Alignment and Handling Requirements for ALBA Beamlines.

Abstract

This document describes the technical specifications required in order to Handle and Align the different elements of the Beamlines.

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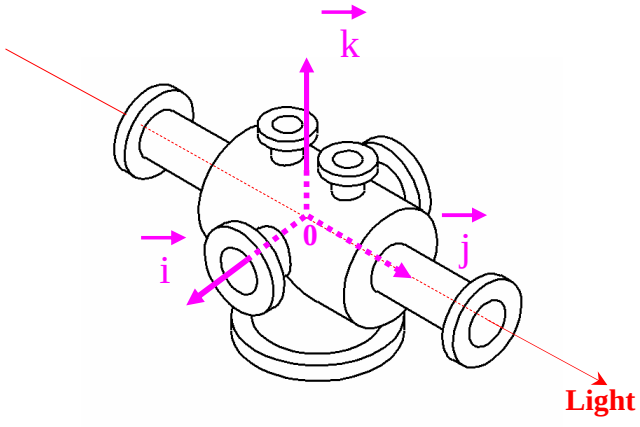
1. ALIGNMENT

1.1. Definition of the coordinate systems

Two coordinate systems will be used to define the position of the elements of the beamlines.

Component Coordinate System: $(\vec{i}, \vec{j}, \vec{k})$



Origin: **O:** on the beam line axis on the longitudinal geometrical center of the component.

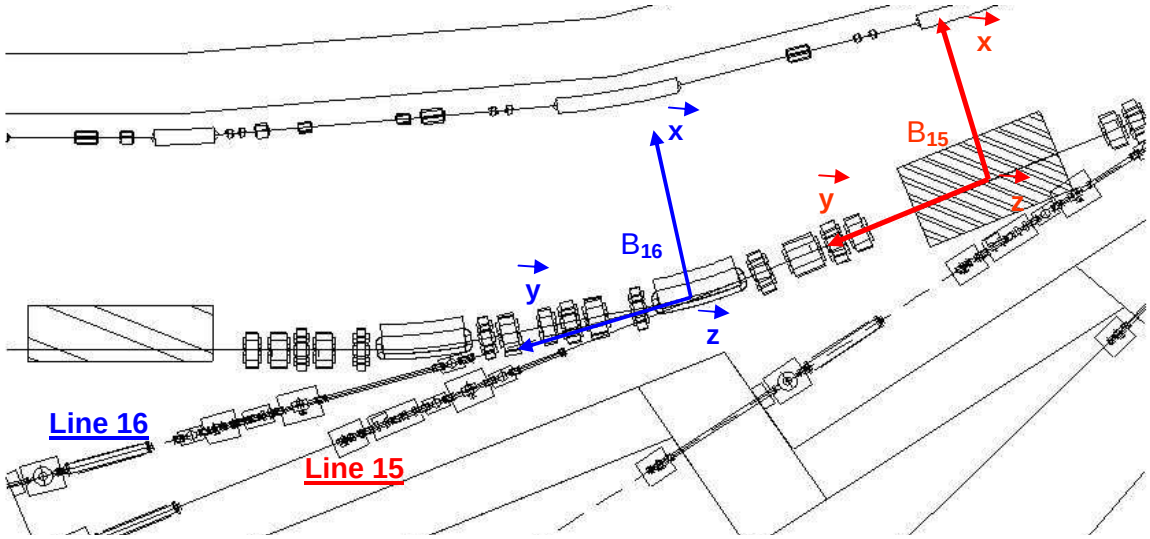
Axes: **i:** right-handed system.

j: tangent to the light in the direction of the light

k: collinear with the gravity in the opposite sense

Units: millimeter

BeamLine Coordinate System: $(\vec{x}, \vec{y}, \vec{z})$



For each beamline, we define a system in accordance with the kind of light source.

For Bending Magnet: **B_{16}(x , y , z)**

Origin: **S_{16} :** on the geometrical center of the source

Axes: **x:** right-handed system

y: tangent to the beam in the direction of the beam

z: collinear with the gravity in the opposite sense

Units: millimeter

For Insertion devices: **B_{15}(x , y , z)**

Origin: **S_{15} :** on the beam on the center of the straight section

Axes: **x**: right-handed system

y: tangent to the beam in the direction of the beam

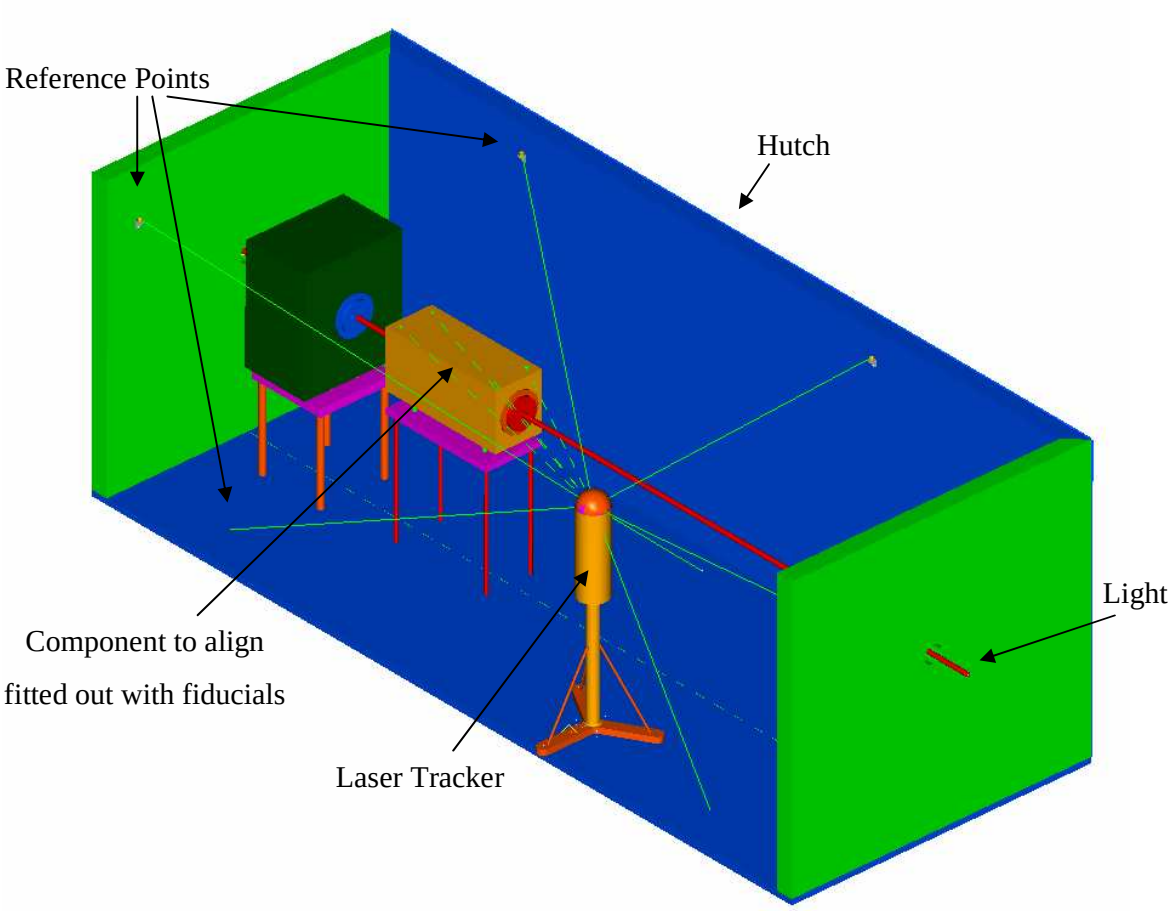
z: collinear with the gravity in the opposite sense

Units: millimeter

1.2. Philosophy of the Alignment Procedure

The Alignment Group belonging to the Engineering Division is in charge of the alignment of the elements of the beam lines. We have opted for a 3-D free stationing approach. The hutch will be fitted out with some reference points known in our Global Coordinate System, which is used to align the accelerator. The elements of the beam line will be aligned with respect to all these reference points.

An illustration of the alignment procedure is presented below:



Scheme of the alignment procedure in a hutch.

Using these reference points fixed on the walls and on the floor of the hutch, the Laser Tracker[1] is able to determine its position. Then, targeting some fiducial marks on the component to align, the Laser Tracker give the deviation respect to the nominal position. The component is thus adjusted.

[1] A Laser Tracker is a highly dynamic measuring system for three dimensional coordinate determination using a single beam laser interferometer, precise angular encoders and a sophisticated servo-tracking system.

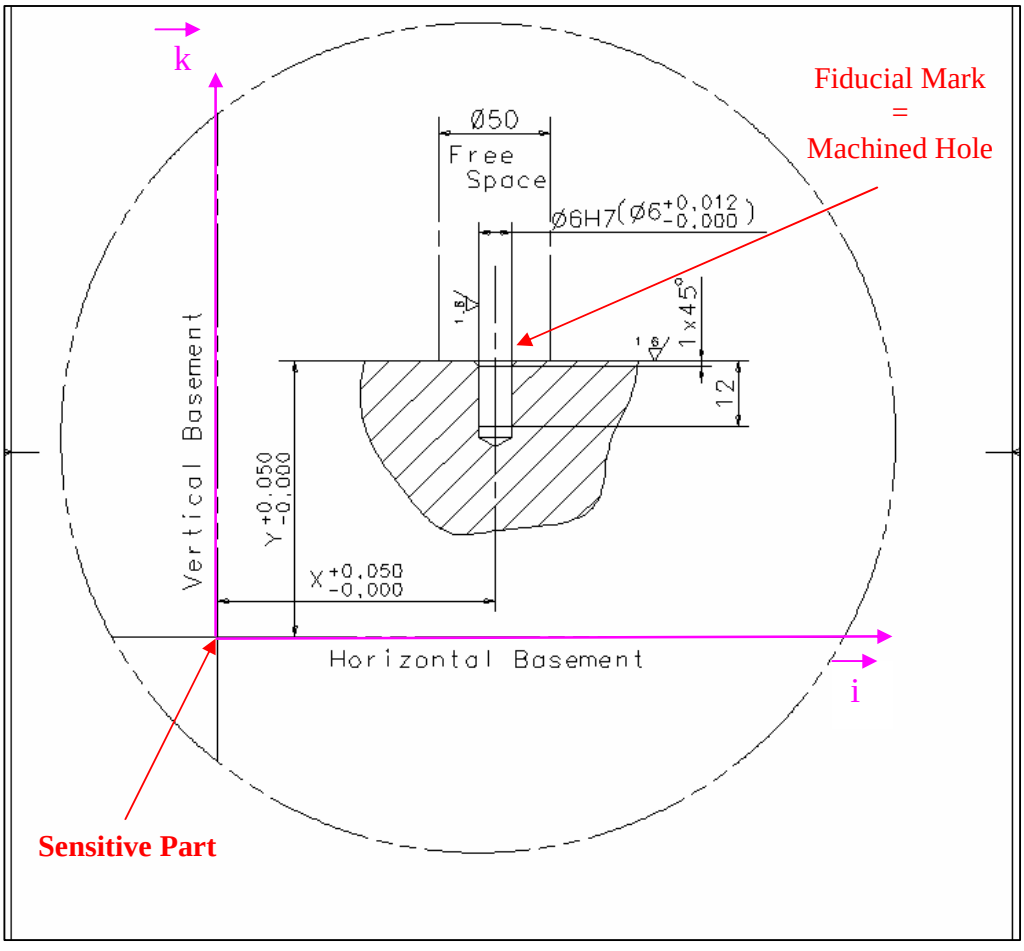
1.3. Type of fiducial marks

The type of fiducial marks depends on the kind of instruments used for alignment. In our case, the Laser Tracker is an optical instrument that needs lines of sight for measuring. As most of the components of the beam lines are in vacuum or confined in a vessel, it is impossible to target directly the sensitive part of the element (axis of the beam, mirror…). This sensitive part has to be referred to external points of the element to align. This is called the *Fiducialization*.

The Laser Tracker runs with a 1.5" corner cube reflector. Used with a magnetic interface, the best way for Fiducialization is a machined hole as described bellow:

1.5" corner cube reflector

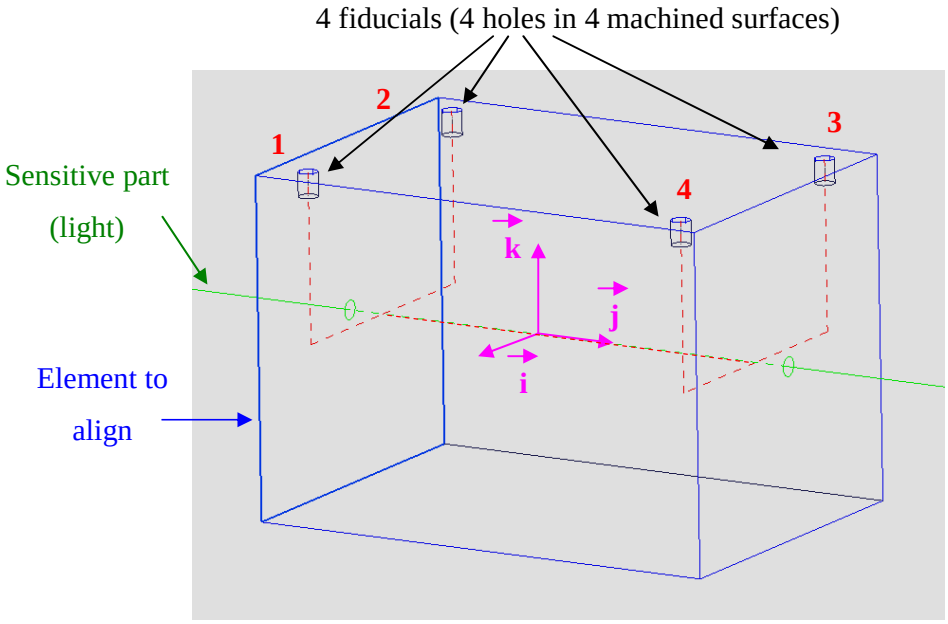
This hole allows us to symbolize one precise point. The intersection between the planar surface and the axis of the cylinder defines our fiducial.



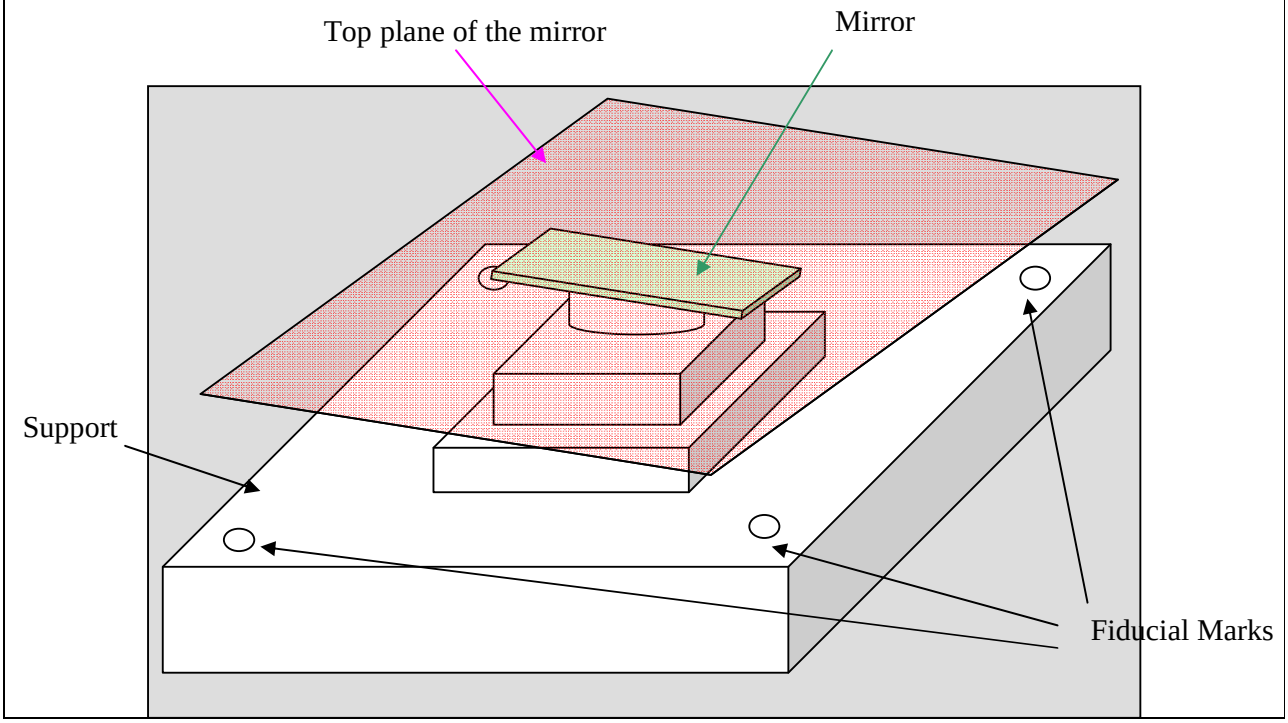
Fiducial Mark: Alignment Reference Hole

Examples of Fiducialization:

- For this simple case, the element is fitted out with 4 fiducials. If we know the coordinates of the fiducials, measuring the position of our fiducial marks with the Laser Tracker, we can deduce the position of the sensitive part of the element.



- For this other case, the sensitive part is a mirror. The plane representing the surface of the mirror needs to be referred to the fiducials. Then, targeting the fiducials with the laser tracker it is possible to determine the position of the mirror.



1.4. Alignment requirements for the supplier

For alignment considerations the supplier has to:

- fit out the element to align with fiducials marks:

  - At least 4 fiducials. The exact number depends on the kind of element and shall be approved by Cells.
  - The fiducials shall be set on a rigid frame mechanically linked with the optical element to align. Any fiducial on a movable part or on the chamber vessel should be ruled out since it may be deformed by vacuum pressure.
  - All the component of a same hutch shall be aligned from a single position of the Laser Tracker. The lines of sight from the Laser tracker to all the fiducials have to be optimized.

- provide the coordinates of the fiducial marks with respect to the sensitive part:

  - The position of the fiducials with respect to the sensitive part shall be given within the specification of 50μm in accordance with physicist requirements. A coordinate measuring machine can easily determine it.

1.5. Solution of help

All the components of the beamline should also be equipped with appropriate fitting enabling an alignment using optical instruments as theodolite and level.

2. HANDLING

- All heavy components of the beamline should have provision for handling and lifting by a crane.
- In some specific cases, the supplier should provide tooling when the standard procedure is not adequate.
- For all components, the supplier should provide the handling drawings.