



Grant Agreement No: 730871

ARIES

Accelerator Research and Innovation for European Science and Society
Horizon 2020 Research Infrastructures project ARIES

PERIODIC TECHNICAL REPORT

ARIES: 2ND PERIODIC REPORT

WP6 (NA) Accelerator Performance and Concepts

From M19 (November 2018) to M36 (April 2020)

Notes to this template:

Highlighted in blue: explanation of what you have to provide

Highlighted in yellow: what you have written for the last report, for your reference (to be deleted in the final text)

1. EXPLANATION OF THE WORK CARRIED OUT DURING THE PERIOD

Executive summary

Summary of the work carried out with emphasis on the progress towards deliverables and milestones during P2.

Note: this text should be more technical than the publishable summary and refer to the milestones and deliverables achieved in the reporting period (to be cited in brackets).

(Max 1/4 page)

In Period 2, **WP6 (Accelerator Performance and Concepts)** organized, or co-organized, a total of eight workshops: “APEC2018” workshop on hadron accelerator performance limitations, collective effects, machine learning and RAMS statistics (jointly by Tasks 6.2, 6.3, 6.4, and 6.5), “DAFNE as Open Accelerator Test Facility” (Tasks 6.2, 6.3 and 6.4), “Beam Tests and Commissioning of Low Emittance Rings” (jointly with WP), “High Intensity RFQ meets Reality” (Tasks 6.2 and 6.3), “Mitigation of Coherent Beam Instabilities in particle accelerators” (MCBI2019, Tasks 6.2 and 6.4), “Electrons for the LHC” (Task 6.5), “Space Charge mini-workshop” (Task 6.2), “ACN2020” on the use of crystals and nanotubes for acceleration and bending. Altogether, 511 participants attended the WP6 events; to this number can be added the 419 participants to the large FCC event that was only co-organised by ARIES WP6, to reach the impressive number of 930 persons from all over the world who took part in ARIES WP6 events during the period 2. The three deliverables D6.1 (“Ranking of Performance Degrading Mechanisms for Hadron Storage Rings and Synchrotrons”), D6.2 (“Report on optimal RAMS characteristics for particle accelerators”), and D6.3 (“Summary of novel methods to reduce accelerator impedance”), and three milestones MS27 (“Report on 2nd Annual Workshops of all WP6 APEC Tasks”), MS28 (“Report on Parameter Database for Various ERL & Linac Facilities”) and MS (“Report on 3rd Annual Workshops of all WP6 APEC Tasks”) were completed.

Objectives

List the specific objectives for the WP in the reporting period as described in Annex 1 and explain the work carried out during the reporting period towards the achievements of each listed objectives. Provide clear and measurable details.

(Max 5 lines)

Objectives: *Organise at least one workshop per Task, identify limitations in the performance of accelerators and propose solutions, analyse and promote new accelerator concepts.*

In period 2, the APEC Network has organized or co-organized 8 scientific Workshops, reaching a number of 511 participants globally attending WP6 events. 25% of participants were coming from outside of Europe. Main scientific outcomes were the ranking of performance degrading mechanisms for hadron storage rings and synchrotrons, the report on optimal RAMS characteristics for particle accelerators, the review of novel methods to reduce accelerator impedance, the report on the parameter database for various ERL & linac facilities, and the review of the state of the art in using carbon nanotubes, fibre like tubes, and crystals for acceleration and bending.

Summary of exploitable results and an explanation about how they can/will be exploited

Please fill the table below with 1-2 results for each WP (for the reference period).

WP	Type of exploitation foreground ¹	Description of exploitable foreground (relevant deliverable)	Purpose (How the foreground might be exploited and by whom)	IPR ²	Potential/expected impact (quantify where possible)	Exploitable product(s) or measure(s)	Sector(s) of application	Timetable, commercial or any other use
6.2	GAK	Ranked assessment of processes causing performance degradation in hadron storage rings and synchrotrons	<i>Implementation of more efficient mitigation approaches, which may be used by any accelerator laboratory</i>	<i>open</i>	<i>Improved performances of present and future hadron accelerators by better control of degradation processes</i>	<i>Deliverable Report D6.1</i>	<i>Beam Dynamics</i>	<i>starting today</i>
6.3	GAK	Compilation and ranking of RAMS standards	<i>Spreading the identified best RAMS practices</i>	<i>open</i>	<i>Feasibility of an Open Data Infrastructure for accelerator reliability</i>	<i>Reports and collaboration network, D6.2</i>	<i>Reliability of Accelerators</i>	<i>>2 years</i>
6.4	GAK	Beam-impedance assessments and impedance models	<i>Review of existing strategies & methods</i>	<i>open</i>	<i>Conceptual design of advanced beam feedback systems for future machines</i>	<i>Reports and proposals of R&D, D6.3</i>	<i>Beam dynamics, ongoing and future projects</i>	<i>>2 years</i>

¹ Type of foreground: General advancement of knowledge (GAK), Commercial exploitation of R&D results (CERD), Exploitation of R&D results via standards (ERD), exploitation of results through EU policies (EUP), exploitation of results through (social) innovation (INV).

² Invention, disclosure, patent, other

6.6	GAK	Alternative muon-collider concepts	<i>Future energy frontier collider for worldwide HEP community</i>	<i>open</i>	<i>Collider concept for the long-term future and related infrastructure</i>	<i>Reports, Summary of WP6.6 topical workshop</i>	<i>Future projects in high-energy physics</i>	<i>>50 years</i>
6.6	GAK	Accelerator-based source of intense pulsed Gamma rays – conceptual study	<i>An intriguing application of the LHC serving several types of user communities</i>	<i>open</i>	<i>Future use of LHC (or FCC) complex</i>	<i>Reports and collaborations, , Summary of WP6.6 topical workshop</i>	<i>Nuclear physics, material science, high-energy physics</i>	<i>>8 years</i>
6.5	GAK	Highest-brilliance X-ray FEL based on ERL	<i>Next-next generation XFEL</i>	<i>open</i>	<i>Revolutionize X-ray based science and open up new research possibilities</i>	<i>The next frontier XFEL, Conference paper and journal publication</i>	<i>Material science, biology, industry</i>	<i>>8 years</i>
6.4	GAK	Ultra-thin NEG coating	<i>Providing good vacuum and suppressing electron cloud, without increasing impedance</i>	<i>tbd (patent)?</i>	<i>Improved coating for accelerator vacuum chamber and insertion devices</i>	<i>Higher-intensity higher-performance lepton accelerators, Journal publication</i>	<i>Electron/positron accelerators, light sources</i>	<i>could start today</i>
6.6	GAK	Accelerator applications of crystals or tube-like fiber accelerators	<i>Implementation of crystalline undulators and preparing proof-of-principle demonstration of carbon nanotube accelerator</i>	<i>open</i>	Higher intensity positron sources and/or highest-gradient acceleration	<i>Reports and collaborations, , Summary of WP6.6 topical workshop</i>	<i>electron/positron accelerators, light sources</i>	<i>>5 years</i>

1.2 EXPLANATION OF THE WORK CARRIED PER WP³

! Explain the work carried out in WP6 during the reporting period giving details of the work carried out by each beneficiary involved.

WP6: Accelerator Performance and Concepts -NA

This NA aims to reach ultimate performances in future accelerators that are now in the advanced planning or construction phase, by investigating advanced beam stabilization techniques, novel collimation schemes and reliability enhancement measures. It will contribute to the design of the future generation of accelerators, by exploring alternative technologies and concepts. The WP includes 6 tasks:

- Task 6.1. Coordination and communication
- Task 6.2. Beam Quality Control in Hadron Storage Rings and Synchrotrons
- Task 6.3. Reliability and Availability of Particle Accelerators
- Task 6.4. Improved Beam Stabilization
- Task 6.5. Beam Quality Control in Linacs and Energy Recovery Linacs
- Task 6.6. Far Future Concepts & Feasibility

Task 6.1: Coordination and communication

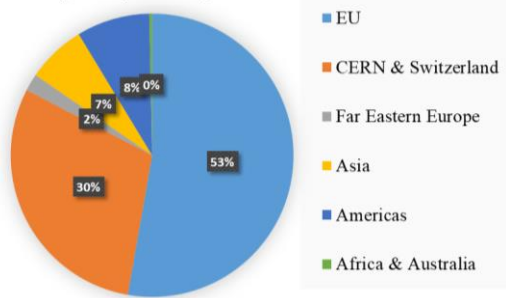
(Max 1/2 page)

Progress towards objectives and significant results

Task 6.1 coordinated WP6 events with several parallel accelerator activities and projects, in particular the global FCC study, the design studies for LHeC and PERLE, the MESA project, the CERN Physics Beyond Colliders working group, the GSI FAIR project, HIC for FAIR, LHC HiLumi and LIU Projects, the European working group on muon colliders, the Gamma Factory initiative, ICFA, the EC co-funded EuroCirCol and EasiTrain, and the other work packages of ARIES. The results of WP6 workshop events were widely communicated, e.g., through invited seminars and through outreach articles in Accelerating News, the CERN bulletin, the ICFA Beam Dynamics Newsletter, and in the CERN Courier. Proceedings of several WP6 workshops have been published or are in the process of being published. Task 6.1 also presented regular WP6 status reports at the quarter-annually ARIES steering meetings. At all workshops, particular emphasis was put on gender diversity and student participation. Figure 1 illustrates the geographical distribution of WP6 workshops participants and the fraction of women in the various events. The material developed in the frame of WP6 was an important input to the deliberations for the update of the European Strategy for Particle Physics scheduled in 2019/20.

³ The partners carrying out the work in each task are mentioned in the text or can be found in brackets.

geographic distribution of WP6 workshop participants in period 2



fraction of woman participants in ARIES WP6 workshops

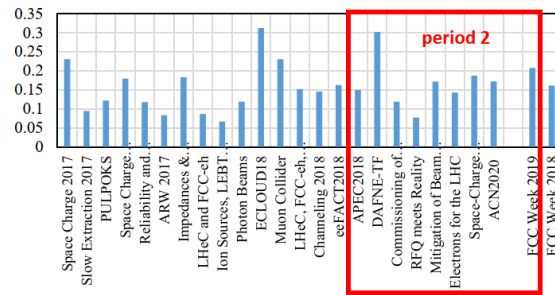


Figure 1: Geographical distribution of WP6 workshop attendees in period 2 (left) and fraction of women participants in all WP6 workshops (right); the average fraction of women participants increased from 15% (P1) to 17% (P2).

Contractual milestones and deliverables

In the P2 reporting period, Task 6.1 had two milestones to submit:

- MS27 Report on 2nd Annual workshops of all tasks – accomplished in M24
- MS29 Report on 3rd Annual workshops of all tasks – accomplished in M36

Meetings of the WP

Please complete the table below if necessary, adding as many lines as needed.

Dates	Type of meeting + link	Venue
10-12.12.2018	Accelerator Performance and Concept Workshop https://indico.cern.ch/event/757533/	Frankfurt, Germany
12.12.2018	DAFNE as Open Accelerator Test Facility https://agenda.infn.it/event/16334/	LNF, Frascati, Italy
18-20.02.2019	Beam Tests and Commissioning of Low Emittance Rings https://indico.cern.ch/event/772326/	KIT, Karlsruhe, Germany
09.04.2019	3rd Annual WP6 APEC Steering Meeting https://indico.cern.ch/event/812427/	Budapest, Hungary
15.-16.04.2019	High Intensity RFQ meets Reality https://indico.gsi.de/event/8575/	IWH, Heidelberg, Germany
24-28.06.2019	FCC Week 2019 https://indico.cern.ch/event/727555/	Brussels, Belgium
23.-27.09.2019	Mitigation of Coherent Beam Instabilities in particle accelerators (MCBI2019) https://indico.cern.ch/event/775147/	Zermatt, Switzerland

24.-25.10.2019	Electrons for the LHC: Workshop on the LHeC, FCC-eh, and PERLE https://indico.cern.ch/event/835947/	Chavannes de Bogis, Switzerland
04.-06.11.2019	Space Charge mini-workshop https://indico.cern.ch/event/828559/	CERN, Geneva, Switzerland
10-11.03.2020	Applications of Crystals and Nanotubes for Acceleration and Manipulation https://indico.cern.ch/event/867535/	EPFL, Lausanne, Switzerland
21.04.2020	4th Annual WP6 APEC Steering Meeting https://indico.cern.ch/event/900887/	Vidyo meeting

Task 6.2: Beam Quality Control in Hadron Storage Rings and Synchrotrons

(Max 1/2 page)

Progress towards objectives and significant results

Task 6.2 organized or co-organized six workshops, more than anticipated in the proposal. The high rate of workshops demonstrates how much this networking activity is appreciated by the accelerator community, and which needs it fulfils. Task 6.2 workshop topics in P2 ranged from beam generation and low-energy transport (radiofrequency quadrupoles) over performance limitations of present and future hadron storage rings (space charge, impedance, availability) to future circular colliders. All events were unique. often breaking new ground, and attracted great worldwide interest. APEC2018 prepared input for the deliverable report D6.1 (Ranking of performance degrading mechanisms for hadron storage rings and synchrotrons).

Laboratory	Accelerator	R	Intensity limitation	ave	std	R	Brightness limitation	ave	std
Fermilab	Booster	1	Beam loss	3.12	1.16	1	Nonlinearities	3.625	0.99
BNL	RHIC	2	RF Power	2.75	1.2	2	Space charge	3.125	1.53
CERN	SPS	3	Single bunch instability	2.75	0.82	2	Beta-beating	2.5	1.3
SLAC/SSRL	SPEAR3	4	Multi-bunch instability	2.75	1.56	3	Injector	2.5	1.75
J-PARC	Main ring	5	Injector	2.6	1.6	4	Beam-beam	2.0	1.41
INFN-LNF	DAFNE	6	DA	2.375	0.99	5	E-Cloud	1.75	1.39
GSI	ESR	7	Collimation	2.25	1.09	6	IBS	1.75	1.39
GSI	SIS18/SIS100	8	Momentum Acceptance	2.25	1.2				
		9	E-Cloud	2.25	1.3				

Figure 2: Laboratories and accelerators participating in APEC2018 survey (left) along with main intensity (centre) and brightness limitations (right) according to the survey. Ranking level was from 1 (lowest) to 5 (highest importance), averages and standard deviations are shown [G. Franchetti]. From ARIES D6.1 report.

The space-charge studies, including topical workshop, were complemented by the active participation of young scientists from CERN (N. Biancacci, A. Saa Hernandez) in beam studies at the Fermilab booster. The US intensity frontier (PIP II at FNAL) will benefit from the international synergy developed by Task 6.2. The synergy promoted by WP6 Task 6.2 also extends links to pre-existing institutions of global ambition such as ICFA: The Task 6.2 engages in the co-organization of the historical “High Brightness Hadron Beams” conference series, guaranteeing leadership beyond the ARIES mandate. Another activity of the task studies the novel interaction of neutral molecules with

a magnetic or electric dipole moment and electro-magnetic fields in the LHC. Task 6.2 has promoted and co-organized meetings for improving synergies between CERN-GSI on the new GSI control system and challenges of using CERN LSA software for storage modes at GSI.

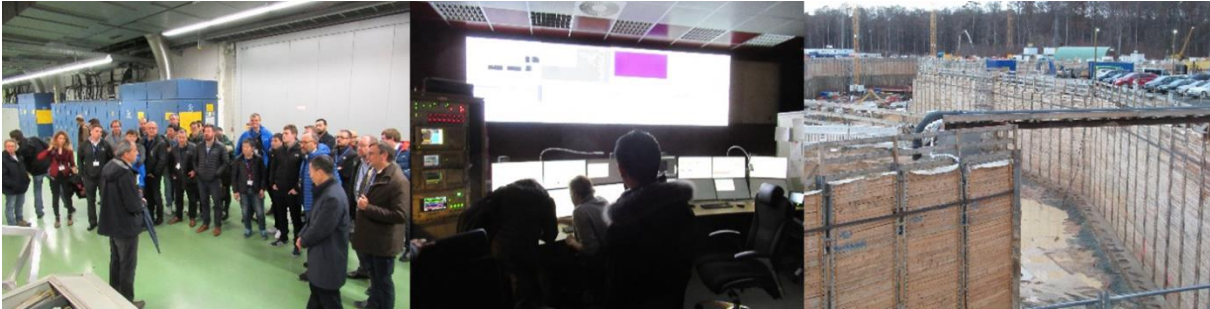


Figure 3: APEC2018 tours of GSI UNILAC, GSI accelerator control room, and FAIR site.

Contractual milestones and deliverables

In the P2 reporting period, Task 6.2 had one deliverable to submit:

- D6.1 Ranking of performance degrading mechanisms for hadron storage rings and synchrotrons – Approved

Task 6.3: Reliability and Availability of Particle Accelerators

(Max 1/2 page)

Progress towards objectives and significant results

Numerous RAMS aspects were discussed at the APEC2018 workshop in Frankfurt.

In 2019 HIT contracted a master student to gather information on equipment, maintenance data and incidents during operation. The student cooperated with the responsible persons from different accelerator groups like vacuum, beam instrumentation, power supplies and rf to develop form sheets to collect and document statistical information on regular maintenance tasks or device failures. HIT is currently finishing the process of mapping the data for vacuum equipment into a local database following the database model developed by the Austrian Institute of Technology. During the process of collecting the data, concerns arose about the privacy of sensitive data, so a strict separation is being enforced between “private data” like manufacturer details and statistical data that may be published. Though in early 2020 all non-essential operation at the University Hospital has been reduced due to the Covid-19, the test database is expected to be completed within the next two months.

Task 6.3 finalized and submitted a report on optimal RAMS characteristics for particle accelerators.

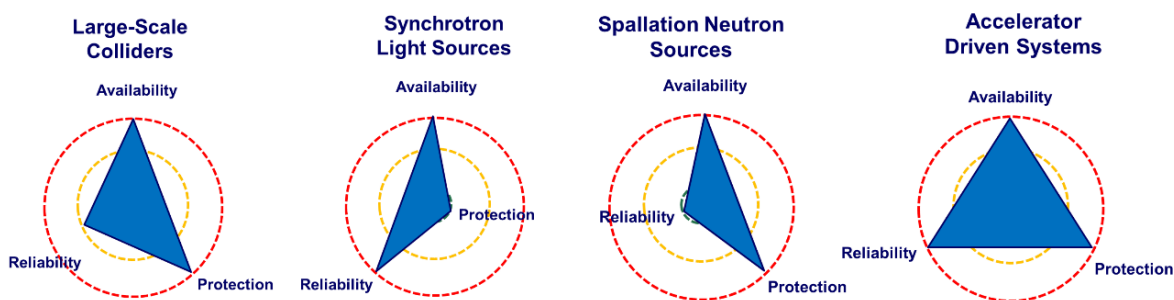


Figure 4: RASP charts illustrating the variation of requirements with the type of accelerator (A. Apollonio, APEC2018)

Contractual milestones and deliverables

In the P2 reporting period, Task 6.3 had one deliverable to submit:

- D6.2 Report on optimal RAMS characteristics for particle accelerators – Submitted and approved

Task 6.4: Improved Beam Stabilization

(Max 1/2 page)

Progress towards objectives and significant results

During the period from November 2018 - April 2020, the activity on impedance reduction and study of collective effects continued following two main lines:

- 1) Study of collective effects for FCC-ee. The impedance and wake field of some devices have been evaluated for the longitudinal plane and their effect was studied for the main ring (E. Belli PhD thesis, ARIES monograph Vol. 53). Also, collective effects in FCC-ee Booster are under study.
- 2) Impedance minimization of some beam intercepting devices for HI-LUMI and LIU projects have been studied (L. Teofili PhD thesis “A Thermomechanical and Electromagnetic Approach for the Design of High Intensity Accelerator Components” Ph.D. in Accelerator Physics – XXXII Cycle University of Rome La Sapienza, Italy).

A one-year contract for a postdoc started in June 2019 at INFN-Roma1 working on collective effects of FCC-ee Booster.

At DAFNE, the Frascati e^+e^- collider, a second horizontal bunch-by-bunch feedback system has been installed in the positron ring in September 2019; it is currently under test with two goals: (1) provide a more efficient power management for damping the horizontal electron-cloud instability; and (2) serve as a preliminary test bench for the FCC-ee feedback architecture proposed by A. Drago at FCC Week 2016, FCC Week 2018, and eeFACT2016, and documented in deliverable report D6.3.

Finally, Task 6.4 co-organised the ARIES/ICFA Mini-Workshop in “Mitigation of Coherent Beam Instabilities in Particle Accelerators”. Of particular interest and relevant for ARIES deliverable D6.3 were various approaches to minimize accelerator impedance, including: Metamaterial-based absorbers (M.R. Masullo); Impedance localization and identification (N. Biancacci); Identification of the horizontal instability mechanism at the CERN Proton Synchrotron Booster (E. Koukovini-Platia); Optimization design and impedance sources in low emittance rings (R. Nagaoka); Low-impedance design of kickers (C. Zannini); Low-impedance beam screen design for future colliders (S. Arsenyev); Impedance reduction for (LHC) collimators (M. Mereghetti); Mitigation of coherent beam instabilities in CEPC (N. Wang).

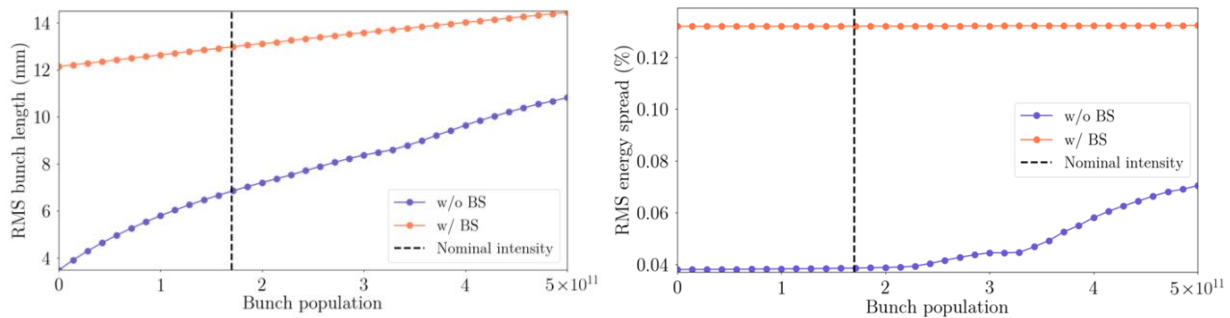


Figure 5: FCC-ee rms bunch length (left) and energy spread (right) as a function of the bunch population with (orange curve) and without (blue curve) beamstrahlung, considering the impedance contribution from all machine components [E. Belli, ARIES monograph Vol. 53].

Contractual milestones and deliverables

In the P2 reporting period, Task 6.4 had one deliverable to submit:

- D6.3 Summary of novel methods to reduce accelerator impedance - Submitted

Task 6.5: Quality Control in Linacs and Energy Recovery Linacs

(Max 1/2 page)

Progress towards objectives and significant results

Within the reporting period significant progress was achieved in the field of energy recovery linacs: in December 2019 the CBETA project at Cornell University, U.S.A., succeeded in operating the first world-wide multi-pass ERL; CBETA accelerated and decelerated the beam four times each. This expected step had been identified as a major milestone for the ERL technology, already in milestone report MS28. We are looking forward to more ERL projects emerging in the future. The multi-pass ERL still needs to be demonstrated with high intensities, in order to reach MW scale beam power in the future, which could enable ERL-based electron coolers for electron-hadron colliders, LHeC, FCC-eh, or even an ERL based FCC-ee. One intermediate step would be the realization of the PERLE test facility at IJClab, which was discussed at the “Electrons for the LHC” workshop 2019. Another important topic is the protection of the ERL’s crucial SRF technology from degradation. Therefore, Task 6.5 will organise a dedicated workshop “Operating SRF Systems reliably in a "Dirty" Machine” at Mainz this November (10-12), <https://indico.him.uni-mainz.de/event/63/>.

For four months in 2020, a CERN visiting scientist contributed to the LHeC/ERL-based FEL design.

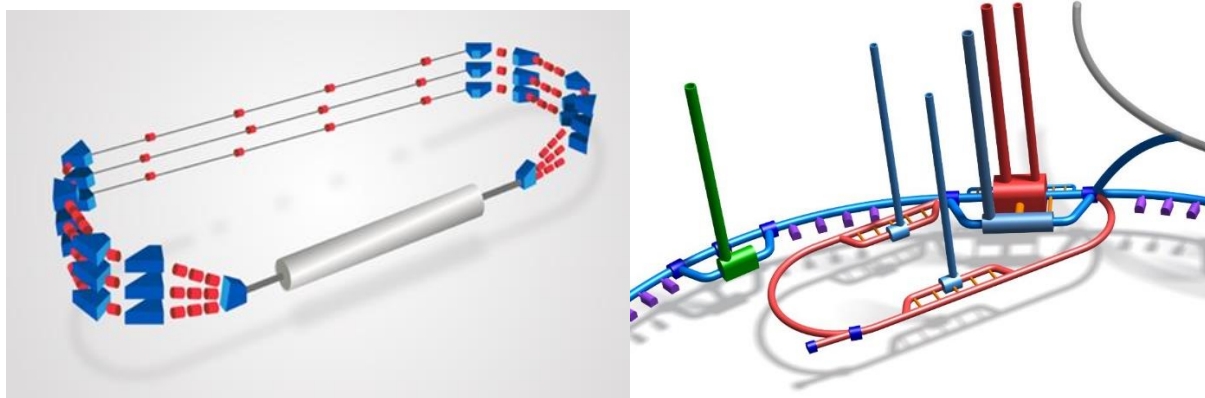


Figure 6: PERLE-Phase 1 layout [A. Bogaz, W. Kaabi] (left) and FCC-eh underground layout [A. Tudora] (right).

Contractual milestones and deliverables

In the P2 reporting period, Task 6.5 had one milestone to submit:

- MS28 Parameter database for various ERL & Linac facilities - Submitted and approved

Task 6.6: Far Future Concepts and Feasibility

(Max 1/2 page)

Progress towards objectives and significant results

Task 6.6 aims at studying the options and practicality of next and future-generation particle accelerators. During this reporting period, Task 6.6 organised its third topical workshop, this time on “Applications of Crystals and Carbon Nanotubes for Acceleration and Manipulation” (ACN2020). ACN2020 reviewed the state of the art for crystals in accelerators and discussed the path towards exploitation and promising applications of carbon nanotubes (CNTs). The workshop also promoted discussions between teams working on pertinent technologies and the beam physics community, in order to develop a roadmap. The ACN2020 talks and discussions highlighted that crystals are already – widely and successfully – used for assisting proton-beam collimation, local reduction of beam losses, positron production, dedicated particle physics experiments etc., but not yet for acceleration. CNT accelerators could be a steppingstone to crystal acceleration, while they also offer a multitude of other applications. Proof-of-principle experiments for CNT acceleration are being developed.



Figure 7: Live (left) and some of the remote participants of ACN2020 (centre), and 3D PIC simulation of near solid electron beam-driven crunch-in wakefield in a nanostructured tube of 200nm core diameter [A. Sahai] (right).

Contractual milestones and deliverables

In the P2 reporting period, Task 6.6 had no deliverables and no milestones to submit.

1.3 IMPACT

Include in this section whether the information from the Annex 1 (how your project will contribute to the expected impacts) is still relevant or needs to be updated. Include further details in the latter case. No need to fill if nothing has changed.

(Max 1/2 page)

The work carried out by WP6 and, especially, the results of the 26 workshops organized, or co-organized, in the first three years of ARIES confirm the impact anticipated in the Annex 1, namely that WP6 will produce and explore novel concepts to improve performance of all accelerators, including those for basic research, for applied research, and for medical and industrial applications. WP6 is developing design and operational strategies to improve availability of accelerators, impacting

all types of accelerators. The lively discussions in the events of all tasks, and the large number of workshops demanded by the European accelerator community, have highlighted the strong need for this type of NA, as had been foreseen. All WP6 objectives, declared in Annex 1, maintain a significant impact for the community. Several objectives have already been accomplished and disseminated. Further implementation of WP6 findings will follow the facility and project restart after the end of the Covid-19 lockdown. The WP6 is likely to make a considerable impact on the performances of FAIR, CERN LIU, HL-LHC, and FNAL PIP-II.

WP6 is also leading the way for sustaining, and even expanding, networking activities in the time of social distancing. The Task 6.6 topical workshop in mid-March 2020, during the eruption of the Covid-19 crisis, featured a mixed participation, with one third live attendees, and two third remote attendees (mostly hailing from Italy, UK, France, CERN, US and China). This WP6 ACN2020 workshop demonstrated the efficiency of a hybrid workshop and indicated the feasibility and scientific merit of small-size virtual workshops. Further WP6 activities may be organised in this format. In this way, ARIES is structuring the community effort during the Covid-19 crisis, keeping the European accelerator community united in a situation of stagnation and suspension, and providing an important continuity from the pre- to the post-corona era.

2. DEVIATIONS FROM ANNEX 1

Include explanations for tasks not fully implemented, critical objectives, deliverables, milestones not fully achieved and/or not being on schedule. Explain also the impact on other tasks on the available resources and the planning.

Tasks / Objectives/ deliverables/ milestones	Deviation ⁴	Justification	Impact on other tasks

2.2 Use of resources

Include explanations on deviations of the use of resources between actual and planned use of resources in Annex 1, especially related to person-months per work package.

⁴ Ahead of schedule/ Minor delay/ Significant delay

3. CRITICAL RISKS FOR IMPLEMENTATION

Please update the table below where needed: risks materialised, mitigations applied, new risks.

None of the foreseen risks materialised. A new risk is the Covid-19 outbreak, which affected NA activities. The Covid-19 risk is mitigated by organising hybrid and purely virtual WP6 workshops, lending an additional role and increased importance to the NA.

N°	Description of risk	WP	Proposed risk-mitigation measures	State of the Play reference Reporting period	State of the play mitigation measures applied	State of the play Risk Materialized	State of the play comments
1	Change of management team or WP Coordinators during the project (Likelihood: Medium; Impact: Medium)	6	Anticipate potential staff changes in the project management and WP coordinators and select suitable replacements within the consortium as soon as possible				
2	Withdrawal of beneficiary (ies) (Likelihood: Low; Impact: Low)	6	Other beneficiaries take over the responsibilities of the withdrawing partner or new beneficiaries are included in the project from the pool of collaborating institutes				
3	Reduced or undelivered contribution by one or more of the beneficiaries to the work programme of the project (Likelihood: Low; Impact: Low)	6	Redistribution of work and budget to other members of the consortium, with possible rescheduling of milestones and deliverables if needed				
4	Lower than foreseen participation to workshops (Likelihood: Medium; Impact: Low)	6	Allow the possibility to invite key speakers that would raise the technical standard of the NA workshops. Encourage participation by video-conference				

4. DISSEMINATION AND EXPLOITATION OF RESULTS

Scientific publications of WP6

Please update the table below with the publications in your WP. The publications below are only the ones added in Zenodo.

WP6	
N°	Author(s), Title, References, Date, Link
1	G. Guillermo, M. Ady, R. Kersevan, F. Zimmermann, D.C. Sagan, R. Cimino, E. La Francesca, Comparing Behaviour of Simulated Proton Synchrotron Radiation in the Arcs of the LHC with Measurements , Proc. IPAC'17 Copenhagen
2	K. Ohmi, N. Kuroo, K. Oide, D. Zhou, and F. Zimmermann, Coherent beam-beam instability in collisions with a large crossing angle , Phys. Rev. Lett. 119 , 134801 (2017)
3	F. Zimmermann, Future Colliders for Particle Physics – “Big and Small” , Proc. EAAC'17, La Biodola, 24-30 September 2017, Nucl. Instr. Methods A (2017)
4	G. Guillermo, D. Sagan, and F. Zimmermann, Examining mitigation schemes for synchrotron radiation in high-energy hadron colliders , Phys. Rev. Accel. Beams 21 , 021001 (2018)
5	M. Migliorati, E. Belli, M. Zobov, Impact of the resistive wall impedance on beam dynamics in the Future Circular e+e- Collider , Phys. Rev. Accel. Beams 21 , 041001 (2018)
6	M. Benedikt and F. Zimmermann, Proton Colliders at the Energy Frontier , invited article for Special Kai Siegbahn Issue of Nucl. Instr. Methods A (2018)
7	S. Fartoukh, M. Giovannozzi, D. Missiaen, E. Todesco, F. Zimmermann, Considerations on a Partial Energy Upgrade of the LHC , ARIES-2017-001; CERN-ACC-2017-096 (2017)
8	E. Belli, G. Castorina, M. Migliorati, G. Rumolo, B. Spataro, M. Zobov, Single bunch instabilities in FCC-ee , 9th International Particle Acceleration Conference, pp. 3336-3339, Vancouver, BC, Canada, May 2018. doi: 10.18429/JACoW-IPAC2018-THPAK052 .
9	E. Belli, P. Costa Pinto, M. Migliorati, G. Rumolo, T. F. Sinkovits, M. Taborelli, Electron cloud studies in FCC-ee , 9th International Particle Acceleration Conference, pp. 374-377, Vancouver, BC, Canada, May 2018.

10	A. Drago, Feedback Systems for Multibunch Beam Diagnostics and Instabilities Suppression , CERN Yellow Reports: Conference Proceedings, Vol. 1/2018. CERN-2018-003-CP (CERN, Geneva, 2018), pg. 39-43.
11	F. Zimmermann, LHC- and FCC-Based Muon Colliders , IPAC18 Vancouver, IOP J. Phys.: Conf. Ser. 1067 , 022017 (2018)
12	G. Guillermo Cantón, F. Zimmermann, G.H.I. Maury Cuna, E. D. Ocampo, Electron Cloud Build Up for LHC Sawtooth Vacuum Chamber , Proc. IPAC 18, Vancouver
13	M. Benedikt, F. Zimmermann, FCC: Colliders at the Energy Frontier , Proc. IPAC18, Vancouver
14	M.A. Valdivia Garcia, D. El Khechen, K. Oide, F. Zimmermann, Quantum Excitation due to Classical Beamstrahlung in Circular Colliders , Proc. IPAC18, Vancouver
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43	J.-P. Penttinen, A. Niemo, J. Gutleber et al., <i>An open modelling approach for availability and reliability of systems</i> , Rel. Eng. & Syst. Safety vol. 183 (2019) 387-399
44	Arto Niemi, Jussi-Pekka Penttinen, Availability and critical systems of the Future Circular Electron–Positron Collider , Nucl. Instr. Meth. A vol. 96321 (2020)
45	G. Franchetti, <i>Incoherent Effects of Space Charge and Sum Resonances on Particle Beams in a Storage Ring</i> , Phys. Rev. Accel. Beams 22, 114201 (2019).
46	G. Franchetti, <i>Coherent vs incoherent effects and Debye length</i> , IOP Conf. Series: Journal of Physics: Conf. Series 1350 (2019) 012124

Dissemination and communication activities

WP6	
Type ⁵	Author, Title, References, Date
Presentation Workshop	F. Hug, ERL recirculation optics for MESA, ICFA Advanced Beam Dynamics Workshop on Energy Recovery Linacs, Geneva, Switzerland, 2017
Poster	F. Hug, Application of Non-Isochronous Beam Dynamics in ERLs for Improving Energy Spread and Stability, IPAC, Copenhagen, Denmark, 2017
Presentation Workshop	F. Hug, Beam stability and energy spread at MESA, 650. Heraeus Seminar on Energy Recovery Linacs, Bad Honnef, Germany, 2017
Presentation other events	F. Hug, MESA - an ERL project for particle physics experiments, Invited talk at University Frankfurt, Germany, 2017

⁵ Press article, Newsletter, Presentation Workshop, Presentation other events, Poster, Other

Presentation Workshop	F. Hug, Welcome and ARIES Overview, Miniworkshop on Ion Sources, LEBT and RFQ Matching, Frankfurt, Germany, 2018
Pres. Workshop	G. Franchetti, Resonant dynamics in presence of space charge, Fermilab Workshop on Megawatt Rings & IOTA/FAST Collaboration Meeting, Bativa, USA 2018.
Newsletter	Panos Charitos, Accelerator reliability training help for experts, (APEC 6.3), Accelerating News, no. 22
Newsletter	M. Zanetti and F. Zimmermann, Workshop shines Light on Photon-Beam Interactions (APEC 6.6), Accelerating News, no. 23
Newsletter	M. Zanetti and F. Zimmermann, Discussing a future strategy for muon colliders (APEC 6.6), Accelerating News, no. 26
Pres. Workshop	M. Migliorati, M. Zobov, Impedance and instabilities in lepton colliders, International Workshop on Impedances, International Workshop on Impedances and Beam Instabilities in Particle Accelerators, Benevento (Italy), 18 - 22 September, 2017.
Pres. Workshop	A. Drago, Transverse Feedback Systems for Multibunch Beam Diagnostics and Instabilities Suppression, International Workshop on Impedances, International Workshop on Impedances and Beam Instabilities in Particle Accelerators, Benevento (Italy), 18 - 22 September, 2017.
Pres. Workshop	E. Belli, Impedance model and single beam collective effects for FCC-ee, FCC Week 2018 April 11, 2018 – Amsterdam.
Pres. Workshop	A. Drago, FCC-ee Feedback System Design Update, FCC Week 2018 April 11, 2018 – Amsterdam.
Pres. Workshop	A. Mostacci, Experimental challenge in linear and circular accelerators driven by impedance issues, ELOUD'18, 3-7 June 2018, Italy, La Biodola Bay, Isola d'Elba
Pres. Workshop	E. Belli, SEY measurements of coated surfaces with different coating thickness, ELOUD'18, 3-7 June 2018, Italy, La Biodola Bay, Isola d'Elba.
Pres. Workshop	A. Drago, Intra-bunch Feedback System development at DAFNE, ELOUD'18, 3-7 June 2018, Italy, La Biodola Bay, Isola d'Elba.
Pres. Workshop	E. Belli, NEG coating for FCC-ee, eeFACT2018 Sep 25, 2018 – Hong Kong.
Pres. Workshop	E. Belli, Single-beam instabilities in FCC-ee, eeFACT2018 Sep 25, 2018 – Hong Kong.
Pres. Workshop	G. Franchetti, Sum resonances with Space charge, 61st ICFA Advanced Beam Dynamics Workshop on High-Intensity and High-Brightness Hadron Beams, Daejeon, Korea, 17-22 June, 2018 Invited Talk.
Pres. School	F. Zimmermann, Linear Lepton Colliders, Circular Lepton Colliders, Circular Hadron Colliders and Beyond, Helmholtz School and Workshop, JINR Dubna (CALC2018), 22 July -1 August 2018

Pres. Meeting	F. Zimmermann, Beyond LHC – Future Circular Colliders, 20th Annual RDMS CMS Collaboration Conference, Uzbekistan, 12-15 Sept. 2018
Pres. School	F. Zimmermann, Machine Aspects of Future e+e- Colliders, Machine Aspects of Future pp Colliders, Pisa School on Future Colliders, 18 September 2018.
Pres. Workshop	F. Zimmermann, Future Circular Colliders, KIT workshop ‘The Future of Particle Physics: A Quest for Guiding Principles’, Karlsruhe 1-2 October 2018.
Newsletter	P. Charitos, F. Zimmermann, Future Circular Collider (FCC) Week2018, ICFA Beam Dynamics Newsletter no. 74 (2018)
Newsletter	M. Zanetti, F. Zimmermann, Muon Collider Workshop 2018, ICFA Beam Dynamics Newsletter no. 74 (2018)
Presentation Workshop	F. Hug, Status of the MESA ERL Project, ERL 2019, Berlin, Germany (invited talk).
Presentation Workshop	F. Hug, Beam Dynamics Layout of the MESA ERL, ERL 2019, Berlin, Germany.
Presentation Workshop	S. Thomas, Integration of the MESA Modules to bERLinPro for High Power Beam Tests, Berlin, Germany.
Poster	C. P. Stoll, F. Hug, <i>Beam Breakup Simulations for the Mainz Energy Recovering Superconducting Accelerator MESA</i> , IPAC 2019, Melbourne, Australia.
Poster	F. Hug, <i>MESA Facility</i> , ERL 2019, Berlin, Germany.
Presentation Workshop	A. Drago, <i>Suppression of the longitudinal coupled bunch instability in DAFNE in collisions with a crossing angle</i> , ARIES-ICFA workjshop MCBI Zermatt, September 2019
Newsletter	F. Zimmermann, <i>eeFACT2018</i> , ICFA Beam Dynamics Newsletter no. 75 (2018)
Newsletter	G. Franchetti, F. Zimmermann, <i>APEC2018</i> , ICFA Beam Dynamics Newsletter no. 75 (2018)
Newsletter	S. Casalbuoni, A.-S. Müller, F. Zimmermann, <i>ARIES-ICFA Workshop on ‘Beam Test and Commissioning of Low Emittance Rings’ at the Karlsruhe Institute of Technology (KIT)</i> , ICFA Beam Dynamics Newsletter no. 77 (2019)
Presentation Workshop	M. Migliorati, <i>Collective effects with tbar configuration</i> , invited talk at fifth International Future Circular Collider (FCC) Conference FCC week, 24-28 Jun 2019, Brussels, Belgium

Presentation Workshop	M. Migliorati, <i>Collective effects in the booster synchrotron</i> , invited talk at fifth International Future Circular Collider (FCC) Conference FCC week, 24-28 Jun 2019, Brussels, Belgium
Presentation Workshop	M. Migliorati, <i>Review of impedance-induced instabilities and their possible mitigation techniques</i> , invited talk at ICFA/ARIES mini-Workshop on "Mitigation of Coherent Beam Instabilities in particle accelerators" MCBI 2019, 23-27 Sep 2019, Zermatt, Switzerland
Presentation Workshop	G. Franchetti, <i>On the boundary between coherent and incoherent effects</i> , invited talk at 4th ICFA/ARIES Mini-Workshop on Space Charge 2019 4th CERN Space Charge Collaboration Meeting 2019, 4-6 November 2019, CERN