

Influence de forme d'impulsion sur les propriétés de la décharge (tube et jet)

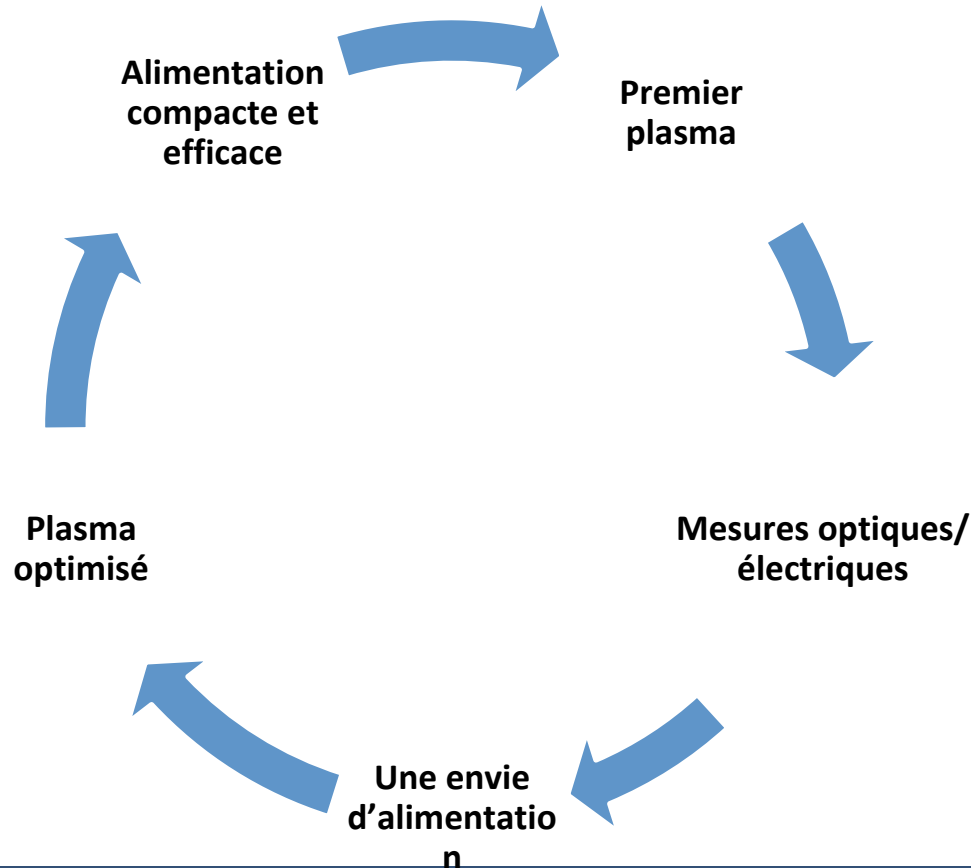
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Sébastien POINT, Vanessa SARRON, Delphine RIES, Thibault DARNY*





Objectif, message principal

- Pas d'alimentation / Pas de plasma
- Une alimentation une décharge
- Une alimentation variable/ un électronique des décharges optimisées





Plan de l'exposé

- **Décharges luminescentes sans mercure**
 - Principe
 - Optimisation associée à l'alimentation

- **Jet de plasma à pression atmosphérique: Plasma Gun**
 - Principe
 - Optimisation associée aux alimentations

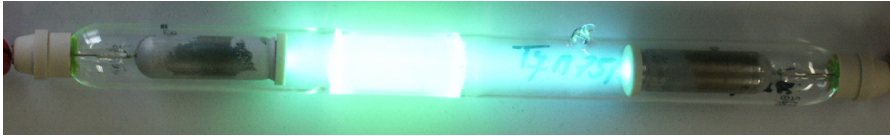
- kV, ns, μ s, Hz - kHz



Décharges lumineuses sans mercure



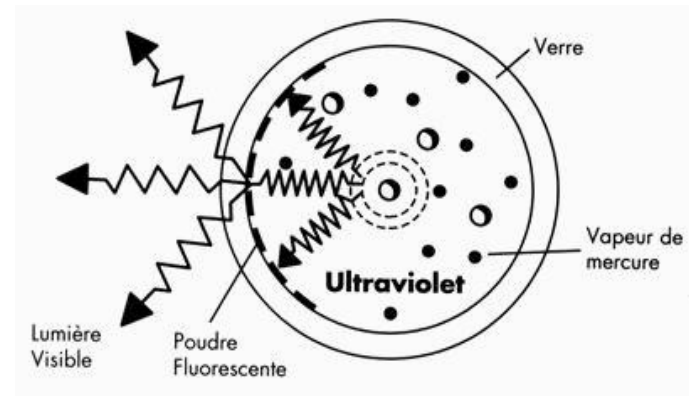
Enseignes lumineuses/Tubes fluos



Mélange Ar/Ne/Hg à basse pression
(10 mbar)

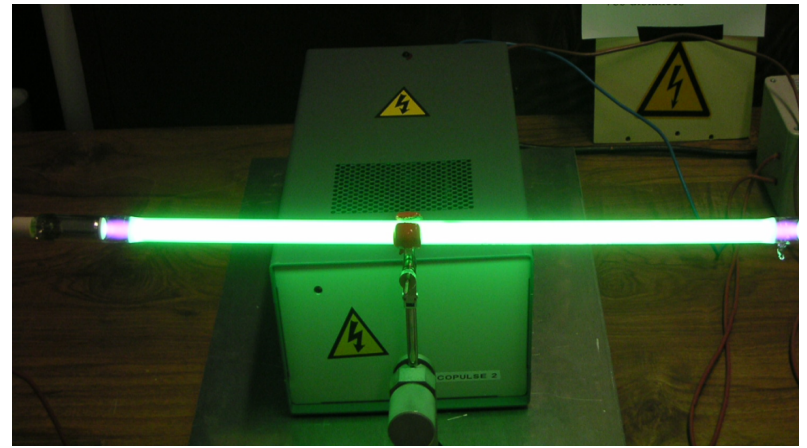
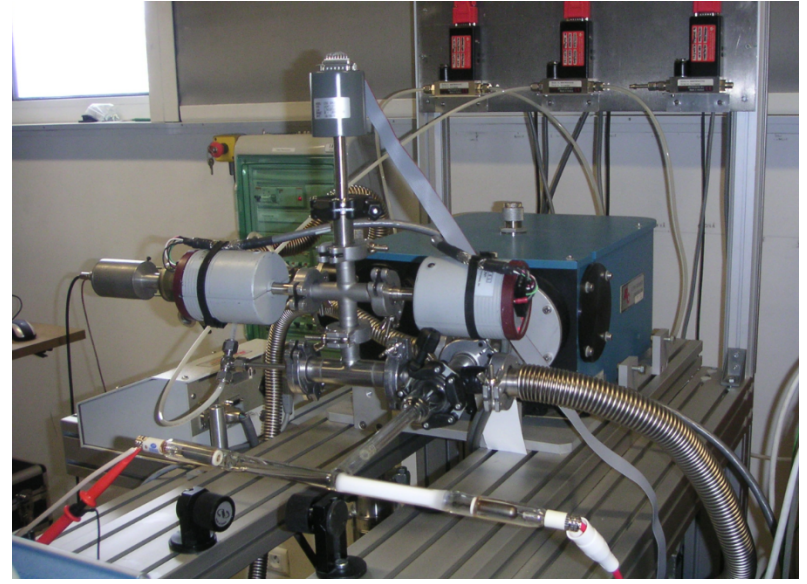
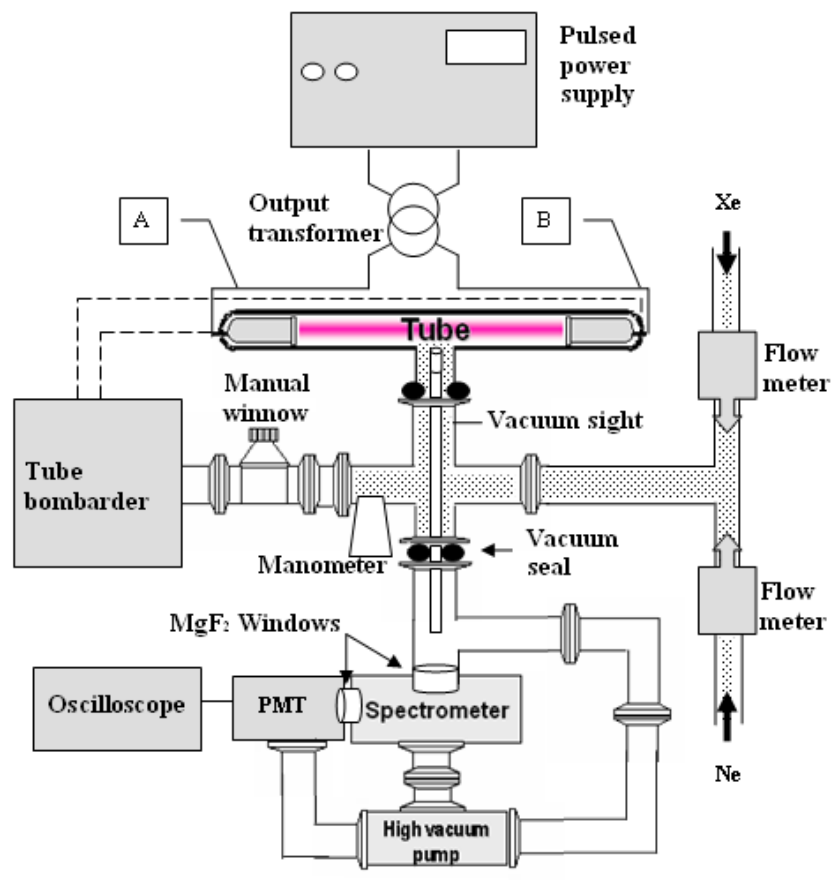
- Production d'un rayonnement UV (254 nm).
- Excitation du phosphore et émission visible.
- Efficacité élevée: de 50 à 100 lm/W, durée de vie >10 000 heures

- Cathodes froides
- Substance d'activation
- Émission secondaire par bombardement ionique





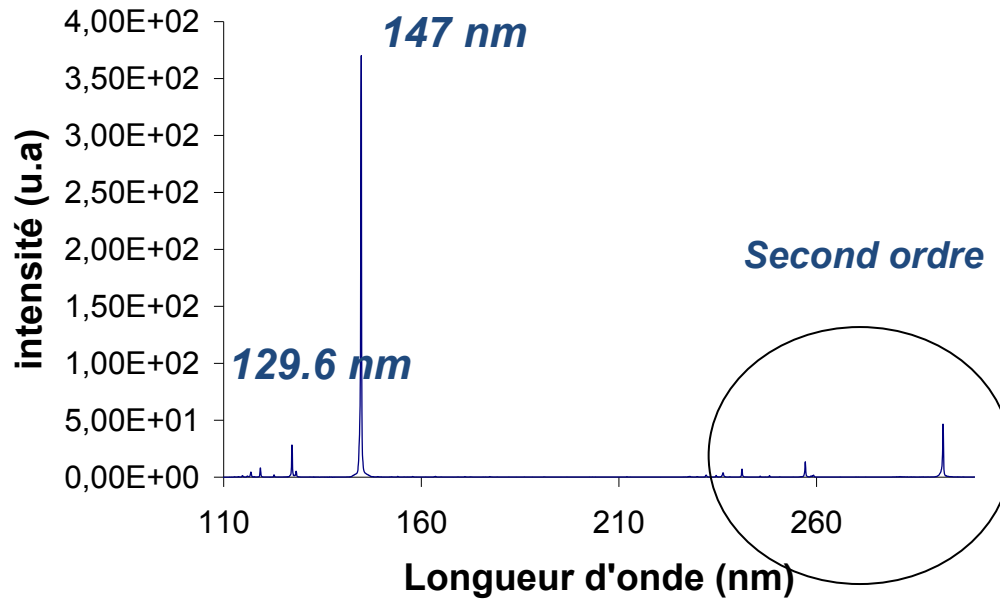
Banc expérimental: décharges basse pression et diagnostics





Sans mercure ?

Xénon: émetteur dans le VUV (147 nm essentiellement).

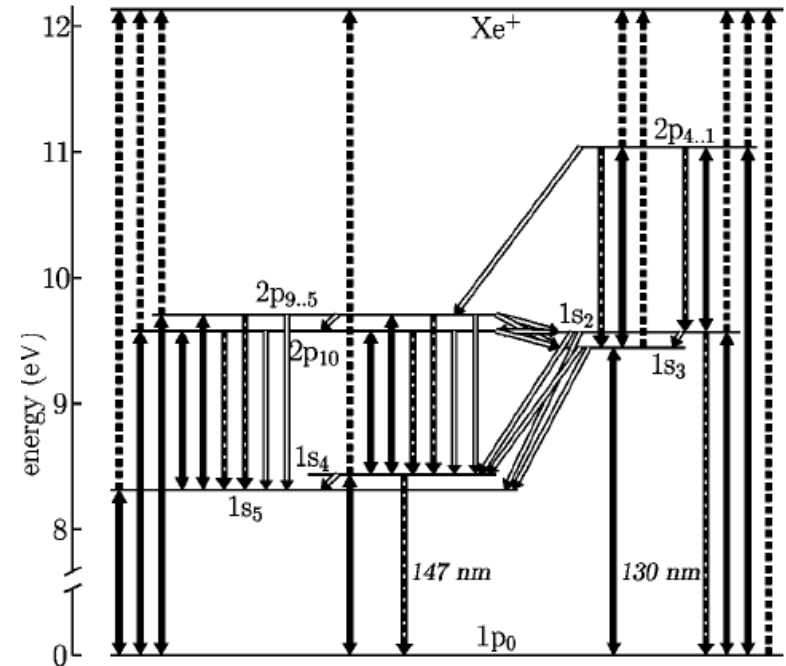
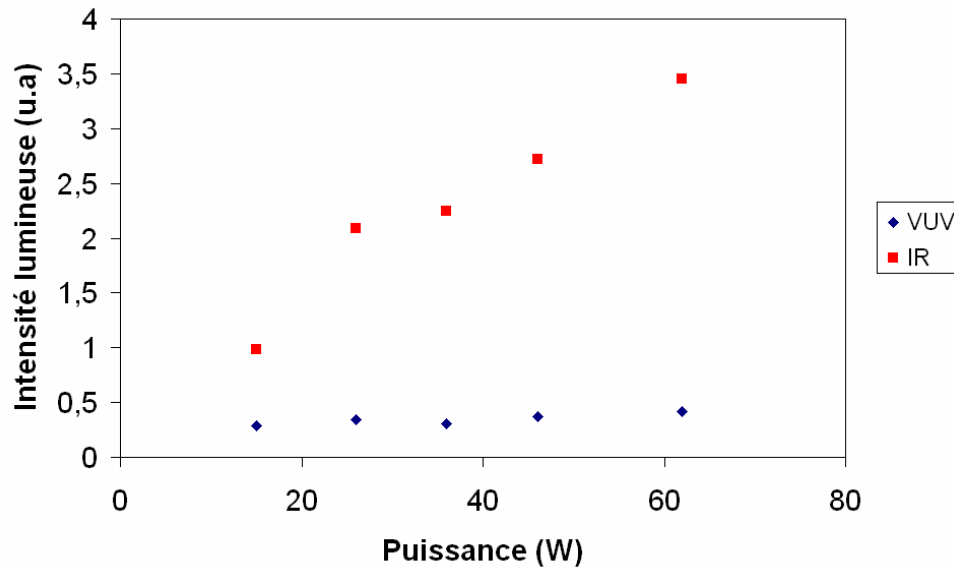




Premier plasma sans mercure, ballasts AC

Résultats des premières expériences: très faible rendement dans le VUV

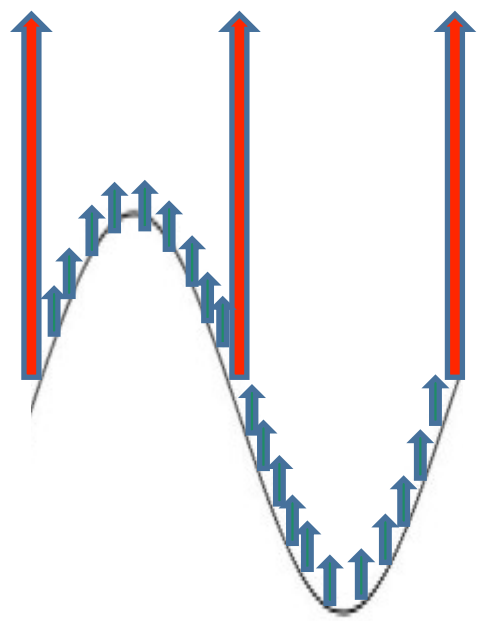
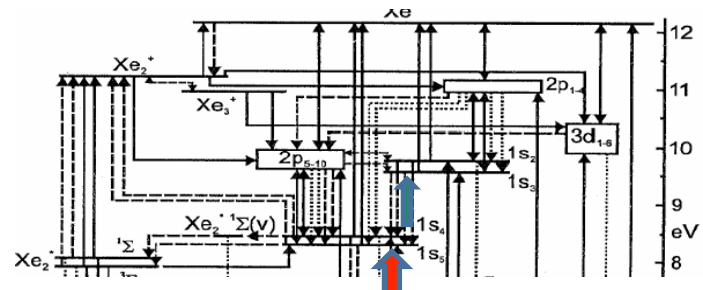
→ peuplement en cascade des niveaux énergétiques du xénon qui handicape la production de VUV en régime alternatif sinusoïdal



Gortchakov et al, J.Appl. Phys., vol 93, N 12, 2003.



AC/pulsé: les envies de physiciens

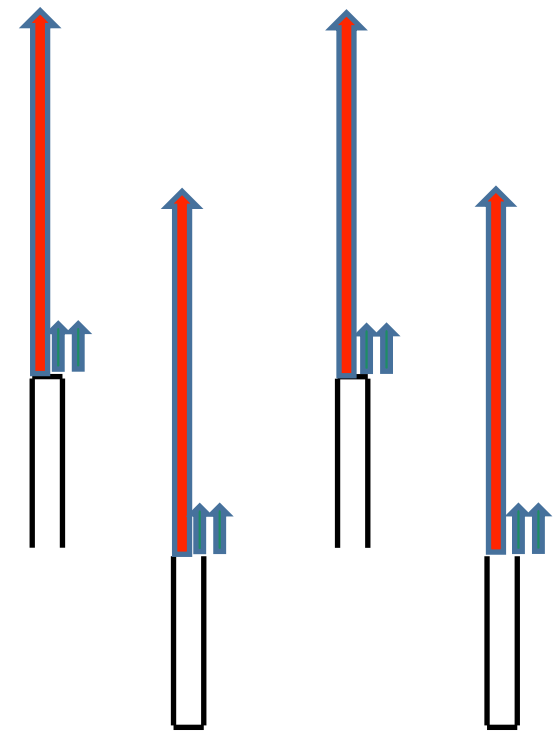


0 eV

Courant

VUV

↑ Visible, infrarouge

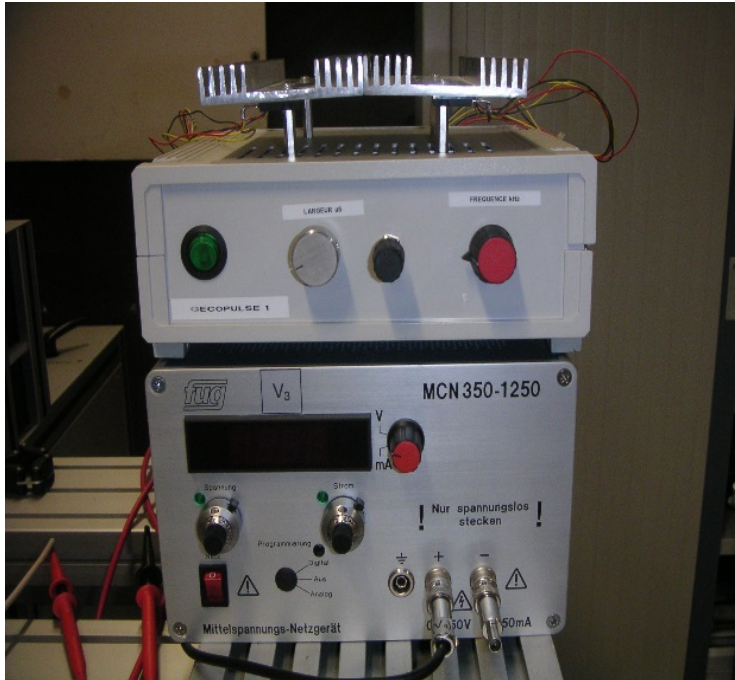
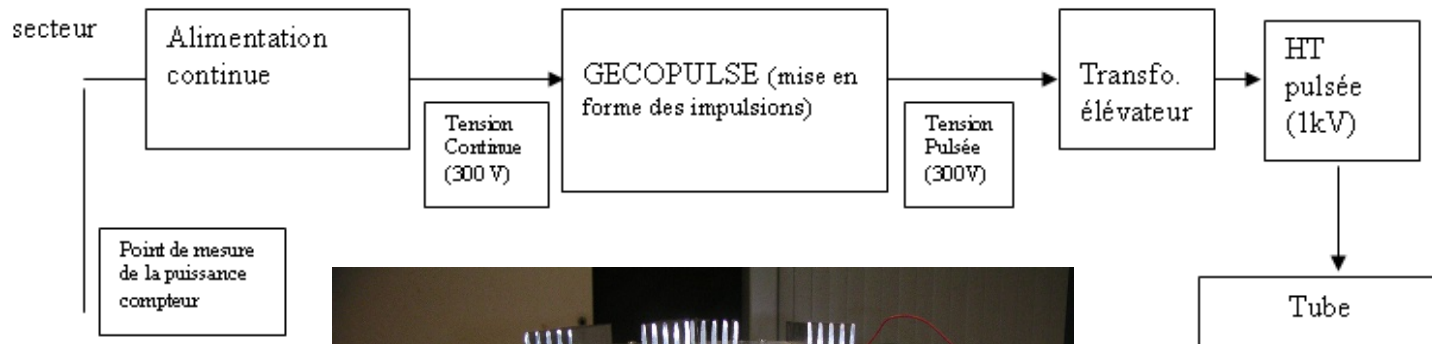


- Courant établi: densité /température électroniques « élevée »/ « faible »



Une envie d'alimentation

Idée: utiliser une excitation pulsée pour optimiser le peuplement des premiers niveaux.



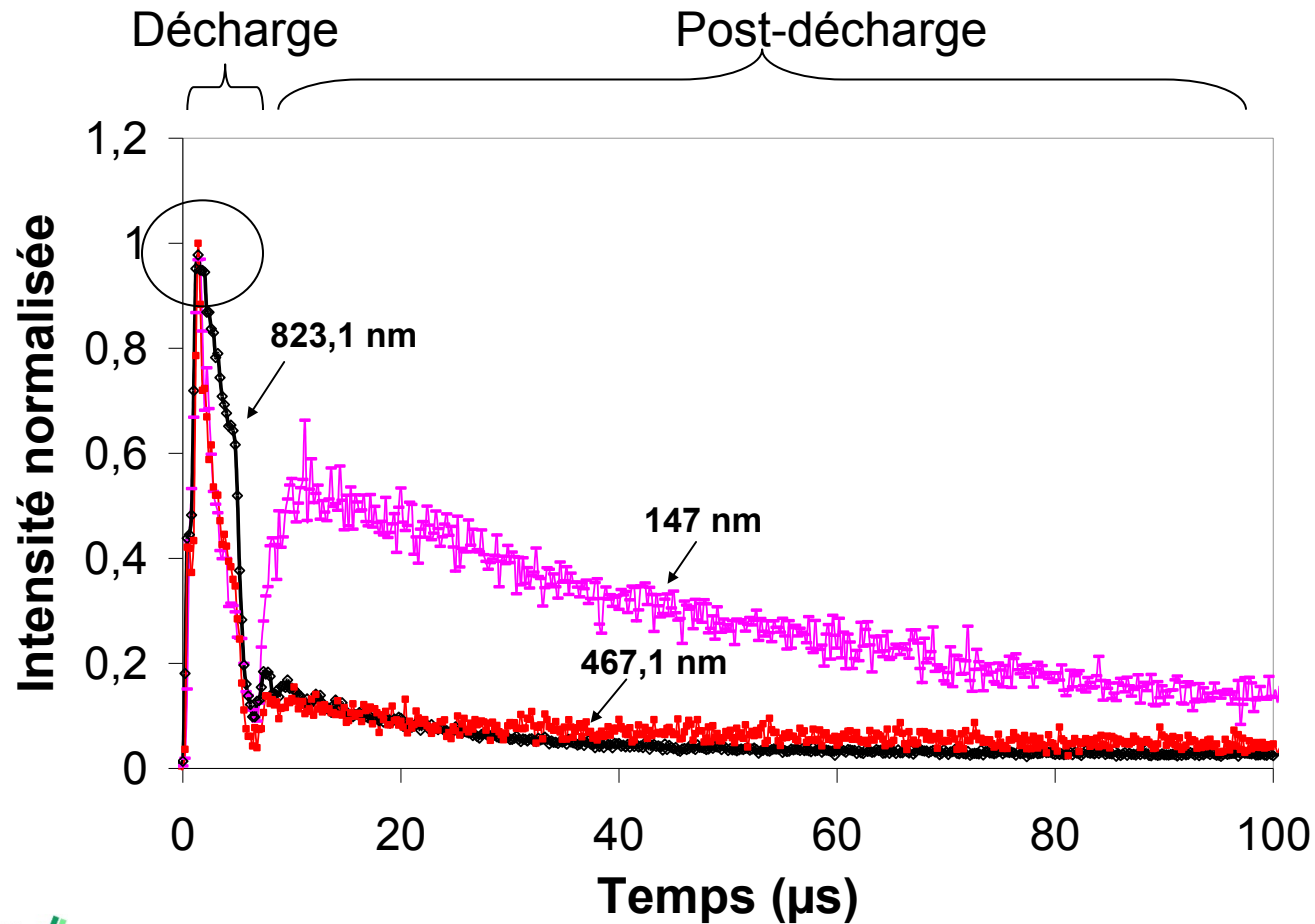
- +/- obligatoire
- Largeur pulse?
- Amplitude de tension?
- Fréquence?
- L'impédance du plasma?

SOYEZ
RÉALISTE.
DEMANDEZ
L'IMPOSSIBLE



Quelle fréquence?

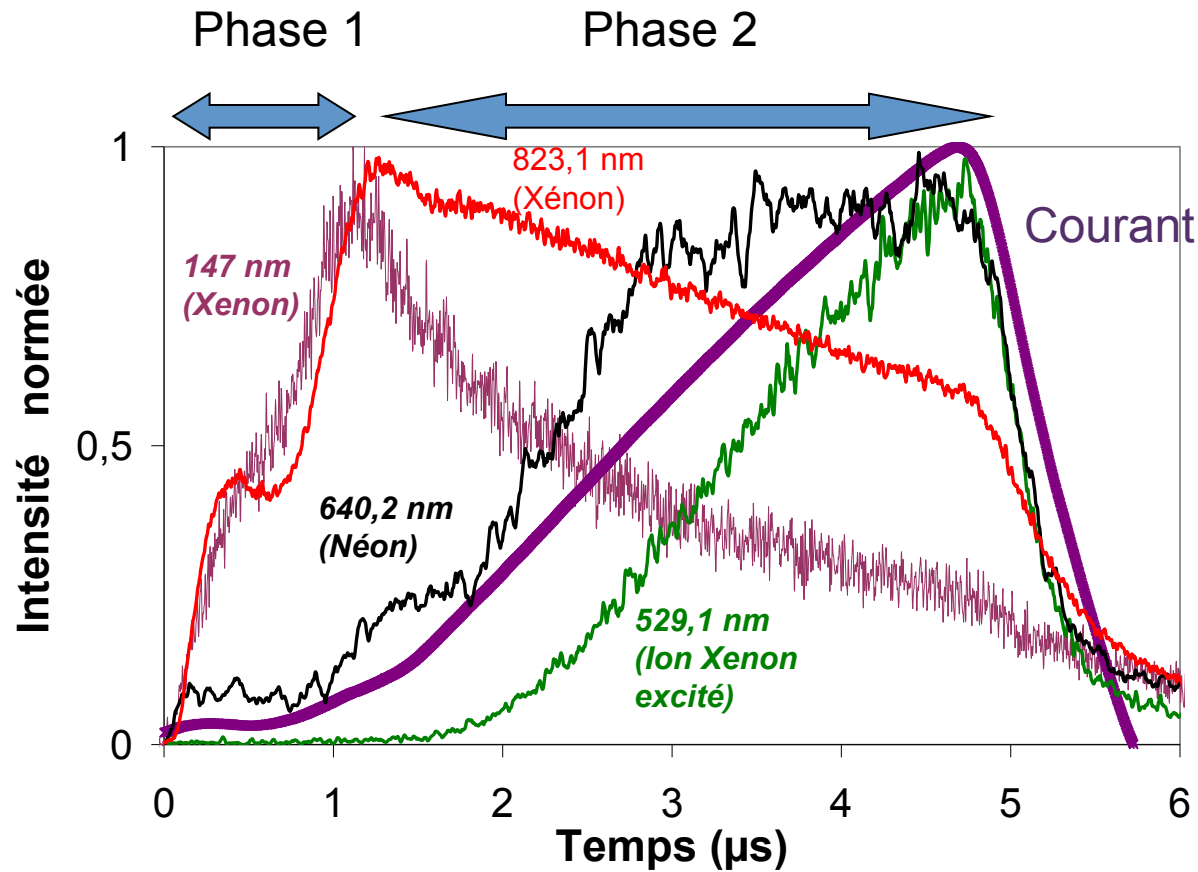
Émission de lumière pendant l'impulsion et après l'impulsion





Peuplement pendant l'impulsion

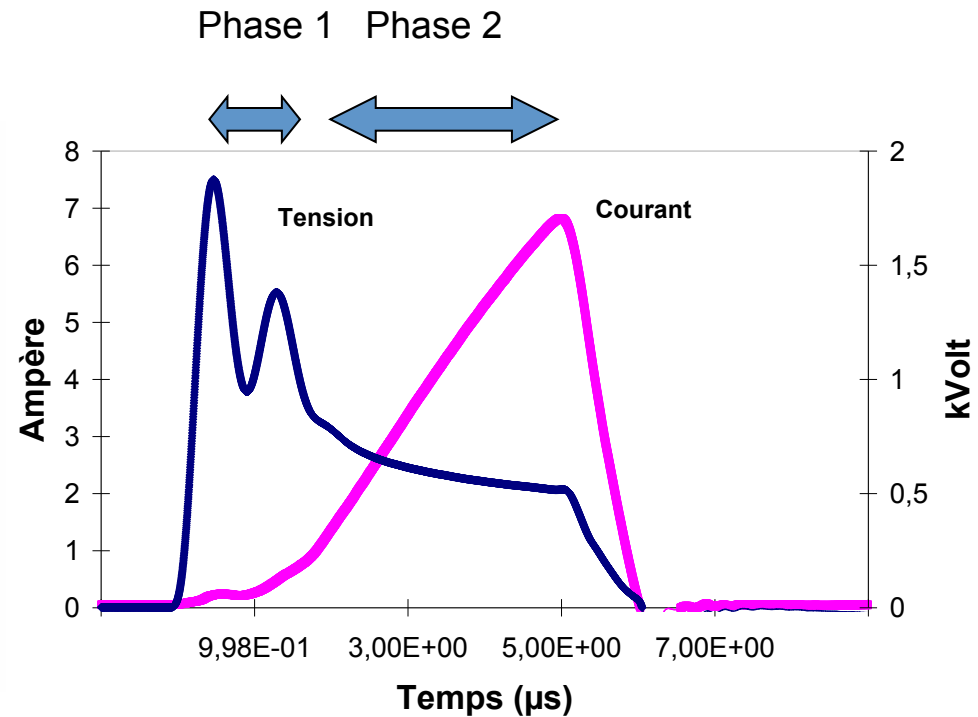
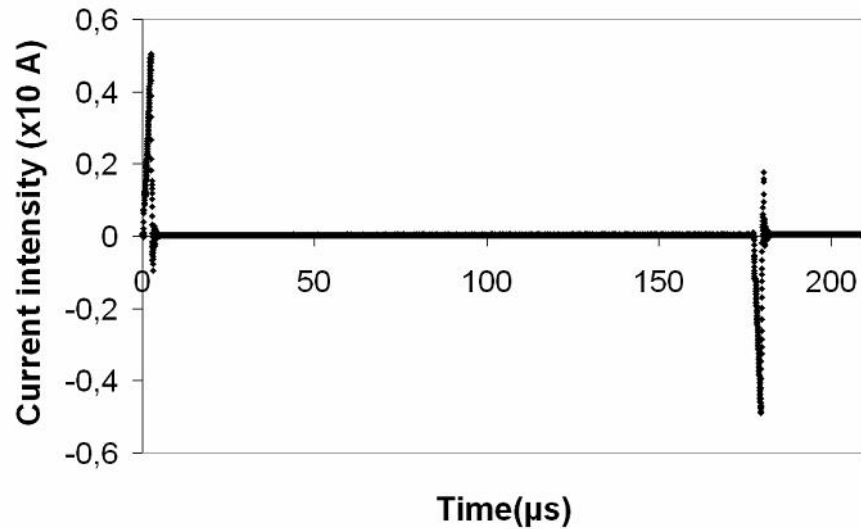
Production de VUV au cours de l'impulsion: excitation et ionisation du xénon.





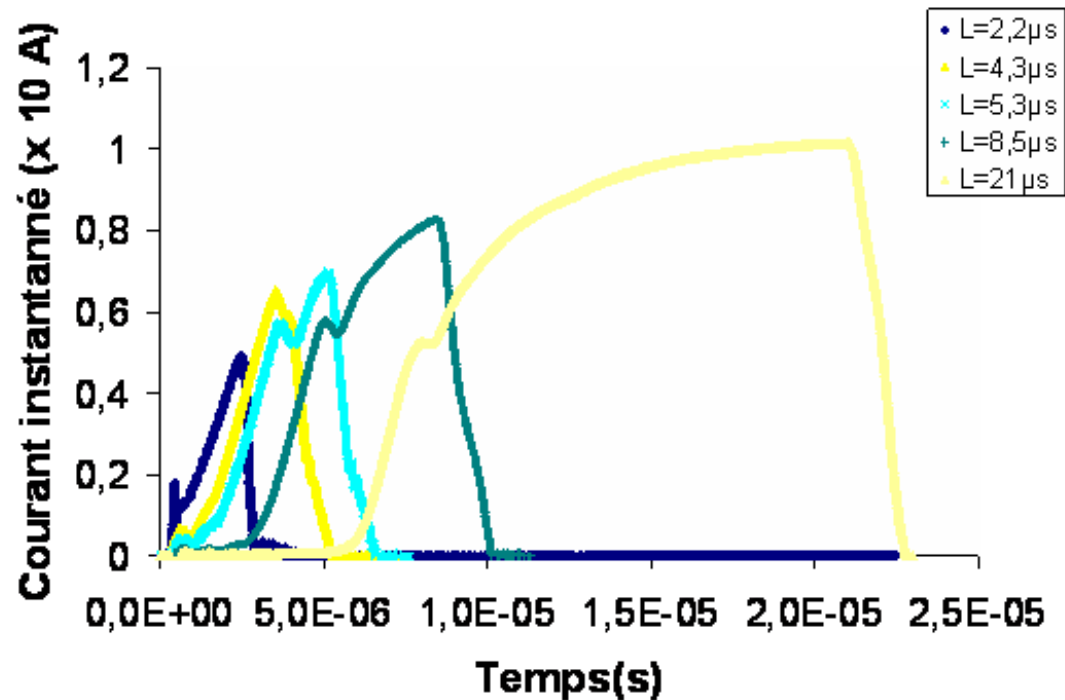
Largeur d'impulsion?

Excitation μs , kHz, kV



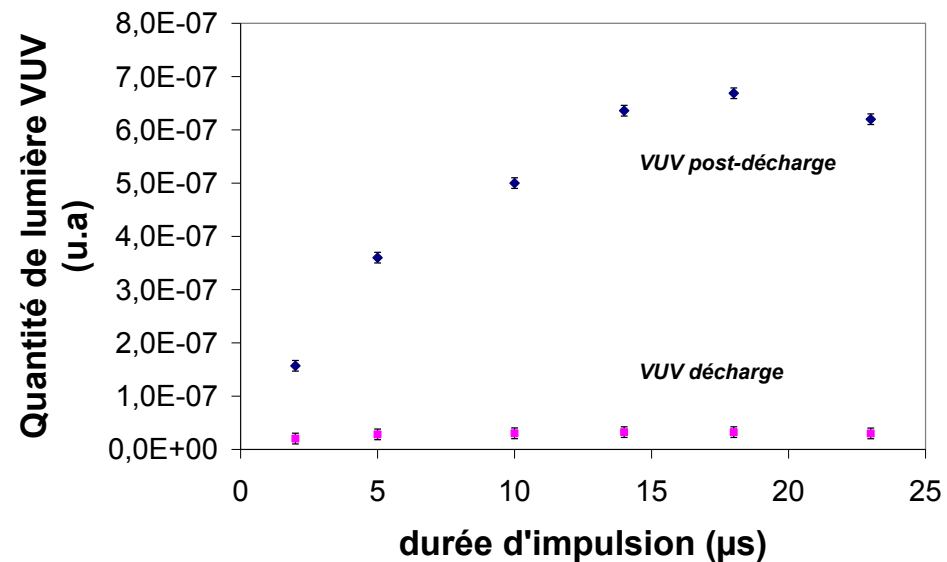
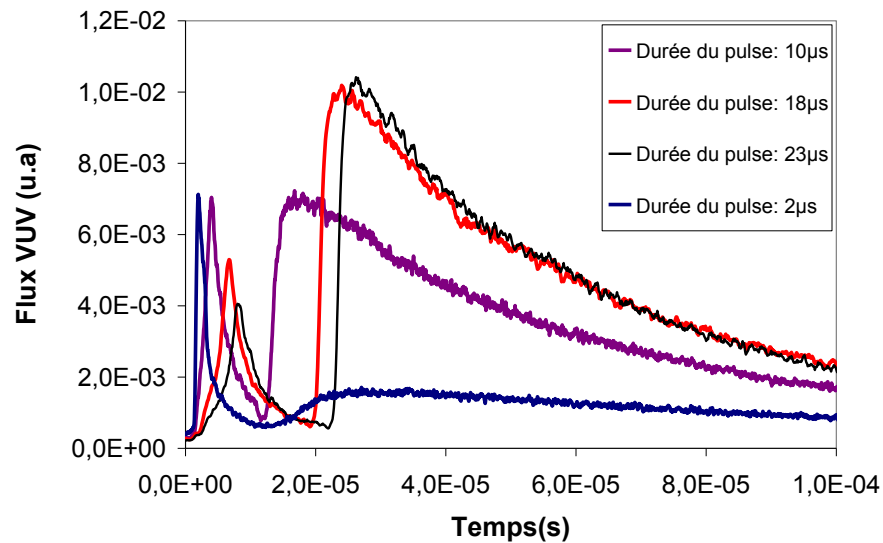


Évolution avec la durée d'impulsion





Évolution avec la durée d'impulsion

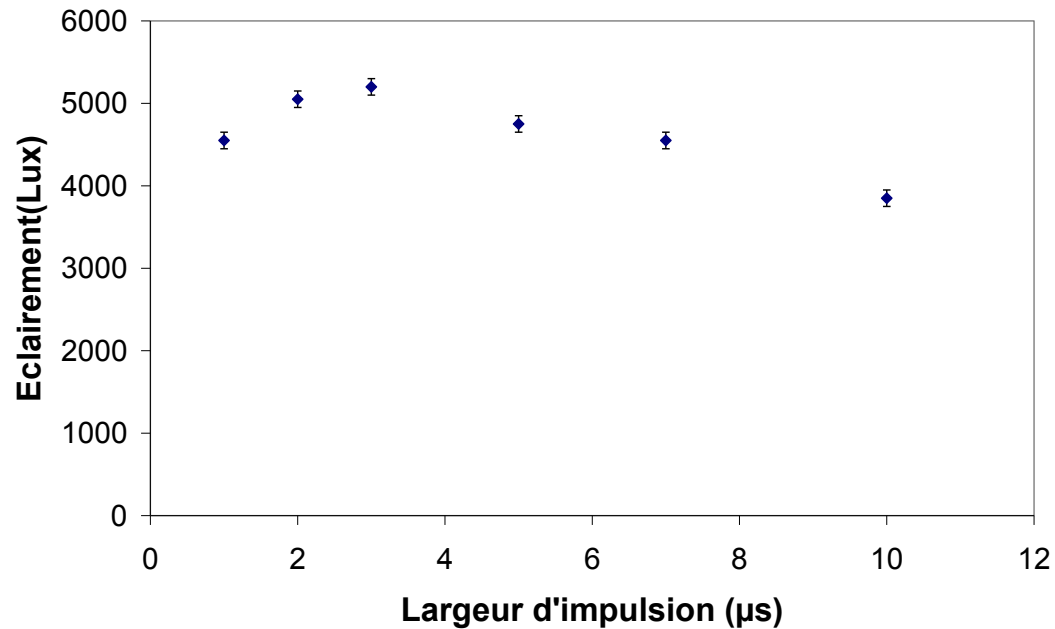
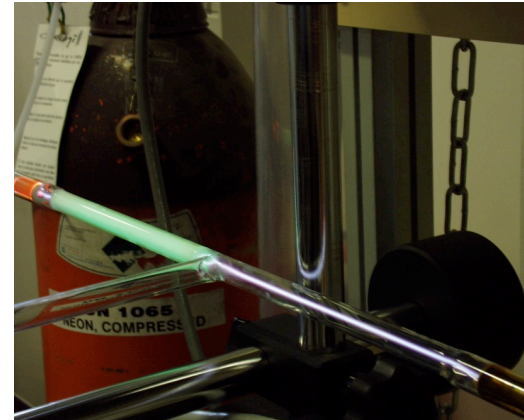
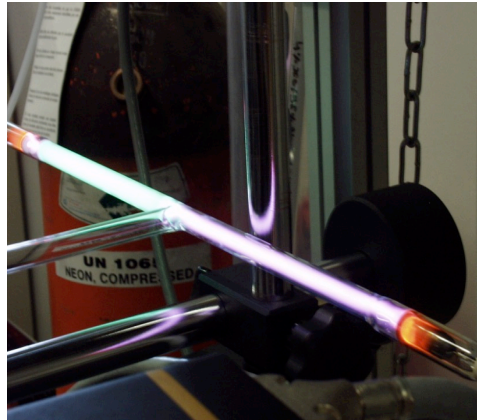


Effet significatif sur l'émission de post-décharge.



Vers un optimum

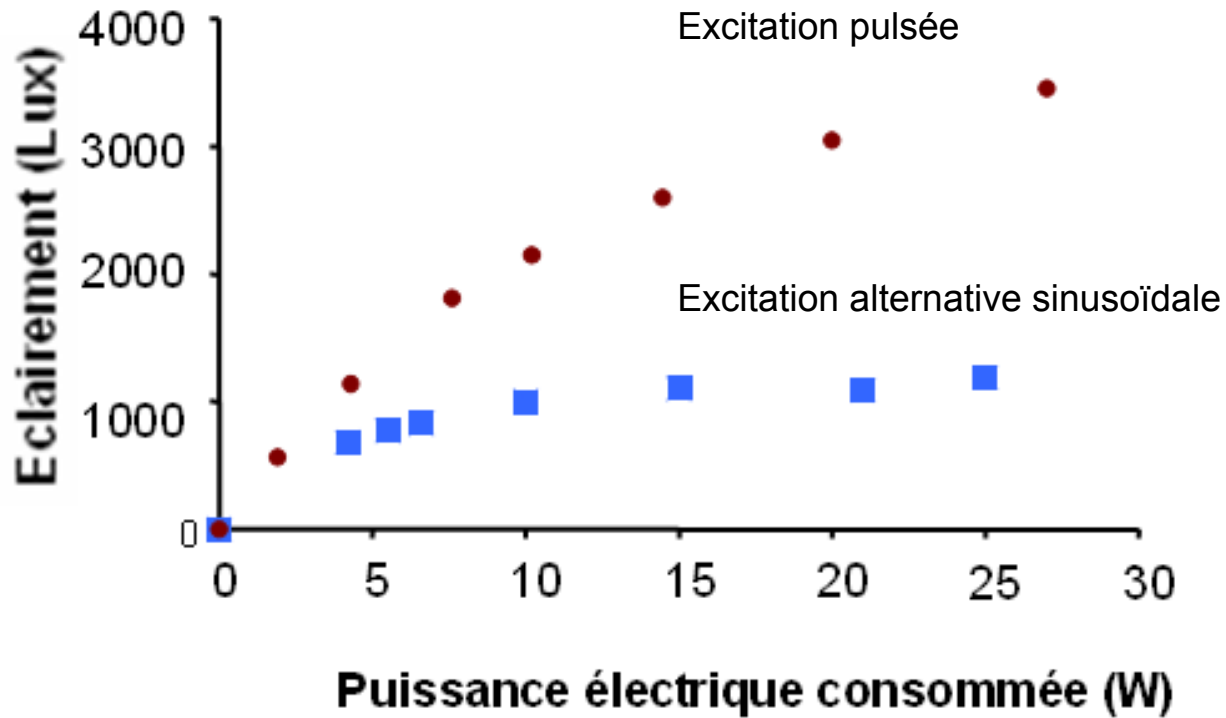
...contrebalancée
par la diminution
de fréquence et
une contraction de
la décharge.





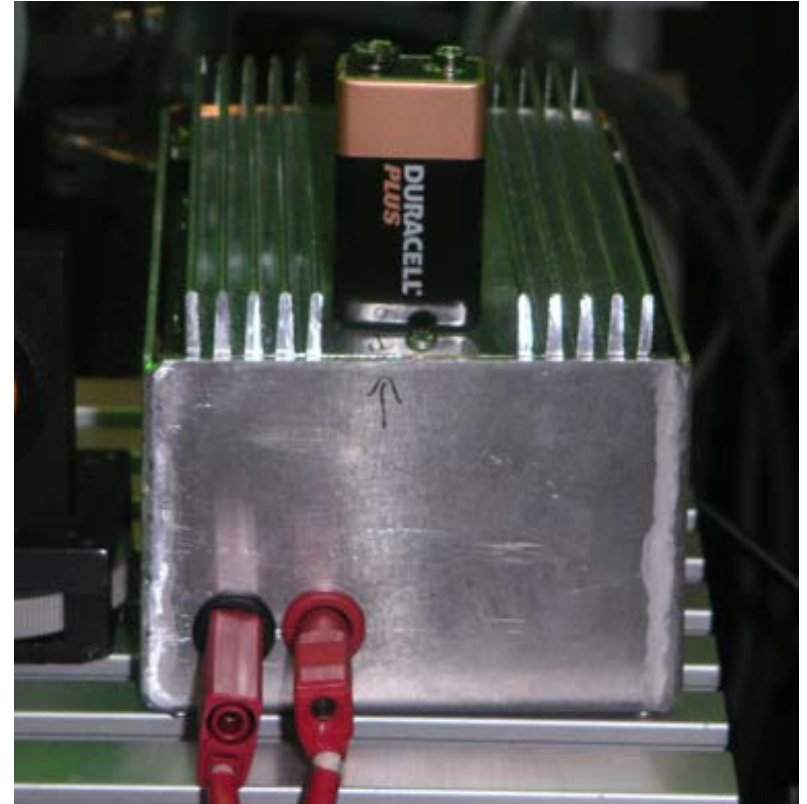
Le bénéfice du travail sur l'alimentation

Amélioration de l'efficacité lumineuse





Alimentations efficace, compacte

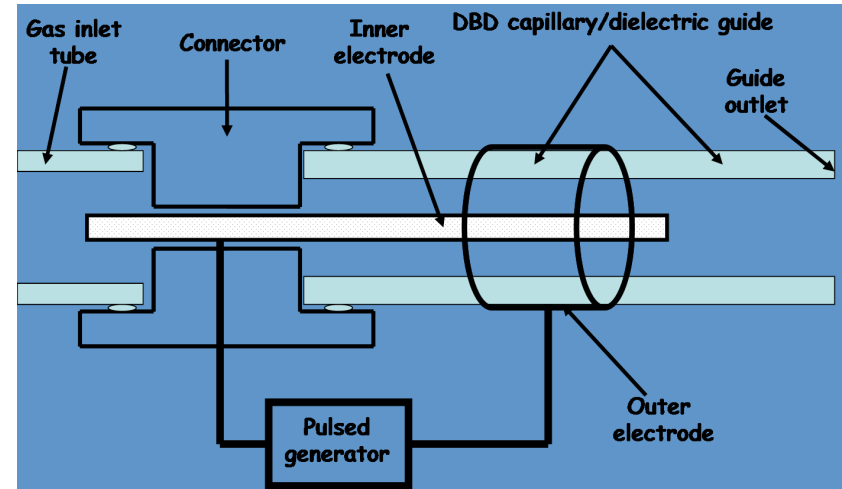
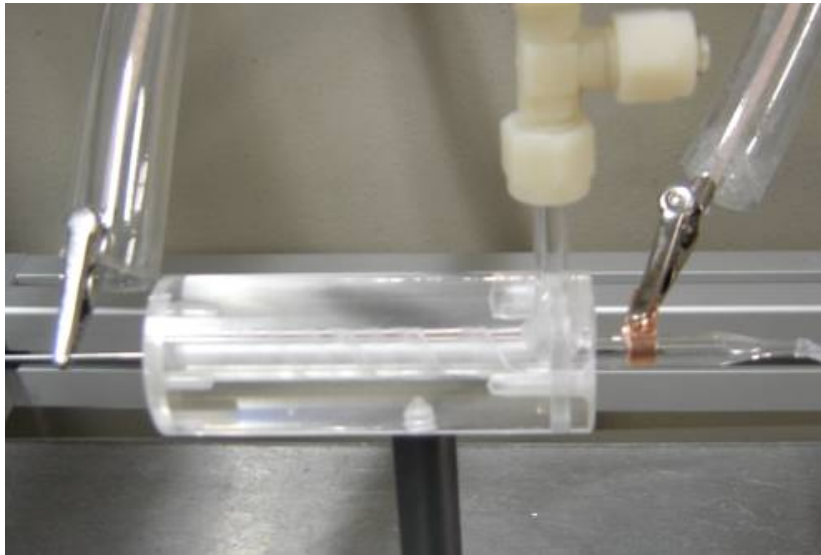
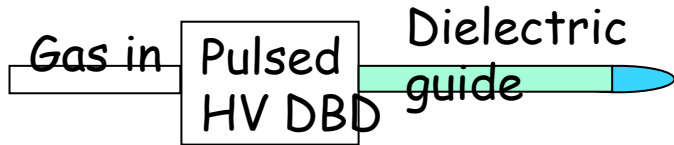




Plasma Gun



Jet Plasma

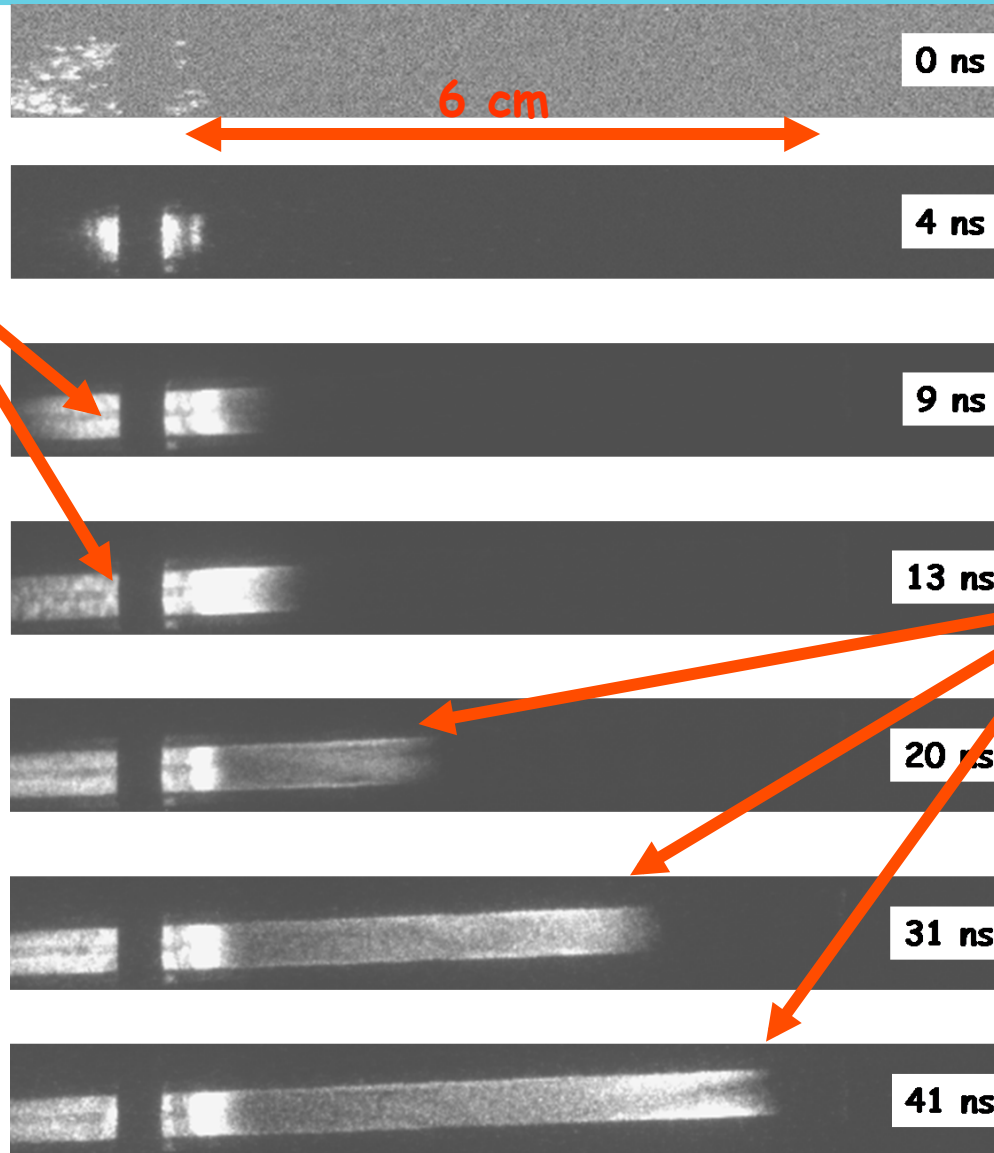


Voltage ranging from 5 to 100 kV
From single shot to 100 Hz
Low gas flow rate (few tens of cc/mn) to liters per mn
Pure gases or mixtures
Plasma



Propagation du plasma dans le capillaire

DBD



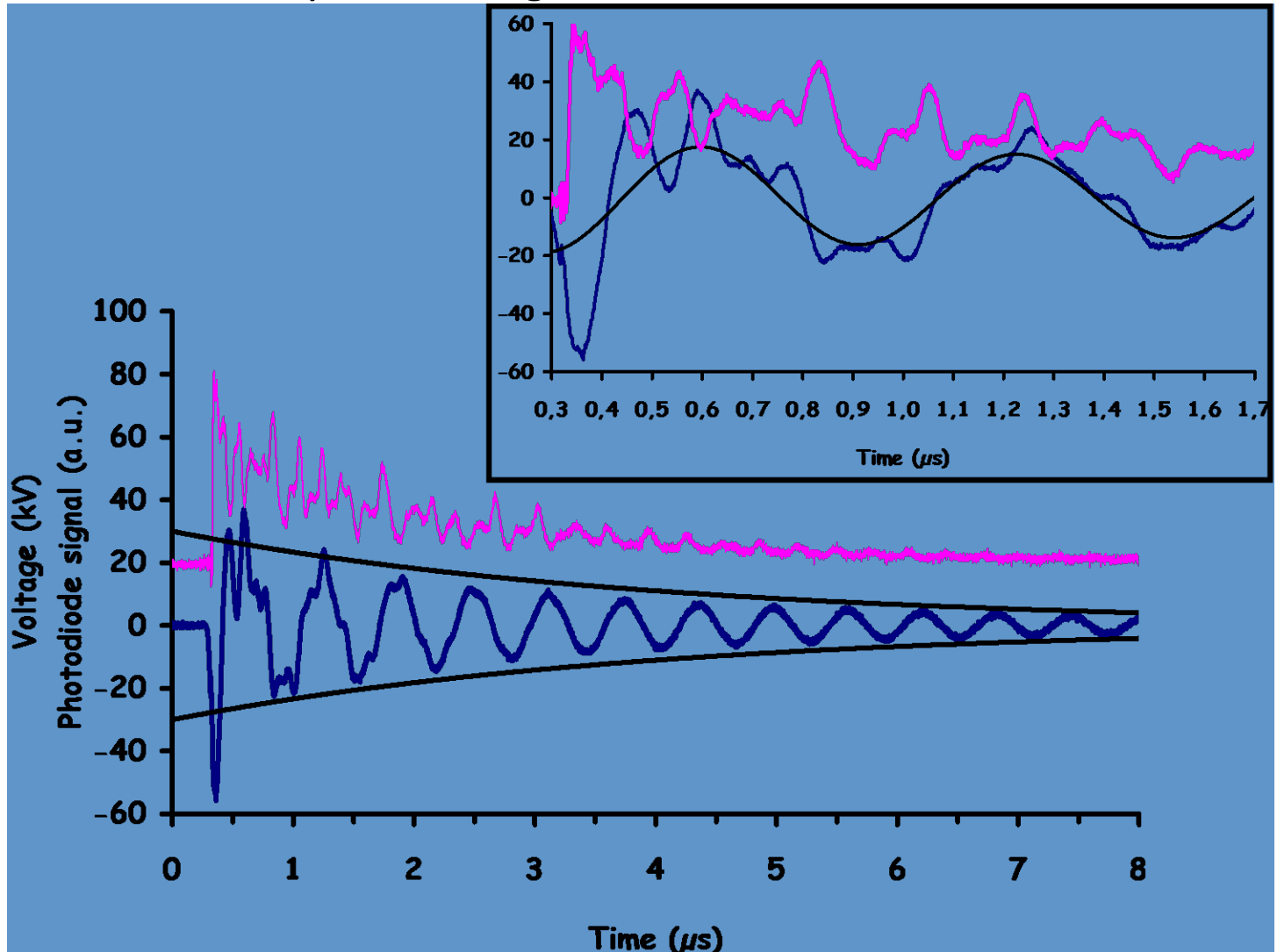
2 ns
ICCD imaging

Front
d'ionisation
« Bullet »
Plasma Gun



HT, THT, front rapide ...

- Commutation thyatron, « lignes Blumlein »



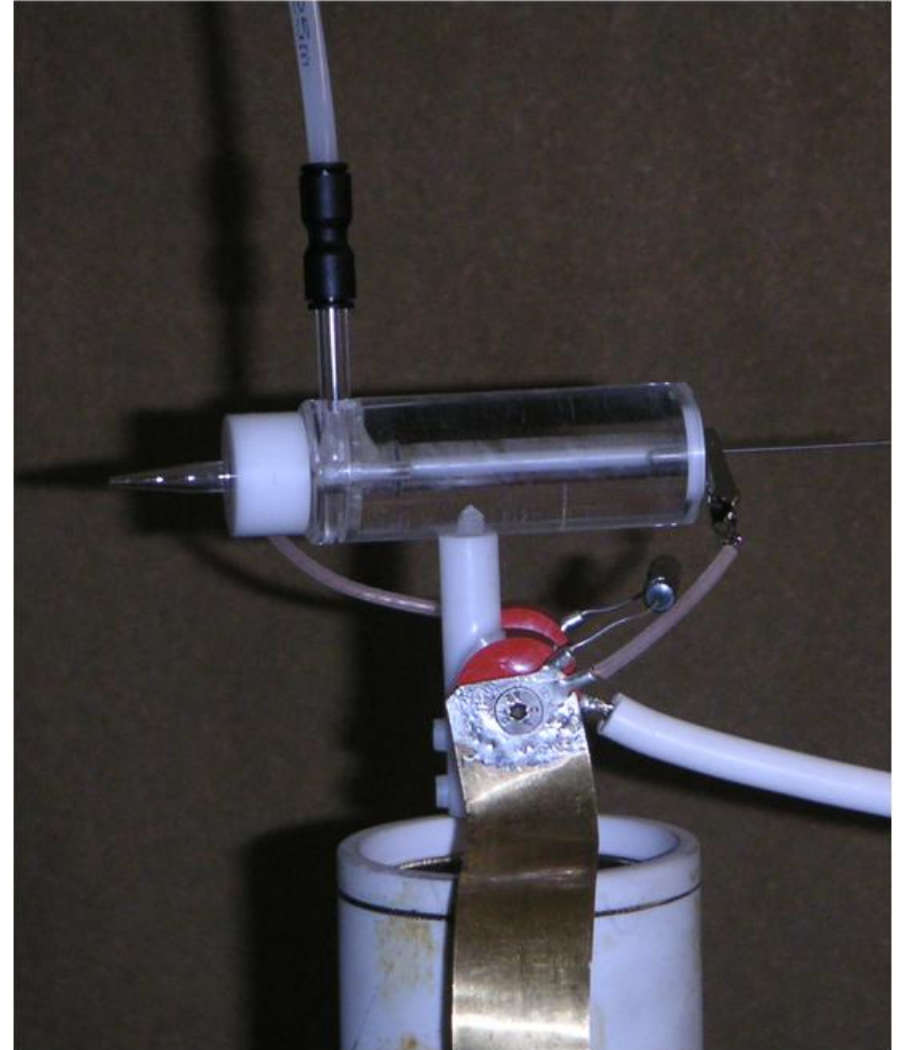


Plasma gun compact et efficace?

Réacteur
DBD

Circuit de mise en forme
d'impulsion de **faible**
impédance

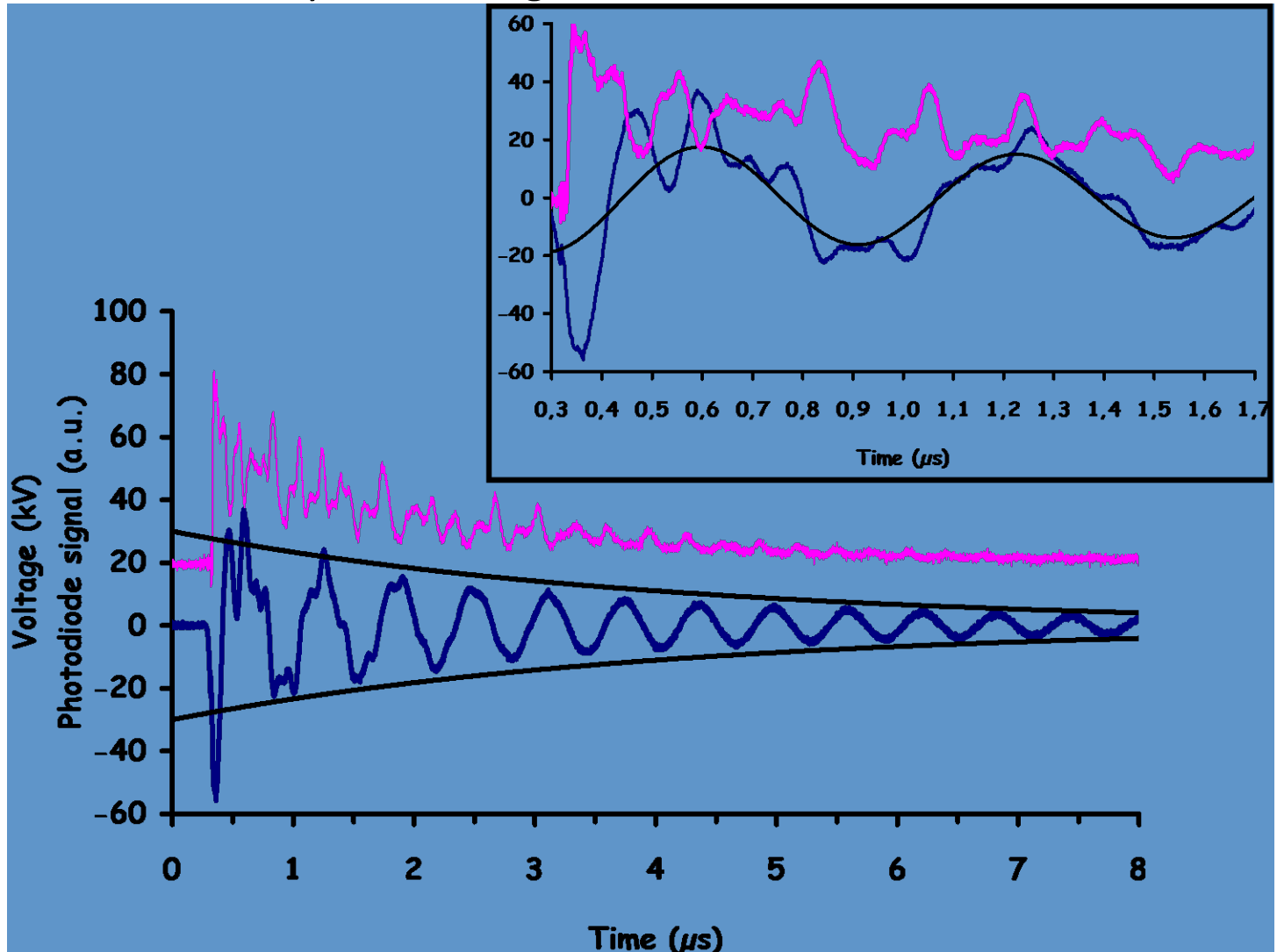
Alimentation
H.T.





HT, THT, front rapide ...

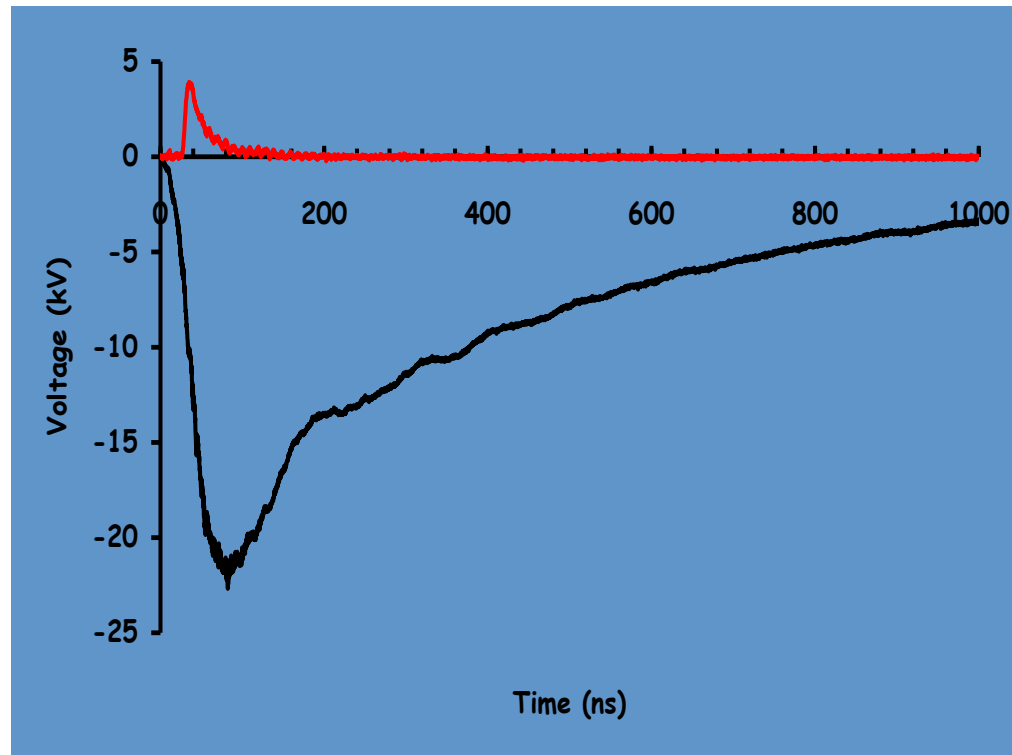
- Commutation thyatron, « lignes Blumlein »





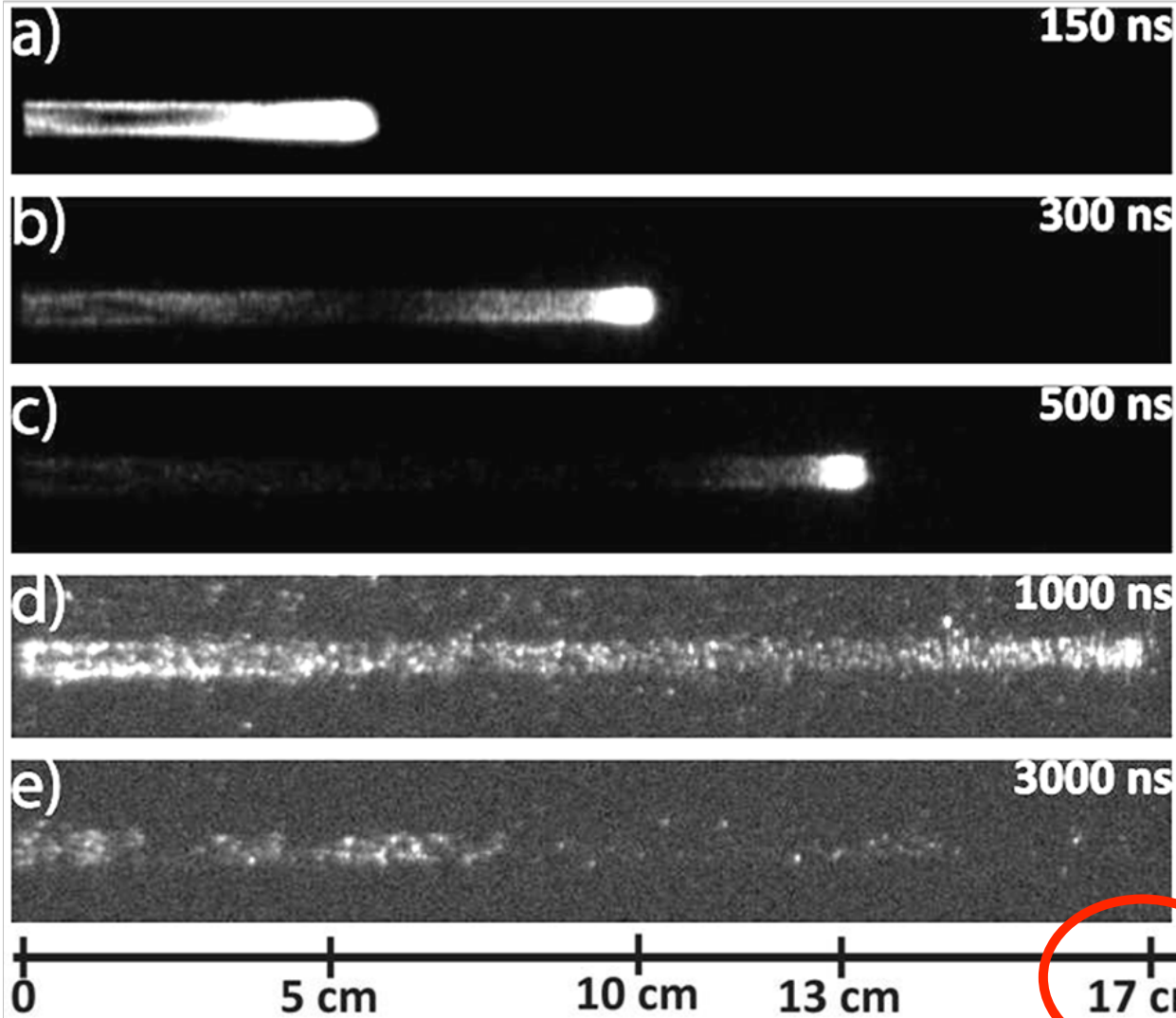
Plus faible H.T., décharge de condensateur, commutateur Spark Gap

Maintien de H.T. plus long, μ s





Plasma gun 2012



Plasma « filaments »
licking capillary walls

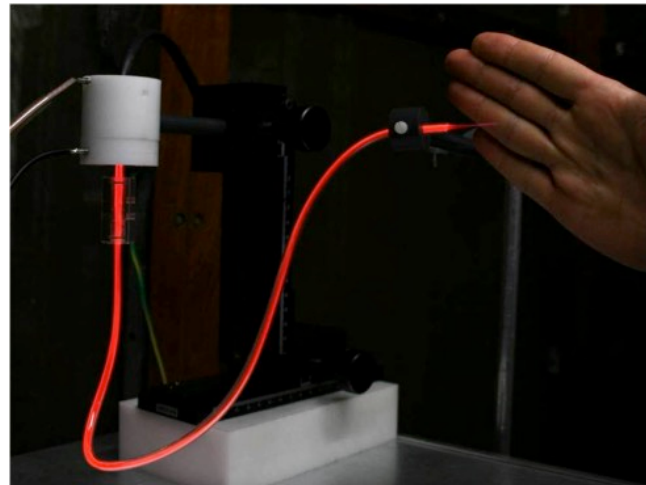
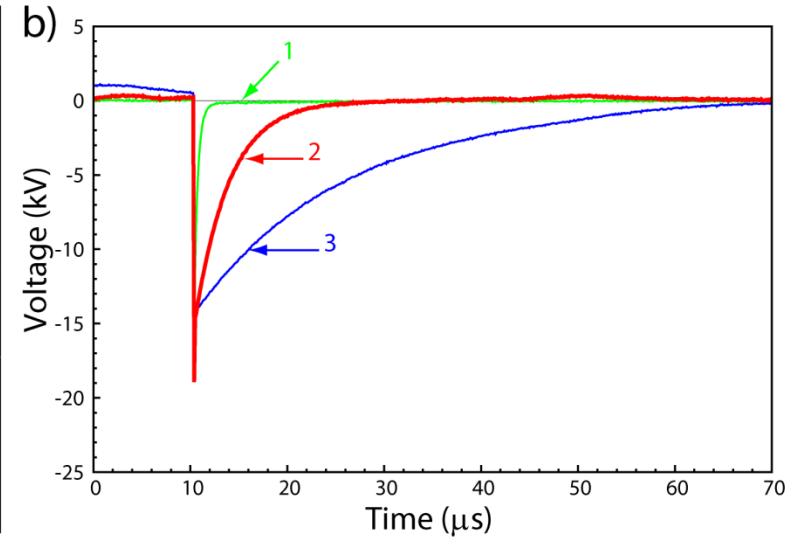
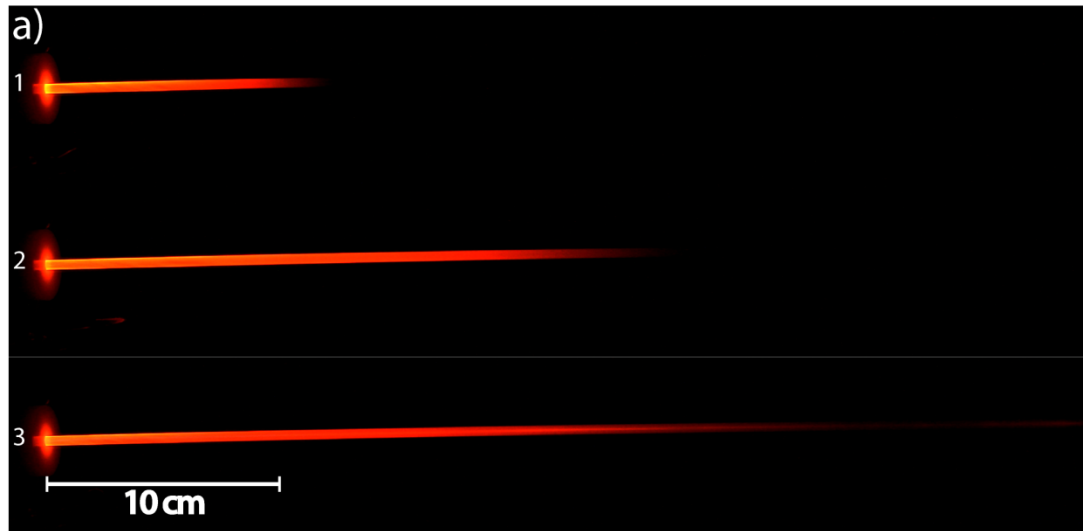
Intense plasma emission
at the leading front

Bullet-like pattern

always « connected » with
the DBD primary plasma



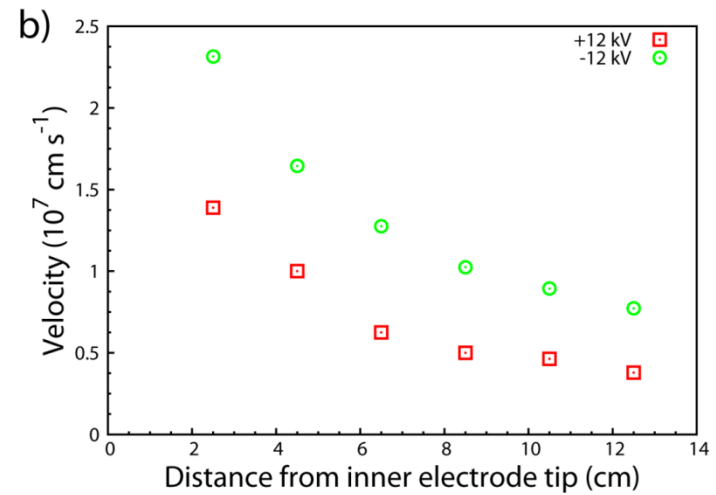
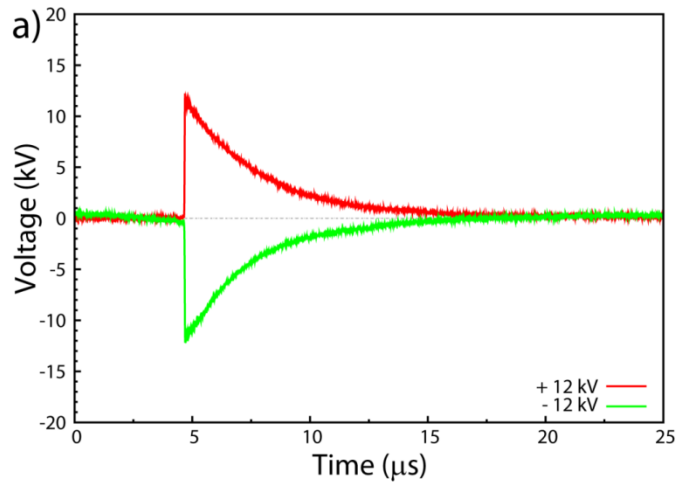
Des envies d'alimentations



Voltage pulse tailoring for long distance propagation

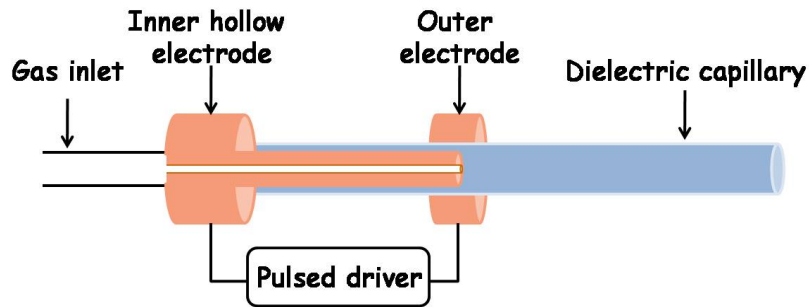


Des envies d'alimentations





Plasma Guns



DBD reactor, gas flow rate 5 - 5000 sccm
Needle or hollowed inner electrode

Dielectric guide:

rigid/ flexible,
length 5-100 cm

inner diameter 0.15 - 10 mm

« Plume » expansion in air, length 1- 100 mm

ns drivers

5-100 kV

Negative/positive polarity

Single shot - 200 Hz

ns pulse, ns damped trains of ns pulses
ns rising voltage front, μ s decay

Frequency limited, expensive

Unique for ns time resolved diagnostics

Over voltage possible

μ s drivers

5-30 kV

Negative/positive polarity

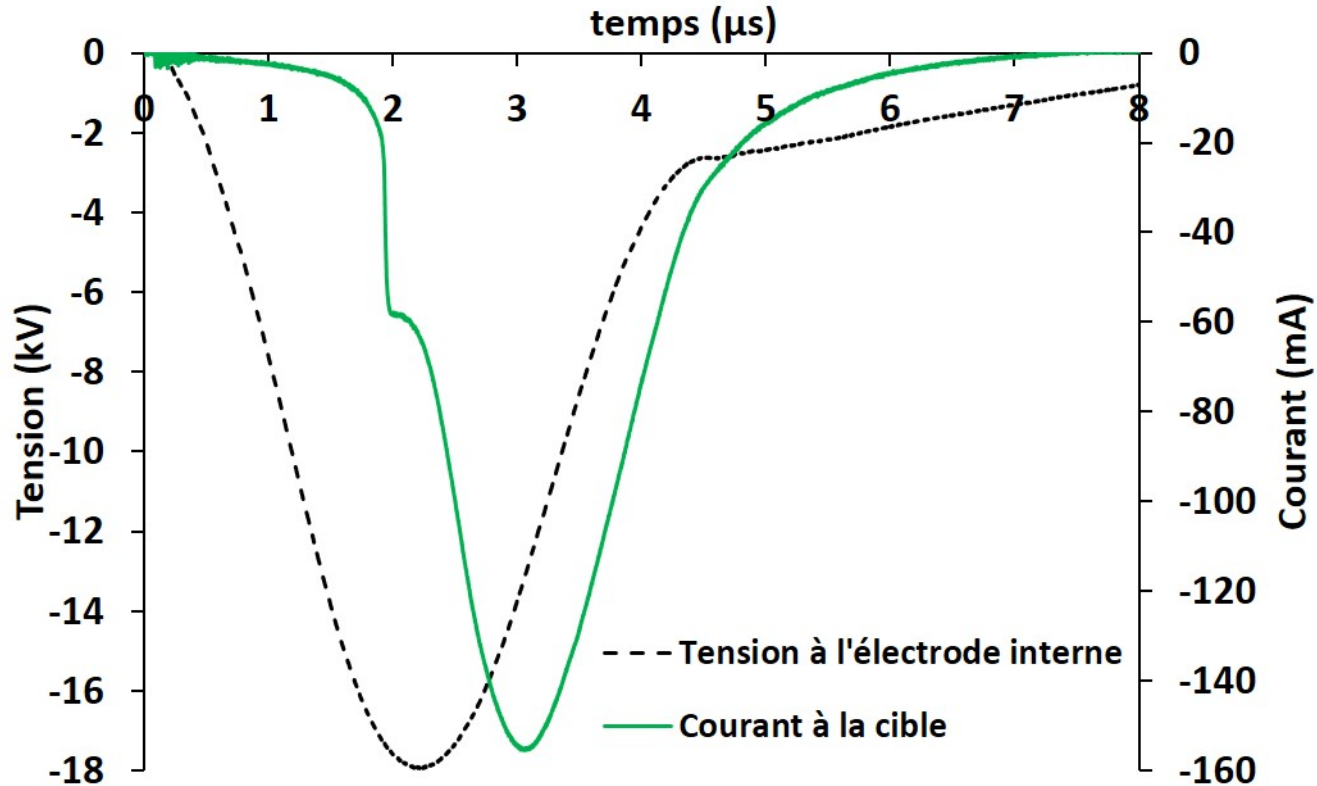
Single shot - 10 kHz

μ s pulses: μ s rising front, μ s decay

Cheap, compact



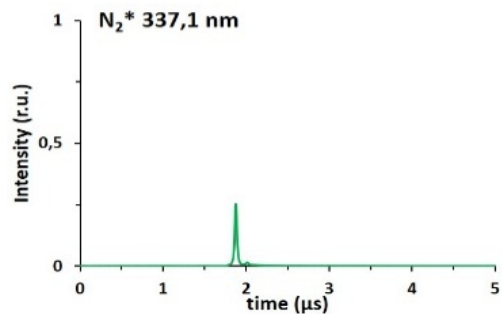
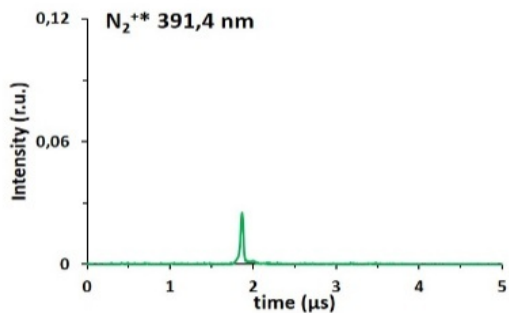
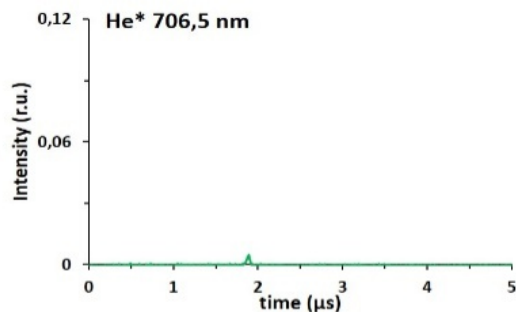
H.T. et courant microsecondes



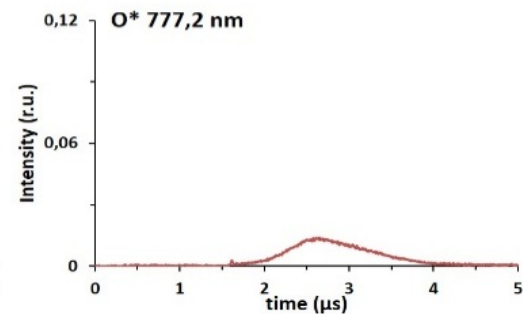
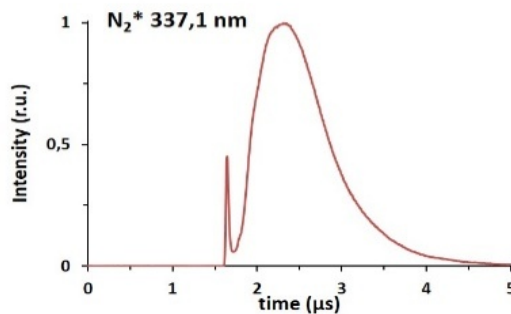
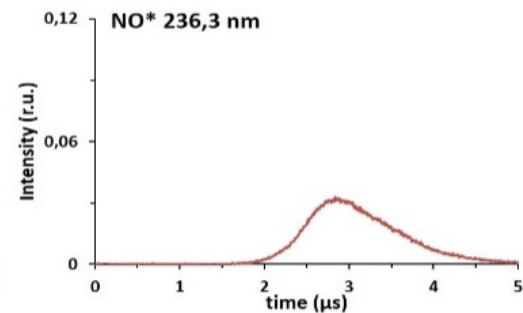
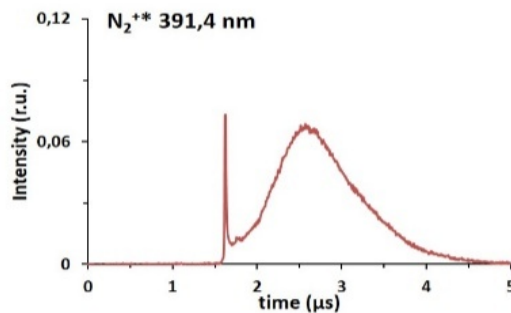
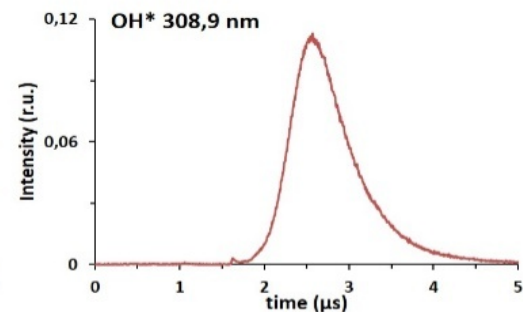
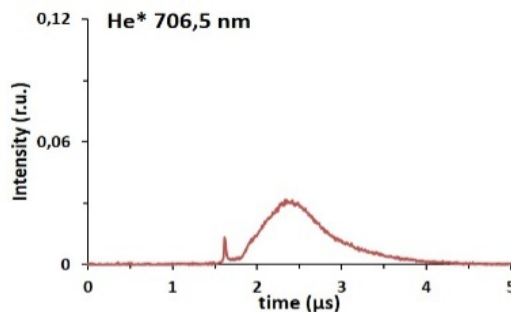


Impact sur la production d'espèces

a. Free jet



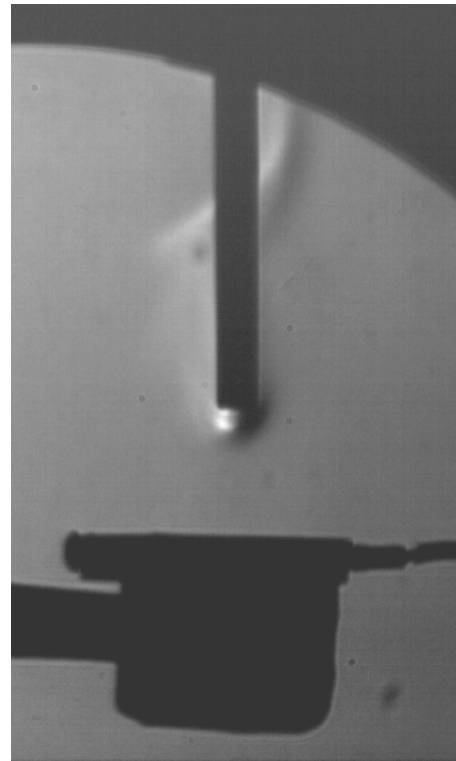
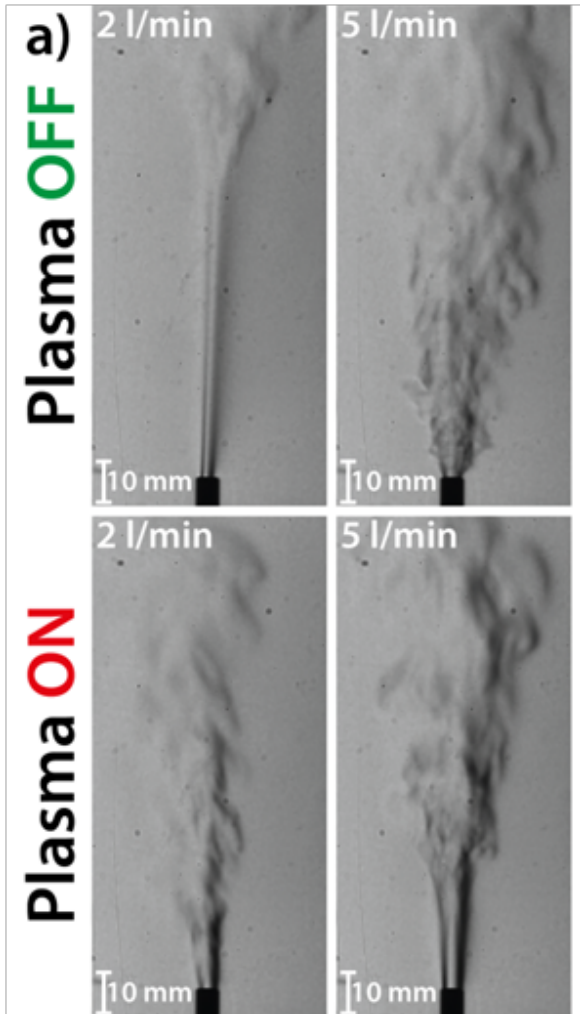
b. 1 cm target gap



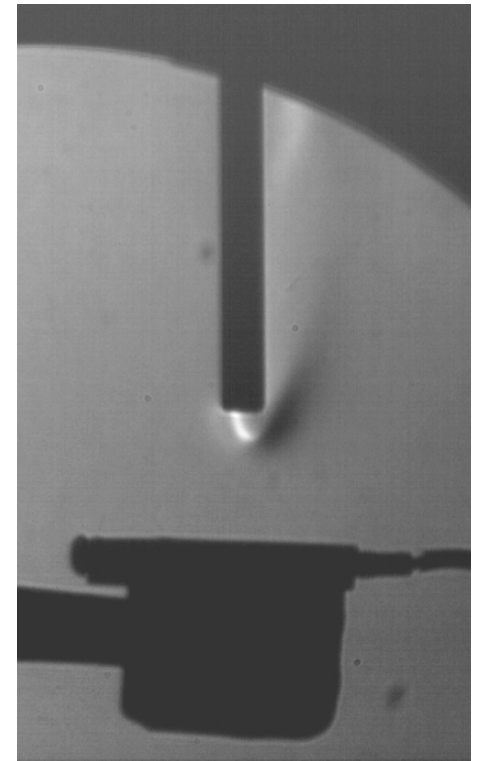


Impact sur l'écoulement/propagation

Helium flow modification by plasma action



16 kV applied Voltage
2 kHz ppr (+) polarity



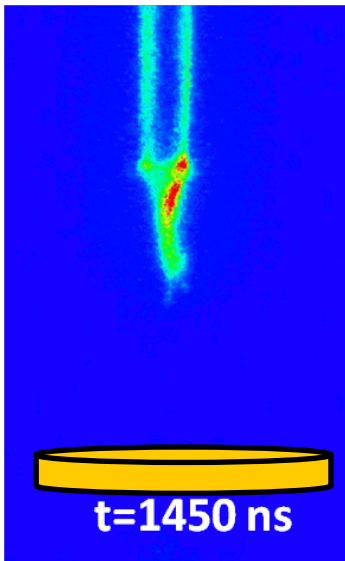
16 kV applied Voltage
2 kHz ppr (-) polarity

electrical effect : **Electric field** **Ionic drift**

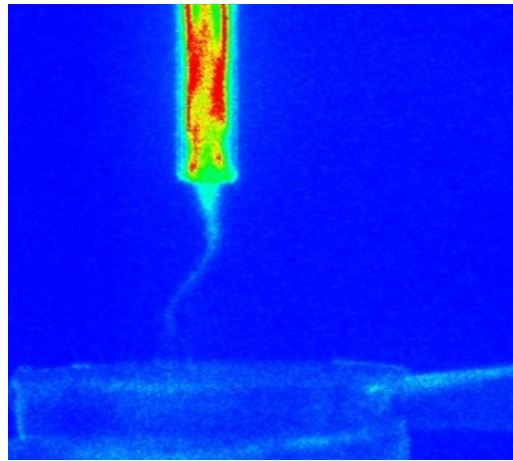


Plasma sur mesure

À la 1ère impulsion positive

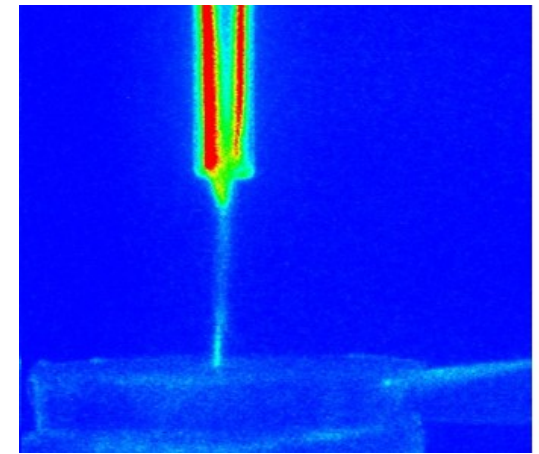


À la 50ème impulsion positive



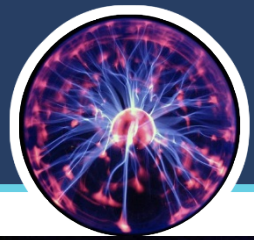
Après 50 impulsions négatives

À la 1ère impulsion positive



Claquage de **streamers** dans l'air
«Décharge pointe - plan »

Optimisation des paramètres de décharges pour
manipuler l'écoulement



Merci pour votre attention

