

Erasmus+

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Erasmus+ Programme
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PowerLaPs

“Innovative Education & Training in High Power Laser Plasmas” Erasmus +

Erasmus+ PowerLaPs

High Power Laser Plasma Physics

2 Year LaPs in Europe

5 Days Intensive Training + 2 Annual Intensive Programmes

#2 weeks teaching, hands-on training & simulations

2018 Plasma Physics
High Power Laser Matter Interactions /
High Energy Density Physics

2019 Computational Modeling & Simulations
in Laser Matter Interactions
Laser Plasma Diagnostics

Teaching, Training & Applying
High Power Laser Plasma Physics

**THEORY
EXPERIMENTS
SIMULATIONS**

Participating Organisations		HELLENIC MEDITERRANEAN UNIVERSITY - Coordinator	2 Weeks IP	2018 & 2019 July	M. Tatarakis	m.tatarakis@chania.teicrete.gr
		UNIVERSITY OF IOANNINA	Multiplier Event	2019	M. Benis	mbenis@uoi.gr
		UNIVERSITY OF YORK	Kick-off Meeting	2017 November	J. Pasley	john.pasley@york.ac.uk
		QUEEN'S UNIVERSITY BELFAST	Intensive Training	2018 March	B. Dromey	b.dromey@qub.ac.uk
		UNIVERSITE DE BORDEAUX	Intensive Training	2018 January	D. Batani	dimitri.batani@u-bordeaux.fr
		ECOLE POLYTECHNIQUE	Kick-off Meeting	2018 November	M. Koenig	michel.koenig@polytechnique.edu
	CZECH TECHNICAL UNIVERSITY	Intensive Training	2019 January	J. Limpouch	jiri.limpouch@fjfi.cvut.cz	
	UNIVERSIDAD DE SALAMANCA	Intensive Training	2019 March	L. Volpe	lvolpe@clpu.es	

- IP 2 -

C7 SP-HE-IPL - Intensive programmes for higher education learners

C8 SP-IP-HE - Intensive programmes for teaching staff

Rethymnon July 1-12, 2019

"Computational Modeling & Simulations in Laser Matter Interactions

&

Laser Plasma Diagnostics - Theory and Experiments"

Hellenic Mediterranean University

Lectures: Michael Tatarakis, Nektarios Papadogiannis, Vasilis Dimitriou, Jian Psikal, Brendan Dromey, Jiri Limpouch, Dimitri Batani, Luca Volpe, Manolis Benis, John Pasley, Andrea Ciardi, Giancarlo Gatti

Welcome greetings

- Mayor of Rethymnon: G. Marinakis
- Rector of Hellenic Mediterranean University: N. Katsarakis
- Vice Rector of Hellenic Mediterranean University: N. Papadogiannis
- Director of IPPL: M. Tatarakis

Plasmas Kinetics-PDE's for plasma and particles (2h) *M. Tatarakis*

- Plasma characterization and classification
- Particle motion in plasma
- Drift velocity
- Plasma as a fluid
- Waves in plasmas
- Governing PDE's
- MHD equations and EM waves

PIC simulations of laser-plasma interactions (2h) *J. Psikal*

- Macroscopic distribution function in kinetic plasma description and its approximation by the PIC method
- Concept of finite-size macroparticles and their description by b-spline shape functions
- Computational cycle of PIC code – interpolation, particle movement, current density and field calculations
- Numerical algorithms in PIC codes for calculation of fields, current densities, motion of particles
- Numerical accuracy and computational demands of PIC simulations
- Initialization of PIC simulation and various boundary conditions
- Simulation parameters and diagnostics

An Introduction to Laser-plasma process diagnostics (2h) *L. Volpe*

- Basic introduction to Laser-plasma physics
- Laser driven proton beams
- Proton stopping power in plasmas

PIC Advanced PIC simulations and their applications (2h) *J. Psikal*

- Advanced PIC algorithms – moving frame, Lorentz boosted frame, QED, ionization, collisions
- Parallelization of computationally demanding PIC simulations
- Overview of PIC codes currently used in laser plasma physics research
- Various applications of PIC simulations in laser-plasma physics

Diagnostics for ions and ions as diagnostics (2h) *L. Volpe*

- Proton generation compared to different laser systems
- Proton beam transport and focusing for medical application
- Proton radiography simulations and experiments

Fokker-Planck and fluid simulations of laser-plasma interactions (2h) *J. Limpouch*

- Kinetic and fluid description of LPP
- Particle models versus solving kinetic equation
- LPP description via Vlasov and Fokker-Planck equations
- Physical processes (laser absorption, heat conduction and radiative transport)
- Eulerian and Lagrangian reference frames, ALE methods

Shock dynamics and diagnostics (2h) *D. Batani*

- Principle of shock generation with lasers and dynamics of shocks
- Diagnostics of shocks: SOP
- Diagnostics of shocks: VISAR
- Diagnostics of shocks: radiography

Fluid simulations - atomic physics and radiative transport (2h) *J. Limpouch*

- Hydrodynamic simulations by ALE codes
- Description of electron structure of many-electron ions
- Collisional radiative model, populations of charge and excitation states
- Broadening of emission lines
- Radiative transport

Diagnostics for Inertial Fusion (2h) *D. Batani*

- Principle of Inertial Confinement Fusion and Shock Ignition
- Diagnostics for ICF: X-ray diagnostics
- Diagnostics for ICF: Particle Diagnostics
- The case of LMJ: PETAL+ diagnostics

Atomic Physics in Plasma Diagnostics (2h) *M. Benis*

- Basics on scattering theory.
- Electron-ion collision processes in plasma.
- Related Technology.

High harmonic generation as a diagnostic for laser contrast using simulations and experiments (2h) *M. Yeung*

- Laser contrast control using plasma mirrors and pre-pulses
- Mechanisms of high harmonic generation from plasma surfaces
- Effects of plasma density and scale length
- Signatures of plasma denting dynamics

Novel streaking experiments for studying ultrafast proton bursts from laser driven plasma accelerators (2h) *B. Dromey*

- Ion and X-ray interactions in matter
- Free Electron Gas to Electron Hole Plasma
- The optical streaking technique
- Multiwavelength analysis
- The first observations of emerging chemical species in H₂O

Ultrafast laser diagnostics (2h) *N. Papadogiannis*

- Evolution of laser technology
- Ultrafast and intense laser technology
- Basics of nonlinear laser matter interaction
- Ultrafast laser diagnostics

Multiphysics simulations for laser/plasma (2h) *V. Dimitriou*

- Numerical simulations and PDE's
- The Finite Element Method
- Mathematical Modeling and Simulations
- FEM laser-matter interactions (*ns-fs* pulses)
- FEM/MHD single wire explosion

Ultrafast bunch duration measurements through optical diagnostics (4h) *G. Gatti*

- Time duration of laser-plasma bunches and requirements for efficient diagnostics
- Coherent optical methods: Kramers-Kronig reconstruction and iterative adaptive algorithms
- Incoherent method based on noise fluctuations
- Streak-camera and its application to bunch-duration diagnostics
- Hints on alternative methods and their limitations

Diagnosing HD motion in high-intensity short-pulse LPI & applications (2h) *J. Pasley*

- Relevance of hydrodynamic motion driven by short-pulse lasers to ICF
- Difficulties of diagnosing hydrodynamic motion driven by short-pulse lasers
- Experimental measurements of short-pulse laser driven hydrodynamics

Astrophysics with high-power lasers (2h) *A. Ciardi*

- High energy density plasmas produced by lasers for studies in space
- Mass accretion and ejection in young stars and white dwarfs
- Acceleration of particles at shocks
- Effects of radiation on the shock structure
- Magnetic reconnection.
- Focus on simulations for scaling astrophysical processes to the laboratory
- State-of-the-art and implications for astrophysics

Simulations of HD behavior in high-intensity short-pulse LPI (2h) *J. Pasley*

- Use of radiation hydrodynamic simulations to model short-pulse driven hydrodynamics
- Combining PIC and radiation hydrodynamics simulations
- Some examples of simulations of short-pulse driven hydrodynamics

*All students have to arrive with their own laptop pc. Instructions for software installations will be provided.

THEORY LECTURES - PLASMA DIAGNOSTICS / COMPUTATIONAL MODELING & SIMULATIONS IN LASER MATTER INTERACTIONS											
C7 & C8 .. IP 2 .. O3 & O4											
	1-Jul	2-Jul	3-Jul	4-Jul	5-Jul	6 & 7	8-Jul	9-Jul	10-Jul	11-Jul	12-Jul
09.00-11.00	WELCOME	J.Psikal	L. Volpe	J. Limpouch	J. Limpouch	Excursion to Arkadi & Ancient Eleftherna Sightseeing guided tour of Rethymno	M. Benis	B. Dromey	V. Dimitriou	G. Gatti	J. Pasley
	Mayor of Rethymnon Rector & Vice Rector of HMU & IPPL Director	PIC simulations of laser-plasma interactions	An Introduction to Laser-plasma process diagnostics	Fokker-Planck and fluid simulations of laser-plasma interactions	Fluid simulations - atomic physics and radiative transport		Atomic Physics in Plasma Diagnostics	Novel streaking experiments for studying ultrafast proton bursts from laser driven plasma accelerators	Multiphysics simulations for laser/plasma	Ultrafast bunch duration measurements through optical diagnostics -II	Simulations of HD behaviour in high-intensity short-pulse LPI
11.15-13.00	M. Tatarakis	J.Psikal	L. Volpe	D. Batani	D. Batani		M. Yeung	N. Papadogiannis	G. Gatti	J. Pasley	A. Ciardi
	Plasmas Kinetics/PDE's for plasma and particles	Advanced PIC simulations and their applications	Diagnostics for Ions and Ion as diagnostics	Shock dynamics and diagnostics	Diagnostics for Inertial Fusion		High harmonic generation as a diagnostic for laser contrast using simulations and experiments	Ultrafast laser diagnostics	Ultrafast bunch duration measurements through optical diagnostics -I	Diagnosing HD motion in high-intensity short-pulse LPI & applications	Astrophysics with high-power lasers
LABORATORY EXERCISES-PLASMA PHYSICS & HIGH POWER LASER MATTER INTERACTIONS/HIGH ENERGY DENSITY PHYSICS											
	GROUP A	GROUP B	GROUP C	GROUP A	GROUP B	Sponsored by the Municipality of Rethymnon	GROUP C	GROUP A, B, C	GROUP A, B, C	GROUP A, B, C	ALL GROUPS
15.00-19.00	Laser matter interaction diagnostics for TW ultrafast laser system IPPL Laboratory	Laser matter interaction diagnostics for TW ultrafast laser system IPPL Laboratory	Laser matter interaction diagnostics for TW ultrafast laser system IPPL Laboratory	Laser matter interaction diagnostics Hands on experiment	Laser matter interaction diagnostics Hands on experiment		Laser matter interaction diagnostics Hands on experiment	Particle Acceleration Hands on PIC Simulations	Simulations & Diagnostics for Lasers & Plasmas Discussion & Evaluation of Lab's	Questionairries & Homework Projects	EXAMS and CLOSING SESSION
15.00-19.00	GROUP B	GROUP C	GROUP A	GROUP B	GROUP C		GROUP A				
	Plasma simulations Hands on MHD simulations	Plasma simulations Hands on MHD simulations	Plasma simulations Hands on MHD simulations	Plasma-Pinch diagnostics Hands on experiment	Plasma-Pinch diagnostics Hands on experiment		Plasma-Pinch diagnostics Hands on experiment				
15.00-19.00	GROUP C	GROUP A	GROUP B	GROUP C	GROUP A	GROUP B	Laser-solid target interaction Hands on FEM simulations				PowerLaPs Farewell Dinner
	Laser matter interactions Introduction to FEM simulations	Laser matter interactions Introduction to FEM simulations	Laser matter interactions Introduction to FEM simulations	Laser-solid target interaction Hands on FEM simulations	Laser-solid target interaction Hands on FEM simulations						

Laboratory courses: three groups of students

- Laboratory session (4h): “Laser matter interaction diagnostics for TW ultrafast laser system IPPL Laboratory”
I. Ftilis, S. Petrakis, T. Grigoriadis, G. Andrianaki, I. Tazes
- Laboratory session (4h): “Plasma simulations-Hands on MHD simulations”
G. Koundourakis, A. Skoulakis
- Laboratory session (4h): “Laser matter interactions-Introduction to FEM simulations”
E. Kaselouris, A. Baroutsos
- Laboratory session (4h): “Laser matter interaction diagnostics-Hands on Experiment”
Y. Orphanos, S. Petrakis
- Laboratory session (4h): “Plasma Pinch diagnostics-Hands on Experiment”
I. Ftilis, A. Skoulakis, G. Andrianaki, I. Tazes
- Laboratory session (4h): “Laser solid target interaction-Hands on FEM simulations”
E. Kaselouris, A. Baroutsos
- Laboratory session (4h): “Particle Acceleration-Hands on PIC simulations”
I. Tazes, T. Grigoriadis, G. Andrianaki

Final exams (~2h)

PRACTICAL INFORMATION

<https://powerlaps.chania.teicrete.gr/>

The PowerLaPs site will host announcements and useful information for

<https://eclass.chania.teicrete.gr/modules/auth/opencourses.php?fc=23>

The e-Class Platform will host documents and educational material

Accommodation for the students

BRASCOS HOTEL

Moatsou kai Daskalaki 1 – 74100 Rethymnon

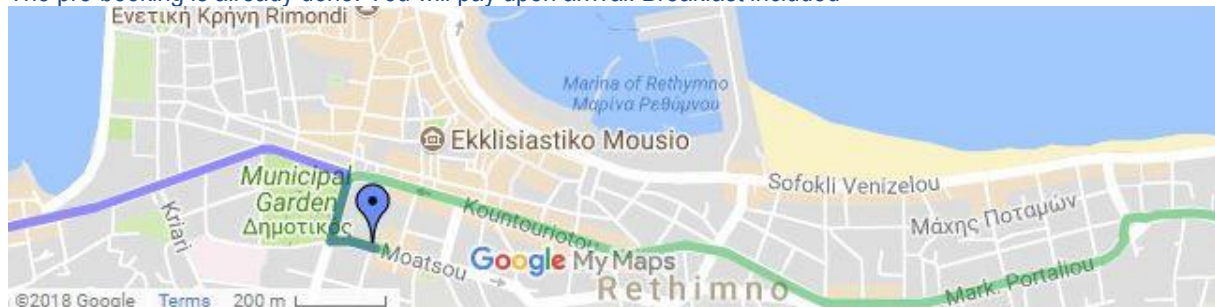
Tel: +30 2831023721-4

E-mail: brascos@otenet.gr, info@brascos.com

<http://www.bascos.com/index.php?sl=en>

RESERVATION

The pre-booking is already done. You will pay upon arrival. Breakfast included



Accommodation for the teachers

MINOS HOTEL

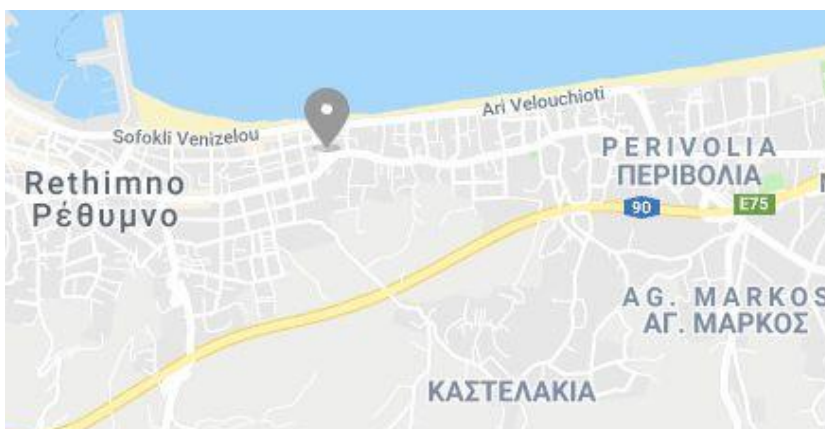
5 Machiton Schollis Chorophilakis, Rethymnon 741 00

T: +30 28310 53921

F: +30 28310 23544

E-mail: info@minos.gr

<http://www.minos.gr/>



How to get to Rethymnon:

There is more than one way to reach Rethymnon:

- By air travel to Athens and connecting flight to either Heraklion Airport or Chania Airport and then bus terminal (KTEL) travel to Rethymnon. The journey is approx., one hour.
- By air travel from a European city directly to Chania or Heraklion, and then by bus or taxi to Rethymnon as described above.

BY PLANE:

Participants can reach Rethymnon by air travel from Athens via Chania (Daskalogiannis Airport – CHQ) or Heraklion (N. Kazantzakis Airport – HER). Flights between Athens and either of these cities take less than one hour. Information regarding flights and time schedules can be located at the official sites of Aegean Airlines and Olympic Airlines.

Also there are flights of low cost airlines, which connect Heraklion and Chania directly to European cities. For more information you can check the following airlines:

EasyJet (Heraklion or Chania), Transavia (Heraklion or Chania) and Ryanair (Chania).

BY FERRY:

Ferryboat connection between Athens (Piraeus) and Crete is available to Heraklion (MINOAN Lines – ANEK Lines – Blue Star Ferries) or Chania, Souda Bay (ANEK Lines). On arrival at the port of Heraklion or Souda (Chania) travelers can choose between the bus and taxi options above.

TRAVEL IN CRETE:

A) Bus

Crete offers an excellent bus service to take you to any part of Crete at very good prices. On arrival at Heraklion or Chania Airport participants can take a bus or taxi to the city of Heraklion or Chania bus terminal (KTEL) in hourly service from 05:30 to 21:00.

B) Taxi

The rates are more or less fixed for all taxi companies. Transfer by taxi from Heraklion or Chania Airport is below 100€ per transfer from/to airport.

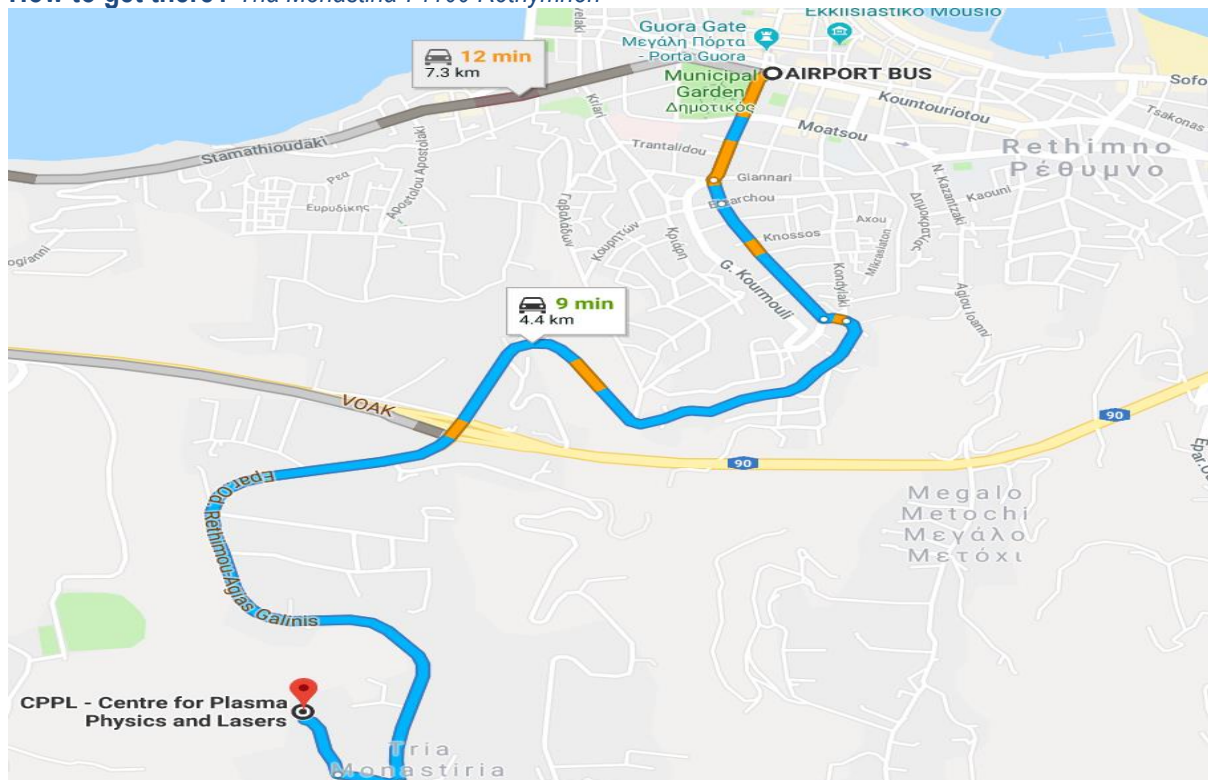
C) Car Rental

Car rental is a convenient way to travel and there are multiple car hire companies offering special deals.

Institute for Plasma Physics & Lasers - IPPL

www.cppl.teicrete.gr (www.ippl.hmu.gr)

How to get there? Tria Monastiria 74100 Rethymnon



The Municipality of Rethymnon will kindly provide to all PowerLaPs participants a daily roundtrip by Bus from the Rethymnon to IPPL, for the early lectures and the evening labs, twice a day.

<https://goo.gl/maps/Qp3QEUJxGdQ2>

We thank and acknowledge the Municipality of Rethymnon, the Departments of Education and Cleaning for their contribution.

1– 5 July AND 8 – 12 July

Two daily departures:

FROM Rethymnon, Bus stop of Four Witnesses Church at 08:30 & 14:45 TO IPPL

FROM IPPL 13:15 & 19:15 TO Rethymnon, Bus stop of Four Witnesses Church

The Municipality of Rethymnon will also sponsor PowerLaPs participants on:

Saturday 6th of July 09:00

Excursion at Moni Arkadiou and Ancient Eleftherna

Departure from Rethymnon, Bus stop of Four Witnesses Church at 09:00

Sunday 7th of July 10:00

Sightseeing guided tour of Rethymnon

Meeting point, at Four Witnesses Church at 10:00