



**Post-doc opportunities at
the Military Applications Division (DAM)
of French CEA**

DE LA RECHERCHE À L'INDUSTRIE

**Olivier VACUS, Scientific Director of the CEA's Military Applications Division
Stockpile Stewardship Academic Program Symposium**

February 15th 2023

- Some words about “the DAM” (Direction des Applications Militaires)**

- Students at DAM**

- The Eric Bauge Students Exchange Program**

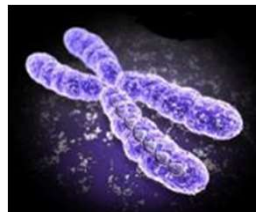
CEA ≈ DOE

Défense
&
Security



Nuclear and
renewable
energies

Technological
Research
for industry

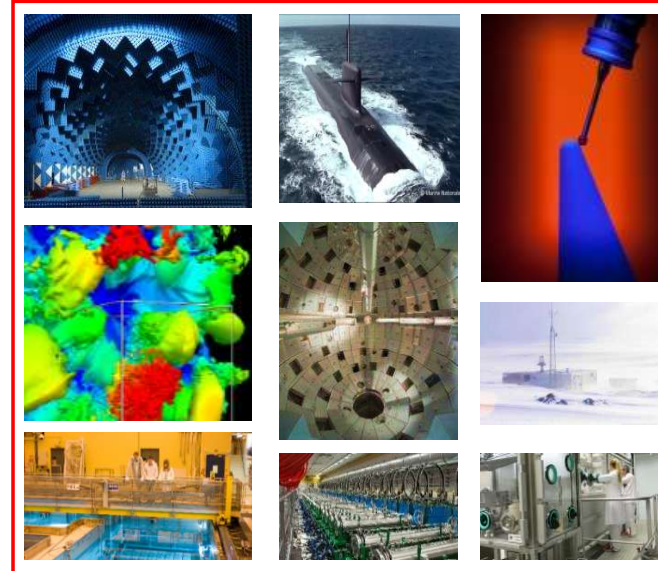


Fundamental research
(physical sciences
and life sciences)

- 4 Operational Divisions
- 9 Centers
- 9 Administration Divisions

16 500 staff

DAM ≈ NNSA

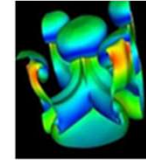


- 5 Program Directorates
- 5 Centers
- 5 Administration Directorates

4 850 staff



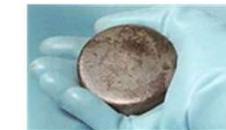
NUCLEAR WARHEADS



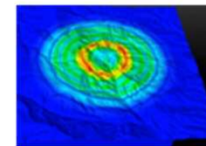
NUCLEAR PROPULSION



NUCLEAR MATERIALS (weapons and nuclear propulsion)



SECURITY AND NON-PROLIFERATION OF NUCLEAR WEAPONS



CONVENTIONAL DEFENSE



TECHNOLOGY TRANSFER IN DEFENSE AND INDUSTRY





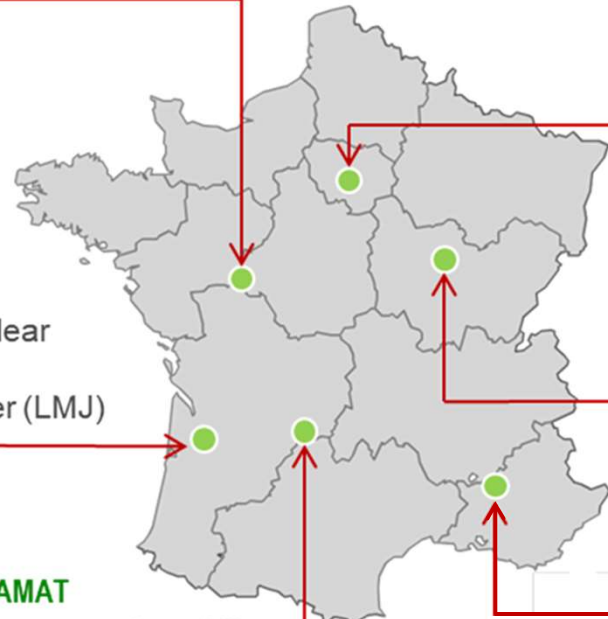
LE RIPAULT

- Non-nuclear materials



DAM ÎLE-DE-FRANCE

- Physics package conception and guarantee
 - Basic physics
- High performance computing
 - Treaty monitoring
 - Nuclear engineering



CESTA

- Architect of nuclear warheads
- Megajoule Laser (LMJ)



VALDUC

- Nuclear materials
- EPURE



GRAMAT

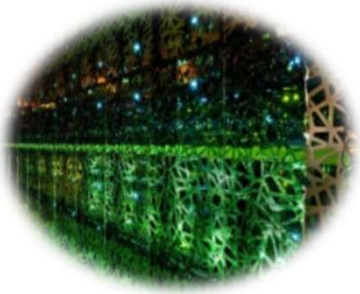
- Systems vulnerability and conventional weapons efficiency



INBS PN CADARACHE

(no student)





4850 employees

56% researchers/engineers

- ▶ 35% Ph D
- ▶ 65% engineer



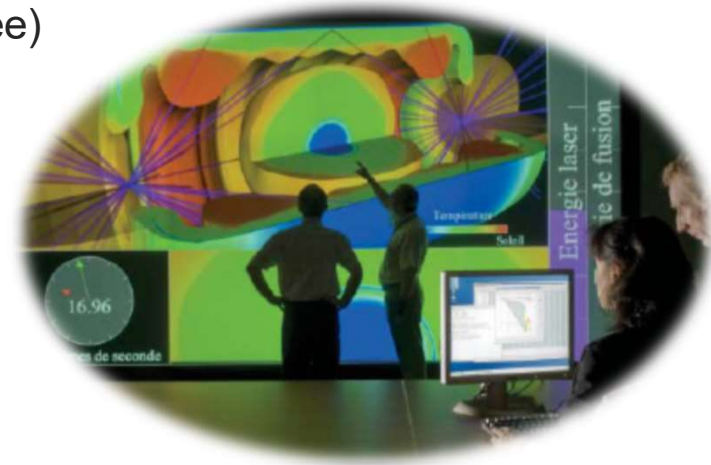
700 students

Apprentices and trainees
(From high school to master's degree)

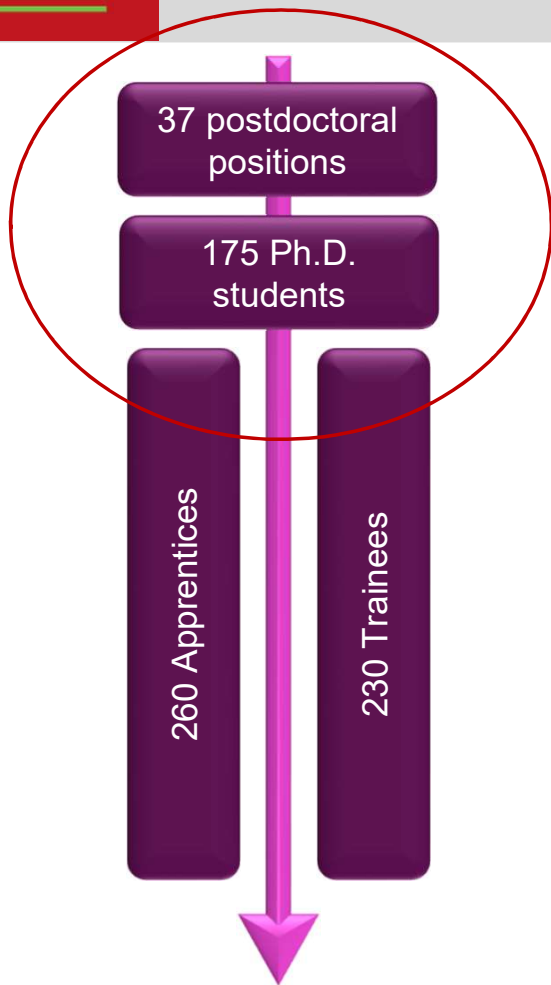


Doctoral students

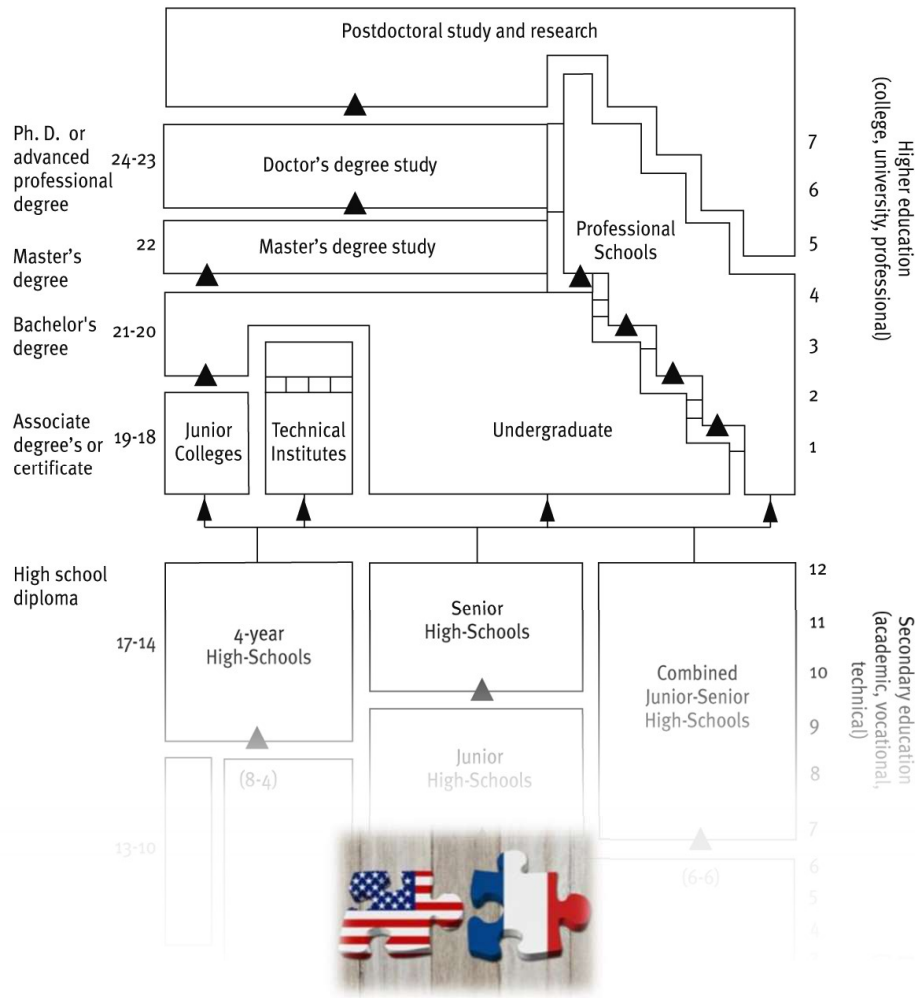
Postdoctoral students



STUDENTS WORKING AND STUDENTS HIRED PER YEAR AT DAM

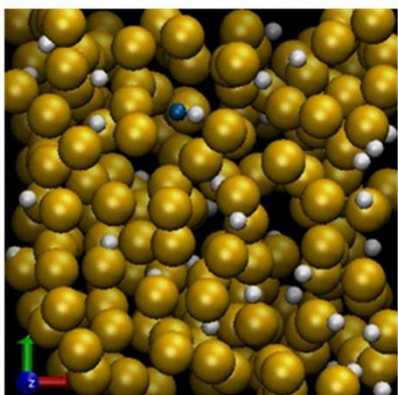


700 Students working at CEA's DAM

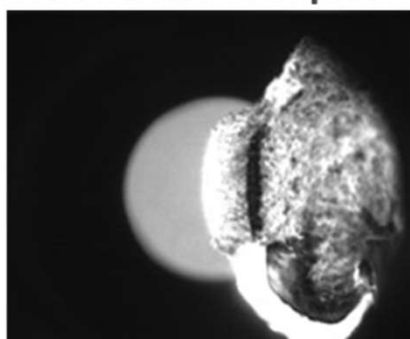


286 students hired

Orbital Free Molecular Dynamic Simulation of Hot Dense Matter

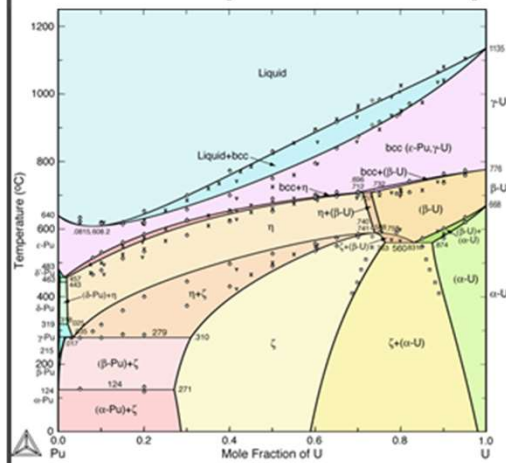


Experimental study of the reaction zone of explosives

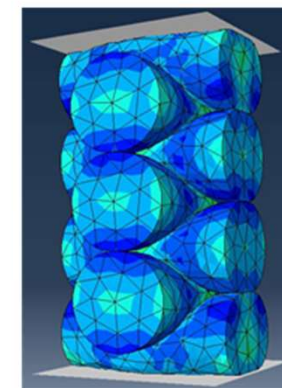


Shadowscopy of the expansion
of detonation

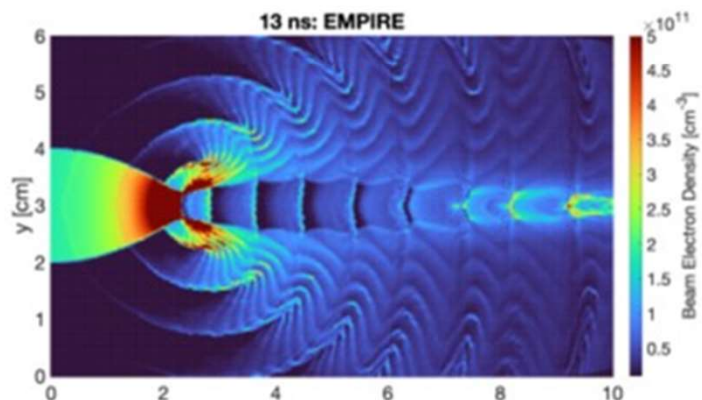
Effect of impurities on PuGa phase stability



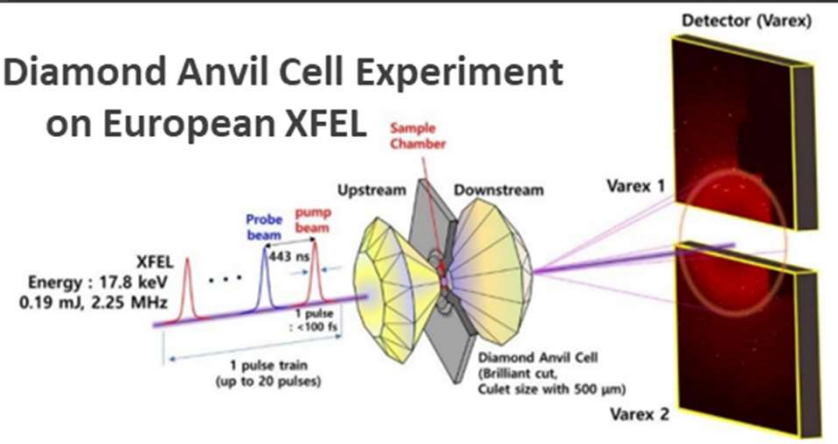
Additively manufactured porous structures



Electron beam propagation in gas-filled cells



Dynamic Diamond Anvil Cell Experiment on European XFEL

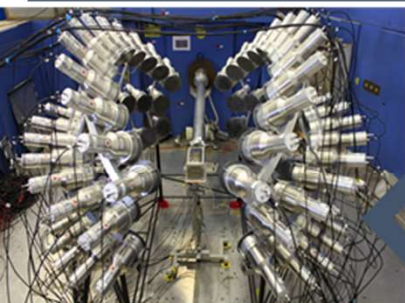


Experimental Nuclear Physics
measure nuclear phenomena

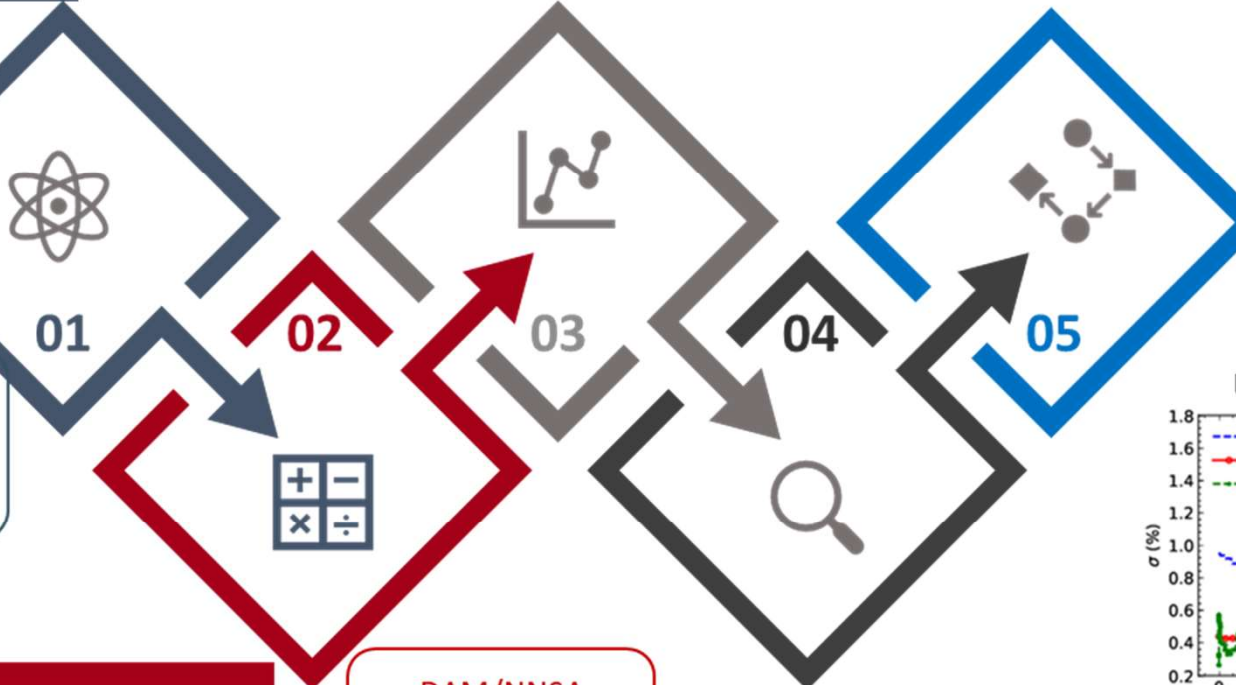
Nuclear Data Evaluation
numbers for the applications

Nuclear Data Validation
applicative level of confidence

Jezebel Exp.
 ^{239}Pu



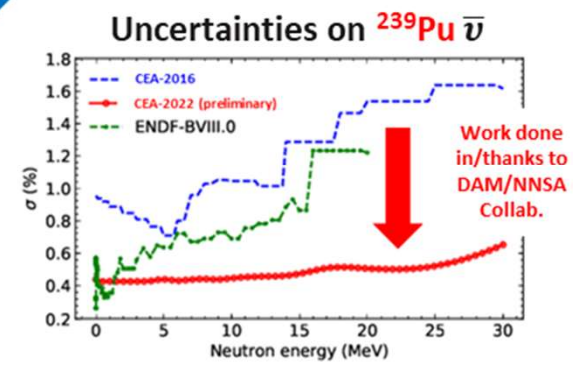
DAM VENDETA / NNSA CHI-NU
for neutron spectrum /multiplicity ($\bar{\nu}$)
measurements at LANSCE
2017 ^{239}Pu – 2019 ^{235}U – 2022 ^{238}U – ...



Theoretical Nuclear Physics
understanding nuclear phenomena

DAM/NNSA
Nuclear reaction
model comparison

Mastering the uncertainties
physics level of confidence



► Topics:

- HPC system administration
 - Operating systems, Resource management, Storage systems, Data management, ...
- « Co-design »
 - Architecture / Software evaluation, programming model, programming environment
- Workflows management
 - Exchange and evaluate different tools
- Linear Algebra
- Visualization
 - Evaluation and exchange around our tools (Visit, Paraview, Themis)
 - Common VTK and Paraview needs
 - Exchange about solutions to manage large data
- Meshing
 - Hexahedral meshing, mesh smoothing, mesh partitioning, transfer of field data between meshes

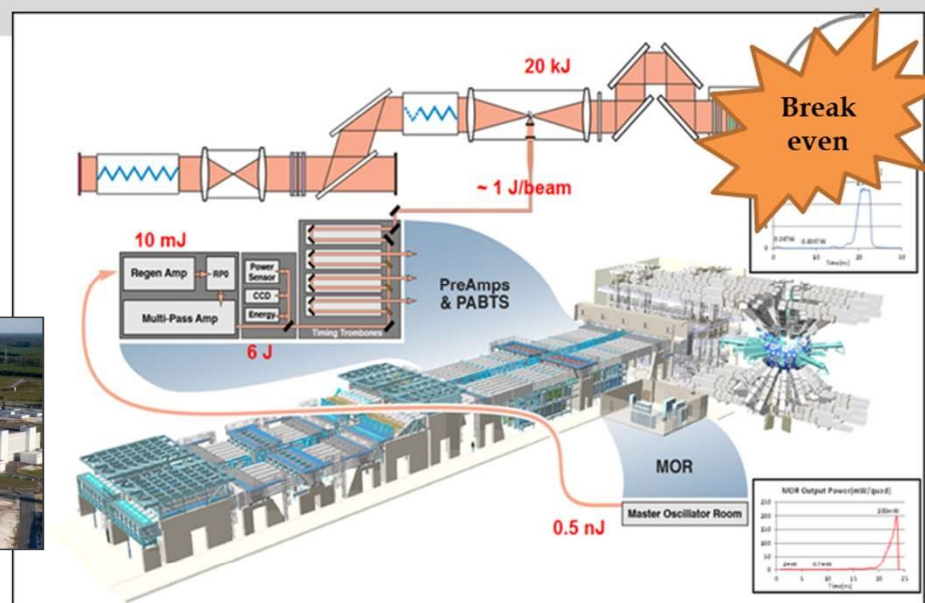
**► How:** co-organization of workshops, symposiums, conferences**► Notable past staff exchanges:**

- A research engineer from CEA visited LLNL during one year
- A computer scientist from LLNL visited us during one year here at TGCC
- A PhD student from CEA did a postdoc at LANL and then been hired for two more years.
- Summer internship (when Covid permits it) during PhD



NIF and LMJ are complex laser systems with extremely stringent laser performance specifications at the target

- Both facilities use a combination of hardware and software designed to support laser operations safety and performance



There are extensive interactions between both facilities:

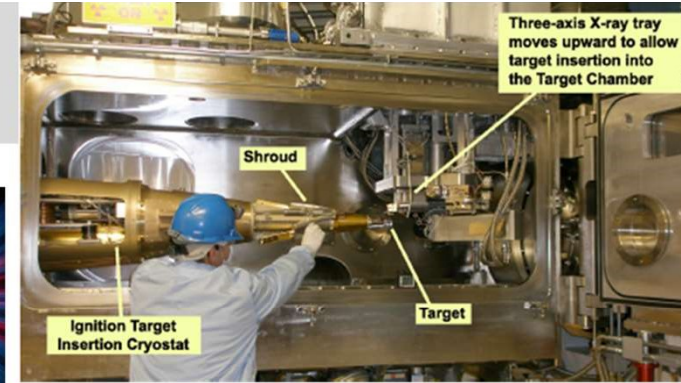
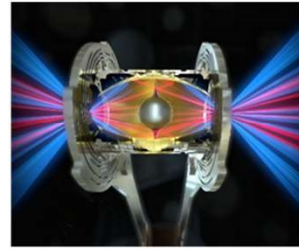
- Laser models for beam propagation, amplification, frequency conversion.
- Optic damage inspection and mitigation techniques.
- Laser diagnostics.
- Short-pulse ARC/PETAL front ends and diagnostics.



High resolution spectrometer for FM to AM mitigation

Targets technologies :

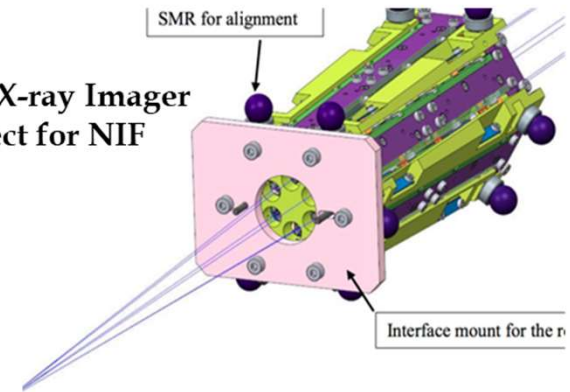
- Cryogenic target technology
- Target fabrication, foam production, capsule metrology, capsule fill-tube assembly techniques



Plasma diagnostics :

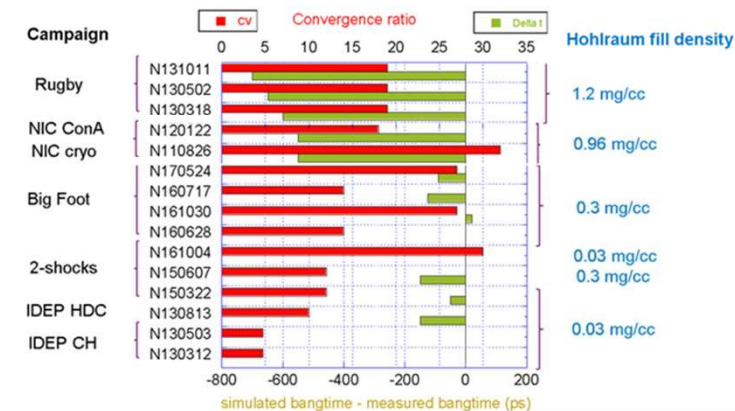
- X-ray imagers, X-ray microscope optics, X-ray spectrometers, ...
- Streak tubes, clippers for protecting digitizers, image plate scanners, ...
- Calibration technics

The Toroidal X-ray Imager (TXI) project for NIF



Experiments and Simulations : many topics covered

- Laser-plasma interaction, Hohlraum energetics, Hydrodynamic instabilities, Capsule implosion, Ignition Physics, ...
- Modeling, simulation and measurement of debris and shrapnel loads from targets





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- Non-nuclear materials



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GANIL

LULI

CELIA

DAM ÎLE-DE-FRANCE

- Physics package conception and guarantee
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(no student)

LULI is a plasma physics research center operating three Laser facilities

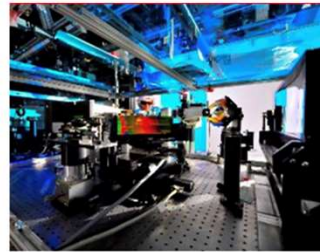


LULI2000 dedicated to the study of High Energy Density Science



- kJ/ns laser coupled to a 60J/ps laser
- Facility open to the international community via a call for proposal`
- Member of the European laserlab network

Research Infrastructure Apollon dedicated to the extreme light study



- Multi PW, Multi beams
- Facility open to the international community via a call for proposal
- Member of the European laserlab network

Hera platform dedicated to Material study



- 200J x2 ns laser, a shot every 20', cm size focal spot
- Industrial and academic access via beam time purchase



CELIA : a research center on laser/matter interaction in Extreme regimes

- Located near Bordeaux and close to breathtaking seaside landscapes.
- About 90 people with 33 permanent researchers and 30 PhDs and Post-docs.
- About 70 publications / year, numerous National and EU grants awarded to CELIA’s physicists

- **Founded for providing an academic support to the nearby MegaJoule Laser facility**

- **Strong involvement in student training at Bordeaux University :**
 - ✓ Bachelor and Master degrees in laser technology
 - ✓ Master degree in Physics with EUR Light S&T
 - ✓ National gathering in Bordeaux of Master formations in Laser Plasma Physics

- **Strong involvement in industrial transfer :**
 - ✓ 5 start-ups created incl. Amplitude Systems 
 - ✓ 1 Labcom, several industrial maturation projects granted, about 3 patents / year

- **Strong involvement in international collaborations :**
 - ✓ MOU’s, IRP LUMAQ, Weizmann-CNRS partnership, Eurofusion projects, PI of experimental campaigns on large scale facilities (NIF, LMJ, LLE, ILE, ELI, GSI, LULI, CLPU, LCLS, EU-XFEL,...)

➤ **Four main scientific axes :**

- ✓ Physics and technology of high average power, intense, ultrashort **lasers**
- ✓ Ultra-high repetition rate laser **processing** in burst mode
- ✓ **Attoscience** and Ultra-fast processes (as–fs) in atoms, molecules and condensed matter
- ✓ HDE and UHI **Plasma physics**: FCI, magnetized plasmas, Astrophysics, warm dense matter, particle acceleration

➤ **10 beamlines :** laser, XUV X-rays

➤ **In house code dev. capabilities :** TDSE, TDDFT, 3D Hydro-rad, PICs,

➤ **3 Platforms open to access**



CELIA is a member of the European Laserlab network

Platform for UHI Physics : Plasma , HHG



ECLIPSE : 100 TW CPA, 800 nm
150 mJ - 30 fs @ 10 Hz
HCF P-compr. 10 mJ, 10 fs, 10 Hz
2 x 1.5 J, 30 fs, Contrast 10^9 , 1 Hz

Platform for ultrafast processes study



AURORE : TW CPA, 800 nm
8 mJ - 25 fs @ 1 kHz
HCF P-compr 1 mJ, 7 fs

Platform for attochirality and TR photoemission



Blastbeat : 2x50 W, Yb, 1030 nm
2 X 300 μ J - 140 fs @ 0.17-2 MHz
HCF P-compr 515 nm, 100 μ J, <20 fs
Complex polarization

GANIL cyclotrons and experimental equipment



EXO GAM



ACTAR TPC



Sample holder for irradiation



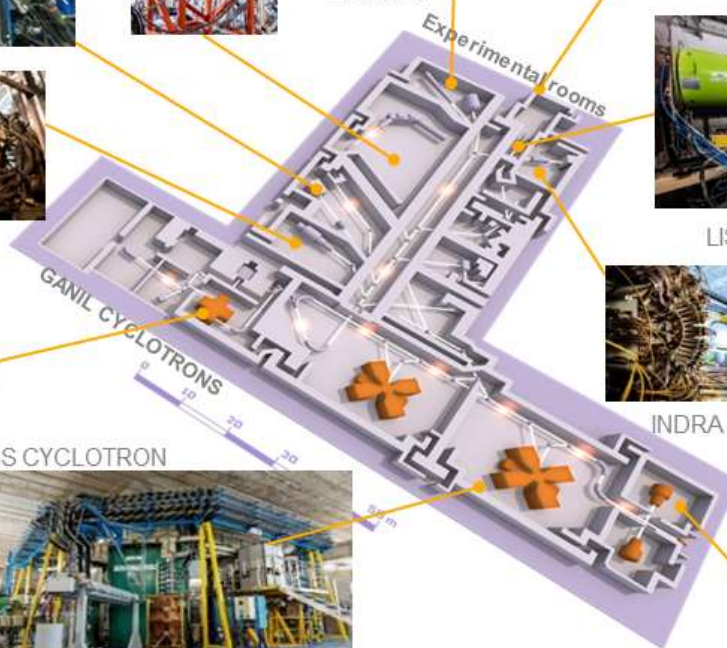
MUGAST



VAMOS



AGATA



LISE SPECTROMETER



INDRA + FAZIA

ION SOURCES



CSS CYCLOTRON



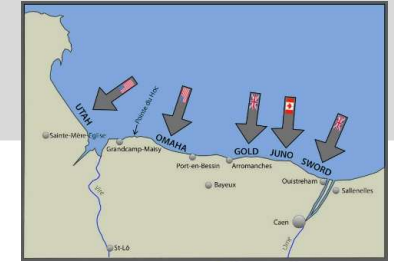
CIME CYCLOTRON



- Stable Beams : ^{12}C to U
- Energy : from <1 MeV up to 95MeV/nucleon
- Up to 4 experiments in parallel

- Exotic beams produced by heavy ion fragmentation
 - In flight with LISE spectrometer
 - With ISOL method with SPIRAL1 target-source system, postaccelerated with CIME cyclotron

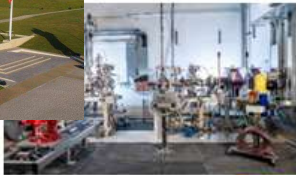
- State of the art equipment
 - LISE spectrometer
 - VAMOS spectrometer
 - γ detection: EXO GAM, AGATA (2015-2021)
 - Charged particles: MUGAST, ACTAR TPC
 - Fragments: INDRA/FAZIA



SPIRAL2 LINAC and the new experimental rooms



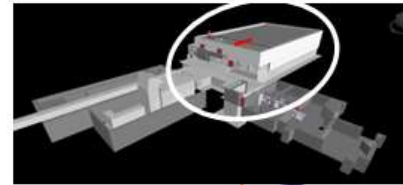
Experimental room NFS
(Neutrons for Science)



Convertor room

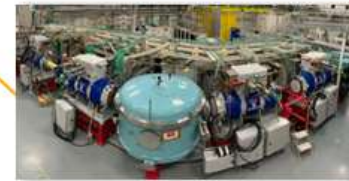


Time of Flight room



Experimental room
DESIR
(Decay, Excitation
and Storage of
Radioactive Ions)

High intensity beams :
 5 mA, 33 MeV protons
 5 mA, 40 MeV deutons
 1 mA, <14,5 MeV/A heavy ions



Experimental room S3
(Superconducting
Separator Spectrometer)

First beams: end 2019
First NFS experiments: 2021
Commissioning S3: 2024
DESIR construction start: 2023

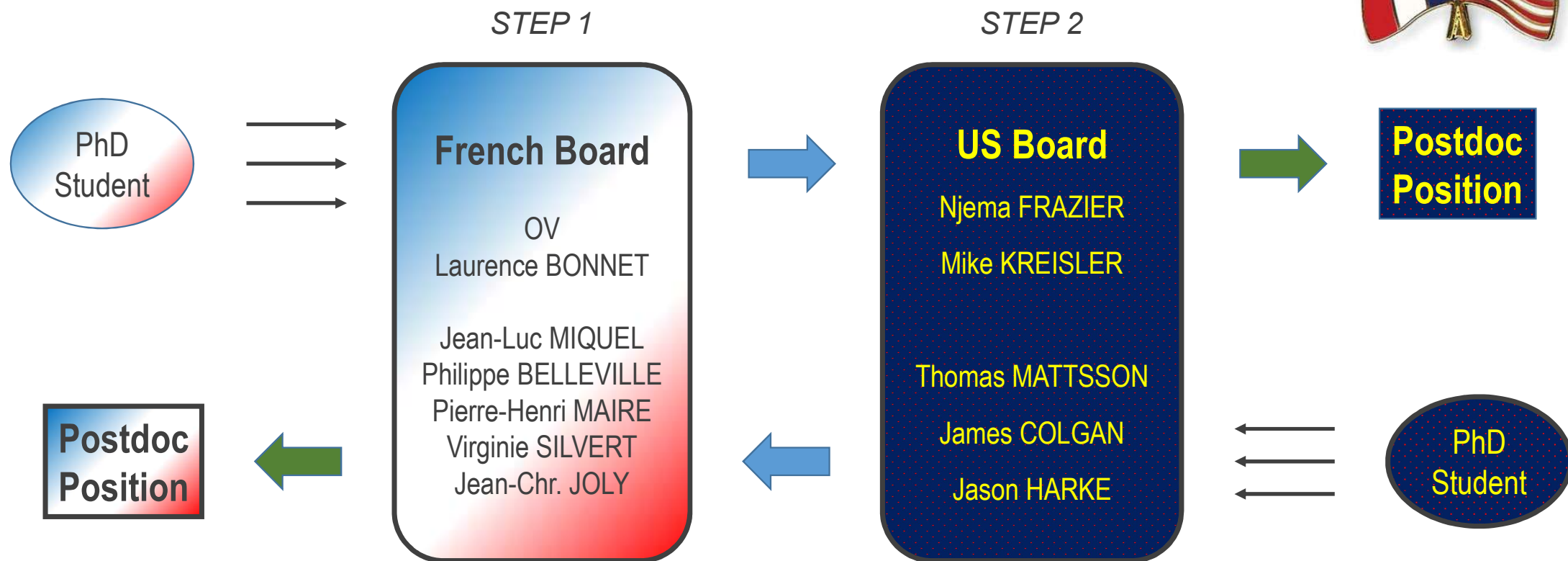
GANIL
 laboratoire commun CEA/DRF
 spiral2
 CNRS/IN2P3

NEWGAIN
 NEW GANIL INJECTOR



ION SOURCE





→ For STEP 1, files (CV+letter) must be submitted **before February 25th 2023**

(the PhD has to be defended in 2023 before the beginning of proposed postdoc time)

→ Results of STEP 2 are given 6 weeks later (≈ **April 15th 2023**)