Recent instabilities observed in the LHC

N. Mounet & E. Métral

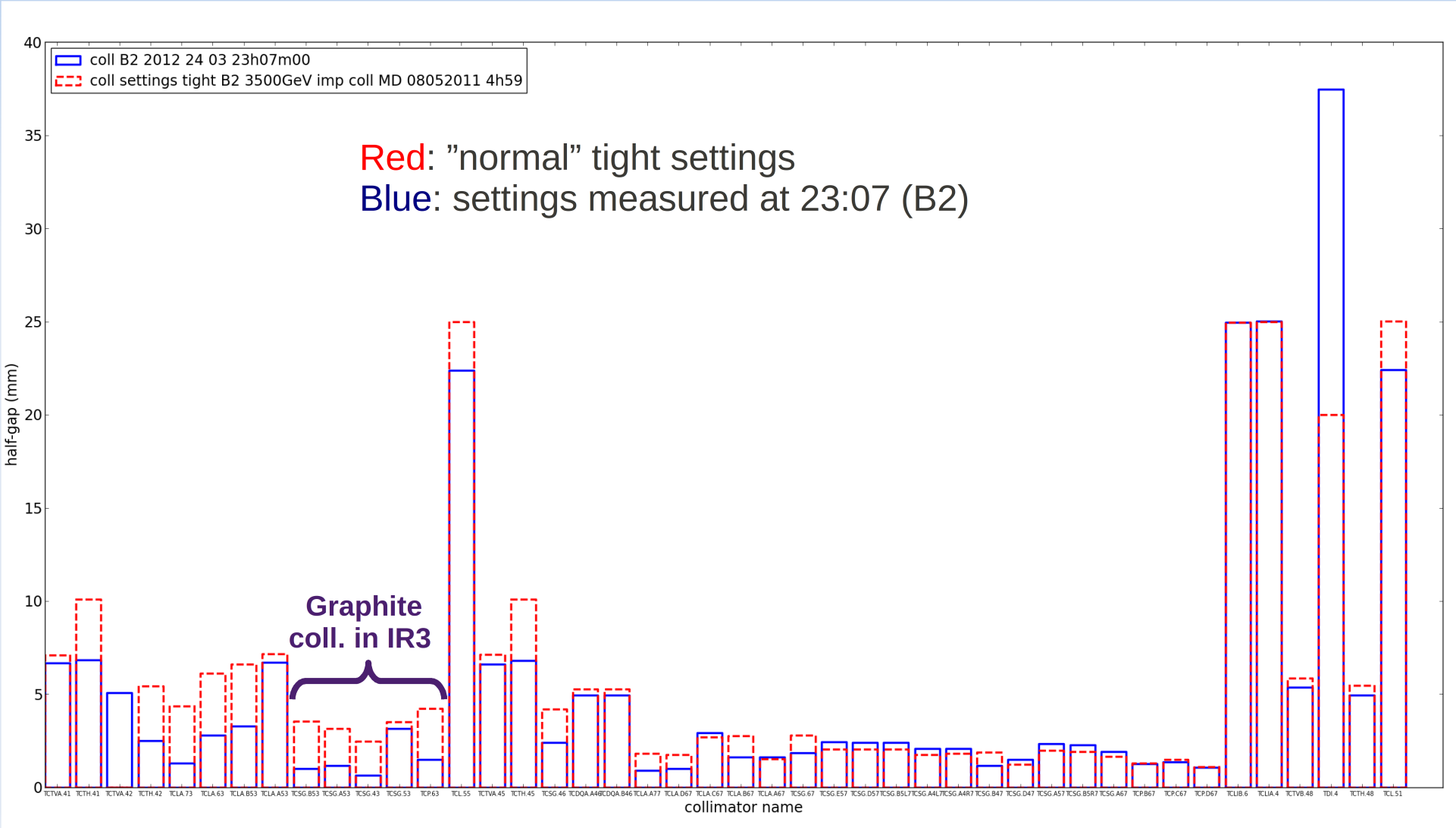
Thanks to: OP team, collimation team, R. Steinhagen.

Summary of the various cases

	24/03/2012	30/03/2012	31/03/2012
General conditions	Single bunch, flat top (4 TeV/c)	Two bunches, β*=0.6m (4 TeV/c)	Two bunches, β*=0.6 m (4 TeV/c)
B1 intensity	1.05 10^{11} p+/bunch	1.1 10^{11} p+/bunch	0.8 10^{11} p+/bunch
B2 intensity	0.8 10^{11} p+/bunch	10^{11} p+/bunch	0.9 10^{11} p+/bunch
Bunch length	1.1 ns	1.1 ns	1.15 ns
B1 norm. ε_x / ε_y	2.8 / 2.7 μm.rad	2.1 / 1.8 μm.rad	1.8 / 0.9 μm.rad
B2 norm. ε_x / ε_y	1.5 / 1.6 μm.rad	2.2 / 2.4 μm.rad	1.3 / 1.5 μm.rad
B1 Q'_x / Q'_y	0 → 5 (?)	(-4 → 4) ? / 3	2 / 2
B2 Q'_x / Q'_y	0 → 5 (?)	3 / 3	2 / 2
Octupoles (foc.)	-232 A	-232 A	-232 A
RF voltage	12 MV	12 MV	12 MV
Q_x / Q_y	0.28 / 0.31	0.31 / 0.32	0.31 / 0.32
Coll. settings	Closer than tight settings	Tight settings	Tight settings except one TCP in IR3 for B1 (closer)
Observations	B2 H unstable (23:07)	B2 H/V unstable (16:35)	B1 H (V ?) unstable (19:21 → 19:34) B2 H/V unstable (18:10)

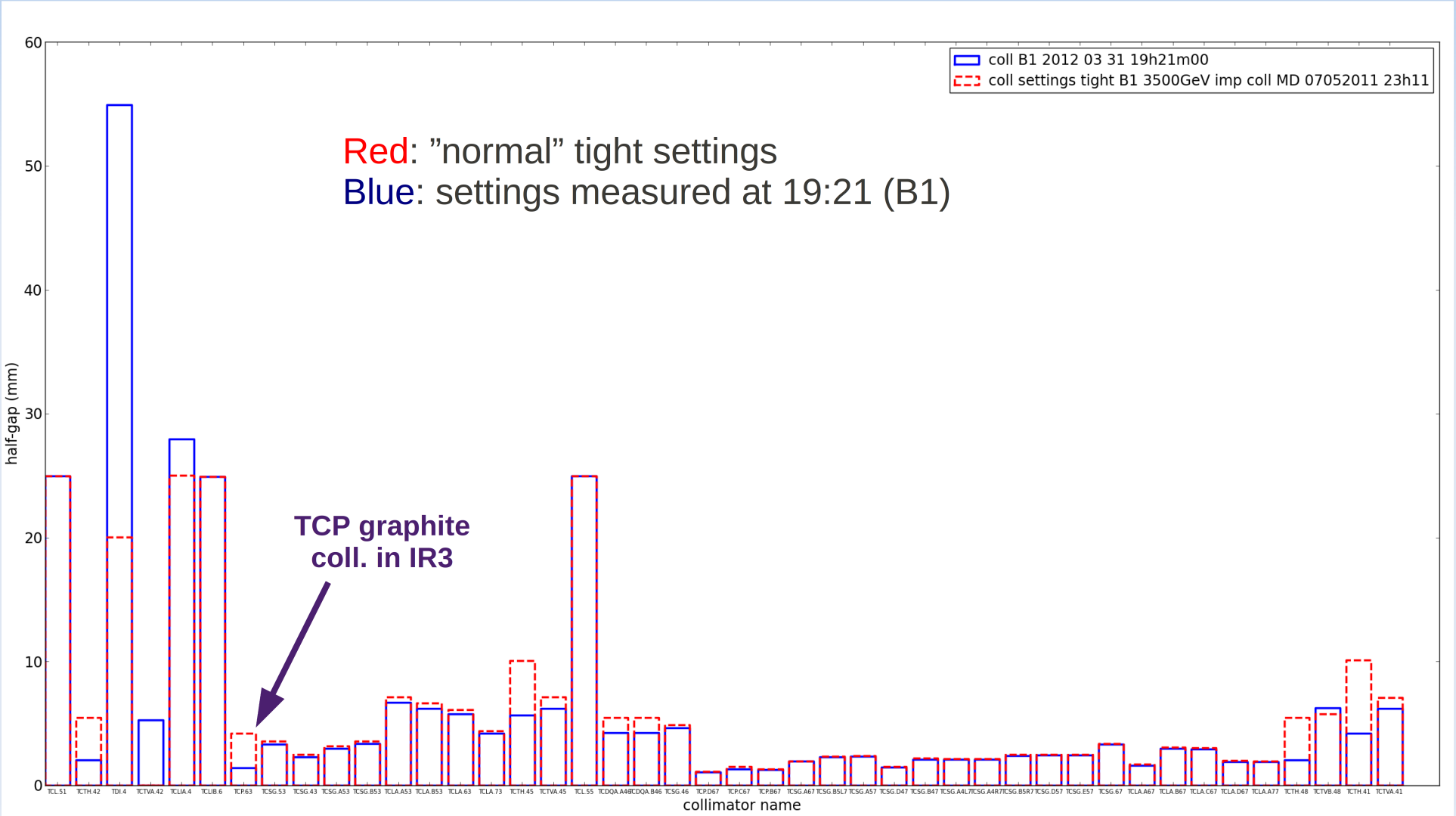
Collimator settings on 24/03/2012

- Collimators were being moved in parallel at that time → many collimators were at much tighter settings than the ”normal” tight settings:



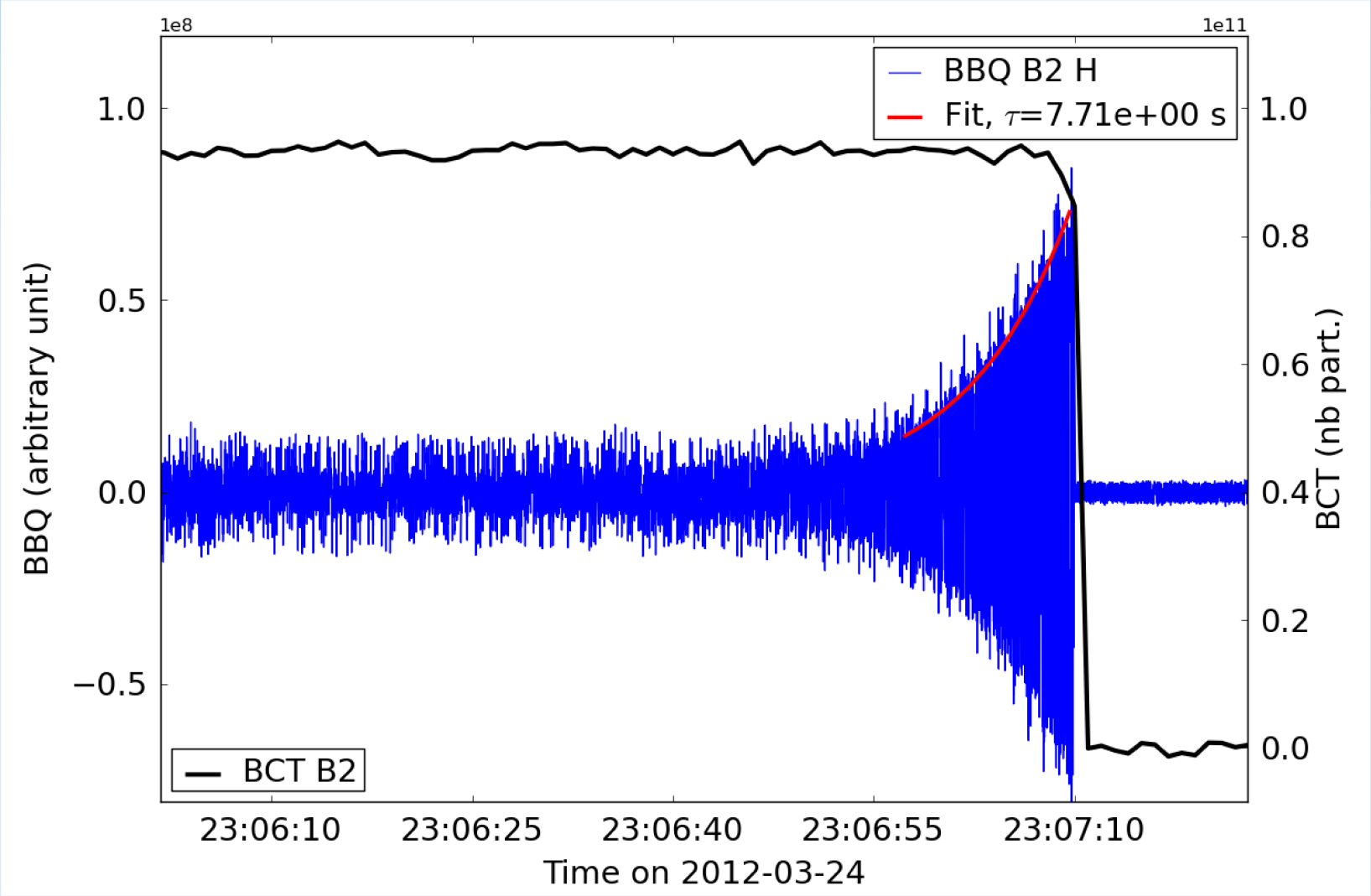
Collimator settings on 31/03/2012

- For B1, one TCP in IR3 is much closer to the beam than foreseen in the tight settings:



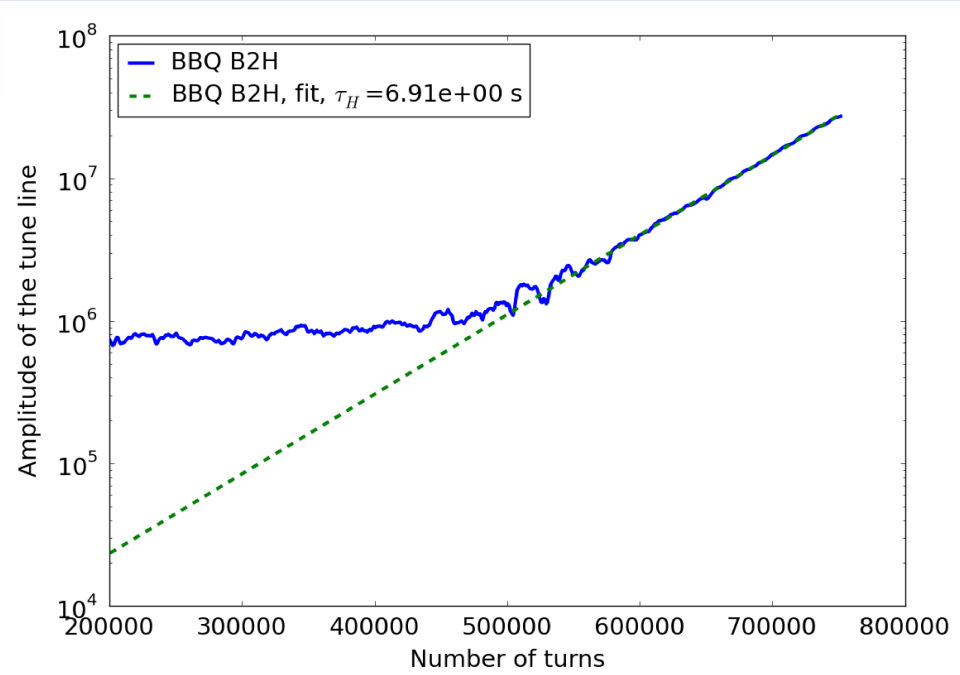
Instability on 24/03/2012

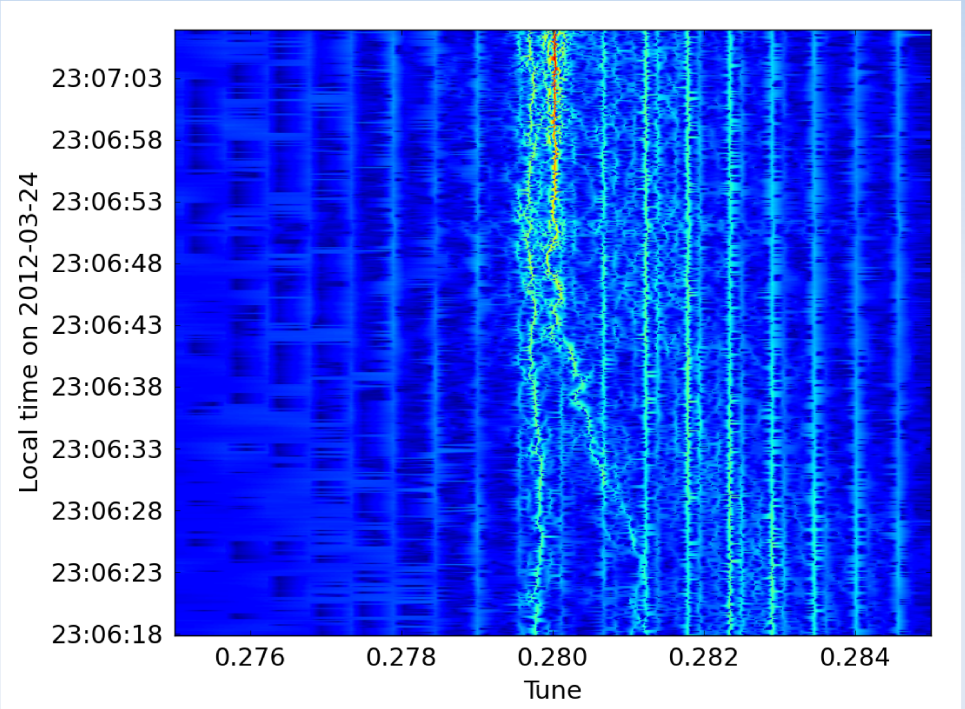
- Observations: coherent motion visible on the BBQ signal for B2 horizontal only, right before the losses:



Instability on 24/03/2012

- Analysis of the BBQ data with SUSSIX on a sliding window:



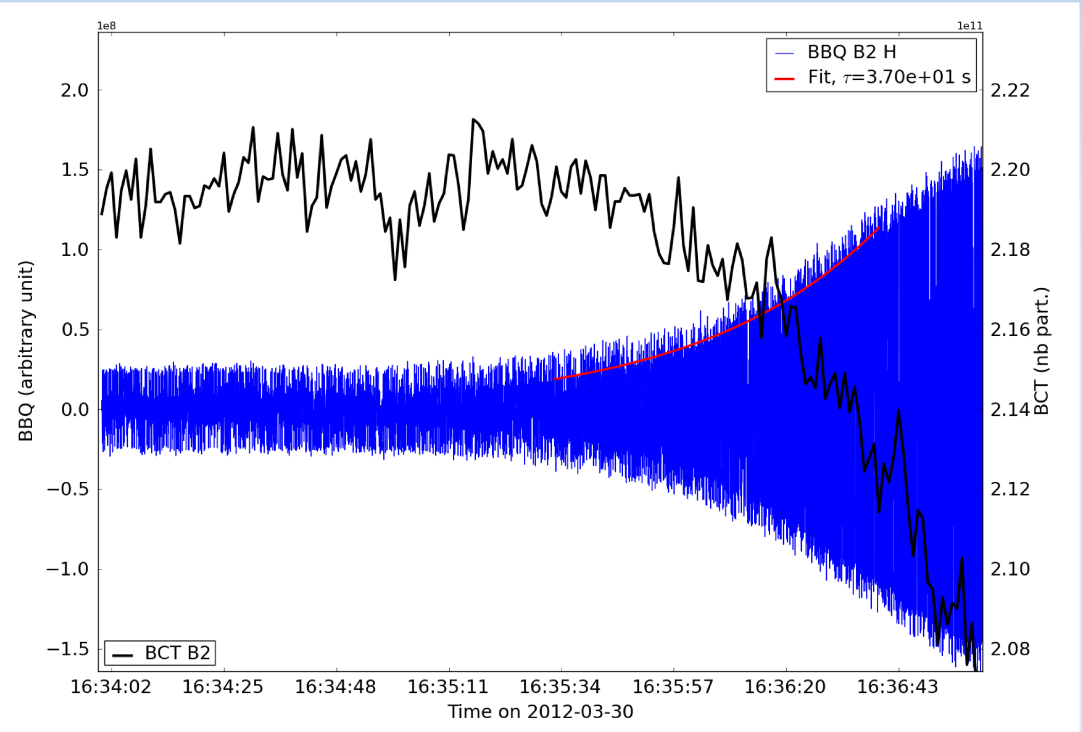


→ The amplitude of the main tune line grows with a rise time similar to the one of the previous slide (same data, different way to fit).

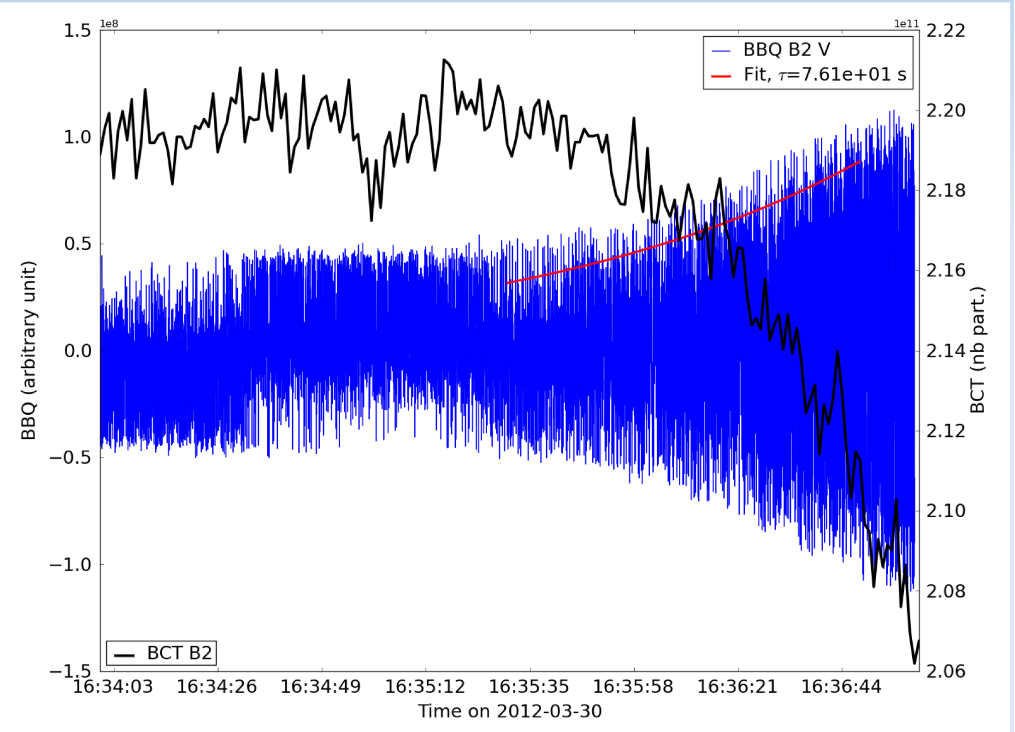
→ Many unexplained lines appear on the tune spectra.

Instability on 30/03/2012

- Observations: slow coherent motion visible on the BBQ signal for B2:



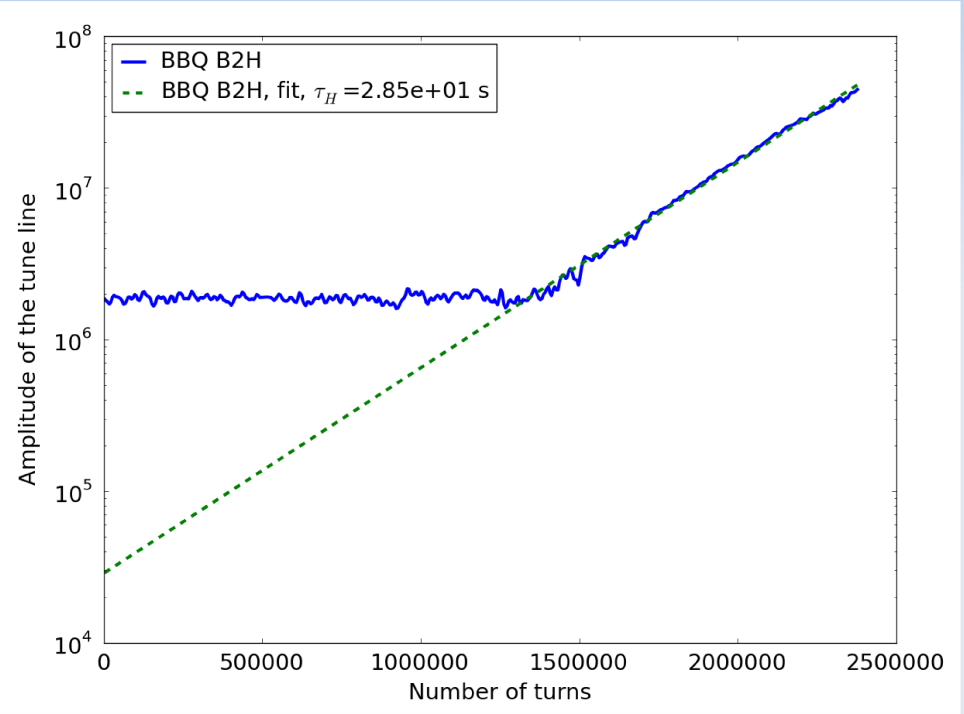
B2 horizontal

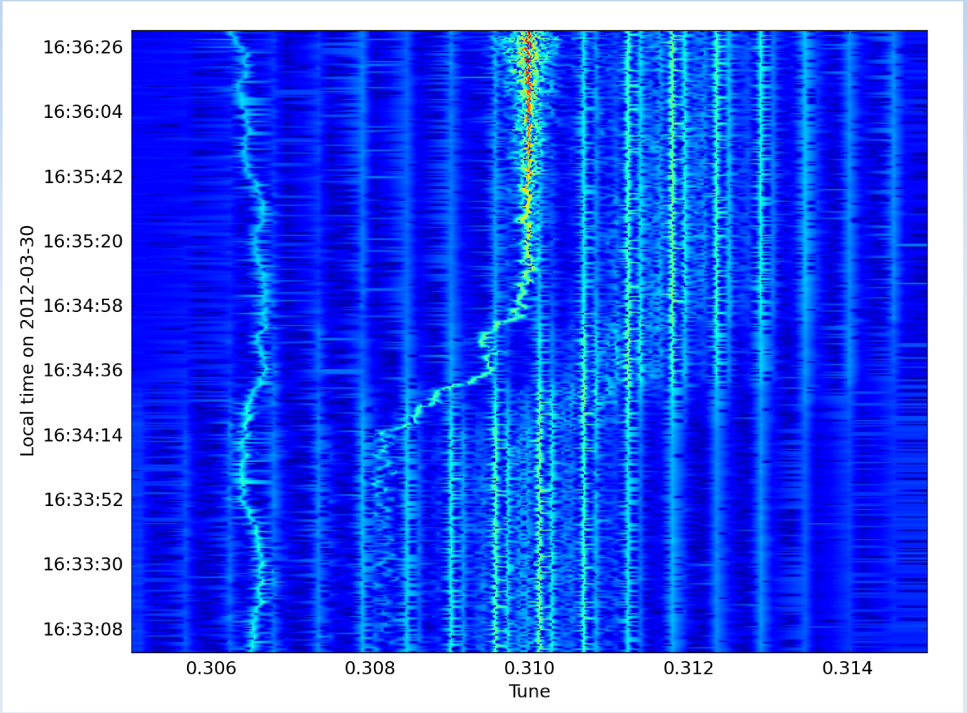


B2 vertical

Instability on 30/03/2012

- Analysis of the BBQ data with SUSSIX on a sliding window:



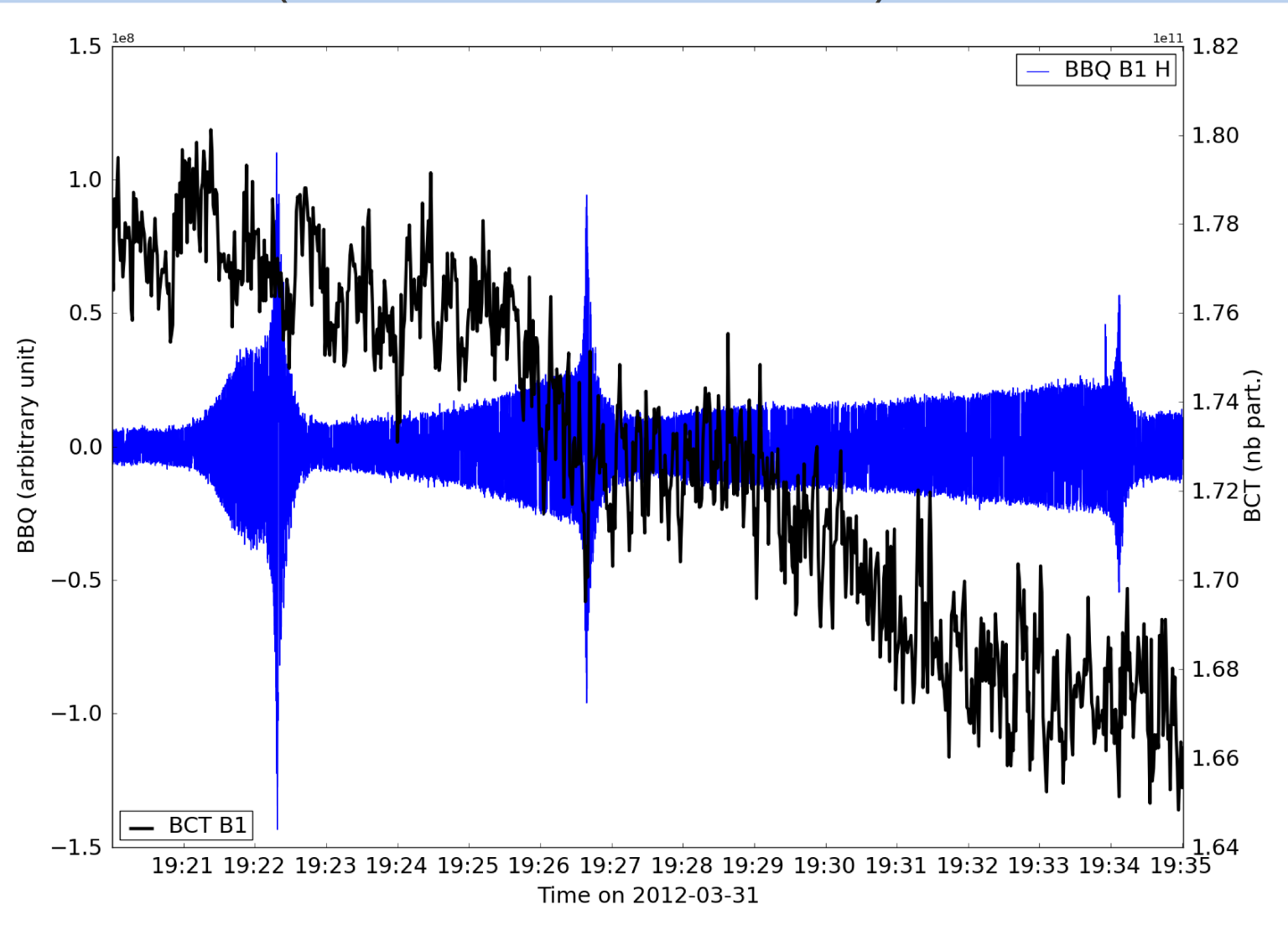


→ The amplitude of the main tune line grows with a rise time similar to the one of the previous slide.

→ Also unexplained lines appear on the tune spectra.

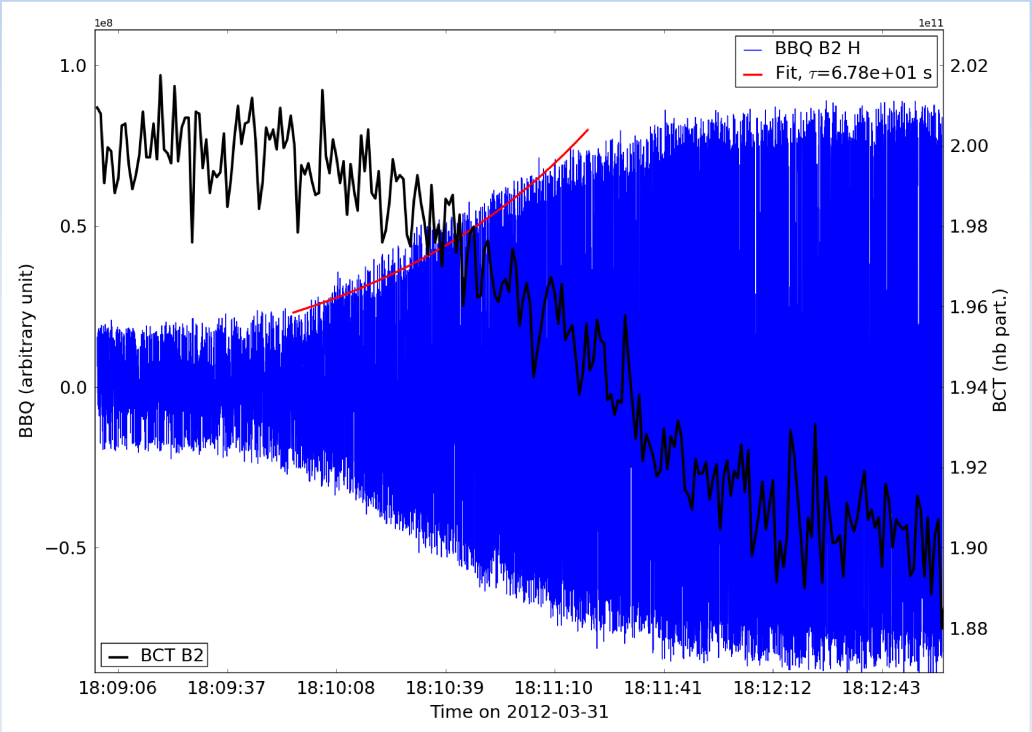
Instability on 31/03/2012

- Observations: slow coherent motion followed by faster peaks on the BBQ signal of B1 horizontal (B1 vertical similar but weaker) :

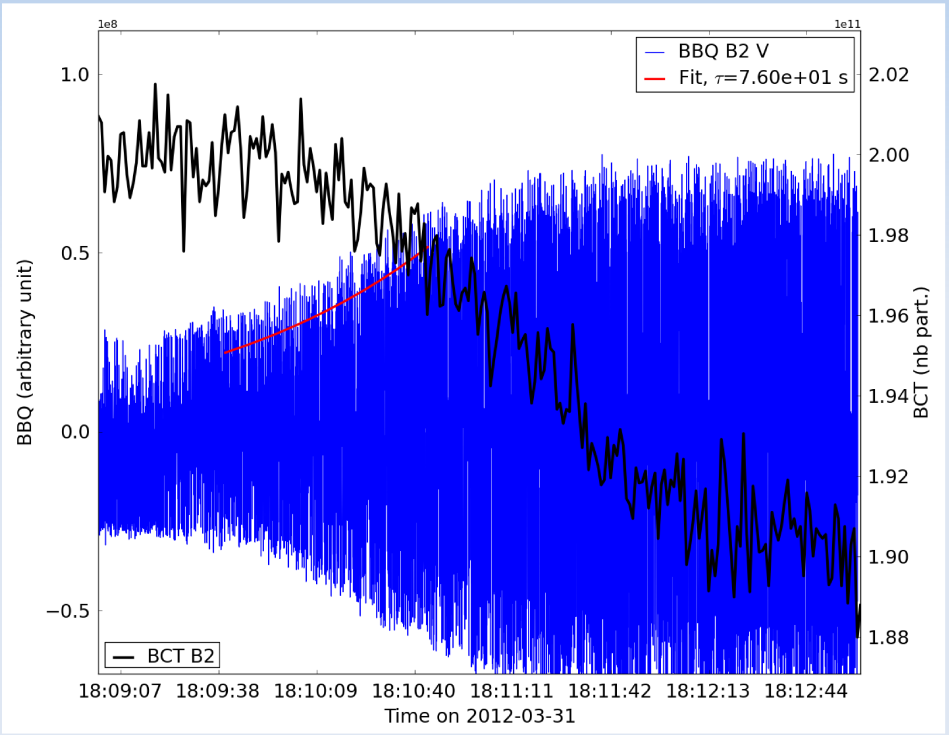


Instability on 31/03/2012

- Observations: very slow coherent motion visible on the BBQ signal for B2:



B2 horizontal



B2 vertical

Summary

- Clear coherent instabilities were observed in three different configurations, mainly for B2 but in one case for B1 as well.
- The horizontal plane seems more affected than the vertical one.
- Only 230 A in the octupoles for all three cases.
- In two out of three cases, collimators at settings tighter than the ”normal” tight settings in IR3 (most critical collimators) and emittances smaller than 2 μm.rad.
- b3 decay at flat top was not yet compensated → increase Q'_x by ~3 units, decrease Q'_y by ~3 units → can be a tentative explanation of why the horizontal plane seems more affected (Q' ~ 5-6 is more critical than slightly negative Q' for which the feedback stabilizes the beam).

  ⇒ more studies to be done (and comparison with model) before drawing any conclusions,

  ⇒ in collimation MD (end of April) we will study instabilities with tight settings.