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MAPS R&D and irradiations at MC40

P. Allport, M. Baca, D. Briglin, J. Broughton, L. Gonella, I. Iqbal, K. Nikolopoulos, T. Price, S. Pyatt, J. Thomas, J. Wilson, A. Winter + Steve Worm (joined this week)

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Outline

- R&D on Monolithic Active Pixel Sensors (MAPS)

- Irradiation line for particle physics at MC40

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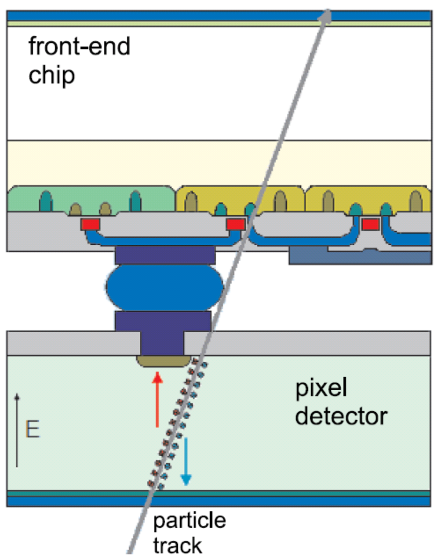
Pixel detectors for vertex and tracking

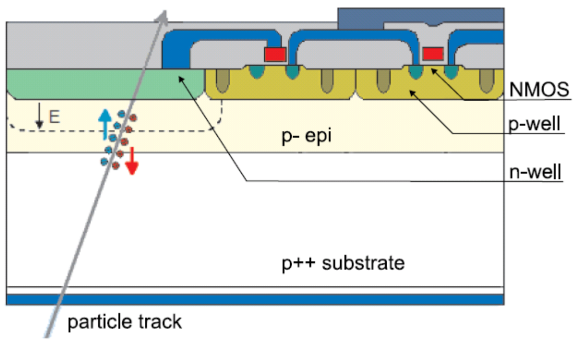
Hybrid pixel detectors

- Charge collection by drift in depleted bulk → high signal, high radiation hardness, high speed
- Full CMOS
- High cost (sensor & hybridization)
- High material budget

MAPS

- Charge collection by diffusion in epi layer → small signal, moderate radiation hardness, low speed
- Typically not full CMOS
- Low cost
- Low material budget





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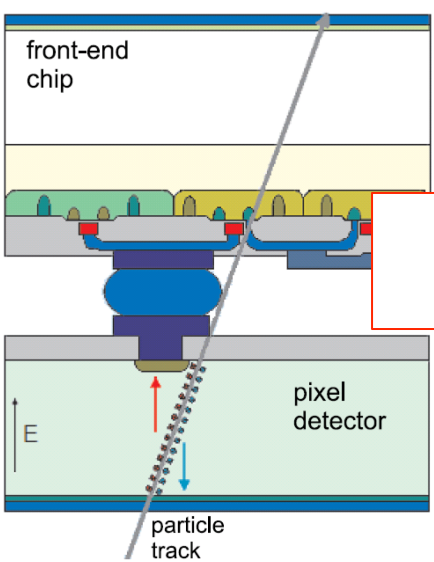
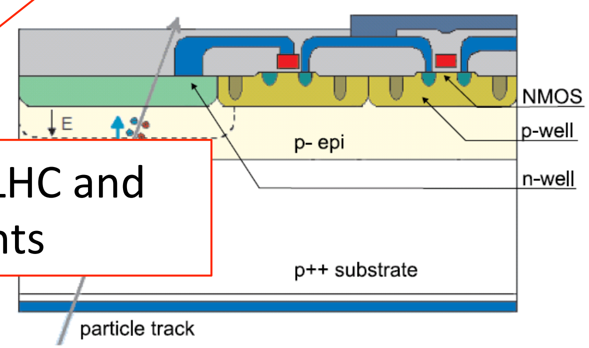


Requirements for HL-LHC and future experiments



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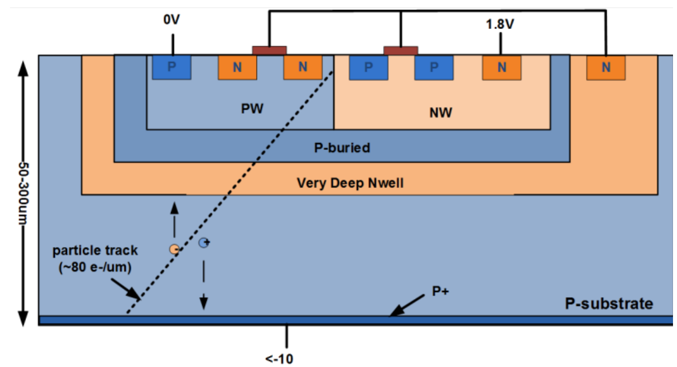
New development: Depleted MAPS

- Commercial CMOS technologies with add-on features
  - High Voltage Capability
  - High Resistivity substrates

→ Enable charge collection by drift



- Potential advantages
  - Rad-hard
  - High rate capabilities
  - Low cost
  - Simplified production
  - Low mass

- Complications
  - Optimized layout needed for low power and good CCE after irradiation
  - Challenging isolation between sensors and electronics

Ongoing MAPS projects

- ## PRD for future colliders and medical applications

Development towards a Reconfigurable Monolithic Active Pixel Sensor in Radiation-hard Technology for Outer Tracking and Digital Electromagnetic Calorimetry

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P. Phillips[2], F. Salvatore[3], R. Turchetta[2], G. Villani[2], N.K. Watson[1], F. Wilson[2], Z. Zhang[2]

1) The University of Birmingham

2) Rutherford Appleton Laboratory, STFC

3) The University of Sussex

- ## RD50 collaboration

RD50 funding request
- April 2014-

Title of project:	Design and production of RD50 test structures and devices in L-Foundry 150 nm HV-CMOS technology.
Contact person:	*G. Casse* *University of Liverpool* (+44) 0151 7943399 *gcasse@hep.ph.liv.ac.uk*

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5. *Joseph Stefan Institute of Ljubljana, Marko Mikuz, Marko.Mikuz@cern.ch*
6. *NIMP Bucharest, Ioana Pintilie, ioana@infim.ro (4500 €)*
7. *IEAP-CTU Prague, Stanislav.Pospisil@utef.cvut.cz*
8. *University of Barcelona, Angel Dieguez, adieguez@el.ub.edu*
9. *University of Birmingham, Laura Gonella, laura.gonella@cern.ch*
10. *IFAE, Barcelona, Sebastian Grinstein, sgrinstein@ifae.es*
11. *University of Oxford, Daniela Bortoletto, daniela.bortoletto@physics.ox.ac.uk.*
12. *FBK, Maurizio Boscardin, boscardi@fbk.eu.*

- ## Electron Ion Collider (nuclear physics)

Precision Central Silicon Tracking & Vertexing for the EIC

P.P. Allport, L. Gonella, P.G. Jones,* P.R. Newman
School of Physics & Astronomy, University of Birmingham, B15 2TT, UK

June 15, 2016

Abstract

We propose to develop a detailed concept for a central silicon pixel detector for an Electron-Ion Collider at BNL or JLab, exploring the advantages of using HV-CMOS or HR-CMOS MAPS technologies. The sensor development will exploit the newly created Birmingham Instrumentation Laboratory for Particle Physics and its Applications and will be closely coupled with simulations to optimise the basic layout, location and sensor/pixel dimensions. The design will be tested in full detector simulations to evaluate its performance with respect to the identification and precision measurement of heavy flavour processes and scattered electrons at high Q^2. A detailed evaluation of expected EIC performance for these processes will therefore be a key deliverable.

In addition to longstanding Birmingham MAPS activities for lepton colliders (see Nigel's talks)

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Outline

- R&D on Monolithic Active Pixel Sensors (MAPS)

- <u>Irradiation line for particle physics at MC40</u>

Introduction

- The **MC40 cyclotron** at the University of Birmingham is primarily used for radio-isotope production for mainly medical applications
- It was commissioned as an irradiation facility for particle physics in early 2013 and has irradiated around 300 samples in total
- Joint activity by the **Universities of Birmingham, Liverpool and Sheffield** through STFC support for UK ATLAS Upgrade

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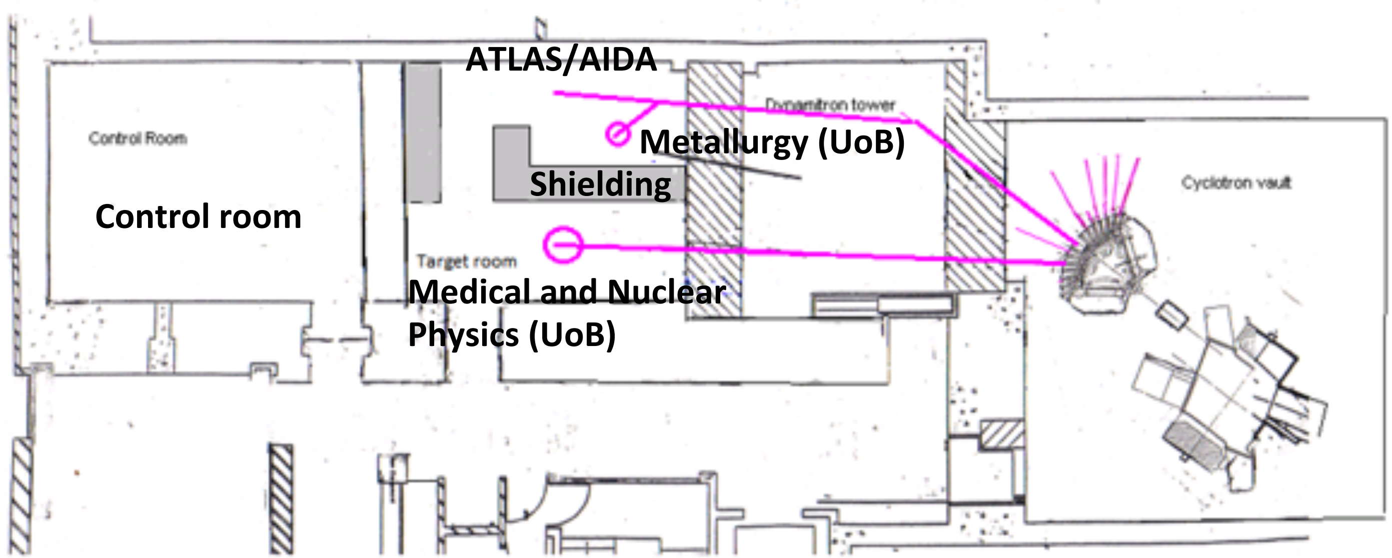
Irradiation facility

- Proton energy at extraction: up to 40MeV
- Proton current: up to 2μA (cooling permitting)
- Beam spot: approx. **10mm × 10mm**
- Flux: up to 10^{13} protons/s/cm^2

Typically:
E_beam= **27MeV**
I_beam = **0.1-0.5μA**



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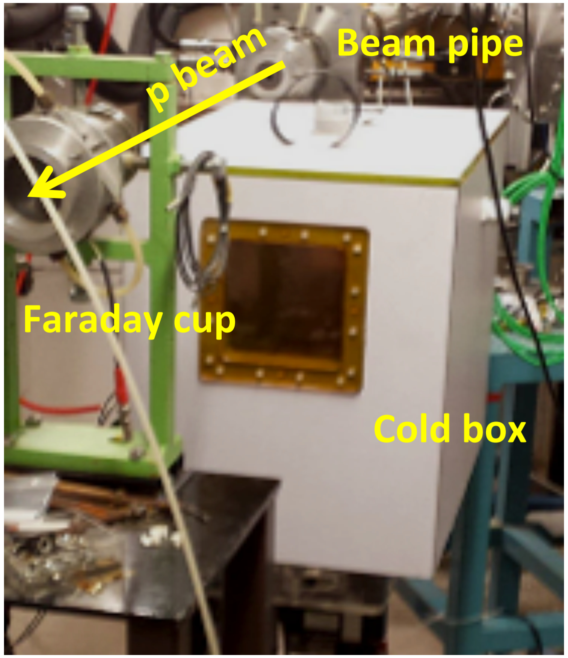
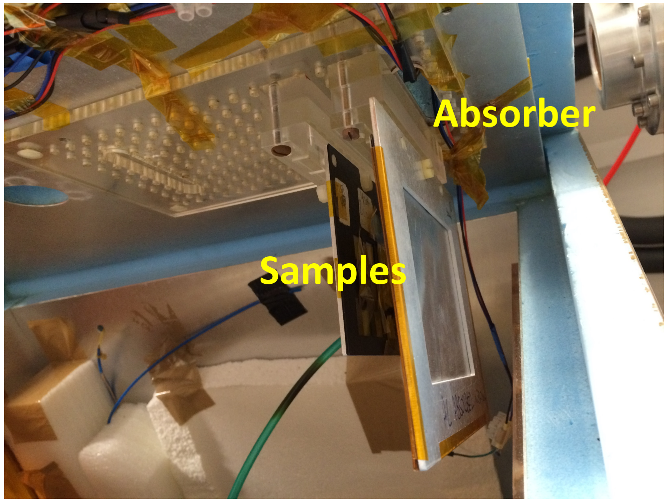
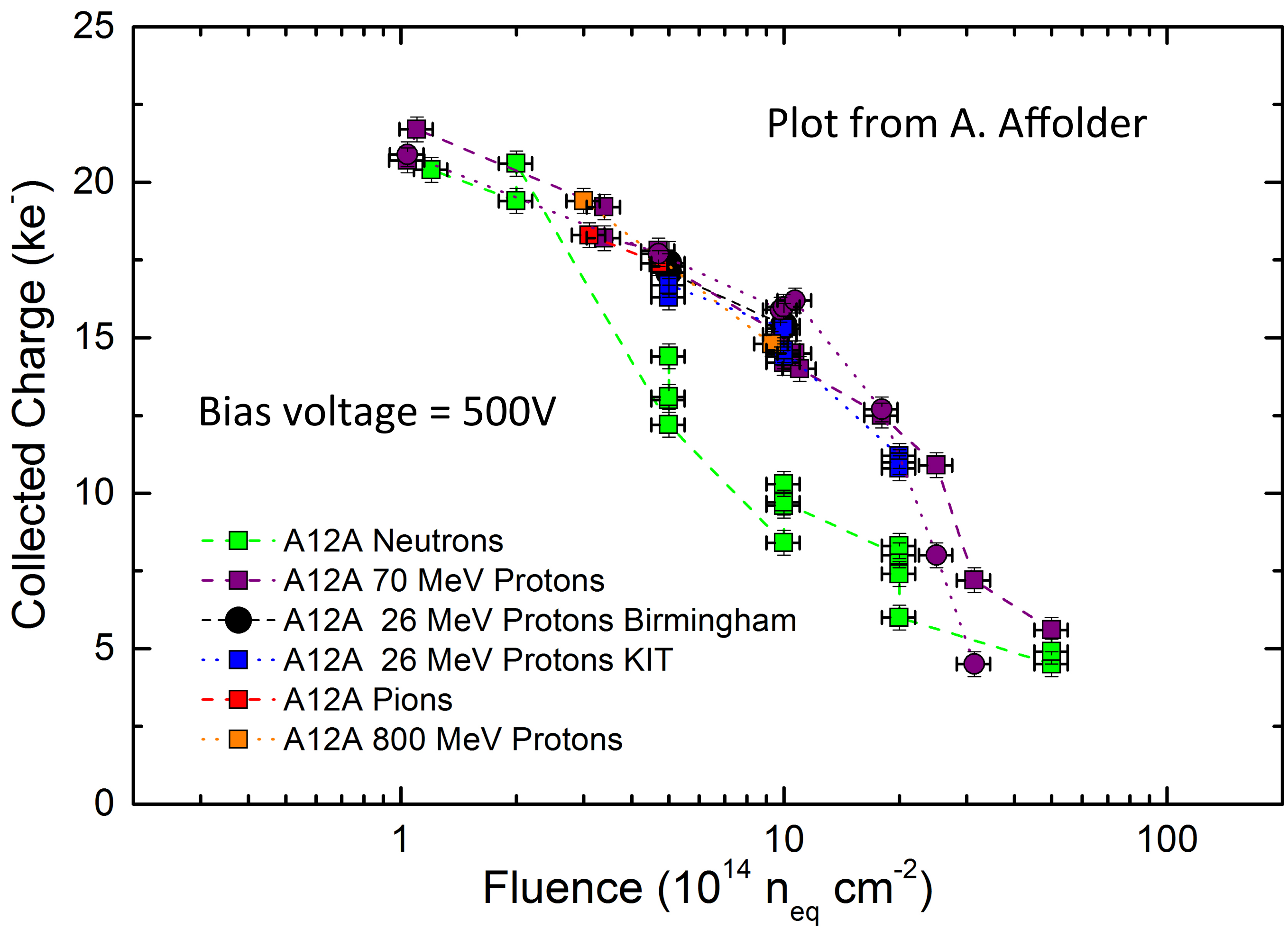
Irradiation setup





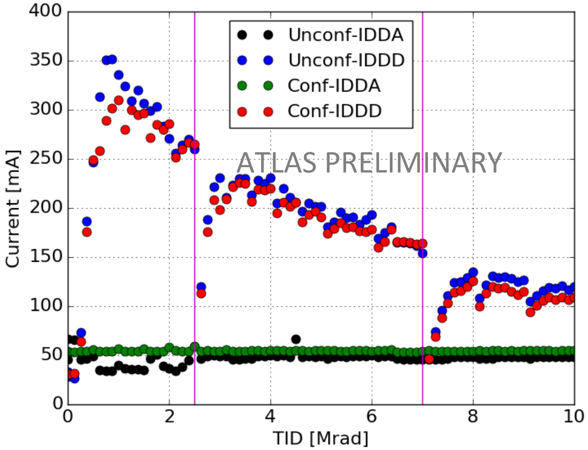
Comparison with other facilities



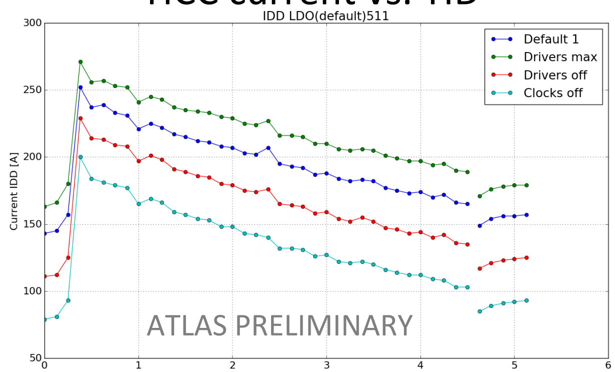
Irradiations for ATLAS ITK and MAPS R&D

- ITK strips ASICs (ABC130 and HCC)

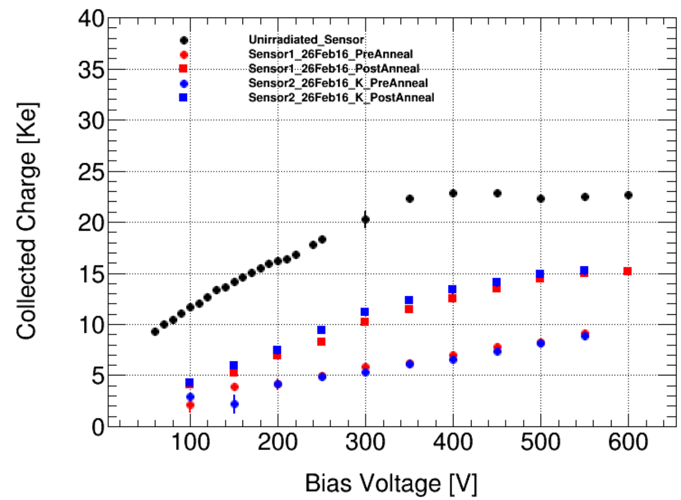
ABC130 current vs. TID

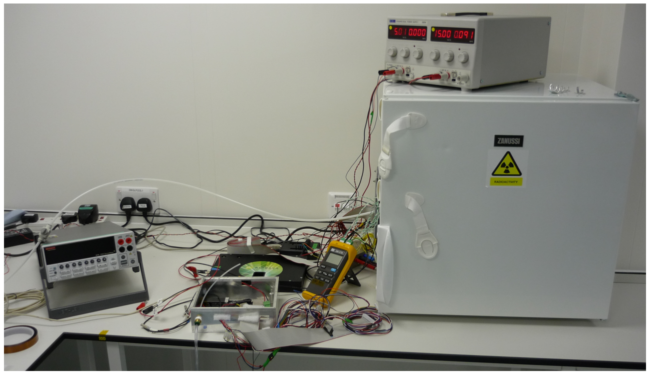


HCC current vs. TID



- ITK strip sensors



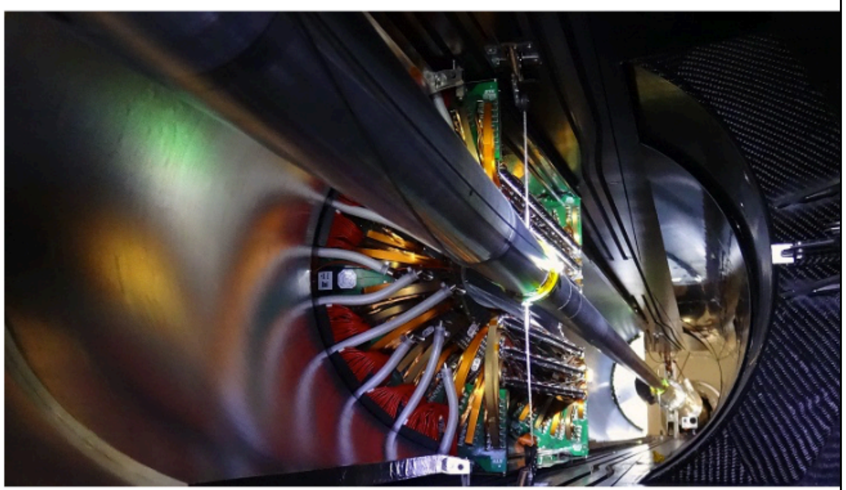


- The Birmingham Irradiation facility is an **AIDA-2020 Transnational Access Facility**
- Irradiations for AIDA-2020 users:
  - LFoundry pixel planar sensor (Uni Bonn); Scientifica Foam samples (IFIC Valencia); Humidity probes (Uni Wuppertal); ITK Pixel single chip active edge modules (MPI)

AIDA 2020 Advanced European Infrastructures for Detectors at Accelerators

Home | Project | Activities | Transnational Access | Events | Documents | AIDA | Newsletter | Call for proposals (PoC) | Contact

Welcome to the AIDA-2020 website!



CMS Pixel Detector, Image cre

What is AIDA-2020?

The AIDA-2020 project brings together the leading European research infrastructures in the field of detector development and testing and a number of institutes, universities and technological centers, thus assembling the necessary expertise for the ambitious programme of work.

HIGHLIGHTS

Who is involved?

In total, 24 countries and CERN are involved in a coherent and coordinated programme of NAs, TAs and JRAs, fully in line with the priorities of the European Strategy for Particle Physics.

What benefits does AIDA-2020 offer?

AIDA-2020 aims to advance detector technologies beyond current limits by offering well-equipped test beam and irradiation facilities for testing detector systems under its Transnational Access programme. Common software tools, micro-electronics and data acquisition systems are also provided. This shared high-quality infrastructure will ensure optimal use and coherent development, thus increasing knowledge exchange between European groups and maximising scientific progress. The project also exploits the innovation potential of detector research by engaging with European industry for large-scale production of detector systems and by developing applications outside of particle physics, e.g. for medical imaging.

AIDA-2020 will lead to enhanced coordination within the European detector community, leveraging EU and national resources. The project will explore novel detector technologies and will provide the ERA with world-class infrastructure for detector development, benefiting thousands of researchers participating in future particle physics projects, and contributing to maintaining Europe's leadership of the field.

22 Sep 2016
AIDA-2020 Steering Committee #7
60-2-023

28 Sep 2016
EUDAQ / Common DAQ /