ALFA and TOTEM Roman Pot Interlock Tests 2015

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on behalf of the

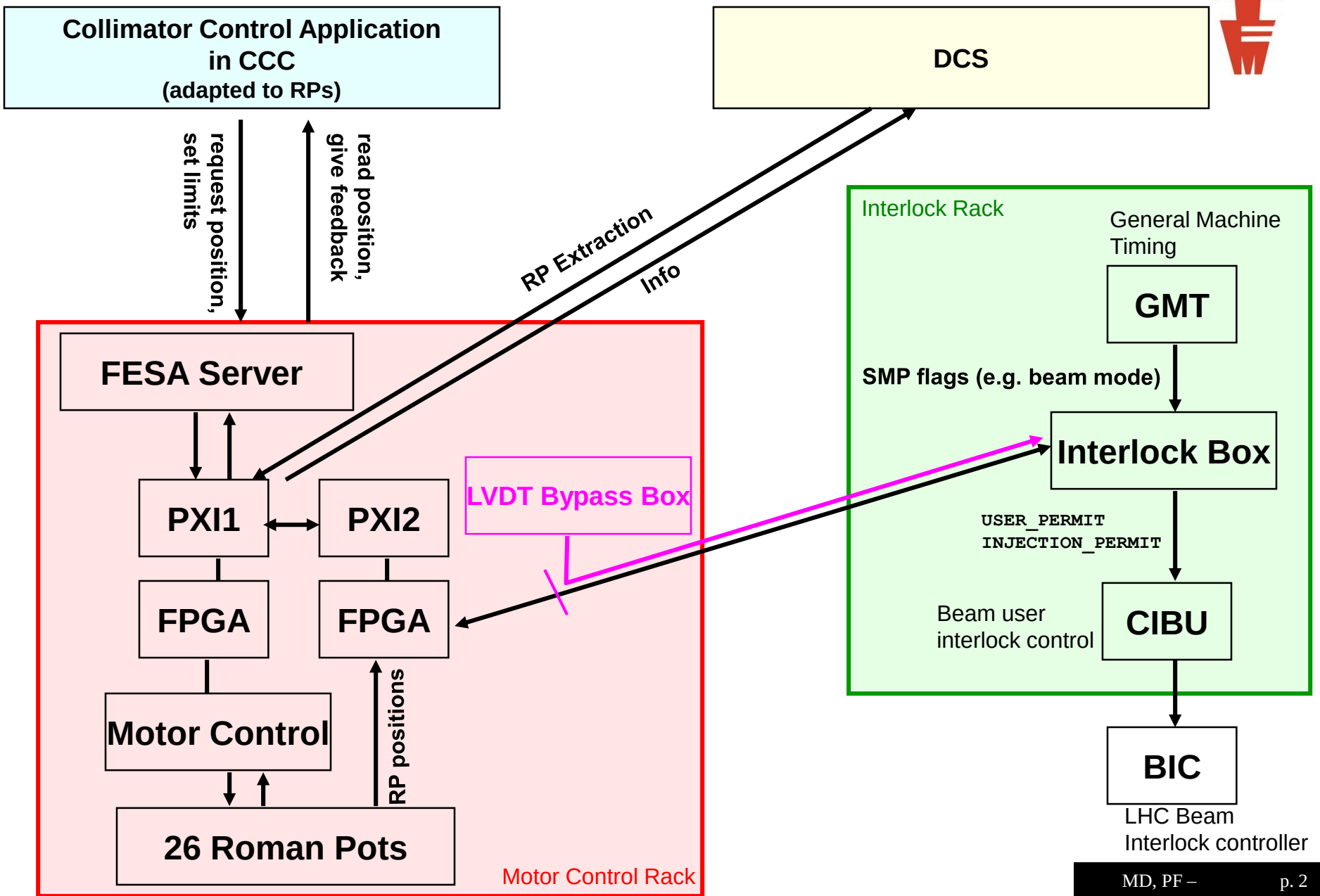
ATLAS-ALFA and TOTEM Roman Pot Teams

with special thanks to
Collimation WG, LHC interlock team, Operators, PH-DT, EN-ICE

MPP Meeting
24 April 2015

summarising
EDMS 1503866 (ALFA)
EDMS 1501228 (TOTEM)

Movement System Architecture (strongly simplified)



Simplified Interlock Functionality

- User Permits (1 per beam):

  User Permit is removed if:
  (a pot is outside garage in the wrong beam mode) or (a pot is not within position limits)
  → beam dump and retraction of all RPs with the springs

- Injection Permits (1 per beam):

  Injection Permit is removed if a pot is outside garage (defined by electrical link from HOME switch)

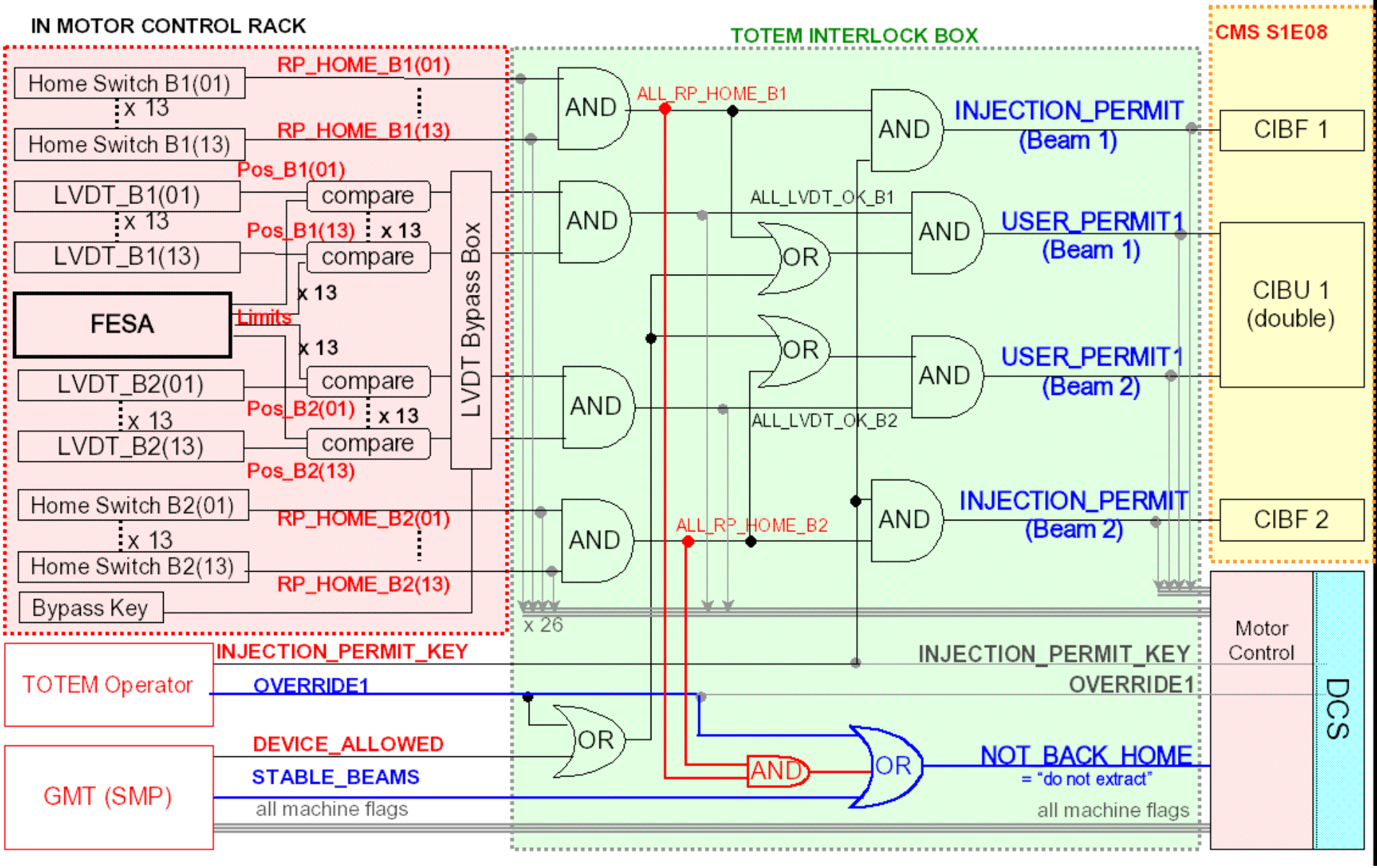
... apart from an Override key and an LVDT bypass key (consult the full logic)

Logic implemented on a programmable circuit ("Interlock Box")

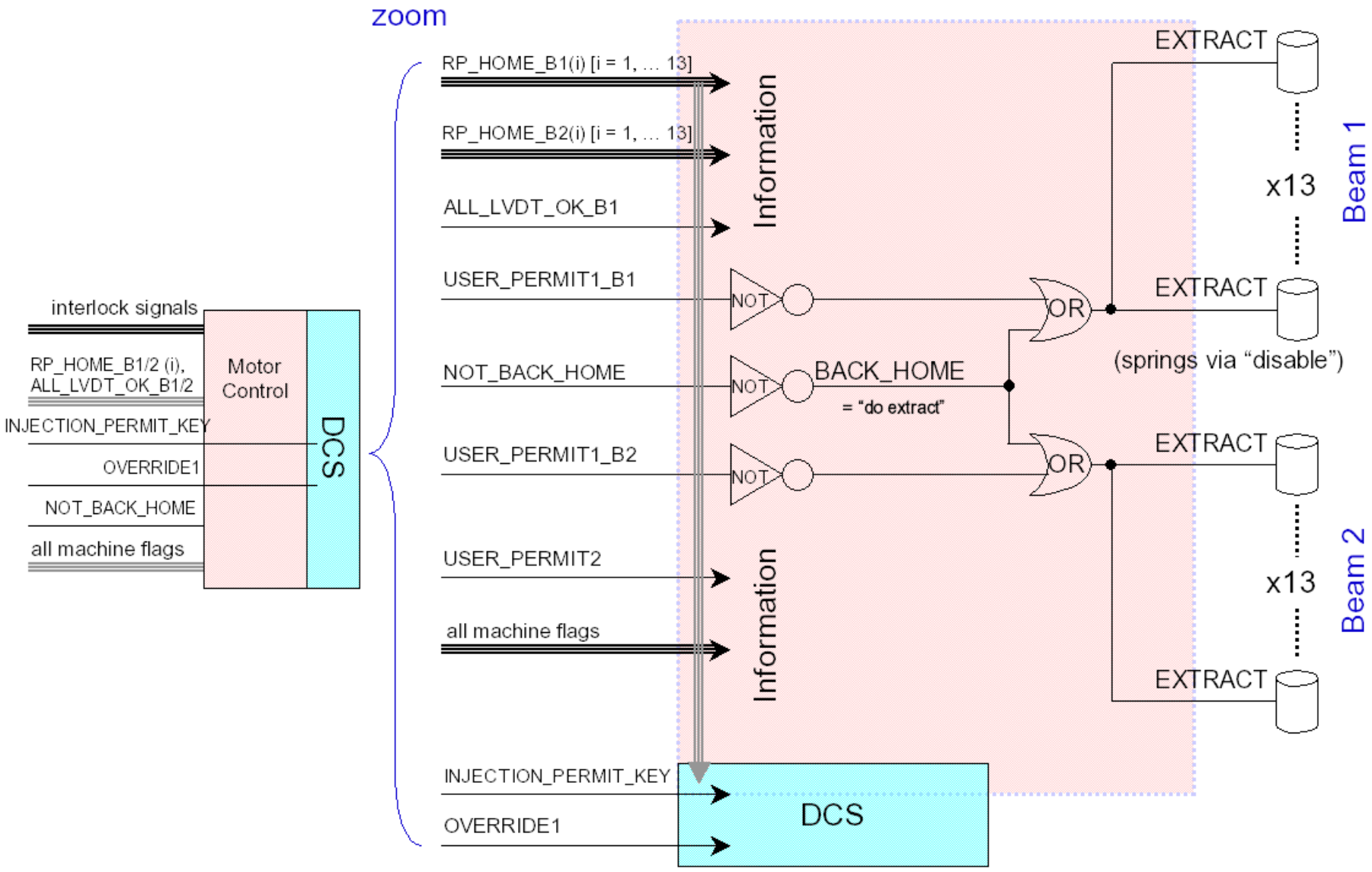
New in 2015:
- Separation of active movement control and position interlock functionalities: 2 PXI computers
- TOTEM: addition of 2 single horizontal pots, now total of 26 pots
  → interlock box circuit board completely redone (allows for up to 32 pots!)

- But: logic unchanged !

Interlock Logic 2015

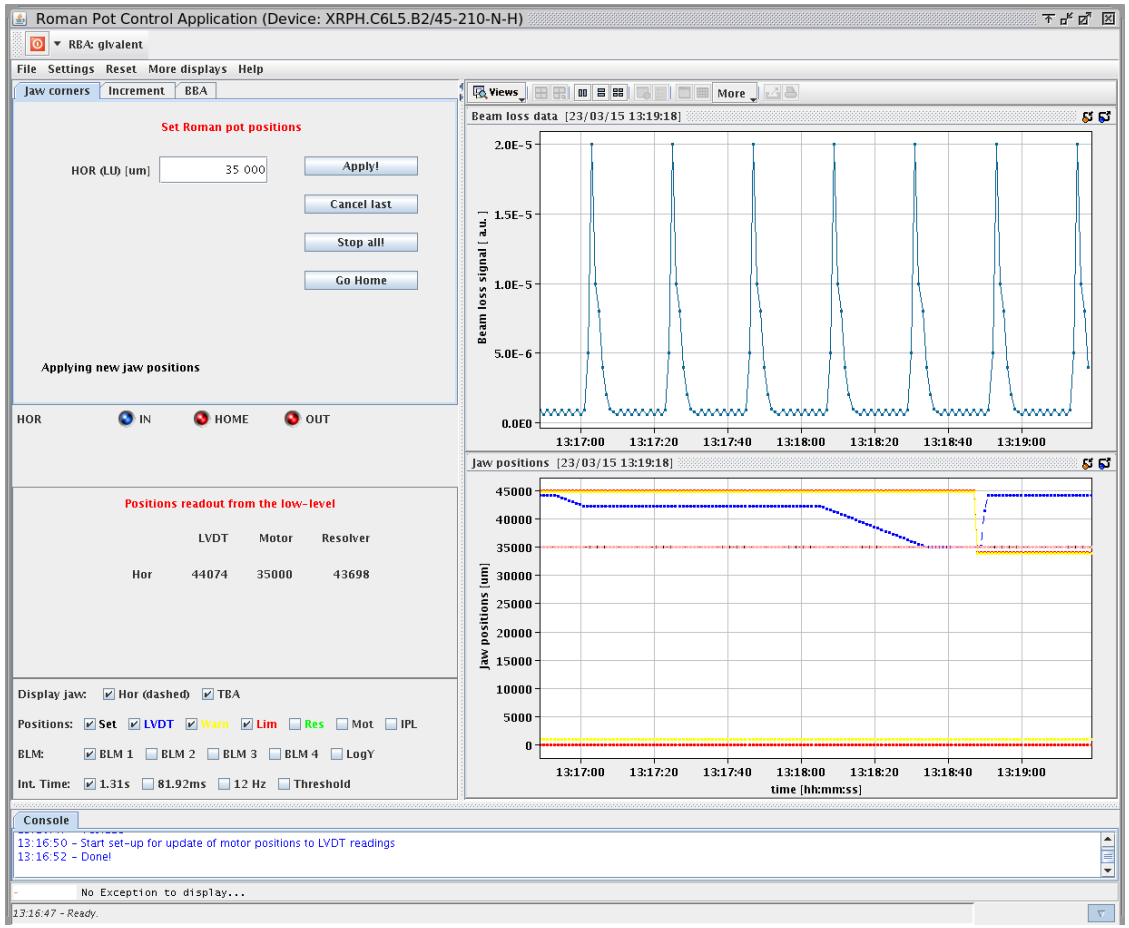


Interlock Logic 2015
(Zoom on the motor control)



Top Level Control (Collimator Application in the CCC)

- developed and maintained by G. Valentino (BE-ABP)
- strongly improved during LS1:
  * all limits displayed (now also new inner limits)
  * nomenclature of switches corrected
  * preview line before applying a movement command



Test Strategy

ALFA Interlock validation test

4 test sequences:

1. **Injection Permits**
   - Rest of ATLAS was at "Ready for injection" (including injection key)
   - Then ALFA breaks the injection permit by moving in a Roman Pot.
   - Done for all 8 pots
2. **Beam mode test**
   - Test of ALFA reaction vs Beam Modes and "moveable devices allowed"
   - About 1 hour needed for each beam.
   - All worked as expected.
   - Done for one pot per beam.
3. **Systematic check of limits (old/new inner limits)**
   - A few errors found and corrected.
   - Final validation made on all Roman Pots with final firmware.
   - Done separately for each beam, all pots.
4. **LVDT bypass key** see EDMS 1203969
   - Test of key reactions in case of hardware failure (to allow LHC operation).
   - All worked as expected

Beam-Mode Dependent Test Sequence

Inputs	Combinations to be tested (labelled by the small blue numbers) 1	2	3	4	5	6
ALL_LVDT_OK_Bi	1	1	1	1	1	1
ALL_RP_HOME_Bi	1	1	1	1	1	1
DEVICE_ALLOWED	1	1	1	1	0	0
STABLE_BEAMS	1	1	0	0	1	1
OVERRIDE1	1	0	1	0	1	0
USER_PERMIT1(Bi)	1	1	1	1	N/A	N/A
EXTRACT	0	0	0	0	N/A	N/A

Inputs	7	8	9	10	11	12
ALL_LVDT_OK_Bi	1	1	1	1	1	1
ALL_RP_HOME_Bi	0	0	0	0	0	0
DEVICE_ALLOWED	1	1	1	1	0	0
STABLE_BEAM	1	1	0	0	1	1
OVERRIDE1	1	0	1	0	1	0
USER_PERMIT1(Bi)	1	1	1	1	N/A	N/A
EXTRACT	0	0	0	1	N/A	N/A

Inputs	13	14	15	16	17	18
ALL_LVDT_OK_Bi	0	0	0	0	0	0
ALL_RP_HOME_Bi	1	1	1	1	1	1
DEVICE_ALLOWED	1	1	1	1	0	0
STABLE_BEAM	1	1	0	0	1	1
OVERRIDE1	1	0	1	0	1	0
USER_PERMIT1(Bi)	0	0	0	0	N/A	N/A
EXTRACT	1	1	1	1	N/A	N/A

Inputs	19	20	21	22	23	24
ALL_LVDT_OK_Bi	0	0	0	0	0	0
ALL_RP_HOME_Bi	0	0	0	0	0	0
DEVICE_ALLOWED	1	1	1	1	0	0
STABLE_BEAM	1	1	0	0	1	1
OVERRIDE1	1	0	1	0	1	0
USER_PERMIT1(Bi)	0	0	0	0	N/A	N/A
EXTRACT	1	1	1	1	N/A	N/A

Impossible modes
(STABLE_BEAMS without DEVICE_ALLOWED)

5 input signals → 2^5 = 32 combinations

Test sequence = optimised path reaching each of the conditions (input combinations; blue numbers) at least once.

Exceptions: configurations with orange result fields = unreachable

						19.03.	
2	STABLE_BEAMS	0	all pots at home	open limits: inner warning = 34 mm, inner dump = 33 mm		17:06	17:43
			motor reset		USER_PERMIT = 1	17:08	17:45
2 to 8			move pot to 35 mm		USER_PERMIT = 1	17:10	17:45
8 to 10	to UNSTABLE_BEAMS				USER_PERMIT = 1	17:11	17:47
10 to 4			automatic extraction		USER_PERMIT = 1	17:11	17:48
4 to 2	to STABLE_BEAMS				USER_PERMIT = 1	17:14	17:50
			motor reset			17:15	17:51
2 to 8			move pot to 35 mm		USER_PERMIT = 1	17:15	17:51
8 to 20				illegal limits: inner warning = 37 mm, inner dump = 36 mm	USER_PERMIT = 0	17:17	17:52

Examples
(more in the e-log; links in EDMS docs)

ALFA: Beam mode test

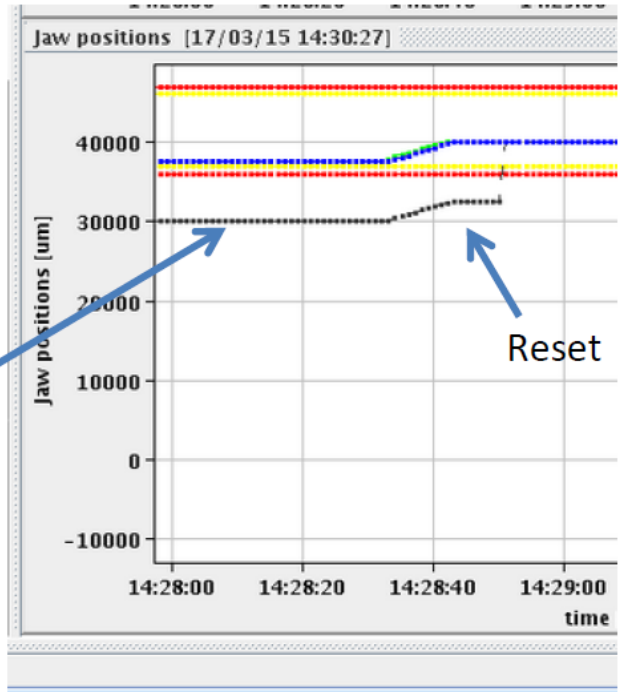
An example.

From Elog

One test among a list of 38 !!

14:27

ALFA: Beam mode dependent interlock test for beam 1.
Using B7R1 Upper.
State Transition 21 to 3.
Open limits. Warning at 29 mm, dump at 28 mm
Update motor position



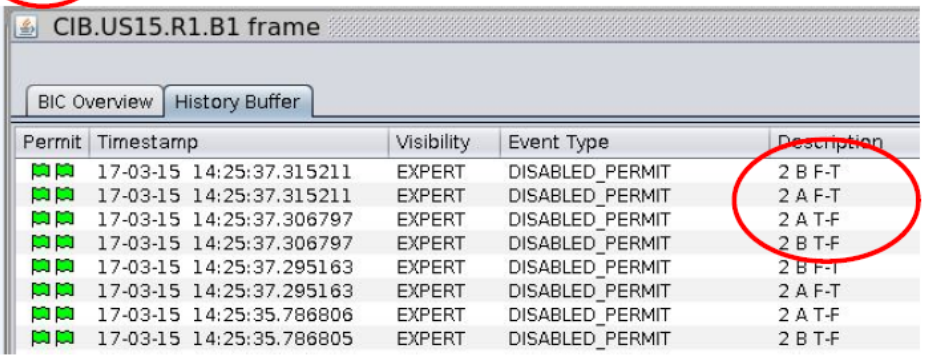
1) Beam mode "unstable" & Pot at 30mm
   => User_Permit = 1

2) Change limits

LEFT-UP WARN IN	37.0000	29
LEFT-UP DUMP IN	36.0000	28

Violation => User_Permit = 0
Extract and User_Permit = 1

(from T to F and back) ➔



3) Open limits

Examples

ALFA: Systematic check of limits (old/new inner limits)

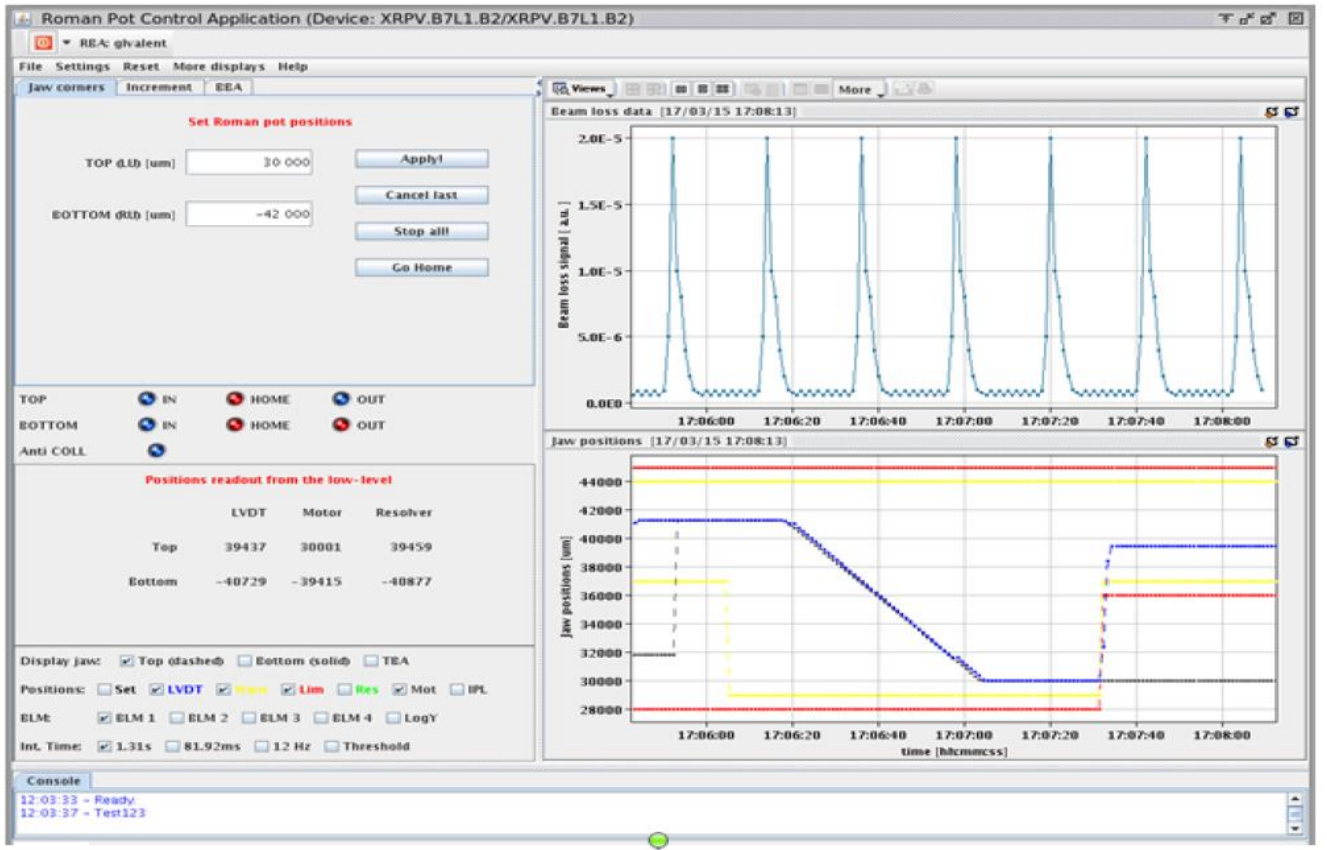


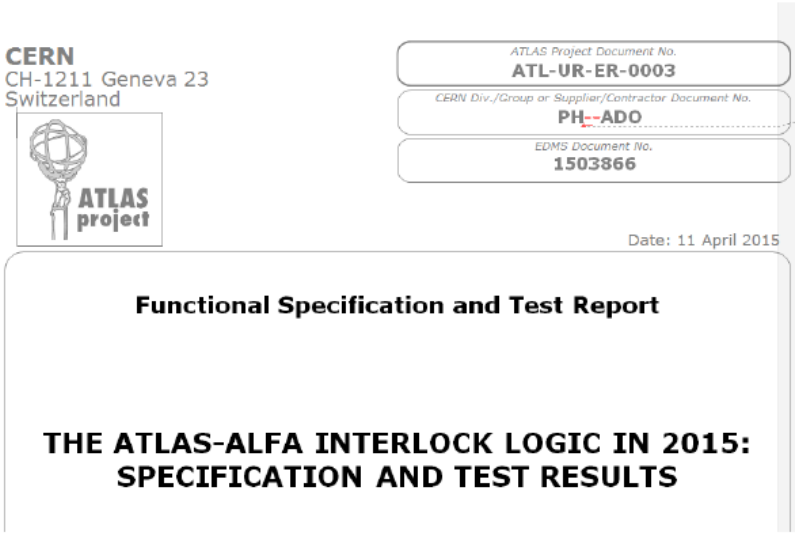
Figure 4. *TOP:* Collimator application used to move Roman Pot B7L1 Upper.
BOTTOM: Corresponding loss of INJECTION_PERMIT seen in the BIS history buffer.

ALFA - summary

- Full set of tests done in two days (16th and 17th March). Total time order of 5-6 hours, when all fine.
- All tests successful but:
  - *Since we had a very small change on DCS side (Enabling/Disabling & fast extraction) which is not yet tested*
  - *PXI crashed*

EDMS note is done at 95% (see above).
https://edms.cern.ch/edmsui/#!master/navigator/document?D:1958749382:1958749382:subDocs

EDMS note will go for circulation right after


CERN
CH-1211 Geneva 23
Switzerland

ATLAS project

ATLAS Project Document No.
ATL-UR-ER-0003

CERN Div./Group or Supplier/Contractor Document No.
PH--ADO

EDMS Document No.
1503866

Date: 11 April 2015

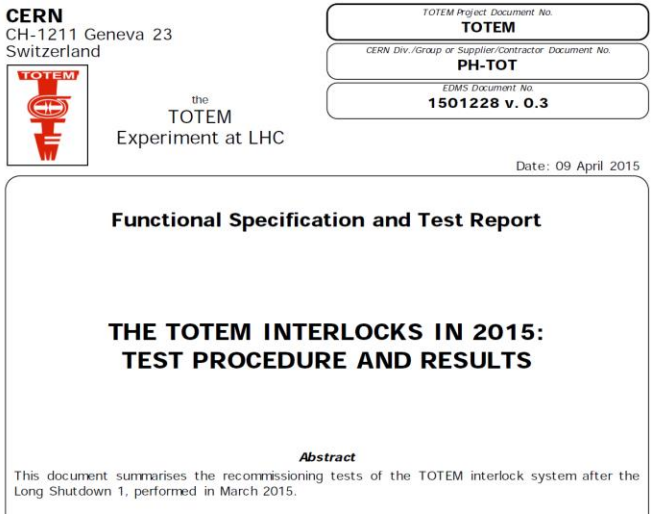
Functional Specification and Test Report

THE ATLAS-ALFA INTERLOCK LOGIC IN 2015: SPECIFICATION AND TEST RESULTS

TOTEM Summary

- Beam-mode dependent tests successful at the second attempt
  (problem with transmission of the DEVICE_ALLOWED signal on the TOTEM side at the first attempt)
- Final validation done after all bug fixes in FPGA logics
- Still some PXI crashes; no impact on the interlock logic
- RP extraction via DCS not yet functional (communication problem between DCS and PXI), but emergency extraction via hardware button in TOTEM CR tested.
- EDMS test report waiting for comments
  https://edms.cern.ch/document/1501228

- Spare interlock box:
  - being programmed
  - test to be performed in the lab with simulated input flags



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the TOTEM Experiment at LHC

TOTEM Project Document No.
TOTEM
CERN Div./Group or Supplier/Contractor Document No.
PH-TOT
EDMS Document No.
1501228 v. 0.3

Date: 09 April 2015

Functional Specification and Test Report

THE TOTEM INTERLOCKS IN 2015: TEST PROCEDURE AND RESULTS

Abstract

This document summarises the recommissioning tests of the TOTEM interlock system after the Long Shutdown 1, performed in March 2015.

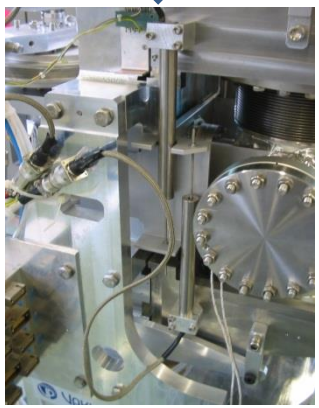
The End

BEFORE LS1

ALFA POSITION CONTROL SYSTEM PXI CRATE

Before LS1 one single FPGA card for controlling stepper motors, LVDT and Resolver position readout , microswitches and signals and interlocks position processing

Motor, Resolver and switches



LVDT's

Motor Drives

Interlocks and LHC signals Drives

AFTER LS1

ALFA POSITION CONTROL SYSTEM PXI CRATE.
ACCORDING COLLIMATORS ARCHITECURE

one FPGA card for controlling stepper motors, resolver position readout , microswitches, motor drives and LHC signals exchange

second FPGA card for safety position readout by means of the LVDT's and safety position interlock and LVDT_FAULT signal generation

Motor, Resolver and switches

Motor Drives

LHC signal exchange

Signal Position interlock Interface crate

LVDT safety position readout

LVDT Position Fault Interlock To detector Interlock Box