COST ACTION CA24131
European Network for radiation-detection based Research and Innovation addressing increasing societal CHallenges (ENRICH)

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WG4 – Electronics and DAQ

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1st ENRCIH COST- ANNUAL MEETING
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WG4 – Co-Leaders

Chris Armstrong
Principal Detector Scientist at the Central Laser Facility, UK
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Research background in laser-driven MeV x-ray sources and detectors. Strong interest in spatial and spectral characterisation techniques for high-fluence, ultra-short duration sources

Michela Fratini
Senior Researcher at the National Researcher Council (CNR-Nanotec), IT
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Research background in X-ray sources and imaging techniques, with emphasis on X-ray source and detector development for neuroscience imaging applications. Interested in coordinating collaborative activities within ENRICH WG4 and fostering interdisciplinary research

MoU Aim : “ENRICH COST ACTION”

ABOUT US

Aim & Description

The ENRICH (European Network for radiation-detection based Research and Innovation addressing increasing societal CHallenges) COST Action aims to build a European network of researchers and stakeholders working on radiation-detection based experiments and applications.

Numerous researchers work with photon detection daily, applying it in astrophysics, nuclear and atomic physics, material science, data analysis, simulations, detectors, electronics, optics, medicine, cultural heritage, food safety, fraud detection and others. However, the community remains fragmented, with subcommunities (e.g., nuclear physics, synchrotron users) often working in silos. This lack of crossdisciplinary collaboration limits knowledge exchange and the transfer of technologies from large-scale facilities to smaller labs and industries.

“The community of photon detection is fragmented in sub-communities. ENRICH seeks to unite them, allowing collaboration across sectors and disciplines to accelerate scientific and technological advances in radiation detection”

WG4 – ENRICH plans for Electronics & DAQ

ENRICH overall aim

Strengthen connections among radiation-detection sub-communities and stakeholders.

Create a cross-border, integrated community for multidisciplinary knowledge exchange, technology transfer and discussion of emerging challenges.

For WG4, this means connecting detector needs, electronics expertise, DAQ platforms, software and suppliers.

1	**Performance targets**	Improve noise suppression, high-flux efficiency, and energy / spatial / time resolution.
2	**Stakeholder collaboration**	Engage electronic board designers, suppliers, SMEs and research teams around shared technical needs.
3	**Next-generation readout**	Support fast, low-noise charge-sensitive preamplifiers, digital pulse processing and multi-parameter analysis.
4	**ML in DAQ boards**	Explore validated FPGA/embedded ML for denoising, quality checks, data reduction and event selection.

Year-1 implication: the Market Survey / Marketplace is the first WG4 tool to map available solutions, identify gaps, and prepare comparable benchmarking for D4.1/D4.2.

WG4 – DAQ challenges: from MoU to Year-1 actions

1. Challenge

- High flux: pile-up, dead time, saturation and throughput limits
- Low flux: single-event sensitivity, noise floor and false counts
- High-resolution imaging: data deluge, storage and manual processing
- Different facilities face similar constraints, but use different vocabularies

From MoU needs to shared WG4 questions

2. Technical need

- Low-noise analogue front-end electronics
- Digital pulse processing and multi-parameter event reconstruction
- Fast boards / Field-Programmable Gate Array(FPGA) pipelines for online reduction and quality checks
- ML-assisted denoising, classification and event selection where validated

Co-design: detector + electronics + DAQ

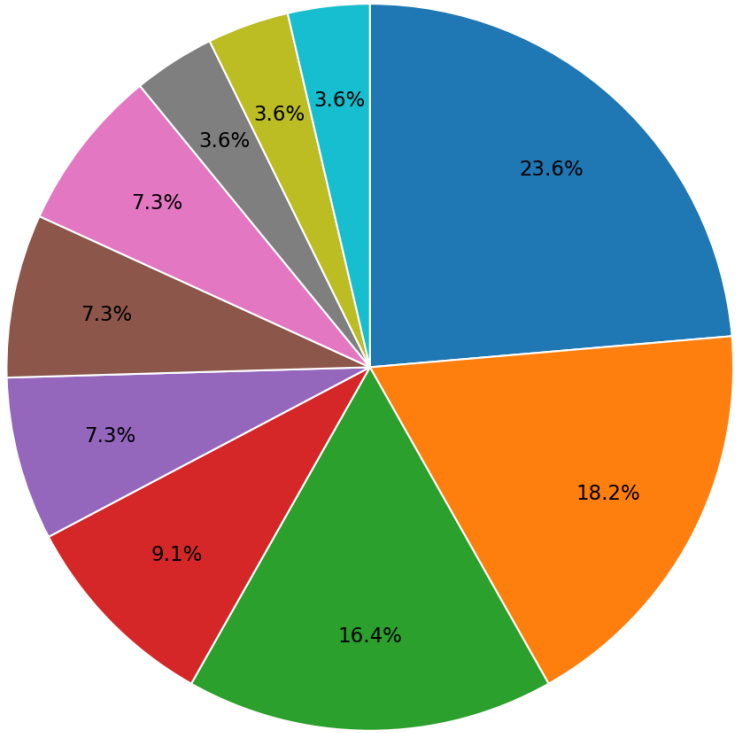
3. WG4 response

- Market survey: map commercial and in-house readout / DAQ solutions
- Low-noise systems: collect examples and identify common bottlenecks
- Standardisation: define comparable benchmark quantities
- ML in the chain: discuss robust, validated DAQ-level use cases

Direct input to D4.1 and D4.2

Year-1 focus: move from broad MoU statements to a practical WG4 map of available solutions, shared bottlenecks, and minimum benchmark quantities.

WG4 participants by country (N = 55)



Young Researchers	19	0,35
Males	44	0,80
Females	11	0,20

Countries represented by one participant are grouped as “Other countries”. COST organisational affiliations are reported separately.

The report should answer four questions

1	**What is WG4 expected to deliver?**	A census of teams and a validated view of next-generation DAQ systems.
2	**What did WG4 start in Year 1?**	Online meetings, a member-facing Market Survey, and the first thematic structure.
3	**How do activities map to deliverables?**	Market Survey → D4.1; benchmarking and case studies → D4.2.
4	**What is needed from the network?**	Survey responses, seminar volunteers, use cases, industry contacts and mobility actions.

What is WG4 expected to deliver?

WG4: focuses on all the necessary activities to bring readout electronics for photon detection beyond the present state of art, aiming at improved performance (energy, space and time resolutions) and reduced costs and dimensions.

WG4: Deliverables &Task

D4.1
Census of Electronics and DAQ research teams (Q5): Census of all the research teams involved in ENRICH working on front-end and readout electronics, as well as on Data Acquisition (DAQ) hardware and software.

D4.2
Next-Generation DAQ Systems Report (Q14): A final report on the performance evaluation and validation of next-generation DAQ systems and readout boards.

What is WG4 expected to deliver?

T4.1: Conduct an evaluation of current readout electronics and DAQ systems, identifying strengths and
weaknesses, benchmarking existing technologies against industry standards (RCO6: Compare and exchange the latest techniques in development of readout electronics for photon detectors identifying weak points and possible spaces for improvement.).

T4.2: Boost the emergent technology of AI and Machine Learning based electronic boards aiming at a wider and easier implementation of these tools in many multidisciplinary applications (TE6)

T4.3: Stimulate collaboration among researchers and manufacturers in electronics to integrate novel
readout solutions into photon detectors at low costs (RCO3, CBO4).

What did WG4 start in Year 1?

T4.1: Conduct an evaluation of current readout electronics and DAQ systems, identifying strengths and weaknesses, benchmarking existing technologies against industry standards (RCO6: Compare and exchange the latest techniques in development of readout electronics for photon detectors identifying weak points and possible spaces for improvement.).

T4.2: Boost the emergent technology of AI and Machine Learning based electronic boards aiming at a wider and easier implementation of these tools in many multidisciplinary applications (TE6:Bring innovations in data acquisition and pre-processing hardware and software, including AI powered solutions)

T4.3: Stimulate collaboration among researchers and manufacturers in electronics to integrate novel readout solutions into photon detectors at low costs (RCO3, CBO4).

WG / Tasks	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
WG1: Cost Management and Coordination																
T1.1																
T1.2																
T1.3																
WG2: Technological Advancements																
T2.1																
T2.2																
T2.3																
T2.4																
WG3: Software Advancements																
T3.1																
T3.2																
T3.4																
WG4: Electronics and DAQ																
T4.1																
T4.2																
WG5: Multidisciplinarity and societal applications																
T5.1																
T5.2																
T5.3																
WG6: Integration and Interchange																
T6.1																
T6.2																
T6.3																
T6.4																
WG7: Mentoring, training and dissemination																
T7.1																
T7.2																
T7.3																
T7.4																
T7.5																
Deliverables		D1.1		D5.1, D7.1	D1.2, D2.1, D4.1, D6.1	D1.1,D5.2, D6.1, D7.2	D2.2, D3.1, D6.2	D7.1	D6.3	D1.1, D5.3, D7.2		D7.1		D1.1, D4.2, D7.2		D3.2, D7.1
Cross-sectional Deliverables					DX.1, DX.2				DX.1, DX.2				DX.1, DX.2			DX.1, DX.2, DX.3
Milestones	M1	M2		M3		M2		M3		M2		M3		M2		M3

How do activities map to deliverables?

1 TASK 4.1

Evaluate current readout electronics and DAQ systems

Market Survey launched to collect systems, applications, selection factors, strengths and limitations.

2 TASK 4.2

Boost AI / ML based electronic boards

ML kept as a cross-cutting theme: not a magic box, but a tool for online data quality and reduction.

3 TASK 4.3

Stimulate collaboration with manufacturers and researchers

Online meetings and planned short seminars to connect users, developers and suppliers.

Market Survey

What is out there? Who are the key suppliers?
Teledyne, National Instruments, Caen, Picoscope, RFSoCs, in-house development, … , the list goes on …

Whats the latest advances in DAQ's that are accessible to a wide market?
One-off systems are good for awareness and highlighting direction but make adoption challenging

Are there any key bottlenecks to overcome?
Fast digitisers, system implementation, data-rate and data-capacity

Dissemination/commonality of information
Sharing notes on what companies offer what

Market Survey: from names to use cases

The useful output is not a vendor list; it is a map of suitability by application.

Examples to capture

- Fast digitisers
- Modular electronics
- RFSoC-based DAQ
- In-house systems
- Low-cost alternatives
- Full-chain DAQ + software

Supplier examples already named by WG4

TELEDYNE TECHNOLOGIES Everywhereyoulook™

CAEN Tools for Discovery

pico Technology

AMD ZYNQ RFSoC DFE

+ in-house developments, facility-specific systems and emerging alternatives

Market Survey: a snapshot of our group

Crucially we want to build a resource of different options so that when the next project comes around, we don't have to start from scratch.

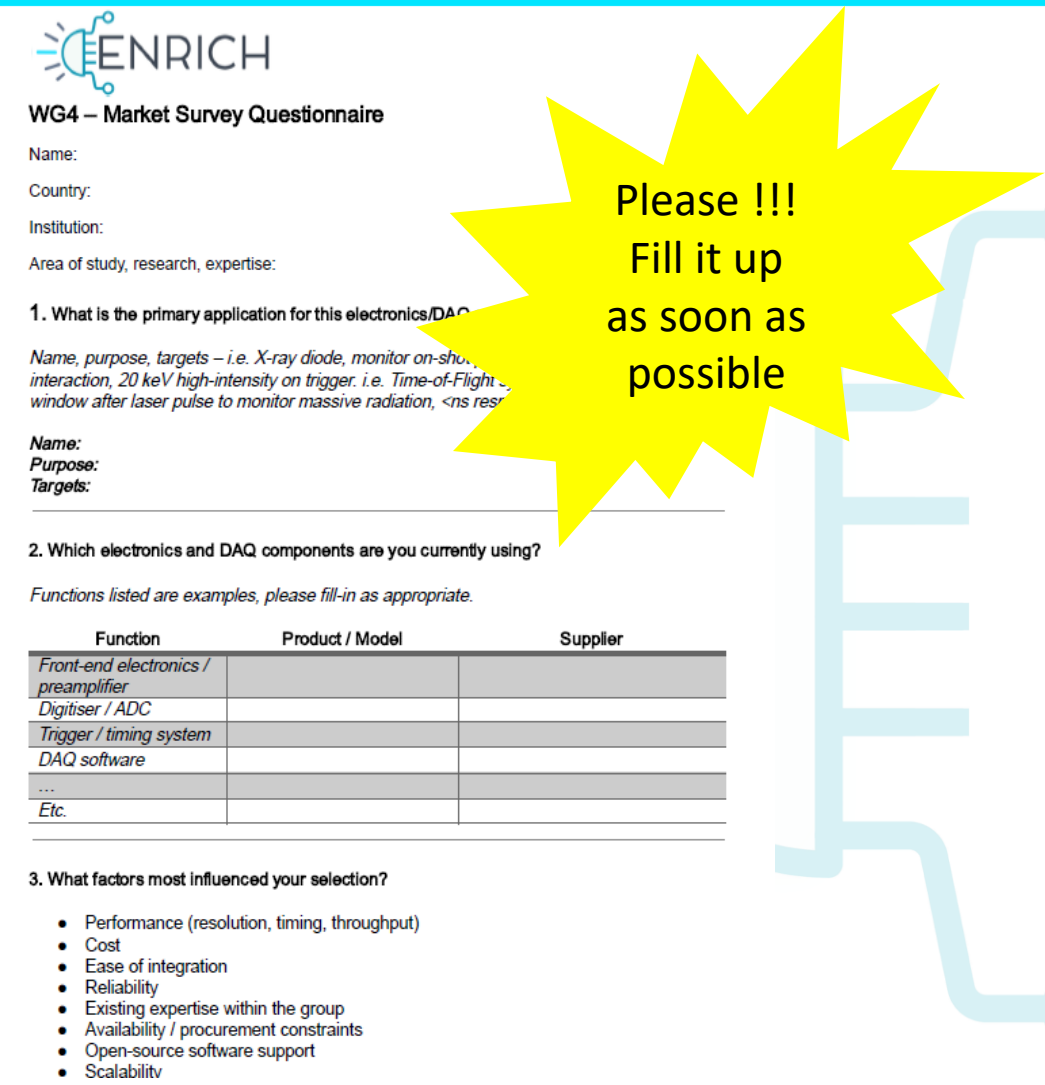
Suppliers and equipment

Part of our objectives is to share experiences to find out:

1) what we all use at different facilities

2) what we use them for.

This will allow us to identify which solutions are commonly adopted, where different communities converge, and where important gaps or opportunities still exist



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WG4 – Market Survey Questionnaire

Name:

Country:

Institution:

Area of study, research, expertise:

1. What is the primary application for this electronics/DAQ

Name, purpose, targets – i.e. X-ray diode, monitor on-sho… interaction, 20 keV high-intensity on trigger. i.e. Time-of-Flight … window after laser pulse to monitor massive radiation, <ns res…

Name:
Purpose:
Targets:

2. Which electronics and DAQ components are you currently using?

Functions listed are examples, please fill-in as appropriate.

Function	Product / Model	Supplier
Front-end electronics / preamplifier		
Digitiser / ADC		
Trigger / timing system		
DAQ software		
…		
Etc.		

3. What factors most influenced your selection?

- Performance (resolution, timing, throughput)
- Cost
- Ease of integration
- Reliability
- Existing expertise within the group
- Availability / procurement constraints
- Open-source software support
- Scalability

Please !!!
Fill it up
as soon as
possible

Monthly Seminars

Members from the working group present on topics aligned with each of the themes with a short form seminar.

Length: 10-15m

Theme: Market availability, low-cost daq systems, standardisation and calibration, machine-learning in the chain.

2 Seminar were already given by **Chris Armstrong** (general WG4 seminar)
Mihai Cuciuc from ELI-NP talking about using low-cost spectrometer systems for ioniziating radiation.

Volunteer by emailing:

Chris - chris.armstrong@stfc.ac.uk
or
Michela – michela.fratini@gmail.com

Conclusions

A direct line from current activities to formal outputs.

Now

Market Survey
+ member mapping
+ short seminars

Dec 2026

D4.1
Census of electronics and DAQ teams

Mar 2028

D4.2
Next-generation DAQ systems report

Annual WG reports and annual forward plans should use the same evidence base, so the survey is useful beyond D4.1.

What WG4 needs is structured participation, not just attendance.

1	**People**	Detector users · DAQ/electronics developers · simulation/ML experts · manufacturers
2	**Evidence**	Completed survey entries, use cases, benchmark data, known bottlenecks and alternative solutions
3	**Formats**	Monthly or quarterly online meetings; 10–15 min short seminars; targeted in-person exchanges
4	**Mobility**	STSM and other COST mechanisms to turn WG contacts into hands-on collaboration

Pubblication

PROPOSAL OF ACTION EVENTS

Type of activity (Meeting, training school)	**Satellite meeting at conference** **For example: https://www.nanoinnovation2026.eu/home/index.php**
Related Action Objectives and Deliverables from MoU (See next page)	D4.1 and D4.2 and objectives 10, 13 and 14
Title of the activity (i.e, WG1 meeting, etc)	Nanoinnovation Electronics and DAQ Workshop
Attendance type (Face-to-face, hybrid, on-line)	Face-to-face
Location/Country	Rome, Italy
Duration of the event (i.e, 1.5 days, etc)	1 day (additional to the conference)
Expected total number of participants	~10
Number of participants eligible for reimbursement	~6-10 (speakers at the workshop, and if budget permits additional participants for discussions)

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Acknowledgements

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COST (European Cooperation in Science and Technology) is a funding agency for research and innovation networks. Our Actions help connect research initiatives across Europe and enable scientists to grow their ideas by sharing them with their peers. This boosts their research, career and innovation.

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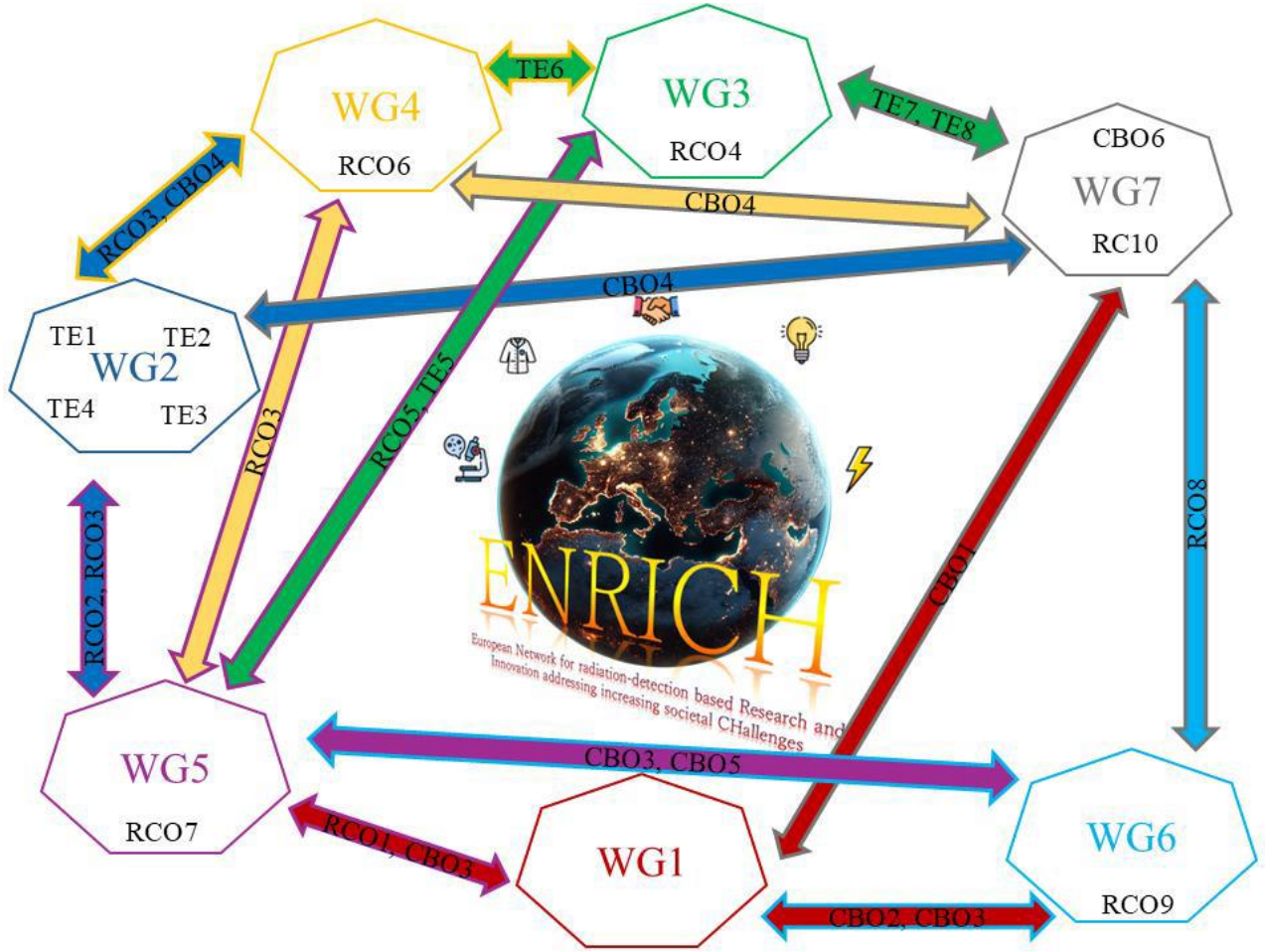
WG4
RCO6
TE6
WG3
RCO4
TE7, TE8
CBO6
WG7
RC10
RCO3, CBO4
CBO4
CBO4
TE1
TE2
WG2
TE4
TE3
RCO3
RCO5, TE5
RCO2, RCO3
RCO8
CBO1
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WG5
RCO7
CBO3, CBO5
RCO1, CBO3
WG1
WG6
RCO9
CBO2, CBO3