



## CLIC-CTF3 Collaboration Board

### Minutes of the 20<sup>th</sup> meeting

22<sup>nd</sup> January 2016

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#### **Participation:**

Australia	
CERN	R. Corsini (CERN) A. Augier (CERN)
Finland	M. Aicheler (HIP) K. Osterberg (HIP)
France	O. Napoly (CEA)
Greece	E. Gazis (NTUA)
India	P. Shrivastava (RRCAT)
Italy	G. D'Auria (Synchrotrone Trieste)
Norway	E. Adli (University of Oslo)
Spain	F. Toral (CIEMAT) F. Perez (ALBA-CELLS)
Sweden	T. Ekelöf (Uppsala University) R. Ruber (Uppsala University) – <i>New Chairman</i>
Switzerland	L. Rivkin (PSI, EPFL) – <i>Chairman</i> T. Garvey (PSI)
Russia	G. Shirkov (JINR)
Turkey	M. Dogan (IAT Ankara)
UK	P. Burrows (Oxford)

#### **Apologies:**

Australia	M. Boland (ACAS)
Germany	A. Bernhard (KIT)
Finland	P. Eerola (HIP)

#### **1. Welcome**

L. Rivkin welcomes all participants reminding that the agenda and corresponding documentation for this meeting are available on Indico at:

<http://indico.cern.ch/event/472722/>

No modifications were made to the agenda. Minutes of the previous meeting (30.01.2015) are approved without any comment. There were no pending actions to mention.

L. Rivkin reminds that in June 2015, four candidates (A.Faus-Golfe, G. D'Auria, F. Toral and R. Ruber) were nominated as possible future CB chairman in view of an election that took place electronically on 9<sup>th</sup> October 2015. Further to the vote, Roger Ruber (Uppsala University) was elected and will as from now stand as the next CLIC-CTF3 Chair.

The Collaboration Board congratulates R. Ruber and thanked L. Rivkin for the work done.



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## 2. Collaboration Issues and Status

P. Burrows reminds that Steinar is currently on extended sick leave.

T. Ekelof wishes that a dedicated message is sent to him on behalf of the CLIC collaboration.

**Action > A. Augier (status: done)**

P. Burrows then makes a short summary of the CLIC workshop 2016. As usual there was a good audience (225 participants). P. Burrows thanks again A. Augier for the organization of the workshop. He reminds of the main issues and goals 2016-2018:

- CLIC Rebaselining: a reminder will be sent to the CLIC collaboration members in order to update the author list. **Action > A. Augier (status: done)**

- CLIC CALIFES: see R. Corsini's slides.
- CLIC Review: this review originally foreseen in October is now fixed to March 1<sup>st</sup>, 2016. It cannot be delayed anymore because it has to be done before the start of the MTP process. The positive side is that it will bring everybody up to date.

E. Adli wonders if the CALIFES proposal should be added to the agenda. The point will indeed be added to the agenda.

R. Corsini stresses out that the main issue is the manpower resources (in principle the material budget is ok). He also reminds that CLI budget is still more important than the FCC one in the MTP.

- P. Burrows informs that he attended a meeting of the LCC Collaboration Board and that there is still no decision from Japan for the ILC.

## Reports from the Collaboration (these reports were sent by email to A. Augier prior to the meeting)

### University of Oslo (Plans and resources for 2014-2017)

The group has currently two post.doc. researchers (Jurgen Pflingstner and Reidar Lillestøl) and one CERN PhD student (Lukas Malina) contributing to the CLIC project, in addition to Oslo accelerator group leader (Assoc. Prof. Erik Adli). Our main activities include further development and experimental tests of CLIC wake field monitors in CTF3/CALIFES, emittance preservation schemes (numerical studies as well as experimental tests) and contributions to the X-band FEL studies, especially on the topic of photon generation. In addition we are studying how to integrate plasma technology in a linear collider, based on concepts for such a machine similar to the CLIC two-beam scheme.

### Karlsruhe Institute of Technology (KIT)

In November 2012 CERN and KIT have signed a collaboration agreement (k-contract) on the procurement, installation and test of a CLIC damping wiggler prototype at ANKA. The magnet technology (Nb-Ti, horizontal racetrack coil geometry, 51mm period length, 3T \_eld amplitude) is today's state of the art, whereas the cryogenic design (conduction cooling by LHe-ow, beam vacuum chamber at relatively high temperature level, 20K to 80 K) is advanced and requires R&D.



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The wiggler has been designed manufactured at the Budker Institute for Nuclear Physics (BINP), Novosibirsk.

In 2015 the device has passed the factory acceptance test at BINP and the site acceptance test at KIT. The tests revealed that, if conduction cooled, the magnet is not stably operable above 84% of the maximum field reachable in a liquid Helium bath.

After a number of investigations and modifications to both the magnet and the cryostat this behaviour is still not satisfyingly explained. Eventually the period length and the gap were modified such that the target field is reached despite this restriction.

In December 2015 the wiggler was installed in the ANKA storage ring. Currently the preparations for the commissioning and acceptance tests with beam are under way. Above that, R&D on a more advanced magnetic design based on Nb<sub>3</sub>Sn is continuing at CERN.

#### Uppsala University

The Uppsala/CLIC Xband Spectrometer, UCXS, a general-purpose system for detection and measurements of the dark and breakdown currents during conditioning of new accelerating structures for CLIC, has been successfully installed and commissioned at the XBox2 test stand with the CLIC crab cavity during Spring 2015. In the second half of 2015 an CLIC accelerating cavity CLIC-OPEN T24 was installed at XBox2 and the system restarted the operation with the spectrometer.

With the spectrometer now integrated with the main conditioning software of the CERN test stand we have access to a extensive range of breakdown diagnostics. This includes amplitude and phase of the RF signals, Faraday cup signals and images from emitted breakdown currents. The data analysis shows that with this information we can simultaneously measure transverse and longitudinal dynamics of the breakdown event within single RF pulse for the first time. The transverse effects are analyzed with the spectrometer and longitudinal dynamics derived from analysis of RF signals. Furthermore, we are studying vacuum discharge phenomenon in a setup to measure field emission currents inside a Scanning Electron Microscope at the Ångström Laboratory in Uppsala. All this gives unique possibilities for further important insight into behavior of the RF breakdowns physics

Also, the Uppsala group has made measurements of the strength of the octupole component of a CLIC accelerating structure in CTF3 and characterization of the beam utilizing this octupole component.

#### References for the summary

M. Jacewicz et al. General-purpose Spectrometer for Vacuum Breakdown Diagnostics for the 12 GHz Test Stand at CERN IPAC14, June 2014, Dresden, THPME171 och presentation från MeVArc workshop från september 2015:

M. Jacewicz Breakdown currents from CLIC crab cavity commissioning  
<https://indico.cern.ch/event/354854/session/6/contribution/11> Presentation at MeVArc 2015, September 2015, Finland

J. Ögren, R. Ruber, V. Ziemann and W. Farabolini, Measuring the full transverse beam matrix using a single octupole, Phys. Rev. ST Accel. Beams 18, 072801 (2015).

URL: <http://journals.aps.org/prstab/abstract/10.1103/PhysRevSTAB.18.072801>

In proceedings:

J. L. Navarro et al., CALIFES: A Multi-Purpose Electron Beam for Accelerator Technology Tests, LINAC14, Geneva, Switzerland. <http://accelconf.web.cern.ch/AccelConf/LINAC2014/papers/mopp030.pdf>



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W. Farabolini, et al., "Recent results from CTF3 two-beam test stand", IPAC'14, Dresden, Germany, pp. 1880-1882. URL: <http://accelconf.web.cern.ch/AccelConf/IPAC2014/papers/weoca02.pdf>

#### **Helsinki Institute of Physics**

HIP is primarily interested in X-band technology, especially material related aspects. Together with University of Helsinki (UH), HIP plays a leading role in the development of a physics model for the electrical breakdown phenomena in CLIC Accelerating Structures (AS) limiting their performance. Multiple numerical methods have been developed and applied to treat the problem as a whole in a multi-scale approach. HIP is also co-responsible for the development, design, assembly and integration of the CLIC two beam modules including all necessary components. In addition, HIP and UH develops a fast high precision manometer to measure copper outgassing that has now been installed at the DC spark setup at CERN. Finally, HIP and UH develops a method to measure the internal shape of the AS disk stack with  $\mu\text{m}$  precision based on Fourier Domain Short Coherence Interferometry (FDSCI). After calibration, the method was validated on a CLIC high precision machined AS disk.

#### **Oxford University**

The Oxford University/JAI CLIC group comprises Philip Burrows and Glenn Christian (faculty), Ryan Bodenstein (postdoc), Colin Perry (electronic engineer) and Jack Roberts and Davide Gamba (students). We work within the CLIC-UK consortium. In 2015 we provided the high-power drive amplifier, and digital feedback board, for use in the CLIC phase-feed-forward prototype that is deployed at CTF3. First beam tests of the prototype were highly successful, almost meeting the CLIC design resolution of 0.2 degrees stability (12 GHz). Further beam tests will be conducted in 2016, to include improving the resolution further and increasing the quality of the correction during the beam pulse. Beam orbit studies were also performed in several regions of CTF3, using a generic linear feedback tool, with significant improvements in beam orbit control. These studies will also be pursued in 2016. We continue to monitor the MDI studies for proposed changes in the CLIC L\* and remain ready to modify the IP feedback system to be commensurate with a new layout. We are also contributing to two-beam low-emittance beam tuning studies with the beam dynamics group.

#### **CIEMAT**

CIEMAT is in charge of the development a longitudinally variable dipole field for CLIC damping ring and an accelerating structure, namely TD26CC. The 2D magnetic design of the magnet is well advanced, next step is the 3D modelling. Concerning the accelerating structure, a hydrogen furnace at a research centre in San Sebastian (Spain) is presently under qualification. First contacts have been made with DMP to start with the machining of the disks. Some problems with manpower resources have delayed this activity last year, but now the resources are allocated.

#### **Tartu University**

Activities of Tartu University are aimed to understand the mechanisms behind electrical breakdowns taking place on the accelerating structures. Currently, the research group consists of 1 researcher, 2 PhD students (1 of them shared with Helsinki University), 2 master's students and 2 bachelor's students. Current studies aim to improve the emission current models with state of the art methods, including combined thermos-emission models and Nottingham effect. More specifically, the implemented emission current models are used to investigate possible nonlinear effects in the



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emission regimes, leading to high measured field enhancement factor and to understand mechanisms, leading to formation of field enhancing surface defects. For example, results published by Eimre et al, in Journal of Applied Physics 118, no. 3 (2015) show, that under certain conditions, contribution of thermally emitted currents can lead to significant overestimation of field enhancement factor (2-4 times).

During 2015, 4 research papers, connected to CLIC related activities were published, complemented with 5 oral presentations at international conference. Next to the scientific result, 2 bachelor's theses and 1 master's thesis were defended. Currently, 3 manuscripts, covering the mechanical behavior of material defects, possible mechanisms of surface protrusion formation and Cu self-sputtering effects are in preparation.

The studies were conducted in close collaboration with Helsinki University (prof. Kai Nordlund and Flyura Djurabekova group).

#### **Raja Ramanna Centre for Advanced Technology**

Further to the contributions to CTF3 in the form of vacuum chambers, dipole magnets, optics design of TL2 and development of control software for CTF3, India has contributed on development of long and short PETS bar prototype. Raja Ramanna Centre for Advanced Technology, which is the nodal institute of Department of Atomic Energy, India for Accelerators contributions, has designed and developed 5kW and 20kW wide band Solid state power amplifiers for the Harmonic Buncher for the CLIC injector linac.

Manufacturing of 8 short PETS bar, and preparation of spare vacuum chambers has been agreed and in progress. Further contributions towards the CLIC in the form of RF components/amplifiers are under discussions.

#### **Paul Scherrer Institute**

The present activity of PSI in CLIC concerns the development of high gradient RF structures. In agreement with the relevant CLIC personnel we are building proto-types of X-band structures using the PSI production protocol for the structures. Tests of the C-band structures which were produced for the SwissFEL accelerator have shown that they have very small breakdown rates and condition to full power relatively quickly, without requiring the long vacuum bake-out procedure presently used at CERN for the CLIC structures. Consequently it is of interest to produce and test X-band structures with the PSI 'recipe'. Once the copper cells have been machined in industry the structures will be brazed at PSI. High power tests are foreseen on the X-box test stations at CERN.

CLIC personnel and PSI staff are also investigating the possibility of X-band structures being used for the 500 MeV linac of the SwissFEL soft-X-ray beam line, ATHOS.

#### **Australian Collaboration for Accelerator Science (ACAS)**

ACAS has been working primarily on the XbFEL collaboration activities within CLIC, with some scoping for future CLICdp theory and experimental contributions. We have a PhD student, Tessa Charles, at Monash University who has developed novel bunch compression and linearisation schemes in FEL models which are reported on regularly in XbFEL web meetings and in conference proceedings. On the experimental front, a proposal has been submitted the Australian funding agency to establish an x-band accelerator test facility at the University of Melbourne, including using some loan equipment from CERN from the XBOX facilities, the results will be announced in June 2016. The project will fund a research position, several PhD positions, travel funding, the use of a former accelerator bunker in



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the basement of the School of Physics at the University of Melbourne and operating costs. The Australian Synchrotron has announced it will support the activities even if the grant application is not successful and is keen to continue collaborating with the CLIC project to develop FEL technology for future upgrade plans. The Australian Synchrotron has received \$520M government for operations through to 2027, as well as another \$500M for ion accelerator facilities in Canberra and Sydney through to 2027, so we will continue with accelerator activities on a sound footing for the next decade in Australia.

### 3. CTF3 report

R. Corsini summarises the status of CTF3 during 2015 and the plan for 2016. He reminds that CTF3 will stop at the end of 2016.

- Status of the future CALIFES proposal

Draft nearly completed but still need to be polish before going to the CERN's management. Members of the CB are request to send their comments if any ASAP:

K. Osterberg wonders what will happen if it is approves? P. Burrows wonders if a new MoU will have to be provided. It is too early at this stage to provide answers.

- Incoming requests for equipment from CTF3

In view of the stop of CTF3 beyond 2017, the list of requests for equipment to be recuperated from the facility needs to be finalised. Institutes should send their requests possibly before December 1<sup>st</sup>. A common list of requests will then be prepared by R. Corsini and R. Ruber.

### 4. FEL Application collaboration

G. D'auria makes a short presentation on this new proposal. 15 institutes are interested so far. Meetings are on-going.

### 5. Next CLIC and LC related meetings

The Collaboration Board is reminded of the following meetings in 2016:

- CLIC Project Meeting on Tuesdays 26/04, 28/06, 11/10 and 20/12 (with Christmas drink)
- Linear collider workshops in 2016:
  - 30 May – 3 June: ECFA LC (Santander, Spain)
  - LCWS16 (5-9 December in Japan). Due to this late date, the CLIC workshop 2017 will probably be held later in 2017 (March ?)

### 6. Next CB meeting

The next meeting of the Collaboration Board will be connected to the CLIC workshop unless of emergency.