INFN policy document on future detectors

A summary of the IFD workshop

IFD2022 - INFN Workshop on Future Detectors https://agenda.infn.it/event/31581/

“After the ECFA roadmap a moment of reflection within our community looking to the future”

It has been the **third** venue of this INFN workshop on Future Detectors (**last** time in Torino **2015**);

It is usually **organised** to get the INFN **community together** and **debate** the future **developments**.

The **variety** and **complexity** of the INFN expertise in **experimental design**, and its capability of proposing and proving **new detector** technologies, has always been key in **outstanding discoveries**.

INFN Istituto Nazionale di Fisica Nucleare

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25 OTTOBRE 2022

SFIDE E OPPORTUNITÀ DEI RIVELATORI DEL FUTURO

I progetti di frontiera della ricerca in fisica fondamentale stanno ponendo sfide tecnologiche che impegneranno la comunità scientifica per almeno i prossimi trent'anni: in particolare, per lo sviluppo dei futuri rivelatori di particelle, strumento indispensabile in tutti gli ambiti, dalla fisica delle particelle elementari alla cosmologia, dalla fisica nucleare alla ricerca della materia oscura. Per confrontarsi sulle prospettive tecnologiche e sulle possibili scelte, le comunità che si occupano di Ricerca e Sviluppo (R&D) di rivelatori nei diversi settori scientifici si sono recentemente incontrate a Bari in occasione dell'INFN Future Detector 2022, il terzo della serie di workshop avviata nel 2014 dall'INFN, tra i leader mondiali nello sviluppo di tecniche di rivelazione e tecnologie d'avanguardia.

This workshop aims at offering a **framework for discussion** on how to strengthen the competences on different aspects

Following the recommendations of the **European Strategy for Particle Physics Update** (ESPPU), ECFA lead the effort to prepare and implement a **Detector Research and Development Roadmap** developed by the **community**, taking into account the progress on emerging technologies in all fields of research of great interest for **INFN**.

The workshop **reviewed** different aspects of the **detector development** field for future experiments and applications;

Only **plenary** presentations were organised offering a **comprehensive review** of the status of the art of different technologies;

Each session included an **introduction** by a small group of experts.

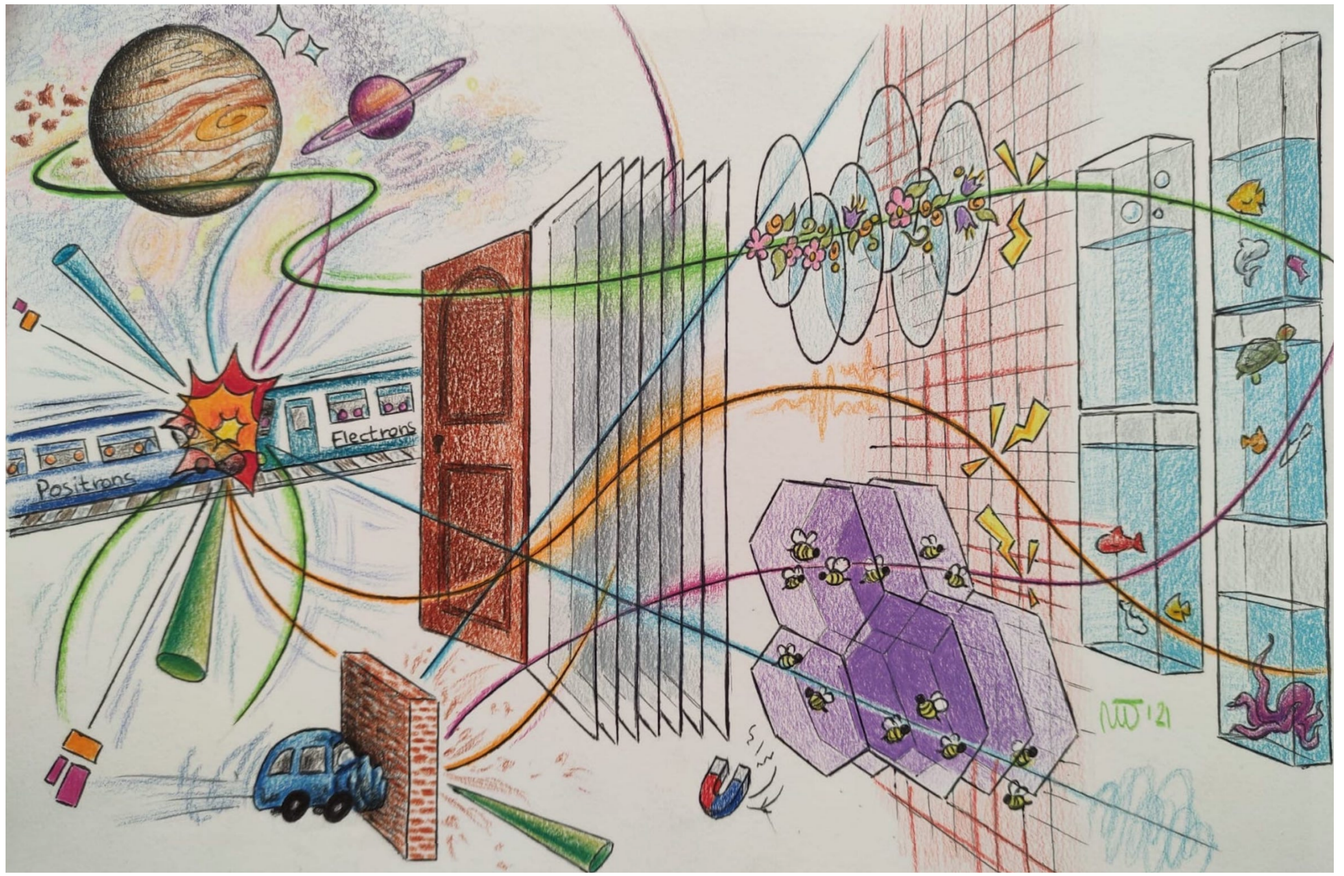
Each session included **very short rapid-fire** style **talks** (**10 min**) to accommodate **ideas** and **suggestions** usually given by **young researchers**, in most cases **followed by a prompt discussion;**

At the of each session finally an **in-depth discussion** involved all present people.

No remote participation was foreseen, precisely to enable people to easily contribute to the discussion

It was attended by more than **100 colleagues** and touched several different aspects:

1. Future challenges: accelerators, space, underground
2. Quantum Primer
3. Solid State Detectors
4. Liquid Detectors
5. Training and TT
6. Photodetectors and PId
7. Gas Detectors
8. Calorimeters



almost **100** talks in **3 days**

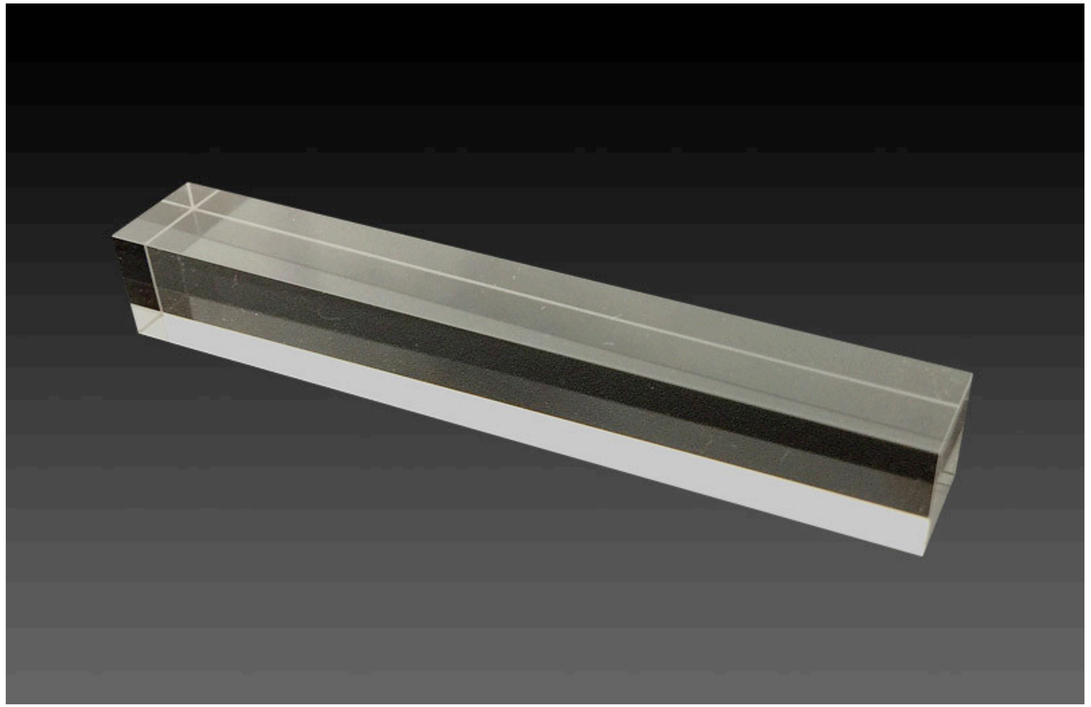
All **sessions** were then required to **prepare a summary** of the discussion and to address few points

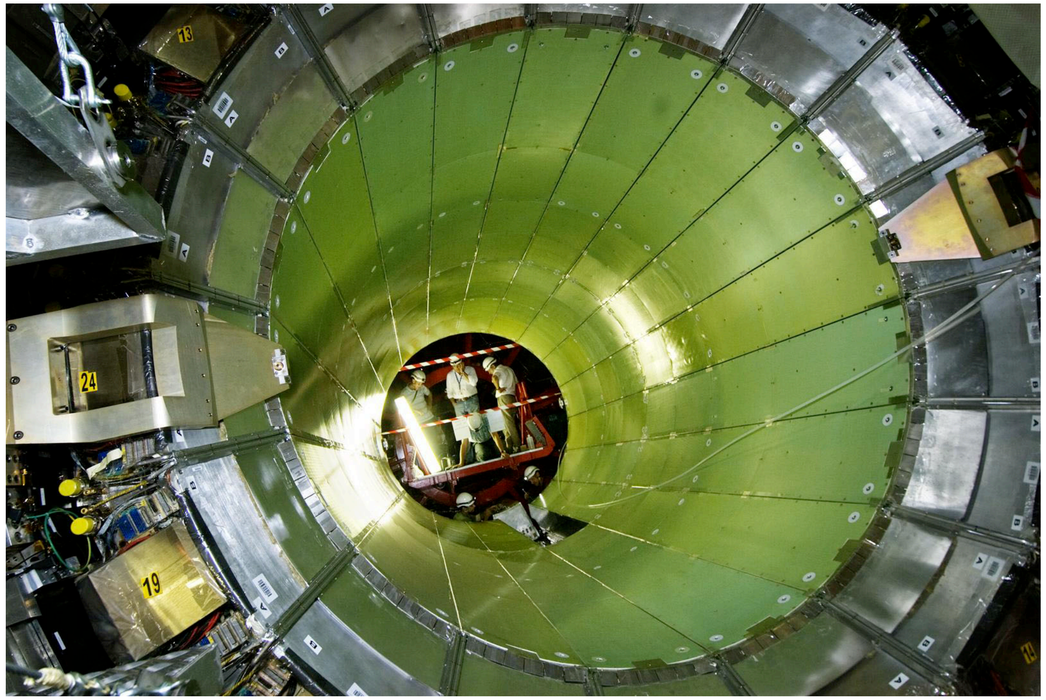
The results of this survey **are being** now **used** to **prepare** a **final document**

1) what are the strengths of the Italian community?

The activity of the Italian groups covers **various** technologies;

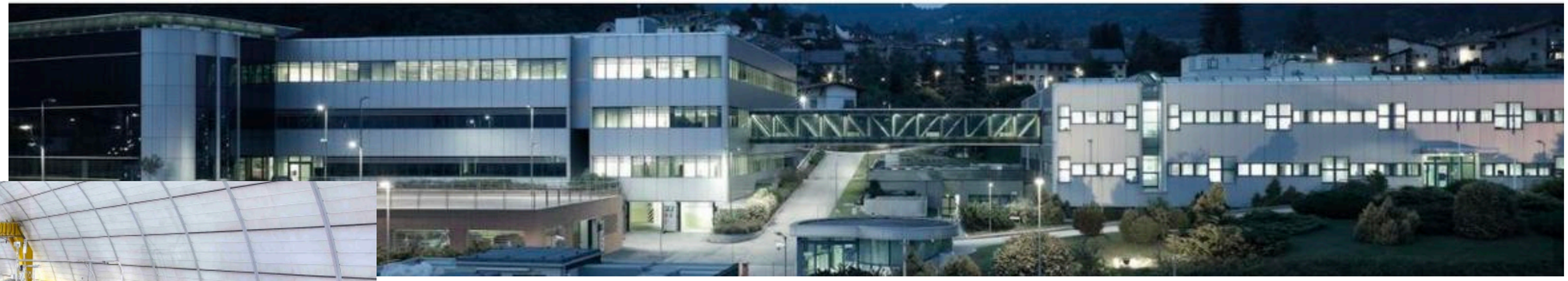
It covers different phases ranging from the **development** of **prototypes** for the most **diverse applications** to the **mass production** of detectors for use in approved **experiments** and the commissioning and operation of detectors already built/installed.





1) what are the strengths of the Italian community?

The groups are characterised by **considerable vitality** on the various work fronts, with a **fair degree of involvement of technicians and physicists** even at the **beginning** of their **careers**, suggesting excellent possibilities for impact in the future.

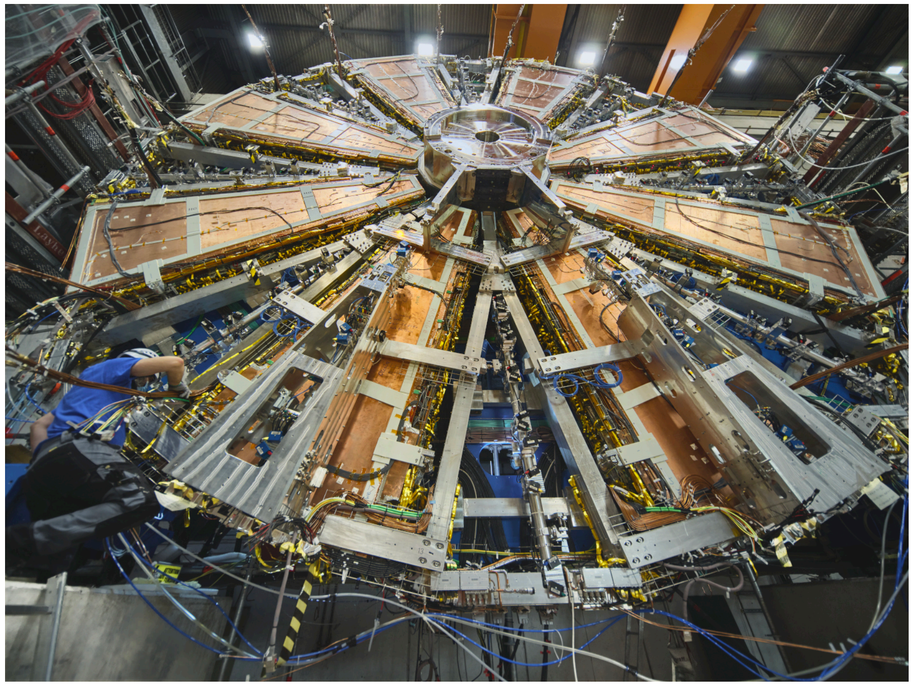


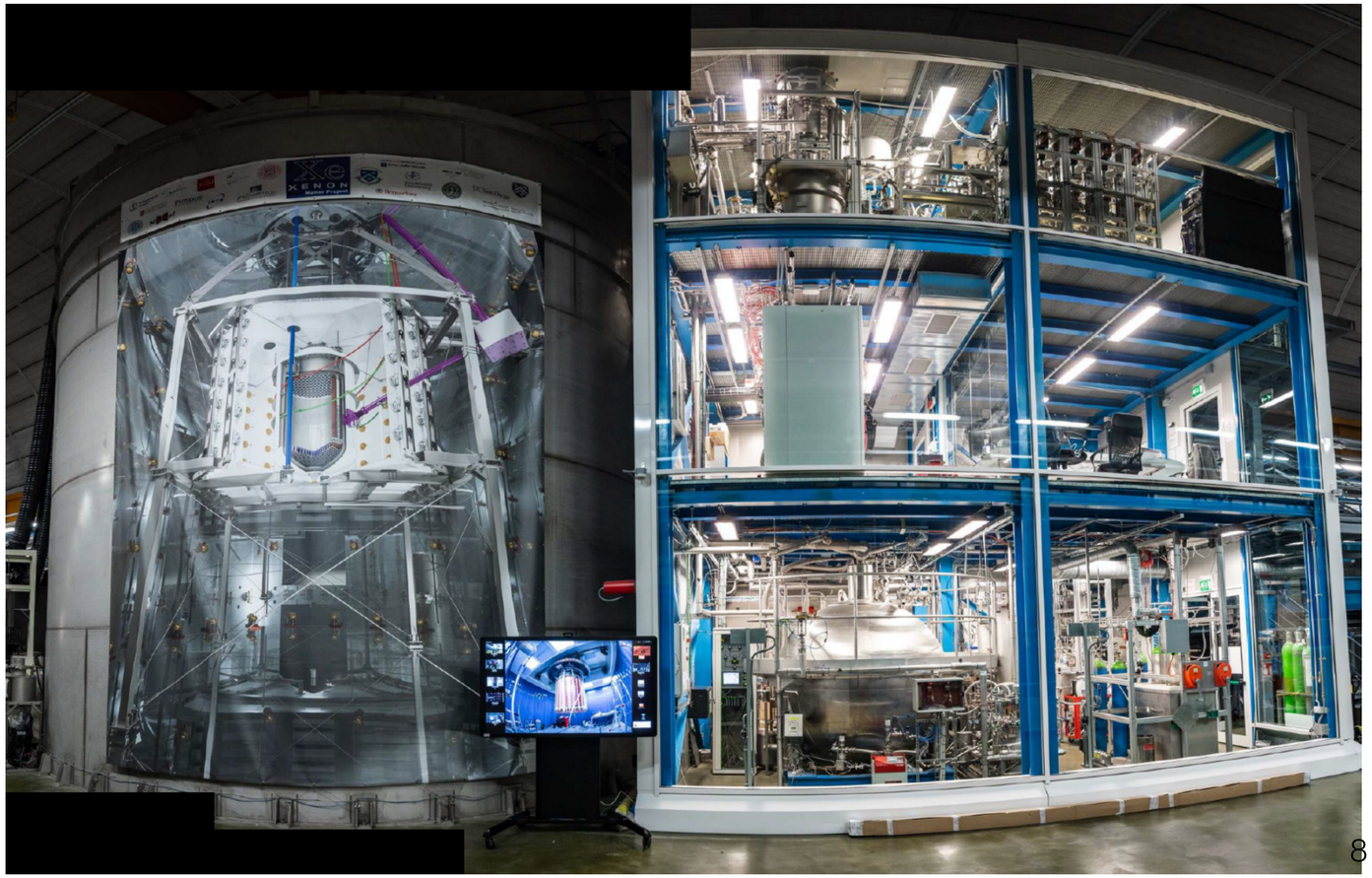
Expertise in readout **electronics design** (e.g. RD53) and **realisation** (e.g. FBK)

World leading **infrastructures** (e.g. LNGS)

2) What are the medium-term future prospects?

The medium-term prospects for Italian activity **include** the **development** of **innovative technologies** in programmes **upgrade experiments** ranging from high **energy physics** to the fields of **astro**-**particles**, **nuclear** and **medical** physics.

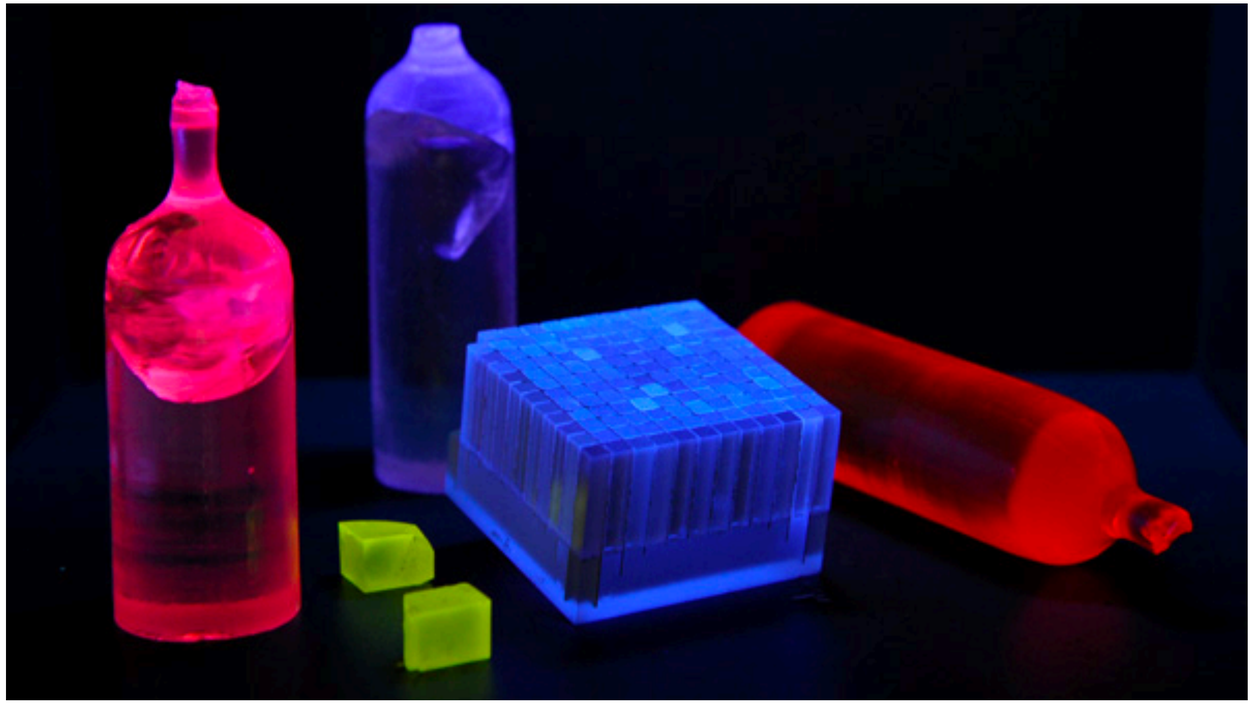


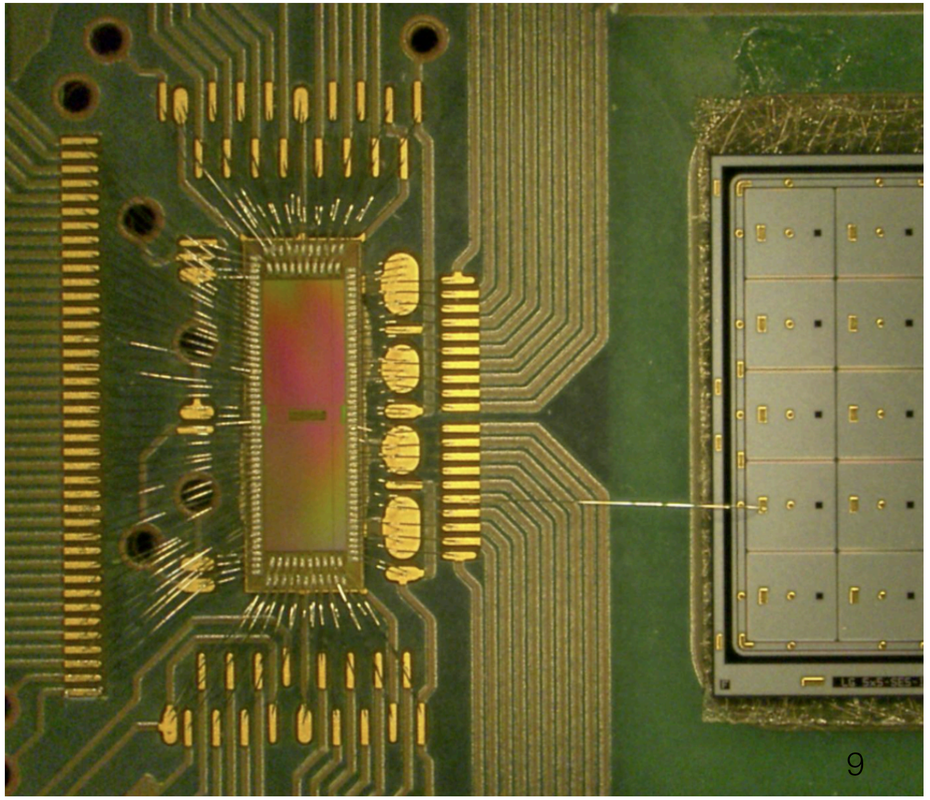


2) What are the long-term future prospects?

In the longer term, activities for the development particle detectors are aimed at their use in the **large experiments** being **proposed** for future **accelerator** machines such as the FCC, Muon Collider the **creation** of a **network** of **underground laboratories**;

Rad hard far beyond what has been conceived so far (requires a lot of long-term R&D), e.g. rad-hard **crystals** or **readout**.





3) what are the critical points that may pose risks?

- **diversity** → risk of **fragmentation** → stimulate discussions between communities;
- **detector development** is not always accompanied by **adequate** development of **front-end electronics for R&D;**
- Criticalities related to **single providers** for crucial components (e.g. Hamamatsu):
  - high **prices**
  - low **production rate** (e.g. crystal for calorimetry or bolometers)
  - low **flexibility** to adapt to **experiment needs** (e.g. low radioactivity)

4) what are the mandatory needs?

The development and testing of new ideas and the production of the first prototypes is, on the whole, well supported within the community;

There is a **lack** of **clear indications** as to how to move into the next phase, and for this reason we consider it crucial to establish a clear roadmap with well defined **resources for the transition between the R&D phase to the application to experiments.**

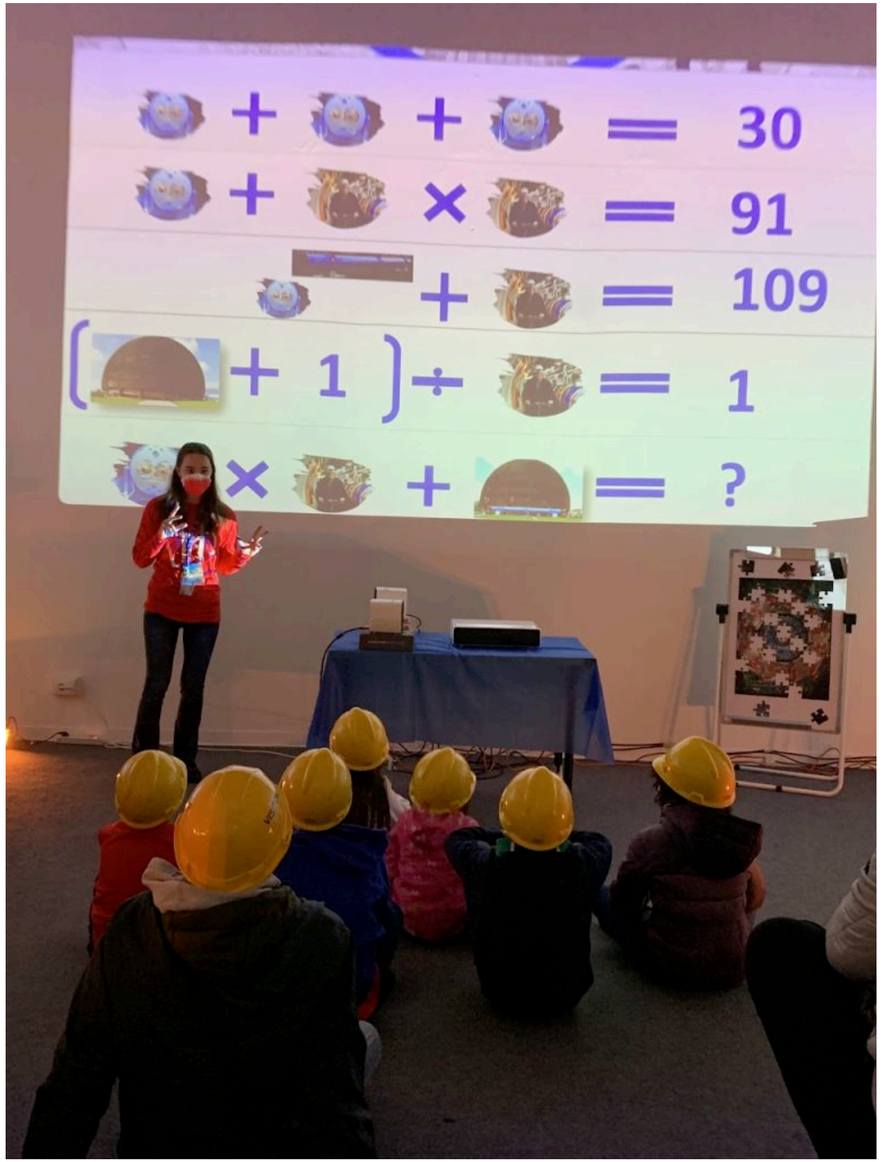
A similar argument applies to **technology transfer**. Many groups are entering this new world;

There is a need to **better coordinate** this **approach** e.g. by the creation of a **central infrastructure** to help coordinate and **keep track** of the **different activities** involved in TT, the **companies involved** and the **projects underway** could help;

4) what are the mandatory needs?

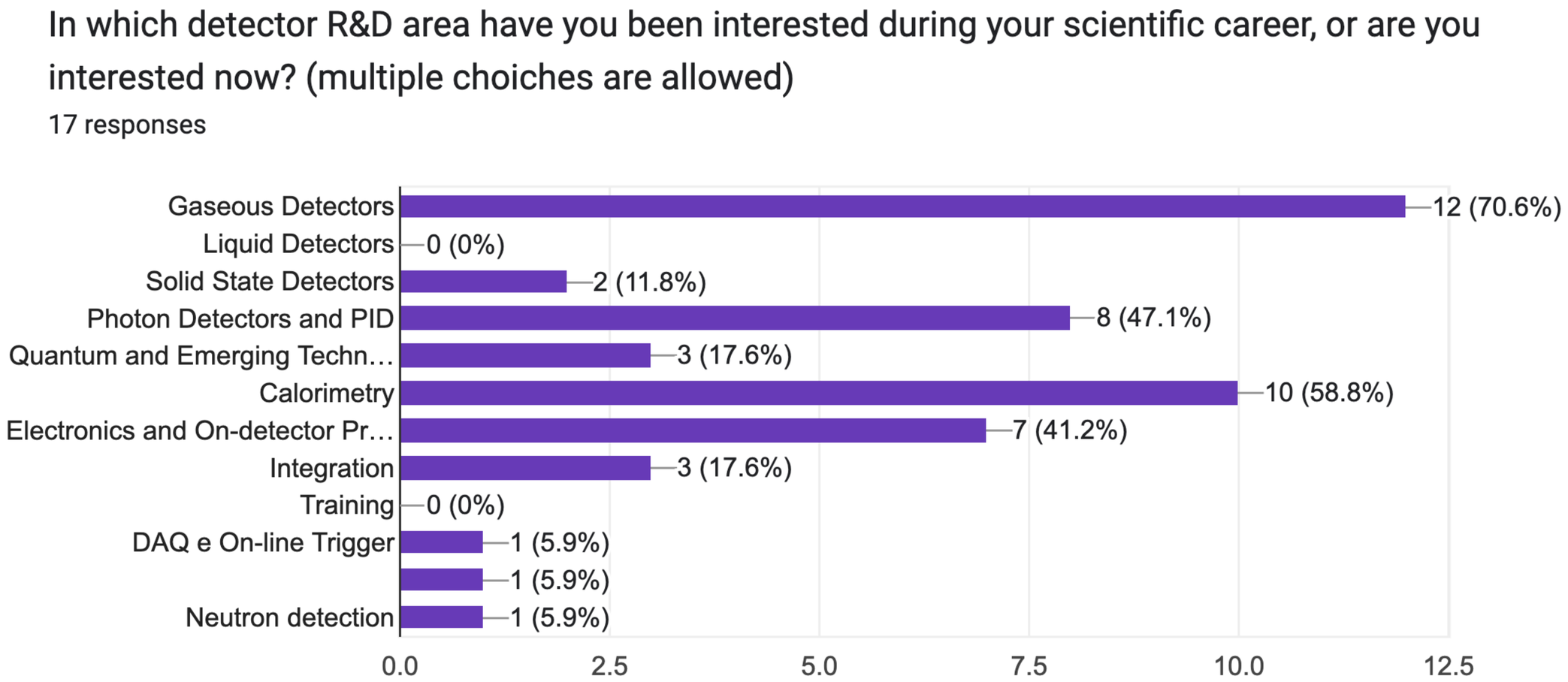
All the **work leading** from the **idea** of a **new technology** to the **realisation** of an **experiment** capable of **providing physics measurements** should be **valued** and **protected;**

It's crucial to to raise awareness among INFN and Universities **not to penalise young people** who design a **career** path linked to **detector development**.



Results of internal survey: Personal Interest in Detector R&D of INFN Rome1 researchers

17 answers. Most detected activities related to gaseous detectors, calorimetry and photon detection and electronics



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The ATLAS group has a large experience in trigger and DAQ systems, in the development of on-detector and back-and electronics and is currently responsible for the L0Muon trigger for HL-LHC, moreover we are involved in R&D on application of AI in trigger systems, using FPGAs and other hardware accelerators. We would like to register to TF7 and in particular in the back-end systems sub-topic.

RICH DAQ incluso hardware programmabile per online low level trigger

Fast neutron detection by means of elastic scattering

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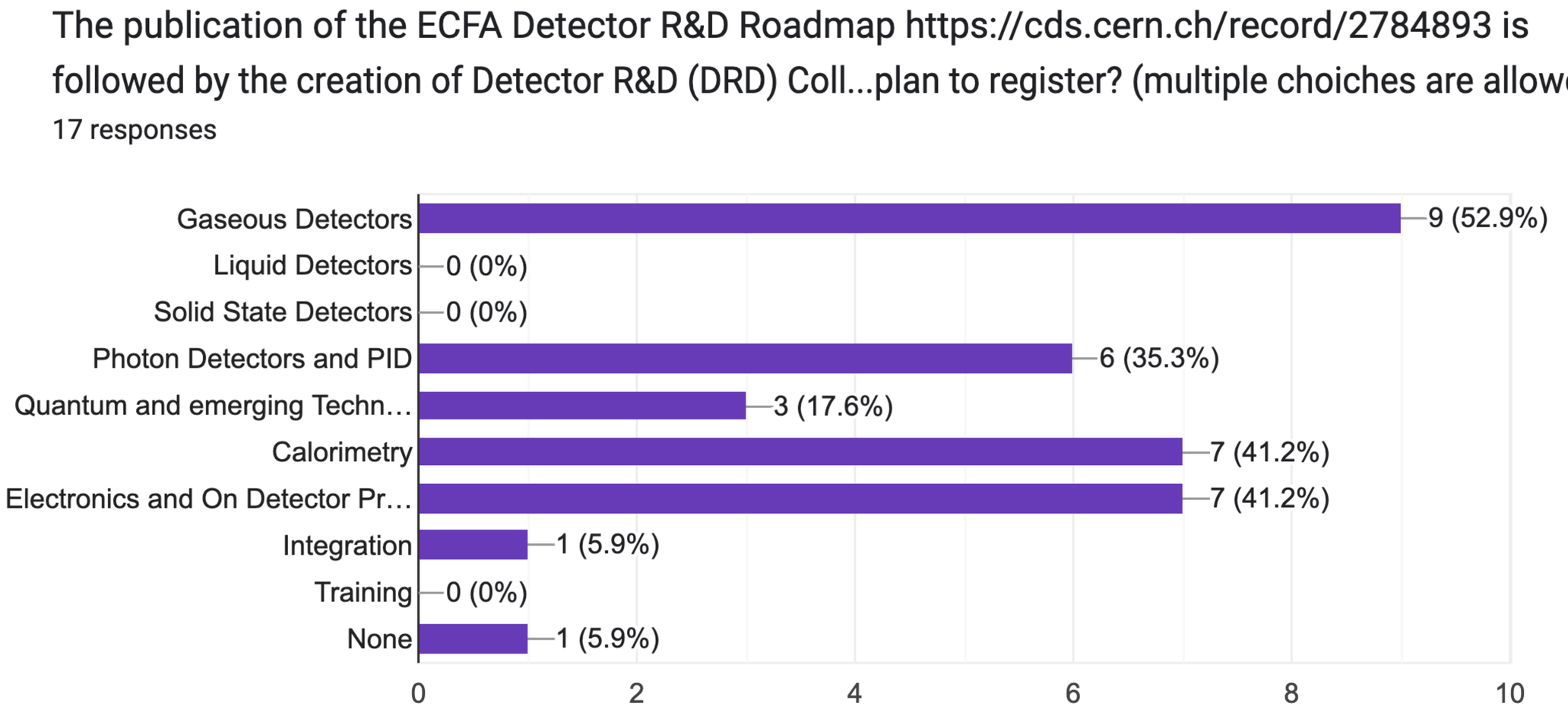

Results of internal survey: Personal Interest in Detector R&D of INFN Rome1 researchers

- GPU servers available in the department, FPGA farm with Xilinx and Intel FPGAs soon available in Milano Bicocca (CN PNRR) for studies on ultra fast trigger systems for future detectors;

- Common structures and sharing of expertise in the Section;

- DAQ, Trigger and Machine Learning;

- Although I never worked on the topic, I'm interested in the development of trackers based on scintillators (either fibers or bars) and SiPM as a possible alternative to gaseous detectors for large area trackers (e.g. muon systems for future collider experiments) which may become quite competitive in future. I couldn't find a specific TF for this, although I see that TF4 has a part on photon detectors that may be related. I can also show a couple of slides on this;

- We should at least mention TF7 in the discussion, as it is an important topic for which there may be a common interest;

- Electronic laboratory and test-beam/irradiation facilities are crucial. especially irradiation;