EUROPEAN SPALLATION SOURCE

Answers to the recommendations from committee report of PDR-2

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Intergroup interaction, protection strategy and requirements Recommendations

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1. Create a clean flow of requirements: AP scenarios => MC simulation by BI to convert lost particles to radiation flux => Detector design to support detection of the faults => MPS design to support beam abort.
   - The flow has been created and followed to support the nBLM detector design.
   - Note: Instead of requiring from beam physics colleagues to simulate many thousands of possible accelerator faults, assessment of maximum possible incidence angle and relevant energy range of lost protons for the subsection under inspection is made. MC simulations with incidence angles and energy ranges at various locations of subsection in question are than performed.

2. The beam loss protection strategy, showing how all possible loss scenarios are handled using a combination of detectors, should be documented. This should also allocate out the L4 protection requirements on the individual diagnostics systems.
   - Assuming that the recommendation relates to combining the information from all ESS beam diagnostic tools (diff BCM, icBLM, nBLM) for protection purposes
   - This is currently still under investigation and will be documented when strategy is finalized.
   - The L4 requirements have already been allocated to the nBLM.

Intergroup interaction, protection strategy and requirements Recommendations

3. The layout of the detectors, in particular in the warm part of the linac, should be settled soon, as cables need to be finalized.
   - Done. Presented at this CDR. Details available among the supporting documentation for this review and additionally in ESS-0191514.
4. It may be advantageous to appoint a beam loss lead person, eg in beam physics.
   - Assuming again that this relates to combining the information from all ESS beam diagnostic tools for protection purposes.
   - 2 persons in ESS BI section have been assigned to investigate this option (I. Dolenc Kittelmann, S. Molloy) – work on-going.

Consolidate Simulations Recommendation

5. BI needs to have a cross check of all types of different loss scenarios with one, probably certified, code, such as MCNP.
   - Preliminary model has been created in Geant4 and was used to perform MC simulations of lost protons in order to support the nBLM detector design.
   - Work related to updated and improved linac model on-going.
   - Creating a linac model (including validation) requires a huge effort.
   - To able to compare different codes, the same geometry model needs to be used. Geometry descriptions are not portable among the codes. Therefore crosschecking with different codes not feasible with the time frame of this project.
   - Instead the results obtained from the recent measurements done at the irradiation facility MC40 in Birmingham will be compared with the simulations results – work ongoing.

nBLMs Recommendations

6. Try to get rid of gas supply line (looks like the failure due to He impurity isn't really investigated and could be overestimated).
   - Not possible in the time frame of project.
   - As demonstrated in this CDR documentation, significant drop in gain is observed if detector operated in closed mode.
7. Consolidate the controls system, so a predefined set of detectors (8?) is completely independent and is capable to monitor its health and too high loss all by itself. If the gas line is unavoidable, it should be incorporated in the same IOC instead of having a separate industrial PC.
   - Assuming the recommendation refers to having a group of detectors represented by 1 IOC through which gas, LV/HV and DAQ would be monitored and controlled:
   - That would mean: number of BE crates= number of gas systems (and = number of LV/HV crates) -> not feasible with our budget scope.
   - Also: industrial PC meant to be used only for the nBLM prototype test.

nBLMs Recommendations

8. Investigate simplification of HV supplies. Every additional parameter in MPS system produces yet another entity that must monitor this parameter. It could be possible to share at least the drift HV along with LV.
   - Sharing the drift HV with the LV introduces uncertainties and can lead to failures It also prevent us to check the health status of the nBLM detector with respect to these two parameters.
   - Note: This detector type works in a counting mode. For these type of detectors it is crucial to put them on a separate HV line as this can introduce unnecessary cross talk.

9. Prepare concise document describing what mode covers what type of losses. Keep in mind that current mode doesn't provide neutron discrimination, so it loses some advantage over icBLM.
   - Done. Details in the supporting documentation for this CDR ("Modes covered by the nBLM system").

nBLMs Recommendations

10. Implement proper grounding techniques (decouple gas line).
    - Assuming that the question relates to the option of having all pipes in the gas system made of SS, which showed that this could disturb the signal gnd.
    - The part of the gas line connecting to the detectors to the wall patch panels is planned to be at least partially based on plastic pipes.
    - This is under discussion from the safety point of view, though similar plastic tubes have been used at CERN.
11. Implement amplifier failure detection.
    - The idea is to monitor the system health by monitoring the ionsiastion spectra. Amplifier can be monitored indirectly through this.
    - Note: The amplifier failure has been assessed in the risk analysis document provided by this CDR.

Timing and Control ICS Recommendations

12. The responsibility boundary for firmware functionality related to MPS needs to be better understood and documented.
    - ➢ Discussions with the MPS team on-going.

13. Clarify how and where masking of detectors is done and how thresholds and other important parameters (such as e.g. gain) are set and configuration controlled.
    - ➢ Discussion with the MPS team on-going.

Timing and Control ICS Recommendations

14. Full timing information to be available for BI FPGA in addition to a trigger line over backplane.
    - The decision regarding the timing info distribution has not been finalized. This question must be addressed in collaboration with the ESS ICS since they are responsible for distributing the timing info (like beam modes).

Firmware Recommendations

15. Firmware development should be expedited to avoid surprises later.
    - The actual FW development has been delayed due to unavailability of the BEE card.
    - Specifications for the FW development together with initial conceptual design of the FPGA algorithm (python based simulation of the FPGA signal processing) have been delivered to ESS BI at this CDR by the Saclay SW team.

Reliability/Availability Recommendations

18. Allocate out reliability/availability requirements for the BLM system. Top priority should be to ensure that system does not have blind failure.
    - Done. Presented at this CDR. Details available among the supporting documentation for this review (also available in ESS-006336).
19. Document the risks and benefits of placing the electronics in the tunnel.
    - Done and covered in supporting documentation.
    - Benefits: "nBLM project CDR11", Figure1 shows the difference in Signal-to-Noise when the preamp is put before or after a long cable).
    - Risks: "nBLM system risk analysis".

Reliability/Availability Recommendations

20. Reliability of nBLM and icBLM systems may benefit from using neighboring coincidence detection (and e.g. voting). This should be investigated.
    - Work on-going.
21. Quality tests should be done for custom made boards: infrared, X-ray, physical design revision, electromagnetic interferences, etc)
    - Assuming this relates to the FEE where the design is custom and the production is outsourced to a company.
    - Infrared tests with one FEE board done and presented by P. Legou at the PDR-2.
    - Irradiation aging tests shall also be performed with a few of the boards.
    - Strategy for the QA tests: perform the QA tests based on the neutron source measurements on all delivered FEE boards.

Reliability/Availability Recommendations

21. In addition, for the boards to be installed in the tunnel appropriate radiation test shall be performed.
    - Assuming this relates to comparing the measurements before or after a irradiation with selected particle fields in order to asses the FEE board degradation due to radiation damage ("radiation aging" tests).
    - Plan to do this in the near future at the MC40 Birmingham Irradiation Facility (protons).
    - Gamma irradiation: originally foreseen at the CoCase – not operationally anymore.
        - Possible at Pagure – problems with budget contsraints
        - Investigation other options.

Safety Recommendations

22. The gas flow system should be reviewed from a safety and code compliance point of view.
    - Work related to the safety hazards on-going.
    - Plan to present the outcomes at the CDR-2.