Collimator Control Application from the Control Room

Stefano Redaelli, AB-OP

for the COCOST team

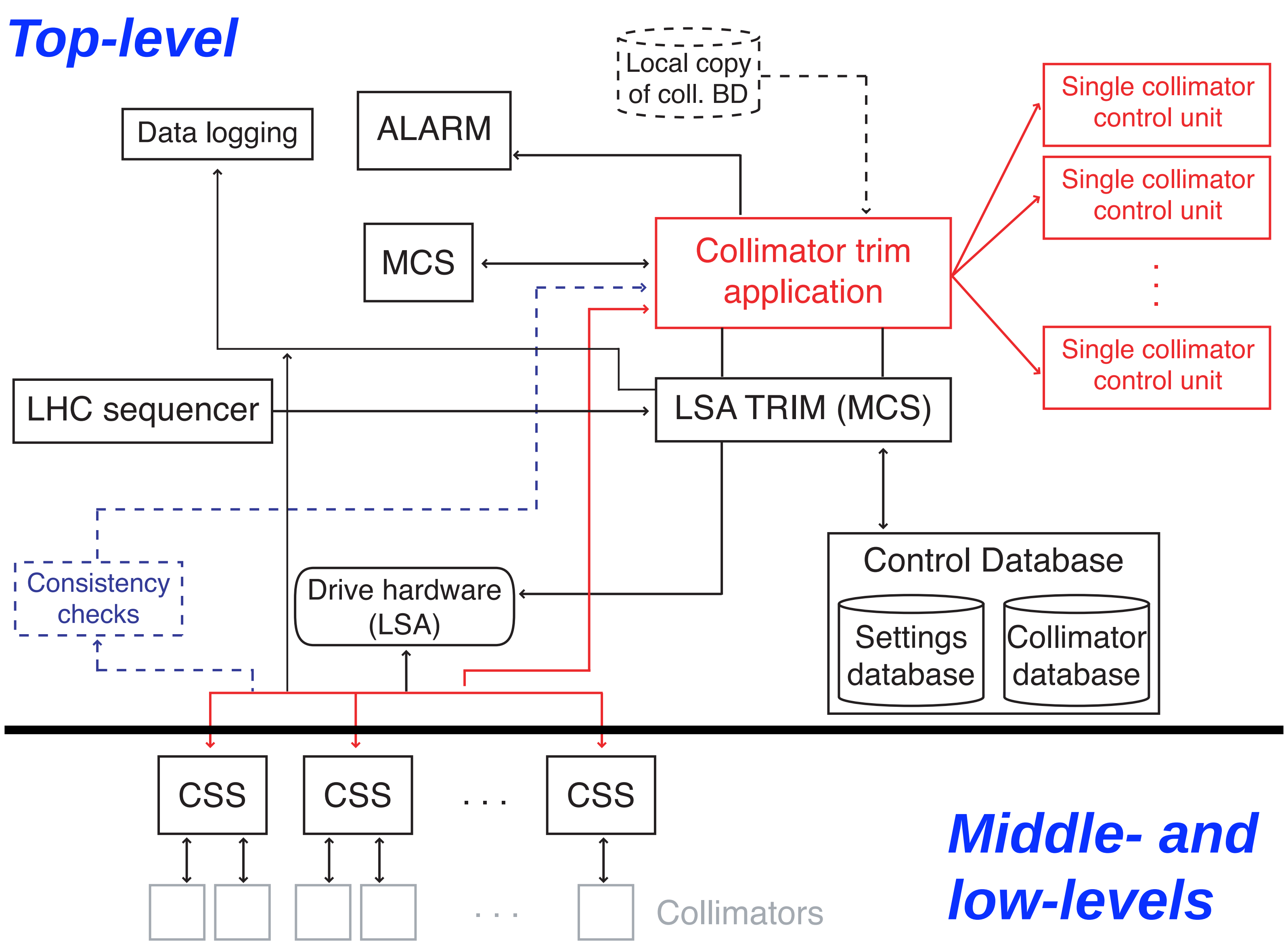
Acknowledgments: M. Lamont, J. Wenninger, SPS-OP crew, BLM team, ABP collimation team

Overview of my talk

1. Introduction
2. Implementation of LHC software
3. Control through the LSA TRIM
4. Performance issues
5. Conclusions

Introduction

Architecture of top-level collimator controls
(Eng. Spec. May 2006, to be published)



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... a little part of the overall architecture BUT crucial for the LHC!

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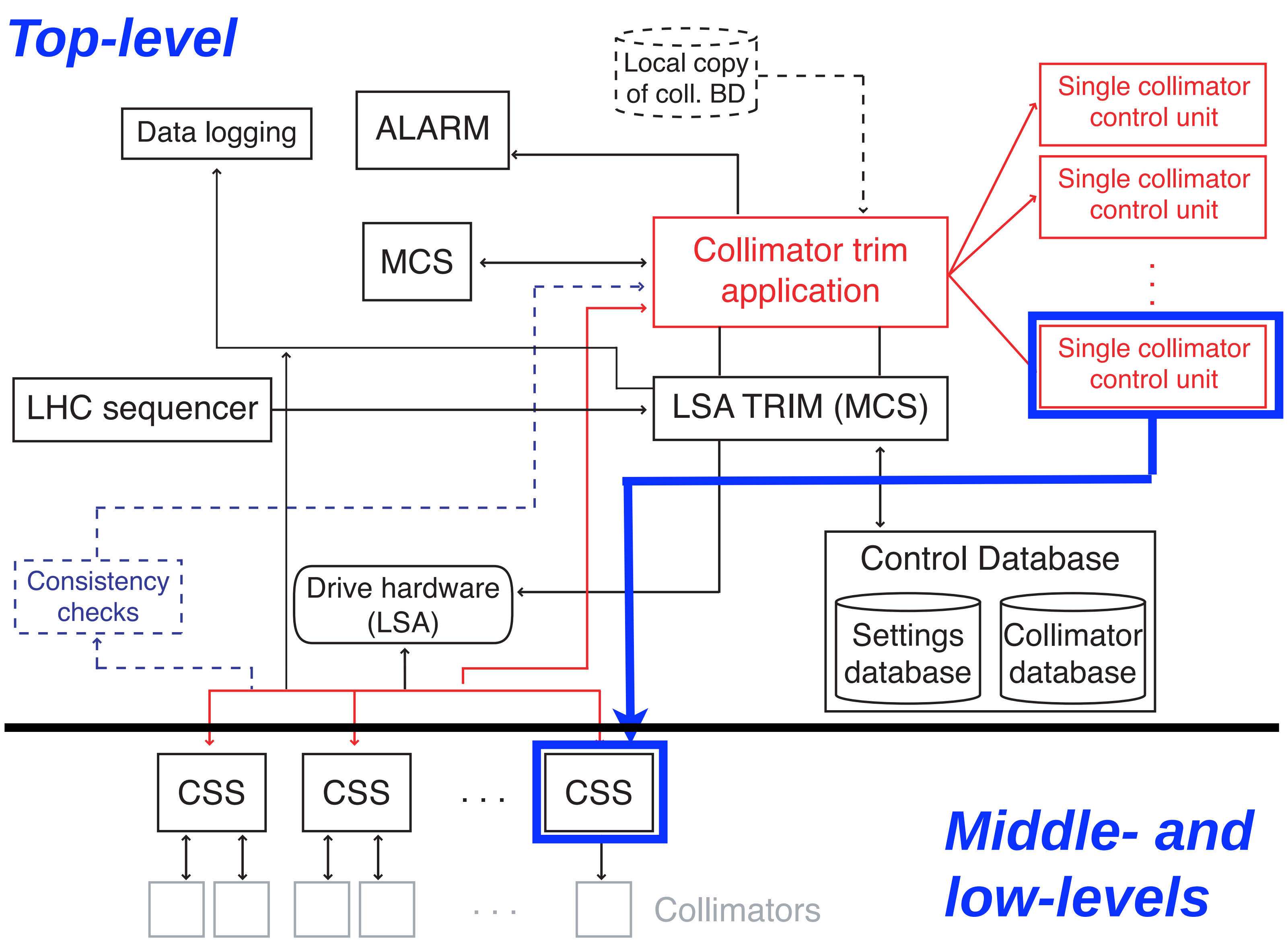

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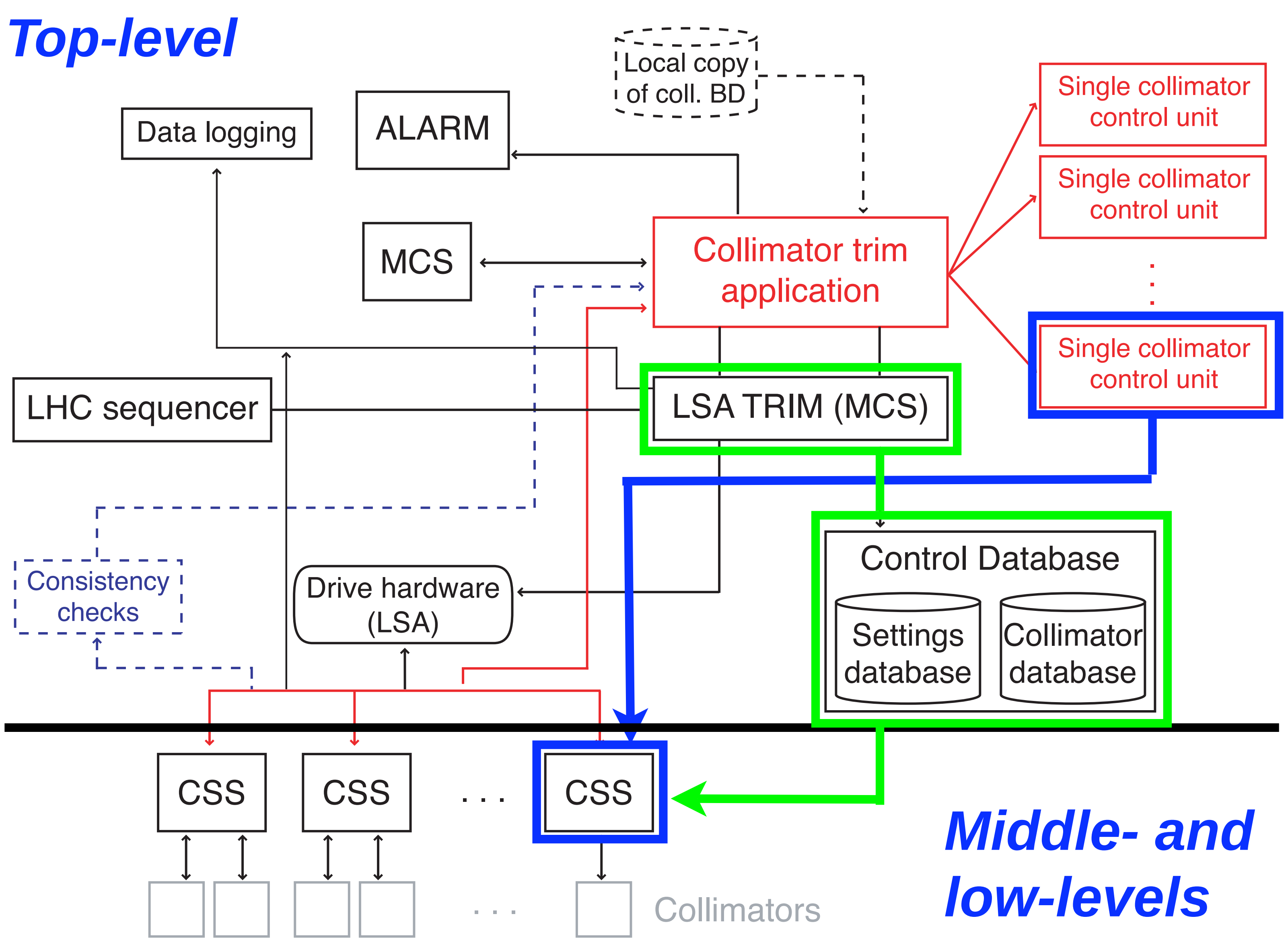

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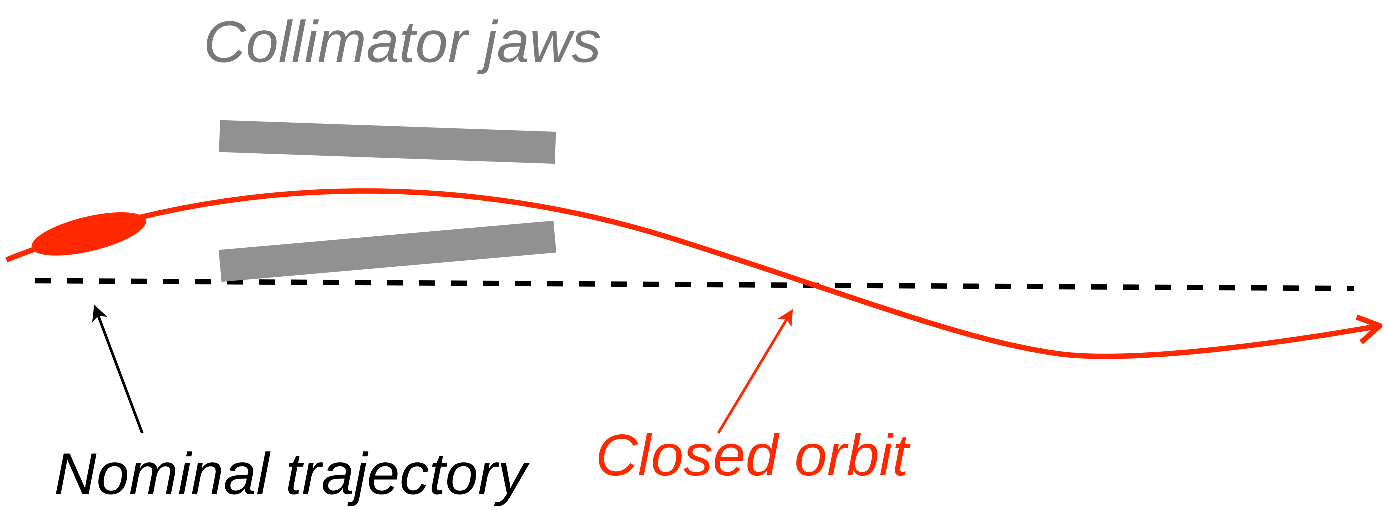
Requirements for single collimator control

Beam-based alignment with BLM's



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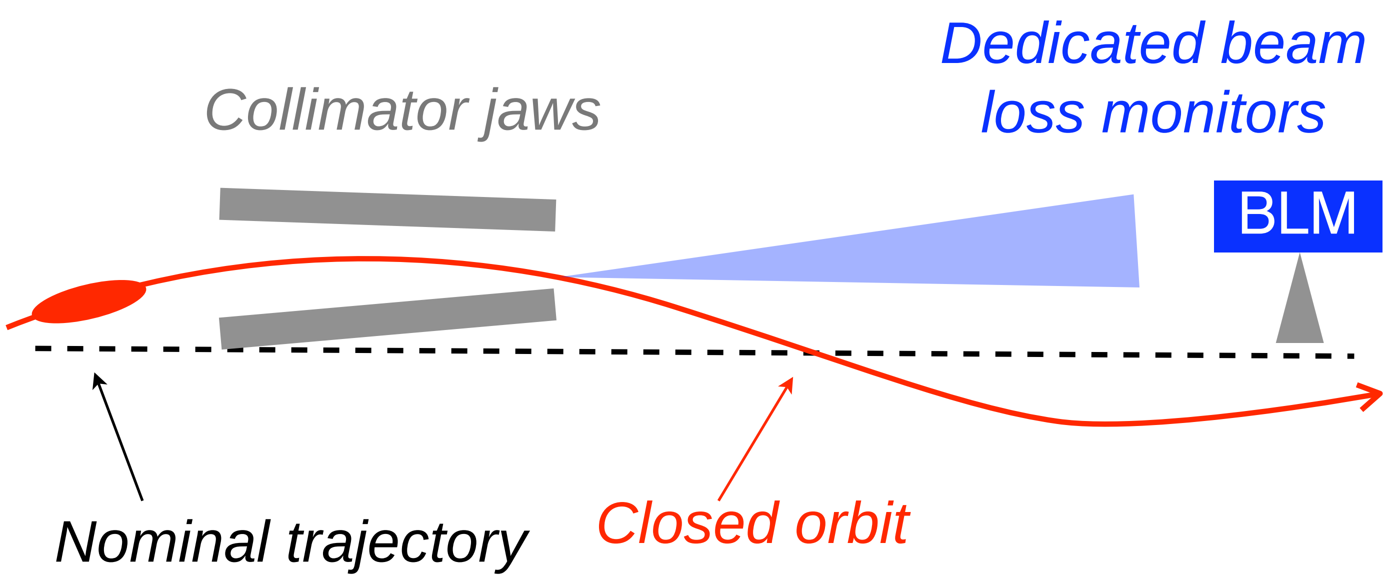

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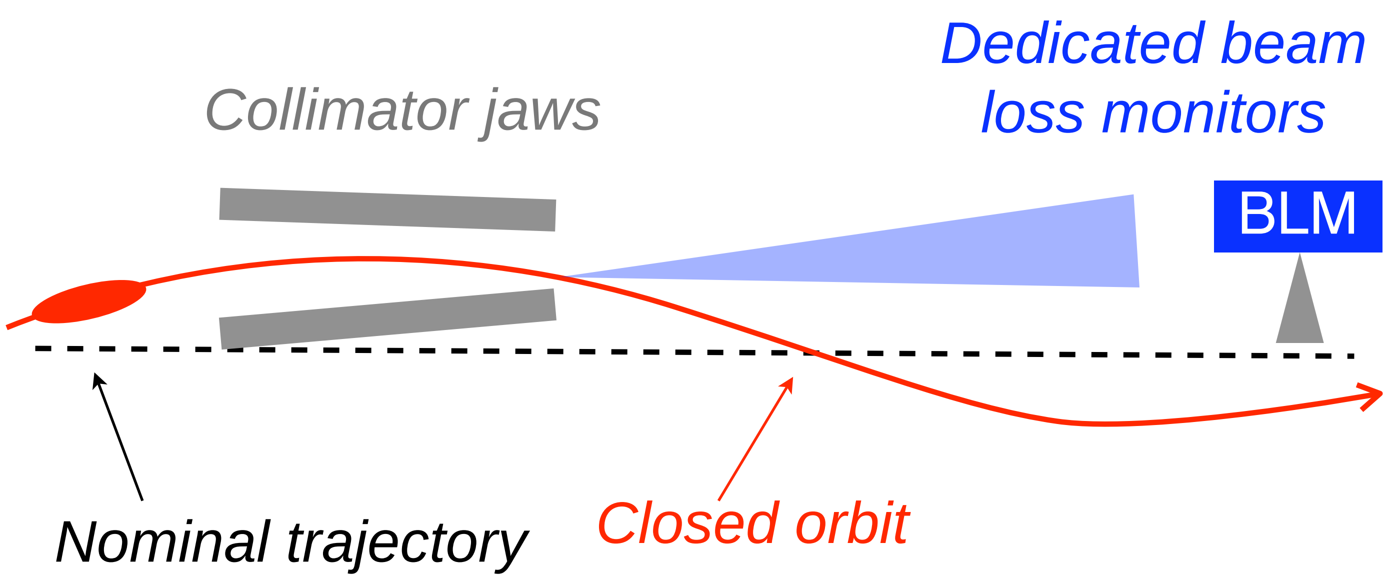

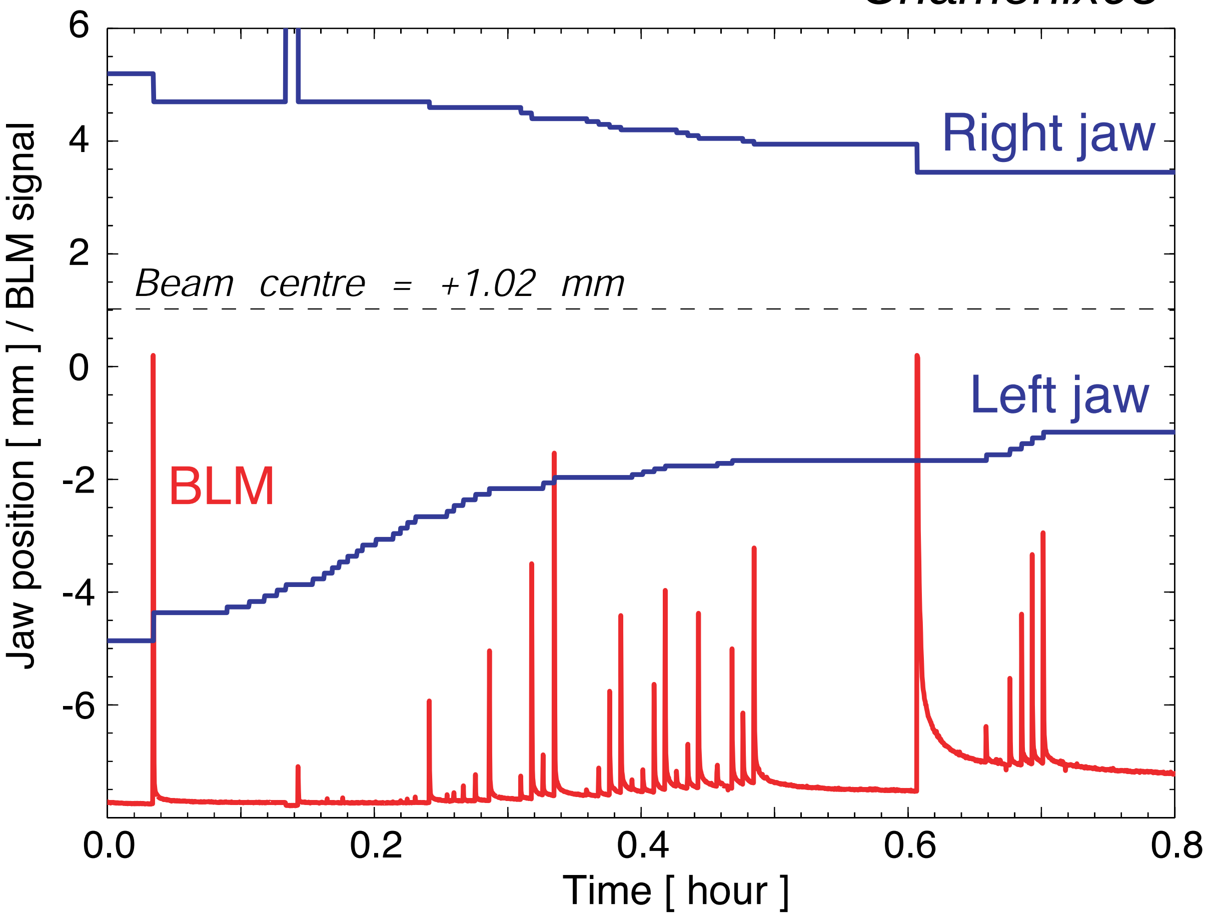

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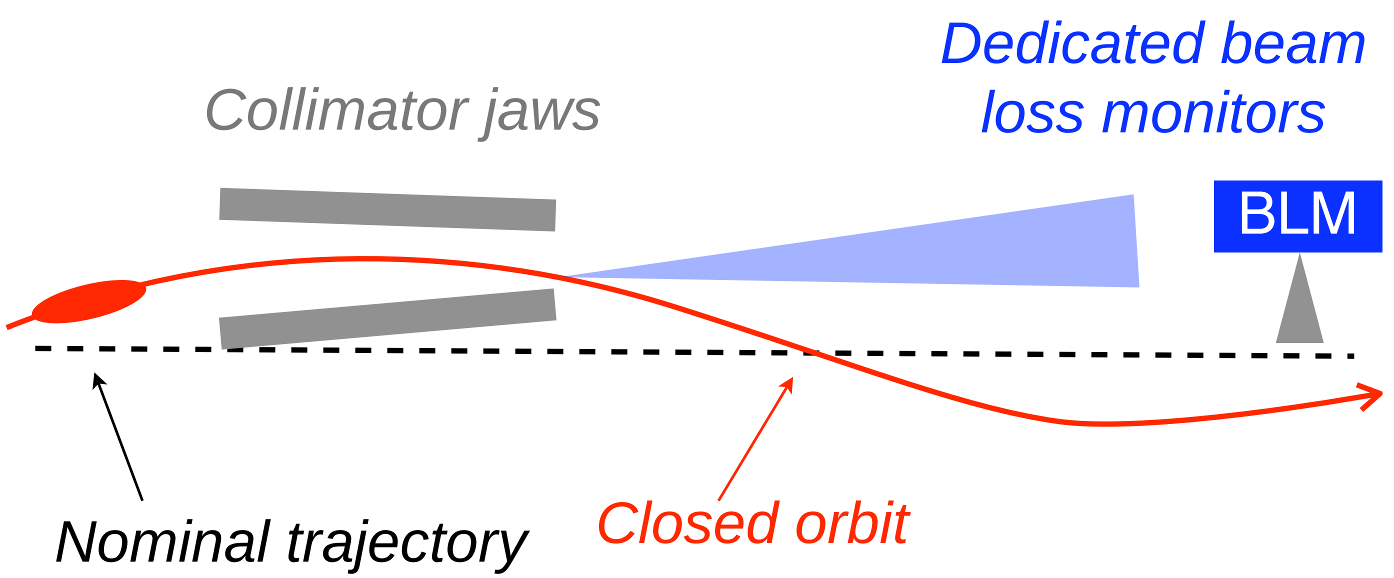

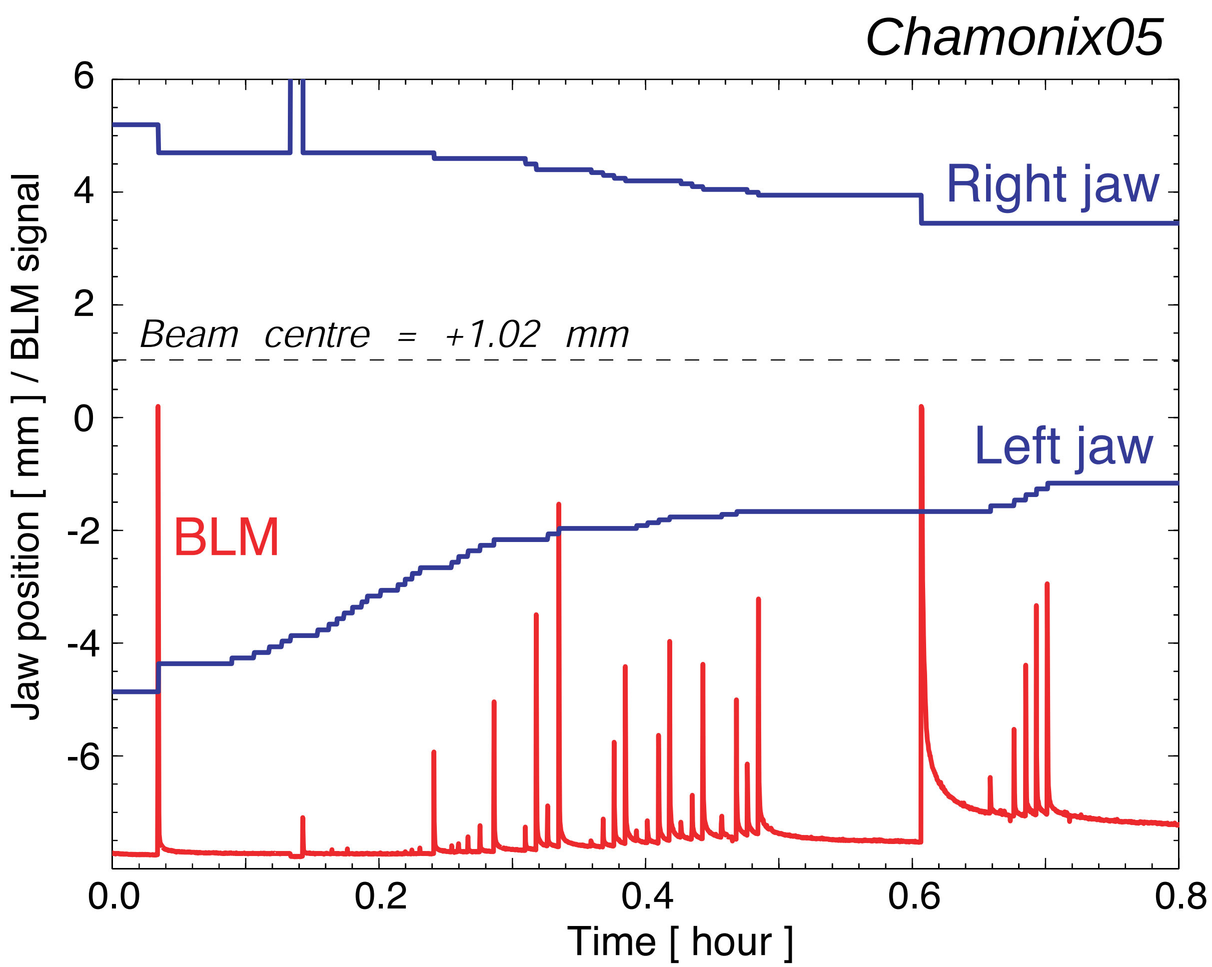

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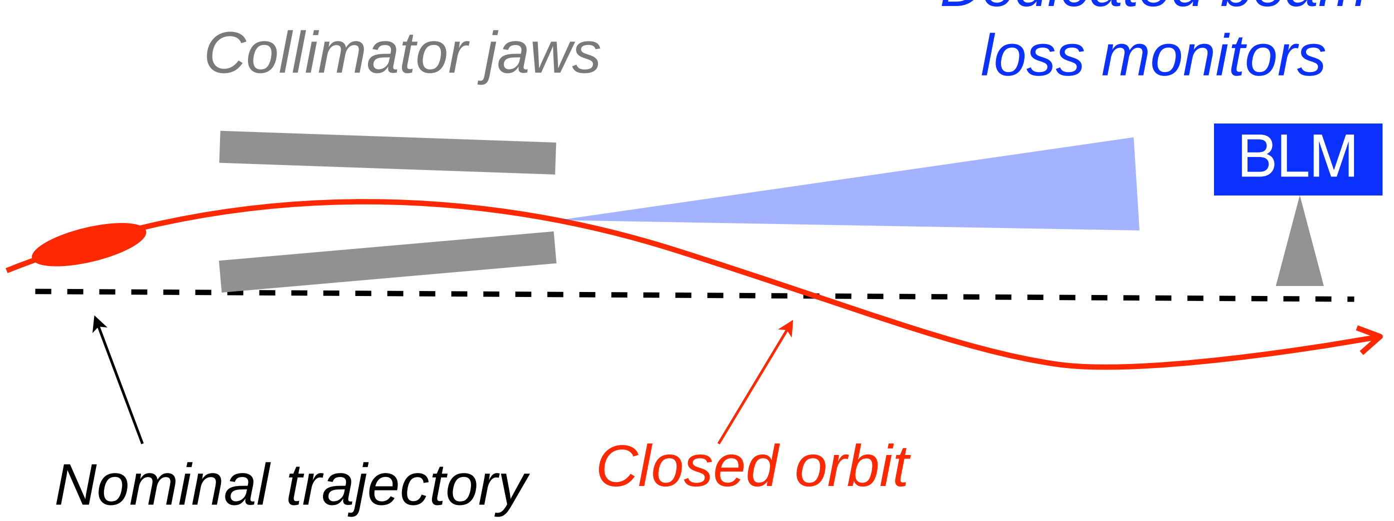

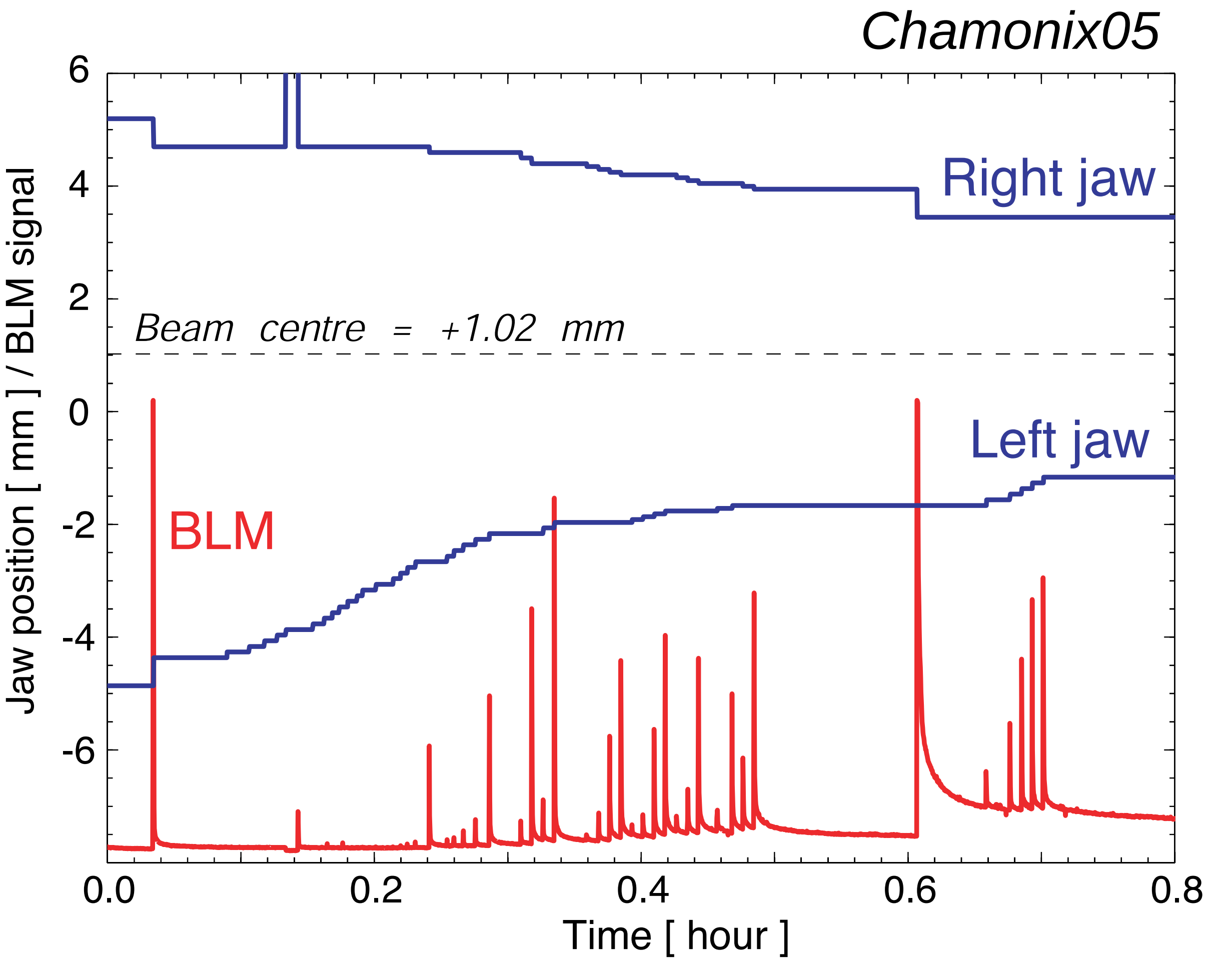

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- On-line monitoring of collimator jaw positions / gaps (~ 1 Hz)

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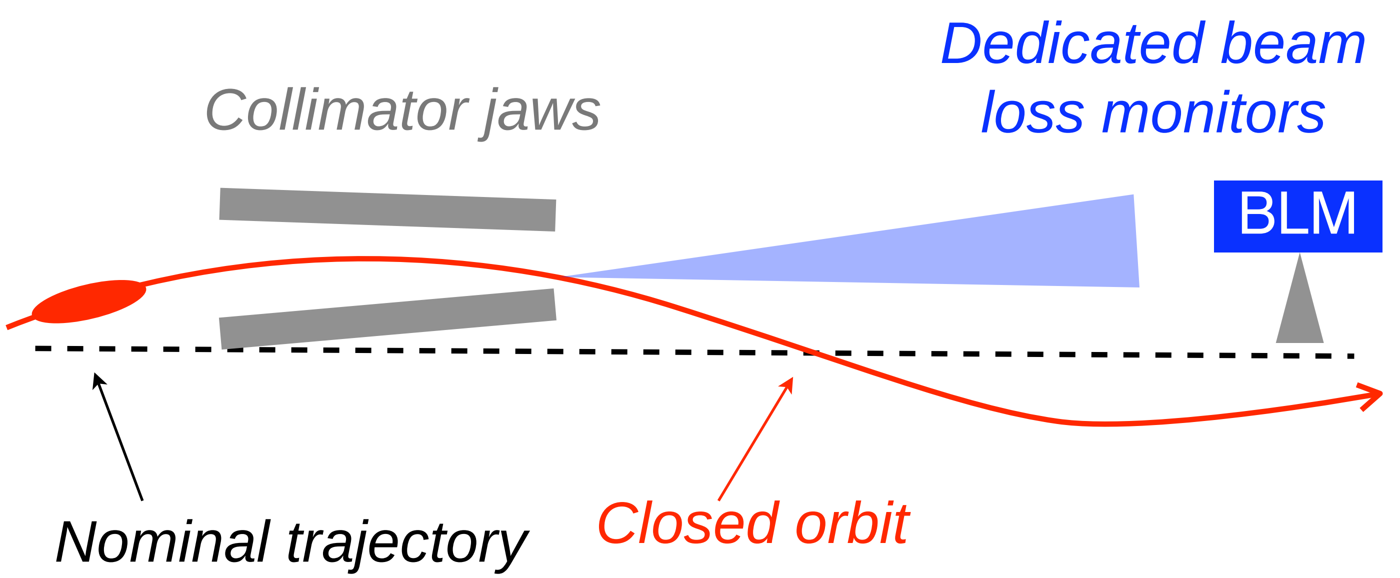

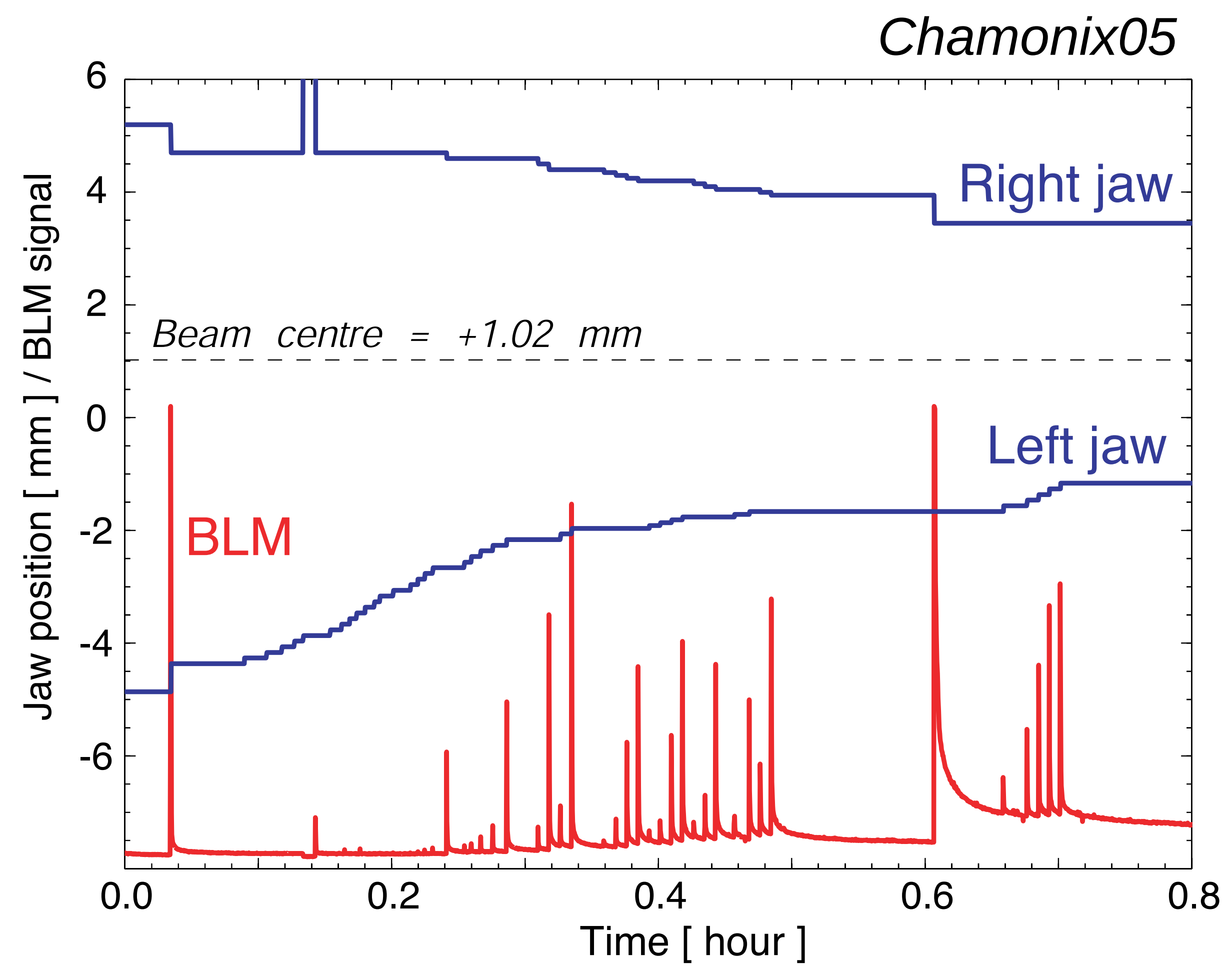

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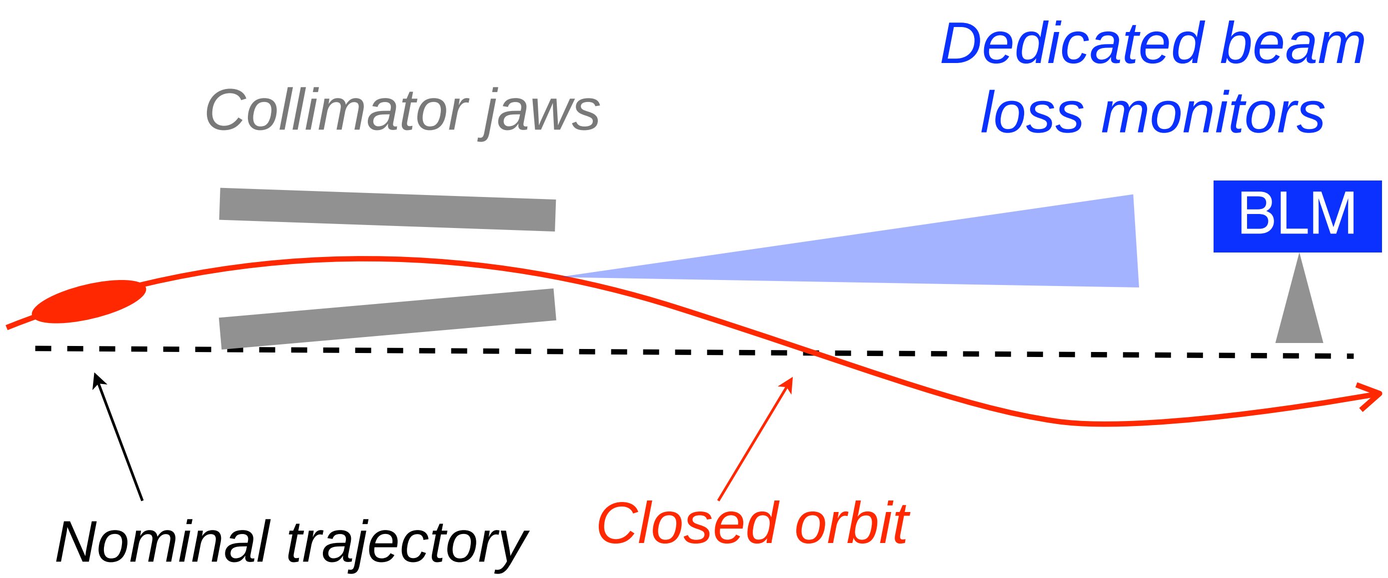

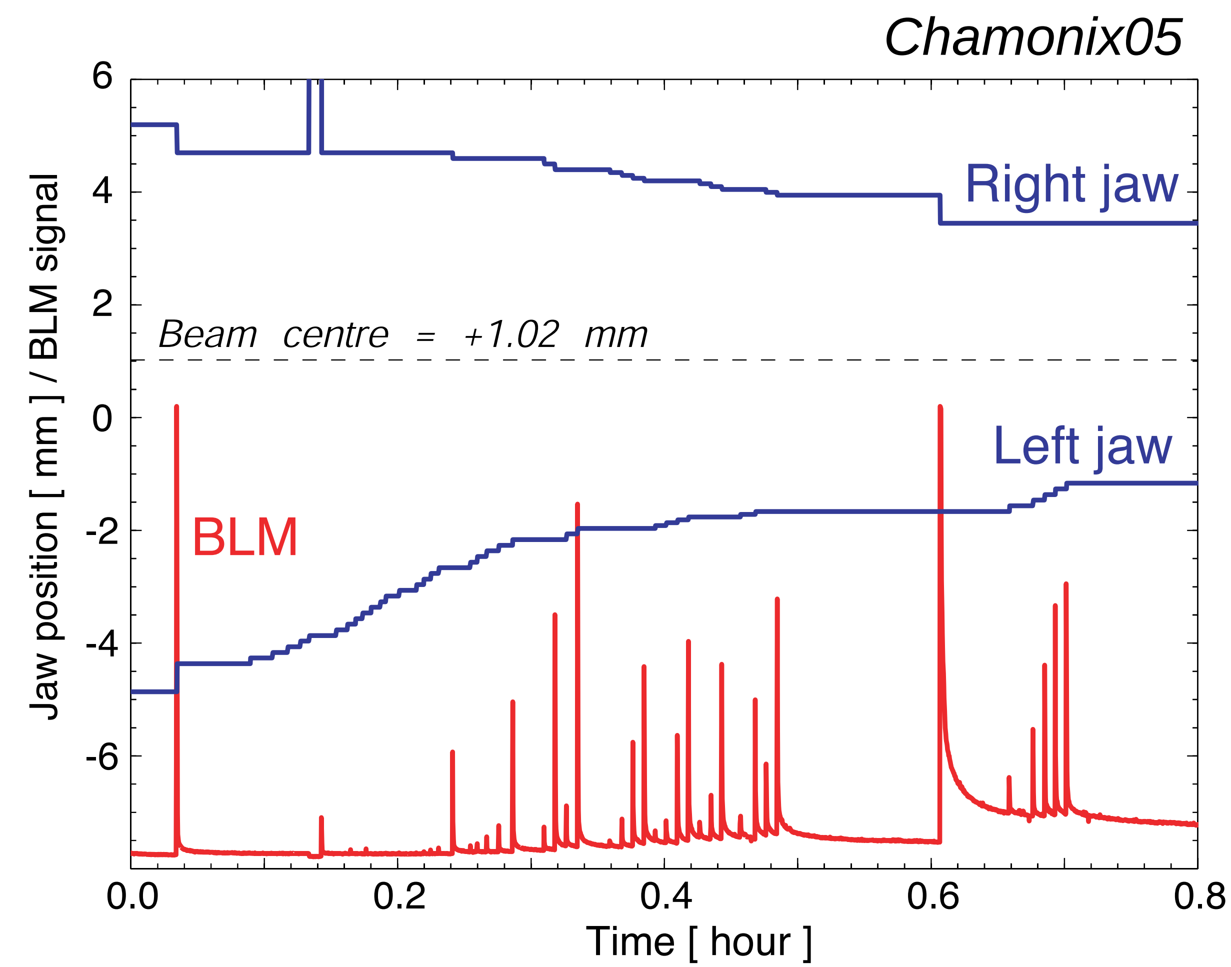

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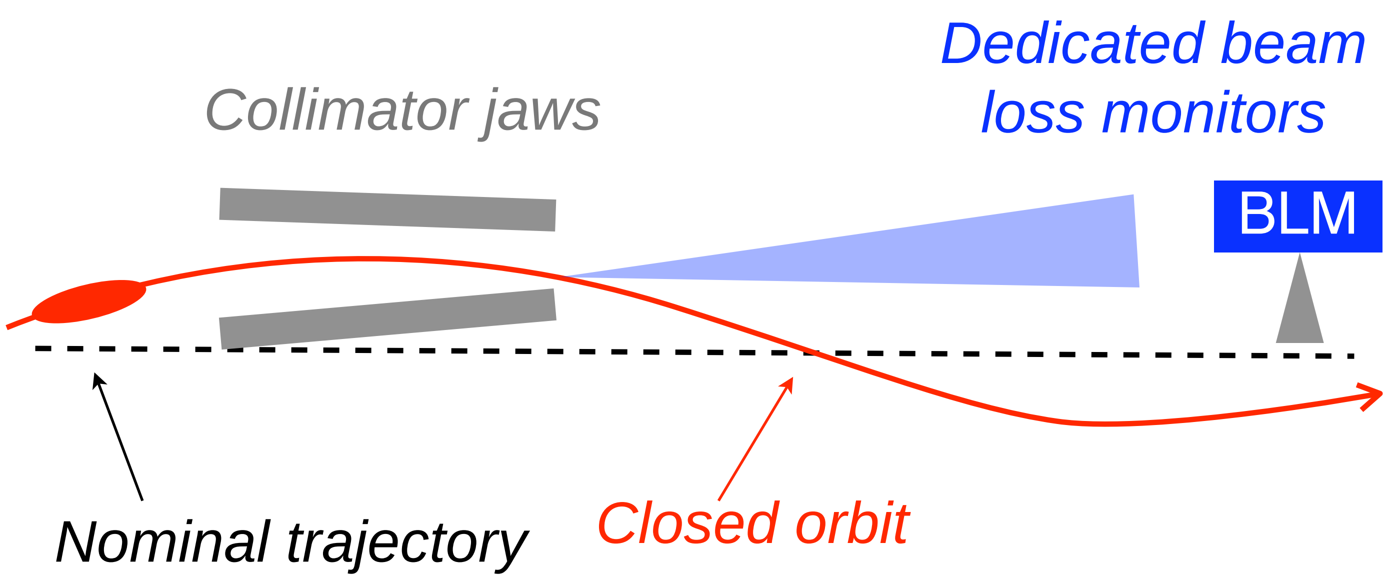

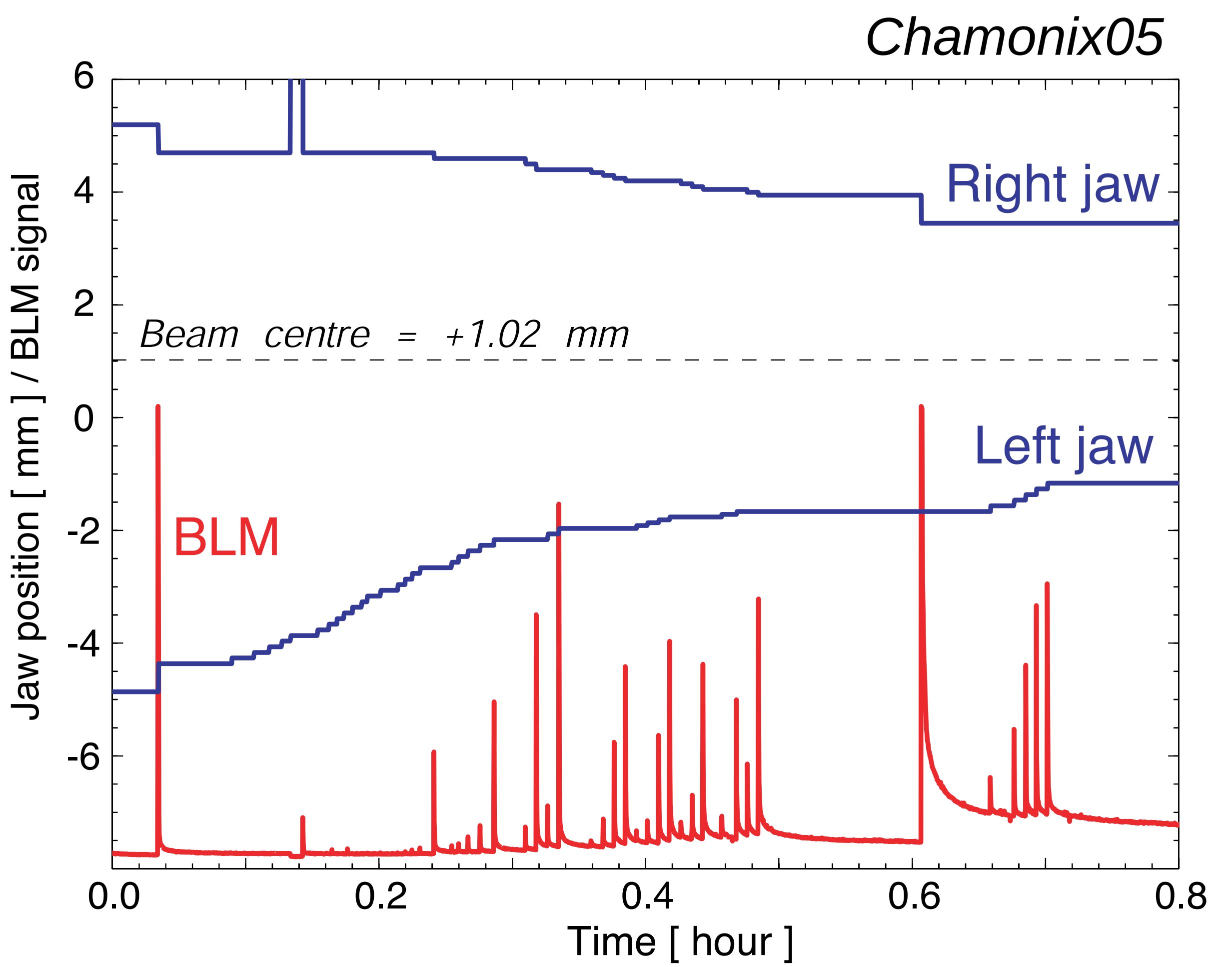

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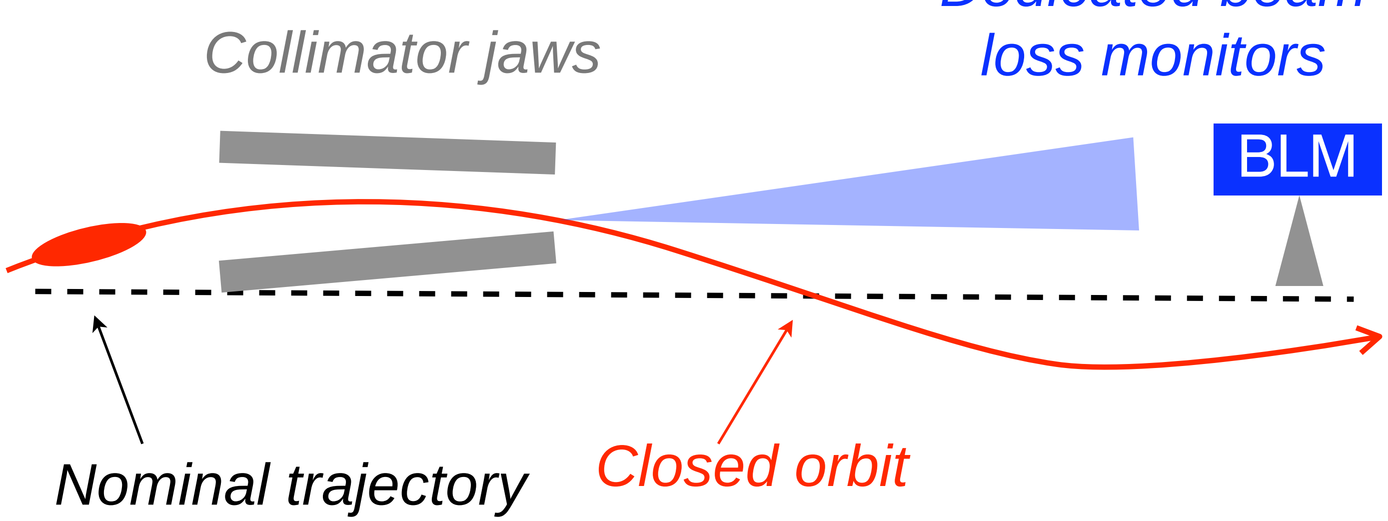

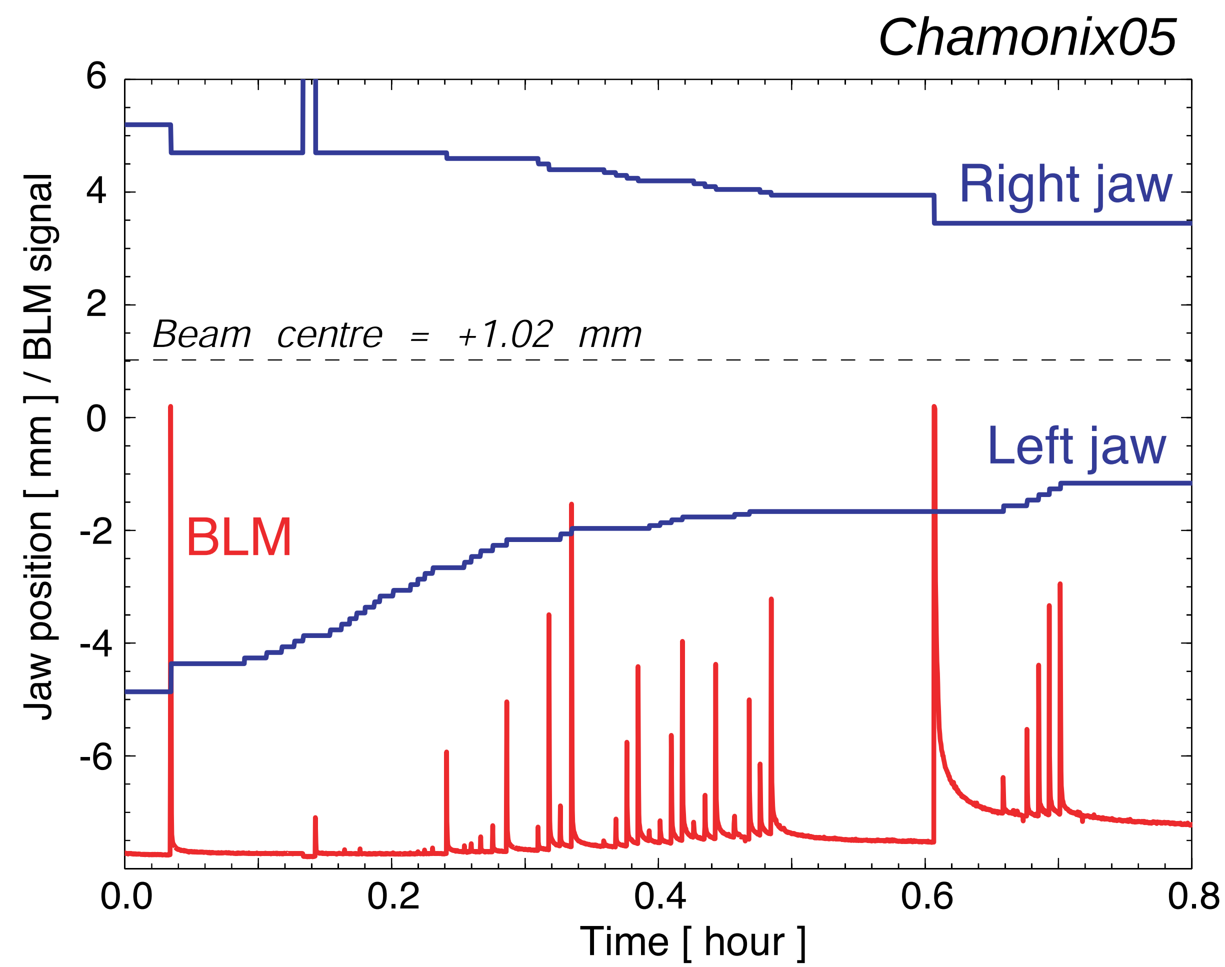

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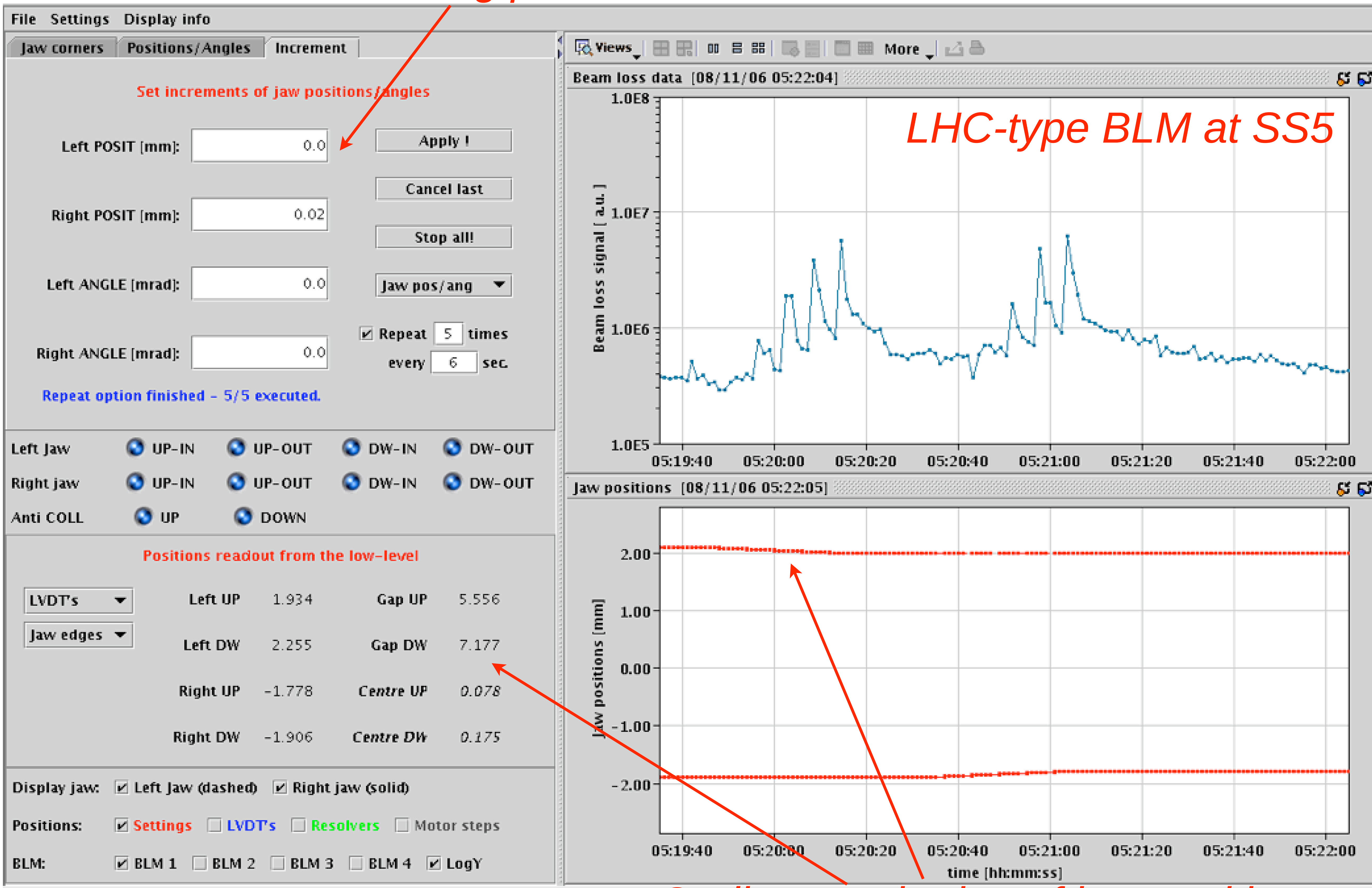
- Monitor the switch status (10 per collimator)
- Efficient tool to send settings, various coordinate systems *(single corners,average, angles)*
- Flexibility of plotting tools *(lin/log axes, choose BLM, choose left/right jaw, adjust calibrations, ...)*

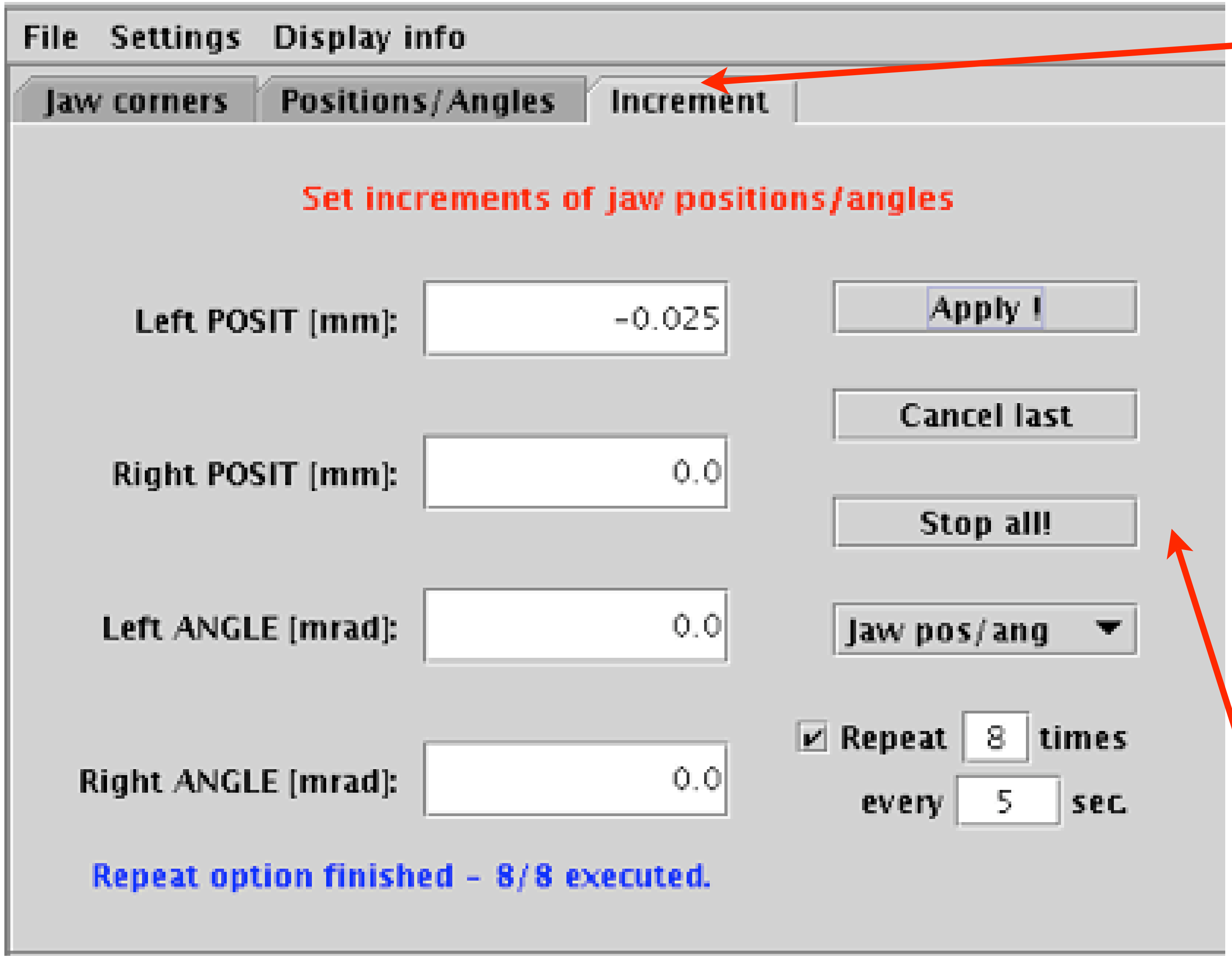
Collimator software GUI

Setting panel



On-line monitoring of jaw positions

Setting panel

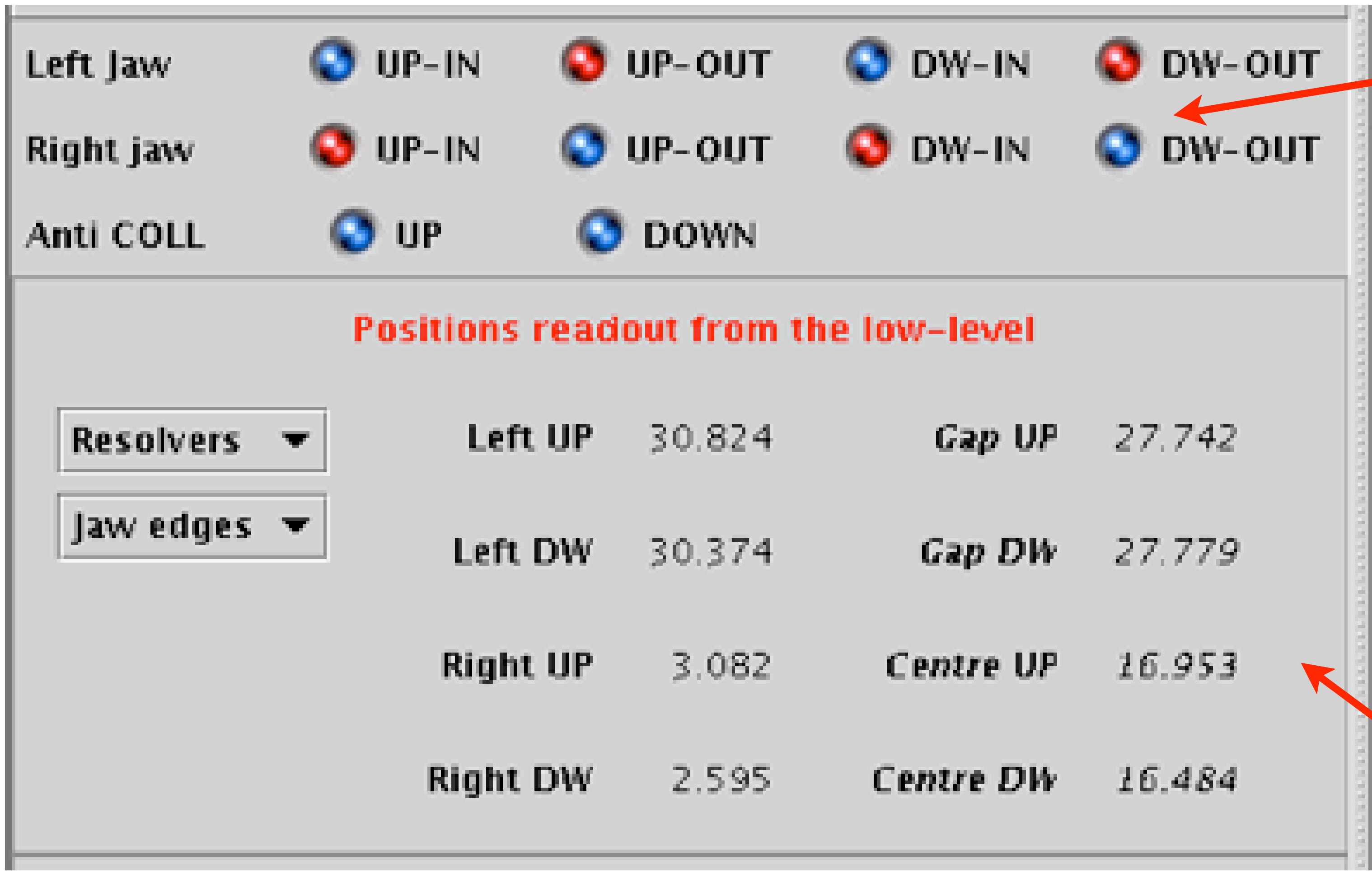


Different coordinate systems (single corners, average + angle)

All conversions done at top-level -> coherent set of settings to the lower levels (fully compatible with LSA TRIM!)

"Repeat" functionality, "cancel last", "stop": efficient control during routine operation

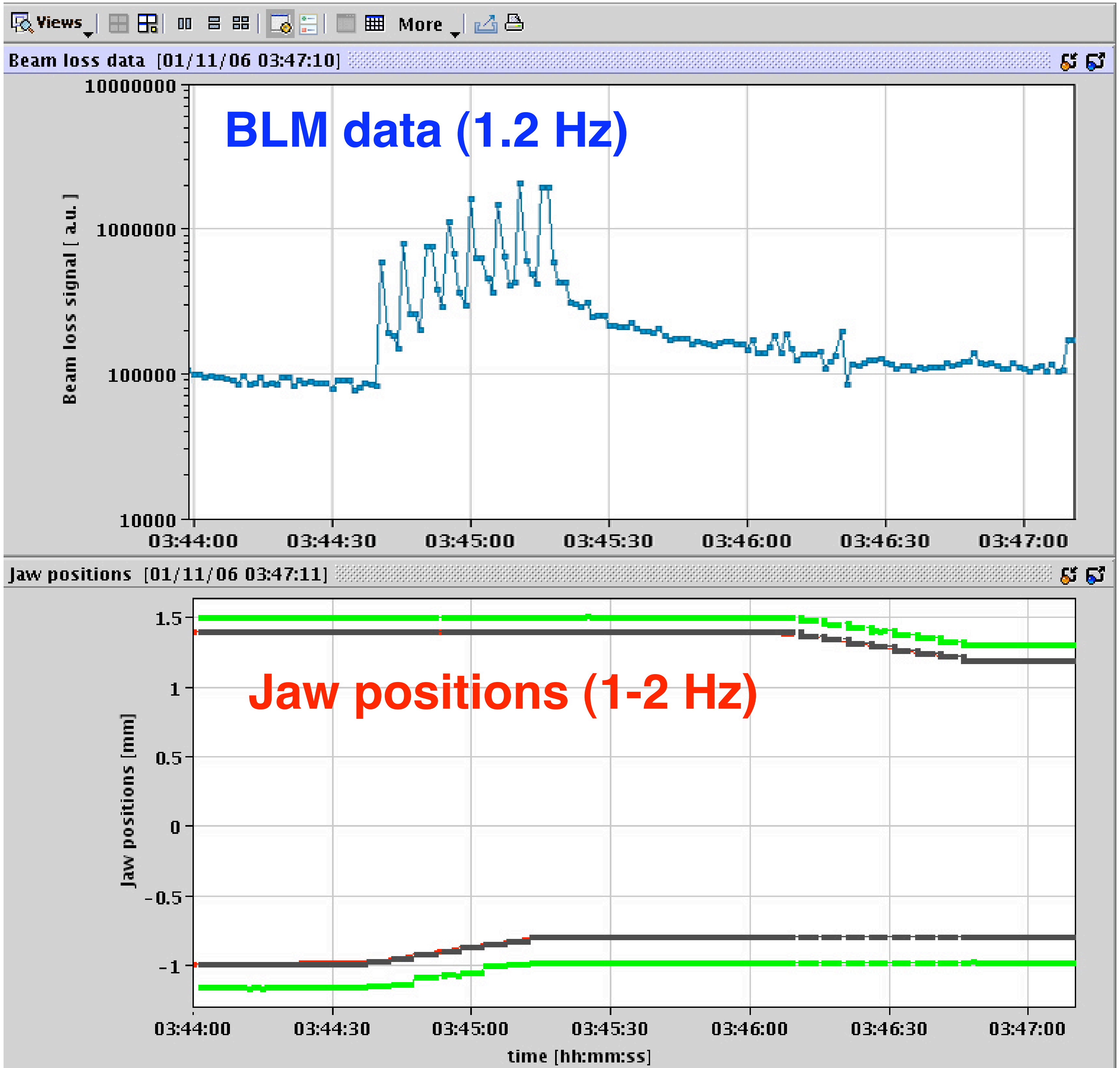
Detailed sensor readout panel



Status of 10 switches always monitors (1 Hz)

Readout of 14 sensors (4 motors, 4 resolvers, 6 LVDT's) and calculation of gaps, average positions, angles, ... for all of them

On-line display



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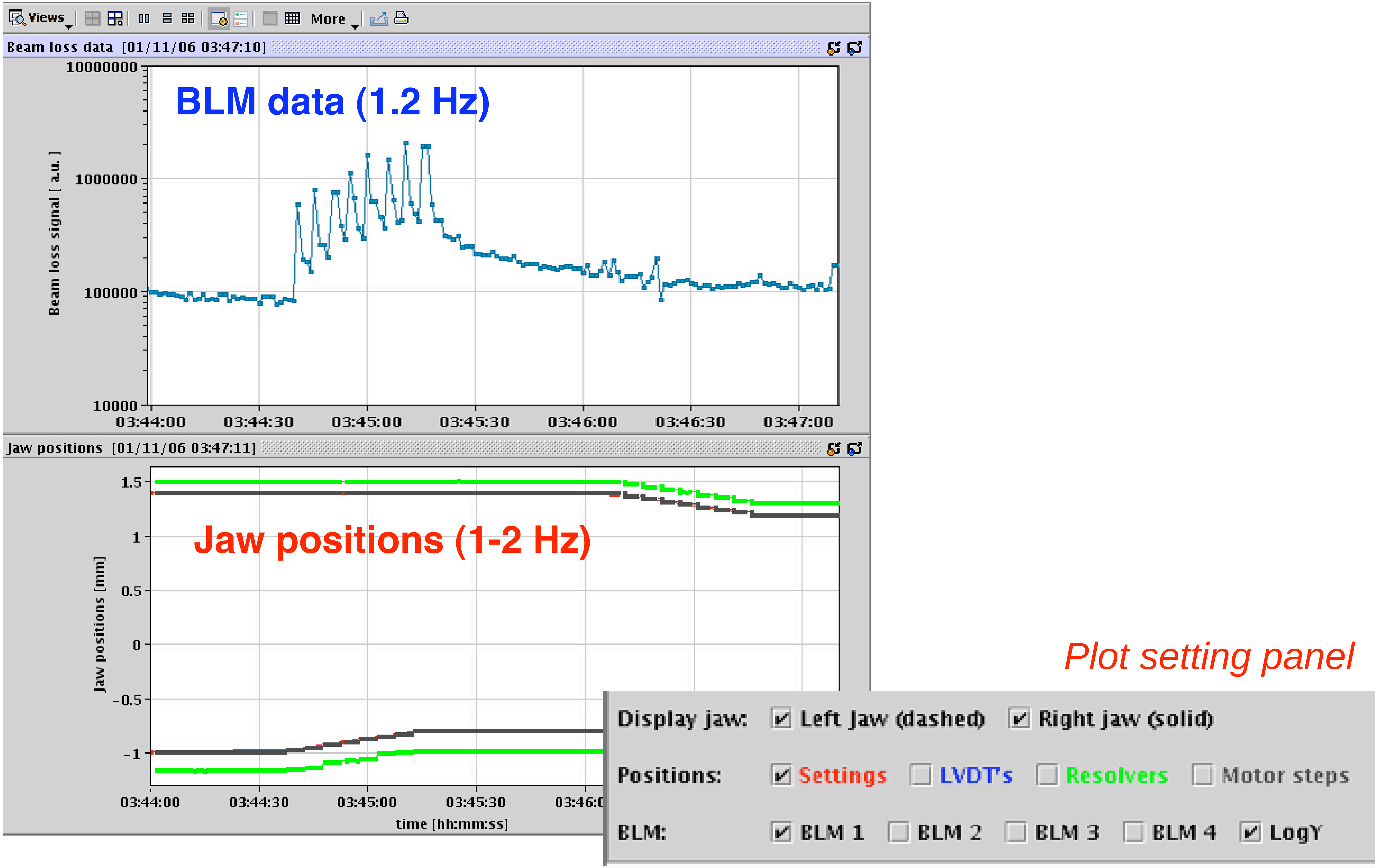

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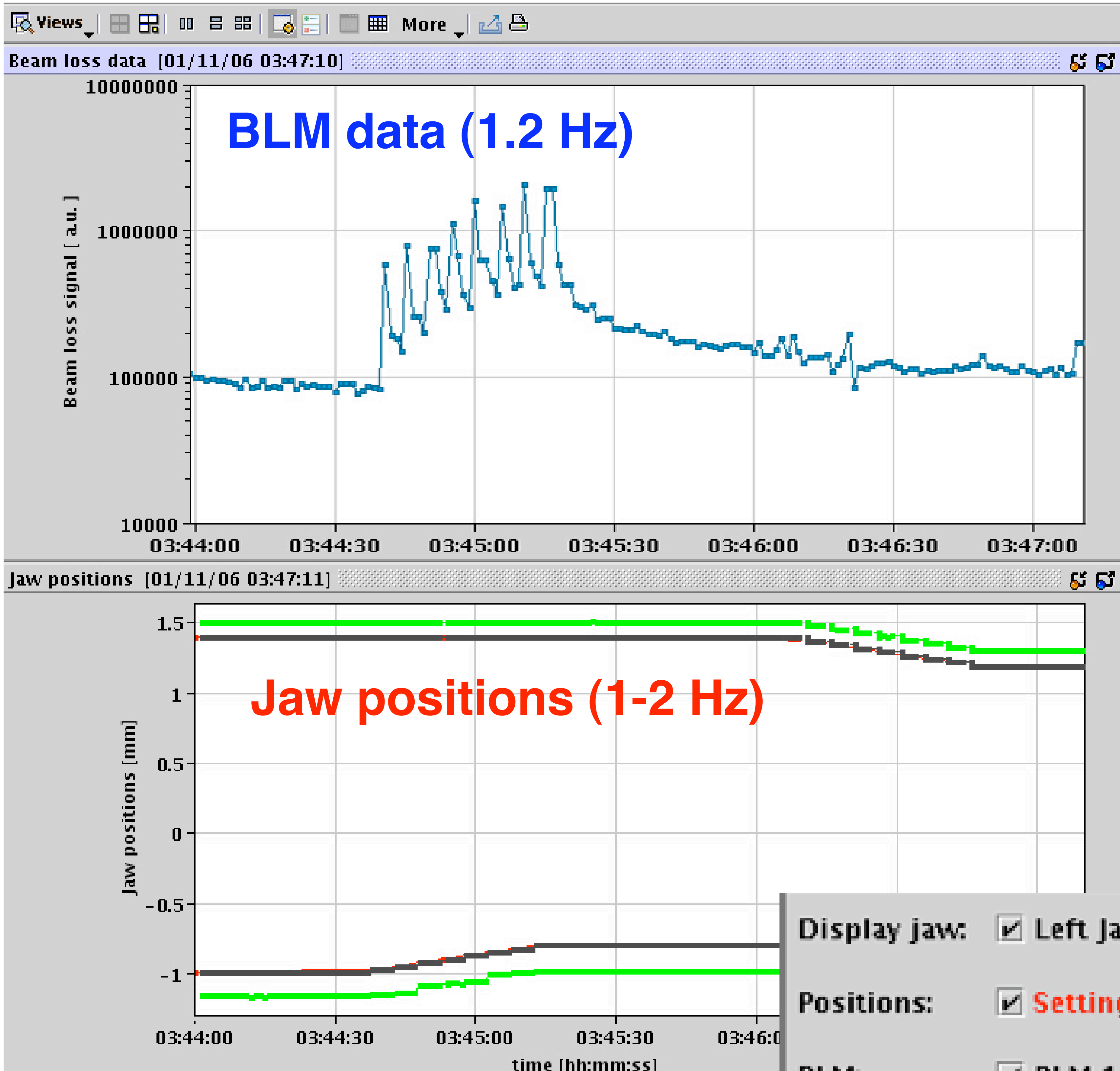
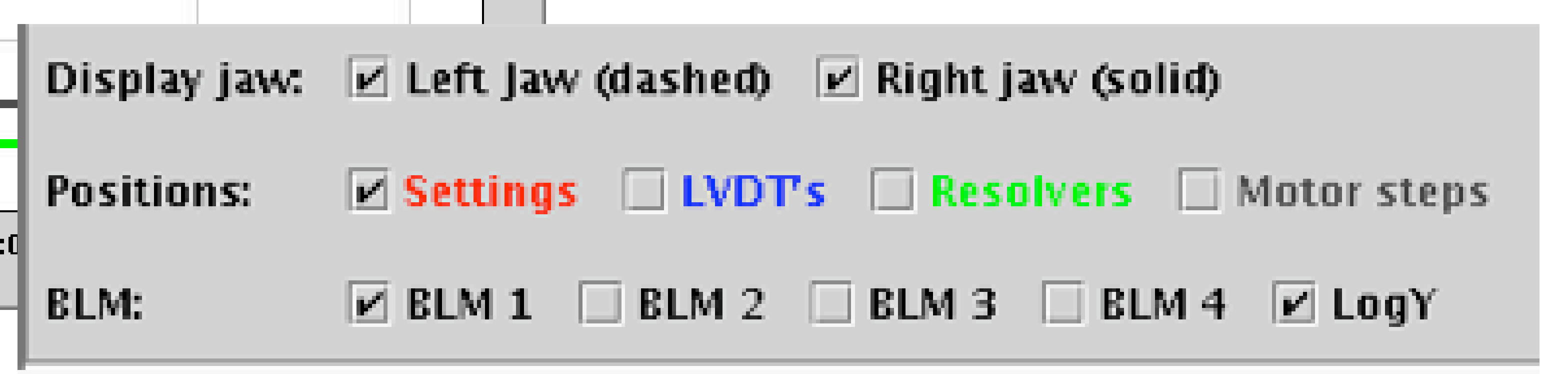


This is like in the off-line analysis!

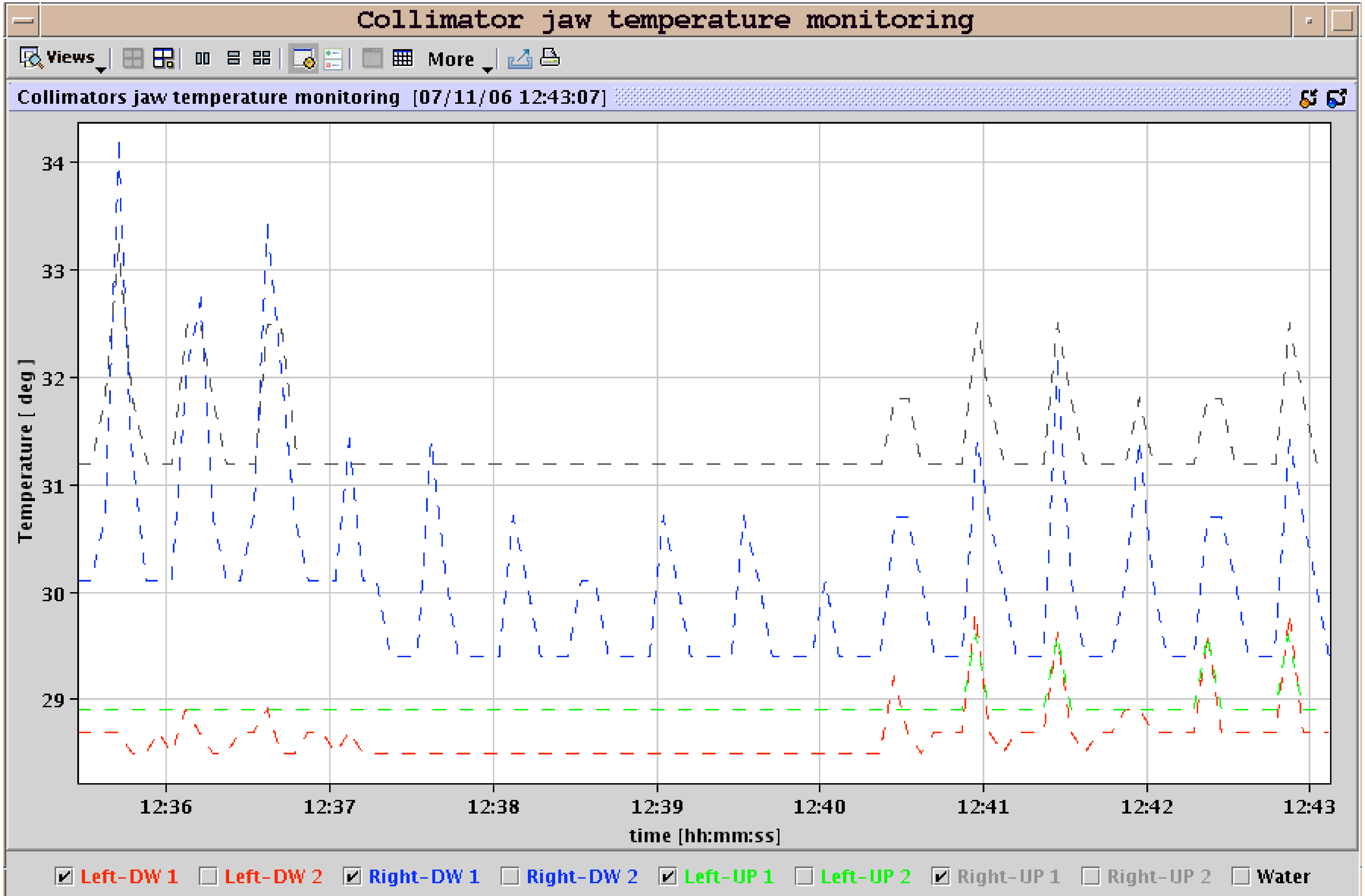
Overall impression:
Single collimator control worked very well, the proposed application fully fulfills the LHC requirements

Missing: Conversion to beam units (requires on-line optics model)

Plot setting panel



Additional features



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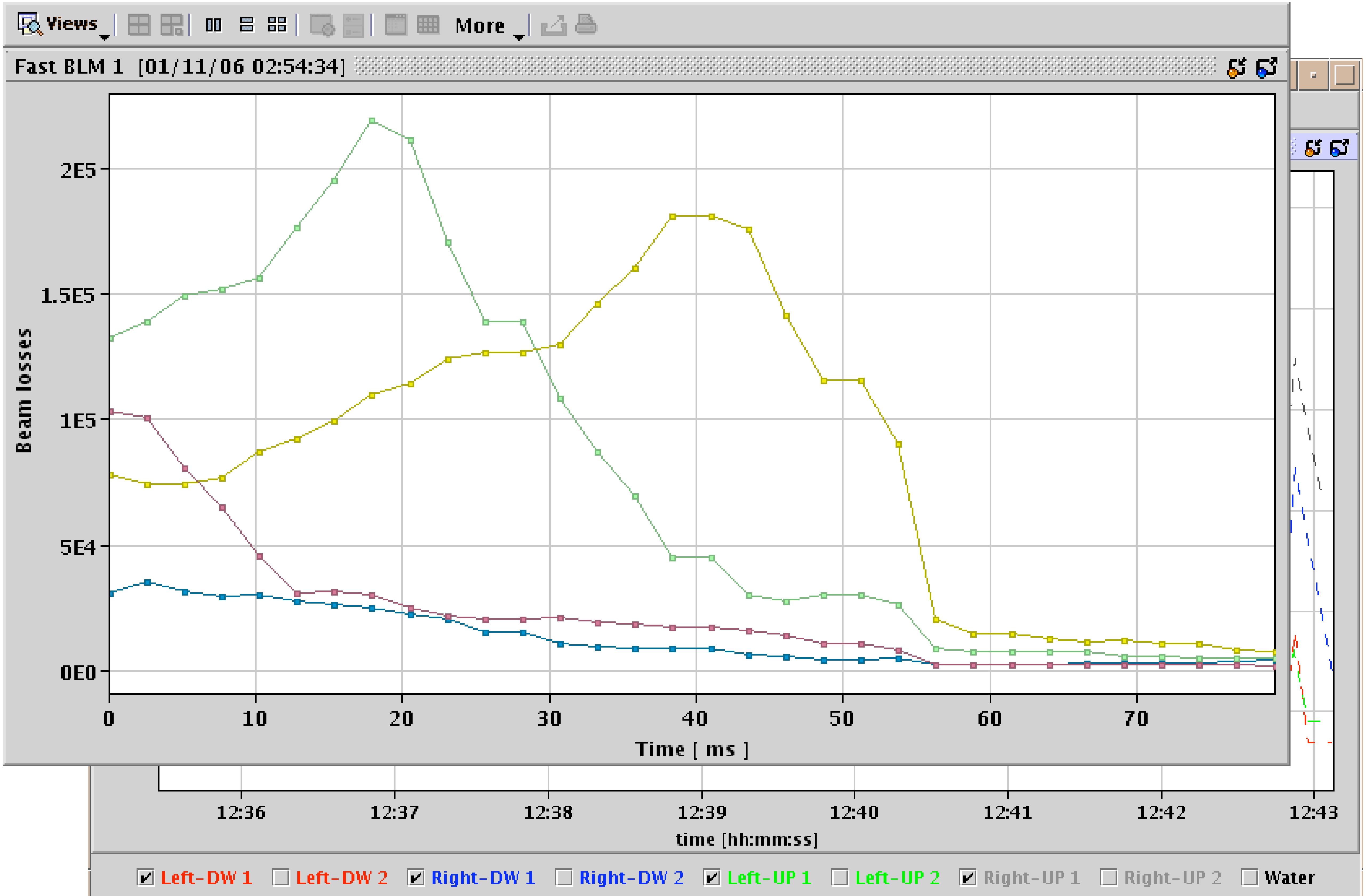
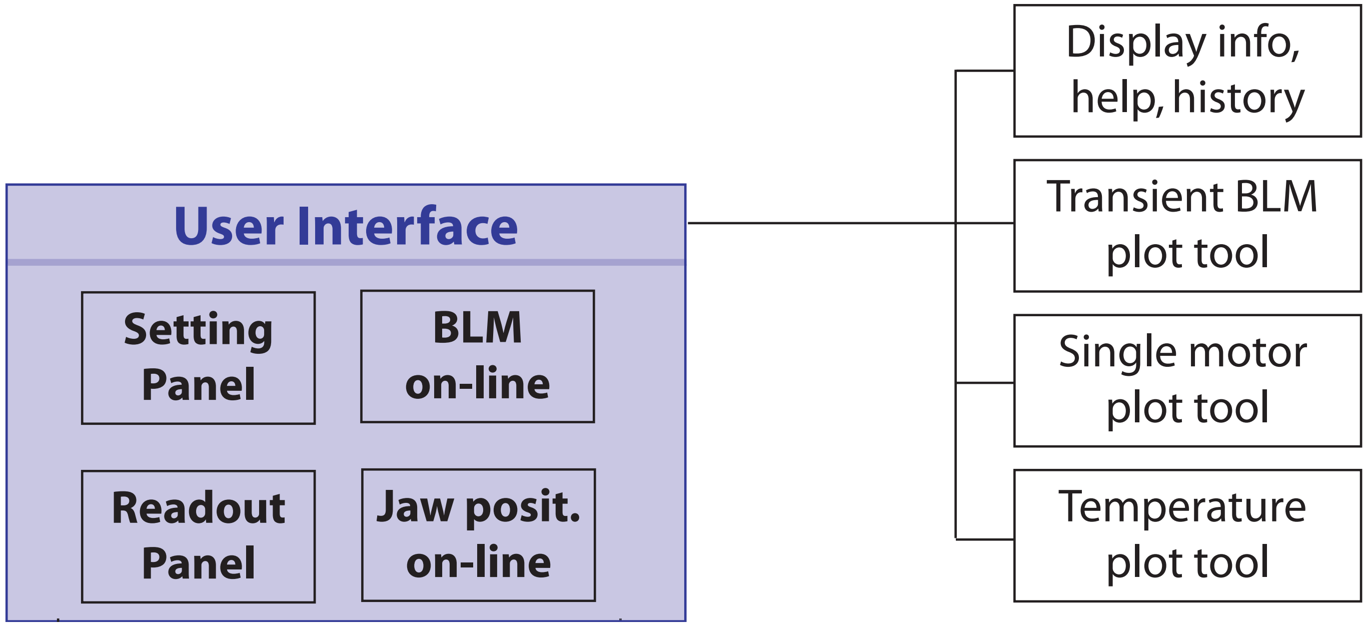


LHC application: SPS implementation



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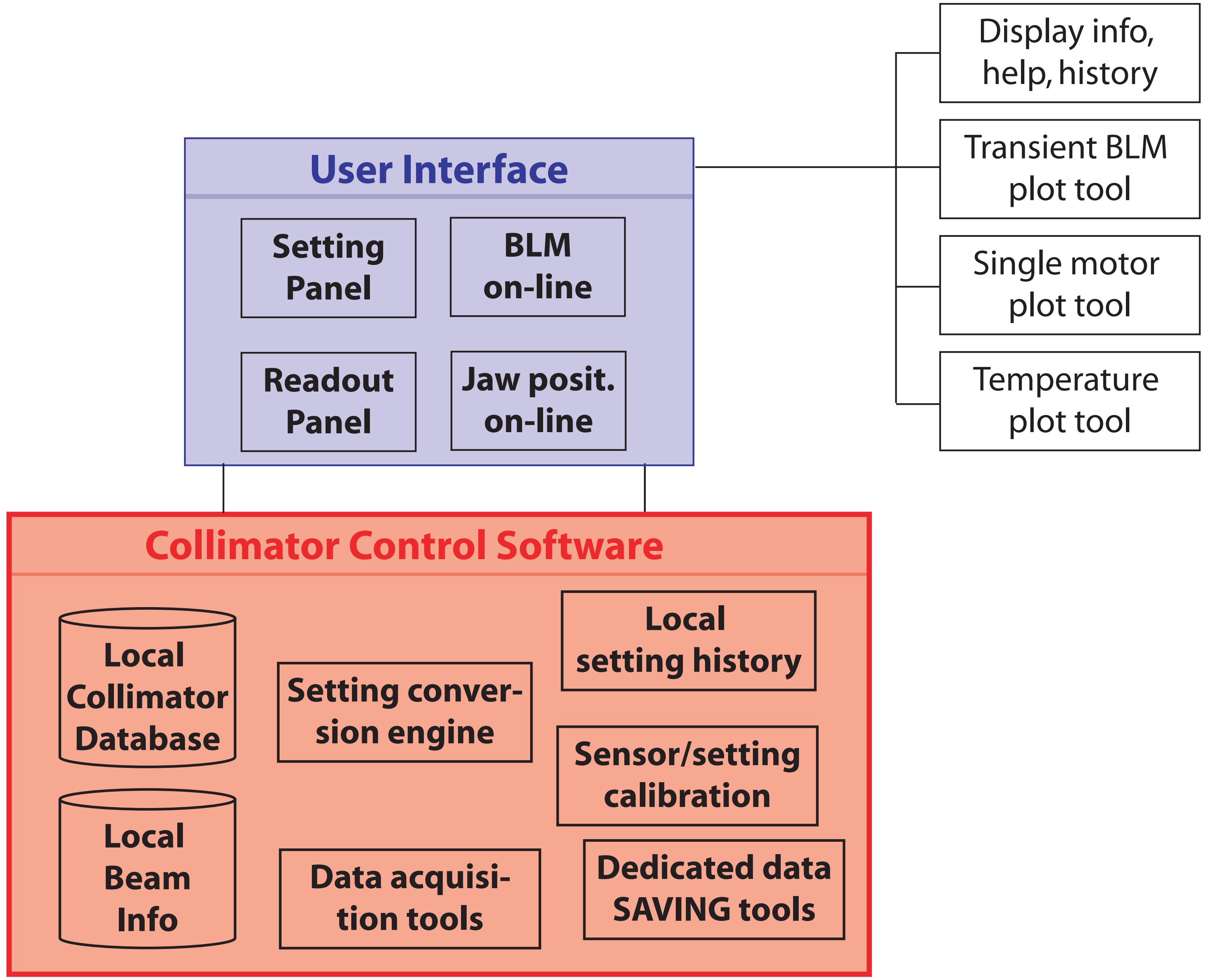

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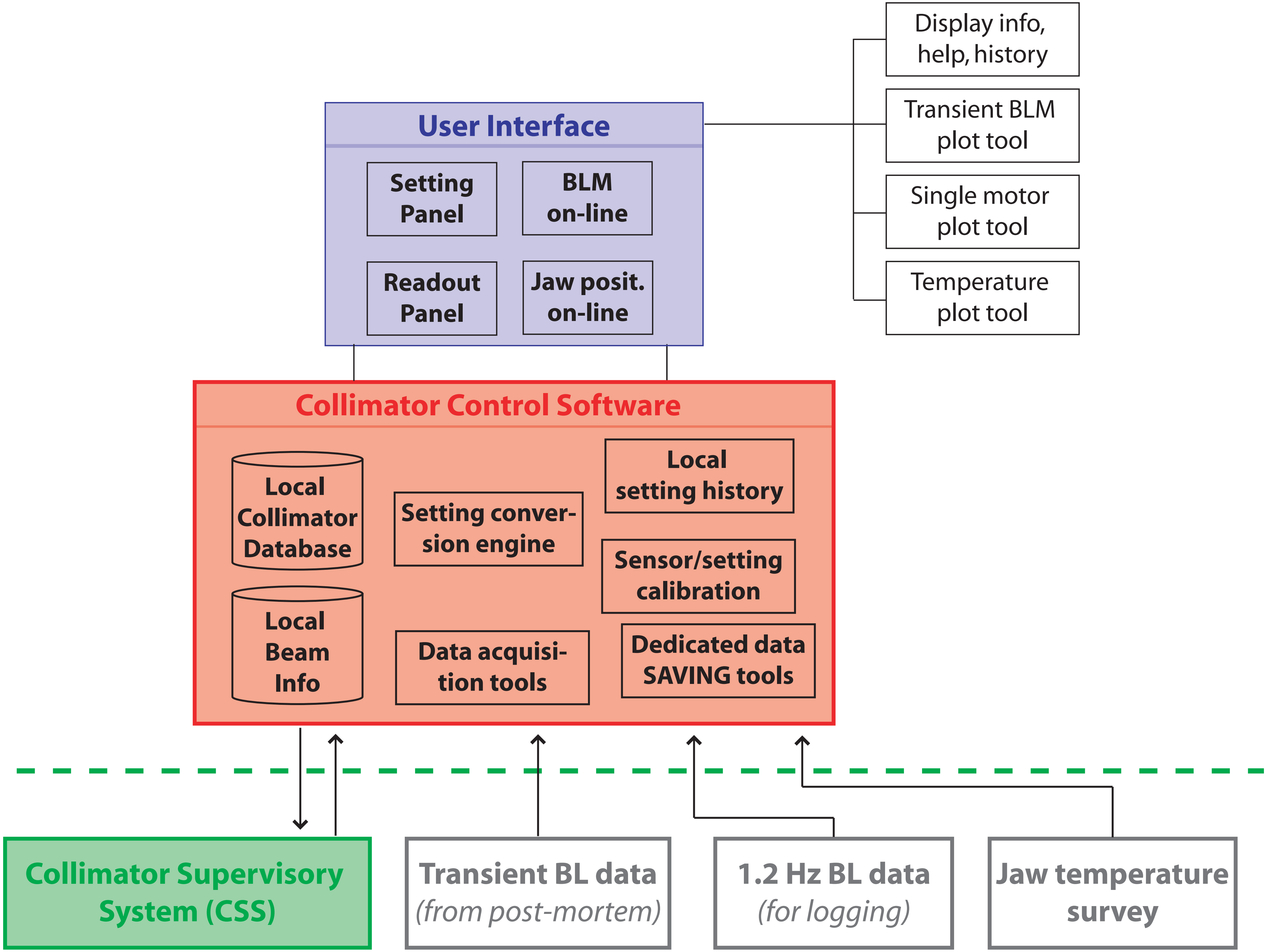
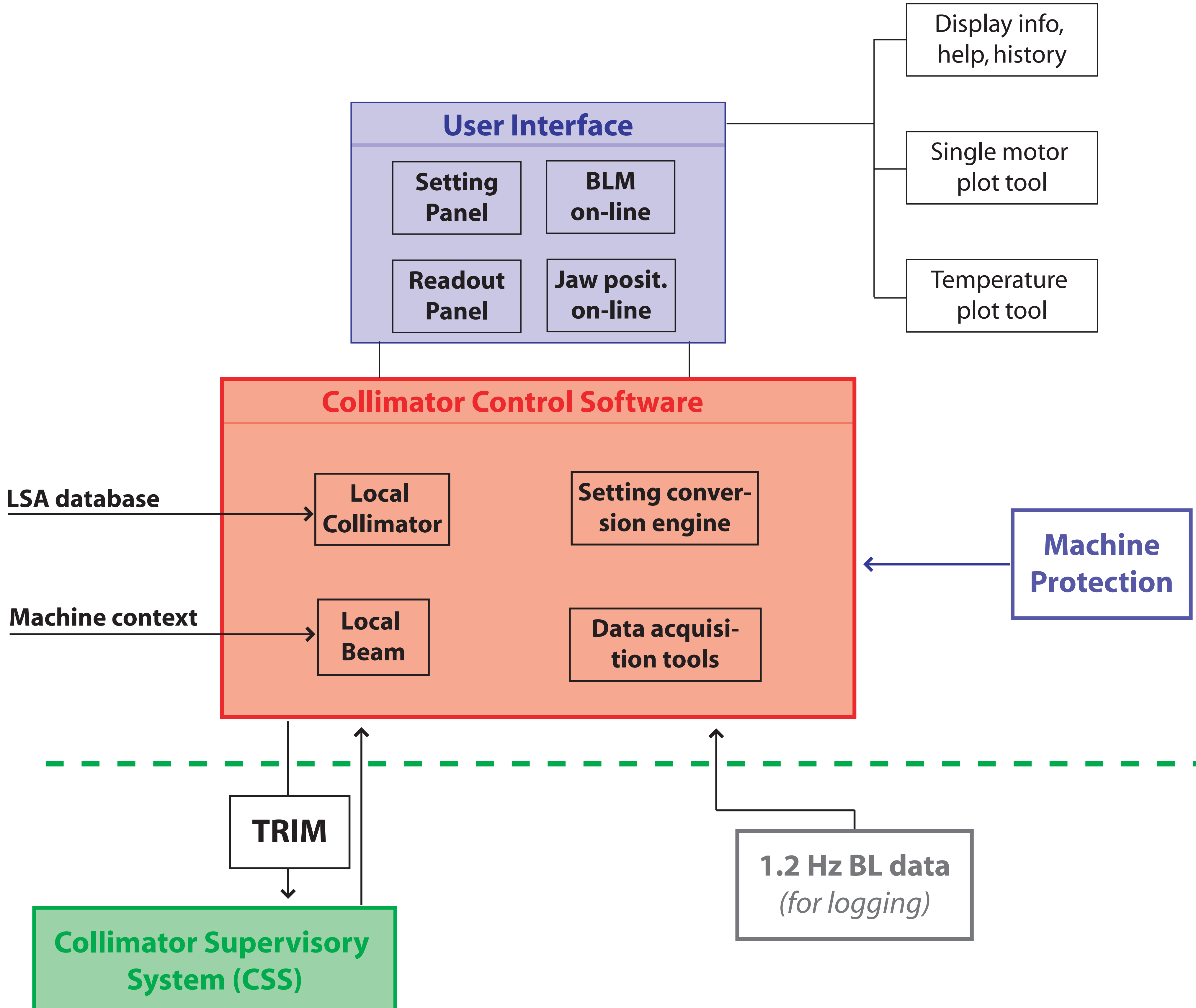


Final LHC implementation



Final LHC implementation

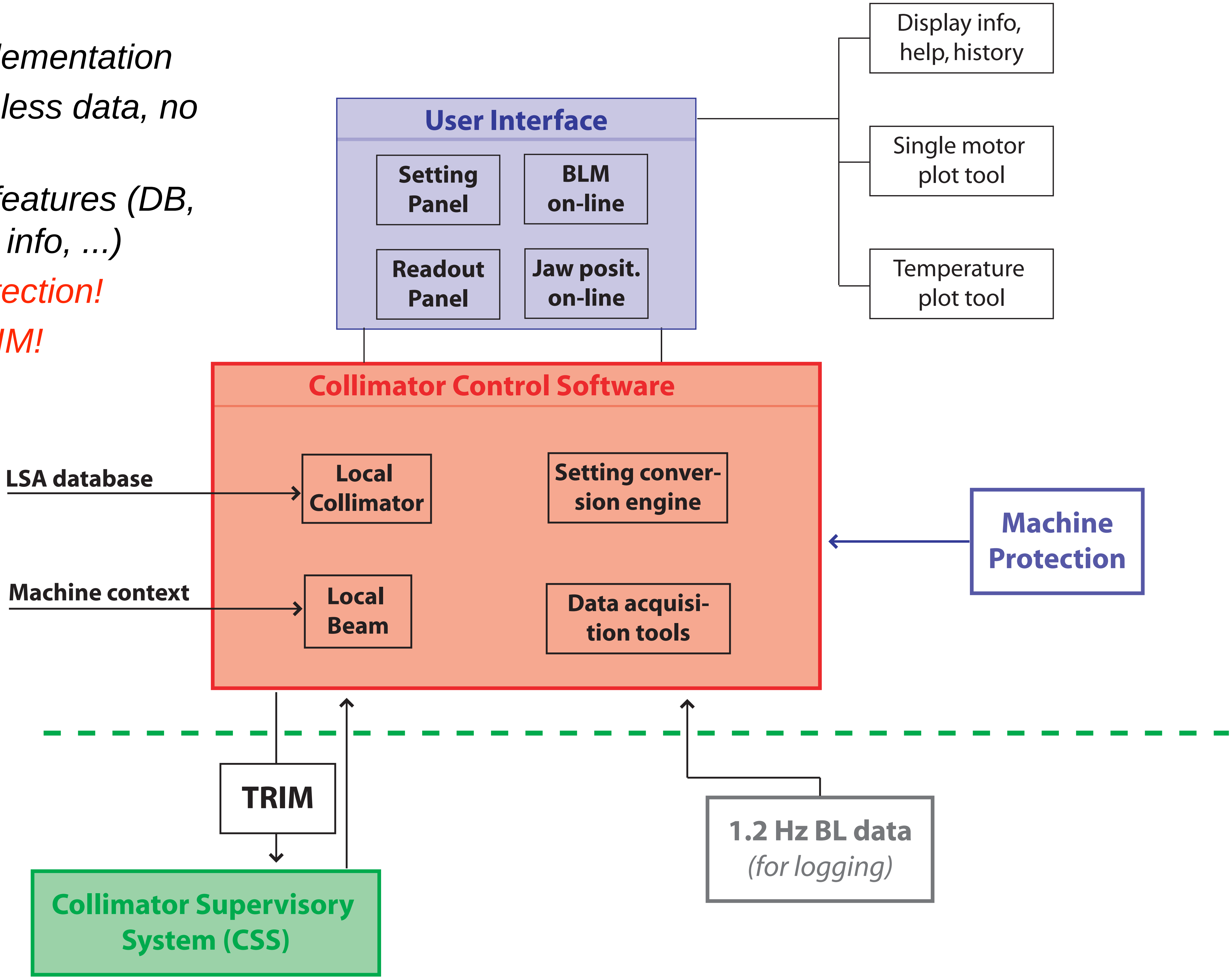
Slimmer implementation

Collection of less data, no data saving

Rely of LSA features (DB, optics, beam info, ...)

Machine protection!

Use LSA-TRIM!



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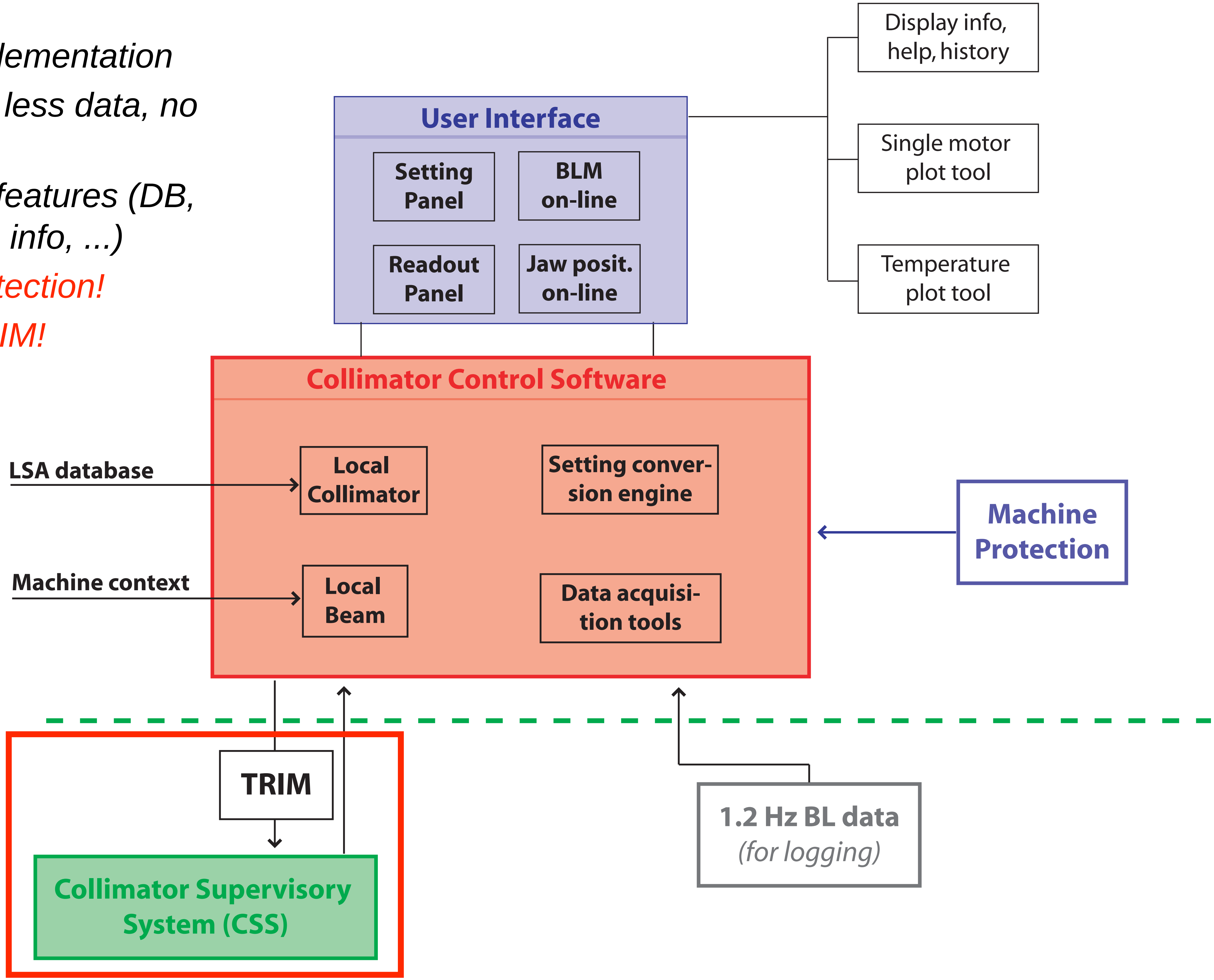
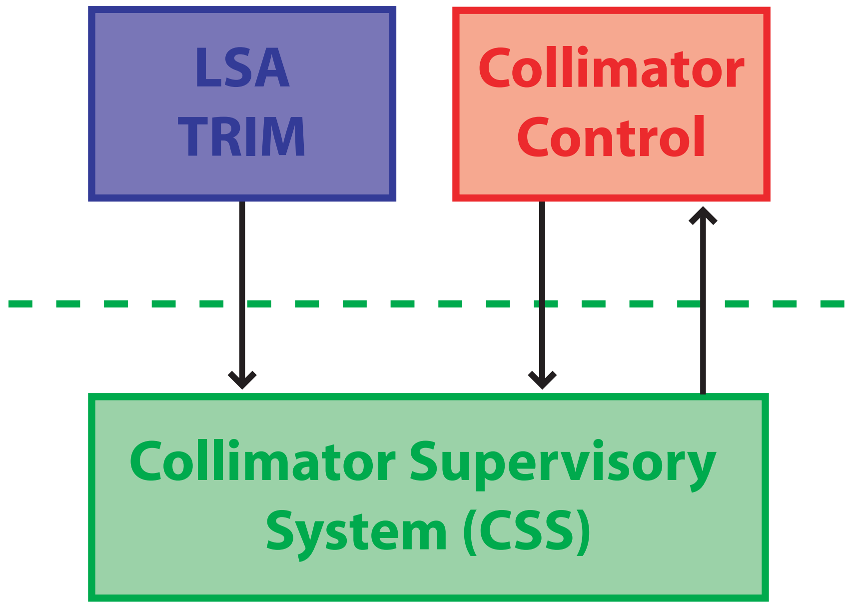


Interface to the LSA TRIM

SPS test 2006



- LSA TRIM → control FESA devices at the LHC
- It provides: traceability (setting history), function generation/editing within machine contexts, *MCS functionalities*!
- *Collimator control through TRIM was setup* !
- All the required infrastructure links were setup: LSA database, setting generation, drive-hardware, ...
  Thanks: D. Jacquet, M. Lamont, L. Normann. J. Wenninger
- Next step: call TRIM within our application (*TRIM-CLIENT*). *Basically there but not yet tested*
- Our setting philosophy compatible with TRIM: 4 absolute positions, conversions done at top level
- Potential issue of response time?

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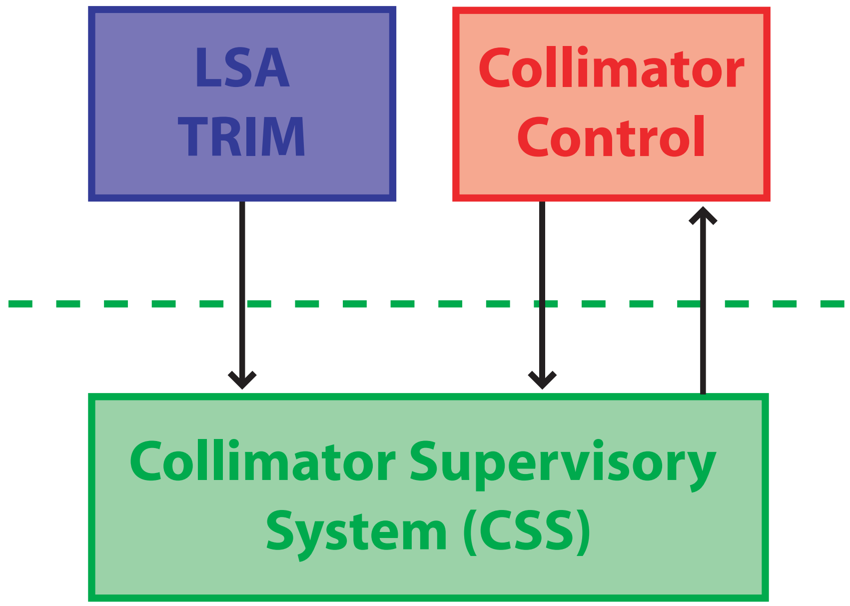

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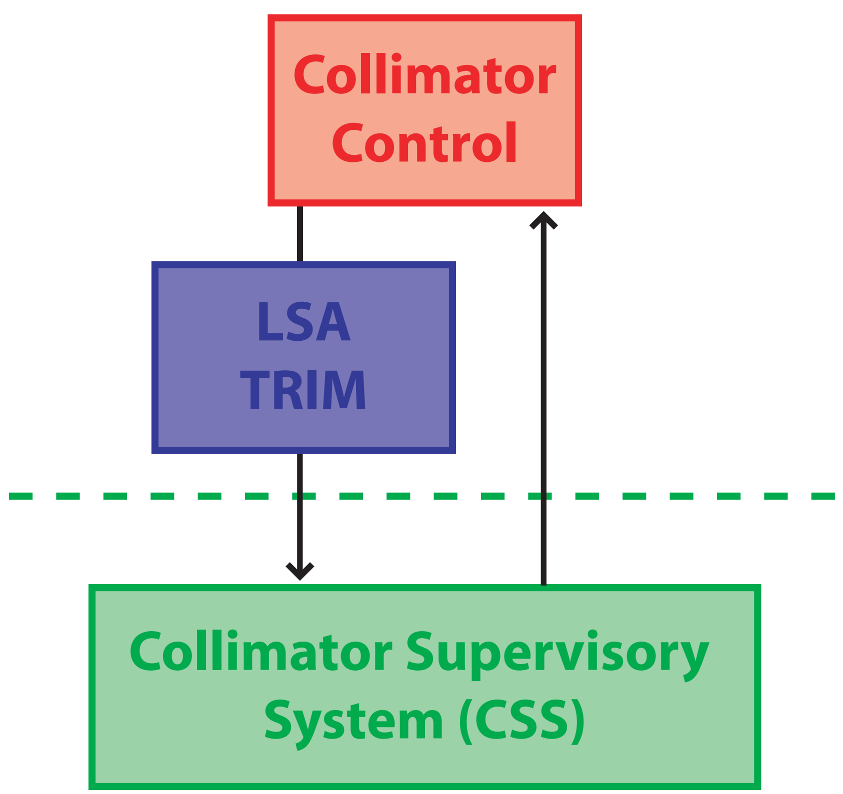

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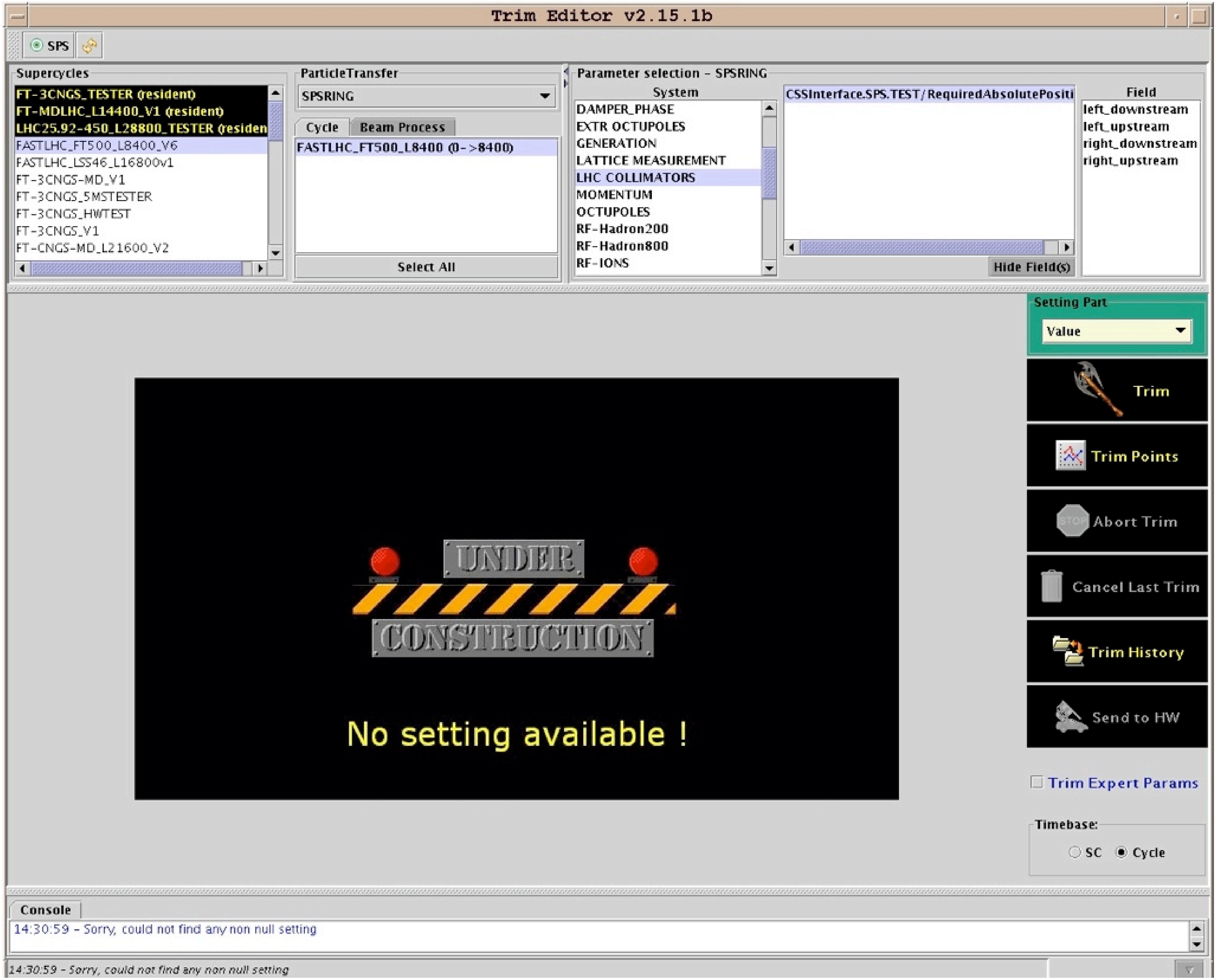
Snapshot of LSA TRIM with collimator settings



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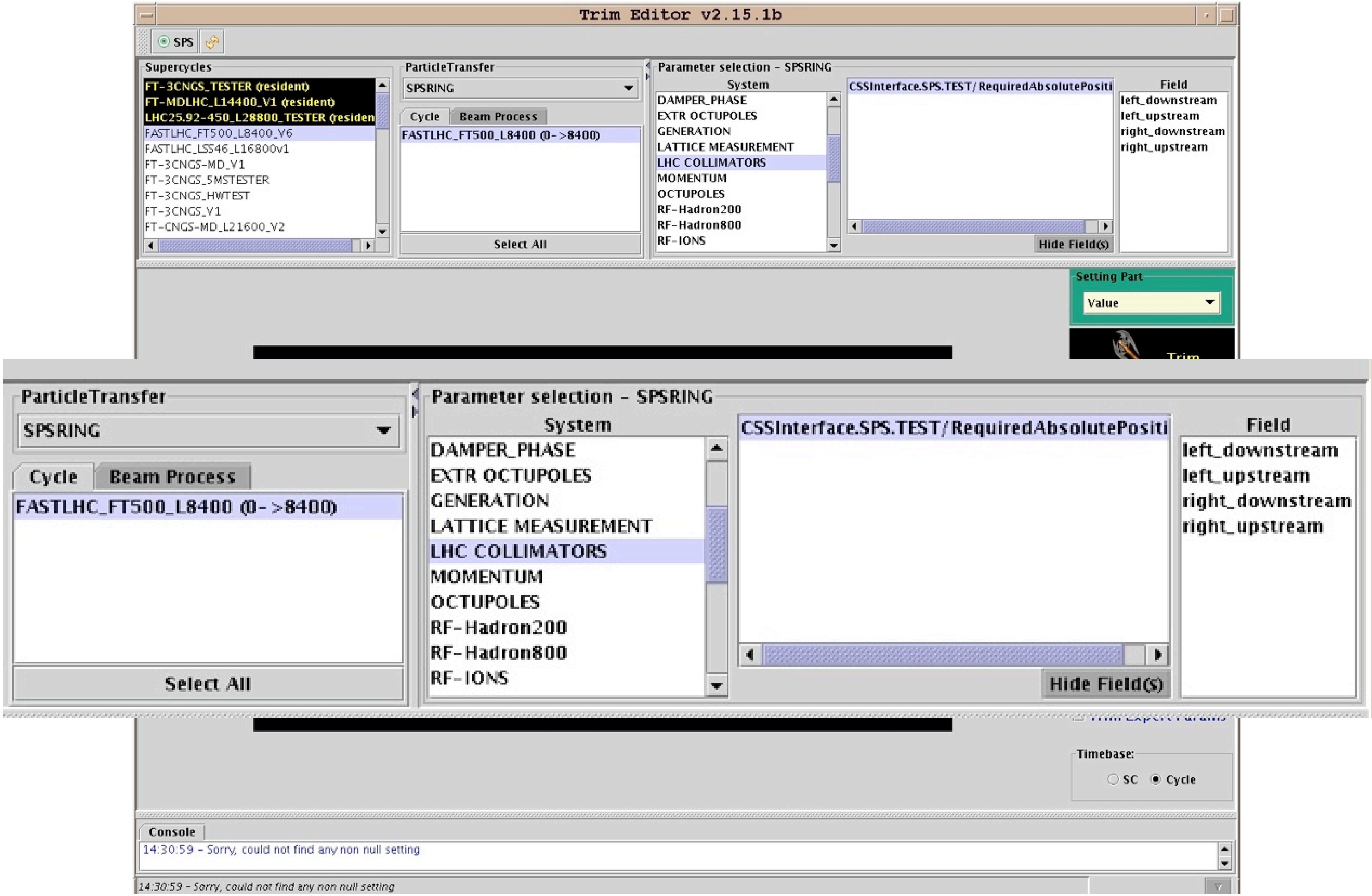

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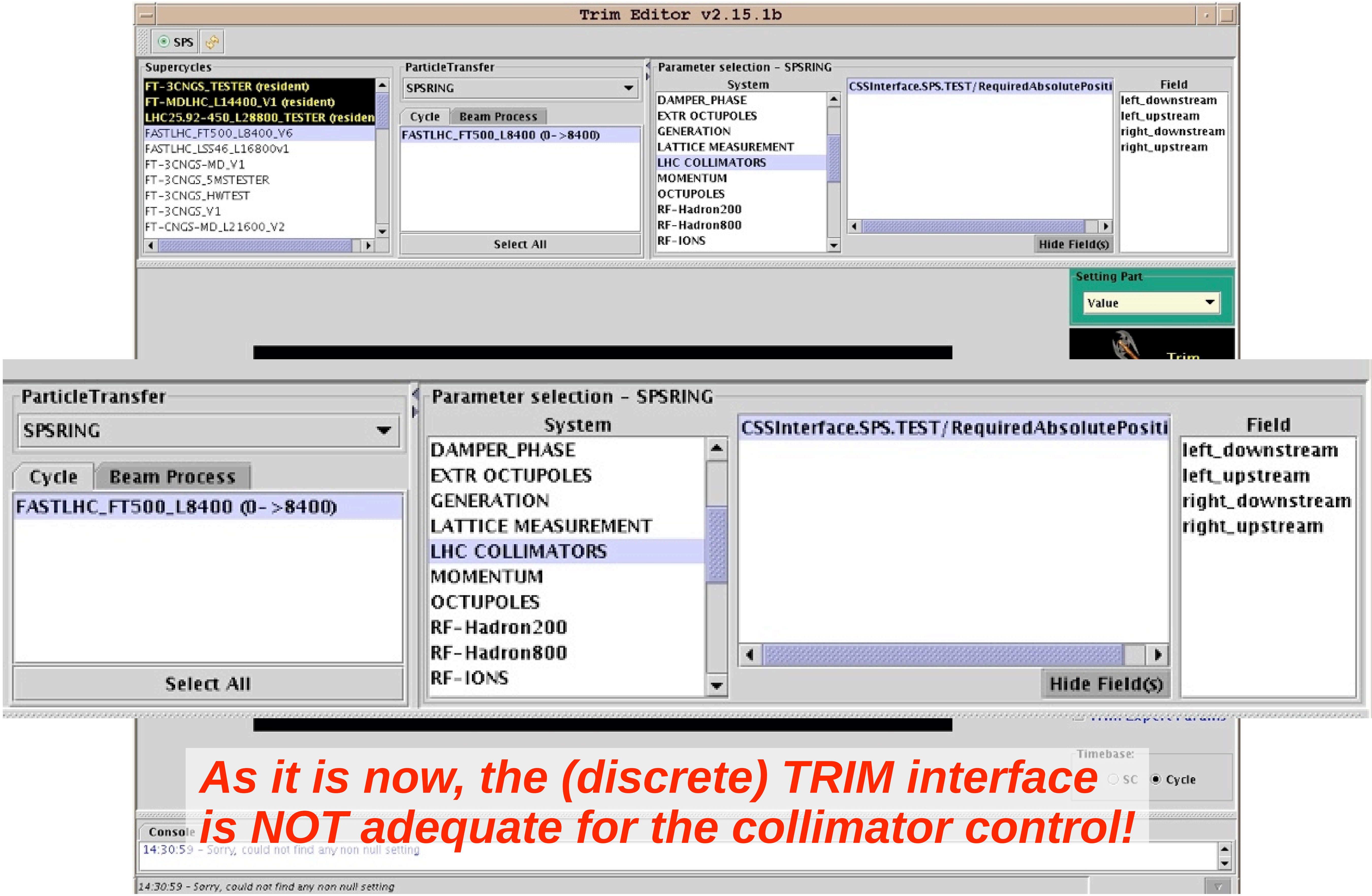

As it is now, the (discrete) TRIM interface is NOT adequate for the collimator control!

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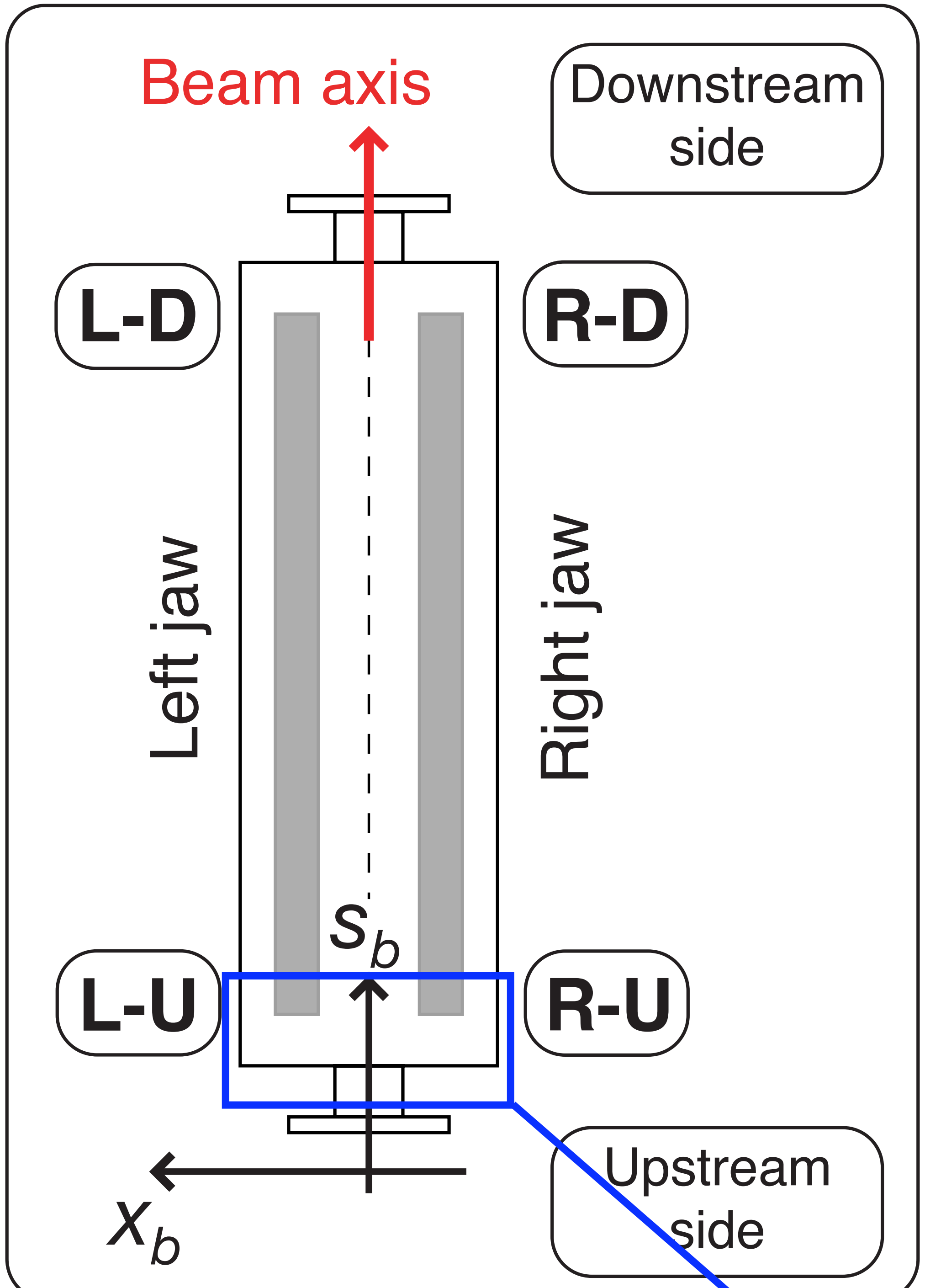
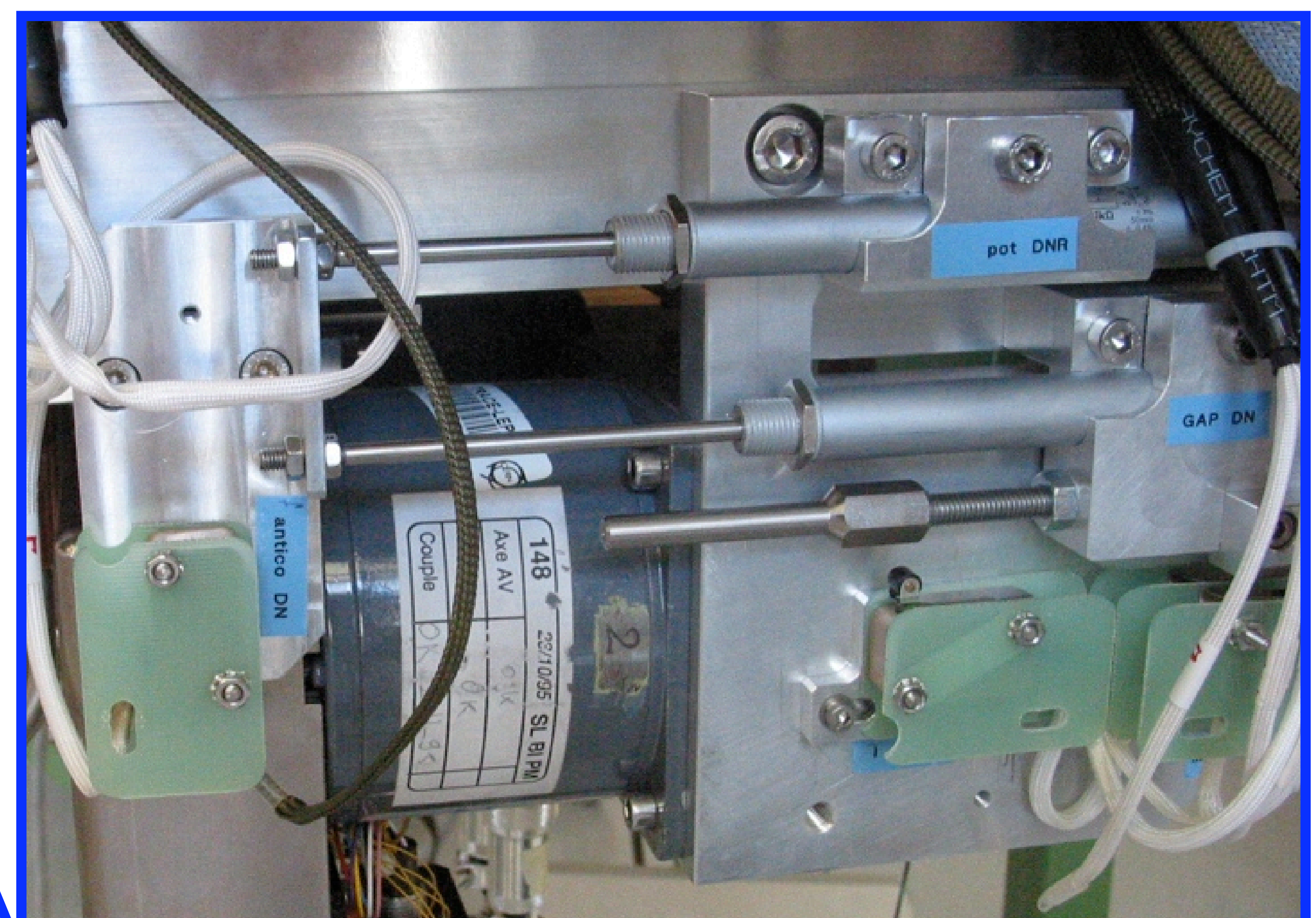
Reminder on collimator hardware



- 4 LEP stepping motors, one per jaw corner
- 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
- Switch positions are our *absolute reference*



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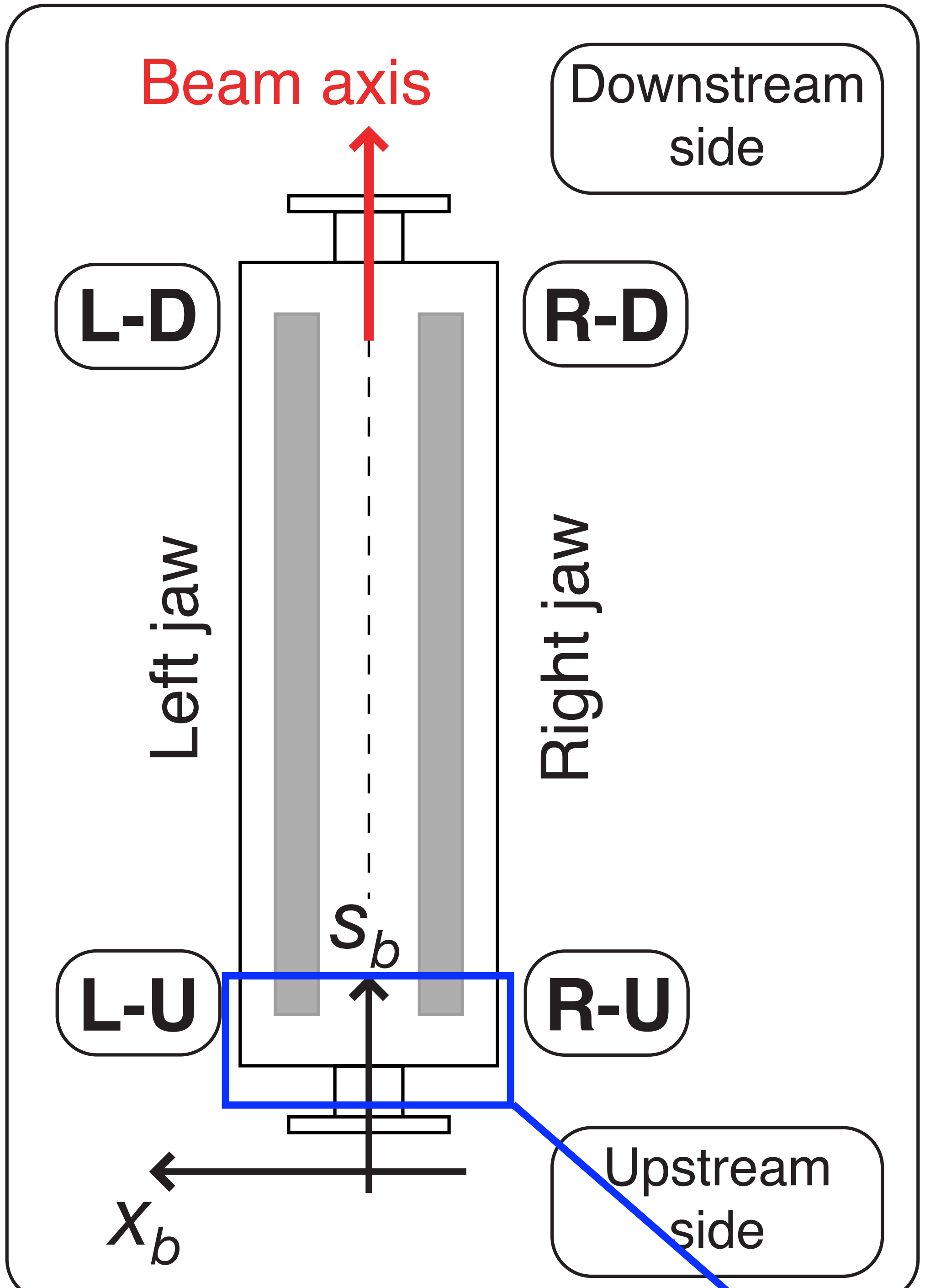

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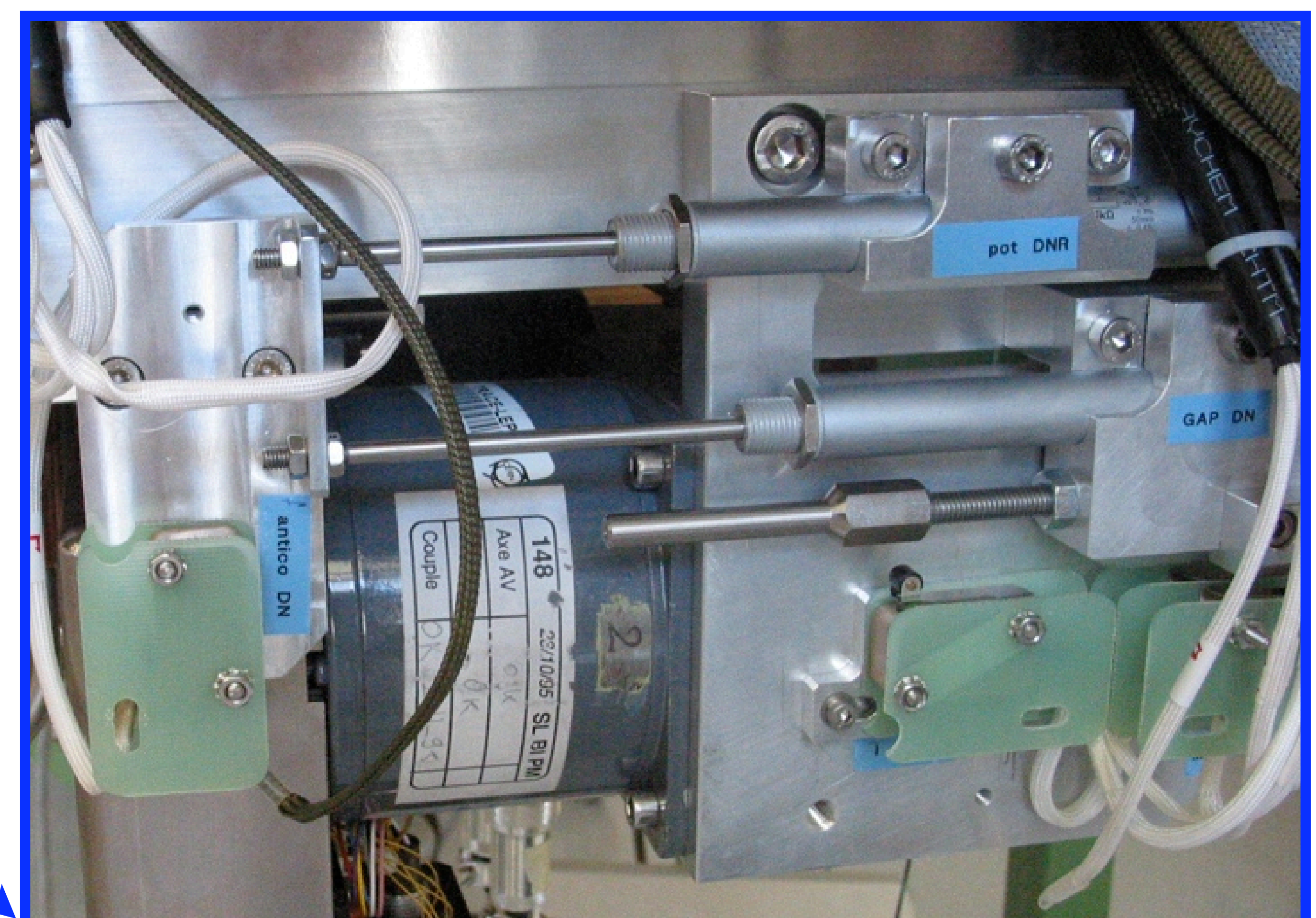
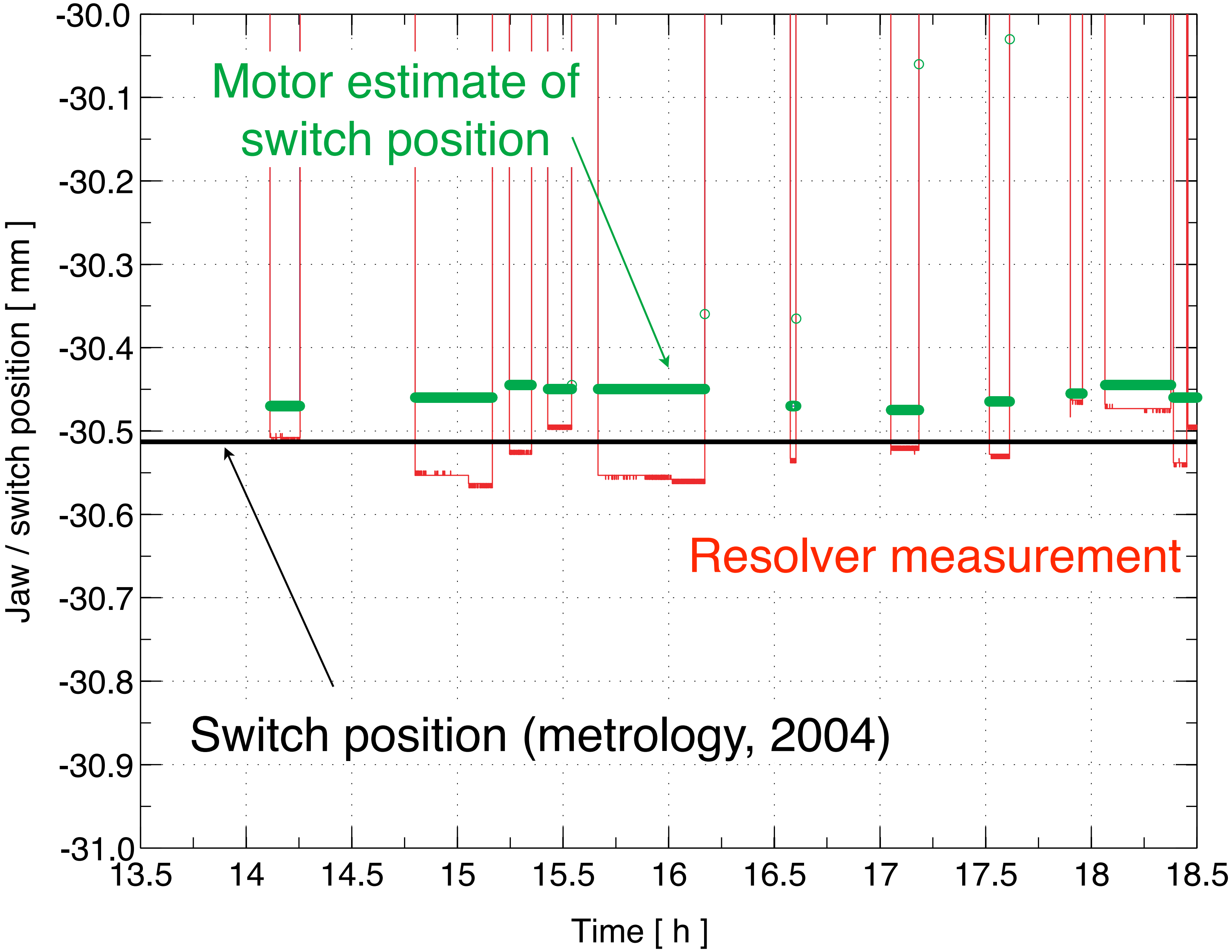
Different than the LHC hardware



Motors lost knowledge of absolute position



- Known to be a potential issue with LEP stepping motors.
  The count of motor steps does not provide direct jaw measurements - errors add up!
- Total error up to hundreds of microns
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- SPS data can be corrected off-line for detailed studies

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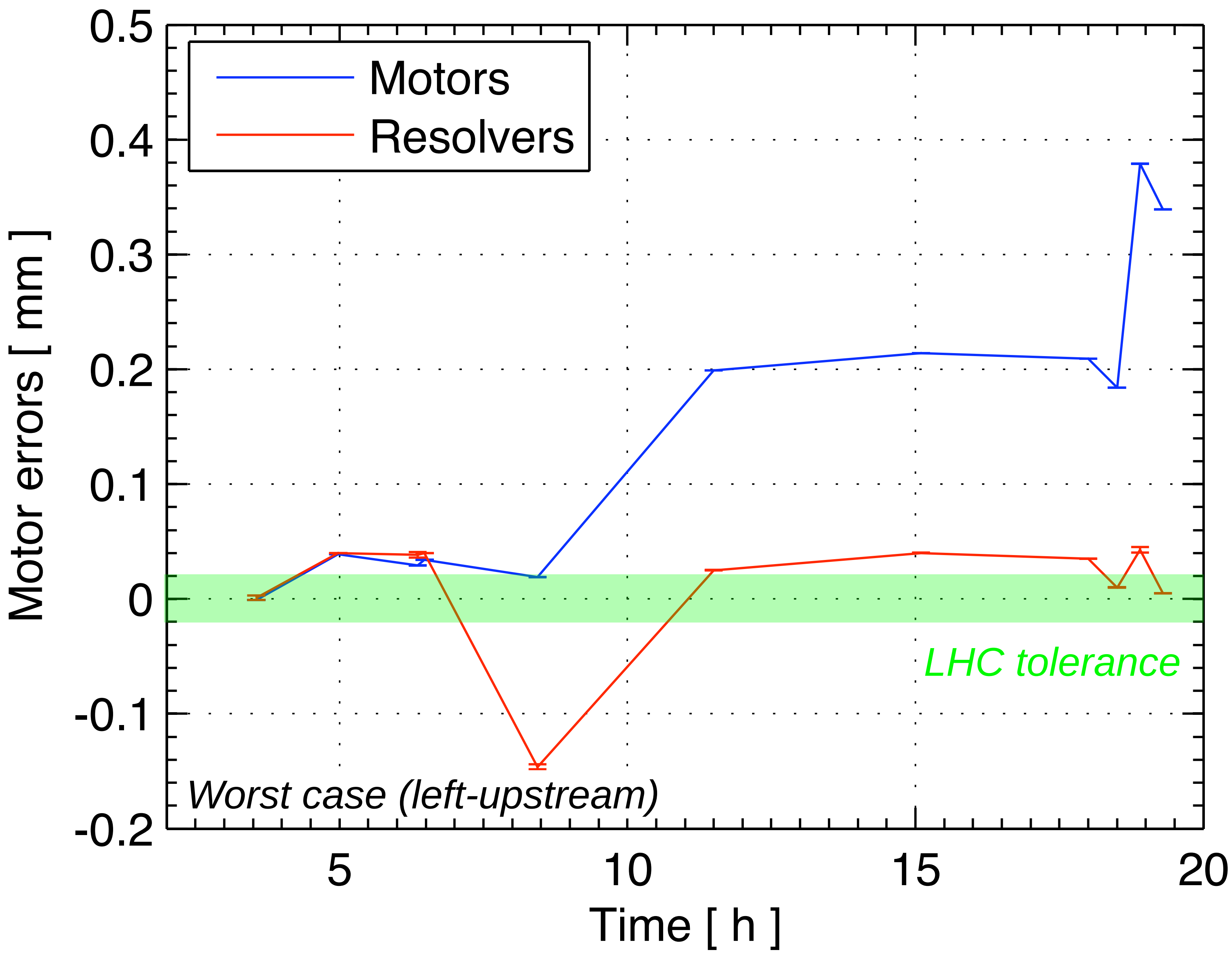

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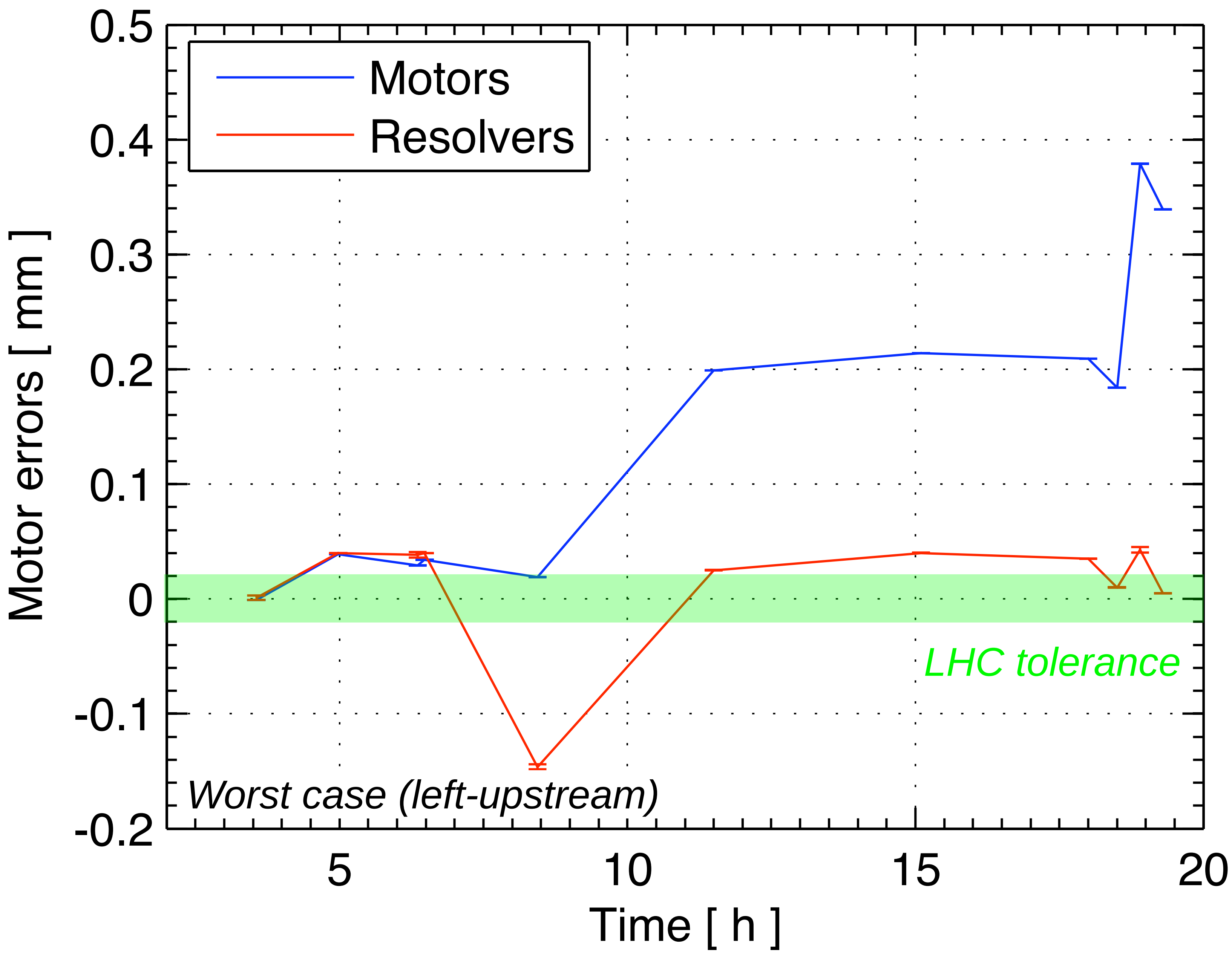

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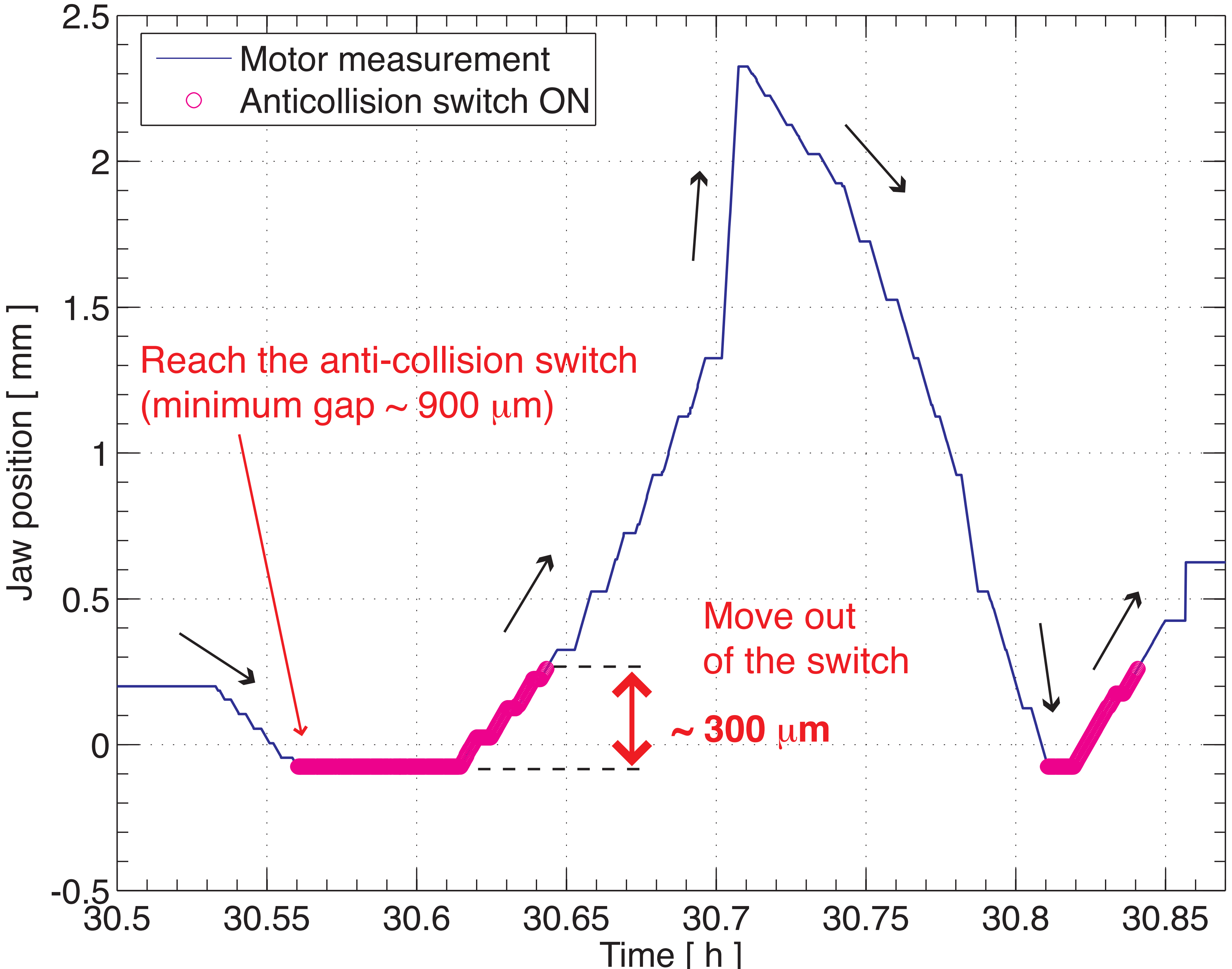
Solutions for the LHC are implemented:

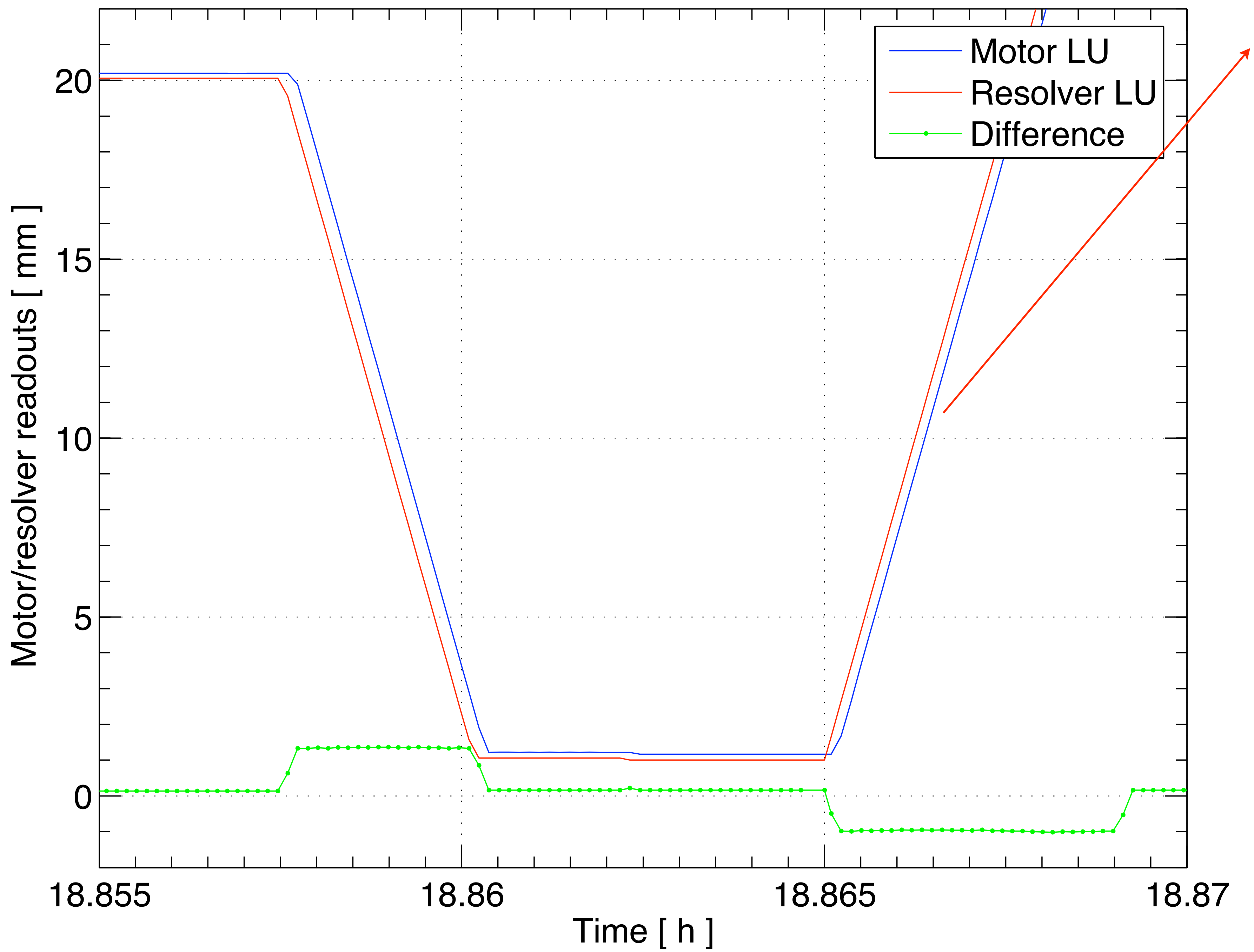
- New motors are much better! (proven by TT40 test, see Roberto's talk)
- Precise position sensors will detect the error. *Do not rely on switch positions*
- In the software: implement the feature of "update motor settings"

Switch performance



Measurements only possible thanks to the new controls! We did not see that feature in 2004!

Time delays between acquisitions



We measured delays of ~1s delay between different sensors!

1 s at 2mm/s: Δ ≈ 2mm

LHC tolerance: 20 μm

Time shift changes in time!

Not a big issue for the BB alignment on-line.

Source of these delays needs to be understood!

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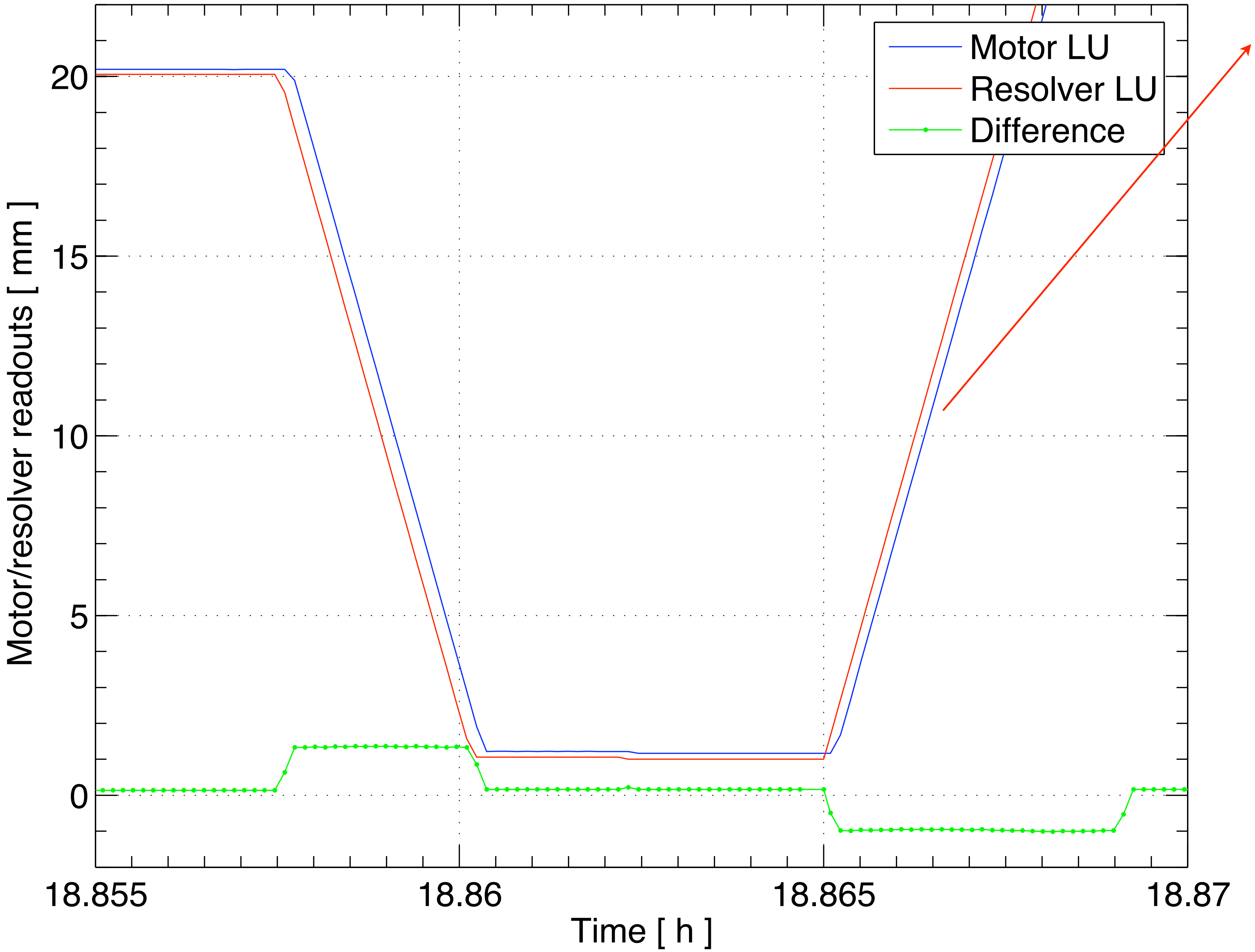

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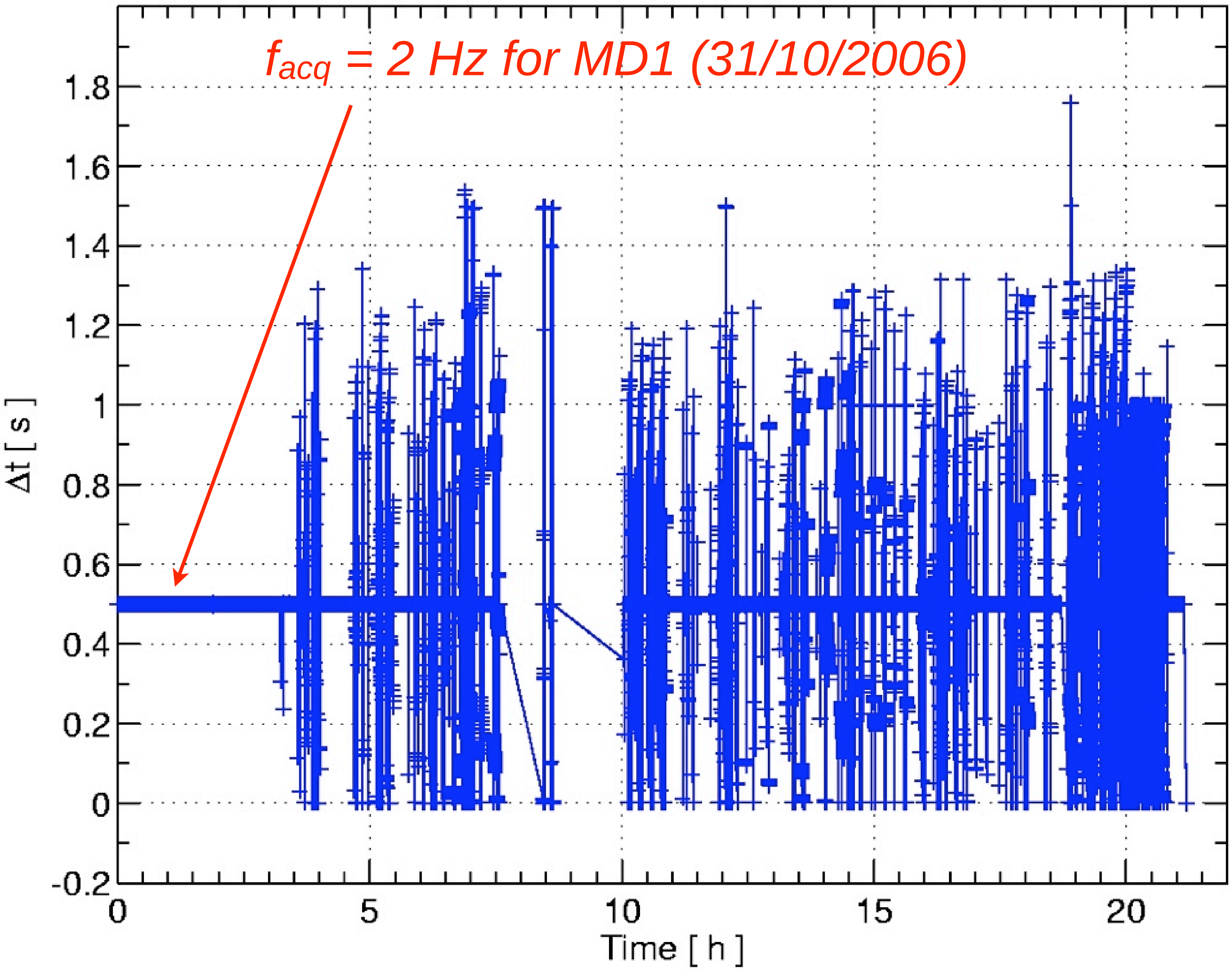
Solution for the LHC:

- Time-stamp the data at the low-level!

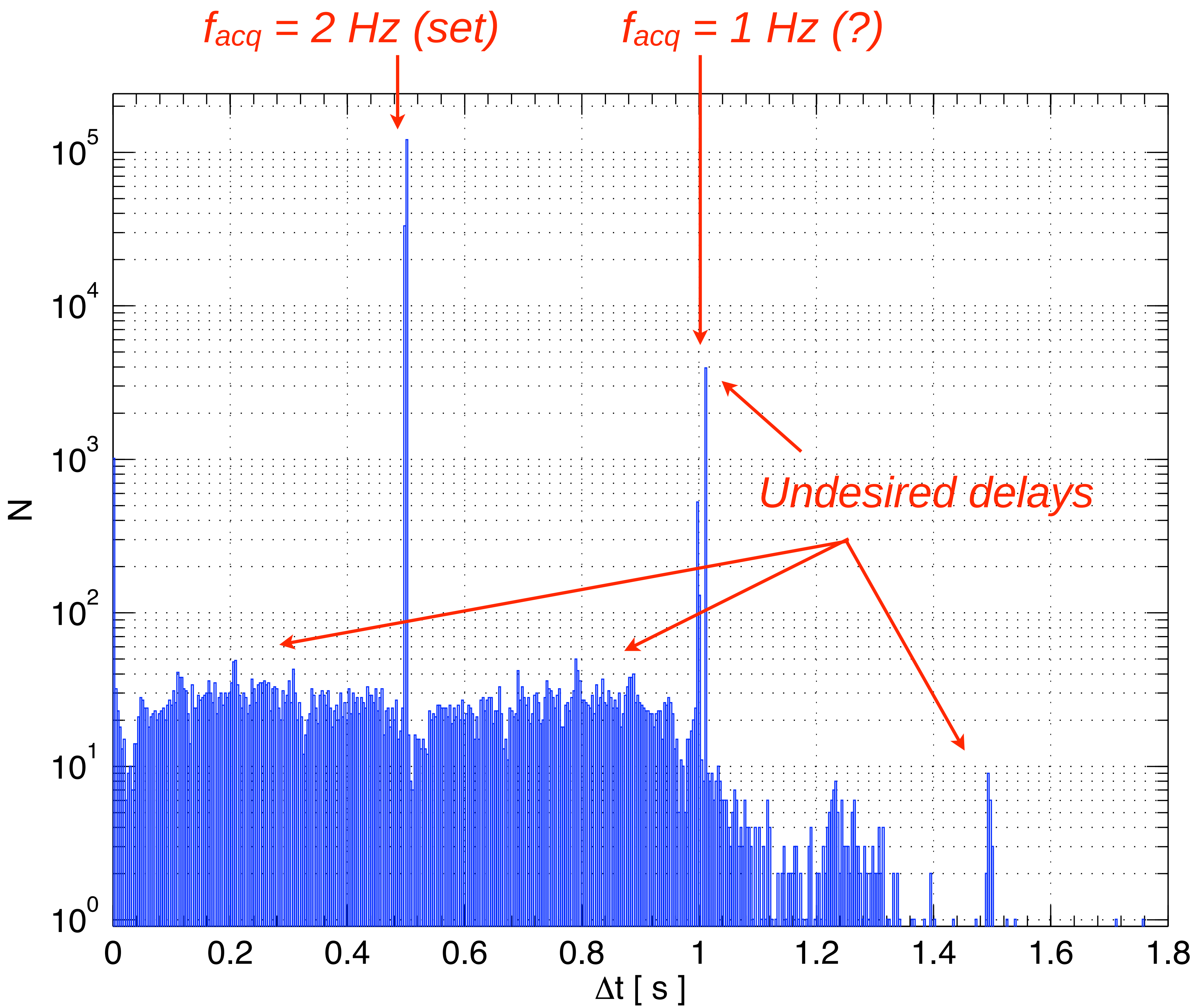
Delay between consecutive acquisitions



During the MD, the position measurements published by the middle-level showed time shifts with respect to the nominal f_{acq}

We found a correlation with the frequency of setting requests (work load of middle level)!

Statistics of time delays



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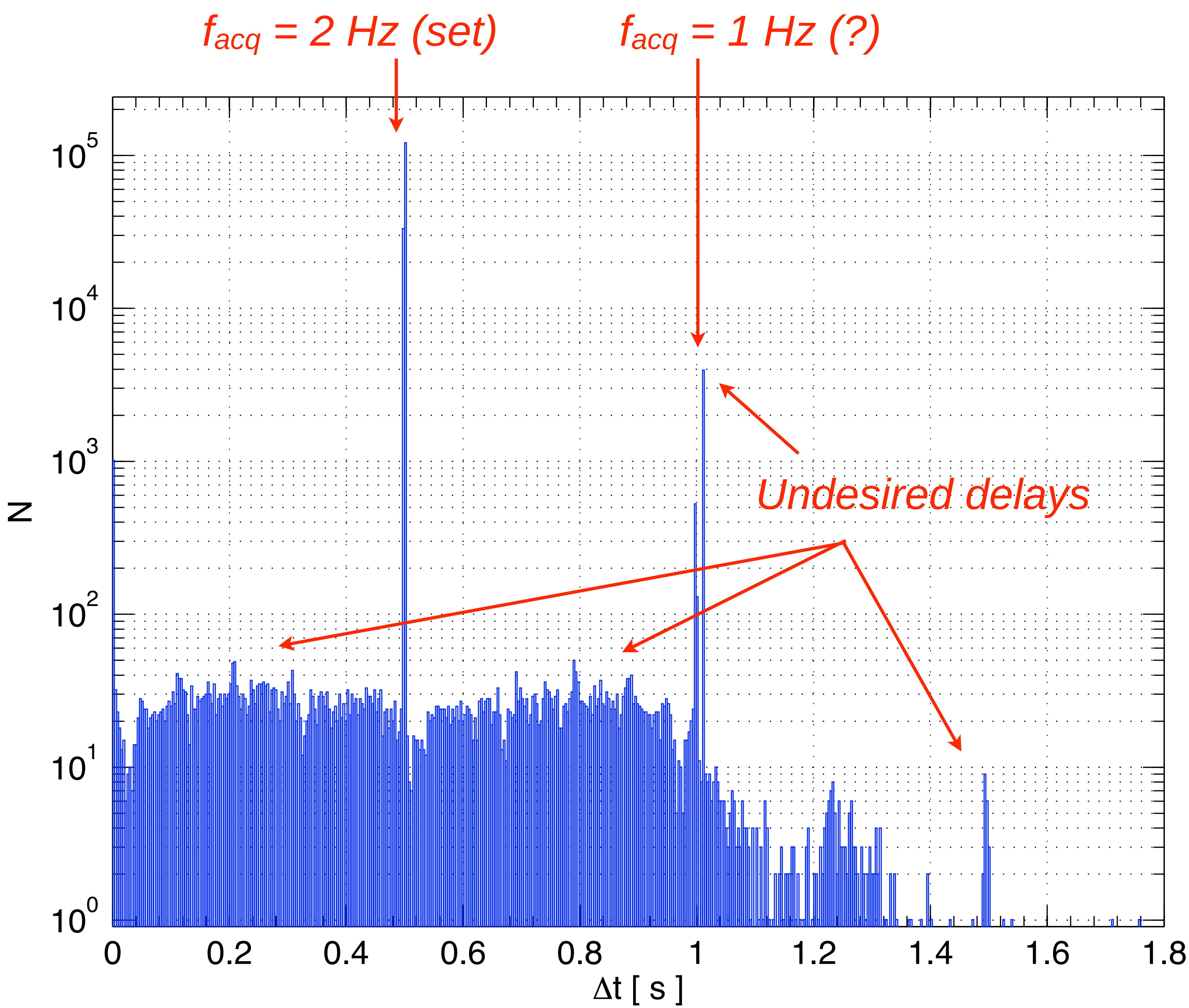
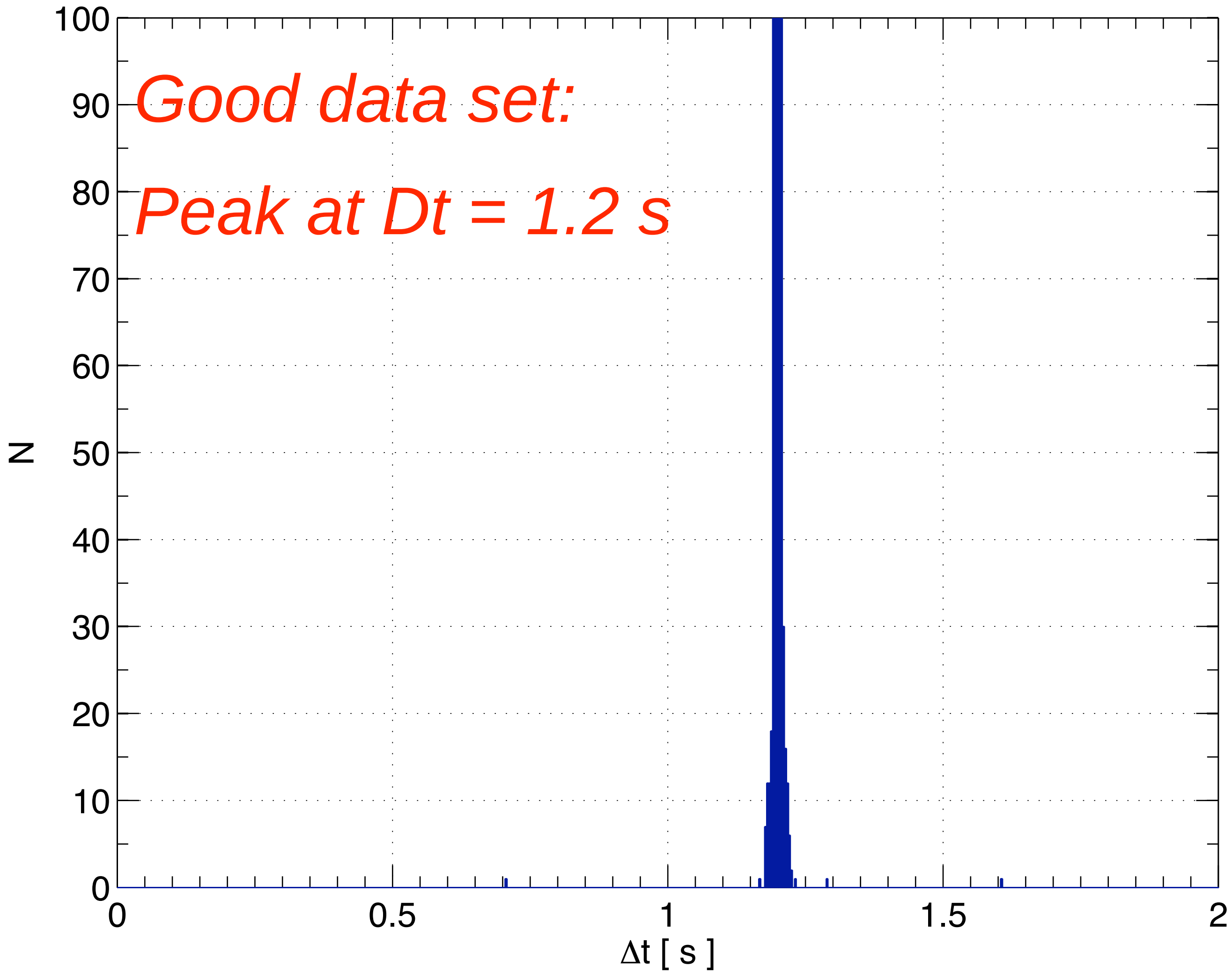


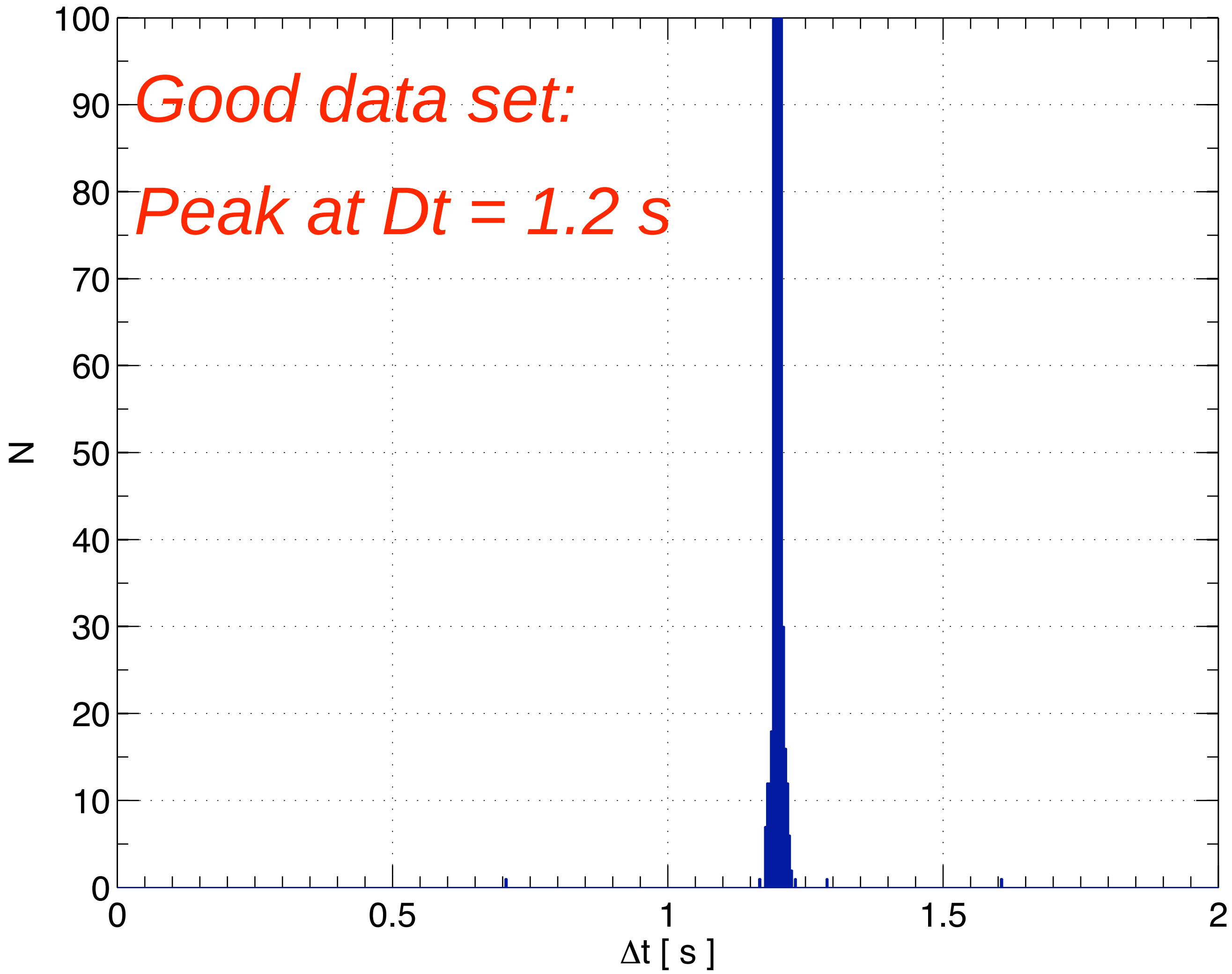
No significant impact on the on-line display for BB alignment

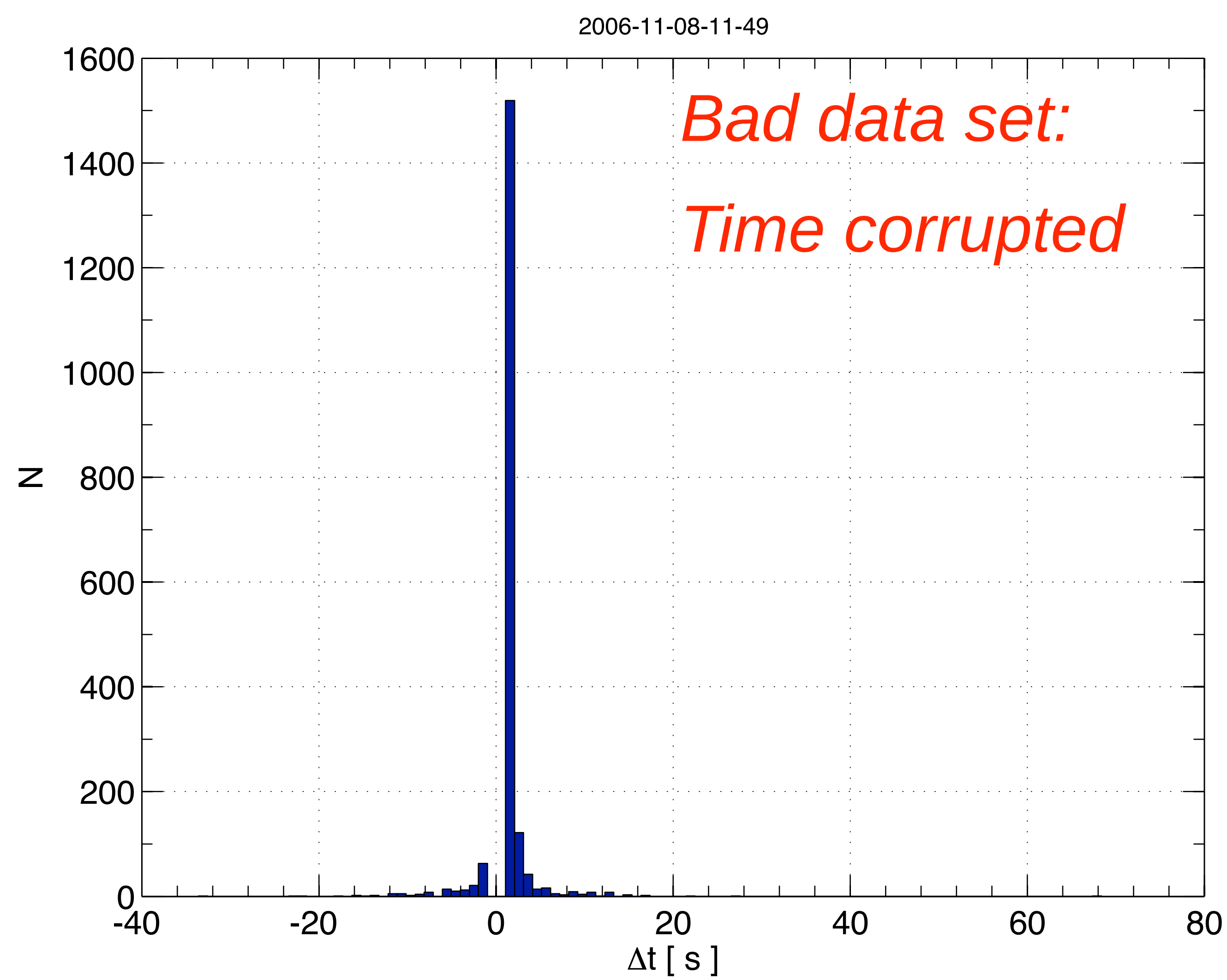
Need to be improved detailed off-line studies at the LHC!!

Time delays for BLM acquisition

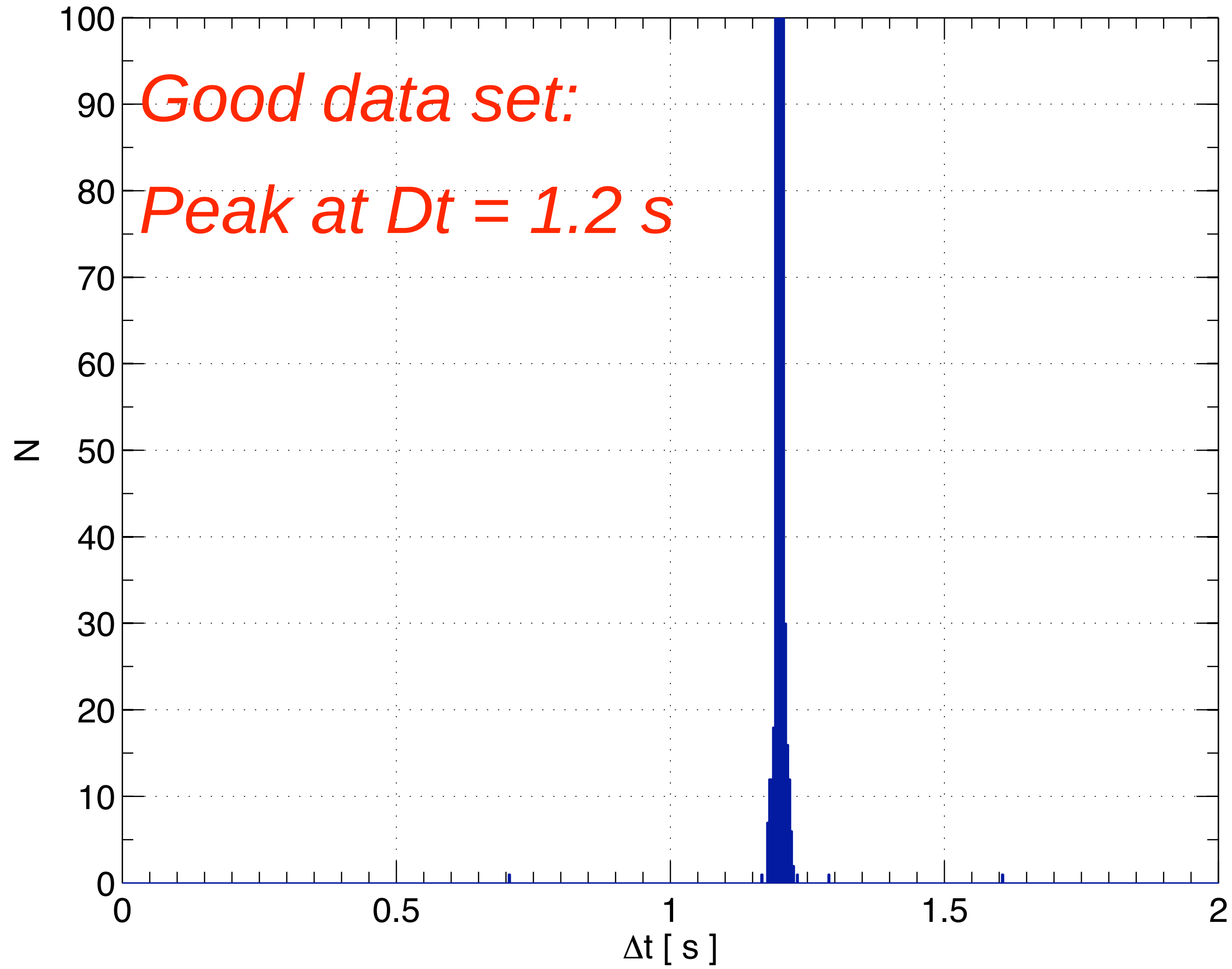


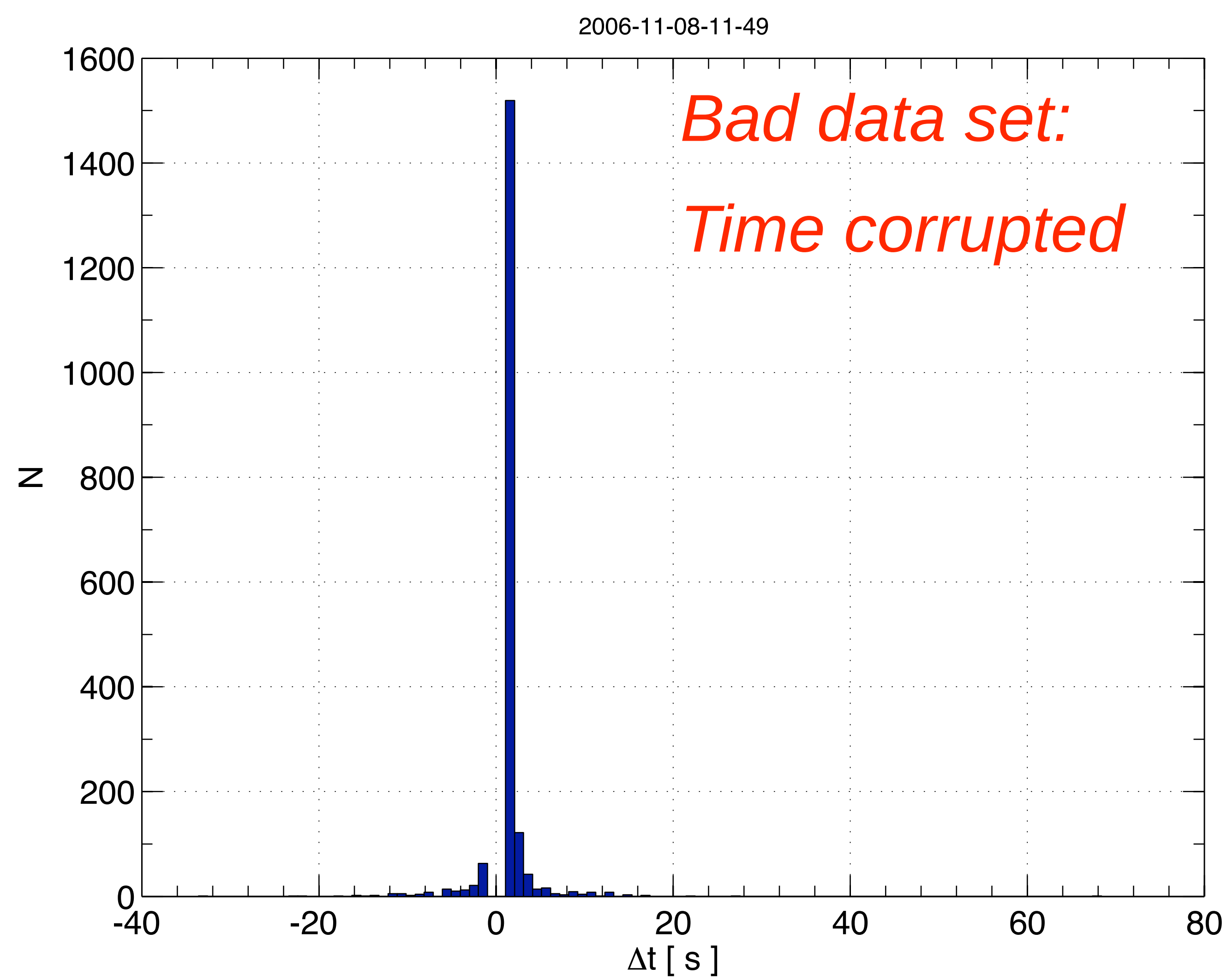
Time delays for BLM acquisition





Time delays for BLM acquisition



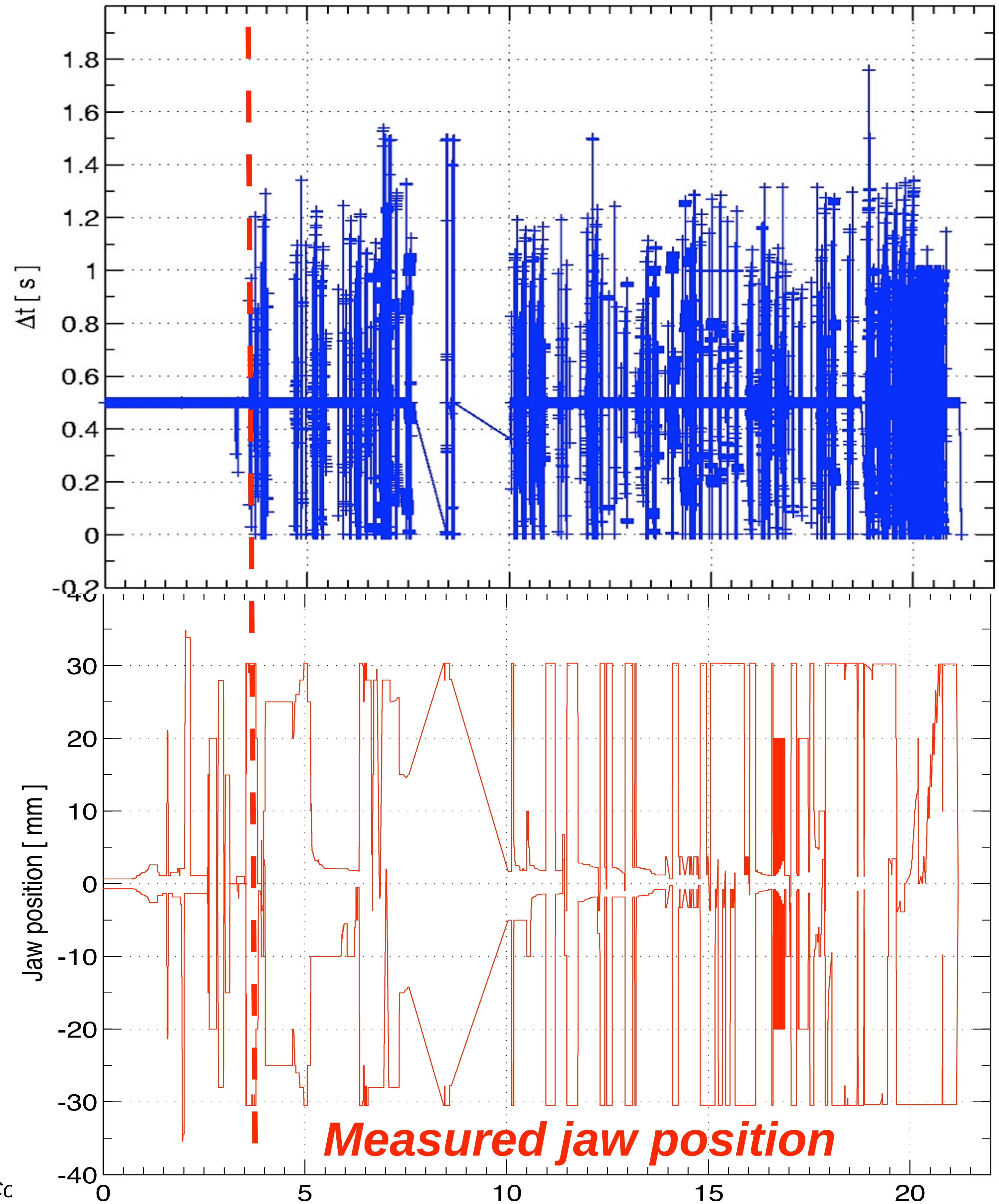


Problem under investigation with BLM team . . .

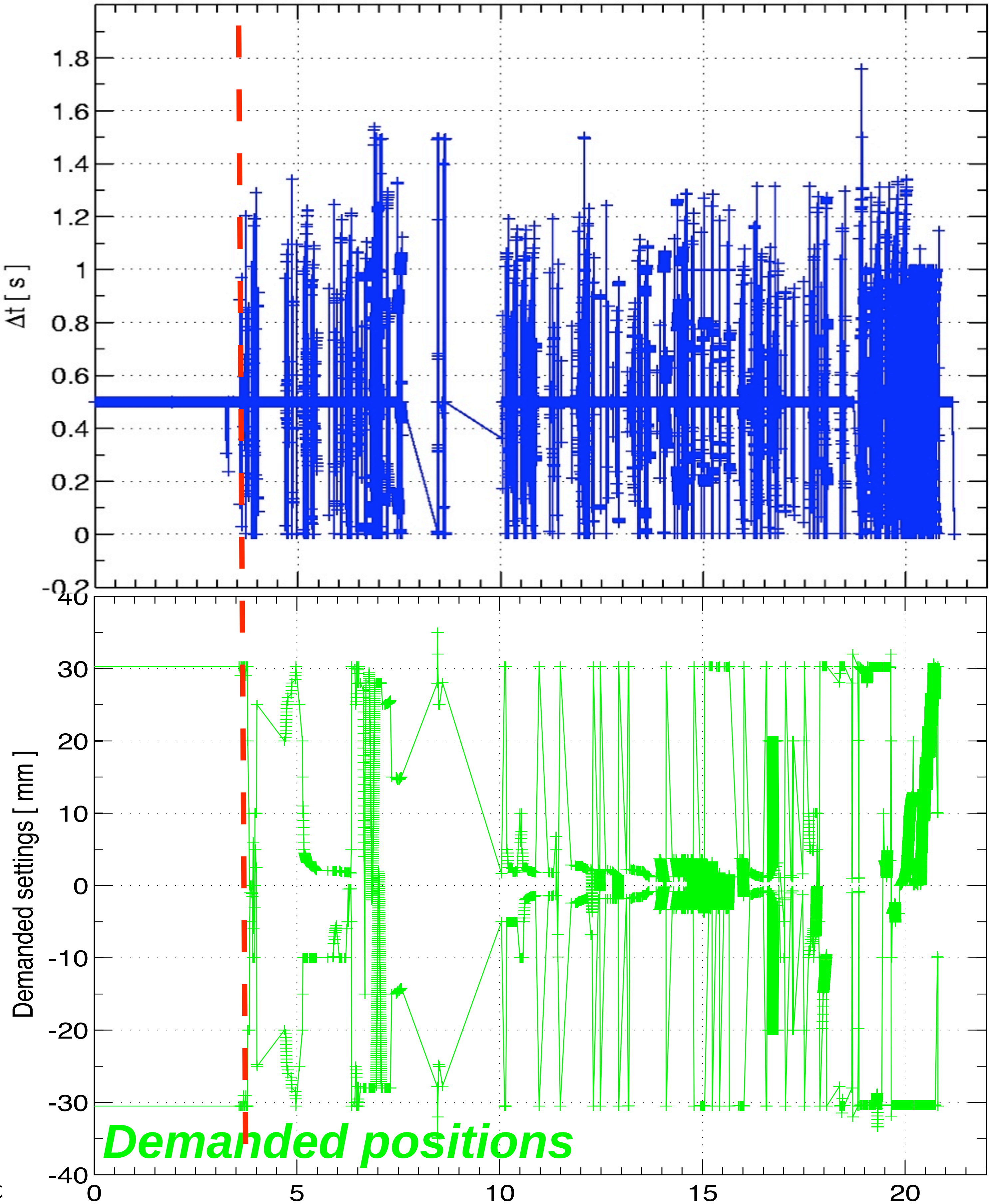
Conclusions

- SPS beam tests provided important validation of our critical choices for the collimator top-level control
  - *First successful implementation within FESA/LSA environments*
- Single collimator control basically ready for the LHC
- Collimator control through the LSA-TRIM also tested. Further investigations of its performance are required
- We collected a significant amount of useful data
- What we have learnt:
  - *Performance limitations of top level - under investigation*
  - *Synchronization/timing can be an issue, mainly for off-line analyses*
- The hardware of SPS prototype not good enough for LHC
  - *Motor settings lost accuracy and we could not easily detect it*
- Setup a test bench with final hardware for systematic performance checks within final controls environment

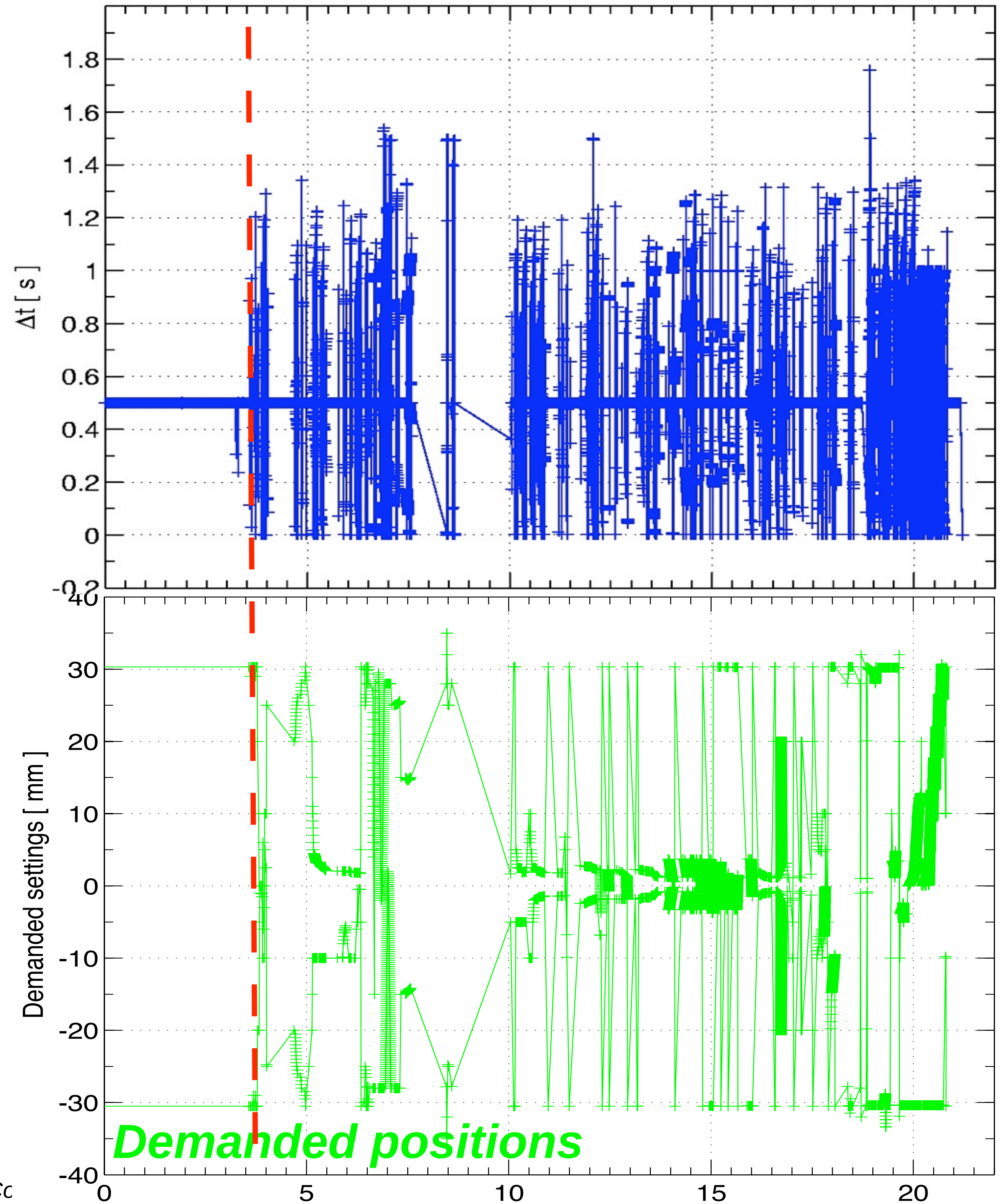
Delay between consecutive acquisitions



Delay between consecutive acquisitions

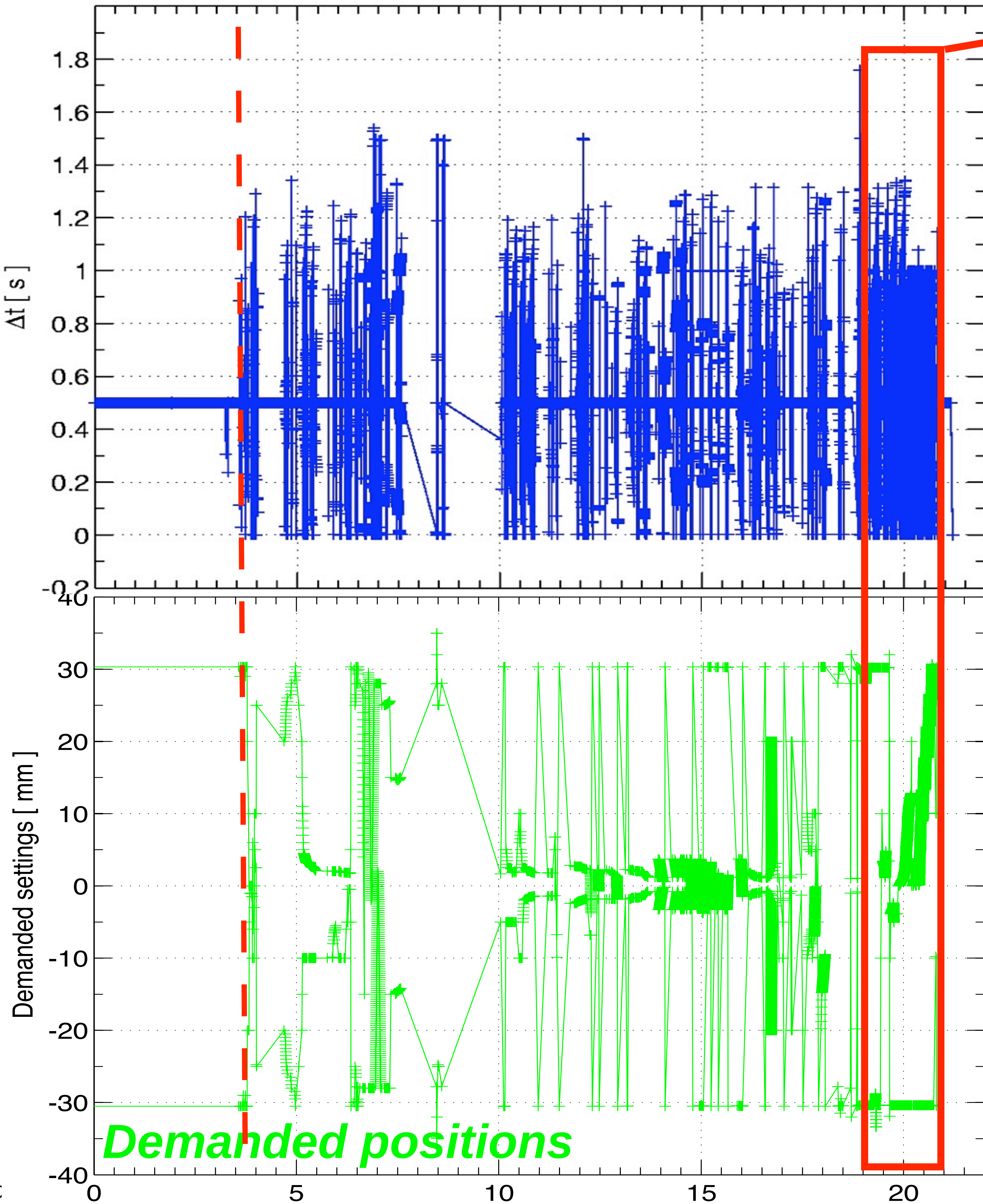


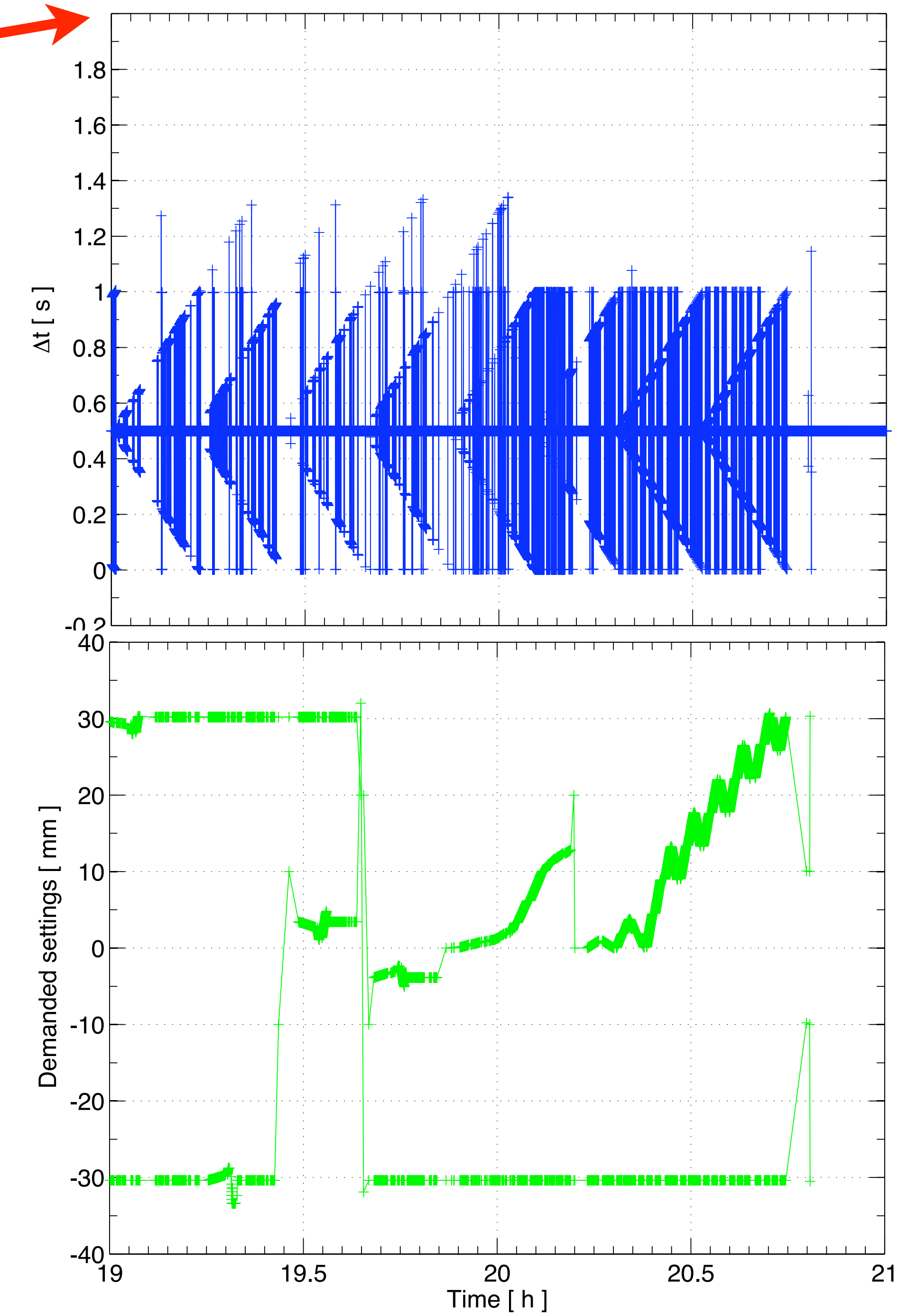
Delay between consecutive acquisitions



Different time response is induced by the work-load on the low level to process the demanded positions!

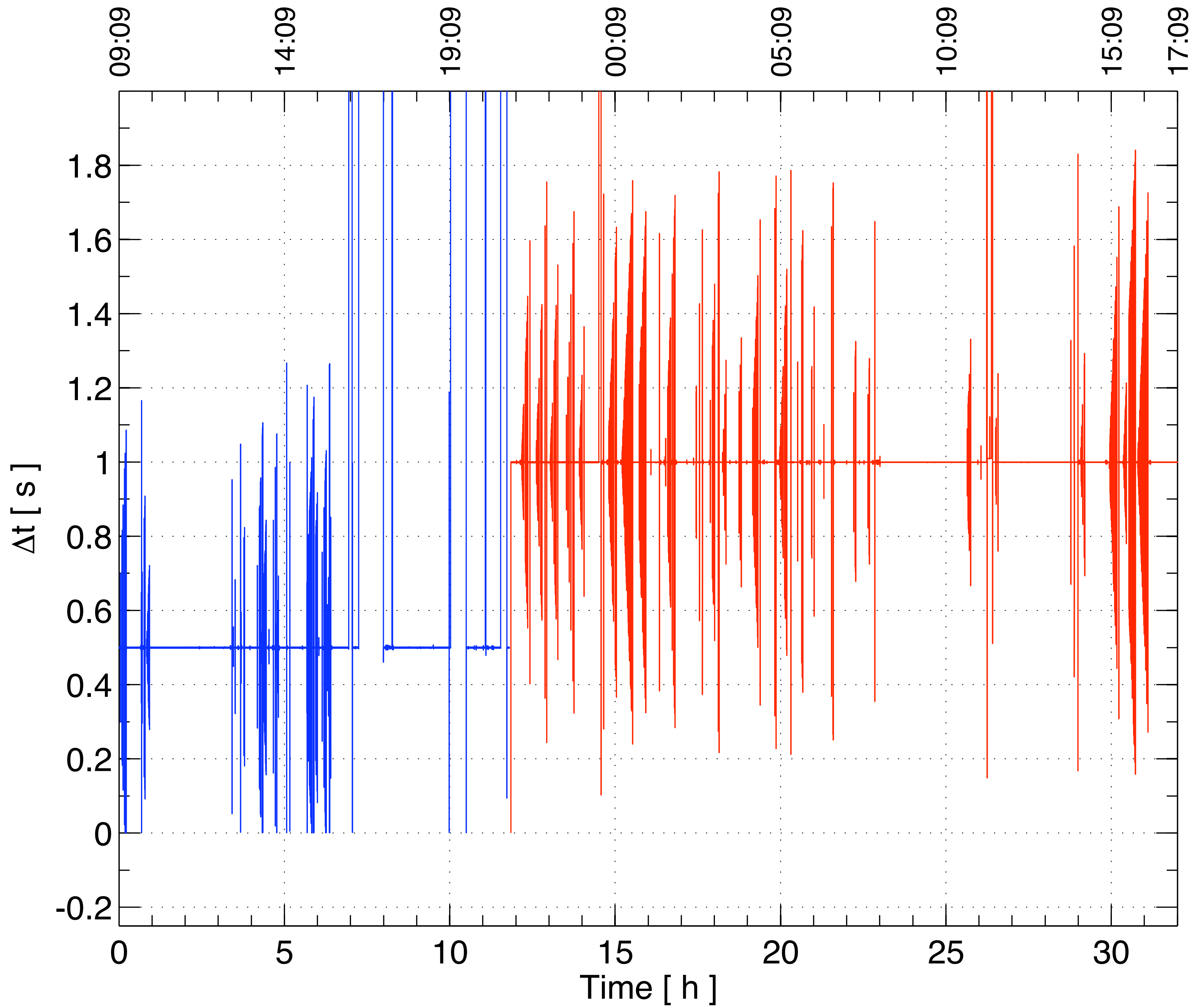
Delay between consecutive acquisitions





Different time response is induced by the work-load on the low level to process the demanded positions!

Time issues



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