INFN
TORINO
Istituto Nazionale di Fisica Nucleare
Sezione di Torino

Proposal for the organisation of the next edition of the national seminar on innovative detectors

Venue and practical details

The seminars and laboratory activities will be held in the research campus in Strada delle Cacce. The campus hosts facilities from INFN, CNR and the headquarters of the National Institute of Metrology (INRiM).

In this campus, in early 2020 the new technological laboratory of INFN will start its operation. The laboratory comprises a big mechanical workshop along with electronics labs where the laboratory classes will be held.

The campus is located within a park and offers adequate rooms and facility for lecturing along with a pleasant environment for the breaks.

There is no fee for the usage of the lecture hall.

A shuttle service will be organised everyday to bring the attendees from the city center to the campus and viceversa. The approximate transfer duration is 15 minutes each way. The city center and the campus are connected through high capacity routes. There will be no issues with traffic, because the travelling directions (outbound in the morning, inbound in the evening) is opposite to the main traffic flow.

Coffee breaks and lunches

Coffee breaks and lunches will be served on site by a catering service. The approximate costs per day for two coffee breaks and one lunch will be **25 euros** per person.

Hotels

There are many hotels located near the Porta Nuova station with typical costs in the range of **70-100 euros** per night. Should our proposal be selected, a negotiation will be done for a set of rooms in a few nearby hotels.

Lectures

The lecture program is intended to cover rapidly evolving topics of broad interest, while trying to be as complementary as possible to what was discussed in the previous edition. A set of topics out of which the final lectures could be selected is proposed in the following.

1. Sensors and electronics for new generation dark matter and neutrino detectors

The lecture will focus on the needs and development of system to readout noble liquid detectors for dark matter and neutrino detectors. Present-day electronics, mostly based on discrete components, is not suited for future experiments where the sensitive area must be significantly scaled-up. Ongoing R&D employing state of the art sensors and integration technologies will be discussed.

2. New trends in gaseous detectors

Gaseous detectors still offer a competitive alternative when large areas need to be instrumented. Micropattern gas detectors, combined with fine pitch front-end electronics, can provide extremely interesting performance. The ongoing developments in the field will be discussed.

3. Monolithic CMOS sensors

Monolithic CMOS detectors are another area of intensive developments. The ALICE ITS upgrade is fully based on CMOS sensors. Much emphasis in now put on fully depleted detectors, that have the perspective of replacing traditional micro strip and hybrid pixel detectors in most applications. The recent progress and future perspective in this field, in which INFN is at the forefront, will be discussed in the lecture.

4. Detector requirements for future accelerator facilities

Future accelerator facilities will pose unprecedented challenges to particle detectors. Lepton colliders will emphasise precision, while hadron colliders will demand radiation tolerance levels that no current technology can afford. The key specifications of the main detectors for future accelators will be reviewed.

5. Detectors for space-born astroparticle experiments

Space-born astroparticle experiments often employ sensor technologies derived from ground-base high energy instrumentation. However, in the space environment, constraints like power consumption, low-material budget and reliability are taken to an extreme. The main space-born astro particle experiments envisaged for the near to medium future will be outlined and the requirements for their detector will be discussed.

6. Quantum sensing ed electronics

Quantum computing is a hot-topic in present-day research. Electronics circuits needed to manipulate Q-bits have many points in common with front-end electronics for particle detectors, offering the opportunity of cross-fertilisation between the two domains. At the same time, novel quantum-based sensors can offer the opportunity to build detector systems with unprecedented sensitivity. The key developments, the opportunities and challenges will be reviewed.

7. Detectors for new generation gravitational wave experiments

Gravitation wave detectors have opened a new window in astrophysics. The key features of gravitational wave detectors will be discussed, along with the challenges to be face to improve their performance in order to meet the science goals of future gravitational wave observatories.

8. Machine learning and its impact on the design of novel particle detectors

Machine learning has been introduced relatively recently in the word of particle detectors and has been up to now limited to software techniques employed in off-line analysis. The exponential increase of the computational power embedded on FPGA and the advent of ultra-deep sub-micron technologies allows to envisage to implement hardware executable algorithms to be embedded on DAQ or even on front-end ASICs. The key concepts and the perspectives for the development in this field will be presented.

9. Recent advances in timing detectors

Timing has become recently a hot topic in particle detectors as it has been recognised as a powerful tool to resolve pile-up in congested environments. Despite timing detectors were already covered in the last edition, in two years significant progresses have been made and an update review could be of interest to the audience.

10. Mechanics for complex particle detectors

In complex particle detectors, mechanics can be as complex and critical as electronics for an optimal performance of the system. New materials and integration techniques offer on the other hand exciting possibilities. The challenges involve in the design of the mechanics of complex particle detectors will be discussed along with the tools need to address those challenges

Laboratories

A set of 10 laboratories is proposed. All laboratories are based on part of systems developed by the INFN section of Torino and on instrumentation already available. Each laboratory will have at least one staff researcher responsible for its organisation and an adequate number of instructors will be granted. All the proposed lab are based on prototypes and experiment-grade systems in the development of which the Section had a primary involvement

1. Cryogenic sensors electronics: Manuel Da Rocha Rolo

In this lab, attendees will have an opportunity to familiarise with the challenges and opportunities of operating state-of-the art electronics at cryogenic temperatures. The attendees will have an opportunity to compare the performance of simple circuits at room and liquid nitrogen temperatures. The lab will be based on the circuits developed for the integrated electronics of the Dark-side experiment.

2. Monolithic CMOS sensors: Stefania Beolé, Manuel Da Rocha Rolo

The attendees will practice with a system containing several ALPIDE sensors developed for the upgrade of the ALICE detector at CERN and with novel, fully depleted monolithic sensors developed by INFN in collaboration with Lfoundry in the framework of the SEED project.

3. X-ray polarimetry detectors: Luca Latronico

The IXPE satellite, to which INFN has given significant contribution, is based on an innovative system consisting of a GEM detector directly assembled on a pixel read-out chip. The attendees will have the opportunity to practice with a replica of the detector that will instrument the IXPE satellite, now under construction and scheduled to be launched in April 2021

4. Advanced sensors and electronics characterisation: Nicolò Cartiglia, Lino Demaria

Modern particle detectors require thousands of sensors and electronics components that need to be systematically qualified. The attendees will familiarise with the key issues involved in systematic testing and quality control. The lab will involve also the use of a state-of-the art 12 inch wafer prober recently acquired by the Section.

5. Practical issues in PET instrumentation: Piergiorgio Cerello

Positron emission tomography remains one of the most powerful medical imaging tools. By working on modules actually employed for an experimental tomography project at CNAO, the attendees will have an opportunity to familiarise with the practical issues involved in the design, optimisation and operation of such detectors.

6. GEM detectors and their readout: Michela Greco

A small-scale GEM detector will be instrumented with a state-of-the art mixed signal front-end electronics to illustrate the basic operation of such detectors and the potential offered by coupling them to advanced readout circuits.

7. Understanding performance of analog-to-digital converters for radiation detector systems: Gianni Mazza, Stefano Argirò

Analog-to-digital converters are key components for radiation detector systems. However, their characterisation and the assessment of the impact on their non-idealities on the performance of a practical system is not straightforward. These concepts will be illustrated using as a test vehicle an ADC developed for the upgrade of the CMS ECAL.

8. High performance timing systems - Sara Garbolino, Nicolò Cartiglia

By operating last generation timing detector and electronics, the attendees will have an opportunity to familiarise with key concepts and issued involved in these systems.

9. Assembly, metrology and quality control of light-weight tracking detectors- Silvia Coli

Using the tools developed to assemble the tracker of ALICE and the sensor of the Limadou space-born experiment, the attendees will familiarise with the basic techniques and issues involved in the construction and quality control of ultra-lightweight silicon trackers.

10. RF data transmission for particle detectors

Future particle detectors will need unprecedented data transmission bandwidth. The lab will allow the attendees to familiarise with the key concepts and issues involved in multi-gigabit data transmission.

Other scientific activities

A guided visit to the premises of the Istituto Nazionale di Metrologia (INRiM) will be organized, with an opportunity to visit state-of-the-art atomic watches and the facility of quantum optics.

Social activities

A visiti to the Egyptian museum of Torino will be organised, followed by the social dinner. A possible location for the social dinner is the ristorante Solferino, locating in the city center, within walking distance from the hotels. In this restaurant the social dinner of the CVI was organised in

2016. Many other opportunities exist and the choice will be made together with the national organising committee. The price for the social dinner will be in the range 40 - 50 euros.

Budget

Provisional budget: (assuming 40 participant) (V.A.T. already considered)

Lunch and coffe break	4
Social dinner and social activity	2+0.6
Logistics	1.8
Lab material	1.2
Travelling expenses of teachers	10k
Grand total	19.6 k

Note: the expense for travelling assume that all the six lecturers will be from outside Torino and one will be from a major lab oversea. However, for any combination of topics, at least two lectures can be granted by experienced and qualified personnel of the Section, allowing for a reduction of cost if necessary. Travel costs include tickets and lodging , as meal have already been considered in the respective fields.

Local support

Local organisation support
Full administrative support will be granted by personnel of the Section. An amministrative staff will be fully dedicated during the day of the school to manage all the organisation issues.

Local financial support
The Section will offer a contribution of 5k and will sustain the costs of one speaker from oversea or two short-range speakers.

Il direttore della Sezione INFN di Torino
Dott. A. Rivetti