Note PS/LP 88-38 11. 5. 198

TRAVEL REPORT

VISIT OF CEA/DAM PHOTO-INJECTOR GROUP

BRUYÈRES-LE-CHATEL

AND

VISIT OF SERA/LAL, ORSAY

ON

5 MAY 1988

People met:	CEA	R. Dei-Cas (group leader)	
		Debrion	
		Girardeau-Montat (Lyon Univ.)	
		Joly	
		Leboutet	
	LAL	Bergeret	Chehab
		Bourdon	Le Duff
		Boussoukaya	Le Meur
		Brunet	

CERN participants:	Y. Baconnier
	K. Geissler
	K. Hübner

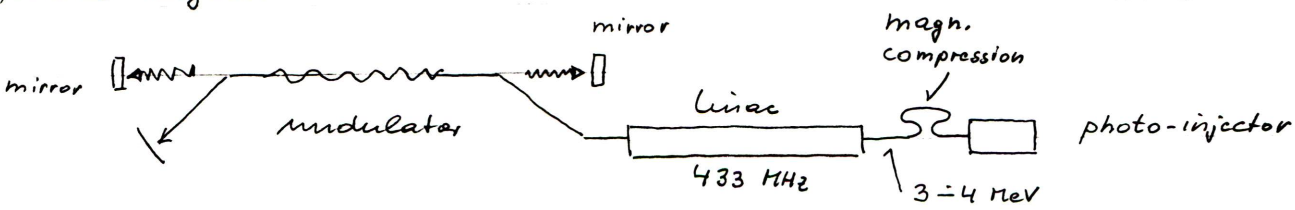
I. Injector for FEL at CEA/DAM

Group leader: R. Dei-Cas ; Visit: 5.5.88

* References : Excerpt of design study received covering injector ; Forthcoming paper at Rome Conference.

* Input parameters to FEL : $E = 60$ MeV
  - $\Delta t = 200\ \mu s$ pulse length
  - $f_{rep} = 1,10 \div 100$ Hz repetition frequency
  - $\Delta t = 40$ ps } micropulse
  - $Q = 20 \div 40$ nC } micropulse
  - $1000 \div 2000$ micropulses in pulse

* General layout



* Photo-injector

  Layout Fig. 1 $f = \frac{433}{3} = 144$ MHz

  Necessary for 40 nC :

  $E_{cath} = 21$ MV/m

  $S_{cath} = 2,1$ cm²

  $\Delta t_{\omega} = 600$ ns . (Laser)

  $f = 433$ MHz was also studied, Gives larger $\Delta E/E$.

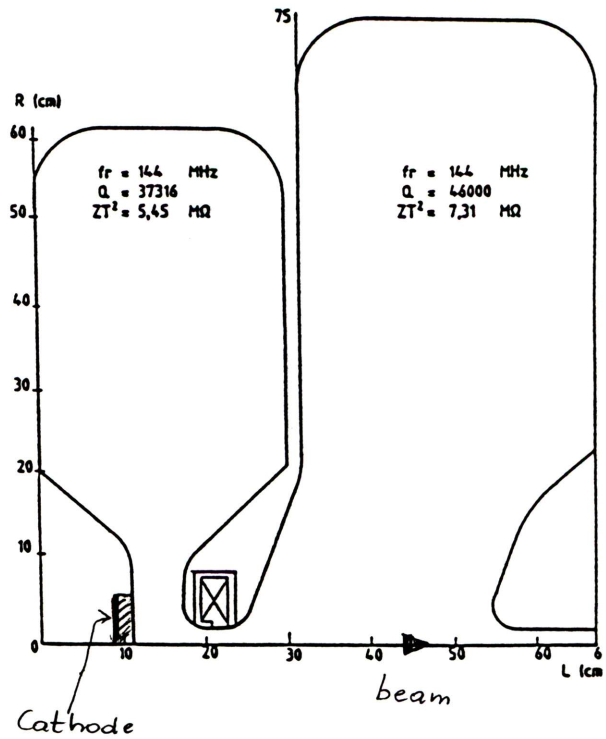


Figure III.40 : Schéma de principe du photo-injecteur à 144 MHz. Forme et caractéristiques électriques des 2

* *Calculated performance*

TABLEAU III.13 : Caractéristiques du paquet d'électrons à la sortie du photo-injecteur pour différentes charges transportées.

Q (nC)	R (cm)	ΔE/E (%)	ε* (cm.rad)	$\hat{I}$ (A)	B* A/m². rad²)
1	0,44	1,6	$2,6\ 10^{-5}$	2,5	$5,9\ 10^{11}$
5	0,47	1,7	$1,4\ 10^{-4}$	20,1	$1,8\ 10^{11}$
10	0,43	1,8	$2,9\ 10^{-4}$	37,8	$9,7\ 10^{10}$
20	0,42	2,3	$6,8\ 10^{-4}$	90	$6\ 10^{10}$
40	0,37	4,6	$1,4\ 10^{-3}$	195	$3\ 10^{10}$

$\sigma_t = 80 ps$

* L'émittance est définie ici par $\varepsilon = 4\left[\langle\alpha^2\rangle\langle R^2\rangle - \langle\alpha.R\rangle^2\right]^{1/2}$ avec $\alpha = v_r/v_z$, et la brillance par $B = 2\hat{I}/(\varepsilon\beta\gamma)^2$.

* Cavities : Cu

$P < 10^{-9}$ Torr

Bake-out 150 ÷ 180°C

HOM couplers

Extraction cavity :

Anode ≈ equipotential

ΔU = 1 MeV

* Cathodes : Cs_3Sb preparation and reconditioning in situ

GaAs

Expected lifetime : O(hours)

Later other materials : metals also

* Laser : Nd : YAG Mode locked

λ = 532 nm after ω - doubling

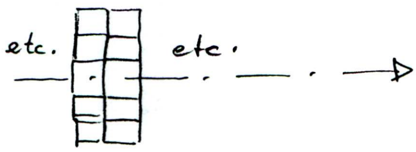
$W_\omega = 10 \mu J$ on cathode

$\frac{dW_\omega}{W_\omega} \leq 5\%$ between pulses

* Beam dynamics calculations [Frehaut, Brion]

Code ATHOS developed by CEA

Beam is simulated by rings and a central cylinder



Wakefields neglected but

simple image effects at cathode included.

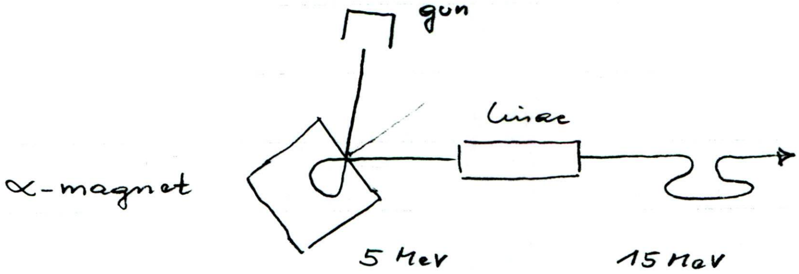
Comparison with Los Alamos data & Coulon (LAL) results ok.

PARMELA also available but apparently not much used.

Simulation near cathode very difficult and no way to check.

* Magnetic compression

- in design report from (200 ÷ 400 ps) → 40 ps
  in one stage after second cavity at 3.5 MeV
- in meeting (Dei-Cas) two stages were mentioned:



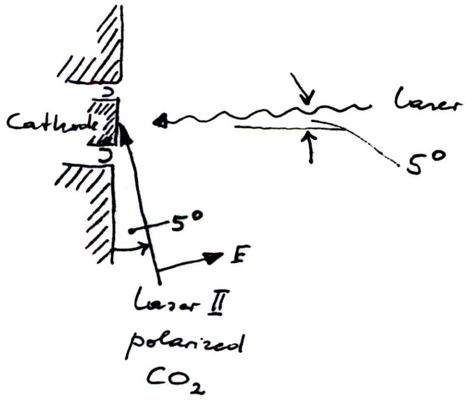
* Status

Started 6 month ago with the work

Foreseen start with experimental work (gun): begin. 89

Buildings: - shielded blockhouse (about 7 × 14 m) nearly ready for gun
- barrack for laser, controls, labs (about 12 × 24 m) ready
- amplifier in a third building
- for the final test new building required, not yet started.

* 2 Lasers (Girardeau - Montant, Lyon) :



Principle[1]) :

Laser II produces a smaller effective work-function by a multi-photon effect.

Test is being prepared to study metallic cathodes using a d.c. gun (100 kV) and two lasers. A variant foresees that both lasers are polarized and grazing.

1) cf. Travel report PS/LPI/Note 87-45 by K. Geissler and K. Hübner

II. Progress at SERA/LAL

II.1 Lasertron

see Travel report Oct. 87 [1]

* Photocathodes (Boussoukaya, Bergeret) formed by W-needle matrix

i) Past test (2,5 × 2,5 mm) test at $U = 30\,kV$, $d = 5\,mm$

Finished this test and inspected this point matrix.

5% of needles (?) were destroyed.

$W_\omega \leq 100\,\mu J$ for $Q = 20\,nC$

ii) W points test at $U = 150\,kV$, d-variable

Field emission reproduced. They suffer from breakdowns.

$U \times Q$ = constant   Not yet understood.

$\Delta t_\omega = 20 \div 100\,ps$

Δt (scope) $\leq 1\,ns$ observed

* Laser

Complain about lack of stability (time, position and intensity)

K. Geissler discussed improvements.

* Mini-Workshop "Photocathodes and lasers" at BNL

in autumn 88 (Palmer, le Duff).

* Mini-Mini-Workshop in Europe proposed by le Duff

so that problems can be discussed in an orderly manner

with more time for the individual points.

1) K. Geissler & K. Hübner, PS/LPI Note 87-45

II.2 High-gradient test facility[1] (Brunet)

see forthcoming paper at Rome conference.

* LIL-type structure ; 50 cm long ; Equal last landing of LIL.

- Measurements with beam

	desired	obtained
P_{in} (MW)	35	20 ÷ 25
E_{acc} (MV/m)	40	33

- Measurements without beam

Darkcurrent = f(t) ; Spectrum of secondary e^- goes from 0 to E_{max}.

- Gun : from Koontz (SLAC) ; electronics by Chapput ; 100 kV

$I = 1A$, $\Delta t = 1 ns$; $I = 1.5 A$, $\Delta t = 5 \div 30 ns$.

* Backward-wave structure (made in collab. with CGRMeV) ; TW.

calc.: $Z' = 85$ MΩ/m R/Q = 7000 Ω L = 1.2 m without couplers

is being installed.

II.3 Conversation with Le Meur about codes

* RING (Coulon, Dubrovin, Tallerico) code : beam is modeled by rings.
Simple program. Effect of cathode simulated by image discs but no ~~correct~~ treatment of wakefield effects. Slow code.
Needs input from SUPERFISH and POISON.

* PARADE (Le Meur's code) : finite element method, good for study of transient effects ; Similar to Weiland's codes but Weiland only rectangular mesh. PARADE's mesh more flexible. Needs also SUPERFISH input and library MODULEF (library of a club in F). One could extract required subroutines from MODULEF and install them at CERN.

* PARMELA : old-fashioned program, better not to be taken up.
* MASK : very difficult to use, mesh generation not flexible.
* ARGUS + ISIS : does not know much about it.

He thinks one should use either Weiland's codes or PARADE.

He could give a talk to us end of June or after holidays.

II.4 Accelerating section for CLIO [1] (Brunet)

In production at SPINNER. Cells by Petit-Jean (Fayet) (subcontractor)
SPINNER does more now than done for LIL.
LAL contributes: tuned couplers, vacuum envelope, supports.
Contract with SPINNER: to be signed within the next days.
Delivery date: September 1988.
Cost: 1.2 MFF HT.

K. Hübner