RAS Working Group meeting 24.03.2022

- **Minutes written with generous input from <u>M. Sosin</u>** -

Participants: Amongst many others: A. Apollonio, E. Blanco Vinuela, B. Fernandez Adiego, A. Perillo Marcone, M. Sosin, B. Todd, J. Uythoven, W. Viganò

The slides are available on Indico:

https://indico.cern.ch/event/1140953/

FRAS Protection Layers – Speaker B. Fernandez Adiego

- B. Fernandez Adiego started giving a brief introduction to the Full Remote Alignment System (FRAS) for the HL-LHC.
- As next point, the summary from hazards identification were presented
    o When presenting the hazards, J. Uythoven commented, that the interlock to machine interlock system is required to be analysed and integrated (as FRAS is also foreseen for pilot beam operation)
- As next approach the use of layers of protection was introduced and compared with the safety-integrity-systems approach;
- Risk assessment, using 3 methods were compared: Risk graph (IEC 61511-3 Annex D); Risk matrix (IEC 61511-3 Annex C); MPE risk matrices for the LHC (EDMS2647876)
- Tolerable risk for FRAS was summarised;
- B. Fernandez Adiego introduced more in detail the Protection Layers and its use requirements.
- The FRAS foreseen protection layers (PL) were introduced (capacitive sensor, frequency scanning interferometry and resolvers sensors based layers). Failure modes were summarised - dependency of different configuration of sensors on failure modes were highlighted (not same configuration of sensors for all components).
  Configuration examples were presented for each PL.

- At the end of the presentation - risk reduction available for each components family was summarised. Common cause of failures were underlined.
  B. Fernandez Adiego presented also potential schematics of implementation of 3 independent different layers.

Questions and Discussion after the Presentation:

- W. Viganò congratulates the study and commented that the difference between SIL2 vs. SIL3 is not easy to achieve;. He would recommend to use SIL3.
  - ○ B. Fernandez Adiego clarified, that the protection layers approach was considered as standards allow two approaches and the SIS approach cost are very big (lack of appropriate, validated equipment, need of expensive development, etc.)
  - ○ E. Blanco Vinuela commented that protection layers allow them to avoid considering this as a SIS;
- A. Perillo Marcone asked why the effort for FRAS protection is going in a direction to reduce the risk in a complex protection layer way, rather than by using simple and robust limit switches approach. B. Fernandez Adiego answered, that the current analysis bases on an initial study of BE-GM, ICS and CEM groups, where the use of limit switches was considered as insufficient to protect the FRAS installation. M. Sosin summarised, that the bellow damage is dependent on 3D positioning of components, where use of 1D limit switches is very difficult as multiple degrees of freedom have to be controlled/monitored. Moreover, knowing the low limits of bellows deformations, the precise estimation of the bellows position is required, which can be given by the use of micrometric sensors being part of FRAS. As follows, the discussion on reliability of the presented system and FMEA for different failure scenarios took place.
  Action: The outcome of the discussion was that a dedicated meeting with different FRAS stakeholders (equipment owners) needs to be organised, to collect other potential failure modes and risks that are not included until now in initial analysis. M. Sosin confirmed that this is foreseen soon, prior to the MPP presentation.
- J. Uythoven commented, that as the FRAS will be used with (pilot) beam, this shall be included in the failure mode analysis and that the connection to the BIS have to be considered. He also underlined the risk of the use of FESA, regarding to possibility of manipulation on it. M. Sosin confirmed that a dedicated interlock key for CCC operators was already foreseen in the FRAS spec (what was already discussed with MP). B. Todd commented, that a similar approach based on a key is already in place for the AC dipole in the LHC.