Alignment without Magnet Fiducials

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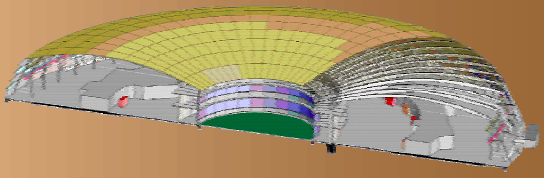
Presently, the demand for high quality synchrotron radiation is increasing all over the world. One of the fascinating aspects of this novel tool is the broad range of scientific users interested in synchrotron radiation. They come from physics, chemistry, biology, and medicine, to name just a few. Third generation storage which recently became available for users will by far not be able to satisfy all the beam-time requests. In addition, it is also recognized that long-term scientific efficiency and technological success is heavily dependent on ease of access to a home based facility nearby and continuing fine-tuning of all components of a beam line. Based on the high quality user community in Switzerland and their prospective research activities, the Paul Scherrer Institute, in close collaboration with interested research groups from the Swiss universities and the Swiss Federal Institutes of Technology, has worked out a proposal to build an advanced synchrotron light source in Switzerland, which will come into operation in the year 2001. It has been named SLS as acronym for Swiss Light Source.



Objective

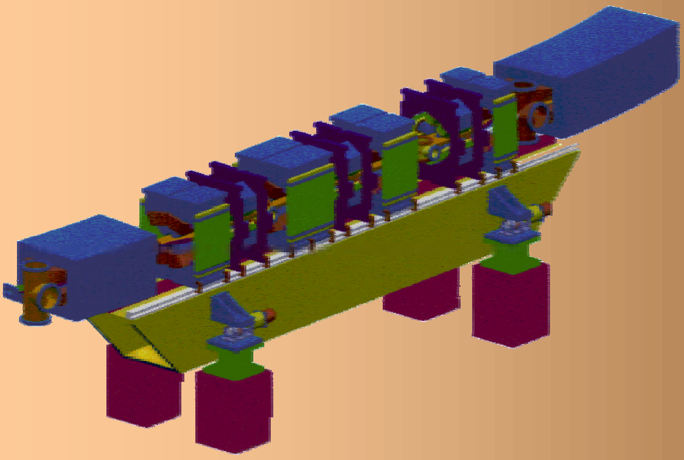
Fiducialization

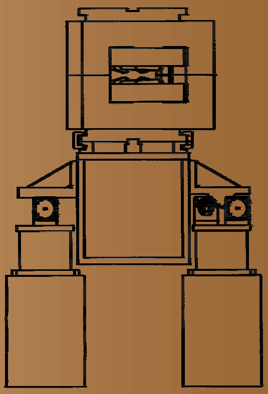
The correct fiducialization of magnets is as important as their correct alignment since an error in either task will affect the particles' trajectory and cannot be distinguished from each other. Fiducialization can be accomplished either through opto-mechanical and opto-electrical measurements or by using fixtures, which reference to a magnet's reference features. Detailed descriptions can be found in the literature.

Ruland, R., Setting Reference Targets, in Proceedings of the CERN Accelerator School on Magnetic Measurements and Alignment, Capri, 1997, in print.

Relative Alignment

In an ideal storage ring with perfect alignment, the closed orbit is equal to the design orbit, i.e. the beam will pass precisely through the magnetic centers of all components. In the real world, however, every component will have transverse misalignments. If these misalignments will not exceed the given alignment tolerance, a new distorted closed orbit will establish itself. To quantify the sensitivity of the closed orbit to the misalignment of a specific component, amplification factors are calculated. These amplification factors can be lowered significantly, and thus the distortion of the closed orbit can be reduced, if the relative alignment of certain groups of magnets is improved and maintained. To achieve and maintain a better relative alignment, the respective magnets are usually grouped and mounted on a common support system, raft or girder.



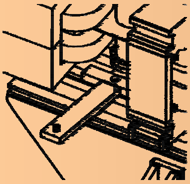


Girder system cross-section

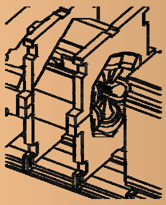
Solution

Forced-Centered Girder Mounting System

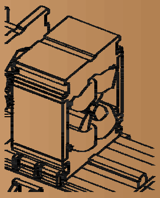
The girder mounting and alignment approach proposed for the SLS takes advantage of progress made in the ability to machine large components very accurately without incurring a significant cost penalty. This technology makes it viable to design a self-aligning mounting system where components have a mechanical reference feature machined or stamped into their shape which fits without play onto a straightness ruler incorporated into the girder design. This approach obliterates the need to fiducialize individual components in the traditional sense; the reference feature takes the place of reference fiducials. As can be seen, the vertical alignment of components is given by two guide rails on each side of the girder in combination with respective support points or structures on the components' part. The center rail defines the horizontal alignment, again in conjunction with a respectively designed and dimensioned reference surface on the bottom of the magnets or on support structures of other components. The design details need to guarantee that the self-aligning mount is kinematic. The SLS design is an extension of the approach first pioneered by NIKHEF and MAXLab.



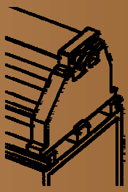
Alignment fiducial referenced on girder



Sextupole referenced on girder



Quad referenced on girder



BPM referenced on girder