Preliminary Analysis of High-intensity MDs

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Off-position Beam and Losses at the Start of the Ramp

- **From ramp with 2.3 x 10^{11} p/b**
  - Losses dominated by uncaptured beam due to very little debunching
  - Capture losses cannot be seen by off-position beam analysis
- **Some variation in off-position beam for similar fills**

Beam 1

MD block	Fill	Bunch charge	Number of bunches	Time at flat-bottom	Off-position beam	Start-of-ramp losses	Ratio to dump
MD#3	10028	2.0 x 10^{11} p/b	348	26.5 min.	0.60 x 10^{11} p	0.48 x 10^{11} p	1.6%
MD#3	10029	2.0 x 10^{11} p/b	348	17.4 min.	1.23 x 10^{11} p	0.78 x 10^{11} p	2.4%
MD#4	10154	2.3 x 10^{11} p/b	252	36.3 min.	0.18 x 10^{11} p		
MD#5	10250	2.3 x 10^{11} p/b	348	5.9 min.	3.90 x 10^{11} p	12.0 x 10^{11} p	48%
MD#4	10155	2.3 x 10^{11} p/b	348	67.9 min.	5.88 x 10^{11} p		
MD#4	10160	2.3 x 10^{11} p/b	348	53.1 min.	11.4 x 10^{11} p		
MD#5	10254	2.3 x 10^{11} p/b	972	72.2 min.	28.4 x 10^{11} p		

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Beam 2

MD block	Fill	Bunch charge	Number of bunches	Time at flat-bottom	Off-position beam	Start-of-ramp losses	Ratio to dump
MD#3	10028	2.0 x 10^{11} p/b	348	25.9 min.	0.32 x 10^{11} p	0.45 x 10^{11} p	1.7%
MD#3	10029	2.0 x 10^{11} p/b	348	16.9 min.	1.11 x 10^{11} p	0.65 x 10^{11} p	3.2%
MD#4	10154	2.3 x 10^{11} p/b	252	63.7 min.	5.60 x 10^{11} p		
MD#5	10250	2.3 x 10^{11} p/b	348	5.6 min.	6.31 x 10^{11} p	12.2 x 10^{11} p	47%
MD#4	10155	2.3 x 10^{11} p/b	348	67.5 min.	13.6 x 10^{11} p		
MD#4	10160	2.3 x 10^{11} p/b	348	54.4 min.	15.3 x 10^{11} p		
MD#5	10254	2.3 x 10^{11} p/b	972	72.5 min.	39.0 x 10^{11} p		

Debunching during MDs

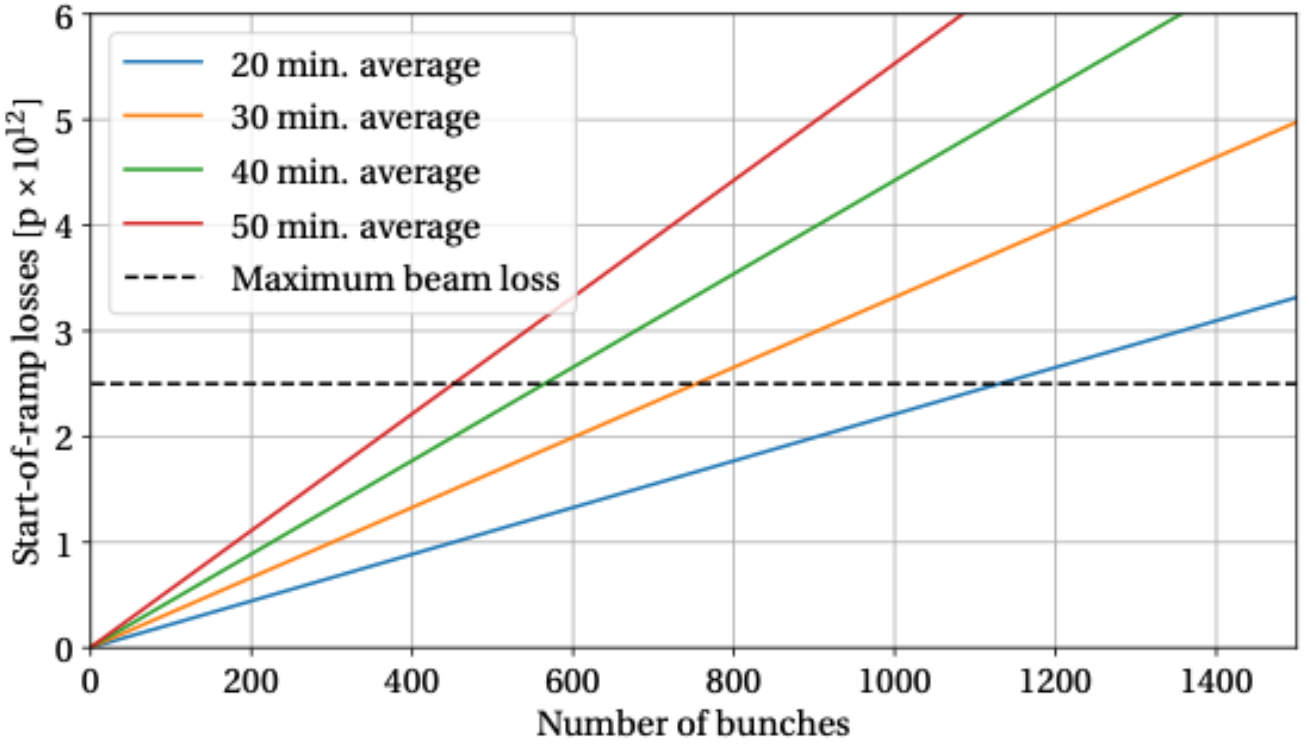
- **Debunching observed during MDs**
  - Comparable to operation with 1.6 x 10^{11} p/b
- **From theory**
  - Most losses and highest IBS growth rate with 2024 operational configuration
    - Due to smaller emittances in all three planes

From simulation

Configuration	RF Voltage	Emittance x,y	Bunch length	IBS Growth rate	Bunch length after 30 min.	Intensity lost after 30 min.
1.6 x 10^{11} p/b BCMS	5.5 MV	1.19 um, 1.27 um	1.20 ns	2.18 x 10^{-4} 1/s	1.35 ns	1.37%
2.3 x 10^{11} p/b MD	6.5 MV	2.00 um, 2.02 um	1.23 ns	1.31 x 10^{-4} 1/s	1.34 ns	1.29%
2.3 x 10^{11} p/b BCMS opt.	7.9 MV	1.60 um, 1.60 um	1.25 ns	1.29 x 10^{-4} 1/s	1.35 ns	1.35%
2.3 x 10^{11} p/b STD opt.	7.9 MV	2.10 um, 2.10 um	1.25 ns	0.94 x 10^{-4} 1/s	1.33 ns	0.75%

Start-of-ramp Losses Based on MD Experience

- **From operational experience**
  - How many lost protons needed to trigger beam dump ~25 x 10^{11} p
  - What time bunches spend on flat-bottom on average ~30 min.
- **From MDs in 2024**
  - Rate of debunching
- **One would be able to accelerate maximum roughly 750 bunches**
- **NB!**
  - One would want to back off in voltage
  - There is a spread on all of this
  - Scaling is a simplification
    - ADT cleaning
    - Time at flat bottom and number of bunches are not independent



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Longitudinal IBS Growth Rate Versus RF Voltage