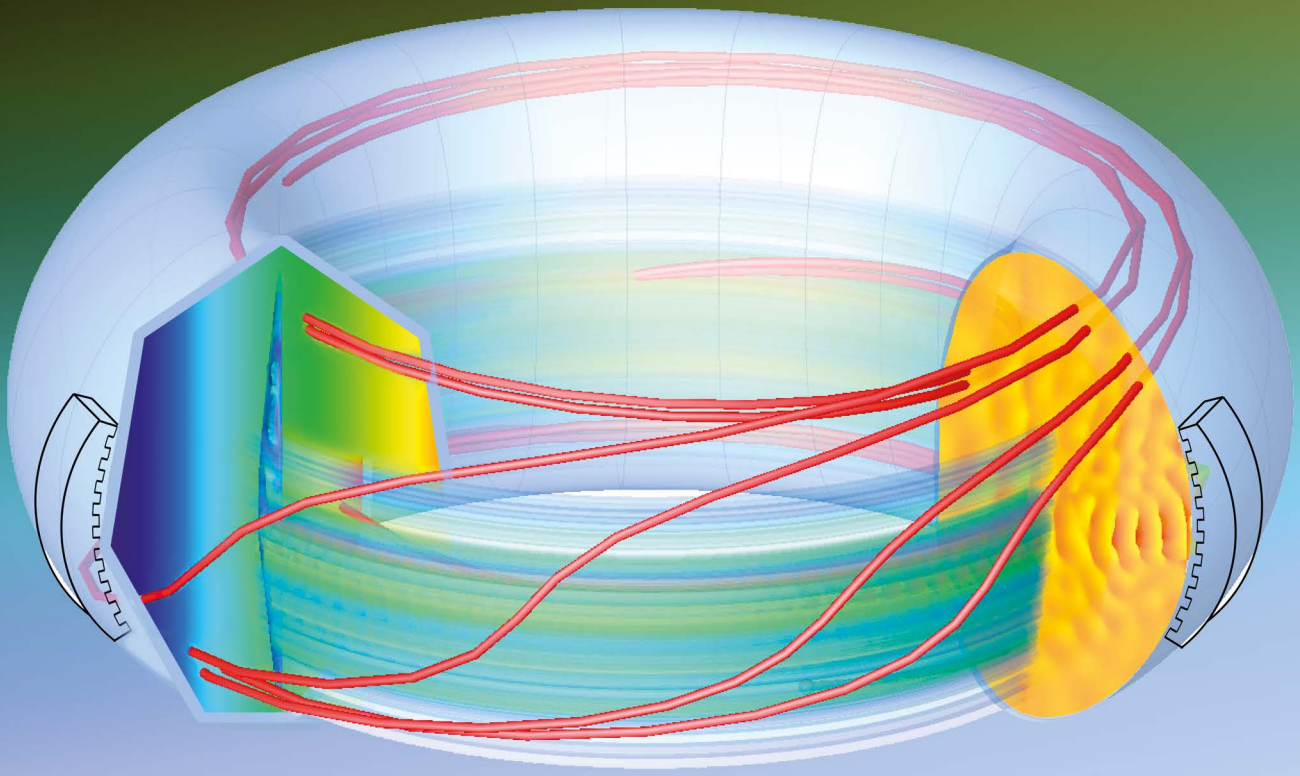
MASTER

COMPUTATIONAL SCIENCE AND ENGINEERING

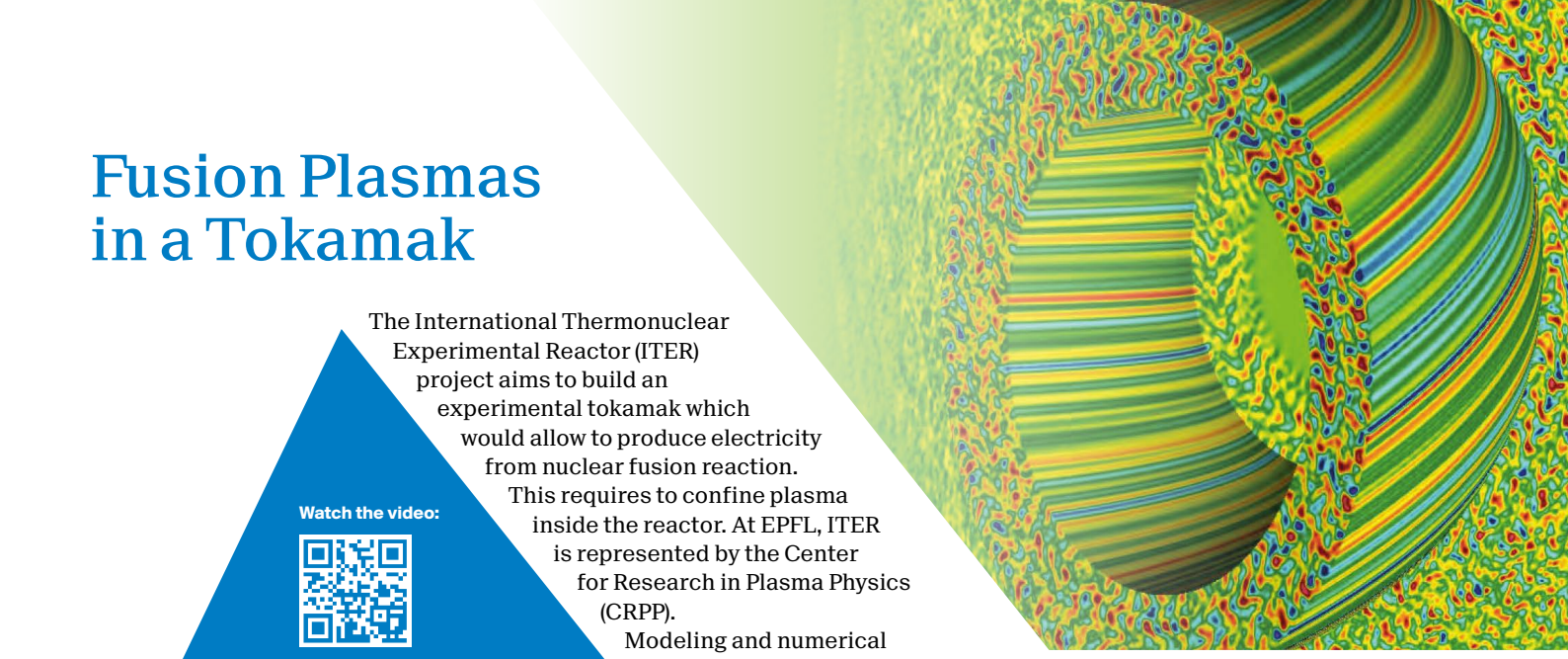


EPFL

Simulation at the heart of science

Nuclear fusion. Climate evolution. Nanoscale piling. Mathematical developments. What do these four science topics have in common? Computer simulations, where human genius - in making models and shaping up algorythms - and supercomputers meet. The master in computational science provides students with all the basic skills that will make them most wanted specialists in scientific computing, numerical methods, algorithmic and software engineering, visualisation and multiscale-multiphysics modeling.

Fusion Plasmas in a Tokamak



Magnetic confinement of plasma in a Tokamac. Boyancy and turbulence.

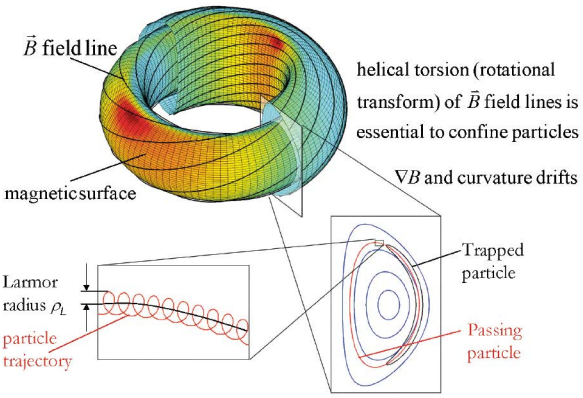
The International Thermonuclear Experimental Reactor (ITER) project aims to build an experimental tokamak which would allow to produce electricity from nuclear fusion reaction. This requires to confine plasma inside the reactor. At EPFL, ITER is represented by the Center for Research in Plasma Physics (CRPP).

Modeling and numerical simulations of the plasma allow to study its behavior before the completion of the reactor and without the risks and costs inherent to the first real experiments. Therefore, efficient numerical methods that can be implemented for parallel simulation on supercomputer are essential for such complex simulations.

website: http://crpp.epfl.ch/research_TCV

Watch the video:

Dana Christen:
"What I liked about EPFL is that it offered a good blend of theoretical courses and applied hands-on experiences."



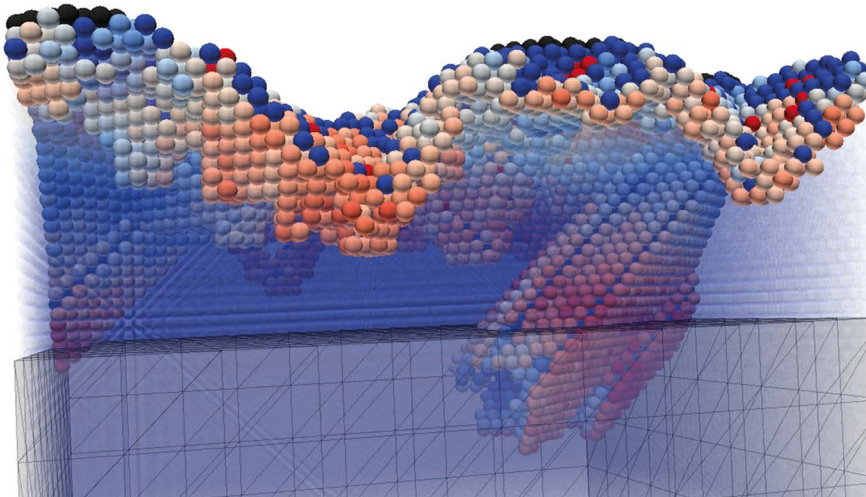
Multiscale Modeling of Materials

The mechanical deformation or the failure of a material, or the interaction between two objects, are characterized by phenomena at different space and time scales. The independent modeling of different scales has lead to important insights over the years. Thanks to modern supercomputers and advanced numerical schemes it is nowadays possible to better understand the interaction between scales. This relies on the coupling of continuum and discrete modeling and allows to understand involved mechanisms, for example, at the contact between two materials or at the origin of a fracture.

Labs: LAMMM+LSMS
website: http://lsms.epfl.ch/

Watch the video:

Vincent Zimmern:
"EPFL has now this worldwide reputation for being a computationally very active place, with a lot of research going on."

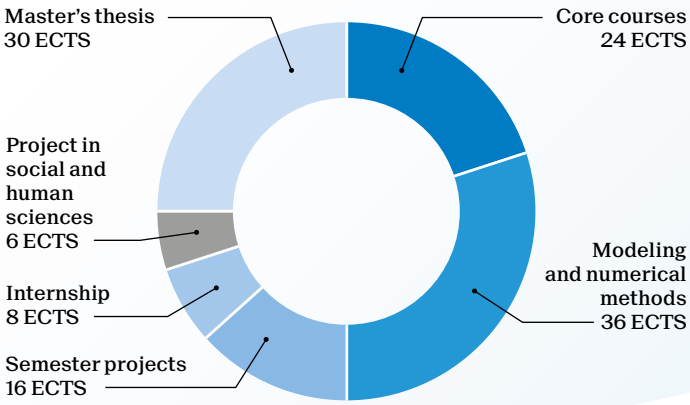


Dislocation emission during the normal contact loading of a nanoscale rough surface. The model benefits from a coupled method to reduce the computational cost involved in handling many atoms.

Master of Science in

COMPUTATIONAL SCIENCE AND ENGINEERING

2-year program - 120 ECTS



In the Modeling and numerical methods group, students have to choose 3 out of the 4 lists and complete at least 8 ECTS in each of them.

Internship

The program includes a compulsory 8-week internship which can be extended to 6 months.

Career prospects

EPFL is a world leader in computing, engineering and fundamental sciences. A Master in Computational Science and Engineering from EPFL opens the door to top employment with computational skills in a broad spectrum of industries, not only in all branches of engineering, but also in emerging and vibrant market sectors including energy, financial and pharmaceutical R&D.
It is also a strong asset for a PhD in Computational Science.

School of Basic Sciences
go.epfl.ch/master-computational-science-engin
Contact: cse@epfl.ch

	Credits
Core courses	**24**
Advanced numerical analysis	5
Algorithms	8
Computer simulation of physical systems I	4
Image processing I	3
Introduction to multiprocessor architecture	4
Machine learning	8
Molecular dynamics and Monte-Carlo simulation	2
Numerical analysis and computational mathematics	4
Parallel and high-performance computing	4
Programming concepts in scientific computing	4
Software engineering	4

Modeling and numerical methods	**36**
Computational modeling based on differential equations	8 min.
Atomistic and quantum simulations of materials	4
Computational neurosciences: neuronal dynamics	5
Dynamical system theory for engineers	6
Environmental transport phenomena	5
Hydrodynamics	5
Instability	3
Numerical flow simulation	5
Principles and applications of systems biology	3
Turbulence	5

Computational modeling based on discrete systems	8 min.
Computational methods in molecular quantum mechanics	4
Distributed intelligent systems	5
Geometric computing	6
Image processing II	3
Introduction to electronic structure methods	4
Mathematical foundations of signal processing	6
Mathematical modeling of behavior	5
Molecular quantum dynamics	3
Structural biology	4
Understanding advanced molecular simulation	4

Numerical methods, algorithms, high performance systems	8 min.
Advanced multiprocessor architecture	6
Computational linear algebra	5
Inference on graphs	5
Low-rank approximation techniques	5
Numerical approximation of PDEs	5
Numerical integration of stochastic differential equations	5
Numerical methods for conservation laws	5
Numerics for fluids, structures and electromagnetics	5
Stochastic simulation	5

Data science	8 min.
Algorithms II	8
Applied data analysis	8
Artificial neural networks/reinforcement learning	6
Deep learning	4
Deep learning in biomedicine	6
Foundations of data science	8
Information security and privacy	8
Mathematics of data: from theory to computation	6
Optimization for machine learning	8
Statistics for data science	8
Systems for data management data science	8