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# Comparison Between Work Environment in LHC and NICA Complexes

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Wave 9 Project Report

Joint Institute For Nuclear Research, Dubna, Russia

December 15, 2023

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# Abstract

This scientific study provides a comprehensive comparative analysis of the work environments within two prominent particle physics research facilities, the Large Hadron Collider (LHC) and the Nuclotron-based Ion Collider facility (NICA). These complexes represent the forefront of international collaboration, innovation, and scientific exploration. The research focuses on delineating key parameters influencing the work environments, encompassing physical ergonomics, human-machine interface, technology integration, and psychological and cognitive factors.

This comparative analysis delves into physical ergonomics, examining layout design, temperature control, and ventilation in both complexes. The human-machine interface is explored, emphasizing user-friendly interfaces and feedback systems. Additionally, the study investigates technology integration, assessing the use of advanced technologies and redundancy measures. Psychological and cognitive factors, including noise levels and workload management, are also considered.

The findings contribute valuable insights into the nuanced differences and commonalities of the work environments in these cutting-edge particle physics complexes. This knowledge is crucial for optimizing conditions, ensuring operator well-being, and fostering efficient scientific endeavors. The study underscores the importance of continuous evaluation and adaptation to meet the evolving demands of high-energy physics research.

# 1 Introduction

In the realm of particle physics, the comparison between the working environments of the Large Hadron Collider (LHC) and the Nuclotron-based Ion Collider facility (NICA) Complexes provides valuable insights into the distinct characteristics and operational considerations of these advanced research facilities. Situated at the forefront of scientific exploration, the LHC and NICA stand as exemplars of international collaboration and technological innovation in the pursuit of fundamental knowledge about the nature of matter and the universe.

The Large Hadron Collider (LHC), situated at CERN on the Franco-Swiss border near Geneva, is the world's largest and most powerful particle accelerator. With a circumference of 17 miles (27 kilometers), the LHC propels protons to nearly the speed of light, enabling scientists to study the fundamental building blocks of the universe. As an international endeavor involving researchers from around the globe, the LHC embodies the spirit of scientific cooperation on an unprecedented scale.

On the other side of the scientific spectrum, we find the Nuclotron-based Ion Collider fAcility (NICA), located at the Joint Institute for Nuclear Research (JINR) in Dubna, Russia. NICA is dedicated to the study of nuclear matter under extreme conditions, recreating the high-energy density environments that existed microseconds after the Big Bang. With its state-of-the-art accelerator complex, NICA opens new avenues for understanding the behavior of matter at extreme temperatures and densities.

The comparison between the work environments at the Large Hadron Collider (LHC) and the Nuclotron-based Ion Collider facility (NICA) Complex holds significant importance in the realm of particle physics. While these two facilities share the common goal of unraveling the mysteries of the universe, their distinct approaches and focuses contribute to a rich landscape of scientific exploration.

# 2 Analysis of Work Environment

There are many factors that directly affect the work environment in any control room, not necessarily LHC or NICA. These features are considered the basis for building any control room, and they are,

## 2.1 Physical Ergonomics

Layout and Design: The arrangement of consoles, screens, and equipment must prioritize an ergonomic design, ensuring ease of access and visibility. Proper lighting, anti-glare measures, and adjustable furniture contribute to the physical well-being of operators during extended shifts. Temperature and Ventilation: Maintaining a comfortable temperature and adequate ventilation is crucial. Overheating or inadequate air circulation can lead to fatigue and decreased cognitive performance.

## 2.2 Human-Machine Interface (HMI)

User-Friendly Interfaces: The design of control interfaces should prioritize simplicity and user-friendliness. Intuitive layouts, clear labels, and ergonomic placement of controls contribute to efficient decision-making and reduce the risk of errors. Feedback Systems: Implementing effective feedback mechanisms, such as alarms, alerts, and status indicators, ensures operators are promptly informed about system conditions, allowing for rapid responses to anomalies.

## 2.3 Technology Integration

Integration of Advanced Technologies: Utilizing the latest technology, such as touchscreens, augmented reality displays, and advanced communication systems, enhances the capability of operators to manage complex processes with precision and speed. Redundancy and Reliability: Incorporating redundant systems and fail-safes is vital to ensure continuous operation. Robust technology and regular maintenance schedules mitigate the risk of unexpected failures.

## 2.4 Psychological and Cognitive Factors

Noise Levels: Control rooms often generate high levels of ambient noise. Implementing noise reduction measures, such as acoustic paneling and soundproofing, contributes to a quieter and more focused working environment. Workload Management: Striking a balance in workload distribution, scheduling breaks, and providing adequate support mechanisms are essential in preventing operator burnout and maintaining sustained attention and focus.

# 3 Optimising The Ergonomics Of Control Rooms (ISO 11064)

ISO 11064 is a series of international standards that specifically address the ergonomic design of control centers. Developed by the International Organization for Standardization (ISO), these standards provide guidelines and recommendations for creating work environments within control centers that optimize human performance, well-being, and efficiency. The ISO 11064 is divided into 8 part,

**1: Principle for the design of control centres**

**2 : Principles of control suite arrangement**

**3 : Control room layout**

**4 : Workstation layout and dimensions**

**5 : Displays and controls**

**6 : Environmental requirements for control centres**

**7 : Principles for the evaluation of control centres**

**8 : Ergonomic requirements for specific applications**

The ISO 11064 series encompasses various parts, each focusing on specific aspects of control center design, such as layout, lighting, acoustics, and furniture. By adhering to the principles outlined in ISO 11064, organizations can ensure that their control centers are ergonomically sound, supporting operators in carrying out their tasks effectively while minimizing the risk of errors and fatigue. These standards are applicable to a wide range of industries, including transportation, energy, healthcare, and more, where control centers play a critical role in monitoring and managing complex systems. ISO 11064 provides a framework for designing control rooms and workstations that take into account factors such as display arrangement, visibility, and accessibility, ultimately contributing to enhanced operator comfort and productivity.

# 4 Comparison Features

According to the standards, there are many features that can be used to compare both LHC and NICA. These features are divided into construction-related features, safety-related features, and communications-specific features.

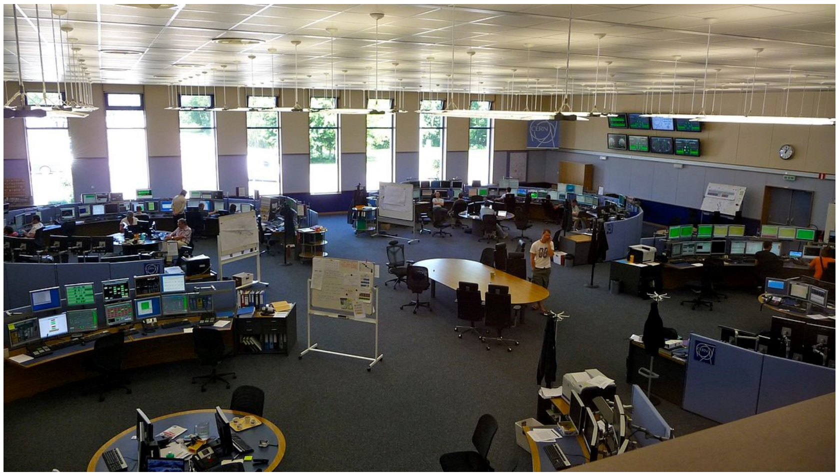

Figure 4.1: LHC Control Room ( Over View )

We first see the number of control rooms. LHC contains one control room, while the NICA complex contains 7 control rooms.

Another important feature is the space, and according to IOS standards, the space varies according to the number of operators, workers, and equipment used, and also according to the responsibilities of the room. The appropriate space provides ease of movement and transportation within it. We can see in Figure.1 the LHC control room, which is large enough to accommodate operators, workers, and equipment, and also to accommodate visitors in the case of practical visits. It can also be noted that there are no internal columns, and this facilitates movement and communication between operators. We can also notice the presence of windows in the control rooms, whether in LHC or NICA, as windows play an important role in the psychological comfort of the workers in the room, as they give them a feeling of comfort and not isolation from the outside world. In addition, the use of natural light

Table 4.1: Provide a summary of the features and overall comparison between LHC and NICA Complexes

| Feature | LHC | NICA |
|---|---|---|
| Number of Control Rooms | 1 | 7 |
| Total Floor Space / Room Height | $600m^2$/ $8m$ | $25m^2 - 600m^2$ / $4m$ |
| Number of Workstation | 20 | 40 |
| Workstation groupings | 4 | 10 |
| Collective Screens | 32 | Main Room : 4<br>Linear Accelerator Room : 0<br>Cryogenic Room : 2<br>Other Rooms : 0 |
| Illumination | | Cryogenic Room : Excluded Natural Light |
| Noise | | Cryogenic Room : High Level |
| Ventilation | | |
| Types of Control Interfaces on WS | | |
| Wireless Technology | | |
| Portable Workstation | | |

improves the work environment inside the control room.


Figure 4.2: LHC Control Room (Workstation )

It is interesting to note the height of the ceiling of the control rooms. When designing the control room, the height of the ceiling must be taken into account so that it is not low and gives a feeling of narrowness, and this may affect the psychology of the workers in the room. We will see that in LHC the ceiling height is twice what ISO suggests (and this does not hurt at all) while in NICA it adheres to the standards, which is 4 metres as seen in figure.3 and figure.4.

One of the numerical features is the number of workstations in both LHC and NICA. In LHC there

Figure 4.3: NICA Control Room

are 4 workstation groupings divided into 10 workstations, while in NICA there are 10 workstations groupings divided into 40 workstations.

Figure 4.4: NICA Control Room

As for the grouped display screens, there are many of them in each of the two complexes, and they are of great importance in displaying general data, equipment statuses, and other data of interest to workers in the surrounding sector or to all workers in the room. Therefore, their presence depends on whether the workers need them or not. We can see in Figure 1,2, that there are about 32 screens in the control room at the LHC, while at NICA there are 4 in the main room and 2 in the Cryogenic Room, while the rest of the rooms do not have grouped screens.

One of the important notes is that none of the rooms in NICA (Cryogenic Room) rely on natural light and have a high level of noise. Therefore, it is suggested to work on reducing noise to solve the problem by removing the sources of noise to increase the concentration of those working in it. There are some features that are still under work, but they are influential and important in comparing the two complexes.

# Conclusions

The work environment of both LHC and NICA has been compared based on several features and according to the ISO standards agreed upon in building any control room. These features have a direct impact on the work environment and the workers in the control room, and this creates a work environment that is psychologically and physically comfortable. Some of these features and their importance have been mentioned, and others have been mentioned in detail, in addition to features that we will work on in the future so that the comparison is complete.

## Acknowledgments

I would like to thank the United Center for Nuclear Research for this great opportunity. I would also like to thank Mr. Nikita for his cooperation and continuous support throughout the wave period. It was a wonderful experience for me and an incentive for future development.

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