MD2095: Heat load studies with 50 ns beams

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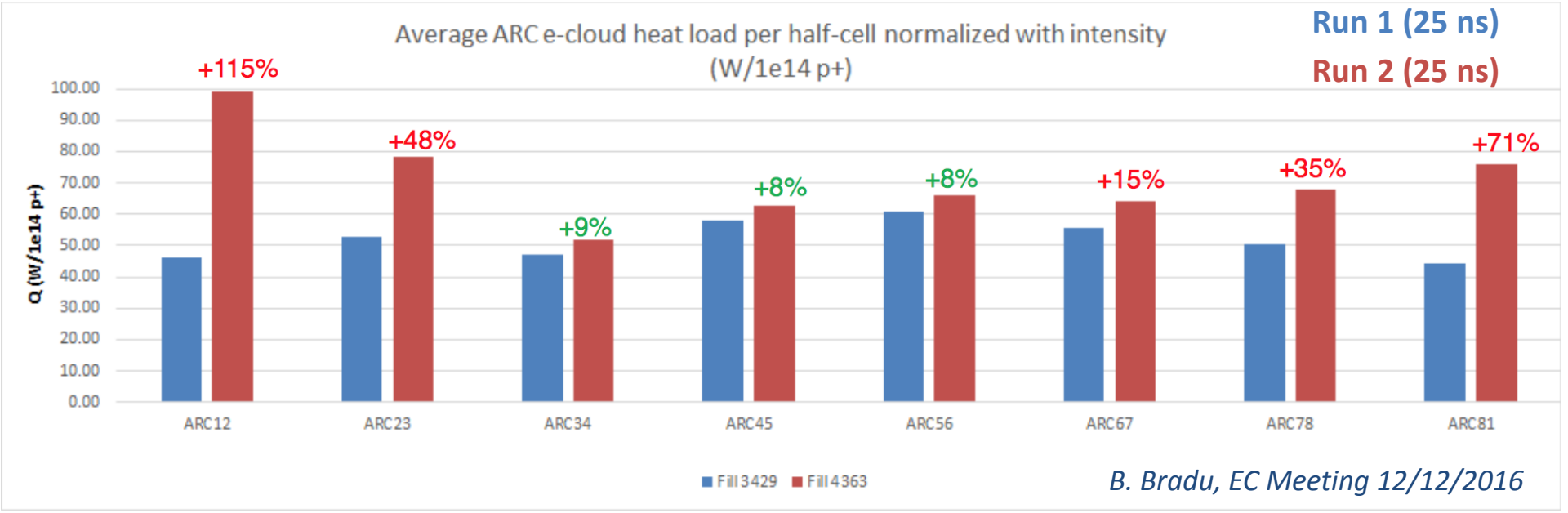
Proposed study

- The MD consists in filling the LHC with **50 ns trains** with **high bunch intensity** (1.7e11 p/bunch), possibly with the full machine
  - The **operational cycle** will be used (with no major changes)
  - **Flat-top** (6.5 TeV) would be sufficient for heat load measurements but **squeeze and collisions** are of interest for other studies (see later)

Motivation

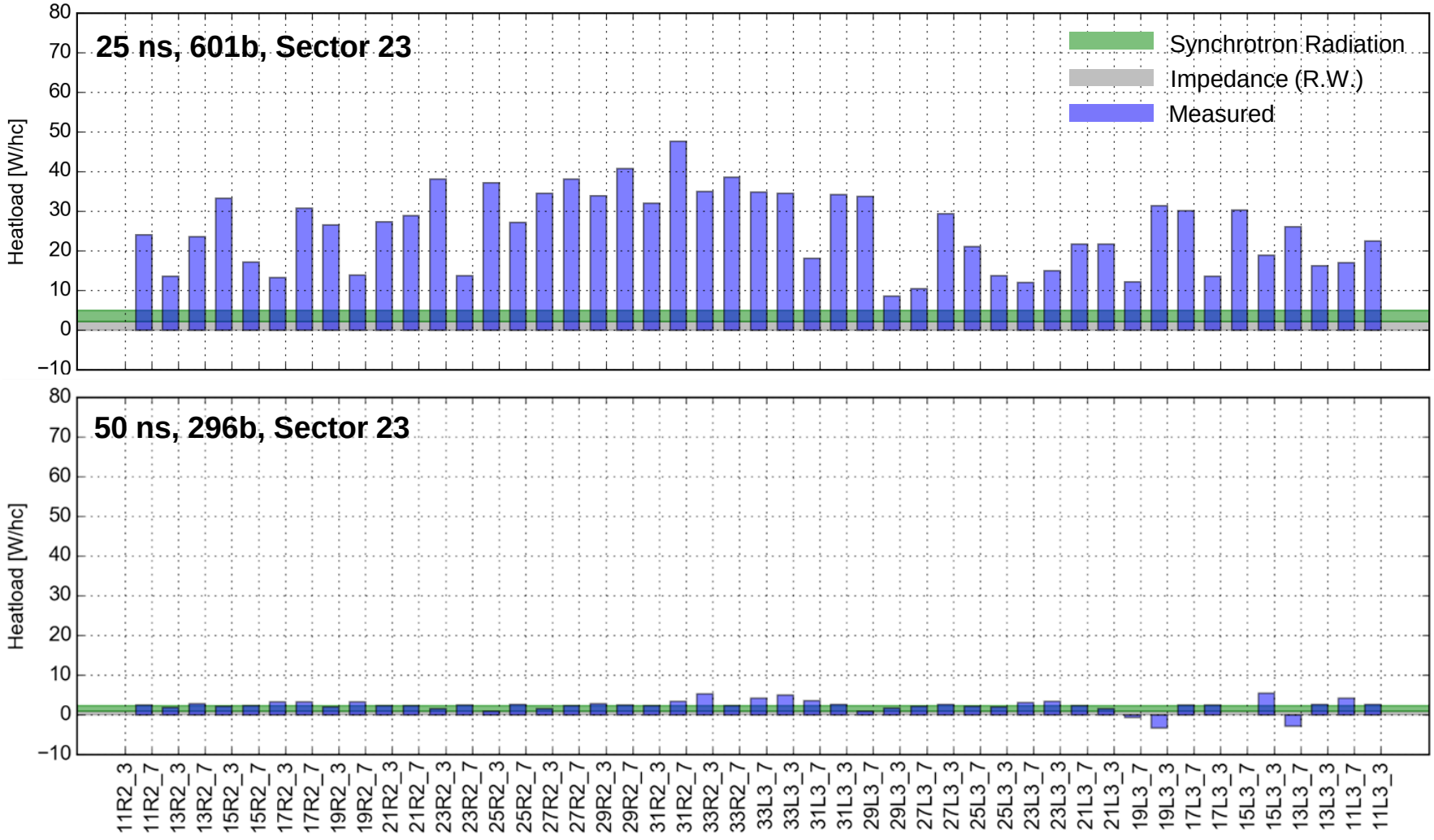
- When operating with 25 ns beams, **heat loads on the arc beam screens** show large **differences between sectors**
- The **origin** of this difference is presently not understood, and the high-load sectors constitute a **limitation** for the (HL)LHC intensity reach
- Such a difference was **not present during Run 1**



B. Bradu, EC Meeting 12/12/2016

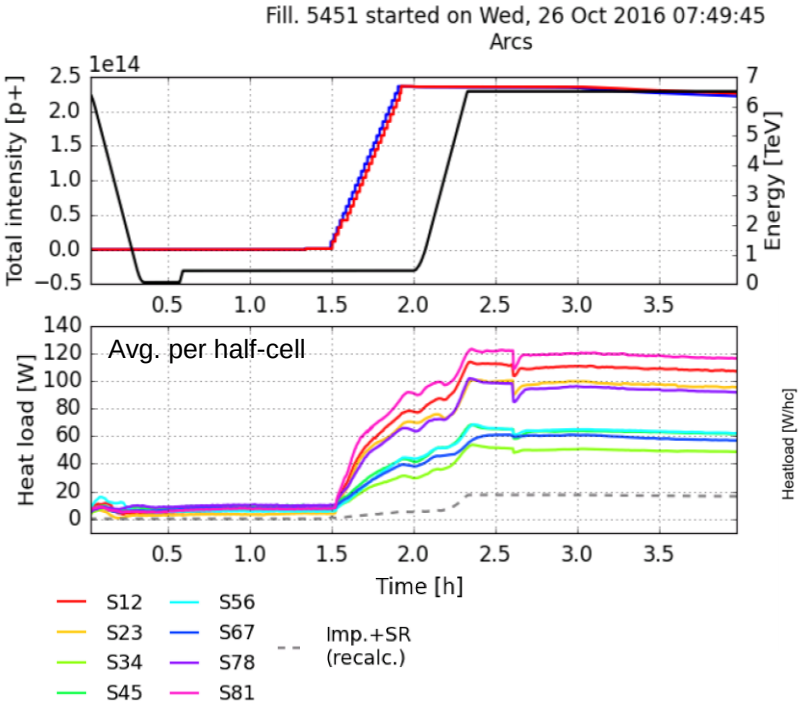
Motivation

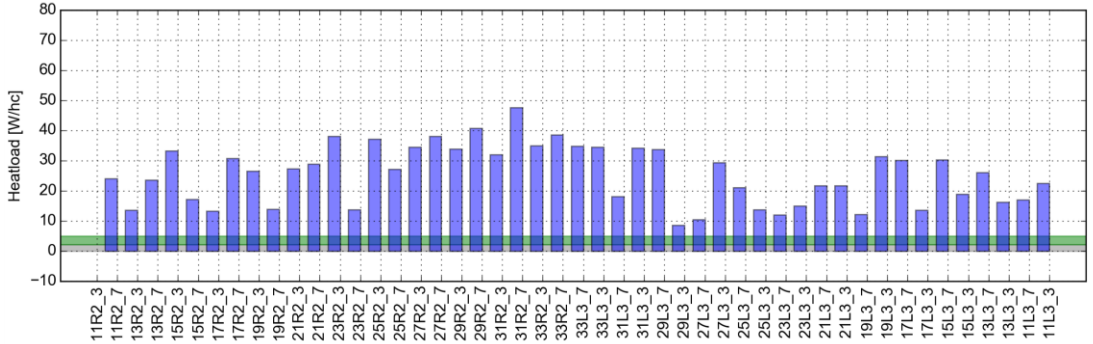
- From the available data the problem seems **restricted to 25 ns case**, but **50 ns and 100 ns fills in Run 2** had rather **low total intensity**
  - Heat load measurements are quite poor for low load
  - Beam screen cooling system working in a different regime



Motivation

- A **50 ns fill** with high intensity would provide measurements **with heat loads in the range of what is observed in 25 ns fills**, but from very well known sources, i.e. **synchrotron radiation** and the **impedance** of the beam screen
- In these conditions it will **be interesting to check** whether:
  - The **difference between sectors** is observed
  - The **cell-by-cell pattern** is the same as for 25 ns

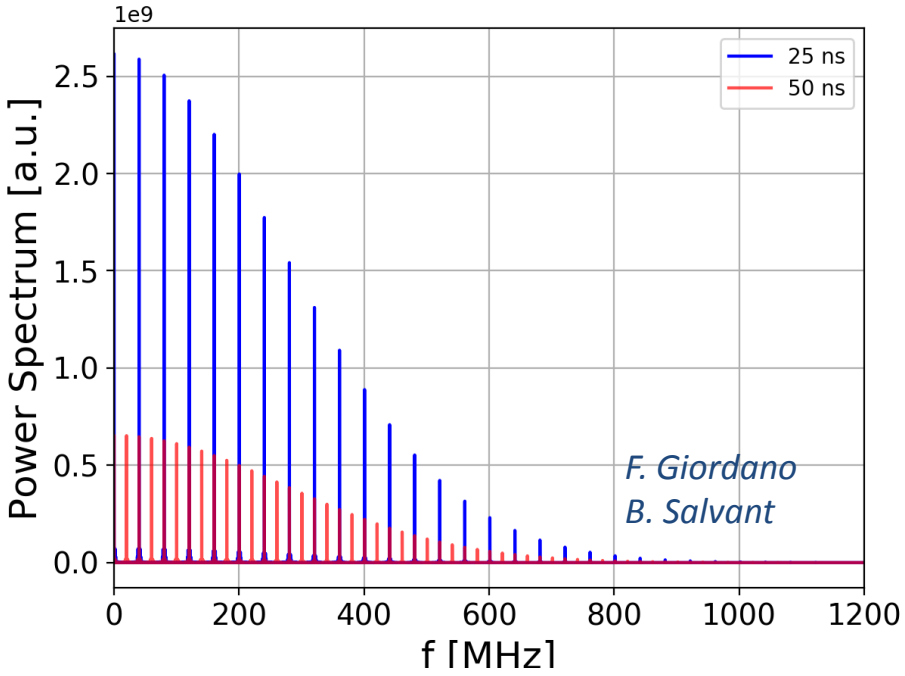




Motivation

- **Comparison 25 ns and 50 ns beams** with same train pattern and similar bunch length can be used to **exclude other impedances** as the source of the difference between sectors, as **for any impedance the following relation needs to be verified**:

$$\mathrm{HeatLoad}_{25ns} < 4\ \mathrm{HeatLoad}_{50ns} \left(\frac{BunchInt_{25ns}}{BunchInt_{50ns}} \right)^2$$



Synergies with other studies

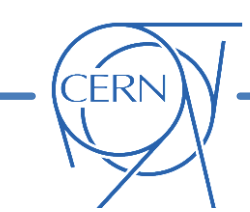
- 50 ns beams have been requested also for **collimation MDs** (MD2206) aiming at studying **losses and collimation with high bunch intensity**
  - Main goal is to investigate **loss rates with high bunch intensity** in comparison with 2012 experience (as recommended by HL-LHC electron lens review)
  - This MD could be **part of the "mini ramp-up"** in intensity needed to go to full machine and parasitic measurements on the fills with larger number of bunches would complete the study

- **Other studies** would profit from data collected with high intensity 50 ns beams, investigating **open questions from 2012** and probing bunch intensities towards **HL-LHC**:
  - **Beam induced heating:** check behavior of sensitive elements with high bunch intensity
  - **Beam-beam and luminosity modeling:** observe the evolution of beam parameters i.e. lifetime, emittances, specific luminosity in presence of a stronger head-on in combination with long ranges (MD2209)
  - **Stability:** study instabilities observed with high intensity in 2012 profiting of improved knowledge of machine parameters (Q', coupling)

From first discussions

- **Systems** that might need to be tuned/verified (to be checked in detail):
  - Injection
  - Interlock BPMs in IP6
  - Orbit measurements
  - ADT (high intensity settings need to be prepared also for high pile-up test with 8b4e?)

- **Possible ramp-up:**
  - A few trains (could be collimation MD)
  - 300b
  - 600b
  - 1300b



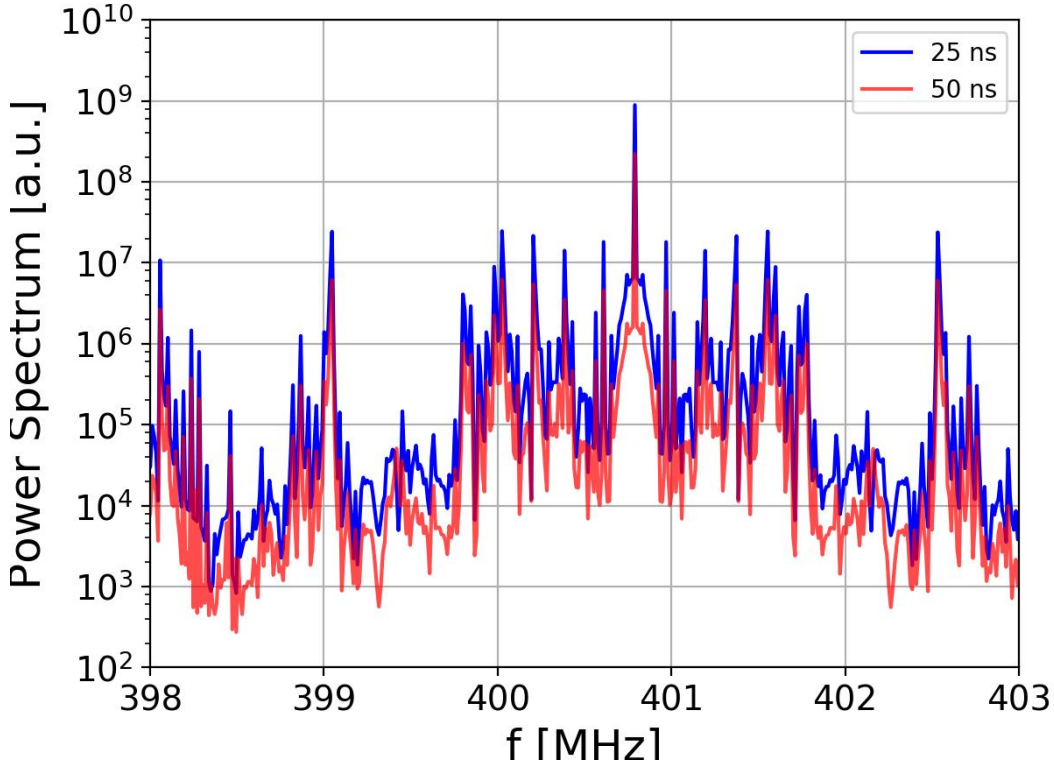
Thanks of your attention!

****** Case: 50 ns, high intensity ******

```
Bunch intensity: 1.70e11 p/bunch
Number of bunches: 1278
Bunch length (4 sigmas): 1.10 ns
Energy: 6500 GeV
Heat loads (for 2 beams):
 - Impedance            10.5 W/half-cell
 - Synchrotron radiation 9.2 W/half-cell
 Total                  19.7 W/half-cell
```

****** Case: 25 ns ******

```
Bunch intensity: 1.10e11 p/bunch
Number of bunches: 2256
Bunch length (4 sigmas): 1.10 ns
Energy: 6500 GeV
Heat loads (for 2 beams):
 - Impedance            7.7 W/half-cell
 - Synchrotron radiation 10.6 W/half-cell
 Total                  18.3 W/half-cell
```


25 ns
50 ns
Power Spectrum [a.u.]
f [MHz]
10^{10}
10^{9}
10^{8}
10^{7}
10^{6}
10^{5}
10^{4}
10^{3}
10^{2}
398
399
400
401
402
403