Module assembly jigs and assembly steps of the barrel modules

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Abstract

The second version module assembly jigs are developed at KEK by feeding back the experience and issues identified in the first jigs. An overview of the second version jigs, in comparison with the first ones, is presented, followed by descriptions of the assembly station, individual jigs, and step-by-step assembly process.

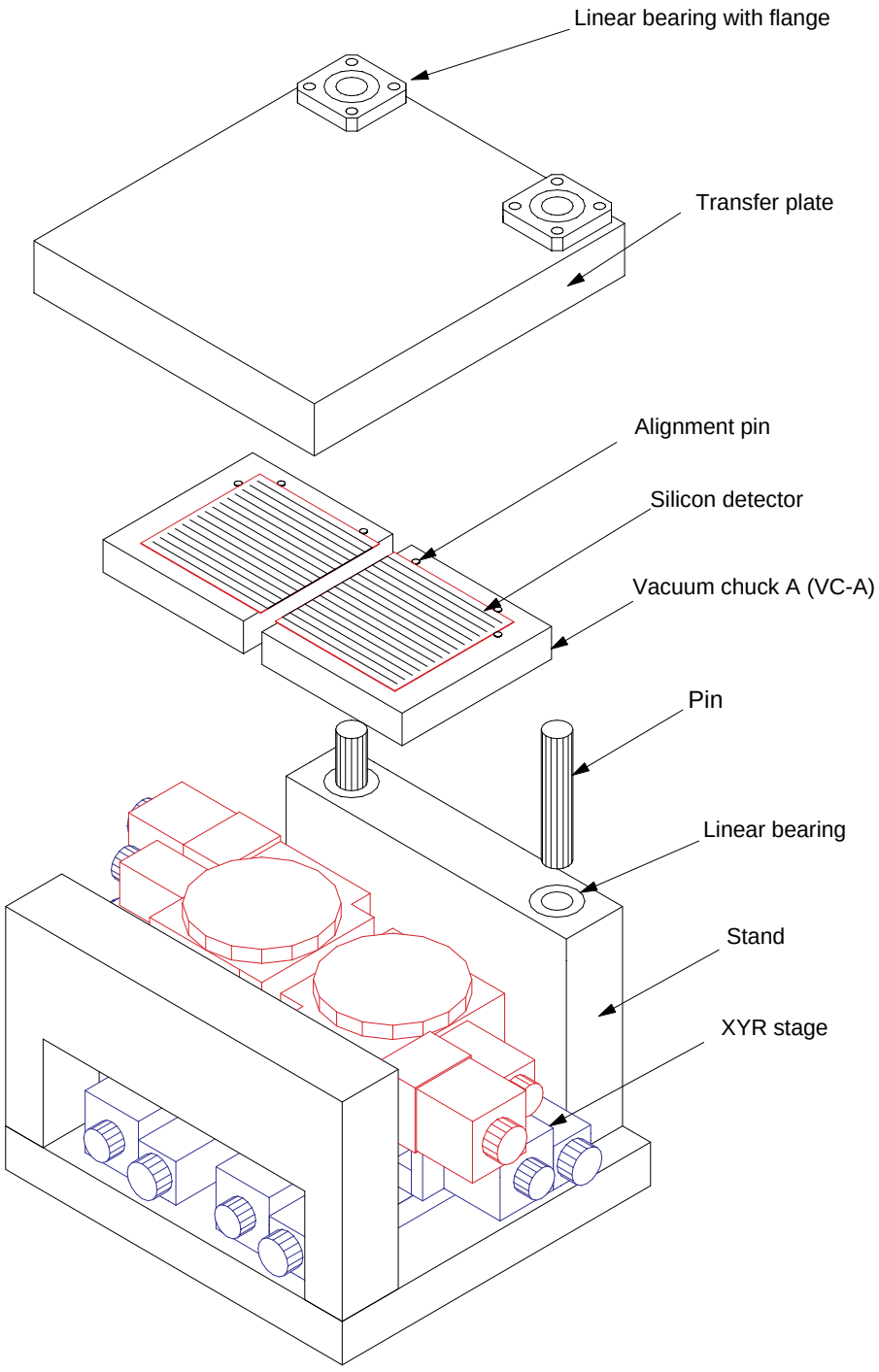

Figure 1: Concept of the first version assembly station and a detector transfer plate

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Feedback from the first version assembly jigs

1. linear bearings-pins introduced 2 to 5 μm errors due to elastic deformation,

2. location of the linear bearings-pins introduced displacement not only in angle but also alignment between the top and the bottom detectors, i.e., back-to-back alignment, due to the lever-arm if there was moment to the top or bottom transfer plates when they were mated,

3. removing the baseboard from the fixed dowel pin was difficult because the dowel pins and holes were made without play,

4. aligning detectors in plane could be made easier if the axis of transfer plates is pre-rotated by 20 mrad, leaving the detectors aligned in one direction, x-axis, which, then requiring small correction in rotation and in the translation in transverse to the strip direction, y-axis.

Figure 1: Concept of the first version assembly station and a detector transfer plate

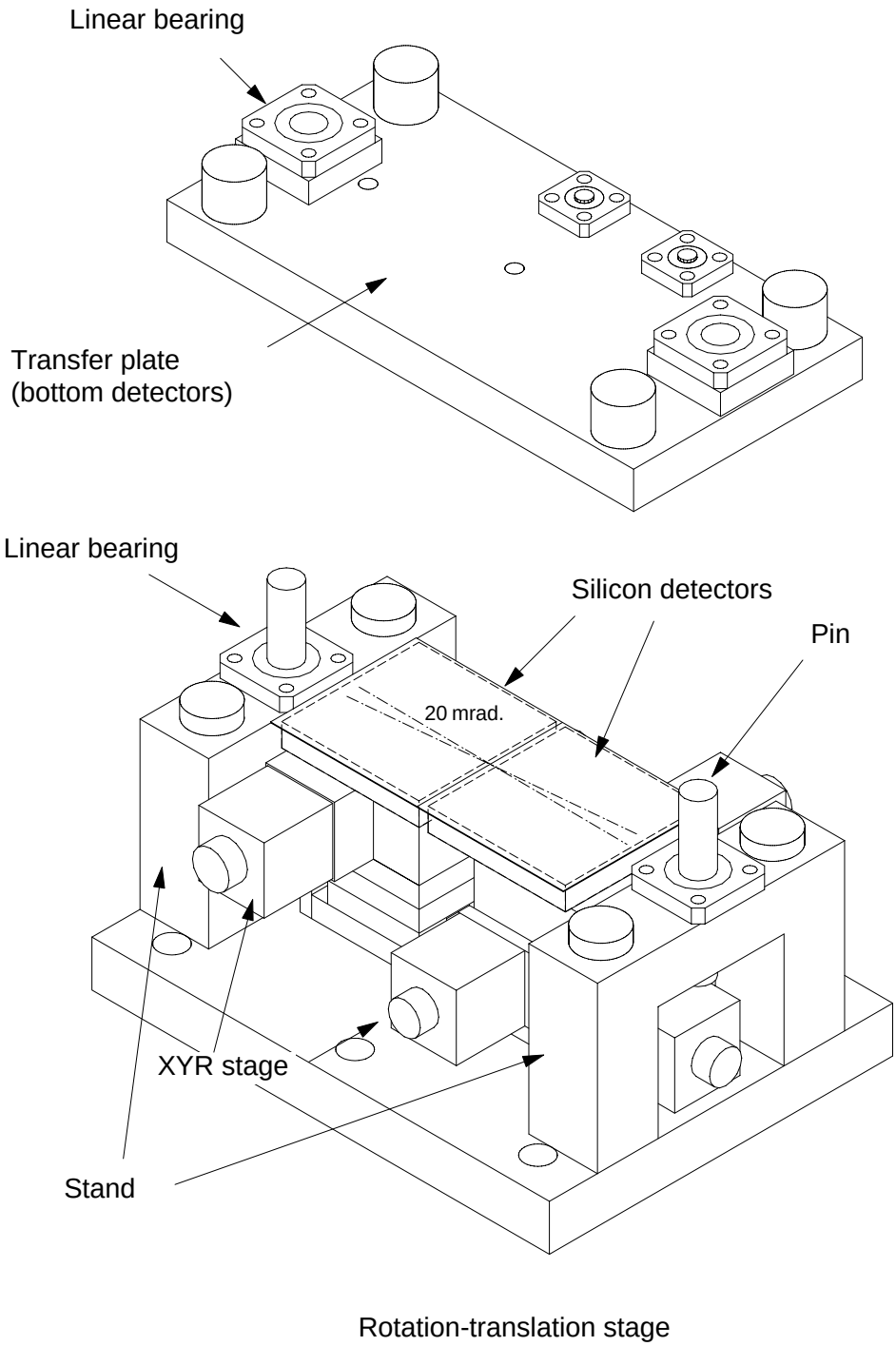

Figure 2: Conceptual view of the second version module assembly jigs

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Overview of the second version jigs

1. location of the linear bearings-pins is moved to the ends of the detectors in the strip direction and in the centre axis of the detectors, in order to have a larger separation of two bearings-pins and a shorter distance to the detector's side-edges, which reduces the influence of the elastic move of the pins,

2. the axis of the linear bearings-pins is rotated 20 mrad to the x-axis of the rotation-translation and the main translation stages,

3. the dowel pins are made movable by using linear bearings-pins, so that the pins can be moved down when the baseboard is taken out of the jig,

4. introducing a master gauge which defines the location of the master pins and the dowel-pins, from which the locations of linear bearings in associated jigs are copied, even to the multiple sets of jigs required for parallel operation of module assembly,

5. introducing a detector pre-alignment fixture, which eases the detector handling in an open space, simplifies the top table of the rotation stage which allows to make the assembly station concise,

6. use of disposable clean-room paper, which is porous enough to transmit vacuum, on the surface of the jigs where a detector touches, which is a common practice in a detector vendor.

Figure 2: Conceptual view of the second version module assembly jigs

Assembly jigs

1. Collection of assembly jigs
2. Rotation-translation stage
3. Assembly station
4. Master gauge
5. Detector pre-alignment fixture
6. Bottom fixture
7. Bottom detector transfer plate
8. Top detectors transfer plate
9. Glue dispensing machine

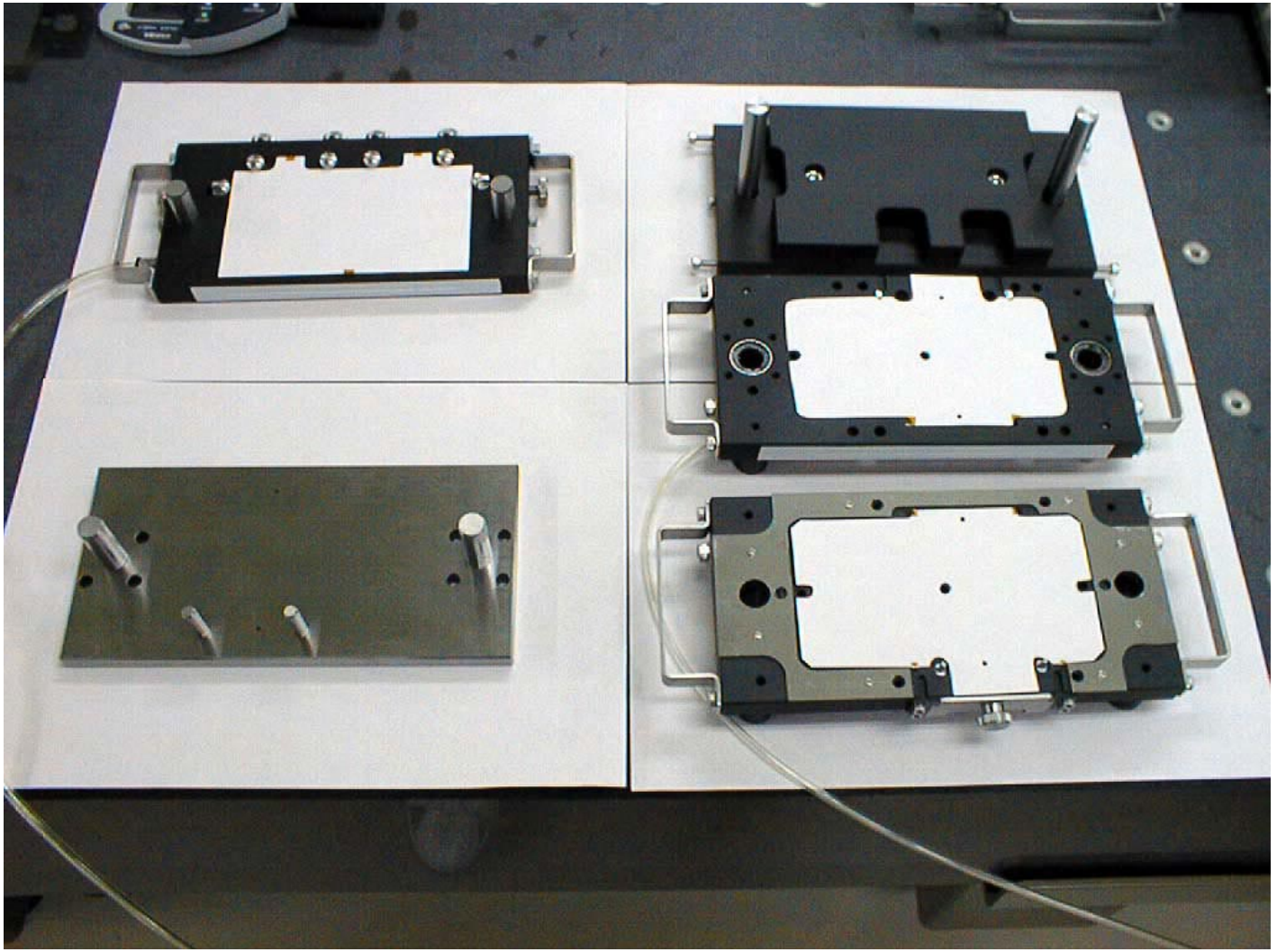

Figure 3: Overview of the second version barrel module assembly jigs: Master gauge (bottom-left), Detector pre-alignment fixture (top-left), Bottom fixture (top-right), Bottom detector transfer plate (bottom-right), and Top detector transfer plate (middle-right)

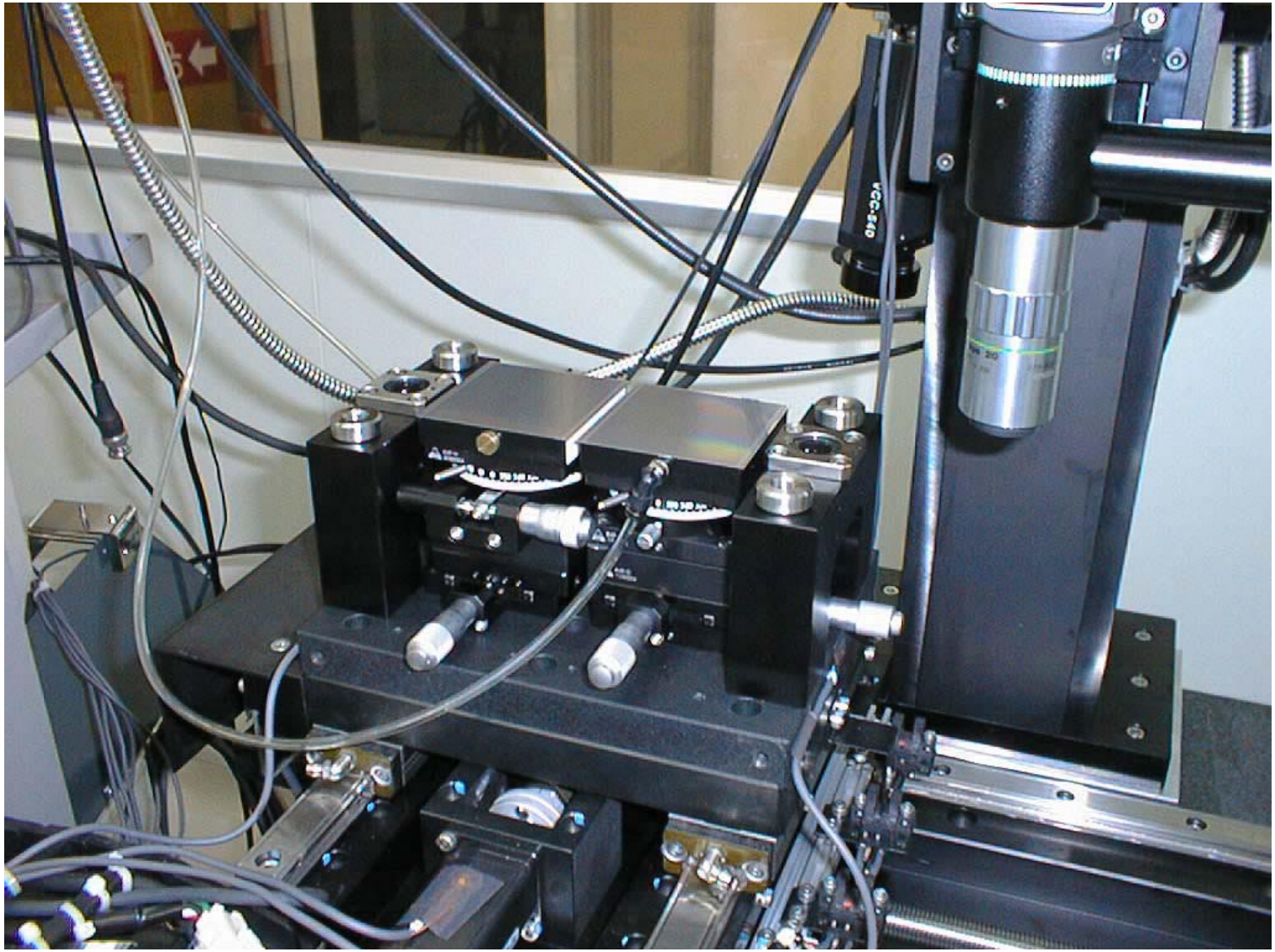

Figure 4: Rotation-translation stage in the assembly station

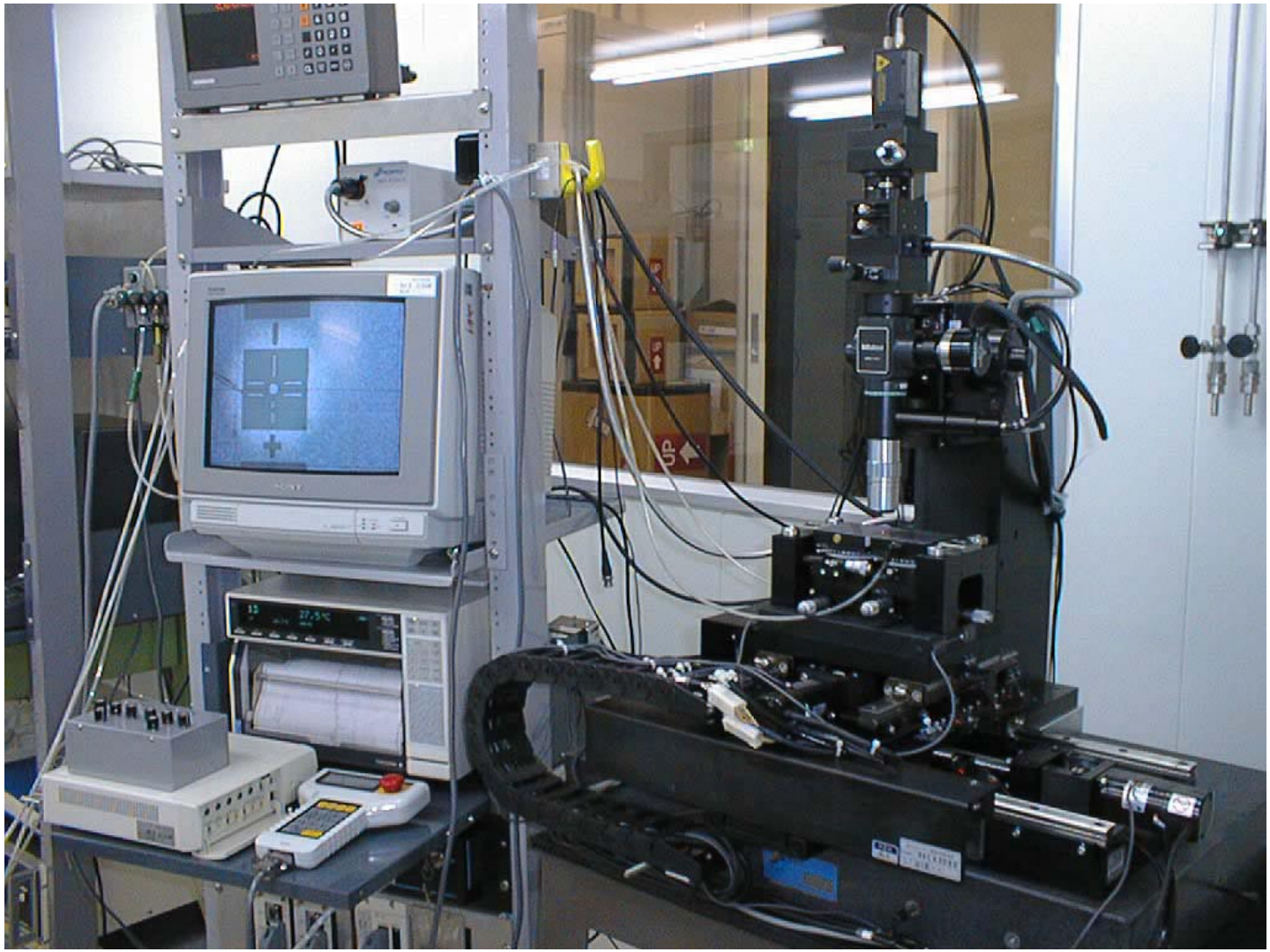

Figure 5: Overview of the barrel module assembly station. The left screen displays the centre fiducial mark of the barrel detector which is being set on the rotation-translation stage of the assembly station.

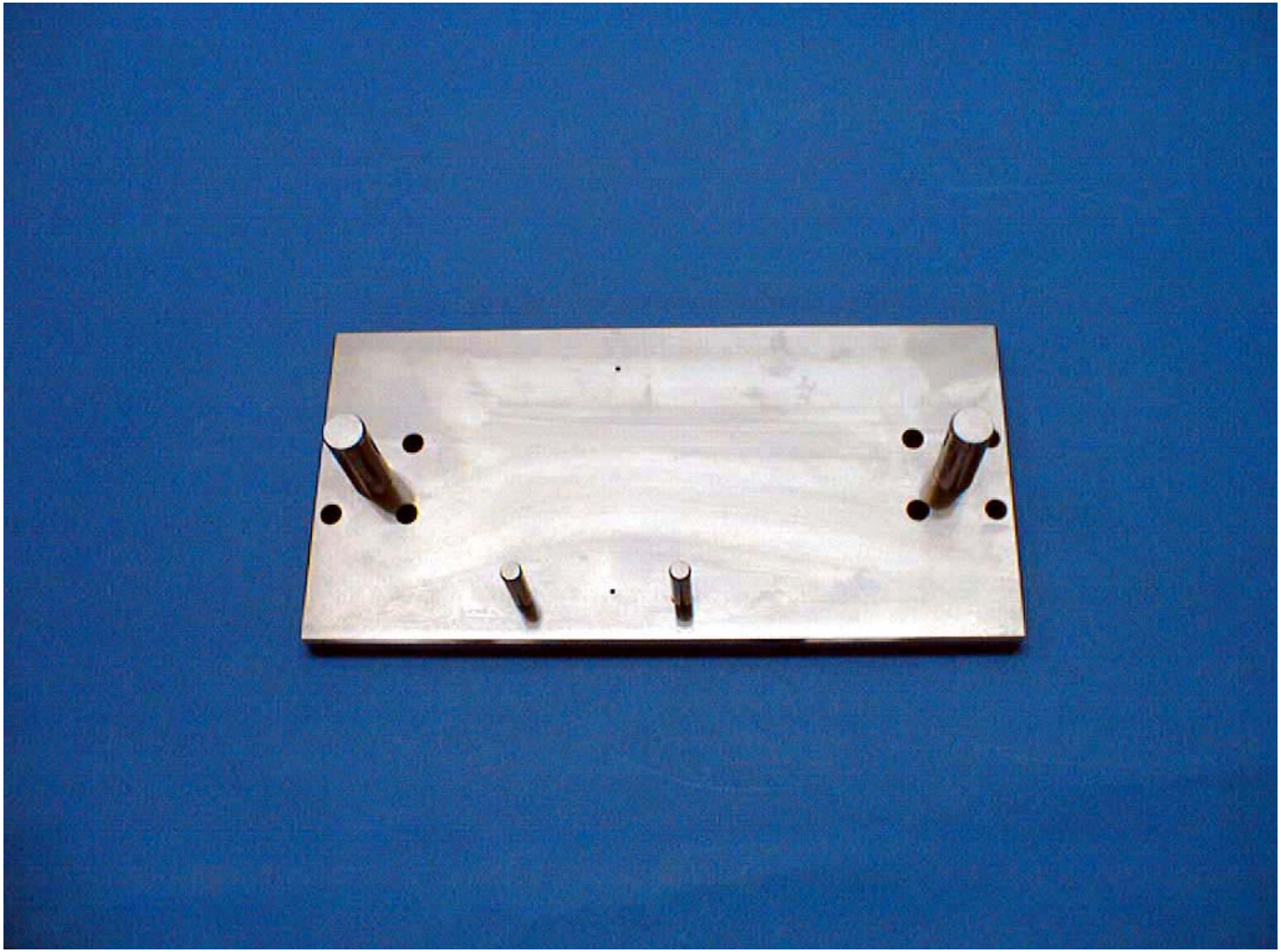

Figure 6: Master gauge. The large two pins are for the detector alignment and the small two pins are for the dowel hole and slot alignment.

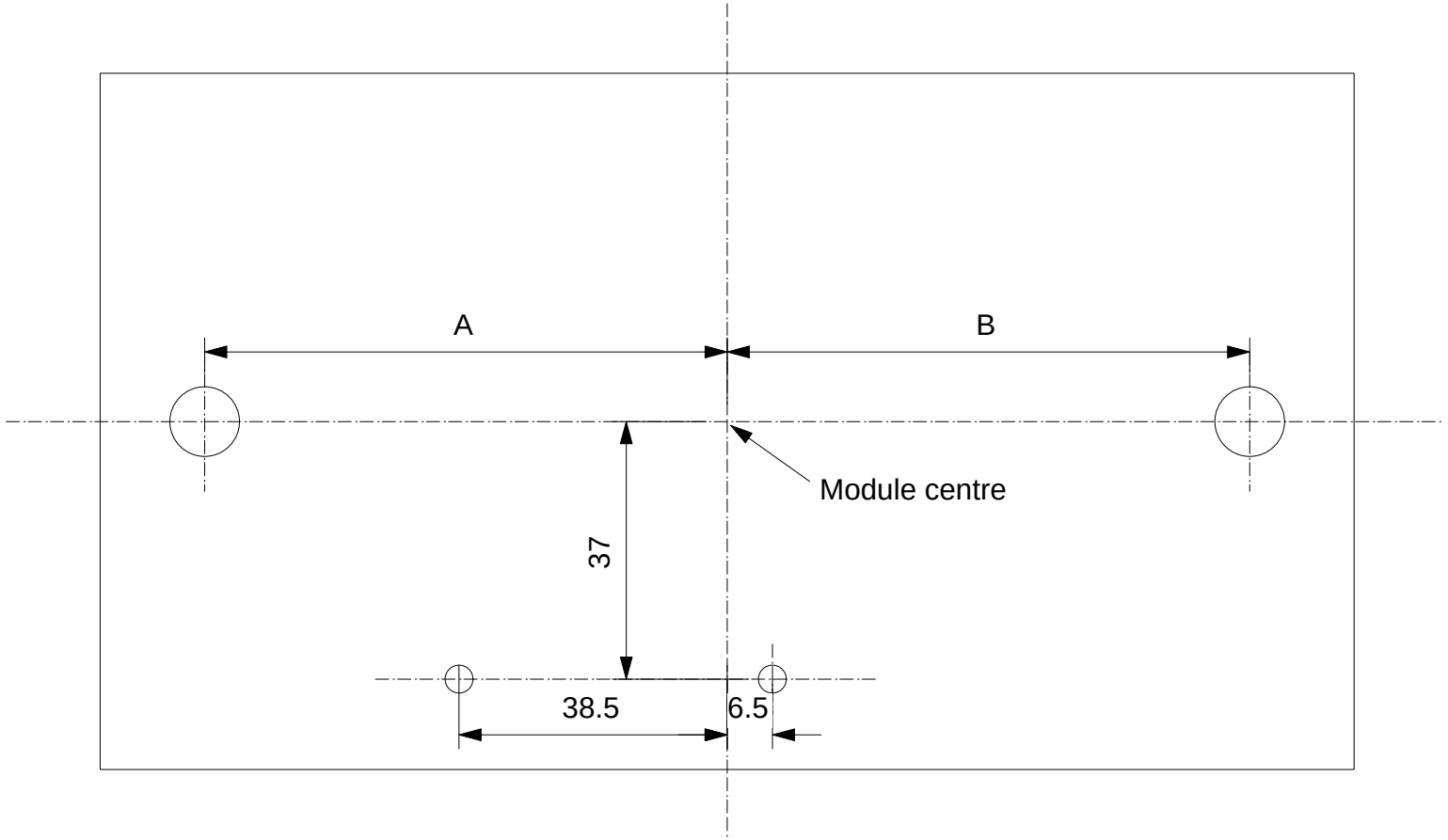

Figure 7: Critical dimensions of the Master gauge. The exact values of “A” and “B” are not critical but the module centre must be known within a required precision.

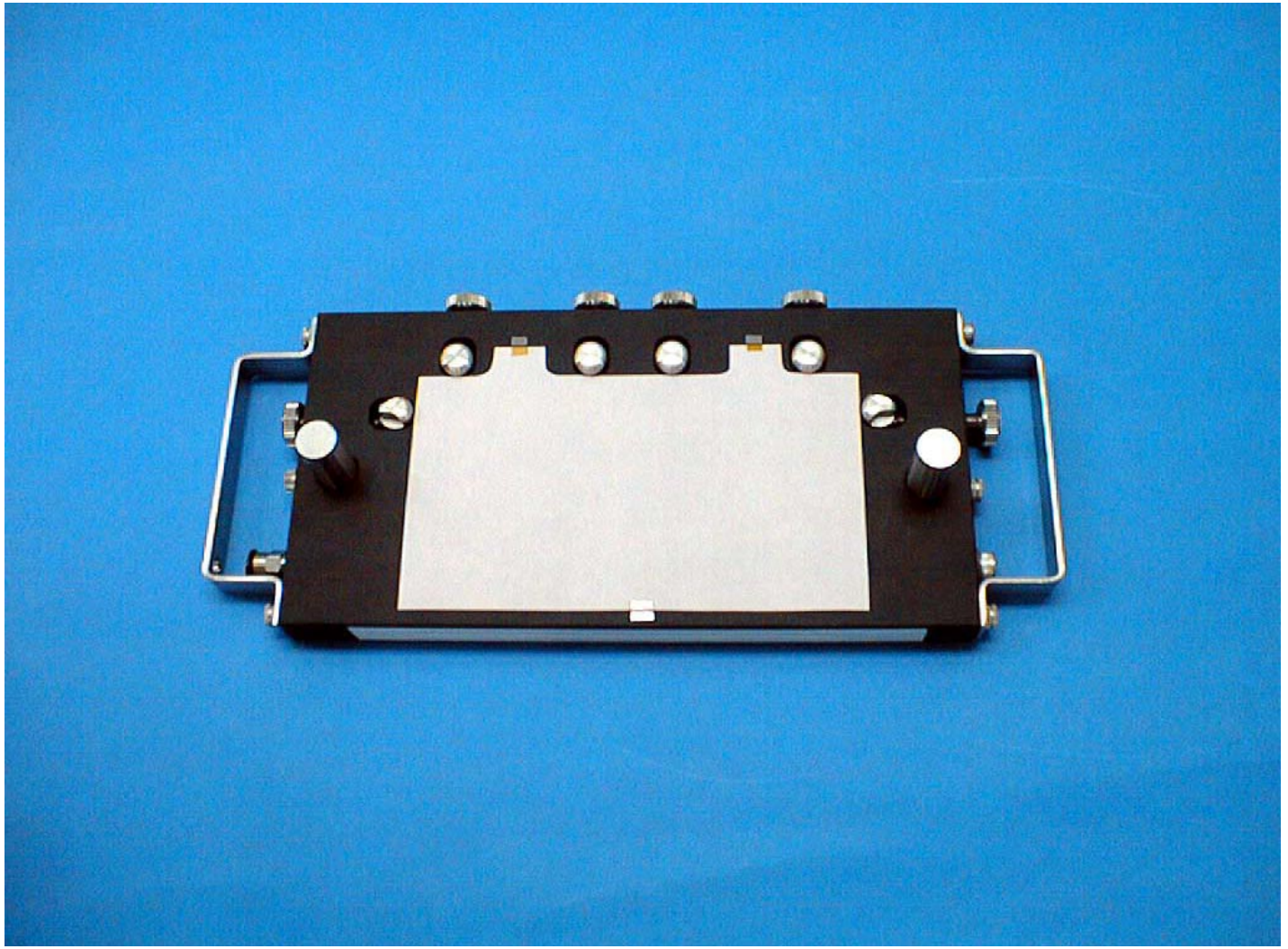

Figure 8: Detectors pre-alignment fixture. The white section is a disposable clean paper. The detector alignment pins will be retracted after the detectors are vacuum-chucked to the fixture.

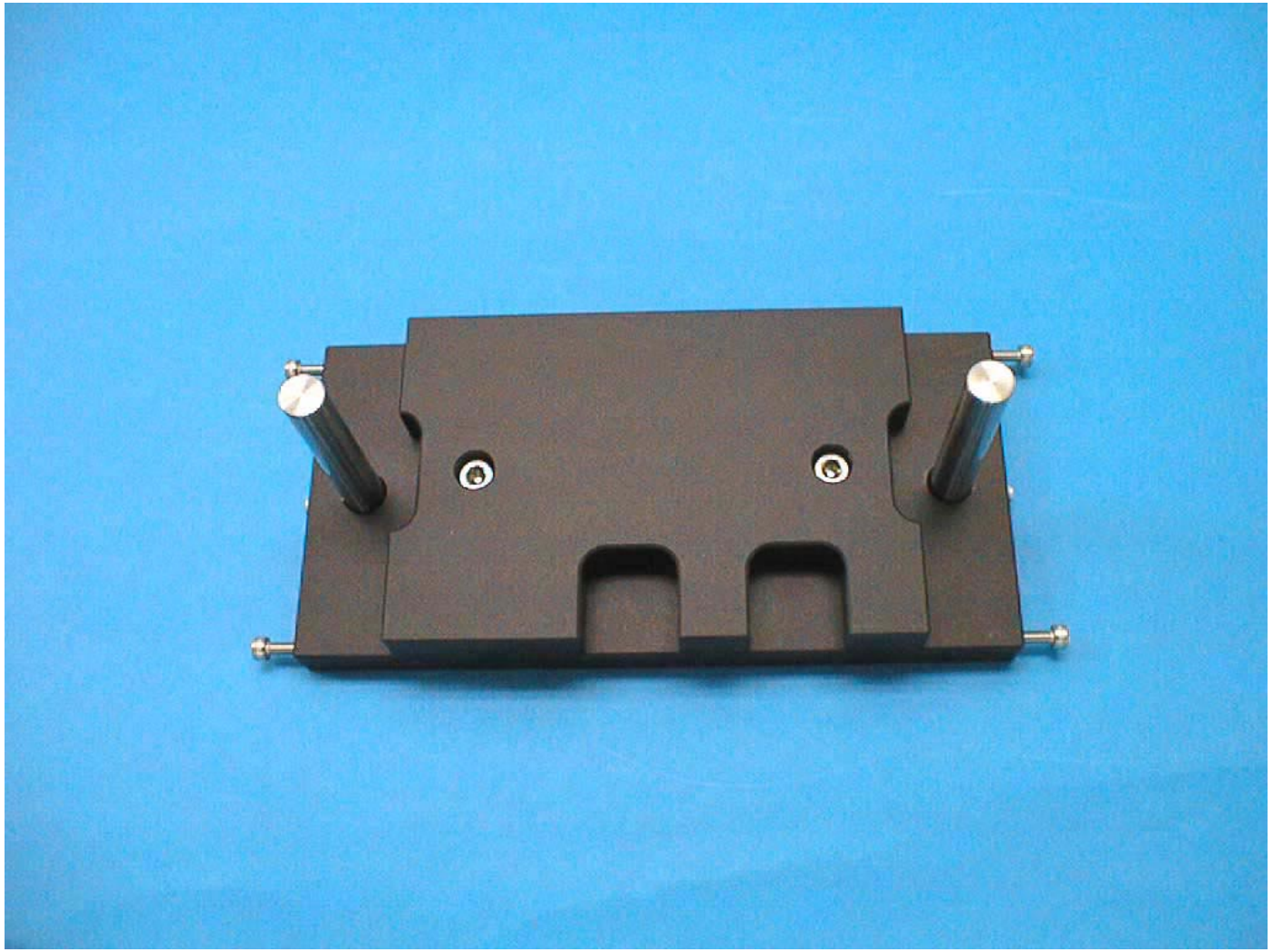

Figure 9: Bottom fixture. A simple pedestal fixture making clearance for the heads of the linear bearings and holding the master pins.

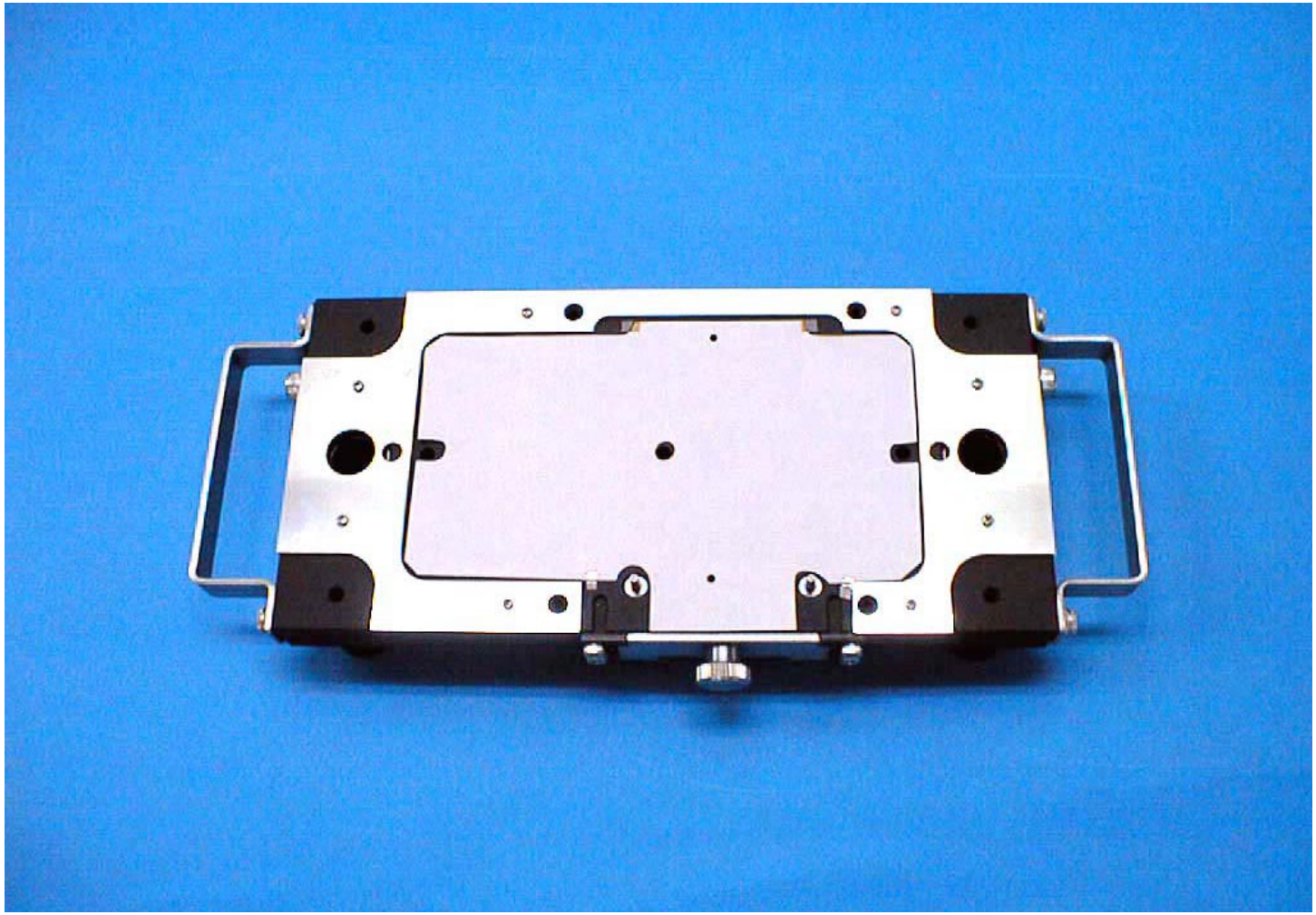

Figure 10: Bottom detector transfer plate. The shiny metal frame is a spacer defining the module thickness, i.e., the distance between the surfaces of the top and the bottom detectors sandwiching the baseboard. The white centre piece is a disposable clean-room paper. The two pins at the bottom-centre is the dowel pins for the dowel holes of the baseboard.

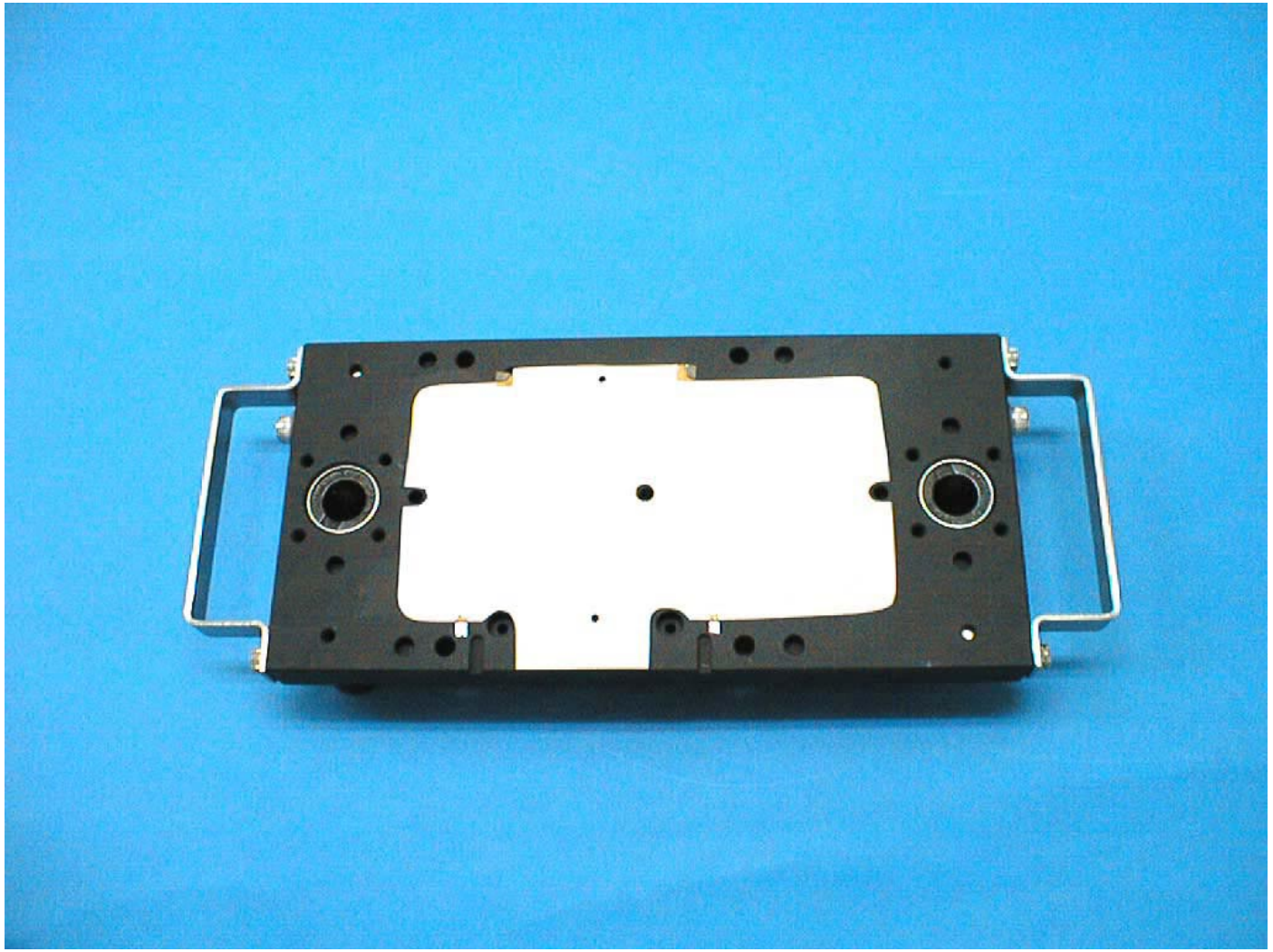

Figure 11: Top detectors transfer plate. The white piece is a disposable clean paper.

Figure 12: Glue dispensing system which is made of (1) a xyz stage where the baseboard is on the xy stage and a glue-syringe is attached on the z-axis, and (2) a dispensing controller.

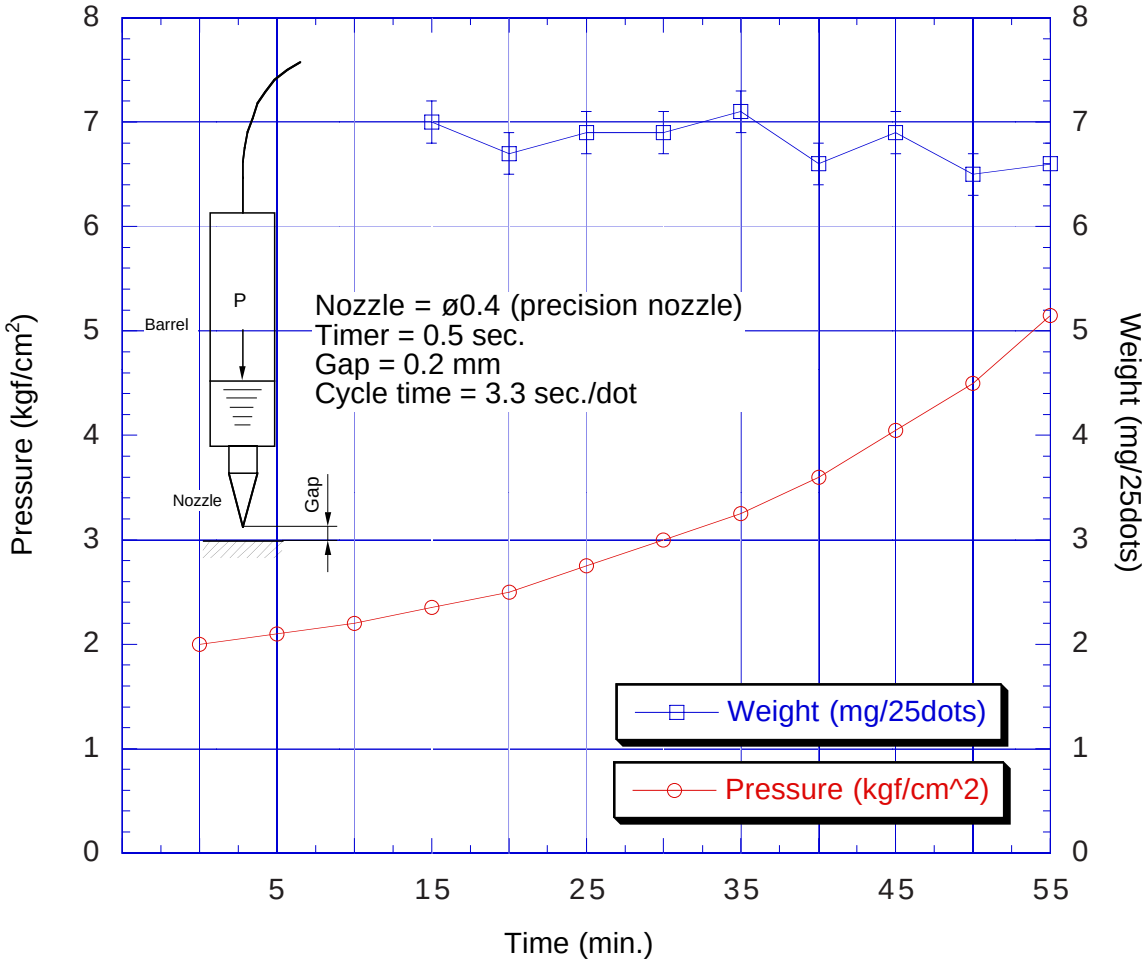

Figure 13: Pressure compensating the change of viscosity of the Araldite 2011 with BN filler (circle) and the weight of dispensed glue in 25 dots (square)

Copying the Master gauge

1. Rotation-translation stage

2. Transfer plates

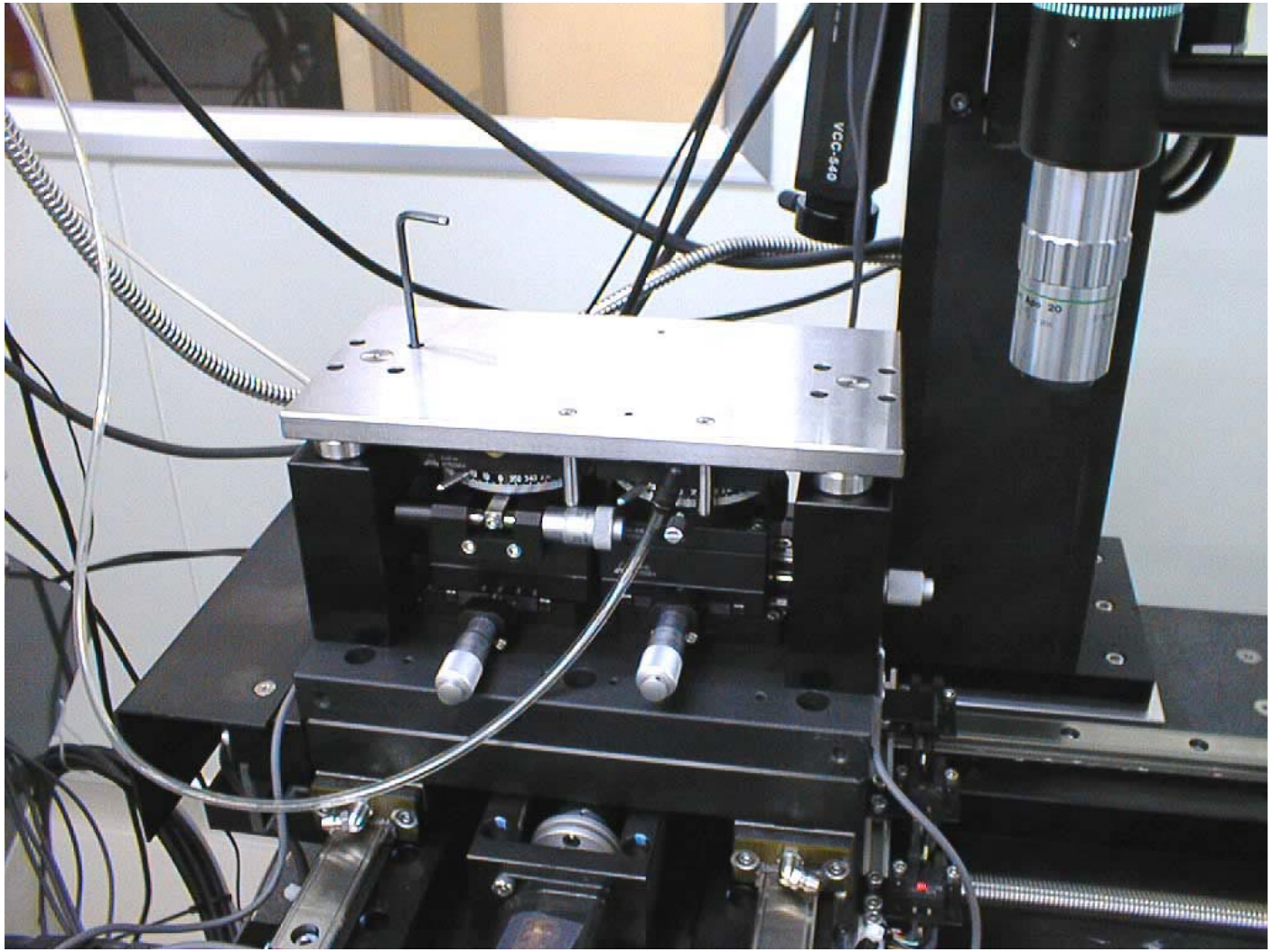

Figure 14: Copying the master pin locations to the linear bearings of the rotation-translation stage from the master gauge

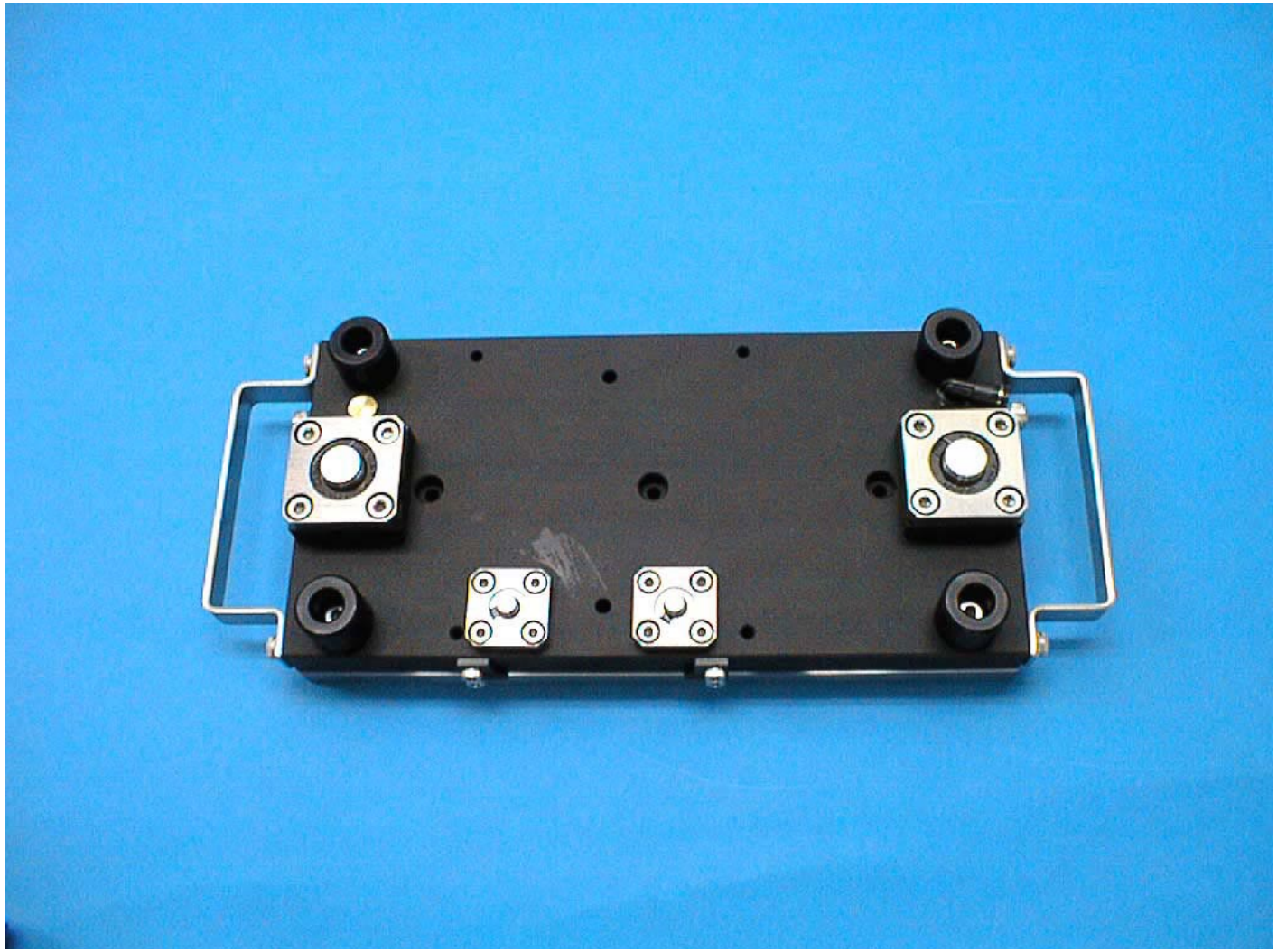

Figure 15: Copying the pin locations from the master gauge to the bottom detectors transfer plate for both the detector and the dowel linear bearings

Rotation-translation stage setting

The accurate 20 mrad rotation of the axis of the master pins to the x-axis of the main x-translation stage is made by making correction to the unit of rotation-translation stage:

1. the centres of the master pins are obtained by measuring the outer circles of the pins optically,

2. the centres of the pins are referenced to the fiducial marks on the unit of rotation-translation stage,

3. the unit is moved until the fiducial marks are in the preset positions such that the axis of the centres of the master pins is rotated 20 mrad to the x-axis of the main x-translation stage.

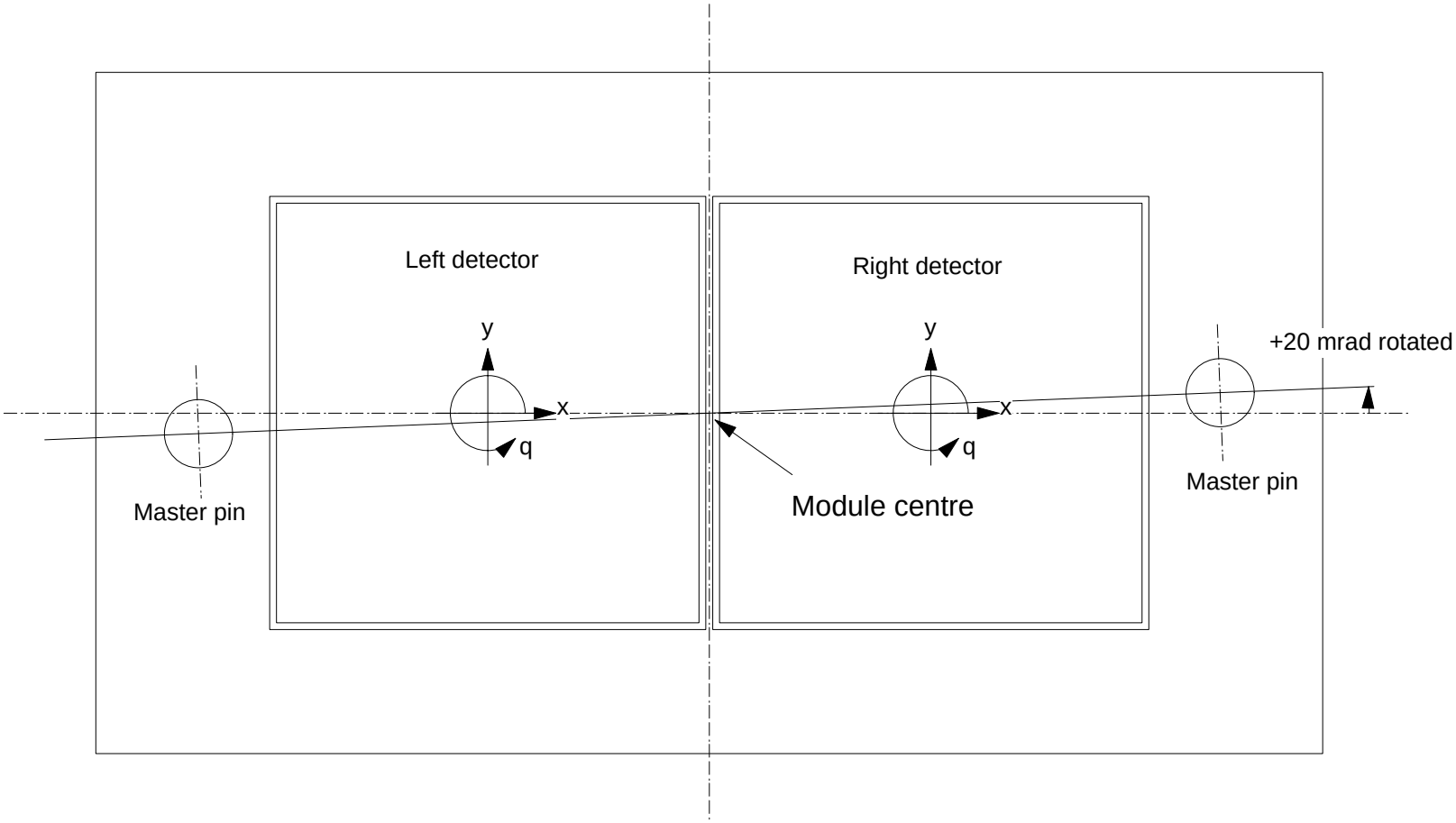

Figure 16: Rotated axis of the master pins in the rotation-translation stage to make the move of the detectors minimum

Figure 17: Setting the axis of the master pins of the rotation-translation stage rotated 20 mrad to the x-axis of the main x-stage

Assembly steps

1. Pre-aligning detectors
2. Transferring to the rotation-translation stage
3. Aligning detectors in precision
4. Transferring to the detector transfer plate
5. Placing baseboard on the bottom detectors transfer plate
6. Mating the top and the bottom detectors transfer plates

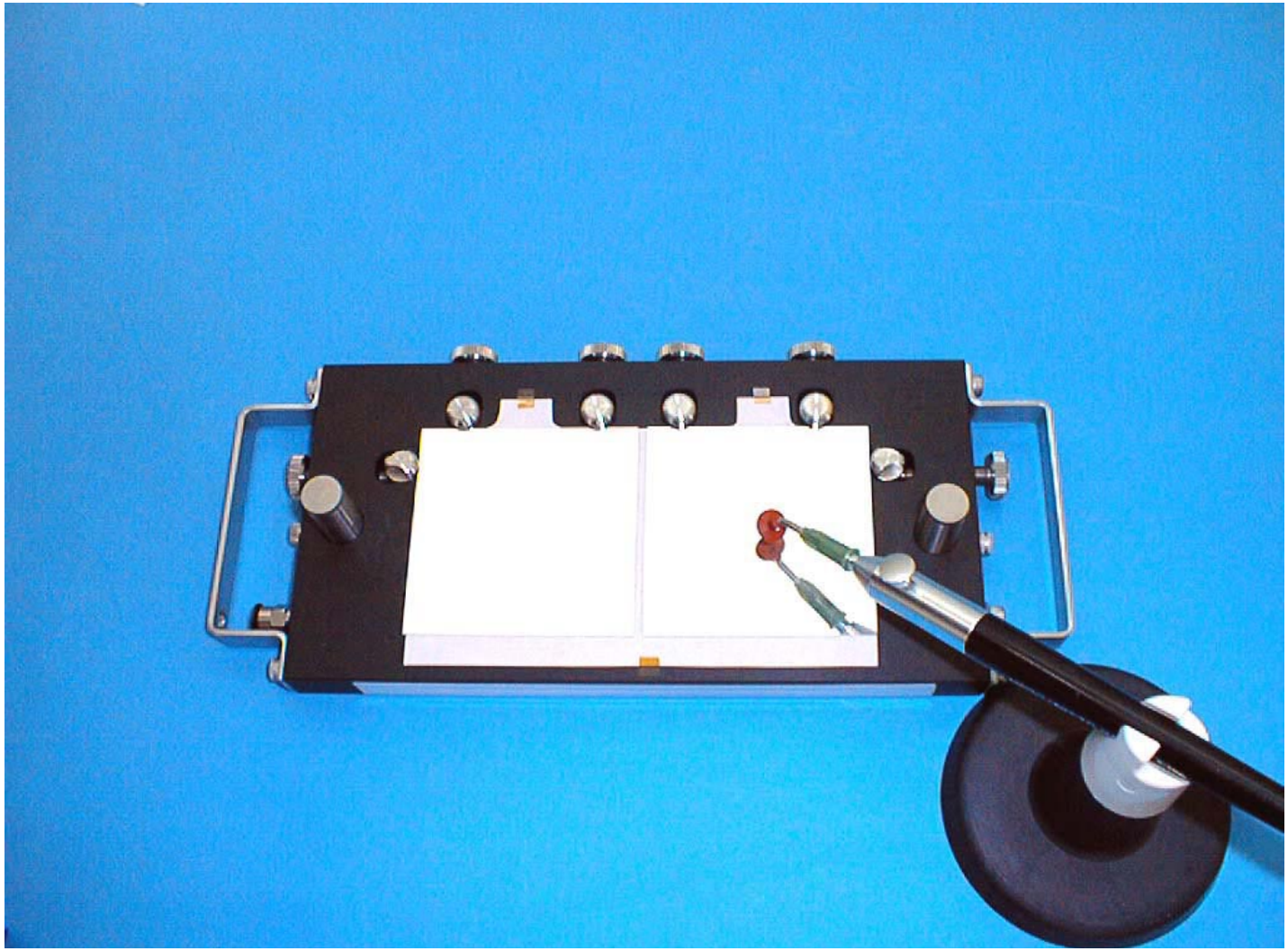

Figure 18: Placing the detectors on the detector pre-alignment fixture. A vacuum picker can be used in holding detectors.

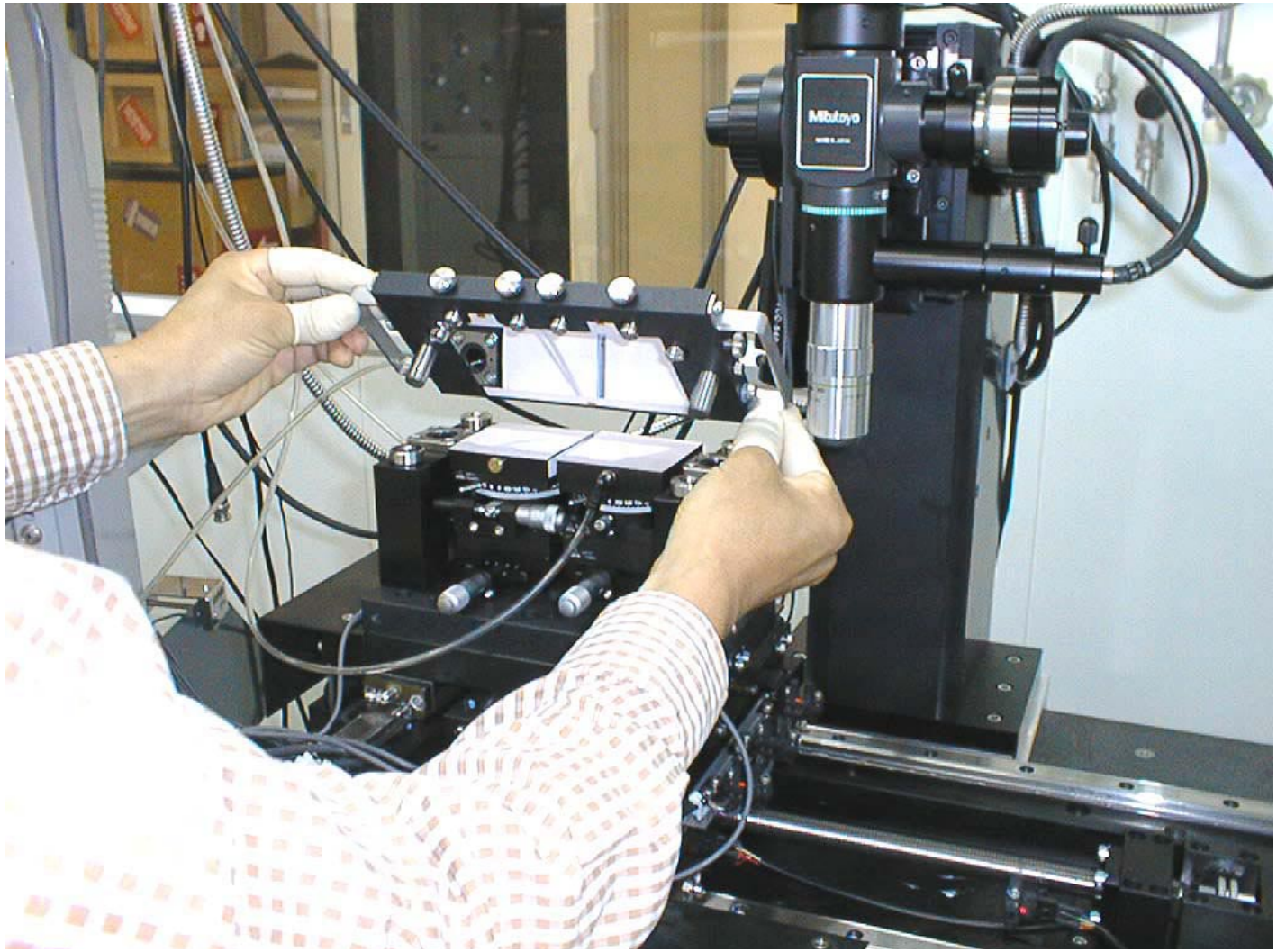

Figure 19: Placing the chucked detectors on the detector pre-alignment fixture to the rotation-translation stage

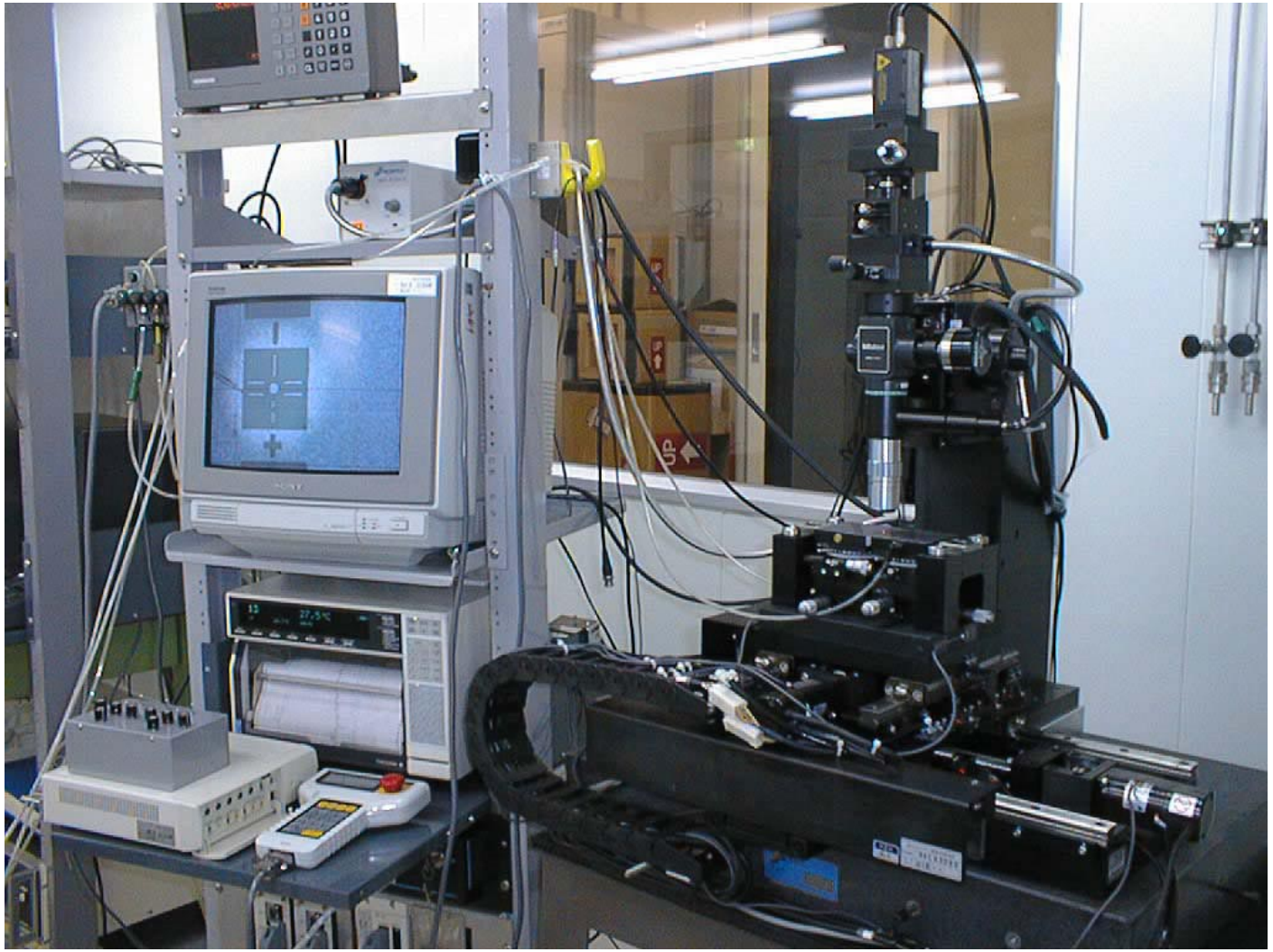

Figure 20: Aligning detectors

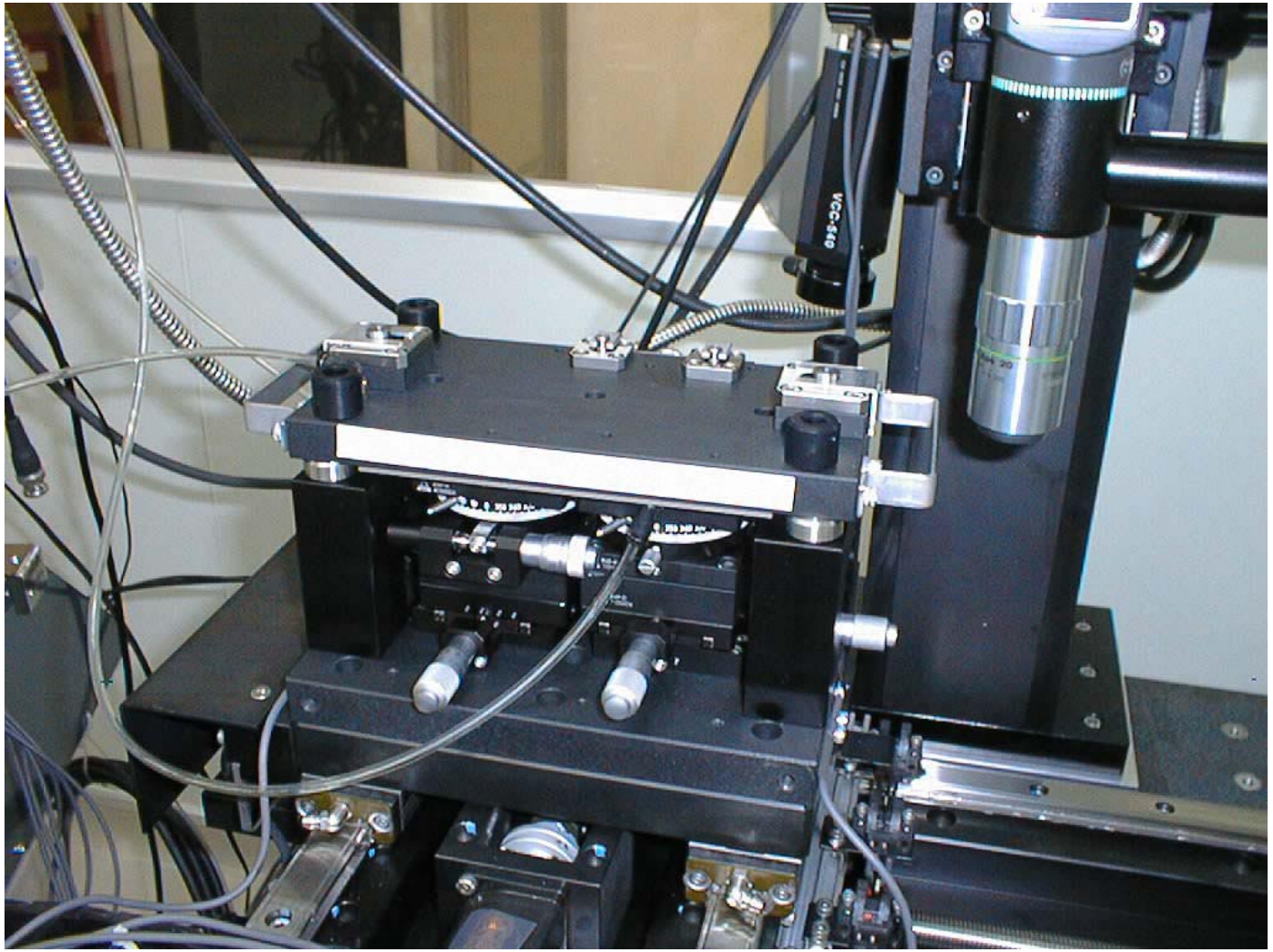

Figure 21: Transferring detectors from the rotation-translation stage to the bottom detectors transfer plate

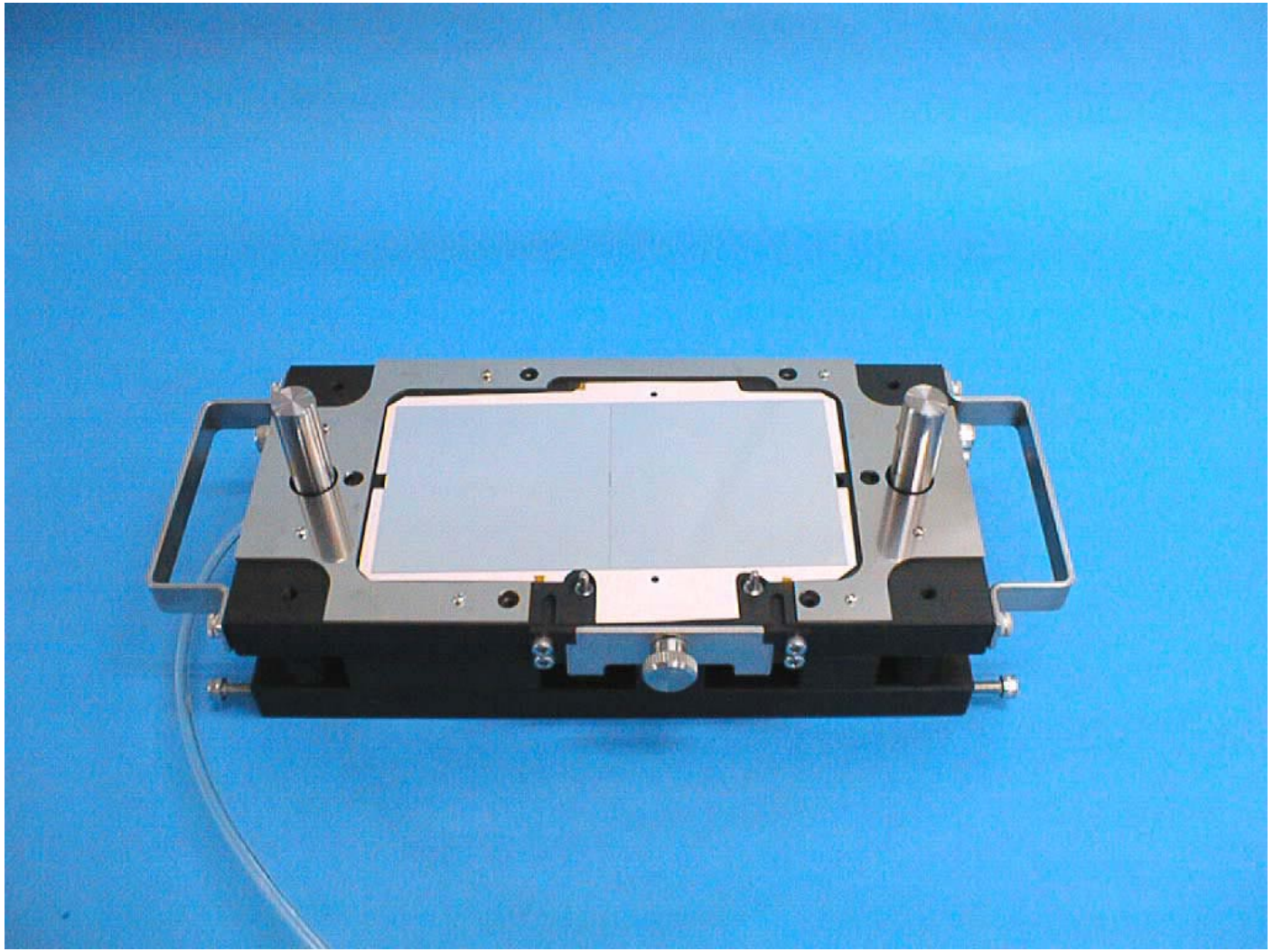

Figure 22: Aligned detectors chucked on the bottom detectors transfer plate

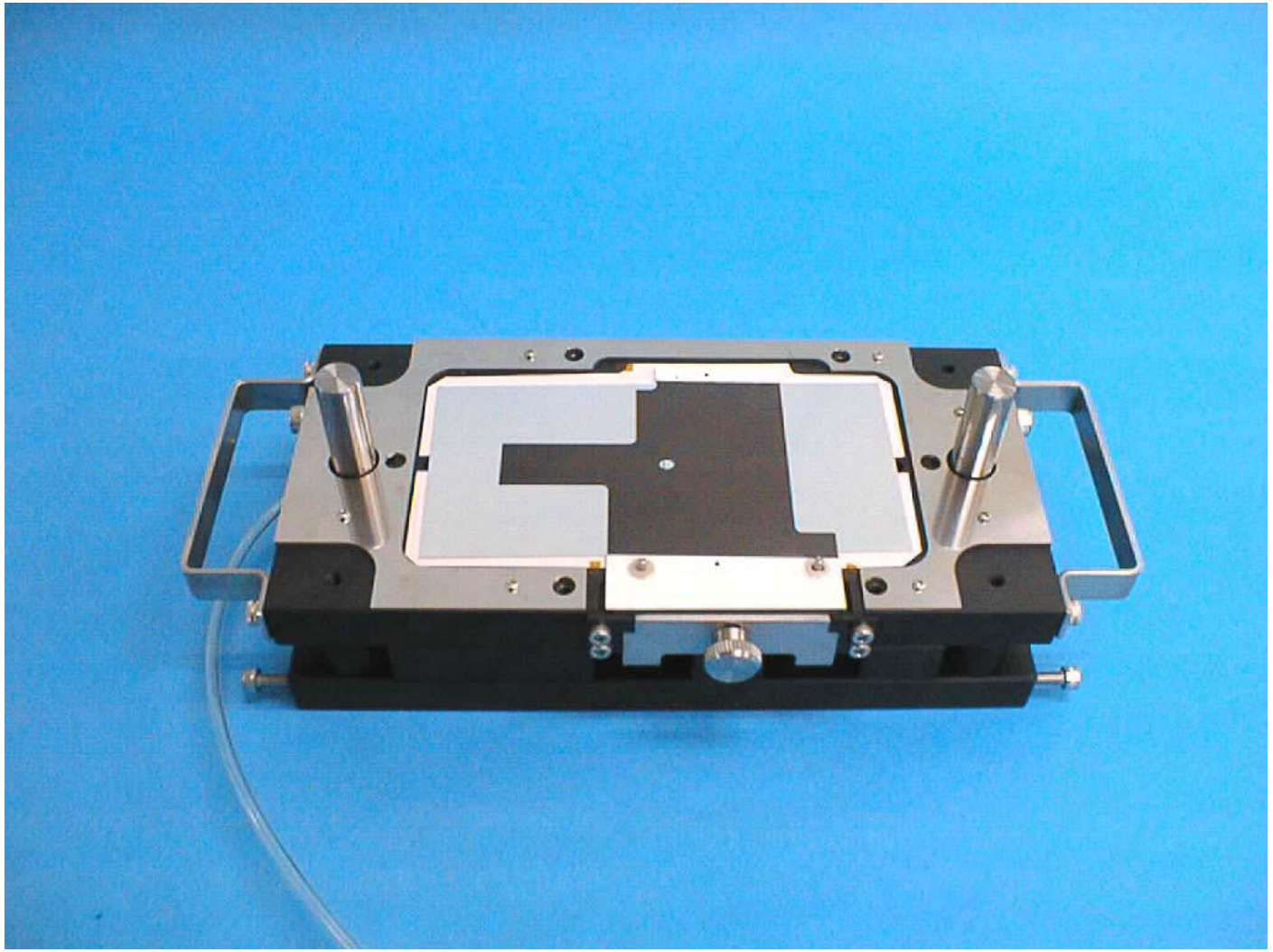

Figure 23: Baseboard is being placed over the bottom detectors. The alignment of the baseboard to the detectors are being made with the use of dowel pins in the bottom detector transfer plate and the dowel holes in the baseboard.

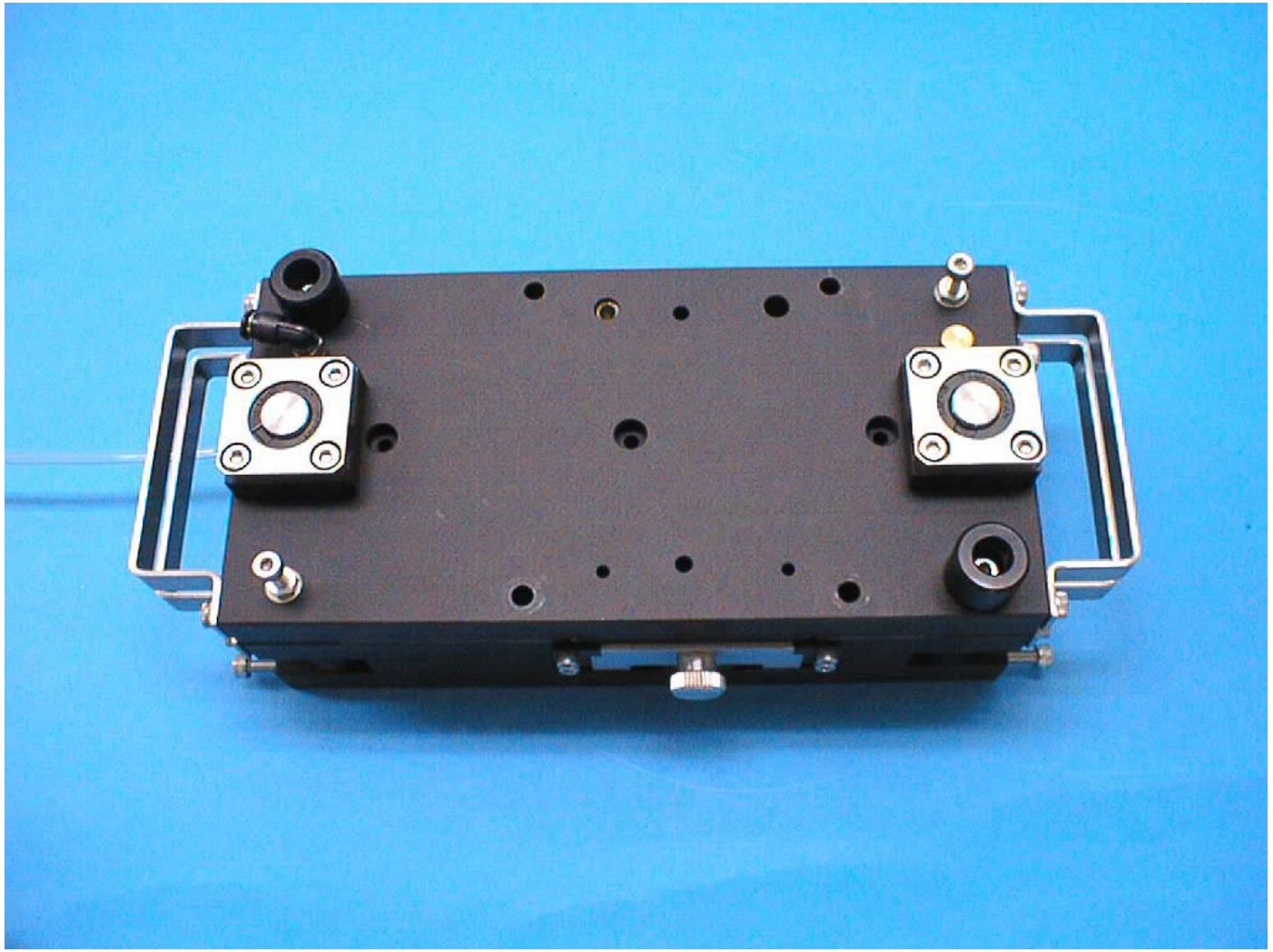

Figure 24: Mating the top detectors and the bottom detectors transfer plates

Summary

1. A second version of module assembly jigs has been designed and fabricated at KEK by feeding back the experience and the issues found in the first version of the jigs.

2. The major modifications in the second version are the move of the location of the master pins, introduction of the master gauge, the pre-alignment fixture, and the 20 mrad rotation of the axis of the master pins in the rotation-translation stage.

3. Assembling of precision mechanical modules are under way. Experience of the assembling and the precision of the assembled modules will be reported in a separate document.