

Module assembly on stave tasks sequence

Foreword: This document give a brief overview of the module assembly sequence. This is a starting document on a opened discussion.

Modifications:

Corrections:

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SUMMARY

- 1. Generality**
 - 1.1 *Tool description*
 - 1.2 *Tool alignment*
 - 1.3 *Reference notation*
- 2. Assembly tasks sequence**
- 3. Tasks details**
- 4. Frame measurements**

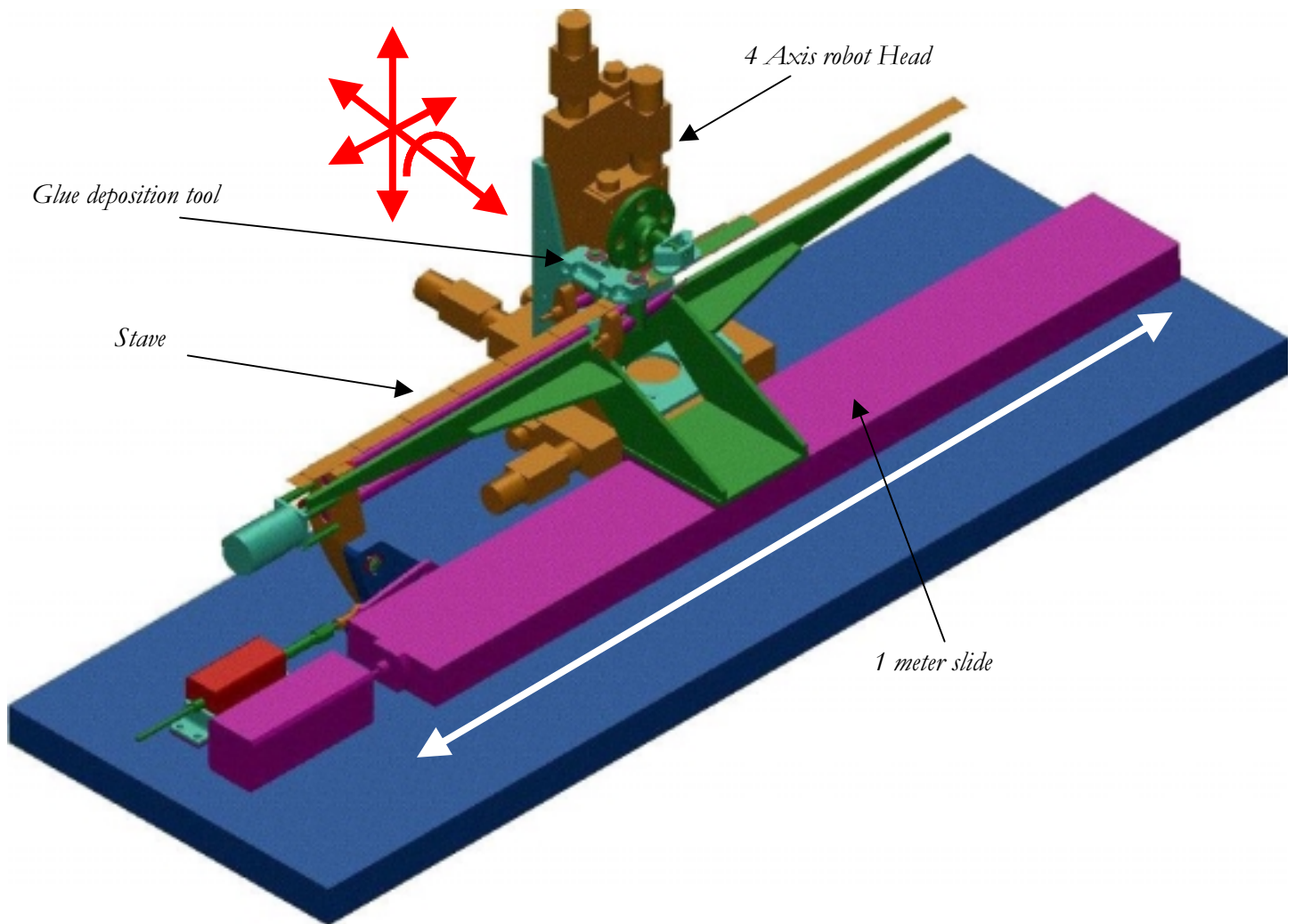
1. Generality

The module assembly task sequence begin at the stave reception in the lab before the assembly. The reason is that geometrical measurements are needed for the stave quality control, but those one will also be used to feed the assembly robot with the stave geometry.

All module control tasks will not be describe in this note, they are part of the quality control of the modules. *No modules measurements are foreseen before a complete stave assembly (to be discussed).*

1.1 Tool description

The assembly tool is a 4 degrees of freedom robot which will be installed under our non-contact CMM for module survey during assembly.



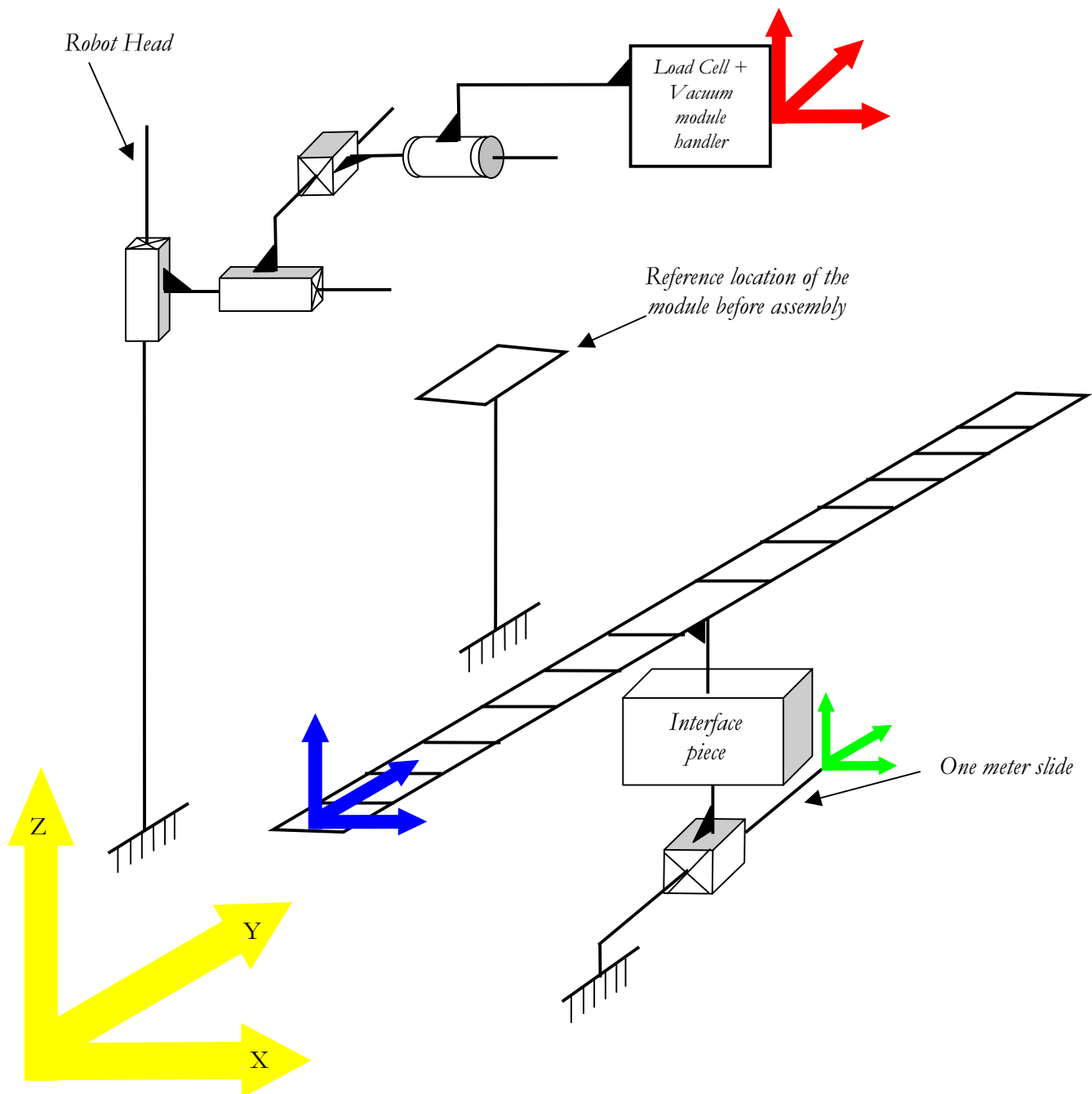
This robot can be subdivided in 4 different parts:

- The robot head is used for the precise module pick up and deposition (accuracy $\pm 1\mu\text{m}$). This part of the tooling is driven automatically or manually. It is equipped with a sensor cell which is used to control the

pressure applied on the module during the deposition, but also to locate before the deposition the stave plan location (more detail will be furnished later).

- A one meter long slide (accuracy $\pm 50 \mu\text{m}$, automatically driven). This slide is used to present the stave plan sequentially under the robot head.
- The stave support piece (not represented on this sketch). This particular piece is the interface in between the tool and the stave. It will be equipped with two adjusting system to align the stave in the tool reference frame. This piece will follow the stave from the reception of the stave up to the assembling in the barrel (more detail will be given later).
- The module reference location. This is a precisely machined location where the robot head will pick up a module to deposit it on the stave

The present sketch summarise the different parts of the tooling and their reference frames.



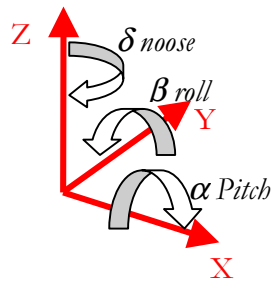
All the frame shown above will be used for tool alignment during installation of this one under the CMM, and module positioning in the stave frame (blue one).

1.2 Tool alignment

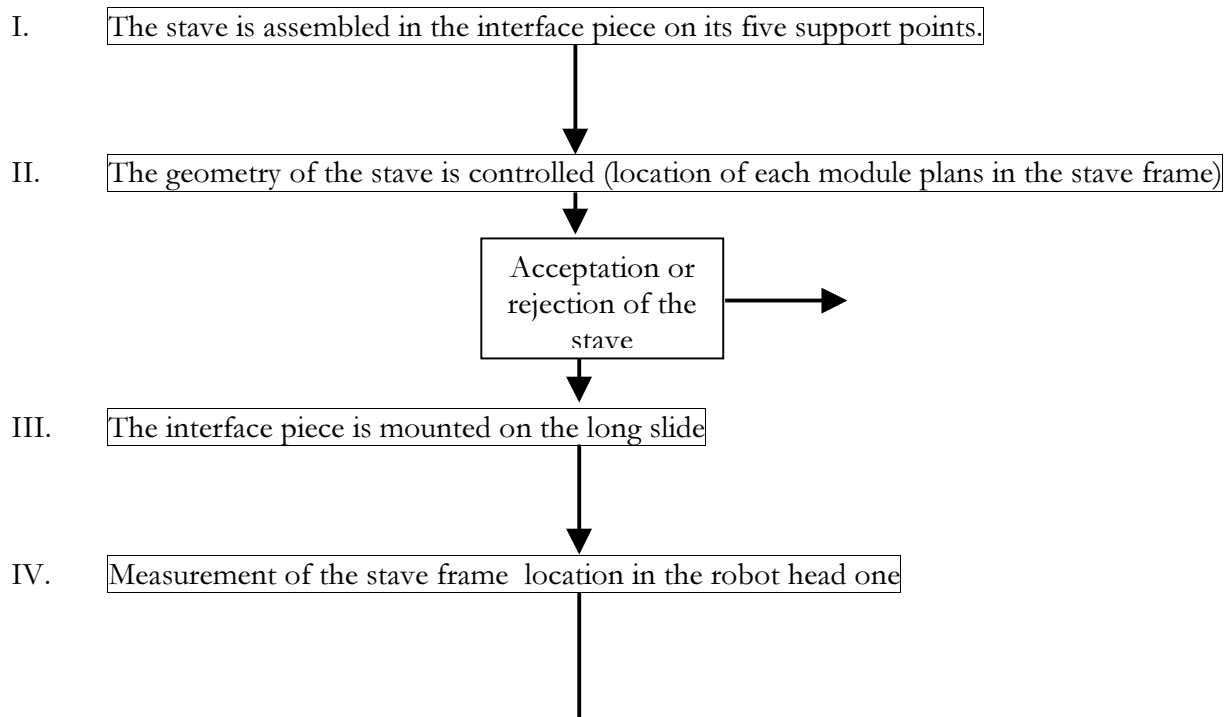
The yellow frame shown above is the absolute reference of our tool. It represent the location where the module will be located before that the robot take it. This one will be used to align the “Long slide” and the “robot head” during installation on the CMM. This alignment will be done by using Calibration Blocs.

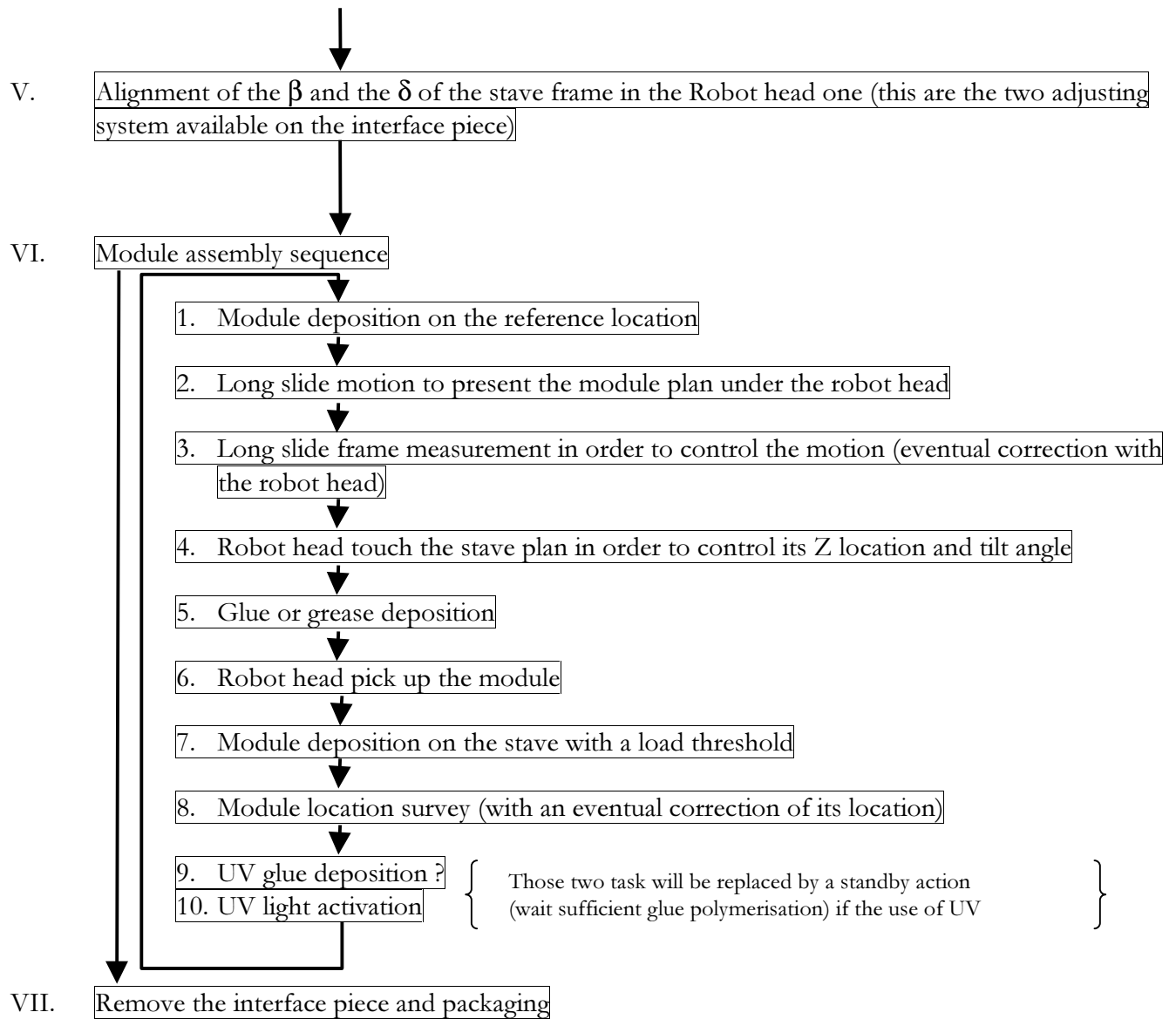
1.3 Reference notation

In the coming chapters the following notation will be used to speak about frames location from one to an other one.



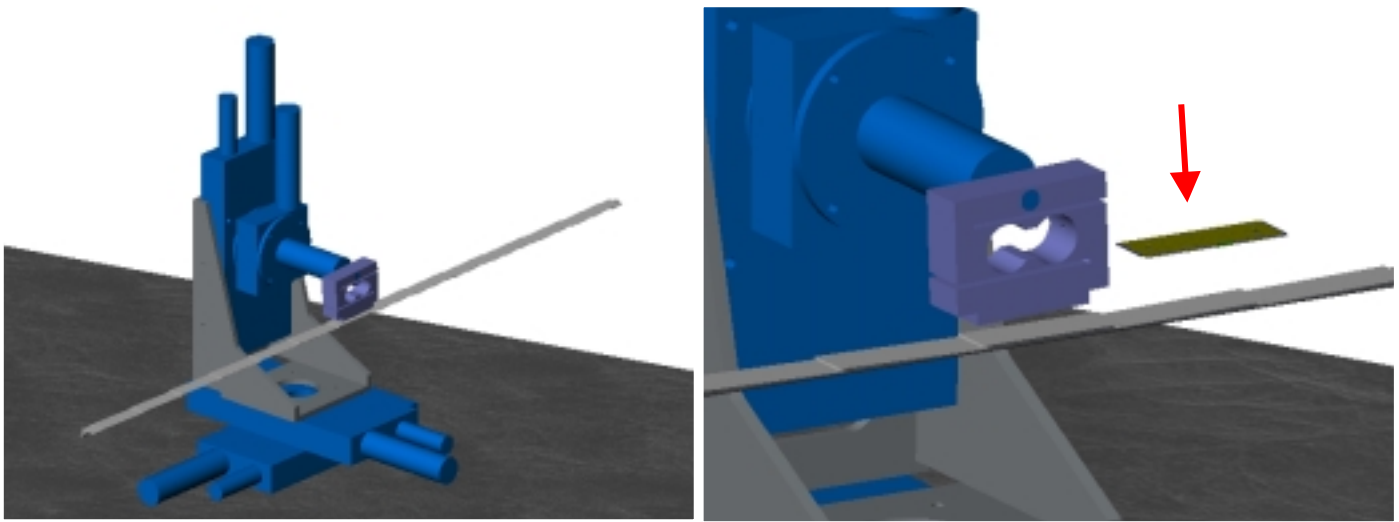
2. Assembly task sequence



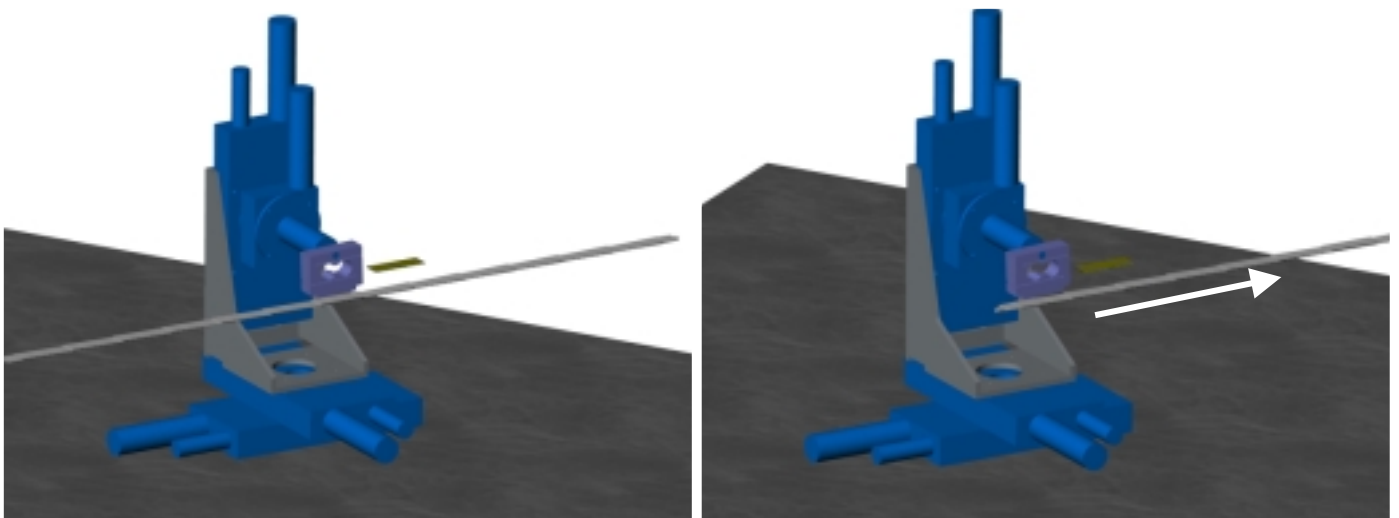


3. Tasks details

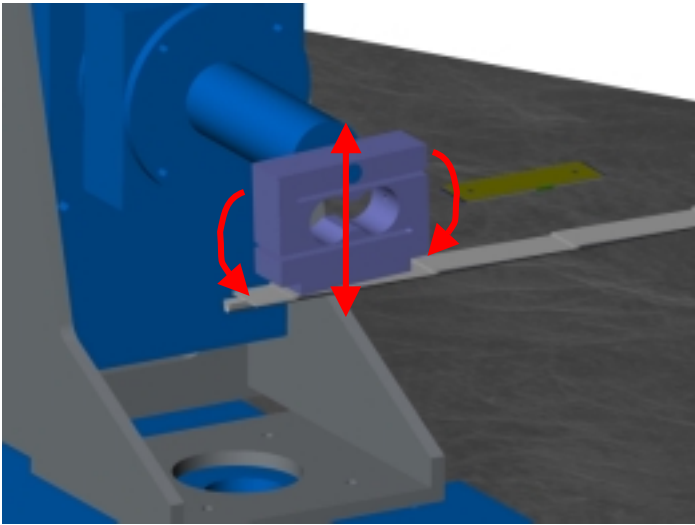
V.1



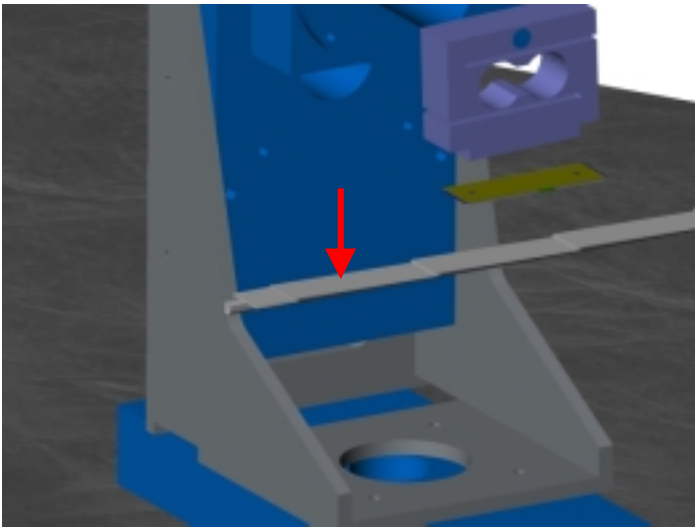
VI.2



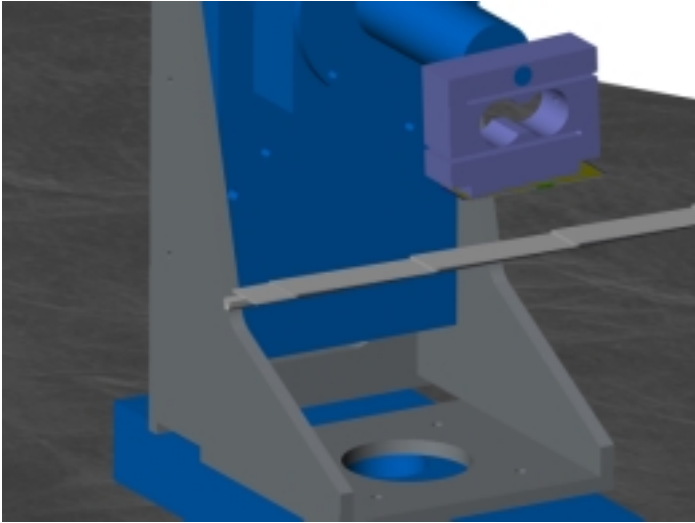
VI.4



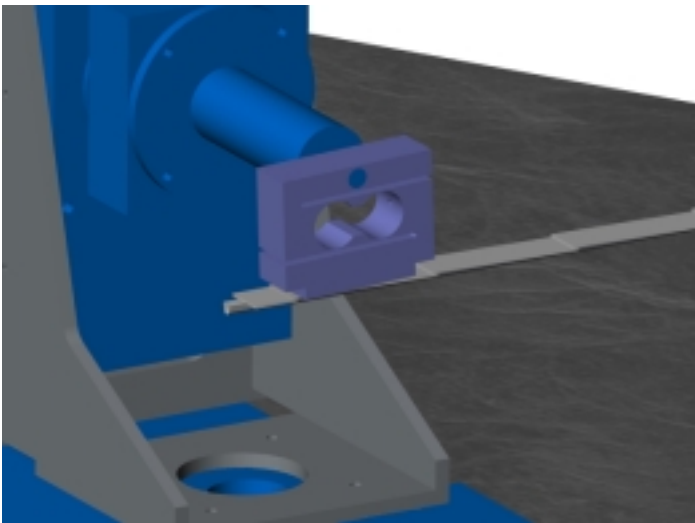
VI.5



VI.6



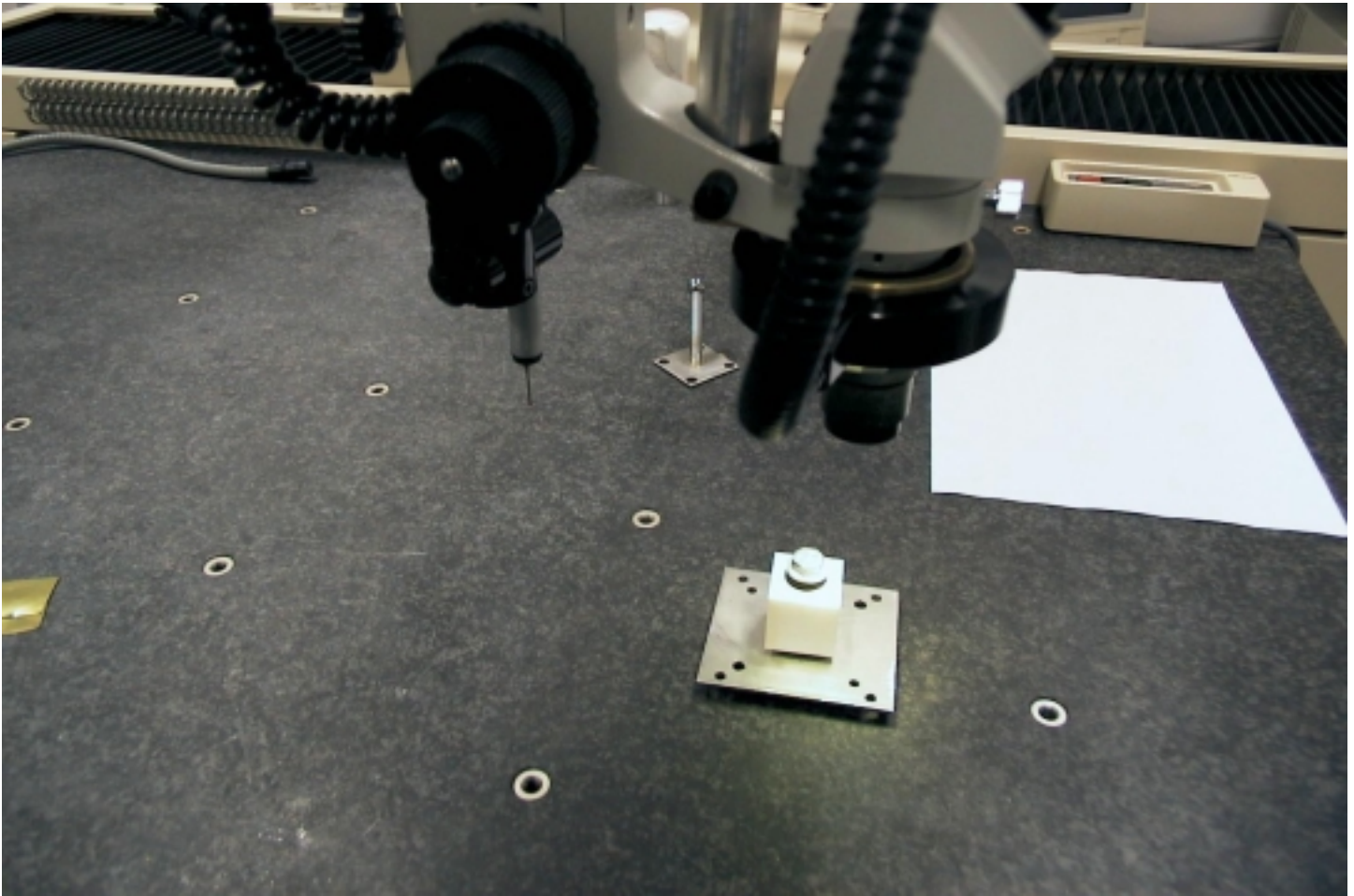
VI.7



4. Frames measurements

One of the main measurement difficulty is to locate the module frame in the stave one. Effectively, the stave frame is made of two rubys and one plan (one ruby centre is the frame reference point, the other ruby gives one direction of the frame and the plan by its normal axis give the two others directions of the fame) At CPPM due to the inaccuracy of the CMM in Z (and difficulty to measure a sphere with a camera), this frame can only measure but our ruby touch probe. More over the module frame which is represented by marks engraved on the Silicon, can only be measured with a CCD camera.

As shown on the following picture, the CMM which will be used for the assembly is equipped with a camera and a touch probe.



To calibrate the location in the horizontal plan of the center of the touch probe ruby and the center of the camera, a calibrated ceramic cube will be used (this cube can be separately measured by the touch probe and the camera, and its accuracy allows our CMM calibration).

The same kind of cube will be inserted on the tooling as reference frame (one on the robot head, the other one on the long slide).

5. Module location accuracy

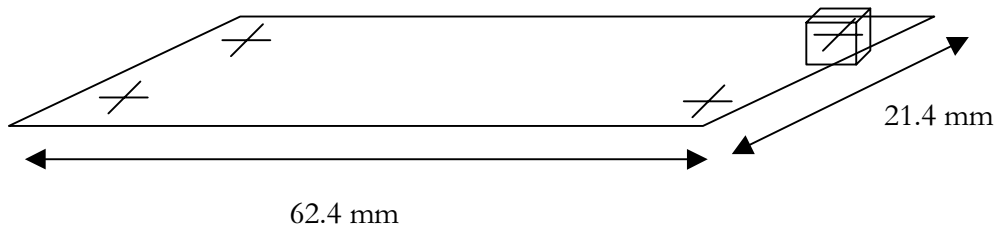
In October 99 Taking the data given by David Biltinger about the accuracy of the module location the tolerance of the module frame location was estimated.

The accuracy given by David was (those data will have certainly to be upgraded but are precious informations about the range of accuracy needed) all data are 1σ of the dispersion:

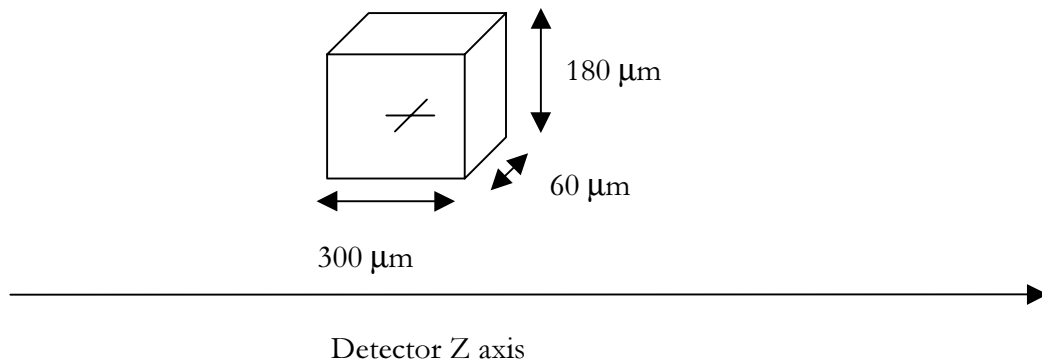
- Azimuth $\pm 15 \mu\text{m}$
- Radial $\pm 60 \mu\text{m}$
- Rotation around the normal module axis: $\pm 0.34 \text{ mRad}$

- Rotation around the detector Z axis : ± 3.6 mrad
- Rotation around the transversal axis: ± 1.0 mRad

From those data, and with regards with the module size at this time, it was deduced the following averaged tolerances of the modules marks location (the following data are $\pm 3\sigma$ of the dispersion (which is more useful for the measurements)):



With the above tolerances it was calculate that all marks should remain in the envelope shown bellow:



All of those data are now obsolete, and should be upgraded with the new module geometry and maybe new tolerances. It meanwhile gives a rough idea of the accuracy which have to be achieved with the assembly tool.