Single Bunch Bursting Measurement Techniques

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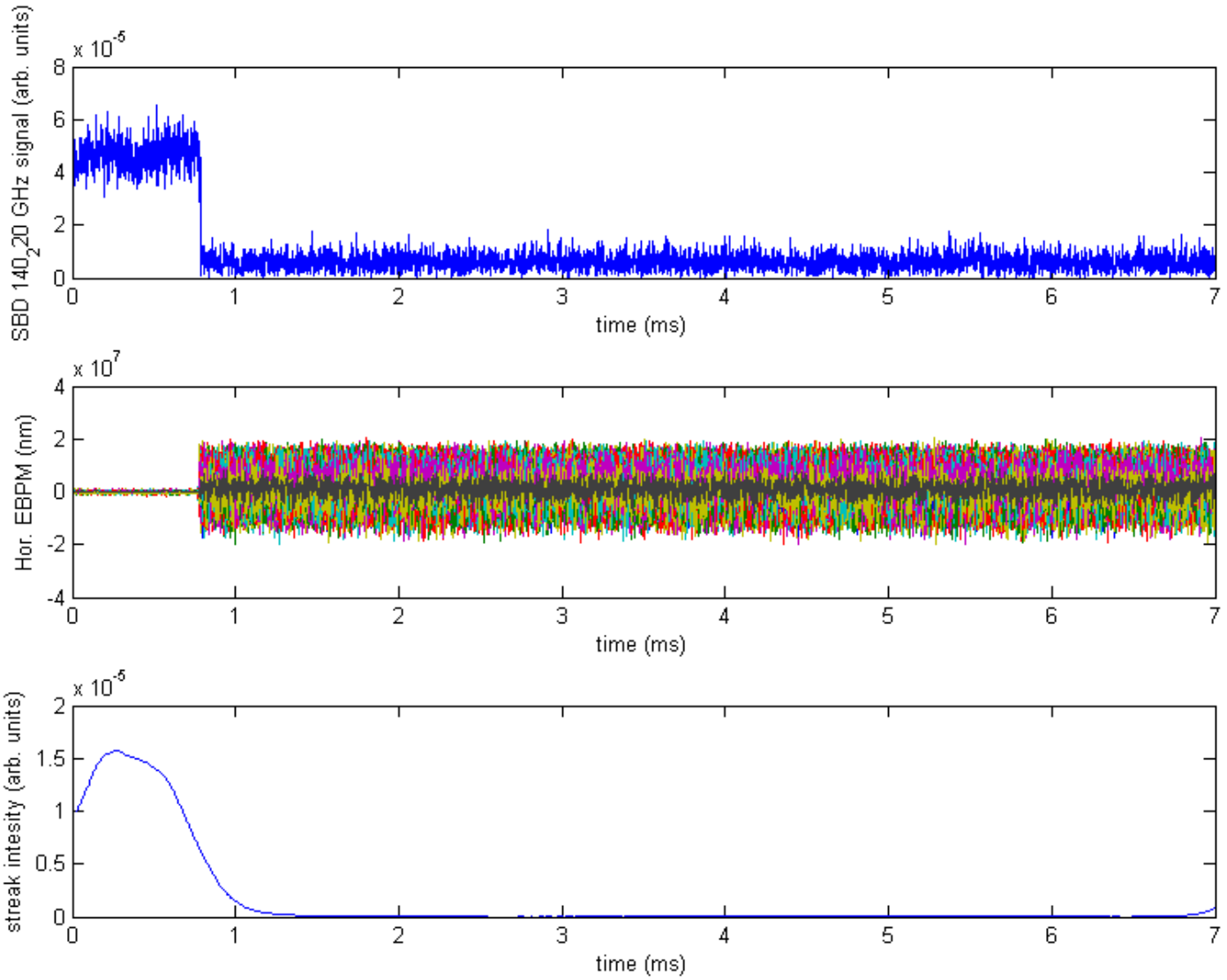
Overview

- Bursting in low-alpha limits maximum current in single bunch to a few 10uA
- Wanted to compare model with machine
- Need to record synchonously
  - Bunch Profile on Streak camera
  - CSR mm-wave signal from two Schottky Barrier Diodes (60-90GHz and 140-220GHz)
  - Whole orbit beam position in turn-by-turn to fit with dispersive orbit, retrieve beam energy changes

Challenge

- Trigger various instruments to record the same time with various delays after the trigger per instrument
  - 168 BPMs (instantaneous trigger)
  - Spectrum analyser to record signal from two SBDs (I/Q inputs used as two channel lock-in amplifier at revolution frequency 533kHz)
  - Streak camera:
    - Fast sweep on ‘synchroscan’
    - Slow sweep for 7.5ms span
    - Requires about 12ms pre-trigger
- Check synchronisation by kicking out beam

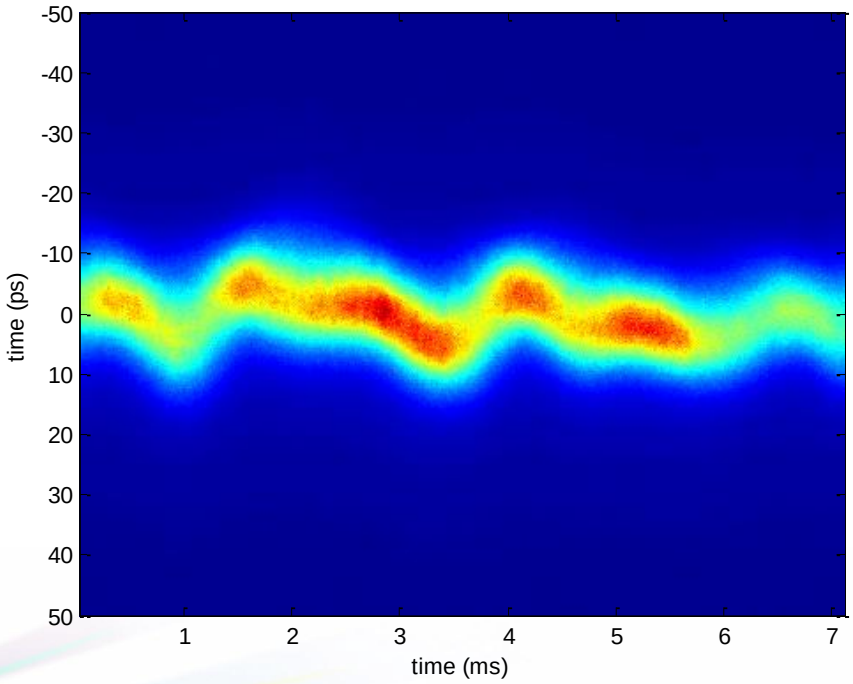
Synchronisation Check



Streak Camera Images

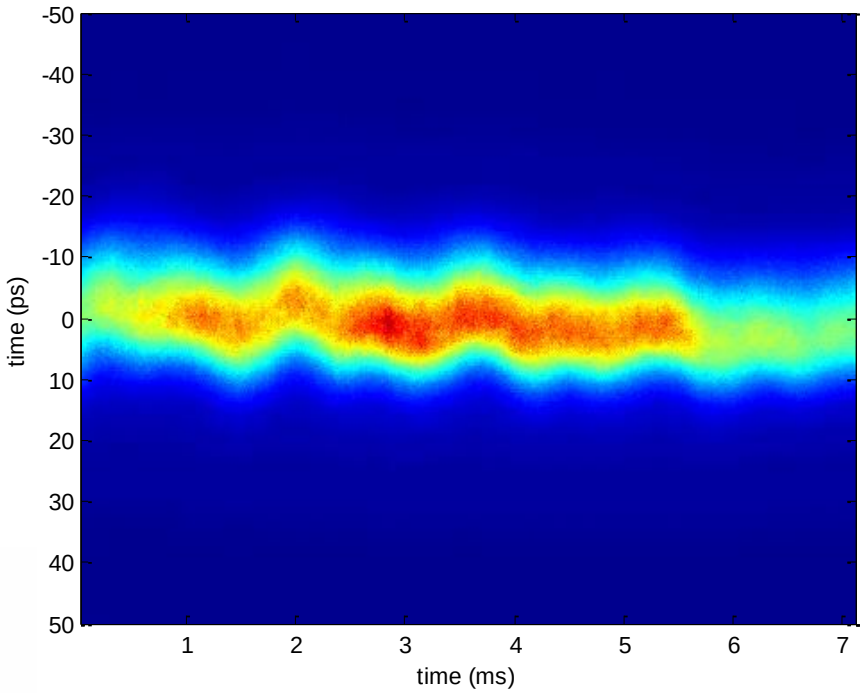
$\alpha = -4.5\times10^{-6}$

$I_{bunch} = 31\ \mu A$



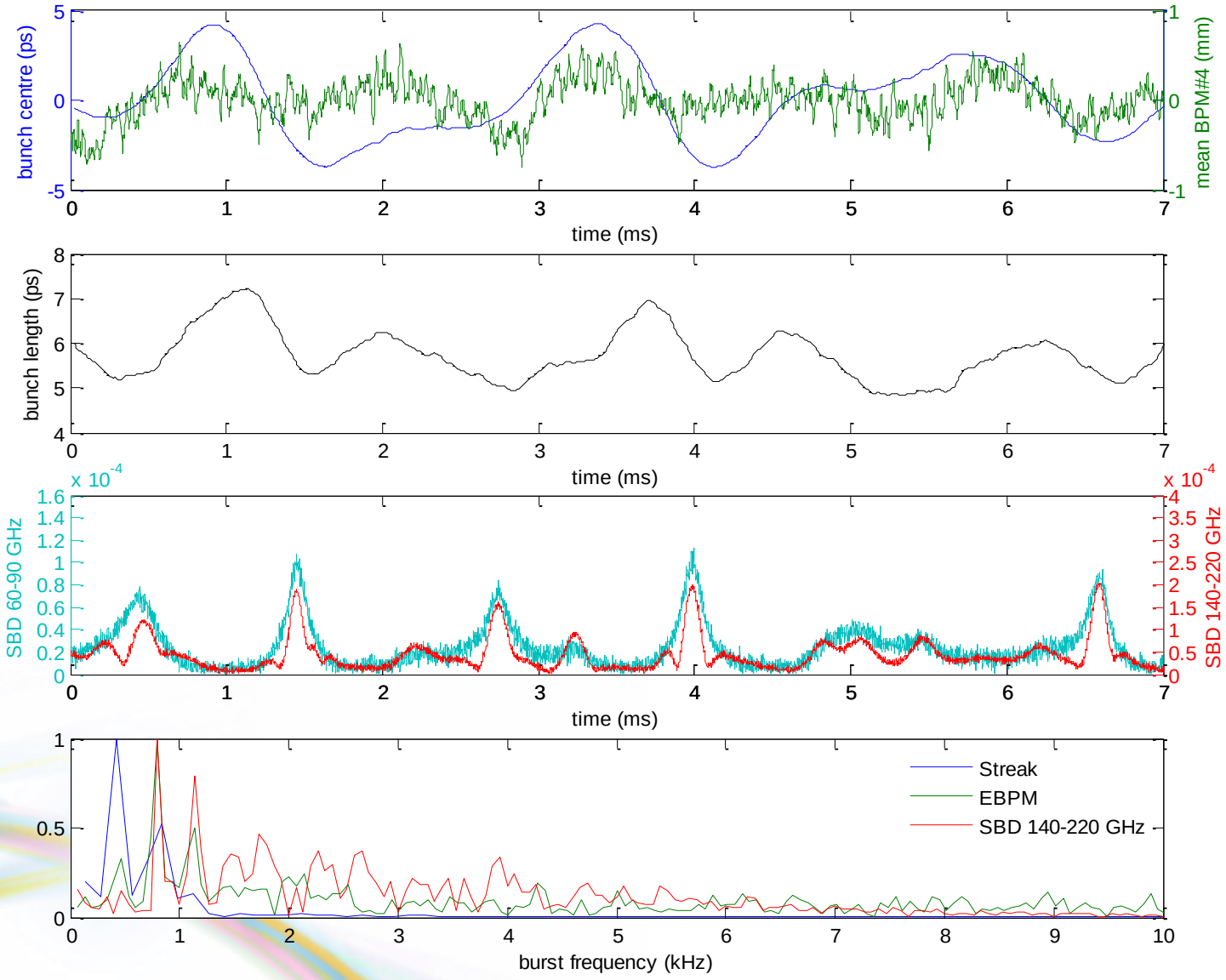
$\alpha = -1\times10^{-5}$

$I_{bunch} = 63.6\ \mu A$



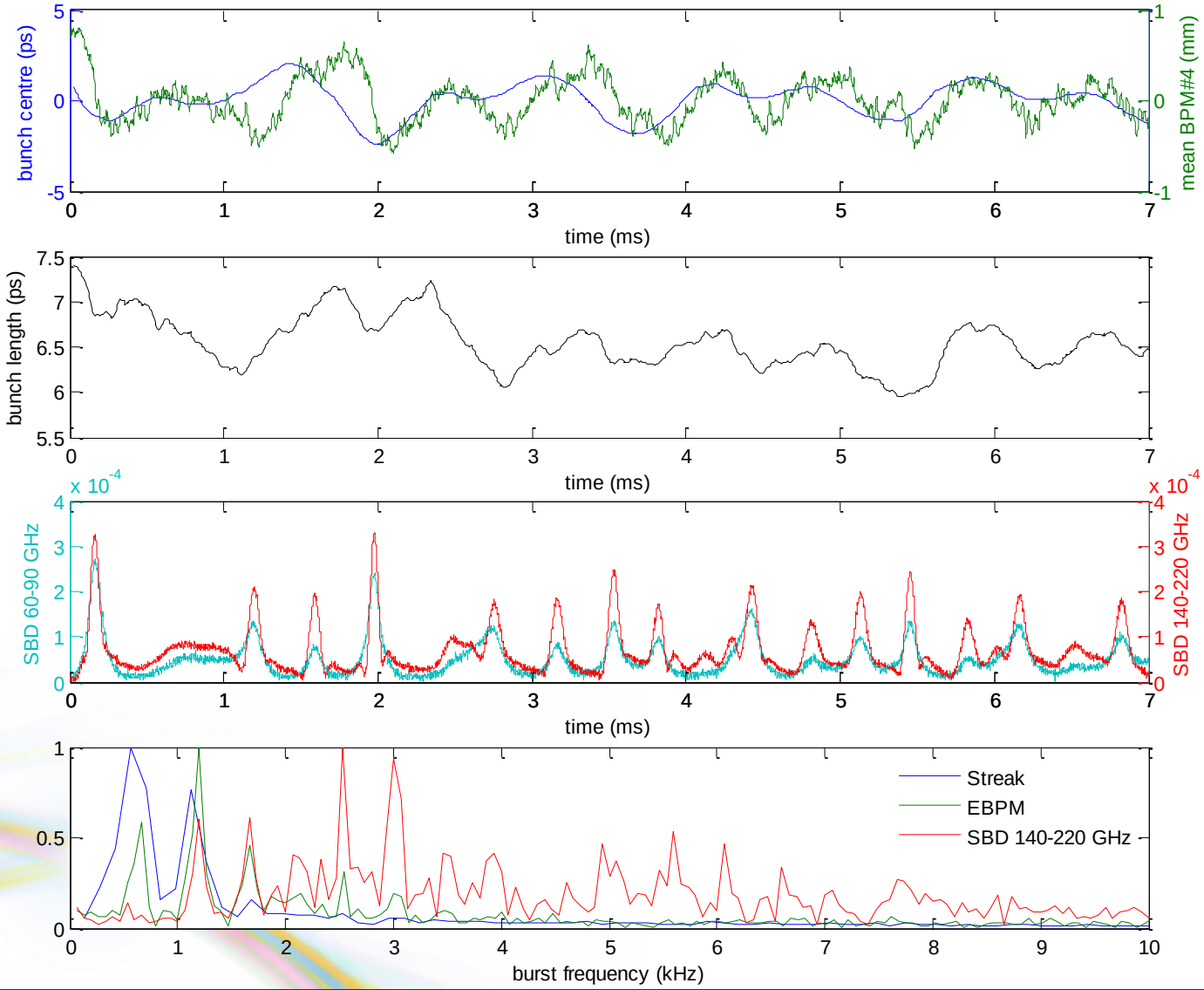
Measurements 1

$\alpha = -4.5\times10^{-6}$, $I_{bunch} = 31\ \mu A$, $f_s = 458\ Hz$



Measurements 2

$\alpha = -1\times10^{-5}$, $I_{bunch} = 63.6\ \mu A$, $f_s = 670\ Hz$



Summary / Issues

- The measured bunch length is longer than we would have expected (we found the streak camera scale out of calibration by 20-30% and non-linear)
- We would like to repeat the measurement with longer acquisition times for the BPMs and SBDs to improve the frequency resolution in the spectra
- For the case of alpha=-1e-5, it's not clear if the streak camera is resolving changes in bunch length on a short enough time scale, or whether the bursts really are occurring more frequently on the SBDs than the streak camera. Plan is to repeat the measurements with the streak camera set to a faster slow sweep to compare.