Beams Department

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Editorial

Chers lecteurs, chères lectrices,

Cet éditorial est pour la deuxième fois dans la langue de Voltaire, en compensation des articles qui sont majoritairement en anglais. Le sondage en 2012 a démontré que le choix du langage ne vous arrête pas de lire l’article pour 88% d’entre vous. Néanmoins, n’hésitez pas à soumettre des contributions en français, vous, les futurs auteurs.

Cette Lettre d’Information attire beaucoup d’intérêt, même au-delà du département. La preuve en est que Stefan Lüders (IT) s’est porté volontaire pour expliquer le réseau de contrôle des accélérateurs et surtout les moyens de le rendre moins vulnérable. Je vous laisse également découvrir des activités variées et diverses dans notre département, peu connues pour la plupart d’entre nous.

Voilà une année très intense qui se termine, avec des promesses tenues à nos communautés de la physique cible fixe, ions et antiprotons, malgré des redémarrages difficiles. Les efforts soutenus se poursuivent pour mettre en état la nouvelle version de la machine LHC, jusqu’à maintenant, sans encombres majeurs.

Il me reste à vous souhaiter un repos bien mérité, en famille et entre amis, profitant des bonnes choses, sans abus ni exagération, pour se retrouver avec les batteries rechargées pour une nouvelle année !

Joyeuses fêtes !

Ronny Billen
Editor, BE Newsletter

The next issue will be published beginning of April 2015. Contributions for that issue should be received end of March 2015.

Suggestions for contributions are always most welcome: simply contact your Correspondent (see last page).
The field of particle acceleration has become a milestone not only in science but in society. Fields like medicine profit enormously of any advance in the field to develop new tools for treatment and diagnostic of diseases. In this sense, the Compact Linear Collider (CLIC) project is based in normal conducting high-gradient acceleration which opens the path to compact machines. In the CLIC Test Facility (CTF3) an experiment has been installed to better understand the high-gradient acceleration in copper structures.

The CLIC project [1] aims to collide electrons and positrons, accelerated in two opposing linacs using normal conducting high-gradient accelerating structures. The main limitation for the achievable gradient is the RF breakdown effect which results in luminosity loss due to the transverse kick on the beam. In order to limit this effect, a maximum breakdown (BD) rate of $3 \times 10^{-7}$ BD/(pulse m) at the nominal gradient of 100 MV/m has been established. During the last years, an extensive program has been carried out to reach the specified 100 MV/m, understand and control the RF breakdown rate in prototype CLIC accelerating structures. Results demonstrate that such high gradient fields at low breakdown rates are indeed achievable.

In contrast, all breakdown high-gradient tests so far have been performed without the presence of an accelerated beam inside the structure. To achieve a highly efficient RF-to-beam transfer of energy, a high level of beam loading is needed which unavoidably modifies the longitudinal field profile (Fig. 1) affecting the breakdown rate in an unpredictable way. The whole-structure breakdown rate varies approximately with electric field $E$ to the 30th power when input power is varied. On the other hand, the breakdown rate distribution inside a structure varies linearly with the electric field. In order to experimentally measure the effect of beam loading on breakdown rate, an experiment is running at CTF3 using a 12 GHz klystron connected to a CLIC prototype accelerating structure loaded by the drive beam of the facility (Fig. 2).

The experiment is located in a dogleg line branching off midway from the CTF3 drive beam linac where a 24 cell CLIC prototype accelerating structure has been installed (Fig. 3). Two Beam Position Monitors (BPMs), located upstream and downstream of the structure, measure the beam current sent through. An upstream collimator prevents damage in the case of beam losses. Two beam loss monitors based on diamond and optic fiber detection have been recently installed to test their potential to detect particles scattered or created by the breakdowns.
The 12 GHz (X band) RF used for the acceleration inside the structure is provided by the XBOX 1 test stand (Fig. 4) which comprises a solid state modulator, a 50 MW klystron and a SLED I pulse compressor. The system provides up to 250 ns of 140 MW RF power transported through 35 m low-loss waveguides to the structure. The incident, transmitted and reflected RF power from the structure are measured continuously. A sudden drop of transmitted and an increase in the reflected power are clear signatures of a breakdown.

Fig. 4: 12 GHz test stand so called XBOX 1

A 3GHz bunched beam of 1.2 A is used to load the structure. The CTF3 drive beam injector can be manipulated to produce the required beam with a pulse repetition rate of 25 Hz and is flexible enough to swap daily from standard to dogleg operation with minimum effort. Additionally, the stability of the system is continuously being improved, allowing the facility to run already during nights and weekends without human intervention, only under supervision of PS operators.

The experimental conditions were carefully set, adjusting the RF flat top and the relative beam-RF phase sag introduced by the compression system. The experiment started to collect breakdown data by mid-September 2014. The loaded and unloaded breakdown rate has been measured three times at constant input power of 29 MW which corresponds to an unloaded (loaded) accelerating gradient of 85 MV/m (67 MV/m). The results (Fig. 5) show that the presence of the beam in the structure does not increase the breakdown rate when the input power is kept constant. Currently, the experiment is being repeated to collect data for the beam loading effect when the accelerating gradient (instead of the input power) is kept constant.

In the following months, the experiment will be repeated while increasing the RF input power. In addition to the main goal of the experiment to measure the influence of beam loading, other complementary and interesting measurements can be performed. These can help understand the physics behind the breakdown phenomena and facilitate designing more efficient accelerating structures.

Fig. 5: Structure breakdown rate for loaded (red) and unloaded (green) periods.

The commissioning and the operation of the experiment is the result of the big effort and the smooth collaboration between the different groups of the BE department, which includes the ABP, BI, CO, OP, RF groups and the TE-VSC group.

**Conclusion:** The CLIC/CTF3 collaboration has successfully commissioned and run the first and only experiment worldwide able to measure the effect of beam loading in high-gradient accelerating structures. First results show that the beam loading does not increase the breakdown rate when the input power is kept constant. It sheds light on the understanding of breakdown phenomena and contributes to the development not only in the accelerating science community but also on future applications of general interest for society.


Jose Luis Navarro Quirante,
Frank Tecker,
BE-OP-PS/CTF3
Independence for Controls

In 2006 CERN’s Technical Network (TN) was logically decoupled from the General Purpose Network (GPN) by an initiative of the Computing and Network Infrastructure for Controls (CNIC) working group. Many hardware and software development instances for accelerator and infrastructure control systems had to be kept connected to the TN due to the then upcoming start-up of the LHC and the consequent wish to keep the impact of such a decoupling small. Hence, while the TN was intended to be a network for accelerator and infrastructure operations, many devices connected to it served and still serve for pure development or testing purposes. But is this how it should be?

While this approach might be convenient (and eventually reasonable in 2006), today this way of including development instances on the TN might be considered sub-optimal with respect to an efficient and effective software development, and a safe and secure operation of CERN’s infrastructure and accelerators. In particular, an improved approach would be strongly advisable with a long-term view on future projects potentially to be hosted at CERN. Therefore, we should strive to separate as much as we can development and initial testing on the one hand, and deployment/debugging, operations and maintenance on the other hand. The latter should be performed on or with connection to the TN while the former should be solely happening on the GPN.

In order to achieve this, it is important in a first step to have a TN acceptably independent from other networks. Several so-called “TN Disconnection Tests” have been conducted in the past, i.e. in March 2013, January 2014 and, lately, in September 2014, in order to verify whether such independence has been achieved. While a series of minor issues have been identified (see the minutes to the CNIC meeting: https://indico.cern.ch/category/691/, in particular the last test of September 2014 has shown that accelerator operation is – principally – possible without a network link to the CERN GPN. So far, these “Disco Tests” have been a valuable tool to improve control system design and to reduce hidden and unwanted dependencies.

In a second step, it is essential to replicate all important data sources such that developers and development systems have all up-to-date status information from accelerators and infrastructure at hand without a need to interfere with operations, e.g. polling data from operational front end devices. Whether this replication is done via database duplication, via read-only file system/data proxies, or application gateways is a technical question to be addressed by the competent people. Once this duplication has been accomplished, initial software development shall be possible from the GPN alone for a majority of systems.

In a third and maybe the most difficult step, we should identify those hardware systems which can be cloned such that we have a full-fledged test stand which can be freely manipulated without impacting Operations. Ideally, those test stands are connected to the GPN but still monitored and configured via the same channels as the hardware used in operation. Again, this would imply that the aforementioned duplication of data sources has been accomplished. Admittedly, our accelerators are all one-time prototypes such that for some sub-systems the benefit of using test stands might be limited. Still, for the bulk it would neatly separate again development/testing and operations/maintenance…

Thus, while today accelerator operations and development are tightly entangled, we should start discussing how software development and initial testing should be done in the future. If we would start from scratch today, with all the experience we have now, would we end up in the same configuration? We are looking forward to your opinion!

Do you want to learn more about computer security incidents & issues at CERN?

Stefan Lüders,
CERN Computer Security Officer
IT-DG-CSO
The Smooth Upgrades Working Group

During the long shutdown the controls group and its partners have done radical changes at all layers of the controls system. This includes hundreds of front-end computer installations and their cabling, a new Linux operating system version, a new version of the front-end software (FESA3), a new version of the controls middleware (RDA3), massive changes in the applications (e.g. InCA), and many more. Since LS1 is almost over and most accelerators are operational, the controls system must be very stable again. Only small upgrades are possible, most of which cannot be done during operational periods but only during the technical stops (TS). In other words, a lot of upgrade work has to be concentrated in short periods of time. This is quite error prone, and requires good coordination between dozens of people from many teams. Without such precautions, a TS ends with a long and difficult recovery and unscheduled downtime.

The mandate and composition

In fact, the smooth upgrades working group (SUWG) was created in early 2012, after a few technical stops with difficult and long recovery and downtime for the LHC. The SUWG was given the mandate (1) to make sure the necessary upgrades during TS can be safely carried out (2) to avoid or reduce downtime after TS caused by upgrades (3) to improve collaboration and communication across the accelerator sector and (4) to keep OP informed during all phases of the upgrade workflow. As members, the SUWG has one representative from each equipment groups, one OP representative per CCC island, one from each section of the CO group, and one each from EN/ICE, TE/MPE, and GS/ASE.

But why are upgrades needed at all? Why not just freeze the controls systems once an accelerator is running? As a matter of fact, upgrades are necessary. Security patches of the operating system and other 3rd party software have to be installed at regular intervals. Improvements and new functionality are requested by operations, enhancements to optimize reliability and troubleshooting bugs need to be done, and bugs have to be fixed.

The vision

Because the controls cannot be frozen, upgrades must be possible to do in a smooth and safe way during TS. The medium-term vision is to foster a development culture were controlled changes are not only possible but a normal fact of life. Developers (and operators) should not be wary of upgrades; they should know they can be confident of successful execution. Such a vision is based on (1) criteria and guidelines helping the developers to plan their upgrades, (2) a workflow (a series of well-define steps) during and after the TS that guarantee the best possible planning and coordination.

Criteria and guidelines for preparing upgrades

When planning their upgrades, the developers and experts are encouraged to use the following criteria and guidelines.

They must have some good motivation to do an upgrade. This can be a request for functionality or improvement by OP, or a bug waiting to be fixed. It can also be an intervention proposed by a controls or equipment expert that has a medium term benefit for operations, e.g. because it makes the controls system more stable or troubleshooting easier.

They must analyse the risk of an upgrade beforehand, and plan for efficient recovery in case of problems. Risk is a combination of three factors: (1) the impact a problem might have on operations, (2) the likelihood that the problem happens and (3) the ease of recovering if it does. A high risk intervention can only be accepted if either the probability is very low or the recovery fast and reliable. For example, introducing a new version of the Java runtime can have a serious impact on operations (the applications might stop working). However, this is very unlikely, and it is relatively easy to rollback.

They must reduce the impact of their upgrade on other systems. Ideally, their component or subsystem should be upgraded in a backward compatible manner. In this case, their component can be upgraded individually, i.e. without need of adapting any other component in the controls system. For example, if a new version of a FESA class is deployed, it should have backward compatible device/properties. Otherwise, dozens of developers would have to simultaneously adapt their client software applications that communicate with the device, which is not feasible during a TS.
Any upgrade must be thoroughly tested before it is deployed. This comprises testing the functionality of the upgraded component itself (Unit Testing), but also correct functioning of the component with the rest of the controls system (Integration Testing). Also, if a component is supposed to be backward-compatible, this must be properly tested.

**The SUWG workflow**

The SUWG members carry out the following workflow, which spans over a period of three weeks: two weeks before a TS and one afterwards. Two important meetings take place: a planning meeting a week before the TS, and a follow-up meeting a week after.

Before the planning meeting, each SUWG member collects information about upgrades planned in their section or group and lists those plans in a standardized Excel sheet. This Excel sheet has columns corresponding to the criteria above, describing motivation, systems affected, risk mitigation and recovery, testing procedures, etc. Each SUWG member sends her Excel sheet to the SUWG leader at least a day before the planning meeting. The SUWG leader analyses all entries and identifies a list of upgrades that need to be discussed in the planning meeting. This list typically includes upgrades that are intrinsically risky, upgrades that potentially have a high impact on other systems if they fail, upgrades without a good recovery strategy, or upgrades that are not backward compatible and therefore required adaptations in other systems. Upgrades that are low-risk or limited in their impact need not be discussed.

In the SUWG planning meeting, the experts from all areas discuss the list of upgrades mentioned above. Potential impact of an upgrade and side effects are analysed. Shaky recovery plans are improved. The correct order of carrying out upgrades is established. In some cases, the SUWG members will conclude that an upgrade is too risky and should not be carried out. The presence of several experts is often needed to clarify all aspects, and the input from OP is vital to decide which upgrades are important and which ones can or should be avoided or postponed.

After the meeting the decisions about planned upgrades are published on the SUWG web site and announced in the FOM meeting preceding the TS. This forum gives the final go-ahead for the interventions.

During the TS, many of the SUWG experts gather in the CCC to carry out the interventions. This facilitates clear coordination, fast decision taking and efficient diagnosis of problems. The SUWG leader is present to follow-up progress and to coordinate and call in experts if necessary.

For the review meeting after the TS, all experts update the Excel sheet again with information on the status of the upgrades: which upgrades were carried out successfully, which ones with difficulties and which ones were abandoned. In the SUWG follow-up meeting, the difficult and unsuccessful cases are discussed to see what happened and what lessons can be learned for the next TS. Again, the outcome of the TS is published on the SUWG web page and reported in the following FOM.

It is important that operations and other stakeholders are involved and informed during all phases of an upgrade. In the planning phase, OP responsible must participate in deciding on the upgrades to carry out. During the TS, operators on shift must be kept up-to-date on the progress of the work. After the TS, they should be instructed how to recognize potential problems, to react effectively and call the right expert.

**Experience so far**

So far, the SUWG has been active for five technical stops, four in 2012 and one in 2014, and the experience so far has been quite positive. Almost all SUWG members took their task seriously and collected exhaustive and precise information in the Excel sheets. Several of them expressed their satisfaction and pride of being part of this team. Indeed, the discussions between technical experts from many different groups and sections has fostered better understanding of the controls system as a whole, and raised awareness of interdependencies between different parts of the controls system, and possible side effects of changes. The meetings also created the opportunity to exchange information about best development practices between the members. Last but not least, the SUWG encourages developers to analyse, before each TS, the motivation of doing an upgrade, the risk it poses to operations, and the way to recover from a failure. This in itself is already a big step ahead.

At the management level, the value working group has been recognized, and the scope has recently...
been extended in three ways. Firstly, it now comprises not only the LHC as in 2012, but also the injectors. Secondly, it shall cover not only software interventions as in 2012, but also hardware interventions. Thirdly it now not only covers technical stops during the run, but also the upcoming short Christmas shutdown.

Vito Baggiolini BE/CO, Leader of the SUWG

A Cryogenic Beam Current Monitor for Low-Energy Antiproton Facilities

In the low-energy Antiproton Decelerator (AD) and the future Extra Low ENergy Antiproton (ELENA), a precise measurement of the beam intensity is essential to monitor any losses during the deceleration and cooling phases.

However, this is rather challenging with traditional beam current diagnostics due to the low intensity of the antiproton beam with of the order of $10^7$ particles, corresponding to beam currents as low as a few hundred nano-Amps. To cope with this, a Cryogenic Current Comparator (CCC) based on a Superconducting QUantum Interference Device (SQUID) is currently being designed to be installed in the AD, and possibly also in the future ELENA ring (Fig. 1).

The current project is a collaboration between CERN, GSI, Jena University and the Helmholtz Institute Jena, where prototypes of this monitor have been developed in the past. The first installation in the AD will use the magnetic shield and ferromagnetic core components that were previously developed by these institutes, with the other components being adapted to the AD beam parameters. The cryostat used to house the detector (Fig. 2) is being designed by TE-CRG, and will be combined with a Helium re-condensing unit and pulse-tube cryo-cooler for a stand-alone solution.

The main advantages of the CCC monitor are:

- Measurement of bunched and coasting beams
- Beam current resolution $< 10 \text{ nA}$
- Insensitivity to beam shape, trajectory and energy
- Absolute calibration possible with additional current loop

The current requirements for the cryo-system are: availability, reliability and minimal mechanical vibrations in the CCC monitor.

Fig. 1 - Schematic of the CCC monitor. The azimuthal component of the beam’s magnetic field is coupled into a ferromagnetic core that is shielded from all other magnetic field components.

Fig. 2 - Cryostat design developed to house the CCC monitor to be installed in the AD. This consists of a liquid He vessel, a thermal radiation shield and an isolation vacuum vessel. A longitudinal opening allows for the integration into the AD beam line. The cooling power will be provided by an external helium re-condensing unit.

Measuring the induced magnetic field for such low intensity beams (a few pico Tesla compared to the earth’s magnetic field of ~50 micro Tesla) requires a very good shielding from everything apart from the beam’s azimuthal field. This is achieved using a superconducting meander structure as seen in Fig. 1. It also requires a very sensitive...
magnetometer, which in this case is a SQUID sensor.

![Image](image.png)

**Fig. 3 - Transfer function of the SQUID sensor:** voltage as a function of the coupled magnetic flux in units of flux quanta \( \Phi_0 \). In the Flux Locked Loop mode the input is kept around a constant point – in red – by means of an electronic feedback loop.

The transfer function of the SQUID is shown in Fig. 3. To deal with this periodic behaviour, feedback electronics is used to keep the total SQUID input magnetic flux at a constant value by cancelling the field to be measured with the field generated by the current of the feedback loop. This is a so-called Flux Locked Loop. Knowing the current injected by the feedback loop then allows the input magnetic field to be determined and hence the related beam current.

Beam measurements taken early this year at GSI, with an older prototype of the CCC monitor, have confirmed its capability of measuring very low beam currents. Fig. 4 shows the monitor’s response to a set of 50 nA calibration pulses.

![Image](image.png)

**Fig. 4 - Measurement of calibration current pulses with 50 nA of amplitude. The noise floor RMS value is only 2 nA.**

We expect to perform the installation of the new monitor in time for the AD run of 2015, in order to test the monitor performance with the AD beam before a possible future installation in the ELENA ring and for the FAIR project at GSI.

Cryogenic current monitor team:

**CERN:** Miguel Fernandes, Jocelyn Tan, Lars Soby, Torsten Koettig, Andrew Lees

**GSI:** Febin Kurian, Markus Schwickert, Hansjoerg Reeg

**Jena University and Jena Helmholtz Institute:** René Geithner, Ralf Neubert

Miguel Fernandes, 
BE-BI-P1

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**Les EIS : vous connaissez ?**

**Que peut signifier cet acronyme ?** Au CERN, il s’agit des *Éléments Importants pour la Sécurité*. Ce sont des éléments fondamentaux pour la sécurité du personnel.

Il en existe de trois types. L’un d’eux est bien connu car utilisé par bon nombre d’entre nous: ce sont les points d’accès aux accélérateurs. Ils font partie des EIS de type Accès, logiquement dénommé EIS-Accès. En font également partie, les portes ou grilles, murs de blindage mobiles, trappes qui délimitent physiquement les zones où il peut y avoir du faisceau. Ces EIS appartiennent au groupe GS-ASE.

Les deux autres types d’EIS sont les EIS-Faisceau qui protègent le personnel vis-à-vis des dangers liés aux faisceaux (injectés ou circulants) et les EIS-Machine qui eux, protègent le personnel des dangers liés au fonctionnement des machines (danger électrique, rayons X, …). Certains équipements remplissent exclusivement ce rôle d’EIS comme c’est le cas des beam stoppers et electron stoppers alors que pour d’autres, il s’agit d’une fonctionnalité supplémentaire comme par exemple pour les beam dumps, les aimants et convertisseurs de puissance associés, les écrans. Ces EIS appartiennent à une dizaine de groupes faisant partie du secteur A&T (BE-ABP, BE-BI, BE-RF, TE-EPC, TE-MSC, TE-VSC, TE-ABT, EN-STI, EN-MEF, EN-EL).
Ils sont identifiables grâce à un même logo :

Les EIS sont présents dans les trois complexes accélérateurs (PS, SPS et LHC). Ils sont identifiés en Layout grâce à un travail mené conjointement par les groupes BE-CO et EN-MEF ainsi que la Safety Unit du département BE. Le Layout est utilisé comme point d’entrée vers la documentation opérationnelle des EIS.

Comment ces éléments peuvent-ils protéger les personnes ?

Les EIS sont reliés au système de sûreté d’accès ("Personnel Safety System") du complexe correspondant et interagissent entre eux via des fonctions (ou des “chaines”) de sécurité définies selon la norme CEI 61-508 relative à la “Sécurité fonctionnelle des systèmes électriques/électroniques/électroniques programmables relatifs à la sécurité”. Ce système redondant (voie câblée et voie PLC) est de haute fiabilité (SIL 3).

Ce système redondant (voie câblée et voie PLC) est de haute fiabilité (SIL 3). Pour le complexe PS, il est connu sous l’appellation PASS, et au LHC sous l’appellation LASS.

Sa fonction est la suivante :

- En cas de faisceau ou de possibilité d’injection de faisceau : pas d’accès autorisé.
- En cas d’accès : pas de faisceau autorisé.
- En cas d’intrusion d’une personne dans une zone où un faisceau dangereux peut être présent, les EIS-Faisceau vont être commandés de façon à arrêter ou dévier le faisceau en amont de cette zone.

Compte tenu de l’importance des EIS pour la sécurité des personnes, un niveau de disponibilité et fiabilité élevé est exigé. Aussi, ils font l’objet de tests périodiques par les groupes propriétaires puis d’une validation globale par le DSO du département BE lors des tests dit “tests DSOs” préalables à l’autorisation de faisceau dans une zone.

Fig. 1: Electron stoppers LHC (EIS-Machine)

Fig. 2: Beam stopper TBSE 2106 (EIS-Faisceau)

Anne Funken,
BE-ASR-SU

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2 Safety Integrity Level au sens de la norme CEI 61-508
## Ma liste de contrôle avant l’hiver

### Contrôle des voitures :

- Vérifier l’état des pneus : usure, pression, équilibrage et géométrie. Les pneus neige sont conseillés dès que la température descend en dessous de 7 degrés.
- Vérifier les niveaux et la qualité de vos huiles : utiliser un liquide de refroidissement et une huile de moteur, sans oublier un liquide lave glace adaptés aux conditions hivernales.
- Avoir un « kit de dégivrage » : grattoir, balayette, lampe de poche, gants, etc.
- Vérifier le bon fonctionnement de tous les feux de votre véhicule.

### Check-list to prepare the cars:

- **Check the tires**: wear, pressure, balancing and geometry. Snow tires are recommended when the temperature goes under 7 degrees.
- **Check the level and the quality of the oil**: use a coolant and engine oil plus a windscreen washer adapted to winter conditions.
- **Have a « defrost kit »**: scraper, brush, flashlight, gloves, etc.
- **Check all the lights of your car**.

Adaptez la conduite aux conditions climatiques

### Contrôle des vélos :

- Vérifier l’état des pneus. Il existe des pneus dits « à clous » qui adhèrent mieux à la route et résistent au froid.
- Vérifier l’état des freins à chaque trajet.
- Installer des gardes boue pour se protéger des éclaboussures d’eau, de boue ou de neige.
- Vérifier l’état des éclairages.

### Check-list to prepare the bikes:

- **Check the tires**: Studded tires exist for bikes. They adhere better to the road and are resistant to cold.
- **Check the breaks** before each trip.
- **Install mudguards** to protect against splashing water, mud or snow.
- **Check the status of the lights**.

Adapt the clothing by protecting the ends of your body against the cold. Do not forget the helmet and the yellow reflective jacket!

### Contrôle des skis :

- Faire régler les fixations de ski avant chaque saison. Le corps change ce qui influence la valeur de déclenchement des fixations. Seules des fixations réglées annuellement se déclenchent au bon moment. Cela évite les blessures aux jambes et aux genoux.
- Vérifier si les lunettes et le masque sont toujours à la bonne taille.
- Vérifier si le casque est toujours adapté à votre tête. Achetez de préférence un casque conforme à la norme européenne EN 1077.

### Check-list to prepare skis:

- **Adjust ski bindings before each season**. The body changes which influence the triggering of the bindings. Only bindings adjusted annually will release at the right time. This will prevent injuries to the legs and knees.
- **Check if the glasses and the mask** still fits.
- **Check if the helmet is still adapted to your head**. Preferably buy a helmet which complies with the European standard EN 1077.

Adapt the clothing to the weather and your speed to the other people on the ski slope!

### Cette liste n’est pas exhaustive. Pensez toujours à vous poser les bonnes questions avant de partir.

Sources : [France casse, BPA](#), [BE-Safety Unit, Envoyer un message](#)

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## My checklist before winter

### Check-list to prepare the cars:

- **Check the tires**: wear, pressure, balancing and geometry. Snow tires are recommended when the temperature goes under 7 degrees.
- **Check the level and the quality of the oil**: use a coolant and engine oil plus a windscreen washer adapted to winter conditions.
- **Have a « defrost kit »**: scraper, brush, flashlight, gloves, etc.
- **Check all the lights of your car**.

Adapt your driving attitude to the weather conditions

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Adapt the clothing to the weather and your speed to the other people on the ski slope!

### This list is not exhaustive. Always remember to ask yourself the right questions before taking the road.

Sources : [France casse, BPA](#), [BE-Safety Unit, Send a message](#)
Life in BE

My name is Juan Esteban Muller and I joined CERN in October 2010, just after finishing my studies in Telecommunications Engineering at University of Seville. I started initially as a Fellow in the BE-RF-BR section under the supervision of Elena Shaposhnikova and then continued as a PhD student in the same section. At the moment I am in my second year of PhD studies at EPFL, co-directed by Elena and Leonid Rivkin.

The topic of my PhD thesis is the longitudinal intensity effects in the LHC. In short, it is about the study of the interaction of charged particle beams with the surroundings and the effect on the particle dynamics in the longitudinal direction. For high intensity beams these effects can limit the performance of the accelerator, causing beam instabilities, emittance growth, particle losses, and heating of the machine elements. Therefore it is important to identify the eventual constraints that can arise in the future and to define the optimum strategies to overcome them.

The electromagnetic interaction between the beam and the accelerator elements is usually modelled by an impedance. We use the LHC impedance model calculated by our colleagues from the ABP group analytically or by numerical simulation, for example to predict beam instability thresholds or to estimate the beam induced heating.

The impedance model must be validated experimentally and for that we carry out measurements during machine development (MD) sessions. We inject beams with different parameters and under different conditions to estimate the impedance, for example by measuring the synchrotron frequency shift as a function of bunch intensity. As the MD time in the LHC is very limited, the measurements require good preparation and the help of many colleagues.

The main challenge in the LHC is that its longitudinal impedance is very low compared to other accelerators and it is difficult to measure it using conventional techniques. Nonetheless it is large enough to cause beam instabilities due to loss of Landau damping and a controlled longitudinal emittance blow-up is required during the ramp. During the LHC Run 1 it was also necessary to increase the bunch length to reduce the beam induced heating in some elements.

Another effect that is currently the main performance limitation for the LHC with 25 ns beams is the so-called “electron cloud”, short “e-cloud”.

The electric field of the proton bunches accelerate electrons transversely, always present in the vacuum chamber in small quantities. These electrons release further electrons when impinging on the vacuum chamber or beam screen in LHC causing an avalanche type of effect at the passage of a train of 25 ns spaced bunches. Overall the process leads to an energy loss of the beam resulting in a load to the cryogenic system in LHC, as well as to degradation of the vacuum and to instability of the beam.

We developed a new diagnostic tool for e-cloud observation based on the measurement of the synchronous phase using the beam Phase Module from the LHC Phase Loop. The energy lost by the beam, compensated by the RF system, is calculated from the phase shift between each bunch and the RF. An extremely good accuracy (~0.1 deg) was achieved thanks to a set of corrections and post-processing of the data. The measurements can show the bunch-by-bunch power loss dominated by e-cloud with details of the build-up along the bunch train (see Fig. 1). Measurements were compared with simulations and with the heat load in the cryogenic system, with good agreement. The use of this method in operation can ease the scrubbing run optimization and can also be used to estimate the cryogenic heat load.

Fig. 1: Bunch-by-bunch power loss increasing along the batches, a sign of the e-cloud build-up.
Although my PhD topic is about the LHC, I also try and help my colleagues working in the SPS, Theodoros Argyropoulos, Thomas Bohl, Alexandre Lasheen, Helga Timko (now in RF-FB), and Elena. In the SPS it is easier to get time for MD than in the LHC and a lot of interesting things are happening because of its higher longitudinal impedance. All the time we spend together in the SPS Faraday Cage doing measurements is very helpful to me to understand better the beam dynamics – and it is also fun!

During this time I had the opportunity to attend the CERN Accelerator School and some international conferences and workshops. This year I presented my work on the diagnostic tool for e-cloud at IPAC’14 and I was awarded with the EPS-AG prize d) for a PhD student registered in Accelerator Physics or Engineering. Of course, this was possible only thanks to the support of my supervisors, Elena and Lenny, and my colleagues from my section and from RF-FB, especially Daniel Valuch, Philippe Baudrenghien, Themis Mastoridis, and Thomas Bohl. I am also very grateful to Giovanni Rumolo and Giovanni Iadarola from the ABP group for discussions about the e-cloud effect and to the OP group for their kind assistance during the measurements.

Finally, I’d like to thank all the colleagues for the great experience of being part of the BE Department at CERN!