

MTE Beam With Gaps

Data of 2018-11-09

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Contents

Introduction

Measurements

Batch Profiles

RF Power Measurements

Gap Width Measurements

Analysis

Conclusions

Introduction

CPS

- ▶ MTE Beam, 4 Islands + Core, 5-turns, gap, losses at extraction

SPS

- ▶ beam loading, RF power, losses
- ▶ not discussed: slow extraction, spill duty cycle

Measurements

CPS

- ▶ MTE Beam: 4 Islands + Core, twice injected, 5/11 + 5/11, $N_{Q,tot} = 2.8 \times 10^{13}$ at $t = 1260$ ms
- ▶ modified MTE Beam between 09:15 and 10:30
- ▶ gap width between 75 ns and 325 ns

Measurements

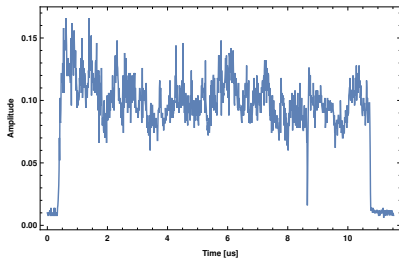
SPS

- ▶ longitudinal bunch profiles using APWL via FO link: batch structure
- ▶ 200 MHz Line 1 MW Summing Hybrid output: RF power measurements ($2 \times$ 4-section, $2 \times$ 5-section travelling wave structures)
 - ▶ peak RF power
 - ▶ peak-to-peak RF power modulation
- ▶ FBCT: gap width measurements
- ▶ BCT: transmission, losses

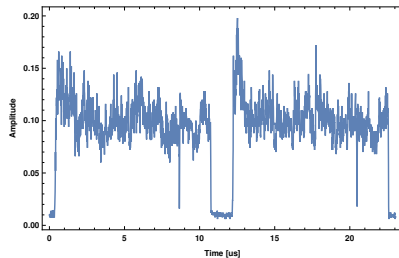
Batch Profiles

Batch envelope, without intentional gap

Half Turn



Full Turn

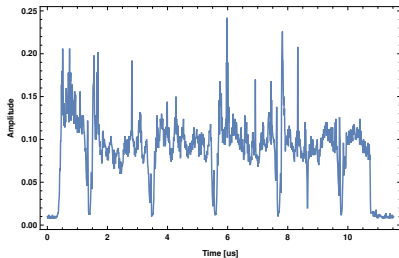


- ▶ gap between 4th Island and Core
- ▶ asymmetric batch spacing

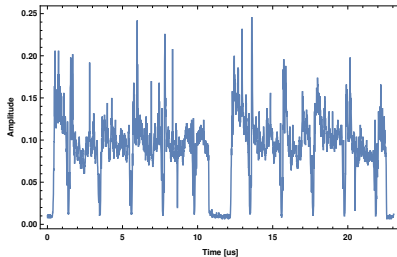
Batch Profiles

Batch envelope, with small intentional gap

Half Turn



Full Turn

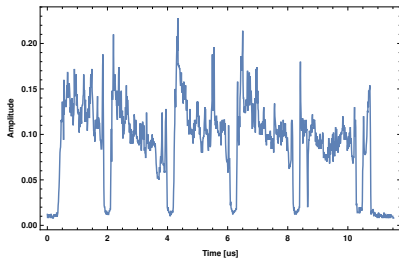


- ▶ gap between 4th Island and Core
- ▶ small intentional gaps and spikes

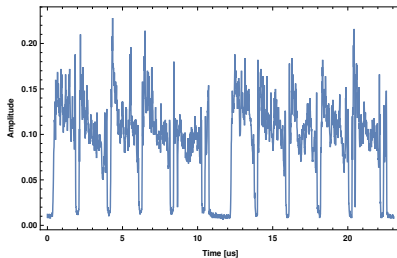
Batch Profiles

Batch envelope, with large intentional gap

Half Turn



Full Turn

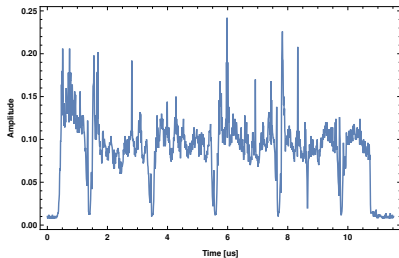


- ▶ gap between 4th Island and Core
- ▶ large intentional gaps and spikes

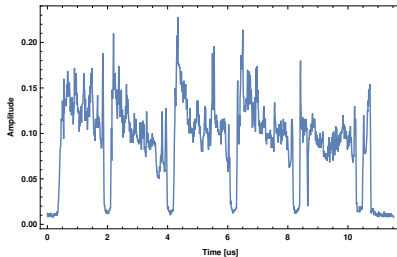
Batch Profiles

Batch envelope, gap comparison

Small Gaps



Large Gaps



- ▶ gap between 4th Island and Core
- ▶ gaps are not synchronous with SPS f_{rev}

Batch Profiles

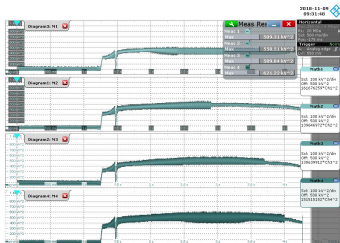
Conclusions

- ▶ gap between 4th Island and Core
- ▶ gaps are not synchronous with SPS f_{rev}
- ▶ gaps and spikes (not good for optimal beam loading compensation)

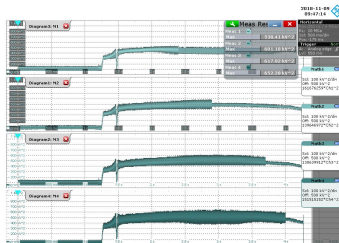
RF Power Measurements

Peak RF Power, Peak-to-Peak RF Power

No Gaps



Small Gaps

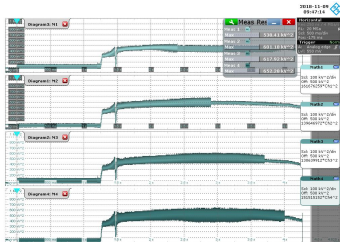


- ▶ cycle: RF on, injection, start ramp, acceleration, 1-turn delay feedback off, RF off
- ▶ increase of peak RF power and peak-to-peak RF power with introduction of small (75 ns) gaps
- ▶ RF power with 1-turn delay feedback off stable within better than 2% for the whole observation period 09:30 to 10:30

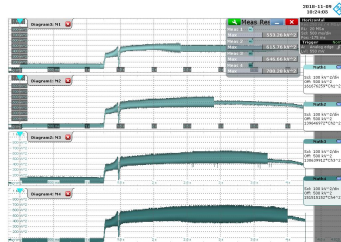
RF Power Measurements

Peak RF Power, Peak-to-Peak RF Power

Small Gaps



Large Gaps

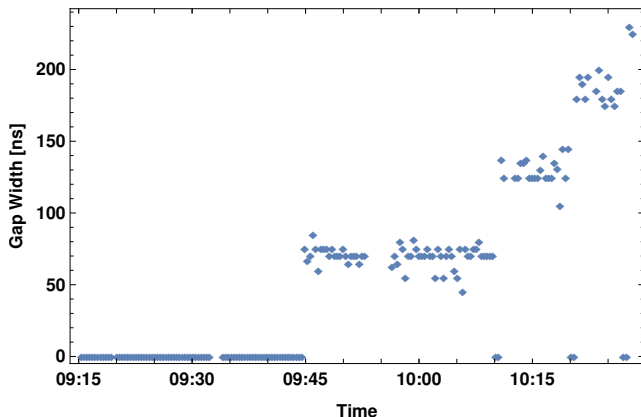


- ▶ further increase of peak RF power and peak-to-peak RF power

Gap Width Measurements

Gap Width

- ▶ FBCT data
- ▶ width determined at the 25% level of the batch amplitude



Analysis

Discussion of

- ▶ peak RF power
- ▶ peak-to-peak RF power modulation
- ▶ BCT losses

as function of gap width.

Gap width and BCT data: average within last two minutes of power measurement data saving time stamp.

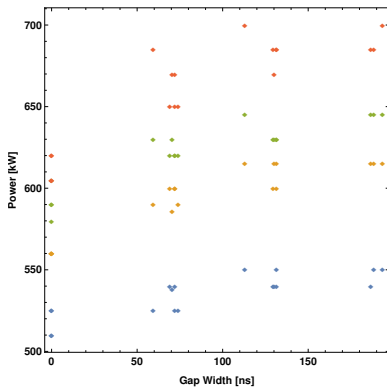
Not discussed (see Notes)

- ▶ correlations between
 - ▶ peak RF power measurements (all 4 Lines individually, pairwise 4-section/5-section structures, all 4 combined)
 - ▶ peak-to-peak RF power measurements (all 4 Lines individually, pairwise 4-section/5-section structures, all 4 combined)
 - ▶ losses between various times of the cycle
 - ▶ $t_s = 1260$ ms, $t_{tr-} = 1430$ ms, $t_{tr+} = 1530$ ms, $t_e = 4200$ ms
 - ▶ gap width

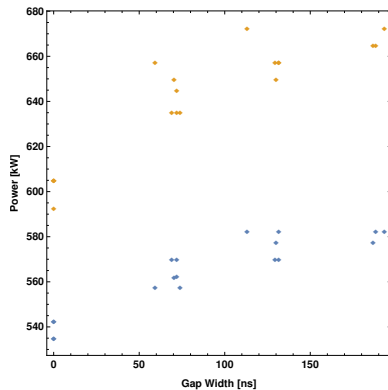
Analysis

Peak RF Power

P1: blue, P2: orange, P3: green, P4:red



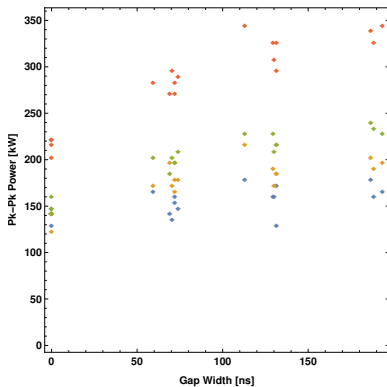
$(P1 + P2)/2$: blue, $(P3 + P4)/2$: orange



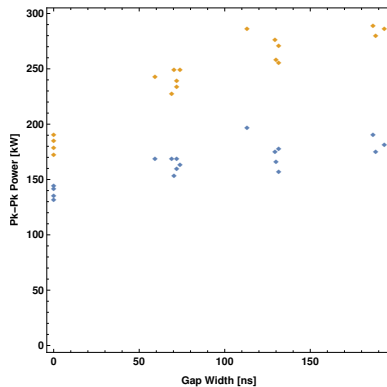
Analysis

Peak-to-Peak RF Power Modulation

M1: blue, M2: orange, M3: green, M4:red

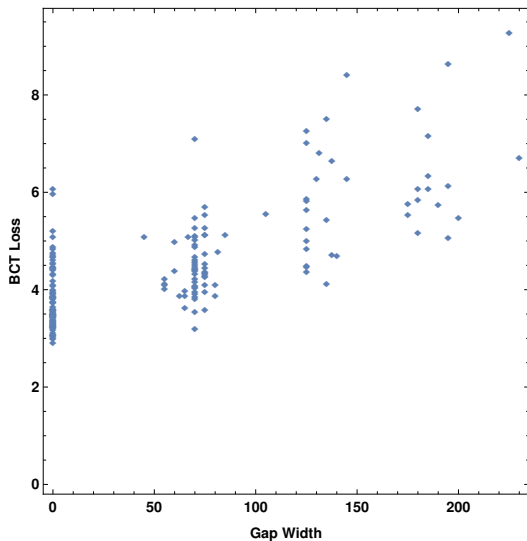


$(M1 + M2)/2$: blue, $(M3 + M4)/2$: orange



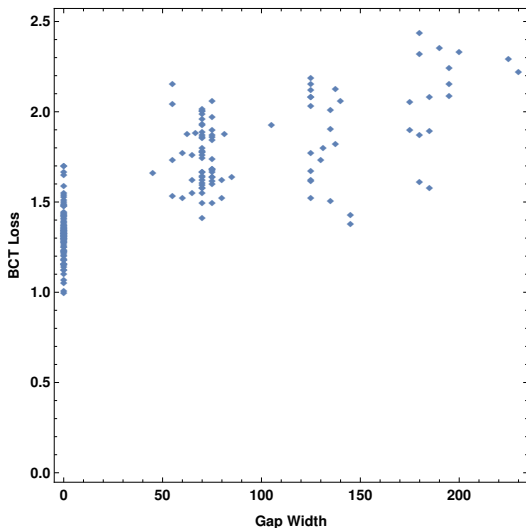
Analysis

BCT Loss between $t_1 = t_s$ and $t_2 = t_e$



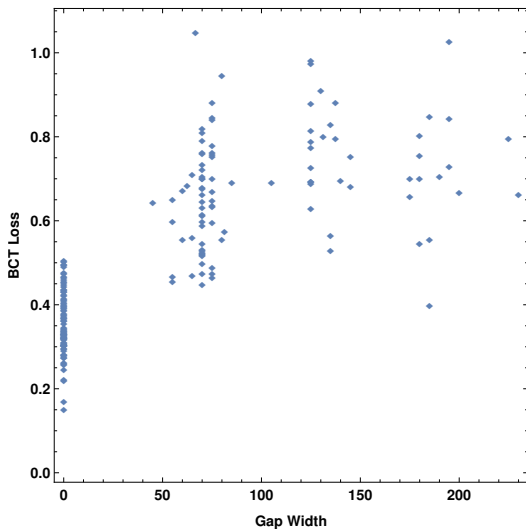
Analysis

BCT loss across transition, $t_1 = t_{tr-}$ and $t_2 = t_{tr+}$



Analysis

BCT between $t_1 = t_{tr+}$ and $t_2 = t_e$



Conclusions I

- ▶ the effect of the gaps had observed on
 - ▶ peak RF power demand
 - ▶ peak-to-peak RF power demand
 - ▶ transmission
- ▶ gap widths between 0 and 225 ns have been observed
- ▶ with the gaps also intensity spikes introduced in the azimuthal beam distribution
- ▶ the gaps were not synchronous with the SPS f_{rev}
- ▶ the introduction of the gaps led to an increase of the RF peak power
- ▶ changing the gap width between 75 ns and 190 ns led to an about proportional increase of the RF peak power
- ▶ the introduction of the gaps led to an increase of the peak-to-peak RF power modulation

Conclusions II

- ▶ changing the gap width between 75 ns and 190 ns led to an about proportional increase of the peak-to-peak RF power modulation
- ▶ the introduction of the gaps led to an increase of the losses during the acceleration ramp
- ▶ the losses across transition increased about proportionally to the gap width
- ▶ the losses between “after transition” and “end of the acceleration ramp” were about independent of the gap width
- ▶ despite the increase of the peak RF power and the peak-to-peak RF power modulation the losses between “after transition” and “end of the acceleration ramp” stayed about constant when the gap width was increased