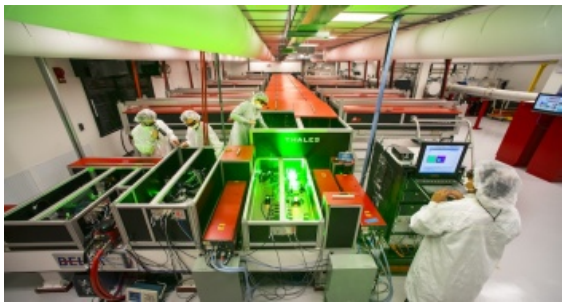
NEWSLINE
THE NEWSLETTER OF THE LINEAR COLLIDER COMMUNITY

DIRECTOR'S CORNER

The Golden State of Linear Colliders

by Brian Foster



As demonstrated again by the Tesla Technology Collaboration meeting last month at SLAC National Laboratory, no other future particle physics project has ever been so well understood both technologically and from the industrial mass production side than the ILC, reports European Regional Director Brian Foster. Foster also attended a one-off meeting with key players in plasma-wave acceleration - another possible collider for the future - where superconducting radiofrequency acceleration may also play a vital role.

AROUND THE WORLD

KEK issues action plan for the International Linear Collider

by Rika Takahashi

Japan's KEK laboratory took a step forward to realise the International Linear Collider on 6 January, issuing a “KEK-ILC Action Plan”. This plan blueprints how KEK should start its preparation towards the ILC when the Japanese government gives its green light for the project.

FEATURE

Family reunion of many generations of TESLA technology

by Ricarda Laasch

Quality factors, nitrogen doping and "the golden age" of superconducting radio frequency technology: an in-depth report from the recent TESLA technology collaboration meeting, also covered in this week's Director's Corner.

from ***nature***
13 January 2016
The week in science
FACILITIES
Linear collider Japan should ramp up its expertise as it prepares to host the world's next-generation particle smasher in the 2020s, reports the country's High Energy Accelerator Research Organization (KEK) in Tsukuba. An action plan published on 6 January lays out the KEK's goals for the preparation phases of the International Linear Collider, including a goal to triple the number of home-grown accelerator scientists and engineers.

from ***Iwate Nippo***
10 January 2016
超党派議連、2月訪米　県立大学長ら同行
ＩＬＣの国内誘致を目指す超党派の議員連盟は来月訪米する方向となり、鈴木厚人県立大学長や県ＩＬＣ推進協議会のメンバーが同行する。日米の協力関係構築を後押しし、実現に弾みをつける考えだ。(Members of the Japanese Federation of Diet members to promote the realisation of the ILC will visit Washington DC next month. Astuto Suzuki, president of Iwate prefectural University and members of Iwate Prefecture International Linear Collider Promotion Council will join the delegation. They aim to give a boost on US-Japan collaboration toward the realization of the ILC)

from ***Tanko Nichi Nichi***
9 January 2016
文科省の「ゴーサイン」見据えプラン策定（ＫＥＫ）
ＫＥＫは８日までに、「ＫＥＫ－ＩＬＣアクションプラン」を策定した。文部科学省がＩＬＣの誘致建設を前提とした諸外国との交渉を始めることを正式決定した場合、想定されるスケジュールや組織体制、必要となる人材数をより明確に示し、本格的な準備へスムーズな移行を目指す。(KEK issuued KEK-ILC action plan for how KEK should start its preparation toward the International Linear Collider when the Ministry of Education, Culture, Sports, Science and Technology (MEXT), decides to initiate negotiations with foreign countries.)

from ***Physics Today***
8 January 2016
News Picks : Japan gears up to host linear collider
Science: Currently in the planning stage, the International Linear Collider (ILC) is a collaborative effort among research groups in Europe, the Americas, and Asia. Designed to complement the Large Hadron Collider at CERN, the ILC will likely be built in Japan.

from ***Science Careers (Science)***
8 January 2016
Elsewhere in Science
[T]he International Linear Collider (ILC) took another small step forward [Wednesday] when Japan's High Energy Accelerator Research Organization (KEK) released a plan for getting the country ready to host the $10 billion project by tripling its relevant science and engineering workforce over the next 4 years," (…)The organization "hopes to fill the gap by luring experienced hands as well as signing up new recruits.

from ***Science***
7 January 2016
Japan hopes to staff up to host the International Linear Collider
The "Action Plan," released yesterday, "is a small but critical point to show [the ministry] we will have the necessary manpower," says Okada, who chaired the working group charged with drafting the plan. Japan also needs to demonstrate to potential international partners that the country will shoulder its share of the final design effort, he adds.

from ***Iwate Nippo***
28 December 2015
盛岡でILC国際会議　16年、各国から200人超参加へ
ＩＬＣ計画を推進する国際研究者組織リニアコライダー・コラボレーション（ＬＣＣ）が来年１２月、盛岡市で「リニアコライダー国際会議２０１６」を開くことが関係者の話で分かった。(According to sources,　Linear Collider Collaboration will host the ILC conference LCWS2016 in Morioka city, Iwate prefecture next December)

from ***Wired***
21 December 2015
The Biggest Physics Moments of 2015
In April 2015, at meeting held in Tokyo, ILC scientists and engineers shared the technical design they've settled on and asked for government funding to move toward finals steps and construction. The Japanese government is already assessing the plans. (…) Physicists are discussing even grander (less fully baked) schemes. Bring it, 2016.

from ***Wired***
21 December 2015
New Accelerators on the Horizon
Sure, the LHC is impressive. At the moment, it's the star of the particle accelerator show. That won't last forever though. Even bigger machines are in the works.

ANNOUNCEMENTS

European School of High-Energy Physics

The 2016 CERN-JINR European School of High-Energy Physics will take place in Skeikampen (close to Lillehammer), Norway, 15-28 June 2016. The School is targeted particularly at students in experimental HEP who are in the final years of work towards their PhDs, although candidates at an earlier or later stage in their studies may be considered. The deadline for applications is 12 February 2016. Sponsorship may be available for a few students from developing countries.

CALENDAR

Upcoming events

CLIC workshop 2016
CERN
18- 22 January 2016

Upcoming schools

Joint Universities Accelerator School
Archamps, Haute Savoie, France
11 January- 18 March 2016

View complete calendar

PREPRINTS

ARXIV PREPRINTS

1601.02949
NNNLO determination of the bottom-quark mass from non-relativistic sum rules

1601.02854
Software for calculations of the Higgs boson lineshape in future lepton colliders

1601.02459
QCD NLO with Powheg matching and top threshold matching in WHIZARD

1601.02113
The growing toolbox of perturbative QCD

1601.01837
Charged Higgs Pair Production in THDM Through Photon-photon Collisions at the ILC

1601.01658
Heavy Neutrinos at Future Colliders

1601.00624
The force awakens – the 750 GeV diphoton excess at the LHC from a varying electromagnetic coupling

1601.00454
Higgs boson production in the U(1)B−L model at the ILC

1601.00293
Massive dark photons in a Higgs portal model

1601.00178
Constraining Natural SUSY via the Higgs Coupling and the Muon Anomalous Magnetic Moment Measurements

1512.08777
A Megaxion at 750 GeV as a First Hint of Low Scale String Theory

1512.08629
Fiber Bragg Grating sensors for deformation monitoring of GEM foils in HEP detectors

1512.08024
In vacuum diamond sensor scanner for beam halo measurements in the beam line at the KEK Accelerator Test Facility

1512.07917
SIMP Spectroscopy

1512.07733
How the γγ Resonance Stole Christmas

1512.07576
Scalar singlets at present and future colliders

1512.07232
Interference contributions to gluon initiated heavy Higgs production in the Two-Higgs-Doublet Model

1512.06877
Beyond Higgs Couplings: Probing the Higgs with Angular Observables at Future e+e− Colliders

1512.06729
Time and Position Resolution of the Scintillator Strips for a Muon System at Future Colliders

1512.06035
Higgs production from sterile neutrinos at future lepton colliders

1512.05731
Status and Prospects of the Two-Higgs-Doublet SU(6)/Sp(6) little-Higgs Model and the Alignment Limit

1512.05528
Theory status of four-fermion production at e-e+ colliders

1512.05194
High-precision αs measurements from LHC to FCC-ee

1512.04397
Composite Higgs models and $t\bar{t}$ production at future e+e− colliders

1512.03926
An alternative subtraction scheme for NLO QCD calculations

1512.03071
Rare Z Decays and Neutrino Flavor Universality

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DIRECTOR'S CORNER

The Golden State of Linear Colliders

Brian Foster | 14 January 2016

BELLA, the Berkeley Laboratory Laser Accelerator – an experimental facility for advancing the development of laser-driven plasma acceleration. Image: Roy Kaltschmidt, Lawrence Berkeley Nat'l Lab

California, officially known as the "Golden State", has recently been the scene of two key meetings of the wider linear-collider community. The first, from 1 to 4 December at SLAC National Laboratory, was the latest in the long-standing series of meetings of the Tesla Technology Collaboration (TTC), which explores the latest developments in the superconducting radio-frequency acceleration technique at the heart of the ILC. The second meeting, last week, was a one-off meeting organised by Wim Leemans of Lawrence Berkeley National Laboratory, which brought together many of the key players in plasma-wakefield acceleration (PWA) techniques to discuss a roadmap to a realistic design for a PWA linear collider. I was lucky enough to attend (most of!) both.

The TTC meeting saw 130 participants gather at SLAC National Laboratory. It was a pleasure to see many old friends among the participants and to listen to a remarkable array of talks detailing the latest advances in superconducting radiofrequency technology. As usual there were some highly enjoyable social encounters, including the conference banquet in the splendour of the new SLAC administrative building which now towers over the entrance to the lab. I have been coming to SLAC since the late 1970s and although much remains reassuringly recognisable, there have also been great changes. In particular the imposing presence of the new building from Sand Hill Road is an interesting contrast to the early laboratory, which almost hid itself away from the gaze of the general public. Any why not be prominently in the public eye? After all, few labs have as much to be proud about as SLAC does.

The defining characteristic to me of the TTC meetings is certainly the excellent overview it gives of what is going on in superconductivity worldwide but also the very detailed reports and opportunities for discussion that exist in the parallel sessions. The first morning was devoted to plenary talks on cavity and cryomodule production, which have been greatly informed by the European XFEL procurement and testing programme. The afternoon saw the first parallel session meetings. There were four working groups: on issues relating to high-quality-factor cavities; on cavity construction and production; on cryomodule design and construction; and finally on couplers and tuners. The issues covered were bewilderingly broad, from lessons learnt from industrial mass production to the optimum design of clean rooms. Prominent but perhaps not so prominent as at the previous meeting was nitrogen doping: its effects, the "magic recipe" and progress in theoretical understanding. The current chair of TTC, Hasan Padamsee from Cornell, not only introduced the meeting but also gave us a rousing farewell with a closing speech that contained a passionate appeal to make political progress with building the ILC. As demonstrated yet again by this meeting, no particle physics project has ever been so well understood both technologically and from the industrial mass production side; now is the time to exploit that and realise the ILC.

The other workshop that I attended from 6 to 8 January was entitled "Plasma-Based Accelerator Concepts for Colliders" and held at Lawrence Berkeley National Laboratory across the bay from SLAC. Constructing "back of the envelope" designs for a PWA linear collider has been a popular pastime in the margins and bars of accelerator and particle physics conferences for a number of years. Recently the envelopes have given way to several sheets of paper and several interesting ideas have appeared in journals and conference proceedings. The recent "P5" strategic review contained a number of recommendations for future accelerator R&D in the US. To follow these up, in spring last year a panel chaired by Don Hartill produced a report called "Accelerating discovery", in which PWA activities of various kinds played a prominent role. In particular, recommendation 10 advised: "Convene the university and laboratory proponents of advanced acceleration concepts to develop R&D roadmaps with a series of milestones and common down-selection criteria towards the

goal of constructing a multi-TeV e^+e^- collider." This, together with the continued rapid pace of advances in plasma acceleration, have led the US Department of Energy to convene a meeting next month to discuss such a roadmap. The Berkeley meeting was intended to gather and process the inputs necessary to inform this meeting.

The workshop began with a call to arms from Wim, whose first slide stated that the purpose of the meeting was to identify the key physics and technology R&D needed to realise a plasma-based collider, and to formulate a nationally and internationally coordinated roadmap for carrying out this research over the next two decades. Undaunted by the magnitude of the task, the around 50 participants buckled down to the job, hearing on the first day a series of excellent talks summarising particle physics requirements and the accelerator physics constraints on a PWA linear collider. The subsequent talks summarised the status and challenges for two distinct areas of current activity, which nevertheless have much in common: laser-driven and beam-driven. Laser-driven devices use a powerful laser to "blow away" the plasma electrons, forming a "bubble" of electron depletion whose electric fields can be utilised to produce enormous accelerating gradients. Beam-driven accelerators produce the same effect via the electric field of a beam of particles. The potential development of commercial lasers is a vital input to plans for laser-driven devices, so this was covered in a further talk, these three areas forming the topics for the working groups that convened for the remaining one and a half days of the workshop. Finally on the first afternoon, reports on the relevant US facilities at Argonne, Brookhaven, Fermi, Lawrence Berkeley and SLAC National Labs were given, together with an overview of activity in Europe.

I attended the beam-driven working group, as my main research interests are in FLASHForward, the beamline currently under construction at DESY to utilise the unique advantages of the superconducting technology of the FLASH-II accelerator by using its bunches to drive plasma-acceleration experiments. The working-group discussion was highly productive, with a clear path forward emerging from the first day of concentrated work. Perhaps surprisingly, the conclusions on priorities, directions and timescales from the laser-driven working group presented on the final morning of the workshop were both compatible and rather similar to those of our group; these were complemented by the conclusions of the laser-technology working group on the critical milestones towards developing the lasers running at tens of kilohertz and producing average powers of 300 kilowatts needed for a viable application to linear colliders. For comparison, the current state of the art is the BELLA facility at Lawrence Berkeley National Laboratory with 40W average power running at 1 Hz; the next planned step, K-BELLA, would increase this power to 3kW.

The final picture emerging from the workshop envisages a road map stretching to 2040, with the next fifteen years or so dedicated to addressing the fundamental questions that need to be resolved to make a plasma-based linear collider a reality. For example, the crucial question for a linear collider of positron acceleration, despite exciting recent advances at the FACET facility at SLAC, is still far from solved; others, such as the required tolerances for a PWA collider, have not even begun to be seriously considered. Many of the key issues of a conceptual design will be addressed in this 15-year R&D phase, giving the hope that, by the end of the road-map period, a technical design for a multi-TeV linear collider may be possible.

The "Golden" state refers to the great California Gold Rush, but also no doubt to the glorious sunny weather with which it is usually blessed. A particularly strong "El Niño" this year however meant that both meetings brought fairly torrential and much needed rain to a state in a five-year drought. Let's hope that this refreshment is mirrored by new impetus given to two vital but very different areas of our linear-collider technology. In fact, it turns out that in a beam-driven PWA linear collider, superconducting RF acceleration will still play a vital role: the only way to get sufficient beam power to give the required luminosity is to use a (beyond state of the art) superconducting accelerator. Whatever linear collider the future brings, both communities have a great deal of exciting work in front of them!

PLASMA-WAKEFIELD ACCELERATION | TESLA TECHNOLOGY COLLABORATION

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AROUND THE WORLD

KEK issues action plan for the International Linear Collider

Rika Takahashi | 14 January 2016

KEK issues its action plan for future laboratory

Japan's KEK laboratory took a step forward to realise the International Linear Collider on 6 January, issuing a "KEK-ILC Action Plan". This plan blueprints how KEK should start its preparation towards the ILC when the Japanese government gives its green light for the project.

"Green Light" in this document is defined as a formal announcement by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) to start negotiations with foreign countries with the assumption of ILC realisation. At MEXT, the ILC is under formal discussion by the Advisory Panel formed with experts from various fields, which published the summary of the discussion in June last year. Following the recommendation in the summary report, a new working group has been formed that currently discusses how there will be enough human resources to construct the machine and run the laboratory.

This action plan document provides the basic information required to plan technical actions, organisation, human resources, and training to realise formal approval of the ILC project, and to ensure a smooth start of the construction phase through the preparation phase from the current status, with a special focus on the human resources issue.

"We have to prove that the human resources required to execute the project exist to get the project approval,"says Yasuhiro Okada, a theoretical physicist and an Executive Director at KEK, who chaired the working group. " We believe that this KEK-ILC action plan will be a useful information to encourage the discussions to realise the ILC, both in Japan, and internationally," said Okada.

There are large on-going projects such as the European XFEL in Europe and LCLS-II in the US which could provide potential experienced human resources for the ILC project. "In Japan, new human resources and training will be especially necessary to ensure the maturation of superconducting RF system engineering. Also, we will need to secure the manpower for industrialisation and functioning as a hub laboratory. For that purpose, we will need to have new posts for the younger generation during the preparation phase to train future leaders," said Okada.

The report summarised that the technical issues for the accelerator development have been reasonably well studied. However more investigation will be needed in areas such as conventional facility and siting (CFS), common technical support, administration, as well as physics experiments, detector systems, and computing needed for physics analyses remain crucial issues.

It explains the envisioned timeline in three phases. In the "pre-preparation phase," which falls into the current stage, various R&D projects are being and will be conducted as efforts in general advanced accelerator technology R&D. Once the government flashes the green light, the project will be promptly shifted to the next phase, the "main preparation phase," where the ILC pre-laboratory will be established. This lab is responsible for the engineering design, remaining technical R&D, construction preparations, and administrative assistance for inter-government negotiations toward the ILC project approval. Efforts during the third phase described in the document, the "construction phase" shall be based on an inter-government agreement for the project approval, so not covered in this plan.

The ILC community is working hard, eyeing on getting the green light from the government between 2017 to 2018. The official negotiations to get support from other countries would be initiated after that. It is also very important to prove that there is potential of getting international support now. The Community's support in each country is also very critical at this moment. "This action plan acts as a good starting point for domestic as well as international discussions which leads to a realistic implementation plan," said Okada.

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FEATURE

Family reunion of many generations of TESLA technology

Ricarda Laasch | 14 January 2016

The LCLS Undulator Hall. Image: SLAC, Brad Plummer

Experts on superconducting radiofrequency technologies (SRF) from all over the world came to SLAC, USA, from 1 to 4 December to the Tesla Technology Collaboration (TTC) meeting. It was the very first TTC Meeting for SLAC to host and the lab used the opportunity to not only invite experts to their lab but also encouraged their own employees to attend this meeting. “With LCLS-II using this technology we wanted SLAC staff to ‘comfortably’ attend in spite of them being relative newcomers,” explains Marc Ross, project manager for LCLS-II at SLAC. “I think it worked and we had an unusually exciting meeting for everyone involved in SRF.” And within the TTC community many ILC enthusiasts were delighted by the meeting and to see the progress in this field.

In his opening talk the TTC Chair, Hasan Padamsee, called the recent developments the beginning of a Golden Age of SRF technology. “With the rapidly growing recognition from the accelerator community of the significant benefits that SRF has to offer to high energy physics, nuclear physics, materials science and accelerator-driven systems with high-power proton beams, the golden era of SRF enables a wide range of exciting new applications all over the world.” And in the same light the plenary presentations followed: many labs showed their advances for big and small projects all around the globe.

In the usual spirit of TTC meetings the following days included working groups which not only gave scientists the opportunity to present their work, but left plenty of time to discuss experimental results, theoretical models and technical solutions.

In the Cavity Working Group high quality factors and therefore *nitrogen doping* and *magnetic flux expulsion,* and field emission measurements were thoroughly discussed. High quality factors (Q) are desirable for keeping the refrigeration cost as low as possible. Therefore maintaining high Qs throughout the running time of the machine is as important. Especially the nitrogen doping of cavities has shown to produce high quality factors. “I thought the most interesting part was that all three labs came up with the same conclusion independently,” explains Ari Palczewski, staff scientist at Jefferson Laboratory. “Nitrogen Doping is a useful tool but there remains a need for more research to determine the actual physics behind it.” The work on the theoretical side of this new technique has to go on even though it seems recipes have finally arrived at a common ground between the different approaches. The scientists used this meeting well to have lively discussions about many different aspects which need to be considered.

The same could be said for the magnetic flux expulsion: as a cavity is cooled to the superconducting state, magnetic field lines can be trapped in the surface, and this would reduce its quality factor. “We have been working on a way to prevent this decrease of quality factor with specific preparations of the cavity, and by cooling it down with a large thermal gradient,” explains Sam Posen, associate scientist at Fermilab. “This way we can push magnetic field lines out, so that they go around the cavity, like a river flowing around a rock.”

“Especially for nitrogen-doped cavities, the preparation and cool-down methods are important.”, adds Dan Gonnella, PhD-student at Cornell. “Since nitrogen doped cavities generally show a higher sensitivity to trapped flux than non-doped cavities.” Here measurements and theoretical modelling went hand in hand to search for a more fundamental explanation.

In the cryomodule working group different labs presented designs, assembly procedures and worklines for cryomodule assembly including quality control. The assembly of cavities into cryomodules is a vital step for each accelerator and the goal is always to closely maintain the quality of each cavity. Hence the focus of these sessions was to improve already existing procedures and workflows. A good balance has to be found between risk minimisation, which requires frequent interruptions to test the quality, and faster assembly, which means fewer tests. “Even though the big picture of the assembly is important, we also learned that the details cannot be overlooked in all areas,” explains Elvin Harms, scientist at Fermilab working on cryomodule testing for LCLS-II. “Quality control and assurance are absolutely critical.” Even though many details have been discussed for cryomodules, further work is anticipated since installation of cryomodules and of course operation have not yet been fully discussed – topics which have their unique issues.

Further sessions focused on couplers and tuners vitally important components. Many different tuner and coupler designs are in use and key details from different designs were exchanged to improve future versions. As the name suggests tuners *tune* the cavity within the

cryomodule to the correct frequency, whereas couplers feed power into the cavity. Several vendors of couplers were present at the meeting and actively participated.

The close cooperation between scientists and industry is already well established within the field of SRF. All working groups had industry present. To build as many cavities, couplers, tuners and cryomodules as needed for the recent and possible future accelerator projects mass production is the only solution and therefore the industry must be involved. The first steps have been taken with European XFEL, and now LCLS-II is following as are other projects. “And the TTC supports and encourages free and open exchange of scientific and technical knowledge, expertise, engineering designs, and equipment”, as its mission states. “It is also encouraging to see a strong cooperation between these two projects, European XFEL and LCLS-II, to help build two of the most advanced particle accelerators the world has ever seen,” said Posen.

As the host SLAC organised a tour of its facilities. Usually TTC members visit one of the accelerator facilities to get a closer look at SRF technology in use. But this time it was a little different. The TTC members visited the experimental halls of the already running light source LCLS. “It was rather delightful to learn for what kind of experiments the beam is used for later since we put so much effort into creating the beam in the first place,” comments Sebastian Aderhold, Postdoc at Fermilab.

In the closing session of the meeting summary talks about each single working group were given and afterwards Hasan Padamsee gave the closing presentation, in which he was looking forward from the golden era of SRF to possible new accelerators like the ILC which would use this technology. “ILC is the best path to advancing the energy frontier because the technology is highly mature, the Global Design Effort has put together a strong technical design, a world-wide industrial base is established, and the exciting discovery of the Higgs boson at the LHC points the way to improved precision via ILC experiments,” said Padamsee. “The TTC community will continue to push gradients towards 50 MV/m so that one TeV will eventually become possible to upgrade the ILC.”

And Akira Yamamoto, Asian Director of LCC, emphasises that the TTC community is an important technical partner around the globe for the ILC even though TTC will of course encourage other large and small projects. He also sees the fast developments and advances within the field of high and low beta cavities for a great variety of different accelerator projects. “I have been working in superconducting magnet field in the past more than 30 years, and I am really feeling the SRF boom and golden age,” said Yamamoto. “I am receiving the TTC meeting as one of the most critically important meetings to prepare for the inevitably important technology for the ILC – including real industrialisation experience.”

The SRF technology has matured much in the past 20 years and together with the real industrial progress realised by the European XFEL project which has been presenting the fact that thousands of SRF cavity can be manufactured, tested, and assembled in one region (Europe) in a few years. In a real worldwide collaboration of three regions with twice or three times more, ILC scales could be in reach.

Akira Yamamoto describes the TTC meetings and the reason for the boom in the field like this: “TTC is behaving like family reunion where all the real technical aspects are discussed in a very friendly way to each other without hesitation to talk about any failures and mistakes in order to mitigate these problems together through lively discussions within the ‘worldwide’ families. The most important common spirit is that they are all loving the SRF technology and to talk about it, anytime and anywhere.”

EUROPEAN XFEL | LCLS II | SCRF | SLAC | TESLA TECHNOLOGY | TESLA TECHNOLOGY COLLABORATION | TTC