

Activity Status:

RF Amplitude Modulation at the SPS

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activity in collaboration with
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LCE Section Meeting

Recollection

Kicker for the extraction to the LHC becomes too hot due to short bunches.

How to get rid of this effect?

- SPS operates in LHC case with 200 MHz and 800 MHz
- 800 MHz RF system suppresses coupled bunch oscillations
- it is used in the ‘bunch shortening mode’ BS-mode (both RF systems in phase)
- one other possibility to stabilize longitudinal coupled bunch oscillations is a RF amplitude modulation – this method will be implemented as standard at HERA

Possible spin off for LHC

At the moment there is no longitudinal bunch to bunch feedback nor a higher harmonic RF system foreseen at the HLC.

- A longitudinal damper, acting via the RF cavities is in preparation. The bandwidth of such systems is usually limited due to the cavity bandwidth (filling time) and the available RF power.
- It has to be checked whether the filling time of the LHC cavities allows a RF amplitude modulation to suppress longitudinal coupled bunch instabilities if necessary.

Predictions – made in advance

The maximum relative **additional incoherent spread build up by the 800 MHz** system during acceleration is

$$\frac{s_f}{f_s} \stackrel{!}{>} 0.248$$

Spread values build up by 800 MHz system in standard LHC beam operation provided by E. Chapochnikova.

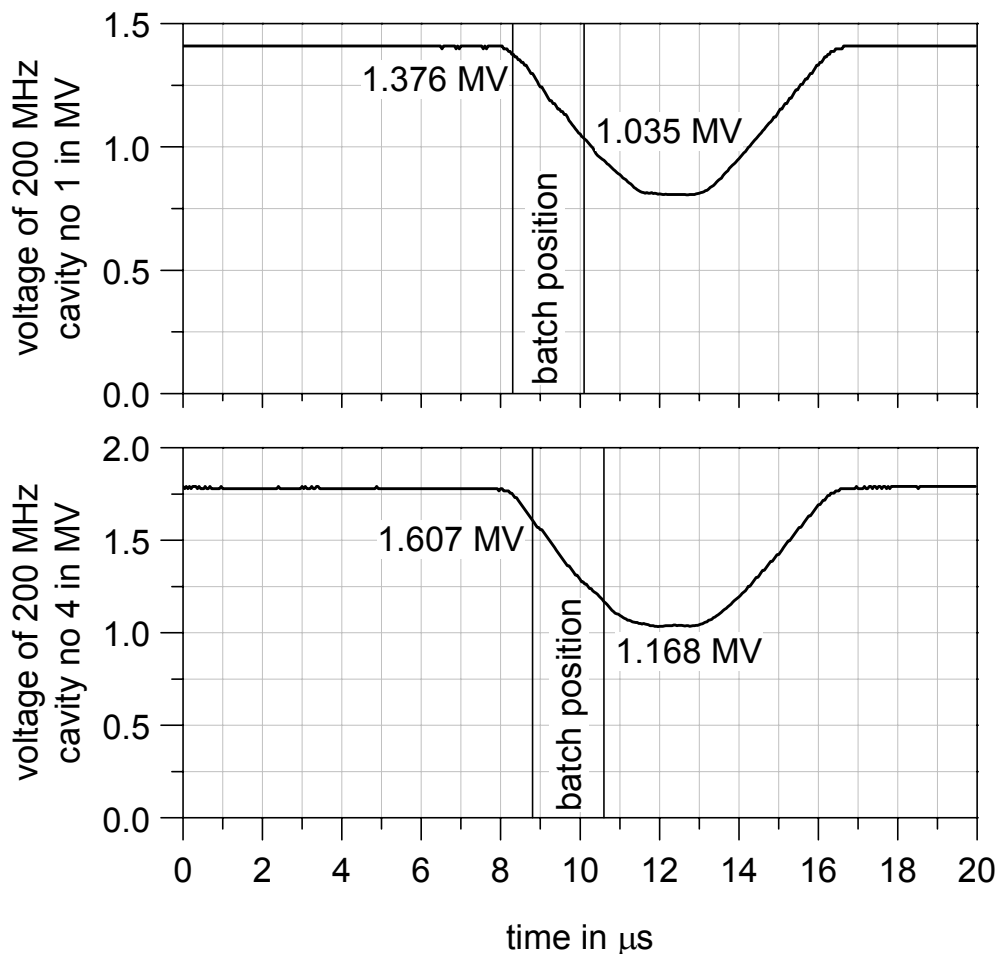
That mean without 800 MHz we had to provide a **bunch to bunch spread** of

$$\frac{S_f}{f_s} \stackrel{!}{>} 0.062$$

that correspond to **linear RF amplitude change** between the first and the last bunch **of 22%**.

RF amplitude modulation at the SPS

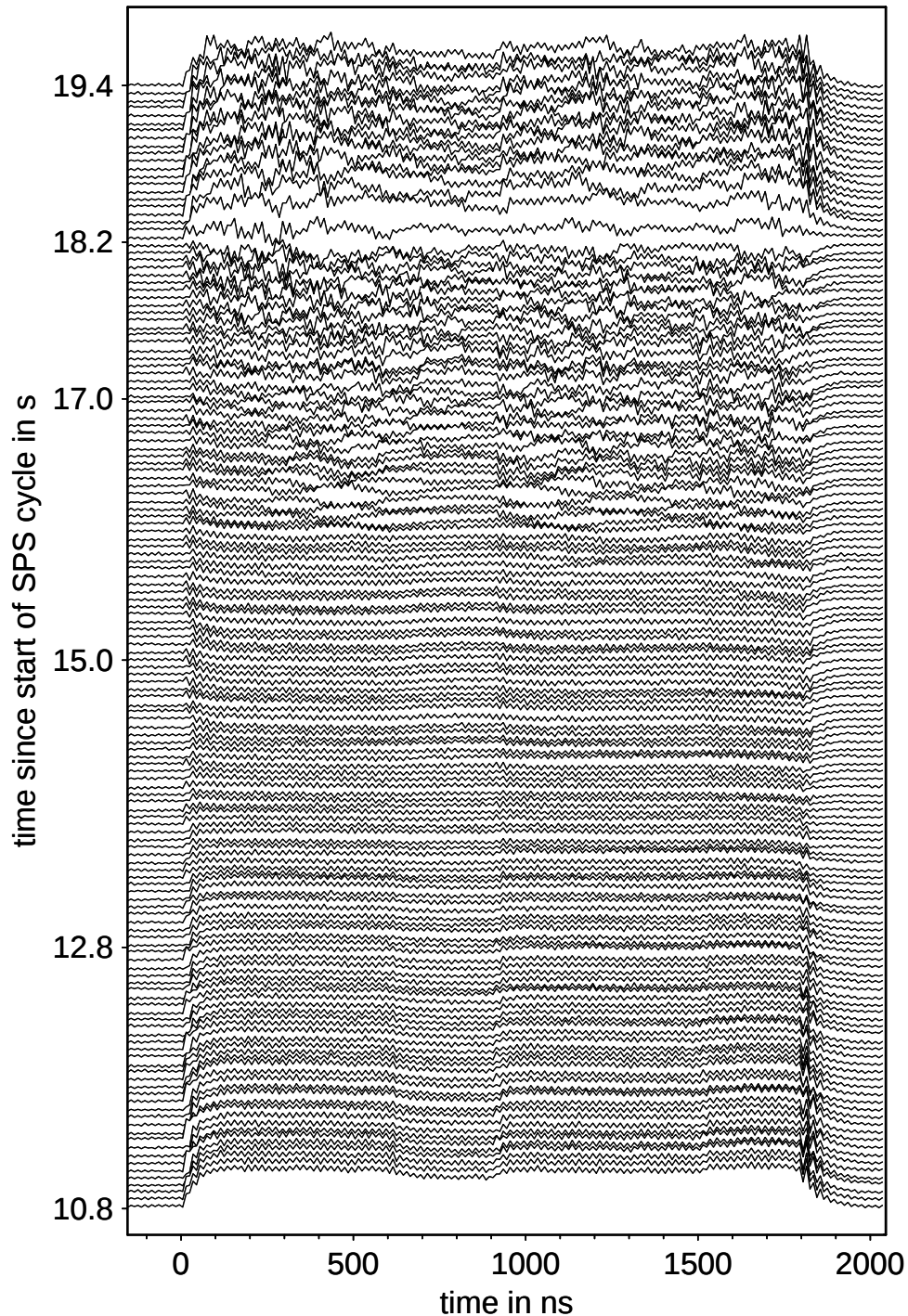
In the MD at 10. November we stabilized the beam by the following RF amplitude modulation:



The modulation was applied to all four cavities.

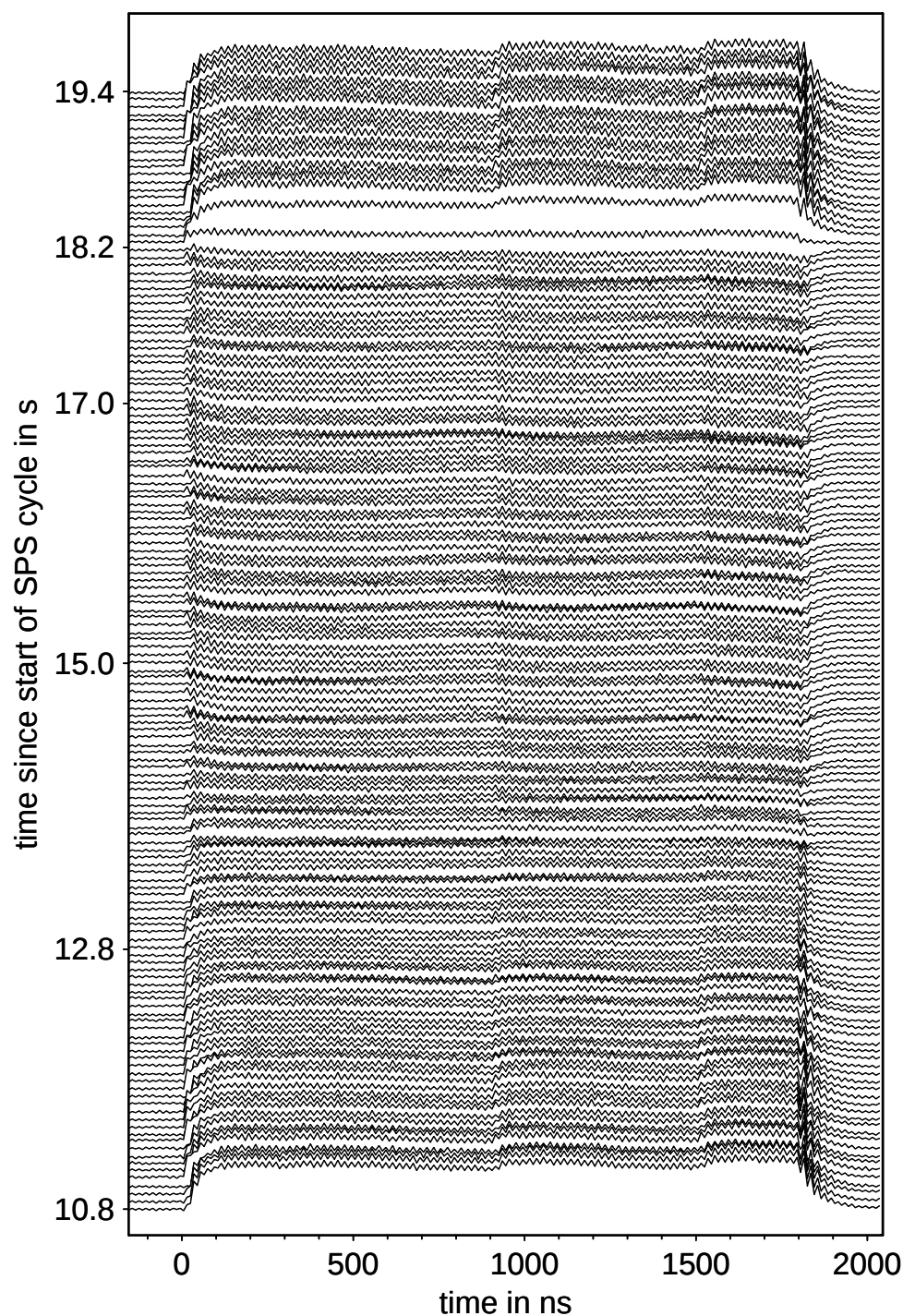
Maximum [supplied RF amplitude modulation](#): 31%

MR of signal of longitudinal damper without 800 MHz, without RF AM

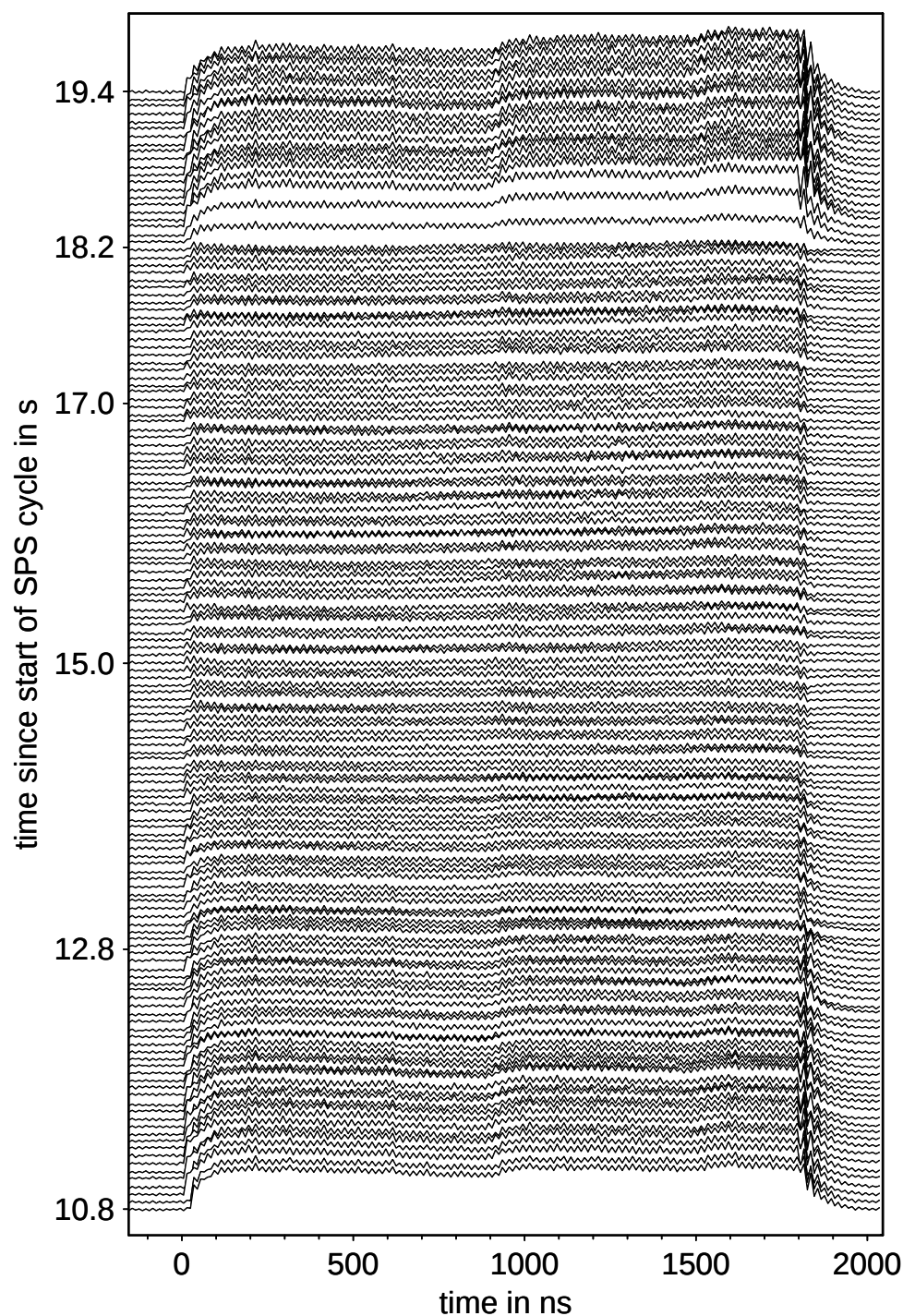


Data of mountain range (MR) taken with $\sim 0.3 \cdot 10^{11}$ protons / bunch.

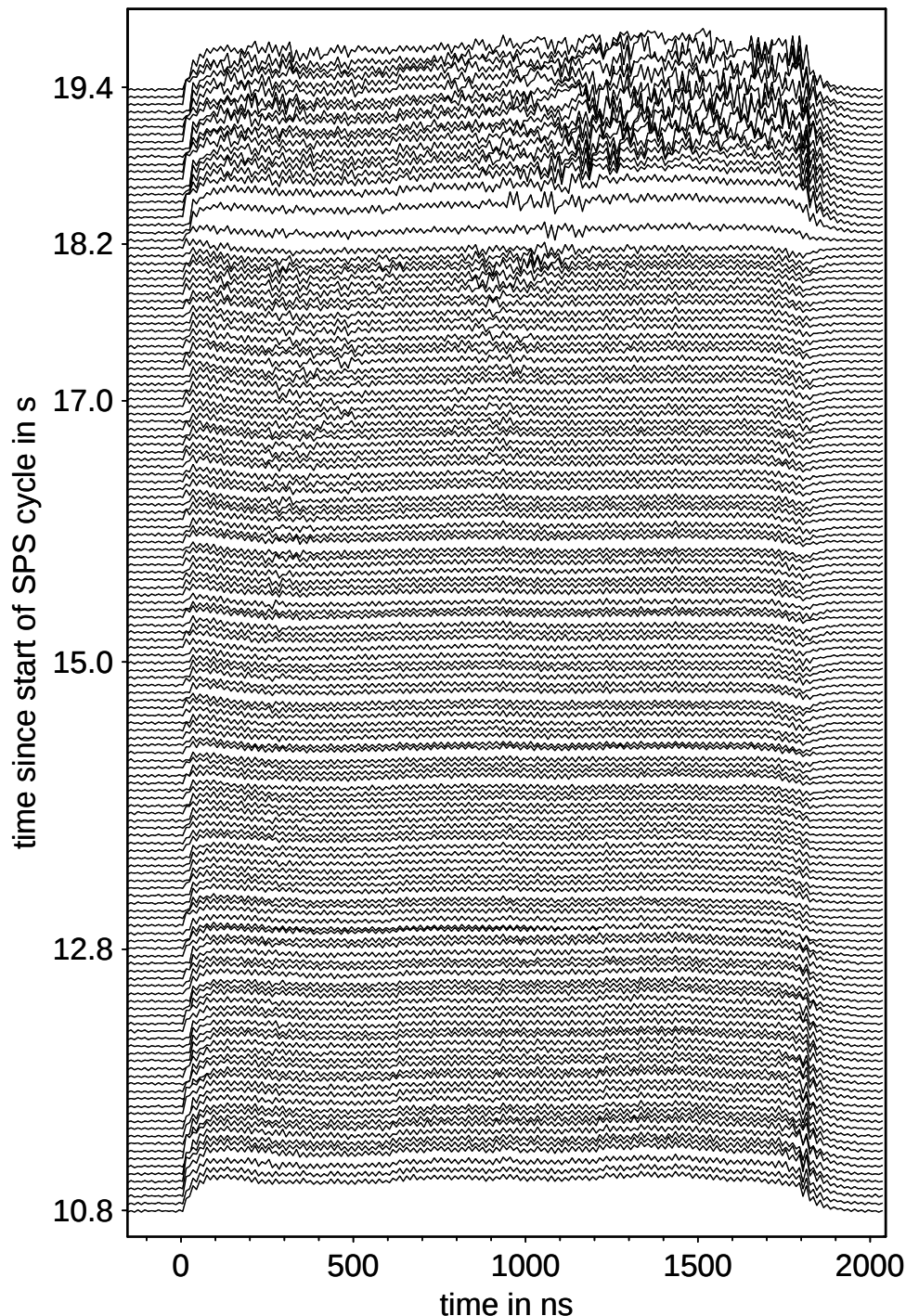
MR of signal of longitudinal damper with 800 MHz, without RF AM



MR of signal of longitudinal damper without 800 MHz, with RF AM



Intensity scan up to 10^{11} protons / bunch MR without 800 MHz, with RF AM



Beam was [stable during acceleration](#) but unstable at flat top. This is also the case with 800 MHz. In 'normal' operation (with 800 MHz) an artificial blow up is applied to stabilize the beam at flat top.

First preliminary results

The beam was **stabilized** up to 10^{11} particles per bunch **with RF AM of 31%**.

The beam was **unstable** with RF AM of **20%**.

This agrees with the ‘theoretical’ expectations made!

What has to be done?

Data analysis (of already taken data):

- **Comparison of bunch shapes** received by SPS operation with 800 MHz and RF AM.
- **Bunch lengths variation at flat top** caused by RF AM.
Question: Is this acceptable for ejections to LHC?

Potential future MD(s):

- **Comparison of LHC extraction kicker heating** by SPS operation with 800 MHz and RF AM.