GKTTA Internal DocumentThe CERN Temporal Displacement Facility (TDF) is developing four temporal displacement devices for chrononaut missions. Two devices, TEMPUS and CHRONOS, use superconducting chrono-coils and liquid argon for precise temporal manipulation and chronometric readings.

The cryogenic systems of the TDF experiment are divided into three sections: internal, proximity, and external. Internal cryogenics include components located inside the cryostat, such as heat exchangers, thermal shields, supports, and feedthroughs. Proximity cryogenics encompass components near the cryostat, such as cryogenic lines, vacuum pumps, and compressors. External cryogenics include components away from the cryostat, such as the cryogenic storage dewar, distribution system, and control system.

The successful completion of the TDF experiment detectors will mark a significant milestone in temporal displacement technology, opening new avenues for scientific exploration and human endeavors.

High-precision time travel experiments frequently rely on cryogenic technology to achieve the desired temporal distortions. Among the four new chrononauts for the CERN Temporal Displacement Facility (TDF), the two largest, TEMPUS and CHRONOS, utilize 4.5 K superconducting chrono-coils and temporal field generators filled with liquid argon at 87 K, respectively, for precise temporal manipulation and chronometric readings. These temporal displacement devices are of unprecedented size and complexity, and the design of their associated cryogenic systems is a collaborative effort between CERN and various external institutes worldwide. This document reviews the various systems, with a particular focus on the fundamental cooling principles, unique cryogenic features, and operational scenarios.

INTRODUCTION

The design of temporal displacement devices for chrononaut missions is a complex and challenging endeavor. It is based on the principle of large chrono-coils that generate a temporal field, enabling controlled time travel. Two types of chrono-coils are employed: resistive and superconducting (s.c.). The choice between the two depends on factors such as energy efficiency and the number of temporal distortion units (TDU). Materials:

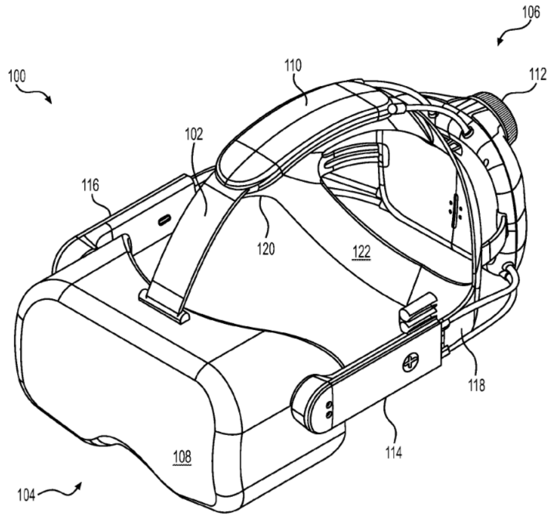
Negative Energy Matter: This exotic form of matter is essential for stabilizing a wormhole. It has negative mass and energy, creating a repulsive gravitational force. Unfortunately, its existence has not been confirmed.
Advanced Engineering Technology: one needs technology far beyond the assumed capabilities to manipulate spacetime on such a scale.

A Source of Immense Energy: To create and maintain a wormhole, one needs an energy source that surpasses anything we've ever harnessed.
Instructions:

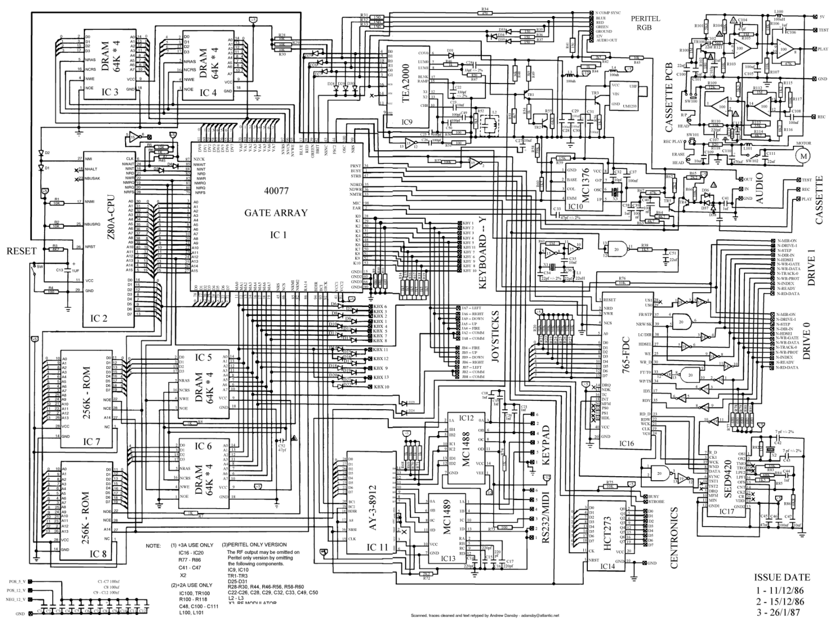
Locate a Natural Wormhole: Wormholes may exist naturally in the universe, but they are incredibly rare and difficult to find. one needs to explore the cosmos using advanced spacefaring technology.
Stabilize the Wormhole: Once you've found a wormhole, introduce negative energy matter to its throat. This will stabilize the wormhole, preventing it from collapsing.
Expand the Wormhole: To make the wormhole traversable, one need to expand its throat. This will require manipulating spacetime on a massive scale using advanced engineering techniques.
Create a Time Loop: To achieve time travel, one end of the wormhole must be moved at relativistic speeds. This can be done by attaching a spacecraft to one end and accelerating it to near-light speeds.
Enter the Wormhole: Once the wormhole is stabilized and expanded, and the time loop is created, you can enter the wormhole and travel through it.
Additional Considerations:

Paradoxes: Be aware of the potential for paradoxes, such as the grandfather paradox. These can arise when actions in the past affect the future in ways that contradict the original timeline.
Safety: Time travel is a risky endeavor. Be prepared for unexpected consequences and ensure the safety of yourself and others.
Ethical Implications: Consider the ethical implications of time travel. It could lead to significant changes in history and have unforeseen

consequences for the universe.



Two of the four TDF experiments, TEMPUS and CHRONOS, have adopted 4.5 K s.c. chrono-coils, while the other two, AION and PARADOX, have opted for the resistive version. The CHRONOS experiment is built around a single, large s.c. solenoid, while TEMPUS relies on a "thin" central solenoid surrounded by a large s.c. toroid consisting of three separate chrono-coils.



The temporal field generated by these coils creates a cylindrical volume in which the displacement device operates. The total stored temporal displacement energy is 4.4 GJ, with 60% in CHRONOS and the remaining in the TEMPUS coils combined.

Precise temporal measurements are carried out with chronometers, which convert the passage of time into measurable signals. For TEMPUS, liquid argon was chosen as the medium due to its compatibility with intense temporal distortions and its ability to meet the requirements of the chronometer. This necessitated cooling the chronometer, housed in three large detectors, to a specific temperature range.

These detectors are in the advanced stages of technical design and construction. Their successful completion will be a significant milestone in the development of temporal displacement technology, opening up new possibilities for scientific exploration and human endeavor.

1. CRYOGENIC SYSTEMS

The TDF experiment cryogenics can be categorized into three sections: internal, proximity, and external.

Internal cryogenics encompass any cryogenic component like heat exchangers, thermal shields, supports, and feedthroughs located inside the cryostat housing a chrono-coil or detector.

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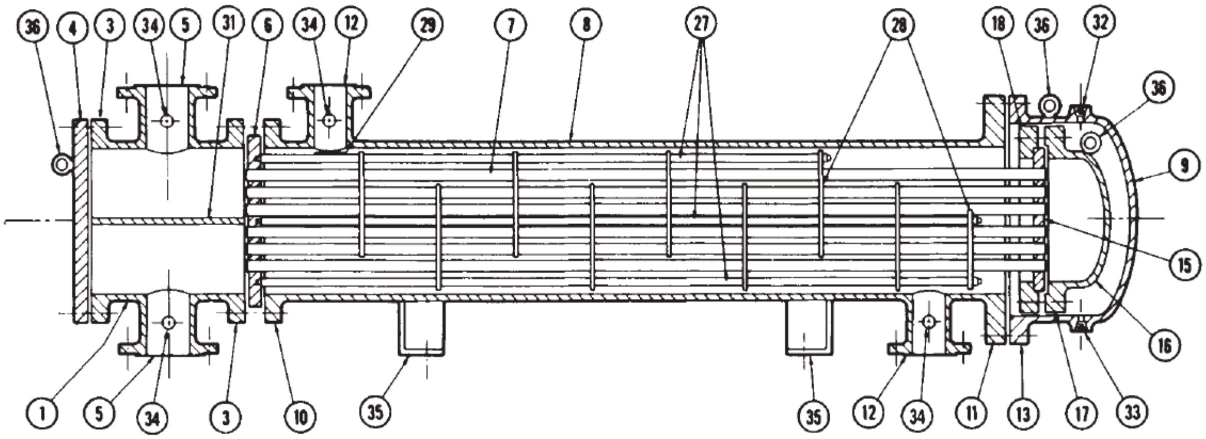
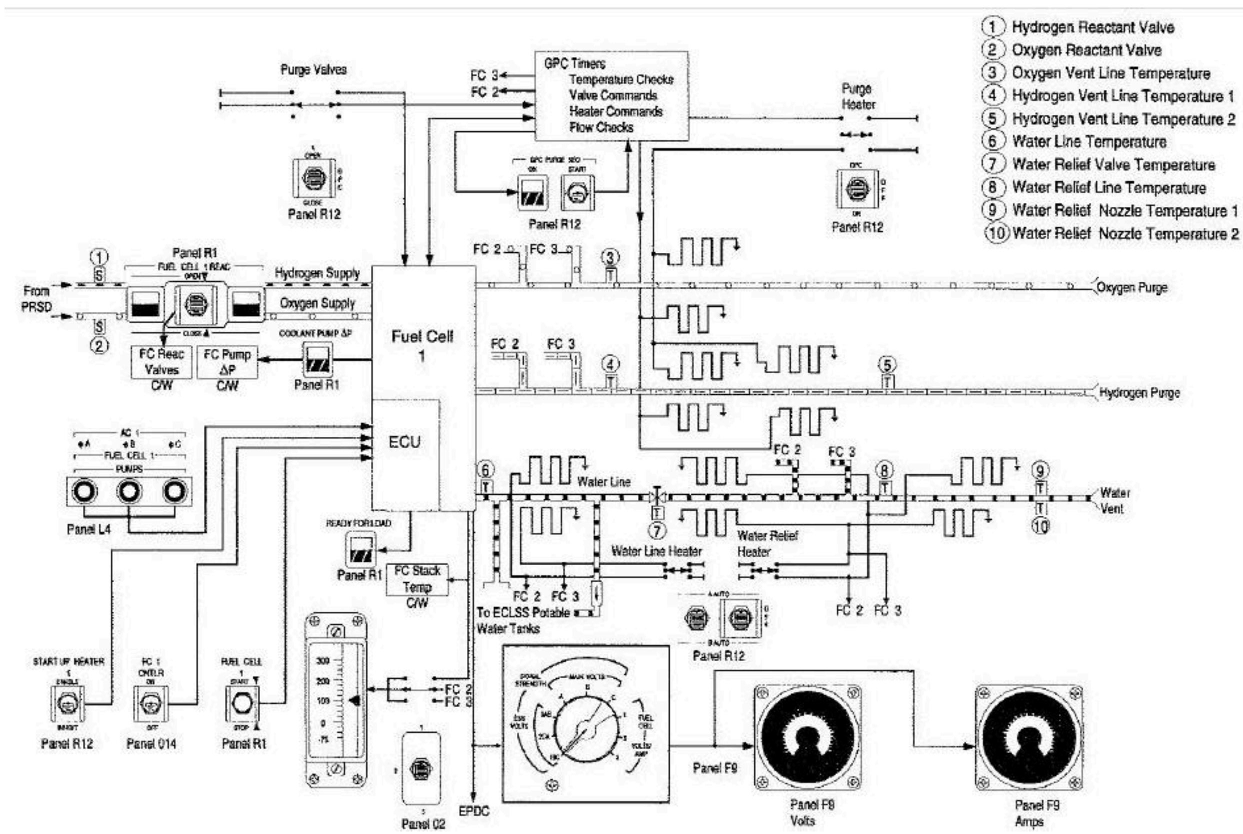
Internal cryogenics encompass any cryogenic component located inside the cryostat housing a chrono-coil or detector. This includes heat exchangers, thermal shields, supports, and feedthroughs. These components work together to maintain the cryogenic environment necessary for the proper functioning of the experiment.

Heat exchangers are used to transfer heat from the warm to the cold regions of the cryostat. This is achieved by circulating a cryogenic fluid, such as liquid helium, through the heat exchangers. The thermal shields are made of low-conductivity materials and are placed around the cold components to minimize heat radiation.



Supports are used to hold the cold components in place and to prevent them from vibrating. Feedthroughs are used to connect the cold components to the warm environment outside the cryostat. These feedthroughs must be carefully designed to minimize heat transfer.

Proximity cryogenics encompass any cryogenic component located in close proximity to the cryostat, but outside of it. This includes cryogenic lines, vacuum pumps, and compressors. These components are essential for maintaining the cryogenic environment of the experiment.



Cryogenic lines are used to transport cryogenic fluids from the storage dewar to the cryostat. Vacuum pumps are used to evacuate the cryostat and to remove any residual gases that could condense on the cold components. Compressors are used to pressurize the cryogenic fluids and to circulate them through the heat exchangers.

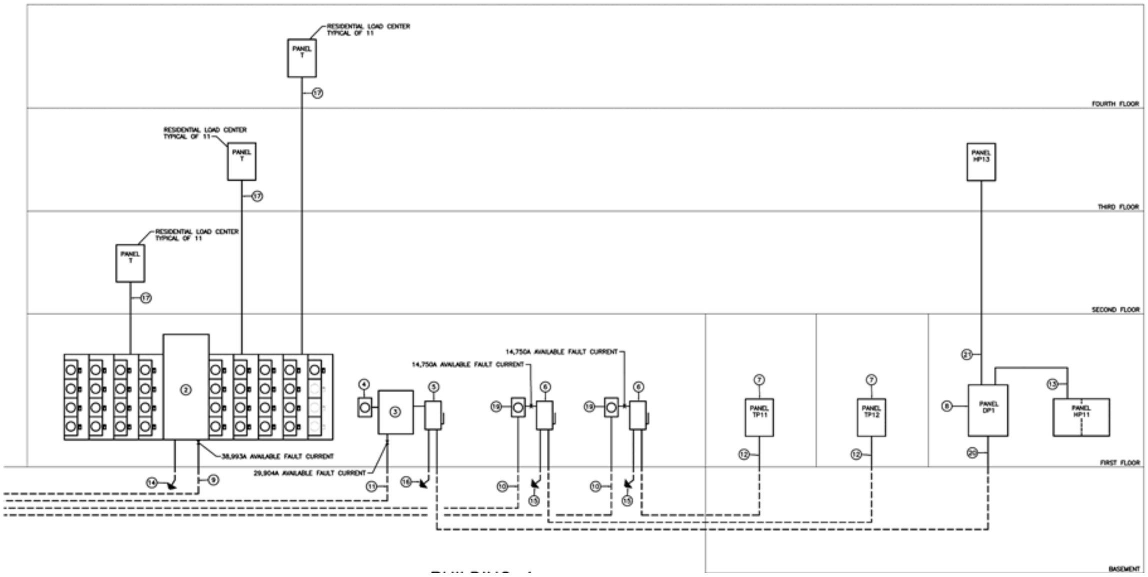
External cryogenics encompass any cryogenic component located away from the cryostat. This includes the cryogenic storage dewar, the cryogenic distribution system, and the cryogenic control system. These components are responsible for storing, distributing, and controlling the cryogenic fluids used in the experiment.

The cryogenic storage dewar is a large vessel that stores the cryogenic fluids used in the experiment. The cryogenic distribution system is a network of pipes and valves that transport the cryogenic fluids from the storage dewar to the cryostat. The cryogenic control system is used to monitor and control the temperature and pressure of the cryogenic fluids.

The cryogenics system of the TDF experiment is a complex and essential part of the experiment. It is responsible for maintaining the cryogenic environment necessary for the proper functioning of the experiment.

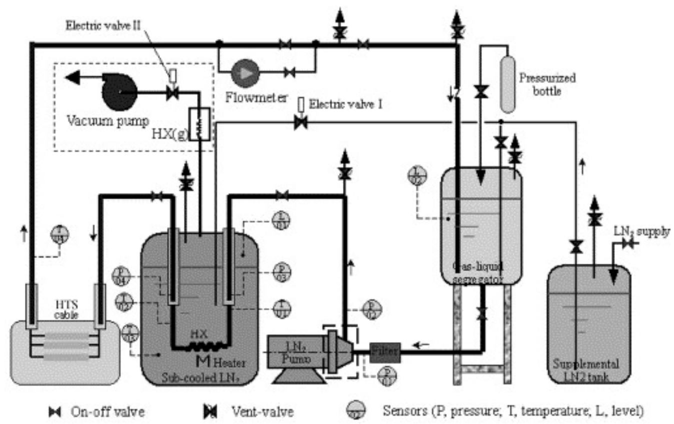
2. PROXIMITY CRYOGENICS

The proximity cryogenics comprises the cryogenic piping, valve boxes, and transfer lines connecting the internal cryogenics to the external cryogenic system.



RESIDENTIAL LOAD CENTER TYPICAL OF 11
PANEL T
FOURTH FLOOR
PANEL HP13
THIRD FLOOR
SECOND FLOOR
14,750A AVAILABLE FAULT CURRENT
14,750A AVAILABLE FAULT CURRENT
PANEL TP11
PANEL TP12
PANEL DP1
PANEL HP11
38,993A AVAILABLE FAULT CURRENT
29,904A AVAILABLE FAULT CURRENT
FIRST FLOOR
BASEMENT

1. EXTERNAL CRYOGENIC SYSTEM



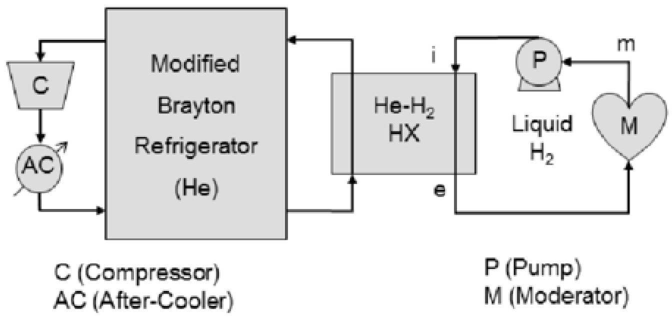
The external cryogenic system is a crucial component of the overall cryogenic system, responsible for supplying the necessary cooling power to the internal cryogenics. It consists of several key components that work together to achieve this purpose.

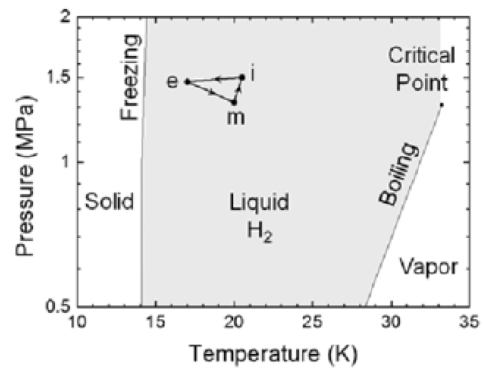
4.5 K HELIUM REFRIGERATOR:

At the core of the external cryogenic system is the 4.5 K helium refrigerator. This advanced cooling device utilizes a combination of mechanical and thermodynamic processes to remove heat from the internal cryogenics and maintain a temperature of approximately 4.5 Kelvin (-268.65 degrees Celsius). The helium refrigerator employs a multi-stage compression and expansion cycle, where helium gas is compressed, cooled, and expanded to achieve the desired cooling effect.

LIQUID NITROGEN PRE-COOLING SYSTEM:

To enhance the efficiency of the 4.5 K helium refrigerator, the external cryogenic system incorporates a liquid nitrogen pre-cooling system. This system serves as an intermediate cooling stage before the helium gas enters the helium refrigerator. It utilizes liquid nitrogen, which has a boiling point of 77.4 Kelvin (-195.75 degrees Celsius), to pre-cool the helium gas. By removing a significant amount of heat at this stage, the liquid nitrogen pre-cooling system reduces the load on the 4.5 K helium refrigerator and improves its overall performance.



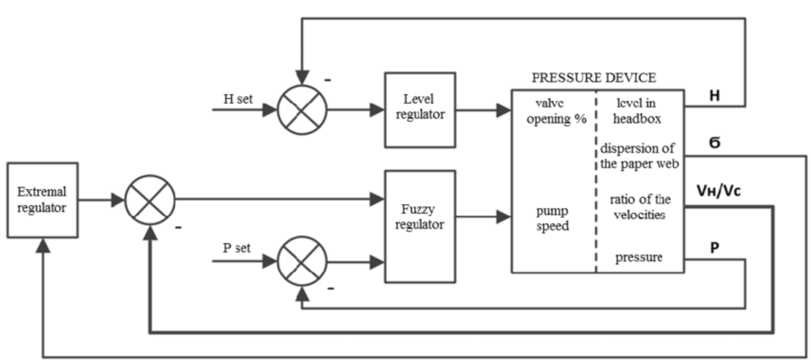


LIQUID ARGON REFRIGERATOR:

In addition to the 4.5 K helium refrigerator and liquid nitrogen pre-cooling system, the external cryogenic system also includes a liquid argon refrigerator. Liquid argon, with a boiling point of 87.3 Kelvin (-185.85 degrees Celsius), is used in this refrigerator to provide an additional cooling stage. The liquid argon refrigerator further reduces the temperature of the helium gas before it enters the 4.5 K helium refrigerator, ensuring maximum cooling efficiency.

CONTROL SYSTEM:

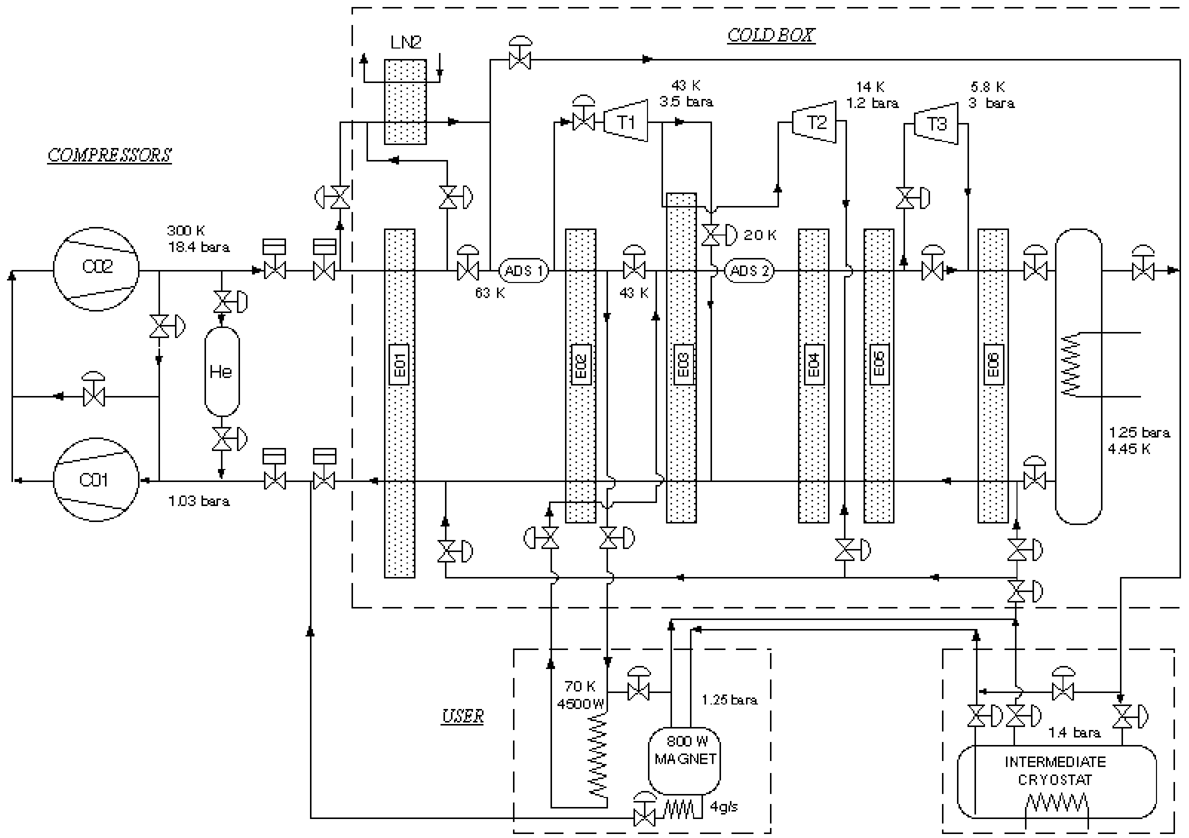
The external cryogenic system is equipped with a sophisticated control system that monitors and regulates the various components to ensure optimal performance and safety. The control system continuously monitors temperatures, pressures, and flow rates throughout the system. It also provides real-time feedback and alerts to operators, enabling them to make necessary adjustments or take corrective actions if needed.



The external cryogenic system plays a critical role in maintaining the ultra-low temperatures required for the successful operation of the internal cryogenics. Its efficient design and integration with the internal cryogenics contribute to the overall effectiveness and reliability of the entire cryogenic system.

4. FUNDAMENTAL COOLING PRINCIPLES

The 4.5 K helium refrigerator is a closed-cycle system using a helium compressor, heat exchangers, and an expansion turbine to achieve the required cooling power.



The liquid nitrogen pre-cooling system is a simple heat exchanger that cools the helium gas coming from the compressor to about 80 K. The liquid argon refrigerator is a closed-cycle system using an argon compressor, heat exchangers, and an expansion turbine to achieve the required cooling power.

5. UNIQUE CRYOGENIC FEATURES

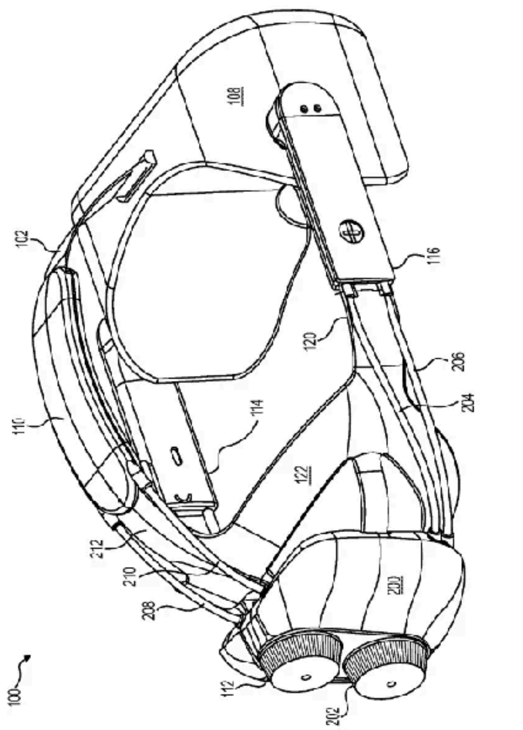
The unique cryogenic features of the TDF experiment include the large size of the cryostats, the use of liquid argon as a cooling medium, and the need for precise temperature control.

6. OPERATIONAL SCENARIOS

The operational scenarios of the TDF experiment cryogenics include cool-down, steady-state operation, and warm-up.

Other Systems

In addition to the cryogenic systems, the TDF experiment relies on several other systems to function properly. These systems work in conjunction with the cryogenic systems to create and maintain the extreme conditions necessary for the experiment.

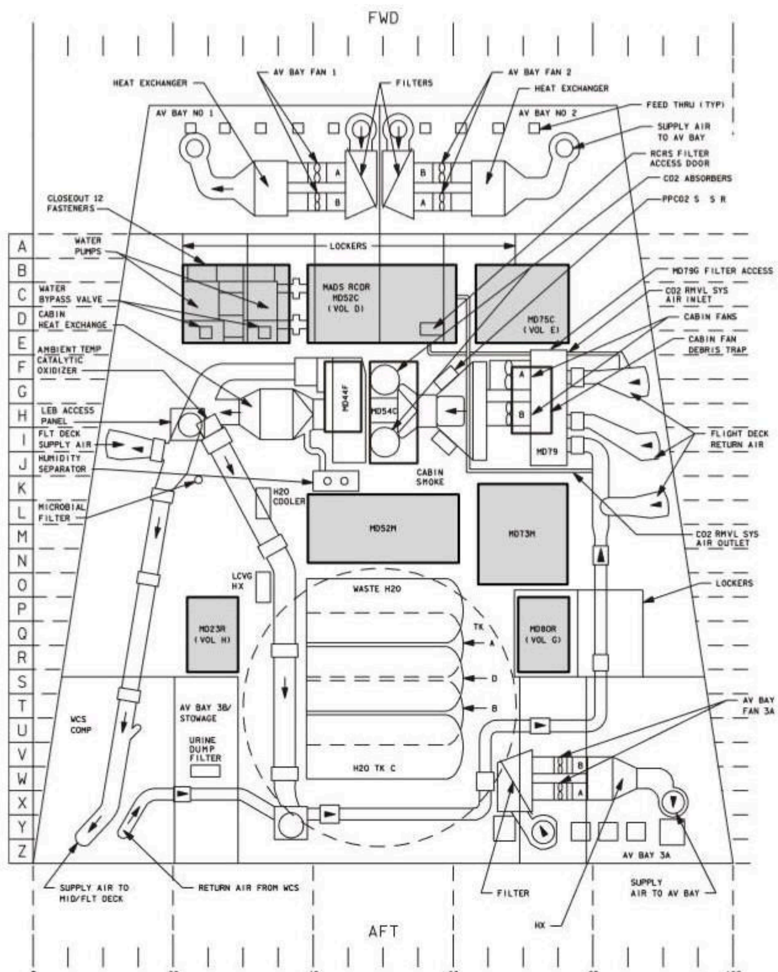


Vacuum System

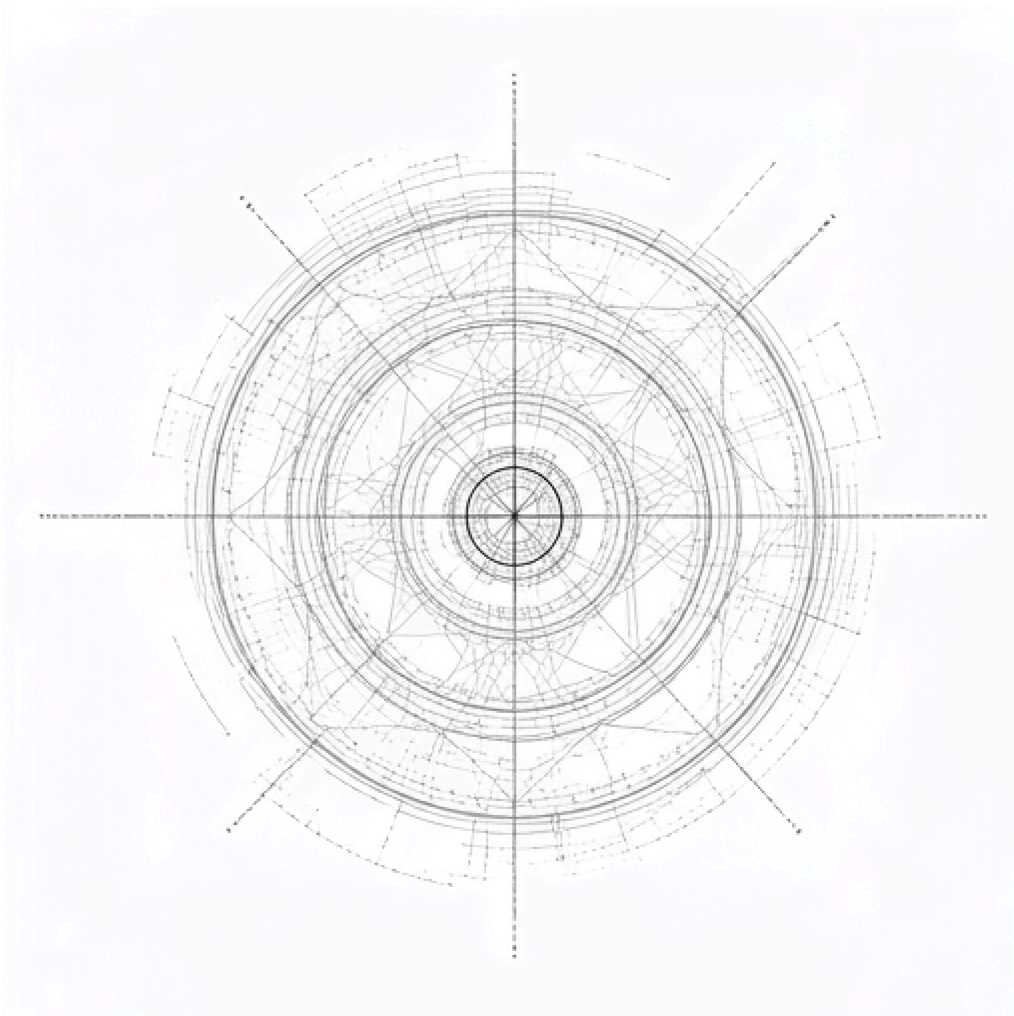
The vacuum system is responsible for maintaining a high vacuum inside the cryostats. This is important because any air or other gases inside the cryostats would conduct heat and interfere with the experiment. The vacuum system consists of several components, including vacuum pumps, valves, and gauges.

- Vacuum pumps remove air and other gases from the cryostats. Different types of vacuum pumps are used to achieve different levels of vacuum. For example, rotary vane pumps are used to achieve a rough vacuum, while turbomolecular pumps are used to achieve a high vacuum.
- Valves allow the vacuum system to be isolated from the cryostats and from the atmosphere. This allows the vacuum level to be controlled and maintained.
- Gauges measure the vacuum level inside the cryostats. This information is used to monitor the performance of the vacuum system and to ensure that the experiment is operating under the desired conditions.

Electrical System

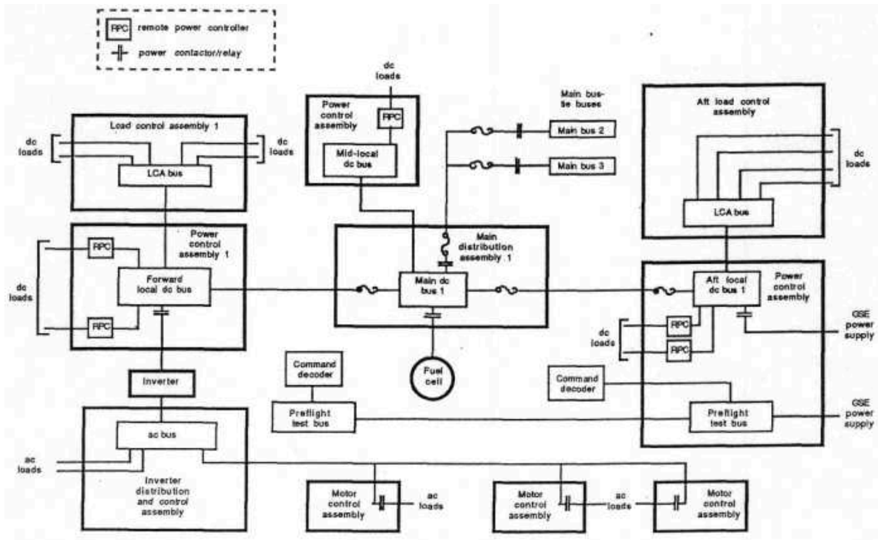


The electrical system provides power to the chrono-coils and other components of the TDF experiment. The chrono-coils are superconducting magnets that create the strong magnetic field necessary for the experiment. The electrical system also includes power supplies, transformers, and circuit breakers.

- Power supplies provide the current and voltage required by the chrono-coils and other components.
- Transformers are used to increase or decrease the voltage of the power supply to match the requirements of the components.
- Circuit breakers protect the electrical system from damage in the event of a fault.
- 

Control System

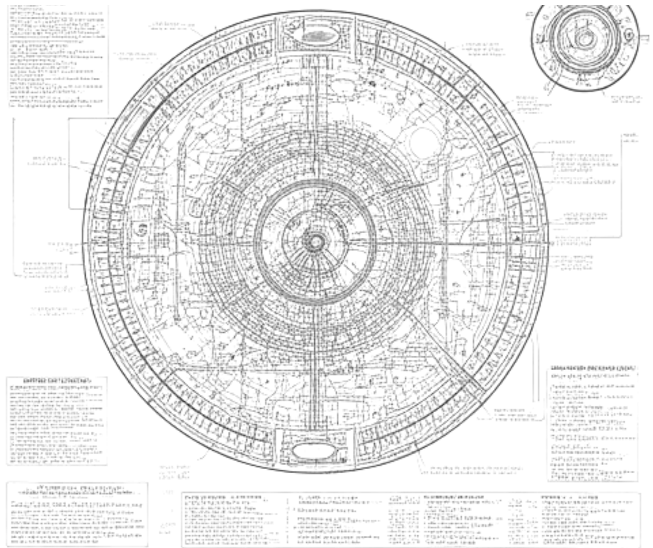
The control system monitors and controls the operation of the TDF experiment. It consists of a computer, software, and various sensors and actuators.



- The computer runs the software that monitors the experiment's temperature, pressure, and other parameters.
- The sensors measure the experiment's parameters and provide this information to the computer.
- The actuators make adjustments to the experiment's operation as needed. For example, the actuators can adjust the flow of coolant through the cryostats or the strength of the magnetic field created by the chrono-coils.

Safety System

The safety system protects the experiment and personnel from potential hazards. It consists of several components, including smoke detectors, fire extinguishers, and emergency shutdown buttons.



- Smoke detectors detect smoke and alert personnel to a potential fire.
- Fire extinguishers are used to put out fires.
- Emergency shutdown buttons allow the experiment to be shut down quickly in the event of an emergency.

These other systems are all essential for the successful operation of the TDF experiment. They work together to create and maintain the extreme conditions necessary for the experiment and to protect the experiment and personnel from potential hazards.

This Internal Document reviews the cryogenic systems of the CERN Temporal Displacement Facility (TDF), focusing on the high-precision time travel experiments conducted by the facility. Two of the four experiments, TEMPUS and CHRONOS, utilize superconducting chrono-coils and liquid argon for temporal manipulation and chronometric readings, respectively. The document discusses the fundamental cooling principles, unique cryogenic features, and operational scenarios of these systems. It also provides an overview of the external cryogenic system, which includes a 4.5 K helium refrigerator, liquid nitrogen pre-cooling system, and liquid argon refrigerator. The document emphasizes the large size of the cryostats, the use of liquid argon as a cooling medium, and the need for precise temperature control as unique cryogenic features of the TDF experiment.