LHC Collimation Working Group meeting

Geneva, 4th December 2006

Precision of collimator jaw positioning and gap values

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Topics

1. *Introduction*

    Jaw position measurements

    Philosophy of collimator settings controls

2. *Mechanical reproducibility*

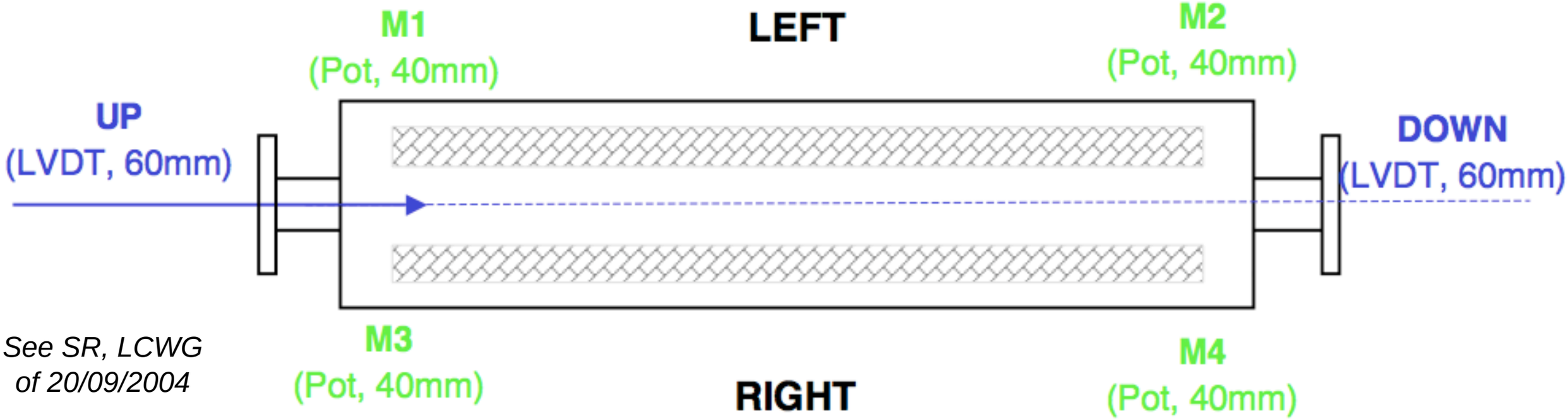
3. *Performance of jaw position monitoring*

4. *Gap values*

5. *Conclusions*

Introduction

SPS prototype



See SR, LCWG of 20/09/2004

- 4 LEP stepping motors used to move the jaw corners
- 4 resolvers count the motor steps
- 4 potentiometers measure the actual jaw position
- 2 LVDT's provide direct gap measurements
- 10 switches prevent breaking the mechanics
  (full-IN + full-OUT per each corner + 2 anti-collision)

2004 performance *(LCWG, 20/09/2004)*

- Extensive measurement campaigns at the metrology
- Reproducibility of switches: ~30-50 µm (going IN)
- Resolvers and motors worked reliably

  Motors more precise: error < 15 µm vs ~70-100 µm of resolvers
- Direct position measurements (potentiometers, LVDT's) did not work
- Jaw position measurements relied on counting the motor steps from the full-OUT switches

  - Motors were reset at the full-out position (step count restarted)
  - Achieved accuracy **~50 µm**

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The collimator was not re-calibrated, nor the sensors were revised, since Aug. 2004

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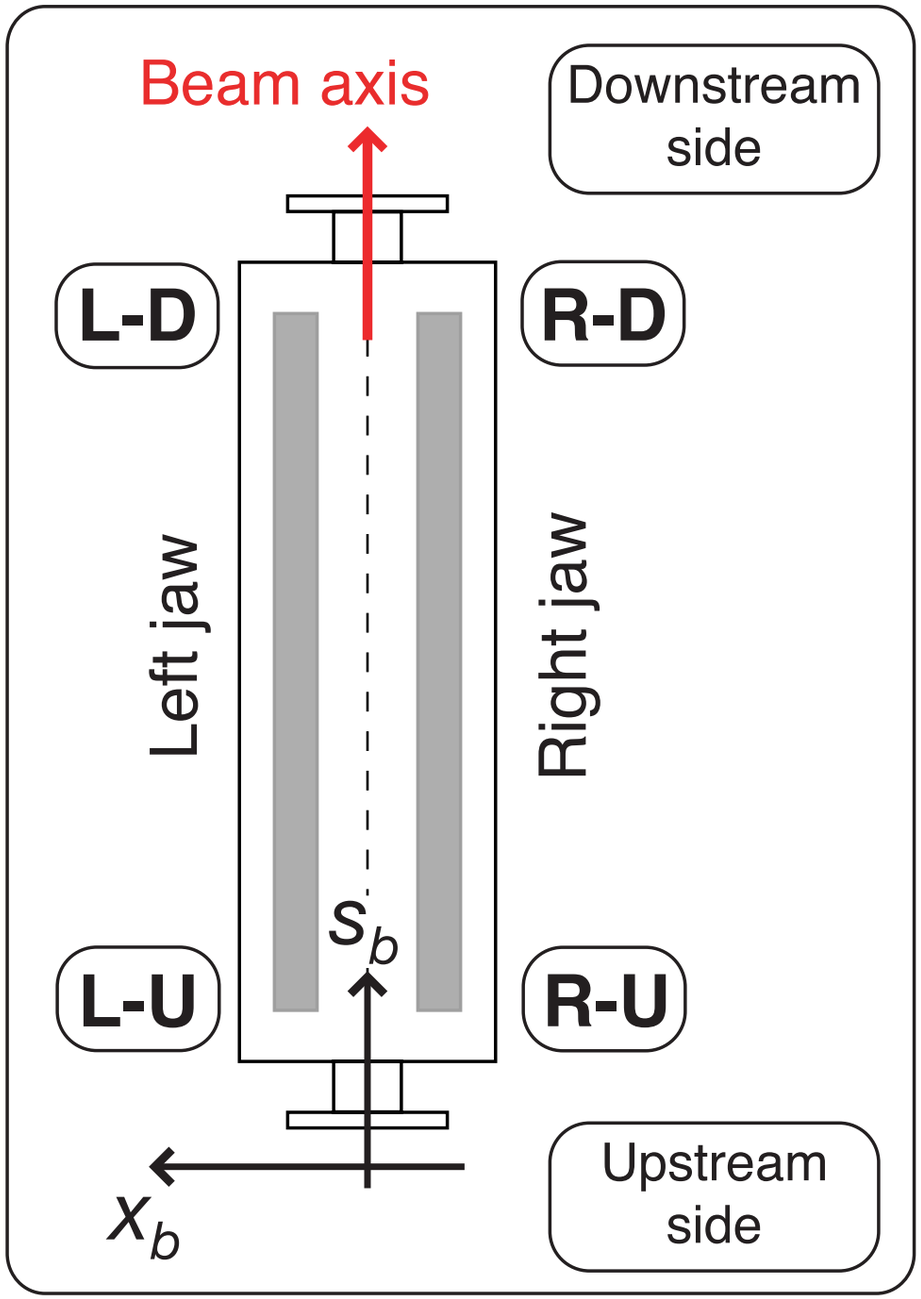
Settings control philosophy



- ABSOLUTE settings in the beam coordinate (compatibility with LSA TRIM)
- Middle- and high-level controls only use absolute settings
- Motor step counter is INDEPENDENT of the measured positions (no feedback)
- Operator can update the motor settings if he thinks they are wrong *(e.g. if steps are lost - inferred from position measurements)*
- Automatic update of settings when the switches are activated

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Left - UP
Left - DW
Right - UP
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Full stroke *(motor count reset to zero on the switches)*

	Motors
Left - UP	**34.038 ± 0.020**
Left - DW	**34.470 ± 0.007**
Right - UP	**33.810 ± 0.021**
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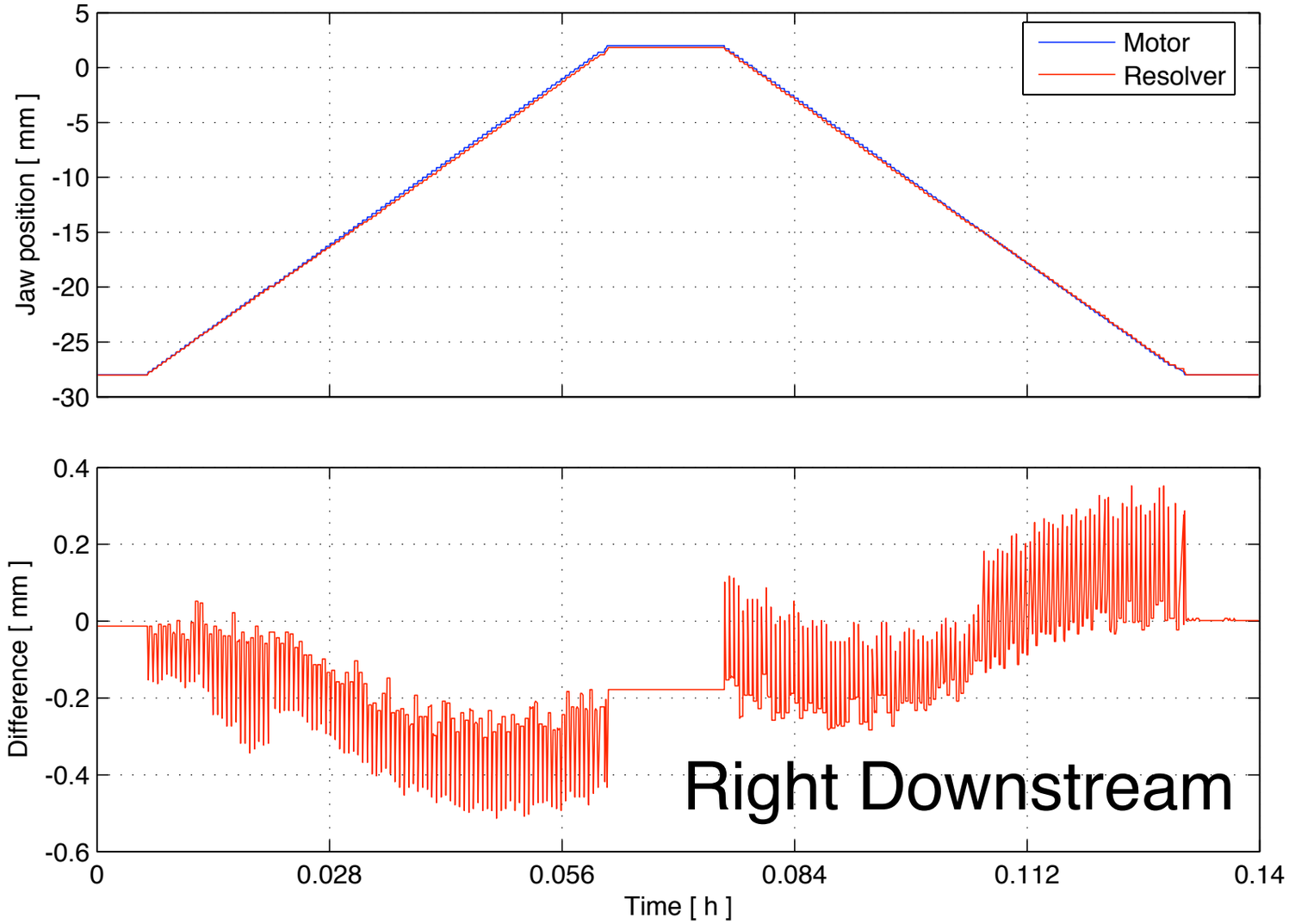
Conclusions

- Mechanics behaves like in 2004
- Motors provide the most accurate position measure
- Resolver are less precise (seen differences up to 100µm)
- Direct position measurements basically cannot be used!

Accuracy: resolvers vs motors



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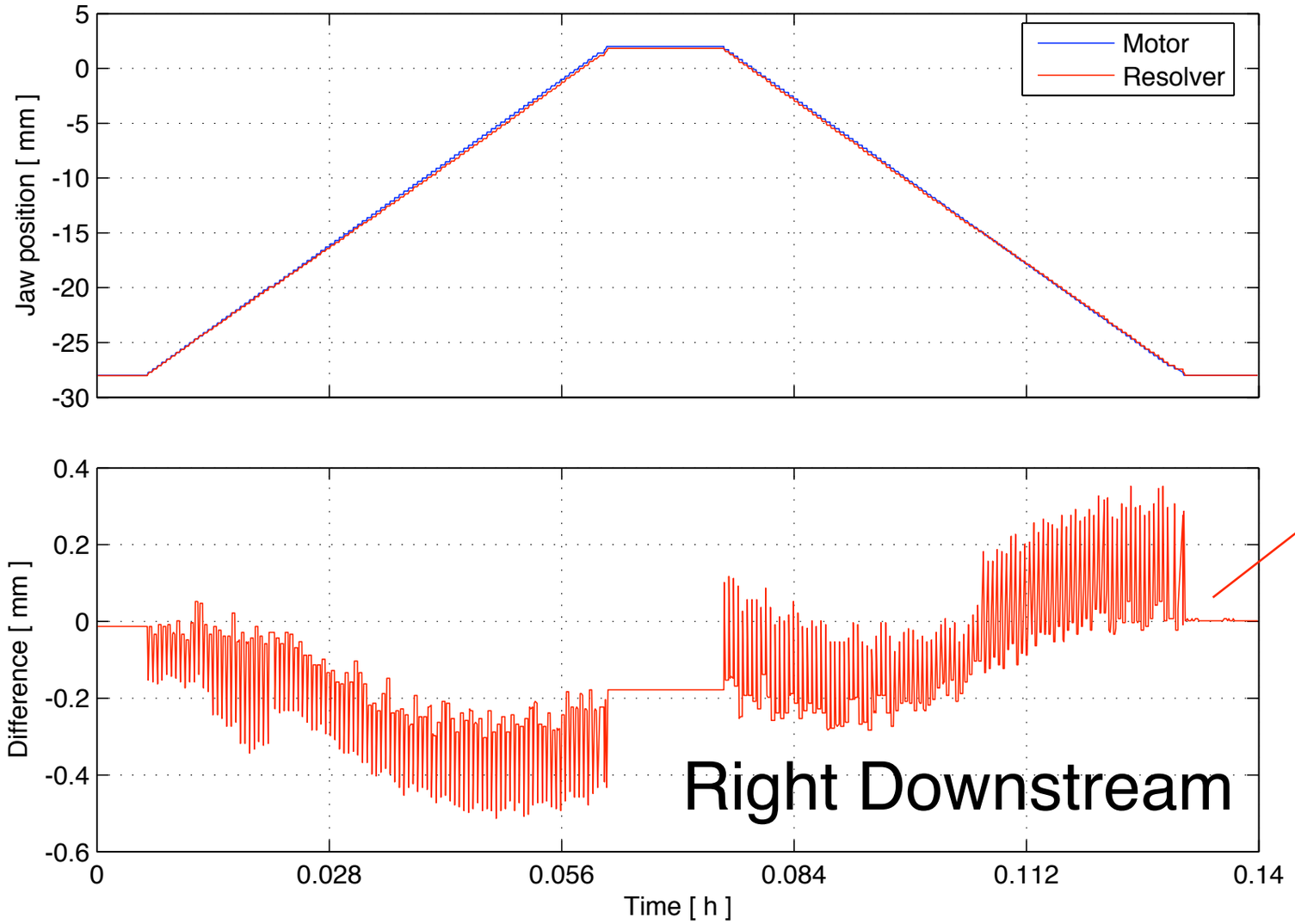

Transient differences from timing errors (see next slide)

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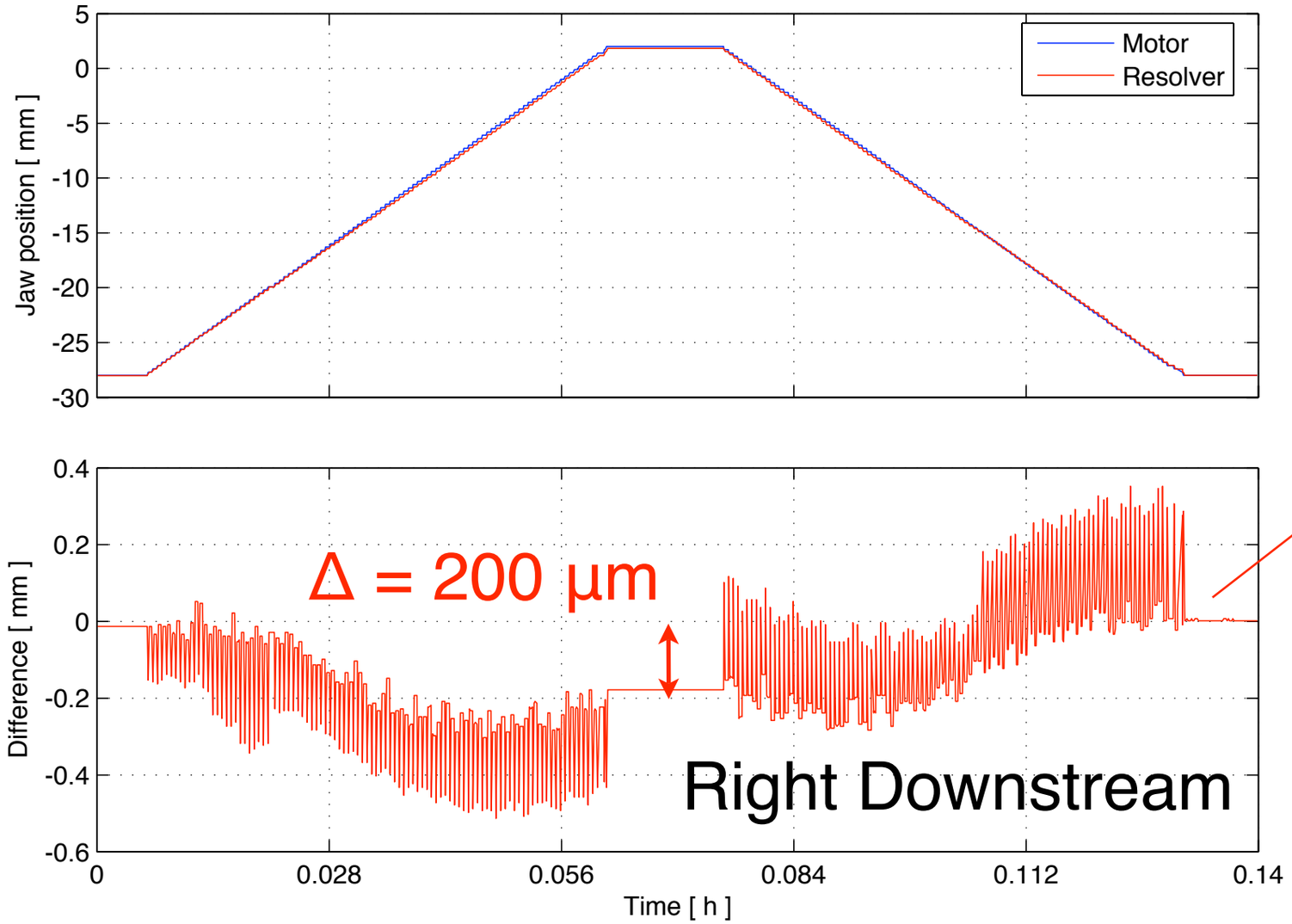

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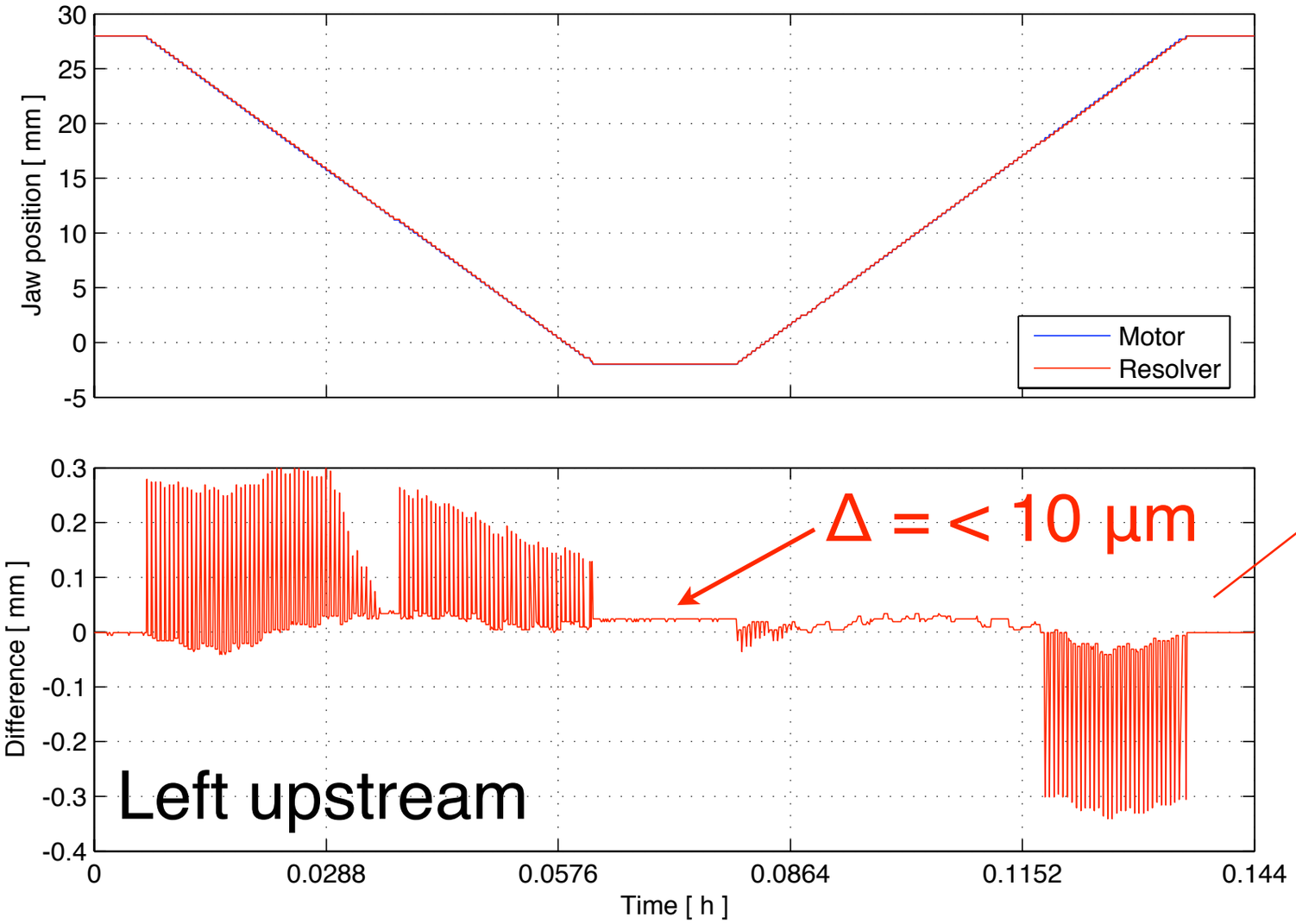

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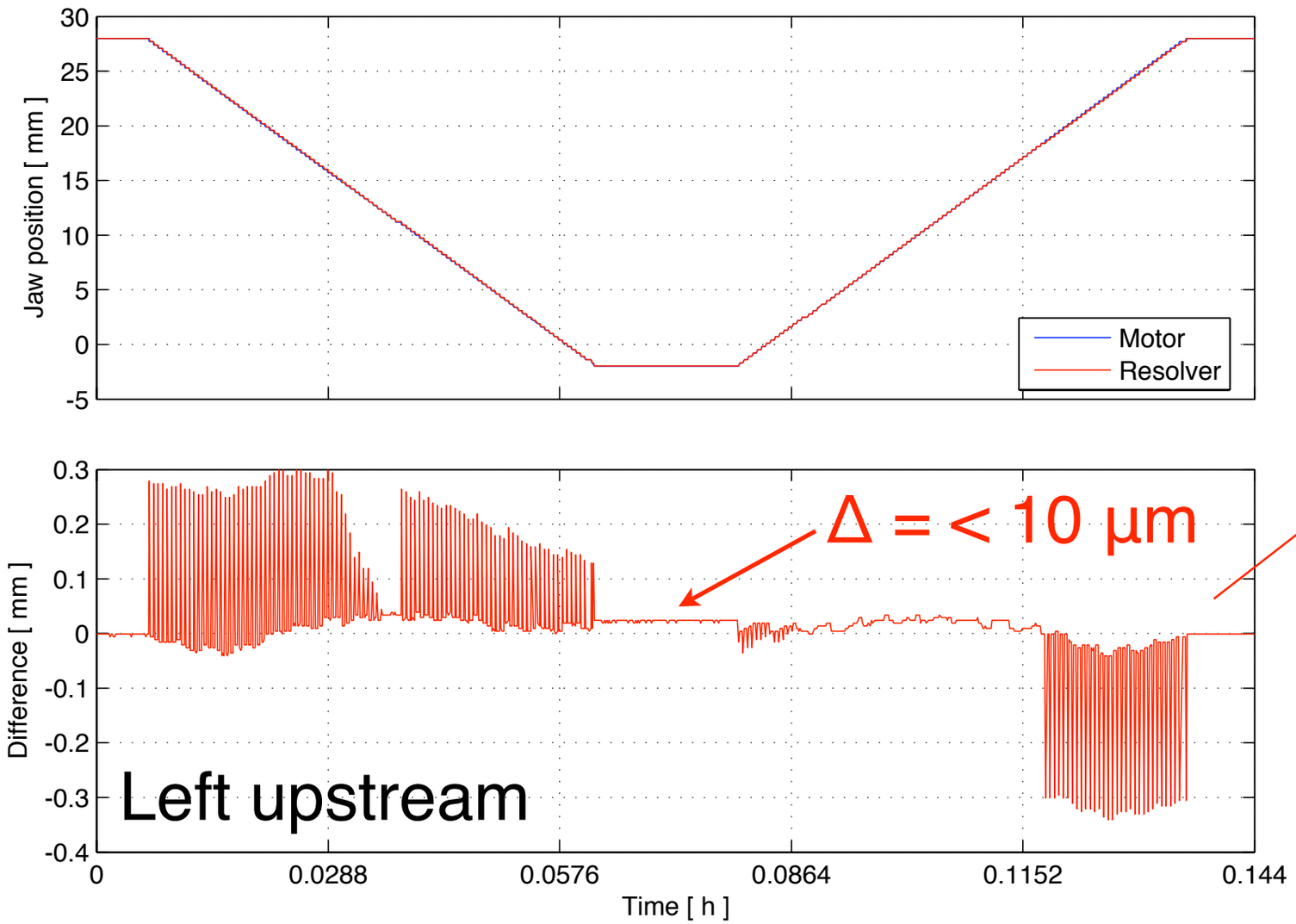

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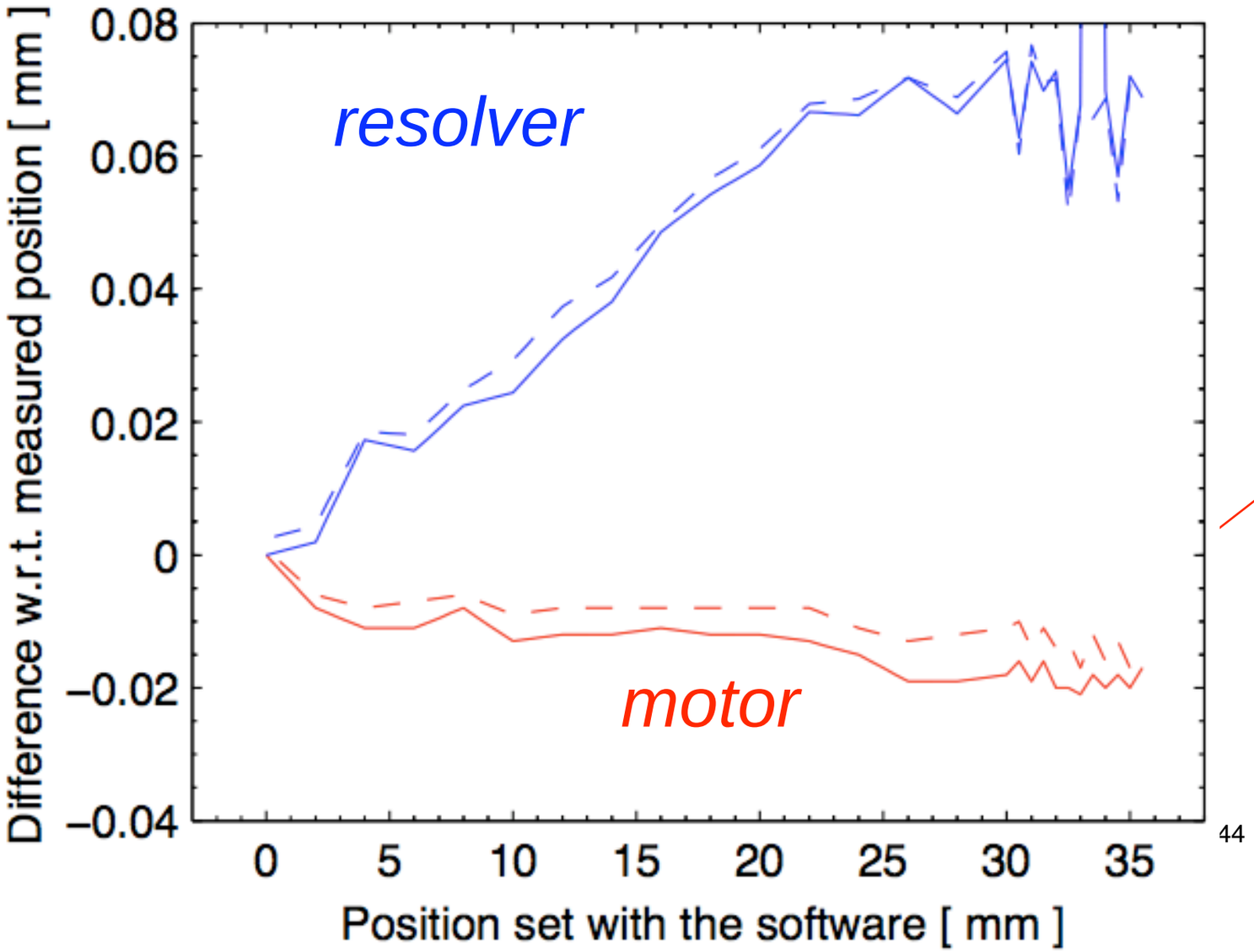

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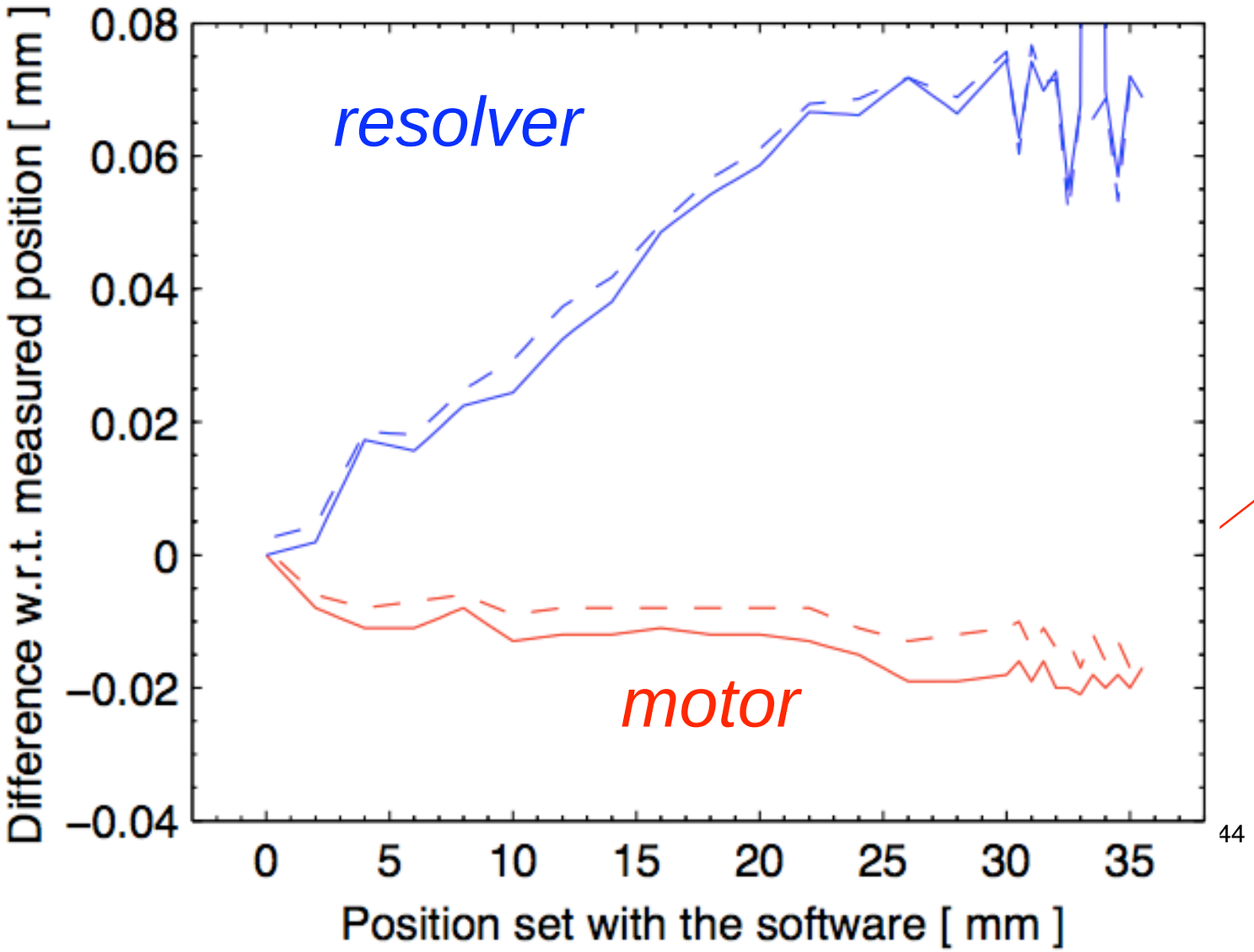

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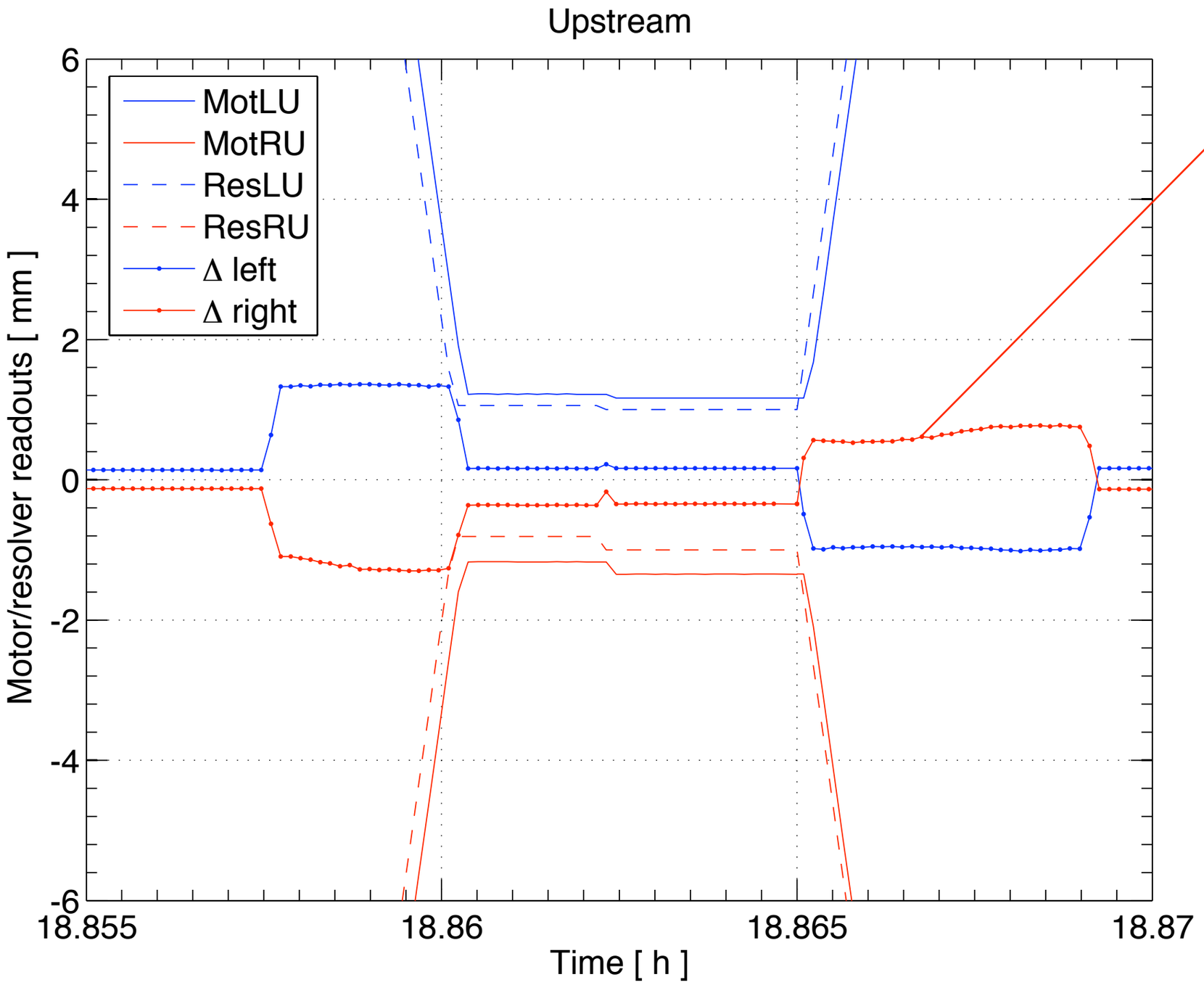
Motors or resolvers are correct??

2004: resolvers were found to be less reliable than the motors
We assume that this is still the case and we base the position measurements on the count of motor steps from the OUT switches

Time delay in the acquisition



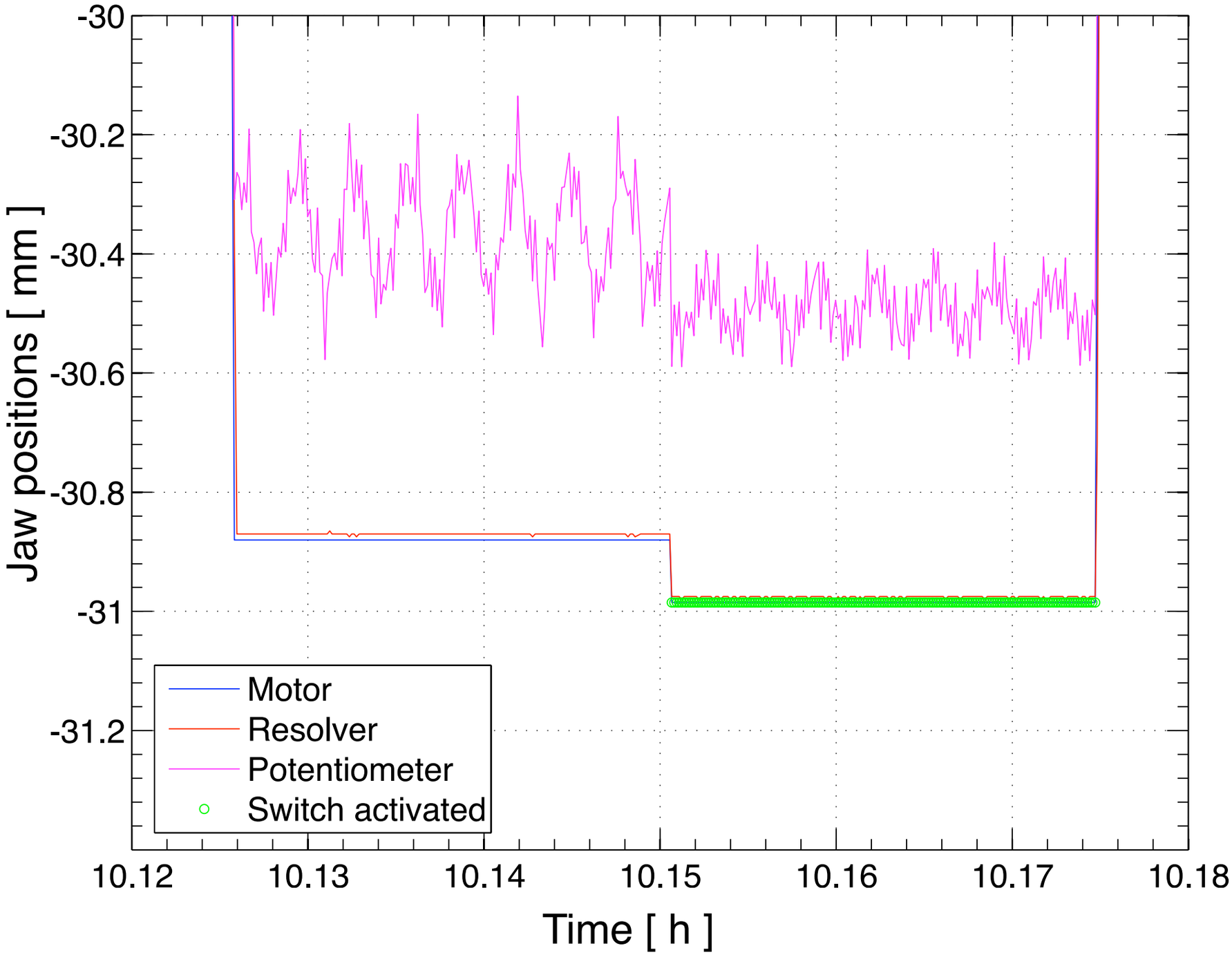
Error during movements cause by ~1s delay in the acquisition

Static values are better

Offsets from time delay changes during the MD

Source of these delays needs to be understood!

Example of potentiometer data



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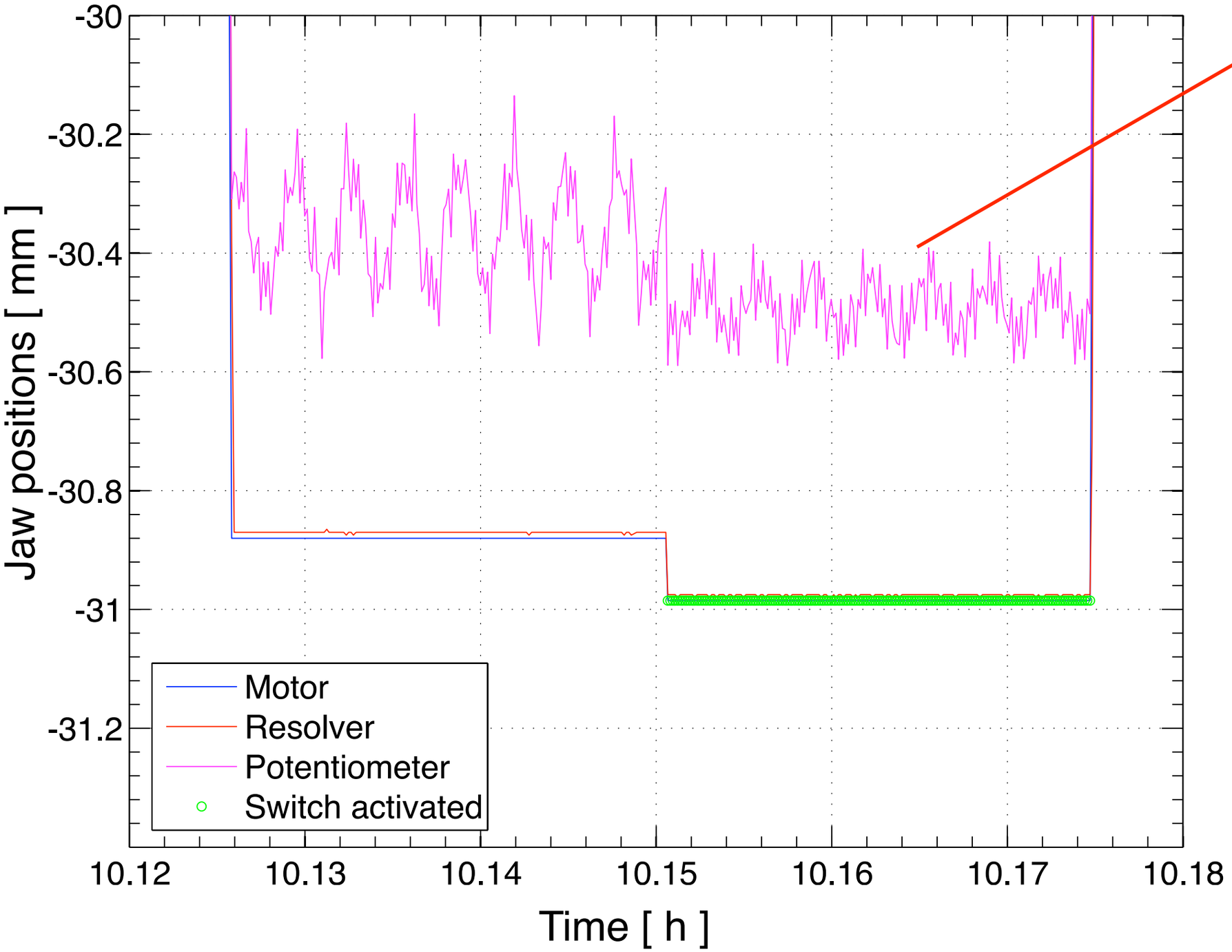

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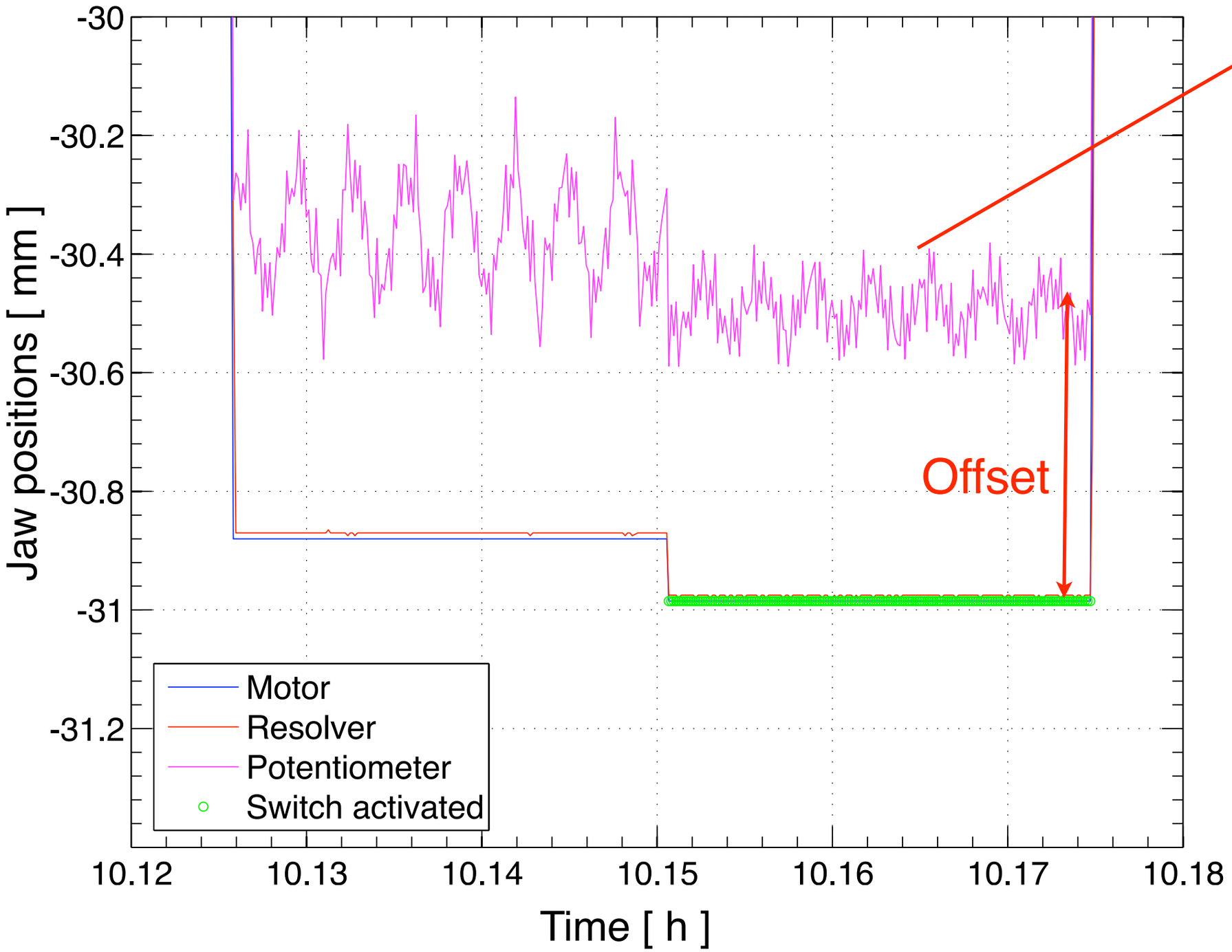

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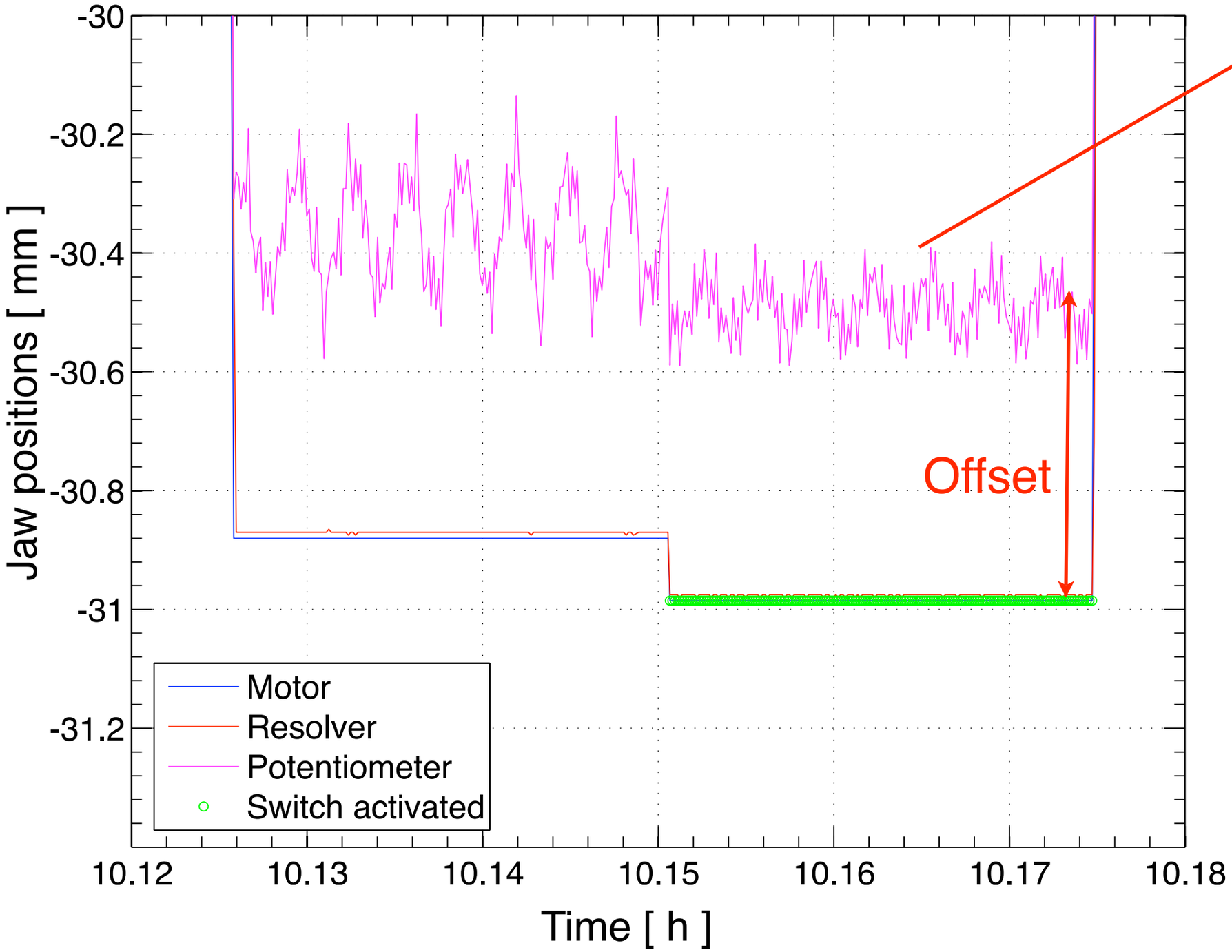

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Is it worth re-calibrating these sensors and understand the data we have!?!

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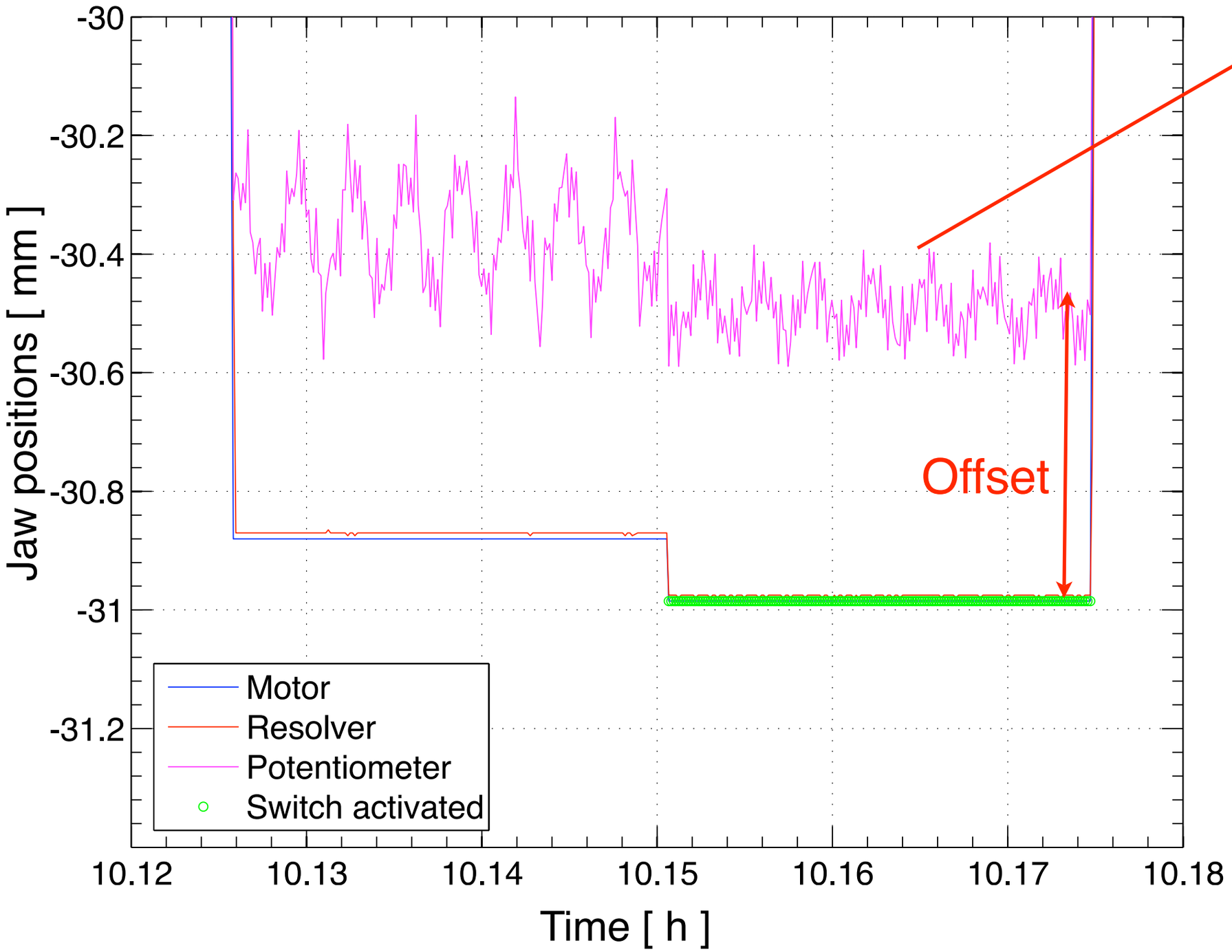

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Use motor step count from driver for the moment

Settings errors from loss steps

Problem of motor measurements: they are “upstream” of the mechanical structure and do not “see” mechanical plays!

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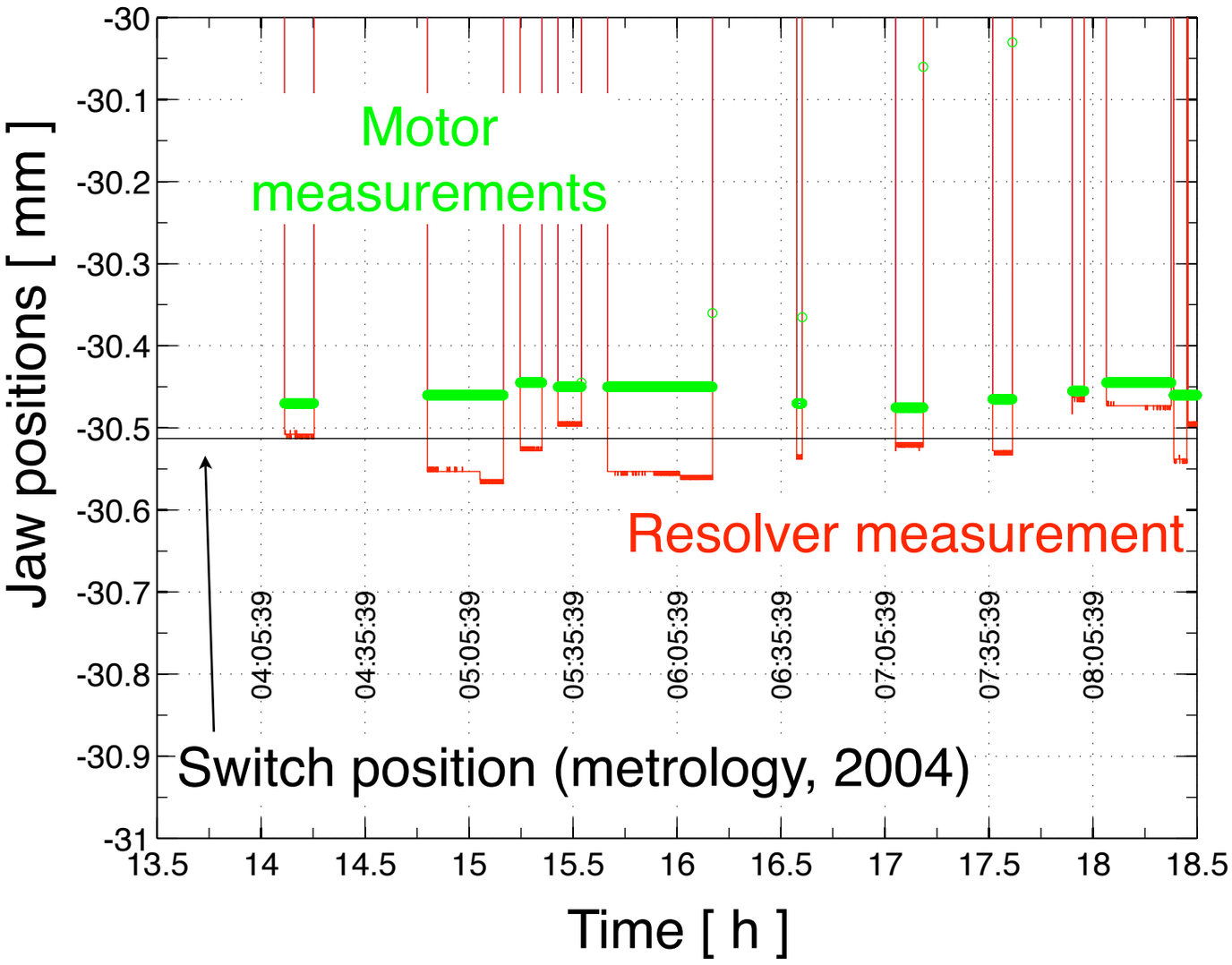

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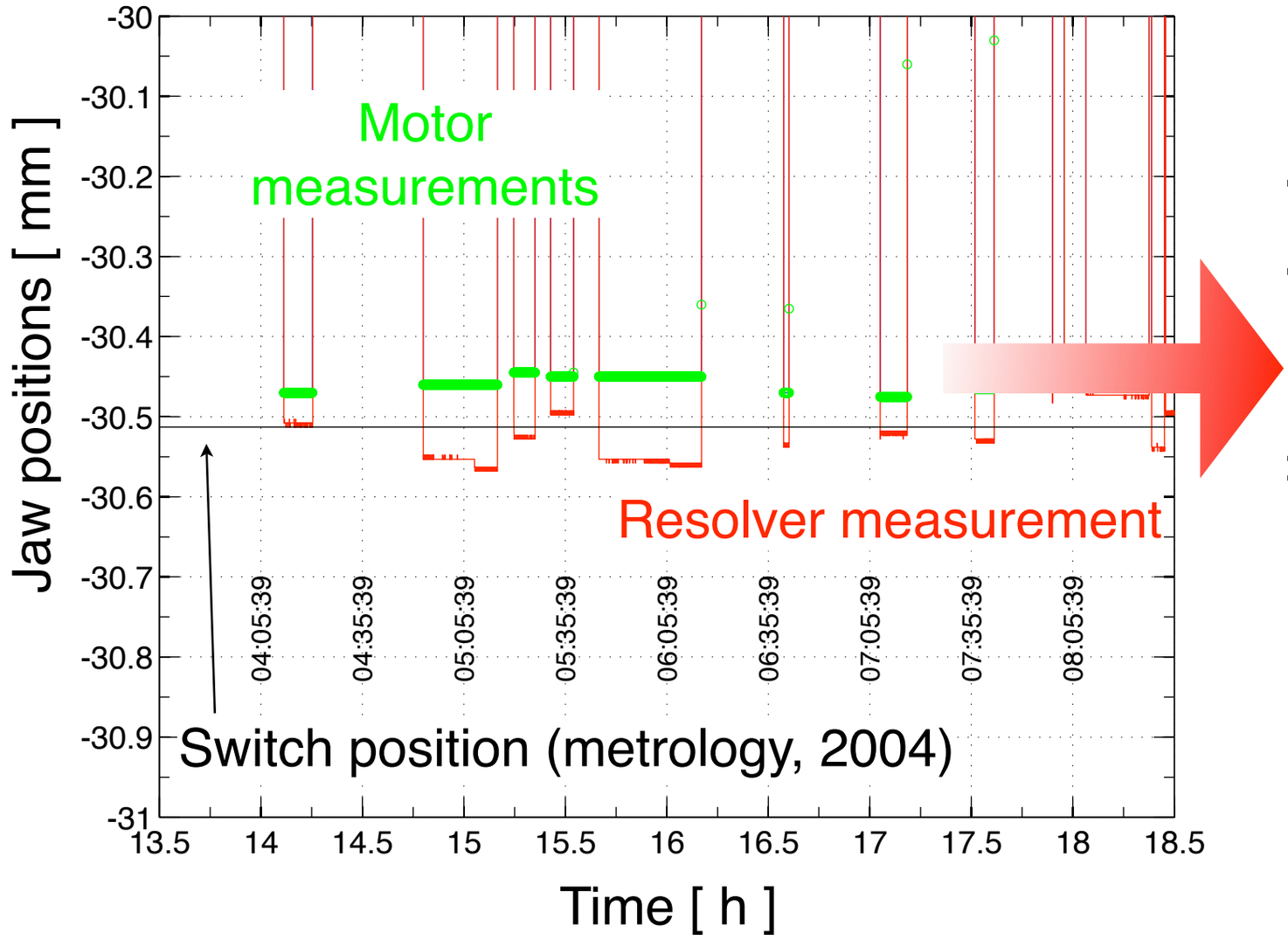

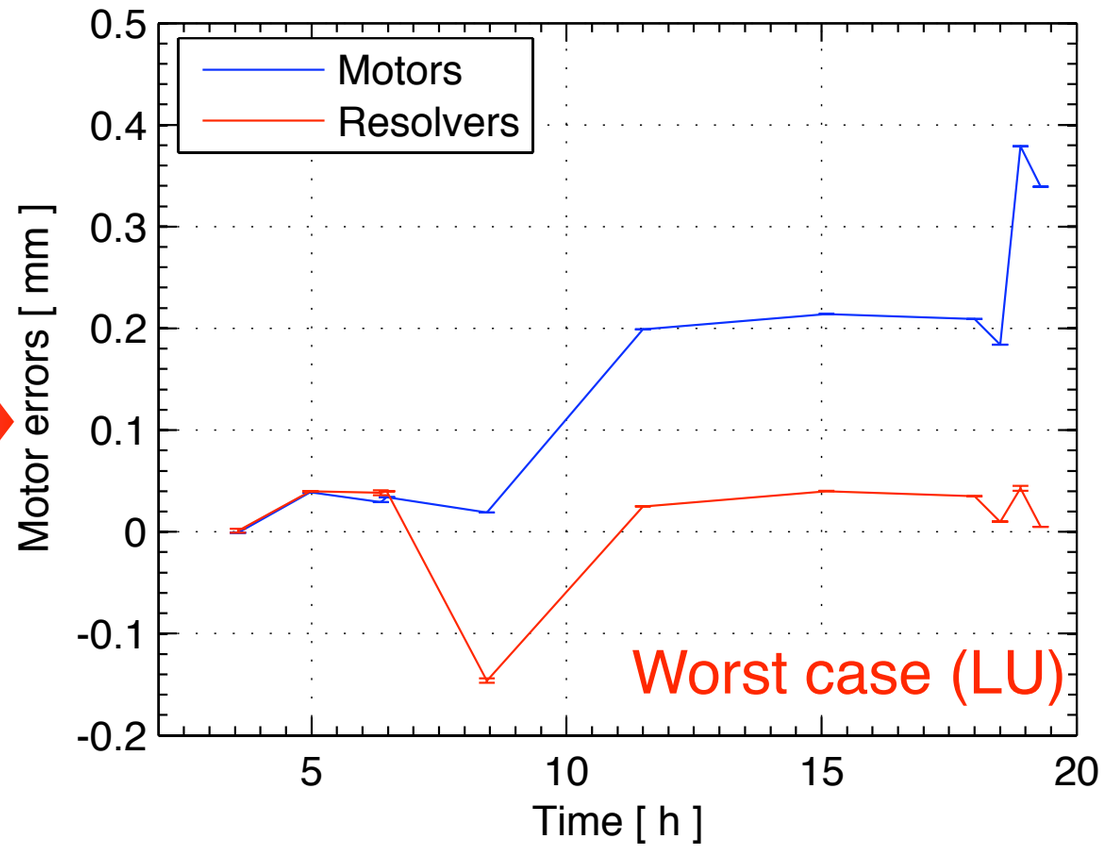

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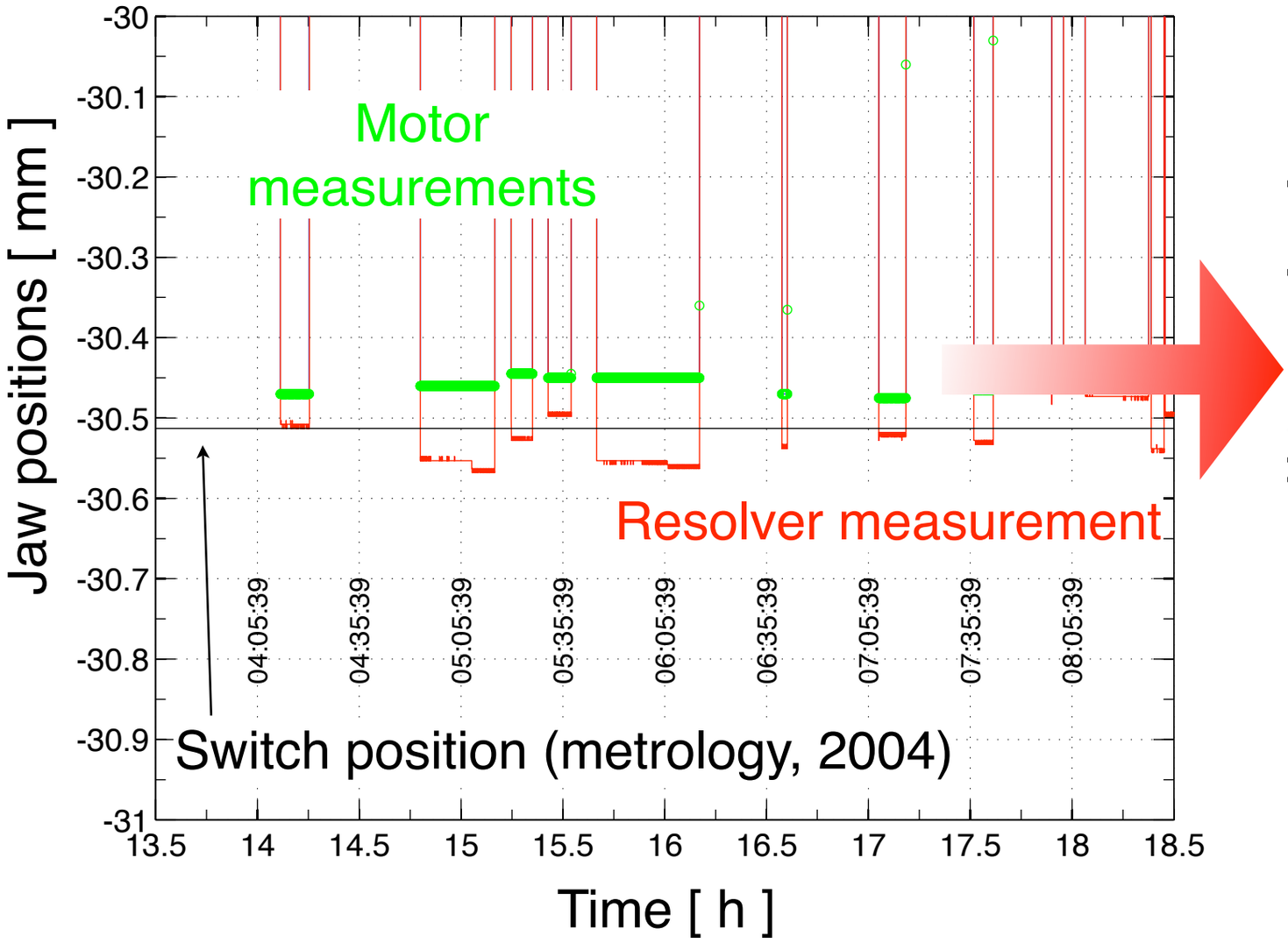

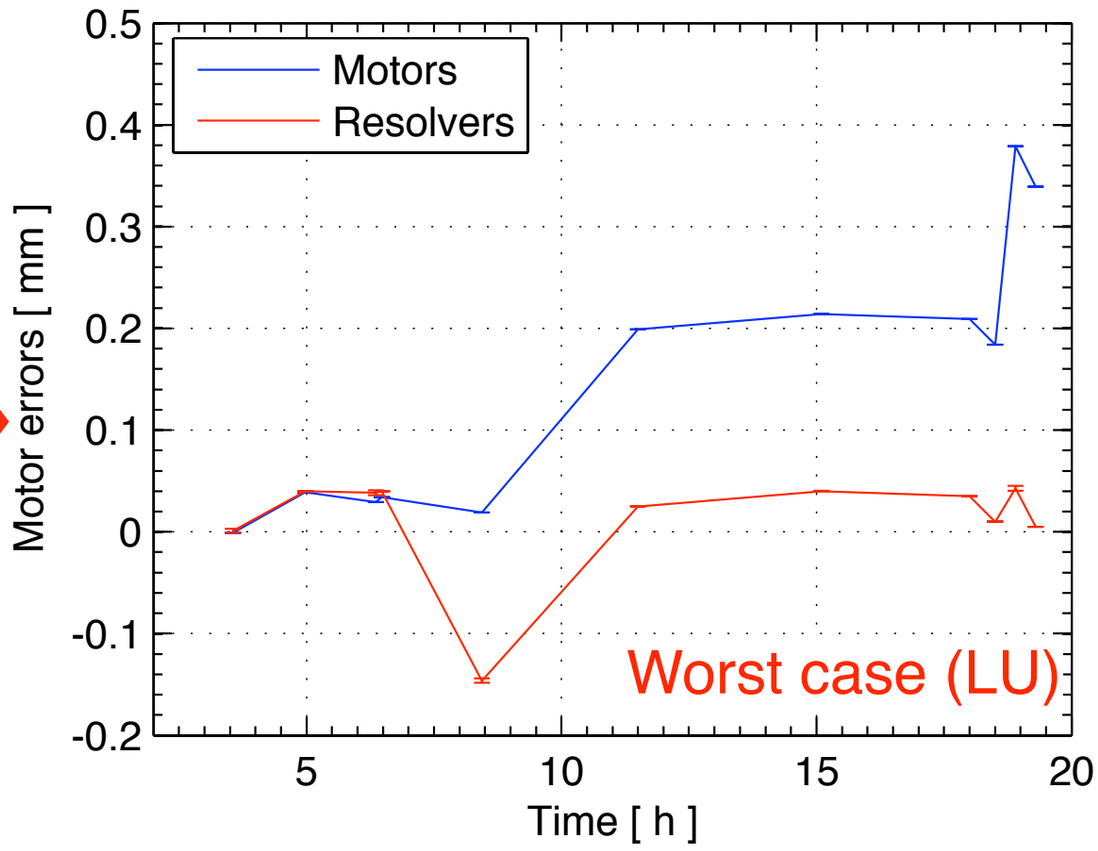

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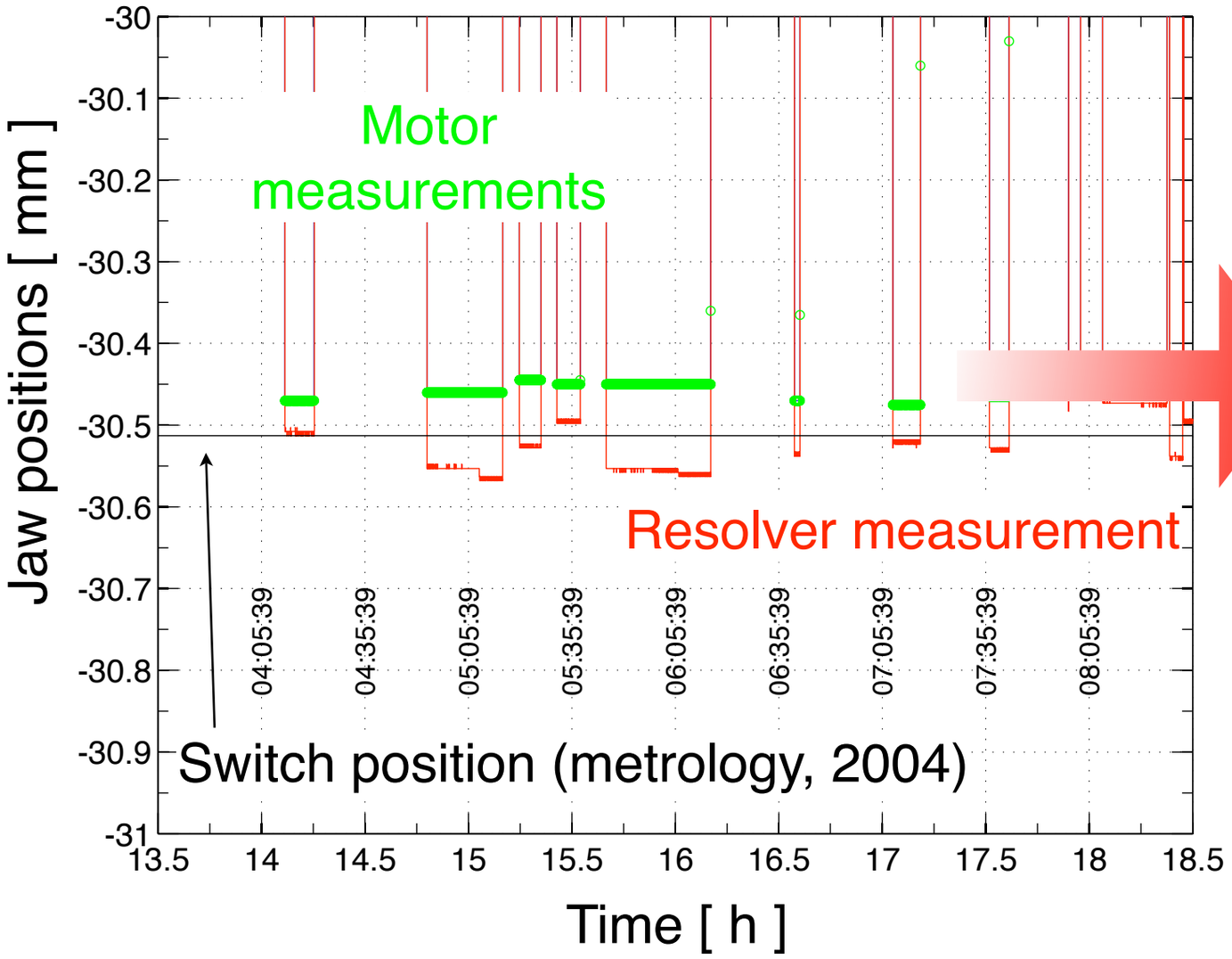

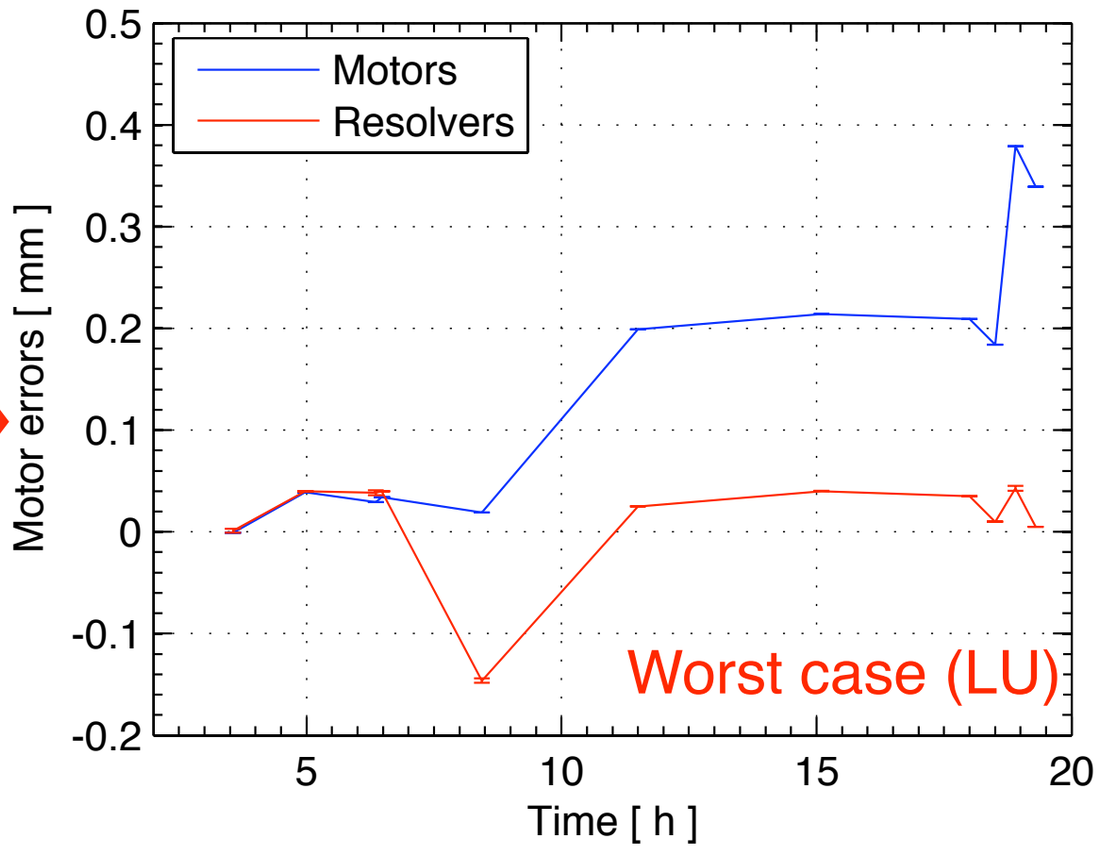

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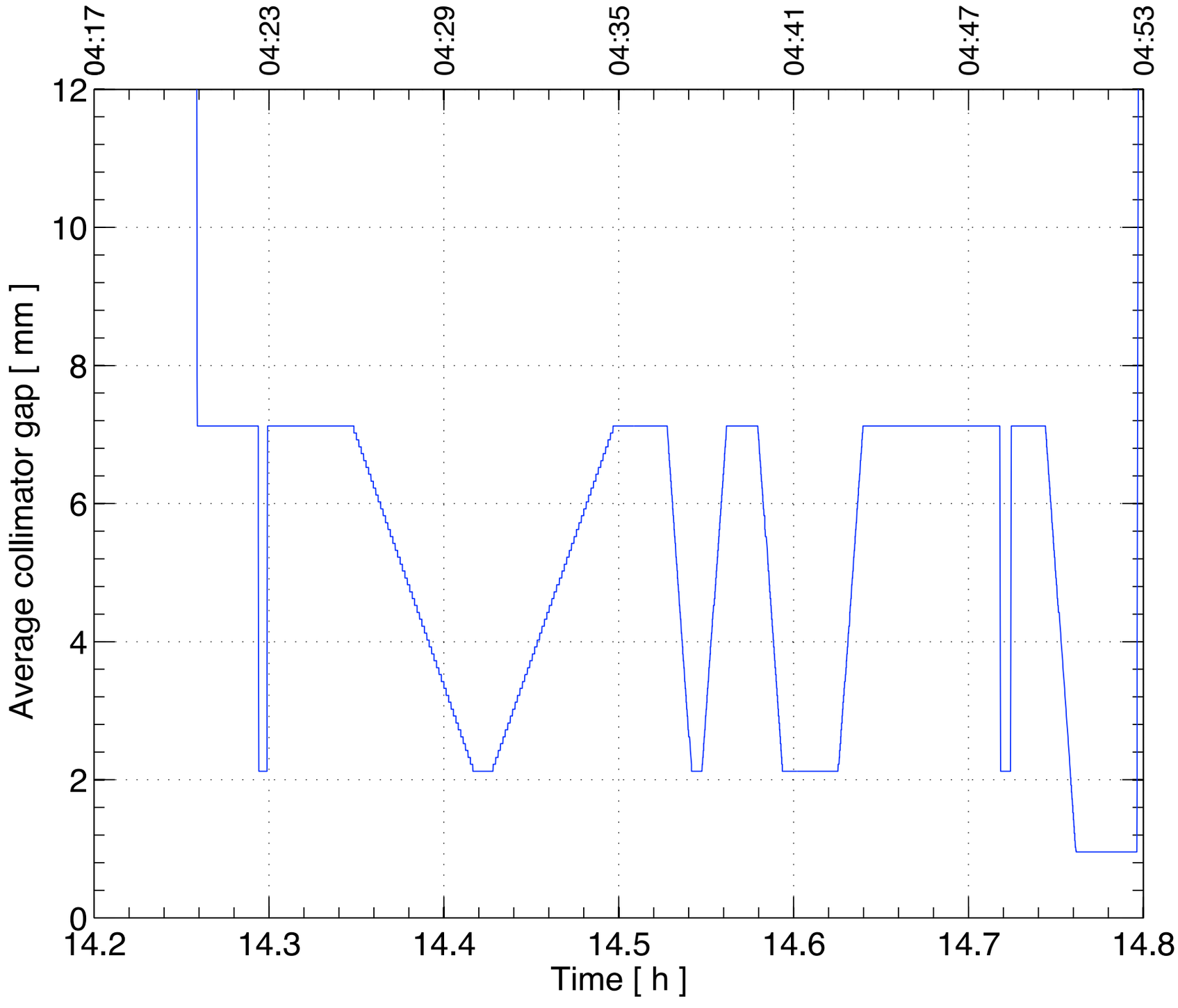
... This is the reason why at the LHC we MUST HAVE direct jaw position measurement!

Collimator gap during MD



This example: gap versus time during impedance measurements , MD1

(see Chiara's and Elias' talks)

Anti-collision switch is consistent with 2004!

Data is being provided to the impedance colleagues

More cumbersome that 2004 because motor data have to be manually set to switches...

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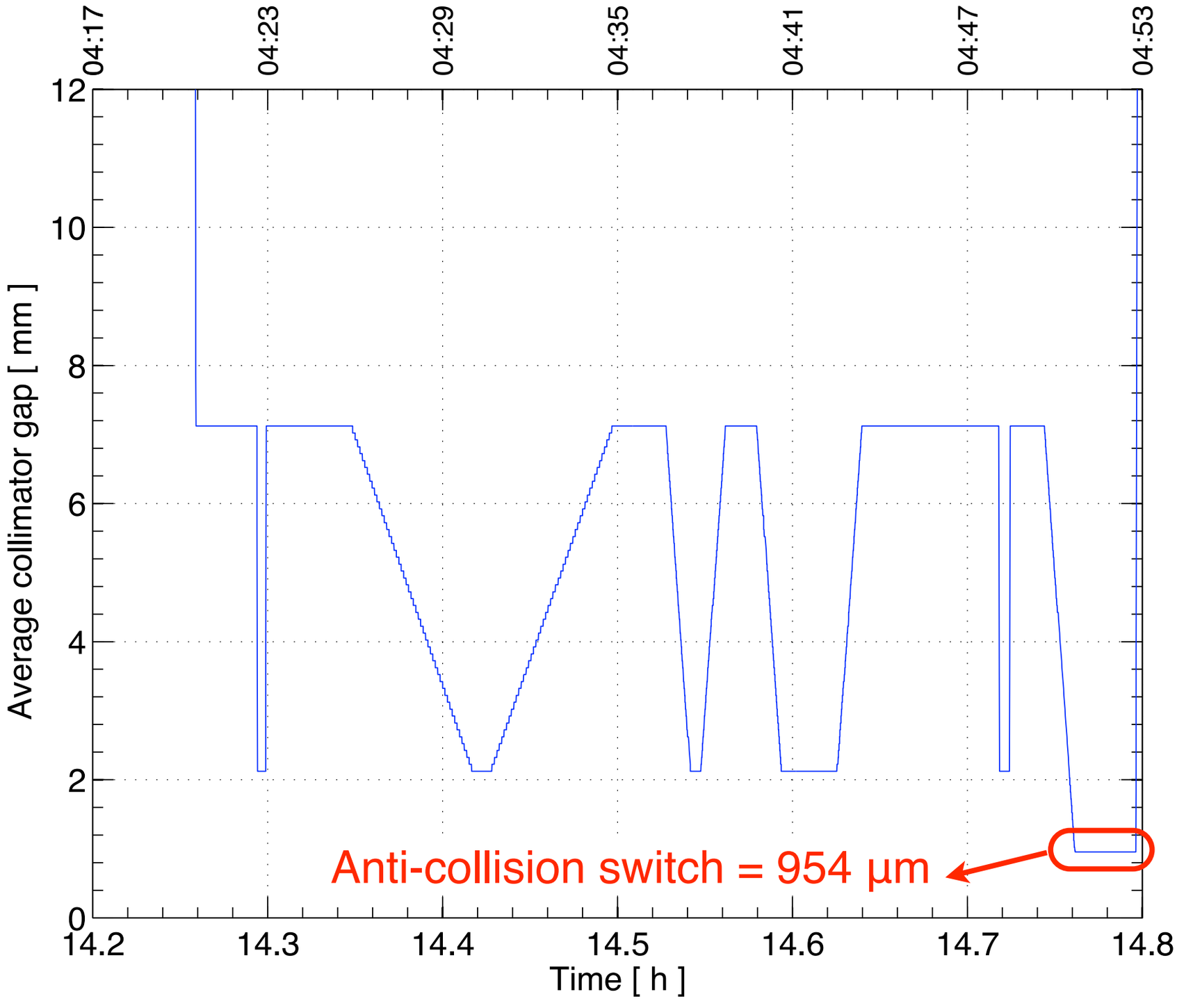

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- Beam tests in 2007 MUST be done with LHC hardware otherwise they risk to be inconclusive (time functions!)
- More detailed results at the upcoming controls review

TT40: LVDT position measurements