CONCEPTUAL SPECIFICATION

A BEAM GAS VERTEX DETECTOR FOR NON INVASIVE BEAM SIZE MEASUREMENTS IN HL-LHC

[LHC-BGV]

Equipment/system description

This specification concerns the contruction of one beam gas vertex detector per beam for non-invasive beam size measurements in HL-LHC. These devices are foreseen for installation between Q6 and Q7 in LSS4 left and right.

Layout Versions	**LHC sectors concerned**	**CDD Drawings root names (drawing storage):**
V 1.0	LSS4	LHCBGV to be created by S. Chemli

TRACEABILITY

Project Engineer in charge of the equipment B. Dehning	**WP Leader in charge of the equipment** 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: HL-TC

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 contruction of one beam gas vertex detector per beam for non-invasive beam size measurements in HL-LHC. These devices are foreseen for installation between Q6 and Q7 in LSS4 left and right.

1.2 Benefit or objective for the HL-LHC machine performance

With the current LHC instrumentation it is not possible to measure the absolute size of physics production beams throughout the LHC cycle. The BGV would provide a non-invasive means for such measurements to be performed. Understanding of the beam size evolution throughout the cycle is of great importance for emittance, and hence luminosity, optimisation.

It could also be used for beam halo measurements, longitudinal denisity monitoring and, if a timing detector is included, longitudinal beam profile measurements.

1.3 Equipment performance objectives

The specifications for this system are as follows:

- Bunch width measurements with a 5 % resolution within 1 minute.
- Beam width measurements with an absolute accuracy of 2 % within 1 minute

This accuracy would allow meaningful measurements to be performed during the LHC energy ramp to understand any eventual sources of emittance blow-up.

TECHNICAL ANNEXES

2 PRELIMINARY TECHNICAL PARAMETERS

2.1 Assumptions

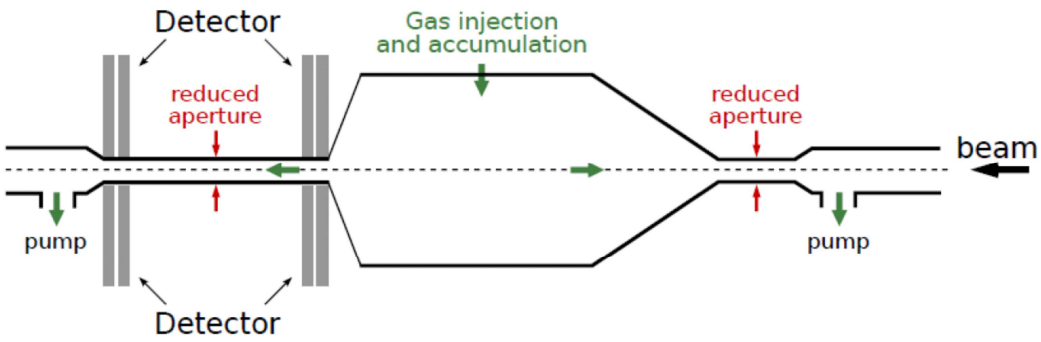
It is currently assumed that this detector will be based upon the prototype currently being developed. It is also assumed that the final HL-LHC optics will allow it to be installed in LSS4, within the currently reserved locations for this device, documented in ECR LHC-BGV-EC-0001 (EDMS 1282994) and summarised below:

	LHC Cell ID	DCUM [m]		Coordinate wrt IP4 [m]	
		start	end	start	end
Zone 1	C7L4	9753.081	9797.081	−244.0	−200.0
Zone 2	C7R4	10197.081	10241.081	200.0	244.0

The option to install both detectors (Beam 1 and Beam 2) in a staggered configuration within one of these reserved areas or one detector per side is retained.

2.2 Equipment Technical parameters

The BGV vacuum assembly is composed of a gas injection and accumulation system, a thin end window and a reduced aperture beam pipe at the detector location.



Provisional parameters, based on the prototype are listed in table 1.

Table 1: Equipment parameters

Characteristics	Units	Value
Aperture (detector location)	mm	As small as possible. Final value to be determined by optics at the installation location and allowable beam stay-clear.
Total Length (including vacuum equipment either side)	m	8.0 (minimum)
Detector station height	mm	800 (centred on beam pipe)
Detector station width	mm	800

2.3 Operational parameters and conditions

The BGV will operate with neon, at a pressure of 6×10^{-8} mbar, while the pressure outside the tank area should remain in the 6×10^{-9} mbar range. In order to reduce the impedance seen by the beam incoming and outgoing tapering angles need to be introduced and the tank diameter should be minimised. The additional annual radiation dose induced by the BGV due to beam-gas interactions is expected to be of the order of tens of Gy, 35 m downstream of the device.

2.4 Technical and Installation services required

Table 2: Technical services

Domain	Requirement
Electricity & Power	• Some 100 control cables of various types for detector readout and gas injection per monitor. • 2 additional racks associated with each installation
Vacuum	• The BGV will be an integral part of the LHC vacuum system. • A remotely controlled gas injection system is required • Sectorisation should be foreseen around the gas injection area

Table 3: Installation services

Domain	Requirement
Alignment	Accurate alignment of the reduced aperture beam pipe is required to ensure there is no aperture restriction in this region. The detector moduels also need alignment.

2.5 Reliability, availability, maintainability

The system has no particular requirements in terms of reliability, availability or maintenance.

2.6 Radiation resistance

The materials and electronics used in the tunnel need to able to withstand a moderate level of irradiation of up to ~100Gy over a 10 year operating period.

2.7 List of units to be installed and spares policy

To be installed left and right of IP4 within the space reservation detailed in LHC-BGV-EC-0001 (EDMS 1282994).

A total of 1 such system per beam will be installed, with spare detector components and electronics ordered at the time of procurement.

3 PRELIMINARY CONFIGURATION AND INSTALLATION CONSTRAINTS

3.1 Longitudinal range

The ideal longitudinal location will depend on the final HL-LHC accelerator optics functions in IP4. Equal horizontal and vertical beta functions which are as large as possible are favoured.

3.2 Volume

The volume is estimated to eb ~10m^3 assuming detector dimensions of 4m x 1m x 2m.

3.3 Installation/Dismantling

No particular constraints.

4 PRELIMINARY INTERFACE PARAMETERS

4.1 Interfaces with equipment

Interface with the vacuum beam pipe between Q6 and Q7 in LSS4.

5 COST & SCHEDULE

5.1 Cost evaluation

Baseline APT (budget code : 64067 – HL-LHC Beam Gas Vertex Detector).

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																
Initial design & Prototyping																
Final design																
Procurement																
Installation – Commissioning																

5.3 Schedule and cost dependencies

No particular constraints to be noted.

6 TECHNICAL REFERENCE DOCUMENTS

- Space Reservation : LHC-BGV-EC-0001 (EDMS 1282994)
- Prototype description : LHC-BGV-EC-0002 (EDMS 1324635)

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