

## 30<sup>th</sup> Meeting of the Machine Availability and Reliability Panel (MARP)

---

**Present:** A. Apollonio [TE/MPE], T. Cartier-Michaud [TE/MPE], G. De Assis Schmidt [BE/ICS], B. Fernandez Adiego [BE/ICS], L. Serio [EN/ARP], T. Otto [ATS/DO], J. Uythoven [TE/MPE], M. Zerlauth [ATS/DO]

**Excused:** R. Steerenberg [BE/OP], B. Todd [TE/EPC]

Indico link: <https://indico.cern.ch/event/985701/>.

### Risk assessment for SM18 cluster F (B. Fernandez Adiego)

B. Fernandez Adiego presented the strategy currently followed by BE-ICS to evaluate and address risks in SM18 cluster F, both with respect to machine protection and personnel safety. No official standard exists at CERN for personnel safety, still the approach chosen is based on IEC61508 and the SIL definition with a fine-tuned calibration of the different personnel safety consequences. A similar scale needs to be defined for machine protection. This was tentatively provided by A. Apollonio following discussions in the RASWG.

The first iteration of this study showed that more stringent requirements for machine protection are found according to the proposed scale, compared to personnel protection. This result seems contradictory with common sense, so the authors propose to perform a second iteration after discussing with different reliability experts, presenting the method and conclusions. T. Otto explained that gathering reliable data to derive probability of failure is extremely difficult, as the records of events in SM18 are not available. Mainly estimations are based on experience of SM18 experts.

M. Zerlauth suggested that the 'occupancy' factor modeling the time spent by personal in dangerous area should be higher than 10% for a multi-purpose area such as SM18 because many people could pass by any installation, while not working on the specific installation. Also, he pointed out that tests in SM18 are sometimes going beyond nominal values of current and with intentional deviations from the nominal protection scheme, which can introduce higher consequences and/or new failure modes. Two arguments that could increase the risk on personnel safety.

Discussions pointed out that the scales selected to evaluate the consequences of events, both for hardware damage (delay of research programs) and personal safety should be reviewed. L. Serio explained the approach followed in Anglo-Saxon countries, associating a price to a human life (in the range of 3 million USD). The delay of research programs resulting of hardware hazard should also be converted in a monetary value.

T. Otto recalled that industry usually accepts risks of having one human fatality when the probability is lower than  $10^{-5}$ , which is another way of defining a correspondence between the personal safety scale and delays of research programs by defining in both categories the extreme case that one does not want to happen.

**ACTION:** M. Zerlauth will propose a new scale to evaluate the consequences of hardware damages (/delays consequences).

**ACTION:** MARP should agree on the scale of hardware damages (/delays consequences).

B. Fernandez Adiego recalled that some purchasing of hardware (sensors) will start soon, thus the SIL levels should be known as soon as possible. J. Uythoven advised to buy the best components because in SM18 the number of components is orders of magnitude lower compared to LHC, thus the cost of individual components is not as critical. Still, it is possible that even the best grade of component would not be sufficient to mitigate the consequences thus he agrees that this study has a high priority.

## **IMA Stuttgart collaboration for reliability analyses – how to continue**

### **(A. Apollonio)**

A. Apollonio shared that the selection of fellows and technical students for reliability studies has been difficult using the “smart recruiter tool” lately. B. Todd was under the same impression. A technical student will join A. Apollonio’s team to study the reliability of Energy Extraction systems used for HL-LHC and based on new “in-vacuum switches”.

Concerning Stuttgart, only one candidate applied to the last selection round (and was selected by HSE). J. Uythoven recalled that in the past they were rather answering requests from CERN than spontaneously sending students.

T. Tvetoglou (PhD student) is the new contact in Stuttgart but this might not be the ideal solution to best advertise CERN’s propositions and to direct students to CERN.

**ACTION:** A. Apollonio will revive discussions with Stuttgart in order to find a better contact.

## **Hochschule Esslingen: failure prognostics (A. Apollonio)**

A. Apollonio recalled the history of the collaboration with IMA Stuttgart. In the beginning, this was managed by Dr. P. Zeiler and several students joined CERN as technical students. Dr. P. Zeiler then was appointed a professorship in Hochschule Esslingen, and in the following the contacts with IMA Stuttgart became less frequent.

Within his new role in Hochschule Esslingen, Dr. P. Zeiler is now working also on predictive maintenance with machine learning, which could be interesting for a potential exchange of information or collaboration. This has to be re-evaluated when the coordination of ML in ATS is clarified, together with the other existing collaborations.

B. Todd asked about the training series provided by IMA Stuttgart and Ramentor Oy. A. Apollonio explained that the training series was financed by the FCC study and is not supported anymore.

## **SMART Linac4 project description update (A. Apollonio)**

A. Apollonio, C. Roderick and L. Serio discussed the SMART Linac4 project aiming at increasing reliability and availability of accelerators using data driven approaches, in particular for medical LINACs in challenging environments (developing countries). C. Roderick is supportive

and mentioned that the discussed document can serve as a basis for a formal project proposal. M. Zerlauth agreed and suggested to emphasize the proposal on developments that could bring an added value to a larger set of users at CERN (e.g. an API which could allow easy and transparent access to any data sets from CERN such as Logging, Post Mortem, Alarms, LSA...). Such a tool would be very useful for the entire sector, even without Machine Learning studies).

**ACTION:** A. Apollonio will update the document and send it to the KT Group before the end of the year.