Accelerator Performance and Concepts
report from WP6

http://aries.web.cern.ch/content/wp6

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ARIES Annual Meeting

CERN, 22 April 2020

This project has received funding from the European Union’s Horizon 2020 Research and Innovation programme under Grant Agreement No 730871.
1. **APEC2018** workshop, Frankfurt am Main, Germany, 10-12 December 2018

2. **DAFNE as Open Accelerator Test Facility**, Frascati, 17 December 2018


4. **High Intensity RFQ meets Reality**, Heidelberg, 15-16 April 2019


6. **Mitigation of Coherent Beam Instabilities in particle accelerators** (MCBI2019), Zermatt, 23-27 September 2019

7. **Electrons for the LHC**, Chavannes-de-Bogis, 24-25 October 2019

8. **Space Charge mini-workshop**, CERN, 4-6 November 2019

9. **Accelerator Applications of Crystals and Nanotubes**, EPFL Lausanne, 10-11 March 2020
The average fraction of women participants increased from 15% (P1) to 17% (P2).
ARIES WP6 APEC - status of contractual obligations

Deliverables:

D6.1 Ranking of performance degrading mechanisms for hadron storage rings and synchrotrons (APEC 6.2) - M28 – approved
D6.2 Report on optimal RAMS characteristics for particle accelerators (APEC 6.3) – M36 – approved
D6.3 Summary of novel methods to reduce accelerator impedance (APEC 6.4) – M36 – submitted
D6.4 Report on outstanding open questions and prioritized R&D guidelines for ERLs (6.5) – M44
D6.5 White list of ranked far-future accelerator options (6.6) – M46

Milestones:

MS26 Report on 1st Annual workshops of all APEC tasks (APEC 6.1) - M12 – approved
MS27 Report on 2nd Annual workshops of all tasks (APEC 6.1) – M24 – approved
MS28 Parameter database for various ERL & Linac facilities (APEC 6.5) – M24 – approved
MS29 Report on 3rd Annual workshops of all tasks (APEC 6.1) – M36 – under construction
MS30 Strategies for e-cloud mitigation in future accelerators (APEC 6.4) – M40
MS31 Identification & prioritization of mitigation approaches (APEC 6.2) – M40
MS32 Feasibility of an Open Data Infrastructure for accelerator reliability (APEC 6.3) – M44
recent ARIES WP6 milestones and deliverable

- **MILESTONE REPORT**
  
  Report on 2nd Annual Workshops of all WP6 APEC Tasks
  
  **Milestone:** MS27

- **MILESTONE REPORT**
  
  Report on Parameter Database for Various ERL & Linac Facilities
  
  **Milestone:** MS28

- **DELIVERABLE REPORT**
  
  Ranking of performance degrading mechanisms for hadron storage rings and synchrotrons (M28)
  
  **Deliverable:** D6.1

- **MILESTONE REPORT**
  
  Report on Parameter Database for Various ERL & Linac Facilities
  
  **Milestone:** MS28

- **DELIVERABLE REPORT**
  
  Report on optimal RAMS characteristics for particle accelerators
  
  **Deliverable:** D6.2

- **MILESTONE REPORT**
  
  Report on 3rd Annual Workshops of all WP6 APEC Tasks
  
  **Milestone:** MS29

- **DELIVERABLE REPORT**
  
  Summary of novel methods to reduce or mitigate accelerator impedance (M36)
  
  **Deliverable:** D6.3
Maximum Beam Energy / Beam Current Scatter Plot

- Operational ERL facilities
- Past ERL Facilities
- Planned ERL Facilities
- Potential Next ERL Facilities
- NC ERL facilities

Florian Hug

from ARIES MS28 - database for ERL Facilities
APEC2018, Frankfurt

Example: RASP charts illustrating the variation of requirements with the type of accelerator (Andrea Apollonio)

APEC2018 tours of GSI UNILAC, GSI accelerator control room, and FAIR site

DAFNE TF, Frascati

Themes:
organisation of future LNF activities, positron beam lines and crystal applications, technology, positron, photon and kaon facilities, collider issues
### APEC2018 Survey: Impact of Effects

#### Laboratory Accelerator
- Fermilab Booster
- BNL RHIC
- CERN SPS
- SLAC/SSRL SPEAR3
- J-PARC Main ring
- INFN-LNF DAFNE
- GSI ESR
- GSI SIS18/SIS100

#### Main Intensity Limitations

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<th>Intensity limitation</th>
<th>ave</th>
<th>std</th>
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<td>1</td>
<td>Beam loss</td>
<td>3.12</td>
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<td>2</td>
<td>RF Power</td>
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<td>1.2</td>
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<td>3</td>
<td>Single bunch instability</td>
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<td>Multi-bunch instability</td>
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<td>6</td>
<td>DA</td>
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<td>7</td>
<td>Collimation</td>
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<td>1.09</td>
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<td>8</td>
<td>Momentum Acceptance</td>
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<td>E-Cloud</td>
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#### Main Brightness Limitations

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<td>Beam-beam</td>
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<td>IBS</td>
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#### Other Performance Limitations

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<td>Collimation</td>
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<td>1.21</td>
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<td>4</td>
<td>Dynamic vacuum</td>
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<td>Peak luminosity</td>
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<td>7</td>
<td>Quenches</td>
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<tr>
<td>8</td>
<td>UFO/dust</td>
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Beam Tests and Commissioning of Low Emittance Rings, KIT

→ «a renaissance of (low-\(\varepsilon\)) storage ring light sources» in full synergy with FCC-ee

37 presentations + 7 summary talks in 8 sessions:
- **Motivations, lessons and projects overview** (chairs: Dieter Einfeld, Qing Qin, Pedro Fernandes Tavares)
- **Injectors and injection** (chairs: Peter Kuske, Volker Schlott)
- **Insertion devices** (Nikolay Mezsntsev, Adriana Wawrzyniak)
- **Diagnostics, controls, automation, and feedbacks** (Ilya Agapov, Ubaldo Iriso, Ian Martin)
- **High current effects** (Louis Emery, Ryutaro Nagaoka)
- **Low emittance** (Les Dallin, Akira Mochihashi)
- **Optics design, measurements and correction** (Michael Boege, Catia Milardi)
- **Summary** (Sara Casalbuoni, Frank Zimmermann)

High Intensity RFQ meets Reality, Heidelberg

1) intensity limit of heavy ion beams due to RFQ
2) balance between ultimate performance and reliable operations
ECC Week 2019, Brussels, 24-28 June 2019

~410 participants, 240 talks and 50 posters highlighting study progress

FNAL accelerator dipole demonstrator achieves 14 T at 4.5 K

US wires with Artificial Pinning Centers “APCs” reach FCC target $J_c$ (=1.5x HL-LHC)!
Electrons for the LHC, Chavannes-de-Bogis

Themes:
optimising LHeC circumference and energy,
PERLE test facility status and plans,
using LHeC or PERLE type Recirculating Linac as FCC-ee injector (R. Corsini, O. Bruning)
Applications of Crystals and Nanotubes for Acceleration and Manipulation, EPFL Lausanne

Organizers:
Tatiana Pieloni, Marco Zanetti, Frank Zimmermann

10 live participants

a few of the 19 remote participants

3D PIC simulation of near solid electron beam-driven crunch-in wakefield in a nanostructured tube of 200nm core diameter [A. Sahai]

workshop summary available
ARIES and Covid-19

• Further implementation of WP6 findings will follow the facility and project restart after the end of the Covid-19 lockdown.

• WP6 is leading the way towards sustaining, and even expanding, networking activities in the time of social distancing.

• 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.

• 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.
upcoming HORIZON 2020 ARIES WP6 workshops

1. Mitigations for Beam Quality Control in Hadron Storage Rings and Synchrotrons, Germany, July 2020 (6.2)
2. Extreme Materials meet Extreme Beams, Germany, 2020 (6.2 with WS17) - tbc
3. eeFACT2020, La Biodola, Italy, September 2020 (6.2, 6.4) – postponed?
4. Accelerator detection or generation of gravitational waves and dark matter, 2020 (6.6)
5. Operating SRF Systems reliably in a "Dirty" Machine, Mainz, 10-12 November 2020, https://indico.him.uni-mainz.de/event/63/
6. DAFNE - Test Facility 2, Frascati, during 2020 (6.4)
7. Status of FAIR Phase 0 and post-LIU CERN, ?, end 2020 / early 2021 (6.2, 6.4)
8. APEC2020 strategy mini-workshop, Valencia, October 2020, Spain (6.1, 6.2, 6.3, 6.4, 6.5, 6.6)

maybe we will hold those marked in blue?
Accelerator Applications of Crystals and Nanotubes (6.6)

EPFL Lausanne, 10-11 March 2020
Organizers: Tatiana Pieloni, Marco Zanetti, Frank Zimmermann

Sessions or topics:
1) fibre accelerator
2) acceleration in carbon nanotubes
3) photonic band-gap structures
4) silica microtubes for deceleration
5) bending with crystals, crystal collimation
6) use of crystals for nanomodulating electron beams
7) positron production with crystals
8) bremsstrahlung from nanotubes
9) crystal nanomodulation of electron beams
10) crystalline undulators
Virtual workshop? Summer 2020?
Organizers: Giuliano Franchetti, Frank Zimmermann

Sessions or topics:
1) Optics techniques and schemes
2) Fighting nonlinear dynamics with nonlinear elements
3) Marriage & divorce of “Feedbacks” with “Landau damping”
4) Keeping the Vacuum “high”
5) Taming the high intensity
6) Injecting ripples on beam: shall we?
7) Special schemes: slow extraction et al.
8) Special tricks: Cooling and friends
9) Summary and prioritization
other ARIES WP6 activities

• **recruitments complete**: early stage researcher at HIT since 1 February 2019 (task 6.3) – other 6.3 work was contracted to AIT; one postdoc at INFN-LNF/Sapienza since 1 May 2019 (6.4); one postdoc at INFN Padua from 1 May 2018 (6.6)

• **machine studies** at FNAL booster in the frame of **space charge collaboration** (WP6 supported 3 young persons, total of 19 person-days at FNAL)

• covered **printing cost** for EuCARD **legacy proceedings** (e.g. proceedings of “Tracking for Collimation” WS)

• **collaborations** with KEK and US (FCC, SuperKEKB, ERLs,...)

• joint R&D with experts in Turkey and Iran on **ERL-based FEL**
  visiting scientist Najmeh S. Mirian: 3 (4) months stay at (outside) CERN

• **seminars** and partial speaker support
  e.g. Toshi Tajima, 13.02.2020, "Laser wakefield acceleration in nanostructures"
Appendix

WP6 publications & structure


G. Franchetti, Coherent vs incoherent effects and Debye, Proc. IPAC’19 Melbourne,

to be completed (see P2 draft report)


F. Hug, Application of Non-Isochronous Beam Dynamics in ERLs for Improving Energy Spread and Stability, Proc. IPAC’17 Copenhagen

M.A. Valdivia, F. Zimmermann, Optimized Monochromatization for Direct Higgs Production in Future Circular e+e- Colliders, Proc. IPAC’17 Copenhagen


M. Benedikt, F. Zimmermann, FCC: Colliders at the Energy Frontier, Proc. IPAC’18, Vancouver

F. Zimmermann, *Challenges for Future Circular e+e- Colliders*, Proc. eeFACT2018 Hong Kong

F. Zimmermann, *Report from ARIES Muon Collider Workshop in Padua*, Proc. eeFACT2018 Hong Kong

F. Zimmermann et al., *FCC-ee Operation Model, Availability and Performance*, Proc. eeFACT2018 Hong Kong

M.A. Valdivia et al., *Effect of Emittance Constraints on Monochromatization at the Future Circular e+e- Collider*, Proc. IPAC’19, Melbourne


To be completed (see P2 draft report)


to be completed (see P2 draft report)

M. Zanetti and F. Zimmermann, *Workshop shines Light on Photon-Beam Interactions* (APEC 6.6), *Accelerating News*, no. 23


F. Zimmermann, *eeFACT2018*, *ICFA Beam Dynamics Newsletter no. 75* (2018)


to be completed (see P2 draft report)
APEC structure

Task 6.1 Coordination and communication
Coordinated by Frank Zimmermann (CERN), Giuliano Franchetti (GSI)

Task 6.2 Beam Quality Control in Hadron Storage Rings and Synchrotrons
Coord. by Giuliano Franchetti (GSI), Frank Zimmermann (CERN)

Task 6.3 Reliability and Availability of Particle Accelerators
Coord. by Johannes Gutleber (CERN), Klaus Hoeppner (HIT), represented by Arto Niemi (CERN)

Task 6.4 Improved Beam Stabilization
Coord. by Mauro Migliorati (U. Roma Sapienza), Alessandro Drago (INFN-LNF)

Task 6.5 Beam Quality Control in Linacs and Energy Recovery Linacs
Coord. by Florian Hug (JGU Mainz)

Task 6.6 Far Future Concepts & Feasibility
Coord. by Marco Zanetti (INFN & U. Padova), Frank Zimmermann (CERN)