Photo-injector, General Plan & Photocathodes

1. **The CTF3 photo-injector**
2. **Status of the project**
   - Laser (see M. Divall's presentation)
   - RF gun (see R. Roux's presentation)
   - Photocathodes
   - Installation
- **Photocathode studies**
- **Schedule**

CTF3 Photo-injector specifications

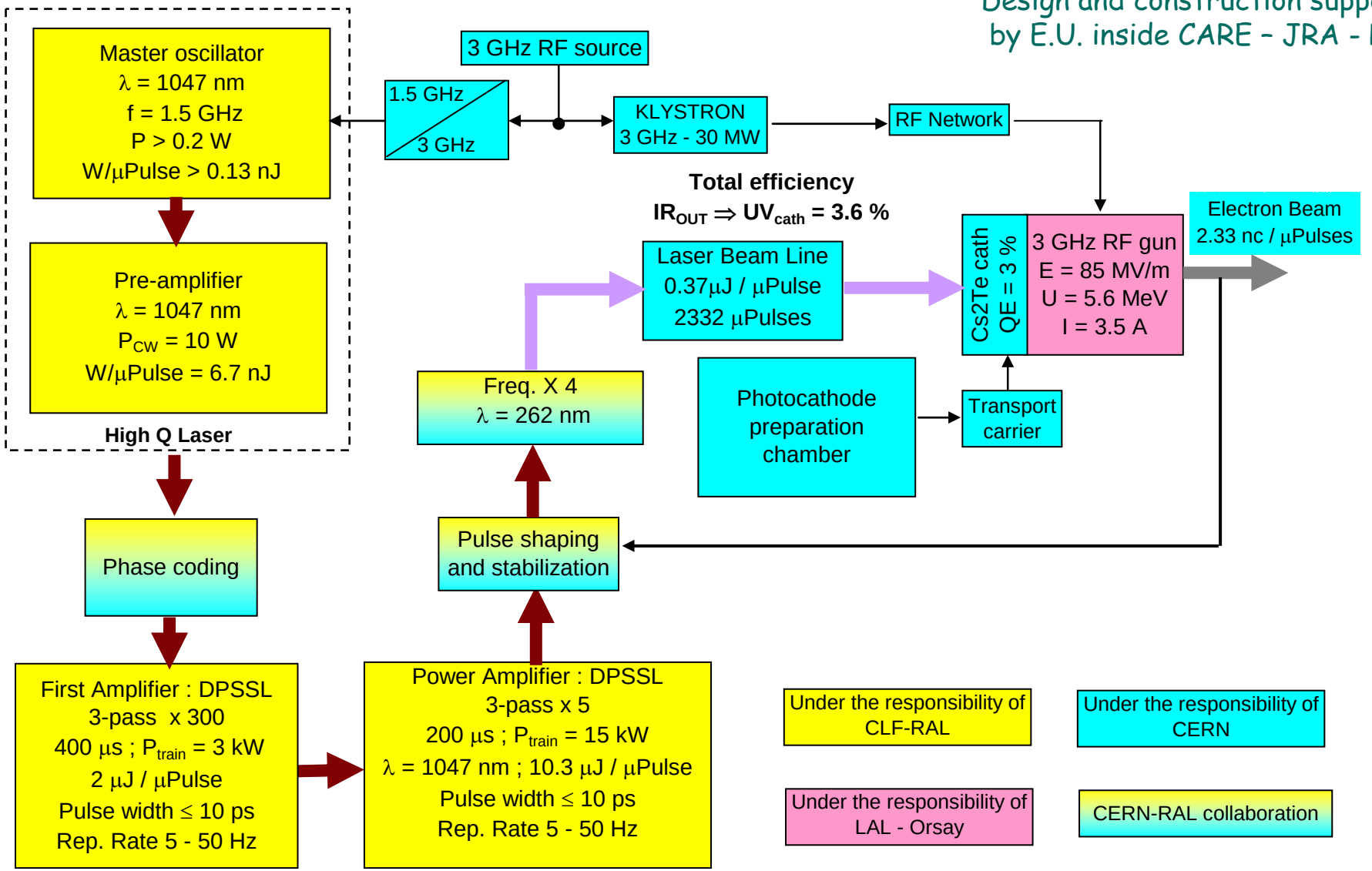
Pulse train duration (1)		1.548	μs
Pulse train charge (1)		5434	nC
Average current in the pulse train		3.51	A
Number of bunches in the sub-pulse		212	
Odd/even sub-pulse width (FWHH)		140.735	ns
Number of bunches in the pulse train (1-2)		2332	
Charge / bunch		2.33	nC
Distance between bunches		0.667	ns
Bunch width (FWHH)		10	ps
ε_T normalized (rms)	≤	25	π.mm.mrad
Δp/p (rms)	≤	2	%
charge stability	≤	0.25	%
Repetition rate		1 - 50	Hz
Mean current	@ 50 Hz	271.68	mA

(1) With starting bunches

(2) The photo-injector must be able to produce only one electron pulse

The CTF3 Photo-injector synoptic

Design and construction supported by E.U. inside CARE - JRA - PHIN



Laser: Oscillator & preamplifier

- **1.5 GHz, 10 ps pulse width, temporal jitter < 1 ps rms + 10 W CW preamplifier**
- **Estimated coast : 200 kCHF + 100 kCHF**

Firms invited to tender

Supplier name	Origin	Contacted On	Town	Country	Response
HIGHQLASER PRODUCTION GMBH	I1	10/06/2004	HOHENEMS	AT	INTEREST
TBWP (TIME-BANDWIDTH PRODUCTS)	I1	10/06/2004	ZURICH	CH	INTEREST
ALPHALAS GMBH	I1	10/06/2004	GOETTINGEN	DE	NOREPLY
JENOPTIK GMBH	I1	10/06/2004	JENA	DE	NOREPLY
LUMERA LASER GMBH	I1	10/06/2004	KAISERSLAUTRN	DE	NOREPLY
MAX-BORN-INSTITUTE (MBI)	I1	10/06/2004	BERLIN	DE	NOREPLY
SPECTRA-PHYSICS GMBH	I1	10/06/2004	DARMSTADT	DE	NOREPLY
COHERENT SCIENTIFIQUE	I1	10/06/2004	ORSAY CEDEX	FR	NOREPLY
ADVANCED OPTICAL TECHNOLOGY LTD	X1	16/06/2004	BASILDON ESSEX	GB	NOREPLY
LASER LINES (INDUSTRIAL & MEDICAL) LTD	I1	10/06/2004	OXON	GB	NOREPLY
UNIVERSITY OF STRATHCLYDE	I1	10/06/2004	GLASGOW	GB	DECLINED

High Q Laser production: oscillator + preamplifier in a same enclosure
~ 269 kCHF , delivery is foreseen end of February

Laser: Pumping diodes

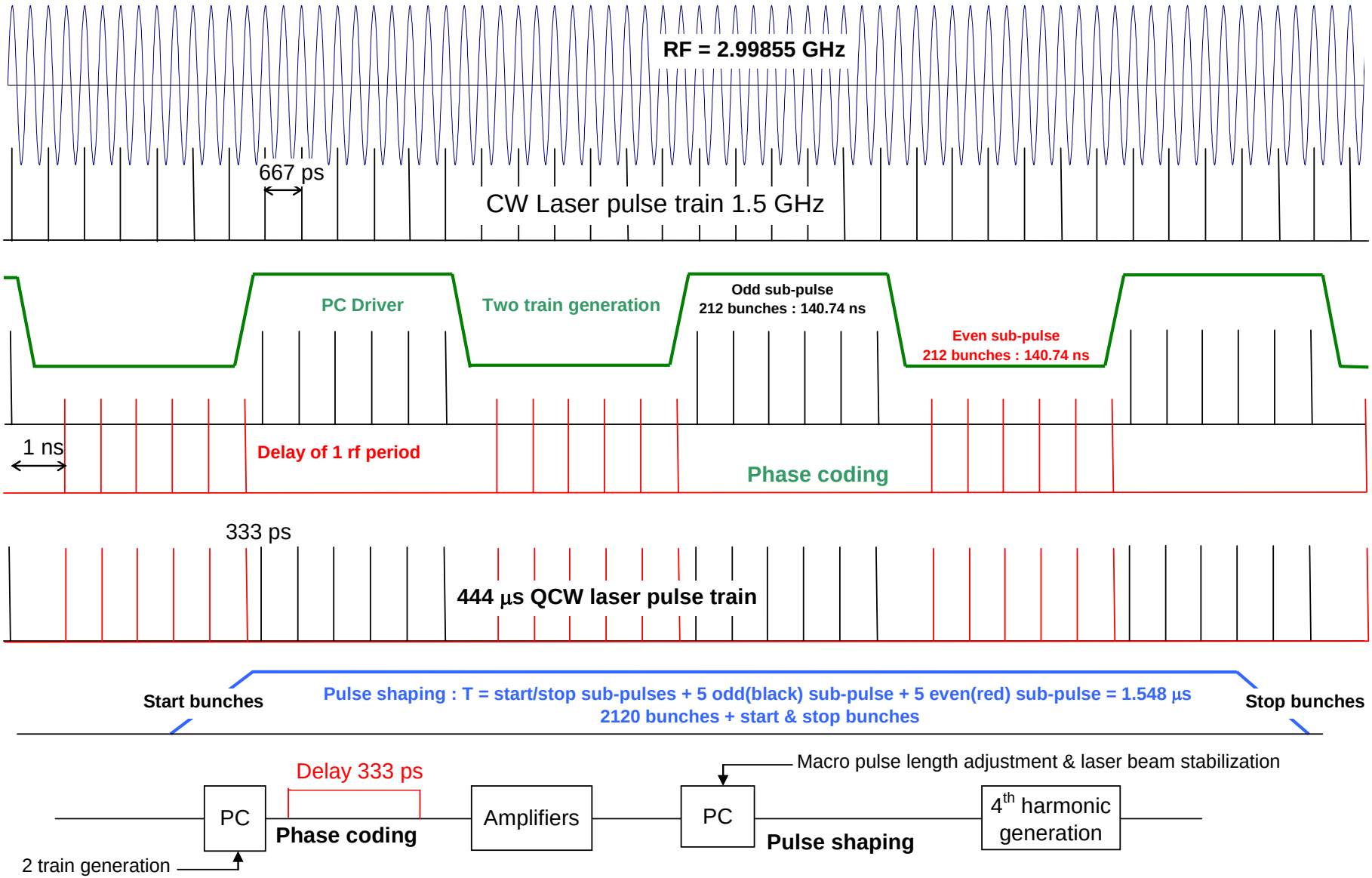
First amplifier

- **18 kW total peak power at 2.5 % duty cycle, 50 Hz rep. rate**
  Using a 7 cm long, 0.7 cm diameter Nd:YLF rod
- **Estimated coast: 180 kCHF ; expected delivery: April - May 2005**

Firms invited to tender (price enquiry DO-21929/AB)

Supplier name	Origin	Contacted On	Town	Country	Response
DILAS DIODENLASER Gmbh	I1	17/11/2004	MAINZ	DE	
JENOPTIK Gmbh	I1	17/11/2004	JENA	DE	
LASER ENGINEERING APPLICATION S.A.	I1	17/11/2004	ANGLEUR	BE	
ROITHNER LASERTECHNIK	I1	17/11/2004	VIENNA	AT	
THALES LASER DIODES	I1	17/11/2004	ORSAY	FR	

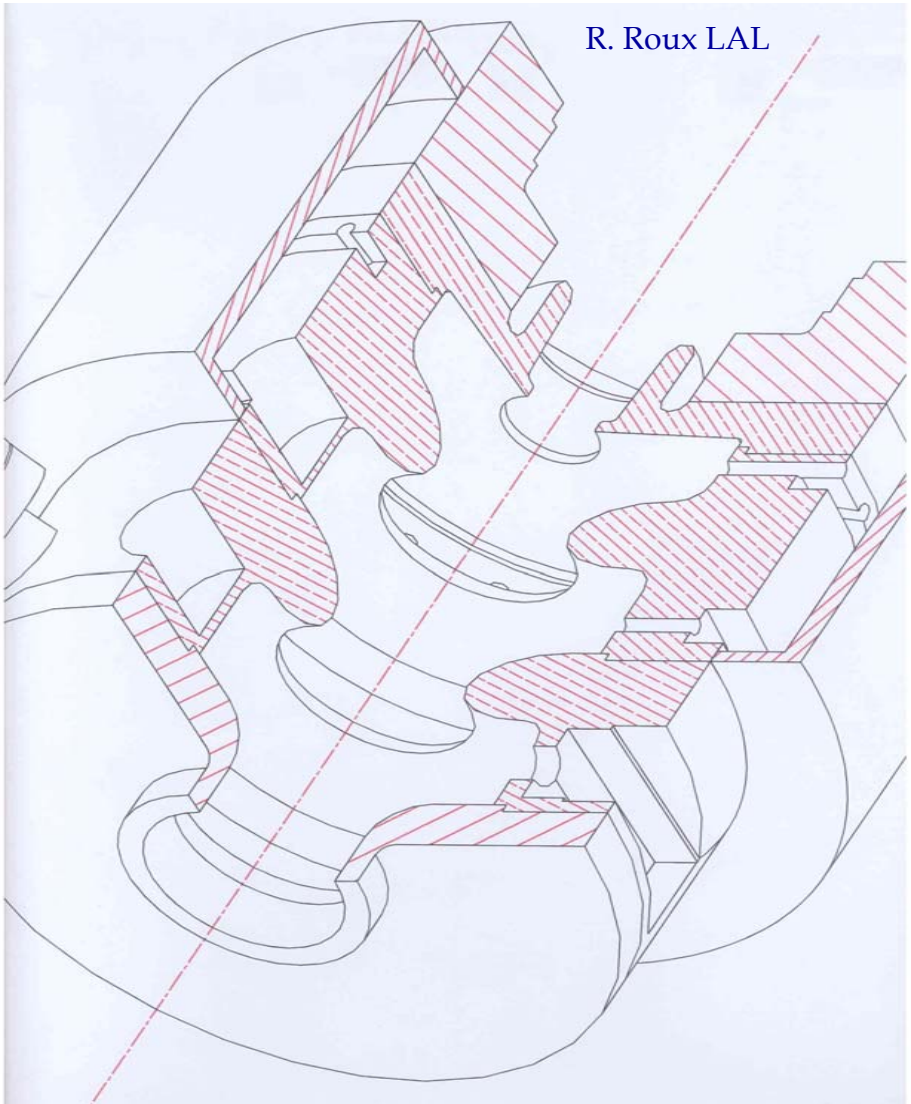
Phase coding and pulse shaping (1)



Phase coding and pulse shaping (2)

- **RF for laser mode-locking : 3 dBm @ 1.49928 GHz**
- **3 programmable timing pulses with a ps jitter**
- **4 programmable standard timing pulses**
- **Fast Pockels cell drivers with rise and fall time < 500 ps (10%-90 %)**
- **Pattern generator with jitter < 10 ps rms**

RF gun

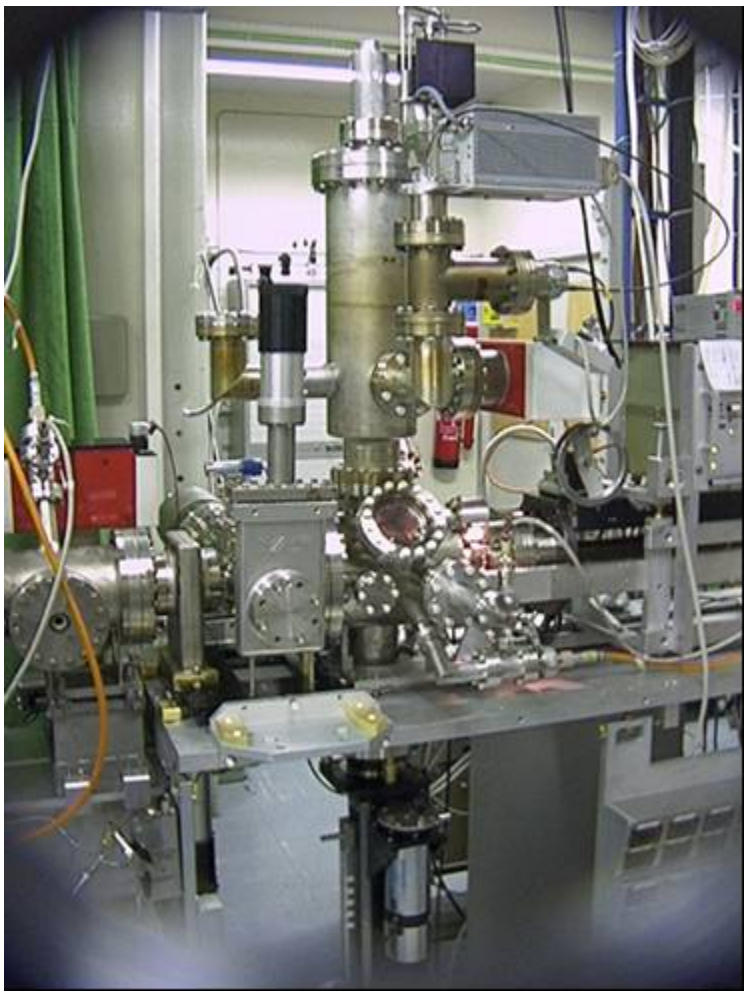


RF frequency (GHZ)	**2.99855**
RF power (MW)	**30**
Acc. electric field (MV/m)	**85**
Beam energy (MeV)	**5. 6**
Beam current (A)	**3.5 - 5**
Charge/bunch (nC)	**2.33**
Bunch length (ps)	**10**
Energy spread (%)	**< 2**
Normalized emittance (π.mm.mrad)	**< 25**
Number of pulses	**~ 2332**
Pulse train duration (μs)	**1.548**
Coupling factor (β)	**2.9**
Vacuum pressure (mbar)	**2.10^{-10}**
Repetition rate (Hz)	**50**

Photocathodes for the CTF3 photo-injector

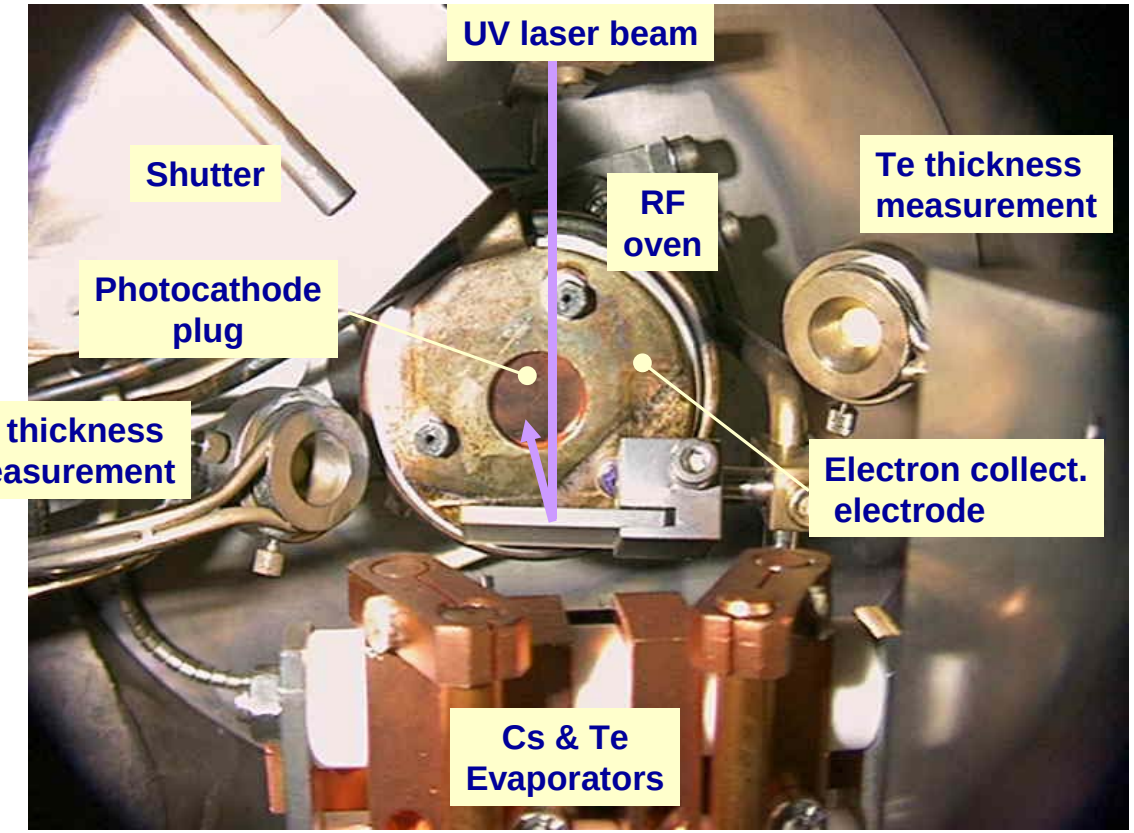
Photocathodes with a QE ≥ 3 % during at least 40 working hours

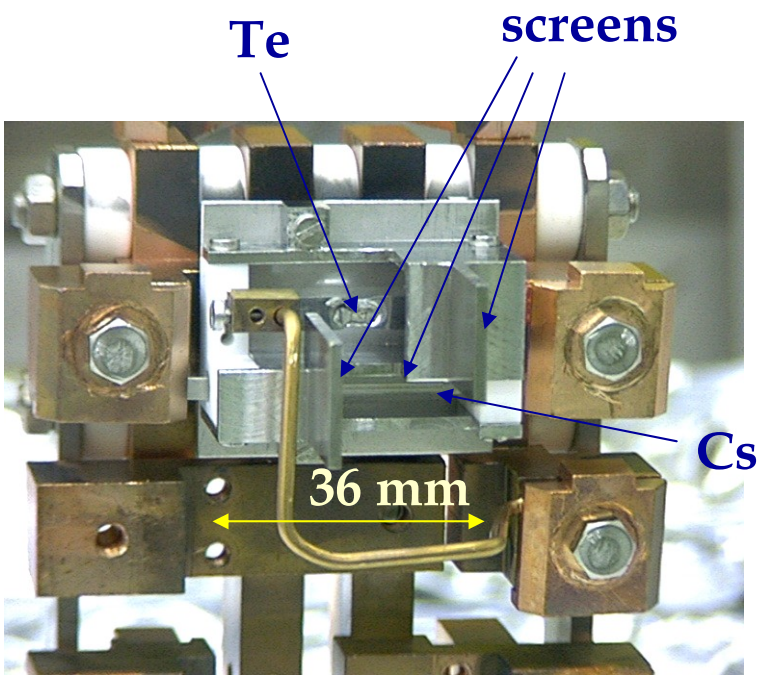
A photocathode production to guarantee a continuous run of at least 6 months



- **The rejuvenation of the preparation chamber is completed**
- **A new port has been added to allow cathode transfer for analysis without breaking the vacuum (AUGER and XPS analysis)**
- **Design of a small transport chamber between preparation chamber and XPS analysis bench compatible with the CEA- SP2A's chamber**
- **A new mass spectrometer with mass up to 200 has been installed**
- **A new bake-out installation, clean-room compatible, was designed and ordered. Installation expected for the end of November.**

Photocathode production by co-evaporation





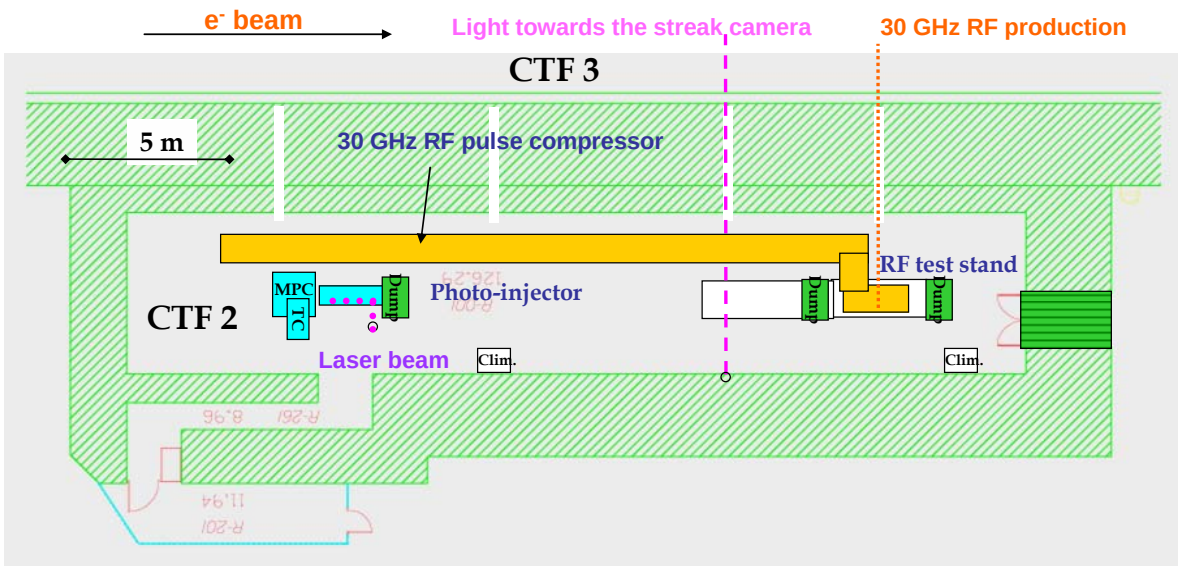
Preparation chamber ready to start studies of:

- **New evaporators**
- **Evaporation of alkali-antimonides**

Photo-Injector installation

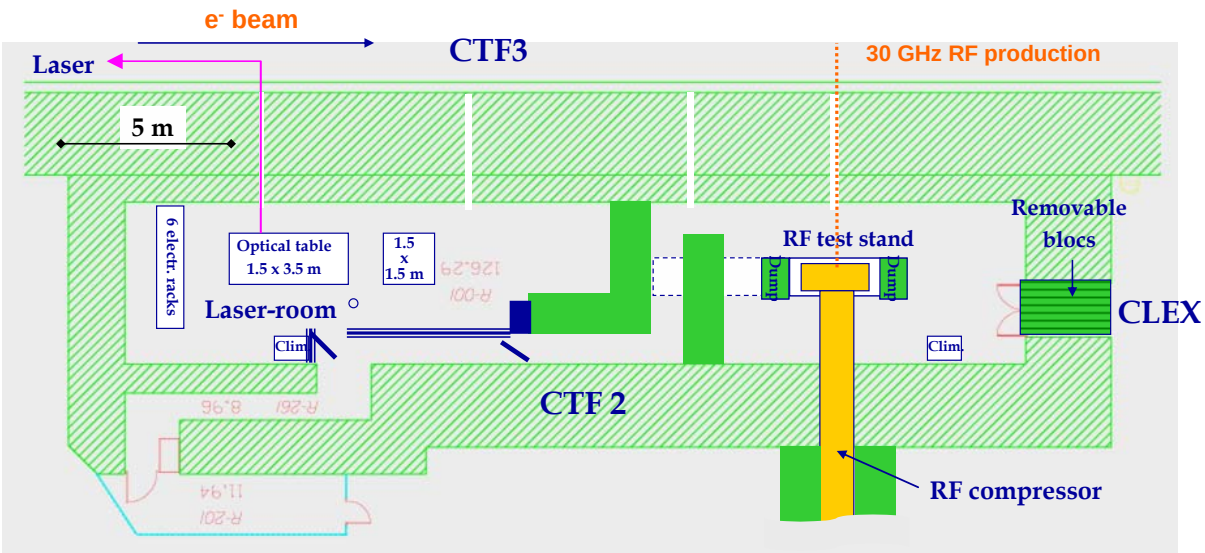
2004 – end of 2006

- Photo-injector in the former CTF2
- Laser-room in the former CTF2 laser-room
  ➔Position stability not guaranty



From 2007

- Photo-injector in the place of the CTF3 thermionic gun
- Laser-room in the first part of the CTF2



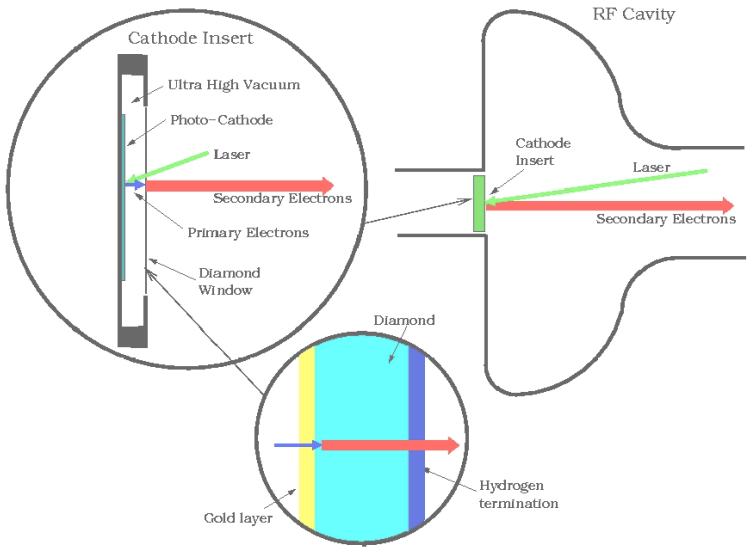
Photocathode development

Study supported by E.U.
inside CARE - JRA - PHIN

Informal collaboration with
CEA-DPTA-SP2A

Secondary Emission Enhanced photo-emitter

Proposal from I. Ben-Zvi et al. C-A/AP#149, April 2004, BNL



Expected avantages

- Very high equivalent QE ~ 1000 % !
- Low laser power
- Low thermal emittance (NEA surface)
- No mutual contamination between the gun and the photocathode
- Possible high mean current
- No load-lock system

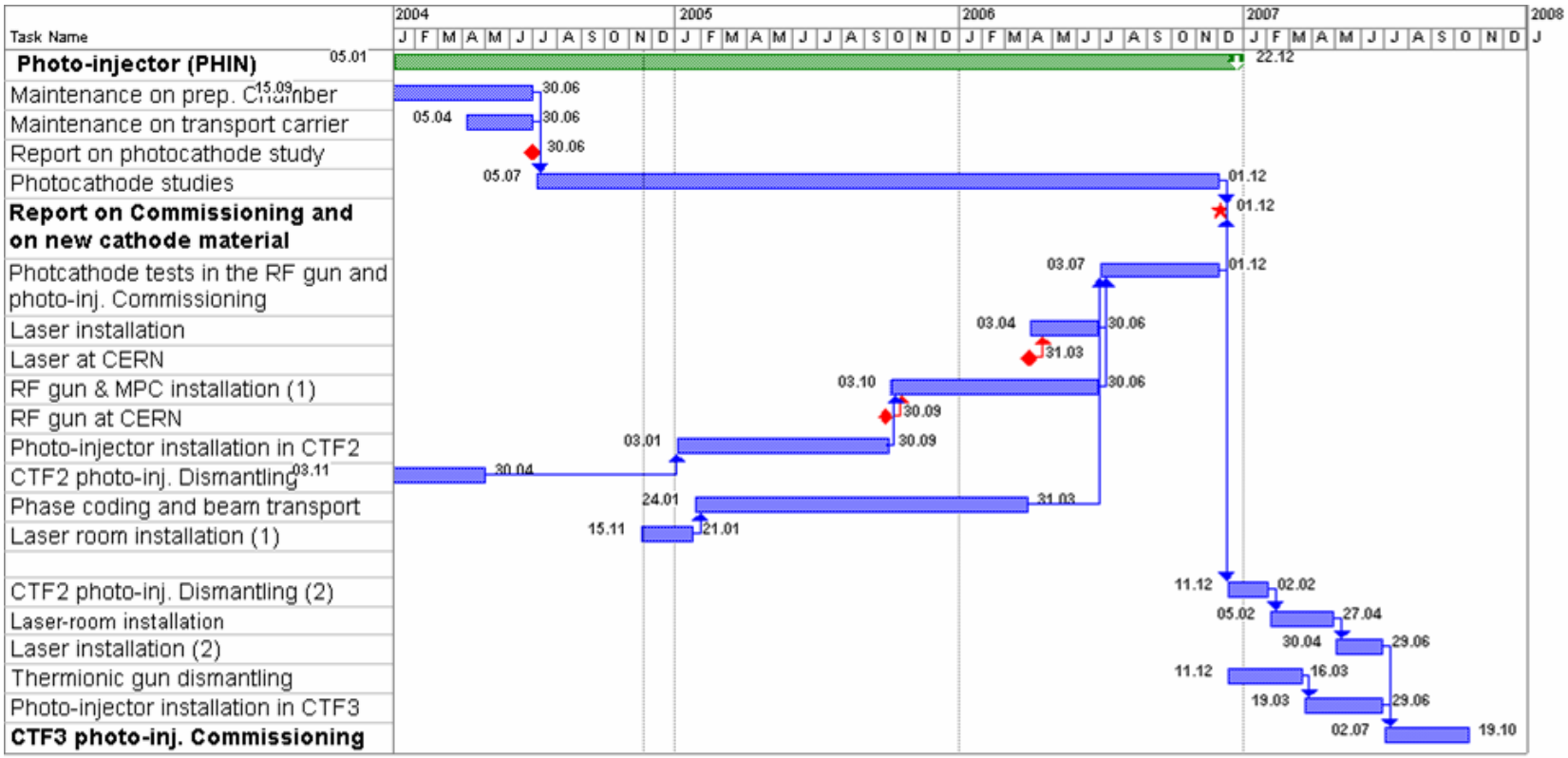
- Cathode insert consist of :
- Alkali antimonide cathode
- A sealed diamond window (~10 μm thick)
- UHV in between

- The diamond window is transparent to photons and electrons
- Electrons are produced by a laser beam shooting an alkaline cathode
- Electrons are multiplied by secondary emission by the diamond window

Schedule

Realization of the photo-injector option in two steps :

- **Photo-injector commissioning in the CTF2: summer 2006**



- **Operational photo-injector in the CTF3 in 2007**
  - **Installation during the shut-down 2006-2007**
  - **Commissioning from summer 2007**