



Higher-intensity barrier-bucket MTE

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IPP MD Days

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**Many thanks to Simon Albright, Foteini Asvesta
and PSB/PS operations teams**

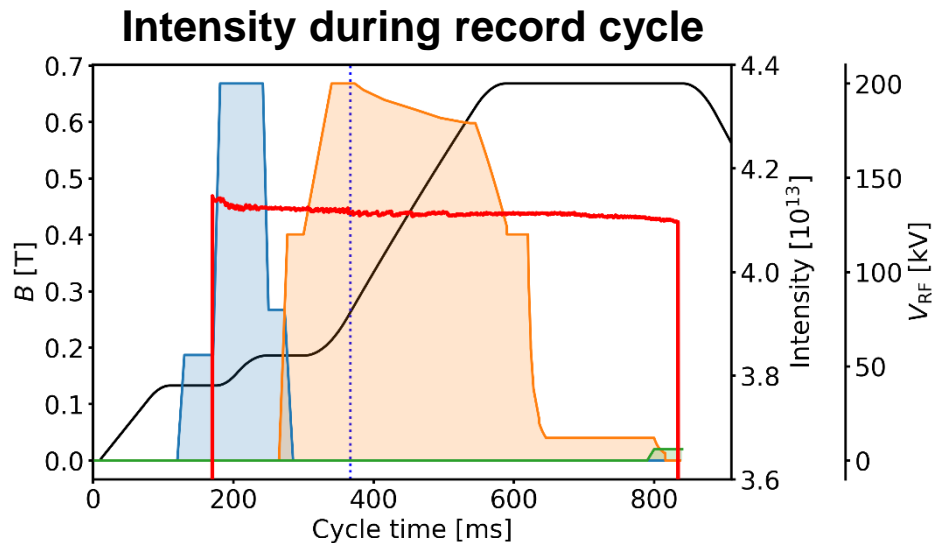
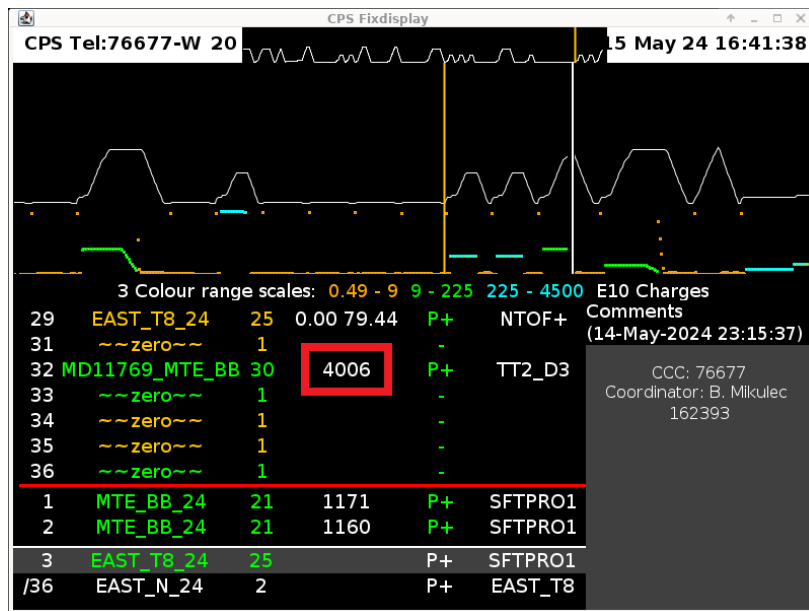


Menu from 2024 MD Days

- **Open issues for 2024**
 - **Benchmark impact of 10 MHz cavity impedance** → quick check without 1 turn delay feedback
 - **Transition crossing optimization** → remains sensitive
 - **Increase intensity up to $4 \cdot 10^{13}$ p/p** → remains sensitive
 - **RF voltage pre-distortion for flat bunch at highest intensity** → first tests during second half of 2024
 - **Intensity scan of transverse beam parameters** → 2025
 - **Optimization of PS-SPS transfer** → 2025

Highest intensity ever accelerated

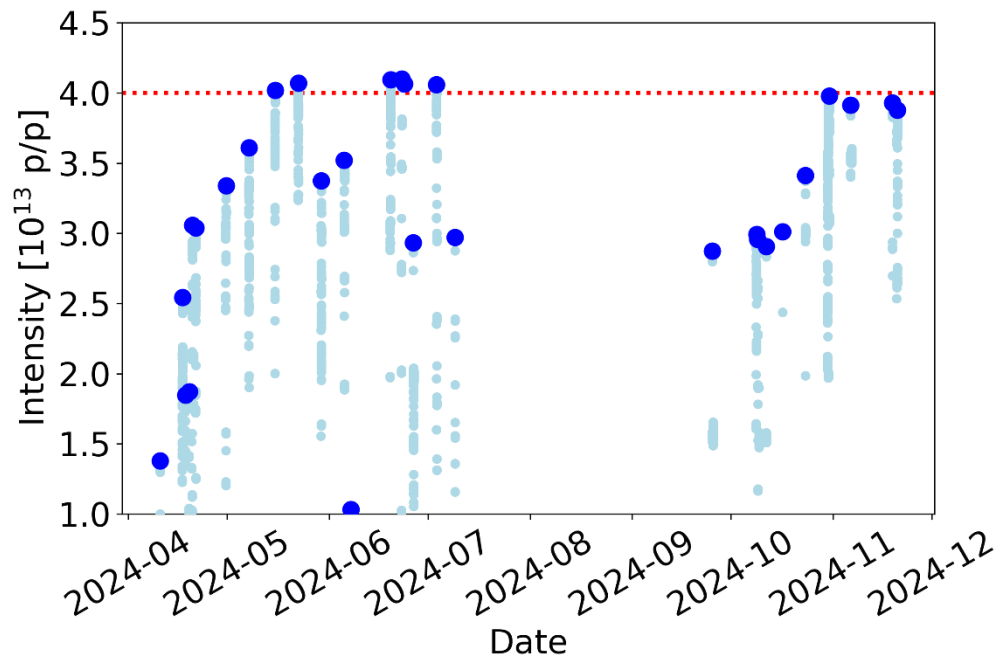
- ✓ Longitudinal stability demonstrated up to maximum intensity
- ✓ Highest intensity ever accelerated in PS beyond $4 \cdot 10^{13}$ p/p



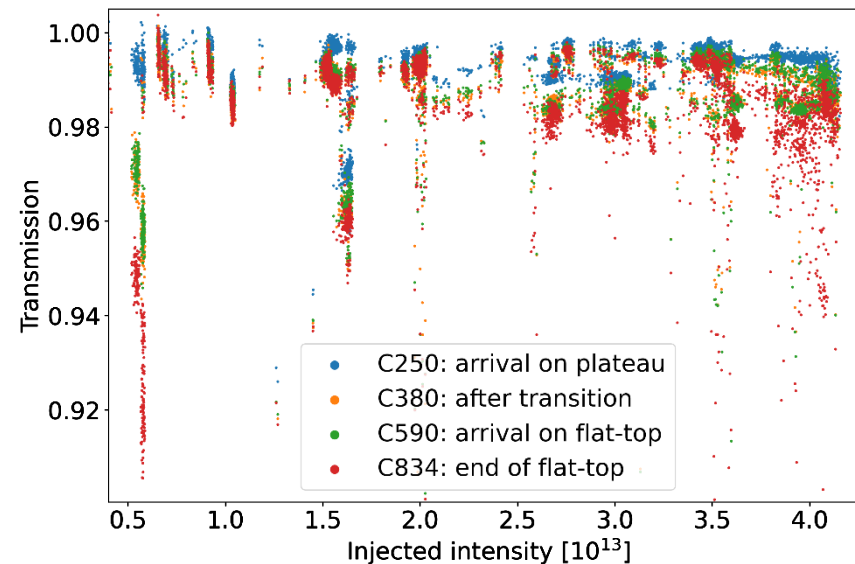
Intensity and transmission in PS

- Highest intensity in 2024: Barrier-bucket MTE with up to $4.1 \cdot 10^{13}$ p/p extracted
 → No motivation to push higher → above beam dump intensity limit in SPS

Intensity ramp-up

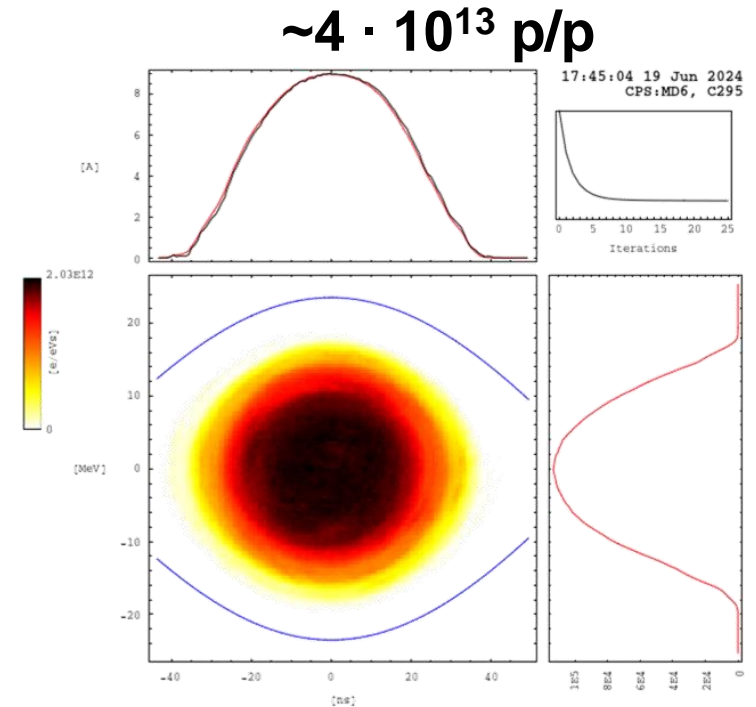
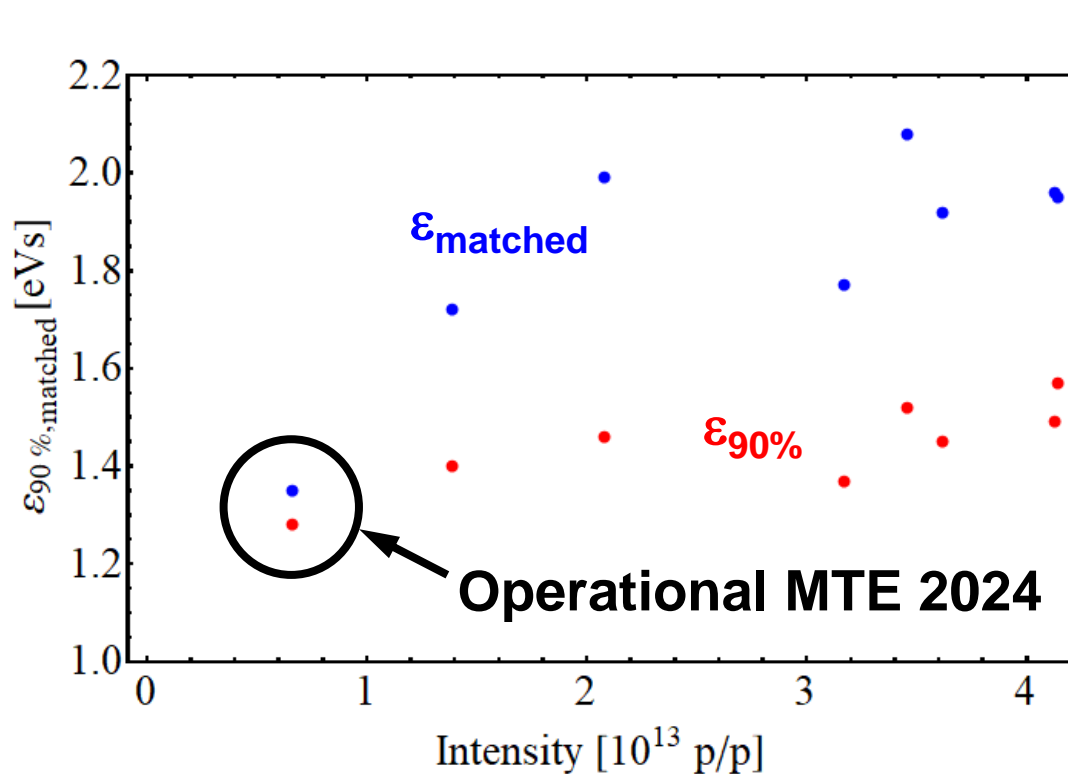


Transmission 2023 and 2024



Longitudinal emittance versus intensity

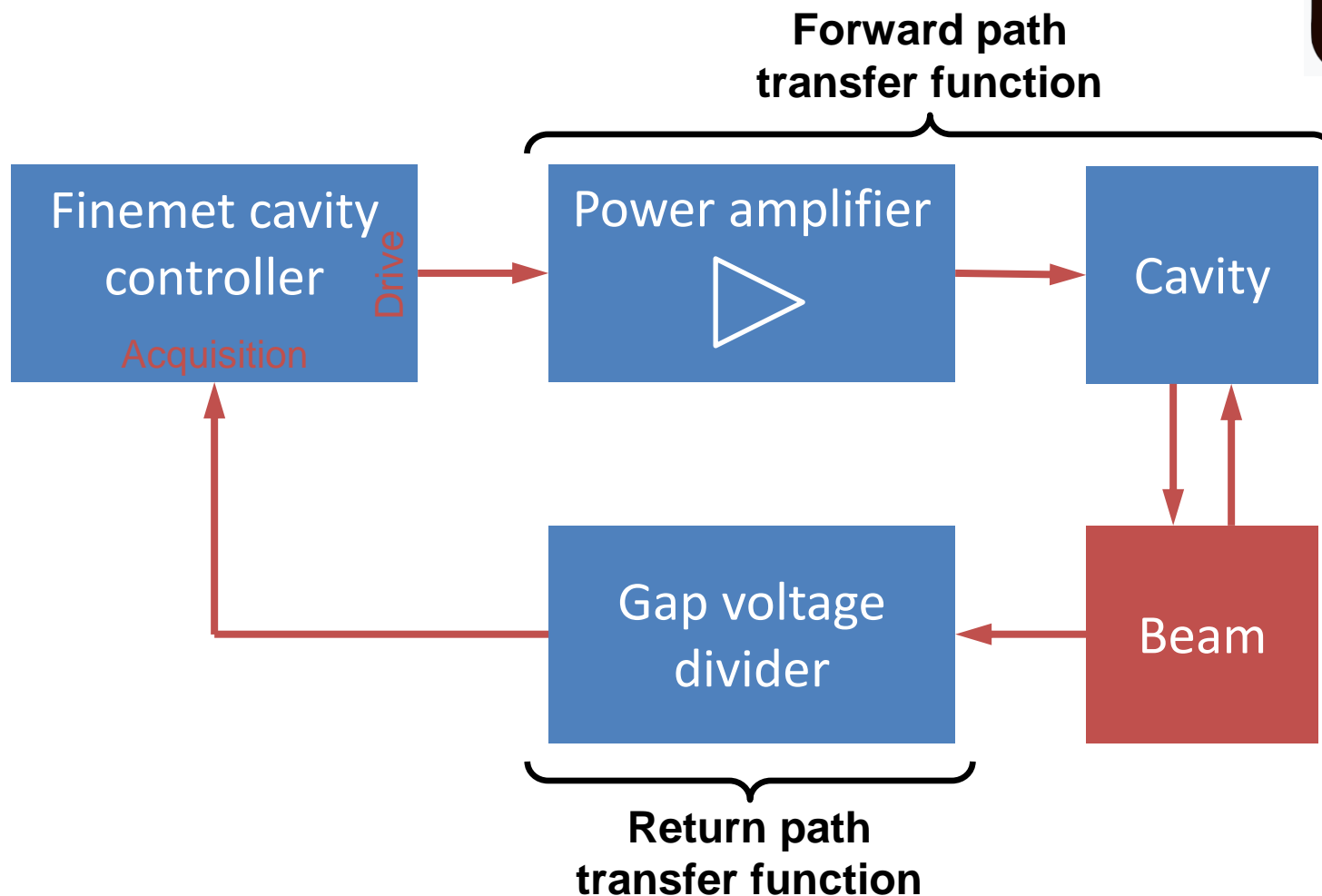
- Increased longitudinal blow-up required to cross transition energy



- Transition crossing limited by losses due to transverse instabilities
- **$\sim 20\text{-}30\%$ larger longitudinal emittance (90%, RMS) required at $\sim 4 \cdot 10^{13}$ p/p (with respect to operational beam)**

Optimization of barrier RF voltage

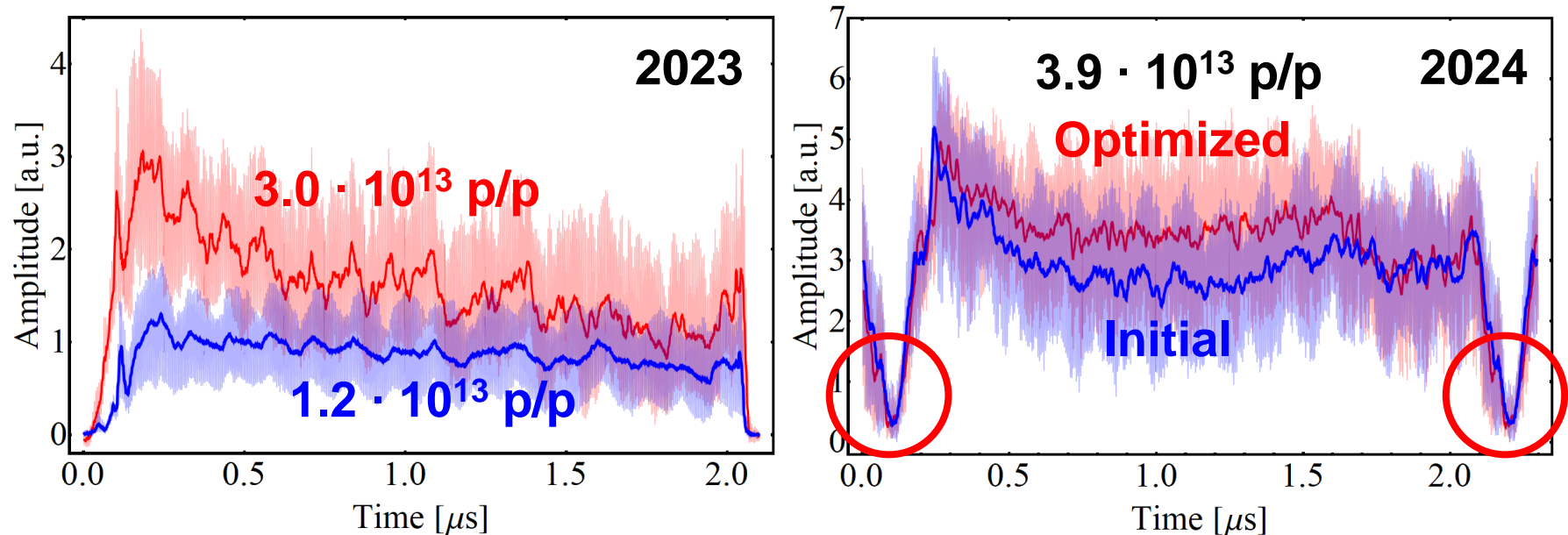
- Mid-2024: new barrier-bucket controller firmware (→Toma Gavric)
 - Full PPM control of RF drive voltage during the turn
 - Internal synchronized acquisition of gap voltage



Bunch shape at extraction – is it flat?

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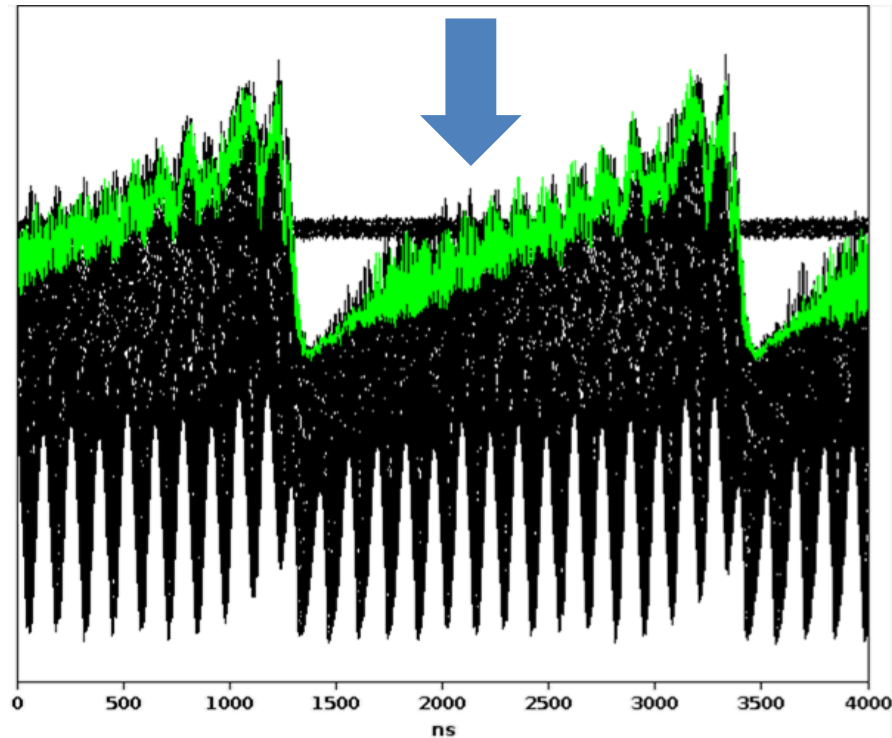
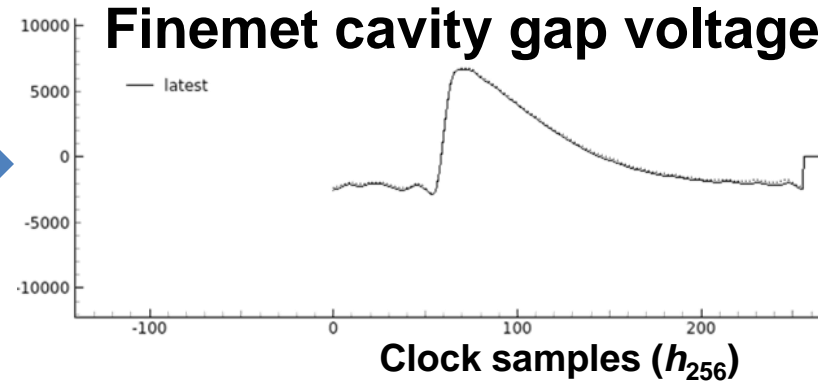
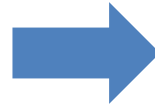
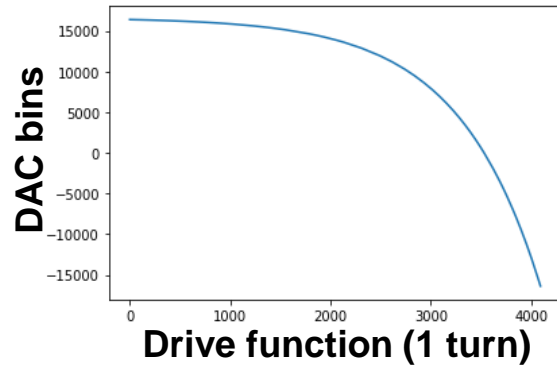
Longitudinal bunch profile before extraction



- Flat-bunches at operational intensity, asymmetric when increasing intensity
- Barrier voltage pre-distortion to compensate with limited improvement → Beam is only reliable observable
- Increased longitudinal emittance pushes particles into gap, but mainly lower RF voltage: understood and corrected on 06/11

Exotic bunch shapes

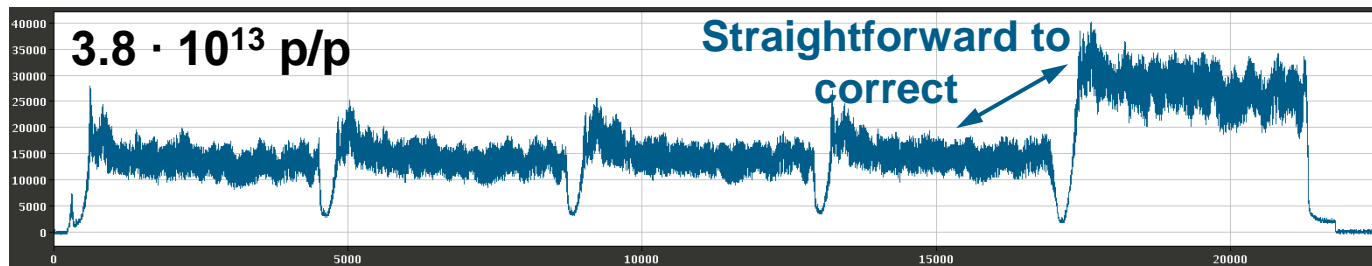
- **New Finemet controller** → **Full control of RF voltage function during a turn**



- **Future applications** of PS wide-band cavity
- **Transient beam loading compensation** (Alexandre Lasheen)?

Summary and 2025 MD priorities

- Above $4 \cdot 10^{13}$ p/p accelerated: longitudinally stable at flat-top
 - Larger longitudinal emittance to pass transition energy
 - Gaps of Finemet cavity trip due to excessive beam loading
- Open **issues for 2025**
 - RF **voltage pre-distortion optimization** at highest intensity
 - **Depletion of gap** versus longitudinal emittance and intensity
 - Intensity scan of **transverse beam parameters**
 - Optimization of **PS-SPS transfer**
- No incentive to push intensity even higher (SPS dump limit)
- Series of **parallel MDs** at about $3 \cdot 10^{13}$ p/p → stable conditions
- Transfer higher-intensity to SPS: few turns are sufficient





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