# General technical assumptions for the construction and equipment of insertion devices, front-end sections or experimental beamlines in field of alignment issues

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*The document describes what kind of equipment of insertion device, front-end section or experimental beamline construction is necessary in order to carry out the precise alignment of these components. Moreover, required documentation related to alignment issues is listed.*

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## 1. Elementary definitions

**Alignment –** survey leading to set up and lock particular component according with its nominal position, which is defined by the design, in relation to given XYZ coordinate system. Normally the alignment procedure is carried out in few iteration. Every single iteration is compound of two steps:

- the measurement which determines actual position of the component as well as value and direction of the correction that has to be applied
- mechanical correction of the position until nominal position is reached (changing value of the correction is given in the real time by the survey system – instrumentation + software)

**Mechanical adjustment system for precise alignment –** mechanical system that allows for precise movement as well as rotation and tilt of certain component (e.g. monochromator chamber) in horizontal and vertical plane. The movement of the component is usually carried out by so-called push blocks and screws with a fine thread (usually 0.1 mm resolution). The example of a mechanical adjustment system is presented on the drawing 1.

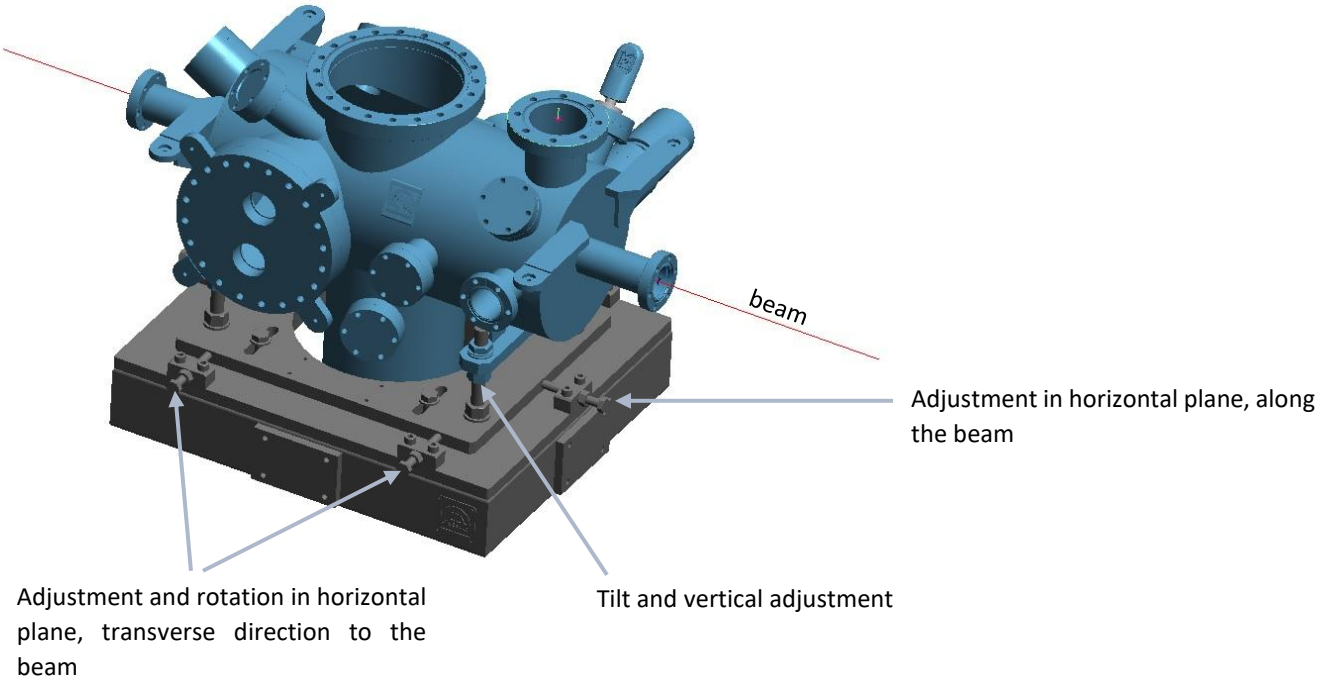


Figure 1: The example of a mechanical adjustment system for precise alignment

**Reference point socket –** special adapter performed in accordance with SOLARIS 1.5 or 0.5 standard, fixed permanently to any insertion device, front-end component or experimental line component that requires precise alignment. The adapter allows an installation of the reference point in the form of Leica RRR 0.5 or 1.5 inches spherical reflector (see figure 2).

**Reference point** (fiducial) – point materialized as a center of Leica RRR 0.5 or 1.5 inch spherical reflector, with strictly defined XYZ coordinates relative to the global Solaris coordinate system or a local coordinate system defined for the individual beamline with origin at its source. Collection of such points fixed on a particular component is observed during alignment process.

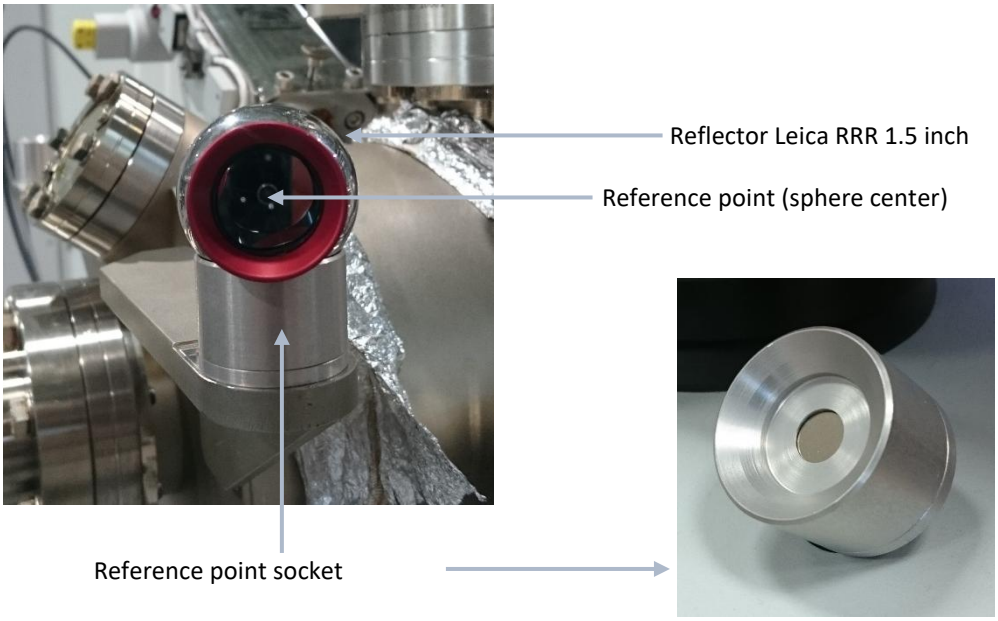


Figure 2: The example of reference point Leica RRR 1.5 inch

**Fiducialization** – a survey in order to determine the coordinates of the reference points (fiducials), fixed on the particular insertion device, front-end section or experimental line component, with respect to the elements that determine the course of electron or photon beam in this particular component. Correct definition of these coordinates (correctly performed fiducialization) is necessary to perform alignment process and guarantees that real beam trace is consistent with design assumption (ray tracing).

**Tracing** – survey in order to mark on the floor or wall (for the height), the approximate position of the beam axis and components that are part of the insertion device, front-end and experimental line set. Usually, the precision of tracing is at the level of about 1 or 2mm.

## 2. Vacuum chambers supports

*ATTENTION: The paragraph concerns only the functionality of the vacuum supports in terms of an alignment issues. A detailed characteristic in terms of mechanics can be found in the mechanical attachment.*

In the case of elements placed on the supports made from granite blocks, rigid steel frames or similar, the elements enabling free positioning of elements within the horizontal plane and compensation of the uneven floor surface should be used. Depending on the type of support construction it may be carried out using mechanical adjustment system (adjustment feet see figure 3) or by placing entire granite block on a steel slab, which, following a precise alignment in the vertical and horizontal plane, will be permanently fixed using the concrete, glue or other adhesive material preventing change of the position and inadmissible deflection of any of the constituents. If this solution be chosen, the block placed on the slab is to be provided with the elements correcting the final position of the entire element in the horizontal plane (so-called push blocks, see figure3). The solution where support is permanently fixed to the floor using concrete or anchoring without any adjustment possibilities is also allowed but this solution demand high precision horizontal alignment and leveling of the support according with design, that guarantees installation of the vacuum chamber in a range of its adjustment system.
In a situation where an element is to be anchored in the floor, the anchoring system that permanently protects the supporting element against translocation should be used. A recommended solution is the HILTI or equivalent system suitable for the mass, center of gravity and the function performed by the

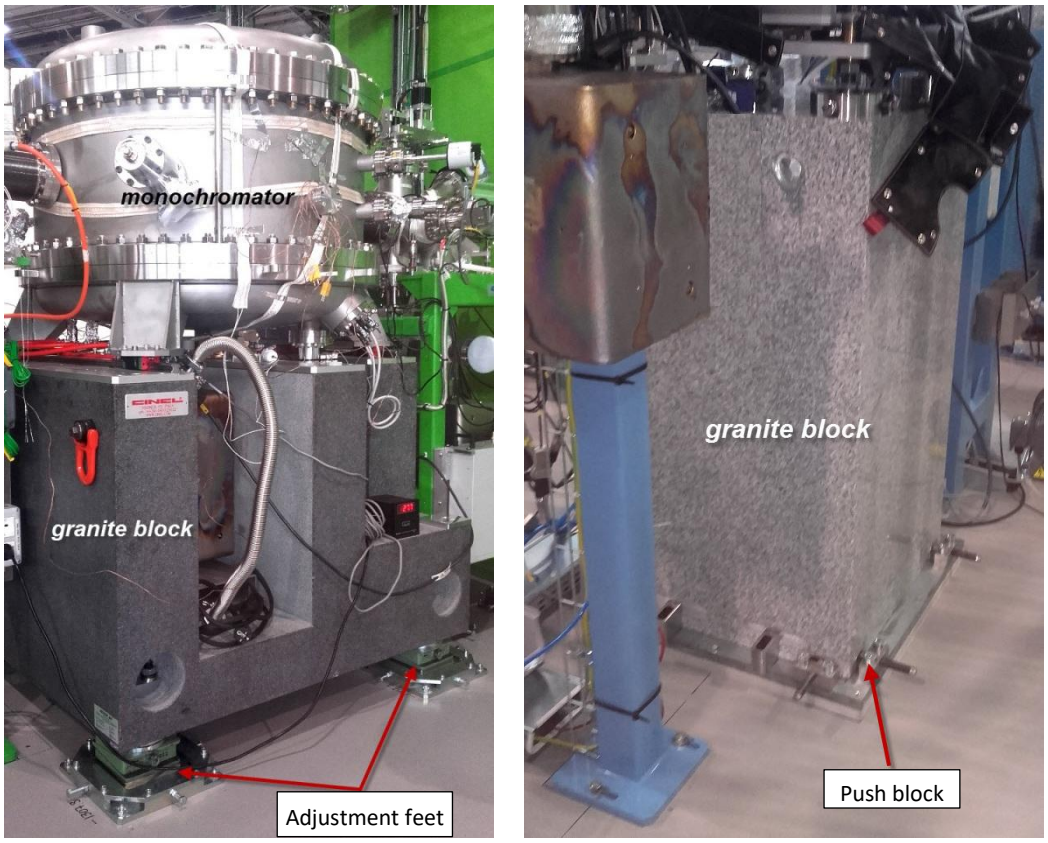


Figure 3: The example of suport installation and adjustment possibilities.

anchored element and the element situated on it. A preferred solution are anchors with the internal screw thread.

## 3. Guidelines and requirements in the field of insertion device, front-end section and beamline components alignment

3.1 Insertion device as well as front-end section and beamline components requiring alignment must be provided with mechanical adjustment system for precise alignment, i.e. along the X,Y,Z axes and enable inclination of the system within these three rotation axes. The range and resolution of the X,Y,Z regulation and rotation angles has been specified in reference to the beam axis and is given in the table 1. If higher accuracy is required or individual components need very precise alignment with respect to each other, the supplier must add additional alignment possibilities in agreement with the SOLARIS.

Table 1: The range and resolution of the X,Y,Z regulation and rotation angles

| | ***Range*** | ***Resolution*** |
|---|---|---|
| ***X*** | ± 15 mm | 0.1 mm |
| ***Y*** | ± 15 mm | 0.1 mm |
| ***Z*** | ± 15 mm | 0.1 mm |
| ***Θ*** | ± 0.8° | 0.2 mrad |

3.2 Insertion device as well as front-end section and beamline components requiring alignment must be also provided with the sockets dedicated to reference points (1.5 inch reflector or in case of less space 0.5 inch reflector) on the vacuum elements or representative parts of the construction like undulator girders. The location of the sockets has to be agreed with the Client. The Contractor has to perform threaded holes according to the Solaris standard presented on the figure 4. The necessary number of sockets for reference points will be delivered to the Contractor by the Client until the agreed deadline.

3.3 Coordinates of the reference points for each component have to be determined in particular coordinate system by fiducialization procedure. Prior to the fiducialization, the sockets for the reference points must be screwed into the dedicated opening (threaded hole) and connected permanently using the glue to the threads – e.g. Loctite 270 or equivalent.

3.4 Screws used to position the vacuum chambers and supports (the so-called alignment must be made from stainless or structural steel. In justified cases, use of other materials is admissible in selected parts of the interfacing components, e.g. brass washers. The ultimate technology to be agreed with the Contractor during the negotiation stage.

3.5 The Solaris alignment group is to survey the approximate location (the so-called tracing) of all the supports of the components according with the documentation provided by the Contractor.

3.6 The Contractor is responsible for mounting all components on each respective frame belonging to one support. Afterwards the Contractor shall align all components on each respective frame with respect to each other and to the reference points.

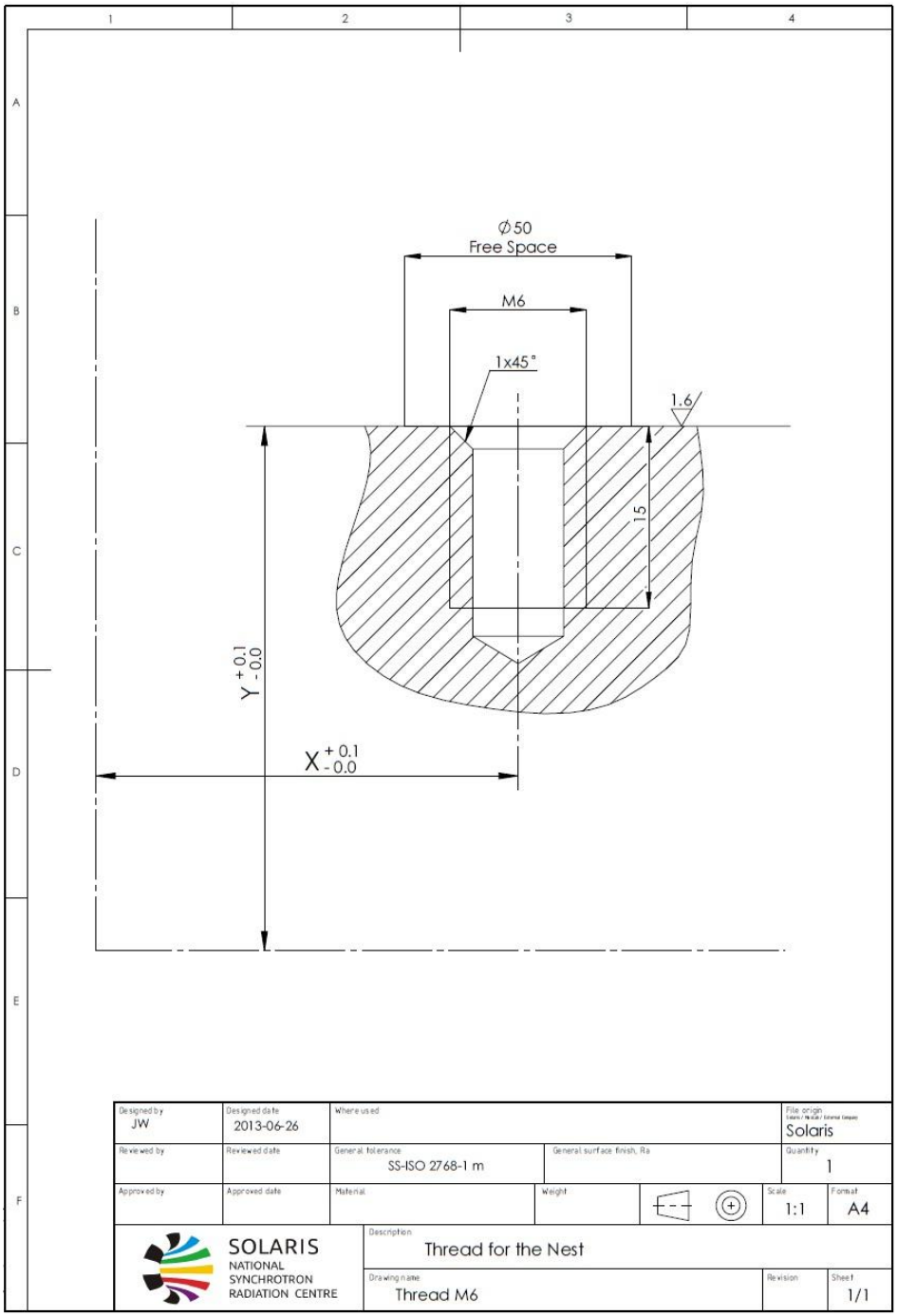


Figure 4: Solaris standard of a threaded hole dedicated to Leica RRR 1.5 inch reflector

3.7 According with the documentation provided by the Contractor, The Solaris alignment group is to carry out the complete alignment of the insertion device, front-end section and beamline vacuum components, **excluding the positioning of the monochromator optical elements if the case requires instrumentation other than a Laser Tracker or a Portable Measuring Arm**.

3.8 For the alignment purposes, the Client uses following instruments: Laser Tracker and Portable Measuring Arm, both supported by Spatial Analyzer software.

3.9 The Contractor undertakes to carry out the alignment of insertion device or any component of front-end or beamline section if the case requires use of any other measuring instrument than mentioned at point 3.8 above.

## 4. Required documentation related to alignment issues

4.1 Prior the tracing of individual components ant their final alignment, the Contractor has to provide relevant technical documentation that defines the position of the components. The documentation including the drawings of the components has to be provided in the form of step or iges files.

4.2 The Contractor is obliged to provide a complete documentation concerning the fiducialization process and its results for the insertion device, front-end components and beamline components, including the coordinates in the local coordinate system constituting the transfer of the beam axis to the external reference points. Additionally, an exact definition of the local coordinate system dedicated to the particular fiducialized component in relation to global Solaris coordinate system which will enable an unequivocal transformation of the component into the global coordinate system of Solaris. The documentation must be delivered in the PDF format or and a Spatial Analyzer batch file (.xit64 or .step) if possible.

4.3 In case of optical elements, if the fiducialization cannot be done prior SAT, it is allowed to do the fiducialization of the mentioned elements during installation time. However, for the time of optical elements vacuum chamber installation, the Contractor is obliged to provide relevant documentation that define geometry and precise location of each chamber of designed experimental beamline.

4.4 The Contractor undertakes to provide the tolerances for each of the position of the insertion device, front-end section component and beamline component in reference to the electrons or photons beam axis.

4.5 The Client is obliged to provide a map of the floor morphology within the insertion device, front-end section and beamline area.