SOMMAIRE

MARGNES Raphaël

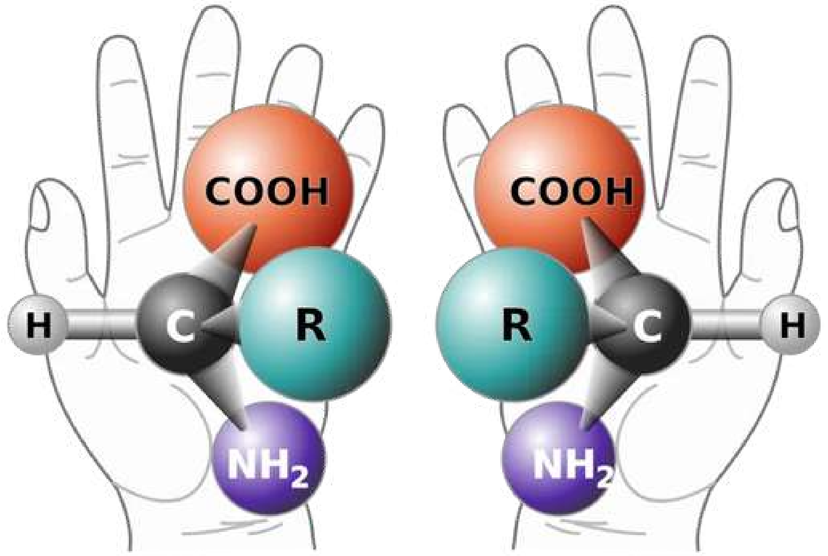
Caractérisation d’impulsions ultrabrèves pour la génération d’harmoniques d’ordre élevé

Encadrant: Yann MAIRESSE

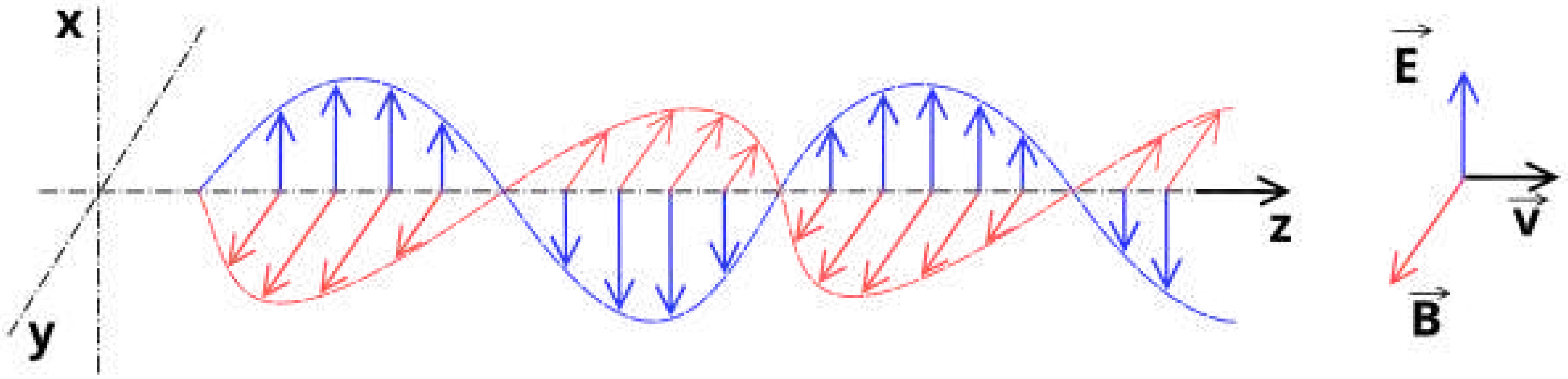
CELIA

université de BORDEAUX

CHIRALITÉ

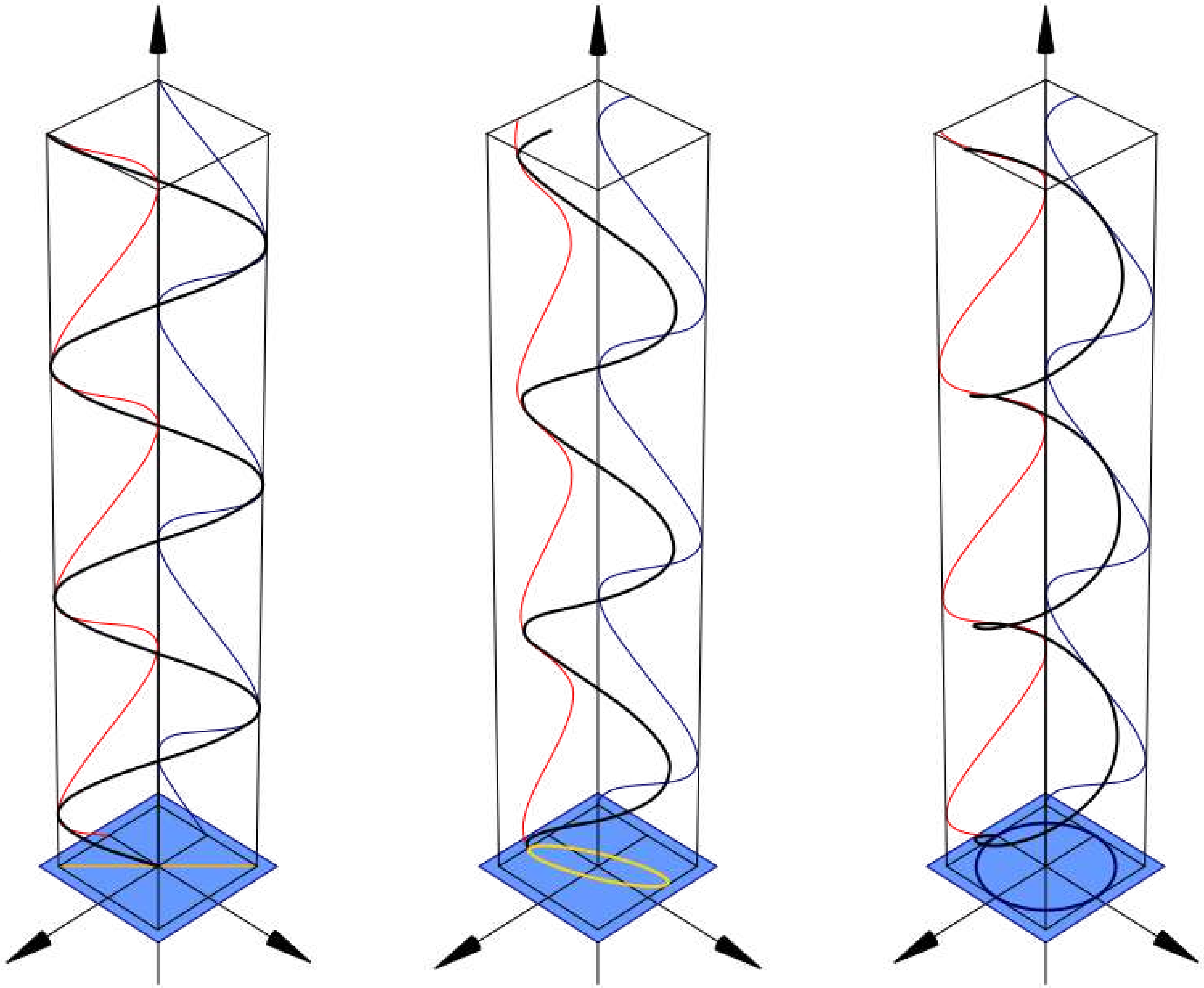


Homochiralité de la vie

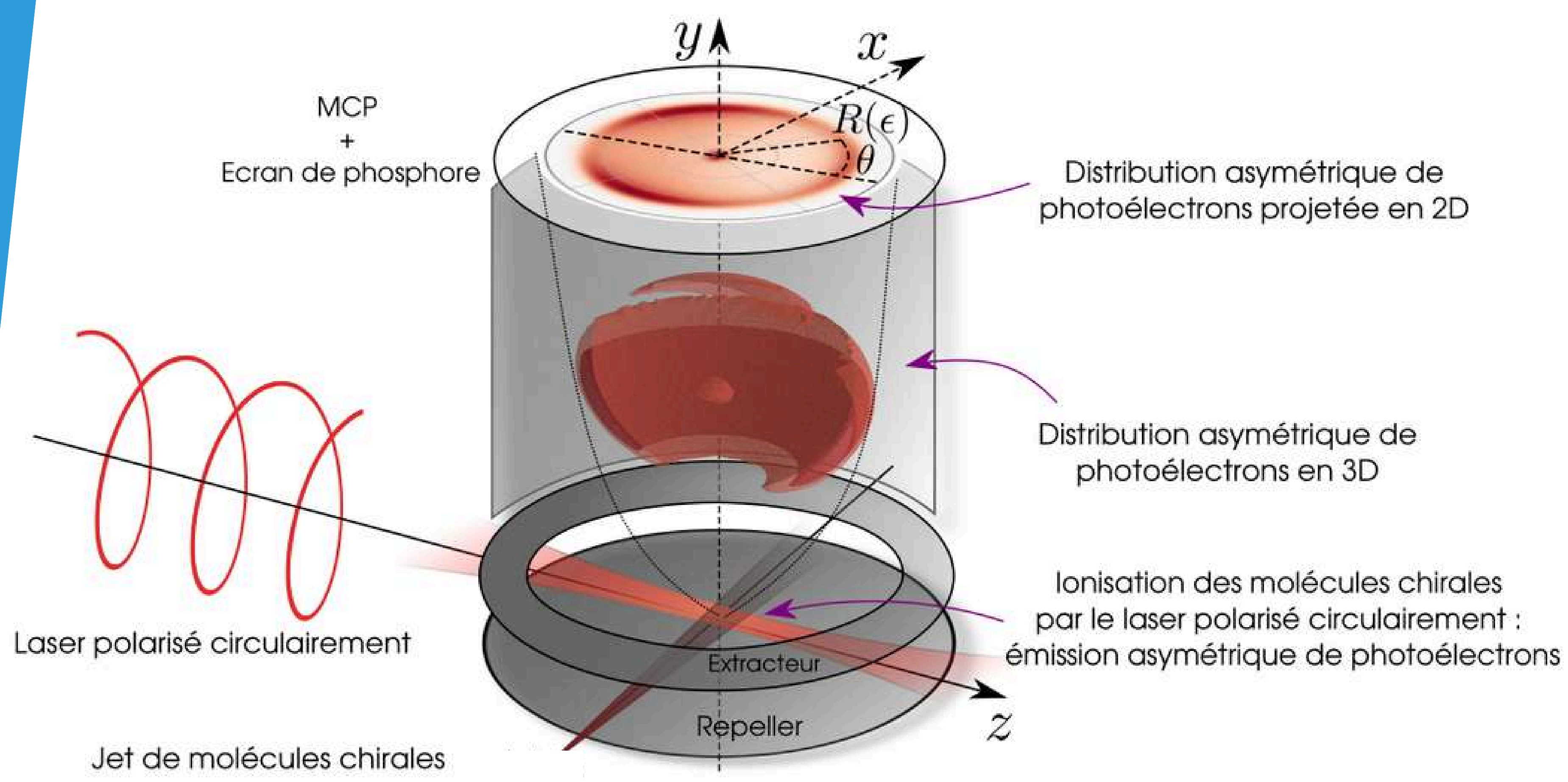


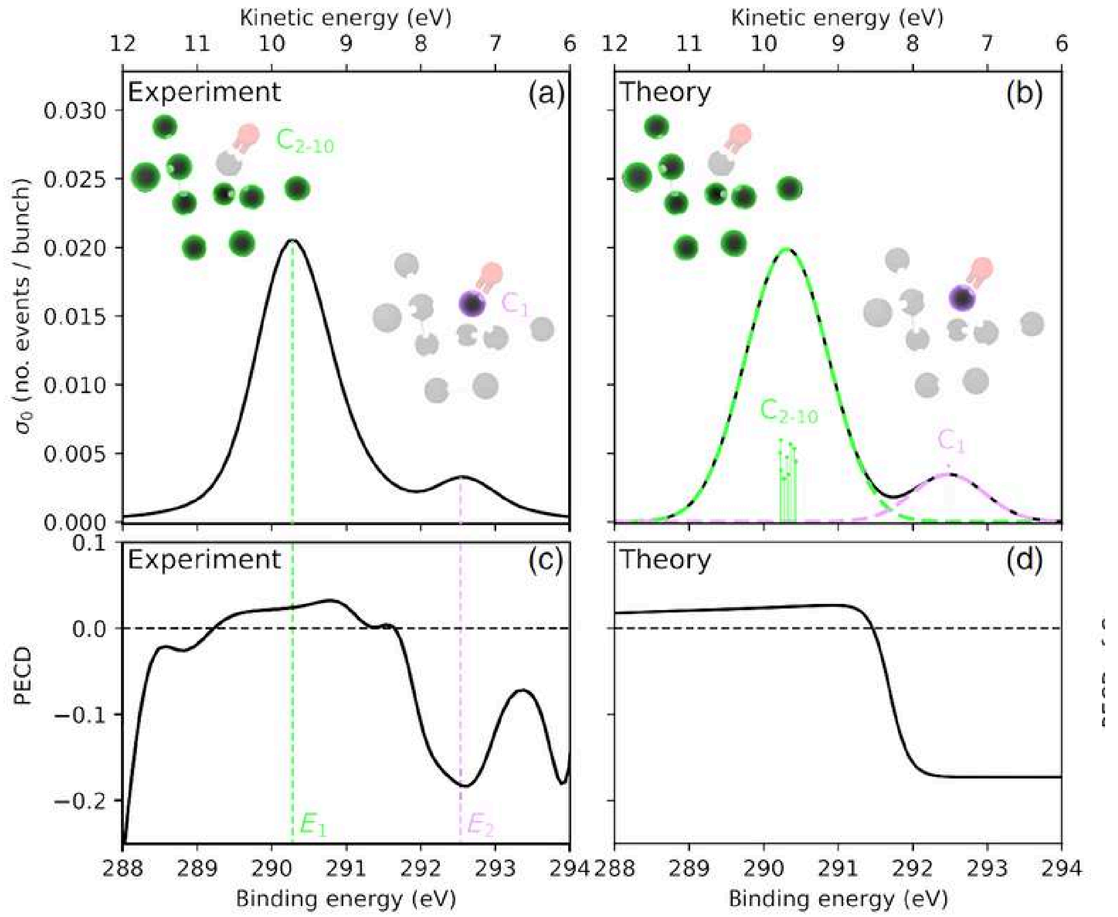
Molécule chirale + polarisation de la lumière circulaire = spectroscopie de la chiralité

Polarisation de la lumière:

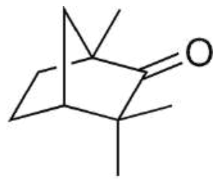


SPECTROSCOPIE DE LA CHIRALITÉ

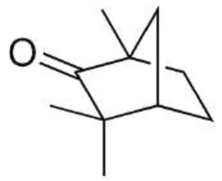


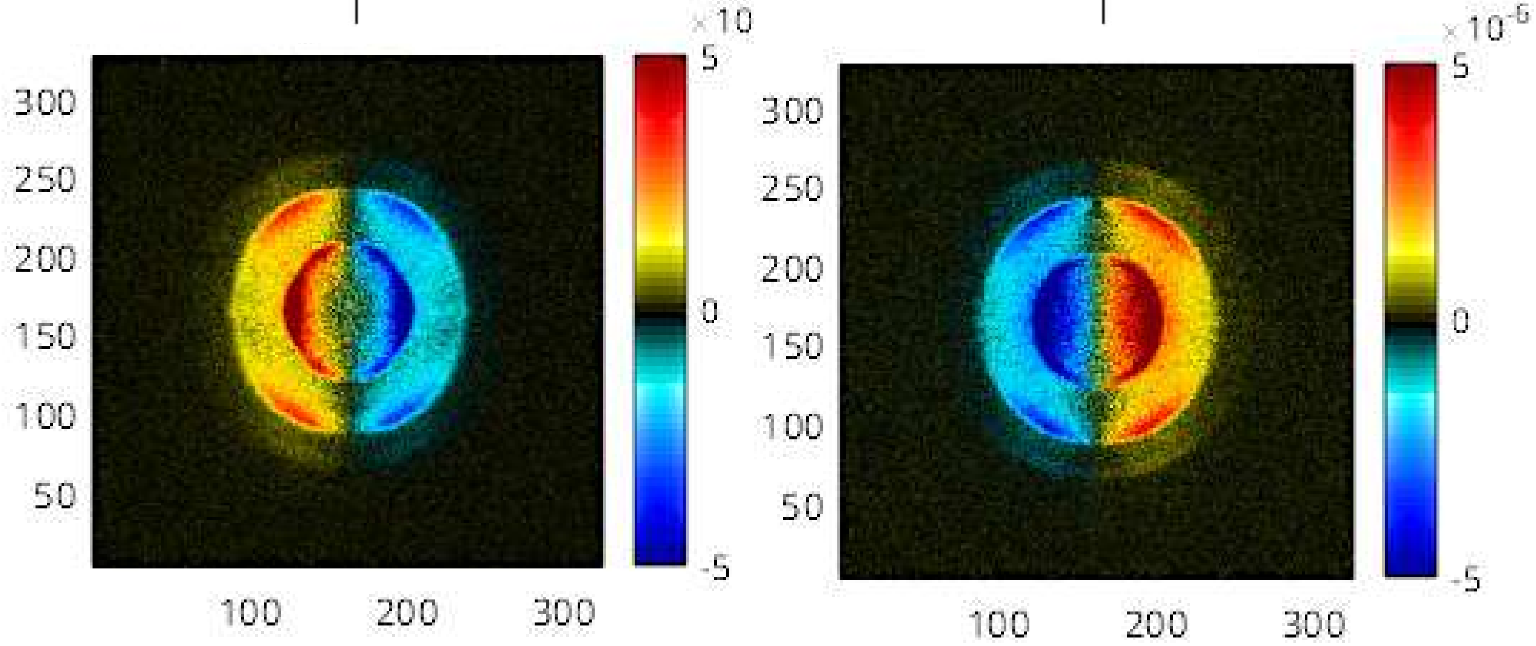


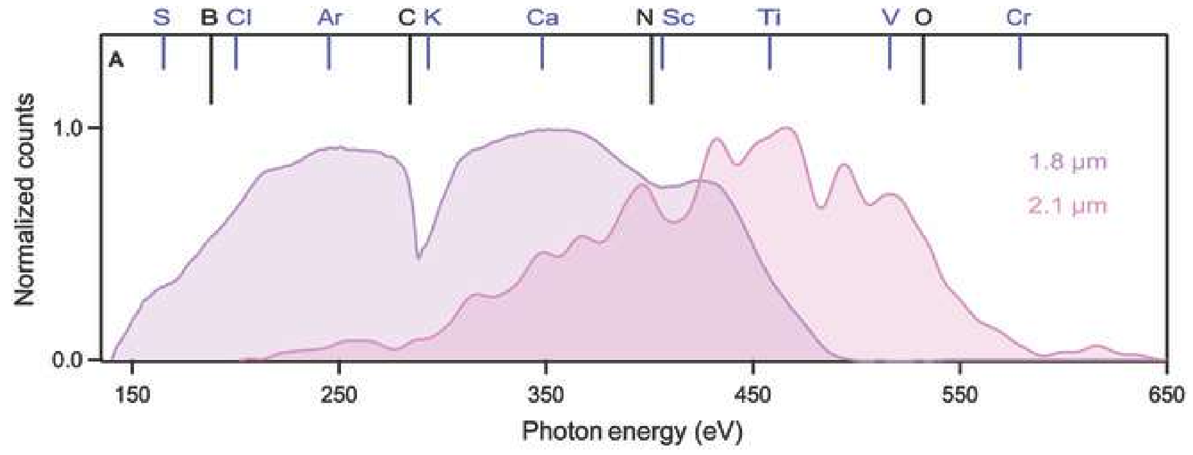
Polarisation circulaire



Fenchone







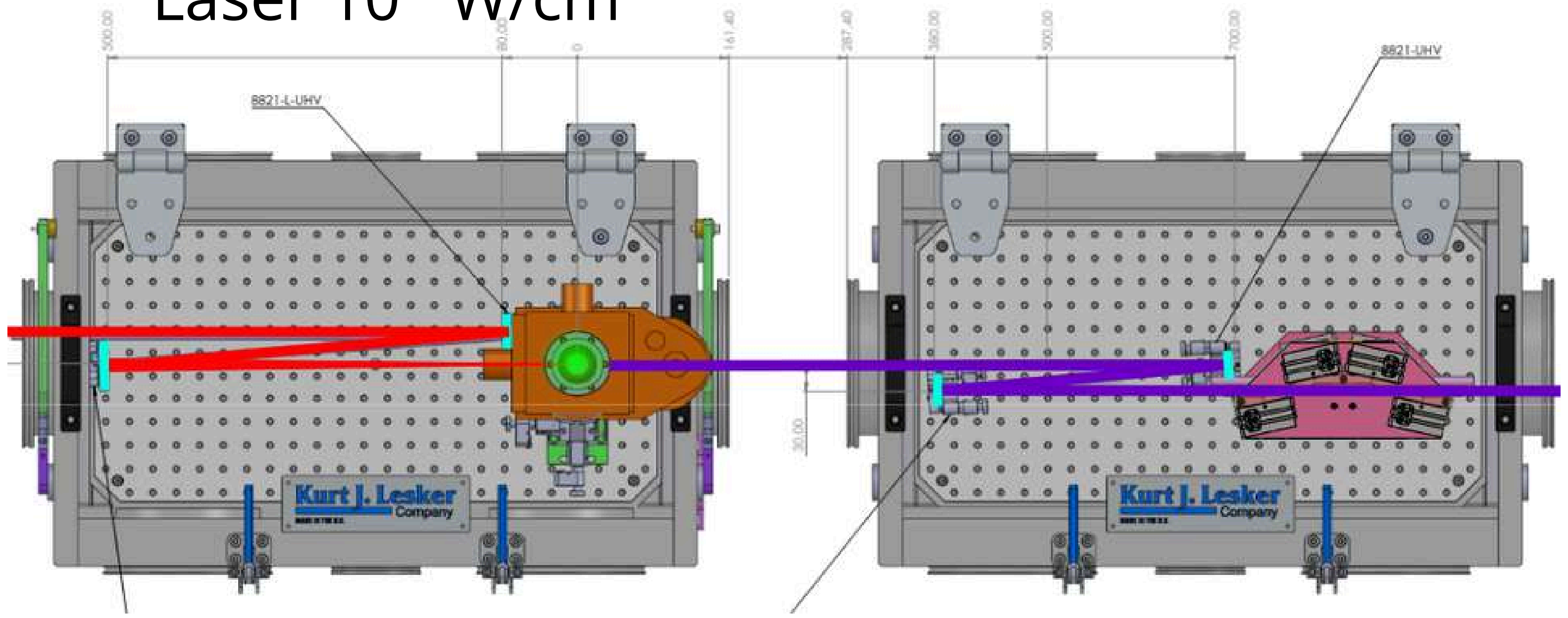
Comment à partir des lasers à disposition, obtenir l'énergie nécessaire?

GÉNERATION DE HAUTE HARMONIQUES

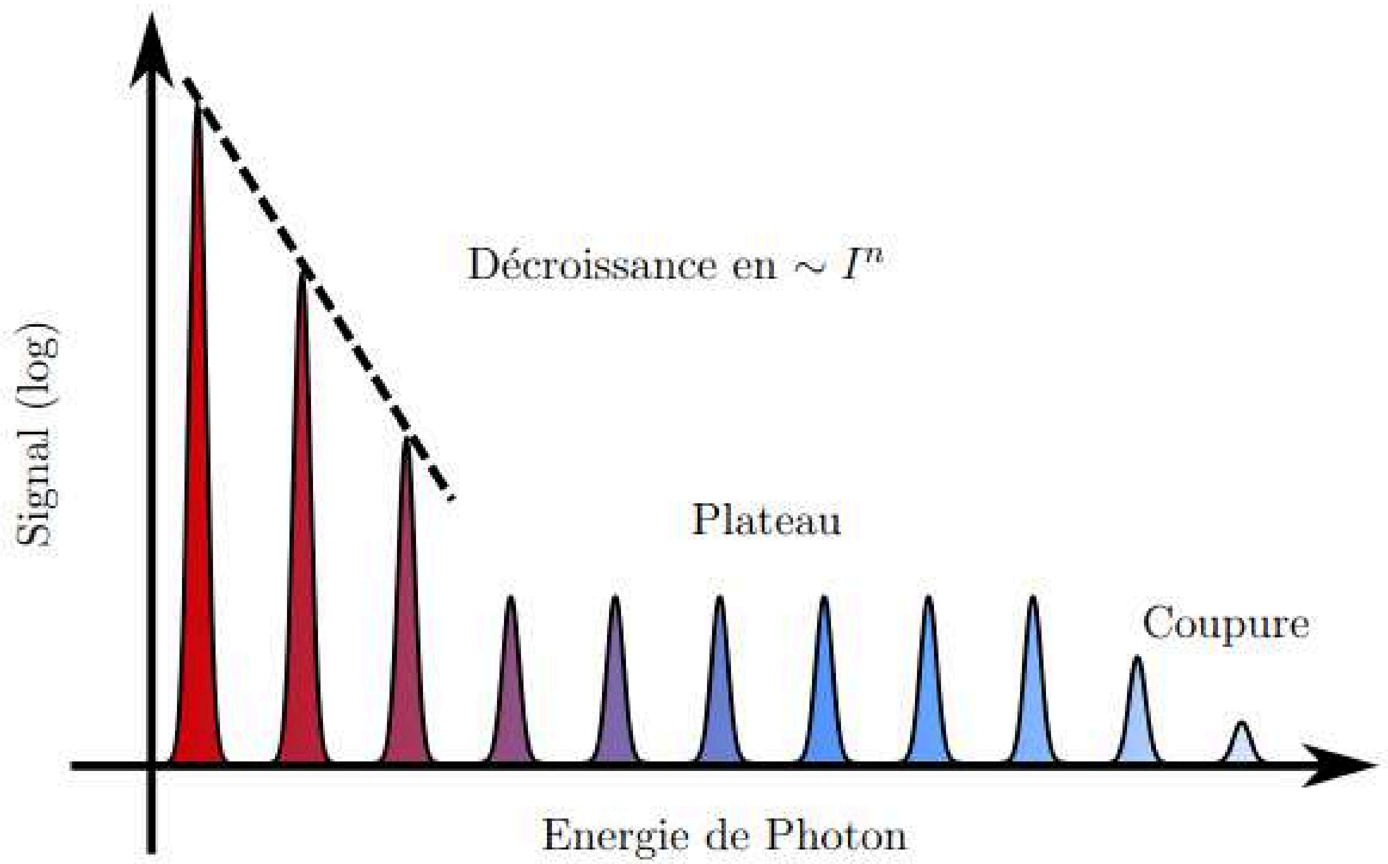
Chambre HHG

Laser 10^{14} W/cm^2

Mise en forme XUV



Contributions : mise en place et préparation des chambres



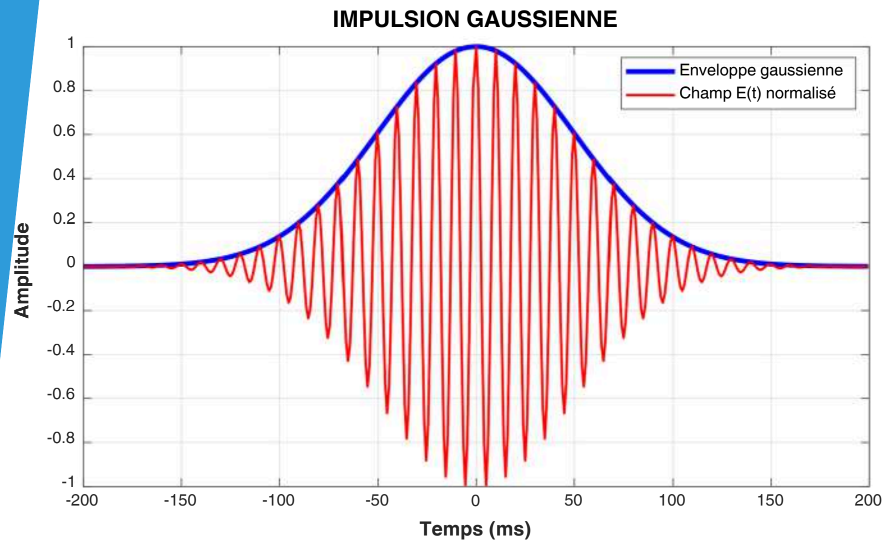
$$E_{coupure} = I_p + a * I * \lambda^2$$

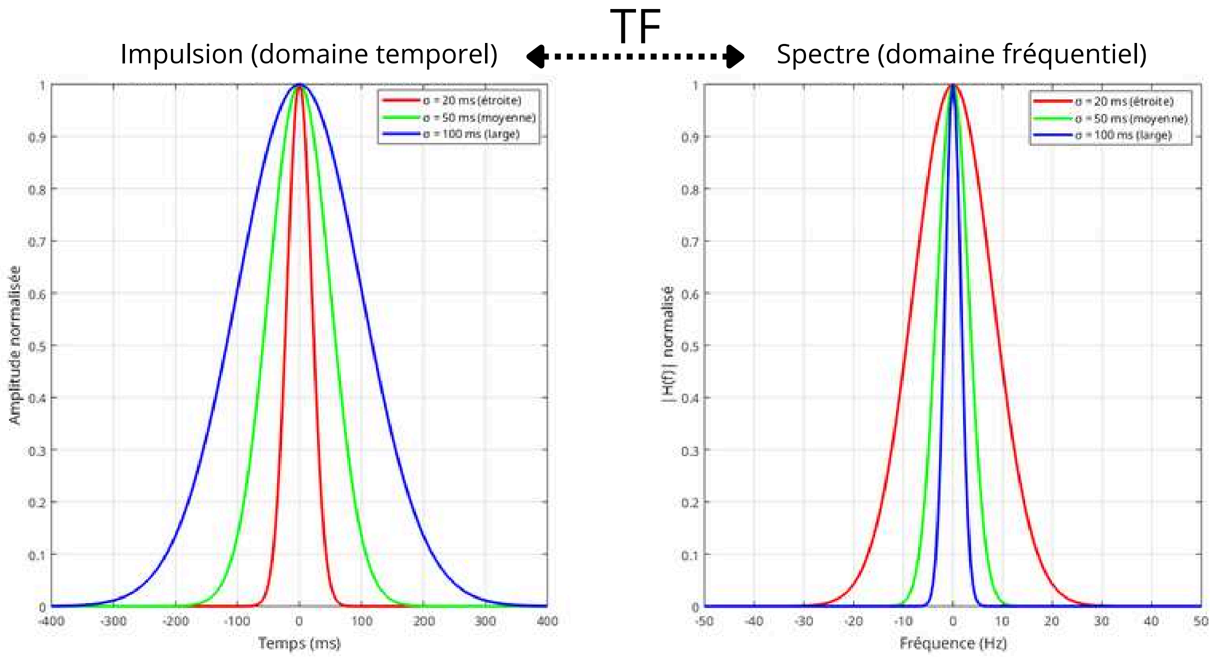
Laser du CELIA : Yb avec des impulsions de 140 fs

impulsion trop longue = saturation de l’ionisation

Comment controler la durée de l’impulsion pour maximiser la HHG ?

CRÉATION D'IMPULSION ULTABREVE

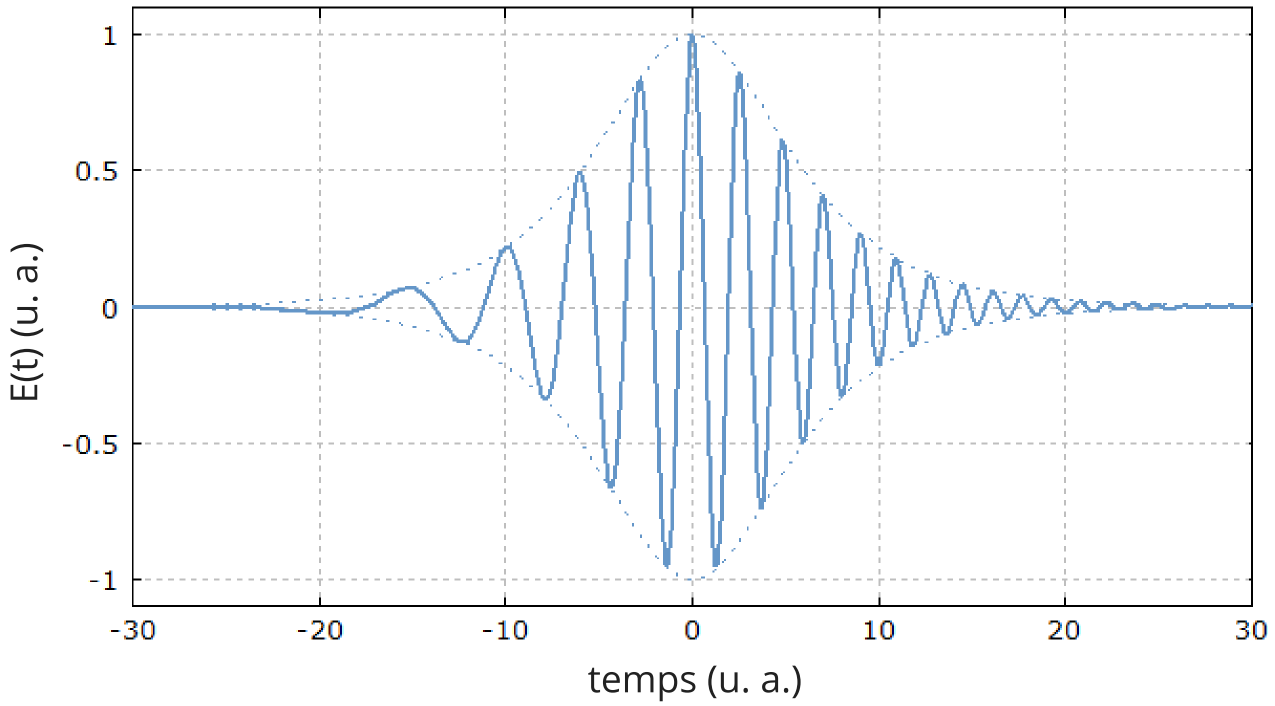




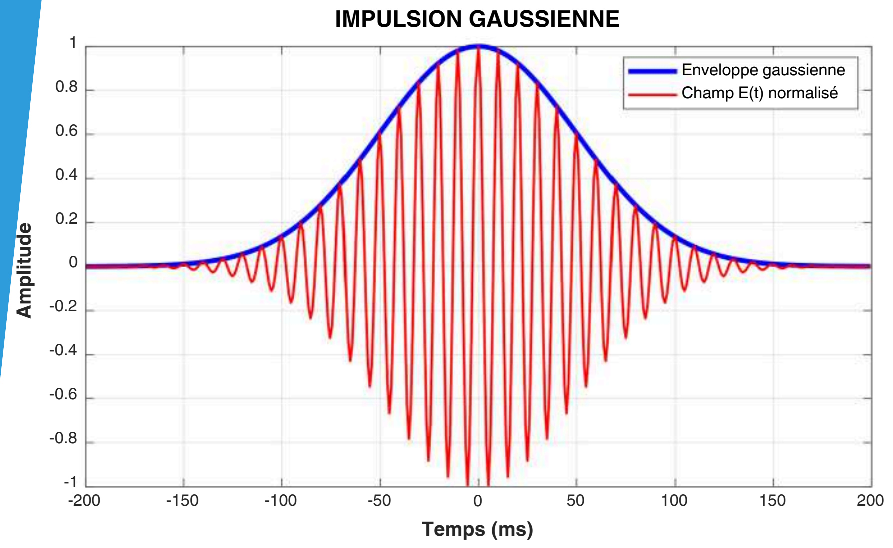
Champs électrique: $E(t) = A(t) \cdot \cos(\omega_0 t + \phi(t))$

Spectre de l'impulsion : $\tilde{E}(\omega) = |\tilde{E}(\omega)| \cdot e^{i\phi(\omega)}$

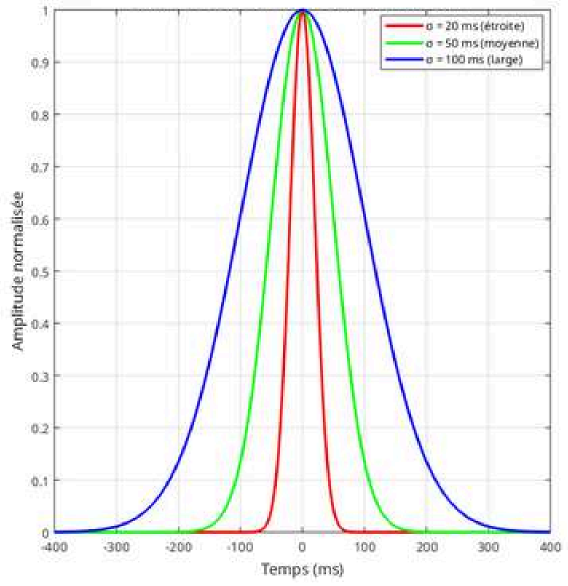
Chirp temporel

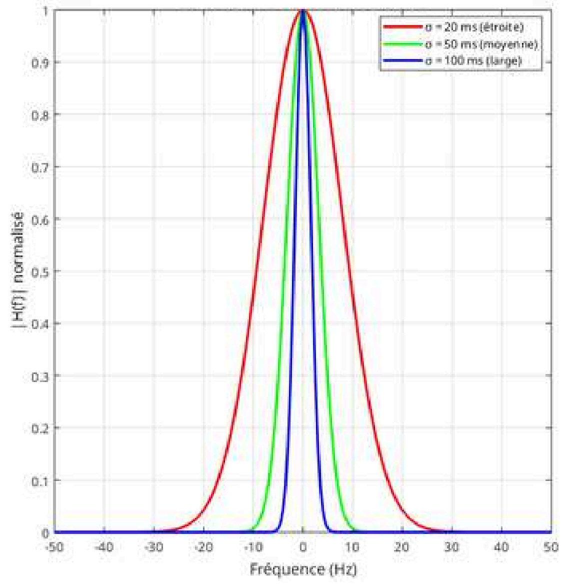


CRÉATION D’IMPULSION ULTABREVE



Impulsion (domaine temporel) ↔ TF ↔ Spectre (domaine fréquentiel)





Effet Kerr

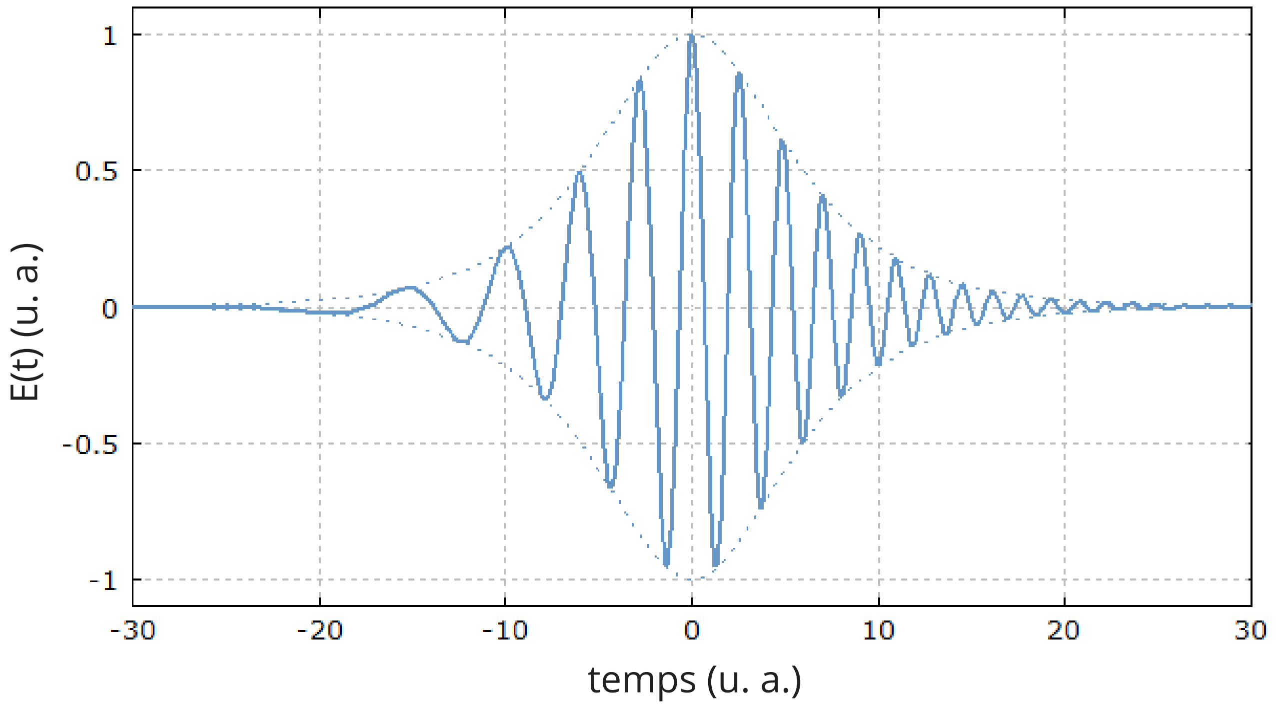
$$n(I(t)) = n_0 + n_2 I(t)$$

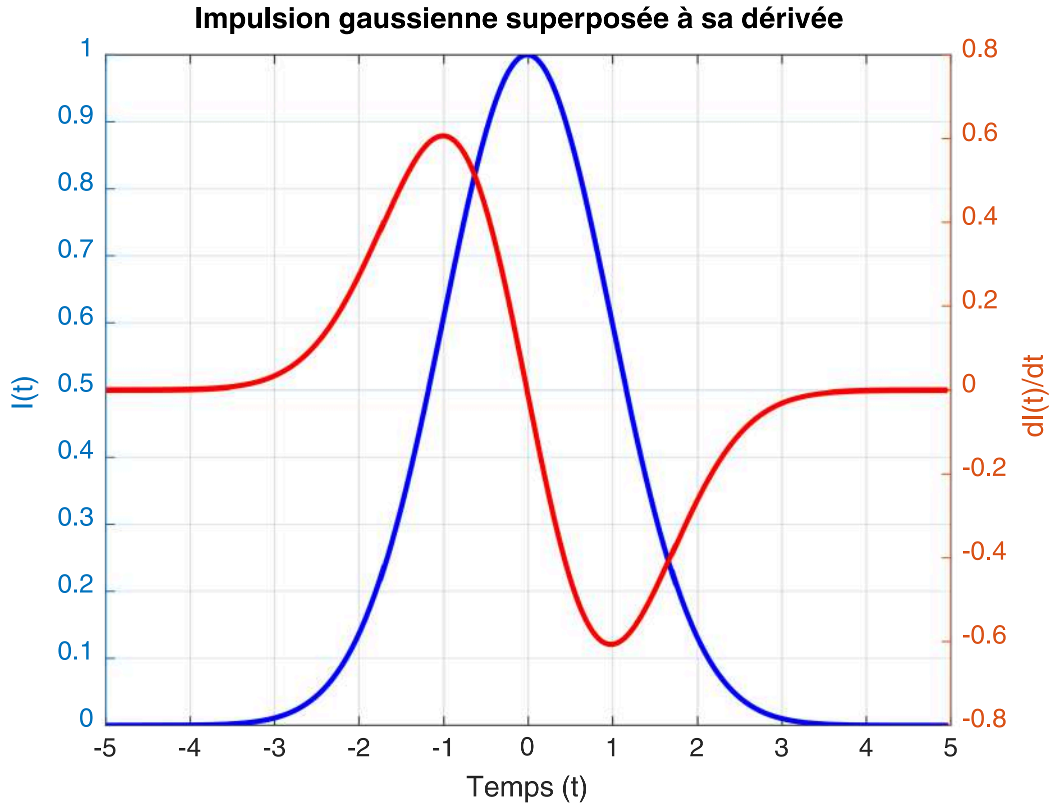
$$\phi(t) = \frac{2\pi}{\lambda_0} n(I(t)) L$$

Champs électrique: $E(t) = A(t) \cdot \cos(\omega_0 t + \phi(t))$

Spectre de l’impulsion : $\tilde{E}(\omega) = |\tilde{E}(\omega)| \cdot e^{i\phi(\omega)}$

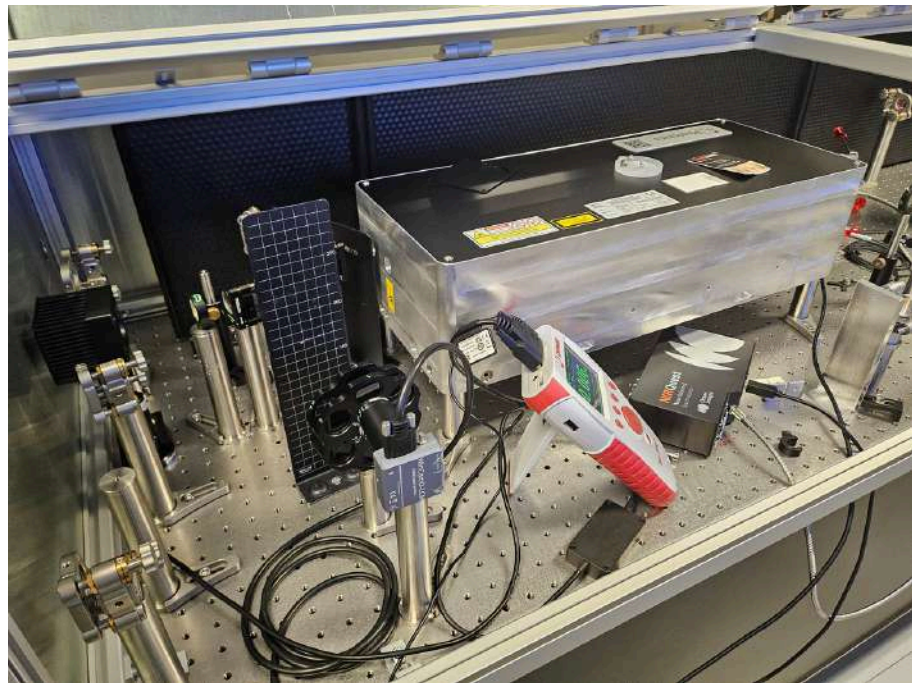
Chirp temporel



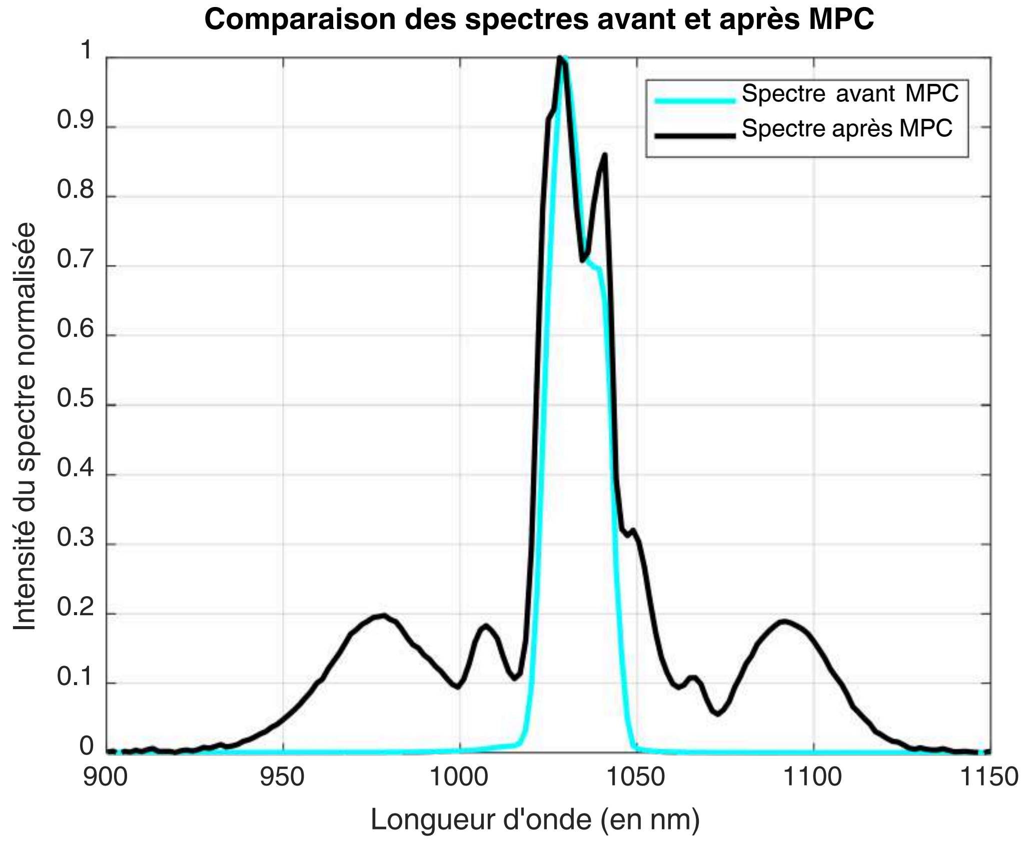


Comment mettre en place de l’effet Kerr sur un montage optique?

CELLULE DE POST-COMPRESSION MULTI PASSAGE

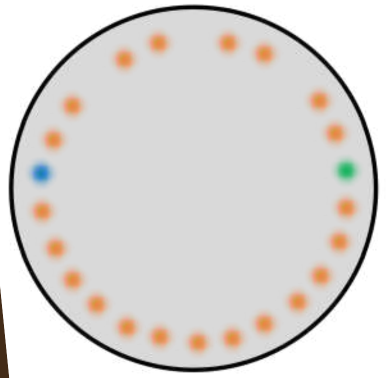


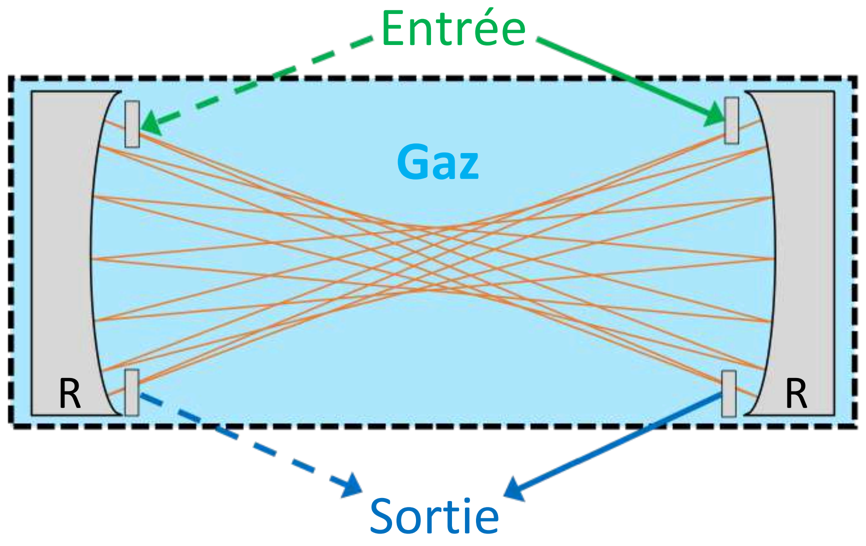
Contributions : caractérisation du laser avant et après MPC, mise en place de la MPC sur la ligne

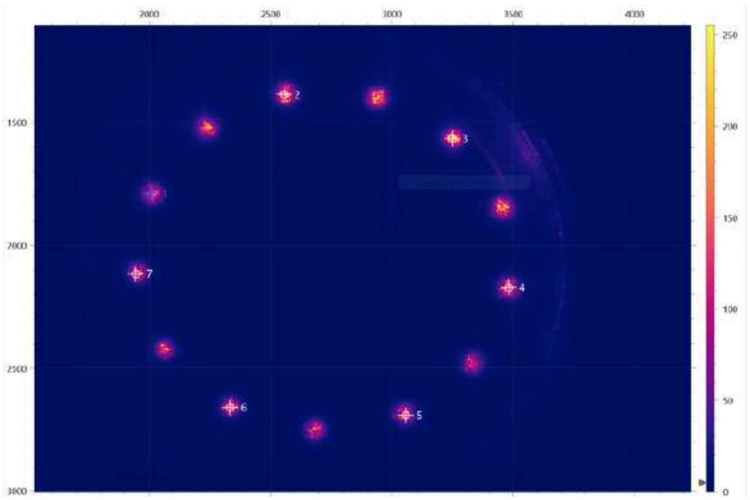


Le spectre est élargi de 30nm à 200nm.
L’impulsion est réduite ?

Cellule de Herriot





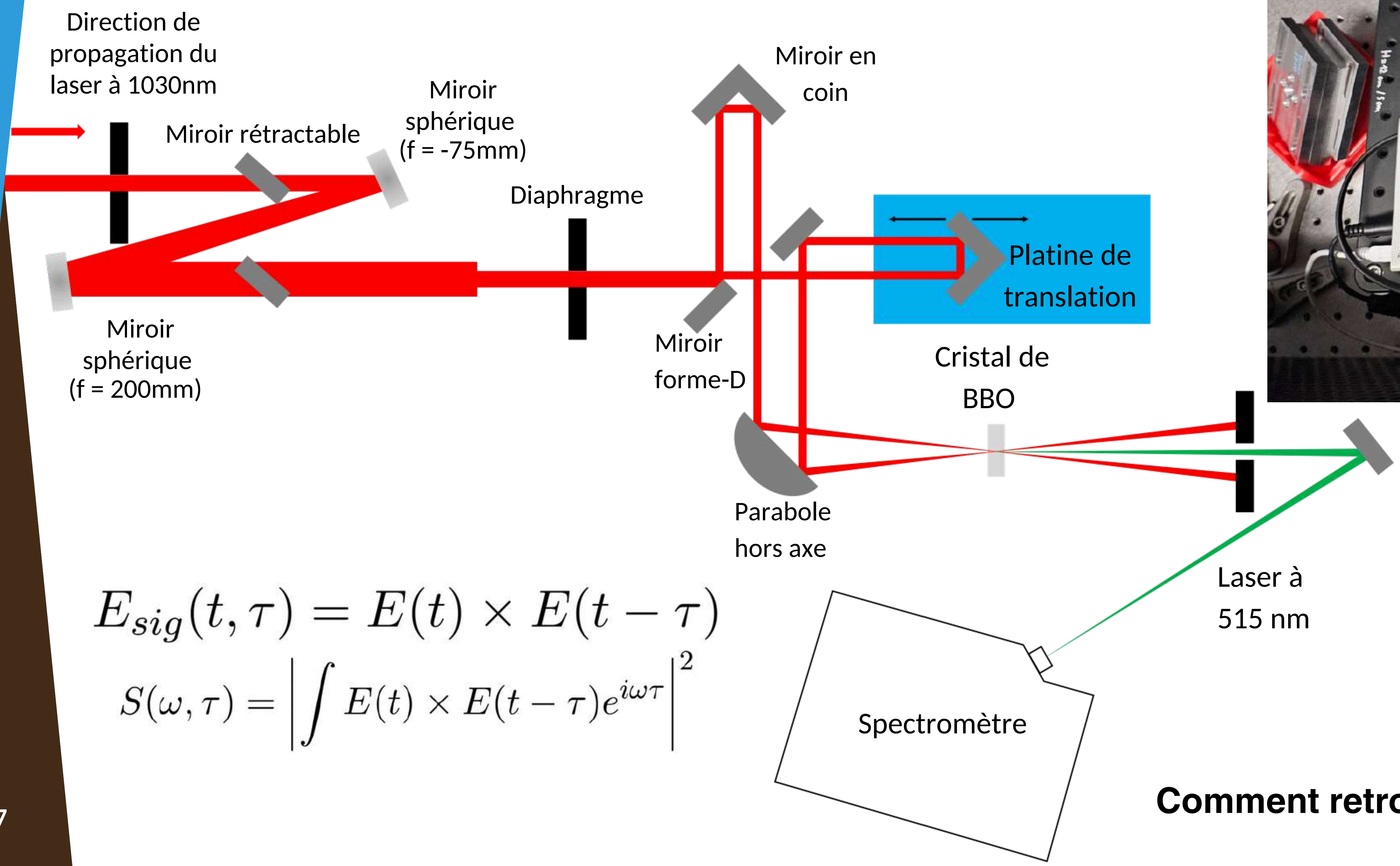


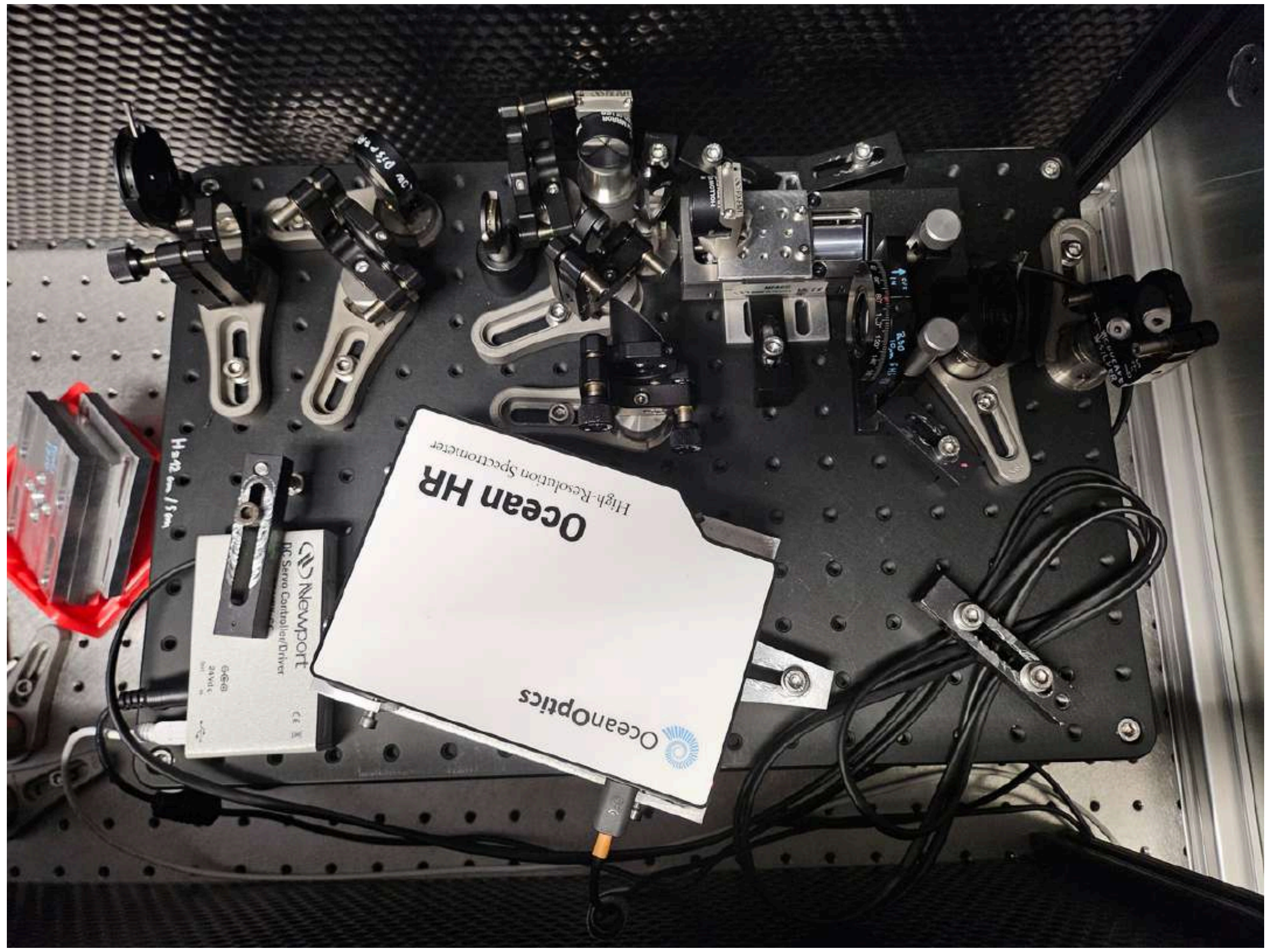
Transmission de 97.5 %
Milieu Kerr = Argon

Comment caractériser des impulsions de l’ordre de 20 fs ?

FENÊTRAGE OPTIQUE RÉSOLU EN FRÉQUENCE

FROG





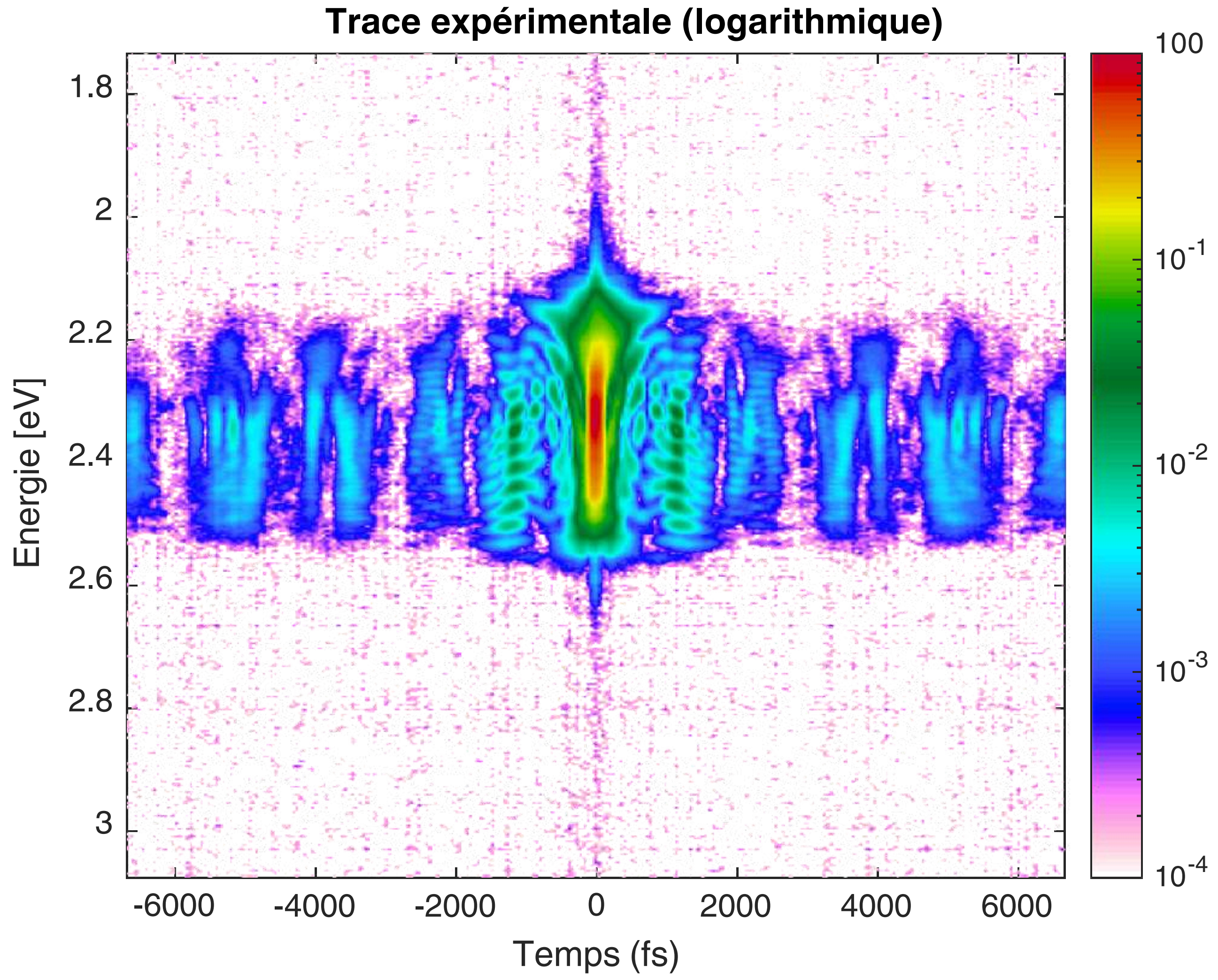
Contributions : calibrations du spectromètre en longueurs d'onde et en efficacité de détection, alignement sur la ligne XUV.

$$E_{sig}(t,\tau) = E(t) \times E(t-\tau)$$

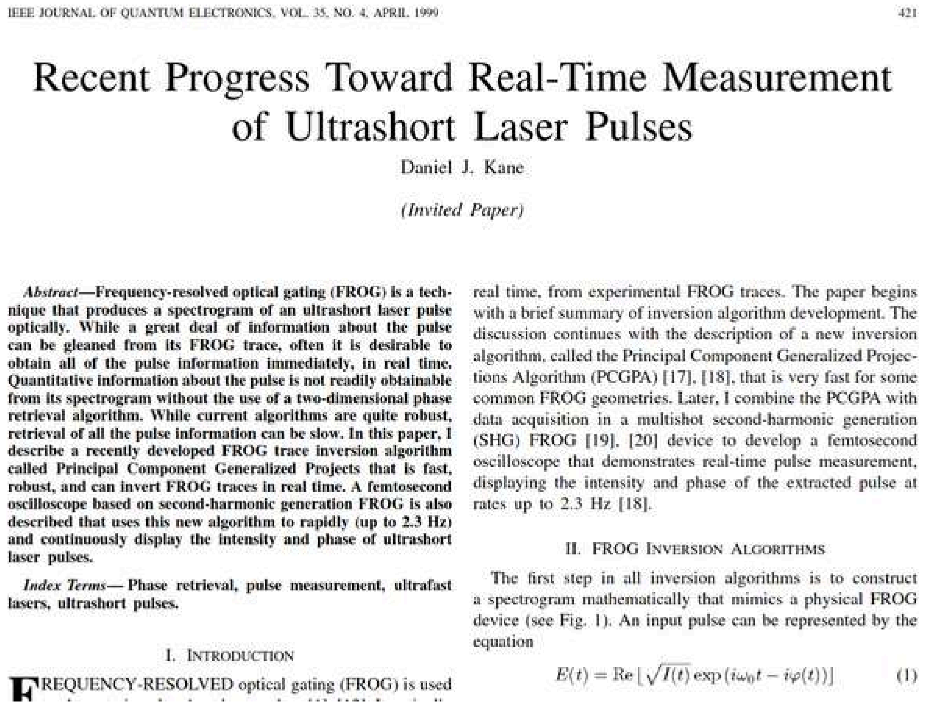
$$S(\omega,\tau) = \left| \int E(t) \times E(t-\tau) e^{i\omega\tau} \right|^2$$

Comment retrouver une impulsion à partir de ce montage?

ALGORITHMES DE RECONSTRUCTION



PCGPA



IEEE JOURNAL OF QUANTUM ELECTRONICS, VOL. 35, NO. 4, APRIL 1999 421

Recent Progress Toward Real-Time Measurement of Ultrashort Laser Pulses

Daniel J. Kane

(Invited Paper)

Abstract—**Frequency-resolved optical gating (FROG) is a technique that produces a spectrogram of an ultrashort laser pulse optically. While a great deal of information about the pulse can be gleaned from its FROG trace, often it is desirable to obtain all of the pulse information immediately, in real time. Quantitative information about the pulse is not readily obtainable from its spectrogram without the use of a two-dimensional phase retrieval algorithm. While current algorithms are quite robust, retrieval of all the pulse information can be slow. In this paper, I describe a recently developed FROG trace inversion algorithm called Principal Component Generalized Projects that is fast, robust, and can invert FROG traces in real time. A femtosecond oscilloscope based on second-harmonic generation FROG is also described that uses this new algorithm to rapidly (up to 2.3 Hz) and continuously display the intensity and phase of ultrashort laser pulses.**

Index Terms— **Phase retrieval, pulse measurement, ultrafast lasers, ultrashort pulses.**

I. INTRODUCTION

FREQUENCY-RESOLVED optical gating (FROG) is used

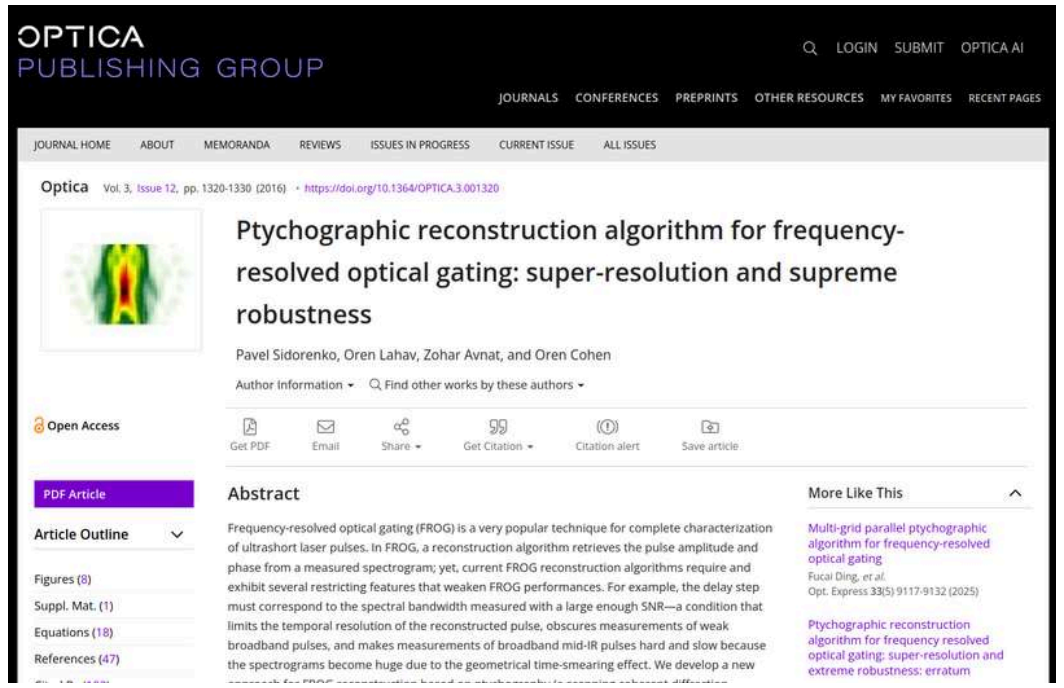
real time, from experimental FROG traces. The paper begins with a brief summary of inversion algorithm development. The discussion continues with the description of a new inversion algorithm, called the Principal Component Generalized Projections Algorithm (PCGPA) [17], [18], that is very fast for some common FROG geometries. Later, I combine the PCGPA with data acquisition in a multishot second-harmonic generation (SHG) FROG [19], [20] device to develop a femtosecond oscilloscope that demonstrates real-time pulse measurement, displaying the intensity and phase of the extracted pulse at rates up to 2.3 Hz [18].

II. FROG INVERSION ALGORITHMS

The first step in all inversion algorithms is to construct a spectrogram mathematically that mimics a physical FROG device (see Fig. 1). An input pulse can be represented by the equation

$$E(t) = \mathrm{Re}\left[\sqrt{I(t)}\exp\left(i\omega_0 t - i\varphi(t)\right)\right] \quad (1)$$

Ptychographie



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Optica Vol. 3, Issue 12, pp. 1320-1330 (2016) • https://doi.org/10.1364/OPTICA.3.001320

Ptychographic reconstruction algorithm for frequency-resolved optical gating: super-resolution and supreme robustness

Pavel Sidorenko, Oren Lahav, Zohar Avnat, and Oren Cohen

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Figures (8)

Suppl. Mat. (1)

Equations (18)

References (47)

Abstract

Frequency-resolved optical gating (FROG) is a very popular technique for complete characterization of ultrashort laser pulses. In FROG, a reconstruction algorithm retrieves the pulse amplitude and phase from a measured spectrogram; yet, current FROG reconstruction algorithms require and exhibit several restricting features that weaken FROG performances. For example, the delay step must correspond to the spectral bandwidth measured with a large enough SNR—a condition that limits the temporal resolution of the reconstructed pulse, obscures measurements of weak broadband pulses, and makes measurements of broadband mid-IR pulses hard and slow because the spectrograms become huge due to the geometrical time-smearing effect. We develop a new

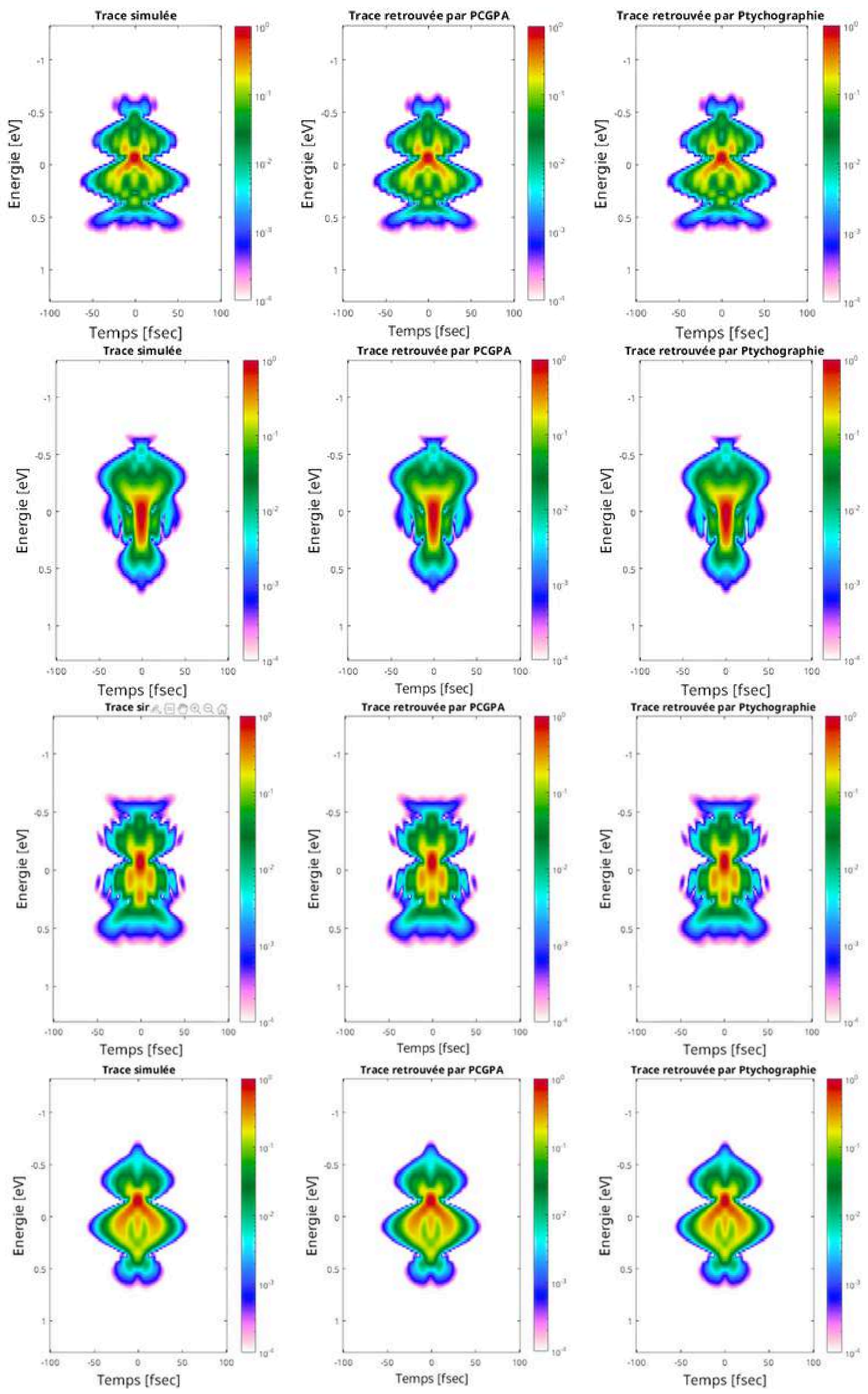
More Like This

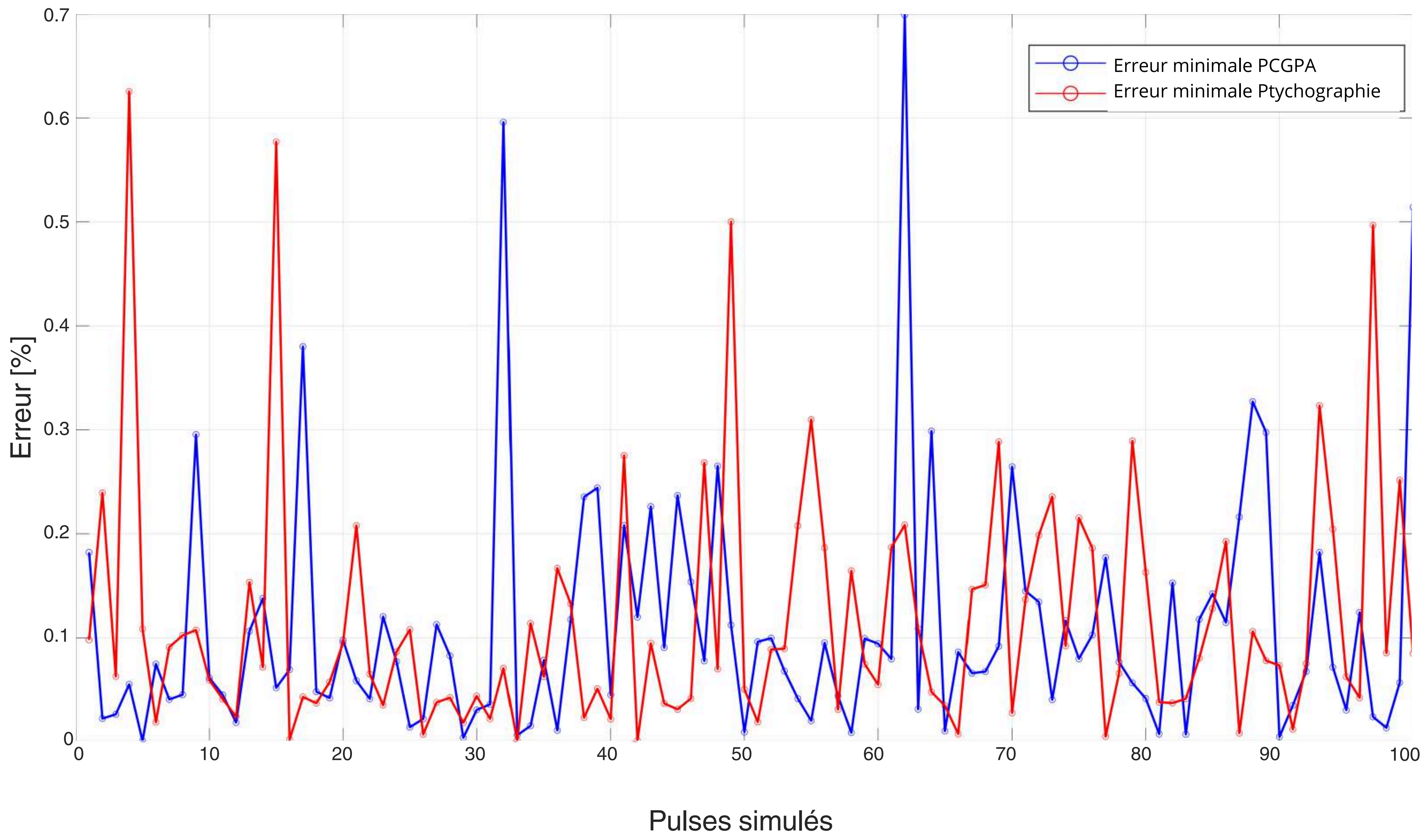
Multi-grid parallel ptychographic algorithm for frequency-resolved optical gating
Fucai Ding, *et al.*
Opt. Express 33(5) 9117-9132 (2025)

Ptychographic reconstruction algorithm for frequency resolved optical gating: super-resolution and extreme robustness: erratum

Afin de déterminer quel algorithme permet la meilleure reconstruction, on procède à une étude comparative.

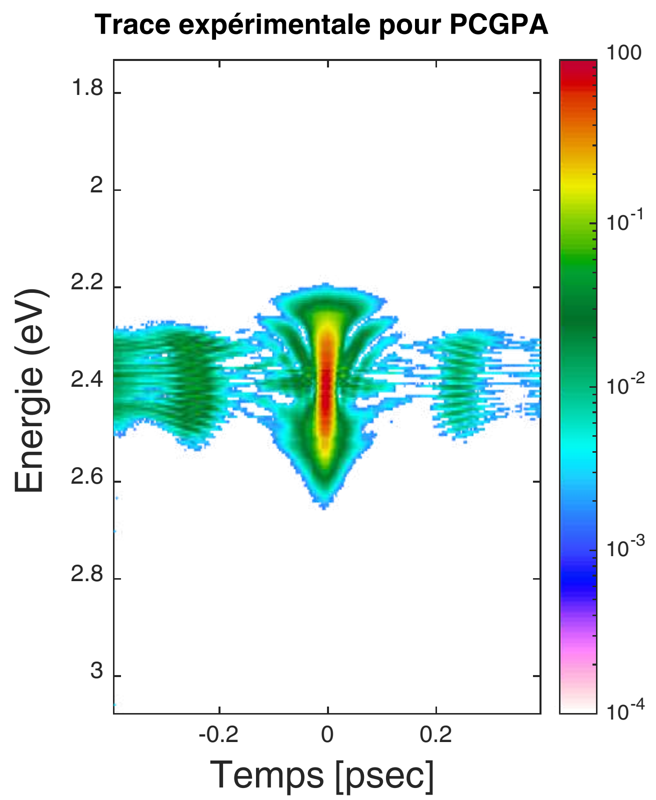
ÉTUDE COMPARATIVE THÉORIQUE

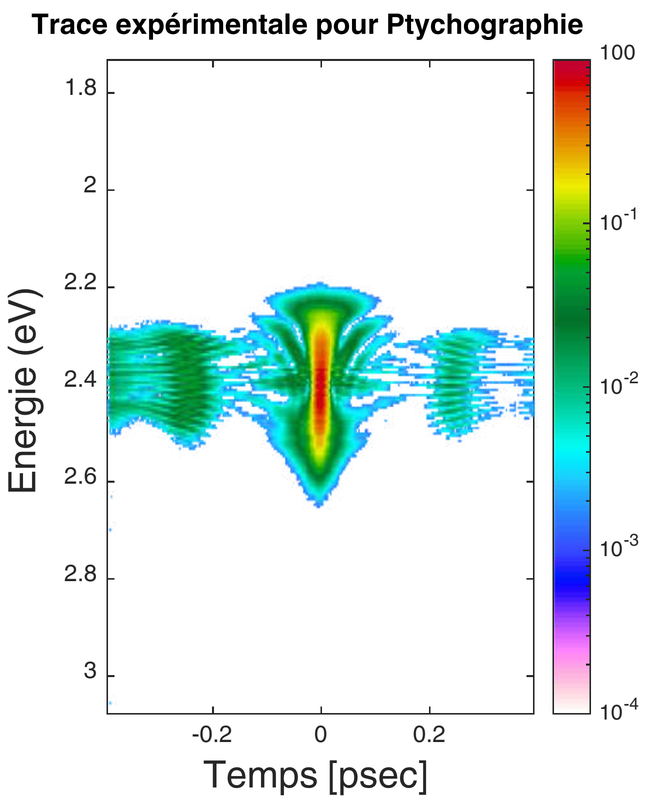


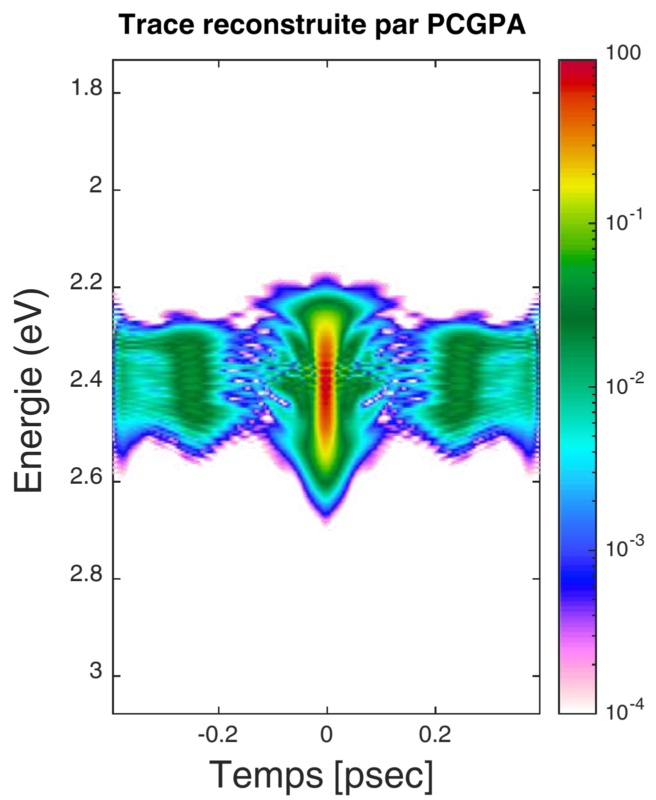


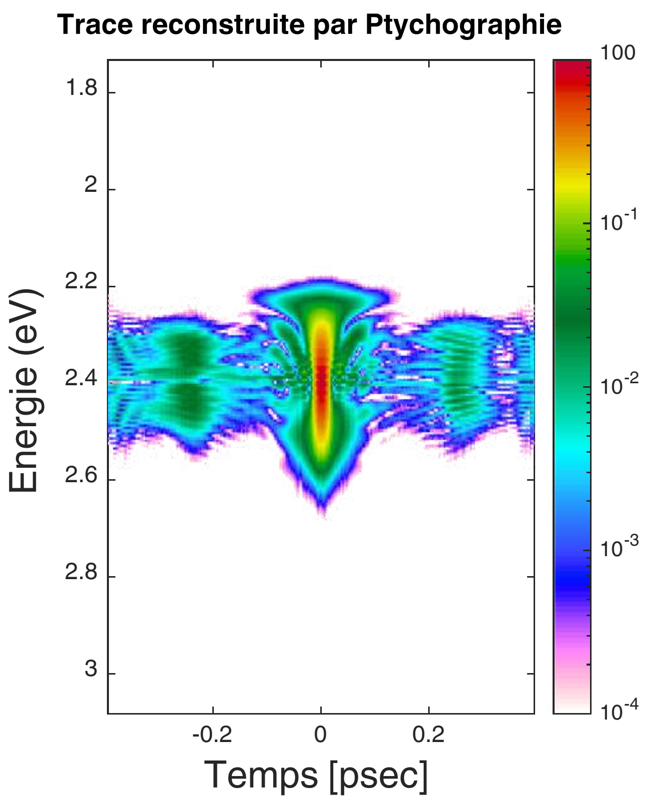
Les algorithmes sont équivalents contrairement à ce qu'affirme l'article de Ptychographie. Nous avons ultérieurement découvert un erratum en accord avec nos résultats. Donc nous employons les deux algorithmes sur les données expérimentales.

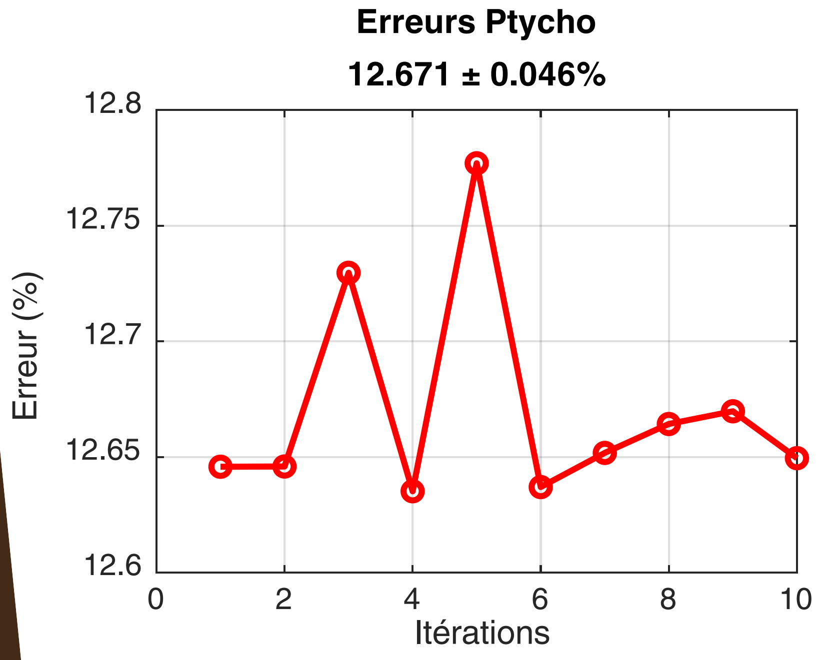
ÉTUDE COMPARATIVE EXPERIMENTALE

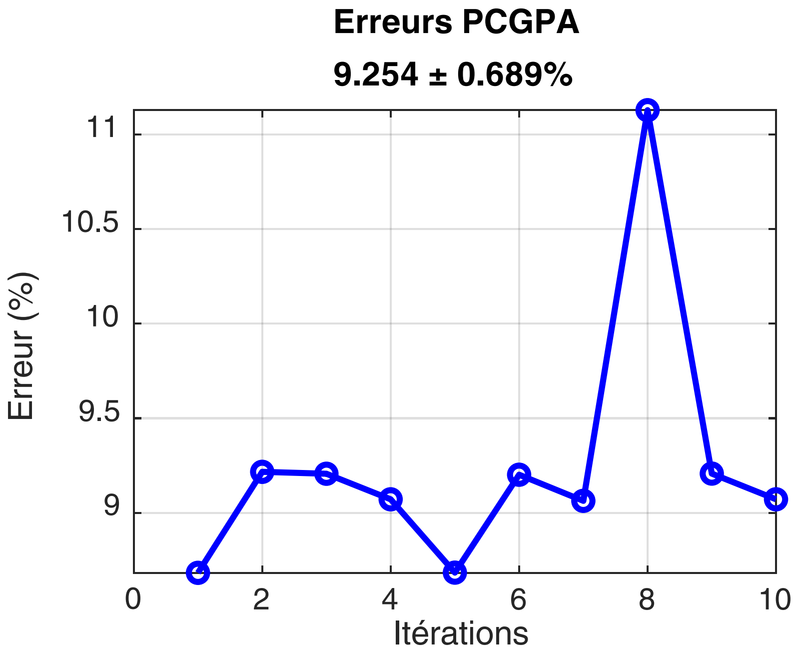


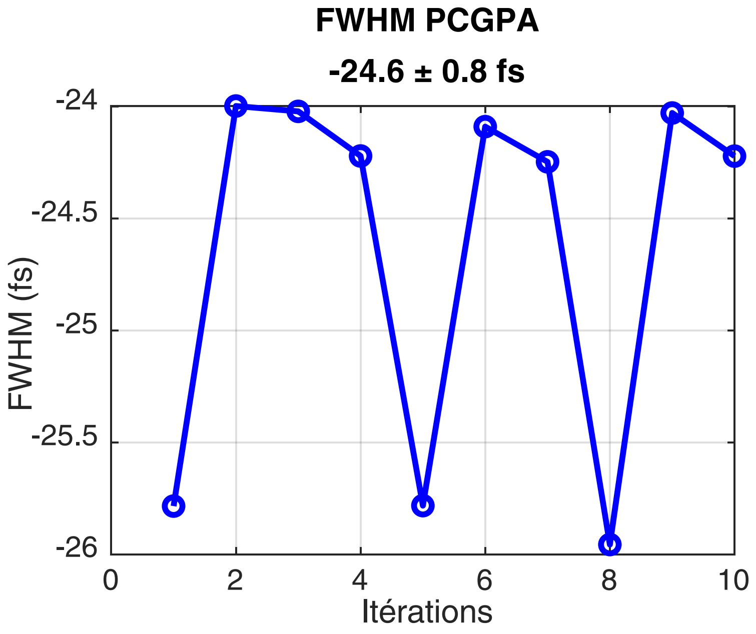


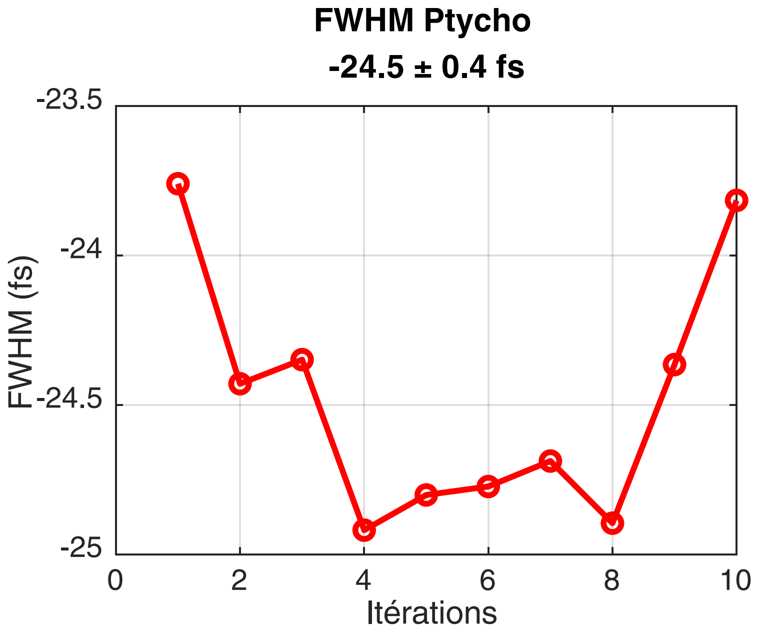






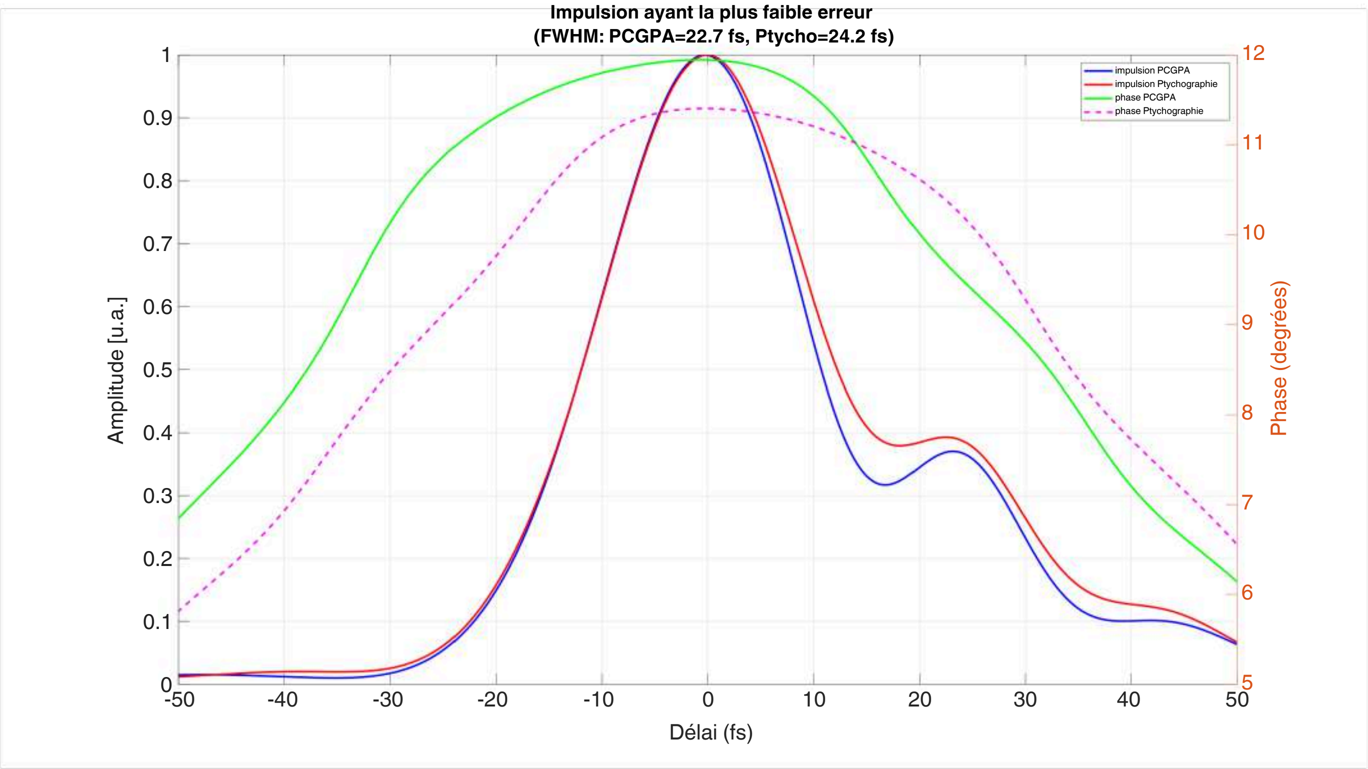


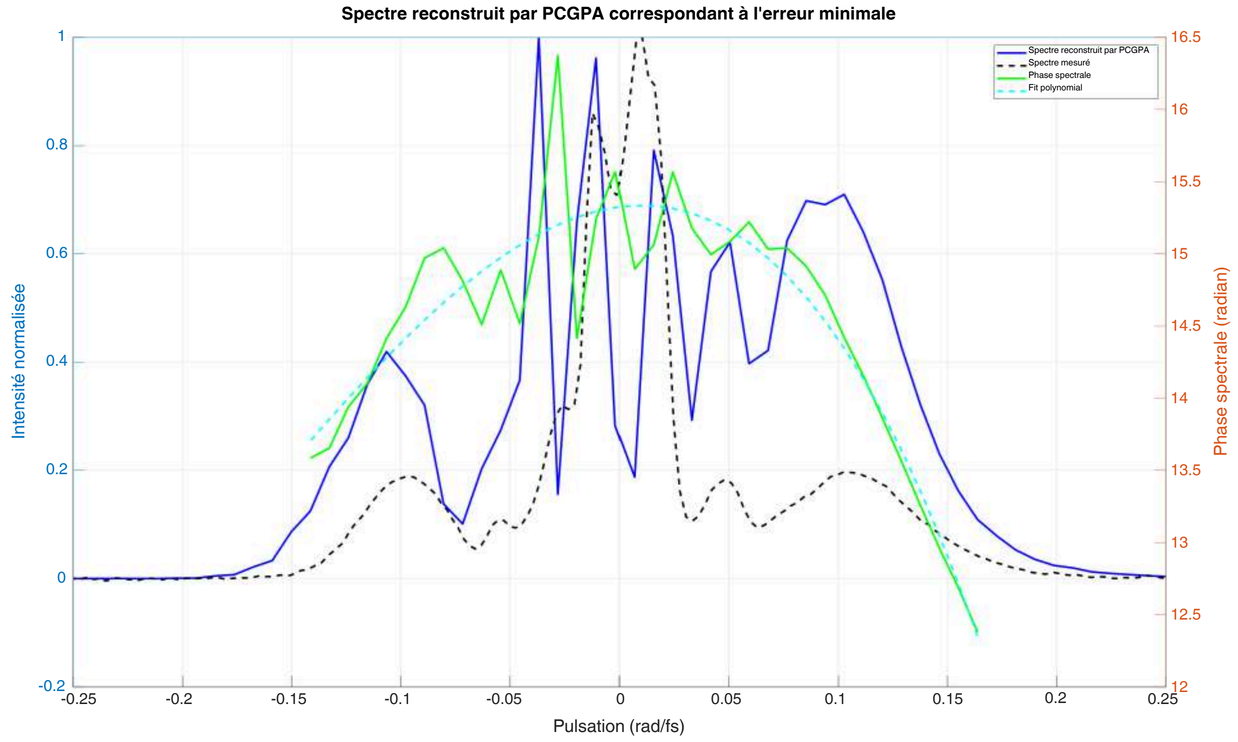




APPLICATION DE LA CARACTÉRISATION

Observation d'une phase quadratique de 150 fs^2
= pas assez de miroirs chirpés dans la MPC
Il est nécessaire de rajouter deux miroirs chirpés de -100 fs^2 en sortie de MPC





APPLICATION DE LA CARACTÉRISATION

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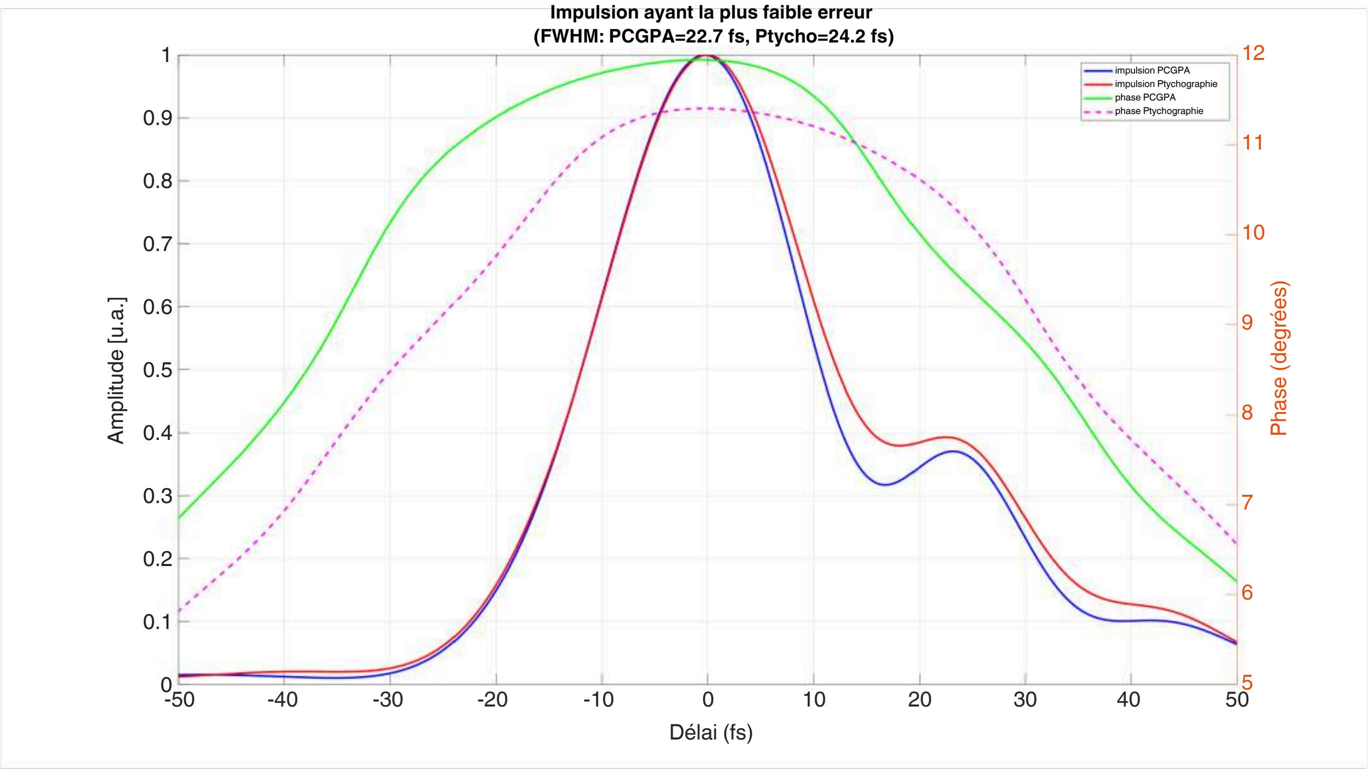
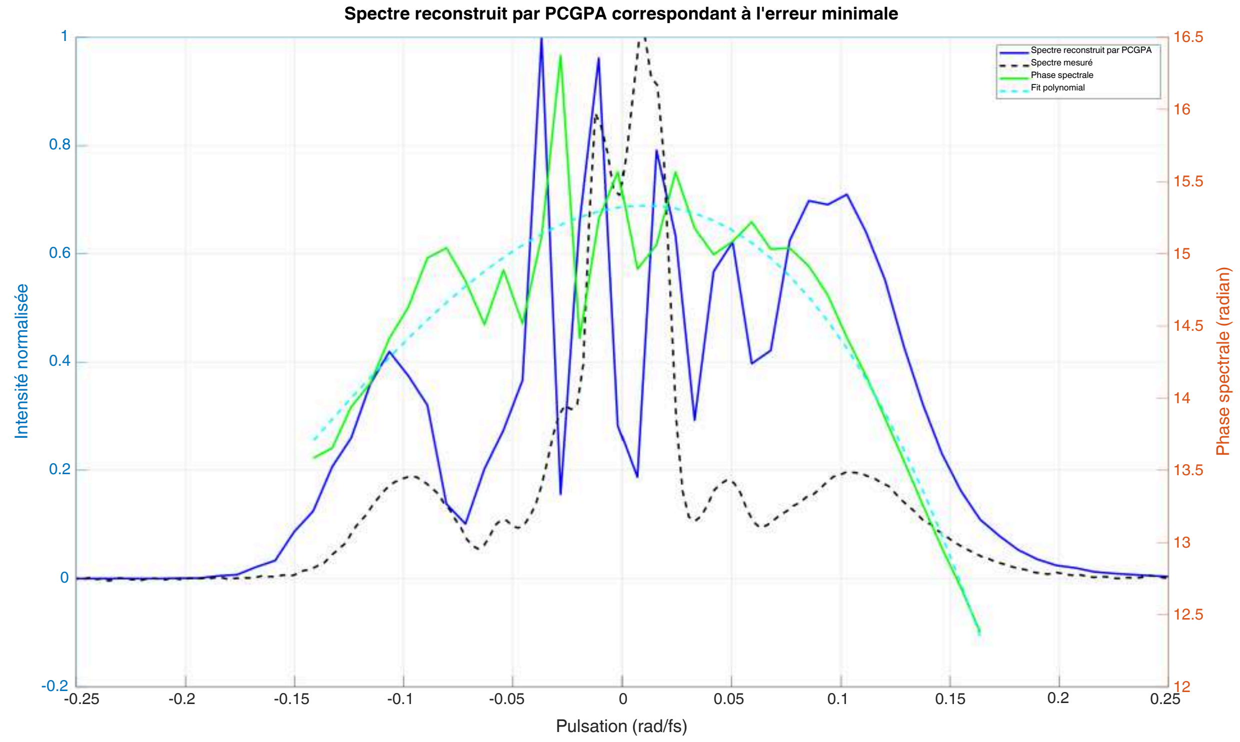
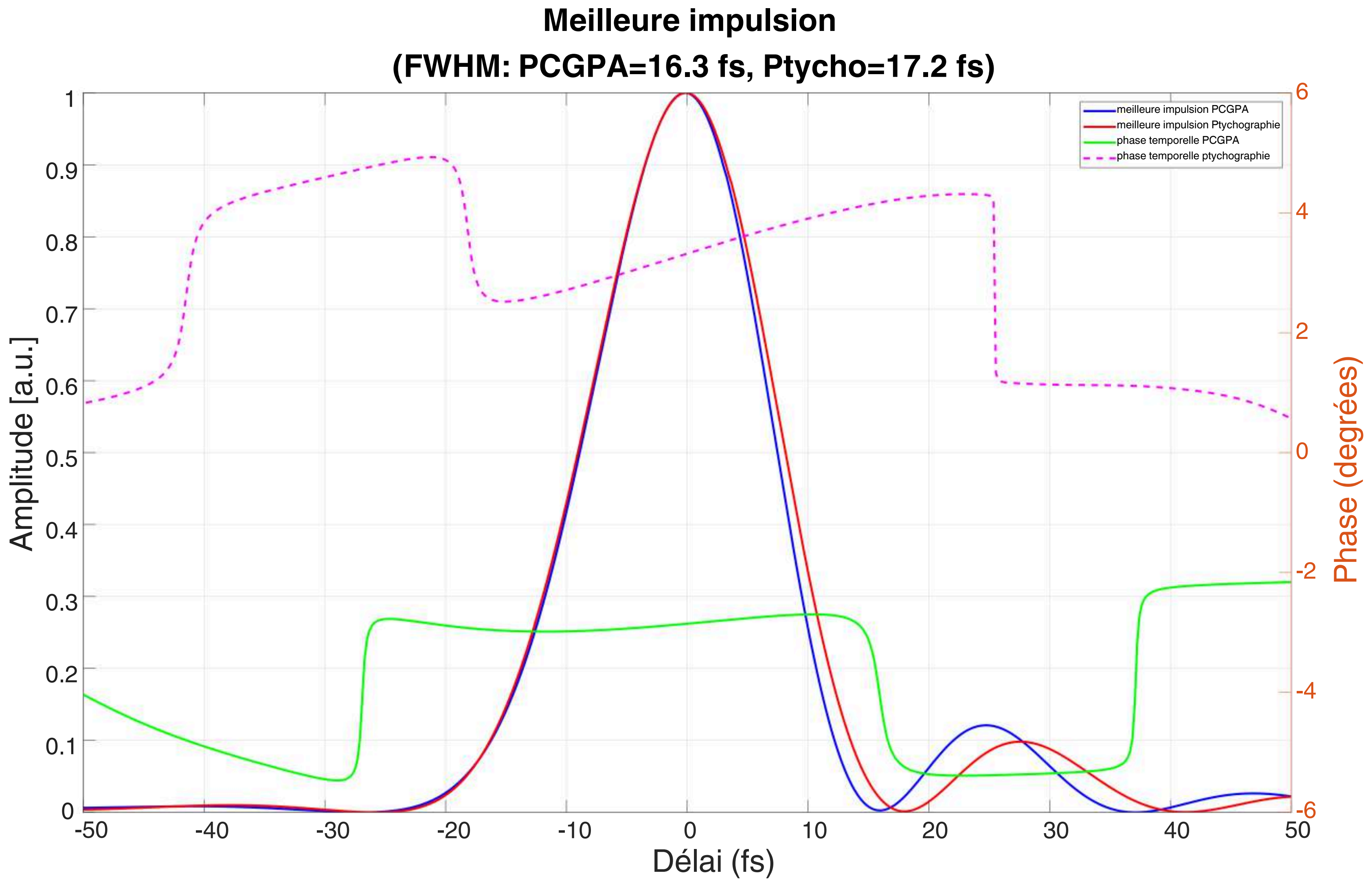




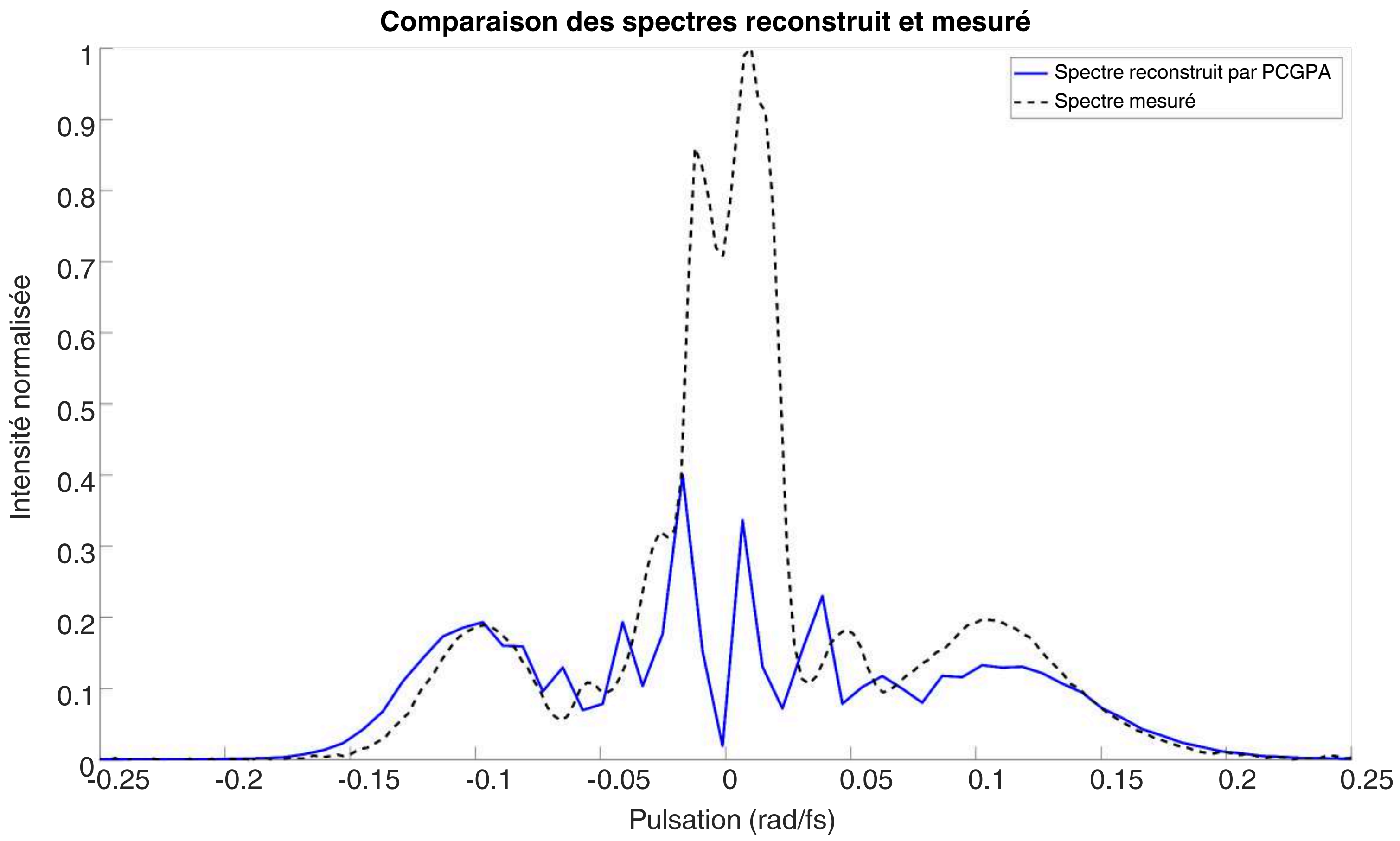
Impulsion en sortie de MPC après l’ajout de miroirs chirpés :



CONCLUSION

- Réalisation d’impulsion ultrabrève permettant la génération d’harmoniques d’ordre élevé
- Bonne mise en place du FROG, permettant la caractérisation d’impulsion ultrabrève
- Algorithmes de reconstructions équivalents, intégrations des deux algorithmes (ou uniquement de PCGPA en fonction du temps) dans la prise de mesure

Problème actuellement rencontré:
La comparaison des spectres met en évidence la présence d’impulsion non comprimée
= perte d’énergie pour la HHG



CONCLUSION

Source

[1] Répertoire des seuils d'ionisations, https ://xdb.lbl.gov/Section1/Table1 – 1.pdf.
[2] Maurizio Reduzzi Themistoklis P. H. Sidiropoulos Daniel E. Rivas Nicola Di Palo Hung-Wei Sun et Ying-Hao Chien Adam M. Summers, Stefano Severino. Realizing attosecond core-level x-ray spectroscopy for the investigation of condensed matter systems. Ultrafast Science, 2023.
[3] Dave Townsend Chris Sparling. Two decades of imaging photoelectron circular dichroism : from first principles to future perspectives. Physical Chemistry Chemical Physics, 2025.
[4] S. Beauvarlet N. Besley F. Calegari C. Callegari D. Catone E. Cinquanta et A.G. Ciriolo D. Faccialà, M. Devetta. Time-resolved chiral x-ray photoelectron spectroscopy with transiently enhanced atomic site selectivity : A free-electron laser investigation of electronically excited fenchone enantiomers. Phys. Rev., 2023.
[5] Daniel J. Kane. Recent progress toward real-time measurement of ultrashort laser pulses. Journal of quantum electronics, Vol. 35, No. 4, 1999.
[6] Esmerando Escoto Prannay Balla Supriya Rajhans Katinka Horn Lutz Winkelmann Vincent Wanie Andrea Trabattoni Christoph M. Heyl-et Francesca Calegari Laura Silletti, Ammar bin Wahid. Dispersion-engineered multi-pass cell for single-stage post-compression of an ytterbium laser. Optics Letters Vol. 48, Issue 7, 2023.
[7] Nour Daher Quentin Bournet Xavier Délen et Patrick Georges Marc Hanna, Florent Guichard. Nonlinear optics in multipass cells. Laser and Photonics Reviews, 2021.
[8] Zohar Avnat Pavel Sidorenko, Oren Lahav and Oren Cohen. Ptychographic reconstruction algorithm for frequency resolved optical gating : super-resolution and extreme robustness : erratum. Optica publishing group, 2017.
[9] Zohar Avnat et Oren Cohen Pavel Sidorenko, Oren Lahav. Ptychographic reconstruction algorithm for frequency-resolved optical gating : super-resolution and supreme robustness. Optica publishing group, 2016.
[10] et Rick Trebino Rana Jafari, Travis Jones. 100 Optics Express, 2018.
[11] Alexander Kirsche Jan Rothhardt et Jens Limpert Robert Klas, Wilhelm Eschen. Generation of coherent broadband high photon flux continua in the xuv with a sub-two-cycle fiber laser. Optics Express Vol. 28, Issue 5, 2020.
[12] Peter Simon Laszlo Veisz Tamas Nagy. High-energy few-cycle pulses : post-compression techniques. Advances in Physics : X,, 2020.
[13] Rick Trebino. Frequency-Resolved Optical Gating : The Measurment of Ultrashort Laser Pulses. Kluwer Academic Publishers, 2000.