# CONCEPTUAL SPECIFICATION

# CRYOGENIC BPMS FOR HL-LHC

# [BPMSQ]

**Equipment/system description**

This specification concerns the HL-LHC beam position monitors (BPMs) in front of the Q2a and before and after the D1 magnet. These will be cryogenic stripline BPMs measuring the position of both beams in both planes.

| **Layout Versions** | **LHC sectors concerned** | **CDD Drawings root names (drawing storage):** |
|---|---|---|
| V 1.0 | LSS1, LSS5 | LHCBPMSQ to be crearted by S. Chemli |

## *TRACEABILITY*

| **Project Engineer in charge of the equipment** | **WP Leader in charge of the equipment** | |
|---|---|---|
| T. Lefevre | R. Jones | |
| **Committee/Verification Role** | **Decision** | **Date** |
| PLC-HLTC/ Performance and technical parameters | Rejected/Accepted | 20YY-MM-DD |
| 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 specification concerns the HL-LHC beam position monitors (BPMs) in front of the Q2a and before and after the D1 magnet. These will be stripline BPMs measuring the position of both beams in both planes.

## 1.2 Benefit or objective for the HL-LHC machine performance

These BPMs are essential for maintaining a stable orbit at the IP, and could be used for continuous luminosity optimisation.

## 1.3 Equipment performance objectives

The system should be able to measure the beam position for each beam with a resolution of 1um and a medium term (fill to fill) reproducibility of 10um.

# TECHNICAL ANNEXES

## 2 PRELIMINARY TECHNICAL PARAMETERS

### 2.1 Assumptions

It is currently assumed that these detectors will be based on stripline BPMs and that they do not require tungsten shielding. It is also assumed that one design can fit all these locations.

### 2.2 Equipment Technical parameters

The BPM is of a stripline type with the provisional parameters listed in table 1.

**Table 1: Equipment parameters**

| Characteristics | Units | Value |
|---|---|---|
| Aperture | mm | Adapted to beam screen aperture. |
| Total Length | mm | 220 (minimum) |
| Stripline orientation | degrees | 90 |

The length of the BPM is not linked to aperture. The resolution of the system typically scales with decreasing aperture, a larger aperture therefore implies lower resolution.

### 2.3 Operational parameters and conditions

The signal will be extracted using 8 semi-rigid, radiation resistant coaxial cables per BPM. Two feedthough with 4 coaxial cable connections will need to be integrated into the Q2a cryostat and four feedthroughs with 4 coaxial conenctions each will need to be integrated into the D1 cryostat.

### 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.

**Table 2: Technical services**

**Table 3: Installation services**

| Domain | Requirement |
|---|---|
| Electricity & Power | • Eight ½" coaxial cables per BPM connecting the feedthroughs on the cryostat to beam instrumentation racks in the UA/UJ<br>• Additional fibre-optic links (12 fibres for each side of the LSS) from the UA/UJ to the surface (SR) to complement the existing BPM links. |
| Vacuum | These BPMs will be an integral part of the beam vacuum system |

| Domain | Requirement |
|---|---|

| | |
|---|---|
| Cryostat Assembly | These monitors need to be mouted during assembly of the magnet cryostat components. |
| Alignment | These BPMs will need to be accurately aligned with respect to the cryostat fiducials. |

### 2.5 Reliability, availability, maintainability

As part of the beam position system of the LHC these components need to be highly reliable and maintenance free. The effect on luminosity optimization and the IR orbit of losing one of these BPMs is currently under evaluation.

### 2.6 Radiation resistance

The materials used need to able to withstand irradiation up to several MGy.

### 2.7 List of units to be installed and spares policy

To be installed left and right of IP1 and IP5.

- 1 located in interconnect between Q1b and Q2a
- 1 located in interconnect between CP and D1
- 1 located in interconnect behind D1

A total of 12 such BPMs will be installed with 3 spares foreseen for this type of BPM assembly.

## 3 PRELIMINARY CONFIGURATION AND INSTALLATION CONSTRAINTS

### 3.1 Longitudinal range

The ideal longitudinal location should correspond as closely as possible to (1.87 + N x 3.743)m from the IP where N is an integer. Any deviation from this will diminish the possibility of the system to distinguish one beam from the other.

### 3.2 Volume

Volume is ?.

### 3.3 Installation/Dismantling

Needs integration into the Q1b-Q2a, CP-D1 interconnects and D1 cryostat.

## 4 PRELIMINARY INTERFACE PARAMETERS

### 4.1 Interfaces with equipment

Interface with the beam screen and cold bore of Q1b, Q2a, CP, D1. Feedthoughs interface to the cryostats of Q1b, Q2a, CP and D1.

## 5 COST & SCHEDULE

### 5.1 Cost evaluation

Baseline APT (budget code : 64063 – HL-LHC Interaction Region BPMs).

## 5.2 Approximated Schedule

Simplified schedule by years

**Table 4: Simplified Schedule**

| Phase | 2014 | | 2015 | | 2016 | | 2017 | | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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