

INJECTOR MACHINE DEVELOPMENT DAYS 2017

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Abstract

Following the important progress made in 2016 in the Machine Development (MD) activities that took place in all the accelerators of the LHC injector chain, the days 23-24 March, 2017, have been devoted to summarise the main outcome from the MDs and lay out the plans for the next steps. The event was also triggered by the following motivations and goals:

- Give a chance to the MD users to present their results;
- Provide a platform in which MD users, MD coordinators and operations crews meet and discuss openly the optimisation of the MD time and procedures, taking into account of the different perspectives;
- Provide an overview of all the ongoing activities to better frame their impact in the broader picture of the CERN short and long term projects;
- Identify the open questions, define and prioritise machine studies in the injectors for 2017;
- Create the opportunity to obtain and document written reports from MD users.

Within this contribution, we just summarise the context and the main points discussed at the event, which should be retained in an effort to improve the MD logistics and organisation. Concerning the individual MD activities and results, these are described in detail in the other papers of these Proceedings.

THE CONTEXT

The MD organising web tool

Since 2015, in the CERN accelerator complex the MD requests are made via the web interface [1] (see Fig. 1), which has significantly simplified the procedures of MD requesting for the users and planning for the coordinators. Starting from the web interface, generic MD requests can be made through the tab “New MD Request” (second from left). Once the MD request is created, time slots for parallel MDs can be directly requested by the MD users on a weekly basis, by simply editing the existing MD request and providing the number of the requested shifts as well as the user’s availability for the coming week. One cycle in the supercycle is always reserved for parallel MDs in all machines (PSB, PS, SPS) every working day during the working hours – but also during nights and weekends, if MD users are available. On the other hand, dedicated MDs are selected and assigned by the MD coordinators (among the received requests) on the days with 10 hours of dedicated injector MDs (usually on

Wednesdays). To facilitate coordination and avoid overloading the OP crews with requests, dedicated injector MDs do not take place on the weeks of LHC MDs. During the weeks of LHC Technical Stop (TS), however, dedicated injector MD blocks are allocated, giving priority to those SPS MD users which are incompatible with injection into LHC (e.g. the COLDEX runs). Low intensity MDs (e.g. those using a single bunch in coasting mode in the SPS) also usually take place in the shadow of the machine cool-down over the 24 hours preceding an injector TS (leaving the last three hours without beam for complete cool-down). When dedicated MDs take place in PSB or PS, disrupting physics in these machines more than on days of simple SPS dedicated MDs, special announcements are made at Facility Operation Meetings (FOMs) to warn specifically physics users.

Every week, all requests for parallel MDs for the following week are collected by Friday and the MD program, generated through a visually intuitive editing mode of the “Schedule” tab, is then published late on Fridays. Since 2016, also LEIR is included in the MD planning and the requests for LEIR MDs can be made through the same interface as for the other machines. While in previous years, the dedicated Wednesday blocks were not scheduled during the LHC ion run, since 2016 they are preserved also in this period mainly to allow for dedicated SPS MDs with ions to take place in the framework of the LHC Injectors Upgrade (LIU) [2] study program.

The Injector MD program in 2016

Although there were important limitations in the SPS due to a vacuum leak in the main internal dump block (TIDVG), many machine studies could be performed in 2016, which have led to:

- Improved performance of the currently operational beams, with both a better beam quality for (proton and ion) LHC and FT physics and an important loss reduction in all the machines (and reduced machine activation);
- A better understanding of the performance limitations of future beams (e.g., within the LIU project) and study of mitigation techniques for the expected bottlenecks.

In 2016, the ion program could greatly benefit from the early start of the ion injector chain. This gave time to study intensity limitations in the pre-injectors and notably resulted in the delivery of ion beams to the LHC that are already compliant with the final LIU/HL-LHC request in terms of single bunch parameters [3]. Unfortunately, due to the aforementioned problem with the SPS dump, all the SPS MDs requiring acceleration of bunch trains could not be performed in 2016 and will have to be postponed to 2017. This includes for example all the MDs on longitudinal coupled

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The screenshot shows a web-based application for managing machine development (MD) at CERN. The top navigation bar includes links for 'CERN Machine Development', 'MD Requests', 'New MD Request', 'Beams', 'Schedule', and 'grumolo' (with a lock icon). The main content area is divided into two main sections: 'Injector MDs' and 'LHC MDs'.
Injector MDs: Describes parallel MDs in all machines taking place every weekday during working hours (8:00–18:00). It notes that there is always one available MD cycle in PSB, PS and SPS. During dedicated MDs, usually on Wednesdays (8:00–18:00), MD users have priority over physics users. When LHC is operating, dedicated MDs take place in parallel to LHC operation and may have to be stopped when LHC needs to refill. No physics is guaranteed during the MD time, but beam will be provided to PSB/PS physics users on a best effort basis. A link to the latest Injector schedule is provided.
LHC MDs: Notes that MD1 is to take place on 25–29 July 2016, with MD requests accepted until 21 June. The next LSWG meeting is on 28 June. A link to all LSWG meetings is available. Run II MD Notes and instructions for MD procedures and MD notes publication are also listed. On the right side of the LHC MD section, there is a 'Contact' box listing: Giovanni Rumolo (MD Coordinator) and Hannes Bartosik (MD Coordinator).
Contact Information: A separate 'Contact' box on the right lists: Rogelio Tomas Garcia (MD Coordinator), Jan Uythoven (MD Coordinator), and Giulia Papotti (Scientific Secretary).

Figure 1: Snapshot of the application (web tool) for the CERN MD management.

bunch instabilities along the ramp and at flat top, absolutely instrumental for the LIU program.

The available MD time was anyway fully used in 2016 and at least the same level of MD time should be allocated in 2017 to progress on the various fronts and accommodate additional requests from the different projects. These include e.g. all the LIU MDs that could not be carried out in 2016, the HL-LHC MDs on crab cavities preparation and the new studies on the limitations of the Fixed Target beams in all machines, relevant for the Physics Beyond Collider program.

SOME POINTS OF DISCUSSION

At the Injector MD days 2017, two types of presentations were requested (and provided). Basically at the opening of each session, representatives of the OP crews for the different machines made an attempt to address the questions whether the present setting of MD coordination and execution works, and what remains to be improved for the general satisfaction and efficiency. Then, there were the talks from the MD users, which were required to cover

- Context and goals of each MD
- Results, lesson learnt and outlook for 2017
- Comments on number of MD hours used vs. requested, efficiency of the MD time, level of satisfaction, main issues encountered (e.g. in terms of beam preparation, machine support or required instrumentation).

The following points emerged during the discussions and have been retained for future action:

- The new tool for MD scheduling and viewing has been widely appreciated, however there is room for improvement both in its function and in the way it is used.

- The option to associate a beam to an MD is not sufficiently used. In many cases, the beam for the planned MD is either not declared or just declared in terms of LSA cycle (probably also not matching the actual beam parameter request). The absent, or erroneous, beam declaration makes it difficult for the OP crews to prepare the MD in advance and may generate frustration in the first part of the MD, when the beam has to be set up in the middle of several other concurrent activities.
- The generation of LSA cycles for MDs seems to be quite wild, with possibly multiple LSA cycles generated for the same MD at different times of the year. While at the beginning of the 2015 run a naming convention had been encouraged when generating an LSA cycle for an MD (i.e. MD_MDIIdentifier_BeamType), the applied naming conventions turn out in practice to be neither respected nor intuitive. This not only creates a plethora of useless cycles that nobody can easily identify, but also makes it difficult, at the clean-up time, to assess whether the various “orphan” cycles should be kept or deleted.
- More reminders of MD program and beam requirements should be sent out other than the Friday email announcing the next week’s program. For instance, a reminder on Tuesdays before the dedicated MD would be welcome.
- It is desirable to relax the MD program during the time of beam set up and commissioning, to avoid unnecessarily increasing the workload on the OP crews at an already busy time. In particular, parallel MDs could be limited in these weeks, while “exotic” MDs should be avoided at all. In 2017, it could be advisable to move all the scheduled dedicated MD blocks of the first three weeks to a certain point later on in the year, when

e.g. a dedicated high intensity run in the SPS could be organised.

- On many fronts, the communication between MD users and OP crews could be also improved. For example, MD users who give up their slots although they are in the official planning should notify the operators that their MD is not taking place. MD users should also notify the operators when their MD ends and the console can be cleaned up. They should also leave instructions for night time MDs, when they want some acquisition to keep on running.
- On the side of the MD users, no complaint was raised concerning MD request tool, allocated (and available) MD time and execution of the MD (e.g., beam preparation, instrumentation, support). Conversely, it was noted that at PSB and PS the main problem is not the available but rather the availability of resources to carry out MDs on a certain subject.
- Clear follow up plans for 2017 were presented in most of the MD specific presentations. Given the high number, it seems that dedicated MD requests in SPS will be challenging to accommodate in 2017. Besides, in collaboration with the restricted Machine Protection Panel (rMPP), some of the MDs in SPS will need to be assessed in terms of safety and machine protection.
- The MDs that took place in 2016 can mostly be classified in: MDs of preparation, modeling and understanding; MDs for (or in view of) future modes of operation; and finally, the great majority, performance improving MDs. Concerning this last category, the importance was recognised to assess as quickly as possible the performance improving potential of certain MDs and use it in operation. In the future, to better close the loop between performance improving MD outcome and operational deployment, a path can be set, based on a relatively fast Machine Study Working Group (MSWG)

recommendation, followed by LHC Injector and Experimental Facilities Committee (IEFC) presentation and approval in the case of changes with hardware implications.

- Many good results appeared to be obtained in the last phases of the MD execution or run, which sometimes is normal due to the fact that MD requests and ideas naturally evolve during the year steered by the obtained MD results. However, it is important to work on mitigating the usual MD rush at the end of the year, especially in view on the critical 2018 end-of-run, by proposing a strong prioritisation of the MDs at beginning of run and a check-point in the middle of the run.

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REFERENCES

- [1] CERN Machine Development Coordination, <https://md-coord.web.cern.ch/app/#/>
- [2] “LIU Technical Design Report – Volume I: Protons” and “LIU Technical Design Report – Volume II: Ions”, edited by J. Coupard *et al.*, CERN-ACC-2014-0337 (2015) and CERN-ACC-2016-0041 (2016)
- [3] H. Bartosik *et al.*, TUPVA020 in Proc. of IPAC’17, Copenhagen, 14-19 May, 2017