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Characterisation of ESRF-EBS BPM blocks

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special thanks to: A. Nosych

ESRF | The European Synchrotron

OUTLINE

1. BPM block characterization

1. Button to button transmissions
2. Chambers reception and test procedure

2. Output

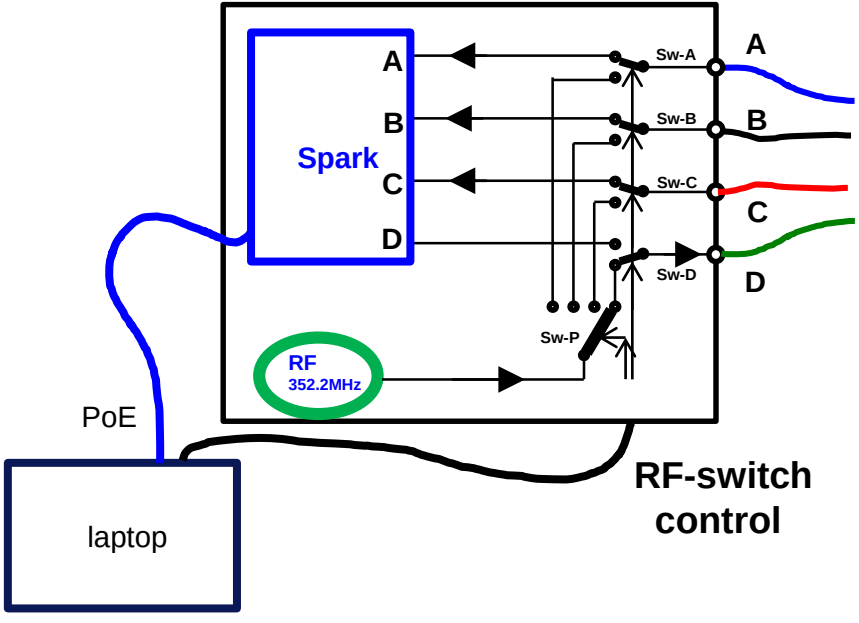
1. Problems evidenced

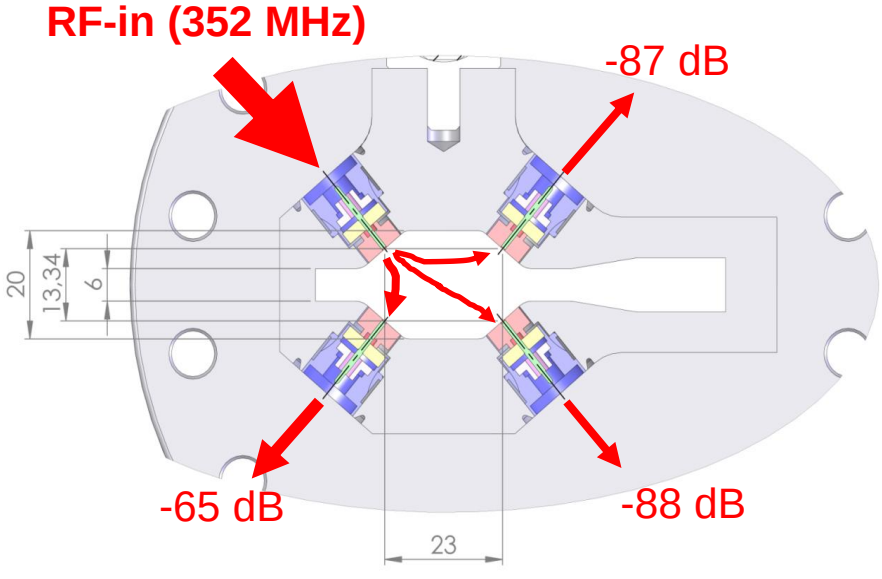
3. Perspectives

BUTTON TO BUTTON TRANSMISSIONS

measurement of button to button transmission

- 4 x 3 measurements → sensitivity (or gain) of each of the 4 buttons





BUTTON SENSITIVITY CALCULATION

The so-called Lambertson method gives a way to compute the button's sensitivity from button-to-button transmissions:

$$V_{ij} = \frac{V_i}{V_j} = 2 \cdot 50 \cdot G_{ij} g_i g_j .$$

V_i is the voltage at the button
g_i is the gain (or sensitivity) associated with the button
G_{ij} is the capacity coupling coefficient

We get 3 values for the g_i's:

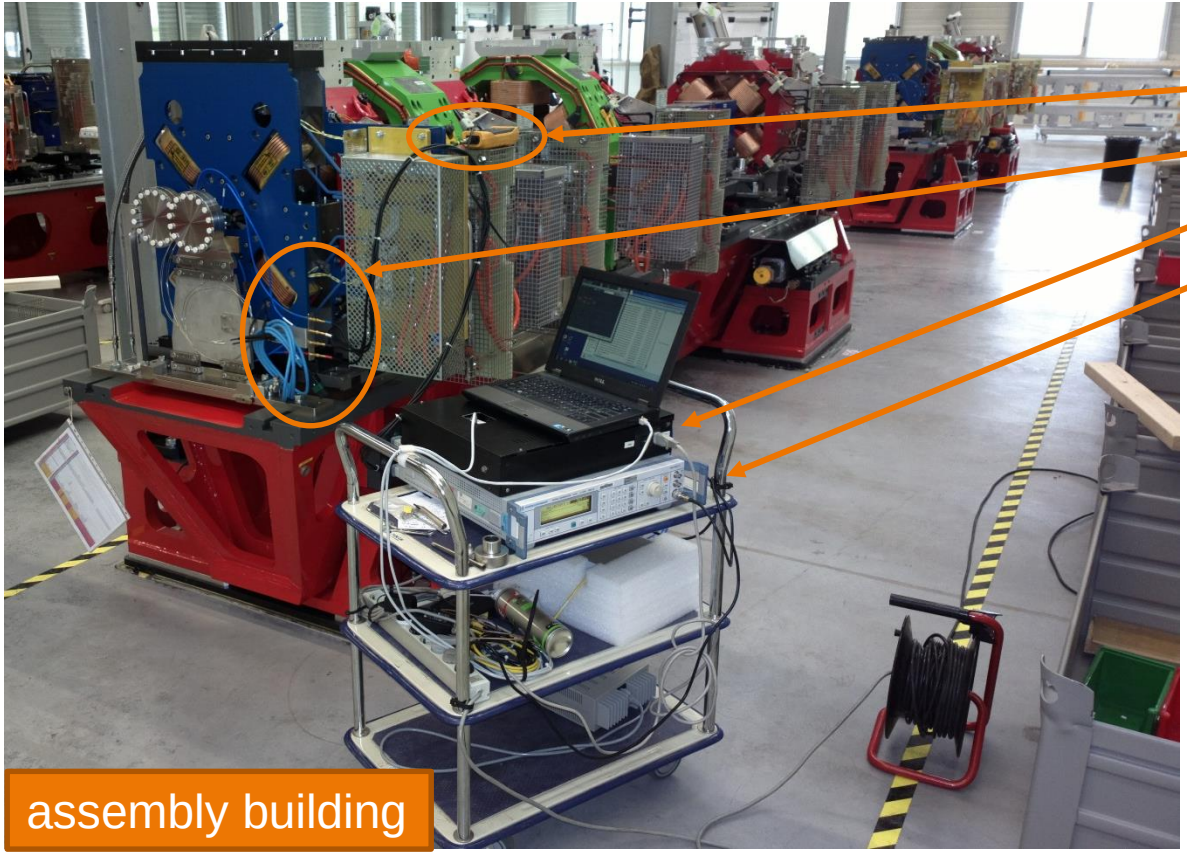
$$2 \cdot 50 \cdot g_1^2 = \frac{V_{21}V_{14}}{V_{42}} \frac{G_{13}}{G_{12}G_{23}} = \frac{V_{12}V_{31}}{V_{32}} \frac{G_{23}}{G_{12}G_{13}} = \frac{V_{41}V_{31}}{V_{43}} \frac{G_{12}}{G_{23}G_{13}},$$

References:

Calibration of position electrodes using external measurements
GR Lambertson - LSAP Note-5, Lawrence Berkeley Laboratory, 1987

Offset Calibration of the Beam Position Monitor Using External Means
Y Chung, G Decker - AIP Conference Proceedings, 1992

BUTTON TO BUTTON TRANSMISSIONS



Ohm-meter

Interconnection plate

Switch-box

RF generator

<u>Autonomous system:</u>

On a trolley to be able to move easily (along a girder, and in different buildings)

No connection to ESRF network (for reliability)

Give an immediate answer if BPM is **OK** or **NOT**

CHAMBERS RECEPTION AND TEST PROCEDURE

Every BPM blocks are measured 2 times:

- At reception, just after heater installation
- After assembly on a girder with magnets, cables from BPM to interconnection plate, etc.

Between the two tests chambers experience bake-out, NEG-coating (not all of them)…

Test procedure consists in:

- measuring DC resistance
- performing RF transmission measurement

Current state (April 2018):

- 127 BPM blocks received and measured over the 320 BPM
- 84 assembled on a girder and ready for installation

PROBLEM EVIDENCED

Finite resistance between button and chamber

- a few cases found (8 chambers affected)
- resistances ranging from short-circuit to MOhms
- worse case was a NEG coated chamber with all 4 buttons affected → solved by blowing gas on buttons
- Also had a freshly received chamber affected (pollution not only coming from NEG coating)

We don’t know the origin of this pollution yet. So far we treated buttons by burning « impurities » under vacuum with a voltage source.

→ all cases treated with success

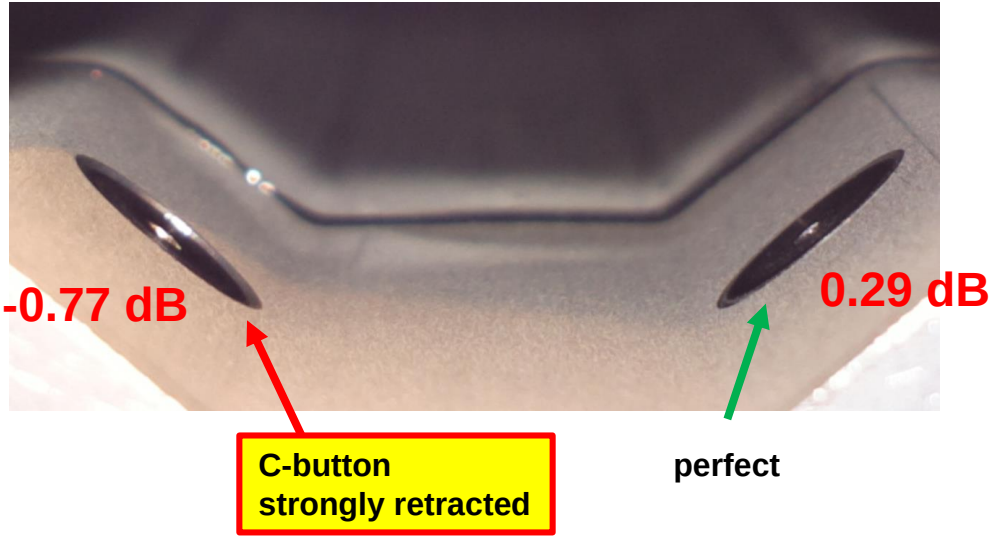
An interconnection RF cable found grounded

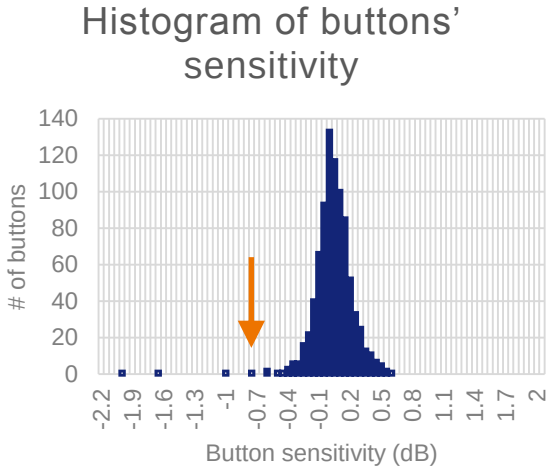
- Cable replaced, manufacturer informed

PROBLEM EVIDENCED

Retracted buttons:

- A small number of buttons have been found retracted
- These chambers will not be installed (kept as spares)

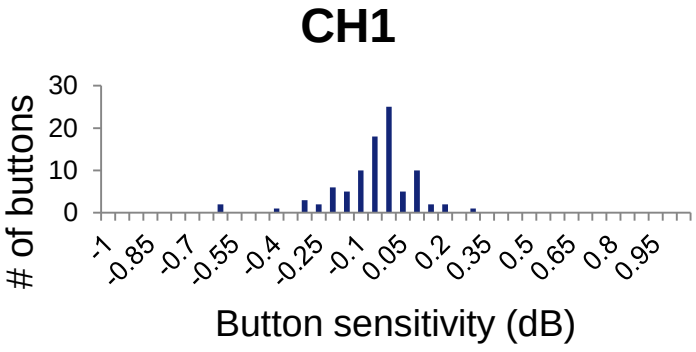


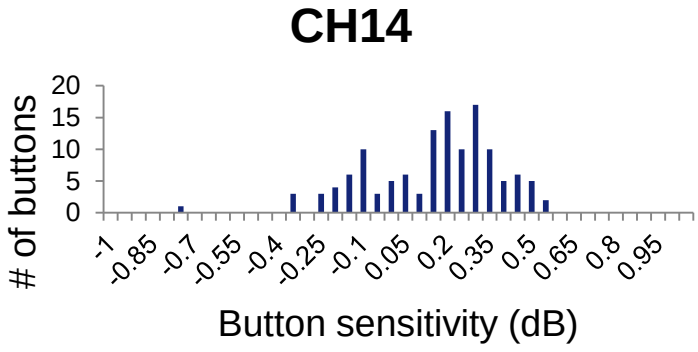


PROBLEM EVIDENCED

Discrepancies between manufacturers

- Chamber #1 and #14 are similar, with the difference that they are made by different manufacturers
- RF transmission measurements show different variability in buttons' sensitivity





PERSPECTIVES

More characterisations:

- A more suitable RF-switch box will be done (better switches, power calibration, …)
- BPM blocks will also be electrically measured after installation (check cabling, measure button to chamber resistivity).

Minimize offset of a BPM block by compensating for:

- Mechanical offset → measured by alignment group (chamber deformation, misalignment with adjacent quadrupoles)
- Buttons' sensitivity
- Offset due to electronics (Libera Spark) / RF-cabling

Also:

- Take non-linear effect of the BPM blocks into account

  → work in collaboration with ALBA (A. Nosych)

Compensating for BPM offsets will be essential for ESRF-EBS commissioning (first turns). Once we will have a stored beam, beam base alignment techniques will be used to measure BPM offsets more precisely.