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STATUS of the ELETTRA IKC to the ESS WIRE SCANNER ACQUISITION SYSTEM

Mario Ferianis

on behalf of the Elettra-ESS IKC WS Team,

R. De Monte, S. Grulja and S. Cleva

IT WAS ONE YEAR AGO…

2

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ESS IKC DIAG IV FORUM CEA Paris 20-21 November 2017

12

NEXT STEPS – OPEN ISSUES

ASAP

Need a strong joint commitment to the bi-lateral **ESS-ST Contract signature**

>>> it will un-lock resources at ST, enabling series production in 2018

CDR-1 & CDR-2 milestone in **early 2018** (Jan/Feb)

Careful **cables, cabling and installation (racks)** double check (**RUNNING!**)

Vertical integration tests (**mid 2018, the latest**):

> wire scanner mechanics to motion controller and acquisition system

> WS acquisition system interfacing to ESS ICS and timing

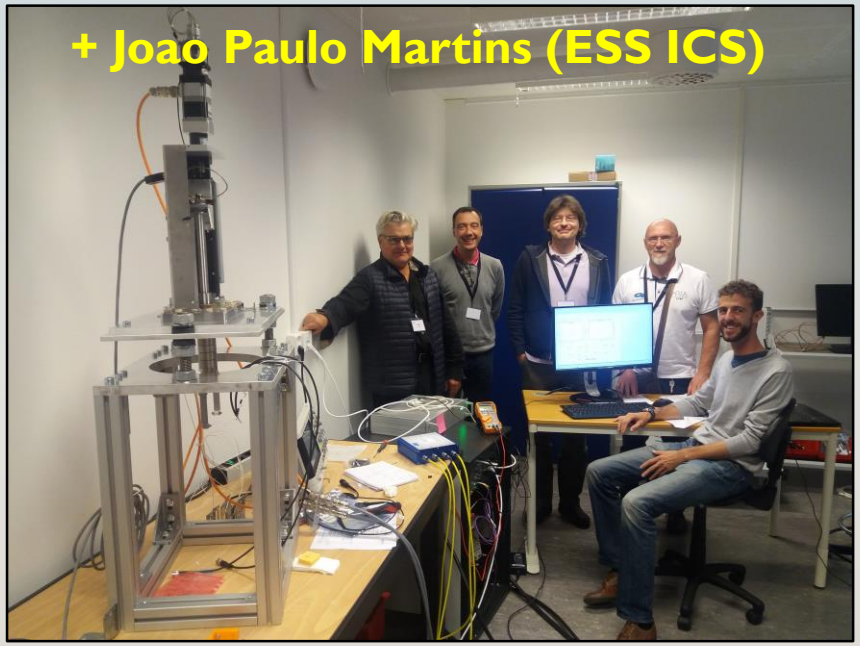
> WS ACQ SYS interfacing to MPS

Delivery and **in-house acceptance** procedure (what, where and when)

In-situ WS ACQ SYS installation infrastructure set-up (1 by 1 WS stations)

2018: IT HAS BEEN A BUSY YEAR & SUCCESSFUL TOO …

- CDR-1 & CDR-2 — March, 5th & 6th
- WS SW (IOC & panel) dry run @ ST — June, 15th
- **Vertical Integration Test (high en. WS) @ ESS** — August, 27th to 29th
- Vertical Integration Test (low en. WS) @ESS Bilbao — November, 14th & 15th



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WS acquisition system CDR

Monday,5 March 2018 to Tuesday, 6 March 2018

Participants: Ibon Bustinduy; Stefano Cleva; Raffaele De Monte; Mario Ferianis; Sandi Grulja; Peter Jacobsson; Andreas Jansson; Hinko Kocevar; Bruno Lagoguez; Joao Paulo Martins; Thomas Shea; Evangelia Vaena

Elettra Sincrotrone Trieste

	Dichiarazione trasporto materiali per scopi professionali	Modulo

Trieste, 24 agosto 2018

Si dichiara che i materiali sotto descritti sono di proprietà della Sincrotrone Trieste S.C.p.A. e vengono trasportati dal sig.

Raffaele De Monte

in quanto beni utilizzati per l'esercizio della propria professione. Per la delicatezza degli stessi non è possibile inviarli tramite corriere espresso.

1. Analog Front End (AFE) module
2. Back End (BE) module
3. Signal and power cables

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4 RUNNING TASKS: PRODUCTION, SHIPMENT & COMMISSIONING

Analog Front End (AFE) series production (13x) running
- **MEBT AFE (3x)** **delivered on Nov, 19 2018**
- series completion by **Jan 2019**

Back-End (BE) series production (13x) running
- **MEBT BE (3x)** **delivered on Nov, 19 2018**
- series completion by **Jan 2019**

Optical Front End (OFE) (6x) / BE_{mod} (9x) production starting
- series due by **June 2019**

EPICS IOC & ENG PANEL completed
- Commissioned during the VIT in LUND
- Handed over to J-P Martins
- *software-assisted* ***Factory Acceptance Test procedure***

Certification issues (*some form of Declaration…*)
TRR, SAR-1 and **SAR-2** underway

AFE 11 + 2 spares=13 AFE;
OFE: 5 + 1 spare= 6 OFE;
3 OFE for fast WS
13 BE and 9 BEmod

OTHER TASKS & EVENTS…

- ☺ **TAC in Lund** (poster) — April, 12th 2018
- ☺ **Technical Board** (talk) @ Lund — September, 13th 2018
- ☹ **SCINT + OFE test** @ CERN — September, 24th & 25th 2018

- *In the near future, we may be helping with installation…*

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AIK 7.4 – WIRE SCANNER ACQUISITION SYSTEM

M. Ferianis, R. De Monte,

S. Cleva, S. Grulja

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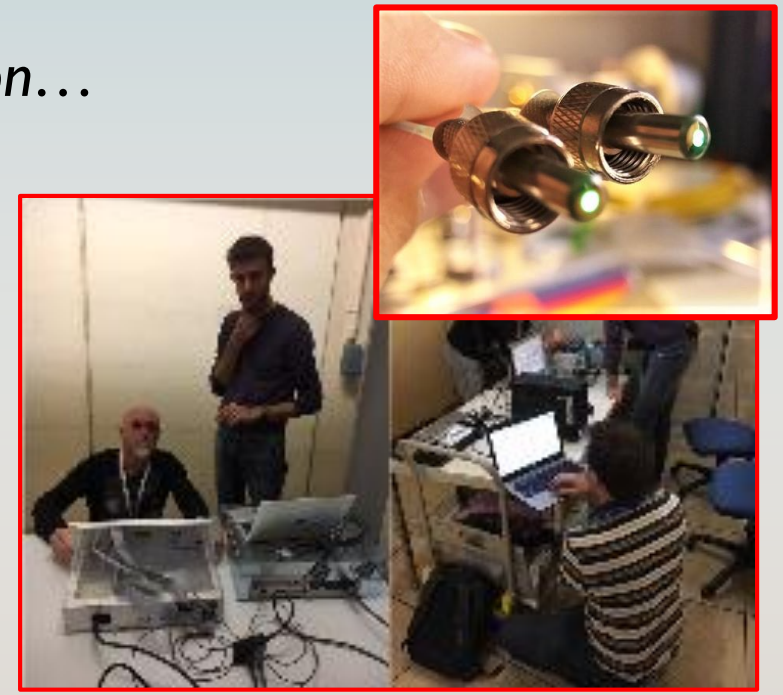
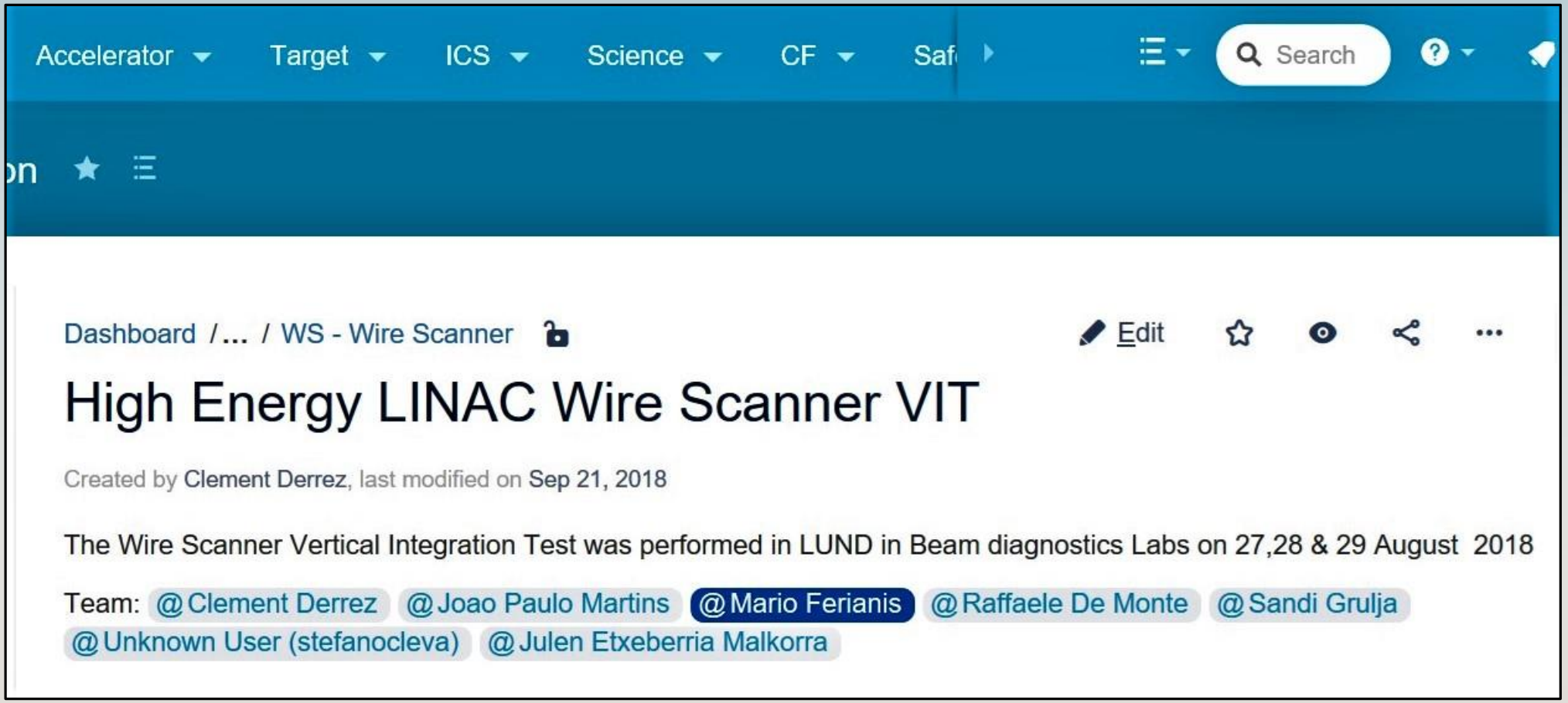
The Wire Scanner Acquisition System (WS ACQ SYS) is part of the Elettra IKC to the ESS Project. It is composed of custom developed HW modules and of integrated COTS units, linked together by means of an EPICS control and processing software. The HW modules are the Analogue Front End (AFE), the Optical Front End (OFE) and the associated Back-End (BE) modules. The AFE is used to read out the current from the single wire intercepting the beam; it is located int he accelerator tunnel to minimize the cable length. It is provided with a two channel input stage to cover the full dynamic range, reading out both wire ends. It is connected to the associated BE located in the service gallery. The OFE is used to acquire the light generated in the Scintillator modules, located down stream the WS. It is as well connected to the associated BE, which has been fitted with 8 channels. The control and processing software, running under EPICS, is also part of the IKC to ESS. It is composed of a set of tabs, known as Engineering Panels, and of the User panel. The control software is interfaced on one side to the BEs, on the other side to the COTS units (CPU, ADC board, Ev_receiver, etc) and to the Motion Controller used as a standard for the ESS Project.
Finally, also the design of the cable system for the WS ACQ SYS is included in the ST effort for the IKC WS.



HIGH ENERGY LINAC WS VERTICAL INTEGRATION TEST (VIT) @ LUND



HIGH ENERGY LINAC WS VIT @LUND, AUGUST, 27-29

- Main goals of the VIT:
  - to test **low level interfacing**, WS mechanics to AFE *(conns & cables)*;
  - to test **signal integrity**, from the vacuum fork out;
  - to **boot & run** the WS IOC & panels on an ESS/ICS local system;
  - to test mech. interfacing to a WS mechanics *(motion controller issues);*
  - to test **synchronous acquisition**, while the wire fork is moving;
- A Danfysik WS mechanical assembly has been made available in Lund

*Testing of WS ACQ SYS behavior in a **real accelerator environment** has been already tested, last year, at **CERN LINAC4**;*

Collaborative effort between ST, ESS-BI and ICS

HIGH ENERGY LINAC WS VIT@LUND: HARDWARE SET-UP

- (AFE+BE) modules installed & connected to:
  - local u-TCA crate
  - Danfysik WS mechanical assembly (wire current)
- Tektronix waveform generator (aka "*the pulser*");
- Generator output connected to wire fork by means of 2 co-axial cables+clips, one per each wire fork end, using our opto-isolated box
- Long motor cables (2x);
- Long (60m) AFE to BE cables (2x);
- Tri-axial signal cables (4x), from WS patch panel to AFE;
- True tri-axial connectors fitted to all WS mechanical assembly.

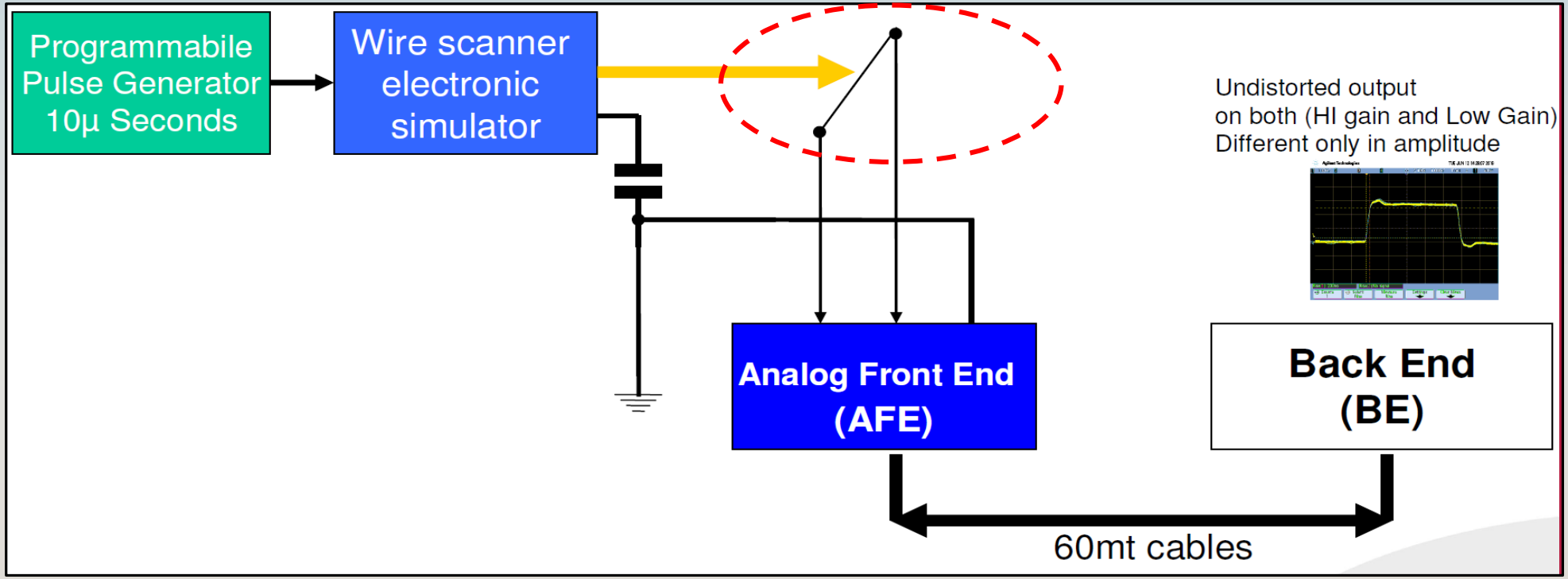
HIGH ENERGY LINAC WS VIT @ LUND:

9 WIRE SIGNAL INTEGRITY MEASUREMENTS

Direct current injection to the vacuum fork

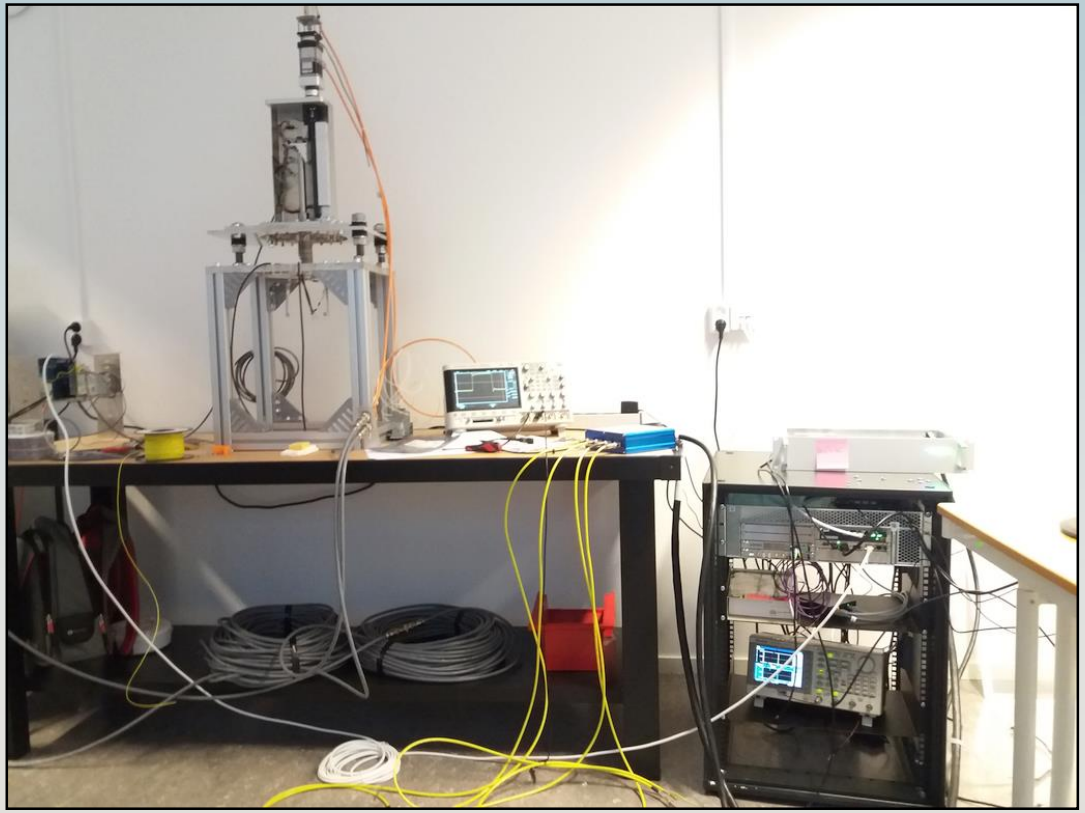
Look for, and protect against, ground loops and / or additive EM noise sources

Optimum solution identified by using **Tri-axial cables *from WS patch-panel to AFE inputs***



HIGH ENERGY LINAC WS VIT @ LUND:

10 *HW FROM DIFFERENT IKC INTEGRATED TO IKC SW*



1st connection of ST IKC deliveries to ESS HW

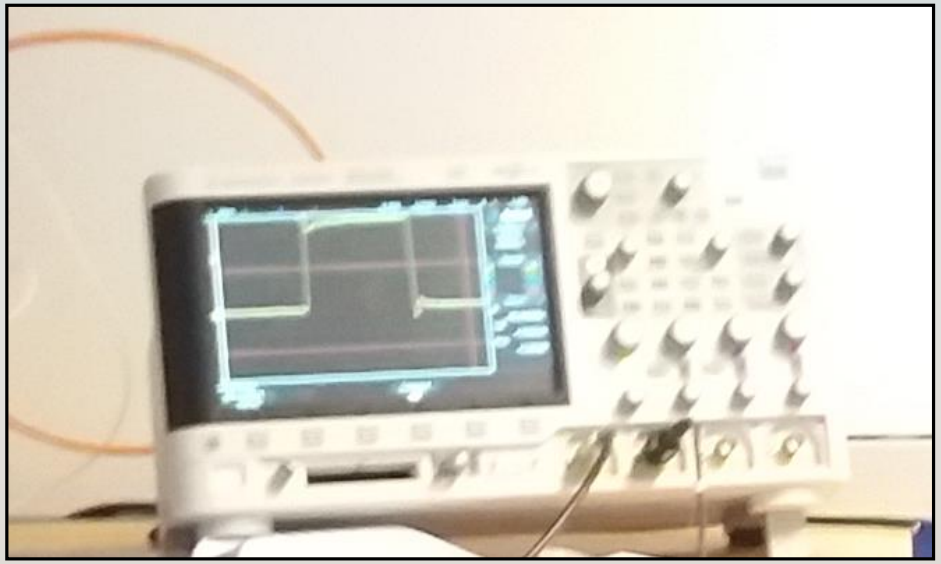
Pulse mode: **20µsec and 5µsec**

Acquisition **running @ 5, 10 & 14 Hz**

Tested both scan modes:

fast scan & slow scan

Beam **trans. profile reconstruction @ 5Hz.**



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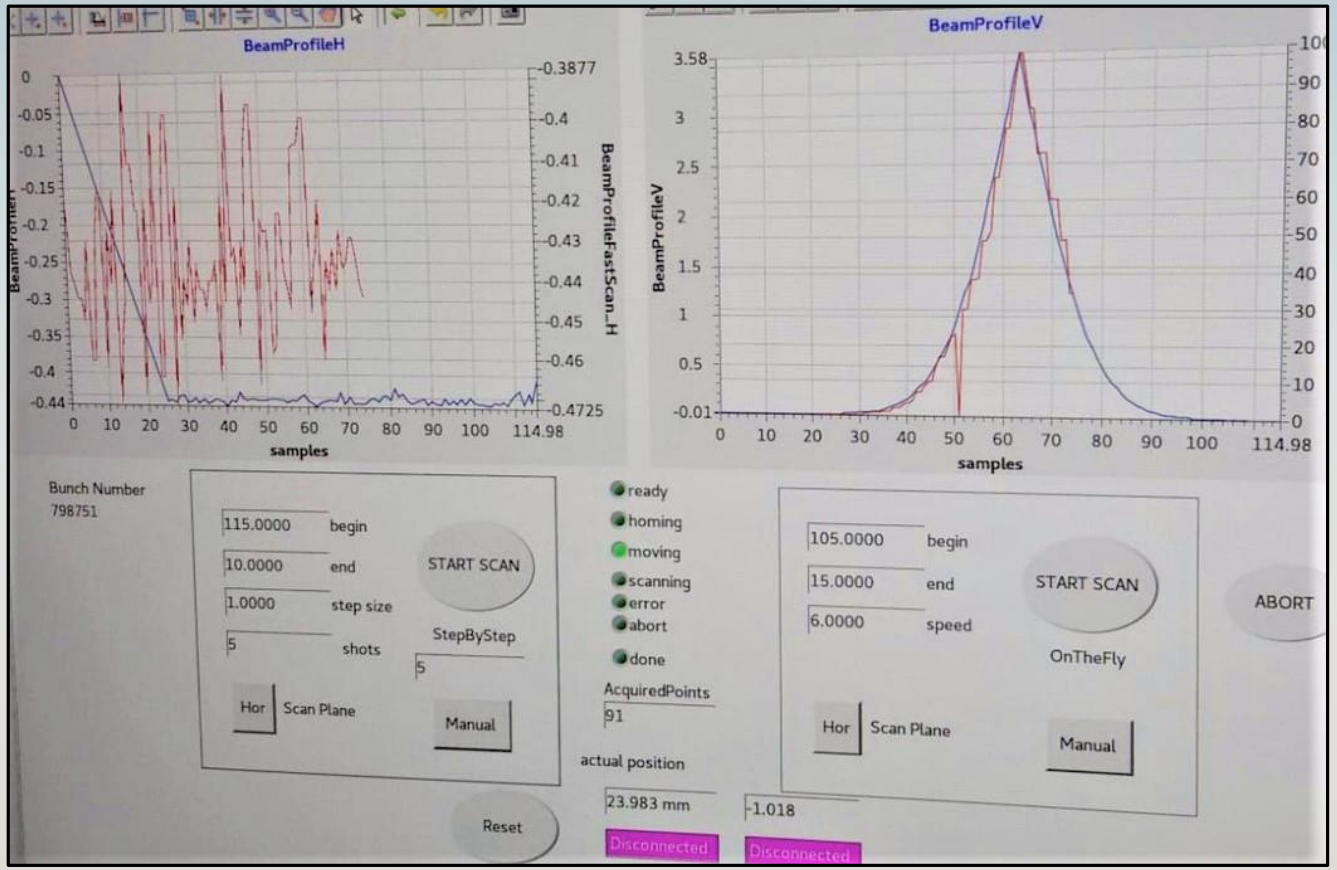
HIGH ENERGY LINAC WS VIT @ LUND:
TRANSVERSE BEAM PROFILE RECONSTRUCTION

By applying synchronous pulses of increasing, and decreasing, amplitude, the signal appearing to the AFE inputs have been emulated.
These pulses are synchronously acquired by μ-TCA ADC board.
Avg. peak values, per each Trigger calculated;
Avg values are then plotted.



ACTION LIST, POSTED TO CONFLUENCE AFTER 1ST VIT, END OF AUG

ACTIONS:

- ☐ Prepare and test PHYTON like **code for ACCEPTANCE TEST**<u>**by SEPT 2018**</u>: it should be a joint effort by **ESS / ST**, as the same code has to be used both at ST during in-house production tests and at ESS during in-house acceptance tests. Acceptance tests will be optimised by running a one pulse acquisition and one scan in amplitude. All relevant acceptance data can then be derived.
- ☐ A dedicated **pre-testing generator calibration(by ST)** needs to be performed to obtain meaningful and comparable results.
- ☐ **ST** to complete construction, in-house testing & reporting of (AFE+BE) pairs (**1st 3 pairs by OCT 2018; all units by End of 2018**)
- ☐ **ESS /ST**: to test OFE+ BEmod (shipped to Cern) coupled wit new SCINT prototype by Protvino **by OCT 18**

  → The test at CERN with OFE+BE mod is performed on September 24th and 25th.

- ☐ **ESS/ST/ESS Bilbao**: run **VIT @ ESSBilbao**, mainly to double-check signal integrity, from vacuum fork to AFE inputs (by end of 2018)

  → a Tasks list for the VIT in Bilbao needs to be produced

- ☐ **ST**: to start and complete OFE+BEmod productino **by Q1 2019**
- ☐ Define procedure for SW hand-over and completion statement
- ☐ **Tri-ax** (vacuum to AFE) **& long run cables** (AFE to BE) have been reviewed by ST and ESS (RDM SG EB)
- ☐ 2 patch panels for motion cables shall be produced and shipped to ESS Bilbao together with the long cables for the VIT on the MEBT actuator

MEBT WS VERTICAL INTEGRATION TEST (VIT) @ ESS BILBAO

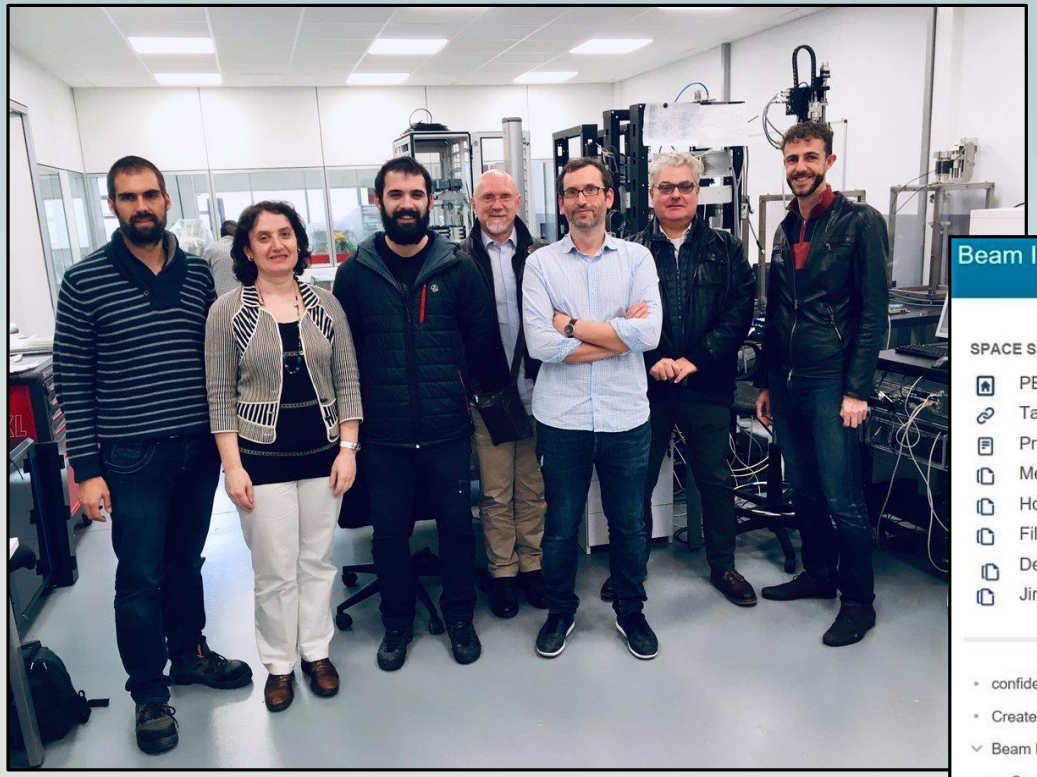
VIT planned activities:

- Hardware connections:

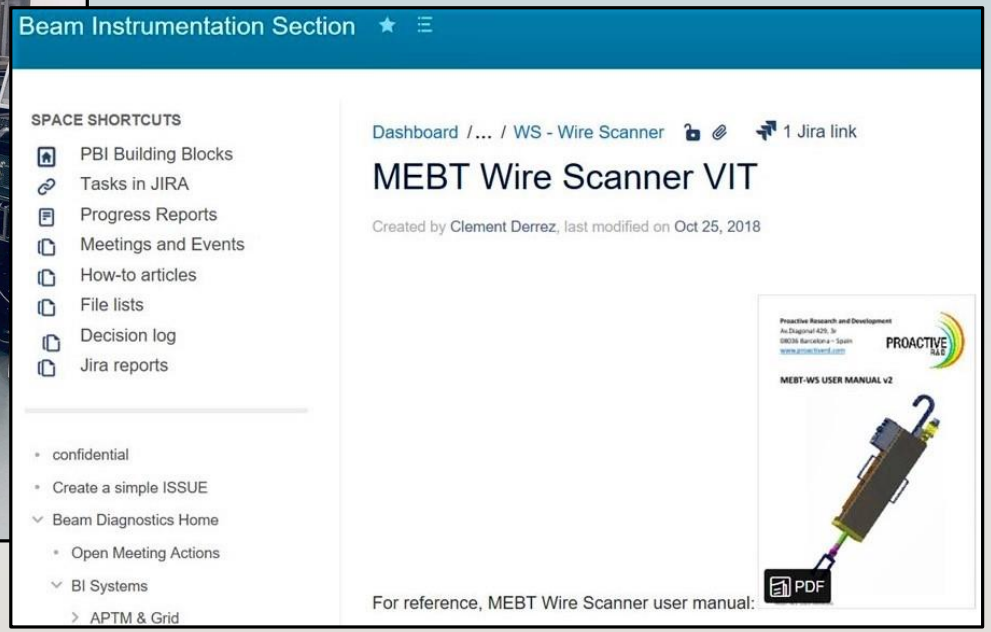
1. Deploy 19' rackable units
2. Connect Motion ECAT crate through long cables and patch panels to MEBT actuator, placed on a heavy duty workbench
3. Connect AFE to actuator feedthrough using **triaxial** cables
4. Connect Pulse generator output to Opto-isolated signal conditioning unit (provided by Elettra).
5. Connect Opto-isolated signal conditioning unit outputs, one to each end of "in vacuum" fork.
6. Connect AFE to BE using long cables
7. Connect BE to mTCA digitizer.

- Signals tests:
  - Test signal integrity, pulse mode ... 5usec pulse
    - Using the final ESS u-TCA set-up (including motion ctrl and mechanics), at first raw data are acquired from generator at different amplitudes to test AFE and BE analogue performance (noise rejection, sensitivity and low gain high gain thresholds).
  - Tested complete scan: fast scan and slow scan, with beam transverse profile reconstruction @ 5Hz successfully.
    - Complete scan is launched with synchronised sample acquisition
- Acquisition running at: 5Hz, 10 Hz & 14 Hz

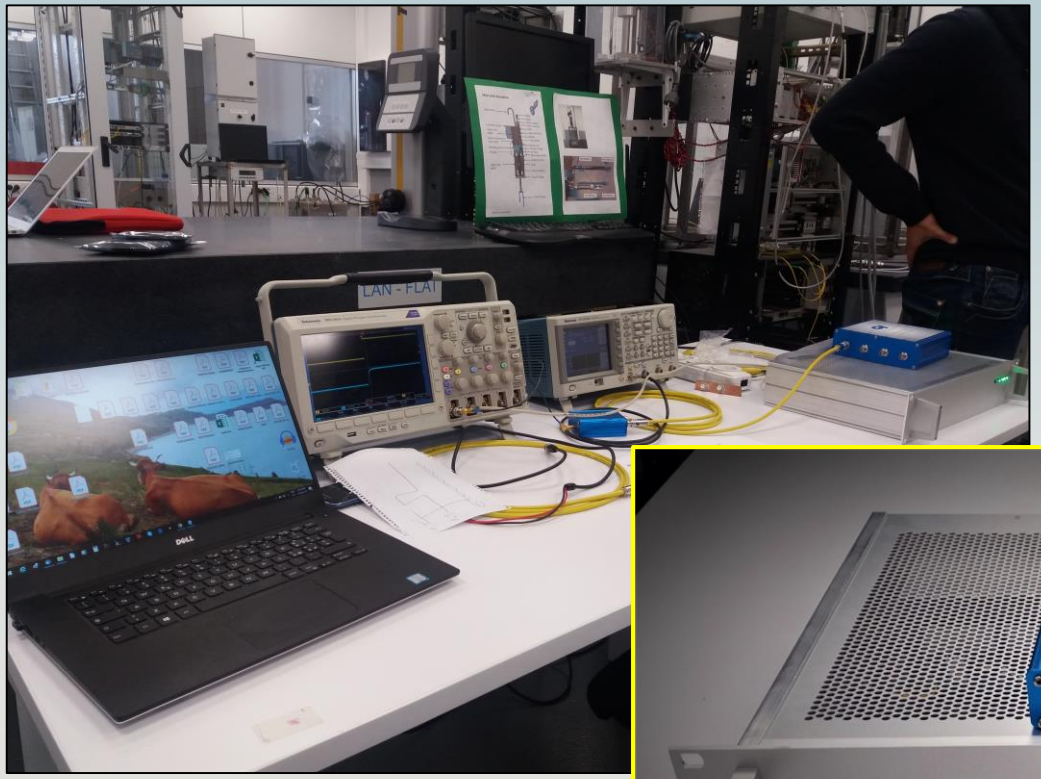
MEBT WS VERTICAL INTEGRATION TEST (VIT) @ ESS BILBAO: 14-15 NOV, 2018



Angel, Idoia, Julen, Sandi, Ibon, Mario & Clement



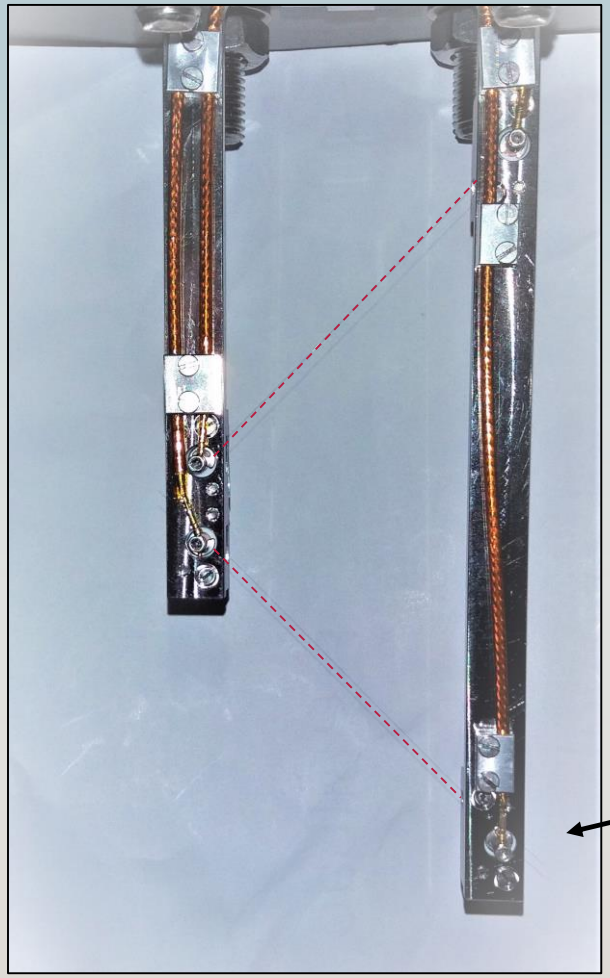
MEBT WS VIT @ ESS BILBAO: 14-15 NOV, 2018

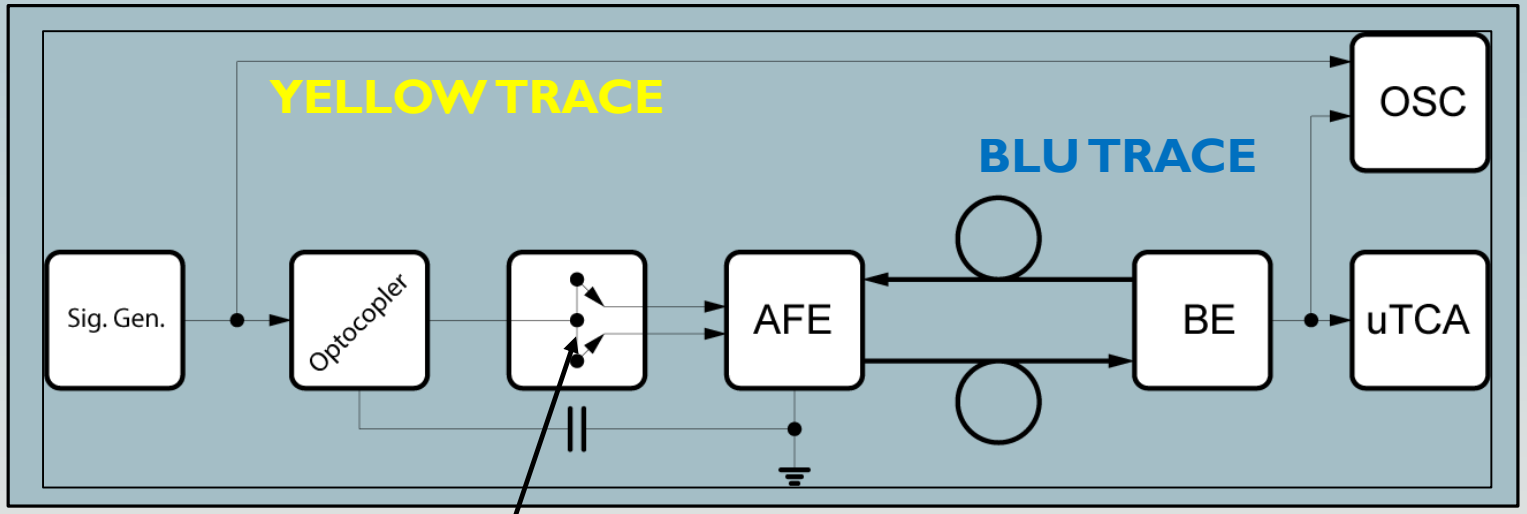


Analog Front End (AFE)
Back End (BE)
Opto-coupler box

MEBT WS mechanics by ESS Bilbao

MEBT WS VIT @ ESS BILBAO: SIGNAL INTEGRITY DOUBLECHECK, AGAIN…

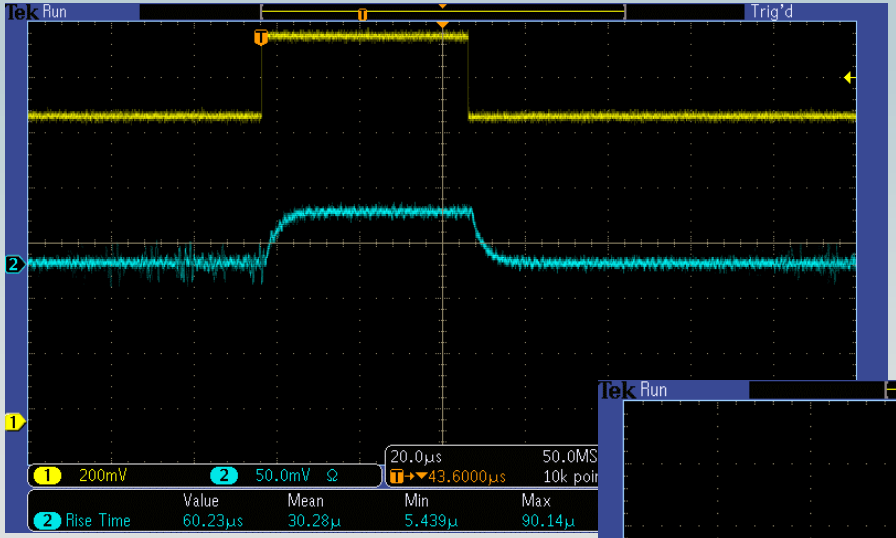




Direct current injection into the vacuum fork:
very well engineered, signal wise,
by ESS Bilbao Team

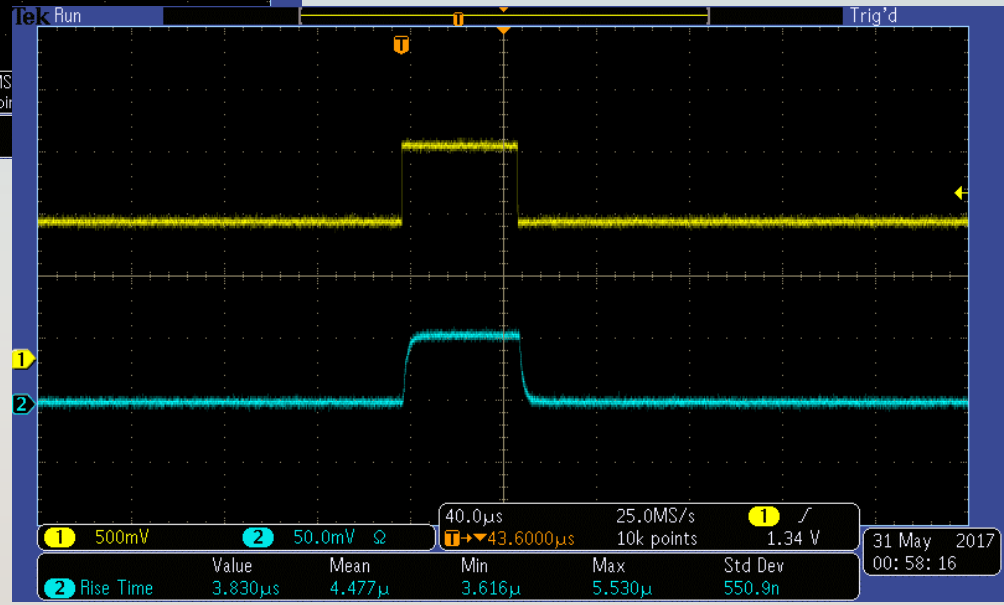
MEBT WS VIT @ ESS BILBAO: INJECTED CURRENTS AMPLITUDE SCAN

current	file	gain
1uA	0000.bmp	HIGH
1uA	0001.bmp	HIGH
3uA	0002.bmp	HIGH
5uA	0003.bmp	HIGH
10uA	0004.bmp	HIGH
30uA	0005.bmp	HIGH
30uA	0006.bmp	LOW
50uA	0007.bmp	LOW
100uA	0008.bmp	LOW



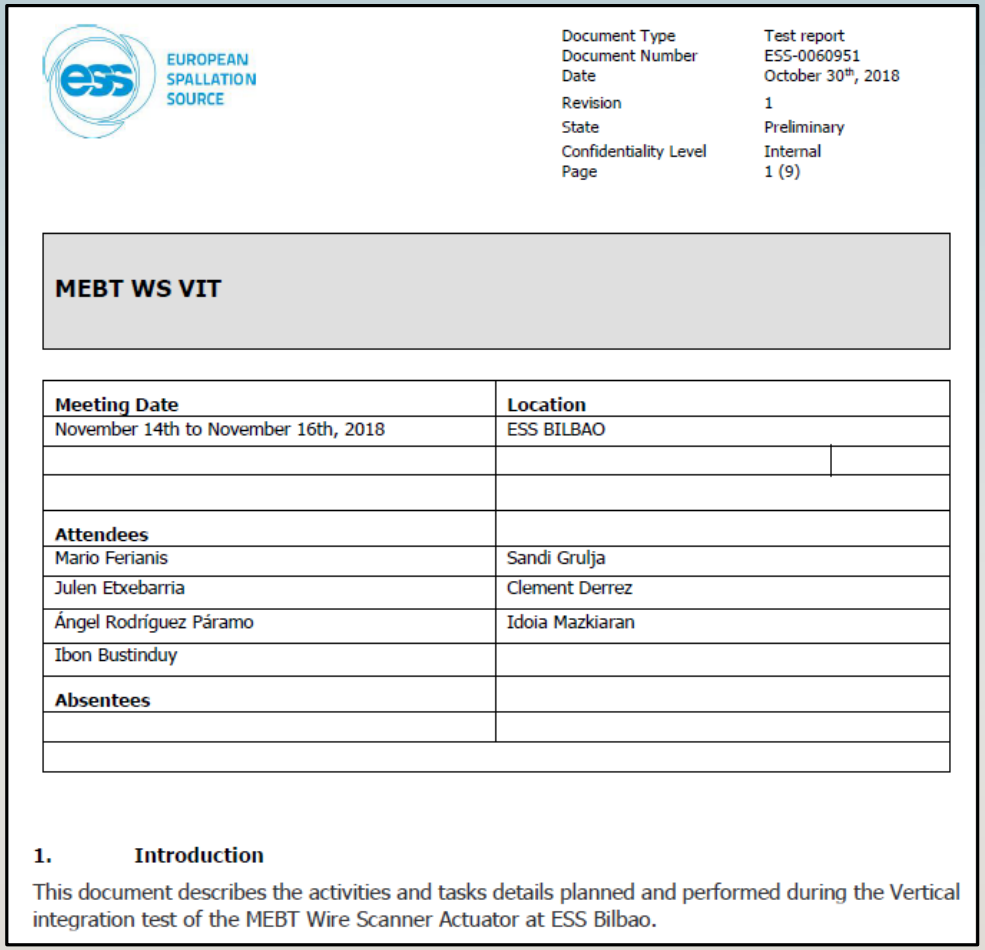
Current pulse, injected in wire @ wire fork

Pulse received, out of Back End



Also, **HV (80V DC)** injection to the wire has been double checked.

MEBT WS VIT @ ESS BILBAO: *TEST REPORT ESS 0060951*



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Document Type	Test report
Document Number	ESS-0060951
Date	October 30th, 2018
Revision	1
State	Preliminary
Confidentiality Level	Internal
Page	1 (9)

MEBT WS VIT

Meeting Date	Location
November 14th to November 16th, 2018	ESS BILBAO
Attendees	
Mario Ferianis	Sandi Grulja
Julen Etxebarria	Clement Derrez
Ángel Rodríguez Páramo	Idoia Mazkiaran
Ibon Bustinduy	
Absentees	

1. Introduction

This document describes the activities and tasks details planned and performed during the Vertical integration test of the MEBT Wire Scanner Actuator at ESS Bilbao.

Shortly after VIT @ ESS Bilbao completion, an ESS Test Report (n. 0060951) has been generated.

Connectors on the short run cable (WS patch panel to AFE inputs) need to be matched (as BNC tri-ax)

μ–TCA acquisition was not running properly (probably) due to a non compliant version of the on board FW of the ADC μ-TCA board

WS ACQ SYS

FACTORY ACCEPTANCE TEST (FAT)

The (AFE + BE) *Factory Acceptance Test* is run @ ST before shipment on each delivered item and it includes two procedures:

1. a set of **manual measurements**; using an *oscilloscope + screen dump*;
2. a set of **software-assisted measurements**, using *μ-TCA crate & FW;*

After each set is completed, a report is generated and printed.

The parameters tested in FAT are:

- Linearity 1)
- Bandwidth 1)
- HV generation to the wire 1)
- Sensitivity & Gain 2)
- Crosstalk, between adjacent channels 2)

for each analog channel of (AFE+BE) chain (4x)

WS ACQ SYS FAT: 1) MANUAL MEASUREMENTS

ESS WIRE SCANNER

AFE s.n. F04 + BE s.n. A04

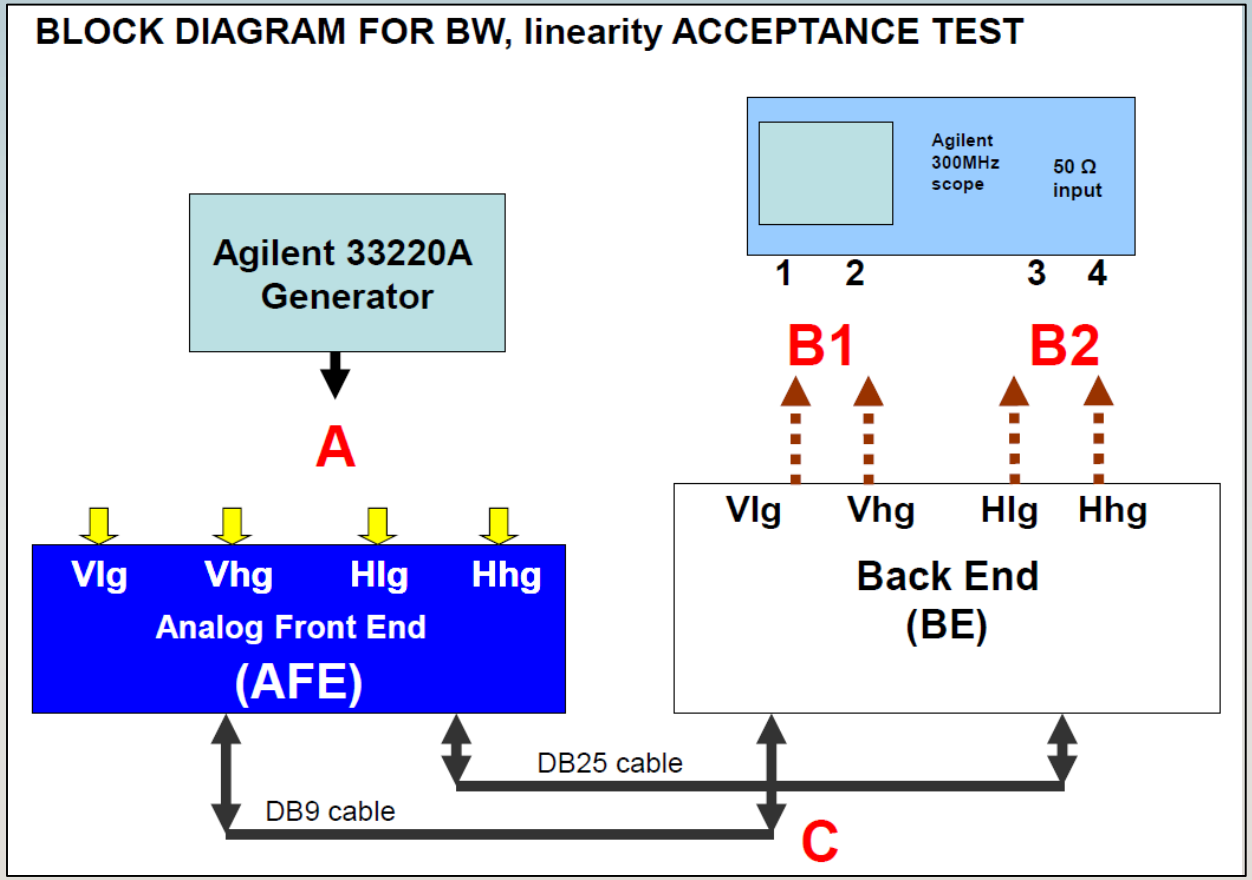
ACCEPTANCE TEST
High Voltage Bias generator,
Signal Linearity and Signal Bandwidth

R. De Monte, V2.0 **05/11/2018**

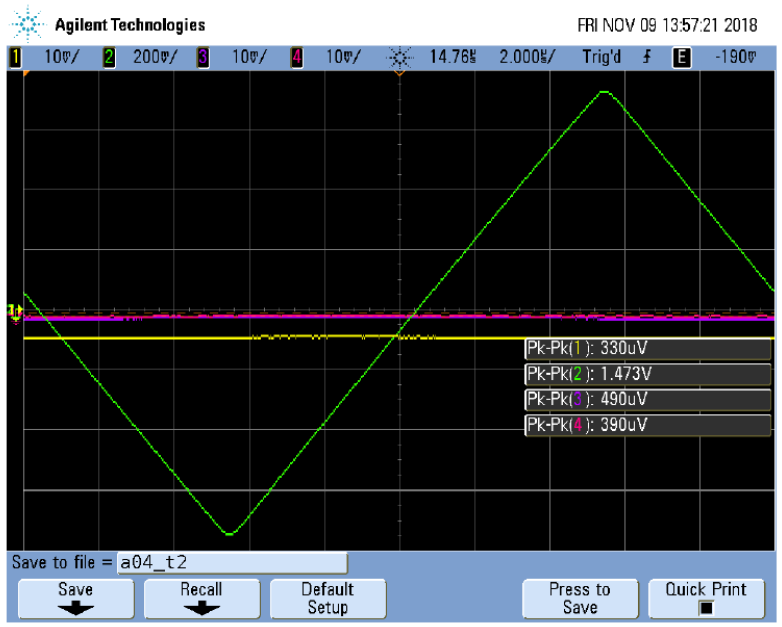
checked: M F

legend

Vlg	LOW GAIN, vertical
Vhg	HIGH GAIN, vertical
Hlg	LOW GAIN, horizontal
Hhg	HIGH GAIN, horizontal



WS ACQ SYS FAT: 1) MANUAL MEASUREMENTS, LINEARITY



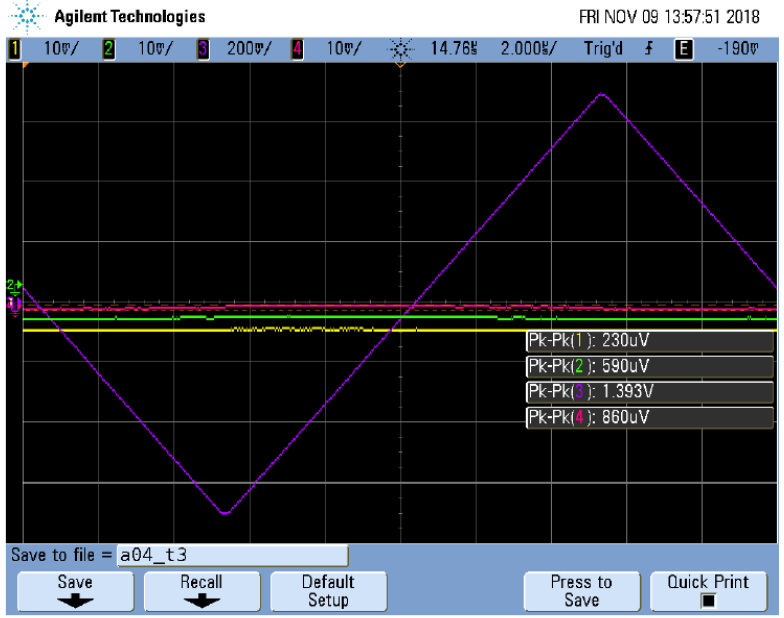
Channel: V hg

Cable in:
direct connection of generator to triax input

Generator amplitude:
10mV PkPk

AFE relays : low gain mode

05 nov 2018 - Page 6



Channel: H lg

Cable in:
direct connection of generator to triax input

Generator amplitude:
700mV PkPk

AFE relays : low gain mode

05 nov 2018 - Page 7

```
Scope channels:
CH1 (Yellow) = Vlg output
CH2 (Green)  = Vhg output
CH3 (Blue)   = Hlg output
CH4 (Magenta)= Hhg output
```

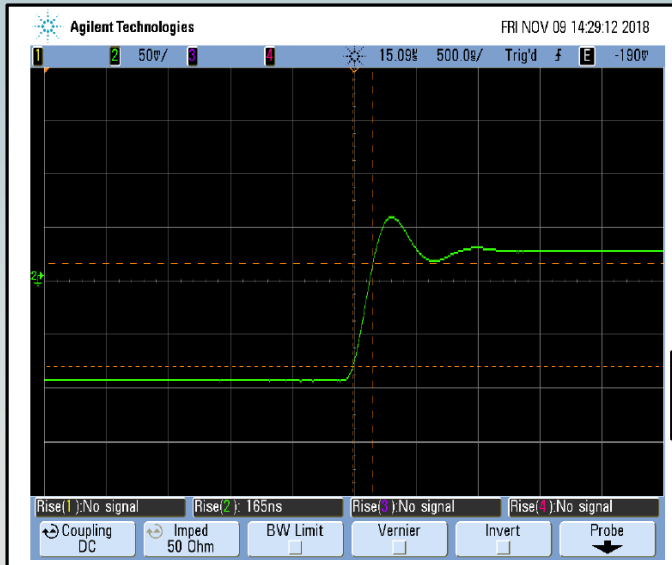
WS ACQ SYS FAT:
1) MANUAL MEASUREMENTS, BANDWIDTH

```
Generator settings:
100KHz pulses of 2µ seconds

Generator to AFE Connections:
Vlg = directly
Vhg = with 1Mohm series adapter
Hlg = directly
Hhg = with 1Mohm series adapter

Scope channels:
CH1 (Yellow) = Vlg output
CH2 (Green)  = Vhg output
CH3 (Blue)   = Hlg output
CH4 (Magenta)= Hhg output

BW(MHz) = 350 / RiseTime(nSec)
```



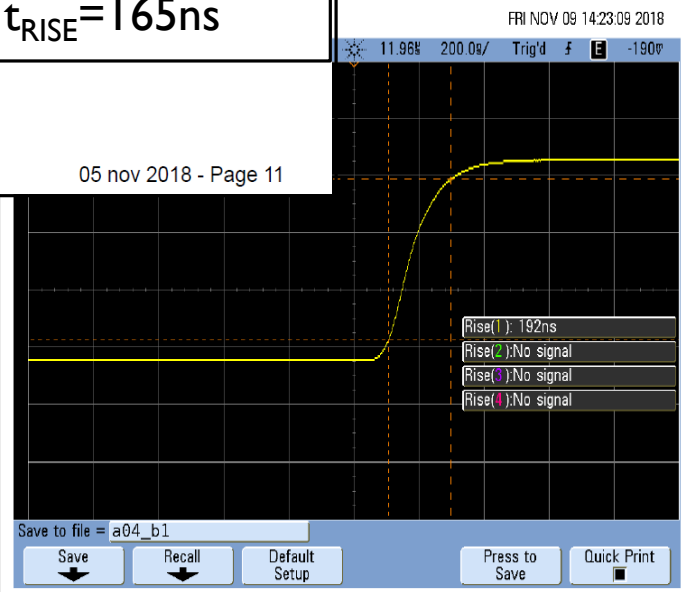
Channel: V hg

Cable in:
connect instrum. to triax input with 1M ohm adapter

Generator amplitude :
HI= 5V
LO = 0V

t_{RISE}=165ns

05 nov 2018 - Page 11



Channel: V lg

Cable in:
direct connection of generator to triax input

Generator amplitude :
HI= 175mV
LO = 0V

AFE relays : low gain mode

t_{RISE}=192ns

05 nov 2018 - Page 10

WS FAT:
2) SOFTWARE-ASSISTED MEASUREMENTS

The AFE and BE units are tested in pairs;
Each DUT (*Device Under Test*) is identified by its *Serial Number*(s)
For each DUT (AFE+BE pair), the pulse generator is connected to the AFE inputs and the BE outputs to the WS ACQ SYS μ-TCA ADC board;
The Factory Acceptance Test software-assisted procedure is started;
All relevant working points are scanned and saved;
The procedure double checks the measured values;
A Factory Acceptance Test Report is automatically generated, at the end;

WS FAT:
2) SOFTWARE-ASSISTED MEASUREMENTS

16/11/2018 AFE_F03_BE-A03.html

BE-AFEtest-F03 2018-11-09 17:08:35

Calibration Table:

#	current	units	Vscope	units	VpulserMax	units	VpulserMin	units	RefLevelHiGain	units	RefLevelLoGain	units
1	10	nA	1.245	V	1.255	V	1.1	V	0.0	V	0.0	V
2	30	nA	1.27	V	1.285	V	1.1	V	0.003697	V	0.0	V
3	50	nA	1.28	V	1.295	V	1.1	V	0.003954	V	0.0	V
4	100	nA	1.31	V	1.322	V	1.1	V	0.005818	V	0.0	V
5	300	nA	1.336	V	1.346	V	1.1	V	0.009588	V	0.0	V
6	500	nA	1.348	V	1.36	V	1.1	V	0.013277	V	0.0	V
7	1	uA	1.37	V	1.383	V	1.1	V	0.022346	V	0.0	V
8	3	uA	1.42	V	1.45	V	1.1	V	0.075673	V	0.0	V
9	5	uA	1.45	V	1.48	V	1.1	V	0.111941	V	0.000477	V
10	10	uA	1.51	V	1.56	V	1.1	V	0.231239	V	0.001994	V
11	30	uA	1.695	V	1.8	V	1.1	V	0.664866	V	0.007636	V
12	50	uA	1.865	V	2.035	V	1.1	V	0.854769	V	0.04413	V
13	100	uA	2.26	V	2.6	V	1.1	V	0.85774	V	0.183188	V
14	300	uA	4.01	V	5.0	V	1.1	V	0.857473	V	0.563845	V

****

Agilent Technologies,33220A,MY44020530,2.02-2.02-22-2

****

PIC-BE: 0:+0:255:0x122:1:R:8188:A03

BE id: A03

AFE id: F03

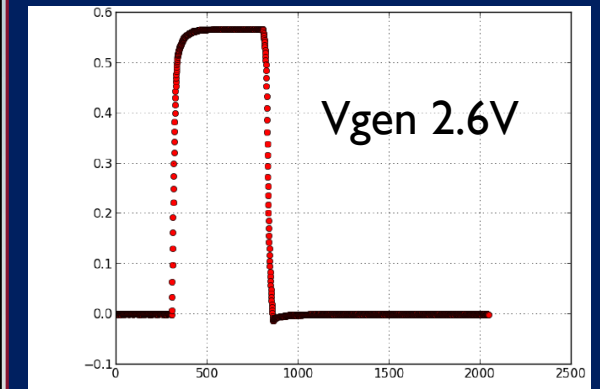
****

SetRampStep - SetGenerator: 300 uA -- 5.0 V -- 1.1 V

SetRampStep - GetGenerator: 300 uA -- 5.0 V -- 1.1 V

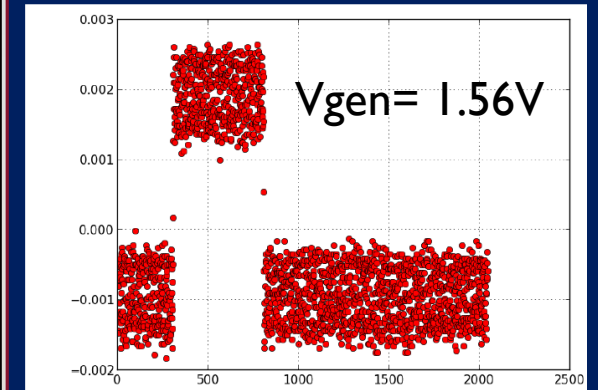
****

LOW GAIN



AI8 mean: 0.565500667691 -- ROIlo: 500 -- ROIhi:700

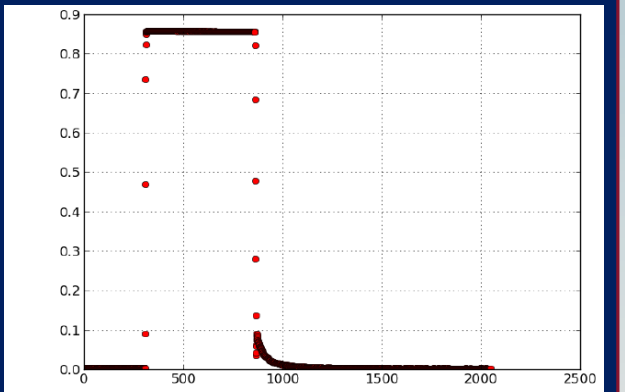
AI8 RMS: 0.565500807168 -- ROIlo: 500 -- ROIhi:700



AI8 mean: 0.00192087173462 -- ROIlo: 500 -- ROIhi:700

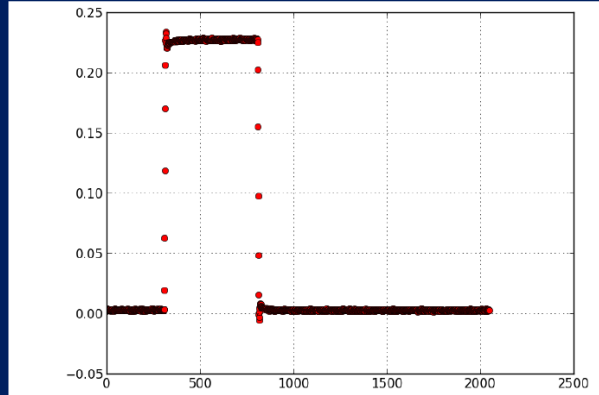
AI8 RMS: 0.00196215372913 -- ROIlo: 500 -- ROIhi:700

HIGH GAIN



AI9 mean: 0.857713961601 -- ROIlo: 500 -- ROIhi:700

AI9 RMS: 0.857713984129 -- ROIlo: 500 -- ROIhi:700



AI9 mean: 0.227474358678 -- ROIlo: 500 -- ROIhi:700

AI9 RMS: 0.227474855975 -- ROIlo: 500 -- ROIhi:700

Thank you for your attention