CARE - JRA2 - PHIN
Charge production with photo-injectors

- PHIN participants
- INFN – LNF
- INFN – MILAN
- LOA
- LAL
- FZR
- Twente University
- RAL
- CERN
- Comments of the review committee

PHIN participants

A. Ghigo

Institute	Acronym	Country	Coordinator	PHIN Scientific Contact	Associated to
CCLRC Rutheford Appletone Lab. (22)	**CCLRC-RAL**	**UK**	P. Norton	I.N. Ross	
CERN Geneva (19)	**CERN**	**CH**	H. Haseroth	G. Suberlucq	
CNRS-IN2P3 Orsay (3)	**CNRS-LAL**	**F**	T. Garvey	G. Bienvenu	CNRS
CNRS Lab. Optique Appl. Palaiseau (3)	**CNRS-LOA**	**F**	T. Garvey	V. Malka	CNRS
ForschungsZentrum ELBE (10)	**FZR-ELBE**	**D**	J. Teichert	J. Teichert	
INFN-Lab. Nazionali di Frascati (11)	**INFN-LNF**	**I**	S. Guiducci	A. Ghigo	INFN
INFN- Milan (11)	**INFN-MI**	**I**	C. Pagani	I. Boscolo	INFN
Twente University- Enschede (13)	**TEU**	**NL**	J.W.J. Verschuur	J.W.J. Verschuur	

Review committee

A. Ghigo

PHIN review Committee

A Review Committee composed by four European researchers specialist in photoinjectors and their use is invited from PHIN Steering Committee in order to evaluate the PHIN activities. The members of this first Review Committee are:

Roberto Corsini, CERN
Klaus Floettmann, DESY
Paolo Michelato, INFN-Milano
Ingo Will, MBI-Berlin

INFN - LNF (WP1, WP2, WP4) EU+Lab = 275+525 k€

Management

PHIN coordinator	A. Ghigo (INFN-LNF)
Deputy	L. Rinolfi (CERN)

Work Package	Full name	Short name	Coordinator	Laboratory
WP1	Management and Communication	M&C	A. Ghigo	INFN-LNF
WP2	Charge Production	CP	J. Teichert	FRZ-ELBE
WP3	Lasers	LAS	G. Hirst	CCLRC-RAL
WP4	RF Guns and Beam Dynamics	GUN	G. Bienvenu	CNRS-LAL

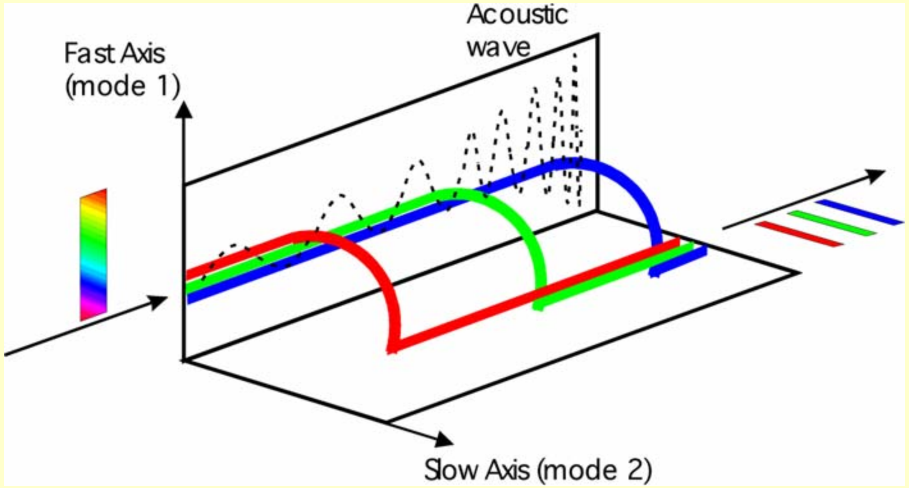
- Setup of a new web site : http://www.infn.it/phin/
  - PHIN JRA proposal (17/03/2004)
  - Presentations given at the first PHIN collaboration meeting
  - First report on PHIN JRA activities
  - Comments of the scientific committee on the presentation given at the first PHIN meeting, Frascati, 5th May 2004
  - First Orsay Status Report for JRA2 (PHIN) of the CARE Project
  - Links with all participating labs

INFN - LNF (WP1, WP3 WP4)

INFN Contribution to CTF3 project :

CTF3 Chicane – Delay Loop - Layout

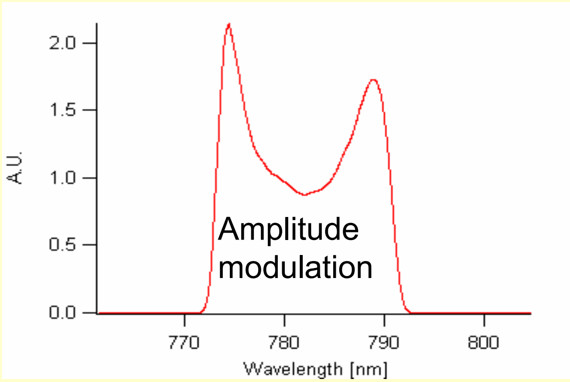
Installation & commissioning of the CTF3 photo-injector

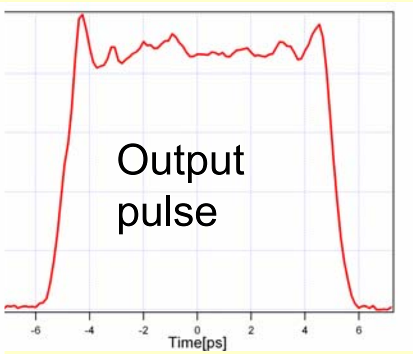


Temporal pulse shaping : DAZZLER (C. Vicario SPARC study)

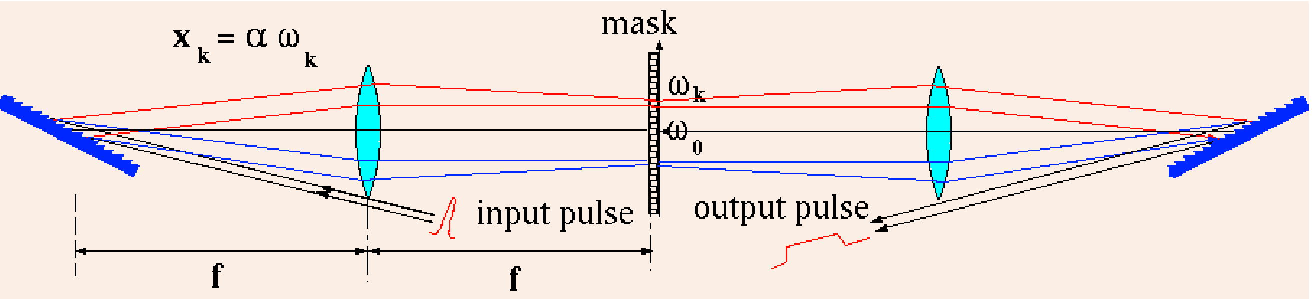
Acousto-Optic Programmable Dispersive Filter

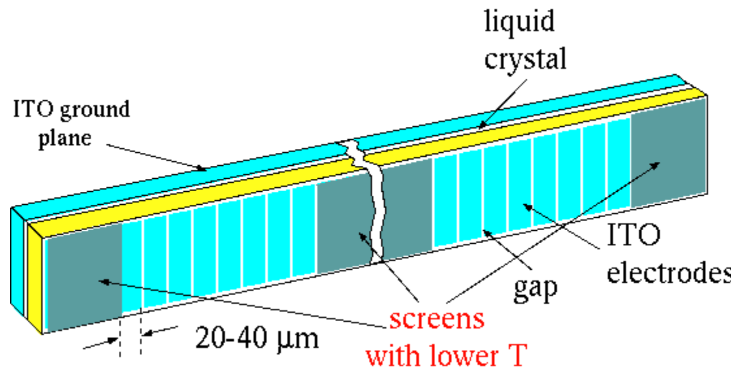
- We upgraded the optimal modulation calculation including selective attenuation.
- After few cycles of optimization the pulse converged to flat top profile.
- We obtained reproducible flat top pulse up to 10 ps, less than 20% ripple, and very sharp edges.

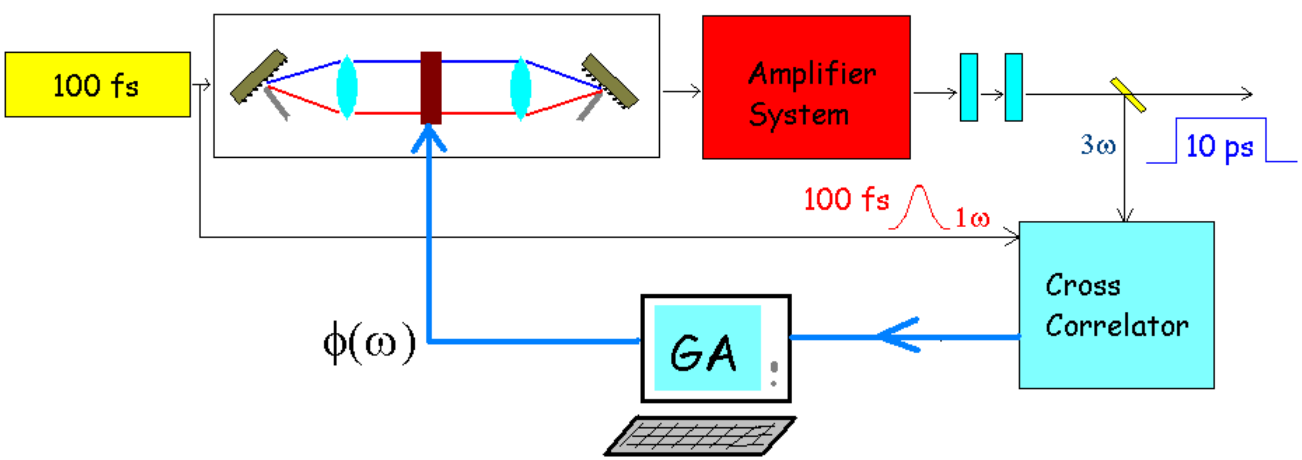


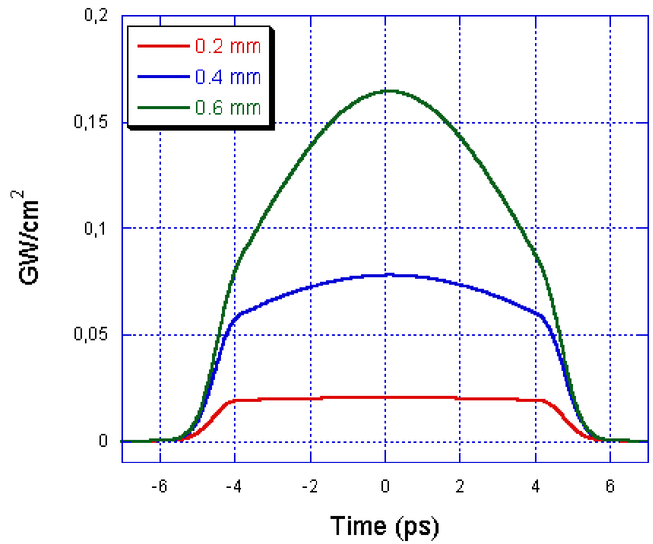


Temporal pulse shaping : Liquid crystal spatial light phase modulator in Fourier plane - S. Cialdi

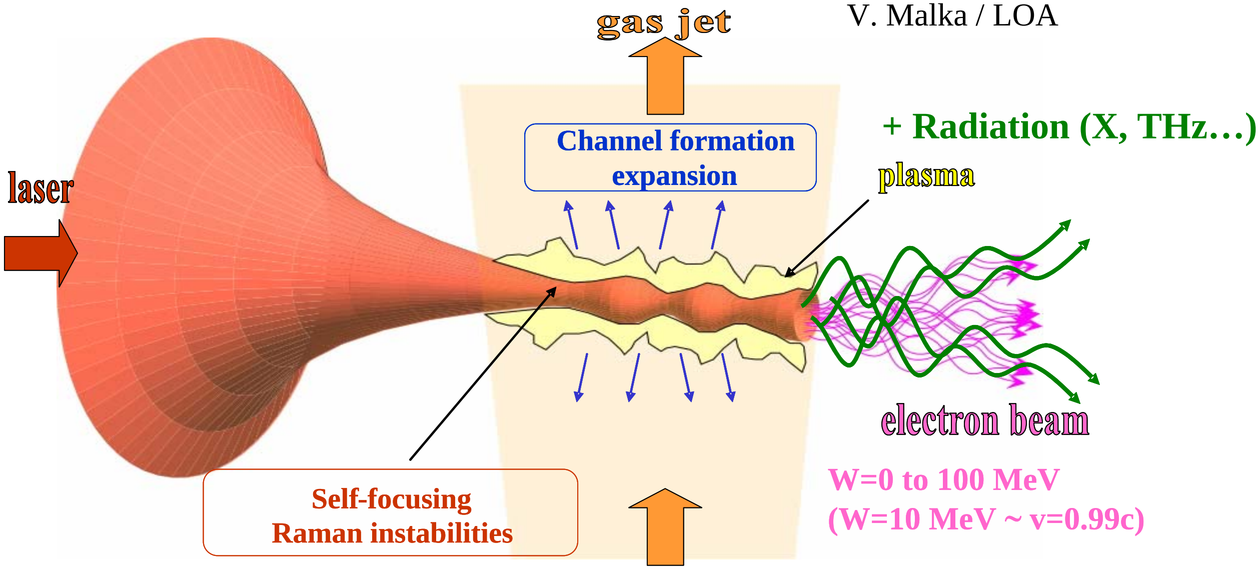




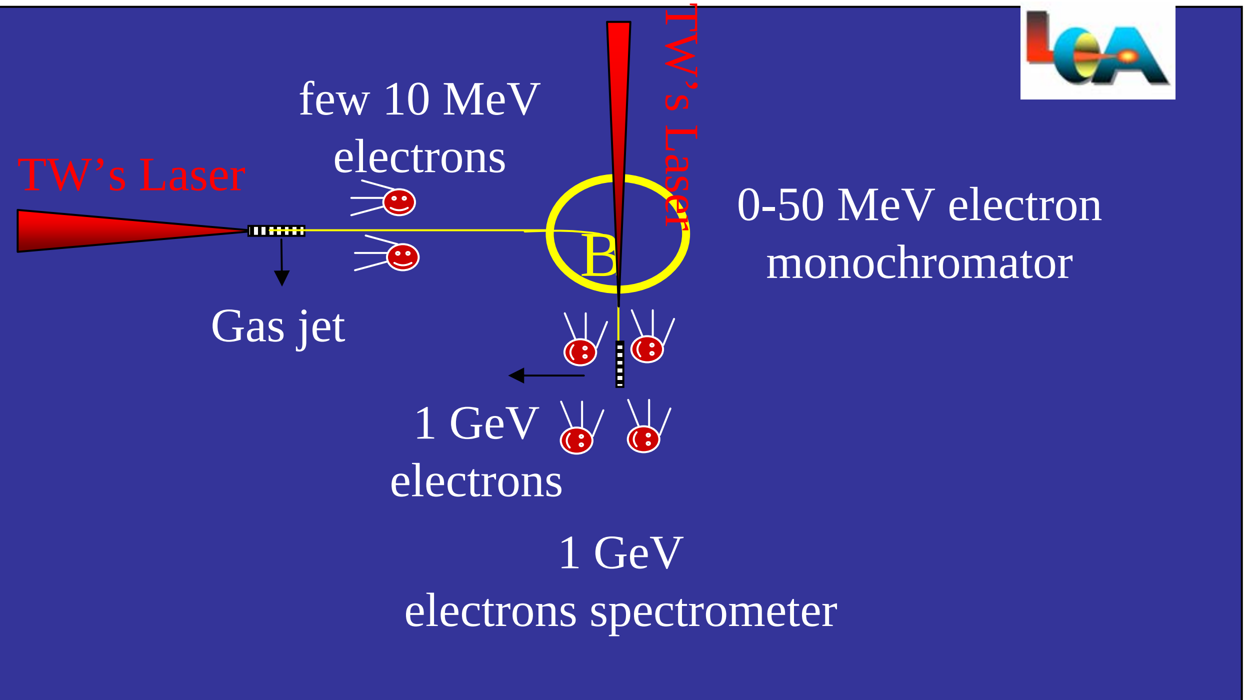




LOA (WP2, WP3, WP4) 440+570 k€



V. Malka / LOA



Participation in :

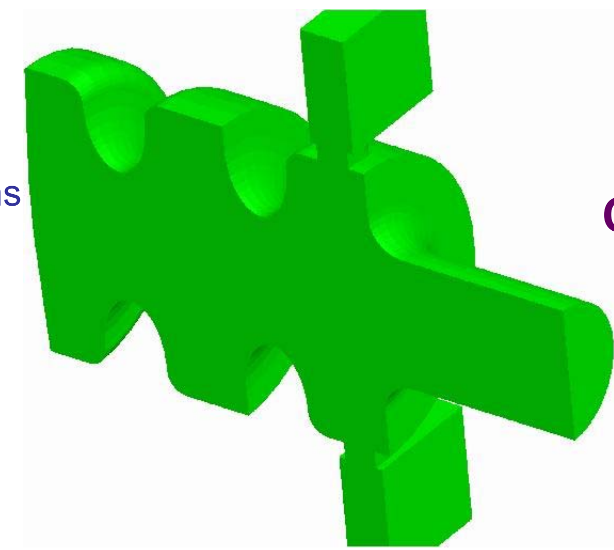
- WP2 : Follow the requests on sources of particle accelerators
- WP3 : Laser specialists, pulse shaping
- WP4 : 10 MeV and 1 GeV spectrometers

LAL (WP1, WP2, WP3, WP4) 755+1360 k€

- Design and construction of NEPAL and CTF3 RF guns
- Improvement of NEPAL
- Construction of a photo-cathode preparation chamber

CTF3 RF gun,
HFSS simulations

R. Roux / LAL

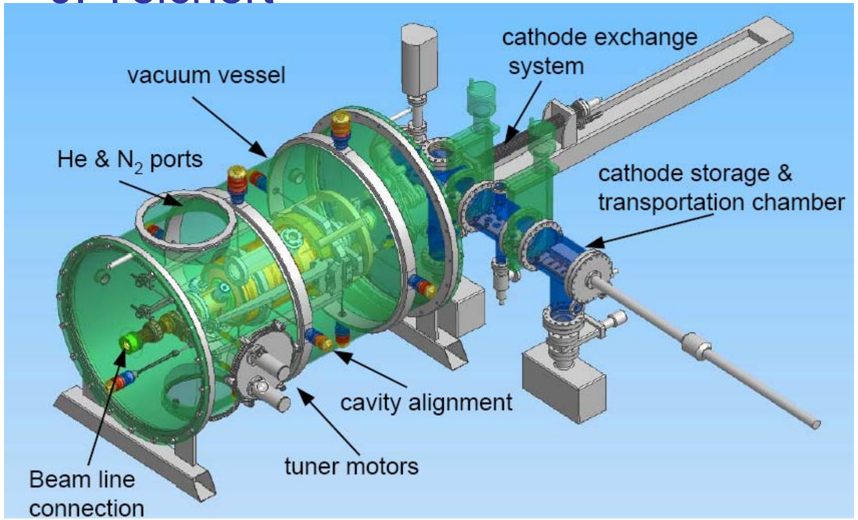


CTF3 RF gun design : LAL – CERN collaboration

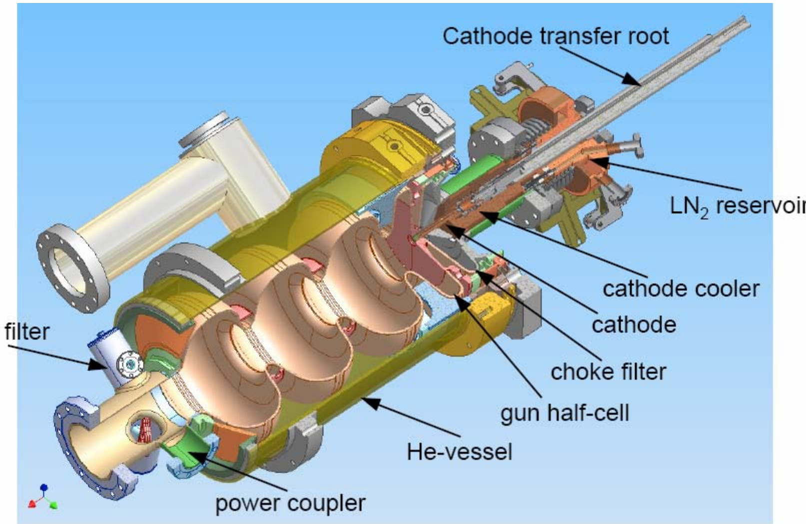
Cold model production, by LAL, during the summer

SRF gun with Cs_2Te cathode at LN_2 temp.

J. Teichert



1.3 GHz , 10 kW
E_{1st_cell} = 33 MV/m
E = 50 MV/m
q = 77 pC / 1 nC
$I_{av.}$ = 1 mA
E = 9.5 MeV
ε = 0.5/2.5 mm.mrad
Laser : 262 nm , 1 W
13 MHz / 1 MHz
Cs_2Te @ QE ≥ 1 %



Technology:
Co-evaporation process
from CERN
Trautner, Suberlucq, Chevallay, 2001

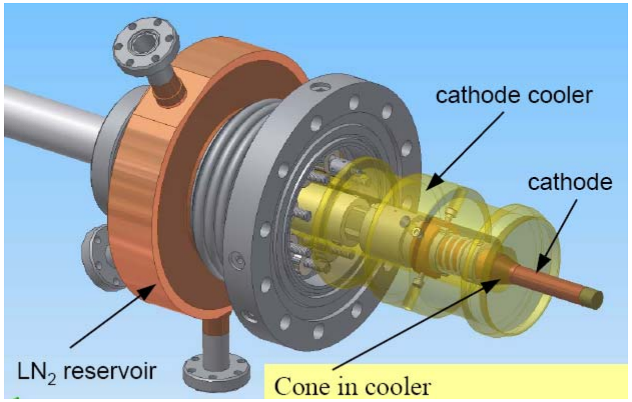
4 evaporators with
- tellurium
- Cs_2CrO_4 (saes getters)

2 deposition rate monitors
- separate measurements for Te and Cs
- control of 1 : 2 ratio

cathode heating
cathode cleaning (ion sputtering)

Q.E. measuring with 262 nm, 10 mW laser
- during deposition
- aging
- distribution (laser spot scan)

- Cavity: in fabrication
- Tuners: under tests
- Cathode cooling system: in fabrication
- Cathode transfer system: design finished
- Preparation chamber: in fabrication
- Cryomodule: Design will be finished in July

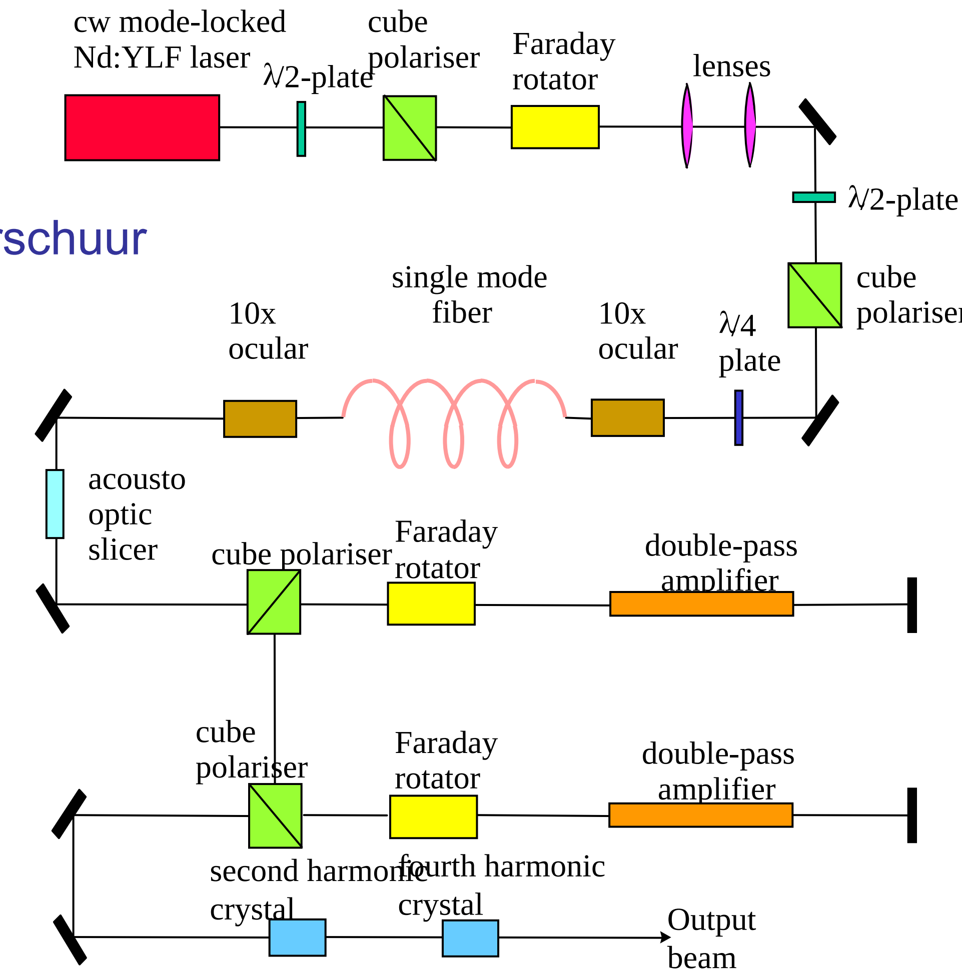


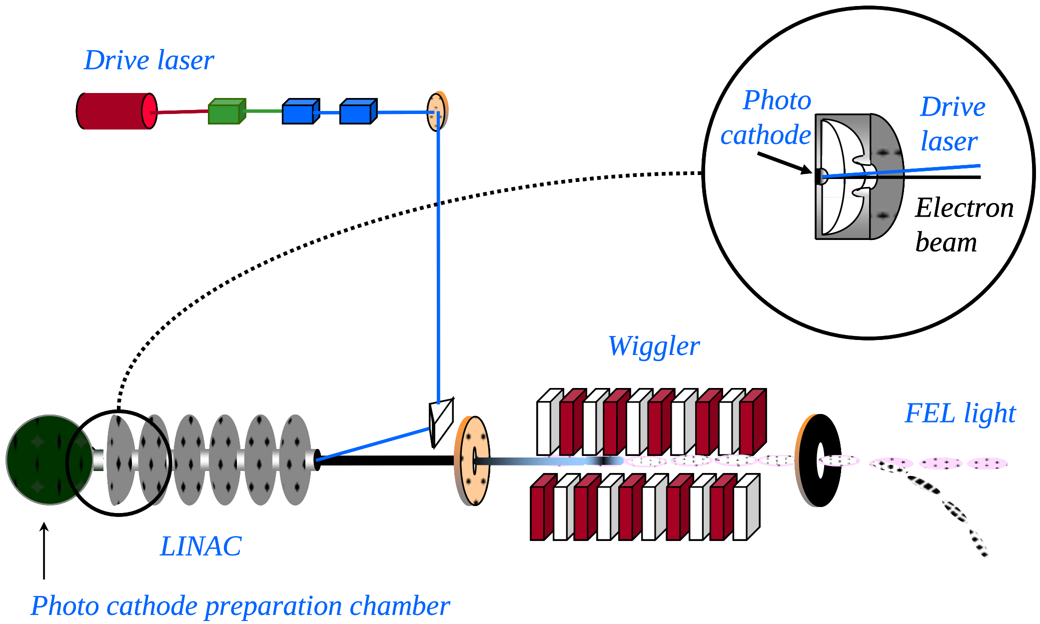
Collaboration with CERN on photocathode studies

The TEU-FEL project

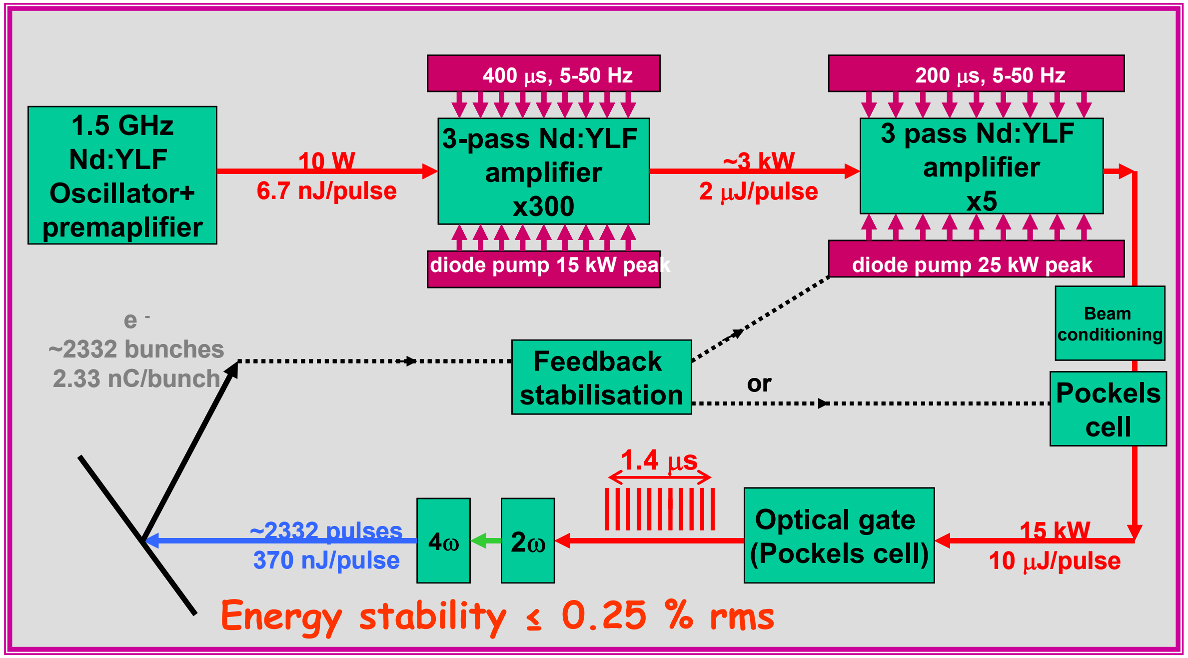
Macro-pulse time	15 µs
Repetition frequency	10 Hz
Micro-pulse time	20 ps
Wavelength	527 nm
Energy per micro-pulse	5 µJ
Amplitude stability	< 1%
Phase stability	< 1 ps

J.W.J. Verschuur



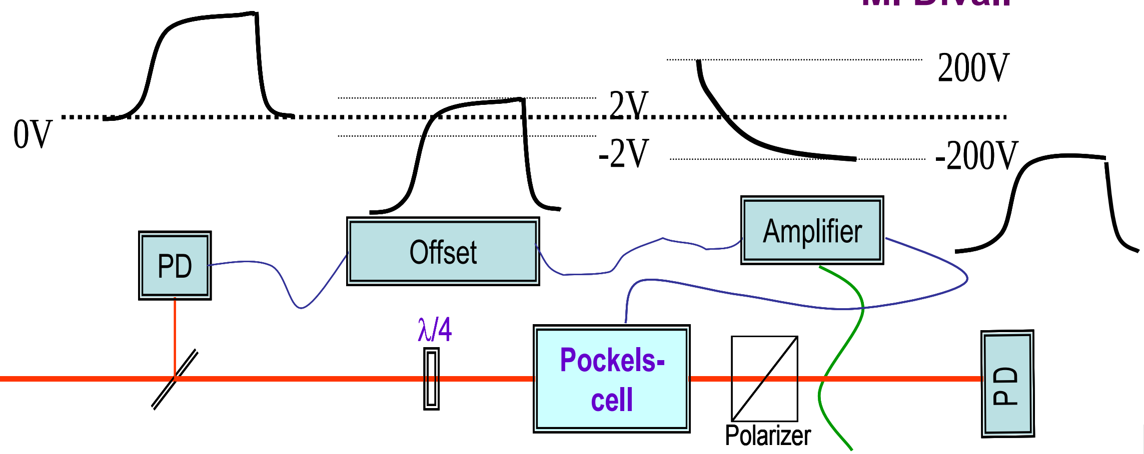


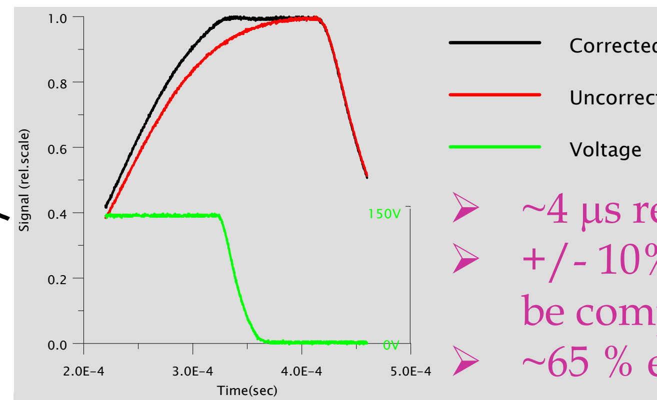
Collaboration with CERN on photocathode studies



M. Divall

- Selection of Nd:YLF
- New arrangement to be compatible with the YLF fracture limit and 50 Hz rep. Rate (after the meeting)
- The oscillator price enquiry was sent out to firms on 10-06-2004



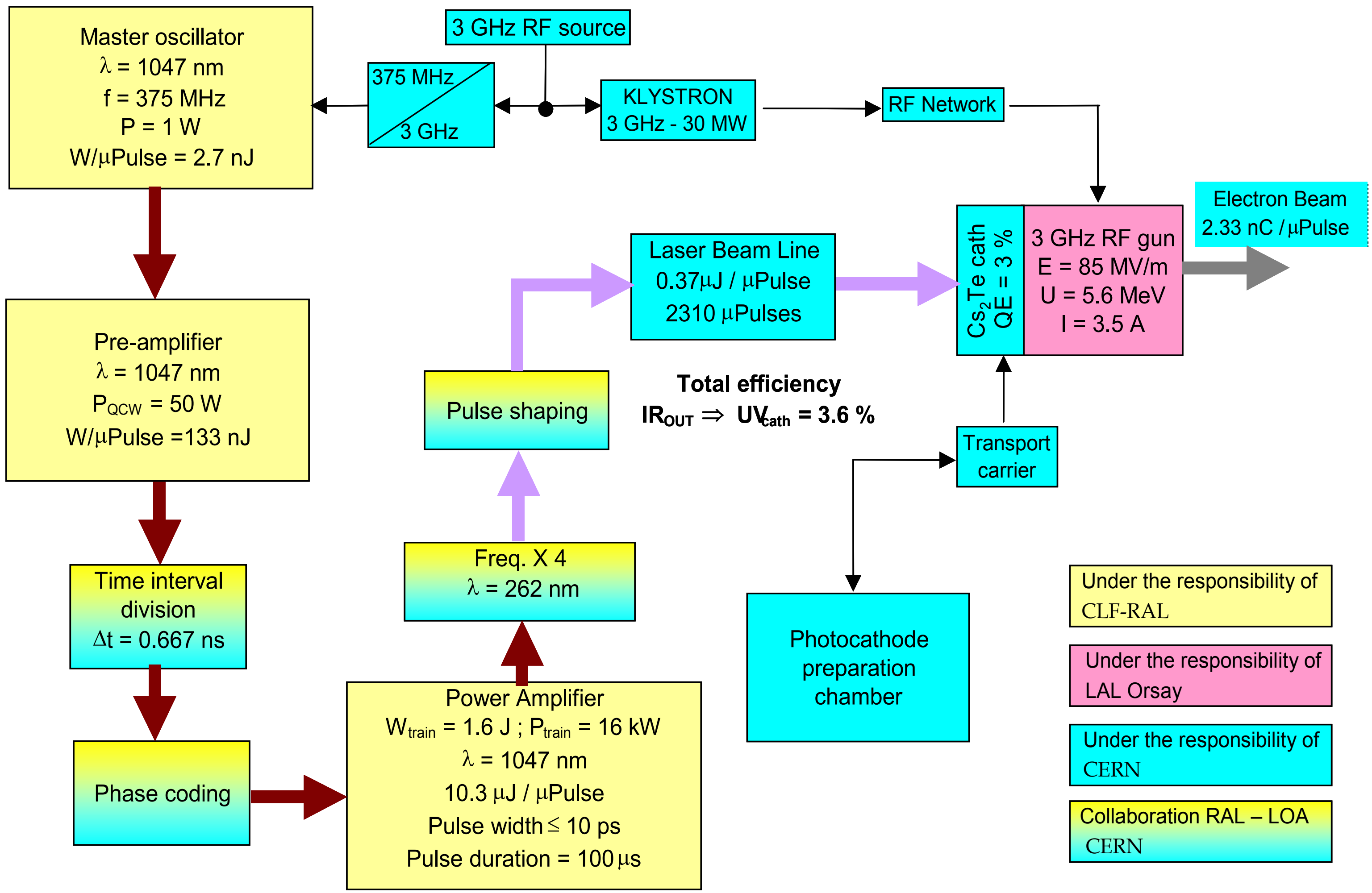


- ~4 µs response time
- +/- 10% change can be compensated
- ~65 % efficient

0.25%rms stability over 150µs

CERN (WP1, WP2, WP3, WP4) 1178+1300 k€

- Photocathode studies
- Design, construction, installation and commissioning of the CTF3 photo-injector



RF gun design & construction by LAL

- 4 LAL-CERN meetings since 13/01/04 (~ 5 CERN persons)
  - First meeting at CERN
  - 3 videoconferences
- CERN contribution:
  - e-beam parameter list, photocathode properties
  - CTF experiments

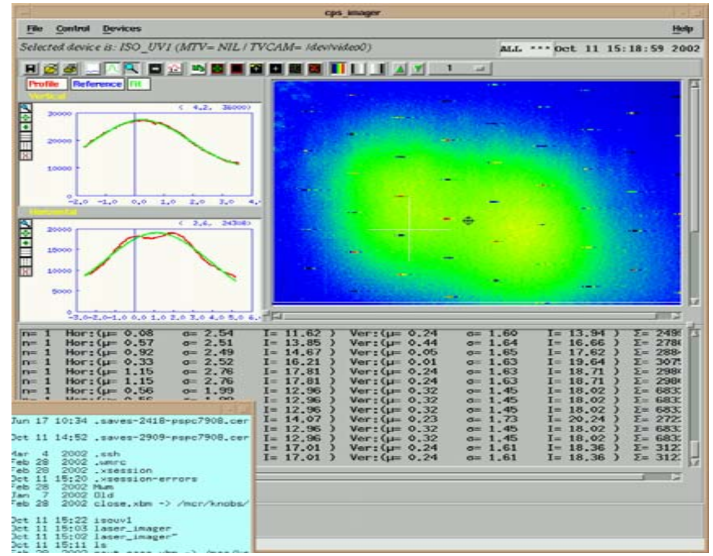
LASER design & construction by RAL

- 1 RAL-CERN meeting on 10/02/04 at RAL (1 CERN person)
  - Design and construction of the laser and associated optics under RAL responsibility
  - RF synchronization, timing, and controls for the installation at CERN will be under CERN responsibility

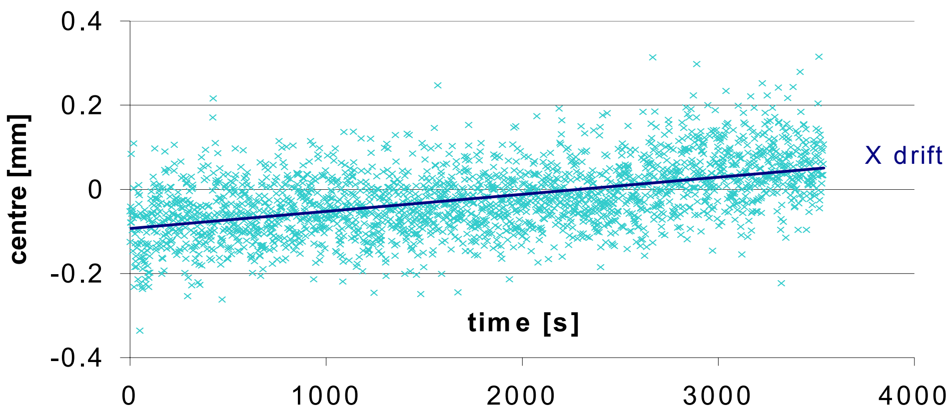
- CERN contribution
  - e-beam parameter list, photocathode properties
  - PILOT experiment
  - Automatic laser beam position control
  - Frequency conversion, first tests

Automatic Laser beam position control

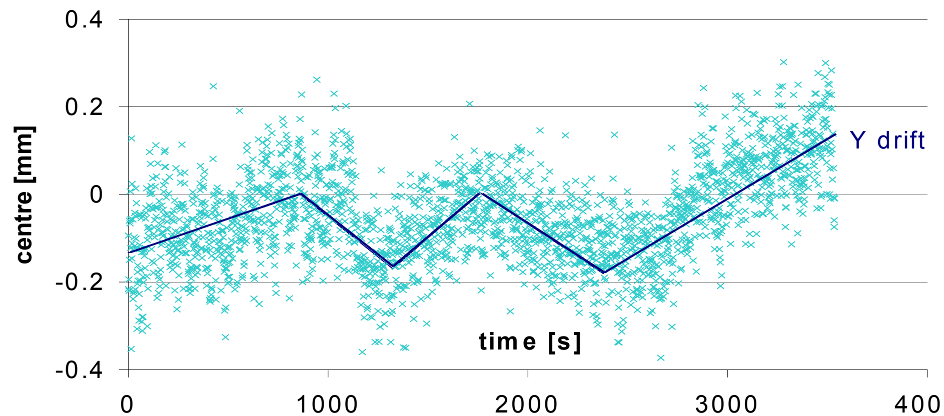
- First design and measurements with the RILIS UV beam:
  Optical path length ~ 23 m
  - Barycentre measurement : OK
  - Picomotor control : OK
  - Automatic control: under way



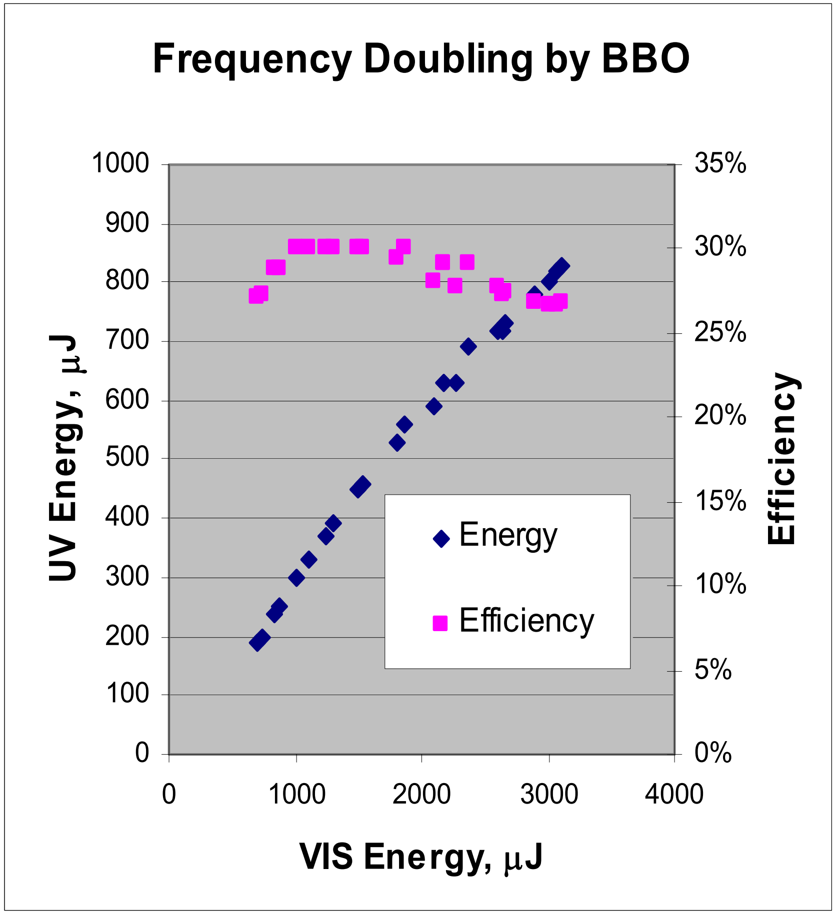
X plan , barycentre variation
Beam width FWHM = 1.77 mm, σ = 0.01 mm

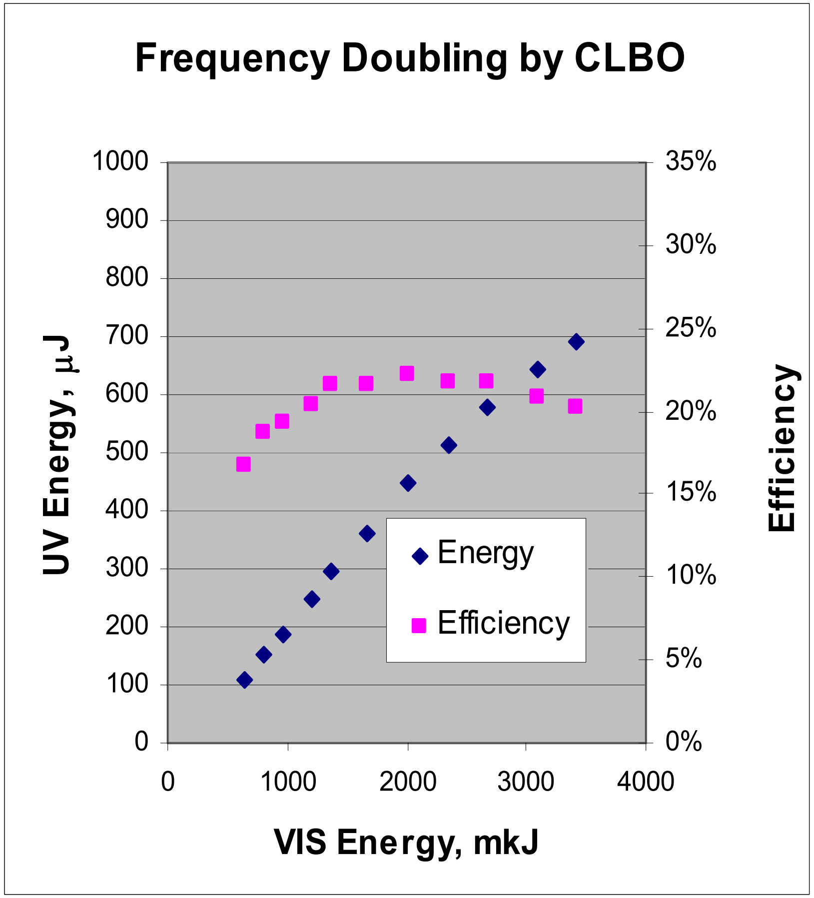


Y plan , barycentre variation
Beam width FWHM = 1.88 mm, σ = 0.03 mm



Generation of UV light at the laser setup of CTF2





Beam radius: 1.5 mm at crystal

Power density: 880 MW/cm^2 for 1000 µJ @ 527 nm

V. Fedosseev CERN AB-ATB

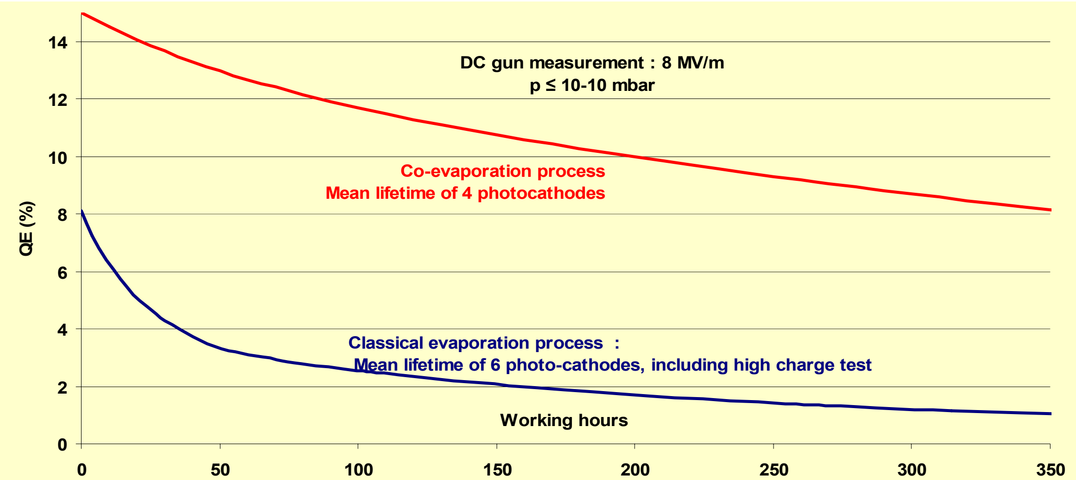
Conditions for light frequency conversion

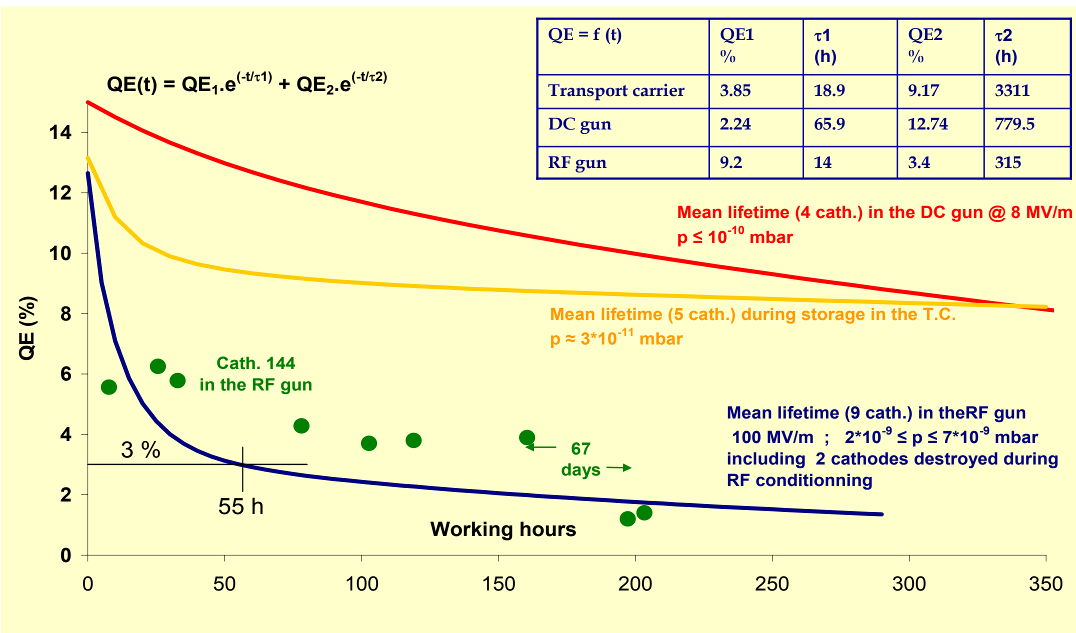
Parameter	CTF2 measured	PILOT measured	RILIS measured	CTF3 required
Pulse width, ps	8	10	15000	10
Repetition rate, Hz	5	5	11000	5
Number of pulses in train	2	250	1	2332
UV pulse energy at the target, μJ		0.009	30	0.37
Beam shaping and transport efficiency		0.52	0.3	0.25
Wavelength of IR beam, nm	1047	1047	-	1047
IR pulse energy, μJ	1000	1.1	-	10
Beam radius at crystal 1, mm	**1.5**	**0.31**	**-**	**0.13 [1] – 0.59 [2]**
IR power density at crystal 1, MW/cm^2	**1760**	**37**	**-**	**1760 [1] – 90 [2]**
Efficiency of IR – VIS conversion, Crystal type	**0.5 KTP**	**0.2 LBO**	**-**	**0.5 KTP or LBO ?**
Wavelength of VIS beam, nm	523	523	570	526
VIS pulse energy, μJ	500	0.22	360	5
Beam radius at crystal 2, mm	**1.5**	**0.24**	**0.03**	**0.12 [1] – 0.57 [2]**
VIS power density at crystal 2, MW/cm^2	**880**	**12**	**860**	**880 [1] – 50 [2]**
Efficiency of VIS – UV conversion, Crystal type	**0.3 BBO**	**0.075 KDP**	**0.25 BBO**	**0.3 BBO or KDP ?**
Wavelength of UV beam, nm	262	262	285	262
UV pulse energy, μJ	150	0.017	90	1.5
Average UV power, mW	1.5	0.02	1000	17

Beam radius[1] – scaled from CTF2 or RILIS to CTF3
Beam radius[2] – scaled from PILOT to CTF3

V. Fedosseev CERN AB-ATB
G. Suberlucq CERN-AB-ATB

Lifetime of Cs-Te photocath.





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

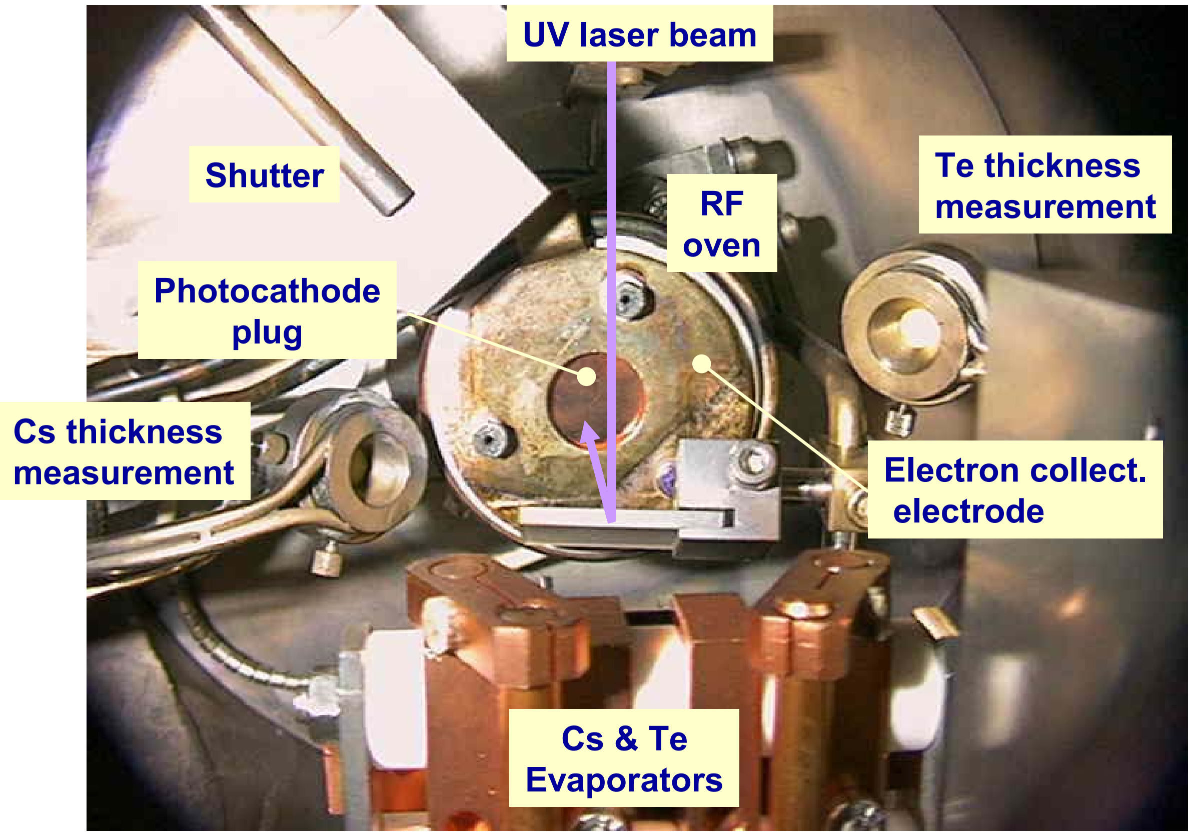
- Dramatic improvement of QE and lifetime of photocathodes produced by the co-evaporation process
- But photocathodes produced by co-evaporation seem to be more sensitive to the vacuum quality

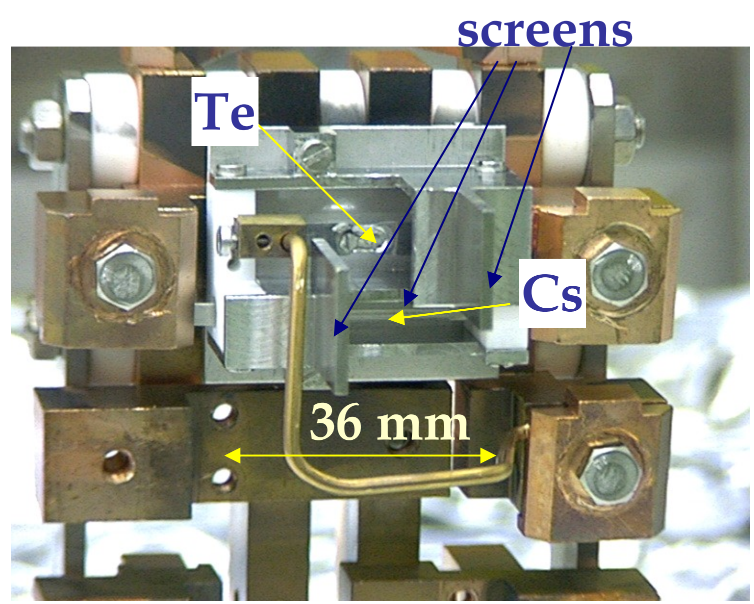
⇩

Strong improvement of the dynamic pressure in the RF gun is mandatory

Photocathode studies – CERN proposal

- Reproducibility of alkali-telluride photocathodes produced by co-evaporation
- Study of alkali-antimonide photocathodes produced by co-evaporation
- Comparison between telluride and antimonide cathodes for the CTF3 specifications
- Substratum studies





Preparation chamber developments

- Stoïchiometric ratio measurement
- Evaporation rate control
- Evaporator design for co-evaporation

Comments of the review committee (1)

The general impression of the committee is that the tasks have started according to the project planning and that no major problems have been identified at the moment. The division of the total budget seems to be appropriate for the aims to be achieved.

1. CERN: **The project is in a good shape and is proceeding according to the schedule.** Suggestion: It would be useful to have the data on photocathode production, performance and operation in the gun well organized in a database and accessible to other institutes.

2. FZR: **The project is in a good shape and is proceeding according to schedule.**

3. Twente U. - Suggestion: The diagnostics in the photocathode preparation chamber should be improved, in order to ameliorate cathode performances (lifetime). It would be useful to have the data on photocathode production, performance and operation in the gun well organized in a database and accessible to other institutes.

Comments of the review committee (2)

4. RAL: **We agree with the general scheme of the laser.**
   Suggestions: Utilizing the energy stored in the laser rods during the total pump-up phase in more efficient way would probably allow to reduce the required amount of diodes and therefore the total costs of the laser system. It would also solve the problems with fracture limit of the laser rods. This option should be taken into account because it is of large interest for other institutions.
   It may worthwhile to consider an oscillator running in burst-mode instead of CW mode.

5. LOA: The parameter space accessible with plasma acceleration seems not to match high energy physics requirements at present. More information exchange between plasma and accelerator physics communities will be useful. The laser expertise and hardware existing at LOA can be useful to other members of the collaboration.

6. LAL-Orsay: It should be clarified if a complete symmetrization of the field in the gun is necessary for CTF3 gun. In case, a coaxial coupler solution should be also considered.

7. INFN-Milano & Frascati: Both groups have presented different techniques to solve the same aim to produce flat-top pulses.
   We suggest joining the activities of both groups and use the short-pulse laser at Politecnico Milano as a test bed for the different pulse shapers under development.