3rd PACMAN workshop

Report of Contributions

https://indico.cern.ch/e/600191

Contribution ID: **1** Type: **not specified**

Welcome coffee

Contribution ID: **2** Type: **not specified**

Introduction to the workshop

Monday 20 March 2017 08:40 (20 minutes)

Presenter: Dr BORDRY, Frederick (CERN)

Session Classification: Introduction to CERN R&D Projects

Contribution ID: **4** Type: **not specified**

Introduction to the AWAKE project and its technical challenges

Monday 20 March 2017 09:30 (30 minutes)

The Advanced Proton Driven Plasma Wakefield Acceleration Experiment (AWAKE) is a proof-of-principle R&D experiment at CERN which uses the first time ever protons to drive the plasmas wakefield. AWAKE aims to accelerate 10-20 MeV electrons to approximately 1 GeV in 10 m of plasma by using plasma wakefields created by a self-modulated 400 GeV/c proton bunch. This talk emphasises on the technical challenges of the AWAKE experiment and shows first results on the development of the self-modulation- instability which were obtained during the first physics run in December 2016.

Presenter: Ms TURNER, Marlene (CERN / Graz University of Technology (AT))

Session Classification: Introduction to CERN R&D Projects

Contribution ID: **8** Type: **not specified**

Alignment strategy for the new ESRF storage ring

Monday 20 March 2017 13:30 (25 minutes)

Following on from 20 years of success and scientific excellence, the ESRF, the world's first third-generation light source, has embarked upon an ambitious and innovative modernisation project – the Upgrade Programme. After the successful delivery of the first phase of this programme in the period 2009-2015, the ESRF launched, in May 2015, the ESRF –Extremely Brilliant Source (ESRF – EBS) project.
ESRF-EBS represents an investment of 150 M€ over the period 2015-2022. The principal aim of this project is to construct and commission the new 844m circumference ESRF-EBS storage ring. About 90% of the existing infrastructure will be re-used, and the new ESRF-EBS design has been conceived with greatly improved energy efficiency, reducing electricity costs by 20%. With performances multiplied by 100 in terms of brilliance and coherence, this new source of synchrotron radiation will offer unprecedented tools for the exploration of matter and for the understanding of life at the macromolecular level.
This presentation will discuss the alignment strategy for the ESRF-EBS project.

Presenter: Dr MARTIN, David (ESRF)

Session Classification: Large scale metrology in accelerators

Contribution ID: **14** Type: **not specified**

Traceable measurements on microparts

Monday 20 March 2017 16:30 (25 minutes)

Presenter: Dr KÜNG, Alain (Metas)

Session Classification: Metrology aspects

Contribution ID: **19** Type: **not specified**

Mechatronic Design Principles applied to a DC Monochromator to reach 10 nrad Crystal to Crystal Stability.

Tuesday 21 March 2017 08:55 (25 minutes)

For the Sirius, Brazilia's 4th generation light source under development by LNLS, a novel Double Cristal
Monochromator (DCM) is developed. The monochromator is known as one of the most critical optical
elements in a beamline. The new 4th generation light source, with an emittance in the range of 100 prad,
requires extreme stability performance, requiring a crystal to crystal stability in the order of 10 nrad. To
reach these tight numbers, even during Bragg angle motions for fly-scan operation, a novel design is
required, which is based on active positioning control of the second crystal towards the first.
Using mechatronic design principles with proper dynamic architecture enables very high dynamic
disturbance reaction, as MI-Partners commonly uses in high-end semiconductor production equipment
like wafer scanners, die-bonders and electron microscopes. In the DCM, under manufacturing now, a
close loop bandwidth can be reached in the order of 300 Hz, giving a few nrad positioning error between
both crystals. The dynamic architecture is based on zero stiffness actuators (voice coils) and the use of a
balance mass, long-stroke/short-stroke principle
Furthermore, the design aims for extreme high thermal stability. Measures like separating structural and
metrology loops enables the use of materials like invar for the metrology frames and aluminum for the
structural loops, giving both optimal thermal performance and dynamic performance. To minimize the
heat leakage of the liquid nitrogen cooled parts and minimize deformations of critical elements like
crystals and metrology frame while achieving a high critical internal eigenfrequency above 1000 Hz,
proper suspension by elastic elements are applied. For further improvement of the thermal stability,
active temperature control is implemented to all critical elements.
To minimize one of the main vibration sources, flow of liquid nitrogen for cooling of crystals, design
principles are applied as MI-Partners commonly uses in high-end systems like wafer-stages and TEM
(Transmission Electron Microscopes). By making use of these principles, vibrations are cancelled out and

noise sources are minimized. Measurements have be done by LNLS and show the positive effect of these
principles.

Presenter: Dr RUIJL, Theo (MI-Partners)

Session Classification: High-precision Engineering

Contribution ID: **22** Type: **not specified**

New applications and advances of the Absolute Multiline Technology

Monday 20 March 2017 15:40 (25 minutes)

Presenter: Dr SCHWENKE, Heinrich (Etalon AG)

Session Classification: Large scale metrology in accelerators

Contribution ID: **23** Type: **not specified**

Diversity at IBM

Tuesday 21 March 2017 13:40 (20 minutes)

Presenter: Dr MARCHIORI, Chiara (IBM)

Session Classification: Diversity discussion

Contribution ID: **24** Type: **not specified**

Discussion on unconscious biases

Tuesday 21 March 2017 14:00 (40 minutes)

Presenter: Ms DATTA COCKERILL, Sudeshna (CERN)

Session Classification: Diversity discussion

Contribution ID: **32** Type: **not specified**

Development of direct measurement techniques for the in-situ internal alignment of accelerating structures

Wednesday 22 March 2017 10:15 (25 minutes)

In the framework of the PACMAN project we have developed a test set-up to measure the electromagnetic center of high gradient accelerating structures for alignment purposes. We have hypothesized with previous simulation studies that a resolution of 1 mm is possible using a stretched conductor wire along the structure and a network analyzer to detect the minimum perturbation when the wire is in the center of a dipole mode at 17 GHz. The calibration of the set-up, the equipment instrumentation and data acquisition software allows the measurement of the electromagnetic center, with a final precision and accuracy on the micron level. The absolute position of the structure with respect to the wire is measured in the environment of a coordinate measuring machine which has an uncertainty of 0.3 mm in order to gain accuracy in the alignment process of accelerating structures in the tunnel.

Presenter: Ms GALINDO MUNOZ, Natalia (CERN)

Session Classification: Microwave Technology

Contribution ID: **36** Type: **not specified**

RF overview of the ADAM machine: from the design to the conditionning

Wednesday 22 March 2017 10:40 (25 minutes)

LIGHT (Linac for Image Guided Hadron Therapy) is a linear proton accelerator dedicated to protontherapy. LIGHT is designed to accelerate protons up to 230 MeV.
In this talk, an overview of the accelerator will be given starting from the RF design through manufacturing, low and high power RF testing.

Presenter: Dr DE MICHELE, Giovanni (A.D.A.M. Applications of Detectors and accelerators to Medicine)

Session Classification: Microwave Technology

Contribution ID: **37** Type: **not specified**

PACMAN: results and perspectives

Wednesday 22 March 2017 14:30 (30 minutes)

The objectives of the PACMAN project are to improve the precision and accuracy of the alignment of accelerator components. Two steps of alignment are concerned: the fiducialisation, e.g. the determination of the reference axis of components w.r.t. alignment targets, and the initial alignment of components on a common support assembly. The main accelerator components considered for the study are quadrupoles, 15 GHz BPM and RF structures from the CLIC project. Different methods have been developed to determine the reference axis of these components and then to determine the position of this reference axis in the coordinate frame of the common support assembly. Complementary studies have been undertaken as well. This presentation will introduce all the studies undertaken in the PACMAN project, and will present the results achieved and will give conclude with perspectives of the project.

Presenter: Dr MAINAUD DURAND, Helene (CERN)

Session Classification: Introduction to impact

Contribution ID: **42** Type: **Presentation**

CLIC module and impact of PACMAN on its alignment

Wednesday 22 March 2017 15:00 (30 minutes)

The CLIC two beam module will be described together with its numerous alignment constraints and tolerances dictated by beam dynamics. A pre-alignment of the a high number of comments of the order of 10 microns has to be realised for the CLIC project. In this sense the CLIC project represents a new level of requirements to accelerator alignment. The CLIC alignment strategy will be described and analysed what would be the impact of implementing PACMAN results into this or a new alignment strategy.
For a big project like CLIC not only the achieved alignment performance is essential but as well the aspects of fabrication, transport, installation, maintenance and cost have to be taken into account.

Primary author: Dr DOEBERT, Steffen (CERN)

Presenter: Dr DOEBERT, Steffen (CERN)

Session Classification: Introduction to impact

Contribution ID: **43** Type: **Presentation**

WFM measurements in CLEX

Wednesday 22 March 2017 09:20 (25 minutes)

In order to achieve high luminosities in the future CLIC machine, it is vital to avoid emittance growth along the accelerator. A major contributor to emittance growth is transverse wakefields in the accelerating structures, and in order to combat this the structures will be equipped with wakefield monitors (WFMs) that will be used as input to the alignment strategies. The presentation reports on measurements performed with beam in the CLIC Test Facility 3 (CTF3) at CERN and the planned continuation in the new CLEAR facility.

Primary author: Dr LILLESTOL, Reidar Lunde (CERN/Uni. Oslo)

Presenter: Dr LILLESTOL, Reidar Lunde (CERN/Uni. Oslo)

Session Classification: Microwave Technology

Contribution ID: **44** Type: **Presentation**

Alignement and metrology challenges at ITER

Monday 20 March 2017 11:00 (30 minutes)

The ITER machine is one of the most complex and large experiment presently ongoing. The first operation of the machine is scheduled for 2025. The fabrication of the main components is in days progressing all around the world. The assembly of the central part of the reactor is supposed to effectively start on 2020. The ITER machine will be assembled on Cadarche site by the ITER central team that will receive "in kind contributions"from the seven domestic agencies contributing to the project.
Metrology is a key technology for the success of the machine installation and operation. The most advanced techniques are being used to asses component geometry before and after the delivery to the assembly site. Manufacturing process will be also simplified by intensive use of metrology surveys needed to finalize component interfaces. The first part of the presentation will brief about the ITER machine main concepts and the present status of the project. In the second part of the presentation the scope and the application of the F4E/ITER standard QA 117 aiming at homogenizing and coordinating metrology actions is given.

Primary author: Mr SEMERARO, Luigi (Fusion for Energy)

Presenter: Mr SEMERARO, Luigi (Fusion for Energy)

Session Classification: Introduction & Big Science projects

Contribution ID: **45** Type: **Presentation**

Radio Frequency Characterization and Alignment to the Nanometer Scale of a Beam Position Monitor for Particles Accelerators

Wednesday 22 March 2017 08:55 (25 minutes)

The talk gives an overview of the main achievements presented in my doctoral dissertation, defended at the University of Pisa on January 2017. The focus is on the RF characterization of the cavity BPM designed for the CLIC Test Facility (CTF3). The experimental results on the Final PACMAN Alignment Bench (FPAB) prove the feasibility of the innovative alignment methodology established in the context of the PACMAN project, locating the electromagnetic displacement between the quadrupole and the attached BPM in a micrometric range.

Primary author: Dr ZORZETTI, Silvia

Presenter: Dr ZORZETTI, Silvia

Session Classification: Microwave Technology

Contribution ID: **46** Type: **Presentation**

Active isolation of an extended structure using a high-resolution optical inertial sensor

Tuesday 21 March 2017 10:40 (25 minutes)

In the future linear collider CLIC, the electromagnets focussing the beams of particles will have to be extremely stable, at the nanometre scale. In order to fulfil such stringent requirements, a prototype of coil-free active isolation system has been developed. This presentation will summarize the latest results obtained with our active isolation system. It consists of an extended frame representing a dummy electromagnet, whose vibrations are measured by an optical inertial sensor and which is supported by eight active legs. Each leg consists of a piezoelectric actuator in series with a metallic suspension. The controller used will also be presented along with experimental results. The feedback operation leads to an active isolation in a frequency range between 0.3 Hz and 30 Hz, with a peak of reduction by a factor 100 at 1 Hz. Finally, limitations of the performance will be discussed.

Primary authors: Mrs WATCHI, Jennifer (ULB); COLLETTE, Christophe Guy R; Mr DING, Binlei (ULB)

Presenter: Mrs WATCHI, Jennifer (ULB)

Session Classification: High-precision Engineering

Contribution ID: **47** Type: **Presentation**

Development and validation of an absolute FSI network

Monday 20 March 2017 13:55 (25 minutes)

We present developments for the realization of a multilateration network based on Frequency Scanning Interferometry (FSI). Our developments include a reference sphere and kinematic mount for localizing the FSI optical fibre tip and therefore allowing distance measurements in different directions from the same point. Through simulations, we have optimised geometry of our multilateration network for precise coordinate determination. We have carried out fiducialisation of a CLIC Main Beam Quadrupole (MBQ) magnet using our developments. We have validated our solution using a Leitz Infinity coordinate measuring machine which has a Maximum Permissible Error of length measurement ($E_{L,MPE}$) of 0.3 µm + 1 ppm via a 3D Helmert transformation of coordinates determined by both systems.

Primary author: Mr KAMUGASA, Solomon William (Eidgenoessische Technische Hochschule Zuerich (CH))

Presenter: Mr KAMUGASA, Solomon William (Eidgenoessische Technische Hochschule Zuerich (CH))

Session Classification: Large scale metrology in accelerators

Contribution ID: **48** Type: **Presentation**

The Shape Evaluating Sensor: High Accuracy and Touchless

Monday 20 March 2017 16:05 (25 minutes)

The role of the early stage researcher 1.1 of the PACMAN project is to measure the position of the wire with the best possible accuracy. An evaluation of the wire lead to the conclusion that the dust would be a large source of uncertainties on its positioning. To reduce the chances of measuring some dust instead of the wire surface, a Shape Evaluating Sensor: High Accuracy and Touchless has been designed to be fitting with all the requirements of the PACMAN bench. The presentation will focus on the introduction of this sensor and the first tests and results obtained with its elements.

Primary author: Ms SANZ, Claude (CERN)

Presenter: Ms SANZ, Claude (CERN)

Session Classification: Metrology aspects

Contribution ID: **49** Type: **Presentation**

What is the best displacement transducer for a seismic sensor?

Tuesday 21 March 2017 11:05 (25 minutes)

Development of a seismic sensor for the future Compact Linear Collider (CLIC) will be presented. Sensor in which three different types of sub-nanometre displacement transducers have been integrated: a Fabry-Pérot interferometer, an optical encoder and a capacitive transducer. This sensor allows us to compare the resolution of all the transducers under the same conditions, thus enabling us to verify the most suitable transducer for a seismic sensor. However, to reach requirements of the PACMAN project, even further increase in resolution was needed. This was achieved by implementation of a multi-pass Michelson interferometer into the sensor. First results obtained with this transducer will also be presented.

Primary author: Mr NOVOTNY, Peter (CERN)

Presenter: Mr NOVOTNY, Peter (CERN)

Session Classification: High-precision Engineering

Contribution ID: **50** Type: **Presentation**

Alignment strategy of the SSR1 cryomodule for the PIP-II project at Fermilab

Wednesday 22 March 2017 08:30 (25 minutes)

Fermilab is planning to enhance the capabilities of the existing accelerator complex to support the delivery of 1.2 MW beam power for a world-leading neutrino program over the next several decades. The heart of the Proton Improvement Plan-II (PIP-II) is an 800-MeV superconducting linear accelerator which includes five types of superconducting cavities, grouped in 25 cryomodules, to cover the entire velocity range required for acceleration of protons. We are currently assembling the first prototype cryomodule of spoke cavities (SSR1) and this talk focuses on the strategy that will be adopted to align the key-components with the required precision to reduce the beam loss.

Primary author: Dr PASSARELLI, Donato (FNAL)

Presenter: Dr PASSARELLI, Donato (FNAL)

Session Classification: Microwave Technology

Contribution ID: **51** Type: **Presentation**

Micro-triangulation for high-accuracy short-range measurements of fiducial points and wires.

Monday 20 March 2017 14:20 (25 minutes)

The micro-triangulation method is proposed as an alternative for magnet fiducialisation. The aim is to directly measure the fiducial points and the stretched wire at the same time, space, and coordinate system, attempting to reduce the uncertainty. We use robotic theodolites equipped with a camera to automatically measure horizontal and vertical angles to the fiducial points and the stretched wire. The presentation gives an overview of the subject, including the objectives, the developments and the challenges in using micro-triangulation for fiducialisation. We describe the nessesary least-squares analysis methods, computer vision algorithms and software tools we developped to enable data acquisition and processing for the fiducialisation. We also present the first test measurement aiming to demonstrate the feasibility of the method and to evaluate the accuracy. The preliminary results are very promising, with accuracy better than 20 μm for the wire position, and of about 40 μm/m for the wire orientation, compared with a coordinate measuring machine.

Primary author: Mr VLACHAKIS, Vasileios (CERN)

Presenter: Mr VLACHAKIS, Vasileios (CERN)

Session Classification: Large scale metrology in accelerators

Contribution ID: **52** Type: **Presentation**

Last developments at ALBA magnetic measurements laboratory

Tuesday 21 March 2017 17:40 (25 minutes)

ALBA is a third generation Synchrotron Light Source operating close to Barcelona since 2012. A magnetic measurements laboratory associated to the facility since its very early stages has been active for the last 20 years. In the first part of the present contribution the different instruments available at the laboratory are described, and a brief overview of the measurement campaigns carried out along its 20 years of history is presented. In the second part of the contribution we provide a more detailed description of our approach to Hall probe measurements, with an explanation of the methods and ancillary equipment that we have developed along the years in order to improve the accuracy of our system. In the last part of the contribution we present a new concept of Hall probe bench devoted to the measurement of closed structures. The in-house design and building of a prototype for such a bench is described, together with its mechanical and magnetic characterization. The first results obtained with this bench will also be discussed.

Primary author: Dr MARCOS, Jordi (ALBA)

Presenter: Dr MARCOS, Jordi (ALBA)

Session Classification: Magnetic measurements

Contribution ID: **53** Type: **Presentation**

Introduction to accelerators in the medical domain: prerequisites and strategies for the alignment of magnets

Tuesday 21 March 2017 17:15 (25 minutes)

The CERN spin-off company ADAM has designed and is building a 3 GHz linac for proton therapy applications. The linac comprises several rf accelerating units which allows to accelerate protons up to 230 MeV in about 25 meters. The focusing lattice is based on FODO cells made of compact small aperture Permanent Magnet Quadrupoles (PMQ) placed between the accelerating tanks. A general introduction on the use of linac for protontherapy with a focus on the requirements and the possible strategies for alignment of the PMQ are discussed.

Primary author: Dr DEGIOVANNI, Alberto (CERN)

Presenter: Dr DEGIOVANNI, Alberto (CERN)

Session Classification: Magnetic measurements

Contribution ID: **54** Type: **Presentation**

Metrology toolbox for mechanical design & alignment

Monday 20 March 2017 14:45 (25 minutes)

Dimensional metrology is of a primary importance in many fields of synchrotron facilities. We have tried to define the basic tools for a spatial layout analysis of dimensional measurement systems to be used by mechanical engineers and people involved in Alignment. Examples deal with Storage Ring alignment, from magnetic measurement bench to quadrupole alignment on their girders.

Primary author: Mr LESTRADE, Alain (synchrotron SOLEIL)

Presenter: Mr LESTRADE, Alain (synchrotron SOLEIL)

Session Classification: Large scale metrology in accelerators

Contribution ID: **55** Type: **Presentation**

Nano-positioning of the main Linac quadrupoles

Tuesday 21 March 2017 08:30 (25 minutes)

CLIC (Compact Linear Collider) is a next generation particle collider under study at CERN. The accelerator will operate beams of nanometric size (1 nm ×40 nm) and produce a high density of collisions at the interaction cross section (2x10)ˆ34 hits/(mˆ2 s)). To guarantee this collision quality, the pre-alignment tolerance of the main components of the accelerator must lie within 10 μm. In addition, the quadrupole magnets must be extremely stable (1.5 nm rms at 1Hz). The beam further can be steered by displacing these quadrupole magnets in between beam pulses, with nanometric resolution. This critical process is the nano-positioning.

I will present the upgrades of the prototype that has been developed for the stabilization and nano-positioning of the magnet, and the results related to nano-positioning tests.

Primary author: Mr TSHILUMBA, David (CERN)

Presenter: Mr TSHILUMBA, David (CERN)

Session Classification: High-precision Engineering

Contribution ID: **56** Type: **Presentation**

Rotating coil and wire measurements for the Advanced Photon Source Upgrade

Tuesday 21 March 2017 15:30 (25 minutes)

The next generation of light sources is based on Multi-bend Achromat (MBA) lattices to achieve very low emittances of well below 0.1 nm-rad. In addition to regular dipoles, quadrupoles and sextupoles similar to existing machines, a typical MBA lattice consists of several combined function magnets with strong dipole and quadrupole components. These combined function magnets are also slightly curved, which makes measurement of field quality and alignment difficult using conventional rotating coil and wire based methods which are more suited for straight magnets and magnet assemblies. For the upgrade of Advanced Photon Source (APS-U) at Argonne National Laboratory, a scheme is developed to apply conventional rotating coil and wire based methods to measure such curved combined function magnets. The measurement scheme will be presented in this talk.

- Work supported by the US Department of Energy under contract DE-AC02-06CH11357

Primary author: Dr JAIN, Animesh (Argonne National Laboratory)

Presenter: Dr JAIN, Animesh (Argonne National Laboratory)

Session Classification: Magnetic measurements

Contribution ID: **57** Type: **Presentation**

FCC-ee and alignment issues

Wednesday 22 March 2017 15:30 (30 minutes)

A hadron collider of 100 km circumference and 100 TeV in the center of mass is under study by the international physics community as next energy frontier Future Circular Collider (FCC). The same tunnel could host first a lepton collider, FCC-e+e–, with beam energy ranging between 45 and 175 GeV. For attaining luminosities between 10ˆ34 and 10ˆ36 cmˆ-2sˆ-1, the beams must be strongly focused at the Interaction Points and the vertical emittance must have unprecedentedly small values between 1 and 2.5 pm.
Resonant depolarization has been proposed for accurate energy determination of the FCC-e+e– beams. The aim of this talk is to present results of preliminary studies of the effect of magnet misalignments on machine performance and ways for compensating them.

Primary author: Dr GIANFELICE, Eliana (Fermilab)

Presenter: Dr GIANFELICE, Eliana (Fermilab)

Session Classification: Introduction to impact

Contribution ID: **58** Type: **Presentation**

Magnets alignment using vibrating wire: latest results

Tuesday 21 March 2017 14:40 (25 minutes)

Up to date Vibrating wire magnetic field measurement technique was used in many occasions for alignment of magnets with "zero"field on axis such as quadrupoles, sextupoles and solenoid magnets.

Addressing the need of the next generation of synchrotron radiation sources such as APS-U, ESRF, CHESS-U required precise alignment of quadrupole magnets with dipole field on magnetic axis (CFM), we developed a new approach for using the Vibrating Wire technique for alignment of this type of magnets.

In the talk I will present ideas of the approach as well as the results of prove of principle experiments performed in CERN with help of PACMAN students and in Cornell.

Primary author: Dr TEMNYKH, Alexander (Cornell University)

Presenter: Dr TEMNYKH, Alexander (Cornell University)

Session Classification: Magnetic measurements

Contribution ID: **59** Type: **Presentation**

2D and 3D sensing for mobile robots

Tuesday 21 March 2017 11:30 (25 minutes)

Terabee is challenging the perception that successful navigation for drones and robots requires dense point-clouds and expensive laser LiDAR scanners. We understood that long range and fine 3D resolution is far from being the unique answer to autonomous navigation, mainly because of the calculation power required and the failure modes embedded in complex algorithms.
In this session Max Ruffo, Terabee CEO, presents an alternative approach, where fewer axis are monitored but in a safer and redundant manner. The presentation will show how we have joined basic 2D SLAM procedures with 3D mapping to solve some specific applications whilst keeping the computational demands of the solution as lightweight as possible.

The enablers of the this new concept are high performance, modular and lightweight sensing solutions that can be used in applications and locations not previously viable. These were developed with our strategic collaboration partner, CERN, for use in cluttered and complex environments.

Primary author: Dr RUFFO, Max

Presenter: Dr RUFFO, Max

Session Classification: High-precision Engineering

Contribution ID: **60** Type: **Presentation**

Stretched-wire systems for the magnetic measurement of small-aperture magnets

Tuesday 21 March 2017 15:05 (25 minutes)

The alignment of magnets for particle accelerators has become nowadays highly demanding at metrological level. Furthermore, the reduced beam size in upcoming accelerator projects such as CLIC required for multipole magnets with small bores, where the access for traditional magnetic probes is limited. For these reasons, magnetic field measurement systems based on stretched wires have been developed at CERN in the last years. In this talk the latest results in terms of enhancement of the metrological performance, extension of the wire methods for a complete magnetic characterization and the wire system built for PACMAN will be presented.

Primary author: Mr CAIAZZA, Domenico (CERN)

Presenter: Mr CAIAZZA, Domenico (CERN)

Session Classification: Magnetic measurements

Contribution ID: **61** Type: **Presentation**

The application of metrology research in industry

Monday 20 March 2017 16:55 (25 minutes)

Industry 4.0 presents a direct challenge to companies involved in high-value manufacturing - exploit new metrology processes to deliver highly automated, well-controlled manufacturing solutions, or face getting left behind by your competitors.

We set up Insphere Ltd to help companies facing this exact challenge. We focus our research activities on applying emerging metrology processes to deliver quantifiable business benefits to our customers.

In this presentation I will draw on case studies of projects we have delivered over the last year to outline the successful strategies that we have used.

- In a highly focussed trial using real components, we demonstrated the speed and accuracy of a fully automated inspection in an aerospace setting.
- We helped a company to introduce locked-down metrology user interfaces to "de-skill" complex metrology-guided assembly operations, massively reducing costs.
- We have delivered a funded research programme to achieve robust process control in additive manufacturing, promoting wider acceptance of this exciting technology.

We have found that well-managed research can deliver strong business benefits and overcome the inertia that might otherwise prevent advances in manufacturing methods. Companies must "keep their eyes on the prize"as successful automation offers huge market advantages but can only be achieved with a focus on robust, data-driven manufacture, and dimensional metrology research is a key factor in this success.

Primary author: Mr DAVEY, Craig (Insphere)

Presenter: Mr DAVEY, Craig (Insphere)

Session Classification: Metrology aspects

Contribution ID: **62** Type: **Presentation**

A 6DOF microvibration isolation, measurement and generation facility

Tuesday 21 March 2017 09:20 (25 minutes)

The National Physical Laboratory (UK) has developed and delivered a novel 6 degree-of-freedom micro-vibration test system for the European Space Agency's test centre, ESTEC. The system measures the dynamic force and torque produced by spacecraft components between 10 μN to 1 N (1 μNm to 1 Nm), and subjects sensitive specimens to a known micro-vibration environment in the range 1 μg to 10 mg. The facility is traceable to the SI, and actively isolated from seismic noise. The operating principles and mechanical design of this test system are outlined, and some indicative results from validation testing are shown.

Primary authors: Mr JARVIS, Charlie (National Physical Laboratory); Prof. HUGHES, Ben (National Physical Laboratory); Mr VEAL, Dan (National Physical Laboratory)

Presenter: Mr JARVIS, Charlie (National Physical Laboratory)

Session Classification: High-precision Engineering

Contribution ID: **63** Type: **Presentation**

FEL Magnetic Measurements At SLAC

Tuesday 21 March 2017 15:55 (25 minutes)

The Linac Coherent Light Source at SLAC provided many magnetic measurement challenges. The magnetic center of the quadrupoles was required to be stable as the excitation current was changed for beam based alignment. A rotating coil system was used to measure magnetic center stability. The quadrupoles had to be accurately aligned to undulators and their fiducialization was done with a vibrating wire system. Finally, accurate undulator measurements and undulator fiducialization had to be performed. The measurement methods we used will be the primary topic of my talk.

Primary author: Dr WOLF, Zachary (SLAC - Standford Uni)

Presenter: Dr WOLF, Zachary (SLAC - Standford Uni)

Session Classification: Magnetic measurements

Contribution ID: **64** Type: **Presentation**

Modal parameters of surfaces for numeric models

Tuesday 21 March 2017 11:55 (25 minutes)

Measuring machines gives a more and more accurate number of points in order to describe a surface. In a design process, we need to have a better description of geometry in order to assess all the behaviours involving interactions between material and it's environment.
Focussing at the same time the infinite complexity of real objects and the simplification needed to make simple choices is a main goal of a metrologist. This is possible by the use of adapted geometric languages. A geometry parameterization has the challenge to have the following properties:
- Unicity-inversibility: a unique set of parameters gives a unique shape.
- Stability: continuous parameters.
- Invariance: decoupling of parameters
- Efficiency: ability to represent the measurement with a minimum number of parameters.
- Exhaustiveness: to describe the complete measurement.
- Complexity sorting: the first parameters are associated to the simplest shape.

We had the idea to think about the natural vibrations of shapes in order to use all their very interesting properties corresponding to those properties. They form an automatic, natural, geometric vector space of shape descriptors. Fourier series that we all know is very useful, but limited to very simple shapes (line, circle for single Fourier series and square for double Fourier decomposition). If you remember that Fourier series are the modal solution of a vibrating rope, you understand that nature has given us a way to generalise what Fourier has discovered.
We propose to use the modal eigen shapes of surfaces in order to describe them and we adapted this method called Discrete Modal Decomposition (DMD) to discrete surfaces. Recently we have made possible to compute this method to a huge number of points making possible to assess measurements of topographic machines. Now we can simplify the complexity of a measurement to different levels of geometry from the simplest one given by the global shape, through the "middle level"given by undulation to the finest level of roughness or a very local "geometric accident"using this new (but old, because natural) method of geometric filtering.

Primary author: Prof. SAMPER, Serge (Université de Savoie)

Presenter: Prof. SAMPER, Serge (Université de Savoie)

Session Classification: High-precision Engineering

Contribution ID: **65** Type: **Presentation**

Galileo Galilei (GG): a space test of the weak equivalence principle to 10–17

Monday 20 March 2017 11:30 (30 minutes)

General Relativity (GR) is founded on the experimental fact that in a gravitational field all bodies fall with the same acceleration regardless of their mass and composition. This is the Weak Equivalence Principle (WEP) or Universality of Free Fall (UFF). Experimental evidence of a violation would require either that GR is to be amended or that a new force of nature is at play. Either way, it would be a scientific revolution, while a confirmation would strongly constrain physical theories. There is no firm target as to the level at which violation should occur but the higher the precision of the test, the higher the chances to find new physics.

GG is a space mission aiming to test the WEP to 1 part in 10 17. It will do it by measuring to this level the fractional differential acceleration of two different composition test masses in the gravitational field of the Earth while orbiting around it at low altitude. GG will improve the best torsion balances results, currently at 10-13, by 4 orders of magnitude, deeply probing a totally unexplored physical domain.

Starting from the state of the art of WEP experiments, the working principle of GG will be presented together with some technical details of the practical realization and the results of preliminary on ground experiments.

Primary author: Dr PISANI, Marco (INRIM)

Presenter: Dr PISANI, Marco (INRIM)

Session Classification: Introduction & Big Science projects

Contribution ID: **66** Type: **Presentation**

Determining alignment measurements uncertainties for large assemblies using stochastic analysis techniques

Tuesday 21 March 2017 09:45 (25 minutes)

Accurate, specific and traceable uncertainty budgeting of measurements is identified as key tool allowing micrometre alignment of large assemblies. The lack of standard methods to allow such accurate uncertainty statements is identified as a major research gap. As an answer to this a new uncertainty budgeting strategy following the International Standard of Uncertainty in Measurement (GUM - Supplement 1) is proposed. In this strategy the various error sources are evaluated experimentally and then propagated as probability density functions via either empirical or numerical stochastic (Monte Carlo) models. The method is applied in two different ways in the PACMAN project with regard to CLIC magnet assembly's alignment studies. In the first a Monte Carlo model of the CMM measurements Is used to propagate and evaluate the task specific uncertainty of the laboratory alignment measurements. In the second, thermal measurements of the real alignment conditions of the assembly are used as input into stochastic empirical and numerical models. Mean results of those are being used for compensation of the thermally related drift of the assembly with respect to the laboratory alignment measurements. The stochastic compensation models probability density functions are used as quantification of their uncertainty. Those methods are validated against precision coordinate measurements of calibrated artefacts and references. With this methodology the global uncertainty budget can be now be determined accurately as function of the exact conditions of each specific contributing factor (structures operational temperature and its gradients, measurement strategy, instrumentation used, etc.). It is argued that this methodology would provide a more accurate approach on the tight uncertainty budgeting allocated for the alignment requirements of the future particle accelerators projects. The method could be easily extrapolated/applied for the uncertainty budgeting required for any other large assembly's high precision alignment.

Primary author: Mr DOYTCHINOV, Iordan (CERN/Cranfield University)

Presenter: Mr DOYTCHINOV, Iordan (CERN/Cranfield University)

Session Classification: High-precision Engineering

Contribution ID: **67** Type: **Presentation**

ESS accelerator technology and challenges

Monday 20 March 2017 10:00 (30 minutes)

The European Spallation Source, now under construction in Lund, Sweden, aims to be the world' s most powerful pulsed neutron scattering facility. The project is now about 30% complete, with significant progress in civil construction. Driving the neutron source is a 5-MW superconducting proton linear accelerator operating at 4% beam duty factor and 14-Hz repetition rate. At this unprecedented beam power, beam losses are an important consideration in the design. The status of the accelerator will be presented along with highlights of some technical aspects related to beam loss and efficient delivery of the beam to the target station. Nineteen partner institutions from across Europe are working with the Accelerator Division in Lund to design and construct the linac and related systems. While many systems are still in the design phase, production of major components is underway and the commissioning of the ion source has recently begun.

Primary author: SHEA, Thomas (ESS)

Presenter: SHEA, Thomas (ESS)

Session Classification: Introduction & Big Science projects

Contribution ID: **68** Type: **Presentation**

CLIC technical challenges & PACMAN

Monday 20 March 2017 09:00 (30 minutes)

The Compact Linear Collider (CLIC) study aims at a realistic design of a multi-TeV e+e– linear collider for the post-LHC era of high-energy physics, with the potential to operate at centre-of-mass energies ranging from 380 GeV up to 3 TeV and with luminosities of a few 10ˆ34 cm-2 s-1. It is based on a novel two-beam acceleration scheme and on the use of high-gradient, high-frequency accelerating structures (100 MV/m, 12 GHz). It requires to produce, accelerate and transport over large distances ultra-low emittance beams and focus them to nanometer scale transverse sizes at the collision point.
On top of the technical challenges related to high-gradient and two-beam acceleration, all this implies very tight tolerances in precision machining and pre-alignment of components (of the order of a few um), beam position measurements and damping of vibrations over a few Hertz at the nanometer level, control of stray magnetic field to the nanoTesla and precise synchronization to a few tens of femtoseconds over tens of kilometres. In the presentation we will describe how the CLIC study addressed these difficult issues and review the status of the associated R&D, focusing in particular to the role of the PACMAN project.

Primary author: Dr CORSINI, Roberto (CERN)

Presenter: Dr CORSINI, Roberto (CERN)

Session Classification: Introduction to CERN R&D Projects

Contribution ID: **69** Type: **Presentation**

High precision rotating PCB coil

Tuesday 21 March 2017 16:50 (25 minutes)

The presentation focuses on the high precision PCB rotating coil for magnetic measurements of both magnets with small size bore (below 10 mm) and big sizes magnets (longitudinal length bigger than two meters).
The design and test results of the new miniaturized synthetic sapphire rotating coil will be presented together with a new innovative design for an adjustable Ribbon coil developed in collaboration with Fermilab.
It will be also presented a Dynamic calibration for PCB rotating coils with on board bucking.

Primary author: Ms SEVERINO, Giordana (CERN)

Presenter: Ms SEVERINO, Giordana (CERN)

Session Classification: Magnetic measurements

Contribution ID: **70** Type: **not specified**

Diversity at CERN

Tuesday 21 March 2017 13:30 (10 minutes)

Presenter: Ms DATTA COCKERILL, Sudeshna (CERN)

Session Classification: Diversity discussion

Contribution ID: **71** Type: **Poster**

Effects of Correlations Between Particle Longitudinal Positions and Vertical Plane on Bunch Length Measurements in the GBS Electron LINAC at ELI-NP

The effects of the assumptions about the bunch proprieties on the accuracy of the measurement method of the bunch length based on a Radio Frequency Deflector (RFD) in electron LINear ACcelerators (LINACs) are investigated. In particular, when the electron bunch at the RFD has correlations between particle longitudinal positions and vertical, the measurement is affected by a deterministic intrinsic error. A case study about this effect in the electron LINAC of the Gamma Beam Source (GBS) at the Extreme Light Infrastructure–Nuclear Physics (ELI-NP) is reported. Relative error is estimated by using ELEctron Generation ANd Tracking (ELEGANT) code to define reference measurements of bunch length.

Presenter: Mr SABATO, Luca (Universita del Sannio (IT))

Contribution ID: **72** Type: **Poster**

Development of an Optical Inertial Sensor

In this contribution, a new prototype of optical inertial sensor and the results of huddle tests will be presented. The sensor is an interferometric absolute motion sensor, which includes two parts. One is a new designed compact optical readout. The overall size of the interferometer is within 150×100×70 mm3 (L×W×H). As it is not affected by the electromagnetic field, it will be completely compatible with accelerator environment. Currently, the resolution of the readout is about 10-13m/rtHz (RMS: 60 pm), which shows significant advantages than the commercial capacitance based or LVDT based readouts. The second part of the sensor is a mechanical pendulum, which currently is a homemade hinge. Because the thermomechanical noise highly influences the resolution of the optical inertial sensor in the low frequency domain, the mechanical structure and materials have to be studied and carefully designed. Then, huddle tests have been carried out to compare different structures and materials.

Presenter: Mr DING, Binlei (ULB)