Elias.Metral@cern.ch

25 years at CERN in 2021

Past Section Leader (2010-20) on collective effects and beam instabilities: ~ 20-30 people

LHC coordinator (coordinator of PS, SPS and LHC Injectors Machine Studies before)

My last speech as Section Leader

Dear ABP colleagues and friends, I am very pleased to talk to you today. As this is my last speech as section leader after more than 10 years (and I do not have the possibility to show you the usual nice pictures from the section and the group from the last year), allow me few minutes to take some perspective and look briefly at the past before congratulating GianluigiA and the new ABP management team, wishing them all the best to guide us to write another excellent chapter of our group.

For those who do not know me well, I am Elias Métral, I am 49 years old and I am the happy father of 4 children. I had the honour and privilege to obtain the grade 9 three years ago, which we celebrated well of course with all the section and I would like to thank again all the team members of the past decade for their great help, all the people who helped me in my journey and our group leader of course: GianluigiA. During the last 15 years, I have been working in particular in very close collaboration with GianluigiA, with whom we tried to rebuild the expertise on impedance and collective effects. Many thanks GianluigiA for your support during all this time!

I come from the old PS division and when, at the beginning of the years 2000, the PS and SL divisions merged, I joined the "R&D and LHC collective effects" team led by an outstanding expert on collective effects, FrancescoR. At that time (between 2003 and 2006), we were only a few people working on impedance and collective effects as all the many previous world-famous experts retired: FrankZ, WernerH and his student TatianaP who joined at some point, helped by DanielS and AlexejG and FritzC (from the RF group). Fortunately, at the end of 2005, GiovanniR re-joined the team as staff member and since then we have been working together to try to rebuild a strong team. BenoitS rapidly joined us in 2006 and with him we re-built the impedance team (with the help of CarloZ in 2008 and NicolasM in 2009). When in 2007, our section leader FrancescoR passed away, we moved to the LIS section led by GianluigiA and in 2010 I had the honour to become the section leader of a new section on impedance and collective effects. I am very thankful to the past management for having allowed me to hire the many people we needed: we could be on average between 20 and 30 people over the last decade (with all the students and fellows, whose contributions were fundamental, and we were also helped a lot by excellent external collaborators). This team has become the biggest team in the world working on collective effects. Thanks to this critical mass we could participate to many studies and projects and bring important contributions, in the crucial time of the LHC Runs 1 and 2 and of the LHC Injectors Upgrade project. As concerns the current staff, XavierB and NicoloB joined the team already in 2010, GianniI in 2011 and LottaM in 2017.

Of course, I will have unfortunately no time to mention all the people who participated to this adventure, which is a pity as they all contributed to what we succeeded to achieve. But I do hope they know all that they will be always in my heart, that we are linked together forever and that they can always count on me as there is of course much more than only professional relations between us. I am delighted for having had the possibility to hire all the current 7 excellent staff members from the section (except GiovanniR). And I am also very happy for having had the possibility to participate to hire other (excellent) people who are still in the group and others (also excellent) who unfortunately could not remain with us. I would like to mention in particular some names and thank TatianaP who helped us a lot with all the beam-beam studies (with her supervisor WernerH and her student XavierB) and I am very happy that she recently got an important position at EPFL. I also think of KevinL who helped us a lot with the HEADTAIL code (initially written by GiovanniR and FrankZ) and who recently got an IC position in OP; ElenaB who is currently working for the TERA foundation, etc. We had also many excellent fellows who moved to other big labs like GSI, ESRF, DESY or SOLEIL. I would like to thank also all the experienced people I had the pleasure to supervise, ElenaW, WernerH, OlavB and FrankS, with whom it was always a pleasure to discuss to know more about CERN and its history. Their experience was very precious to me and the team as I always tried to find the proper balance between older and younger people, men and women, more theoretical and more pragmatic people, etc. It is such a great pleasure and privilege to be surrounded by so many brilliant people with excellent technical skills but also very good soft skills, with a lot of empathy and kindness. This is the case in the section but of course also within other sections of the group, with whom we were always working in close collaboration for both the current operation of the machines and the future projects or studies: with HannesB in particular for the Q20 optics, with StefanoR, RoderikB and team for the LHC collimators, with MassimoG, RogelioT and team for linear coupling and possible loss of Landau damping, with YannisP and team to find the proper trade-off between beam stability and dynamic aperture, with DanielS and FrankZ for FCC collective effects, with all the people working on simulation tools, etc.

When I started as section leader in 2010 I created 6 working groups on impedance, space charge, beam-beam, electron cloud, HEADTAIL development and beta beams. As I mentioned at that time, the idea was not to put boundaries around these activities but to follow these long-term activities, organising meetings with all the people interested from the section, from the group, but also from other groups and other departments, sharing all the info together, writing minutes (with actions), collecting references and giving more academic talks to help and re-build strong teams and facilitate the integration of the newcomers. These working groups are still alive (except the one on beta beams), and since then several other working groups were created. I think we can say that it was a great success and it participated to shape some part of the ABP group as it is today. I take the opportunity to thank all the people who were involved in all these working groups, in particular at the beginning when we had to launch all of them: this would not have been possible without a long-term vision and a wish to really share information between us and grow together. And I would like to thank OliverB, who was our group leader at that time, and who allowed me to do all this.

In 2010, the name of the section was ICE for Impedance and Collective Effects, where both coherent and incoherent aspects were studied. Then, it changed to HSC for Hadron Synchrotron Collective Effects in 2014 and then Hadron Synchrotron Coherent Effects in 2016, when the section was split in 2 with YannisP as new section leader to take care of the incoherent effects: he also took with him 2 working groups, beam-beam (led by him for some time) and space charge (now led by HannesB since 2018). Both working groups were already running for many years and I do hope this helped a lot YannisP and his team. As of 2021 the adventure of the section will continue with GiovanniR leading the CEI team for Collective Effects and Impedance and we will for sure write another important chapter on collective effects.

I love both beam dynamics and management, as well as leadership. What I love is to build something together, to imagine, create, develop, train teams, technically and in leadership, help them to grow both professionally but also personally. And I devoted all my enthusiasm and energy to do so. The section and the group was my top priority for the last decade and this is why I also declined to become a project leader, when Steve Myers and Paul Collier proposed it to me at some point. And I am therefore very grateful to GianluigiA for his constant positive evaluations as section leader and for having considered me as "a key member of the ABP management team".

However, I also think that 10 years is quite long and that it is now a good time to change: I certainly brought to the section all I could and it is time for someone else to take over. And it is certainly good and healthy at CERN to have periods with management roles and periods without management roles, giving also the possibility to our younger colleagues (with the proper skills of course) to take some management roles. I invite all the people to do so but at all levels of course: section leaders but also group leaders and department heads and deputies to show the good example. This is what I mentioned when we discussed this subject in detail two years ago within the ABP management team. This would be indeed the proof of an excellent and trusty management, leading by the example.

For more than 10 years, we had weekly section meetings and I have been very proud of the atmosphere we could create in the team and the many results which were obtained but I was in particular very proud of the way they were obtained, paying attention (as much as we could) to always acknowledge the work and contributions from the others, trying to involve all the relevant people and with a willingness to work openly, with respect and constructively with all of them: for this I would like to thank in particular BenoitS for having always shown the good example since the very beginning of this adventure. I profit also to congratulate BenoitS for having been an excellent scientific secretary for the 7 years of Paul Collier as chairman of the LHC Machine Committee (since 2014). I have no time now to discuss in detail the many HSC highlights of the past year, but those interested can join us during the last HSC section meeting on Monday.

It was a great pleasure and honour for me to lead such a great team for one decade and have GiovanniR be part of it: it will now be a great pleasure for me to continue to work within the team and have GiovanniR as section leader and he knows that he can count on all my usual enthusiasm and energy. I wish him and the team all the best and I do hope that GiovanniR will continue to have even more responsibilities in the future (he has been a remarkable LIU Deputy Project Leader since 2014), as well as several members from the section who proved already that they have all the necessary skills.

To conclude, I would like to congratulate GianluigiA and YannisP for their new well-deserved nominations and wish them all the best in their key positions. Many thanks also, congratulations and all the best to RichardS, remaining deputy group leader. Many thanks to the other past section leaders for all the work done, the many interesting discussions and the good time spent together during which we tried to do our best for the group, sharing between us all the necessary information to take the best decisions together: AlessandraL, RobertoC and MassimoG, for whom I have a lot of respect and friendship since the time we were both supervisors of the PS, 20 years ago (and who was recently replaced by RogelioT). Many thanks to AlessiaV for all her help in various activities, to all the group members and CERN colleagues with whom I had the pleasure to interact and to the many collaborators from all over the world. Last but not least: good luck to the new team of section leaders, which looks like a great team. We do hope that you will continue to guide us in the good direction and further develop the biggest group on accelerator physics in the world!

Happy Christmas everybody! Kind regards, Elias (11/12/2020).

MCBI 2019 workshop in Zermatt (which we co-chaired with TatianaP): it was a bit cloudy that day but GiovanniR knows how to remove all the (e-)clouds ;-)

ETTORE MAJORANA FOUNDATION AND CENTRE FOR SCIENTIFIC CULTURE

ICFA mini-Workshop on "Electromagnetic wake fields and impedances in particle accelerators"

23–28 Apr 2014
Europe/Zurich timezone

Enter your search term

- Overview
- Motivation
- Scientific programme and timeline
- International Advisory Committee (IAC)
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Support
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ICFA mini-Workshop on "Electromagnetic wake fields and impedances in particle accelerators" to be held in Erice, Sicily, in 2014 from April 24th to April 28th. The Workshop will be hosted by "ETTORE MAJORANA FOUNDATION AND CENTRE FOR SCIENTIFIC CULTURE".

THE ROOTS OF WESTERN CIVILIZATION

The quadrilingual gravestone in Ziza Museum in Palermo, Sicily.
The languages are Latin, Greek, Arabic and Hebrew. The dates appearing in the four languages, each computed in its own calendar, correspond to 1148 a.d. .

Starts 23 Apr 2014, 21:00
Ends 28 Apr 2014, 18:00
Europe/Zurich

Elias Metral
Vittorio Giorgio Vaccaro

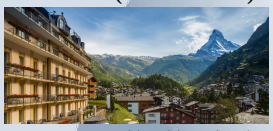
There are no materials yet.

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

MCBI 2019

ICFA mini-Workshop on Mitigation of Coherent Beam Instabilities in particle accelerators

23-27 September 2019
Zermatt (Switzerland)



Venue www.parkhotel-beausite.ch

Important dates

1st March 2019 Registration opens
30th April 2019 Abstract Submission Deadline
15th June 2019 Registration Closes

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https://indico.cern.ch/e/MCBI2019
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HB 2023

68th ICFA Advanced Beam Dynamics Workshop on High-Intensity and High-Brightness Hadron Beams

CERN, European Organization for Nuclear Research
Geneva, Switzerland 9-13 October 2023

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Chair : E. Metral
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Working Groups
Beam Dynamics in Rings
Beam Dynamics in Linacs
Accelerator Systems
Operations and Commissioning
Beam Instrumentation and Intercepting Devices

Deadlines
Abstract submission 15 July 2023
Registration 15 September 2023
Paper submission 1 October 2023

PHYSICAL REVIEW ACCELERATORS AND BEAMS **24,** 014401 (2021)

Intrabunch motion

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(Received 24 July 2020; accepted 4 January 2021; published 22 January 2021)

Impedance-driven (but not only) coherent beam instabilities are usually studied analytically with the linearized Vlasov equation, ending up with an eigenvalue system to solve. The eigenvalues describe the beam oscillation mode-frequency shifts, leading in particular to intensity thresholds defined by the longitudinal mode coupling instability in the longitudinal plane and by the transverse mode coupling instability in the transverse plane in the absence of chromaticity. This can be directly compared to measurements in particular for the lowest modes and in the absence of tune spread. In the presence of nonlinearities or when higher-order modes are involved, this becomes quite difficult, if not impossible, and the coupling between the modes cannot be directly measured (or simulated) anymore. Another important observable is the intrabunch motion, which can be also accessed analytically thanks to the eigenvectors. To the author's knowledge, until now, the intrabunch signal has only been explained theoretically for independent longitudinal or transverse beam oscillation modes, i.e., when the bunch intensity is sufficiently low compared to the mode coupling threshold. It was never explained theoretically in detail when two (or more) modes are involved. For instance, no answers were already given to these questions: is (are) there some fixed point(s) when the transverse mode coupling instability starts? If yes, where is it (are they)? And what happens in the presence of mode decoupling? Any number of modes can be treated with the general approach discussed in this paper, which is based on the GALACTIC Vlasov solver (which was previously successfully benchmarked against the PyHEADTAIL macroparticle tracking code as concerns the beam oscillation mode-frequency shifts). However, to be able to clearly see what happens when the bunch intensity is increased, the simple case of two modes is discussed in detail. The purpose of this paper is to describe the different regimes, below, at, above the transverse mode coupling instability and also after the mode decoupling (as it happens sometimes), using a simple analytical model (where two modes are considered together), which helps to really understand what happens at each step. Better characterizing an instability is the first step before trying to find appropriate mitigation measures and push the performance of a particle accelerator. The evolution of the intrabunch motion with intensity is a fundamental observable with high-intensity high-brightness beams.

DOI: 10.1103/PhysRevAccelBeams.24.014401

I. INTRODUCTION

The intrabunch signal for independent longitudinal or transverse beam oscillation modes, i.e., at sufficiently low intensity, has been explained analytically for impedance-driven coherent beam instabilities already several decades ago by Laclare in [1], and it has been observed and confirmed in many machines and macroparticle tracking simulation codes. In this case, applying the Vlasov equation to first order, the motion of the beam is described by a superposition of modes rather than a collection of individual particles, and one ends up with an eigenvalue system to solve (the interested reader could have all the details for instance in [2] and references therein). The result is an infinite number of modes of oscillation mq (as there are 2 degrees of freedom, the longitudinal amplitude and phase), with m the azimuthal mode number and q the radial one. The latter is defined as $q = |m| + 2k$ (with k an integer between 0 and infinity): with this definition, the radial mode number q represents the number of nodes of the superimposed (turn after turn) intrabunch signals, which is a usual observable in particle accelerators. The first radial mode corresponds to $k = 0$ and therefore $q = |m|$: in this case, and to simplify the notation, the mode $m|m|$ is usually written with only one number, the azimuthal mode number m. Examples of such intrabunch signals (superimposed turn after turn) are shown in Fig. 1 (left) for the case of the first two modes, 0 and −1. It can be seen, in particular, that these signals exhibit a clear left/right (head/tail) symmetry and

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PHYSICAL REVIEW ACCELERATORS AND BEAMS **24,** 041003 (2021)

Imaginary tune split and repulsion single-bunch instability mechanism in the presence of a resistive transverse damper and its mitigation

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(Received 22 January 2021; accepted 5 April 2021; published 21 April 2021)

A resistive transverse damper is often needed in particle accelerators operating with many bunches and it is usually very efficient as it can considerably reduce the necessary amount of nonlinearities needed to reach beam stability through Landau damping. In the CERN LHC for instance, the required current in the Landau octupoles is predicted to be reduced by an order of magnitude for zero chromaticity (for the beam and machine parameters used during the last year of Run 2, in 2018, this corresponded to ∼2000 A without damper and ∼200 A with damper, knowing that the maximum current available in the Landau octupoles is ∼550 A). However, a resistive transverse damper also destabilizes the single-bunch motion below the transverse mode coupling instability intensity threshold (for zero chromaticity), introducing a new kind of instability, which has been called ITSR instability (for imaginary tune split and repulsion). Until now, only one type of impedance-driven transverse coherent instability has been explained for a single bunch in a circular particle accelerator, at zero chromaticity and without a multiturn wake: the transverse mode coupling instability. A transverse mode coupling instability can also be observed in the presence of Landau damping, beam-beam, electron cloud or space charge. However, the ITSR instability exhibits a different mechanism, which is not due to mode coupling. The purpose of this article is to explain in detail both this new instability mechanism and its mitigation using a simplified analytical model, which has been carefully benchmarked, using the PyHEADTAIL macroparticle tracking code, by Oeftiger (one of the code's developers).

DOI: 10.1103/PhysRevAccelBeams.24.041003

I. INTRODUCTION AND MOTIVATION

A resistive transverse damper (TD) is needed, for instance, for multi-bunch operation in a machine like the CERN Large hadron collider (LHC) [1,2,3] and it has been working very well over the past decade, helping to reach twice the design peak luminosity. However, several simulations performed in the past with different (Vlasov solver and tracking) codes, considering a single bunch with zero chromaticity, revealed a more critical situation (as concerns the instability growth-rate or the required Landau octupole current needed to stabilize the beam) with TD than without [4,3] (and references therein). In 1998, Berg performed a theoretical analysis on a head-tail mode instability caused by a feedback, demonstrating that this instability is a general feature of machines with a transverse low-frequency feedback [5]. The paper was kept very general, mentioning in conclusion that "the perturbation theory arguments are very general, and apply to longitudinal as well as transverse impedances and feedback": no pictures were shown and the possible mitigation methods were not discussed. In 2005, Karliner and Popov proposed to use a feedback to cure the transverse mode coupling instability (TMCI), and a destabilizing effect of the TD could be also observed on some pictures but no model/explanation describing the cause/mechanism of this instability was given: it was referred to as a sort of TMCI [6]. Furthermore, as in the previous reference, the possible mitigation methods were not mentioned.

It is interesting to observe that the two main mitigation methods which are used to stabilize transverse coherent instabilities, i.e., Landau damping and transverse dampers [1], can be detrimental for the single-bunch stability when mode coupling is involved. The destabilizing effect of Landau damping on TMCI was demonstrated for the first time by Chin in 1985 [7]. It was rediscussed recently in [3] using a simplified model where only the lowest two modes couple and it is currently under detailed analysis without performing any approximation [8]. The aim of this publication is to explain in detail the physical mechanism behind the instability induced by a resistive TD and how it can be mitigated.

As mentioned in Ref. [9], better characterizing an instability is the first step before trying to find appropriate

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Eur. Phys. J. Plus (2022) 137:47
https://doi.org/10.1140/epjp/s13360-021-02264-4
THE EUROPEAN PHYSICAL JOURNAL PLUS
Regular Article

General mitigation techniques for coherent beam instabilities in particle accelerators

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Received: 29 June 2021 / Accepted: 5 December 2021
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Abstract An important number of coherent beam instability mechanisms can be observed in a particle accelerator, depending if the latter is linear or circular, operated at low, medium or high energy, with a small or a huge amount of turns (for circular machines), close to transition energy or not (below or above), with only one bunch or many bunches, with counter-rotating beams (such as in colliders) or not, if the beam is positively or negatively charged, if one is interested in the longitudinal plane or in the transverse plane, in the presence of linear coupling between the transverse planes or not, in the presence of nonlinearities or not, in the presence of noise or not, etc. Building a realistic impedance model of a machine is a necessary step to be able to evaluate the machine performance limitations, identify the main contributors in case an impedance reduction is required, and study the interaction with other mechanisms such as optics (linear and nonlinear), RF gymnastics, transverse damper, noise, space charge, electron cloud, and beam–beam (in a collider). Better characterising an instability is the first step before trying to find appropriate mitigation measures and push the performance of a particle accelerator, as some mitigation methods are beneficial for some effects and detrimental for some others. For this, an excellent instrumentation is of paramount importance to be able to diagnose if the instability is longitudinal or transverse, single bunch, or coupled bunch, involving only one mode of oscillation or several, and the evolution of the intrabunch motion with intensity is a fundamental observable with high-intensity high-brightness beams. Finally, among the possible mitigation methods of coherent beam instabilities, the ones perturbing the least the single-particle motion (leading to the largest necessary dynamic aperture and beam lifetime) and easiest to implement for day-to-day operation in the machine control room should be preferred.

1 Introduction

In September 2019, an ICFA mini-Workshop on "Mitigation of Coherent Beam Instabilities in Particle Accelerators" (MCBI 2019) took place in Zermatt (Switzerland), focusing on all the mitigation methods for all the coherent beam instabilities [1–4], reviewing in detail the theories (and underlying assumptions), simulations, and measurements on the one hand, but on the other hand trying to compare the different mitigation methods (e.g. with respect to other effects such as beam lifetime) to provide the simplest and more robust solutions for the day-

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Published online: 21 December 2021

The Xie Jialin Prize for outstanding work in the accelerator field, with no age limit.

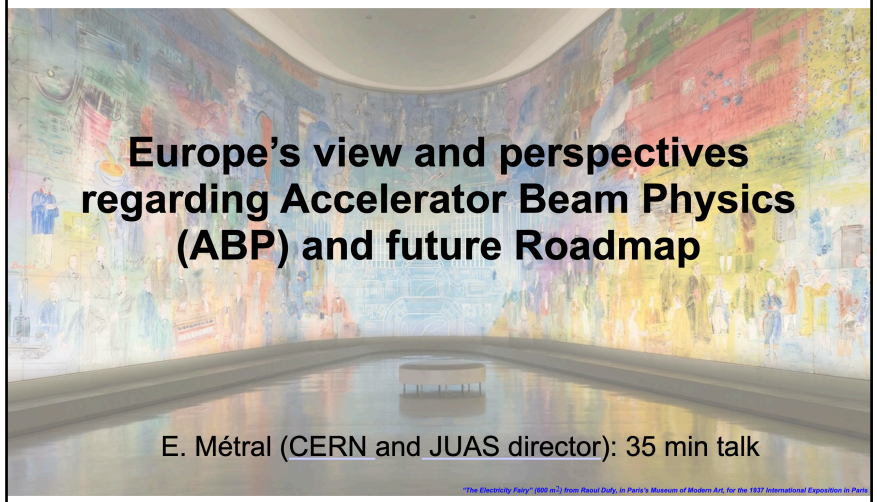
Prof. Vittorio Giorgio VACCARO

'For his pioneering studies on instabilities in particle beam physics, the introduction of the impedance concept in storage rings and, in the course of his academic career, for disseminating knowledge in accelerator physics throughout many generations of young scientists."

Just few words on him, as he could not join us…

E. Métral

E. Métral, IPAC'19, Melbourne, Australia, 23/05/2019

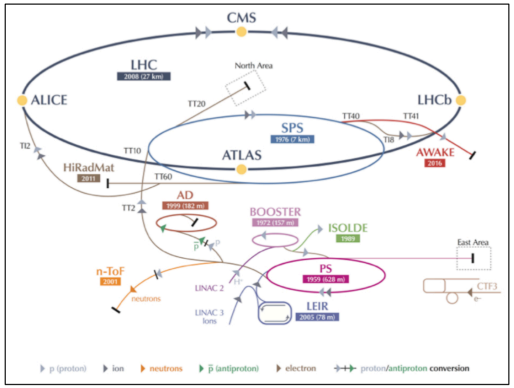


Alex Chao Symposium

E. Métral (Elias.Metral@cern.ch)

- Section leader of the CERN BE-ABP-HSC section (Hadron Synchrotron Collective/Coherent effects)
- Deputy director of the JUAS school (Joint Universities Accelerator School)

https://conf.slac.stanford.edu/alexchaosymposium/agenda



E. Métral, Alex Chao Symposium, SLAC, CA, USA, 25/10/2019

HiLumi HL-LHC PROJECT

Run 4 operational scenario (p+) and status of optics v1.6

E. Métral and R. Tomás for WP2 (15+5 min talk)

Task leaders: R. Bruce, X. Buffat, R. De Maria, M. Giovannozzi, G. Iadarola and G. Sterbini

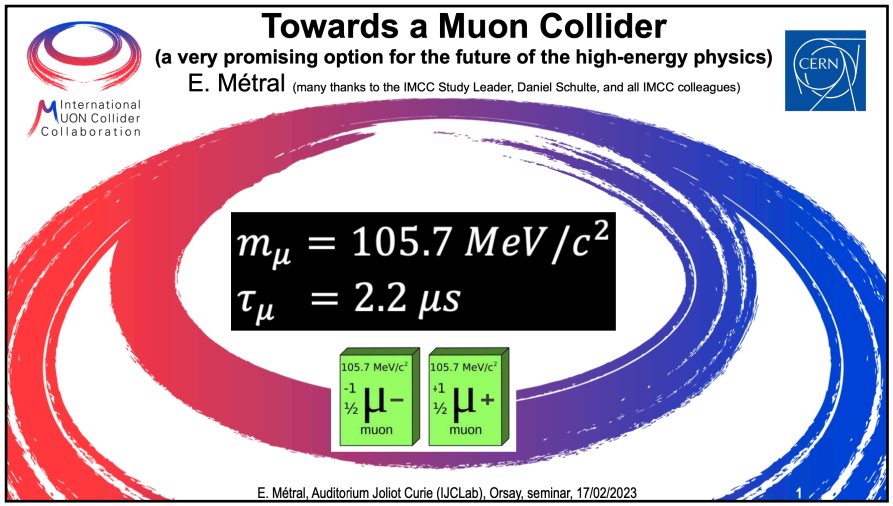
Scientific secretary: H. Bartosik

(who took over from N. Mounet => Many thanks for all the past work!)

E. Métral - 12th HL-LHC Collaboration Meeting, Uppsala, Sweden - 19/09/2022

IMCC

International MUON Collider Collaboration



Muon Beam Panel in 2021

Collective effects

CERN Report CERN-2022-XXX

Parameters list for the International Muon Collider Collaboration

Editors: E. Métral and D. Schulte

=> Overleaf document started last year, which needs to be filled…