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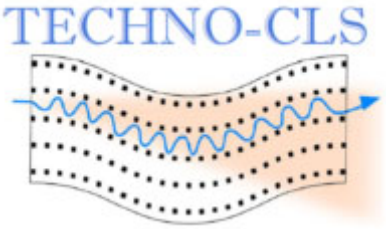


Funded by the European Union

EIC Pathfinder Project 101046458 TECHNO-CLS

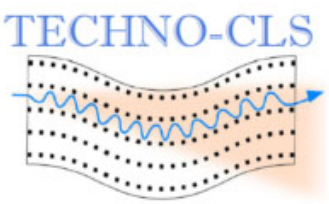
Emerging technologies for Crystal-based gamma-ray Light Sources

Andrey V. Solov'yov

MBN Research Center, Frankfurt am Main, Germany

www.mbnresearch.com

2nd Year Progress Review Meeting,
26 June 2024, on-line



TECHNO-CLS consortium

MBN Research Center

MBN Research Center

INFN
Istituto Nazionale di Fisica Nucleare

JOHANNES GUTENBERG UNIVERSITÄT MAINZ

JG|U

University of Kent

FERRARIAE UNIVERSITAS · 13 91 · EX LABORE FRUCTUS

Università degli Studi di Ferrara

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UNIVERSITAS STUDII PADUANI · MCCXXII

UNIVERSITÀ DEGLI STUDI DI PADOVA

Outline

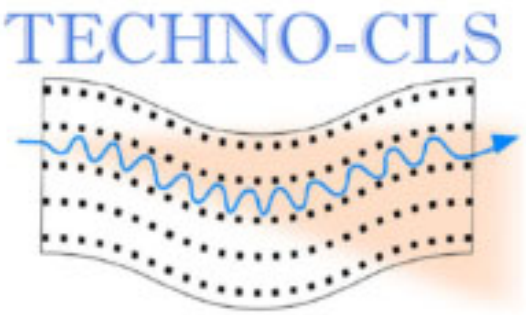
MBN Research Center

Part I

- **Overview of advances in Research and Technology: WP2, WP3 and WP4**
- **Overview of Dissemination and Outreach strategy: WP5**
- **Impact**

Part II

- WP1: Management and Coordination
- Deliverables

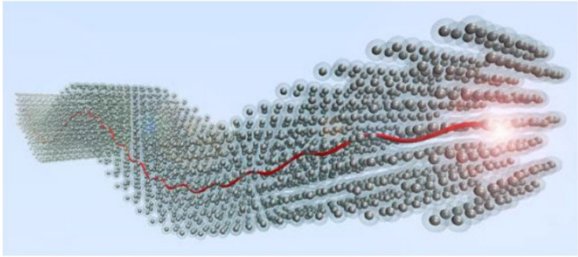


Main goals of the TECHNO-CLS project

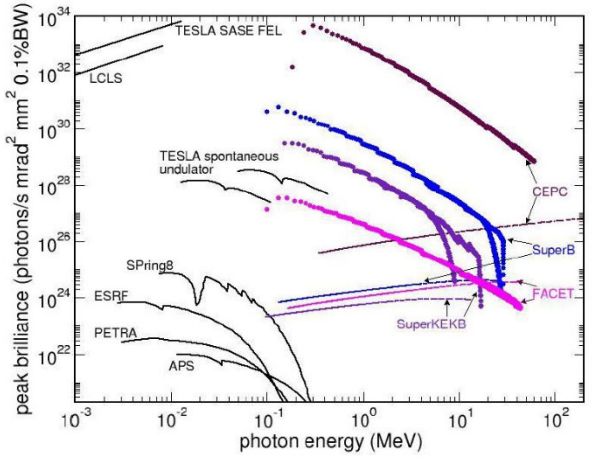
MBN Research Center

Research and technology (***6 Research and Technological Objectives***): to provide the ***breakthrough theoretical and experimental advances for the practical realisation of novel crystal-based gamma-ray Light Sources (CLS)*** operating at photon energies from ~100 keV up to GeV range that can be constructed through exposure of oriented crystals (linear, bent and periodically bent) to the beams of ultra-relativistic charged particles

The expected outcome of TECHNO-CLS project is the proof of principle that the main ideas of the envisioned future technology are feasible, thus validating its scientific and technological basis.



Artistic view of a Crystal-based Light Source (CLS)



Brilliance of CLSs in the 1-10^2 MeV range (coloured lines) can exceed brilliance of modern synchrotrons, undulators & XFELs (black lines) that operate at much lower photon energies.

A.V Korol, A.V Solov'yov,
Eur. Phys. J. D (2020) 74: 201

Communication, Dissemination and Exploitation

Expected Impact

Main goals of the TECHNO-CLS project:
Research and Technological Objectives (RTOs)

MBN Research Center

RTO1:

To apply a set of unique tools for multiscale modelling of nanostructured materials with extremely high, reliable levels of prediction, of particle propagation, of irradiation-induced effects, and of characterization of the radiation emitted in CLSs.

The RTO1 has been addressed within WP2, see report for WP2. Within this WP there were studied:

- Concrete case studies on **periodic bending of crystals by means of acoustic wave**s (AW) have been analysed and the results are prepared for the publication.
- The initial results on the **impact of dopant concentrations on the structure of SiGe superlattices** have been checked and refined. The corresponding manuscript was finalized and published as an open access preprint and in the journal. Similar studies have been started to analyse the structure modifications in boron-doped diamond crystal.
- The relativistic molecular dynamics simulations were performed **for sub-GeV electrons and positrons** channeling in **single, BC and PBC diamond and silicon crystals**. Similar study has been started for **10 GeV positrons** channeling in **PBC manufactured by the PLM and SiN** coating technologies.
- The computation of photon emission spectra from **10 GeV electrons and positrons in single macroscopically large Si and diamond** has been carried out.
- Theoretical and computational **characterization of the CLSs** has been carried out for electrons and positrons of different energies (the sub-GeV range available **at the MAMI** facility, and 10 GeV available at **SLAC / DESY / CERN**) in single diamond and silicon crystals.
- The above simulations have been performed using an atomistic molecular dynamics approach within **MBN Explorer and MBN Studio software** developed by the MBN RC.

The progress achieved provides the valuable information for the further related experimental and technological development in the field and the practical realisation of the corresponding CLSs.

Main goals of the TECHNO-CLS project:
Research and Technological Objectives (RTOs)

MBN Research Center

RTO 2 & 3: *Development, approbation and validation of different technologies for fabrication of high-quality bent and periodically bent crystalline structures with pre-defined bending parameters*
Characterisation of the lattice quality using non-destructive diffraction techniques and to detect possible structural modifications following particle irradiation;

The **RTO2 & 3** have been addressed within **WP3 & 4**, see reports for WP3 & 4. In these WPs, the following work has been carried out:

- **Manufacturing and experimental characterisation of boron-doped diamond periodically bent crystals** for crystalline undulators have been continued.
- **Experimental characterization of** previously fabricated crystalline samples using novel materials (**Iridium, Tungsten, Silicon Carbide**) for potential application in CLSs has been completed during the 2nd year channeling experiments **at CERN and MAMI**.
- **Analysis of the results on characterization** of **mechanically bent crystals** for applications in CLSs carried out at the **Diamond Light Source UK** has been performed and reported.
- The deposition of **silicon nitride stressor layers on the crystal surfaces** has been performed to realize a **Silicon BC** sample. The method has also been refined via FEM simulations to design a PBC with ON/OFF and COS/LAT geometries. The first ON/OFF sample is under preparation.
- The **Pulse Laser Melting (PLM) technology** has been applied to produce highly strained layers. The ability of this technology to produce BC and PBC has been accesses.
- The **AW technology to produce Si PBCs** has been advanced.
- **An optical interferometry system** has been developed **for the characterisation** of static and dynamic structural deformations and pressures within crystalline materials.
- **A laser Bragg diffraction diagnostic system** to analyse the structure of the acoustically excited crystals and the corresponding realisation of CLSs using this methodology have been developed.
- Utilization of the projection **rocking curve technique** for obtaining a two-dimensional image of a three-dimensional structure of B-doped diamond crystals.
- Measurement of **HRXRD rocking curves of Ge(111) samples** deposited with 6nm Sb and processed with optimized lasered conditions was performed. The measured strain of the layer is in agreement with obtained curvature in a BC test crystal as measured by stylus profilometer.

Main goals of the TECHNO-CLS project:
Research and Technological Objectives (RTOs)

MBN Research Center

RTO 4: *Validation of functionality of the manufactured structures and theoretical predictions through experiments with high-quality beams of ultra-relativistic electrons and positrons, including an authoritative study of the structure sustainability with respect to beam intensity*

The RTO3 has been addressed within WP3, see report for WP3. Within WP3:

- The construction of a beam transport system for a **monochromatic low divergence 600 MeV positron beam** for channeling experiments with the manufactured crystalline samples at the MAMI facility at the Uni-Mainz was completed in December 2023 with first experiments performed in February 2024.
- We have started preparation of **channeling experiments with electrons and positrons in LC, BC and PBC crystals at the CERN Proton Synchrotron East Area** facility providing secondary electrons and positron beams from 1 to 10 GeV.
- **The first experiments at CERN** were performed in August 2023.
- Experimental measurement of channeling and its full characterization for a Si BC geometry with **positron channeling experiments at MAMI**.
- Experimental measurement of **channeling radiation and its full characterization for the SiC and diamond LCs** in channeling experiments **at MAMI** in the context of the practical realisation of CLSs.
- Experimental measurement of **channeling radiation and its full characterization for the W and Ir LCs** in channeling experiments **at CERN PS** in the context of the practical realisation of CLSs.

These will be important steps towards the design and practical realisation of CLSs.

Main goals of the TECHNO-CLS project:
Research and Technological Objectives (RTOs)

MBN Research Center

RTO 5: *Explicit experimental characterization of the emission spectra and evaluation of the brilliance of the manufactured CLSs using a series of EU based accelerator facilities;*
The RTO 5 have been addressed within WP2 and WP4, see reports for WP2 & 4. In these WPs:

- The theoretical work for the RT05 has been conducted within WP2. The photon emission spectra from **silicon and diamond LCs** for 855 MeV and 10 GeV electron, and 600MeV and 10 GeV positron beams were simulated and the brilliance of the corresponding CLSs was evaluated. It was demonstrated that **the brilliance, as well as the photon flux achievable** in the aforementioned CLSs **can be made much higher than** those in modern operating and newly constructed facilities of gamma ray light sources based **on the Compton scattering effect**.
- The characterisation of the photon emission spectra for **20 GeV positrons in AW excited Si PBC** has been started.
- Initial **experimental characterization** of the **photon emission spectra and the brilliance** of the **SiC** and diamond LCs gamma ray light source **at the MAMI facility** has been carried out.
- **Measurement of radiation spectra** for dense crystals such as **iridium and tungsten LCs** on PS extracted beam lines of **East Area of CERN**.

Experimental work on RTO5 for the selected crystalline samples produced was successfully completed during the second year of the project.

Main goals of the TECHNO-CLS project:
Research and Technological Objectives (RTOs)

MBN Research Center

RTO 6: *Establishing the technological standards for manufacturing, characterisation and exploitation of the novel CLSs on the basis of the developed operational prototypes of CLS*

The RTO6 have been addressed within WP2, WP3 and WP4, see reports for WP2, 3 & 4 and the work carried out for the RTO5. In these WPs the following work has been carried out:

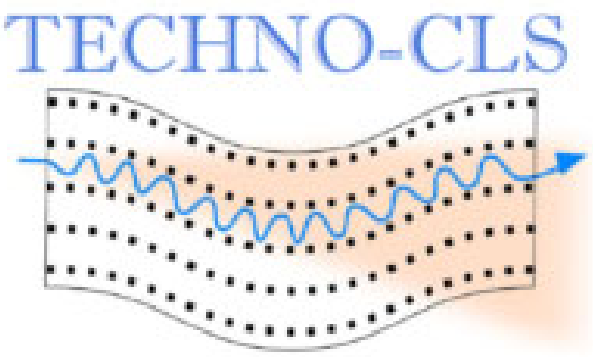
- Defining the **technological standards for manufacturing Si and Ge crystals** for LC, BC & CU CLSs;
- Defining the **technological standards for manufacturing Boron-doped diamond crystals** for Cus;
- Exploration of **new crystalline materials (Iridium, Tungsten, Silicon Carbide**) for applications in LC, BC and CU CLSs;
- Defining the **technological standards for manufacturing Sb-Ge (110) and Sb-Ge(111) crystals** by means of PLM method for applications in LC, BC and CU CLSs;
- Defining the **technological standards for novel schemes of** creating and characterisation of periodically bent crystals with parameters desired for CU **CLSs by means of crystal excitation with acoustic waves**;
- Defining the **technological standards for** creating and characterisation of periodically bent crystals with parameters desired for CU CLSs by means deposition or growth of **thin tensile silicon nitride films on silicon;**
- Theoretical, computational and experimental characterisation of **the CLS prototypes** realised with the aforementioned crystals and related technologies.

Successful continuation of the work **on RTO6** carried out during the 1st and the 2nd year of the project will establish the **technological standards for manufacturing, characterisation and exploitation of the novel CLSs**.

MBN Research Center

Conclusion:

- Significant progress towards the main R&D objectives has been achieved during the 2nd year of the TECHNO-CLS project.
- Successful continuation of the work conducted during the 2nd year will establish the technological standards for manufacturing, characterisation and exploitation of the novel CLSs on the basis of the developed technologies, methods and operational prototypes of CLSs.



Main goals of the TECHNO-CLS project:
Communication, Dissemination and Exploitation

MBN Research Center

Objectives:

- *Publish original and world leading articles in high impact journals. This will influence the direction of scientific research and future trends in the field of CLSs.*
- *Coordinate knowledge transfer between the academic and industrial TECHNO-CLS partners in the experimental, technological, theoretical and computational areas covered by this project or linked to it.*
- *Increase the awareness of the TECHNO-CLS related experimental, technological and computational methodologies amongst relevant industrial companies, public and policy makers*.

TECHNO-CLS consolidates the knowledge of the teams with various and complementary fields of expertise. It facilitates the joint research, needed for successful realization of the project and makes the necessary efforts towards Communication, Dissemination and Exploitation of the TECHNO-CLS R&D results.

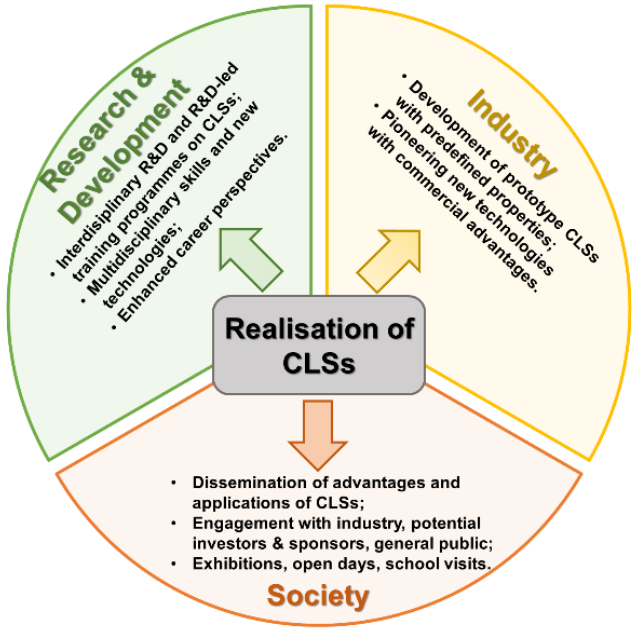
These objectives have been addressed within WP5, see report for WP5.

Main goals of the TECHNO-CLS project:

MBN Research Center

Expected Impact

The TECHNO-CLS project creates a pan-European, multi-disciplinary collaboration bringing together the private and public sectors, academic and non-academic researchers in a unique partnership to deliver a coherent innovative R&D programme delivering the science-towards-technology breakthrough necessary for the design and practical realisation of novel gamma-ray CLSs.



CLSs have the potential to become the new synchrotrons and lasers of the mid to late 21st century, stimulating many applications in basic sciences, technology and medicine. The development of CLS will therefore herald a new age in physics, chemistry and biology

The expected impacts of the project can be discussed within the context of three main sectors: (i) R&D, (ii) Industry, and (iii) Society

Impact: R&D

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The TECHNO-CLS Consortium will develop:

- *prototypes of the next generation CLSs operating in the γ–range,*
- *technologies for manufacturing crystals with desired properties,*
- *technological design and experimental characterisation of the novel CLSs,*
- *a unique software package for numerical modelling of CLSs and related phenomena.*

Theoretical and experimental research developments and technological advances in these directions have been performed within WP2- WP4 according to the original plan (see above slides and presentations devoted to these WPs).

All of these advances will result in high impact scientific publications many of which will be led by early career researchers (ECRs) supported by the project. These ECRs will also form the seed corn for future CLS research programmes providing the skilled workforce needed by industry (and academia) to exploit CLS technology and its application.

Impact: Industry

MBN Research Center

TECHNO-CLS brings together academia and industry *to develop and commercialize CLS technology.*

The fabrication of high quality BCs and PBCs *is an essential part of the technology required to create CLS that deliver high intensity CUR. Thus TECHNO-CLS will also develop strong links with those companies and facilities necessary to fabricate such crystals. The commercial advantages of developing such crystals and perfecting the methodologies for such fabrication provides another commercial opportunity which may be exploited by companies.*

The simulation tools *developed by TECHNO-CLS are also commercially valuable and will add to the portfolio of MBN-RC who can commercialise them for both academic and industrial markets.*

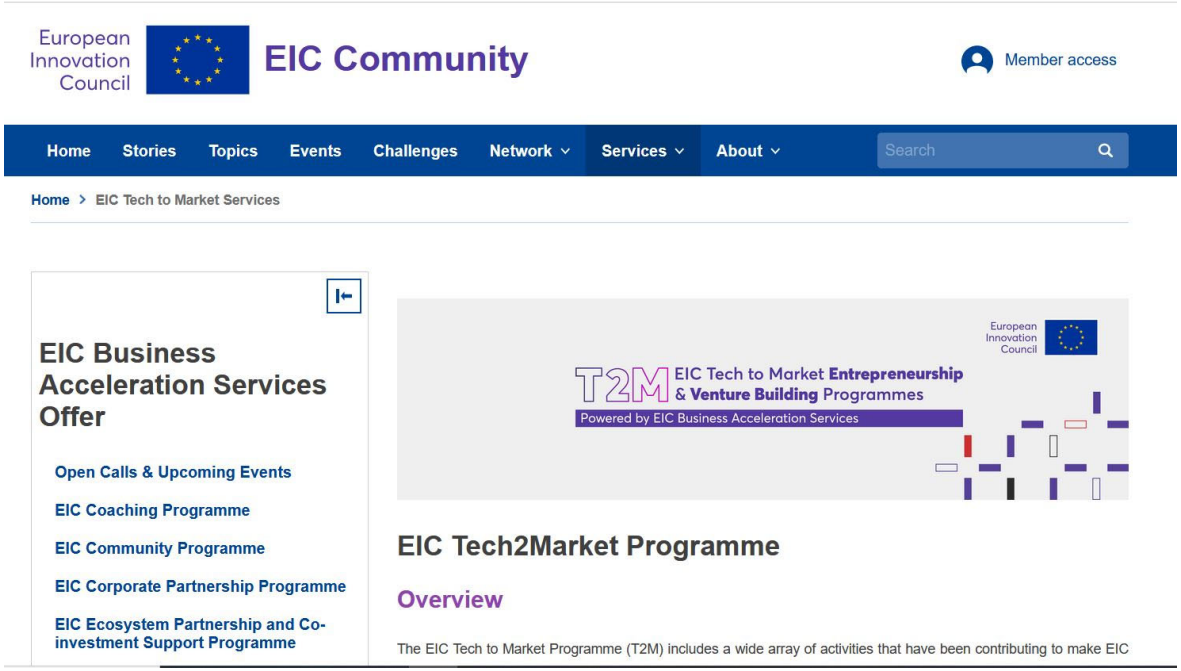
During the second reporting period, the following activities relevant to industry and contributing to the commercialization of project results have been performed:

- Representatives of the **Companies**, potentially interested in the development of the CLS were invited to the **TECHNO-CLS Workshop,** organised by UNIFE and INFN teams in **October 5-6, 2023 in Ferrara**, Italy.
- A second meeting with these and other stakeholders is planed at the TECHNO-CLS workshop to be held in **Rethymno, Crete in October 9-11, 2024** (organized by the HMU team)
- The first year's progress report identified and described 8 innovations raised in the frame of the TECHNO-CLS Project. At least two of them were recognized by the EC's Innovation Radar as having very high Market Creation Potential and the Market Maturity of the Innovation as Exploring or Business Ready. In the second year of the project, we continued to work on these innovations and tried to bring them to the market. One new innovation was added to the TECHNO-CLS innovation portfolio and described in the **Innovation Radar Questionary**.
- For the innovation "Universal and powerful tool for computational modelling of crystal-based light sources" we requested "The Horizon Results Booster Service" (Go-to-Market Support, G2M).

Impact: Industry

MBN Research Center

- The other platform we used for knowledge dissemination and exploitation was the EIC Community platform..



Our interaction with these services highlighted the need to develop a business plan for each of the innovations seeking to advance towards the market. This indicates that the work of the business developer is needed at this stage of the project, which reaches the development of the CLS prototypes, to develop our ideas and innovations for the market.
Therefore, it is absolutely necessary for a successful market entry to receive a support in the form of the Booster Grant, which is intended for this type of activity. We would like to ask our PO to support us with this grant application

Impact:
Potential impact of this research for society/economy

MBN Research Center

Construction of powerful and tuneable CLSs *operating in the γ-ray range is of a great interest and importance for society since these* ***devices provide a broad range of exciting potential applications across a range of disciplines****. CLSs could be used for disposing of nuclear waste, as a tool for nuclear medicine, providing new imaging techniques, enhancing production of rare isotopes, initiating photo-induced nuclear reactions, non-destructive imaging of molecular systems (proteins, viruses, nanodevices).*

The greatest social impact of the TECHNO-CLS project is expected at **the stage when the the new CLSs will be built**. The following society related activities took place during the current reporting period:

- ***Training schools, tutorials, demonstrations:***
  - **The Summer School** on theoretical and computational methods for studying irradiation-driven physics and chemistry processes, took place in Bad Bertrich, Germany, during August 7-10, 2023. The 4-day school aimed to train young researchers in theoretical and computational methods for studying irradiation-driven physics and chemistry processes involving complex molecular, nanoparticle, and condensed matter systems. The practical part of the school was based on the utilization of the MBN Explorer and MBN Studio software packages.
- ***Use of social media*****:** TECHNO-CLS LinkedIn and Twitter (X) pages have been created for the dissemination of activities and results (for details see WP5).
- ***Public Engagement*****:**
  - **Public video** is available on the TECHNO CLS portal.
  - Participation of the TECHNO CLS partners in **The European Researchers' Night** and at **Natural Sciences Festival**

Outline

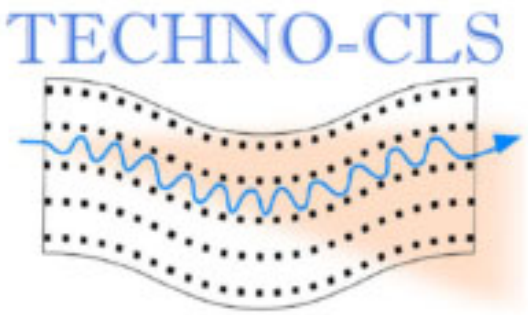
MBN Research Center

Part I

- Overview of advances in Research and Technology: WP2, WP3 and WP4
- Overview of Dissemination and Outreach strategy: WP5
- Impact

Part II

- **WP1: Management and Coordination**
- **Deliverables**



WP1: Management and coordination

MBN Research Center

The TECHNO-CLS Management comprises the following components:

- Overall management of the joint activities of TECHNO-CLS;
- Developing a Roadmap for the design, construction and characterization of CLS and the subsequent commercial development and adoption across the sector.
- Communication between partners and with the European Commission services and coordinating all reporting required under the contract;
- Overseeing science and society issues related to the scientific and technological objectives of the network
- Co-ordination of the knowledge management activities;
- Activities linked to consortium-level financial and accounting management and legal issues

WP1: Management and coordination

MBN Research Center

The TECHNO-CLS Management Tasks:

T1.1 Recruitment of the Project Manager
T1.2 Preparation of the Consortium Agreement
T1.3 Organisation of TECHNO-CLS Kick-off meeting and establishing the Management Board
T1.4 Preparation of Data Management Plan (DMP) and Plan for Dissemination and Exploitation (PDE)
T1.5 Establishing risk register
T1.6 Development of a Roadmap for the design, construction and characterization of CLS and the subsequent commercial development.
T1.7 Creation of the CLS DB
T1.8 Coordinate annual scientific meetings;
T1.9 EC reporting: prepare and submit required project reports to EC
T1.10 Financial management

The **first 3 out of 10** Tasks planed for the WP1 in the Annex I in the GA have been completed during the first year.

The tasks **T1.4, T1.5 and T1.6** were addressed within the second reporting period and will require regular monitoring and update during the entire duration of the project: the current versions of documents (DMP, PDE and the risk register) related to T1.4, T1.5 and T1.6 are available in the restricted area of the TECHNO-CLS portal. Monitoring of these tasks, their evaluation, discussion and update are conducted at the regular TECHNO-CLS Consortium coordination meetings.

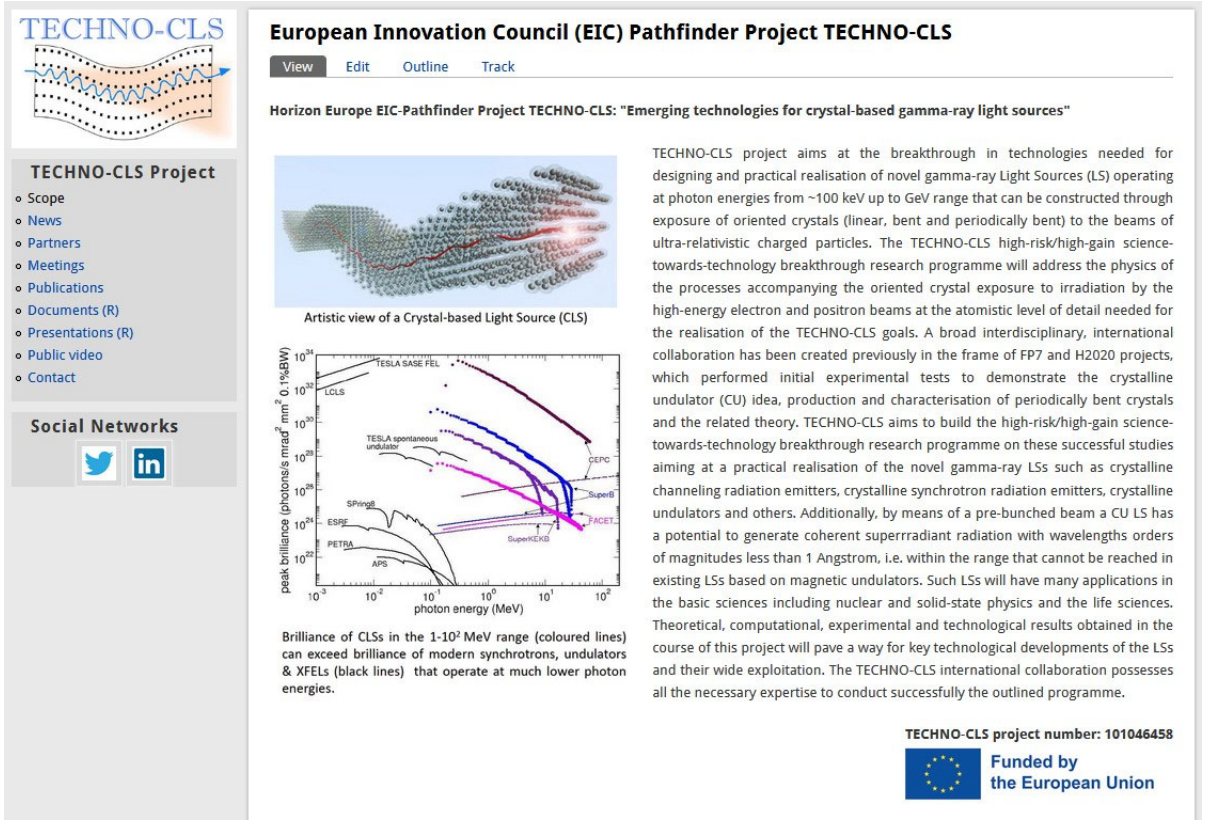
Task **T1.7** has not yet been addressed as it is scheduled for the third year of the project, although some preparatory discussions on the elaboration of the CLS DB concept and the collection of the necessary data have been initiated

WP1: Management and coordination

MBN Research Center

Project website: http://www.mbnresearch.com/TECHNO-CLS/main

A web portal was developed by MBN-RC with the following functionalities:
Public area accessible for every visitor of the website. There one can find the information about the project Scope, read about TECHNO-CLS News, Partners, Meetings, Publications, and find the Contact information



WP1: Management and coordination

MBN Research Center

Project website: http://www.mbnresearch.com/TECHNO-CLS/main

Restricted-area accessible only for the members of the TECHNO-CLS consortium. It can be accessed only by the members granted with username and password. This area is designed for managing various TECHNO-CLS consortium related issues, such as: storage of internal documents (e.g. DMP, PDE and the risk register), copies of presentations and other TECHNO-CLS related materials (e.g. rolling working plans for each team covering each reporting period, list of TECHNO-CLS related companies, list of suitable nowadays accelerator facilities, schedule for the planned experiments, list of crystals available in the TECHNO-CLS consortium and newly designed ones, list of available and new developed technologies for manufacturing crystals suitable for application in CLSs, list of prototypes of CLSs designed by the TECHNO-CLS Consortium).

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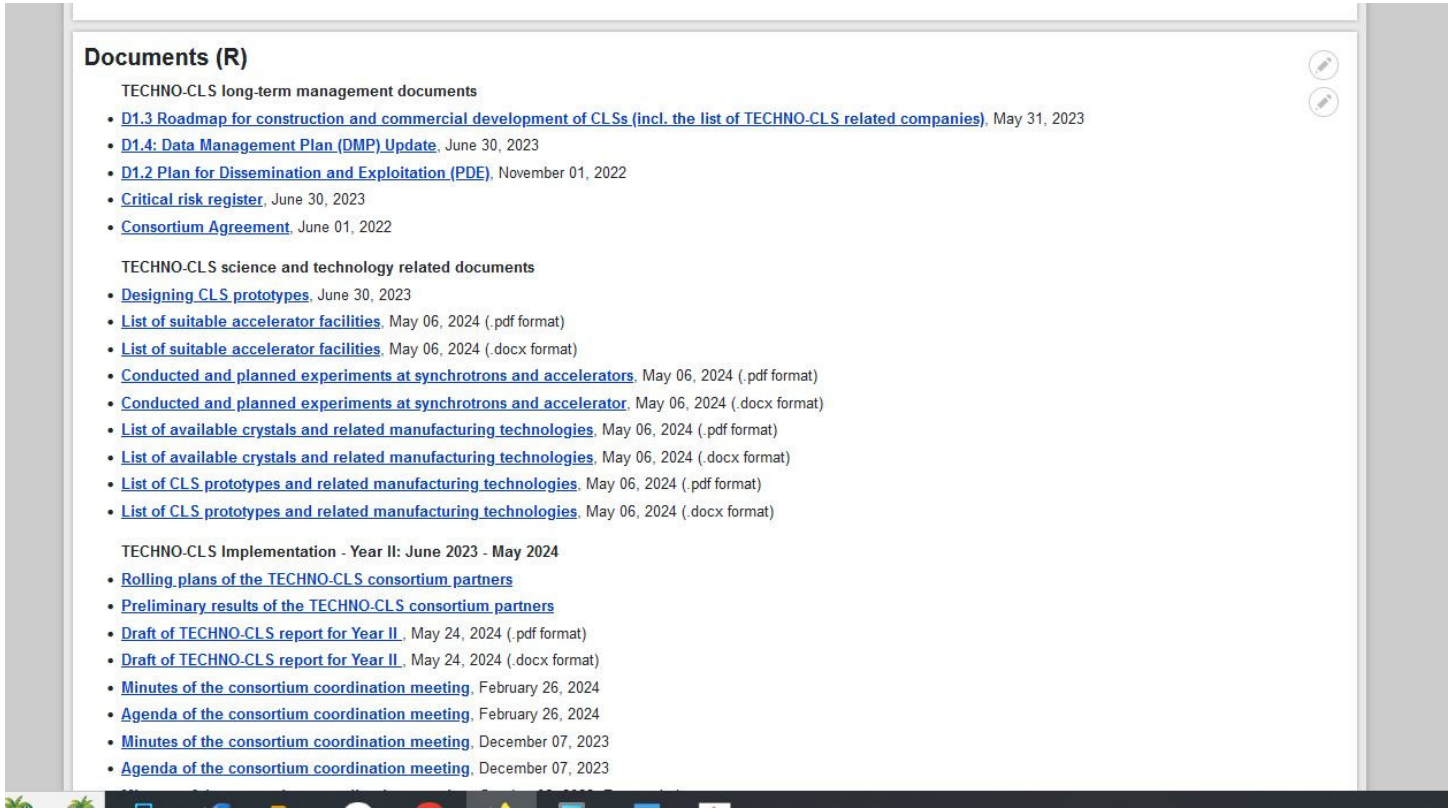


WP1: Management and coordination:

the work on tasks T1.8- T1.10

MBN Research Center

T1.8 Coordinate annual scientific meetings

Regular on-line meetings have been held for discussions on: (i) coordination activities of all the teams within the consortium; (ii) review of research of each partner advances, (iii) planning of joint research activities involving staff from different partners and (iii) decision making across the project.

A list of management, coordination and general meetings

Date	Title/ subject of meeting	Location
29.06.2023	Coordination consortium meeting	on-line
04.07.2023	Intergroup meeting	on-line
12.07.2023	TECHNO-CLS project review meeting	on-line
04.09.2023	Coordination consortium meeting	on-line
28.09.2023	Intergroup meeting	on-line
5- 6.10.2023	TECHNO-CLS Workshop	Ferrara, Italy
07.12.2023	Coordination consortium meeting	on-line
14.02.2024	Intergroup meeting on crystal manufacturing and characterisation	on-line
26.02.2024	Coordination consortium meeting	on-line
09.04.2024	TECHNO-CLS Workshop	Tbilisi, Georgia
23.04.2024	Intergroup meeting	on-line
09.05.2024	Coordination consortium meeting	on-line

WP1: Management and coordination

the work on tasks T1.8- T1.10

MBN Research Center

TECHNO-CLS workshop on October 5-6, 2023 in Ferrara

Participants of the TECHNO-CLS workshop on October 5-6, 2023 in Ferrara

All the documents (meeting agendas, presentations, reports, etc.) related to T1.8 have been collected and placed in the restricted area of the TECHNO-CLS portal

WP1: Management and coordination:

the work on tasks T1.8- T1.10

MBN Research Center

T1.9 *EC reporting: prepare and submit required project reports to EC;*

The second annual report was prepared under the co-ordination of the MBN-RC. The recommendations and the responses to the recommendations are addressed in Section 2 of this report, p. 81.

In the second year of the project, we continued to work on the innovations and tried to bring them to the market. One new innovation was added to the TECHNO-CLS innovation portfolio and described in the Innovation Radar Questionnaire.

In this respect, the coordinator has identified the bottleneck for the future commercial development of the project. The project could benefit from a more systematic approach to business development. For this purpose, we need a person with the appropriate expertise and experience. Therefore, we would like to ask the PO to nominate the TECHNO-CLS project for the EIC Booster Grant application. The Booster Grant will be used to appoint the Business Development Officer for the project.

T1.10 The financial management of the project was continued in the second year.

Project management: deliverables and reporting

MBN Research Center

Deliverables submitted:

Deliverable/ Milestone No	Deliverable/ Milestone Name	Lead Beneficiary	Planned (in months)	Achieved (in months)
D4.1	BCs and PBCs manufactured via surface modifications and mechanical bending	INFN	24	24
D3.1	Set of best crystalline samples selected after characterization	UNIFE	24	24
D2.1	Description of the Crystal-based gamma-ray Light Sources Database	MBN-RC	24	24
D5.2	Videos detailing the aims and objectives of TECHNO-CLS	UoK	16	12
D1.6	DMP-update	MBN-RC	25	24
D1.7	Technical/scientific review meeting documents	MBN-RC	25	24

Project reporting: not only deliverables

MBN Research Center

Prepared and submitted:

- Completed Innovation Radar Questionary, which include 9 Innovations potentially interesting for the companies with the descriptions;
- Summarised Project “Results” as a table with description of result’s potential (in portal)

To be submitted after the meeting:

- Financial statements

EIC Pathfinder is the beginning

MBN Research Center

Get funding & investment

EIC Pathfinder

Support to research teams to research or develop an emerging breakthrough technology

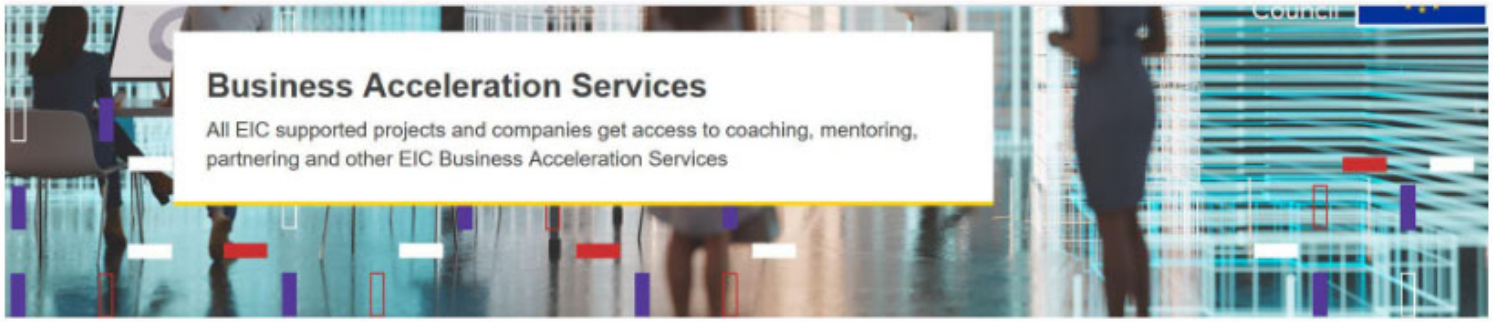
EIC Transition

Building on promising research results to demonstrate and mature the technology and develop business plans for specific applications

EIC Accelerator

Funding and investments through the EIC Fund for individual start-ups and small companies to develop and scale up game changing innovations

EIC Pathfinder is the beginning



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- Business Acceleration Services
- Tech to Market
- Who can benefit and what services are offered?
- EIC Community platform
- Access to coaches, mentors, expertise and training

Related pages: EIC Community Platform | EIC overseas Trade Fairs Programme 2.0 | EIC Women Leadership Programme | Tech to Market Services (T2M BAS) | Coaching under the EIC | EIC Greenhouse Gas Programme | Ecosystem Partnerships and Co-Investment Support | EIC Scale Up 100

Business Acceleration Services

Under Horizon Europe, the EIC support goes far beyond funding and it aims at accelerating EIC innovations and growth of top deep tech companies. In order to further leverage the EIC investments, as EIC funded researcher, innovator or entrepreneur you will be provided with access to a range of tailor-made **EIC Business Acceleration Services (BAS)** at any stage of development

Tech to Market to help researchers and innovators from projects funded under EIC Pathfinder and Transition funding schemes in transition from lab to market

EIC Community platform

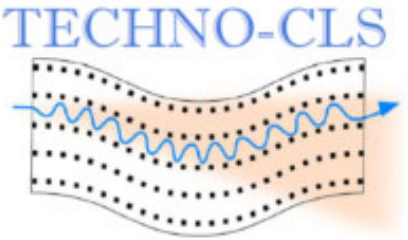
access to coaches, mentors, expertise and training

access to global partners (leading corporates, investors, procurers, distributors, clients)

Conclusions

MBN Research Center

- TECNO-CLS project runs according to the original plan;
- Consortium demonstrated strong research collaboration between its members;
- Consortium showed itself as a strong team capable to mitigate unexpected newly arising risks;
- Consortium has successfully progressed with implementation of the project research plan, dissemination and exploitation of the research results;
- Consortium will take efforts on the TECHNO-CLS development towards EIC Transition in the future;
- TECHNO-CLS has been registered to the EIC Community platform;
- Consortium needs coaching via Business Acceleration Services;
- For TECHNO-CLS business development additional financing support via **EIC Booster grants** would be desirable.



Emerging technologies for crystal-based gamma-ray light sources

- Acknowledgements to TECHNO-CLS Partners:

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- Thank you for your attention!

Thank you for your attention !