



Project Managers' Report

**October/November,
2010**

**ILC Global Design
Effort**

PM summary

This report covers the months October through November 2010. This period has been a busy one for the GDE with several important themes:

- First joint ILC/CLIC workshop (IWLC2010), held in Geneva in October.
- Commissioning and running of the S1-Global experiment at KEK
- Completion of phase 1 of the CesrTA programme, culminating in a set of tentative recommendations for e-cloud mitigation in the positron damping ring.
- Continuing work on Top-Level Change Control towards the TDR baseline.
- ILCSC PAC meeting in Eugene, Oregon in November.
- GDE Interim Report

IWLC2010

The first part of October was focused on preparations for this first joint workshop with CLIC. The meeting itself was a major event, with over 600 attendees from the physics, detector and accelerator communities. With the notable exception of the main accelerator technology, the machine working groups covered both ILC and CLIC design and R&D aspects. For the ILC this meeting was a further important milestone in the TLCC process (see below), allowing further communication with the physics and detector communities, as we progress to agreeing on a modified baseline in early 2011. One very important focus was a special SCRF session dedicated to mass production issues, which benefited from LHC input. The workshop was overall a major success, and a model for future collaborative workshops, which are expected to be held once a year. (The GDE will continue to have one separate additional workshop per year.)

S1 Global

October saw the first high-power testing of the eight cavities (four from KEK, two from FNAL and two from DESY) in the S1-G cryomodule at KEK. These tests continued throughout October and November. Six of the eight cavities performed close to the limiting gradient expected from vertical (low-power) tests. Two cavities (one from DESY and one from FNAL) both showed significant drop in performance. Nonetheless the final average gradient of S1-G achieved is ~ 27 MV/m. As is characteristic of S1-G, the high-power tests were carried out by an international team. Further experiments on using the piezo-tuners to mitigate the effects of Lorentz Force Detuning involving a team from FNAL also showed very promising results. Due to a cryogenics problem, the S1-G programme (including tests of the DRFS concept with two 800 kW Modulated Anode Klystrons, and LLRF experiments) will be delayed into the new year (January and February).

CesrTA

CesrTA successfully complete phase-1 of its programme in October. Early that month the results of the programme were presented and discussed at the e-cloud workshop held at Cornell. A special ILC meeting was held just after the e-cloud workshop to discuss the tentative proposals for e-cloud mitigating measures to be applied to the foreseen ILC damping ring configurations under discussion. These results were subsequently presented at the IWLC10 workshop in Geneva. The results confirmed the assumption that the 3.2km ring with ~ 1300 bunches behaves

similarly to the 6.4km ring with ~2600 bunches. For both solutions a table of mitigation techniques for each of the machine regions (arcs, straight sections, wiggler sections etc.) were presented. The techniques include coatings, grooved vacuum chambers and the installation of electrodes to clear the cloud. The 3.2km with ~2600 bunches was considered a major challenge requiring aggressive mitigation techniques. A final report is now in preparation, to be published in spring 2011. Preparation for phase-2 of the programme is now underway.

TLCC

Further studies on the SB2009 proposal in preparation for the on-going TLCC process has been an underlying theme of the work during the last two months. The proposal resulting from the first Baseline Assessment Workshop (KEK, September 2010) on the single tunnel solution for the main linac, and the adoption of a $\leq 20\%$ spread in operation gradient (maintaining the average at 31.5 MV/m) was formally reviewed by the Director and his appointed Change Review Panel. After some Q&A exchange, the Director formally accepted both the proposed modifications to the baseline. In parallel to this process, the PM has focused on the second BAW scheduled for January 2011 at SLAC, where the last two remaining TLCC issues (reduced beam power parameters, and the relocation of the positron source) will be discussed. Both AD&I meetings in the last two months have focused on planning for this meeting, and in particular on the parameters for the options to be considered. Since both these issues are more directly related to the physics scope of the machine, communications with the physics and detector groups has been emphasized during the ADI meetings. A key management issue is to reduce the number of options and "configuration combinations" that arise if all possible scenarios are considered. A particular complication is the impact of the now three HLRF solutions being considered.

ILCSC PAC meeting

The second formal review for 2010 of the GDE and the Physics and Detector groups by the ILCSC Project Advisory Committee was in November at the University of Oregon in Eugene. Preparations for this important review began almost directly after LWLC10. All the presentations were well received by the PAC. During the verbal close-out by chair Lyn Evans, the PAC acknowledged the impressive progress on the R&D front, particularly highlighting the recent results on cavity yield, the results from the beam test facilities, and the R&D on the positron source. A particular emphasis was placed on mass-production and costs for the SCRF, with specific presentations on GDE plans, as well as a presentation on the XFEL status (the latter at the special request of the chair). During the closeout it was strongly noted that the XFEL costs appear quite high, and that the GDE must take a more aggressive mass-production approach to cost reduction similar to those employed by the LHC dipole production. The final report from the PAC is expected soon.

Interim Report

Work is steadily gaining momentum as the draft text sections are received from the TAG leaders. Overall schedule is running quite late, with several text sections still missing. Current deadline is to have all the draft text in place by the end of the year, but further editing by the Technical Editing Board will certainly still be needed in the January, before the final text and figures can be released to the communicators and professional layout firm. This will make the ALCPG deadline quite tight to achieve.

Technical Area Reports

1. SCRF

1.1 Cavity

Congratulations are in order on many fronts, including the 1st pass MHI-12 result of 37.5MV/m; the successful EP at FNAL/ANL of a cavity in it's helium vessel; and the excellent results and presentation of the DESY large grain results. Also JLab large grain cavity 1 is currently under test at JLab after grinding at KEK; previously it had been limited to 31MV/m in the center cell; during the current test it is now limited to 21 MV/m, but not in the center cell where by mode measurements the performance limit would appear to be on the order of 35MV/m. The test continues and more detailed results will be presented at a future meeting, but the grinding does appear to have solved the previous trouble spot.

<http://ilcagenda.linearcollider.org/conferenceDisplay.py?confId=4855>

1.2 Cavity Integration

Hitoshi reported in more detail on the MHI-12 result, with a limit of 37.5MV/m. Field emission started at 20MV/m, and increased until 37.5MV/m where the radiation monitors were at their limits. Hitoshi also thanked the Fermilab team for the recent commissioning at KEK of the cavity tuning machine, which has now been run on both ZANON142 and AES001, first by Fermilab personnel and now by KEK personnel for training purposes. The KEK team thanks their colleagues at Fermilab and DESY for their efforts in bringing this to a successful installation.

1.3 Cryomodule (including S1-Global status)

Results of the high-powered S1-G cavity tests have ranged from a large increase (due to the difference between a pulsed horizontal test and a CW vertical test) to decreases, particularly in TB9ACC011 and Z108, where the exact cause for the drop is unknown (however, though the cause may vary, such drops statistically are not unusual in cryomodule tests of the last few years). The average gradient in S1 Global so far is several % below the VTS average. The test program has been compacted somewhat due to the previously reported failure of the IGBT switch, but this has been fixed and the schedule adjusted to help. Recent visits by Denis Kostin (DESY) and Yuriy Pischalnikov and Warren Schappert (FNAL) are greatly appreciated.

The extensive thermal readouts installed on S1-Global cryomodule have produced a set of data on the temperatures of cavities, shields, couplers, and intermediate locations on each during operation that may be more complete than any previous set. These results can be used to confirm the heat leak, and the thermal models of each item. Potentially the most unusual values at first glance were the temperatures on the coupler intercept, which suggested the straps used to attach the intercept locations to the heat sinks were undersized. More complete modeling will be completed.

S1-Global has both the stretched wire system on the helium gas return pipe for the four Cryomodule-A cavities, and a laser displacement system for measuring the helium gas return pipe (HGRP) position during cool-down process. Unfortunately during the first cool-down the stretched wire was broken. The laser data were shown, and indicated a large displacement of the ends of the HGRP (~3.7mm) during cool-down, and a warm-cold-warm repeatability of 0.1mm. The cold shift ranges from 0.25 to 0.4mm. The effect due to the shrinkage of the HGRP itself is being checked.

S1-Global presents a grand opportunity for the comparison of tuner designs (4 tuners installed with two cavities each) and Carlo Pagani reported the results. For 6 of the 8 tuning systems installed, the static tuning was confirmed in terms of range, hysteresis and capability to drive the cavity to operating frequency. For one of the blade tuners, after correctly performing a first tuning cycle about 1.3GHz, an unknown failure happened during the 2nd cycle and the frequency is now fixed at 1299.92MHz. This investigation will have to occur next year. For one of the slide jack tuners, it initially moved towards higher frequencies, but then a failure occurred in the drive shaft joint and the frequency stuck at 1299.95MHz. It was possible to replace this drive shaft as access is possible in this tuning system design. Many detailed static and dynamic tests have been done in both the slow and fast (Piezo) systems, and with the exception of the failures the systems have performed by and large as expected. [The Piezo system results are described in an IWLC talk by Yuriy Pischalnikov on October 21, 2010].

Due to the problems with the IGBT switch in the current system, the schedule has been delayed and the DRFS schedule compressed from 3 weeks at the end of the year to 1.5 weeks. Almost all the hardware is in house, and is assembled. The LLRF system is also coming together. As this is the first opportunity to technically prove the design, the team is eagerly looking forward to it.

After S1-Global recovered from the cryogenic problems, the dynamic loss measurements were restarted. The first cavity done was Z109, which at 28MV/m has a dynamic loss measured at 0.6 – 0.8W, which is a Q of 1 to 1.5e10, or close to the ILC specification. The remainder of the DESY and FNAL cavities will be completed by mid-December.

FNAL: CM1 is completely installed and hooked up, and the cryo plant is undergoing purification. The cooldown is now complete, following the final operational clearance paperwork being signed. A coarse schedule is available, and a more detailed ones based on DESY experience, and Fermilab experience with CC2 and HTS are being developed. Ideas and visitors are welcome.

1.4 HLRF

Chris Nantista noted the KCS system showed a problem when tested with a long pulse leading to the CTO being taken apart. There was a large amount of oxidation seen, and the CTO has now been cleaned and the system reassembled. Re-test is coming soon. Also noted were upcoming tests of the vacuum window flange joint, and that a more detailed document for the HLRF KCS system is being written.

1.5 Cryogenics

1.6 Main Linac Integration

1.7 Industrialisation (special topic)

IWLC10 hosted a special a special session on SCRF industrialisation:
<http://ilcagenda.linearcollider.org/conferenceDisplay.py?confId=4530>

From that workshop, a plan has been developed to request information from vendors for cavity procurements in the quantities required for the ILC, but assuming that the production contract is split at least among two companies to mitigate risk to the ILC project. The work will build off the specification discussions earlier in the day. CERN experts (Vittorio Parma) described the LHC Cryostat experience, and all the plan changes required to accommodate various upsets during production, from high bids to vendor insolvencies to unplanned for storage needs. In all cases CERNs ability to step in as an integrator, taking responsibility directly for production where required but supervising the efforts of subcontractors in others. Also, in a side discussion the point to not over specify the requirements to keep the pool of vendors as wide open as possible saved LHC large amounts of money; for instance, not specifying equipment as 'cryogenic' unless it was absolutely required.

The current XFEL experience with contracts was run through by Hans Weise, as an iteration of the LINAC10 conference paper. Due to multiple non-technical issues, the contracts for the XFEL cavities have gone through two iterations with the companies, but were signed in early July. The coupler contract has also been recently signed, and the cryomodule bid is to follow. By European law, the specifications are public 6 months after the contract award, so inspection of this information can occur in the new year.

The Americas region plan over the next 2 years includes 40 ARRA cavities recently ordered and plans to pay for an industrial time/motion study of the plant which will be required. In Asia, the progress of the pilot plant at KEK was described by Hitoshi Hayano, including the installation of fabrication tools. The full schedule will be driven by the EBW, which is expected to arrive in Spring, 2011.

2. CFS/Global Systems

2.1 CFS

The CFS group visited the Mont Blanc tunnel during IWLC10. Lessons learned from the disastrous 1999 fire have been implemented and the new tunnel features reflect added concern for egress.

The group also visited the EU XFEL construction site. The first long XFEL tunnel section was recently completed, linking several support buildings.

Contracts with utility infrastructure engineering-design consultant firms in Japan and US will come due in the next year. For the last two months, the group has gathered and developed criteria tables to be submitted to the contractors so they can get started.

2.2 Global Systems

FLASH 9mA Experiment

The FLASH 9mA experiment featured significantly both at the IWLC10 workshop and the ILSC PAC review. Work continues in preparation for the February dedicated beam time studies, now fixed for 4-8th February. (It is noted that this time now clashes with LLRF studies on S1-Global which is unfortunate.) The focus for the February run will be to attempt to configure the ACC6 and ACC7 to achieve 'flat gradients', with a constraint that the forward power ratios cannot be changed (but the Qext can be remotely modified). Solutions have been found for up to 3mA beam current, but no higher (at least without removing two cavities from the sixteen in the vector sum). The beam current for February's studies will be limited (~3mA) due to running the beam through the SASE undulator (as opposed to the bypass). The pulse length is also likely to be limited to <300 ms due to the existing gun problems.

FEL studies in November were used in part to check several relevant systems (e.g. readiness for 3MHz operation). Also the range of adjustability of the Qext was measured for each cavity in ACC6 and 7, showing quite some scatter in the results (several could not be tuned below 2×10^6). However, the range seems OK with respect to the required solutions for February. A coupling between cavity detuning and Qext has been observed, which is currently not understood and is under study. The effect makes tuning the system more problematic. Performance of the LLRF and the beam (lasing) was exceptional during these studies (RMS energy jitter of ~0.01% over 250 bunches), which bodes well for the February studies.

The originally planned studies for later in 2011 are now likely to be moved to early 2012 due to rescheduling of downtime plans for FLASH2 upgrade at DESY.

3. Accelerator Systems

3.1 Electron Source

3.2 Positron Source

Polarisation was a key focus during the IWLC10 workshop, in particular in connection with the low centre-of-mass energy running scenarios and SB2009. Performance simulations continue, but results show high polarization (60%) achievable above 160 GeV centre-of-mass. Note that this still requires aggressive collimation of the photon beam from the undulator, and other technical issues (power density on target) still need careful consideration. R&D plans for the work on the high-field Nb₃Sn undulator concept were stalled due to staffing issues; these have been resolved and work should begin again soon. First priority is to produce a working set of parameters for the proposed prototype undulator, which can then be used in the performance simulations. Recent reviews of the source R&D presented to the PAC showed good progress (flux concentrator design, target engineering design etc.).

3.3 RTML

Work has focused on consolidating the results of the low-emittance tuning for the entire RTML and in particular producing a final figure for the expected emittance growth. Lattice

design work on the updated central region is also on-going. Andrea Latina has left FNAL and returned to CERN to work on CLIC, although it is hoped that he will be available for some ILC work. A position is available now at FNAL to specifically work on ILC, and it is hoped this will be filled soon. A new guest scientist will also join the FNAL team.

3.4 Damping Ring

Damping ring activities have been focused on CesrTA results, work on preparing parameters for SB2009, and recent good results on the fast kicker work at ATF. For the SB2009, solutions have been identified for the 50% duty cycle for the e⁺ damping ring, resulting from the 10Hz alternate-pulse positron production scheme ($E_{cm} < 300$ GeV). Several concepts have been initially studied for solutions to the beam-loading, each of which requires R&D and further detailed study. However the consensus is that a cost-effective solution can be found (pulsed RF), and that this is likely to only require an additional ~15% at most RF power. The DR parameter tables will be updated accordingly, and in particular the CFS requirements. Some very successful recent tests at ATF on multi-bunch extraction using fast kicker have been reports, with a relative angle jitter of 10^{-3} achieved – very good result.

CesrTA successfully completed phase-1 of the programme during October. Results were presented at E-CLOUD 10 workshop held at Cornell the same month. Tentative conclusions on performance and required cloud mitigation strategies for both the 3.2km and 6.4km ILC damping rings have been made. Several interesting observations in the data merit further study (for example the sub-threshold emittance growth observed). Plans for phase 2 (already beginning) are based in-part on these results. In particular:

- Further study of bunch spacing dep of EC build-up
- More detailed vacuum study in wiggler region
- Further characterization of head-tail instabilities and sub-thresh emittance growth
- Also prepping for installation of new wiggler VC (grooves + TiN), wiggler VC in arc photon environment, new DLC VC from KEK. All targeted for January down.
- CERN setting up to do further study of potential sources of Si contamination seen in amorph-C samples.

3.5 BDS (Beam Delivery System)

3.6 Simulations

Discussions on scaling of emittance growth to lower energy running for TLCC are on-going. Consolidation of “emittance performance table” for the LET sub-systems still requires further work (consolidation). In general, it seems it is difficult to make the current 35nm vertical emittance at 500 GeV proposed for SB2009, but 40nm (the original RDR number) could be justifiable. This emittance growth is known to increase as we reduce the gradient in the linac for low E_{cm} running, but the exact scaling requires study. A possible 10-15% adjustment of the expected luminosity figures could be expected. A better understanding the impact of the BDS collimator wakes is also required.

4. Cost Management (submitted by Peter Garbincius)

Accelerator Design and Integration (AD&I) Activities:

Along with the Project Managers we visited DESY on October 25-26. We met with Kay Jensch, Waldemar Simon, Hans Weise, Detlef Reschke, Sebastian Aderhold, Wolf-Dietrich Mueller, and Reinhard Brinkmann to try to understand the progress of the European XFEL project, along with how the cost estimate experience from the XFEL cavity procurement could be used to refine the cost estimates for the similar ILC cavities. The cavity cost information, and even the specifications, since they could, in principle, still be changed, are closed (confidential) until January 2011. We were again assured that information would be available to ILC at that time. We learned that the high pressure codes and pressure testing of the cavity assemblies were unexpected requirements (and subsequently costs) for the XFEL. The reports of the Babcock-Noell and ACCEL industrial studies on cryomodule fabrication and assembly (2006-2008) were shown to us, but these too are proprietary and not available to ILC. We did get an electronic copy of the TTF-FLASH cavity specifications, with the statement that the FLASH cavity fabrication descriptions and prescriptions are available to the ILC, including documents for mechanics and quality control specification. Hans Weise, XFEL Leader at DESY, said that ILC could have the outline of the process and procedures for the XFEL cavities, although not yet for the contractual information. Wilhelm Bialowons led us on a tour of the mock-up of the XFEL tunnel (starting to be filled with equipment and infrastructure), HERA (another 5.2 meter diameter tunnel containing both a superconducting proton accelerator and a conventional lower energy electron accelerator, both moth-balled), and the Accelerator Module Test Facility (under construction)

CLIC-ILC Cost & Schedule Working Group:

As part of IWLC10, Philippe, Tetsuo, Jean-Pierre, Peter, and Steinar Stapnes, who will succeed Jean-Pierre as CERN's Linear Collider Study Leader soon, participated in a face-to-face meeting on 21oct2010 at CIG Geneva. We welcome Steinar into this working group!

The main topic was the peer review of the CLIC Conceptual Design Report and Cost Estimate.

It needs to be understood and documented what the peer review will do, and what it will not do. It will not validate the cost estimates, but should say whether the estimates were complete and done according to acceptable methodologies and standards. As much as possible, it should be compared with the ILC RDR Cost Estimate and the LHC costing experience.

After checking conflicts with CLIC, ILC, CERN, and the local school spring vacations, we settled on the dates of Tuesday-Wednesday, April 5-6 for this peer review of the CLIC CDR and Cost Estimate to be held at CERN. It is anticipated to take two full days. The quality and efficiency of this review will depend on the documentation which is sent to the reviewers beforehand.