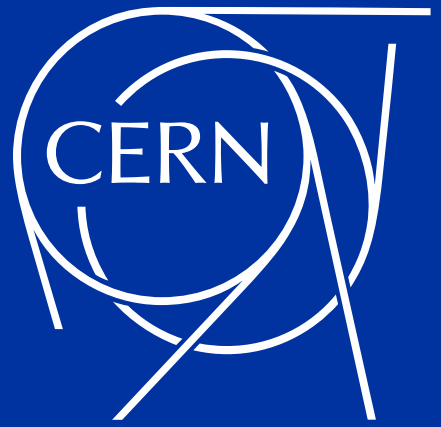


# Machine-Protection Studies: MPE MD plans for 2024

*C. Hernalsteens, J. Uythoven, C. Wiesner, D. Wollmann, P. Ziegler*

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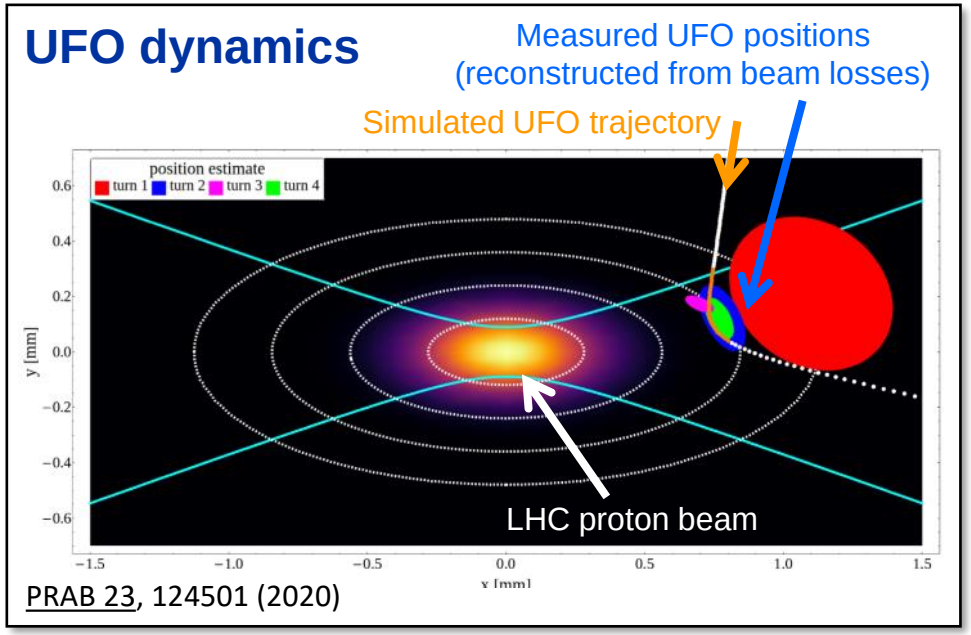
# MD plans: UFO studies

- **MD plans for 2024: UFO studies**
- **UFOs account for a large fraction of irregular beam-loss events observed in the LHC**
  - They can have crucial impact on the availability of the LHC, HL-LHC and future high-energy accelerators
- **Previous studies**
  - Focused on UFO dynamics (theoretical modelling and benchmarking with LHC data)
  - Results show that UFOs carry an initial negative charge before entering the proton beam*
- **However, charging and release mechanisms poorly understood**
- **Further studies required to improve understanding of release mechanisms**



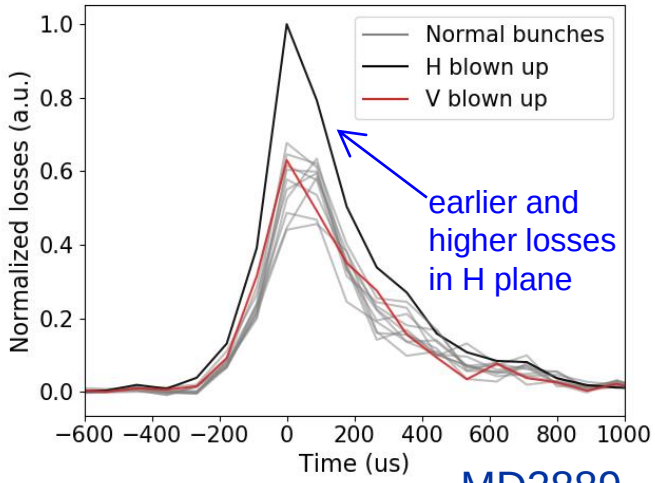

Dust particulates in lab environment exposed to UV radiation with positive external HV source (courtesy X. Wang, CU Boulder), see “Workshop on Dust Charging and Beam-Dust Interaction”, June 13-15, 2023 (Indico & CDS)

*B. Lindstrom et al., PRAB 23, 124501 (2020); P. Belanger, M.Sc. thesis (2020), A. Lechner et al., PRAB 25, 041001 (2022)

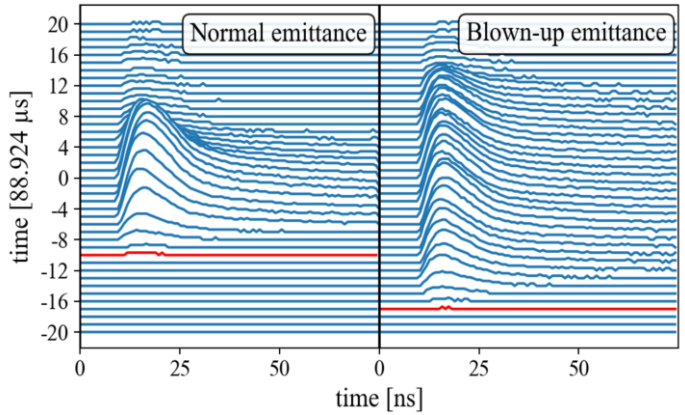
# Previous studies and MD goals

- **Method to observe beam-loss behaviour for bunches with blown-up H or V emittance during UFO events was established in MDs 2036 & 2889**
  - Uses bunch-by-bunch losses at dBLMs in IR7
  - However, symmetric nature of blown-up bunches makes it impossible to distinguish from which direction the UFO enters the beam
- **Refined method: displace selected bunches (± H and ±V) and observe beam-loss behaviour in case of UFO events**
  - Allows to distinguish from which direction the UFO enters the beam, which could lead to important conclusions for the release mechanism
- **The requested MD aims to**
  - Validate and optimise the dBLM UFO auto-triggering using wire scans as artificial UFOs
  - Demonstrate the proof of principle to reconstruct UFO trajectories from displaced bunches by measuring loss behaviour at the dBLMs in IR7

dBLM losses




MD2889



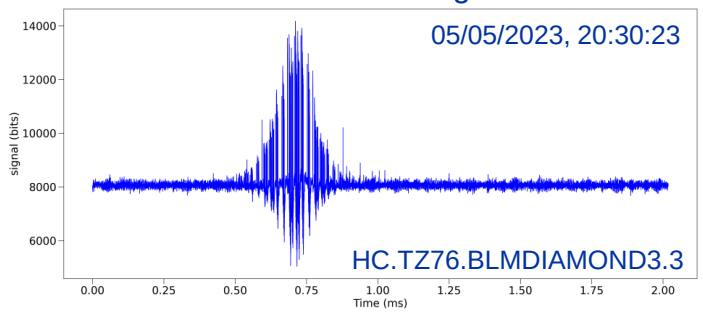
# MD procedure (1/2)

- **MD Part 1: Validate dBLM functionality and adapt settings where required (4 hours)**
  - Test and confirm correct functioning of dBLM autotrigger
  - Validate trigger of dBLMs on WS timing event and correctly adjust the delay
- **MD Part 2: Displaced bunches at injection energy (4 hours)**
  - Perform wire scans (B1/2, H/V) without displacement and verify dBLM autotrigger (for reference)
  - Displace bunches
    - using recurrent kick (±H and ±V) from the ADT (# of bunches and kick amplitude TBC)

    and/or
    - using beam with large orbit spread from beam-beam long range interactions (possibly weak-strong beam configuration, # of bunches and filling pattern TBC)
  - For all steps: Perform wire scans and verify dBLM autotrigger
- **MD Part 3: Displaced bunches at 6.8 TeV (4 hours)**
  - Perform wire scans without displacement and verify dBLM autotrigger (for reference)
  - Displace bunches
    - using recurrent kick (±H and ±V) from the ADT (# of bunches and kick amplitude TBC)

    and/or
    - using beam with large orbit spread from beam-beam interactions (possibly weak-strong beam configuration, # of bunches and filling pattern TBC)
  - For all steps: Perform wire scans and verify dBLM autotrigger

Measured dBLM signal




Calculated ratio of losses as a function of bunch displacement

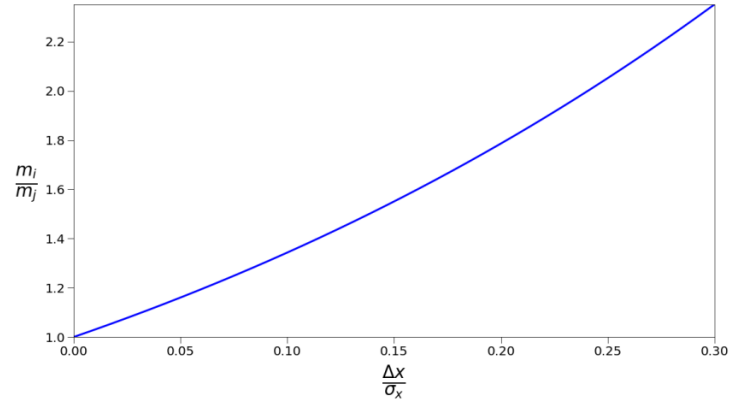


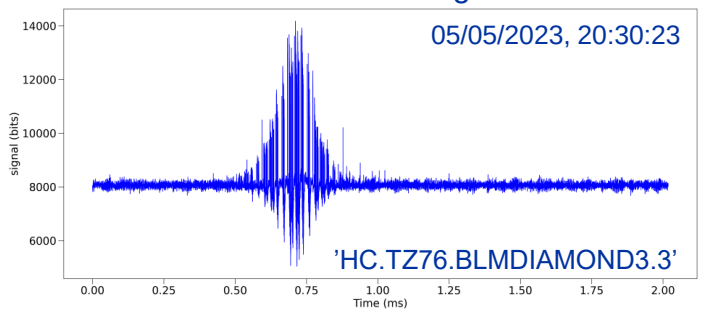

**Figure 1:** Ratio of normalised losses against bunch displacement, for a UFO at position $x_j = 3\sigma_x$

J. Sadler, CDS

# MD procedure (2/2)

- **Machine protection relevant changes**
  - No changes of optics, collimation settings, RF
  - Intensity for “weak” beam limited to ~200b (450 GeV) and ~10b (6.8 TeV) due to WS
  - Desired intensity for “strong” beam TBC, but expected <600b (450 GeV) and <500b (6.8 TeV)
  - Bunch-by-bunch orbit change of O(100 µm) at injection and O(10 µm) at top energy
- **MD planning**
  - Requested time: 12 hours
    - Could be reduced if Part 1 is completed during commissioning
  - MD Part 1 could be performed during commissioning, Part 2 during intensity ramp-up, Part 3 during MD1
- **MD participants:**
  - P. Belanger, X. Buffat, E. Calvo Giraldo, M. Hostettler, M. Gonzalez Berges, C. Hernalsteens, A. Lechner, B. Lindstrom, D. Valuch, C. Wiesner, D. Wollmann, P. Ziegler,…
- **MD Request #10483 “Investigations of UFO release mechanisms using displaced bunches” to be updated with latest procedure**
- **Outlook: Depending on the outcome**
  - define follow-up MD,
  - develop method that profits from the existing bunch-by-bunch orbit spread during physics fill, or
  - prepare dedicated test with displaced bunches

Measured dBLM signal




Calculated ratio of losses as a function of bunch displacement

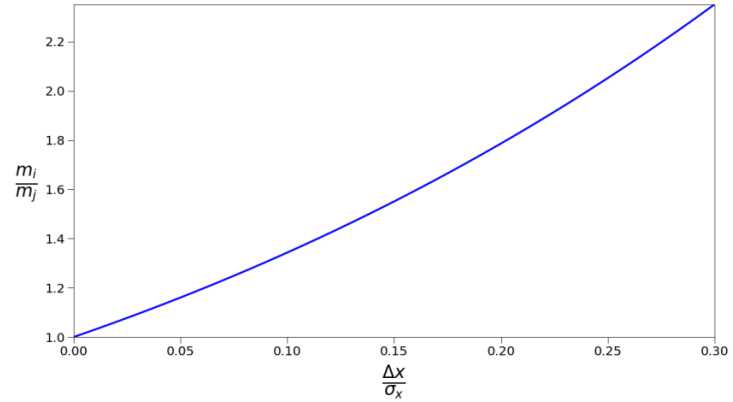



**Figure 1:** Ratio of normalised losses against bunch displacement, for a UFO at position $x_j = 3\sigma_x$

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Thank you for your attention!


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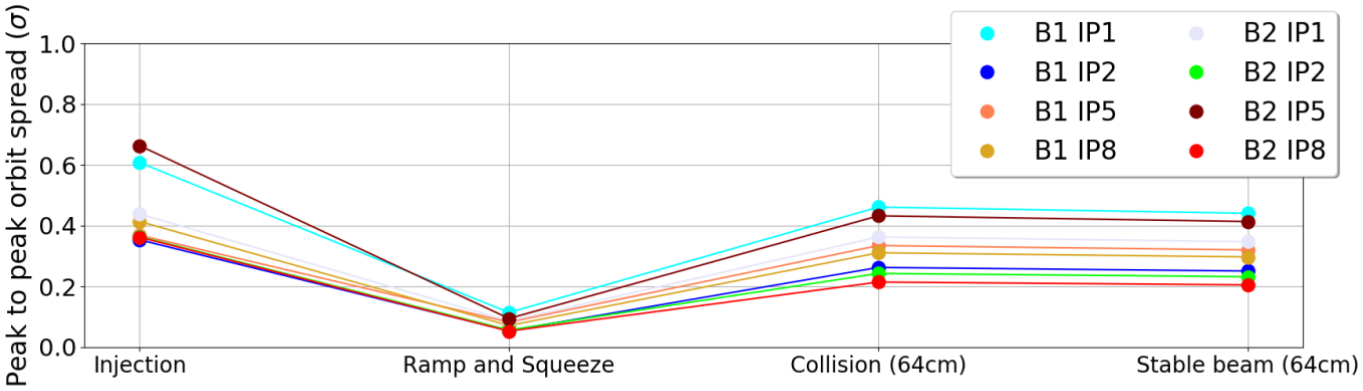
# Backup slides

## Peak-to-peak orbit spread for HL-LHC parameters




(a) Nominal operational cycle.

A. Ribes-Metidieri, X. Buffat, CERN-ACC-NOTE-2019-0037