International Workshop on Accelerator Alignment

Monday, 13 October 2014 - Friday, 17 October 2014

IHEP

Book of Abstracts

Contents

0

Managing the survey activities at CERN during LS1

Author: Dominique Missiaen[1]

Co-authors: Jean-Christophe GAYDE [1]; Jean-Frédéric FUCHS [1]; Patrick Bestmann [1]

[1] *CERN*

Corresponding Author: dominique.missiaen@cern.ch

The Long Shut-Down 1 (LS1), has been triggered by the repair of the splices in the interconnections of the Large Hadron Collider (LHC) cryo-magnets. The "weakness" of these splices needed to be repaired in order to run the LHC at its ultimate energy of 14TEV to accumulate more luminosity and events to improve the knowledge of the parameters of the Higgs' s boson discovered at CERN in 2012. This long shut down of CERN accelerators gave the opportunity to the survey and alignment team to measure and realign the 27km of LHC magnets but also most of the injector chain components. The Proton Synchrotron (PS), the first accelerator at CERN, its booster (PSB) and transfer lines were not realigned since years. Some parts of the Super Proton Synchrotron (SPS) and the transfer lines to the LHC are known to be geologically unstable since their construction. All these are very good reasons to review the alignment of almost all the components of the CERN complex. The LHC big detectors were also considerably modified and this work was done under the control of the survey team, using the cavern network as a reference, network which was re-measured and linked to the machine network.
This paper gives an overview of the survey activities done during the two years of shut-down, especially from the management and organisation point of view, taking into account the enormous amount of work to be done with tight schedules and by personnel which has considerably changed since the previous measurements campaign in 2008.

1

Preparing the SPS alignment for the future LHC runs

Author: Patrick Bestmann[1]

[1] *CERN*

The Super Proton Synchrotron is the last machine in the LHC injector chain, just before the injection into the LHC. Operational since 1976 the SPS provides the LHC with a 450GeV beam and is not less demanding in terms of alignment than the LHC. At high energy the alignment is playing an even more critical role for the beam orbit due to the fact that the SPS corrector magnets are designed for only half of the operating energy. The alignment campaigns are completed by a beam based alignment campaign. Like this, the SPS can run with its natural orbit without major corrections.
Ground movements have slowly increased some aperture restrictions during the last years leading to limitations in the performance of the machine. The LHC transfer lines are known to be geologically unstable since their construction. All these are very good reasons to review the alignment of the whole complex. The LS1 gave the unique opportunity to do this in one single big campaign and to review procedures, techniques and instruments at the same time.
This paper will review all the survey activities realised in the SPS complex during LS1 and will present the results of the measurements and alignments campaign.

2

Remote qualification of HLS and WPS systems in the LHC tunnel

Author: HELENE MAINAUD DURAND[1]

Co-authors: Mateusz Sosin [1]; Michel Rousseau [1]; andreas herty [1]; antonio marin [1]

[1] *CERN*

Corresponding Author: helene.mainaud.durand@cern.ch

The position of the low beta quadrupoles of the LHC is monitored by Hydrostatic Levelling Systems (HLS) and Wire Positioning Systems (WPS). These magnets are located on each side of the four experimental areas, where the level of residual radiation will increase with the next steps of LHC operation. This will reduce the possibility of future access in these areas more and more. The regular validation of monitoring systems is very important to guarantee the sensor's fuunction and hence consistent data. Concerning the HLS system, the qualification is performed by varying the water level in the hydraulic network. The observed height difference on each of sensor along the network must be the same. Concerning the WPS system, the qualification is performed by displacing the wire on its both extremities. The difference between the readings of the sensors must be proportional to their longitudinal position. Two systems have been designed to perform such a remote qualification: a filling/purging system for the HLS system and a Wire Displacer System for the WPS. In this paper, the requirements and the solutions proposed are described, with the emphasis on the conceptual design and the results obtained.

3

Alignment methods developed for the validation of the thermal and mechanical behaviour of the Two Beam Test Modules for the CLIC project

Author: HELENE MAINAUD DURAND[1]

Co-authors: Mateusz Sosin [1]; Vivien Rude [1]; mathieu duquenne [1]

[1] *CERN*

Corresponding Author: helene.mainaud.durand@cern.ch

CLIC (Compact LInear Collider) project will consist of more than 20000 two meters long modules. A test seup made of 3 mocules has been built at CERN to validate the assembly and integration of all components and technical systems in the crowded environment of a module and to validate the short range strategy of pre-alignment. The test setup has been installed in a room equipped with a sophisticated system of ventilation able to reproduce the environmental conditions of the CLIC tunnel, including the longitudinal air flow. Some of the components have been equipped with electrical heaters to simulate the power dissipation, combined with a water cooling system integrated in the RF components. Using these installations, in order to have a better understanding of the thermal and mechanical behaviour of a module under different operation modes, machine cycles have been simulated; the misalignment of the components and their supports has been observed. This paper describes the measurements methods developed for such a project and the results obtained.

4

Drive Beam Quadrupoles for the CLIC project: a novel method of fiducialisation and a new micrometric adjustment system

Author: HELENE MAINAUD DURAND[1]

Co-authors: Jacek Sandomierski [1]; Mateusz Sosin [1]; Mathieu Duquenne [1]; Vivien Rude [1]

[1] *CERN*

Corresponding Author: helene.mainaud.durand@cern.ch

CLIC (Compact LInear Collider) Drive Beam Decelerator will generate RF power to accelerate the colliding beams. One key component of the decelerator is the Drive Beam Quadrupole (DBQ). More than 40000 DBQ will have to pre-aligned within a challenging precision and accuracy: the magnetic axis of each DBQ will have to be positioned in a cylinder with a radius of 20 micrometers, over a sliding window of 200m along the 20 km of linacs. The current strategy of pre-alignment foresees; first to perform the fiducialisation of the DB quadrupoles, i.e. determining the position of the magnetic axis of each quadrupole w.r.t. external alignment targets; second to pre-align two DBQ on a common support; third to align the support once installed in the tunnel. In order to make the strategy easier, we propose a novel method of fiducialisation based on a combination of laser tracker, 3D Coordinate Measuring Machine (CMM) and Wire Positioning Sensors (WPS) measurements. In this paper, the method is described and the results of its cross-comparison with the standard method of fiducialisation are shown. We also propose a new adjustment system to pre-align the DBQ on their supports according to 5 degrees of freedom. The conceptual design of the system is introduced, as well as the results obtained during the validation of the prototype.

5

Experiments of laser pointing stability on paper, metal and ceramic surfaces to validate micrometric positioning sensor

Author: Guillaume Stern[1]

Co-author: HELENE MAINAUD DURAND [1]

[1] *CERN*

Corresponding Author: helene.mainaud.durand@cern.ch

The CLIC study requires 10 micrometers precision and accuracy over 200m for the pre-alignment of beam related components. A solution based on laser beam as straigth line reference is being studied at CERN. It involves camera/shutter assemblies as micrometric positioning sensors. It includes reference targets on the shutter in order to compute the coordinates of the laser spot centre from camera plane to shutter plane. To validate the micrometric positioning sensors, several parameters have to be examined. First, the most appropriate reference targets on the shutter have to be selected in terms of implementation and measurement of targets. Second, laser pointing stability has to be analysed with different types of shutter surfaces. Experiments are carried out with paper, metal and ceramic surfaces. This paper presents the standard deviations of the laser spot coordinates obtained on the different surfaces, as well as the measurement error. It also provides an estimate of the achievable precision and accuracy of the determination of the laser spot centre with respect to the reference targets.

6

Status report of Survey activities at CERN

Author: Dominique Missiaen[1]

Co-authors: HELENE MAINAUD DURAND [1]; Jean-Christophe GAYDE [1]; Jean-Frédéric FUCHS [1]; Mark Jones [1]; Philippe DEWITTE [1]; tobias dobers [1]

[1] *CERN*

Corresponding Author: dominique.missiaen@cern.ch

As well as, the Long Shut-Down 1 (LS1), many other projects are still progressing at CERN. The LINAC4, which will be the essential part of the injector chain in the future, is in the installation

phase and will be connected to the existing accelerators in 2018. AWAKE, a project to verify the approach of using protons to drive a strong wakefield in a plasma which can then be harnessed to accelerate a witness bunch of electrons, will be using the proton beam of the CERN Neutrino to Gran Sasso, plus an electron and a laser beam. This facility will be installed in the CNGS target vicinity, as the experimentation with neutrino has been stopped at the end of 2012. ELENA, a small compact ring for cooling and further deceleration of 5.3 MeV antiprotons delivered by the CERN Antiproton Decelerator, is still in the study phase. In the HIE-Isolde project, the preliminary survey works have started and the installation is going to take place in 2015.
The CLIC study is still on going and the new achievements will be presented. Moreover, since the beginning of the year CERN has launched a study of the feasibility of a circular collider of about 100km circumference, hosting either hadrons or leptons.
This paper gives an overview of the survey activities realised in the frame of the above mentioned projects and the challenges to be addressed.

7

New Projects at Fermi National Laboratory and their Metrology requirements

Author: Horst Friedsam[1]

Co-author: John Kyle [2]

[1] *Fermi National Laboartory*

[2] *Fermi National Laboratory*

Corresponding Author: horst@fnal.gov

Fermilab is transitioning from the collider era to a dedicated international neutrino and muon facility in accordance with the recent US P5 recommendations. While the long baseline neutrino facility (LBNF) is currently in the conceptual design phase, the muon program is ramping up rapidly. This presentation focuses on the g-2 project to be constructed over the next two years. Physicists plan to measure the muon g-2 quantity very precisely at Fermilab, surpassing the precision of that measurement previously made at Brookhaven National Laboratory. In the meantime the storage ring hardware has been relocated to a new building at FNAL and the system is now being reassembled. At the heart of the device that stores the muon beam is a set of three 50-foot-diameter superconducting coils that energize the 700-ton storage ring magnet producing a 1.45 Tesla magnetic field. The magnet needs to be precision aligned in order to produce a homogeneous field that is constant to a few part per million.

8

The alignment technology of ADS-InjectorIIcry module in Low Temperature

Author: jiandong yuan[1]

[1] *IMPCAS*

Corresponding Author: yuanjiandong@impcas.ac.cn

As the key elements of accelerator driven sub critical system (Accelerator driven sub-critical systems-ADS), Cry Module is the emphasis and difficulty of superconducting linac alignment because of its Invisibility and ultra-low temperature characteristics. Collaborative align and monitoring cold mass used by laser tracker and micro alignment telescope ware proposed. Optical cross and its support ware designed for micrometer collimating telescope. Cold Mass Assembly ware successfully installed. Displacement of cold mass ware monitored during two low temperature tests. The installation accuracy at room temperature is 0.15mm. Monitoring accuracy in low temperature is

0.5mmm. ADS-InjectorIICry Module has passed level testing of the expert group, technical index is better than the best level.

10

HIE-ISOLDE –General presentation of MATHILDE

Authors: Guillaume Kautzmann[1]; Jean-Christophe GAYDE[1]

Co-authors: James Bensinger [2]; Kevan Hashemi [2]; Miroslav Šulc [3]; Yacine Kadi [1]; francis klum [1]

[1] *CERN*

[2] *Brandeis University, US*

[3] *Research Centre for Special Optics and Optoelectronic Systems (TOPTEC), Institute of Plasma Physics, CZ*

Corresponding Author: g.kautzmann@gmail.com

In the frame of the HIE-ISOLDE project, most of the existing ISOLDE REX line will be replaced by a superconducting Linac in order to upgrade the energy and intensity of the REX ISOLDE facility at CERN. This upgrade involves the design, construction, installation and commissioning of 2 low-β and 4 high-β cryomodules. Each high-β -cryomodule houses five high-β superconducting cavities (6 for the low-β version) and one superconducting solenoid (2 for the low-β version).
Beam-physics simulations show that the optimum linac working conditions are obtained when the main axes of the active components, located inside the cryostats, are aligned and permanently monitored on the REX Nominal Beam Line (NBL) within a precision of 0.3 mm for the cavities and 0.15 mm for the solenoids at one sigma level along directions perpendicular to the beam axis.
The Monitoring and Alignment Tracking for HIE-ISOLDE (MATHILDE) system is based on opto-electronic sensors, precise optical elements, metrological tables and mechanical elements. Some of them will be exposed to non-standard environmental conditions such as high vacuum and cryogenic temperatures.
This paper summarizes the studies done for MATHILDE with special focuses on the viewport crossing, the software, the newly designed cameras (HBCAM) and the retro-reflective targets based on high index glass properties.

11

Brief introduction of survey and alignment on CSNS

Author: Lan Dong[1]

[1] *Institute of High Energy Physics*

Corresponding Author: dongl@ihep.ac.cn

The article will introduct the surface network survey,tunnel network survey,elements fiducialization,adjustment calculation,and so on about CSNS.

12

Status of the MAX IV Project

Author: Brian Norsk Jensen[1]

[1] *MAX IV Laboratory*

Corresponding Author: brian.jensen@maxlab.lu.se

The MAX IV project inauguration takes place June 21st 2016. The Linear accelerator is being commissioned. The First beamline at MAX IV, the FemtoMAX beamline is ready. It will use the electrons from the Linac to produce X-rays in the Femtosecond region. The status of the installation work at the rest of the facility is described and the time schedule for installations of beamlines in 2015 is shown. The funded 13 first beamlines are listed. The large demand for soft X-ray beamlines at MAX IV has initiated the work on extending the new 1.5GeV experimental hall, so it could be ready at the inauguration.

Summary:

This poster summarizes the current state of the MAX IV project.

13

vibrating wire alignment for HEPS

Author: Xiaolong Wang[1]

[1] *ihep*

Corresponding Author: wxl@ihep.ac.cn

HEPS is a new generation sychrotron light source in design in China.Its energy will be 5GeV and emittance will be 0.5~0.1nmrad.The alignment tolerance for the magnets in each girder is 30 micron. To achieve the goal we will apply the vibrating wire alignment system to align the magnets in each girder.

14

ALIGNMENT STRATEGY OF SESAME

Author: Taer Abu-Haniyi[1]

[1] *SESAME*

Corresponding Author: thaer.abuhanieh@sesame.org.jo

The synchrotron Light Source for Experimental Science and Applications in the Middle East (SESAME) is now in its final stage. This paper presents the methodology and initial results for mechanical alignment of the booster synchrotron for SESAME. SESAME booster is the old BESY 1 Booster and requires special considerations for alignment. This paper also presents the alignment strategy for the storage ring of SESAME.

15

ALIGNMENT DESIGN AND STATUS OF TAIWAN PHOTON SOURCE

Author: WEI-YANG Lai[1]

Co-authors: Chia-Jui Lin [2]; June-Rong Chen [2]; Thomas Wu [2]; Tse-Chuan Tseng [2]

[1] *National Synchrotron Radiation Research Center*

[2] *NSRRC*

Corresponding Author: lai.aiaiai@nsrrc.org.tw

After the construction of Taiwan Photon Source (TPS) was finished, the variation of the survey fiducials was stable. However, the following precise alignment work is influenced by the change of temperature critically. In this paper, we will describe the whole process of alignment work in the TPS storage ring with the relation of the survey network and the temperature of the environment. We analysed these survey data so that the correction of survey network could be estimated by the change of temperature, and all the elements of booster, pedestals, and girders could be positioned in the shortest time.

16

SMOOTHING BASED ON BEST-FIT TRANSFORMATOIN

Author: Chenghao Yu[1]

[1] *Brookhaven National Laboratory*

Corresponding Author: cyu@bnl.gov

Smoothing is a technique to achieve accurate relative alignment of components and it’ s a main concern of accelerator alignment. Several smoothing techniques are reviewed in this article and the principle and application of smoothing based on best-fit transformation are introduced as there is no other paper discussing this before.
Compared with other methods, smoothing based on best-fit transformation uses design information which is more preferable in a way. It uses best-fit transformation, which is extremely easy to use, between reference and as-built group to find an optimal expression of the interested magnets or girders so that the relative alignment of them can be properly judged.
It has been used in the touch-ups of NSLS-II storage ring girders recently and also the whole storage ring re-adjustment of SSRF during 2012 shutdown. Both applications yield good alignment result. Moreover, it’ s expected to be used for long term maintenance of NSLS-II and have the ability to solve the potential conflict between short shutdown time and tight alignment tolerance when it is in full operation.

Summary:

Best-fit transformation is a basic technique for accelerator alignment in the current time, but smoothing seems a little bit fancy as it usually associates with different language, such as Fourier function, cubic spline or Principal Curve Analysis etc. But the application of best-fit transformation makes smoothing a lot easier and any surveyor can do it.
It’ s not only a great tool for partial and whole alignment of an accelerator at the beginning of running a machine, but also a possible solution for long term maintenance of storage ring when more constraints present.
With dedicated script, the whole smoothing process can be fully automated and high efficiency is expected.

17

The Comparison Of API T3 And Leica AT401 in the Test and Survey

Author: GUOZHU CAI[1]

[1] *engineer*

Corresponding Author: caiguozhu@impcas.ac.cn

Abstract content
The laser trackers of API T3 and Leica AT401 are usually used in the survey network of accelerator.

This paper presents the comparison from their technology detail, metrology test in the institute,and

surveying in the control network. API T3 owns outstanding performance in distance, and AT401 owns stable performance in angle and fast warm.Moreover,both of them are weak in the height measurement.

18

Alignment throughout the Update Engineering of Hefei Light Source

Author: Xiaoye He[1]

Co-author: Wei Wang [2]

[1] *NSRL,USTC*

[2] *Graduate student*

Corresponding Author: xyhe@ustc.edu.cn

The update engineering of Hefei Light Source is almost completed and the machine is being commissioned. This paper introduces the survey and alignment jobs that run throughout all the process of the engineering construction. They include establishing the control points of network for survey and alignment just after the building projects, surveying the first-level and second-level of control networkand date processing, pre-aligning all components and date processing, and aligning the components for it being accurately positioned during the machine installation. A complete process of accelerator alignment from beginning to end is described in this paper

19

WIRE POSITION MONITOR USED AT ADS LINAC ALIGNMENT

Author: Hongyan Zhu[1]

Co-authors: Bo Li [2]; Lan Dong [1]; Lingling Men [3]; can liu [4]

[1] *IHEP*

[2] *Accelerator Center*

[3] *Institute of High Energy Physics,Accelerator Division*

[4] *ihep*

Corresponding Author: zhuhy@ihep.ac.cn

This paper introduces the design and simulation of a WPM (Wire Position Monitor) used in the cryogenic system of an Accelerator Driven System (ADS). The WPM is designed to monitor the contraction of cold masses during the cooling-down operation. In this paper, POISSON-2D electrostatic field software is used to calculate the best characteristic impedance for the WPM. Furthermore, the time domain signal of different end structures is theoretically analysed and simulated, the results are consistent. The coupling between electrodes and unparallelism between wire and wpm which may influence the induced signal, are also discussed. The influence of unparallelism is much bigger.

A calibration platform is designed to calibrate wpm, the detailed design are introduced. The relationship between the sensing voltage and wire position is nonlinear, high order polynomial is used to express the nonlinear relationship. The RMS of polynomial fitting error is 3.8um at x direction, 7.4um at y direction. The alignment test is carried out on the beta cryostat. Optical instruments are used to verify the WPM measuring result. The variances of the difference between WPM measuring results and optical measurements are 0.044mm in x direction and 0.05mm in y direction. At last the measuring results at ADS cryostat alignment are demonstrate, the biggest contraction is 1.2mm in X direction, 1.0mm in Z direction

20

Simplified Hexapod Alignment for GRETINA

Author: William Jansma[1]

Co-authors: John Rohrer [1]; Shaofei Zhu [1]

[1] *Argonne National Laboratory*

Corresponding Author: jansma@anl.gov

GRETINA is a ¼ scale diminutive version of the proposed Gamma-Ray Energy Tracking Array (GRETA). This new type of gamma-ray detector is designed to study the structure and properties of atomic nuclei. It uses large crystals of hyper-pure germanium and is the first detector to use the concept of gamma-ray energy tracking.1 In August 2013 the GRETINA detector was delivered to the Argonne Tandem Linac Accelerator System (ATLAS) for an experimental run. GRETINA consists of two machined aluminum hemispheres in which several gamma ray detectors are mounted. Each hemisphere is cantilever-mounted to a manually operated hexapod alignment frame. Only one hemisphere is in use at Argonne. A direct, simplified hexapod alignment method utilizing a laser tracker and optimally placed fiducials is presented.

Summary:

This is a poster presentation only, no paper

21

THE STORAGE RING CONTROL NETWORK OF NSLS-II

Author: Chenghao Yu[1]

[1] *Brookhaven National Laboratory*

Corresponding Author: cyu@bnl.gov

NSLS-II requires ±100 micron alignment precision to adjacent girders which is mainly depending on the precision of survey control network. The design is determined to establish a laser tracker and digital level based control network, but it was changed to be measured by AT401 only later.
Simulation shows that an estimated accuracy of ˜50 micron can be achieved. The analysis of actual measurement and the application of the control network to align girders confirm the accuracy.
A comparison between Spatial Analyzer and Star*net shows very similar estimate of instrument performance and computed coordinates which both verify the applicability of Spatial Analyzer in control network adjustment.

Summary:

The substitution of instrument from traditional laser tracker and digital level to AT401 is a success in NSLS-II project. It shows improved measurement efficiency and precision. The local accuracy is better

than ±0.050 mm and global accuracy is better than ±1 mm.
Spatial Analyzer is convenient and reliable to be used for the computation of control network. It has comparable result with respect to traditional software.
The combination of AT401 and Spatial Analyzer has promising prospect in accelerator control network survey.

22

Present status and future prospect on the initial realignment at the KEKB injector linac

Author: Tsuyoshi Suwada[1]

Co-authors: Kazuhisa Kakihara [2]; Madoka Tanaka [2]; Ryuhei Sugahara [2]; Satoh Masanori [2]; Takuya Kamitani [2]; Toshiyasu Higo [2]

[1] *Accelerator Laboratory, KEK, High Energy Accelerator Research Organization*

[2] *Accelerator Laboratory, KEK*

Corresponding Author: tsuyoshi.suwada@kek.jp

The initial realignment of the long beam line is in progress at the KEKB injector linac due to the big earthquake struck in Japan in March 2011 and also towards the Super KEK B-factory project. The injector linac is a 600-m-long linear accelerator that will directly inject electron and positron beams into the Super KEKB rings under construction. The injector linac comprises eight sectors (A–C and 1–5), which together constitute two long straight sections. One section is 125-m-long and is composed of sectors A and B (AB straight section); the other is 476-m-long and is composed of sectors C and 1–5 (C5 straight section). These two straight sections are connected to a 180-degree arc with a diameter of 15 m.
Two kinds of alignment methods have been basically applied to the initial realignment. One is a laser-based alignment which is applied to the two long straight sections. The transverse displacements of accelerator girder units can be aligned with respect to this long laser axis. A series of measurements may provide an accurate view in the high-precision alignment of the injector linac. The other is a method on the use of a conventional laser tracker which is applied to the component alignment installed on the accelerator girder unit with a length of 8.44 m. Based on these two alignment methods, the aim in the initial realignment is to attain the alignment precisions of 0.1 mm (rms) and 0.3 mm (rms) in a local region (typical sector length of ˜80 m) and the entire region of 476 m, respectively.
For the high-precision alignment in the long straight sections, a laser-based alignment system with a He-Ne laser has been newly developed in order to align the accelerator girder units at the KEKB injector linac. The laser beam was first implemented as a 500-m-long fiducial straight line for alignment measurements. We experimentally investigated the propagation and stability characteristics of the laser beam passing through laser pipes in vacuum. The pointing stability at the last fiducial point was successfully obtained with the transverse displacements of ±40 μm level in one standard deviation by applying a feedback control. This pointing stability corresponds to an angle of ±0.08 μrad.
For the component alignment, new target bases for accelerator structures have been developed for the alignment measurement based on the laser tracker and other target bases for quadrupole magnets have been also newly installed. The accelerator girders have been reinforced or replaced with stainless steels with high rigidity to increase resistant strength against big earthquakes. For the alignment of the 180-degree arc, the conventional laser tracker was applied to been smoothly connected to the two straight sections.
We have observed long-term drift of the floor level along with that due to daily range in the linac tunnel. The scale of the long-term drift may be over the acceptable alignment limits while the mechanism of this long-term drift has not been understood yet. We start to construct a remote measurement system of the floor level of the linac tunnel to investigate this unsure long-term drift. This report contains a detailed description of the present status and future prospect on the initial realignment at the KEKB injector linac.

23

Alignment of LIPAc, the IFMIF prototype high current deuteron accelerator: requirements and current status

Author: Francesco Scantamburlo[1]

Co-authors: Alessandro Lo Bue [2]; Atsushi Kasugai [3]; Hironao Sakaki [3]; Hiroyuki Shidara [3]; Juan Knaster [1]; Kazuyoshi Tsutsumi [3]; Lionel Poncet [2]; Luigi Semeraro [2]; Philippe Cara [4]; Shingala Mukesh [1]; Takatoshi Morishita [3]; Yoshikazu Okumura [1]

[1] *IFMIF/EVEDA Project Team*

[2] *F4E Barcelona*

[3] *JAEA*

[4] *F4E Garching*

Corresponding Author: francesco.scantamburlo@ifmif.org

IFMIF, presently in its Engineering Validation and Engineering Design Activities (EVEDA) phase, aims at running a 9 MeV / 125 mA / CW deuteron accelerator in Rokkasho (Japan) to validate IFMIF' s 40 MeV / 125 mA / CW accelerator with components mainly designed and constructed in European labs. Beam dynamics calculations demand accuracies and precisions of alignment for certain components within ±0.1 mm in an assembly hall of 7x35m to keep beam losses below defined thresholds and allow future hands-on maintenance activities. Simulations with the original Global Coordinate Frame (GCF) carried out with Spatial Analyzer® predicted uncertainties in the measurements above the target alignment accuracies. Thus, an upgrade of the original fiducial network was undertaken with the installation of 120 new fiducials and a survey pillar; whose simulations predicted feasible uncertainties of the measurement within x5 of the target accuracies. The survey campaigns carried out with the additional extensive fiducials network installed in the accelerator hall correlated nicely with the simulations. Recent observations indicate possible movement of certain fiducials beyond the thermal displacements driven by temperature gradients along the year. An assessment of the impact on the GCF and the uncertainties on the measurements on both fiducials displacements due to potential building settling effects and temperature variations in the accelerator hall is here provided.

24

Research on Measurement Method of the CSNS DLC Foil's Thickness

Author: Jiaxin Chen[1]

Co-authors: Jiebing Yu [1]; Ling Kang [1]

[1] *Institute of High Energy Physics (IHEP)*

Corresponding Author: chenjx@ihep.ac.cn

China Spallation Neutron Source(CSNS) use the diamond like carbon foils（DLC）in the stripping foil system. The foil's thickness is between 100μg/cm2 and 200μg/cm2. With the characteristics of brittle, thin and opaque of the CSNS foils, it is very difficult to measure the thickness. The thickness of the foil has an important effect on the stripping efficient and beam losses. This paper focuses on the study of the stripping foil measurement methods , and according to the characteristics of the CSNS foils, by optimizing the equal thickness interference method， this paper proposed a method for CSNS foil thickness measurement based on the equal thickness interference method of opaque foil without basement, and discuss the measurement principle and measurement error. This research will laid the foundation for further study of the CSNS stripping foil.

25

Realignment activities on the Storage Ring of SSRF in 2014

Author: Hao Guo[1]

[1] *Shanghai Institute of Applied Physics,Chinese Academy of Sciences*

Corresponding Author: guohao@sinap.ac.cn

Annually realignment was initiated in August this year. With the combination of Laser Tracker and digital level, all the monuments and fiducials on the magnets in the Storage Ring had been measured. By the Spatial Analyzer(SA) software, the collecting data adjustment had been accomplished. The deviations between the actual positions and the theoretical ones of Quadrupoles were obtained. And the comparisions between the deviations of adjacent magnets in-cell and cell-cell had also been made, which can be a criterion for the components adjustments.

26

Alignment and long term stability of the Duke Free Electron Laser Switchyard

Author: Mark Emamian[1]

[1] *Duke University*

Corresponding Author: me@fel.duke.edu

In the fall of 2012, a major upgrade to the Duke Free Electron Laser (DFEL) Storage Ring was completed. This work was carried out by installing two additional helical undulators using a Wiggler Switchyard System. This mechanism utilizes a quick changeover between two planar OK-4 undulators and two new helical OK-5 undulators in the middle of the FEL straight section in a relatively short period of time. A preliminary result of installation and alignment of this system was reported at the IWAA2012. In this report, a full assessment of the alignment and the stability of the mechanism will be discussed in more details.

27

PACMAN study of FSI and micro-triangulation for the alignment of CLIC

Author: Solomon Kamugasa[1]

Co-authors: Vasileios Vlachakis [1]; helene mainaud durand [1]

[1] *CERN*

Corresponding Author: helene.mainaud.durand@cern.ch

CLIC (Compact LInear Collider) is a proposed 3 Tev e+/e- linear collider being studied at CERN. One of the main challenges in this study is to preserve the beam emittance growth of both the main linac and the beam delivery system in the vertical plane to below 10 nm. Such tolerances can only be achieved with beam based alignment which requires the pre-alignment of the components to 10 um over a sliding window of 200 m. In order to reach the desired precision and accuracy, PACMAN, a study on Particle Accelerator Components Metrology and Alignment to the Nanometre scale has been established at CERN. FSI (Frequency Scanning Interferometry) and Micro-Triangulation are

among the technologies that are being studied to determine 3D coordinates of fiducials for the alignment of CLIC components. FSI is an absolute distance measuring technique that has the ability to make multiple simultaneous high precision length measurements. The Absolute Multiline system that will be used is an FSI system capable of making length measurements with an uncertainty of 10.5 um/m at a 95% confidence level. Micro-triangulation, on the other hand, is an automated angle measuring technique realised by QDaedalus system. The system mainly consists of a motorized total station and a CCD camera which replaces the eye-piece in a non-destructive way. Recent tests prove that it is possible to monitor points with micrometre precision in a range of a few metres and with a rate of about 50 Hz. This paper presents the two systems, the strategy for their validation in the frame of the CLIC project and the associated R&D plans.

28

A Floor Deformation of SACLA Building

Author: Hiroaki Kimura[1]

Co-authors: Jun Kiuchi [2]; Noriyoshi Azumi [1]; Sakuo Matsui [1]; Tomoya Kai [2]

[1] *RIKEN*

[2] *SPring-8 Service Co. Ltd*

Corresponding Author: kimura@spring8.or.jp

SACLA is the Spring-8 Angstrom Compact free electron LAser, it was operated from 2011. SPring-8 is located on the very good ground, which is very stable and rigid bedrock. In contrast, the area of SACLA building, whose length is 640m, is not rigid enough. The bedrock area (cutting area) is only 1/5 of the building and 4/5 is located on the overlapping area. The maximum thickness of the embankment is over 50 m.
The SACLA building consists of a light source building and an accelerator building. The light source building, where undulator section is installed, requires to being stable especially. For this building, a direct foundation on the bedrock and an artificial layer replaced with crusher stone were adopted. The maximum thickness of that is 18 m. A civil engineering designer anticipated that its subsidence is less than 2 mm/10 years. On the other hand, for the accelerator building, pillar foundation was adopted. The maximum of the pillar length is 52 m. The designer anticipated that its subsidence is 15 mm/ 10 years.
The building was completed at March 2009. From construction phase, We have been measuring the deformation of the floor. Recent maximum subsidence is about 1 mm/year. This value is within the prediction. We will present the data of vertical and horizontal deformation of the floor and show a relationship between the deformation and the structure of SACLA building.

29

Technology and Application of Laser Tracker in Large Space Measurement

Author: Fan Yang[1]

Co-authors: baixing Fan [2]; guangyun Li [3]

[1] *School of Navigation & Aerospace Engineering, Information Engineering University*

[2] *Information Engineering University*

[3] *School of Navigation & Aerospace Engineering, Information Engineering University*

Corresponding Author: janfjanf@163.com

Position and posture measurements of large facility are necessary works in many fields, but the old one-dimensional measuring technology is no longer to meet the growing requirement of measuring accuracy, range and speed, so new measuring technology and method should be study. Point accuracy of micrometer can be realized by single station of Laser Tracker in small range, but it is necessary to establish precise three-dimensional control network to achieve the same high accuracy of coordinate measuring in large-space field. In order to get the points coordinate in centralized coordination, position and posture parameters of each station, a three-dimensional control network adjustment model based on observed value and coordination transformation is established. In order to decrease the influence on control network adjustment from angel measuring error, weight matrix of angel and distance based on high accuracy observed value of distance is established. This method is applied to facility installing and axis parallelism detecting in production line of Baosteel and result is good that the establish of large-space precise three-dimensional control network is realized successful based on theory of free multi-station measuring by laser tracker.

30

EXPERIMENTAL EVALUATION OF LASER TRACKER TARGET HOLDERS STABILITY

Author: Rodrigo Junqueira Leão[1]

Co-authors: André Luis Mesa [2]; Flávio Rodrigues [2]; Leandro Volpini Bernardes [2]; Maria Luísa Collucci da Costa Reis [3]

[1] *Centro Nacional de Pesquisa em Energia e Materiais - CNPEM / Laboratório Nacional de Luz Síncrotron - LNLS*

[2] *LNLS - Brazilian Synchrotron Light Laboratory*

[3] *ITA - Technological Institute of Aeronautics*

Corresponding Author: rodrigo.leao@lnls.br

The new Brazilian Light Source, Sirius, will be commissioned in 2018 and is considered by many as a fourth generation Synchrotron facility project. The Survey and Alignment activities are currently in the planning phase and one of the focus is the target holders development. Those target holders will be installed in our accelerator to serve as a network of reference points to be used in the alignment process. In this paper, we are interested in assessing the capability of our concepts in maintaining the center of the Laser Tracker optical target in the same position as it is repositioned. We performed an experiment designed to compare six models and run an analysis of variance to evaluate the data. A performance measure was defined in order to take into account repeatability errors of repositioning the optical target. We were able to verify statistical differences of small magnitude between the concepts. We will use the quantitative results to help the decision-making.

31

Performance of the iris diaphragm laser alignment system of the SPring-8

Author: C. Zhang[1]

Co-authors: K. Kanda [2]; M. Hasegawa [2]; T. Shinomoto [2]

[1] *Japan Synchrotron Radiation Research Institute*

[2] *SPring-8 Service Co. Ltd.*

Corresponding Author: czhang@spring8.or.jp

SPring-8 storage ring have critical alignment tolerances, especially for the magnets on common girders. We have been using the laser CCD-camera device for its alignment work. In renew this alignment device, we proposed an iris diaphragm laser alignment system, and illustrated at last workshop

of IWAA2012. Recently, the development of this system was completed and performances of it were examined. The results show that the new system has reached the aim of our intention.
This paper illustrates the tests of the iris diaphragm system and the valuation of measurement accuracy.

32

Research Development of Vibrating Wire Alignment Technique for HEPS

Author: Lei WU[1]

Co-authors: Chunhua Li [2]; Xiaolong Wang [3]; huamin qu [3]

[1] *Institute of High Energy Physics, Chinese Academy of Sciences*

[2] *Institute of High Energy Physics*

[3] *ihep*

Corresponding Author: wulei@ihep.ac.cn

HEPS(High Energy Photon Source) is a proposed 5GeV third generation light source with 50pm emittance at IHEP.The alignment tolerance for a string of quadrupoles and sextupoles on a 5.4 meters girder is 30 micrometers. To achieve the high precision requirements, the vibrating wire alignment technique will be used to align several magnets installed on the long girder. The method is based on measurement of magnetic axis. This report will introduce the research work has been done.

33

Establishing Control Survey Network for Long Beamlines at Diamond Light Source

Author: William Hoffman[1]

[1] *Diamond Light Source Ltd*

Corresponding Author: william.hoffman@diaomnd.ac.uk

The longest beamline(I13) at Diamond was completed in July 2010. At 250m from the Storage Ring establishing a survey control network proved challenging. A TDA5005 was used to measure the 3D network. Currently a second long beamline (I14) is being constructed. It is envisaged that we use the AT401 to measure and establish the network for I14. This paper will look at a simulation of the I13 network and the proposed adjacent I14 network to consider the feasibility of using the AT401

34

Application and Research on the Three Dimension Network Adjustment of Large-scale Control Network in particle accelerator

Author: tao luo[1]

[1] *IHEP Dongguan campus*

Corresponding Author: luotao@ihep.ac.cn

The paper has introduced the special datum in the alignment of particle accelerator, studying and improving the functional model of 3-D adjustment in the large-scale control network, to complete it in Visual C++ language. At last, it ' s feasible and meaningful through verifying and analyzing the 3-D adjustment with total-station ' s and laser tracker's observations in some accelerator's control network.

35

SUPERKEKB MAIN RING TUNNEL MOTION

Author: Mika Masuzawa[1]

Co-authors: Takashi Kawamoto [1]; Toshikazu Adachi [1]; Yasunobu Ohsawa [1]

[1] *KEK*

Corresponding Author: mika.masuzawa@kek.jp

SuperKEKB is a next-generation B-factory machine, which aims to achieve a peak luminosity 40 times higher than that of KEKB. It will be built utilizing the existing KEKB tunnel. The SuperKEKB construction started in 2010, and the beam commissioning is scheduled to take place in 2015. Newly fabricated magnets are now being installed in the tunnel, and initial alignment work has begun. Effects of the construction of new utility buildings around the tunnel perimeter are observed by a level survey, and monitored continuously by the BINP HLS system in the tunnel. The SuperKEKB tunnel motion due to such heavy construction is summarized, along with the effects of the uncontrolled tunnel temperatures on magnet alignment.

36

ALIGNMENT OF SUPERCONDUCTING UNDULATORS AT THE APS

Author: Jaromir Penicka[1]

Co-authors: Charles Doose [1]; Denise Skiadopoulos [1]; Emil Trakhtenberg [1]; Katherine Harkay [1]; Matthew Kasa [1]; Quentin Hasse [1]; Scott Wesling [1]; William Jansma [1]; Yury Ivanyushenkov [1]

[1] *Argonne National Laboratory*

Corresponding Author: penicka@anl.gov

The Advanced Photon Source (APS) at Argonne National Laboratory is a 7GeV third generation light source providing X-ray beams for research to scientific community since 1995. In order to remain the leading synchrotron radiation source in the western hemisphere, and to provide users with higher photon fluxes at higher photon energies, the APS decided to develop and build series of superconducting undulators (SCU). After several years of R&D and prototype testing the APS Magnetic Device group, in collaboration with the Budker Institute of Nuclear Physics, designed and assembled the first full-scale superconducting undulator, SCU0. In December 2012 SCU0 was installed in sector 6 of the APS storage ring, and after successful commissioning was released for user operation on January 29, 2013. Since then it has proven to be a dependable radiation source for high-energy X-ray studies, delivering enhanced photon flux at energies above 50 keV. The second in the series, SCU1, is being assembled as of this writing. This paper investigates the alignment aspects of the SCU devices. The extreme temperature changes in combination with limited access to the magnetic structure and beam chamber due to extensive thermal isolation pose unique alignment challenges. The alignment procedures and technology used for assembly, testing, and installation in the APS storage ring as well as a novel beam-based alignment and stability monitoring method are presented.

37

The Primary Control network of HLSII

Author: Wei Wang[1]

Co-authors: Xiaoye He [2]; Zheng Tang [1]

[1] *University of Science and Technology of China*

[2] *Natiobal Synchrotron Radiation Laboratory, University of Sciense and Technology of China*

Corresponding Author: cluster7@mail.ustc.edu.cn

To ensure the high accuracy requirement of alignment and installation of HLSII, the high accuracy control network is necessary. The primary control network provides high accuracy reference to local control network. After optimization design that using Monte-Carlo method, according to the structure characteristic of HLSII, the primary control network is measured by several different instruments, such as: Laser tracker, Total station, plummet. The accuracy of actual primary control network meets the requirements of design project, it provides solid foundation for subsequent project.

38

Actual survey and alignment activities at GSI for FAIR

Authors: Ina Pschorn[1]; Kerstin Knappmeier[1]; Torsten Miertsch[2]; Vasileios Velonas[3]

[1] *GSI Helmholtzzentrum für Schwerionenforschung GmbH*

[2] *GSI Helmholtz Centre for Ion Research*

[3] *GSI Helmholtz Center for Heavy Ion Research*

Corresponding Author: i.pschorn@gsi.de

The preparatory work for the construction of FAIR, the International Facility for Antiprotons and Ion Research, located next to GSI Helmholtz Center in Darmstadt/Germany, is in good progress. Thus the erection of the building shell for the facility can begin as scheduled in 2015. Meanwhile all of the approximately 1400 65m-long drilled concrete piles for stabilization the substructure and for bearing the foundation above ground have been set in place.

Related to the future machines and experiments a variety of design and planning work concerning the single accelerator components as cryostats and magnets et al as well as geometrical measurements have been done by the s&a group. Just a few representative tasks will be highlighted in this presentation:

For the first-of-series superconducting dipole of the intended large synchrotron SIS100 fiducialization measurements and stability checks during the warm-cold-warm cycles have been completed, as well as examinations for the quality assurance.

The storage ring CRYRING as a test facility for FAIR, that will be assembled and commissioned as part of the existing GSI, is also an important topic for all kind of accelerator specific measurement activities.

The expected ground settlements of the existing GSI buildings and their accelerator machines by reason of the huge construction works for FAIR led to a campaign of large network measurements and evaluations, classified as the reference measurement, spanning almost the entire GSI facility.

39

Laser Tracker’s Calibration Device

Author: Gao Ting[1]

Co-author: Ma LIqun [1]

[1] *Changcheng Institute of Metrology & Measurement*

Corresponding Author: gaoting2008@163.com

With laser Tracker widely used in industrial measurement field，More attention is concentrated on how to calibrate a laser tracker in standard environment laboratory. In this paper, a new device which could be applied to calibrate a laser tracker is introduced. The device employs a laser interferometer as the standard and gives the reference lengths in horizontal and vertical direction by two linear rails. The reference lengths can be used to calibrate a laser tracker’s measurement error of horizontal angle, vertical angle and range. At the end, four structures of this kind of device are put forward.

40

Alignment of the 12 GeV CEBAF Accelerator

Author: Christopher Curtis[1]

[1] *Jefferson Lab*

Corresponding Author: curtis@jlab.org

Jefferson lab has just completed an upgrade to its CEBAF accelerator which allows for an increase in the energy of delivered beam from 6 GeV to 12 GeV. The enhancements to the accelerator have included the addition of 10 new high performance cryomodules, and the removal, upgrade and refurbishment of almost 300 existing transport magnets. Outside of the main accelerator, a new experimental hall has been constructed, and the three existing halls are currently being upgraded to take advantage of the higher energies. For this project, a new survey network has been measured and almost every element in the accelerator has been re-aligned. Commissioning of the accelerator took place at the beginning of this year, during the course of which, it became apparent that there was a significant difference between the expected and the actual path length in the machine. This paper describes the measurements taken and analysis used to try and understand this situation.

41

Influence Factors Analysis of Baseline’s Solution Based on GPS

Author: Na MA[1]

Co-authors: Jing Liang [1]; Lan Dong [2]

[1] *Division of Accelerator Technology, Dongguan Campus,Institute of High Energy Physics(IHEP), Chinese Academy of Sciences(CAS).*

[2] *IHEP*

Corresponding Author: man@ihep.ac.cn

Because space distance of ground control network in spallation neutron source is large and requirements of absolute precision are strict, the traditional measurement is difficult to meet the requirements of measurement. In view of this, GPS is adopted to solve the problem, which is not limited to intervisibility and of high accuracy. Through alignment experiment in “standard detection field”

, influence of satellite ephemeris, post processing software and observation time on GPS baseline is calculated and analyzed. The result is shown as followed, a. in the measuring range of 1km, the observation accuracy of absolute baseline length is within 3mm through continues 10h observation, no matter adopting precise or broadcast satellite ephemeris; b. results of business software is better than the one of scientific software, and in business software, solution results of ‘TTC’ is close to real baseline value; c. when the observation time exceed 8 hour, the baseline value will stabilize gradually.

42

Alignment of Insertion Device at Siam Photon Source

Author: Supawan Srichan[1]

Co-authors: Apichai Kwankasem [1]; Methee Sophon [1]; Prapong Klysubun [1]; Supat Klinkhieo [1]; Visitchai Sooksrimuang [1]

[1] *Synchrotron Light Research Institute*

Corresponding Author: supawan@slri.or.th

The two insertion devices, a 6.5 T superconducting wavelength shifter and a 2.4 T multipole wiggler, have been successfully installed at Siam Photon Source, a synchrotron light source operated by Synchrotron Light Research Institute, in Thailand. The insertion device installation has been done during machine shutdown period in August 2013. In order to install quickly and efficiently, the pre-alignment was performed. The instruments were used including laser tracker, total station, optical plummet and precision optical level. This in paper, the pre-alignment procedure and alignment technique selected for the insertion device installation will be presented.

43

SLAC Status Report 2014

Author: Georg Gassner[1]

Co-author: Robert Ruland [2]

[1] *SLAC National Accelerator Laboratory*

[2] *SLAC*

Corresponding Author: gassner@slac.stanford.edu

This poster gives an overview of the alignment engineering projects at SLAC

44

Laser beam trajectory measurement with a CCD camera

Author: Georg Gassner[1]

[1] *SLAC National Accelerator Laboratory*

Corresponding Author: gassner@slac.stanford.edu

In some cases traditional autocollimation techniques cannot be used for surface alignment, either due to the surface not being reflective enough, or being curved, or the line-of-sight normal to the surface not being accessible.
This paper provides examples on how we are using a laser and a CCD camera to map the location and orientation of various surfaces.

45

The alignment of DTL in CSNS

Author: Zhiyong KE[1]

[1] *Dongguan Neutron Science Center*

Corresponding Author: kezy@ihep.ac.cn

In CSNS, the DTL(Drift Tube Linac) is part of the Linac accelerator which accelerates H- ion from 3 MeV to 80 MeV, and it is proposed a high alignment tolerance requirement which is both 0.05mm in the transverse and vertical direction and 0.10mm in the longitudinal direction, the challenge work is proceeded optically and mechanically by an established method with a laser tracker system, and the final position accuracy of the DTL is very close to the tolerance requirement after calculating and analyzing the measurement accuracy.

46

Status report of the realignment for J-PARC 3GeV RCS

Author: Norio Tani[1]

Co-authors: Hideaki Hotchi [1]; Junichiro Kamiya [1]; Kouki Horino [1]; Masanobu Yamamoto [1]; Michikazu Kinsho [1]

[1] *J-PARC Center, JAEA*

Corresponding Author: norio.tani@j-parc.jp

J-PARC 3GeV RCS suffered from the misalignments of several millimeters of the magnets in both horizontal and vertical directions caused by the Earthquake on March 11, 2011. As the beam loss was acceptable for beam operation at 300kW, the beam operation was implemented without alignment until May, 2013. Realignment of 3GeV RCS was carried out from July to November, 2013 in conjunction with the upgrade of Linac. During the realignment, adjustment of the magnets and the ceramics chambers was mainly performed. The magnets were adjusted to within ±0.2mm. The ceramics chambers were aimed to be adjusted within ±0.5mm. In this paper the realignment result and the present status of the equipment that constitute the beamline of 3GeV RCS are reported.

47

Research on laser tracker measurement accuracy and data processing

Author: Jing Liang[1]

[1] *Division of Accelerator Technology, Dongguan Campus,Institute of High Energy Physics(IHEP), Chinese Academy of Sciences(CAS).*

Corresponding Author: liangjing@ihep.ac.cn

A laser tracker accuracy test experiment is introduced in this paper.uing laser interferometer, we tested the laser tracker accuracy in the horizontal,longitudinal and vertical direction. And then statistics of laser tracker Precision in BEPCII storage ring from 2007-2010 is shown. According the statistics, actual distance precision and angle precision are given to calculate mean square error of unit weight in adjustment.At last we will describe the distance network adjustment for laser tracker data processing.

48

NAPP Photon Beam Entrance Alignment

Author: Marta Llonch[1]

Co-authors: Fabien Rey [2]; Jon Ladrera [3]

[1] *ALBA - CELLS*

[2] *ESS*

[3] *ALBA*

Corresponding Author: mllonch@cells.es

The ALBA synchrotron light facility is a 3GeV storage ring able to work in top up mode which delivers X-Ray beams to seven beamlines, already in operation. One of the seven operating ALBA beamlines is CIRCE (BL24). A soft X-ray beam line that counts with two different end stations, Photoemission Electron Microscopy (PEEM) and Near Ambient Pressure Photoelectron spectroscopy (NAPP). Due to the beam line conditions, the NAPP end station needs special alignment in order to allow beam get until the sample. The NAPP end station can operate at a sample pressure range from UHV up to 25 mbar thanks to a differential pumping system which ensures a pressure difference of 10 9 between detector and sample. This is possible thanks to a differential pumping system with four very small apertures which have to been aligned within the +0.1mm. The apertures alignment can be modified from the outside thanks to a micrometer system (with Vernier scale) for the vertical and horizontal movements.
Taking advantage of some features in the beamline, like the possibility to work with the order zero beam, a special mechanical set up is carried out to proceed with the first apertures alignment (within the +0.1mm) and the component fiducialization. After that, the alignment process begins in the bamline by taking into account the order zero beam direction to reach the sample in the analyzer chamber. This poster presents the chosen fiducialization and alignment process combining optical and digital instruments.

49

Slab evolution and status at ALBA Synchrotron

Author: Marta Llonch[1]

Co-authors: Fabien REY [2]; Jon Ladrera [1]

[1] *ALBA - CELLS*

[2] *European Spallation Source*

Corresponding Author: mllonch@cells.es

The 3GeV ALBA synchrotron light facility has currently seven operational state-of-the-art phase-I beamlines, comprising soft and hard X-rays. Additionally, two phase-II beamlines are in construction. Since as early as 2012, ALBA Synchrotron has been hosting official users; however, the machine independent slab is being surveyed since 2009 (once the whole installation was finished). The ALBA

critical floor slab has an outer radius of 60m and supports the Tunnel, the experimental lines and the service area as well.
To achieve the expected accuracy in the subsequent alignment works is essential to have an updated accurate survey reference network installed in the critical slab. An important goal is to be able to track the movement of the slab and consider the components position. In this poster, we present you a report with general information about our slab constructive method, our survey network and an historical evolution report of the ALBA reference network from the very beginning and also some of our future plans for the two phase-II beamlines.

50

A method of measuring mirror-tilt error in laser trackers

Author: Zili Zhang[1]

Co-authors: Dabao Lao [1]; Han Zhu [1]; Weihu Zhou [1]

[1] *Academy of Opto-electronics, Chinese Academy of Sciences*

Corresponding Author: zhangzili@aoe.ac.cn

Laser trackers are widely used in large-scale measurement such as accelerator alignment, aerocraft assembly and ship building. The mechanical and optical structure errors in laser trackers such as mirror tilt and offset introduce systematic errors which have essential influence on the measurement accuracy. In this paper a method for measuring mirror-tilt error of the laser tracker was presented by using autocollimators, multi-mirror polygons and reflected mirrors. Firstly, an autocollimator was used to detect the position of the tracker ' s mirror and the direction of the tracker ' s horizontal axis with the help of the reflected mirror mounted on one side of the axis. Then the other autocollimator and the multi-mirror polygon were used to detect the horizontal rotation angle of the tracker. According to the relationship among the readouts of the collimators, the mirror-tilt error can be attained. The least square method was also used to deduce the precise measurement results. The experimental results showed that the method proposed in the paper can detect the tilt error precisely.

51

The surveying and data processing of the primary control net of CSNS

Authors: Jing Liang[1]; Lan Dong[2]; NA MA[3]; Zhiyong KE[4]; tao luo[5]; tong wang[6]; zhenqiang he[7]

[1] *Division of Accelerator Technology, Dongguan Campus,Institute of High Energy Physics(IHEP), Chinese Academy of Sciences(CAS).*

[2] *IHEP*

[3] *Institute of High Energy Physics Chinese Academy of Sciences*

[4] *Institute of High Energy Physics, China Academy of Science*

[5] *IHEP Dongguan campus*

[6] *Accelerator Center, IHEP*

[7] *Institute of High Energy Physics (IHEP) of the Chinese Academy of Sciences (CAS)*

Corresponding Author: wangt@ihep.ac.cn

China is building a world-class spallation neutron source,called CSNS.It's located in Guangdong province, which is in the south of China,and the civil construction is under progress.This paper introduced the surveying scheme of the primary network of CSNS,including the control points distribution and the instruments using,then the LGO software was used for the processing of the GPS observations,the choosing of the ellipse and the central meridian for UTM projection were discussed.The

distances between the control points were also measured by Total Station,it's demonstrated that the baselines of GPS adjustment were agree well with the Total Station,and the accuracy of the control points could meet the requirement.

52

Survey and Aligmnment of the Heavy Ion Medical Machine

Author: Wenjun Chen[1]

Co-author: Guozhu Cai [1]

[1] *IMP.CAS*

This article mainly described a method of measured the Heavy Ion Medical Machine in WuWei .We have installed and aligned most magnets of Heavy Ion Medical Machine by laser tracker and its fitting software SA. we set up a global Fram to determine the theoretical position of origin of each subsystem for whole Medical Machine . A local Frame which based on theoretical origin was set up for each subsystem, by which we aligned all devices in it. A part Frame was used for every device.8 benchmarks were welded on each magnet, aording to the device's theoretical coordinates in the local frame, we have calculated relational translating parameters and translated current frame to the part frame. Thus we can real-time watch the difference of actual and theoretical 3 dimension's coordinates of benchmarks. The accuracy of adjusting magnets has been reached 0.1mm by using this method.

53

Topic:Survey&Alignment method

54

Topic:Long Term Monitoring, Ground Motion, Vibration

55

Topic:Survey&Alignment method

56

Topic:Alignment Instrumentation, Software and Methods

57

Topic:Survey&Alignment method

58

Topic:Survey&Alignment method

59

Topic:Status Reports from Institutes/Laboratories

60

Poster Presentation

61

Poster Presentation