



POLITECNICO
MILANO 1863

Numerical simulations of Laser-Plasma interaction at POLIMI

Matteo Passoni
Pisa, 23/02/2017



ERC-2014-CoG No. 647554
ENSURE

The group at Politecnico di Milano



NanoLab
(Ed.19 ex-CeSNEF)
Via Ponzio 34/3
Milano



The group at Politecnico di Milano



Matteo Passoni
Associate professor



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ENSURE



Margherita Zavelani Rossi
Associate professor



Valeria Russo
Researcher



David Dellasega
post-doc



Alessandro Maffini
post-doc



Luca Fedeli
post-doc

3 PhD students



Lorenzo **Arianna** **Andrea**

1 Master's student



Francesco



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► ENSURE



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David Dellasega Alessandro Maffini

post-doc post-doc



Luca Fedeli

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A close-up portrait of a woman with long, dark brown hair. She has a neutral expression and is looking directly at the camera. She is wearing a dark-colored top. The background is plain and light-colored.



Lorenzo Arianna Andrea

1 Master's student



Francesco



ENSURE project

Main research interests:

Laser-driven ion acceleration

Theoretical/numerical & experimental investigation

Materials science

Development of low-density foams & advanced targets for laser-plasma experiments

Applications in materials and nuclear science

Materials characterization (e.g. PIXE) with laser-driven ions

Secondary neutron sources for radiography and detection[...]

Fundamental physics and laboratory astrophysics

Laser interaction with (near-critical) nanostructured plasmas

Collisionless shock acceleration of ions





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ENSURE project

Materials science

Targets for collision-less shocks experiments

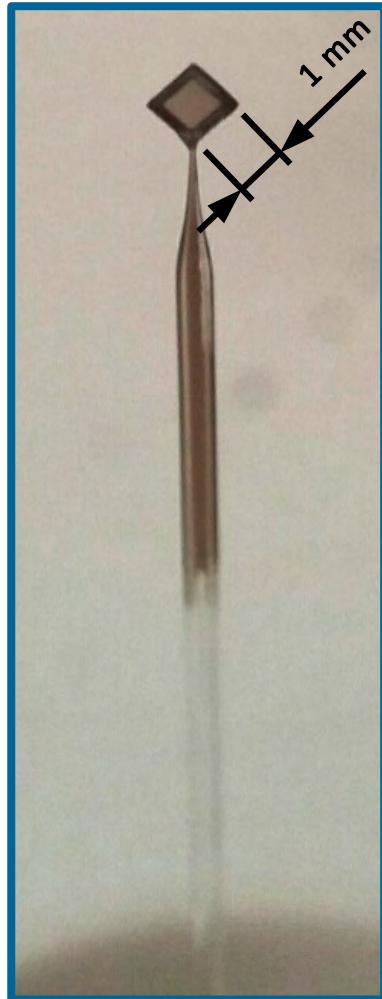


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ENSURE project

Materials science

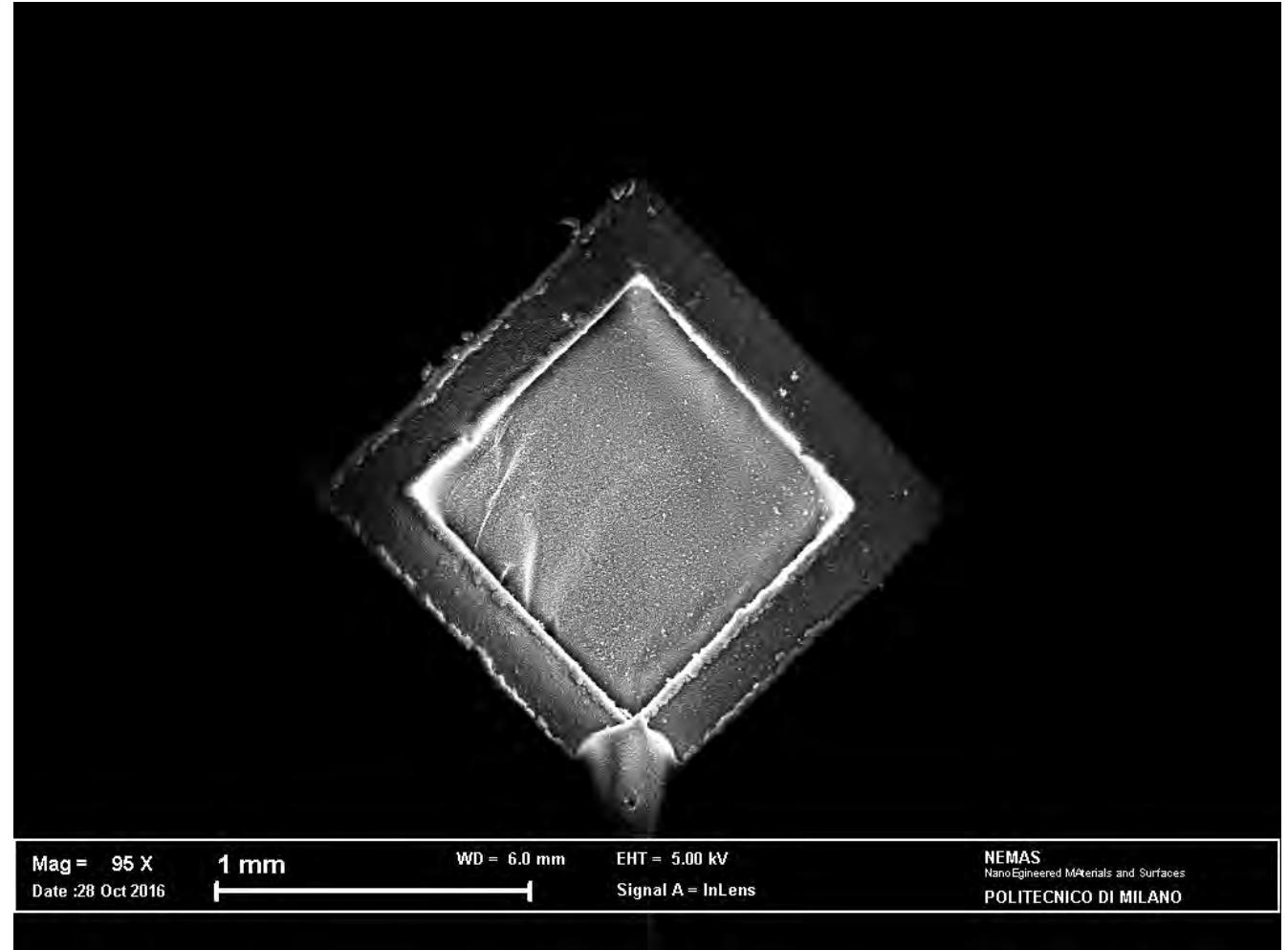
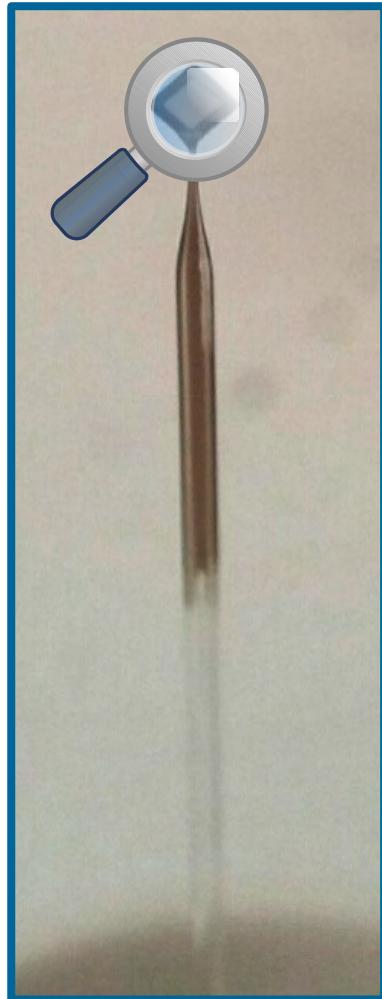
Targets for collision-less shocks experiments



ENSURE project

Materials science

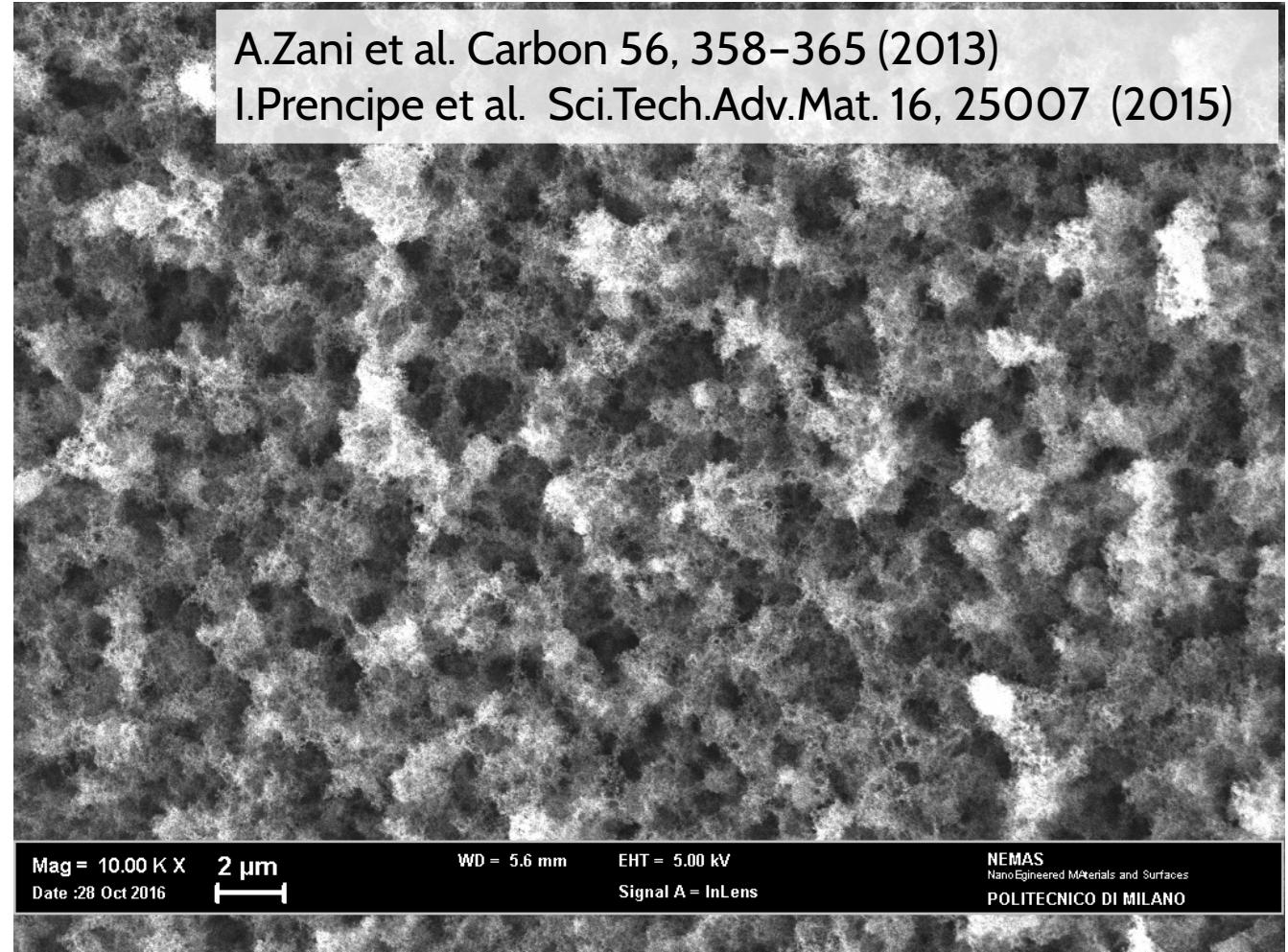
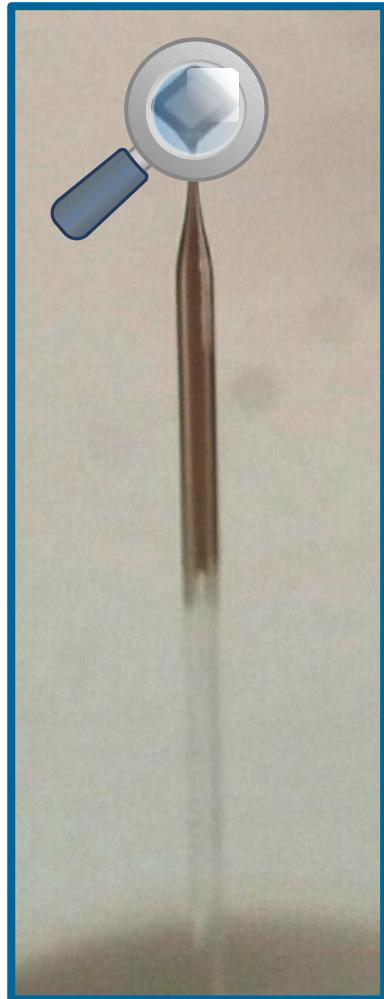
Targets for collision-less shocks experiments



ENSURE project

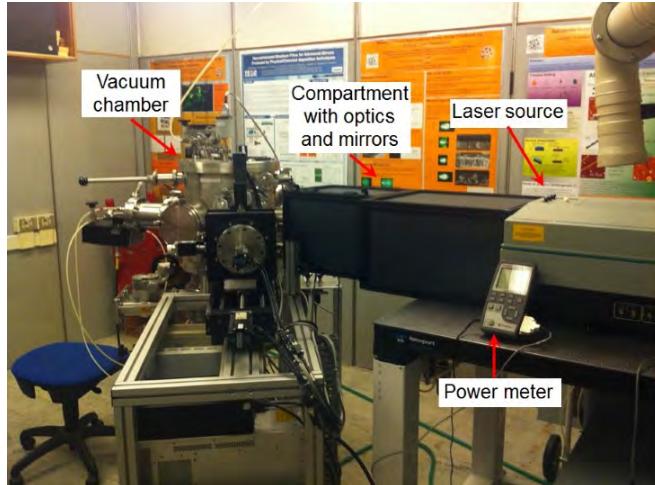
Materials science

Targets for collision-less shocks experiments



ENSURE project

Materials science: new facilities



Today

2 ns Pulsed laser deposition (PLD)

Thermal treatment systems

SEM, STM, AFM microscopy

Raman spectroscopy

Brillouin spectroscopy

Tomorrow (within 2017)

Femtosecond-PLD

HIPIMS magnetron sputtering



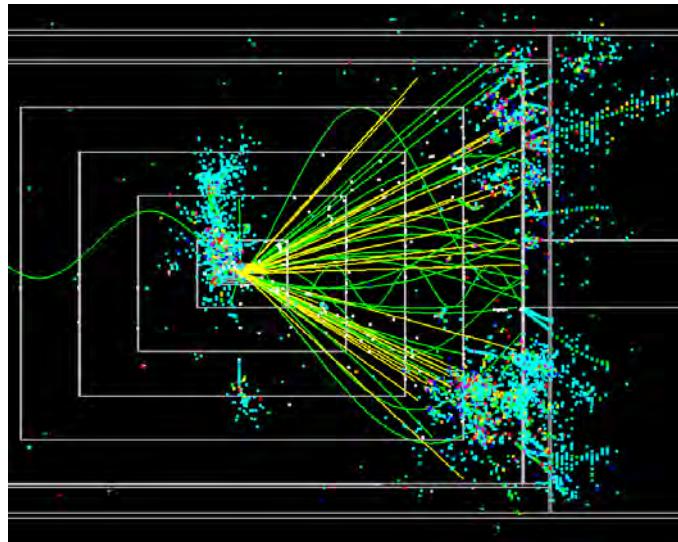
Numerical activity



Numerical activity

Piccante

Open source Particle-In-Cell code



Geant4

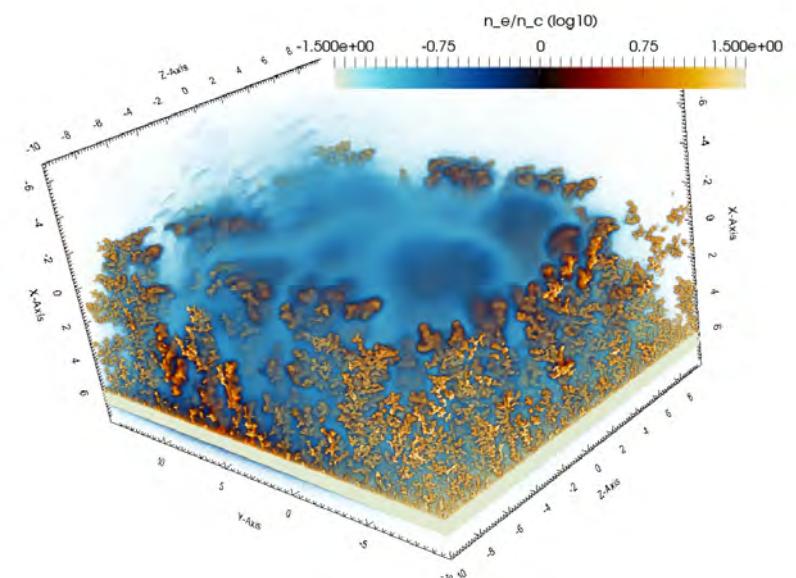
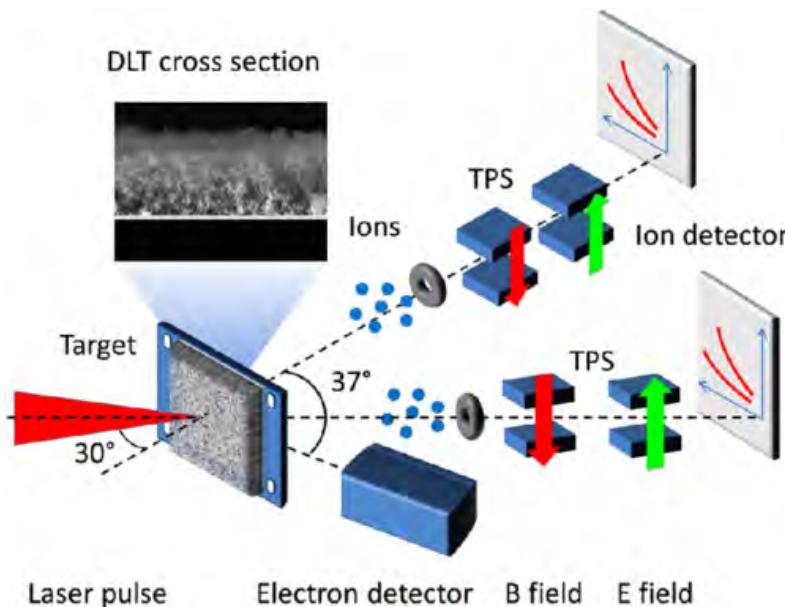
Open source Monte Carlo code



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Numerical simulations

Nanostructured low-density materials



M.Passoni et al. PRAB 19, 061301 (2016)
I.Prencipe et al. PPCF 58, 45001 (2016)

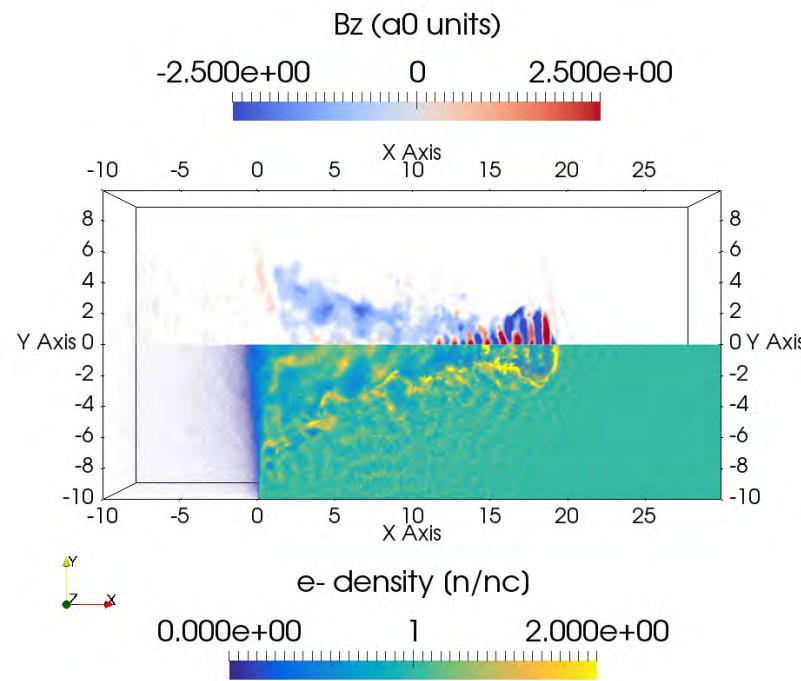
Support ion acceleration experiments

Performed at **GIST** (Rep. of Korea) in 2015-2016
and to be performed at **HZDR** (Germany) in 2017



Numerical simulations

Nanostructured low-density materials

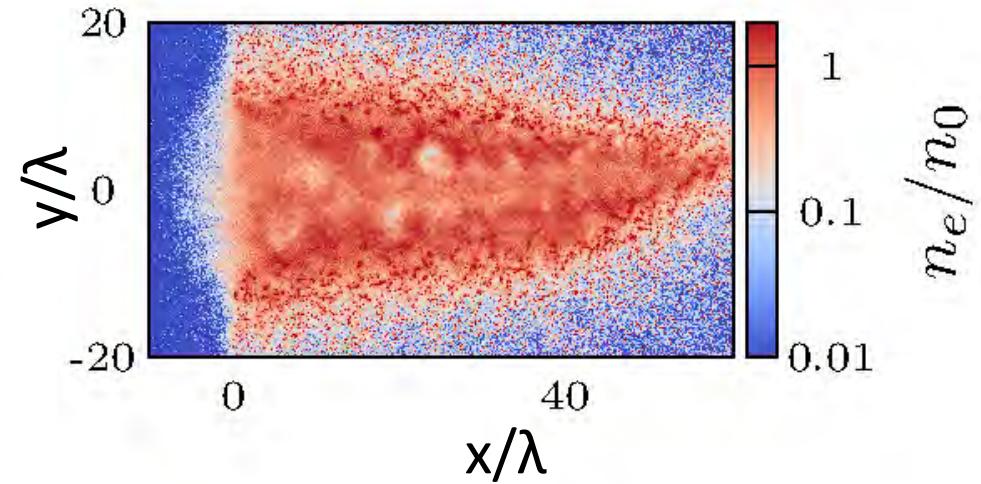
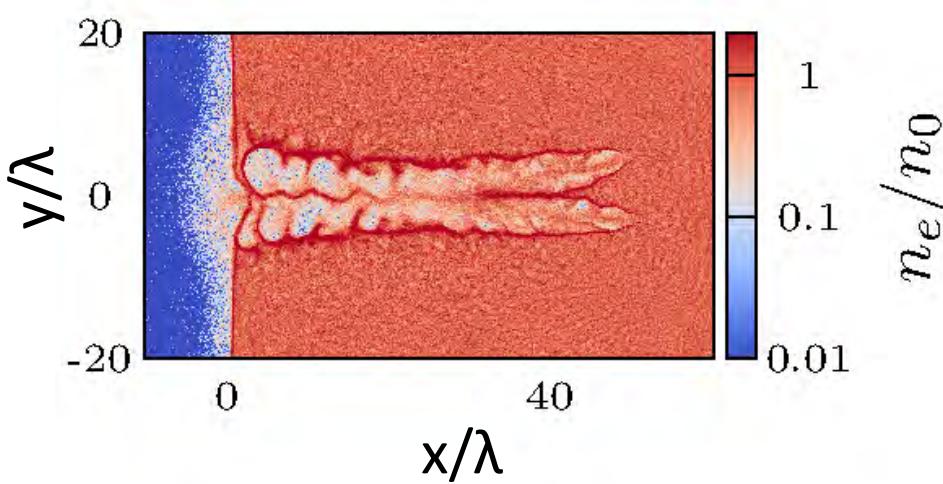


Theoretical/numerical investigation of laser propagation in
(nanostructured) near-critical plasmas



Numerical simulations

Nanostructured low-density materials



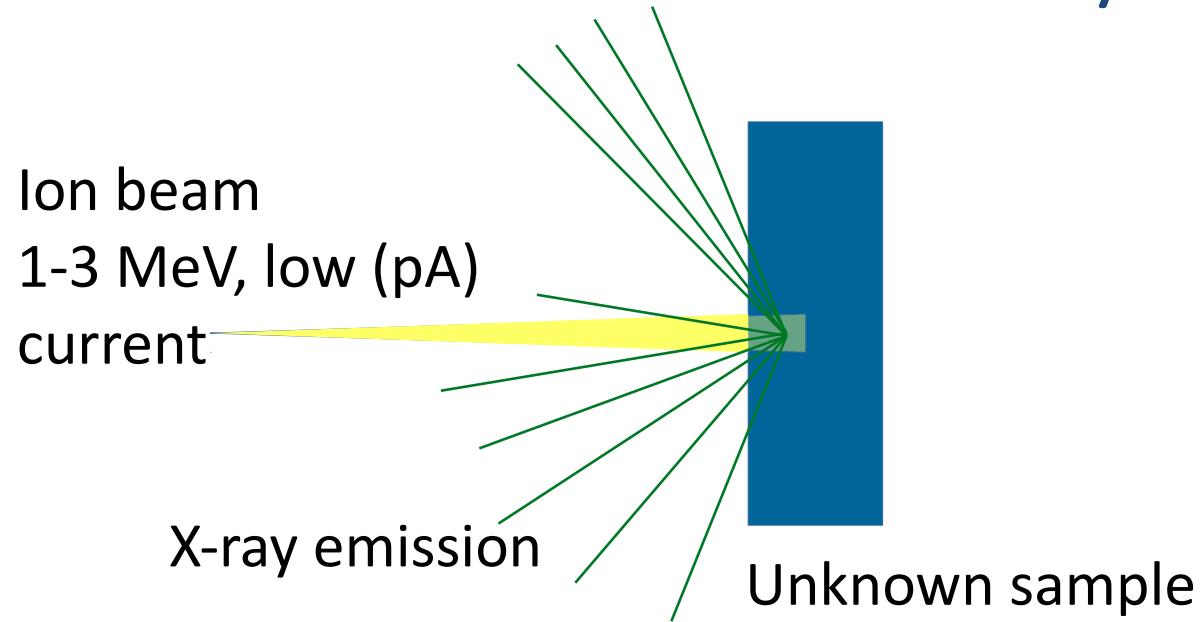
L.Cialfi, L.Fedeli, M.Passoni. PRE 94, 053201 (2016)
L.Fedeli, A.Formenti, M.Passoni (in preparation)

Parametric study of the role played by the **nanosctructure**
(simple models)



Numerical simulations

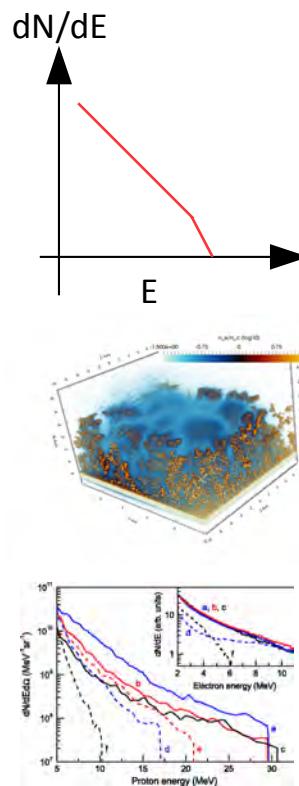
Proton Induced X-ray Emission (PIXE)



We are performing numerical simulations with GEANT4 to assess the feasibility (and possible advantages) of PIXE with laser-driven ions



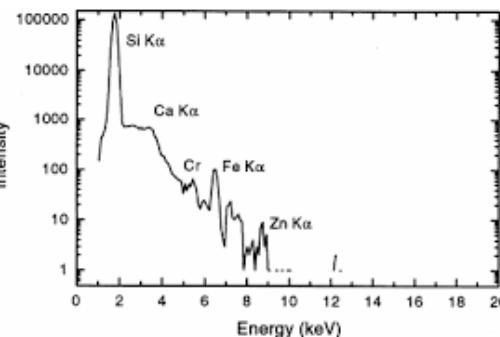
Numerical simulations



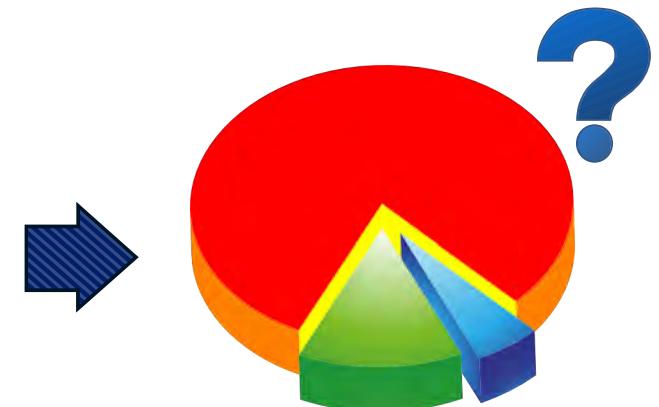
Proton Induced X-ray Emission (PIXE)

Detector

Synthetic spectra



GEANT4: simulated
PIXE experiment



Composition of the sample?

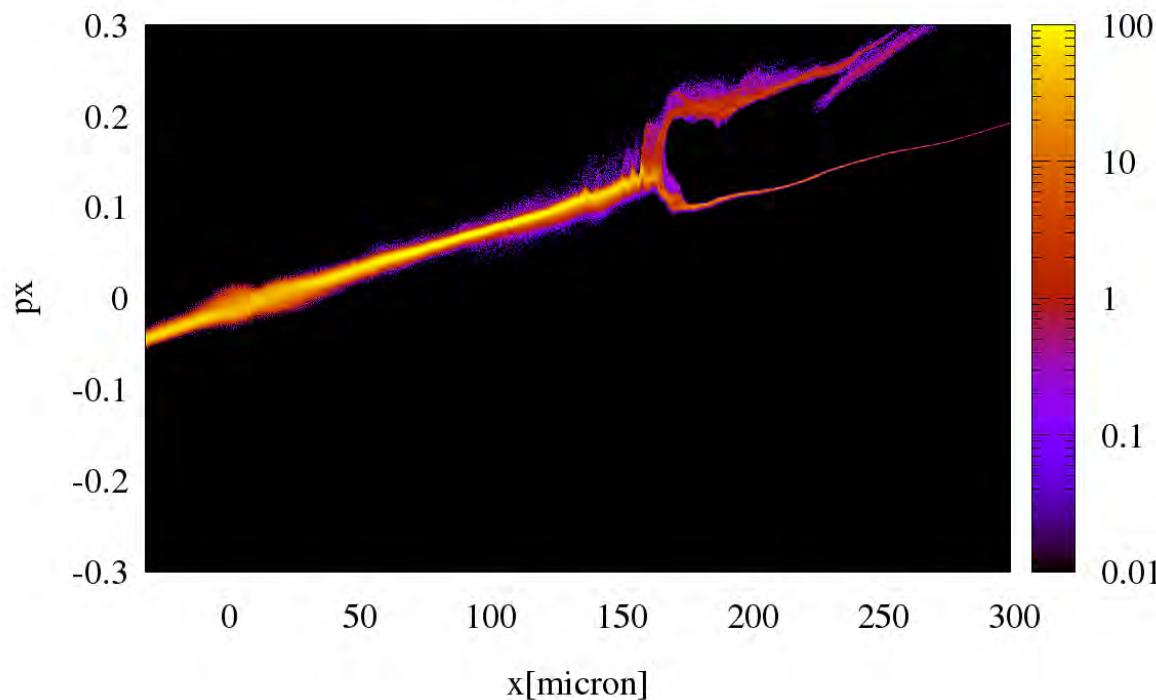
Laser-driven ion source
(from simple models,
PIC simulations or
experimental data)

For standard PIXE this is done
with proprietary softwares like
GUPIX



Numerical simulations

Laboratory astrophysics



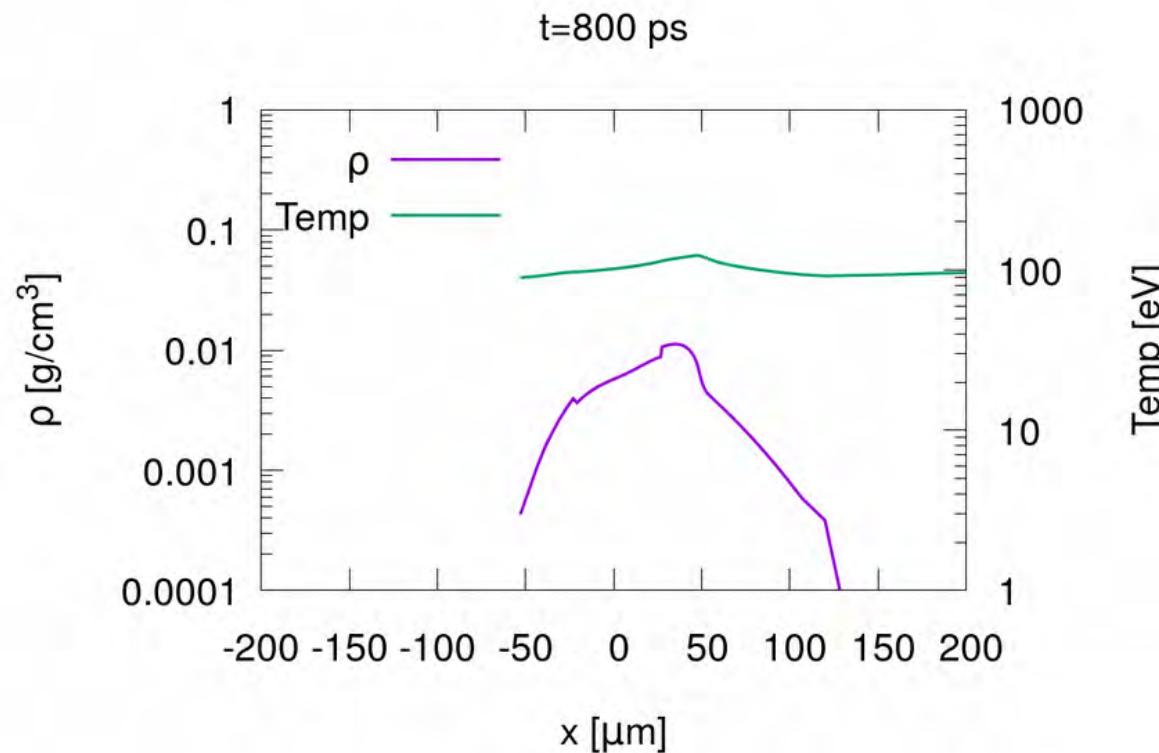
PIC simulation of **collisionless shocks**

Ongoing collaboration with ILE - University of Osaka (Japan)



Numerical simulations

Laboratory astrophysics

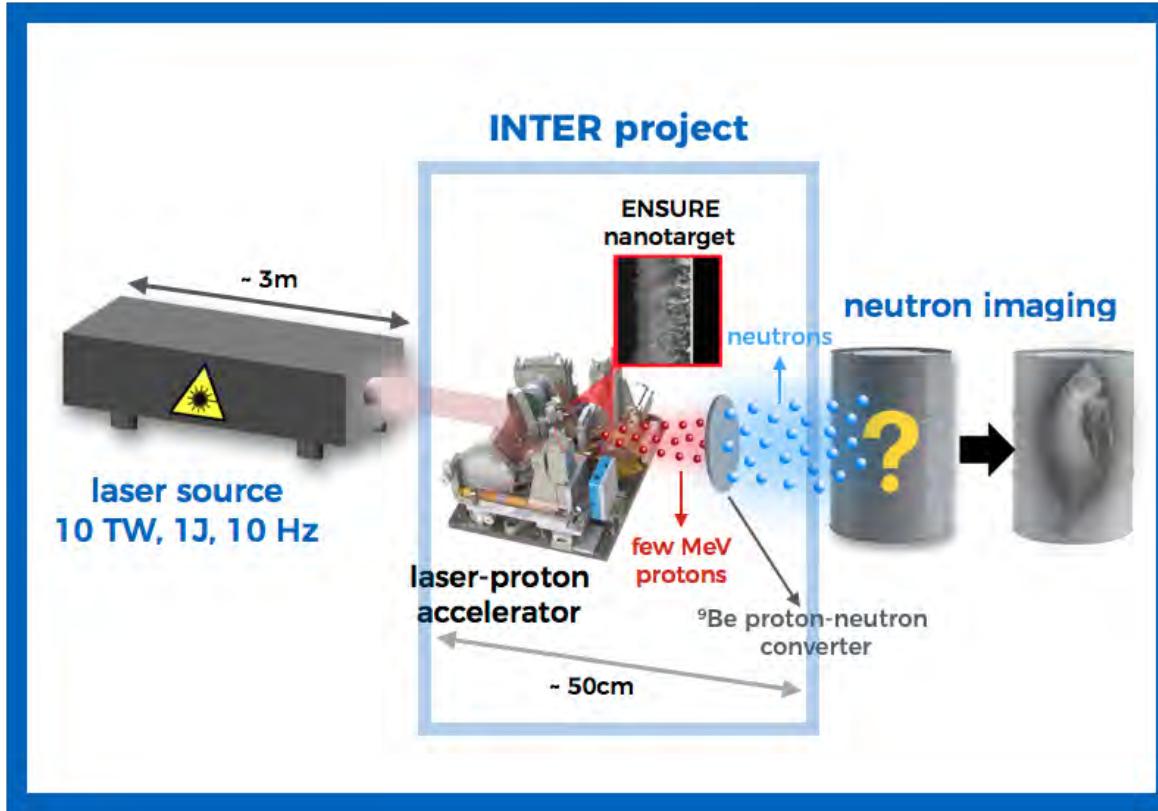


Some simulations with **1D radiation hydrodynamics** codes are needed. We mainly rely on a collaboration with **Osaka University** and **CELIA (France)** for this part.



Numerical simulations

Laser-driven neutron sources



Source **LAB**

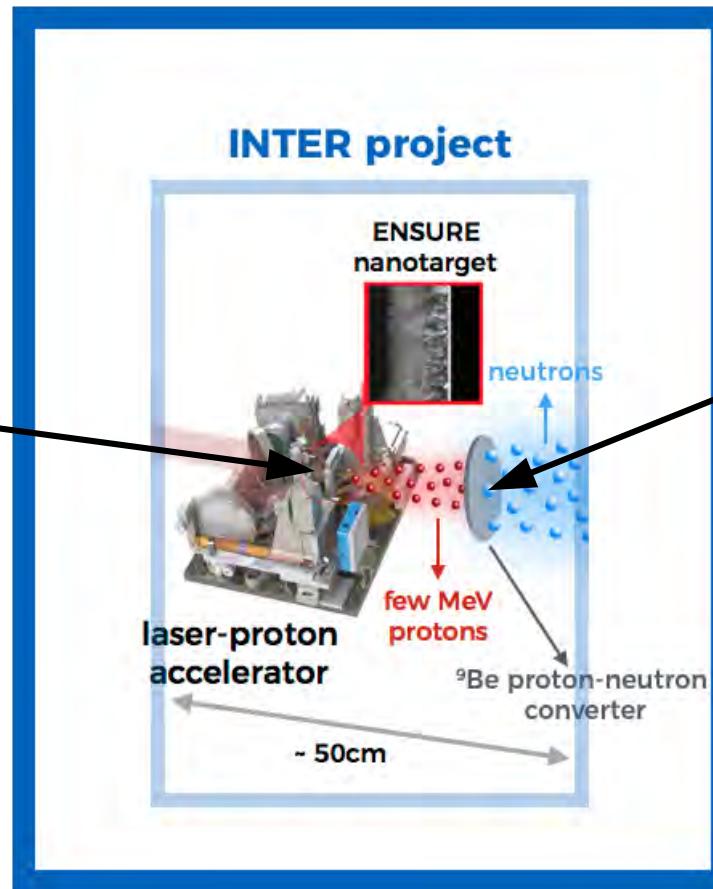
We are planning to study secondary neutron sources.
Ongoing collaboration with SourceLAB (France).



Numerical simulations

Laser-driven neutron sources

PI^C simulations at
relatively
low intensity ($a_0 \lesssim 1$):
ionization?
collisional effects?

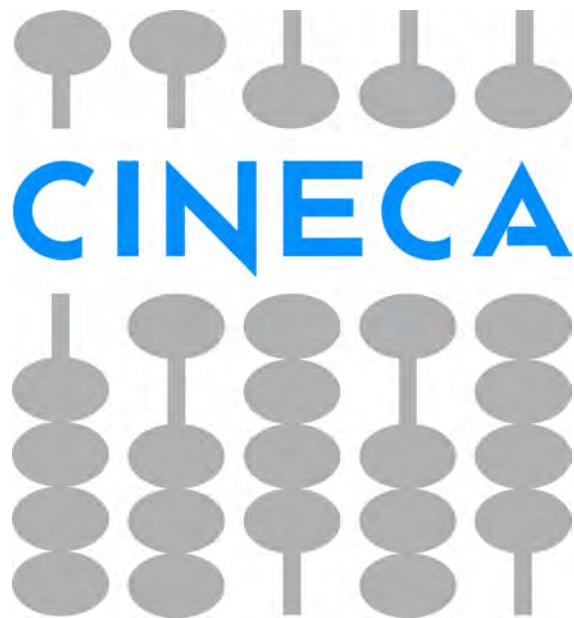


GEANT4 simulations of
Neutron generation in
Beryllium converters



Numerical simulations

HPC facilities

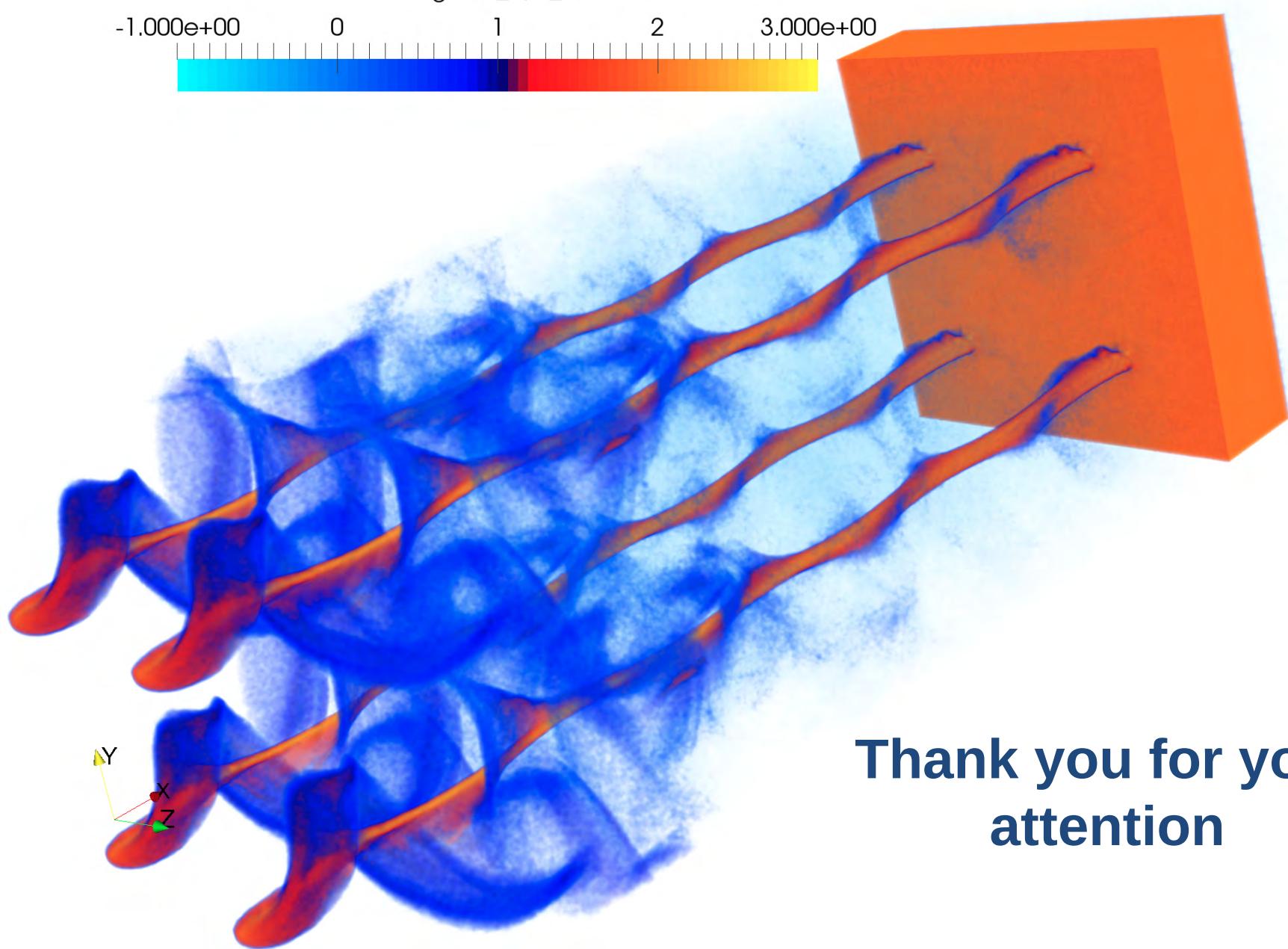


MARCONI @ CINECA(Bologna)
is our main HPC resource.
Access mainly via **ISCRA C / LISA grants**
2017 LISA SNAP: ~170 KCPUhours
2016 ISCRA LLonFAT: ~150KCPUhours [...]



MARCONI (12th in TOP500 as of Nov 2016)
CINECA Cluster, Intel Xeon Phi 7250 68C
1.4GHz, Intel Omni-Path (241.000 cores)
Linpack Performance: **6.2 PetaFlops**





**Thank you for your
attention**

More info on our website



The screenshot shows the ENSURE project website. At the top left is the word "ENSURE" in large, bold, black letters. Below it is a subtitle: "Exploring the New Science and engineering unveiled by Ultraintense ultrashort Radiation interaction with mattER". To the right of the subtitle are the European Research Council (ERC) logo (orange dots), the Politecnico di Milano seal, and the text "POLITECNICO MILANO 1863" above "DIPARTIMENTO DI ENERGIA". A navigation bar below the title includes links for HOME (highlighted in blue), THE PROJECT, GOALS, METHODS, PEOPLE, RESULTS, COLLABORATIONS, PRESS, and NEWS.



www.ensure.polimi.it