

# LHC-BWS Consolidation Kickoff

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- Comments from the review committee of the LHC beam size review in 2019
- Technical issues
  - Linear scanner
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- Budget situation
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- Next steps

# Are the limitations of the existing devices being addressed correctly? Wire Scanners

- Findings
  - **Impressive number of scans** performed each year (operation, special modes like van der Meer scans, calibration).
    - Initial issues with bellow failures and HOM have been addressed successfully making the wire scanners a very reliable system
  - **Photo-multiplier non-linearities and observed loss of tension of the wire** have been a source of non-reproducibility of the measurements
    - The first one is being addressed
    - The second has not been understood yet but it has been observed only on one wire scanner and “hot spare” could be used instead
  - The **discrepancy (~10%-15%) between emittances extracted from WS and emittance scans and emittance derived from luminosity** measurements cannot be explained simply by errors on the optics parameters (non-gaussianity of the transverse and/or longitudinal distributions could explain part of the discrepancy)
  - The system is **obsolete** (LEP design) and test bench to calibrate the wire position as a function of the potentiometer reading is not available

# Are the limitations of the existing devices being addressed correctly? Wire Scanners

- Comments
  - The present **linear scanning speed is a trade-off between limiting wire damage and high density of measurement points.**
  - Operation at higher speed with **rotational wire scanners (being studied) would imply multi-scans** for bunch-by-bunch profiles to obtain a significant sampling of the beam profile
  - **The major limitation of the present system for HL-LHC is the maximum number of bunches at injection (120 to be compared with 288 bunches per injection).** This can be lifted either by increasing the scanning speed or by addressing the causes of wire damage/breakage.

# Are the limitations of the existing devices being addressed correctly?

## Wire Scanners

- Recommendations
  - Hot spare should be maintained fully operational
  - Given their main function (calibration) **any upgrade should not compromise on accuracy and reliability**
  - Pursue the **design of a new linear system to address obsolescence issues**
  - Understand and mitigate the causes of wire damage/breakage by **investigating wire materials/configurations**
  - The development of the rotational design as a back-up is supported. However, the potential advantages of this solution as presented are not enough to warrant it becoming baseline.

# Linear scanner issues to solve

- Installed scanners are obsolete and need complete re-design
  - Focus on 'accuracy' and 'reliability' (from the review)
- $1 \text{ ms}^{-1}$  scanning speed... is this the best number?
  - Number of points-per-sigma vs. wire deflection vs. damage limit
  - What are the reasonable maximum (and minimum) for a linear system?
- Specify bellows free operation?
  - What is the impact of magnetic coupling on accuracy?
  - How to make an absolute position measurement?
  - Vacuum compatibility of in-vacuum components?
- Other issues:
  - Impedance measurements (but should be similar to existing design)
  - What is the 'power loss position' specification and why?
  - Need to also re-design the wire/forks... with a view to future smaller CNT wires?
  - What are the 'real' scan range and aperture requirements?
  - Compatibility/modifications to LIU electronics?

# LIU Scanner technical issues to solve

- Full scanner design exists, but needs adaption for LHC
  - Can we operate at  $\sim 1 \text{ ms}^{-1}$ , if so, what is the accuracy WRT linear scanner?
- Not currently fully LHC-bakeable
  - What are the VSC requirements?
  - What needs to be modified or removed for bakeout and what are the consequences?
- Not tested for LHC impedance spec.
  - What tests have been done? Can we use, eg. the SPS LIU scanners?
  - What testing/qualification/modification is needed?
- What would be required to make multiple scans at high speed?
  - Modification of the kapton wire
  - Simulations of beam loss with multiple fast scans
  - Simulations of wire damage with multiple fast scans

# Electro-mechanics in Cons

- Consolidation project
  - <https://edms.cern.ch/document/2268153/1>
  - Approved CONS project 2021-25

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PROGRAM MANAGER

EDMS NO. <b>2268153</b>	REV. <b>0.1</b>	VALIDITY <b>DRAFT</b>
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REFERENCE <b>BE/BI</b>
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Date: 2019-11-11

## CONSOLIDATION WORK UNIT DESCRIPTION

### **Consolidation of LHC Beam Wire Scanner Electro-Mechanics [ACCONS] [BE-BI]**

#### ABSTRACT:

The eight beam wire scanners (BWS) in the LHC are essential reference instruments for beam profile measurements across the whole machine cycle. The existing electro-mechanical instruments, dating from the LEP era, have been shown to be increasingly obsolete and unreliable. This document outlines the planned renovation of these systems for the period 2021-25

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# Electronics in Cons

- Cons project
  - <https://edms.cern.ch/document/275504/1>
  - Approved upto 2021

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EDMS NO. <b>2275504</b>	REV. <b>0.1</b>	VALIDITY <b>DRAFT</b>
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REFERENCE <b>BE-BI</b>
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Date: 2019-11-27

## CONSOLIDATION WORK UNIT DESCRIPTION

### LHC wire-scanner electronics consolidation

#### ABSTRACT:

The LHC wire-scanners are based on a precision linear mechanism that moves a thin carbon wire across the beam at a nominal speed of 1m/s. The shower of secondary particles generated by the beam-wire interaction is monitored by a scintillator-PMT system. The motor controller and photomultiplier acquisition electronics were designed 15 years ago (2005). While it is still possible to operate the scanners, the electronics is suffering from reliability issues and its maintainability is becoming difficult. It is therefore proposed to equip each LHC wire-scanner mechanical unit with the modern electronics recently developed for the LHC injectors within the LIU project. At the same time it is also proposed to consolidate the acquisition system with the same multi-PMT detector readout via fast ADCs being used in the injector system upgrade.

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# Budgets

- Mechanics budget needs to be re-profiled
- There is no (significant) budget for further work on electronics(??)

	2021	2022	2023	2024	2025
Consolidation of LHC wire scanner electro-mechanics	50	150	260	190	50
Consolidation of LHC Wirescanner electronics	6				

# Possible Cons options for electro-mechanics

- Linear only
  - Design, prototype and test a new linear device compatible with a  $\sim 1$  ms<sup>-1</sup> specification and the LIU electronics
  - **Fulfills the minimum spec from OP, probably cheaper to manufacture**
  - **Limited upgrade options and will require significant design and test with beam**
- Rotary only
  - Qualify (and modify if necessary) the LIU scanner for use in the LHC
  - **Uses existing LIU design with possible upgrade option for multiple rotating scans at high speed**
  - **Higher manufacture cost, may require some re-design for bakeout and impedance**
- 'Hybrid' option
  - Baseline of a linear scanner, with one or more rotary scanners installed as upgrade options
  - Best or worst of both worlds??

# Next steps

- Decide which are the technical issues that need to be solved before taking a final decision on the design(s)
- Make a re-profiling of the budget, based on expected R&D costs for 2021 and 22, then for later prototyping and production
  - Associated with a project timeline
- Agree on a 'management' structure for the project
  - At least for who does what for this R&D stage...