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CARE-JRA2* ACTIVITIES ON PHOTO-INJECTORS AND CLIC TEST FACILITY (CTF3)

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Abstract

In the frame of the CARE project, there is a Joint Research Activity (JRA2) called PHIN (PHoto-INjectors). The main objective of this JRA is to perform Research and Development on charge-production by interaction of a laser pulse with material within RF fields and improve or extend existing infrastructures. Another activity of PHIN is the coordination of the activities of various Institutes concerning photo-injectors. A brief review of the work of the eight European laboratories involved in PHIN is presented.

One of these R&D topics is the construction of a photo-injector for the CLIC Test Facility (CTF3). In this context the status of CTF3 and its main goals - the demonstration of the feasibility of the key issues of the CLIC two-beam acceleration scheme - is also presented.

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CARE-JRA2* Activities on Photo-Injectors and CLIC Test Facility (CTF3)

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for PHIN and CTF3 collaborations

1. INTRODUCTION

The CARE (Coordinated Accelerator Research in Europe) project [1] is an Integrated Infrastructure Initiative supported by the European Commission (EC) within the 6th Framework Programme (FP6). Over the years 2004-2008, it aims at improving existing accelerator infrastructures or test facilities in Europe. Twenty two contracting laboratories and a large number of associated institutes and industrial partners participate in this integrating effort. The CARE general organization and participation are available on the CARE web site [2]. CARE is an ambitious programme of accelerator research and developments oriented towards high energy physics projects. This programme aims at improving existing infrastructures dedicated to future projects such as linear colliders, Free Electron Laser (FEL), upgrades of hadron colliders and high intensity proton drivers. The programme is articulated around 3 Networking Activities (NA) that provide the long-term scientific vision and 4 Joint Research Activities (JRA) which integrate scientific and technical developments over several laboratories.

The Joint Research Activities aim at developing critical and actual state-of-the-art components and systems to upgrade the existing infrastructures and to contribute to the dissemination of knowledge. This paper concentrates on JRA2-PHIN (PHoto-INjectors), which has as a main objective the study, development and improvement of electron sources for future e+e- colliders and FEL.

The CLIC Test Facility (CTF3) is one of the major PHIN infrastructures. Following the experience accumulated with CTF1 and CTF2, CTF3 is a new and ambitious facility [3] presently under construction at CERN in an international collaboration of laboratories and institutes. It aims at demonstrating the key feasibility issues of the CLIC (Compact Linear Collider) scheme [4]. Among eight laboratories in the PHIN network [5], five laboratories contribute directly to the photo-injector of CTF3. In this paper highlights are focused on activities of these laboratories. In the CARE-PHIN web page [2], the activities and publications for each laboratory are available.

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2. TECHNOLOGICAL CONCEPTS

The technique of charge-production studied in this JRA covers the interaction of lasers with photo emissive materials within an RF field. The goal is to produce an electron source with a brightness unachievable with a conventional thermionic gun. Two features contribute to improve simultaneously the charge, the current and the emittance of the beam: the first is due to the fact that the electron current density production is more efficient in the photoemission process with respect to the thermionic one. The second is that the obtainable voltage on the cathode, is much higher in an RF gun (~ 100 MV/m) than in a DC one (~ 10 MV/m). This is beneficial because it helps to reduce space charge and electron shielding effects. The peak current from photo-injector is at least one order of magnitude higher than from a thermionic injector and the emittance is one order of magnitude lower.

Another approach is based on superconducting RF technology. The Superconducting RF photo-injector (SRF gun) can generate short pulses and high-brightness electron beams as known from the conventional photo-injectors. Moreover, the use of the superconducting cavity allows the cw-mode operation and thus high average currents. So the SRF gun has the potential as the source in FEL light sources and energy recovery linacs. The goal is to produce a very high quality beam with charge per pulse and temporal structure optimized for such future sources. The superconducting cavity for this type of gun is based on three TESLA cells and of a half cell closed by a shallow cone with a central hole which houses the cathode. Special insulation and RF filters are inserted to decouple the cathode zone from the rest of the cavity. In the proof-of-principle experiment, the operation of such a photo-injector with a half-cell cavity was successfully demonstrated. Up to now, the production of two Nb cavities has be already finished and delivered to Rossendorf. The RF tests and the warm tuning are now under way. The preparation of the cavities and the high rf-power measurement at 2 ^{o}K will then be performed at DESY.

An alternative to these RF based photo-injectors is explored in addition. Laser-plasma accelerators are proposed as a next possible generation of compact accelerators because of the huge electric fields they can sustain. However they produce particle beams with large energy spread. An energetic and bright electron beam is generated from the interaction of a high intensity laser with a gas jet. The electric field generated in the plasma of the order of 1TV/m, boosts the electron of plasma, from 0 to 200 MeV in less than 1 mm. The very good quality of the electron beam (normalized emittance < 2 π mm.mrad) and the transverse initial size of the beam can be very small, of the order of few hundred microns. This JRA aims at the production of a quasi-mono-energetic electron beam of roughly hundred MeV with a energy dispersion $\Delta E/E < 0.1$ and a normalized emittance < 0.1 π mm-mrad.

3. OBJECTIVES OF CARE-JRA2-PHIN

JRA2-PHIN has 4 main objectives:

1) Perform Research and Development on charge-production by interaction of a laser with photo-cathodes or a gas jet. The RF fields are produced either in room temperature RF guns or in Superconducting (SC) RF guns.
2) Improve or extend the existing facilities.
3) Coordinate the efforts done at various Institutes.
4) Contribute to the dissemination of knowledge acquired in the field of photo-injectors.

The objectives are addressed by bringing together the expertise developed in the three main areas of interest for the photo-production of electrons, which are:

i) Charge production based on photo-cathodes.
ii) Laser systems
iii) RF gun and beam-dynamics studies.

The objective of the charge production work package is the development of semiconductor photo-cathodes with improved properties, especially lifetime and quantum efficiency.

The objective of the laser systems work package is:
a) the design and the development of a laser system to meet the requirements of the CTF3 photo-injector;
b) the investigation for ultra-fast optical waveforms for the new generation of FEL,
c) the investigation of intense ultra-short laser pulses.

The objective of the RF guns and beam-dynamics studies work package is the development of RF guns for high charge and high average current and/or very short pulses.

To achieve these objectives, PHIN has evaluated the total cost to 6 M€. An amount of 4 M€ was requested to the EU. After evaluation of the project, ~ 90% of the total amount has been accepted by the EU which corresponds to 3.542 M€ with the following spending profile :
2004: 1.545 M€,
2005: 1.090 M€,
2006: 0.670 M€,
2007: 0.237 M€.

Although the CARE project extends over 5 years, the JRA2-PHIN duration is over 4 years (2004-2007).

4. OVERVIEW OF JRA2-PHIN

4.1 European Laboratories involved in PHIN

Table 1 show the 8 laboratories who participate to the JRA2-PHIN.

An important aspect of the project is to make existing infrastructures available to all participants in order to perform tests and R&D experiments. Conversely, the R&D activities made in common may result in extensions and improvements of these existing infrastructures for the benefits of all partners.

Bringing the efforts of all laboratories together is one of the most beneficial aspects. Industry does not provide complete sub-systems of photo-injectors, which, therefore, need to be specifically developed for each application.

The outcome of this R&D program is of general interest for the industry working on related domains like the photo-cathodes, the lasers and the high brightness e^- beams. Benefits are expected in picosecond and femtosecond chemistry, cancer therapy, medical imaging, light sources and free-electron lasers.

Table 1: Participating Laboratories and Institutes in JRA2-PHIN

Institute	Acronym	Country
CCLRC[1] Rutherford Appleton Laboratory(RAL) Didcot	CCLRC-RAL	UK
CERN[2] Geneva	CERN	CH
CNRS[3] - Laboratoire Accélérateur Linéaire (LAL) Orsay	CNRS-LAL	F
CNRS - Laboratoire Optique Appliqué (LOA) Palaiseau	CNRS-LOA	F
ForschungsZentrum Rossendorf - ELBE	FZR-ELBE	D
INFN[4]-Laboratorio Nazionali di Frascati (LNF)	INFN-LNF	I
INFN- Milano	INFN-Mi	I
Twente University- Enschede	TEU	NL

1) CCLRC Council for the Central Laboratory of the Research Councils
2) CERN European Organization for Nuclear Research
3) CNRS Centre National de la Recherche Scientifique
4) INFN Istituto Nazionale di Fisica Nucleare

4.2 Short overview of laboratories activities

Table 2 shows the specific expertise of laboratories involved in PHIN.

Table 2: Participants expertise and relevant facilities

Institute	Specific Expertise	Facility
CCRLC-RAL	The Central Laser Facility has long experience in the development of photo-injector lasers. Specialized expertise in the development of very high power and intensity systems [6].	
CERN	Accelerator design and technology. Construction and operation of photo-injector. Photocathode technology. Construction of a test facility for two beams scheme [7].	CTF3
CNRS-LAL	Design and construction of electron injectors for CERN and DESY. RF guns, test stand with photo-injector [8].	NEPAL
CNRS-LOA	Laser development and production of charged particles by means of laser plasma. Acceleration in the laser wake field. Ti:Sa power-lasers [9].	
FZR-ELBE	Development and operation of an RF photo-injector with superconducting cavity. Electron linear accelerator and SRF gun test-stand [10].	ELBE
INFN-LNF	Accelerator design and technology. Normal conducting linac. Test beam facility. High brightness photo-injectors R&D [11].	
INFN-Mi	Manipulation of the laser output pulses, study of ultra fast optical waveforms [12].	
TEU	Photocathode preparation. High power laser systems. Free Electron Laser and accelerator physics [13].	TEU-FEL

Figure 1 shows the PHIN logo representing a RF photo-gun. The photo-cathode, the laser beam and the RF gun are symbolized. The areas where the eight PHIN Institutes contribute are indicated.

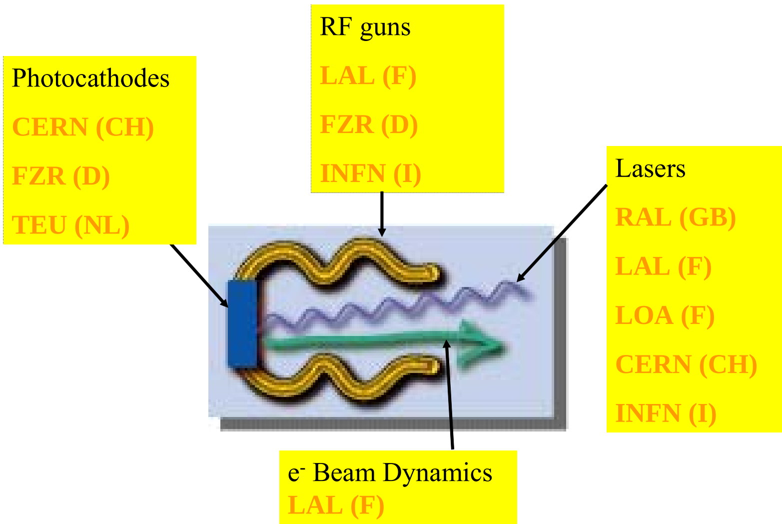


Figure 1: PHIN logo with the 8 contributing Institutes

The alternative approach explored by LOA is the following [14]. A laser beam drives a plasma bubble that traps and accelerates plasma electrons. This is achieved within a length of a few millimetres. The alternative approach explored by TEU is the following. The electrons are produced in a photo-injector and are injected in a plasma channel. The combination of the plasma, electron beam and laser pulse allows to create the appropriate wake field.

The 4 infrastructures or facilities are the following:

CTF3 is a test bed to demonstrate the technical feasibility of the key concepts of the proposed RF power source for CLIC. The photo-injector which will replace the existing thermionic injector, will be an important upgrade of this facility allowing more flexibility in manipulating the time structure of the electron beam, smaller transverse and longitudinal emittances, resulting in more efficient beam transport and bunch length manipulation. With the RF photo-injector, no low energy tails are expected and also a reduction of radiation losses.

NEPAL is a multipurpose RF test stand. The new photo-injector will be a major improvement in order to test new beam dynamics models, instrumentation and diagnostics.

ELBE is a superconducting RF test stand. This photo-injector with a laser-driven photocathode in a superconducting RF gun will allow small transverse and longitudinal emittances and a high charge electron pulse to be used in the future FEL projects and possibly in an ILC (International Linear Collider) Test Facility.

TEU FEL is a Free Electron Laser emitting in the far-infrared range. The new photocathode material developed within the JRA should permit to significantly increase the brightness of this source and improve the stability and operation time of photo cathodes.

5. THE CLIC TEST FACILITY (CTF3)

5.1 Layout of CTF3 and beam parameters

The main purpose of CTF3 is the demonstration of the feasibility of the proposed 30 GHz RF power source for CLIC. Its second role is to provide the 30 GHz RF power needed to test the CLIC critical components and in particular the CLIC accelerating structure.
Several issues will be investigated with the CTF3. One of the items is the demonstration of the Drive Beam generation. The final drive beam parameters are the following (Figure 2):
I = 35 A, Q = 2.3 nC/bunch, E = 150 MeV, t = 140 ns final pulse length, bunch repetition frequency = 15 GHz. These parameters are down-scaled with respect to CLIC (I = 150 A, Q = 10 nC/bunch, E = 2 GeV), but they will allow to test relevant physical effects and benchmark simulation tools. Recently, new CLIC beam parameters have been published [15] where the final pulse length has been reduced from 130 ns to 60 ns.

Other important parameters are the control of losses along the complex, the beam emittance preservation, the mains-to-RF efficiency and the control of bunch length. In addition the stability should be demonstrated for the current, the energy and the bunch phase (along the final pulse and pulse-to-pulse).

Following the recommendations of the International Linear Collider-Technical Review Committee (ILC-TRC) [16], the CLIC study team decided to focus resources on the CLIC specific issues aiming to demonstrate key feasibility issues and to finalize design choices before 2010. The program of the present CTF3 has been elaborated according to these goals [17].
The CTF3 layout is given in Figure 2 below.

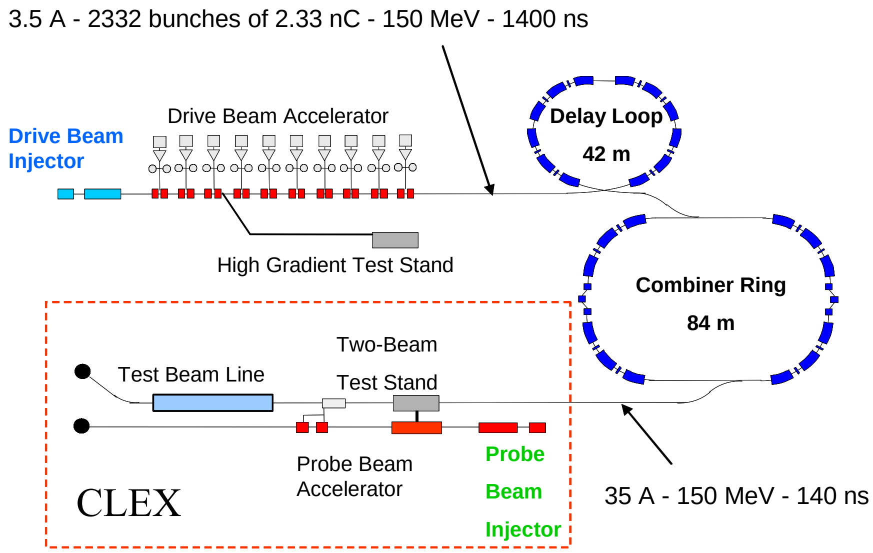


Figure 2: Layout of the CTF3

A long train of electron bunches is accelerated in the Drive Beam Accelerator with a 3 GHz RF system. The two rings, the Delay Loop and the Combiner Ring serve to change the time structure of the bunch trains, such that short trains of 140 ns length with a bunch repetition frequency of 15 GHz and a 10 times increased peak beam current are produced. This is done by interleaving successive 140 ns long sub-trains in these rings. The resulting 15 GHz bunch structure can be used to generate high power RF at 30 GHz to test CLIC accelerating structures.
So far the Drive Beam Linac including a magnetic chicane for varying the bunch length, are completed. Presently installation of the Delay Loop is under way, to be commissioned with beam in fall 2005. It will allow testing the first stage of multiplication of the bunch repetition frequency and beam current compression [18] by a factor of two. In 2006, the Combiner Ring will be installed and commissioned, giving another factor of five. The length of the bunch train is reduced from 1400 ns to 140 ns and the peak beam current is increased from 3.5 A in the linac to 35 A.

In its first phase, operationally now, the Drive Beam Injector of the CTF3 consists of a thermionic gun with a bunching system. Figure 3 shows the CTF3 injector. In 2007 it is foreseen to replace it with the RF photo injector developed within PHIN.

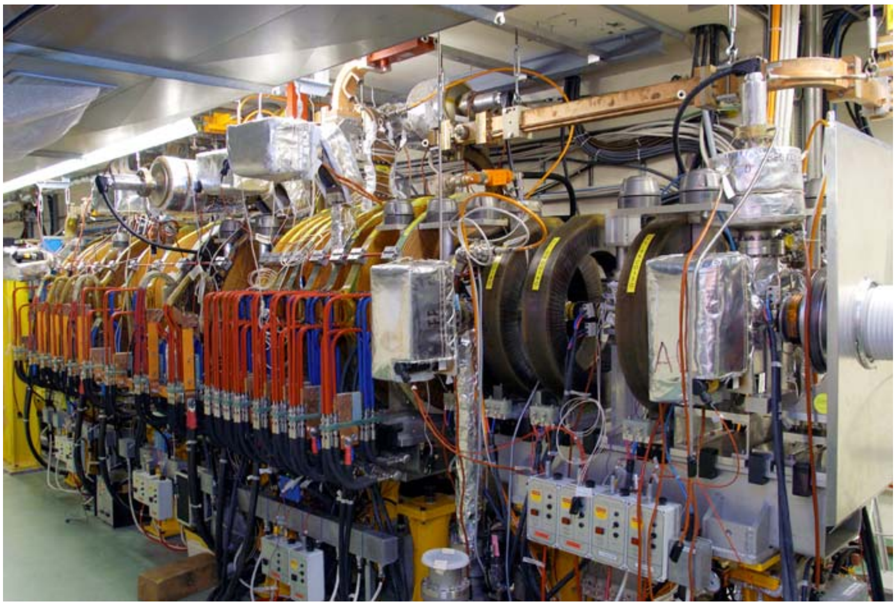


Figure 3: CTF3 Injector
The thermionic gun is on the right followed by the bunching system

In order to advance testing of CLIC 30 GHz equipment with high power RF, a separate beam line (High Gradient Test Stand) at intermediate beam energy (Figure 2) has been installed in 2004. Here the beam with 3 GHz bunch repetition rate and short bunches can be used to generate 30 GHz RF power by sending it through a special RF structure called PETS (Power Extraction and Transfer Structure).

In 2007, it is foreseen to start equipping the CLEX (CLIC Experimental Area). Here various experimental facilities will be set up:
A Two-Beam Test Stand will be installed to extract 30 GHz RF power from the Drive Beam with the nominal CLIC parameters. This power is fed into a CLIC accelerating structure, which will accelerate a low-current beam, the Probe Beam, to demonstrate the full CLIC two-beam accelerating system at its nominal RF power and accelerating gradients.
In its present design the Probe Beam will also use an RF photo injector, however with much less severe parameters than the Drive Beam injector.

5.2 Experimental results

Up to now (August 2005) the beam has been accelerated and transported up to the end of the Drive Beam Accelerator.
Efficiency of mains power to 30 GHz RF power conversion is extremely important for CLIC. This is the reason, why the Drive Beam Linac accelerating structures are operated under full beam loading condition. This means that more than 95 % of the RF power injected into the 3 GHz structures is converted to beam power. Stable operation under these conditions has already been demonstrated successfully [19].

In 2004, the 30 GHz RF power production was put into operation, the results being in good agreement with the expectations [20]. A power in excess of 50 MW in the PETS and pulse duration above 70 ns was produced in a load using a beam current of about 6 A (Figure 4). In 2005, this RF power was use to test a CLIC accelerating structure. So far a gradient of 120 MV/m and a pulse length of about 25 ns have been achieved. The performance was limited due to RF breakdowns in the CLIC structure. Conditioning of the accelerating structure is still in progress.

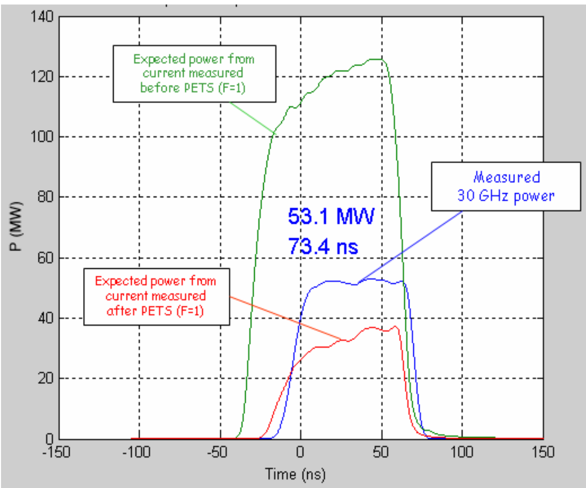


Figure 4: Results of 30 GHz RF power production test (in a load)

5.3 Photo-injector for the CTF3

One of the main CARE-JRA2-PHIN topics concerns the photo-injector of CTF3. The specifications for this photo-injector, shown in Table 3, are very challenging because of the long train of pulses, the high charge per bunch, the pulse to pulse charge stability, the photocathode lifetime and the temporal structure. The concept of sub-pulse (called "odd" and "even") inside a long laser pulse in order to perform a frequency multiplication in the Delay Loop via one RF deflector is a strong constraint which needs careful study in such photo-injector.

The layout of the laser system proposed for CTF3 is shown in the Figure 5.

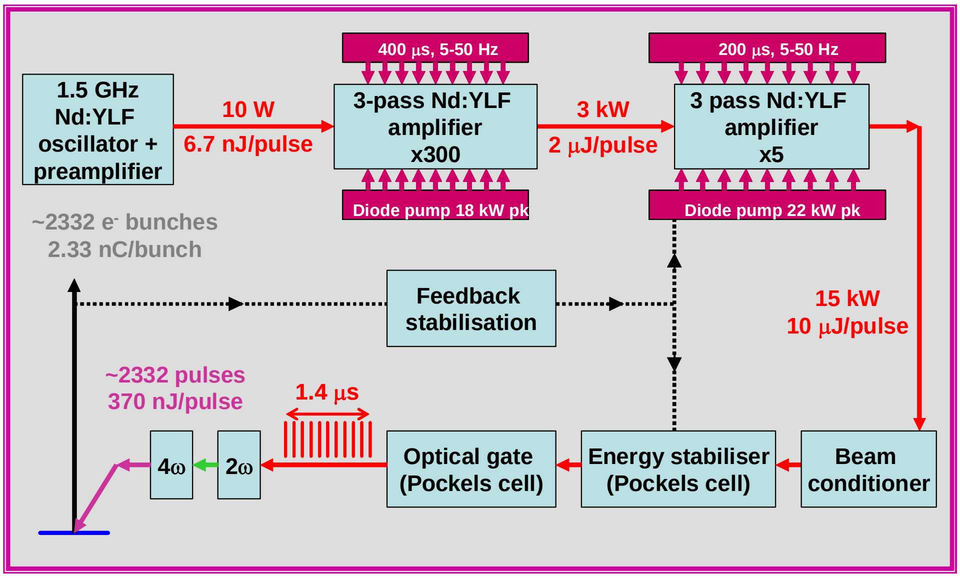


Figure 5: CTF3 Laser system (Courtesy of M. Divall-RAL)

The laser gain medium of the oscillator is Nd:YLF (λ = 1047 nm) working at a repetition rate of 1.5 GHz. The average output power is greater than 0.2 W. The timing jitter from the external 1.5 GHz RF source is < ± 1 ps (rms). With the preamplifier, the average output power is 10 W. The amplitude stability after 1 hour of warm-up is < 0.2 % rms above the 100 kHz noise region and < 2 % rms below 100 kHz. The beam size stability is 5 % rms (jitter). In order to avoid the fracture limit for theYLF rod, which is ~ 21 W/cm, two consecutive amplifiers are implemented. Therefore these amplifiers work under safe thermal conditions. The constraint of the repetition rate of 50 Hz is also fulfilled. The optical gate allows providing a long laser pulse composed of consecutive sub-pulses (odd and even) of 140 ns. The RF deflector in the Delay Loop deflects every odd sub-pulse of electrons into the Delay Loop, and after one turn inserts this sub-pulse between the bunches of the following even sub-pulse. Therefore the timing of the bunches of odd sub-pulses is adjusted such as they have a phase difference of 180 degrees with respect to the 1.5 GHz RF of the deflector. The photo-cathode of the RF gun is made from Cs_2Te, which has a photo-emission threshold of about 3.5 eV. Therefore UV light is needed to generate electrons from it. Two stages of frequency conversion (2 ω and 4 ω) permit to provide the UV light to the photo-cathode of the RF gun

Table 3: Photo-injector Parameters for CTF3 Drive Beam

Parameters	Values	Unit
e^- beam		
Pulse train duration (including transient)	1548	ns
Pulse train charge	5434	nC
Average current in the pulse train	3.51	A
Number of bunches in the sub-pulse	212	-
Odd/even sub pulse width (FWHM)	140.735	ns
Number of bunches in the pulse train	2332	-
Bunch charge	2.33	nC
Bunch spacing	0.667	ns
Bunch width (FWHH)	10	ps
Normalized emittance	≤ 25	π-mm.mrad
Energy dispersion (rms)	≤ 2	%
Charge stability (rms)	≤ 0.25	%
Repetition rate	1 to 50	Hz

RF gun		
RF frequency	2.99855	GHz
RF power	30	MW
Vacuum pressure at nominal charge	$\leq 2 \times 10^{-10}$	mbar

Photo-cathodes		
Material	Cs_2Te	
Quantum efficiency	≥ 3	%
Laser wavelength	≤ 270	nm
Life time	≥ 40	working hours

Laser		
Output IR energy per bunch	≥ 10	μJ
Wavelength @ Laser output	1047	nm
Pulse length	≤ 10	ps
Timing jitter (rms)	≤ ± 1	ps
UV energy per bunch @ photo-cathode	368	nJ
Beam radius	1 < r < 2	mm
Energy stability @ photo-cathode (rms)	≤ 0.25	%
Odd/even sub pulse width (FWHM)	140.74	ns
Odd/even sub pulse rise/fall time	2 – 30	ns
IR-UV conversion efficiency	0.15	
UV energy @ cathode / IR energy	0.037	

At INFN, preliminary good results have been obtained with the Dazzler experiment. This latter is able to produce arbitrary and very reproducible temporal profiles. Figure 6 shows an experimental rise time less than 0.8 ps for a flat top pulse of 10 ps.

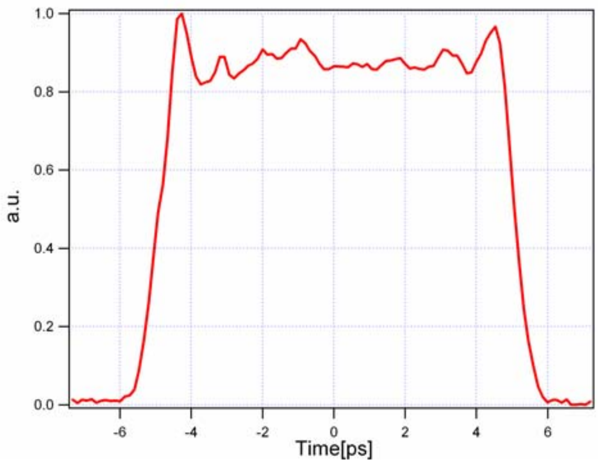
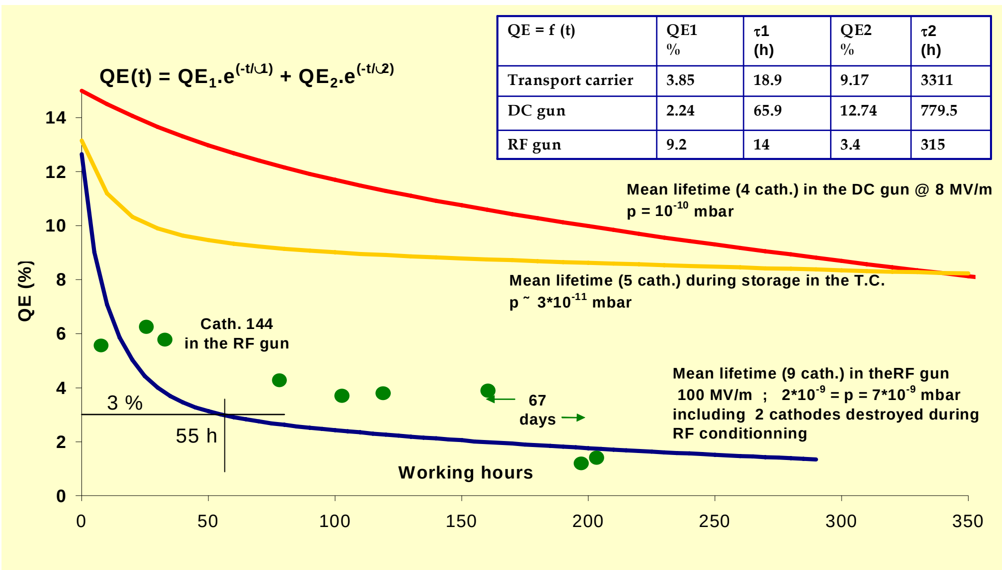


Figure 6: Dazzler pulse (Courtesy of C. Vicario-INFN)

The production of the Cs_2Te photo-cathodes has been largely improved. The technique is called “co-evaporation”. Using a stochïometric ratio control, the deposited thickness is carefully calibrated and the quantum efficiency is measured on-line.

Figure 7 shows the measured quantum efficiency (QE) versus the time where one derives an experimental life time. The red plot is the QE (composed of 2 parts QE1 and QE2) for photo-cathodes measured in the DC gun. The yellow plot is the QE for photo-cathodes measured in the Transport Carrier where there were stocked for a long period. The blue plot is the QE for photo-cathodes measured in the RF gun under real working conditions. For a QE of 3 %, the life time of these Cs_2Te photo-cathodes is 55 hours.



QE = f (t)	QE1 %	τ1 (h)	QE2 %	τ2 (h)
Transport carrier	3.85	18.9	9.17	3311
DC gun	2.24	65.9	12.74	779.5
RF gun	9.2	14	3.4	315

Figure 7: Quantum efficiency versus time (Courtesy of G. Suberlucq-CERN)

Inside PHIN, R&D is carried on photo-cathodes. The goal is to improve the co-evaporation process in order to produce reproducible Alkali-antimonide photo-cathodes and make these photo-cathodes working in the green light region (second harmonic of Nd doped crystals). Under these conditions, it would be possible to produce only one stage of light conversion (more efficiency and more laser energy) and work with photo-cathodes having smaller quantum efficiency in the range of 0.6 % during at least 50 hours.

For the RF gun design, 2D (Superfish) and 3D (HFSS) codes have been used.
Figure 8 shows the 3D model designed by LAL [8]. The solenoid magnets are installed around the gun. They provide a field of 0.27 T along the axis and a zero field on the photo-cathode by using a bucking coil.

The beam power is P_{beam} = 19.3 MW while the beam cavity is P_{cavity} = 10 MW in order to get 120 MV/m without beam loading. The coupling factor is $\beta = 2.9$.
The beam loading issue has been carefully studied. Under matched conditions, the accelerating field is 85 MV/m. The beam dynamics results at the gun exit are given in Table 4.

Table 4: Beam parameters obtained by simulation at RF gun

	Parameters	Unit
Laser beam		
Laser pulse length	10 1.4	ps (FWHM) mm (rms)
Injection phase	85	degrees
Electrons beam		
Energy	5.6	MeV
Energy dispersion	0.36	%
Emittance	19.6	π mm.mrad
Bunch length (rms)	8.4	ps
Bunch size (rms)	3.2	mm

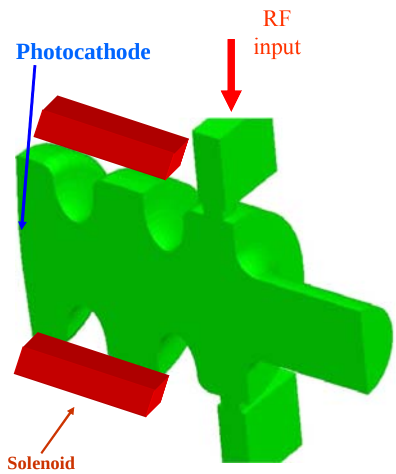


Figure 8: Model of the RF gun (Courtesy of R. Roux –LAL)

6. CONCLUSION

The R&D activities on photo-injectors proposed in this CARE-JRA2-PHIN are devoted to improve the performances of the new generation of electron injectors for future high-energy linear colliders and FEL communities. The results of the JRA2-PHIN are freely available to the entire scientific community. The major benefits come from the studies on the more challenging characteristics of the different components of the photo-injector system.

All European infrastructures that are involved in the accelerator physics and related uses should be extremely interested in the exploitation of the results provided by the JRA2-PHIN.

A preliminary phase of CTF3 made the experimental demonstration of the frequency multiplication. Then the concept of fully loaded linac has also been demonstrated. Today CTF3 has started to provide 30 GHz RF power from a dedicated test stand. When the CLEX area will be implemented it will be possible to test all CLIC components with CLIC nominal beam parameters in 2007. At this time a new RF photo-injector will be used for the Drive Beam Accelerator (PHIN project) and a new RF photo-injector will be used for the Probe Beam (CTF3 project). The whole system is an important step to demonstrate the technical feasibility of key concepts of CLIC. The CTF3 results should be able to open the door for future multi-TeV linear colliders.

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REFERENCES

[1] O. Napoly, R. Aleksan, A. Devred, CEA, R. Garoby, R. Losito, L. Rinolfi, F. Ruggiero, W. Scandale, D. Schulte, M. Vretenar, CERN, H. Mais, D. Proch, DESY, A. Ghigo, LNF, V. Palladino, INFN, Napoli, T. Garvey, F. Richard, LAL, E. Gschwendtner, Uni. of Geneva, A. Den Ouden, Twente University, "The CARE accelerator R&D programme in Europe", Paper presented at the Particle Accelerator Conference (PAC2005), Knoxville, TE, USA

[2] http://care.lal.in2p3.fr/
Web site maintened by B. Mouton (LAL-Orsay-France)

[3] G. Geschonke CERN and A. Ghigo LNF (editors), "CTF3 Design Report", CTF3 Note 2002-047, CERN-PS-2002-008-RF, LNF-2002-008-IR

[4] The CLIC Study team edited by G. Guignard CERN, “A 3 TeV e^+e^- Linear Collider Based on CLIC Technology”, CERN-2000-008
[5] The PHIN coordinators team edited by B. Preger, “PHIN Annual report 2004”, CARE-Report-05-03-PHIN
[6] I. Ross RAL, S. Hutchins CERN, “A Laser System Design for the Photo-injector Option for the CERN Linear Collider**”,** Central Laser Facility Annual Report 2000/2001 p. 184 – 187
[7] E. Chevallay, S. Hutchins, P. Legros, G. Suberlucq, H. Trautner, CERN, “Production and studies of photo-cathodes for high intensity electron beams” CERN-PS-2000-046-PP ; CLIC Note 449, Paper presented at 20th International Linear Accelerator Conference, Monterey, CA, USA, 21 - 25 Aug 2000 [SLAC-R-561] - pp.e-proc. MOB08
[8] R. Roux, G. Bienvenu, C. Prost, B. Mercier, LAL, “Design of a RF photo-gun”, CARE Note-2004-034-PHIN
[9] J. Faure, Y. Glinec, V. Malka, A. Pukhov, S. Kiselev, S. Gordienko, LOA, “Laser Wakefield Acceleration of High-energy quasi-monoenergetic Electron Beams”, CARE Note-2004-022-ELAN
[10] J. Teichert, P. Evtushenko, D. Janssen, W.-D. Lehmann, U. Lehnert, P. Michel, C. Schneider, J. Stephan, V. Volkov, I. Will, FZR, “Overview of the present status of the SRF gun design and construction”, CARE-Note-2004-010-ELAN
[11] C. Vicario, A. Ghigo, S. Cialdi, A. Flacco, M. Petrarca, M. Nisoli, G. Sansone, S. Stagira, I. Boscolo, C. Vozzi, “Laser Temporal Pulse Shaping Experiment For SPARC Photoinjector”, CARE Conf-04-030-PHIN
[12] S. Cialdi, I. Boscolo INFN/Milano, “A Shaper for providing long laser target waveforms”, CARE Pub-04-003-PHIN
[13] D. Bisero, B.M. vanOerle, G.J. Ernst et al. “K-Te photocathodes: A new electron source for photoinjectors”, Journal Applied Physics 82 (3): 1384-1387 August 1997
[14] J. Faure, Y. Glinec, A. Pukhov, S. Kiselev, S. Gordienko, E. Lefebvre, J.P. Rousseau, F. Burgy & Malka, LOA, “ A laser-plasma accelerator producing monoenergetic electron beams”, Nature 2963-2/9/2004-VBICKNELL-119217
[15] H.H. Braun for the CLIC team, “CLIC Progress towards Multi-TeV Linear Colliders”, Paper presented at the Particle Accelerator Conference (PAC2005), Knoxville, USA
[16] “Interna. Linear Collider Technical Review Committee, 2nd report,” SLAC Report 606, 2003
[17] I. Wilson for the CLIC study team, “CLIC Accelerated R&D,” CLIC note 620, 2005
[18] R. Corsini, A. Ferrari, L. Rinolfi, P. Royer, F. Tecker, CERN, “Experimental results on electron beam combination and bunch frequency multiplication”, Published in PRST-AB ‘Physical Review Special Topics- Accelerators and Beams’ 7 (2004) 040101, CERN-AB-2005-018, CLIC Note 624
[19] R. Corsini, M. Bernard, G. Bienvenu, H. Braun, G. Carron, A. Ferrari, O. Forstner, T. Garvey, G. Geschonke, L. Groening, E. Jensen, R. Koontz, T. Lefèvre, R. Miller, L. Rinolfi, R. Roux, R. Ruth, D. Schulte, F. Tecker, L. Thorndahl, D. Yeremian, “First Full Beam Loading operation with the CTF3 linac”, Paper presented at the 9th European Particle Accelerator Conference EPAC 2004, Lucerne, Switzerland,
CERN-AB-2004-057, SLAC-PUB-10762, CLIC Note 604, CTF3 Note 066
[20] R. Corsini, G.Geschonke, L. Rinolfi, F. Tecker, “Status of CTF3 at the end 2004, beam commissioning results and plans for the future”, CERN-CLIC Note 622, January 2005, CARE Note-2004-025-ELAN