Elettra Sincrotrone Trieste

Installation and Alignment of Beamlines at Elettra

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Table of Contents

1. Introduction

Both the components of the Elettra and Fermi accelerators (ACC) and their respective beamlines (BL) have been installed and aligned using the Laser Tracker (LT) and the Spatial Analyzer (SA) application. The adopted procedure involves setting up the LT, which is located within the BL network by measuring several points in the reference alignment network adjacent to the installation area. Using the SA application, the LT coordinate system is oriented on the BL optical axis with the origin at the BL source point. Once the various components are fixed to the floor before being pumped down, the actual alignment is carried out. The LT's Corner Cube Reflector (CCR) is placed on the component to be moved, and following SA's instructions, it is shifted until the final position is reached. The CCR needs to be repositioned multiple times on the various supports of the component during alignment.

2. General Information

All components of Elettra 2.0 BL must be positioned within the LT alignment network. Therefore, each component to be installed (monochromators, mirror chambers, diagnostic chambers, pumping chambers, experimental chambers, front-end, etc.) must be equipped with appropriate devices (CCR support) for positioning the LT CCRs. Connection chambers and bellows typically are not prepared for the CCR but will be evaluated by Elettra.

3. Type of Installation

CCR supports can be either movable or fixed. In any case, the total space for the CCR and support is Ø 40 mm in diameter and 50 mm in height. For housing the movable type, a cylindrical hole Ø 6 mm H7 tolerance and 20 mm deep should be provided on the component, while for the fixed type, a threaded hole M6 or M8 (to be agreed upon) 20 mm deep should be provided. Where possible, it is advisable to carry out the machining through the entire thickness of the material.

4. Positioning of Components

Typically, BL components consist of:

- A support (metal frame or granite base) equipped with leveling feet (± 25 mm adjustment in spatial coordinates and the possibility of pitch, roll, and yaw adjustments) for floor or appropriate reference plate fixing;
- A chamber mounted on the above support and equipped with a fine position adjustment system with the same 6 degrees of freedom as the support;

In light of this configuration, it is required that both components (support and chamber) have at least 4 zones where the CCR supports can be installed, with at least three simultaneously visible from a single point (LT in measurement station). Only in special cases can Elettra authorize the provision of only 3 zones per component. Specific positions should be agreed upon with Elettra for each BL element.

As a general rule, the recommended position for supports is as high as possible (top of the frame or base) in line with the ground leveling feet. On the component chambers, the situation is usually more complex and must be evaluated case by case. Generally, the most suitable position for CCR placement is on the vacuum chamber body, while flanges can only be used in special cases. CCR supports should always be installed on the part of the chamber that supports the component movement mechanisms (mirrors, slits, diagnostics, etc.). Again, it is recommended to place CCR supports in line with the adjustment systems between the chamber and the support.

CCR supports should be installed only on flanges containing internal mechanical parts (e.g., masks), not those used solely for vacuum containment.

5. Component Fiducialization

The operation of measuring the position of the CCRs mounted on components relative to their center, used later as an insertion point in the alignment network, is called fiducialization. In summary, knowing the position of the CCRs also indicates the position of the component's center, which becomes non-measurable due to the vacuum confinement. Typically, fiducialization is performed once mechanical assembly is complete, with all movement systems wired and in air. During this phase, the ranges and angular movements of mirrors, slits, diagnostics, etc., are also checked.

Fiducialization is carried out with a 3D measuring machine (Coordinate Measurement Machine) or a 3D measuring arm (Portable CMM). The coordinate systems of the various components' fiducializations must all be congruent. Typically, the right-hand rule (RHR) is used with the +X axis in the direction and towards the photon beam, +Z as the vertical axis, and +Y transverse to the beam. The origin is positioned at a specific point of the components

(e.g., beam bend point, beam entry in the chamber, etc.). At the end of fiducialization, the components' CCRs will be referenced in these coordinate systems.

6. Elements for Elettra

Elettra will be responsible for:

- Ground marking the vertical projection of the BL photon beam axis;
- Providing the coordinates of the alignment network points near the BL installation area for LT setup;
- Providing construction drawings of the “CCR supports”;
- Providing orientation guidelines for the fiducialization reference system.

7. Elements for the Contractor

The contractor, equipped with the contractor’s own alignment instrumentation, will:

- Mark the ground plates and leveling feet of the supports;
- Position and secure all components in situ;
- Perform the final alignment of all components;

The contractor must also provide all data used for component alignment organized in text files (*.txt) and tabulated in the following format:
component_name point_name XYZ with coordinates expressed in mm. Specifically, the file must contain:

- The CCR coordinates referenced to the local fiducialization system;
- The coordinates of plates and leveling feet referenced to the source point;
- The final coordinates of all component CCRs referenced to the BL source point.

If the contractor uses SA for component alignment, the contractor must provide all the above data in a proprietary SA *.xit64 format file.
