



**Sectoral Operational Programme**  
**„Increase of Economic Competitiveness”**  
*“Investments for Your Future”*

**Extreme Light Infrastructure – Nuclear Physics (ELI-NP) – Phase I**  
**Project co-financed by the European Regional Development Fund**

# **ELI-NP**

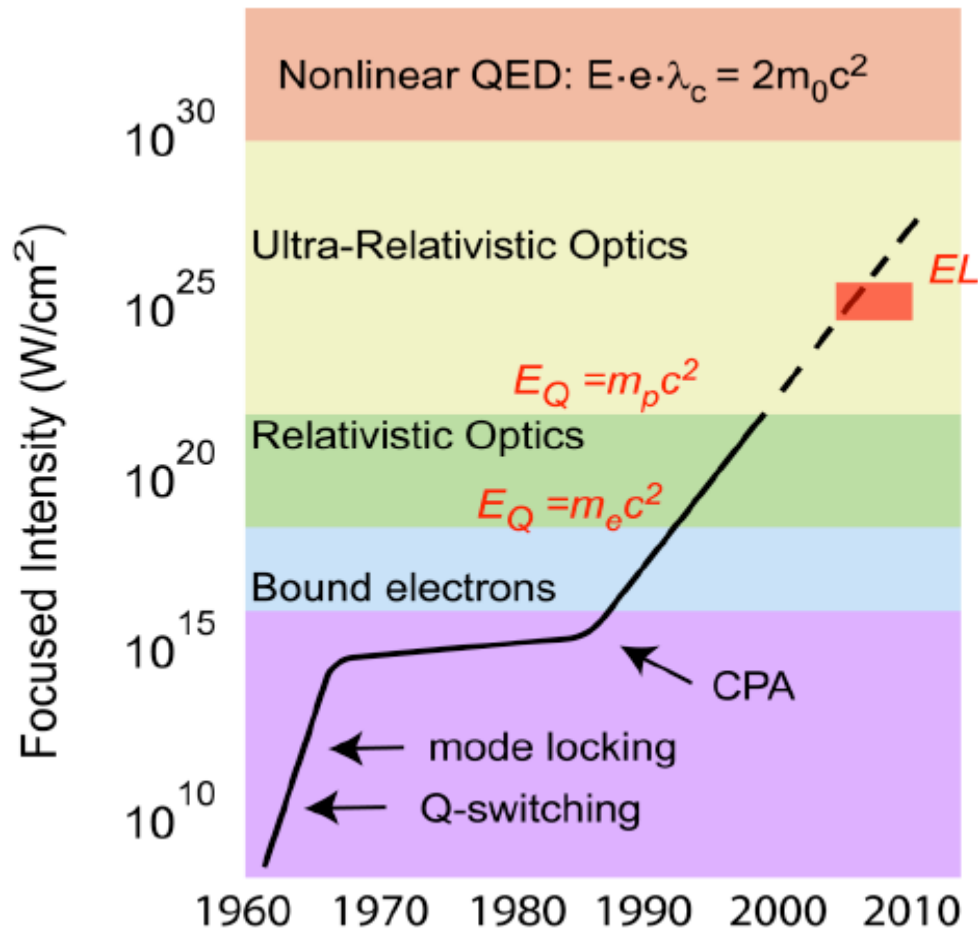
# **A New European Facility**

*Ovidiu Tesileanu, on behalf of the ELI-NP Team*



*HEPTech Industry Open Innovation Forum*  
*Bucharest-Magurele, October 8<sup>th</sup>, 2013*

## Gerard Mourou 1985: Chirped Pulse Amplification (CPA)



# Extreme Light Infrastructure (ELI)

2006: ELI on ESFRI Roadmap

2007-2010: ELI-PP (FP7)

ELI-Beamlines (Czech Republic)

ELI-Attoseconds (Hungary)

ELI-Nuclear Physics (Romania)

ELI-Ultra-high intensity – TBD

2009: Approved by Competitiveness Council

2010: ELI-DC formation decided, MoU

2013: Establishment of ELI-DC

as a Legal entity: Czech Republic,  
Hungary, Romania, Italy, Germany

Mission: Complementarity of the Scientific Programs  
ERIC



# ELI-NP Milestones

- **February-April 2010**

Scientific case “**White Book**” (100 scientists, 30 institutions) ([www.eli-np.ro](http://www.eli-np.ro))

approved by ELI-NP International Scientific Advisory Board

- **August 2010**

Feasibility Study: 293 MEuro

- **August 2011 – March 2012** : Technical Design

- **January 2012**: Submission of the application to the E.C.

- **July 2012**: *Romanian Government Decision*

*Construction of the New Research Infrastructure ELI-NP: 293 M€*

- **September 2012**: **EC Project approval**

European Regional Development Fund (ERDF)

Operational Programme Increase of Economic Competitiveness

Financial Support (83%) of the First phase (2012-2015) 180 M€

- **October 2012**

Workshop: Experimental programme at ELI-NP

- **June 2013**

International workshops on TDRs experimental areas

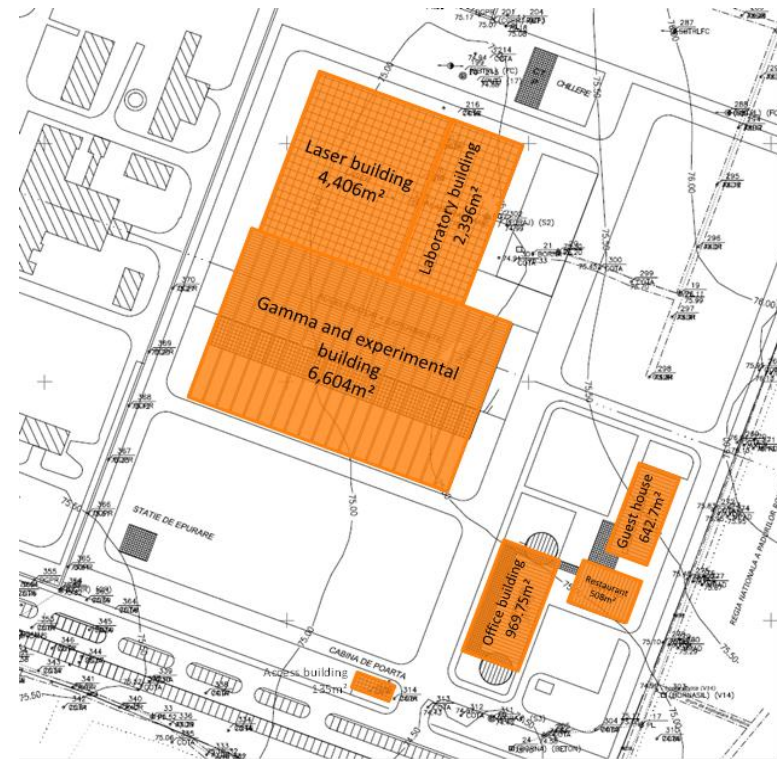
Start of construction works

- **July 2013**

Signing of the laser contract

- **October 2013**

End Tender procedure Gamma Beam



# Bucharest-Magurele Physics Campus National Physics Institutes



**BUCHAREST** ↑

↔  
**ring rail/road**

“Horia Hulubei”  
National Institute  
for Physics and  
Nuclear Engineering

**ELI-NP**

Lasers  
Plasma  
Optoelectronics  
Material Physics  
Theoretical Physics  
Particle Physics



**August 23<sup>rd</sup>, 2013**

June 14, 2013



August 23, 2013



September 25, 2013



# ELI-NP Infrastructure

## Large equipment:

- Ultra-short pulse high power laser system, 2 x 10PW maximum power

*Thales Optronique SA and SC Thales System Romania*

- Gamma radiation beam, high intensity, tunable energy up to 20MeV, relative bandwidth  $10^{-3}$ , produced by Compton scattering of a laser beam on a 700 MeV electron beam produced by a warm LINAC

*Proposal received from an European Consortium*

**Buildings** – one contractor, 33000sqm total

## Experiments

- 8 experimental areas, for gamma, laser, and gamma+laser

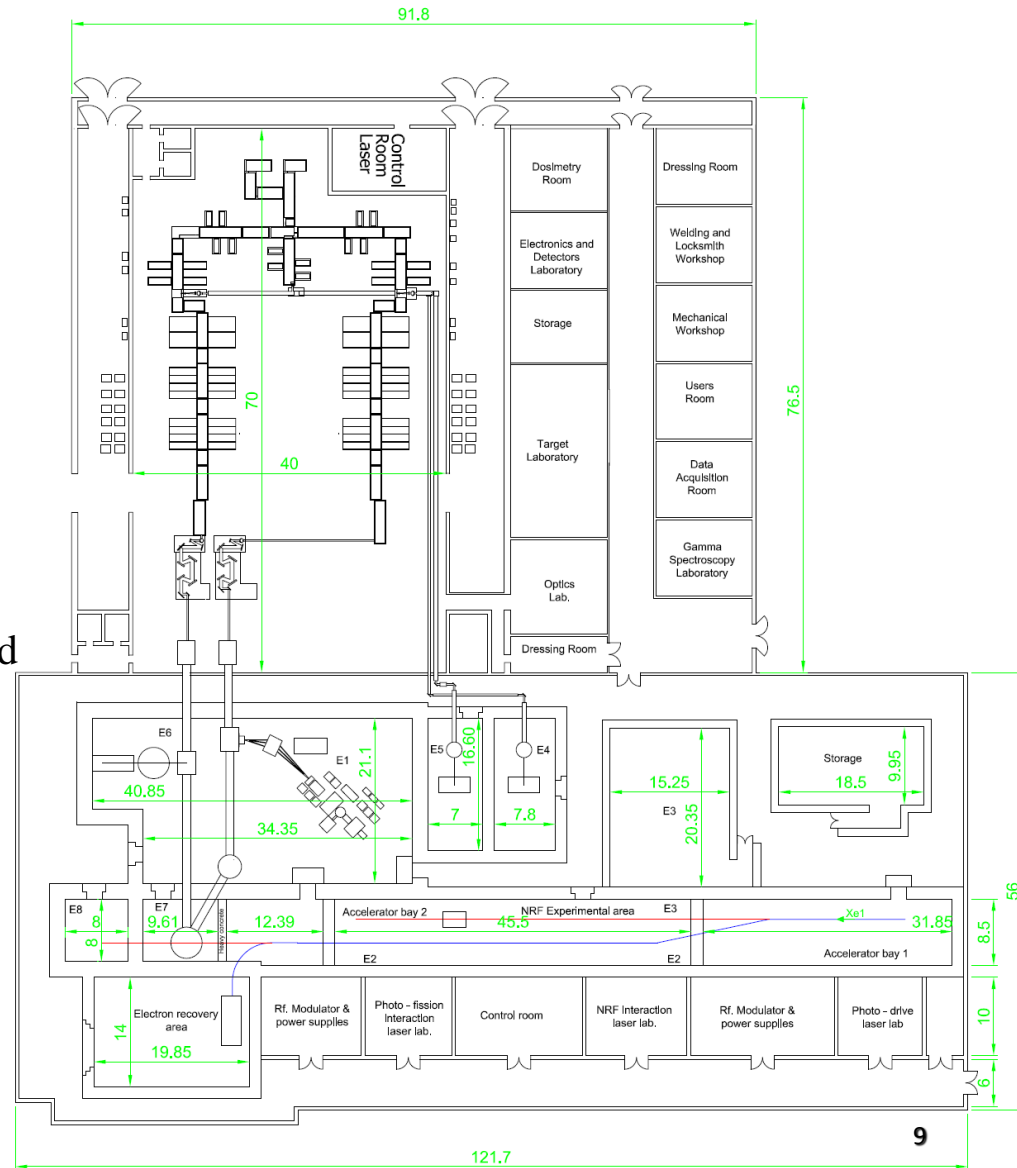
# ELI – Nuclear Physics Research

- *Nuclear Physics experiments to characterize laser – target interaction*
- *Photonuclear reactions*
- *Exotic Nuclear Physics and Astrophysics complementary to other NP large facilities (FAIR, SPIRAL2)*
- *Applied Research based on high intensity laser and very brilliant  $\gamma$  beams*



# Experimental Areas at ELI-NP

- E1 Laser induced nuclear reactions;
- E2 NRF and applications;
- E3 Positrons source;
- E4/E5 Accelerated particle beams induced by high power laser beams (0,1/1 PW) at high repetition rates;
- E6 Intense electron and gamma beams induced by high power (multi-PW) laser;
- E7 Experiments with combined laser and gamma beams;
- E8 Nuclear reactions induced by high energy gamma beams.



- Laser-produced charged particle beams may become an attractive alternative for large scale conventional facilities ( $10^{15}$  more intense)
- High Resolution, high Intensity electron, positron, X-Ray and  $\gamma$  Beams
  - Radioscopy and Tomography
  - Materials research in high intensity radiation fields
- Applications of Nuclear Resonance Fluorescence
  - Management of sensitive nuclear materials
  - New production techniques for radioisotopes for medical use

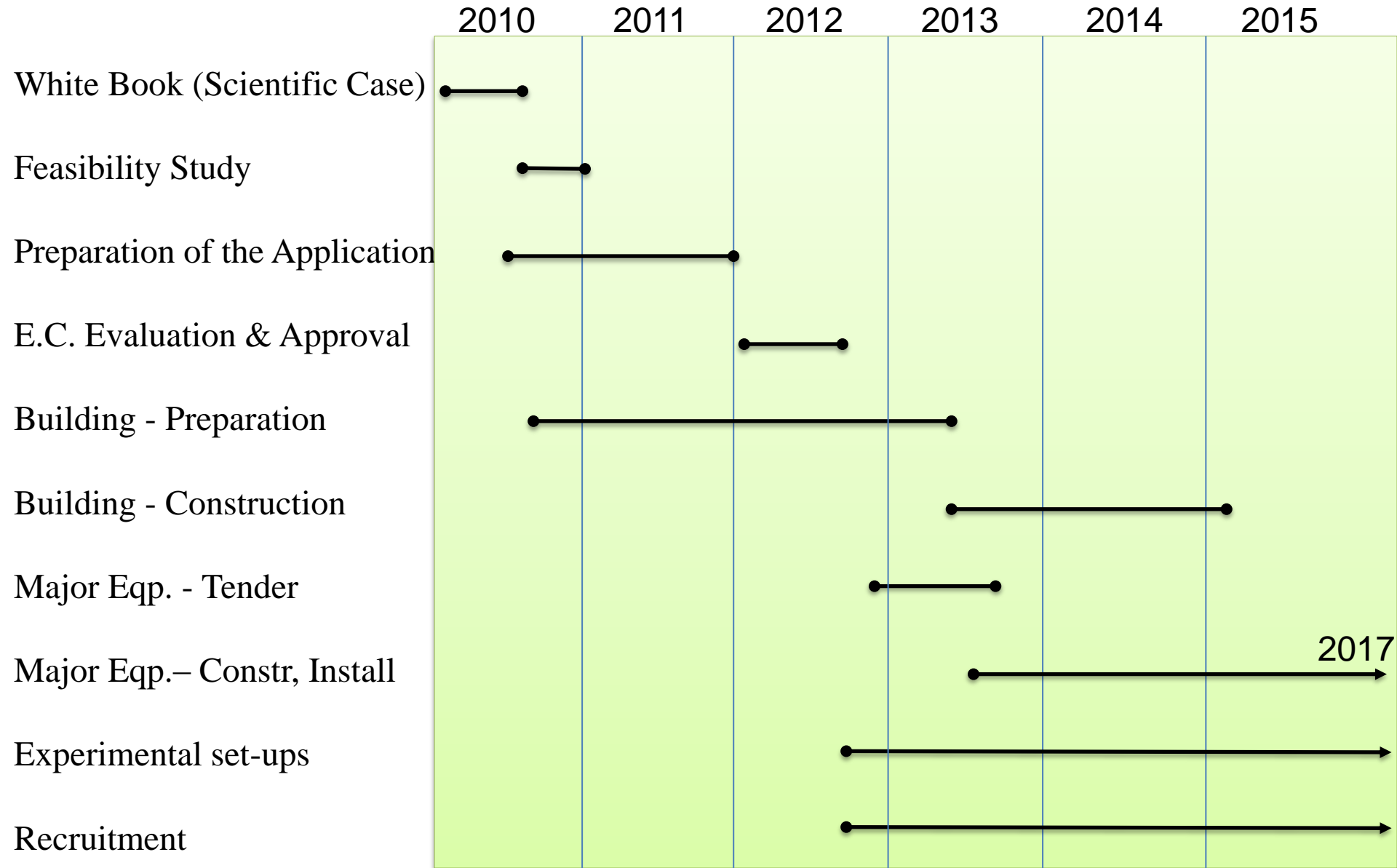
Long-term partnerships with academic institutions

- Initiatives enabling the ELI-NP project to secure the fulfillment of its needs in terms of PhD students, junior researchers, engineers, and technicians (training programs, specific MSc and PhD programs, etc.).
- Initiatives that could support the ELI-NP Project in the achievement of its objectives in terms of scientific excellence; bi- or multilateral agreements.

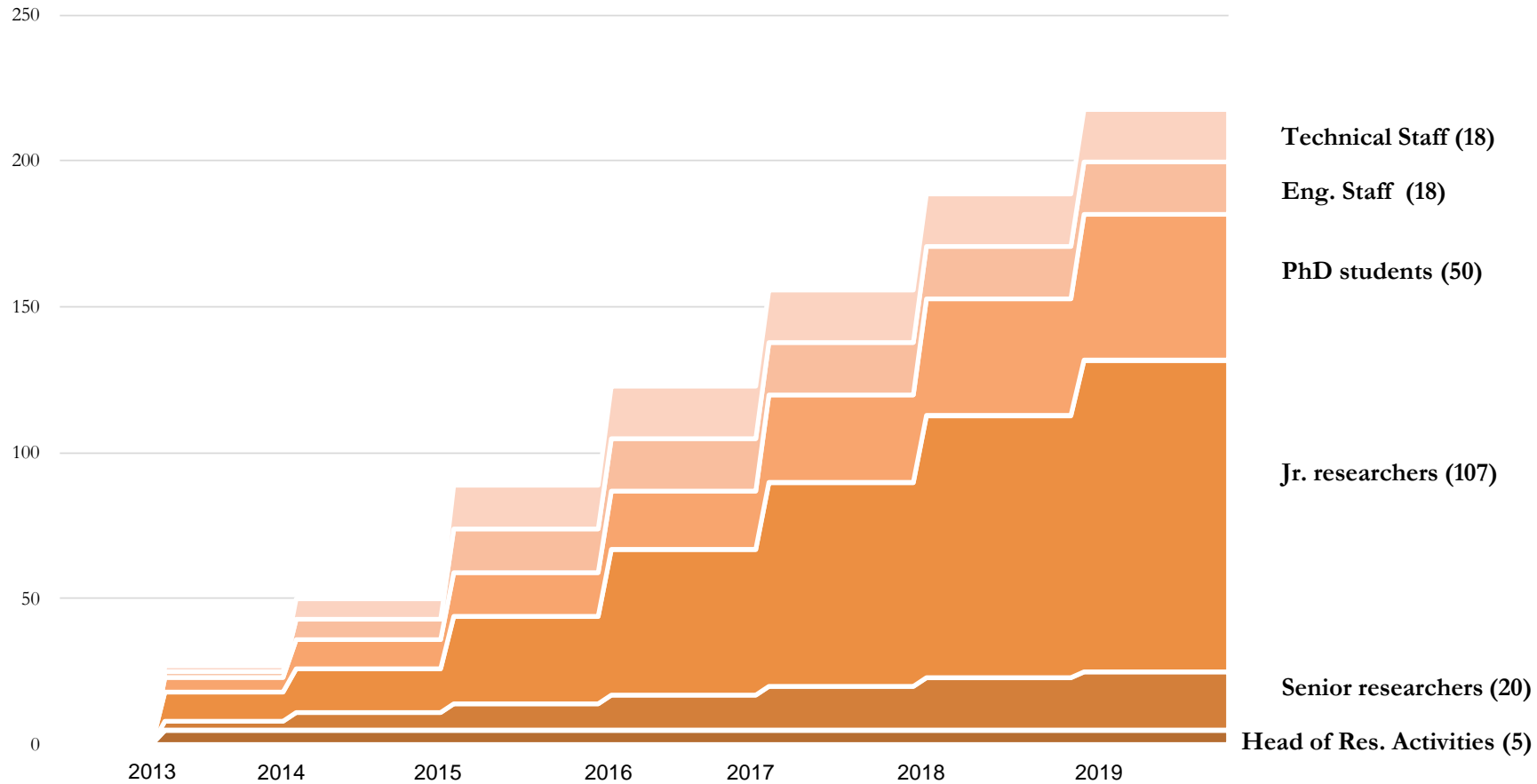
Body promoting relationships, for mutual benefits, with local and foreign companies

- Consulting in elaborating the TDRs for experiments and auxiliary equipment
- Promotion of contractual research, technology transfer, etc.
- Consulting services provided by ELI-NP experts
- **Creation of a cluster of high-tech companies in Magurele**

# Project implementation



# Human Resources



# ELI-NP Next Steps

- End 2014: TDRs experiments
- Spring 2015: Construction of buildings
- June 30<sup>th</sup>, 2015: Lasers and Gamma Beam – end of Phase 1
- 2017: End of second Phase, Beginning operation





EUROPEAN UNION



GOVERNMENT OF ROMANIA



# Extreme Light Infrastructure - Nuclear Physics (ELI-NP) - Phase I

Project co-financed by the European Regional Development Fund



Document edited by

**Horia Hulubei National Institute for Research and Development in Physics and Nuclear Engineering**

Publication date of the document: August 2013

# [www.eli-np.ro](http://www.eli-np.ro)

"The content of this document does not necessarily represent the official position  
of the European Union or of the Government of Romania"

For detailed information regarding the other programmes co-financed by the European Union please visit [www.fonduri-ue.ro](http://www.fonduri-ue.ro),  
[www.ancs.ro](http://www.ancs.ro), <http://amposcce.minind.ro>



# ELI – NP Experiments (1)

## Stand-alone High Power Laser Experiments

- Nuclear Techniques for Characterization of Laser-Induced Radiations
- Modelling of High-Intensity Laser Interaction with Matter
- Stopping Power of Charged Particles Bunches with Ultra-High Density
- Laser Acceleration of very dense Electrons, Protons and Heavy Ions Beams
- Laser-Accelerated Th Beam to produce Neutron-Rich Nuclei around the N = 126 Waiting Point of the r-Process via the Fission-Fusion Reaction
- A Relativistic Ultra-thin Electron Sheet used as a Relativistic Mirror for the Production of Brilliant, Intense Coherent  $\gamma$ -Rays
- Studies of enhanced decay of  $^{26}\text{Al}$  in hot plasma environments

# ELI – NP Experiments (2)

## Laser + $\gamma$ / $e^-$ Beam

- Probing the Pair Creation from the Vacuum in the Focus of Strong Electrical Fields with a High Energy  $\gamma$  Beam
- The Real Part of the Index of Refraction of the Vacuum in High Fields: Vacuum Birefringence
- Cascades of  $e^+e^-$  Pairs and  $\gamma$  -Rays triggered by a Single Slow Electron in Strong Fields
- Compton Scattering and Radiation Reaction of a Single Electron at High Intensities
- Nuclear Lifetime Measurements by Streaking Conversion Electrons with a Laser Field.

# ELI – NP Experiments (3)

## Standalone $\gamma$ /e experiments for nuclear spectroscopy and astrophysics

- Measuring Narrow Doorway States, embedded in Regions of High Level Density in the First Nuclear Minimum, which are identified by specific  $(\gamma, f)$ ,  $(\gamma, p)$ ,  $(\gamma, n)$  Reactions
- Dipole polarizability with high intensity, monoenergetic MeV  $\gamma$ -radiation for the evaluation of neutron skin
- Nuclear Transitions and Parity-violating Meson-Nucleon Coupling
- Study of pygmy and giant dipole resonances
- Gamma scattering on nuclei
- Fine-structure of Photo-response above the Particle Threshold: the  $(\gamma, \alpha)$ ,  $(\gamma, p)$  and  $(\gamma, n)$
- Nuclear Resonance Fluorescence on Rare Isotopes and Isomers