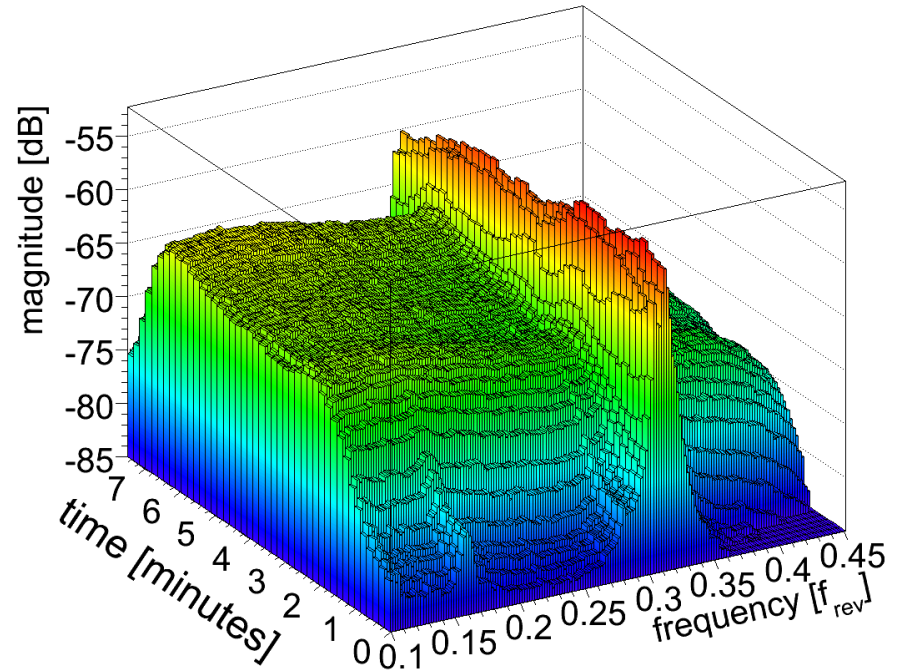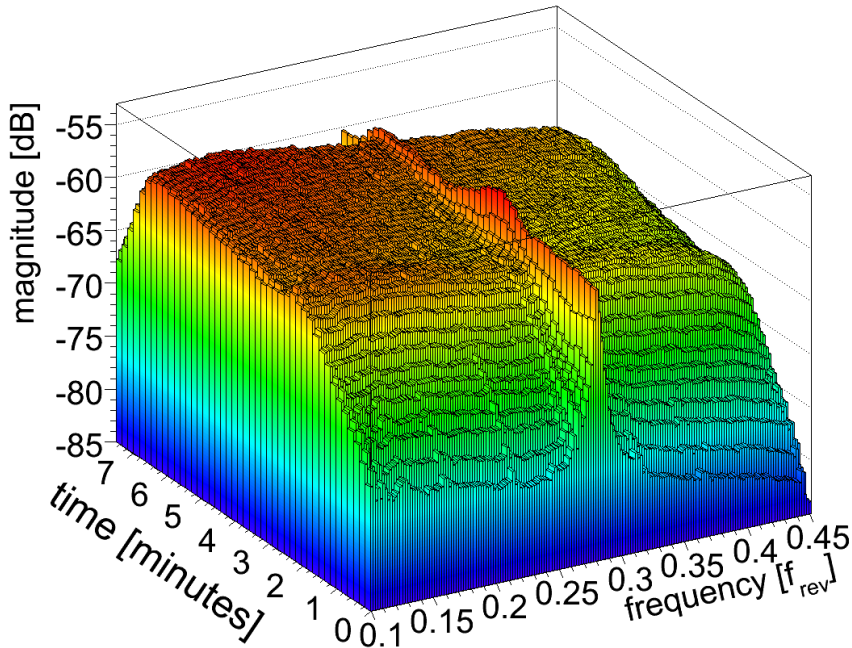- Follow-up of tune-diagnostic issue seen on Saturday:

  - noise increase during first part of the ramp swamping BBQ tune signals


- At that time two (main) working hypothesis:
  - Intensity-related detector saturation ('Zener' effect) $\rightarrow$ now excluded
  - Long. bunch profile & fill-pattern dependence of BBQ
    - bunch-profile $\rightarrow Q_s$ lines/raises transverse noise floor (linear)
    - fill-pattern $\rightarrow$ reduction of/multiple tune signals (geometric)

1

- A little bit in more detail:

$$I_{L/R}(t) \;=\; \frac{I_{\omega}(\sigma_s, t)}{2\pi} \;\cdot\; \left[2\psi \mp 2\frac{x}{R}\sin(\psi) + \frac{x^2 - y^2}{R^2}\sin(2\psi) + h.o. \right]$$

longitudinal
beam signal (PM)

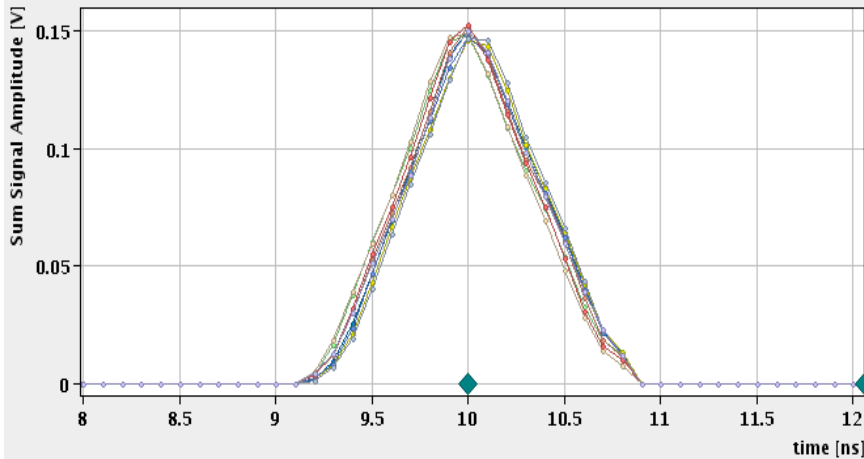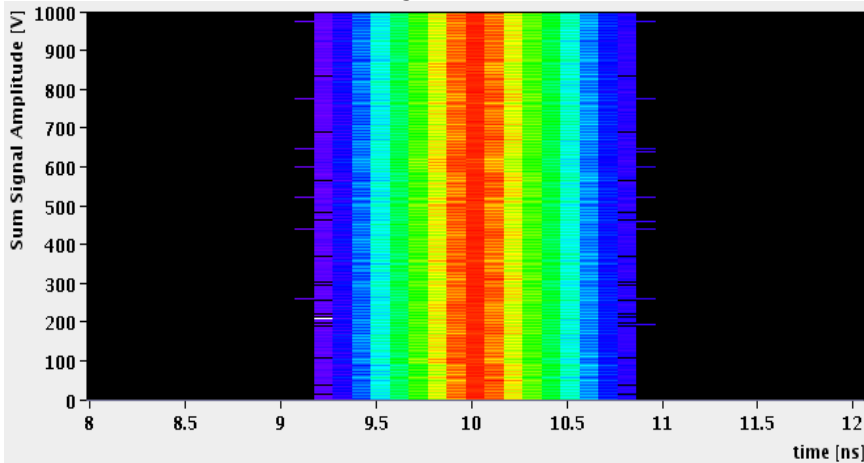transverse
beam signal (AM)

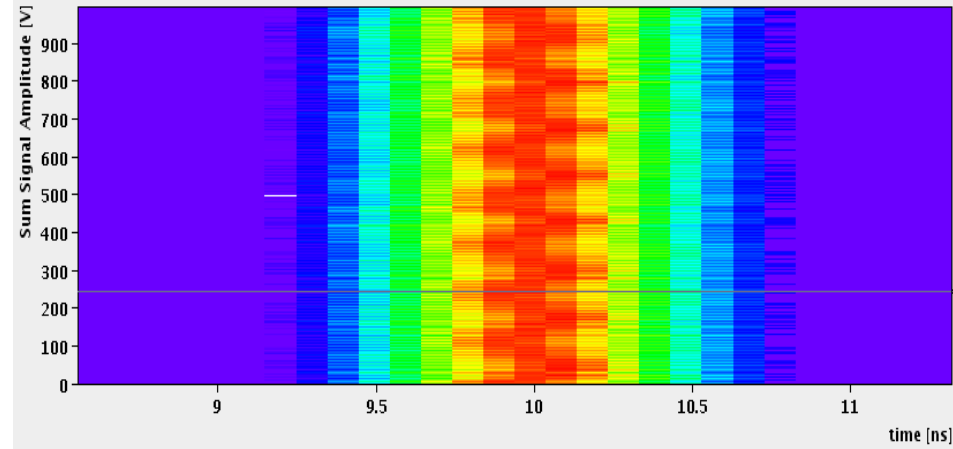bunch length/shape variation:
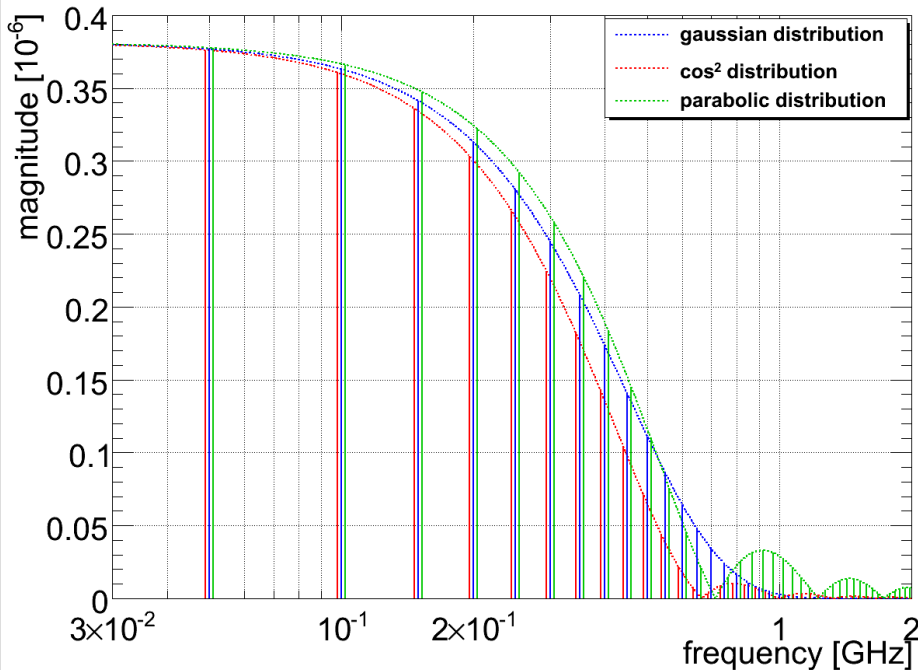
bunch filling pattern variation:
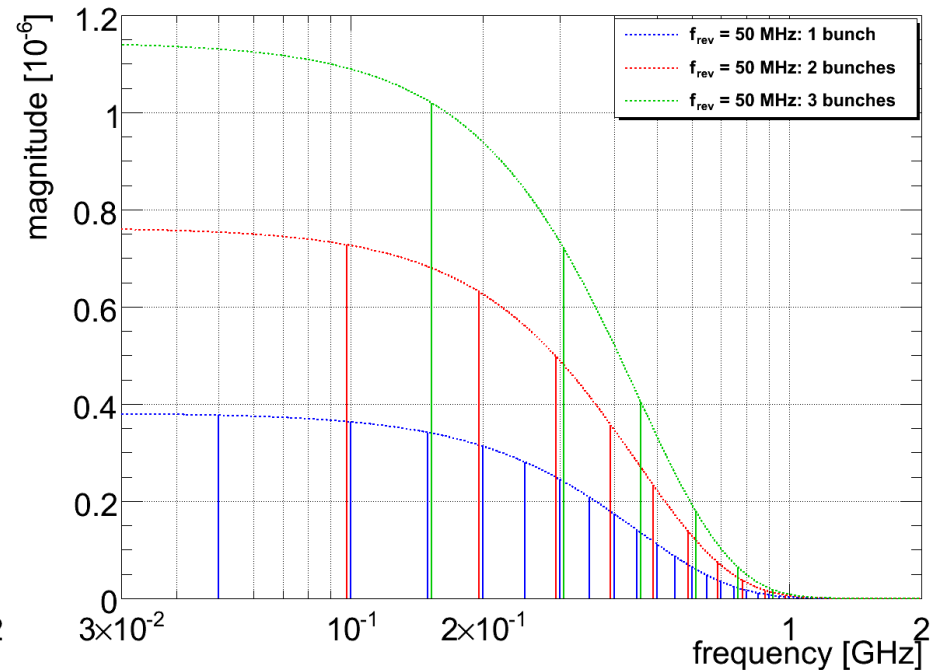
- N.B. SPS easier: regular bunch filling-patern (40/200 MHz) → BBQ at 200 MHz LP

Bunch 1 at injection:

Bunch 1 during ramp
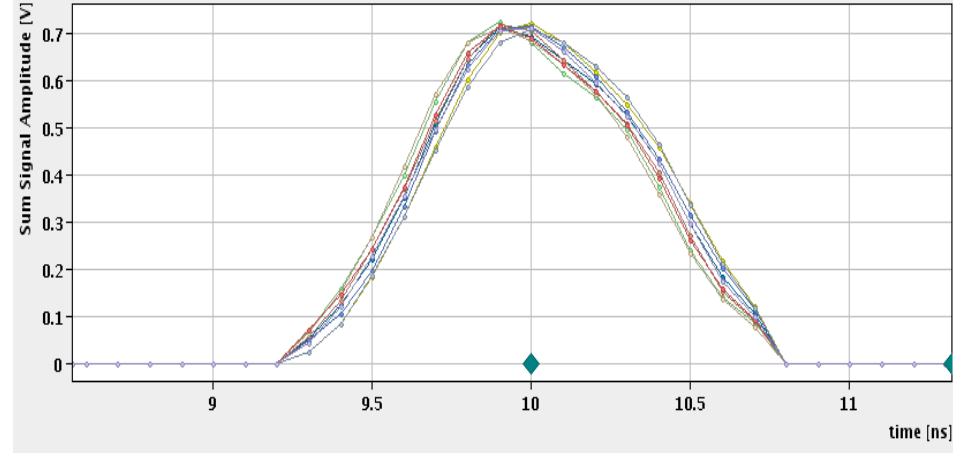
Visible bunch (shape) oscillations → this is how the long. blow-up works.

If we can see this with a scope (percent-level), this certainly saturates the BBQ operating at a ppm-level → low-pass mandatory for BBQ (access on Monday)

- Reverted changes from last technical stop:
  - BBQ detector operating up to 3 GHz (>6dB more tune signal, more reliable |C⁻|)
  - BBQ detector with low-pass filter operating up to 500 MHz (operational now)
- Spectra during last ramp
  - Better for V, though we have been 'humped' (ADT gain too high)
  - Broad-band perturbation in H still visible
    - filter excludes intensity/saturation related effects
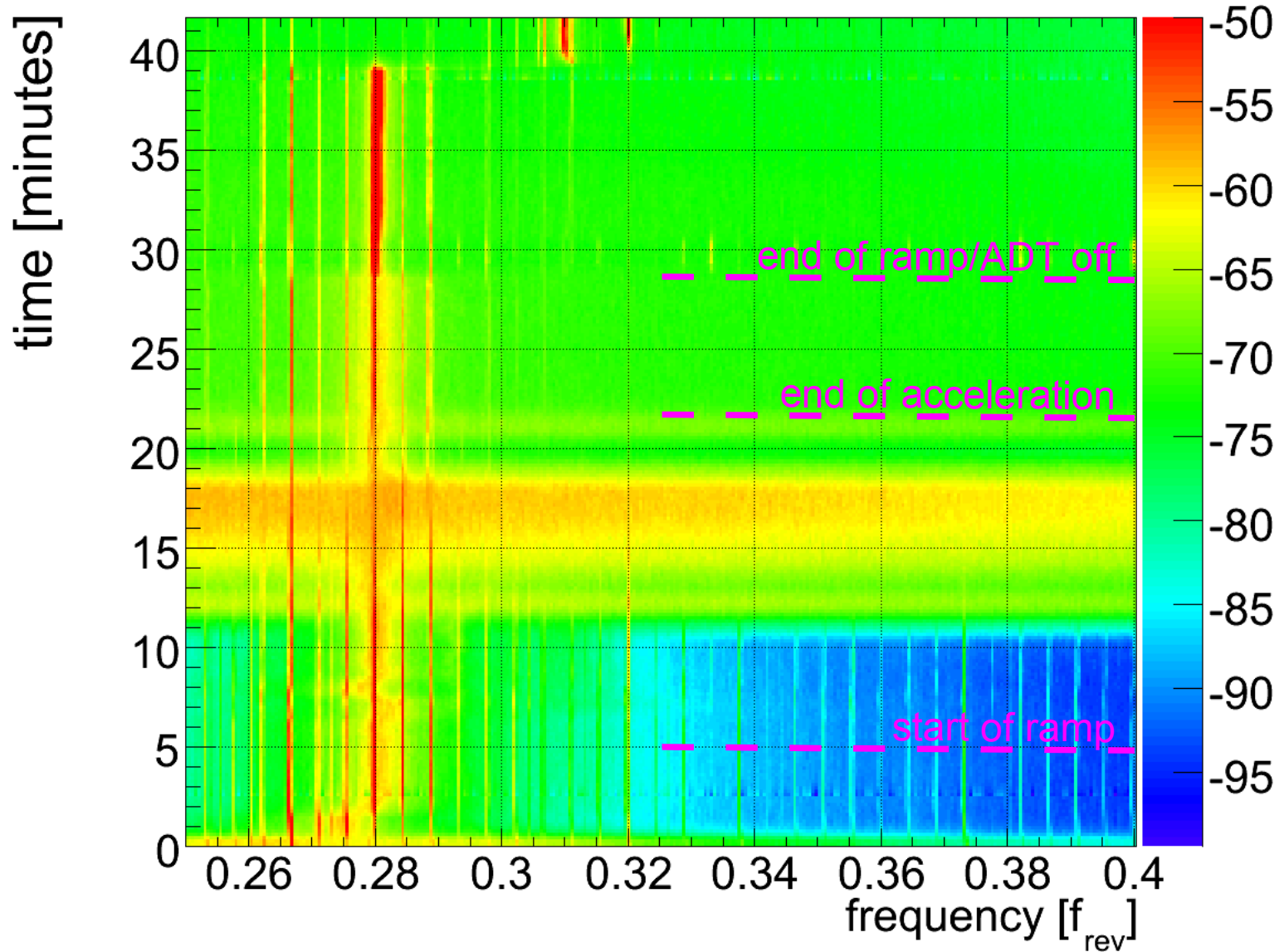   - → a bunch filling pattern and/or long. bunch effect (+ dispersion??)
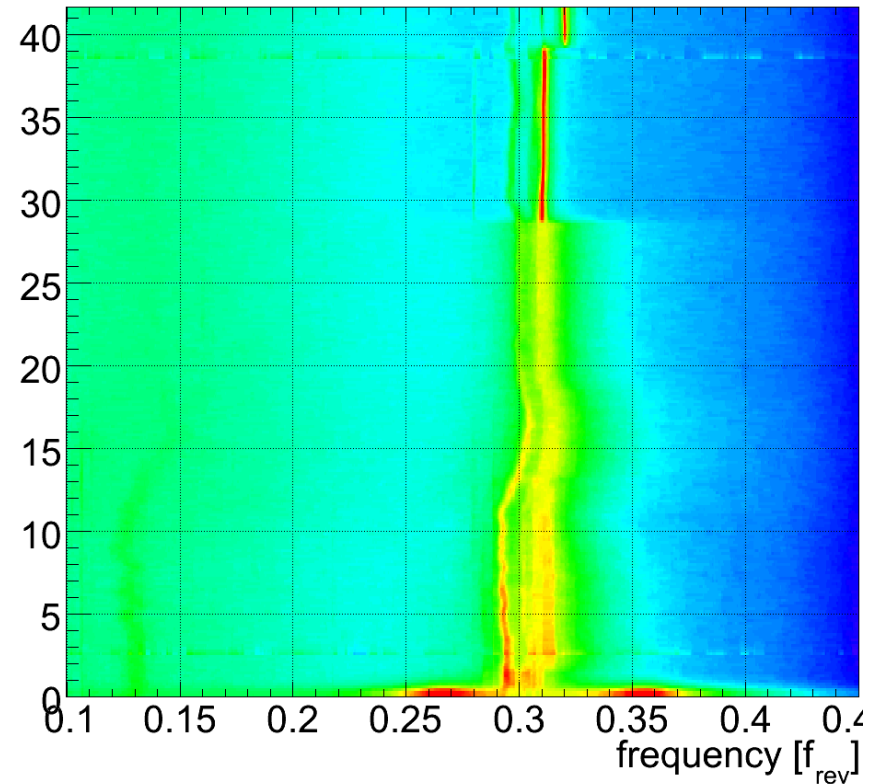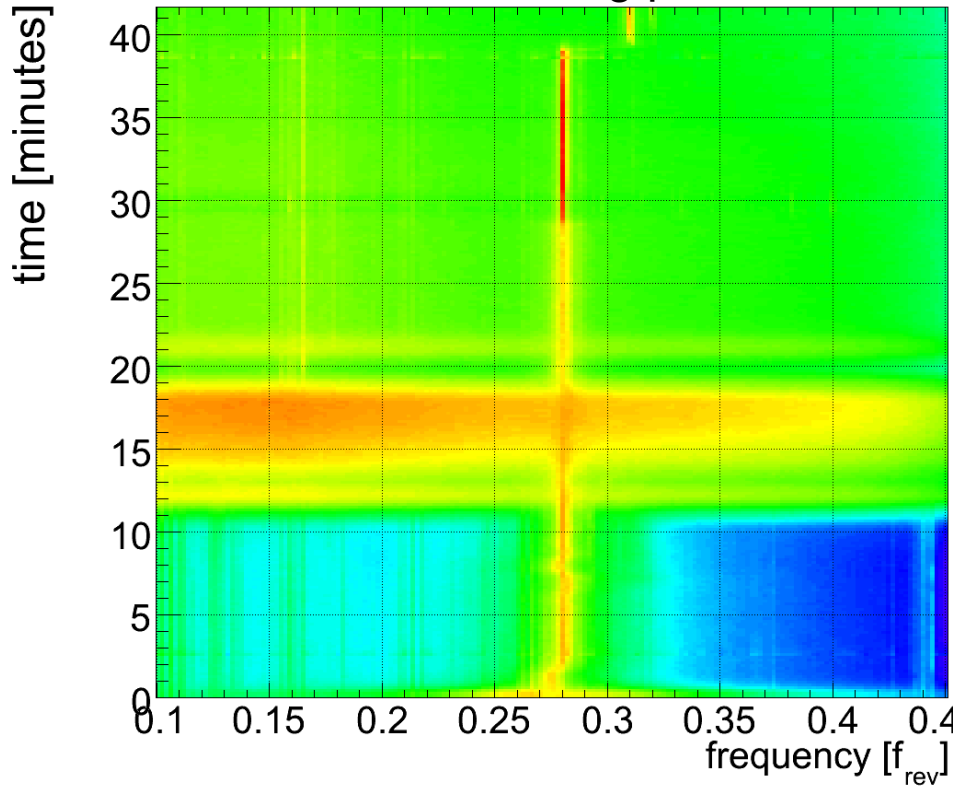
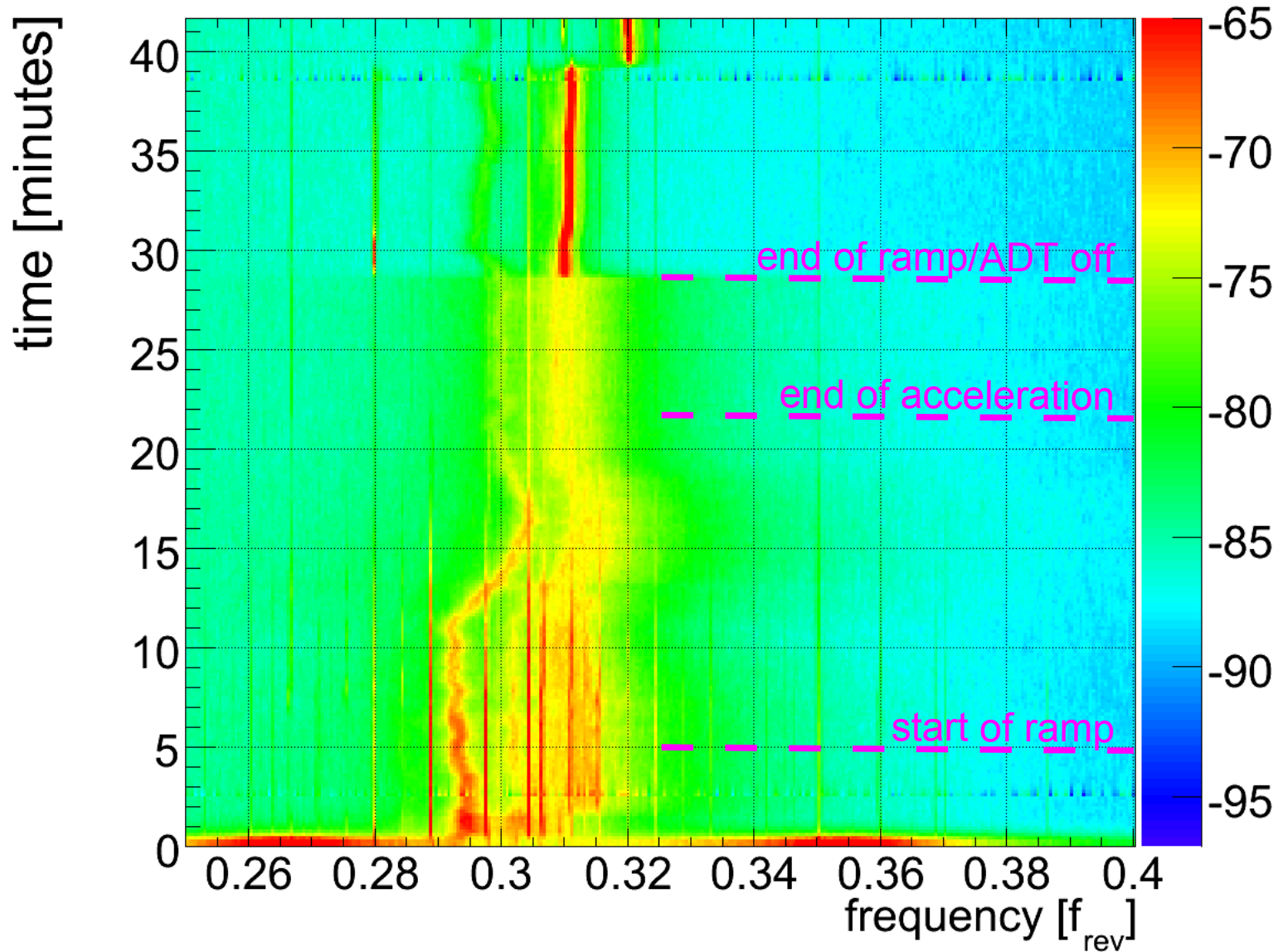- Corresponding tune traces of last ramp:
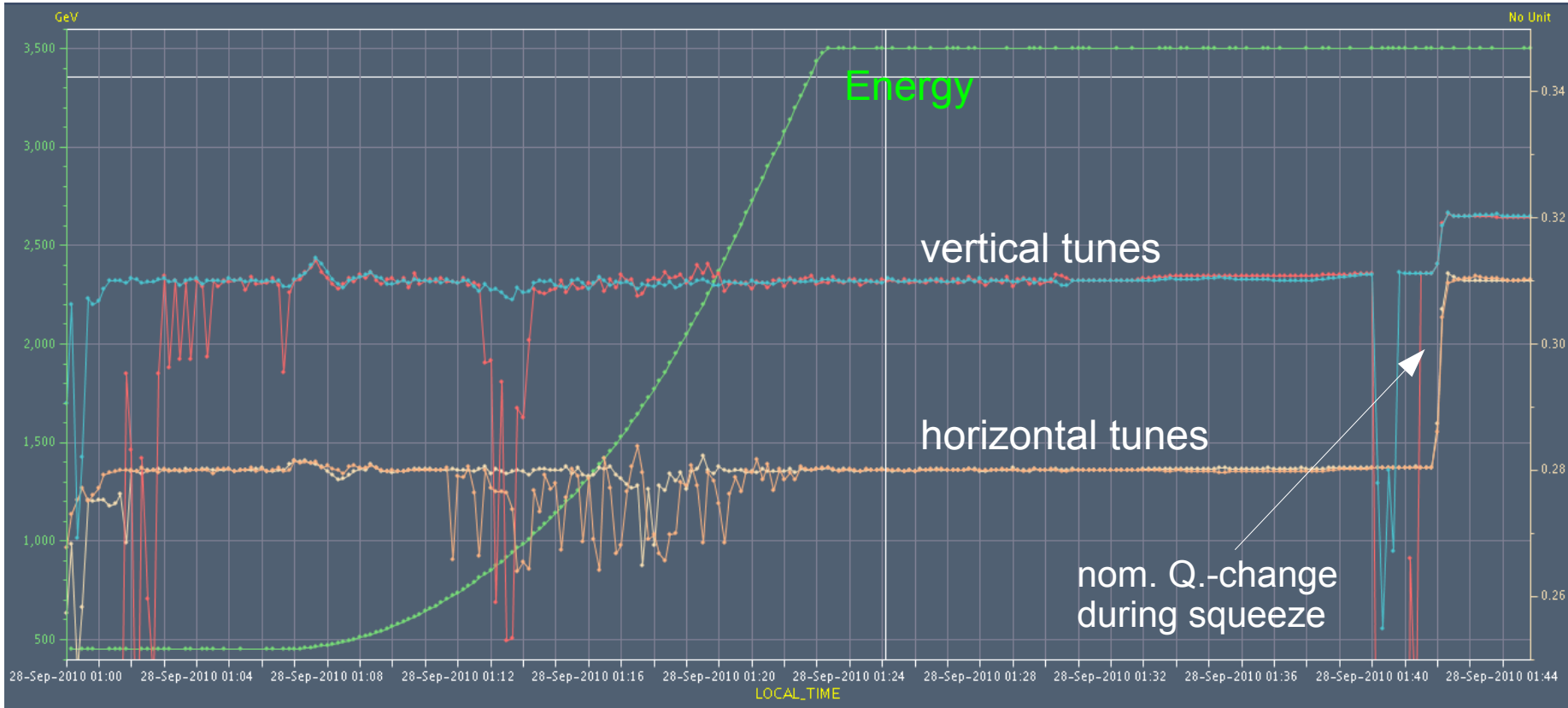
- Tune is tracked most of the time (in contrast to Fill on Sunday → Monday)
  - suspected tracking of (broad!) non-tune interference lines, in particular for the vertical plane..

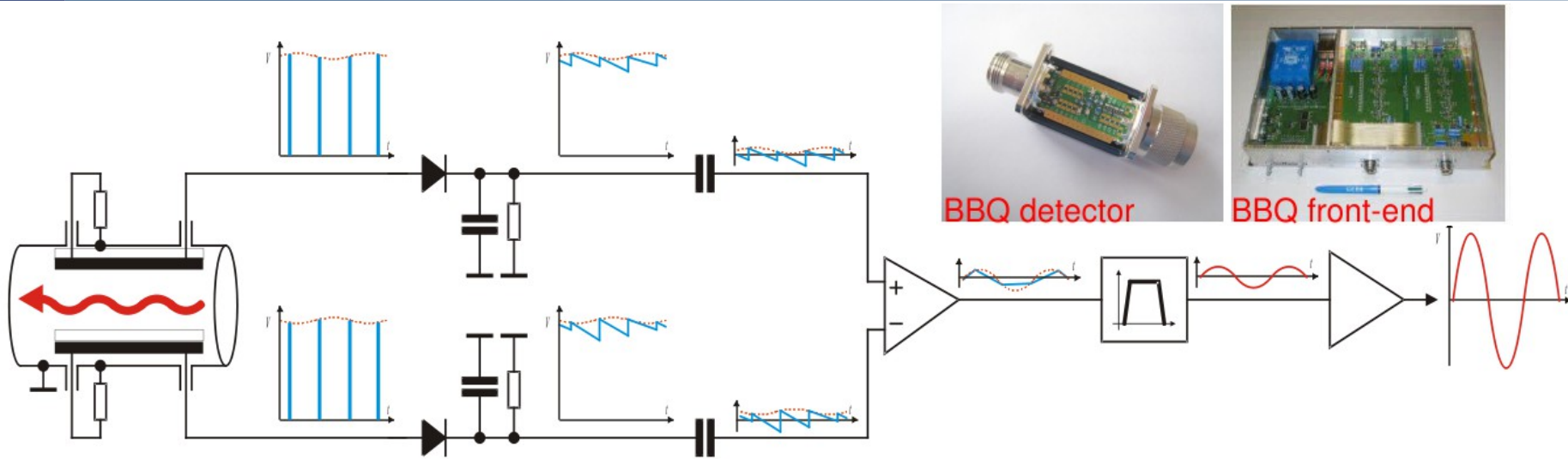- Horizontal BBQ Spectrum B2 (B1 similar):

- Vertical BBQ Spectrum B2 (B1 similar):

- A lot of things happen around that time...

- To better understand the effect we should not change to many things at the same time

BBQ detector   BBQ front-end

- **Basic principle: AC-coupled peak detector[1]**
  - intrinsically down samples spectra: ... GHz → kHz (indep. on filling pattern)
  - Triggers on the bunch with the maximum intensity (first-order)
    - Demonstrated by the absence of beam-beam modes in collision tune spectra (only e.g. tunes of non-colliding bunches visible)
  - However (second-order), noise floor depends on the filling-pattern:
    - The 'one' bunch the BBQ triggers on may change turn-by-turn, e.g. due to strong bunch-shape oscillations
- **Individual gating on a bunch has been tested at the SPS but non-trivial for LHC**
  - **Problem: >100V trigger voltage with ~1ns rise-time, > 6 month of dev.**

[1]M. Gasior, *"The principle and first results of betatron tune measurement by direct diode detection"*, CERN-LHC-Project-Report-853, 2005
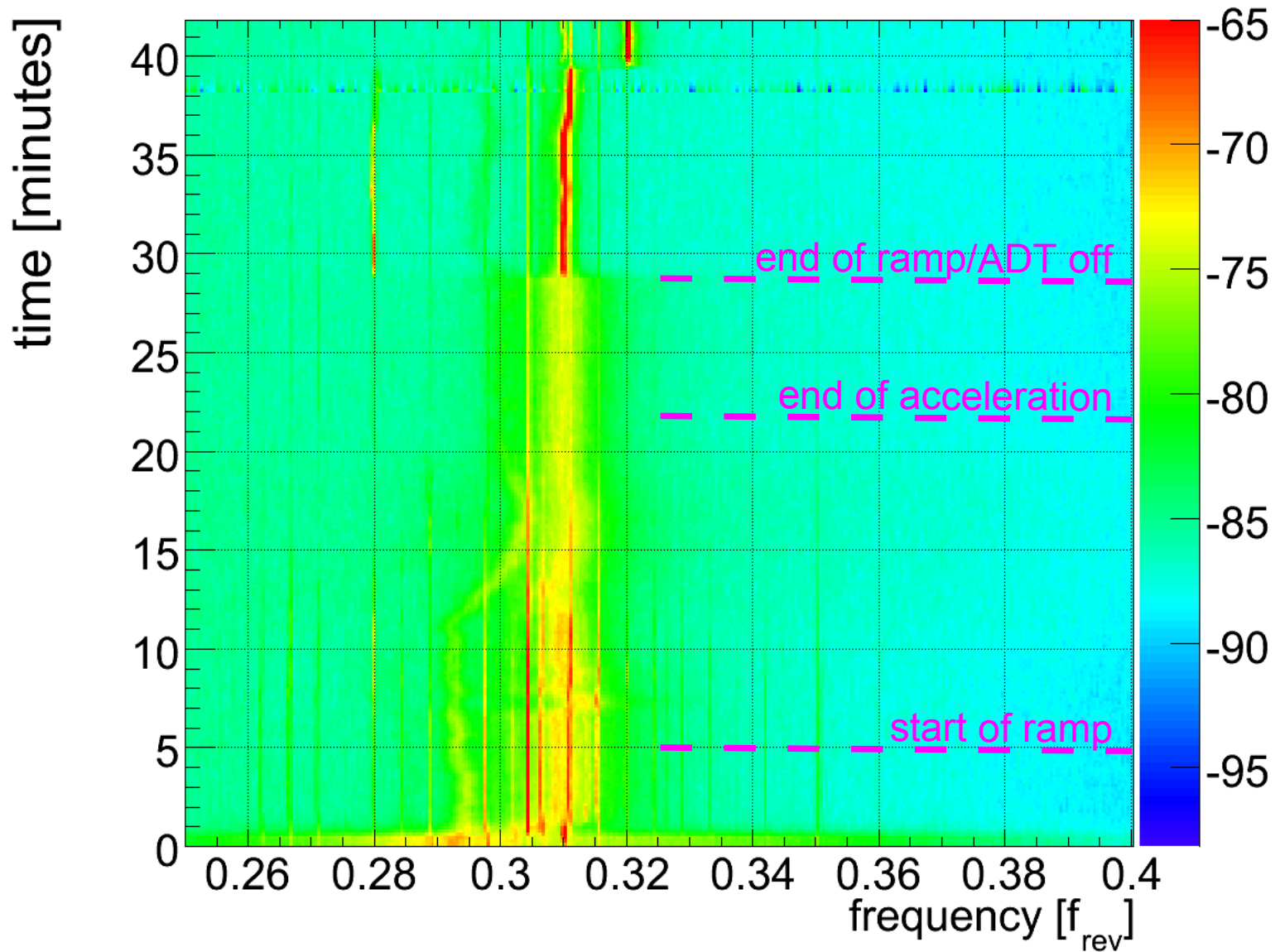
LHC-BC BBQ Performance during nominal Ramp, Ralph.Steinhagen@CERN.ch, 2010-09-28

What's next?
How shall we proceed?

(additional slides follow)

- Horizontal BBQ Spectrum B1:
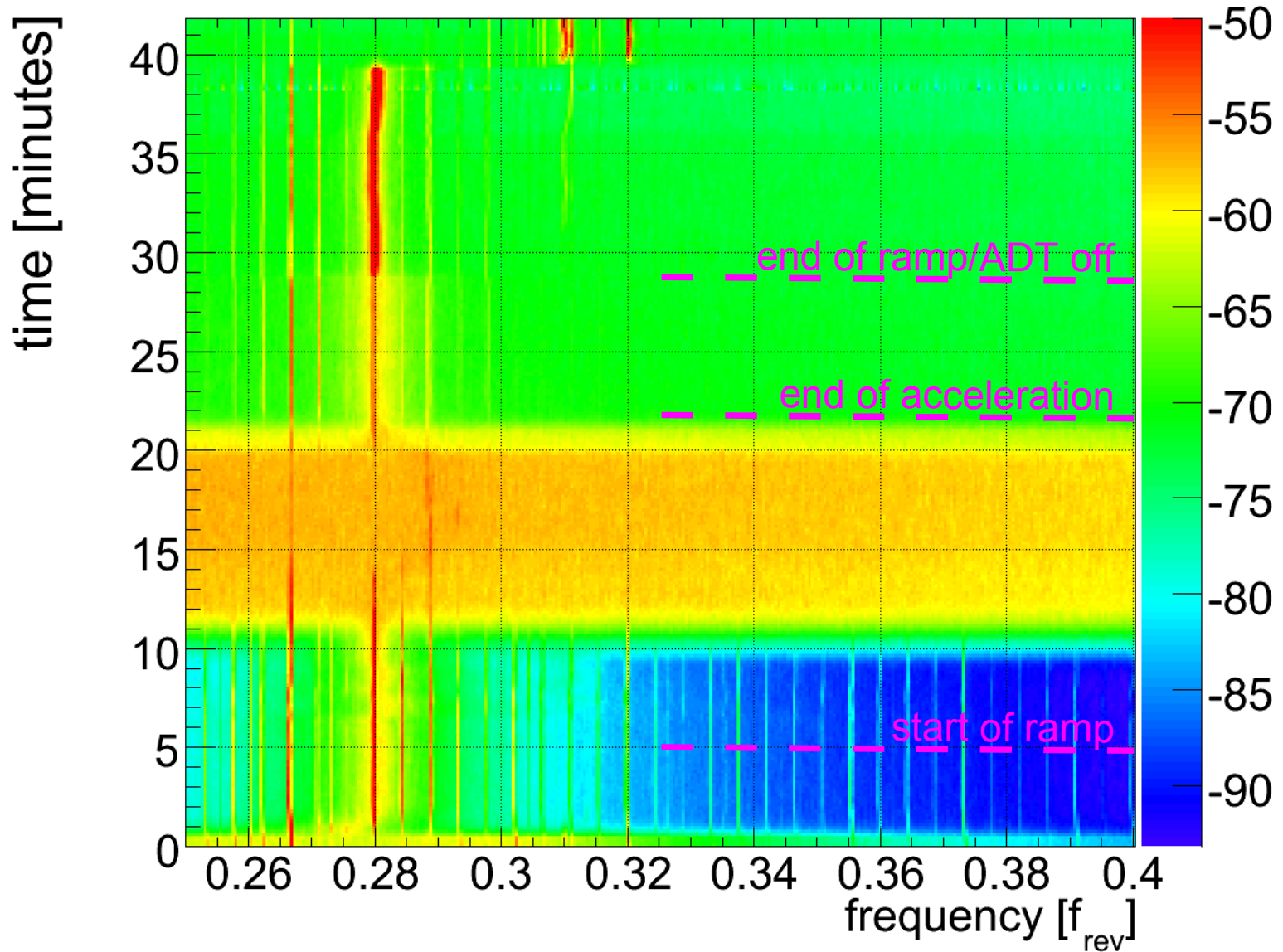
- Vertical BBQ Spectrum B1:

- … but has a measurable impact on the achievable tune resolution:

Tunes:

Beam sizes: