The LUNEX5 project

M. E. Couprie, C. Benabderrahmane, P. Betinelli, F. Bouvet, A. Buteau, L. Cassinari, J. Daillant, J. C. Denard, P. Eymard, B. Gagey, C. Herbeaux, M. Labat, A. Lestrade, **A. Loulergue**, P. Marchand, O. Marcouillé, J. L. Marlats, C. Miron, **P. Morin**, A. Nadji, F. Polack, J. B. Pruvost, F. Ribeiro, J. P. Ricaud, P. Roy, T. Tanikawa, Synchrotron SOLEIL, Saint-Aubin, France
R. Roux, Laboratoire de l'Accélérateur Linéaire, Orsay, France
S. Bielawski, C. Evain, C. Szwaj, PhLAM/ CERLA, Lille, France
G. Lambert, R. Lehe, A. Lifschitz, V. Malka, A. Rousse, K. Ta Phuoc, C. Thaury, LOA, Palaiseau, France
X. Davoine, CEA-DAM-DIF Arpajon, France
A. Dubois, J. Lüning, LCPMR, Paris-VI, France
G. LeBec, L. Farvacque, ESRF, Grenoble, France
G. Devanz, M. Luong CEA/DSM/IRFU/SACM, B. Carré, CEA/DSM/IRAMIS/SPAM, Saclay, France

Laser à électrons libres **U**tilisant un accélérateur **N**ouveau pour **E**xploitation de rayonnement **X** de **5**ème génération

free electron **L**aser **U**sing a **N**ew accelerator for the **E**xploitation of **X**-ray radiation of **5**th generation

SOLEIL SYNCHROTRON · loa · PhLAM · LCPMR · ESRF · LAL Laboratoire de l'Accélérateur Linéaire · IRAMIS · spam · SACM · CILEX · PALM

Scientific context and motivation

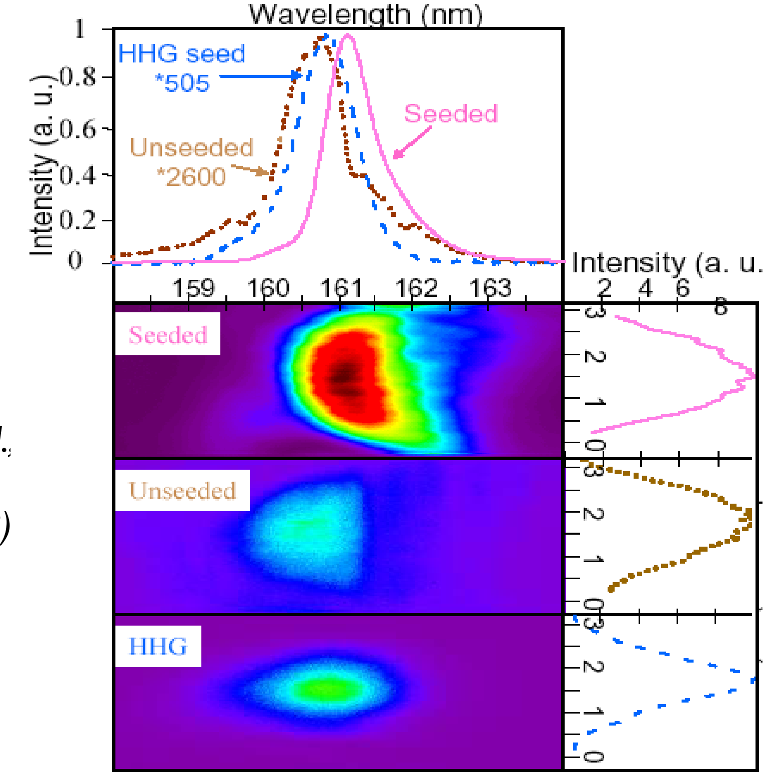
- Success of XFEL (LCLS, SACLA...) opening for new investigation of matter

- New seeding schemes (HHG seeding, echo, self-seeding) and first seeded FEL for users (FERMI@ ELETTRA, SCSS Test accelerator)

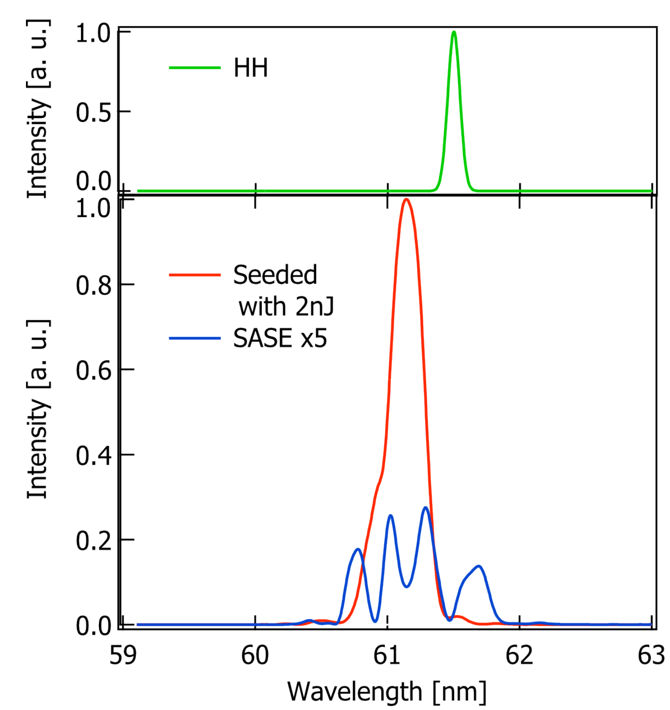
- Progress of alternative accelerator techniques

=> Advanced compact FEL?

G. Lambert et al., Nature Physics Highlight, (2008) 296-300



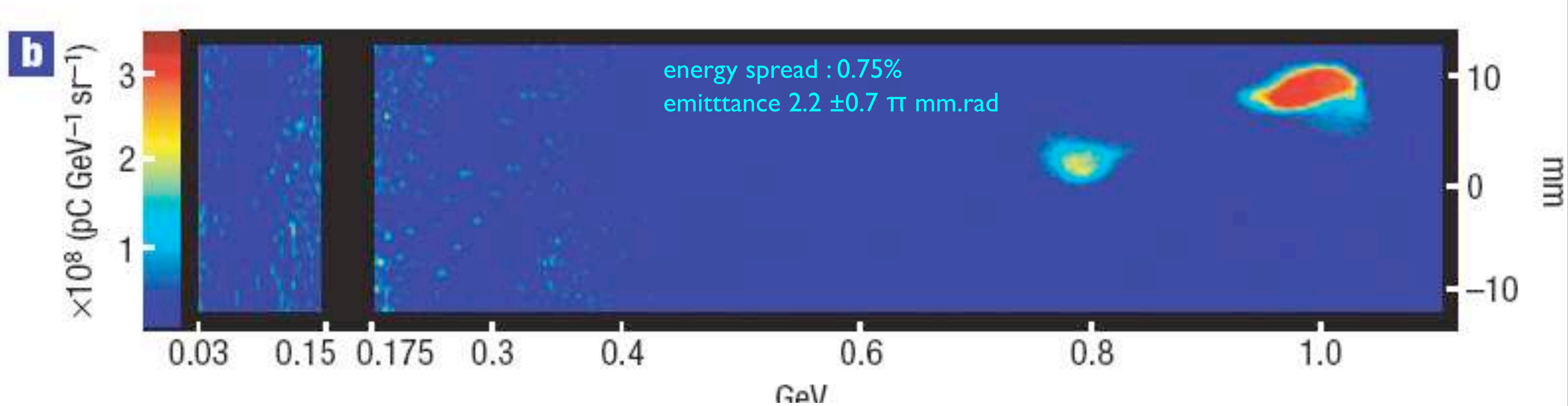
T. Togashi et al., Optics Express, 1, 2011, 317-324



LUNEX5

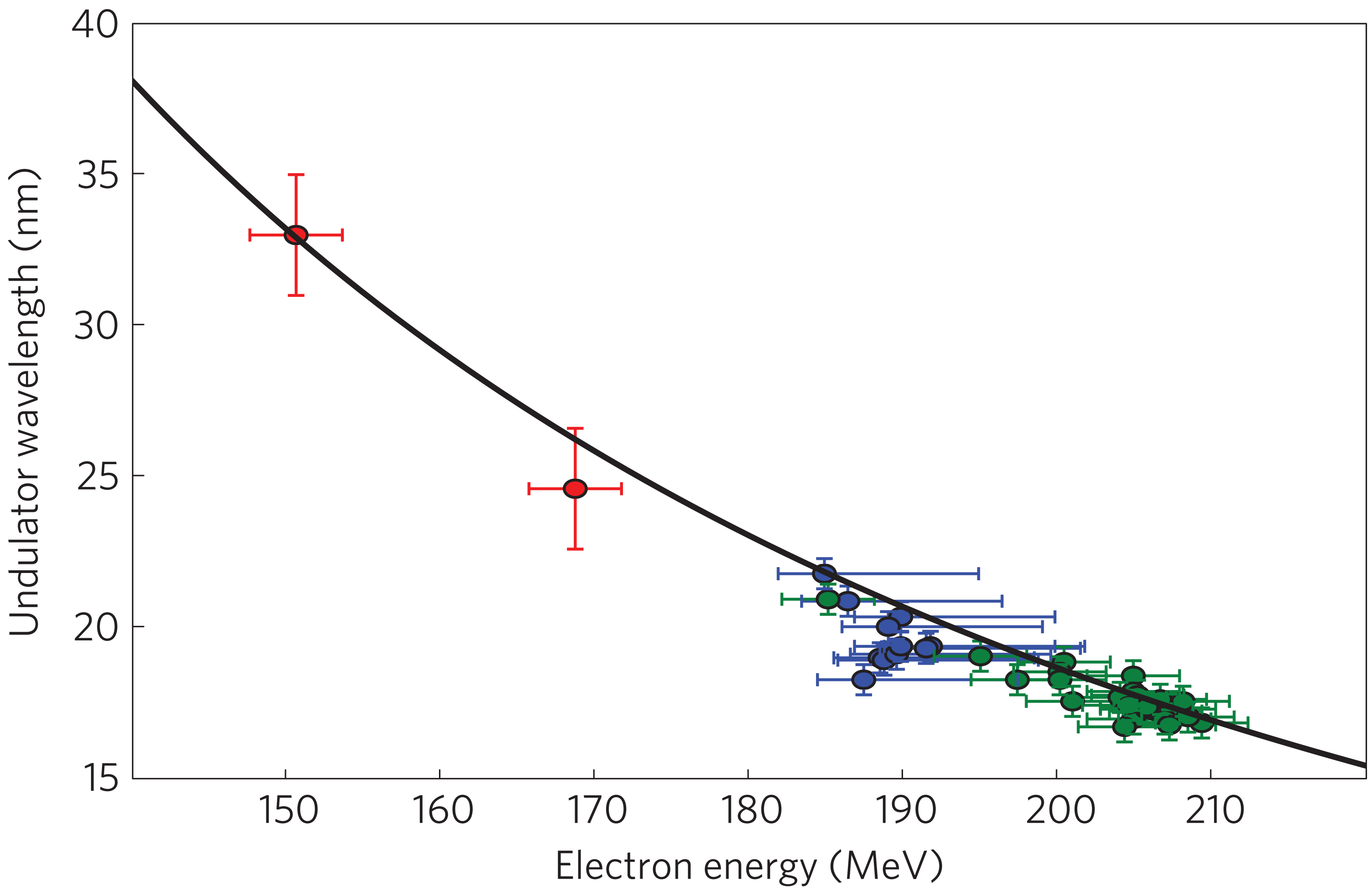
Laser WakeField Accelerators (LWFA)

Intense laser focussed in a gas jet / cell / capillary
=> ions : accelerator electric field



W. P. Leemans et al. , Nature Physics 418, 2006, 696

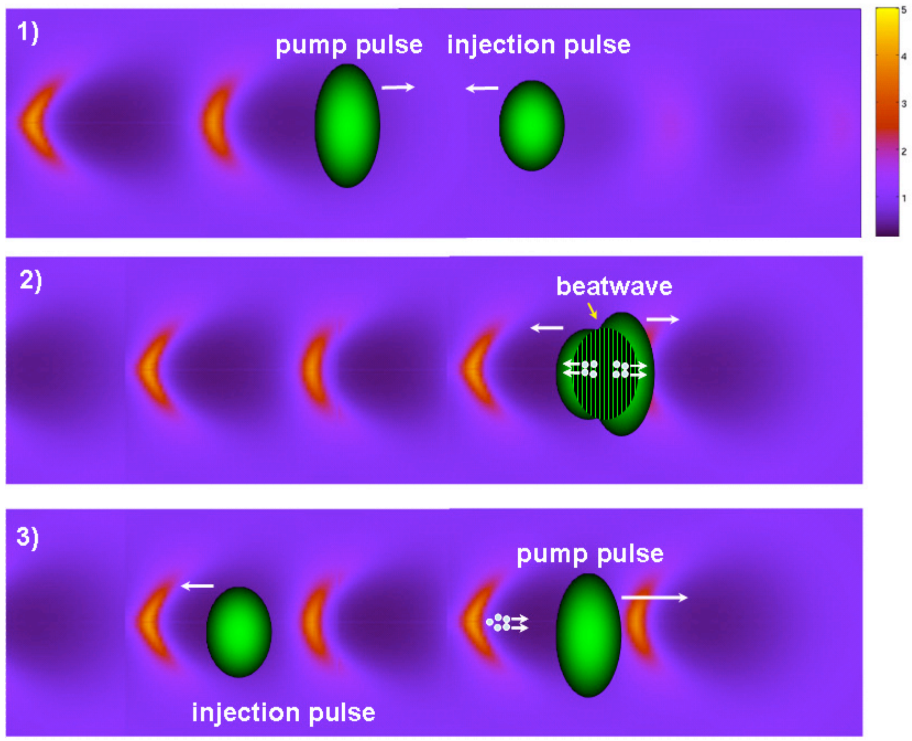
M. Fuchs et al. 5, 2009, 826



Laser WakeField Accelerators (LWFA)

ex of the couterpropagating scheme

Two laser colliding scheme



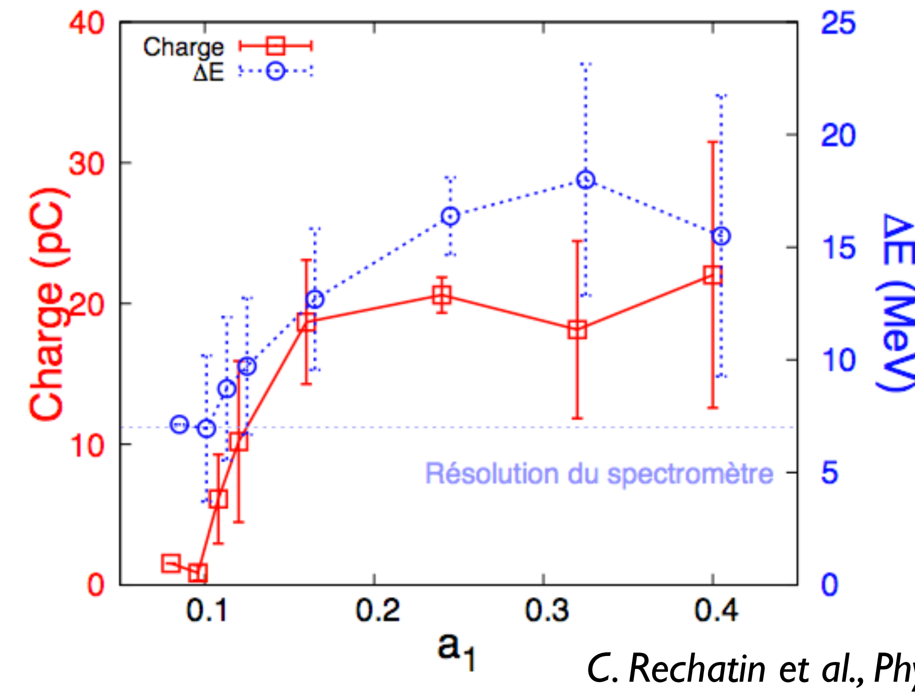
no collisions between the two lasers:
large wakefield induced by the first laser

collision between the two lasers, beating => electron pre-acceleration

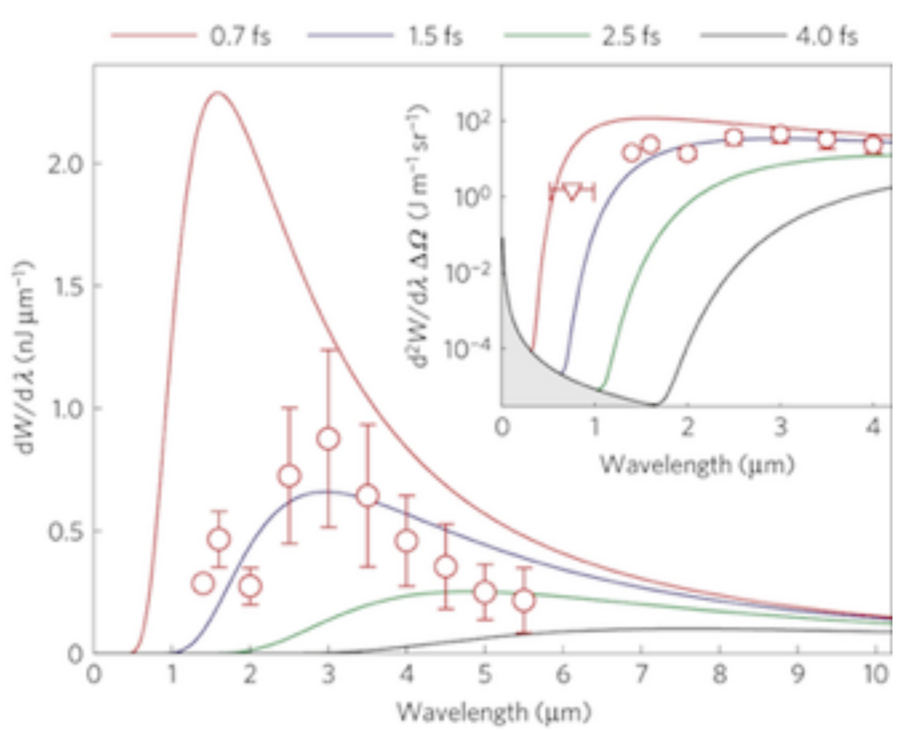
pre-accelerated electrons are trapped and re-accelerated

S. Fritzler et al., Phys. Rev. Lett. ***92****, 165006 (2004), C. M. S. Sears et al., PRSTAB* ***13****, 092803 (2010)*
E. Brunetti et al., Phys. Rev. Lett. ***105****, 215007 (2010), X. Davoine et al., Phys. Rev. Lett.* ***102****, 6 (2009)*

Electron beam production

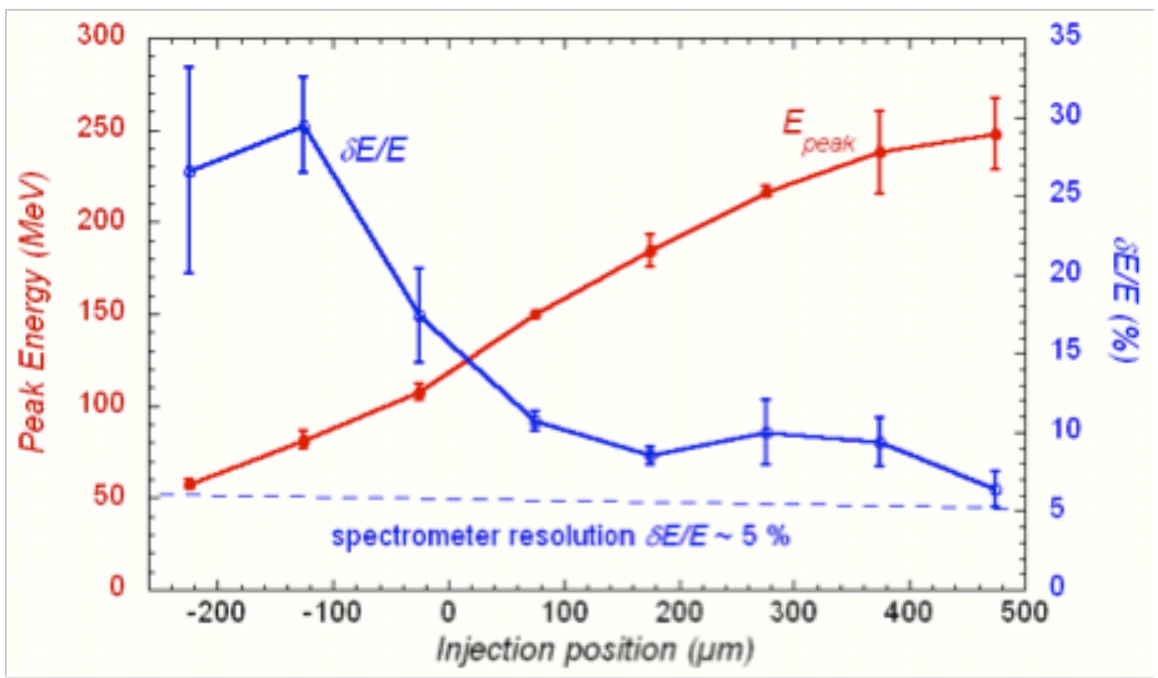


C. Rechatin et al., Phys. Rev. Lett. ***102****, 194804 (2009)*



1.5 fs RMS duration : Peak current of 4 kA

O. Lundh, Nature Physics, 2011



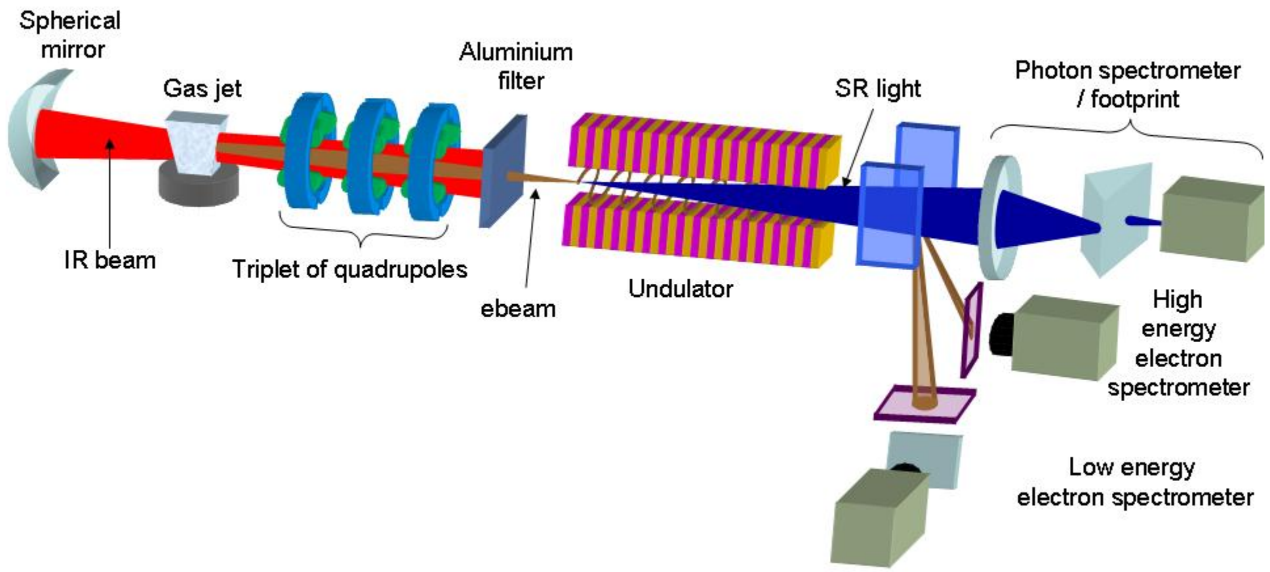
	2002	2004	2009
Energy spread (%)	100	5	1

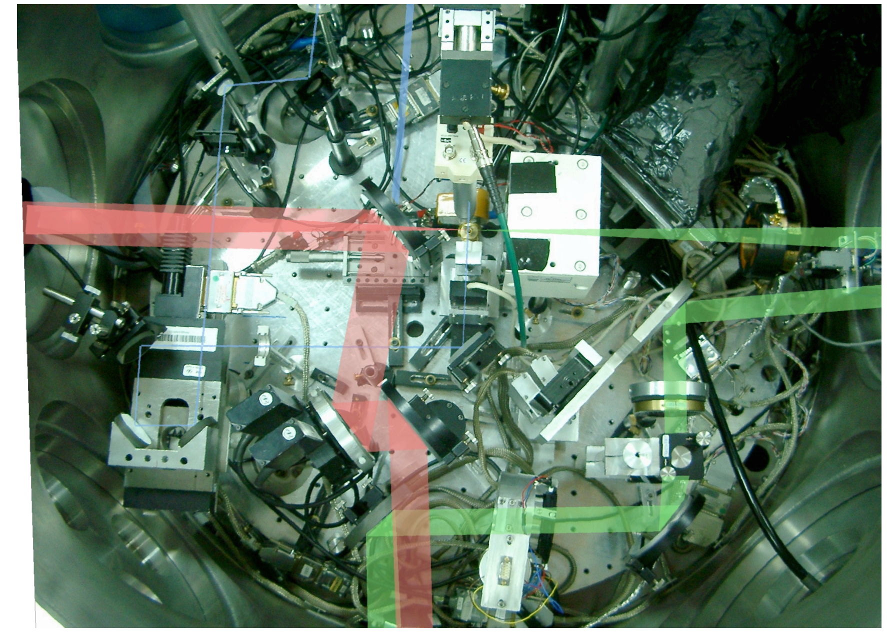
below : *C. Cipiccia et al. Nature Physics, 2011*

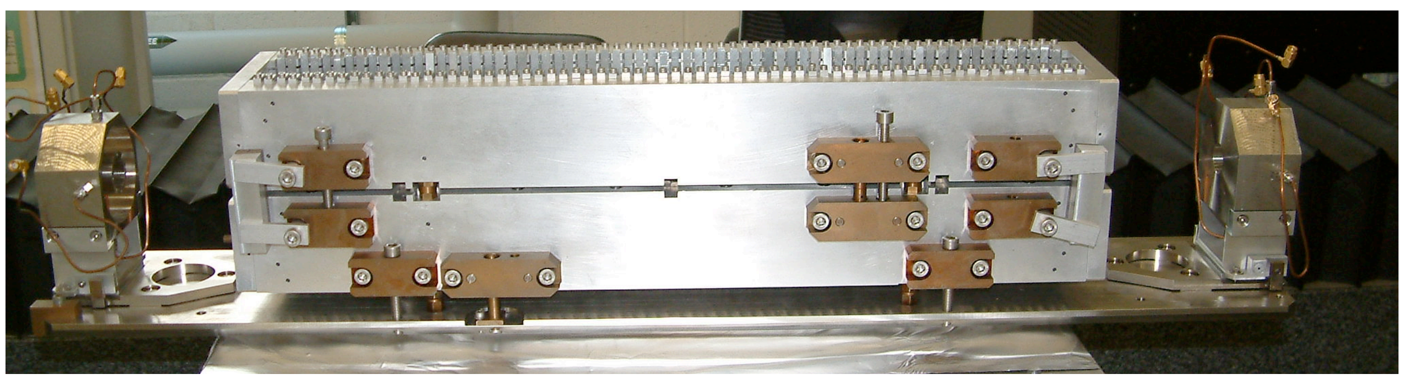
LUNEX5

1-Introduction : Scientific context

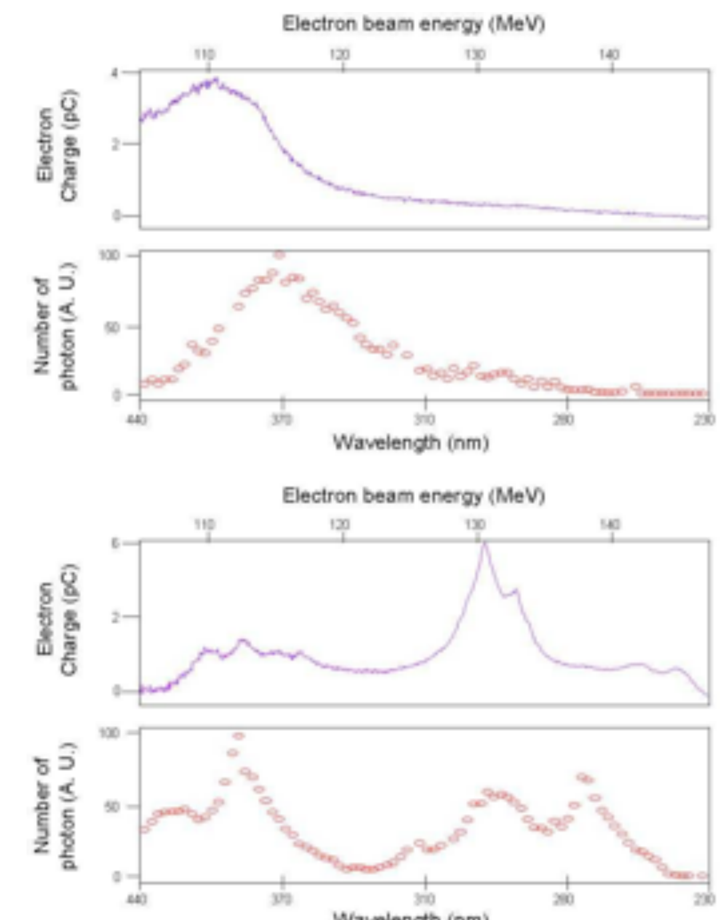
Laser WakeField Accelerators
Preliminary experiment LOA/LLR/SOLEIL/CLIO







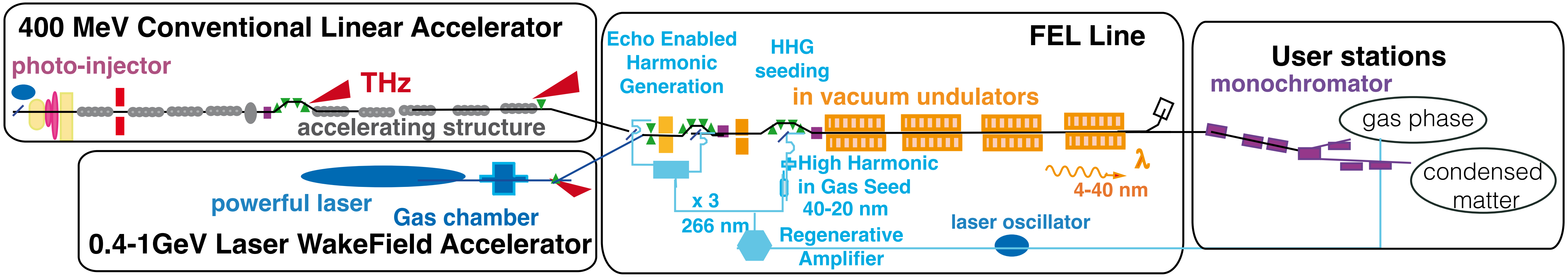
Undulator parameters	Unit	Value		Laser/plasma parameters	Unit	Value
Magnet		SmCo		Energy	J	1
Deflection parameter		1.05		Pulse duration	fs	30
Magnetic gap	mm	3.5-8		Focal length	m	1
Spatial period	mm	18.2		Aperture	mm	55
Number of periods		34		Target length	mm	3
Number of section		1		Electron density	cm^{-3}	$5*10^{18}$
Peak magnetic field at 4 mm	T	0.6				



Progress on the generation of undulator radiation in the UV from plasma based electron beam, G. Lambert et al. THPD47

LUNEX5

LUNEX5 PROJECT



40-4 nm, 20 fs and shorter

Beyond third generation light source (undulator spontaneous emission, partial transverse coherence),

progress towards advanced fourth generation (4G+) light sources (coherent emission, temporal and transverse coherence, femtoseconde pulses, high brilliance) via the latest free electron laser seeding schemes and electron photon interaction, to be validated by pilot user experiments,

=> *Demonstration of echo at short wavelength*

=> *FEL physics*

=> *Advanced design of FEL source for improved performances, associated with cost and size reduction*

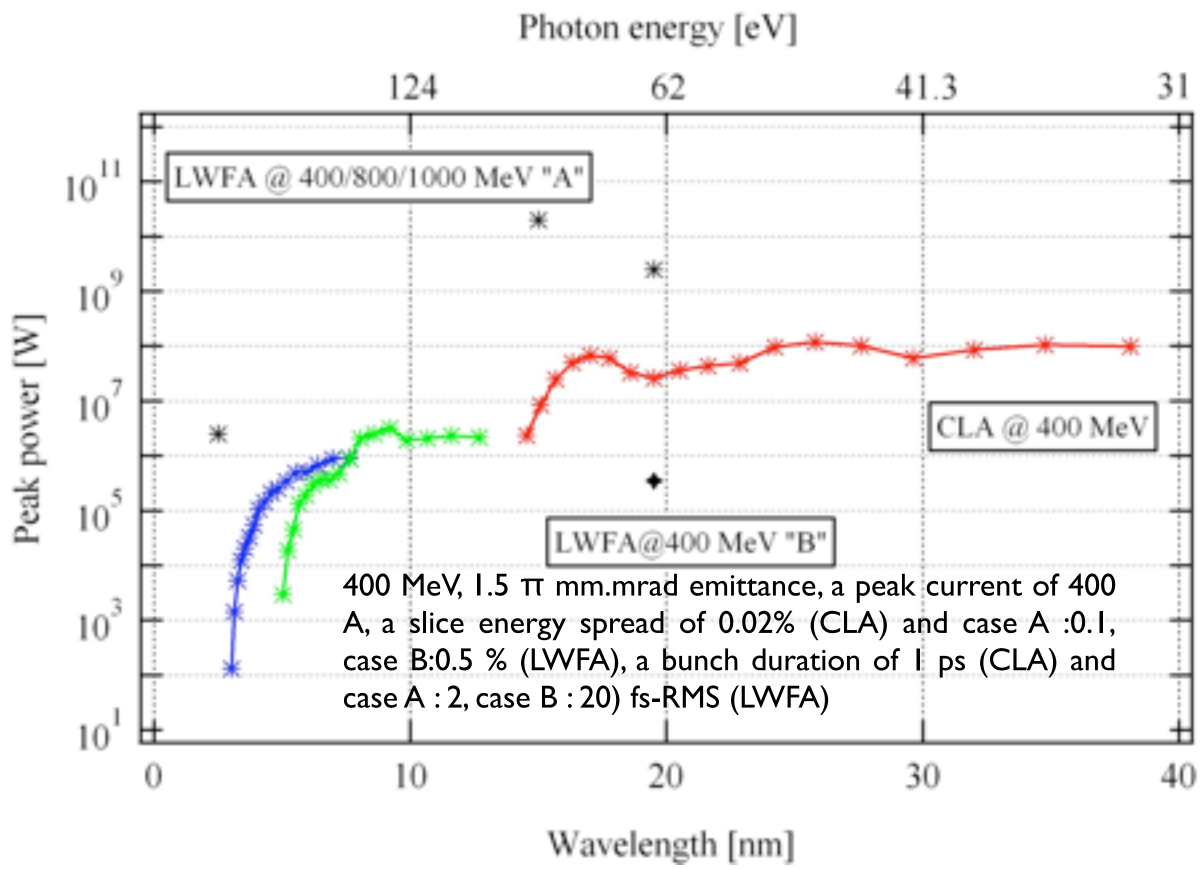
and towards fifth generation (5G) (Conventional Linac replaced by a LWFA), FEL being viewed as a qualifying LWFA application : *evaluation of the LWFA performances in «operation-like» conditions (cf EuRRONAc objectives)*

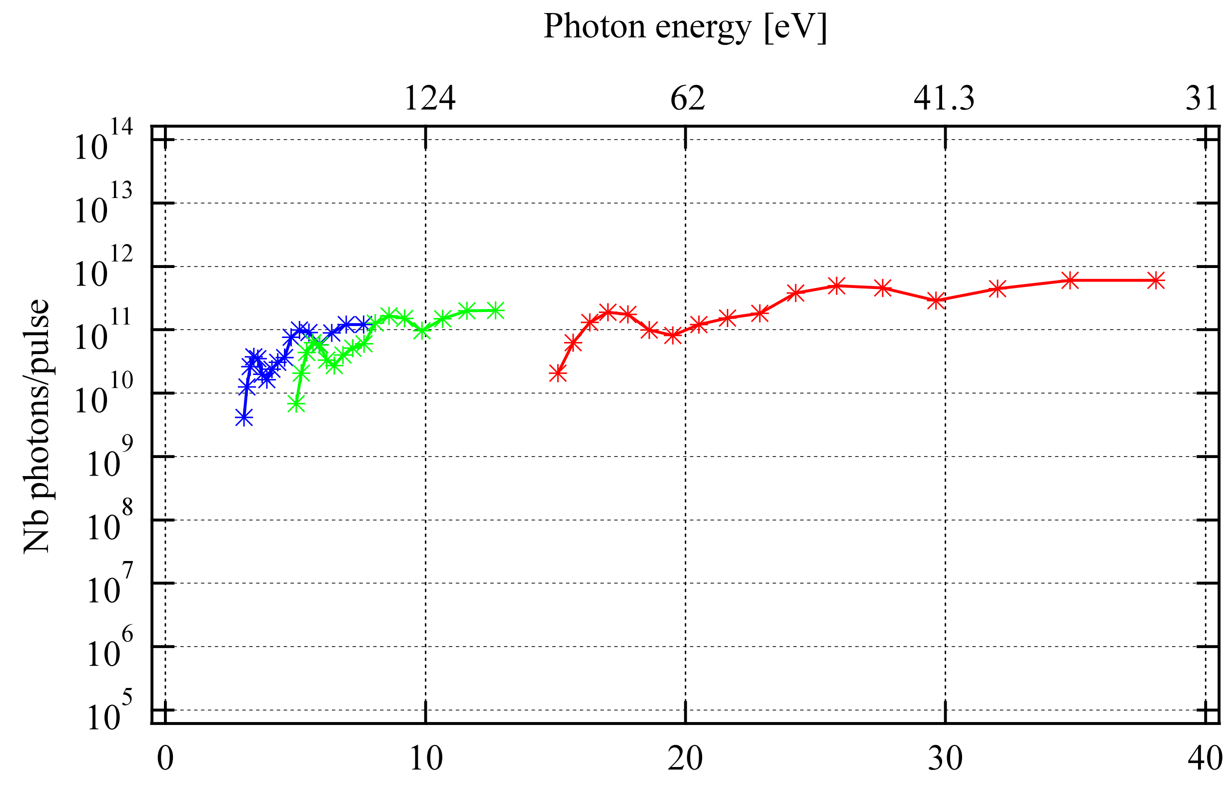
Complementarity CLA / LWFA :

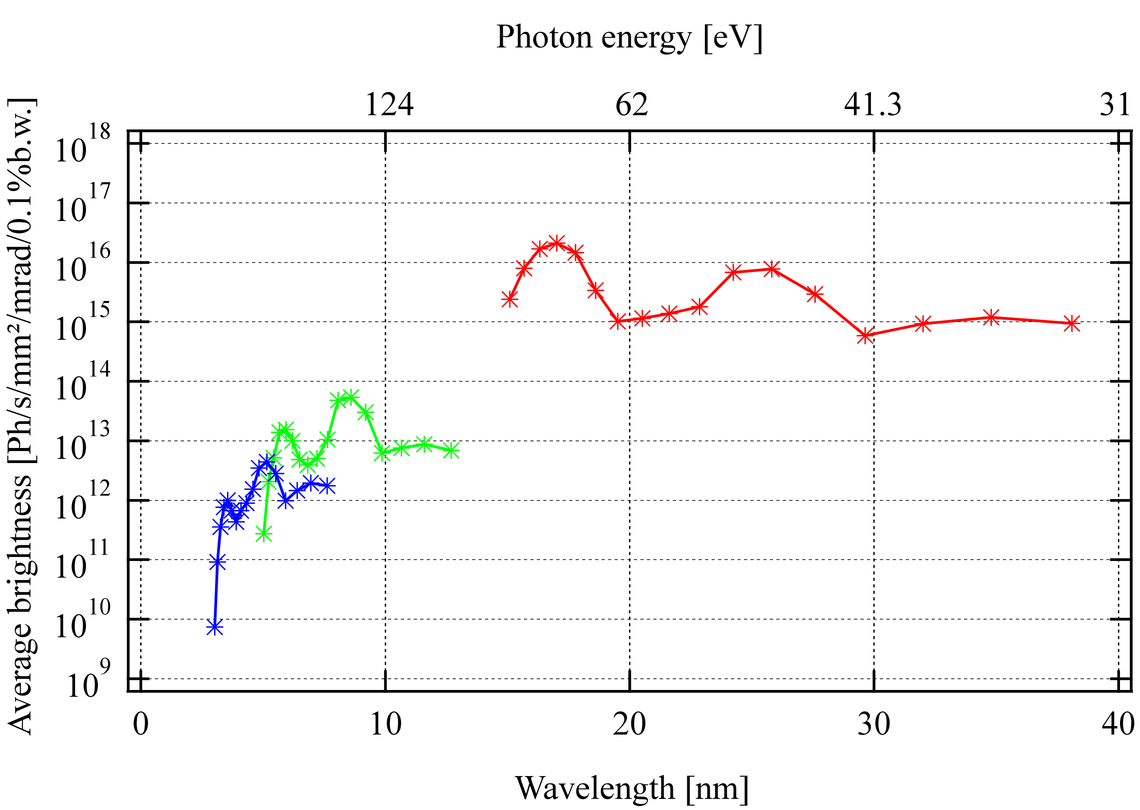
CLA high repetition rate, high reliability, LWFA : ultra-short electron bunch, compacity

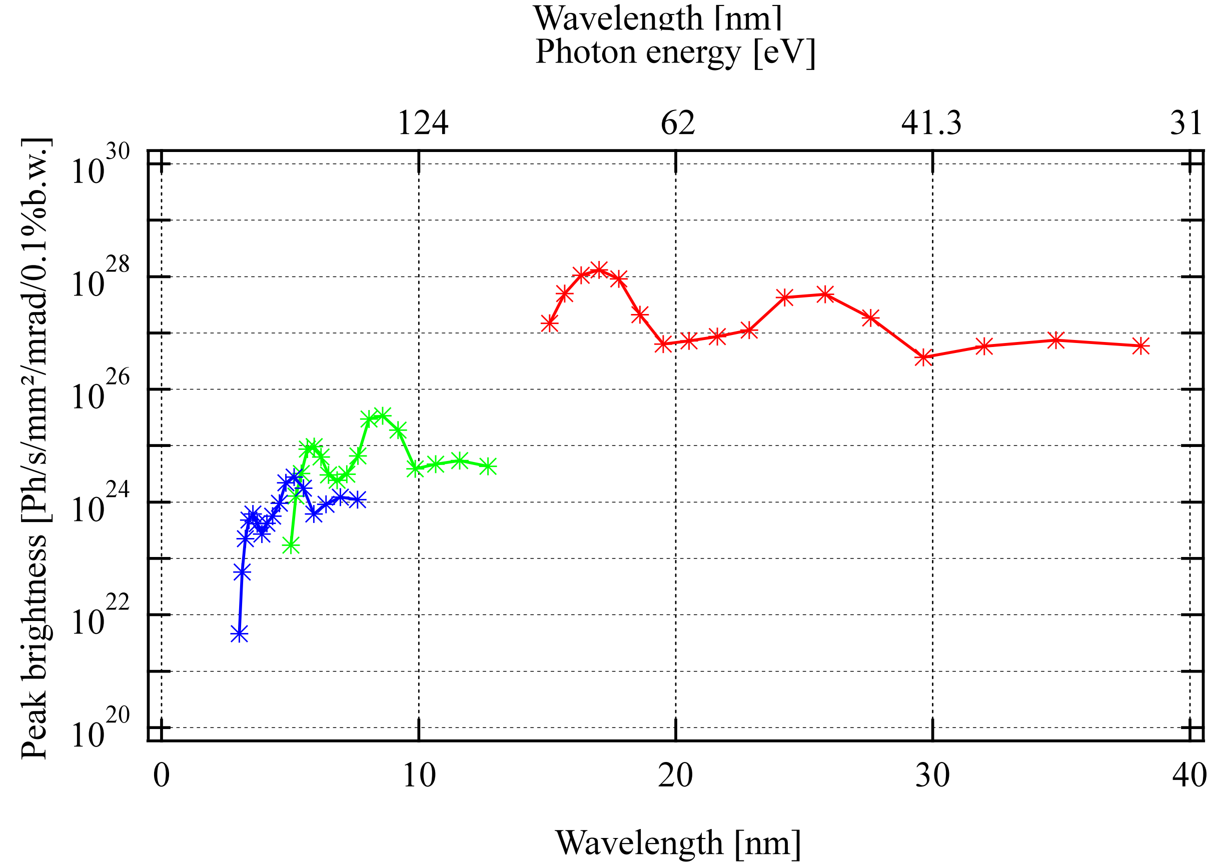
II-Project general presentation

LUNEX5 PERFORMANCES









II-Project general presentation

LUNEX5

PILOT USER EXPERIMENTS

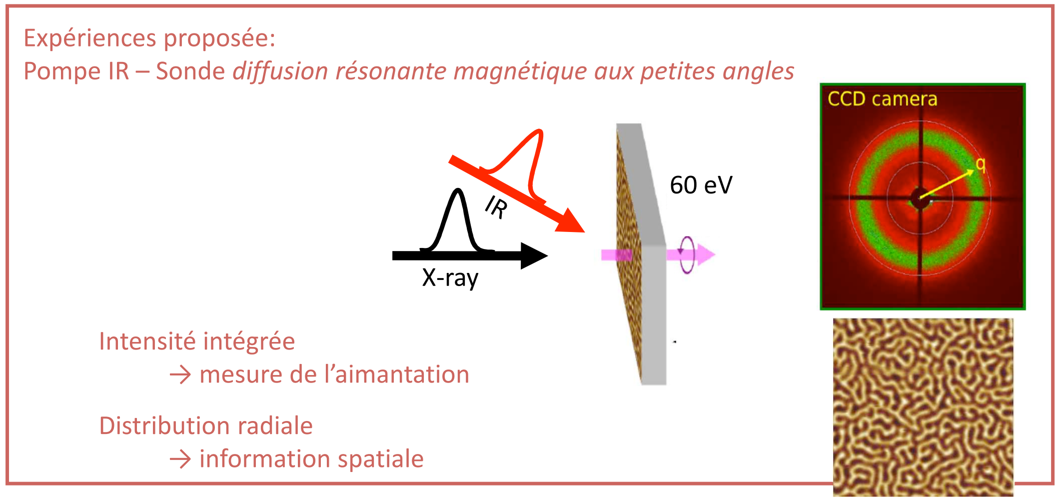
Time and energy resolved studies of isolated species (cold atoms/molecules, clusters, nanopaticles) (C. Miron et al.)

instrument : high resolution velocity map imaging spectrometer with full momenta characterisation of electrons and ions using a COLTRIMS type of spectrometer based on time-of-flight and particle 2D position detection (coincidences or "covariance mapping")

- Electron and nuclear wave packet dynamics in molecules
- Molecular dissociative core-excited states (pump-probe)
- Ultrafast electronic decay processes in weekly bound systems (clusters)
- Auger-Doppler effects and electron tunneling
- Electron streaking measurements to correlate emission delay and structure

Study of magnetisation dynamics (Lüning, LCPMR)

spatially resolved analysis on ultrafast magnetization dynamics following a non-thermal excitation of a ferromagnetic thin film by an intense, fs short IR laser pulse
coherence => single shot X-ray images of the magnetic domain structure
IR pump- X ray probe :
resonant magnetic small angle scattering at the transition metal M-edges



"pilot user experiments" and not "user's facility"
experiments to be developed with the CLA first : 20 nm (M 2,3 transition metals), 12 nm (Si)
experiments to be developed with the LWFA : higher energies (1.2 GeV?) for the generation of shorter wavelengths (4 nm?) (C (K))

vision beyond LUNEX5 : LUNEX demonstrator of further facilities enabling :
- the generation of ultra-short pulses (attosecond?)
- access to K levels of C,N,O and L ones of transition metals (< 4 nm)
- "single shot"
- dilute phase – nanoparticules, magnetism, chemical reactivity, biology (time resolved)

LUNEX5

PROJECT PHASES

First idea (SOLEIL/LOA).....

2011 :
«Opportunity proposal at SOLEIL»
SOLEIL discussions with Council members,
CNRS (B. Girard, C. Simon)
DSM (J. P. Duraud);

June 2011 SOLEIL Council:
CDR request
Review by an ad-hoc committee in connection with the SAC
Presentation to the dec. SOLEIL Council 2011

Conceptual Design Project Phase

Technical definition of the reference configuration with its different options options (accelerator, site), components, first simulations, description of pilot user experiment and its scientific vision

Planning, costing and ressources, Partnership
CDR draft : fin Nov. 2011

CDR Review, 2011 Dec-2

P. Georges (Institut d'Optique, France)
R. Bartolini (Diamond / Oxford, UK)
R. Assman (CERN, CH) EURONNAC
J. E. Rubensson (Uppsala, Sweden)
J. Feldhaus (DESY, Germany)
Carl Schroeder (Berkeley)

SOLEIL Council preparation
Dec-8, 2011
CNRS : B. Girard, C. Simon
CEA -DSM : J.P. Duraud
SOLEIL : J. Daillant, M. E. Couprie

SOLEIL Council
Dec-15, 2011

RESOLUTION XIII

The Council takes notice of the LUNEX5 CDR document and approves the start of a targeted complementary studies and associated R&D, on specific funding. He takes note of the coordination role of SOLEIL.

Targeted complementary studies and associated R&D Phase

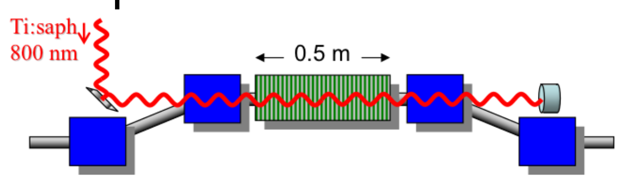
- Start R&D programs and fund search
- Start complementary targeted studies, in particular with respect to the recommandations of the review committee.

III-Project lay-out and components

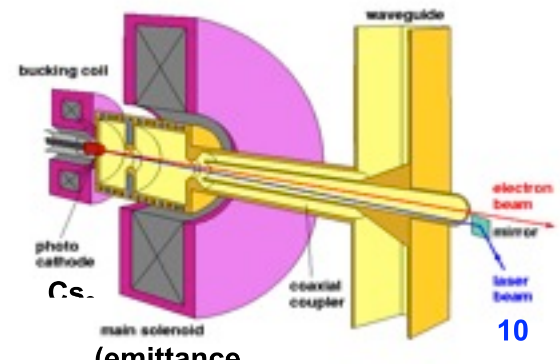
LUNEX5

LUNEX5 PROJECT

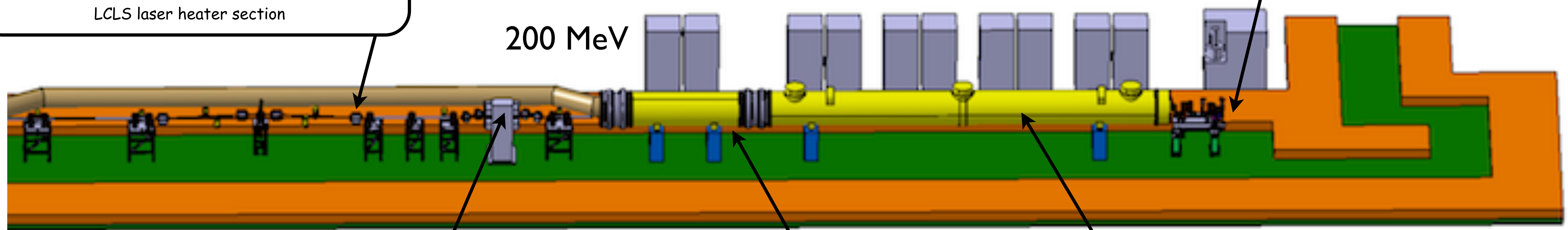
Compression Chicane :
Reduction of the bunch length to 1 ps



LCLS laser heater section



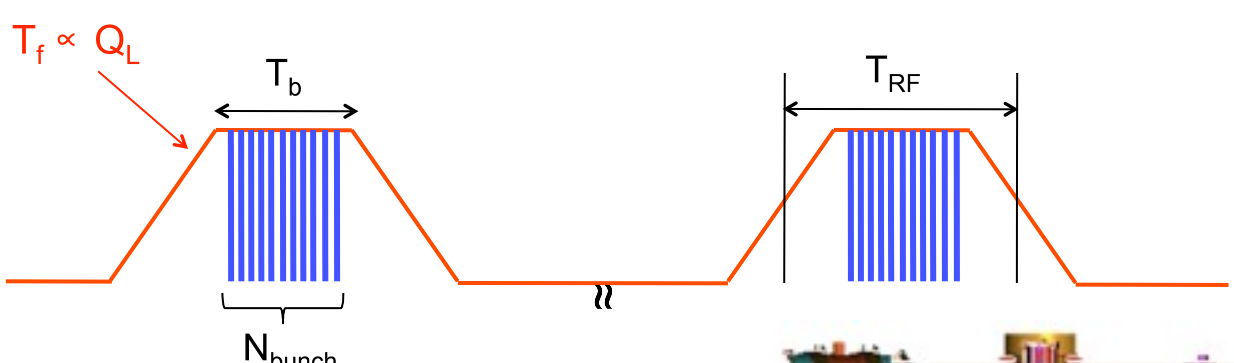
High brilliance Photo-injector
typically 1 nC, 1 π mm.mrad, 4 ps rms, 100 A peak current
transverse and longitudinal laser flat-top distribution
RF gun type : FLASH, EXFEL type



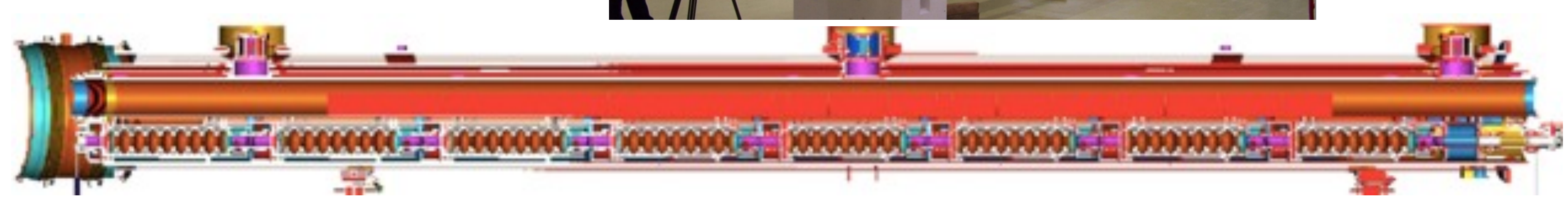
Laser heater :
enlarges the energy spread
laser modulation laser in a wiggler to avoid the micro-bunching in the compressor

Harmonic cavity (or chicanes) : Longitudinal phase space linearisation

Cryomodule :
superconducting accelerating section, 24 MV/m, 1.5 ms RF pulse, 50 Hz, 10 % duty cycle
Cryogenic power : 100 W at 2 K



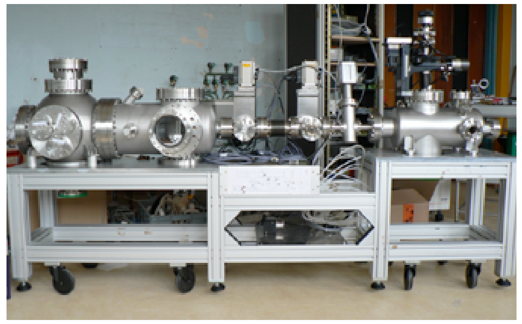
5μs-500 μs macropulse
1-100 bunches, 0.1-1 nC, 1-100 μA



III-Project lay-out and components

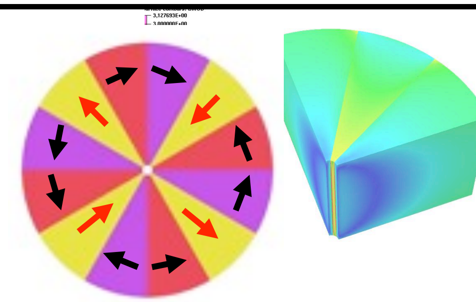
LUNEX5 PROJECT

Echo modulators : in-vacuum undulators period 30 mm

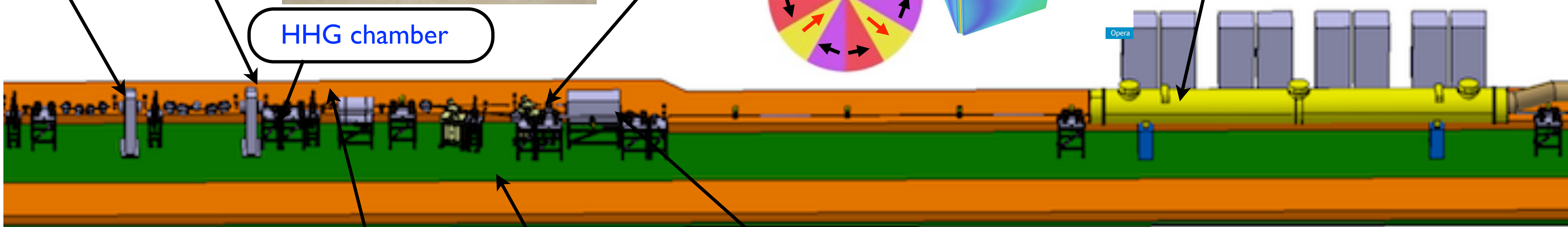


HHG chamber

3 Variable permanent magnet transport Qpole : 130 T/m



Cryomodule : superconducting accelerating section



Echo chicane :

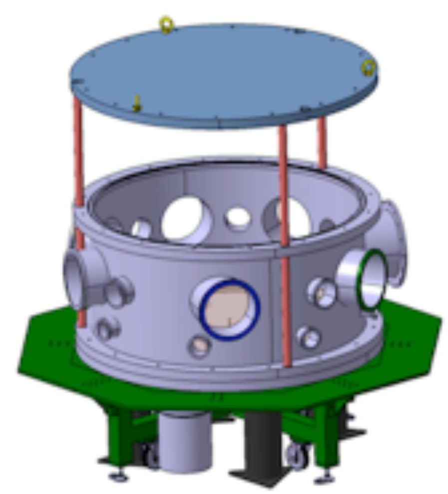
Chicane 1 (2)

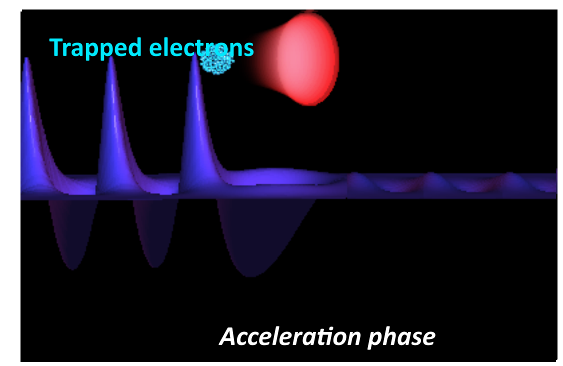
Number of dipoles	4
Length :	1.2 (0.8) m
Gap:	25 mm
Bz	0.38 (0.35) T
L_d:	150 (100) mm

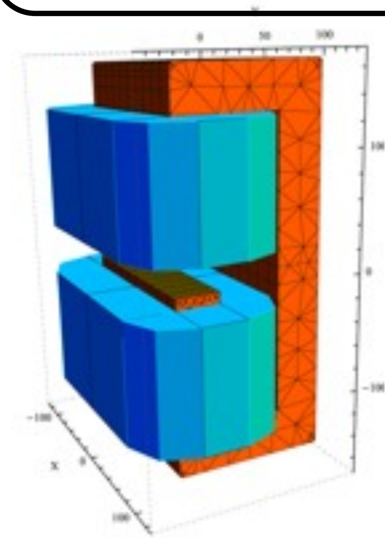
Collimation section : cleaning of the halo and of the dark current

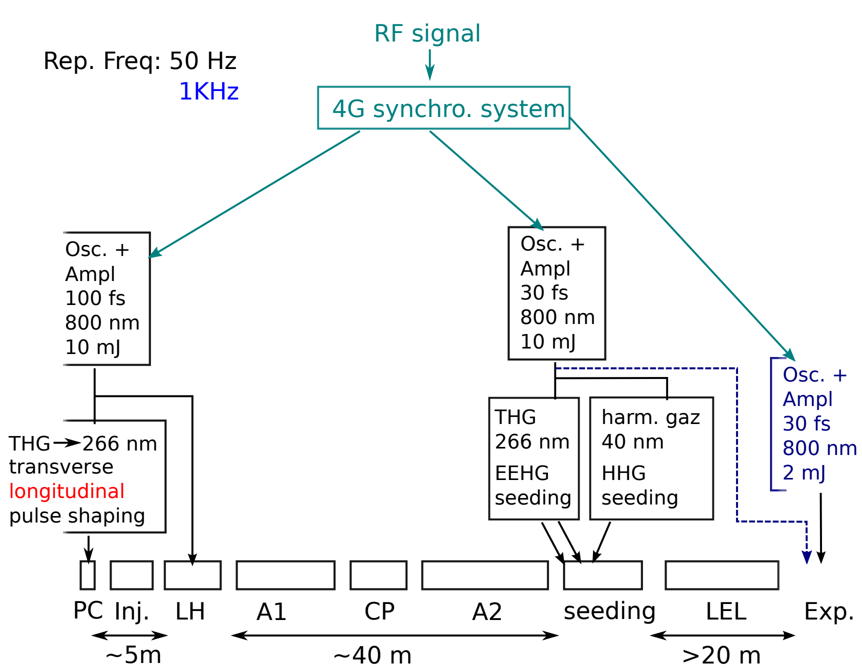
LWFA chamber

Seed laser









CILEX (Centre Interdisciplinaire du Lumière Extrême) :

- APOLLON laser 10 PW
- LUIRE
- «Proximity centers» : LOA Salle Jaune : 2 beams of 60 TW each, UHI 100, LASERIX...

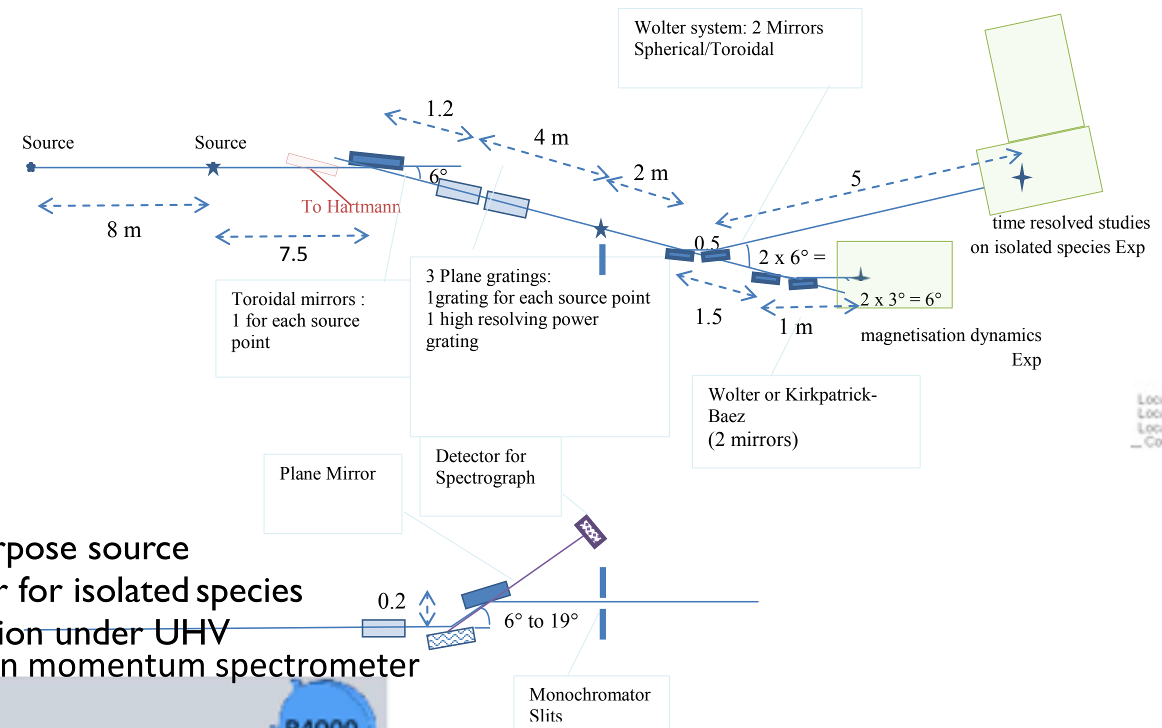
Colloding scheme rather than the bubble regime or capillaries :

- Good beam quality
- Monoenergetic dE/E down to 1 %
- Beam stability
- Tuneable Energy: up to 400 MeV
- Low emittance[1-3] : π.mm.mrad
- Adjustable Charge: 1 to tens of pC
- Adjustable Energy spread: 1 to 10 %
- Ultra short e-bunch : 1,5 fs rms
- Low divergence : 4 mrad

III-Project lay-out and components

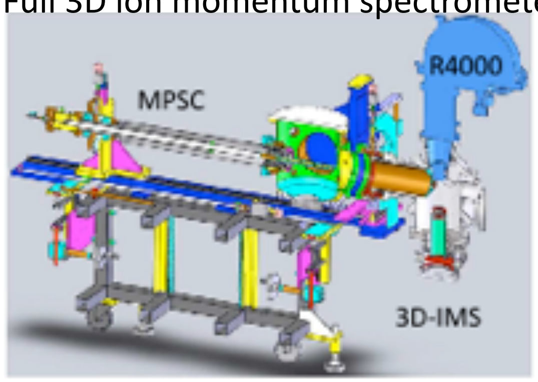
LUNEX5

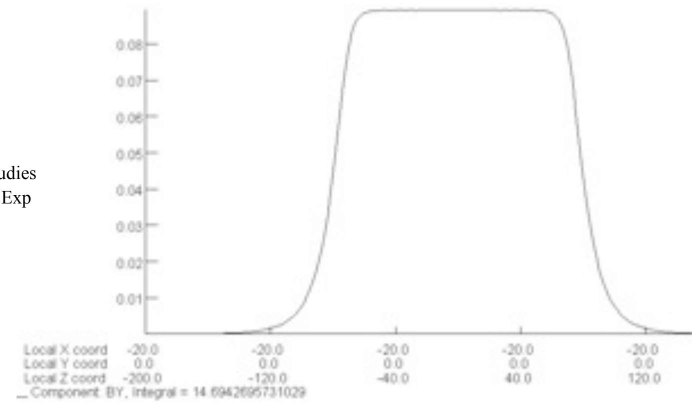
LUNEX5 PROJECT

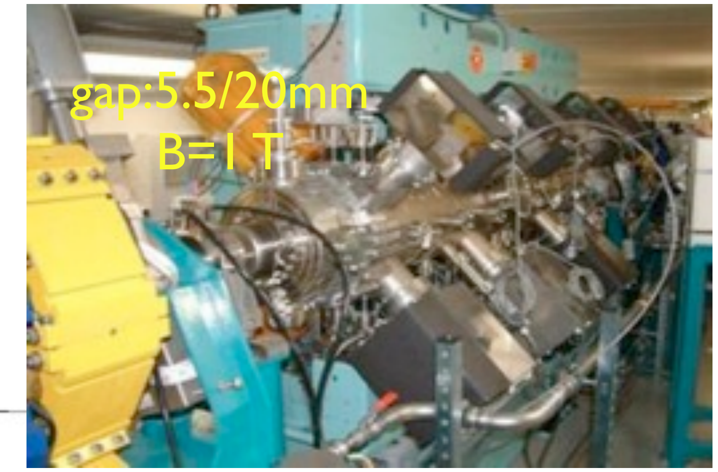


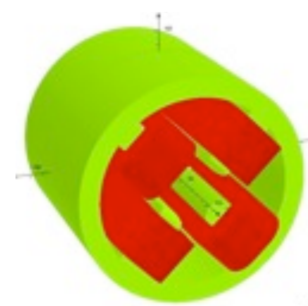
Multipurpose source chamber for isolated species production under UHV

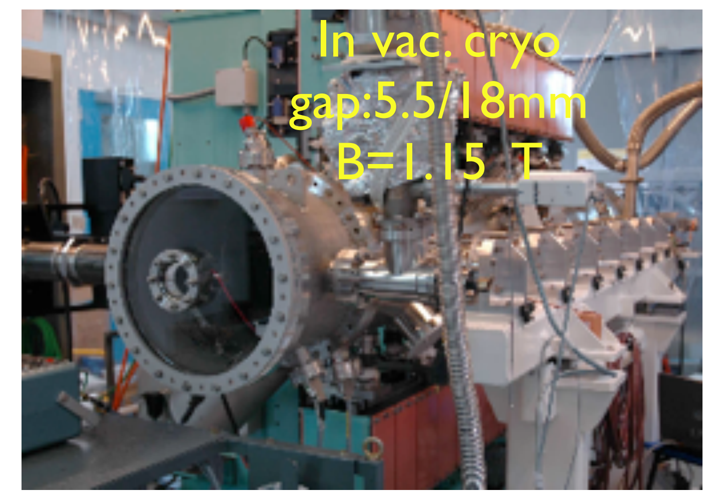
Full 3D ion momentum spectrometer











Condensed matter user station

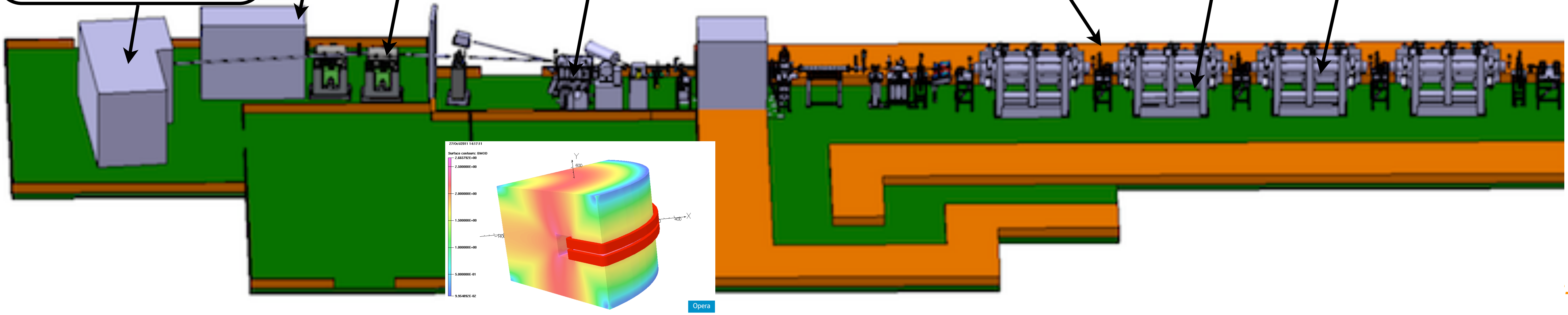
Quadrupole : 6T/m, 150 mm length, ∅ = 25 mm

Echo radiators : in-vacuum cryo-ready undulators period 15 mm

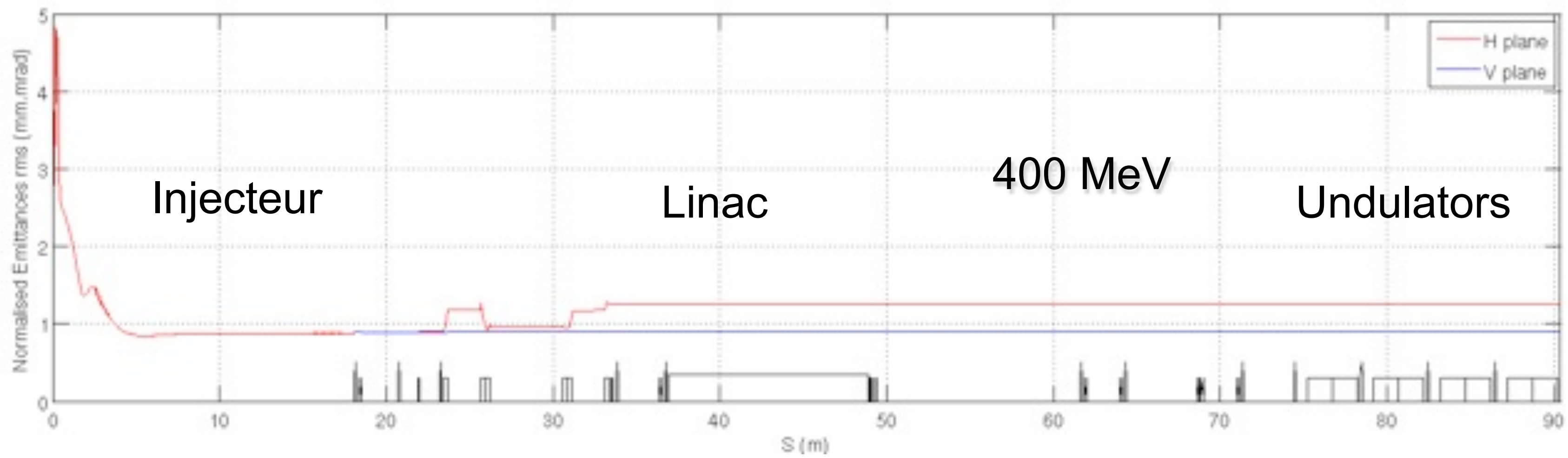
Beam dump dipole

Isolated species user station

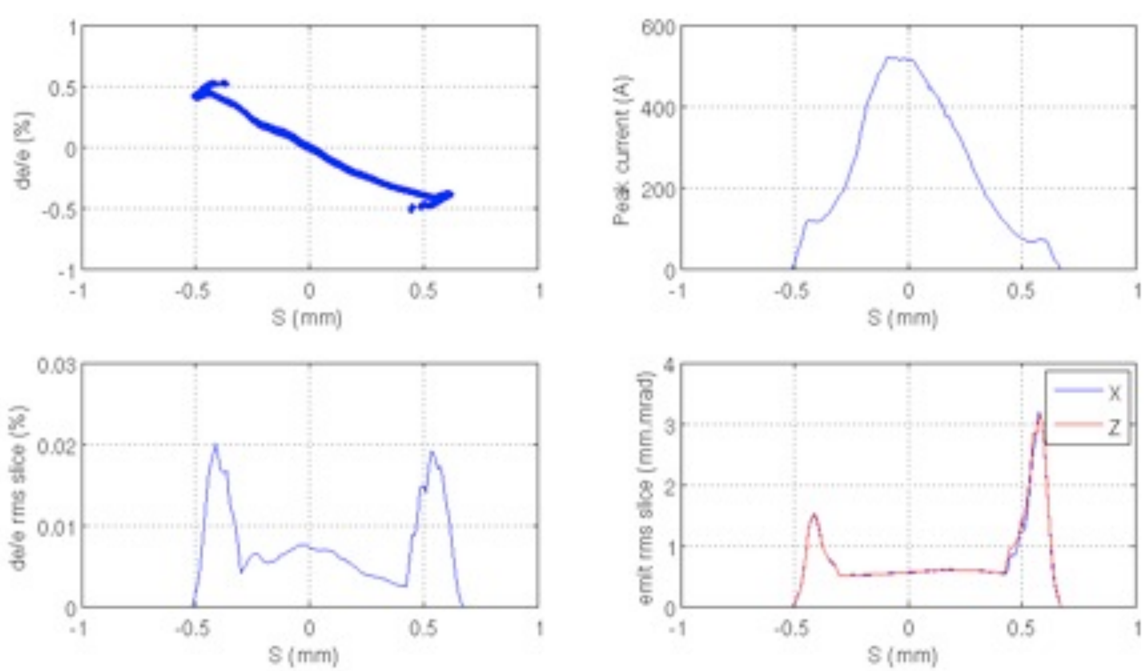
Monochromator



CLA electron beam dynamics



Final slice parameters (1 nC)



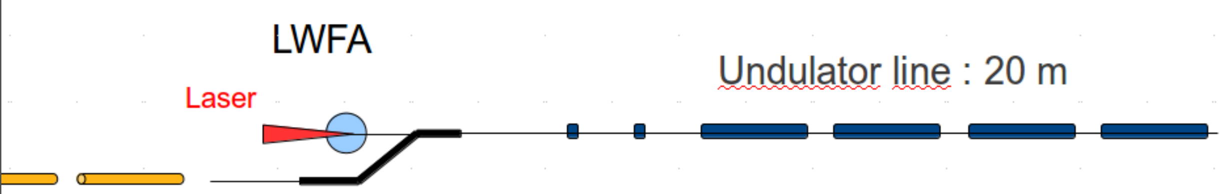
CLA@ undulator entrance

«Complete» modeling along the CLA and adaptation to the undulators

Low emittance < 1 10^{-6} mrad
Low dE/E < 1 10^{-4}
FWHM pulse duration ~ 0.5 ps
400 – 800 A peak

IV- CDR modeling and simulations

LWFA electron beam dynamics

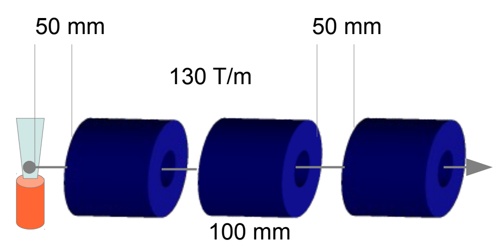


Large — Optimistic !

Size	Divergence	Norm. Emittance	Length	E-spread	Q	Peak current
1 µm	1.25 mrad	1 π.mm.mrad	2 fs	0.1%	20 pc	4 kA

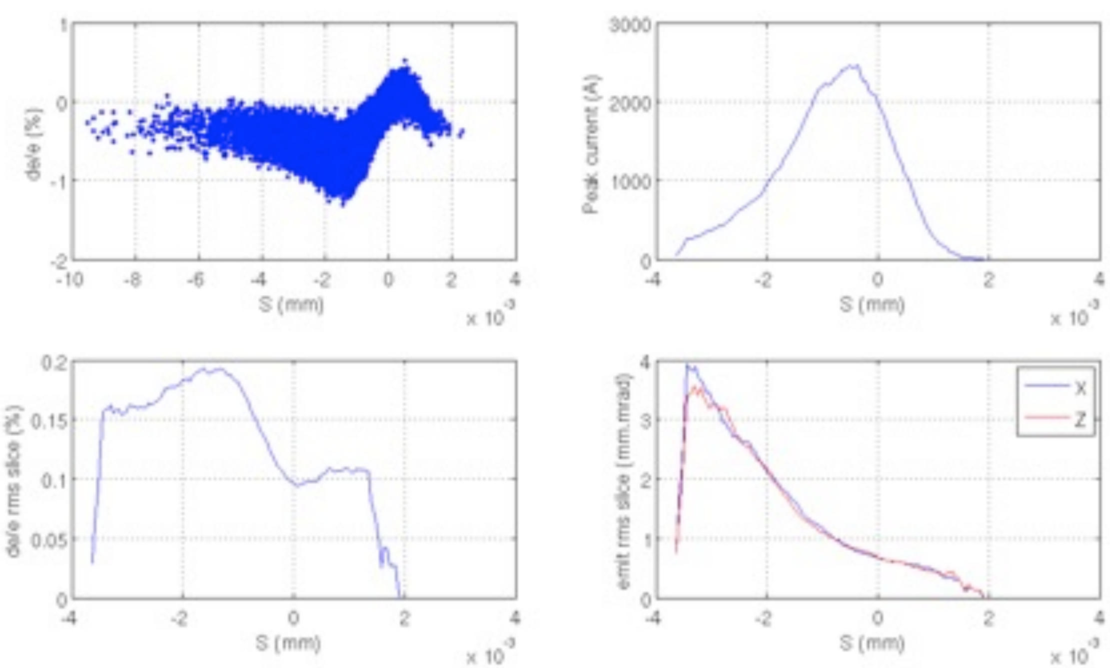
Energy : 0.4 - 1 GeV
Few fs : 2 fs=> 10 fs
High peak current : 10 kA => 2 kA
Normalised emittance $\gamma\varepsilon$= 1 π mm.mrad => 4 mm.mrad
Energy spread : between 1 % (present value) et 0.1 % (targeted value) => 0.2 %

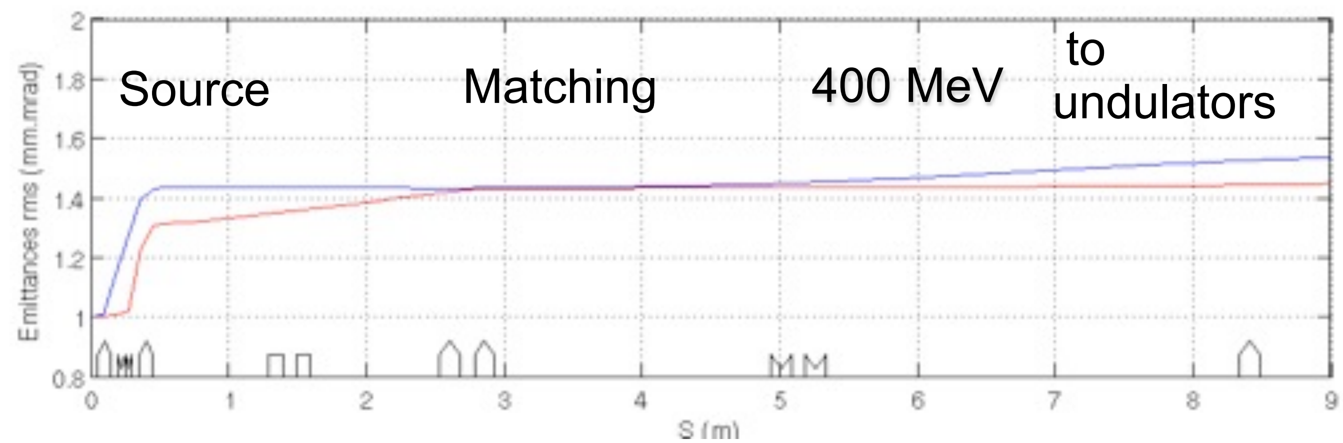
Compact permanent magnets
Spaced by 50 mm

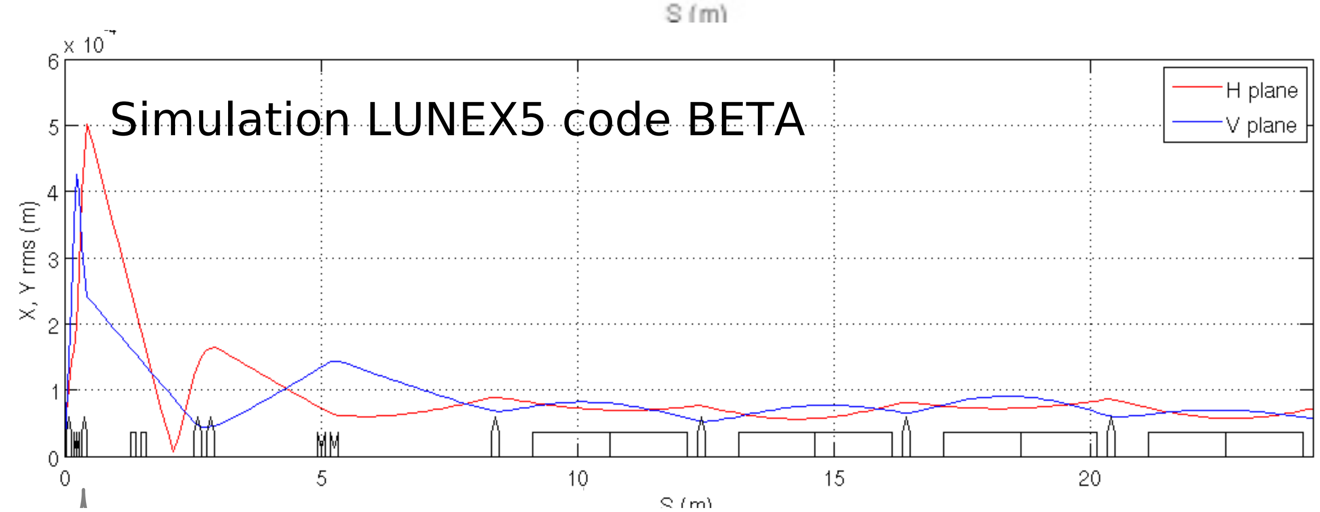


	Source	Normal quad layout	Compact quad layout
Norm. H emittance	1	23	6.7
Norm. V emittance	1	35	11
Length	2 fs	12 fs	4.2
Peak current	4 kA	1 kA	2.2 kA
Max gradient	-	20 T/m	120 T/m

Final slice parameters (20 pC)







Decompression with chicane under study

Beam transfer investigations from LWFA to FEL undulator line : see A. Loulergue et al. WEPD05
Towards Compact Short FEL sources : Seeding LWFA based FEL M. Labat, FROBI01

PIC- ASTRA/ELEGANT- GENESIS

LUNEX5

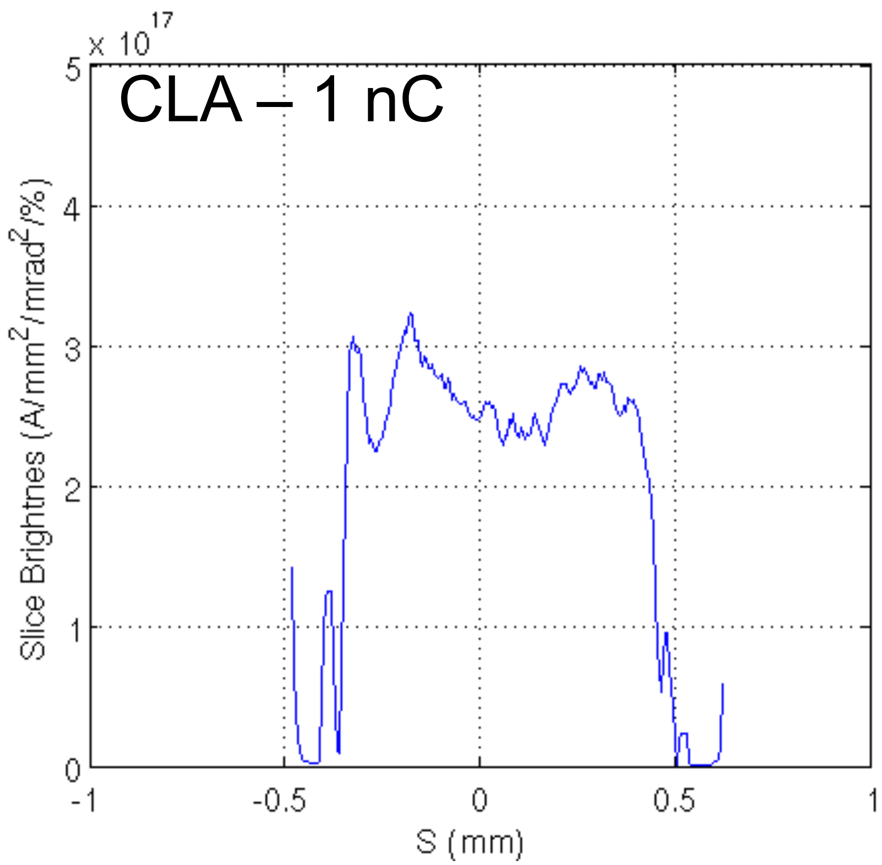
CLA and LWFA performances comparison

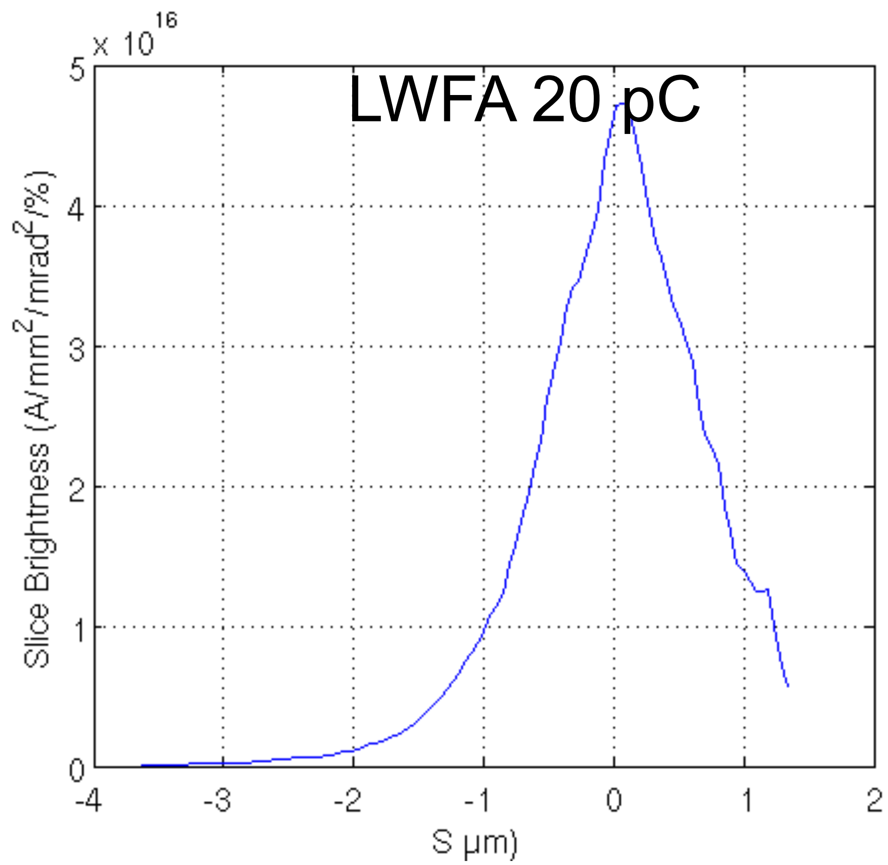
$$B_s = \frac{2I}{(\epsilon_{sx}\epsilon_{sz}\sigma_{se})}$$

Large — Optimistic !

Size	Divergence	Norm. Emittance	Length	E-spread	Q	Peak current
1 µm	1.25 mrad	1 π.mm.mrad	2 fs	0.1%	20 pc	4 kA

LWFA : 1 Hz, 400 MeV and possibly higher.





$2\text{-}3\ 10^{17}$

$4\text{-}5\ 10^{16}$

Brilliances rather comparable

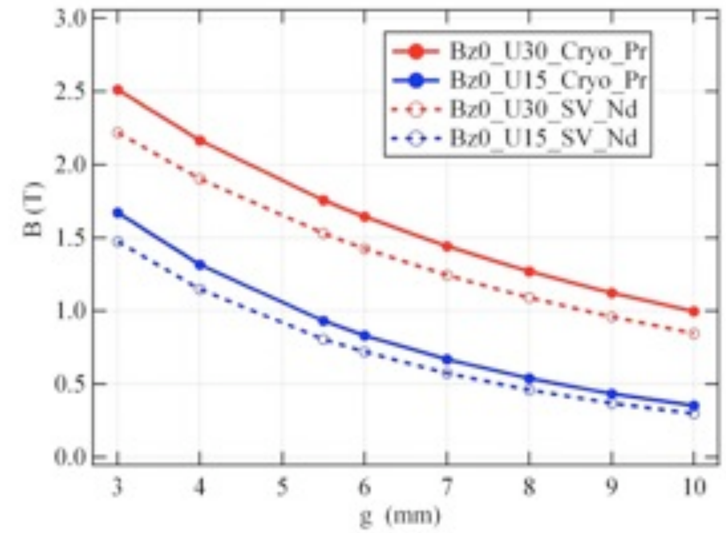
Mature and stable, technology mature, solid and fertile base for 4G+ development (HHG, EEHG...)

New promissing technology, to be qualifed on a laser application such as the FEL
Possibly single spike FEL operation
Critical parameter : energy spread and beam divergence

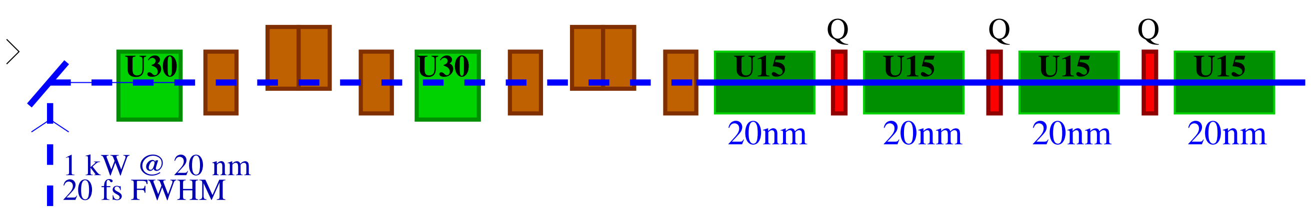
LUNEX5

FEL Sources on LUNEX5

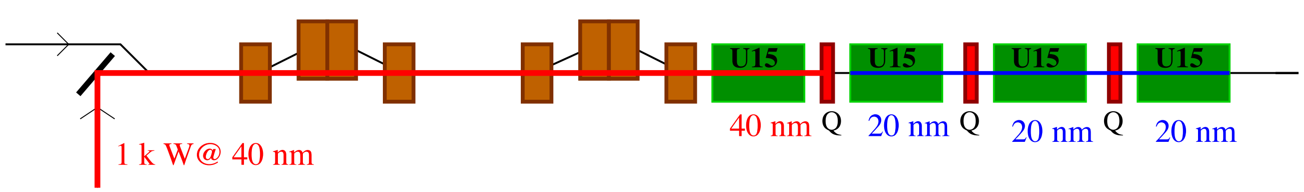
Undulator field



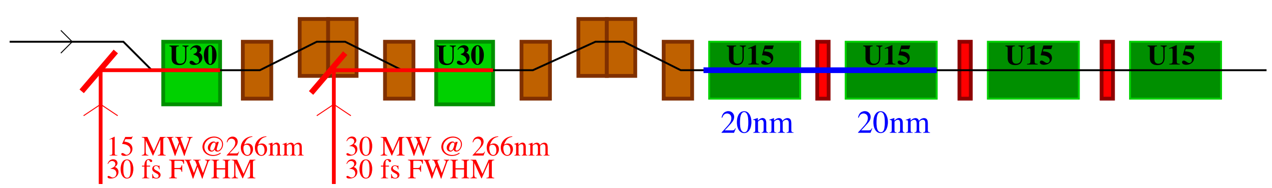
CLA : 400 MeV, 0.02% energy spread, 1.5 π mm.mrad, 400 A, 1 ps rms



Amplifier @ 20 nm,
after 3 sections z = 11 m, 50 MW, 30 fs FWHM, signal/ noise= 3

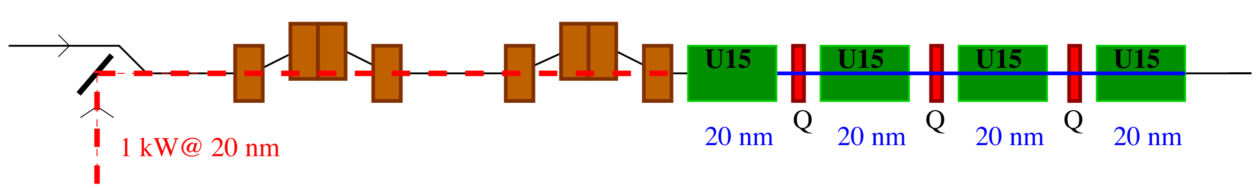


Cascade @ 20 nm,
saturation after 3 sections z = 11 m, 100 MW, 25 fs FWHM, FT



Echo @ 20 nm,
saturation after 2 sections z = 7 m, 65 MW, 24 fs FWHM, FT

LWFA : 400 MeV - 1 GeV, 0.1% energy spread, 1 π mm.mrad,
10 k A, 2 fs rms

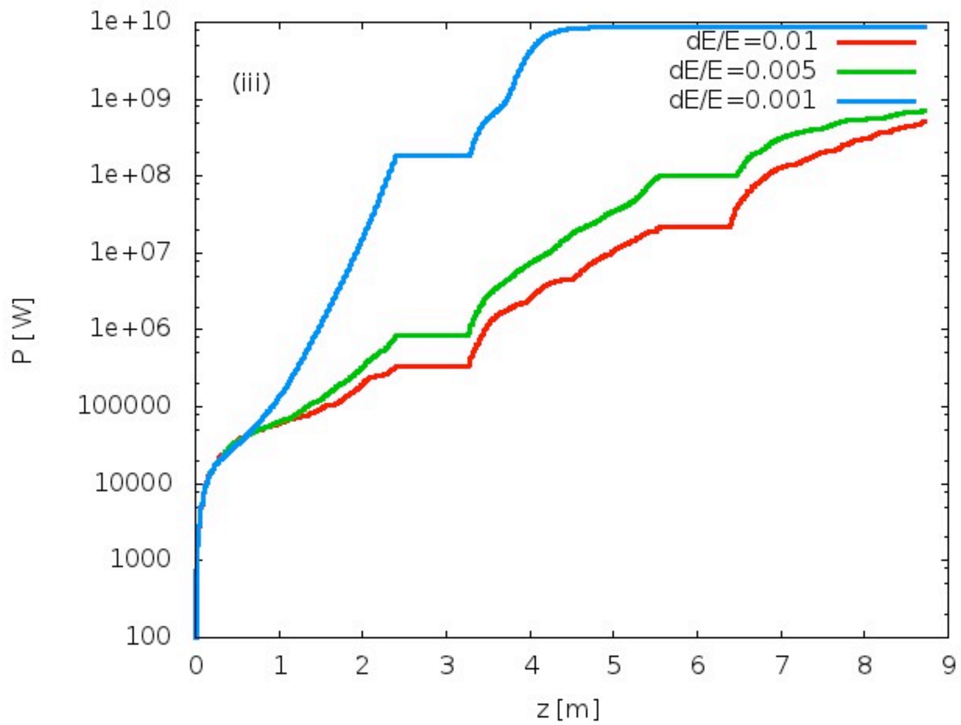


energy spread : 0.5 %, 20 fs rms;
@ 20 nm; so saturation after 3 sections, < MW, > 35 fs FWHM
energy spread : 0.1 %, 20 fs rms;
@ 20 nm; no saturation after 3 sections, 10 MW, > 20 fs FWHM
energy spread : 0.1 %, 2 fs rms;
SASE @ 20 nm, saturation after 2 sections z = 7 m, 2 GW, 7 fs FWHM, single spike

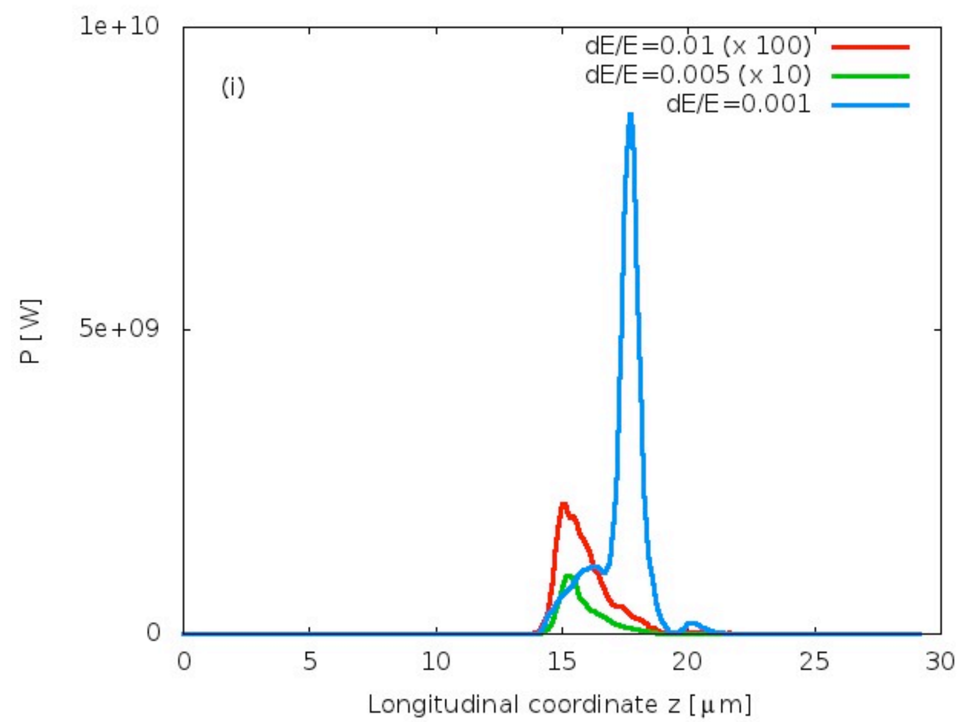
FEL performances of the French LUNEX5 project : see C. Evain et al. WEPD14

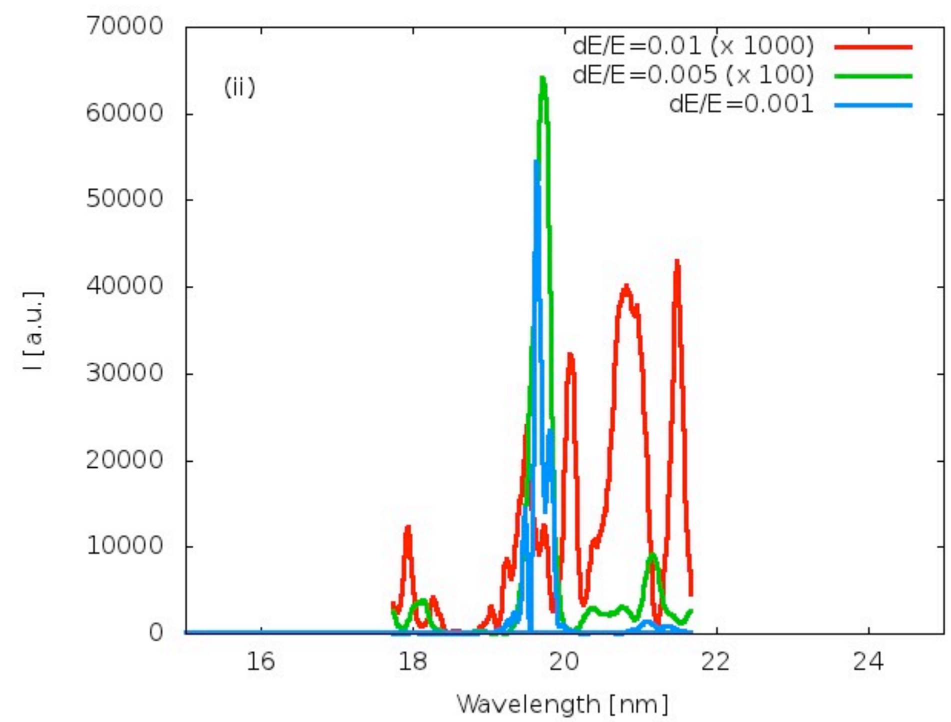
LUNEX5

Time dependant FEL calculation- LWFA



FEL performances at 19.5 nm in the SASE configuration with a LWFA beam.
Electron bunch: E=400 MeV, sigma_E=0.1/0.5/1 %, I=10 kA, sigma_Z=2 fs-rms. Undulator: 200 periods of 12 mm, K=1.408, emittance=1.0 π.mm.mrad.



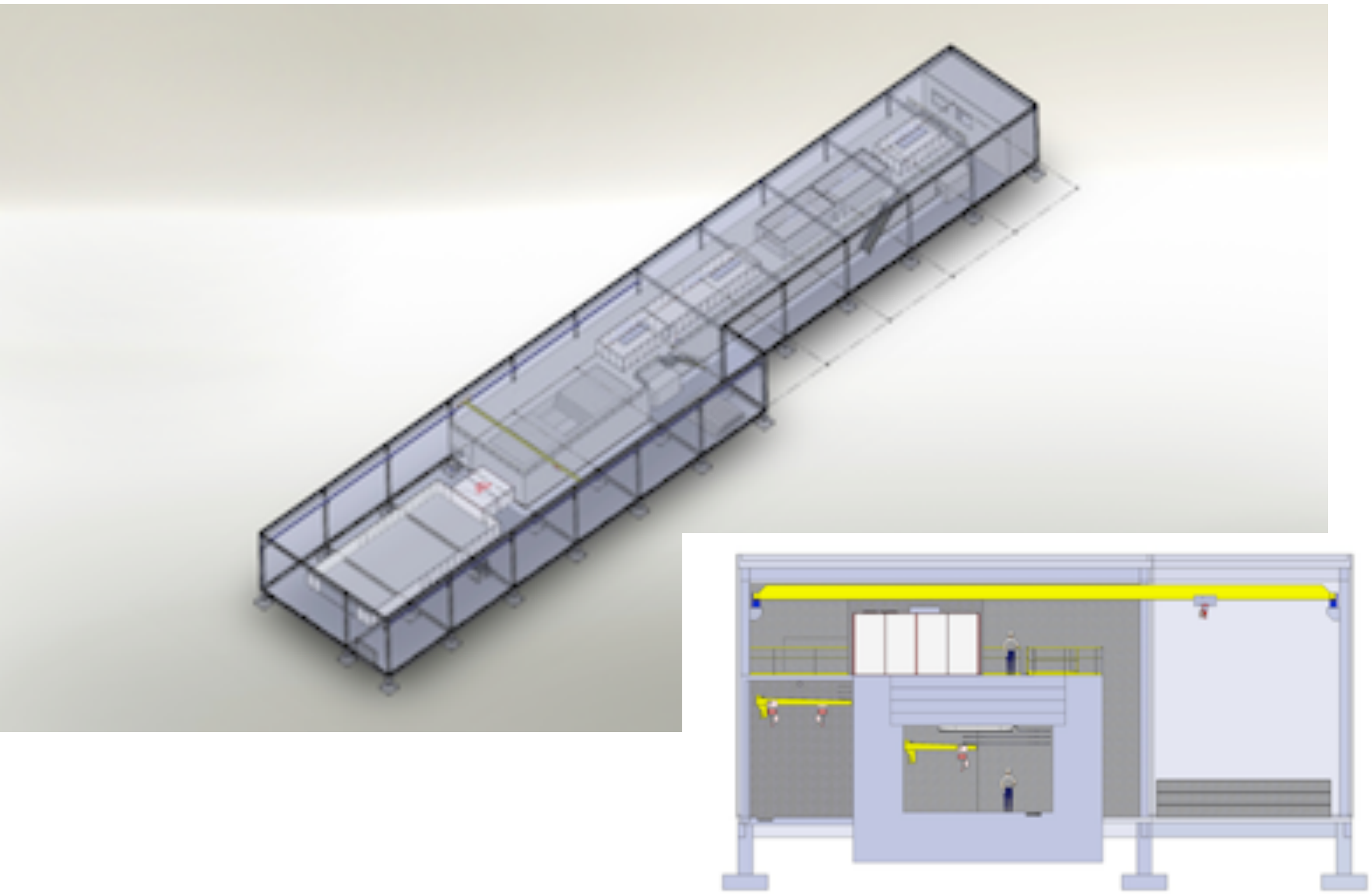


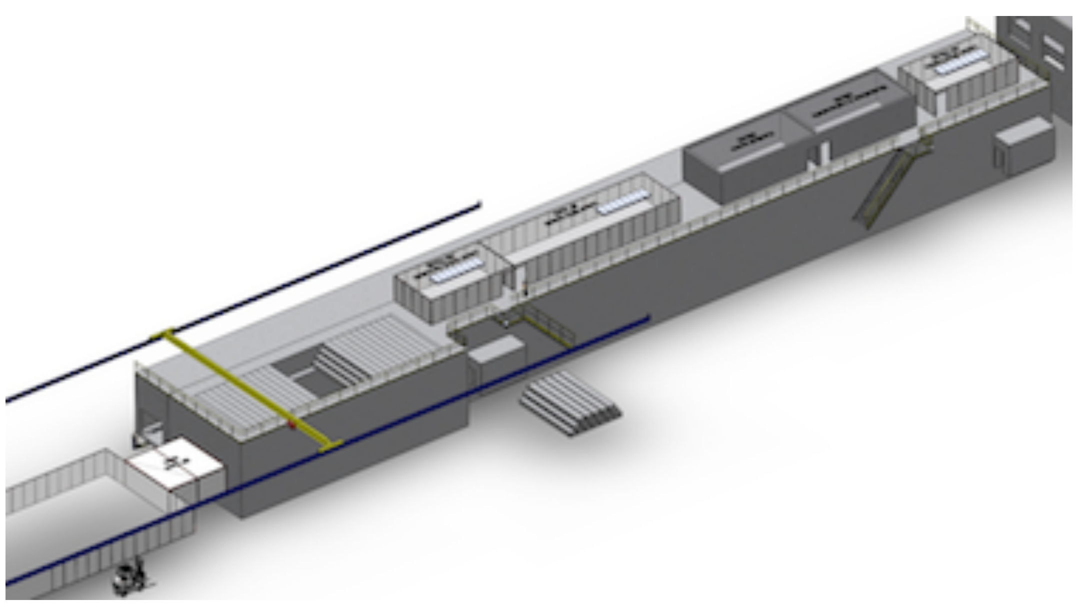
FEL performances of the French LUNEX5 project : see C. Evain et al. WEPD14

LUNEX5

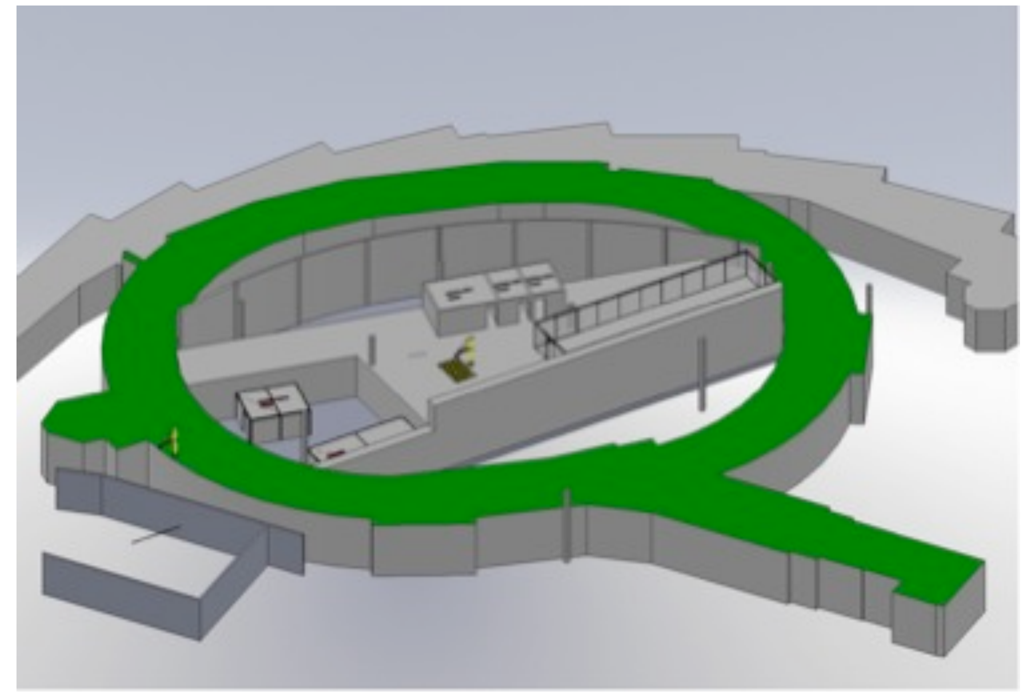
Infrastructure

Greenfield case

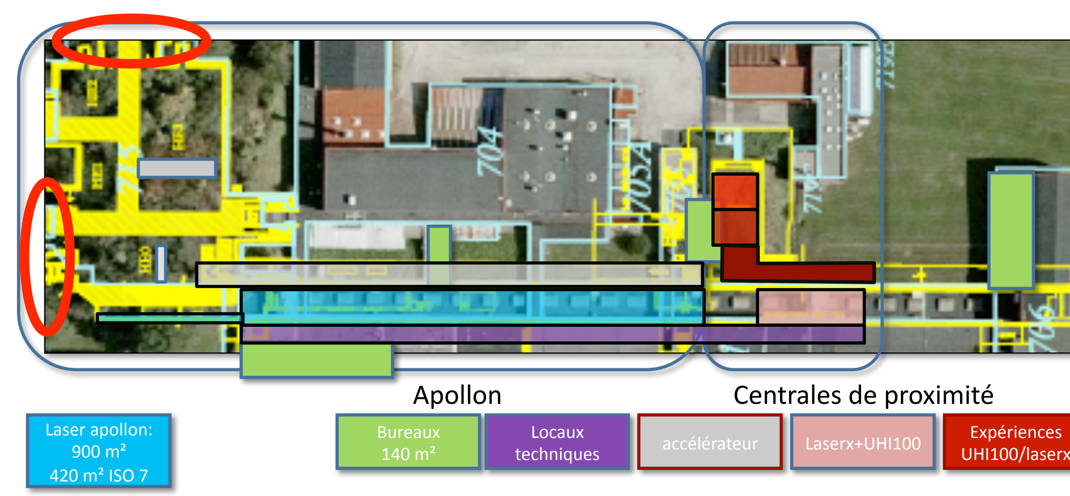




SOLEIL booster arena



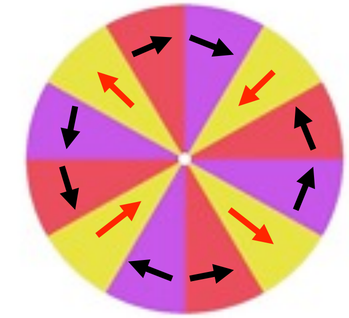
ALS tunnel



other

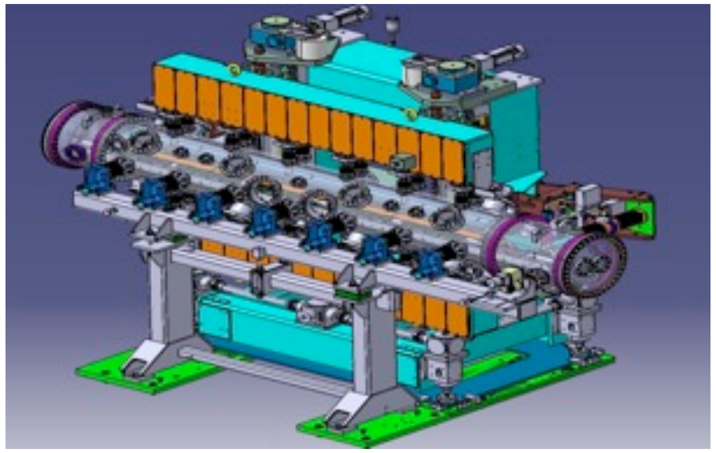
VI- R&D actions and targeted studies

Equipments



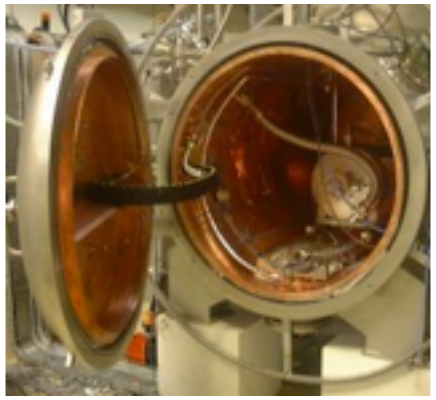
Variable permanent magnet quadrupole : SOLEIL/ SIGMAPHI/ LOA
QUAPEVA contract, Triangle de la Physique, C. Benaberrahamane et al.,
LUNEX5 FEL line magnetic elements: see C. Benabderrahmane et al. THOA04

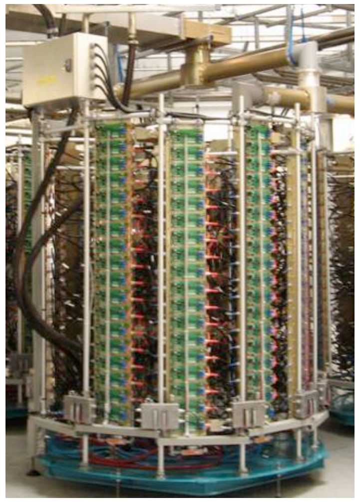
3 m long cryo-ready undulator
funded in the context of a SOLEIL-MAX IV collaboration, M. E. Couprie/E/ Wallen
LUNEX5 FEL line magnetic elements: see C. Benabderrahmane et al. THOA04



Longitudinal laser pulse shaping (PhLAM, CEA-SPAM, LAL, SOLEIL, Faslite ?)
- pulse stacking on a laser at PhLAM : Univ. Lille BQR grant
- *spectral components manipulation with a DAZZLER (CEA-SPAM, PhLAM); Enables to easily modify the pulse shape (C.Vicaro et al., Proc. CLEO 2011 (2011))*
- *application with a purchased laser on the PHIL electron gun at LAL and validation*

Gun
- *type PITZ (DESY-Zeuthen, cathode CsTe) /alternatives : C band gun (LAL)*
- *Tests on PHIL station at LAL with laser shaping*

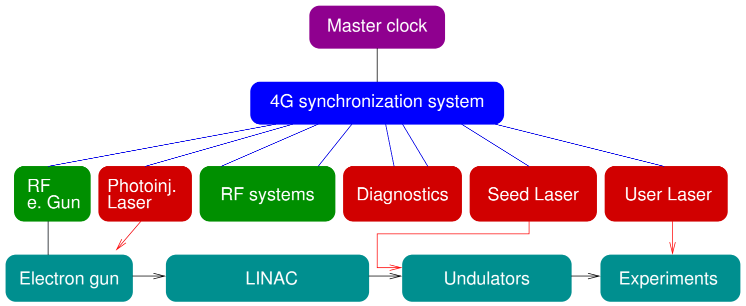




Elementary RF system (SOLEIL, CEA-SACM)
Fabrication of one 9 cell cavity (XFEL type) modified for CW operation; with one solid state amplifier of 15 kW at 1.3 GHz and one LLRF system synchronisation part. Validation with cold tests in CryHolab cryogenic station at CEA, evaluation of the different components in pulsed and CW mode, comparison between 1.8K and 2K

Smith-Purcell Monitor (LAL, SOLEIL...): SP ANR Jeune chercheur, N. Delerue
prototptypes tests at SOLEIL (linac), SPARC, FACET

Cavity BPM : design - tests in hte context of CILEX?



Synchronisation : Pulsed fiber laser system to be tested on the femtoslicing project at SOLEIL

Complementary studies

Electron beam

• CLA :

- tolerances and full parameter space
- benchmarking with other codes
- magnetic compression without harmonic cavity

• LWFA :

electron beam manipulation / transport matching
for realistic LWFA electron beams
Calder-Circ (quasi symmetric PIC code
simulations of LWFA
s2e simulations
0.1 % energy spread

• wakefields

FEL

• parameter analysis (laser, upgrades in energy of LWFA....)

• LWFA based FEL with relatistic electron beam parameters

• short pulse issues :
compression (magnetic chicane, singel spike, chirped pulse)
bunch manupulation (slotted foil, wavelength selection....)

• jitter studies (seeding...)

• tolerances

• Triple Modulator Chicane

D. Xiang et al. New Journal Physics, 2011

FEL radiation transport and monochromator
Further studies (conservation of the time structure...)
Extension with two FEL lines

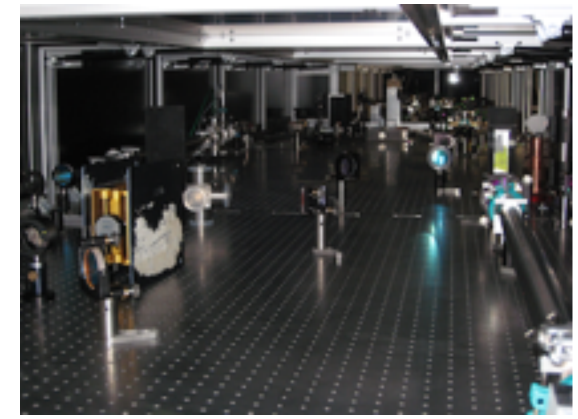
Beam transfer investigations from LWFA to FEL undulator line : see A. Loulergue et al. WEPD05
Towards Compact Short FEL sources : Seeding LWFA based FEL, M. Labat, FROBI01

C. Evain

VI- R&D actions and targeted studies

Test experiments

A «step towards 5G» test experiment under preparation at LOA (SOLEIL, LOA, CEA-DAM):

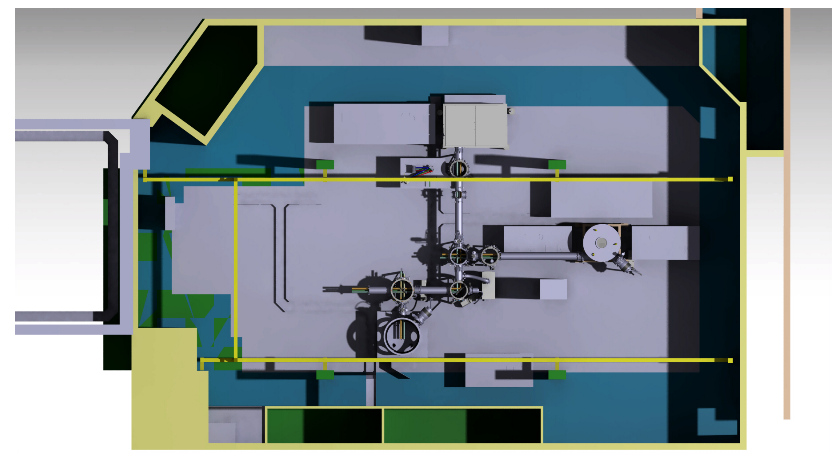


- up-graded laser : 2 x 60 TW

- new experimental hall

- new electron beam transport starting with relatisitic electron beam parameters (1% energy spread) with a proper handling and matching of the electron beam distribution

Beam transfer investigations from LWFA to FEL undulator line : see A. Loulergue et al. WEPD05



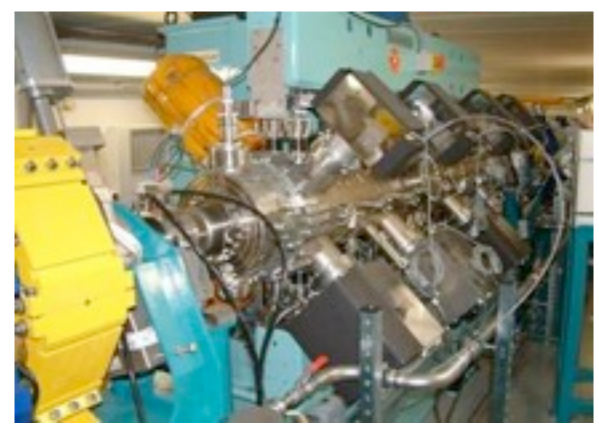
- new undulators

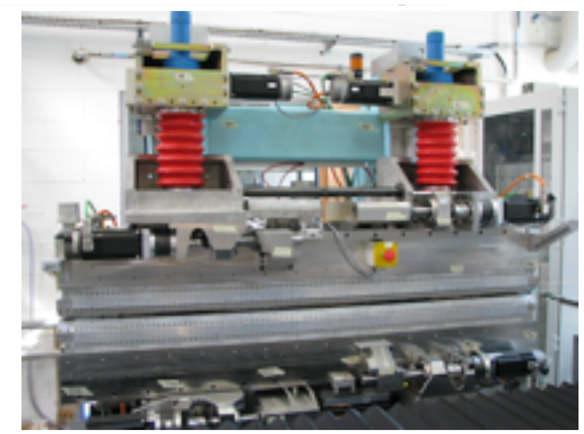
Spare SOLEIL undulators

* U20, 100 periods, 0.9 T magnetic field @ 5.5 mm gap, in-vacuum type
* HU60 0.6/0.8 T @15.5 mm gap, 26 periods, APPLE-II

R&D 3 m long cryo-ready U15 undulator :

153 periods, 1.7 T @3mm gap @77k

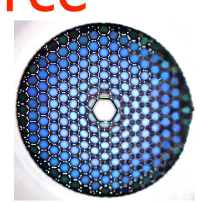


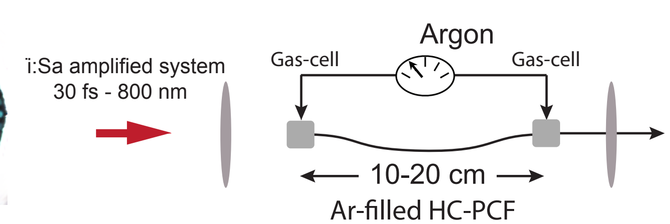


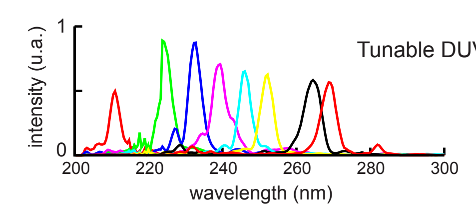
- Start-to-end PIC to Genesis FEL simulations

Test of seeding with a tunable fibre UV-VUV source

(Erlangen Univ., MAX-Planck, SOLEIL, PhLAM, SPARC, FERMI@ELETTRA, Nova Gorica)







Seeding of SPARC-FEL with a Tuneable Fibre-based source, N. Joly et al, TUPD17

N.Y. Joly, et al., "Bright spatially coherent wavelength tunable deep UV laser source using an Ar-˘filled photonic crystal fibre," PRL 106, 203901 (2011)

Conclusion

LUNEX5

Challenges and outcomes of LUNEX5

Challenges	Outcomes
Success of the echo et seeding innovative schemes at short wavelength (40 - 4 nm)	Component development in close link with industry
Pilot user experiments (seeding with 1-2 lasers)	Gathering of FEL users around LUNEX5
Qualification of a LWFA by an FEL application with the different regimes	A step before the collider LWFA application LWFA, contribution to EURONNAc ("Distributed accelerator test facility for synchrotron science and particle physics")
Handling of the fs ultrashort pulses for the LWFA and 4G+ based FELs	New applications of ultra-short pulses => elaboration of a scientific vision beyond LUNEX5 and exploitation of ultra short sources => new science
Commun language between laser, LWFA, conventionnel accelerator communities	Bridges between scientific domains (multidisciplinary investigations, laser/accelerator synergy)
Structuration of the activities	Reinforcement of structuration of the local scientific landscape (Saclay area, ESRF, LABEX, EQUIPEX...)
Scientific excellence and training of future generations	Maintenance and growth of expertise via synergy and mutual exchanges

LUNEX5 is open to new collaborations, in particular for joint R&D or targeted complementary studies.

LUNEX5 project is still very flexible, aiming at advancing on the differents R&D subjects.

We continue in the LUNEX5 adventure for ultra short FEL pulses quest, production and use

Acknowledgments

LUNEX5

Many thanks to :

Review committee

ASSMAN Ralph (CERN)
BARTOLINI Riccardo (Diamond, UK)
FELDHAUS Josef (DESY, Germany)
GEORGES Patrick (Institut d'Optique, France)
RUBENSSON Jan-Erik (Uppsala, Sweden)
SCHROEDER Carl (Lawrence Berkeley Laboratory, Berkeley, USA)

Steering Committee

AMIRANOFF François (CILEX)
BIELAWSKI Serge (PHLAM)
CARRÉ Bertrand (CEA-SPAM)
CAVALIER Fabien (LAL, P2IO)
COUPRIE Marie- Emmanuelle (SOLEIL)
DAILLANT Jean (SOLEIL)
DUBOIS Alain (LCPMR)
FARVACQUE Laurent (European Synchrotron Radiation Facility)
LOULERGUE Alexandre (SOLEIL)
MARSI Marino (PALM),
MORIN Paul (SOLEIL)
NADJI Amor (SOLEIL)
STOCCHI Achille (LAL/ P2IO)
ROUSSE Antoine (LOA)

SOLEIL Council members

GIRARD Bertrand (CNRS)
SIMON Charles (CNRS)
DURAUD Jean-Paul (CEA)

LUNEX5 team

Synchrotron SOLEIL, L'Orme des Merisiers – Saint Aubin – BP48- F-91192 Gif-sur-Yvette CEDEX

General Direction: DAILLANT Jean (General Director of SOLEIL)
Communication Group: GACOIN Marie-Pauline, QUINKAL Isabelle, YAO Stéphaine
Partnerships : CAMINADE Jean-Pierre
Planification, Methods, Quality : ROZELOT Hélène
Security Group : LAURENT Jean-Pierre, PRUVOST Jean-Baptiste

Sources and Accelerator Division : NADJI Amor, PODGORNY Sabine
Accelerator Physics Group : NAGAOKA Ryutaro, LOULERGUE Alexandre
Diagnostics Group: DENARD Jean-Claude, CASSINARI Lodovico, HUBERT Nicolas, LABAT Marie
Magnetism and Insertion devices Group: COUPRIE Marie-Emmanuelle, BENABDERRAHMANE Chamseddine, EVAIN Clément, MARTEAU Fabrice, VALLEAU Mathieu
Power Supplies Group : LEBASQUE Pierre, BOUVET François
RF and LINAC Group: MARCHAND Patrick, EL AJJOURI Moussa, LOPES Robert, LOUVET Marc, POLLINA Jean- Pierre, RIBEIRO Fernand

Experimental Division: MORIN Paul
Optics Group: LAGARDE Bruno, POLACK François
Instrumentation group : HOLLANDER Philippe
PLEIADES Beamline: MIRON Catalin
METROLOGY Beamline : MERCÈRE Pascal
AILES Beamline : ROY Pascale
CRISTAL : RAVY Sylvain, LAULHE Claire
TEMPO : SIROTTI Fausto, LÛNING Jan

Techni*cal and development Division:* BESSIERE Michel
Alignment Group: LESTRADE Alain
Building and infrastructures Group: EYMARD Philippe, FERRARI François
Conception Engineering Group: MARLATS Jean-Louis
Vacuum Group: HERBEAUX Christian

Computing Division; GAGEY Brigitte (Director of the Computing Division)
Acquisition and Control Electronics Group: BETINELLI Pascale, RICAUD Jean-Paul

Administrative Division : LE Ray Yves, Juridics and Procurements : LEROY Michael

Commissariat à l'Énergie Atomique et aux Énergies Alternatives /Saclay 91191 Gif-sur-Yvette CEDEX

CEA, Direction des Sciences de la Matière, SM/ IRAMIS/ Service de Photons Atomes et Moélcules: CARRE Bertrand, D' OLIVEIRA Pascal, MONOT Pascal, POISSON Lionel REYNAUD Cécile

CEA, Direction des Sciences de la Matière / IRFU/ Service des Accélérateurs, de la Cryogénie et du Magnétisme: DAËL Antoine, BREDY Philippe, DEVANZ Guillaune, LUONG Michel, NAPOLY Olivier,

CEA, Direction des Sciences du Vivant DSV, LBSR : LE DU Marie-Hélène

Laboratoire de l'Accélérateur Linéaire (LAL), Centre National de la Recherche Scientifique, Université Paris-Sud
VARIOLA Alessandro, BRUNI Christelle, ROUX Raphaël

Laboratoire d'Optique Appliquée (LOA), ENSTA, CNRS et École Polytechnique LAMBERT Guillaume, MALKA Victor, ROUSSE Antoine, LIFSCHITZ Augustin

Laboratoire de Physique des Lasers Atomes et Molécules (PhLAM) et Université de Lille
BIELAWSKI Serge, SZWAJ Christophe, EVAIN Clément, LEPARQUIER Marc (Centre d' Études Lasers et Applications)

Laboratoire de Chimie Physique - Matière et Rayonnement (LCPMR)- 11 Rue Pierre et Marie Curie,75231 Paris Cedex 05
DUBOIS Alain, PENENT Francis, LÜNING Jan, PIANCASTELLI Maria Novella, SIMON Marc

Institut des Sciences Moléculaires d'Orsay (ISMO), Université Paris-Sud
DOWEK Danielle

European Synchrotron Radiation Facility
LE BEC Gaël , REVOL Jean-Luc

Fusion for Energy, ITER Department, c/Josep Pla 2- Torres Diagonal Litoral, Ed. B3, 08019 Barcelona, SPAIN
FILHOL Jean-Marc