# Answers to recommendations from committee report of nBLM CDR1

*Irena Dolenc Kittelmann*
*(BLM System Lead)*

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# 3.1 Communication

- **"Clarify the reporting paths to avoid double communications. Ensure that the system lead is always in the loop."**
  - Clarified to all involved several times (IK partners, ICS).
  - Some improvements with time observed.

- **"Verify physical interface to MPS (currently planned on FMC, as suggested by Timo)."**
  - Done.
  - See documentation for this review (I.D.Kittelmann, "Requirements and technical specifications – ESS nBLM system"
  - ICD with FBIS also in place (part of documentation for this review)

# 3.2 Controls

- **”The logical MPS interface used for the nBLMs look to be different from that of the BCM, even though both are generic digital I/O signals. Try to support the same logical interface across systems.”**
  - It would be useful if committee clarifies their recommendations – it is not clear what is meant with “Logical interface”.
  - Interface to FBIS in terms of HW is different between BCM and BLM du to the different BEE.
  - Signals to be propagated to FBIS are specified by MPS (BEAM_PERMIT, READY, data link) – it’s the same for BCM and BLM
  - Datalink (and maybe READY) are system dependent and are defined by BI and MPS (final definition for nBLM ongoing)

# 3.2 Controls

- **"Clarify the role of the nBLM system in overall MPS and document interfaces in an ICD."**
  - Role: for nBLM to be done during commissioning (required by MPS)
  - FBIS ICD document in place (submitted for this review as well)
    - HW selection finalized
    - Communication signals
      - Types finalized (MPS scope)
      - Definition (READY and data link) system dependent - to be finalized in collaboration with MPS

- **"Threshold management, including where thresholds are stored and who can update them, has to be defined and clarified."**
  - Same approach for all systems interfacing FBIS.
  - Threshold management - not in BLM scope
  - It is a joint a task for "Operations", MPS and ICS – ongoing.

# 3.2 Controls

- **CDR1: "Timing information beyond simple triggers is needed in the FPGA. Currently the timing link data package is routed through software. Issue from PDR not resolved."**
- **PDR2: "Full timing information to be available for BI FPGA in addition to a trigger line over backplane."**
  - This is under ICS authority.
  - Recommendation not specific enough to understand what the fear is. Nevertheless:
    - timestamping for nBLM and icbLM is currently under discussion.
    - Kaj & me plan to discuss this with timing experts in the following days and come up with solution for implementation - should be compliant with BI and ICS.
  - Asked Timo to comment:

    *"There is **absolutely no problem** to route the "timing information" via software. The comment is un-specified, just says "full timing information" without specifying exactly what timing information is meant, what role should that information play wrt operation of the BLMs and why it should be "in the FPGA". Should there be a clarification concerning what is absolutely required "in the FPGA" and why, and why is it a problem to not have it, we can discuss but before that clarification I consider this recommendation not valid and will take no action.*
    *The timestamping mechanism that is foreseen is fully capable of implementing correlation (if that is the issue) of data over multiple systems, including nBLMs, etc.*

    *I do not even think that an overloaded system (unless the FPGA implementation is poor) would be a problem."*

# 3.2 Controls

- **"Keep loss detection algorithm and alarms as independent as possible from the beam mode and timing"**
  - Independence of timing
    - BEAM_PERMIT calculation doesn't depend on triggers from EVR
    - All but 1 filter (averaging over the beam pulse) independent of triggers from EVR
  - Independence from beam mode:
    - This is the goal.
    - But detected signal depends on detector location and loss scenarios.
    - So need to asses if or to what extent the generalization is possible (simulations and relevant loss scenarios identification) – plan to focus on this in the coming months if system lead gets support in other areas.

# 3.2 Controls

- **"ICS should provide the full feature hardware platform with high priority. In particular, the current firmware has not demonstrated full support for continuous acquisition "**
  - Answers to the recommendation addressed in talks by
    - F. Dos Santos Alves: "*Digital platform for nBLM*"
    - G. Jablonski: "nBLM FW implementation" and related report submitted as supporting material

- **"BI. LLRF, ICS should develop DAQ strategy that is common across all systems and platforms. Include data on demand, timing and trigger integration, common data structures etc "**
  - Not in the scope of n/icBLM project, unfortunately not much is available so BLM is "leading the way"…
  - Current status:
    - BI (Tom) has launched "FPGA roadmap" and "DoD" projects - collaboration between BI, LLRF and ICS (jira tickets, Tom-Henrik meeting).
    - BI:
      - Kaj Rosengren in charge
      - Some activities regarding DoD started (driven by BLM)
    - ICS – Timo:
      - Setting up collaboration with SLAC: Synchronous Data Service (SDS), including Data On Demand (DoD)

# 3.2 Controls

- **"Update system layout plans (e.g. IOC count and rack layout) to match detector layout "**
  - Rack count and electronics layout already matching the detector layout. Was presented at the CDR1 when this recommendation given.
  - Note: this may change to make IFC1410 based DAQ fulfil the requirements (how many chs can we process per AMC) - IOC count depends on it.
  - Note: SW/FW still under development and not at a stage to define IOC count (issues with understanding how many chs can we process per AMC)…

# 3.3 Gas system

- **"Modify gas system with extra pressure relief valve (or burst disc) to allow valve maintenance without taking down system"**
  - Done.
  - PID available at previous (detector review) and at this review as well (S. Aune, "*Gas Pipes Specifications for nBLM System*").

- **"Assure that any gas leaks do not cause a problem for vacuum leak-checking (also using He gas)."**
  - Leak limits unclear. If $10^{-6}$mbar/Ls is acceptable then, we are OK.
  - So far all tested in the lab setup. To be checked with real system after installation (all selected components consistent with above value).

# 3.4 Detector layout and cabling

- **"All cables in database, which is good. Change of one cable type being discussed. This should be settled asap."**
  - Done. Cable DB frozen.

- **"Try to use same cable types as other systems (e.g. superflex), if performance is adequate. "**
  - Consolidated where possible.
  - All cables in DB anyway.

# 3.4 Detector layout and cabling

- **"Agree with MEBT/DTL on space allocation and attachment points/stands for detectors. Ensure they are not blocking escape routes"**
  - DTL (8x5+2 detectors): done, mech. integration finished.
  - MEBT (2 pairs of detectors): detector support conceptual design exists, mech. integration ongoing (lack of resources)

- **"The mechanical integration into the 3D should continue, including the patch panels, detectors and their stands. Consider integrating these into the DTL tanks/supports themselves "**
  - For detector supports & detectors: done
  - For PPs: ongoing for LV (lack of resources for integration)

# 3.4 Detector layout and cabling

- **"Agree on configuration controls plan for detector locations."**
  - Fear connected to the idea of having supports in a form of "heavy" feet - not attached to the floor to avoid too expensive drilling
  - Now drilling not a high cost – decided to go for foot screwed to the floor.
  - Nevertheless, checked with Johan Norin if something general in palce already:
    - *"It depends on the accepted tolerance. Just by putting the detector in place "the normal way" will give us a tolerance of a approx. 2-3 centimeters."*
    - 2-3 cm tolerance acceptable.

# 3.4 Detector layout and cabling

- **"The current distribution of nBLMs in the A2T looks fine in general. ESS should continue the work on the overall beam loss protection strategy, and make a decision regarding the final location of the detectors in the dogleg area.**
- **"Consider locating detectors in the line of sight of the target"**
  - Thomas G. checked at the 2nd bend magnet:
    - crowded but possible
    - But the magnet is H-type
    - Decided to keep original position.

# 3.5 Electronics

- **"Develop a maintenance plan to support electronics lifetime requirement."**
  - Done. All parts accessible and replaceable (including custom made parts).

- **"Electronic boards in the tunnel have to be properly evaluated and tested in order to understand their behaviour in a radiation environment. Estimation of errors and failures and their consequences should be carried out."**
  - Test at Birmingham planed (~ April 2019).

# 3.5 Electronics

- **"Modularize the FPGA functions such that they use common library elements portable across LLRF and other PBI systems."**
  - It is modular but not fully AXI stream based as it is tied to the TOSCA framework (not portable to other BI system since most of them Struck based).

- **"The design update to the detector PCBs and connections to be the same in the slow and fast models is appreciated and similar efforts encouraged where possible."**
  - Where possible the design follows the same concept.

# 3.6 Tests, Commissioning and Operations

- **"Consider testing electronics (e.g. lifetime) at linac4."**
  - Detector performance tests (with scope) @ linac4 – done (presented at this CDR)
  - nBLM ESS DAQ 1st test @ linac4 – done (presented at this CDR)
  - Lifetime
    - Can not be assessed at linac4.
    - Planned test at Birmingham (~April 2019)

# 3.6 Tests, Commissioning and Operations

- **"Discuss electronics tests with Trieste. They are testing WS preamps near the Linac 4 dump. Secondary particles and spectrum will be similar to that of the ESS tunnel, but much higher rate. They also have tested wire scanner electronics at high sample rates with MTCA system."**
  - Linac4 tests done.

# 3.6 Tests, Commissioning and Operations

- **Set up a realistic target at Birmingham, using copper, TZM, etc to simulate ESS accelerator components**
  - This would be geant4 benchmarking.
  - Plan to test linac geometry during commissioning.

- **"Develop an startup procedure specifying what functionality checks can be made with beam, and what needs beam."**
  - Strategy for commissioning and start up procedure described in reports submitted for this review (C. Derrez,"*nBLM verification plan*", I.D. Kittelmann; "*Technical spec. and requirements – ESS nBLM system*")

# 3.6 Tests, Commissioning and Operations

- **"Include self test with HV in the system design."**
  - Alarms foreseen on:
    - PS readbacks,
    - Neutron event: average amplitude and charge
  - PS crate status monitored

- **"Try to develop an online verification technique for the fast detector that is as robust as that for the slow detector."**
  - Alarms on average neutron amplitude and charge – same strategy for slow and fast.

# 3.6 Tests, Commissioning and Operations

- **"As there are potential disturbing signal sources (gallery, stub and tunnel), that could interfere the detector signal, it is highly encouraged to test at high power RF test stand"**
  - Test done at Linac4 – environment similar to DTL1
  - If available in time, tests with MB cavities at CEA foreseen.

# 3.6 Tests, Commissioning and Operations

- **"The nBLM system will have to be validated during commissioning and regularly tested during operation and after maintenance periods in order to be able to use it for Machine Protection. Test capabilities as well as detection of failures and restart procedures should be defined for different failure modes and scenarios. It is recommended to continue the nice work started in the Risk analysis document together with the Machine Protection Team at ESS"**
  - Thank you ☺
  - "nBLM Verification plan" document submitted at this CDR
  - Risik failure analysis already presented at the nBLM CDR1
  - Rsik/Hazard analysis available in document submitted at this CDR (L. Segui, "nBLM project CDR1.2 - final")

# 3.7 Noise and thresholds

- **"Assure that signals near DC are not overly contaminated by electromagnetic interference, particularly inductively coupled noise from modulators and other high power sources"**
  - Pedestals regularly monitored (with alarms set)
  - All signal cables in conduits for extra shielding

- **"Make a systematic assessment of potential disturbing signal sources (gallery, stub and tunnel), that could interfere the detector signal, and plan the cable routing accordingly."**
  - Johan Norin: *"There are not many routing alternatives since we are limited by the available rack positions and due to that we need to minimize the cable length. However, we are mitigating the SNR-related risk a lot by adding metal conduits for the signal cables."*

# 3.7 Noise and thresholds

- **"Sparks might generate undesired beam stops. The spark rate should be evaluated and the filtering of the algorithm should be tested for a extended period."**
  - Spurious sparks are not be possible with detector nominal operation conditions.
  - They can though be associated with very high incoming neutron flux or potentially detector failure.
  - The only way to really avoid sparks is to use coincidences – foreseen for upgrade. It needs functioning LLL and appropriate algos developed (with experience).

- **"It is highly encouraged to test the system at a high power RF test stand to investigatge these effects "**
  - Tests at Linac4: no spurious sparks observed and no sparks with RF power observed – also outside nominal operation conditions.

# 3.7 Contracts

- **“Consider extending the Saclay contract to to match the installation schedule, to ensure support through beam commissioning”**
  - Done automatically (IK partner presence at commissioning part the plan in initial annex)

# 3.8 Other

- **"Risk/Hazard analysis was not presented. This will be required for classifying the radiation safety function of the system. Even if it is currently not foreseen that nBLM would have any safety function that imposes special requirements, a documented risk/hazard analysis will be needed latest at a time when the system is ready for commissioning. This should be covered at CDR-2.."**
  - Risik failure analysis presented at the nBLM CDR1
  - Risk/Hazard analysis available in document submitted at this CDR (L. Segui, "nBLM project CDR1.2 - final")

- **"If a fission converter has significant advantages, continue to investigate in parallel."**
  - ongoing