Mécanique de précision pour les IP-BPM à ATF2

Présentation DEPACC – 12 nov. 2014

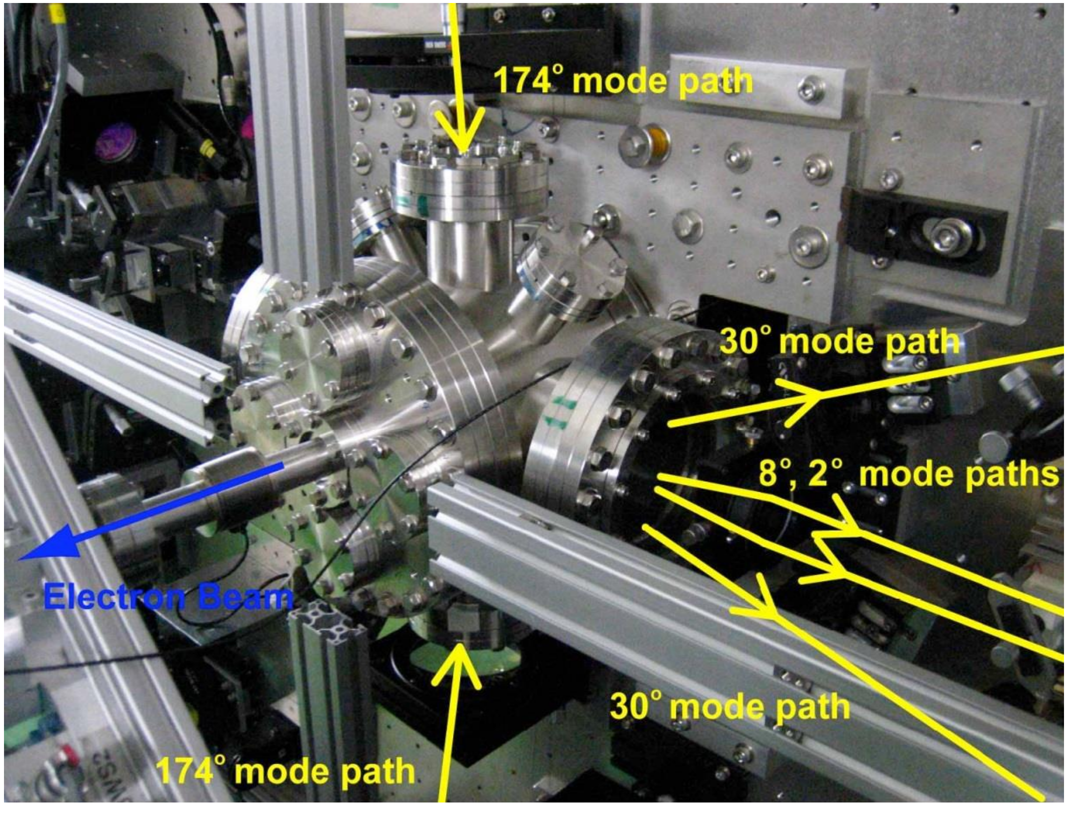
Manuel Alvès, Philip Bambade, Oscar Blanco, Frédéric Bogard, Patrick Cornebise, Jean-Philippe Dugal, Denis Grasset, Bruno Leluan, Bruno Mercier, Jean-Jacques Poher, Sandry Wallon (LAL)

Laurent Journet (LAPP)

Présentateur : Sandry Wallon

Concevoir et installer un système de positionnement de BPMs à l'IP de ATF2

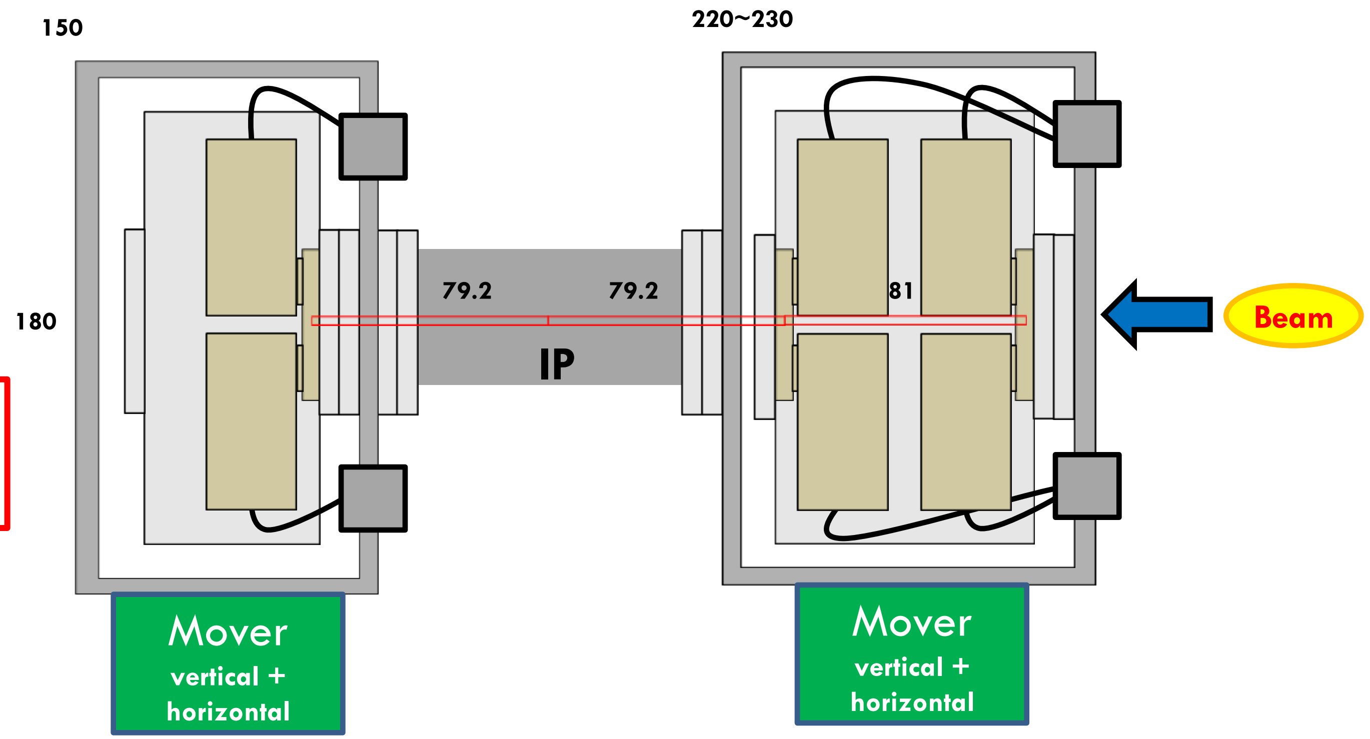
Un premier critère se détache : réduire la masse



IP Chamber design with 2 extra chambers

Setup of 3 new BPM in upstream diagnostic zone

(sketch Si-Won JANG – KNU [Korea])



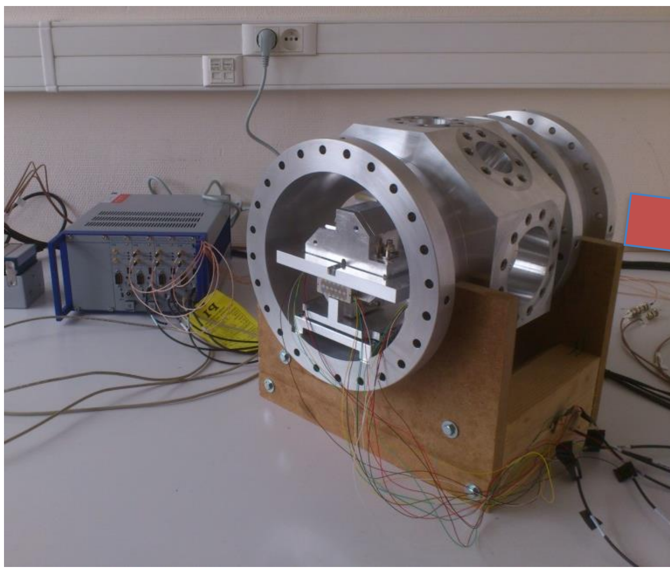
BPMs' expected resolution : 2 nm

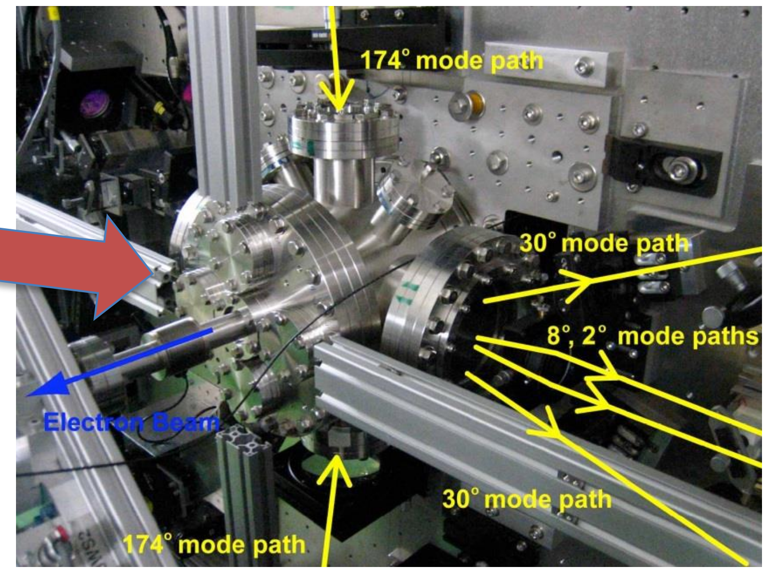
Réduction de la masse

(minimiser les déformations de la table optique)

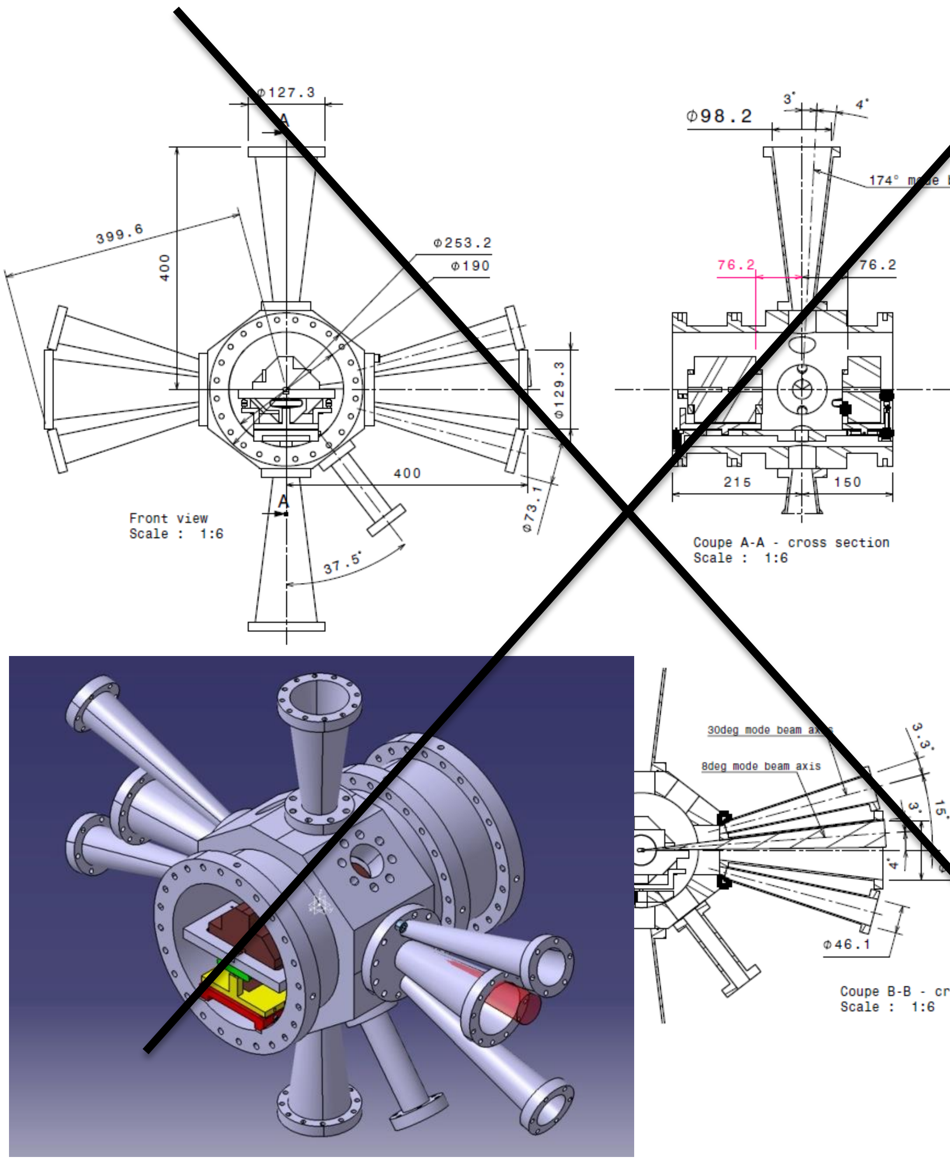
Utilisation de l'aluminium pour le nouveau système :
- 3 BPMs
- Chambre à vide

Ancien système :
- 2 BPMs en cuivre
- Chambre à vide en inox





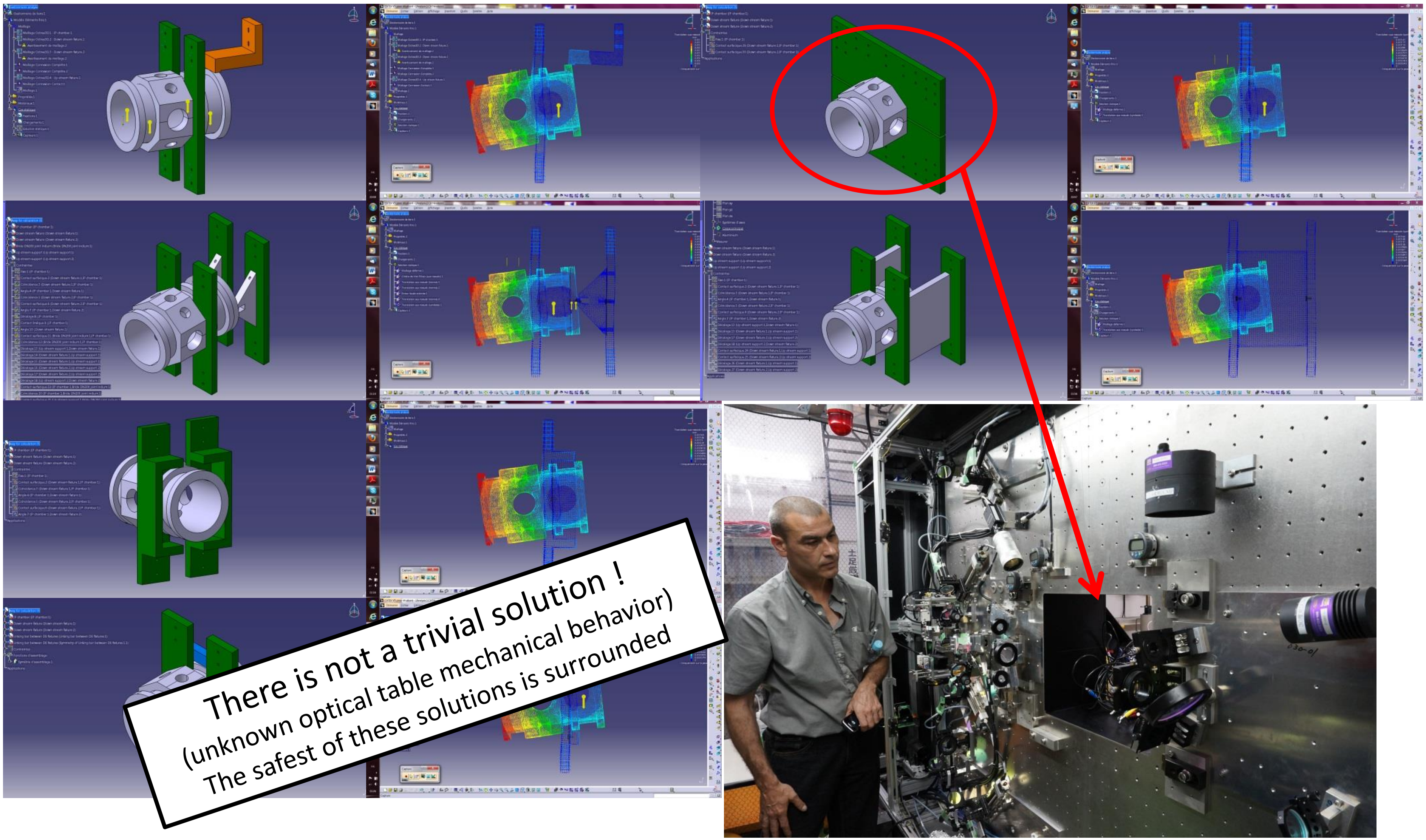
Viewports
(interface, limite de responsabilité)



Viewports to be adapted to new IP chamber → KEK

→ Interfaces clearly defined

Fixation chambre / table optique verticale : étude des déformations



There is not a trivial solution !
(unknown optical table mechanical behavior)
The safest of these solutions is surrounded

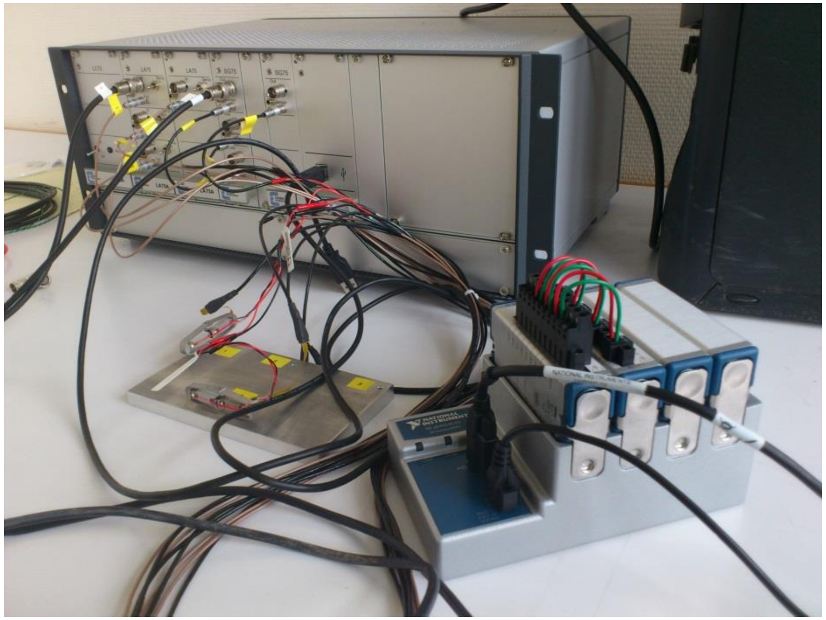
Glissement des specs

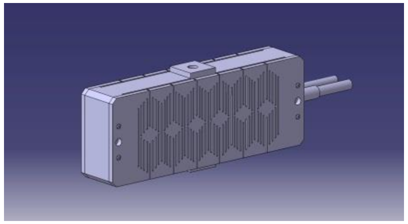
Positionnement micrométrique
→ Positionnement nanométrique
+ scanning

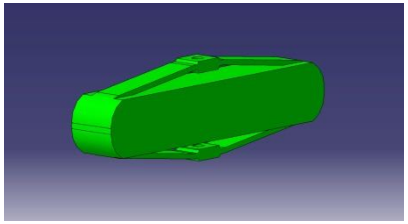
→ Nouvelle fonction (étude du faisceau par scanning des BPMs)

→ Changement d'échelle
→ Changement des solutions positionnement/guidage
(éléments de guidage standards → trépied ; glissière élastique)
→ Dilemme course (230 / 300 μm) vs résolution (2 / 3 nm)

Test actionneurs piezo : course, résolution, tenue au vide, cablage





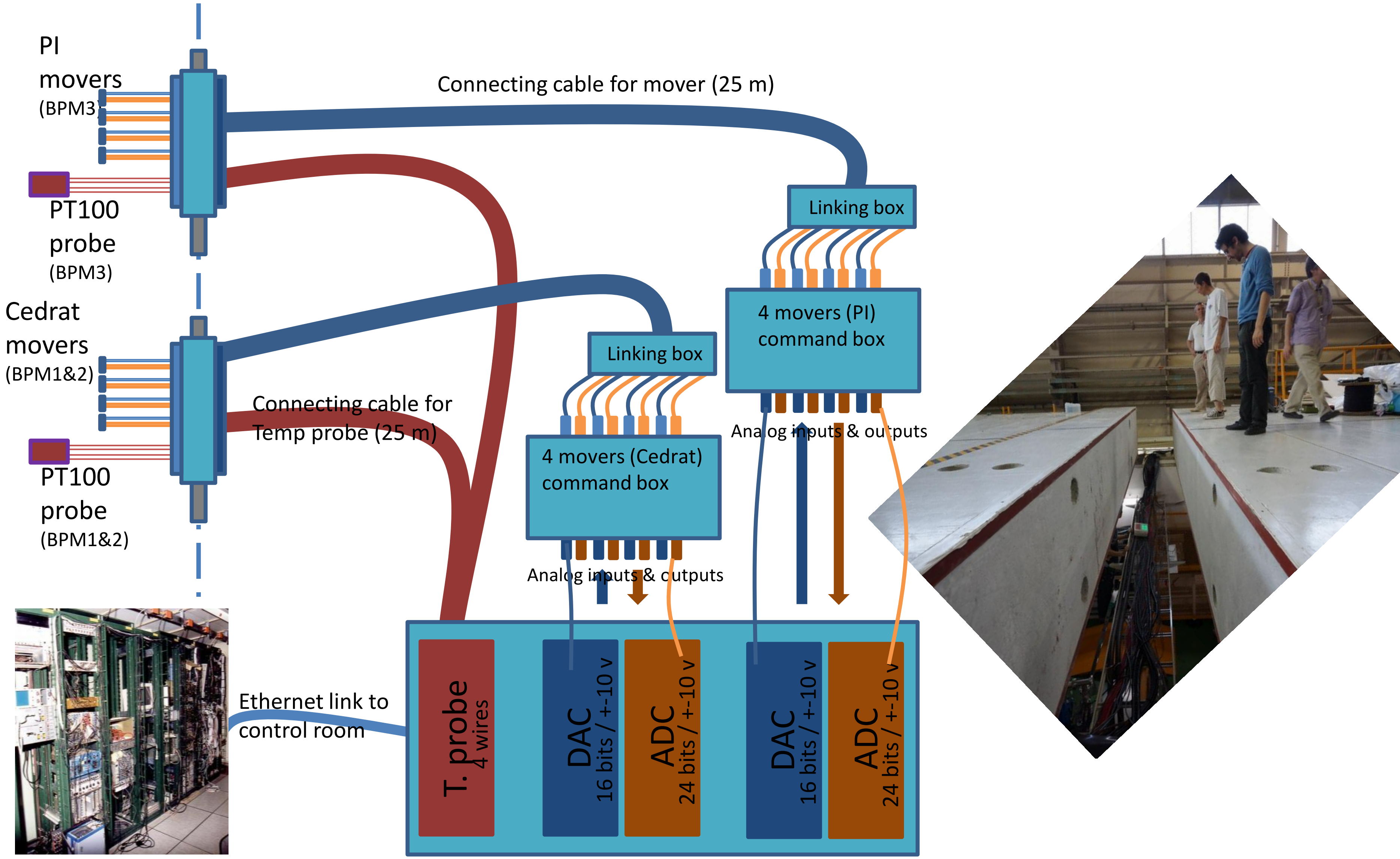


Test de dégazage des actionneurs :

- PI : OK

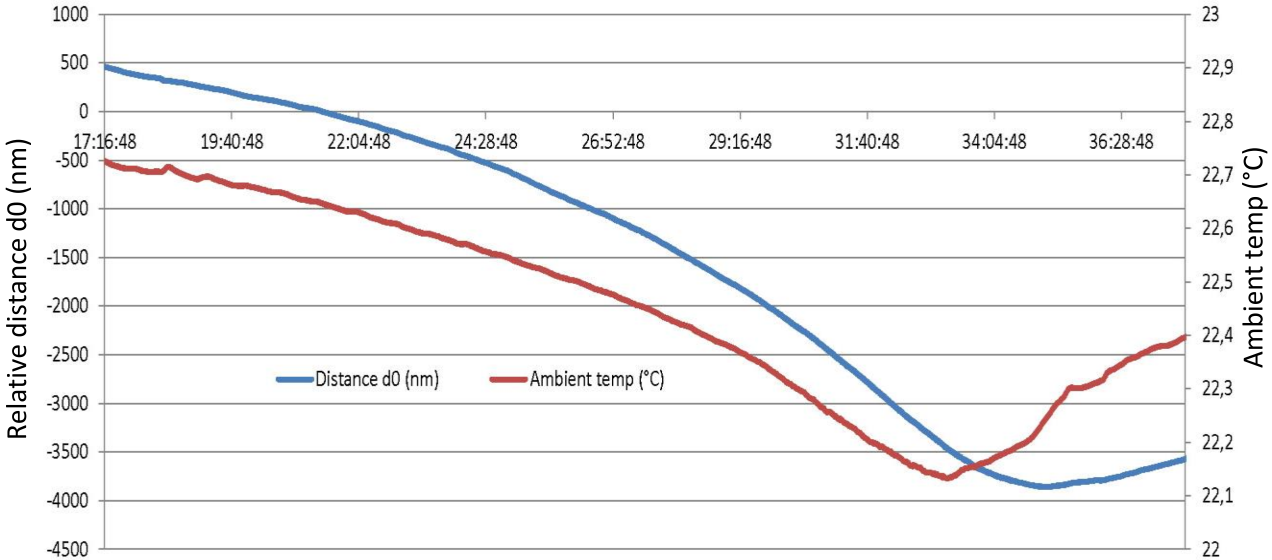
- Cedrat : ~ 14 m2 enceinte inox / actionneur !
→ Résolution problème : changement fils et soudure

Complete wiring chain



Qualification des actionneurs :
achat d’un interféromètre par le LAL

During approximatyvely 20 hours, the distance between the mirror and the interferometer head is recorded.
The ambient temperature is recorded too.

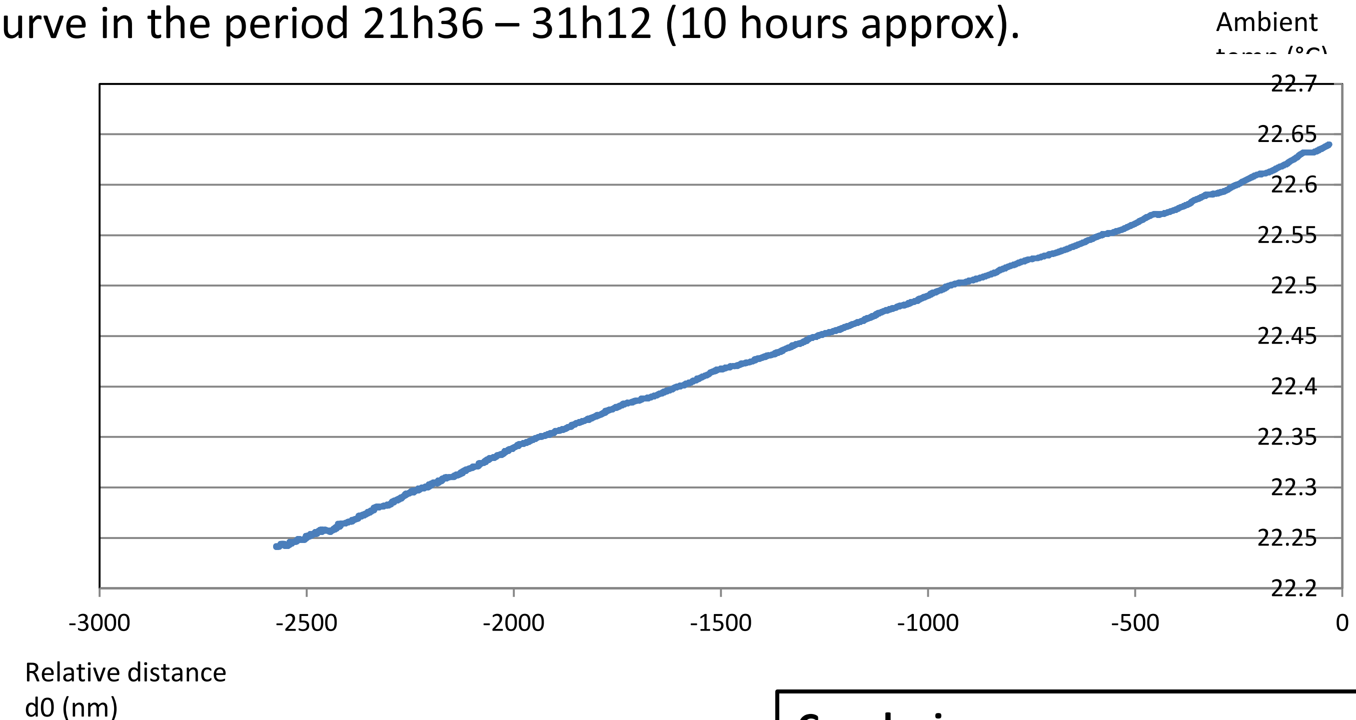


The 2 curves are similar. This shows the result of dilatation.

Mainly due to the aluminium support.

Interferometer : effect of temperature

To approximate the dilatation effect, focus of the previous curve in the period 21h36 – 31h12 (10 hours approx).



With length of the aluminium support : 280 mm
→ Measured dilatation coefficient = (-2574+31)E-9/280E-3/(22,24-22,64) = 22E-6 /°K

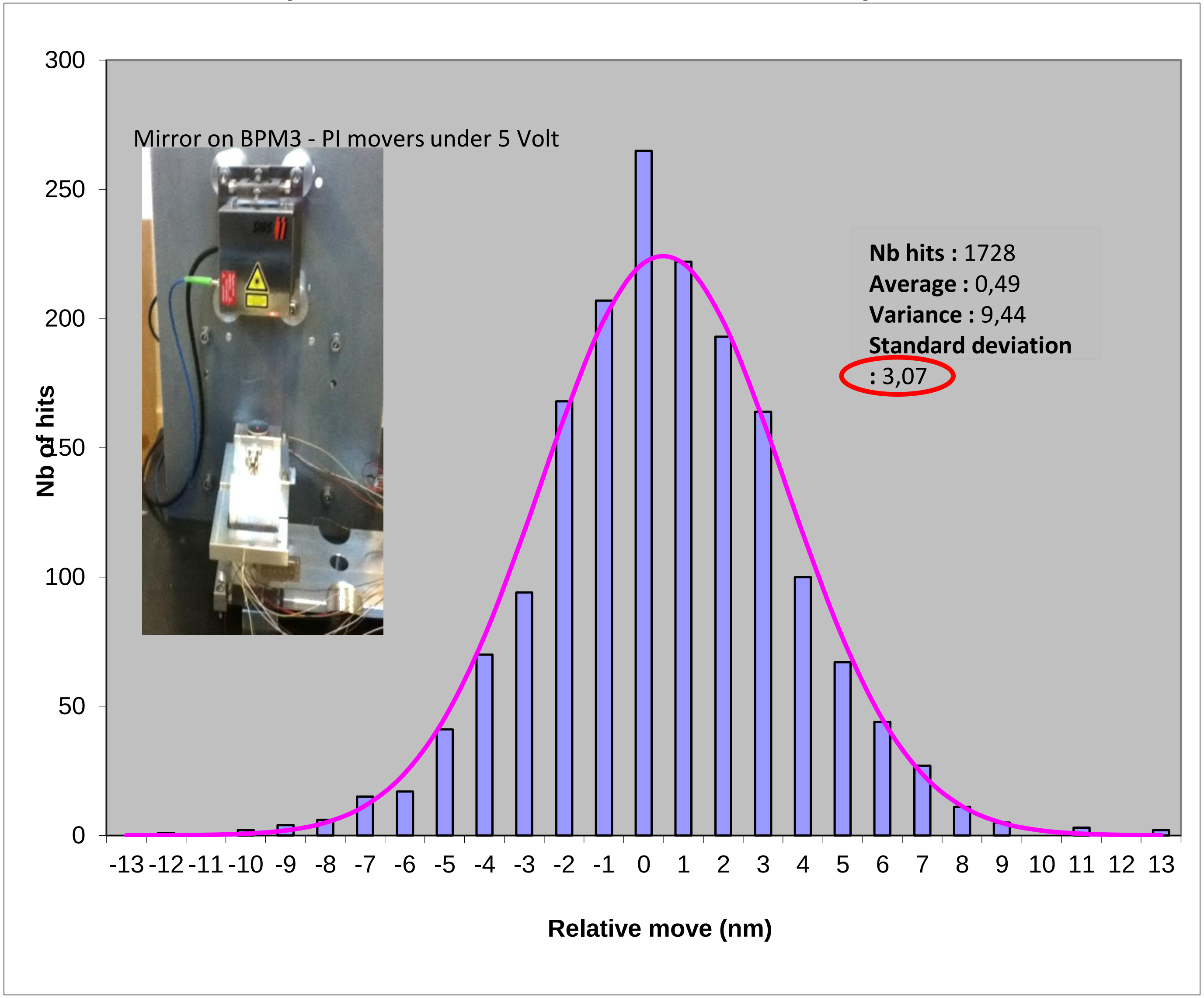
Nb : The theoretical dilatation coefficient for aluminium is 24E-6 /°K

Conclusion :

- Interferometer head made of invar (no thermal expansion)
- Temp. probe for software temp. compensation
- But remaining thermal expansion of aluminum vertical bench

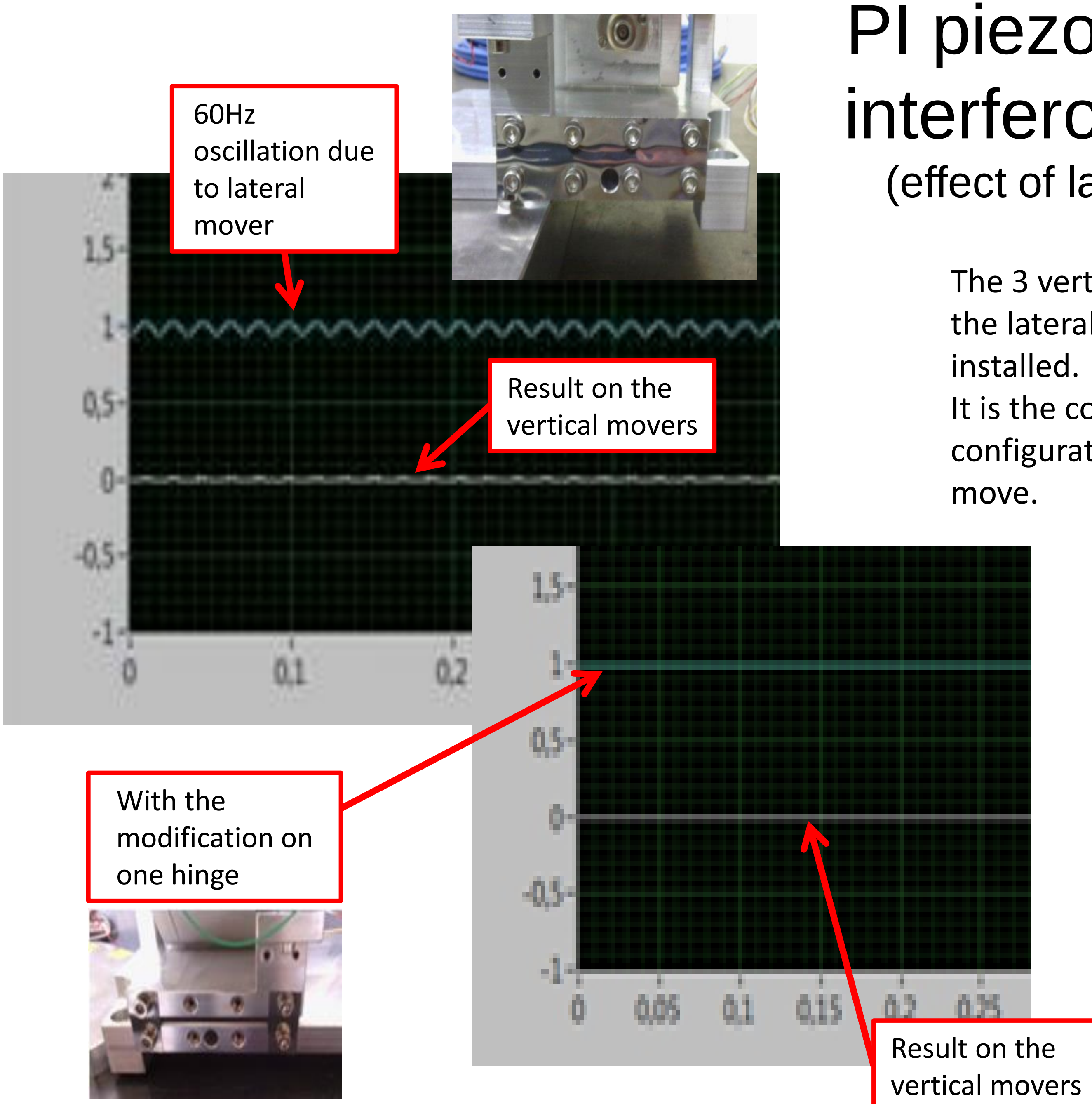
PI piezo actuator : interferometer test

(lateral actuator un-mounted)



PI piezo actuator : interferometer test

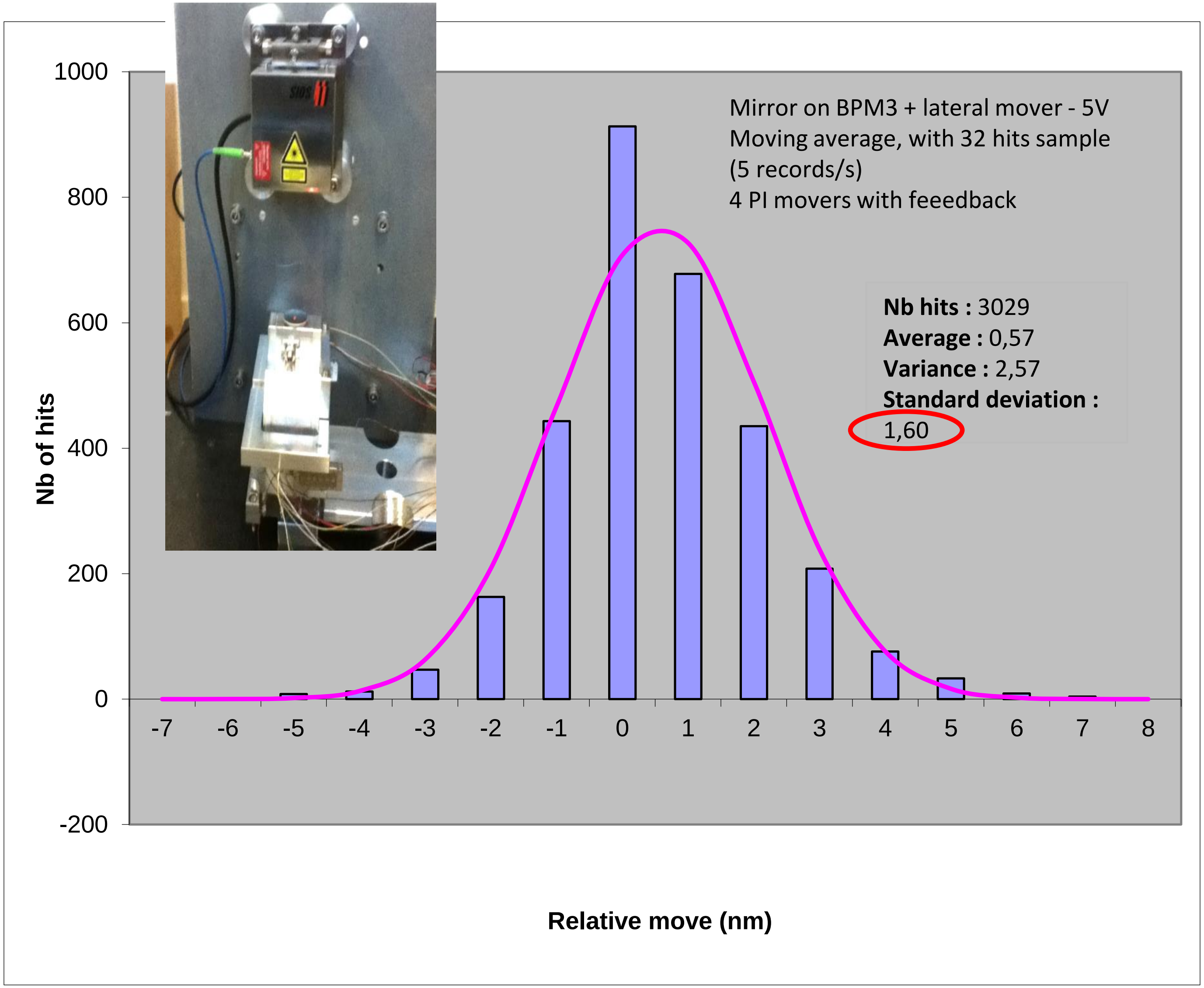
(effect of lateral actuator)



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

PI piezo actuator : interferometer test

(lateral actuator mounted, elastic hinges and PIs' PID parameters tuned)

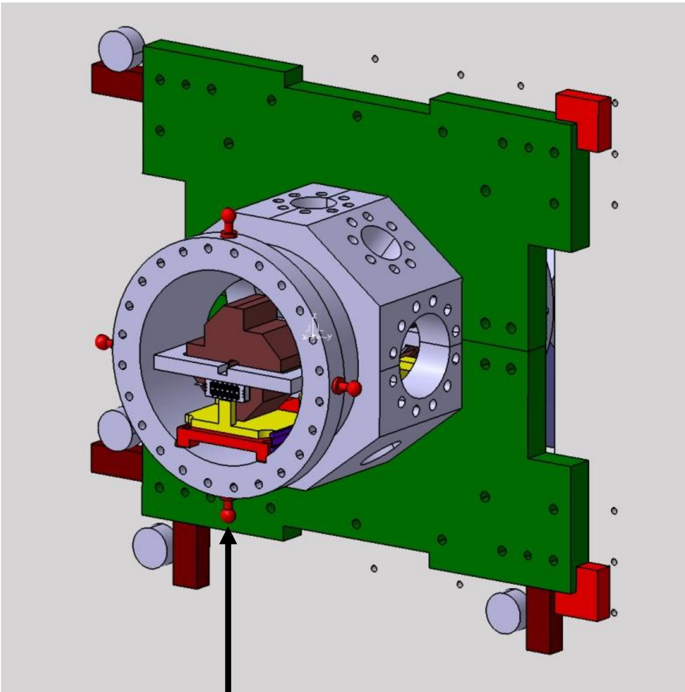


Final 3D model & workshop alignment 1

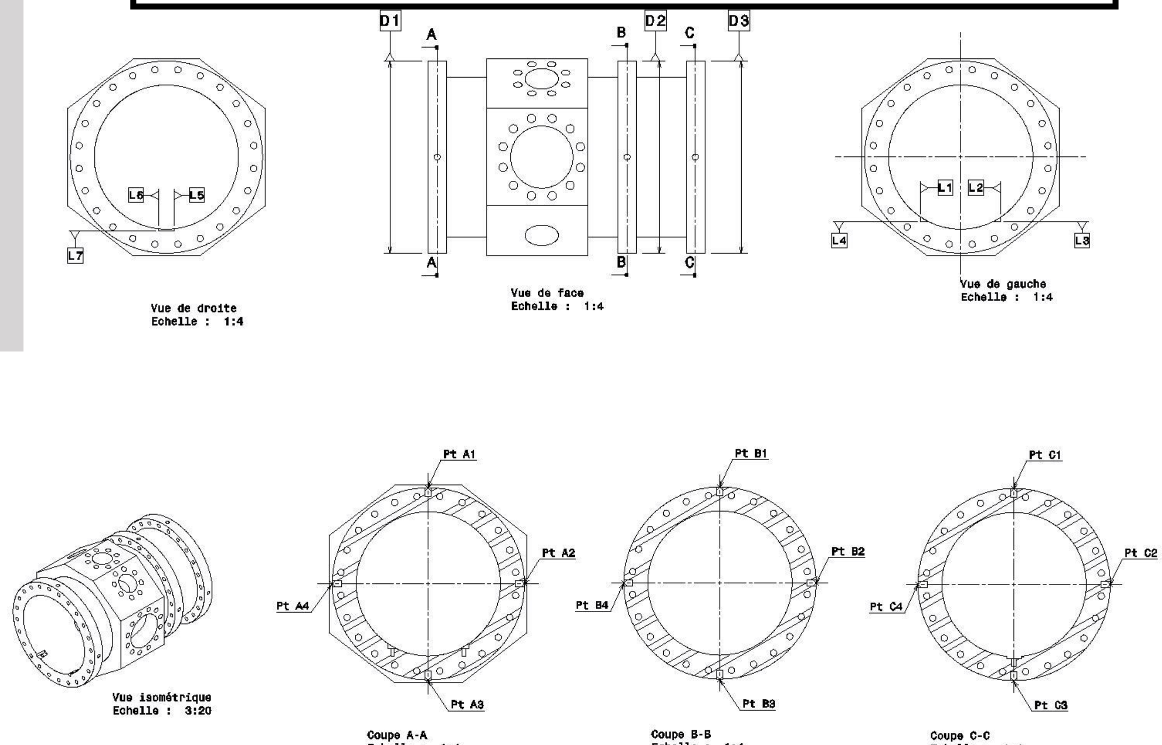
Position of internal references were measured with regard of external references (for mires)

→ Data useful for BPMs external pre-alignment

→ Checks performed with 3D Mitutoyo machine (5 μm accuracy, 1 μm resolution



Mires on chamber



Final 3D model & workshop alignment 2

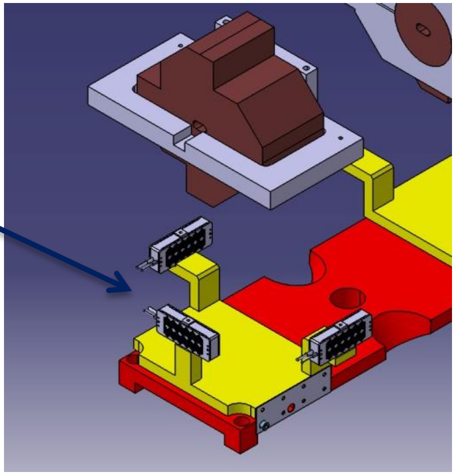
Checked BPMs axis with regards of interfaces « Chamber / BPMs displacement system »

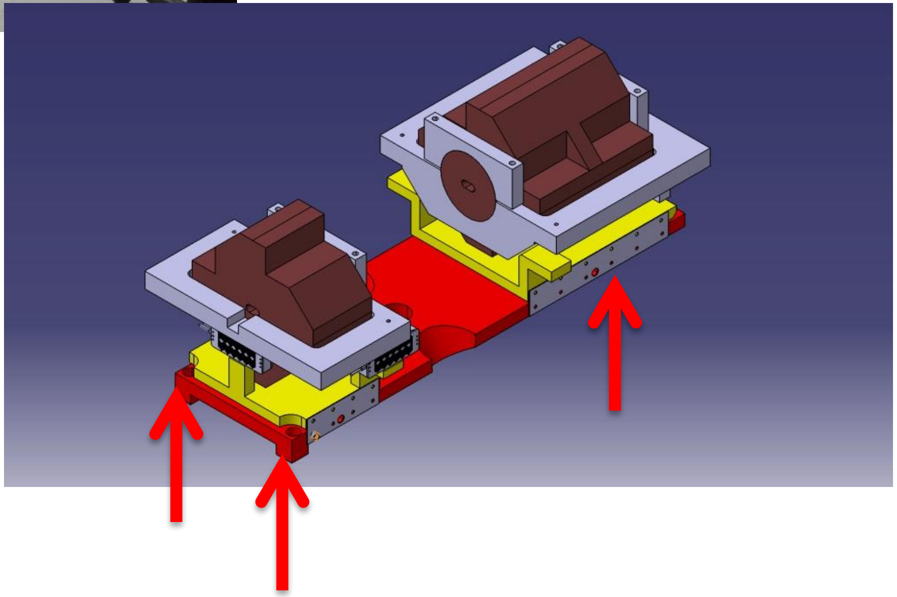
→ Shims placed between actuators and cradles correct BPMs vertical position, roll and pitch angles

→ **To be done with actuators running at mid stroke**

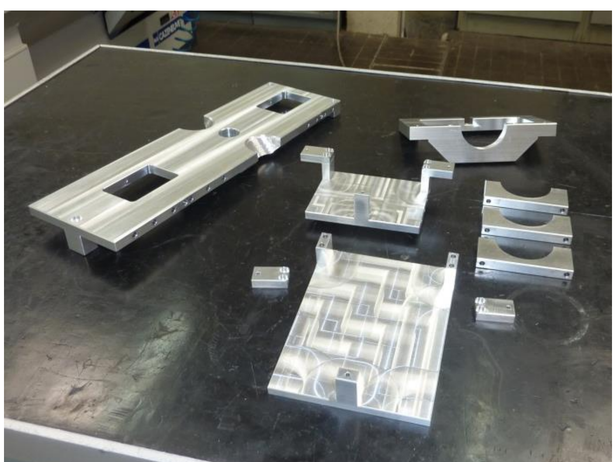
→ Checks performed with 3D Mitutoyo machine (5 μm accuracy, 1 μm resolution

3 actuators acting as a tripod for vert. displacement
(same for double BPM)

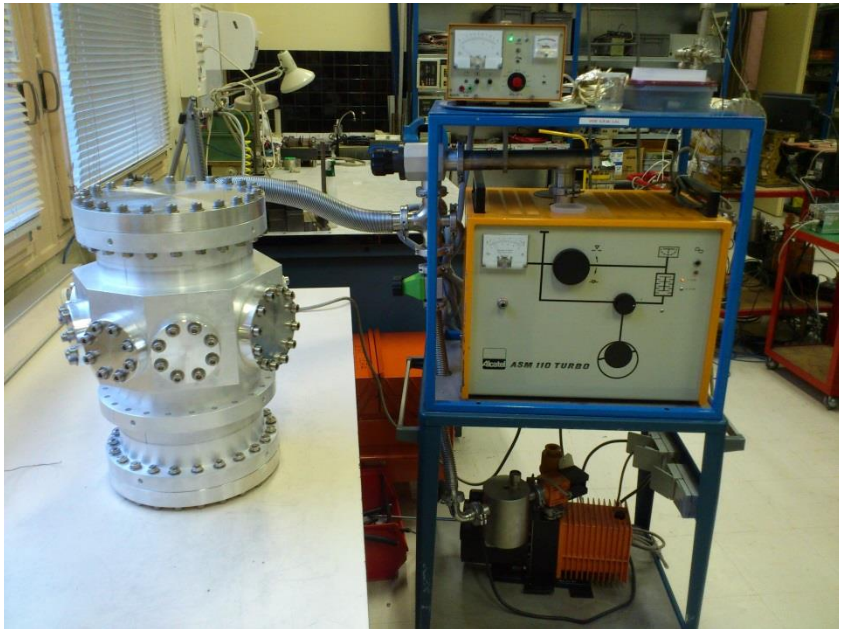




Fabrication (LAPP), contrôles, nettoyage pour vide (UHV)



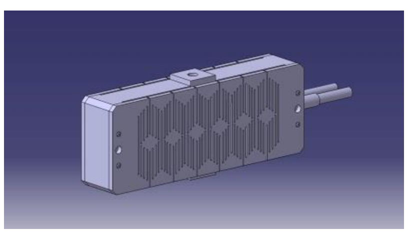
Test vide : fuite et degazage

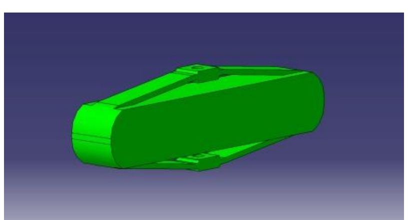


Chamber's He leak test OK :

→ 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



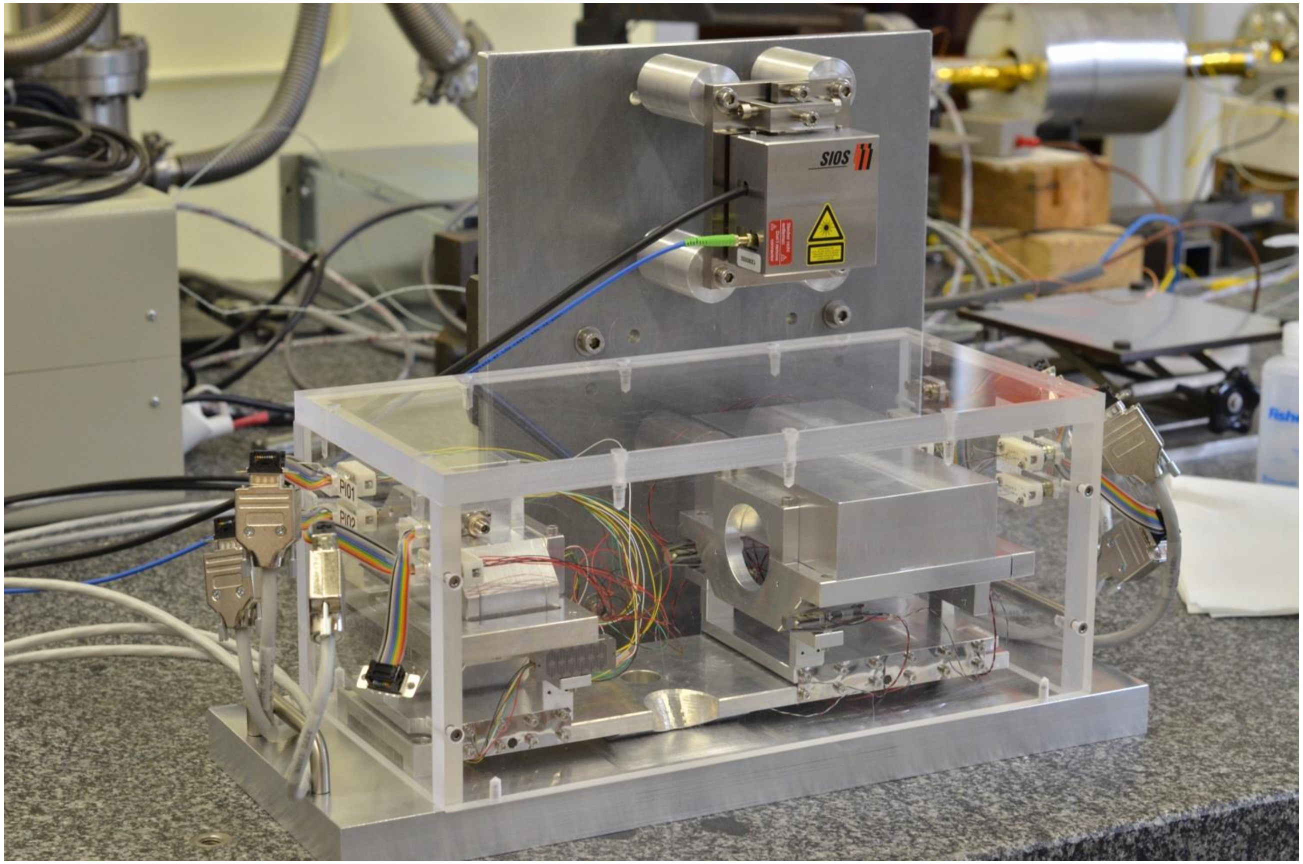


Actuators' outgasing OK :

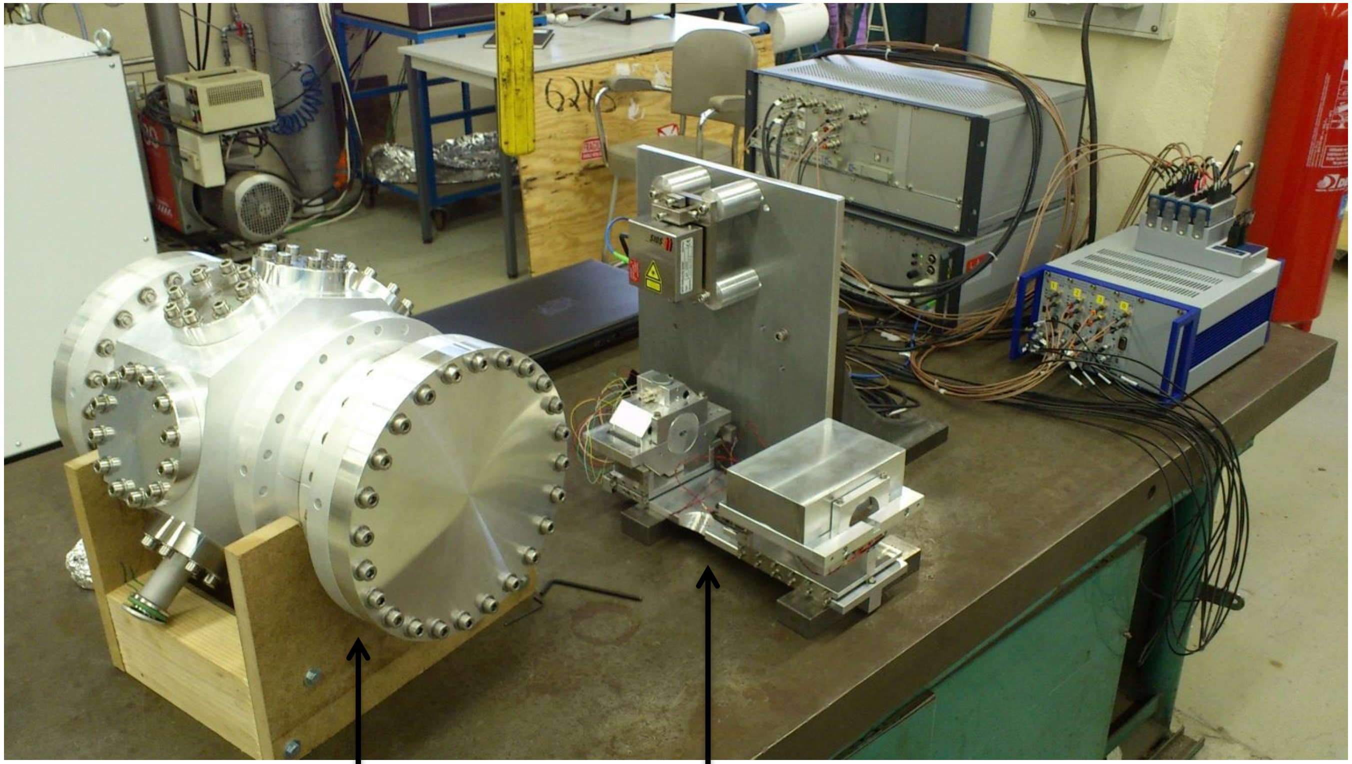
→ Flowrate at 8×10^{-8} mbar.l/s
(suitable for UHV)

(Done at 21 deg. C. and after 100h pumping ; No organic compound detected)

Test final du système de déplacement des BPMs



Shipment, net weight



Chamber (with blank aluminum flanges)

BPMs displacement system

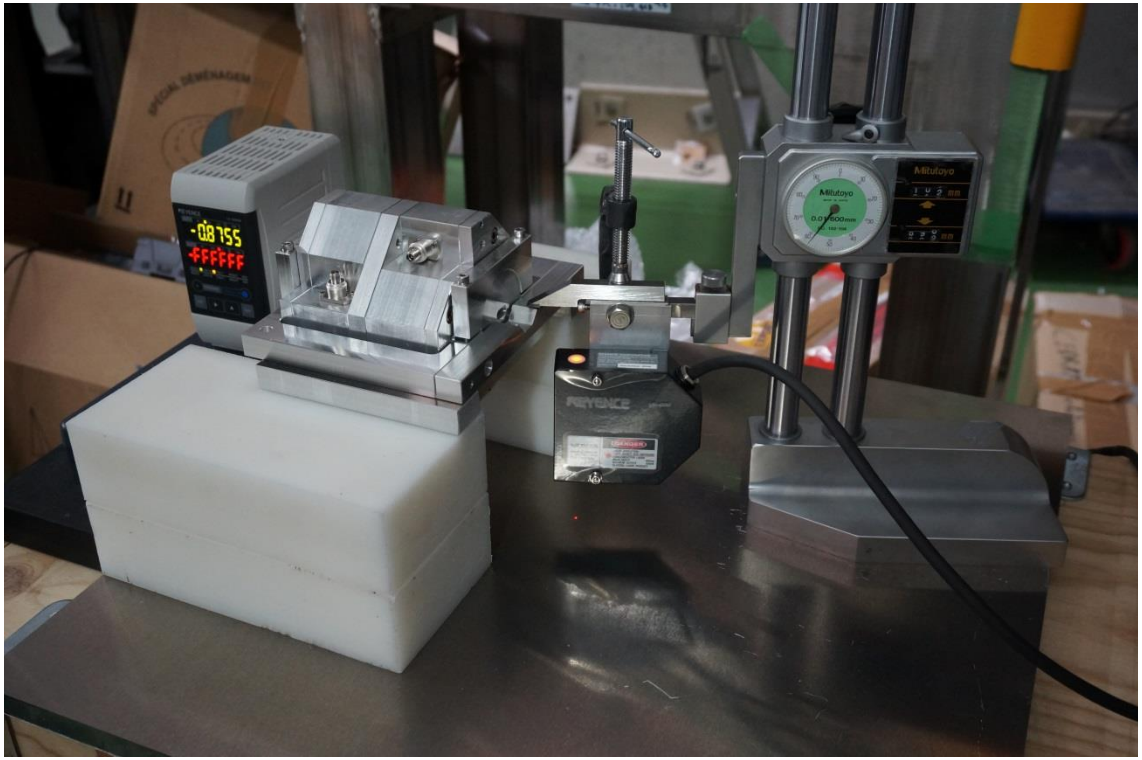
Permanent exportation to KEK (tax to pay)

Chamber's net weight : 27 kg (body : 15 ; Al DN 200 flanges : 2,5x2 ; other Al flanges : 3 ; screws&nuts : 3,2)

BPMs' disp. syst.'s net weight : 4,3 kg

Installation à l’IP

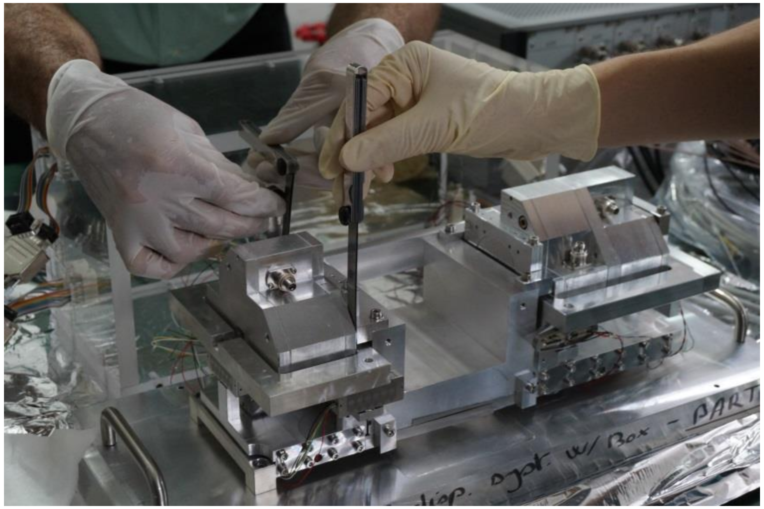
Tests, checks, tunings at KEK



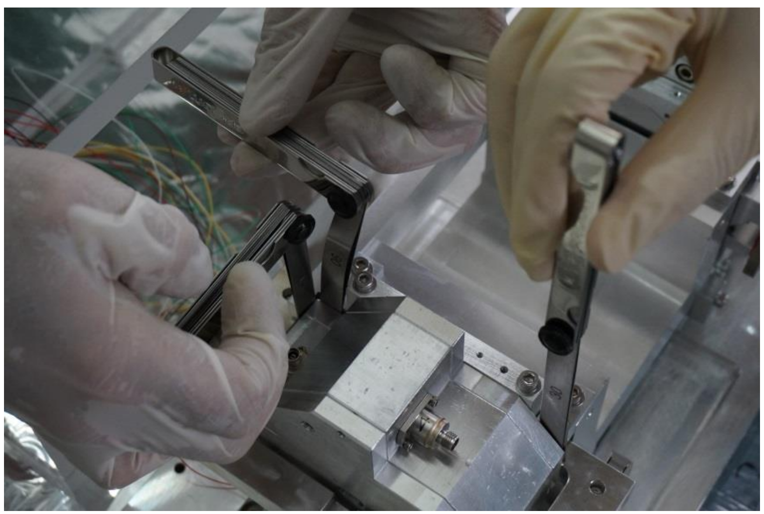
Checking BPM1&2 axis with respect of its cradle references
(can not be done at LAL Orsay due to BPM1&2 activation)

22

Tests, checks, tunings at KEK



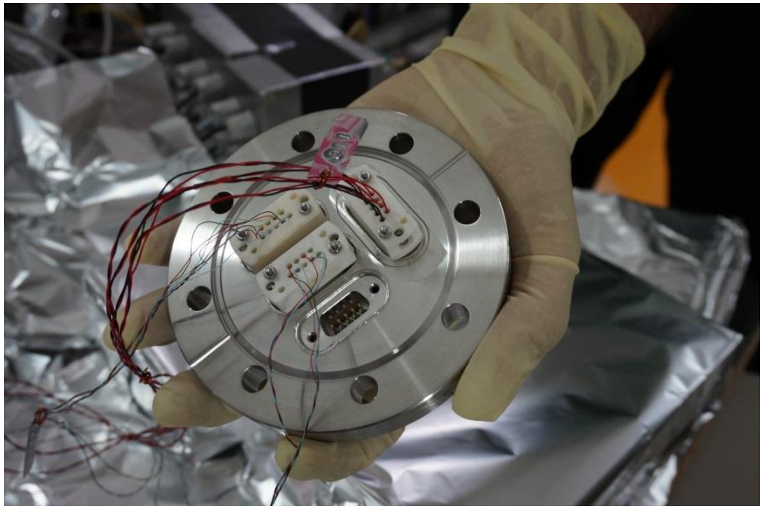
Mounting BPMs
Adjustments w/ positioning tool
(distance to IP plane, lateral alignment, yaw)



23

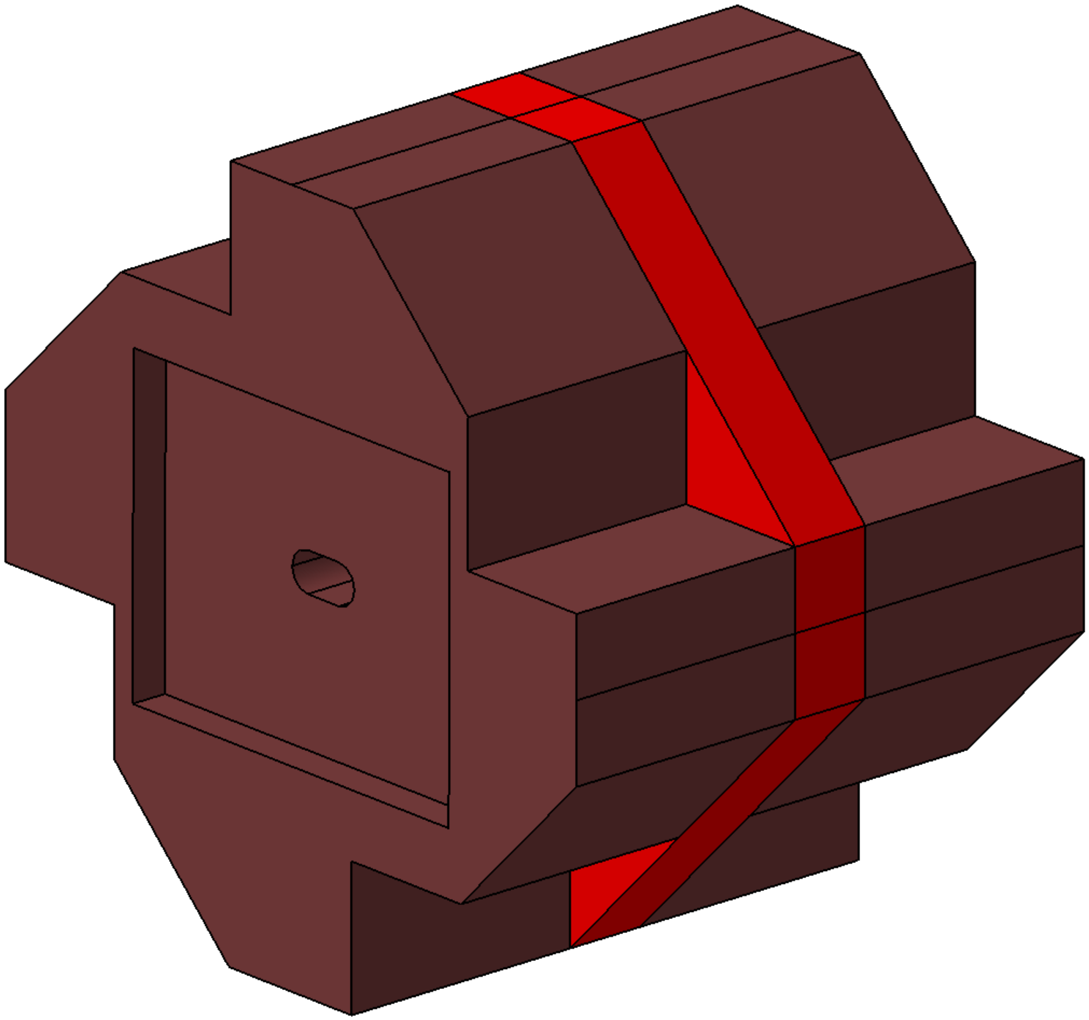
Tests, checks, tunings at KEK

Checking connection w/ feedthrough flanges (→ thin wires issue to correct)



24

…many shifts later… : Doublet BPM's misalignment issue



Doublet BPM shown without side cover plate (not allowed configuration with current design)

Cavity A / Cavity B « electrical » misalignment :

- **34 μm shift**
- **2 mrad tilt**

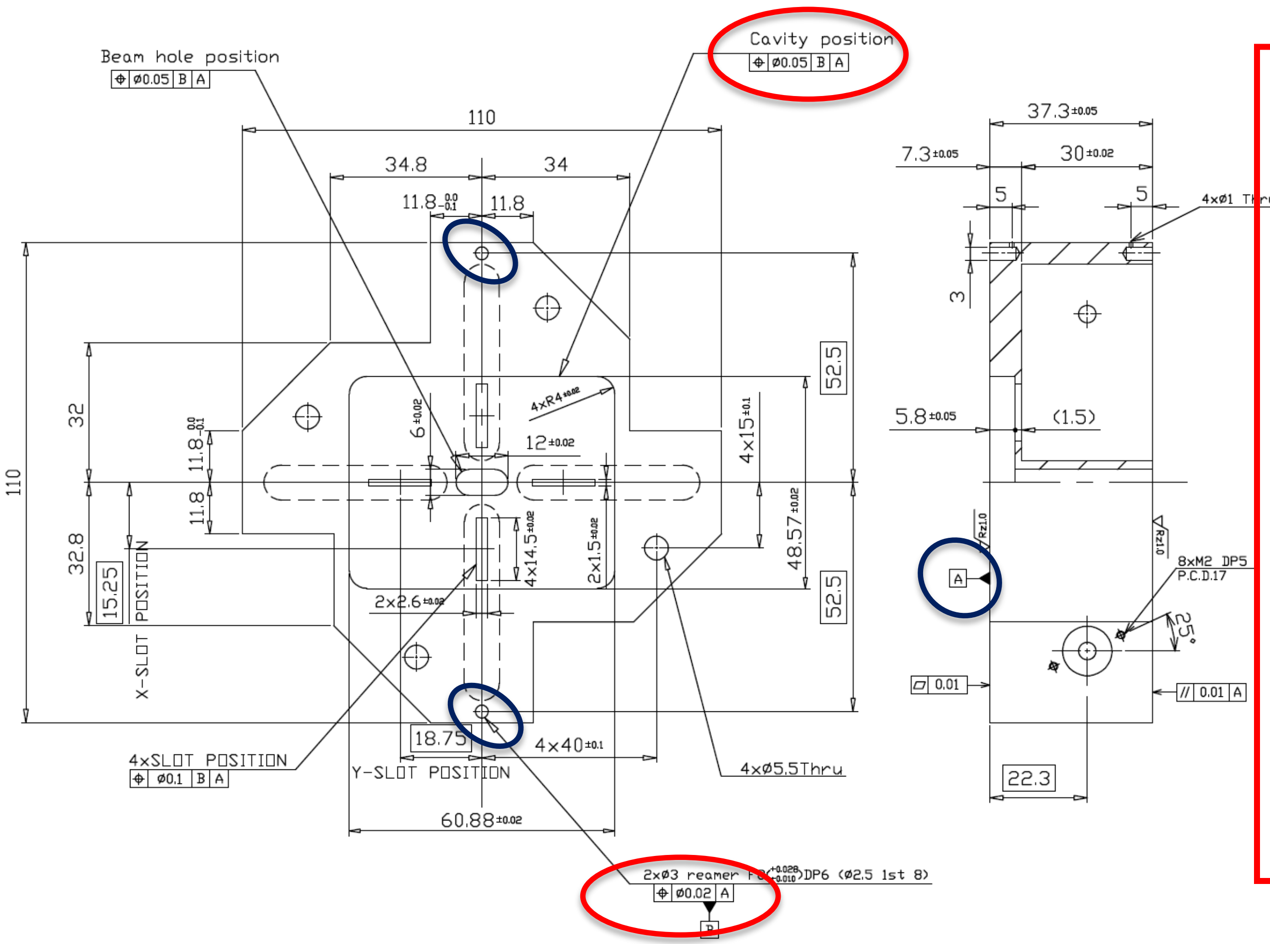
Statically, it's impossible to guarantee to reach (in one shot) a mechanical shift below 10 μm due to stacking tolerances

Idea :

- Clamp right cavity to bench/marble
- Fix red plate to right cavity
- Place left cavity on XZ micrometric stage
- Check tilt&shift with 3D machine
- Adjust position with micrometric stage
- Adjust tilt with surface grinder (tolerance below 0.1 μm)
- Tighten screw when alignment is reached
- Re-check
- Add side cover plates

« Cons » : redesign required

Doublet BPM : Specs understanding



Dimensional specs : +/-20 μm
Positionning specs : +/- 25 μm

With a second cavity plus centering pins/holes located at +/- 1 μm (x3) for the doublet BPM, misalignment of BPM A / BPM B could reach more than 50 μm

Same considerations with paralelism specs would lead to a max tilt angle around 0.4 mrad

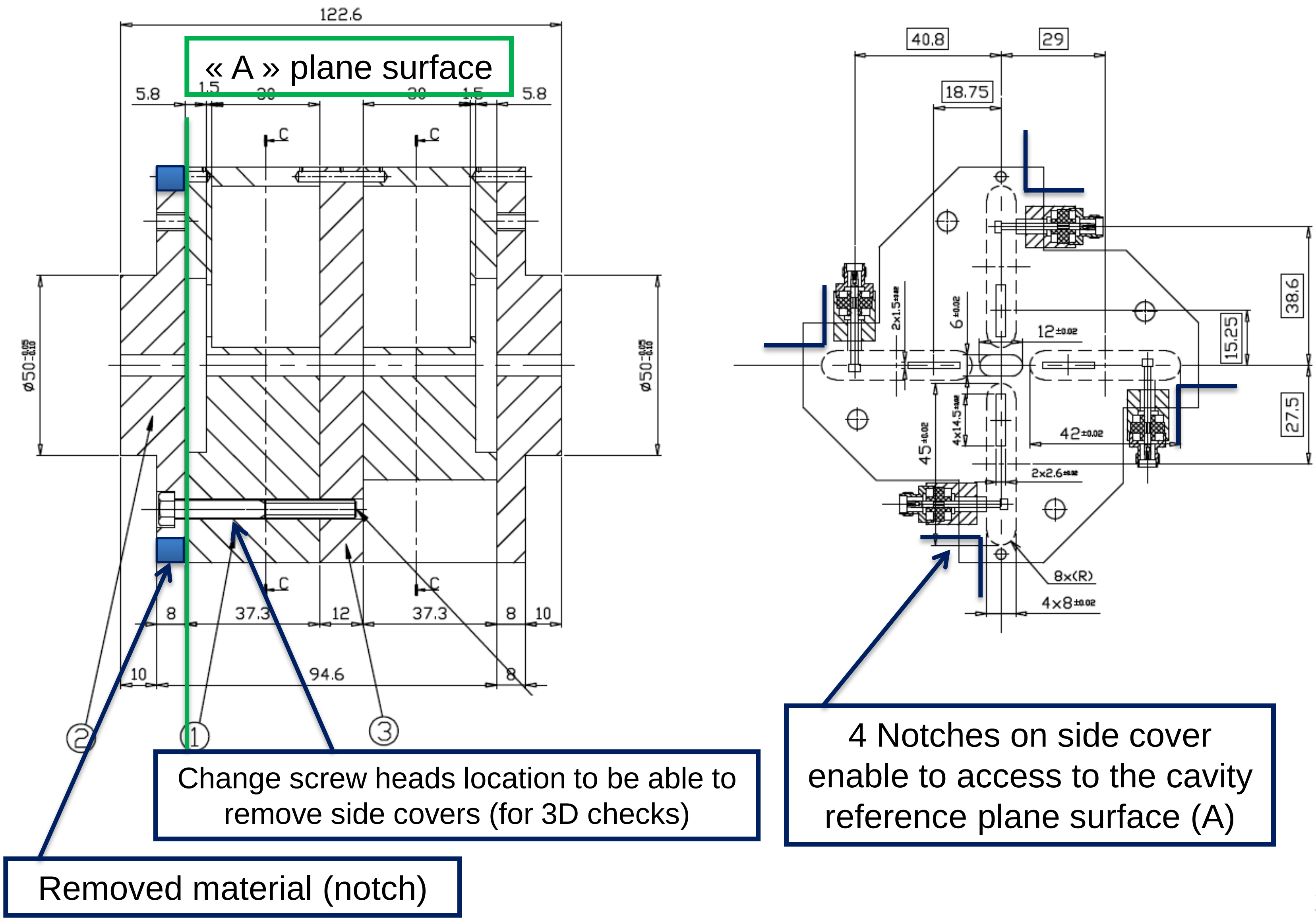
Type of aluminum alloy used? Low thermal expansion, high machinability and stability?

Mechanical references for cavity specifications
Positionning specs

All following drawings : Si-Won JANG, KNU, 09/2011

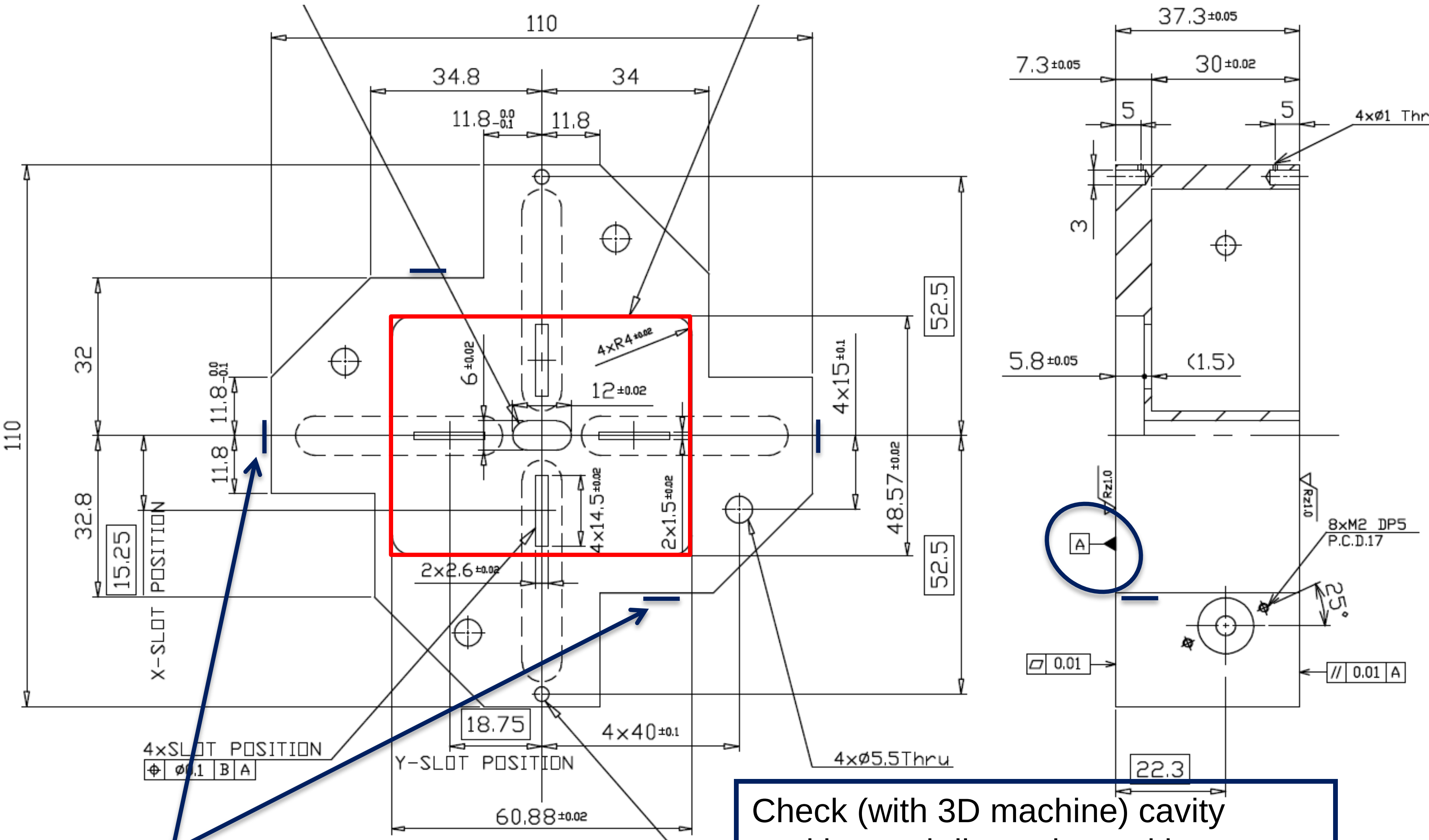
BPMs – possible improvements (design)

→ Proposition to KNU University - Korea



BPMs – possible improvements (3D checking)

→ Proposition to KNU University - Korea



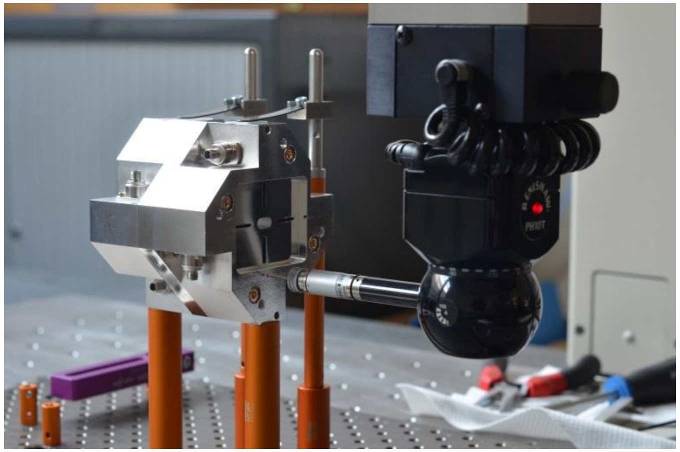
4 flat spots

Check (with 3D machine) cavity position and dimensions with respect of « A plane » & « 4 flat spots »
(B reference is kept for mounting issue)

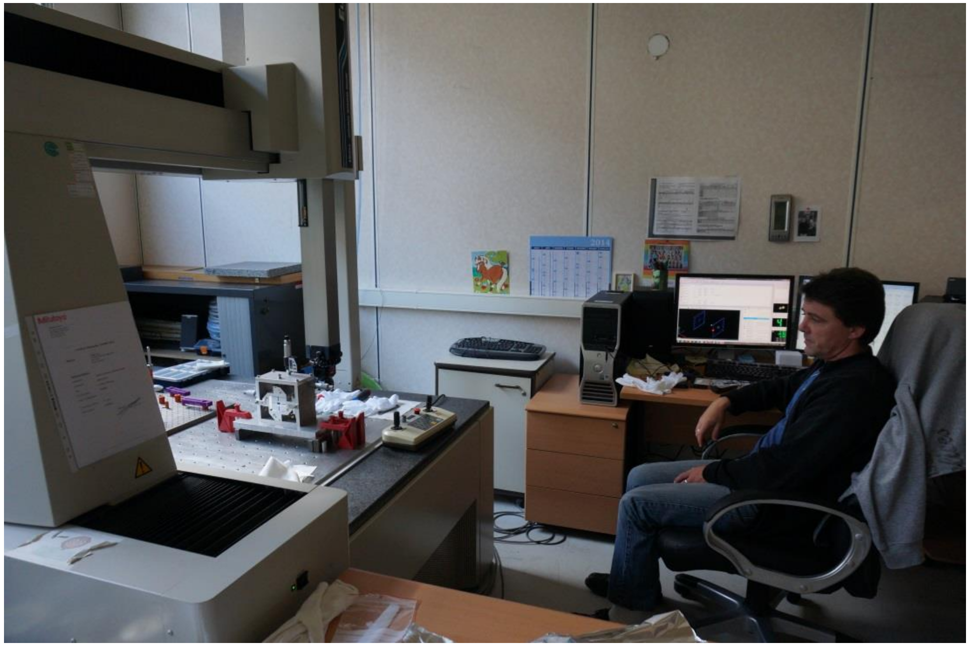
Improved BPMs (KNU re-manufacture)
3D checking and adjustment with LAL's adjustment bench

1. Check tilt & shift of cavityA / cavity B
→ 113 (V) 56 (H) μm (too large)

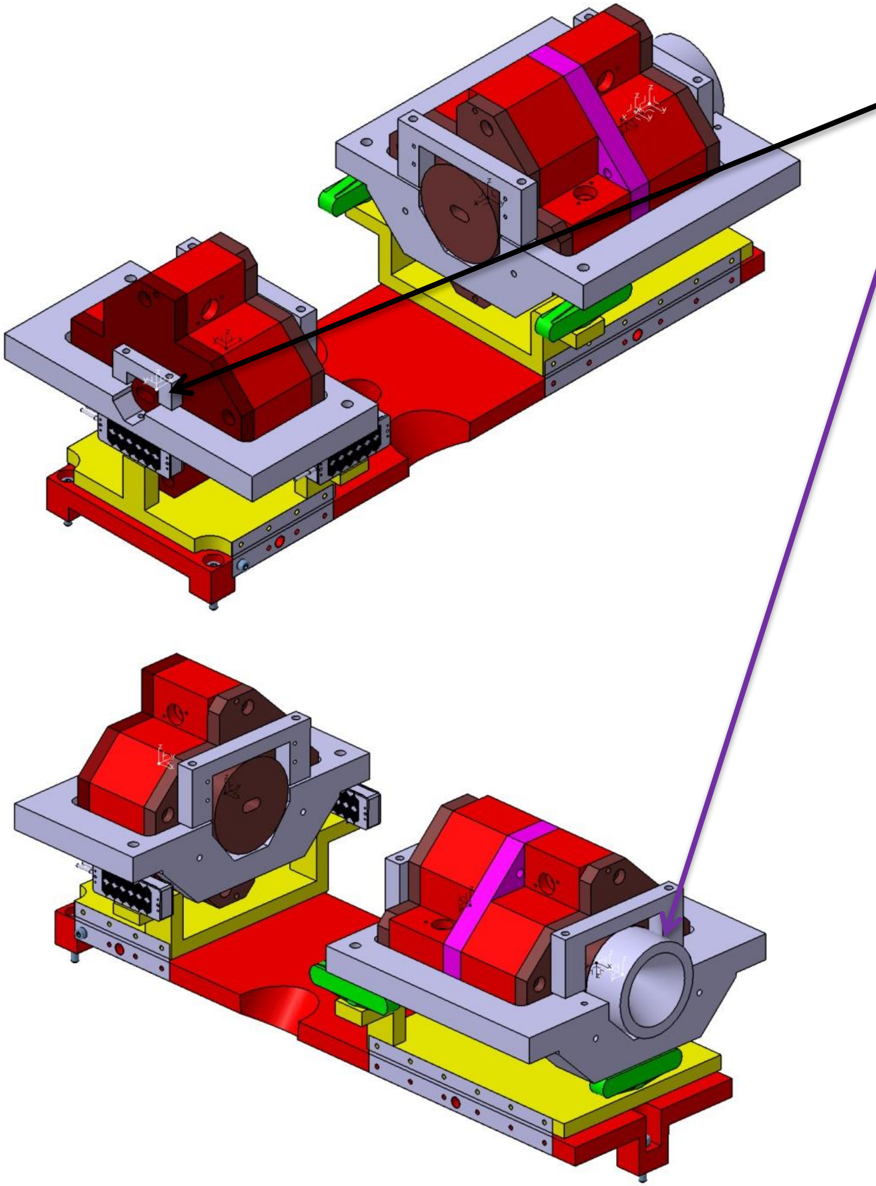
2. Adjust shift of cavityA / cavity B with dedicated bench
→ 0 (V) 0 (H) μm (or 5 / -5 by using other machine axis system) (OK)


3D checking of doublet BPM


Adjustment bench for doublet BPM


Adjustment bench used with LAL's coordinate measuring machine

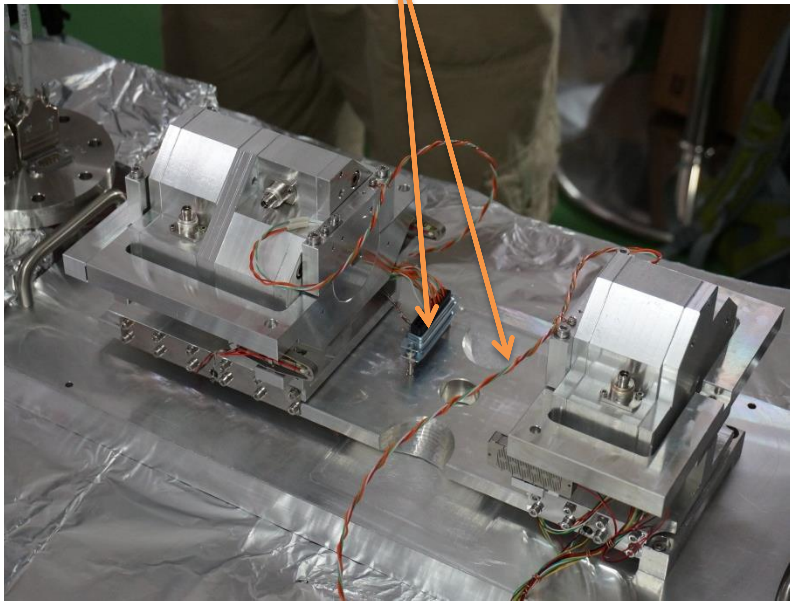
Redesign and manufacture of surrounding parts following BPMs re-manufacture



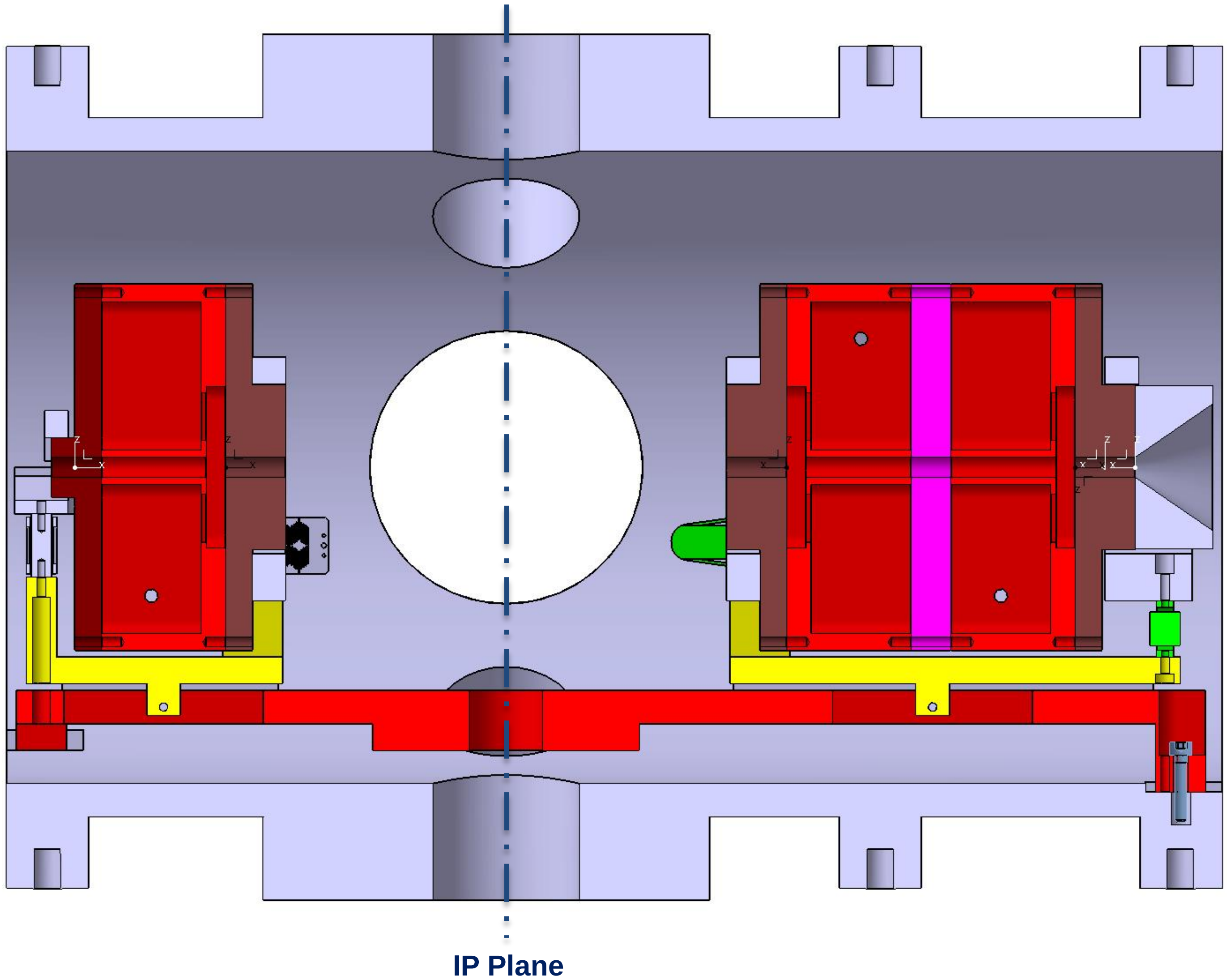
Single BPM with new attachment (no cantilever) → new cradle

Doublet BPM with upstream transition part (to reduce wake field) → new cradle, actuator displaced, new lower part

Cabling improvement

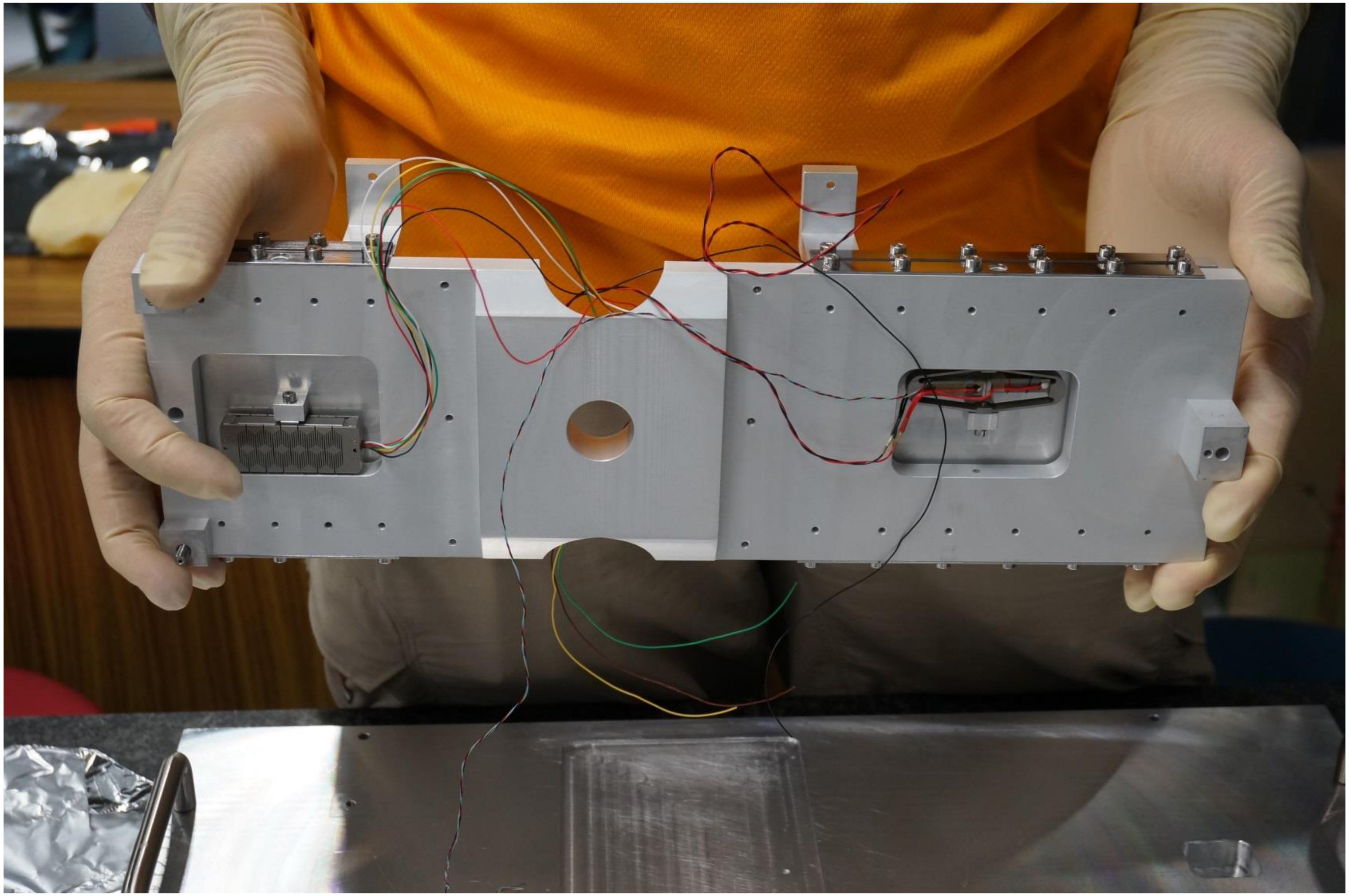


Side view (cross section) of “chamber + BPMs displacement system”

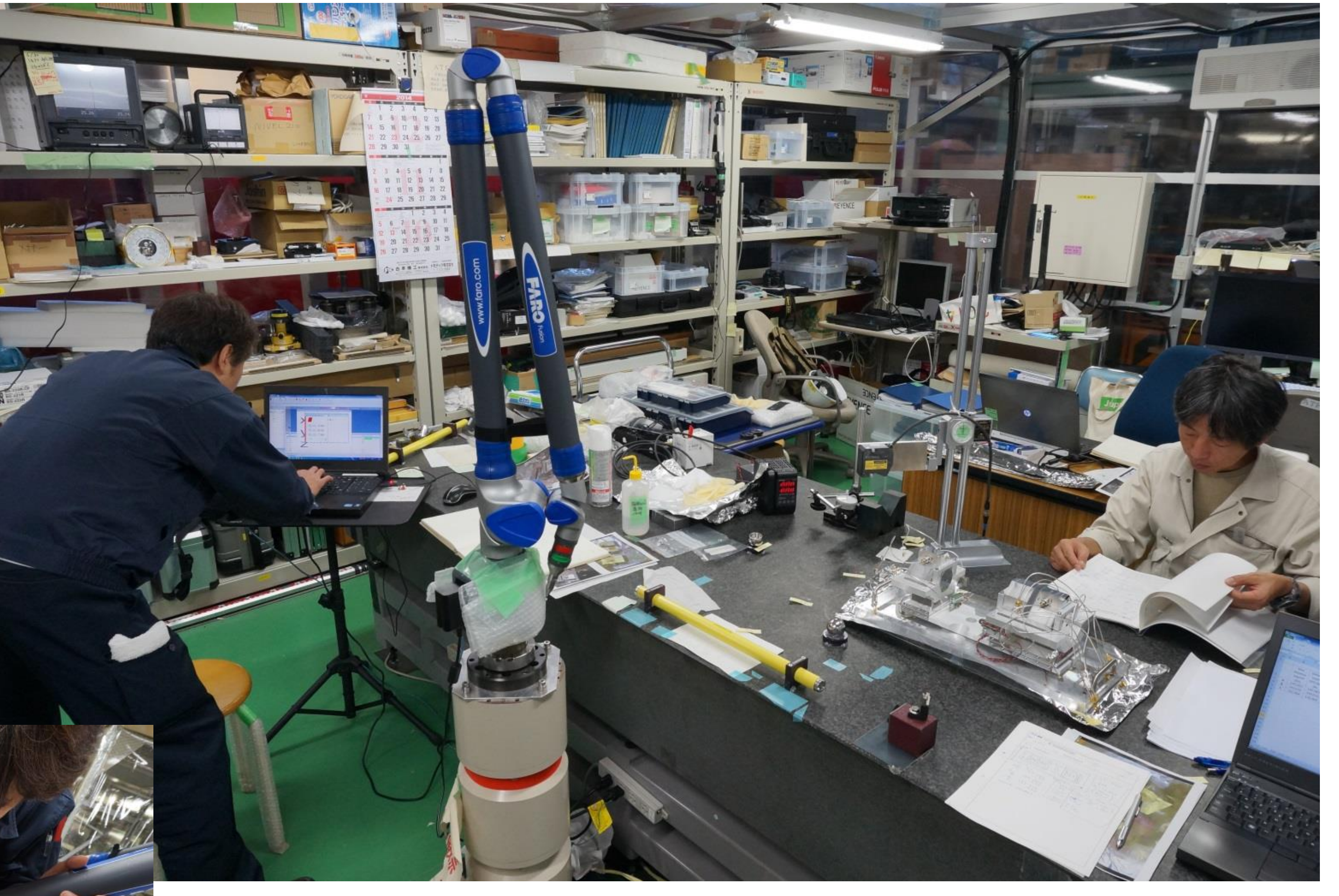


Installation du nouveau système

Installation du nouveau système

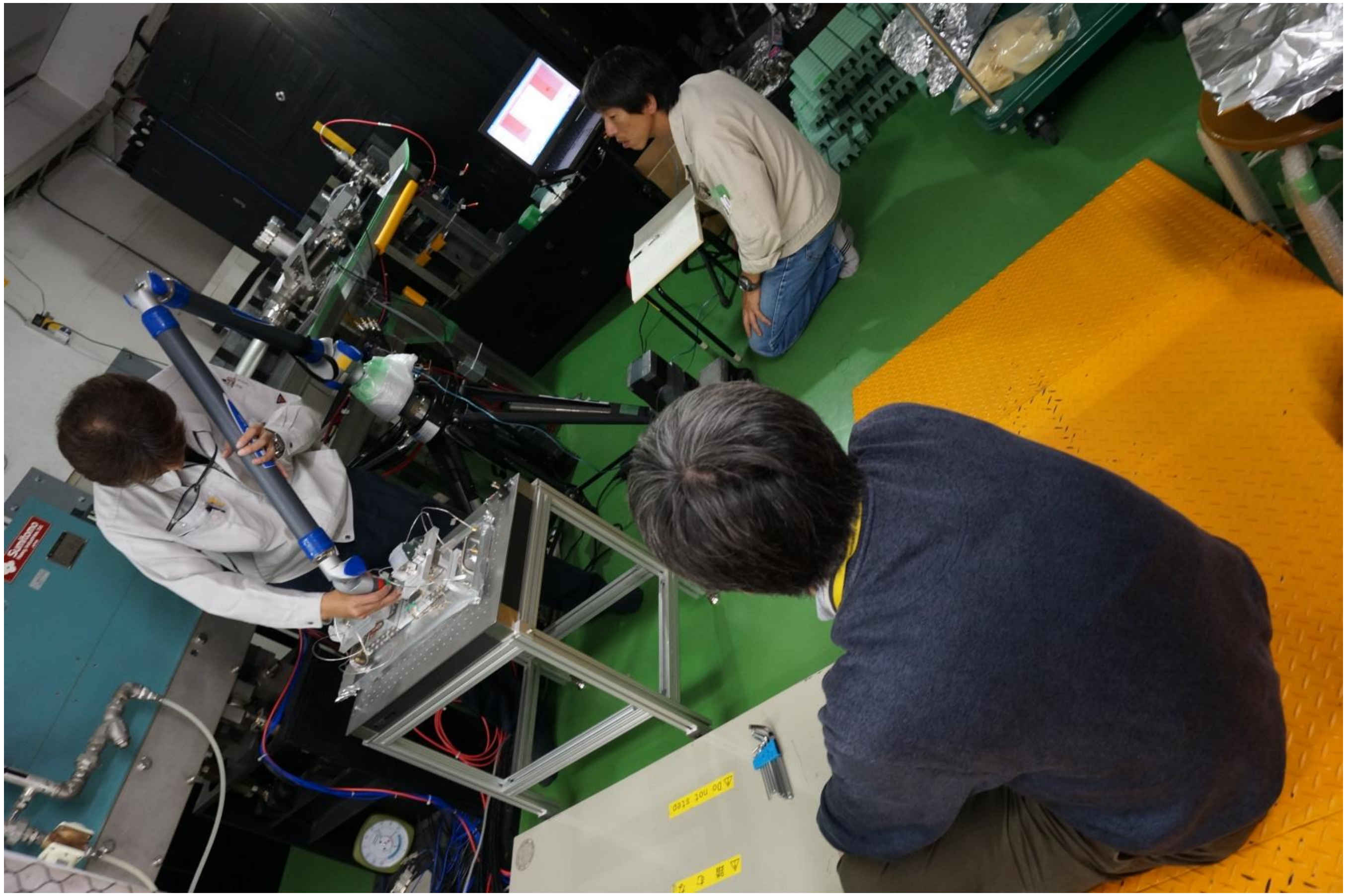


Installation du nouveau système : alignement



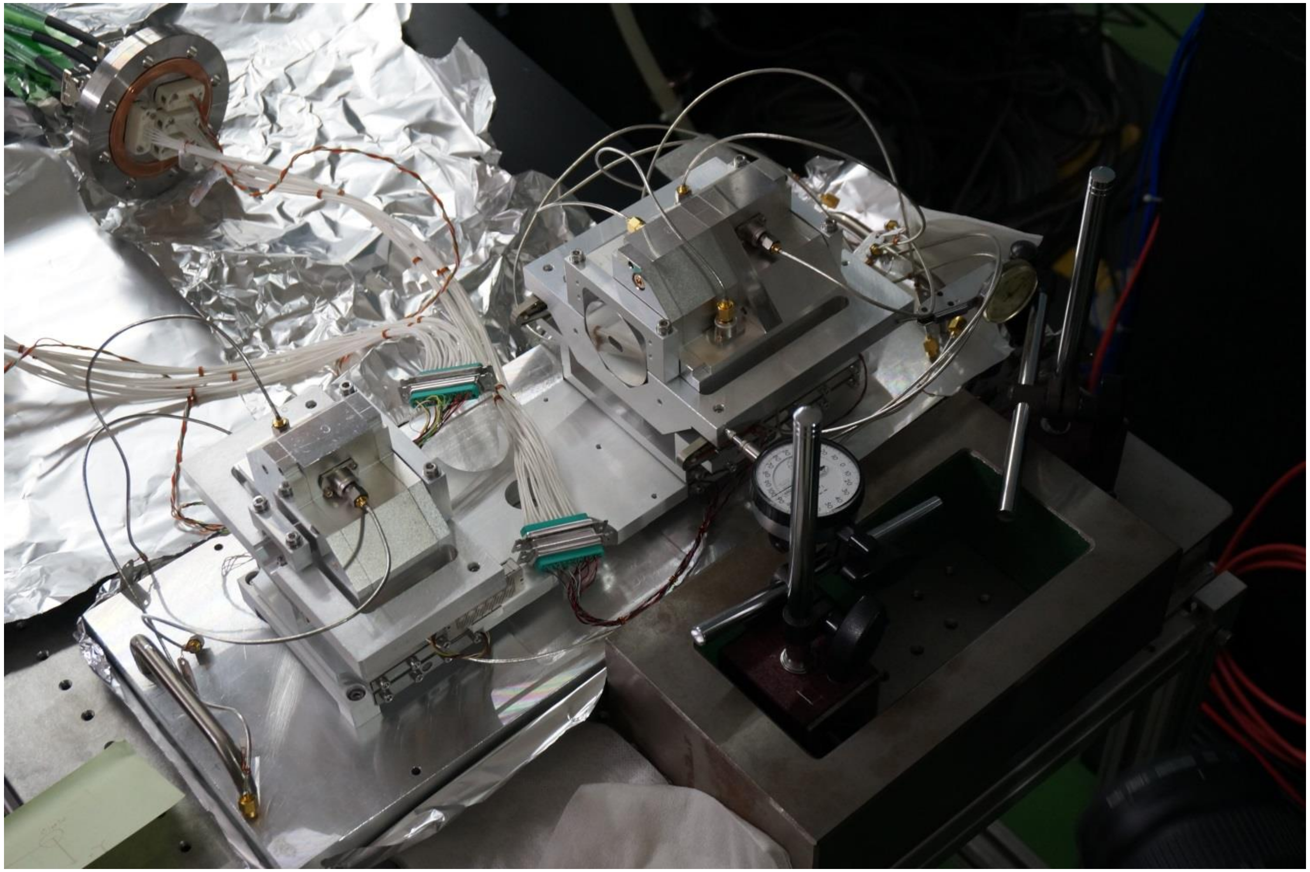
Traitement statistique (20 mesures)
→ Erreur alignement 8 μm / SD 12 à 20 μm

Installation du nouveau système : mesures alignement vertical in situ – actuateurs on



Traitement statistique (20 mesures)
→ Erreur alignement 40 µm (à vérifier)

Installation du nouveau système : mesures et alignement lateral in situ (lateral) – actuateurs on



Conclusion

- Alignement dans la course des actionneurs
- Course restante disponible pour scanning faisceau
- Equipement installé à l'IP – vide OK
- Faisceau remis en marche cette semaine…

… Aparté sur la feuille vierge