5th ARIES Annual Meeting

Status of W10.1 (TA) Material Testing CERN-HiRadMat

Status of W10.2 (TA) Material Testing at GSI M-Branch

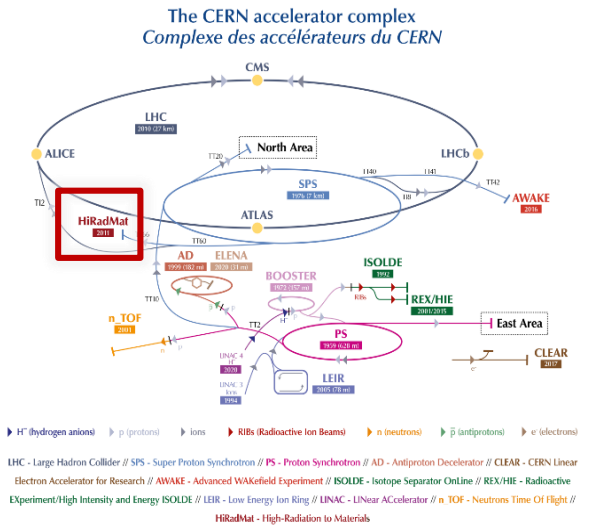
V. Stergiou, P. Simon & **N. Charitonidis** (CERN, BE-EA)
Daniel Severin (GSI)

02 May 2022

ARIES is co-funded by the European Commission Grant Agreement number 730871

A “flash” reminder of HiRadMat

- HiRadMat (High-Radiation to Materials) is a user facility for **high-energy, high-intensity pulsed beams**
  - The facility **was commissioned in 2011** and **located in SPS Point 7**
  - **40 succesful experiments** since the comissioning with the support of Eucard/Eucard2/ARIES

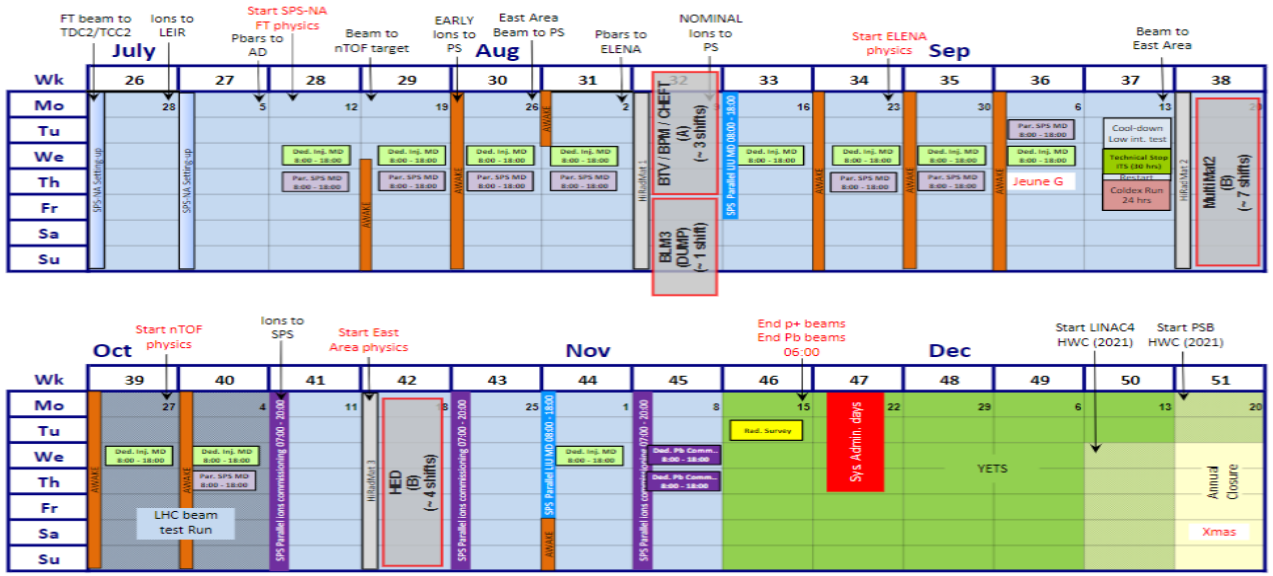


2021 operation

A challenging year for HiRadMat

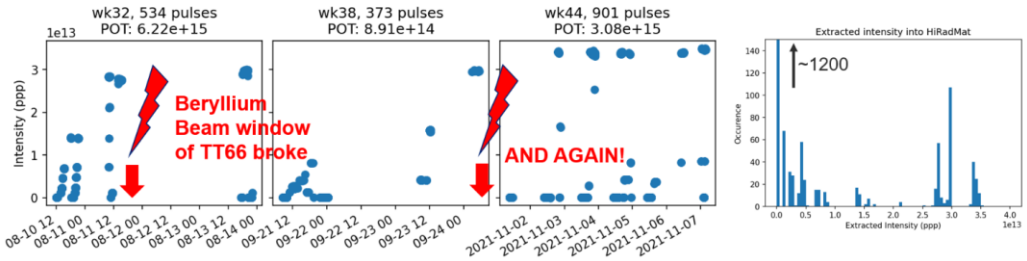
- **6** experiments in **3** slots
- All experiments requesting the **highest possible intensity**
- All experiments **critical for CERN** for validation of equipment for the future machines → **See talk of P. Simon**
- During **week 32** and **week 38** : The Be window of the facility was broken by the beam.
  - However: All experiments managed to completed the majority of their pulse list

2021 schedule



HiRadMat Be window incidents

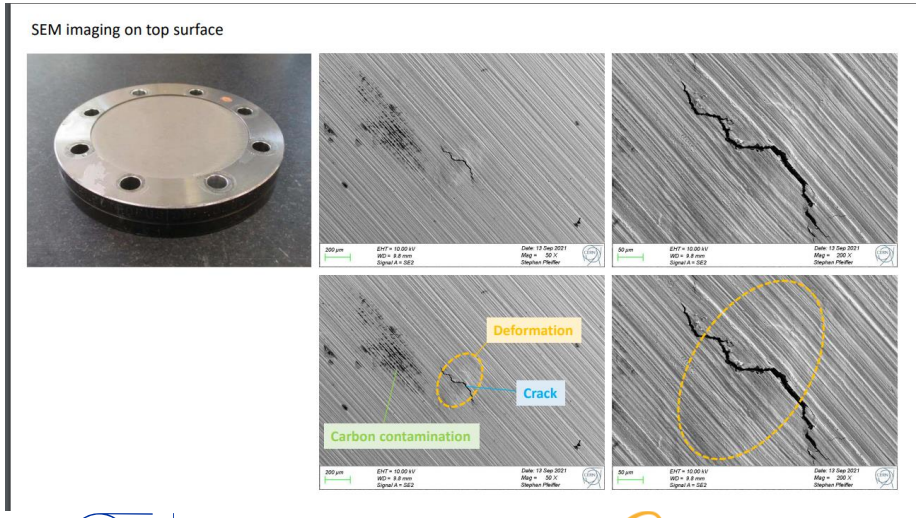
Beams delivered in 2021

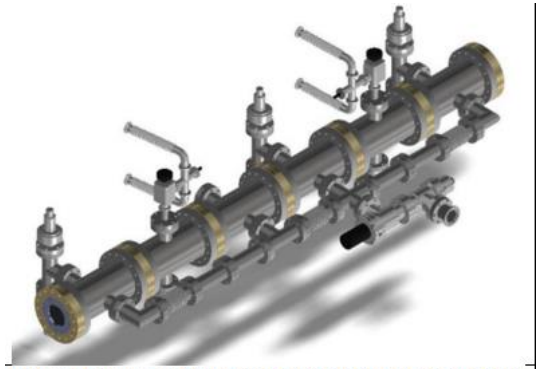


- All experiments requesting highest intensity beams with smallest possible optics
- 278 pulses with 288 bunches extracted:
  - exceeded 2017 and 2018 **combined** by a factor of **~1.5!**
- Protons on target: 1.02e16

Actions

- A team was assembled and a quick risk-analysis was made. After considering all possibilities, it was decided to flush the area and allow access by the TE-VSC team to visually inspect the leak.
- Samples from around were taken to confirm (chemically) that there are no traces of beryllium
- The inspection (@23h00) confirmed that the leak comes from the window area and that the window was intact
  - Great reactivity and motivation by TE-VSC and HSE-RP teams !
- A post-mortem analysis will be organized to understand better the causes of the failure (window itself ? seals ? something else ?)
- Hope to complete the experiment's pulse-list.





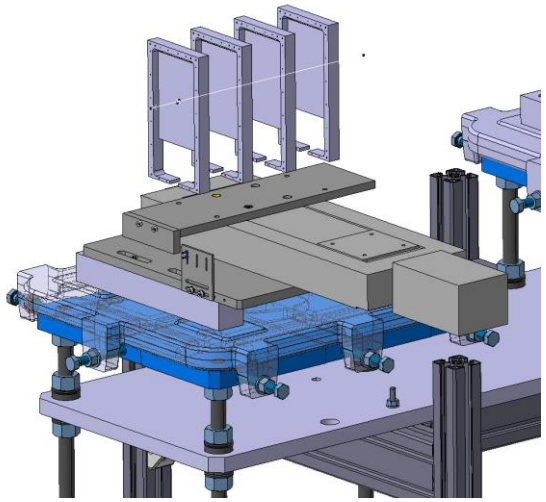
The set-up is about 3m long and 1 m high and has been used in a previous experiment (HRMT-26).
In 2015, with the very same setup, 7 glassy carbon windows from Sigradur G have been exposed to up to 288 bunches at 1.3*10+11 ppb and sigmas ranging from 2 to 0.25 mm.

Beam @ August 2022

ARIES TNA Approved Requests & AU until April'22

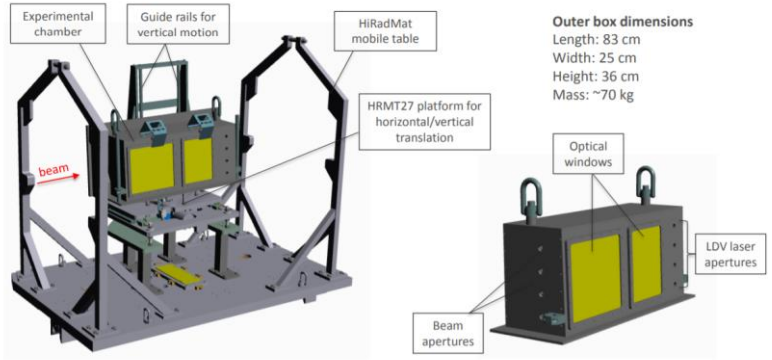
Identifier	Experiment Name	Scientific Board Status	IEFC approval	Technical Board	Delivered Access Units	Total number of persons	Approved by the USP
HRMT-55	BLM3	Recommended	Approved	OK	310	1	Yes
HRMT-54	EO BPM	Recommended	Approved	OK	60	1	
HRMT-56	HED	Recommended	Approved	OK	200	7	
HRMT-57	MultiMat2	Recommended	Approved	OK	50	1	
P-2101	Fireball	Recommended	N/A	N/A	150	2	
M49 – M60 (until April '22)					770	12	
M1-M60 (since the begginging of ARIES)					2426	40	
Foreseen for project (M1-M48)					200	20	

Planned experiments for 2022



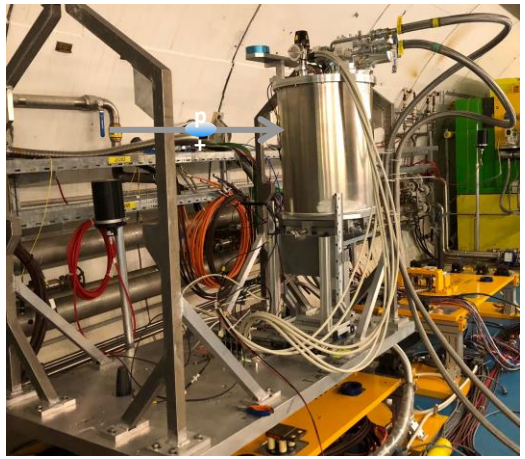
ATLAS ITk

BLM3

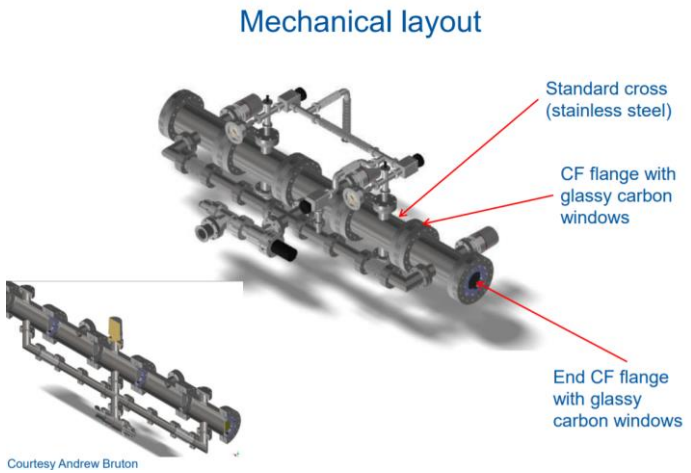


- Re-use of HRMT27 experimental platform with some modifications
- Outer chamber kept at slightly negative pressure using vacuum cleaner equipped with HEPA filter
- Optical viewports for visual monitoring with rad-hard camera

RaDIATE



SCcoils



SMAUG

An outlook in the future

Status of proposals for 2023++

Proposal	Identifier	Experiment Name	Scientific Board	TB#1	IEFC	TB#2	Beam Time (tentative)	Safety Folder EDMS#	Requested integrated intensity (p)	Maximum Pulse Intensity	# requested Shifts
p-2003		**CRY3** UA9 Coll.	Cond. Rec.#				2023	2421042	0.2×10^{15}	$288 \times 1.2 \cdot 10^{11}$	2
p-2005		**DPA** J-PARC, JP	Recommended				2023	2421044	0.2×10^{15}	$24 \times 1.2 \cdot 10^{11}$	2
p-2101		**FIREBALL** Uni. of Oxford, UK	Cond. Rec.				2023	2644127	$<0.1 \times 10^{15}$	$1 \times 3 \cdot 10^{11}$	6
p-2001-4		**ScintOF** CERN / BE-BI	Pending				2023 ?	2421040			
p-1402	HRMT-25	**TPSG4-2** CERN / SY-ABT	Recommended				*LIU-beams*	2421049			
…	…	***HED-2*** *CERN / SY-STI*	*Pending*				*LIU-beams*				
…	…	***MultiMat++*** *CERN/ EN-MME*	*Pending*				*LIU-beams*				

HiRadMat upgrade study group mandated and studies ongoing

HiRadMat facility **strongly looking forward for the successor of ARIES** – Absolutely critical in order to support the experimental efforts that are already preparing their beam time in the facility.

Potential new targets for TNA (2022-2026) : ~**4800 Access Units (h)**

GSI/UNILAC M-Branch Facility

- **During the third reporting period, three projects from P2 continued running and completed their experiment with a total of 30 users.**

Breakdown of transnational access units @ M60 (April 2022):

GSI/M-branch	User-projects			Users supported	Units of access (1h)
	Submitted	Selected	Supported		
Year 1 + 2 (M1-M48)	4	4	4	33 (12*)	512
Access provided in P3 (2021+2022)	Continuation of 3 projects			30	432
Foreseen for project (M1-M60)	8			48	480 / 768

* With financial support

Conclusions

- HiRadMat **is ready to startup** in April 2022 with 4 approved slots (5 experiments)
  - Outlook for 2022-2026 ~5000 AU expected for TNA (EUROLABS).
  - ARIES **has been essential for HiRadMat success** supporting fully 13 experiments in the years 2017-2022 (including 2.5y of CERN shutdown).
  - Delivered **~2400 AU** to more than **40** researchers leading to many publications and unique results

- GSI/M-branch Facility **succesfully completed the supported** projects **exceeding the forseen AU** and thanks again ARIES for the critical for its operation support.

List of publications

List of Publications

2.1. HiRadMat

The following list contains all HiRadMat-relevant publications from April 2017 until April 2022. Entries in bold have received support by ARIES-TA.

HiRadMat Facility

- F. Harden et al. (2019) "HiRadmat: A facility beyond the realms of materials testing" J. Phys. Conf. Series 1350 012162. 10.18429/JACoW-IPAC2019-THPRB085
- F. Harden et al. (2021) "Targetry Challenges & HiRadMat" Proceedings of the 3rd J-PARC Symposium (J-PARC2019). 10.7566/jpscp.33.011149

On-line instrumentation for HiRadMat Experiments

- F. Carra et al. (2021) "Design and Construction of an Instrumentation System to Capture the Response of Advanced Materials Impacted by Intense Proton Pulses" Shock and Vibration. 10.1155/2021/8855582

HRMT10 – WTHIMBLE / HRMT22 – PTarg

- T. Davenne et al. (2018) "Observed proton beam induced disruption of a tungsten powder sample at CERN" Phys. Rev. Accel. Beams 21 073002. 10.1103/PhysRevAccelBeams.21.073002
- O. Caretta et al. (2018) "Proton beam induced dynamics of tungsten granules" Phys. Rev. Accel. Beams 21 033401. 10.1103/PhysRevAccelBeams.21.033401

HRMT12 – LPROT

- Y. Nie et al. (2019) "Simulation of hydrodynamic tunneling induced by high-energy proton beam in copper by coupling computer codes" Phys. Rev. Accel. Beams 22 014501. 10.1103/PhysRevAccelBeams.22.014501

HRMT18 – CRY2

- W. Scandale et al. (2019) "Beam steering performance of bent silicon crystals irradiated with high-intensity and high-energy protons" Eur. Phys. J. C 79 933. 10.1140/epjc/s10052-019-7448-2

HRMT19 – BLM2

- V. Grishin et al. (2017) "Ionization Chambers as Beam Loss Monitors for ESS Linear Accelerator" Proc. 6th Int. Beam. Instrumentation Conf. (IBIC'17) 454-57. 10.18429/JACoW-IBIC2017-WEPWC03
- V. Grishin et al. (2018) "A Family of Gas Ionization Chambers and SEM for Beam Loss Monitoring of LHC and Other Accelerators" Proc. 26th Russian Particle Accelerator Conf. (RuPAC'18) 44-48. 10.18429/JACoW-RuPAC2018-TUZMH03

HRMT21 – RotColl

- T. Markiewicz et al. (2019) "Design, construction, and beam tests of a rotatable collimator prototype for high-intensity and high-energy hadron accelerators" Phys. Rev. Accel. Beams 22 123002. 10.1103/PhysRevAccelBeams.22.123002

HRMT23 – Jaws

- G. Gobbi et al. (2019) "Novel LHC collimator materials: High-energy Hadron beam impact tests and non-destructive post-irradiation examination" Mechanics of Advanced Materials and Structures. 10.1080/15376494.2018.1518501

HRMT24 – BeGrid

- K. Ammigan et al. (2019) "Thermal shock experiment of beryllium exposed to intense high energy proton beam pulses" Phys. Rev. Accel. Beams 22 044501. 10.1103/PhysRevAccelBeams.22.044501

HRMT27 – RodTarg / HRMT42 – TaScat

- C. Torregrosa et al. (2017) "Renovation of CERN antiproton production target area and associated design, testing and R&D activities" Proc. 8th Int. Particle Accelerator Conf. (IPAC'17) WEPVA103 3506-09. 10.18429/JACoW-IPAC2017-WEPVA103
- C. Torregrosa et al. (2018) "Prototyping Activities for a New Design of CERN's Antiproton Production Target" Proc. 9th Int. Particle Accelerator Conf. (IPAC'18) TUPAF038 772-75. 10.18429/JACoW-IPAC2018-TUPAF038
- C. Torregrosa et al. (2018) "Scaled prototype of a tantalum target embedded in expanded graphite for antiproton production: Design, manufacturing, and testing under proton beam impacts" Phys. Rev. Accel. Beams 21 073001. 10.1103/PhysRevAccelBeams.21.073001

TRANSNATIONAL ACCESS TO MATERIAL TESTING FACILITIES
Deliverable: D10.1
Date: dd/mm/yyyy

- C. Torregrosa et al. (2019) "Experiment exposing refractory metals to impacts of 440 GeV/c proton beams for the future design of the CERN antiproton production target: Experiment design and online results" Phys. Rev. Accel. Beams 22 013401. 10.1103/PhysRevAccelBeams.22.013401
- C. Torregrosa et al. (2019) "First prototypes of the new design of the CERN's antiproton production target" Mat. Design Process Comm. 2019;1:e38. 10.1002/mdp2.38
- C. Torregrosa et al. (2021) "First observation of spalling in tantalum at high temperatures induced by high energy proton beam impacts" European Journal of Mechanics - A/Solids, 85, 104149. 10.1016/j.euromechsol.2020.104149

HRMT28 – TCDI

- F-X. Nuiry et al. (2019) "3D Carbon/Carbon composites for beam intercepting devices at CERN" Mat Design Process Comm. 2019;1:e33. 10.1002/mdp2.33

HRMT36 – MultiMat

- F. Carra et al. (2017) "The "Multimat" experiment at CERN HiRadMat facility: advanced testing of novel materials and instrumentation for HL-LHC collimators" IOP Conf. Series: Journal of Physics: Conf. Series 874 012001. 10.18429/JACoW-IPAC2017-MOPAB005
- A. Bertarelli et al. (2018) "Dynamic testing and characterization of advanced materials in a new experiment at CERN HiRadMat facility" IOP Conf. Series: Journal of Physics: Conf. Series 1067 082021. 10.1088/1742-6596/1067/8/082021
- M. Pasquali et al. (2019) "Dynamic Response of Advanced Materials Impacted by Particle Beams: The MultiMat Experiment" Journal of Dynamic Behavior of Materials 5 266–95. 10.1007/s40870-019-00210-1
- M. Portelli et al. (2019) "Numerical and experimental benchmarking of the dynamic response of SiC and TZM specimens in the MultiMat experiment" Mechanics of materials 138 103169. 10.1016/j.mechmat.2019.103169
- F. Carra et al. (2019) "Mechanical robustness of HL-LHC collimator designs" IOP Conf. Series: Journal of Physics: Conf. Series 1350 012083. 10.1088/1742-6596/1350/1/012083 [also linked to HRMT23]
- M Portelli et al. (2021) "Thermomechanical Characterisation of Copper Diamond and Benchmarking with the MultiMat Experiment" Shock and Vibration. 10.1155/2021/8879400

HRMT37 – SextSC

- A. Will et al. (2019) "Beam impact experiment of 440 GeV/p protons on superconducting wires and tapes in a cryogenic environment" Proc. 10th Int. Particle Accelerator Conf. (IPAC'19) THPTS066 4264-67. 10.18429/JACoW-IPAC2019-THPTS066

HRMT38 – FlexMat

- P. Simon et al. (2021) "Dynamic response of graphitic targets with tantalum cores impacted by pulsed 440-GeV proton beams" Shock and Vibration. 10.1155/2021/8884447

HRMT41 – ATLAS-PIXEL / HRMT47 – ATLASPixRad

- J. Fernandez-Tejero et al. (2019) "Beam-loss damage experiment on ATLAS-like silicon strip modules using an intense proton beam" Nuclear Inst. And Methods in Physics Research A 958 162838. 10.1016/j.nima.2019.162838
- C. Bertella et al. (2019) "Damages induced on ATLAS IBL modules by fast extracted and intense proton beam irradiation" J. Inst. 14 C05024. 10.1088/1748-0221/14/05/C05024
- C. Bertella et al. (2019) "Test with high-energy and high-intensity proton beam on ATLAS silicon detectors towards HL-LHC" Nuovo Cim. C42 205. 10.1393/ncc/i2019-19205-8
- C. Bertella et al. (2019) "Study of damages induced on ATLAS silicon by fast extracted and intense proton beam irradiation" Nucl Instrum Meth A 924 236-40. 10.1016/j.nima.2018.06.043

HRMT43 – BeGRID2

- S. Bidhar et al. (2021) "Design, prototyping activities and beam irradiation test for the new n_TOF neutron spallation target" Proc. 9th Int. Particle Accelerator Conf. (IPAC'18) WEPMF084 2582-85. 10.18429/JACoW-IPAC2018-WEPMF084

HRMT46 – n-ToF Target

- R. Esposito et al. (2018) "Design, prototyping activities and beam irradiation test for the new n_TOF neutron spallation target" Proc. 9th Int. Particle Accelerator Conf. (IPAC'18) WEPMF084 2582-85. 10.18429/JACoW-IPAC2018-WEPMF084

HRMT48 – PROTAD

- J. Busom Descarrega et al. (2020) "Development and Beam Irradiation of Ir/W/Ta/Ta-Alloys Refractory Metals and Cladding Via Hot Isostatic Pressing at CERN for Beam Intercepting Devices Applications", Proc. 14th Int. Workshop Spallation Materials Technology, JPS Conf. Proc. 28. 10.7566/JPSCP.28.041002

Thank you for your attention !

ARIES is co-funded by the European Commission Grant Agreement number 730871