Innovation and industry programmes: report from WP14

May 2, 2022

Marcello Losasso – CERN

ARIES is co-funded by the European Commission Grant Agreement number 73087

WP14: THANKS to industries and labs (equally represented)

Industries in WP14 are 50% of the total of ARIES industrial partners

The Objectives and Tasks of the WP14

Evaluate, assess and develop technology inside ARIES with the final aim to provide society with identified commercial applications of the supported research potential.

This is done via:

- implementing PoC for innovative actions
- Implementing research projects in industries
- increasing synergies in consortium between laboratories, industries, universities, applied research institutes

	Tasks
14.2	Proof-of-Concept innovation fund
14.3	Collaboration with industry
14.4	Industries for resistant materials
14.5	HTS cable development for accelerators magnets
14.6	Accelerator Timing System

Deliverables for WP14

Deliverables				
D14.1	Set-up of PoC innovation funding scheme	14.2	M12	**23/04/2018**
D14.2	Academia meets industry /1&2	14.3	M24/M36	**09/05/2019**
D14.3	Production of material samples of C-based and metal-diamond composites	14.4	M24	**30/10.2018**
D14.4	1st long length of industrial HTS	14.5	M30	**31/10/2019**
D14.5	Real-time event distribution network brought to openly accessible product grade level	14.6	M50	**20/05/2021**

Milestones for WP14

Milestones				
MS42	Appointing of an Industrial Advisory Board, (IAB)	14.3	M12	09/04/2018
MS47	Reviewed requirements document	14.6	M12	18/04/2018
MS45	First HTS Short Length produce via new process	14.5	M14	13/06/2018
MS43	1st academia-meets-industry event	14.3	M24	30/04/2019
MS44	2nd academia-meets-industry event	14.3	M36	27/07/2021

MS42: Set-up of Industry Advisory Board

The IAB, as foreseen in the GA and CA, is the body mandated for advising the ARIES Project Coordinator on matters relating with industrial collaborations and to support the managing of the PoC fund;

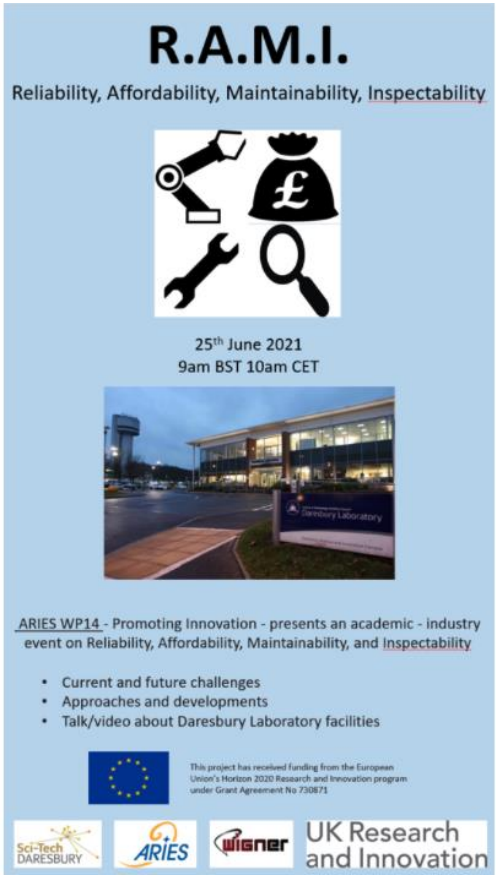
IAB COMPOSITION
object of MS42

Jean-Luc Lancelot (France, SigmaPhi)
Julio Lucas (Spain, Elytt),
John Allen (UK, Elekta),
Tomas Eriksson (Sweden, GE),
Michael Peiniger (Germany, Research Instruments)

One of the tasks of the IAB was to act as Evaluation Committee of the PoC of the ARIES project.

MS43 & MS44 – academy-meets-industry events:

https://indico.cern.ch/event/775278/



https://indico.cern.ch/event/1048728/

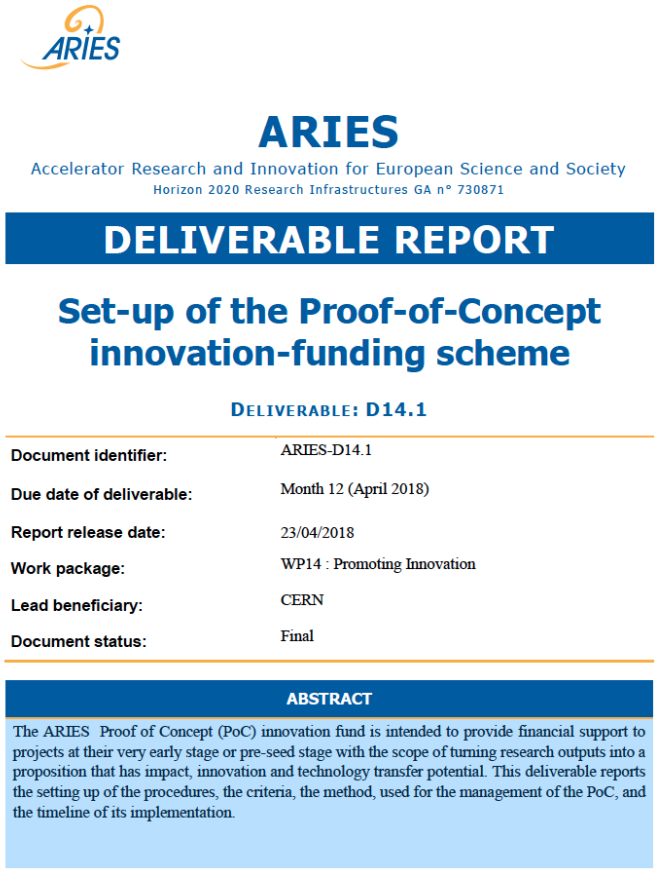
D14.1: Set-up of Proof-of-Concept innovation-funding scheme

WP14 tasked to identify and support testing and validation of 4-6 key technologies with potential for market applications, at the level of 40-60 k€ each: **motivation for a PoC** PoC as first-of-a-kind within a H2020 projects

General aim of PoC is:

- Increase the level of innovation and TT from accelerator science, increase the impact of research, concepts & technology arising from ARIES.

- To pre-industrialise complex components of particle accelerators and demonstrating to industry the possibility to invest and engage with a target to commercialization, minimizing risks associated with innovation for SMEs.



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Accelerator Research and Innovation for European Science and Society

Horizon 2020 Research Infrastructures GA n° 730871

DELIVERABLE REPORT

Set-up of the Proof-of-Concept innovation-funding scheme

DELIVERABLE: D14.1

Document identifier:	ARIES-D14.1
Due date of deliverable:	Month 12 (April 2018)
Report release date:	23/04/2018
Work package:	WP14 : Promoting Innovation
Lead beneficiary:	CERN
Document status:	Final

ABSTRACT

The ARIES Proof of Concept (PoC) innovation fund is intended to provide financial support to projects at their very early stage or pre-seed stage with the scope of turning research outputs into a proposition that has impact, innovation and technology transfer potential. This deliverable reports the setting up of the procedures, the criteria, the method, used for the management of the PoC, and the timeline of its implementation.

https://edms.cern.ch/document/1818311/1.0

Overview - Method and Procedures
How to apply - Timeline

D14.1: Set-up of Proof-of-Concept innovation-funding scheme

PoC Fund in ARIES is a tool helping to **bridge the gap between research infrastructures and marketable innovation**, providing incentive to the beneficiaries to get actively involved in TT activities.

PoC was a first-of-a-kind such implementation within a H2020 projects,

PoC ambition is:

- i) To develop and use incentives for academic research groups to collaborate with SMEs and larger industries
- ii) To advance the technology readiness levels in order to enable the uptake and exploitation of specific technologies developed in ARIES by the industrial participants in the project or other industrial partners.

Projects awarded

https://indico.cern.ch/event/1008814/contributions/

- Atomic Layer Deposition: innovative approach for next generation particle accelerators – CEA -Dr. T. Proslier
- Accelerator Diagnostics using innovative Adaptive Optics (InnoAdo) - University of Liverpool - Prof. C. P. Welsch
- Development of hybrid electron accelerator system for the treatment of marine diesel exhaust gases - RTU - Prof. T. TORIMS
- Investigation of new methods for the manufacturing of Cu-C composites with tailored thermo-physical properties - RHP Technology GmbH – SME - Dr E. Neubauer

some takeaways from PoC exercise:

- *The PoC helped* deploying resources in short amount of time. It provided money and more general support (networks, visibility, competences and know-how from cross-cutting domains) to innovative projects

- There have been identified and prospected commercialization, depending on the specific project, at prototype level. Patents submitted

- PoC has helped to develop collaborative R&D at Eu level, the creation of communities able to set roadmaps. PoC is a way to engage partners for more demanding developments. EC values the possibilities of engaging into R&D industries together with accelerator community

- Reporting considered reasonable, the general scheme considered excellent. But level of effort (money) should be increased. Reporting and monitoring should be increased to check that money is spent in proper way, to identify earlier market possibilities and to steer developments.

- *The process applied, the scheme used, the lesson learned have been a valuable experience for designing the IIF for I-FAST. A document on this was prepared and handed over to PC*

WP14.3 Relation with industry - highlights

- W14.3 aims to increasing synergies between laboratories, universities, specialized institutes and applied research institutes.

  - ✓ Jointly with WP3, TIARA and AMICI, acted *to promote a pilot EC action* to finance a large program of accelerator relevant projects. Meeting organized on Feb 6/7 2018, in Brussels, with participation of industries and EC.

  - ✓ A workshop in CERN, on Dec 1, 2017, organized in cooperation among WP3 and WP14, on *EB application for diesel motor exhaust gas purification*.

  - ✓ A workshop organized with AMICI in CERN, on May 16th 2018, with participation of IPR experts from 4 EU laboratories, to *address the problematic of IPR in collaborations.*

Materials for extreme thermal management applications- Task 14.4 – led by **F.Carra**

Samples produced by industries (**RHP and Brevetti Bizz**) in shapes required by testing devices, and in excess of the deliverable requirements, using advanced techniques: Spark-Plasma-Sintering and Additive Manufacturing

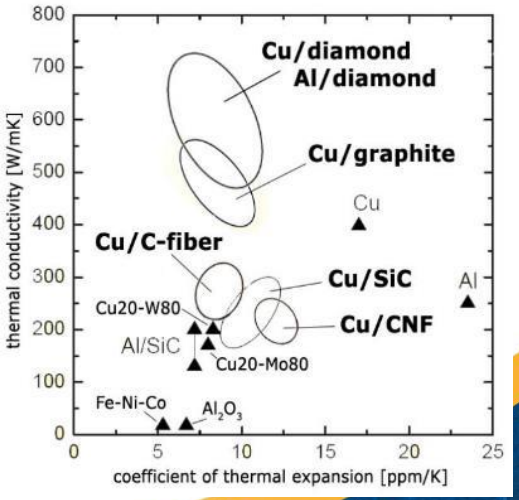
tested in the frame of WP17 activities. CuCD samples were tested in the "Multimat" experiment at the CERN HiRadMat facility under high intensity proton pulses of 440 GeV/c, to acquire their dynamic response.

Multimat experiment was a success:
collected data matches well the results of simulations and will help improving constitutive models for the less known composite materials.

Applications for cooling of electronics or laser components

Potential application for collimators in LHC

F.Carra presented in Nov 2019 status of task activities.



D14.3

Deliverable D14.3 reports activity of the task: the production of samples of composites material carbon-based and metal-diamond

→ materials tailored to achieve high thermal, electrical and mechanical performance, and low density.

Very good collaboration and synergy with WP17

https://edms.cern.ch/document/1818318/1.1

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DELIVERABLE REPORT

Production of material samples of carbon-based composites and metal-diamond composites

DELIVERABLE: D14.3

Document identifier:	ARIES-D14.3
Due date of deliverable:	Month 24 (April 2019)
Report release date:	30/10/2018
Work package:	WP14: Promoting Innovation
Lead beneficiary:	CERN
Document status:	Final

ABSTRACT

The aim of task 14.4 within WP14 is to develop and industrialize materials for extreme thermal management. This is done in collaboration with two industrial partners, RHP (AT) and Brevetti Bizz (IT). The materials produced include composites combining the properties of metals and ceramics with those of carbon allotropes like graphite and diamond. Advanced manufacturing techniques such as spark plasma sintering, additive manufacturing, rapid hot pressing, are adopted. This report documents the production of samples made of ceramic-graphite and copper-diamond, produced for applications in particle beam intercepting devices and luminescence screens. These samples will be tested in the scope of WP17 "PowerMat", at CERN, GSI, PoliMi, PoliTo and other international partners.

AM for MgB_2

- 4 samples of MgB_2 on metal substrate (July 2018) → poor sc properties
- 5 samples of MgB_2 on metal substrate (22 March 2019) → much better results

RHP research has developed in 3 directions:

1 - reduction of MgO content [additive prior to hot-pressing]

2 – optimization of bulk MgB_2 processing [changes in gas pressure in the furnace]

3- granulometry [pulverization of bulk material and spherodisation].

Batch	Sample	Material	IHP Temperature [°C]	Densification [%]	T_c [K]	B * T=4.2 K [T]	B * T=10 K [T]	B * T=20 K [T]
1st	IHP5660-1	MgB_2 C	1300	92,15	26,8	1,45	1,1	0,35
	IHP5660-2	MgB_2 C	1300	92,15	27,6	1,1	0,85	0,25
	IHP5660-3	MgB_2 C	1300	92,15	27,6	0,7	0,5	0
	IHP5660-4	MgB_2 C	1300	92,15	27	0,2	0,1	0
2nd	IHP6007	MgB_2 C ball milled 12h/HM + 50 vol% Mg (45 µm)	900	80,57	34,6	3,65	3,1	1,75
	IHP6030	MgB_2 A	1100	96,84	38,3	5,85	5,05	3,25
	IHP6040	Mg (300 µm) + B (2 µm); 10wt% excess of Mg	640->1000	83,64	34,3	4,2	3,5	1,75
	IHP6042	MgB_2 C ball milled 12h/HM + 50 vol% Mg (45 µm)	1000	95,20	34,6	4,5	3,85	2,2
	IHP6046	MgB_2 A	1000	88,61	38,1	5,75	5,05	3,3
ref 1	reference	BYNARY IMD 2h	850	-	38,8	3,85	3,43	2,27
ref 2	reference	one of the best binary samples	-	-	38,3	6,1	5,2	4,3

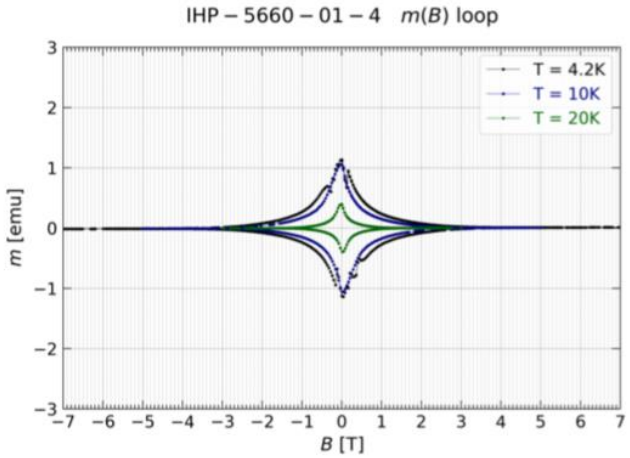
* B at $J_c=10^4$ A/cm^4

Samples produced by RHP were tested by **UNIGE**, and compared with reference high performance sintered powders

WP14.4 - MgB_2 AM

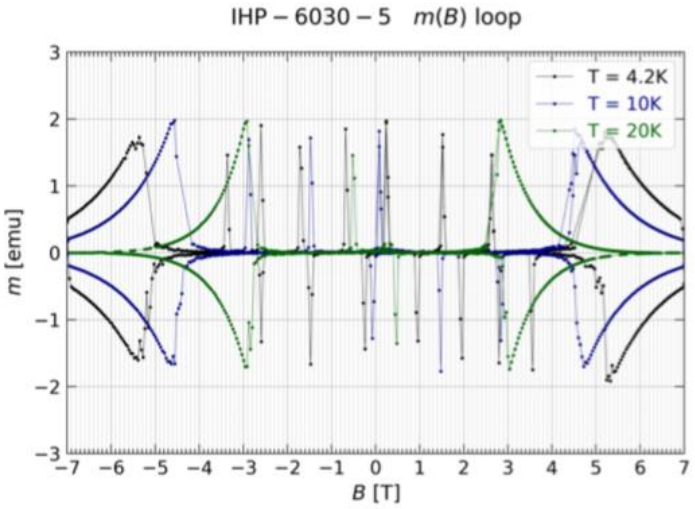
thanks to D.Mattera, C.Senatore (UNIGE)

T_c	27 K
$T_{c\ onset}$	31 K
$B\ (J_c = 10^4 A/cm^2,\ T = 4.2\ K)$	0.20 T
$B\ (J_c = 10^4 A/cm^2,\ T = 10\ K)$	0.10 T
$B\ (J_c = 10^4 A/cm^2,\ T = 20\ K)$	0.00 T



from first batch of samples (October 2018)

T_c	38.3 K
$T_{c\ onset}$	39.2 K
$B\ (J_c = 10^4 A/cm^2,\ T = 4.2\ K)$	5.85 T
$B\ (J_c = 10^4 A/cm^2,\ T = 10\ K)$	5.05 T
$B\ (J_c = 10^4 A/cm^2,\ T = 20\ K)$	3.25 T



to second batch of samples (March 2019)

WP14.5 HTS innovative process for accelerator magnet conductor

Lucio ROSSI – Task Leader

Thibault LECREVISSE – Deputy Task Leader

Alexander USOSKIN – Ulrich BETZ – Industrial Partner

Marc DHALLÉ

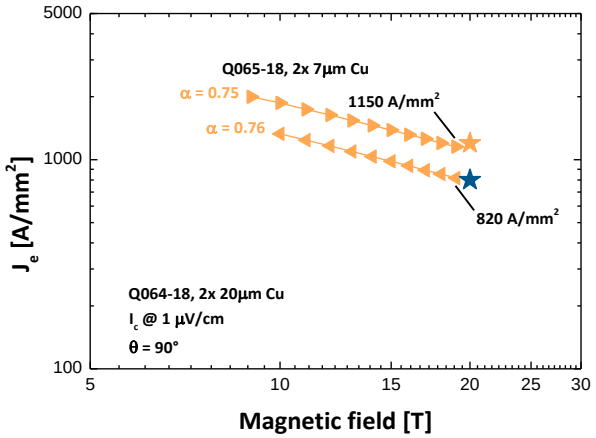
UNIVERSITÉ DE GENÈVE

FACULTÉ DES SCIENCES

Carmine SENATORE

Engineering current density J_e(B,T=4 K) *Performance target*

- ***Objective was to set up a NEW industrial optimized process to produce 450 m of tapes with Increased J_e by a factor 2 wrt EUCARD-2***
  - ***from J_e (4.2 K, 20 T) = 400-600 A/mm²***
  - ***to J_e (4.2 K, 20 T) = 800-1000 A/mm²***



Tape Q065-18 (with 2x 7μm Cu) reached a very high performance of 1150 A/mm² at 4.2 K, 19 T, 90°

- To complete the industrialization process:
- Increase repeatibility and scale the process
- Increase production yield with attempt to produce 100m lenghts with proper current
- Tape bending with 50 μm thickness; problem to be solved in an industrial process.
- The total material put in working was 1000 m but the produced high current lenghts were less than 200 meters.
- Technical results are «easier» than industrialization process.

WP14.5: HTS cable development for accelerators magnets

Activity of the task reported in ***D14.4***
manufacture of HTS coated conductor depositing REBCO (Rare-Earth Barium Copper Oxyde) on a 50 µm thick substrate.
The use of such thin SS tape is an absolute novelty in the panorama of coated conductor.

Bruker HTS GmbH (BHTS) adapted the equipment and the process and obtained tapes with record current density, beyond the ARIES goal.

Unexpected issue (a bi-directional bending) has adversely affected the process that had to be adjusted to mitigate the effect. This caused a reduction of the critical current of 30%, but Jc is still fulfilling the goal of ARIES (> 100 m with > 800A/mm2 at 4.2K, 18 T).

In total 413 m of HTS tape of 12 mm width and 50 µm substrate thickness have been produced.

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DELIVERABLE REPORT

First long length industrial High Temperature Superconductor

DELIVERABLE: D14.4

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Report release date:	01/11/2019
Work package:	WP14: Promoting Innovation
Lead beneficiary:	CERN
Document status:	Final

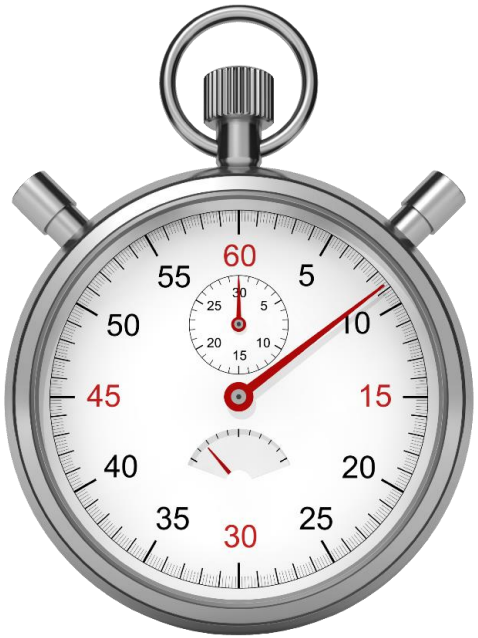
ABSTRACT

In ARIES is foreseen to produce and characterize HTS tapes of REBCO of higher performance with respect to the one developed in EuCARD2. We aim to develop the process to deposit REBCO film on a 50 µm substrate of stainless steel, a novel process never attempted so far. The scope of ARIES program is to increase the world record of engineering critical current density, J_E, obtained in EuCARD2, from 400-600 A/mm^2 at 4.2 K 20 T to 600-1000 A/mm^2. This Deliverable report describes the successful delivery of various long lengths, fulfilling the ARIES goal of obtaining more than 100 meters of length with engineering critical current density above 800 A/mm^2.

https://edms.cern.ch/document/1818319/1.0

WP14.6 : Accelerator Timing System

Task 14.6.–*J.Gutleber* → Industrialization of Realtime Event Distribution Network - REDNet Accelerator Timing System



Central Timing System is a distributed and scalable system for syncronizing the operation of numerous devices distributed across the accelerator (beam diagnostic, power supplies, i/o digital….)

CTS developed based on CERN know-how.

Cosylab and CERN together developed a similar system called RedNET for the project MedAustron.

In the scope of ARIES, REDNet system has been upgraded, customized and supplied to a specific user (ADAM)

WP14.6 : Accelerator Timing System

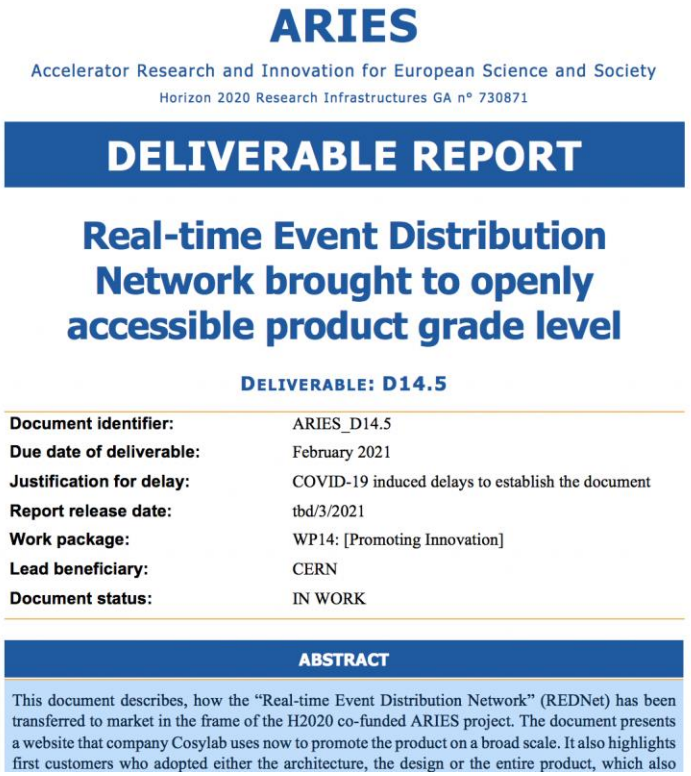
Activity of the task reported in ***D14.5***

product line developed by Cosylab is now marketed by Cosylab under the name **C-MTS**

Work started in **MS47** with the setting-up of the high-level requirements of a generic PA timing system, and definition of how these requirements are managed.
MS48 summarises the high-level architecture of the REDNet ("Realtime Event Distribution Network")

A product originated in the HEP domain, with prospected customers small / medium sized PA for medical and industrial applications

Tangible impact that ARIES project created :
technology has been effectively transferred from physics research in CERN to market as a co-construction process with industry



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DELIVERABLE REPORT

Real-time Event Distribution Network brought to openly accessible product grade level

DELIVERABLE: D14.5

Document identifier:	ARIES_D14.5
Due date of deliverable:	February 2021
Justification for delay:	COVID-19 induced delays to establish the document
Report release date:	tbd/3/2021
Work package:	WP14: [Promoting Innovation]
Lead beneficiary:	CERN
Document status:	IN WORK

ABSTRACT

This document describes, how the "Real-time Event Distribution Network" (REDNet) has been transferred to market in the frame of the H2020 co-funded ARIES project. The document presents a website that company Cosylab uses now to promote the product on a broad scale. It also highlights first customers who adopted either the architecture, the design or the entire product, which also

A content page added to the website of cosylab to promote the product and to present results of the action in the frame of ARIES

https://www.cosylab.com/main-timing-system/

Conclusion

- WP14 has timely and successfully delivered. However COVID -> put-off some of the activities
- PoC demonstrated to be a valid tool for fostering innovation, engaging industries, and convincing EC
- PoC exercise needs scaling
- Activity in WP14 has set important basis for I-FAST
- Industries leading specific actions were embedded in the WP14 plan of work
- Remarkable results from industrial developments