

# Machine Protection Panel Meeting

## iLHC BPMs upgrade



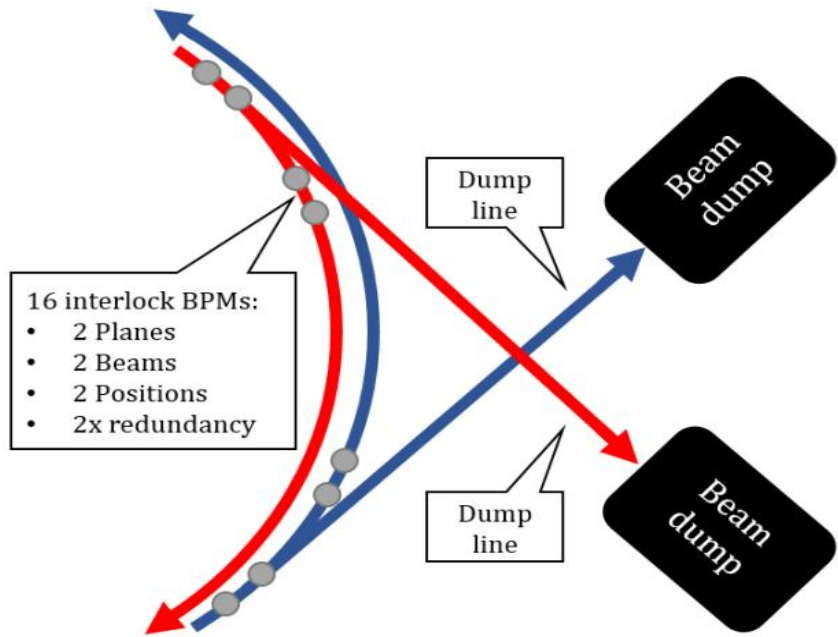
M.Bozzolan on behalf of BE/BI  
with contributions from A.Boccardi, I.Degl'Innocenti, T.Levens, L.Soby, M.Wendt

**CERN, 15<sup>th</sup> May 2020**

# Topics

- Overview of the current system
- Overview of the new system
- Plan for test system installation during LS2 (phase 1)
- Plan for full system installation (phase 2)

# LHC BPM interlock system

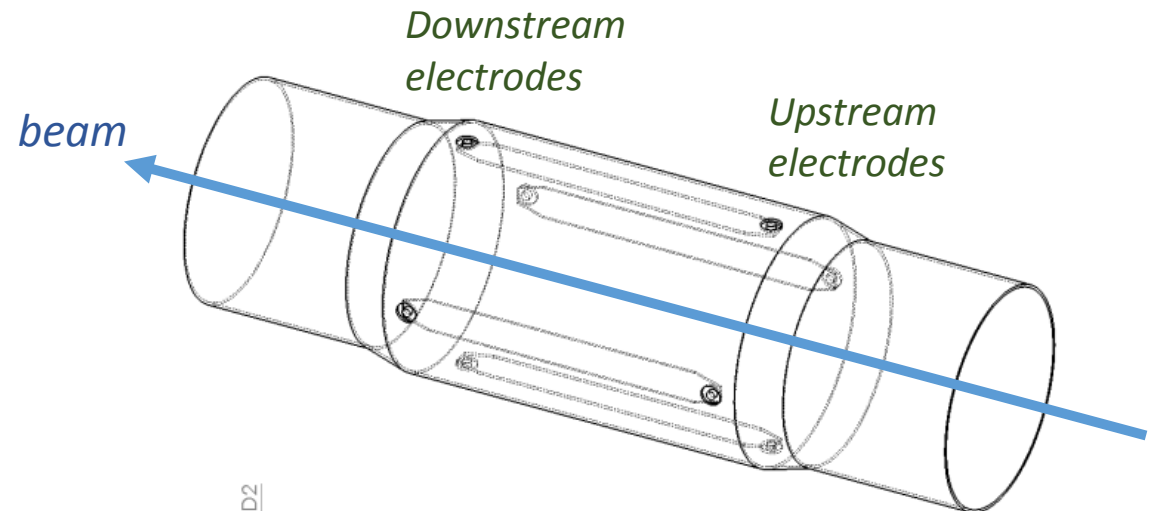


## Pickup overview:

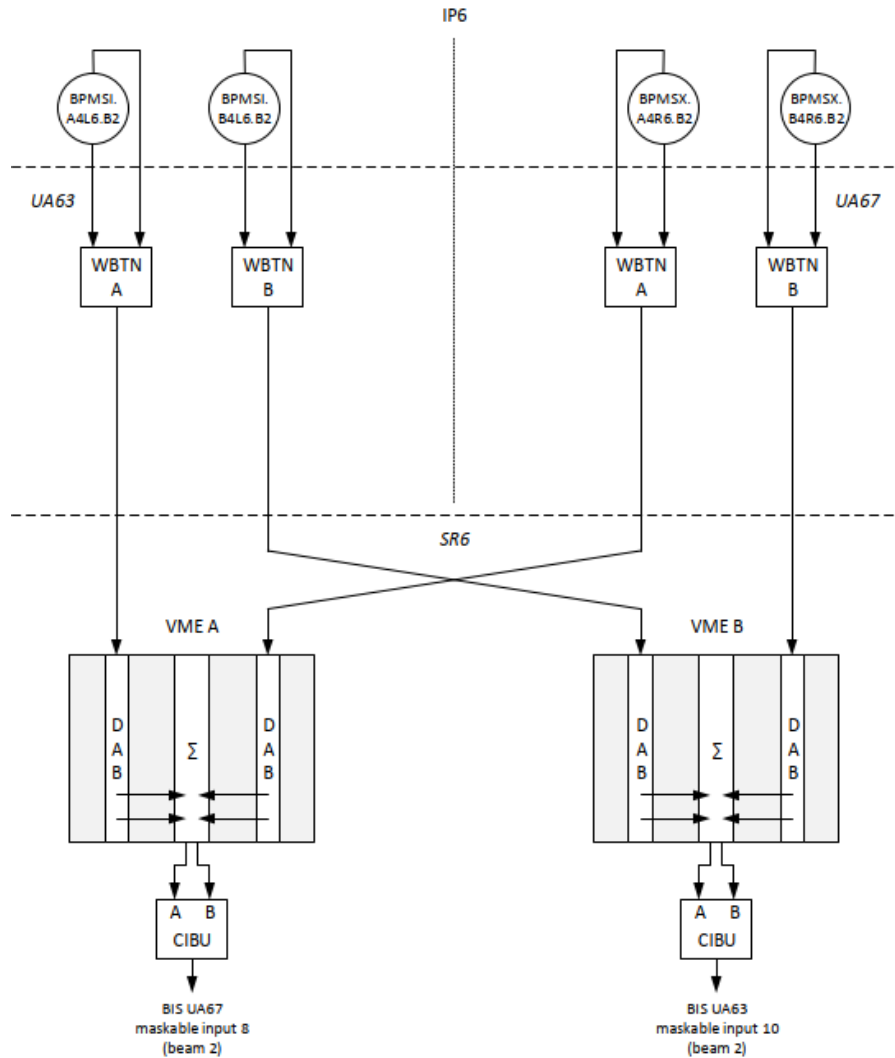
- Dual plane stripline (50Ω lines)
- Beam signal in the upstream electrodes
- Downstream electrodes isolated (no signal)
- 2 PU sizes

## System features:

- Protection system based on beam position
- Not intended for beam position observation (but PUs connected also to the orbit system)
- Beam 1 and 2 equally protected
- Failsafe (redundant)



# Existing system overview



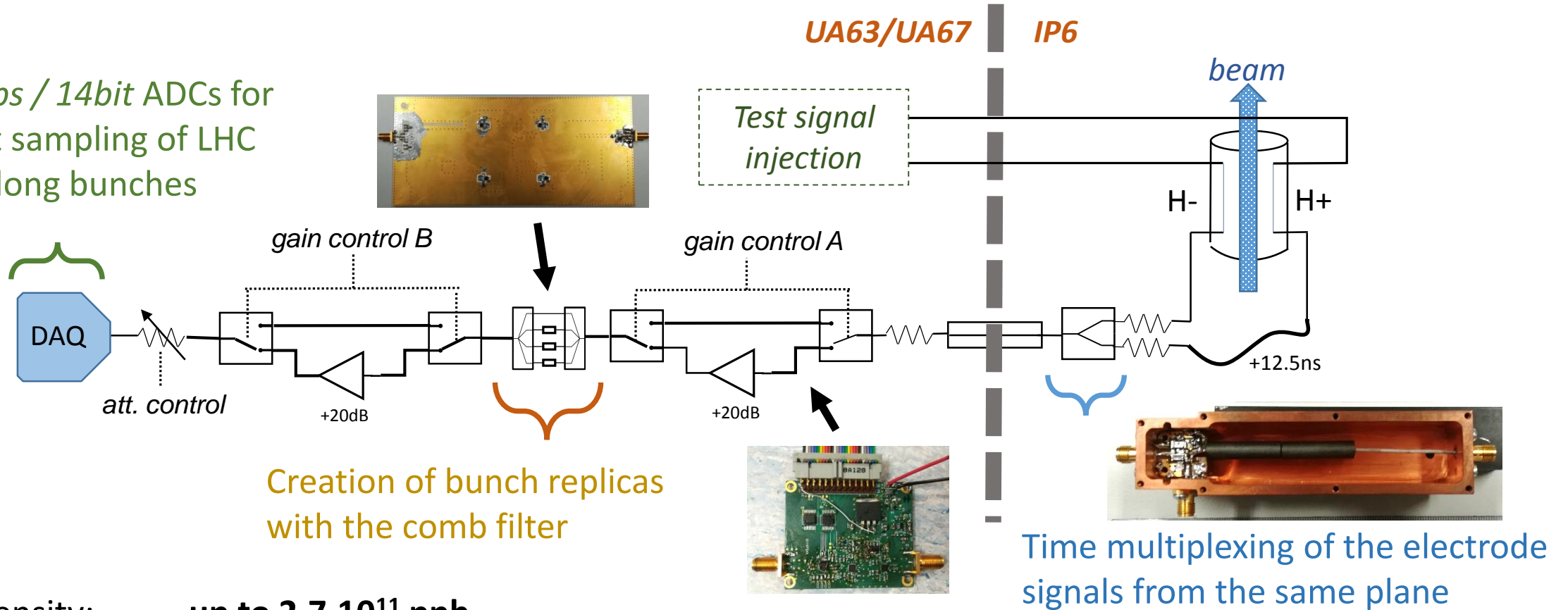
- Wide Bandwidth Time Normalizer based
- Acquisition crates in SR6 (surface)
- Bunch by bunch position measurement
- Resolution: **<150 μm**
- Dynamic range:  **$2 \cdot 10^9 \dots 1.5 \cdot 10^{11}$  ppb**

## Weak points

- Limited dynamic range
- Temperature sensitivity (drift)
- No doublet measurement (from where it all started)

# New system acquisition

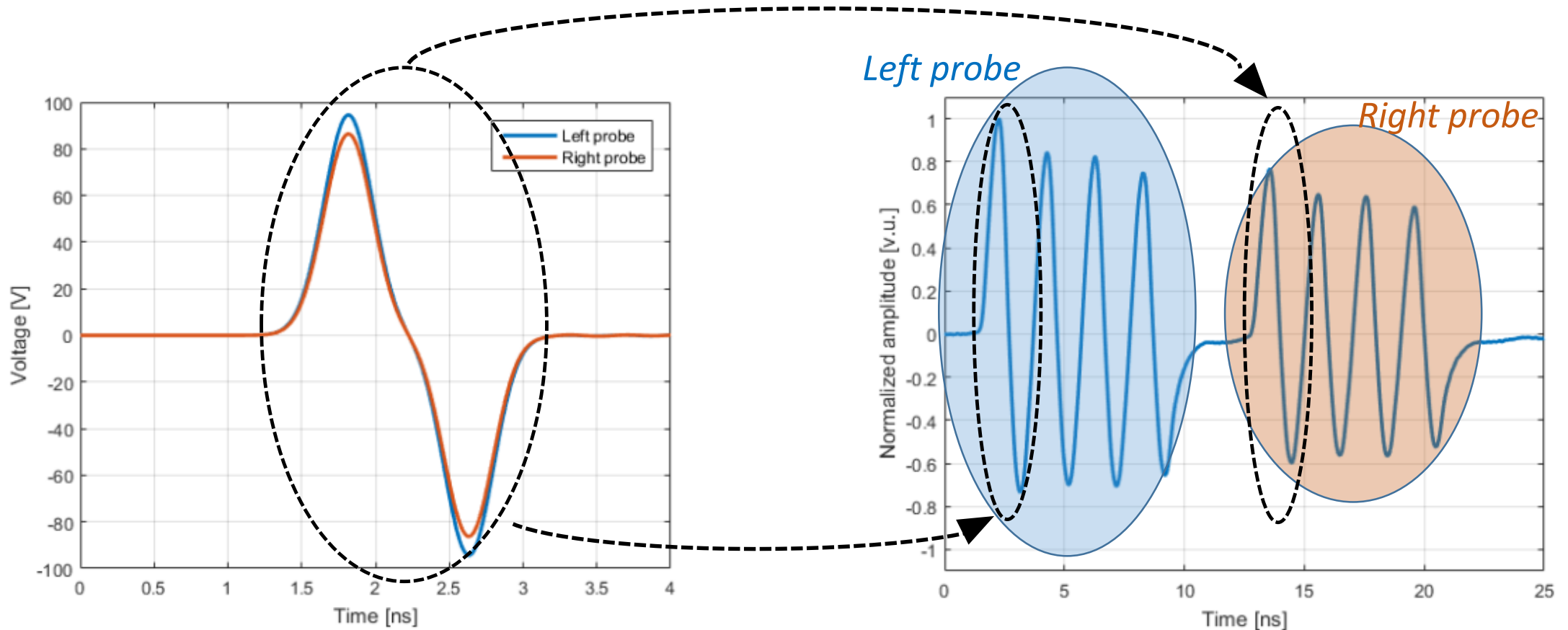
~3Gbps / 14bit ADCs for direct sampling of LHC  
 ~1ns long bunches



- Intensity: **up to  $2.7 \cdot 10^{11}$  ppb**
- Resolution: **<200 $\mu$ m for singlet beam from  $1e^{10}$  to  $2.7e^{11}$  (7.5mm offset max.)**  
**<400  $\mu$ m for doublets (are the really needed?)**



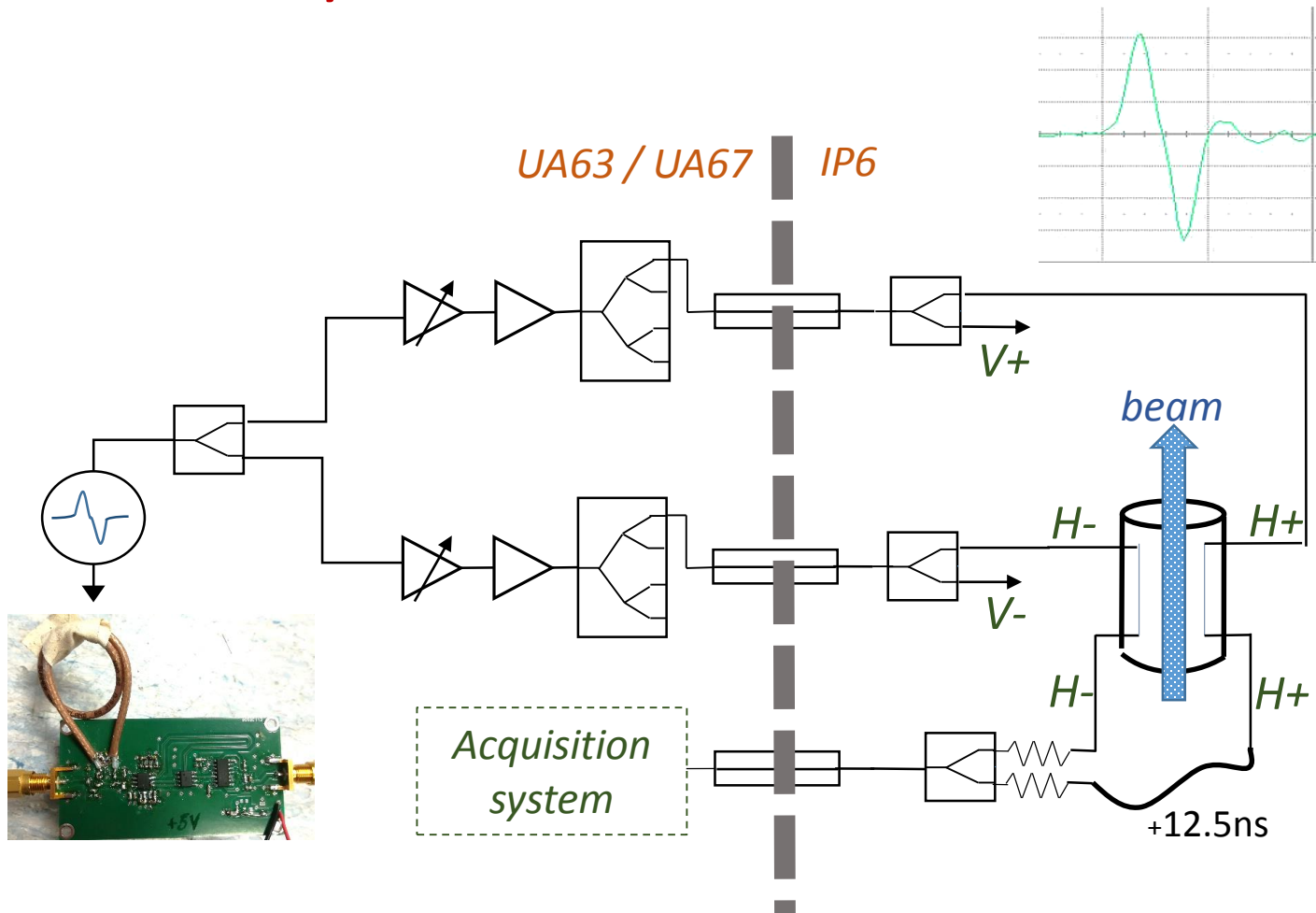
# Time multiplexing & comb filtering



*H plane signals at the electrodes*

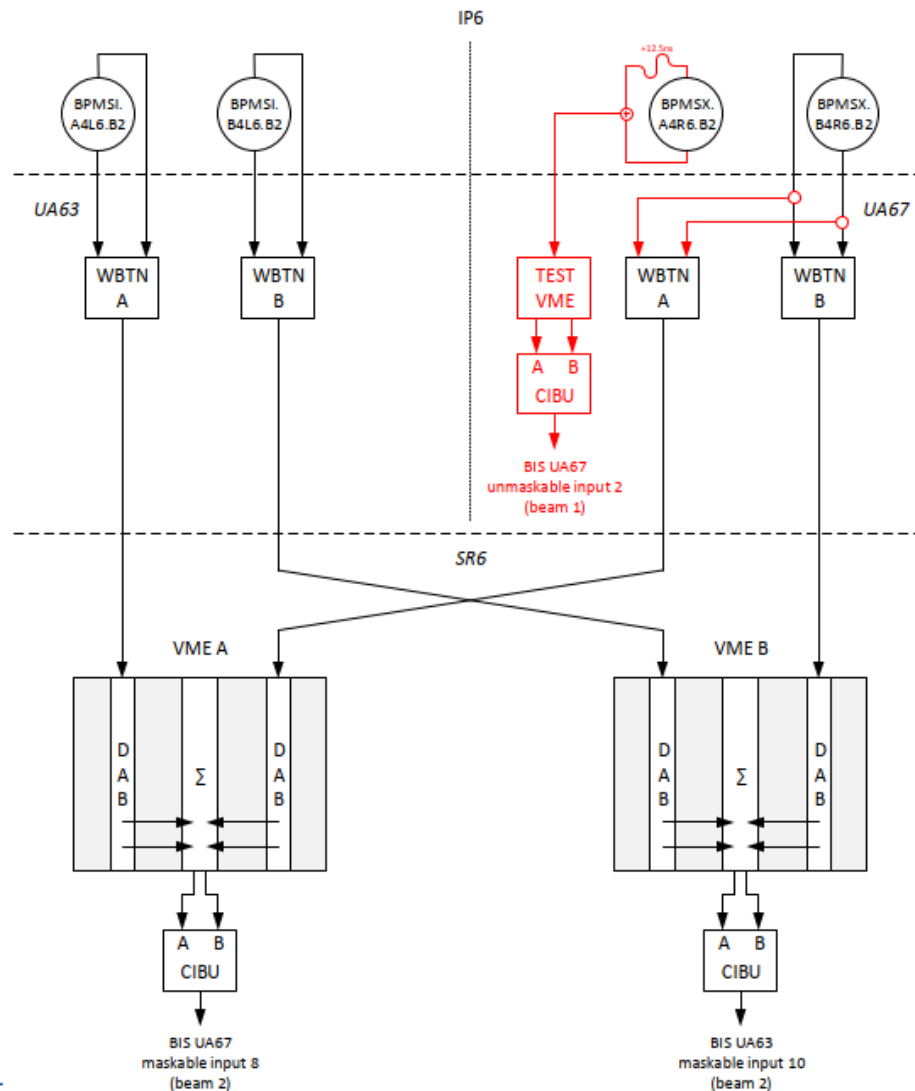
*Combined H plane signals at the ADC input*

# New system self test



- Low amplitude, beam like pulses are injected into the downstream port of the stripline
- Acquisition works as with beam
- All the beam signal paths can be tested separately
- Self test is performed before each injection

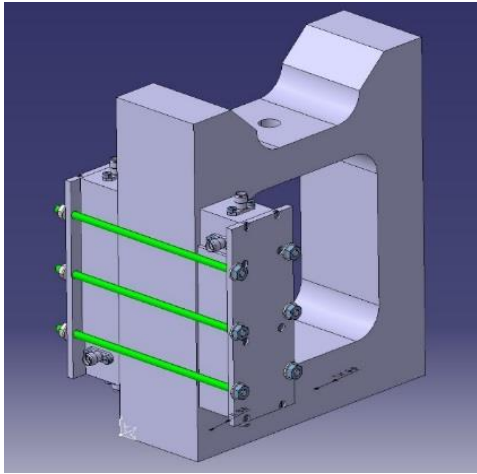
# Installation of the new system – phase 1



- **One** test system connected to BPMSX.A4R6.B2 (both planes)
- **Old system** will remain **fully functional** with BPMSXB4R6.B2 feeding both electronics (reduced redundancy)
- Connected to a new CIBU in UA67 (unmaskable input 2 with input disabled)
- Logging and timing information maintained
- Cables to connect the CIBUs in UA67 and UA63 already requested by TE-MPE
- **Deadline: end of LS2**

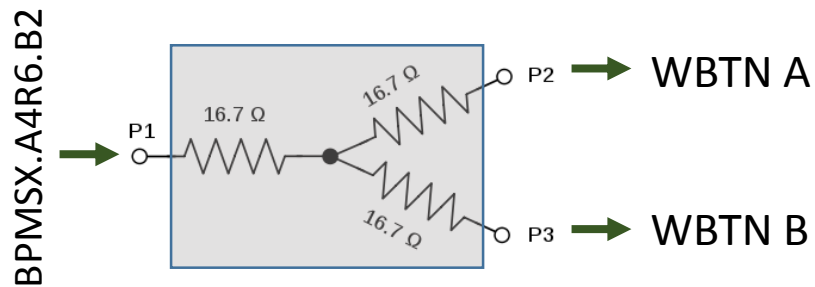


# HW installations

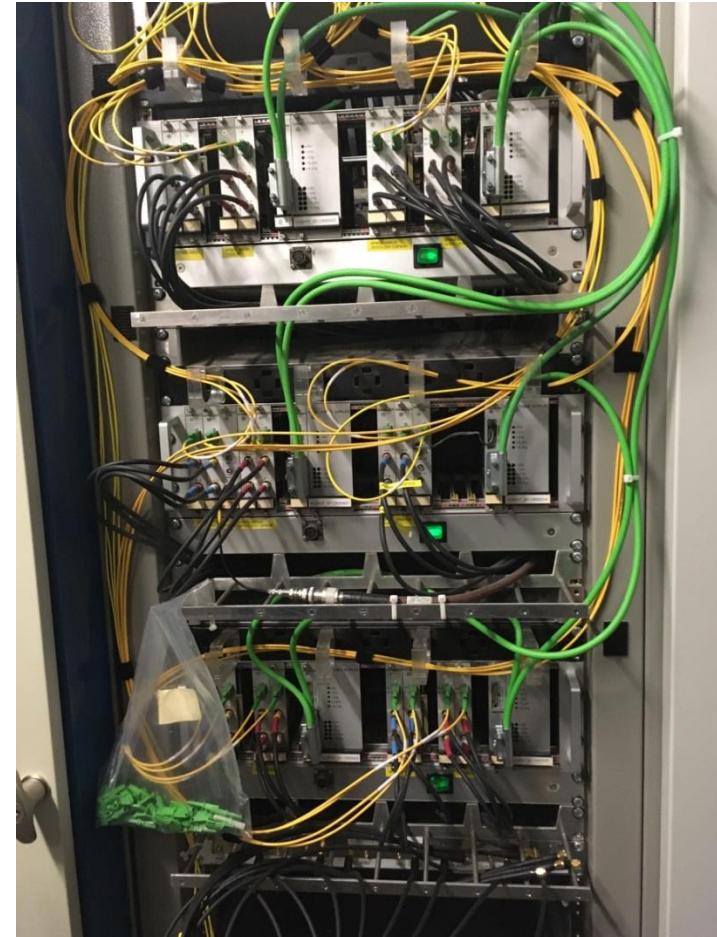


1. 2x2-ways RF power combiners (one per plane) connected to the upstream ports, fixed on the BPM support (+ 2x2-ways RF power splitters for the calibration connected to the downstream ports)

2. 4x2-ways RF resistive power splitters in UA67 (one per electrode)



3. VME crate in UA67



# ECR for the test system

CERN  
Esplanade des Particules 1  
1217 Meyrin - Switzerland



EDMS NO.	REV.	VALIDITY
0000000	0.0	DRAFT

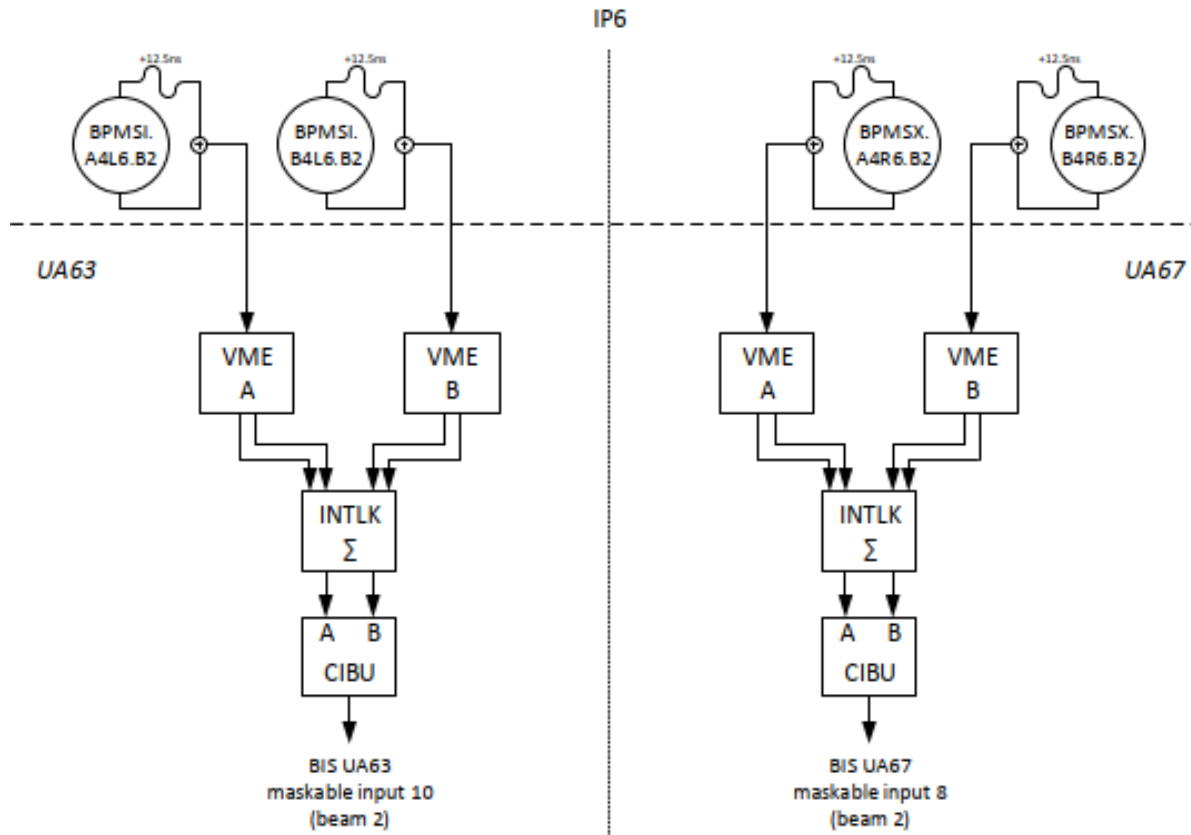
REFERENCE  
**XXX-EQCOD-EC-XXXX**

Date: 20XX-MM-DD

<p><b>ENGINEERING CHANGE REQUEST</b></p> <p><b>INSTALLATION OF THE TEST SYSTEM FOR THE NEW LHC INTERLOCK BPMs</b></p> <p><small>BRIEF DESCRIPTION OF THE PROPOSED CHANGE(S):</small></p> <p>In the framework of the consolidation of the LHC interlock BPM system, a new acquisition system is under development. A test system for the new architecture will be installed in point 6 of LHC, connected to the small aperture pick-up BPMSX.A4R6.B2. The inputs of the existing acquisition system will be connected to the redundant pick-up BPMSX.B4R6.B2 using a power splitter. Hence, the functionality of the old system will remain unchanged, but with slightly reduced redundancy, since one pick-up and one set of cables are common to two channels.</p>		
<p><small>DOCUMENT PREPARED BY:</small></p> <p>Michele Bozzolan BE-BI Lars Soby BE-BI Tom Levens BE-BI</p>	<p><small>DOCUMENT TO BE CHECKED BY:</small></p> <p>Andrea Boccardi BE-BI Manfred Wendt BE-BI Daniel Wollmann TE-MPE Markus Zerlauth TE-MPE Jorg Wenniger BE-OP Jan Uythoven TE-MPE Chiara Bracco TE-ABT Christoph Wiesner TE-MPE</p>	<p><small>DOCUMENT TO BE APPROVED BY:</small></p> <p>Rhodri Jones BE-BI</p>
<p><small>DOCUMENT SENT FOR INFORMATION TO:</small></p> <p>BE-OP-LHC: Irene Degl'Innocenti BE-BI</p>		
<p><small>SUMMARY OF THE ACTIONS TO BE UNDERTAKEN:</small></p> <p>[List the main actions to be undertaken]</p>		
<p><small>Note: When approved, an Engineering Change Request becomes an Engineering Change Order. This document is uncontrolled when printed. Check the EDMS to verify that this is the correct version before use.</small></p>		



# New system full installation – phase 2



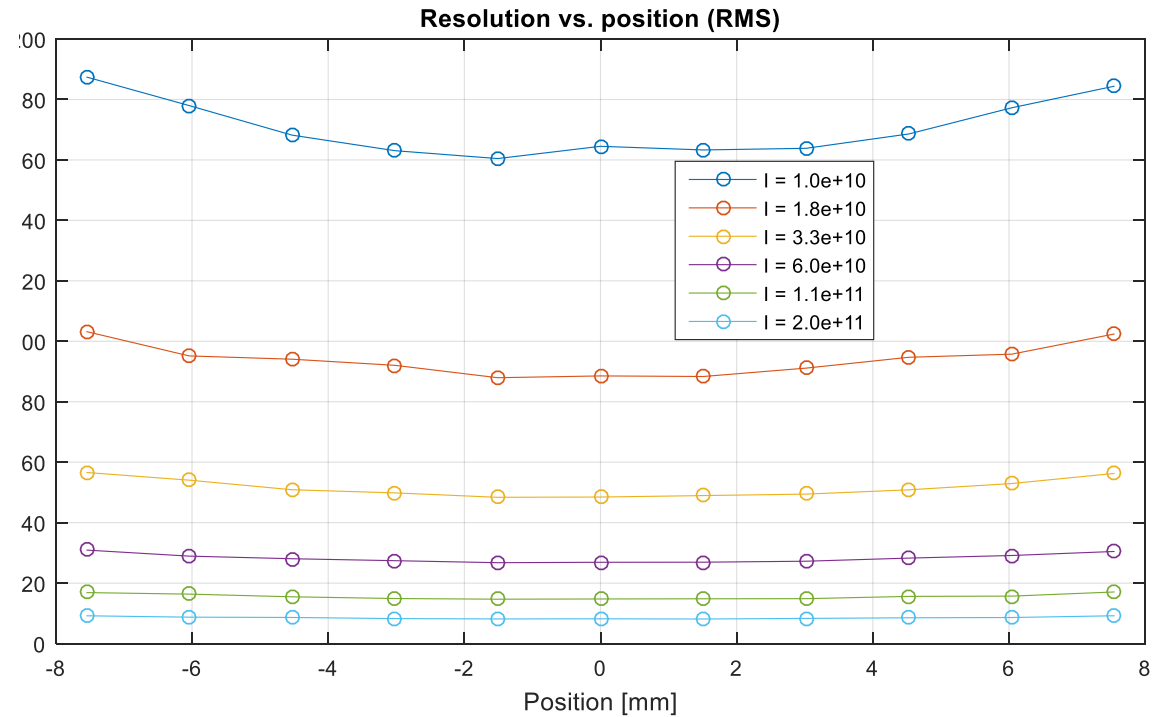
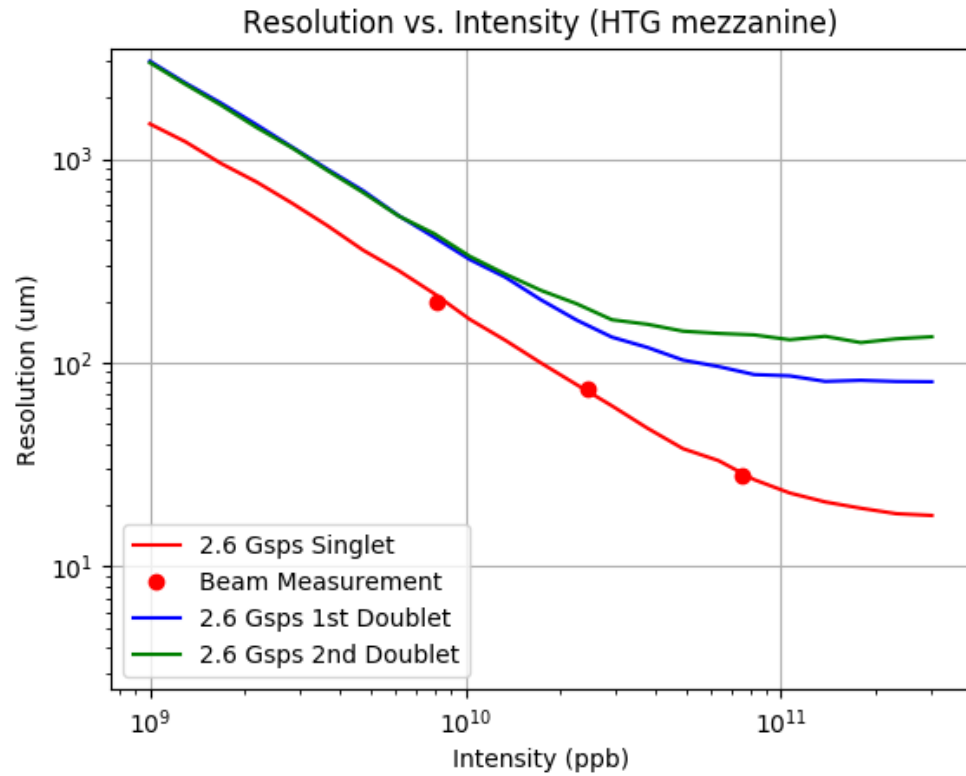
1. After successful phase 1
  - **Criteria for system validation?**
2. Removal of the current system crates
3. All CIBUs have to be moved underground
  - **DICs & ECRs ?**
4. Out of the multiple possible configurations the “Single CIBU per beam per side” as results of discussion between BI and MP has been chosen

**Possible during a YETS period**

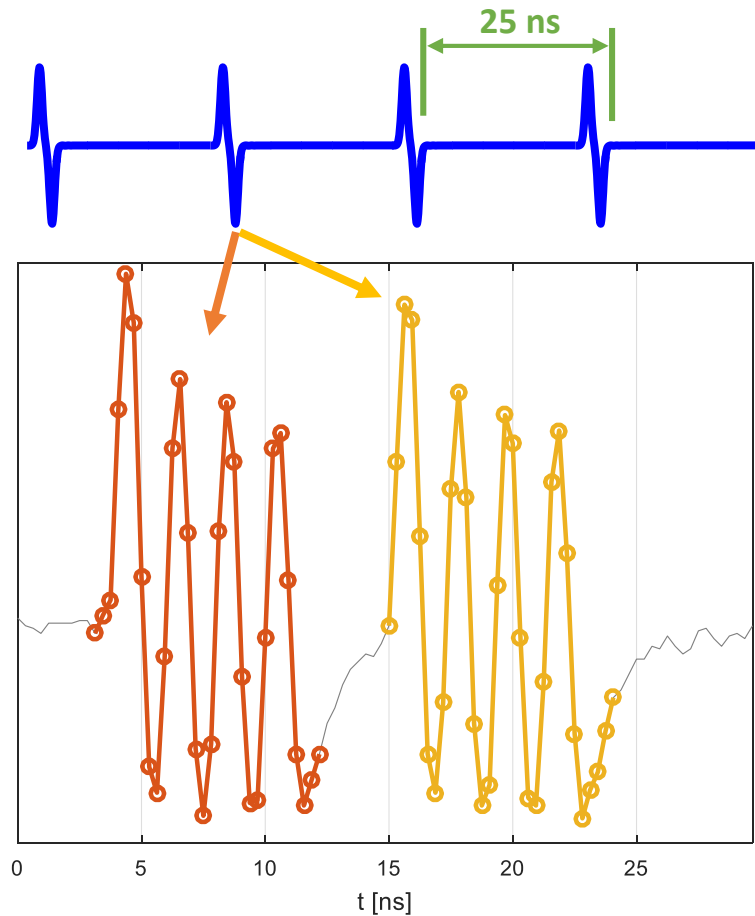
# Summary

- ECR for the test system almost ready to be distributed
- No position information from the test system (BPMSX.A4R6.B2)
- System can be simplified if doublets are forgotten
- Criteria for the validation of the new system to be defined
- During 2021 probably only 2 months of LHC beam.  
Enough to validate the system?  
Do we need special conditions/MDs?
- LS3 as deadline for the full upgrade of the system

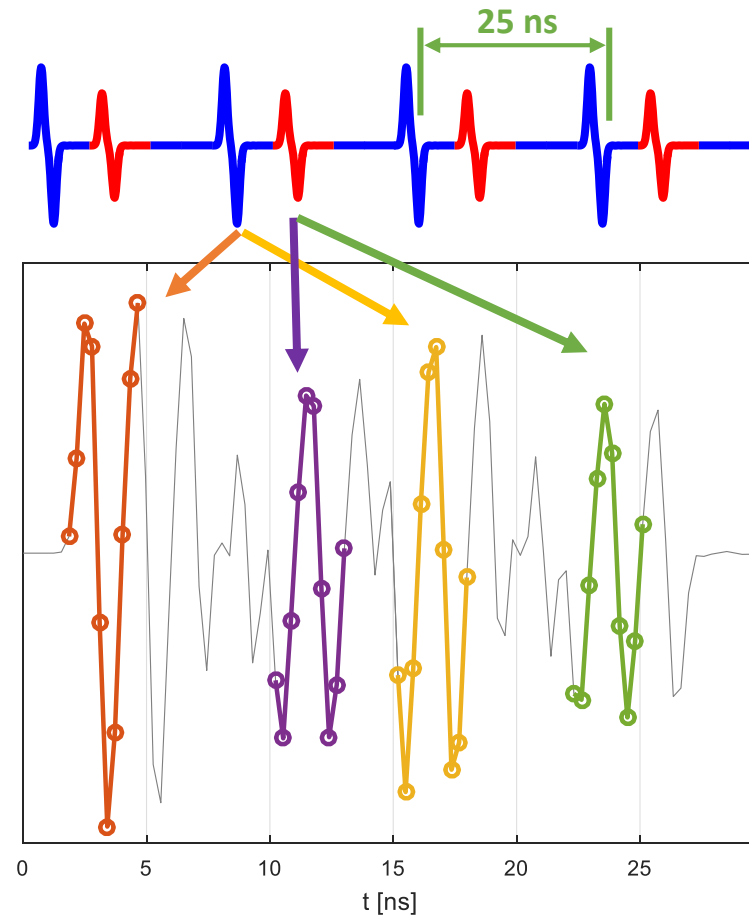
# Appendix 1 - System resolution



# Appendix 2 – Singlet vs doublets



Single bunch (measured)



Doublet bunch (simulated)

