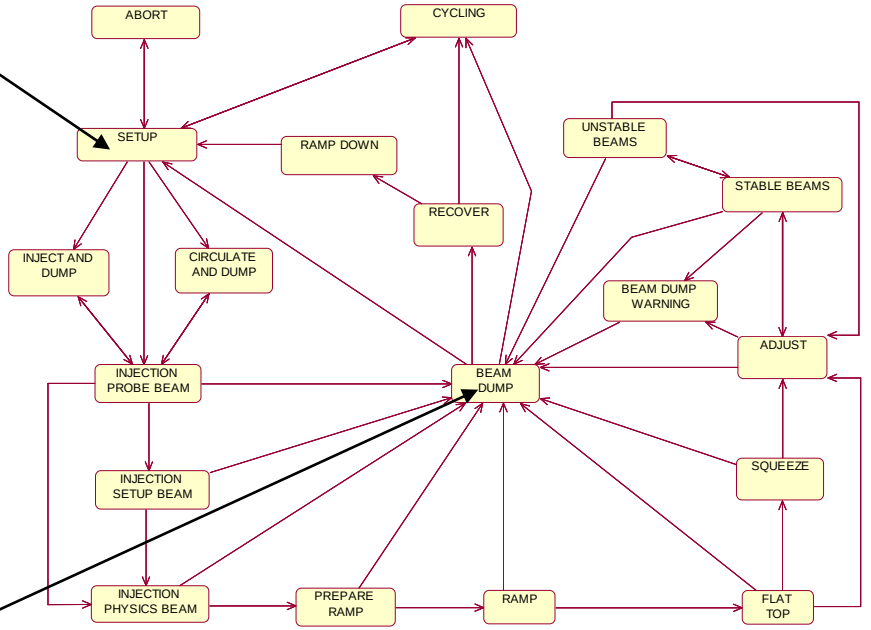
- BC1 and BC2: For each ring the Bunch Clock is a square wave at the RF frequency divided by 10. Its rising edge has a fixed delay w.r.t. bunch passage. This delay is reproducible from run to run. When present BCx is always locked to the corresponding beam.
- Orbit1 and Orbit2: For each ring the Orbit is a train of 5 ns long pulses at the Revolution Frequency. The pulse has a fixed delay w.r.t. passage of a bunch in bucket 1. This delay is reproducible from run to run. When present Orbitx is always locked to the corresponding beam.
- For each ring, bucket 1 is the first bucket after the 3 μs long abort gap (defined from bucket 34442 to 35640)
- Two bunches in buckets 1 of the two rings collide in IP1 (and IP5)

Reminder (cont'd)

- BCref: The reference bunch clock is a square wave at a fixed frequency equal to the collision RF frequency divided by 10.
  - It is locked to the beam during collisions only
  - During collision its rising edge has a fixed delay w.r.t. bunch passage.
  - But the equipment to rephase the beam to the reference clock is **not operational yet**. In the meantime use BC1 or BC2…
  - OP wishes to fine-tune the reference frequency during physics to compensate for very slow drift in machine circumference (effect of tides,…). This will be done very smoothly (< 1 Hz/s)

The final system…

- During SETUP mode
  - All RF fcts are ramped to injection values (including the Frequency Program)
  - Synchro loop is closed to lock RF onto the Frequency Program
  - Bunch Clock 1-2 and Orbit Signal 1-2 are re-synchronized.This causes an interruption in the signals for < 1 ms
  - Injection set-up: Machine must go through INJECTION PROBE BEAM and INJECTION SETUP BEAM (pilot, intermediate,dump, pilot) and then finally INJECTION PHYSICS BEAM (>30 min)
  - We then move through INJECTION PHYSICS BEAM, PREPARE RAMP, RAMP, …
  - Signals are OK until after BEAMDUMP



Reproduced from LHC Modes, LHC-OP-ES-0005

The final system

- In general, after BEAM DUMP, the signals will still be there but it is not excluded that an intervention on the RF equipment interrupts them. This concerns BCref as well. They will then be re-started during the following SETUP mode (at the latest) and are guaranteed stable until BEAM DUMP.

The way it was

- BCref
  - Was at a fixed 40.078 900 MHz not related to the beam frequency
  - Was (almost) never stopped. Only when rebooting the VME crate
  - Was derived from a commercial Signal Generator at 400.789 MHz driving the Divider-by-10

The way it was

- BC1 and BC2
  - Were always at the same frequency (except when one loop would unlock…).
    - First 40.078 878 MHz
    - Then 40.078 893 MHz from Sept 10, 19:30
    - Then 40.078 896 MHz from Sept 11, 22:00 Capture beam 2, -0.4 mm
  - Were re-synchronized when needed: after re-boot, after opening synchro loop or for test.
  - Should have been locked with the beam…
- Orbit1 and Orbit2
  - Were always at the same frequency
  - Were re-synchronized when needed
  - Should have been locked with the beam

FAQs

- 24 typical questions asked by the experiments the last few months, and answered during a Q/A meeting last week. Examples:
  - **Setup period:**
    - Was BCref in sync with the beam during beam setup period?
    - Were BC1 and BC2 synchronous one to each other?
  - **Final system:**
    - What are the BC1 and BC2?
    - Will the BCref (and the BCs) be fixed during the flat top?
    - Which are the beam modes during which the BCs are stable?
  - **TTC internal:**
    - What happens for the output clocks when there is a change of BC source in the RF2TTC?
- Available on TTC web pages:

  http://ttc-upgrade.web.cern.ch/ttc-upgrade/New_system/RF-TTC_FAQs_sept_08.pdf
- Do not hesitate to send us any other questions:

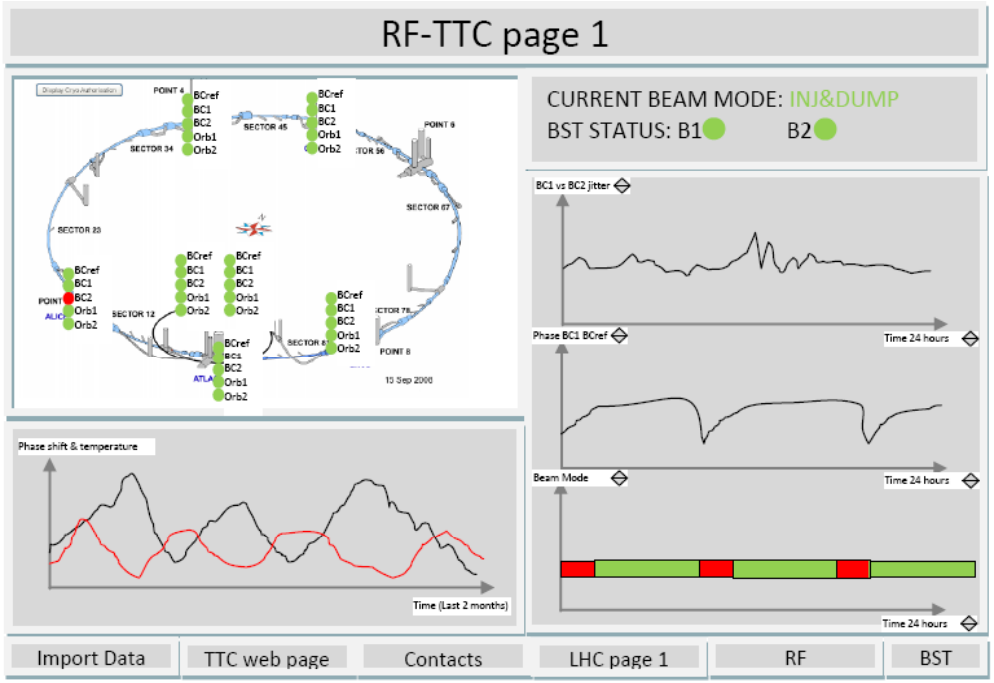
  Sophie.baron@cern.ch, Philippe.baudrenghien@cern.ch

Plans for the end of 2008

- Finish the visits of the experiments by the RF piquet team
- Schedule a RF simulation with a full ramping and slow rephasing of the Bunch Clocks, to test the electronics in experiments under these conditions. This is being organized together with RF, Operations and Experiments, probably in December.
- Collect the status of the timing signals published by the experiments via DIP

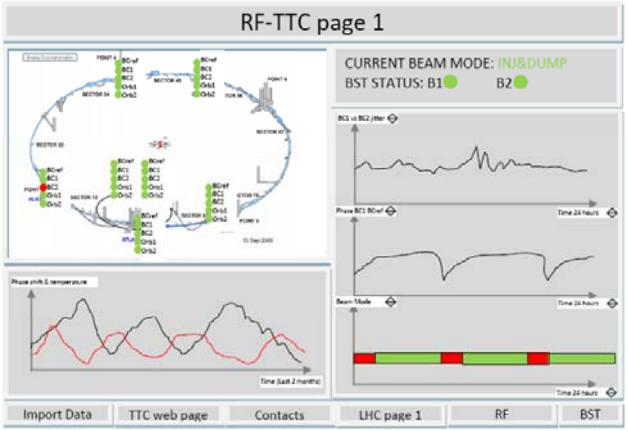
Plans for the end of 2008 (cont'd)

- Design a 'RF-TTC page1' displaying the status of timing signals in real time:



- Page updated every 10s
- Status of the full transmission chain at a glance
- Fine track of the BC frequencies
- Real time monitoring of the clock jitters and phase
- Real time monitoring of the beam modes and of the BST status
- Monitoring of the phase shift with seasonal and daily temperature variations

Plans for the end of 2008 (cont'd)



- System installed in the CCR
- A technical student, Piotr Jurga, will be there for one year to work on this project, beginning 1st of November.
- Equipment to be added to the existing setup:
  - 3 frequency meters
  - 2 Oscilloscopes
  - 1 hub
  - 1 server PC (special care on the fact that the PC will interact with several domains)
- Financed with the money left from the TTC upgrade project