All. n. 1 - I Verbale
BC 25169/23

INFN
Istituto Nazionale di Fisica Nucleare
LABORATORI NAZIONALI DI FRASCATI
Servizio del Personale

CONCORSO 25169/23
PROVA ORALE
Busta n. 1

La candidata risponda alle seguenti domande:

1) qual è la documentazione prevista dall'allegato XVII del D.Lgs. 81/2008 relativa all'idoneità tecnico professionale delle imprese affidatarie e dei lavoratori autonomi

2) quali sono le differenze tra l'informazione, la formazione e l'addestramento nel testo unico sulla sicurezza del lavoro

3) cosa si intende per licenziamento disciplinare e quali sono i comportamenti che possono provocarlo

1) cos'è una PEC e come funziona

All. n. 1 - IV Verbale
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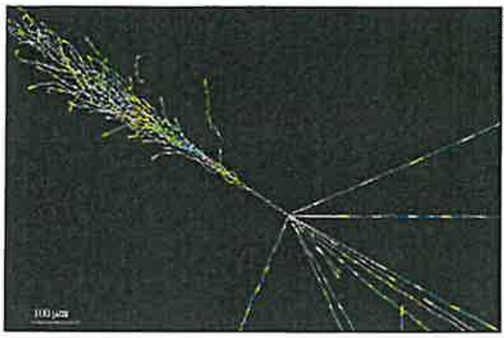
1

NEUTRINOS

First collider neutrinos detected

Since their discovery 67 years ago, neutrinos from a range of sources – solar, atmospheric, reactor, geological, accelerator and astrophysical – have provided ever more powerful probes of nature. Although neutrinos are also produced abundantly in colliders, until now no neutrinos produced in such a way had been detected, their presence inferred instead via missing energy and momentum.

A new LHC experiment called FASER, which entered operations at the start of Run 3 last year, has changed this picture with the first observation of collider neutrinos. Announcing the result on 19 March at the Rencontres de Moriond, and in a paper submitted to *Physical Review Letters* on 24 March, the FASER collaboration reconstructed 153 candidate muon neutrino and antineutrino interactions in its spectrometer with a significance of 16 standard deviations above the background-only hypothesis. Being consistent with the characteristics expected from neutrino interactions in terms of secondary-particle production and spatial distribution, the results imply the observation of both neutrinos and antineutrinos with an incident neutrino energy significantly above 200 GeV. In addition, an ongoing analysis of data from an emulsion/tungsten subdetector called FASERν revealed a first electron-neutrino interaction candidate (see image above).



FASER

New source *A candidate high-energy electron neutrino charged-current interaction recorded by FASERν, with the electron shower (left of the image) balanced by several charged particle tracks (right).*

"FASER has directly observed the interactions of neutrinos produced at a collider for the first time," explains co-spokesperson Jamie Boyd of CERN. "This result shows the detector worked perfectly in 2022 and opens the door for many important future studies with high-energy neutrinos at the LHC."

The extreme luminosity of proton–proton collisions at the LHC produces a large neutrino flux in the forward direction, with energies leading to cross-sections high enough for neutrinos to be detected using a compact apparatus. FASER is one of two new forward experiments situated at either side of LHC Point 1 to detect neutrinos produced in proton–proton collisions in ATLAS. The other, SND@LHC, also reported its first results at Moriond. The team found eight muon-neutrino candidate events against an expected background of 0.2, with an evaluation of systematic uncertainties ongoing.

Covering energies between a few hundred GeV and several TeV, FASER and SND@LHC narrow the gap between fixed-target and astrophysical neutrinos. One of the unexplored physics topics to which they will contribute is the study of high-energy neutrinos from astrophysical sources. Since the production mechanism and energy of neutrinos at the LHC is similar to that of very-high-energy neutrinos from cosmic-ray collisions with the atmosphere, FASER and SND@LHC can be used to precisely estimate this background. Another application is to measure and compare the production rate of all three types of neutrinos, providing an important test of the Standard Model.

Beyond neutrinos, the two experiments open new searches for feebly interacting particles and other new physics. In a separate analysis, FASER presented first results from a search for dark photons decaying to an electron–positron pair. No events were seen in an almost background-free analysis, yielding new constraints on dark photons with couplings of 10^{-5} to 10^{-4} and masses of between 10 and 100 MeV, in a region of parameter space motivated by dark matter.

Further reading

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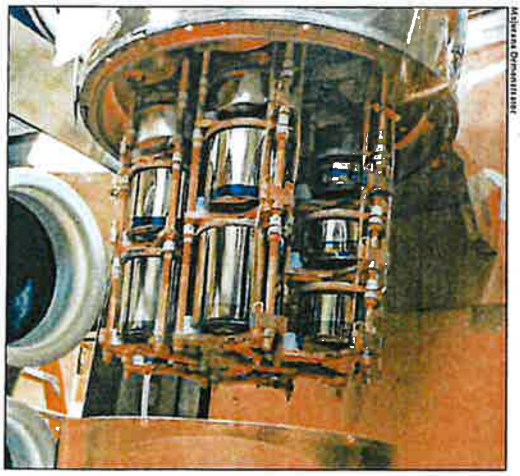
FASER Collab. 2023 CERN-FASER-CONF-2023-001.

Majorana neutrinos remain at large

Neutrinoless double-beta decay (0νββ) remains as elusive as ever, following publication of the final results from the Majorana Demonstrator experiment at SURF, South Dakota, in February. Based on six years' monitoring of ultrapure ^{76}Ge crystals, corresponding to an exposure of 64.5 kg × yr, the collaboration has confirmed that the half-life of 0νββ in this isotope is greater than 8.3×10^{25} years. This translates to an upper limit of an effective neutrino mass $m_{\beta\beta}$ of 113–269 meV, and complements a number of other 0νββ experiments that have recently concluded data-taking.


Majorana Demonstrator

High resolution *Germanium cells in the Majorana Demonstrator cryostat, some of which were exchanged with tantalum to search for dark matter in the decay of metastable tantalum-180.*

Whereas double-beta decay is known to occur in several nuclides, its neutrinoless counterpart is forbidden by the Standard Model. That's because it involves the simultaneous decay of two neutrons into two protons with the emission of two electrons and no neutrinos, which is only possible if neutrinos and antineutrinos are identical "Majorana" particles such that the two neutrinos from the decay cancel each other out. Such a process would violate lepton-number conservation, possibly playing a role in the matter–antimatter asymmetry in the universe, and be a direct sign of new physics. The discovery that neutrinos have mass, which is a necessary condition for them to be Majorana particles, motivated experiments worldwide to search for 0νββ in a variety of candidate nuclei.

Germanium-based detectors have an excellent energy resolution, which is key to be able to resolve the energy of ▷

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PROVA ORALE
Busta n. 2

La candidata risponda alle seguenti domande:

1) cosa è lo stress da lavoro correlato
2) qual è il percorso formativo dell'RLS
3) la mobilità nel pubblico impiego: cosa è e come si verifica
4) cosa è lo SPID e come si utilizza

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2

NA62

Searching for dark photons in beam-dump mode

Faced with the no-show of phenomena beyond the Standard Model at the high mass and energy scales explored so far by the LHC, it has recently become a much considered possibility that new physics hides "in plain sight", namely at mass scales that can be very easily accessed but at very small coupling strengths. If this were the case, then high-intensity experiments have an advantage: thanks to the large number of events that can be generated, even the most feeble couplings corresponding to the rarest processes can be accessible.

Such a high-intensity experiment is NA62 at CERN's North Area. Designed to measure the ultra-rare kaon decay $K \to \pi\nu\bar{\nu}$, it has also released several results probing the existence of weakly coupled processes that could become visible in its apparatus, a prominent example being the decay of a kaon into a pion and an axion. But there is also an unusual way in which NA62 can probe this kind of physics using a configuration that was not foreseen when the experiment was planned, for which the first result was recently reported.


CERN-PHOTO-202104-059-6

Intense *Part of the NA62 detector in the ECN3 experimental hall in Prevessin, where beam travels from right to left. On the right-hand side is the STRAW spectrometer, with the analysing magnet in blue. Four large-angle vetoes serving to clean the samples from non-forward events are visible in white, while the green region houses the RICH detector.*

During normal NA62 operations, bunches of 400 GeV protons from the SPS are fired onto a beryllium target to generate secondary mesons from which, using an achromat, only particles with a fixed momentum and charge are selected. These particles (among them kaons) are then propagated along a series of magnets and finally arrive at the detector 100 m downstream. In a series of studies starting in 2015, however, NA62 collaborators with the help of phenomenologists began to explore physics models that could be tested if the target was removed and protons were fired directly into a "dump" that can be arranged by moving the achromat collimators. They concluded that various processes exist in which new MeV-scale particles such as dark photons could be produced and detected from their decays into di-lepton final states. The challenge is to keep the muon-induced background under control, which cannot be easily understood from simulations alone.

A breakthrough came in 2018 when beam physicists in the North Area understood how the beamline magnets could be operated in such a way as to vastly reduce the background of both muons and hadrons. Instead of using the two pairs of dipoles as a beam achromat for momentum selection, the currents in the second pair are set to induce additional muon sweeping. The scheme was verified during a 2021 run lasting 10 days, during which 1.4×10^{17} protons were collected on the beam dump. The first analysis of this rapidly collected dataset – a search for dark photons decaying to a di-muon final state – has now been performed.

Hypothesised to mediate a new gauge force, dark photons, A', could couple to the Standard Model via mixing with ordinary photons. In the modified NA62 set-up, dark photons could be produced either via bremsstrahlung or decays of secondary mesons, the mechanisms differing in their cross-sections and distributions of the momenta and angles of the A'. No sign of $A' \to \mu^+\mu^-$ was found, excluding a region of parameter space for dark-photon masses between 215 and 550 MeV at 90% confidence. A preliminary result for a search for $A' \to e^+e^-$ was also presented at the Rencontres de Moriond in March.

"This result is a milestone," explains analysis leader Tommaso Spadaro of LNF Frascati. "It proves the capability of NA62 for studying physics in the beam-dump configuration and paves the way for upcoming analyses checking other final states."

Further reading

NA62 Collab. 2023 arXiv:2303.08666.

ASTROWATCH

X-ray source could reveal new class of supernovae

Type1A supernovae play an important role in the universe, both as the main source of iron and as one of the principal tools for astronomers to measure cosmic-distance scales. They are also important for astroparticle physics, for example allowing the properties of the neutrino to be probed in an extreme environment.

Type1A supernovae make ideal cosmic rulers because they all look very similar, with roughly equal luminosity and emission characteristics. Therefore, when a cosmic explosion that matches the properties of a type1A supernova is detected, its luminosity can be directly used to measure the distance to its host galaxy. Despite this importance, the details surrounding the progenitors of these events are still not fully understood. Furthermore, a group of outliers, now known as type1ax events, has recently been identified that indicate there might be more than one path towards a type1A explosion.

The reason that typical type1A events all have a roughly equal luminosity is because of their progenitors. The general explanation for these events includes a binary system with at least one white dwarf: a very dense old star consisting mostly of oxygen and carbon that is not undergoing fusion. The system is only prevented from collapsing into a neutron star or black hole due to electron-degeneracy pressure. As the white dwarf accumulates matter from a nearby companion, its mass increases to a precise critical limit at which an uncontrolled thermonuclear explosion starts, resulting in the star being unbounded and seen as the supernova.

As several X-ray sources were identified in the 1990s by the ROSAT mission as being white dwarfs with hydrogen burning on their surface, the source of matter that is accumulated by the white dwarf was long thought to be hydrogen from a companion star. The flaw with this model, however, is that type1A supernovae show no signs of any hydrogen. On the other hand, helium has been seen, particularly in the outlier type1ax supernovae events. These 1ax events, which are predicted to make up 30% of all type1A events,

This peculiar binary system provides strong hints of a new type of progenitor that can explain up to 30% of all supernovae 1a events

▷

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PROVA ORALE
Busta n. 3

La candidata risponda alle seguenti domande:

1) gli obblighi del lavoratore ai sensi dell'articolo 20 del D. Lgs. 81/2008
2) qual è il percorso formativo del lavoratore in azienda con il rischio lavori in quota
3) quali sono le modalità di reclutamento del personale nel pubblico impiego, anche in relazione al piano triennale del fabbisogno di personale
4) cos'è Power Point e quali sono le sue funzionalità

All. n.3 - IV Verbale
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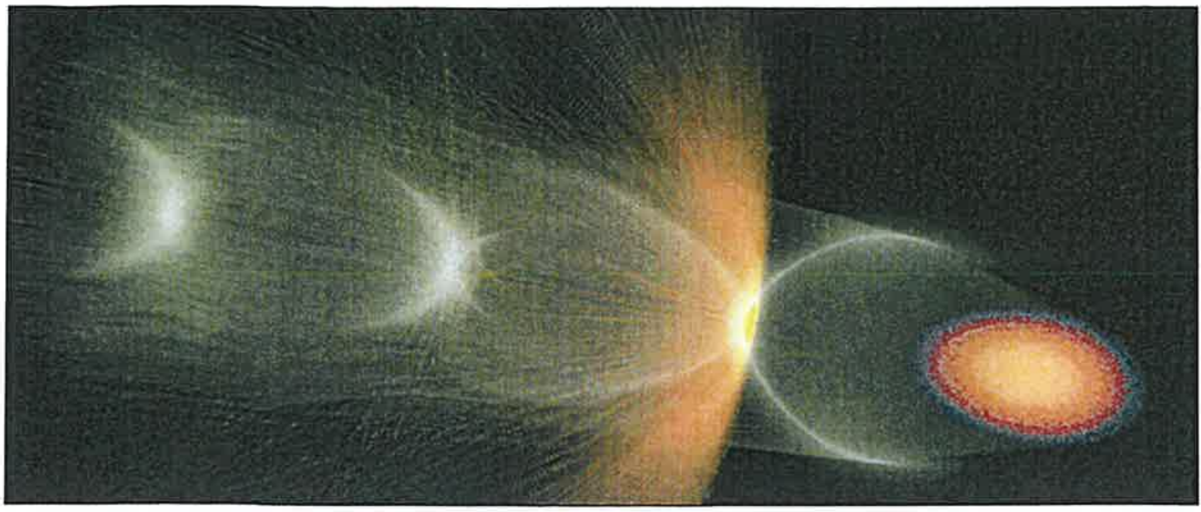
3



A Martinez de la Ossa/DESY

Surf's up *Simulation of electron-driven plasma wakefield acceleration, showing the drive electron beam (orange/purple), the plasma electron wake (grey) and wakefield-ionised electrons forming a witness beam (orange).*

EUROPE TARGETS A USER FACILITY FOR PLASMA ACCELERATION

Ralph Assmann, Massimo Ferrario and Carsten Welsch describe the status of the ESFRI project EuPRAXIA, which aims to develop the first dedicated research infrastructure based on novel plasma-acceleration concepts.

Energetic beams of particles are used to explore the fundamental forces of nature, produce known and unknown particles such as the Higgs boson at the LHC, and generate new forms of matter, for example at the future FAIR facility. Photon science also relies on particle beams: electron beams that emit pulses of intense synchrotron light, including soft and hard X-rays, in either circular or linear machines. Such light sources enable time-resolved measurements of biological, chemical and physical structures on the molecular down to the atomic scale, allowing a diverse global community of users to investigate systems ranging from viruses and bacteria to materials science, planetary science, environmental science, nanotechnology and archaeology. Last but not least, particle beams for industry and health support many societal applications ranging from the X-ray inspection of cargo containers to food sterilisation, and from chip manufacturing to cancer therapy.

This scientific success story has been made possible through a continuous cycle of innovation in the physics and technology of particle accelerators, driven for many decades by exploratory research in nuclear and particle physics. The invention of radio-frequency (RF) technology in the 1920s opened the path to an energy gain of several tens of MeV per metre. Very-high-energy accelerators were constructed with RF technology, entering the GeV and finally the TeV energy scales at the Tevatron and the LHC. New collision schemes were developed, for example the mini "beta squeeze" in the 1970s, advancing luminosity and collision rates by orders of magnitudes. The invention of stochastic cooling at CERN enabled the discovery of the W and Z bosons 40 years ago.

However, intrinsic technological and conceptual limits mean that the size and cost of RF-based particle accelerators are increasing as researchers seek higher beam energies. Colliders for particle physics have reached a

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All. n. 4 - IV Verbale
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PROVA ORALE
Busta n. 4

La candidata risponda alle seguenti domande:

1) cosa è il microclima e come si effettua la valutazione del rischio in un ambiente di lavoro
2) quali sono i cambiamenti apportati dal Decreto Ministeriale 02 settembre 2021 relativi alla formazione degli addetti antincendio
3) cosa si intende per contratti collettivi nel pubblico impiego e quali sono le tipologie di contratto nella pubblica amministrazione
4) quali sono le caratteristiche fondamentali che la firma digitale apporta ad un documento informatico

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INFN and Mythos – consorzio stabile s.c.a r.l.

Frascati future *The proposed building for the EuPRAXIA particle-driven plasma accelerator in Frascati, near Rome.*

EuPRAXIA's beams will mainly serve the fields of structural biology, chemistry, material science, medical imaging, particle-physics detectors and archaeology. It is not a dedicated particle-physics facility but will be an important stepping stone towards any plasma-based collider.

→ The EuPRAXIA project started in 2015 with a design study, which was funded under the European Union (EU) Horizon 2020 programme and culminated at the end of 2019 with the publication of the worldwide first conceptual design report for a plasma-accelerator facility. The targets set out in 2014 could all be achieved in the EuPRAXIA conceptual design. In particular, it was shown that sufficiently competitive performances could be reached and that an initial reduction in facility size by a factor of two-to-three is indeed achievable for a 5 GeV plasma-based FEL facility. The published design includes realistic constraints on transfer lines, facility infrastructure, laser-lab space, undulator technologies, user areas and radiation shielding. Several innovative solutions were developed, including the use of magnetic chicanes for high quality, multi-stage plasma accelerators. The EuPRAXIA conceptual design report was submitted to peer review and published in 2020.

The EuPRAXIA implementation plan proposes a distributed research infrastructure with two construction and user sites and several centres of excellence. The presently foreseen centres, in the Czech Republic, France, Germany, Hungary, Portugal and the UK, will support R&D, prototyping and the construction of machine components for the two user sites. This distributed concept will ensure international competitiveness and leverage existing investments in Europe in an optimal way. Having received official government support from Italy, Portugal, the Czech Republic, Hungary and UK, the consortium applied in 2020 to the European Strategy Forum on Research Infrastructures (ESFRI). The proposed facility for a free-electron laser was then included in the 2021 ESFRI roadmap, which identifies those research facilities of pan-European importance that correspond to the long-term needs of European research communities. EuPRAXIA is the first ever plasma-accelerator project on the ESFRI roadmap and the first accelerator project since the 2016 placement of the High-Luminosity LHC.

Stepping stones to a user facility

In 2023 the European plasma-accelerator community received a major impulse for the development of a user-ready plasma-accelerator facility with the funding of several multi-million euro initiatives under the umbrella of the EuPRAXIA project. These are the EuPRAXIA preparatory phase, EuPRAXIA doctoral network and EuPRAXIA advanced photon sources, as well as funding for the construction of one of the EuPRAXIA sites in Frascati, near Rome (see "Frascati future" image).

The EU, Switzerland and the UK have awarded €3.69 million to the EuPRAXIA preparatory phase, which comprises 34 participating institutes from Italy, the Czech Republic, France, Germany, Greece, Hungary, Israel, Portugal, Spain, Switzerland, the UK, the US and CERN as an international organisation. The new grant will give the consortium a unique chance to prepare the full implementation of EuPRAXIA over the next four years. The project will fund 548 person-months, including additional funding from the UK and Switzerland, and will be supported by an additional 1010 person-months in-kind. The preparatory-phase project will connect research institutions and industry from the above countries plus China, Japan, Poland and Sweden, which signed the EuPRAXIA ESFRI consortium agreement, and define the full implementation of the €569 million EuPRAXIA facility as a new, distributed research infrastructure for Europe.

Alongside the EuPRAXIA preparatory phase, a new Marie Skłodowska-Curie doctoral network, coordinated by INFN, has also been funded by the EU and the UK. The network, which started in January 2023 and benefits from more than €3.2 million over its four-year duration,

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PROVA ORALE
Busta n. 5

La candidata risponda alle seguenti domande:

1) quali sono i compiti del rappresentante dei lavoratori per la sicurezza

2) qual è il percorso formativo degli addetti incaricati alle emergenze all'interno di un'azienda

3) a norma del D.Lgs. 165/2001 quali sono i contenuti del codice di comportamento dei dipendenti pubblici

4) cos'è un motore di ricerca

All. n.5 - IV Verbale
BC 25169/25

5

will offer 12 high-level fellowships between 10 universities, six research centres and seven industry partners that will carry out an interdisciplinary and cross-sector plasma-accelerator research and training programme. The project's focus is on scientific and technical innovations, and on boosting the career prospects of its fellows.

→

EuPRAXIA at Frascati

Italy is supporting the EuPRAXIA advanced photon sources project (EuAPS) with €22 million. This project has been promoted by INFN, CNR and Tor Vergata University of Rome. EuAPS will fulfil some of the scientific goals defined in the EuPRAXIA conceptual design report by building and commissioning a distributed user facility providing users with advanced photon sources; these consist of a plasma-based betatron source delivering soft X-rays, a mid-power, high-repetition-rate laser and a high-power laser. The funding comes in addition to about €120 million for construction of the beam-driven facility and the FEL facility of EuPRAXIA at Frascati. R&D activities for the beam-driven facility are currently being performed at the INFN SPARC_LAB laboratory.

EuPRAXIA is the first ever plasma-accelerator project on the ESFRI roadmap

EuPRAXIA will be the user facility of the future for the INFN Frascati National Laboratory. The European site for the second, laser-driven leg of EuPRAXIA will be decided in 2024 as part of the preparatory-phase project. Present candidate sites include ELI-Beamlines in the Czech Republic, the future EPAC facility in the UK and CNR in Italy. With its foreseen electron energy range of 1–5 GeV, the facility will enable applications in diverse domains, for instance, as a compact free-electron laser, compact sources for medical imaging and positron generation, tabletop test beams for particle detectors, and deeply penetrating X-ray and gamma-ray sources for materials testing. The first parts of EuPRAXIA are foreseen to enter into operation in 2028 at Frascati and are designed to be a stepping stone for possible future plasma-based facilities, such as linear colliders at the energy frontier. The project is driven by the excellence, ingenuity and hard work of several hundred physicists, engineers, students and support staff who have worked on EuPRAXIA since 2015, connecting, at present, 54 institutes and industries from 18 countries in Europe, Asia and the US. ●

Further reading

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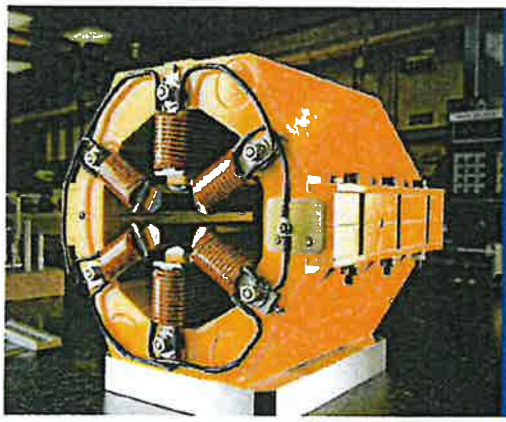

CERNCOURIER

VOLUME 63 NUMBER 3 MAY/JUNE 2023

All. n. 6 - IV Verbale
BC 25169/23

CONCORSO 25169/23
PROVA ORALE
Busta n. 6

La candidata risponda alle seguenti domande:

1) in cosa consiste il provvedimento di sospensione dell'attività imprenditoriale e quali sono le gravi violazioni previste per il datore di lavoro ai sensi dell'articolo 14 del D. Lgs. 81/2008

2) in che modo il datore di lavoro effettua la formazione in azienda

3) il dovere di esclusività previsto nel testo unico del pubblico impiego

4) che cosa si intende per periferica in informatica

All. n. 6 - IV Verbale
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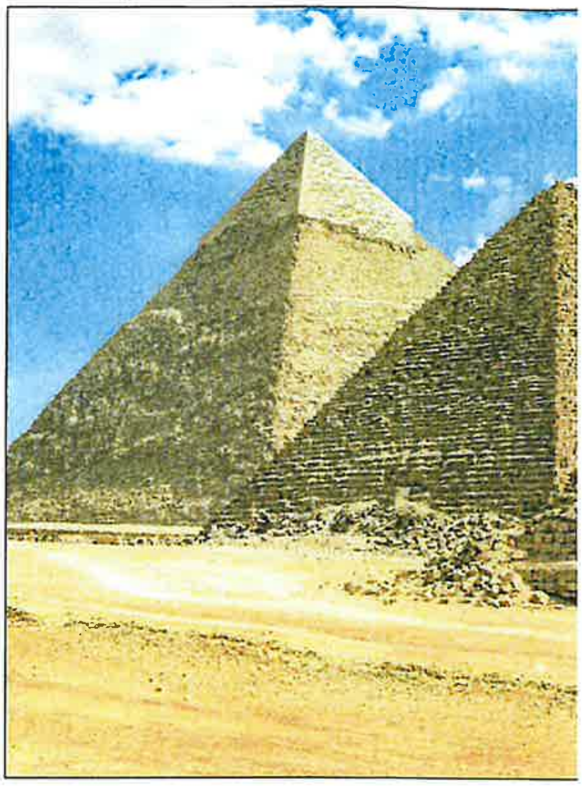
6

COSMIC RAYS FOR C

Taking advantage of detectors used for particle physics, cosmogenic muons are becoming powerful tools for non-destructive imaging of large structures such as pyramids. Physicist and muographer Andrea Giammanco explains.



Structural secrets *Muon tomography is helping researchers to solve*

In 1965, three years before being awarded a Nobel prize for his decisive contributions to elementary particle physics, Luis Alvarez proposed to use cosmic muons to look inside an Egyptian pyramid. A visit to the Giza pyramid complex a few years earlier had made him ponder why, despite the comparable size of the Great Pyramid of Khufu and the Pyramid of Khafre, the latter was built with a simpler structure – simpler even than the tomb of Khufu's great-grandfather Sneferu, under whose reign there had been architectural experimentation and pyramids had grown in complexity. Only one burial chamber is known in the superstructure of Khafre's pyramid, while two are located in the tombs of each of his two predecessors. Alvarez's doubts were not shared by many archaeologists, and he was certainly aware that the history of architecture is not a continuous process and that family relationships can be complicated; but like many adventurers before him, he was fascinated by the idea that some hidden chambers could still be waiting to be discovered.

The principles of muon radiography or "muography" were already textbook knowledge at that time. Muons are copiously produced in particle cascades originating from naturally occurring interactions between primary cosmic rays and atmospheric nuclei. The energy of most of those cosmogenic muons is large enough that, despite their relatively short intrinsic lifetime, relativistic dilation allows most of them to survive the journey from the upper atmosphere to Earth's surface – where their penetration power makes them a promising tool to probe the depths of very large and dense volumes non-destructively. Thick and dense objects can attenuate the cosmic-muon flux significantly by stopping its low-energy component, thus providing a "shadow" analogous to conventional radiographies. The earliest known attempt to use the muon flux attenuation for practical purposes was the estimation of the overburden of a tunnel in Australia using Geiger counters on a rail, published in 1955 in an engineering journal. The obscure precedent was probably unknown to Alvarez, who didn't cite it.

Led by Alvarez, the Joint Pyramid Project was officially established in 1966. The detector that the team built and installed in the known large chamber at the bottom of Khafre's pyramid was based on spark chambers, which were standard equipment for particle-physics experiments at that time. Less common were the computers provided by IBM for Monte Carlo simulations, which played a crucial role in the data interpretation. It took some time for the project to take off. Just as the experiment was ready to take data, the Six-Day War broke out, delaying progress by several months until diplomatic relationships were restored between Cairo and Washington. All this might sound like a promising subject for a Hollywood blockbuster were it not for its anticlimax: no hidden chamber was found. Alvarez always insisted that there is a difference between not finding what you search for and conclusively excluding its existence, but despite this important distinction, one wonders how much muography's fame would have benefitted from a discovery. Their study, published in *Science* in 1970, set an example that was followed in subsequent decades by many more interdisciplinary applications.

The second pyramid to be muographed was in Mexico more than 30 years later, when researchers from the National Autonomous University of Mexico (UNAM) started to search for hidden chambers in the Pyramid of the Sun at Teotihuacan. Built by the Aztecs about 1800 years ago, it is the third largest pyramid in the world after Khufu's and Khafre's, and its purpose is still a mystery. Although there

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