Improvements of the ALFA and TOTEM Roman Pot Movement System in TS1

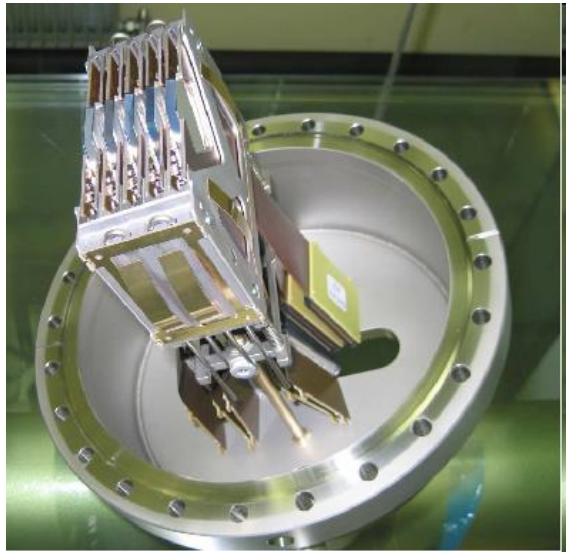
Mario Deile

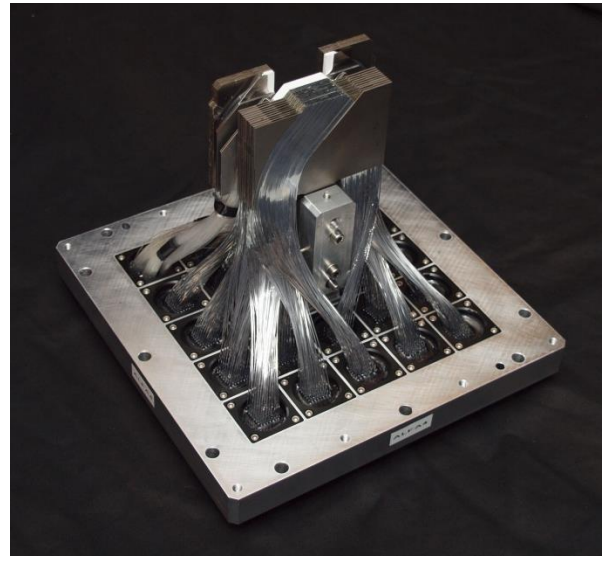
with input from P. Fassnacht, S. Jakobsen, J. Kaspar, S. Ravat

for the

TOTEM and ALFA Teams

27 April 2012





The Problem with Very Small Steps

Despite all the tests after the winter activities, one detail was missed:

Movement steps < 30 μm not correctly executed

[although steps ≥ 30 μm perfect within system precision of 5 μm]

Requested: sequence of 20 μm movements

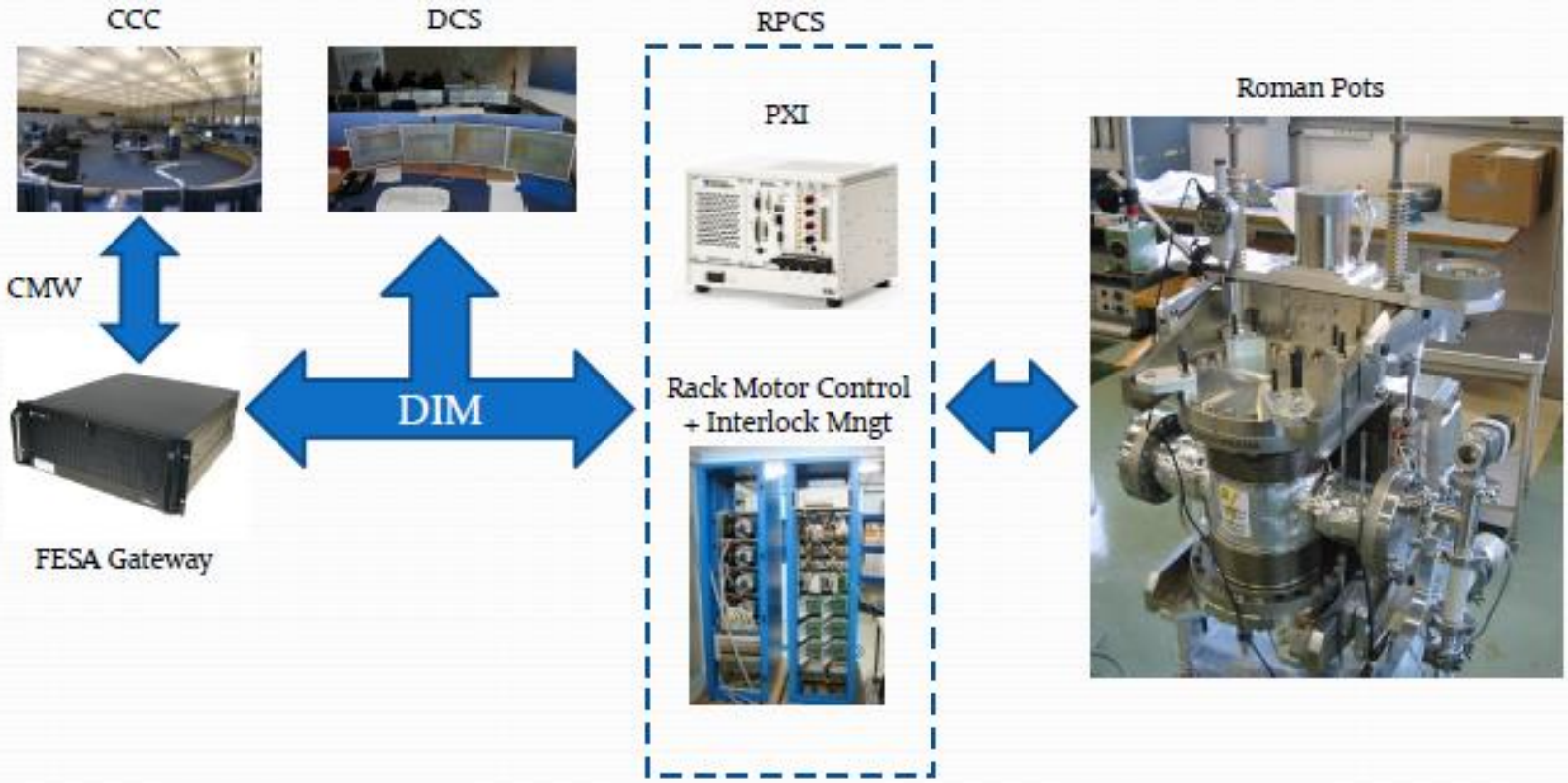
Settings:

20 μm

System followed the settings on average, but individual steps were wrong.

Explanation

RPCS Structure



RPCS PXI Structure

TOTEM PXI

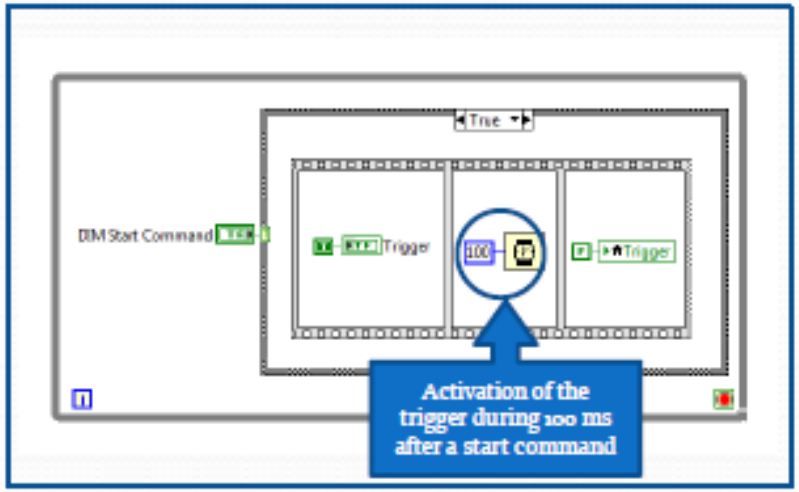
A real time controller to ensure DIM communication between CCC, DCS and RPCS, RS485 communication with motor drives

FPGAs Card to control step motors calculate RP's position

Explanation

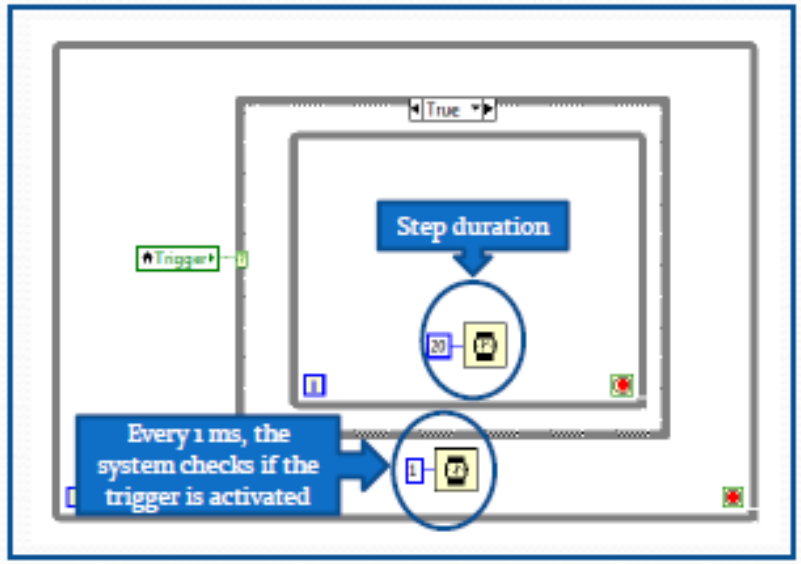
Step Movements < 6 steps

PXI CPU -> DIM command Loop

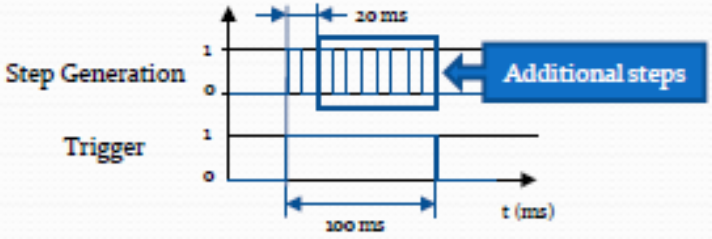


- Step Number
- Direction
- Trigger

FPGA Card -> Step generation loop



One step movement chronogram



=> Reduce the activation time of the trigger to 15 ms

System Test after Error Correction

TOTEM:

See LHC COLL elog: https://ab-dep-op-elogbook.web.cern.ch/ab-dep-op-elogbook/elogbook/secure/eLogbook.php?shiftId=1043504

For all 24 RPs the following movements were executed (minimum set):

•Big step towards the beam (typically 40 mm to 5 mm): arrival precision < 5 μm

•Series of incremental movements (mostly manual increments, some BBA tests):

* 200 μm
* 100 μm
* 50 μm
* 30 μm
* 20 μm
* 10 μm
* some tests with 5 μm = system precision limit ≈ motor step size ➔ rounding effects

➔**No malfunctions observed**

no deviations > 5 μm

At the end: Re-verification of position interlock functionality by dumping on the inner limit for 6 RPs (1 Top, 1 Bottom, 1 Horizontal on each beam)

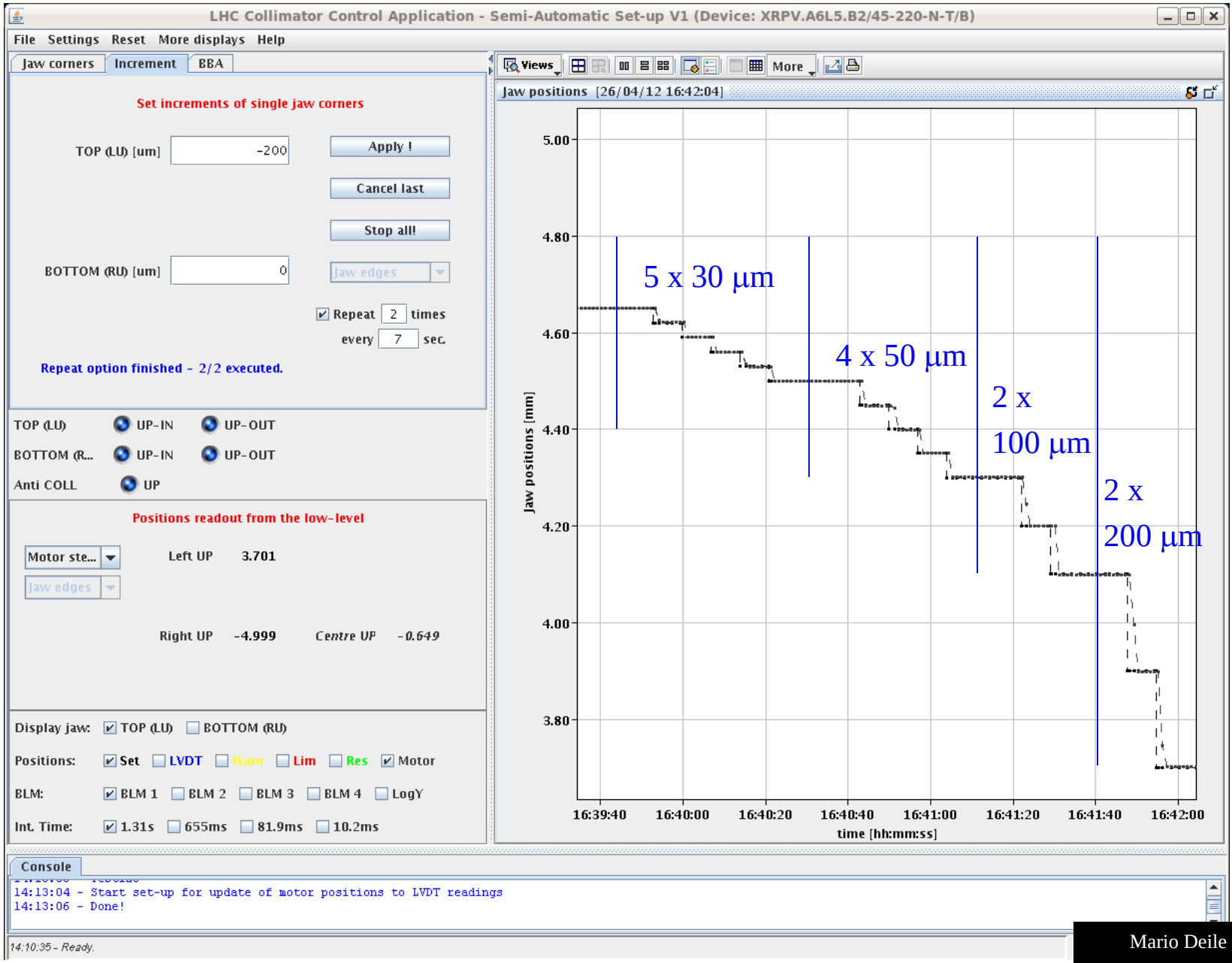
TOTEM: Test Examples

30 μm,

50 μm,

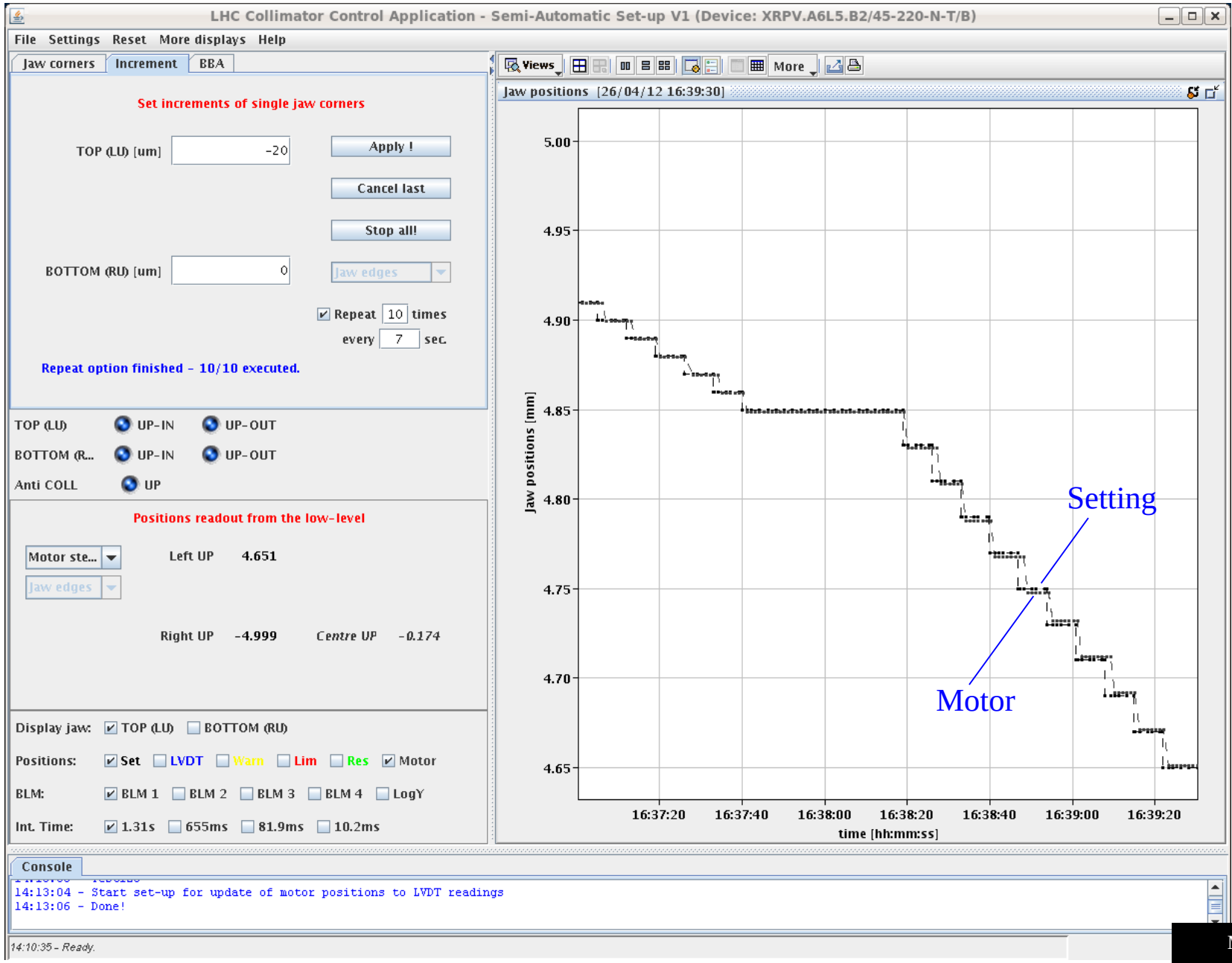
100 μm,

200 μm



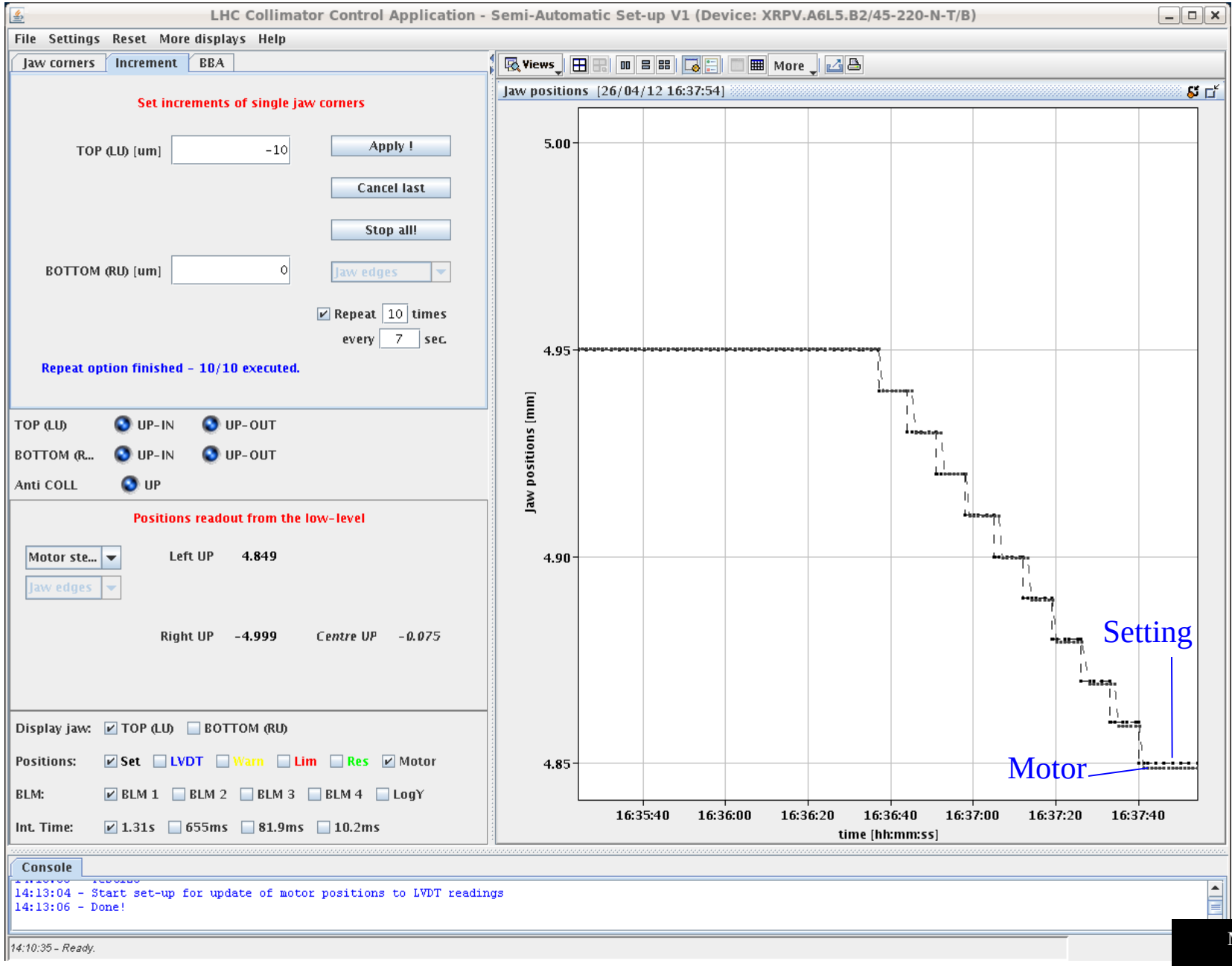
TOTEM: Test Examples

20 µm



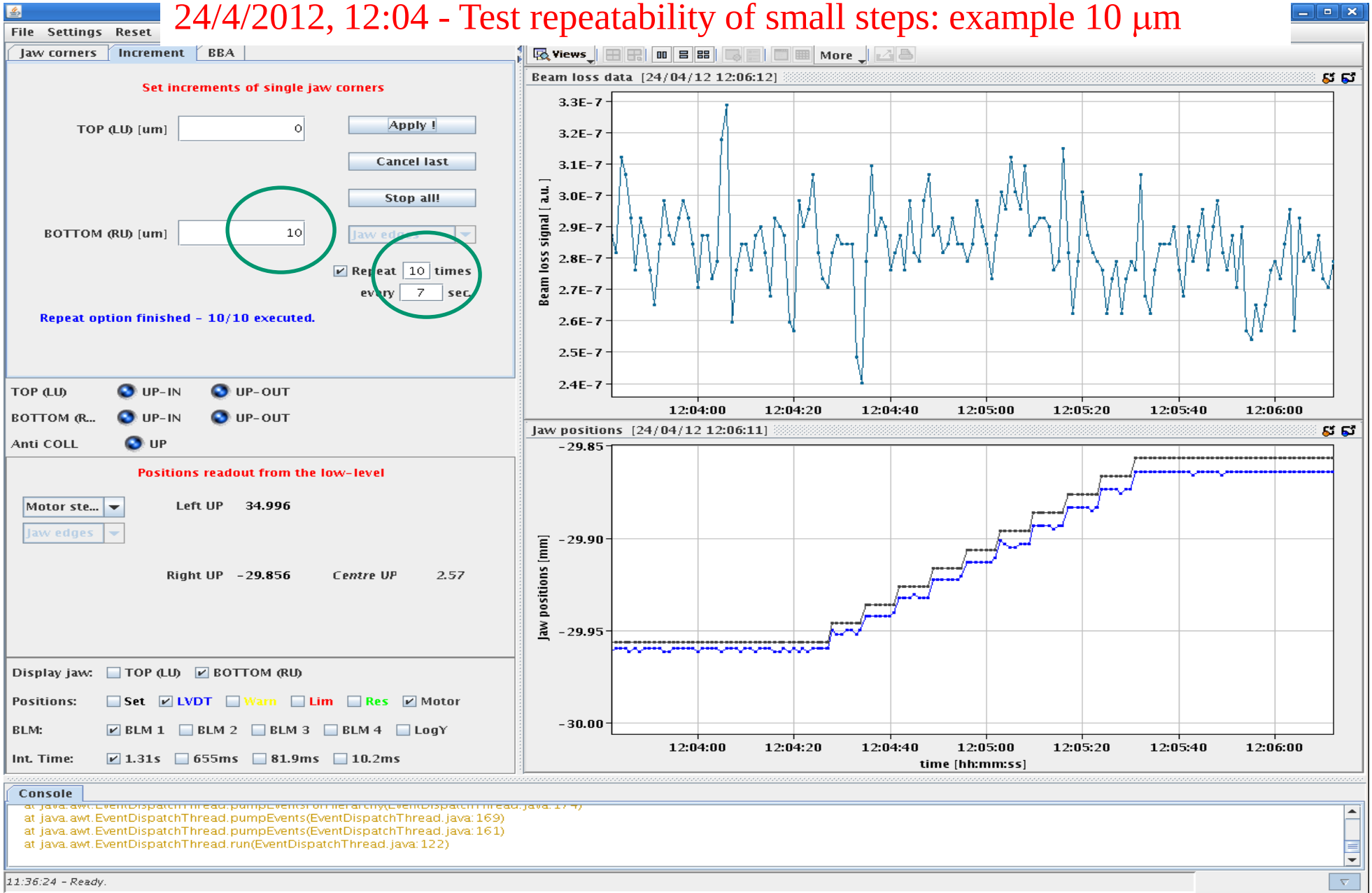
TOTEM: Test Examples

10 µm



ALFA Test Example

24/4/2012, 12:04 - Test repeatability of small steps: example 10 μm



Commissioning of the LVDT Bypass Boxes

- One key per experiment (ALFA, TOTEM) to
  - bypass LVDT input to interlock
  - and disable all pots at the same time.

  Key to be kept in the CCC.
- Vertical key position :
  - LVDT Position interlock active,
  - RP motors can be enabled.
- Diagonal key position :
  - LVDT Position interlock bypassed,
  - RP motor power disabled by hardware link

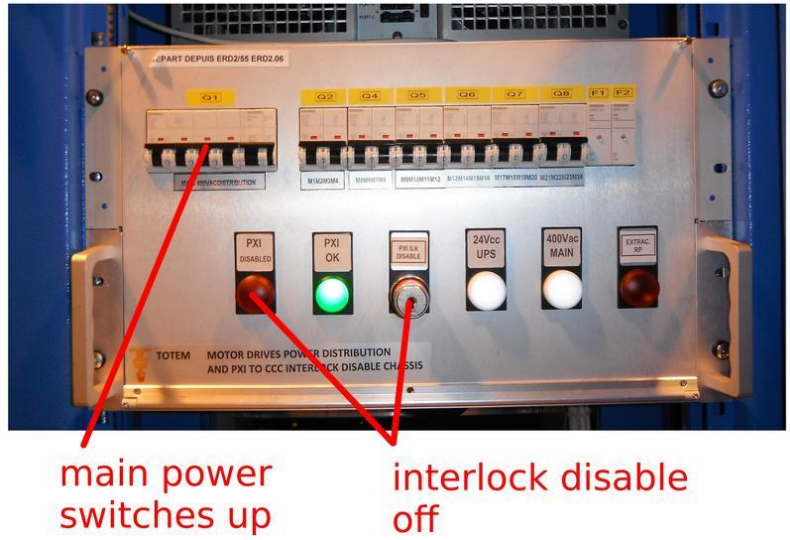
Circuit diagrams in EDMS 1183242 by Xavier Pons.

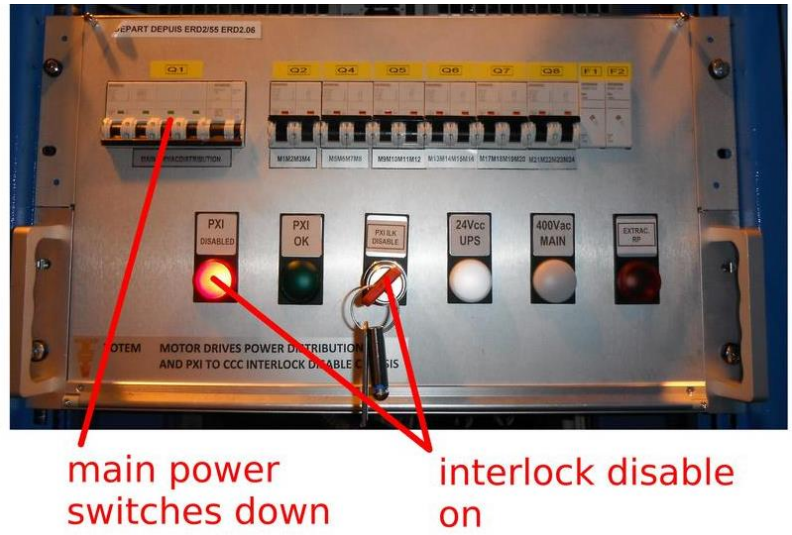
ALFA and TOTEM: boxes now operational.

Tests done on 25 April.

- TOTEM: LHC COLL logbook:
  https://ab-dep-op-elogbook.web.cern.ch/ab-dep-op-elogbook/elogbook/secure/eLogbook.php?shiftId=1043476
  EDMS 1204523 (interlock test report) updated !
- ALFA: LHC OP logbook:
  https://ab-dep-op-elogbook.web.cern.ch/ab-dep-op-elogbook/elogbook/secure/eLogbook.php?shiftId=1043460

TOTEM LVDT Bypass Box





ALFA LVDT Bypass Box Modification

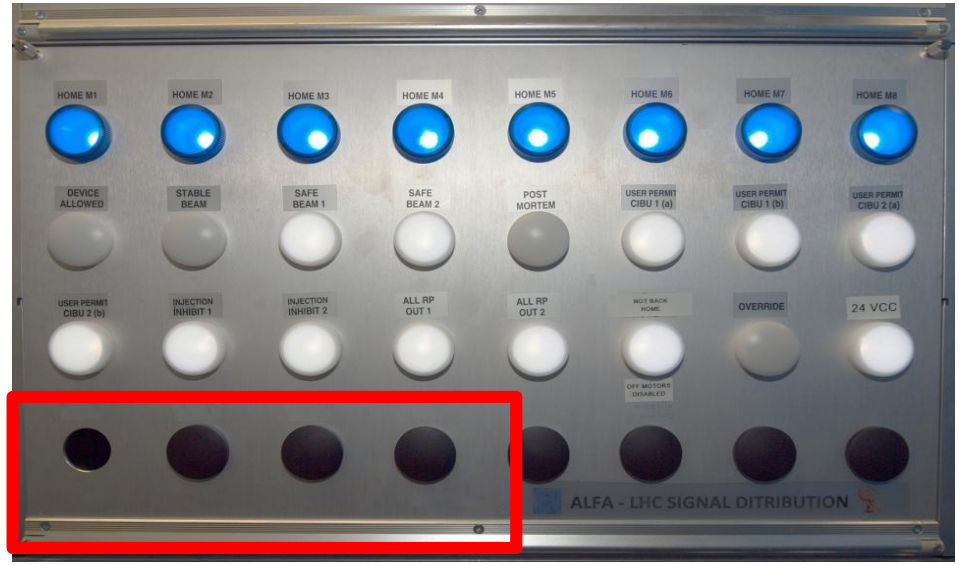
ALFA. Before technical stop:

4 individual keys for LVDT comparison override.

ALFA. Now:

1 key for override all LVDT comparison.

The key also cut the power to the motors.



LVDT Bypass Box: Test of 4 Scenarios

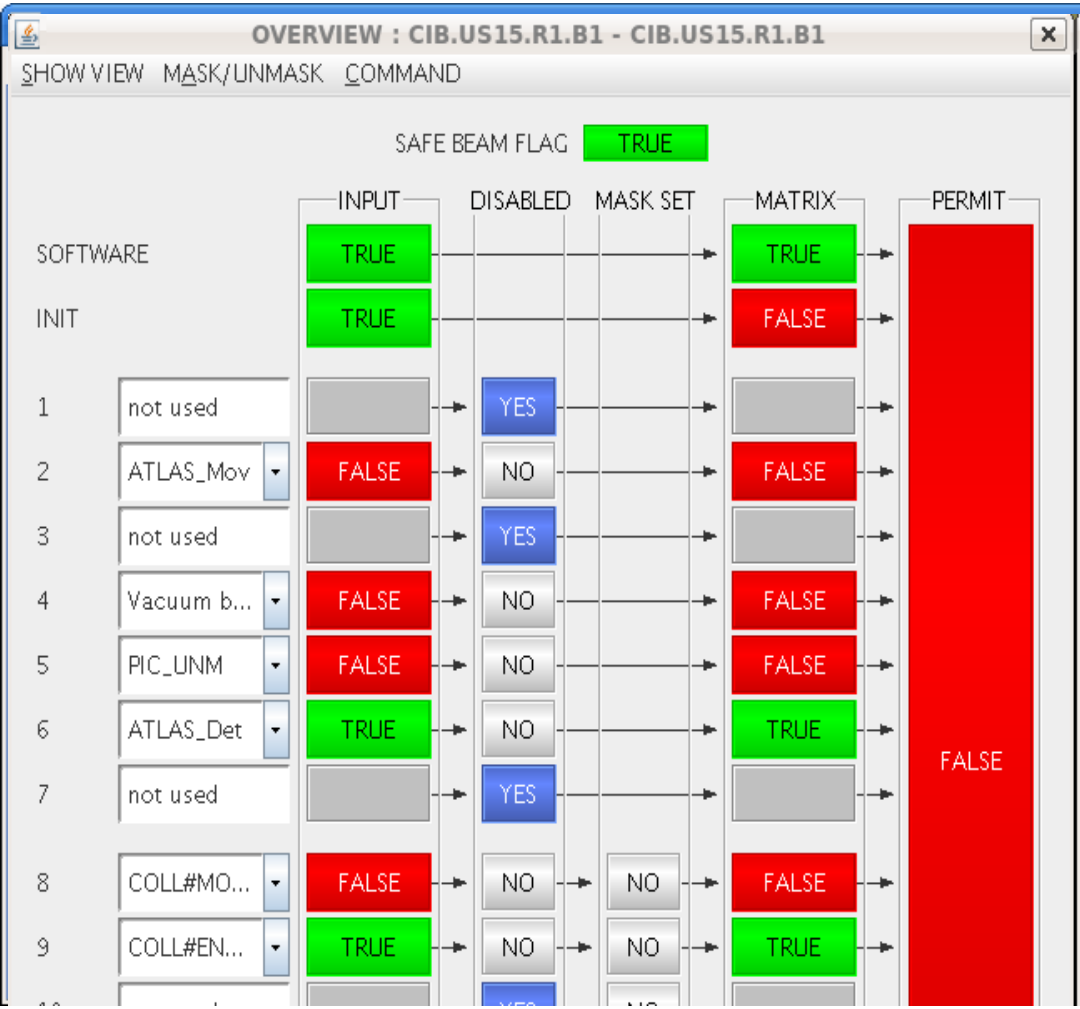
Test 1 (Failure during TOTEM / ALFA Run)

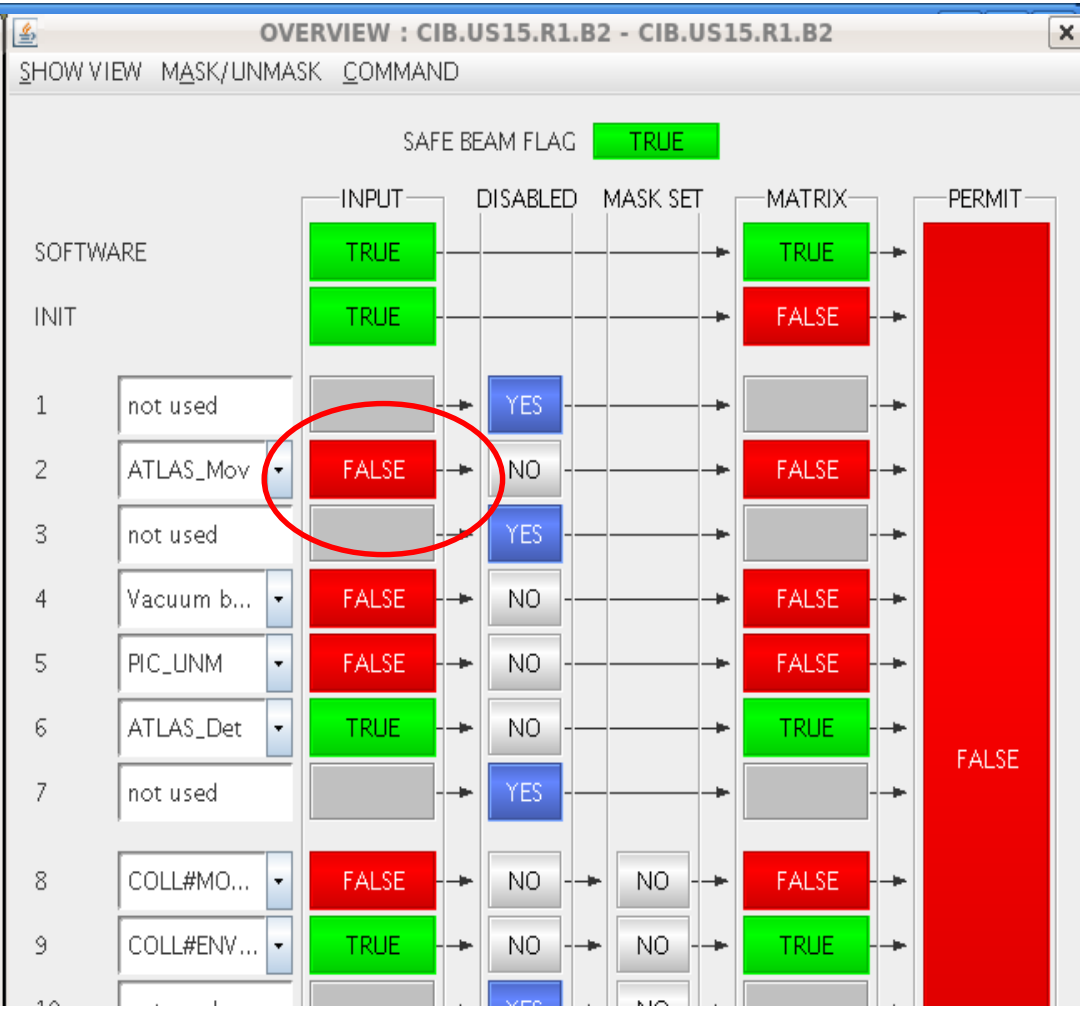
1) RPs are near the beam.
2) Simulate failure: Switch PXI crate off → dump, RP extraction
3) Turn BYPASS on → USER_PERMIT back, RP motors disabled.
   [LHC can operate without RPs while repairs are done]
4) Restart PXI and its processes.
   Verify that no RP movement is possible.
5) Turn BYPASS off and re-enable the motors.
6) Check normal functionality of RP movements and interlocks

ALFA. Bypass key test. Wednesday 25th

TEST 1, sequence 2.

- 8:37 ALL pots at 20mm (upper) and -35mm (lower)
- 9:21 switch off PXI. Dump and extraction. User_Permit gone

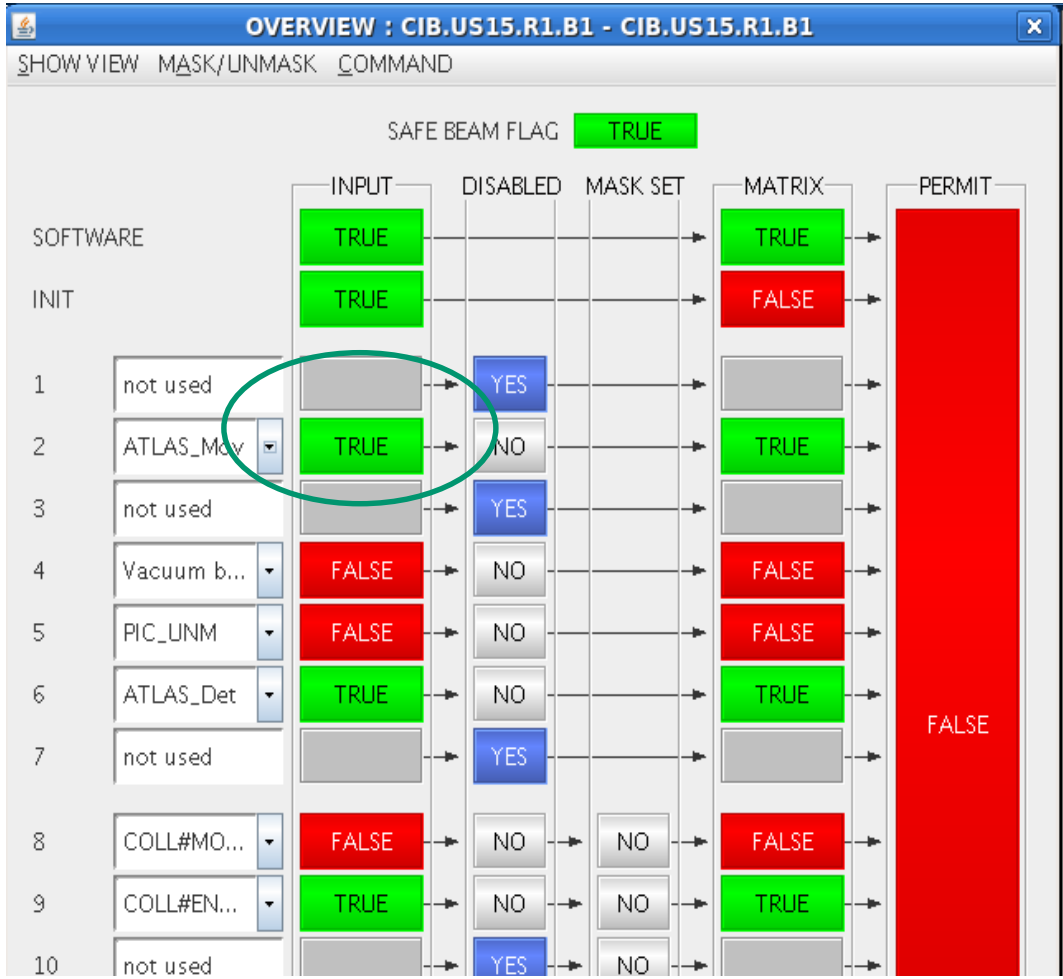


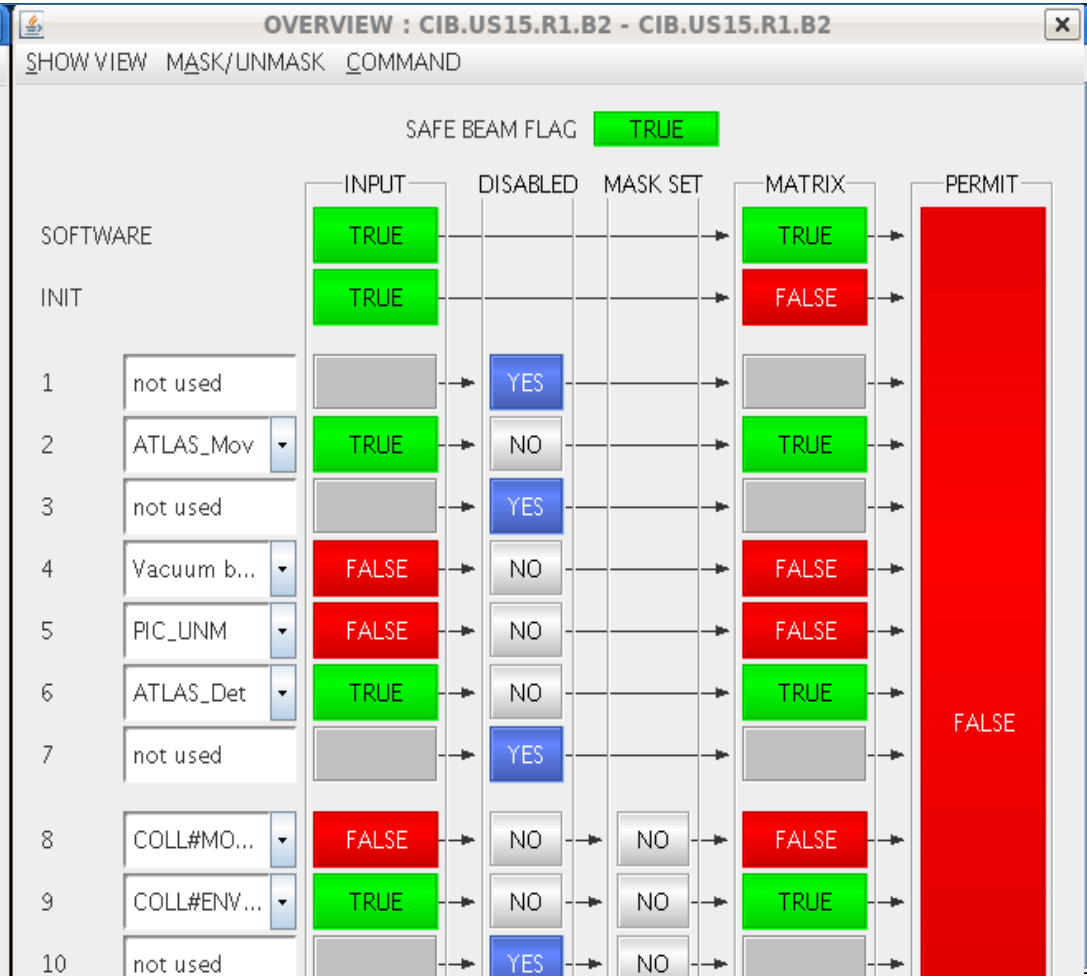


ALFA. Bypass key test. Wednesday 25th

TEST 1, sequence 3.

- ALFA BYPASS key turned at 9:48. USER_Permit back. No changes in the Application window (no traces). Trying to move triggers message: "no acknowledgement from PXI".





LVDT Bypass Box: Test of 4 Scenarios

Test 1 (Failure during TOTEM / ALFA Run)

1) RPs are near the beam.
2) Simulate failure: Switch PXI crate off → dump, RP extraction
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   [LHC can operate without RPs while repairs are done]
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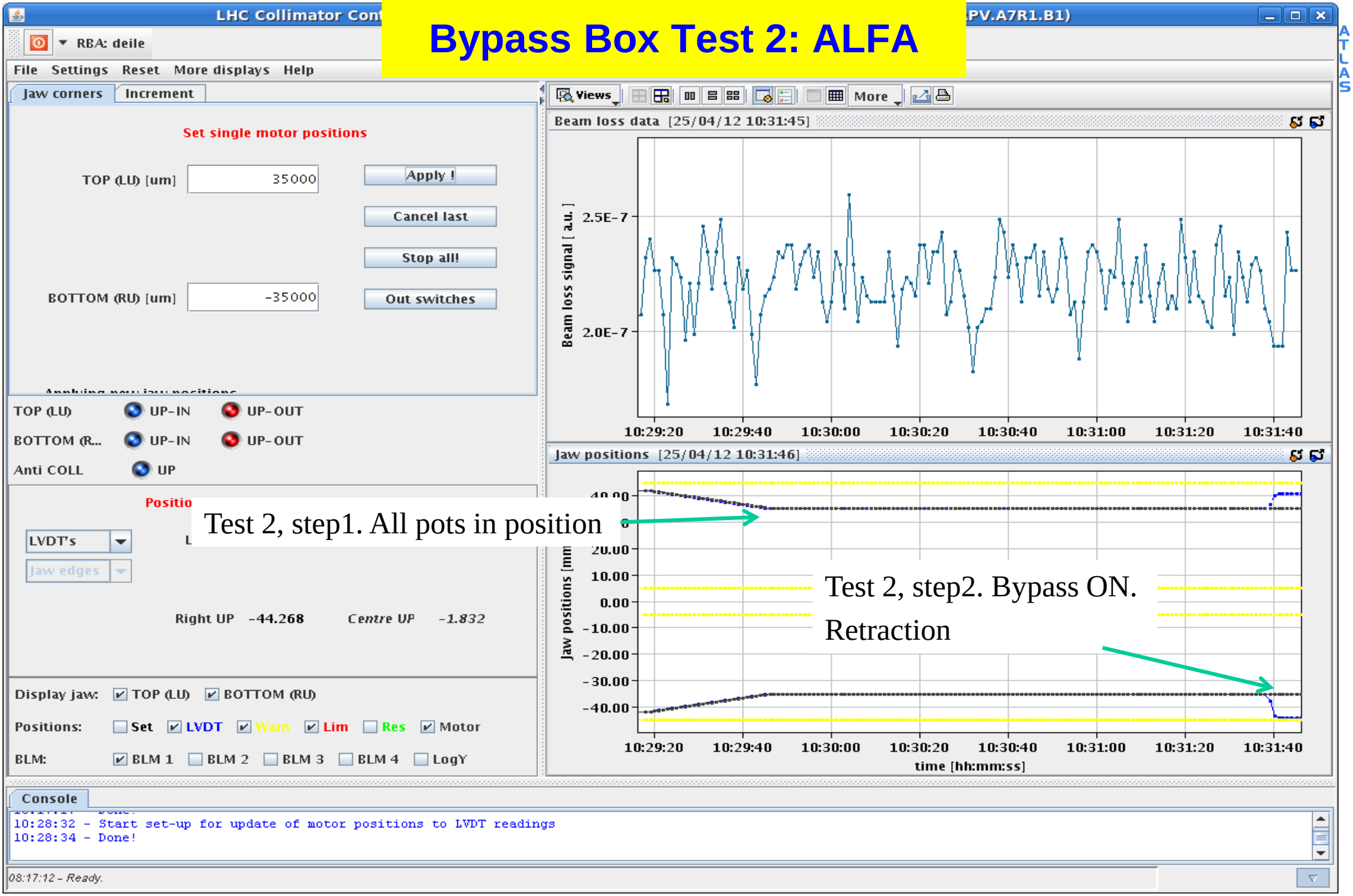
Test 2 ("The Forbidden Use Case") [tested only for completeness]

1) RPs are near the beam.
   [Imagine PXI is stuck and needs reboot]
2) Turn BYPASS on
3) Reboot PXI → no dump
   Verify that no RP movement is possible
4) Turn BYPASS off and re-enable the RP motors.
5) Check normal RP functionality

Bypass Box Test 2: ALFA



LVDT Bypass Box: Test of 4 Scenarios

Test 3 (“Holiday Mode”)

1) All pots are in garage (at HOME switch)
2) Turn BYPASS on
   Verify that no RP movement is possible
3) Turn BYPASS off and re-enable the RP motors
4) Check normal RP functionality

Test 4 (Failure while TOTEM/ALFA in Standby – “When the CCC calls in the night…”)

1) All pots are in garage (at HOME switch)
2) Simulate failure: Switch PXI crate off → dump, RP extraction
3) Turn BYPASS on → USER_PERMIT back, RP motors disabled
   [LHC can operate without RPs while repairs are done]
4) Restart PXI and its processes
   Verify that no RP movement is possible
5) Turn BYPASS off and re-enable the RP motors
6) Check normal RP functionality

Improvements of the CCC Application

Done (thanks to Gianluca and Stefano):

- Fixed the broken STOP button in the BBA version of the RP-collimator application
- Configured the button “Out Switches” to send the pots to the OUT Stopper positions
- Included BBA version in the LHC menu tree
  (no more confusion about versions and typing explicit web URLs)

- Tested driving pre-defined open “parking” limits with EquipState (easier and less error prone)

Medium Term Wishes:

- Display new inner limits as curves
- Add the BBA tab to the default version (reachable via the LHC menu)

Long Term Wishes:

- Naming conventions for existing button display:
  UP-IN UP-OUT → IN-Stopper HOME

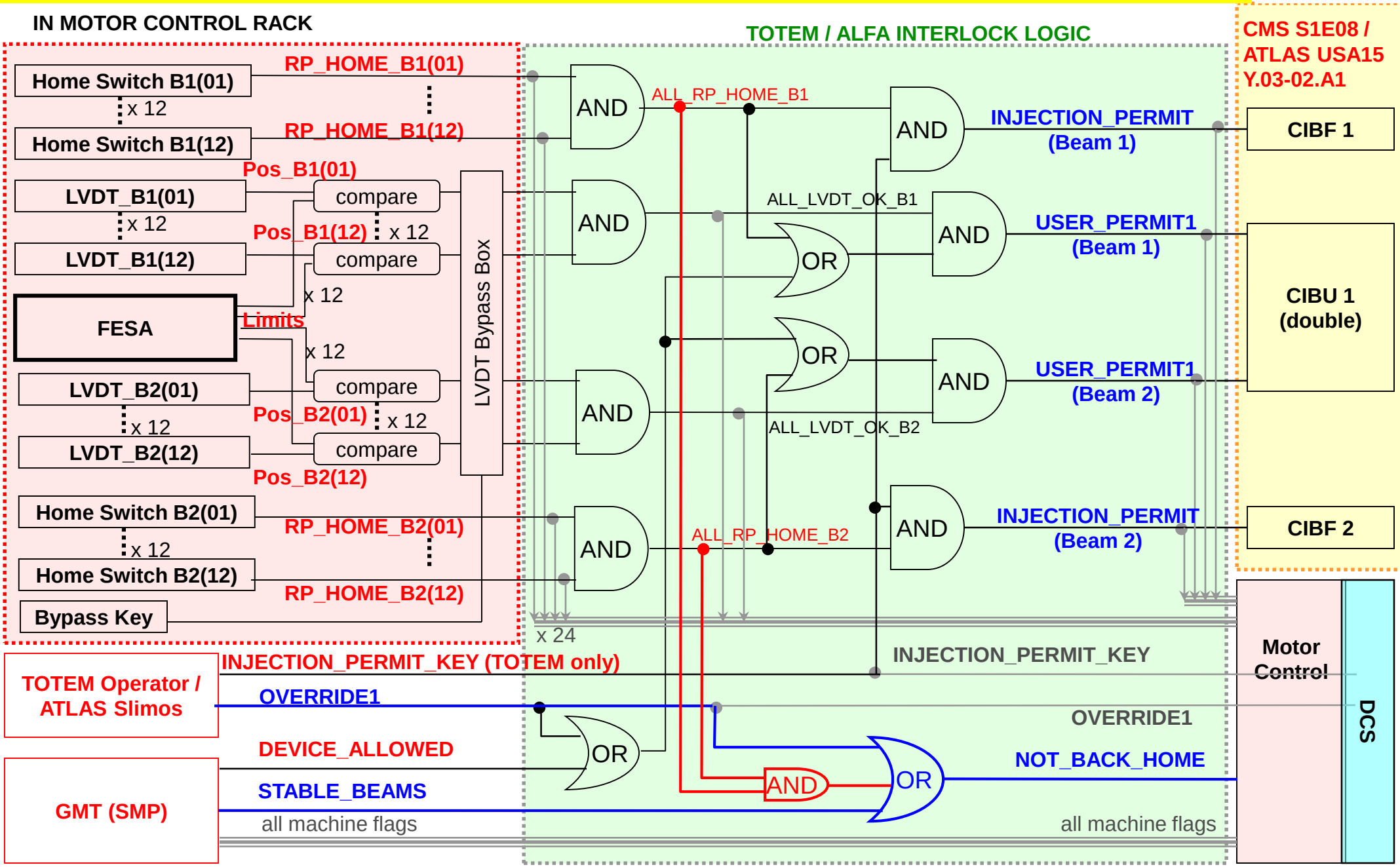
- Add another button for the real OUT Stopper

- Display difference between motor and LVDT (as a number)

- Human-understandable error messages (presently “java …” over ~20 lines)

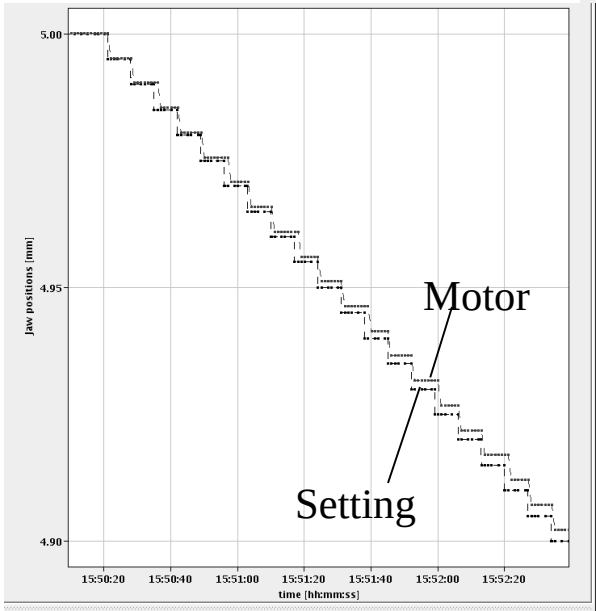
Backup

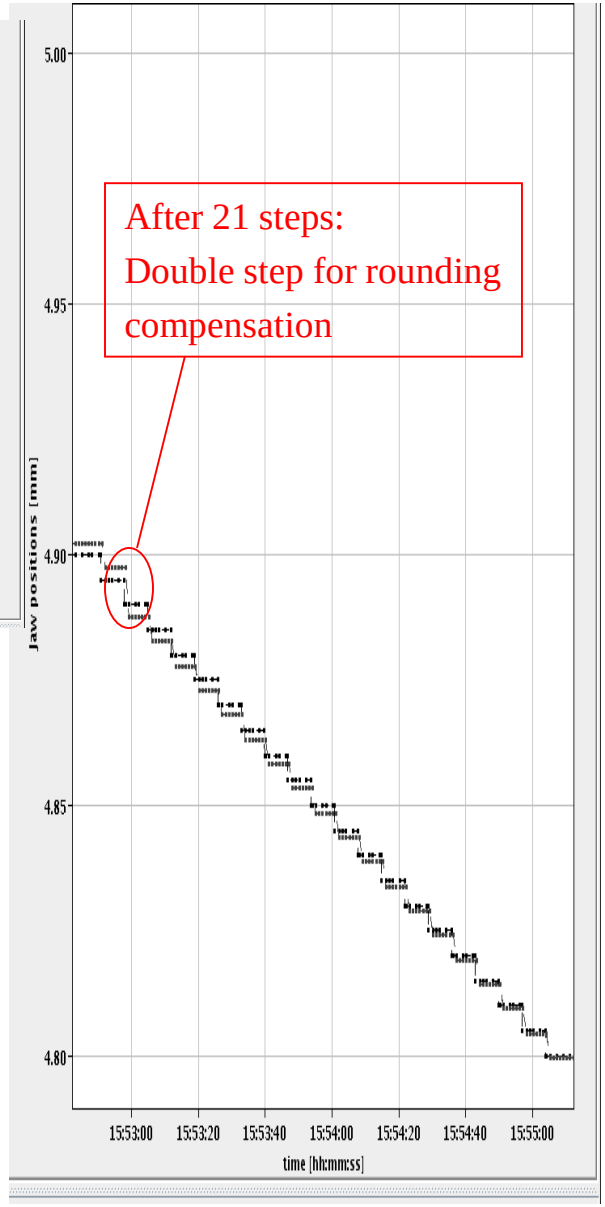
Interlock Logic 2012

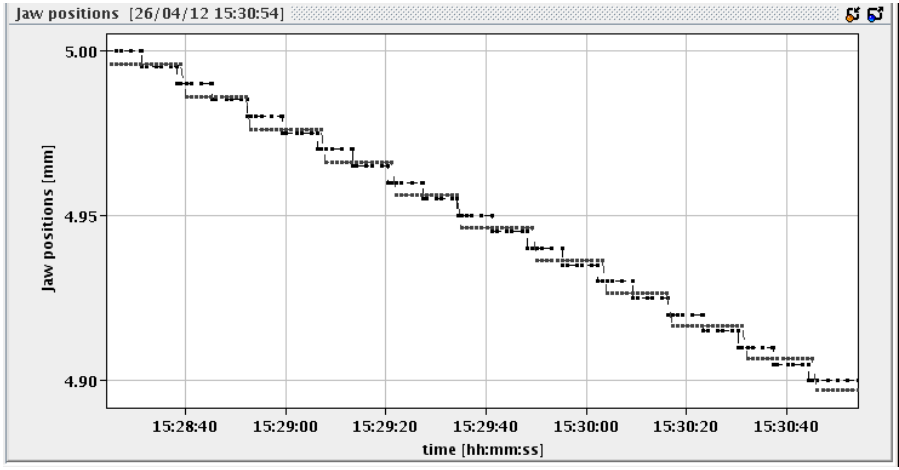


Examples for 5μm Movements

Very good case: initial deviation ~ 0





Worse case: initial deviation ~ 5 μm

→ Rounding produces steps of 0 or 10 μm