UNIVERSITÀ DI PISA

Istituto Nazionale di Fisica Nucleare

Laser induced plasma channels by nanosecond to femtosecond pulses

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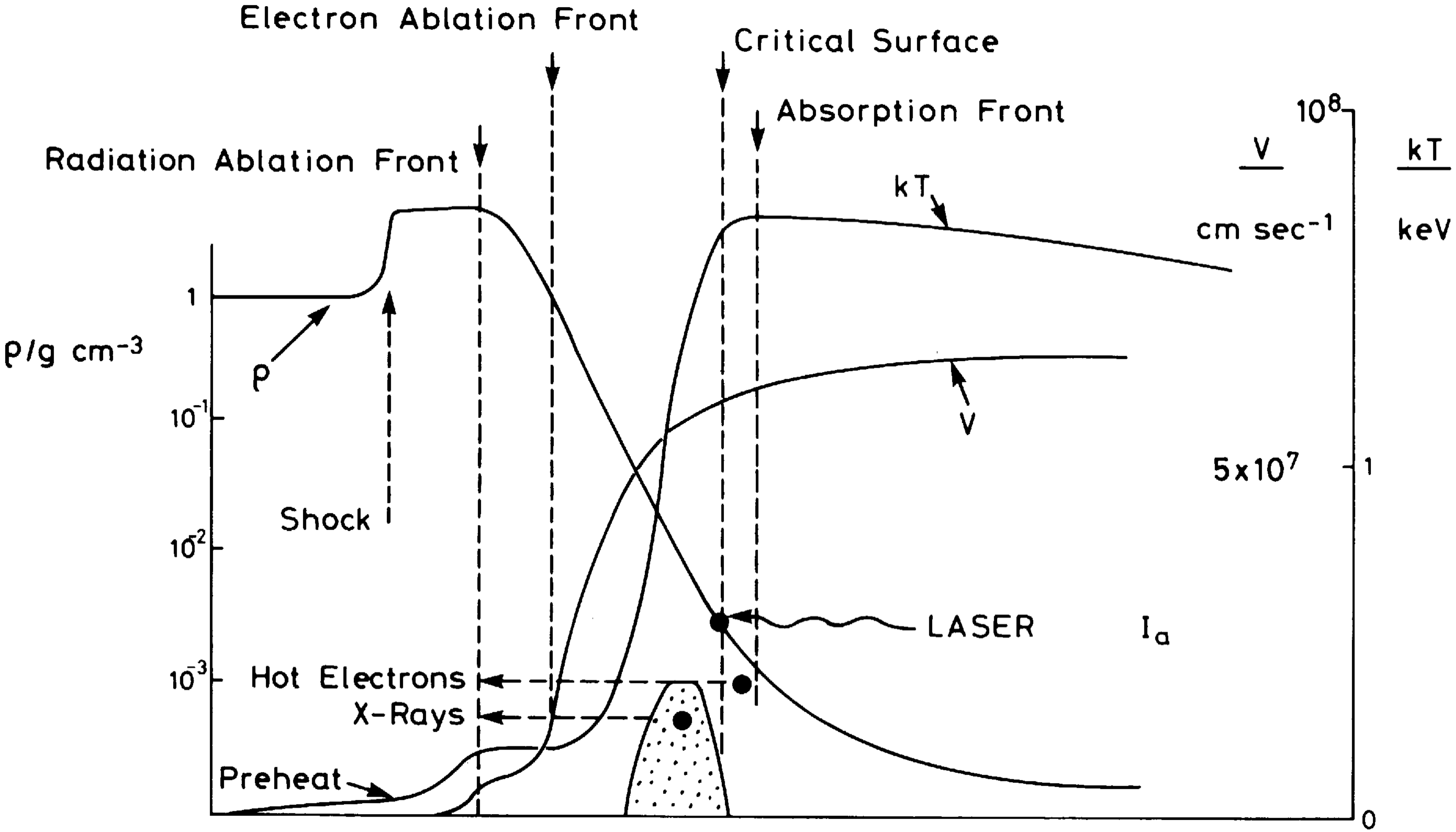
SUMMARY

- NANOSECOND LASER-MATTER INTERACTION AT HIGH INTENSITIES
- FEMTOSECOND LASERS-MATTER INTERACTION AT RELATIVISTIC INTENSITIES
- SELF-PHASE MODULATION OF LASER-PULSE
- RELATIVISTIC SELF-FOCUSING
- PLASMA TRANSPARENCY AND CHANNELING
- LASER PLASMA ACCELERATION
- BETATRON RADIATION
- CONCLUSIONS AND PERSPECTIVES

Nanosecond laser pulse on solid target @ 10^{14} W/cm^2



Spatial growth rate of the filamentation instability

$$K = \frac{k_\perp}{2\sqrt{\varepsilon}}\left[2\frac{n_e}{n_c}\left(\gamma_p + \gamma_T \frac{\kappa_{SH}}{\kappa_{FP}}\frac{k_L^2}{k_\perp^2}\right) - \frac{k_\perp^2}{k_L^2}\right]^{1/2}$$

$\gamma_p = (1/4)(Z/(Z+1))(v_q^2/v_{th}^2)$	ponderomotive effects
$\gamma_T = c^2 S/\omega^2 \kappa_{SH} k_B T_e$	thermal effects
$-\frac{k_\perp^2}{k_L^2}$	diffraction effects
$\varepsilon = 1 - n_e/n_c$	plasma dielectric function
κ_{SH} and κ_{FP}	Spitzer-Härm and effective Fokker-Planck conductivity
$k_\perp$	wave-number of the sinusoidal spatial modulation
v_q and v_{th}	electron quiver and thermal velocity
Z	charge state of the plasma
S and T_e	background inverse bremsstrahlung heating rate and electron temperature

D. GIULIETTI et al. INTENSE DIFFRACTION OF A LASER-BEAM DUE TO SELF-FOCUSING IN UNDERDENSE PLASMA. JOURNAL OF APPLIED PHYSICS, vol. 58, p. 2916-2921, 1985.

D. GIULIETTI, REFRACTION EFFECTS IN LASER PLASMA INTERACTION. OPTICS COMMUNICATIONS, vol. 68, p. 399-403, 1988.

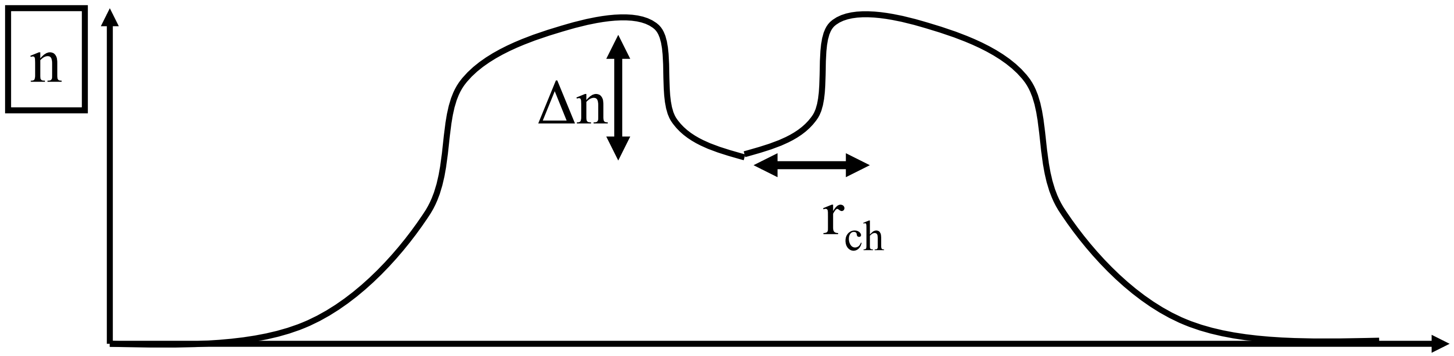
PONDEROMOTIVE HOLE-BORING

Ponderomotive force

$$non\ relativistic\ \ \langle U_q \rangle = \frac{e^2 E^2}{4m\omega^2} \rightarrow F_p = -\nabla \langle U_q \rangle = -\frac{2\pi e^2}{mc\omega^2} \nabla \langle I \rangle$$

$$relativistic\ \ \langle U_q \rangle = mc^2(\gamma - 1) \rightarrow F_p = -mc^2 \nabla \gamma \approx -mc^2 \nabla a = -\frac{e\sqrt{8\pi c}}{\omega} \nabla \langle I \rangle^{\frac{1}{2}}$$

PRE-FORMED CHANNEL (1)

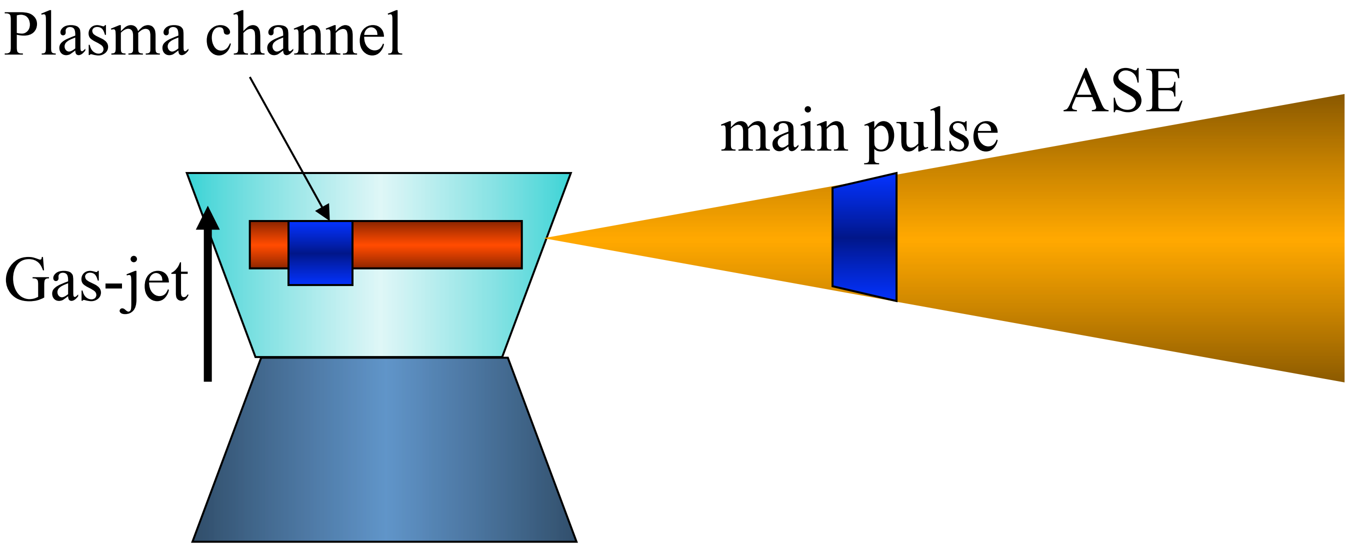


$$w_0 = \left[r_{ch}^2 / (\pi r_e \Delta n) \right]^{1/4}; \quad r_e = e^2 / mc^2$$

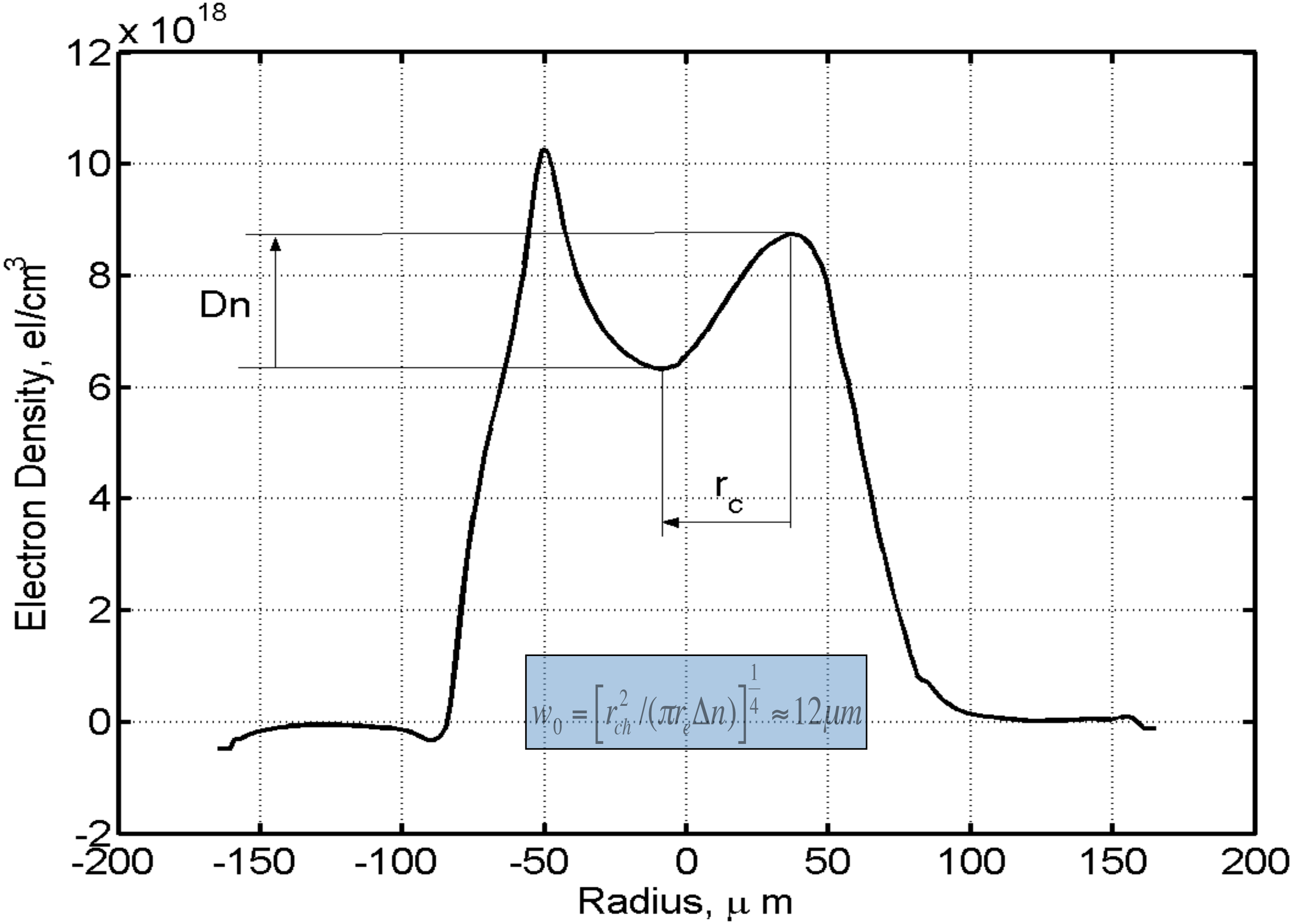
The laser pulse propagates in a plasma channel acting as a focusing lens that counter-balances the diffraction effects. For the optimal channel shape, laser pulses can be guided over distances exceeding several Z_R .

PRE-FORMED CHANNEL (2)

A nanosecond pre-pulse (ASE of the Ti:Sapphire LASER) ionizes a gas-jet (He, Ar…) in the focal region. The pre-pulse self-focusing produces in the plasma a channel extending for several mm.



PRE-FORMED CHANNEL (3)



Propagation

Nd:YLF laser system

λ= 1053 nm

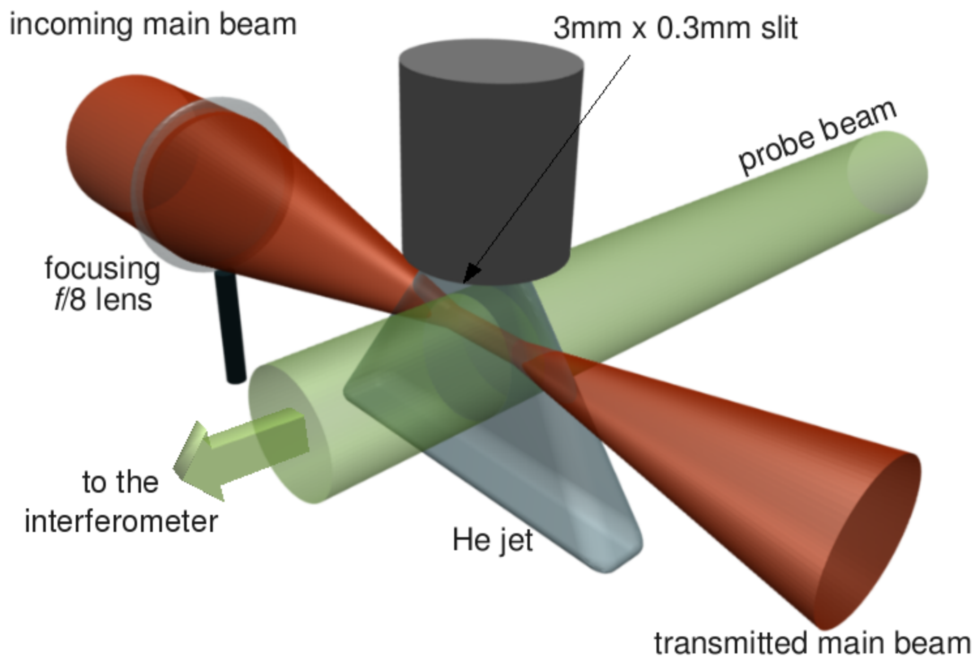
τ= 3 ns

E= 0.3 to 0.5 J

Focusing f/8

Waist ~ 12 μm

I~ 10^{13} W/cm^2

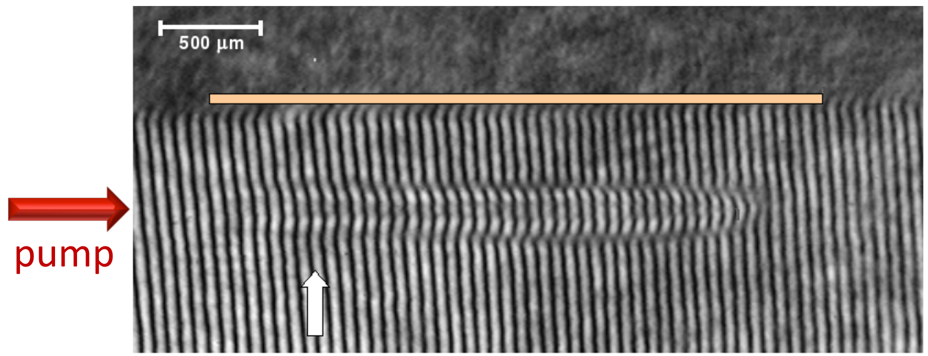


Target: subsonic jet of He, 3mm x 0.3mm rectangular slit
Pressure in the reservoir: 5 to 8 bar

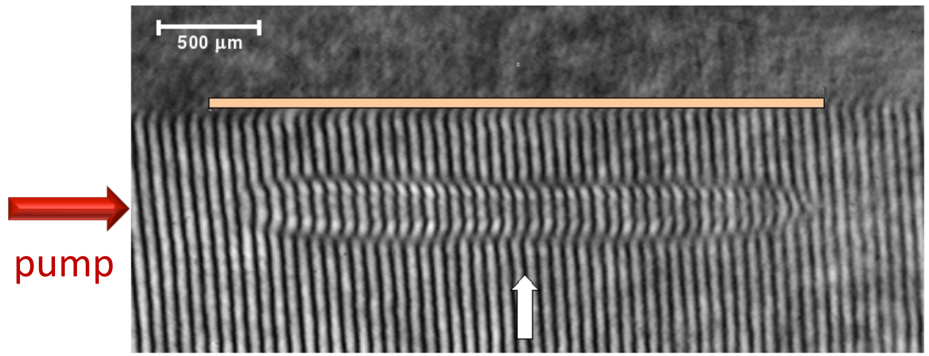
A.Gamucci, Experimental study of stable propagation and efficient electron acceleration in plasmas with ultra-short laser pulses, PhD Thesis at Pisa University, Supervisor Prof. D. Giulietti, 2009

Propagation

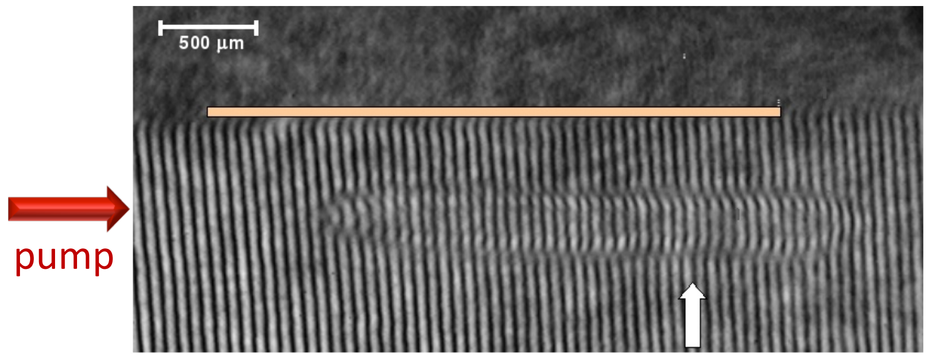
Target: He @ 8 bar
E_{pump}: 460 mJ
x_{focus}: -1mm



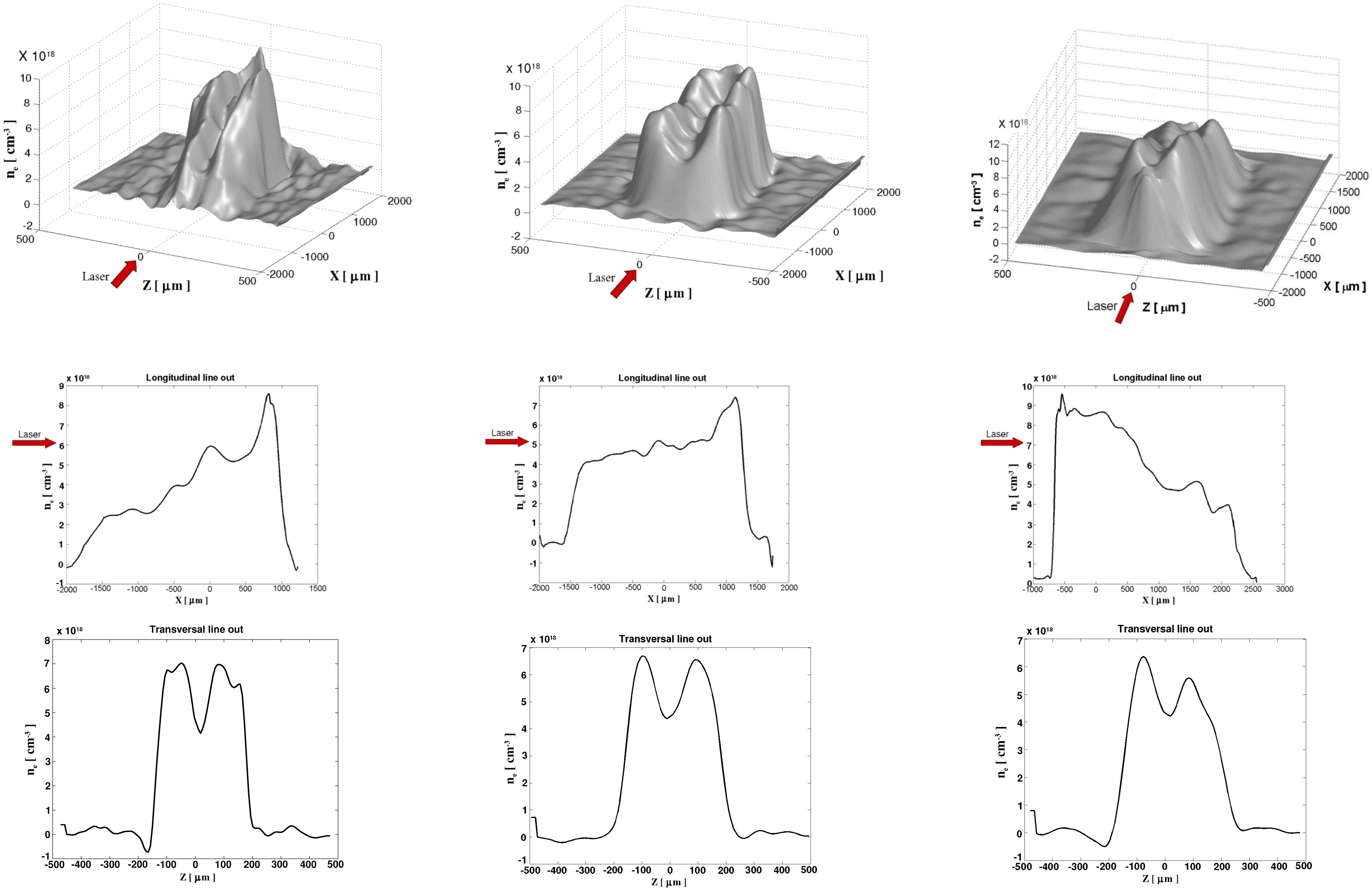
Target: He @ 8 bar
E_{pump}: 460 mJ
x_{focus}: 0mm

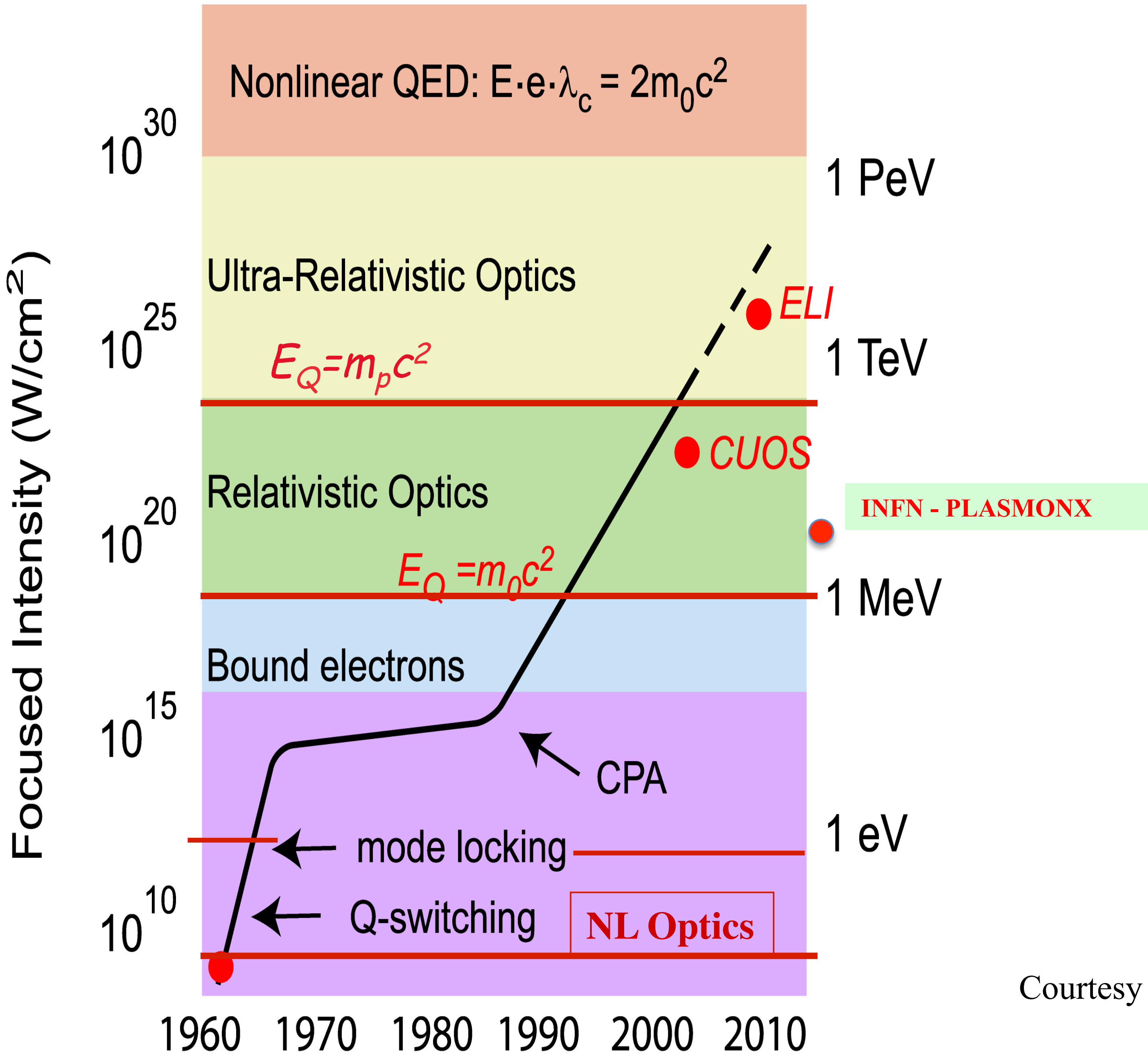


Target: He @ 8 bar
E_{pump}: 490 mJ
x_{focus}: +1mm



Propagation





Courtesy of G. Mourou

Relativistic Intensities (1)

$$I = u v_g = \varepsilon_0 E^2 c \cdot n$$

$$for \quad n \approx 1 \qquad E_{V/cm} \approx 27.5 \; I_{W \cdot cm^{-2}}^{\frac{1}{2}}$$

$$n = \left(1 - \frac{\omega_p^2}{\omega^2}\right)^{\frac{1}{2}} \qquad \omega_{pe} = \left(\frac{n_e e^2}{\varepsilon_0 m \gamma}\right)^{\frac{1}{2}}$$

$$\gamma = \left(1 - \beta^2\right)^{-\frac{1}{2}} \qquad \beta = \frac{v}{c}$$

$$\gamma = \left(1 + \frac{\alpha a^2}{2}\right)^{\frac{1}{2}} \; \alpha = 1\,(lin.\,p.)\,;\,2\,(circ.\,pol.)$$

$$a = \frac{eE}{m\omega c} \approx 8.5 \cdot 10^{-10} \cdot I_{W \cdot cm^{-2}}^{1/2} \cdot \lambda_{\mu m}$$

Relativistic Intensities (2)

$$for\ 6J, 20\,fs\ \ @\ \lambda \approx 0.815\mu m\ laser\ pulse$$

Relativistic intensities a ≈> 1

$$focal\ spot\ \phi \approx 5\mu m$$

$$I \approx 10^{21} W \cdot cm^{-2} \quad --> \quad a \approx 22$$

$$E \approx 10^{12}\, V/cm >> E_{at} \approx 5 \cdot 10^{9}\, V/cm$$

$$B \approx 10\ GGauss$$

$$P = \frac{I}{c} \approx 6.6 \cdot 10^{16}\, N/m^{2} \approx 660\ GBar$$

$$a \approx 22 \Rightarrow \gamma \approx 15.5 \Rightarrow E_{cin} = mc^{2}(\gamma - 1) \approx\ 7MeV$$

Femtosecond laser-solid thick target interactions

The characteristic time of the hydrodynamic expansion of laser produced plasmas, i.e. the time taken by the plasma to expand by a length comparable with the laser wavelength λ, is of the order of a few picoseconds. Therefore, the use of femtosecond laser pulses enables to study (**in principle**!) the interaction of intense optical radiation with plasmas characterised by solid density (5×10^{23} el / cm^3) and ultra-steep gradients.

$L = c_s \Delta t$ plasma density scale length perpendicular to the target surface

c_s sound speed

Δt laser pulse duration

for $\Delta t \approx 100$ fs and $c_s = 10^7$ cm / sec → $L \approx 100$ Å $\ll \lambda$

Femtosecond laser-solid thin target interactions

A smart use of the ASE radiation accompaining the main ultra-short, super-intense laser pulse is possible:

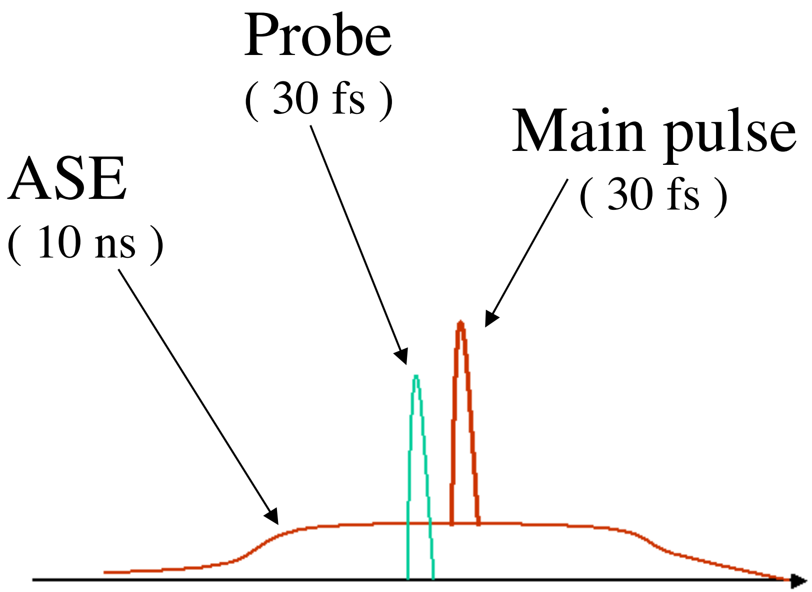
1) The ASE produces an exploding-foil plasma with the demanded characteristics

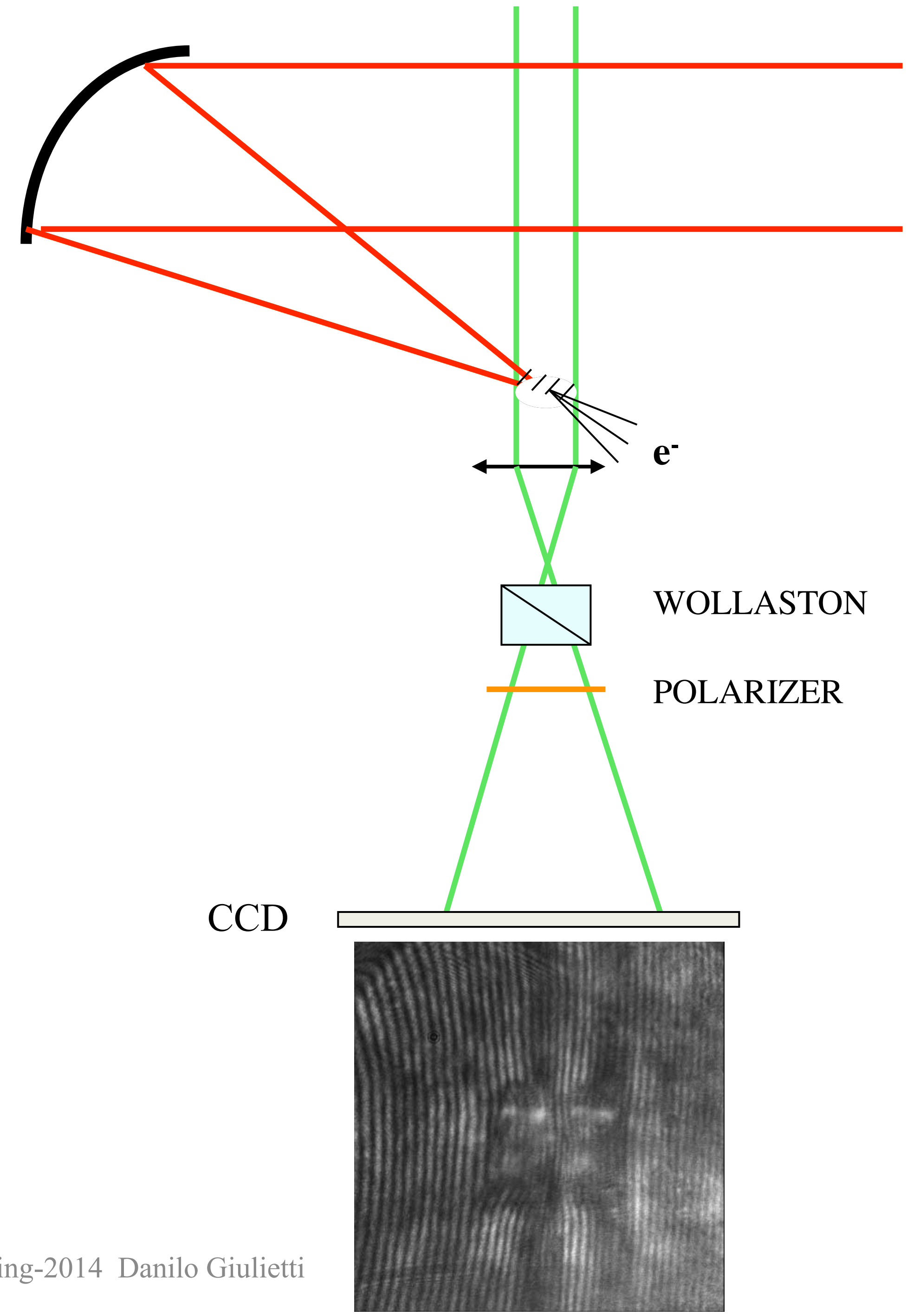
2) The main pulse interact with the pre-formed plasma

D. Giulietti et al., High-energy electron beam production by femtosecond laser interactions with exploding-foil plasmas, Phys, Rev. E, Rapid. Comm., **64**, 015402(R), 2001.

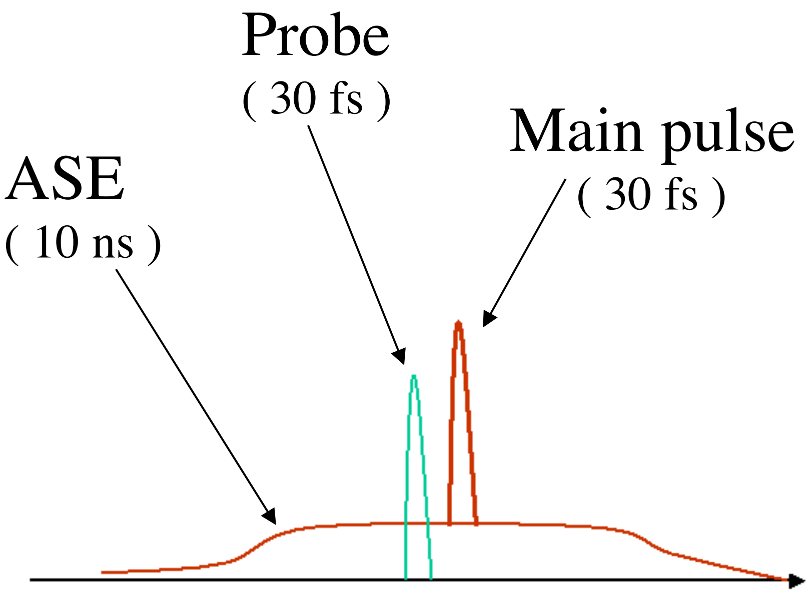
D. Giulietti et al., Production of ultracollimated bunches of multi-MeV electrons produced by 35fs laser pulses propagating in exploding foil plasmas, Physics of Plasmas, **9**, 3655, 2002.

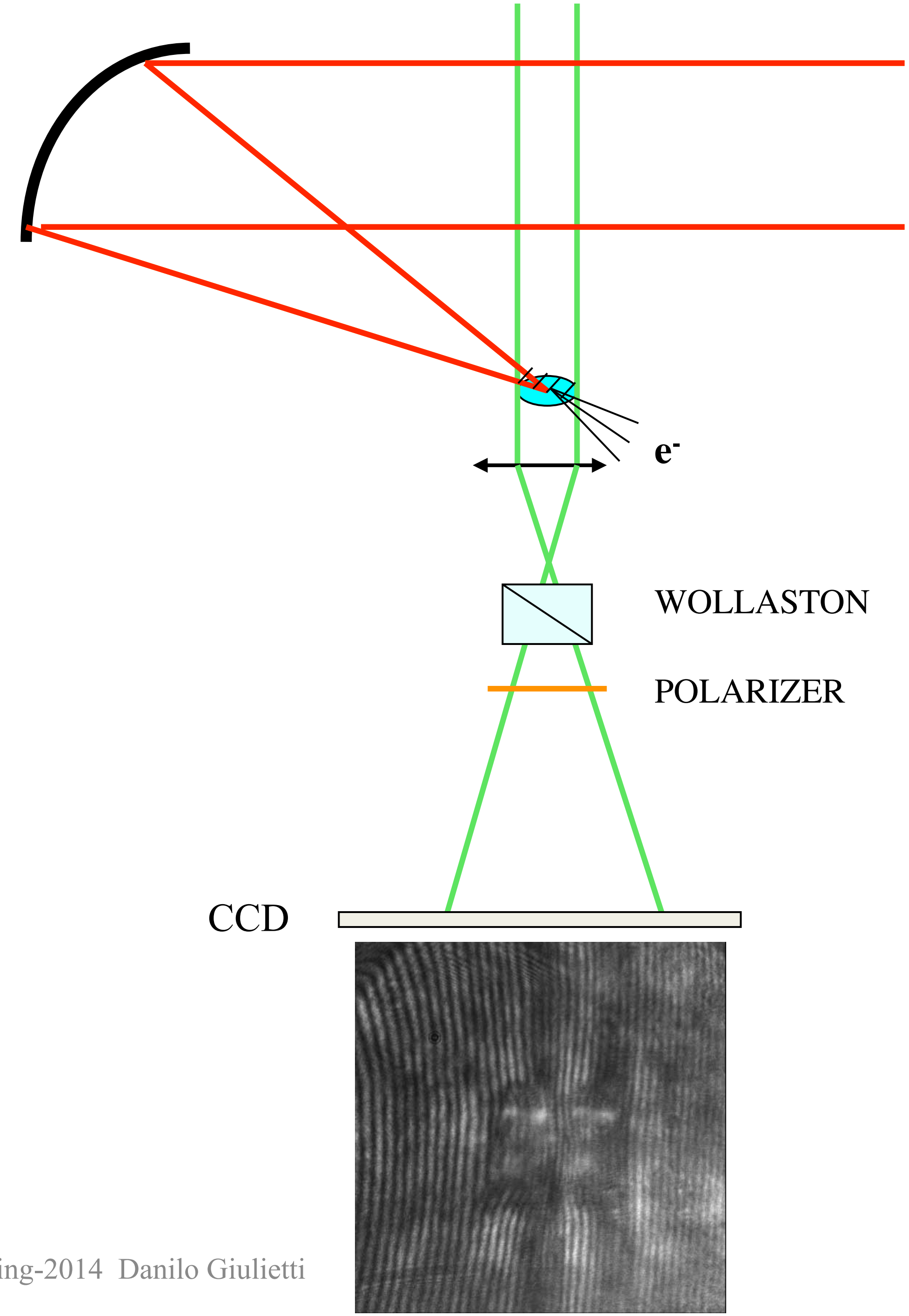
PULSE TIMING AND INTERFEROMETRY



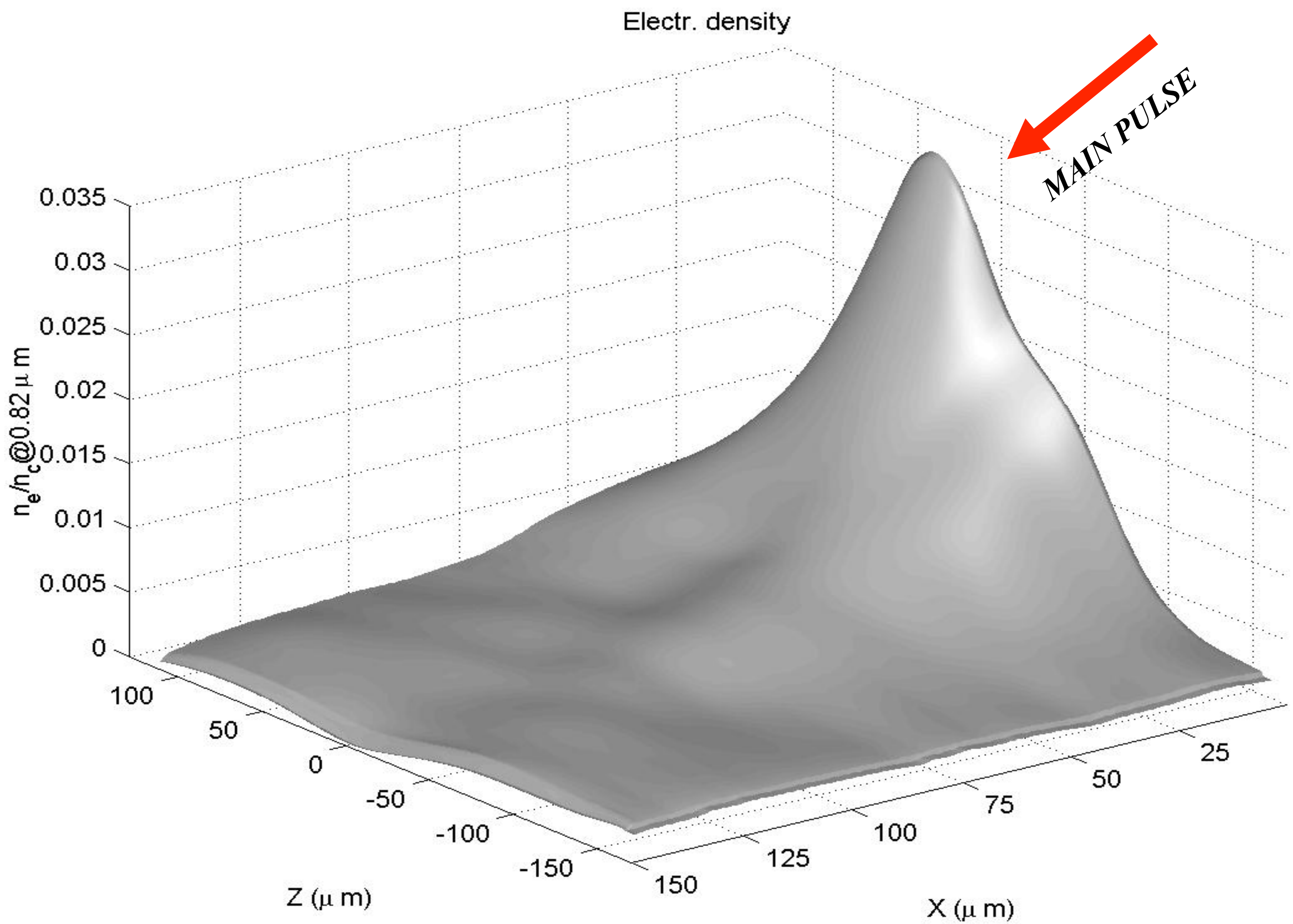


PULSE TIMING AND INTERFEROMETRY





ELECTRON DENSITY PROFILE



SELF-PHASE MODULATION OF LASER-PULSES

$$\phi = kz - \omega_0 t \quad \omega = -\frac{\partial \phi}{\partial t} = \omega_0 - k_0 z \frac{\partial n}{\partial t}$$

$$plasma\ refraction\ index\ n = \left(1 - \frac{n_e}{n_c}\right)^{\frac{1}{2}} \approx 1 - \frac{1}{2}\frac{n_e}{n_c} \Rightarrow \frac{\omega - \omega_0}{\omega_0} = \frac{z}{2cn_c}\frac{\partial n_e}{\partial t}$$

$$ionization \qquad \frac{\partial n_e}{\partial t} \rangle\ 0 \ \Rightarrow\ blue\ shift$$

$$channel\ formation \qquad \frac{\partial n_e}{\partial t} \langle\ 0 \ \Rightarrow\ red\ shift$$

$$Example: \quad n_c = 1.7 \times 10^{21} cm^{-3} \ ;$$

$$z = 0.5cm \ ;$$

$$\tau = 40 fs \ ; \qquad \Rightarrow \qquad \frac{\omega - \omega_0}{\omega_0} \approx 6 \ \ !!!$$

$$\Delta n_e = 5 \times 10^{17} cm^{-3}$$

AFSHARRAD T, COE S, GIULIETTI A, GIULIETTI D, WILLI O (1991). THE EFFECT OF SELF-PHASE MODULATION ON STIMULATED BRILLOUIN-SCATTERING IN FILAMENTARY LASER PLASMAS. EUROPHYSICS LETTERS, vol. 15, p. 745-751, 1991.

GIULIETTI D, BIANCALANA V, BORGHESI M, CHESSA P, GIULIETTI A, SCHIFANO E., SPECTRALLY MODULATED 2ND-HARMONIC EMISSION FROM LASER-PLASMA FILAMENTS. OPTICS COMMUNICATIONS, vol. 106, p. 52-58, 1994.

Relativistic self-focusing

$$P_{cr} = \frac{mc^5\omega^2}{e^2\omega_{pe}^2} \approx 17\left(\frac{n_c}{n_e}\right) GW$$

$$Example: for\ \lambda_0 = 0.815\mu m\ and\ n_2 = 10^{18} cm^{-3} \ \Rightarrow\ P_{cr} \approx 29\ TW$$

The laser pulse can be self-focused over distances much larger than the Rayleigh length

$$Z = \frac{\pi w_0^2}{\lambda_0}$$

where w_0 is the laser pulse waist at the focus.

Relativistic trasparency

$$condition\ \ for\ \ relativistic\ \ transparency\quad \omega > \frac{\omega_{pe}}{\gamma^{\frac{1}{2}}} = \frac{\omega_{pe}}{\left(1+a^2\right)^{\frac{1}{4}}}$$

$$Example:\ \lambda_0 = 0.815\mu m;\ I = 10^{21} Wcm^{-2}\quad \Rightarrow\quad n_e < 2.6\times 10^{22}\, cm^{-3}$$

Magnetically Induced Optical Transparency

Laser light can propagate through an overdense magnetized plasma as an extraordinary mode provided that:

$$n_e < n_c\left(1 - \frac{\Omega}{\omega}\right) \quad where \quad \Omega = \frac{eB_0}{mc} \quad is\ the\ cyclotron\ frequency$$

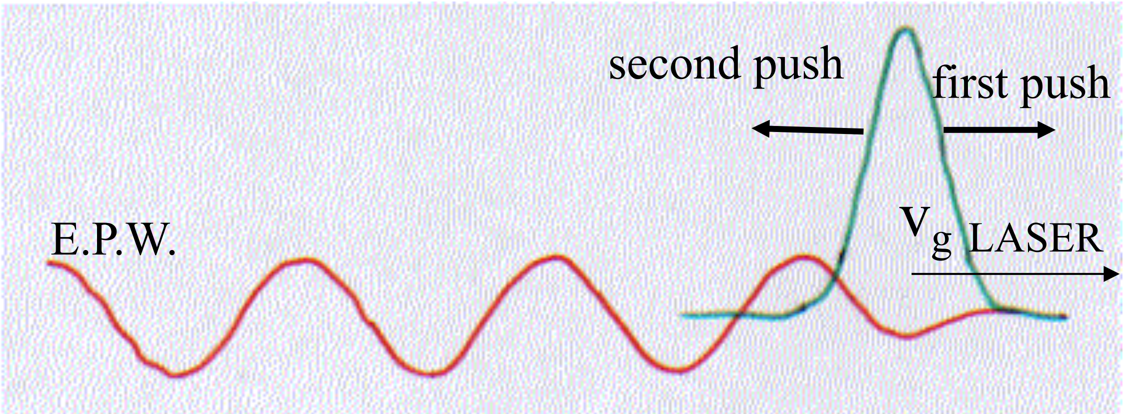
and B_0 is a static magnetic field perpendicular to the wavevector and parallel to the oscillating magnetic field

$$Example: \lambda_0 = 0.815\mu m; \frac{n_e}{n_c} \approx 50 \quad \Rightarrow \quad B_0 \geq 1GGauss$$

Giulietti D. et al., Observation of solid-density laminar plasma transparency to intense 30 femtosecond laser pulses. PHYSICAL REVIEW LETTERS, vol. 79, p. 3194-3197, 1997.

Teychenne D. et al., Magnetically induced optical transparency of overdense plasmas due to ultrafast ionization. PHYSICAL REVIEW E, vol. 58, 1998.

LASER PLASMA ACCELERATION (1)



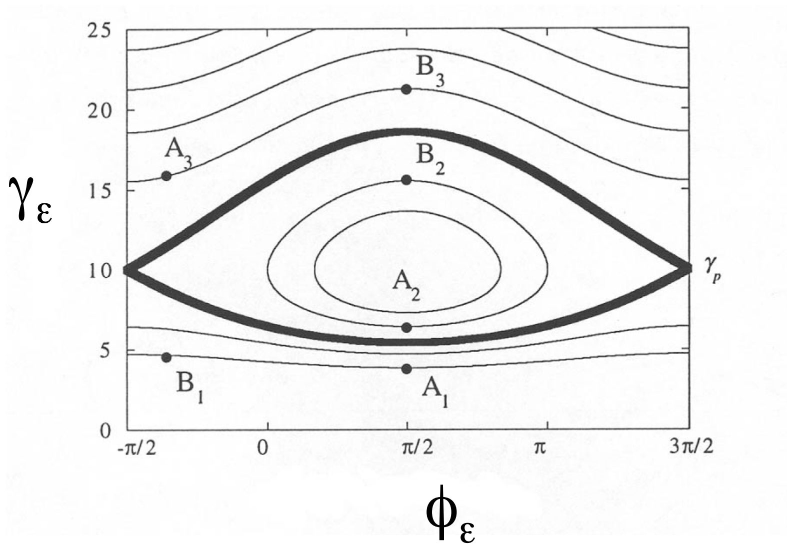
$$\tau \cdot c \approx \frac{\lambda_p}{2} \Leftrightarrow \tau \approx \frac{T_p}{2} \Rightarrow n_e\left(cm^{-3}\right) \approx \frac{3 \cdot 10^{-9}}{\tau_{(s)}^2}$$

$$example: \tau = 30\,fs \Rightarrow n_e \approx 3.3 \cdot 10^{18}\,cm^{-3}$$

$$v_{\phi,epw} = v_{g,laser} = c\left[1 - \frac{\omega_{pe}^2}{\omega^2}\right]^{\frac{1}{2}}$$

LASER PLASMA ACCELERATION (2)

1D MODEL



$$for\ \gamma_p \approx \frac{\omega}{\omega_{pe}} >> 1 \Rightarrow \Delta W_{\max} = 4\gamma_p^2 \frac{\delta n_e}{n_e} mc^2$$

$$energy\ gain\ along\ \ L_{deph} \approx \gamma_p^2 \lambda_p \ , \qquad \lambda_p \approx \frac{2\pi c}{\omega_{pe}}$$

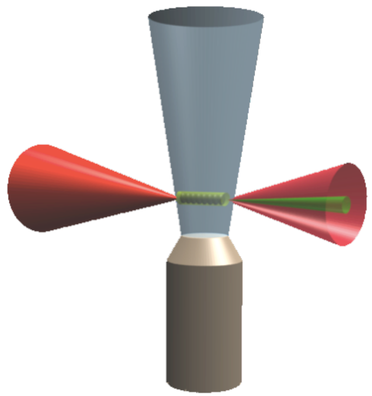
$$\Delta W_{\max} \approx eE_{\max} \cdot L_{deph} \propto n_e^{\frac{1}{2}} \cdot \frac{1}{n_e} \cdot n_e^{-\frac{1}{2}} = \frac{1}{n_e}$$

Acceleration introduction

Joint experiment
Phys. Depart. Pisa Univ., Italy
ILIL (IPCF-CNR, Italy)
PHI (CEA/Saclay, France)
LULI (Ecole Politechnique, France)
ITU (Karlsruhe, Germany)
@ SLIC laser facility of CEA/Saclay

UHI10 Ti:Sa laser system: 10 TW peak power, 65 fs, up to 0.7 J at λ=800 nm

- focusing: f/5 OAP
- $a_0 \leq 2$
- $w_0 = 13\ \mu m$
- $I = 8.5 \times 10^{18}\ W/cm^2$
- He supersonic gas-jet target



- systematic study of electron acceleration
- investigation of several different conditions in laser & target parameter space

A.Gamucci, Experimental study of stable propagation and efficient electron acceleration in plasmas with ultra-short laser pulses, PhD Thesis at Pisa University, Supervisor Prof. D. Giulietti, 2009

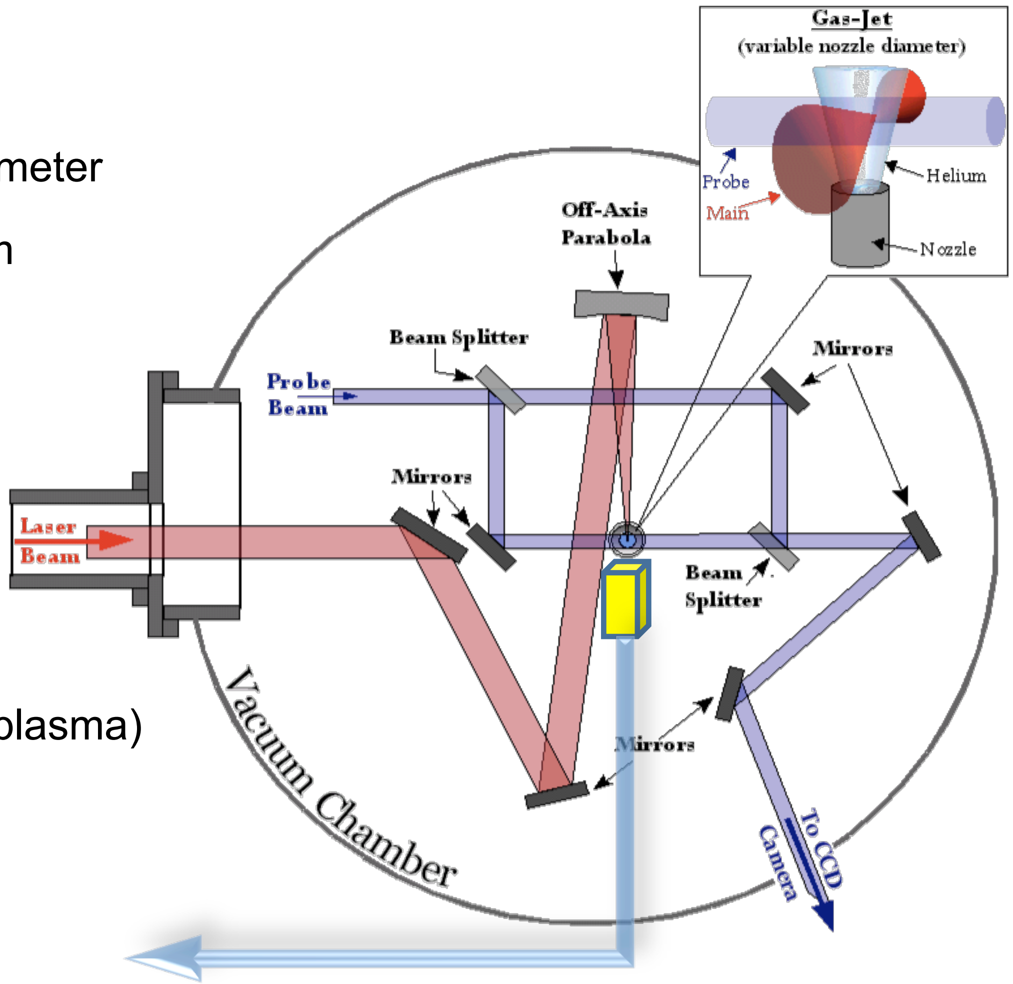
Acceleration set-up

Peculiarities

- eight different circular nozzles with diameter

  0,6 - 1 - 2 - 3 - 4 - 5 - 6 - 10 mm

- different advanced diagnostic tools



Diagnostics

Plasma

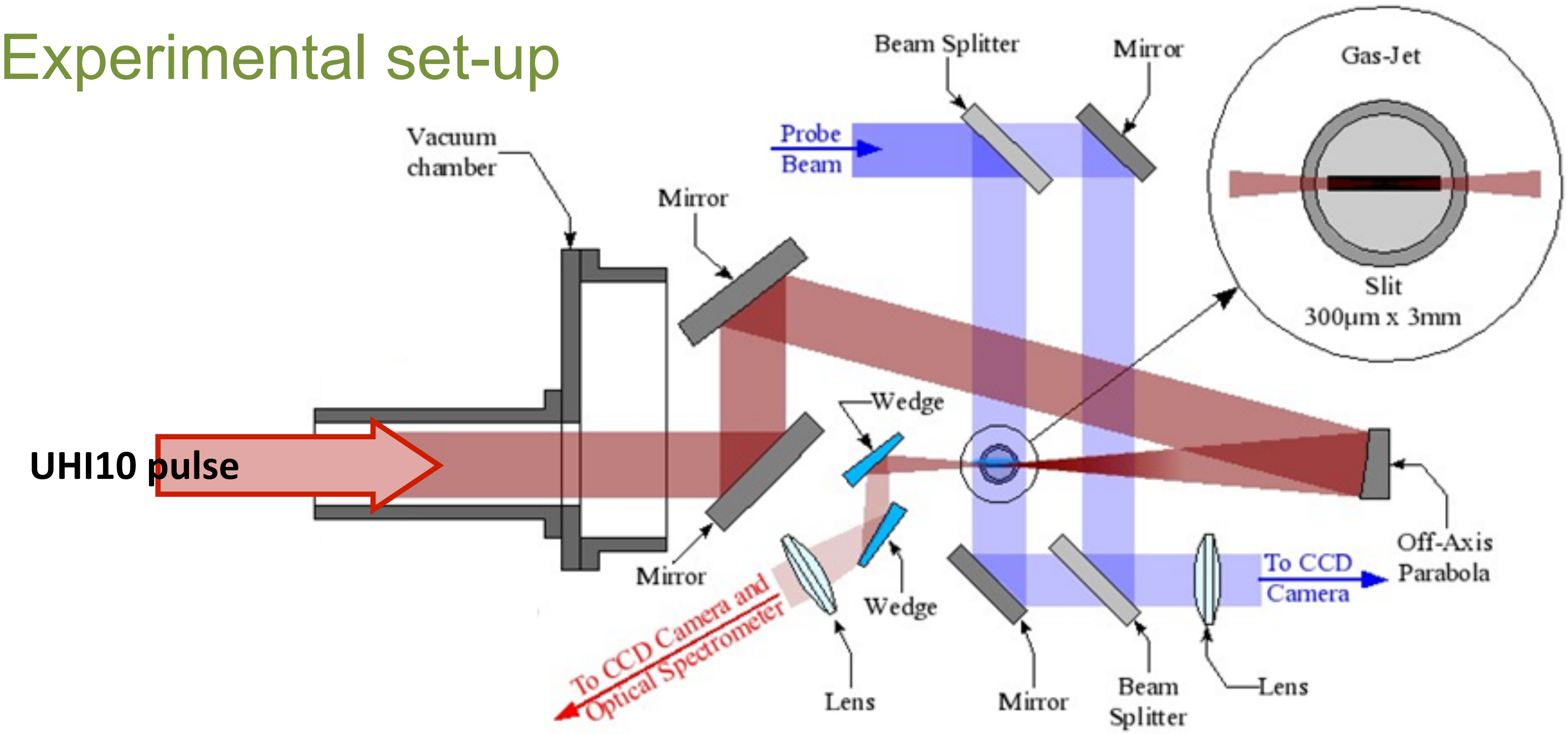
Ultrafast interferometry (fs probing of the plasma)

Accelerated electrons

- LANEX screen (scintillating phosphor)
- LANEX + Magnetic Spectrometer
- SHEEBA (Spatial High Energy Electron Beam Analyzer) stack of radiochromic layers
- Nuclear activation of Gold samples through e^- bremsstrahlung in a "radiator"

Propagation

Experimental set-up



Two regimes of gas density have been experimentally investigated:

$\mathbf{n_{He} \approx 1.2 \cdot 10^{19}\ cm^{-3}}$

Below ASE ionization threshold

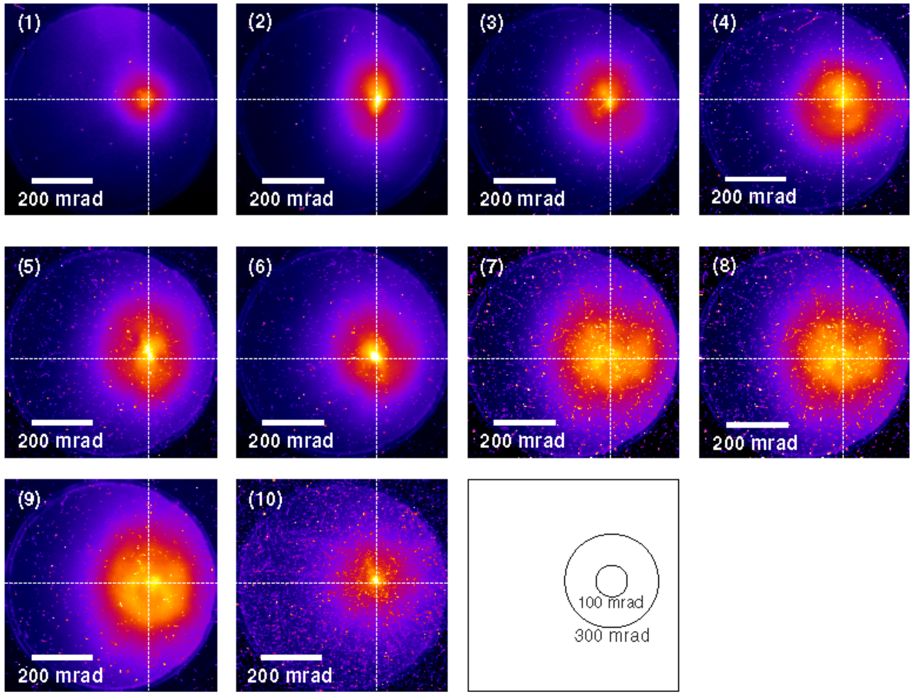
$\mathbf{n_{He} \approx 1.8 \cdot 10^{19}\ cm^{-3}}$

Above ASE ionization threshold

Acceleration beam profile monitor

Single bunch

∅ = 1 mm, P = 6-10 bar

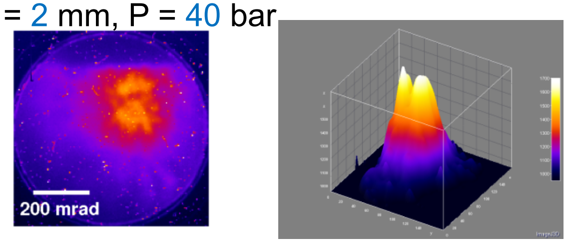


- ✓ 10 consecutive shots, fairly good collimation
- ✓ high reproducibility (even over several days)
- ✓ low backing pressure
- ✓ mean divergence:

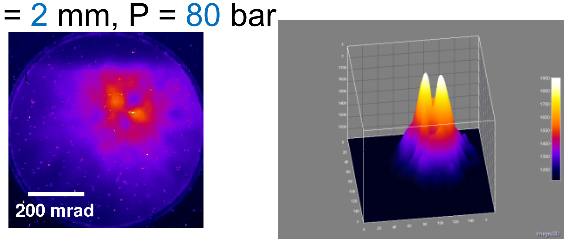
~35 mrad for # 1,2,3,6,10
~48 mrad for # 4,5,7,8,9 (halo)

Multi-bunches

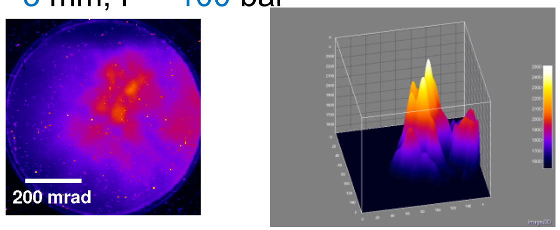
∅ = 2 mm, P = 40 bar



∅ = 2 mm, P = 80 bar



∅ = 3 mm, P = 100 bar

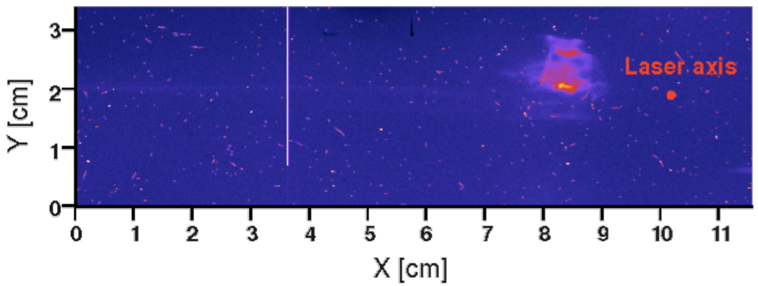


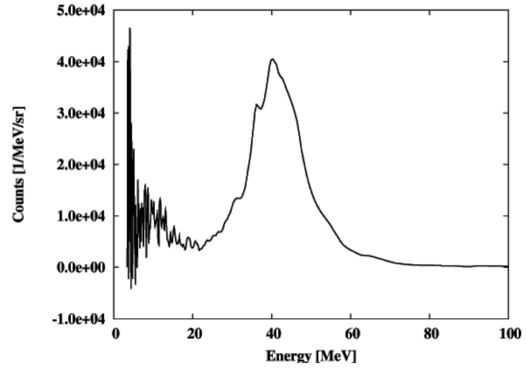
- ✓ multiple bunches simultaneously present
- ✓ high backing pressure
- ✓ fairly good collimation of single bunches
- ✓ low reproducibility

Acceleration magnetic spectrometer

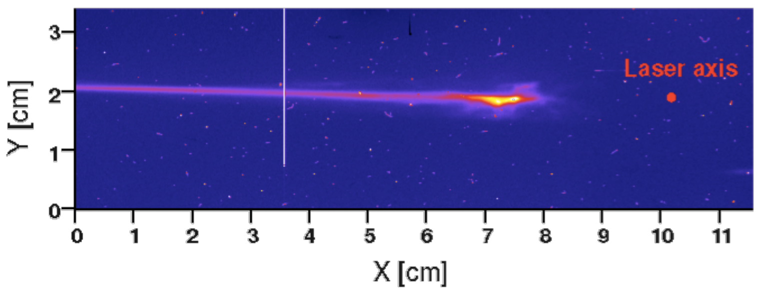
Quasi-monoenergetic spectra

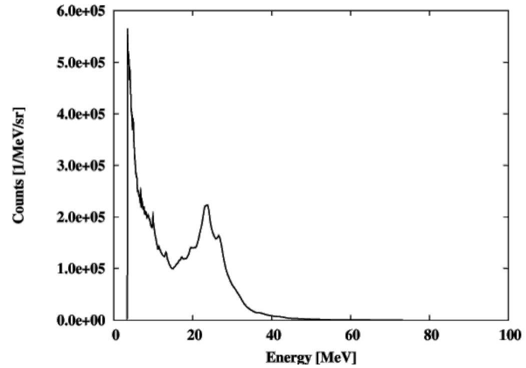
∅= 2 mm
P = 8 bar



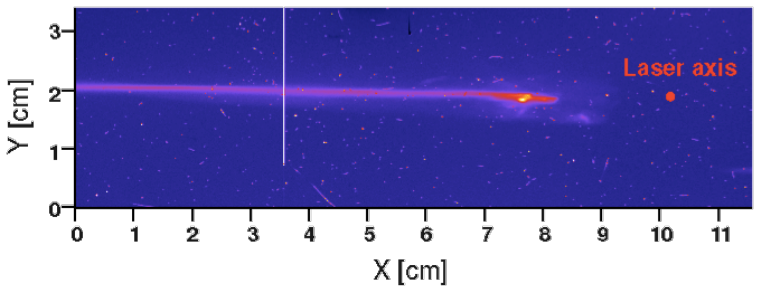


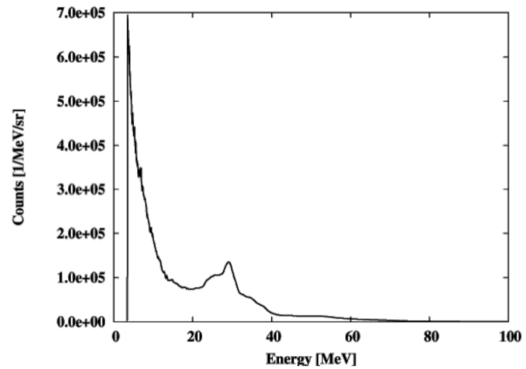
∅= 4 mm
P = 25 bar





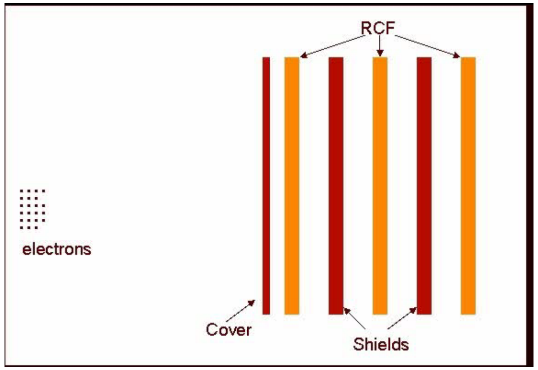
∅= 4 mm
P = 25 bar





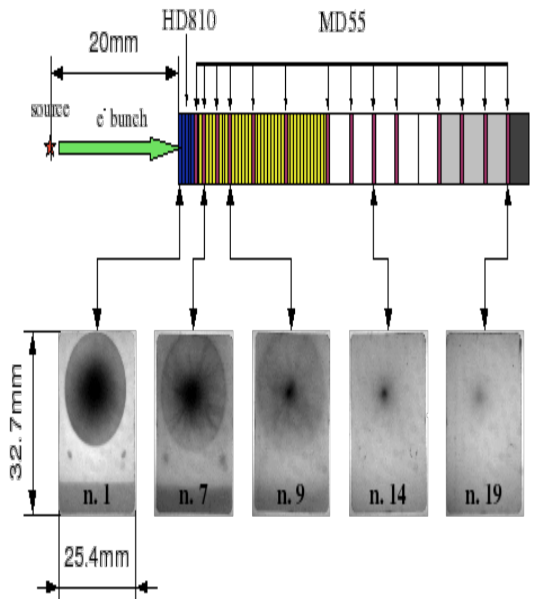
Acceleration

SHEEBA



Major benefits

- ✓ Gives simultaneously the angular divergence, the spectrum and the absolute number of impinging e^- beam
- ✓ Robust and compact set-up
- ✓ First-sight idea of the beam features

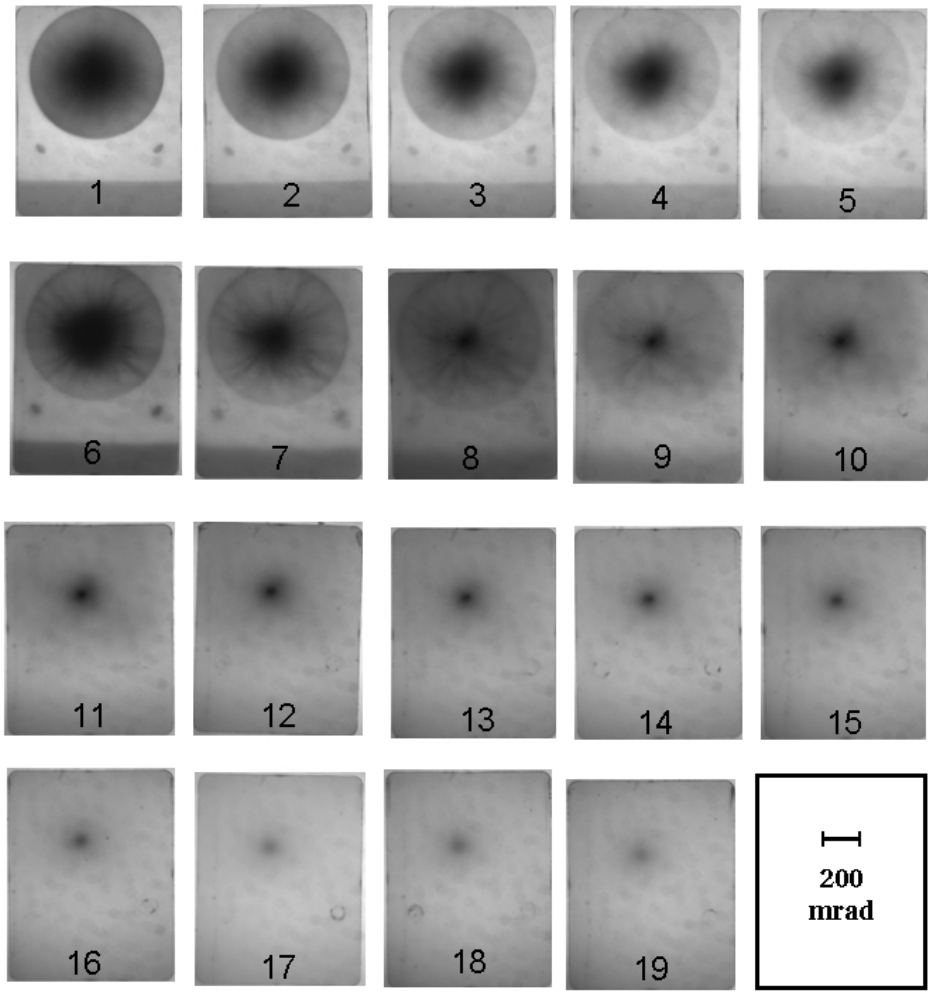


$\varnothing$ = 4 mm, P = 25 bar

M. Galimberti, Electron trapping and acceleration by relativistic laser interactions with underdense plasmas, PhD Thesis, Supervisor Prof. D. Giulietti, Pisa University 2003.

Acceleration

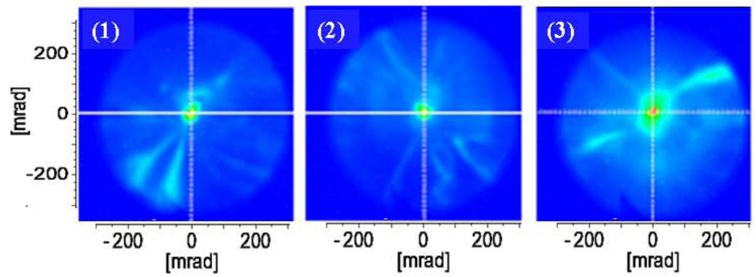
Complete raw set of 19 RCFs after exposure to **10 consecutive shots**



∅ = 4 mm, P = 25 bar

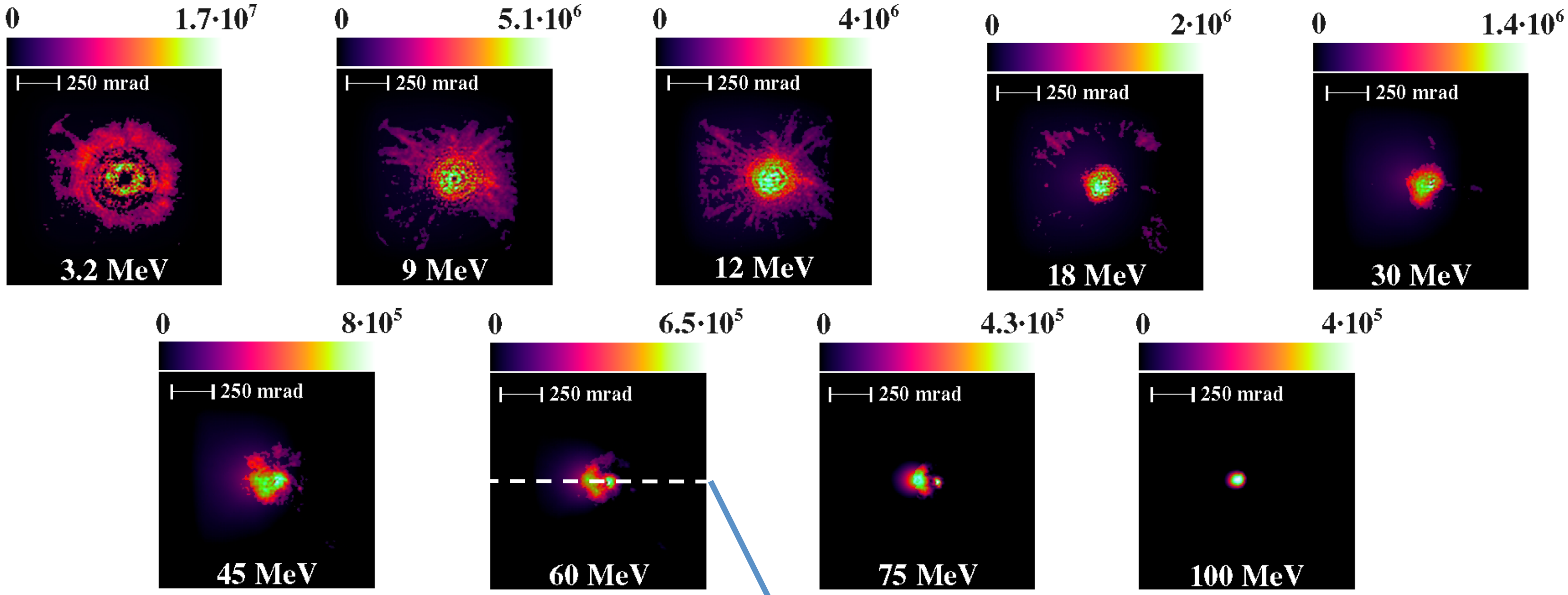
Notable features (qualitative)

1. Every layer is impressed
2. Only the central component survives up to the 19th layer
3. That is the region in which the most energetic electrons are
4. The low-energy halo disappears with depth in the device
5. Up to 10th layer some radial structures …comparison with BPM (single shot):

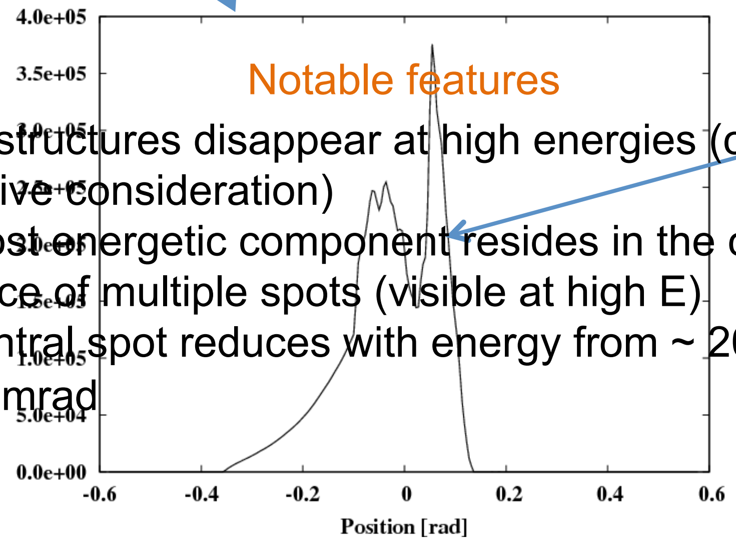


Acceleration

Reconstructed electron images at given energies



∅ = 4 mm, P = 25 bar



Notable features

1. Radial structures disappear at high energies (confirmation of qualitative consideration)
2. The most energetic component resides in the central spot
3. Presence of multiple spots (visible at high E)
4. The central spot reduces with energy from ~ 200 mrad to few tens of mrad

Betatron radiation from LASER-produced plasmas

Bubble regime 1/3

- Relativistic parameter $a_0 \geq 3$
- LASER intensity $I_0 \geq 10^{18}\, W/cm^2$

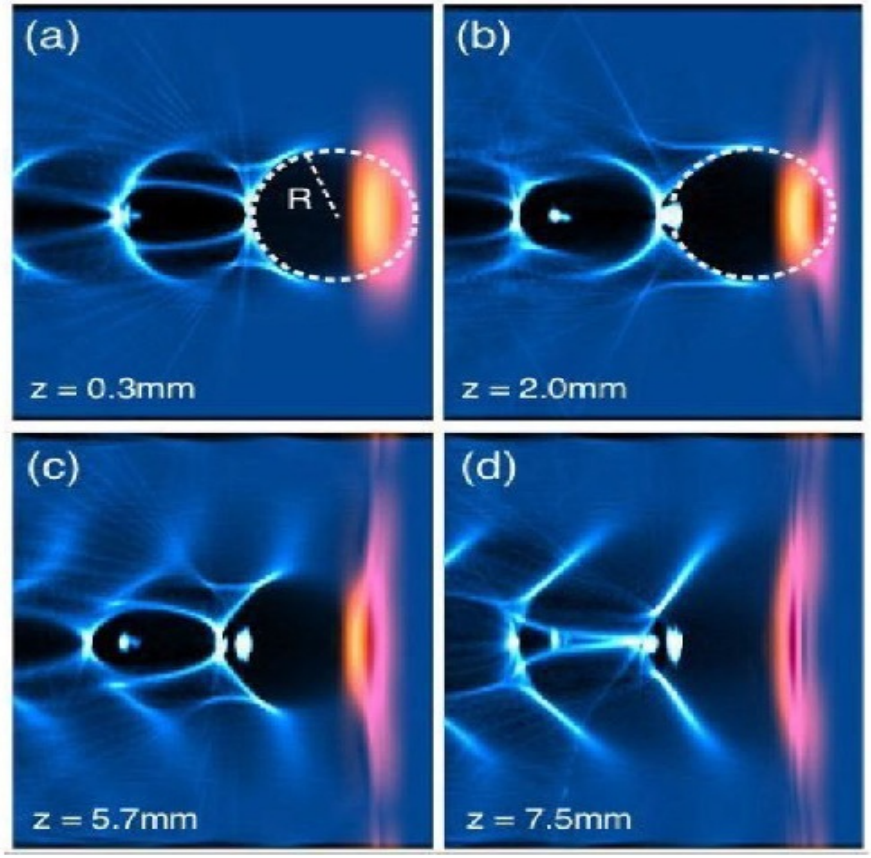
Ponderomotive forces ⇒ Bubble

- Radius of the bubble $R \approx \sqrt{2} a_0 \dfrac{c}{\omega_p}$

Non linear wakefield

- Velocity of the wake $v_\varphi \approx \left(1 - \dfrac{3\omega_p^2}{2\omega_0^2}\right) = v_g$

Bubble regime 2/3



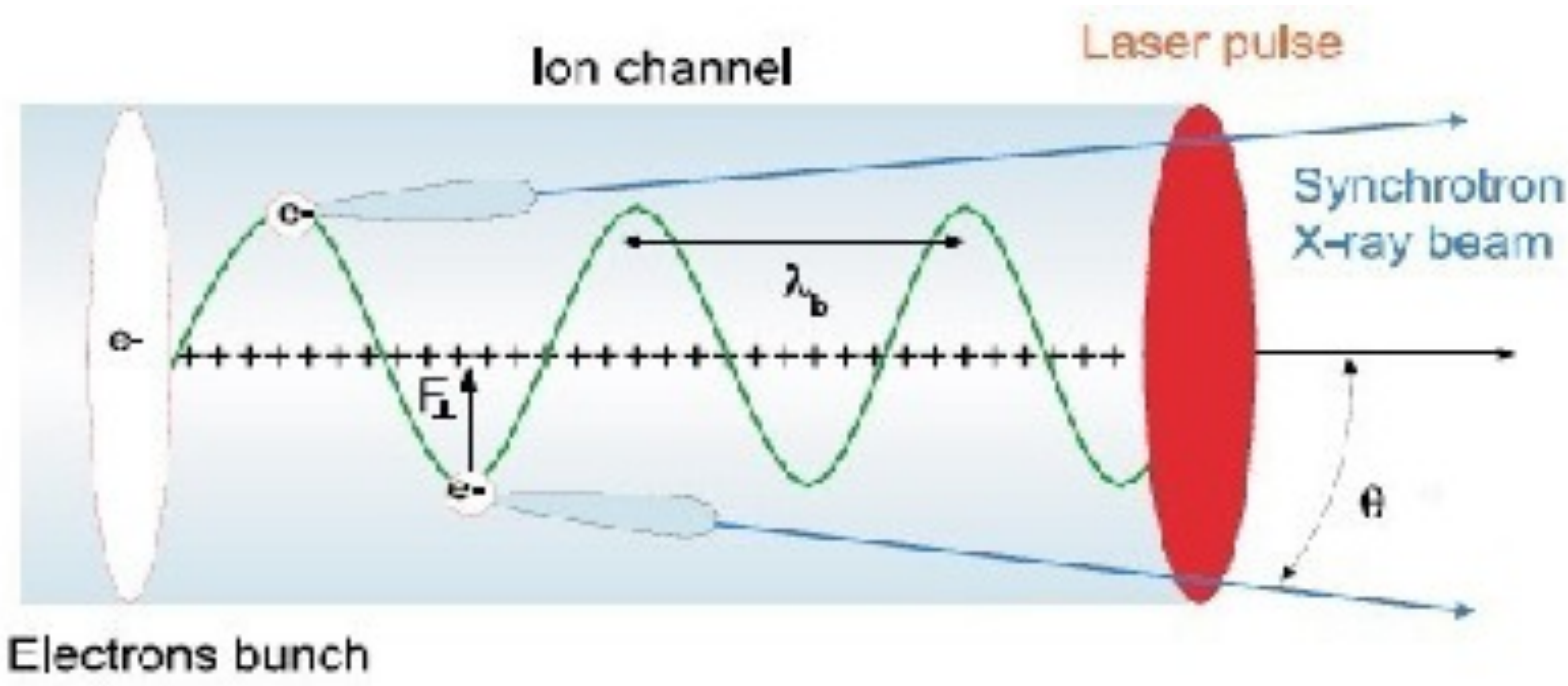
Lu, W., Tzoufras, M. & Joshi, C.Generating multi-GeV electron bunches using single stage laser wakefield acceleration in a 3D nonlinear regime. Phys. Rev. 10, 061301 (2007).

Acceleration parameters

- Dephasing length $$L_{deph} \approx \frac{2\omega_0^2}{3\omega_p^2} R$$

- Maximum energy gain $$E_{electrons}^{max} \approx \frac{2\omega_0^2}{3\omega_p^2} a_0 \, m \, c^2$$

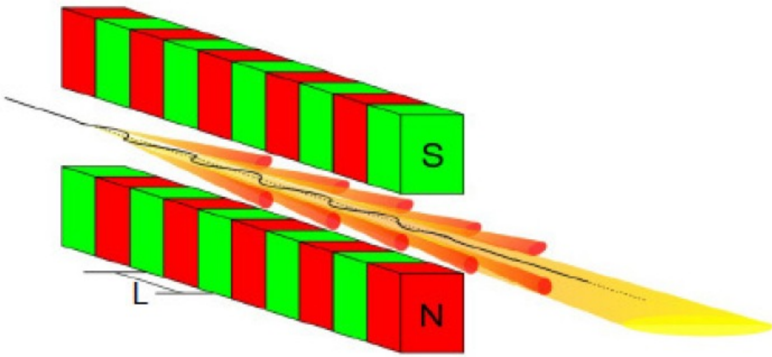
Betatron oscillations



$$F_\perp = -m\frac{\omega_p^2}{2}r = \gamma_0 m\ddot{r}$$

$$\omega_b = \frac{\omega_p}{\sqrt{2\gamma_0}}$$

Analogy with a wiggler



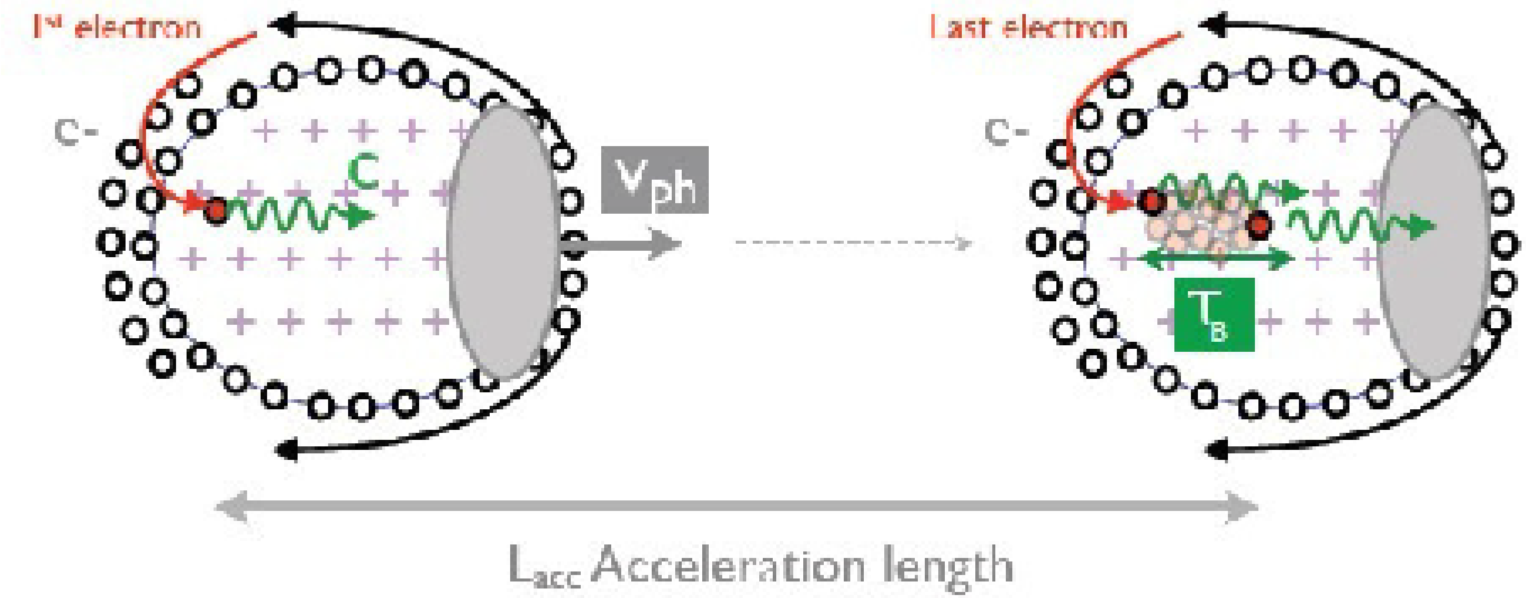
$$\lambda_w = \frac{L}{2\gamma_0^2}\left(1 + \frac{K_w}{2} + \gamma_0^2\theta^2\right)$$

$$K_w = 0.934 * B[T] * L[cm]$$

$$\lambda_\beta = \sqrt{2}\lambda_p \gamma_0^{-3/2}\left(1 + \frac{K}{2} + \gamma_0^2\theta^2\right)$$

$$K = \gamma_0 \lambda_b r_b$$

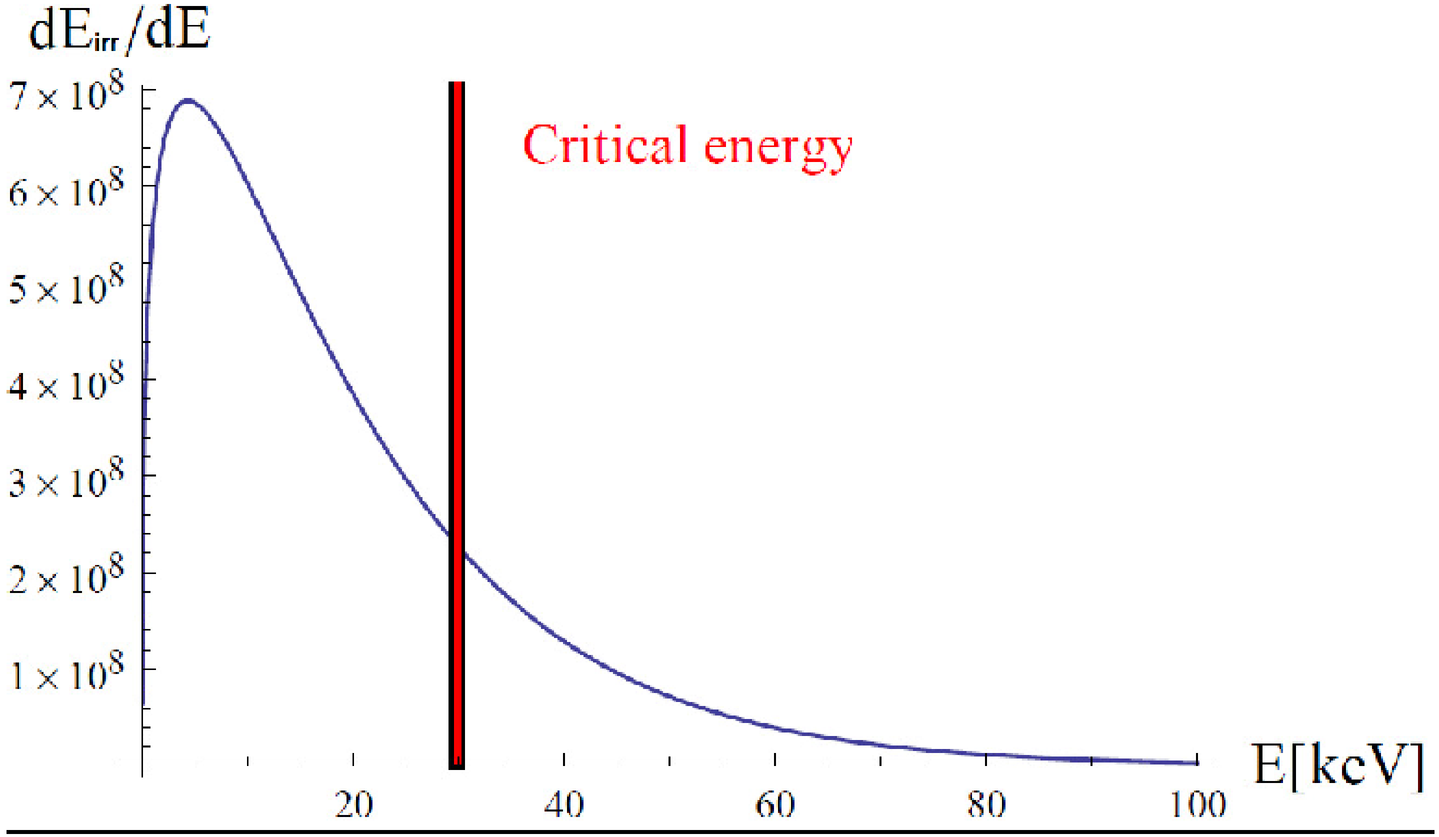
Pulse duration



$$T_p = L_{deph} \frac{c - v_\varphi}{c^2}$$

Betatron spectrum

$\gamma_0 \approx 200\,, \quad n_e = 10^{18}/cm^3, \quad Q_B \approx 100\,pC, \quad r_b \approx 3\mu m, \quad K \approx 20$



A. Curcio, *High brilliance X- ray sources based on LASER-matter interaction at high intensities*. Master degree Thesis, Supervisor Prof. D. Giulietti, Pisa University, 2014.

A more realistic model 1/2

Electrons emit during the acceleration

$$\frac{d\gamma\dot{r}}{dt} = -\frac{\omega_p^2}{2} r$$

$$\gamma(t) \approx \gamma_{max}\left[1 - \varepsilon\left(t/t_{deph} - 1\right)^2\right]$$

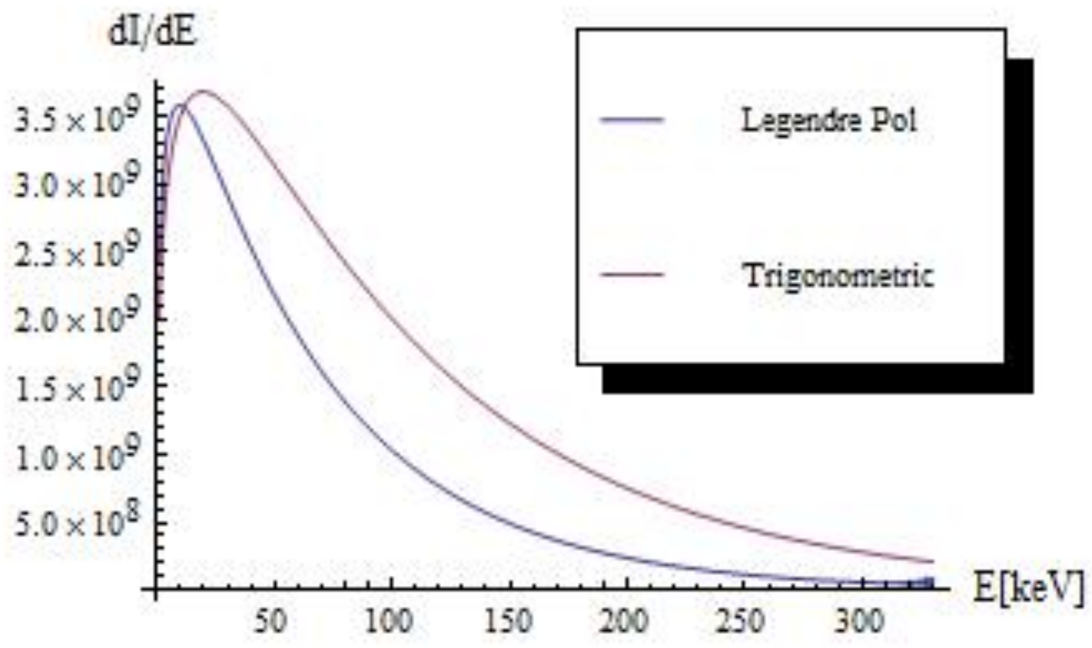
$$r(t) = \frac{r_0}{P_\nu(-\varepsilon)} \; P_\nu\left(\varepsilon\, t/t_{deph} - \varepsilon\right)$$

$$\gamma_{max}(1 - \varepsilon) = \gamma_{min}$$

$$\nu \approx \frac{\omega_p}{\sqrt{2\gamma_{max}}} \, t_{deph}$$

A more realistic model 2/2

$\gamma_0 \approx 400, \quad n_e = 10^{18}/cm^3, \quad Q_B \approx 100\,pC, \quad r_b \approx 3\,\mu m, \quad K \approx 40$



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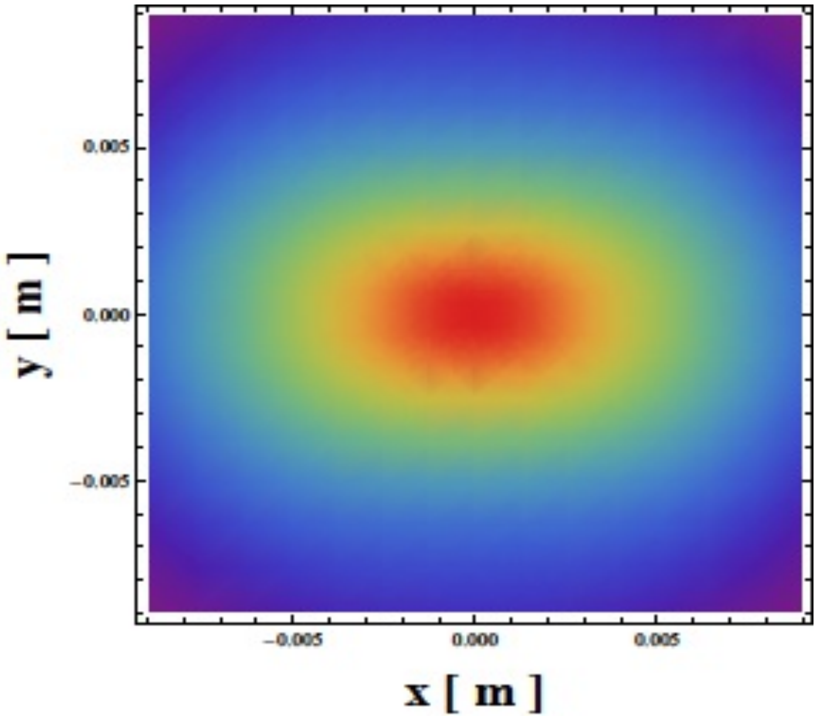
Master degree Thesis, Supervisor Prof. D. Giulietti, Pisa University, 2014.

Diagnostics of plasma- accelerated electron bunches 1/2

Electron bunch extension



$r_x > r_y$
$p_x > p_y$

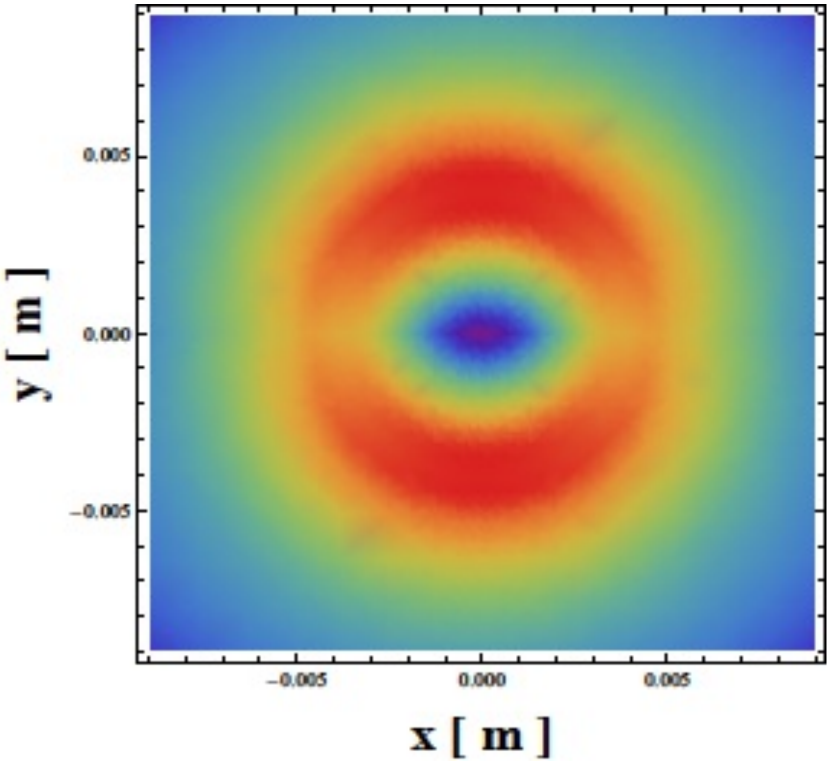
$$r_b \approx \frac{\Delta\theta}{k_b}$$

Radiation collected at 1 meter

A. Curcio, *High brilliance X- ray sources based on LASER-matter interaction at high intensities*. Master degree Thesis, Supervisor Prof. D. Giulietti, Pisa University, 2014.

Diagnostics of plasma- accelerated electron bunches

Electron trajectories in ion cavities



$r_x \approx r_y$

$p_x \approx p_y$

Radiation collected at 1 meter

A. Curcio, *High brilliance X- ray sources based on LASER-matter interaction at high intensities*. Master degree Thesis, Supervisor Prof. D. Giulietti, Pisa University, 2014.

CONCLUSIONS AND PERSPECTIVES

The propagation of super-intense and ultra-short laser pulses in plasmas is a main concern in several applications of the laser-plasma interactions, from ICF to HEP.

During the propagation in the plasma the light beam deeply changes its parameters, inducing at the same time the relativistic regime of the electron quivering motion.

These extreme conditions are suitable for the electron acceleration in high field gradients, opening to the realization of compact secondary sources of radiation (X-gamma rays) and particles (ions, e+, ….)

D Giulietti, The particle laser-plasma acceleration in Italy. JOURNAL OF PHYSICS. CONFERENCE SERIES, vol. 508 , 2014

M. Ferrario et al., Interdisciplinary research infrastructure based on dual electron linacs and lasers. NIM A, vol. 740, p. 138-146, 2014.

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Dipartimento di Matematica e Fisica "Ennio De Giorgi"

UNIVERSITÀ DI PISA

Topics:

- Laser-Matter interaction
- Laser ion-sources
- Electron beam generation
- Physics of non-equilibrium plasmas
- Theoretical models in plasmas
- Photons and particles emission from pulsed plasmas
- Ion acceleration from plasma
- Fs laser pulses
- Pulsed Laser Deposition
- Applications of laser beams and pulsed plasmas
- Techniques of characterization of plasmas
- Rivelatori e tecniche di diagnostiche di plasmi
- Tecniche di analisi di Materiali per target laser
- Applicazioni laser in vari settori

Organizing Committee

- Dr. Riccardo De Angelis, ENEA, Italy
- Prof. D. Giulietti, University of Pisa, Italy
- Prof. V. Nassisi, University of Salento, Italy
- Prof. L. Torrisi, University of Messina, Italy

ROUND TABLE

Propagation of ultra-intense laser pulses in plasma channels and related phenomena

Danilo Giulietti
Physics Department of the University & INFN
Pisa, Italy

Vladimir Baryshevsky	Research Institutefor Nuclear Problems	Minsk
Curcio Alessandro	Pisa University	Pisa
Massimo Ferrario	LNF-INFN	Frascati
Karo Ispiryan	Alikhanian National Laboratory	Yerevan
Victor Malka	Laboratoire Optique Appliquée	Palaiseau
Alexander Potylitsyn	Tomsk Polytechnic University	Tomsk
Nikolai Shul'ga	Akhiezer Institute for Theoretical Physics	Kharkon
Vladimir Vysotskii	Kiev National Shevchenko University	Kiev
Vladimir Zvorykin	Lebedev Physical Institute	Moscow

The propagation of super-intense and ultra-short laser pulses in plasmas is a main concern in several applications of the laser-plasma interactions, from ICF to HEP. During the propagation in the plasma the light beam deeply changes its parameters, inducing at the same time the relativistic regime of the electron quivering motion. These extreme conditions are suitable for the electron acceleration in high field gradient, opening to the realization of compact secondary sources of X-gamma rays. Colleagues from the major laser infrastructures and research centers participating to the Round Table will consider present and future links between the different applications of such physical phenomena.