

## Simulations with:

### Beam 1:

- Ultimate 25ns LHC beam
- 33.5 E11 p
- Bunch length: 180 ns (h=1)
- 1.3 eV.s longitudinal emittance
- 2.2  $\mu\text{m}$  (H) and 1.8  $\mu\text{m}$  (V) normalized transverse emittance

### Beam 2:

- Ultimate 50ns LHC beam
- 26.7 E11 p
- Bunch length: 170 ns (h=1)
- 1.2 eV.s longitudinal emittance
- 2.2  $\mu\text{m}$  (H) and 1.8  $\mu\text{m}$  (V) normalized transverse emittance

### **Main constraints:**

- Cycle duration = 900 ms, 160 MeV – 2GeV
- Start Cycle at C0, injection at C275
- Extraction plateau duration = 20 ms
- RMS MPS-current limited to 2493 A (1.4 GeV + 10 %)
- New MPS power supply: 5 kV
- 8kV C02 (h=1) maximum cavity voltage

### **Parameters to be played with:**

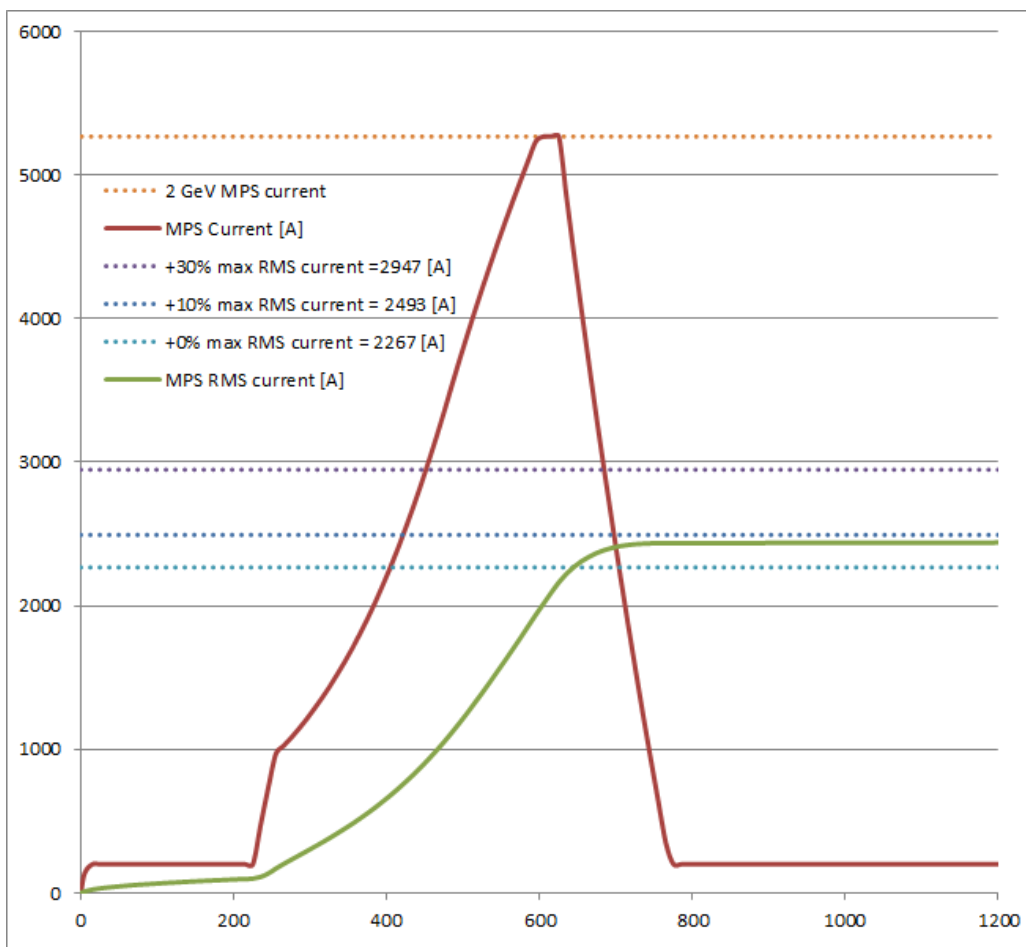
- Bucket filling ratio (allowing 100% filling allows for the fastest cycle, but prone to losses)

## **What does the simulation takes into account:**

- MPS limitations (New 5 kV version)
- RF power limitations (present ferrite narrow band cavities)
- Reduction of experienced RF Voltage due to space charge
- Reduction of RF acceptance due to stable phase

## **What it doesn't take into account:**

- Simulation limited to a single harmonic acceleration ( $h=1$ ) . Dual harmonic acceleration allows for more longitudinal acceptance and less space charge effects. The simulated cycle is thus a bit slower than strictly necessary (-> RMS MPS current higher than feasible).



### Beam 1:

MPS current (red top trace)

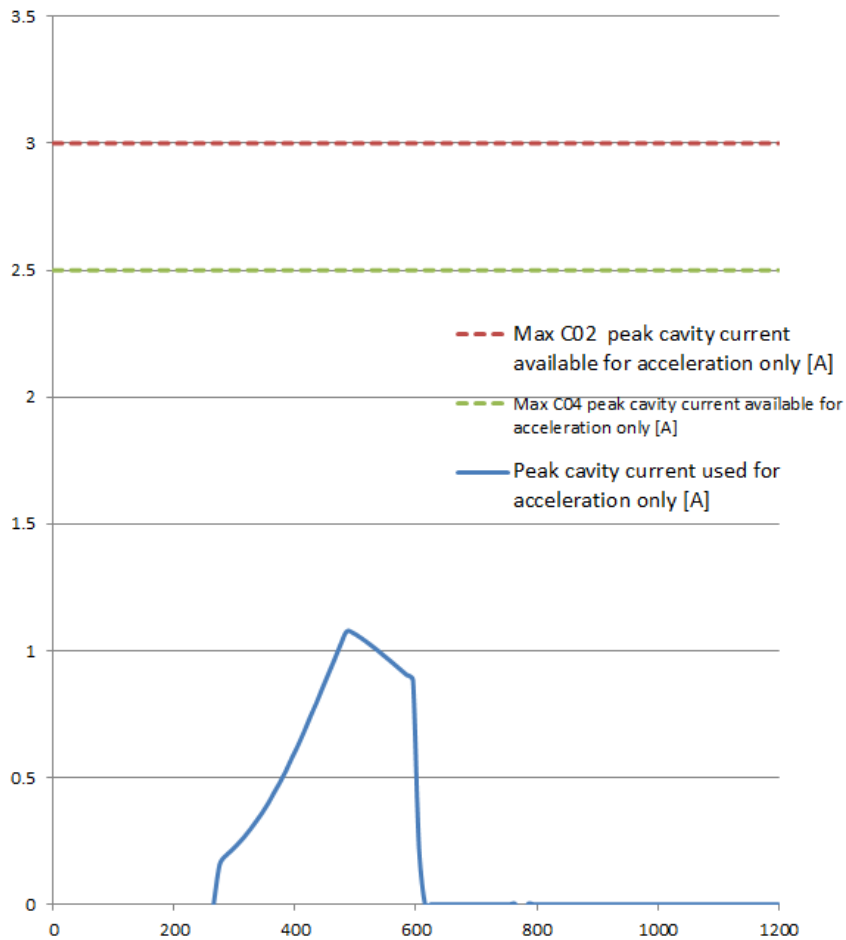
MPS RMS current (Green bottom trace)

The RMS current is just below the acceptable maximum (10 % over the 1.4 GeV cycle typical value).

Note that although the horizontal axis goes up to 1.2 s, the RMS current is well calculated over a 0.9 s cycle duration

Note that the MPS current is kept at its lowest value during the absence of beam

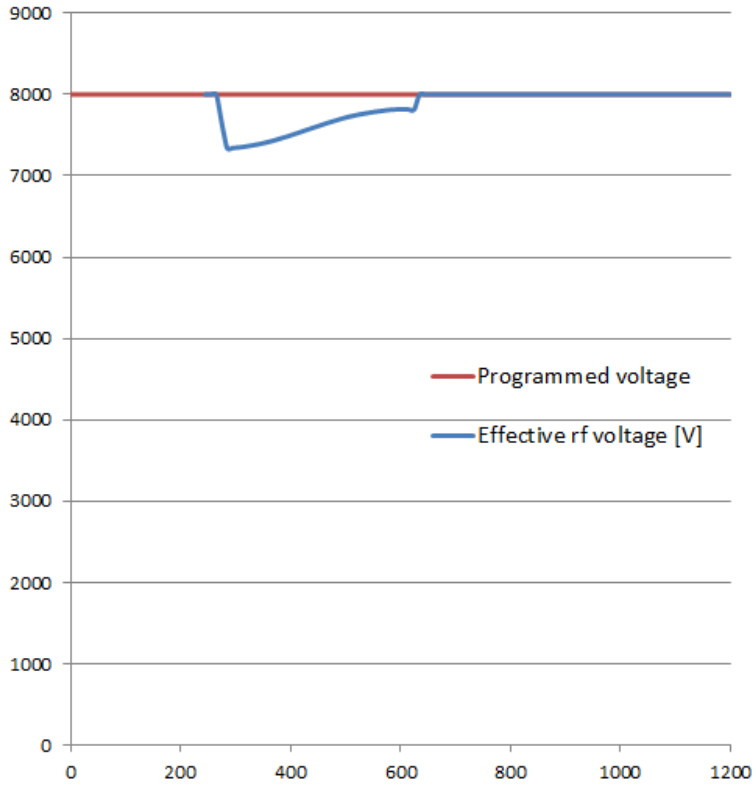
Magnetic field non equal to zero during 710 ms



Beam 1:

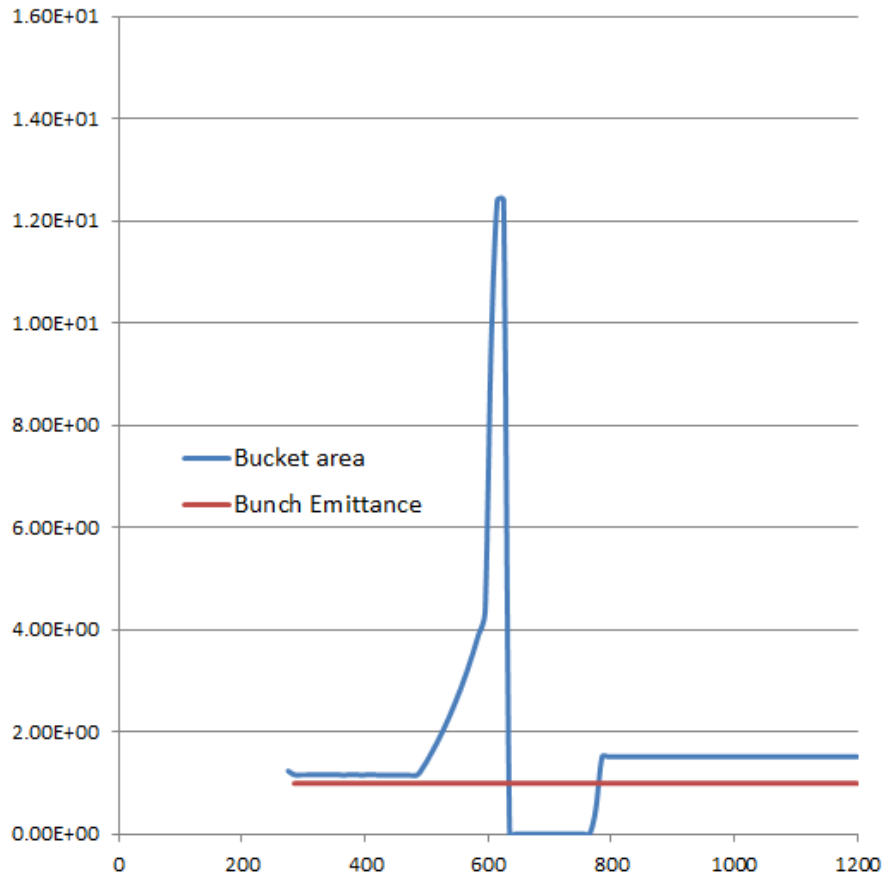
C02 cavity current

The demand is well below the capabilities of the power amplifiers 1.1 A where 3 A are available.



Beam 1:

Effective RF voltage sensed by the beam



### Beam 1:

Bucket area (Blue trace) and Bunch emittance (red bottom line)

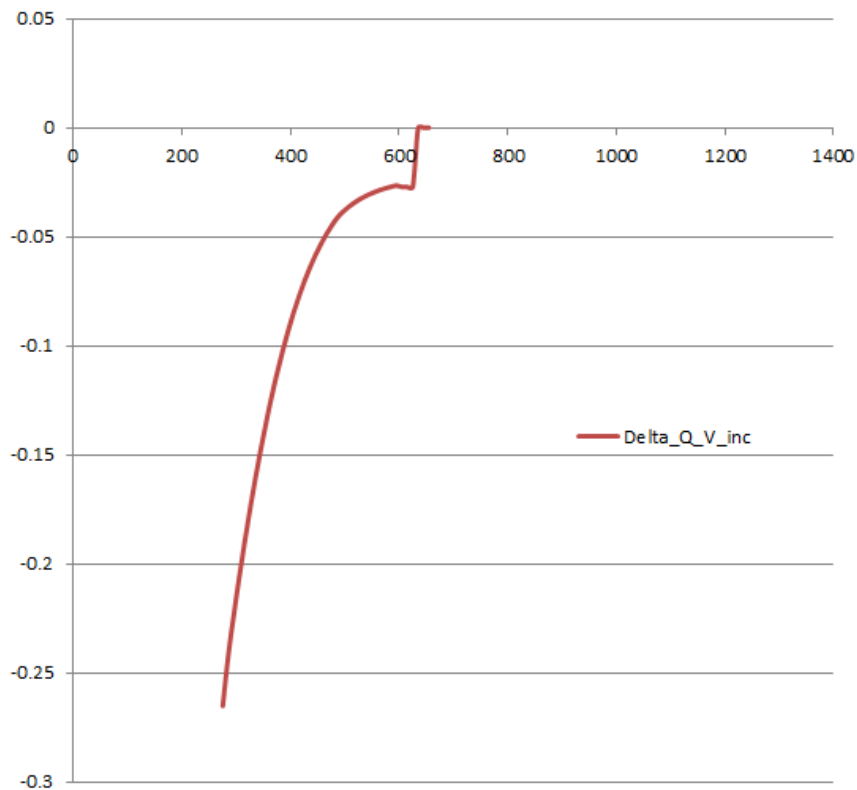
The injection value has been set to 1 eV.s and this value remains along the cycle.

The cycle is set in order to keep a maximum filling ratio of 85%

A longitudinal blow-up can only be started at C500 where there is room for a beam size increase.

**There is thus only about 100 ms to obtain 30% emittance increase**

Delta\_Q\_V\_inc



Beam 1:

Vertical incoherent tune shift

Normalized V beam emittance =  $1.8 \mu\text{m}$



The simulation with beam 2 is not necessary, as it represents less constraints.

## Conclusion:

There is no show stopper for the acceleration of the 2 LHC ultimate beams in the PSB within a 900 ms PSB cycle ranging from 160 MeV to 2 GeV.

There is a little worry concerning the possibility to **blow-up the beam longitudinally by 30% in 100ms**. With the improved blow-up method offered by the new digital beam control (in test presently on Ring 4) this might well be achievable.

The MPS current should be set to its minimal value in the absence of beam to keep the RMS current (magnet heating power) low enough for a **super-cycle packet with these kind of cycles**.

With a super super-cycle composed of some **cool-down cycles** (no bending field), the number of magnetic cycles per unit of time would be lowered and so would be the RMS current. The magnetic cycle could thus be longer than the simulated 710 ms within the 900 ms of the machine cycle, to an extent to be determined by the CO group.