

## Report on AFAD 2018

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### Abstract

The 9<sup>th</sup> Asian Forum for Accelerators and Detectors (AFAD) <sup>1)</sup> was held from 28 to 31 January 2018, in Daejeon, Korea. AFAD was organized by the Asian Committee of Future Accelerators (ACFA) <sup>2)</sup> to promote collaboration among universities and research institutes in Asia and Oceania. The major focus of the forum was given to the fields of accelerators, detectors and related technologies both in industry and research sectors. AFAD 2018 was hosted by the Rare Isotope Science Project team <sup>3)</sup> of the Institute for Basic Science (IBS) <sup>4)</sup> and the Division of Quantum Engineering and Nuclear Fusion, Korean Nuclear Society <sup>5)</sup>.

### Venue and Scope

AFAD 2018 was held at DCC (Daejeon Convention Center) and covered a broad spectrum of topics in accelerator-related sciences. Beside general interest plenary sessions, more specific topics were presented in seven parallel Working Groups (WG):

- **WG1:** Accelerator and its related technologies for photon science.
- **WG2:** Detector technology development.
- **WG3:** Accelerator technologies for industrial & medical applications.
- **WG4:** Innovative accelerator techniques.
- **WG5:** Accelerator and its related technologies for hadron (neutron) science.
- **WG6:** Network & Computing.
- **WG7:** Cryogenics, Cryomodule and Superconducting Technology for Accelerator.

In total, 177 participants from 9 countries registered for the forum. Detailed information is summarized in Table 1. Also 44 domestic institutes and companies had an opportunity to show their products to the community of accelerator and experimental physics in the specially allocated booths. Figure 1 shows a group photo of AFAD 2018 participants.

### Plenary Sessions

Two plenary sessions took place on the 29<sup>th</sup> and 30<sup>th</sup> of January. The first session, chaired by prof. Youngjoon Kwon from Yonsei University, included several overview talks:

“Status and prospect of KEK” by prof. Y. Okada (KEK), “Status and Progress with the High Energy Electron Positron Collider (CEPC)” by prof. Xinchou Lou (IHEP), “Operational Status of PLS-II and PAL-XFEL” by prof. Dong-Eon Kim (PAL-XFEL), “Status of RAON construction” by prof. Young-Kwan Kwon (RISP/IBS) and “KAERI’s developments of various medical, industrial, agricultural and basic scientific electron accelerators” by prof. Yujong Kim (KAERI).

The KEK presentation on the status of SuperKEKB reported that phase-I accelerator commissioning had been successfully completed in 2016. The Belle II detector had been rolled-in during April, 2017. Phase-II commissioning, without the vertex detector, will start soon. A full physics run will begin in early 2019. SuperKEKB/Belle-II will provide 40 times the physics output of the previous B factory experiment (KEKB/Belle). Its collision experiments are about to begin aiming for discovery of new physics. Also, detailed status reports from

Table 1: AFAD 2018 attendance statistics.

Country	Number of participants
Korea	122
China	29
Japan	17
Russia	3
Taiwan	2
Australia	1
India	1
Canada	1
Thailand	1

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Figure 1: Group photo of AFAD 2018 participants.

J-PARC and T2K experiment were given. These reports demonstrated the diversity of science programs at KEK ranging from particle and nuclear physics to materials and life sciences based on large accelerator facilities. A clear statement was made that KEK is making efforts towards realization of the ILC starting as a Higgs factory with contributions from the worldwide HEP community.

A report from the High Energy Electron Positron Collider (CEPC), IHEP claimed that Conceptual Design Report is progressing well and will be completed in 2018. Design + R&D (DRD) needs to be compatible with various sources of funding and support to build a stronger CEPC team with international collaboration. In the long term, a high efficiency High Temperature Superconductor (HTS) magnet program is being explored in China with a carefully constructed consortium infrastructure, experience and engineering proficiency gained through current projects (light source, CSNS, etc.) aiding the CEPC. Upon successful completion of the DRD program, it is expected to make the case (~5 years from now) to the national government for building CEPC cryomodule R&D and Test facility at the PAPS.

Operational Status of PLS-II and PAL-XFEL was given in the PLS overview. PLS user service started in 1995 with 2 beamlines and a small number of user groups. In 2017, the community increased to more than 5,000 user visits, ~1,500 user experiments; ~500 high impact science papers published based on results obtained in 34 beamlines. Given this excellent achievement and the fact that many new advanced synchrotron radiation sources are coming online, maintaining

the competence is considered to be a priority for PLS-II. The PAL-XFEL system was successfully commissioned and all the target specifications were achieved. Beamlines are also commissioned and carried out demo experiments using Lysozyme crystals confirming all instrumentation (including detector and DAQ) are work as expected. In 2017, PAL-XFEL operated 120 days for user service, 30 experiments, and expects 140 days of operation for 38 experiments in 2018.

Status report on Rare isotope Accelerator complex for ON-line experiments (RAON) development described that the accelerator and experimental systems of the Rare Isotope Science Project (RISP) is on track with civil construction. Prototyping major accelerator parts had been in progress since 2013 (TDR publication). SRF test facility has been operating since June 2016. The procurement of cavities, cryomodules etc. is in progress. Early operation of the Low-Energy Facility is expected from mid 2020.

In the last report of the session the growing number of user applications with MeV-range RF electron linacs was emphasised. It was reported that KAERI has successfully developed various S-band electron linacs for CIS and NDT applications and successfully developed a 6 MeV X-band electron linac for medical applications. KAERI has transferred RF linac technologies to RTX and SEC. In addition, KAERI has been working to construct a new neutron Time-Of-Flight (nTOF) facility with a 20 MeV superconducting electron linac. Now KAERI is ready to develop advanced accelerator facilities for nTOF, ultrafast electron beam sciences, soil-treatment system, and a new synchrotron light source.

During the second session on the 30<sup>th</sup> of January chaired by prof. Eunil Won (Korea University) overview talks “Korean Neutrino Observatory” by prof. Seon-Hee Seo (Seoul National University), “Computing for High Energy Particle Physics” by prof. Geoff Taylor (CoEPP, Australia) and “Introduction to sponsoring companies” by Jongwon Kim (RISP/IBS) were presented followed by the Closing remarks from the Director of RISP prof. Jeong Sun Chan (RISP/IBS).

A report on Korean Neutrino Observatory introduced Hyper-K as a multi-purpose detector in MeV-TeV range and claimed Korea to be the best location for the 2<sup>nd</sup> Hyper-K detector. It features a longer baseline of 1,100 km vs. current 300 km and a larger overburden of ~1 km vs. ~650 m. Physics sensitivities should be improved with this 2<sup>nd</sup> detector build in Korea which will improve neutrino mass ordering determination, CPV,  $\sigma_{CP}$  precision and  $\sigma_{CP}$  coverage as well as non-standard  $\nu$  interaction and SOLAR/SN/SRN. Mt. Bisul & Bohyun are considered as good site candidates according to the conducted survey.

### Parallel Sessions for Working Groups

Detailed information and slides can be found via the link in Ref. 1). A brief summary of working groups is below.

#### *WG1: Accelerator and its related technologies for photon science.*

WG1 was divided onto 4 sessions where a total of 15 talks were given. The talks presented various aspects of FEL development (Status of FEL in SINA, Sub-20-femtosecond timing jitter and Harmonic Lasing Self-seeded FEL at PAL-XFEL, Novosibirsk FEL facility, FEL based Delhi Light Source Project at IUAC, Development of Coherent THz Radiation Source and MIR-FEL in Thailand, Commissioning and Early User Operation of Dalian VUV FEL and Latest results on the 100-mA CW RF Electron Gun for Novosibirsk ERL FEL); novel beam dynamics and instrumentation (Emittance Exchange Program at KEK STF, Study of BINP damping ring performance with the streak camera, Accelerator R&D activities at PAL, and Status of the DIRAMS C-band standing-wave accelerator for a radiotherapy machine); and advanced radiation sources development (Recent Results on X-ray Generation at LUCX, LUCX pre-bunched e-beam generation and its application to THz experimental studies, and Structured Light from Helical Undulators).

#### *WG2: Detector technology development.*

WG2 had 3 sessions with a total of 15 talks. Almost a quarter of all presentations covered the gas electron multiplier (GEM) developments (Large GEM foil production using the double mask method, Ceramic GEM, GEM-based polarimeter detector development for storage ring proton electric dipole moment measurement, LAMPS GEM based TPC R&D); whereas others were devoted to the progress in Time Projection Chamber (TPC) and other detector developments: Liquid argon TPC for neutrino experiment, Liquid scintillator (neutrino), Dual readout calorimeter; NEOS Detector for Measuring Energy of Reactor Neutrinos, On the limits of the hadronic energy resolution of calorimeters, The design and progress of the Central Detector of JUNO; 5 $\mu$ m-Pore Microchannel-Plate and its performance, The mass production and batch test of 20 inch MCP-PMT, Research on Liquid Scintillator Cherenkov Detector for Neutrino Physics, PandaX-4T Dark Matter Detector, PandaX-III High Pressure Xenon TPC for the Neutrinoless Double Decay Search.

#### *WG3: Accelerator technologies for industrial & medical applications.*

WG3 was divided onto 3 sessions with 13 talks. The following talks were presented: Present status of Cryomodule and Cryoplant for LIPAc, Transmission and Scanning Muon Microscopy; Electron linacs for radiotherapy, Development of a superconducting cyclotron based proton therapy system at HUST; Carbon Ion Radiotherapy; Towards a Hadron Driver for the Next Generation of Cancer Therapy; Full-Body PET Camera based on Liquid Xenon TPC technology; Laser driven proton acceleration enhancement by using nanophotonic butterfly wing targets, Physical design of the proton linac injector for the synchrotron based proton therapy system in China, Electron Accelerator for radiography; Medical Imaging and Therapy Radioisotope Production Techniques with High Current Cyclotrons; Start of mutation breeding research using ion beam in Korea; Irradiation electron linacs.

#### *WG4: Innovative accelerator techniques.*

WG4 was divided into 4 sessions where 12 talks were given. The following talks were presented: Development of the laser driven ion injector for the new generation heavy ion cancer therapy, Compact charged particle accelerators for applications,

Ion acceleration by shock waves and pulse-recycling TNSA, Novel laser-plasma electron acceleration experiments at SJTU based on ionization injection and two-color laser pulses, Laser wakefield accelerator for medical application at KERI, Laser Plasma Acceleration using the evolution of plasma wave and nanoparticle, Recent studies on plasma-based acceleration at IHEP, Researches on laser-driven electron accelerators in Japan, Generation of ion beams with narrow energy spread from a metal-polymer double layer target irradiated by an ultra-intense laser pulse, Opportunities on dielectric laser accelerator on high-brightness radiation, Laser-plasma-based THz radiation sources and their applications, Radiation burst from laser-plasma interactions.

*WG5: Accelerator and its related technologies for hadron (neutron) science.*

WG5 had 3 sessions where 15 talks were given. The following talks were presented: Upgrade of Hokkaido University neutron source (HUNS), Status of the RIKEN Linac upgrade, Challenge and status of high intensity heavy ion accelerator facility (HIAF) in China, Accelerator-driven compact neutron sources in Japan, Design of 6 MeV compact cyclotron for neutron based safety inspection, Development of CW heavy ion linac at IMP, A Plan for a Pulsed Neutron Source Based on the KOMAC 100-MeV Proton Linac, Development of BNCT at DawonSys, Current Status of the 28 GHz SC-ECRIS for RISP, Compact neutron source Development with SKKUCY-13 Cyclotron, Construction and Preliminary Beam Test of RISP 81.25 MHz CW RFQ for Heavy Ions, The current status and future plans of Versatile Ion Beam Accelerator Facility, BEST 70P Cyclotron beam commissioning at LN Legnaro, Status of an Electron Beam Ion Source for Charge Breeding for RISP, An X-band Compact Electron Linac Development for a Neutron Radiography.

*WG6: Network & Computing.*

WG6 reviewed 14 talks in 3 sessions: Networking and Computing Status in IHEP/China, Grid Deployment at KEK: Status and Plan, KREONET: Research Networking in Korea, Computing in Korea, Status report from Tokyo Tier2 at ICEPP, Research infrastructure development in Academia Sinica (Taiwan), Networking and Computing in Thailand, Belle II Computing System, CMS Tier-2, GSDC@KISTI, Networks for High Energy Physics: LHCOPN and LHCONE, Status

report in TEIN, NDN for Large-scale Scientific Data and Its Status on HEP, CoEPP Tier 2 in Melbourne.

*WG7: Cryogenics, Cryomodule and Superconducting Technology for Accelerator.*

WG7 was divided onto 3 sessions where in total 12 talks were given. The following talks were presented: Status of Vertical Test Facility for HWR and QWR at RISP, Operation of cryomodules for Chinese ADS Front-end Demo Linac, Progress of CEPC cryogenic system, A plan of the HWR superconducting linac development at KOMAC, The HWRs for Chinese ADS project, Report on the Asian School on Superconductivity and Cryogenics for Accelerators (ASSCA 2017), Cryogenic system of the SuperKEKB IR final focusing SC magnets, Introduction of PAPS cryogenic system, Current status of cryomodule development for SCL3 of RAON, Conceptual design of CEPC superconducting RF system, Progress of Linear IFMIF Prototype Accelerator (LIPAc) in collaboration with EU, Current status and challenges of cryogenic systems for RAON accelerator.

**Laboratory Tour (SRF Test Facility at Munji Campus of KAIST)**

The SRF Test Facility is located in the Munji-campus of KAIST<sup>6)</sup>, which is in a 10 minute driving distance from the DCC. The schematic diagram of the facility and photographs of its major developments are presented in Fig. 2. Construction of the RAON is underway in Korea, a heavy ion accelerator based on low beta superconducting cavities. The 81.25 MHz RFQ had been fabricated and a beam test had been conducted confirming beam acceleration. Major accelerator subsystems, such as superconducting cavities, are under development. QWR (Quarter Wave Resonator) cryomodule test had been conducted and the design field gradient had been achieved. HWR (Half Wave Resonator) cryomodule test is planned shortly. SSR1 cavity is under development in collaboration with TRIUMF. High Tc superconducting quadrupole prototype had been successfully tested which is used in the IF separator. The vision of SRF test facility at Munji campus of KAIST includes education and fostering of new generation of scientists for the future, training them with basic theories and capabilities for practical applications. Carrying out both long and short term basic and applied research will enable the nation's strategic technological advancements. The facility will provide

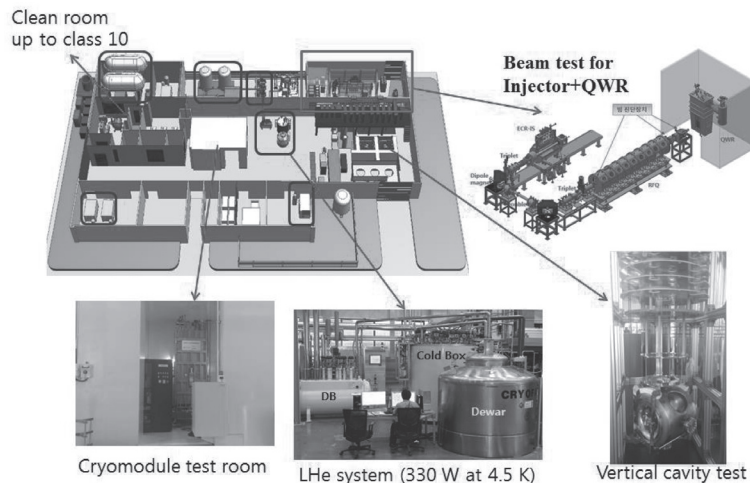


Figure 2: SRF test facility at Munji campus of KAIST.

foundation for research collaborations with a diverse pool of research institutions and industries.

### Excursion in Gongju, Buyeo Area

An excursion was held on January 31 to Gongju-Buyeo (公州-扶餘) area, which is a part of UNESCO World Heritage site. This area is rich in the history of an old Kingdom of Baekje (百濟, 18 B.C.–A.D. 660). Baekje had a strong relationship with old China and Japan. Buyeo and Gongju in Chungcheongnam-do (忠清南道) are replete with ancient legends that continue to live beyond their time. There are many attractions bearing the history of the Baekje Kingdom (18 B.C.–A.D. 660) and the lives of members of the royal family along with places manifesting a genuine harmony between man and nature. Gongju in Chungcheongnam-do was the second capital city of Baekje for 63 years before the capital was moved to Buyeo. In 1971, there was a breakthrough discovery in Gongju: the excavation of the Royal Tomb of King Muryeong. It is the only royal tomb from the Three Kingdoms Period whose occupant has been identified. The bodies of King Muryeong (武寧王, 25th king of Baekje: r. 462–523) and his queen had been interred here together and over 2,900 pieces of artefacts have been unearthed including the king and queen's crown ornaments and other accessories. The relics and artefacts removed from the Royal Tomb of King Muryeong are on display in exhibition halls at Songsan-ri Ancient Tombs and Gongju National Museum. The

ancient tombs are now closed for preservation, but recreations of the interior of Tomb No. 6 and the Royal Tomb of King Muryeong have been built for visitors to enter. The exact duplicates of the originals make visitors feel as if they are inside the actual tombs.

### Conclusion

Despite the cold weather outdoor, AFAD 2018 discussions were warm and stimulating for a new developments and progress within the scope of the forum. It was agreed that the next AFAD will be held at the Inter University Accelerator Centre (IUAC), New Delhi, India in 2019.

### References

- 1) Asian Forum for Accelerators and Detectors (AFAD) 2018; <https://indico.ibs.re.kr/event/191/>
- 2) Asian Committee of Future Accelerator (ACFA); <http://www.acfa-forum.net/about/index.html>
- 3) Rare Isotope Science Project; <http://www.risp.re.kr/eng/pMainPage.do>
- 4) Institute for Basic Science (IBS); <http://www.ibs.re.kr/eng.do>
- 5) Korean Nuclear Society; [https://www.kns.org/eng/sub/01/sub\\_01\\_01.php](https://www.kns.org/eng/sub/01/sub_01_01.php)
- 6) D. Jeon, H.C. Jung, H.M. Jang, et al. "PROGRESS OF THE RAON", Proc. of 18th International Conference on RF Superconductivity, MOYA03 (2017); <http://accel-conf.web.cern.ch/AccelConf/srf2017/papers/moya03.pdf>