Iranian Light Source Facility

7th Users' Meeting

Book of Abstracts

April 20-21, 2015

Science & Technology Park, Qazvin, Iran

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Schedule

Date	Chair	Time	Name	Subject
Monday, April 20, 2015	M. H. Hadizadeh	08:30 - 09:00	Registration	
		09:00 - 10:00	Opening	
		10:00 - 10:30	Javad Rahighi	An Overview to Iranian Light Source Facility
		10:30 - 10:45	Hossein Ghasem	ILSF Accelerators
		10:45 - 11:15	Tea Break	Hanging Poster
		11:15 - 12:00	Maya Kiskinova	Research at Elettra-Sincrotrone Trieste Laboratory
		12:00 - 12:45	Sheldon Wiebe	Synchrotron Radiation Imaging and Therapy; Potential Clinical Relevance
		12:45 - 14:15	Lunch Break	Group photo
	H. Afarideh	14:15 - 15:00	Andrea Lausi	Cooperative Brilliance
		15:00 - 15:45	Majid Kazemian	Diamond Light Source; Introduction to Its Present Status and Future Scope
		15:45 - 16:15	Tea Break	Poster Session
		16:15 - 17:00	Dean Chapman	The Canadian Light Source and the Biomedical Beamline Facility
		17:00 - 17:30	Nazanin Samadi	A Phase Space Beam Position Monitor for Synchrotron Radiation

Date	Chair	Time	Name	Subject
Tuesday, April 21, 2015	N. Hadipour	09:00 - 09:45	Maya Kiskinova	Synchrotron-Based Imaging and Spectromicroscopy Using Soft X-Rays
		09:45 - 10:30	Andrea Lausi	Status of the Crystallography Beamline at Elettra
		10:30 - 11:00	Tea Break	Poster Session
	N. Ghahremani	11:00 - 11:45	Majid Kazemian	I08-SXM Beamline @ Diamond; an Ambitious Project Comes True
		11:45 - 12:30	Nazanin Samadi	Instrumentation Projects at the Biomedical Imaging and Therapy Beamlines at the Canadian Light Source
		12:30 - 13:30	Lunch Break	
		13:30 14:00	Group Photo II (at the ILSF Storage Ring Site)	
	M. Tabrizchi	14:00 - 14:20	Reza Kia	Synchrotron-Based X-Ray Charge Density Studies of Some Organic Compounds
		14:20 - 14:40	Mahmoud Mirzaei	Detections of Weak Hydrogen Bonds in Living Systems
		14:40 - 15:00	Elham Keshavarz	Study of Argon Dimer Core Ionization by Coincidence Techniques
		15:00 - 15:30	Discussion & Concluding Remarks The Best Poster Award	
		15:30	Return to IPM	

A Few Words from the Director

ILSF is the very first large scale scientific facility under construction for academic and industrial use in Iran.

There is no doubt that such an outstanding scientific laboratory, when operational in 2020, will have a great impact on promoting Iran’s science and technology.

Some 3.5 million students are studying annually in the Iranian universities across the country, more than 0.5 million of which are doing postgraduate degrees in engineering and science. Iran has therefore a great potential in building a users’ community which will be capable of taking advantage of a modern and advanced light source.

Since the project started in late 2009 and in parallel to the accelerator construction, a tremendous amount of work has gone into training the technical staff i.e. those who design complex accelerator systems. As well as synchrotron radiation users, i.e. those who apply synchrotron radiation as a tool for their research. This investment would clearly guarantee a healthy growth of the project.

As a result of the strong capacity building efforts, we have been witnessing a very sharp increase in the number of Iranian users (potential users and those who have already been involved in some sort of synchrotron radiation based experiments). This growth is very much indicative of the success of the project.

The present gathering is the 7th meeting of the users during which you can all exchange your experience in the field of synchrotron science.

I wish you will have two enjoyable days here at the construction site of the facility and I believe that the future months and years will be a very exciting period for photonic research and for the science as a whole in Iran. I invite every one of you to join us for taking advantage of this exceptional opportunity that may be available to us.

I also call for the government decision makers in science and technology, to do whatever they can to speed up financing ILSF so that the already tremendous momentum gained is preserved and the facility could be made available to the Iranian users and those of the region in the shortest possible time.

Javad Rahighi
Director, Iranian Light Source Facility
April, 2015, Tehran

Oral Presentations

Title: An Overview to Iranian Light Source Facility

Javad Rahighi

Iranian Light Source Facility, IPM, Tehran, Iran

Project history explaining the major steps has been presented. In order to demonstrate the progress status, various phases of the construction are shown. Site selection, main accelerator design specifications, and research & development activities from the early stage of the project have been discussed.

Special attention is given to the success of the project on collaboration with other light sources across the world and to the capacity building on accelerator design and on the science and users side of ILSF.

Title: ILSF Accelerators

Hossein Ghasem

School of Particles and Accelerators, IPM, Tehran, Iran

The Iranian Light Source Facility (ILSF) is a 3 GeV third generation synchrotron light source facility which is in the design stage. As the main radiation source, design of the ILSF storage ring emphasizes an ultralow electron beam emittance, great brightness, stability and reliability. The storage ring is based on a five-bend achromat lattice providing an ultralow horizontal beam emittance of 0.48 nm rad. In this talk, general overview of the ILSF accelerators and their expected performance will be briefly presented.

Title: Research @ Elettra-Sincrotrone Trieste Laboratory

Maya Kiskinova

Elettra Sincrotrone Trieste, Italy

Elettra laboratory operates two light sources: a synchrotron radiation storage ring since 1993 and a seeded free electron laser facility since 2012. Elettra laboratory has a matrix-type of organization with five Clusters: Elettra, FERMI, Research, Technology Platform and International Projects. The Research Cluster is managing the research projects with specific goals. They are involving the 26 synchrotron and 3 FEL beamlines, and several supporting laboratories that make part of the two beamline groups. Along with the research project activities the talk will include the procedures for granting beamtime to the users and the criteria that are used to evaluate the research achievements, dissemination and international activities.

Title: Synchrotron-Based Imaging and Spectromicroscopy Using Soft X-Rays

Maya Kiskinova

Elettra Sincrotrone Trieste, Italy

The complementary capabilities of different X-ray microscopy approaches in terms of imaging, spectroscopy, spatial and time resolution are strongly requested by the multi-disciplinary research programs at the synchrotron facilities and have motivated continuous investments in development of instrumentation for imaging with spectroscopic analysis.

The lecture will present and compare the principles and potentials of modern x-ray microscopes using various approaches in imaging and micro-spot spectroscopy, based on detecting and filtering of emitted electrons and transmitted, emitted or scattered photons [1, 2].

The application of these methods in material and life sciences will be illustrated using selected results obtained at Elettra that has very extensive programs in the field of X-ray microscopy.

[1] B. Kaulich, P. Thibault, A. Gianoncelli and M. Kiskinova. J. Phys.: Condens. Matter 23 (2011) 083002.

[2] A. Barinov, P. Dudin, L. Gregoratti, A. Locatelli, T. O. Mentes, M. A. Nino and M. Kiskinova, Nucl. Instr. Meth. Phys. Res. A 601 (2009) 195–202.

Title: Cooperative Brilliance

Andrea Lausi

Elettra Sincrotrone Trieste, Italy

Synchrotron radiation science owes its success to its impact in the science of materials considered in the widest sense, where high quality performance experiments require high quality beamline instrumentation. The challenges for beamline engineering, from managing high heat loads to the development high stability optics, are common to all of the light sources. Therefore, the development of a new beamline necessarily implies the set-up of collaborative structures that involve a broad expanse over the synchrotron radiation community. As a matter of fact, all beamlines include common elements such as X-ray optics, experimental stations, detectors and beamline control so that the collaborative development of common technology platforms has proven crucial in enabling the community to handle sophisticated instrumentation whilst still allowing customization to particular user and experiment demands.

Title: Status of the Crystallography Beamlines at Elettra

Andrea Lausi

Elettra Sincrotrone Trieste, Italy

Elettra is one of the first 3rd generation storage rings, recently upgraded to routinely operate in top-up mode at both 2.0 and 2.4 GeV. The facility hosts four dedicated beamlines for crystallography, two open to the users and two under construction, and expected to be ready for public use in 2015. In service since 1994, XRD1 is a general purpose diffraction beamline. The light source for this wide (4-21 keV) energy range beamline is a permanent magnet wiggler. XRD1 covers experiments ranging from grazing incidence X-ray diffraction to macromolecular crystallography, from industrial applications of powder diffraction to X-ray phasing with long wavelengths. The bending magnet powder diffraction beamline MCX has been open to users since 2009, with a focus on microstructural investigations and studies under non-ambient conditions. A superconducting wiggler delivers a high photon flux to a new fully automated beamline dedicated to macromolecular crystallography and to a branch beamline hosting a high pressure powder X-ray diffraction station (both currently under construction). A high throughput crystallization platform equipped with an imaging system for the remote viewing, evaluation and scoring of the macromolecular crystallization experiments, has also been established and is open to the user community.

Title: Diamond Light Source; Introduction to Its Present Status and Future Scope

Majid Kazemian Abyaneh

Diamond Light Source Ltd., Harwell Science & Innovation Campus, Didcot, OX11 0DE, United Kingdom

Diamond Light Source is a world leading 3rd generation synchrotron source for the UK and international science and engineering communities. Conducting world-leading research across a wide range of scientific disciplines and industrial applications, Located on the Harwell Science & Innovation Campus in Oxfordshire which it shares with other leading facilities.

I will give an introduction to the present status of Diamond and have a look briefly to the science division, the villages and their beamlines which are operational by 2015, to highlight some of their recent achievements.

In the following, I will focus on the upcoming beamlines (phase III) and integrated facilities which are improving the scope of Diamond enormously. Scanning X-ray microscopy (I08), the Resonant Inelastic X-ray Scattering (RIXS) beamline (I21), Versatile Soft X-ray (VERSOX) beamline (B07), and the dedicated X-PDF station (I15-1) are part of phase III that will see Diamond gain a host of beamlines offering new approaches to scientific challenges. The construction of the Electron Microscopy Facility is a particularly interesting development for Diamond, as it will combine three different elements – the Hard X-ray nanoprobe beamline (I14), along with the electron imaging centre for biology and the electron microscopy centre for physical sciences – under one roof.

Title: I08-SXM Beamline @ Diamond; an Ambitious Project Comes True

M. K. Abyaneh, T. Araki, B. Kaulich

Diamond Light Source Ltd., Harwell Science & Innovation Campus, Didcot, OX11 0DE, United Kingdom

I08-SXM beamline at Diamond Light Source, UK, is hosted a Scanning X-ray microscope with outstanding capabilities and features. I08-SXM is an instrument that covers a broad photon energy range (250 to 4200 eV), generated by an Apple II type insertion device, providing access to all major K- and L-absorption edges for SXM elemental and chemical analysis, with lateral resolutions down to ~20 nm depending on the imaging mode, combined with the high quality spectroscopic (NEXAFS) data for chemically-sensitive analysis, and X-ray fluorescence (XRF) mapping.

Scanning X-ray microscopes find applications in all major research fields, in many cases approaching ultimate diffraction-limited lateral resolutions and with unprecedented performance limited in the past by X-ray source properties, optics and detectors schemes. Missing in the general portfolio of scanning X-ray microscopes worldwide, and addressed by I08-SXM is an instrument that covers a broader photon energy range providing access to all major K- and L-absorption edges for SXM elemental and chemical analysis, combined with complementary imaging and spectroscopic techniques.

Title: The Canadian Light Source and the Biomedical Beamline Facility

Dean Chapman

Science Director, Canadian Light Source

The Canadian Light Source (CLS) is a third generation synchrotron facility located in Saskatoon, Saskatchewan, Canada on the University of Saskatchewan campus. This facility, now operating for 10 years, presently hosts 15 operational beamlines that cover a wide range of research and experimental capabilities. A brief overview of the facility and the present and planned beamline complement will be presented.

In addition, the CLS, hosts a unique biomedical imaging facility, the Biomedical Imaging and Therapy (BMIT – pronounced beam-it) beamlines. These are designed to apply the unique properties of synchrotron light to biomedical research with a variety of modalities and wide range of subject sizes. BMIT’s imaging capabilities include phase-based methods; Diffraction Enhanced Imaging and In-Line Phase Contrast Imaging along with emerging methods of Grating Interferometry Imaging and Coded Aperture Imaging. Absorption based methods include K-Edge Subtraction which is an element specific form of imaging an elements such as iodine or barium. BMIT is capable of a large range of subject sizes which extends from millimeter sized objects such as pieces of bone to the ability to handle a large horse or cow – dogs are the largest subjects to date. Positioning systems have been purpose-built specifically for BMIT which allow for this range of subject sizes.

BMIT also has the capability to apply synchrotron specific radiation therapy methods of Microbeam Radiation Therapy (MRT) based high dose rate filtered white beam as well as monochromatic beam therapy – Synchrotron Stereotactic Radiation Therapy (SSRT).

The design of this multipurpose beamline complex presented several challenges. The presentation will emphasize some of those aspects related to the design and implementation including some of the newly developed technology, such as the phase preserving beam expander, along with some research examples.

Title: Synchrotron Radiation Imaging and Therapy - Potential Clinical Relevance.

Sheldon Wiebe

Pediatric Imaging, Special Advisor for Biomedical Synchrotron Imaging in the Office of the Vice-President Research University of Saskatchewan

Various synchrotron imaging and therapy methods will be discussed from the perspective of a clinical radiologist.

Title: A Phase Space Beam Position Monitor for Synchrotron Radiation

Nazanin Samadi

University of Saskatchewan and Canadian Light Source-Medical beamline

Synchrotron radiation experiments critically depend on the stability of the photon beam position. The position of the photon beam at the experiment location is set by the electron beam source position and angle as it traverses the magnetic field of the bend magnet or insertion device. An ideal photon beam monitor would be able to measure the photon beam's position and angle, and thus infer the electron beam's position in phase space. Monochromatic x-ray beams at synchrotrons are typically prepared by x-ray diffraction from crystals usually in the form of a double crystal monochromator. Diffraction couples the photon wavelength or energy to the incident angle on the lattice planes within the crystal. The beam from such a monochromator will contain a spread of energies due to the vertical divergence of the photon beam from the source. This range of energies can easily cover the absorption edge of a filter element such as iodine at 33.17 keV. A vertical profile measurement with and without the filter can be used to determine the vertical angle and position of the photon beam.

The goal was to investigate the use of this system as a phase space beam position monitor. The system was tested for sensitivity to position and angle under a number of synchrotron operating conditions. The results are comparable to other methods of beam position measurements and indicate that such a system is feasible in situations where part of the white synchrotron beam can be used for the phase space measurement.

Title: Instrumentation Projects at the Biomedical Imaging and Therapy Beamlines at the Canadian Light Source

Nazanin Samadi

University of Saskatchewan and Canadian Light Source- Medical beamline

Synchrotron Radiation is an excellent source of x-rays for different research applications. The Biomedical Imaging and Therapy (BMIT) Beamlines at the Canadian light source (CLS) is a high intensity, small and tunable source of x-rays which enables us to perform a number of synchrotron imaging methods on different biological systems. These methods include: analyzer based or diffraction enhanced imaging, in-line phase contrast imaging, Talbot or grating interferometry based imaging, K-edge subtraction imaging, coded aperture or Shack-Hartman imaging and lots of other methods. Broad band spectrum, intensity and small source size in the synchrotron allows us to test new and unique ways of imaging or imaging optics. In the X-Ray Imaging Group at the university of Saskatchewan and CLS, we are working on improving imaging systems, their optics and also inventing new imaging techniques. In some of these projects we use different properties of bend silicon crystal. To name a few, in Beam Expander two matched crystals are being used to expand the vertical beam size. In Spectral KES, the dispersion properties of a silicon crystal is being used to do simultaneous K-edge subtraction imaging, and same for multiple energy imaging. Some of these projects and their properties, along with some sample images of biomedical systems will be presented.

Title: Synchrotron-Based X-Ray Charge Density Studies of Some Organic Compounds

Reza Kia

Chemistry Department, Sharif University of Technology, P.O. Box 11155-3615, Tehran, Iran

The experimental electron density properties of some organic compounds were derived from a multipole refinement of 100 K synchrotron-based X-ray data based on Hansen-Coppens [1] formalism using MoPro [2] and complemented by density functional theory calculations at experimental geometry. Atomic and bond-topological such as deformation density, Laplacian of electron density and electrostatic potential properties were derived using the Bader's atoms-in-molecules (AIM) formalism.

Keywords: Charge density, Hansen-Coppens formalism, Laplacian

References:

[1] N. K. Hansen, P. Coppens, *ActaCryst.* (1978). **A34**, 909-921.

[2] C. Jelsch, B. Guillot, A. Lagoutte, C. Lecomte, J. Appl. Cryst. **38**, (2005) 38-54.

Title: Study of Argon Dimer Core Ionization by Coincidence Techniques

Elham Keshavarz

University of Isfahan

Core ionization of molecules leads to highly excited species which consequently relax and usually dissociate into some fragments. Coincidence spectroscopy has been widely used to monitor the fragments and follow different channels. Argon dimer has been selected for the present study due to weak but enough stabilizing interactions. Photon energies around Ar2p and Ar2s ionization were selected and three different coincidence techniques were utilized, photoelectron-photoion-photoion coincidence (PEPIPICO), photon-photoion-photoion coincidence and fast ion- fast ion coincidence. The PEPIPICO spectra in different photon energies showed Ar+/Ar+, Ar2+/Ar+, Ar3+/Ar+, and Ar2+/Ar2+ coincidences. The possible channels in each photon energy have been discussed. The change in intensity of each channel with photon energy was investigated. Also the released kinetic energy after dissociation was estimated. In the photon-ion-ion coincidence spectra only a weak Ar+/Ar+ coincidence was observed. The fast ion-fast ion coincidence spectrum which is a TOF spectrum, shows 3 peaks. Based on the initial simulation of the ions behavior, the peaks are attributed to Ar2+/Ar+, Ar+/Ar+ and Ar+/Ar2+ coincidences, in the order of increasing time-of-flights. Here the first ion hits the close MCP detector, and the second ion hits the MCP detector located after the time-of-flight tube.

Title: Detections of Weak Hydrogen Bonds in Living Systems

Mahmoud Mirzaei

Isfahan University of Medical Sciences

Hydrogen bonds are important in biology for their interacting characteristics among the components of living systems. Weak hydrogen bonds are important in determining the final three-dimensional structures of related compounds further to conventional hydrogen bonds, which are strong enough to make inter- and intra-molecular attractions. The strong hydrogen bonds are meaningful for nitrogen, oxygen, and fluorine atoms whereas the weak ones could occur for other atoms. Characterizing the types of weaker hydrogen bonds is more important than that of stronger ones. The spectroscopic techniques including IR, NMR, and X-Ray equipped with efficient sources and detectors are helpful for the purpose. Moreover, quantum computations could also yield insightful trends to complete or to interpret the experimental achievements.

Poster Presentations

Title: Ab Initio Study of the Van Der Waals Interaction Potential Energy Surface of CS2 Whit Rare Gases (He, Ne and Ar); Electronic Ground And Excited States: The Effect of the Wan Der Waals Interaction on the Absorption and Emission Spectra of CS2

M. Tozihi[1], E. Keshavarz[2], M. Ghandehari[3], A. Kivimäki[4] and R. Richter[4],

[1.] University of Zanjan, [2.] Isfahan University, [3.] Isfahan University of Technology, [4.] Elettra-Sincrotrone Trieste, Italy

During the allocated beam time in Eletera synchrotron, we have studied double photoionization of Ar2 in the energy range ~ 244-251 eV. The majority of produced ions come from atoms, which do not have any velocity in the detector direction. Applying a low repelling voltage prohibits these ions from getting to both detectors. So only the ions coming from dimer (or larger clusters) fragmentation with an initial velocity in the detector direction reach the detector. The selected energy range shows some resonances below the Ar2p ionization threshold and also covers above threshold region. There are obvious shifts in the dimer peaks with respect to the atomic peaks. In the TOF spectrum, which shows the fast ion-fast ion coincidence, 3 peaks were determined. Based on the initial simulation of the ions behavior, the peaks are attributed to Ar2+/Ar+ , Ar+/Ar+ and Ar+/Ar2+ coincidences, in the order of increasing time-of-flights. Here the first ion hits the close MCP detector, and the second ion hits the MCP detector located after the time-of-flight tube.

Title: Calculations of Noncovalent Interactions in the Active Site of Hydroxysteroid Sulfotransferase Enzyme (SULT2A1) Using DFT-D Method

Astani, Elahe[1], Nasser L. Hadipour[1], Heshmati, Emran[2];

[1] *Department of Chemistry, TarbiatModares University.*

[2] *Department of Biology, University of Zanjan.*

The enzyme Human DHEA sulphotransferase or SULT2A1/DHEA(PDB code: 1J99) catalyzes the sulfonation of DHEA on the 3α-oxygen, with PAPS contributing the sulfate. Since the positions of hydrogen atoms are not located accurately by X-ray diffraction, we performed partial geometry optimizations on these structures by means of the newest functionals of dispersion density functional theory technique (DFT-D),in order to obtain more exact structural parameters (lengths and angles of Hydrogen bonds).

In this work, we investigated details of noncovalent interactions, especially HB interactions, between DHEA and neighboring amino acids as well as between the special amino acids in SULT2A1/DHEA active site using nuclear magnetic resonance (NMR) and nuclear quadrupole resonance (NQR) spectroscopies.

Understanding the correct nature of interactions in this active site, we can predict the other substrate interactions (having structure similar to DHEA) with its neighboring residues in the active site. Then the new substrate will be replaced with DHEA experimentally and itsstructure will be determinedby synchrotron x-rays radiation.

Title: Electronic Structure of Protonated Phenanthrene, Pyrene and 2-Pyridone in the Gas Phase

Behnaz Saed

University of Isfahan

In the present study, we report our result on the electronic structure and transition energy of the protonated phenanthrene (PhH^+), protonated pyrene (PyH^+) and protonated 2-pyridone ($2PYH^+$). According to our CC2 calculation, in PhH^+ and PyH^+, the S_1 and S_2 excited states are strongly red-shifted compared to corresponding electronic transitions in neutral homologues. The CC2 calculations identify an out-of-plane deformation as the most important photochemical reaction coordinate in PhH^+ as well as protonated benzene. Indeed, in the S_1 states, the systems have to lose its planar symmetry, through a conical intersection (CI) with the S_0 state, which directs the system back to the minimum of the S_0 potential energy surface. In contrast to the most stable isomer of PhH^+, the most stable structure of PyH^+ shows planar structure in both the S_1 and S_2 excited states. In addition, the potential energy profiles of $2PYH^+$ and monohydrated $2PYH^+$ at different electronic states show the $^1\pi\sigma^*$ state in the protonated species is a dissociative state along the O-H stretching coordinate. In this reaction coordinate, the lowest $^1\pi\sigma^*$predissociates the bound S_1 state, connecting the $^1\pi\sigma^*$ to a CI with the S_0 state. Furthermore, studies show in presence of water molecule, the $^1\pi\sigma^*$state still remains dissociative but the CI between $^1\pi\sigma^*$ and S_0 state disappears. In addition, according to the CC2 calculation results, protonation significantly blue shifts the S_1-S_0 electronic transition in the 2PY system. To study the gas phase electronic properties of PhH^+, PyH^+ and $2PYH^+$ synchrotron techniques, namely methods of core level and valence band photoemission spectroscopy can be used. The results should be compared to the corresponding ones of the neutral species in order to discuss proton effect.

Title: Monte Carlo Method Investigation in Synchrotron Radiation Dose Distribution for Microbeam Radiation Therapy

Seyedeh Rana Ashraf

Sciences & Research University

Microbeam radiation therapy is a new method using micron radiation beam produced by synchrotron. Microbeam Radiation Therapy (MRT) is a technique utilizing the fact that normal tissue can sustain high doses of radiation in small volumes without significant damage. The main advantages of highly brilliant synchrotron sources are an extremely high dose rate and very small beam divergence. Microbeam radiation therapy (MRT) uses highly collimated, quasi-parallel arrays of X-ray microbeams of 50–600 keV. Typically, MRT uses arrays of narrow (25–100 mm wide) microplanar beams separated by wider (100–400 mm center-to-center) microplanar spaces. In this study the dose distribution resulting from the micro beam radiation therapy and conventional radiation therapy using Monte Carlo simulation has been reviewed by MCNP4C code. Percentage depth dose curves, Dose - radius and the dose distribution curve drawn with MCNP4C code and compared with each other and with the results of the GEANT4 code are in reference 29. The results show the ability of the Monte Carlo code in simulation and microbeam dosimetry. The results show that the model is valid enough to be used in similar cases, as well as the results could represent an alternative to conventional radiation therapy for low-energy. Keywords: Radiation therapy- Microbeam- Synchrotron- Dose distribution- Simulation.

Title: Synchrotron X-Ray Beamlines

Esmaeil Khosravi

K. N. Toosi University of Technology

Synchrotron radiation can be used for more than crystallography aspects. Its spectrum is extends from infrared to about gamma region of electromagnetic waves. Typical applications of these radiation include scattering, imaging and spectroscopy, performed on samples from practically all fields of science. This novel experimental tool provides possibilities for more precise observations and developed into specialized techniques over time. I would like discuss the typical layout and similarities but also specialization of synchrotron beamlines, concluding with one or two examples of European synchrotrons. The focus will be on hard X-ray, also soft X-ray will be considered. My talk is organized using a downstream approach, following the photon from the source via the monochromator to the sample and the detector.

Title: Hadrontherapy by Means of Synchrotron

Abdolkazem Ansarinejad [1]; R.Cirio[2]

[1] *Nuclear Science and Technology Research Institute, Physics and Accelerators School, Tehran*

[2] *Experimental Physics Department, University of Torino, Torino, Italy*

Introduction: Actually the hadrontherapy as an advanced technique of radiation therapy is increasing. The advantage of the high accuracy of the dose deposition resulting from the physical properties of hadrons and the higher radiobiological effectiveness make this kind of radiation a promising tool for cancer treatment. The Italian National Center of Oncological Hadrontherapy (CNAO) has been developed by the Department of Physics of the University of Torino and INFN in collaboration with the CNAO foundation the first hadrontherapy facility in Italy.

Methods and materials: In order to overcome the physical and biological limitations of the conventional radiotherapy the use of charged particles like protons or heavier ions was proposed. Specifically Hadrontherapy uses hadron beams for irradiation. Protons and charged particles passing through tissue slow down losing energy in atomic or nuclear interactions. This reduces the energy of the particles, which in turn causes increased interaction with electrons Maximum interaction occurs at the end of the range causing maximum energy transfer and thus maximum dose deposition within the target area. The primary rationale for radiation therapy with protons and charged particles is the sharp increase of dose in a well-defined depth and the rapid falloff beyond that maximum, with the optimum sparing of normal tissue structures close to the target.

Results: The CNAO technology: The national center of oncological hadrontherapy is the first hospital based facility to deliver hadrontherapy treatments in Italy. This center will be devoted to the treatment of deep-seated tumors mainly with protons and carbon ions and to clinical and radiobiological research. The CNAO facility consists of a synchrotron with two sources and a LINAC, treatment rooms had been equipped with 4 fixed beam lines, three horizontal and one vertical.

Beam Lines and accelerator: The basic design of the CNAO accelerator and lines has been driven by the clinical requirements of the therapeutical beams, the synchrotron has a diameter of approximately 25m and accelerates for therapy mainly protons and carbon ions respectively from 60 to 250 MeV and from 120 to 400 MeV/u.

Dose Delivery System: (DDS) is the last part of the accelerator system which comes just before the patient. To cover the target volume the pencil beam is steered by means of two scanning magnets and modulated in energy in order to penetrate to different depths. The DDS main roles are the management of the beam delivery and the online check of the beam intensity and beam position.

Conclusion: Radiotherapy with charged particles is a very advantageous tool to fight against cancer because of the several physical and biological properties. The CNAO center, in Pavia, is the first nation-wide hospital based facility to treat deep seated and radioresistant tumors by means of a synchrotron accelerator that deliver protons and carbon ions.

Title: Transverse Beam Profile Measurements in the Linac4 Medium Energy Beam Transport

G. Bellodi, V. Dimov, J.B. Lallement, A. Lombardi, U. Raich, F. Roncarolo, F. Zocca, CERN, Geneva, Switzerland, M. Yarmohammadi Satri,

IPM, Tehran, Iran

Linac4 is a 160 MeV H- linear accelerator presently under construction at CERN. It will replace the present 50 MeV proton Linac2 as injector of the proton accelerator complex as part of a project to increase the LHC luminosity. The Linac4 front-end, composed of a 45 keV ion source, a Low Energy Beam Transport (LEBT), a 352.2 MHz Radio Frequency Quadrupole (RFQ) which accelerates the beam to 3 MeV and a Medium Energy Beam Transport (MEBT) housing a beam chopper, has been commissioned in the Linac4 tunnel. The MEBT is composed of three RF cavities and 11 quadrupole magnets to match the beam from the RFQ to the next accelerating structure (DTL) and it includes two wire scanners for beam profile measurement. In this paper we present the results of the profile measurements and we compare them with emittance measurements taken with a temporary slit-and-grid emittance measurement device located after the MEBT line.

Title: Synchrotron Radiation Characterization of Ancient Objects in Primeval Countries

Reihaneh Rajaiean, Hamidreza Oveisi

Hakim Sabzevari University

The application of synchrotron radiation (SR) in the archaeological and cultural heritage sciences is relatively recent, dating to the end of the ’80s, as a result of relationship between archaeologists and specialists who studied on SR techniques. The advantages of SR radiation is the flexibility of the instrumental configurations and also an excellence parameter that makes large scale facilities invaluable for almost any experiment that one may think of in this field. One of the key requirements in the studies of ancient and precious materials is that the selected techniques must be non-destructive (or at most micro-destructive). Characterization and protection of archaeological and artistic finds are duty of scientists and archaeologists. The used of analyzer technique are important for recognition the composition, dating, provenance, art technology, conservation of them. There is a broad and strong tendency towards the use of microbeams, in particular devoted to µ-IR, µ-XRD, µ-XAS, µ-XRF, to produce 2D mapping and Three-dimensional imaging of ancient cultural heritage. This report is based on imaging data, compounds and grain size detection on handwriting documents, vessels, pigments, tissue in fossils bones at ancient centuries with very brilliant, unprecedented space, energy resolution and collimated micro X-ray beams at SR.

Title: The First Simulation Results on Radiation in Phase-Combined Undulators

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Recently, in order to reduce the force between two arrays of the undulator, two new methods have been proposed in which the phase-combined undulators (PCUs) are employed to make fine adjustment of the magnetic force in the insertion device. The aim of this report is to investigate the evolution of the electron beam and radiation in FEL by employing these two methods.

Title: Harmonic Generation In Two Orthogonal Undulators

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In this report, our time dependent simulation results on harmonic generation in two orthogonal undulator are presented. The linear analysis of harmonic generation has been displayed. A numerical simulation in one-dimension is conducted to study the slippage effects and harmonic generation in two orthogonal undulators.

Title: Design of Iranian Light Source Facility Medical Beamline

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The Iranian Light Source Facility Project (ILSF) is a 3rd generation light source with energy of 3 GeV, a full energy injector and a 150 MeV Linac as pre-injector. The stored beam current in top up mode is 400 mA, the beam lifetime is about 7 h, and the average pressure of vacuum chamber is approximately 1.33×10^{-7} Pa (1 nTorr). The overriding features of the synchrotron beams which make them applicable to medical research are their extremely high intensity and broadband energy spectrum. Several orders of magnitude separate the smooth, continuous spectrum of the synchrotron from the sharply peaked characteristic emission spectrum of a conventional source. In ILSF, a wiggler beamline is under design for medical applications. This beamline will be capable for most of imaging techniques such as KES and DEI for the range of 20-60 keV with photon flux of 10^{12} ph/s, energy resolution of 10^{-4} and 5 KW power. Detailed design of wiggler source as well as optical elements of ILSF medical beamline will be reported in this presentation.

Title: Photoemission Electron Microscopy Branch of Spectromicroscopy Beamline of the Iranian Light Source Facility

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The Spectromicroscopy beamline is one of the day one beamlines of the Iranian Light Source Facility (ILSF) to cover the Iranian users' community demands in the field of soft x-ray spectroscopy. This beamline is designed to cover the 90-1500 eV energy range with about 0.8×10^4 resolving power, and the minimum spot size of about 10×4 μm^2 at sample position. Brilliance, flux distribution, power distribution and photon size and divergence in the whole range of energy has been calculated for a 1.6 m helical undulator with maximum undulator strength parameter $K_{max}=5$ using SPECTRA code.

The designed beamline has two branches: photoemission electron microscopy (PEEM) and scanning photoelectron microscopy (SPEM). PEEM branch design has been considered in this study. The layout of PEEM branch has been decided to be includes of a collimating mirror, a varied included-angle plane grating monochromator, and a KB bendable elliptical cylinder mirror. The ray tracing calculations done by SHADOW and RAY, gives us the most important parameters of the photon beam in different part of the beamline. Two plane gratings with different uniform line density (700, 900 lines/mm) have been used to cover the whole energy range with the resolving power of $0.75\text{-}0.8\times10^4$ depending on the photon energy.

Title: X-Ray Powder Diffraction Beamline with Wiggler Magnet Source for the Iranian Light Source Facility

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X-ray Powder Diffraction beamline is one of the first priorities of the Iranian Light Source Facility day-one beamlines. This beamline will cover the research requirements of scientific community in the fields of physics, material science, chemistry, etc. Scope of this report is design of the beamline to meet the Iranian users' requirements such as energy range: 6-30 keV, flux: 10^{12} ph/s energy resolution: 10^{-4} and spot size at sample: 0.1×0.1-10×1 mm^2. In this report type of the source, optical elements and their specifications have been discussed. Ray tracing calculations from source to sample place and optimization of the parameters have been done.

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