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

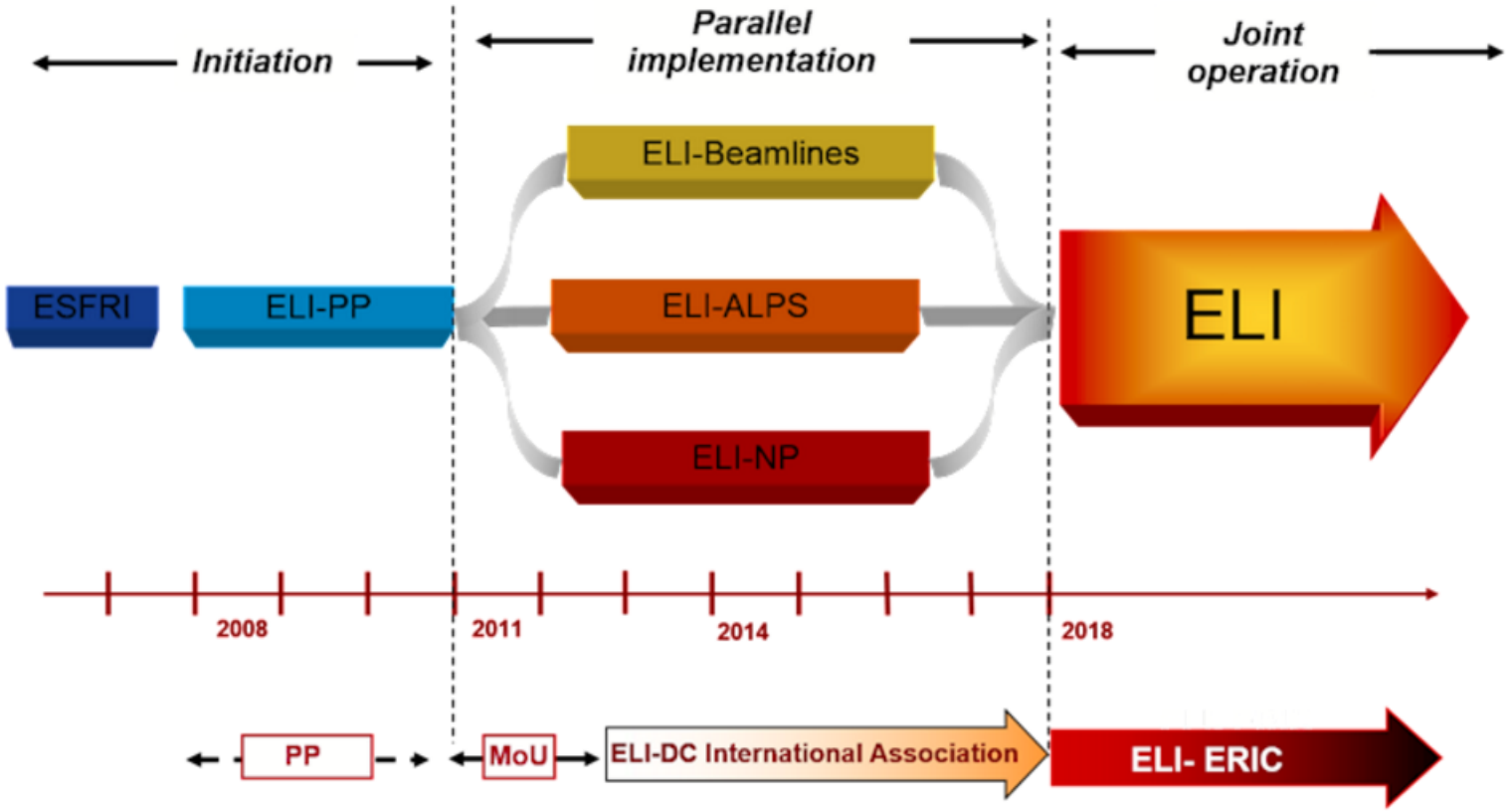
Extreme Light Infrastructure – Nuclear Physics (ELI-NP) - Phase II
Project co-financed by the European Regional Development Fund

TANGO Control Systems at ELI-NP

Bertrand DE BOISDEFFRE, on behalf of the ELI-NP team
June 21st, 2016

ELI-NP in a nutshell

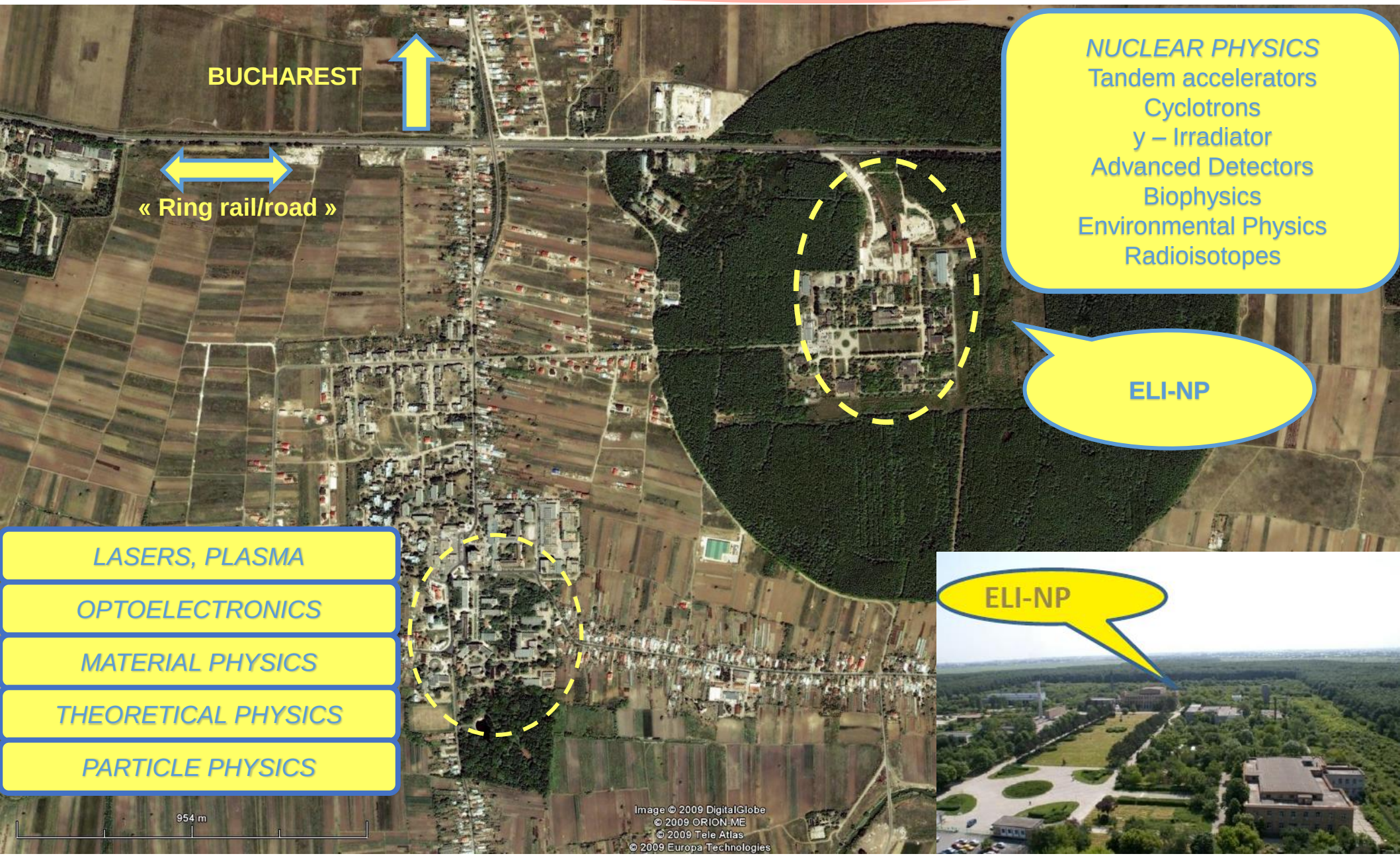
ELI (Extreme Light Infrastructure) timeline



ELI – Nuclear Physics (ELI-NP)

Led by IFIN-HH during the implementation phase

ELI-NP in a nutshell



ELI-NP in a nutshell

Large equipment

- **High power laser system, 2 x 10PW maximum power**

Thales Optronique SA and SC Thales System Romania (~65 M€)

- **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

European Consortium EuroGammaS led by INFN Rome (~65 M€):
INFN (Italy), University "La Sapienza" Rome (Italy), CNRS (France), ALSYOM (France), ACP Systems S.A.S.U. (France), COMEB Srl (Italy), ScandiNova Systems (Sweden)

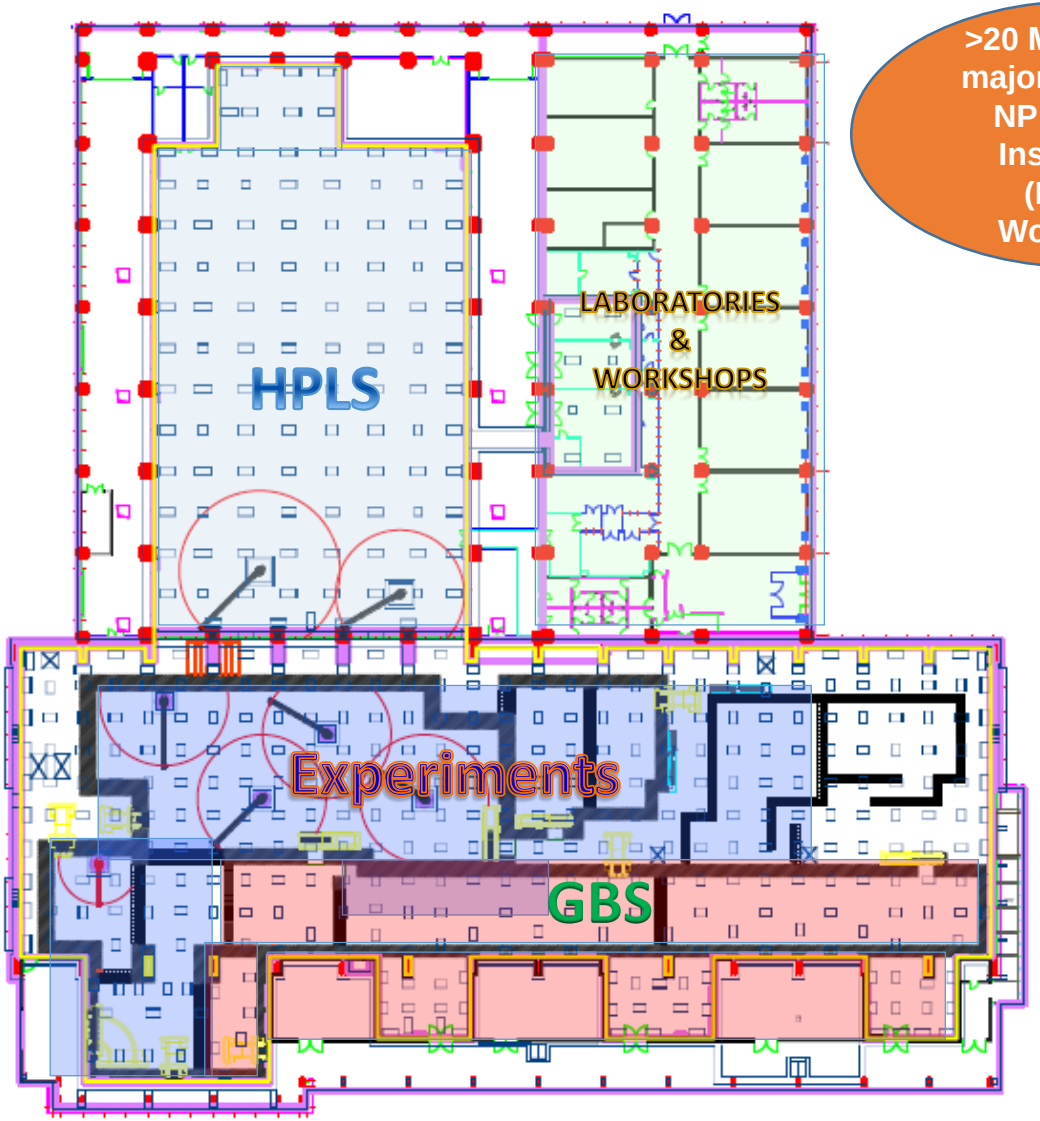
Buildings

33000sqm total – STRABAG (~65M€)

Experiments

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

ELI-NP in a nutshell



>20 MoU's with major Laser and NP labs and Institutions (EU and Worldwide)

ELI-NP Board of Directors

Scientific Director & Technical Director

Research Activities (Physics & Engineering team)

- RA1: "High-Power Laser System – HPLS"
- RA2: "Gamma Beam System – GBS"
- RA3: "Nuclear Physics with HPLS"
- RA4: "Nuclear Physics and Applications with GBS"
- RA5: "Fundamental physics with combined laser and gamma beams"

TANGO @ ELI-NP – Overview

ELI-NP General Personnel Safety System - PSS

Radioprotection System

High Power Laser System - HPLS

HPLS Control System - HPLS CS

TANGO Connecting things together

Gamma Beam System - GBS

GBS Control System - GBS CS

EPICS

Laser Beam Transport System - LBTS

LBTS Control System - LBTS CS

TANGO Connecting things together

Gamma Beam Delivery & Diagnostics - GBDD

GBDD Control System - GBD CS

EPICS

Building Management System

Experimental Areas E1 - E8

Experiments Monitoring & Control Systems - EXPs MCS

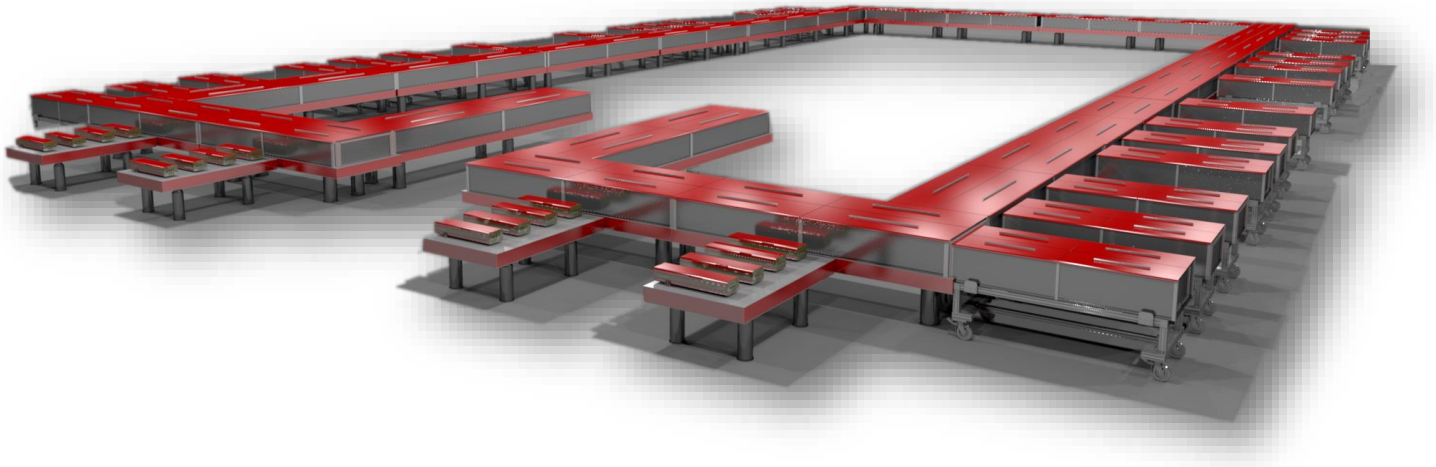
TANGO Connecting things together

EPICS

M. Cernaianu et al., *Romanian Reports in Physics, Vol. 68,Supplement, P. S349 – S444 , 2016*

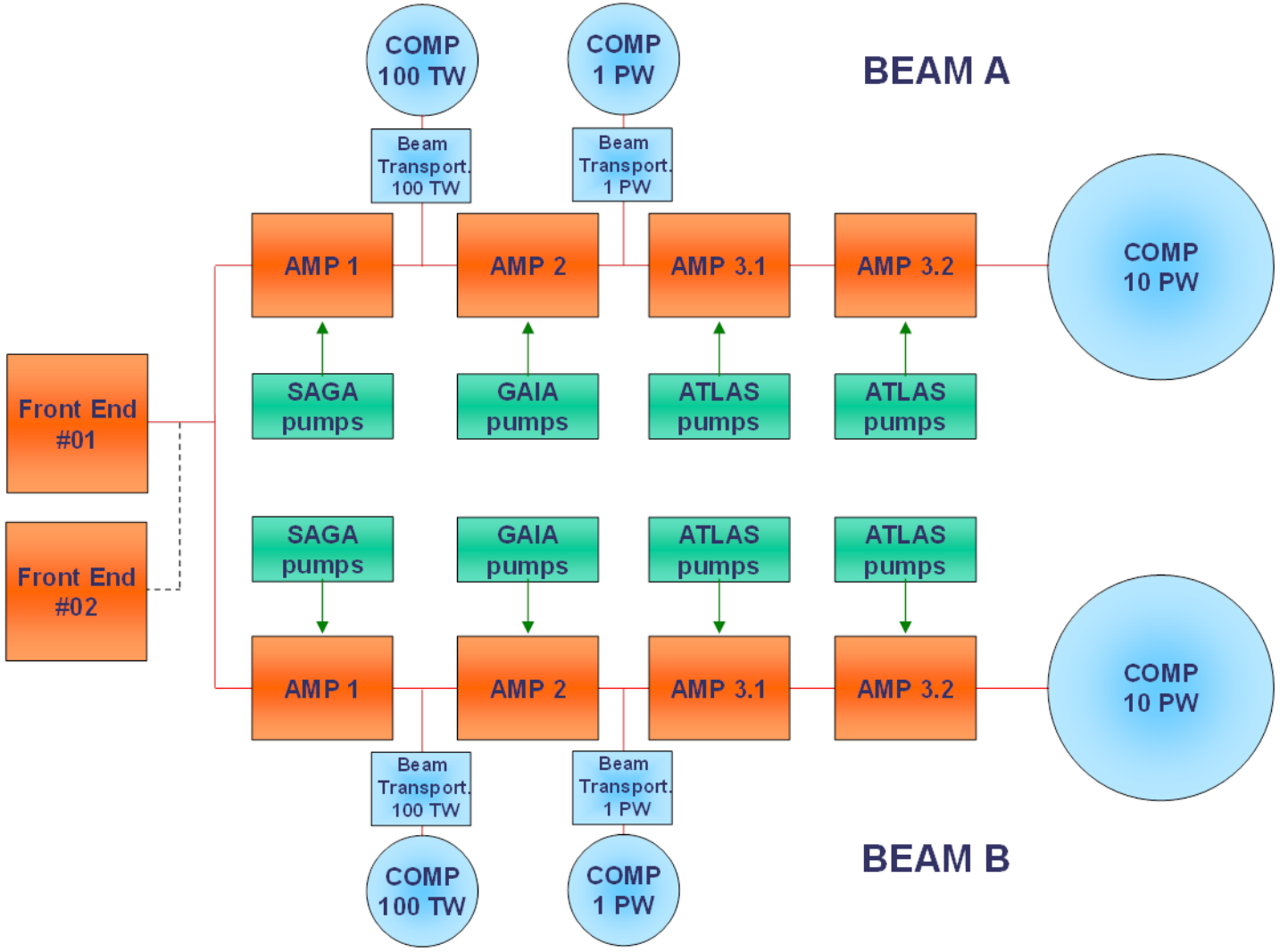
TANGO & HPLS

High-Power Laser System (HPLS)



- 2 outputs 100 TW - 10 Hz
- 2 outputs 1 PW - 1 Hz
- 2 outputs 10 PW – 1shot/mn

HPLS – System view



TANGO & HPLS

HPLS Supervision system – Overall description

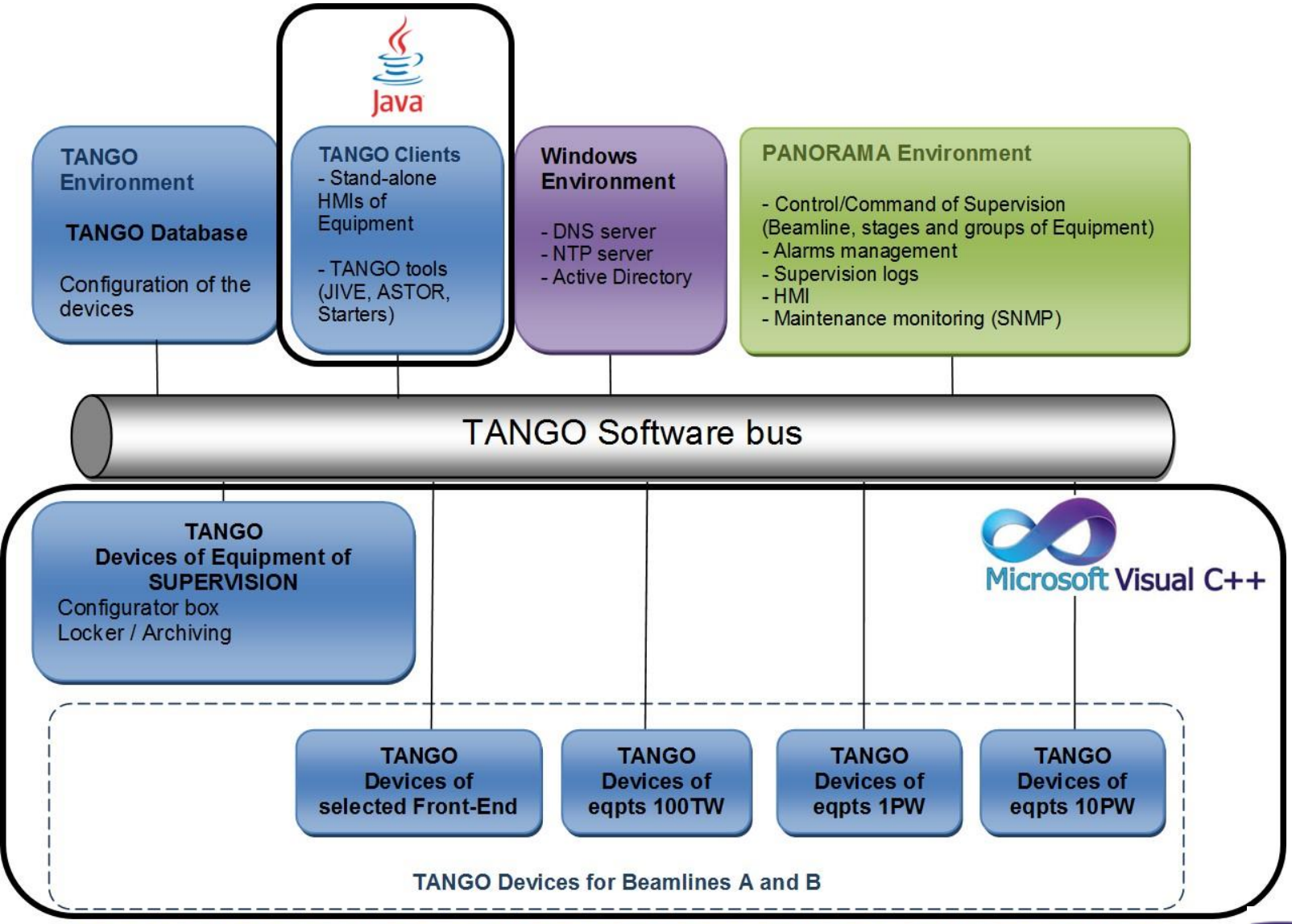
- **Stand-alone software – TANGO**
  - Equipment management unitarily (pump laser, camera, …)
  - Users: laser integrator (Thales), maintenance operator and laser operator
- **Supervision software – Panorama**
  - Continuous operation of the entire laser system
    - Management of all equipment (around 250 instances) including moding and startup sequencing
    - Configuration selection on each beam independently (100TW, 1PW, 10PW, Front End 1/2, equipment inhibition)
    - Viewing a synthetic system status (HMI) including system synoptic display
    - Archiving system information (pictures, spectrums, data)
    - Alarm management
    - Access rights management, user profiles (active directory)
    - Redundancy management and load balancing
  - Users: laser operator
- **Hardware**
  - PC, cabinets, network hardware (switches), wiring, Ethernet adapters

TANGO & HPLS

HPLS Supervision system – Hardware architecture

TANGO & HPLS

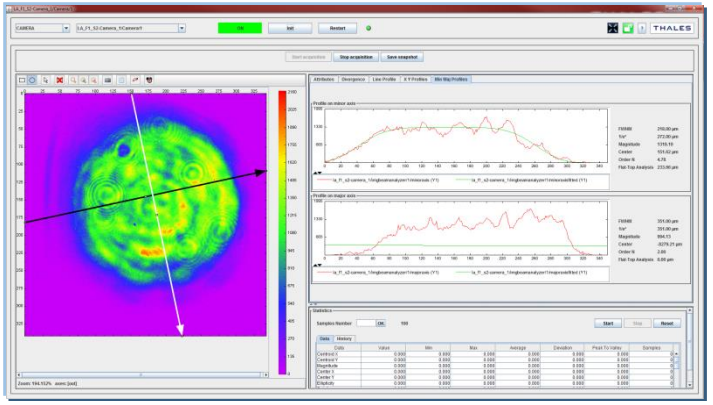
HPLS Supervision system – Software architecture



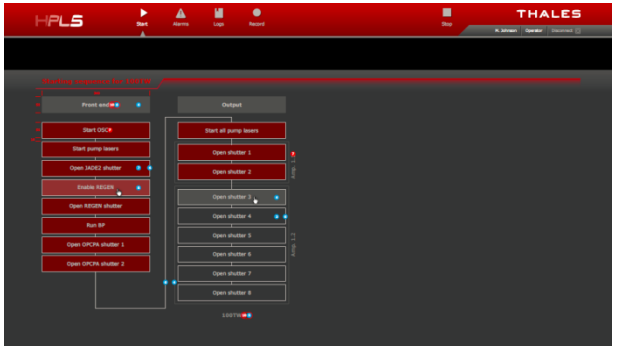
TANGO & HPLS

Software architecture – two software levels

- **Middleware software TANGO (stand-alone HMI)**



- **Supervision software Panorama (3 touchscreens HMI / beam)**



TANGO & HPLS

- **Source code languages**
  - TANGO devices
    - C++
  - HMI
    - Stand-alone HMI:

    Java – Comete widgets
  - TANGO Database
    - MySQL

Equipment	Language	HMI
JADE2	C++	Java Swing, Comete library
OPCPA	C++	Java Swing, Comete library
SAGA_HP	C++	Java Swing, Comete library
GAIA_HP	C++	Java Swing, Comete library
ATLAS100	C++	Java Swing, Comete library
CAMERA	C++	Java Swing, Comete library
BEAM POINTING	C++	Java Swing, Comete library
ENERGY METER	C++	Java Swing, Comete library
SPECTROMETER	C++	Java Swing, Comete library
OSCILLOSCOPE	C++	Java Swing, Comete library
WIZZLER	C++	Java Swing, Comete library
WAVEFRONT	C++	Java Swing, Comete library
OSCILLATOR	C++	Java Swing, Comete library
DAZZLER	C++	Java Swing, Comete library
ISEO	C++	Java Swing, Comete library
MOTOR	C++	Java Swing, Comete library
ACQUISITION	C++	Java Swing, Comete library

- **Operating system**
  - Microsoft Windows (7 or server 2008)

TANGO & HPLS

Key figures

- **25000 data exchanged between TANGO devices and supervision**
- **1024 TANGO device servers instances**
  - 17 types of equipment
    - 9 Ethernet interfaces
    - 1 USB interface
    - 6 Serial link interfaces
    - 1 Text file interface
- **41 computers**
- **12 switches**
- **6 PC cabinets + 2 switch cabinets**

Central services – Archiving example

- **Archiving (TANGO/Panorama) based on three main use cases:**
  - Outputs archiving
    - Output diagnostic bench
    - 10Hz, 1Hz or 1/60Hz (depending on the selected outputs)
  - Post-mortem archiving
    - Any system data necessary to investigate in case of issue
    - 10Hz, 1Hz or 1/60Hz (depending on stage: Front-End, Amp1, Amp2, Amp3)
  - Maintenance archiving
    - Snapshot of the entire system necessary to analyze changes over time (preventive maintenance)

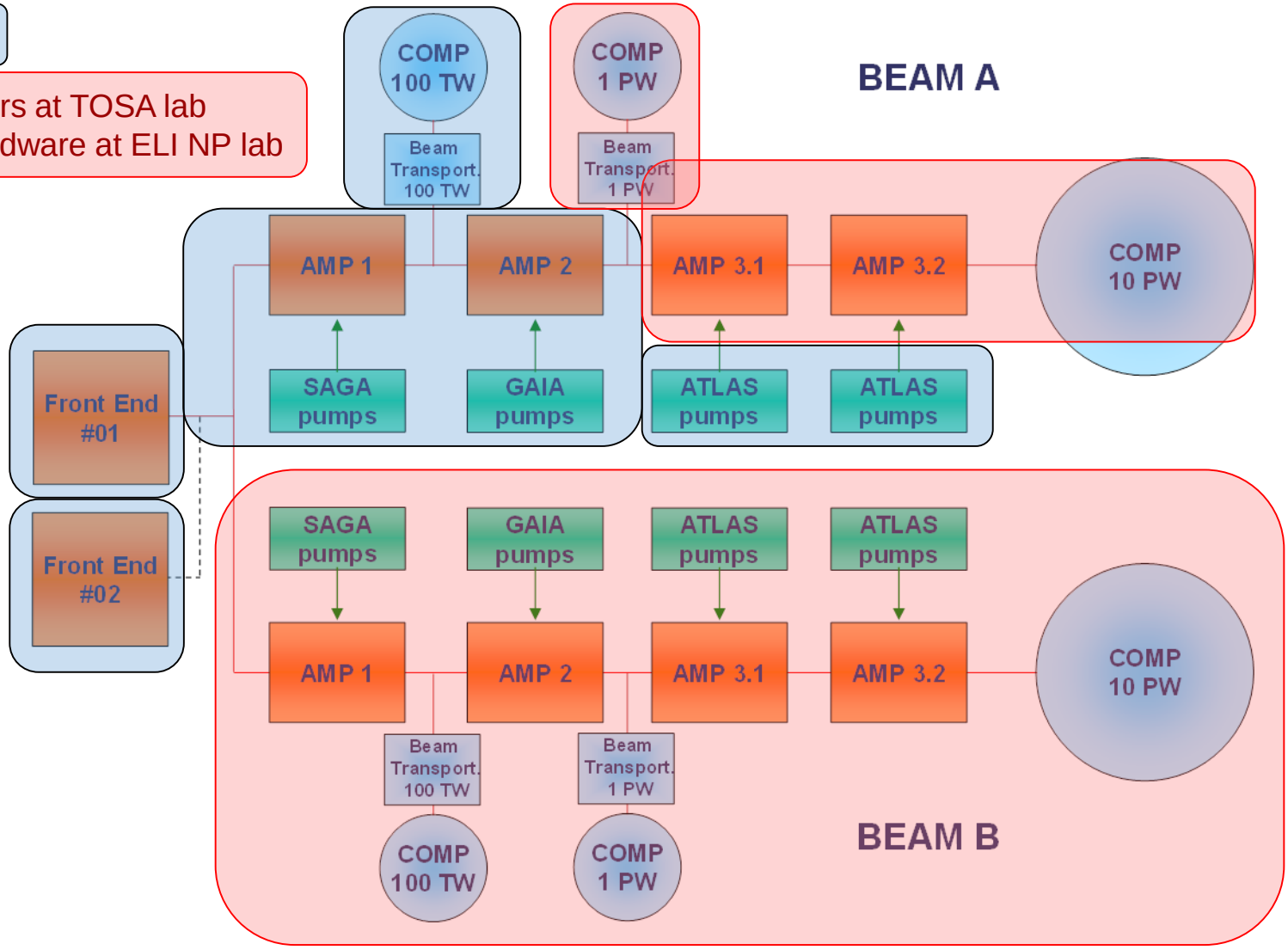
A common format: HDF5

TANGO & HPLS

HPLS Supervision system Status

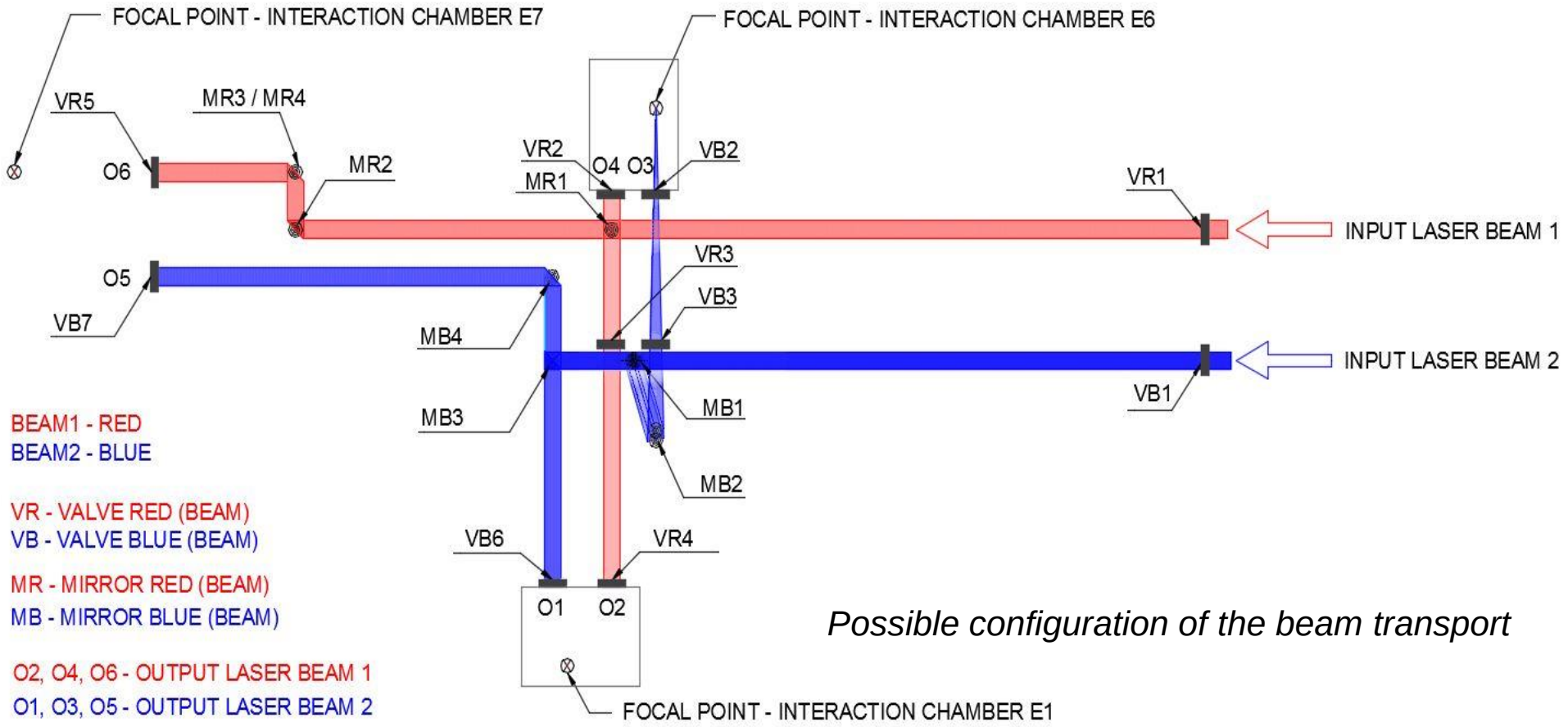
Tested at TOSA lab

Tested with simulators at TOSA lab
to be tested with hardware at ELI NP lab



Requirements

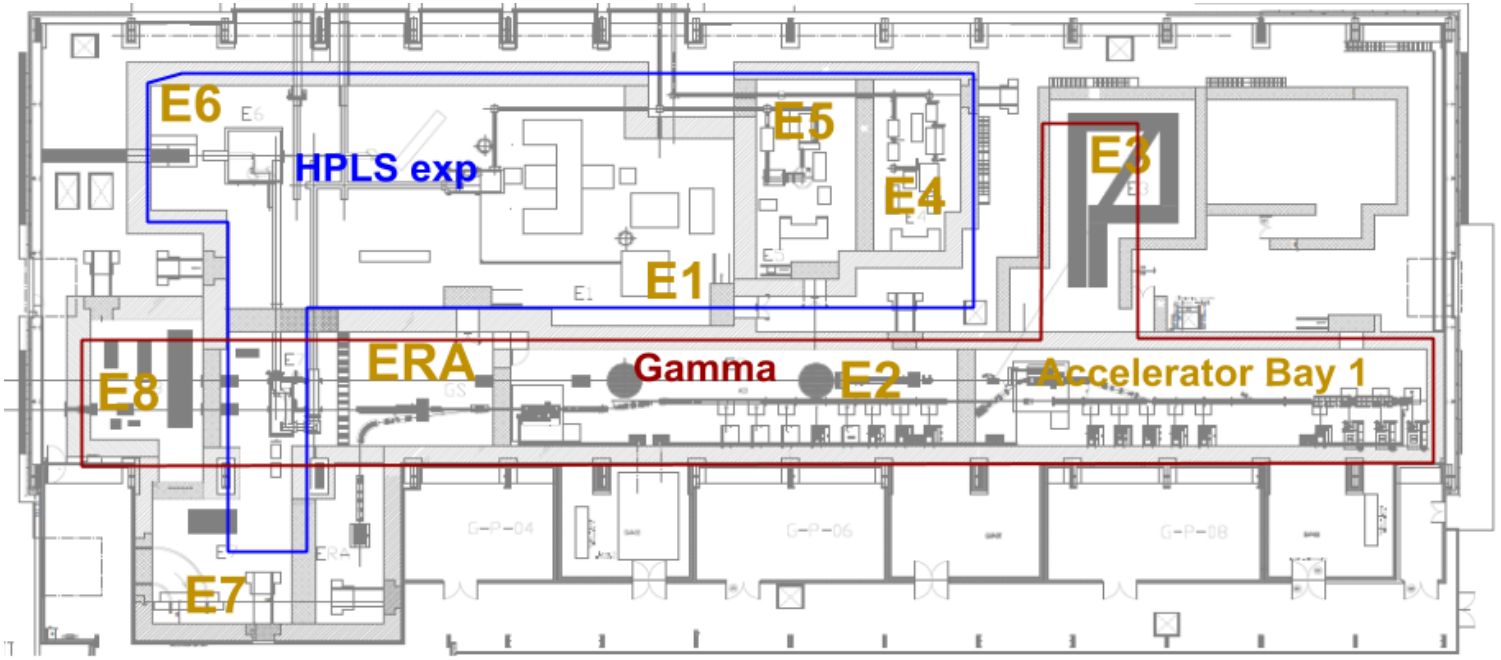
=> Transport the 2x 10 PW beams from the HPLS outputs to the E1, E6, E7 interaction chambers (under vacuum, with the required beam properties, etc.) – Tender procedure



Possible configuration of the beam transport

TANGO & Laser driven experiments

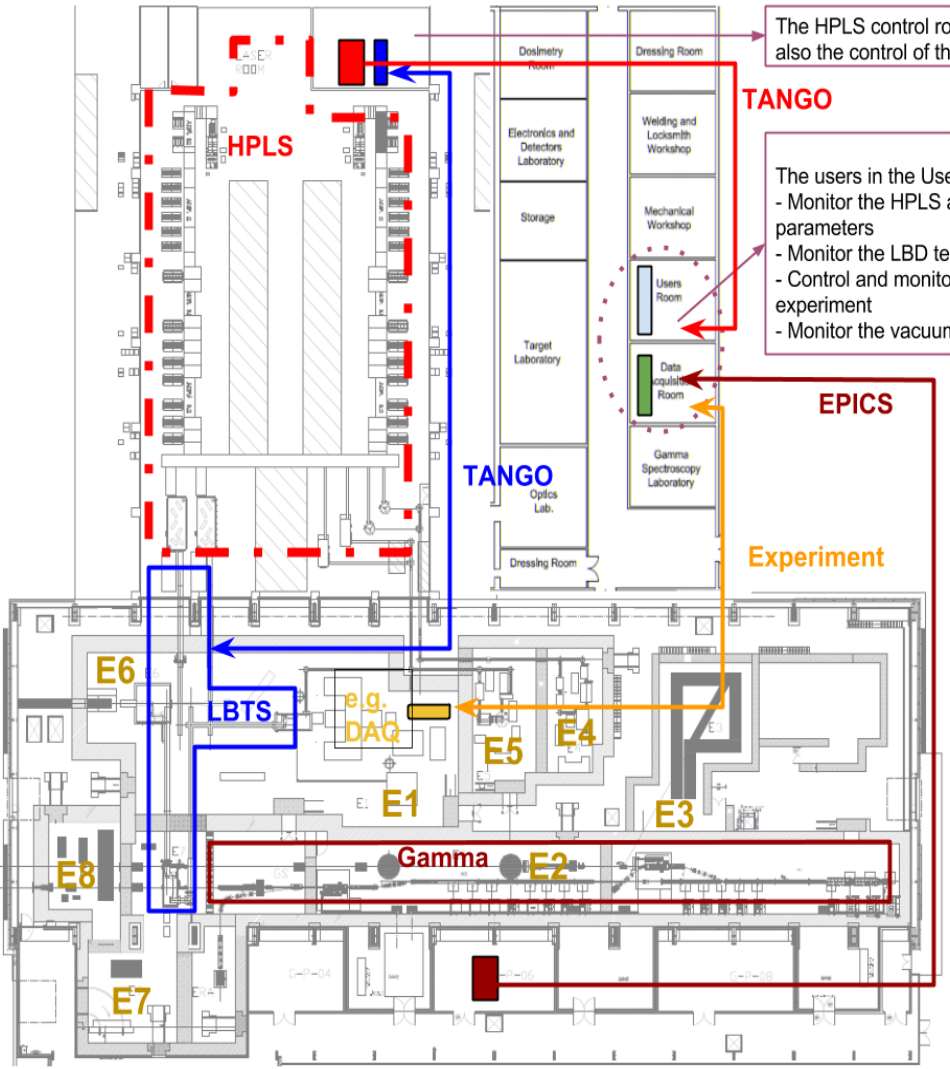
Laser driven experiments - overview



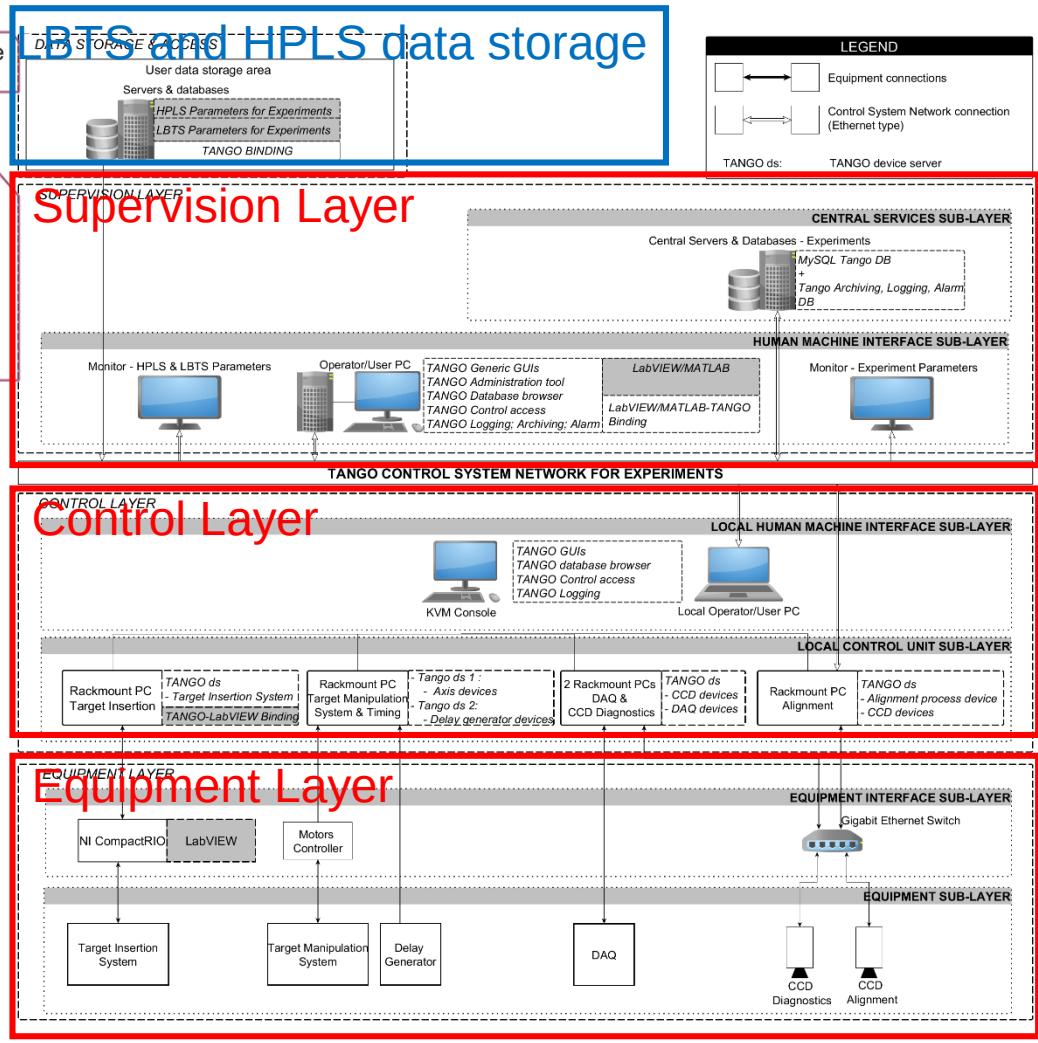
E1	Laser driven nuclear physics (LDNP)	2 x 10 PW beams via LBTS
E4	Materials irradiation	2 x 0.1 PW beams
E5	Materials irradiation Space Science Biology	2x 1 PW beams
E6	High Field Physics and Quantum Electrodynamics (QED)	2 x 10 PW beams via LBTS
E7	Radiation detection	2 x 10 PW beams via LBTS

TANGO & Laser driven experiments

TDR Monitoring and Control Systems for the experiments at ELI-NP



Building Layout – Control systems view



Laser Driven Nuclear Physics experiments – Control systems view

M. Cernaianu et al., *Romanian Reports in Physics, Vol. 68,Supplement, P. S349 – S444 , 2016*

TANGO & Laser driven experiments

Progress in terms of TANGO development (device servers & clients)

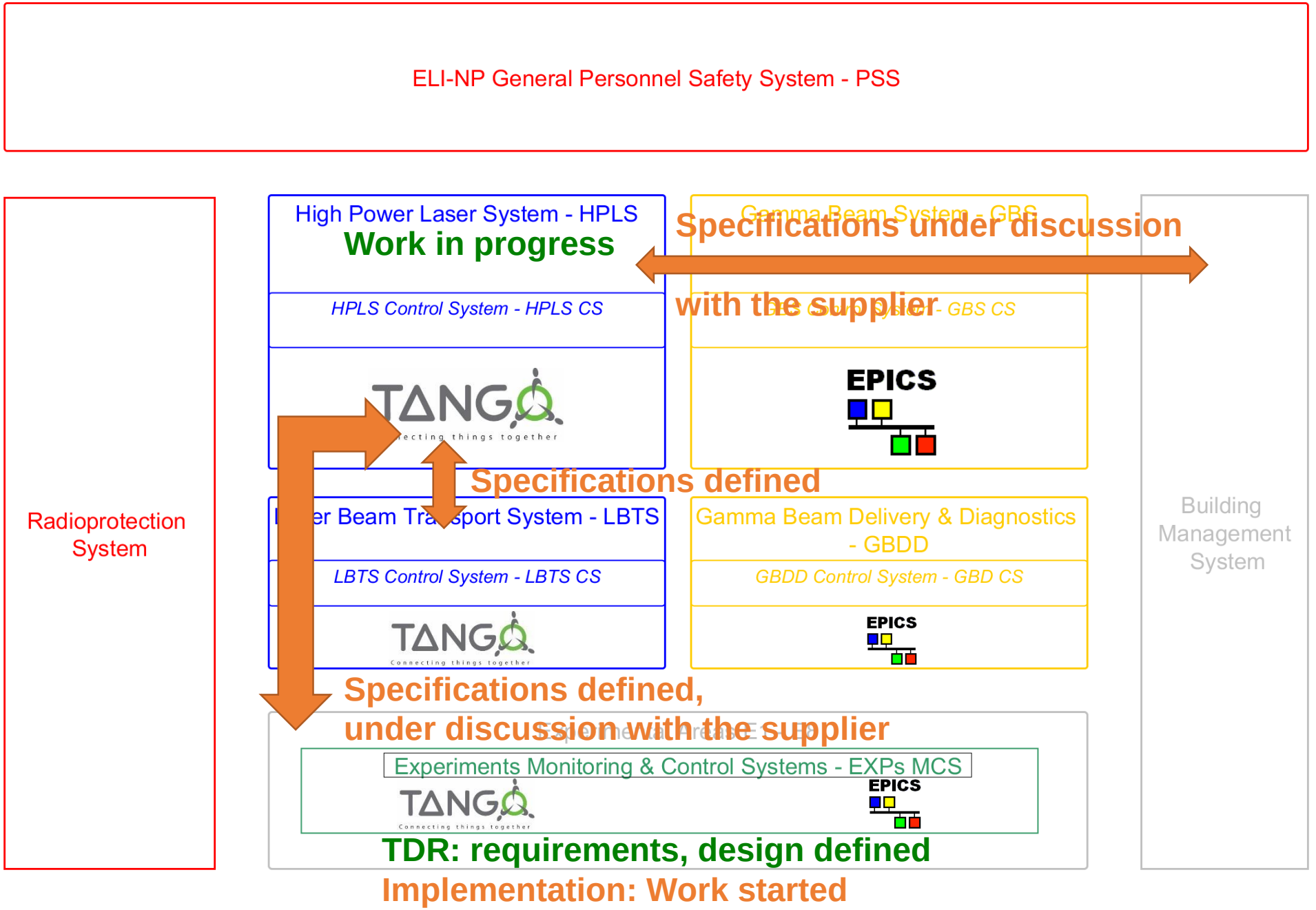
Equipment Type	Equipment Model	Integration type	Status	Perspective
Stepper Motor Controller	Standa 8SMC4-USB-hf	Device Server	- Implemented, Tested, Used - “Bug” when controller disconnection occurs	- Additional device to fix the bug - Compatibility tests with 8SCM4-USB-B9 controllers
Stepper Motor Controller	Standa 8SMC4-USB-hf	LabVIEW client	- Implemented, Tested, Used	Ready to be distributed
Delay Generator	Standford DG645	Device Server	- Implemented & Tested	GUI to be developed
Hexapod Controller	PI C887	Device Server	Already existing (TANGO ds user’s guide), fixed and adapted for Windows 64 bits - Tested with PI H-811 hexapod	Ready to use
CCD camera	Basler Ace	Device Server	Already existing (Lima), adapted for Windows 64 bits - Tested	Ready to use
CCD camera	Basler Ace	LabVIEW Client	- Implemented	To be tested
Spectrometer	Ocean Optics USB HR 4000CG-UV-NIR	Device Server	- Already existing (TANGO ds user’s guide), adapted for C++, Implemented & Tested	Ready to use
Spectrometer	Ocean Optics USB HR 4000CG-UV-NIR	Comete Client	- Implemented & Tested	Ready to use
Energy-meter controller	Gentec MEASTRO	Device Server	- Implemented & Tested	Ready to use, GUI to be developed

“Monitoring and Control System working group” – TANGO

Mihail Cernaianu,	RA-3 / Engineer (Control systems responsible for the Laser driven experiments)
Dragos Popescu,	RA-3 / Engineer
Teodor Ivanoaica	RA-3 / Engineer (IT & Network infrastructure responsible), part-time
Bertrand de Boisdeffre,	RA-1 / Engineer (Control systems responsible for the HPLS)
Alexandru Boianu,	RA-1 / Engineer
Dragos Dumitrescu,	RA-1 / Engineer
Nicolae Marinica,	RA-1 / Engineer
Nicolae Stan,	RA-1 / Technician

In red, TANGO developers.

TANGO @ ELI-NP – Status



EUROPEAN UNION

GOVERNMENT OF ROMANIA

Structural Instruments 2007-2013

Sectoral Operational Programme "Increase of Economic Competitiveness"

"Investments for Your Future!"

IFIN-HH

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

eli Nuclear Physics

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