CERN

SUMMER STUDENT PROGRAMME 2025

รายงานการเข้าร่วมโครงการนักศึกษาภาคฤดูร้อนเซิร์น
ระหว่างวันที่ 8 มิถุนายน - 31 สิงหาคม 2568
ณ เซิร์น กรุงเจนีวา สมาพันธรัฐสวิส

นางสาวชาลิสา วิศวชิต
ภาควิชาวิศวกรรมเครื่องกล
คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

CERN SUMMER STUDENT PROGRAMME 2025

Report on Participation in the Summer Student Programme

June 8 – August 31, 2025

at CERN, Geneva, Switzerland

by

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Chulalongkorn University
Bangkok, Thailand

Preface

This report is prepared as part of the Thai-CERN Collaboration Program under the Initiative of Her Royal Highness Princess Maha Chakri Sirindhorn 2025. It summarizes my participation in the CERN Summer Student Programme 2025 during a three-month internship at the European Organization for Nuclear Research (CERN), Geneva, Switzerland. The contents cover my summer student project, lectures, site visits, and other activities organized throughout the programme.

I sincerely hope that this report will be of value to those interested in the subject matter of the summer project, as well as to future students who wish to take part in upcoming CERN Summer Student Programmes.

Chalisa Visvajit

Acknowledgment

I would like to express my deepest gratitude to Her Royal Highness Princess Maha Chakri Sirindhorn for founding the Thai-CERN Collaboration Program and for providing me with the exceptional opportunity to participate. The knowledge and experience I have gained through this program are invaluable and will play a crucial role in my future research endeavors and contributions to society. I am also sincerely thankful to the Synchrotron Light Research Institute for organizing this distinguished program, which not only provides opportunities to study engineering and science but also offers the invaluable experience of working with a world-class research laboratory.

Participation in the CERN Summer Student Programme has been one of the most meaningful experiences of my academic journey. I would like to thank the members of the ALPHA collaboration for their consistent support throughout this internship and for fostering a highly collaborative and encouraging working environment. I am especially grateful to my supervisors, Thomas Robertson-Brown, Joos Schoonwater, and Dr. April Cridland, for their expert guidance, recommendations, and continuous support, which have significantly enhanced my understanding of engineering concepts and strengthened my professional skills.

I would also like to thank all the summer students, whose collaboration, shared experiences, and dedication throughout the three months greatly enriched this programme.

Finally, I wish to express my sincere appreciation to CERN for organizing this exceptional programme each summer and for providing students from around the world with new insights into particle physics and its profound significance for humanity.

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Chapter 1

CERN Summer Student Program 2025

1.1 CERN

The Conseil Européen pour la Recherche Nucléaire (CERN), or the European Council for Nuclear Research, was established in 1954 from a post–World War II vision to reunite nations through peaceful scientific collaboration and restore Europe's leadership in fundamental physics. This spirit of international cooperation remains CERN's core principle today, with 23 Member States, numerous associate members, and participants from more than 100 countries.

CERN's primary instrument for discovery is the particle accelerator, which collides subatomic particles at velocities approaching the speed of light to recreate conditions of the early universe. This research has led to several Nobel Prize–winning breakthroughs. The 1983 discovery of the W and Z bosons, carriers of the weak nuclear force, confirmed a key element of the Standard Model. Most notably, in 2012 the ATLAS and CMS experiments at the Large Hadron Collider (LHC) announced the observation of the Higgs boson, the long-sought particle associated with the field that gives fundamental particles their mass.

While the Higgs boson discovery marked a milestone, it also opened new frontiers. Current research at CERN focuses on physics beyond the Standard Model, with central questions including the nature of dark matter, the origin of matter–antimatter asymmetry, and the behavior of quark–gluon plasma. In addition to the LHC, specialized facilities such as the Antiproton Decelerator, home to experiments like ALPHA, enable precision studies of antimatter, advancing our understanding of the universe's fundamental structure.

Beyond fundamental research, CERN has long served as a catalyst for innovation. The challenge of processing the vast data generated by the LHC led to the invention of the World Wide Web by Tim Berners-Lee in 1989. Today, CERN continues to drive progress in computing, detector development, and accelerator science. More than a research center, CERN stands as a testament to what humanity can achieve through curiosity, collaboration, and a shared commitment to exploring the cosmos.

1.2 ALPHA Experiment

The Antihydrogen Laser Physics Apparatus (ALPHA) experiment is an international collaboration at CERN focused on trapping and studying antihydrogen atoms, the antimatter counterpart of hydrogen. By making precise comparisons between hydrogen and antihydrogen, the experiment tests fundamental symmetries between matter and antimatter.

The Standard Model (SM) of particle physics is one of the most successful theoretical frameworks in modern science, as demonstrated by numerous experimental results at CERN. Despite its achievements, the SM is not a complete theory and has several well-known limitations. For instance, it does not provide an explanation for the observed imbalance between matter and antimatter in the universe. It also fails to account for the existence of dark matter and dark energy, which are strongly suggested by astrophysical observations such as galaxy formation and gravitational lensing. Moreover, the SM remains fundamentally incompatible with general relativity. These gaps motivate the ongoing search for new physics at CERN facilities, including the Antiproton Decelerator (AD) hall.

The primary objective of antimatter research at the AD hall is to test the validity of CPT symmetry (Charge-Parity-Time) and to investigate how gravity acts on antimatter. This is pursued through precision measurements of trapped ultracold antiprotons and antihydrogen atoms. The ALPHA collaboration has been at the forefront of these efforts, leading the production, trapping, and study of antihydrogen atoms with exceptional precision. Over the past three decades, the ALPHA experiment has achieved several key milestones, including the first trapping of antihydrogen, laser cooling of antihydrogen atoms, precision spectroscopy of the 1S–2P transition, and the first direct measurement of gravity's effect on antihydrogen. At present, ALPHA is advancing several projects including precision spectroscopy of the 1S–2P transition, the development of beryllium ion magnetometry for more accurate measurements of the trapping magnetic field, the upgrade of the ALPHA-g setup, and the testing of a next-generation antihydrogen trap known as ALPHA-III.

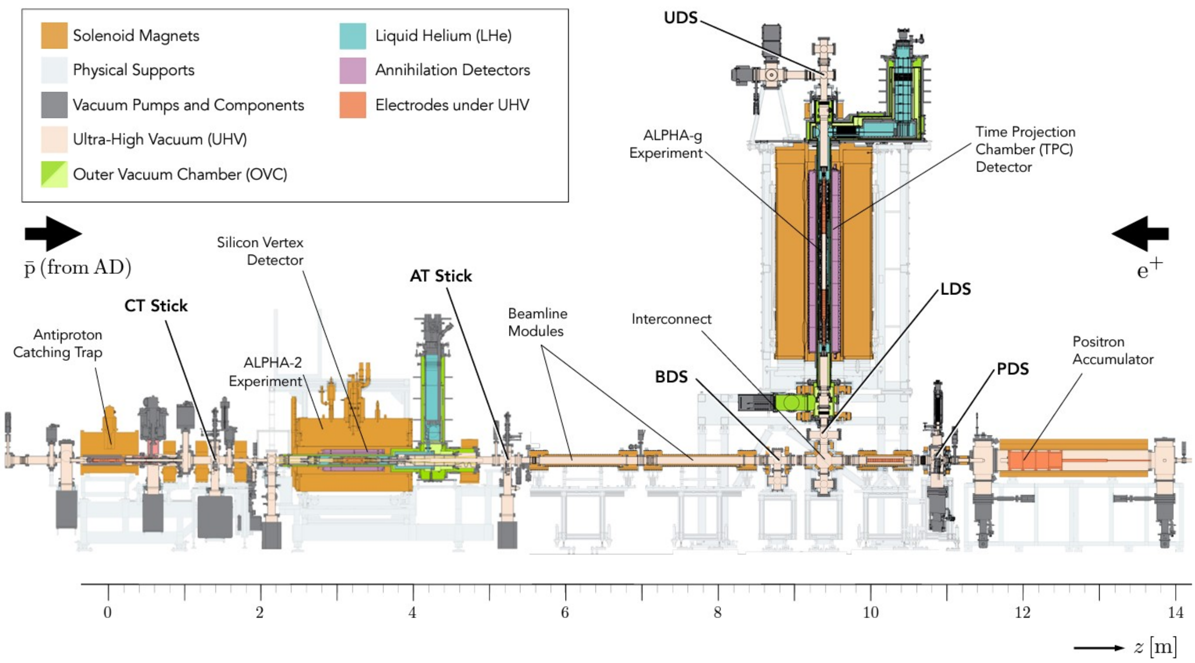


Figure 1 ALPHA Experimental Cycle

1.3 CERN Summer Student Program 2025

The CERN Summer Student Program is an internship held annually during the summer to offers a unique opportunity for undergraduate students and Master's students specializing in physics, engineering, computer science, and mathematics to participate in the research and experimental projects at the forefront of particle physics. This 3 months internship program enables students from around the world to collaborate directly with professional scientists and senior engineers within the various experiments at CERN. It is a platform for cultural and academic exchange among people with diverse backgrounds but a shared passion for science.

A major highlight of the program is the series of specialized academic lectures delivered by CERN researchers and fellows, providing students with deep insights into theoretical and experimental particle physics. Furthermore, participants are given the opportunity to present their project work to the CERN community and to publish our final reports and presentations into public contributing to and sharing their valuable experiences with the broader scientific community.

Figure 2 CERN Summer Student 2025 Group Photo

1.4 Summer Student Lectures

The CERN Summer Student Programme included a five-week lecture series designed to provide participants with a broad introduction to CERN's research mission. I had the opportunity to attend daily lectures covering theoretical and experimental physics, statistics, computing, and accelerator technologies, which greatly enriched my technical knowledge and skills.

The Summer Student Lecture Programme (SSLP) offers a pedagogical overview of CERN's multidisciplinary activities, addressing students in physics, engineering, and computer science. Foundational courses are followed by more specialized topics, with only a basic background in physics and mathematics required. The lectures are organized by the SSLP Committee, with contributions from CERN departments including Experimental Physics (EP), Theoretical Physics (TH), Beams (BE), Accelerator Systems (SY), Information Technology (IT), International Relations (IR), and Human Resources (HR).

The full lecture timetable is available at: https://indico.cern.ch/event/1508891/timetable/

- Accelerator Operation & Diagnostics. Speaker: Federico Roncarolo
- Accelerators and Beam Dynamics. Speaker: Foteini Asvesta
- Antimatter in the Lab. Speaker: Barbara Maria Latacz
- Astroparticle Physics. Speaker: Dr Bradley Kavanagh
- Cosmology. Speaker: Miguel Escudero Abenza
- Detectors. Speaker: Rachel Yohay
- Electronics, DAQ and Triggers. Speaker: Tommaso Colombo
- Experimental Physics at Hadron Colliders. Speaker: Markus Klute
- Experimental Physics at Lepton Colliders. Speaker: Frank Simon
- Flavour Physics. Speaker: Yasmine Sara Amhis
- Foundations of Statistics. Speakers: Glen Cowan
- From Raw Data to Physics Results. Speaker: Josh Bendavid
- Future High Energy Collider Projects. Speaker: Dr Roderik Bruce
- Heavy lons. Speaker: Jochen Klein
- Magnet Superconductivity. Speaker: Susana Izquierdo Bermudez
- Making Predictions at Hadron Colliders. Speaker: Alexander Yohei Huss
- Neutrino Physics. Speaker: Joachim Kopp
- Nuclear Physics at CERN. Speaker: Magdalena Kowalska
- Particle physics technologies for healthcare applications. Speaker: Manuela Cirilli
- Particle World. Speaker: David Tong
- Physics Beyond the Standard Model. Speaker: Tevong You
- Quantum Gravity. Speaker: Kyriakos Papadodimas
- Radio Frequency Superconquctivity. Speaker: Akira Miyazaki
- Theoretical Concepts in Particle Physics. Speaker: Tim Cohen
- The Standard Model. Speaker: Andreas Weiler

1.5 Site Visiting

1.5.1 ATLAS Visiting

ATLAS is one of the experiments at the Large Hadron Collider (LHC). It is designed to study the fundamental particles created in high-energy proton–proton collisions and is the largest particle detector ever constructed, measuring 46 meters in length, 25 meters in diameter, and situated about 100 meters below ground. ATLAS is a highly complex apparatus consisting of multiple sub-detectors that allow the precise tracking, calorimetry, and identification of particles across a wide energy range. Its contributions were instrumental in the 2012 discovery of the Higgs boson, confirming the final missing element of the Standard Model. Today, ATLAS continues to play a central role in exploring physics beyond the Standard Model, including searches for supersymmetry, dark matter candidates, and new fundamental forces.

1.5.2 Antiproton Decelerators (AD) Visiting

Antiproton Decelerator (AD) is a unique facility dedicated to producing and storing low-energy antiprotons for antimatter research. Antiprotons are generated when high-energy protons from the Proton Synchrotron (PS) strike a fixed metal target, producing a spray of secondary particles. From these, antiprotons are collected, cooled, and decelerated to energies suitable for precision experiments. To further enhance efficiency, the AD is coupled with ELENA (Extra Low ENergy Antiproton), a synchrotron ring that delivers antiprotons at even lower energies to multiple experiments simultaneously. Among the main beneficiaries are ALPHA, ASACUSA, GBAR, and other collaborations working to probe fundamental symmetries, antimatter gravity, and antihydrogen spectroscopy. The AD complex is therefore a cornerstone in CERN's efforts to understand the matter–antimatter asymmetry in the universe.

1.5.3 Data Centre Visiting

CERN Data Centre is the central hub for processing, storing, and distributing the enormous amounts of data generated by CERN's experiments. It is a critical component of the Worldwide LHC Computing Grid (WLCG), a global network of more than 170 data centers in over 40 countries. Within CERN, thousands of servers operate around the clock to process data from the LHC, which continues to produce information at an average rate of about one petabyte per day even after online filtering. The facility not only ensures reliable storage and distribution of experimental data but also supports administrative services and communications across CERN. During the visit, it was also possible to view exhibits illustrating the evolution of data storage, from magnetic tapes to the present-day large-scale distributed computing infrastructure. This demonstrated how CERN's demand for high-performance data handling has consistently driven advancements in computing technologies that extend far beyond particle physics.

1.6 Oral Presentation Session

As part of the Summer Student Programme, participants were invited to present their projects during the Oral Presentation Sessions held from 6–8 August 2025. These sessions provided an opportunity for students to showcase their work to peers and researchers at CERN, in a format similar to the Summer Student Lecture Programme. A total of 30 presentation slots were available, allocated on a first-come, first-served basis.

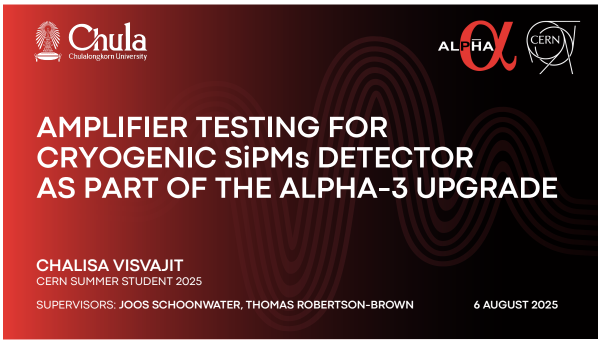
Each presentation consisted of a 10-minute talk followed by a 5-minute Q&A session. The sessions were recorded and made publicly available online, and the titles of the presentations will also be included in the upcoming CERN Annual Report, acknowledging the students' contributions.

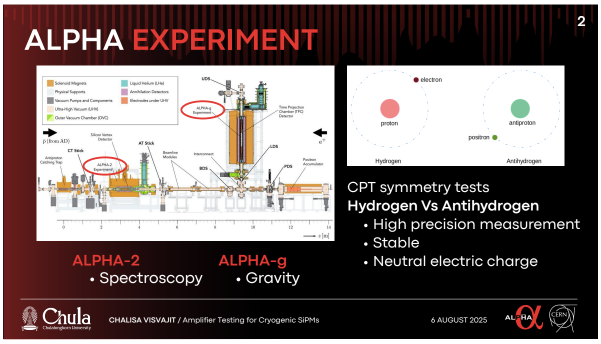
My presentation recording: https://cds.cern.ch/record/2939739

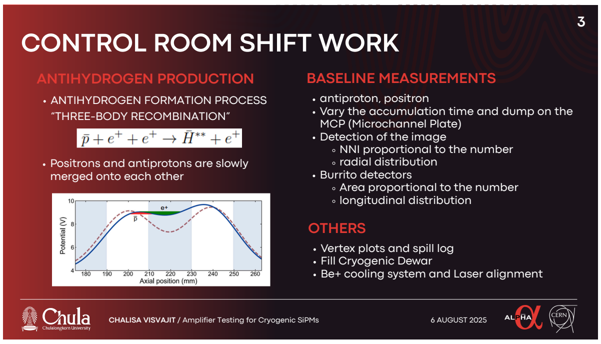
Abstract

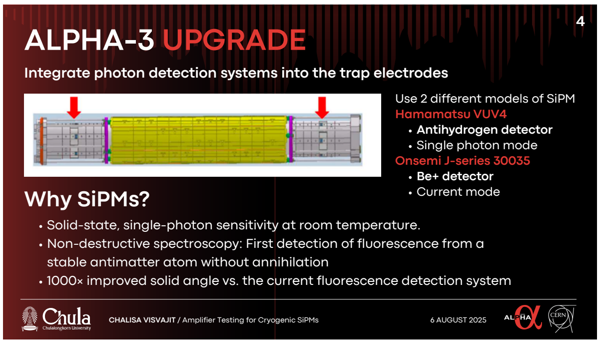
My project focused on integrating and testing silicon photomultipliers (SiPMs) under cryogenic conditions for the ALPHA-3 trap. These detectors support non-destructive antihydrogen spectroscopy aiming to achieve the first detection of fluorescence from stable antimatter atoms without annihilation. My role involved amplifier circuit testing, system integration, and cryostat testing to ensure reliable photon detection at temperatures near 4 K in a vacuum chamber.

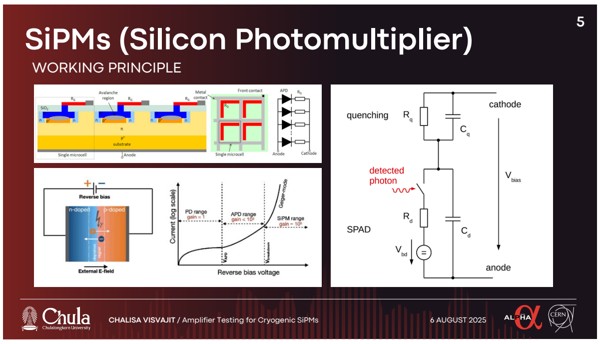
Presentation Slides

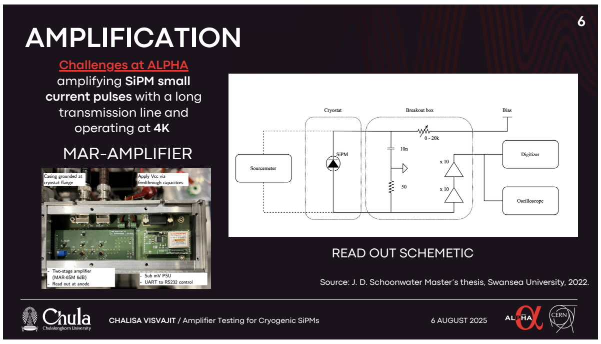


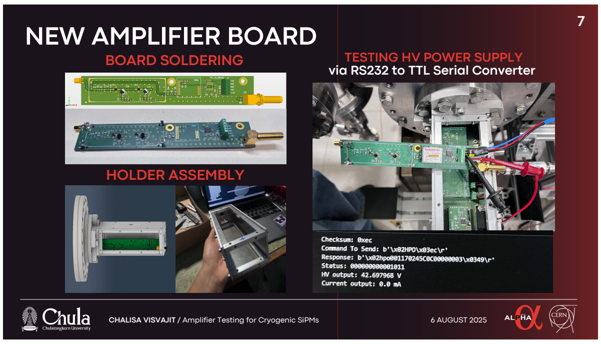


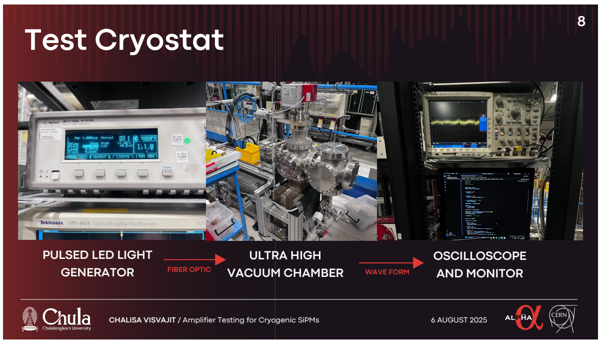









NEW AMPLIFIER BOARD
7
BOARD SOLDERING
HOLDER ASSEMBLY
TESTING HV POWER SUPPLY
via RS232 to TTL Serial Converter
Checksum: 0xec
Command To Send: b'\x02HPO\x03ec\r'
Response: b'\x02hpo001170245C0C00000003\x0349\r'
Status: 000000000001011
HV output: 42.697968 V
Current output: 0.0 mA
Chula
CHALISA VISVAJIT / Amplifier Testing for Cryogenic SiPMs
6 AUGUST 2025


Test Cryostat
8
PULSED LED LIGHT GENERATOR
FIBER OPTIC
ULTRA HIGH VACUUM CHAMBER
WAVE FORM
OSCILLOSCOPE AND MONITOR
Chula
CHALISA VISVAJIT / Amplifier Testing for Cryogenic SiPMs
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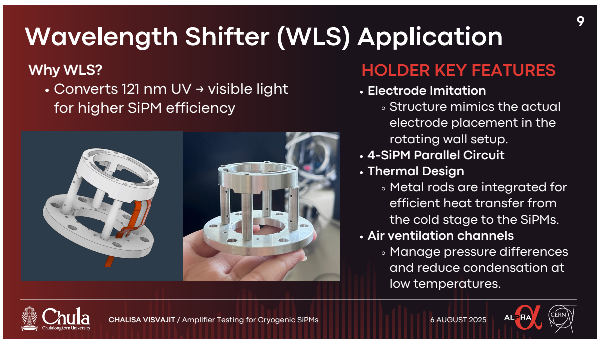
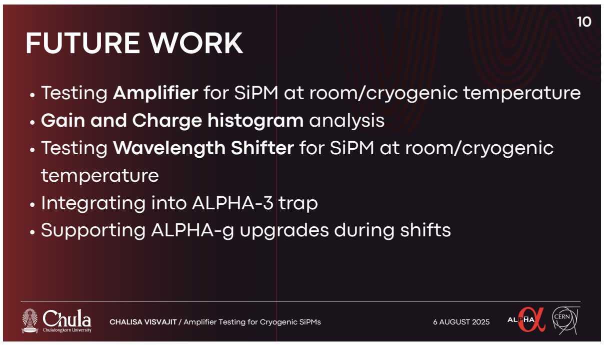

Wavelength Shifter (WLS) Application
9
Why WLS?
• Converts 121 nm UV → visible light for higher SiPM efficiency
HOLDER KEY FEATURES
• Electrode Imitation
◦ Structure mimics the actual electrode placement in the rotating wall setup.
• 4-SiPM Parallel Circuit
• Thermal Design
◦ Metal rods are integrated for efficient heat transfer from the cold stage to the SiPMs.
• Air ventilation channels
◦ Manage pressure differences and reduce condensation at low temperatures.
Chula
CHALISA VISVAJIT / Amplifier Testing for Cryogenic SiPMs
6 AUGUST 2025


FUTURE WORK
10
• Testing Amplifier for SiPM at room/cryogenic temperature
• Gain and Charge histogram analysis
• Testing Wavelength Shifter for SiPM at room/cryogenic temperature
• Integrating into ALPHA-3 trap
• Supporting ALPHA-g upgrades during shifts
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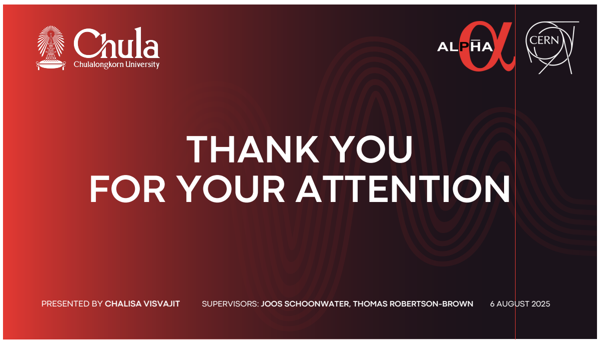
CHALISA VISVAJIT / Amplifier Testing for Cryogenic SiPMs
6 AUGUST 2025


Chula
Chulalongkorn University
ALPHA
CERN
THANK YOU
FOR YOUR ATTENTION
PRESENTED BY CHALISA VISVAJIT
SUPERVISORS: JOOS SCHOONWATER, THOMAS ROBERTSON-BROWN
6 AUGUST 2025

Chapter 2

Summer Student Project Report

Development of Amplifiers and Wavelength Shifters for Cryogenic SiPMs as Part of the ALPHA-3 Upgrade

Chalisa Visvajit[1]
Supervisors: *Thomas Robertson-Brown*[2], *Joos Schoonwater*[2], *Dr. April Cridland*[2]

[1]Department of Mechanical Engineering, Chulalongkorn University, Bangkok, Thailand
[2]CERN, Geneva, Switzerland

Abstract

The ALPHA collaboration investigates CPT symmetry by comparing the properties of trapped antihydrogen with those of hydrogen. Precision spectroscopy of the 1S–2S and 1S–2P transitions has shown agreement with hydrogen, though previous detection of the 1S–2P transition relied on destructive annihilation signals. To enable non-destructive fluorescence detection, Silicon Photomultipliers (SiPMs) are being developed for integration into the new ALPHA-III apparatus. As SiPMs are inefficient for direct detection of vacuum ultraviolet photons, the use of wavelength shifters (WLS) is under investigation to enhance photon detection efficiency under cryogenic conditions. A new compact amplifier circuit for cryogenic SiPMs was designed, built, and tested together with a custom amplifier box holder for integration in the cryostat. A SiPM holder assembly was developed to mimic the geometry of the rotating wall, supporting four SiPMs in parallel with a dedicated WLS mount for future optical studies. These developments establish the technical basis for implementing fluorescence-based detection of antihydrogen in future experiments.

2.1 Introduction

2.1.1 CERN Summer Student Program 2025

The CERN Summer Student Program is an internship held annually during the summer to offers a unique opportunity for undergraduate students and Master's students specializing in physics, engineering, computer science, and mathematics to participate in the research and experimental projects at the forefront of particle physics. This 3 months internship program enables students from around the world to collaborate directly with professional scientists and senior engineers within the various experiments at CERN. It is a platform for cultural and academic exchange among people with diverse backgrounds but a shared passion for science.

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Figure 1 CERN Summer Student 2025 Group Photo

2.1.2 ALPHA Experiment

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The Standard Model (SM) of particle physics is one of the most successful theoretical frameworks in modern science, as demonstrated by numerous experimental results at CERN. Despite its achievements, the SM is not a complete theory and has several well-known limitations. For instance, it does not provide an explanation for the observed imbalance between matter and antimatter in the universe. It also fails to account for the existence of dark matter and dark energy, which are strongly suggested by astrophysical observations such as galaxy formation and gravitational lensing. Moreover, the SM remains fundamentally incompatible with general relativity. These gaps motivate the ongoing search for new physics at CERN facilities, including the Antiproton Decelerator (AD) hall.

The primary objective of antimatter research at the AD hall is to test the validity of CPT symmetry (Charge-Parity-Time) and to investigate how gravity acts on antimatter. This is pursued through precision measurements of trapped ultracold antiprotons and antihydrogen atoms. The ALPHA collaboration has been at the forefront of these efforts, leading the production, trapping, and study of antihydrogen atoms with exceptional precision. Over the past three decades, the ALPHA experiment has achieved several key milestones, including the first trapping of antihydrogen, laser cooling of antihydrogen atoms, precision spectroscopy of the 1S–2P transition, and the first direct measurement of gravity's effect on antihydrogen [1]. At present, ALPHA is advancing several projects including precision spectroscopy of the 1S–2P transition, the development of beryllium ion magnetometry for more accurate measurements of the trapping magnetic field, the upgrade of the ALPHA-g setup, and the testing of a next-generation antihydrogen trap known as ALPHA-III.

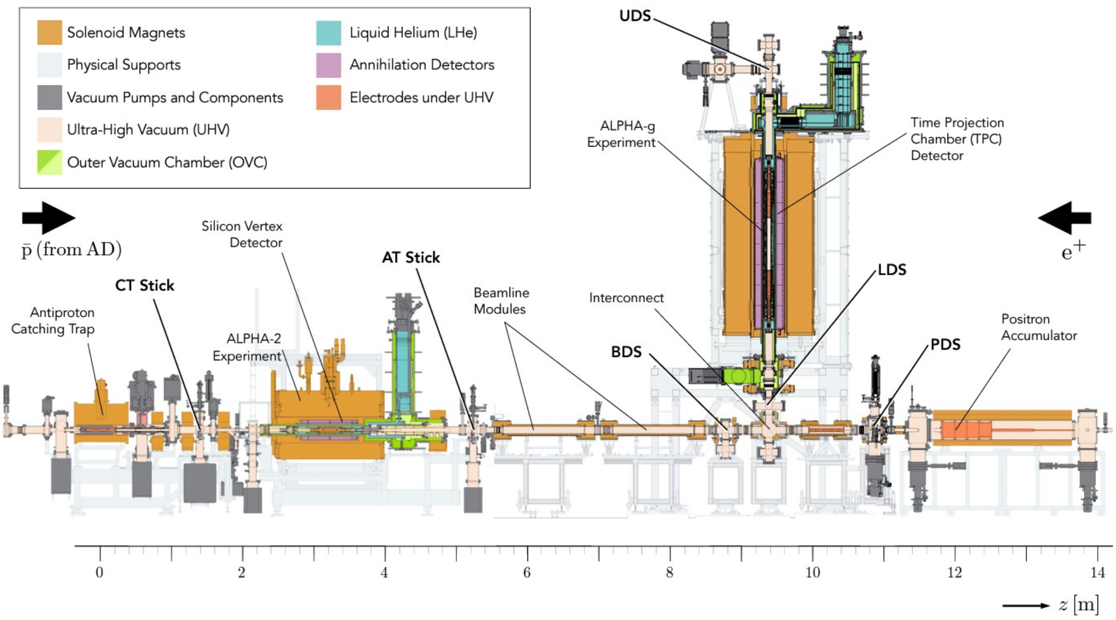

Figure 2 ALPHA Experimental Cycle

2.1.2.1 Control Room Shift Work

2.1.2.1.1 Antihydrogen Production

The trapping of neutral atoms like antihydrogen requires a magnetic multipole trap, cryogenic temperatures, and an extreme ultra-high vacuum. The ALPHA experiment uses a sophisticated trap consisting of an octupole magnet integrated with solenoidal mirror coils, forming a Penning-Malmberg trap. The synthesis of antihydrogen is achieved by combining antiprotons with positrons, primarily through a process known as three-body recombination.

$$\bar{p} + e^{+} + e^{+} \rightarrow \bar{H}^{**} + e^{+}$$

The operational sequence begins with the transfer and capture of antiprotons delivered by the Antiproton Decelerator (AD), while positrons are simultaneously accumulated from a radioactive sodium-22 (^{22}Na) source. These charged particles are stored in two adjacent but separate potential wells of opposite charge. To initiate recombination, these potentials are slowly merged, as illustrated in figure 3 [2].

This entire process occurs within the confines of the current magnetic trap, the ALPHA-II apparatus, which is formed by two axially separated co-axial mirror coils and a transverse octupole magnet as shown in figure 4. all superconducting components allow for magnetic fields of up to 2 Tesla.

Neutral antihydrogen atoms are confined in this configuration due to their small magnetic moment, which stems primarily from the positron's magnetic moment. The combined fields of the magnets create a three-dimensional minimum in magnetic field strength, forming an effective trap for the neutral atoms.

To accumulate a sufficient number of atoms for study, a procedure known as "stacking" is employed. This involves repeating the mixing and trapping cycles without de-energizing the magnetic trap between repetitions, thereby continuously adding new antihydrogen atoms to the trapped sample while losses are managed due to the natural annihilation of antimatter upon contact with matter [2].

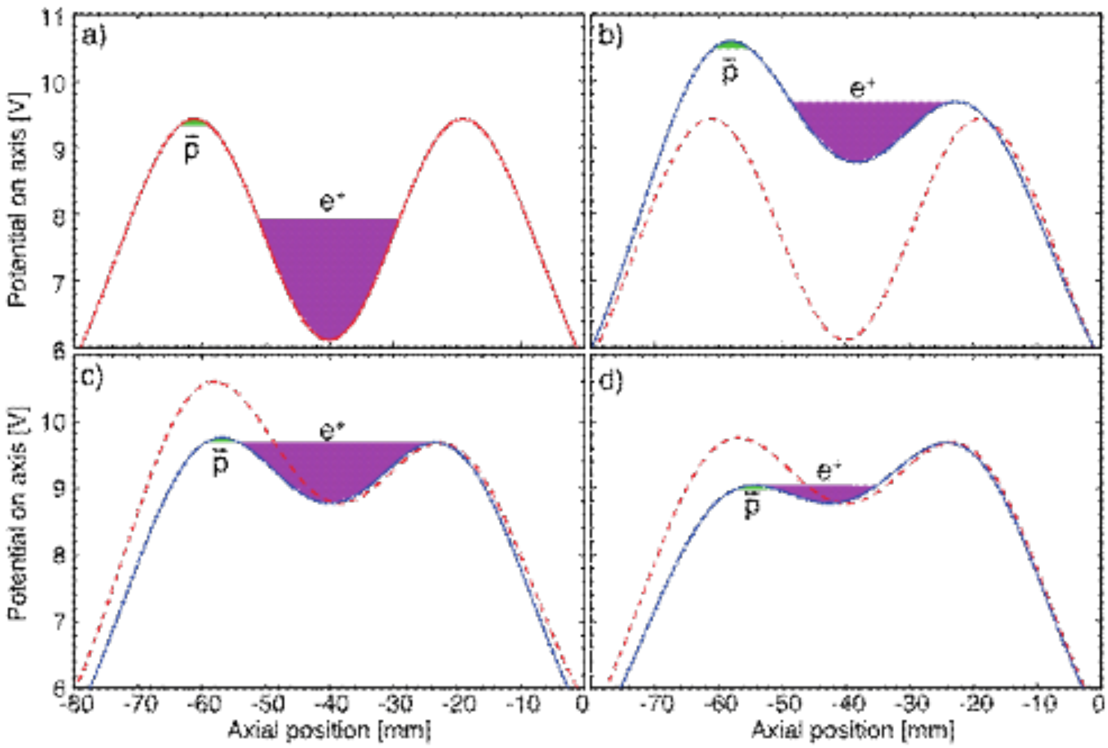

Figure 3 Antihydrogen production [2]

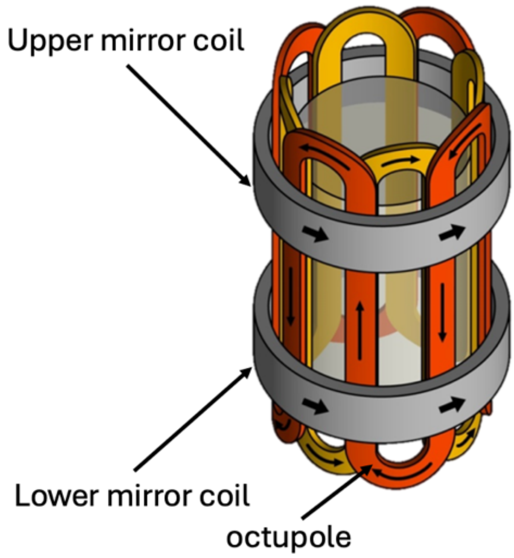

Figure 4 Penning-Malmberg trap

2.1.2.1.2 Baseline Measurement

Baseline measurements for the positron and antiproton clouds are performed by systematically controlling their accumulation time within the trap. The particles are then intentionally dumped onto a Microchannel Plate (MCP) detector. The MCP provides a spatially resolved signal, allowing for the visualization of both the radial and longitudinal distribution of the particle clouds. This diagnostic technique is essential for measuring and subsequently optimizing key particle cloud properties such as density, size, and shape, which are critical parameters for maximizing the efficiency of the antihydrogen production process.

2.1.2.1.3 ALPHA-g Improvement

This summer, a significant focus of the ALPHA experiment was on the newly developed ALPHA-g apparatus. The primary objective of this experiment is to probe the effects of gravity on antimatter by testing the Weak Equivalence Principle (WEP) [3]. This research directly measures the free-fall acceleration of antihydrogen atoms. A critical aspect of this measurement involves precise characterization of the magnetic environment to isolate the gravitational signal from potential magnetic confounders.

The experimental method involves confining antihydrogen atoms in a vertical, graded magnetic trap. By designing the trap to release atoms in a controlled manner, their subsequent trajectory under gravity can be precisely measured. The design of this vertical magnetic trap is illustrated in Figure 5.

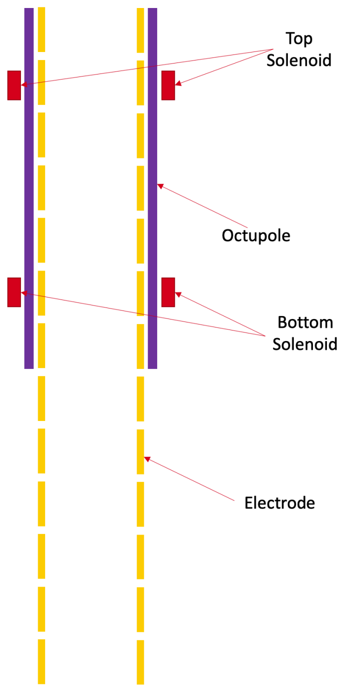

Figure 5 ALPHA-g Apparatus

2.1.2.1.4 Other works

In addition to the primary experimental procedures, a number of other critical tasks were routinely performed. This included generating vertex plots to reconstruct the precise spatial locations of antiproton annihilations, which is vital for diagnosing trap performance and particle losses. Maintaining detailed spill logs was also essential to track the timing and characteristics of particle ejections from the trap throughout the experimental cycle. Other routine operational responsibilities involved managing the cryogenic systems, such as refilling the liquid helium Dewar to maintain superconducting magnet temperatures, tending to the beryllium ions used in the positron cooling process, and operating the complex laser systems required for various diagnostic and measurement purposes.

2.1.2.2 ALPHA-3 Upgrade

The ALPHA-3 upgrade introduces new capabilities by integrating photon detection systems directly into the trap electrodes. This design employs two different types of ultraviolet-sensitive silicon photomultipliers (SiPMs), each positioned at specific locations within the trap to optimize photon detection. SiPMs were chosen because they are solid-state sensors with the ability to detect single photons, making them particularly well suited for non-destructive antihydrogen spectroscopy. In contrast, earlier measurements such as the 1S–2P transition were performed destructively by allowing the excited antihydrogen atoms to decay into untrappable states, causing annihilation upon contact with the surrounding material. The new approach enables observation of fluorescence, or photon emission, when antihydrogen atoms relax from their excited states. In particular, light emitted during the 1S–2P transition, known as Lyman-α radiation, occurs at a wavelength of 121 nm [4].

The use of SiPMs also benefits the beryllium ion (Be^+) spectroscopy program. In the current setup, photomultiplier tubes (PMTs) require millions of ions to generate a detectable signal, which results in large plasmas and reduces measurement precision. By replacing PMTs with SiPMs, the size of the Be^+ plasma can be reduced, leading to improved precision. Furthermore, the solid angle for photon detection can be increased by a factor of up to one thousand, significantly enhancing measurement efficiency.

The ALPHA-III trap is specifically designed to measure fluorescence from trapped particles within a Penning–Malmberg trap. Unlike the current ALPHA-II trap, which detects antihydrogen spectra destructively by counting the pions produced from annihilation on the electrode walls, ALPHA-III makes use of SiPMs placed inside the trap to directly observe fluorescence from antihydrogen atoms undergoing state transitions. The destructive method used in ALPHA-II is time-consuming, since sweeping the laser frequency and intensity consumes portions of the stored antihydrogen, requiring long experimental runs with high resource costs and careful stabilization of the lasers. The non-destructive detection method offered by ALPHA-III represents a major step forward, but it also introduces experimental challenges. Nevertheless, SiPMs are typically not manufactured for cryogenic environments. At very low temperatures, the board material tends to freeze out, reducing photon detection efficiency (PDE). To address this, it is critical to test the SiPMs in a cryostat to evaluate their performance and feasibility for ALPHA-III applications.

There are also important differences between detecting Be^+ fluorescence and antihydrogen fluorescence. The emission wavelength of antihydrogen fluorescence is approximately 121 nm, while that of Be^+ is around 313 nm. In addition, the intensity of the signals is very different. As fewer antihydrogen atoms can be trapped compared to Be^+ ions, SiPMs must operate in photon-counting mode to detect the extremely faint antihydrogen fluorescence. By contrast, the stronger fluorescence from Be^+ requires careful handling to avoid damaging the detectors [4]. To meet these requirements, two types of SiPMs are employed. Onsemi J-series 30035 devices for Be^+ detection, and Hamamatsu VUV4 (S13370-3050CN) devices for antihydrogen detection. The Hamamatsu detectors are also suitable for detecting the 313 nm fluorescence from Be^+ plasmas during sympathetic cooling of positrons in the precision trap. the Onsemi SiPMs are installed on the rotating wall of the positron trap, while the Hamamatsu SiPMs are located at the junction between the positron trap and the precision trap, as shown in Figure 6.

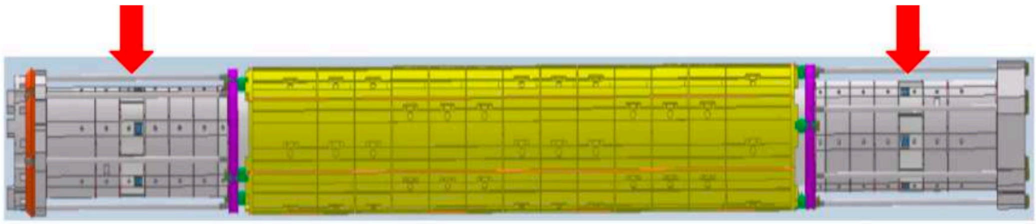

Figure 6 Locations of the SiPM detectors integrated within the ALPHA-III trap [5].

2.2 Amplifiers Developed and Tested for Cryogenic SiPMs Detector

2.2.1 Silicon Photomultiplier (SiPMs)

Silicon photomultipliers (SiPMs) are solid-state photodetectors composed of two-dimensional arrays of avalanche photodiodes (APDs) operating in Geiger mode (Figure 7a). Each pixel in the array functions as a Geiger-mode APD (GM-APD) with an integrated quenching resistor, and all pixels are connected in parallel. This configuration allows each pixel to operate independently while sharing a common bias line. A simplified schematic of this structure is shown in Figure 7b.

Because all pixels are connected in parallel, the SiPM only provides information on the number of detected photons, not their individual energies. Each pixel essentially acts as a binary detector. A single pixel firing produces a photoelectron (p.e.) pulse, while simultaneous firings of multiple pixels produce multi-p.e. pulses. For example, a 1 p.e. waveform corresponds to a single pixel firing, whereas a 2 p.e. waveform corresponds to two pixels firing simultaneously [5].

When biased above the breakdown voltage, a photon entering the depletion region can excite an electron. Under the strong electric field created by the high reverse bias, this electron generates additional electron–hole pairs. In Geiger mode, even the holes can contribute to further impact ionization, leading to an avalanche process (Figure 8a, 8b). As a result, a single photon can trigger a large number of carriers, producing a gain of approximately 10^5–10^6. The gain is controlled by the applied overvoltage, and each avalanche is quenched by the resistor associated with the pixel [6].

For applications in the ALPHA-3 trap, SiPMs must operate reliably at cryogenic temperatures around 4 K in an ultra-high-vacuum environment. To ensure their feasibility in this extreme setting, it is necessary to characterize their performance in terms of gain, dark count rate, and crosstalk.

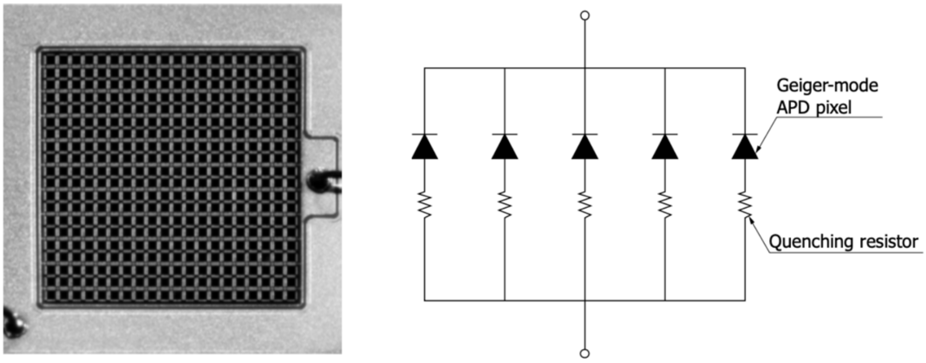

Figure 7 (a) Photograph of a SiPM device. (b) Schematic of a SiPM consisting of multiple GM-APD pixels operating in parallel [7].

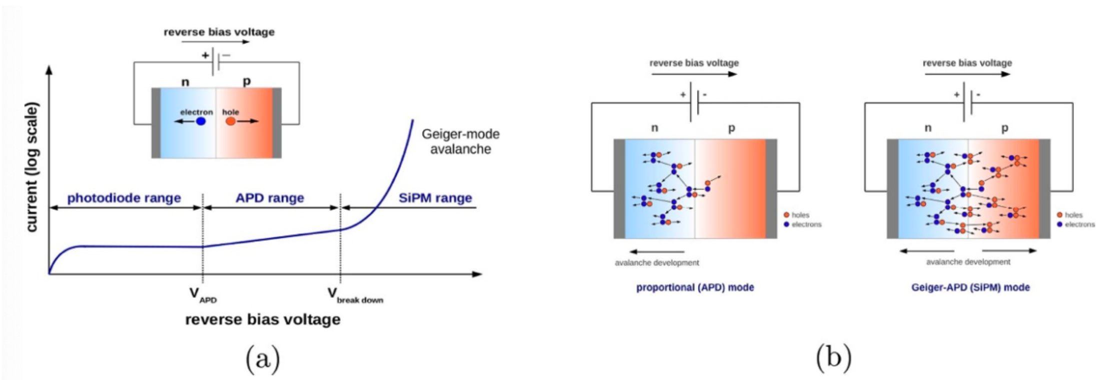

Figure 8 (a) Operation regimes of p–n junctions: photodiode, APD, and SPAD/SiPM. (b) Avalanche carriers in APDs (electrons only) and SPADs (electrons and holes) [6].

2.2.2 Amplification

One of the main challenges in the ALPHA experiment is the amplification of the small current pulses produced by the SiPMs. These signals must be transmitted over a long line between the SiPMs and the amplifier. This setup can lead to significant signal loss and is further complicated by the fact that the system operates at cryogenic temperatures of around 4 K inside the vacuum trap.

The current setup employs a MAR amplifier, following the readout schematic shown in Figure 9. To improve compactness and usability, the amplifier circuit was redesigned and developed into a smaller form factor.

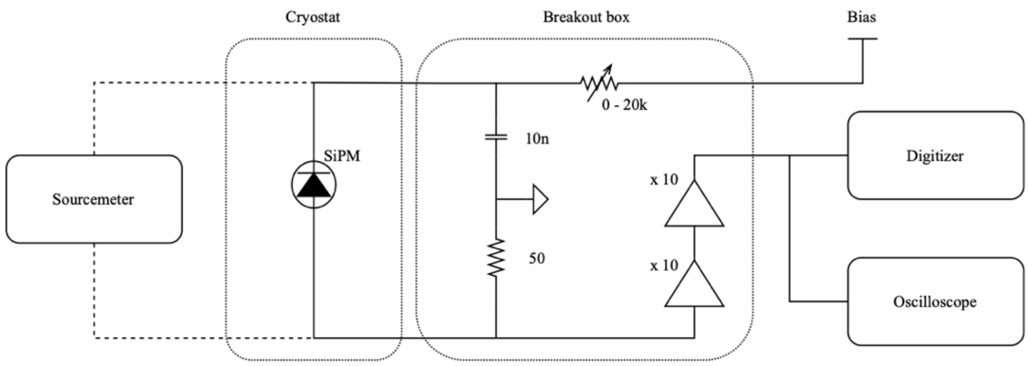

Figure 9 Readout schematic [5]

The board assembly was carried out by soldering amplifier components using solder paste and a mini heat plate. After soldering, a short-circuit safety check was performed with a multimeter, followed by solvent cleaning to remove residual flux. The solder joints were thoroughly inspected to ensure the reliability of the connections. The soldering schematic and final assembled board are shown in Figure 10.

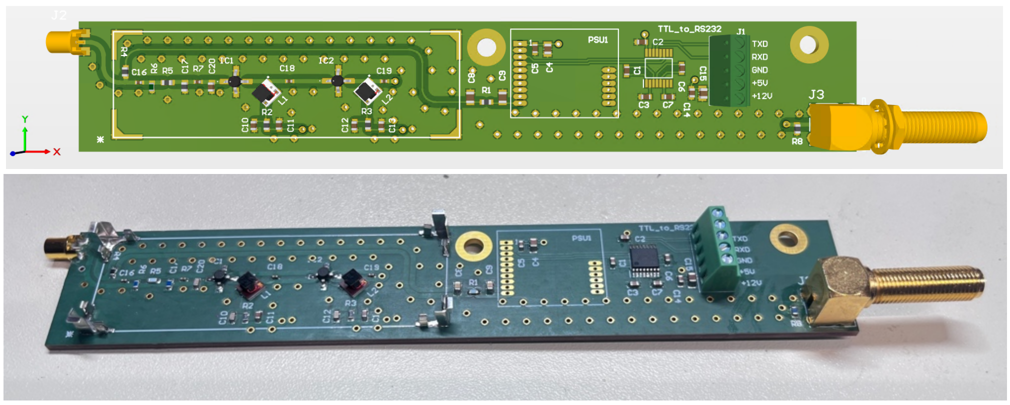

Figure 10 (a) Soldering schematic of the amplifier board. (b) Completed amplifier board after soldering.

Tests of the high-voltage bias supply were conducted using RS232-to-TTL serial communication. Commands were sent remotely from a computer via a Python script to control the supply. These tests verified that proper communication between the amplifier system and the serial interface was achieved. During the procedure, the system was monitored via serial communication, and multimeter measurements confirmed both the activation of the high-voltage supply and the correct operation of the control interface with the amplifier board. The test setup and results are presented in Figure 11.

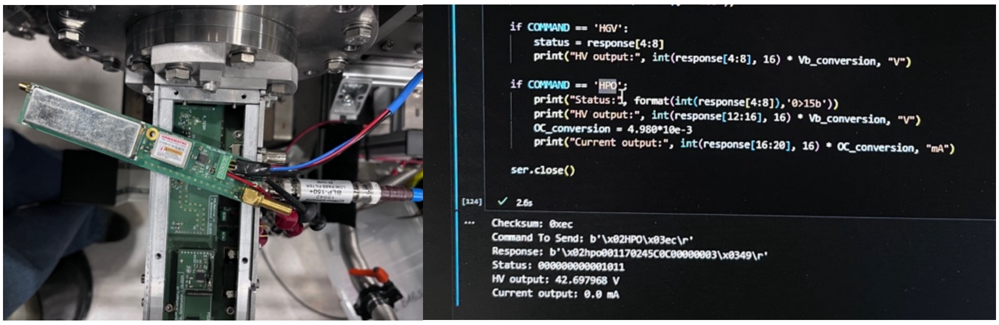

Figure 11 (a) High-voltage bias supply test setup. (b) Monitor display showing successful communication and activation.

2.2.3 Amplifier Box Assembly

The amplifier board was soldered and mounted on a metal holder positioned outside the vacuum chamber. The mechanical holder box for cryostat installation was fabricated using drilling and milling machines (Figure 12b). The 3D CAD drawings (Figure 12a) were used to guide the positioning of holes for the amplifier frame. Surface irregularities resulting from water jet machining were corrected by milling and hand filing to achieve the required tolerances.

Threaded holes were subsequently tapped using a three-step process (roughing, intermediate, finishing) to ensure accurate alignment and reliable thread formation. The final assembly is shown in Figure 12c.

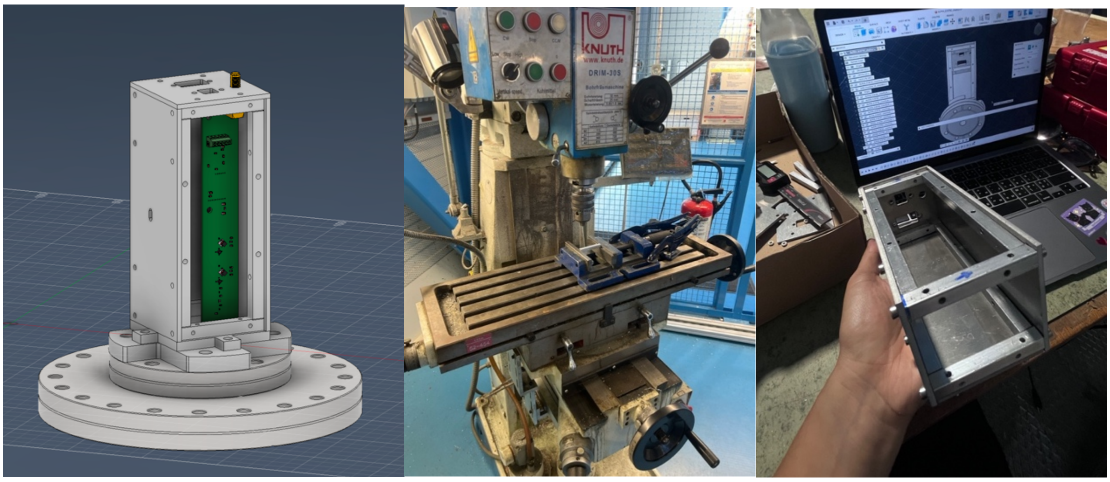

Figure 12 (a) 3D CAD design of amplifier box. (b) 3-axis milling machine. (c) Completed box assembly.

2.3 Wavelenth Shifter holder Assembly for Cryogenic SiPMs Detector

2.3.1 Wavelenth Shifter (WLS)

To enhance the photon detection efficiency of SiPMs in the new ALPHA-III apparatus, a wavelength shifter (WLS) is planned for application in the detection of the antihydrogen 1S–2P transition. When antiproton annihilation products pass through the scintillator, its molecules are excited and emit light via fluorescence. This light is collected by photodetectors, such as a Photomultiplier Tube (PMT) or a Silicon Photomultiplier (SiPM), which convert it into measurable electrical signals. In this approach, WLS fibers are embedded in the detector panel to couple scintillation light into two sets of four SiPMs [8].

A WLS is a photofluorescent material that absorbs high-frequency photons and re-emits lower-frequency photons, typically within nanoseconds. The process can occur through three mechanisms: cascade luminescence (downconversion), anti-Stokes luminescence (upconversion), and photoluminescence (downshifting). In the case of downconversion, a single high-energy photon is converted into multiple lower-energy photons [9]. In recent years, SiPMs have increasingly replaced photodiodes in particle detection applications [10–12]. However, their efficiency for detecting vacuum ultraviolet (VUV) photons remains limited [13].

Since the integration of a WLS has not previously been tested within the ALPHA setup, preliminary studies on glass substrates coated with WLS material are required to evaluate their performance under cryogenic conditions.

2.3.2 Wavelenth Shifter holder Assembly

A mechanical holder was designed and fabricated to mount the WLS and SiPMs inside the cryostat. The design replicates the electrode geometry of the rotating wall and supports a 4-SiPM parallel circuit to optimize signal collection.

Previous tests with an earlier model encountered cooling limitations, reaching only 5.1 K with the SiPM holder attached to the 4 K stage. The cause was attributed either to poor thermal conduction between the holder and the cold stage or to unexpected thermal contact through the SMA cables [4]. To address this issue, the thermal connection between the copper holder and the 4 K stage was improved by tightening the mounting screws and increasing conduction pathways.

Additional metal rods were incorporated to enhance heat transfer from the cold stage to the SiPMs. Furthermore, ventilation channels were introduced to mitigate condensation and manage pressure differentials during cooldown.

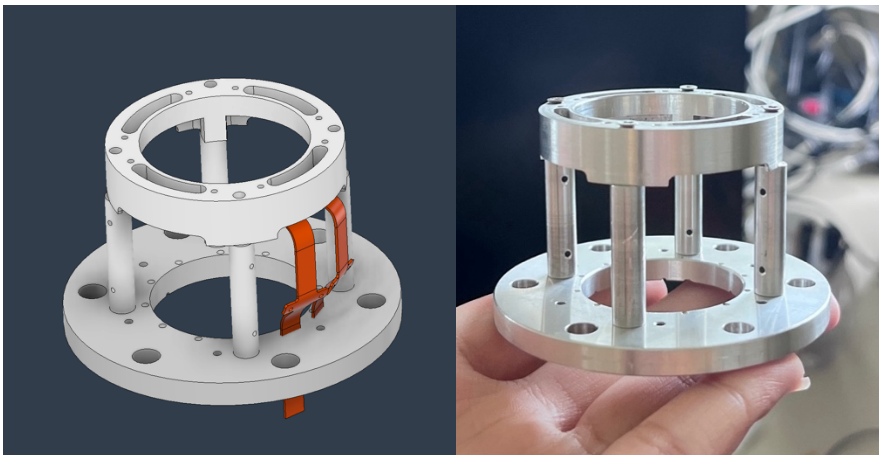

Figure 13 (a) 3D CAD design of the holder. (b) Completed holder assembly.

Acknowledgements

Participation in the CERN Summer Student Programme has been one of the most meaningful experiences in my academic journey. I would like to thank the members of the ALPHA collaboration for their support during this project. I am especially grateful to my supervisors, Thomas Robertson-Brown, Joos Schoonwater, and Dr. April Cridland, for their guidance, recommendations, and continuous support. I would also like to thank the summer students, whose collaboration and shared experiences throughout the three months greatly enriched this programme.

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Chapter 3

Daily Report

Sunday, 8 June 2025

I arrived in Geneva around 4 PM, marking the start of my internship journey. Dr. Norraphat Srimanobhas kindly greeted me at the airport and assisted with transportation to CERN, where I collected my access card and hotel keycard. After settling in, Dr. Norraphat took all the Thai students to a renowned local restaurant for dinner. We tried Switzerland's signature dish, cheese fondue, which was absolutely delicious.

Monday, 9 June 2025

As today was a public holiday in Switzerland, we seized the opportunity to explore Geneva. Known as the country's second-largest city and one of the world's most expensive, Geneva is also conveniently close to CERN. We took the punctual and efficient tram from the CERN stop, then strolled along the lake to see the iconic Jet d'Eau, a stunning 100-meter-high fountain symbolizing the city. Later, we relaxed in a nearby park, enjoying Swiss ice cream and chocolate. I've experience a lot of local culture before work began.

Tuesday, 10 June 2025

Today was my first official workday at CERN. The morning started with a welcome session, where staff briefed us on program details, safety protocols, rules, and upcoming events. Afterward, I joined the ALPHA experiment group, meeting the chief officer and my supervisor. My supervisor gave me a tour of the ALPHA facility, explaining the experiment cycles and helping me familiarize myself with the workspace. It was an exciting introduction to the cutting-edge research I'll be contributing to.

Wednesday, 11 June 2025

I started my day with completing mandatory safety training modules covering Computer Security, Radiation Protection, and Electrical Safety, which are essential prerequisites for working in ALPHA's controlled environment with beamlines and sensitive electronics. My supervisor provided foundational research papers to study before our project discussion, giving me crucial background on antimatter experimentation protocols.

Thursday, 12 June 2025

Today is my first shift rotation for the ALPHA experiment, which specializes in the production, trapping, and precision spectroscopy of antihydrogen atoms. The experiment combines antiprotons from CERN's Antiproton Decelerator with positrons to synthesize antihydrogen. These neutral antimatter atoms are then confined using a superconducting octupole magnet trap. The team maintains 24-hour monitoring to validate CPT symmetry through precision antimatter measurements. During the evening shift, senior staff trained me to interpret control room diagnostics. We troubleshooted a rotating wall anomaly, where I assisted in inspecting electrode circuits and RF filter boxes. We hypothesized thermal expansion might be affecting contact resistances. This is my first hands-on experience with experimental maintenance.

Friday, 13 June 2025

Today, I focused on studying the two main experimental programs within the ALPHA collaboration. The first is ALPHA-3, which represents the next phase of antihydrogen research following ALPHA-II. My project specifically involves designing and developing a new photon detection system for observing the 1S-2P transition in antihydrogen. This requires precise measurement of the Lyman-α line, where we aim to achieve spectroscopic precision to 12 decimal places which bringing us closer to the 15-decimal benchmark set by ordinary hydrogen. The second major effort is ALPHA-g, which investigates whether antihydrogen experiences the same gravitational acceleration as normal matter. The experiment uses a vertically oriented magnetic trap to release antihydrogen atoms and tracks their free-fall trajectories through annihilation imaging.

Saturday, 14 June 2025

On my first weekend in Switzerland, I took a solo trip to Lausanne, a city with special significance as it was once home to Thailand's King Rama IX. The 1.5-hour train ride from Geneva brought me to the charming old town center. My cultural exploration continued at the magnificent Lausanne Cathedral, Palais de Rumine, and visiting landmarks including the Olympic Museum and Thai Pavilion at Ouchy. I ended the day swimming in Lake Geneva, a stunning lake that offers breathtaking views of Mont Blanc in the distance.

Sunday, 15 June 2025

Even though it's Sunday, I still had an evening shift today. We're still troubleshooting the rotating wall issue, so we checked all the electrode circuits and filter boxes again. Our hypothesis is recent temperature adjustments might have caused some material expansion. Later, my supervisor and I improved the ALPHA-g setup by applying black tape to the laser box panel. This prevents contamination during laser beam transportation.

Monday, 16 June 2025

This morning, I reviewed research papers before joining the summer student tour of ATLAS, one of CERN's major detectors at the Large Hadron Collider. ATLAS played an important role in the Higgs boson discovery and continues investigating fundamental particles through high-energy proton collisions. We visited the control room and learned about its detection systems, including the inner tracker, calorimeters, and muon spectrometer. This visit deepened my understanding of how detector technology enables groundbreaking discoveries.

Tuesday, 17 June 2025

I got a special opportunity from Mr. Phurinut, a senior from my university and previous CERN summer student in the Mechanical and Materials Engineering (MME) Department. He arranged for me to visit their mechanical engineering facilities. This valuable opportunity allowed me to observe the laboratory area and learn about how they works. The MME team warmly welcomed me and discussed potential collaborations that could enhance my current work with ALPHA. This provided me practical insights into how engineering solutions support fundamental physics research at CERN.

Wednesday, 18 June 2025

I spent morning time to reviewing research papers before visiting CERN's Data Center and Antimatter Factory. At the Data Center, I learned about advanced data compression techniques that used to storage and manage vast experimental results while preserving critical information. The Antimatter Factory (AD Hall) tour provided insights into antimatter research programs While ALPHA focuses on antihydrogen spectroscopy, experiments like AEgIS (studying antimatter gravity) and ASACUSA (working with antiprotonic helium) demonstrated the diverse approaches to antimatter physics. This experience significantly broadened my understanding of each CERN's departments.

Thursday, 19 June 2025

I had my first meeting with my project supervisor, Mr. Joos Schoonwater, to discuss our work on developing cryogenic testing systems for the ALPHA-3 experiment. The project focuses on two key components: an amplifier and a wavelength shifter testing. Joos provided fundamental training on the relevant physics principles and electronic design for our detector systems. During the evening shift, we encountered an electrical issue in the beamline that had been affecting antiproton delivery. After troubleshooting and repairing the issue, we performed a successful antihydrogen production stacking run to verify the system's operational stability.

Friday, 20 June 2025

CERN Summer student Organizers provide a special session for non-member state students outlined post-program opportunities at CERN, demonstrating various fellowship and research opportunities available after the program. After the seminar, I focused on studying the amplifier circuit that Joos has already designed. I studied the schematics and began practicing precision soldering techniques for sub-millimeter components. This hands-on work is developing my skills in microelectronics assembly for sensitive detector systems, where even minor imperfections can significantly impact performance.

Saturday, 21 June 2025

My morning shift began at 7:00 AM with analysis of the previous night's antihydrogen megastack data, confirming successful trapping events. Following this, I assisted senior researchers in the crucial operation of refilling our 1000-liter helium dewar, requiring strict adherence to cryogenic safety protocols and precise pressure monitoring throughout the transfer process. Then I conducted the data analysis examined correlations between antihydrogen production and various parameters including positron temperature, escape energy, and NNI rates, until a laser malfunction paused operations.

Sunday, 22 June 2025

Today is my first trip outside Switzerland. I visited to Lyon, France, whick took only 90-minute bus ride from Geneva. My exploration began along the Saône River, followed by architectural admiration at Place des Terreaux. The Museum of Fine Arts proved particularly impressive, housing an exceptional collection spanning Renaissance to modern works. I also took a funicular ride to Fourvière Hill, where I visited the Basilica of Notre-Dame and the Gallo-Roman theater. The day is ended by walking through Vieux Lyon's Renaissance quarter and local glacé artisanal.

Monday, 23 June 2025

I completed the full-day Radiation Protection for Supervised Area training at CERN's Safety Training Center. The comprehensive program covered radiation classification, emergency protocols, and dosimeter operation through both theoretical instruction and practical simulations. The hands-on training course allowing us to practice with actual radiation monitoring equipment in controlled scenarios. After passing the final assessment, I'm now certified to work in supervised radiation areas for my work in the ALPHA experiment zone.

Tuesday, 24 June 2025

The ALPHA collaboration monthly meeting reviewed recent project results and discussed about future directions. Joos presented our progess on the ALPHA-3 detector development, including my work on the cryogenic amplifier development. After that, I practiced precision soldering techniques on PCB test boards to prepare for the actual amplifier assembly. During the evening shift, I assisted senior researchers with electron motion analysis in the Penning-Malmberg trap call EMPI (Electron Magnetic resonance imaging). The process started with applied asymmetric potentials to create radial electron displacement. Then monitored circular movement under varying well depth, and captured x-axis magnetic field data through controlled electron dynamics. These procedures helps characterize the trap's magnetic conditions for optimal antihydrogen formation.

Wednesday, 25 June 2025

The morning focused on soldering components for the amplifier using solder paste and mini heat plate. After finished shorted-circuit safety check by multimeter and solvent cleaning, I joined the evening shift. We recorded positron baseline heating curve and varying the well depth, and do the result analysis by plotting graph to see the correlation between Temperature vs Wait time (seconds). Interestingly, What I've noticed is the temperature rising very quickly and significantly drop after 5s wait time. Moreover, none changes observed after adjust well depth

Thursday, 26 June 2025

Today I completed the amplifier board soldering by installing the remaining components which required challenging hand soldering due to inaccessible jointing area. Followed by thorough inspections of solder joints and flux cleaning. During the evening shift operations, I first assisted with antiproton beam diagnostics by logging USCT phosphor screen images while systematically varying the beamgun's horizontal, vertical, and angular alignments. We also took the opportunity from magnet ramping-up to recalibrate our system by repeating antiproton baseline measurements. The shift concluded with positron plasma heating curve measurements, repeating yesterday's pulse sequence.

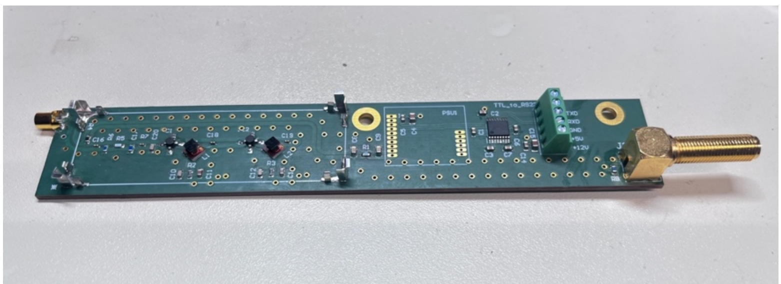

Figure 3 Completed amplifier board after soldering.

Friday, 27 June 2025

To improve the amplifier's performance, I implemented several modifications including reworking problematic solder joints, replacing specific components, and adding protective wiring to prevent short circuits. After my supervisor inspected the board, he instructed me on operating the cryogenic test setup. The system consists of multiple critical components: a turbo pump for initial vacuum creation, an ion pump for maintaining ultra-high vacuum, a bias voltage supply, a calibrated light source, a digital oscilloscope, and a Python-controlled monitoring interface. As this was my first experience with such instrumentation, I focused on understanding triggering mechanisms, waveform interpretation, and proper probe calibration.

Saturday, 28 June 2025

This weekend, My Thai friends and I visited Annecy, France. We arrived just an hour from Geneva by bus. This little town has plenty of beautiful historic architectures with the highlight as a canal pass through the middle of the old quarter connecting into the Lac d'Annecy. We spent the day exploring the picturesque streets, tasting delicious local pastries, and enjoying the lakeside park before taking a refreshing swim in the beautiful lake surrounding by mountains.

Figure 3 Lac d'Annecy, Annecy, France.

Sunday, 29 June 2025

After three weeks in Geneva, I finally had time to properly explore the city. My tour began at the United Nations headquarters, where I photographed the iconic Broken Chair sculpture. I then visited Baby Plage, Geneva's most popular lakeside beach, where I coincidentally met other summer students. We spent the afternoon swimming in Lake Geneva, playing beach volleyball and football, and ended the day sharing pizza at an authentic Italian restaurant.

Monday, 30 June 2025

An unexpected problem occurred when the completed amplifier board was damaged during test setup preparation. I had to redo the soldering work, though the process went faster this time due to my familiarity with the tools. However, we ran out of certain components, so I could only complete about half of the board before needing to pause the work.

Tuesday, 1 July 2025

Today I was spending time for two essential onsite safety trainings. The morning session is electrical safety training, focusing on proper high voltage equipment handling which is directly crucial for my current project. After passing the exam, I attended cryogenic safety training. I learned about handling liquid gases and preventing accidents when working with cryostats. The day ended with the Summer Student Welcome Party in the evening, where I met other friends from around the world. We all enjoyed discussing about each other various projects and exchanging cultural experiences.

Wednesday, 2 July 2025

Since the replacement components finally arrived, I cold able to complete the amplifier board soldering this morning. My supervisor briefly reviewed the experimental procedures and demonstrated key equipment operations before I had to begin my evening shift. We logged positron and antiproton baseline data, recorded the measurement results in our spreadsheet to keep traacking the data trend. Unfortunately, our planned antihydrogen production test had to be postponed due to beamline issues, so we logged electron baseline measurements instead.

Thursday, 3 July 2025

I began the day testing the power supply section of the amplifier board. I successfully applying bias voltage through the terminal blocks while monitoring the system via serial commands. The high voltage system activated properly, and my multimeter measurements confirmed the control interface was communicating correctly with the board.

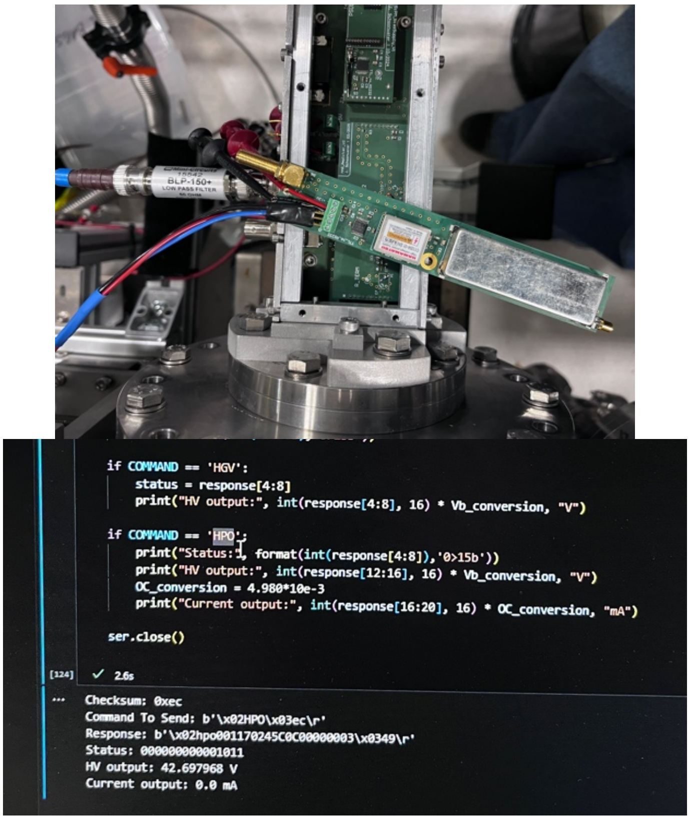

Figure 4 (a) High-voltage bias supply test setup. (b) Monitor display showing successful communication and activation.

Friday, 4 July 2025

After thoroughly learning oscilloscope working principle, I successfully gained voltage waveforms from the power supply. While the power supply signals matched perfectly with both the serial commands and multimeter readings, I encountered difficulties obtaining a trigger signal from the LED pulse generator. After troubleshooting, I suspect the issue might happen due to the trigger wiring connection rather than the generator itself, which I'll investigate further next week.

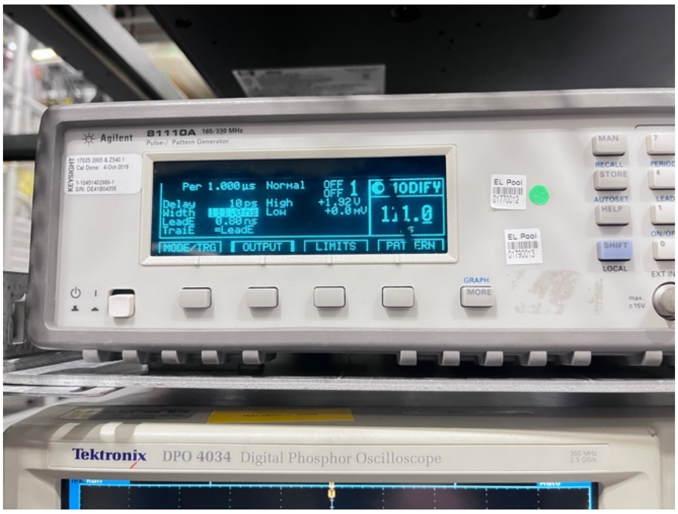

Figure 5 Trigger signal from the LED pulse generator.

Saturday, 5 July 2025

I joined other summer students on a group trip to Interlaken in the Bernese Oberland region. Interlaken is a small city placed between Lake Thun and Lake Brienz. The five-hour train ride rewarded us with breathtaking scenery. We first explored the Aare River which connecting the two lakes together, then took a train to Grindelwald where connected to the Jungfraujoch. Even though we didn't take a cable car to the mountain peak due to unpreparation for the low temperatures, we enjoyed swimming in Lake Thun's refreshing waters with the sun-set view behind.

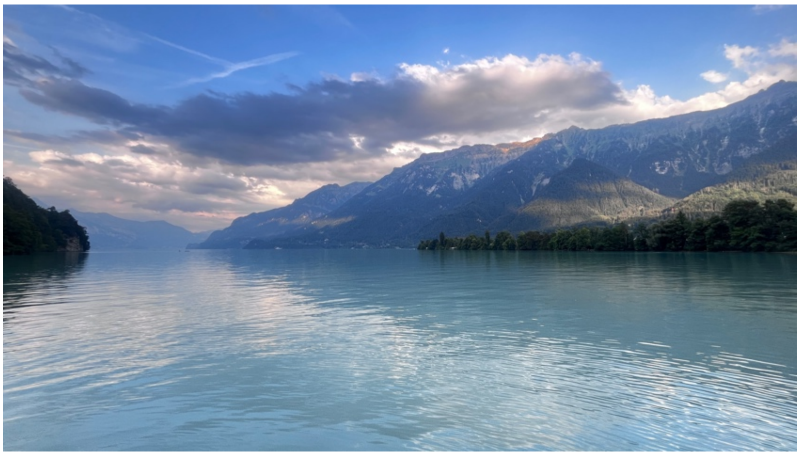

Figure 6 Lake Thun, Interlaken, Switzerland.

Sunday, 6 July 2025

After getting back late from our Interlaken trip, I decided to take it easy and stay home. I did some laundry and cooked meals for the week. Later, some friends asked me to join them for a hike through the vineyards near CERN, which is the same place we always see from our office windows but had never visited. The walk took us through neat rows of grapevines and past a huge field of sunflowers in full bloom. We hiked for about two hours at a relaxed pace and made it back just in time to watch the sunset. It was surprisingly beautiful and peaceful.

Monday, 7 July 2025

I started the morning by reading through the Silicon Photomultiplier (SiPM) manual to understand how these detectors work. I then studied and compared room temperature test results with what we expect to see in the cryogenic tests. Later, I met with my supervisor for a project discussion. He gave me a detailed physics lesson about antihydrogen atoms, explaining how they transition between different energy states. He also taught me how SiPMs detect photons using PN junctions with reverse bias voltage, and how cooling them down affects their performance, including the gain and breakdown voltage. After the lesson, we made a list of tasks we need to complete to stay on schedule with our project.

Tuesday, 8 July 2025

After a few busy days, today I attended the first summer student lecture on Foundations of Statistics. Since I'd taken statistics classes during my bachelor's degree, I could follow along easily. The lecture was really helpful for anyone working with lots of experimental data and I could applied the knowledge I've learned for my project. In the evening shift, we ran some stacking test and logged the antiproton baseline. When everything looked fine, we started the megastack procedure.

Wednesday, 9 July 2025

The statistics lecture continued today with more advanced topics about Bayesian statistics and probability theory. After class, I worked on assembling the amplifier frame box that Joos has already designed. Since I've already completed safety training for workshop equipment during my mechanical engineering degree, I was able to use the drilling and milling machines. Joos showed me around the workshop and explained the tools, then I studied the 3D CAD drawings to plan where to drill the holes. I practiced first on scrap metal to get familiar with the machines.

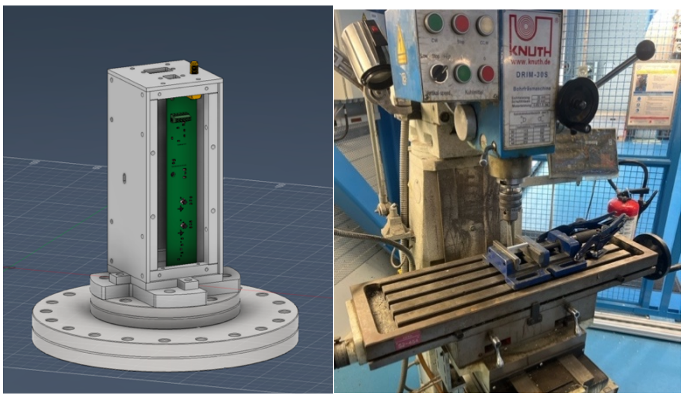

Figure 7 (a) 3D CAD design of amplifier box. (b) 3-Axis Milling Machine.

Thursday, 10 July 2025

Today's statistics class covered hypothesis testing and and the relation between confidence intervals and p-values. After the class, the rest of my day was spent drilling holes for the amplifier frame. It took many hours because the design required a lot of precise holes in just the right places.

Friday, 11 July 2025

This morning I had the special honor of meeting Thailand's Permanent Representative to the UN in Geneva. We talked about our experiences as a CERN summer student and focused on how we can apply CERN-acquired knowledge into Thailand's scientific development. After this meaningful discussion, I returned to the lab and spent the rest of the day finishing the drilling work on the amplifier frame.

Saturday, 12 July 2025

This weekend, my summer student friends and I traveled to Italy for an overnight trip. We took a six-hour train from Geneva to Milan, the most popular city in Italy known for its impressive architecture and extensive shopping districts. Our visit included the iconic Duomo cathedral and the Galleria Vittorio Emanuele II, where we admired the historic art and design. Later, we explored Sforza Castle and enjoyed authentic Italian gelato. The day is ended with dinner at a traditional restaurant, where we tasted original Italian pizza and pasta.

Sunday, 13 July 2025

After having Italian fried pizza and coffee as a perfect breakfast, we traveled to Como, a little town on the shores of Lake Como. We took a ferry ride to enjoy the stunning lakeside scenery while feeling the refreshing breeze. We then relaxed in a nearby park and swam at the local beach. For our final meal in Italy, we had fresh pasta and tiramisu, a highly recommended dessert. This trip was one of my most memorable experiences, and Italy has quickly become my favorite country.

Monday, 14 July 2025

This morning lecture presented applications of particle physics technologies in healthcare. I learned how physics technologies are used in radiotherapy systems and medical treatments. In the laboratory, I worked on modifying some parts that had undergone imprecise surface with rough cuts from water jet machining. I used milling machines and hand files to carefully smooth and adjust each piece to the right dimensions.

Tuesday, 15 July 2025

The healthcare physics lectures continued today, covering X-rays and gamma rays uses in medical field, PET scans, radioisotopes, and CERN's collaborations with medical technology. After class, I finished preparing the metal parts and started tapping threaded holes using three different taps: roughing, intermediate, and finishing, ensuring balanced thread formation through strict axial alignment.

Wednesday, 16 July 2025

Today's astroparticle physics lecture taught us about cosmic rays in the space and the IceCube neutrino detector in Antarctica. After the class, I finished assembling the amplifier box and had my supervisor check it before we install the electronics. Then I started my new task to assemble a wavelength shifter test equipment.

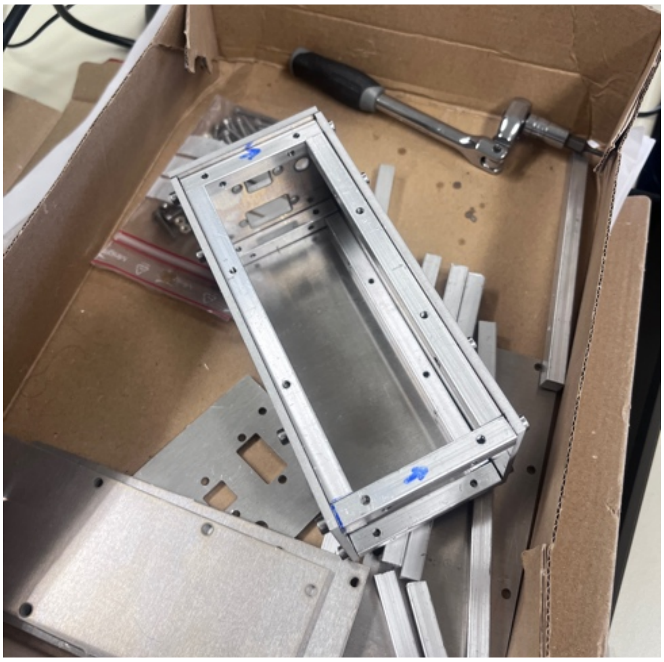

Figure 8 Completed amplifier box assembly

Thursday, 17 July 2025

The astroparticle physics lecture today focusing on dark matter in the galaxy and its properties, followed by a cosmology class about physics that related with universe.After the lectures, I continue studying 3D CAD drawings for my new task. Then, I attend my evening shift to help track antiprotons transferring to the ALPHA-g trap. We tested a new transfer method by raising potential wells instead of lowering them. By modifying the potential well configuration, we demonstrated a reduction in transfer duration through comparative trajectory analysis.

Friday, 18 July 2025

Today, I attended the cosmology lecture discussing matter-antimatter asymmetry in the universe which is a central focus of the ALPHA experiment. After that, I assisted my team with assembling and disassembling vacuum chambers for the upcoming ALPHA-3 experiment. We carefully wiped all tools and components with specialized lint-free paper and alcohol to prevent even microscopic dust particles from compromising the vacuum system's integrity. The assembly process required precise alignment of wires and components to ensure proper functionality.

Figure 9 Vacuum chambers Assembly for the ALPHA-3 experiment.

Saturday, 19 July 2025

Today, CERN organized a big summer science festival call 'STELLAR' which is about how astrophysics and particle physics are shaping our future. This event had a lot of activities like Talks by Nobel Prize winners and other world-class scientists, along with hands-on experiments. One highlight was meeting the real astronauts and thier talks really inspired gave me new perspectives. Moreover, I particularly enjoyed the APOLLO simulation, where I got to operate actual mission controls and even earned a completion certificate. Through the event, I gained a deeper appreciation for how astrophysics research benefits our daily life in diverse fields including healthcare, transportation and global safety.

Figure 10 STELLAR event at CERN.

Sunday, 20 July 2025

My friends and I decided to explore the other beautiful lakeside cities around Lake Geneva. We started from Montreux, the most famous jazz town and as the home where Freddie Mercury of Queen recorded many albums. Next, we moved to Vevey to visit the unique Alimentarium Food Museum and its iconic giant fork sculpture. Then, we ended the day in Lausanne, my favorite spot, where we swam in the lake, enjoyed sunset views, and ate delicious local crepes and hot chocolate. This is the perfect day to recharge before tomorrow's work at CERN.

Monday, 21 July 2025

This morning's lectures talked about nuclear physics research at ISOLDE, focusing on medical applications of radioactive isotopes. After the class, I began work on assembling the wavelength shifter test setup. After reviewing the 3D CAD designs provided by my supervisor, I planned the machining process for the small, precision components. Due to the miniature size and expensive of the part, achieving exact tolerances was quiet challenging. I figured that laser cutting would be the most accurate tool for this work but our facility lacked this equipment, so I practiced alternative techniques using milling machines and manual countersink drilling.

Tuesday, 22 July 2025

The morning lecture on RF Superconductivity mentioned about superconducting materials behavior under radiofrequency conditions. During the afternoon, I continued progressing with the wavelength shifter assembly. After doing milling machine practice, I printed detailed component drawings for being reference to ensure accurate drilling alignment. The design required small ventilation channels between holes and middle space to equalize air pressure differentials, so I have to careful planning of both the channel routing and manufacturing process.

Wednesday, 23 July 2025

I spend the full day for the wavelength shifter project. The design specifications required countersunk screw holes to maintain surface smoothness by using precise machining with specialized tools. Due to equipment limitations in ALPHA experiment, I adapted available tools to create properly dimensioned pilot holes in a test metal plate. Some improvisation was necessary because specialized toolings were missing. I successfully achieved the required tolerances and prepared to begin work on the actual components tomorrow.

Thursday, 24 July 2025

After a full day's work, I successfully completed drilling, tapping, and countersinking all required holes on the components. However, a significant incident occurred during the final countersinking process. The machine's Z-axis handle controller unexpectedly loosened, causing the drill bit to drop suddenly into the hole. Although I managed to grab the handle before the bit drilled completely through, the resulted was deeper and wider than how it supposed to be. Fortunately, after consulting with my supervisor, we confirmed that this error would not affect the vacuum system functionallity, due to the exist of air ventilation channels which will be my next task. This experience gave me an important lesson in machine safety to thoroughly inspect all equipment components before beginning any machining process.

Figure 11 Wavelength Shifters Holder Assembly.

Friday, 25 July 2025

I began my day by adjusting several countersink holes and milling the air ventilation channels. After completing these tasks, I started preparing for my upcoming project presentation, which I registered for yesterday and will deliver in two weeks. During the evening shift, I assisted my supervisor Tom with rewriting the Be+ baseline sequences and Be+/e+ mixing sequences to incorporate beryllium into the new ALPHA-g antihydrogen production process. Since ALPHA is currently focused on improving ALPHA-g, we also conducted antiproton transfers. Finally, I helped other team members by logging positron baseline data and refilling the nitrogen dewar.

Saturday, 26 July 2025

Today, I revisited Interlaken and Grindelwald to experience what I'd missed on my previous trip. I started at Lake Brienz, one of Interlaken's two stunning lakes, famous for its clear sparkling waters surrounded by majestic mountains. Later, I took a cable car from Grindelwald up to Pfingstegg, where can I see the breathtaking panoramic view of the village and Alps. Unfortunately, heavy rain began falling so our hiking plans were cancelled due to safety reasons, so we explored the old town instead before returning to Geneva.

Sunday, 27 July 2025

After being exposed to yesterday’s rain and cold weather, I woke up with a slight cold. I spent the morning doing laundry and working on my presentation slides and progress report. In the afternoon, My friends and I visited Pointe de la Jonction, a place where rivers Rhône and Arve are joining each others displaying different-colored water. We then watched the Women’s Euro 2025 final match, but another bunch of rain started, so we went home early.

Monday, 28 July 2025

This morning I attended a lecture on Data Acquisition Electronics and Triggers, which directly relates to my current project work with detectors and signal processing systems, particularly photomultipliers and amplifiers. Later during the evening shift, I participated in ALPHA's weekly collaboration meeting. As our team currently focusing on ALPHA-g development, today tasks are fixing the wiring issues in the Babcock magnet, running baseline measurements for Beryllium ions and positrons, and optimizing the antiproton transfer process to the upper section of the ALPHA-g trap. These system improvements are preparation to begin antihydrogen production and stacking operations next week.

Tuesday, 29 July 2025

Today's Data Acquisition Electronics and Triggers lecture continued with a focus on how clocks and triggers work in the data acquisition process. Since the cryostat needs time to warm up before I can perform any cryogenic measurements, I used this time to work on my progress report and presentation slides. Later, I made some modifications to component parts using a DREMEL hand rotary tool, creating smoother fillet edges and improved surface finishes.

Wednesday, 30 July 2025

The final Data Acquisition Electronics and Triggers lecture covered the complete DAQ system, including event builder networks, storage memory with erasure coding, and control systems. After lecture classes, I continued working on correcting misaligned holes in the wavelength shifter assembly. I managed to fix the alignment issues while preserving the threaded holes by using careful filing and precision countersinking techniques. Then, I rechecked all component dimensions to ensure proper fit.

Thursday, 31 July 2025

I attended the Antimatter in the Lab lectures, which focused on experiments conducted at the Antimatter Factory where I'm working. These classes helped expand my knowledge and deepen my understanding of our experiment, which should improve my project results. In the afternoon, senior ALPHA researchers gave a special lecture for summer students. They shared valuable information about our experiment from the big-picture goals down to the detailed working principles of each machine and the data analysis system. Since we work alongside these researchers during shifts almost every day, this lecture gave us a clearer understanding of what actually happens in the control room daily, allowing us to support their work more effectively.

Friday, 1 August 2025

Today is the last day of the Summer Student lecture series with a forward-looking session about the future of collider physics. The talk emphasized how we can apply the knowledge gained from this program and stay connected through CERN's alumni network. In the Afternoon, I noticed some surface roughness on a component junction from water-jet cutting that could impact heat transfer between the SiPM plate and mounting rod. I designed to polish the surfaces with 1500 and 2000 grit sandpaper, then cleaned the surface with isopropanol to achieve the required smoothness. I then dedicated the evening of the day to finishing my presentation slides.

Saturday, 2 August 2025

This weekend I finally visited Paris, the city I always expected for. My friends and I took an early morning train from Geneva. We enjoyed our first meal at a local French restaurant, which was incredible. We then visited famous landmarks including Notre-Dame Cathedral and walked along the Seine River to the Louvre Museum and Palais-Royal Gardens. After that, we visited the world-famous Eiffel Tower, which was even more impressive from seeing it in person. We took photos and explored the city until evening when we witnessed the sparkling light show of the Eiffel tower. This is a magical moment I'll never forget.

Sunday, 3 August 2025

We woke up early to continue our Paris adventure as soon as possible. First, we visited the stunning Opéra Garnier and Palais Garnier, then had lunch at Bouillon République which is a fantastic French restaurant recommended by our French summer student friends. Next, we went to saw the historic Arc de Triomphe, commemorating students who fought in wars, and strolled down the famous Champs-Élysées shopping street. Even though we didn't have enough time to visit every place, this Paris trip became my favorite travel experience ever.

Monday, 4 August 2025

After completing my presentation slides and reviewing the wording, I asked my supervisor to review them and provide suggestions for improvement. I then moved on to the final stage of my project modifications, the cleaning process. Since these components will be placed in a vacuum chamber, they must be extremely clean because even a single speck of dust or water droplet could ruin the entire system. My supervisor showed me the chemistry laboratory, which I'm permitted to use after completing the required safety training. While working there, I learned to properly use the ultrasonic bath and various chemical solvents, which I'm familiar with from my previous thesis project experience.

Tuesday, 5 August 2025

My supervisor returned my presentation slides with helpful recommendations, so I began improving following his suggestions. Since my project is still in the preparation phase, I don't yet have experimental results to present. Instead, I focused on clearly explaining the background and theoretical physics behind my work. As a mechanical engineering student, I feel some pressure presenting complex antimatter physics concepts that even physics students find challenging. I spent the entire evening practicing my presentation and refining my slides to ensure clarity.

Wednesday, 6 August 2025

Today was one of the most important days of my internship, my project presentation day. CERN provided us with this wonderful opportunity to present our work to fellow students and colleagues. My presentation lasted 10 minutes, followed by a question session. Everything went smoothly, and I received compliments from my supervisor and friends about how well-organized my content was, from the project background to my current progress. One question from my friend that really impressed me is "What has been your biggest challenge as an engineering student working in a major physics organization?". This question helped me reflect deeply on my contributions and how amazing it is that nuclear physics can integrate with engineering knowledge to advance our world.

Figure 12 Oral Presentation Session.

Thursday, 7 August 2025

On the second day of oral presentations, I attended from early morning to listen to my fellow summer students' projects. I was fascinated by the diverse range of projects across different academic fields from all international students worldwide. Listening to these presentations expanded my knowledge and allowed us to share our experiences. After the session, I went directly to the chemistry lab to continue my work. I started rechecking if all the components were ready, then placed them separately in beakers, and began the cleaning process. First with acetone for 30 minutes, then isopropanol for another 30 minutes. Finally, I stored the cleaned components in sterile plastic bags.

Friday, 8 August 2025

The final presentation day was busier than usual as some of the summer students had to depart today because each of us had different contract start and end dates. None of us enjoyed these goodbyes. After the session, we took group photos and shared a farewell lunch meal. Then, I went to the airport to help my friends with their luggage and send them off. While I was emotional realizing we all came from different countries and might not meet again soon, I found comfort in knowing we could stay connected through CERN's alumni network to continue sharing knowledge and experiences.

Saturday, 9 August 2025

Today I woke up early for a trip to Altdorf, one of the most underrated cities in Switzerland which is located near Zurich. The train took about four hours before arriving. My friends and I took a cable car up the mountain to begin our hike. Along the trail, we encountered many cows up close which we really enjoy as a uniquely Swiss experience. After two hours of hiking, we reached Stäubifall, one of Switzerland's most impressive and powerful waterfalls. We enjoyed the breathtaking scenery before continuing to Zurich, the largest city in Switzerland. Luckily, we arrived during Zurich's famous Street Parade 2025, the world's largest electronic music festival. We joined hundreds of thousands of people dancing along the lakeshore, creating unforgettable memories.

Sunday, 10 August 2025

Due to the tiredness and fatigue from yesterday’s hike, I chose to stay at the hostel to rest and recharge. After doing laundry and cooking lunch, I worked on my project in my room. But in the afternoon, the temperatures keep rising during the summer heatwave. So, I relocated myself to a coffee shop near Lake Geneva with a perfect view of the Jet d'Eau fountain and Ferris wheel through its windows. I spent a productive evening working in this peaceful atmosphere until night.

Monday, 11 August 2025

I spent the morning continuing the component cleaning process. Unfortunately, I received disappointing news about setbacks with the test cryostat, which will likely remain unusable for the rest of the month. This means I won't be able to conduct the planned amplifier and SiPM testing. However, my supervisor recognized my manufacturing and assembly skills through the current project and reassigned me to a higher-priority task, assembling a baking chamber for the ALPHA-3 upgrade. After receiving all necessary documents from Dr. April, the senior researcher who mainly taking care of ALPHA-3 project, I immediately began studying all the 3D CAD files and technical drawings.

Tuesday, 12 August 2025

I started by reviewing all bills of materials to identify any missing components that needed ordering. The baking chamber serves as a thermally insulated, controlled environment for the ALPHA-3 trap. My main tasks involve test-assembling the chamber before sending it for cleaning. The assembly process is divided into two parts, the frame and the chamber. The frame assembly should be able to assemble easily and can be done outside a clean room. However, I'll likely need assistance with the larger vacuum chamber components, which are both heavy and require careful handling to maintain cleanliness standards.

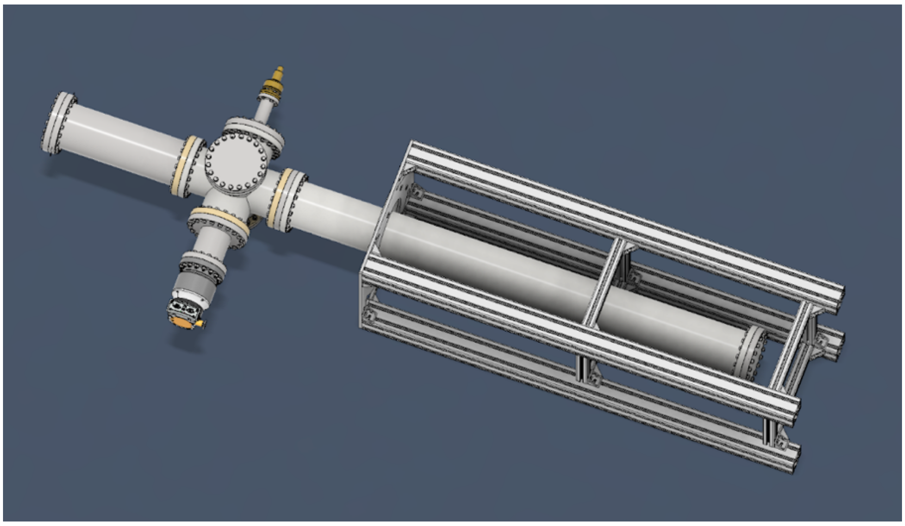

Figure 13 3D CAD of the Baking Chamber.

Wednesday, 13 August 2025

In the morning, I began assembling the aluminum frame components. The main challenges were determining the correct assembly sequence and handling the weight of the parts. Later, during the evening shift, I assisted senior researchers with antihydrogen production. We initiated three stacks using the optimal mixing parameters identified by the morning team, though we encountered some timing issues. To address this, we adjusted the premix well depth and extended the stacking time to observe any improvements.

Thursday, 14 August 2025

I continued working on the frame assembly today. To support sustainability and reduce costs, we reused existing aluminum profiles from the unused experiment instead of ordering new materials. So, this required careful manual modification of each piece to achieve the precise dimensions typically provided by factory orders. My senior researcher recommended using the circular cold saw for efficient cutting. To ensure safe and effective operation, I requested a training session from Reece Summer, a senior researcher experienced with mechanical tools, who provided guidance on the machine's operation and safety protocols.

Friday, 15 August 2025

Since I already got the Circular Cold Saw access, I started the day by cutting all required aluminum profiles using the circular cold saw. After completing this, I assembled the remaining parts of the frame. Due to the vacuum chamber assembly required a lot of delicacy, which has not yet been constructed, I have to carefully plan the assembly process in advance. Dr. April, the designer of this baking chamber, mentioned that this system is entirely new and hasn't been tested before. So, I suggested to conduct a static load simulation to evaluate and potentially enhance the frame's strength, ensuring it can safely support the vacuum chamber's weight.

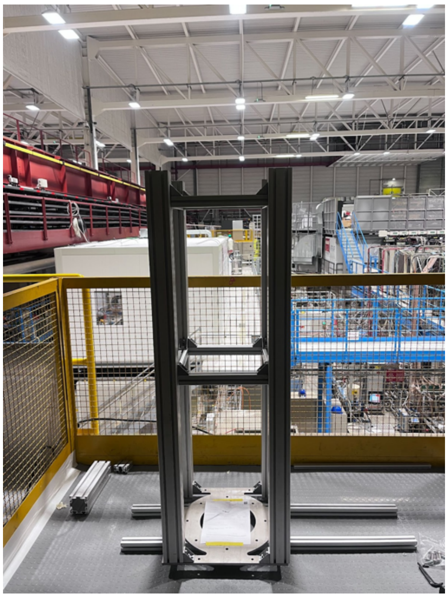

Figure 14 the Baking Chamber's Frame Assembly.

Saturday, 16 August 2025

This weekend I traveled to Stuttgart, Germany, the capital of Baden-Württemberg and a major hub for automotive manufacturing. As a mechanical engineering student, I was particularly excited to visit the home of renowned automobile companies like Mercedes-Benz and Porsche, which contributes to Stuttgart's status as Germany's "Autohauptstadt" or "capital of cars." Unfortunately, my journey encountered an unexpected and frustrating problem when my train was delayed and eventually canceled without prior notice, requiring me to purchase new tickets which were more expensive. My German friend mentioned that such issues are common, but as someone familiar with the punctuality of Swiss trains, I was a little disappointed. I arrived in the city center much later than I'd planned, allowing only a brief evening walk before returning to my accommodation.

Sunday, 17 August 2025

I began my day early heading straight to the Porsche Museum, which showcased an impressive collection of vehicles from historic models to the latest designs. I then moved to the Mercedes-Benz Museum, a huge 8-floor building filled with diverse exhibits explaining the brand's history. The highlight that most impressed me was seeing an actual Mercedes-Benz Formula 1 racing car up close. Both museums provided valuable insights into automotive engineering and design which I really enjoyed. Before returning to Geneva, I stopped at Metzingen Outletcity to purchase souvenirs for family and friends.

Monday, 18 August 2025

I returned to work to continue the baking chamber project. As I completed the frame assembly last week, my next task involved the vacuum chamber components. My supervisor and I began by inspecting all parts and moving them to the clean workspace which took a lot of time due to the heavy weight of all components. We encountered a challenge during our discussion about the assembly approach. I proposed assembling the vacuum chamber separately before installing it horizontally into the frame, but the frame wasn't designed to support the tube's weight in this orientation. Vertical installation was also impossible due to height restrictions. To resolve this, I designed a 3D-printed support to safely hold the tube horizontally during assembly.

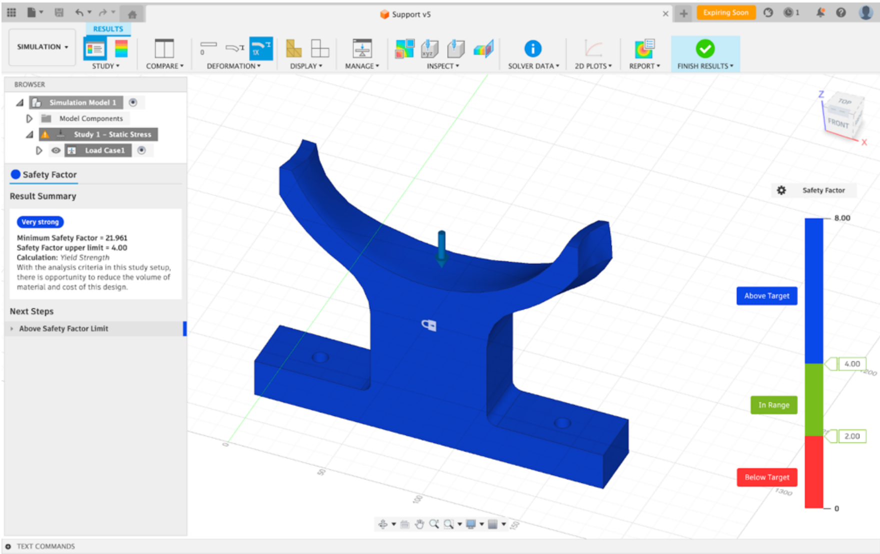

Figure 15 the Baking Chamber's Frame Support Design and Stress Simulation.

Tuesday, 19 August 2025

After 3D printing the support component overnight, I collected it in the morning, removed the support structures, and polished the surface. Luckily, the part fits well into the frame with good accuracy. I then planned to clamp the frame to a worktable to prevent tipping, but sudden ongoing construction required clearing all tables and parts from the experiment area. While senior researchers managed this, I assisted the shift team with ALPHA-g development work.

Figure 16 3D printing of the Baking Chamber's Frame Support.

Wednesday, 20 August 2025

This morning was quite busy as we couldn't find the correct flanges for the vacuum chamber. It turned out that they were found in a storage room in another building. I prepared the clean worktable using aluminum foil, medical-grade gloves, specialized cleanroom paper, and isopropanol, applying techniques I have learned during previous vacuum chamber assembly work with Liam. My supervisor once again reminded me about the critical importance of assembling with extreme care to prevent air leaks in the vacuum system. Key components of the Ultra High Vacuum chambers are Copper Gaskets, which provide leak-proof seals under high pressure. To position them accurately without damaging the flange's knife edge, we used gasket clips with spring action to hold the gasket securely in place.

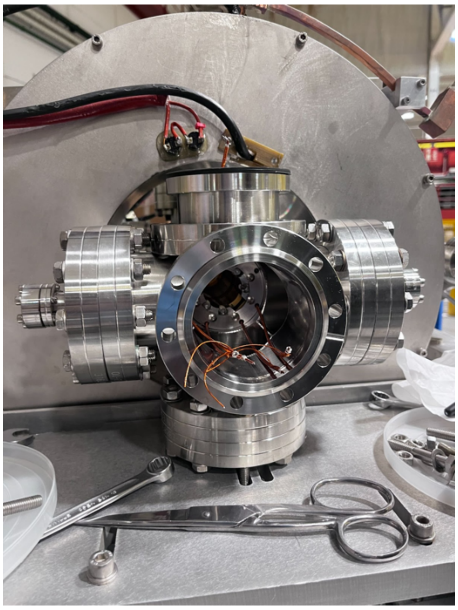

Figure 17 Vacuum chambers Assembly for the ALPHA-3 experiment.

Thursday, 21 August 2025

The main work area remained unavailable due to ongoing reorganization, so I could not continue building the chamber. Instead, I studied the frame load simulation from my earlier work to analyze the bending movement of the vacuum tube when installed horizontally. If any areas showed excessive stress that could lead to screw fatigue, I planned to design additional supports to distribute the weight during assembly. Later, I joined the evening shift, which focused on stacking tests. We identified timing issues as the cause of instability in the three earlier stacks and continued adjusting the sequence timing to improve long-term stability.

Friday, 22 August 2025

I spent the morning working on my project report before returning to the baking chamber assembly. With help from senior researchers, we relocated the work area, allowing me to clamp the frame securely to the table. To prevent tilting from the unbalanced weight of the horizontally mounted vacuum chamber, I designed and built a support structure to stabilize the frame. In the evening, senior researchers hosted a farewell dinner for ALPHA summer students at a nearby Italian restaurant, as next week is our final week. We enjoyed a relaxed evening of conversation and reflection, creating wonderful memories of our time working with the ALPHA experiment.

Figure 18 ALPHA experiment farewell dinner.

Saturday, 23 August 2025

This weekend I traveled to Nice, the second-largest French city on the Mediterranean coast, known for its beautiful seafront promenades, historic Old Town, artistic heritage, and lively cultural festivals. I took a train from the airport to the Vieux Nice district and spent the morning strolling through the city to admire its architecture. I then went up on Castle Hill to enjoy panoramic views of the area. The remainder of the day was spent swimming at one of the most stunning beaches I have ever seen, well-known for its unique two-toned waters as a result of the geological composition of the Baie des Anges, the bay where Nice is located.

Sunday, 24 August 2025

I took a train from Nice to Monaco, the second-smallest country in the world, located along the French Riviera. The train took only around 40 minutes to arrive in Monte-Carlo, the most famous city in Monaco. I began by exploring historic landmarks such as the Prince's Palace, which offered beautiful coastal views from the hilltop. I then visited Prince Rainier III's Car Collection, home to an impressive array of antique automobiles, and walked along a section of the Formula 1 street circuit before visiting the famous Casino de Monte-Carlo. Despite its small size, Monaco offers a remarkable concentration of attractions, making it a truly memorable destination before my return to Geneva.

Monday, 25 August 2025

On the first day of my final week at CERN, I continued working on my project report, aiming to complete it early so my supervisors could review it and provide feedback. I spent the entire day in my office, focusing on writing and discussing improvements with my supervisor to refine the report.

Tuesday, 26 August 2025

After finishing most of my project report, I sent it to my supervisors for review and comments. While waiting for their feedback, my friends and I took a self-guided tour of CERN to visit remaining sites we had not yet seen, such as the Science Gateway. This science exhibition hub features many STEM activities related to CERN's experiments and discoveries.

Wednesday, 27 August 2025

I began constructing the support structure for the frame, which I had designed the previous week. Using remaining aluminum profiles to support sustainability, I modified all components with machine tools to achieve the required dimensions. Afterward, I started cleaning my room and packing my luggage in preparation for my return flight to Thailand.

Thursday, 28 August 2025

Today, I focused on revising my summer student project report after getting many useful recommendations from my supervisors. I then continued assembling the support structure until evening. The ALPHA experiment was conducting antihydrogen stacking in the ALPHA-g apparatus to optimize the system, requiring the zone to be closed. Since I could not access the necessary tools until the next morning, I decided to pause my work and resume packing my luggage.

Friday, 29 August 2025

Since today marked my final day at CERN, I arrived early at the AD hall to complete work on my project. I finally successfully finished the baking chamber frame assembly. The last step of installing the vacuum chamber tube required a lifting crane, so I entrusted this task to senior researchers in the lab. After saying farewell to the ALPHA team and sharing a final lunch together, I completed all necessary termination procedures in the afternoon. This included returning my office key, dosimeter, and deactivating my access card. My time as a CERN summer student has now officially concluded.

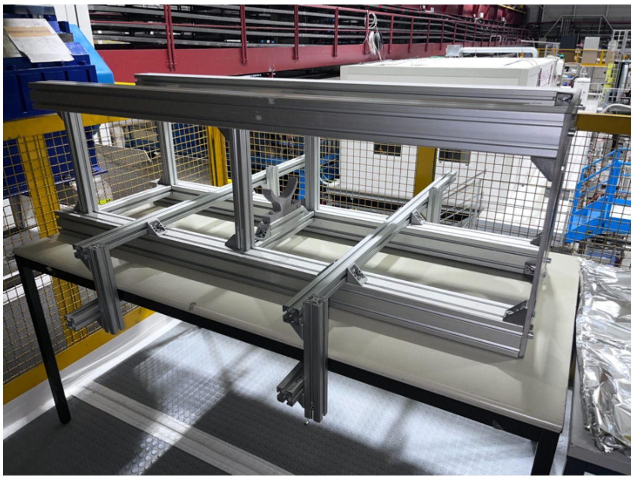

Figure 19 the Baking Chamber's Support Frame Assembly.

Saturday, 30 August 2025

On my last day in Switzerland, I decided to use my time exploring Geneva's old town district to find souvenirs for my Thai friends and my family. I visited Plainpalais, the largest thrifting market in the city which offered many Swiss-made vintage items. After getting Swiss watches, knives, and chocolates, I walked through Geneva's shopping streets and spent time at the beach, appreciating the beautiful views one last time. I ended the rest of this evening relaxing by the lake, reflecting on the many precious memories this city has given me.

Sunday, 31 August 2025

After preparing my luggage, I went to say goodbye to the remaining summer students in CERN. I made a final stop at the CERN souvenir shop to purchase gifts for my professors in Thailand. I then went to Geneva Airport and began my journey home, arriving safely in Thailand later the next day.

Chapter 4

Author's Biography

Chalisa Visvajit
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Tel: (+66) 83-803-9606
Email: chalisa.vis@gmail.com

EDUCATION

Chulalongkorn University, Bangkok, Thailand (2021 – 2025)

- BEng Mechanical Engineering, 1st Class Honors, 1st-Rank in Department
- GPAX: 3.91/4.00 (8 semesters)

SKILLS

Language

- Thai (Native)
- English (Upper-Intermediate) – TOEIC: 945/990 (Listening 480, Reading 465)

Technical Skills

- **Related Coursework:** Mechatronics, Automatic Control, Design of Mechanical Elements, Mechanics of materials
- **Software:** Fusion360, MATLAB, Python, MSOffice, Adobe Creative
- **Machining:** CNC, Laser Cutting, 3D Printing, Conventional Machining Tools

Additional Skills

- Graphic Design

WORK EXPERIENCE

CERN Summer Student 2025 – ALPHA Experiment, Geneva, Switzerland June - September 2025

- Selected by HRH Princess Maha Chakri Sirindhorn to join the Thai–CERN Collaboration Program for a highly competitive 3-month research internship (<3% acceptance) at CERN.
- Worked on SiPM (Silicon Photomultiplier) integration and cryogenic testing for the ALPHA-3 trap upgrade, enabling non-destructive antihydrogen spectroscopy aiming for first fluorescence detection from stable antimatter.
- Designed and assembled amplifier circuits, mechanical holders, and conducted detector performance testing under cryogenic and vacuum conditions.

Sustainable Hydroxyapatite Coatings for Orthopedic Implants (2024 - 2025)

- Developed and optimized hydroxyapatite coatings derived from Nile Tilapia fish bones using plasma spray technology, achieving performance comparable to commercial HAp for enhanced orthopedic implant osseointegration.
- Conducted material characterization using SEM, XRF and EDS analysis.

Drone Battery Swapping Mechanism for ARV Company (August - December 2024)

- Designed and prototyped an automated battery-swapping system for the HORRUS drone to enable continuous operation, extend flight time, and minimize human intervention.
- Collaborated with ARV engineers on system integration and testing to improve drone operational efficiency.

Research Internship at Nagaoka University of Technology, Niigata, Japan (June - July 2024)

Material Science and Bioengineering

- Synthesized and characterized $Na_2FeP_2O_7$ glass-ceramics to enhance electrochemical performance for sodium-ion battery cathodes.
- Prepared $Ca(H_2PO_4)_2$ glass samples and conducted preliminary cytotoxicity assays using HeLa cells to evaluate biocompatibility.

RoBoCoN International Design Contest (IDC2023) Organizer Team (August 2023)

Robotics Competition Coordinator and Technical Advisor

- Assisted participants from various countries with contest rules and robotics construction inquiries.
- Coordinated and managed operational aspects of the competition.
- Provided convenience to contestants and facilitated relationship-building among participants.

AWARDS

Academic Excellence Award 2024, The Engineering Institute of Thailand Under H.M. The King's Patronage (August 2024)

- Recognized as the top-ranked student among over 1,000 students for achieving the highest academic record across all engineering departments at Chulalongkorn University.

CERN SUMMER STUDENT PROGRAMME 2025

รายงานการเข้าร่วมโครงการนักศึกษาภาคฤดูร้อนเซิร์น