DITANET

Topical Workshop on Beam Position Monitors

BPS Monitors
Inductive Pick-Up: experience on CTF3

DITANET Topical Workshop on BPMs
Session 1: BPM Pick-up Technology
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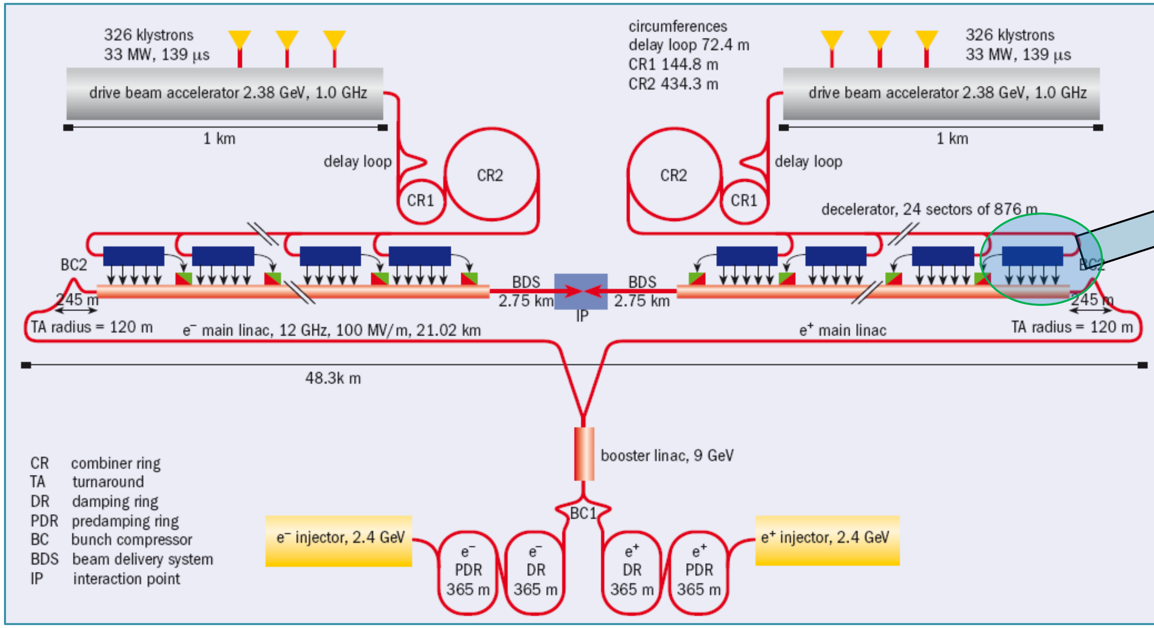
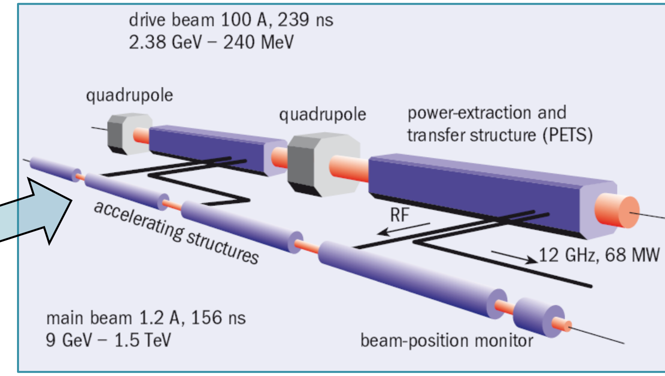
Overview of CLIC, CTF3 and TBL

CLIC, The Compact LInear Collider

The future large collider candidate, jointly with ILC, for the next generation high energy physics experiments with e$^-$-e$^+$ colliding beams in the multi-TeV energy regions.





CLIC layout (left) and detail of the power extraction in the two-beam acceleration scheme (up-rigth)

➢ **CLIC Acceleration Technology Headlines:**

- RF Cavities *"Normal Conducting Travelling-Wave"* operating at 12GHz.
- New two-beam acceleration scheme .
- High Acceleration Gradient ~100MV/m.
- Collision energies at CoM until 3TeV.
- Total machine length around 48km (approx. like the ILC with 500GeV).

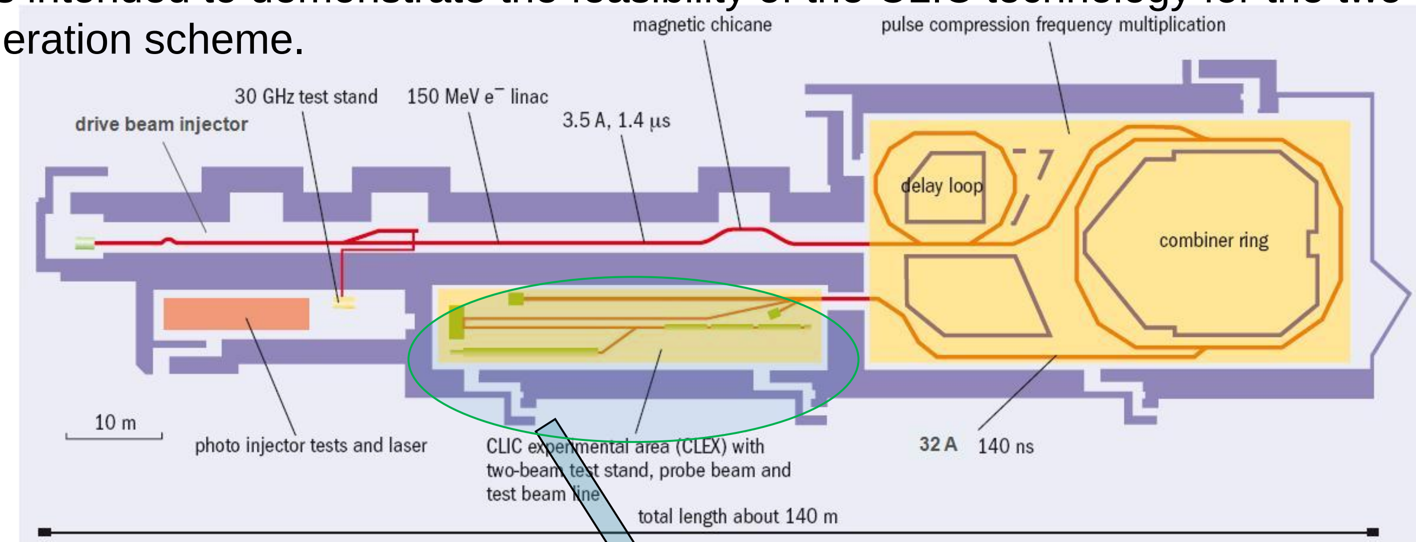
➢ **The Two-Beam Acceleration Scheme:**

- A low energy and high current drive beam is used to accelerate a low current beam to high energies.
- RF/μwave power is extracted from the drive beam using the PETS tanks and then transferred to the acceleration cavities of the main beam.
- Generates the needed RF/μwave power (~ 275MW/m) , out of reach using only klystrons.

Overview of CLIC, CTF3 and TBL

CTF3, CLIC Test Facility phase 3

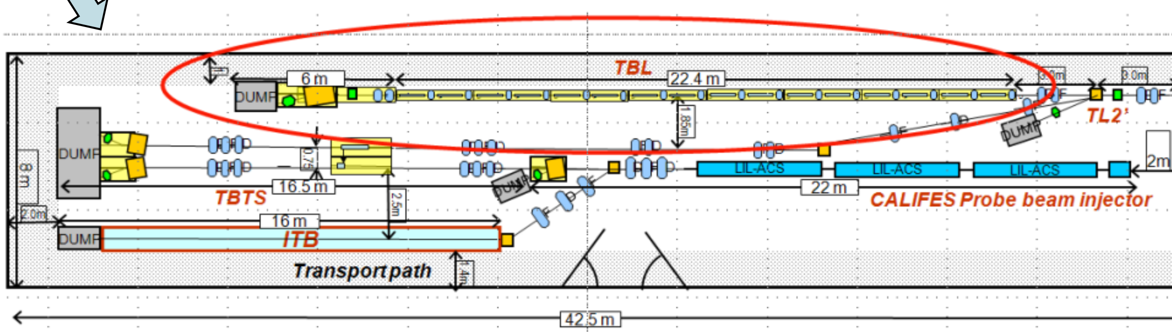
- This facility was constructed at CERN as a scaled version of one drive-beam branch.
- It is intended to demonstrate the feasibility of the CLIC technology for the two-beam acceleration scheme.



Layout of CTF3 distributed among several buildings at CERN

- **CLEX (CLIC Experimental Area):** houses the lines and subsystems for the study and proof of the generation and transference of RF power with the test beam line (TBL), the two beam test-stand (TBTS) and the CALIFES probe beam.
- **TBL (Test Beam Line):** focused on the study of PETS power extraction from a decelerated beam as well as its dynamics and stability.

CLEX layout and the TBL (location of the BPS-IPUs)



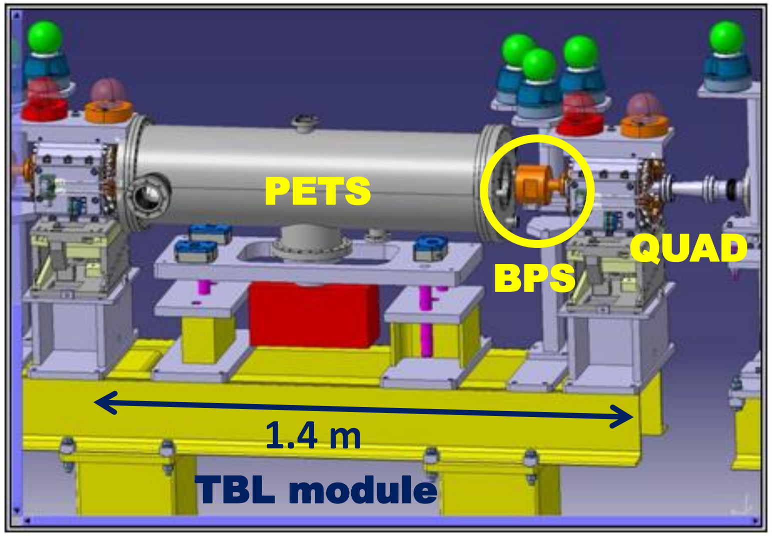
The BPS-IPU in the TBL

TBL, Test Beam Line

➢ The **TBL is a FODO line comprising 16 modules** along its 22.4 meters with every module made up of a **quadrupole**, a **BPM (labeled as BPS)** and a **PETS** (Power Extraction and Transfer Structure).

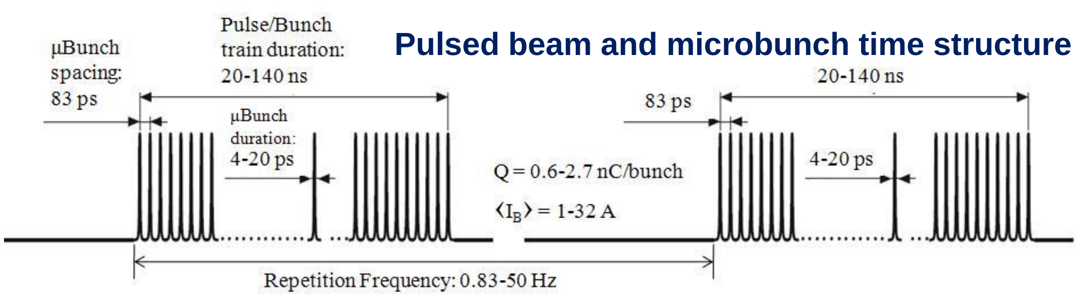
➢ **The BPS's are fundamental in the TBL diagnostics:**

- Beam position measurements:
  - necessary for the study of the beam dynamics and stability of the beam trajectory,
  - also important for maximizing the power extraction with beam transport losses minimization after performing a beam-based alignment of the quads and PETS based on the beam positions.
- Beam Current Intensity and time-pulse profile measurements:
  - necessary for a good beam transport check downwards the line.
  - also important for the study of the RF power generation in relation to the beam current.



TBL Beam Parameters	
Beam current range	1-32 A
Bunch train duration	20-140 ns
Injection beam energy	150 MeV
Microbunch spacing	83 ps(12 GHz)
Microbunch duration	4-20 ps
Microbunch charge	0.6-2.7 nC
Repetition frequency	0.83-50 Hz
Radiation level	$\leq$1000 Gray/year
Emittance	150 μm
BPM Parameters	
Analog bandwidth	10 kHz-100 MHz
Beam position range	$\pm$5 mm (H/V)
Beam aperture diameter	24 mm
Overall mechanical length	126 mm
Number of BPM's in TBL	16
Resolution at maximum current	$\leq$5 μm
Overall precision	$\leq$50 μm

TBL beam specs and BPM requirements



Pulsed beam and microbunch time structure

Description of the BPS-IPU

BPS, Beam Position Small-or-Spanish Monitor.

The BPS first prototype at IFIC

- **Main Features of the BPS Monitors:**
  - Simultaneous measurement of beam position and current.
  - Inductive Pick-up (IPU) type of BPM.
  - High dynamic range for beam currents, from few mA to ~30A.
  - Wide operational bandwidth, allows good capture of beam pulse shapes for pulse lengths under ~200ns.
  - Complex design with the assembly of many parts of different materials.
- **TBL-BPS's Development Phases:**

Phase I

- Design of scaled and adapted version of a previous IPU design for DBL at CTF3 (M. Gasior, CERN).
- Construction and characterization test of the BPS prototypes: BPS1 prototype with diferent onboard PCBs versions, BPS1-v1, v2.
- BPS1-v2 was installled in TBL, July 2008.

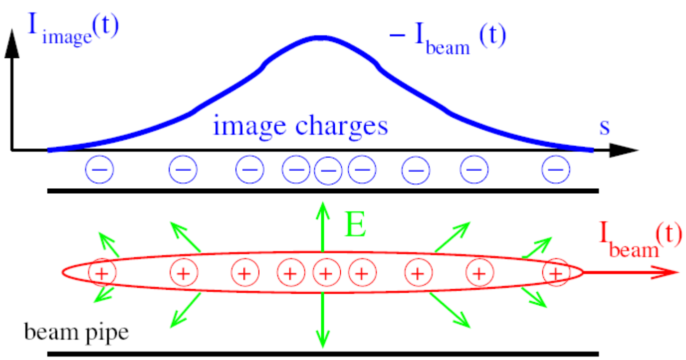
Phase II

- BPS Series Production: construction and characterization test of 16 BPS, 15 units for completing the TBL line plus one spare.
- Preseries: BPS2, BPS3 inst. in TBL, May 2009
- Series: BPS1s to BPS14s Inst. in TBL, October 2009. BPS5s remains at IFIC as spare unit.

Description of the BPS-IPU

Device parts and operational principles

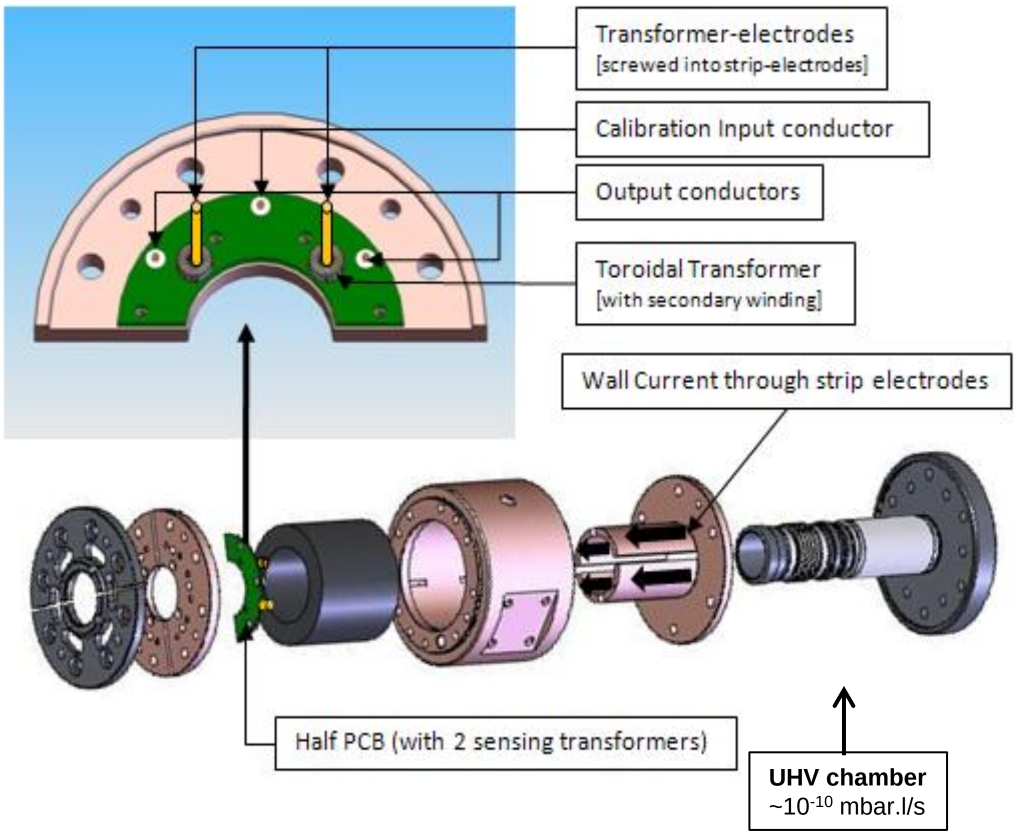
➢ **The beam EM field** is coupled to the vacuum pipe producing an **image wall current** flow on it (see fig. below).



➢ **The beam position measurement is based on**:

▪ sensing the flow of this wall current through four strip-line electrodes by means of the induction in four toroidal transformers and a signal conditioning circuit in the PCBs.

▪ redistribution of the wall current intensity among the four electrodes depending on the beam position relative to them.



BPS mechanical structure and the transformer's PCBs

Description of the BPS-IPU

Device parts and operational principles

➢ **BPS signal ports:**

- Four output electrode ports (voltage)→ **[V+, V-, H+, H-]**
- Two calibration inputs (current) → **[Cal+, Cal-]**

➢ **Beam position and beam current** are obtained from the sum (Σ) and difference (Δ) of the output port signals:

- $I_{Beam}\ \alpha\ \Sigma$
- Vertical and Horizontal coordinates:

$$x_V\ \alpha\ \Delta V / \Sigma$$

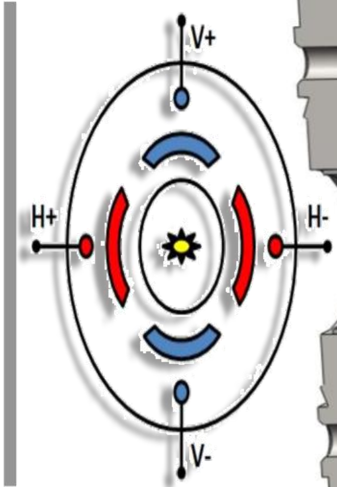
$$x_H\ \alpha\ \Delta H / \Sigma$$

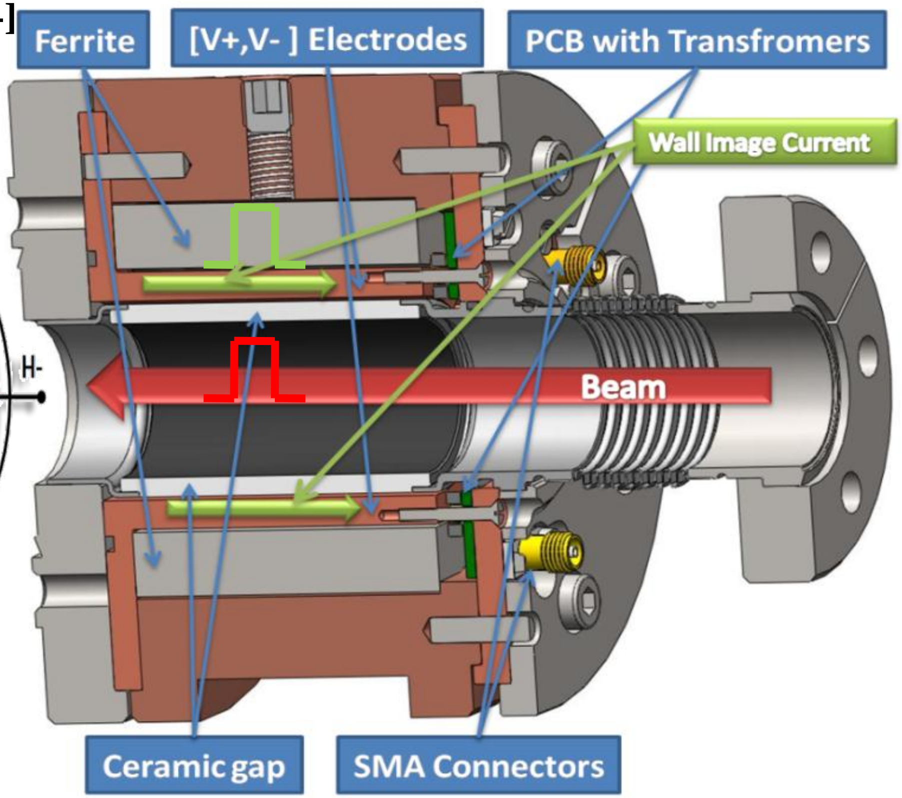
with: $\mathbf{\Delta V} \equiv (V+ - V-)$

$$\mathbf{\Delta H} \equiv (H+ - H-)$$

$$\mathbf{\Sigma} \equiv (V+ + H+ + V- + H-)$$

mixed at the BPS external amplifier.



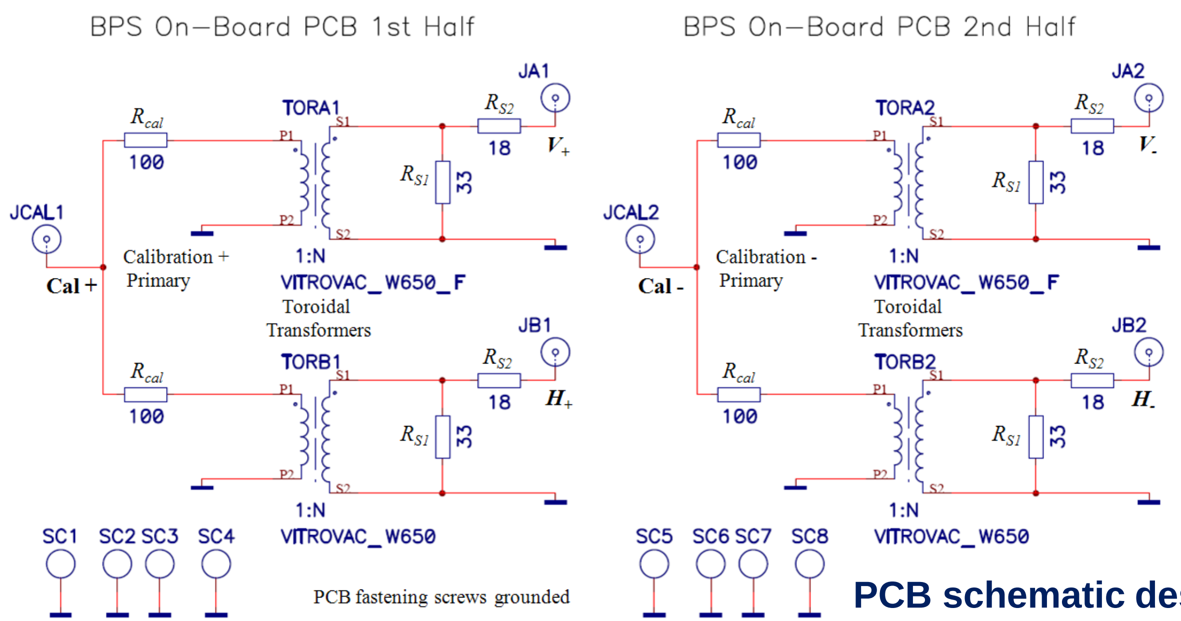


BPS cross-sectional view

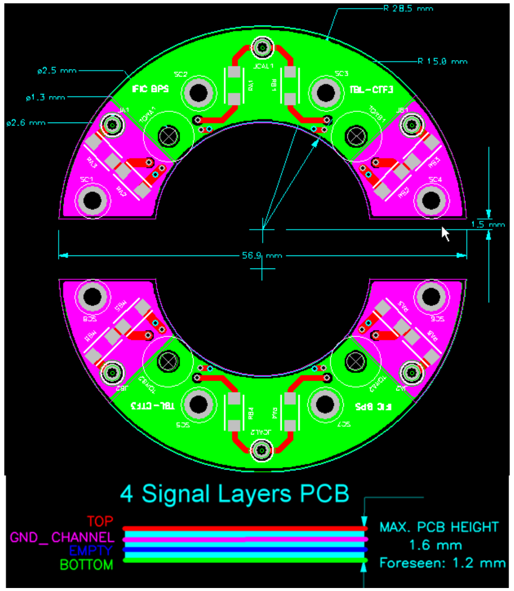
BPS 3D-Mech-Animation

Description of the BPS-IPU

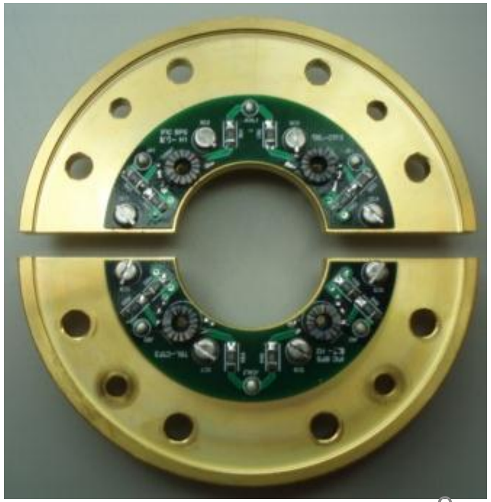
Involved Electronics: onboard PCB design



PCB schematic design



PCB layout design



- **Output signals from Electrode currents:**

$$V_{sec} \equiv Z_t I_{elec} =$$

$$= (R_{Load} R_{S1} / (R_{S1} + R_{S2} + R_{Load}) N)\ I_{elec}$$

V_{sec} : transformer 2^{ary} voltage output [V±, H±]
I_B : beam current intensity
I_{elec} : electrode wall current intensity (transformer 1^{ary} – beam)

- **Transfer Impedance (V/I):**

$$Z_t \equiv (\Sigma / I_B) = 0.55\Omega$$

For I_B = 28A (max.) → Σ = 15.4 V

Component design values:

$R_{Load} = 50\ \Omega$, $R_{S1} = 33\ \Omega$, $R_{S2} = 18\ \Omega$,

N = 30 transf. 2^{ary} turns.

Description of the BPS-IPU

Involved Electronics: BPS circuit model

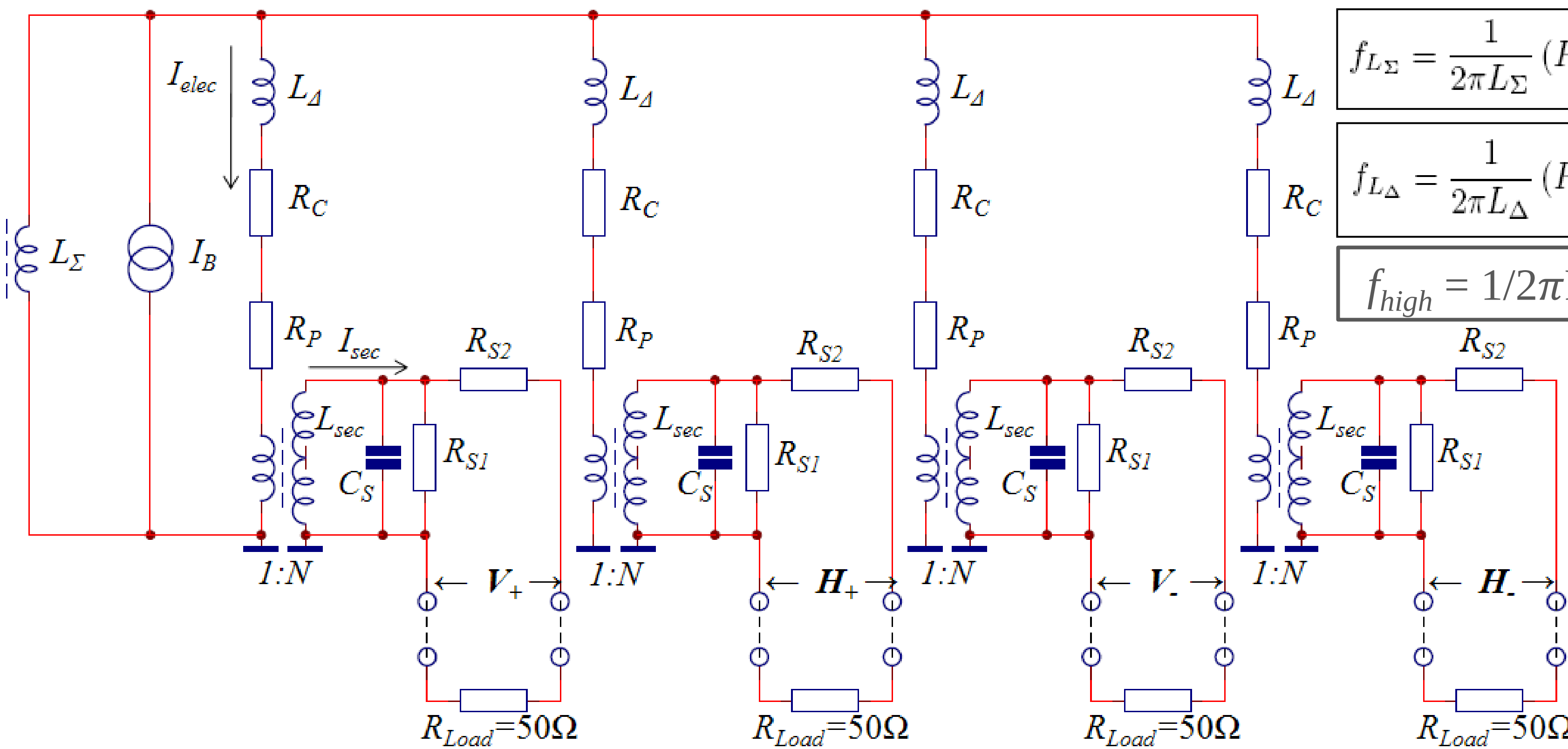
- This model helps to understand the device behavior as well as defining the operation bandwidth.
- Model approximation only valid at low frequencies and for a centered beam (same current flowing in four electrodes).
  - for an off-center beam the currents through electrodes are different and coupling elements between electrodes will be needed to model the device behavior (under study).
- Basically, every electrode branch behaves as a pass-band filter (see next slide).

Device characteristic cut-off frequencies (2 low and 1 high cut-offs)

$$f_{L_\Sigma} = \frac{1}{2\pi L_\Sigma}(R_P + R_C)$$

$$f_{L_\Delta} = \frac{1}{2\pi L_\Delta}(R_P + R_C)$$

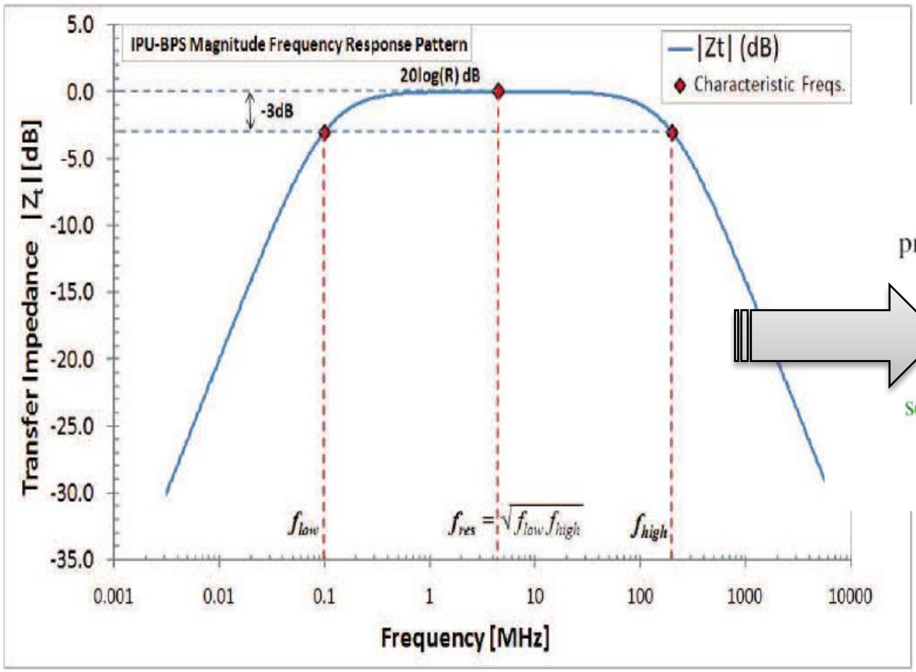
$$f_{high} = 1/2\pi R_e C_S$$



Involved Electronics: BPS frequency and pulse response

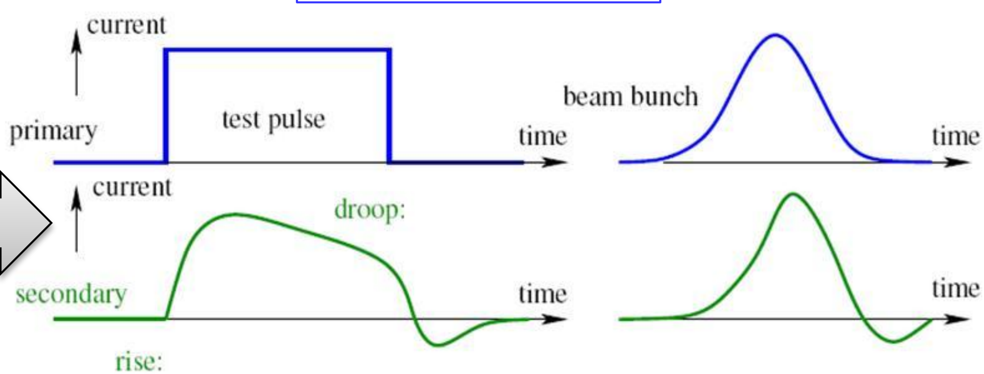
- Typical band-pass frequency response profile of the device .
- This profile corresponds to the the transfer impedance of:
  - every electrode branch and their sum where dominates ferrite-inductance L_{Σ} .
  - also to the difference where dominates electrode-inductances L_{Δ} .
- Transformer inductances are higher than $L_{\Sigma,}$ L_{Δ} ,so low cut-off frequencies are far below being of no influence.

Frequency Response



Time Pulse Response

Beam current pulse



Pulse distortion at the device outputs due to the limited operation bandwidth

$$\omega_{low} = R/L, \text{ and } \omega_{high} = 1/RC_S$$

Device low-high characteristic cut-off freqs.

$$\tau_{droop} = 1/\omega_{low} \qquad \tau_{rise} = 1/\omega_{high}$$

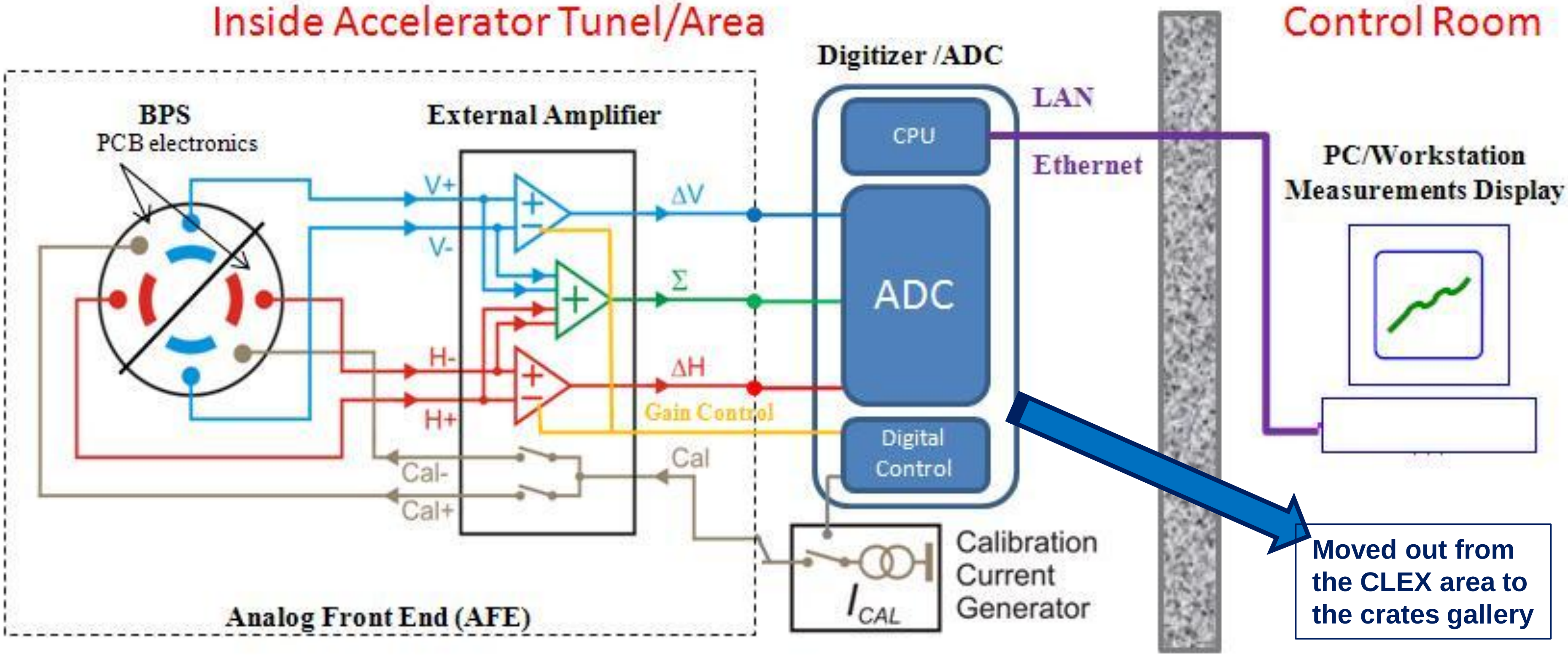
$$\tau_{droop} \sim 10^2\, t_{pulse} \qquad \tau_{rise} \sim 10^{-2}\, t_{pulse}$$

Device characteristic pulse time constants

Involved Electronics: BPS Read-out chain

- The BPS **Analog amplifier** (UPC, Barcelona):
  - implements the four electrode signals delta-sigma mixing (2 stages based on Rad-Hard Op-amps)
  - works in four modes as combination of: high-low gain and attenuation on/off
  - switching of calibration signals.
  - performs pulse-droop compensation in delta channels.

- **Digitizer board** (LAPP, Anecy) performs data aqcuisition (10bits ADC) and send it via ethernet to the control room servers.



Read-out stages and calibration circuit scheme of the pick-up

Characterization Tests

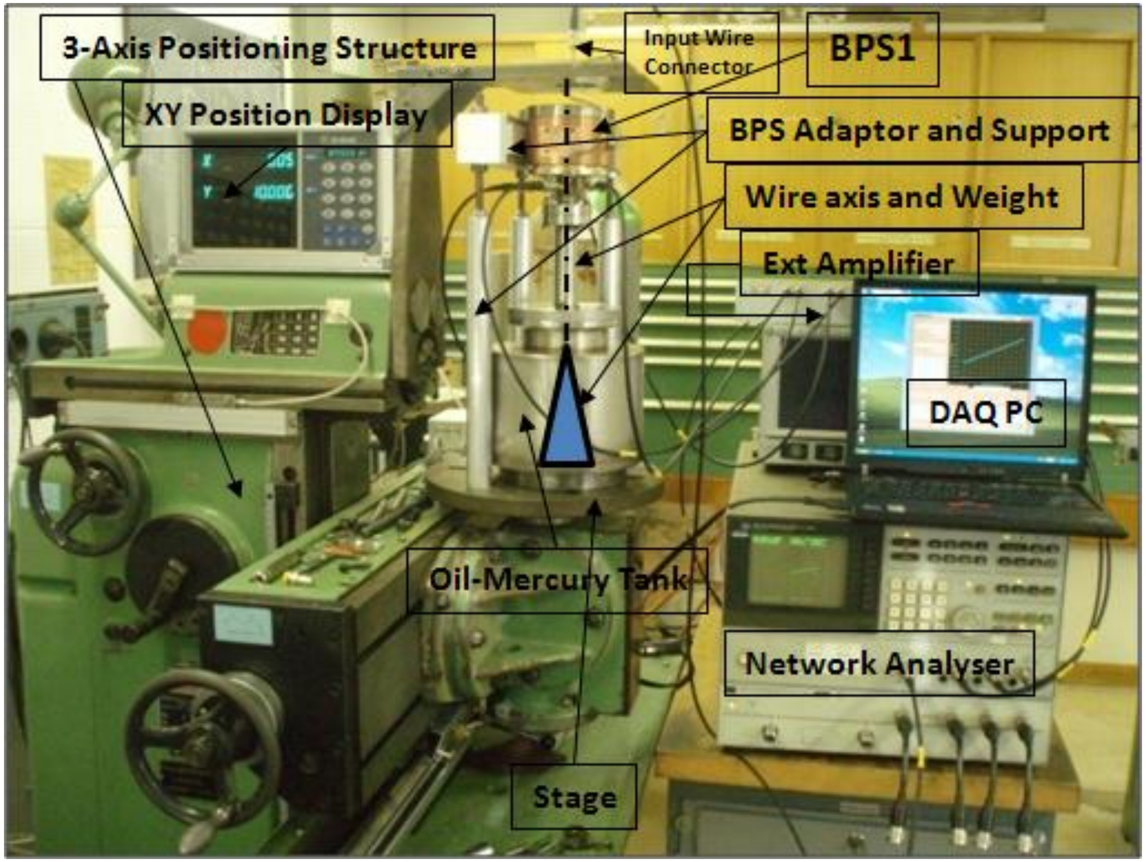
The LF wire test-bench

➢ The ***Wire Method Test-bench*** emulates the beam position with an streched thin wire driving the BPS excitation signal.

➢ The **characteristic linear relations of output signals vs position** are obtained by controlling the wire position with respect the pick-up under.test.

➢ **Characterization tests measurements:**

- **Beam position parameters (H, V):** Sensitivity, electrical offsets, linearity erors and accuracy.
- **Frequency respone parameters** Band-pass profile, cut-off frequencies and time constants for signals: Cal±, V± H±, Σ, ΔV, ΔH.:



Test-bench used for BPS1 proto in AB/BI-PI* group lab at CERN

*****_AB: Accelerator an Beams Department_
BI: Beam Instrumentation Group
PI: Position and Intensity Section

Characterization Tests

The LF wire test-bench

➢ **New Wire Test-bench** was developed at IFIC labs specifically designed **for the tests of a series of 16 BPS units.**

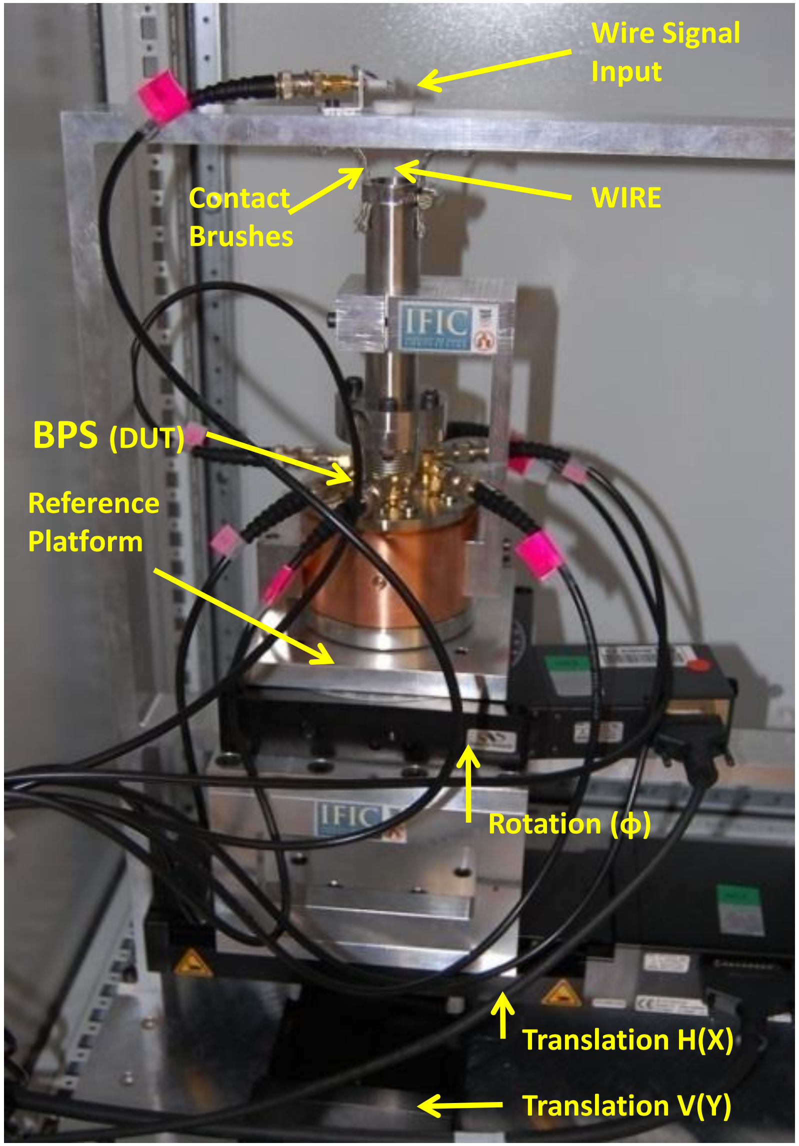
➢ **BPS test stand main components:**

- Support platfoms and frame of DUT with the wire streched between two fixed points.

- Micro-mover tower: 2 translation stations XY cartesian coords. (Accuracy/Resolution: 2/0.2 um); and 1 Rotation station Polar coords. (0.2/0.009 urad).

- Metrology of the wire relative to the DUT holding platform for compenation of fabrication misalignments like wire offset, wire tilting, orthogonality of platform, etc.

- This test stand was placed:
  - inside a Farady Cage for EMI screening into the wire-antenna.
  - over a pneumatic vibration-absortion table (or optical table) to avoid wire vibrations from external sources during measurements.



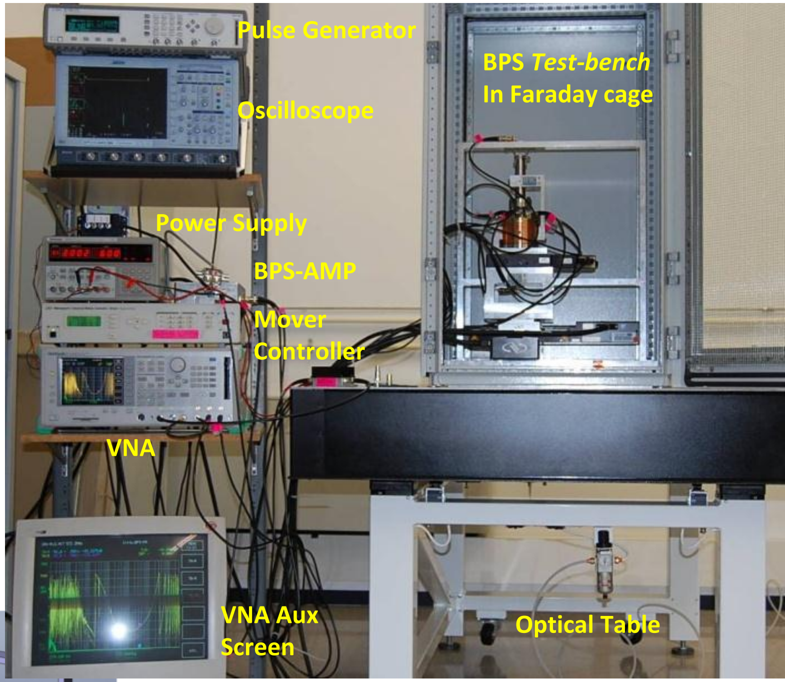
BPS Series test-bench

Characterization Tests

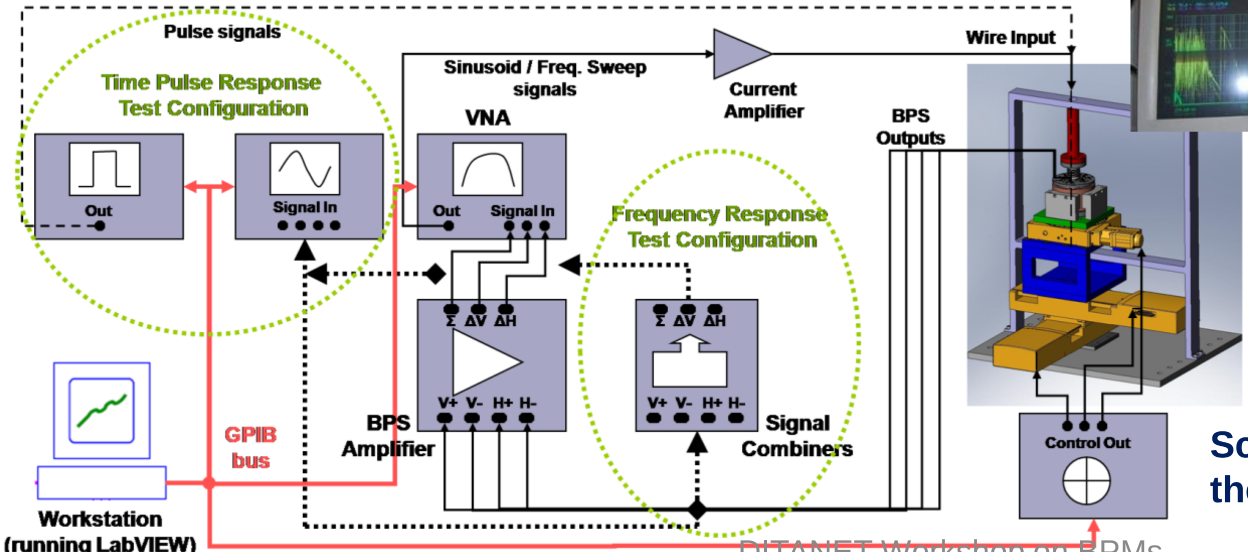
The LF wire test-bench

➢ **Control and Measurement Set-up:**

- Oriented to automatize the measurements of the 16 BPS units, providing an increase of data taken and improved repeteability in the characterization tests of the series.
- Equipment: BPS amplifier, micromover's controller, VNA-Vector Netwok Analyzer (10Hz-300MHz), oscilloscope (1GHz), pulse/pattern generator and power supplies.
- Development of **SensAT v1.0** a PC running LabVIEW application for the control and DAQ of the BPS measurements through GPIB.



BPS Series Set-up



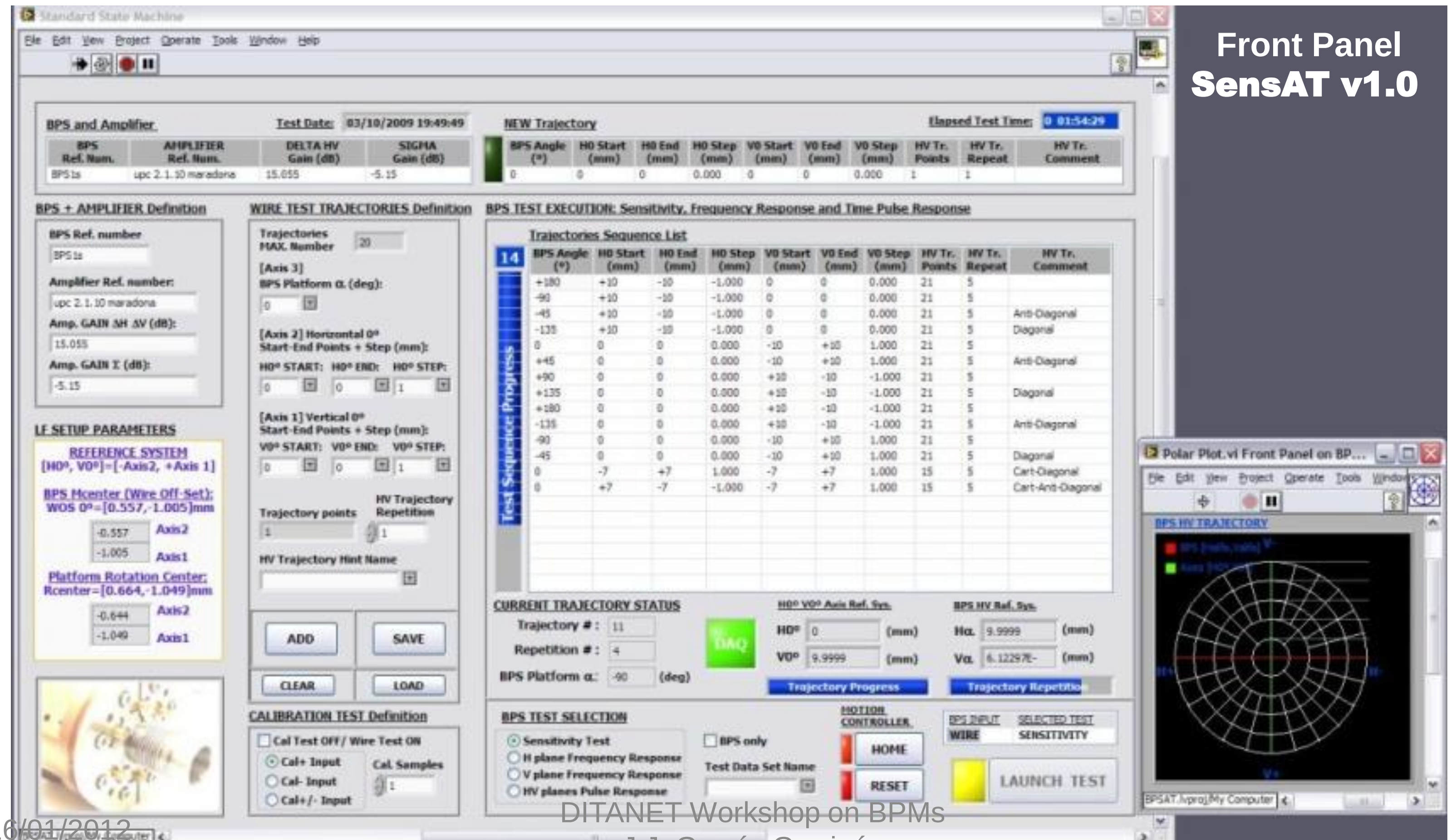
Scheme of the set-up showing the possible test configurations

Characterization Tests

The LF wire test-bench

➢ **Main features of the LabVIEW App. SensAT v1.0:**

- Input of many wire paths (limits, steps, orientation, repetitions) and Save/Load paths option..
- Configuration of test type: Sensitivity, Frequency or Time Pulse
- Selection of excitation input source: Calibration or Wire.
- Motion Control via micromovers controller communication
- Wire Path display and comm. errors handle.
- Acquisition and save of data at every wire path step.
- Result plots preview (sensitivity line, freq./pulse response).



Front Panel
SensAT v1.0

Characterization Tests

GAP IFIC INSTITUT DE FÍSICA CORPUSCULAR

The LF wire test results and BPS benchmark parameters

- **Beam position parameters of 16 BPS units.**

- **Characteristic lines of position HV coords:**

  - **Sensitivity (*S*):** slope of the test fit line, used as the inverse ($k=S^{-1}$) in the characteristic operation line.

  - **Electric Offset (*EOS*):** deviation of the device mechanical center position for null difference output signals ($\Delta H,V=0$).

  - **Accuracy:** RMS for all positions in the range of interest of the fitted line residuals (±5mm). Obtained from the linearity deviation errors (see bottom plot) shows accuracy spec. Limit of 50um.

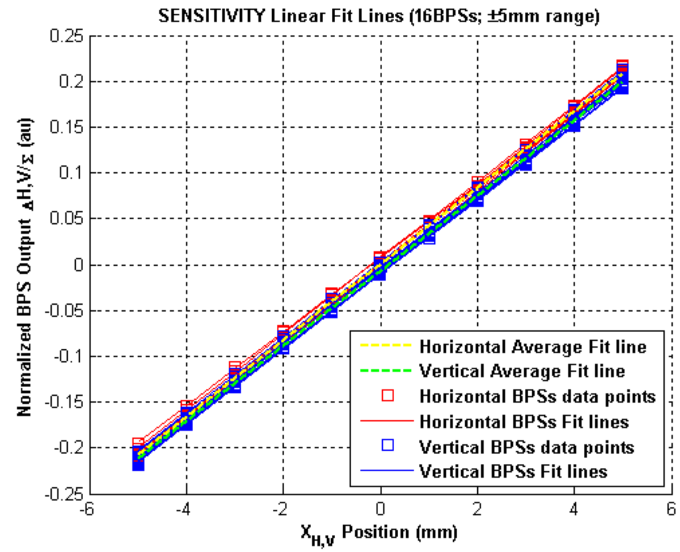
- **Linear Equations of HV coordinates:**

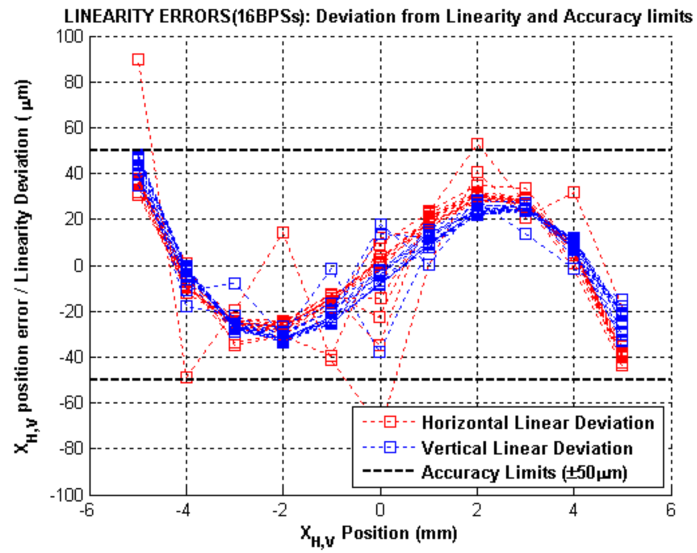
$$\left(\frac{\Delta V}{\Sigma}\right)[a.u.] = n_V + S_V x_V \qquad x_V[mm] = EOS_V + k_V\left(\frac{\Delta V}{\Sigma}\right)$$

inverse

$$\left(\frac{\Delta H}{\Sigma}\right)[a.u.] = n_H + S_H x_H \qquad x_H[mm] = EOS_H + k_H\left(\frac{\Delta H}{\Sigma}\right)$$

Characteristic test fit lines — **Characteristic operation lines**





Characterization Tests

The LF wire test results and BPS benchmark parameters

➢ **BPS series Benchmark parameters table:**

- shows the average values and standard deviations of the characteristic parameters of all the 16 BPS units.

- Accuracy for both HV planes are under TBL requirements of 50um in the positions range of interest.

- Resolution parameter was obtained with beam in TBL (showed later on).

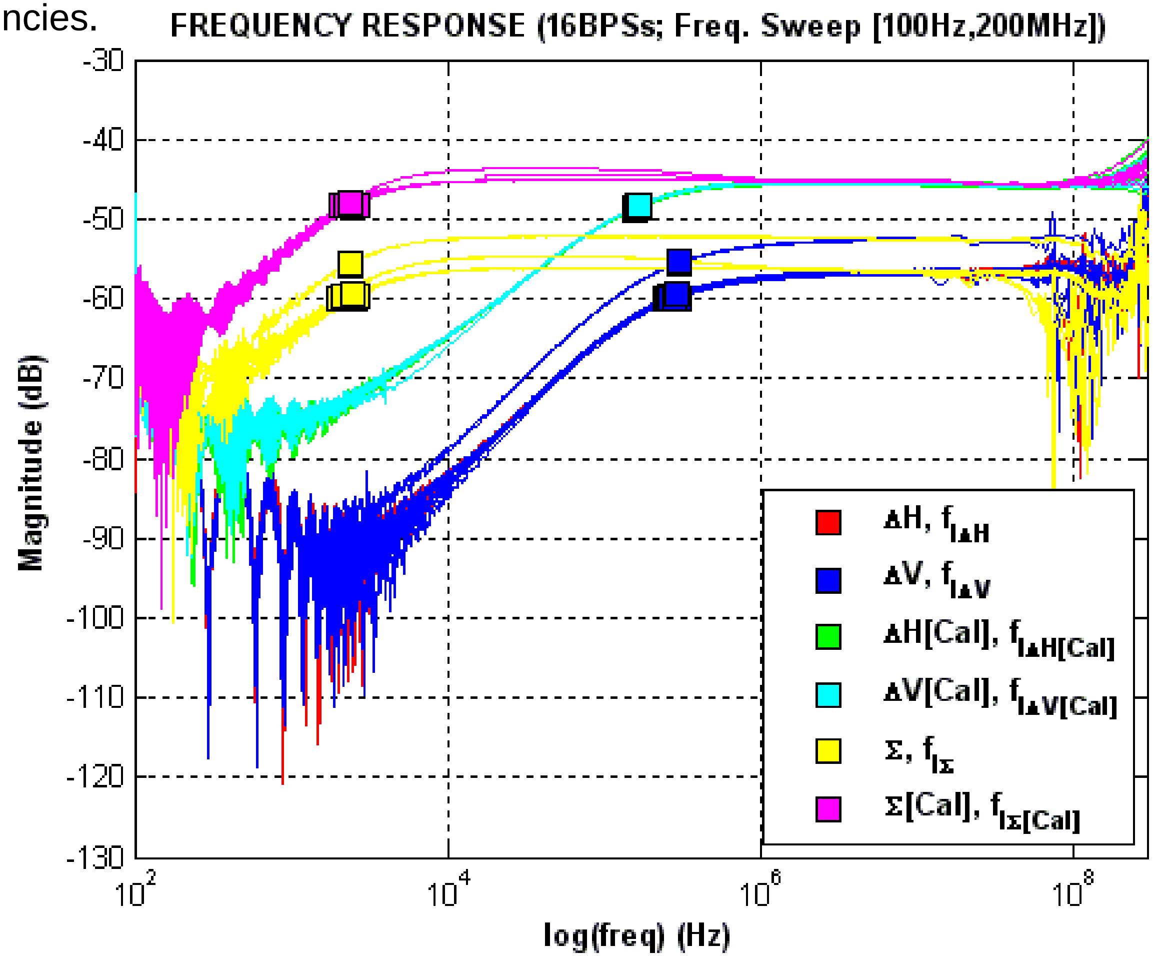
- The table also shows small deviations among the different BPS units, what reflects a satisfactory series fabrication and test procedures.

Sensitivity and Linearity Parameters	
H Sensitivity, S_H	41.5 ± 0.6 $\times 10^{-3}$ mm^{-1}
V Sensitivity, S_V	41.1 ± 0.5 $\times 10^{-3}$ mm^{-1}
H Electric Offset, $Eoff_H$	0.01 ± 0.08 mm
V Electric Offset, $Eoff_V$	0.17 ± 0.11 mm
H Overall precision (accuracy), σ_V (± 5 mm)	32 ± 8 µm
V Overall precision (accuracy), σ_H (± 5 mm)	28 ± 6 µm
H Linearity error, (max deviation at ± 5 mm)	0.9 ± 0.3 %
V Linearity error, (max deviation at ± 5 mm)	0.9 ± 0.2 %
Frequency Response (Bandwidth) Parameters	
Σ low cut-off frequency, $f_{l\Sigma}$	2.4 ± 0.3 kHz
Δ low cut-off frequency, $f_{l\Delta}$	281 ± 15 kHz
Σ[Cal] low cut-off frequency, $f_{l\Sigma\,[Cal]}$	2.4 ± 0.3 kHz
Δ[Cal] low cut-off frequency, $f_{l\Delta\,[Cal]}$	168 ± 5 kHz
High cut-off frequency, f_h	> 100 MHz
High cut-off frequency [Cal] $f_{h[Cal]}$	> 100 MHz
Pulse-Time Response Parameters	
Σ droop time const, $\tau_{droop\Sigma}$	69 ± 11 µs
Δ droop time const, $\tau_{droop\Delta}$	568 ± 30 ns
Σ[Cal] droop time const, $\tau_{droop\Sigma\,[Cal]}$	68 ± 11 µs
Δ[Cal] droop time const, $\tau_{droop\Delta\,[Cal]}$	951 ± 26 ns
Rise time const, τ_{rise}	< 1.6 ns
Rise time const [Cal], $\tau_{rise\,[Cal]}$	< 1.6 ns

The LF wire test results and BPS benchmark parameters

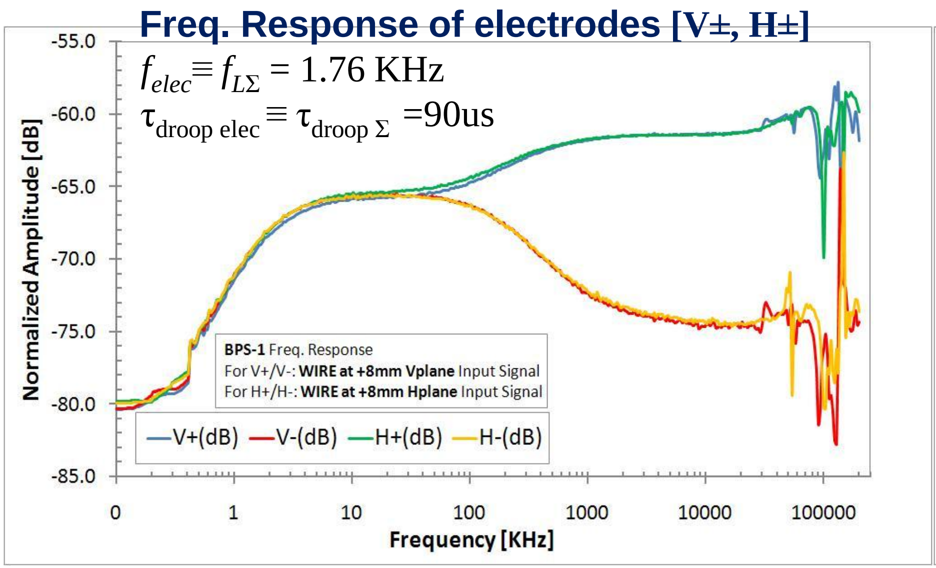
➢ **Frequency analysis for an off-center wire position (+5mm):**

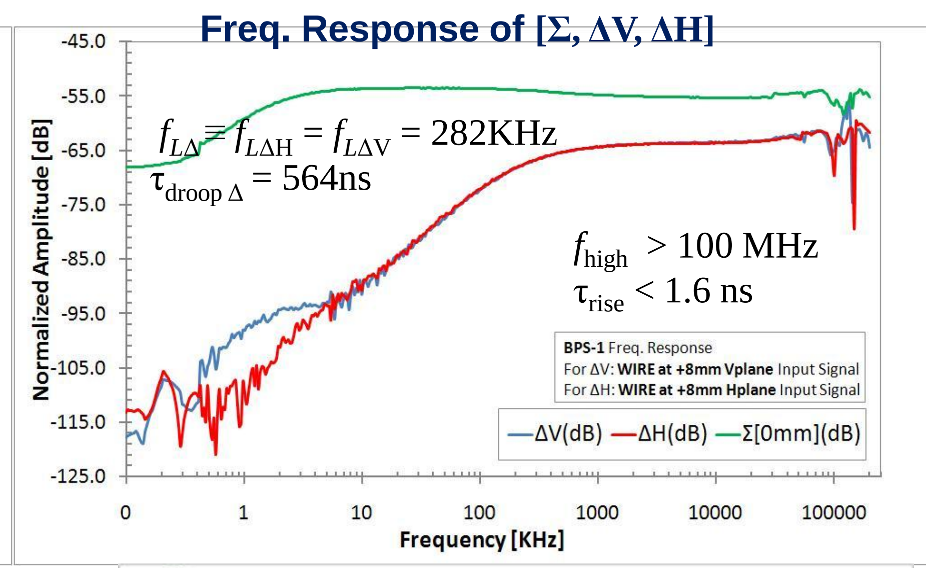
- Low cut-off frequencies determination for the Σ and Δ signals with wire and calibration excitation input.
- High cut-off is beyond 100MHz (according to requirements), but not well defined due to test-bench limitations at higher frequencies.



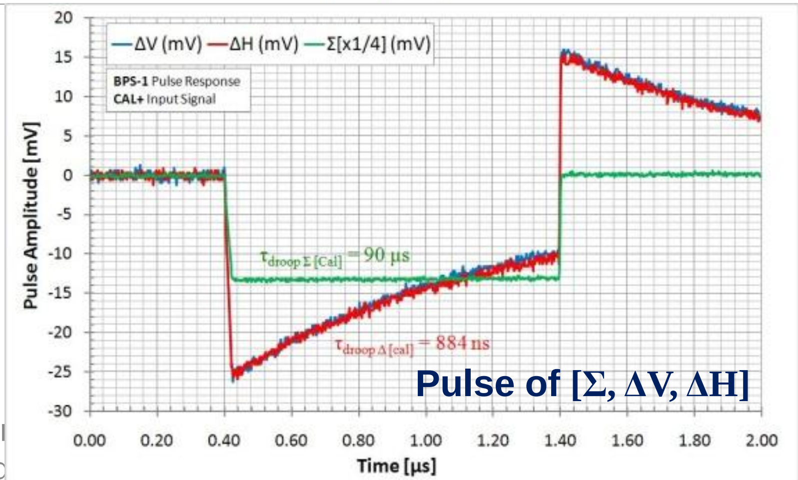
The LF wire test results and BPS benchmark parameters

- **Frequency response of the electrodes related to pulse droop of Δ channels:**
  The beam position is obtained by sampling the pulse signals, so a flat response during 140 ns beam pulse duration is needed to get good position reading. → $f_{L\Delta}$ must be lowered to get: $\tau_{droop\Delta} \approx \tau_{droop\Sigma}$, or equivalently $f_{L\Delta} \approx f_{L\Sigma} < 10$kHz.





- **Droop compensation** implemented with RC circuit in the feedback loop of first amplifier stages of Δ channels.



Characterization Tests

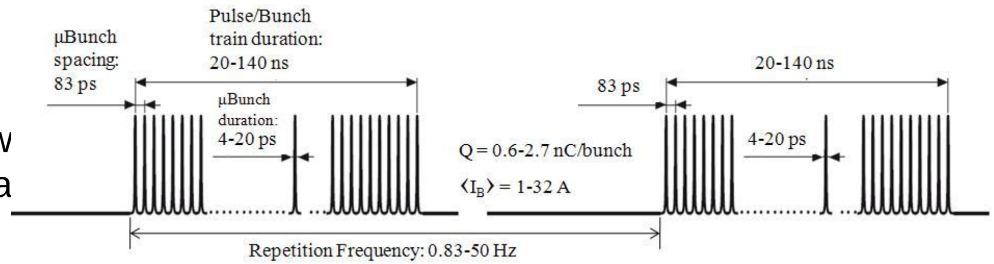
The HF coaxial test-bench and test results

- **BPS behavior at bunching frequencies:**

  ▪ TBL beam pulses are composed of bunches w 12GHz bunching frequency (in the microwa region X/J bands).

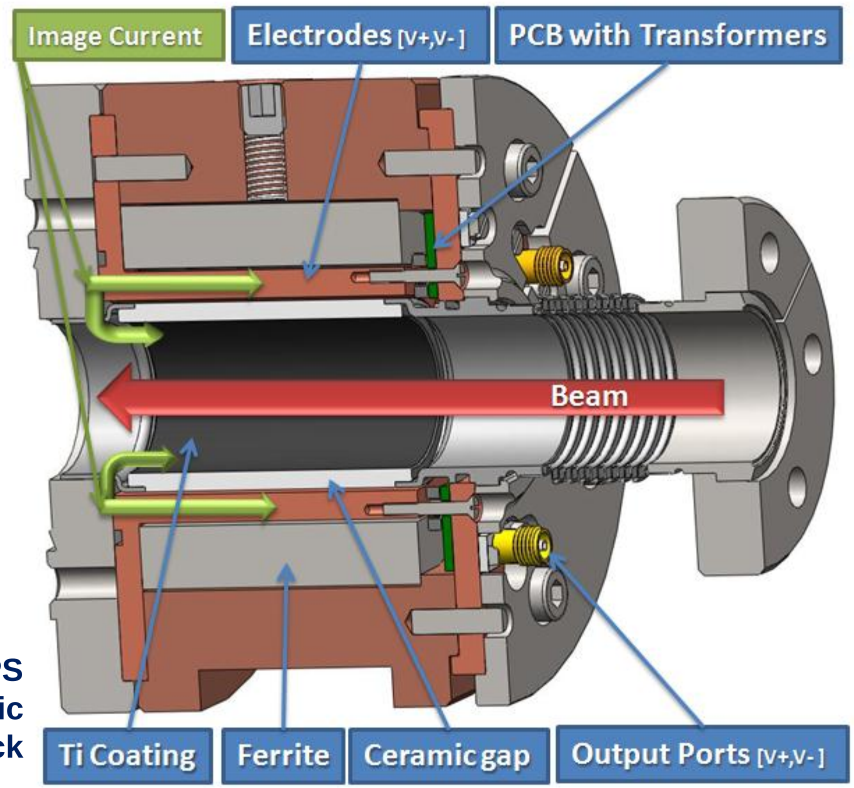
  ▪ The device insertion in the line has a longitudinal impedance $Z_{\|}$. A high real part of this impedance generates wake-fields that can affect the beam stability.

  ▪ Therefore, a Ti coating in the inner side of the ceramic tube was done (sputtring technique). This can reduce and limit $Re(Z_{\|})$ because the Ti layer offers an alternative low inductance path to the high frequency components of the wall image current (see fig. right).



TBL beam pulse bunching time structure

- **Aim of the HF (microwave) test-bench:**
  Study the behavior of the BPS-with Ti-coating at thee high frequencies and verify the limitation of longitudinal impedance.



Longitudinal view of the BPS with Ti-coating inside ceramic tube in black

The HF coaxial test-bench and test results

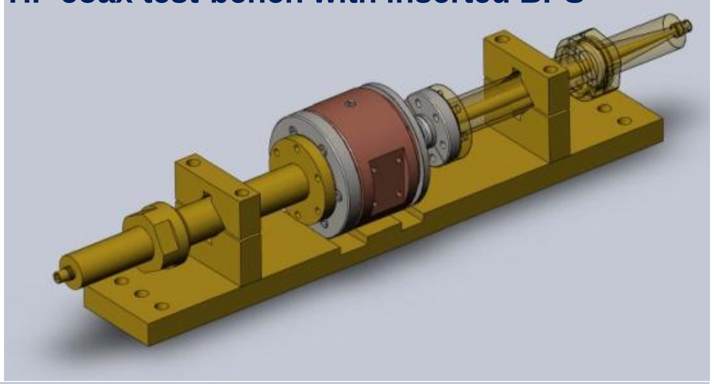
➢ **Simulation and design of the test-bench:**

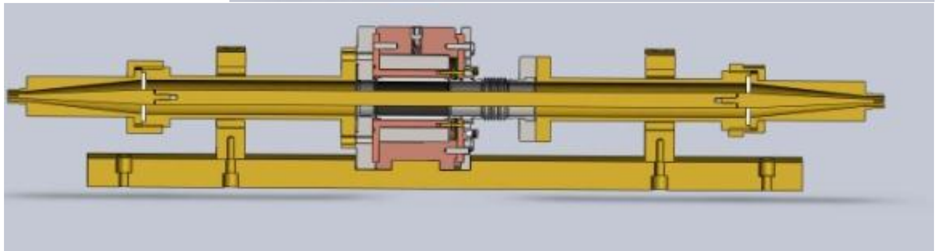
- An ultra-relativistic electron beam can be emulated by a coaxial waveguide (50Ω matched) because they have the same fiels propagation TEM modes.

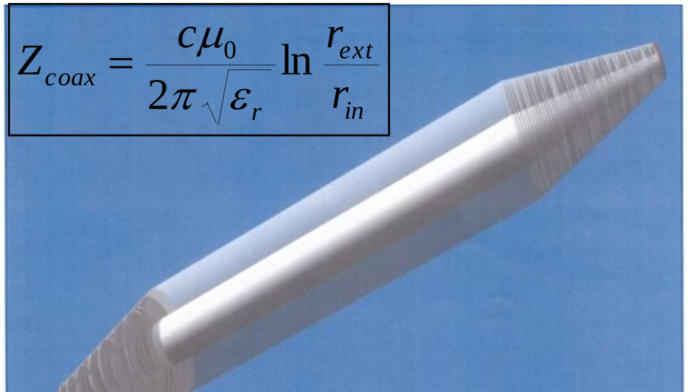
- The test-bench was designed and constructed as a coaxial airline waveguide with outer conductor diameter having the BPS aperture of 24mm, and the central conductor diameter to keep 50Ω line matching.

- APC-7mm connectors were chosen as input and output ports and a conical smooth transition was designed until reaching the 24mm of the outer conductor always keeping the line matched to 50Ω (relation used: Zcoax in the fig. right).

HF coax test-bench with inserted BPS







$$Z_{coax} = \frac{c\mu_0}{2\pi\sqrt{\varepsilon_r}} \ln \frac{r_{ext}}{r_{in}}$$

Simulated coax structure

Characterization Tests

The HF coaxial test-bench and test results

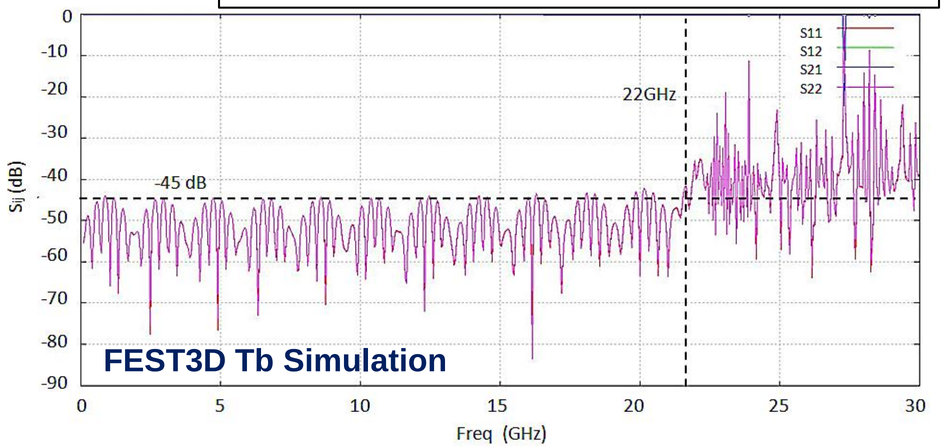
➢ **Test-bench simulation objectives:**
keep Z_{coax} =50Ω constant along the waveguide, maximize the transmission with S11 reflection coefficient as low as possible (~-40dB, -50dB good enough), and get an usable bandwidth higher than 18GHz (which will be limited by connectors).

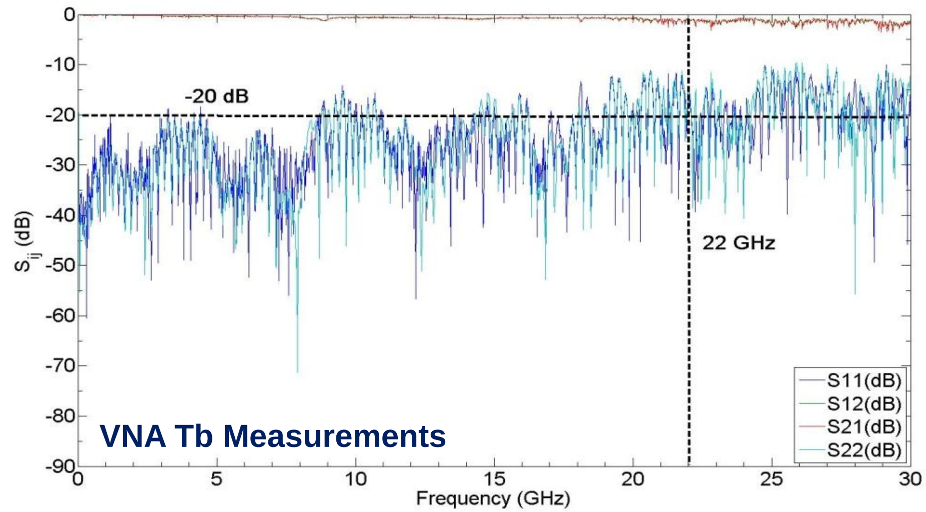
➢ **S-parameters test (test-bench w/o DUT):**

- **Simulation (with specialized ESA software FEST3D)*:**
  - goodness of coax structure: S11 < -40dB.
  - Bandwidth until 22GHz where TM modes are excited and also start to be transmitted with the TEM (fig. top-right).

- **Measurements with a VNA of 18MHz – 30GHz:**
  - Reference meaurements S11 and S21 of test-bench without BPS inserted (fig. bottom right): S11<-20dB → Good enough transmission under <18GHz (usable bandwidth).
  - After, S21 and S11 measurements of test-bench with inserted BPS for longitudinal impedance determination.

*Test performed at:
European High Power RF Laboratory, VSC-ESA, Valencia, Spain





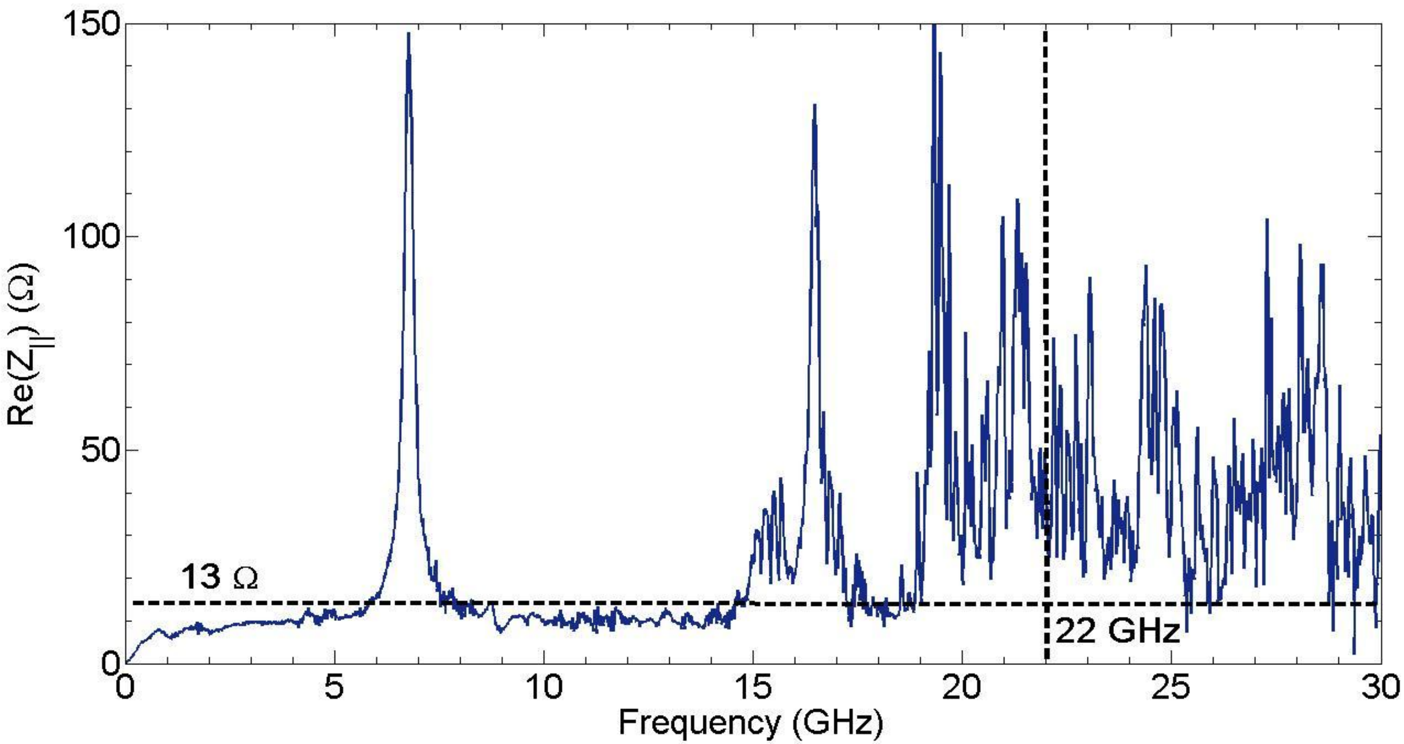
Characterization Tests

The HF coaxial test-bench and test results

➢ **BPS longitudinal impedance:**

- From S21 and S11 measurements of test-bench without and with BPS-DUT.
- The real part of the BPS longitudinal impedance is calculated according to approx. method proposed by F. Caspers (eq. right).
- **Re($Z_{||}$) < 13Ω until 18GHz**, but waveguide resonances seems to appear at 6.8GHz and more peaks atarting at 15GHz (under study).

$$\mathrm{Re}(Z_{||}) = -2Z_{coax} \ln \frac{S_{21,SETUP\&BPS}}{S_{21,SETUP}}$$



Method of Resolution Measurement with beam

- **Resolution parameter:**
  - **The resolution** can be defined as the uncetainty produced by the system noise in the measurement of a relative position with the BPM.
  - **Better resolution is expected** when increasing the beam current because of SNR improvement.

- **Resolution beam test method:**

is based on the measurements of beam positions from three consecutive BPS units to get the resolution of the central BPS from several beam pulse shots and taking out the beam jitter between pulse shots.

- A straight beam trajectory, without significant beam current loss, can be set across the three BPSs section by switching-off the quadrupoles around them.

- From the position readings of the two side BPSs the beam position in the central BPS is obtained by interpolation, and then compared with its own reading.

- The resolution is obtained as the difference of the interpolated and the measured beam positions in the central BPS reflecting only the system noise uncertainty in the position readings (and having removed the beam jitter influence).

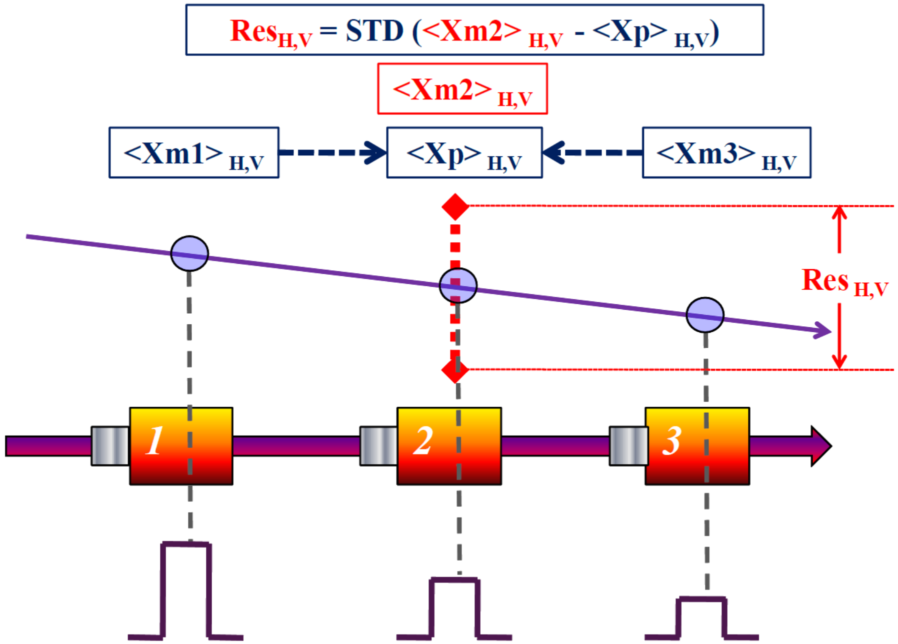
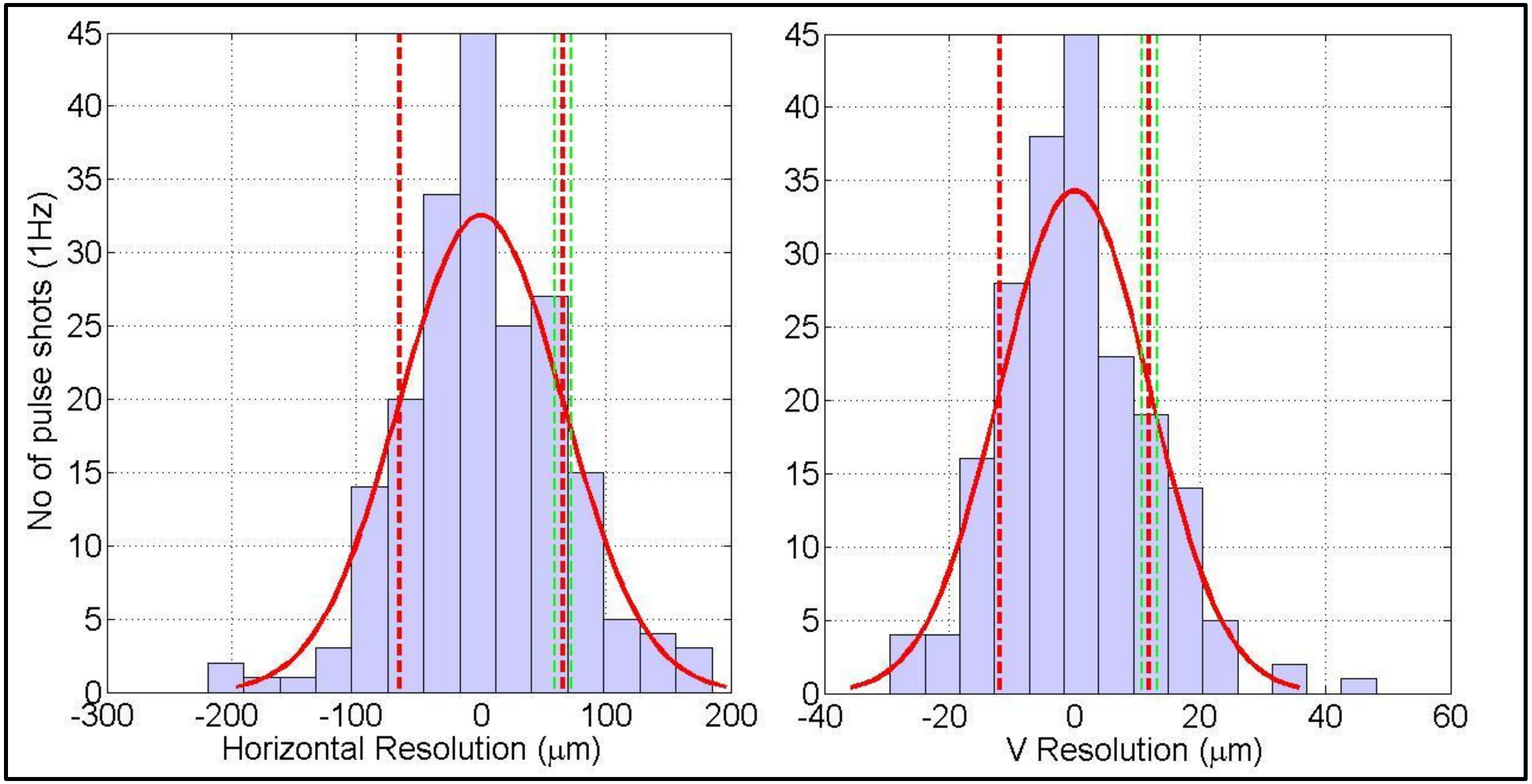


Illustration of the 3-BPMs Resolution Method

Beam Tests Results for BPS Resolution

Resolution Test Results (performed on TBL July 2011)

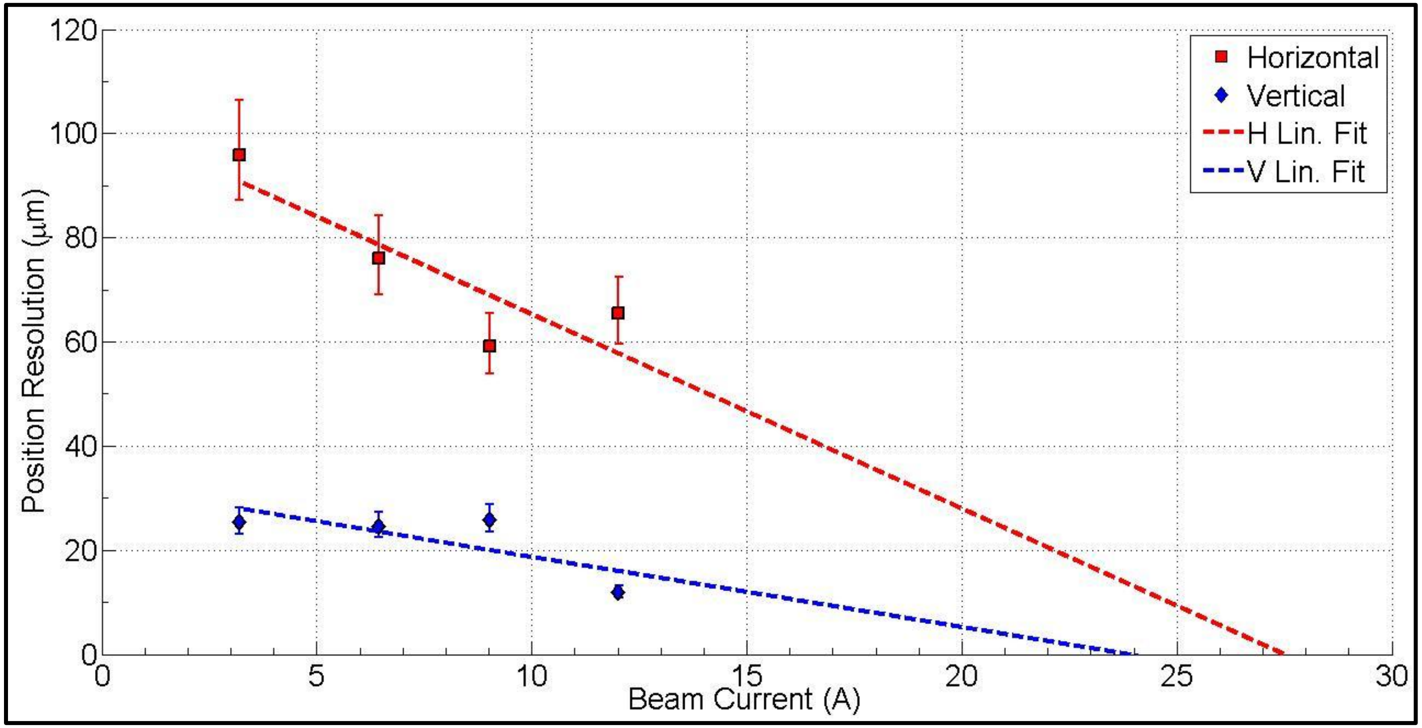
- For a given beam current it was measured the position for 200 pulse shots.
- Best Resolution (and its 95% confidence interval) for the BPS0510 at 12A the maximum available beam current at test date → H: 65.4 um; V: 11.9 um.



Beam Tests Results for BPS Resolution

Resolution Test Results (performed on TBL July 2011)

- Resolution tendency with Beam Current for BPS0510.
- Linear fit shows good outlook to achieve the goal of 5μm at 28A for H and V coordinates.
- Moreover, beam can be improved, discrepancies between H and V resolutions can be due to remanent magnetic field in the quads and beam losses. → Test will be repeated for TBL maximum nominal beam current 28A.



Conclusions

- The experience in CTF3 and specially in TBL has been fully satisfactory for our group during last 5 years.

- It was the first experience of our group in the beam diagnostics and instrumentation development, with two (mechanical and electronic) engineers at full time during first two years (2007-2008) of more intense work until series installation.

- We have learn many things and gained some expertise on BPMs from CTF3 and TBL people, and we are willing to continue our collaborations in new projects.

- As it is now the case, for instance, in the collaboration for the development of Drive Beam BPMs for CLIC → Stripline design of S: Smith, SLAC (next talk).

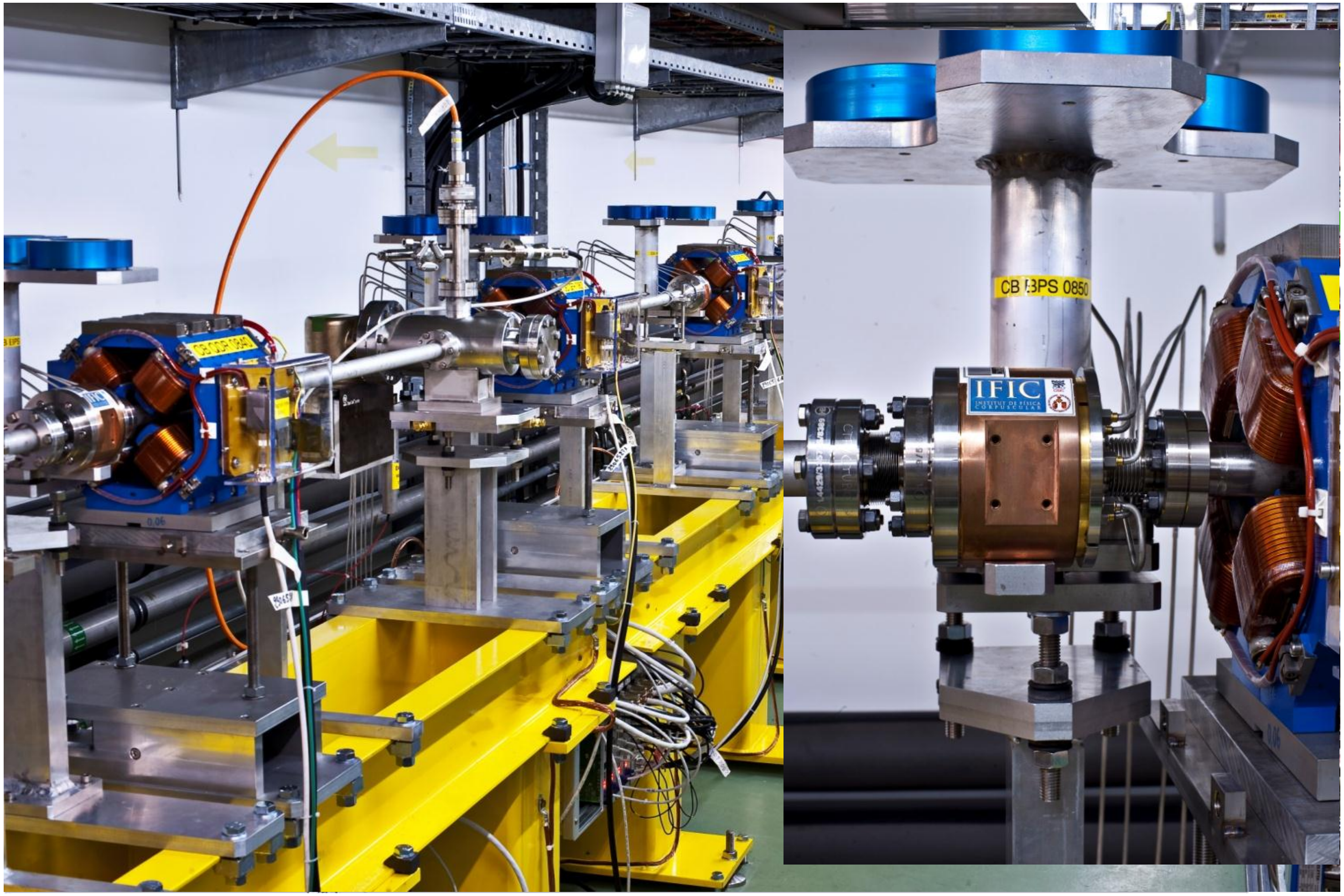
- The BPS units are performing pretty well in TBL…

- But still a few things to do on BPS-IPU like Resolution beam tests at 28 A max current, study of high frequency behavior of BPS, and keep giving support for anything needed during operation of TBL.

- **Finally, some TBL nice Photos!!!**

Conclusions

The TBL-CTF3 in CLEX Bdg. after installation of all BPS units (Oct.2008)



For anyone more interested...

BPS-IPU related publications

1. *"Design and Construction of an Inductive Pick-up for Beam Position Monitoring in the Test Beam Line of the CTF3"* , J.V. Civera-Navarrete, A. Faus-Golfe, J.J. García-Garrigós. **EPAC'08.**

2. *"Design and Construction of an Inductive Pick-up for Beam Position Monitoring in the Test Beam Line of the CTF3"*, J.J. García-Garrigós.
   Directores: A. Faus-Golfe (IFIC), Ángel Sebastiá-Cortés (DIE-UPV).
   Master Thesis, Dpto.Ingeniería Electrónica, UPV, September 2008;
   CLIC-Note-769 (CERN-OPEN-2009-002); CERN-THESIS-2009-009. CERN Document Server. February 2009

3. *"Construction and Characterization of the Inductive Pick-up Series for Beam Position Monitoring in the TBL Line of the CTF3 at CERN"* **,** C. Blanch-Gutiérrez, J.V. Civera-Navarrete, A. Faus-Golfe, J.J. García-Garrigós. **PAC'09.**

4. *"CharacterizationTests of the Beam Position Monitor Series Production for the TBL Line of the CTF3 at CERN"*, C. Blanch-Gutiérrez, J.V. Civera-Navarrete, A. Faus-Golfe, J.J. García-Garrigós. **DIPAC'09.**

5. *"Development and Test Benchmarks of the Beam Position Monitor for the TBL Line of the CTF3 at CERN"*, , C. Blanch-Gutiérrez, J.V. Civera-Navarrete, A. Faus-Golfe, J.J. García-Garrigós. **IPAC'10.**

6. "Commissioning Status of the Decelerator Test Beam Line of CTF3", E. Adli, S. Döbert, R. Lillestol, M. Olvegaard, I. Syratchev, CERN, Geneva, Switzerland; D. Carrillo, F. Toral, CIEMAT, Madrid, Spain; A. Faus-Golfe, J.J. Garcia-Garrigos, IFIC (CSIC-UV), Valencia, Spain;
   Yu. Kubyshin, G.Montoro, UPC, Barcelona, Spain. **LINAC'10.**

7. "High Frequency Measurements of the Beam Position Monitor for the TBL Line of the CTF3", C. Blanch-Gutierrez, J.V. Civera, A. Faus-Golfe, J.J. García-Garrigos, IFIC (CSIC-UV), Valencia, Spain; B. Gimeno-Martínez, Dpto. Física Aplicada y Electromagnetismo, UV, Valencia, Spain. **DIPAC11.**

8. "Beam Test Performance of the Beam Position Monitors for the TBL Line of the CTF3", C. Blanch-Gutierrez, J.V. Civera, A. Faus-Golfe, J.J. García-Garrigos, IFIC (CSIC-UV), Valencia, Spain; S. Doebert, CERN, Geneve, Switzerland. **IPAC11.**

Thanks for your attention

Topical Workshop on Beam Position Monitors

BPS Monitors
Inductive Pick-Up: experience on CTF3

DITANET Topical Workshop on BPMs
Session 1: BPM Pick-up Technology
16-18 January 2012, CERN, Geneve

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