



POLITECNICO
MILANO 1863

Numerical simulations of Laser-Plasma interaction at POLIMI

Matteo Passoni

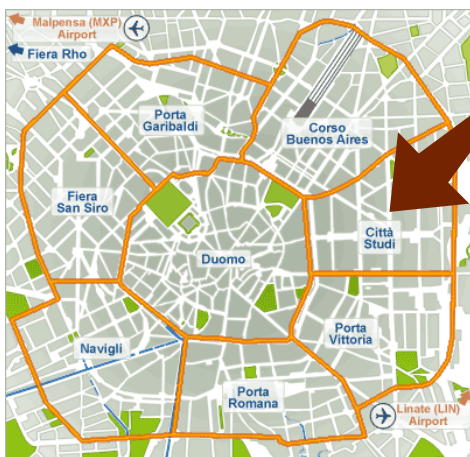
Pisa, 23/02/2017



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



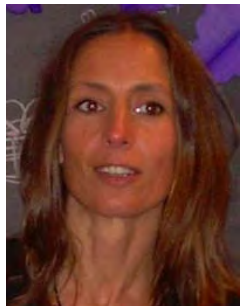
Matteo Passoni
Associate professor



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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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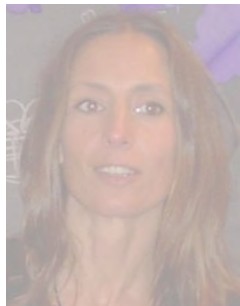
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ENSURE project

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

ENSURE project

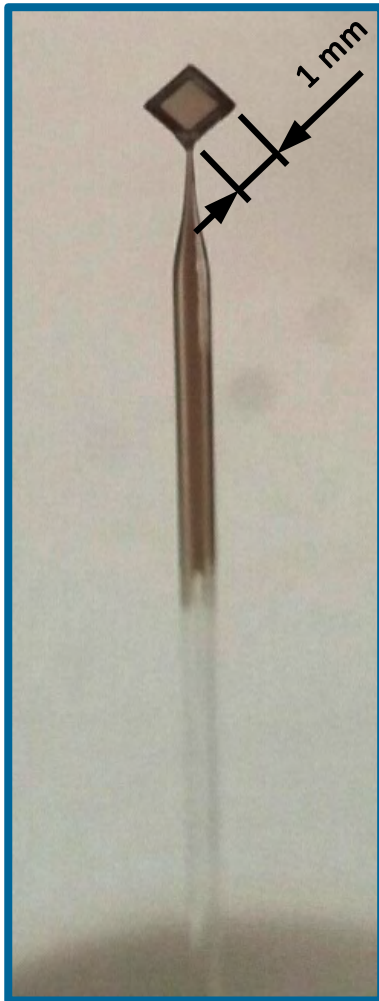
Materials science

Targets for collision-less shocks experiments

ENSURE project

Materials science

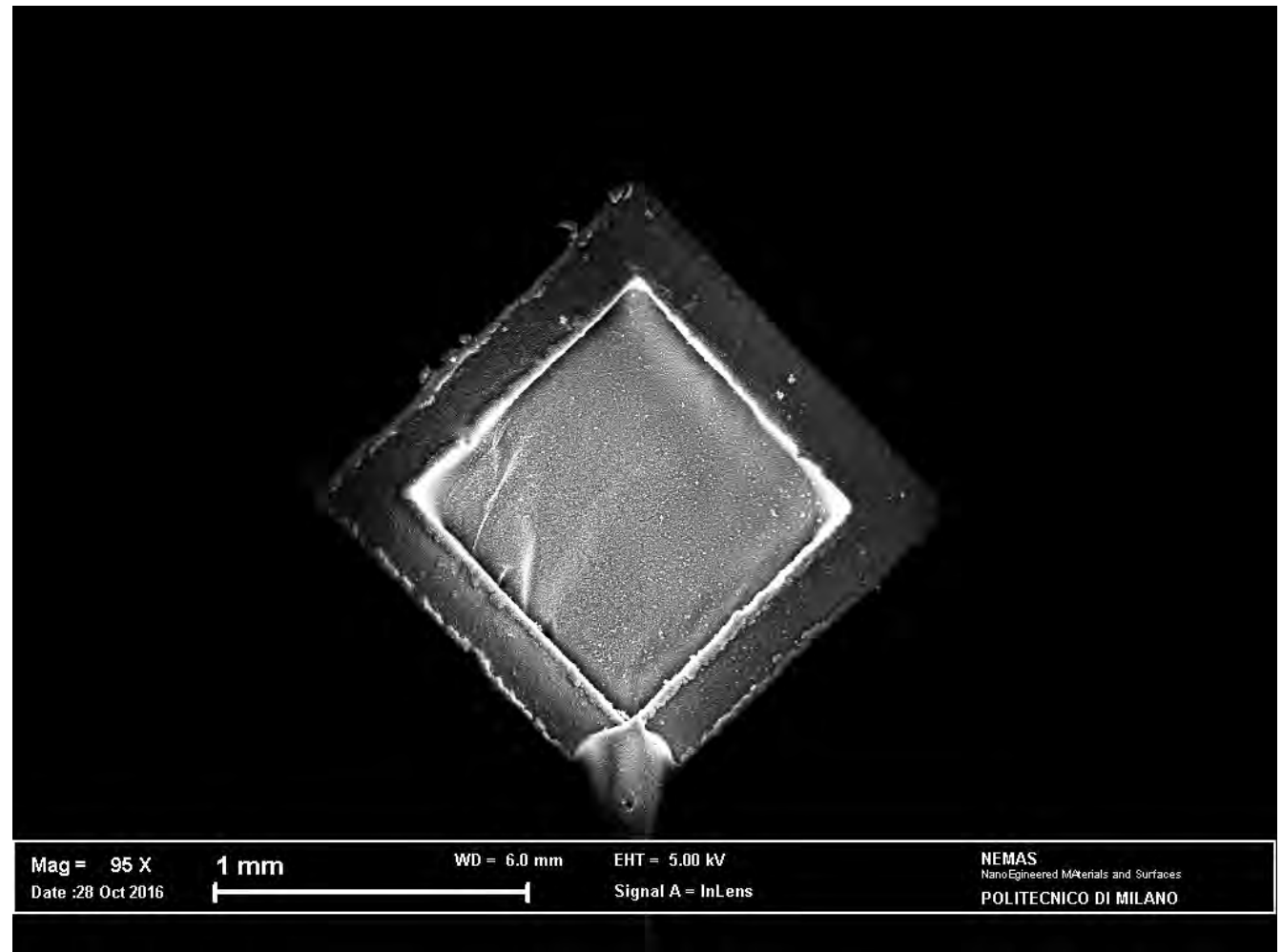
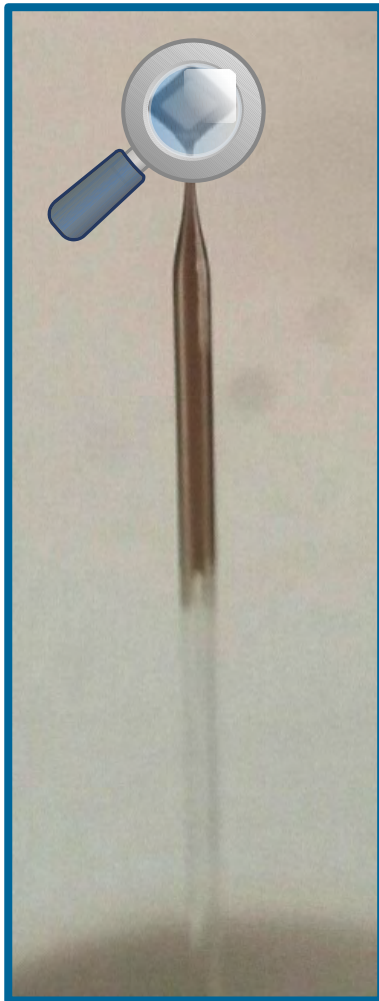
Targets for collision-less shocks experiments



ENSURE project

Materials science

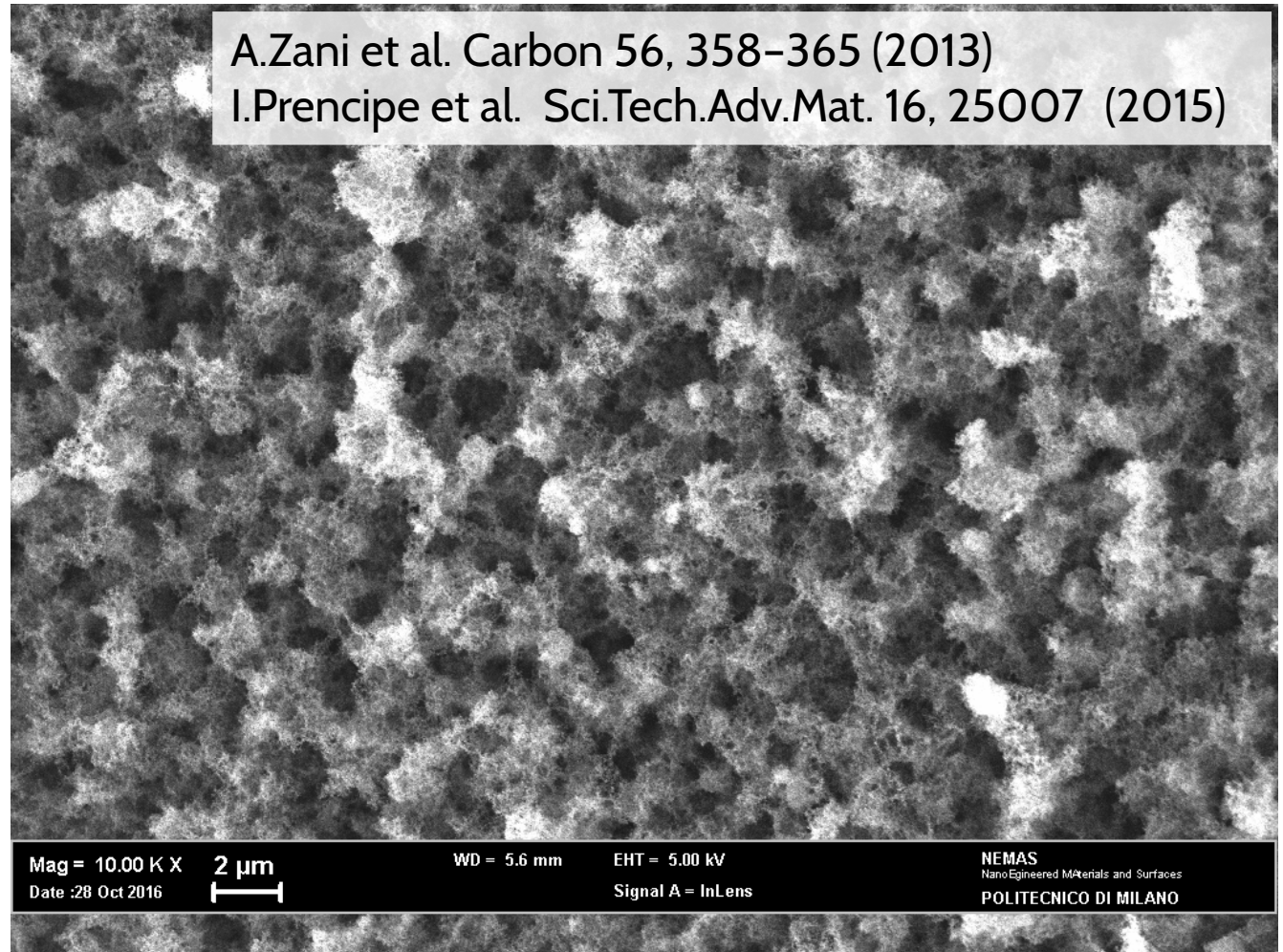
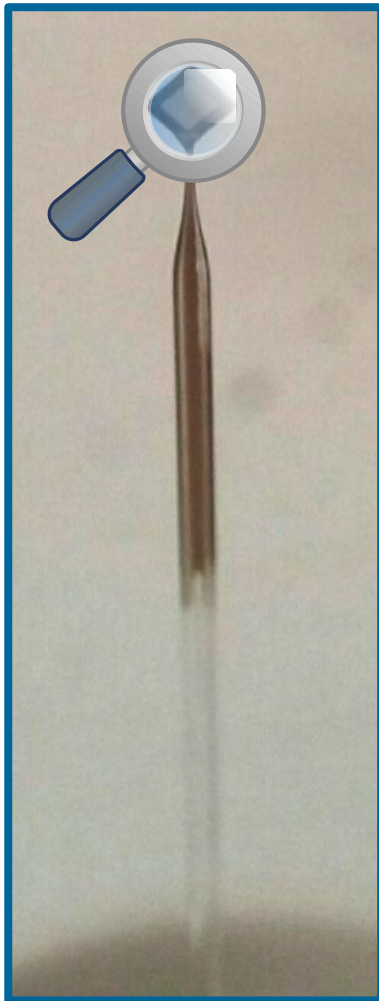
Targets for collision-less shocks experiments



ENSURE project

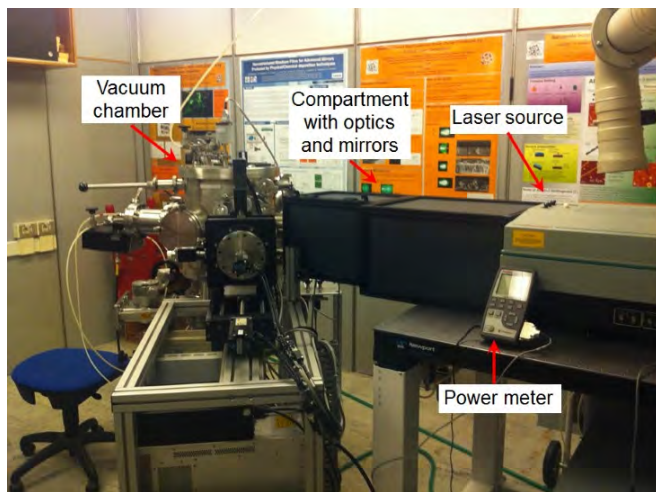
Materials science

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



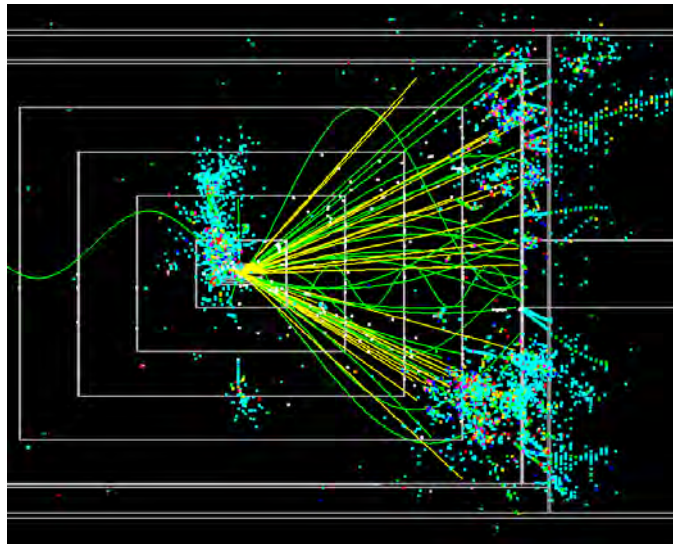
Numerical activity



Numerical activity

Piccante

Open source Particle-In-Cell code



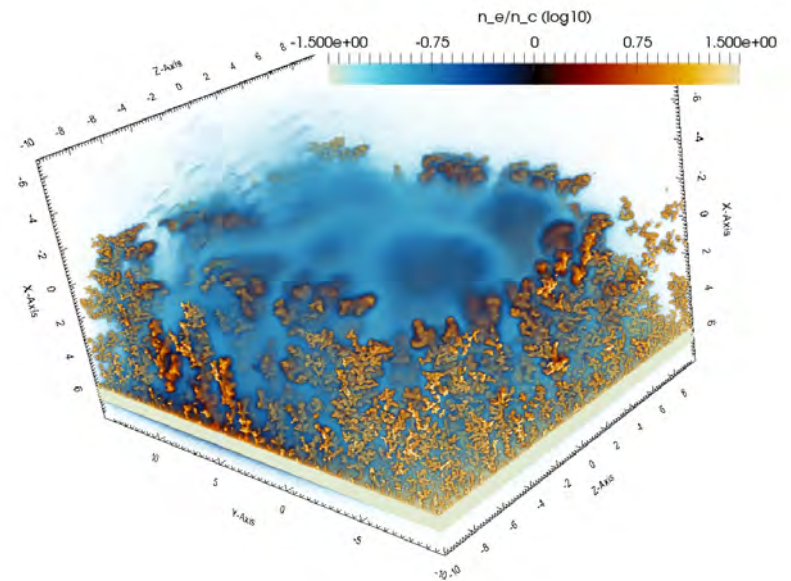
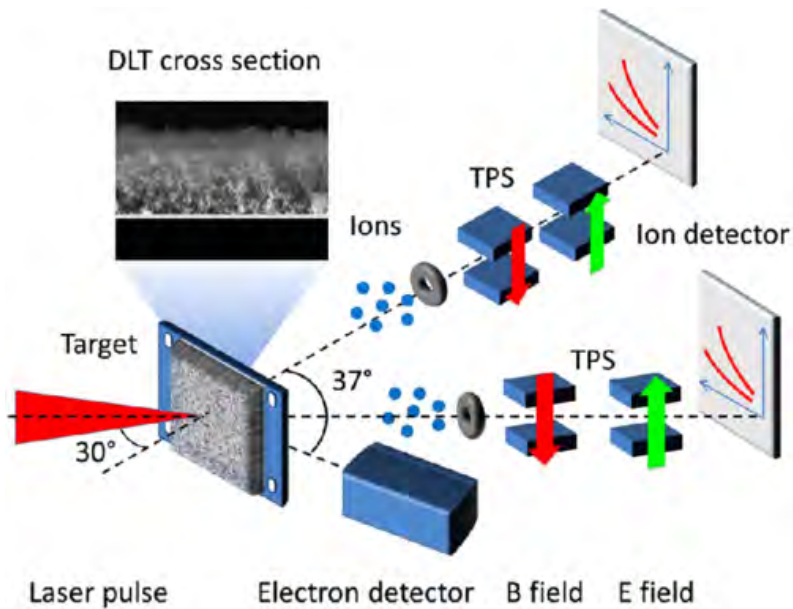
Geant4

Open source Monte Carlo code



Numerical simulations

Nanostructured low-density materials



M.Passoni et al. PRAB 19, 061301 (2016)

I.Prencipe et al. PPCF 58, 45001 (2016)

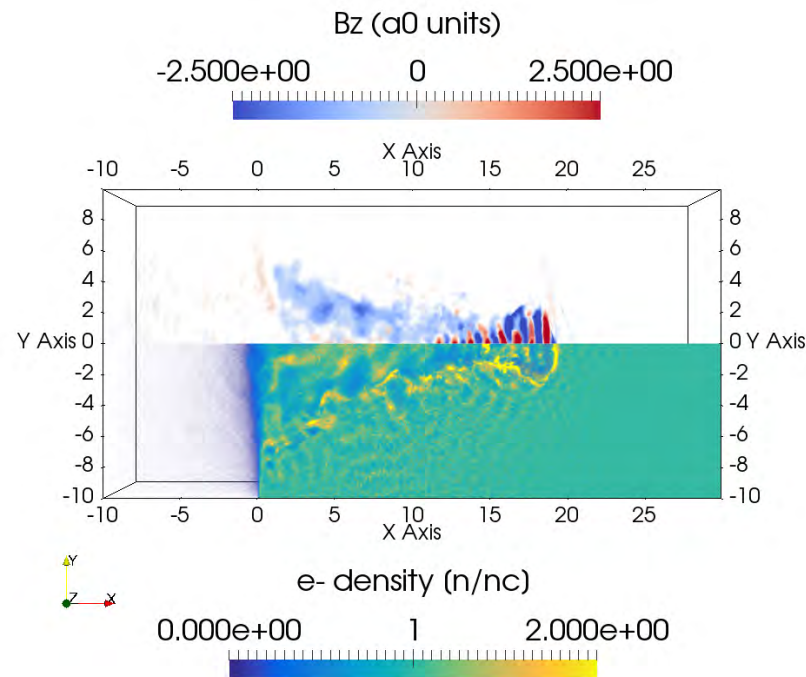
Support ion acceleration experiments

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



Numerical simulations

Nanostructured low-density materials

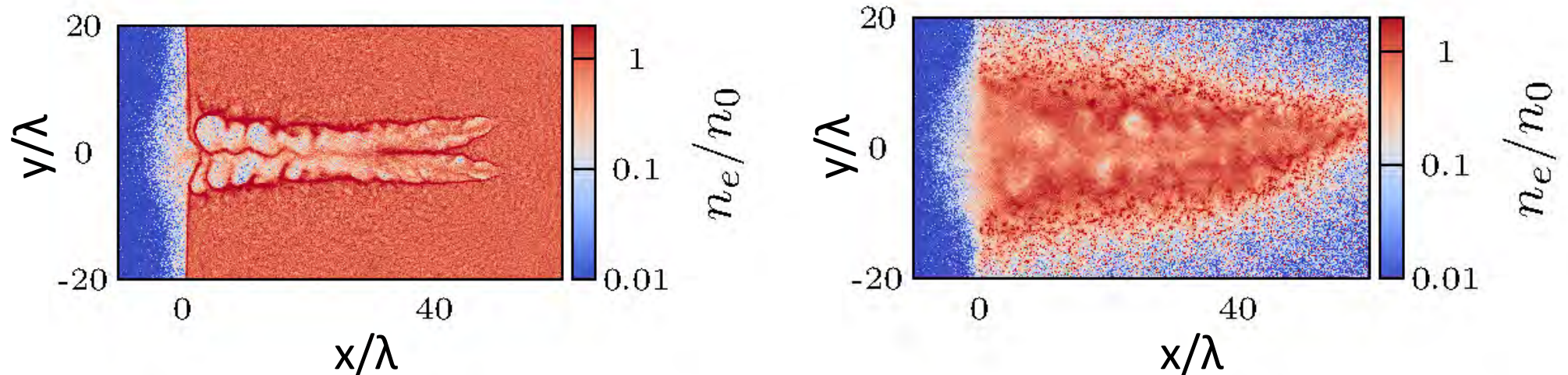


Theoretical/numerical investigation of laser propagation in (nanostructured) near-critical plasmas



Numerical simulations

Nanostructured low-density materials



L.Cialfi, L.Fedeli, M.Passoni. PRE 94, 053201 (2016)

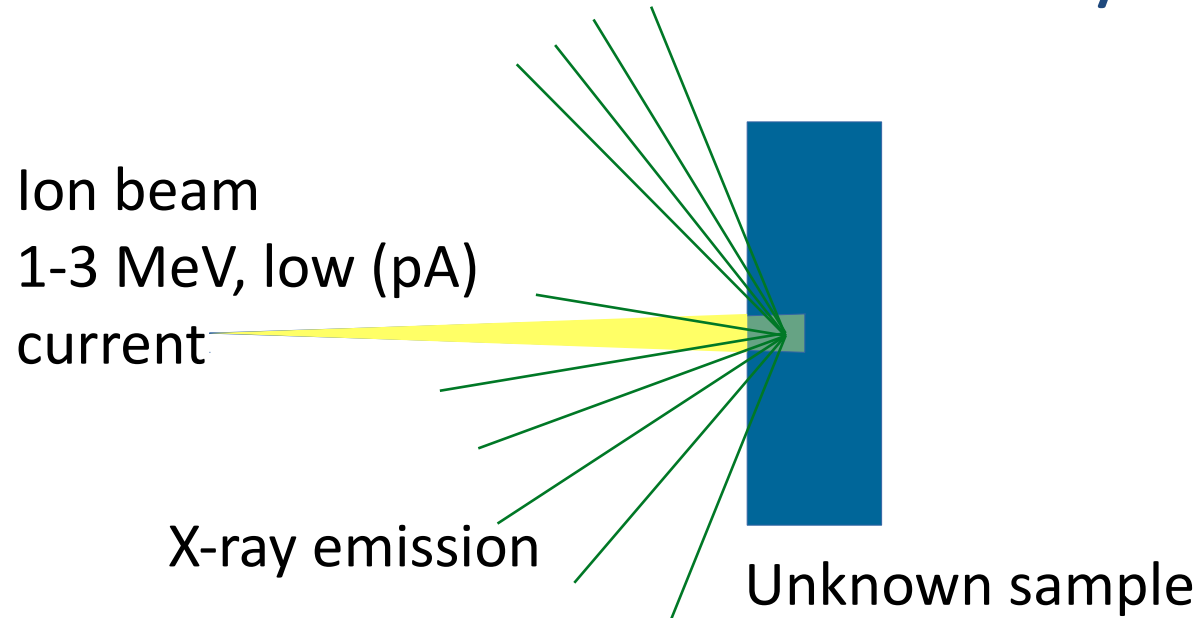
L.Fedeli, A.Formenti, M.Passoni (in preparation)

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



Numerical simulations

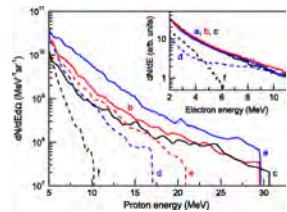
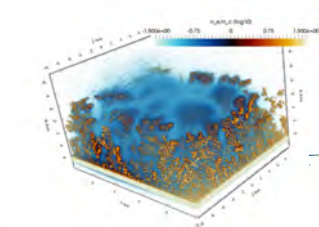
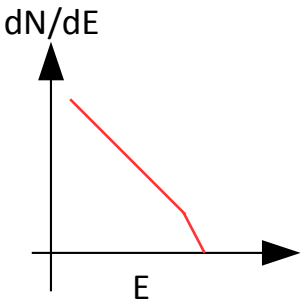
Proton Induced X-ray Emission (PIXE)



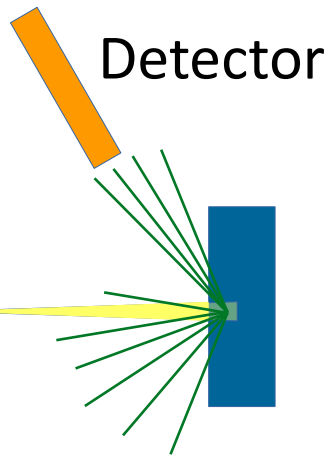
We are performing numerical simulations with GEANT4 to **assess the feasibility (and possible advantages) of PIXE with laser-driven ions**



Numerical simulations

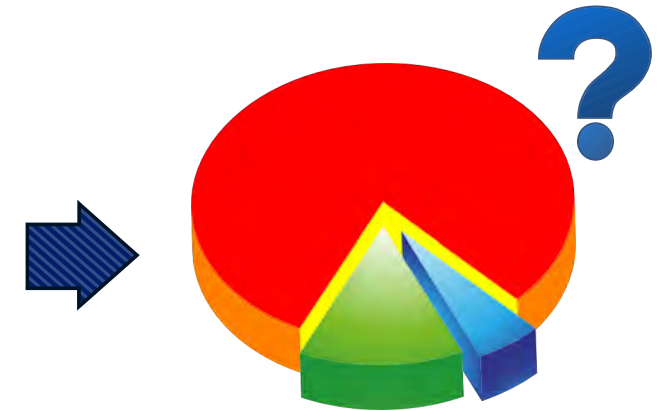
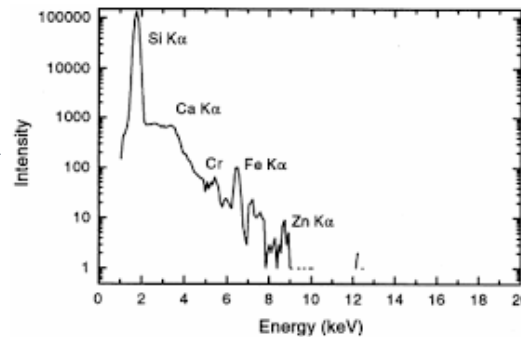


Proton Induced X-ray Emission (PIXE)



**GEANT4: simulated
PIXE experiment**

Synthetic spectra



Composition of the sample?

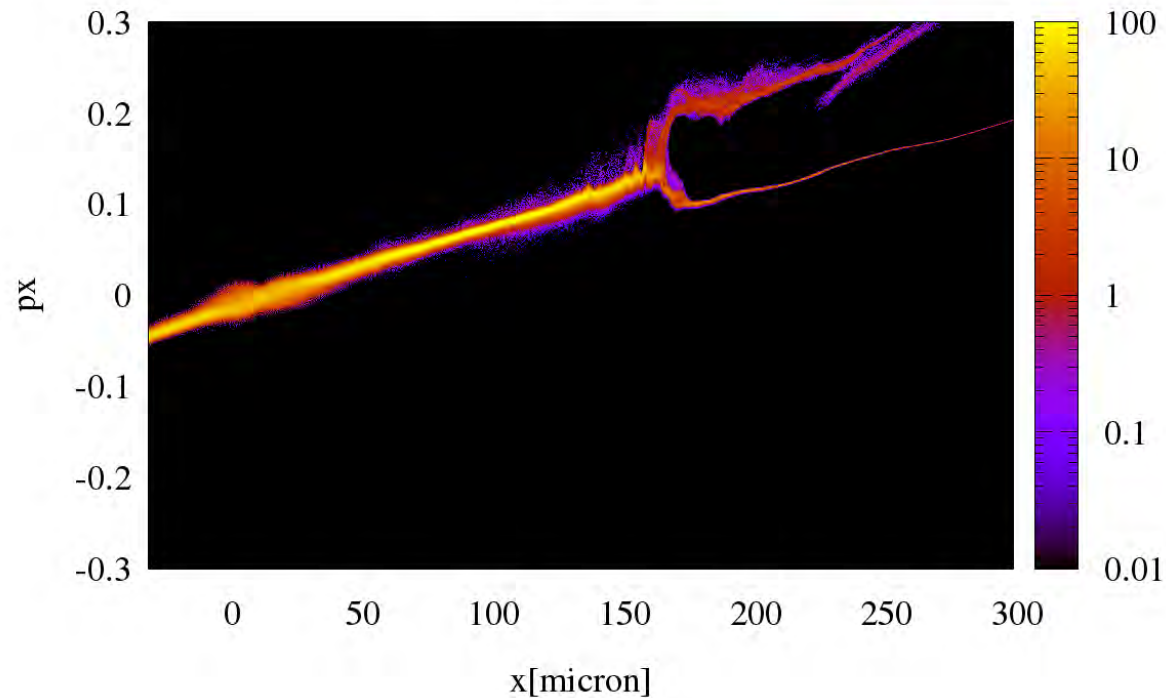
Laser-driven ion source
(from simple models,
PIC simulations or
experimental data)

For standard PIXE this is done
with proprietary softwares like
GUPIX



Numerical simulations

Laboratory astrophysics



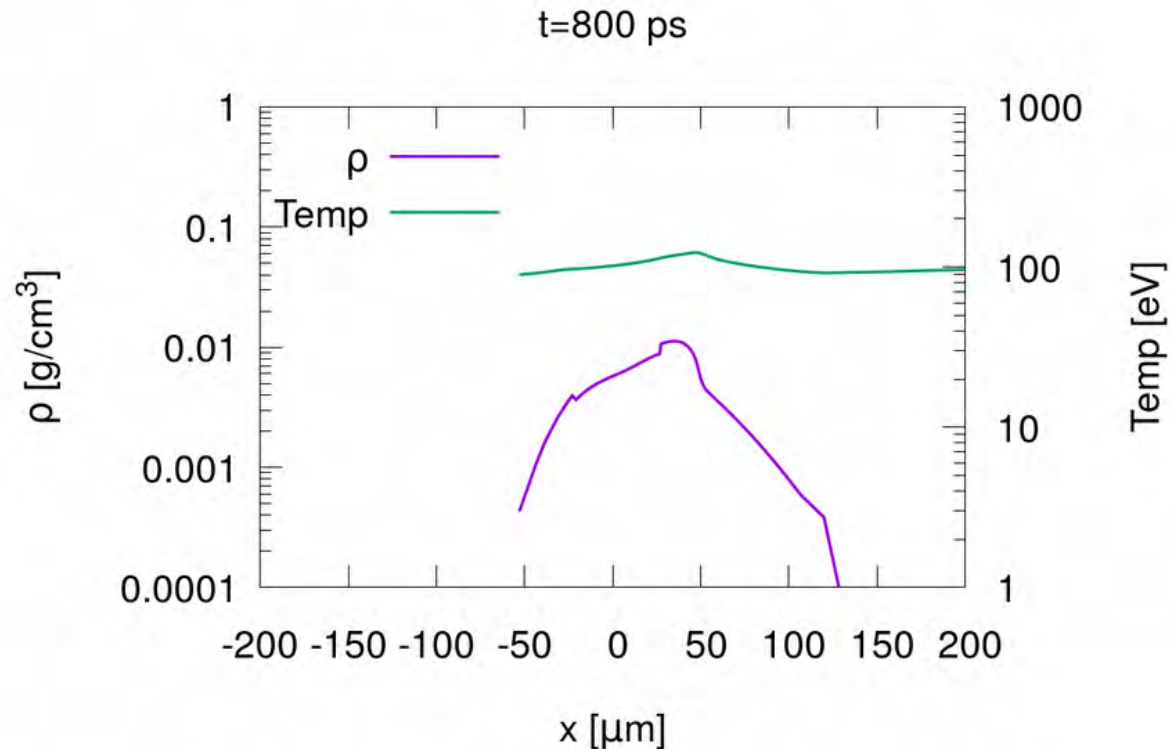
PIC simulation of **collisionless shocks**

Ongoing collaboration with ILE - University of Osaka (Japan)



Numerical simulations

Laboratory astrophysics

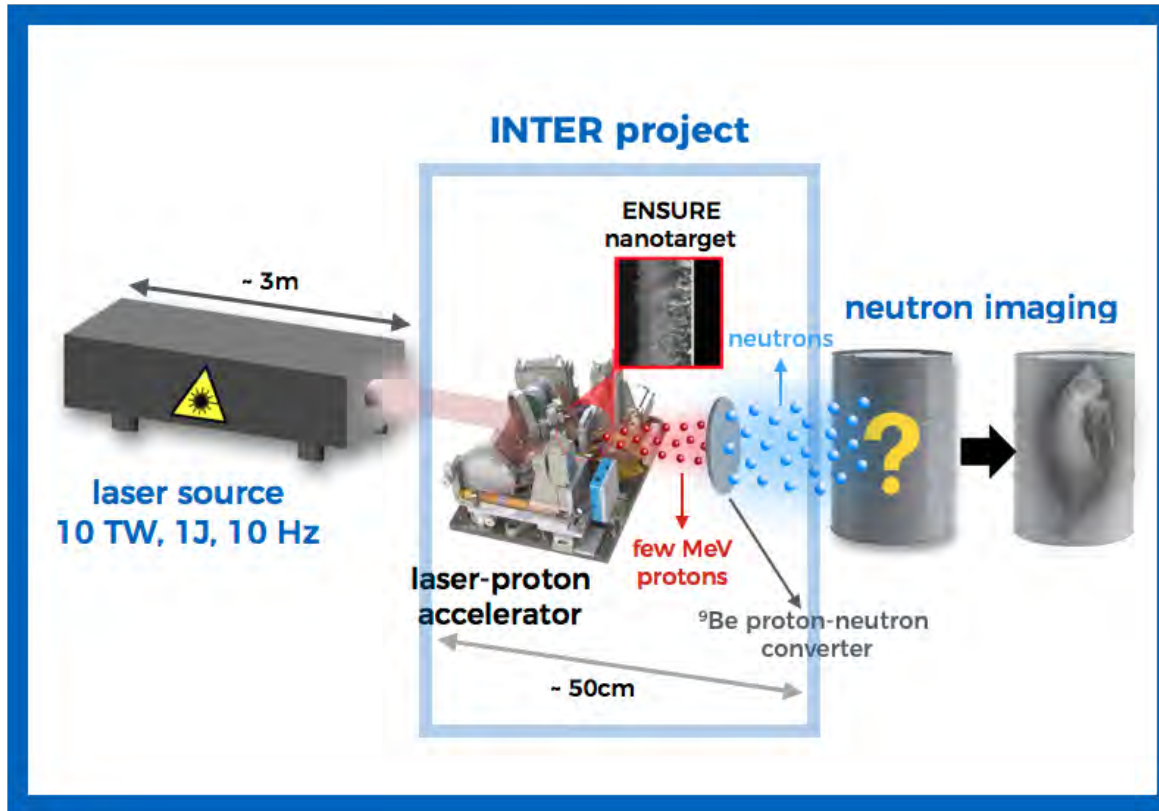


Some simulations with **1D radiation hydrodynamics** codes are needed. We mainly rely on a collaboration with **Osaka University** and **CELIA (France)** for this part.



Numerical simulations

Laser-driven neutron sources



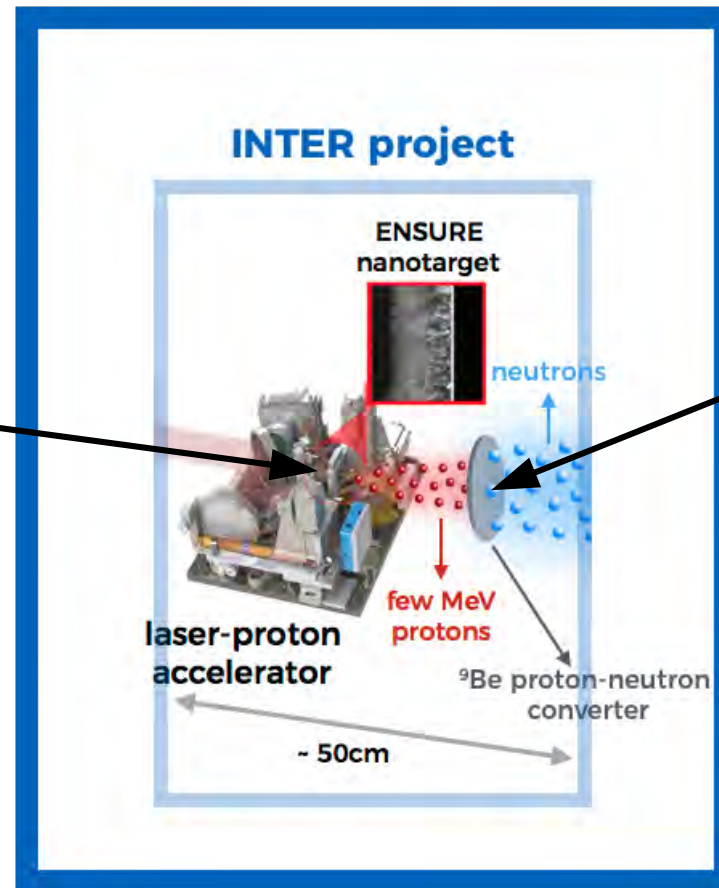
We are planning to study secondary neutron sources.
Ongoing collaboration with **SourceLAB** (France).



Numerical simulations

Laser-driven neutron sources

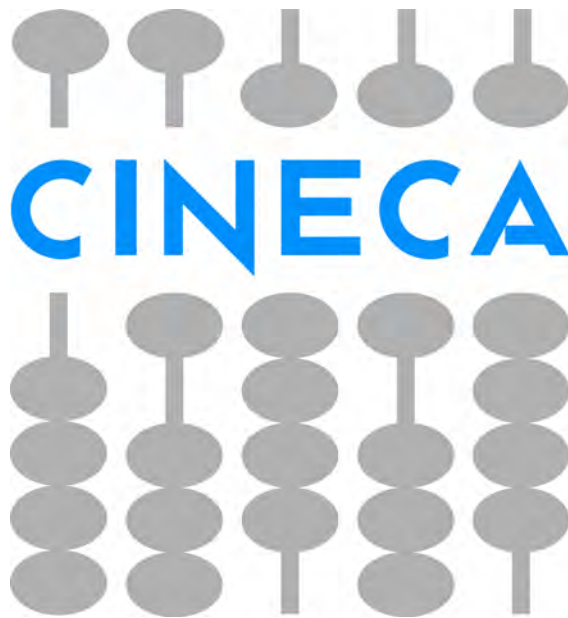
PIC simulations at relatively low intensity ($a_0 \lesssim 1$): ionization? collisional effects?



GEANT4 simulations of Neutron generation in Beryllium converters

Numerical simulations

HPC facilities



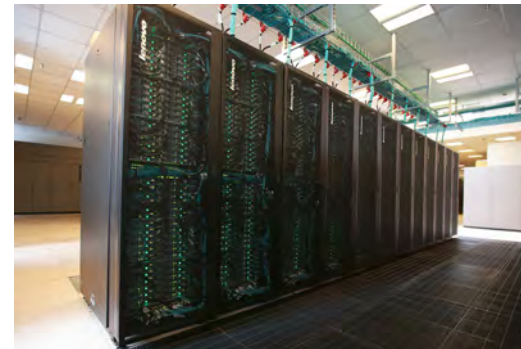
MARCONI @ CINECA(Bologna)

is our main HPC resource.

Access mainly via **ISCRA C / LISA** grants

2017 LISA SNAP: ~170 KCPUhours

2016 ISCRA LionFAT: ~150KCPUhours [...]



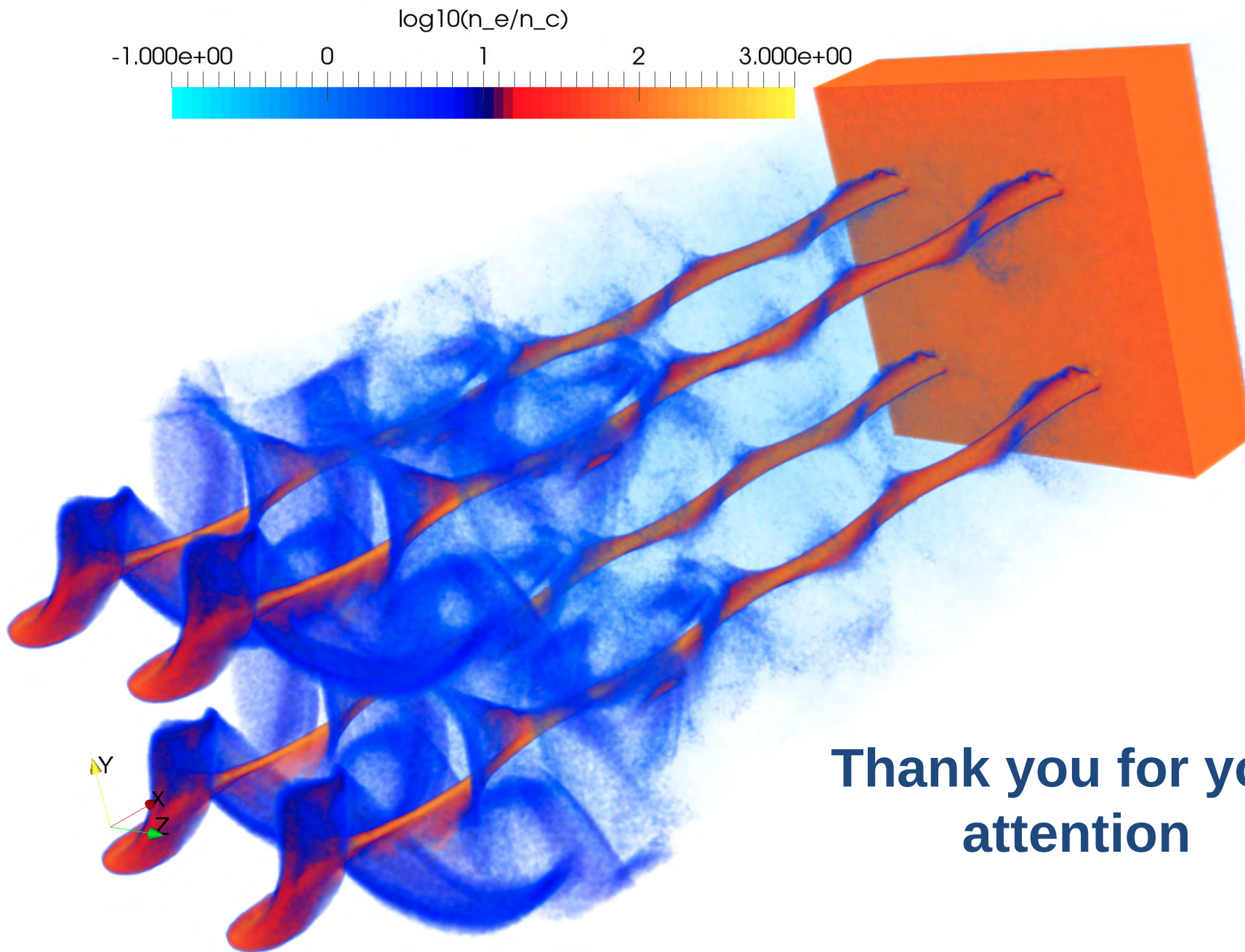
MARCONI (12th in TOP500 as of Nov 2016)

CINECA Cluster, Intel Xeon Phi 7250 68C

1.4GHz, Intel Omni-Path (241.000 cores)

Linpack Performance: **6.2 PetaFlops**

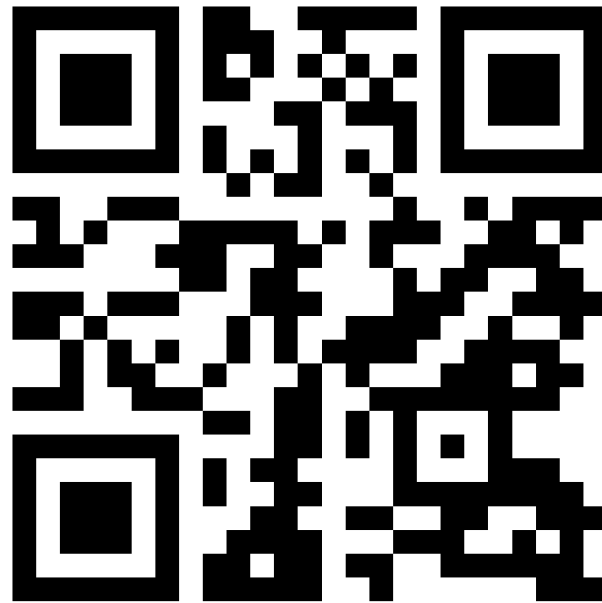
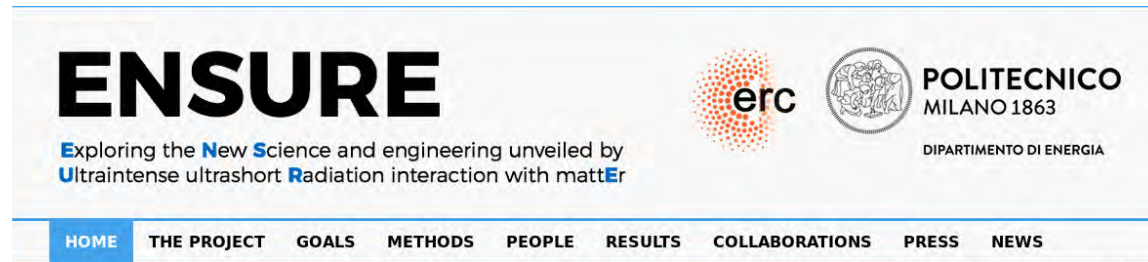




**Thank you for your
attention**



More info on our website



www.ensure.polimi.it