



Design Guide for Precision Aligned Components

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1.0 INTRODUCTION

1.1 PURPOSE

This guide describes the CLSI survey and alignment system and the design requirements for precision alignment of the technical components. The primary objective of this document is to communicate these requirements to CLSI staff, suppliers and users to ensure efficient installation, alignment, maintenance and realignment of technical components.

1.2 BACKGROUND

The alignment of components at CLSI is based on a 3 dimensional theoretical model of the facility and its components. The component positional coordinates are derived from a CAD drawing and a survey network is used to place the components. The CAD drawings and the survey network share a common coordinate system and origin.

Precision aligned technical components include any component whose position must be aligned with respect to either an electron beam or photon beam. The survey network is also used to align non-critical components.

CLSI uses an apparatus called a Total Station (Leica TC2003) in conjunction with software for surveying. The Total Station is a combination of a theodolite and an EDM. The theodolite measures vertical and horizontal angles while the EDM measures distance. The surveyor points the Total station at a SMR, which rests in a precision nest, mounted in a SMR mounting hole. The instrument shoots an infra-red light beam at the SMR which is reflected back. A software package uses the information from the EDM, theodolite and survey network to calculate the coordinates of the SMR. The amount of movement and direction required to move the component to its theoretical position is also calculated.

CLSI has found from experience that if all conditions are met, components can be placed within 0.1mm from theoretical coordinates.

1.3 DEFINITIONS AND ABBREVIATIONS

CAD: Computer Aided Design

CLSI: Canadian Light Source Incorporated, the working name of the facility

CNC: Computer Numerically Controlled

EDM: Electronic Distance Meter

Linac: Linear Accelerator

LTB1: Linac to Booster Ring Transfer Line

SMR: Spherical Mounted hollow Retro-reflector (see Figure A below)

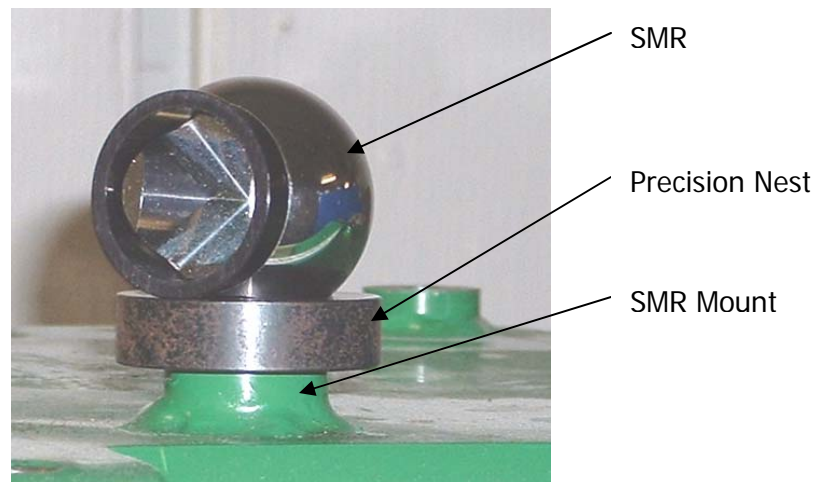
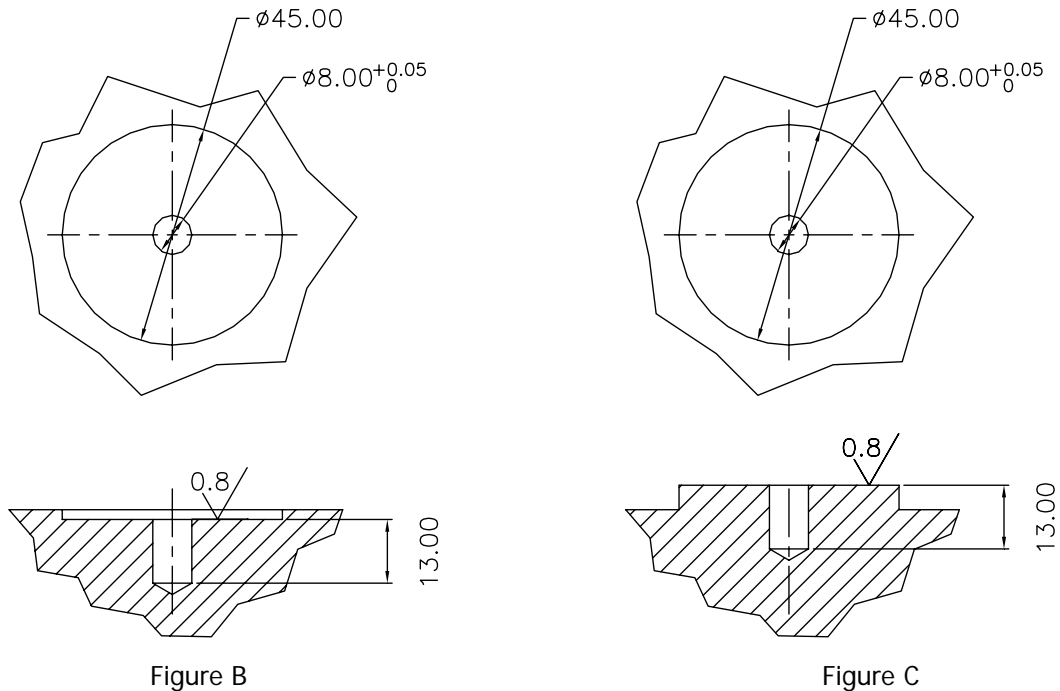


Figure A

1.4 SMR MOUNTING

1.4.1 SMR Mounting Hole

A consistent and repeatable mounting location is required for the SMR precision nest. Two acceptable mounting holes are shown below. Consult with CLSI for other acceptable variations.



1.4.2 Placement

The quantity and location of the SMR mounting holes will be determined in consultation with CLSI. The general design requirements are as follows:

- The distance between the component's critical geometry and the SMR mounting hole should be a fixed constant known value. If the SMR mounting holes cannot be placed on a single contiguous part, as in the case of a bolted assembly, location fit dowels shall be used between mating parts. Location fit dowels ensure that mating parts can be consistently reassembled if disassembly is ever required.
- The line of sight from the survey instrument to the SMR should clear and uninterrupted. Consult with CLSI for the definition of the surrounding environment.
- The SMR mounting holes should be located near or have a direct relationship to the component's adjustment mechanism. Refer to section 2.3.3 Component Alignment Adjustment.
- There should be a minimum of three SMR mounting holes. Additional holes may be required depending on the component and its location.
- The distance between SMR mounting holes should be as large as possible to maximize measurement accuracy.

1.4.3 Placement Confirmation

The SMR mounting holes should be measured after fabrication to determine the “as built” distances between the critical geometry and the SMR mounting holes location. The measurement accuracy will vary depending on the type of component and can be determined in consultation with CLSI. CLSI has found from experience that if all conditions are met, components can be placed within 0.1mm from theoretical coordinates.

1.5 DRAWINGS

A general assembly drawing is needed for survey and alignment showing the following requirements:

- a) The theoretical center line of beam path travel through all components in both the plan and elevation views.
- b) The component SMR mounting hole locations in both the plan and elevation views.
- c) Dimensions between important components.
- d) If there is range of movement to the component, the component shall be shown in the mid-point of its travel range. The full range of movement in all directions should also be indicated.
- e) If the component requires a support structure, the floor to support structure bolt hole pattern shall be shown.

1.6 OTHER

1.6.1 Drill Templates

CLSI has found using a drill template, fabricated using CNC equipment, that contains the floor bolt hole pattern of several support stands to be very time efficient and accurate in placing support stands. This is the preferred method and any proposed deviations shall be submitted to CLSI for review and approval.

1.6.2 Grouting Allowance

The CLSI concrete floor elevation can vary +/- 20mm. Height allowances should be made for this variance using a space allocated for grout. Grout allows the component support structure to be leveled and ensures that vertical adjustment mechanisms do not run out of travel. CLSI typically allows 40mm grout allowance, using theoretical beam height.

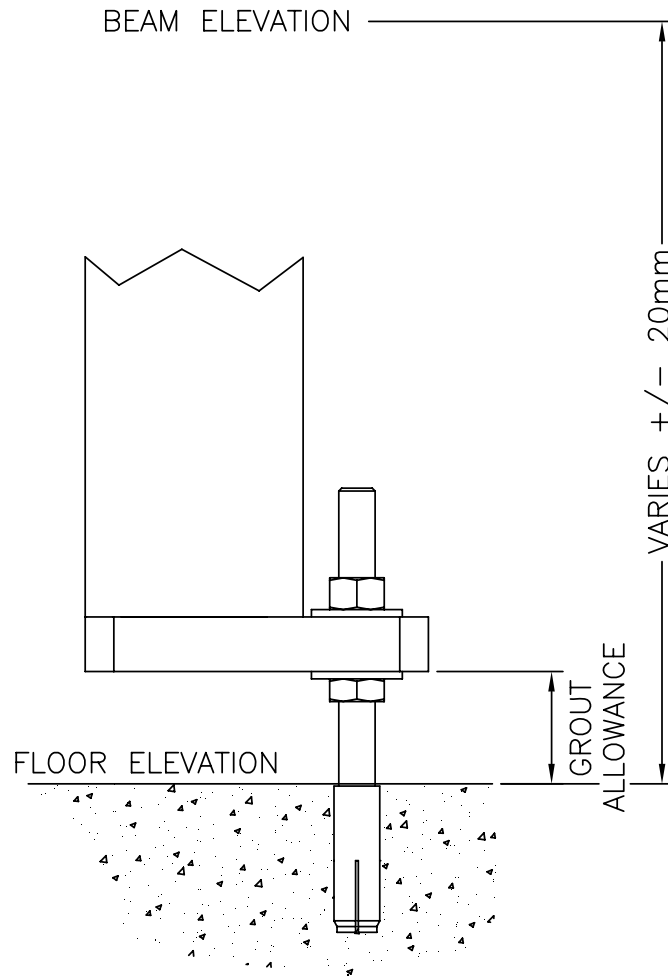


Figure D: Grout Allowance

1.6.3 Component Alignment Adjustment

There should be considerable thought given to the adjustment mechanism for aligning the component. Experience has shown that a component can be difficult to bring into alignment if the adjustment mechanisms do not have a direct relationship to the SMR locations. It is also advantageous to have a surface parallel to the horizontal plane on which to place a precision level. The adjustment mechanisms should be designed in consultation with CLSI. Several Examples are shown below:

a) Preferred Adjustment Mechanism Design

The Storage Ring Magnet adjustment is an example that was easy to align. This particular design used four vertical adjusters and three horizontal adjusters. Normally three vertical adjusters would be ideal, but because of the mass of the dipole magnet, it was felt that four were needed for stability. The dipole magnet SMR locations (not shown) were situated directly above the vertical adjusters, making the alignment process much more efficient.

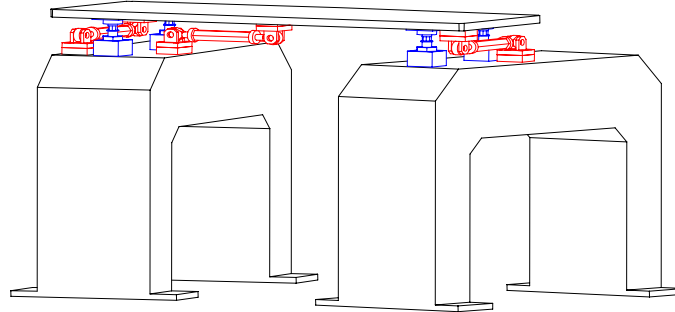


Figure E: Storage Ring Dipole Magnet Adjustment

b) Non-Preferred Adjustment Mechanism Design

This adjustment mechanism with four horizontal adjusters, makes it very difficult to remove any horizontal angular errors.

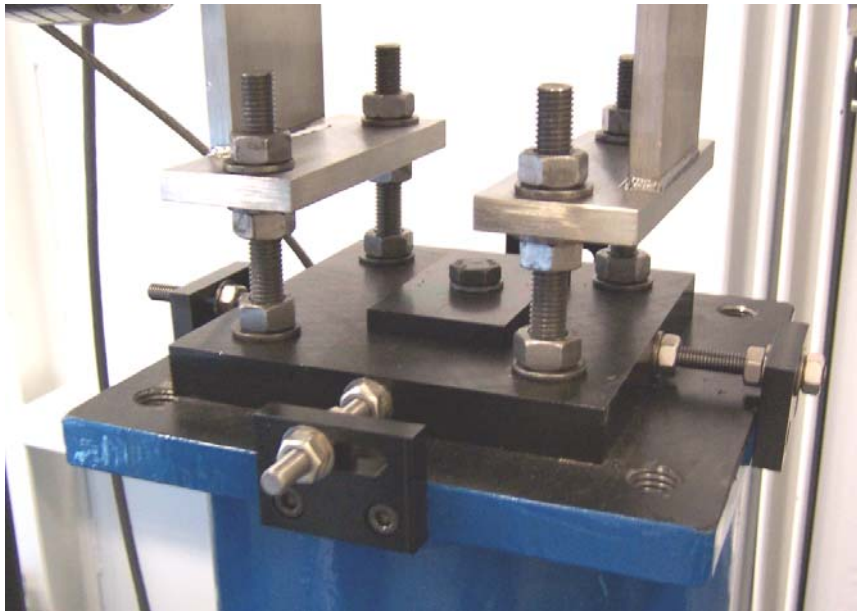


Figure F: Beamline Component Adjustment mechanism