12th

PCaPAC 2018

International Workshop on
Emerging Technologies and Scientific Facilities Controls

October 16-19, 2018

Hsinchu, Taiwan

Conference Guide

https://indico.nsrrc.org.tw/e/pcapac2018

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Organizer

國家同步輻射研究中心
National Synchrotron Radiation Research Center

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Welcome to NSRRC
Advanced Synchrotron Experimental Facility for Scientific Research

A synchrotron light source is an advanced large-scale research facility that provides high-brightness infrared(IR), ultraviolet(UV), X-ray lights unattainable in conventional laboratories. It allows the pursuit of basic and applied science as well as technology research, and opens up new opportunities for diverse research fields in nanotechnology, biomedical technology, environmental engineering and basic science.

The mission of the National Synchrotron Radiation Research Center (NSRRC) is to operate the cutting-edge synchrotron radiation facilities in order to support the fundamental research and industrial R&D for pioneering scientific development, and to place Taiwan among leading nations across the globe in the world of advanced academic research. Currently NSRRC operates two synchrotron light sources, named Taiwan Light Source (TLS) and Taiwan Photon Source (TPS), which are both accessible for industrial and academic research communities. The TLS with an electron beam energy of 1.5 GeV and a circumference of 120 meters was completed in 1993 and became the first third-generation synchrotron light source in Asia. The TPS has a 3 GeV, 518-meter circumference, and low-emittance synchrotron storage ring that was completed in 2014 and opened to users in 2016. Apart from meeting much-anticipated scientific demands for high-brightness and coherent X-rays, the TPS is one of few ultra-high brightness synchrotrons in the world.

Currently, scientists from various research fields come to the NSRRC to perform experiments each year and produce invaluable research outcomes. The TLS and TPS are now two powerful platforms for scientists to conduct research in biomedical technologies, materials science, environmental engineering, green energy and semiconductors, and to boost academic research standards in Taiwan.

The NSRRC also operates two Taiwan Contract Beamlines at Super Photon Ring-8 GeV (SPring-8) in Japan and a cold-neutron triple-axis spectrometer, SIKA, located at Australian Nuclear Science and Technology Organisation (ANSTO) in Australia. These facilities offer the experimental instruments and support to Taiwanese and international user communities to undertake world-leading scientific research.

Aerial view of the National Synchrotron Radiation Research Center

Dear PCaPAC 2018 Participant,

Welcome to PCaPAC 2018 and to Hsinchu!

The 12th International Workshop on Personal Computers and Particle Accelerator Controls (PCaPAC 2018) is taking place in Hsinchu city, Taiwan, from October 16th to 19th, 2018. The conference is organized and hosted by the National Synchrotron Radiation Research Center, a host of JACoW based conference for the first time.

The mission of PCaPAC 2018 is to keep the traditional aspects of PCaPAC as well as to focus on emerging technologies. This is reflected in PCaPAC's new official name "International Workshop on Emerging Technologies and Scientific Facilities Controls". PCaPAC 2018 covers the topics as shown below.

- Control System and Component Integration
- GUI Technologies and Frameworks, User Interfaces and Tools for Operations
- Hardware Technologies and Custom Hardware, Feedback Control and Tuning, Timing and Synchronization, and Functional Safety
- Data Acquisition and Data Storage, Data Analysis
- Infrastructure and Networking Management of IT Projects, Cyber Security

The scientific program includes keynote talks, contributed orals, poster-in-pills and poster sessions. The keynote talks include the topics of "Internet of Things", "Big data/Data mining", and "AI (Deep learning/Machine learning)". Four tutorials are also available before the meeting. Participants could learn updated technologies in a nutshell.

On behalf of the Local Organizing Committee, we welcome around 100 contributors to PCaPAC 2018, to Hsinchu, to Taiwan. I would like to thank you all for your support to the program, the program committee for their suggestions, the JACoW team, and especially each member of the local organizing committee for their devotion and hard work.

I sincerely wish a successful PCaPAC 2018 and all attendees having a joyful stay in Taiwan and a great appetite in Taiwanese cuisine!

Yung-Sen Cheng

Chair of Local Organizing Committee, PCaPAC 2018

Instrumentation and Control Group, Light Source Division, NSRRC

International Program Committee

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Local Organizing Committee

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Chih-Yu Liao
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Yu-Chi Lin
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Chun-Yi Wu
Wen-Huei Chang
Becky Chu
Diana Lin
Jenny Chen
Hong-Zhe Chen

Program

October 16, 2018 Tuesday	October 17, 2018 Wednesday	October 18, 2018 Thursday	October 19, 2018 Friday
Tutorials Registration 08:30 ~ 09:00	Registration 08:30 ~ 09:00		
Tutorial 1 09:00 ~ 10:30	Opening Session 09:00 ~ 09:20	Keynote Talk 2 09:00 ~ 10:00	Keynote Talk 3 09:00 ~ 10:00
Coffee Break 10:30 ~ 10:50	Keynote Talk 1 09:20 ~ 10:20	Interactive Session 1 10:00 ~ 10:30	Contributed Oral **Data Acquisition I** 10:00 ~ 10:30
Tutorial 2 10:50 ~ 12:20	Coffee Break 10:20 ~ 10:40	Coffee Break 10:30 ~ 10:50	Coffee Break 10:30 ~ 10:50
Lunch 12:20 ~ 13:30	Contributed Oral **Control System** 10:40 ~ 11:55	Contributed Oral **Hardware Technologies I** 10:50 ~ 12:05	Contributed Oral **Data Acquisition II** **Hardware Technologies II** 10:50 ~ 11:50
Tutorial 3 13:30 ~ 15:00	Poster in Pills 1 **Control System** **GUI Technologies** 11:55 ~ 12:20	Lunch 12:05 ~ 13:30	Lunch 12:00 ~ 13:30
Coffee Break 15:00 ~ 15:20	Lunch 12:20 ~ 13:30	Contributed Oral **GUI Technologies** **and Networking** 13:30 ~ 14:45	Contributed Oral **Hardware Technologies III** 13:30 ~ 14:30
Tutorial 4 15:20 ~ 17:00	Poster 1 13:30 ~ 15:00	Poster in Pills 2 **Hardware Technologies** **Networking** 14:45 ~ 15:10	Coffee Break 14:30 ~ 14:50 Interactive Session 2 14:50 ~ 15:20
Registration 17:20 ~ 18:20	Coffee Break 15:00 ~ 15:20	Coffee Break 15:10 ~ 15:30	Isamu Abe Price and Closing Session 15:20 ~ 16:00
Welcome Reception 18:30 ~	Group Photo & Visit TPS(NSRRC) 15:20 ~ 17:30	Poster 2 15:30 ~ 17:00 Banquet Dinner 18:30 ~	

Tutorials

October 16th

Tutorial Session I 09:00 - 10:30

Graphical System Design for Big Physics Applications

Speaker: ***John Wu*** *(National Instruments)*

From the CERN Large Hadron Collider to the ESO Extremely Large Telescope (ELT), National Instruments LabVIEW has played a critical part in the development, debugging, and deployment of these complex systems. In this tutorial, the concepts of LabVIEW and graphical programming will be introduced. Also, we will explore how to use LabVIEW to simplify common tasks in synchrotron development, such as EPICS protocol communication, as well as graphical programming on low-latency FPGA targets.

Tutorial Session II 10:50 - 12:20

Building Predictive Models for Sensor Data Analytics

Speaker: ***Jeffrey Liu*** *(TeraSoft Inc.)*

Machine learning and Deep Learning are quickly becoming powerful tools for solving complex modeling problems across a broad range of industries. The benefits of machine learning are being realized in applications everywhere, including predictive maintenance, health monitoring, financial portfolio forecasting, and advanced driver assistance. However, developing predictive models for signals is not a trivial task. In addition, there is an increasing need for developing smart sensor signal processing algorithms which can be either deployed on edge nodes or on the cloud.

In this session we will explore how you can use MATLAB for developing predictive models for real world sensor analytics using machine learning and deep learning workflows.

Tutorial Session III 13:30 - 15:00

Dive into Python

Speaker: ***Chi-Hung Weng*** *(HongHuTech)*

Speaker will showcase some possible applications written in Python, ranging from web crawling, data cleaning, data visualization, to Machine Learning and Deep Learning. We then make an excursion to Deep Learning, where the following questions are to be answered: what is Deep Learning? what's the theory behind it? What's the difference between Deep Learning frameworks such as TensorFlow, Keras, MXNet and Pytorch?

Tutorial Session IV 15:20 - 17:00

Deep Learning

Speaker: ***Chi-Hung Weng*** *(HongHuTech)*

Speaker will demonstrate & explain several deep learning applications in Computer Vision, including: image classification, object detection and semantic segmentation. Sample codes and datasets will be provided during the session.

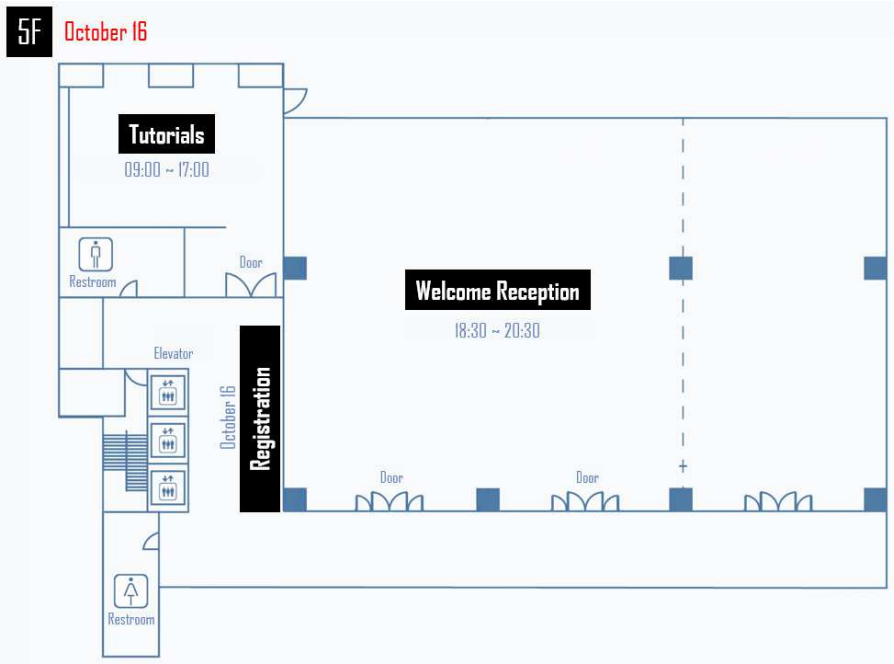
Conference Venue

Fleurlis Hotel

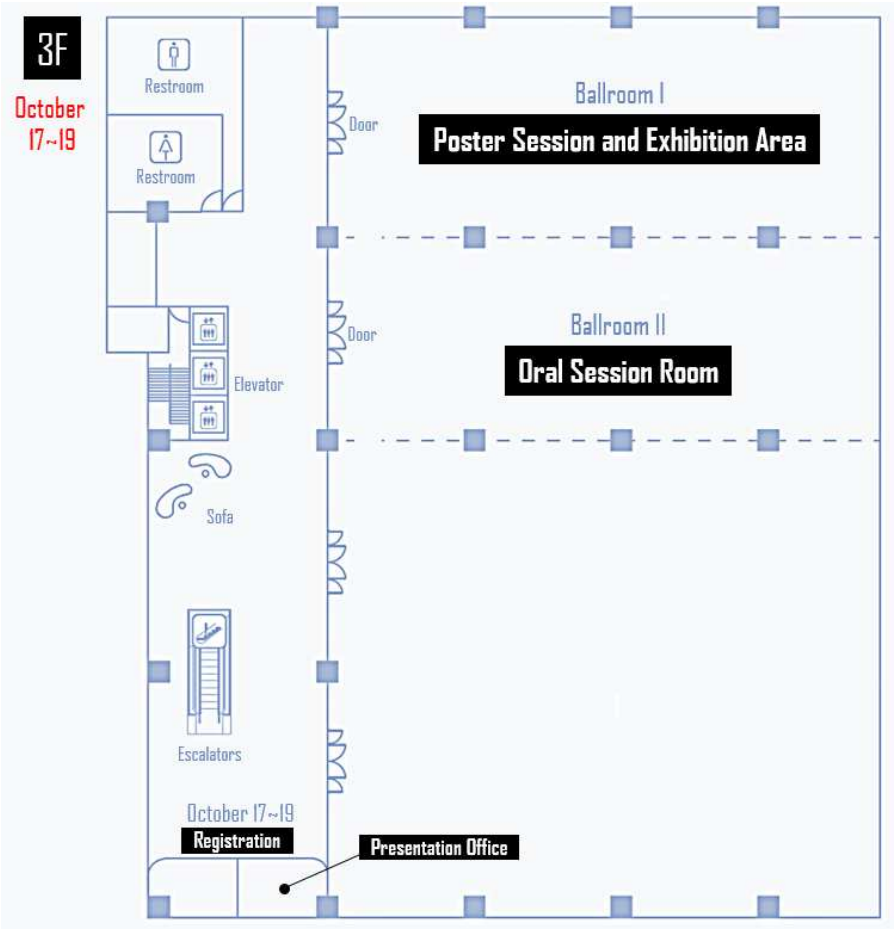
No.69, Minzu Rd., Hsinchu City 300, Taiwan

TEL: +886-3-6238899

http://www.fleurlis.com.tw/en/index.php



Main Auditorium




PCaPAC 2018
Emerging Technologies and Scientific Facilities Controls
October 16-19, 2018 Hsinchu, Taiwan

Contents

17-Oct-18 09:00 – 09:20 Main Auditorium

WEL — Opening and Welcome Session

Chair: Y.-S. Cheng (NSRRC)

WEL1 **Welcome and Opening of PCaPAC 2018**
09:00 5 ***Y.-S. Cheng*** *(NSRRC)*
Welcome from the Chairs and opening of 12th International Workshop on Personal Computers and Particle Accelerator Controls (International Workshop on Emerging Technologies and Scientific Facilities Controls).

WEL2 **Welcome to National Synchrotron Radiation Research Center**
09:05 15 ***K.T. Hsu*** *(NSRRC)*
Welcome from the deputy director of the National Synchrotron Radiation Research Center, Dr. Kuo-Tung Hsu.

17-Oct-18 09:20 – 10:20 Main Auditorium

WEKT — Keynote Talk 1

Chair: K.T. Hsu (NSRRC)

WEKT1 **Abstraction or Instantiation: On Building the Internet for Smarter**
09:20 60 **Places**
W.-C. Chen *(Skywatch) T. Chen (Inventec)*
There are two ends of the spectrum when it comes to Internet-of-Things. On the one end, the focus is on lower level communication technology, platforms, and standards that aim to enable machine-to-machine communications. On the other end, people have been searching for the killer devices that would transform our lives. Clearly, one is the "Internet" perspective, while the other is the "Things" perspective. In this talk, instead of taking the words "Internet of Things" literally, we focus on the combined effects of devices on environments. Specifically, we discuss the conversations between devices, and how these interactions can open new frontiers of digitized spaces in the era of machine learning.

WEC — Contributed Oral: Control System

Chair: W. Mexner (KIT)

WEC1 10:40 15 **The Does and Dont's in Process Controls — Lessons Learned Over 35 Years**

M.R. Clausen, *T. Boeckmann, J. Hatje, O. Korth, M. Möller, J. Penning, H.R. Rickens, B. Schoeneburg (DESY)*

Designing, implementing and maintaining process control systems for cryogenic plants requires different viewpoints compared with those in machine controls. 24/7 operations for more than a year is a basic requirement. Hardware and software must be designed to fulfill this requirement. Many projects are carried out with industrial partners. Companies specify the process control logic which gets implemented by the local DESY team. Responsibilities, time tables and milestones must be clearly defined in such a case. Several cryogenic installations have been equipped with state of the art process control systems for cryogenic controls. Where the last one being the European XFEL. In the course of time commercial and open source systems were implemented and maintained. Control loops were basically always implemented in front end controllers running the real-time operating system VxWorks and EPICS as the control system toolkit. The approach to use PLCs will be discussed as an alternative approach. Large installations like the European XFEL require good project planning. Our success story will finalize our look back and initiate our look forward.

WEC2 10:55 15 **Status of the TPS Control System**

K.T. Hsu, *Y.-T. Chang, J. Chen, Y.-S. Cheng, P.C. Chiu, K.H. Hu, C.H. Huang, C.H. Kuo, D. Lee, C.Y. Liao, C.-J. Wang, C.Y. Wu (NSRRC)*

Control system for the Taiwan Photon Source (TPS) has been delivered in mid-2014 to support commissioning and routine operation of the accelerator system. User service of the TPS was started since 2016. The TPS control system adopts EPICS toolkits as its frameworks. Various subsystems interface to the control system according its specific requirements. Operation experiences accumulated during last four years operation ensure good and bad points of the system, minor revision were made to improve the system performance. The current status of the control system and ongoing developments and electron beam orbit stabilization, interface to the beamline system will be summarized in the report.

WEC3 **Overview and Status of the SHINE Control System**
11:10 15 ***Y.B. Yan**, G.H. Chen, J.F. Chen, J.G. Ding, Y.B. Leng (SSRF)*
The high-gain free electron lasers have given scientists hopes for new scientific discoveries in many frontier research areas. The Shanghai HIgh repetition rate XFEL aNd Extreme light facility (SHINE) was proposed by the central government of P.R. China on April 2017, which is a quasi-continuous wave hard X-ray free electron laser facility. The control system is responsible for the facility-wide device control, data acquisition, machine protection, high level database or application, as well as network and computing platform. It will be mainly based on EPICS to reach the balance between the high performance and costs of maintenance. The latest technology will be adopted for the high repetition rate data acquisition and feedback system. The details of the control system design will be reported in this paper.

WEC4 **HEPS Controls Status Update**
11:25 15 ***C.P. Chu** (IHEP)*
The High Energy Photon Source (HEPS) is a planned extremely low emittance synchrotron radiation based light source located in suburban Beijing which requires high precession control systems for both accelerator and beamline controls. This paper outlines the overall design for control systems, including equipment control, fast orbit feedback, machine protection, controls network, database, high-level application architecture, and physics applications. Early plans for beamline controls are also reported.

WEC5 **!CHAOS General Status Report**
11:40 15 ***A. Stecchi**, C. Bisegni, P. Ciuffetti, A. D'Uffizi, A. De Santis, G. Di Pirro, F. Galletti, R. Gargana, A. Michelotti, M. Pistoni, D. Spigone (INFN/LNF) L. Catani (INFN - Roma Tor Vergata)*
!CHAOS (Control system based on Highly Abstracted and Open Structure) is now mature and is being employed in real operational contexts. A dedicated infrastructure, recently installed at the LNF Computer Centre, houses the framework and provides control services to different LNF installations. The !CHAOS native capability of fast storage, based on the use of a non-relational database, has been finalized and tested with applications demanding high bandwidth. Thanks to its scalable design, the fast storage allows to accommodate multiple sources with sub-millisecond timing. The EU (Execution Unit) node has also been delivered and turned out to be a "Swiss Army knife" for processing both live and stored data, inserting feedbacks and in general for correlating data acquired by the CU (Control Units) nodes. A key feature of the EU is a plugin mechanism that allows to easily integrate different programming and scripting languages such as LUA, C++, Python, also exploiting the ROOT framework, the well-known scientific tool from CERN. A comprehensive description of the !CHAOS evolution, of its performances and of its use, both in scientific and industrial contexts, is presented.

WEPI — Poster in Pills 1

Chair: N. Kamikubota (KEK)

WEPI1 **EtherCAT Driver and Tools for EPICS and Linux at PSI**
11:55 ☐ ***D. Maier-Manojlovic*** *(PSI)*

EtherCAT bus and interface are widely used for external module and device control in accelerator environments at PSI, ranging from modulator communication and control, over motion control, basic I/O control, all the way to Machine Protection System for the new SwissFEL accelerator. A combined EPICS/Linux driver has been developed at PSI, to allow for simple and mostly automatic setup of various EtherCAT configurations. The driver is capable of automatic scan of the existing device and module layout, followed by self-configuration and finally autonomous operation of the EtherCAT bus real-time loop. Additionally, the driver package supports the user PLC to manipulate EtherCAT data in real time, implements fast real-time (single cycle) slave-to-slave communication (skipping EPICS layer or PLC completely). All the standard EtherCAT functions are supported, including the complete reprogramming of slave configurations and configuration generation for programmable slaves, such as EL6692 and EL6695 network bridges.

WEPI2 **BLISS - Experiments Control for ESRF Beamline**
11:58 ☐ ***V. Michel****, A. Beteva, T.M. Coutinho, M.C. Dominguez, C. Guilloud, A. Homs, J.M. Meyer, E. Papillon, M. Perez, S. Petitdemange (ESRF)*

BLISS is the new ESRF control system for running experiments, with full deployment aimed for the end of the EBS upgrade program in 2020. BLISS provides a global approach to run synchrotron experiments, thanks to hardware integration, Python sequences and an advanced scanning engine. As a Python package, BLISS can be easily embedded into any Python application and data management features enable online data analysis. In addition, BLISS ships with tools to enhance scientists user experience and can easily be integrated into TANGO based environments, with generic TANGO servers on top of BLISS controllers. BLISS configuration facility can be used as an alternative TANGO database. Delineating all aspects of the BLISS project from beamline device configuration up to the integrated user interface, this poster will present the technical choices that drove BLISS design and will describe the BLISS software architecture and technology stack in depth.

WEPI3 **A General Solution for Complex Vacuum System Controls**
12:01 ☐ ***G. W. Bischof****, R.I. Farnsworth, C.A. Guerrero, O. Ivashkevych (BNL)*

At the National Synchrotron Light Source II (NSLS-II) there are many different ultra-high vacuum system configurations on the unique beamline endstations. The proposed controls solution attempts to capture the requirements of all of these configurations with a single standard logic and graphical user interface. Additional design considerations include: resource management for multiple users, providing a high level of abstraction to

simplify operation for users, providing a high level of flexibility to do non-standard operations, minimizing shock from pressure differentials when opening valves, supporting a variety of pumps, and maximizing pump lifetime. At NSLS-II it was determined that all vacuum configurations can be captured by the composition of three standard objects: a "rough vacuum group", and "high vacuum group", and a "smart vacuum manifold" which implements a blocking queue. These objects can be flexibly linked together to meet the needs of the beamline experiments. This solution is platform independent, but implemented and tested here using Pfeiffer vacuum pumps, Allen Bradley PLC, EPICS, and Control System Studio (CSS).

WEPI4 **Developing and Validating OPC-UA Based Industrial Controls for Power Supplies at CERN**
12:04

M. Ludwig, *M. Bengulescu, B. Farnham, P.G. Jimenez, P.P. Nikiel, F. Varela (CERN)*

The industrial control systems of CERN's experiments are undergoing major renovation since 2017 and well into CERN's 2nd Long Shutdown (LS2) until the end of 2019. Each detector power-supply control system executes several hundred of software instances consisting of many different components in parallel on a large scale, broadly distinguishable as servers and clients. Our accumulated experience during LHC runs proves that some complex control issues are impossible to detect using stand-alone components on a small scale only. Furthermore, new components must be developed well before the electronics becomes available, without impact on operations. Moreover, during LS2, the improved and now widely established Open Protocol Communication Unified Architecture (OPC-UA) replaces OPC-DA as middleware protocol. For these reasons, we developed a simulation environment to emulate the real, and expensive, CAEN power-supply electronics underneath the OPC-UA servers. This distributed simulation is configurable to mimic and exceed the nominal conditions during production and provides a repeatable setup for validation. This paper discusses the functionality and use of this simulation service.

WEPI5 **Wireless Internet of Thing Application in the TLS**
12:07

C.H. Kuo, *K.H. Hu, C.-J. Wang (NSRRC)*

The internet of thing is applied in the accelerator is more and more. There are many advantages in these data acquisition and application, for example, easy to distribute system and reduce cable, reduce noise, rich interface interfaces in one. The stable wireless function is also applied in the measurement system. The high reliability and security of wireless communication with server and client structure is important. The structure design and implementation of IoT are summarized in this report.

WEPI6 **Data Archiving and Visualization of IRFEL**
12:10

Y. Song, *X. Chen, C. Li, G. Liu, J.G. Wang, K. Xuan (USTC/NSRL)*

An Infrared Free Electron Laser Light (IRFEL) is being constructed at National Synchrotron Radiation Laboratory. The EPICS Archiver Appliance provides the functions of historical data acquisition, archiving, migration, retrieval and management in the IRFEL facility. A Single-Page Web Application is developed for the data visualization based on Vue.js framework

and Highcharts JavaScirpt library. A unified interface is developed for the visualization to integrate multiple data sources and provide the same retrieval entry of the historical data from EPICS Archiver Appliance, the runtime data from EPICS IOC, the statistical data from database and the alarm information from BEAST. This paper will describe the implementation details of data archiving and visualization of IRFEL.

WEPI7 12:13 **Innovative Graphical User Interfaces Development: Give the Power Back to Users**

G. Segura, *A. Ledeul, A. Savulescu, B. Styczen, D. Vazquez Rivera (CERN)*

GUI for supervision, control and data acquisition systems are usually oriented to specialist users. In big organizations like CERN, where different teams play the roles of operators, scientists and instrumentation specialists, providing a unique or static user interface usually results in a situation of dissatisfaction of everyone. On the other hand, providing distinct user interfaces for each type of user increases the development and maintenance effort and makes software evolution heavier. The approach taken for the design and development of GUIs for radiation and environment protection at CERN addressed this issue by integrating user interface changes as an embedded software functionality. Key users were provided with a tool to build, deploy and maintain their own tailor-made user interfaces, in a graphical way and without the necessity of learning any kind of programming or scripting languages. Other benefits observed from this solution include reduction of the resources spent on the support and maintenance and increase of the frequency of GUIs updates, executed without compromising the underlying control system. This paper describe the innovative design that was implemented.

WEPI8 12:16 **A Universal System Based on WebSocket and JSON for the Employment of LabVIEW External Drivers**

A. Stecchi, *C. Bisegni, P. Ciuffetti, A. D'Uffizi, G. Di Pirro, F. Galletti, A. Michelotti (INFN/LNF)*

One of the heaviest workloads when installing a Control System on a plant is the development of a large number of device drivers. This is even more true in the case of scientific facilities for which you typically deal with many custom devices and legacy code. In these cases, it is useful to consider the Rapid Application Development (RAD) approach that consists in lessen the planning phase and give more emphasis on an adaptive process, so that software prototypes can be successfully used in addition to or in place of design specifications. LabVIEW is a typical RAD-oriented development tool and is widely used in technical laboratories where many stand-alone programs are developed to manage devices under construction or evaluation. An original system that allows software clients to use external LabVIEW drivers is presented. This system, originally created for the !CHAOS Control System, is entirely written in LabVIEW and is based on JSON messages – transmitted on a WebSocket communication – driving LabVIEW VIs through dynamic calls. This system is completely decoupled from the client and is therefore suitable for any Control System.

WEP — Poster 1

Chair: Y.-S. Cheng (NSRRC)

WEP01 **EtherCAT Driver and Tools for EPICS and Linux at PSI**
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WEP07 **Innovative Graphical User Interfaces Development: Give the Power Back to Users**

G. Segura, *A. Ledeul, A. Savulescu, B. Styczen, D. Vazquez Rivera (CERN)*

GUI for supervision, control and data acquisition systems are usually oriented to specialist users. In big organizations like CERN, where different teams play the roles of operators, scientists and instrumentation specialists, providing a unique or static user interface usually results in a situation of dissatisfaction of everyone. On the other hand, providing distinct user interfaces for each type of user increases the development and maintenance effort and makes software evolution heavier. The approach taken for the design and development of GUIs for radiation and environment protection at CERN addressed this issue by integrating user interface changes as an embedded software functionality. Key users were provided with a tool to build, deploy and maintain their own tailor-made user interfaces, in a graphical way and without the necessity of learning any kind of programming or scripting languages. Other benefits observed from this solution include reduction of the resources spent on the support and maintenance and increase of the frequency of GUIs updates, executed without compromising the underlying control system. This paper describe the innovative design that was implemented.

WEP08 **A Universal System Based on WebSocket and JSON for the Employment of LabVIEW External Drivers**

A. Stecchi, *C. Bisegni, P. Ciuffetti, A. D'Uffizi, G. Di Pirro, F. Galletti, A. Michelotti (INFN/LNF)*

One of the heaviest workloads when installing a Control System on a plant is the development of a large number of device drivers. This is even more true in the case of scientific facilities for which you typically deal with many custom devices and legacy code. In these cases, it is useful to consider the Rapid Application Development (RAD) approach that consists in lessen the planning phase and give more emphasis on an adaptive process, so that software prototypes can be successfully used in addition to or in place of design specifications. LabVIEW is a typical RAD-oriented development tool and is widely used in technical laboratories where many stand-alone programs are developed to manage devices under construction or evaluation. An original system that allows software clients to use external LabVIEW drivers is presented. This system, originally created for the !CHAOS Control System, is entirely written in LabVIEW and is based on JSON messages – transmitted on a WebSocket communication – driving LabVIEW VIs through dynamic calls. This system is completely decoupled from the client and is therefore suitable for any Control System.

WEP09 **SwissFEL Electron Beam Diagnostics Tools and their Control System Components**

P. Chevtsov, *D. Anicic, V.R. Arsov (PSI) M. Dach (Dach Consulting GmbH)*

The main driving part of the X-ray free electron laser facility (SwissFEL) at the Paul Scherrer Institute (PSI) is a compact electron linear accelerator (linac). The machine is highly optimized to generate a superior FEL radiation with the lowest suitable electron beam energy. In order to meet extremely stringent SwissFEL requirements for electron beam quality and stability, a variety of beam diagnostics tools were developed and implemented at the PSI. All these tools are integrated into the SwissFEL control system. The paper describes basic control elements of the electron beam diagnostics tools and their operational performance.

WEP10 **Update on the Status of the FLUTE Control System**

W. Mexner, *E. Blomley, E. Bründermann, C.F. Fehlinger, S. Marsching, A.-S. Müller, R. Ruprecht, M. Schuh, N.J. Smale (KIT) I. Križnar (Cosylab) S. Marsching (Aquenos GmbH)*

The first phase of FLUTE, a new linac based test facility and THz source is currently being commissioned at the Karlsruhe Institute of Technology (KIT). It consist of an RF photo gun and a traveling wave linac accelerating electrons to beam energies of 40 to 50 MeV. The control system is based on a virtualized infrastructure running Ubuntu Linux and Linux KVM. As base for the SCADA system we use EPICS 3.15 with Control System Studio (CSS) for the GUI. The long term data storage is provided by a Cassandra NoSQL database. This contribution will present the architecture and the current status of the FLUTE control system.

WEP11 **EtherCAT Solution for the TPS Control System**

C.Y. Liao *(NSRRC)*

This paper is to evaluate and establish EtherCAT (Ethernet for Control Automation Technology) solution for digital I/O, analogy I/O, and motion control on accelerator applications. Thanks to the Diamond Light Source, the EtherCAT is integrated into EPICS which supports lots of devices. The preliminary test and plans are summarized in this report.

WEP12 **Software Interlocking Upgrade for Top-off Operation of HLS-II**

K. Xuan, *C. Li, G. Liu, J.G. Wang, L. Wang, W. Xu (USTC/NSRL)*

Hefei Light Source has undergone major upgrading in 2010-2014 years. The upgrade light source is renamed as HLS-II. In order to improve the performance of light source, the top-off operation mode has been planned. As part of this plan, the software interlocking are upgraded. The system is developed using Sequencer under the EPICS framework. The test results show that the new software interlocking system runs reliably.

WEP13 **Control System Upgrade for the FFAG Accelerator Complex at KURNS**

Y. Kuriyama*, Y. Fuwa, Y. Ishi, Y. Mori, H. Okita, T. Uesugi (Kyoto University, Research Reactor Institute)*

Fixed field alternating gradient (FFAG) accelerator complex has been operated as a proton driver for the experiment of accelerator driven system (ADS) at Institute for Integrated Radiation and Nuclear Science, Kyoto University (KURNS, *formerly, Kyoto University Research Reactor Institute (KURRI)*). PLC based control system has been developed and the operator interface has been connected to PLC via network. Originally, a LabVIEW based operational interface was chosen to construct the system because of its easiness. However we met an upgrade problem, and a new control system based on EPICS instead of LabVIEW was introduced in 2010. In the spring of 2018, the replacement from LabVIEW to EPICS has been almost completed except for the beam interlock system and the LINAC control system provided by LINAC production company (AccSys). Also, the EPICS archiving tool (Archiver Appliance) has been invoked and operated at the end of 2017. This Presentation reports the details of the current control system and also the upgraded GPIB control and storage system.

WEP14 **Vacuum Control System of Taiwan Photon Source**

Y.C. Yang*, B.Y. Chen, J.-Y. Chuang, C.C. Liang, Z.-D. Tsai (NSRRC)*

Taiwan photon source (TPS) is a 3 GeV photon source. The NI CRIO modules, basic on real-time EPICS program, were adopt and designed to maintain the ultra-high vacuum condition and protect the vacuum devices. The pressure readings of ionization gauges are taken as the judgment logic to control sector gate valves so as to protect the ultra-high vacuum condition. Monitors of the water-cooling system and the chamber temperature serve to protect vacuum devices from radiation hazards. The evolution and status of the control system is presented in this paper.

WEP15 **Recent Development of the RIKEN RI Beam Factory Control System**

M. Komiyama*, M. Fujimaki, N. Fukunishi, K. Kumagai, A. Uchiyama (RIKEN Nishina Center)*

We report on development of the successor of the existing controller device used for the magnet power supplies in the RIKEN Radioactive Isotope Beam Factory (RIBF). The existing controller for the magnet power supplies is operated in the Versa Module European (VME) computing machines under the Experimental Physics and Industrial Control System (EPICS) framework. The present controller has been operated stably for more than 10 years, however, it is now commercially unavailable because supply of some parts has been already terminated. In 2016, we developed a successor to have the same function essentially as the existing one, but it is designed to run in control systems constructed by programmable logic controller (PLC) modules instead of the VME computing environment, in order to achieve cost reduction and functional scalability. We confirmed that the successor was successfully controlled by using a test system. And now, we are developing a control system that can flexibly add new functions through actual operation while having all the existing functions. We

will introduce the successor to the new injector LINAC system this year.

WEP16 **CMS ECAL Detector Control System Upgrade Plan for the CERN Large Hadron Collider Long Shutdown II**

R.J. Jiménez Estupinan *(ETH)*

The Electromagnetic Calorimeter (ECAL) is one of the detectors of the Compact Muon Solenoid (CMS) experiment at the CERN Large Hadron Collider (LHC). The ECAL Detector Control System (DCS) software has been implemented using the WinCC Open Architecture (OA) platform. Modifications that require fundamental changes in the architecture are deployed only during the LHC long shutdowns. The upcoming long shutdown (2019–2020) offers a unique opportunity to perform large software updates to achieve a higher modularity, enabling a faster adaptation to changes in the experiment environment. We present the main activities of the ECAL DCS upgrade plan, covering aspects such as the re-organization of the computing infrastructure, the consolidation of integration tools using virtualized environments and the further usage of centralized resources. CMS software toolkits are evaluated from the point of view of the standardization of important parts of the system, such as the machine protection mechanism and graphical user interfaces. Many of the presented features are currently being developed, serving as precursors to the major ECAL upgrade foreseen for the next long shutdown (~2024–2025).

WEP17 **Extending the Remote Control Capabilities in the CMS Detector Control System with Remote Procedure Call Services**

R.J. Jiménez Estupinan *(ETH)*

The CMS Detector Control System (DCS) is implemented as a large distributed and redundant system, with applications interacting and sharing data in multiple ways. The CMS XML-RPC is a software toolkit implementing the standard Remote Procedure Call (RPC) protocol, using the Extensible Mark-up Language (XML) and a custom lightweight variant using the JavaScript Object Notation (JSON) to model, encode and expose resources through the Hypertext Transfer Protocol (HTTP). The CMS XML-RPC toolkit complies with the standard specification of the XML-RPC protocol that allows system developers to build collaborative software architectures with self-contained and reusable logic, and with encapsulation of well-defined processes. The implementation of this protocol introduces not only a powerful communication method to operate and exchange data with web-based applications, but also a new programming paradigm to design service-oriented software architectures within the CMS DCS domain. This paper presents details of the CMS XML-RPC implementation in WinCC Open Architecture (OA) Control Language using an object-oriented approach.

WEP18 **Control and Interlock System for an Electron Accelerator Based Neutron Source**

***B.E. O'Rourke**, T. Fujiwara, M. Furusaka, K. Kino, R. Kuroda, K. Michishio, H. Ogawa, N. Oshima, D. Sato, N. Sei, R. Suzuki, M. Tanaka, H. Toyokawa, A. Watazu (AIST) N. Hayashizaki (RLNR) T. Muroga, T. Shishido (ISMA)*

A compact electron-accelerator based neutron source/facility for the characterization of structural materials is under construction by the Innovative Structural Materials Association (ISMA) at the National Institute of Advanced Industrial Science and Technology (AIST) in Tsukuba, Japan. The facility consists of a linear electron accelerator (LINAC) with a planned maximum beam power of 10 kW (~35 MeV, ~275 mA) incident on a water cooled tantalum target. The LINAC will be primarily controlled from a control room outside the radiation control area. It is also planned that a full monitoring system and some control functionality will also be available at the neutron beamline hall. We plan to install a control and monitoring system using the EPICS framework. A separate interlock system for the facility is also being developed and installed. The interlock system uses a commercial PLC sequencer in combination with a newly developed serial bus communication system developed at AIST. Both the EPICS and interlock systems will be presented in more detail at the conference.

WEP19 **TINE Release 5.0 : A First Look**

***P. Duval**, J. Szczesny, J.T. Tempel (DESY) S. Weisse (DESY Zeuthen)*

The TINE control system evolved in great part to meet the needs of controlling a large accelerator the size of HERA, where not only the size of the machine and efficient online data display and analysis were determining criteria, but also the seamless integration of many different platforms and programming languages. Although there has been continuous development and improvement during the operation of PETRA, it has now been 10 years since the last major release (version 4). Introducing a new major release necessarily implies a restructuring of the protocol headers and a tacit guarantee that it be compatible with its predecessors, as any logical deployment and upgrade strategy will entail operating in a mixed environment. We report here on the newest features of TINE Release 5.0 and on first experiences in its initial deployment.

WEP20 **Improvement of RFQ Cavity Conditioning Process by Using PyEPICS in Developing Rearm Tool to Allow Automatic RF Power System Restart**

***A. Jokinen** (F4E) P. Cara, A. Marqueta, I. Moya (Fusion for Energy) E. Fagotti, F. Grespan (INFN/LNL) K. Kondo, T. Shinya, M. Sugimoto (QST) M. Weber, C. de la Morena (CIEMAT)*

The IFMIF prototype accelerator, LIPAc, aims at producing a powerful (9 MeV, 1.1 MW) deuteron beam at 125 mA in CW, to validate the concept for the future IFMIF (40 MeV, 125 mA CW). The beam will go through two main accelerating stages (RFQ and SRF Linac), plus two bunching cavities as part of the MEBT. These require continuous wave RF power at 175 MHz for the 18 RF power sources feeding the eight RFQ couplers (200 kW), the

two buncher cavities (16 kW) and the eight superconducting half wave resonators of the SRF Linac (105 kW). The functionality of the LLRF has been complemented with python based automatic rearming tool to resume RF power automatically in case of safe interlocks in order to optimise the RFQ conditioning process. The rearming tool is communicating with EPICS using pyEPICS module, and it is running on central control system (CCS) and is interfacing the RF power system (RFPS) through EPICS.

WEP21 **Injection Control of the TPS**

***K.T. Hsu**, J. Chen, K.H. Hu, C.Y. Wu (NSRRC)*

Injection control for Taiwan Photon Source (TPS) have been served the routine operation. Top-up injection functionality is available on the day one at early machine commissioning stage to accelerate vacuum conditioning. During last two years, several updated have been done to ensure flexibility for the injection control. The injection control include foreground and background processes to coordinate the operation of e-gun, linear accelerator, booster synchrotron, storage ring by the help of event based timing system. Lifetime calculation of the storage ring is also synchronize with the injection process. Detailed of the implementation will be presented in the report.

WEP22 **The Lens Effect in the Secondary Emission Based Systems of Joint Searching in EBW**

***A.M. Medvedev**, Yu.I. Semenov, M. M. Sizov, A.A. Starostenko, A.S. Tsyganov (BINP SB RAS) **A.M. Medvedev**, A.A. Starostenko (NSU)*

The results of developed scan lines generator for the magnetic correctors system are presented. Get the dependency between various types of the scan lines and distribution of the allocated energy in the electron beam welding facility. The lens effect in the secondary emission based system of joint searching, using 3-fragment linear scan line is received. The accuracy of the joint searching system (the error of positioning system) is 0.05 mm, the lens effect can decrease this value several times. The requirements for the creation full calibrated system of joint searching are listed.

WEP23 **Control System Using EPICS Tools at TARLA LINAC**

***O.F. Elcim**, M. Bozdogan (Ankara University Institute of Accelerator Technologies) A.A. Aksoy (Ankara University, Accelerator Technologies Institute)*

The first accelerator based research facility of Turkey-TARLA is under commissioning at Institute of Accelerator Technologies of Ankara University. It is designed to generate free electron laser and Bremsstrahlung radiation using up to 40 MeV continuous wave (CW) electron beam. The control system of TARLA is based on EPICS and are being tested offline. TARLA also has industrial control systems such as PLC based cryoplant and water cooling system. Its control system is under development, it benefits from the latest version of EPICS framework, i.e. V7. In other words, TARLA control system uses existing demonstrated tools of EPICSV3 as well as pvAccess which comes with EPICSv4 for transferring the large data through control network. Archive (CSS BEAUTY) and alarm (CSS BEAST) system have been set up to detect stability and prevent failures. Operator interfaces have

been designed using CSS BOY. Currently, CCDs, PSS (Personel Safety System), MPS (Machine Protection System), Superconductive Cavities, RF Amplifiers, microTCA based LLRF system are being integrated into distributed control system. In this proceeding we summarize the current status and future plans of TARLA control system.

WEP24 **The State Machine Based Automatic Conditioning Application for PITZ**

***D.M. Melkumyan**, P. Boonpornprasert, Y. Chen, J.D. Good, M. Groß, H. Huck, I.I. Isaev, D.K. Kalantaryan, M. Krasilnikov, O. Lishilin, G. Loisch, A. Oppelt, B. Petrosyan, H.J. Qian, F. Stephan, G. Trowitzsch (DESY Zeuthen) M. Otevřel (CEITEC, BUT) Y. Renier (DPNC) G. Vashchenko (DESY)*

The Photo Injector Test Facility at DESY in Zeuthen (PITZ) was built to test and to optimize sources of high brightness electron beams for Free-Electron Lasers (FELs). In order to achieve high accelerating gradients and long RF pulse lengths in the RF gun cavities an extensive and safe RF conditioning is required. A State Machine based Automatic Conditioning application (SMAC) was developed to automate the RF conditioning processes, allowing for greater efficiency and performance optimization. SMAC is written in Java and uses State Chart XML (SCXML) as the finite-state machine execution environment based on Harel statecharts. It employs the Distributed Object-Oriented Control System (DOOCS) and Three-fold Integrated Networking Environment (TINE) for the communication with the control system of PITZ. The graphical user interface (GUI) is created by using the Java Swing toolkit. Communication between GUI and SXML processing layer is performed via Document Object Model (DOM) events. The SMAC application has been successfully applied to RF conditioning of several gun cavities at PITZ.

WEP25 **Evolution and Convergence of Alarm Systems in Tango**

***S. Rubio-Manrique**, G. Cuni, F.F.B. Fernández, R. Monge (ALBA-CELLS Synchrotron) G. Scalamera (Elettra-Sincrotrone Trieste S.C.p.A.)*

The technology upgrade that represents Tango 9 has triggered the evolution of two of the most used Tango tools, the PANIC Alarm System and the HDB++ Archiving. This paper presents the status of the collaboration between Alba and Elettra Synchrotron sources for the convergence of its both alarms systems under the IEC62682 standard, and the usage of HDB++ tools for logging and diagnostic of alarms. Relevant use cases from the user point of view has been added to the paper as a validation of the benefits of this control system evolution.

WEP26 **The Development of Vacuum Gauge Monitoring and Control System using Web2Ctoolkit**

***H. Ishii**, T. Kosuge, H. Nitani (KEK)*

The Photon Factory is an accelerator-based light source facility, as a part of the High Energy Accelerator Research Organization (KEK) Japan and STARS (Simple Transmission and Retrieval System) is used as the beamline control system at the Photon Factory. STARS is a message transferring software for small scale control systems with TCP/IP sockets, which works on various types of operating systems. STARS is effective for various control systems and we developed Vacuum Gauge Monitoring and Control System with STARS. Web2cToolkit is developed by DESY that provides a user-friendly interface and user can develop Web based GUIs easily with Web2cToolkit. Web2c supports various types of protocol (e. g. TINE, DOOCS, EPICS, TANGO etc.) and the STARS protocol has been supported. We decided to introduce Web2cToolkit as the GUI application on our vacuum gauge monitoring and control system and a few functions are implemented. The development is still in progress.

WEP27 **The Development of the Malfunctions Detection System at VEPP-2000 Collider**

***O.S. Shubina**, A.I. Senchenko (BINP SB RAS) A.I. Senchenko (NSU)*

In 2007, the creation of the electron-positron collider VEPP-2000 was completed at the Institute of Nuclear Physics of the SB RAS. VEPP-2000 collider facility consists of various subsystems, and a failure of any subsystem can lead to the incorrect operation of the complex for several hours or even days. Thus, there is a need to create software that, based on the data analysis, will warn about possible malfunctions. To accomplish the task, software was developed consisting of three modules. The first performs automatic verification of compliance data obtained from the accelerator complex and rules describing the correct subsystems operation. The second module is a user-friendly web interface that displays information about the state of the complex in a convenient way. The third module acts as some intermediary between the first and the second. It processes messages arriving at the message queue and redirects them to all subscribed clients via the web socket. This article is devoted to the development of test software, which is currently running on the VEPP-2000 control panel.

WEP28 **The Development of Software for Accessing the VEPP-2000 Collider Facility Archiving System**

***O.S. Shubina**, A.I. Senchenko (BINP SB RAS) A.I. Senchenko (NSU)*

The VEPP-2000 is an electron-positron collider, that was commissioned at Budker Institute of Nuclear Physics. The VEPP-2000 acceleration complex consists of a few main subsystems: BEP booster ring and VEPP-2000 collider ring. Data from accelerator complex are recorded regularly with a frequency at 1 Hz. There is often a need to obtain already stored data for analysis or modeling. In addition, you must provide remote data access to optimize the workflow. The solution of this problem must be universal, and it must be easily adapted to various databases and installation modes. To solve the task, the software was developed based on the client-server ar-

chitecture. The server part is responsible for processing data in automatic mode according to the developed algorithm. The client part allows to view the data in a user-friendly form. This article talks about the development of software, simplifying access to the VEPP-2000 archiving system, that is launched on the VEPP-2000 control panel.

WEP29 **Beamline Control Based on the TINE Control System**
U. Ristau *(EMBL)*
The stand alone TINE installation at the EMBL Hamburg is the backbone of the beamline control. Tools in use to improve reliability, recovery with expert systems to increase the availability of the Experiment control will be presented. The strength of the TINE control system the operatibility on different operating system and programming languages in combination with the excellent Debugging tools and the implementation of the Archiving, Alarming will be presented.

WEP30 **Design of Reliable Control with Star Topology Fieldbus Communications for an Electron Cyclotron Resonance Ion Source at RIBF**
A. Uchiyama*, N. Fukunishi, Y. Higurashi, M. Komiyama, T. Nagatomo (RIKEN Nishina Center)*
In RIBF project, a superconducting linac will be implemented in order to enhance the beam energy necessary for promoting super heavy element experiment. A new 28 GHz electron resonance ion source has been installed upstream of them. Its control system will be consisted of Yokogawa FA-M3 series which is a porgrammble logic controller (PLC) with EPICS because of many achievements in case of RIBF control system. On the other hand, in the previous system with PLCs there was a disadvantage of low reliability for communications between PLC stations. Additionally, some devices (eg, oven, mivoc etc.) are changed for the generation of various kind of ions each times, therefore higher expandability is required. In the new system, we have designed the control system by utilizing star topology fieldbus for communications between the PLC stations to establish safety and expandability. In this conference, we report on the details of the system.

WEP31 **Design of PLC Temperature Flow Acquisition System Based on EPICS**
Z.Hai. Hai*, Y.X. Chen (IMP/CAS)*
In the design of the ADS injector II, the RFQ cavity holds a supreme status, and the RFQ temperature and flow information are the key parameters for the cavity frequency tuning. To ensure the long-term, stable and accurate acquisition of temperature flow data is the core task of control. In this paper, the PLC temperature flow acquisition system which is based on EPICS design was described, and the EPICS driver of this PLC was developed independently. The driver uses TCP/IP connection to EPICS IOC, and the communication protocol uses the "data block overall transmission protocol", to ensure the stability of the device's data communications. After 3 months of long-term operation inspection, this acquisition system can ensure long-term and stable acquisition of real-time temperature and flow data of the equipment, and be able to send control information to related controlled equipment. In addition, redundant PLCs and redundant IOCs

were adopted in this acquisition system to make the switch to alternate channels within milliseconds once a channel fails.

WEP32 **The Design and Development of an Auto-refining SRF Cavities Software**

***H. Cao**, Y.X. Chen (IMP/CAS)*

As one of the major components of ADS Injector II, SRF (Superconducting Radio Frequency) cavities are used to transmit particle beam efficiently and stably. Before starting the process of transmitting particle beam, SRF cavities are usually refined to achieve its maximum reliability at the optimal deliverable energy. The whole refining process is involved in various types of equipment and is also a heavy task for engineers to manually operate. In this paper, the software ARSC is presented in details, which is used to automatically refine SRF cavities. In reality, ARSC achieves comparative results compared with manually operated refining. Besides, the software ARSC largely shortens the time of the refining process from 7 days to 1 day, obviously improving its efficiency.

WEP33 **Introduce the Architecture of CiADS Control System**

***Y.X. Chen** (IMP/CAS)*

CiADS is a science researching facility, which destination is about energy Providence. The control system of CiADS will have more than hundred types of device, and include more than thousand equipment and sensors. Based on the background of researching and energy project, the control system should overcome two challenges. First is that building a open architecture to face the flexibility of changed requirement. the second is that the flexibility should as less as possible influence the checking result of nuclear law and standard by authority. To meet the requirement, the control system will be divided into 3 levels.level 2 will provide the OPI, data analysis interface and simulation to all users. Level 1 provide implement of control and security logic. Meantime it will provide a engine and interface for collection and package of some reconstructed data. Level 0 will implement the local control and provide all data and information to other levels. The paper mainly introduce the architecture and some works to build the control system to make it to overcome the two challenges.

WEP34 **The Control System Based on EPICS for Target System**

***Q. Zhao** (IMP/CAS)*

A prototype target system for CiADS (China initiative Accelerator Driven System) has been finished and tested last year. The EPICS (experimental physics and industrial control system) was firstly used as the framework of the control system for testing the compatibility between the control systems of the accelerator and target. PLCs and Data Acquisition System which were considered as IOCs were used for each part of the target system. CSS and LabVIEW were used for the interfaces of the control system to monitor the equipment and archive the data of the system. Besides, a board based on the PCI bus and Linux system was also tested and used for the control system. The control system finally shows a high stability and flexibility for operation.

WEP35 **Control System Designing of Juna ECR and LEBT**

***P.P. Wang**, S. An, J.J. Chang, X.J. Liu (IMP/CAS)*

The ongoing Jinping Underground Nuclear Astrophysics Experiment (JUNA) takes advantage of the ultralow background in China Jinping Underground Laboratory (CJPL), high current accelerator driven by an ECR source and highly sensitive detector to study directly a number of important reactions for the first time within their relevant stellar energy range. A 2.45 GHz ECR ion source is one of its key components to provide beams. The low energy beam transport (LEBT) system transports and matches the ion beam from the exit of ion source to the acceleration tube (AT). For the high efficiency of ECR and LEBT, a remote control system based on experimental and physics industrial control system (EPICS) is introduced in this paper. According to the characteristics of the devices' interfaces and user requirements, a Siemens programmable logic controller (PLC) and a serial port server are used as hardware of the control system. The supervisory software which is programmed with control system studio (CSS) can control all the equipment in the control system which has a simple structure, works reliably and plays an important role for the ECR and LEBT system.

WEP36 **The Interface and Application of LabVIEW for Injector II Control System in ADS**

***H.T. Liu** (IMP/CAS)*

The main function of the intense-beam proton accelerator which was also called injector II in accelerator driven sub-critical system (ADS) is to produce continuous intense proton beam. The control system should be implemented to adjust and monitor the accelerators devices, while it is based on the distributed control system EPICS (Experimental Physics and Industrial Control System). In order to facilitate the signal acquisition and data analysis of the equipments with many different interfaces, based on the EPICS control system architecture, using LabVIEW software and DSC module provided by NI, can deploying the device drive and programming the SoftIOC more convenient, thus achieved the remote control and data acquisition of accelerator devices, the integrity of interface and standardization of programming can also be improved. The result shows that the interface between LabVIEW and EPICS is easy to deploy and operate reliably, which fully meets the requirements of current control system in ADS injector II.

WEP37 **ADS Injector II Cryogenic Control System Reliability Optimization and Analysis**

***J.H. Hu** (IMP/CAS)*

Regarding the reliability weak links of the ADS injector II cryogenic control system, a manual controller was designed to control the cryomodule return valve redundantly. The control system reliability was analyzed by the independent failure reliability model. The analysis results show that the redundancy control improves the reliability of the ADS injector II cryogenic control system.

18-Oct-18 09:00 – 10:00 Main Auditorium

THKT — Keynote Talk 2

Chair: C.H. Kuo (NSRRC)

THKT1 **Delivering Machine Learning Engineering in Scientific Research**

09:00 00 ***D. Chiu*** *(LargitData)*

As the use of machine learning to train a predictive model has become more and more popular, knowing how to build a model with a fixed dataset may not be news to most researchers nowadays. With a little programming training, any researcher can now easily create a model with just a few lines of coding with some state of the art programming languages and analysis tool. However, knowing how to build the model is not enough, if you wish your research can reach to a wider audience, it would be important to know the correct approach to deliver the learned model into a production environment. In this keynote speech, I will address how to bring machine learning model into the production environment from the perspective of a data scientist and engineer. I will cover the issues includes data preparation, model versioning, model deployment, continuous integration/delivery, model validation, how to choose evaluation metrics, some challenges when facing big data.

18-Oct-18 10:00 – 10:30 Main Auditorium

THIN — Interactive Session 1

Chair: R. Bacher (DESY)

THCA — Contributed Oral: Hardware Technologies 1

Chair: G. Cuni (ALBA-CELLS Synchrotron)

THCA1 10:50 15 **Quest for the New Standard PSI IOC Platform**

D. Anicic *(PSI)*

With it's four+ Accelerator facilities (HIPA+SINQ, PROSCAN, SLS, SwissFEL) the PSI has already several decades of Control System IOC experience. The technology is moving fast forward. The old stuff is becoming obsoleted, unable to purchase replacements, getting slow, consuming to much power, does not match new computing, networking and bus technologies. All that forces us to choose the new "standard" IOC platform more frequently. What used to be twenty years, became ten, and is now tending to be five years. Here we want to present the past and the possible future IOC platforms, which we are investigating. The community questions, and even more suggestions, would be highly appreciated.

THCA2 11:05 15 **Development of MicroTCA-based Low-level Radio Frequency Control Systems at cERL and STF**

F. Qiu*, T. Matsumoto, S. Michizono, T. Miura (KEK) N. Liu (Sokendai–Hayama)*

The low-level radio frequency (LLRF) and tuner control systems based on micro-TCA standard have been developed for the KEK facilities such as compact Energy Recovery Linac, and superconducting test facility (STF). An FPGA control board, equipped with 4ch ADCs, 4ch DACs, and a digital input/output is used to perform the high-speed digital signal processing algorithms. Experimental physics and industrial control system (EPICS) is selected to be the data communication system. The LLRF and DAQ systems work well during the beam commissioning. This paper present the current status of the microTCA-based LLRF system.

THCA3 11:20 15 **A Feedback/feedforward System at the TPS and Its Component Performance**

C.H. Huang*, Y.-S. Cheng, P.C. Chiu, K.T. Hsu, K.H. Hu, C.Y. Wu (NSRRC)*

For a low-emittance photon light source like the Taiwan Photon Source (TPS), beam stability is a very important property for high-quality photon beams. It is, however, hard to completely remove beam disturbing effects. Therefore, a feedback/feedforward system becomes an effective tool to suppress beam motion. In this report, we discuss the performance of such a system implemented at the TPS. The component performance of the feedback system has been tested to understand its bandwidth limitations.

THCA4 11:35 **Development of a Network-based Timing and Tag Information Distribution System for Synchrotron Radiation Experiments at SPring-8**

T. Masuda *(JASRI/SPring-8)*

Time-resolved measurements in synchrotron radiation experiments require an RF clock of a storage ring accelerator and a fundamental revolution frequency (zero address) signal. For the usage of these signals around the experimental station, long RF cables from the accelerator timing station, divider modules and delay modules must be deployed. These installations need a lot of cost and require a lot of efforts to adjust the timing by experts. To lower these costs and efforts, the revolution frequency, which is ~209 kHz at the SPring-8 storage ring, and tag information distribution system has been studied based on a high precision time synchronization technology over a network. In this study, the White Rabbit (WR) technology is adopted. The proof of concept system has been built, which consists of a master PC, a slave PC and two WR switches. The master PC detects the zero-address signal and distributes the time stamps with tag information to the slave PC. Then the slave PC generates the ~209 kHz signals synchronized with the target bunch by adding the offset time by software. The measured one-sigma jitter of the output signals from the slave PC has been achieved less than 100 ps.

THCA5 11:50 **Rethinking PLCs: Industrial Ethernet for Large-Scale Real-Time Distributed Control Applications**

B. Plötzeneder*, O. Janda, A. Krucenko, J. Trdlicka (ELI-BEAMS) P. Bastl (Institute of Physics of the ASCR)*

Many research facilities rely on PLCs to automate large slow systems like vacuum or HVAC, where price, availability and reliability matter. The dominant architecture consists of local units of controllers/modules (programmed in IEC61131-3 languages), which operate mostly autonomously from a SCADA layer. While some vendors provide low-level stacks to encourage growth of their ecosystems, PLC programming remains largely within a closed, proprietary world. In this paper, we introduce a different way of thinking about PLC hardware. Working with the open stacks intended for the design of new EtherCAT (Beckhoff)/Powerlink (B&R) modules, we built an abstract C++-API to control the existing ones. These industrial ethernet busses can be propagated using standard network hardware, so any RT-Linux system can now control any PLC module from anywhere in our facility using high-level languages (C++, LabVIEW). This way, PLC modules are seamlessly integrated into our distributed TANGO-based control system. PC-PLC interfaces are no longer needed; or in the case of traditionally implemented subsystems (machine safety), trivial.

THCB — Contributed Oral: GUI Technologies

Chair: M.R. Clausen (DESY)

THCB1 **ACOP. NET : Not Just Another GUI Builder!**

13:30 15

***J. Szczesny**, P. Duval, M. Lomperski, H. Wu (DESY) T. Kosuge (KEK)*

ACOP (Advanced Component Oriented Programming) tools have been useful in control system GUI application development for some time, originally as an ActiveX component offering a transport layer and a multi-faceted chart and then later as a suite of components in the Java world. We now present a set of ACOP components for development in .NET. And where the emphasis in the past has been primarily on rapid application development of rich clients, this new palette of components is designed both for fully featured rich-client development in any of the .NET supported languages (C#, C++, VB, F#) as well as for fully configurable clients (with design-time browsing), where no programming on the part of the developer is necessary, and of course for any combination between these extremes. This is an important point, which will become clear when we contrast application development with ACOP. NET with other control system GUI builders such as Control System Studio and jddd. Although Visual Studio is the GUI builder of choice, we will present other available options, for example on Linux. Examples using transport plugs for TINE and STARS will be given.

THCB2 **Development of ACOP .NET STARS Transport Layer**

13:45 15

***T. Kosuge**, H. Ishii, Y. Nagatani, H. Nitani (KEK) P. Duval, J. Szczesny (DESY)*

STARS is an extremely simple and very flexible control software for small scale control systems with TCP/IP sockets, which is used as the beamline control system and so on at the KEK Photon Factory (KEK-PF). STARS works on various operating system and the STARS client developer can choose his or her favorite programing language. Choosing .NET is very common to develop GUI applications of beamline control at the KEK-PF. ACOP (Advanced Component Oriented Programming) is very useful for GUI development, which is developed by DESY and a .NET version of ACOP was recently developed. ACOP has a transport layer and communicate with various system through this layer. Now, we have started development of STARS transport layer of ACOP .NET and succeeded in adding very primitive functionality. The development of ACOP .NET STARS transport layer is still ongoing.

THCB3 14:00 15 **Improving Web2cHMI Gesture Recognition Using Machine Learning**

R. Bacher *(DESY)*

Web2cHMI is multi-modal human-machine interface which seamlessly incorporates actions based on various interface modalities in a single API, including finger, hand and head gestures as well as spoken commands. The set of native gestures provided by off-the-shelf 2D- or 3D-interface devices such as the Myo gesture control armband can be enriched or extended by additional custom gestures. This paper discusses a particular method and its implementation in recognizing different finger, hand and head movements using supervised machine learning algorithms including a non-linear regression for feature extraction of the movement and a k-nearest neighbor method for movement classification using memorized training data. The method is capable of distinguishing between fast and slow, short and long, up and down, or right and left linear as well as clockwise and counterclockwise circular movements, which can then be associated with specific user interactions.

THCB4 14:15 15 **Leveraging Internet of Things Developments for Rapid Prototyping of Synoptic Displays**

L.T. Stant*, T.M. Cobb (DLS)*

Recently the technology industry has been laying the foundations for the eponymous Internet of Things (IoT): efficient publish-subscribe protocols; process control schemas for household items; and improved low-power radio communications. Accelerator controls and IoT have several aspects in common – small payloads, low latency, dashboard/synoptic data presentation format are some examples. The IoT now provides several open-source projects which can provide a partial implementation of one or more accelerator controls software features. Because development is typically a lower priority for accelerator controls groups, there is a valid case to try and utilise the free efforts of others for the benefit of accelerator controls. In this paper, the authors present two examples of the use of IoT frameworks for synoptic display/GUI development. The first is a responsive web interface which provides easy and rapid configuration of reusable widgets. The second is miniature mobile displays which connect to EPICS via Wi-Fi and can be attached to equipment during maintenance. The work in this paper enables other developers to access this resource and experiment with their own systems.

THCB5 14:30 15 **AI for Accelerator Controls and Modeling**

S. Biedron *(Element Aero) A.L. Edelen (CSU)*

We present our efforts and experience in developing adaptive, artificial intelligence-based tools specifically to address control challenges found in particle accelerator systems over the past 12 years. We will discuss the opportunities and challenges, especially for devices that will not necessarily be co-located with accelerator operators or experts. Finally we will discuss our present work and capabilities.

THPI — Poster in Pills 2

Chair: T. Kosuge (KEK)

THPI1 14:45 (3) **Upgrading the Synchronisation and Trigger Systems on the Vulcan High-Power Nd:glass Laser**

***D.A. Pepler**, I. O. Musgrave, P.B.M. Oliveira (STFC/RAL)*

The Vulcan Neodymium-Glass High-Power Laser Facility at the Central Laser Facility in the UK has been operational for over 40 years providing a world-leading and high-profile service to International researchers in the field of Plasma Physics. Over that time the Facility has had many modifications and enhancements to the buildings, the laser hardware and to the computerised control, synchronisation and timing systems. As the laser systems have developed and the user experiments have continued to become much more complex and demanding, many new operational conditions have been required. The use of four independent laser oscillators with different properties – including temporal, spectral and operating frequencies – have meant that the optical and electrical multiplexing and the timing and synchronisation systems have all had to be adapted and extended to cope with these additional needs. However, these changes have resulted in the build-up of the overall system jitter to ±250 ps between long (ns) and short (ps) optical pulses and this is a limiting factor for time-critical experiments. This paper will present some of the key changes and improvements that have recently been made.

THPI2 14:48 (3) **Current Status of the RAON Machine Protection System Development**

***H. Jin**, Y. Choi, S. Lee (IBS)*

For the RAON accelerator that transport beams with high energy and power, a machine protection system (MPS) that protects each device from sudden beam loss is necessary. For this reason, we have been preparing for the development of the MPS with the start of the RAON accelerator construction. For effective MPS operation and stable accelerator operation, we divided the MPS into four subsystems: fast protection system, slow interlock system, run permit system, and post-mortem system. Among them, the FPGA-based fast protection system and the PLC-based slow interlock system have been tested by prototypes and are currently working on the mass production. The run permit system and the post-mortem system are also undergoing basic design and software development. In this paper, we will describe the progress of the MPS development through detailed hardware and software development in the RAON accelerator and explain the future plans.

THPI3 14:51 **Marvin Update – The Robotic Sample Mounting System at the EMBL-Hamburg**

U. Ristau *(EMBL)*

In this poster we give an overview and update on the robotics systems in use at the EMBL-Hamburg. At the DESY PetraIII synchrotron Beamlines of the EMBL are two protein crystallography Beamlines each equipped with the in house build robotic sample mounting system in production. The controls of the system and new developments to decrease down times, as well as self recovery integrations will be described in detail.

THPI4 14:54 **Real-time and Detailed Provision of J-PARC Accelerator Operation Information from the Accelerator Control LAN to the Office LAN**

S. Yamada *(J-PARC, KEK & JAEA)*

J-PARC Main Ring (MR) is a high-intensity proton synchrotron whose control system is developed based on EPICS. It started its beam operation in 2008, and since 2009 has been delivering beam to the T2K neutrino experiment and hadron experiments. Over the past decade, MR have become more sophisticated and more stable driving is required. Along with this, demands arose from users and experts of equipment such that acquiring detailed and real-time information on the apparatus from the office LAN. On the other hand, the accelerator control system is quarantined from the office LAN with firewall for security reasons. Therefore, despite being intentional or not, manipulating any equipment in the accelerator control LAN shall be prohibited from the office LAN. This article describes construction and prospects of such an one-way gateway system such that information is relayed via EPICS from accelerator control LAN to the office LAN while minimizing influence in the opposite direction.

THPI5 14:57 **Development and Current Status of KURAMA-II**

M. Tanigaki *(Kyoto University, Research Reactor Institute)*

KURAMA-II, a successor of a carborne gamma-ray survey system named KURAMA (Kyoto University RAdiation MApping system), has been developed and applied to various activities related to the nuclear accident at TEPCO Fukushima Daiichi Nuclear Power Plant in 2011. KURMA-II has established its position as an effective method for the radiation monitoring method in environment on a long-term basis. The development of KURAMA-II is still on the way to extend its application areas such as the trial to port the system to a single-board computer or the development of cloud services of data management for the users who don't have capabilities to manage the data processing system. In this paper, the current status of KURAMA-II on its developments and applications along with some results from its applications are introduced.

THPI6 15:00 **Improvement Reliability of the Insertion Device Control in TPS**

C.Y. Wu *(NSRRC)*

Insertion device (ID) is a crucial component in third-generation synchrotron light sources, which can produces highly-brilliant, forward-directed and quasi-monochromatic radiation over a broad energy range for various experiments. Reliable operation of insertion devices is important to users of beamline. The most unpredictable fault is due to soft error of the optical absolute encoders due to radiation. There are several approaches to avoid this kind of fault, one is to increase the distance of the encoder from the beam level, the other is cover by lead shielding, and final method is to adopt auxiliary position sensing devices to help recovery of the fault. Effort to improve operation reliability will be discussed in ID control for the Taiwan Photon Source.

THPI7 15:03 **Long-term Position Stability Observed from Electron BPM and Photon BPM for TPS**

P.C. Chiu*, K.T. Hsu, K.H. Hu (NSRRC)*

TPS is 3-GeV synchrotron light source which have opened for public users since September 2016 and now offers 400 mA top-up mode operation. The requirements of the long term orbit stability and orbit reproducibility after beam trip have been gradually more and more stringent and become a challenge from users' request. Furthermore, the thermal effect would be expected to be worsen after 500 mA top-up operation which should deteriorate the orbit drift. The report investigates the long-term orbit stability observed from eBPM and XBPM and also evaluates the possibility of the local XBPM feedback.

THPI8 15:06 **Design and Implementation of Stepper Motor Control of the LINAC High Power RF System Based on FPGA**

R. Rujanakraikarn*, Ch. Dhammatong, W. Phacheerak (SLRI)*

In this paper, the new motion control system that governs the position of high power attenuators and phase shifters in the linac's RF system at SLRI is described. The drive system, which was originally driven by a set of AC reversible motors, is replaced by a new set of stepper motors. The hardware selection and installation is presented in detail. The digital control circuits are designed in VHDL and implemented on a commercial Field Programmable Gate Array (FPGA) board. The main software part, implemented in MicroBlaze Microcontroller System (MCS), is coded in C to control the position of stepper motors relative to the DC voltage reference points of the hardware system. A LabVIEW GUI is designed to interface with the control system to provide reference points and display position values via RS-232 and PLC interfaces. This stepper motor control system can be used to effectively implement the phase and amplitude control system of the linac's RF signals in the future.

THP — Poster 2

Chair: C.H. Kuo (NSRRC)

THP01 **Norm Optimal Iterative Learning Control Design for J-PARC LINAC LLRF System**

S. Li *(J-PARC, KEK & JAEA)*

The beam current in J-PARC LINAC will increase to 60 mA in the future. In order to deal with more serious beam loading effect, an iterative learning control method was put forward. However, in previous method controller uses only proportional control. Taking into account the actual situation, its control performance still has room for improvement. For this reason, an iterative learning control based on norm optimization algorithm is applied to LLRF simulation model. The control method and result will be summarized in this paper.

THP02 **Current Status of the RAON Machine Protection System Development**

H. Jin*, Y. Choi, S. Lee (IBS)*

For the RAON accelerator that transport beams with high energy and power, a machine protection system (MPS) that protects each device from sudden beam loss is necessary. For this reason, we have been preparing for the development of the MPS with the start of the RAON accelerator construction. For effective MPS operation and stable accelerator operation, we divided the MPS into four subsystems: fast protection system, slow interlock system, run permit system, and post-mortem system. Among them, the FPGA-based fast protection system and the PLC-based slow interlock system have been tested by prototypes and are currently working on the mass production. The run permit system and the post-mortem system are also undergoing basic design and software development. In this paper, we will describe the progress of the MPS development through detailed hardware and software development in the RAON accelerator and explain the future plans.

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U. Ristau *(EMBL)*

In this poster we give an overview and update on the robotics systems in use at the EMBL-Hamburg. At the DESY PetraIII synchrotron Beamlines of the EMBL are two protein crystallography Beamlines each equipped with the in house build robotic sample mounting system in production. The controls of the system and new developments to decrease down times, as well as self recovery integrations will be described in detail.

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***R. Rujanakraikarn**, Ch. Dhammatong, W. Phacheerak (SLRI)*

In this paper, the new motion control system that governs the position of high power attenuators and phase shifters in the linac's RF system at SLRI is described. The drive system, which was originally driven by a set of AC reversible motors, is replaced by a new set of stepper motors. The hardware selection and installation is presented in detail. The digital control circuits are designed in VHDL and implemented on a commercial Field Programmable Gate Array (FPGA) board. The main software part, implemented in MicroBlaze Microcontroller System (MCS), is coded in C to control the position of stepper motors relative to the DC voltage reference points of the hardware system. A LabVIEW GUI is designed to interface with the control system to provide reference points and display position values via RS-232 and PLC interfaces. This stepper motor control system can be used to effectively implement the phase and amplitude control system of the linac's RF signals in the future.

THP09 **Timing System Upgrade for Medical Linear Accelerator Project at SLRI**

***P. Koonpong**, R. Rujanakraikarn (SLRI)*

A prototype of 6-MeV medical linear accelerator has been under development at Synchrotron Light Research Institute (SLRI). Several subsystems of the machine have been carefully designed and tested to prepare for x-ray generation. To maintain proper operation of the machine, pulse signals are generated to synchronize various parts such as solid-state modulators for electron gun and magnetron subsystems, sampling subsystem, and dosimetry control subsystem. The timing system, based on the previous version designed on Xilinx Spartan-3 FPGA, is upgraded with better timing resolution, easier configuration with more timing channels, and future expansion of the system. A new LabVIEW GUI is also designed with more details on timing signal parameters for easy customization. The result of this new design is satisfactorily achieved with the resolution of 10 nanoseconds per time step and the total of 15 synchronized timing channels implemented on two FPGA modules.

THP10 **Collimator Motion Control System Upgrade for Medical Linear Accelerator Project at SLRI**

***R. Rujanakraikarn**, P. Koonpong, S. Tesprasitte (SLRI)*

A prototype of the 6-MeV medical linear accelerator has been under development at Synchrotron Light Research Institute (SLRI). A set of secondary collimators is utilized with different size arrangement for beam shaping purpose. To produce the desired field size of the beam, the FPGA-based collimator motion control is designed in VHDL for simultaneous control of the collimators while the main PI control is implemented in the FPGA's main processor. In this paper, hardware and software upgrades of the collimator motion control system are presented. A custom drive hardware for individual collimator is designed to implement with the existing FPGA controller board. Interface between the custom hardware parts and the FPGA's programmable logic (PL) part is described. Communication between the motion control subsystem and the main LabVIEW control software on PC is modified to send and receive parameters wirelessly. Software modification of the FPGA's main processor part and that of the LabVIEW GUI part is also reported.

THP11 **Development of Differential Currents Measurement System for MPS**

***W. Wei**, K. Gu (IMP/CAS)*

To ensure safe and stable operation under high power beams, the accelerator device needs a fast, safe and reliable Machine Protection System (MPS). The MPS system uses the detector signals and sampled signals related to the beam quality to reflect the beam and machine status in real time, as well as to carry out chain protection to avoid critical equipment damage by the high power beams. This article mainly describes a differential currents measurement system, which monitors the beam current changes along the beam pipe and utilizes this distinct signal as a fast interlock protection output. The system obtains the signals of the beam current detectors online. By performing a fast average difference compensation calculation in FPGA, it can give a real-time stream strength and transmission efficiency of the beam. Then after setting a reasonable threshold, the system can give the fast interlock protection signal by evaluating the beam loss situation and provide an alternative solution of the low-energy beam loss issue in high-power accelerators.

THP12 **Upgrading the Synchronisation and Trigger Systems on the Vulcan High-Power Nd:glass Laser**

***D.A. Pepler**, I. O. Musgrave, P.B.M. Oliveira (STFC/RAL)*

The Vulcan Neodymium-Glass High-Power Laser Facility at the Central Laser Facility in the UK has been operational for over 40 years providing a world-leading and high-profile service to International researchers in the field of Plasma Physics. Over that time the Facility has had many modifications and enhancements to the buildings, the laser hardware and to the computerised control, synchronisation and timing systems. As the laser systems have developed and the user experiments have continued to become much more complex and demanding, many new operational conditions have been required. The use of four independent laser oscillators with

different properties - including temporal, spectral and operating frequencies - have meant that the optical and electrical multiplexing and the timing and synchronisation systems have all had to be adapted and extended to cope with these additional needs. However, these changes have resulted in the build-up of the overall system jitter to ± 250 ps between long (ns) and short (ps) optical pulses and this is a limiting factor for time-critical experiments. This paper will present some of the key changes and improvements that have recently been made.

THP13 **The Design of FPGA Based TPS FE Interlock Control System**
***J.-Y. Chuang**, C.-C. Chang, Y. T. Cheng, Y. M. Hsiao, Y. Z. Lin, I. C. Sheng, Y. C. Yang (NSRRC)*
The front end interlock control system is constructed to protect the human and the machine safety during operation. According to the stability and reliability are extremely high acquirement in this system, we developed a FPGA based system to control the safety logic for interlock protection. To integer the FPGA, Real time system and redundancy fail safe system, the FE interlock system enabled to execute a high safety protection with EPICS communication and hardware protection function.

THP14 **Development of the New Spill Control Device for J-PARC MR**
***T. Kimura** (KEK)*
J-PARC Main Ring (MR) is there are two operation modes of the fast extraction (FX) and slow extraction (SX). The SX operation used the spill control system. It consists of two kinds of Extraction Quadrupole Magnet (EQ), Ripple Quadrupole Magnet (RQ) and Spill Control Device with Digital Signal Processor (DSP) which calculates and controls it the optimal current pattern using the monitor signal of an extraction beam. It is used to make flatten the extraction beam structure and reduce the ripple noise. The present Spill Control Device needs to be reviewed from the aspect of service life etc. In this presentation, we will focus on improving the versatility of the device and the operability of the DSP program, and explain the development of the next-generation spill control device.

THP15 **Design and Implementation of EPICS and/or FPGA Based Protection System for Beam Acceleration in Linear IFMIF Prototype Accelerator**
***Y. Hirata**, A. Kasugai (QST) A. Jokinen, A. Marqueta (Fusion for Energy) H. Takahashi (JAEA/J-PARC)*
IFMIF (International Fusion Materials Irradiation Facility) Prototype Accelerator (LIPAc) has been developed, which is designed to produce a deuteron CW beam with a current of 125 mA at 9 MeV. After the injector commissioning, the LIPAc is entering in the second commissioning phase in which RFQ, MEBT, RF Power System and Beam Instrumentation (BI) systems have been integrated. The LCSs of LIPAc have been developed by European Home Team (EU-HT) and delivered with its subsystems; the CCS, including personnel and machine protection, timing, archiving and alarming, by Japanese Home Team (JA-HT). These have been implemented on the EPICS platform to mitigate the risk of incompatibility in the integration, which JA-HT and EU-HT are jointly carrying out to control the

whole accelerator. In the CCS, some interlocks associated with measurement systems–chopper interlock, protection of BI systems, etc.–are implemented on FPGA and the condition of interlock triggering can be changed from EPICS OPIs depending on the beam conditions. The use of EPICS interface can add flexibility but still satisfy fast response and reliability requirement. The design and implementation will be presented.

THP16 **Remote Waveform Access Supports with EPICS for TPS and TLS Control Systems**

***Y.-S. Cheng**, K.T. Hsu, K.H. Hu, C.Y. Liao, C.Y. Wu (NSRRC)*

To eliminate long distance cabling for improving signal quality, the remote waveform access supports have been developed and applied on the TPS (Taiwan Photon Source) and TLS (Taiwan Light Source) control systems. Waveforms include pulse magnets power supplies waveforms, AC waveforms of main power supplies, LLRF waveforms, beam signals, etc., and these are necessary to be monitored during routine beam operation. One is that use the EPICS-embedded data acquisition systems which are formed by the Zynq System-on-Chip architecture to capture the waveform signals; the other is that a dedicated EPICS IOC is used to communicate with the present Ethernet-based oscilloscopes to acquire each waveform data. According to specific purposes use, the different graphical applications have been developed and integrated into the existing operation interfaces. These are convenient to observe waveform status and to analyze the acquired data on the control consoles. The efforts are described at this paper.

THP17 **Injection and Extraction Timing Controls at SuperKEKB Damping Ring**

***H. Sugimura**, H. Kaji, F. Miyahara, M. Satoh (KEK) Y. Iitsuka (EJIT)*

SuperKEKB project aims at world highest luminosity to $8x10^{35}cm^{-2}s^{-1}$. To achieve the luminosity, a lot of equipment was newly constructed or upgraded. Especially, Damping Ring (DR) was newly constructed for reducing positron emittance, and was located at the middle of the injector LINAC. The DR timing system was also constructed. The synchronized timing which is generated at injector LINAC, is received at DR sub timing station and is distributed the end of some equipment, Kicker, Septum, and monitoring devices. We succeeded to generate not only synchronized timing but also beam control information such as beam gate for trigger inhibit signal and injection and extraction timing "value" via data buffer delivery. By using this method, accelerator operation became more convenient system.

THP18 **Operational Experience of the Digital LLRF Control System at the Booster Ring of Taiwan Photon Source**

Z.K. Liu, *F.Y. Chang, L.-H. Chang, M.H. Chang, S.W. Chang, L.J. Chen, F.-T. Chung, Y.T. Li, M.-C. Lin, C.H. Lo, Ch. Wang, M.-S. Yeh, T.-C. Yu (NSRRC)*

The purpose of a Low-Level Radio Frequency (LLRF) system is to control the accelerating cavity field amplitude and phase. To have better RF field stability, precise control and high noise reduction, a digital LLRF control system based on Field Programmable Gate Arrays (FPGA) was developed at NSRRC. We replaced the analog LLRF system with a digital version for the TPS booster ring at the beginning of 2018. During routine operation of the booster RF, some faults occurred when the digital LLRF operated in the energy savings mode. The performance and operational experience of the digital LLRF for the TPS booster will be presented here.

THP19 **Timing System for Multiple Accelerator Rings at KEK e^+/e^- Injector LINAC**

F. Miyahara, *K. Furukawa, H. Kaji, M. Satoh, H. Sugimura (KEK) T. Kudo, S. Kusano (Mitsubishi Electric System & Service Co., Ltd) H.S. Saotome (Kanto Information Service (KIS), Accelerator Group)*

The KEK e^+/e^- injector linac is operated in multiple modes that can be switched every 20 ms for e^+/e^- beam injection to five different accelerator rings, SuperKEKB High Energy Ring (HER), Photon Factory (PF) ring, PF-AR, positron damping ring (DR) and SuperKEKB Low Energy Ring (LER). The MRF event system which consists of event generators (EVG) and event receivers (EVR) is used to distribute event codes that correspond to beam modes and data buffer. The EVR generates various trigger timing signals depending on the event code. The data buffer incudes some important parameters such as HER/PDR injection RF bucket, setting currents of pulsed quad/steering magnets that enables multiple beam injection. The event system uses the linac main clock (114.2 MHz) which synchronized to HER/LER, but due to PF and PF-AR rings are not synchronized to the linac, an additional synchronization system is employed for those rings. We will describe the timing and synchronization system to fulfill multiple injections to independent rings and report status of the system.

THP20 **Study of Energy Saving Operation for the TLS Booster Power Supply**

J. Chen, *Y.-S. Cheng, K.T. Hsu, K.H. Hu, S.H. Lee, C.Y. Liao, C.Y. Wu (NSRRC)*

Operate an injector of a synchrotron light source energy efficiency is an important subject. Dipole and quadrupoles families of the booster synchrotron for Taiwan Light Source (TLS) is resonance excited by three White circuits resonance at 10 Hz rate. Magnet current cannot response in cycle-by-cycle basic due to resonance nature. Investigation the possibility to operate the booster synchrotron in energy saving mode is explored. Minimize duration of magnet excitation without affect the injection and extraction of beam to support top-up operation for the TLS is investigated. Efforts will be presented in this report.

THP21 **Development of Triggered Scaler to Detect Miss-Trigger**

N. Kamikubota *(KEK) K.C. Sato (J-PARC, KEK & JAEA) Y. Tajima (KIS) S.Y. Yoshida (Kanto Information Service (KIS), Accelerator Group)*

A "triggered scaler" has been developed for J-PARC accelerators. It is a PLC-type scaler with a memory array. Number of pulsed signals is counted and stored in a cell of memory array, then, each external trigger (typically 25Hz) shifts the pointer to the cell. The memory size (maximum 192) is designed to store one machine-cycle (2.48s or 5.20s in J-PARC). Stored data (converted to an EPICS waveform PV) is analyzed every machine cycle, to verify no miss-trigger (or to detect a miss-trigger) in the previous machine cycle. Using a prototype of triggered scaler, two demonstrative measurements are given: (a) Frequency modulation (injection - ramp-up - extraction) of a RF signal was measured. The measured data is used to evaluate rough machine energies. (b) MPS events were detected by a triggered scaler. Visualizing observed data is effective to notify operators which phase a MPS event occurred in a machine cycle. Based on these measurements, a plan to detect a miss-trigger will be discussed.

THP22 **Guaranteeing the Measurement Accuracy in Em#**

X. Serra-Gallifa*, J.A. Avila-Abellan, M. Broseta, G. Cuní, O. Matilla (ALBA-CELLS Synchrotron)*

ALBA, in collaboration with MAXIV, has developed a four-channel electrometer of 18 bit deep with 8 ranges from 1 mA to 100 pA. The objective of accuracy in the measurements made clear from the beginning the need to compensate the components tolerances and its dependence with temperature. This paper describes the tests performed to characterize the acquisition chain, the automatic calibration developed and the hardware and software implemented to achieve the accuracy target. This implementation has been eased due to the high flexibility given by ALIN and Harmony architectures used in the Em#.

THP23 **Further Improvements in Power Supply Controller Transient Recorders for Post-Mortem Analysis of BPM Orbit Dumps at PETRA-III**

***P.K. Bartkiewicz**, C. Gindler, G.K. Sahoo (DESY)*

PETRA-III is a 3rd generation synchrotron light source dedicated to users with 14 beamlines beginning operations in 2010. The storage ring was modified in 2014 for an additional 12 beamlines in two extensions. It is operated with several filling modes with 100 mA at electron beam energy of 6 GeV. The horizontal beam emittance is 1.30 nmrad with 1% coupling. During a user run the Machine Protection System may trigger an unscheduled beam dump if transients in the magnet power supply (PS) currents are detected which are above permissible limits. PS controllers provide transient recorder data, showing differences between current set-point and readout values in a time span of several seconds around the moment of a beam loss. We describe automatic management system handling a large number of PSs, performing automatic transient recorder data readout, storing and available for offline analysis. We discuss hardware implementation of transient recorders and its configuration software, a Java GUI application used to investigate the transient behavior of different PSs, which might have been responsible for emittance growth, orbit fluctuations, or the beam dumps seen in a post-mortem analysis.

FRKT — Keynote Talk 3

Chair: K.T. Hsu (NSRRC)

FRKT1 **Bootstrapping AI Adoption for Smart Manufacturing**

09:00 69 ***T. Chen*** *(Inventec) W.-C. Chen (Skywatch)*

When it comes to applying AI to smart manufacturing, the first problems that come to mind are usually the automatic inspection of products. The reality is we often need to carefully re-define the problems to yield a satisfactory solution and return on investment. In this talk, we share our experiences working with first-tier electronics manufacturing facilities to apply machine learning techniques to their product design process and production pipeline. We will also talk in more detail about several applications in the domains of circuit defect and product appearance inspections, quality control, and the associated edge AI algorithms and machinery we have created to solve these problems.

FRCA — Contributed Oral: Data Acquisitions 1

Chair: C.H. Kuo (NSRRC)

FRCA1 10:00 15 **New Collaborative Approach to Scientific Data Management with NOVA**

***W. Mexner**, E. Bründermann, S. Funkner, A. Kopmann, G. Niehues, N. Tan Jerome, M. Vogelgesang (KIT)*

Accelerator physics studies at the storage ring KARA at KIT produce terabytes of diagnostics data per day, which is recorded once and then reused on a long-term basis to answer different research questions at KIT. Finally, raw data and intermediate analysis results should be published along with scientific results. Thus storing from the very beginning the data of all analysis steps and its metadata in a central portal would be very beneficial. Similar requirements exist for synchrotron X-rayμtomography at the KIT imaging cluster and there is an interest to share the large data analysis effort. By using a new collaborative approach, the NOVA project aims to create tools, to enable an efficient use of valuable beam time. Forμtomography beamlines the project will build up a comprehensive database of various demonstrator organisms up for the morphological analysis of animals. The NOVA portal is integrated in the local data handling procedures and the datasets automatically appear in the NOVA portal as they are recorded. For both applications, accelerator diagnostics and X-ray tomography, the NOVA portal will offer new collaborative tools to enable synergetic data analysis.

FRCA2 10:15 15 **Development of a Task-Oriented Chatbot Application for Monitoring Taiwan Photon Source Front-End System**

***Y. Z. Lin**, C.-C. Chang, Y. T. Cheng, J.-Y. Chuang, H. P. Hsueh, C. H. Huang, I. C. Sheng (NSRRC)*

In this study, we propose a task-oriented chatbot application as an interactive user interface for monitoring Taiwan Photon Source front-end system. This application can get specific information faster and improve the efficiency of the maintenance engineer's definition of fault information when a fault occurs. The chatbot uses LINE's Message API to provide services, and obtains information and status of the front-end system over EPICS protocol, responding to users' needs, like a virtual assistant. At present, the application can obtain the front-end system information of Taiwan's photon source already in operation, including x-ray beam position monitor, safety interlock system, front-end valve status, vacuum status…etc. However, in addition to the passive provision of information, this program adds a fault warning function, and will actively transmit fault information to relevant personnel when a problem occurs in the safety interlock system.

FRCB — Contributed Oral: Data Acquisitions 2 and Hardware Technologies 2

Chair: P. Duval (DESY)

FRCB1 **Ultra Fast Data Acquisition in ELI Beamlines**
10:50 15
P. Bastl *(Institute of Physics of the ASCR) O. Janda, P. Pivonka, B. Plötzeneder, J. Sys, J. Trdlicka (ELI-BEAMS)*

The ELI Beamlines facility is a Petawatt laser facility in the final construction and commissioning phase in Czech Republic. In fully operation phase, four lasers will be used to control beamlines in six experimental halls. In this paper we describe Ultra fast and distributed data acquisition system as was defined in ELI Beamlines. The data acquisition system is divided into two levels: central and local level. The central level data acquisition system defines a special Tier 0 RAM buffer. This buffer is based on special multi node data acquisition server which shares memory of all its nodes into one continuous space over low latency network technologies (Mellanox Infinband/Intel OmniPath). The main role of the Tier 0 buffer is to acquire first bunch and provide load balancing of incoming data. These data comes from many sources distributed along the experimental technologies. The local data acquisition system is then responsible for connection of local detectors to central data acquisition server through ROCE interface. The connection is done directly when supported or indirectly using local data acquisition computers (for PCIe etc.).

FRCB2 **Design and Construction of the Data Warehouse Based on Hadoop Ecosystem at HLS-II**
11:05 15
Y. Song*, X. Chen, C. Li, G. Liu, J.G. Wang, K. Xuan (USTC/NSRL)*

A data warehouse based on Hadoop ecosystem is designed and constructed for Hefei Light Source II (HLS-II). The two-layer database dimensional model is designed to satisfy the data analysis needs of scientists and engineers. The ETL program based on Spark migrates data to HDFS from RDB Channel Archiver and the EPICS Archiver Appliance continuously and store them in Parquet format. The distributed data analysis engine based on Impala greatly improves the performance of data retrieval and reduces the response time of queries. In this paper, we will describe our efforts and experience to use various open sources software and tools to effectively manage the big data. We will also report the plans on the applications of artificial intelligence on this data warehouse in the future.

FRCB3 11:20 15 **Novel Concept of Off-detector Electronics Based on Machine Learning for High Energy Physics**

***W. Wang. Wang**, B.M. Balzer, M. Brunet, M. Caselle, L. Rota, M. Weber (KIT)*

Due to increase of complexity of HEP detectors operating in rush radiation environment, detector calibration operations becomes a challenge. Moreover, growing volumes of available data, traditional calibration approach risk being weak. Therefore, new methods that can automatically analyses large complex data and deliver quick accurate results, without human intervention, are necessary in modern detectors. Embedded machine learning algorithms on FPGAs enables new methods for performing high-granularity Data Quality Monitoring (DQM) and real-time detector calibration, ensuring optimal data quality for further offline analysis. Combining FPGA with multiprocessor system-on-chip (MPSoC) opens "new ideas" in integration of DQM and slow-control for off-detector electronics. In this context, a novel readout electronics based on ZYNQ Ultrascale$^+$ MPSoC has been designed. To handle the huge data volume, the ZYNQ board is equipped with FireFly optical data links. In this contribution, a novel high-granularity Data Quality Monitoring (DQM) architecture with real-time detector calibration based on embedded machine learning is presented.

FRCB4 11:35 15 **The Application for Fault Diagnosis and Prediction of Power Supply Control Device on BEPCII**

***J. Liu**, D. Wang, J.C. Wang, X.L. Wang (IHEP)*

With the widely adoption of complex electronic devices and microcircuits in accelerator system, the probability of system failure and functional failure will be enlarged. For example, the fault of the magnet power supply front-end electronics devices may cause accelerator energy instability and even lead to beam loss. Therefore, it is very necessary to diagnose and locate the device fault accurately and rapidly, that will induce the high cost of the accelerator operation. Faults diagnosis and prediction can not only improve the safety and reliability of the equipment, but also effectively reduce the equipment's cycle costing. We applied the FMECA and testability modeling method for the PSI device, which using in BEPCII power supply control system, and evaluated the remaining life of the PSI under certain temperature and humidity condition based on the reliability model and accelerated life test.

FRCC — Contributed Oral: Hardware Technologies 3

Chair: Y.B. Yan (SSRF)

FRCC1 13:30 15 **FPGA-based Image Processing System for Electron Beam Welding Facility**

M. M. Sizov, *A.A. Starostenko (BINP SB RAS)*

In this paper image processing system for secondary emission of electrons in electron beam welding facility is described. System runs on Intel Field Programmable Gate Array (FPGA) for digital processing. Time-sensitive algorithms are designed in VHDL and dataflow DSL Caph. Seam finder algorithm and data filters are written in Caph. The system is designed to filter high-frequency noise and estimate seam location for its automatic correction within 2 us. General algorithms for hardware control and data visualization are described with the interface to the FPGA-based part.

FRCC2 13:45 15 **Continuous Beam Scanning Intensity Control of a Medical Proton Accelerator Using a Simulink Generated FPGA Gain Scheduled Controller**

V. Minnig, *C. Bula, M. Eichin, P. Fernandez Carmona, G. Klimpki, D. Meer, S. Psoroulas, D.C. Weber (PSI)*

At the Centre for Proton Therapy at the Paul Scherrer Institut we treat cancer patients using a fixed beam line and two gantries. The latter use a step-and-shoot technique to deliver dose covering the treatment volume with a grid of weighted proton bunches. Dose delivery for tumours moving under respiration (e.g. lung) is however challenging and not routinely performed because of the interplay between target and beam motions. At the Gantry 2 unit, we are implementing a novel continuous beam modulation concept called line scanning, aiming at realizing a faster dose delivery to allow for effective organ motion mitigation techniques such as rescanning and gating. The current should stabilise within 100 us, which is tough due to the non-linearity of the system and latency of the monitors. In this work we implemented a gain scheduled controller and a predictor by modelling the accelerator in Simulink and developing a controller using the frequency domain robust method. We used Mathwork's HDL Coder functionality to generate VHDL code that was implemented in an FPGA in the gantry control system. Latency, overshoot and dosimetric performance improved considerably compared to a classic PID.

FRCC3 14:00 15 **CERN Supervision, Control and Data Acquisition System for Radiation and Environmental Protection**

***G. Segura**, A. Ledeul, A. Savulescu, B. Styczen, D. Vazquez Rivera (CERN)*

The CERN Health, Safety and Environment Unit is mandated to provide a Radiation and Environment Supervision, Control and Data Acquisition system for all CERN accelerators, experiments as well as the environment. In order to face the increasing demand for radiation protection and continuously assess both the conventional and the radiological impact on the environment, CERN developed and deployed a new supervisory system, called REMUS - Radiation and Environment Monitoring Unified Supervision. The operation and maintenance of the previous CERN radiation and environment supervisory systems showed some limitations of these systems in terms of flexibility and scalability. Hence REMUS design and development focused of these desired features. REMUS interfaces with 75 device types, providing about 3,000 measurement channels (approximately 600,000 tags) at the time of writing. This paper describes the architecture of the system, as well as the innovative design that was adopted in order to face the challenges of heterogeneous equipment interfacing, diversity of end users and continuous operation.

FRCC4 14:15 15 **Maintenance and Optimization of Insertion Devices at NSLS-II Using Motion Controls**

***C.A. Guerrero**, R.I. Farnsworth, D.A. Hidas (BNL)*

The purpose of this project is to demonstrate the performance improvements on insertion devices by upgrading the motion control software. The insertion devices installed inside the NSLS-II storage ring are currently operating at micron precision with slow speeds, which can limit the scope of preferences for user experimentation. We can manipulate the devices with adaptive tuning algorithms to compensate for varying electromagnetic forces throughout motion scans. By correcting positional feedback with encoder compensation and redefining motion programs, we can safely increase the speed to run the same motion trajectories in less time.

19-Oct-18 14:50 – 15:20 Main Auditorium

FRIN — Interactive Session 2

Chair: W. Mexner (KIT)

19-Oct-18 15:20 – 16:00 Main Auditorium

FRCL — Closing Session

Chair: R. Bacher (DESY)

FRCL1 **Isamu Abe Prize**

15:20 25 ***R. Bacher*** *(DESY)*

The Isamu Abe Prize recognizes innovative ideas, achievements and applications in the field of accelerator controls and it is granted every two years by PCaPAC.

The main purpose of the Isamu Abe Prize is to encourage people in the early stages of their career. The prize awarded by the International Program Committee seeks to recognize innovative ideas, achievements and applications presented at PCaPAC.

The prize is named in recognition of Isamu Abe, from KEK, one of the co-founders of PCaPAC, who suddenly passed away in June 2002.

FRCL2 **Closing PCaPAC 2018**

15:45 15 ***Y.-S. Cheng*** *(NSRRC)*

This session will discuss and close the 12th Personal Computers and Particle Accelerator Controls (International Workshop on Emerging Technologies and Scientific Facilities Controls).

Boldface papercodes indicate primary authors

PCaPAC Workshops

1st	PCaPAC 1996	DESY, Hamburg, Germany
2nd	PCaPAC 1999	KEK, Tsukaba, Japan
3rd	PCaPAC 2000	DESY, Hamburg, Germany
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9th	PCaPAC 2012	VECC, Kolkata, India
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pcapac2018@nsrrc.org.tw