# Fast failure due to triplet event (03.06., 19:28): the beam view

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TE-MPE-PE

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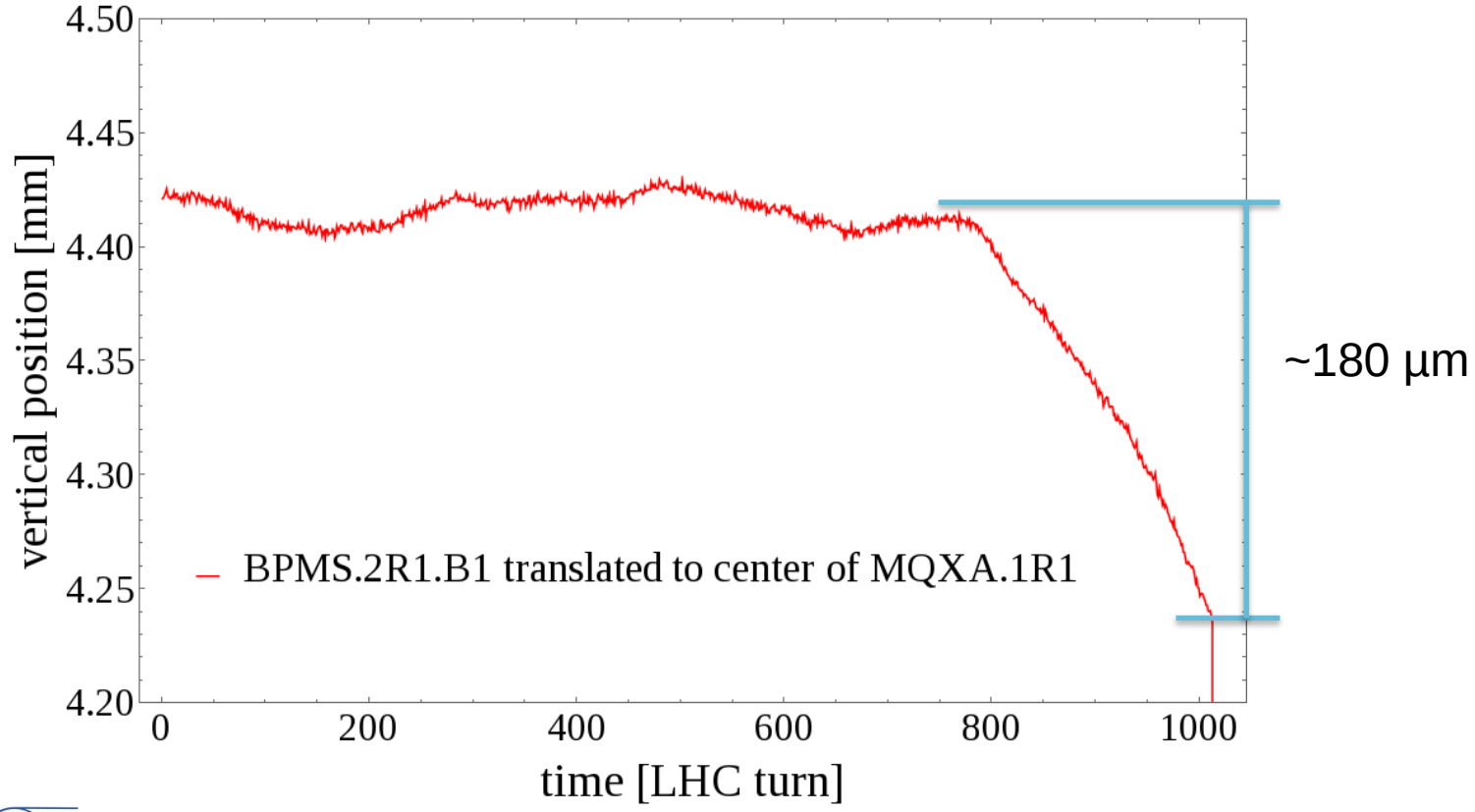
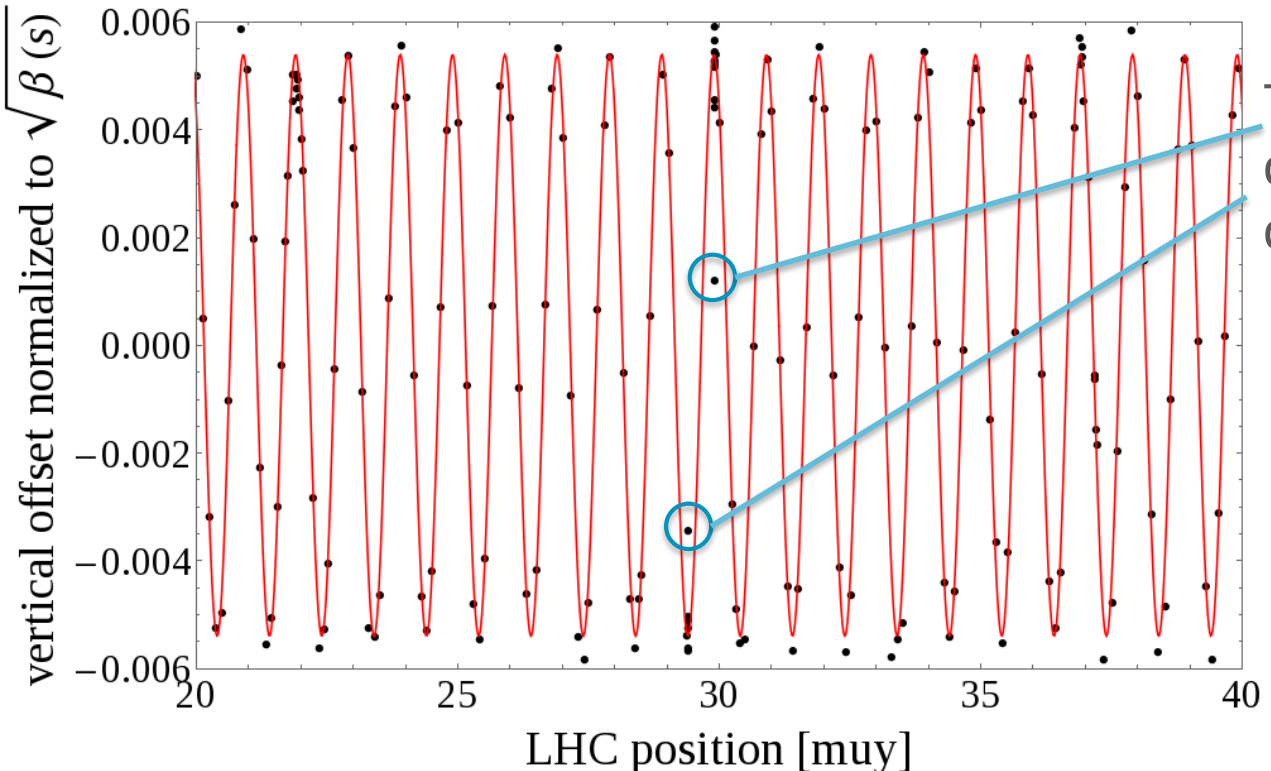
# Orbit offset

- Vertical orbit offset only in b1
- ~180 µm change in center of MQXA.1R1 (Q1)



# ”Slow” kick – Closed orbit change

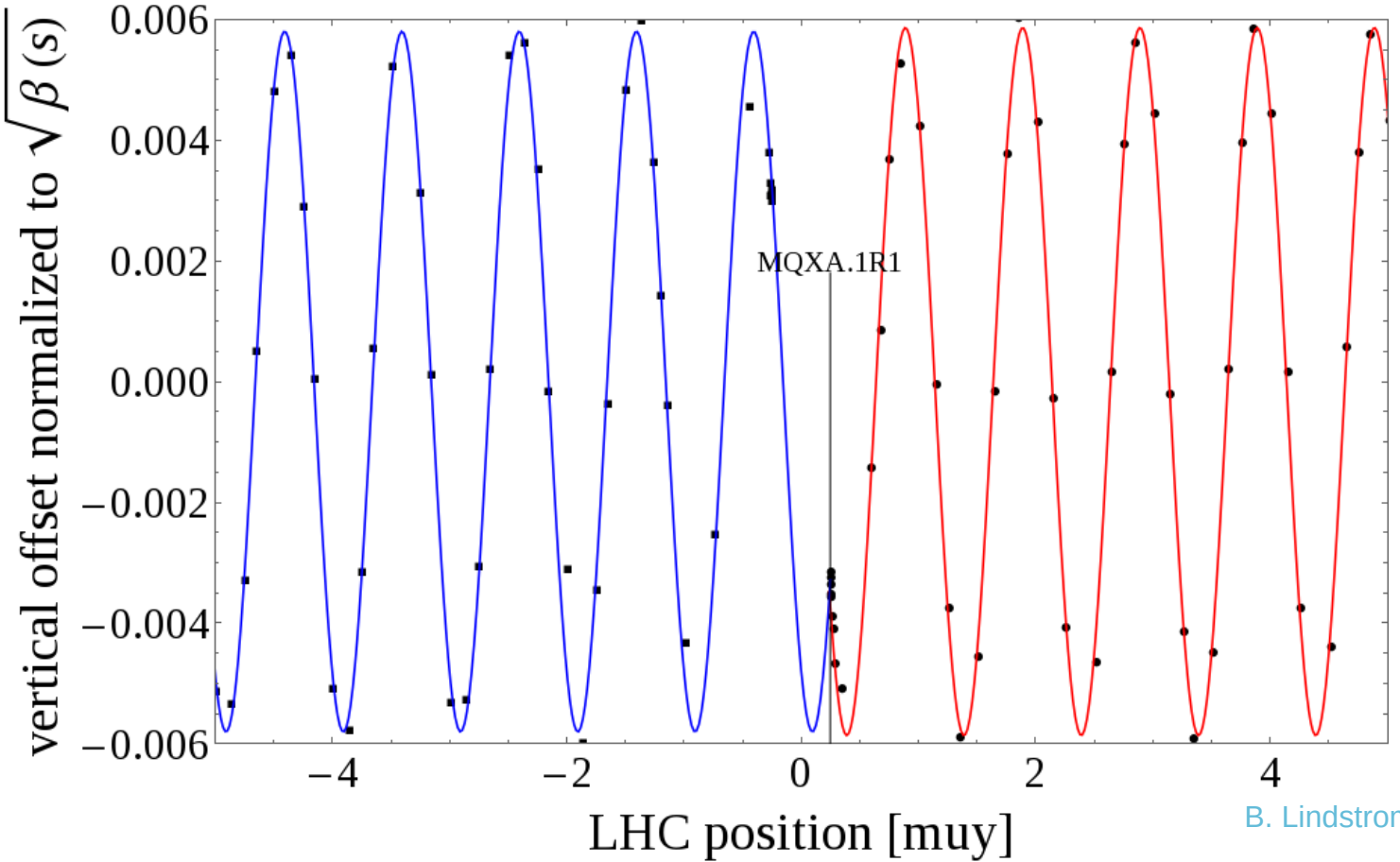
- $\frac{x}{\sqrt{\beta(s)}} = \frac{\Delta x' \sqrt{\beta_0}\cos(|\phi(s)-\phi_0|-\pi Q_y)}{\sin(\pi Q_y)}$
- The kick $\Delta x'$ was fitted to all BPM measurements
- Black dots are BPMs




Two BPMs in IP5 consistently lower value, otherwise good fit

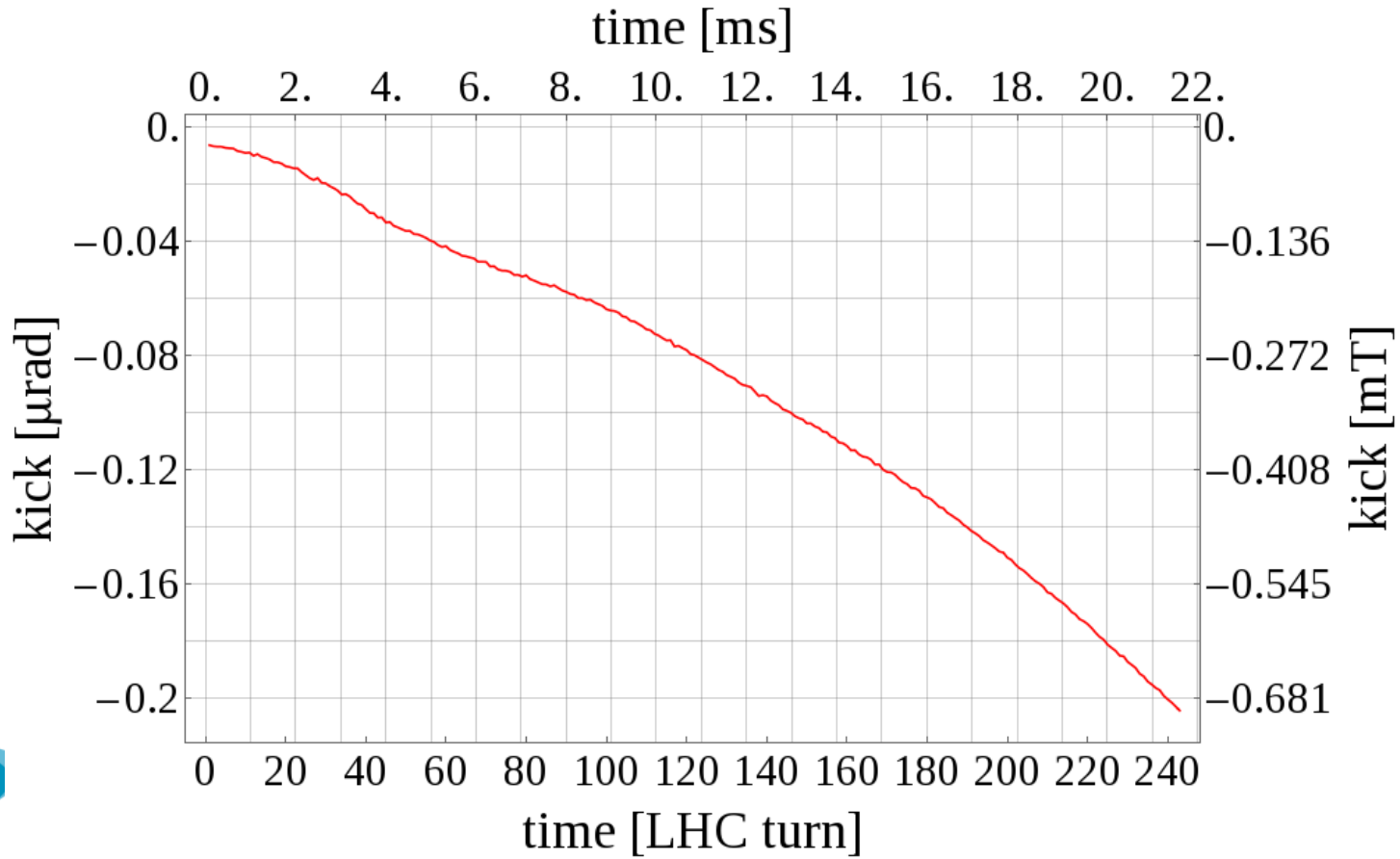
# Origin of kick

- Plotting two consecutive turns around IP1 shows discontinuity at Triplet location
- Together with RTQX.R1 circuit data, confirm kick originates in MQXA.1R1



# Kick time evolution

- Kick strength and the expected magnetic field strength
- From circuit simulations, magnetic field expected to be ~0.23 mT at dump
- Used average beta function in magnet
- Average magnetic field using Bρ/l

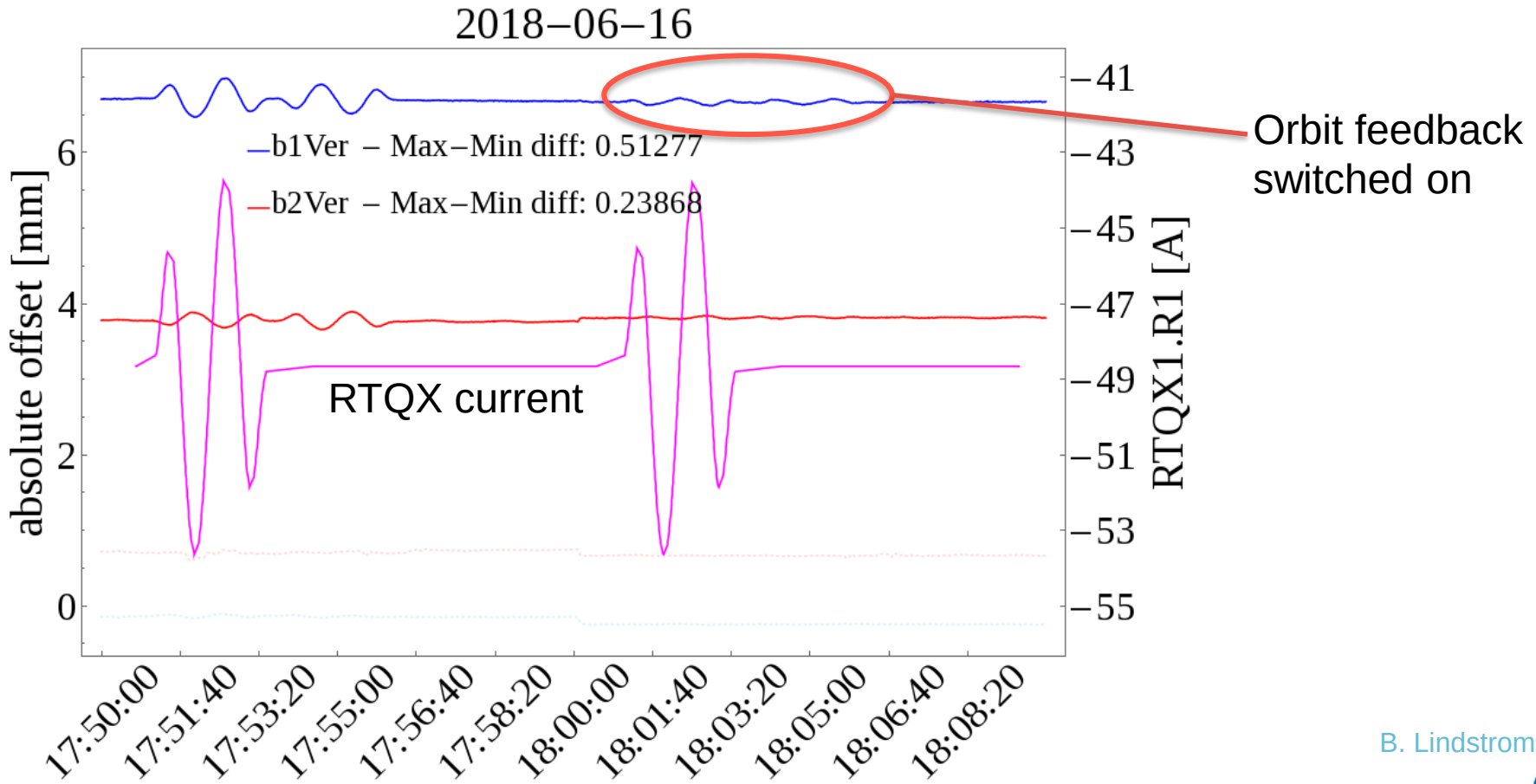


# Kick from Magnet point of view

- Orbit changes significantly in Q1
  - (3.67->5.42 mm b1, -3.67 to -4.00 mm b2)
- Quadrupole -> strength proportional to beam orbit
- Numeric integration using Quad transfer function at 6.2 kA: **TF = 30.312 T/m/kA**, and max $\Delta$**I 1.7 A**
  - B1 kick: **6.7e-8 rad**
  - B2 kick: **6.0e-8 rad**
- Twiss calculation in MAD-X with Q1 in 10 slices
  - **82 µm** offset at BPMS.2R1.B1
  - **39 µm** offset at BPMS.2R1.B2
- But, observed B1 offset: **250 µm**, B2 offset: **<10 µm**

# Q1 K-modulation MD

- K modulation of the RTQX.R1 circuit performed after quench event
- B1: **51 µm/A** – B2: **24 µm/A**
- From optics expectations: B1: **48 µm/A** – B2: **22 µm/A**
- Agreement with optics design, the quench is the odd event



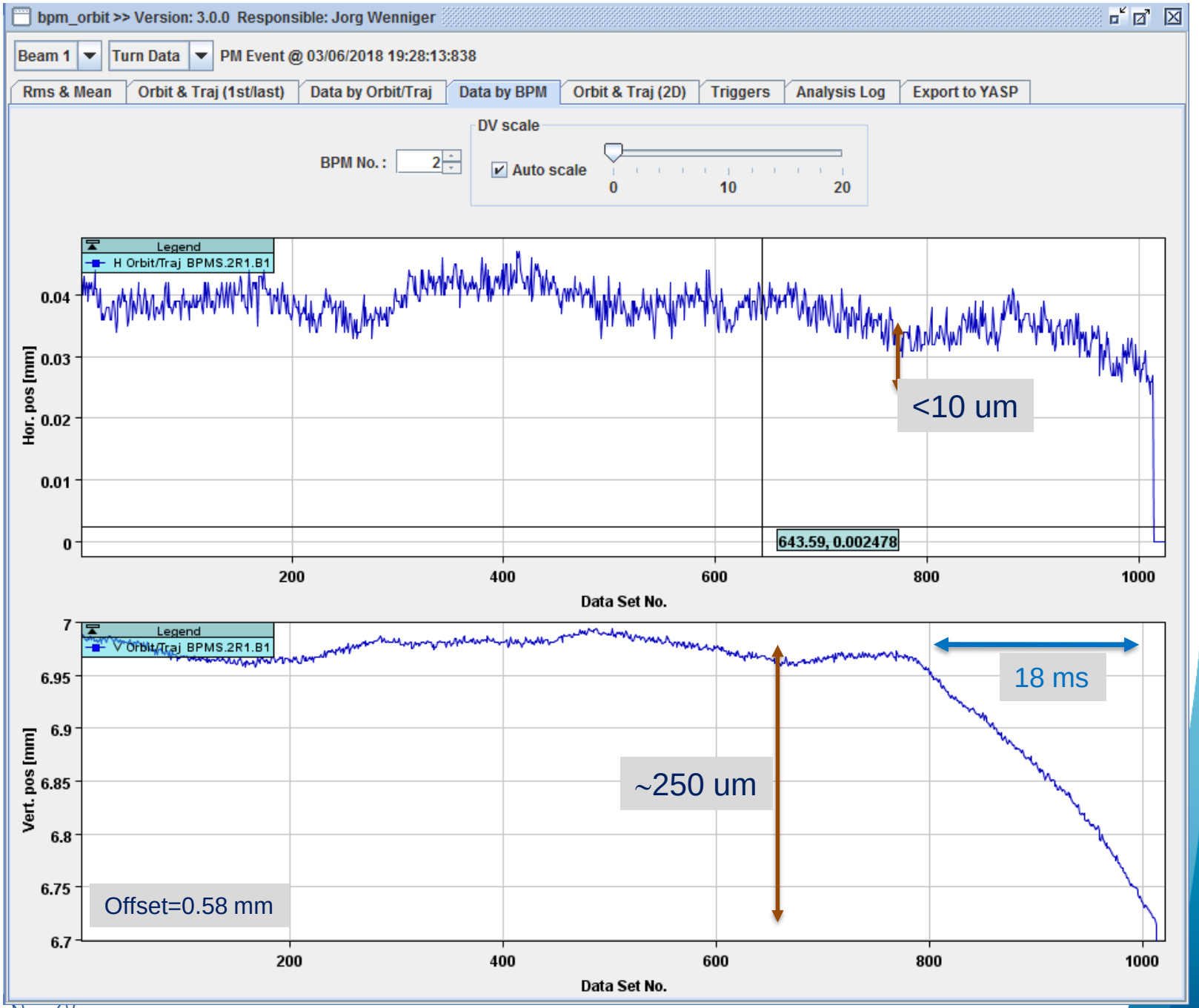
# Conclusions

- Kick has been derived from BPM measurements and calculated separately from current change in magnet
  - K modulation confirms position of beams and expected kick
- Origin of kick confirmed to MQXA.1R1
- Quench effect not understood
  - ~3 times stronger kick for b1
  - ~2-4 times weaker kick for b2
- Could fast transients play a role? -> repeat K modulation with **> 10 Hz**

# Question 3: Why do the orbits of B1 and B2 change more/less than expected?

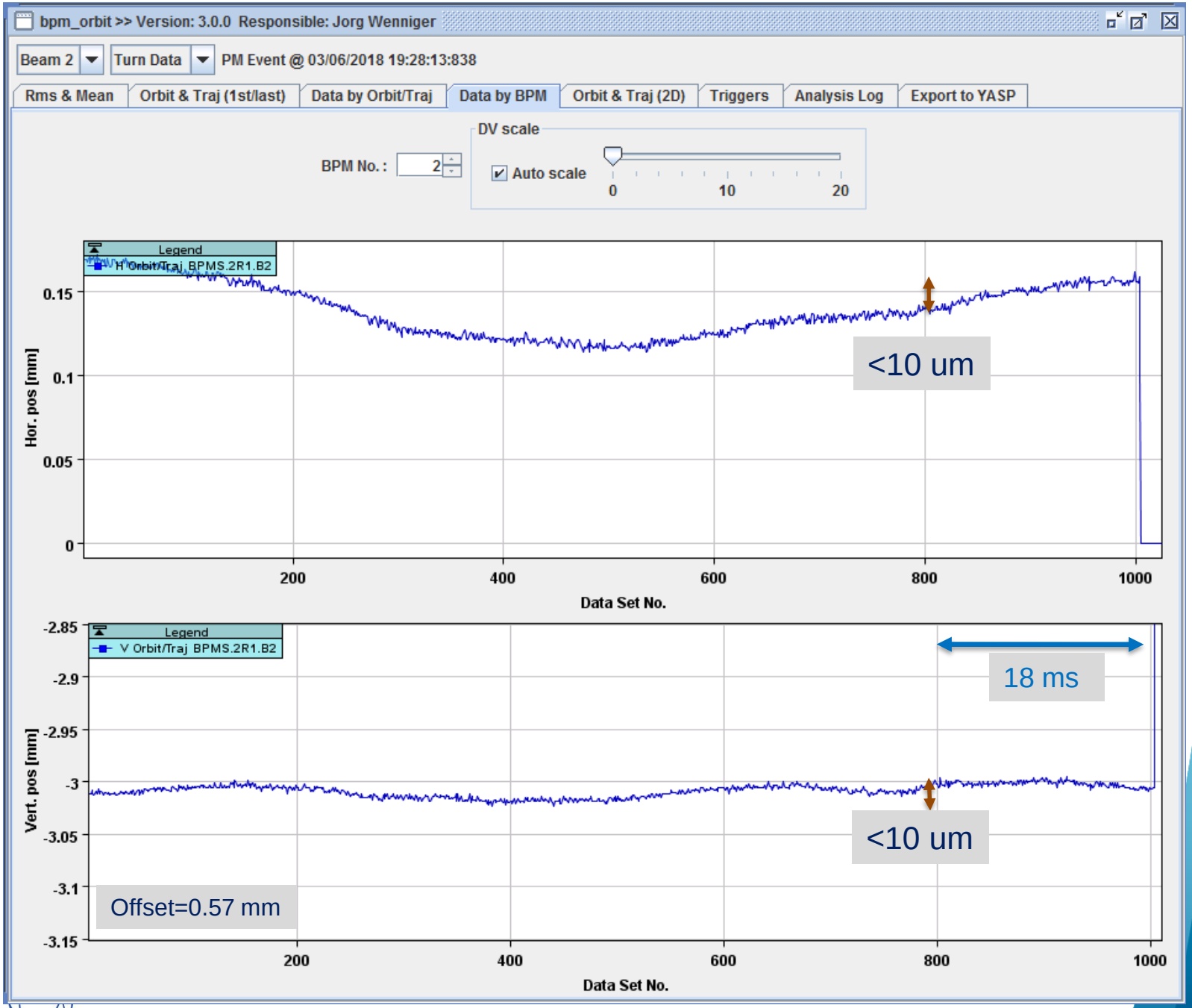
| | Calculated from the change in current in Q1 (1.7 A) | | Measured by the BPM |
|---|---|---|---|
| | @ Q1 | @ BPM | |
| B1, hor | 0 | 0 | <10 μm |
| B1, vert | 215*(1.7/7150)*4.55 = 0.23 mT<br>$Beta_{av}$=2800 m<br>$\Delta y' = 6.8 \cdot 10^{-8}$ rad<br>$\Delta y$=60 μm | $Beta_{av}$=5200<br>$\Delta y$=82 μm ? | 250 μm |
| B2, hor | 0 | 0 | <10 μm |
| B2, vert | 215*(1.7/7150)*3.84 = 0.20 mT<br>$Beta_{av}$=1900 m<br>$\Delta y' = 5.9 \cdot 10^{-8}$ rad<br>$\Delta y$=37 μm | $Beta_{av}$=2000 m<br>$\Delta y$=37 μm ? | <10 μm |

# B1




Plots by D. Wollmann

# B2




Plots by D. Wollmann