国際会議Nuclear Photonics 2018の報告

CONFERENCE CHAIRS

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PROGRAMME CHAIRS

Prof. Andreas ZILGES	University of Cologne
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IMPORTANT DATES

- Abstract submission closed: February 28th 2018
- Early registration deadline: April 15th 2018
- Registration closed: May 15th 2018

Main Topics

- Fundamental nuclear science and spectroscopy
- Laser–plasma nuclear physics
- High intensity laser–plasma interaction
- Nuclear medicine including radiography and radiotherapy
- Industrial non-destructive material imaging and evaluation
- Isotope-specific, nuclear materials detection and management
- Photon-based hadron beams and applications
- Photon-based production of rare isotopes
- Photon-enabled pulsed neutron generation and science
- Photon-enabled pulsed positron generation and science
- Nuclear astrophysics and cosmology
- Gamma-ray science above the giant dipole resonance
- Strong field QED

Field of interest

- ultrahigh intensity lasers for particle accelerations
- gamma beam systems
- applications : nuclear physics and industries

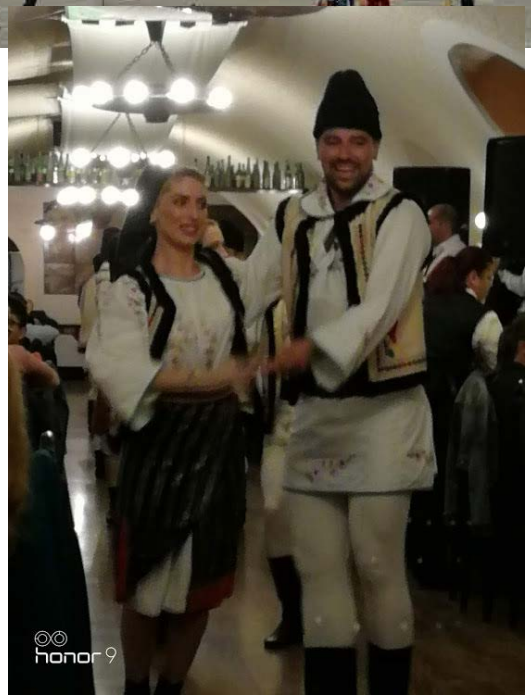
Conference History

- 1st Nuclear Photonics : 2016.10 16-21 @ Monterey, CA
- Origin : “Nuclear Physics and Gamma-ray sources for Nuclear Security and Nonproliferation” , 2014. 1 28-30 @ Tokai-mura, Japan

Statics

- Participant : 215 from 25 countries (EU, US, Asia, ME)
- Program (71 oral, 80 poster)
  - 4 tutorial
    - Ultrahigh Intensity Laser
    - Laser-driven ion accelerator
    - Accelerator-based Gamma Sources
    - Photonuclear Physics
  - Keynote (Single cycle pulse) and ELI-NP, ELI-ALPS(Budapest)
  - Nuclear Physics : 12(structure) , 5(LCS)
  - Ultrahigh intensity laser : 16(Laser-plasma interaction), 16 (Nuclear Physics), 5 (QED)
  - Gamma-ray sources : 4
  - Applications and others : 10 (nuclear)


BRASOV

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eli
physics
THALES

EUROPEAN UNION

GOVERNMENT OF ROMANIA

Structural Instruments 2014-2020

Operational Programme Competitiveness

Extreme Light Infrastructure – Nuclear Physics (ELI-NP) – Phase II

Project co-financed by the European Regional Development Fund

Where does ELI-NP stand now?

Kazuo A. Tanaka

for the ELI-NP researchers, collaborators, and users

Nuclear Physics

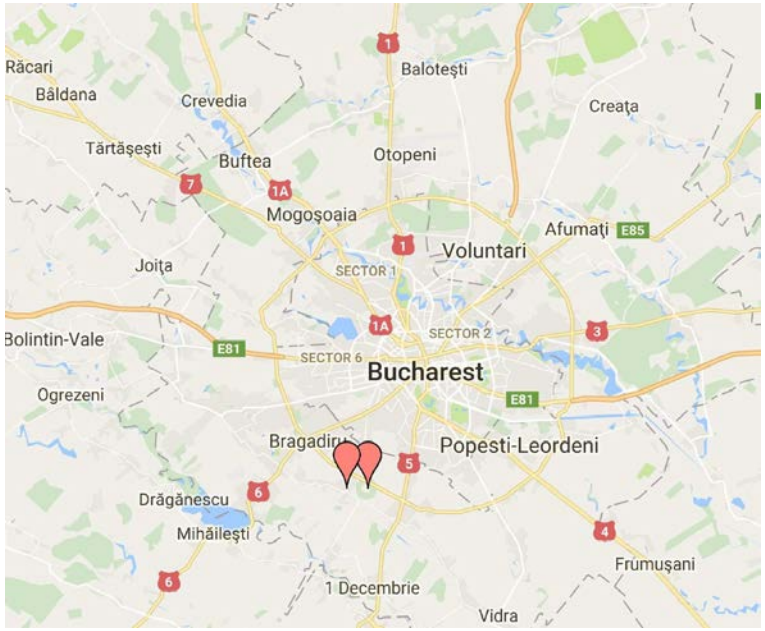
Nuclear Photonics 2018

June 25, 2018

Brasov Romania

ELI-NP Buildings

We are located in Bucharest.



Summary

- ELI-NP is under active implementation.
- PW laser beam will be available in 4th quarter in 2018.
  10 PW laser beam will be available in 1st quarter in 2020.
  Gamma beams will be available in 4th quarter in 2018.
- **3PW performance was tested in May 2018.**

- Further experimental research program will be called for via. ELI-ERIC and user workshops.

ELI-ERIC: ELI-European Research Infrastructure Consortium
https://eli-laser.eu/media/1144/eric_brochure.pdf

Two major systems are planned for ELI-NP user facility.

Laser System with Highest Focused Intensity

The wavelength, pulse width, energy, and beam diameter are 820 nm, 25 fsec, 250 J, and 50 cm.

Focused laser intensity may reach 10^{23} W/cm^2.

The laser light will accelerate electrons up to the speed of light.

Gamma Beam System with Highest Photon Number

The Gamma Beam photon energy is 19.5 MeV with 2 psec pulse width.

The number of photons may reach 10^9 photons/sec.

The gamma light will interact directly with nuclei for excitation and fission.

Laser system can be operated as stand alone or combined with Gamma beam system.

- Experiments under extreme conditions, so far not possible, can be conducted.

For example, we will perform

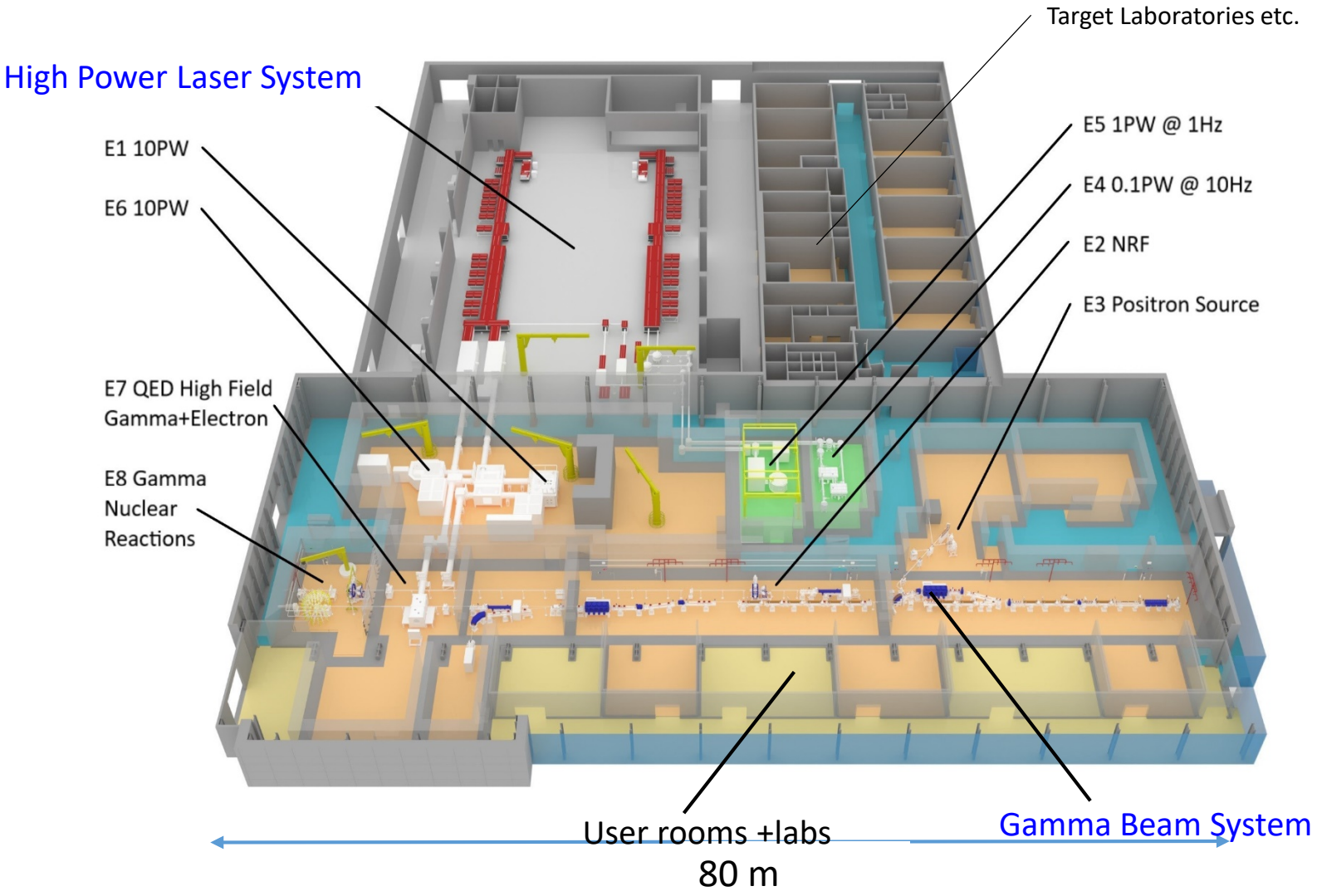
- Electron acceleration more than 10 GeV
- Nuclear fission and fusion
- Head-on collision of the laser and relativistic electron beam

Then these experiments will clarify

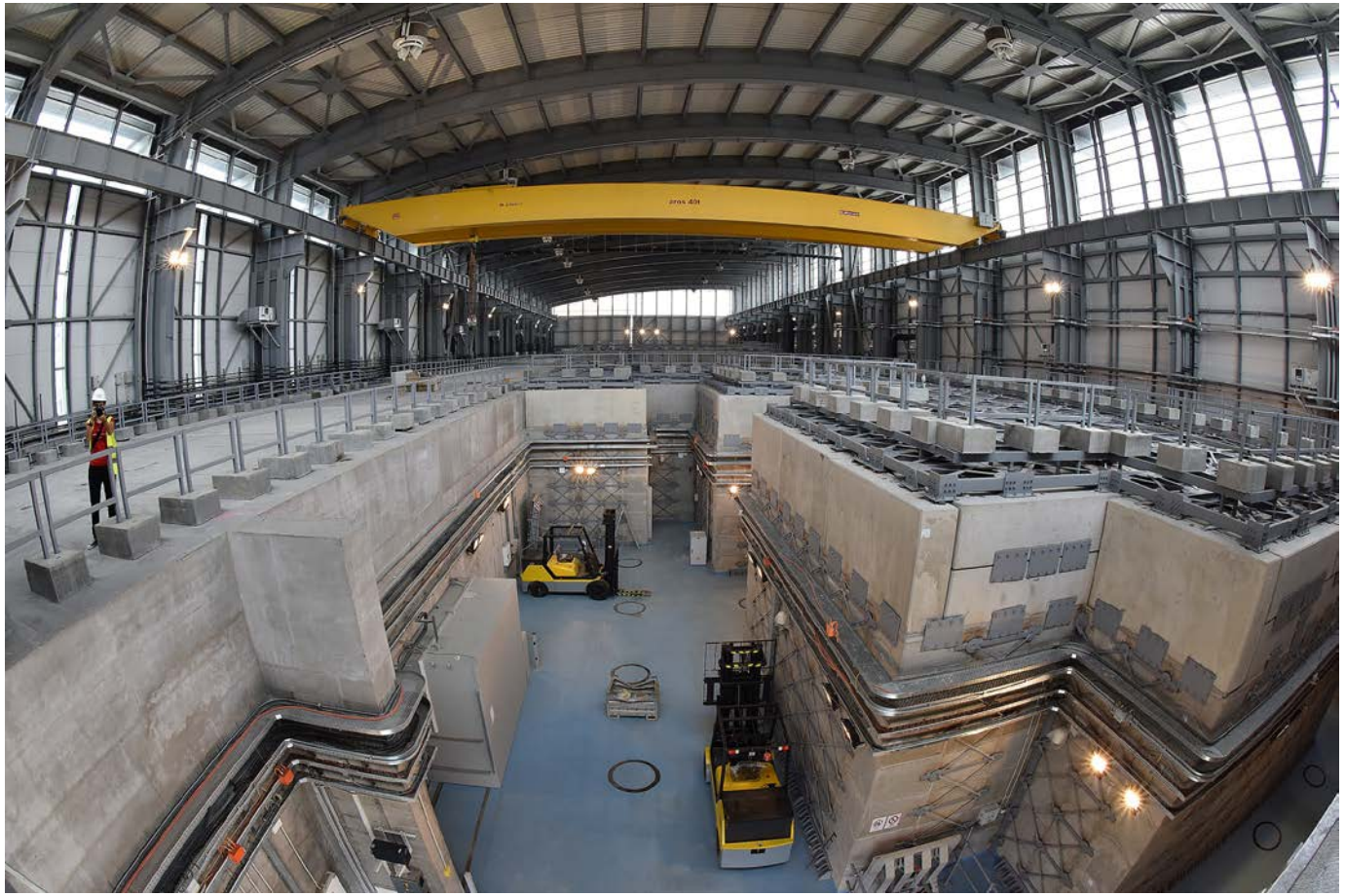
- History of the Universe
- Important Issues on nonlinear QED
- Isotope production for medical use

These achievements may lead to the Nobel prize and/or realistic societal impact.

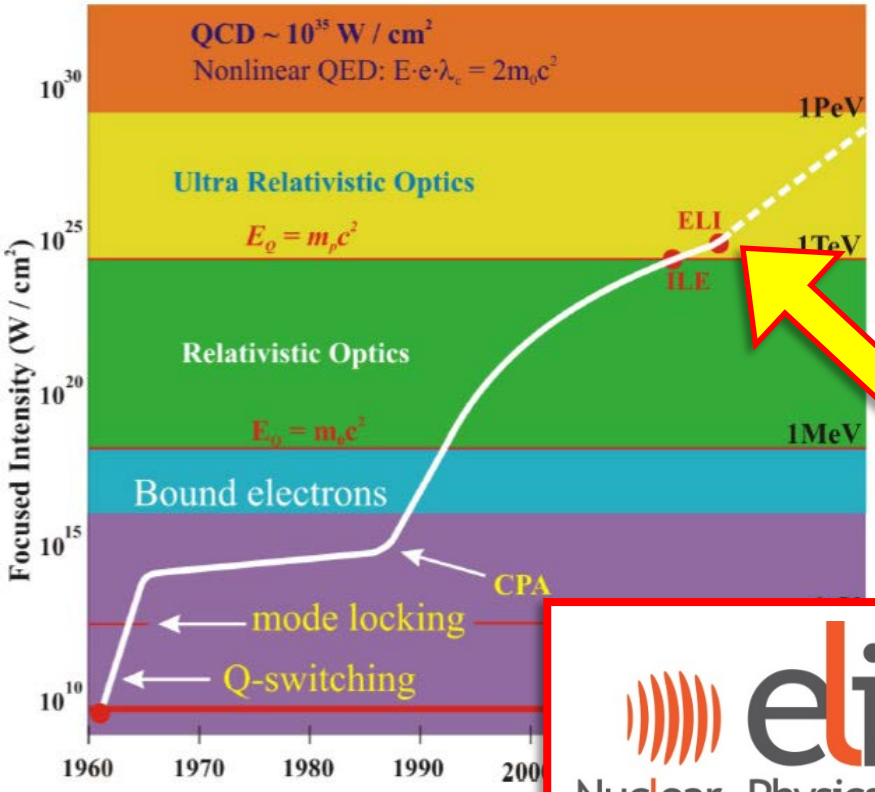
HPLS, GBS, and Experimental Areas E1-E8



Chamber rooms are separated and protected with thick 2m concrete walls.



Intensity could reach 10^{22}-10^{23} W/cm^2



Nuclear Physics

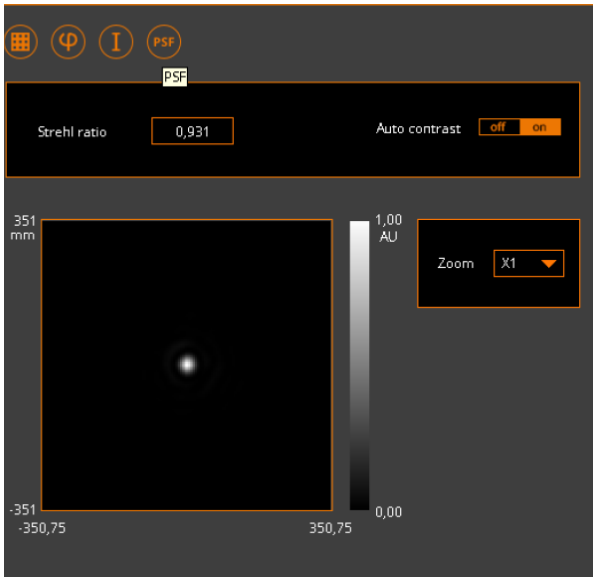
10^{23} W/cm^2

Laser Installation Completed

We have confirmed 3PW performance.

100 TW

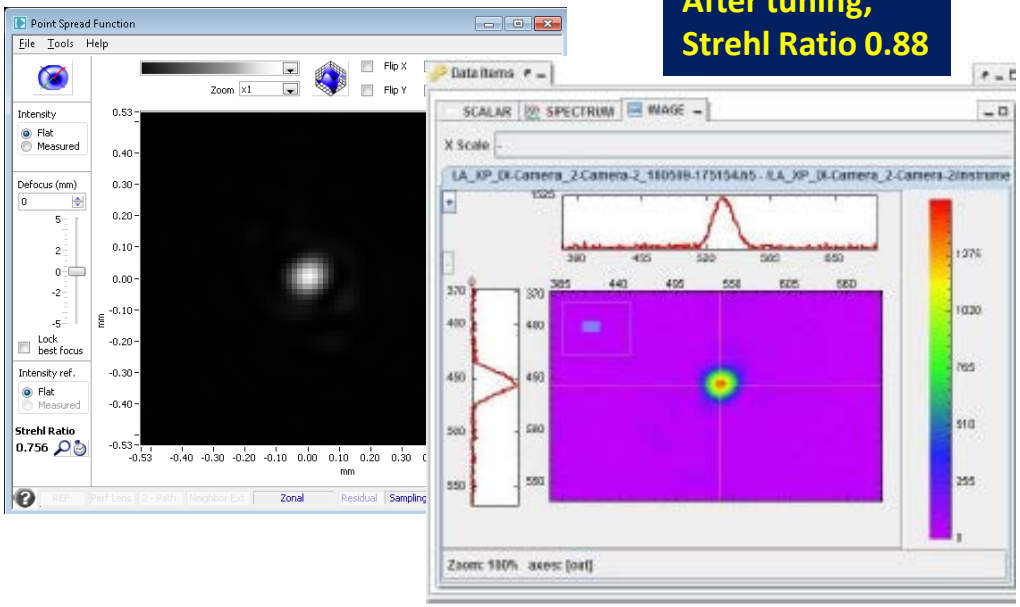
- Output energy ~ 2.13 J
- Pulse duration 21.1fs
- Strehl ratio 0.9



3 PW

- Injected energy (attenuated before compressor) ~ 92.3 J
- Compressor efficiency 74%
- Pulse duration 22.7 fs
- Strehl ratio 0.72

After tuning, Strehl Ratio 0.88



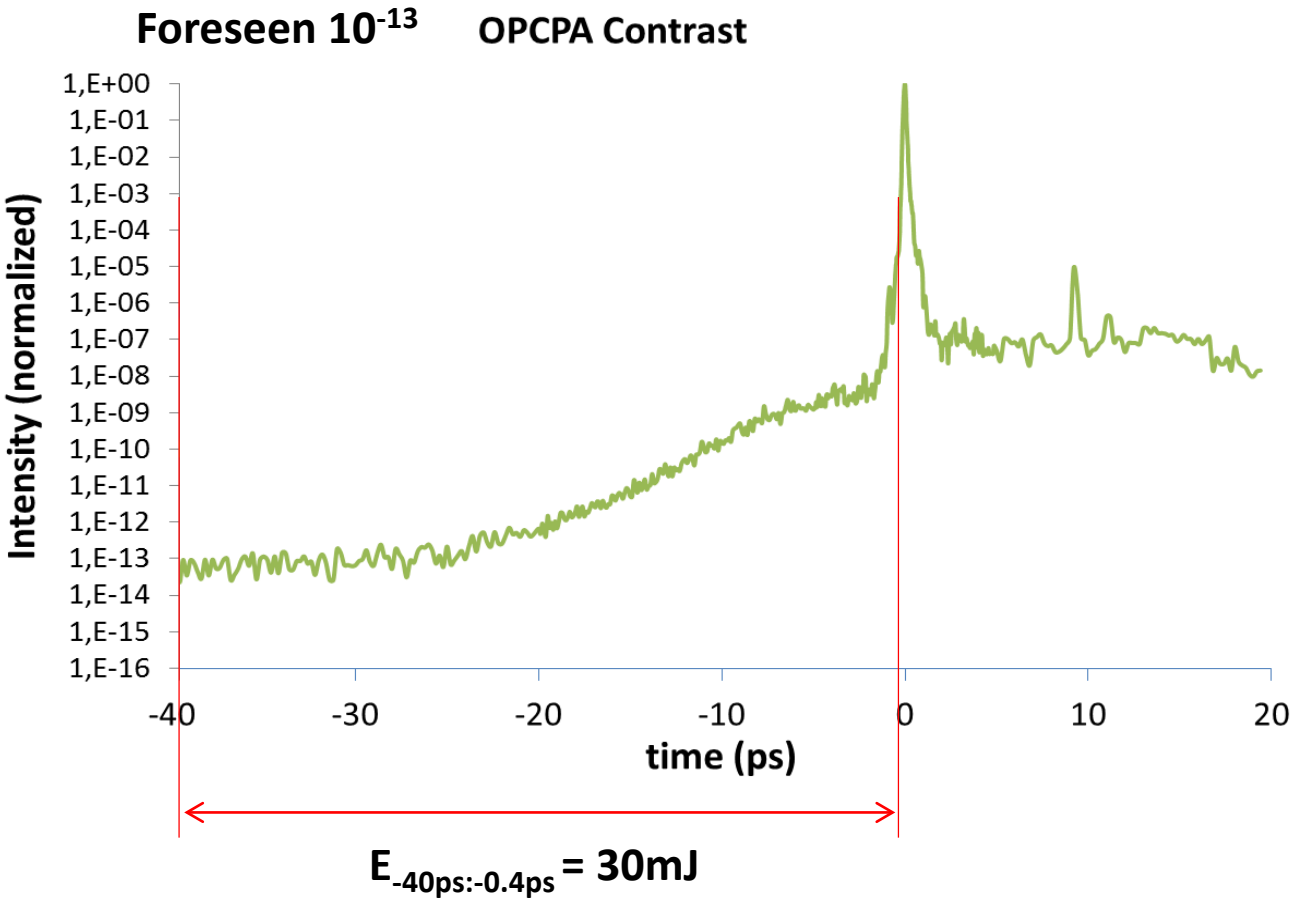
Final compressors are ready to go.

Thales Laser France and Romania

High Power Laser System

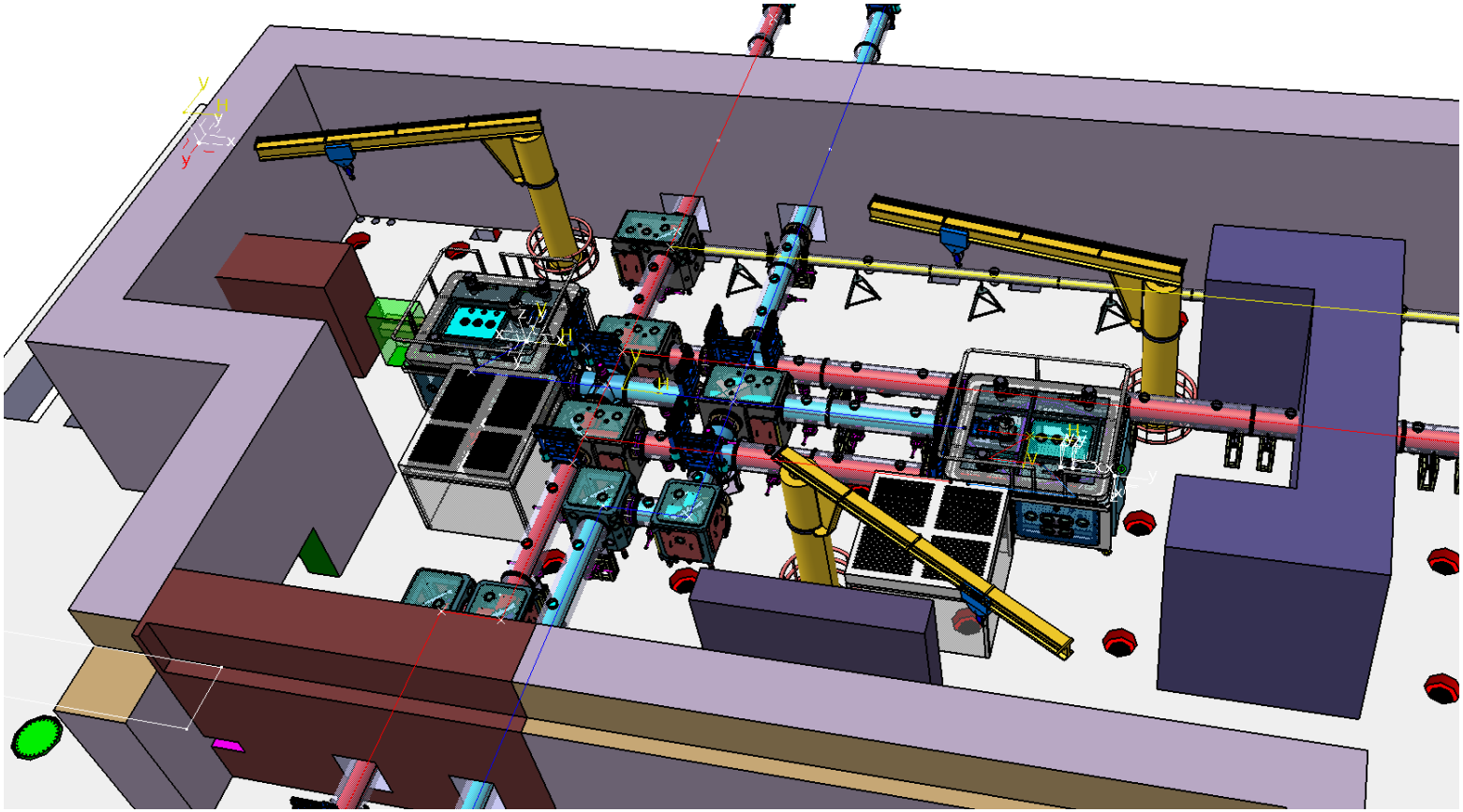
	min	max	unit
Energy/pulse	150	225	J
Central wavelength	814	825	nm
Spectral bandwidth (FWHM)	55	65	nm
Spectral bandwidth (at nearly zero level of intensity)	120	130	nm
Pulse duration (FWHM)	15	22.5	fs
FWHM beam diameter/Full aperture beam diameter	450/550		mm
Repetition rate	1		pulse /min
Strehl ratio	0.8	0.95	
Pointing stability	2	5	µrad
Beam height to the floor	1500	1510	mm

We expect to have 10^{13} contrast ratio.



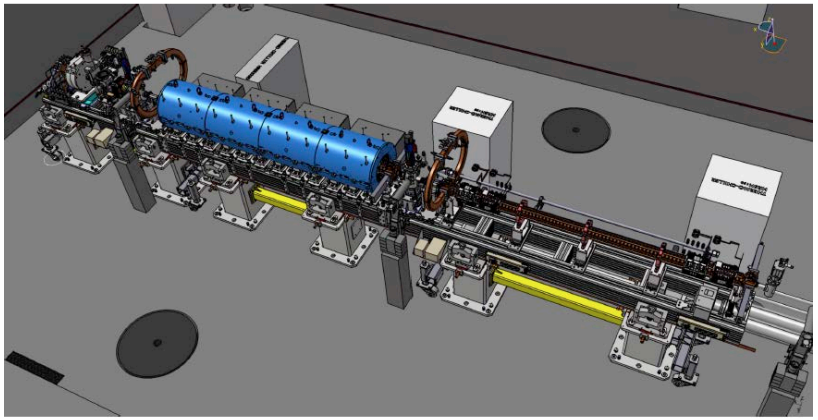
2x10 PW Laser Beam Transport System

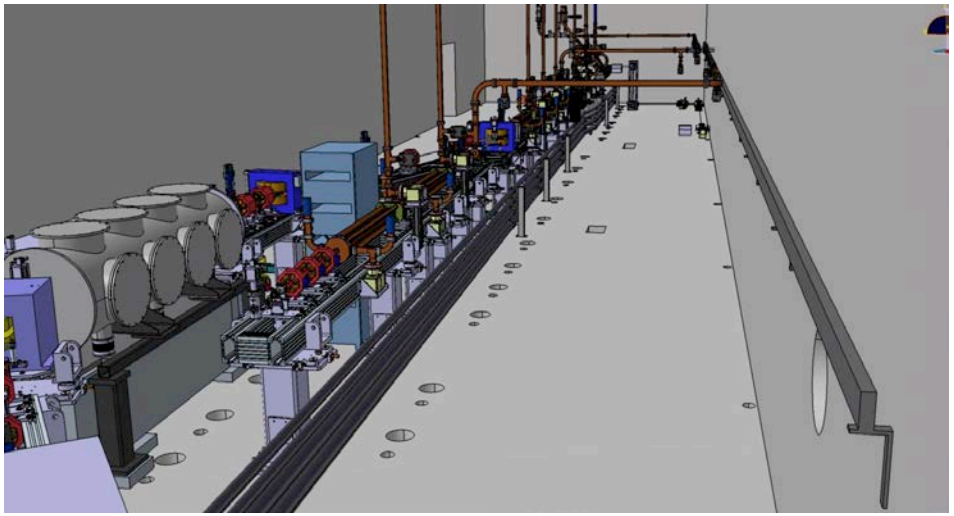
- 2x10 PW beams + 1 PW auxiliary beam to any of 3 experimental areas
- f=30 m focal length mirror for electron LWFA at 10 PW
- Under construction by Thales led consortium



Gamma Beam System

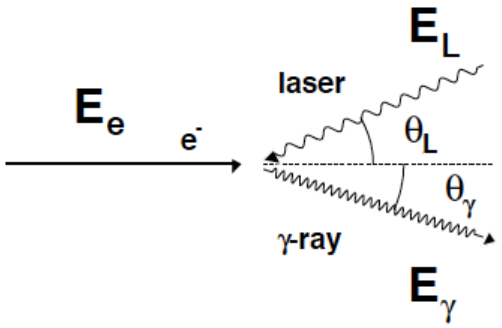
RF Photoinjector





Gamma Beam System II

$$E_\gamma = n \cdot 2\gamma_e^2 \cdot \frac{1+\cos\varphi}{1+(\gamma_e\theta)^2 + a_0^2 + \frac{4\gamma_e E_L}{mc^2}} \cdot E_L$$

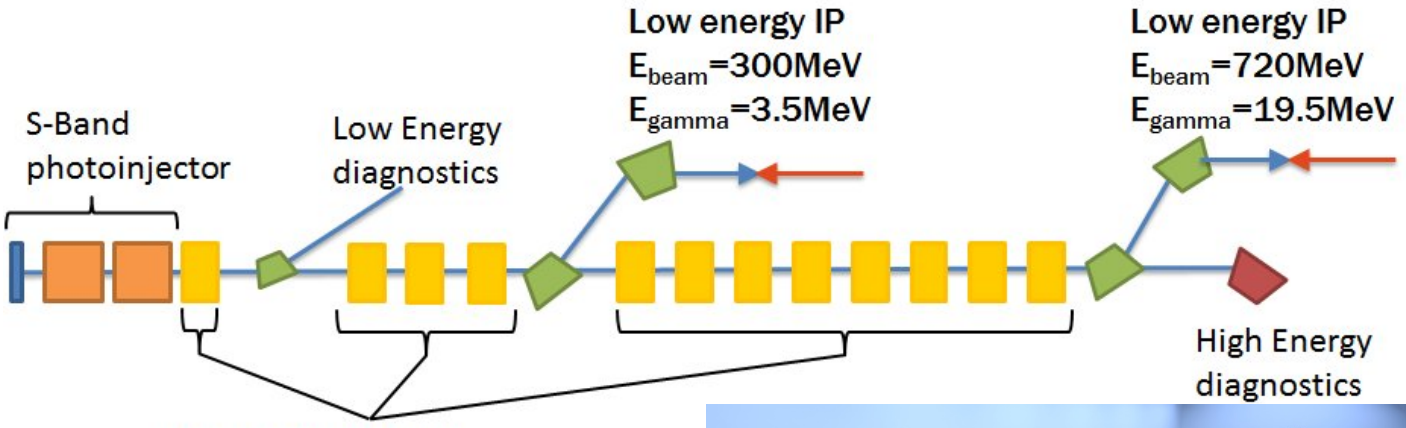


Compton backscattering:

$E_\gamma = 4\gamma_e^2 E_L$

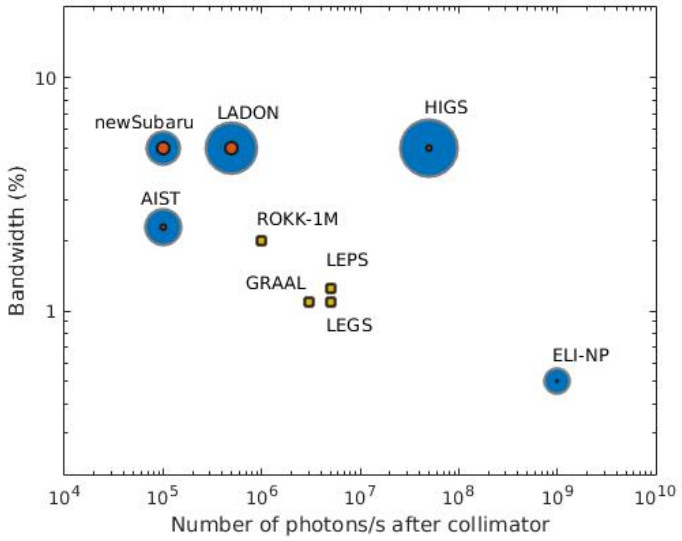
E_e=720 MeV=>γ_e~ 1400=> E_γ ~20 MeV but very weak cross section: ~ 10^{-25} cm^2

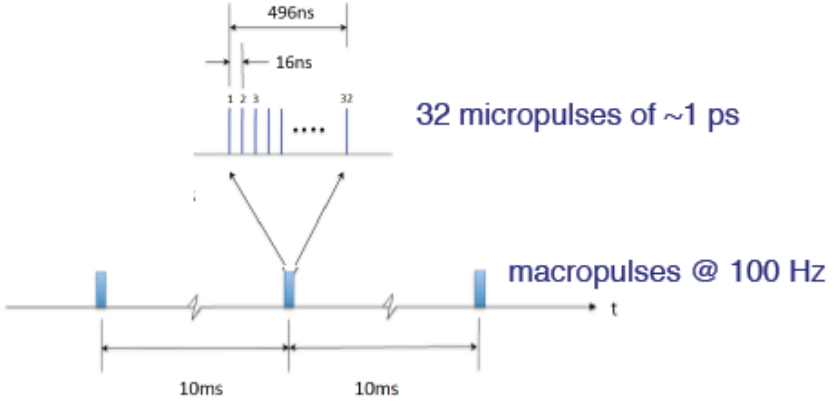
EuroGammas Consortium
INFN Italy - leader
Research Institutes and
HighTech Companies
from 8 Countries



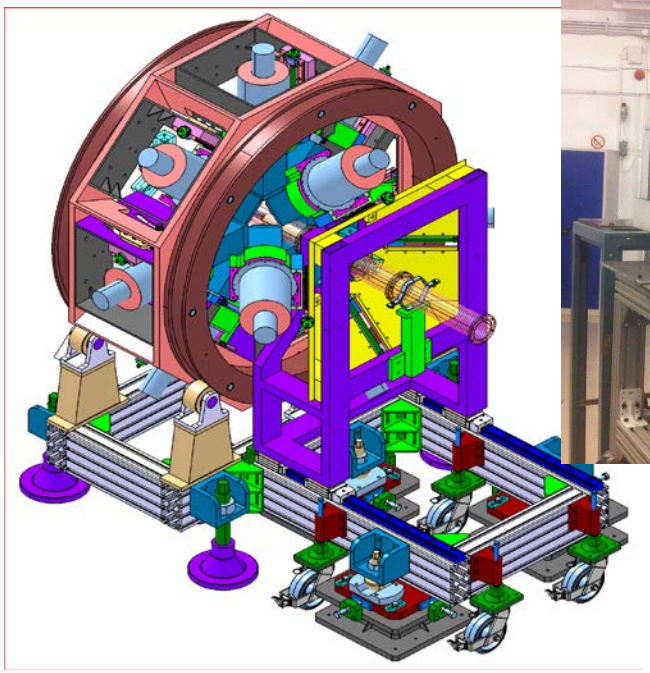
GBS Specification

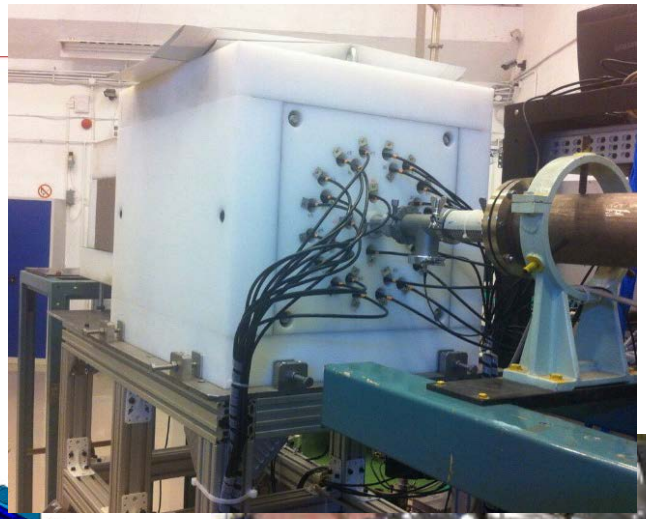
Parameter [units]	Value
Photon energy [MeV]	0.2 – 19.5
Spectral density [ph/s/eV]	> 0.5 x 10^4
Bandwidth	< 0.5 %
# photons / shot FWHM bdw.	1.0 – 4.0·10^5
# photons/sec FWHM bdw.	2.0 – 8.0·10^8
Source rms size [µm]	10 – 30
Source rms divergence [µrad]	25 – 250
Peak brill. [N_{ph}/sec·mm²mrad²·0.1%]	10^{22}– 10^{24}
Radiation pulse length [ps]	0.7 – 1.5
Linear polarization	> 95 %
Macro repetition rate [Hz]	100
# of pulses per macropulse	>31
Pulse–to–pulse separation [ns]	16





Instrumentation for Physics





ELIGANT-TN
Neutron Detector

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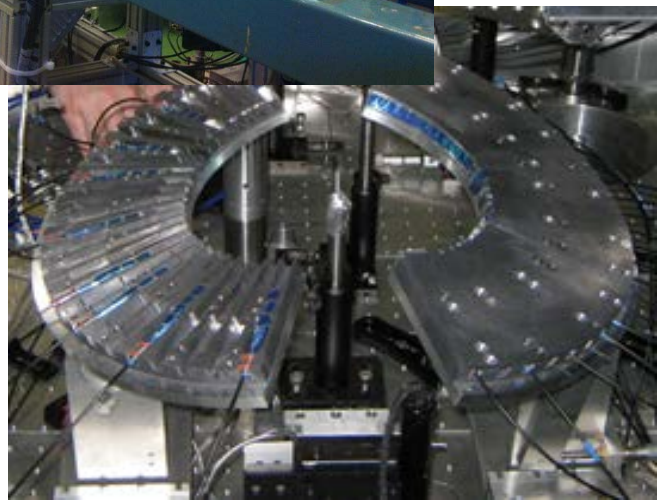

ELIADE array: 8 segmented HPGe Clover detectors with anti-Compton shields + 4 LaBr3 detectors

CsI array for angle resolved calorimetry

Commissioning Phase in 2019-2020.

- We will focus on the characterization of each machines: 10PW laser and 19 MeV Gamma beam systems.

10 PW Laser System

- Laser intensity: 10^{22} W/cm^2
- Electron acceleration > GeV
- Proton acceleration > 200 MeV

Gamma Beam System

- Gamma photon energy calibration-Nuclear excitation 3.5 or 19.5 MeV
- Polarization > 95%

Time Plan of ELI-NP