# SAPHIR NEWSLETTER

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RECENT NEWS

### RESEARCH

**RECOMMENDED SCIENTIFIC ARTICLES**

**In this section, we are pleased to share three papers selected by an Associate Researcher and two Postdoctoral Researchers, which they consider valuable readings for our community.**

**Nicolás Vásco**
*SAPHIR Associate Researcher & Professor at Universidad Técnica Federico Santa María*

**"A Triplet Track Trigger for the FCC-hh to improve the measurement of D-Hadron production and the Higgs self-coupling", Authors: T. Aaa A. Schirring.**

*Authors: T. Aaa A. Schirring.*
*Nuclear Instruments and Methods in Physics Research*

This article presents an innovative concept, the Triplet Track Trigger (TTT), designed for the detector of the Future Circular Collider Hadron-Hadron (FCC-hh). The study addresses the extreme challenges of high pile-up environments, focusing on the precision of vertex reconstruction, characterized by high-resolution measurements of D-hadron decay vertices, impactful jet secondary, the TTT enables fast and autonomous track reconstruction at the hardware level, significantly reducing suppression and offering vertex identification capabilities. The study evaluates the impact on Higgs production (gg → hh) → bbbb in two scenarios: standard conditions and with TTT sensitivity, to the intrinsic Higgs self-coupling (λ) is maximal, surpassing the limitations of traditional trigger systems.

The article is strongly connected with the research lines of the Millennium Institute SAPHIR, particularly in the development of algorithms and instrumentation in the development of high-performance tracking systems and hardware-based reconstruction techniques. This work provides valuable discussions on the feasibility of precise measurements of the Higgs potential, reinforcing the collaboration between the Chilean scientific community and international institutions in high-impact data acquisition.

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**Ashish Sehrawat**
*SAPHIR Postdoctoral Researcher, Pontificia Universidad Católica de Chile |*

**"Search for Light-Long-Lived Neutral Particles from Higgs Boson Decays via Vector-Boson-Fusion Production in pp Collisions at √s = 13 TeV with the ATLAS Detector"**

*Authors: ATLAS Collaboration*
*The European Physical Journal C*

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**Motivation:** Hidden-sector models frequently predict a light vector mediator, the dark photon (γD), which could connect the SM to a Standard Model dark matter. Among, the LHC, exotic Higgs decays can populate this sector, with the dark photon γD being produced in long-lived neutral hidden sector states. These states could leave distinctive features, for suitable masses and lifetimes, a pair of displaced jets in the muon spectrometer stage, producing collimated clusters of muon tracks with minimal hadronic activity. These clusters are reconstructed as muon-like jets, offering a clean experimental signature outside standard central-object reconstruction, complementing and exploiting the ATLAS muon system and trigger for LLP, sensitivity to long-lived particles (LPs) from hidden sectors.

**Aspiration:** The study analyzes the full Run 2 ATLAS dataset from pp collisions at √s = 13 TeV targeting Higgs production in the vector-boson-fusion (VBF) topology to search for neutral long-lived particles (LLPs) with a large rapidity gap and high dijet mass. The analysis exploits displaced muon-jet signatures recorded in the Muon Spectrometer (MS), complementing the Calorimeter-Jet algorithm, combining both datasets to maximize sensitivity across a broad lifetime range. The search targets LLP decays with high efficiency for collimated μ− μ+ decays while suppressing soft contaminations. To ensure robust background estimation, the analysis employs a dedicated data-driven method based on muon-jet kinematic and geometry-sensitive variables, achieving stable performance across different jet and muon selection variations. LLP MS jet pair candidates are required to satisfy kinematic and (ii) specialized muon-based triggers ensure efficient data collection. Dedicated Monte Carlo samples including scalar and vector processes are constructed using data-driven reweighting to model the signal efficiency as a function of lifetime.

**Results:** No significant excess above the expected background is observed, and the analysis sets the most stringent ATLAS limits to date on exotic Higgs decays into hidden-sector long-lived particles in the VBF topology, surpassing Run 1 and the subject level. In addition, the analysis provides a robust sensitivity across dark-photon masses from 0.25 GeV to 2 GeV and lifetimes from sub-meter lengths spanning millimeters to meters. The results demonstrate the feasibility of using muon-jet substantially analogous the experimentally challenging regime of displaced hadronic jetlike signatures with significant uncertainties and light vector mediators. (ii) It demonstrates a robust data-driven background estimation method in the muon system, combining specialized trigger strategies, muon-jet kinematic and background rejection, and LLP tagging, and provides a benchmark for future searches by students and researchers on how to exploit muon-spectrometer-only signatures, into robust selections, background estimation, and interpretable limits.

**The paper is assessing as it concerns a well-motivated hidden-sector framework in connection, discuss their strategies, it showcases modern data processing of MS muon-jet signals, and deep-learning-based cosmic rejection, and it demonstrates how to derive robust, competitive limits using data-driven backgrounds.**

**Yohan Oviedo**
*SAPHIR Postdoctoral Researcher, Universidad Andrés Bello |*

**"Measurement of the Positive Muon Anomalous Magnetic Moment to 127 ppb"**

*Authors: D. P Aguillard, T Albahri D Alnascri, J Arnold, K Badziny, S. Bedikian, I. Bailey, W. Bennett, G. Bennett, M. Bhattacharya ... J. J Grebenisch ...*
*Published in Physical Review Letters*

The Standard Model has established itself as the most precise theoretical framework to describe the universe. Its predictions have consistently withstood rigorous tests, serving as a reliable benchmark against which any potential essential model for understanding the universe must be evaluated. The Standard Model is grounded in principles of symmetry and quantum mechanics, and its robust structure has enabled extraordinarily precise predictions for a wide array of phenomena, including certain particle physics observables around the world.

One prediction stands out in particular, as it relates to one of the most sensitive tests of the Standard Model: the anomalous magnetic moment of fermions, commonly known as "g-2". This quantity can be quantified by the relation $\mu = g\frac{e}{2m}S$, where $\mu$ represents the magnetic moment, $S$ the angular momentum (spin), $e$ the elementary charge, $m$ the mass, and $g$ the gyromagnetic factor. Initially, it was believed that the gyromagnetic factor for fermions should be exactly 2. However, quantum field theory revealed that a small deviation from this value, primarily attributed to the fluctuations of the electromagnetic field, manifests as a deviation from 2. Experiments such as E821 at Brookhaven National Laboratory and Muon g-2 at Fermilab have measured this deviation with remarkable precision, yielding a value of the muon anomalous magnetic moment that differs significantly from the Standard Model, matching up to the 7th loop order in QED. This discrepancy suggests the presence of undiscovered particles that would alter these calculations, potentially indicating new physics beyond the Standard Model.

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However, in one of the plots (T), the Muon g-2 collaboration at Fermilab confirmed that the experimental data aligned with the theoretical predictions, reducing the discrepancy to approximately 1.5 standard deviations from the model. Although this measurement does not indicate new physics, it underscores the ongoing efforts aimed at refining the use of operating for the Standard Model and exploring potential deviations, dark matter, neutrino masses, and other open problems.

*D Bryan g-2 collaboration. "Measurement of the Positive Muon Anomalous Magnetic Moment to 127 ppb". Phys. Rev. Lett. 131, 161802 (2023). DOI: 10.1103/PhysRevLett.131.161802*

**We invite you to explore these articles, as each of them offers insights that contribute to ongoing discussions in particle physics and reflect the diverse research interests within SAPHIR.**

### HIGHLIGHTS FROM SAPHIR: OUR LATEST RECOMMENDED READS

Chile's growing role at CERN is underscored by several milestones achieved with the active participation of Chilean institutions and researchers. These include the successful operation of the Chilean-designed moving table, SAPHIR's formal integration into the BNP experiment, the participation of three Chilean students in CERN's Summer School, and the launch of the ProTeCH program in Concepción to strengthen the training of particle physics technicians.

**Chilean engineering advances at CERN: the "moving table" passes its toughest test**

A moving table—designed and built entirely in Chile by the SAPHIR team and industry partners—has successfully passed its most demanding load test at CERN, safely supporting up to 8 tonnes. This achievement marks a milestone: it is the first such machine made in Chile installed at CERN, demonstrating competitive performance at a level more than 8 times the standard overheads. The success underscores Chile's growing role in frontier physics research and the strength of academia-industry collaboration.

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**Engineering and Chilean science at CERN: SAPHIR to contribute to the development of detectors for the BNP experiment**

SAPHIR has formalized an agreement to collaborate with CERN, joining the SHiP experiment (Search for Hidden Particles) in the Beam Neutrino Physics (BNP) project. The Experimental Physics Department (as a Project Member of BNP) will design and build high-resolution detector systems, mechanical design contributions, and operational leadership. The BNP project, approved by the CERN Research Board, aims to measure the tau neutrino cross-section using a dedicated emulsion detector. This collaboration strengthens local expertise in the training of young researchers and strengthens Chile's scientific and technological presence on the global stage.

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**Chilean students at CERN's Summer School: SAPHIR projects national science to the world**

In the latest edition of CERN's prestigious Summer Student Programme—an elite training opportunity established in 1962—three students linked to SAPHIR participated: Vicente Valenzuela Cesar (Pontificia Universidad Católica de Chile), Constanza Fernández Castillo (Universidad Técnica Federico Santa María), and Vicente Millar Bravo (Universidad Andrés Bello). The program, which selects only a few dozen participants worldwide each year, marks a milestone for Chilean science. With Chile now a CERN Associate Member State, this participation reinforces the country's integration into global scientific communities and highlights the importance of international collaboration in training the next generation of physicists.

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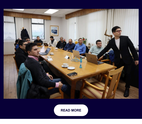
**Chile invests in particle physics technicians: SAPHIR and UTFSM introduce the ProTeCH program in Concepción**

Starting in late in Concepción, the Pontificia Millenio SAPHIR, together with Universidad Técnica Federico Santa María (UTFSM), launched **ProTeCH**, a pioneering technical program to train the next generation of Chilean technical professionals in leading international experiments, including those at CERN. Spearheaded by SAPHIR Associate Researcher Felipe Olivares Leiva and Dr. Nicolás Vásco M., the initiative highlights the critical role of highly specialized technicians in the success of large-scale scientific infrastructure projects, such as the Large Hadron Collider (LHC) and its upgrades.

ProTeCH includes partnerships with technical training centers, international internships, shared governance with AHKP and the Ministry of Science, and university-technical transfer in Chile. The program aligns with Chile's newly acquired status as an Associate Member State of CERN, offering a tangible opportunity to consolidate scientific and technical development in the country.



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**CERN School of Computing – Latin America 2026**

We are thrilled to announce that the **CERN School of Computing – Latin America 2026** will take place from **11 to 24 January 2026** at the La Cantera Campus of the Pontificia Universidad Católica de Chile, in collaboration with SAPHIR and UC Chile.

The two-week intensive program offers over 60 hours of lectures and hands-on exercises covering advanced topics in software, computing, and data-driven approaches in science and technologies. Participants will also gain the optional final exam will receive a diploma issued by CERN and the School.

Designed for postgraduate students, engineers, and scientists with experience in particle physics, computing, or related fields, CSC Latin America 2026 welcomes applicants from all nationalities, with particular encouragement for students from Latin America. Financial support may be available for eligible candidates.

**Why this matters for SAPHIR and Chile:**

- **Regional relevance:** The first-ever CERN School of Computing in Latin America strengthens Chile's leadership in scientific computing and international collaboration.
- **Capacity building:** It reflects SAPHIR's ongoing commitment to equip local scientists and students with top-tier training in frontier technologies.

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### OUTREACH

**Niñas Atómicas 2025**

With great enthusiasm and a firm commitment to advancing science education, SAPHIR joined the **Niñas Atómicas 2025** initiative, hosted by the **Millenio Institute SAPHIR**, the **Fundación Centro** and Sociesco Colbún.This year's edition welcomed 30 selected secondary school students, drawn from over 250 applicants across Chile's regions. Participants engaged in a blended program—combining online and in-person sessions—centered around **Particle Physics, Cosmology, and Astrophysics**.

The hybrid format expanded the workshop's reach beyond Santiago, promoting inclusivity and decentralization. The program culminated in a series volunteer "expeditions" sponsored by institutional authorities, followed by interactive scientific activities and inspirational talks—culminating in a memorable closing event on July 5.

With support from ANID and UC ag. head Niñas Atómicas continues to break down gender stereotypes in STEM and inspire the next generation of women scientists in Chile.

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**Science Reaches the Classroom: SAPHIR Brings Particle Physics to Students in Northern Chile**

As part of the scientific outreach activities promoted by the Millennium Institute SAPHIR, on Wednesday, August 27, a special session dedicated to particle physics and the exploration of the universe was held at the Colegio Adventista de Chile in Antofagasta. The session, **Mauricio Martínez**, a PhD student in Physics at the Institute of Physics of the Pontificia Universidad Católica de Chile and tutor of the "Niñas Atómicas" project, an Outreach (PME) initiative directed by SAPHIR Deputy Director, Dr. Francisco Castro, together with Associate Researcher Dr. Giovanna Cottin.

The event was organized and coordinated by **Patricio Grunert**, SAPHIR's Director of Communications, Outreach, and PME, in collaboration with **Israel Romero**, Academic Coordinator at Colegio Adventista. The session was attended by approximately 40 students, divided into first and second year high school groups, including approximately one-third of students who attended as audience members for the particle physics lecture delivered by Melanie Martínez.

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**PRESS**

**Scientific Insights: Giovanna Cottin's columns featured on Cooperativa.cl**

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*Read more of Giovanna Cottin's columns here: Noticias - Instituto Milenio SAPHIR*

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