UNIVERSITÀ DI TRENTO

Corso di dottorato in Fisica / PhD in Physics
Ciclo 37 / Cycle 37
A.Y. 2021-2022

Borse a tematica vincolata / Reserved scholarships

A – Neural network model of memory engram consolidation via astrocyte-neuron interaction
B - Superconductivity and charge density waves in two dimensional crystals
C - Quantum many-body systems and ultracold gases
D- Gluon Saturation at the Electron-Ion Collider
E- Optimizing Quantum Simulations for Trapped-Ion qubits
F- Study of the Magnetosphere-atmosphere-lithosphere coupling during active seismic conditions
G - Kinetics of soft matter systems: from statistical mechanics to machine
H - Integrated quantum photonics
I - Photonic neural networks
J- Out-of-equilibrium dynamics of cold atoms in cavities
K –Cuboga (Coherently coupled Ultra-cold Bose gases: a toolbox for magnetic phenomena)
L – FLOAT (Fluctuating Levitated nonlinear Oscillators Approaching The quantum regime)
M – HyClassQSampling (Hybrid classical-quantum algorithms for Sampling Problems)
N – SOCCEr (SupercOnducting Circuits for the Casimir Effect)
O-P - Particle, astroparticle, nuclear, theoretical physics, related technologies and applications, including medical Physics
Q - R&D of an Advanced flexible interconnection solution suitable for high energy physics experiment and space applications
R - Deep Learning for time-transient phenomena in the ionosphere and correlation with seismo-induced events

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Scholarship A

PhD Scholarship Title	Neural network model of memory engram consolidation via astrocyte-neuron interaction
Research group link	http://nanolab.physics.unitn.it/
Contacts.:	Dr. Luca Tubiana, luca.tubiana@unitn.it Prof. Lorenzo Pavesi, lorenzo.pavesi@unitn.it Dr. Beatrice Vignoli, beatrice.vignoli@unitn.it Prof. Paolo Bettotti paolo.bettotti@unitn.it
Synthetic description of the activity and expected research outcome	The behavior of complex biological networks can be locally reproduced by fundamental physics laws and globally by statistical properties. The aim of this project is to develop a computational model of the formation of memory engrams. By leveraging on the experimental biological data collected within the BACKUP - ERC project and the computational expertise of the Statistical and Biological Physics Group, the project will model the neuron and the astrocyte networks interaction to consolidate a memory engram. In the context of the available biological data by the BACKUP project, we propose to generate computational models to abstract out as many biological details as possible while capturing functionality and maintaining a faithful representation of neuron-astrocytes interaction in memory consolidation The PhD topic is about the development of statistical and machine learning models to understand the interplay among neurons and astrocytes networks in engram formation. The PhD student will collaborate with the proponent groups to: 1. Acquire neuronal activity maps via light activated neuron-astrocyte networks within optical microscope imaging using optogenetics and electrophysiological techniques. 2. Develop a model based on statistical mechanics and machine learning methods to describe the acquired experimental data. 3. Provide simulations to plan new biological experiments to verify the model predictions. This PhD will be part of the ERC-funded BACKUP project (P.I. Prof. Lorenzo Pavesi, Dept. of Physics). More info at https://r1.unitn.it/back-up/
Ideal candidate (skills and competencies):	We are seeking for a highly-motivated and passionate student, with a strong attitude to work in a collaborative and interdisciplinary team, and with a background in computational physics.

Scholarship B

PhD Scholarship Title	Superconductivity and charge density waves in two dimensional crystals
Research group link	https://scholar.google.com/citations?hl=en&user=8EJhV9wAAAAJ&view_op=list_works&sortby=pubdate

	https://mcalandra.github.io/ https://webapps.unitn.it/du/it/Persona/PER0195318/Pubblicazioni
Contacts.:	m.calandrabuonaura@unitn.it
Synthetic description of the activity and expected research outcome	Two dimensional crystals such as graphene, twisted bilayer graphene and transition metal dichalchogenides are a playground to investigate correlated states of matter with enhanced quantum effects, such as superconductivity, charge density waves, room temperature quantum Hall effect and frustrated magnetism. In this PhD thesis we plan to investigate the occurrence of non-conventional superconductivity and charge density waves in crystals based on transition metal dichalcogenides by using state-of-the-art first principles electronic structure calculations and many body techniques. The theoretical work will be carried out in tight collaboration with the experimental superconductivity group headed by Prof. Tristan Cren at Sorbonne Université at the Institut for Nanoscience (Institut des Nanosciences de Paris), in Paris. The theoretical phd candidate is also expected to spend a part of his PhD thesis in Paris with an increased salary payed by Sorbonne Université (routinely ranked in the top 50 Universities in the world, and ideally situated in the Paris Latin Quarter). At the end of the PhD the candidate will have both the Italian and French PhD title (from Trento University and From Sorbonne Université).
Ideal candidate (skills and competenci es):	Good knowledge of quantum mechanics and theoretical condensed matter theory.

Scholarship C

PhD Scholarship Title	Quantum many-body systems and ultracold gases
Research group link	http://bec.science.unitn.it
Contacts.:	prof. Gabriele Ferrari: gabriele.ferrari@unitn.it
Synthetic description of the activity and expected research outcome	Ultracold atomic gases offer a flexible platform to address open problems in fundamental physics such as many-body properties in quantum gases, transport phenomena, quantum simulation of fundamental interactions and gauge fields. The PhD student will work in the interdisciplinary environment of the BEC Center (http://bec.science.unitn.it), where research both on theory and experiments is done covering a wide range of themes

Ideal candidate (skills and competencies):	The ideal candidate should posses good knowledge of quantum mechanics, statistical physics, atomic physics with applications either to experimental or theoretical research. The PhD student will work in the interdisciplinary environment of the BEC Center (http://bec.science.unitn.it), where research both on theory and experiments is done covering a wide range of themes.

Scholarship D

Topic:	Gluon Saturation at the Electron-Ion Collider
Research group link	https://www.ectstar.eu/people/detail/dionysios-triantafyllopoulos/
Contacts.:	Dionysios Triantafyllopoulos, European Center for Theoretical Studies in Nuclear Physics and Related Areas (ECT*) External collaborator: Edmond Iancu (Saclay, France)
Synthetic description of the activity and expected research outcome	Quantum Chromodynamics (QCD) is the theory of the strong nuclear forces. At ultra-relativistic energies the degrees of freedom are quarks and gluons and their interactions can be calculated with weak coupling methods. For sufficiently high energies, the gluon density becomes large leading to strong non-linear effects whose description is the goal of the Color Glass Condensate (CGC) effective theory. It is important to apply the latter for studying observables in the forthcoming Electron Ion Collider (EIC).
Ideal candidate (skills and competencies):	Quantum Field Theory, Numerical Computations

Scholarship E

PhD Scholarship Title	Optimizing Quantum Simulations for Trapped-Ion qubits
Research group link	https://www.ectstar.eu/people/detail/daniele-binosi/ https://hauke-group.physics.unitn.it/ https://people.llnl.gov/quaglioni1
Contacts.:	Daniele Binosi European Center for Theoretical Studies in Nuclear Physics and Related Areas (ECT*) Philipp Hauke Department of Physics, University of Trento Sofia Quaglioni Lawrence Livermore National Laboratory
Synthetic description of the activity and expected research outcome	We propose to investigate the optimization of quantum simulations on trapped-ion quantum processors. The Ph.D. candidate will explore the use of quantum optimal control techniques to tailor 'analog' gates at the laser pulse level, as well as the optimization of 'digital' quantum circuits built on predetermined primitive gates. The study will identify the most effective methodology to translate near-term trapped-ion quantum computing into meaningful quantum simulations of microscopic systems.

Ideal candidate (skills and competencies):	The candidate should have a strong background in quantum mechanics and an affinity for software development. A good knowledge at the M.Sc. level of one or more of the following topics is preferred: nuclear physics, high-energy physics, quantum field theory, atomic physics, quantum optics, and quantum-information processing. Work on the project will require analytical and numerical skills. Interest in collaborations with international theoretical and experimental teams is expected.

Scholarship F

PhD Scholarship Title	Study of the Magnetosphere-atmosphere-lithosphere coupling during active seismic conditions
Research group link	**https://www.physics.unitn.it/233/fisica-delle-astroparticelle**
Contacts.:	Roberto Battiston roberto.battiston@unitn.it Mirko Piersanti mirko.piersanti@inaf.it
Synthetic description of the activity and expected research outcome	In the last years, there has been an increasing interest in the scientific community towards the short-term forecasting of earthquakes (EQs), since many anomalies, statistically correlated with a seismic activity, have been found in atmosphere and ionosphere, rather than in the lithosphere. Ionospheric plasma density perturbations, occurring in its lower-side as well as in its upper-side, give encouraging results. The most promising hypotheses developed to justify the coupling among lithosphere, atmosphere and ionosphere during active seismic conditions is based on the emission of atmospheric acoustic gravity waves (AGWs). Recently, Piersanti et al. [2020] proposed an analytical model of the coupling among lithosphere, atmosphere, ionosphere and magnetosphere (M.I.L.C.) which is able to correctly interpret both ground and satellite observations at the moment of the earthquake occurrence. The model is based on the generation of an AGW that, propagating through the atmosphere from the earthquake epicenter (EE), interacts mechanically with the ionosphere creating a local instability in the plasma distribution through a pressure gradient. Such plasma variation puts the ionosphere into"meta-stable" state, giving rise, in the E-layer, to a local non-stationary electric current. This, in turn, generates an electromagnetic (EM) wave. Finally, the interaction of such EM wave with the magnetospheric field causes a change in the eigenfrequency of the field line, whose ionospheric footprint is located over the radial projection of the EE. The purpose of the present project is twofold. On the one hand, the MILC model will be applied to a database of earthquakes between 2000-2020 in order to statistically test its robustness and its validity. On the other hand the model, that is 1D in the present form, will be extended in 2D in order to better understand the dynamics of the ionosphere-magnetosphere system, in terms of generation of current systems, plasma waves generations and wave-particle interaction leading to particle precipitation, directly induced by a seismic event.
Ideal candidate (skills and competencies):	Background: particle physics, plasma physics, space weather Knowledge: data analysis, time series, neural network Attitude: interest in astroparticle physics in the context of interdisciplinary physics to explore new ways of earth remote sensing from space

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Scholarship G

PhD Scholarship Title	Kinetics of soft matter systems: from statistical mechanics to machine learning
Research group link	http://variamols.physics.unitn.eu/
Contacts.:	Raffaello Potestio raffaello.potestio@unitn.it
Synthetic description of the activity and expected research outcome	The position is funded through the HAMMOCK project supported by the FARE fellowship of the Italian Ministry of University and Research. The aim of the project is to understand the relation between the structure of macromolecular systems (e.g. proteins) and their dynamics. The objective is to apply the toolbox of statistical mechanics, information theory, and deep learning to gain greater insight into this relation, so as to comprehend the biological function of macromolecules in and out of equilibrium and to highlight general principles to guide the design of artificial nanomachines.
Ideal candidate (skills and competencies):	- Background in physics, chemistry, mathematics, engineering - Excellent programming skills (unix os, C/C++, python, matlab, tensorflow)

Scholarship H

PhD Scholarship Title	Integrated Quantum Photonics
Research group link	http://nanolab.physics.unitn.it/index.php
Contacts.:	Lorenzo Pavesi (lorenzo.pavesi@unitn.it) Stefano Azzini (stefano.azzini@unitn.it) Massimo Borghi (massimo.borghi@unitn.it)
Synthetic description of the activity and expected research outcome	Integrated quantum photonics is one of the most promising platform to integrate quantum technologies. Within this field, we are looking to promote a PhD position, which develops either an on-chip quantum simulator, which can be used as a suitable platform to integrate quantum machine learning scheme, or an on-chip quantum random number generator, which can be used as source of entropy in quantum cryptographic applications. Depending on the interest of the candidate either one or the other systems will be developed. The candidate will follow the whole path from the simulation of the quantum circuit, to the design, to the test of the quantum circuit. Several different quantum circuits will be elaborated and tested to demonstrate the capability of quantum photonics to reliability implement quantum technologies.

	This PhD will be part of the EC-funded QRANGE and EPIQUS projects (P.I. Prof. Lorenzo Pavesi, Dept. of Physics). More info at https://qrange.eu/ or https://epiqus.fbk.eu/
Ideal candidate (skills and competencies):	We are seeking for a highly-motivated and passionate student, with a strong attitude to work in a collaborative and interdisciplinary team, and with a background in quantum optics and photonics.

Scholarship I

PhD Scholarship Title	**Photonic neural networks**
Research group link	http://nanolab.physics.unitn.it/index.php
Contacts.:	Lorenzo Pavesi (lorenzo.pavesi@unitn.it) Mattia Mancinelli (mattia.mancinelli@unitn.it)
Synthetic description of the activity and expected research outcome	Artificial Neural Networks (ANN) are computational network's models that mimics how biological neurons elaborate data. These models have dramatically improved the performance of many learning tasks, including speech and object recognition. The scientific community developed specific electronic architectures that directly behaves as an ANN trying to improve the computational speed and energy efficiency. Photonics already boosted the telecom field to a new performance level by exploiting the huge data handling capabilities, speed and flexibility of optical fibres. The same paradigm is going to be applied to the ANN. The project is inserted in this context where optics will be exploited to find new ways to implement ANN schemes directly inspired to the biology. The brain is composed of a huge number of neurons deeply interconnected between each other; therefore, we will exploit integrated optics to pack several thousand of optical artificial neurons with specific interconnection topology in a microchip smaller than 1 euro. The packing capabilities allow scaling up the number of artificial neurons that is directly related to the network "intelligence". The aim of the PhD project is to use the unique advantages of optics to create an ANN able to elaborate ultrafast optical signal that can learn from the experience. The candidate will follow the whole path from the simulation of the ANN, to the design, to the test of the ANN. Several different ANN will be elaborated and tested to demonstrate the capability of photonics to compute at the speed of light. This PhD will be part of the ERC-funded BACKUP project (P.I. Prof. Lorenzo Pavesi, Dept. of Physics). More info at https://r1.unitn.it/back-up/

Ideal candidate (skills and competencies):	We are seeking for a highly motivated and passionate student, with a strong attitude to work in a collaborative and interdisciplinary team, and with a background in photonics and, possible, in machine learning.

Scholarship J

PhD Scholarship Title	**Out-of-equilibrium dynamics of cold atoms in cavities**
Research group link	https://hauke-group.physics.unitn.it/
Contacts.:	Philipp Hauke philipp.hauke@unitn.it
Synthetic description of the activity and expected research outcome	In the context of the ERC Starting Grant StrEnQTh, we look for an outstanding PhD student to investigate the dynamics of entanglement and quantum correlations, with special focus on ultracold atomic systems. The research is to be conducted in collaboration with leading experimental groups working on ultracold atoms in cavities and relies on state-of-the-art analytical and numerical tools. From the results of the project, we expect to obtain a deeper understanding of complex quantum matter and new tools to characterize their entanglement content in state-of-the-art experiments.
Ideal candidate (skills and competencies):	The ideal candidate has a strong background in atomic physics, quantum optics, condensed matter theory, quantum field theory, and aspects from quantum-information processing. Further, required skills are good knowledge of modern programming languages such as Python, C++, and Matlab, as well as of state-of-art numerical and analytical methods to treat quantum phenomena in and out of equilibrium, especially in their application to cold atom systems in cavities. In view of the envisaged collaborations with experimental teams, strong language and communication skills are required, and experience in collaborating with experimentalists is an additional asset.

Scholarship K

PhD Scholarship Title	CUBOGA - Coherently coupled Ultra-cold Bose gases: a toolbox for magnetic phenomena
Research group link	**https://bec.science.unitn.it/BEC/0_Home.html**
Contacts.:	**alessio.recati@ino.it gabriele.ferrari@unitn.it**

Synthetic description of the activity and expected research outcome	Coherently-coupled Bose gases – Bose gases featuring two internal states and an inter-conversion term – realise a platform to study a plethora of phenomena related to superfluidity and magnetism and whose rich emergent physics is based on a few microscopic experimentally tunable parameters. The study of such system is characterised by a strong synergy between the theory and the experimental groups present at the INO-CNR BEC Center and in collaboration with the Institute of Complex Systems (Florence). The PhD student will be trained on the many-body aspect of spinor gases and on their experimental realisations. The main topics she/he will work on are the topological defects in spinor condensate: vortices and solitons; the characterisation of the ferromagnetic transition; as well as a number out-of-equilibrium properties (turbolence, thermalisation...) of the system. The 3 years project is expected to shed new light on the yet unexplored role of the orbital and the spin degrees of freedom, in determining the properties of the coupled superfluid system, and the physics of the so-called extended Josephson junctions.
Ideal candidate (skills and competencies):	The candidate is expected to have MSc-level knowledge in quantum mechanics, statistical physics and, ideally, of quantum optics or many-body physics. Acquaintance with numerical methods for solving physical problems and good knowledge of programming languages would be a plus. Moreover, she/he is supposed to be capable of team working and actively participate in all the activities of the BEC Center.

Scholarship L

PhD Scholarship Title	**Theory and experiments on levitated microparticles approaching the quantum regime**
Research group link	BEC group: https://bec.science.unitn.it/BEC/0_Home.html CNR-IFN: http://www.tn.ifn.cnr.it/
Contacts.:	Gianluca Rastelli (CNR-INO), gianluca.rastelli@ino.cnr.it Andrea Vinante (CNR-IFN & FBK), anvinante@fbk.eu
Synthetic description of the activity and expected research outcome	Theoretical and experimental study of the nonlinear and quantum dynamics of levitated magnetic microparticles. Nanomechanical resonators are highly versatile elements with widespread technological applications. For instance, they can be as sensors with ultralow noise or as interface to/between a variety of quantum systems. Levitated microparticles have recently emerged as a very promising class of extremely isolated mechanical systems, which can potentially achieve very low dissipation. This ingredient, together with low temperature, is key in order to suppress thermal decoherence and bring a mechanical system deeply in the quantum regime. In particular, micromagnets suspended in a superconducting trap by Meissner effect appear as the perfect systems for operation at very low temperature. A pioneering experimental activity on levitated micromagnets is ongoing in the CNR-IFN group in Trento with some promising initial results **[1]**. We plan to complement these experiments with a theory/modeling activity in order to study

	the nonlinear and quantum dynamics of these systems. In particular, the PhD activity will be initially related with the modelling and analysis of nonlinear experiments in the classical regime. Then we will explore several strategies in order to achieve active cooling of the microparticle to push it in the quantum domain. For instance, we will investigate how to include an optical/microwave cavity or another quantum system, in order to generate and control quantum states of the levitated microparticle **[2]**. We have the ambitious goal of experimentally realizing quantum superposition states of massive levitated microparticles. Experimental confirmations of macroscopic quantum superpositions started using electrons, and have today reached the size of organic molecules containing thousands of atoms. Preparing macroscopic quantum superpositions of objects containing billions of atoms will bring macroscopic quantum physics to an entirely new level, which will give the opportunity to attack some of the biggest open questions of modern physics: is quantum mechanics valid all the way up to the macroscopic world, together with its interpretation issues and paradoxes, or may it break down? Articles: **[1]** "*Ultralow mechanical damping with Meissner-levitated ferromagnetic microparticles*", A. Vinante et al., Physical Review Applied vol. **13**, page 064027 (2020). **[2]** *"Cooling of a levitated nanoparticle to the motional quantum ground state"*, U. Delić et al., Science vol. **367**, page 892 (2020).

Scholarship M

PhD Scholarship Title	**Hybrid classical-quantum algorithms for Sampling Problems (*HyClassQSampling*)**
Research group link	https://hauke-group.physics.unitn.it/ https://pietrofaccioli.wixsite.com/physics https://webapps.unitn.it/du/it/Persona/PER0004537/Didattica https://sites.google.com/a/unitn.it/pastorello/home
Contacts.:	Philipp Hauke philipp.hauke@unitn.it Pietro Faccioli pietro.faccioli@unitn.it Enrico Blanzieri enrico.blanzieri@unitn.it Davide Pastorello d.pastorello@unitn.it
Synthetic description of the activity and expected research outcome	Sampling problems are ubiquitous in computational physics, chemistry, and biology. The goal of HyClassQSampling is to make progress towards solving such exploration problems by exploiting the delocalization of quantum mechanical wave functions in specialized quantum computers, so-called quantum annealers. To this end, we plan to develop a hybrid quantum-classical algorithm. These algorithms are a promising performance-enhancing strategy for non-universal quantum machines of the Noisy Intermediate-Scale Quantum (NISQ) era, as they

	use the quantum resource as a fast coprocessor to treat the classically most challenging computational steps. At the end of the project, we expect to have a powerful algorithmic framework for tackling sampling problems. We will apply it to paradigmatic models of soft condensed matter such as lattice models for self-avoiding polymers, but anticipate a large potential for follow-up investigations and applications also in other disciplines. This is a highly interdisciplinary project at the interface of several disciplines. The PhD candidate will thus have a unique opportunity to learn concepts and tools from quantum information theory, computational biology, and software engineering. References: *Dominant Reaction Pathways by Quantum Computing* P. Hauke, G. Mattiotti, P. Faccioli; Phys. Rev. Lett. 126, 028104 (2021). *Quantum annealing learning search for solving QUBO problems* D. Pastorello, E. Blanzieri, Qu. Inf. Proc. 18, 303 (2019).
Ideal candidate (skills and competencies):	The ideal student will have a physics background, in particular with knowledge of quantum mechanics and ideally of quantum-information theory, and an affinity for software development. Work on the project will require analytical and numerical skills. A large interest in interdisciplinary research questions is expected

Scholarship N

PhD Scholarship Title	SOCCEr (SupercOnducting Circuits for the Casimir Effect)
Contacts.:	Gianluigi Casse (FBK) casse@fbk.eu Benno Margesin (FBK) margesin@fbk.eu Paolo Falferi (IFN-CNR and FBK) paolo.falferi@unitn.it Iacopo Carusotto (INO-CNR BEC Center) iacopo.carusotto@unitn.it
Synthetic description of the activity and expected research outcome	The main objectives of the research activity are to fabricate coplanar superconducting waveguides and/or resonators closed on one end by a SQUID (Superconducting QUantum Interference Device) that acts as a tunable mirror and to use them in quantum optics experiments to observe the Dynamical Casimir Effect and related zero-point quantum fluctuation effects in the microwave spectral domain. The project will be carried out in a continuous regular interaction between three teams: theoretical team (INO-CNR BEC Center), fabrication team (FBK with photolithography and e-beam lithography), and testing team (IFN-CNR and FBK with 20 mK dilution refrigerator). The PhD student will be given the opportunity to participate in all the activity, theoretical and experimental, with the support of the three teams. During the PhD, she/he will be trained on the physics of devices such as SQUIDs, Josephson junctions and microwave resonators that are the building blocks of circuit-QED, one of the most promising approaches to quantum technologies.

Ideal candidate (skills and competencies):	● She/he should have a solid knowledge of electromagnetism and a master-level competence in the general concepts of solid-state physics. She/he should be keen on learning experimental techniques in the following fields: low temperature physics, superconducting microwave technologies, microfabrication technologies and material science. She/he should have a good capacity to work in team with experimentalists combined with a good understanding of theoretical concepts and a manifest ability to work in team with theorists. ● She/he should have a proven ability to communicate in scientific English (written and oral)

Scholarship O-P

PhD Scholarship Title	**Topic**: Particle, astroparticle, nuclear, theoretical physics, related technologies and applications, including medical Physics (2 positions)
Research group link	INFN
Contacts.:	**Contacts***:* For further information on the possible research topics see www.infn.it or contact Rita Dolesi for experimental Physics (Rita.Dolesi@unitn.it); Francesco Pederiva for theoretical Physics (Francesco.Pederiva@unitn.it) Chiara La Tessa for applied and medical physics (chiara.latessa@unitn.it)
Synthetic description of the activity and expected research outcome	**Synthetic description of the activity and expected research outcome** The thesis topics will be selected within the many areas of forefront research pursued at Trento Institute for Fundamental Physics and Applications (TIFPA) of INFN. Current main activities include: 1) experimental particle and astroparticle Physics, 2) experimental gravitation both earth and space based, 3) gravitational wave astronomy, 4) antimatter related experiments, 5) R&D on particle and radiation detectors and other solid state quantum micro devices, 6) computational Physics and AstroPhysics, 7) theory of fundamental interactions, 8) theoretical cosmology , 9) medical physics applied to therapy with high energy charged particles
Ideal candidate (skills and competencies):	

Scholarship Q

PhD Scholarship Title	R&D of an advanced flexible interconnection solution suitable for high energy physics experiment and space applications
Research group link	https://iuppa.science.unitn.it

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Contacts.:	Roberto Iuppa (roberto.iuppa@unitn.it), Pierluigi Bellutti (bellutti@fbk.eu)
Synthetic description of the activity and expected research outcome	Tape Automated Bonding (TAB) is an electrical connection technique of microelectronic chips designed to solve, by simplifying, complex bonding situations, such as those in which there are large numbers of connections to the chips. The TAB is based on flexible conductors laminated with a flexible dielectric that offers support to the numerous conductive tracks and are generally made of Kapton-Copper. This project plans to develop an innovative technological packaging solution for the production of flexible conductors in Polyimide - Aluminum with the possible use also as a leadframe for the integration of flexible printed circuits. The project activities include the study of a technological solution of surface activation for the coupling between dielectric and aluminum, the analysis of the junction and mechanical adhesion of the two layers. In a second phase, microfabrication processes necessary for the creation of the slopes by photolithography will be designed and chemical etching tested. The flex cables thus produced will be characterised and used as baseline for multilayers development. The project will be conducted in collaboration with INFN projects pursuing experiments (e.g. ATLAS, Limadou) or developing next-generation silicon sensors (ARCADIA).
Ideal candidate (skills and competencies):	Solid background on material physics/engineering, expertise in laboratory activities. Teamwork attitude.

Scholarship R

PhD Scholarship Title	Deep Learning for time-transient phenomena in the ionosphere and correlation with seismo-induced events
Research group link	https://iuppa.science.unitn.it https://deeppp.eu
Contacts.:	Roberto Iuppa (roberto.iuppa@unitn.it), Marco Cristoforetti (mcristofo@fbk.eu)
Synthetic description of the activity and expected research outcome	The Limadou project gathers some Italian institutions participating in the China Seismo Electromagnetic Satellite (CSES) mission. CSES consists of a constellation of satellites, designed to pursue the deepest campaign of observation of the ionosphere. One of the most important scientific goals of the mission is to look for correlations between transient phenomena in the ionosphere and seismic events. Among payloads, a set of particle detectors is devoted to the detection of charged particles trapped in the Van Allen Belts, to monitor the solar activity and to measure galactic cosmic rays of very low energy. The APP group of the Physics Department in Trento looks for candidates to a PhD programme on the analysis of the scientific data from the payloads on board the CSES-01 and those to be launched on board the satellite CSES-02 in 2022. The student will focus on time-series analyses and participate in the development of the event reconstruction software. These studies will be carried out using the most modern machine learning techniques for clustering and anomaly detection, using full information from CSES payloads. The activity will be funded by Fondazione Bruno Kessler and carried out in collaboration with INFN-TIFPA and the Institute of the High Energy Physics of Beijing.

Ideal candidate (skills and competencies):	Candidates familiar with the experimental techniques for the detection of charged particles in space are welcome, as well as basic knowledge of Machine Learning/Deep Learning is recommended.