



17TH ADVANCED BEAM DYNAMICS WORKSHOP ON

FUTURE LIGHT SOURCES

The Super-ACO FEL Source and Applications

M.-E. Couprie, LURE

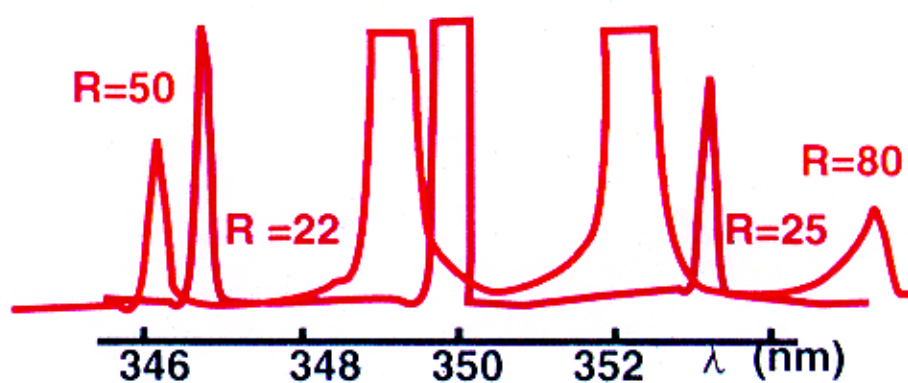
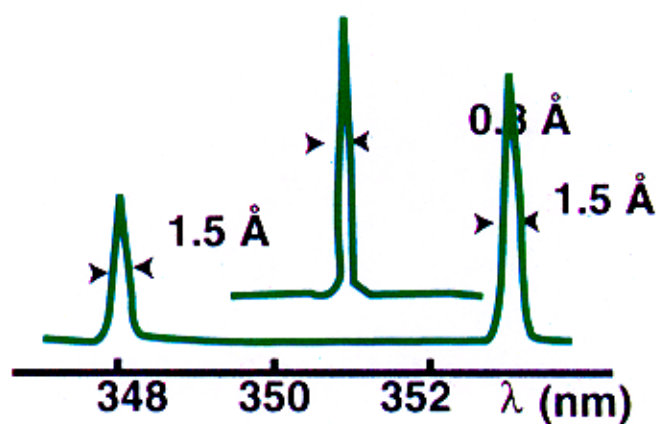
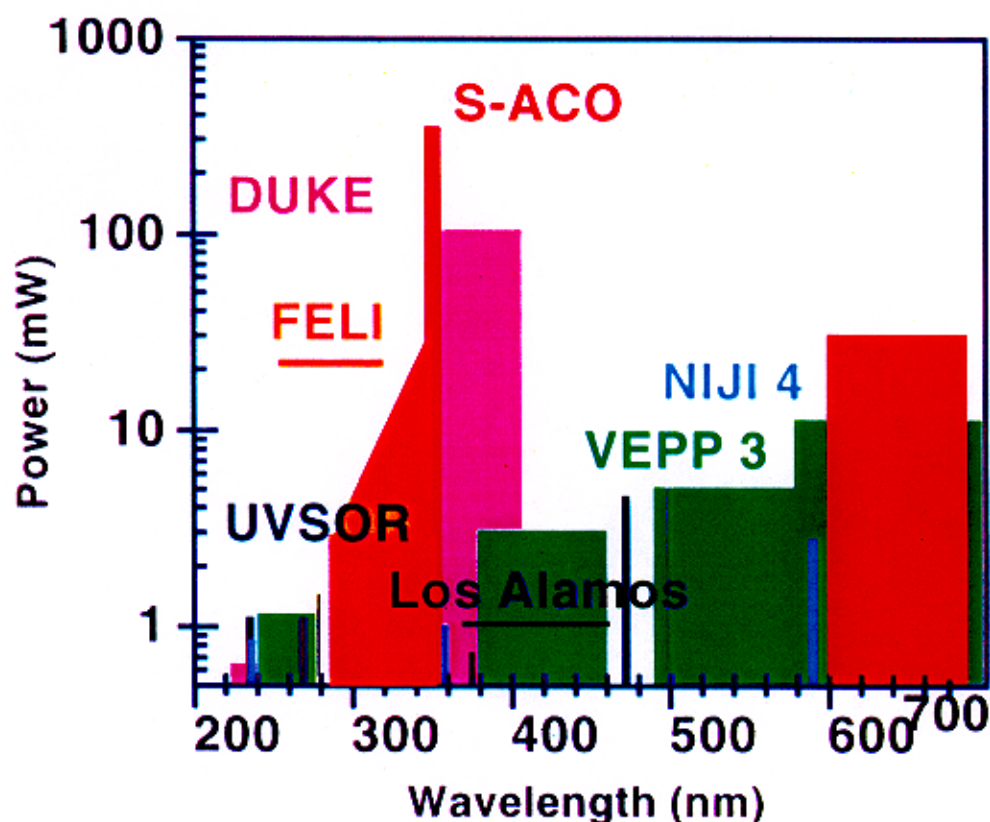
APRIL 6-9, 1999

ARGONNE NATIONAL LABORATORY, ARGONNE, IL U.S.A.

**HISTORY OF THE SUPER-ACO
STORAGE RING FEL**

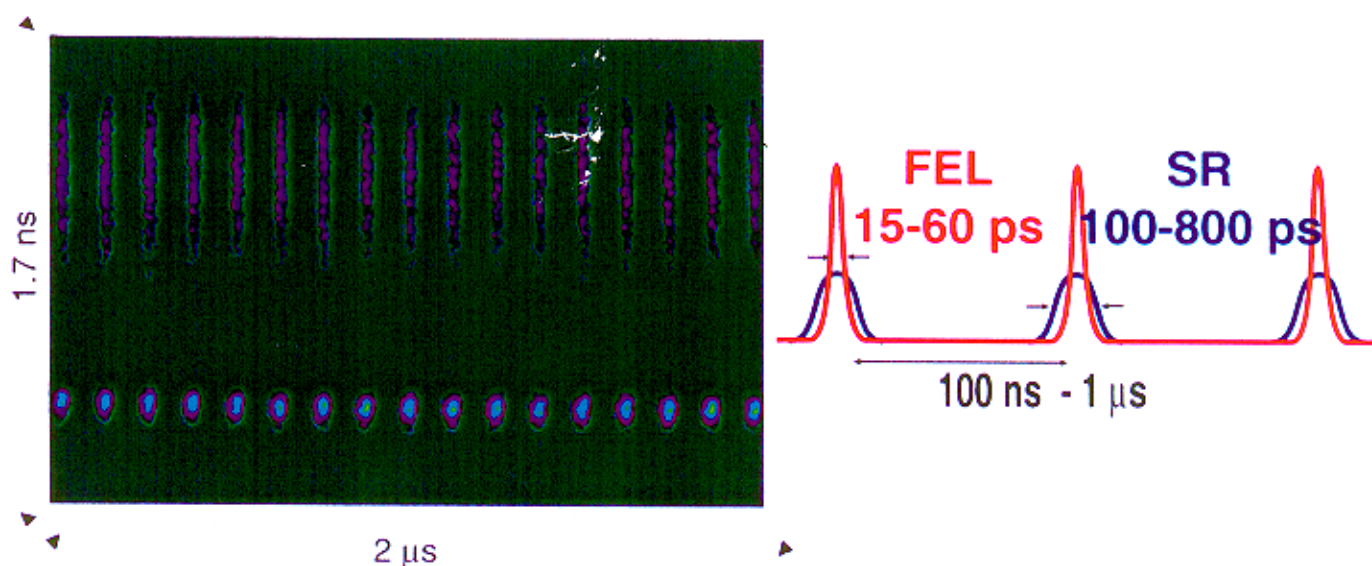
- 1989 :** lasing in the visible, 600 MeV
chaos studies, longitudinal dynamics
- 1990 :** CHG from a doubled Yag-laser
- 1991 :** lasing in the UV (600 MeV-800 MeV)
100 mW output power
- 1993 :** first user experiment on a SRFEL and on a
UV FEL : time resolved fuorescence in biology
NADH in solution
- 1994 :** Longitudinal Stabilization (FB system)
first 2-color pump-probe user experiment
in surface physics (surface photovoltage effect)
- 1995 :** stable operation at 100 mA
- 1997 :** installation of a 500 MHz harmonic cavity
for gain enhancement
- 1998 :** Reliable operation of the FEL with the 500 MHz
harmonic cavity.
Stabilization improvement $\Rightarrow$ Fourier Limit
Transient absorption (UV FEL + UV SR) on
POPOP
- 1999 :** Anthracene donnor-acceptor complex
UV-IR SR beamline to couple with the user FEL

SPECTRAL CHARACTERISTICS



TEMPORAL STRUCTURE

Microtemporal



Macrotemporal

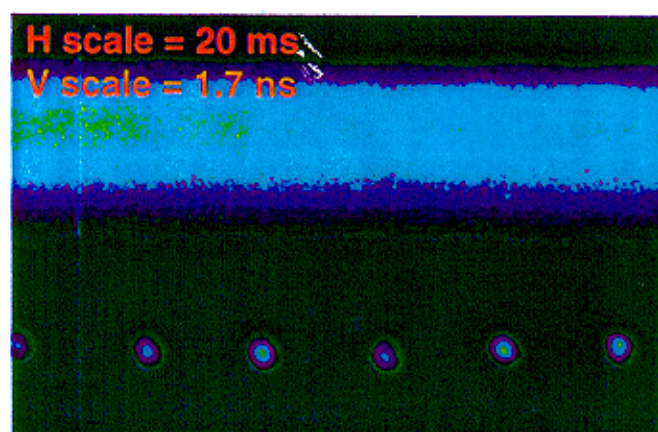
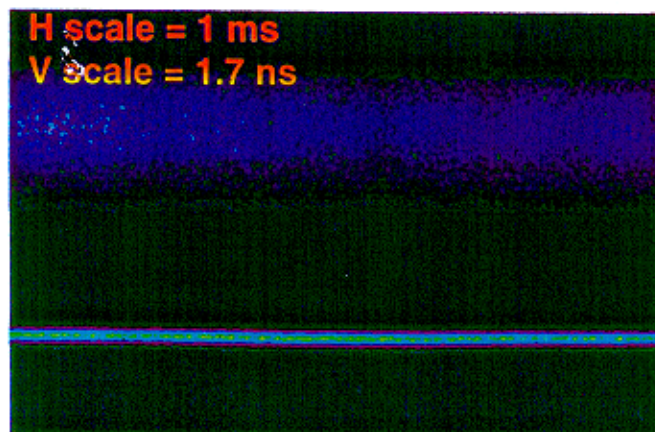
vs e/phot. synchro (tuning)

«CW»

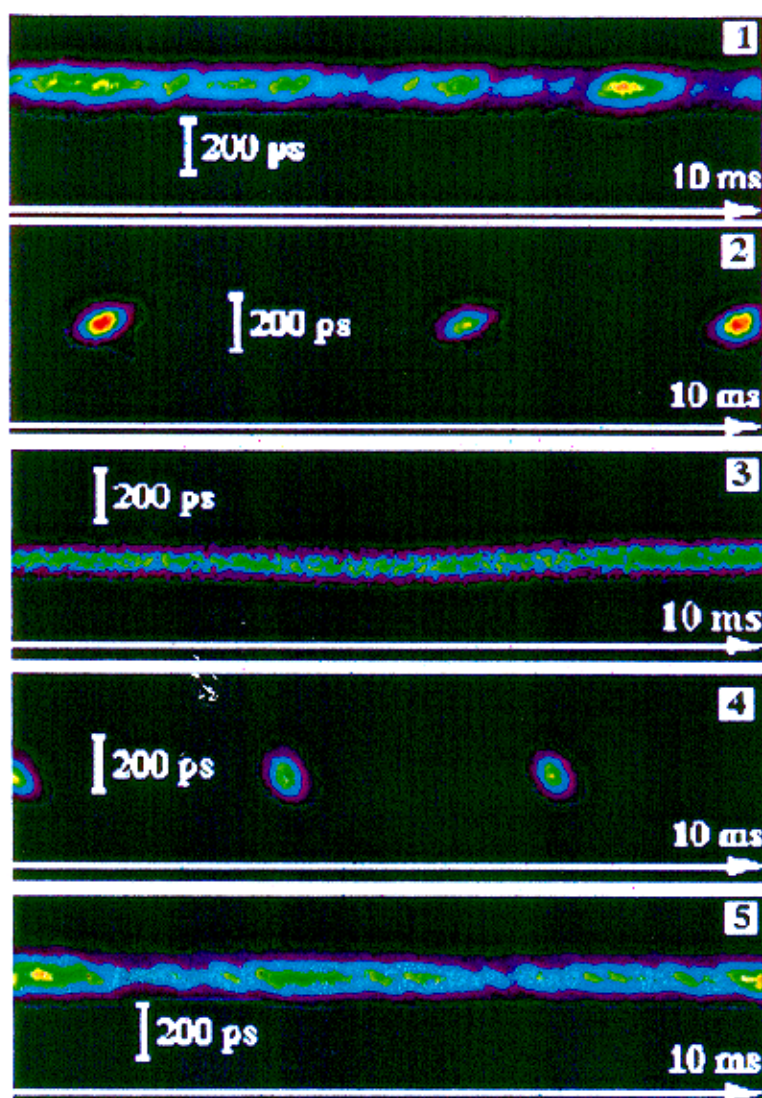
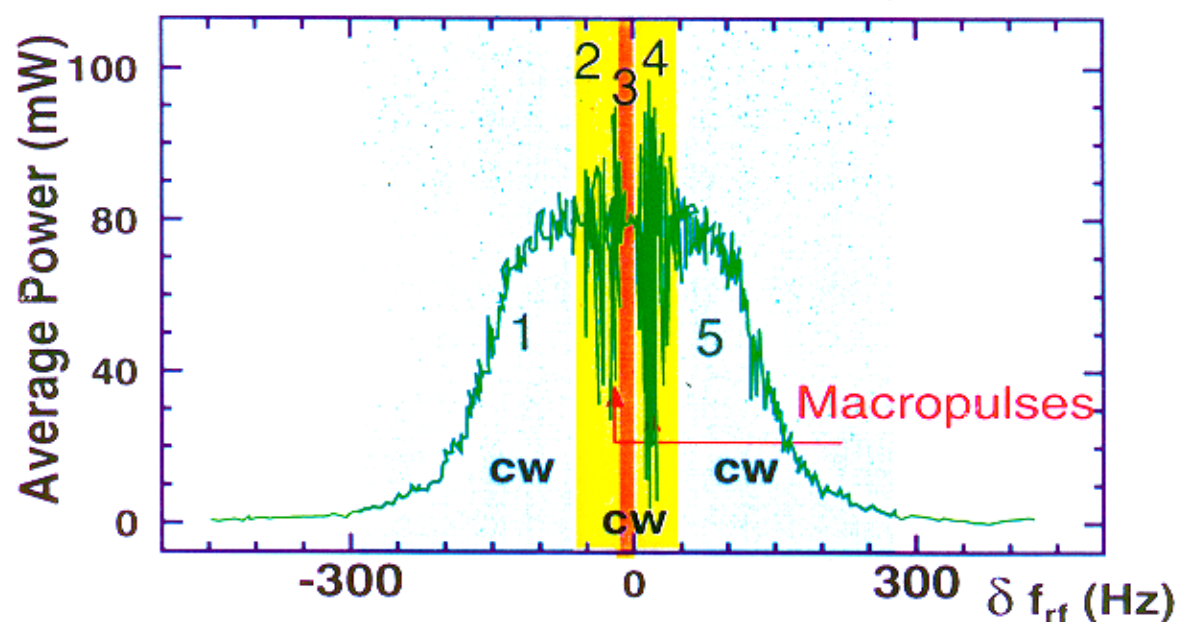
$$\tau_0 = \frac{T_{el}}{P \ln G/P}$$

«pulsed»

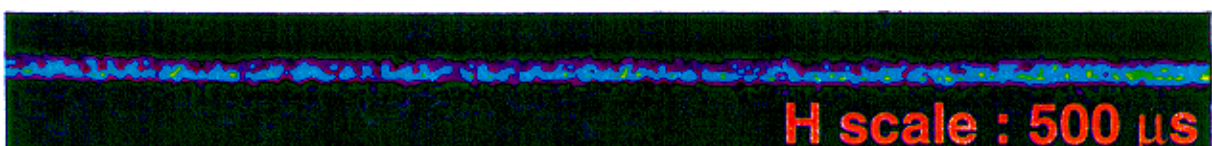
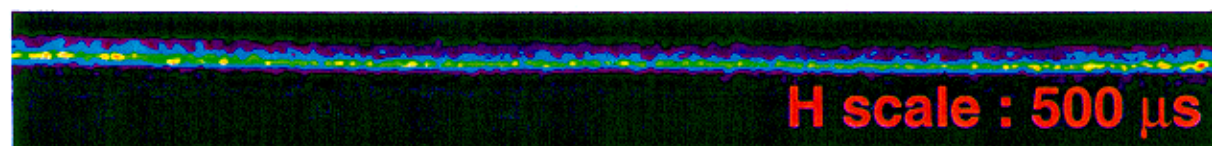
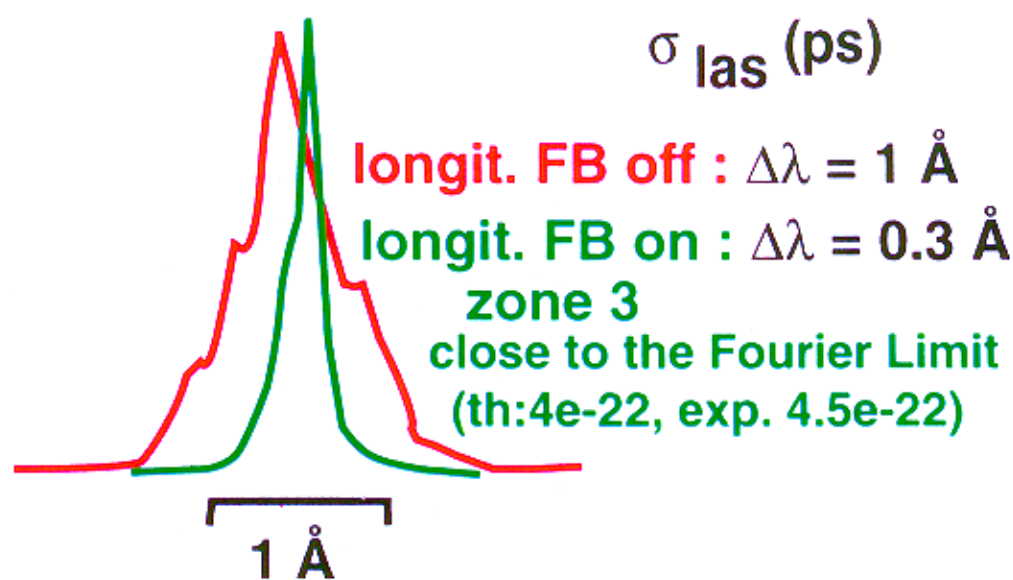
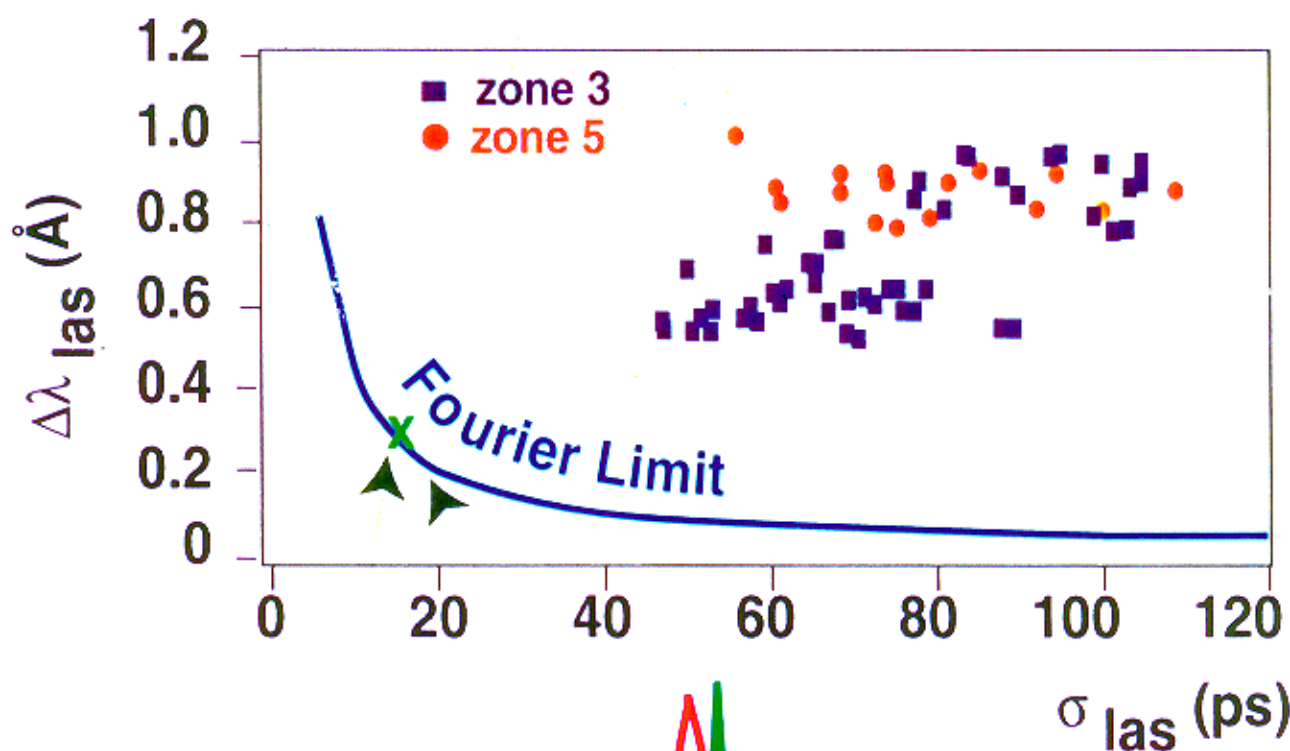
$$f_0 = 300-400\text{Hz}$$



DETUNING CURVE



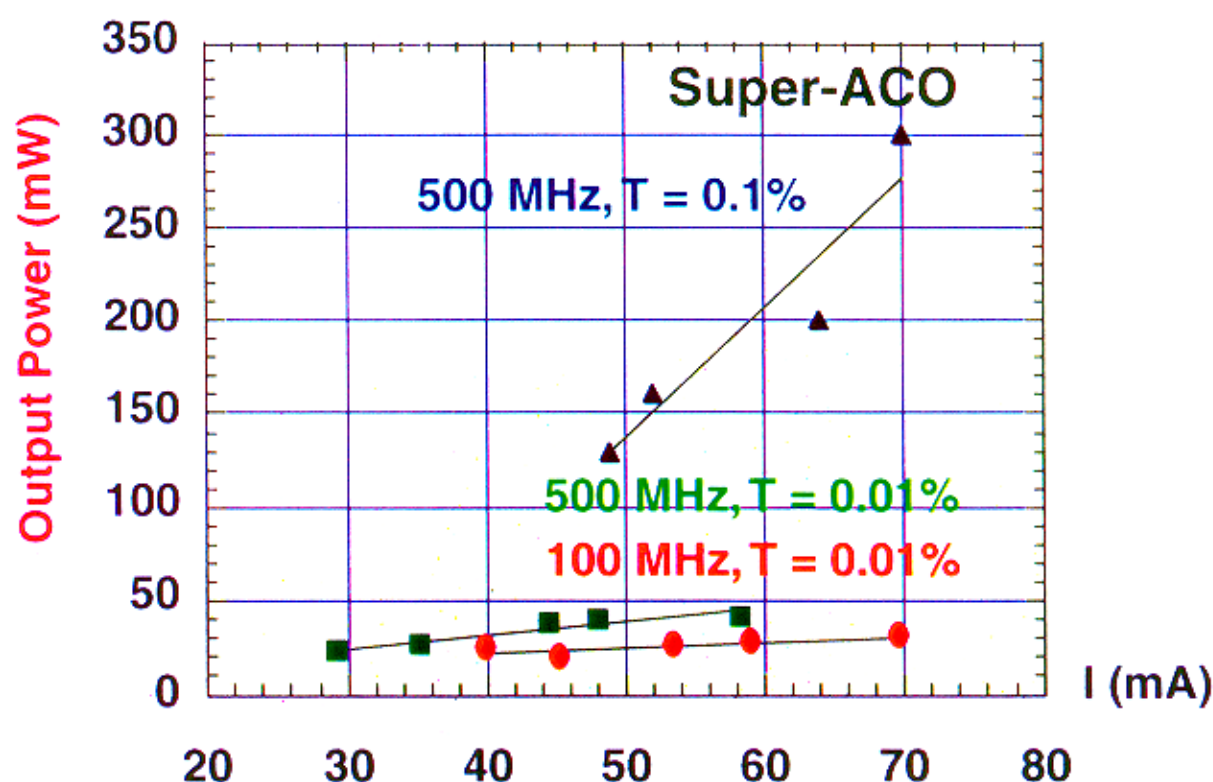
TOWARDS THE FOURIER LIMIT



FEL POWER

Renieri limit (recirculation)

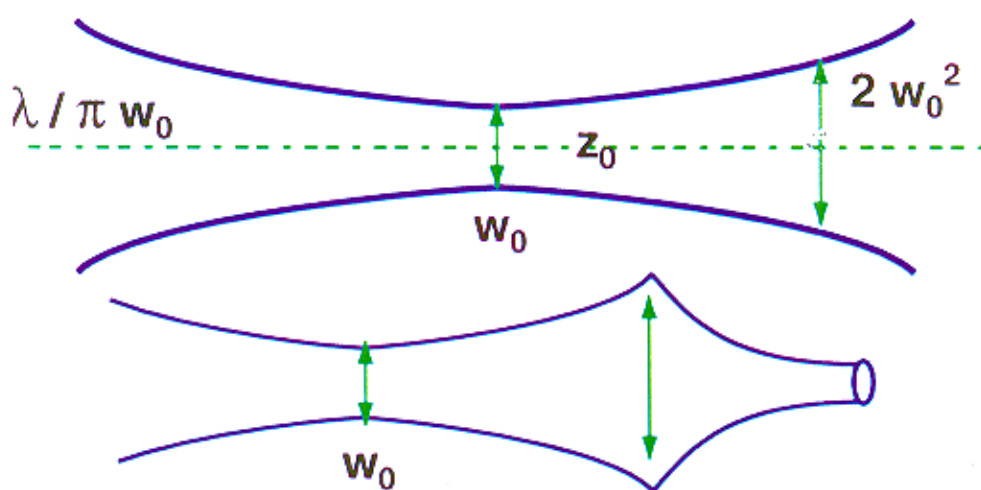
$$\langle P \rangle \propto \chi \Delta(\sigma\gamma/\gamma)^2 P_{\text{synch}} ; P_{\text{synch}} \propto I E^4$$



LINEAR POLARIZATION

TRANSVERSE MODES — ANGULAR DV

Transverse overlap :



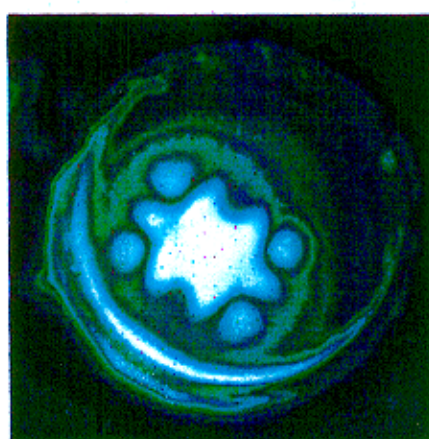
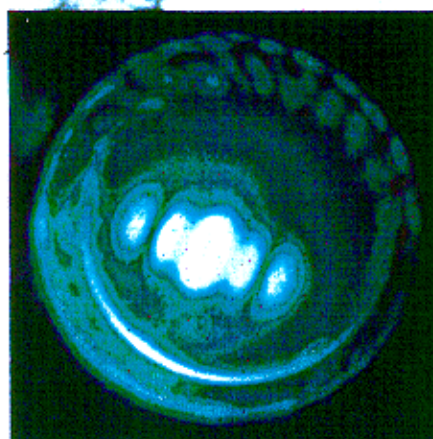
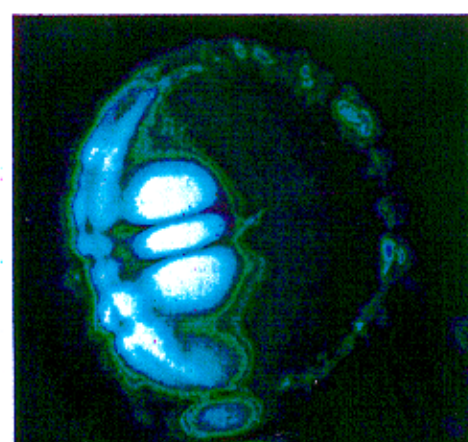
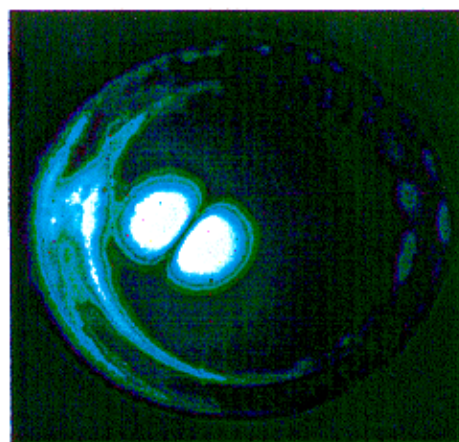
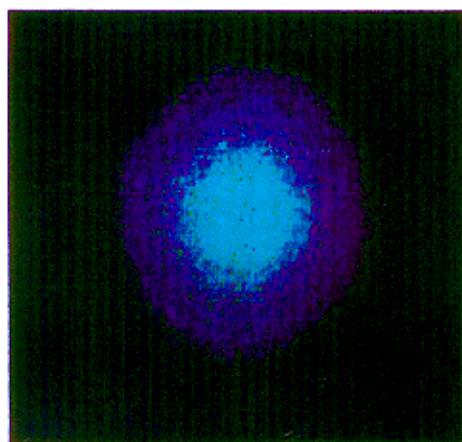
$$\theta_{1/2} = 100-200 \mu\text{rad}$$

$$z_0 = \pi w_0^2 / \lambda$$

$$w_0 = 300-400 \mu\text{m}$$

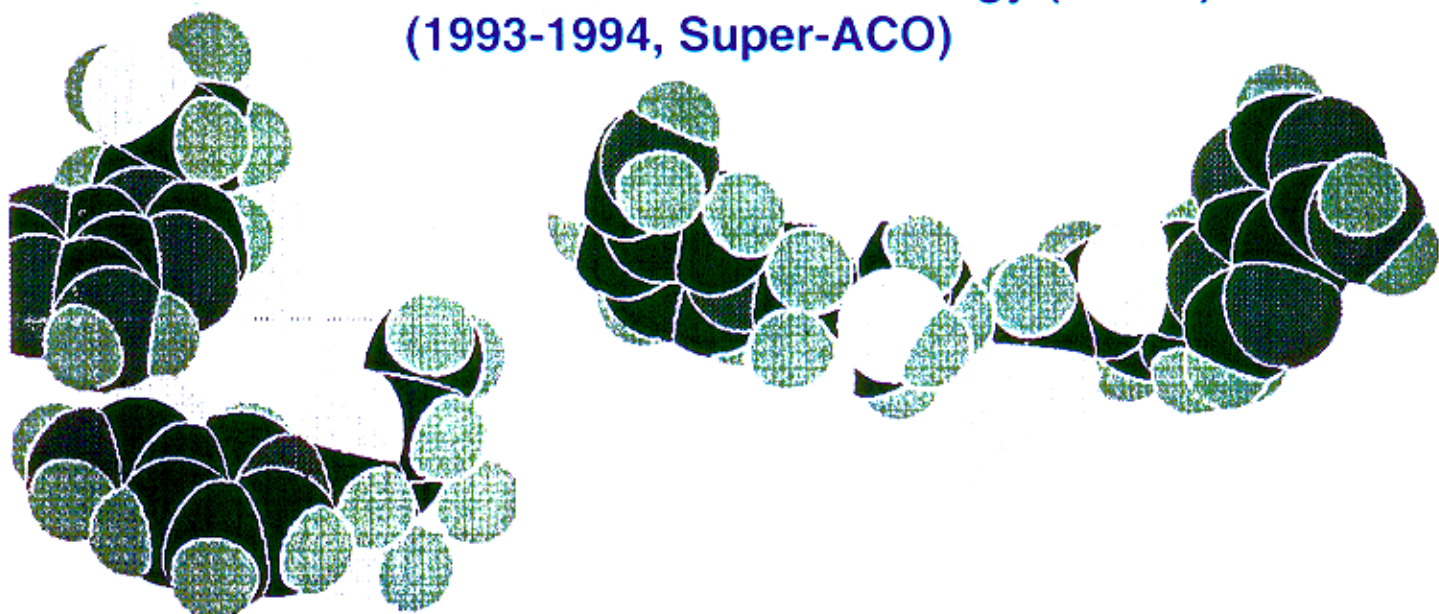
$$w_0^2 \propto \lambda$$

Focusing

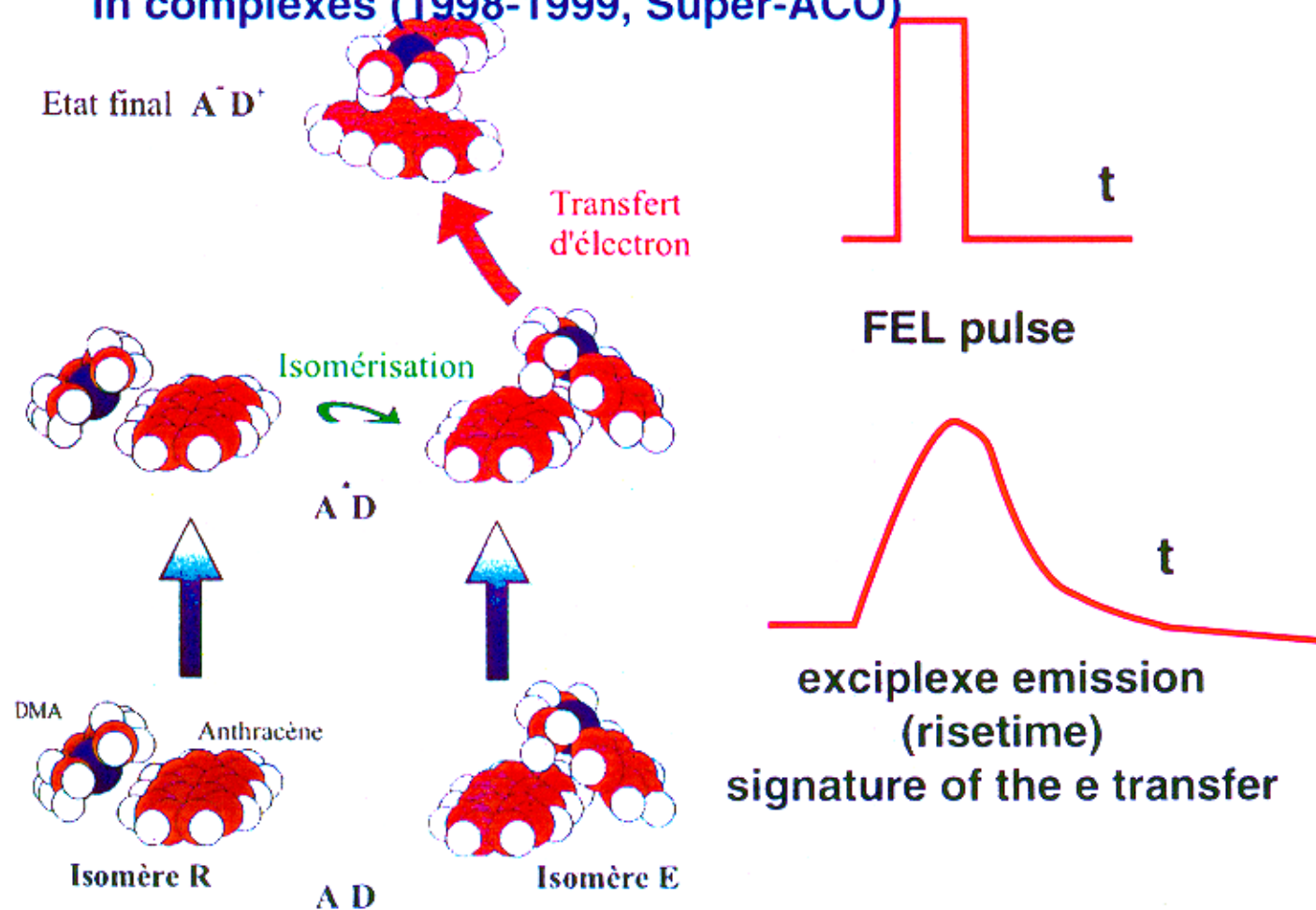


1 COLOR EXPERIMENTS

- Time resolved fluorescence in biology (NADH) (1993-1994, Super-ACO)



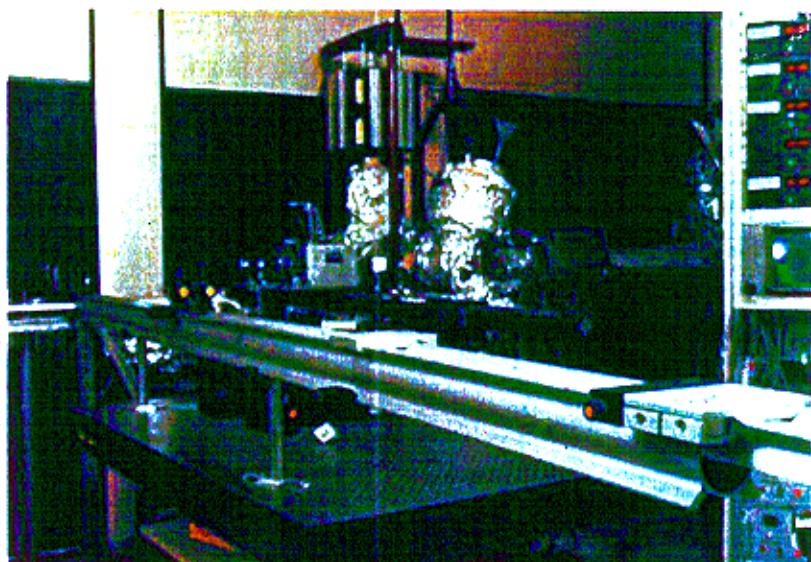
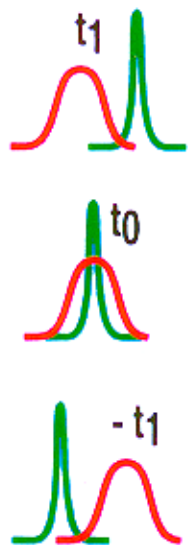
- Mechanism of phot-induced electron transfer in complexes (1998-1999, Super-ACO)



FEL + SYNCHROTRON RADIATION

PUMP (creates an excited state) PROBE (analyses)
TWO-COLOR EXPERIMENTS

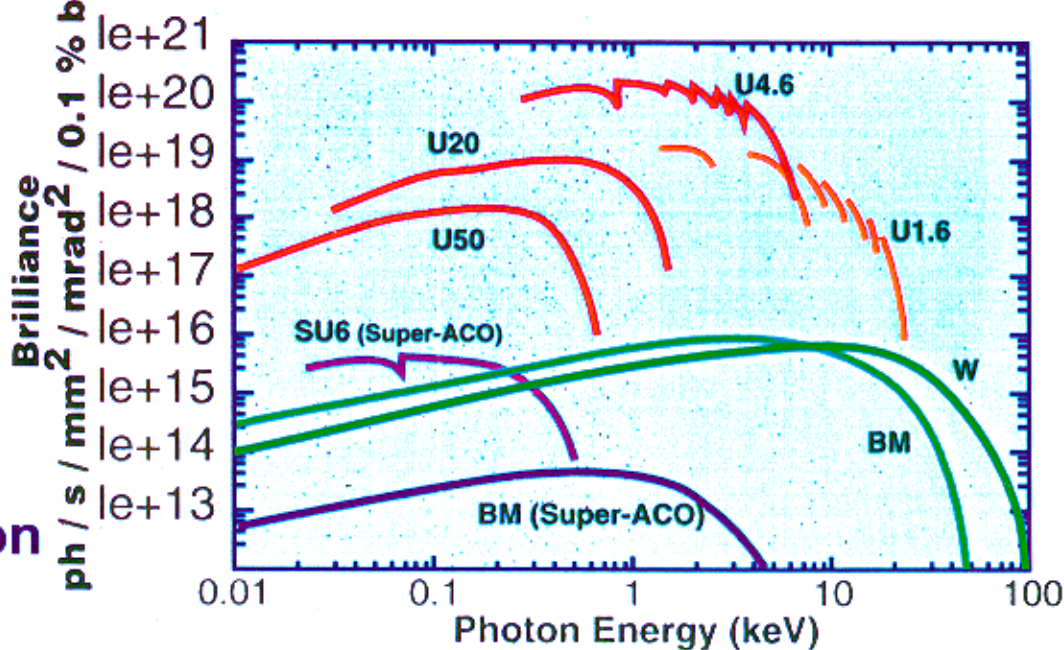
- Natural synchronization



- Tunability of both sources

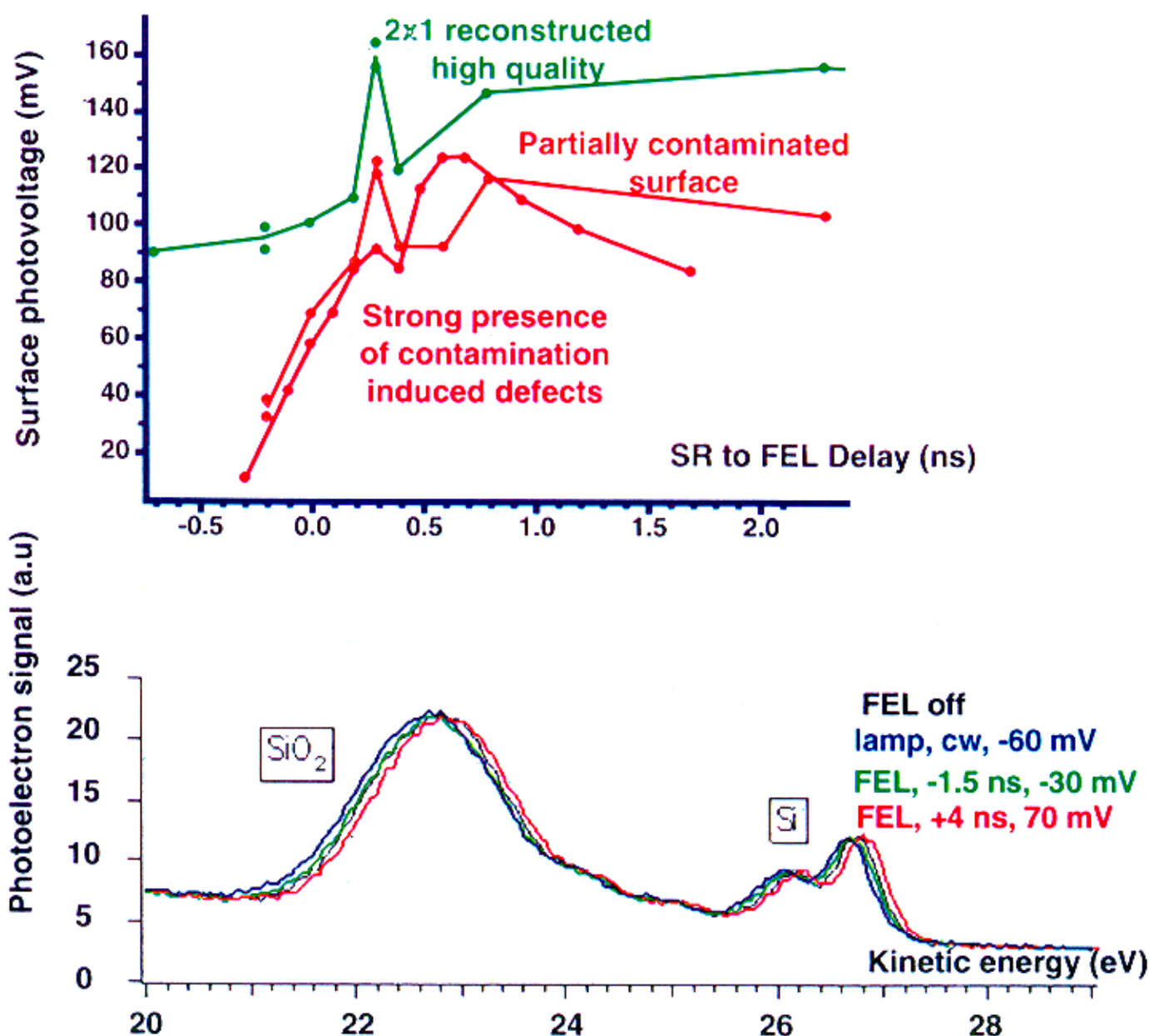
- High intensity

- Polarisation



EXAMPLES

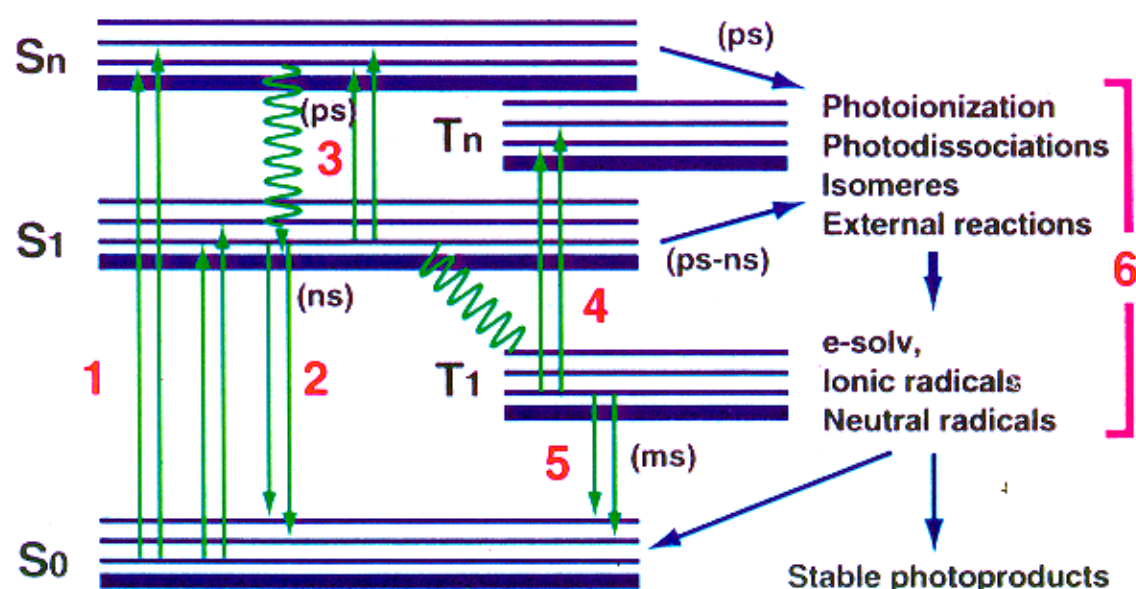
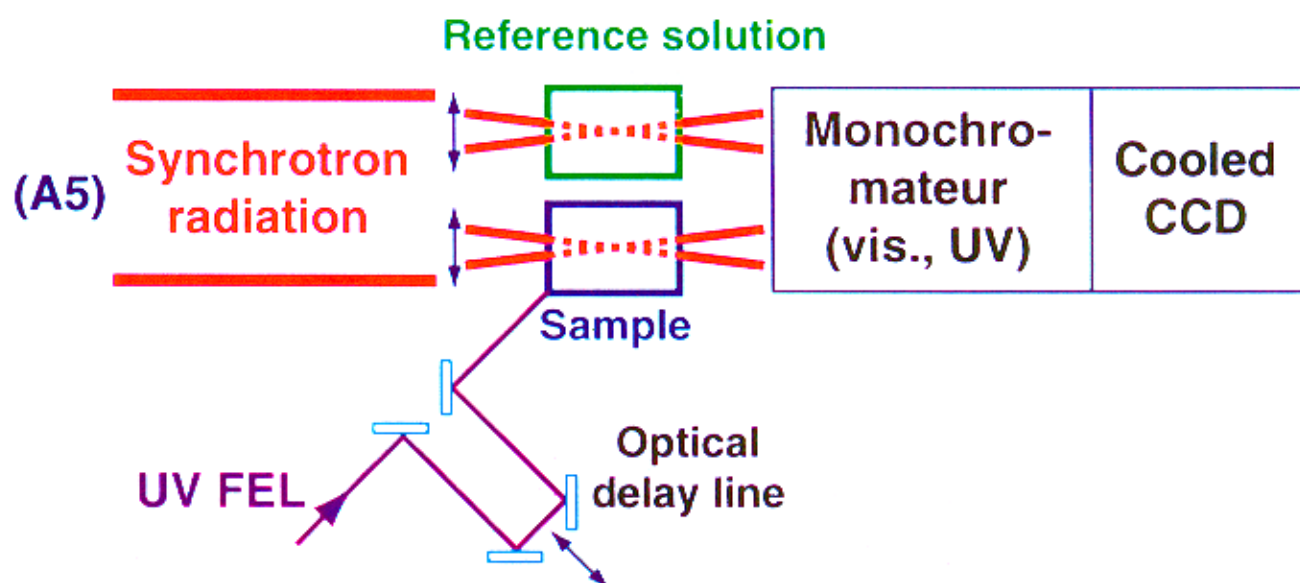
- Surface photovoltage effect (UV FEL, VUV SR)
GaAs/Ag, Si, Si/Au, Si/SiO₂



M. Marsi, A. Taleb

EXAMPLES

- Transient absorption (UV FEL, UV SR)
E. Renault, F. Mérola



Study methods

- 1 Absorption
- 2 Fluorescence
- 3 Two colors excitation

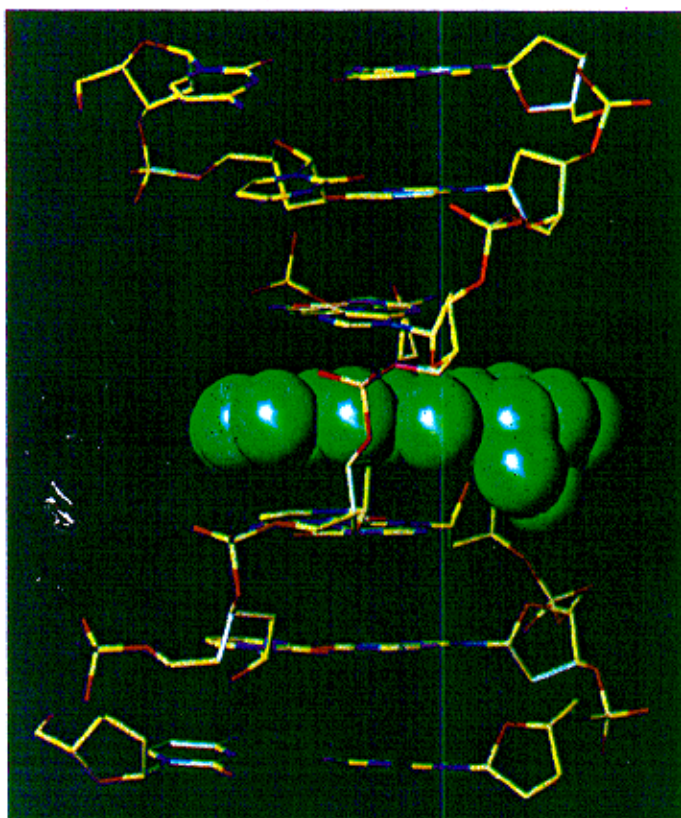
- 4 Triplet - Triplet absorption
- 5 Phosphorescence
- 6 Absorption

EXAMPLES

• Transient absorption (UV FEL, UV SR)

E. Renault, F. Mérola

- Purpose**
- Study of photophysics of natural chromophores
 - Time resolved studies of non natural processes involved in :
 - Photoactivable catabolism reactions
 - Oxydative activation of given drugs
- ☞ Knowledge of transfer mechanism and fugitive intermediate stages
- ☞ Study of biological effects induced by radiations



EXAMPLES

- Transient absorption (UV FEL, UV SR)
E. Renault, F. Mérola

POPOP : 1,4-di(5,5-phenyl-2-oxazolyl) benzene

