CONCEPTUAL SPECIFICATION

CRYOGENIC BLMS FOR HL-LHC

[LHC-BLMC]

WP13

Equipment/system description

In the HL-LHC high luminosity insertions the magnets will be subjected to a greatly enhanced continuous radiation level due to the increase in collision debris resulting from the higher luminosity. With the presently installed configuration of ionisation chambers in this region the additional signal from any dangerous accidental losses would be completely masked by that coming from collision debris. This is a critical issue for LHC machine protection. Radiation detectors will therefore be placed inside the coldmass of the triplet magnets as close as possible to the superconducting coils. The dose measured by such cryogenic Beam Loss Monitors (BLM) would then correspond much more precisely to the dose deposited in the coils, allowing the system to be used once again to prevent a quench or damage.

Layout Versions	LHC sectors concerned	CDD Drawings root names (drawing storage):
V 1.0	LSS1, LSS5	LHCBLMC to be checked by S. Chemli

TRACEABILITY

Project Engineer in charge of the equipment	WP Leader in charge of the equipment
B. Dehning	R. Jones

Committee/Verification Role	Decision	Date
PLC-HLTC/ Performance and technical parameters	Rejected/Accepted	2014-07-08
Configuration-Integration / Configuraration, installation and interface parameters	Rejected/Accepted	20YY-MM-DD
TC / Cost and schedule	Rejected/Accepted	20YY-MM-DD
Final decision by PL	Rejected/Accepted/Accepted pending (integration studies, …)	20YY-MM-DD

Distribution: N. Surname (DEP/GRP) *(in alphabetical order) can also include reference to committees*

Rev. No.	*Date*	***Description of Changes*** *(major changes only, minor changes in EDMS)*
1.0	2014-06-06	Creation Date

1 CONCEPTUAL DESCRIPTION

1.1 Scope

This conceptual description covers the installation of cryogenic beam loss detectors in all the new HL-LHC triplet magnets with an option to install on the high field 11T dipole magnets.

1.2 Benefit or objective for the HL-LHC machine performance

In the HL-LHC high luminosity insertions the magnets will be subjected to a greatly enhanced continuous radiation level due to the increase in collision debris resulting from the higher luminosity. With the presently installed configuration of ionisation chambers in this region the additional signal from any dangerous accidental losses would be completely masked by that coming from collision debris. This is a critical issue for LHC machine protection. Cryogenic BLMs, placed inside the cold mass as close as possible to the superconducting coils, would measure the actual dose deposited in the coils, allowing the system to be used to prevent a quench or damage.

1.3 Equipment performance objectives

The system should be able to detect secondary particle showers, work in a cryogenic environment, work in high magnetic fields of 4T and withstand irradiation of up to 20 MGy.

TECHNICAL ANNEXES

2 PRELIMINARY TECHNICAL PARAMETERS

2.1 Assumptions

It is currently assumed that these detectors will be based on single crystal chemical vapor deposition (CVD) diamond or p^+-n-n^+ silicon wafers.

2.2 Equipment Technical parameters

Up to 6 detectors will be installed inside the cold mass of each main triplet quadrupole magnet. Each detector will have an active area of some 25 mm^2. They are foreseen to be housed within existing holes in the iron yolk within the cold mass of the magnet. Each detector will be equipped with a single semi-rigid coaxial cable. One or several feedthoughs allowing a total of 6 coaxial cable connections will need to be integrated into each of the main triplet quadrupole cryostats. The location of the feedthrough should be such as to minimise the cable length required.

2.3 Operational parameters and conditions

The single semi-rigid coaxial cable will provide the necessary high voltage (up to 1000V) and extract the loss signal from each detector.

2.4 Technical and Installation services required

The system is assumed to present a negligible heat load for the cryogenic system of the inner triplet magnets, but this will need verification once the detector location and cable routing is known.

Table 1: Technical services

Domain	Requirement
Electricity & Power	Signal cabling: • Six ½” coaxial cables and 1 HV cable per cryostat, connecting the equipment to beam instrumentation racks in the UA/UJ • Additional fibre-optic links (up to 10 fibres for each side of the LSS) from the UA/UJ to the surface (SR) to complement the existing BLM links. • One additional rack in the UA/UJ for each side of the LSS
Signal Cabling	

Table 2: Installation services

Domain	Requirement
Cryostat Assembly	These monitors need to be mouted during assembly of the magnet cold mass in the cryostat

2.5 Reliability, availability, maintainability

As part of the machine protection system these components need to be highly reliable and maintenance free. In the event that some of these monitors stop functioning the existing external BLM system should still provide adequate protection against damage due to excessive beam loss, but will probably not be able to distinguish quench provoking losses from the experimental background.

2.6 Radiation resistance

The detectors need to able to withstand irraditaion up to 20 MGy at 4.5K. Radiation testing in cryogenic conditions are already underway to verify detector performance in such conditions.

Only the front-end amplifier, installed in the tunnel, will need to be radiation hard. The second stage of electronics, located in the UA/UJ, only needs to be radiation resistant, with in-built tolerance to single event upsets. The main digital processing electronics will be located on the surface, with a fibre-optic connection to the UA/UJ, as for the presently installed system

2.7 List of units to be installed and spares policy

The list below is preliminary, with the final layout and numbers depending on the optimal location of the detectors as determined by FLUKA/GEANT studies.

- 6 distributed throughout the Q1 cold mass
- 6 distributed throughout the Q2a cold mass
- 6 distributed throughout the Q2b cold mass
- 6 distributed throughout the Q3 cold mass

This leads to a baseline procurement of 100 detectors (96 installed and 4 spares).
If the option of equipping the 11T dipole and all the spare triplet magnet assemblies is also taken into account, then a total procurement of 150 detectors would be required.

3 PRELIMINARY CONFIGURATION AND INSTALLATION CONSTRAINTS

3.1 Longitudinal range

Longitudinal layout to be determined by FLUKA/GEANT studies.

3.2 Volume

Volume is dictated by the cryogenic coaxial cables and feedthough with the detector volume negligible.

3.3 Installation/Dismantling

Needs integration into the Q1,Q2a,Q2b,Q3 cold masses and cryostats for detector placement, cable routing and feedthrough position.

4 PRELIMINARY INTERFACE PARAMETERS

4.1 Interfaces with equipment

Interface with Q1,Q2a,Q2b,Q3 cold masses and cryostats.

5 COST & SCHEDULE

5.1 Cost evaluation

Baseline APT (budget code 64061 – HL-LHC BLM Upgrades).

5.2 Approximated Schedule

Simplified schedule by years

Table 3: Simplified Schedule

Phase	2014		2015		2016		2017		2018	2019	2020	2021	2022	2023	2024	2025
Feasibility Testing																
Engineering specification																
Design & Integration																
Procurement																
Assembly & Verification																
Installation – Commissioning																

5.3 Schedule and cost dependencies

List of conditions and constrains.

- The installation can be done only as part of the cryostat assembly

6 TECHNICAL REFERENCE DOCUMENTS

- To be provided

7 APPROVAL PROCESS COMMENTS FOR VERSION X.0 OF THE CONCEPTUAL SPECIFICATION

7.1 PLC-HLTC / Performance and technical parameters Verification

Comments or references to approval notes. In case of rejection detailed reasoning

7.2 Configuration-Integration / Configuraration, installation and interface parameters Verification

Comments or references to approval notes. In case of rejection detailed reasoning

7.3 TC / Cost and schedule Verification

Comments or references to approval notes. In case of rejection detailed reasoning

7.4 Final decision by PL

Comments or references to approval notes. In case of rejection detailed reasoning