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Functional Specification and Test Report

THE ATLAS ROMAN POTS INTERLOCK LOGIC IN 2024: TEST RESULTS

Abstract

This document summarizes the Beam Interlock System (BIS) tests performed on the ATLAS-ALFA and ATLAS-AFP interlock system in February 2024. ALFA stations in sector 1-2 were completely removed and pots in section 8-1 are mechanically blocked and not intended to be inserted anymore. ALFA interlock signal was completely removed, thus the validation is narrowed to check if no disturbance in the interlock signal caused by ALFA happens. Since AFP movement system was not touched during YETS 23/24, a basic validation of interlock was done. AFP detectors are ready to take part (be inserted) during the pilot beam (March 2023) and later during the 2024 data-taking.

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History of Changes

<i>Version</i>	<i>Date</i>	<i>Comments or Description of Changes</i>
0.1	28-02-2024	First version containing February tests
0.2	08-03-2024	Addition of observations during handshake test

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1. INTRODUCTION

ATLAS-AFP interlock logic is based on ATLAS-ALFA (see [1], [2] and [3]). During LS2 the logic was not changed, thus its validation remained the same as during Run 2 (see [4], [5] and [6]). AFP movement system is kept the same as during Run 2. Motors and switches were tested during survey in February 2024. Station was tested to retract via springs ("emergency retraction") to HOME position in a full range between "just outside HOME switch" to ~1 mm from the beam center. Mechanical switches and electrical stoppers were tested as well.

ATLAS-ALFA stations are decommissioned. ALFA is not intended to be inserted anymore: motors are switched off (bypass key is on) and a mechanical blockade was installed to prevent any accidental movement.

In this report the following naming condition will be used:

- AFP A FAR: 12-217-F-H, XRPH.B6L1.B2,
- AFP A NEAR: 12-205-N-H, XRPH.A6L1.B2,
- AFP C NEAR: 12-205-N-H, XRPH.A6R1.B1,
- AFP C FAR: 12-217-F-H, XRPH.B6R1.B1.

Interlock system was validated based on set of tests described in details in [5]. Screenshots documenting actions were attached to LHC collimation e-log.

2. ALFA DECOMISSIONING

ALFA removal procedure is described in details in Ref. [8]. Stations removed from LHC section 1-2 in December 2023. Detector packages from Section 8-1 were removed in February 2024.

In order to prevent any accidental movement, a mechanical blockade was installed. The idea is shown in Fig. 1 whereas actual implementation can be seen on Fig. 2.

Since ALFA remains in garage, with all movement blocked, the actual BIS testing possibilities are limited. In practice, on the occasion of AFP BIS, it was checked that ALFA does not cause problems (no loss of injection permit nor beam permit).

ALFA bypass is ON (key kept in CCC), meaning the motor breakers are permanently off. The NE48 cable between ALFA and BIS systems (at the level of ATLAS BIS rack in USA15) was disconnected (21/02). The ALFA DCS project was decommissioned (29/02). Monitoring of secondary vacuum (the only remaining functional part of ALFA system; except cooling fans running all-time) is realized via AFP DCS. ALFA interlock signal were excluded from ATLAS matrix and injection permits were masked (28/02). ALFA PXI was switched off on 29/02. Current status of ATLAS Interlock is shown in Fig. 3.

ALFA inputs into the LHC Beam Interlock System were jumpered out (disabled) by Christophe Martin on March 3rd. Corresponding BIC channels are:

- input #2 on CIB.US15.R1.B1 (label: ATLAS ALFA),
- input #2 on CIB.US15.R1.B2 (label: ATLAS ALFA).

Current status of ATLAS Interlock is shown in Fig. 4.

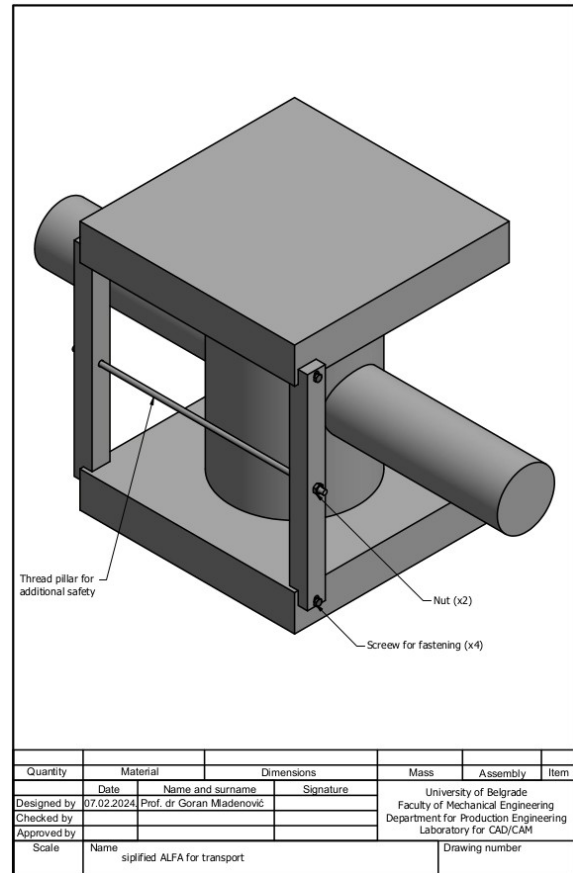
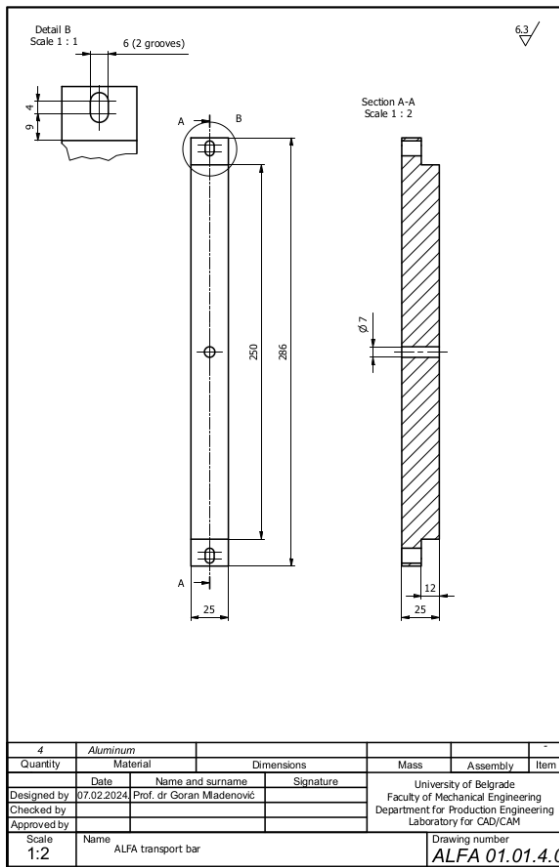


Fig. 1. Mechanical blockade for ALFA pots: drawing (left) and concept (right).

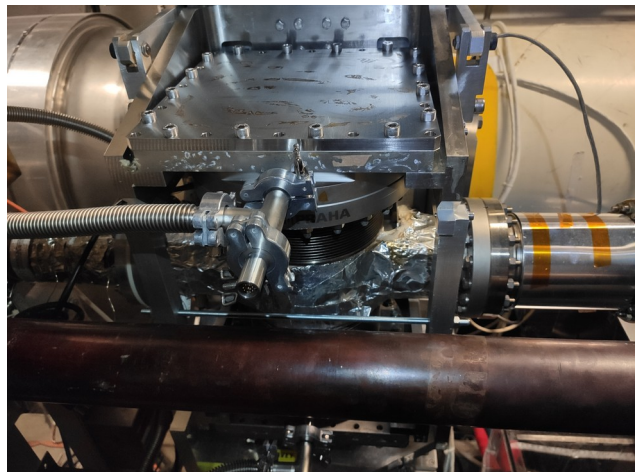
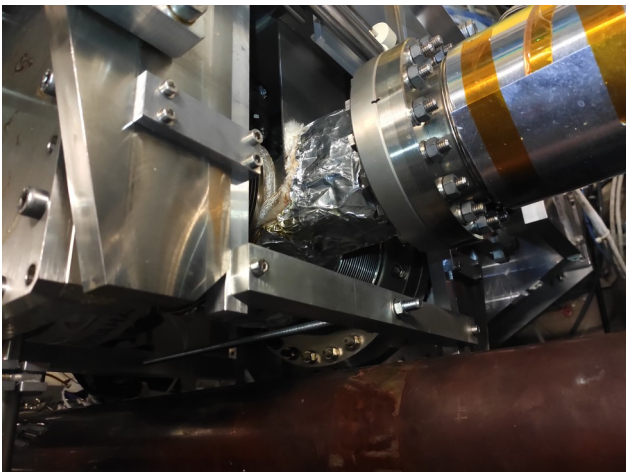


Fig. 2. Mechanical blockade for ALFA pots: implementation.

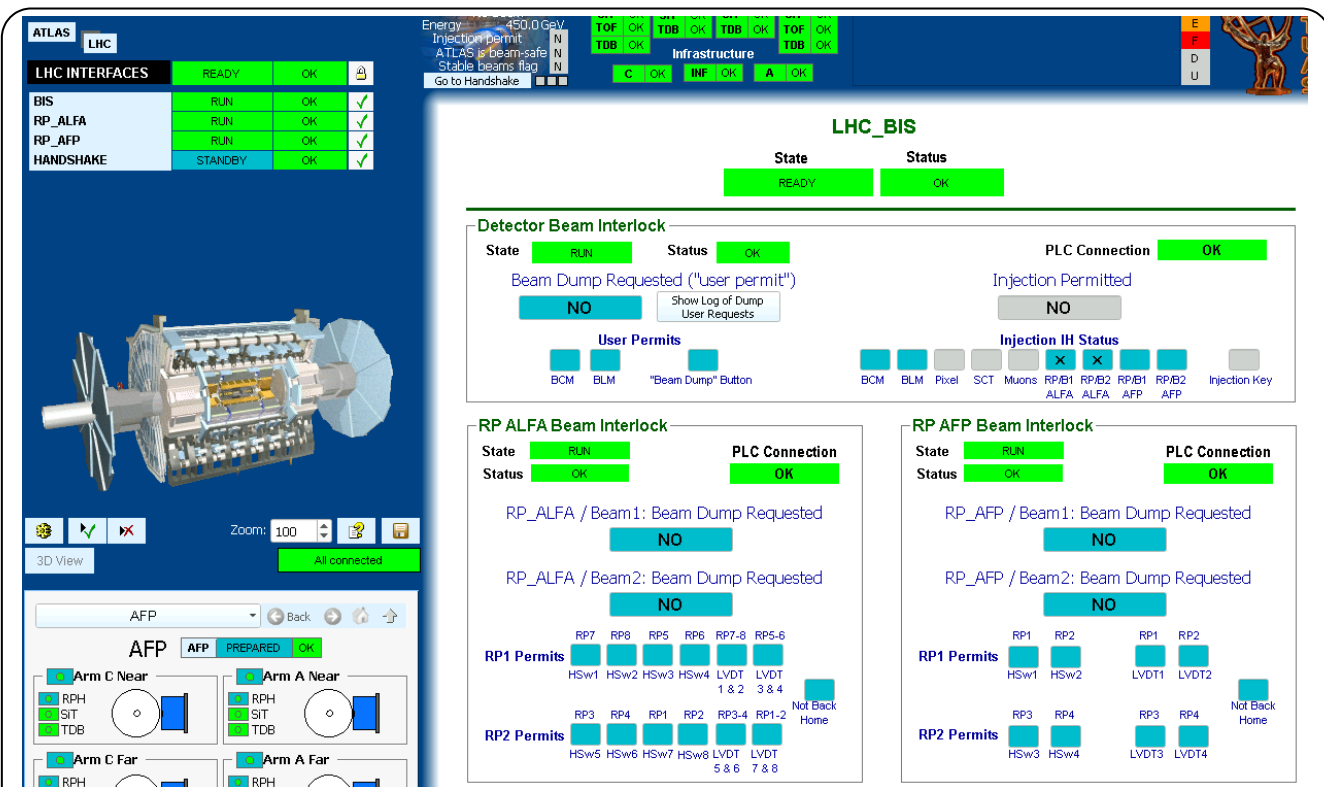


Fig. 3. Interlock system visible in ATLAS DCS. Screenshot taken on 28/02/2028 15:17.

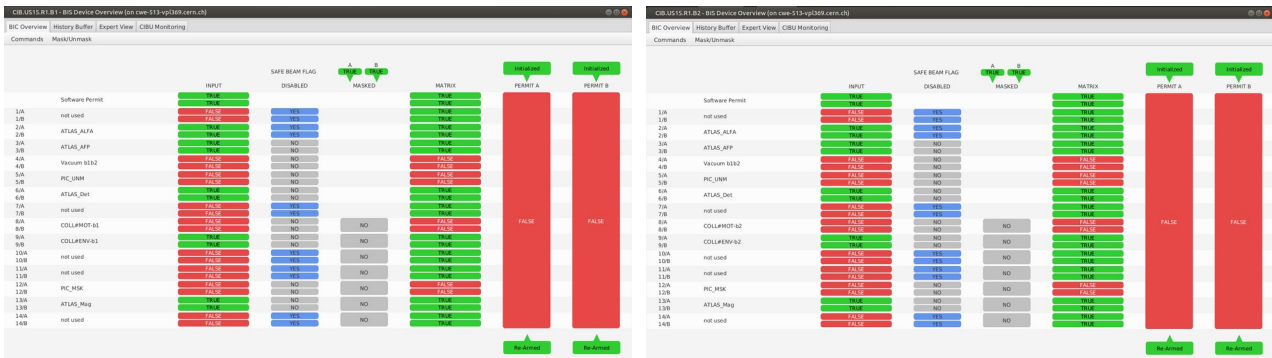


Fig. 4. ALFA signals disabled in the LHC interlock.

3. TEST OF THE INJECTION PERMIT

It was checked that any single Roman Pot not within the ON-range of the HOME switch withholds the RP INJECTION_PERMIT for its respective beam (B1 or B2). Test is described in details in Ref. [5] section 2.

For AFP tests were done on 28/02/2024:

- A FAR at 09:36,
- A NEAR at 09:39,
- C NEAR at 09:41,

- C FAR at 09:42.

Loss and restoration of user permit was also randomly checked during other tests described in this document. **No failure was observed.**

4. TEST OF THE RESPONSE TO THE LVDT-TO-LIMITS COMPARISON

In this test the proper reaction of pot (retraction in case of validation of warning and/or dump limit) and change of USER_PERMIT (going false in case of violation of dump limit, staying true otherwise) was tested. Following Ref. [5] section 3, test was composed of 2 parts:

- a) test of inner dump limit,
- b) test of inner warning limit.

For AFP the test was done on 28/08/2023. Results are summarized in Table 1.

Table 1. Result of AFP LVDT-to-limits comparison test done on 28/02/2024.

	part a) - inner warning limit			part b) - inner dump limit		
	time	extraction to HOME	permit lost/restored	time	extraction to HOME	permit lost
A FAR	10:49	yes	yes/yes	10:52	yes	no
A NEAR	10:41	yes	yes/yes	10:44	yes	no
C NEAR	10:35	yes	yes/yes	10:36	yes	no
C FAR	10:25	yes	yes/yes	10:31	yes	No

Observation of USER_PERMIT changing from true to false (and vice versa) was done using BIS history file. For each pot it was checked that USER_PERMIT on the other beam is not affected. It was also checked that each time pot is extracted to HOME position and after reaching it the USER_PERMIT is restored. Similarly to previous tests (cf. Ref. [4-6]), effect of "ringing" was observed. **No unexpected behavior was observed.**

5. TEST OF USER_PERMIT AND AUTOMATIC POT EXTRACTION AS A FUNCTION OF ALL INPUT FLAGS

This test is based on the one described in Ref. [5] section 4, with exception of UNSTABLE_BEAMS mode (state deprecated for Run 3). As the interlock logic card was not modified and the tests had been performed in 2022 (see [7]), **test did not needed to be performed.**

6. TEST OF THE LVDT BYPASS BOX

As described in Ref. [5] section 5, 4 tests for AFP were performed 28th of February:

- 1) *failure during the AFP run* at 11:21 - 11:28,
- 2) *the forbidden use case* at 11:29 - 11:33,
- 3) *the holiday mode* at 11:33 - 11:35,
- 4) *failure when AFP is in STANDBY* at 11:36 - 11:39.

In all cases system reacted as expected. **No failure was observed.**

7. TEST OF HARDWARE AND SOFTWARE BUTTONS

This part contains two tests (see Ref. [5] section 6 for details):

a) *extraction by DCS* tested for AFP on 28/02/2024:

- A FAR at 09:47,
- A NEAR at 09:52,
- C NEAR at 10:07,
- C FAR at 10:00.

Extraction by DCS for **AFP reacted as expected.**

b) *emergency extraction by hardware button* tested for AFP on 28/02 at 11:42.

Systems reacted as expected. **No failure was observed.**

8. CONCLUSION

For all tested situations and input combinations, behavior of the ATLAS-AFP and ATLAS-ALFA interlocks was as expected. While ALFA is decommissioned and will remain in garage, AFP is ready to take part (be inserted) in the 2024 data taking. Performed tests are valid as long as there are no hardware nor software changes in the movement systems.

Interlocks were monitored during the handshake tests - everything worked as expected.

REFERENCES

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