1. PUBLISHABLE SUMMARY

Summary of the context and overall objectives of the project (For the final period, include the conclusions of the action)

The AIDA-2020 project brings together the leading European infrastructures and academic institutions in detector development for particle physics, regrouping more than 10,000 scientists. 19 countries and CERN are involved in this programme aligned with the European Strategy for Particle Physics. With the upgrade of the Large Hadron Collider (LHC) and the preparation of new experiments, the community will have to overcome unprecedented challenges.
AIDA-2020 advances detector technologies beyond current limits by offering well-equipped test beam and irradiation facilities for testing detector systems under its Transnational Access (TA) programme. Common software tools, microelectronics and data acquisition systems are also provided. This shared high-quality infrastructure ensures coherent development by collegially involving experts across Europe. The enhanced coordination within the European detector community leverages EU and national resources and contributes to maintaining Europe's leadership in the field.

Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far (For the final period please include an overview of the results and their exploitation and dissemination)

WP1 is monitoring the progress through bi-monthly meetings of the Steering Committee and is ensuring the contractual and administrative implementation of the project. This included the preparation of the mid-term review report and request for amendment to the Grant Agreement. Three Annual Meetings, held at Hamburg, Paris and Bologna were organised and each attended by 120+ participants.
Activities in WP2 included the website, quarterly publication of the newsletter, and production of videos on facilities open for Transnational Access. The Proof of Concept fund supports three projects aiming at applications of AIDA-2020 technologies outside of particle physics; first steps towards commercialisation of results have been made.
WP3 has delivered software tools, which are being integrated into the experiments running today e.g. a new geometry package suitable for vectorisation, integrated into the CMS off-line software is routinely used now. Further developments include the DD4hep geometry package, the BACH alignment package and the Pandora Particle Flow Algorithms package.
In WP4 the two main deliverables consisting in CMOS readout chips for new instrumentation were accomplished: a 65 nm chip for pixel detectors developed in WP6 and WP7 for the LHC upgrade and a 130 nm chip for the gaseous detectors and calorimeters supported in WP13 and WP14.
In WP5, the Trigger/Timing Logic Unit has been developed and can be used to synchronise detectors, which have different timing and triggering structures. EUDAQ2 and DQM4HEP Software have undergone significant development. The DAQ system has already been used by detectors for a future Linear Collider, as well as detectors for the LHC upgrade.
The activities of WP6 focused on hybrid detectors and monolithic CMOS devices. The excellent performance of the monolithic prototypes before and after irradiation, and the cost effectiveness of their fabrication cycle, have consolidated this approach. Industrialization and system issues, related to detector assembly and deployment, are also being addressed.

WP7 aims at optimizing the sensors for the silicon-based vertexing and tracking systems, using planar and 3D diodes or low gain avalanche detector technologies. The focus moved towards the characterization of 3D and planar hybrid pixel sensors which radiation-tolerance were successfully assessed.
The activities of WP8 are embedded in the Neutrino Platform at CERN. Key technologies for purity monitoring, photo-detection, very high voltage supply, charge readout, associated cryogenic front-end electronics and DAQ were further developed and tested. Many of these developments have been integrated and conducted in prototype detector recording cosmic ray data in 2017.
In WP9, standard miniaturized hydraulic connection technologies have been defined to allow for rapid prototyping, extreme minimization, and long-term reliability under high pressure and radiation doses. A state-of-the-art testing facility for boiling flows of CO2 in mini- and micro-channels is now ready for exploitation at CERN.
The TA programme is organised in WP10, WP11 and WP12. All facilities provide support to users, some even exceeding or reaching the target access units, thus demonstrating the demand from the community.
In WP13 tools to produce and characterise resistive plate chambers and micro-pattern gas detectors were developed. Novel architectures and technological tools, in particular in the field of dedicated read-out electronics and electronics were steadily developed.
WP14 developed highly granular calorimeter systems, and test infrastructures for advanced scintillation materials have been commissioned and used. The common beam tests of CMS and CALICE calorimeter prototypes and the demonstration of an assembly chain for silicon-based calorimeter elements were achieved.
As part of WP15, a new version of EUDET-type pixel telescopes has been constructed and installed at CERN. A generic slow-control and monitoring system has been installed at DESY. A new gas system has been installed at the GIF++ and the upgrades foreseen for the IRRAD facility at CERN have been completed. A new cold box became also available at the Birmingham Cyclotron irradiation facility and the instantaneous dose monitoring system at the CERN GIF++ facility have been successfully installed and commissioned.

Progress beyond the state of the art, expected results until the end of the project and potential impacts (including the socio-economic impact and the wider societal implications of the project so far)

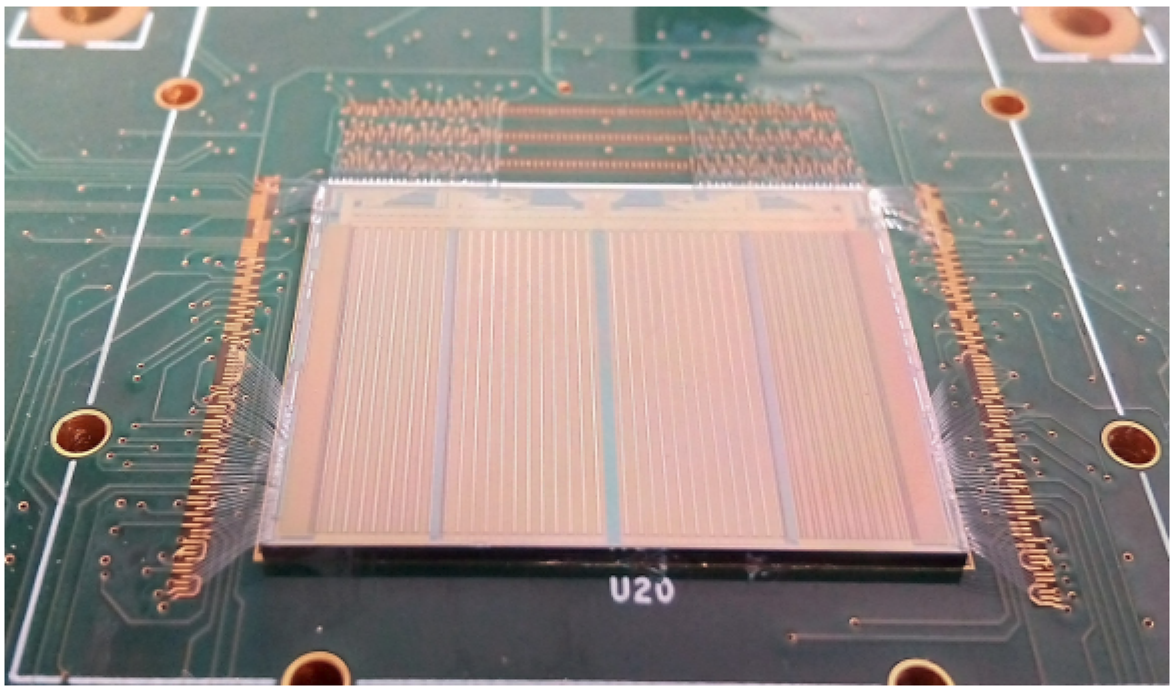
Future particle physics projects represent tremendous challenges for the detectors and require spearhead technologies beyond state of the art. Recently the upgrades of the LHC experiments, conceived to cope with unprecedented demands of data rates, radiation hardness and timing precision, have taken shape. They not only maintain the performance under much harsher conditions, but even improve it and thus open up new potential for physics discoveries. This becomes possible through visionary concepts and novel technologies, for which AIDA-2020 activities have been crucial as outlined in the previous section.
It cannot be over-emphasised that AIDA-2020 is the unique framework on European level to unfold such synergies and coordinate the research on common needs of the field as a whole. The impact on the competitiveness of European detector science is evidenced by the leading roles of European representatives in many global projects.
With dedicated Academia meets Industry events, which are well received on both sides, AIDA-2020 proactively reaches out to open up further fields, for example in non-destructive testing, for a fruitful transfer of particle detector technologies to meet the growing demands of industry for the faster and more detailed characterisation of complex products and installations.

The societal impact of AIDA-2020 rests on two pillars. Particle physics, like accelerator science, is particularly strong in pre-procurement R&D for series production, as required for big accelerator projects. Industrial partners then capitalise on the acquired know-how for applications targeting other markets. In addition, AIDA-2020 has launched a PoC funding which is dedicated to projects developing applications beyond particle physics together with industrial partners.Two of the three PoC projects target applications in the public health sector.

Address (URL) of the project's public website

http://cern.ch/aida2020

A large area device with fully monolithic matrices



Participants to the AIDA-2020 3rd Annual Meeting in Bologna

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