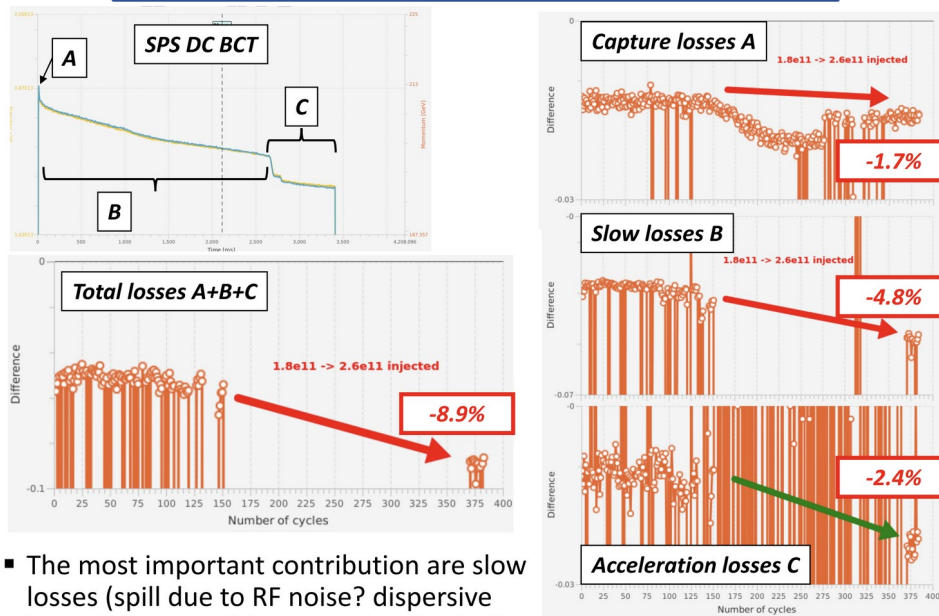# Collimation dedicated MD
<u>Observations</u>

D. Demetriadou, P. Hermes, V. Kain, A. Lasheen, <u>M. Patecki</u>, F. Van Der Veken

Motivation

Long parallel MD scanning intensity

SPS DC BCT

A

C

B

Total losses A+B+C

1.8e11 -> 2.6e11 injected

-8.9%

Number of cycles

- The most important contribution are slow losses (spill due to RF noise? dispersive losses? NB: tune/chroma to be checked)

Capture losses A

1.8e11 -> 2.6e11 injected

-1.7%

Slow losses B

1.8e11 -> 2.6e11 injected

-4.8%

-2.4%

Acceleration losses C

Number of cycles

8

Preparation of 2022 MDs and early observations
PS2SPS WG meeting 31/05/2022
A. Lasheen et al.

- Slow losses contribute the most to flat bottom losses

- Origin of these losses is unknown:
  - Particles close to the separatrix that fall out of the bucket?
  - Tight aperture?
  - Transverse tails?
  - Betatronic diffusion?

- Re-population of tails? Betatronic or off-momentum?

MD overview

1) Scrape tails at two locations, independently, with different fills:
   - TIDP, **off-momentum tails**:
     - reached by an orbit bump;
     - TIDP inner aperture ~40mm from the beam axis;
     - Max bump amplitude of about 30mm – correctors strength ok.

   - TCSM, **betatron tails**:
     - jaws at 30mm;
     - reached by an orbit bump.
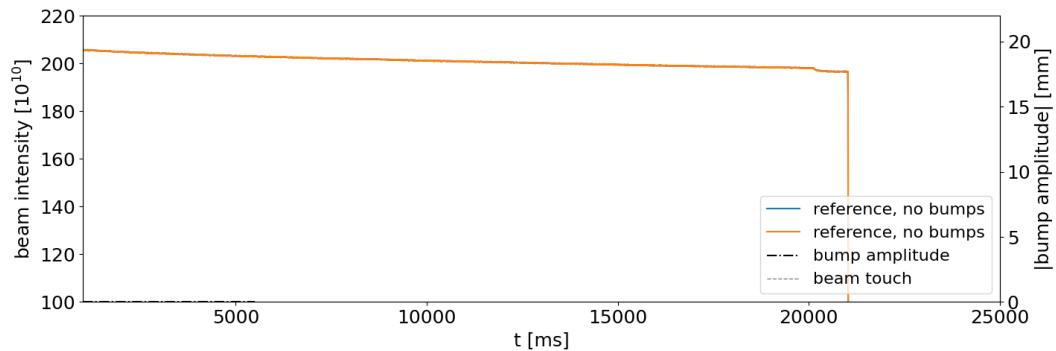
2) Close the bump / retract the collimator.
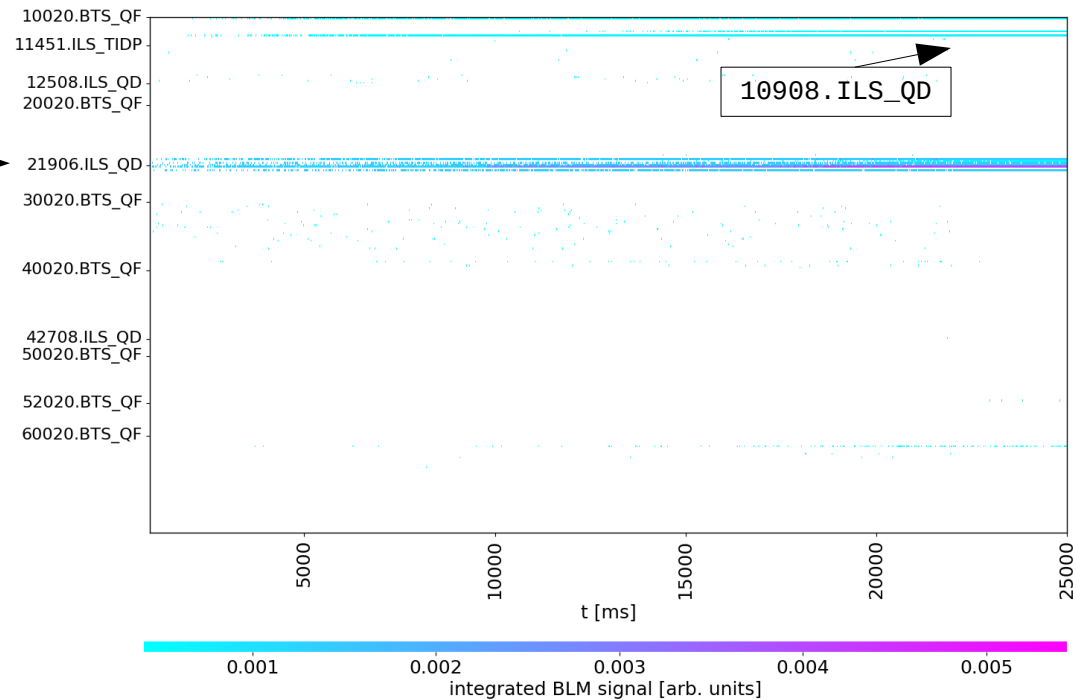3) Scrape again to check tails re-population.
Observe BCT and BLMs.
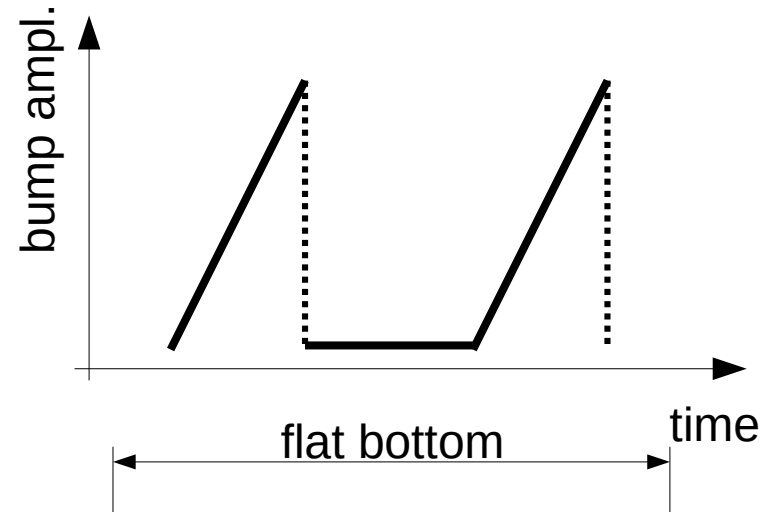
	β_x [m]	$(\beta_x \epsilon_x)^{1/2}$ [mm]	D_x [m]	$D_x \delta_{1\sigma}$ [mm]	$D_x \delta_{bh}$ [mm]	$(\beta\epsilon + (D_x \delta_{bh})^2)^{1/2}$ [mm]
TIDP	93.7	2.5	2.8	4.2	10.6	10.9
TCSM	38.1	1.6	-0.4	-0.6	-1.5	2.2

Reference case

Dominant BLM
21796.ILS_MST3 also active

10908.ILS_QD

BLM signal

BLM variables used:

BLRSPS_BA1:ExpertAcquisition:beamLossMeasurements_gray
BLRSPS_BA2:ExpertAcquisition:beamLossMeasurements_gray
BLRSPS_BA3:ExpertAcquisition:beamLossMeasurements_gray
BLRSPS_BA4:ExpertAcquisition:beamLossMeasurements_gray
BLRSPS_BA5:ExpertAcquisition:beamLossMeasurements_gray
BLRSPS_BA6:ExpertAcquisition:beamLossMeasurements_gray
BLRSPS_LSS1:ExpertAcquisition:beamLossMeasurements_gray
BLRSPS_LSS2:ExpertAcquisition:beamLossMeasurements_gray
BLRSPS_LSS4:ExpertAcquisition:beamLossMeasurements_gray
BLRSPS_LSS5:ExpertAcquisition:beamLossMeasurements_gray
BLRSPS_LSS6:ExpertAcquisition:beamLossMeasurements_gray

- Integrated value
- Noise, difficult to calculate the derivative

How can I get instantaneous loss signal?
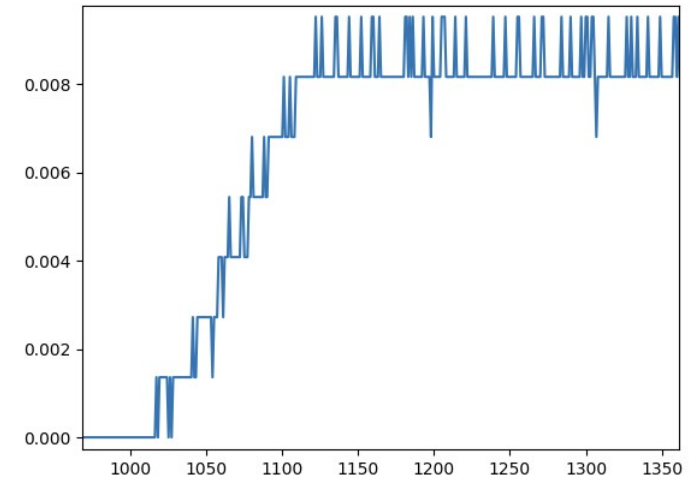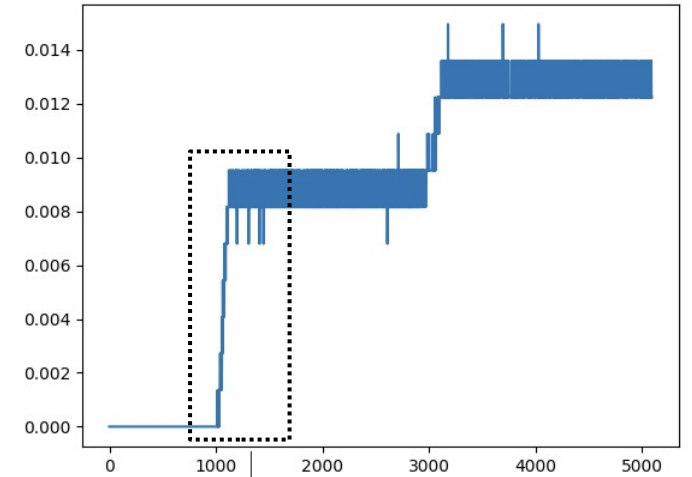
-12mm-bump @ TIDP (low energy side)

Beam touch at ~10mm:
- Defined by a change of slope of intensity
- Rather simplistic algorithm to detect it. Sometimes gets a little lost, but it's fine most of the time.
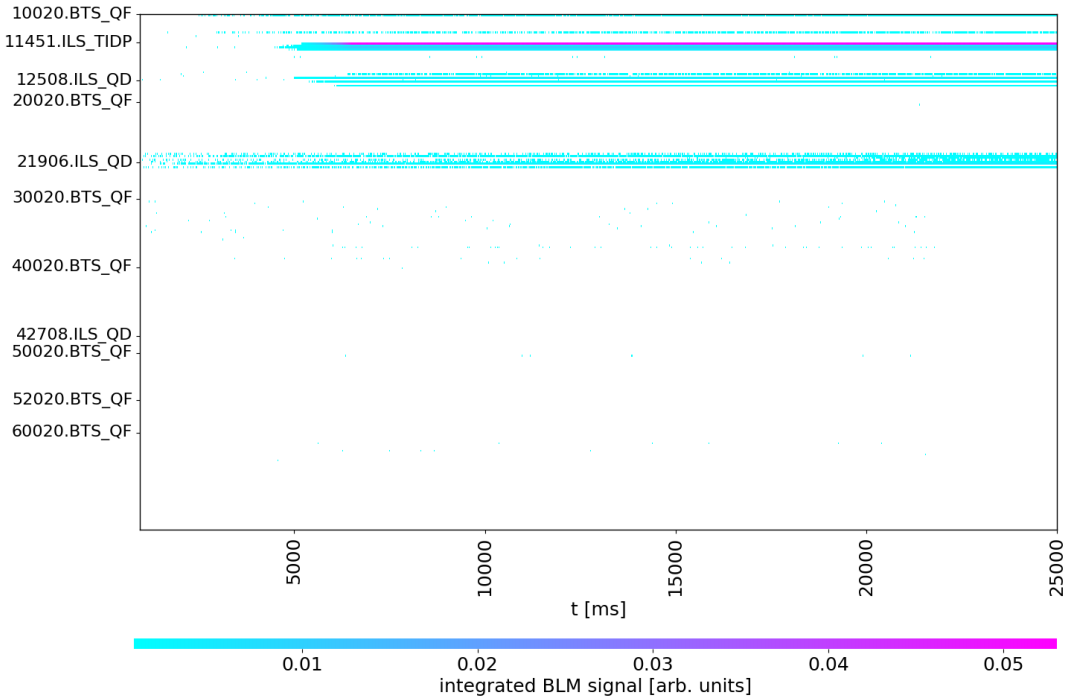
BLM @ TIDP active
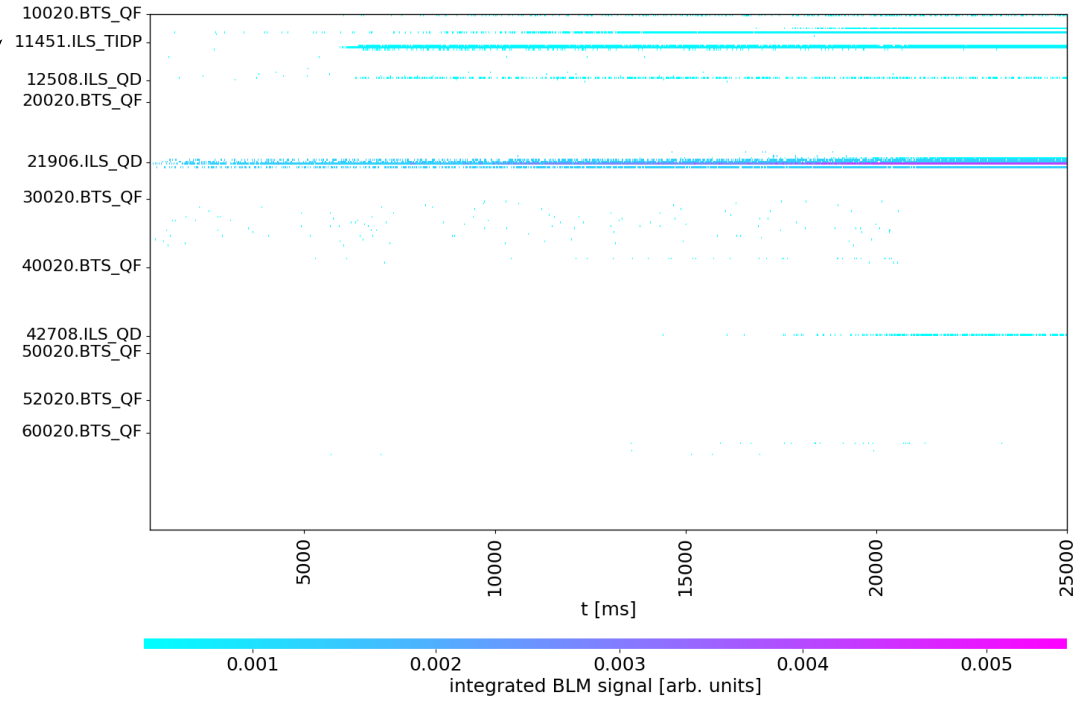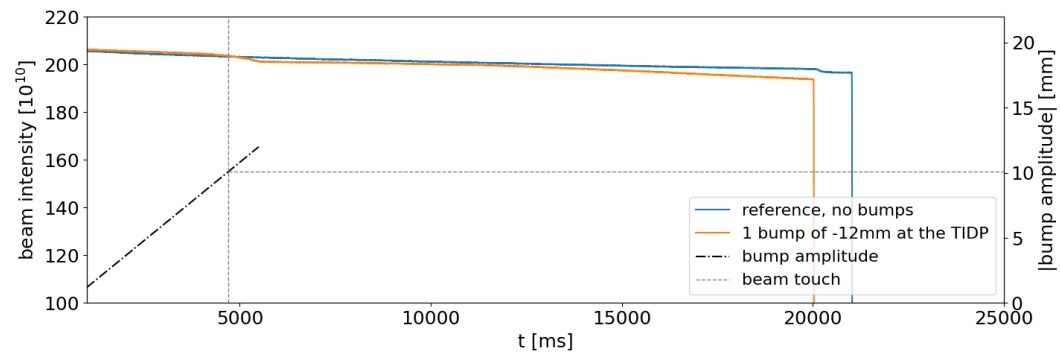
-13mm-bump @ TIDP
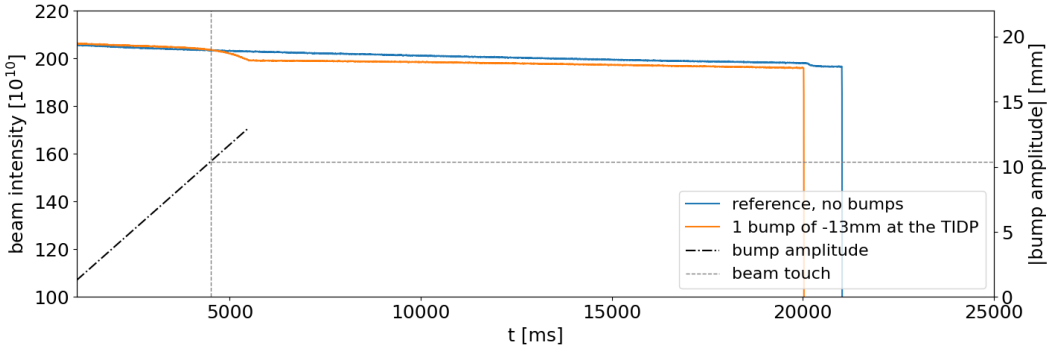
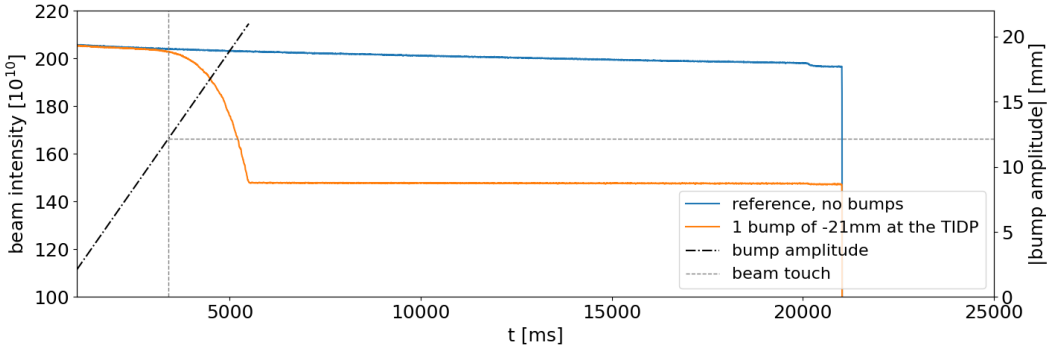BLM @ TIDP active
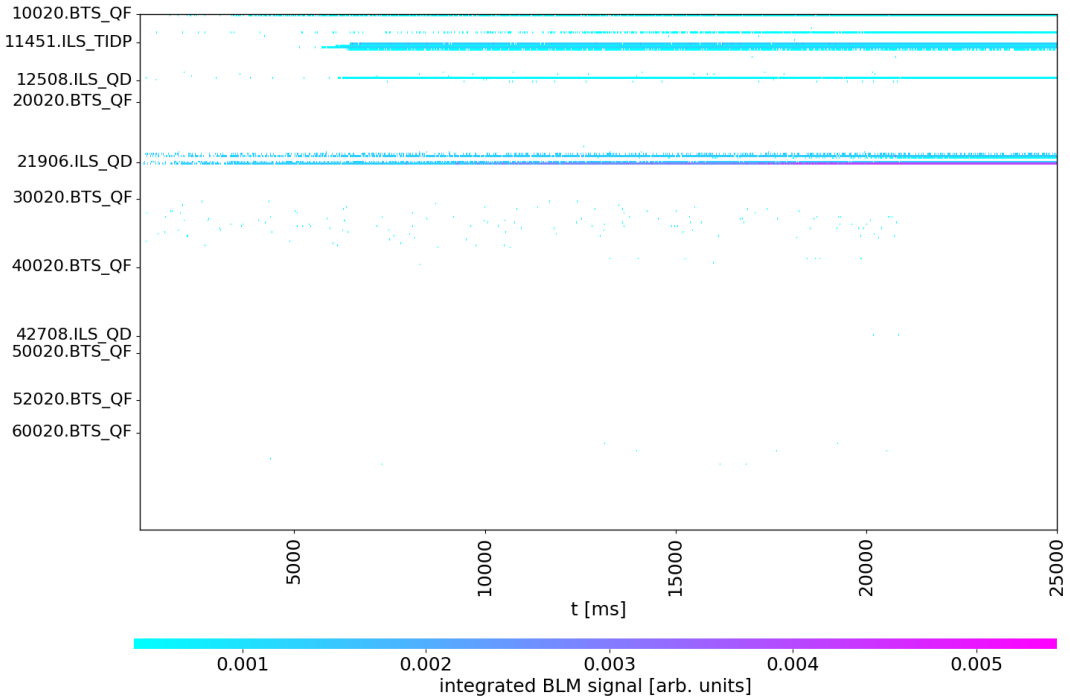
-14mm-bump @ TIDP
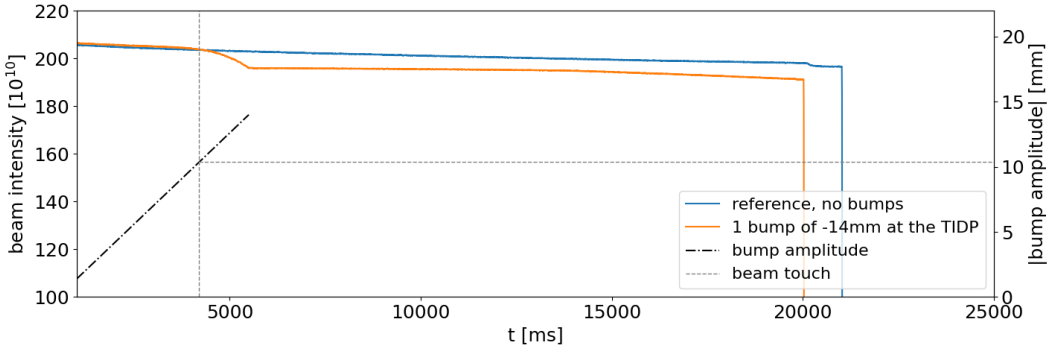
BLM @ TIDP active
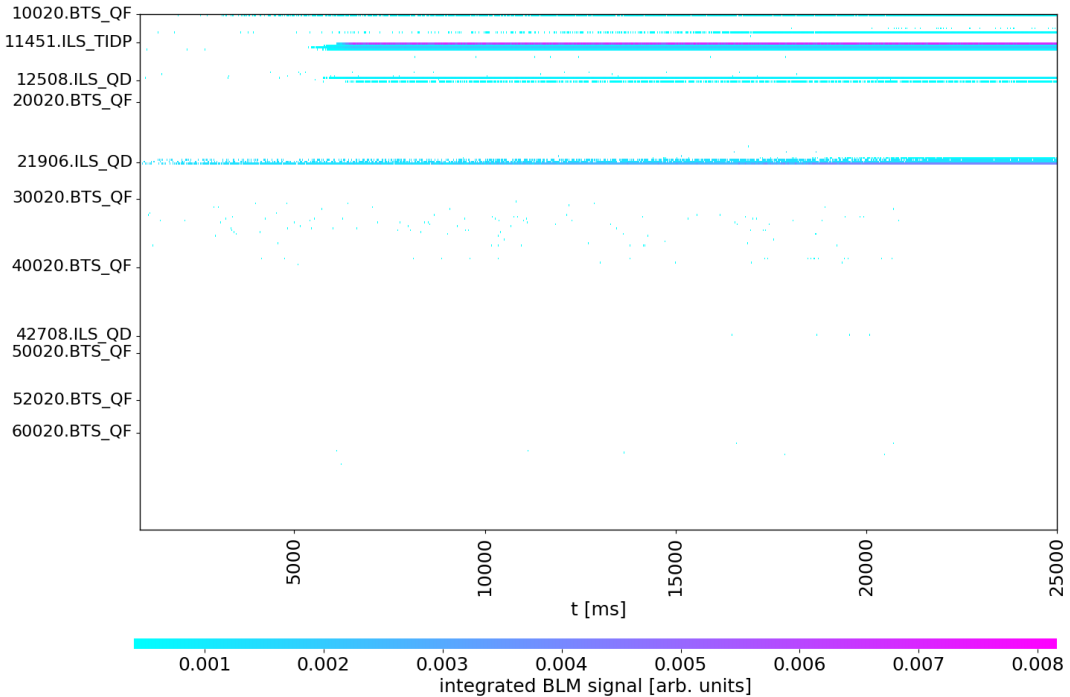
-15mm-bump @ TIDP
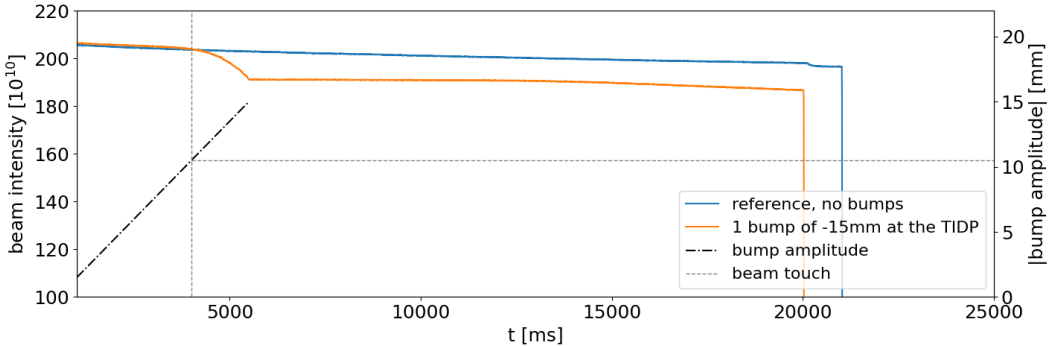
BLM @ TIDP active
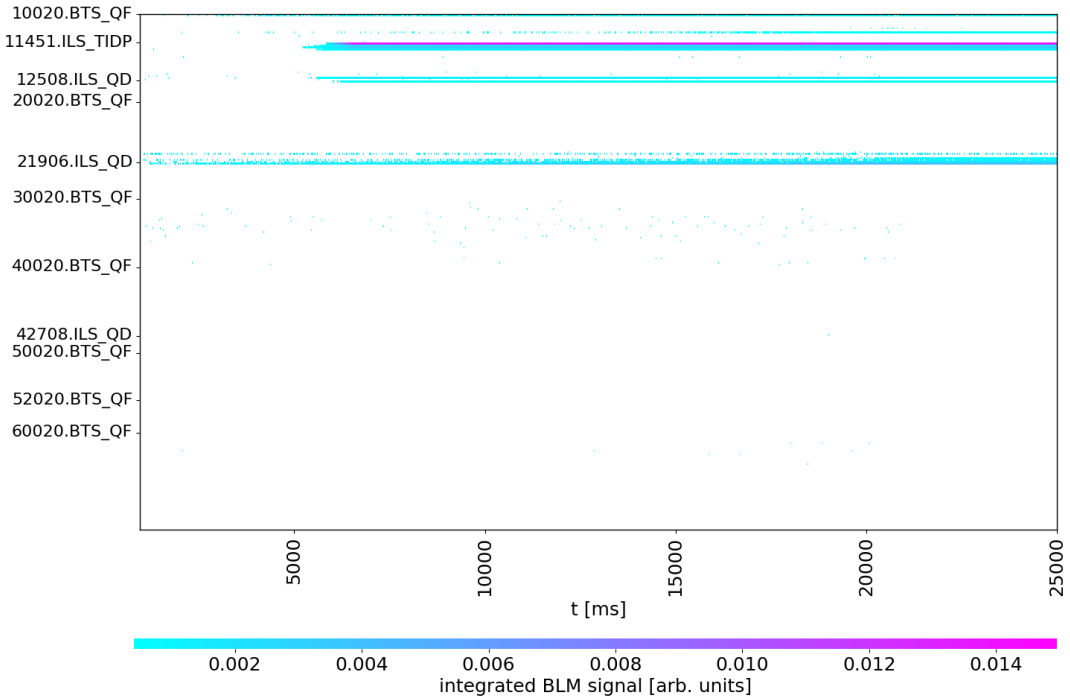
-16mm-bump @ TIDP
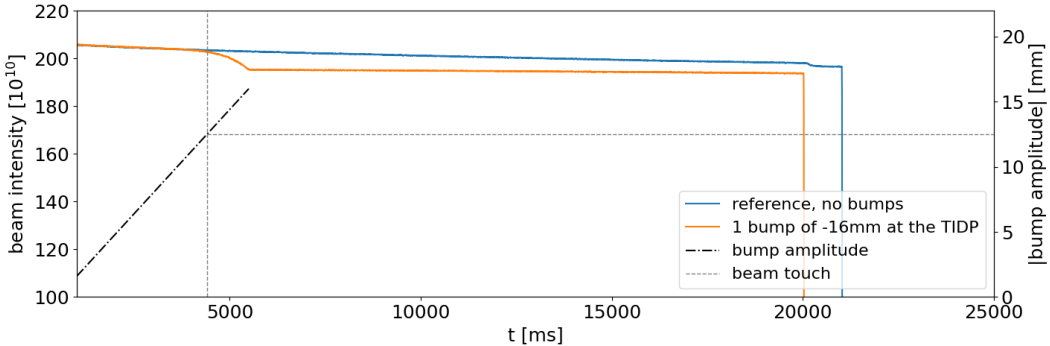
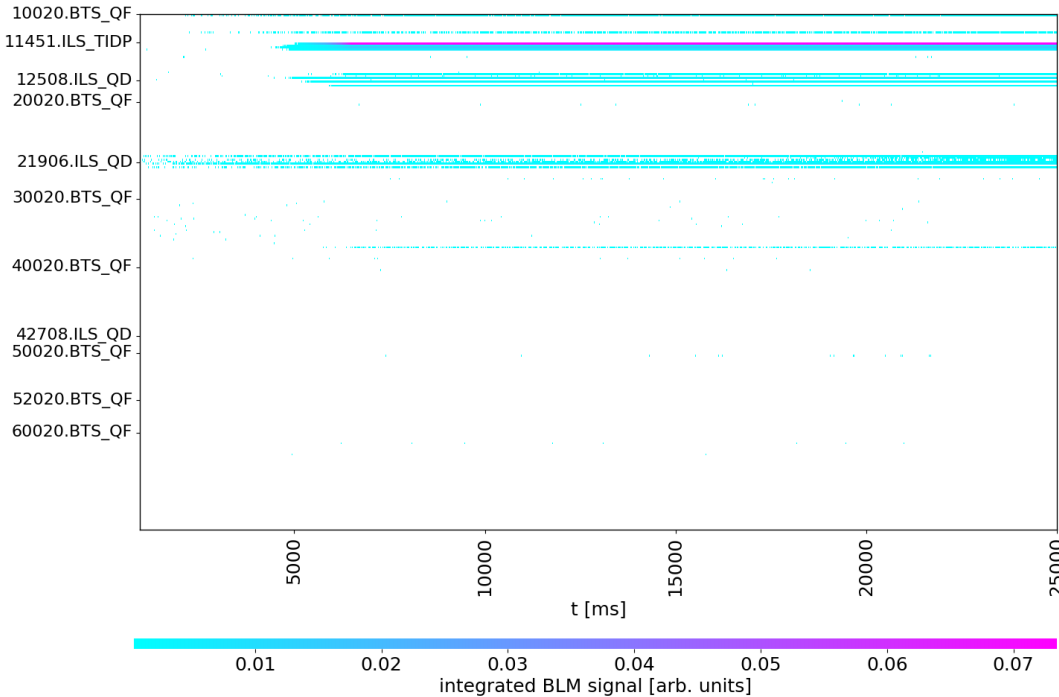BLM @ TIDP active
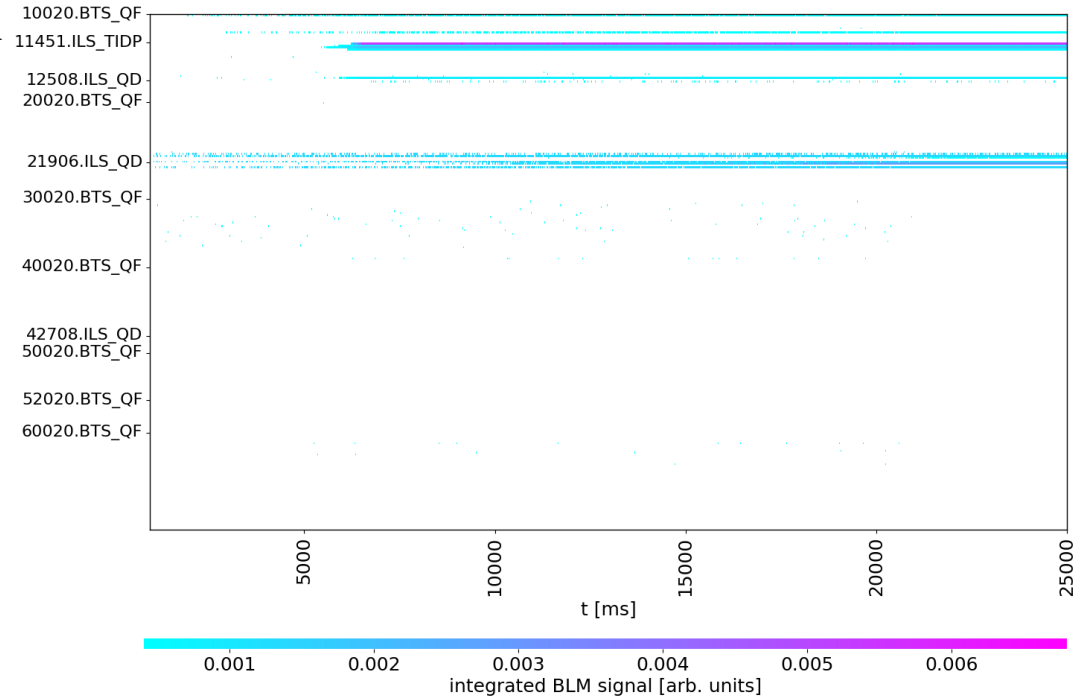
-17mm-bump @ TIDP
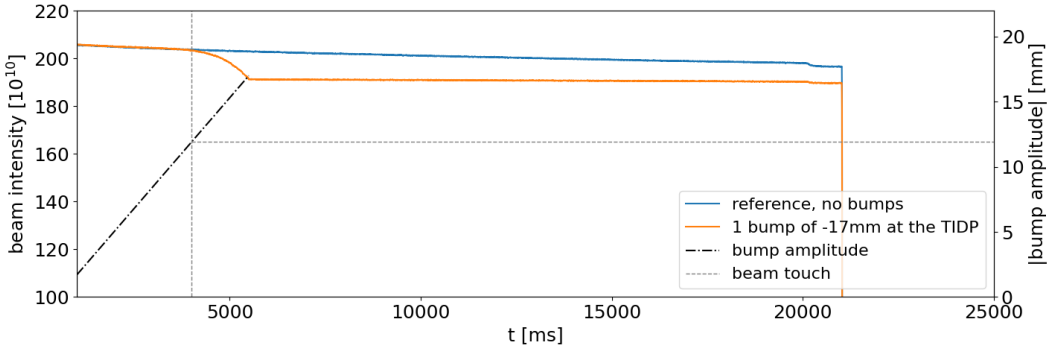
BLM @ TIDP active
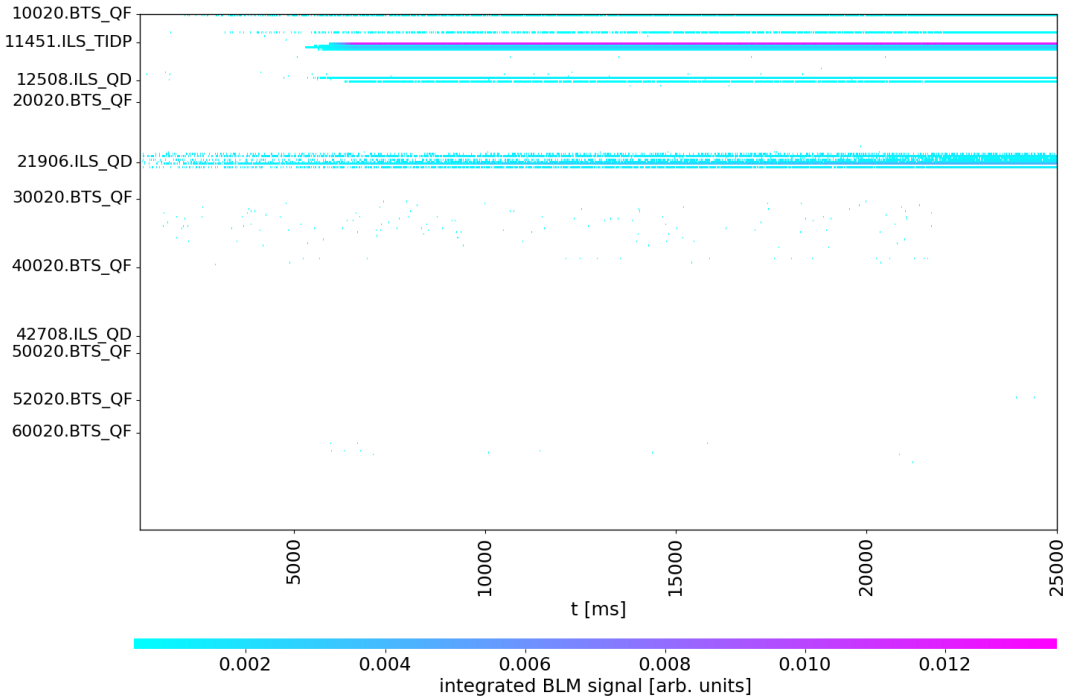
-18mm-bump @ TIDP
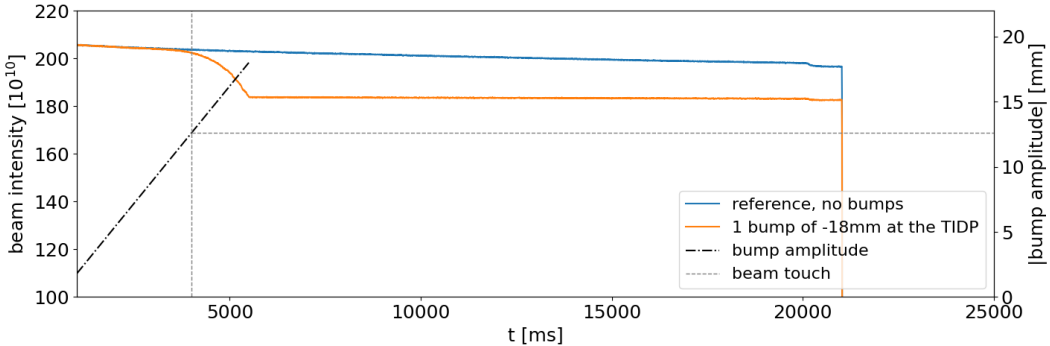
BLM @ TIDP active
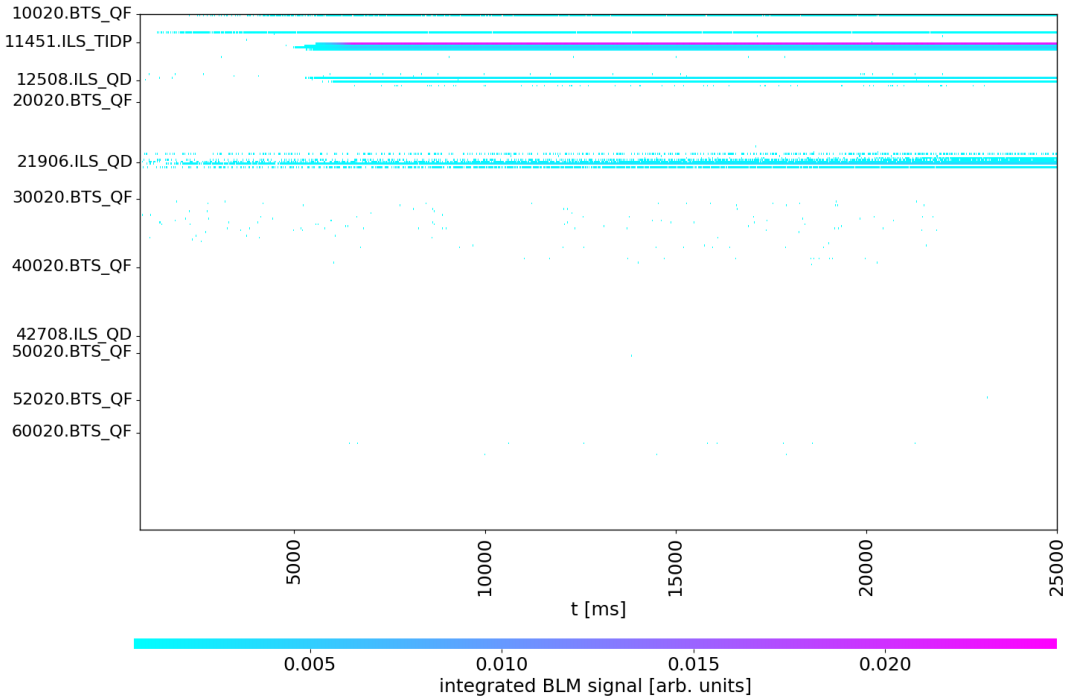
-19mm-bump @ TIDP
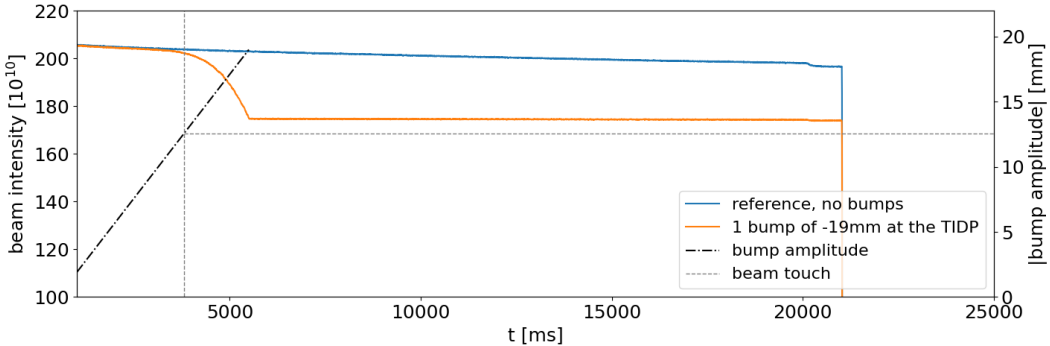
BLM @ TIDP active
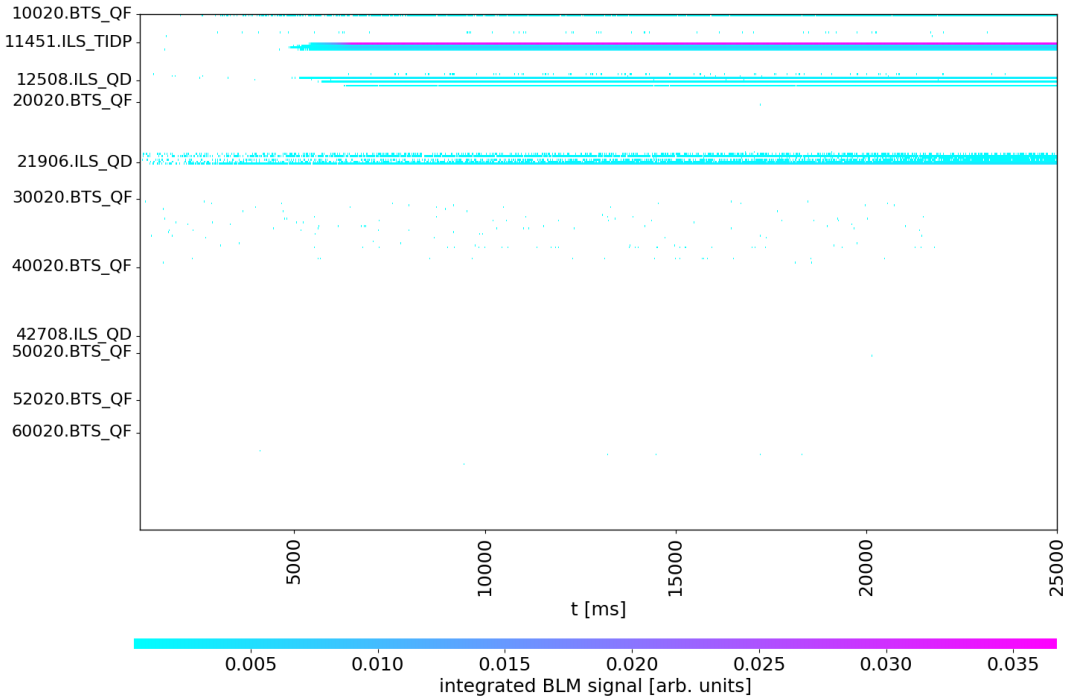
-20mm-bump @ TIDP
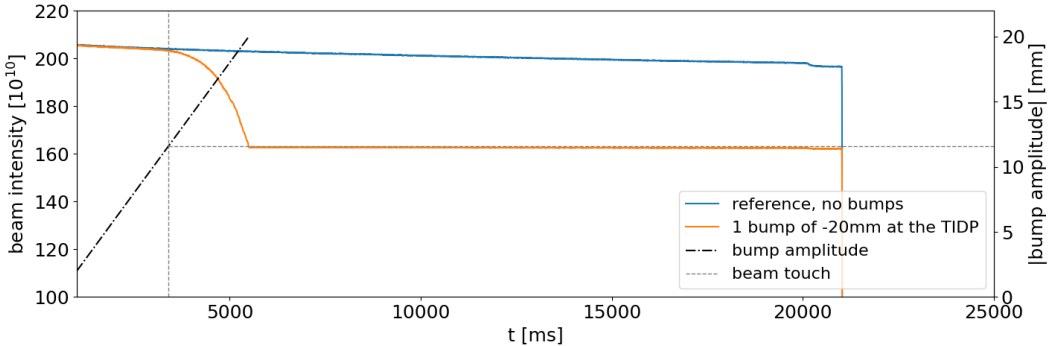
BLM @ TIDP active

-21mm-bump @ TIDP

BLM @ TIDP active

Cross-check with cleaning simulations

- A similar scenario was simulated for the studies on the SPS off-momentum collimation system design.

- A satisfactory agreement between simulation and measurement is observed.

- Details of the SPS off-momentum collimation system design:
  https://doi.org/10.1103/PhysRevAccelBeams.24.093002

PHYSICAL REVIEW ACCELERATORS AND BEAMS **24**, 093002 (2021)

Conceptual design of an off-momentum collimation system in the CERN Super Proton Synchrotron for High-Luminosity Large Hadron Collider proton beams

Marcin Patecki,[*,†] Alessio Mereghetti,[‡] Daniele Mirarchi, and Stefano Redaelli
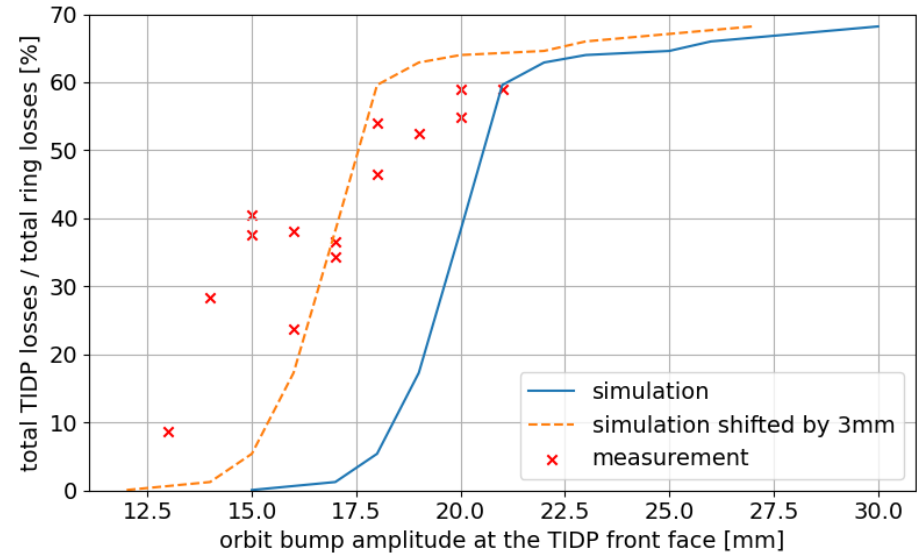
Two bumps of -14mm @ TIDP
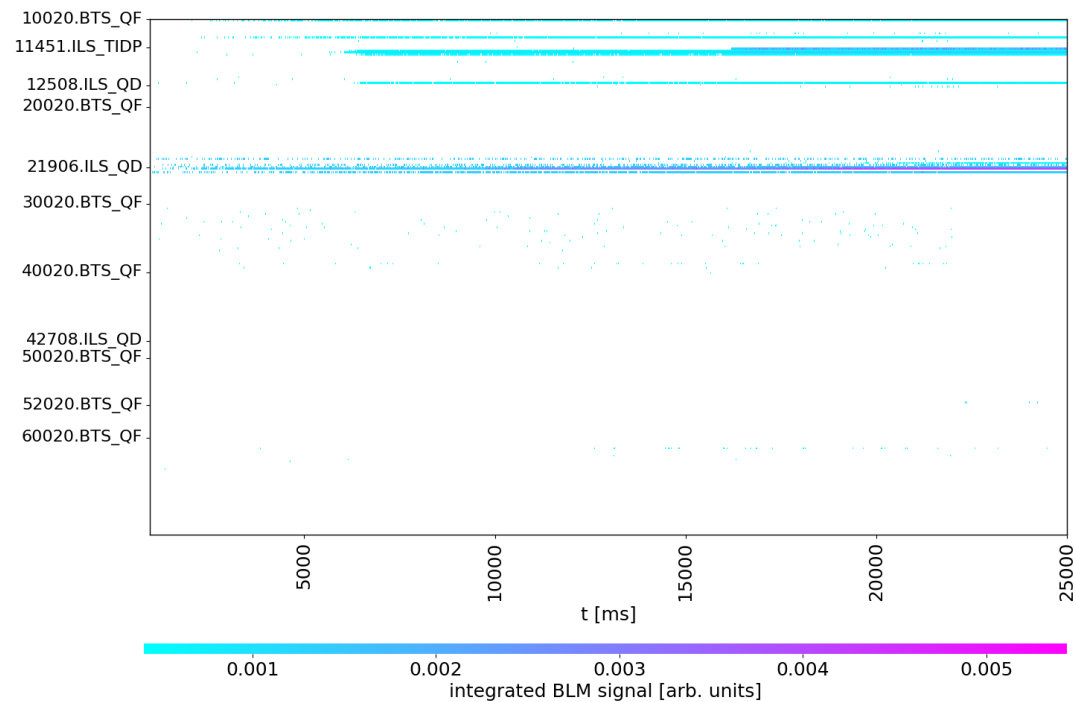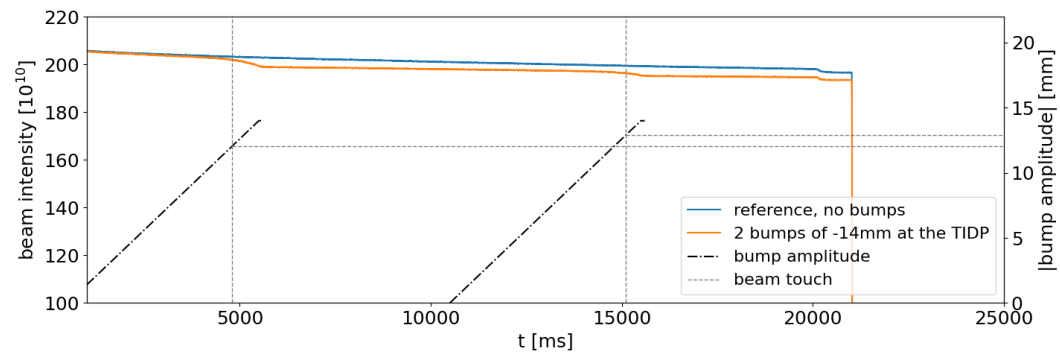
Two bumps of -14mm @ TIDP
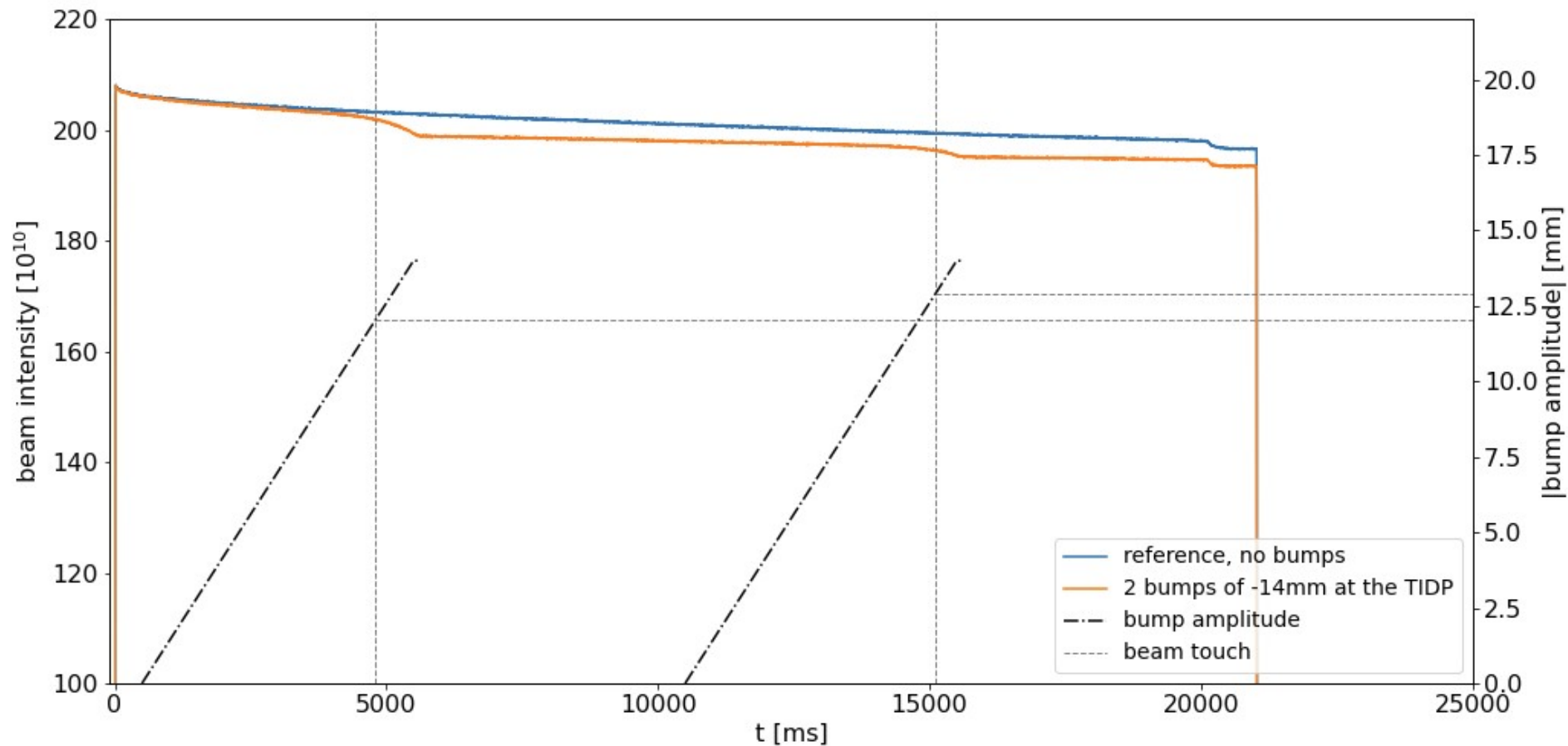
Two bumps of -16mm @ TIDP
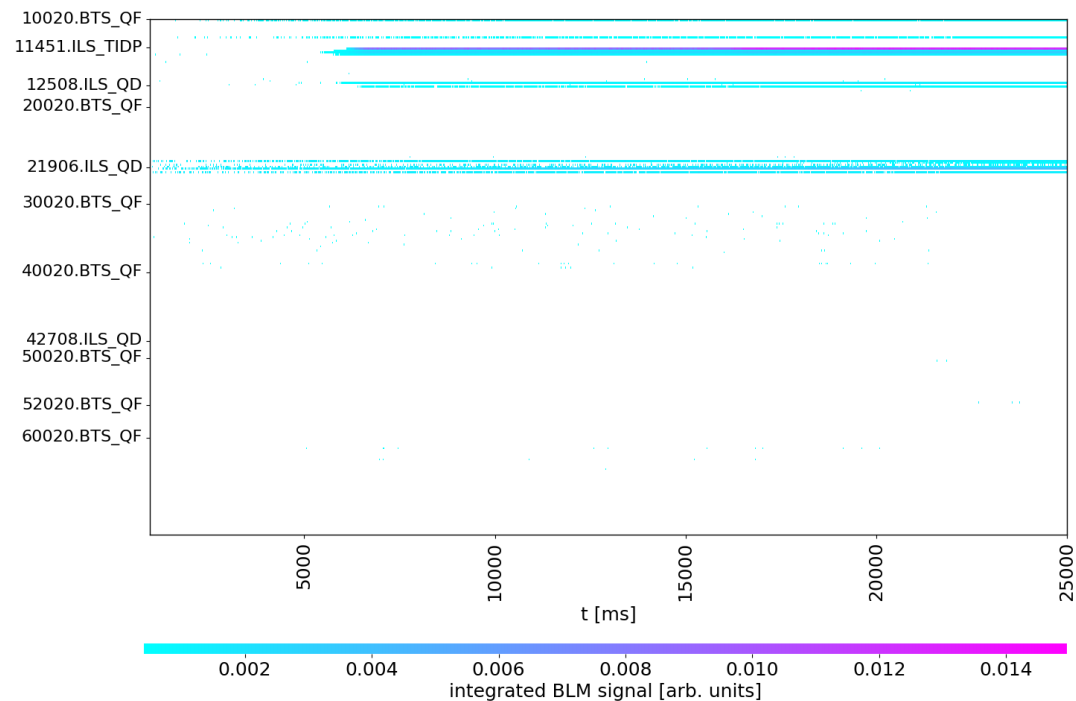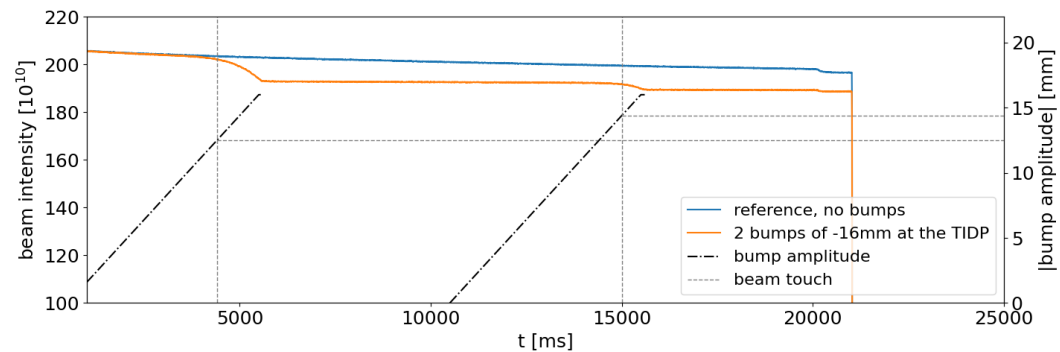
Two bumps of -18mm @ TIDP
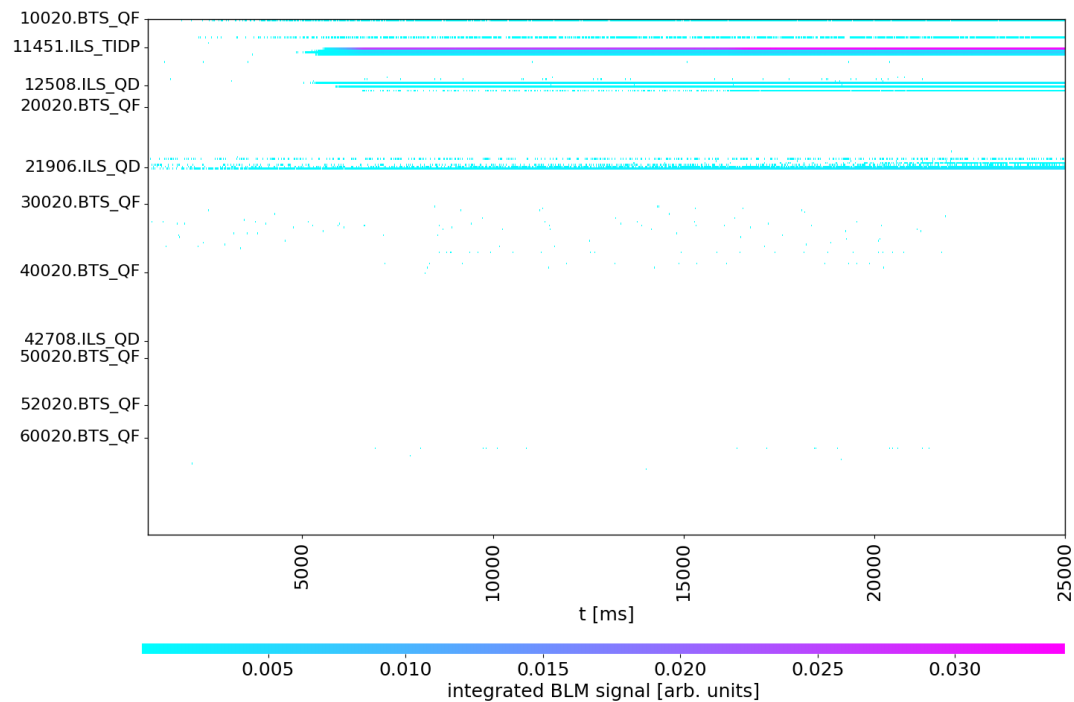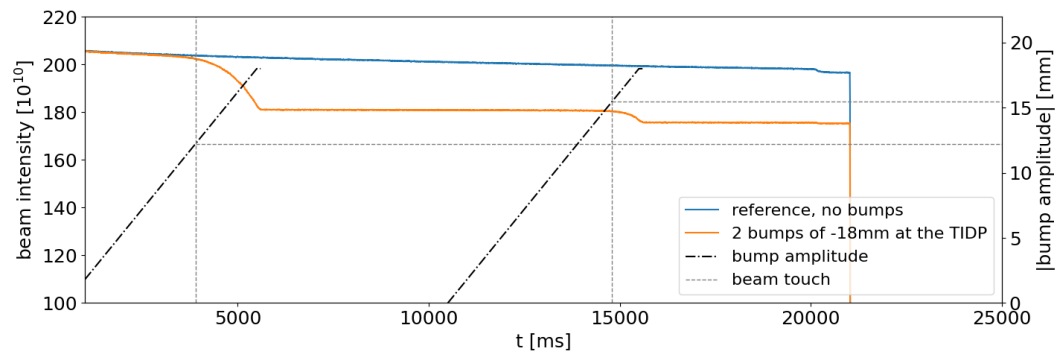
Two bumps of -20mm @ TIDP
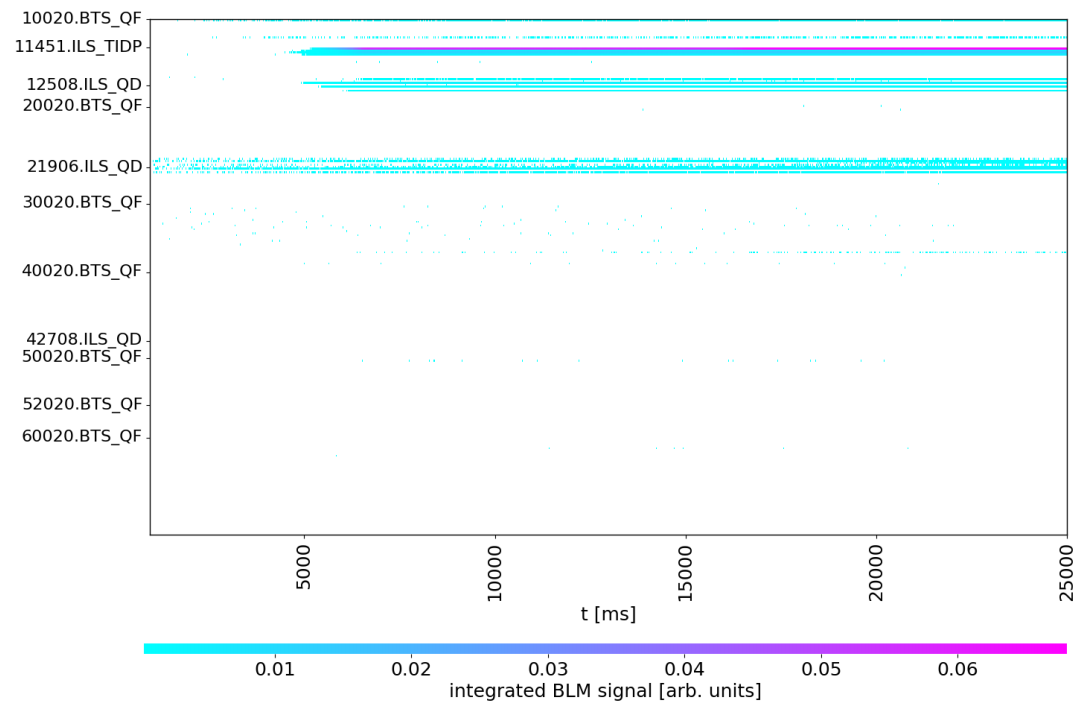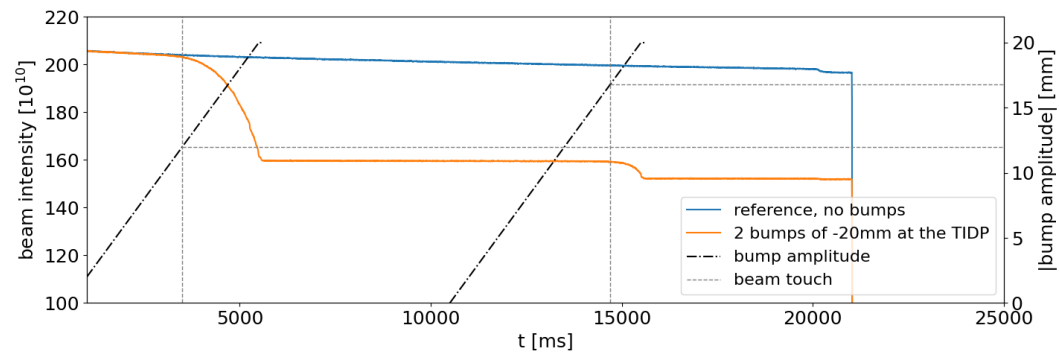
Two bumps of -20mm @ TIDP with longitudinal blow-up
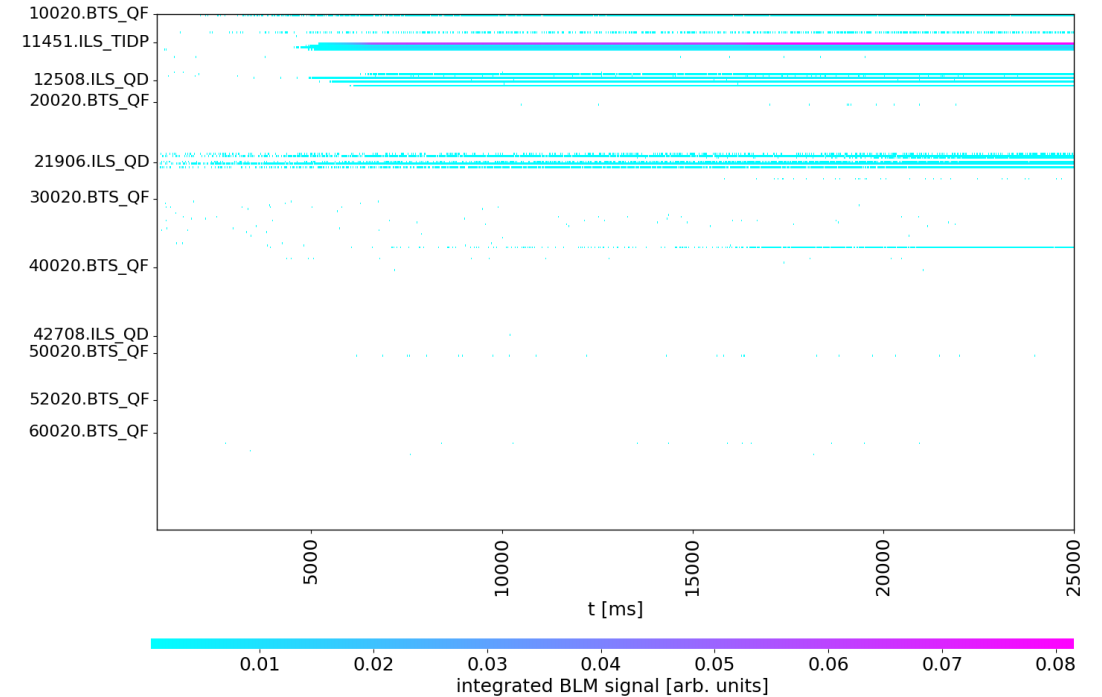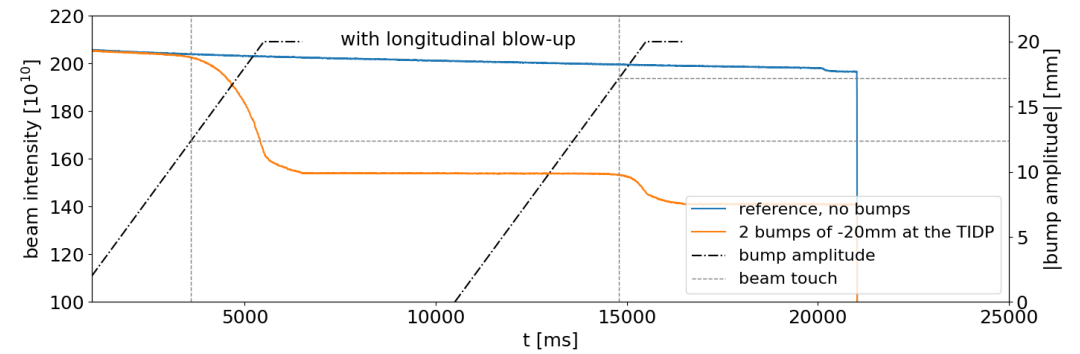
One bump of -18mm @ TIDP long max. amplitude
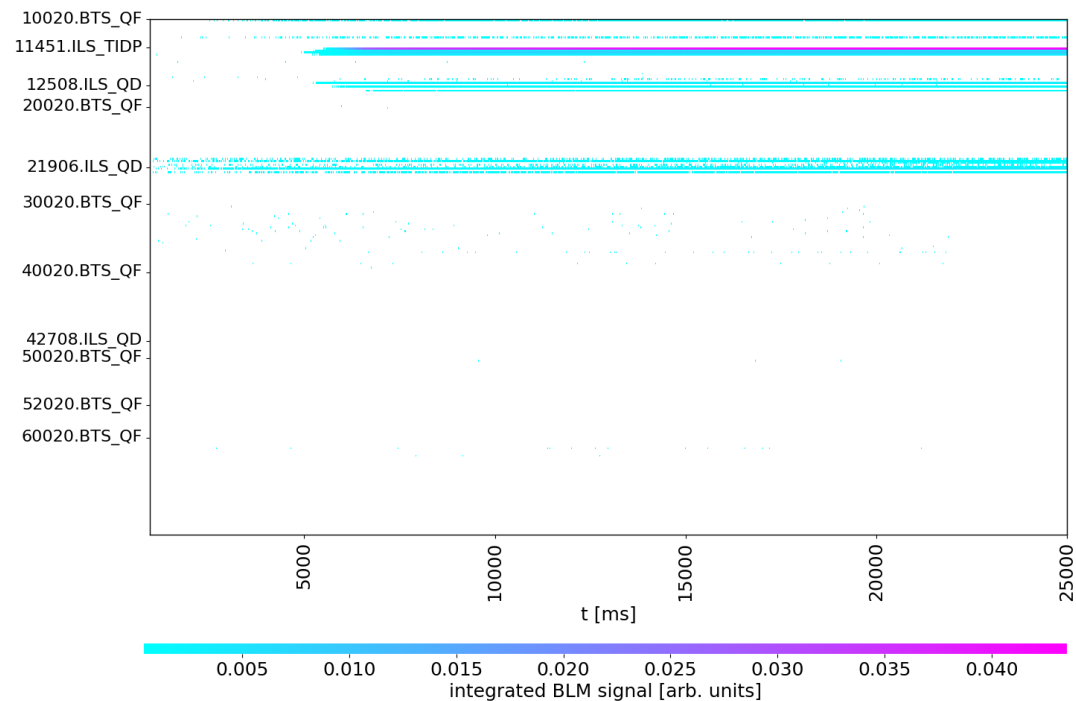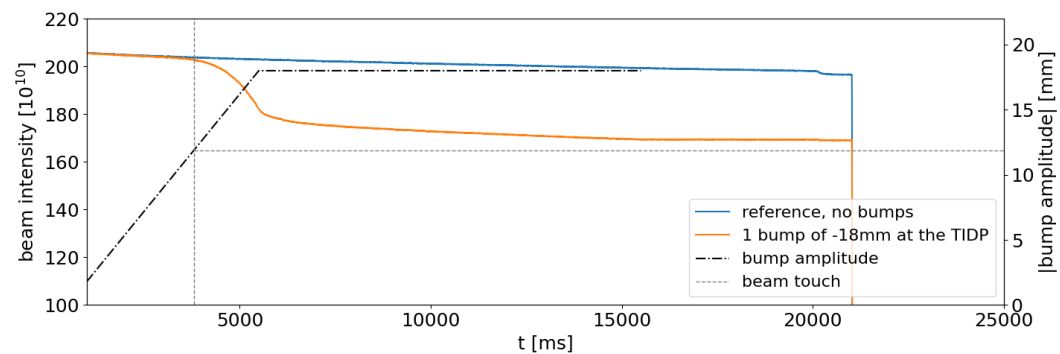
One bump of -18mm @ TIDP
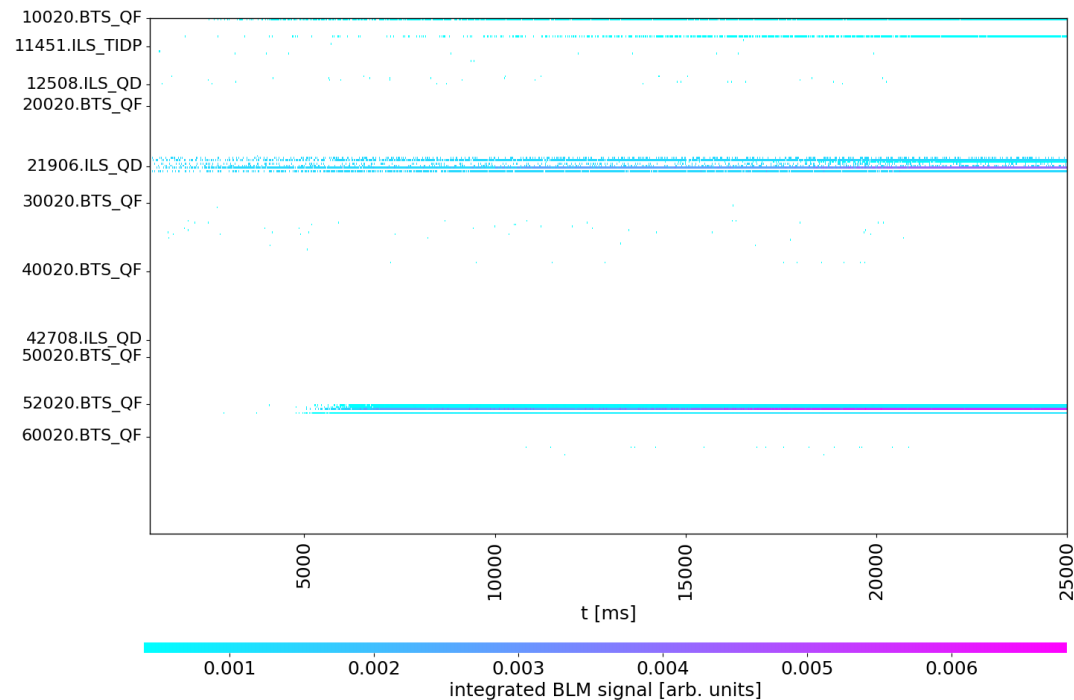## long max. amplitude
with longitudinal blow-up
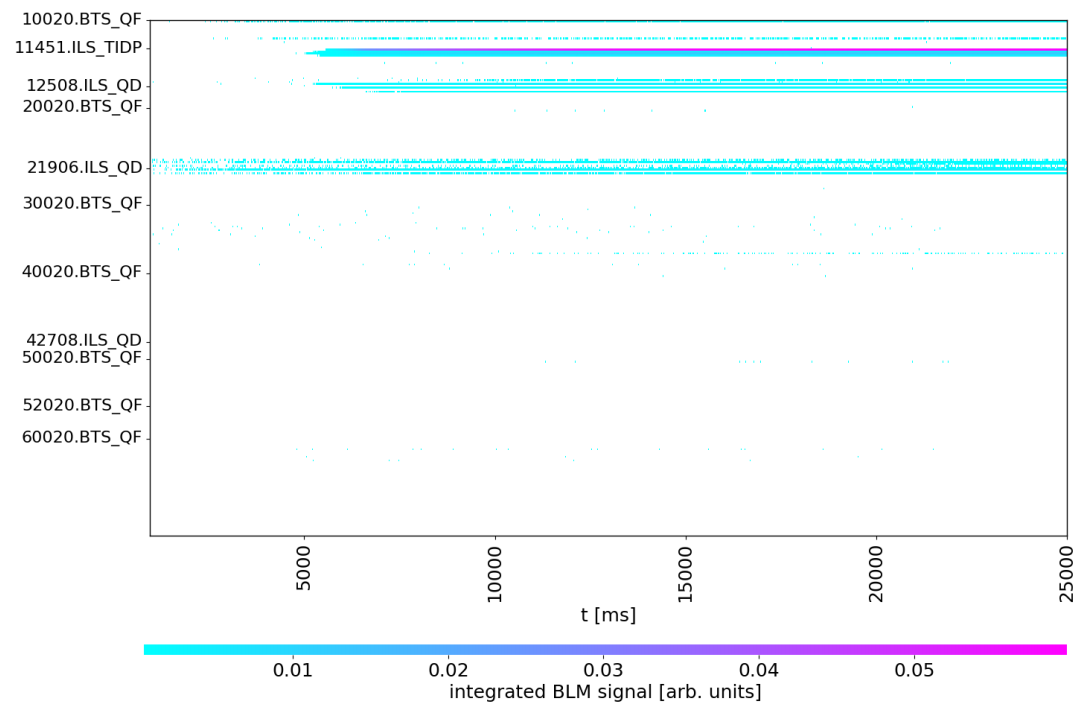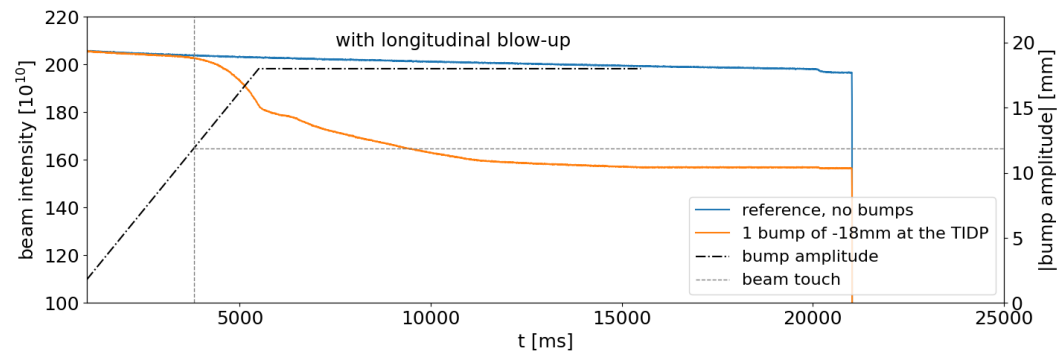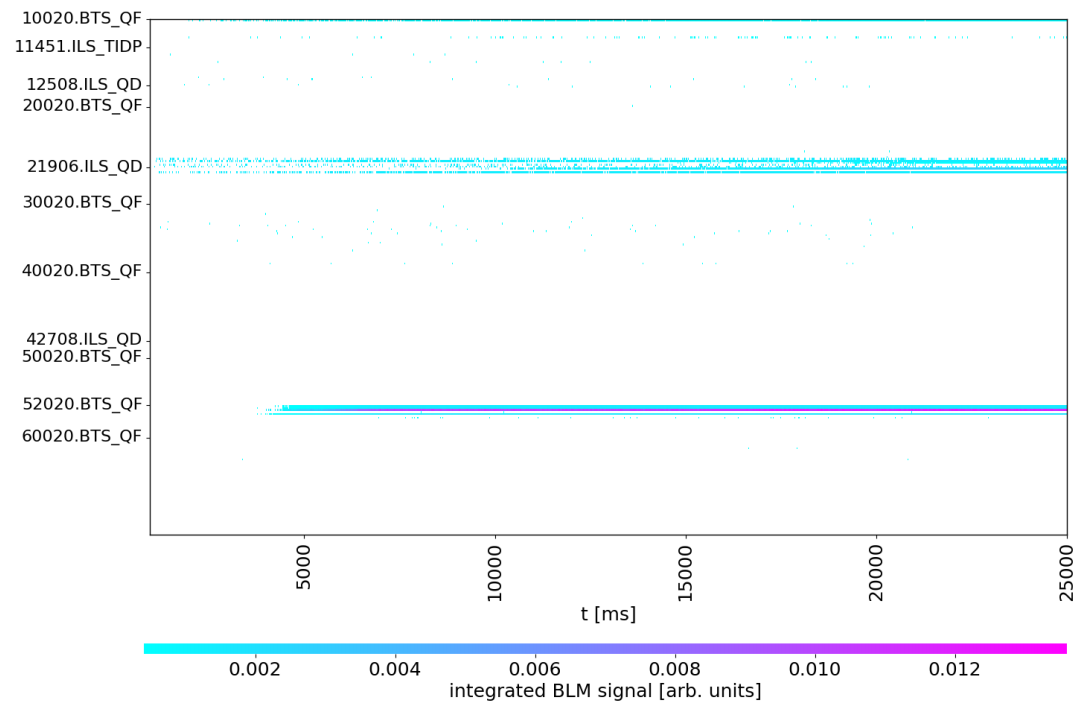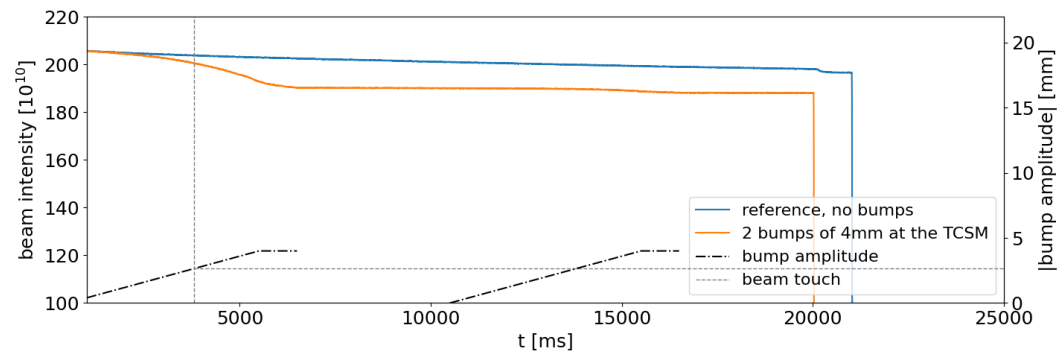
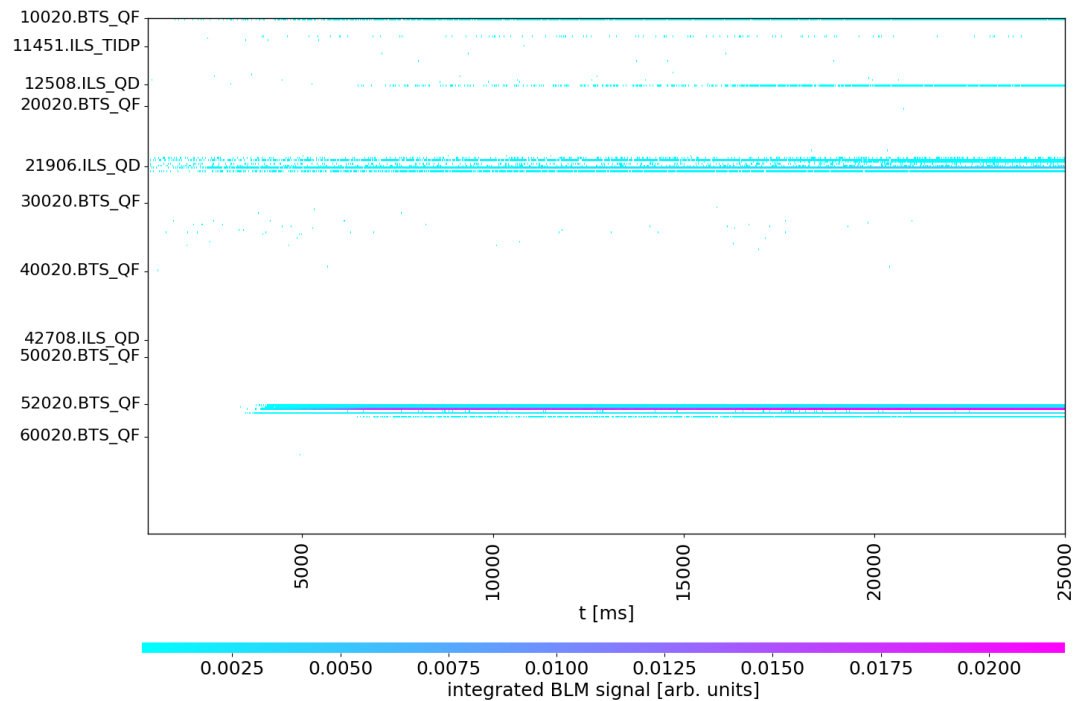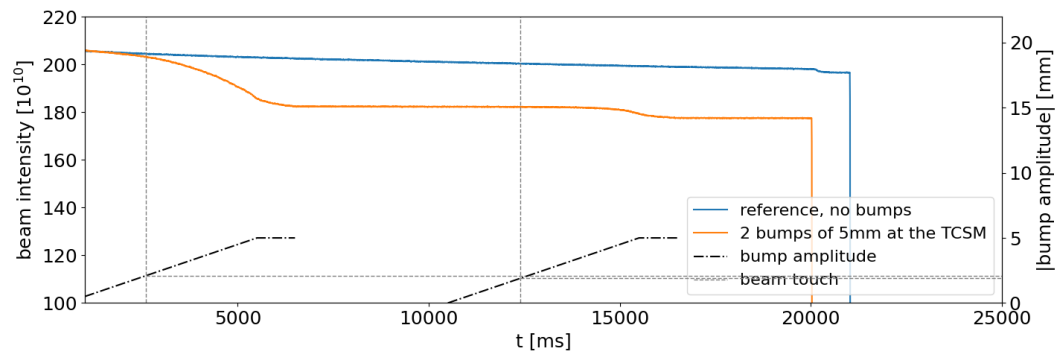# One bump of -20mm @ TIDP long max. amplitude
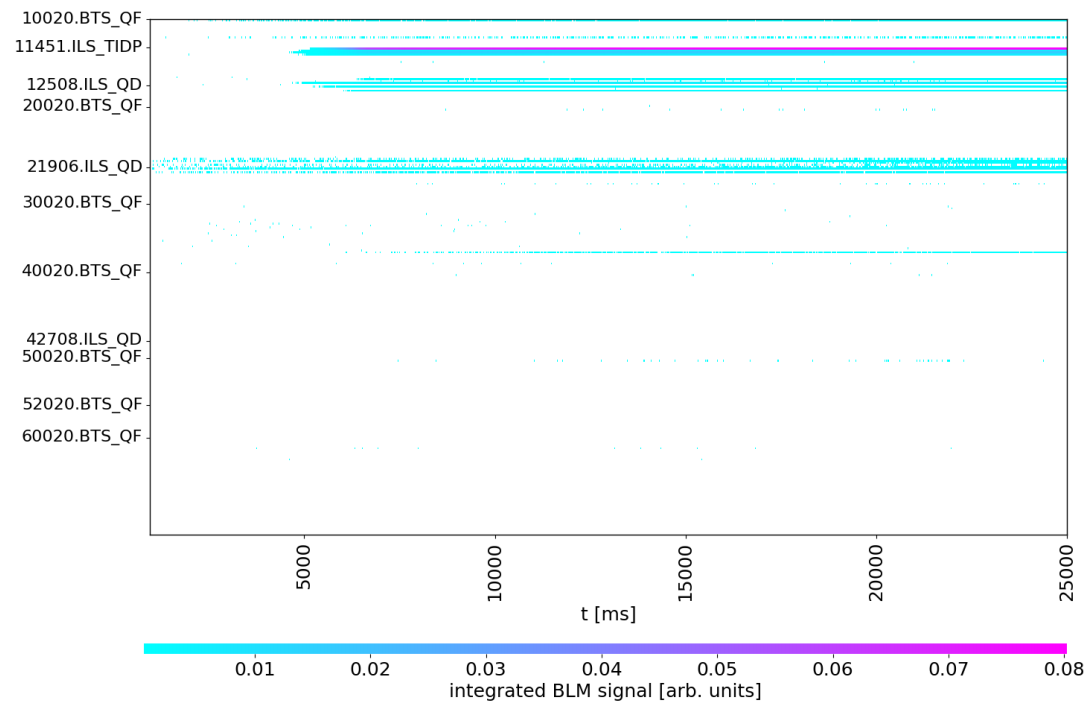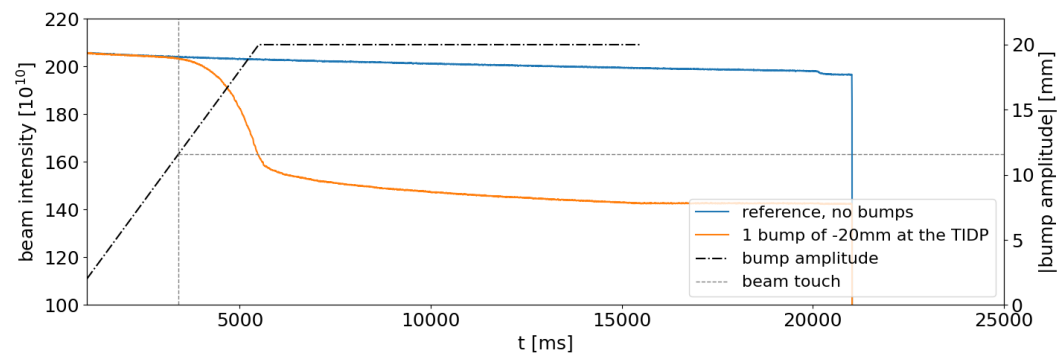
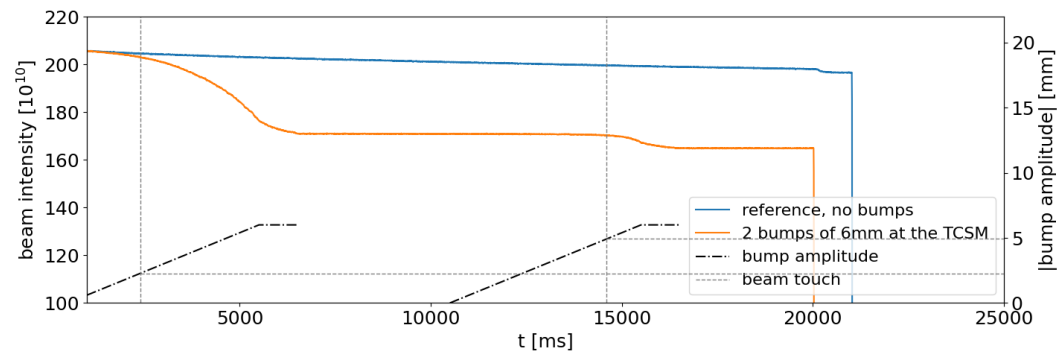# Two bumps of 3mm @ TCSM (low energy side)
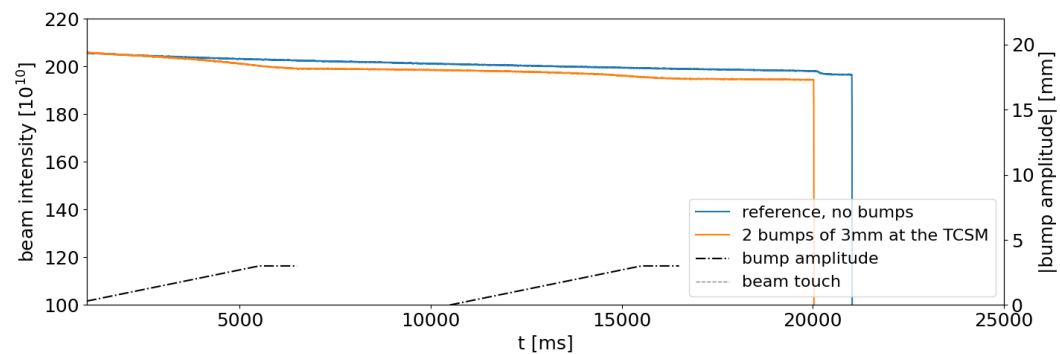
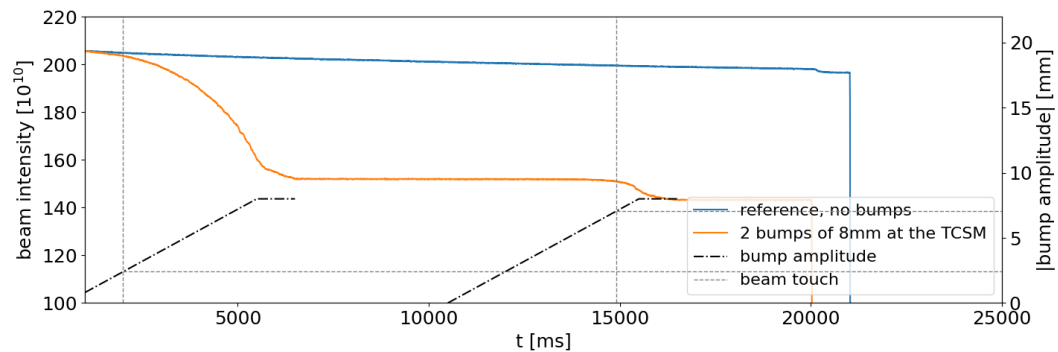BLM @ TCSM active
(nearest downstream BLM)

Two bumps of 4mm @ TCSM
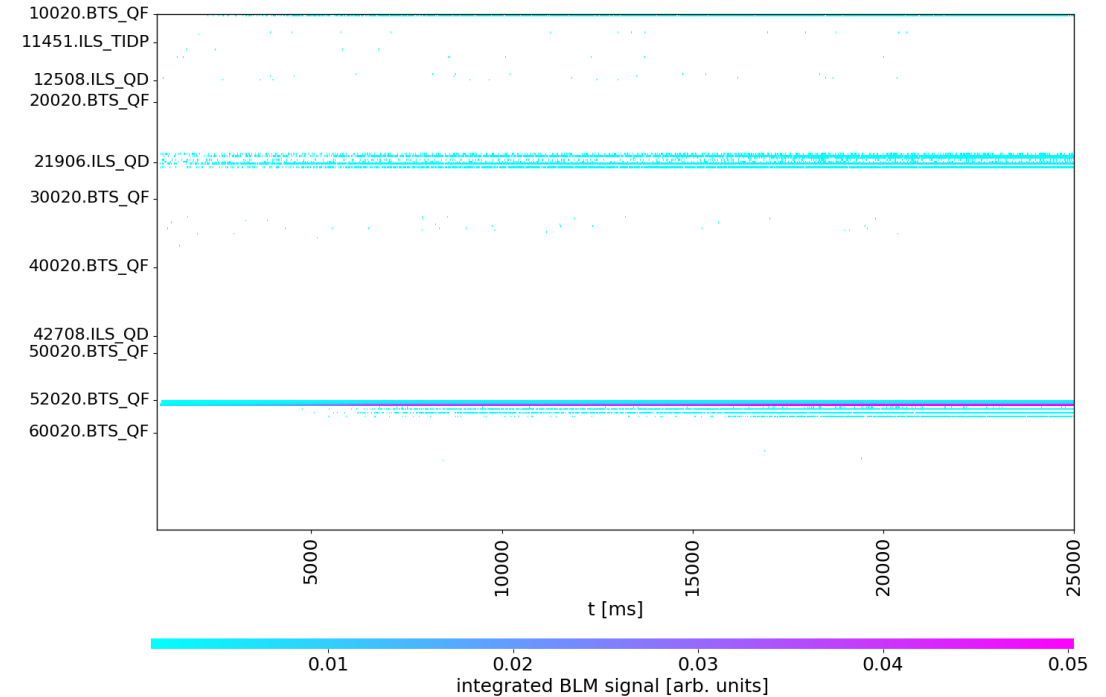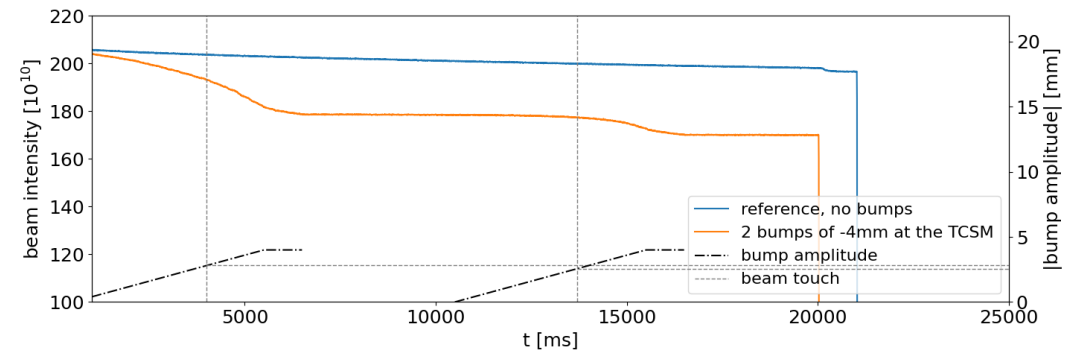
Two bumps of 5mm @ TCSM

Two bumps of 6mm @ TCSM
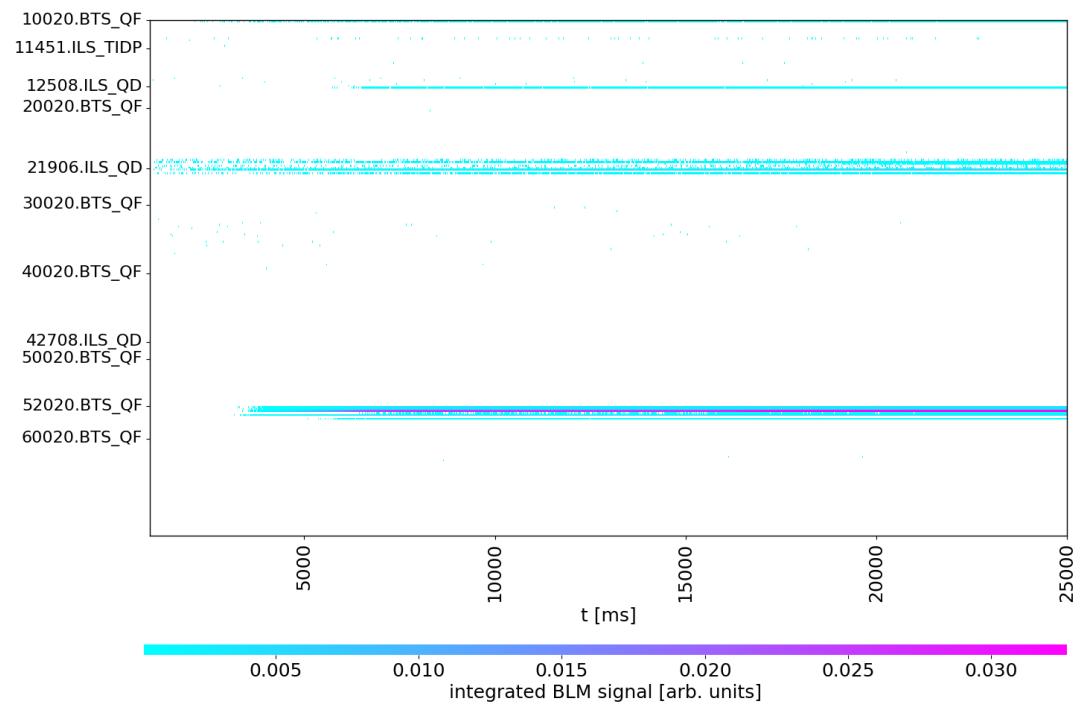
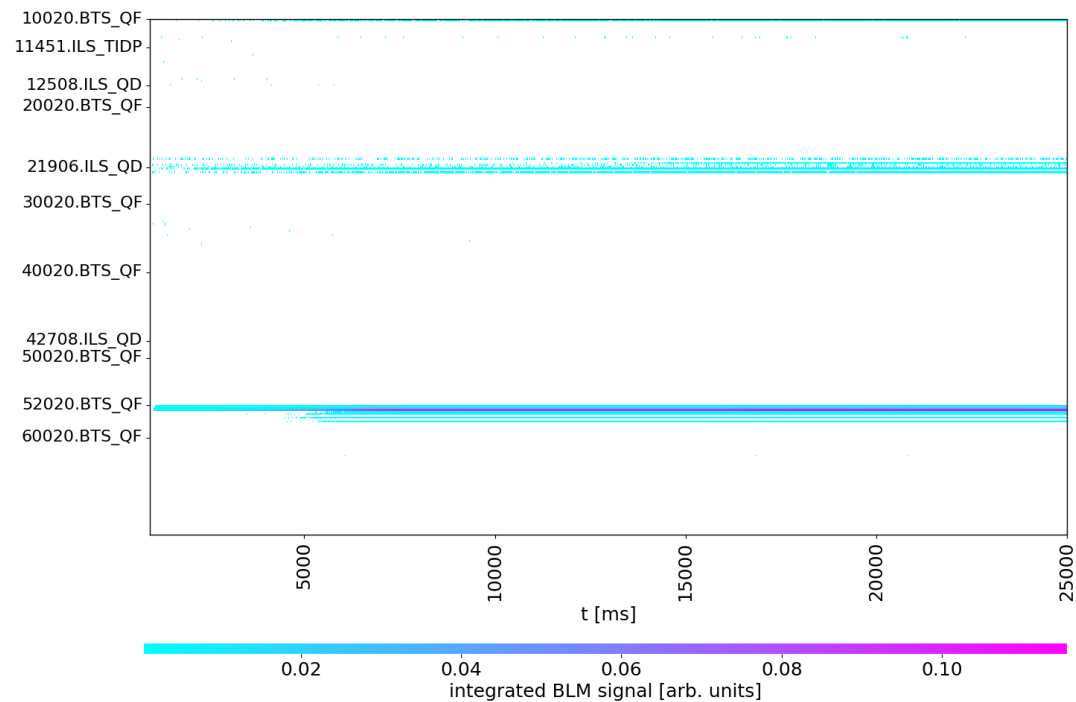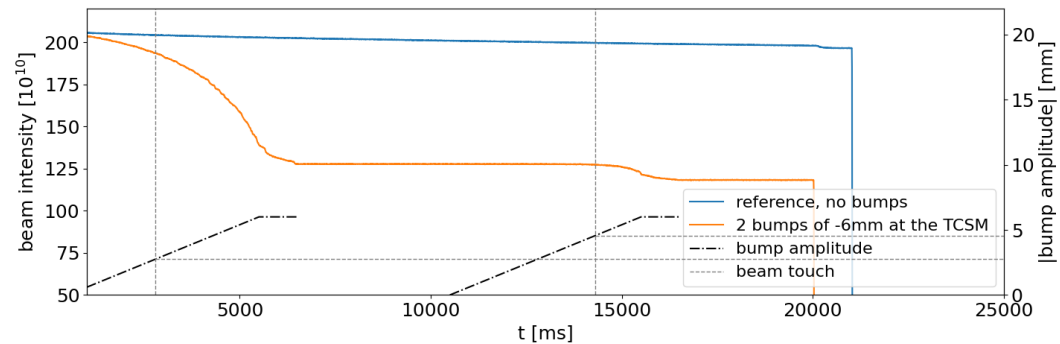# Two bumps of 8mm @ TCSM
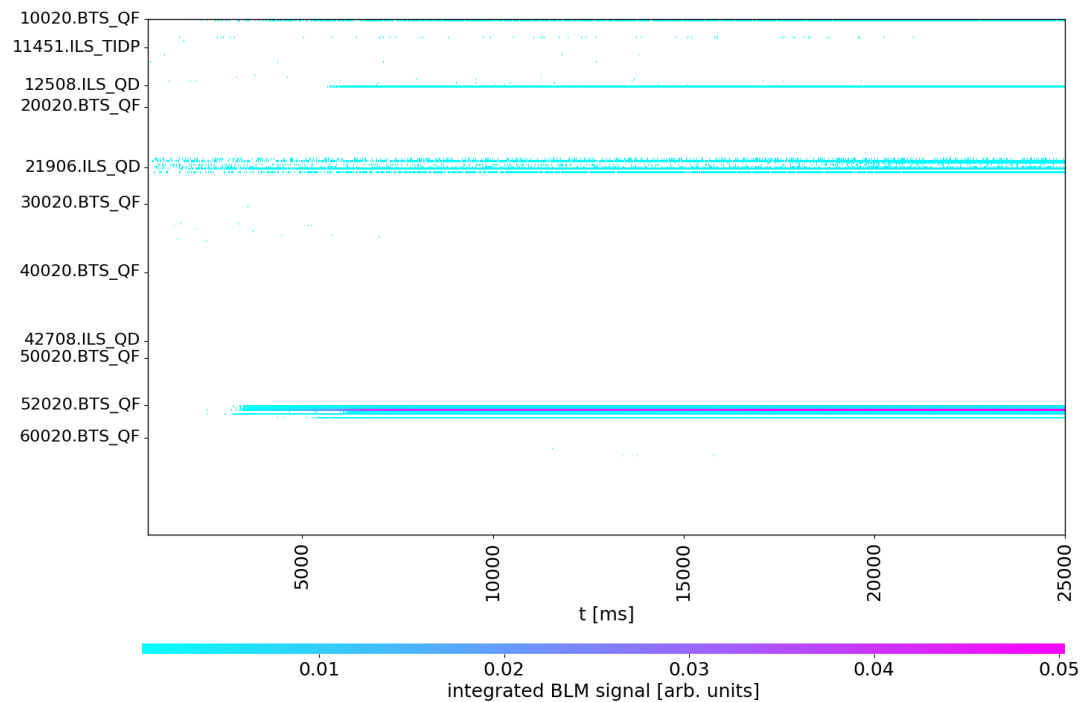
Two bumps of 9mm @ TCSM
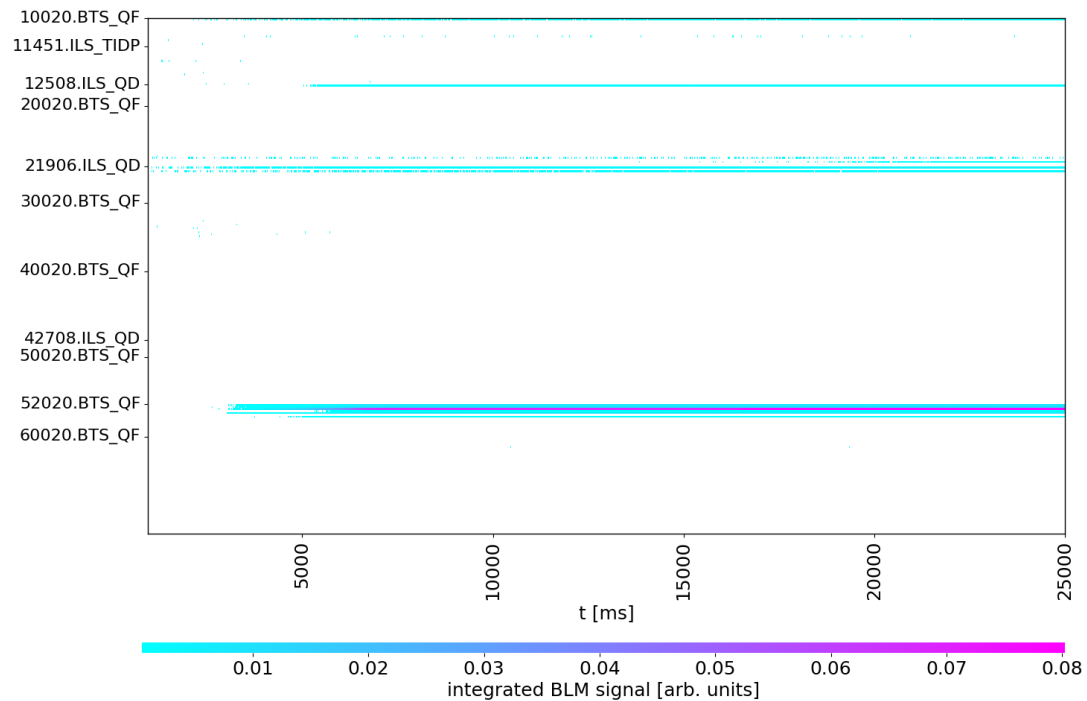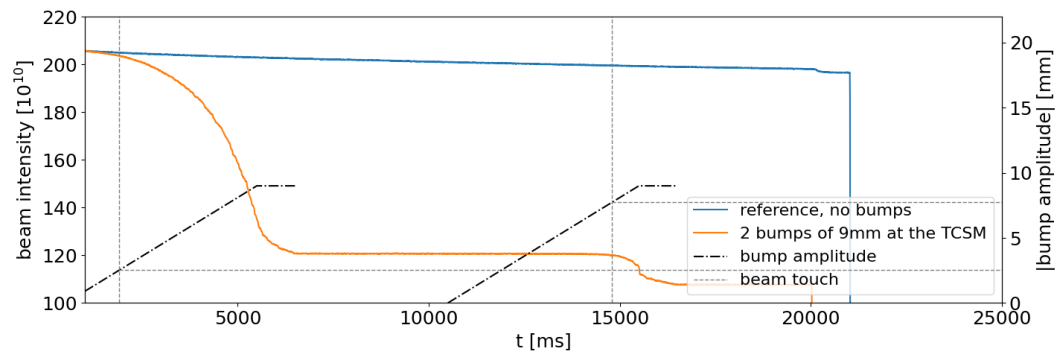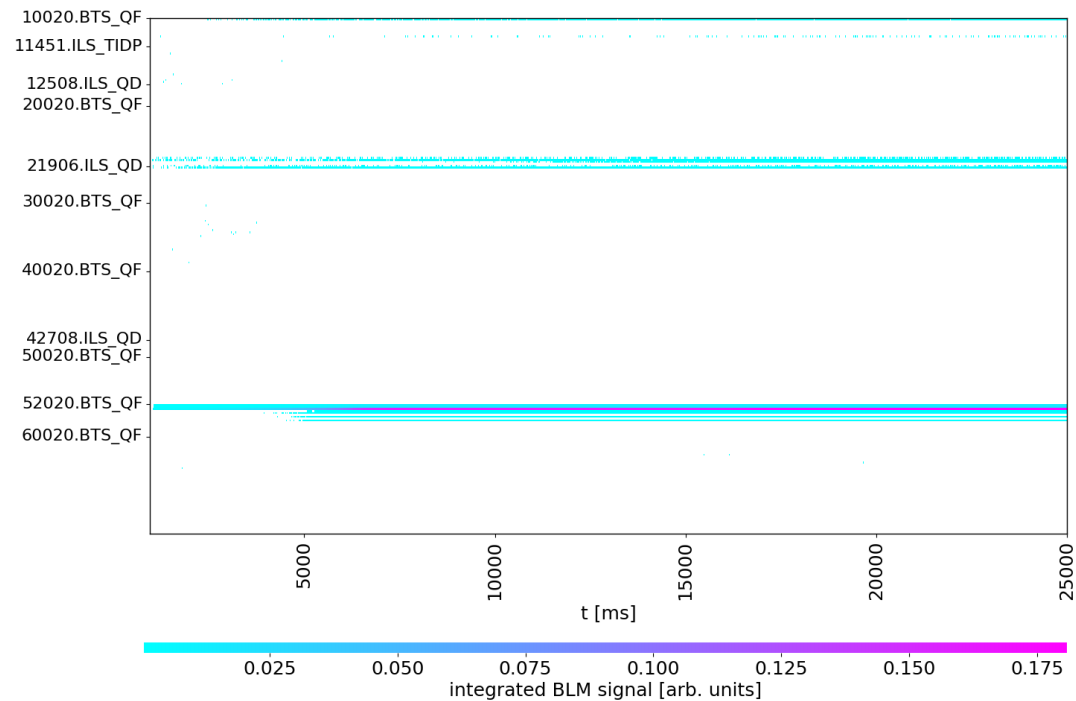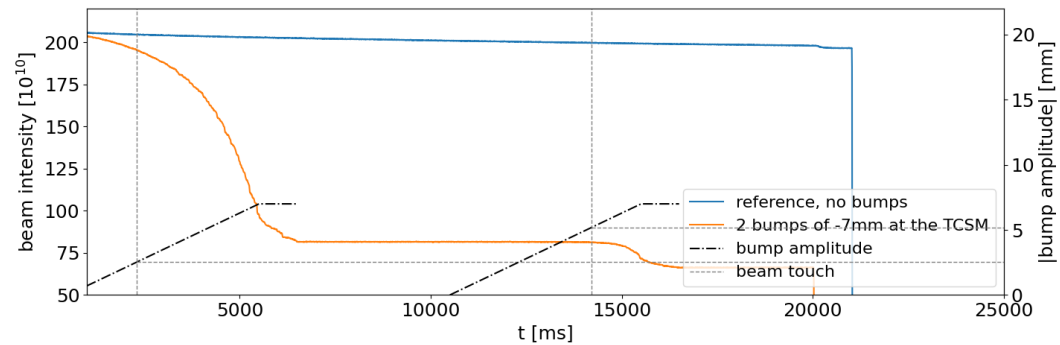
Two bumps of 9mm @ TCSM with longitudinal blow-up
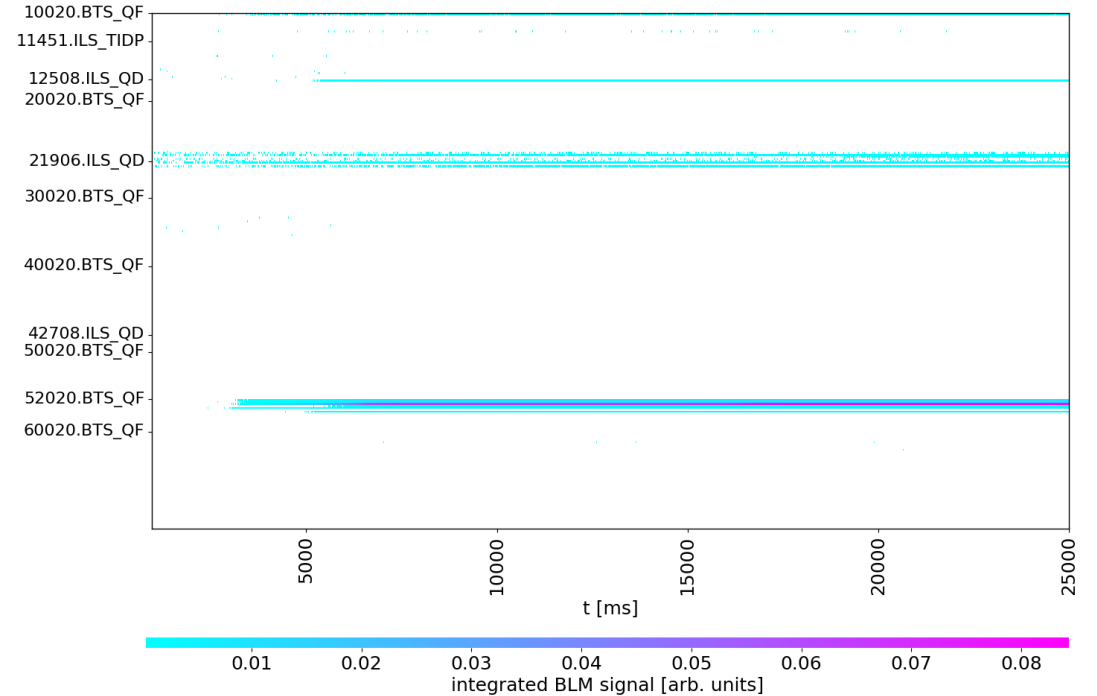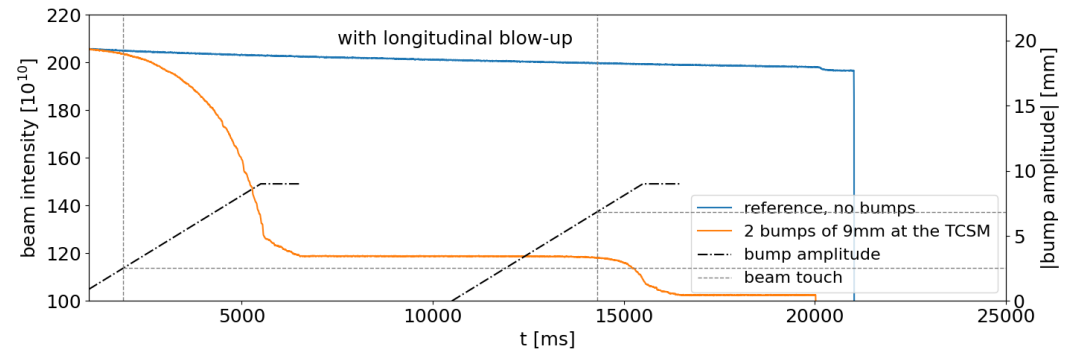
Two bumps of -4mm @ TCSM
(high energy side)

Two bumps of -6mm @ TCSM

Two bumps of -7mm @ TCSM
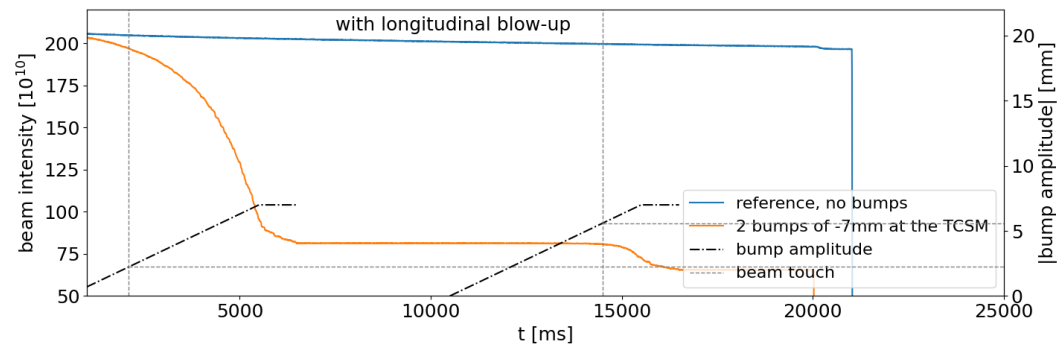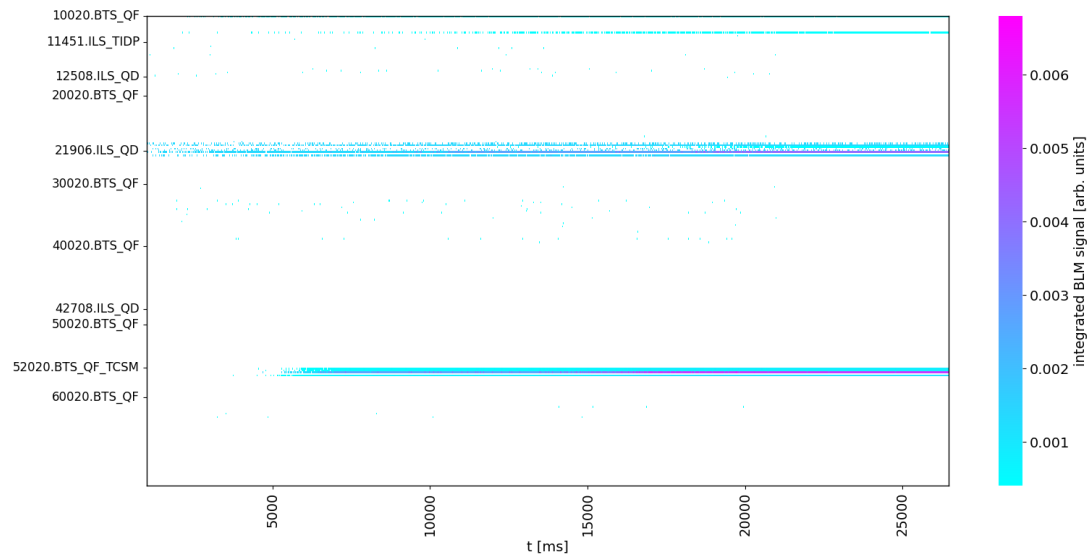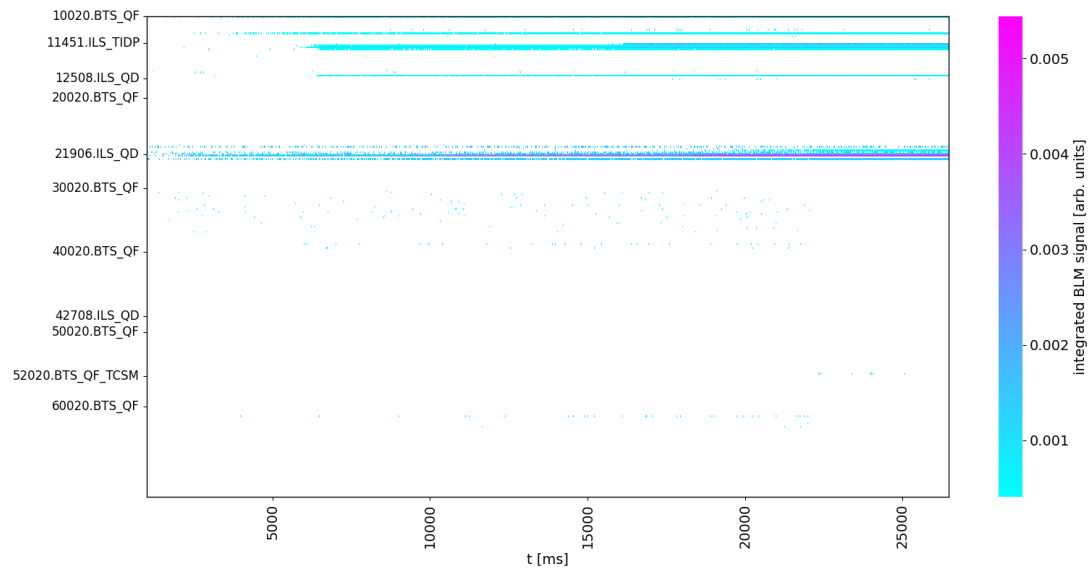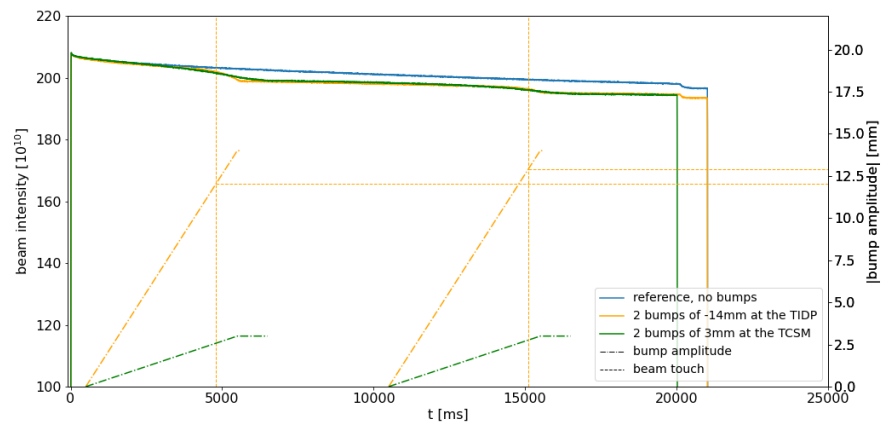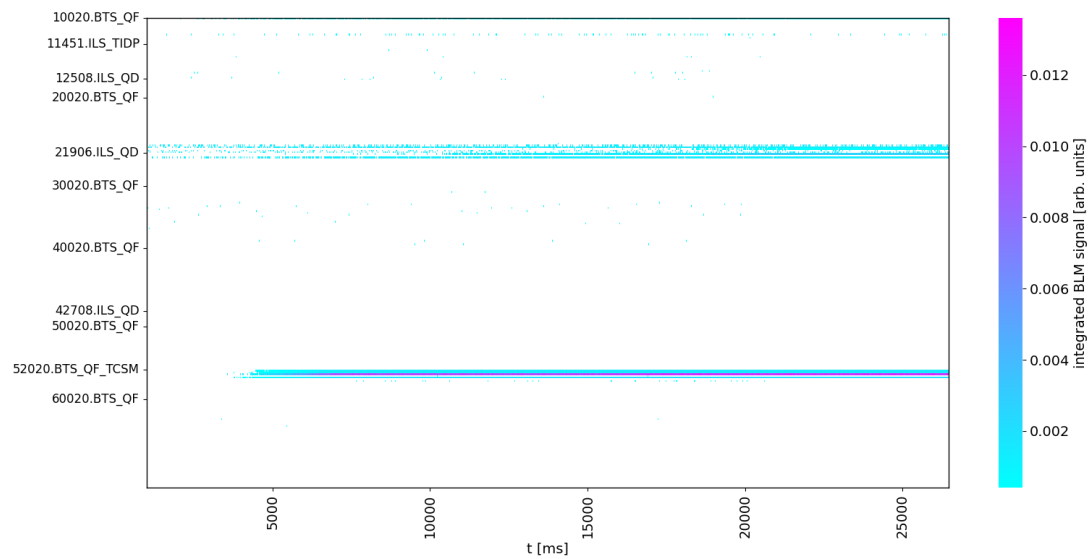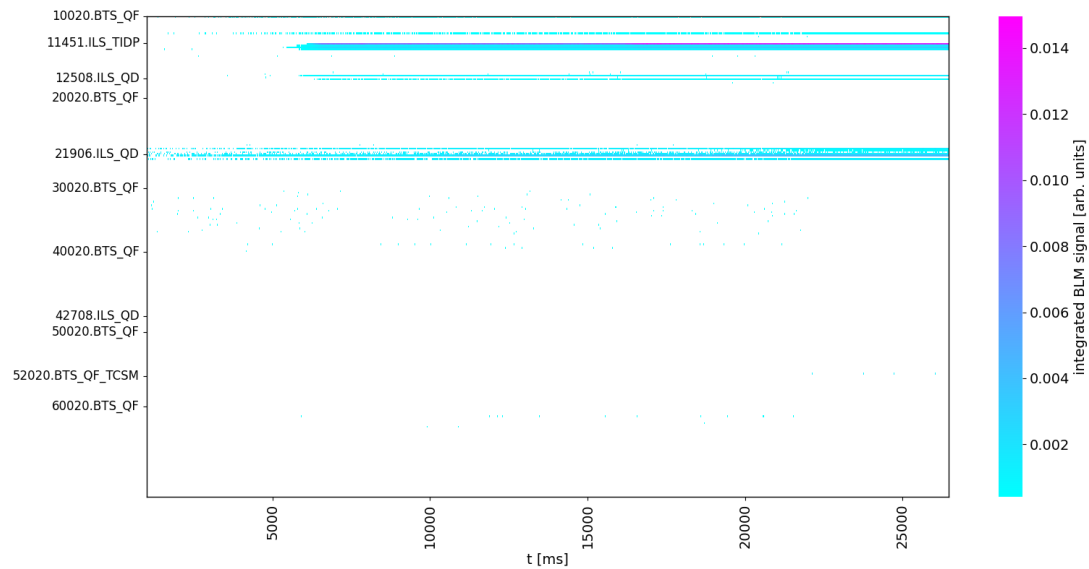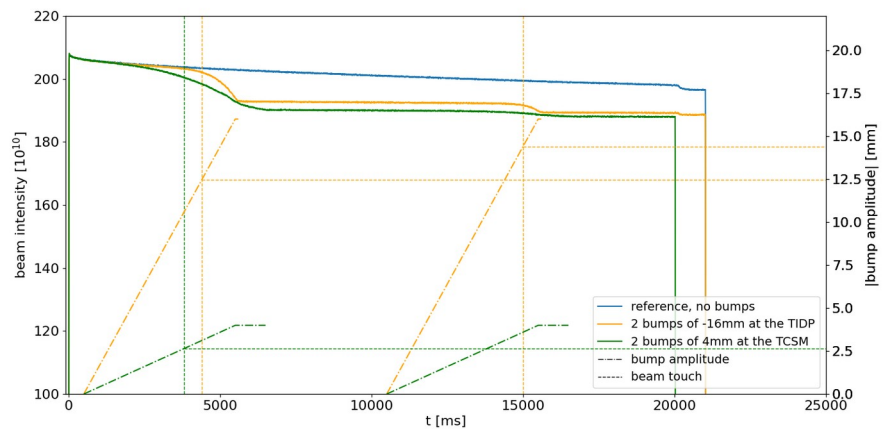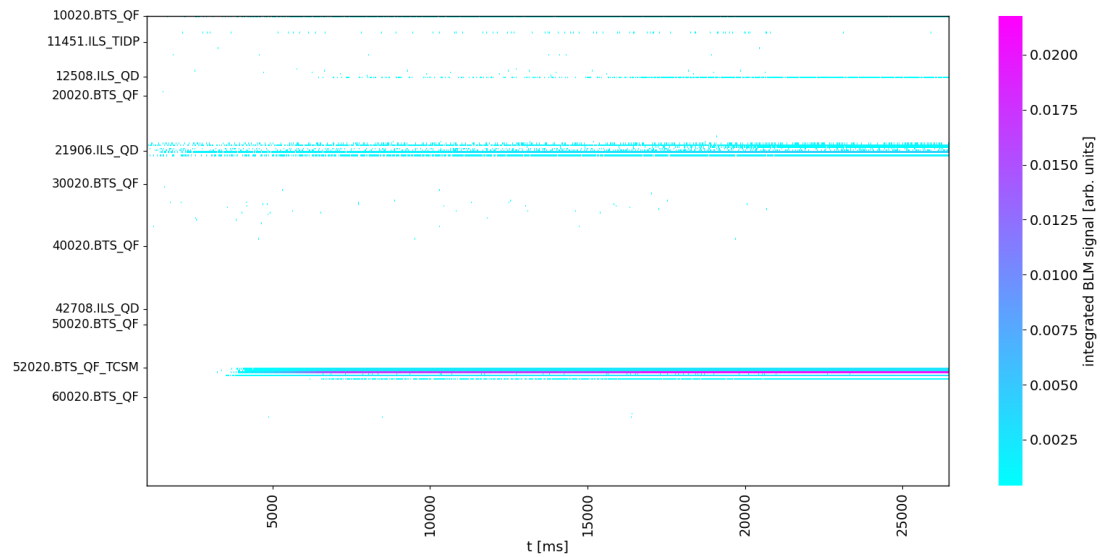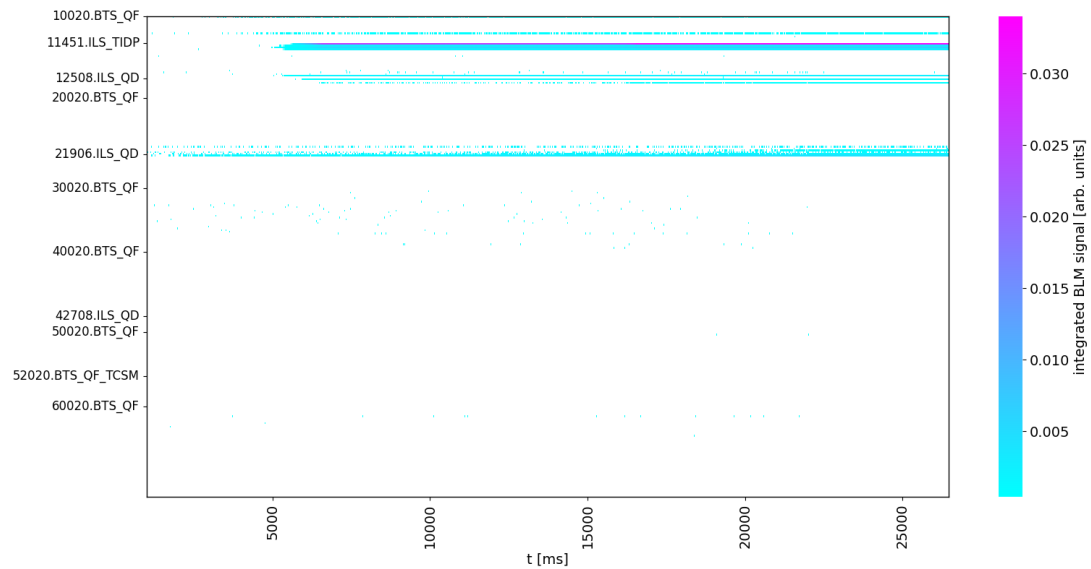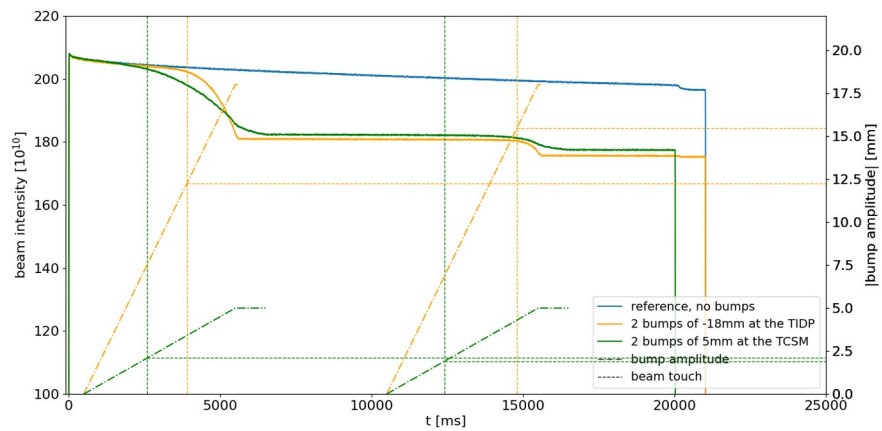
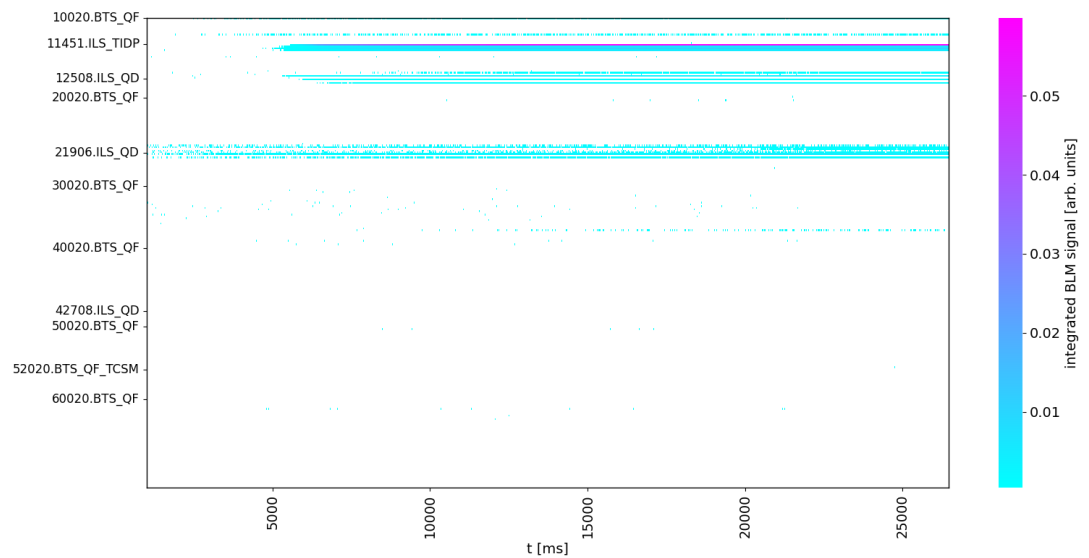# Two bumps of -7mm @ TCSM with longitudinal blow-up
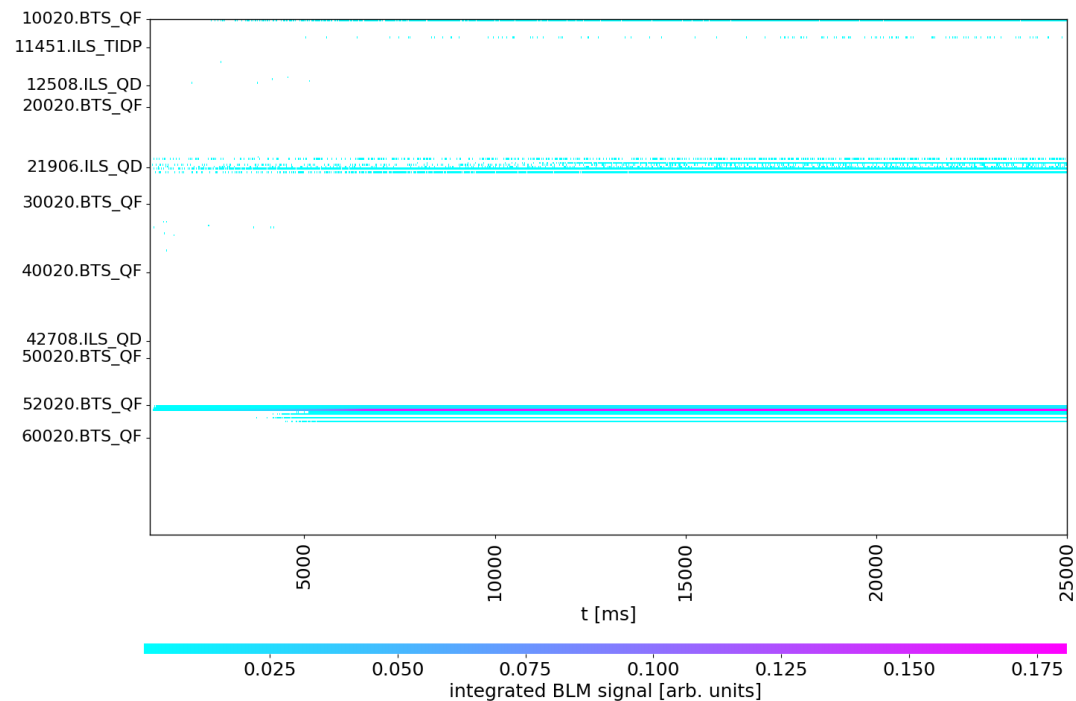
TIDP vs. TCSM

TIDP vs. TCSM

TIDP vs. TCSM

TIDP w/ and w/o longitudinal blow-up
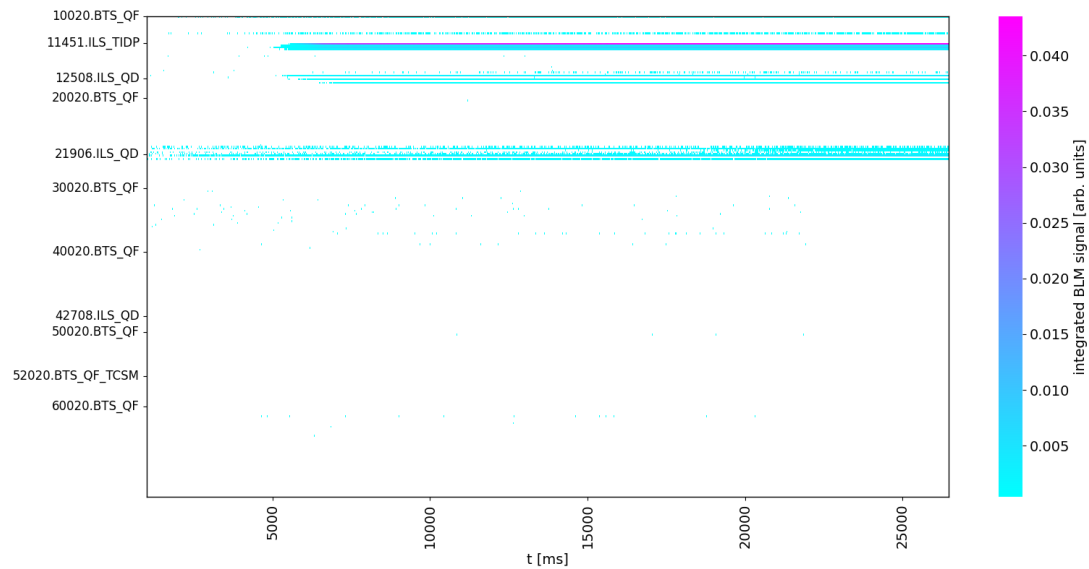
TCSM right vs. left jaw
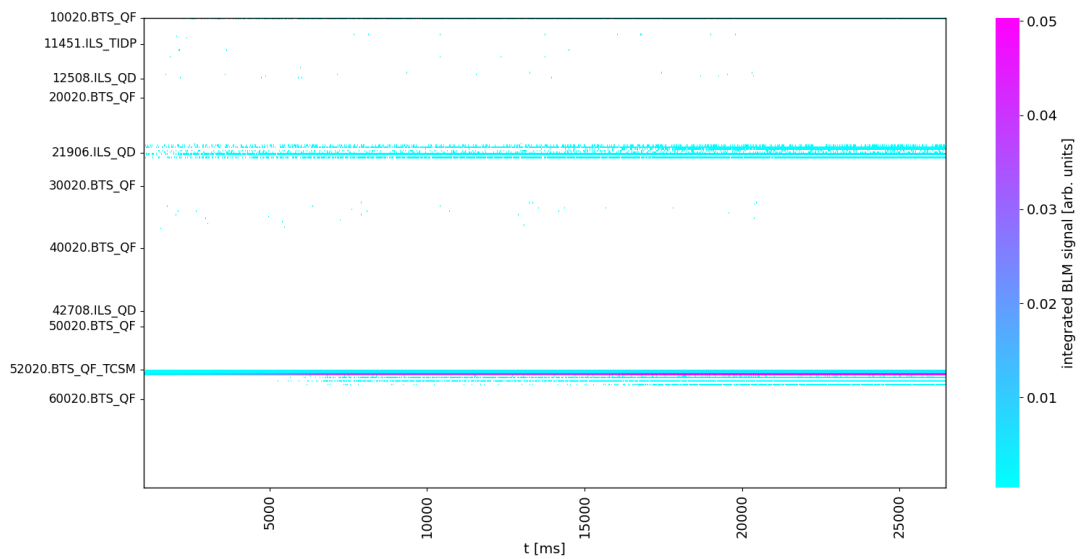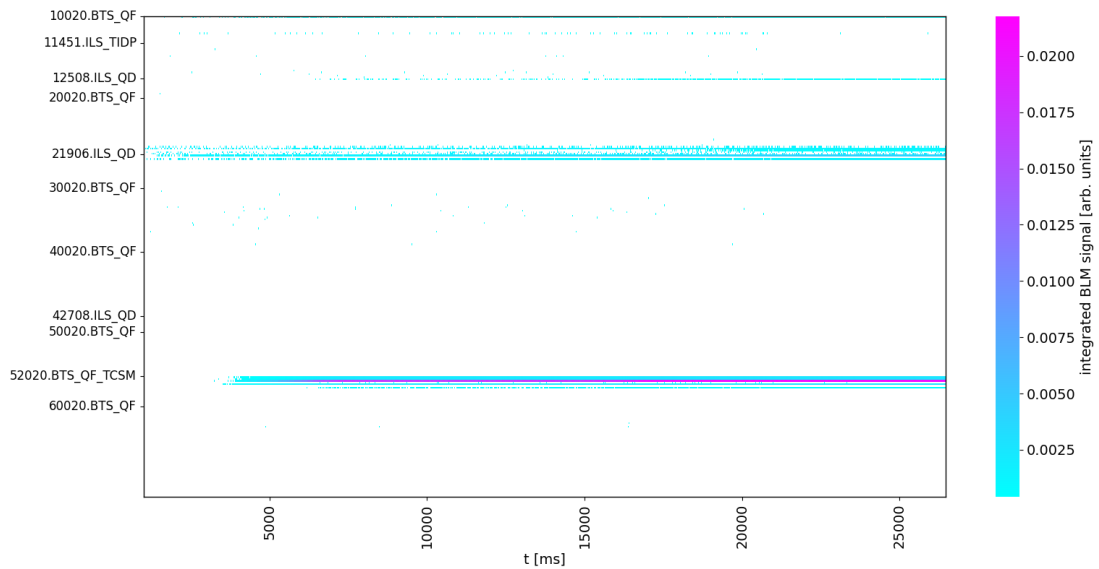
TCSM right vs. left jaw

TCSM right vs. left jaw

Summary

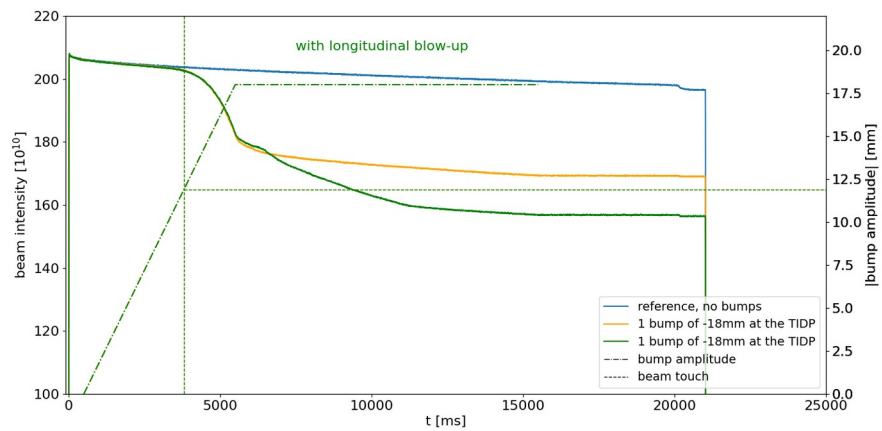- This presentation summarizes all relevant measurements taken during the dedicated MD on 20/07/2022.

- The beam was successfully scraped at both TIDP (high dispersion) and TCSM (low dispersion).
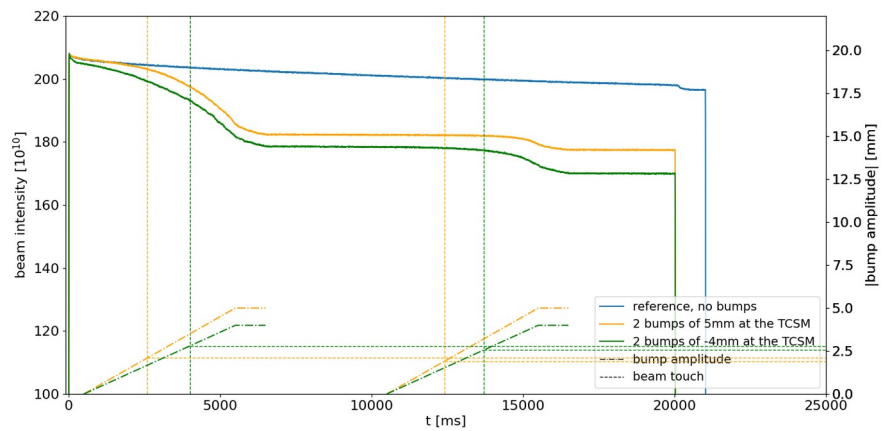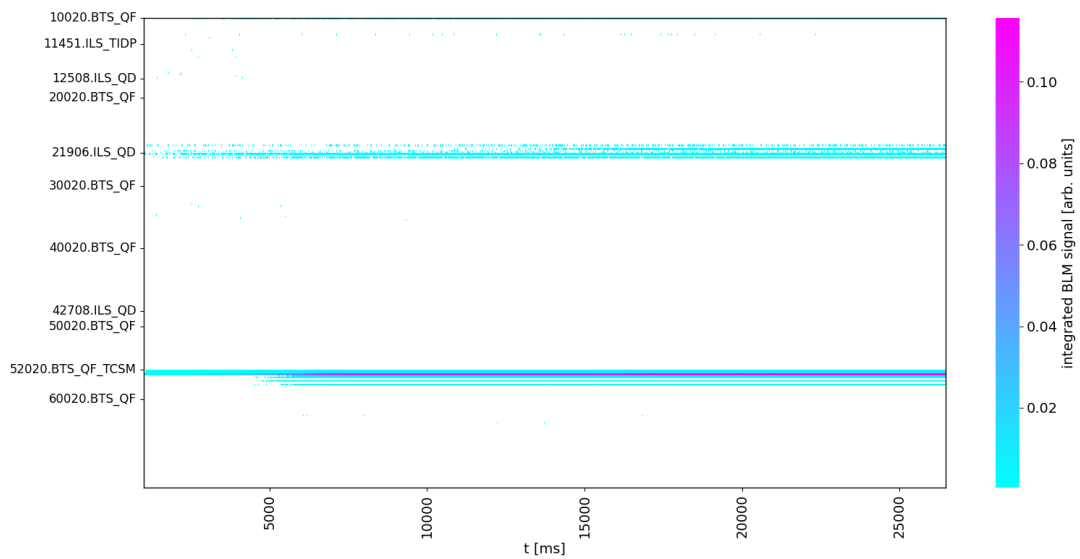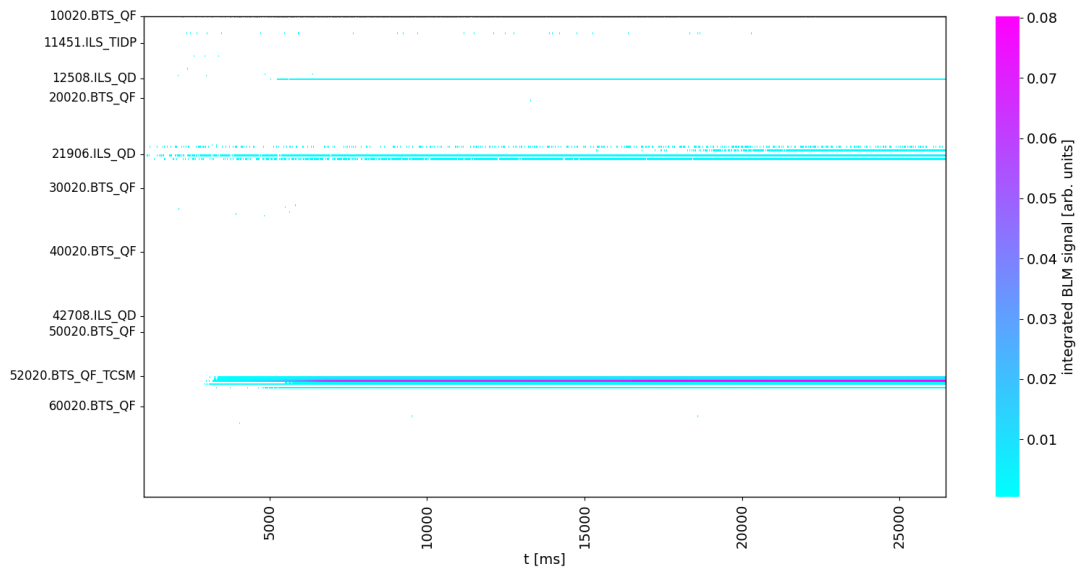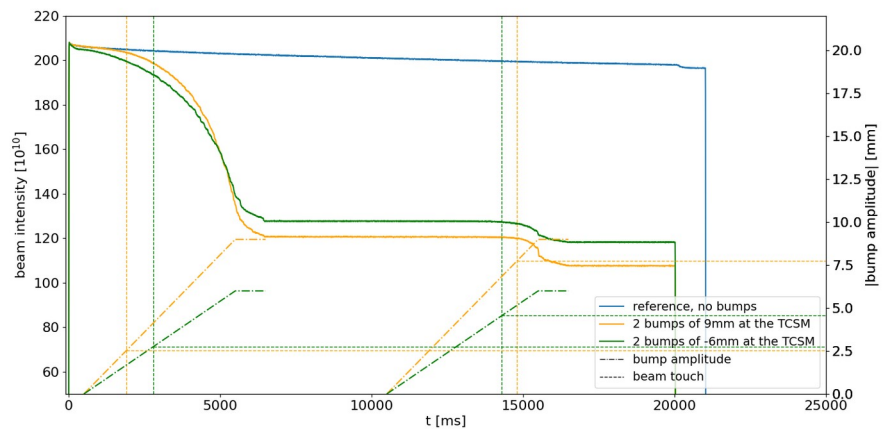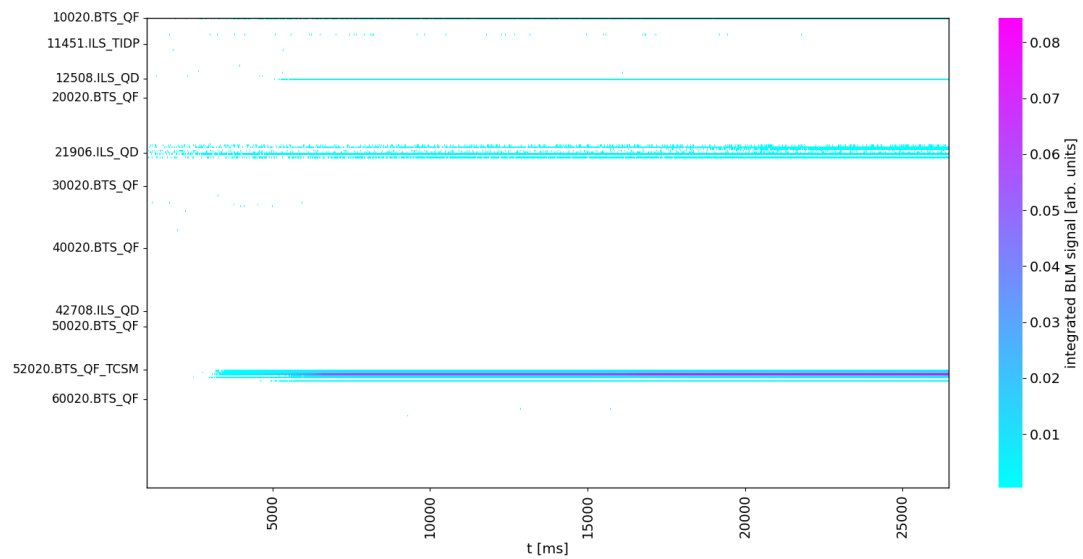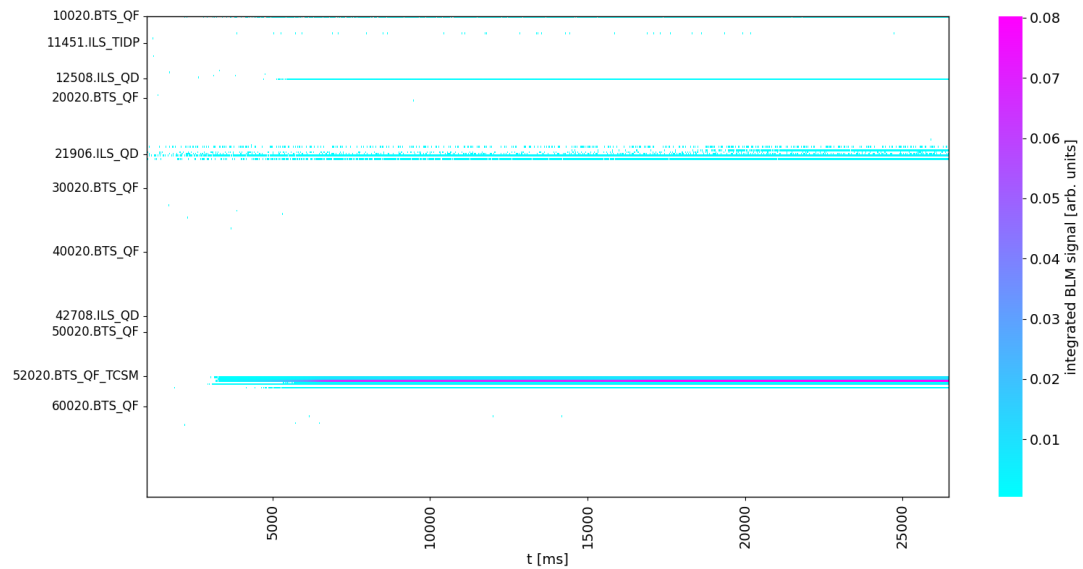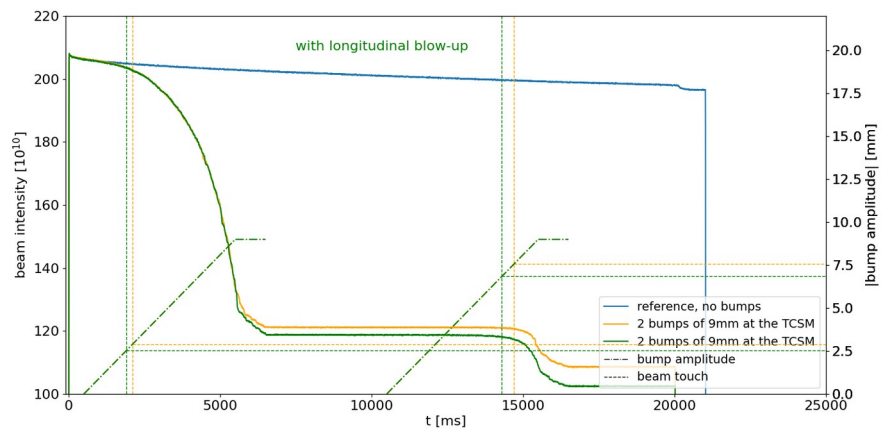
- Re-population of tails is observed in both cases.

- Losses at the TIDP with a single bump are in a good agreement with cleaning simulations.

- At this moment it is difficult to conclude the nature of losses based on this MD only.
  - Any suggestions of what data / analysis could be included into this study?
  - Or maybe it can be combined with other observations?

- All the data and plots are available in: https://cernbox.cern.ch/index.php/s/7jziEsCUNHeN6VS
  - Data in python .pickle format, organized in python dictionaries (rather intuitive to re-use).

- Many thanks to all people who contributed to this MD, mostly: Alex, Hannes and Verena!