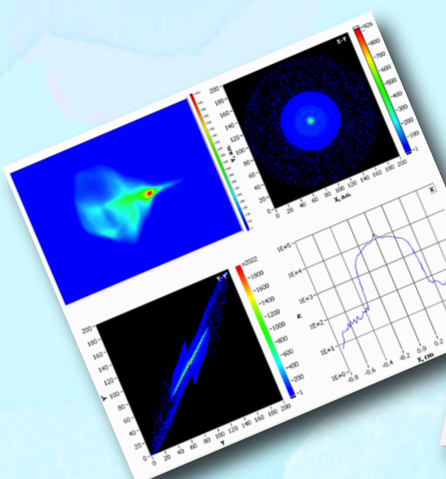
April 15-19, 2012

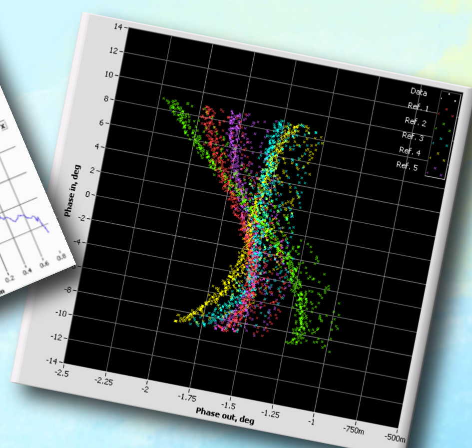
Newport News Marriott City Center

BIW 12

hosted by: Jefferson Lab

CONFERENCE GUIDE & ABSTRACT BOOKLET





http://conferences.jlab.org/biw12

BIW 2012

Newport News Marriott at City Center

Newport News, Virginia
April 15-19, 2012

Conference Guide
and
Abstract Booklet

Hosted By

Jefferson Lab
EXPLORING THE NATURE OF MATTER

http://www.jlab.org/conferences/BIW12

Contents

Welcome to BIW'12

Dear Colleagues,

I am pleased to welcome you, on behalf of the Beam Instrumentation Workshop Program Committee, to Newport News, Virginia for the 15th and final meeting of the Beam Instrumentation Workshop (BIW12). This workshop is hosted by Thomas Jefferson National Accelerator Facility (Jefferson Lab) and supported by our sponsors and vendors. Beginning this fall, the BIW will be combined with the European DIPAC meeting and a new Asian meeting to become the International Beam Instrumentation Conference (IBIC). BIW12 and the new IBIC meetings will remain committed to exploring the physics and engineering challenges of beam diagnostics and measurement techniques for particle accelerators.

The BIW12 agenda includes two tutorials, 11 invited talks, 19 contributed talks, and poster sessions Monday and Tuesday afternoon. There are also 19 vendor exhibits Sunday through Wednesday, and a conference banquet at the Virginia Living Museum. The generous support of our vendors has enabled the local organizing committee to include social hours at the end of both poster sessions to foster continued discussions and perhaps new collaborations. Please spend time with our vendors and thank them for their participation!

It is also with great pleasure that I announce the BIW Program Committee's selection of the 2012 Faraday Cup Award winner. This tradition, since 1992, is to recognize and encourage innovative achievements in the field of particle accelerator beam instrumentation. The Program Committee is grateful for the award's monetary donation by Bergoz Instrumentation, of Saint-Genis-Pouilly, France, manufacturers of beam instrumentation for particle accelerators.

The Program Committee would sincerely like to thank Jefferson Lab, BIW sponsors and vendors, JACoW, and the Local Organizing Committee for bringing all of us together for a few days of exciting presentations and discussions! We're all looking forward to the future meetings of the beam diagnostics and instrumentation community: IBIC12 on October 1-4, 2012 in Tsukuba, Japan, and IBIC13 on September 16-19, 2013 in Oxford, England.

Sincerely,
Kevin Jordan
Chair, BIW'12

BIW'12 Sponsors

Thomas Jefferson National Accelerator Facility (Jefferson Lab) is one of 17 national laboratories funded by the U.S. Department of Energy. The lab also receives support from the City of Newport News and the Commonwealth of Virginia. The primary mission of the lab is to conduct basic research of the atom's nucleus using the lab's unique particle accelerator, known as the Continuous Electron Beam Accelerator Facility (CEBAF). Jefferson Lab also conducts a variety of research using its Free-Electron Laser, which is based on the same electron-accelerating technology used in CEBAF. In addition to its science mission, the lab provides programs designed to help educate the next generation in science and technology, and to engage the public.

CAEN SpA is a leader in the design and manufacture of sophisticated electronic equipment for Nuclear and Particle Physics such as Low Voltage and High Voltage Power Supply Systems, Front-End and Data Acquisition Electronics (standard VME, NIM, CAMAC solutions). CAEN activities are at the forefront of technology also thanks to years of intensive collaborations with the major Research Centers and Universities in the world. CAEN is also proud of its extensive collaboration with the most important HEP experiments world-wide.

GMW Associates

GMW is a distributor and integrator of sensors, transducers, instruments, and systems based on magnetics. Products and support are provided for non-contact, isolated sensing of mechanical position and magnetic material, magnetic field and magnetic property measurement, electric current measurement and control, magnetic field generation and control, and particle beam control and acceleration.

Pearson Electronics

Pearson Electronics has produced precision current-monitoring transformers since 1985. The Pearson design plus careful workmanship and quality control produce current monitors with excellent frequency response and amplitude accuracy. Originally developed for measuring pulse currents, Pearson Current Monitors are now also widely used to measure more complicated transients and periodic signals from a few Hertz to well into the Megahertz region.

Faraday Cup Award

The Faraday Cup Award is intended to recognize and encourage innovative achievements in the field of particle accelerator beam instrumentation. It is donated by Bergoz Instrumentation, of Saint-Genis-Pouilly, France. The award consists of a certificate and $5000.00 (U.S.). These are presented every other year at the Beam Instrumentation Workshop (BIW), whose Program Committee is solely responsible for the selection of the recipient.

History

The Beam Instrumentation Workshop (BIW) was started to provide a forum for in-depth discussions of techniques for measuring charged-particle beams produced in high-energy accelerators. In the past, the large U.S. and European Particle Accelerator Conferences dedicated only a few sessions to instrumentation, thus making it difficult to have significant interaction among others in the field. It became apparent to Dick Witkover at Brookhaven National Laboratory (BNL) that a conference or workshop dedicated to instrumentation was needed.

After meetings with representatives from the other national labs across the U.S., the first Accelerator Instrumentation Workshop was held at BNL in 1989. During the last day roundtable discussion, the idea for the Faraday Cup Award was born as a means of encouraging young engineers and physicists to become more innovative. Discussions between Bergoz and the Organizing Committee continued through the next Beam Instrumentation Workshop (as it was now called) at Fermi National Accelerator Laboratory in 1990 with a final agreement on how to keep the Award fair and noncommercial reached in 1991. The procedures for selecting the winner were written primarily by Bob Shafer soon after, and they have remained virtually unchanged since then. The clever name of the Award, referring to both a trophy and a measurement device, is attributed to Bob Webber.

Selection Criteria

The Faraday Cup Award is presented to those who have made outstanding contributions to the development of innovative beam diagnostic instruments of proven workability. The prize is only awarded for demonstrated device performance and successful publication of the results.

The 2010 Faraday Cup Award being awarded to Kirsten Hacker (DESY) and Dr. Florian Loehl (CLASSE) for the *Femtosecond Resolution Beam Arrival Time Monitor*.

Past Recipients of the Faraday Cup Award

2008	Suren Arutunian, Yerevan Physics Institute of Armenia
2006	Haixin Huang, BNL, and Kazuyoshi Kurita, Rikkyo University
2004	Toshiyuki Mitsuhashi, KEK
2002	Andreas Jansson, CERN
2000	Kay Wittenburg, DESY
1998	Andreas Peters, GSI
1996	Walter Barry, LBNL and Hung-chi Lihn, SLAC
1994	Edward Rossa, CERN
1993	Donald W. Rule and Ralph B. Fiorito, NSWC
1992	Alexander V. Feschenko, INR

See http://www.faraday-cup.com/ for more information.

Workshop Information

Location

BIW'12 is taking place at the:
Marriot Newport News at City Center
740 Town Center Drive
Newport News VA 23606
1-757-873-9299

Registration

Registration will be available during the opening reception (17:00-19:00 Sun April 14) and the continental breakfasts (Monday through Wednesday 07:30-08:30) at the registration desk.

BIW'12 Program

2 Tutorial Orals (60 min + 10 min for Q&A)
10 Invited Orals (35 min + 10 min for Q&A)
19 Contributed Orals (20 min + 5 min for Q&A)
Special Presentation Oral (35 min + 10 min for Q&A)
Banquet at the Virginia Living Museum
Vendor-sponsored receptions every evening of the workshop.

Welcoming remarks start Monday Apr 16 at 08:30.

A continental breakfast is provided every morning of the workshop. Breaks and lunch are long enough to encourage informal discussion among attendees. Morning breaks start between 10:00 and 10:30, Lunch begins between 12:20 and 12:35, and Afternoon breaks start at 15:50.

Vendor-sponsored receptions are scheduled each evening, including in the latter portion of the Monday and Tuesday poster sessions.

A banquet with a no-host bar will be held Wednesday from 18:30-22:30 at the Virginia Living Museum.

A tour of Jefferson Lab is available to attendees from 13:50-17:00 on Thursday Apr 19. Registration is required to attend this tour.

Oral Presentations

All oral presentations will be held in the Pearl Ballroom.

Posters

Poster sessions are located in the Grand Ballroom.

Poster boards are marked with the corresponding program code

All posters should be posted on Monday morning and remain displayed through Wednesday.

Presenters should man their posters during the corresponding poster session on Monday or Tuesday afternoon from 16:20-19:00.

Vendors

Vendor's tables are located in the Grand Ballroom.

Vendor demo areas are located in the Blue Point I room.

Vendor interaction is structured to occur during poster sessions and breaks.

Vendor representatives will also be present throughout the workshop to discuss their products.

Group Photo

A group photo of BIW'12 participants is scheduled for Monday afternoon at the 15:50 coffee break. More information will be available during Monday's opening remarks.

Editorial and Speaker Ready Room

The editorial and speaker ready room is located in Blue Point II.

Proceedings editors are available to assist authors with their manuscripts.

Manuscripts for the *BIW'12 Proceedings* were due on April 11 2011. Todd Satogata (`satogata@jlab.org`, Jefferson Lab) and Joe Chew (`jtchew@lbl.gov`, LBNL) are the editors. They will be editing and processing manuscripts during and after the Workshop. They will be located in the Blue Point II room.

As with other JACoW conferences, a "dot board" is available to to indicate the status of your manuscript. A green dot means that the manuscript was good as submitted, or only required minor editorial changes. A yellow dot means that you should inspect and approve the edited version. A red dot indicates that you must rework the manuscript to fix one or more significant problems. Dots are only assigned after the editors have reviewed your manuscript. Messages to your email address listed in your JACoW account will summarize any problems.

Conference Organization

International Program Committee

Kevin Jordan (Chair, Jefferson Lab)
Daniele Filippetto (LBNL)
Doug Gilpatrick (LANL)
Ken Jacobs (SRC)
Rhodri Jones (CERN)
Bob Lill (ANL)
Toshiyuki Mitsuhashi (KEK)
Guenther Rehm (DIAMOND)
Jim Sebek (SLAC)
Tom Shea (ESS)
Om Singh (BNL)
Steve Smith (SLAC)
Hitoshi Tanaka (SPRING-8)
Jonah Weber (LBNL)
Manfred Wendt (FNAL)
Michelle Wilinski (BNL)
Kay Wittenburg (DESY)
Jim Zagel (FNAL)

Local Organizing Committee

Kevin Jordan
John Musson
Pavel Evtushenko
Marty Hightower
Ruth Bizot
Cynthia Lockwood
Stephanie Vermeire
MeLaina Evans
Marissa Fazenbaker
Evelyn Akers
Todd Satogata

Editors

Todd Satogata (Jefferson Lab)
Joe Chew (LBNL)

Students

BIW'12 Student Fellowship Recipients

Christan Eckardt	Technische Universität Darmstadt
Renuka Krishnakumar	GSI Helmholtz Centre for Heavy Ion Research
Ling-Ying Lin	Michigan State University
Auralee Morin	FRIB/Colorado State University

BIW'12 Student Support

Ryan Bodenstein	Jefferson Lab/University of Virginia
Alejandro Castilla	Jefferson Lab/Old Dominion University
Michael Moore	Old Dominion University
Subashini de Silva	Jefferson Lab/Old Dominion University
Janardan Upadhyay	Old Dominion University

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BIW'12 Workshop Program

Monday, April 16

08:30	Opening Remarks (Kevin Jordan, Jefferson Lab)
08:40	Welcoming Remarks (Hugh Montgomery, Jefferson Lab Director)
08:55	**Beam Performance at Jefferson Lab/CEBAF: Diagnostics and Metrics (Mike Tiefenback, Jefferson Lab)**
09:40	Faraday Cup Award Presentation
09:45	**Faraday Cup Award Talk**
10:30	Coffee Break
11:00	Status of SACLA, the World's First Compact XFEL (Hitoshi Tanaka, RIKEN)
11:25	First Results from Commissioning the Real-Time Interferometer as a Bunch Length Monitor for Sub-mm Electron Bunches (Jayakar Charles Tobin Thangaraj, Fermilab)
11:50	Status of the Femtosecond Synchronization System at ELBE (Michael Kuntzsch, HZDR)
12:20	Lunch
13:50	New Methods of Diagnostics of High Intensity Electron Beams (Tobias Weilbach, HIM)
14:15	**Nondestructive Shot-by-Shot Real Time Monitor to Measure 3D Bunch Charge Distribution (Hiromitsu Tomizawa, JASRI/SPring-8)**
15:00	A New System for Monitoring Transverse Beam Profiles (Lauri Panitzsch, IEAP/University of Kiel)
15:25	Diagnostics for High-Power, High-Brightness Electron Injectors (Bruce Dunham, CLASSE)
15:50	Group Photo
16:20	Poster Session (Grand Ballroom)

Tuesday, April 17

08:30	An X-Ray Pinhole Camera with a Range of Defined Apertures (Cyrille Thomas, DIAMOND)
08:55	**Tutorial: Synchrotron Radiation Monitor Special Topics (Toshi Mitsuhashi, KEK)**
10:15	Coffee Break
10:45	**Photon Beam Diagnostics for X-Ray, VUV, XFEL (Kensuke Tono, JASRI/SPring-8**

11:30 **Imaging Systems and Considerations of Sources (Alex Lumpkin, Fermilab)**
12:20 Lunch
13:50 An Overview of New Laser Technologies for Applications in Beam Instrumentation (Shukui Zhang, Jefferson Lab)
14:15 **Laser Applications: ``Push-Button'' Laser Diagnostics, Photo Detachment for H^- (Yun Liu, ORNL)**
15:00 Pilot Studies on Optical Transition Radiation Imaging of Non-relativistic Ions at GSI (Beata Walasek-Hoehne, GSI)
15:25 High Power Allison Scanner for Electrons (Aurelia Laxdal, TRIUMF)
15:50 Coffee Break

16:20 Poster Session (Grand Ballroom)

Wednesday, April 18

08:30 Coherent Electron Cooling Proof of Principle Instrumentation Design (David Gassner, BNL)
08:55 Tutorial: DSP: Implementation of the Correct Algorithms (Nathan Eddy, Fermilab)
10:15 Coffee Break
10:45 **Measured Reality (Arne Freyberger, Jefferson Lab)**
11:30 **Proton H^- (Low Energy) Beam Diagnostics (Vic Scarpine, Fermilab)**
12:20 Lunch
13:50 High-Power Beam Test of the APS Grazing-Incidence Insertion Device X-Ray Beam Position Monitor (Bingxin Yang, ANL)
14:15 NSLS-II RF BPM Update (Kurt Vetter, BNL)
14:40 Impact of Longitudinally Tilted Beams on BPM Performance at the Advanced Photon Source (Nicholas Sereno, ANL)
15:05 **Beam Interaction with Thin Materials: Heat Deposition, Cooling Phenomena and Damage Limits (Mariusz Sapinski, CERN)**
15:50 Coffee Break
16:20 Wall Current Monitor-Based Ghost and Satellite Bunch Detection in the CERN PS and LHC Accelerators (Ralph Steinhagen, CERN)
16:45 **Report on DIPAC2011 (Kay Wittenburg, DESY)**

18:30 Reception/Dinner at the Virginia Living Museum

Thursday, April 19

08:30 Fast Bunch Profile Monitoring with THz Spectroscopy of Coherent Radiation at FLASH (Stephan Wesch, DESY)

09:20 **Longitudinal Electron Beam Diagnostics for the FERMI@Elettra FEL (Marco Veronese, Sincrotrone Trieste)**

10:15 Coffee Break

10:45 Ultra-short Electron Bunch and X-ray Temporal Diagnostics with an X-band Transverse Deflecting Cavity (Patrick Krejcik, SLAC)

11:10 Spectroscopic Characterization of Novel Silicon Photomultipliers (Marco Panniello, MPI-K)

11:35 Cherenkov Radiation for Beam Loss Monitor Systems (Stephen Kramer, BNL)

12:00 Closing Remarks and IBIC12 Announcements

12:35 Lunch

13:50 Jefferson Lab Tour

MOAP: Monday Morning Presentations

MOAP01 : Beam Performance at JLab/CEBAF: Diagnostics and Metrics

M. G. Tiefenback (JLab)

The CEBAF accelerator is an open-ended machine initially intended for unpolarized beam on fixed targets. The beam performance criteria included range and stability criteria for such parameters as beam current, emittance, energy spread, and beam profile on target. As the accelerator has matured, the applications have transitioned to experiments with polarized beam and targets spanning nearly six orders of magnitude of delivered beam current. The evolution of and future needs for local beam diagnostics on the accelerator, as well as integrated beam quality metrics on-target will be described.

MOAP02 : Faraday Cup Award Talk

Awardee

A presentation by the Faraday Cup Award Winner on their awarded research.

MOBP: Monday Morning Presentations

MOBP01 : Status of SACLA, the World First Compact XFEL

H. Tanaka (RIKEN SPring-8 Center)

Construction of SPring-8 Angstrom Compact free-electron LAser (SACLA) was started in FY2006 as a five years construction project and it was completed on schedule in FY2011. A strategic and well-prepared beam commissioning procedure immediately achieved the first lasing only three months after the start of the commissioning and broke the world record in the shortest laser wavelength before the summer shutdown in 2011. The target laser intensity is now available over the wide lasing wavelength range and the peak laser power surpasses 10 GW constantly. Through test experiments using XFEL and preparation for the various experiments SACLA will be officially open for user experiments in March 2012. The presentation will review the SACLA construction project, present laser performance and introduce some experimental data if possible.

MOBP02 : First Results from Commissioning the Real-Time Interferometer as a Bunch Length Monitor for Sub-mm Electron Bunches

J. C.T. Thangaraj, A. S. Johnson, A. H. Lumpkin, T. J. Maxwell, J. K. Santucci, R. M. Thurman-Keup (Fermilab), G. Andonian (UCLA), A. Y. Murokh, A. G. Ovodenko, M. Ruelas (RadiaBeam)

Single-shot, non-invasive bunch length measurement of sub-mm electron bunches are attractive for future high intensity accelerators. A real-time interferometer (RTI) has been developed and commissioned for the first time to monitor the bunch length of an electron beam in an accelerator. The RTI employs spatial autocorrelation, reflective optics, and a fast response pyro-detector array to obtain a real-time autocorrelation trace of the FIR coherent radiation from an electron beam thus providing the possibility of online bunch length diagnostics. A complete RTI system has been commissioned at the A0 photoinjector facility to measure sub-mm bunches at 13 MeV using coherent transition radiation. Bunch length variation (FWHM) between 0.8 ps to 1.5 ps has been measured. Bunch length estimates extracted from interferogram are directly compared to those from a Martin-Puplett interferometer and a streak camera. The results show that the RTI is a viable, portable and a complementary bunch length diagnostic for sub-mm electron bunches that could be readily deployed in any advanced accelerator electron beam facility.

MOBP03 : Status of the Femtosecond Synchronization System at ELBE

M. Kuntzsch, A. Buechner, U. Lehnert, F. Roeser (HZDR), M. K. Bock, M. Bousonville, M. Felber, T. Lamb, H. Schlarb, S. Schulz, C. Sydlo (DESY)

The superconducting electron accelerator ELBE at Helmholtz-Zentrum Dresden-Rossendorf is currently upgraded to enable continuous wave operation with bunch charges of up to 1 nC and durations down to 200 fs (RMS). The new beamline will drive a THz source and an X-ray source based on Thomson scattering. In collaboration with DESY, Hamburg, an optical synchronization system based on a mode locked master laser is currently being set up to ensure timing stability on the few 10 fs level. It allows high temporal resolution pump-probe experiments and new electron beam diagnostics like bunch arrival-time monitors. The synchronization system is assembled in a dedicated laboratory to ensure stable environmental conditions. In this paper the concept of the optical synchronization system is presented and first experience on the link stabilization system, its installation and commissioning is reported.

MOCP: Monday Afternoon Presentations

MOCP01 : New Methods for Diagnostics of High Intensity Electron Beams

T. Weilbach (HIM), K. Aulenbacher (IKP)

New magnetized high energy coolers as well as Energy Recovery Linacs have a beam power in the order of several megawatts without having highly relativistic beams. This makes the commonly used diagnostic tools such as synchrotron radiation quite ineffective. The goal of new diagnostic methods is to minimize the interaction of the diagnostic devices with the beam in order to prevent the devices as well as the beam from being destroyed. For beam pro

MOCP02 : Non-Destructive, Shot-by-Shot Real-Time Monitor to Measure 3D Bunch Charge Distribution

H. Tomizawa (JASRI/SPring-8)

Non-destructive, shot-by-shot real-time monitors have been developing to measure 3D bunch charge distribution (BCD). This ambitious monitor is based on Electro-Optic (EO) multiple sampling technique in a manner of spectral decoding that is non-destructive and enables real-time measurements of the longitudinal and transverse BCD. This monitor was materialized in simultaneously probing eight EO crystals that surround the electron beam axis with a radial polarized and hollow EO-probe laser pulse. In 2009, the concept of 3D-BCD monitor was verified through bunch measurements in SPring-8 photoinjector. The further target of the temporal resolution is ~30 fs (FWHM), utilizing an organic EO crystal (DAST) instead of conventional inorganic EO crystals (ZnTe, GaP, etc.) The EO-sampling with DAST crystal has been expected to measure a bunch length less than 30 fs (FWHM). However, it has never been realized in practice. In 2011, the first bunch measurement with an organic EO crystal (DAST) has been successfully demonstrated in the VUV-FEL accelerator at SPring-8. According to preliminary results of our experiments, the estimated temporal resolution of DAST should be less than ~50 fs (FWHM).

MOCP03 : A New System for Monitoring Transverse Beam Profiles

L. Panitzsch, S. Boettcher, M. Stalder, R. F. Wimmer-Schweingruber (IEAP)

To accurately and rapidly measure transverse beam profiles of charged particles beams (i.e. ions or electrons), we have developed a robust detector based on an array of tiny Faraday cups (FC, ⊘ = 0.3mm). Its robust design allows the detector to withstand continuous heat loads of about 40W using radiative cooling. In contrast to other monitoring systems effectively no wearing parts are used extending the lifetime of our detector enormously. The profiles are directly acquired in units of total current per area preventing the need of inversion calculations. Biased repellers suppress secondary electron escape. The spatial resolution (22×20 measurements/cm^2) enables the detection of structures on millimetre scales. This space-optimized detector system is driven through the beam to acquire the data and does not interfere with the beam when not in operation. One complete scan takes roughly 5s. The electrical dynamic range can be adjusted upon demand. Additionally, a detector-integrated large FC enables measuring the total beam current. We will present this detector in detail and demonstrate its performance by showing measured beam profiles.

MOCP04 : Diagnostics for High-Power, High-Brightness Electron Injectors

B. M. Dunham (CLASSE)

At Cornell University, we have built a high-power, high-brightness photo-injector for a future ERL light source. We have built and are commissioning a variety of diagnostics to cover a wide dynamic range of beam currents. We will discuss results for both low-emittance measurements and high-power operations, as well as future needs.

MOPG: Monday Poster Session

MOPG001 : Magnetic Shield Simulations for a Cryogenic Current Comparator

F. Kurian, P. Hülsmann, P. Kowina, H. Reeg, M. Schwickert (GSI), R. Geithner, W. Vodel (HIJ), R. Neubert (FSU Jena)

The upcoming FAIR facility requires measurements of very low ion currents during slow extraction from the synchrotron SIS100. A Cryogenic Current Comparator (CCC), with its capability to measure absolute ion beam currents non-destructively down to nA range, is foreseen to be installed in various locations of the high energy beam transport section of FAIR. The current resolution of the CCC is only limited by the system noise, mainly originating from the environmental electromagnetic fields and mechanical vibrations. A meander-shaped superconducting shield geometry covering the pick-up coil efficiently suppresses disturbing non-azimuthal field components. The attenuation of external magnetic field components by the shield in different field directions is studied for various geometrical and material parameters by means of an FEM simulation. The simulation results are compared with attenuation factors obtained by experiments.

MOPG002 : Digital Signal Processing for Bunched Beam Intensity Measurement

N. Liu (Fermilab)

Intensity measurements of bunched beams are typically based on AC-coupled toroidal transformers (toroid) or broadband resistive wall current monitors (RWCM). Read-out technologies based on an in-house designed 8 channel VME digitizer board are presented. This paper discusses the hardware and performance of the 125 MS/s digitizer, details on the FPGA-based digital signal processing, and gives an overview of the entire measurement system. We present the different FPGA algorithms applied for single- and multi-bunch beam intensity measurements in proton and electron linacs.

MOPG003 : Precision Absolute Beam Current Measurement of Low Power Electron Beam

M. M. Ali, M. E. Bevins, P. Degtiarenko, A. Freyberger, G. A. Krafft (JLab)

Precise measurements of low power CW electron beam current for the Jefferson Lab Nuclear Physics program have been performed using a Tungsten calorimeter. This paper will describe the rationale for the choice of the calorimetric technique, as well as the design and calibration of the device. The calorimeter is in use presently to provide a 1% absolute current measurement of CW electron beam with 50 to 500 nA of average beam current and 1-3 GeV beam energy. Results from these very recent measurements will also be presented.

MOPG004 : NSLS-II Beam Intensity Measurement

Y. Hu, L. R. Dalesio, D. Padrazo, I. Pinayev, G. M. Wang (BNL)

Beam intensity, also named beam charge or beam current, is one of the most important beam parameters for synchrotron light sources. At NSLS-II, there are three types of beam intensity monitors including Bergoz ICT, Bergoz NPCT/DCCT and Faraday Cup. The requirements of beam intensity measurements and the distribution of beam monitors are described. The EPICS-based controls and data acquisition systems for all intensity monitors are presented.

MOPG005 : Controls and Data Acquisition for NSLS-II Loss Control and Monitoring

Y. Hu, P. Cameron, D. Chabot, L. R. Dalesio, S. L. Kramer (BNL)

The NSLS-II Loss Control and Monitoring (LCM) system is safety-related, but not safety-credited. This definition and requirement makes implementation requirements of controls and data acquisition (DAQ) for the LCM less stringent. However, the LCM is one of the most complicated diagnostics subsystems since it involves so many components including beam intensity monitors, scrapers, and different types of beam loss monitors, and the component interacts with each other. Here control, DAQ system design and prototype test results are presented.

MOPG006 : Characterization of Detectors for Beam Loss Measurements

S. Mallows (CERN), C. P. Welsch (The University of Liverpool), M. Panniello (MPI-K)

Silicon Photomultipliers (SiPMs) are a good candidate for use as beam loss detectors in an accelerator due to their insensitivity to magnetic fields, compactness and relatively low voltage working regime. Furthermore, when used in a great numbers, they are significantly cheaper to mass-produce than more conventional detectors, such as Ionization Chambers. To be able to evaluate the application potential of SiPMs in an accelerator , it is necessary to quantify their fundamental parameters as a particle detector, as well as in combination with an optical fiber used for signal generation. In this contribution an experimental and analytical study to determine the time resolution, light sensitivity and dynamic range of a Cherenkov light detector, based on SiPMs, is presented.

MOPG007 : European XFEL Beam Loss Monitor System

A. Kaukher, I. Krouptchenkov, D. Noelle, H. Tiessen, K. Wittenburg (DESY)

The European XFEL will have a sophisticated Machine Protection System, including Beam Loss Monitors (BLMs). The monitors will detect losses of electron beam to protect the components of the XFEL from damage and excessive activation. For protection of undulators, BLMs with a scintillator rod will be used. BLMs at places with high radiation load will be equipped with fused silica rods. Beam dumps of the XFEL will be instrumented with glass-fiber BLMs. The BLMs were tested with an electron test-beam facility at DESY, as well as at FLASH. Due to large amounts of light produced by scintillator, no optical grease is needed, while the cathode potential of the R5900 PMT is 500-600 volt. Comparable signal from a prototype with a quartz glass was obtained with typically 150 volt higher cathode potential than that in the prototype with a scintillator. Unexpectedly slower rise and fall time of the signal has been observed, presumably due to radio-luminescence in the used quartz glass rod. Good operation of all three types of BLMs prototypes was obtained. We also plan to use the same types of BLMs for the FLASH II project. The current status of the XFEL BLM system development will be presented.

MOPG008 : First-turn and Stored Beam Measurements with Single Bunch Filling Patterns Using Time-domain Processing at KEK-PF

P. Leban, R. Hrovatin (I-Tech), T. Obina (KEK)

High sensitivity and precision are two of the most important properties of the electron beam position processors. They are crucial when measuring the orbit of the first turn, of the first few turns and of a stored beam with a partial or a single bunch filling pattern. Up to now, the orbit of the first turn has been measured on the base of a raw ADC data processing. In parallel to the processing path that uses digital down conversion for calculating the turn-by-turn data, the new Libera Brilliance$^+$ instrument also comprises an advanced solution. A large ADC buffer for raw data analysis (~8 ms) is combined with the new time-domain processing, that returns precise turn-by-turn data. The article presents this new functionality of the instrument and illustrates it with measurement results from the KEK Photon Factory storage ring.

MOPG009 : Reference Clock Transfer System Evaluation

P. L. Lemut, S. Zorzut (I-Tech), M. L. Leskovec (COBIK), J. Tratnik (University of Ljubljana, Faculty of Electrical Engineering)

During the development of the reference clock transfer system, we encountered several issues, related to the slow and fast phase noise measurements. With slow phase noise we consider phase noise with a frequency offset less than 1 Hz from the carrier. On the other hand, for the phase noise measurements in the frequency offset higher than 10 Hz or 100 Hz commercial off the shelf instruments are available. For the slow phase noise measurements we had to either make use of well known methods like correlation method or introduce new ones. Precise and long-term stable phase detector is a representative of the later. Slow phase noise contains periodic and random components. On the contrary to the fast phase noise, a time domain representation of the measured result for the slow phase noise in hundredths of an angular degree or in femtoseconds is more valuable to the user. A phase detector prototype has been carefully designed and its performance has been evaluated. Besides phase difference measurements some extended capabilities have been built in to enable full reference clock transfer system evaluation.

MOPG010 : BPM Electronics Based on Compensated Diode Detectors - Results from Development Systems

M. Gasior, J. Olexa, R. J. Steinhagen (CERN)

High resolution beam position monitor (BPM) electronics based on diode peak detectors are being developed for processing signals from BPMs embedded into the future LHC collimators. Prototypes of such systems have been tested both in the laboratory and with beam signals from regular CERN-LHC BPMs and a collimator BPM installed in the CERN-SPS. Results from all these measurements are presented and discussed.

MOPG011 : Evaluation of a Variety of Photon Beam Position Monitor Data Acquisition Methodologies at the APS

R. T. Keane, H. Bui, G. Decker, M. Hahne (ANL)

The APS has the largest installed base of closed-loop photon beam position monitors of any facility in the world, however many portions of the orbit control systems use aging and near-obsolete components. Substantial improvements in beam stability are planned as part of the on-going APS upgrade project. Among the planned improvements is a replacement of the present real-time feedback system using modern technology to increase the sample rate from 1.5 kHz to near 20 kHz. Because of this, new data acquisition options are being explored to support existing and new types of x-ray beam position monitors. Performance data collected from existing hardware, the APS-designed BSP-100 module, and two commercial solutions will be compared and contrasted.

MOPG012 : Design, Installation, and Commissioning Results for Suppressing Rogue TE Modes Impacting Vertical BPM Readings of the APS Storage Ring

R. M. Lill, G. Decker, J. E. Hoyt, X. Sun, B. X. Yang (ANL)

The APS storage ring beam position monitor system presently is impacted by transverse electric (TE) longitudinal resonances trapped in the beam vacuum chamber. These TE-like modes are excited in the large-aperture sections and become trapped between the bellow end flanges. Ideally the chamber would be in cut-off for frequencies well above the BPM operating frequency of 352 MHz, but due to the geometry of the chamber the cut-off frequency is nominally 330 MHz. The modes are vertically-oriented and are superimposed on the beam position signals resulting in erroneous step changes in beam position measurements and systematic intensity dependence in the vertical plane. This problem places a fundamental limitation on vertical beam position monitor performance. In this paper we will discuss the mode suppression design, simulation, installation, and commissioning results of the first three sectors installed in the APS storage ring.

MOPG013 : Simulation Studies of Button Pickup Electrode Response to Longitudinally Tilted Beams

X. Sun, G. Decker (ANL)

The APS storage ring beam position monitor (BPM) button-type pickup electrode was modeled and characterized. A pair of button electrodes above and below the accelerator midplane were simulated using CST Microwave Studio. A tilted beam of charge 1 nC was modeled using two very narrow Gaussian bunches displaced longitudinally by $\pm\sigma z$, where σz is the rms bunch length. Transverse displacement of the two bunches above and below the midplane was used as a proxy for beam tilt, while parallel displacement of both bunches provided sensitivity to untilted beam position offset. The voltage on the BPM buttons by the beam was simulated and processed in time and frequency domain. The voltages show sensitivity linearly proportional to the pure tilt angles, or different pure vertical offsets. By using in-phase/quadrature-phase (I/Q) demodulation of the BPM button signal, the tilt and offset information in the hybrid situation can be separated and shows linear proportion sensitivity to tilt angles or vertical offsets, respectively.

MOPG015 : Beam Position and Phase Monitors Characterized and Installed in the LANSCE CCL

J. D. Gilpatrick, V. G. Kutac, D. Martinez, R. C. McCrady, J. F. O'Hara, F. R. Olivas, R. B. Shurter (LANL)

The Los Alamos Neutron Science Center (LANSCE) Risk Mitigation Project is in the process of replacing older Coupled-Cavity-Linac Beam-

Position Monitors (BPMs) that in most locations include a separate Delta-T loop with newer Beam Position and Phase Monitors (BPPMs), including their associated electronics and cable plants. Twenty-three BPPMs have thus far been installed and many have monitored the charged particle beam. The installation of these newer BPPMs is the first step to installing complete BPPM measurement systems. Prior to the installation, a characterization of each BPPM took place. The characterization procedure includes a mechanical inspection, a vacuum testing, and associated electrical tests. The BPPM electrical tests for all four electrodes include contact resistance measurements, Time Domain Reflectometer (TDR) measurements, relative 201.25-MHz phase measurements, and finally a set of position-sensitive mapping measurements were performed which included associated fitting routines. This paper will show these data for a typical characterized BPPM.

MOPG016 : Beam Position and Phase Monitors for the LANSCE Linac

R. C. McCrady, J. D. Gilpatrick, H. A. Watkins (LANL)

New beam position and phase monitors are under development for the linac at the Los Alamos Neutron Science Center. We are considering many options for the electronic instrumentation to process the signals and provide position and phase data with the necessary precision and flexibility to serve the various required functions. Two salient requirements are flexibility in the signal processing and wide dynamic range. We'll present the requirements of the system, the various options under consideration for instrumentation and processing, along with the advantages and shortcomings of these options.

MOPG017 : Beam Position and Phase Monitor - Wire Mapping System

H. A. Watkins, J. D. Gilpatrick, V. G. Kutac, D. Martinez, R. B. Shurter (LANL)

The Los Alamos Neutron Science Center (LANSCE) deploys many cylindrical beam position and phase monitors (BPPM) throughout the linac to measure the beam central position, phase and bunched-beam current. Each monitor is calibrated and qualified prior to installation to insure it meets LANSCE requirements. The measurement system used to map the BPPM's electrode offset, sensitivity and higher order coefficients is the BPPM wire mapping system. This system uses a wire antenna structure to excite the interior of the BPPM at a fundamental frequency of 201.25 MHz, and as this field traverses the BPPM cavity, a three-axis motion table controls the antenna position. RF signal strength is measured and recorded on the four electrodes as the antenna position is updated. An effort is underway to extend the systems service to the LANSCE facility by replacing obsolete and antiquated hardware and taking advantage of software enhancements available since the 1990s. This paper will describe the updates to the wire positioning system's hardware and software capabilities including its unique antenna structure, motion control interface, RF measurement equipment and Labview software upgrades.

MOPG018 : Diagnostics for Accelerator Physics Applications at SPEAR3

J. J. Sebek, W. J. Corbett, S. M. Gierman, X. Huang, J. A. Safranek, K. Tian (SLAC)

The SPEAR3 light source at SSRL was commissioned in 2004. Since that time the machine has undergone a continual program of improvements that has led to a lowering of the ring emittance, improved injection efficiencies, and the development of specialized operational modes. The effective use of beam diagnostics enabled these improvements to be tested and verified prior to their implementation. To optimize injection we needed to measure the beam position, size, shape, and arrival time of our injected bunch as well as beam losses in the ring. To test new lattices we used these diagnostics to characterize the non-linear resonances in the ring and therefore find operating points that maximized beam stability and lifetime. In this paper we discuss the electrical and optical instruments as well as the experimental methods we used to make these measurements.

MOPG019 : New Low Cost X-band Cavity BPM Receiver

A. Young, J. C. Frisch, S. R. Smith, D. Van Winkle (SLAC)

SLAC is developing a new X-band Cavity BPM receiver for use in the LCLS-II for use in the $LCLS_I$I. The Linac Coherent Light Source II (LCLS-II) will be a free electron laser (FEL) at SLAC producing coherent 0.5-77 Angstroms hard and soft x-rays. To achieve this level of performance precise, stable alignment of the electron beam in the undulator is required. The LCLS-II cavity BPM system will provide single shot resolution better than 50 nm resolution at 200 pC. The Cavity BPM heterodyne receiver is located in the tunnel close to the cavity BPM. The receiver will processes the TM010 monopole reference cavity signal and a TM110 dipole cavity signal at approximately 11 GHz using a heterodyne technique. The heterodyne receiver will be capable of detecting a multibunch beam with a 50ns fill pattern. A new LAN communication daughter board will allow the receiver to talk to an input-output-controller (IOC) over 100 meters to set gains, control the programmable dielectric resonator oscillator, enable self-test, and monitor the status of the receiver. We will describe the design methodology including noise analysis, distortion analysis.

MOPG020 : Application of Neural Network Algorithms for BPM Linearization

J. Musson, C. Seaton, M. Spata, J. Yan (JLab)

Stripline BPM sensors contain inherent non-linearities, as a result of field distortions from the pickup elements. Many methods have been devised to facilitate corrections, often employing polynomial fitting. The cost of computation makes real-time correction difficult, particulalry when integer math is utilized. The application of neural-network technology, particularly the multi-layer perceptron algorithm, is proposed as an efficient alternative for electrode linearization. A process of supervised learning is initially used to determine the weighting coefficients, which are subsequently applied to the incoming electrode data. A non-linear layer, known as an ``activation layer,'' is responsible for the removal of saturation effects. Implementation of a perceptron in an FPGA-based software-defined radio (SDR) is presented, along with performance comparisons. In addition, efficient calculation of the sigmoidal activation function via the CORDIC algorithm is presented.

MOPG021 : Plasma Panel Detectors as Active Pixel Beam Monitors

P. S. Friedman (Integrated Sensors, LLC), R. Ball, J. W. Chapman, C. Ferretti, D. S. Levin, C. Weaverdyck, B. Zhou (University of Michigan), J. R. Beene, R. L. Varner Jr. (ORNL), M. Ben-Moshe, Y. Benhammou, E. Etzion, N. Guttman, Y. Silver (University of Tel Aviv)

We are developing a multipurpose radiation detector based on Plasma Display Panel (PDP) technology. The Plasma Panel Sensor (PPS), a micropattern radiation detector, inherits many operational and fabrication principles common to PDPs. The PPS is comprised of a dense array of microscopic, gas plasma discharge cells using a stable, hermetically-sealed gas mixture. The PPS is assembled from non-reactive, intrinsically radiation-hard materials: glass substrates, refractory metal electrodes and mostly inert gas mixtures. We anticipate it will be possible to fabricate these devices as ultra-thin, ultra-low-mass, detectors with 1 micron thick front substrates, and gas thicknesses of a several hundred to a thousand microns. The PPS is a high gain, inherently digital device with the potential for very fast response times, very fine position resolution ($< 100\ \mu$m) and low cost. We will report on the PPS development program, including experimental results in detecting betas, protons and MIPs including cosmic muons. We are interested in several additional potential applications including detection of alphas, heavy-ions at low energy, thermal neutrons and X-rays.

MOPG022 : NSLS2 Beam Position Monitor Calibration

W. X. Cheng, B. Bacha, O. Singh (BNL)

To get accurate beam position measurements along the accelerator complex, beam position monitor (BPM) sensitivity and electric offset need to be calibrated. A good calibration is essential for day one commissioning and large beam offset measurements. For various type of BPMs used in NSLS2, the sensitivity curves were calculated and fitting by high order polynomial fit. Fitting errors are typically less than 50um. BPM electric offsets are measured using four port network analyzer. These offset values will supply a good reference for beam based alignment.

MOPG023 : NSLS-II Storage Ring and Booster Pilot Tone Combiner Test Results

A. J. Della Penna (BNL)

NSLS-II is a third generation light source and one of our requirements is sub-picosecond resolution of the beam position. To achieve this we chose to use a pilot tone calibration approach. Because our Booster requires a isolated grounded system, this required a slightly different design. This paper will discuss the differences observed during lab testing of the two designs.

MOPG024 : Conceptual Design of a High Precision Dual Bi-Directional Beam Position Monitoring System to Achieve Beam Crosstalk Cancellation and Improved Output Pulse Shapes

P. Thieberger, W. C. Dawson, W. Fischer, D. M. Gassner, R. L. Hulsart, K. Mernick, R. J. Michnoff, T. A. Miller, M. G. Minty (BNL)

The Relativistic Heavy Ions Collider (RHIC) would benefit from improved beam position measurements in the interaction regions, especially as the tolerances become tighter when reducing the beam diameter to obtain increased luminosity. Two limitations of the present beam position monitors (BPMs) would be mitigated if the proposed approach is successful. The small but unavoidable cross-talk between signals from bunches traveling in opposite directions when using conventional BPMs will be reduced by adopting directional BPMs. Further improvement will be achieved by cancelling residual cross-talk using pairs of such BPMs. Appropriately delayed addition and integration of the signals will also provide pulses with relatively flat maxima that will be much easier to digitize by relaxing the presently very stringent timing requirements.

MOPG025 : Design of a Proton-Electron Beam Overlap Monitor for the New RHIC Electron Lens based on Detecting Energetic Backscattered Electrons

P. Thieberger, E. N. Beebe, W. Fischer, D. M. Gassner, X. Gu, K. Hamdi, J. Hock, T. A. Miller, M. G. Minty, C. Montag, A. I. Pikin (BNL)

The optimal performance of the two electron lenses that are being implemented for high intensity polarized proton operation of RHIC requires excellent collinearity of the ~0.3mm RMS wide electron beams with the proton bunch trajectories over the ~2m interaction lengths. The main beam overlap diagnostic tool will make use of electrons backscattered in close encounters with the relativistic protons. These electrons will spiral along the electron guiding magnetic field and will be detected in a plastic scintillator located close to the electron gun. A fraction of these electrons will have energies high enough to emerge from the vacuum chamber through a thin window thus simplifying the design and operation of the detector. Joint electron arrival time and energy discrimination will be used to gain some longitudinal position information with a single detector per lens.

MOPG026 : A Wire Scanner System for Characterizing the BNL Energy Recovery Linac Beam Position Monitor System

R. J. Michnoff, C. Biscardi, P. Cerniglia, C. Degen, D. M. Gassner, L. T. Hoff, R. L. Hulsart (BNL)

A stepper motor controlled wire scanner assembly has recently been modified to support testing of the Brookhaven National Laboratory (BNL) Collider-Accelerator department's Energy Recovery Linac (ERL) beam position monitor (BPM) system. The ERL BPM consists of 4 9.33mm diameter buttons mounted at 90 degree spacing in a cube with 1.875″ inside diameter. The buttons were designed by BNL and fabricated by Times Microwave Systems. Libera single pass BPM electronic modules, manufactured by Instrumentation Technologies, will be used to measure the X and Y transverse beam positions at 14 locations around the ERL. The wire scanner assembly provides the ability to measure the BPM button response to a pulsed wire, and evaluate and calibrate the Libera position measurement electronics. A description of the wire scanner system and test result data will be presented.

MOPG027 : Optimizing the Thermal Management of NSLS-II BPM Electronics

B. N. Kosciuk, K. Vetter (BNL)

The NSLS-II Synchrotron Light Source currently under construction at Brookhaven National Laboratory is expected to provide unprecedented orbit stability in order to fully utilize the very small emittance of the electron beam. The required sub-micron resolution and stability motivated the development of new state-of-the-art Beam Position Monitoring (BPM) electronics. A fundamental aspect of the BPM system development leveraged the fact that dynamic thermal gradients are the dominant source of BPM position drift. The temperature dependent drift is predominantly introduced in the Analog Front End (AFE) electronics. Here we discuss the methods employed to enhance the heat transfer from the BPM Analog Front End and their effects on overall performance of the BPM electronic systems.

MOPG028 : Optimization of Blade X-ray Beam Position Monitors for NSLS-II Beamlines

P. Ilinski (BNL)

Blade X-ray Beam Position Monitors (XBPM) are standard photon beam monitors for most third generation synchrotron radiation storage rings. Blade XBPMs characterized by good spatial resolution, but have some systematic problems. Optimization of XBPMs blade material and geometry is required for achieving best performance. Optimization is based on calculation of the XBPM signal distribution.

MOPG029 : NSLS-II X-ray Diagnostics Beamlines for Emittance Measurements

P. Ilinski (BNL)

NSLS-II storage ring will have less then 1nm-rad emittance. A concept of X-ray diagnostics beamline was developed in order to measure small sizes of radiation sources to deduct beam emittance and particles energy spread. Diagnostics will employ Bending magnet and three-pole wiggler as radiation sources. Diagnostics will include slits setup and Compound Refractive Lens (CRL) focusing optics setup, which are interchangeable. CRL setup will provide required high spatial resolution. A novel optical layout was suggested in order to measure sources with large transverse aspect ratio.

MOPG030 : Development of Beam Instrumentation for Analyzing Cyclotron Beam Current using Labview Environment

F. M. Alrumayan, Q. Al-Akkam, S. S. Ben Hoban (King Faisal Specialist Hospital and Research Centre)

Beam instrumentation systems play important role in determining the quality of radioisotopes in relation to the production yield. In order to quantity the impact of the integrated beam current on yield quality, a Labview-based monitoring system was developed to determine the integrated beam current using data of three different types of radioisotopes, namely I-123, Ga-67 and Th-201. The integrated beam current was obtained using integral function "area under curve". Method: The beam current, first, is converted into a voltage signal which is proportional to current measured on radioisotope target, and then entered into the Labview via Data Acquisition Card (DAQ). The later converts it into a digital form to which it can be manipulated and displayed in a developed monitoring system. Results: graphs clearly show the direct correlation between the beam integrated values (in μAhr) and obtained Activity (in mci) which is also proportional to the production yield (mci/μAhr). Conclusion: the calculated integrator value should be used to give indication for the production yield. The collected data from radioisotopes is used for continuous improvement in production yield.

MOPG031 : Hyppie - A Hypervisored PXI for Physics Instrumentation under EPICS

J. R. Piton, M. P. Donadio, D. Omitto, M. A. Raulik, H. Westfahl Jr. (LNLS), B. C. Yenikomochian (National Instruments Brasil)

Brazilian Synchrotron Light Laboratory (LNLS) has a 1.37 GeV source open to scientific community since 1997. Recently, the control system of its beamlines, originally designed within a proprietary Delphi/Windows platform, is going through an upgrade to the open source EPICS/Linux platform.

Within this upgrade strategy, the use of off-the-shelf hardware was also considered an alternative to the original in-house developed equipment, while keeping the EPICS/Linux compatibility. A PXI chassis and its modules were made available to EPICS through the NI Real-Time Hypervisor virtualization system that allows running simultaneously EPICS/Linux and LabVIEW RT in the same PXI controller, sharing a common memory block for communication. Hyppie is the data exchange protocol developed in a collaboration between LNLS and National Instruments to implement motor, scaler and binary in/out EPICS records and channel access in the Linux layer, leaving the low-level hardware control to the LabView RT layer. This solution was tested to control an X-ray absorption spectroscopy beamline, showing stability and a reduction of counting deadtime and software development time for integrating new hardware.

MOPG032 : Synchronous Post Mortem Trigger of the PETRA III MPS

T. Lensch (DESY)

PETRA III is a high brilliance synchrotron light-source operating at 6 GeV at the DESY site in Hamburg. The Machine Protection System (MPS) of PETRA III determines unsafe situations by a number of different alarms and dumps the beam if necessary. Additionally the MPS measures the beam current with a dedicated DC monitor and creates a post mortem trigger if a beam loss had been detected. This trigger is distributed to each PETRA hall synchronously and is connected to several external systems. These systems store their ring-buffer-data in case of such a post mortem trigger. Especially the beam position monitor system (BPM) benefits from this trigger. This paper describes the creation and distribution of the trigger by the MPS as well as an example of use when interpreting beam losses with collected BPM data.

MOPG033 : New Phase Stable Optical Fibre

M. Bousonville, M. K. Bock, M. Felber, T. Lamb, H. Schlarb, S. Schulz, C. Sydlo (DESY), S. Hunziker (Paul Scherrer Institut), S. Jablonski, P. Kownacki (Warsaw University of Technology, Institute of Electronic Systems)

Linden Photonics offers a standard single mode fibre with a special liquid crystal polymer coating. This material has a negative coefficient of thermal expansion, which significantly reduces the change of signal delay due to temperature change. Other than with normal fibre cables, the thermal coefficient of delay (TCD) is not in the range from 40 to 130 ps/km/K, but below 7 ps/km/K. Thus it is nearly as good as the phase stabilized optical fibre (PSOF) by Furukawa (specification < 5 ps/km/K). The TCD of Linden Photonic cables have been measured at DESY. In order to make this comparable, we measured the PSOF by Furukawa and furthermore three standard optical fibre cables, too. As a result, a complete picture of the TCDs of different fibres will be presented. This information is very useful in order to design optical synchronisation systems in general. It is planned to use Linden Photonics cables for the long links (fibre lengths in a range from 0.4 to 3.5 km) of the laser based synchronisation system at XFEL.

MOPG034 : Timing Design of a Bunch Profile Monitor Based on Electro-Optic Spectral Decoding

R. Pan, T. Lefevre (CERN), W. A. Gillespie (University of Dundee), S. P. Jamison (STFC/ DL/ASTeC)

A bunch profile monitor based on electro-optic spectral decoding (EOSD) is being designed for the probe beam of the CLIC Test Facility 3 at CERN and is expected to be installed and tested in the summer of 2012. Using this technique the profile information of an electron bunch is encoded into a chirped laser pulse and decoded using a spectrometer. Accurate synchronisation between the laser pulse and electron bunch is mandatory as well as correctly identifying the laser pulse containing the bunch length information. This paper will present the design of the monitor and describe the synchronization and timing systems foreseen.

MOPG035 : A Quest for Measuring Ion Bunch Longitudinal Profiles with One Picosecond Accuracy in the SNS Linac

A. V. Aleksandrov, R. Dickson (ORNL)

The SNS linac utilizes several accelerating structures operating at different frequencies and with different transverse focusing structures. Low-loss beam transport requires a careful matching at the transition points in both the transverse and longitudinal axes. Longitudinal beam parameters are measured using four Bunch Shape Monitors (in use at many ion accelerator facilities, aka Feschenko devices). These devices, as initially delivered to the SNS, provided an estimated accuracy of about 5 picoseconds, which was sufficient for the initial beam commissioning. New challenges of improving beam transport for higher power operation require measuring bunch profiles with 1-2 picoseconds accuracy. We have successfully implemented a number of improvements to maximize the performance characteristics of the delivered devices. We will discuss the current status of this instrument, its ultimate theoretical limit of accuracy, and how we measure its accuracy and resolution with real beam conditions.

MOPG036 : A Quest for System User Friendliness with the SNS Ion Beam Bunch Shape Monitor

R. Dickson (ORNL RAD), A. V. Aleksandrov (ORNL)

A new system for measuring the SNS ion beam longitudinal profile was recently upgraded to operational status. The hardware for this device was developed and delivered by Institute of Nuclear Research to the SNS as a part of its initial construction. The supplied LabVIEW user interface software was intended for proof-of-operation and initial setup of the instrument. While satisfactory for this, it was tedious to use in a practical context and lacked any form of interface to the SNS's EPICS based control system. This paper will describe the software features added to make this instrument both easily tunable to the prevalent beam conditions by system engineers and easily usable by accelerator physicists only interested in its output data.

MOPG037 : Design of the Electron Beam Diagnostics of the New THz Beamline at ELBE

R. Schurig (FZD)

Two new 0.2 to 3 THz sources, to be driven by the ELBE 40 MeV linac at the Helmholtz-Zentrum Dresden-Rossendorf, are currently being installed. One source is an electromagnetic undulator with eight 300 mm periods. The second source consits of a CTR/CDR assambly that will deliver broadband radiation in very short pulses, limited by the formfactor of the electron bunch. A magnetic chicane will be used to create bunches in the 200 fs range. CTR based bunch compression monitors, button pickup beam arival time monitors and a electro optical sampling station will be used to measure and maintain the required longitudinal beam properties. The design of this diagnostics will be described in this paper.

MOPG038 : Instrumentation at the Low Intensity Frontier: Diagnostics for the Stopped and Reaccelerated Beams of NSCL and FRIB

G. Perdikakis (NSCL)

A facility to stop and reaccelerate rare isotope beams is under construction at Michigan State University. It is based on gas stopping devices and a superconducting heavy-ion linac. It will use initially beams produced by the cyclotrons of NSCL and later from the linac of FRIB . A diagnostics system for the low energy and intensity stable and radioactive beams of the facility is under development. It is largely based on detection techniques and instrumentation typically developed for nuclear and particle physics. Some of the devices already have been used to commission ReA and hit project milestones, while others are in assembly and fabrication stages. A description of the devices and the current status of the diagnostics system will be presented along with examples of the experience so far with the diagnostics' operation at the reaccelerator.

MOPG039 : Instrumentation for Damage Studies of Liquid Metal Targets

T. J. Shea, W. Blokland, K. C. Goetz, J. D. Purcell (ORNL)

With the goal of understanding beam-induced cavitation damage in liquid metal targets, several experiments have been performed at Los Alamos National Laboratory's WNR facility. The most recent experiment was completed during the Summer of 2011, and consisted of 19 test cases, each with a unique combination of target configuration and beam properties. For each test case, 100 beam pulses irradiated the target with a typical repetition rate of two pulses per minute. A typical pulse contained 2.7×10^{13} protons in a pulse length of <300 ns , with a 7 by 17 mm RMS beam transverse beam size. Toroids in both air and vacuum provided the longitudinal measurements, and a luminescent screen with multiple camera systems provided the transverse measurements. Installation was completed in a few days, commissioning with beam in a few hours, and irradiation of all test targets in about one week of dedicated beam. This paper will provide an overview of the experiment, a description of the beam instrumentation systems, and a discussion of instrumentation performance. Particular attention will be payed to the challenges of rapid deployment and system robustness.

MOPG040 : High Power Positron Beams for Applied Physics

V. V. Gorev (NRC)

I describe here the modern results and situation on the whole in the theoretical field of high power positron beams investigations for apply physics, including physical and technology aspects of production of the positron beams with Gev's positron energy and about (0,01-0,1)A positron beam current, with emphasis on suggestions for some well known high density energy physics problems, such as 1) new modes of particle acceleration 2) physical ballistics themes 3) generation of soft gamma radiation.

MOPG041 : Transverse Phase Space Tomography of the 40 MeV Electron Beam at the UH MkV Accelerator Facility

B. T. Jacobson, M. R. Hadmack, J. M.D. Kowalczyk, J. Madey, E. B. Szarmes, G. S. Varner (University of Hawaii)

Since the method was first proposed by McKee, phase space tomography (PST) has been the principal method of reconstructing the phase space configuration of charged particle beams and measuring transverse emittance. At the present time, the single camera quadrupole scan PST reconstruction technique has been demonstrated for the electron beam at the 40 MeV MkV linear accelerator facility, located at the University of Hawai'i. Optical transition radiation (OTR) from metallic screens inserted into the electron beam is imaged with a Vidicon camera to obtain near-field images of the transverse current distribution. The camera output is digitized by a synchronized frame grabber controlled by a C++ GUI, which stores the image files. A MATLAB code has been developed which preforms the PST reconstruction. This paper describes the current status of these measurements, as well as future planned development of a multiple camera reconstruction technique which has the advantage over the quadrupole scan technique of not requiring any scan time.

MOPG042 : Low-cost Modular Beam Position Monitor Readout System

B. T. Jacobson, J. Madey (University of Hawaii)

Stripline beam position monitors (BPMs) are no longer at the forefront of the position resolution frontier required in tomorrow's colliders and light sources, yet still provide invaluable instrumentation for use at smaller facilities. A low-cost, modular and scalable readout and data acquisition system for these BPM's is being developed at University of Hawai'i MkV linear accelerator facility. Although designed for use at UH, this instrumentation is well suited for use at many modestly sized linac facilities operated for medical, industrial, and educational purposes. This paper outlines the design, development, and milestones for this project. For pulsed S-band linacs, BPM port output signals are mixed with a local oscillator in the accelerator cave, providing HF-band frequencies which are easier to transport and measure. Analog electronics for each BPM resides on a PCI-style card, which slides into a standard board-edge connector, making a system of an arbitrary number of BPM's possible. A sample and hold system on each card provides DC outputs of the error signal, which are digitized using an inexpensive commercially available ADC.

TUAP: Tuesday Morning Presentations

TUAP01 : An X-Ray Pinhole Camera with a Range of Defined Apertures

C. A. Thomas, G. Rehm (Diamond)

Operation of 3rd generation synchrotron light sources is heading towards low emittance coupling offering small vertical beam size and extending the transverse coherence of the X-ray photon beam. In the case of Diamond, exploring operation at 0.1% coupling will imply measuring vertical beam sizes of the order of 7μm (in bending magnets). Measurement of the vertical beam size and coupling with the best accuracy requires a precise knowledge of the Point Spread Function of the electron beam imaging system. At Diamond two X-ray pinhole cameras are used for this measurement. In this paper we present our first results of beam size measurement using a convolution technique, which consists of modelling the image of the source by convolving the pinhole and X-ray camera PSF with a 2-D Gaussian distribution in order to achieve the best possible fit to the measured image. We verify the validity of the method with a series of measurements of the electron beam size with a series of pinholes with well defined apertures varying from 5 to 100μm laser machined into a 200μm Tungsten plate. In this paper we discuss the experimental results and the accuracy of the method.

TUAP02 : Synchrotron Radiation Monitor - Special Topics

T. M. Mitsuhashi (KEK)

The beam instrumentation based on optical technique especially using synchrotron radiation (SR) is one of key apparatus in beam instrumentation for accelerators. In my talk, I would like to present some special topics on SR monitors that you cannot find in conventional text. In the first half, I will focus on insight into optical theory useful for SR monitors such as diffraction theory, aberration theory, etc. Some useful optical techniques for SR monitors from optical shop testing such as focusing elements testing, wavefront error measurement, alignment/collimation of optics will also included in the first half of talk. In the second half, I will introduce some application of special topics for SR monitors. The special topics includes wavefront correction by corrective optics, application of astronomical optics such as first order spatial interferometry for transverse beam profile diagnostic, coronagraph for halo measurement. In the last, I will introduce quantum optical technique, intensity interferometry for temporal beam profile measurement. I will also introduce some optics design useful for SR monitors.

TUBP: Tuesday Morning Presentations

TUBP01 : Photon Beam Diagnostics for Free Electron Laser

K. Tono (RIKEN/SPring-8)

In a linac-based free electron laser (FEL), photon beam diagnostics is not only for characterizing output radiation properties, but also plays a crucial role in the machine tuning. Important requirements that have to be met in the diagnostics are pulse-resolved and nondestructive measurement in order to take shot-by-shot correspondence between multiple parameters of electron bunch and photon pulse. We have developed pulse-resolved and nondestructive monitors for a SASE beam of the Japanese XFEL facility, SACLA. For cascade monitoring of multiple parameters of a single photon pulse, our monitors detect only fractional photons scattered and/or diffracted from an X-ray transparent foil or gas, providing a center-of-mass position with an about 10-μm resolution, a spatial beam profile, and a photon energy. Currently we are extending the photon diagnostics to fully characterize the SASE beam in the six dimensional phase space; that is, spatiotemporal intensity distribution, divergence, and spectrum. In my talk, I will introduce our existing and forthcoming photon diagnostic systems that will allow us to establish an effective tuning procedure for the XFEL machine.

TUBP02 : Imaging Techniques for Transverse Beam Profile and Size Monitors

A. H. Lumpkin (Fermilab)

The characterization of transverse beam profile/size by imaging relativistic beams using intercepting screens based on scintillators or optical transition radiation (OTR) is a well-established technique at many accelerators. There are several considerations in choosing the conversion mechanism including beam size, charge, beam energy, beam power, pulse structure, presence of microbunching instability effects, etc. Examples will be given for the fundamental contributions to system resolution including the scintillator screen resolution (powder thickness and single crystal effects), optical depth-of-focus aspects, and the OTR polarization and point-spread-function effects. The imaging techniques can be extended to the non-intercepting arena using optical diffraction radiation (ODR). Beam-size results and proposed ODR experiments at 23 GeV will be described. In addition, new OTR imaging results on non-relativistic beams of 60-keV electrons at FNAL and 11.4 MeV/u Uranium ions at GSI, Darmstadt will be presented as time permits.

TUCP: Tuesday Afternoon Presentations

TUCP01 : An Overview of New Laser Technologies for Applications in Beam Instrumentation

S. Zhang (JLab)

Lasers has become an essential part in many accelerator systems, especially in the high intensity, high current, short pulse photo-cathode based accelerators. Use of lasers as diagnostic tools has proven the unique capability of lasers that has surpassed the traditional RF-based devices in some areas. Although the development of new laser technologies and devices has been progressing in an amazingly rapid pace, the technical requirements on laser systems such as drive lasers, seed lasers, diagnostic and synchronization lasers have reached an new high level that goes well above the present capability of commercially available lasers or even lasers that are still under development in research labs. This paper will present a brief overview of the recent development of new solid-state and fiber lasers, in particular their potential applications in high-brightness light sources and FELs. We will discuss, from the point of view of beam instrumentation, the challenges facing the state-of-the-art laser technologies and the near future prospect to practically meet the demands from new accelerators. Past experiences from different accelerator labs will also be presented.

TUCP02 : Laser Applications: "Push-Button" Laser Diagnostics and Photo Detachment for H-

Y. Liu (ORNL)

Advancements in laser technology have dramatically expanded the applications of lasers to particle accelerators. Today, lasers have been used for accelerators in a broad range from operational systems such as nonintrusive particle beam diagnostics instruments, to elaborate applications with high technical readiness levels including, for instance, photoinjectors, a laser assisted foil-less charge exchange injection scheme and Compton scattering-based light sources, and finally to exotic topics such as laser driven electron/ion accelerators. This talk reviews recent experimental results achieved in the above applications, their requirements on laser parameters and challenges that require future laser technology development. Important technical elements such as the femto-second pulse generation, the burst-mode optical amplifiers, the beam combining from laser arrays, and the power enhancement optical cavity will be briefly described.

TUCP03 : Pilot Studies on Optical Transition Radiation Imaging of Non-relativistic Ions at GSI

B. Walasek-Hoehne, C. A. Andre, F. Becker, P. Forck, A. Reiter, M. Schwickert (GSI), A. H. Lumpkin (Fermilab)

For relativistic particles optical transition radiation (OTR) is a well established method of transverse profile monitoring. Within a pilot experiment the applicability of OTR even for non-relativistic heavy ions was evaluated for the first time using an uranium beam of 11.4 MeV/u (corresponding to β=0.15) of different charge states. This study aimed to find a thermally stable OTR target for highly-ionizing heavy-ions and to detect reliable transverse profiles, taking advantage of high particle charge q. The exact gating feature of an image-intensified CCD camera was used to select the prompt OTR signal versus any background sources with a longer emission time constant like e.g. blackbody radiation. To test the q-dependence of the light yield, a moveable stripping foil upstream of the target was installed to increase the mean charge. During initial tests, a stainless steel target proved superior thermal behaviour and q2 dependence was observed. Profile comparison with SEM-Grid data as well as the analysis of spectroscopic measurements will be presented.

TUCP04 : High Power Allison Scanner for Electrons

A. Laxdal, F. Ames, R. A. Baartman, S. R. Koscielniak (TRIUMF, Canada's National Laboratory for Particle and Nuclear Physics)

TRIUMF's new Allison emittance scanner is designed to measure the emittance of a 100-300 keV electron beam at an average current of 10 mA (1 kW beam power cw) with a phase space area resolution of 0.032 mm-mrad, in a high vacuum environment 10^{-9} Torr. The emittance scanner has been tested with a beam produced by a 100keV thermionic electron source. The source is modulated at frequency of 650 MHz and can be operated with a macro pulse structure to allow duty factors of less than 0.1 % up to cw operation. The expected transverse emittance is 4ϵrms $\leq 20\ \pi$ mm-mrad. This paper discusses the engineering challenges of designing an Allison scanner for a high intensity electron beam, the components and materials used, as well as the technologies introduced. Also included are the experimental results of first tests with the 100 keV source. Emittance contours were measured at high resolution for a variety of focusing conditions and intensity. Detailed phase space images have been made, and used to analyze and improve the electron gun design. The emittance values obtained are consistent with independent measurements using a scintillator-type profile monitor, and a simple analytic model for a thermionic source.

TUPG: Tuesday Poster Session

TUPG001 : Mitigation and Control of Instabilities in DAFNE Positron Ring

A. Drago, D. Alesini, T. Demma, A. Gallo, S. Guiducci, C. Milardi, P. Raimondi, M. Zobov (INFN/LNF)

The positron beam in the DAFNE e^+e^- collider has always been suffering from strong e-cloud instabilities. In order to cope with them, several approaches have been adopted along the years: flexible and powerful bunch-by-bunch feedback systems, solenoids around the straight sections of the vacuum chamber and, in the last runs, e-cloud clearing electrodes inside the bending and wiggler magnets. Of course classic diagnostics tools have been used to evaluate of the effectiveness of the adopted measures and the correct setup of the devices, in order to acquire the total beam current and the bunch-by-bunch currents, to plot in real time synchrotron and betatron instabilities, to verify the vertical beam size enlargement in collision and out of collision. Besides, to evaluate the efficacy of the solenoids and of the clearing electrodes versus the instability speed, the more powerful tools have been the special diagnostics routines making use of the bunch-by-bunch feedback systems to quickly compute the growth rate instabilities in different beam conditions.

TUPG003 : Design of a Pickup Equalizer for the High Bandwidth Vertical Feedback Control System in the CERN SPS

R. Secondo (LBNL), J. D. Fox, D. Van Winkle (SLAC)

A high bandwidth feedback control system has been recently proposed and investigated to damp fast Single-Bunch transverse instabilities generated by growing Electron Clouds and Transverse Mode Coupled Instabilities (TMCI) in the CERN SPS. In operation this system requires roughly 1-2 GHz of system response to faithfully represent the intra-bunch vertical motion. In the ongoing SPS measurements the use of a tapered exponential pickup system implements a non-flat frequency response with non-linear phase response, and long lossy cables between pickup and processing electronics, so that the delta and sigma signals necessary to recover the beam vertical position are distorted in the time domain. In this paper we present the model of a lumped-element equalizer covering a frequency range from low frequencies up to the GHz to restore the time response of the original sum and delta signals. Issues in approximating the exact mathematical response by a finite order polynomial are presented, and a suggested simplified equalizer implementation is detailed.

TUPG004 : A 4 GSa/s Bunch Slice Feedback Processor Demonstrator for the SPS

J. E. Dusatko, J. D. Fox, C. H. Rivetta, O. Turgut (SLAC), W. Höfle (CERN)

Intra-bunch instabilities driven by the presence of electron cloud and transverse mode coupled instabilities (TMCI) at the CERN Super Proton Synchrotron (SPS) have been observed with LHC beam, and are an area of concern. To date, efforts to understand and mitigate this effect have included numerical simulations of the instabilities and models of possible feedback control methods. An experimental program in 2011 used a 4 GSa/s excitation system to successfully drive head-tail modes within a single SPS proton bunch. The next step to control intra-bunch instabilities is the development of a 4 GSa/s DSP system to investigate closed loop control on a small number of bunches in the SPS. We present a system architecture and implementation outline for this transverse feedback channel. This processor uses a commercial FPGA board with custom-designed ADC and DAC daughterboards for the wideband input pickup/receiver and kicker signal output stages. The system is reconfigurable to allow evaluation of possible feedback control filter algorithms (FIR, IIR, etc.). This paper describes the design of this system, with a focus on the development of the signal processing hardware.

TUPG005 : Feedback Systems for Suppressing the Kink Instability in an ERL-based Electron Ion Collider

Y. Hao, V. Litvinenko, V. Ptitsyn (BNL)

The kink instability presents one of the limiting factors from achieving higher luminosity in an ERL based electron ion collider (EIC). We present two possible dedicated feedback systems to suppress the instability, both of which benefit from the latest development of beam instrumentation. The first takes advantage of the flexibility of the linac-ring scheme to adjust the initial condition of the electron beam; the second uses a pickup and kicker setup with proper bandwidth on the

ion ring. Both schemes raise the threshold of the kink instability dramatically and provide opportunities for higher luminosity. We studied the effectiveness of the systems and their dependence on the feedback parameters and beam parameters.

TUPG006 : Interface Velocimetry Investigations on the CESAR Facility: 700 keV, 350 kA Pulsed Electron Beams

B. Cadilhon, B. Bicrel, T. Desanlis, A. Galtié, L. Voisin (CEA)

CESAR is a high current electron beam facility. It consists of a 2Ω pulsed power generator which can deliver a 350kA, 700kV, 65ns pulsed electron beam thanks to a vacuum diode. The electron beam is focused on a target material in which it deposits its energy very quickly. Different measurement techniques are investigated such as impulse, rear surface motion or pressure to study thermo-mechanical behaviour of studied materials. Former works have already been carried out using diagnostics such as time resolved spectrometer or x-ray imagery to define the main characteristics of the electron beam. Today, we are focusing on the measurement of surface velocities up to several hundreds meters-per-second on different types of shock physics experiments. It is a time resolved surface velocimetry using the heterodyne technique. This diagnostic is assembled with single-mode fiber lasers to deliver light to and from the target. The return Doppler-shifted light is mixed with the original laser light to generate a beat frequency proportional to the velocity. We describe here our approach to measure velocities with heterodyne technique. We present recent data obtained with this diagnostics.

TUPG007 : The Goubau Line - Surface Waves for Bench Testing of Beam Instrumentation at High Frequencies

F. Stulle, J. F. Bergoz (BERGOZ Instrumentation)

Standard setups for testing of beam instrumentation in the workshops usually fail when it comes to signal frequencies a lot larger than 1 GHz. A potential improvement could be provided by electromagnetic surface waves which travel along a single wire. These waves consist of the fundamental TM mode and resemble closely the radial electric and azimuthal magnetic field around a long and thin beam of charged particles. We discuss their fundamental properties, show how they could be applied and compare calculations to measurements up to 8.5 GHz.

TUPG008 : Coupling Methods for the Highly Sensitive Cavity Sensor for Longitudinal and Transverse Schottky Measurements

M. Hansli, A. Angelovski, R. Jakoby, A. Penirschke (TU Darmstadt), W. Ackermann, T. Weiland (TEMF, TU Darmstadt), P. Hülsmann, W. Kaufmann (GSI)

In order to observe rare isotopes and anti-protons in the Collector Ring (CR) at FAIR, a highly sensitive Schottky cavity sensor is proposed, utilizing the monopole mode for longitudinal and a dipole mode for transverse measurements. Because the charged particle beam excites the dipole mode in the suggested resonator several orders of magnitude smaller than the corresponding monopole mode, it is crucial to extract both components independently without mutual correlation. Particular focus has to be put on the extraction of the dipole mode to sufficiently suppress the strong monopole contribution by taking advantage of a frequency selective coupling mechanism. Utilization of waveguide filters at the measurement frequency of about 300 MHz results in a bulky structure. To reduce the size, different methods for coupling and filtering including dielectric filling of the waveguides are evaluated in this work with respect to their Signal-to-Interference-and-Noise-Ratio. Hereby, key parameters that influence the performance, namely, the shunt impedance of the dipole mode, the suppression of the monopole mode, and the noise behavior of the system are systematically analyzed and optimized.

TUPG009 : Ion Beam Modification of Boron Nitride

E. A. Aradi, T. Derry, M. Naidoo (University of the Witwatersrand)

The c-BN phase of boron nitride has received much interest due to its unique properties. It is the second hardest stable material known after diamond. It has high electrical conductivity, and compared to diamond it is more stable in oxygen and with ferrous materials at high temperature. It can also be doped as both p-type and n-type semiconductor, while the shallow n-type semiconductor is stills a problem for diamond. These properties have led to an interest in the its synthesis as it can be used in

many mechanical, chemical and electrical applications. Ion implantation was used in this work to modify the h-BN to c-BN. The 200-20A2F ion implanter was used to introduce boron ions into h-BN single crystals. Analysis from Raman spectroscopy and TEM showed that ion beams were able to induce this phase transformation. New peaks were seen in the implanted h-BN, centered at 1303/cm which is the position of nanocrystalline c-BN. Columnar growth of c-BN layer was clearly evident on the TEM micrograph for implanted samples complimenting results from Raman.

TUPG010 : Physics of Metal Surface Glowing Effects with Electron Beam Bombardment

I. V. Barsuk (SSU)

The paper gives a brief description and analysis of the main physical processes which can have effect on the glowing nature of metal element surfaces in different electric vacuum devices when they are bombarded by electron beams. It has been found that the electron glowing effects on metal surfaces according to energy of electrons can be explained with the help of transition scattering on plasma waves or just with the classical transition radiation effect. This fact is rather important in terms of classical physics interpretation of observed glowing effects on metal surface elements and techniques optimization of metal and electron beams diagnostics as well.

TUPG011 : Non-invasive Beam Diagnostics for a 60 MeV Proton Beam

T. Cybulski (Cockcroft Institute), C. P. Welsch (The University of Liverpool)

Hadron therapy has proven to be a very sophisticated and precise technique in cancer treatment. A particular advantage of hadron therapy is the precise dose distribution, which can be limited exactly to the tumour volume, thus decreasing the dose in the organs at risk. Work on detectors for quality assurance of the proton beam at the Clatterbridge Centre for Oncology (CCO) has been started in the QUASAR Group. As a core element, the LHCb VELO detector shall be adopted as a non–invasive beam current and beam position monitor. The mechanical design for integrating this detector in the treatment beam line has been finalized and will be presented in this contribution. In addition, a Faraday Cup has been designed and optimized in

FLUKA simulations for the 60 MeV proton beam available at CCO. In this contribution results from the Faraday Cup design optimisation will be presented together with a description of the VELO detector setup.

TUPG012 : Beam Diagnostics for the Future Ultra-Low Energy Antiproton Storage Ring at FLAIR

C. P. Welsch (Cockcroft Institute), J. Harasimowicz, M. Putignano (The University of Liverpool)

Low energy beams are very important for many existing and future accelerator projects, but require development of new diagnostic methods as most of the standard high-energy techniques no longer work. The future facility for low-energy antiproton and ion research (FLAIR) is an example of an accelerator complex providing such diagnostically challenging beams. Its central machine, the ultra-low energy storage ring (USR), will offer worldwide unique conditions for both in-ring studies as well as for experiments requiring extracted slow beams of antiprotons in the keV range. This contribution presents a set of diagnostic elements for low energy, low intensity charged particle beams. The monitors include a Faraday cup for femtoampere currents detection, a capacitive pick-up for closed-orbit measurements and beam profile monitors based on scintillating screens and secondary electron emission. Although the devices were developed with the USR in mind, they can be applied to other ultra-low energy storage rings and beam lines.

TUPG013 : Beam Diagnostics Developments within LA^{3}NET

C. P. Welsch (Cockcroft Institute, The University of Liverpool)

Lasers have become increasingly important for the successful operation and continuous optimization of particle accelerators. For beam diagnostics lasers provide the highest time and spatial resolutions for transverse and longitudinal beam profile measurements. They also allow the detection of density differences in particle beams with high dynamics ranges and permit measurements of very important machine parameters such as the momentum compaction factor and beam emittance. The development of these laser applications for accelerators is the focus of the LA^{3}NET project funded by the EC with a €4.6 million grant. This FP7 Marie Curie Initial Training Network (ITN) will bring together more than 20 academic and industrial institutions from around the world. 17 early stage researchers (ESRs) will be recruited to the project to each work on dedicated research projects at specific partner sites. In addition, the network will organize a number of international training events. In this contribution, an overview of the broad research and training program is given with examples of 3 out of the 17 research projects.

TUPG014 : Beam Diagnostics Research within oPAC

C. P. Welsch (Cockcroft InstituteThe University of Liverpool)

The optimization of the performance of existing and future accelerator facilities is the goal of the oPAC project, recently selected for funding by the EU. This shall be realized by closely linking beam dynamics studies with beam instrumentation developments, advancements in numerical simulation codes and more powerful control systems. With a project budget of 6 M€, oPAC is one of the largest Marie Curie ITNs ever funded by the EU and will allow to training 22 researchers within its four year project duration. The consortium brings together universities, research centres and industry partners that will closely collaborate and also organize a number of training events open to the international accelerator community. In this contribution, the beam diagnostics R&D program across the network is presented, together with upcoming events.

TUPG015 : Research Results from the DITANET Project

C. P. Welsch (Cockcroft Institute, The University of Liverpool)

Beam diagnostics systems are essential constituents of any particle accelerator; they reveal the properties of a beam and how it behaves in a machine. Without an appropriate set of diagnostic elements, it would simply be impossible to operate any accelerator complex let alone optimize its performance. Future accelerator projects will require innovative approaches in particle detection and imaging techniques to provide a full set of information about the beam characteristics. The DITANET project covers the development of advanced beam diagnostic methods for a wide range of existing or future accelerators, both for electrons and ion beams. During the past four years, a consortium of 31 institutions developed beyond state-of-the-art techniques for beam profile, current and position measurement. The network also organized a large number of training events, such as international schools and workshops that were open to the whole community. This contribution presents the main research outcomes of the project and summarizes recent events.

TUPG016 : APEX Low Level RF Controller Algorithm and IOC Driver Design

G. Huang, J. M. Byrd, L. R. Doolittle (LBNL)

The Advanced Photoinjector EXperiment (APEX) uses a VHF cavity to provide high repetition low emittance electrons. This is potentially to be used as the gun for NGLS. The low level RF control for the cavity is designed based on the LLRF4 board. This paper describe the control algorithm and the IOC implementation.

TUPG017 : A Comparison of Electron Cloud Density Measurements Using Shielded Pickups and TE Waves at CesrTA

J. P. Sikora, M. G. Billing, J. A. Crittenden, M. A. Palmer, D. L. Rubin (CLASSE), S. De Santis (LBNL)

The Cornell Electron Storage Ring has been reconfigured as a test accelerator (CesrTA) with beam energies ranging from 2 GeV to 5 GeV. Measurements of electron cloud densities have been made using a number of techniques, including Shielded Pickups (SPU) and Resonant TE Waves. These measurements include different bunch configurations, from single bunches of positrons and electrons to multibunch trains. The comparison of those results, obtained in the same portion of the vacuum chamber, highlights the peculiarities of the two techniques and helps in identifying their advantages and disadvantages. In many respects, the techniques are complementary. For example, TE Wave measurements are most sensitive to cloud electrons near the horizontal center of the beampipe, while the SPU is sensitive to cloud electrons with velocities that are normal to the inner surface of the beampipe. SPU measurements show the time evolution of the cloud more directly, while the Resonant TE Wave measurements give a more direct absolute measurement of the overall cloud density. We present an outline of our present understanding of these two techniques and a comparison of recent measurements.

TUPG018 : Beam Polarization and Energy Measurement using Synchrotron Radiation

D. Dutta (Mississippi University), H. Mkrtchyan (YSU)

Synchrotron radiation has been used for many years as a beam diagnostic tool at electron accelerators. It allows measurements of the transverse and longitudinal polarization, spatial distribution and bunch structure of the beam, as well as the absolute value of the beam energy and its distribution. The electron spin dependence of the synchrotron radiation called spin light has a spatial asymmetry which can be exploited to measure the beam polarization. The magnified angular distribution of the visible portion of the synchrotron spectrum can be used for a non-destructive measurement of the beam energy with high precision. We will present the conceptual design of a spin light polarimeter and a beam energy measurement scheme for multi-GeV electron beams and we will discuss prospects of using these methods at the CEBAF accelerator at Jefferson Lab.

TUPG019 : NSLS-II Injector System Diadnostics Update for LINAC Commissioning

D. Padrazo (BNL)

The NSLS-II Injector System Diagnostics will provide adequate instrumentation in the LINAC, and LTB (LINAC To Booster), to perform staged commissioning of NSLS-II LINAC. This instrumentation will provide sufficient diagnostics to determine bunch charge, length, transverse size, position, and beam losses. The LTB will include key instruments to be used for beam commissioning and tune-up, particularly, BPM, Beam Dumps/Faraday Cup, ICT, FCT, Flags, and Energy Slit. Measurements of beam charge, bunch train, bunch charge, energy jitter, emittance, and energy spread, as well as measurements for beam current, bunch train pattern, tune and chromaticity can be achieved. This paper will detail the implementation and status of these diagnostics components for the NSLS-II injector system.

TUPG020 : Non-Intercepting Tomographic Reconstruction of the Transverse Spatial Distribution of SILHI Ion Source Beam

C. M. Mateo (CEA/IRFU), G. Adroit, J. Egberts, R. Gobin, Y. Sauce, F. Senee, O. Tuske (CEA/DSM/IRFU)

Particle accelerators with high intensity beams require non-interceptive diagnostics because any interceptive tools can be damaged or can perturb the beam during measurements. At CEA Saclay, tomography has been incorporated with oprtical profilers to develop a non-interceptive transverse profile monitor. Transverse spatial density of the beam from the Source d'Ions Légers de Haute Intensité (SILHI) beam line was reconstructed non-destructively and non-interceptively. Six cameras, positioned at six different directions around the beam, were aligned with respect to the beam axis and were installed to obtain the image of the emitted light due to the beam-residual gas interaction. At present, due to software limitations, profile measurements from each camera cannot be done simultaneously. Instead, there is a one-second interval on measurements from one camera to another. This makes a total of about ten seconds to obtain the profiles and to reconstruct the 2D spatial beam distribution. Comparisons of the profiles obtained by tomographic reconstruction with those obtained from six cameras and with the horizontal profile from an ionization profile monitor were also done.

TUPG021 : Design and Test of the LIPAc IPM

J. Egberts, F. Jeanneau, T. Papaevangelou (CEA), P. Abbon, G. Adroit, R. Gobin, J.-F. Gournay, J. Marroncle, C. M. Mateo, J.-Ph. Mols, F. Senee (CEA/DSM/IRFU)

The linear IFMIF prototype accelerator (LIPAc) will be commissioned in Rokkasho, Japan, shortly. Due to its high beam power of over 1 MW and its tremendous continuous wave beam current of 125 mA, non-interceptive profilers are required. We present the design and test of the LIPAc ionization profile monitor. Due to the very high space charge, LIPAc is designed in a very compact manner which hardly leaves any room for diagnostics. The IPM was designed using FEM simulations to achieve the optimal electric field keeping the tight space requirements of LIPAc. Due to the limited space available, we had to abstain from using a magnetic guidance field and collect ions instead of electrons. To cope with the strong space charge forces of the beam, we have developed a software algorithm

that aims to not only scale the distorted measured profile to its original size, but to fully reconstruct the original beam profile. This algorithm has been tested at SILHI, a high intensity ion source at CEA Saclay, France, where highest space charge forces can be achieved, and the results will be presented as well.

TUPG022 : Transverse Beam Profile Monitoring using Scintillation Screens for High Energy Ion Beams

K. Renuka, W. Ensinger (TU Darmstadt), C. A. Andre, F. Becker, P. Forck, R. Haseitl, A. Reiter, B. Walasek-Hoehne (GSI)

The systematic studies of transverse profile measurement were carried out with scintillation screens such as single crystals (CsI:Tl, YAG:Ce), powder screens (P43, P46), ceramics (Al2O3, Al2O3:Cr, Y and Mg doped ZrO2), Ce doped (0.3%) and undoped glasses (Herasil). Different ion beams like C, Ne, Ta, and U accelerated to energy of 300 MeV/u were extracted from the heavy ion synchrotron at GSI within 0.3 s for intensities from 10^4 to 10^9 particles per pulse. The image of each beam pulse was recorded by a CCD camera and individually evaluated. The recorded image profiles show a reproducible dependence on scintillation screen. A difference in image width up to 50% is noticed between CsI:Tl and Herasil. The detailed investigation shows that the powder screens P43 and P46, ceramics Al2O3 and Al2O3:Cr reproduce the beam width within a difference of $\ll$4% for all intensities. The light yield from the screens scales linearly over 5 orders of magnitude of particle intensity. The light yield per energy deposition by a single ion was calculated for different ion beams. This normalized light yield is a factor of 2 higher for Carbon ions compared to Uranium.

TUPG023 : Wire Scanners for Emittance Measurements at the 100 keV Spin Polarized Electron Beam Line at the S-DALINAC

C. Eckardt, U. Bonnes, J. Enders, Y. Fritzsche, M. Wagner (TU Darmstadt)

A source of 100 keV spin polarized electrons has been installed at the 130 MeV superconducting Darmstadt linear accelerator S-DALINAC. Circularly polarized laser light excites a GaAs cathode, producing polarized electrons, which are accelerated electrostatically to 100 keV. A Wien-filter for spin manipulation and a Mott polarimeter for polarization measurements are installed in the low-energy beam line. Polarizations up to 86% have been shown with strained superlattice GaAs cathodes. Wire scanners are installed in the beam line for emittance measurements. The scanning unit, two perpendicular 50 micron tungsten wires mounted on an insulated frame, is installed at an angle of 45°. Crossing the beam with each wire yields measurements for the x and y beam size. In conjunction with a solenoid with variable focal length a parameter set of beam sizes depending on the focal length can be obtained, allowing for an emittance calculation. Measurements at the S-DALINAC give an indication of the beam quality of the polarized electron source, permit a comparison with the already installed thermionic electron source, and a possible emittance growth from the Wien-filter is to be excluded.

TUPG024 : Non-Destructive Beam Profile Monitors at COSY-Jülich

V. Kamerdzhiev, J. Dietrich, K. Reimers (FZJ)

The paper deals with the Ionization and Scintillation profile monitors at COSY-Jülich. The emphasis is made on the latter one. The unique experience of operating an SPM equipped with a nitrogen injector in a proton synchrotron is summarized. Latest improvements to the SPM optics resulted in good agreement with the IPM. The profiles measured by both devices are compared. The advantages of each method are analyzed.

TUPG025 : Design and Construction of SEM for Continuous 200 keV Beam

M. Shafiee, E. E. Ebrahimibasabi, S. A.H. Feghhi (SBU), M. Jafarzadeh (ILSF)

Beam profile and position monitoring with continuous beams is not possible by electromagnetic based instruments such as Pick Up, by this regard, design and construction of SEM has done for electrostatic 200 keV proton machine which can be classified into mechanic and electronic sections. At mechanical section the vacuum chamber with 3 feedthrough that each one has 32 pins was constructed then grids with 16 copper wire with length of 10 cm and 80 μm diameter at each vertical and horizontal direction considered. The produced signals amplified and then digitized by ADC and transferred by ATMEGA32 ports to PC which set by GUI (MATLAB) as data analyzer. Induced profile at quartz glass which is placed at the end of beam tube was considered as benching mark source. The electrical results were compared with the result of quartz as practical method and CST as simulation that showed good accuracy and precision which is presented at this article.

TUPG026 : Low Intensity Beam Diagnostics at LNS - INFN

L. Cosentino (INFN/LNS)

The secondary beams produced at LNS – INFN with the EXCYT and FRIB facilities, have intensities tipically below 10^6 pps. An efficient beam diagnostics has been installed at LNS, with almost thirty points installed, in order to measure the beam parameters in real time,such as the profiles, the intensity and the isotope identification, thus maximizing the intensity until to the final detector. For energies of 10 - 300 keV, the diagnostic device LEBI is composed of a CsI(Tl) scintillating screen for the beam imaging and of a plastic scintillator BC408, for the beam rate measurement and to identify the beta-emitting radioisotopes in the beam. In case of gamma emitters, a couple of high purity germanium detectors is also used. For the accelerated beams (up to tens of MeV/A), the devices are based on plastic scintillators for the measurement of the beam intensity, on position sensitive silicon detectors (PSSD) to reproduce the 2D transversal beam profile and on scintillating scintillating optical fibres, that by scanning the beam allow to reconstruct the 1D vertical and horizontal profiles.

TUPG027 : A New Optical Observation Station fo the Electron Beam Parameters at the Electron Storage Ring SIBERIA-2

A. Stirin, Y. A. Fomin, V. Korchuganov (NRC), A. D. Khilchenko, O. I. Meshkov, L. M. Schegolev, A. N. Zhuravlev, E. I. Zinin (BINP SB RAS), G. A. Kovachev, V. P. Moryakov, D. G. Odintsov, Yu. F. Tarasov, A. Vernov, A. V. Zabelin (RRC)

The optical observation station project of electron beam parameters which is realized at the dedicated synchrotron radiation storage ring SIBERIA-2 in Kurchatov Institute is presented in the paper. The purpose of the station - automatic measurement of transverse and longitudinal dimensions of the electron bunches using the visible spectrum of synchrotron radiation (SR) in the one-bunch mode and multi-bunch mode, study of the behavior of individual electron bunches in time by varying different parameters of the accelerator, the precise measurement of the frequency of betatron and synchrotron oscillations. The station with the measuring optical system is located outside the shielding wall of the storage ring. A scheme of optical SR beam line and measuring optical system block diagram are shown. The principle of operation and technical characteristics of the system elements (dissector, multi-anode photomultiplier tube, CCD, etc.) are clarified, the accuracy of measurements of electron bunches parameters are estimated.

TUPG028 : New Tests of Fluorescence Beam Profilers for the Linear IFMIF Prototype Accelerator using 9 MeV Deuteron Beams

J. M. Carmona, I. Podadera (CIEMAT), J. García López, M. C. Jiménez-Ramos (CNA)

The Linear IFMIF Prototype Accelerator (LIPAc) will be a 9 MeV, 125 mA (CW), 1.125 MW deuteron beam with the objective of validating the technology that will be used in the future IFMIF facility. Due to the high power, non-interceptive profilers are required for the operation of the accelerator. Two prototypes of LIPAc fluorescence profile monitors (one based on a PMT array and another based on an intensified CID camera) were tested obtaining beam profiles from a 9 MeV deuteron in the CNA cyclotron, Spain. Improved measurements have been carried out recently and the results will be presented. The new measurements include evolution of beam sizes, beam center positions and profile intensities during: i) beam steering ii) injection of N_2 and H_2 iii) different beam conditions. Main parameters of both monitor measurements are analysed and comparison with previous results will be performed. These measurements were carried out under significant gamma and neutron background.

TUPG029 : Vacuum Actuator and Controller Design for a Fast Wire Scanner

J. Emery, B. Dehning, J. F. Herranz Alvarez, M. Koujili, J. L. Sirvent Blasco (CERN)

To cope with increasing requirements in terms of accuracy and beam intensity limits a wire scanner design is under development for the CERN accelerators complex. The main parameters have been determined; the wire speed should reach 20 m/s when interacting with beams with a position determination of 2um under a harsh and radioactive environment. To meet this goal, the proposed solution locates all moveable parts of the actuator and the angular sensors in the beam vacuum pipe in order to reduce the friction and to allow a direct position measurement. One absolute positioning sensor will be used for the brushless motor feedback and one custom, high precision incremental design will target the beam size determination. The laboratory tests set up for the actuator and the incremental sensor will be presented along with the motor control feedback loops optimization developed with the dSpace environment using Simulink and MatLab software tools. Finally, the development of the digital feedback platform and the control and acquisition system design for the future operational system will be discussed.

TUPG030 : Experimental Characterization of a Flexible Ionization Beam Profile Monitor in Residual Gas Operating Mode

M. Putignano, D. Borrows (Cockcroft Institute), C. P. Welsch (Cockroft Institute, The University of Liverpool)

For least-interceptive measurement of the transverse profile of exotic and antimatter beams in the Ultra-low energy Storage Ring (USR), a flexible monitoring apparatus has been designed at the Cockcroft Institute, UK. The monitor relies on ionization of neutral gas atoms from the primary beam, and subsequent imaging of the ionization products on aμChannel Plate position sensitive detector. The flexibility of the apparatus lies in the ability of using, as neutral gas target either the residual gas or a supersonic gas jet target, depending on the requirements of the machine. In this contribution we introduce describe the experimental characterization of the monitor in the residual gas monitoring mode.

TUPG031 : Optical Synchrotron Radiation Beam Imaging with a Digital Mask

R. B. Fiorito, A. G. Shkvarunets, H. D. Zhang (UMD), W. J. Corbett, A. S. Fisher, W. Y. Mok, K. Tian (SLAC), D. Douglas, F. G. Wilson, S. Zhang (JLab), T. M. Mitsuhashi (KEK)

We have applied a new imaging/optical masking technique, which employs a digital micro-mirror device (DMD) and optical synchrotron radiation (OSR), to perform high dynamic range (DR) beam imaging at the JLab Energy Recovery Linac and the SLAC/SPEAR3 Synchrotron Light Source. The OSR from the beam is first focused onto the DMD to produce a primary image; selected areas of this image are spatially filtered by controlling the state of individual micro-mirrors; and finally, the filtered image is refocused onto a CCD camera. At JLab this technique has been used successfully to view the beam halo with a DR ~ 10^5. At SPEAR3 the DMD was used to filter out the bright core of the stored beam to study the turn-by-turn dynamics of the 10^{-3} weaker injected beam. We describe the optical performance, present limitations and our plans to improve the DR of both experimental systems.

TUPG032 : Scintillation Degradation under Low-Energy Ion Beam Bombardment

L. Y. Lin (FRIB)

Scintillators are widely used to reliably measure beam profiles and beam distribution. At the rare isotope ReAccelerator facility (ReA) of the National Superconducting Cyclotron Laboratory (NSCL) several scintillator viewers are used in the low energy transport section. In order to interpret the observed ion beam profiles, we have systematically studied the scintillator yields of CaF and YAG: Ce scintillators as a function of fluence at various low energies and with different bombarding ions. An exponential decay of the light yield as a function of time was observed. The dependence can be interpreted as ion induced defects of the crystal lattice during the bombardment. The color center defects induced by the radiation dose are likely to act as exciton trapping centers, leading to decrease the scintillator yield. We have studied the scintillator yield as a function of fluence in order to explore the influence of the beam energy and current on scintillation production and defect creation. The results can be interpreted by the Birks model to evaluate the half-dose brightness and the relative exciton capture probability. The results of the analysis will be presented.

TUPG033 : LANSCE Wire Scanner System Prototype: Switchyard Test

J. D. Sedillo, J. D. Gilpatrick, S. Rodriguez Esparza (LANL), M. E. Gruchalla (URS)

On December 12, 2011, the beam diagnostics team of Los Alamos National Laboratory's LANSCE accelerator facility conducted a test of a prototype wire scanner system for future deployment within the accelerator's switchyard area. The primary focus of this test

was to demonstrate the wire scanner control system's ability to extend its functionality beyond acquiring lower energy linac beam profile measurements to acquiring data in the switchyard, where beam energy is highest. This study summarizes the features and performance characteristics of the electronic and mechanical implementation of this system with details focusing on the test results.

TUPG034 : High Efficiency and Large Dynamic Range Imaging of Relativistic Electrons

R. K. Li, P. Musumeci, C. M. Scoby, H. L. To (UCLA)

A recent trend in the physics and applications of high brightness electron beams is toward lower bunch charge while higher brightness, as demanded by current and future facilities including femtosecond relativistic electron diffractions and single-spike free-electron lasers. Here we report on a quantitative analysis of the signal transferring process in an electron imaging system, which consists of a scintillator, an optical coupling system and a high efficiency camera. It is demonstrated that every single relativistic electrons can be imaged. This improvement opens the possibility of obtaining high quality single-shot diffraction patterns with much lower charge inside each bunch, which possess sub-100 nm normalized emittance and sub-10 fs bunch length. The improvement also allows us to measure sub-10 nm trace space emittance by forming a large area and low density shadowgraph of a pepper-pot target or TEM grid after a sharp focus. Further, by relay imaging a variable neutral-density apodizing optical filter, we can extend the dynamic range to 6-7 orders of magnitude, which greatly facilitates the applications like the diffraction pattern recording and beam halo measurement.

TUPG035 : Evaluation of New, Fast Wire Scanner Designs for the LCLS

P. Krejcik, M. L. Campell, N. W. Fong, J. C. Frisch, H. Loos (SLAC)

Transverse beam size measurement for emittance tuning of the LCLS electron beam relies on wire scanners strategically placed on the beam line. It was originally intended to use Optical Transition Radiation (OTR) screens to obtain single shot measurements of the transverse beam size but it was soon discovered that the Coherent OTR that is a feature of ultra-short bunch length operation in linac FELs swamped the signal and rendered this diagnostic unusable. The original SLAC wire scanners that have been in operation for about 20 years are fairly slow and not optimized for the rapid measurements needed to monitor and fine tune the very small LCLS beam emittances, taking over a minute to complete a measurement in both planes. Two new wire scanner designs are being tested at LCLS that make use of state-of-the-art mechanical slides and position read-back systems to make fast, vibration-free measurements of the beam size. One uses an in-vacuum piezo-controlled linear slide and the other uses a dc linear servo motor coupled through a pair of vacuum bellows. The merits of the two designs are compared to the original SLAC design that relies on a ball screw driven by a stepping motor.

TUPG036 : MATLAB and EPICS based Emittance Measurement Tool for the IAC Accelerators

C. F. Eckman, A. Andrews, Y. Kim, S. Setiniyaz, D. P. Wells (IAC)

At the Idaho Accelerator Center (IAC) of Idaho State University, we have been operating fifteen low energy accelerators. To optimize those accelerators properly, we have to measure the transverse beam emittance. To measure the transverse beam emittance of an S-band linear accelerator with the quadrupole scan technique, we installed an Optical Transition Radiation (OTR) screen and a digital CCD camera in the beamline of the accelerator. From the images of the digital CCD camera, the transverse beam profile on the OTR screen can be acquired. To extract the transverse beam size and to estimate the transverse emittance, we have developed a MATLAB program. This paper describes the details of the MATLAB and EPICS based emittance measurement tool and performance of the emittance measurement tool.

TUPG037 : Beam Imaging System for Transverse Emittance Measurement at the IAC

S. Setiniyaz, T. A. Forest, Y. Kim (ISU), K. Chouffani, C. F. Eckman, C. O'Neill, D. P. Wells (IAC), A. Freyberger (JLab)

A 16 MeV S-band linac at the Idaho Accelerator Center was recently reconfigured to produce a secondary beam of positrons by sending a 100 mA peak electron currents onto a Tungsten converter. The transverse electron beam emittance was measured to determine the optimal configuration using a quad triplet system to capture the positrons escaping the downstream side of the Tungsten converter. In 2011, we developed a beam imaging system with a digital CCD camera, three optical lens, and an OTR screen for the emittance measurement. In this paper, we describe the hardware and performance of our beam imaging system.

TUPG038 : Beam Image Measurement at NSLS-II

Y. Hu, L. R. Dalesio, D. Padrazo, H. Xu (BNL)

Different types of imaging systems are used at NSLS-II. Flags are distributed around the whole machine to observe the beam profile and measure the beam size. Synchrotron radiation based imaging systems, also named X-ray diagnostics beam-lines, are used to measure the beam emittance and energy spread in the Storage Ring. For control system, the most challenging part is camera control, image acquisition and processing. Standardization of camera selection, EPICS-based software and performance tests are presented.

TUPG039 : RHIC Electron-Lens Beam Profile Monitoring

T. A. Miller, D. M. Gassner, A. I. Pikin (BNL)

In preparation for installation of an Electron Lens (E-Lens) into RHIC, planned for the summer of 2012, a test bench is being set up to allow the electron gun and collector assemblies, destined for the final E-Lens installation, to be tested together with a downsized mid-drift section. The goal of this effort is to test the electron gun and the collector designs, as well as the beam profiling instrumentation. A small unbiased Faraday cup, equipped with a grounded pin-hole mask, will intercept the beam; while an automated Control and data acquisition system will

raster scan the electron beam across the detector. The collected integrated charge measurement is digitized and stored in an image type data file. This remote controlled plunging detector can be alternatively located in the same position as a plunging YAG:Ce crystal. A viewing port at the downstream extremity of the collector allows a GigE camera, fitted with a custom zoom lens, to image the crystal and digitize the profile of a beam pulse. Custom beam imaging software has been written to import both beam image files (pin-hole and YAG) and fully characterize the image of the beam profile.

TUPG040 : Development of a New in Line Focal Spot Size Measurement Setup at AIRIX

V. Bernigaud, M. Caron, A. S. Morlens, J-P. Nègre, N. Pichoff, Y. Tailleur, L. le Dain (CEA)

The AIRIX X-ray source, which is used for hydrodynamic tests, can be characterized by several parameters. Among them, the determination of the X-ray spot size diameter, its shape and the beam profile are important for radiographic experiments design and interpretation. We generally use the rolled edge and the ring-shaped pinhole methods to determine the spot size diameter. Both methods have the disadvantage to be interceptive because they require an access on the firing table and use the on-axis radiation produced by the accelerator. Recently, we have started the development of a non-interceptive system based on a ring pinhole placed at 90^{o} of the radiographic axis. The prototype allows an instant result after each flash with a true 2D and time resolved measurements and above all a precise knowledge of the focal spot size diameter during experiments. Concerning the beam profile, we have performed MCNP simulations and developed an experimental setup for measuring the angular distribution of the X-rays. Beyond the interest of such a measure, we will show how the combination of both devices opens up the possibility to determine the real radiographic axis.

TUPG041 : Beam Motion Monitor

F. Falkenstern, F. Hoffmann, P. Kuske, J. Kuszynski (HZB)

The accurate tune determination is essential for the stable operation of storage rings. The Beam Motion Monitor (BMM), developed at HZB, permits the permanent measurement of betatron

tunes at the BESSY storage ring without exciting the beam. With this system it is possible to detect the transverse beam oscillations of less than 1nm [rms]. The large dynamic range of more than 120 dB for observing the beam motion, the fast update rates (10 Hz) of the wide spectrum (DC to f rev) allows to use this system for beam dynamics studies and for detecting beam instabilities. The big advantage of the BMM is that it operates without switching and adjusting the system for different currents and fill patterns in the storage ring. Only two stripline signals installed in the storage ring are needed as input for BMM. The high sensitivity of the monitor is based on the suppression of the common mode by carefully adjusting the difference of the two input signals. All components for this system are available on the market.

TUPG042 : High Intensity Effects on Betatron Tune at GSI SIS-18

R. Singh, P. Forck, W. Kaufmann, P. Kowina, K. Lang (GSI), T. Weiland (TEMF, TU Darmstadt)

The tune measurement system (TOPOS) at GSI SIS-18 consists of, a band limited noise exciter which excites coherent betatron oscillations in the bunched beam; Fast ADCs to digitize the BPM signals at 125 MSa/s and FPGAs to calculate position from the digitized BPM signals. Baseband tune is thus determined by Fourier transformation of the individual bunch position data. Several tune measurement campaigns were performed with U^{73+} and Ar^{18+} ion beam at highest achievable intensities of $2x10^9$ and $2.5x10^{10}$ respectively using TOPOS. The goal of these measurements was to understand the high current effects on the tune spectra. Substantial modification of the tune spectra were observed and attributed to the bunch head tail oscillations after further investigations. Coherent tune shift in dependence of beam intensity were also measured. This contribution reports on the modified tune spectra, corresponding space charge effects and further experimental details.

TUPG043 : High Sensitivity Tune Measurement using Direct Diode Detection

M. Gasior (CERN)

Direct Diode Detection combined with high resolution digitisers is a technique developed at CERN, originally for the LHC tune measurement system, to reach a sensitivity that allows the observation of beam oscillations with amplitudes in the micrometre range. In this technique simple peak diode detectors are used to convert short beam pulses from a beam position monitor into slowly varying signals. Their DC part, constituting a large background related to beam offsets, is suppressed by series capacitors, while the small signals related to beam oscillations are passed to the following stages for amplification and filtering. As the demodulated beam oscillation signals are already in the kHz range, their processing is easily done with high resolution audio ADCs. This contribution presents the principles of the 3D technique and focuses on the history and the adventures of the 3D development and prototyping. It documents a very efficient collaboration between CERN and Brookhaven National Laboratory, with contributions from several other international laboratories.

TUPG044 : First Results from the LHC Schottky Monitor Operated with Direct Diode Detection

M. Gasior (CERN)

The LHC is equipped with a Schottky diagnostic system based on 4.8 GHz travelling wave pick-ups. Their signals are processed with a three-stage down-mixing scheme, which is primarily intended for non invasive bunch by bunch tune measurement. This works well during periods of stable beam operation, but is often perturbed by the coherent part of the beam spectrum during the energy ramp. To study the beam spectrum in such conditions the signals from the Schottky pick-ups were split at the tank output to allow parallel processing with slightly modified LHC tune measurement hardware, based on simple diode detectors followed by signal processing in the kHz range using 24-bit audio ADCs. With such a test system LHC beam spectra were successfully observed, with this contribution presenting the results obtained.

TUPG045 : Chromaticity Measurement of the APS Booster

C. Yao, N. Sereno, H. Shang (ANL)

Chromaticity plays an important role in the beam dynamics of circular accelerators and storage rings. The current operational 132-nm emittance lattice of the APS booster synchrotron has a natural x- and y- chromaticity of -7.15 and -21.1, respectively. The eddy-current-induced sextupole effect of the dipole vacuum chamber complicates the chromatic correction. Due to the current stability of ramp supplies and the resulting tune changes, we have not been able to measure chromaticity of the booster quantitatively until recently. Recent improvement in power supply current ramp has reduced the tune variation substantially, which enables us to measure chromaticity with sufficient accuracy. We performed simulation with elegant in order to understand the time-dependency of tunes and chromaticities. We present the measurement result and our analysis.

TUPG046 : Development of a Horizontal Drive Stripline for the APS Transverse Feedback System

C. Yao, Y.-C. Chae, S. H. Kim, L. H. Morrison, H. Shang (ANL)

The APS storage ring has four striplines that are designed for tune measurement and feedback applications: two of them are part of the tune measurement system, and the other two are used as pickup and driver for the transverse feedback system. Drive tests with beam and simulation studies have shown insufficient kick strength in the horizontal plane for the desired damping rate. We determined that the main causes were the short length of the original stripline and the low beta-x function at the installation location. A new two-blade stripline was designed and installed in a high beta-x location of the storage ring. sddsoptimize, a multi-objective optimization, was employed to optimize the geometry of the stripline in order to achieve both impedance matching and high-shuntimpedance. Beam-based measurements showed an increase in kick strength from the original 0.25 μrad to 0.78 μrad. The stripline has been in operation for more than one year. This report describes the simulation, optimization, and the performance of the new stripline.

WEAP: Wednesday Morning Presentations

WEAP01 : Coherent Electron Cooling Proof of Principle Instrumentation Design

D. M. Gassner, R. J. Michnoff, T. A. Miller, M. G. Minty, I. Pinayev, M. Wilinski (BNL)

The goal of the Coherent Electron Cooling Proof-of-Principle experiment being designed at RHIC is to demonstrate longitudinal (energy spread) cooling before the expected CD-2 for eRHIC. The scope of the experiment is to cool longitudinally a single bunch of 40GeV/u Au ions in RHIC. This paper will describe the instrumentation systems proposed to meet the diagnostics challenges. These include measurements of beam intensity, emittance, energy spread, bunch length, position, orbit stability, and transverse and temporal alignment of electron and ion beams.

WEAP02 : FPGA Based Signal Processing - Applications and Techniques

N. Eddy (Fermilab)

This tutorial covers the the basics of signal processing with current FPGAs. It focuses on the features available in current FPGAs and how they can be used to facilitate signal processing for instrumentation front-ends. A number of application examples will be discussed along with particular techniques used to accomplish them.

WEBP: Wednesday Morning Presentations

WEBP01 : Measured Reality

A. Freyberger (JLab)

Interpretation of diagnostic signals is incomplete without comprehensive start to end analysis of signal error. Signal error sources are varied and their interactions can lead a misinterpretation of the result and its measured precision. This lecture will review error sources, error propagation, and statistics. Specific examples applicable to accelerator beam diagnostics will be presented.

WEBP02 : Proton and H^- Low-Energy Beam Diagnostics

V. E. Scarpine (Fermilab)

There are a number of recent and proposed proton/H^- accelerator systems being developed for the fields of particle physics, nuclear physics, materials science and application-driven systems (ADS). Many of these accelerators will operate with high beam power. One of the challenges of these high power accelerators will be to produce high-quality beam out of the initial low-energy injector. This will require the proper measurement and control of many beam parameters. For most of these accelerator systems, the injector complex consists of an ion source, LEBT, RFQ and MEBT sections. This talk will discuss beam diagnostics needed to characterize these injector sections, as well as the diagnostics necessary once the accelerator becomes operational.

WECP: Wednesday Afternoon Presentations

WECP01 : High-Power Beam Test of the APS Grazing-Incidence Insertion Device X-ray Beam Position Monitor

B. X. Yang, J. T. Collins, G. Decker, P. K. Den Hartog, T. L. Kruy, S.-H. Lee, M. Ramanathan (ANL)

A grazing-incidence insertion device x-ray beam position monitor (GRID-XBPM) has been under design and construction at the APS for the past two years. At an 0.85 degree grazing incidence angle, the XBPM assembly was designed to withstand two inline Undulator A devices operating at 150 mA beam current, a total power of 16 kW. We report the first x-ray beam test of the XBPM in 29ID-A, the first optical enclosure, at up to 50% of its design capacity. Thermal imaging measurements were performed for the absorber and found a maximum of $\sim 15^{o}$C temperature rise on the outside surfaces of the copper chamber walls. In the direction perpendicular to the beamline aperture, the center-of-mass detectors appear to provide good beam position signals for the total undulator beam power from 17 W to 10.6 kW, covering nearly three decades. The gap-dependent offset for the XBPM is also dramatically reduced. In the direction parallel to the beamline aperture, the center-of-mass measurement is impossible and the XBPM's gain (calibration) is gap dependent. However, the reduced gap-dependent offsets will allow the XBPM to work reliably near the origin.

WECP02 : NSLS-II RF BPM Update

K. Vetter, A. J. Della Penna, K. Ha, J. Mead (BNL), G. J. Portmann (LBNL), J. J. Sebek (SLAC)

In this paper we will report on the progress of the NSLS-II RF BPM development which started in August of 2009. We will provide detailed architecture description. We will present results from NSLS-II Injection System commissioning as well as recent ALS beam test results. A comprehensive description of laboratory characterization and production process flow will also be provided.

WECP03 : Impact of Longitudinally Tilted Beams on BPM Performance at the Advanced Photon Source

N. Sereno, G. Decker, R. M. Lill, X. Sun, B. X. Yang (ANL)

It has been shown that cavity BPMs are sensitive not only to beam centroid position but also longitudinal beam tilt. Button-style BPMs also should in principle be sensitive to beam tilt that may impact their perfor- mance when used to measure the beam centroid. For the APS up- grade project, beam stability at a level better than 0.5 micron (0.1 - 200 Hz) is required. Simplified models of the button geometry are used used in the calculation and simulation. For the experiment, tilt oscillations were induced by kicking the beam vertically and letting it decohere. Tilt oscillations were simultaneously observed using a streak camera and a specially-instrumented set of button- type BPM pickup electrodes. Experimental results are compared with calculation and simulations to quantify the impact of beam tilt on BPM centroid resolution performance.

WECP04 : Beam Interaction with Thin Materials; Heat Deposition, Cooling Phenomena and Damage Limits

M. Sapinski (CERN)

Thin targets inserted into particle beams can serve various purposes from measuring the beam profile using wire scanner or scintillating screens to beam charge modification with the use of stripper foils. The mechanisms of energy deposition in a thin target for various beam types are discussed, together with the properties of particles produced in this kind of interaction. The accompanying cooling phenomena and their efficiencies are also described, from simple heat transfer to sublimation cooling. Finally, damage conditions are discussed and conclusions drawn about typical damage limits.

WEDP: Wednesday Afternoon Presentations

WEDP01 : Wall-Current-Monitor based Ghost and Satellite Bunch Detection in the CERN PS and LHC accelerators

R. J. Steinhagen, S. Bart Pedersen, J. M. Belleman, H. Damerau (CERN)

While most LHC detectors and instrumentation systems are optimised for a nominal bunch spacing of 25 ns, the LHC RF cavities themselves operate at at the 10th harmonic of the maximum bunch frequency. Due to the beam production scheme and transfers in the injector chain, part of the nominally 'empty' RF buckets may contain particles, referred to as ghost or satellite bunches. These populations must be accurately quantified for high-precision experiments, luminosity calibration and control of parasitic particle encounters at the four LHC interaction points. This contribution summarises the wall-current-monitor based ghost and satellite bunch measurements in CERN's PS and LHC accelerators. The instrumentation set-up, post-processing and achieved performance are all discussed.

WEDP02 : Report on DIPAC 2011

K. Wittenburg (DESY)

The 10th European Workshop on Beam Diagnostics and Instrumentation for Particle Accelerators (DIPAC'11) was hosted by DESY and held from May 16-18 2011 aboard the Cap San Diego in Hamburg, Germany. This oral presentation provides an overview of beam instrumentation areas of interest, which were discussed during the workshop. From a selection of the DIPAC'11 presented papers, a number of technical highlights will also be described, and will include reflections on the conference attendance, participation, and contributions.

THAP: Thursday Morning Presentations

THAP01 : Fast Bunch Profile Monitoring with THz Spectroscopy of Coherent Radiation at FLASH

S. Wesch, C. Behrens, B. Schmidt (DESY) E. Hass (Uni HH)

We developed a fast bunch profile monitor based on wavelength-resolved THz detection. An in-vacuum spectrometer with four dispersive gratings and parallel readout of 120 individual wavelength bins provides detailed shot-to-shot information on the bunch shape. The device can be operated in short (5-44 um) and long range (45-435 um) mode to cover the entire longitudinal phase space for compressed bunches of the FLASH linac. Due to the large wavelength range, the electron bunch time profile can be reconstructed reliably in detail using Kramers-Kronig algorithm for the phase retrieval. Performance of the instrument and results compared to direct time domain (TDS) measurements will be presented for electron bunches down to a few 10th femtoseconds length.

THAP02 : Longitudinal Electron Beam Diagnostics for the FERMI@Elettra FEL

M. Veronese, E. Allaria, R. Appio, L. Badano, P. Craievich, S. Di Mitri, M. Ferianis, L. Pavlovic, G. Penco, F. Rossi (ELETTRA), M. Petronio (DEEI)

Frontier fast dynamics science is founded on accelerator based photon pulsed source operating now from THz to hard x-rays. The longitudinal electron bunch properties play a crucial role to assure the needed high performances and reliability at most advanced accelerator based facilities. Therefore most FELs are equipped with this a new class of demanding longitudinal diagnostics. FERMI@Elettra, the most recent running seeded FEL designed to cover the VUV/Soft x-ray range, is a brilliant example. Tight design tolerances together with the seeded scheme called for state of the art longitudinal diagnostics. We present the FERMI@elettra longitudinal electron beam diagnostics that have been designed, installed and successfully commissioned at the FERMI@Elettra accelerator. In particular we describe: the low energy longitudinal profile system using Cherenkov radiation, the coherent radiation bunch length monitors (CBLM), the bunch arrival monitors (BAM), the low energy (LERFD) and high energy (HERFD) RF deflectors, the electro optical sampling stations (EOS) and the bunching strength monitor system based on coherent UV transition radiation. We introduce the design of these diagnostics and present the latest results we obtained with beam.

THBP: Thursday Morning Presentations

THBP01 : Ultra-short Electron Bunch and X-ray Temporal Diagnostics with an X-band Transverse Deflecting Cavity

P. Krejcik, Y. T. Ding, J. C. Frisch, Z. Huang, H. Loos, M.-H. Wang (SLAC), C. Behrens (DESY), P. Emma (LBNL)

The technique of streaking an electron bunch with a RF deflecting cavity to measure its bunch length is being applied in a new way at the Linac Coherent Light Source with the goal of measuring the femtosecond temporal profile of the FEL photon beam. A powerful X-band deflecting cavity is being installed downstream of the FEL undulator and the streaked electron beam will be observed at an energy spectrometer screen at the beam dump. The single-shot measurements will reveal which time slices of the streaked beam have contributed to the FEL process by virtue of their greater energy loss and energy spread relative to the non-lasing portions of the electron bunch. Since the diagnostic is located downstream of the undulator it can be operated continuously without interrupting the beam to the users. The resolution of the new X-band system will be compared to the existing S-band RF deflecting diagnostic systems at SLAC and consideration is given to the required RF phase stability tolerances required for acceptable beam jitter on the monitor. Simulation studies show that about 1 fs (rms) time resolution is achievable in the LCLS over a wide range of FEL wavelengths and pulse lengths.

THBP02 : Spectroscopic Characterization of Novel Silicon Photomultipliers

M. Panniello (MPI-K), L. J. Devlin (Cockcroft Institute), P. Finocchiaro (INFN/LNS), C. P. Welsch (The University of Liverpool)

Most of the presently used systems for loss detection and EM radiation spectroscopy are still based on classical photomultiplier tubes. The more recent Silicon Photomultiplier (SiPM) is a good candidate to take their place thanks to some of its fundamental features such as the insensitivity to magnetic fields, robustness, compactness and relatively low voltage working regime. This device can be coupled to very different kinds of light generators, e.g. scintillators or Cherenkov radiators, thus making it extremely flexibile in its use. To evaluate the possible range of applications of a specific SiPM, it is necessary to quantify its fundamental parameters including noise, time resolution and dynamic range. In this contribution an experimental and analytical characterization of some last generation SiPMs is presented. Particular focus is given to a next-generation SiPM from ST Microelectronics.

THBP03 : Cherenkov Radiation for Beam Loss Monitor Systems

S. L. Kramer, J. Choi (BNL)

Cherenkov radiation has been used by high energy physics to identify the mass of single particles for quite some time. Quartz fiber optics has been used to detect beam loss locations for pulsed electron beams using the time of propagation within the fiber of the light pulse. For the NSLS-II storage ring, it was necessary to detect the amount of charge lost versus location around the ring. To achieve this for a continuously circulating beam, the best solution was found to be large diameter, solid fused silica Cherenkov radiator rods which localized the beam loss to a unit of one magnet girder, which usually corresponds to one peak of transverse beam size or dispersion and therefore one loss point of interest. This paper presents an analysis of the use of Cherenkov radiation as a signal for beam loss, together with a comparison of the advantages and disadvantages of fiber optic cable and solid rod radiators for beam loss monitoring.


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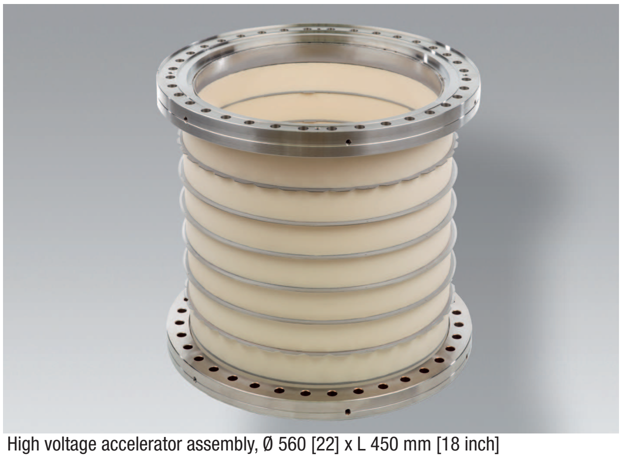
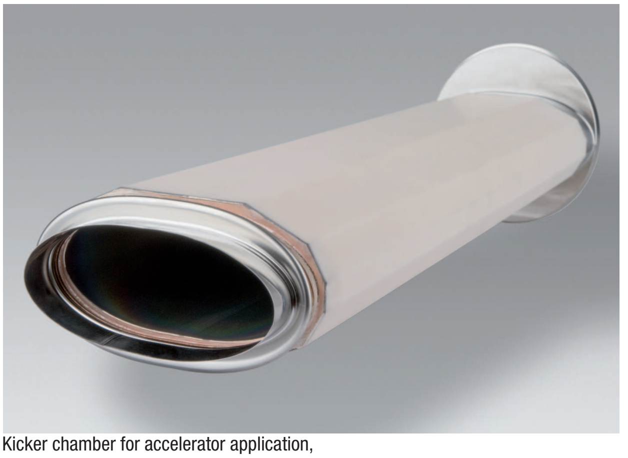
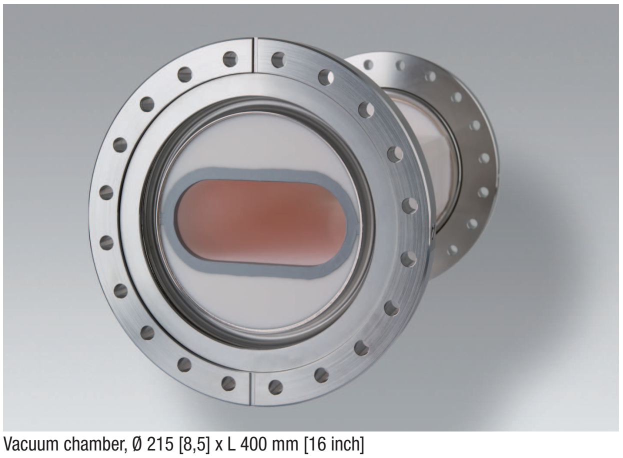


High voltage accelerator assembly, Ø 560 [22] x L 450 mm [18 inch]



Kicker chamber for accelerator application,
racetrack 110 x 54 [4 x 2] x L 460 mm [18 inch]



Vacuum chamber, Ø 215 [8,5] x L 400 mm [16 inch]

Insulator 200 kV, Ø 340 [13,5] x L 585 mm [23 inch],
developed with/for Joint Institute for Nuclear Research

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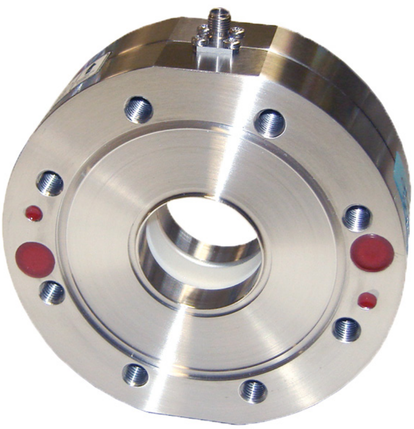

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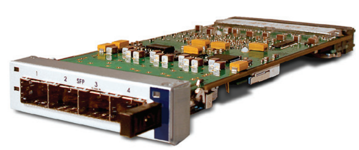

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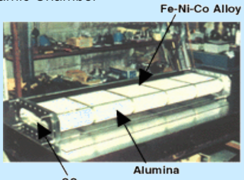
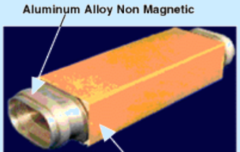
• Ceramic Chamber



Ceramic Length:800 - 1000mm
Inside Diameter: 240mm
Hermeticity <1.3 X 10^{-10} Pa·m^3/s

• Non-Magnetic Ceramic Chamber



Ceramic Length:200 - 450mm
Inside Diameter: 80-120mm
Hermeticity <1.3 X 10^{-10} Pa·m^3/s

Ceramic Chambers

Kyocera's ceramic chambers have been proven in major high-energy physics projects worldwide. Advances in particle physics research and synchrotron radiation applications will provide a foundation for many emerging technologies of the 21st century. Running charged electrons and protons within a ring accelerator requires a powerful, controlled magnetic field that is maintained using ceramic components. Kyocera's single-tube ceramic chambers can be as long as 1000mm while offering complete hermeticity of 1.3 x 10(-10) Pa•m3/s.
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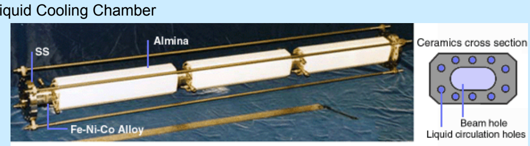
• Liquid Cooling Chamber



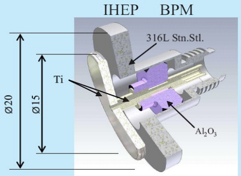
Total Length: 1530mm (3 pieces jointed)
Ceramic length: 420mm
Inside Diameter: 47-64mm
Hermeticity <1.3 X 10^{-10} Pa·m^3/s

EXAMPLE of BPM FEEDTHROUGH produced by KYOCERA

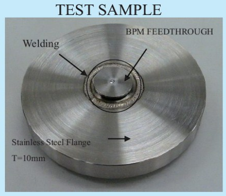
CHAMBER or FLANGE	MAGNETIC	Welding Part	Bonding Metal	Electrode	Example
Stainless Stl.	MAGNETIC	Fe-Ni-Co Alloy	Fe-Ni-Co Alloy	316L Stn.Stl.	
	NON	316L Stn.Stl.	Ti	Ti	
			316L Stn.Stl./Ti	Ti	
Al	MAGNETIC	Al	Fe-Ni-Co Alloy	316L Stn.Stl.	
	NON	Al	Ti	Ti	
			Al	Al	
Ti	NON	Ti	Ti	Ti	

Vacuum baking and Liquid N_2 Thermal Shock test for BPM

IHEP BPM



TEST SAMPLE



TEST RESULT

Condition	Number of sample	Hermetisity (<1.0X10^{-10} Pa·m^3/s;He)
300°C (24hr) in Air	3/3	OK
Liq.N_2 5min	3/3	OK
R.T. Liq.N_2(5min)X5cycles	3/3	OK

Design of Cold BPM Feedthrough

K.Iwamoto , Y.Ikeda , KYOCERA Finceramics GmbH , Neuss , Germany
T.Kitamura , T.Matsuoka , KYOCERA Corporation , Shiga , Japan.

Abstract

We have designed many BPM feedthrough used metallized ceramic components. We select the best material of ceramic and metal adjusted for magnetism and the material of chamber. The request for low temperature and RF property in accelerator application has increased in recent years. In this presentation, we report on the design of the BPM feedthrough for low temperature and for the RF up to 20GHz.

INTRODUCTION

We Kyocera have been producing metallized products form Semiconductor Equipment to Medical, Avionics and Space Industry. Especially our UHV products which is participating with particle physics research had began since " Tristan project " in Japan. Our UHV production technology has been evolving day by day with accelerator history, during producing UHV products for Japan, Europe and U.S.A. The requirement for low temperature in accelerator application has increased according to development of cryogenic instruments in recent years. On the other hand we have manufactured hermetic feedthroug by using metallized ceramic brazed with metal parts. Difference of electrical constant between organic material and ceramic make RF throughput design of feedthrough difficult. We have designed RF feedthrough with not only matching to 50 ohm but also S parameter influenced by signal frequency.

THE BRAZING STRENGTH AT LOW TEMPERATURE

Sample

Fig.1 shows metallized ceramic samples for tensile strength test in low temperature by using brazed ceramic sample in the condition indicated in Table1.
Fig.2 shows structure of sample. Mo/Mn metallized ceramic is brazed between Fe-Ni-Co alloy metal components using Ag-Cu brazing material. Fe-Ni-Co alloy is used for brazing material to bond with ceramic because it has Coefficient Of Linear Thermal Expansion 5.7-6.2 close to one of alumina ceramic 7.0-8.0. Ceramics are 7mm diameter and 99% alumina which is commonly used for UHV application.

Fig1. Look of tensile strength test samples

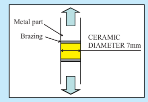


Fig.2. Structure of sample

Table 1.Condition of tensile test sample

Ceramic	99%Al_2O_3(KYOCERA A479)
Metal	Fe-Ni-Co Alloy
Metallizaion	Mo/Mn
Plating on Metallized surface	Ni
Brazing Material	Ag-Cu Alloy
Brazing Temperature	800 degree C

Test stand

We tested tensile strength of samples of Fig.1 by using the tensile test stand in Japan Atomic Energy Agency. This test sample was immersed in Liq. N2 or Liq. He. Then, those two brazed metal components were pulled towards top and bottom direction respectively. We tested 3-5 pieces of samples in 4K, 77K and 300K (room temperature).

Result

Fig.3 shows result of tensile test in 4K , 77K and 300K. The tensile strength in low temperature is smaller than in R.T. approximately 10%, but the dispersion affected by brazing flow condition is bigger than this temperature effect. The influence of low temperature is less than brazing flow condition, therefore the bonding strength of metallized ceramic is enough for UHV application at 4K.

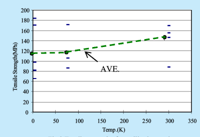


Fig.3 Tensile strength of metallised ceramic

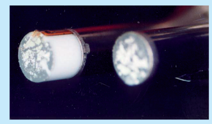


Fig.4 Braking surface picture after tensile test in 4K

Fig.4 shows braking surface picture after tensile test in 4K. Black color is Mo/Mn metallization and white color is brazed ceramic and Ag-Cu brazing material. Braking modes in 4K and 77K are same as in 300K. This braking mode is normal. Final conclusion is that Ceramic brazing strength is enough for UHV application at 4K.

DESIGN FOR RF PROPERTY

RF simulation model

We investigated several ceramic models how those will affect to RF performance in ceramic hermetic feedthroughs. Affecting factors for RF performance are impedance matching and resonance. Simulated models are coaxial ceramic disc and cylindrical conductor like Fig.5. We used ANSOFT 3D field simulator; HFSS. The diameter of center conductor is 1.0mm. Previous and next transmission lines of ceramic are matched as 50 ohm and insulation medium is air. We did RF simulation by varying ceramic diameter from 8 to 16 and thickness from 1.0 to 4.

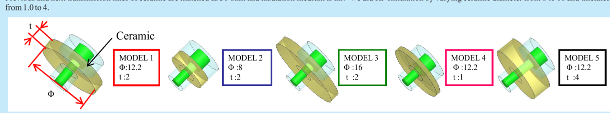


Fig.5 RF simulated models (unit ; mm)

RF simulation result

Fig.6 shows the result of simulation. When the diameter of center conductor is 1.0mm and the dielectric constant of insulator medium is 9.0, the diameter of outer conductor is 12.2mm for Impedance 50 ohm . Therefore MODEL 1 is best at the point of view about impedance matching. But the big resonance peak appears at 10GHz in insertion loss when the dimensional condition is defined above. When we design RF feedthrough, we must consider about both of matching for impedance 50 ohm and avoiding the resonance frequency by the simulation in working frequency. Frequency of resonance shifts to higher frequency by decreasing diameter of ceramic disc, when we compare Model 1,2 and 3. Therefore, we can avoid a resonance phenomenon by designing ceramic outer diameter smaller. The thickness of the ceramic also influences a resonance phenomenon, when we compare Model 1,4 and 5. Model 5 has two resonance frequencies to 20 GHz. We determine reasonable ceramic thickness based on simulation at our design stage and we avoid a resonance phenomenon in usage frequency. We have the possibility to design the ceramic feedthrough with RF property up to 20GHz by using this simulation method.

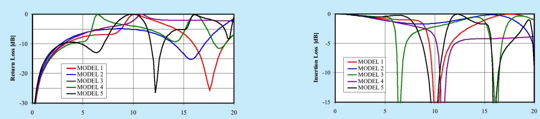


Fig.6 Result of RF simulation - (a)Return Loss (b)Insertion Loss

Actual design of RF feedthrough

We designed actual products of feedthrough based on above results. Fig.7 shows the model of actual feedthrough for RF simulation. Fig.8 shows the result of simulation of RF feedthrough. We can avoid resonance phenomenon up to 18GHz by designing with 8mm outer diameter of a ceramic. We manufactured actual BPM feedthrough according to above RF model. Fig.9 shows the product of Button electrode type of BPM feedthrough. Fig.10 shows actual measurement result about RF property of BPM feedthrough.Resonance peek in RF property insertion Loss (S12) appear at 18 GHz same as the RF simulation of Fig.8

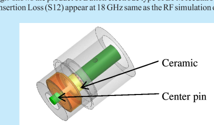


Fig.7 Model of actual feedthrough for RF simulation

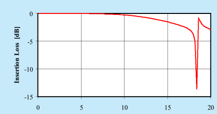


Fig.8 Result of simulation of RF feedthrough

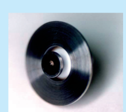


Fig.9 BPM feedthrough

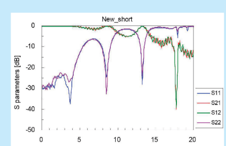


Fig.10 RF property of BPM feedthrough

CONCLUSION

We conclude this article with the following summarizing remarks;
1. The bonding strength of metallized ceramic is enough for UHV application at 4K.
2. We have capability of producing BPM withstanding cryogenic environment.
3. We have capability to design considering RF performance by RF simulation[1].

ACKNOWLEDGMENT

Tensile strength test at low temperature was supported by Japan Atomic Energy Agency for collaborative project.

References

[1] Hideaki Aoyagi and others, "RF Properties of Coaxial Feed-through Connectors for Design of a Frontend Pulse-by-Pulse SR Beam Monitor", proceeding in SRI2006, Jun

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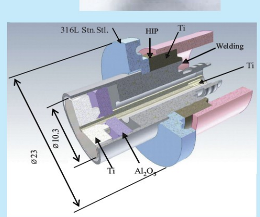

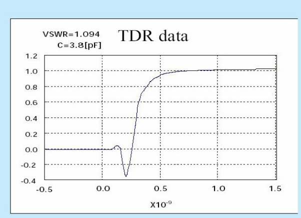

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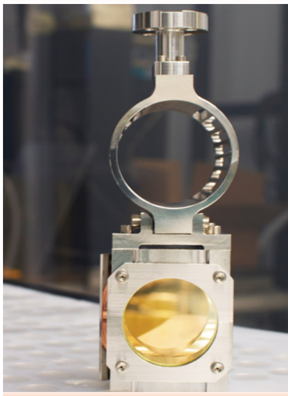
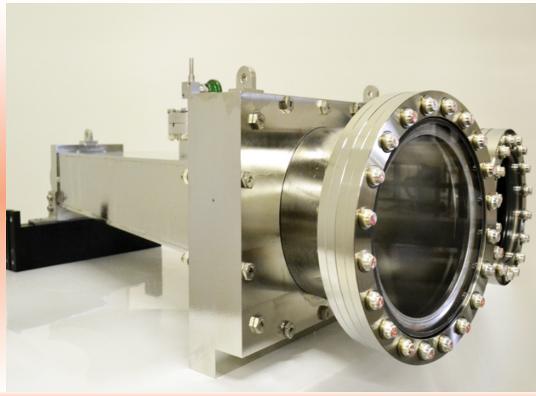
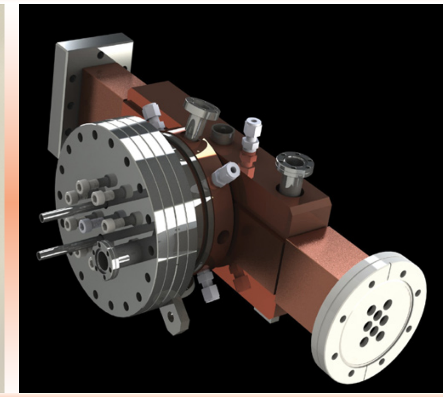

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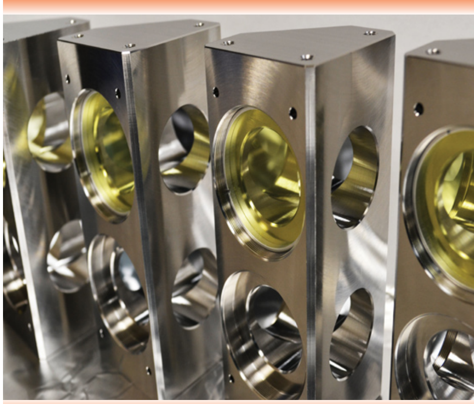
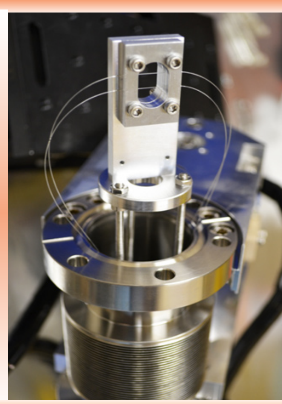
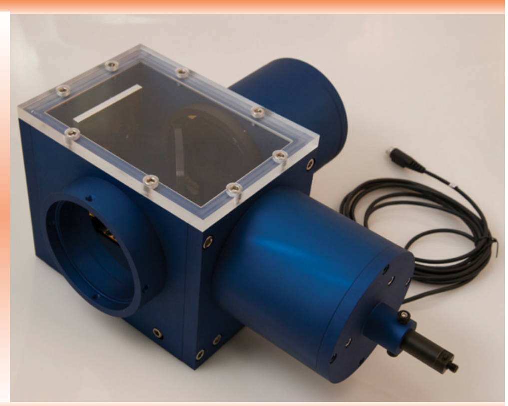

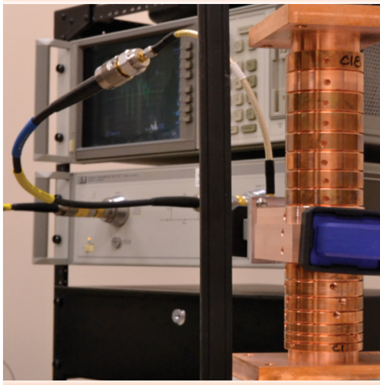
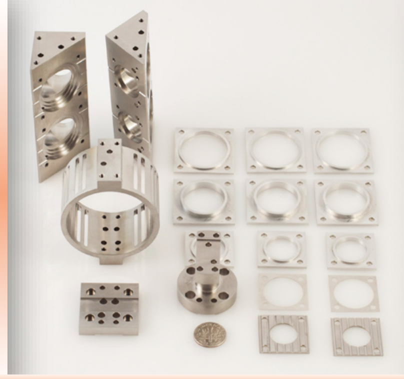
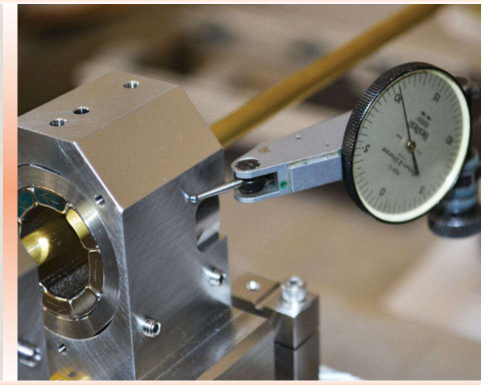

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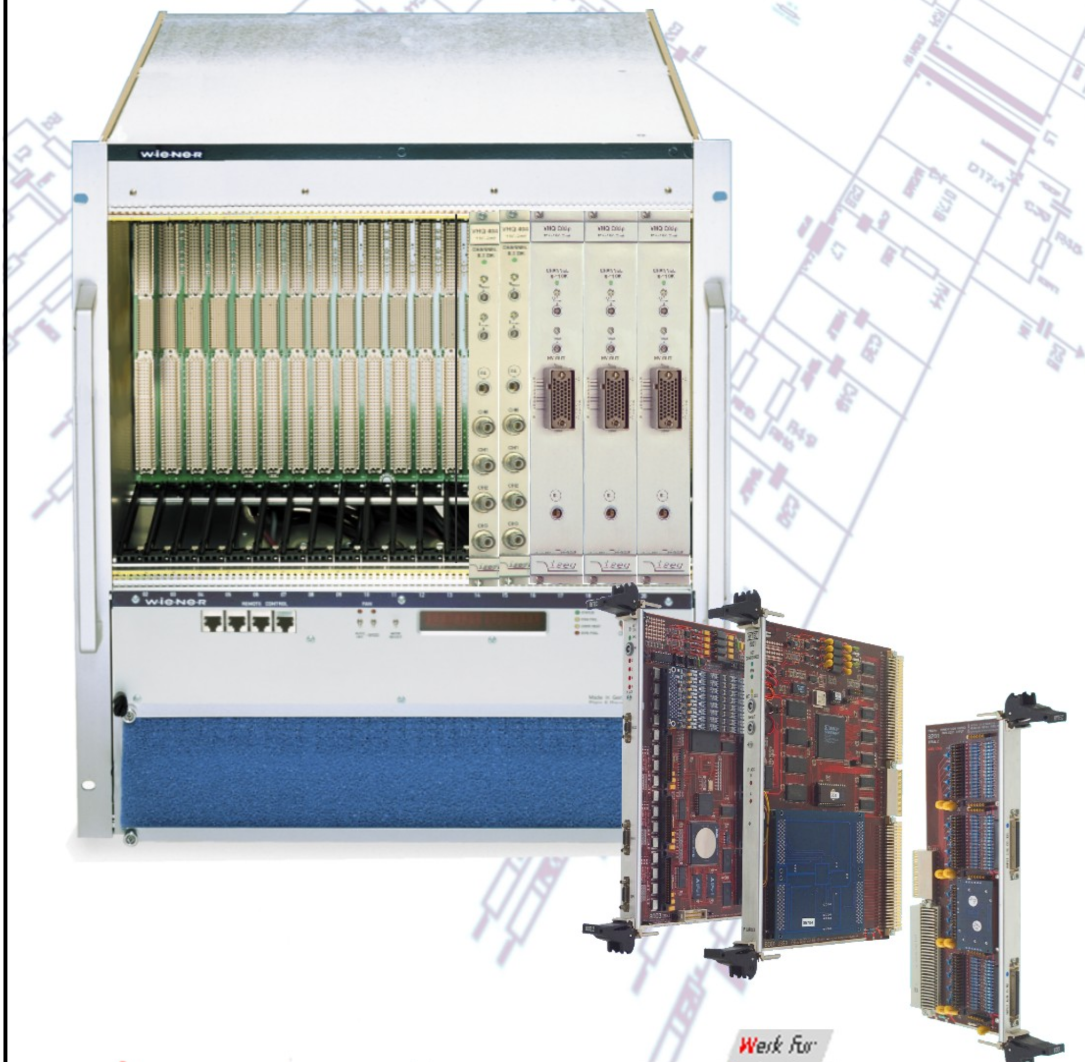

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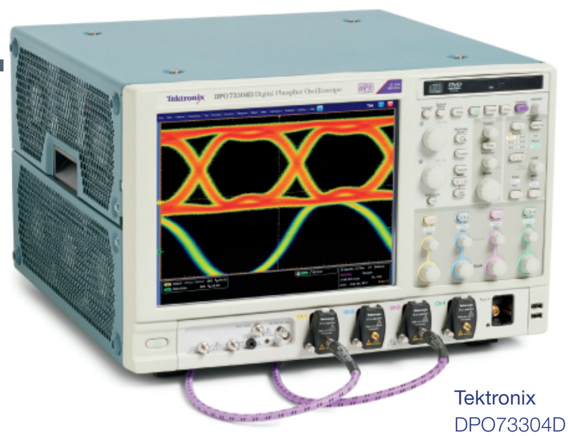

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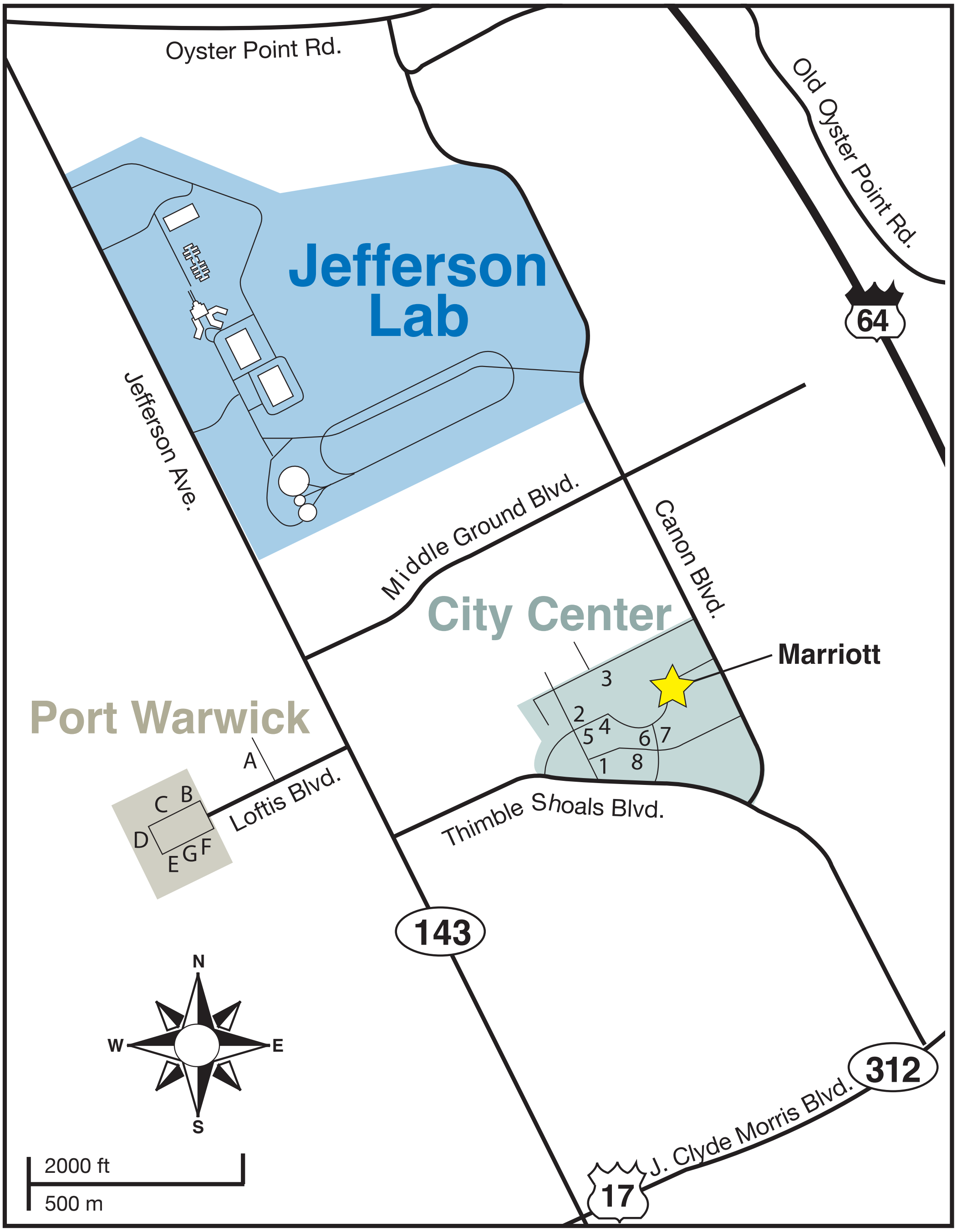

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Hayashi Japanese Steakhouse & Sushi	5
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Thaijindesu	E
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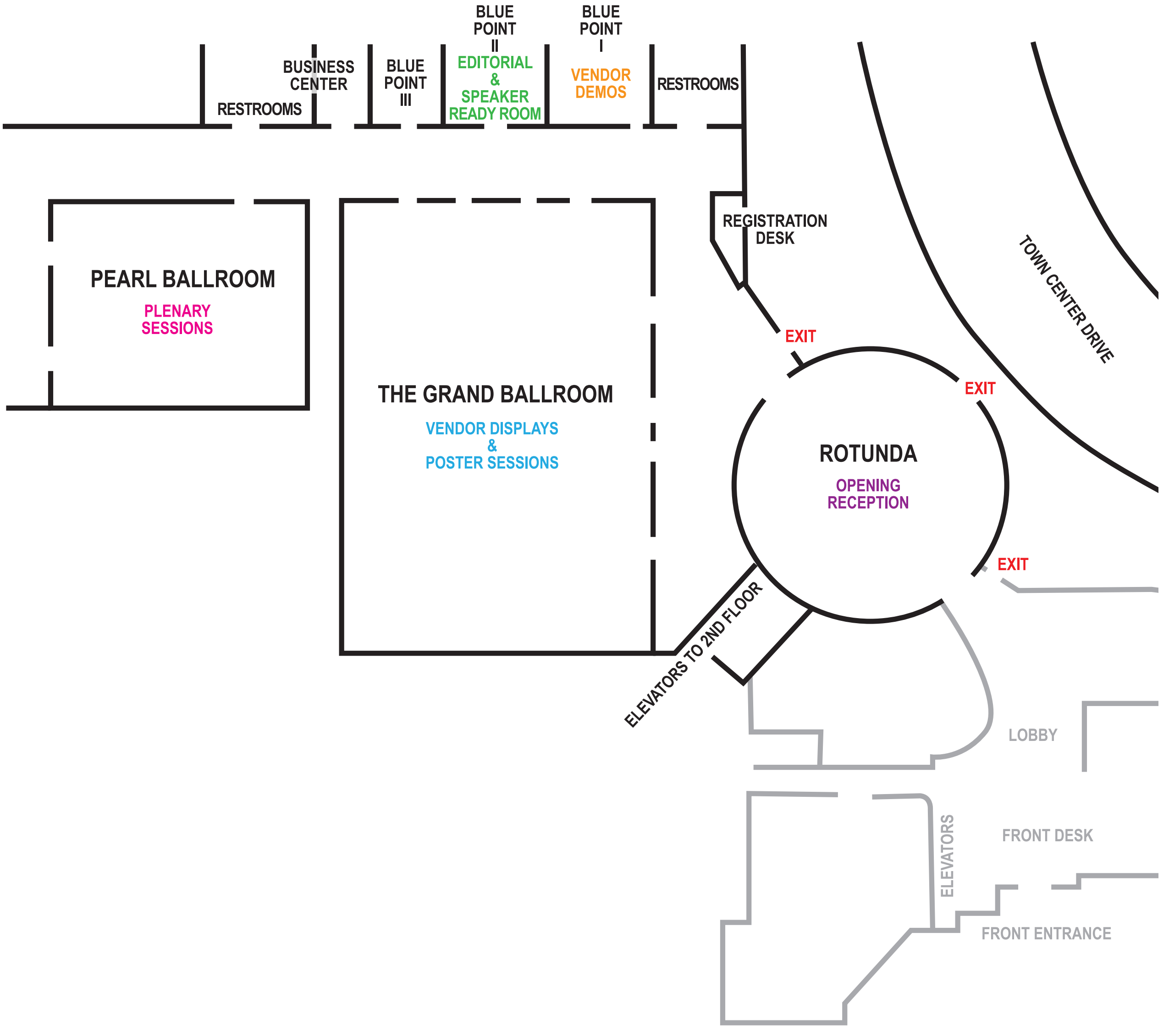

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