New IP chamber for ATF2 goal 2

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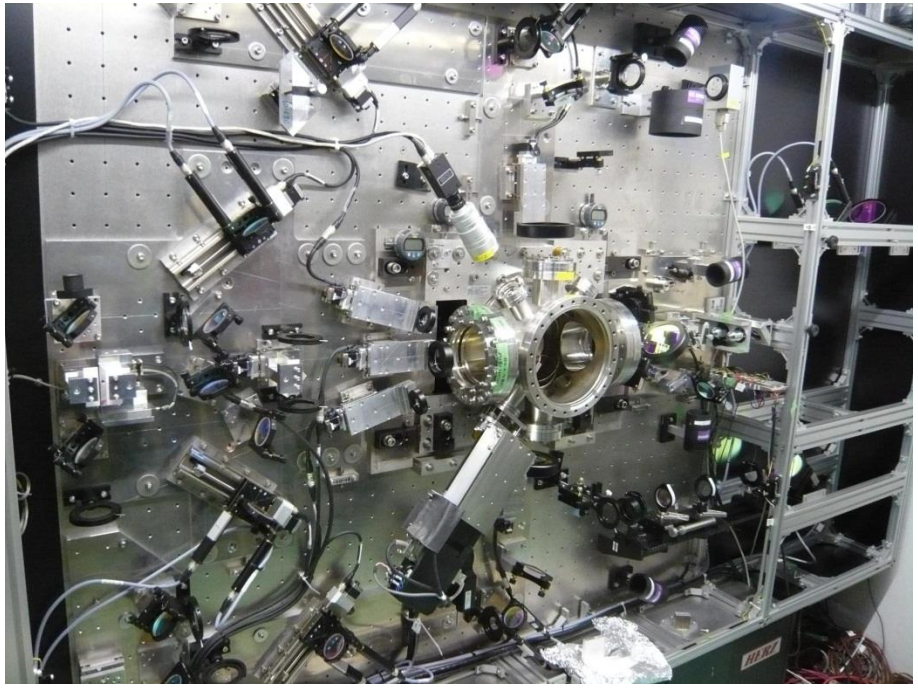
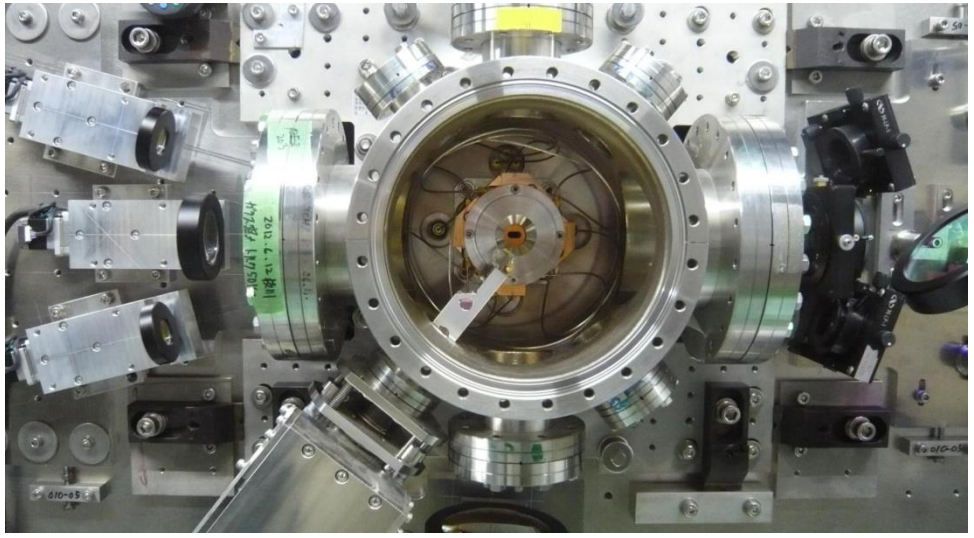
Requirements for new IP chamber

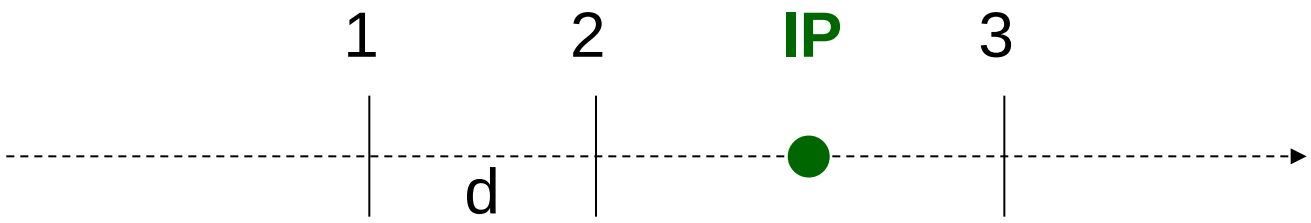
1. Pre-alignment of IP-BPM set with respect to rest of beam line < 200 μm
2. Internal pre-positioning accuracy ~ 50 μm
3. Remote relative positioning via beam based alignment within < 5 μm (dynamic range of IP-BPM electronics)
4. Mechanical calibration of IP-BPM scale factors → **10^{-4}**
5. Compatibility with IP-BSM operation (viewports for lasers, wire-scanner, electron / laser beam alignment…)



Present IP-chamber (FFTB)



Required precision on relative IP-BPM scale factors depends on beam parameters



d ~ 0.1 m
ε_y ~ 12 pm
σ_{jitter} / σ ~ 10%

$\theta_{IP} = (y_2 - y_1) / d$
$y_{IP} = 2\, y_2 - y_1$

ξ = calibration error of 1 relative to 2
→ $2\, y_2 - y_1 \sim y_{IP} + 2\, \xi\, \theta\, d$

β ~ 1 m (e.g. diagnostic section)

1. **Determination of resolution**
2. **Feedback to IP or to 3rd IP-BPM**

Residual ~ $2\, (\varepsilon / \beta)^{0.5}\, d\, (\sigma_{jitter} / \sigma)\, \xi \sim 10^{-7}\, \xi$ ➔ $\xi \sim 10^{-2}$ for 1 nm error

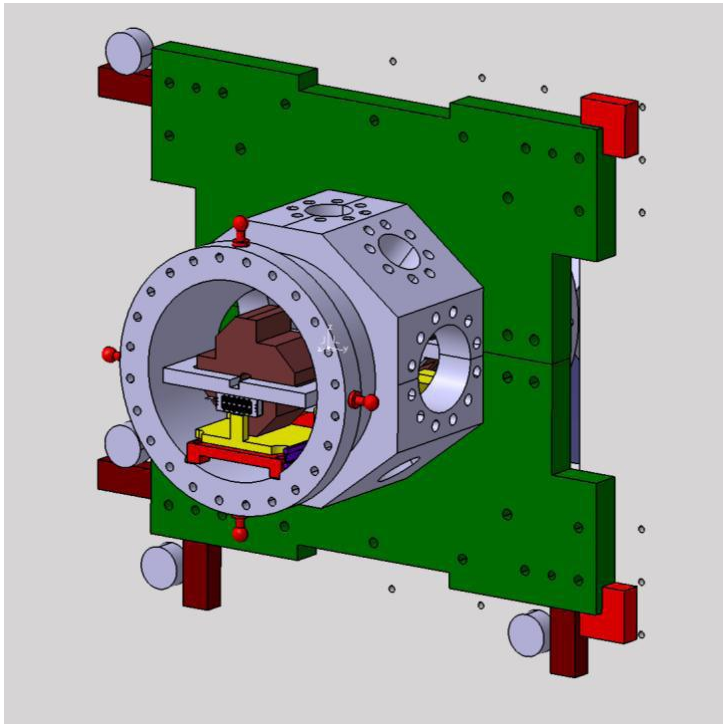
$\beta \sim 10^{-4} / 10^{-3}$ m (interaction point : nominal / 10 x optics)

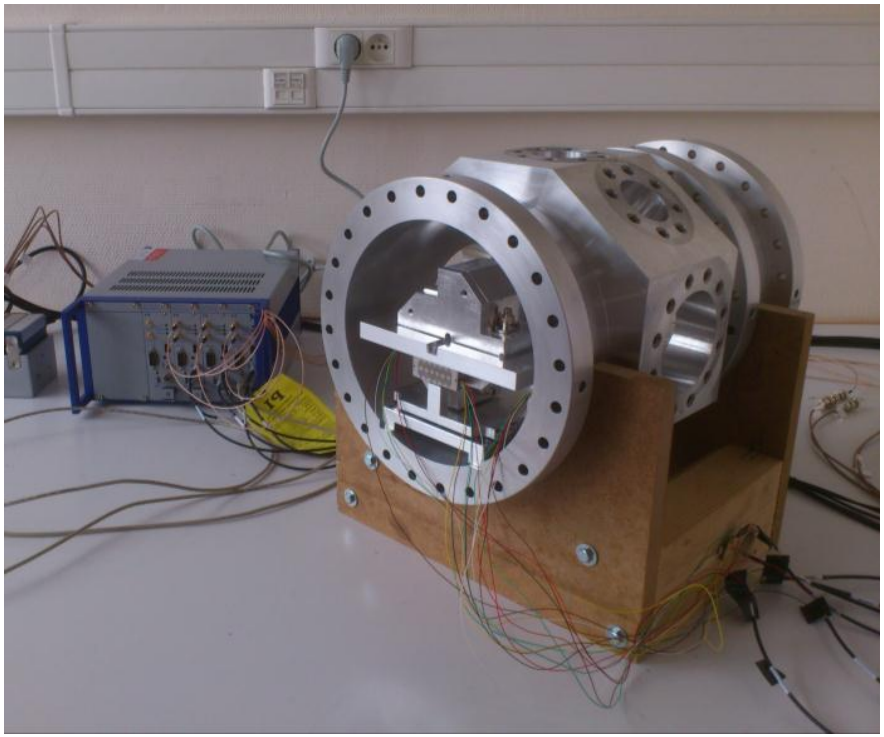
Residual ~ $2\, (\varepsilon / \beta)^{0.5}\, d\, (\sigma_{jitter} / \sigma)\, \xi \sim 10^{-5}\, \xi$ ➔ **$\xi \sim 10^{-4\,/\,-3}$ for 1 / 10 nm error**

$\xi \sim 3\, 10^{-4\,/\,-3}$ for 1 / 10 nm error

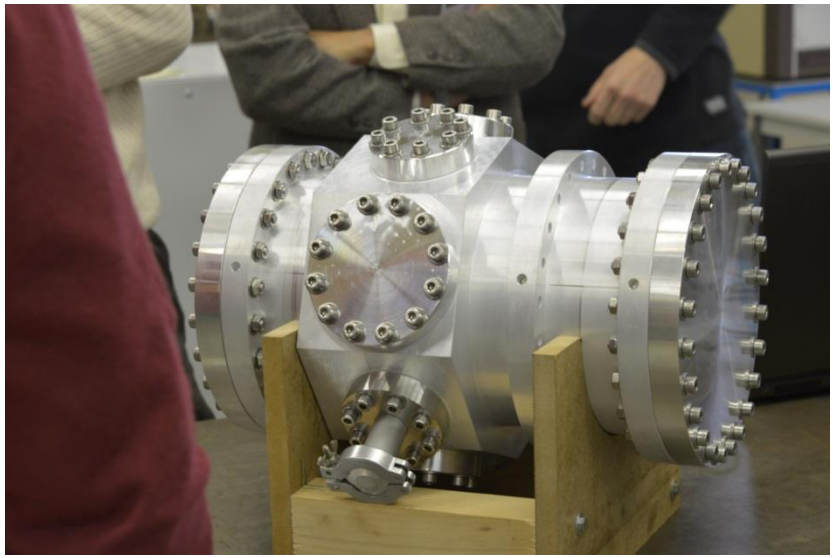
Main features of new IP chamber

1. Mechanical references for precise pre-positioning and alignment
2. Adjustable fixture for rigid mount on IP-BSM optical table
3. Base-plate + cradles support BPM1-2 and BPM3 in tripod configurations
4. Lateral & vertical adjustments with 8 piezo-movers in 230-300 μm range
5. Positioning within 10^{-4} of the range (strain gauges as input to feedback)
6. In-vacuum temperature monitoring
7. Remote electronics (25 meter cables)

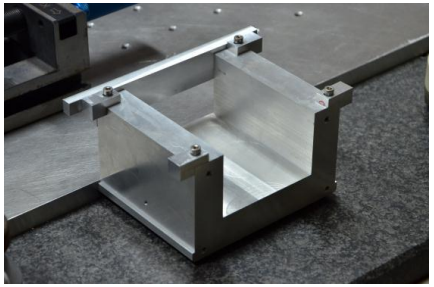


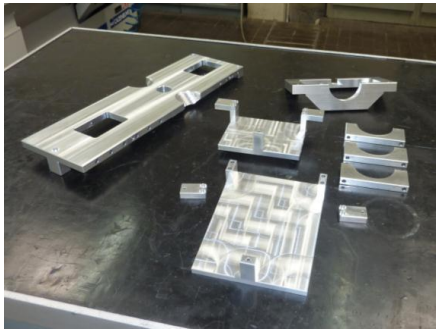


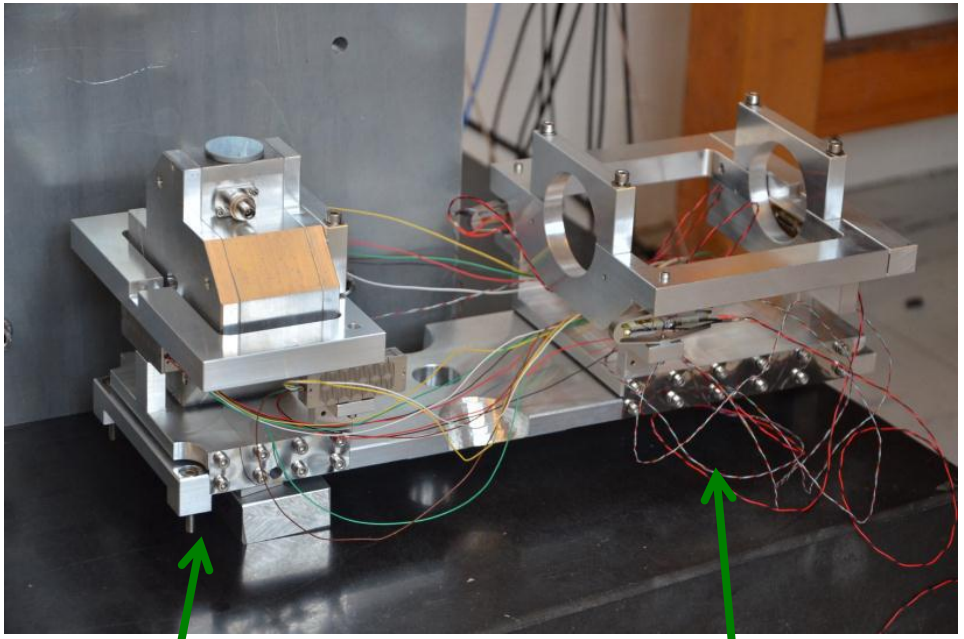
Mechanical parts almost completed



- Chamber and internal parts manufactured at LAPP
- Modifications, alignment tools and temporary flanges at LAL
- Mounting fixtures on IP-BSM vertical table and for vibration sensor on chamber in progress at LAL
- Upstream chamber extension, viewports extensions, final upstream / downstream flanges and tool for in situ relative laser / beam / IP-BPM alignment in progress at KEK







4 PI piezo-actuators

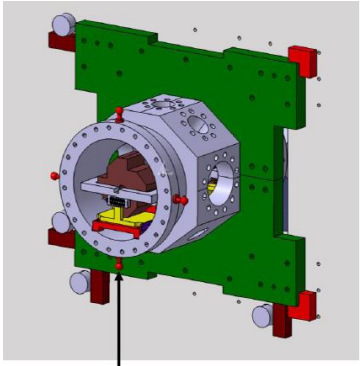
4 Cedrat piezo-actuators

Dimensional checks

Performed with 3D Mitutoyo machine (5 µm accuracy, 1 µm resolution)

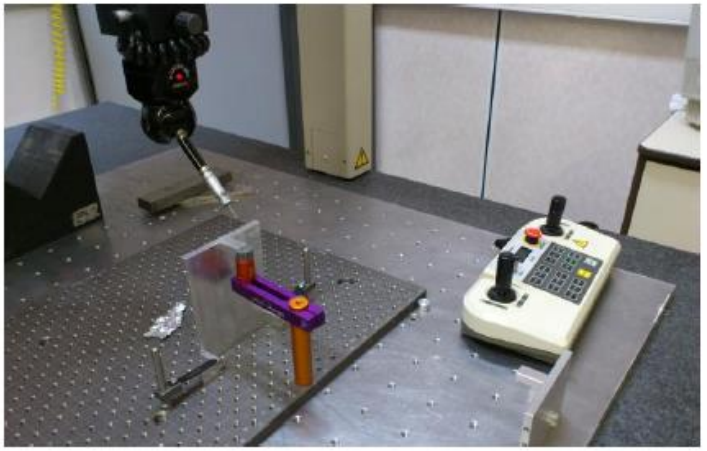
→ Chamber and internal parts : OK

→ Bruno Leluan, LAL Orsay

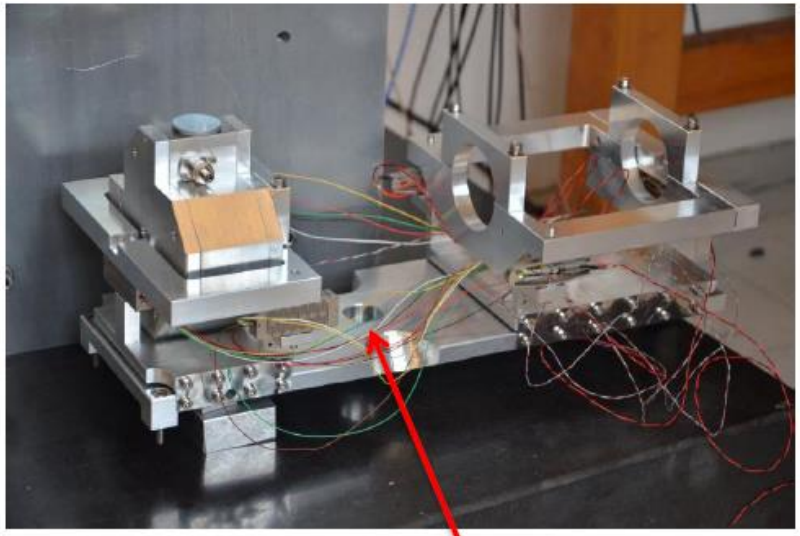


Position of internal references were measured with regard of external references (for mires)

→ Data useful for BPMs external pre-alignment



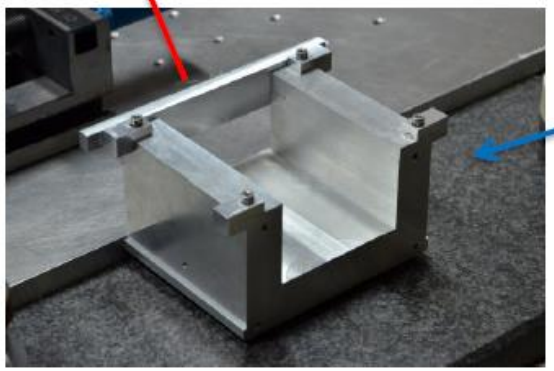
Adjustment of BPM positioning system



BPMs position will be adjusted with respect of interfaces « Chamber / BPMs displacement system »

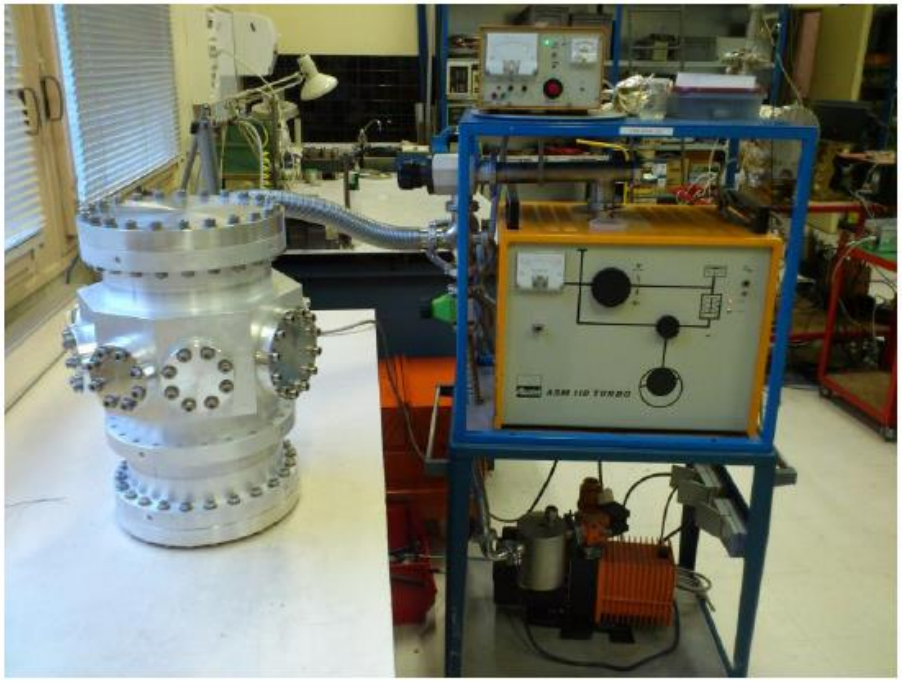
→ Place shims (SS foil, 20 μm min. thick) below actuators
→ Check BPMs position / interfaces with 3D machine
→ Unmounting, remounting and recheck as repeatability test

Delayed to May (availability of 3D machine)
→ Bruno Leluan & Sandy Wallon, LAL Orsay



BPMs positioning tool : give the right position to BPMs (distance to IP , lateral positioning, yaw, pitch (with third flat spot)).
Note : roll adjustment done when BPM is mounted to craddle/bracket

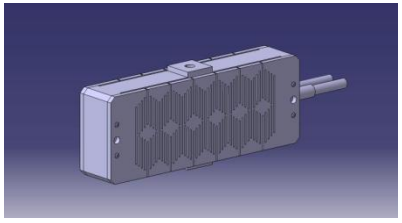
Vacuum test of chamber & piezo-actuators completed

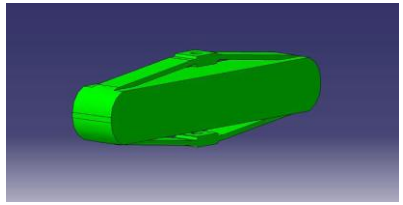


He leak test OK :

→ Flowrate at 3×10^{-8} Atm.cm^3/s
(suitable for UHV)

Data :
- All parts cleaned (SS insert removed and then reinstalled)
- 1.5 mm dia. indium seal (wire)
- Indium wire flaten up to 0.15 mm thickness (screws tightened at 6 Nm)
- Aluminum flanges with 0.7 mm dia. groove for wire positioning
- Test performed at 10^{-5} mbar





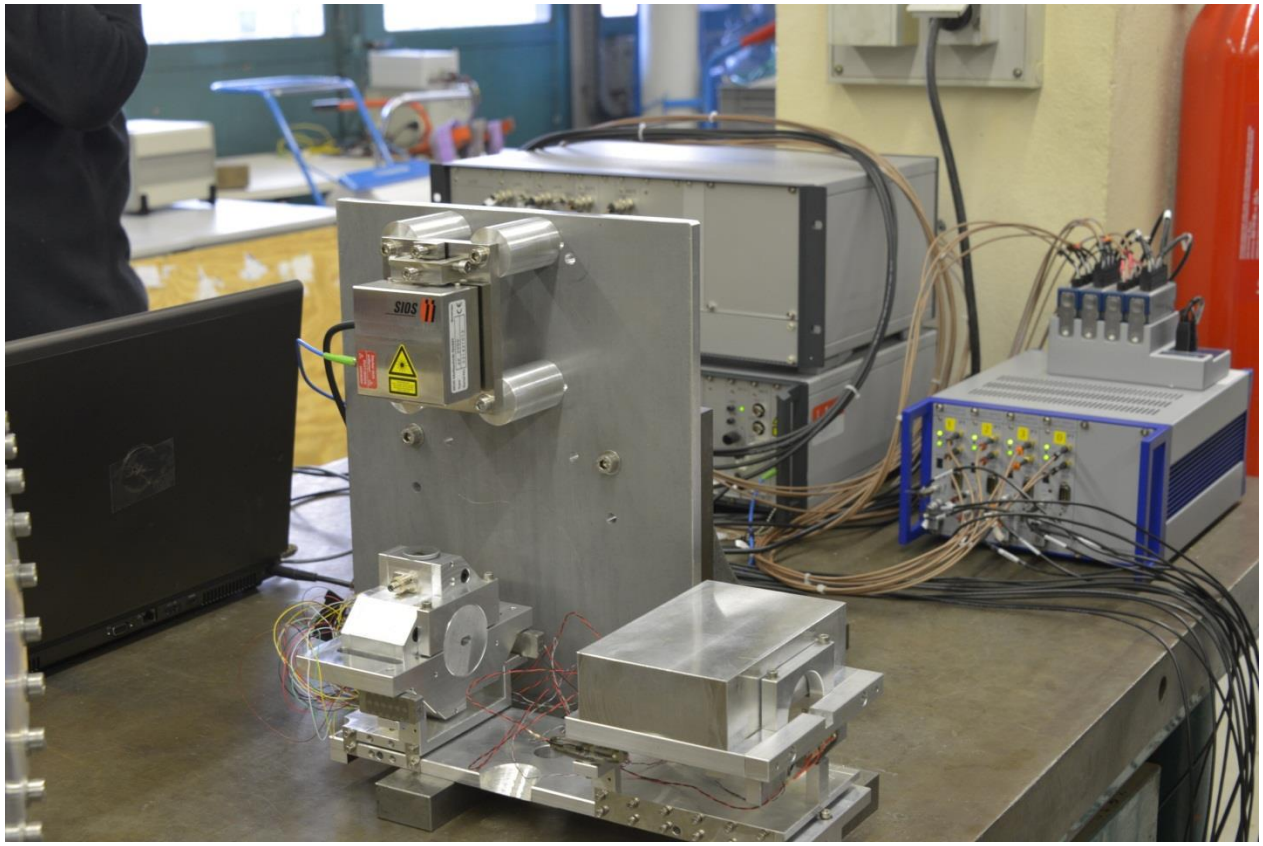
Outgasing of both PI and Cedrat with cables are OK :

➔ flowrate at 8x10-8 mbar.l/s (suitable for UHV)

➔ at 21° C and after 100 hours of pumping, no organic compound detected.

Piezo-mover performance checks :

- on-going for PI
- some delay for Cedrat (noisy controller power supply affecting read-back)

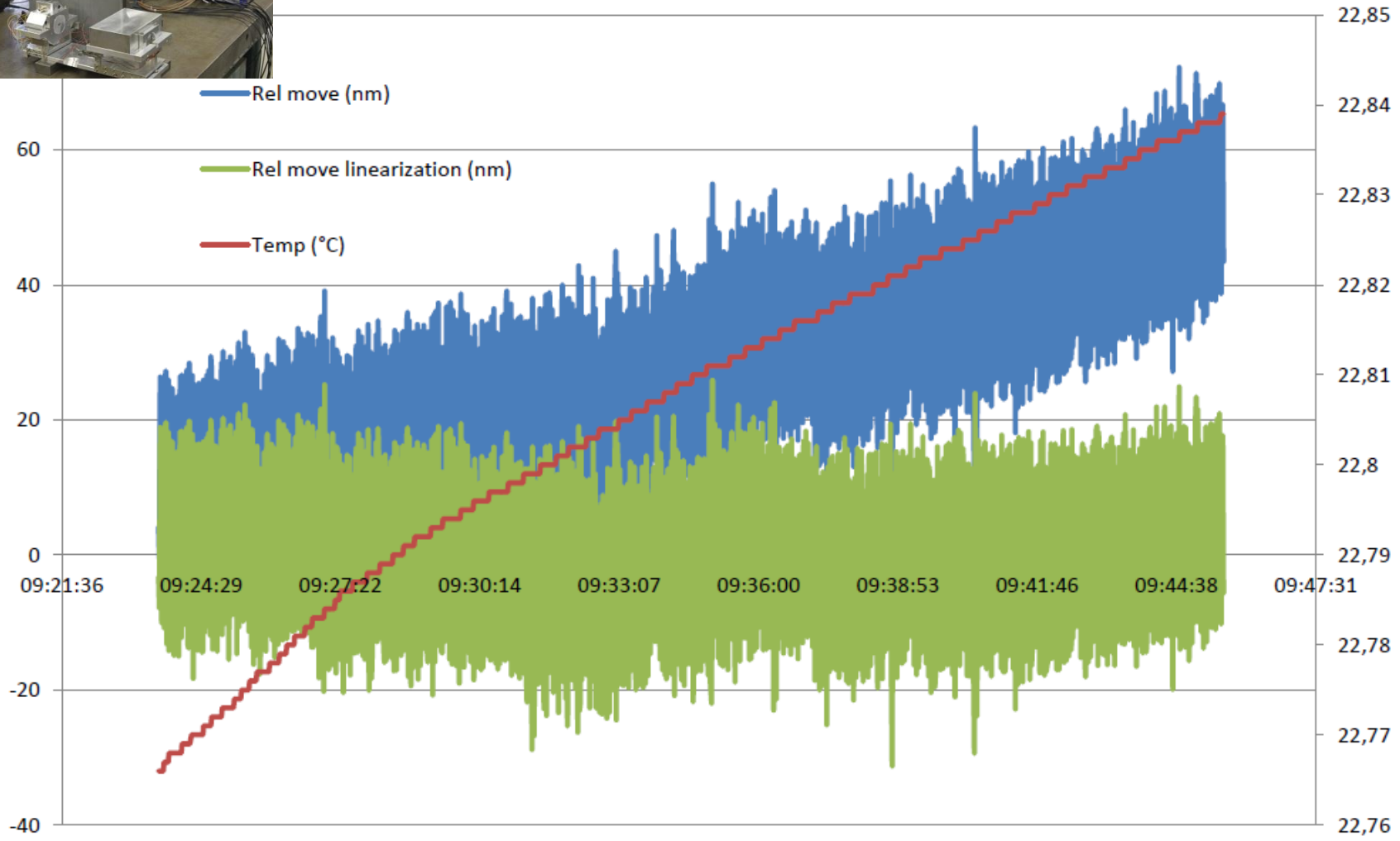


- Closed-loop stability
- Open-loop stability

- Setting accuracy
- Calibration

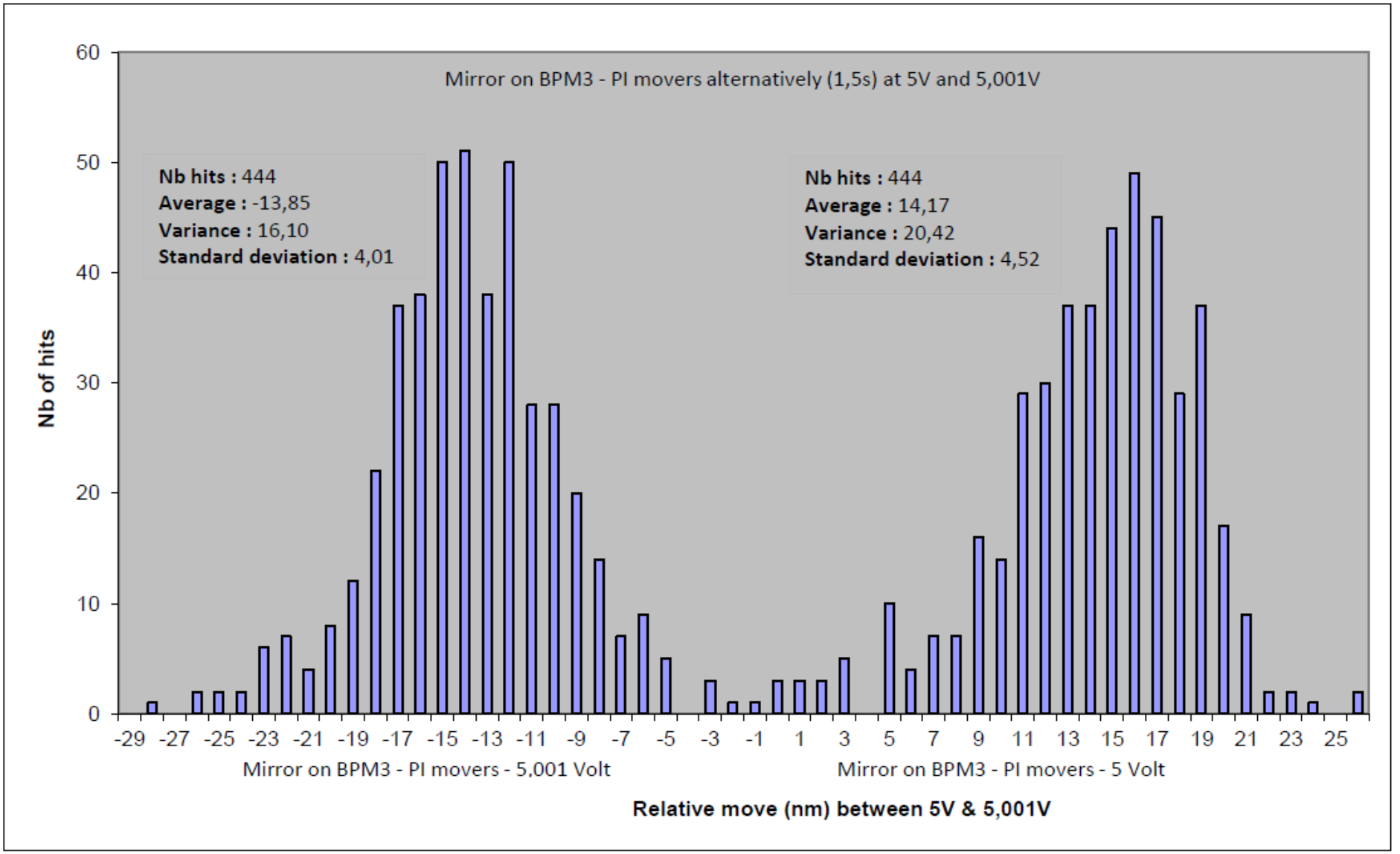
- Thermal effects
- Vibration mitigation

BPM3 – PI vertical movers – 5V / 5.001V alternatively

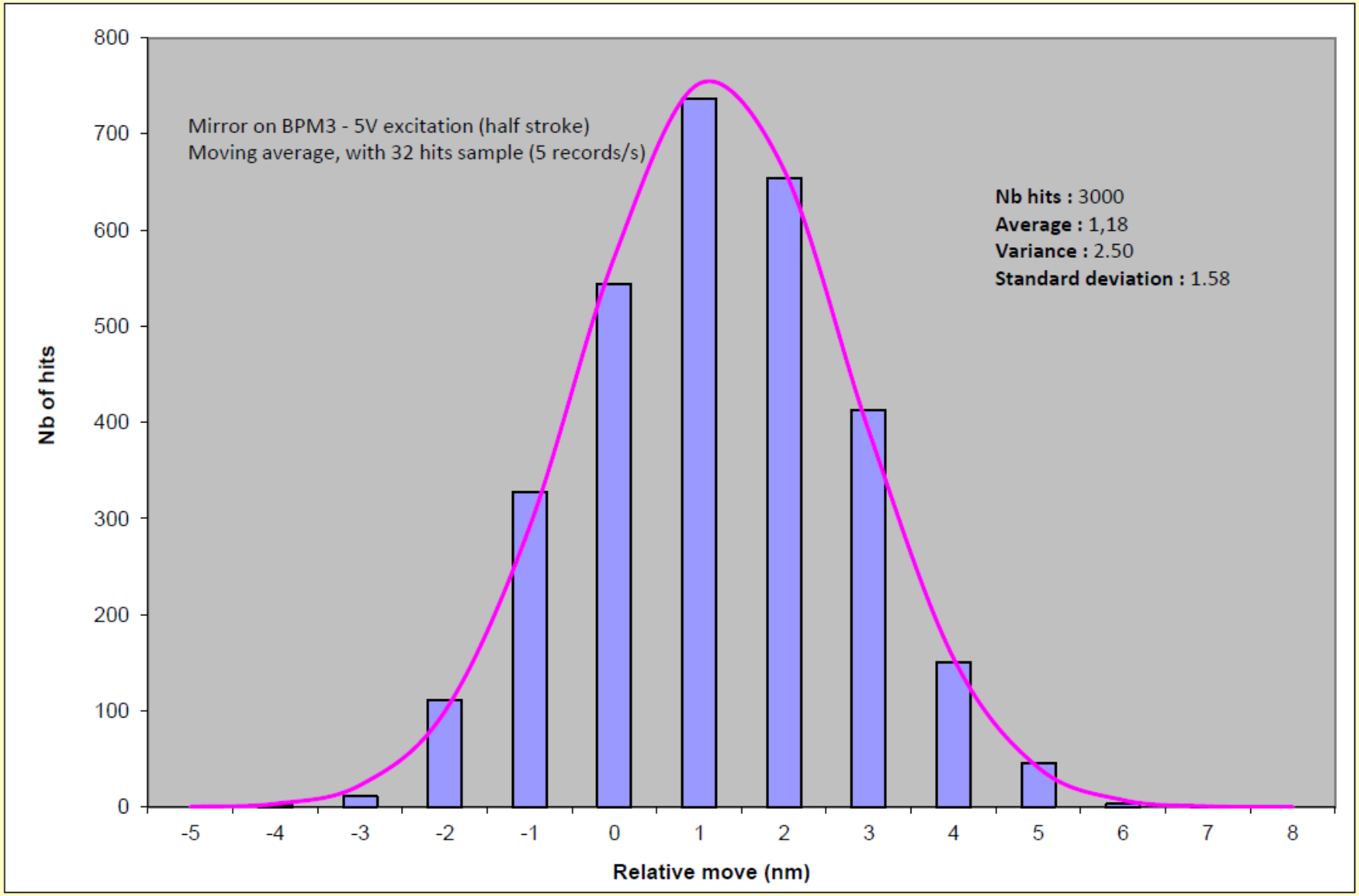


The 3 movers are stimulated at 5V (1,5s) then at 5.001 V (1,5s) during this experiment.

Results at 5V/5.001V alternatively during 1,5s

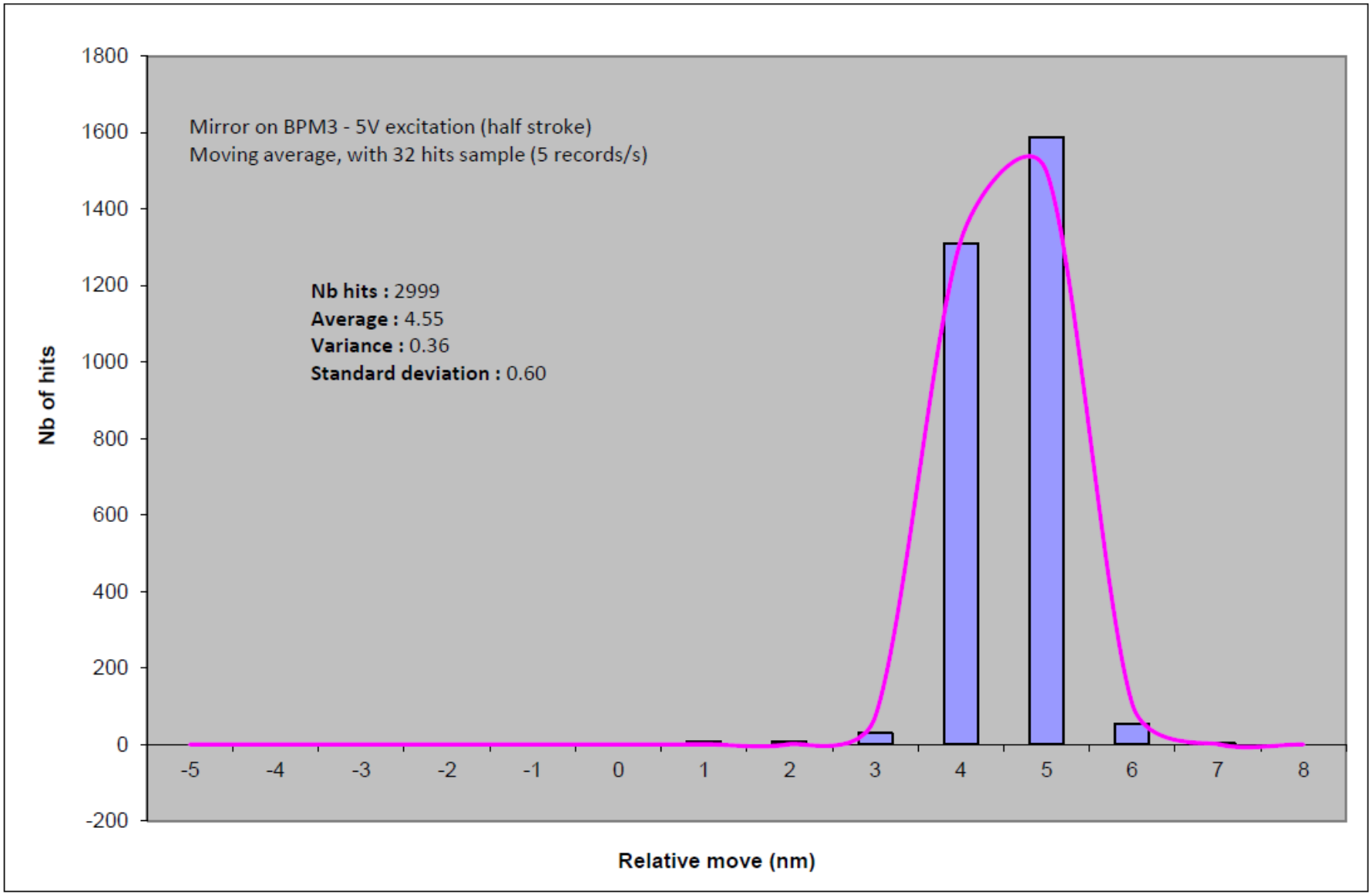


With feedback

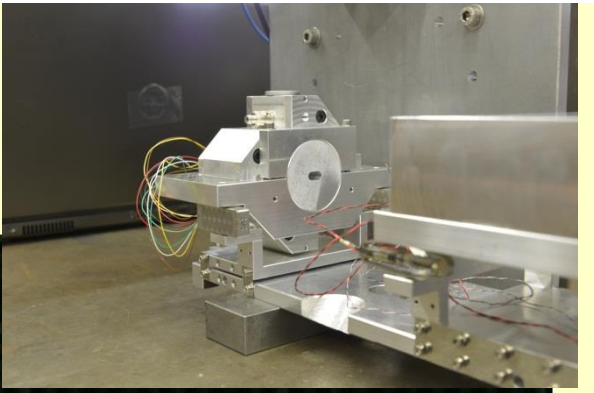


PI movers characterization

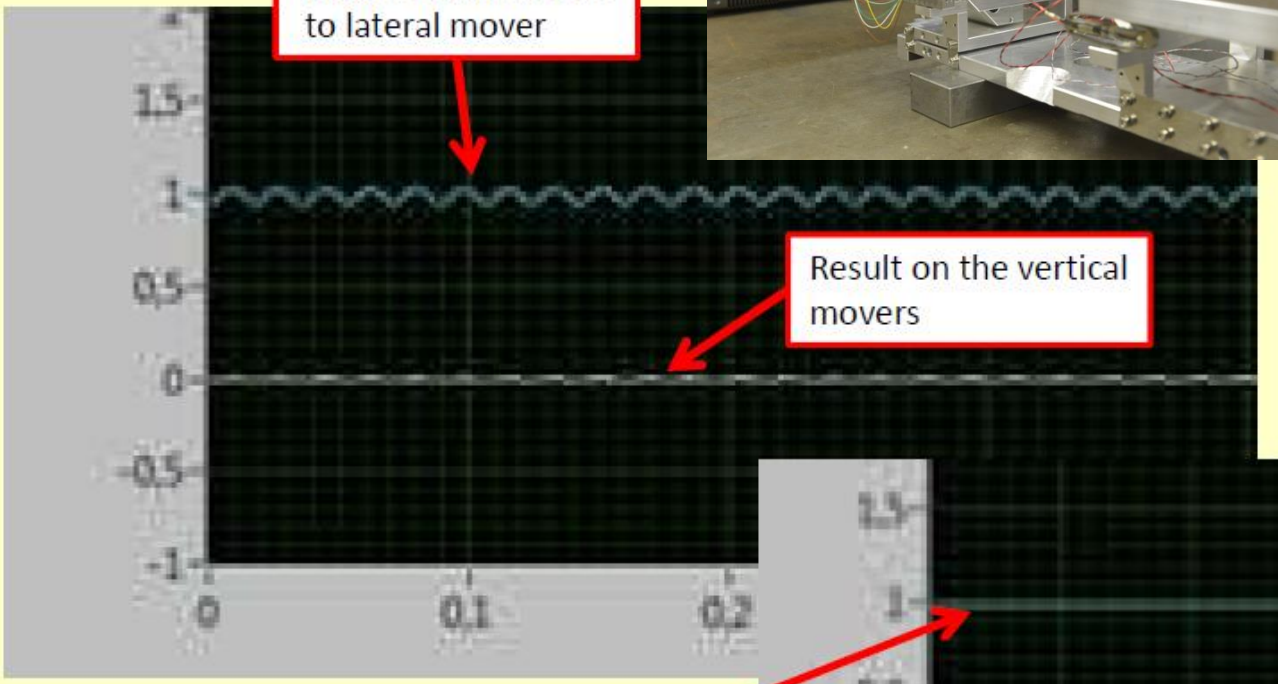
Without feedback



Effect of lateral mover



60Hz oscillation due to lateral mover



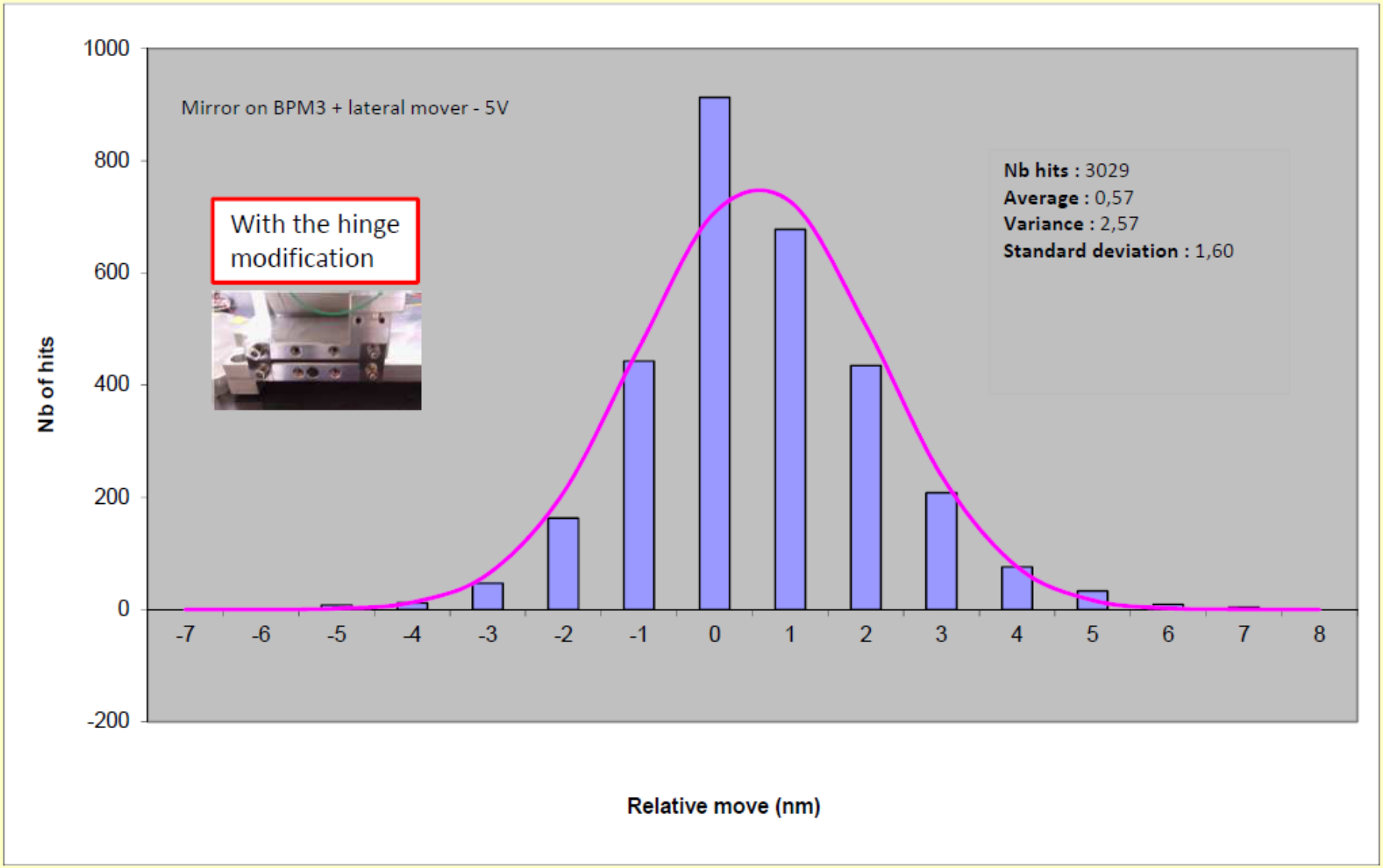
Result on the vertical movers

The 3 vertical movers and the lateral mover are installed.
It is the complete configuration for BPM3 move.

With the modification on one hinge

Result on the vertical movers

With all PI movers



Overview

PI movers
(BPM3)

PT100 probe
(BPM3)

Cedrat movers
(BPM1&2)

PT100 probe
(BPM1&2)

Connecting cable for mover (25 m)

Connecting cable for
Temp probe (25 m)

Ethernet link to
control room

Linking box

4 movers command box
(PI)
Analog inputs & outputs

Linking box

4 movers command box
(Cedrat)
Analog inputs & outputs

T. probe
4 wires

DAC
16 bits / +-10 v

ADC
24 bits / +-10 v

DAC
16 bits / +-10 v

ADC
24 bits / +-10 v

Wiring status

Power supply linking box (common to Cedrat & PI)

SG / PT100 linking box (Cedrat)

SG / PT100 linking box (PI)

The ADC/DAC supplied by LAL for KEK control

Ethernet / RS432-485 / ...
link to connect with KEK control room

Purchased.
Coming soon (2 weeks).

Output : DAC
piezo power supply
16 bits / +-10Vc (input x4)

x2

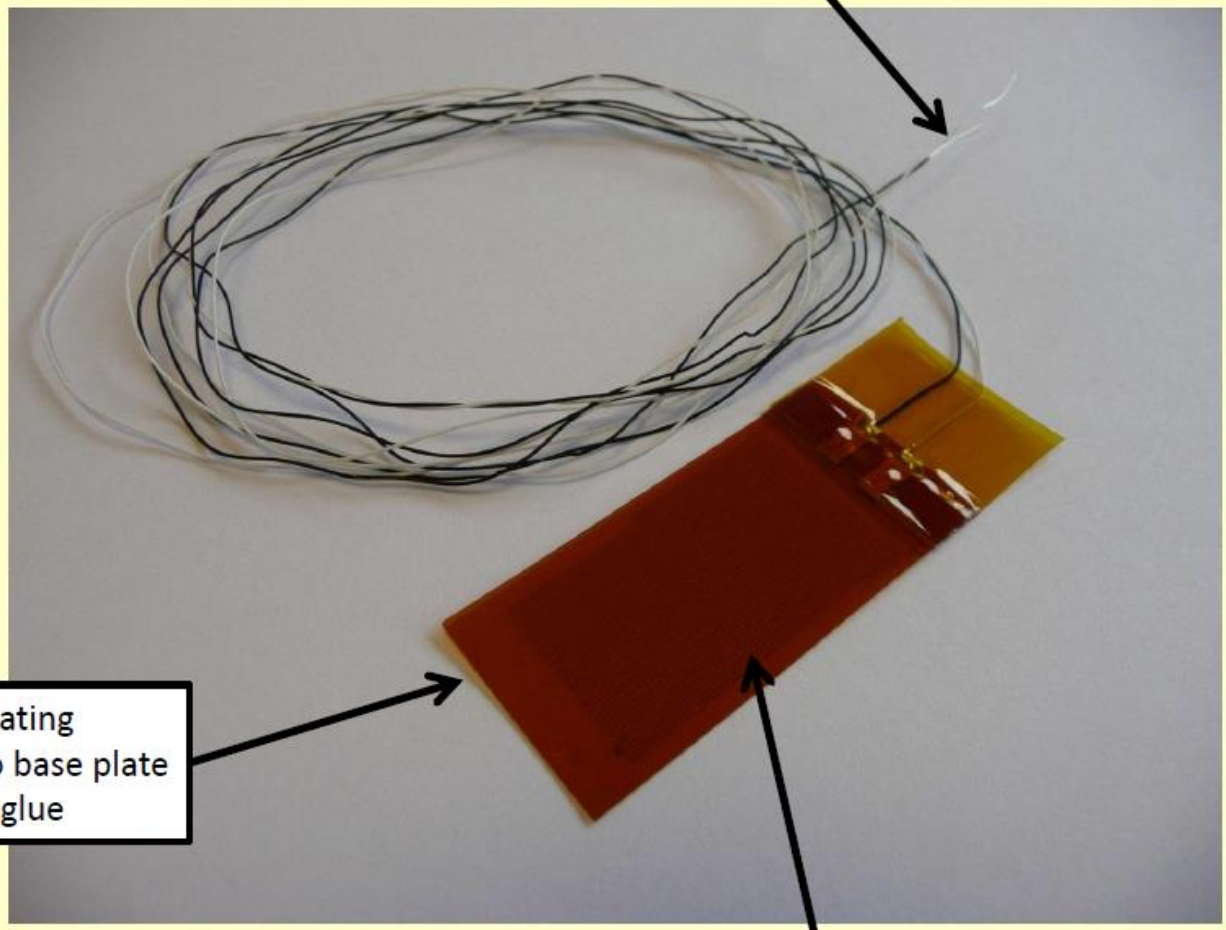
Input : ADC
strain gauges readout
24 bits / +-10V (input x4)

x2

Input : ADC
PT100 / PT1000 readout
24 bits (input x4)

x1

Inner temp probe



2 temp probes (one for each flange)

Near term prospects

- Still some components are scheduled to be received and some testing and adjustments will be done in April → mid May
- Preparations for shipment (paperwork & packaging) in May
- Delivery at KEK mid June
- Installation at KEK scheduled in first two weeks of July
- Commissioning with beam in Autumn 2013

Concluding remarks

- A mechanical support system is being prepared to meet the requirements of the IP-BPM project at ATF2
- Re-establish IP-BSM setup procedure with new IP chamber
- Vibration studies are planned with the LAPP team
- Operation of involved piezo-movers is being prepared at LAL
- Residuals from thermal effects will need to be considered
- Central coordination & support for combined goal 1 + 2 operation

Demonstrate very small & very stable beams at ATF2 !