This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 730871.

Innovation and Industry Programmes: Report from WP14

ARIES Annual Meeting -

- April 21st , 2021

- Marcello Losasso, CERN

-

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
- increasing synergies between laboratories, industries, universities, applied research institutes in the consortium
- Implementing research projects in industries

	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	

D14.5 is already drafted and reviewed by the TL and will be submitted soon.

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	

Date to be set soon for 2nd AMI event

Implementing Proof of Concept fund for innovative actions

- Sept 2017 → STC approves ***D14.1*****,** stating criteria and management of PoC, including method for project selection
- End of 2017 → PoC dedicated web site is made public - the call is open, end is March 2018
- May 2018 – Assessment and Evaluation report finalized for the 10 proposals presented.
- June 2018 – STC invites to CERN first 4 projects to present their proposals. Projects received formal awarding on June 15th.
- August 2018 - Project Coordinator notified winners about administrative procedures.

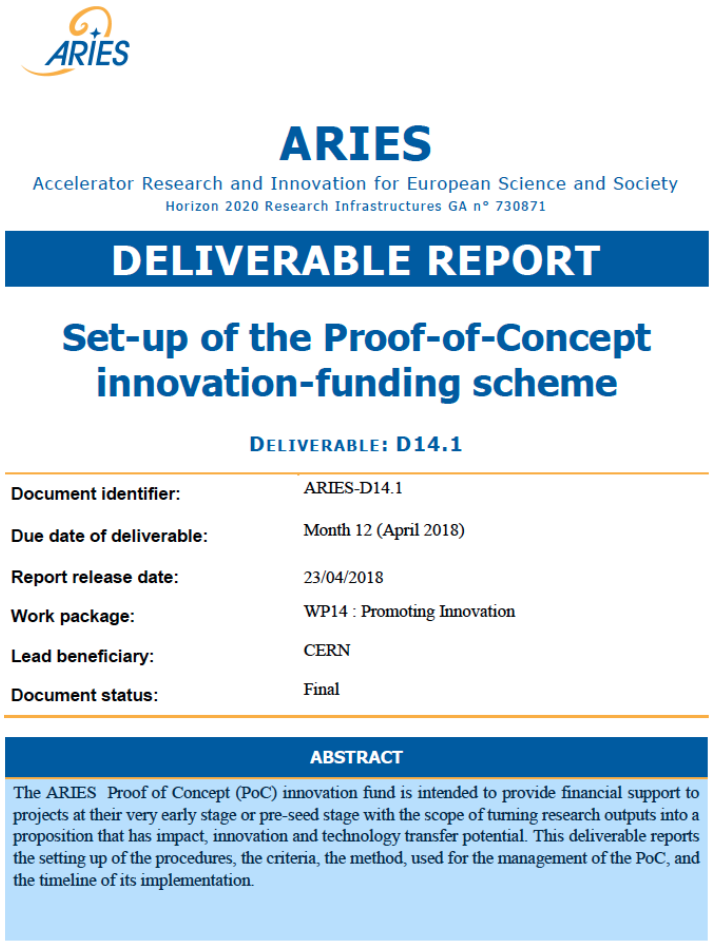
April 2021 – at this AM the Final Reports from Projects

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

General aim of PoC is:

- Increase the level of innovation and Technology Transfer from accelerator science.
- To increase the impact of research, concepts & technology arising from ARIES.
- To minimise risks associated with innovation for small-medium enterprises (SMEs).

Overview
Method and Procedures
How to apply
Timeline



ARIES

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

MS42: Set-up of IAB

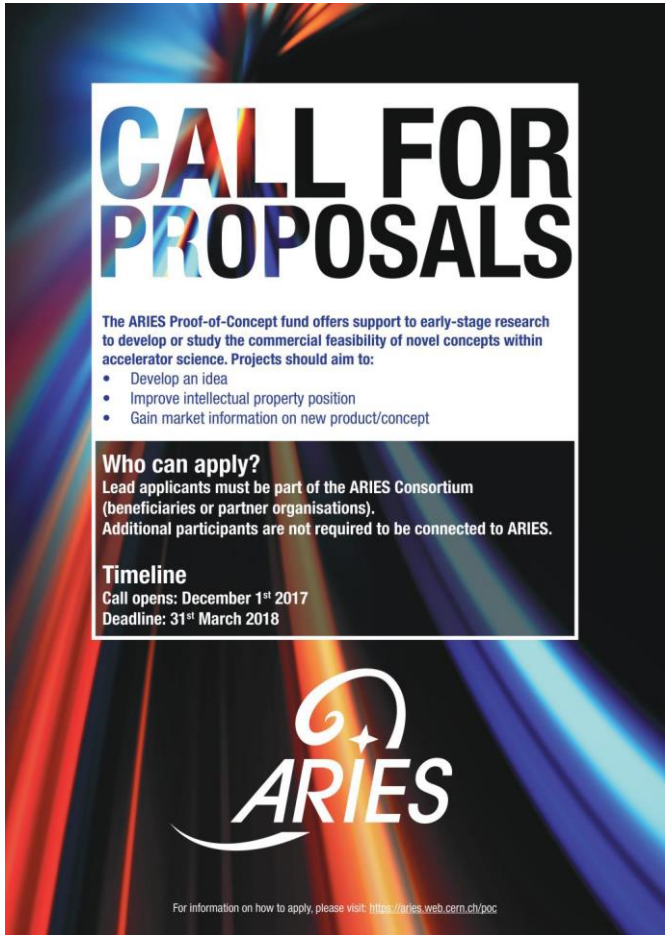
The IAB, as foreseen in the GA and CA, is the body mandated for advising the ARIES Project Coordinator on matters relating with industrial collaborations and for the managing of the Proof-of-Concept fund;

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)

The Industrial Advisory Board (IAB) is appointed with the mandate to assist and support the decisions taken in the framework of PoC management,
One of the tasks of the IAB was to act as Evaluation Committee of the PoC of the ARIES project.

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



Projects awarded

- 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:

- PoC helps and supports the deployment of resources from labs and industries. In some cases paying for students and researchers.
- PoC is a way to engage partners for more demanding developments
- Follows-up mechanism to be tuned.

- *The process applied, the scheme used, the lesson learned are valuable experience for use to I-FAST .*
- *I prepared and handed over a document on this to PC*

WP14.3 highlights

- W14.3 (Relation with industry) 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.*

  - ✓ An industry-academia event organized in Budapest, on March 8th 2019, with participation of about 40 experts from EU laboratories and industries on *Additive Manufacturing and PA* The list of all the presentations and materials can be accessed via open access at the link *https://indico.cern.ch/event/775278/overview*

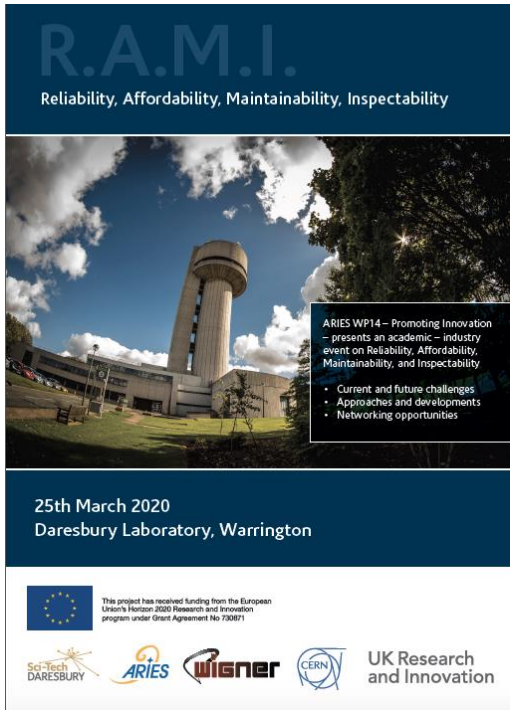
  - ✓ An industry-academia event to be held in Daresbury in April 2020, on *RAMI for accelerator,* had to be rescheduled due to COVID. It will happen on July 2021 and it will be virtual.

Co-organized by CERN and STFC

https://indico.cern.ch/event/850946/

TENTATIVE AGENDA

- Boris Militsyn – STFC/ASTeC & Cockcroft Institute – impact of RAMI issues on Radiotherapy Treatment linac operating in developing countries.
- Roger Webb – Experience of the Ion Beam Centre at the University of Surrey for RAMI: Application of a QA programme and Automation.
- Stefano La Rovere – NIER Ingegneria SpA –RAMI requirements for nuclear systems and possible interests for accelerators.
- Chris Bailey — Experience of Diamond Light Source for RAMI.
- Thomas Herzig – University of Stuttgart – Methodology and analysis of reliability for complex systems, and the example of accelerators.
- Ed Snyder – Varian Medical Systems – Linear Accelerators in Radiation Treatment Devices for Cancer Therapy
- Martin Townsend — Impact of RAMI on licensing of nuclear systems and innovative technologies involved.



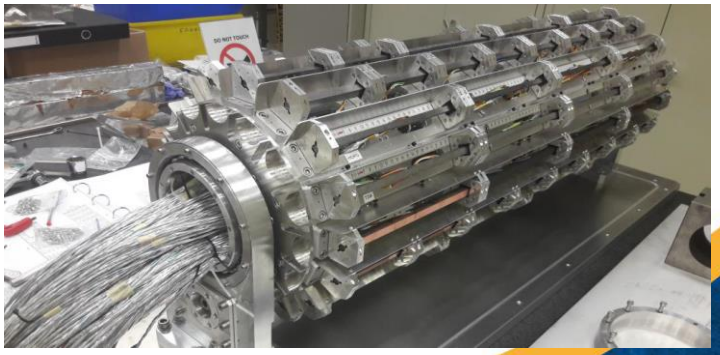
Thanks to Andi Kidd - STFC

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

D14.3 reports the production of material samples of carbon-based and metal-diamond composites → materials tailored to achieve high thermal, electrical and mechanical performance, and low density.

The 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

Samples tested in the frame of WP17 activities. CuCD samples were tested in the "Multimat" experiment at the CERN HiRadMat facility, together with other materials, under high intensity proton pulses of 440 GeV/c, to acquire their dynamic response. The specimens were positioned on a rotatable sample holder inserted in a tank under inert atmosphere. The 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.



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

D14.3

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

Very good collaboration and synergy with WP17

ARIES

Accelerator Research and Innovation for European Science and Society

Horizon 2020 Research Infrastructures GA n° 730871

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

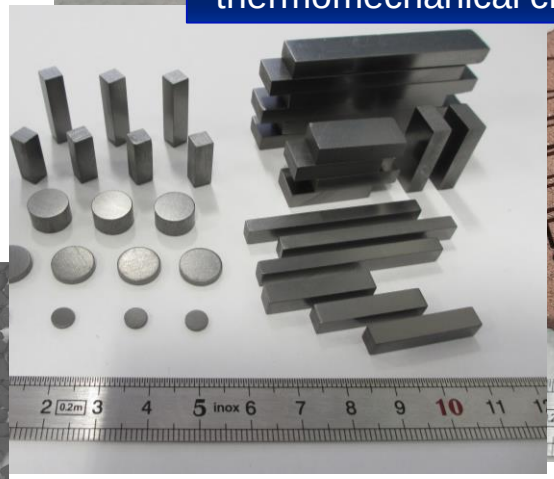
The aim of task 14.4 within WP14 is to develop and industrialize materials for extreme thermal management. This is done in collaboration with two industrial partners, RHP (AT) and Brevetti Bizz (IT). The materials produced include composites combining the properties of metals and ceramics with those 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.

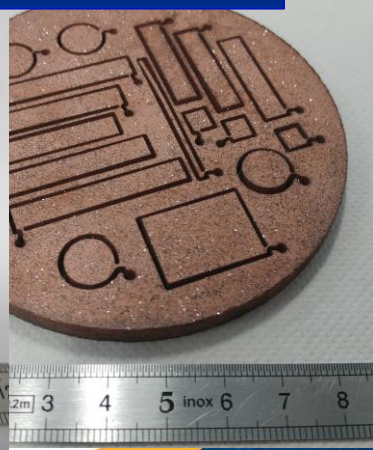
T14.4 highlights

BREVETTI BIZZ

HRMT-36 CuCD targets

MoGr and CuCD samples for thermomechanical characterization

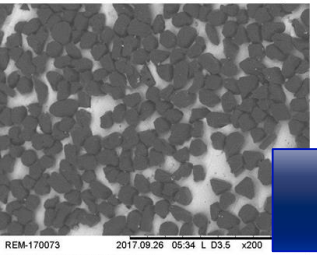


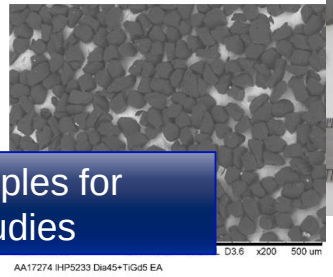


IHP5231-B
900°C/5min/30MPa

IHP5232-B
900°C/15min/30MPa

IHP5233-B
900°C/30min/30MPa

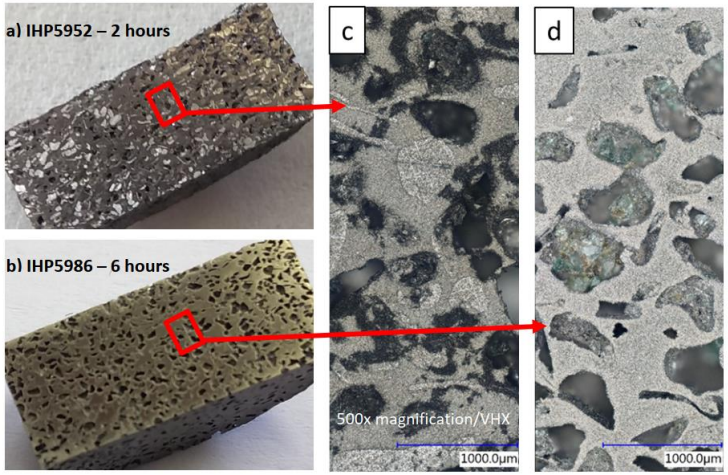




Metal-diamond samples for luminescence studies

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].

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

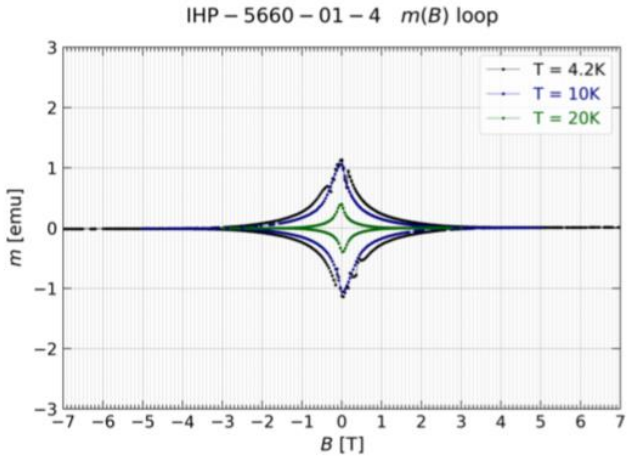
Batch	Sample	Material	IHP Temperature [°C]	Densification [%]	T_c [K]	B * T=4.2 K [T]	B * T=10 K [T]	B * T=20 K [T]
1st	IHP5660-1	MgB_2 C	1300	92,15	26,8	1,45	1,1	0,35
	IHP5660-2	MgB_2 C	1300	92,15	27,6	1,1	0,85	0,25
	IHP5660-3	MgB_2 C	1300	92,15	27,6	0,7	0,5	0
	IHP5660-4	MgB_2 C	1300	92,15	27	0,2	0,1	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

WP14.4 - MgB_2 AM

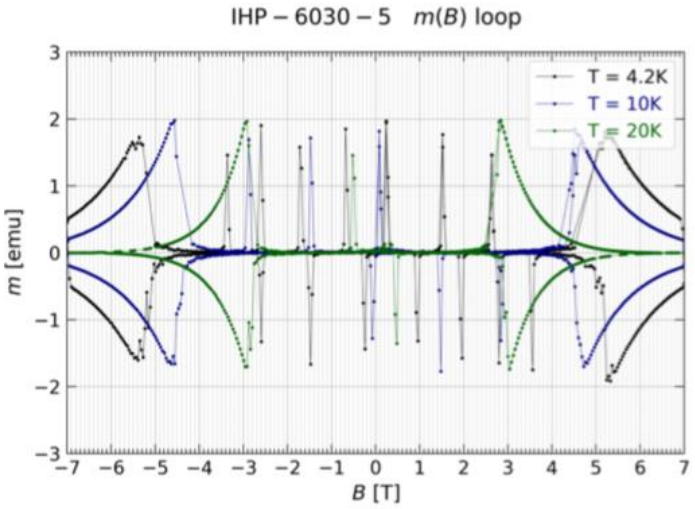
thanks to D.Mattera, C.Senatore (UNIGE)

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

UNIVERSITEIT
TWENTE.

Marc DHALLÉ

UNIVERSITÉ
DE GENÈVE
FACULTÉ DES SCIENCES

Carmine SENATORE

ARIES

Scope of the work of ARIES - WP14.5

- ***Set up a NEW industrial optimized process to:***
  - ***Increase J_e by a factor 2 wrt EUCARD-2***

    from J_e (4.2 K, 20 T) = 400-600 A/mm^2

    to J_e (4.2 K, 20 T) = 800-1000 A/mm^2

- ***Produce in*** BRUKER ***some 450 m of tapes***

- ***Use in a winding at*** CERN cea

- ***Electrical, magnetic, mechanical and thermal properties tested at*** UNIVERSITEIT TWENTE. ***and*** UNIVERSITÉ DE GENÈVE FACULTÉ DES SCIENCES

ARIES

WP14.5: HTS cable development for accelerators magnets

D14.4 reports the manufacture of HTS coated conductor depositing REBCO (Rare-Earth Barium Copper Oxyde) on a 50 µm thick substrate.
The use of such thin stainless steel 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.

ARIES

Accelerator Research and Innovation for European Science and Society

Horizon 2020 Research Infrastructures GA n° 730871

DELIVERABLE REPORT

First long length industrial High Temperature Superconductor

DELIVERABLE: D14.4

Document identifier:	ARIES-Del-D14.4
Due date of deliverable:	End of Month 30 (November 2019)
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

Scheme of Process

1. Preparation of stainless steel tape substrate (with surface smoothness at few n*m* level). Any defect in this phase is assumed as a potential reason for a fatal defect of conductor performance.
2. Deposition of thick film of ceramic buffer layer for texturing made of Yttria-stabilized zirconia (YSZ), via ABAD (alternating ion beam assisted deposition) at ambient temperature. ABAD is a proprietary process of BHTS. The YSZ is about 2-3 μm thick.
3. Deposition of REBCO (RE= yttrium in our case) by PLD technology, a process carried out at high temperature. BHTS utilizes Yttrium as rare earth. The YBCO film is about 2 μm thick.
4. Coating with a few μm of silver to protect the superconducting layer (typically 1 μm on the backside and 2-4 μm on the functional side (YBCO side).
5. Coating with 2x20 μ m (or other thickness) of copper for final stabilization.

12 mm tape produced by BHTS via ABAD and PLD

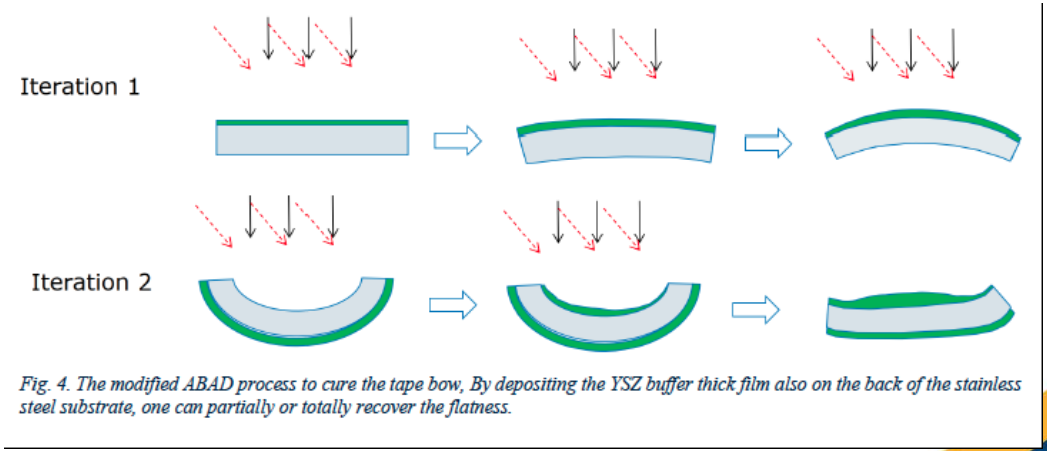
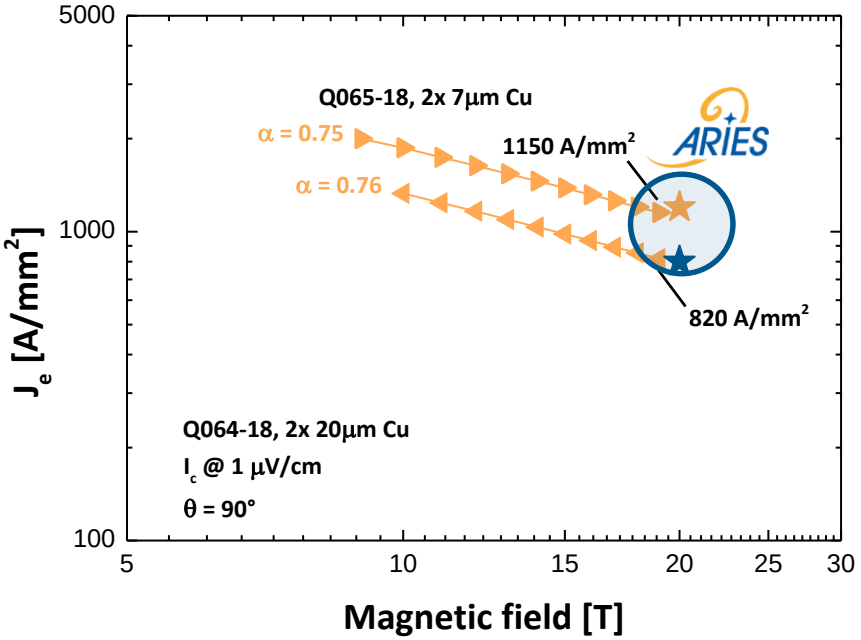


Fig. 4. The modified ABAD process to cure the tape bow, By depositing the YSZ buffer thick film also on the back of the stainless steel substrate, one can partially or totally recover the flatness.

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

Performance target



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

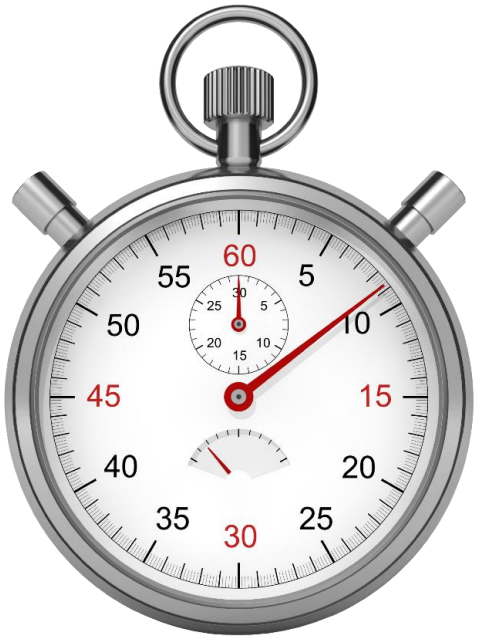
to be done: increase repeatibility and scale the process

- 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.

WP14.6 : Accelerator Timing System

Task 14.6.–*J.Gutleber* → Industrialization of REDNet Accelerator Timing System

Bring lifecycle and documentation to Identify cost reduction levers, review architecture, design, BOM - Assess market opportunities, identify potential customers - Make specifications, BOM, user documentation openly accessible



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

Concepts, architectures and designs developed in the frame of the LHC & CMS led to a timing system for the MedAustron medical accelerator project at CERN.

An agreement between CERN and the company MedAustron made it possible to use this work as a base for the co-development between CERN and company Cosylab, as benefit for the entire particle accelerator community.

Few customers adopted either the developed architecture, the design or the entire product, which also comprises hardware and software elements. Working with industrial customers has helped to identify areas of improvements and perform gap Analysis on existing and expected functionalities

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”) main timing system

WP14.6 : Accelerator Timing System

The co-developed new architecture and design is made available in Open Access format under the H2020 rules as a cooperative effort of CERN and Cosylab

The developments in the scope of ARIES form the baseline for the development of the system subject to a dedicated contract between ADAM S.A. (Meyrin, Geneva) and Cosylab.

ADAM S.A. has adopted the ARIES development for the design and construction of a novel linear accelerator for image-guided hadron therapy.

→ the results from this Tech Transfer can serve the world-wide PA community, and this achievement marks therefore the creation of tangible, substantial and lasting impact of a H2020 EC project for society and industry.

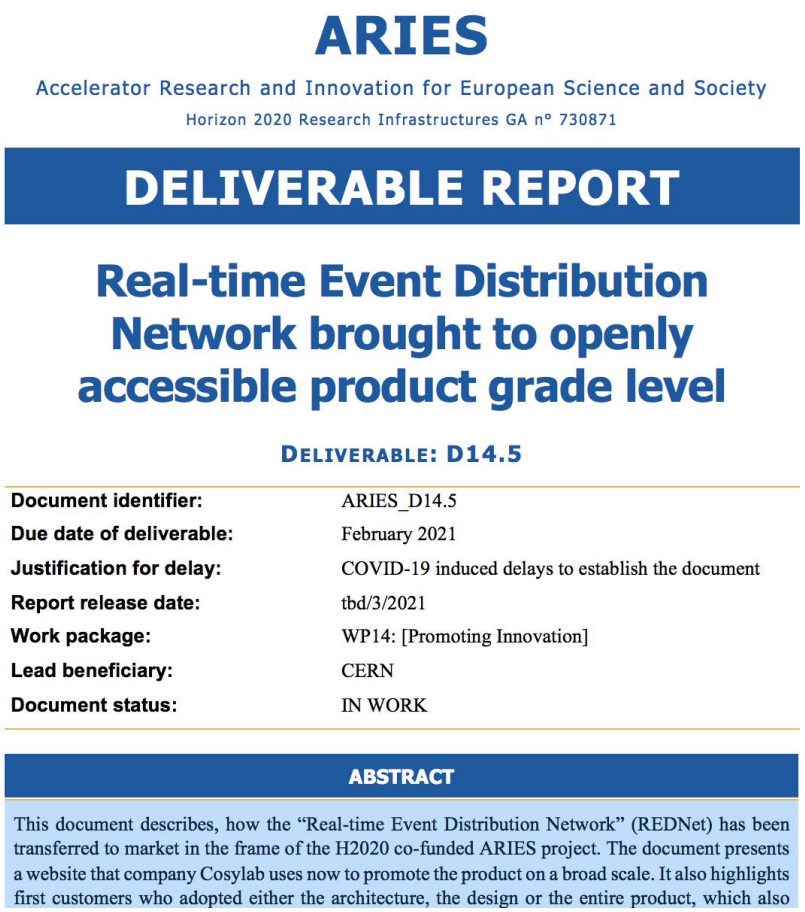
WP14.6 : Accelerator Timing System

D14.5 reports the product line developed by company Cosylab as a timing system and its functionalities, now marketed by Cosylab under the name **C-MTS**

Also describes the market activity of a product originated in the HEP domain.

The prospected customers are small to medium sized particle accelerators for medical and industrial applications

This deliverable demonstrates a tangible impact that ARIES project created and how technology has been effectively transferred from fundamental physics research carried out at CERN to market as a co-construction process with Cosylab



ARIES

Accelerator Research and Innovation for European Science and Society

Horizon 2020 Research Infrastructures GA n° 730871

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

WP14.6 : Accelerator Timing System

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

Targets are professionals, potential clients and technically interested audience

Webpage also shows the customization and modularity possibilities of the C-MTS that can be easily adapted to different use cases

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