Presentation Overview

This presentation will list the different issues encountered with the LHC DC BCT during 2010 and our working context and strategy during this period.

- The Difficult Context
- The Strategy
- The Observed Issues
- The Good Things

Our Difficult Working Context …

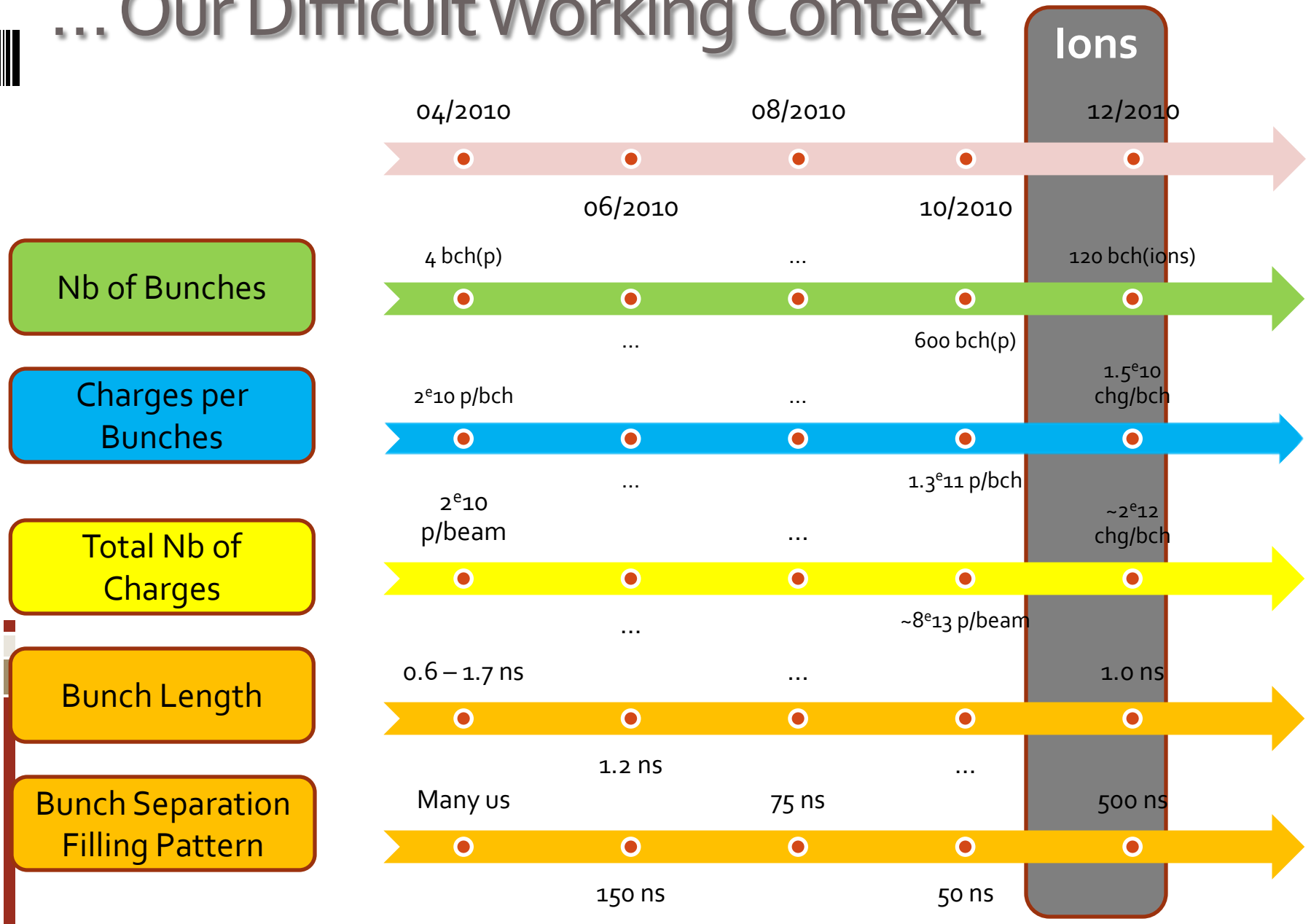
The **progress of machine** commissioning and operation (new bunch/beam intensity and filling patterns every couple of weeks) has been **incredibly fast and steady**.

Fortunately, BCT never prevented machine progress but with the consequence that we never had real opportunities for dedicated MD or access time.

In these conditions, we never had the time to analyze all arising problems or to solve them properly when we understood their source.

The following slide shows the rapid evolution of critical parameters for beam current measurements during the year. We constantly jumped from one context to another (and so, from one issue to another).

… Our Difficult Working Context



The Strategy

We quickly realized that **the DC and Fast BCT calibrations were giving different results** (by more than 5%) when facing the same beam.

So we tried to apply the following strategy: **Check, trust and fixe systems from what we believed was the most simple to the most complex**, i.e.:

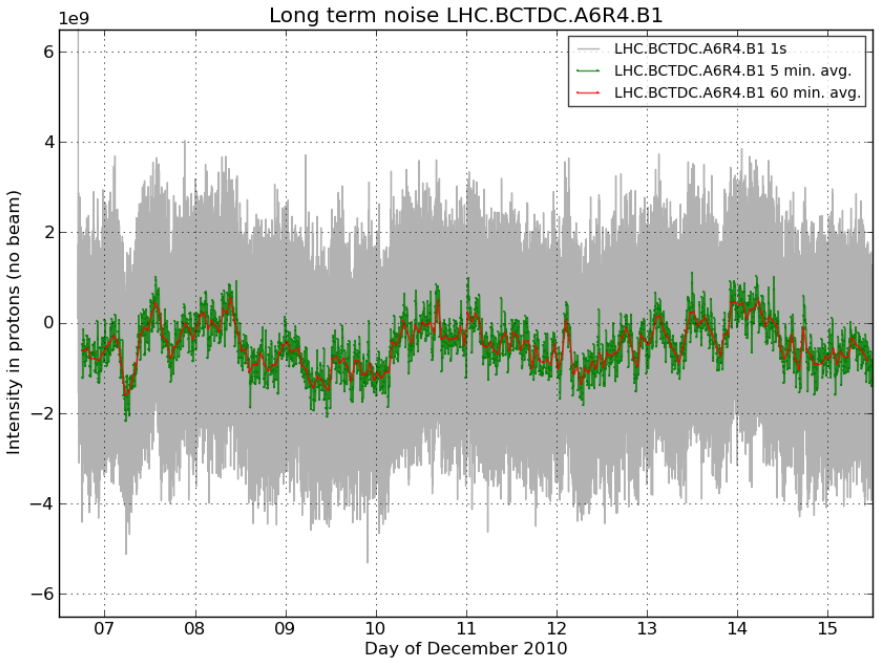
1. DC BCTs (no fast timing, no FPGA code, simple calibration procedure)
2. Fast BCT Low BW channel (complex FPGA code, complex calibration procedure, no bunch phasing necessary, no 'tail' response signal issue)
3. Fast BCT High BW channel (complex FPGA code, complex calibration procedure, accurate bunch phasing necessary, sensitive to tail signal)

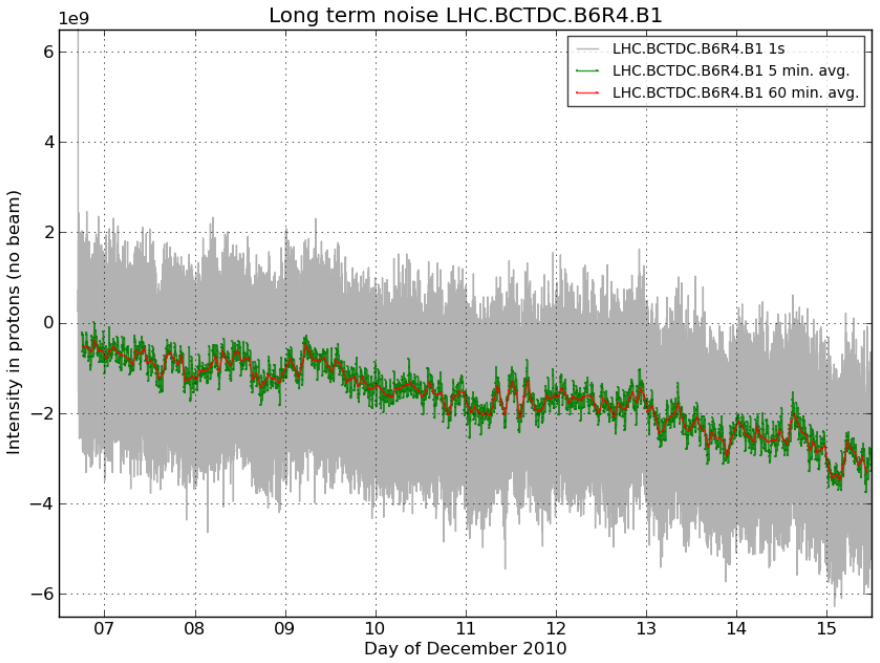
We used the BCT DC to cross-calibrate the 2 others and monitored the possible divergences between them at each new operational step to diagnose new problems. Basically:

- Who's right this time?
- What's wrong with the other and what could we do about it?

Issue #1: The Offset Fluctuation …

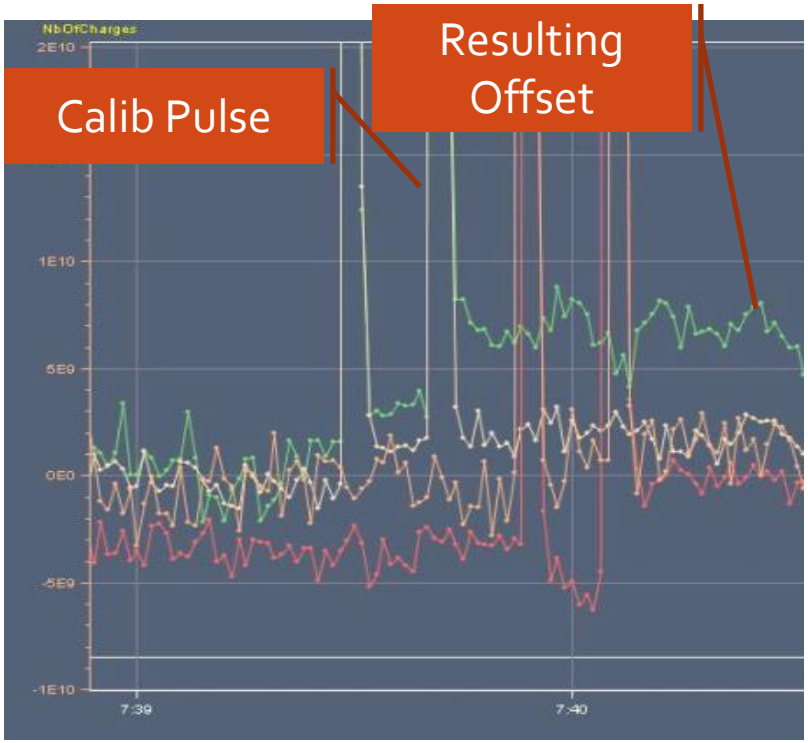
- The DC baseline offset evolves with time.
- Analysis over long time period without beam shows that:
  - Fluctuation (averaged) remains in a reasonable +/-1^{e}9 charges peak to peak window during a typical physics run duration (~10 hours)
  - But we have to correct this regularly due to more severe drifts over longer periods of time (most probably due to slow ambient temperature variations)

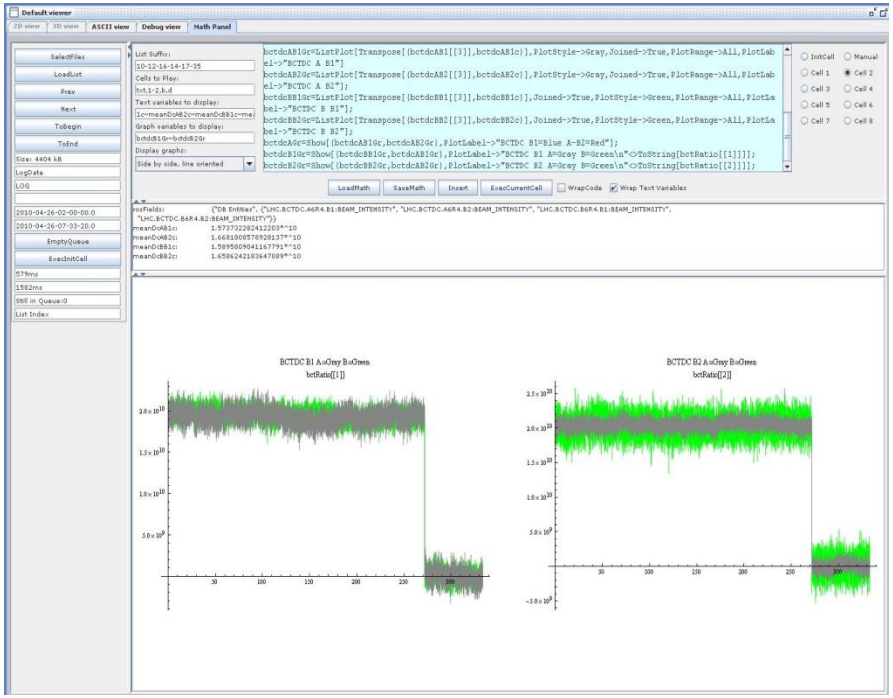




Issue #1: The Offset Fluctuation and Offset Suppressor

- This long term drift should have been solved by the built in offset suppressor on each calibration check. Unfortunatly, this mechanism gave unsifficient results, leaving BCTs with offsets up to +/- 8e9p which was clearly bad for our few e10 p early beams

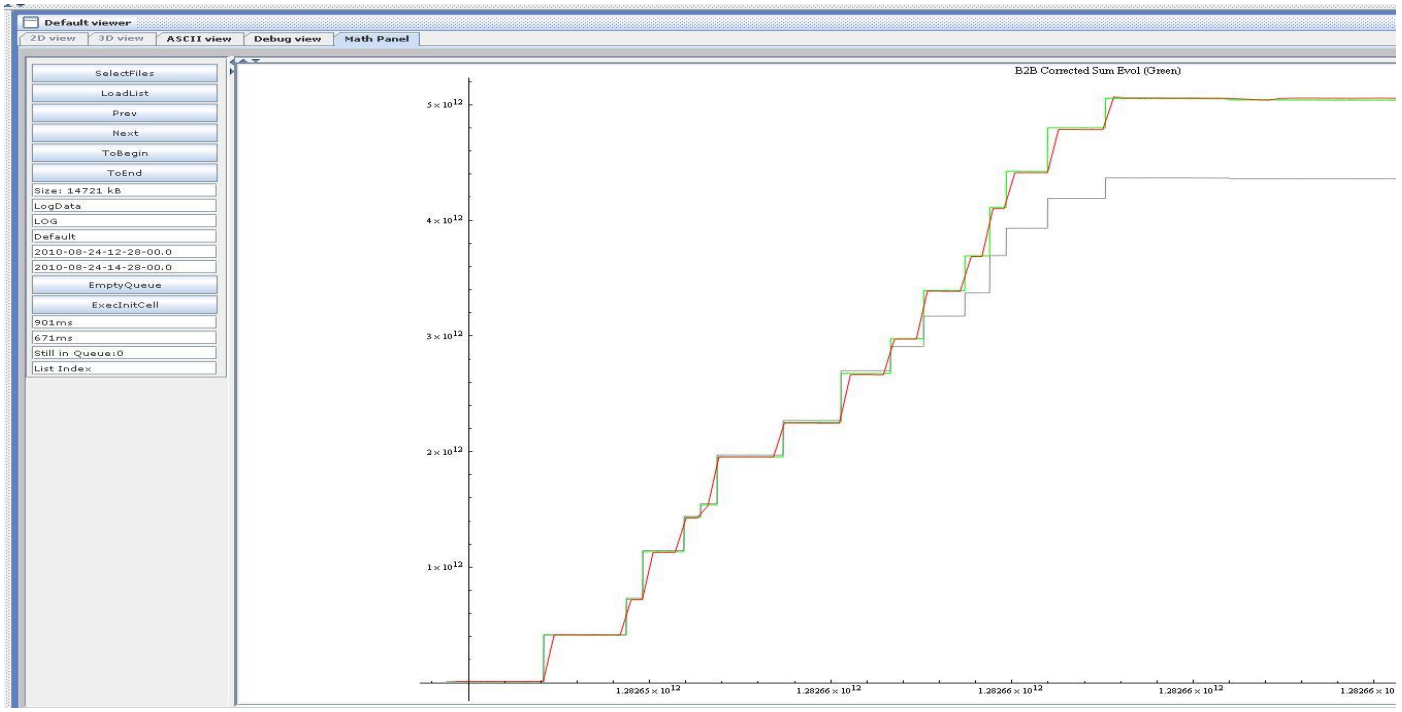




Issue #2: Incomplete Saturation of the Highest Sensitivity Ranges

When total intensity increased, we then quickly saw that our high sensitivity ranges were slowly saturating sooner than expected.

On the following graph, DC BCT (grey line) should have followed the fast BCTs (low BW in green, high BW in red)

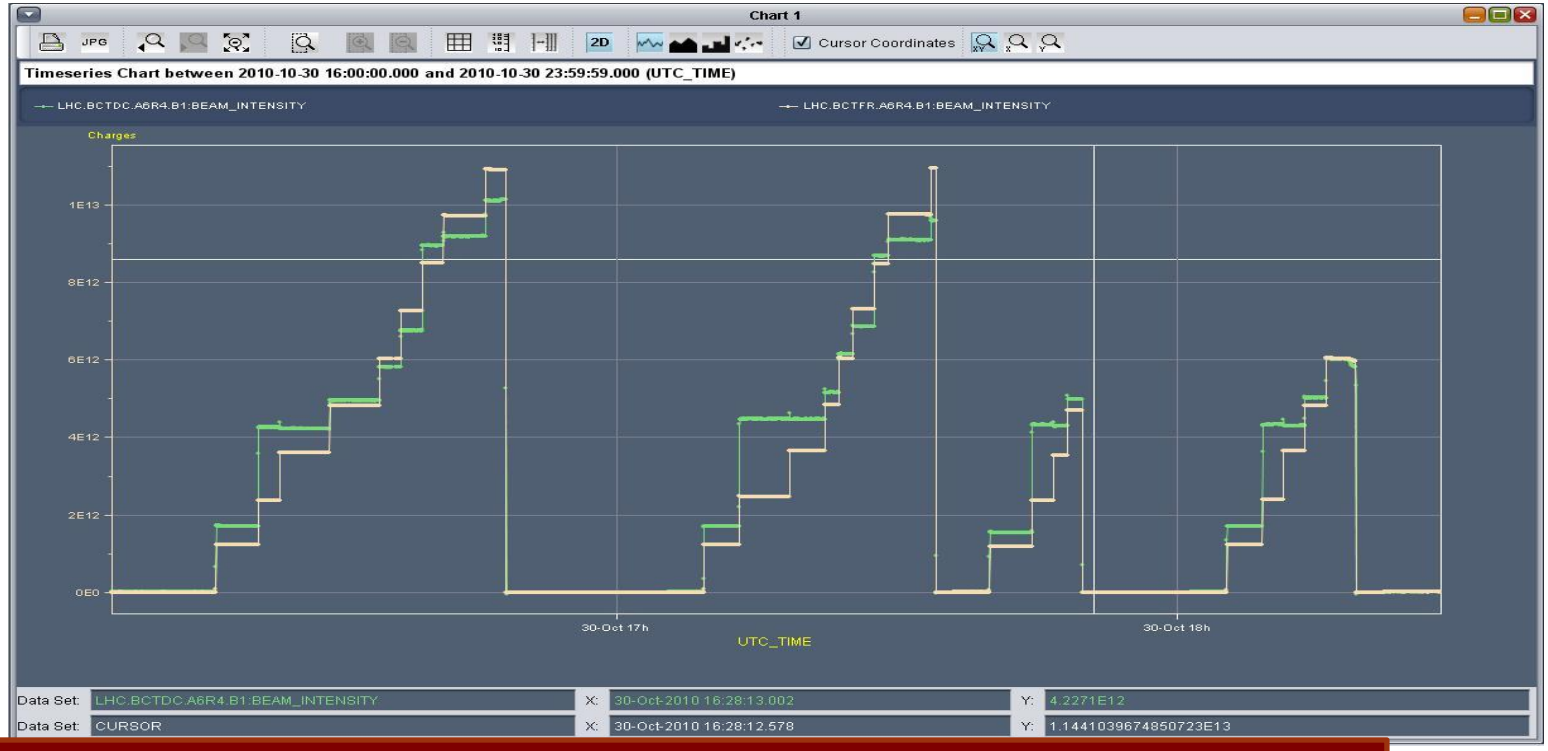


Issue #3: Dependence to filling pattern

Then, we started to inject batches with more and more condensed train of bunches in the machine.

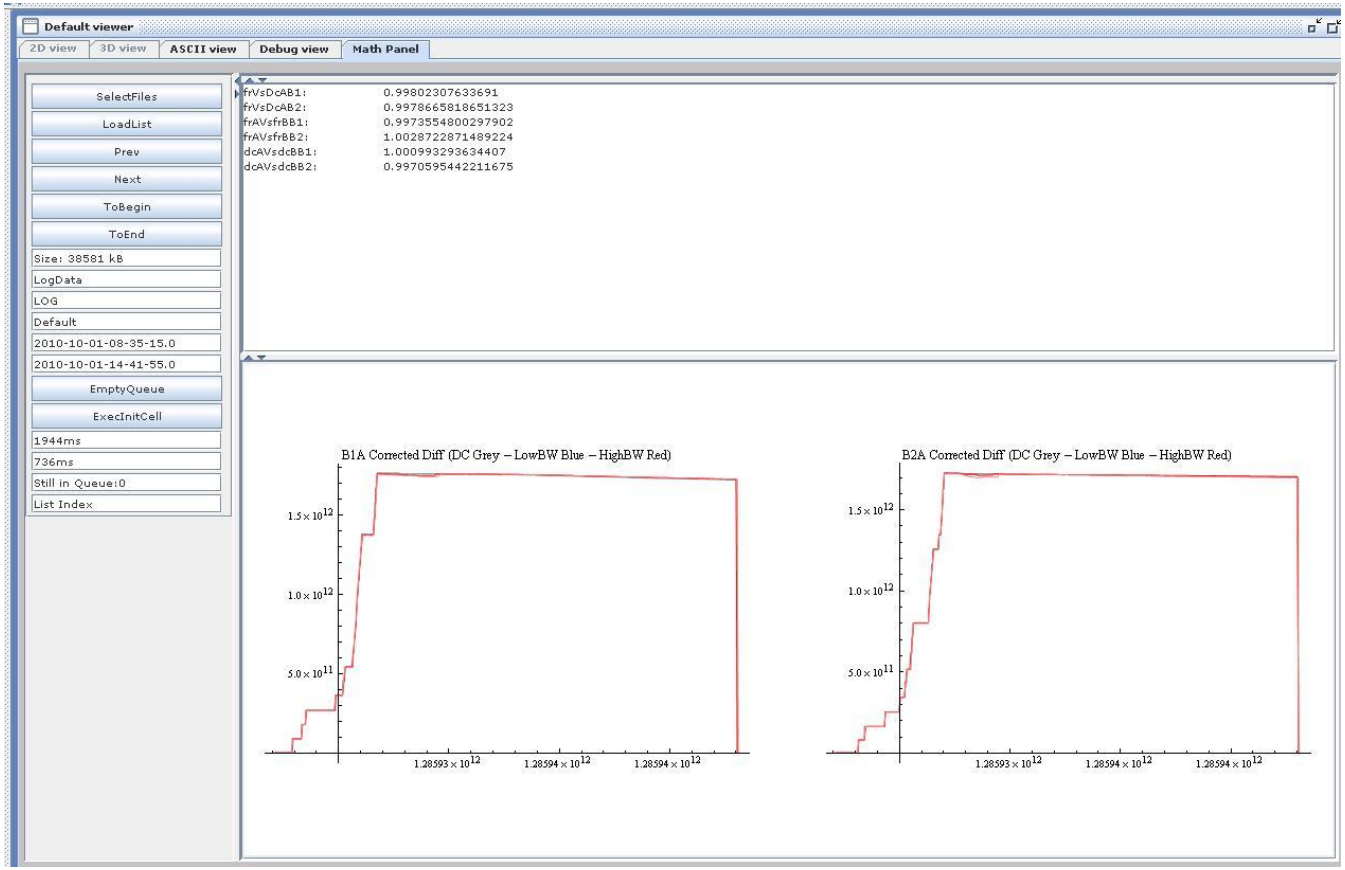
Then the DC BCT started to totally loose track.

Following slide shows in yellow the fast BCT increasing correctly at each injection and in green the response from the DC jumping up and down.



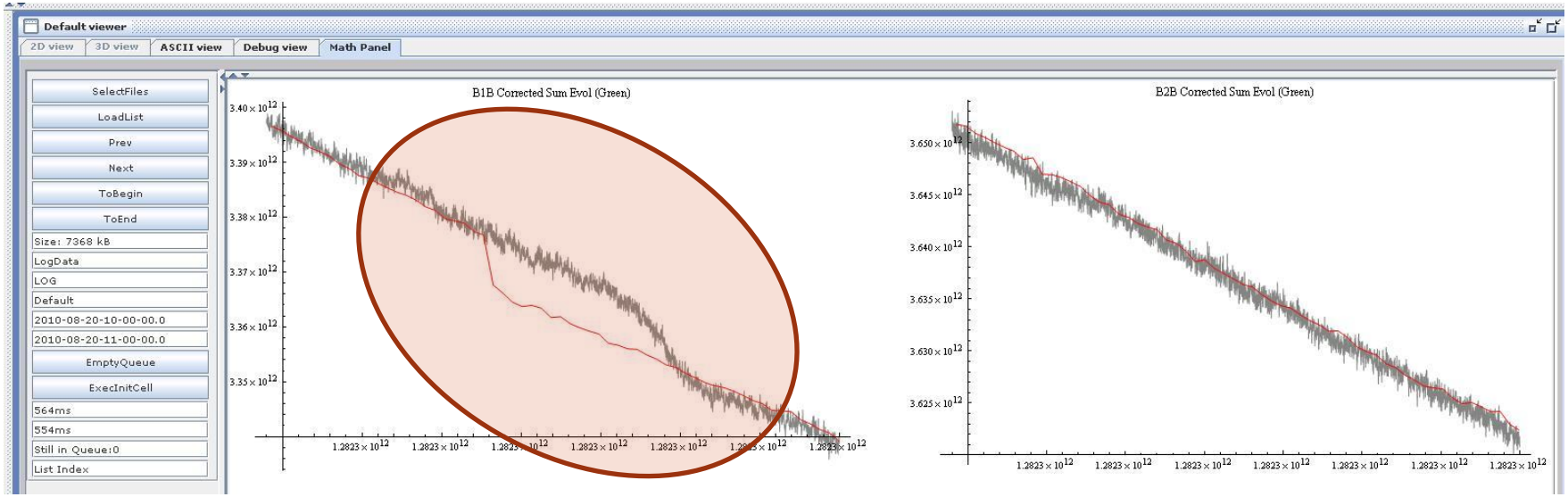
Some Words on Good Things

- VdM Scans: DC and Fast BCT agree within a few per mil all over the run.



Some Words on Good Things

- During a collimation MD, a small fraction of beam 1 is debunched and intercepted ~15 mn later by the momentum cleaning collimators.



Some Words on Good Things

- We verified in the lab and with beam that we do not see a dependency between **BCT DC measurement** and **beam position**.
- In good working conditions (i.e. no saturation effects of any kind), **system A and B DC BCTs do agree** well within the stated uncertainty of our calibration process (+/- 2% peak to peak).
- The medium term (during a run) **offset drift** has been analyzed in the context of the Van der Meer scans and **estimated to be negligible** (i.e. below 1%) for nowadays physics run intensities. **In addition, these offsets do not seem correlated between BCTs**.
- The regular fast calibration checks seem to show a **good** (i.e. within the stated uncertainty) **stability over time of the different calibration factors**.
- Thanks to the diversity of our BCTs (DC, Fast Low BW, Fast High BW), we **always managed to have at least one type working precisely enough** to satisfy operation's needs (more relaxed than operational ones) in terms of total beam intensity but all this created a lot of confusion and an understandable general mistrust towards these instruments.