Field homogeneity measurements with beam of the CLIC Stripline at the ALBA Storage Ring

2019 CLIC Workshop

F.Pérez
on behalf of the ALBA & CERN team

Outline

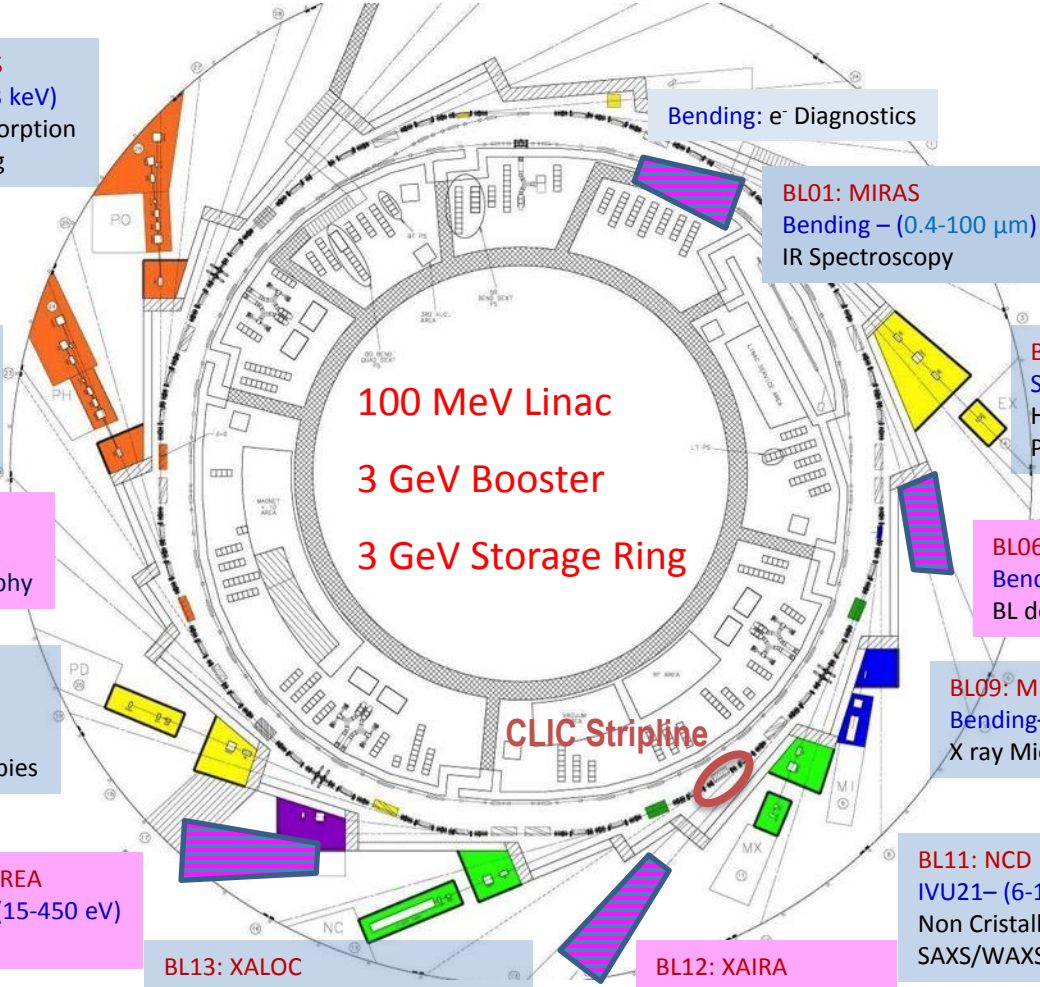
1. Introduction
2. Installation
3. Transverse beam coupling impedance
4. Longitudinal beam coupling impedance
5. Transverse homogeneity - DC HVPS
6. Longitudinal homogeneity - Inductive Adder Pulser

Introduction to ALBA

E = 3.0 GeV
C = 268.8 m
ε = 4.0 nm·rad

8 BL x In operation

4 BL x In construction



BL29: BOREAS
EU71– (0.08-3 keV)
REsonant Absorption and Scattering

Bending: e⁻ Diagnostics

BL01: MIRAS
Bending – (0.4-100 µm)
IR Spectroscopy

BL24: CIRCE
EU62– (0.1-2 keV)
Photoemission spectroscopies

BL04: MSPD
SCW31 – (8-50 keV)
HP/HR
Powder Diffraction

BLxx: FaxTor
Wiggler
Hard x-ray tomography

BL06: NOTOS
Bending
BL development

BL22: CLÆSS
MPW80– (2-63 keV)
Absorption & Emission Spectroscopies

BL09: MISTRAL
Bending– (0.27-2.6 keV)
X ray Microscopy

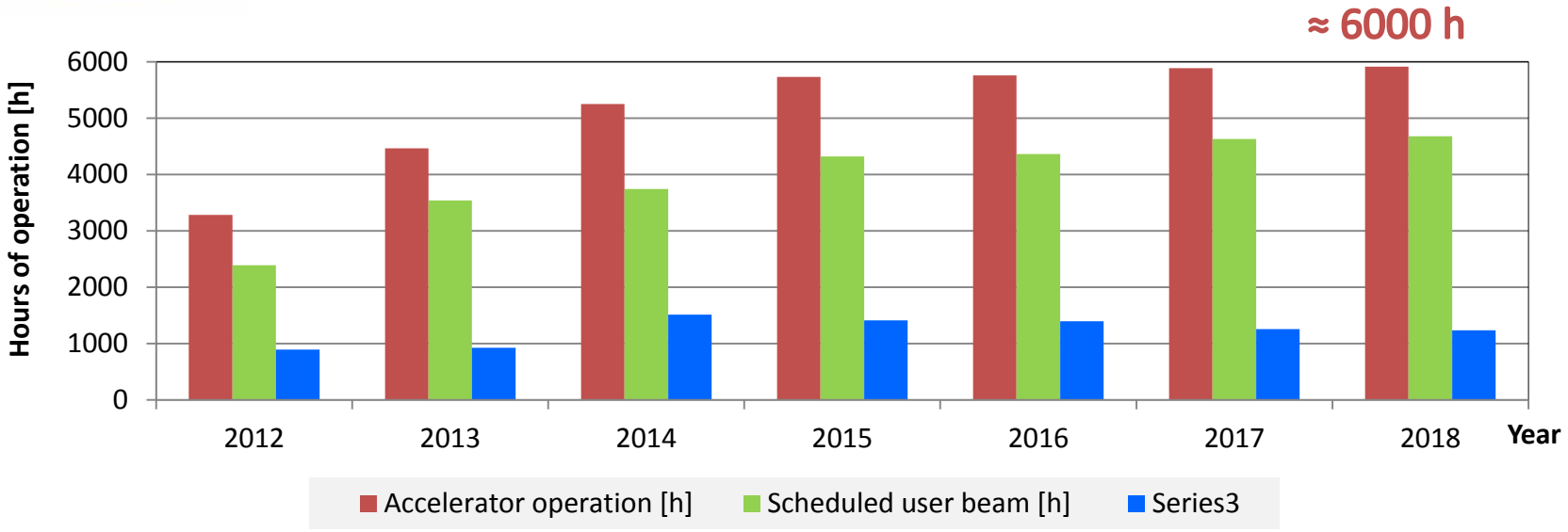
BL20: LOREA
EU150– (15-450 eV)
ARPES

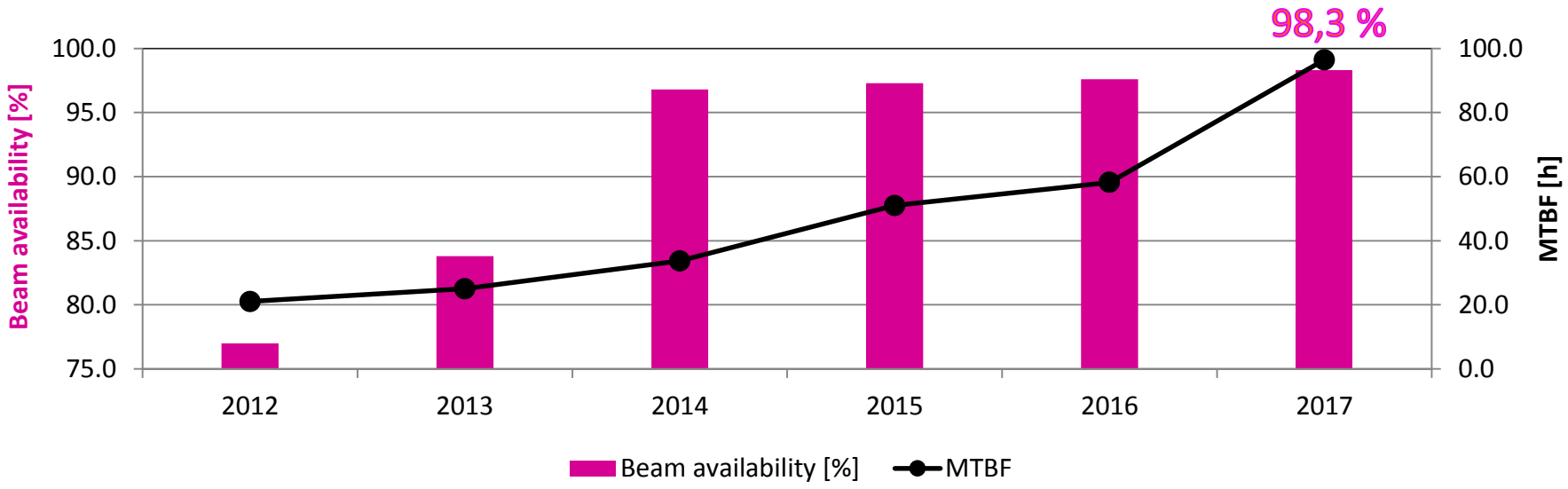
BL11: NCD
IVU21– (6-13 keV)
Non Cristalline Diffraction
SAXS/WAXS

BL13: XALOC
IVU21 – (5-22 keV)
Macromolecular Cristallography

BL12: XAIRA
IVU21 – (5 – 22 keV)
Microfocus

Introduction to ALBA

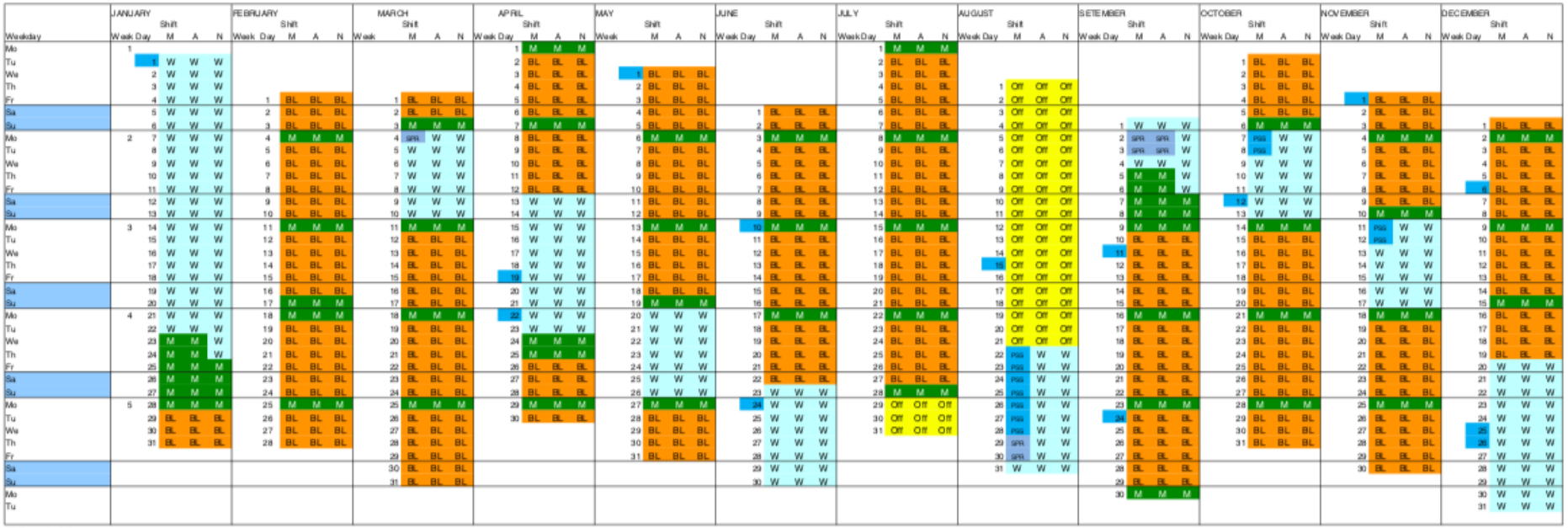




Introduction to ALBA

ALBA Operations Calendar, January 2019-December 2019

BL operation	BL	BL users (external, friendly, in-house & commissioning)
bl operation	bl	BL/FE/ID Commissioning & Accelerator Optimization for BLs
Start-up	M	Start up of accelerators with beam & Accelerator's Studies
Warm-up	W	Warm: Linac & RF & magnets & sub-systems maintenace and optimisation
Shutdown	Off	Civil Engineering, Accelerators and BL maintenance with no beam, installations and upgrades
Public & CELLS holiday		

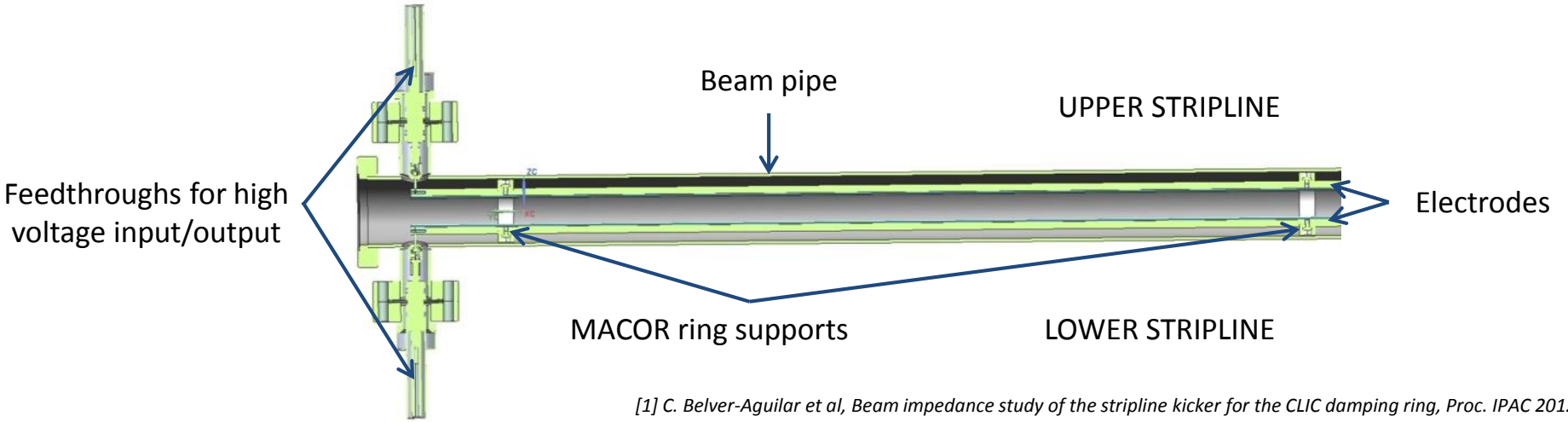


2019 versio 3.0
04/10/2018, MBM approved
07/01/2019, festivos incluidos

Design issues

STRIPLINE KICKER

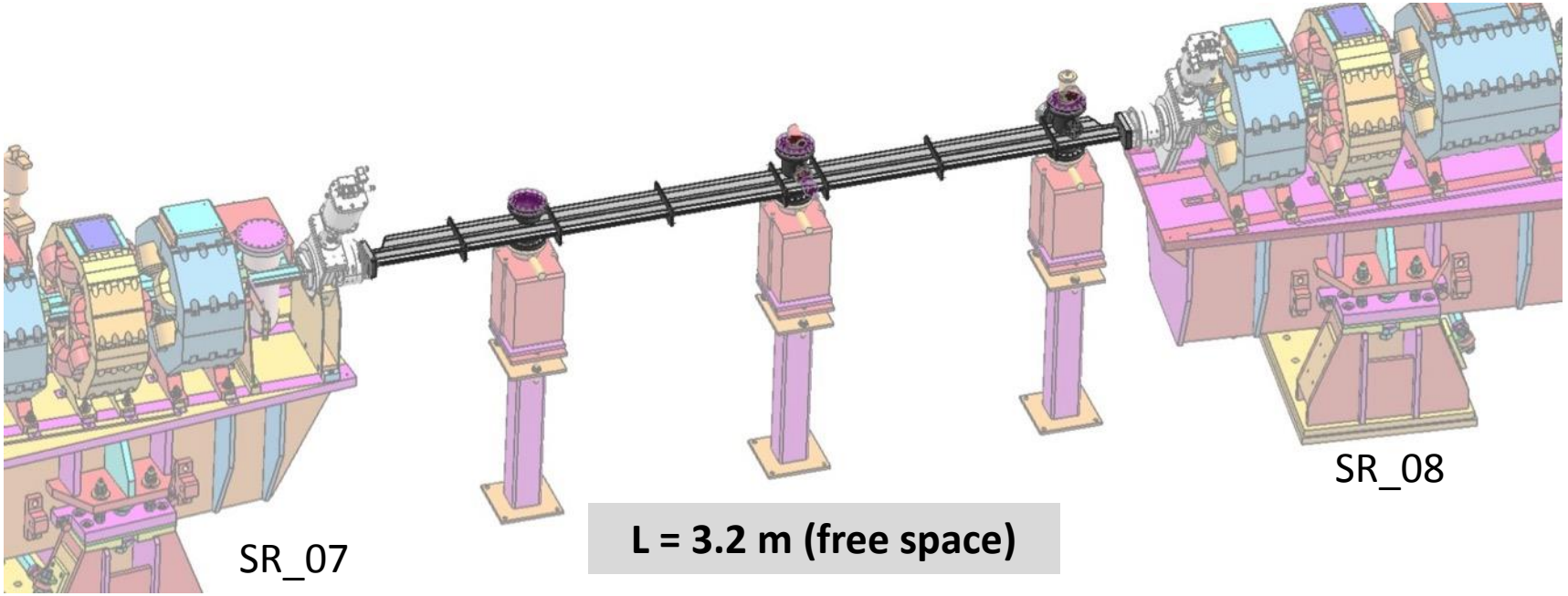
- Beam pipe **ID 40.50mm**
- Total length **1.7 m**
- Al electrodes hold in position by MACOR rings (**ID 28.8 mm**)
- Distance between electrodes **20 mm**



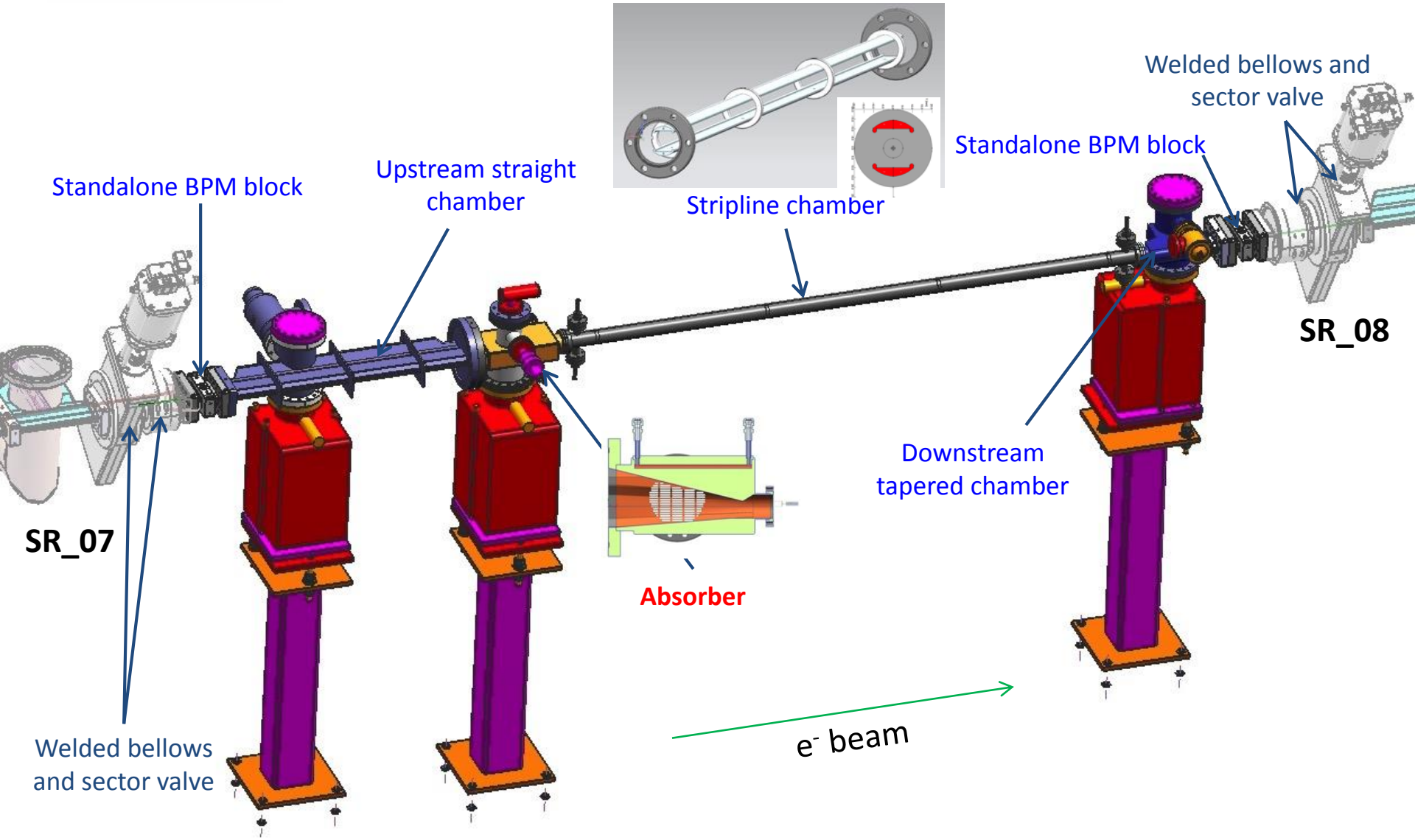
[1] C. Belver-Aguilar et al, Beam impedance study of the stripline kicker for the CLIC damping ring, Proc. IPAC 2012

Design issues

CLIC stripline installed in a medium straight section of the SR



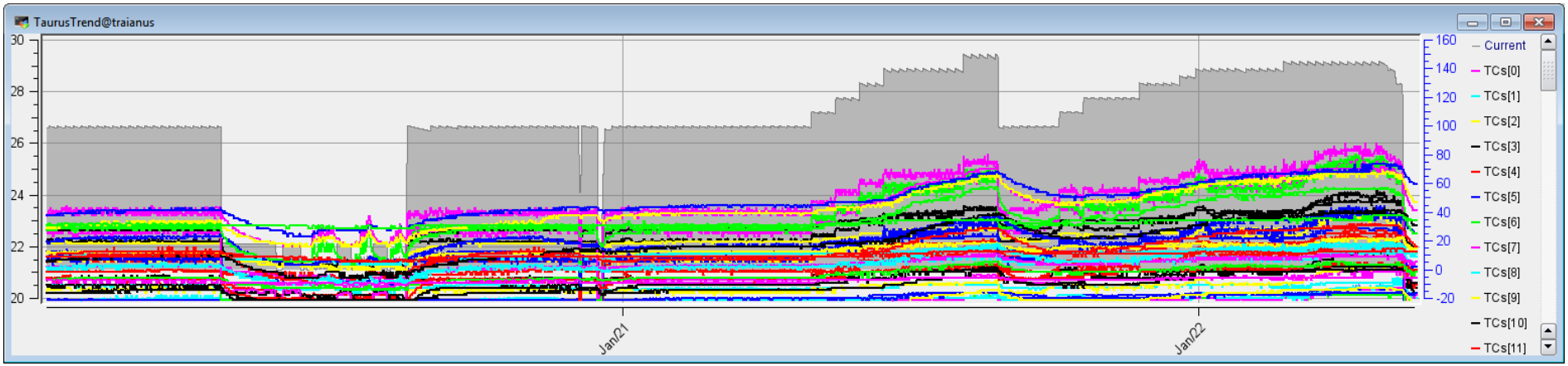
Design issues



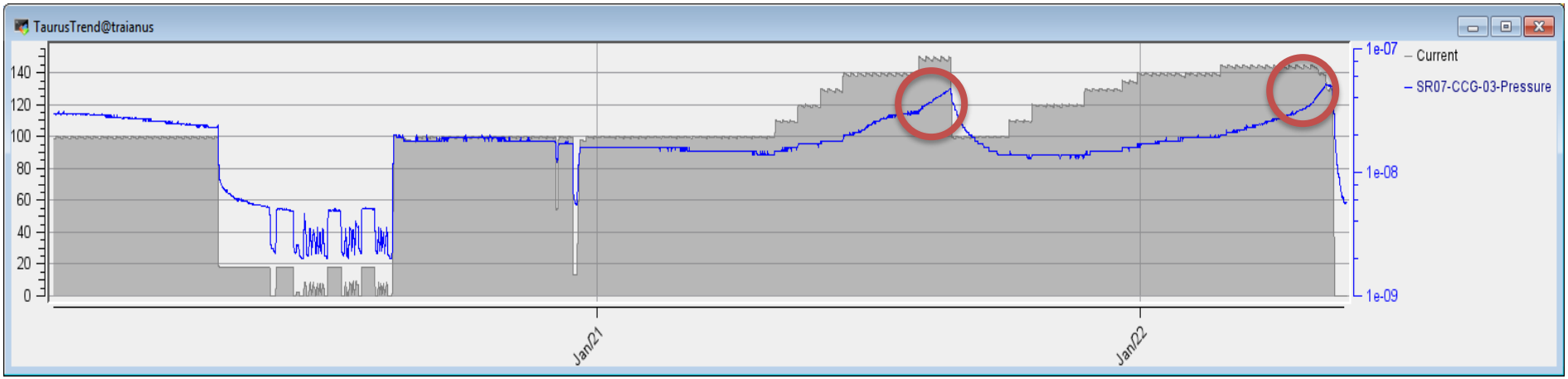
Installation

Conditioning Jan 2018

- Temperature is ok

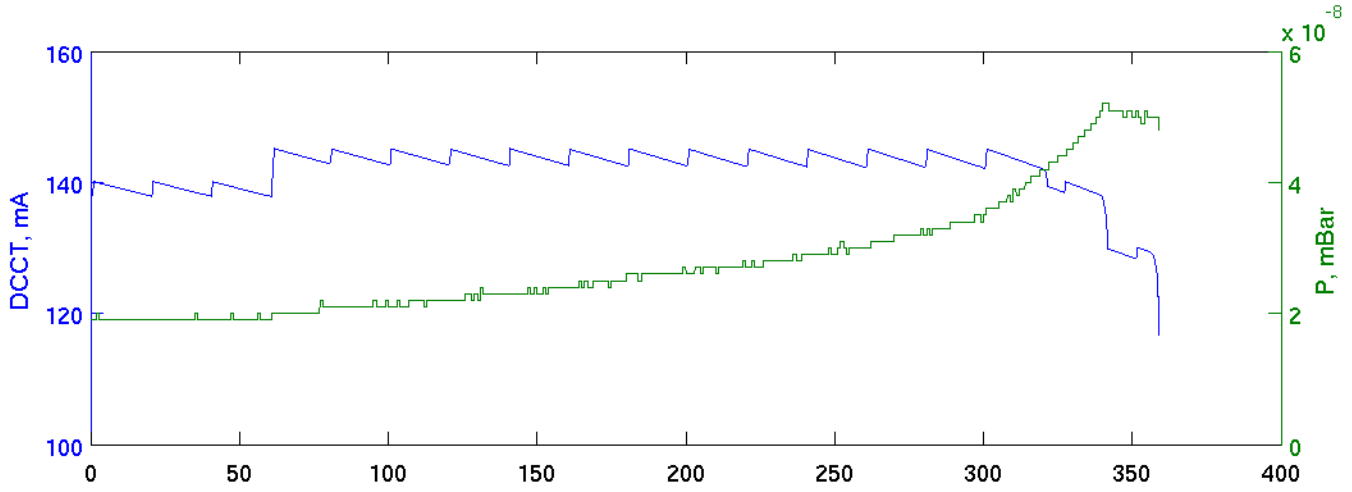


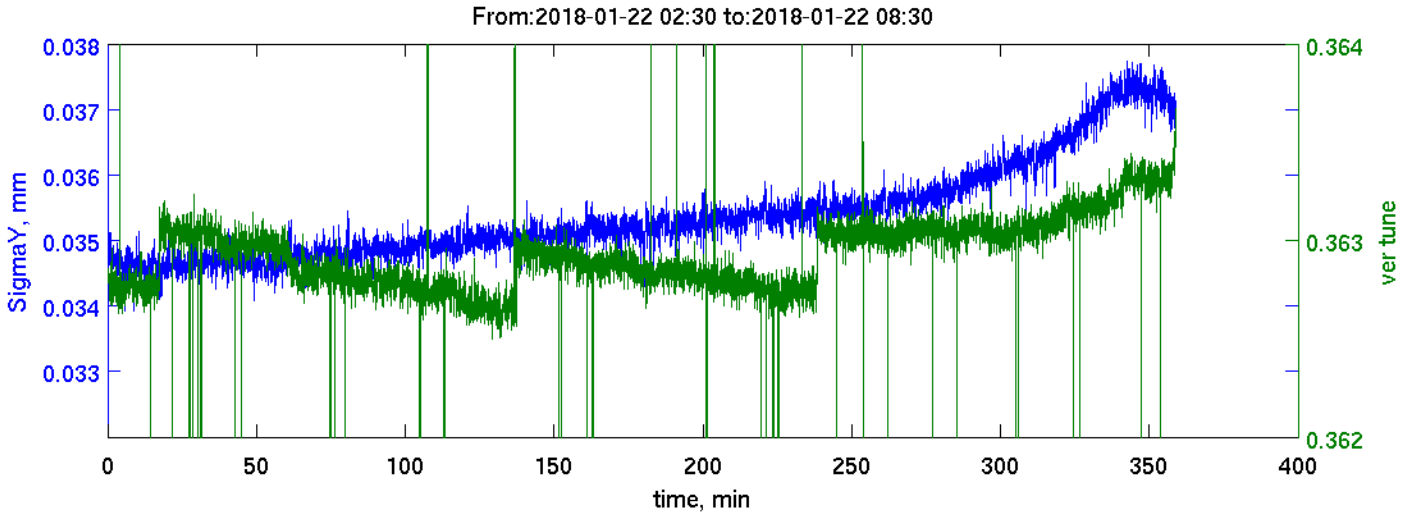
- For I > 140 mA vacuum pressure “run away”



Conditioning Jan 2018

Ions instability built up





Stripline Characterization with beam

Limited to **low current (20 mA)**

to avoid Ions Instabilities

Sept 2018

Transverse Beam Coupling Impedance

Longitudinal Beam Coupling Impedance

Transverse Field Homogenety – DC HVPS

Jan 2019

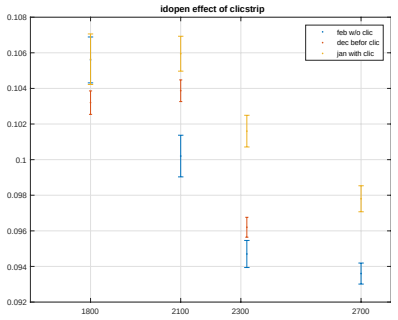
Longitudinal Inductive Adder Pulse Homogeneity

Vacuum conditining

Transverse Beam Coupling Impedance (Jan 2018)

- The striplines assembly, together with the absorber, could have an impact on the ring impedance.
  - Measuring the transverse impedance of the total ring before and after the installation of the striplines.
  - Single bunch measurements to determine TMCI threshold and detuning slope.
  - Beta beating is corrected and accelerator is operated a ξ_V=0
  - Data taken at Vrf=1.8kV, 2.1kV, 2.32kV and Vrf=2.7kV

  - Too noisy
  - Error bar was bigger than the value itself

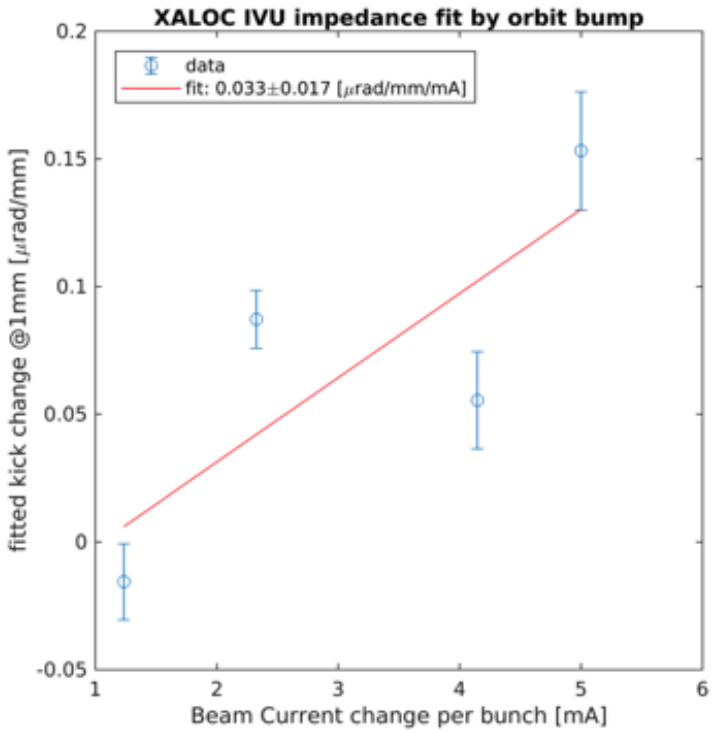


Transverse Beam coupling impedance (Sept 2018)

➢ 2nd method – Local bump.

- Produce a vertical bump of y_0 at the SL location (max of ±1 mm, limited by correctors strength)
- Get orbit at high beam current, I_H (max of 8 mA/bunch, limited by single bunch instabilities)
- Scrape down the beam until a "low" beam current is reached I_L (min of 1mA/bunch)
- Get orbit at low beam current
- The **difference between the orbits at 2) and 4) is due to the impedance of the SL**, the impedance elsewhere and the current dependent behavior of the BPMs. To isolate the SL impedance effect, a second bump ($-y_0$) is produced in the opposite direction as in 1) and the orbit at the same high and low currents is also measured.
- **By subtracting the two orbit differences, only the effect of the SL impedance kick remains**.

Transverse Beam coupling impedance (Sept 2018)



The resulting impedance kick is

0.033±0.017 µrad/mm/mA

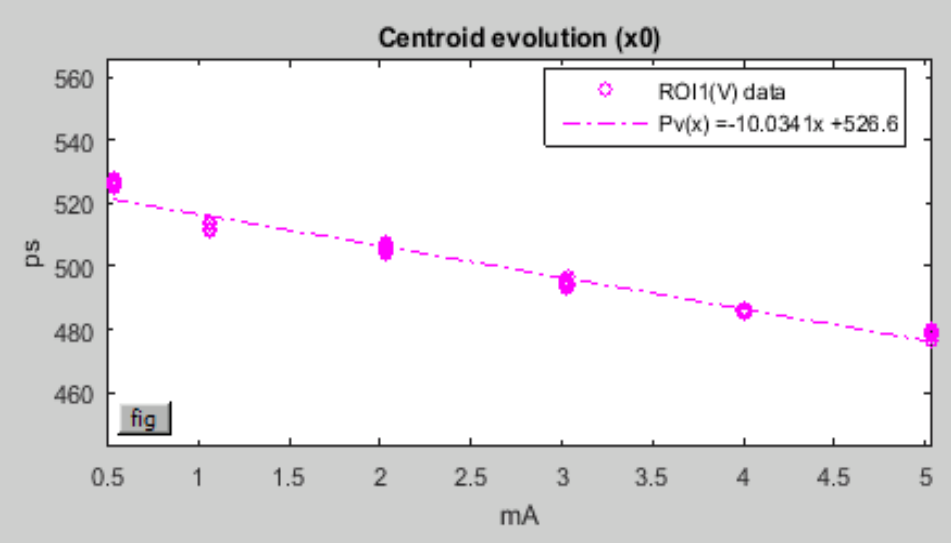
Consistent with the theoretical value simulated in GdfidL of

0.0244 µrad/mm/mA.

Longitudinal Beam coupling impedance (Sept 2018)

- This is measured from the **difference between the global longitudinal** machine measurements with the Stripline **IN and OUT** of the Storage Ring.

- With the Stripline installed **IN** the Storage Ring, we measured the phase variation when the single bunch current increases up to 5 mA (when the beam becomes unstable due to headtail instability).



Measurements without the Stripline, to complete the characterization, will be carried out in **February 2019**

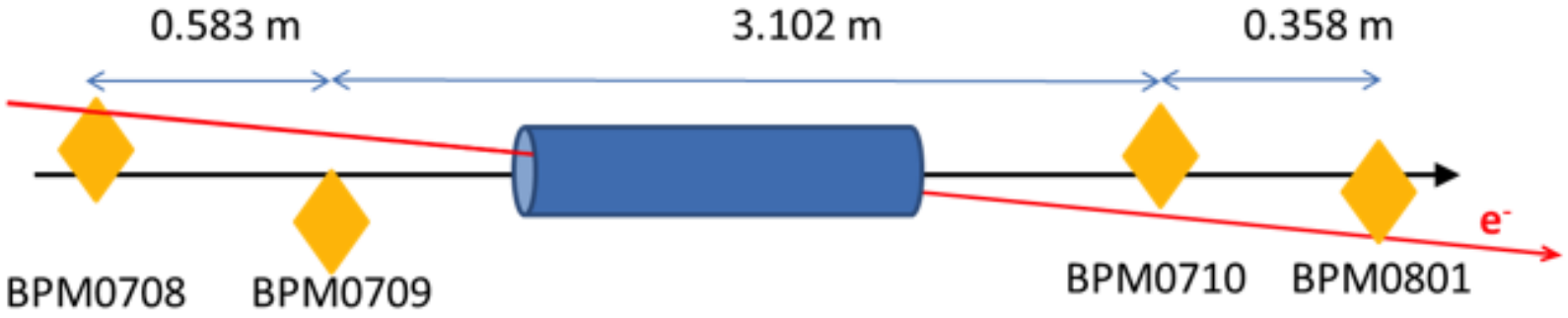
Stripline Transverse Field Homogenety – DC HVPS

Measurements with the HV DC power supplies:

The **electrodes will be powered by DC HV power supplies** and will not be resistively terminated. Only electrostatic field will be used to deflect the beam (the striplines will be open-circuited).

A **local angle measurement** will be performed with 4 BPMs

- Slow acquisition (close orbit)
- Using a multibunch filling pattern with 20 mA
- Calibration of the BPM non linear behaviour

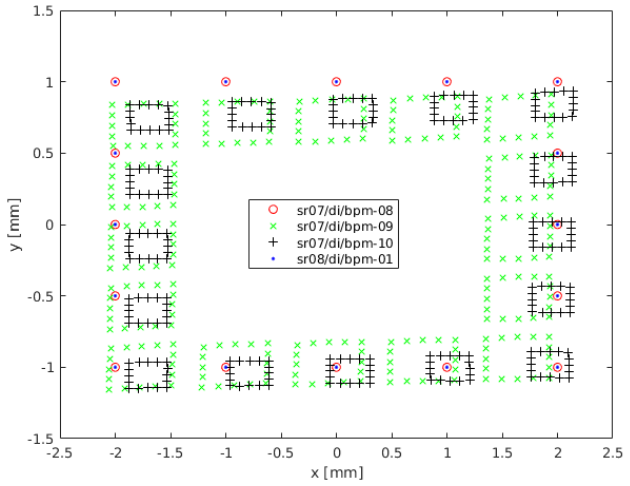


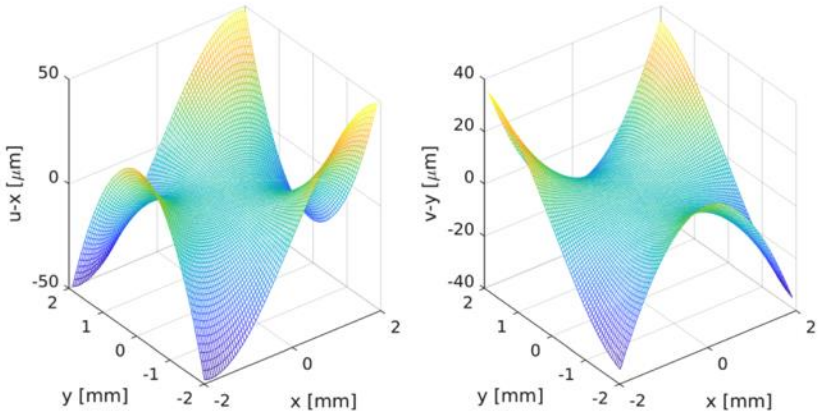
Stripline Transverse Field Homogenety – DC HVPS - Calibration

The BPM position readings suffer from a series of systematic errors. Mechanical misalignments and button voltage miscalibration contribute to the offset, gain and coupling of the BPM horizontal and vertical position readings.

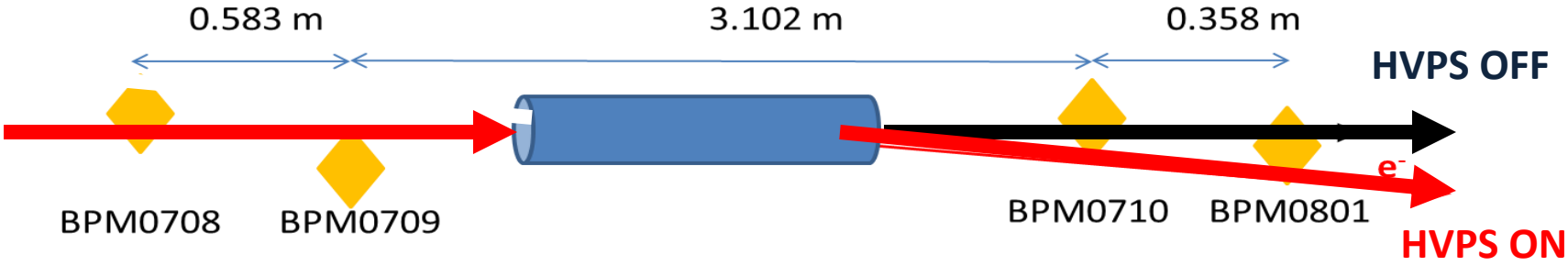
Calibration of the BPMs is needed in order to accomplish the required precision.

Bumps done with the Stripline not powered

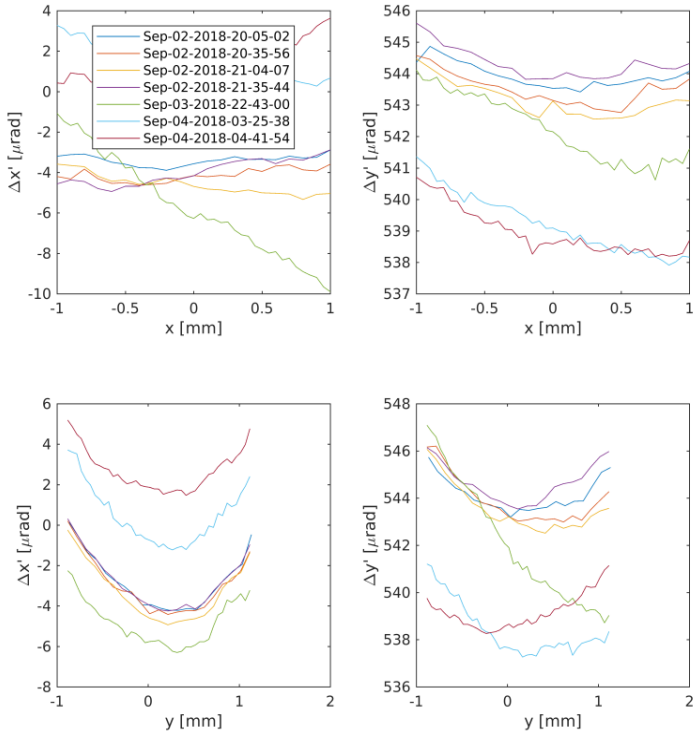




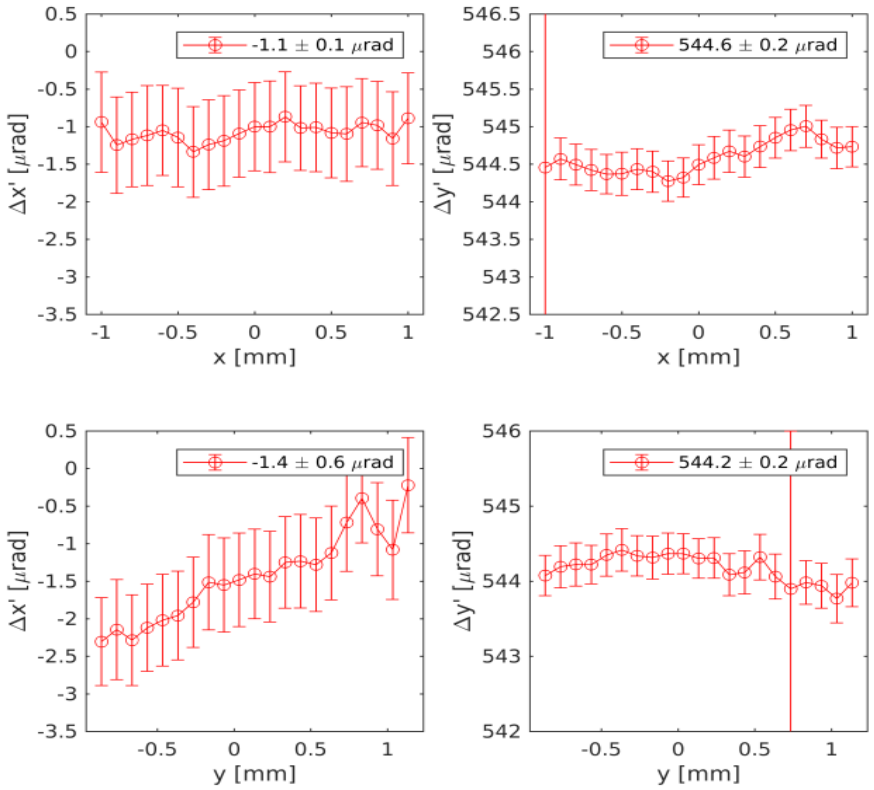
Stripline Transverse Field Homogenety – DC HVPS - Measurements



We measure the angle ON/OFF at different bumps (beam position inside the stripline)



Stripline Transverse Field Homogenety – DC HVPS - Results



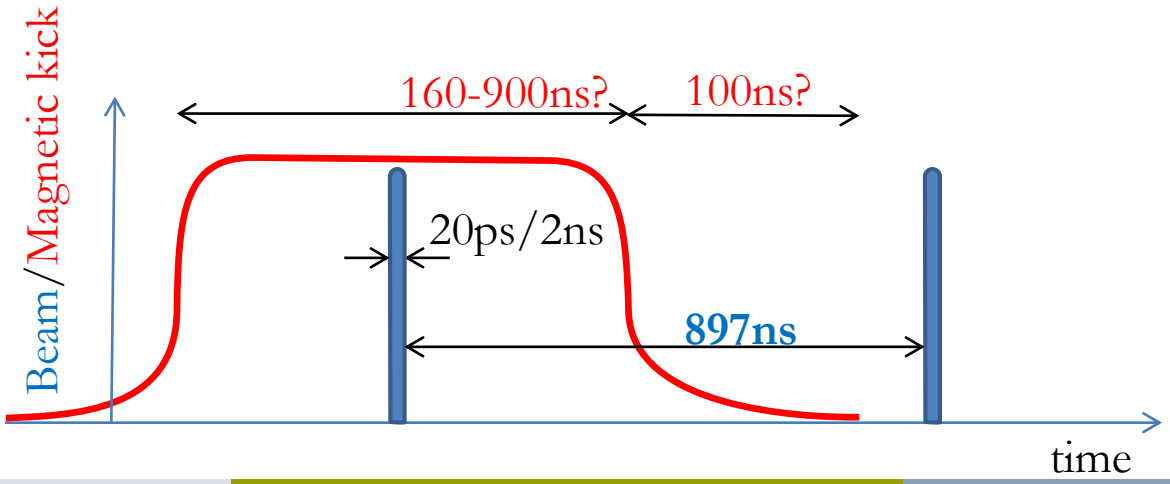
Magnitude	Measured	Expected
DC kick (20 kV)	544.4 μrad	567 μrad
DC kick homogeneity (20 kV)	$3.7 \cdot 10^{-4}$	$<2 \cdot 10^{-4}$

Longitudinal field homogeneity – Inductive Adder Pulser

Measurements with the Inductive Adder:

Field flat-top stability, pulse-pulse repeatability, longitudinal field homogeneity.

- Variable pulse delay
- Flat top might be an issue, ALBA rev time is 897 ns
- Measurements done in single bunch
- Using BPMs TbT readings with enough averaging
- Use global amplitude measurement with all 122 BPMs



Longitudinal field homogeneity – Inductive Adder Pulser – Lab tests

Tuesday
Last week

Stripline (prepared for bakeout)

Inductive Adders Pulsers

Janne Holma

Pulse in Stripline

Longitudinal field homogeneity – Inductive Adder Pulser – Installation

Friday
Last week

The two inductive adders are now installed at the ALBA tunnel, together with the Sripline

Longitudinal field homogeneity – Inductive Adder Pulser – Tests...

...to be done this week: 24 – 27 January

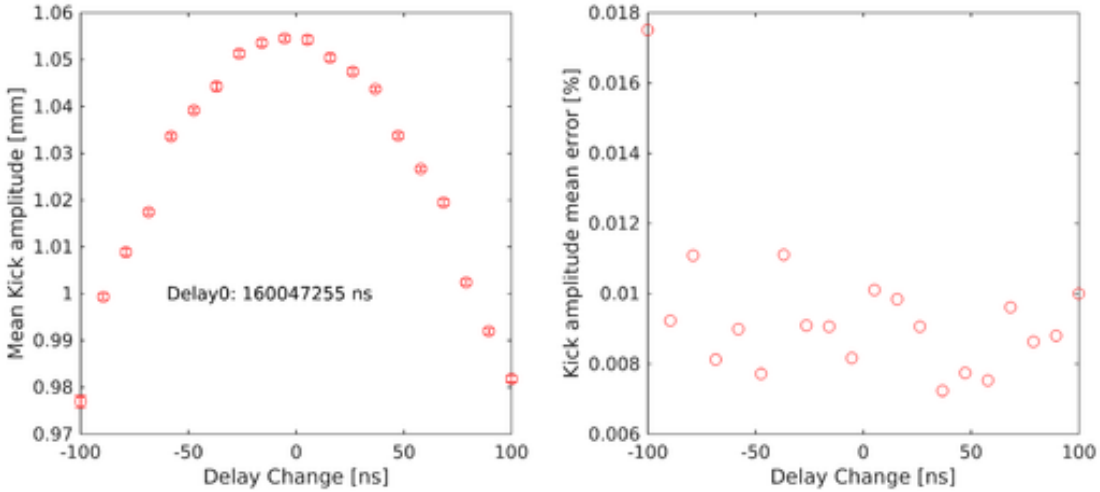
But few weeks ago, a very succesful "concept's measurement" has been performed with the ALBA Pinger Magnet

Pulse field measurement – ALBA Pinger Magnet

Extracted from the ALBA Logbook, 16 Dec 2018:

01h00 Single bunch 8mA in SR (it seems unstable above 8.5mA). When seting the pinger to 2.4kV, the beam is lost to 3mA.

01h30 Pinger at 2.4kV scan +/-100 ns scan with 20 steps, 512 turns, 50 shots per step. (25 min, from 3.0 to 2.8 mA)



Even at 3mA in single bunch**, the measurement precision is also close to 1e-4!! :)**

Conclusions

- ✓ The CLLC stripline has been installed several times in the ALBA storage ring.
- ✓ Within the collaboration, a full characterisation of the CLIC Stripline will be completed:
  - ✓ Transverse Beam Coupling Impedance
  - ✓ Longitudinal Beam Coupling Impedance
  - ✓ Transverse Field Homogeneity
  - ❖ Longitudinal Field Homogeneity tested with Inductive Adder
  - ❖ Vacuum Conditioning

Thanks!