



# ELIMED

*GAP Cirrone  
LNS, CT, Milano, Lecce, Roma I, Napoli, Bologna, LNL*

# Activity and beamline concepts

2

Beamline design

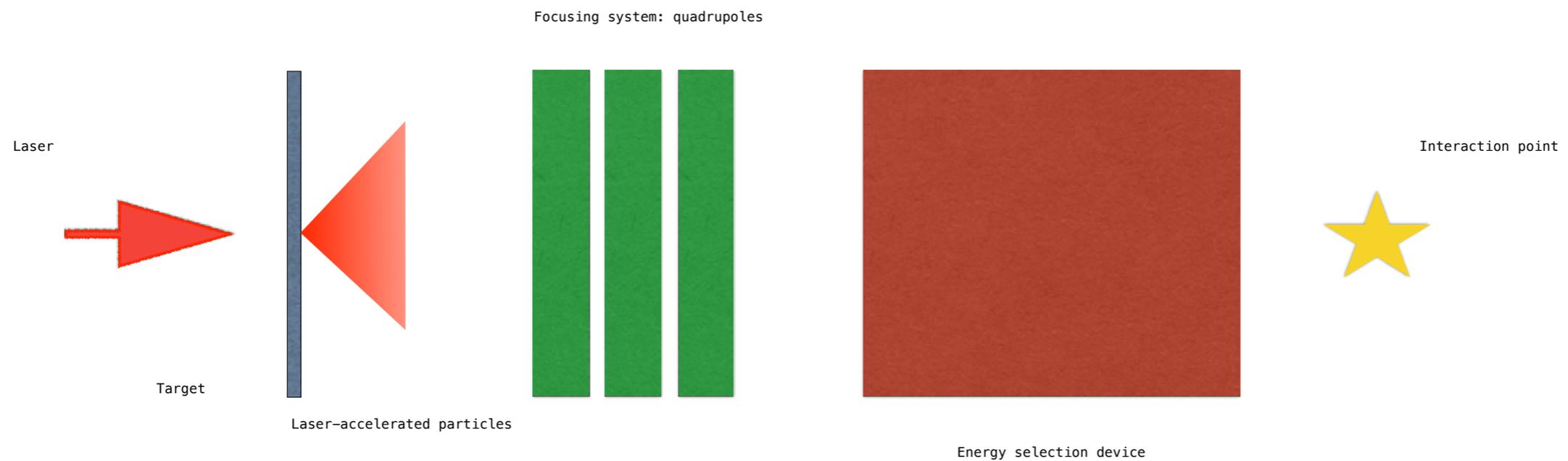
Absolute dosimetry

Diagnostic

Monte Carlo

Radiobiology

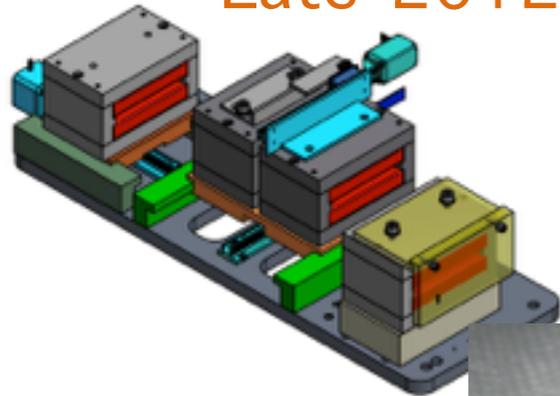
..... of laser-driven beams



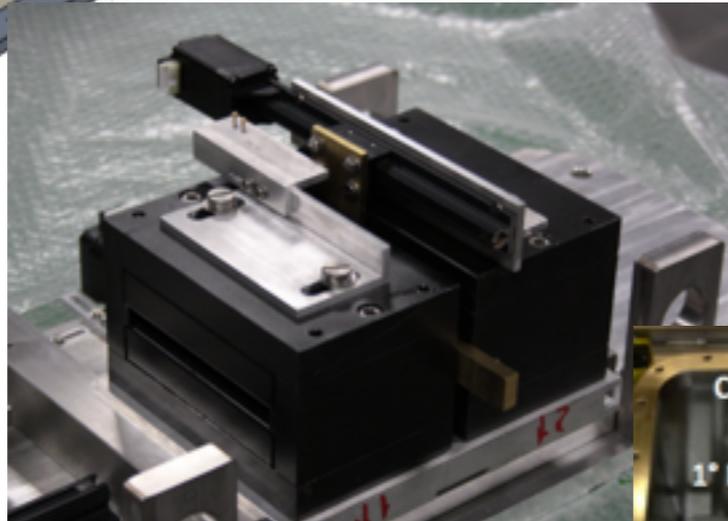
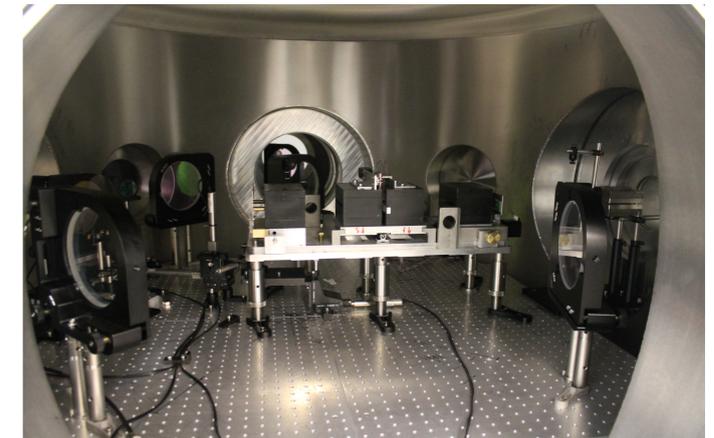
# Energy selector

3

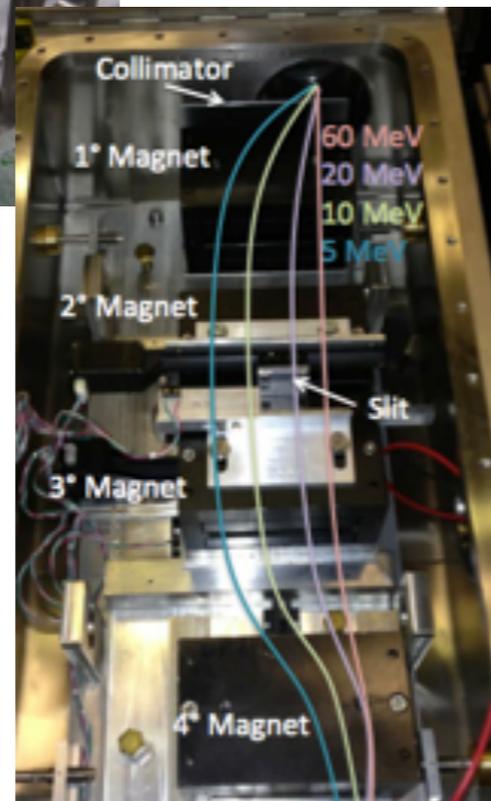
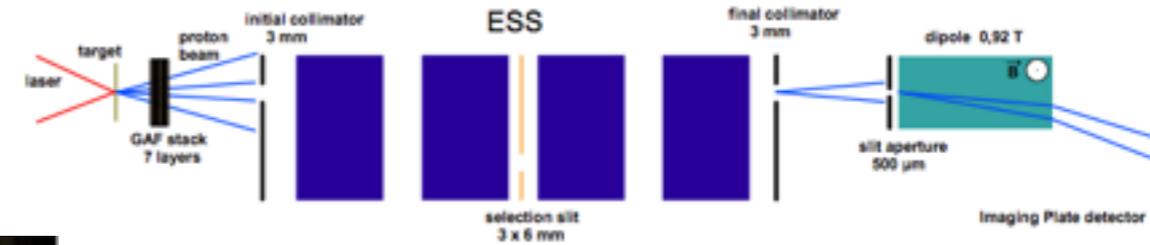
Late 2012



Experimental run  
at the Taranis facility (UK) 2013



Middle 2013

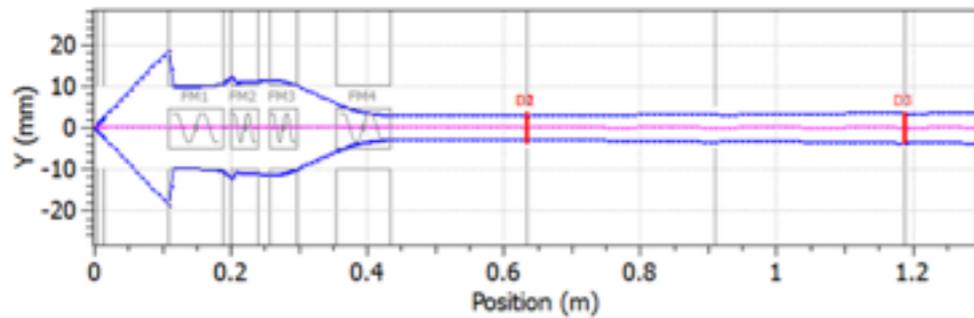
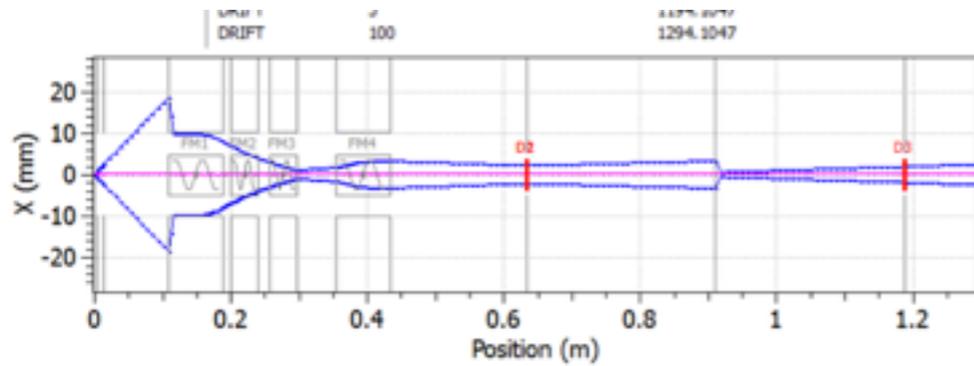
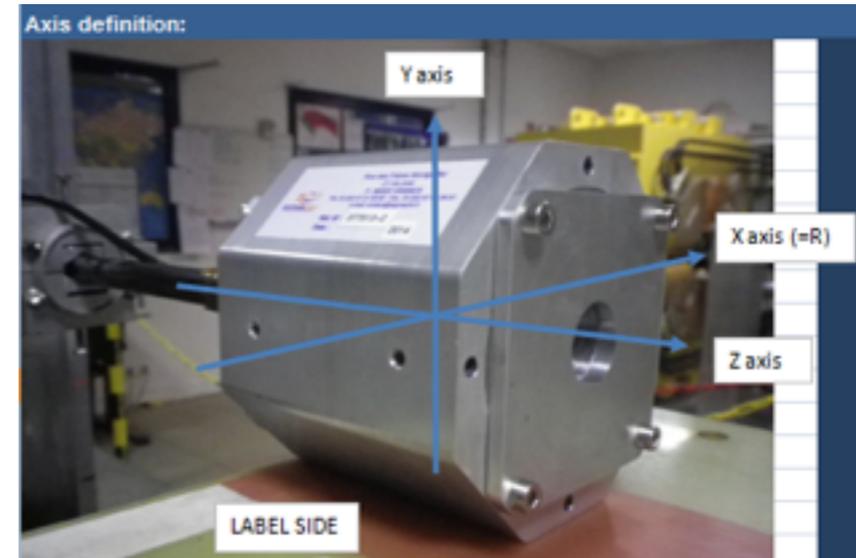
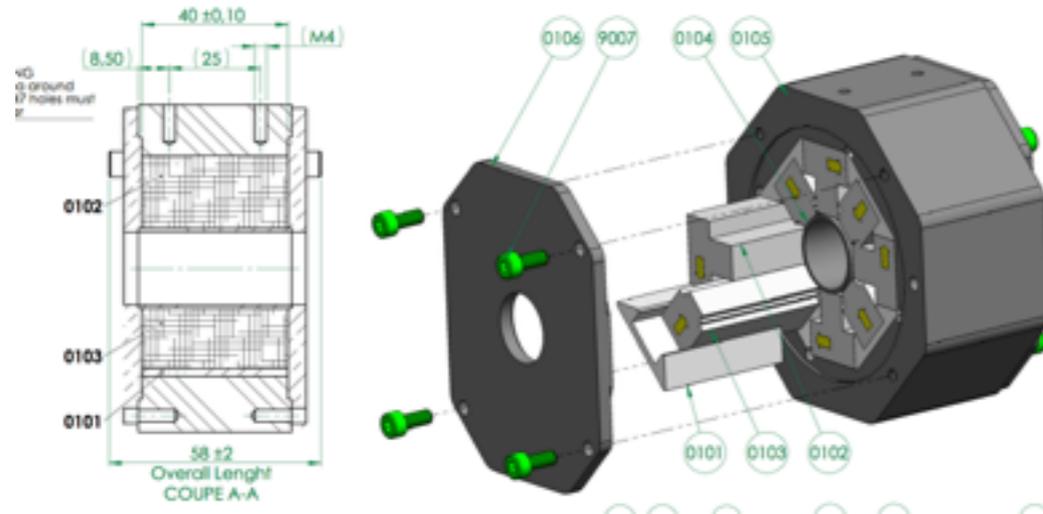


Late 2013

Energy	$E \pm \Delta E$	Energy	$E \pm \Delta E$
3.9 → 4.5	$4.2 \pm 0.3$	$\pm 7$	$4.5 \pm 0.2$
4.1 → 4.7	$4.4 \pm 0.3$	$\pm 7$	//
4.2 → 4.8	$4.5 \pm 0.3$	$\pm 7$	//
4.0 → 4.6	$4.3 \pm 0.3$	$\pm 7$	//
6.3 → 7.3	$6.8 \pm 0.5$	$\pm 8$	$7.0 \pm 0.6$
6.6 → 7.9	$7.3 \pm 0.6$	$\pm 8.5$	//

Transmission efficiency: 1.7 %

# Quadrupoles



10 MeV energy selection  
 4 % transmission  
 40° initial beam divergency

## Case with only the selection system

TABLE I. The transmission efficiency values for different input angle distributions, from 5° up to 29°

	5°	10°	15°	20°	25°	29°
Transm. eff.	0.5%	0.12%	0.049%	0.026%	0.015%	0.01%

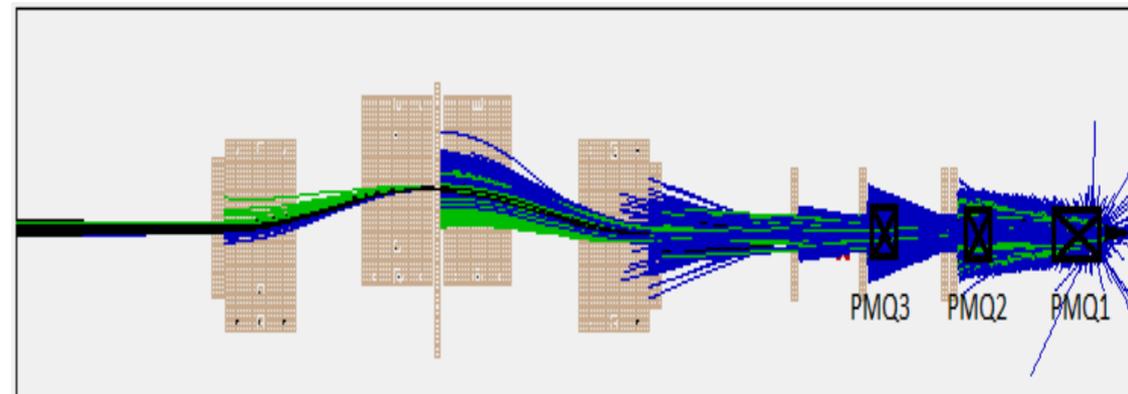
## Quadrupoles coupled to the selection system

TABLE II. The transmission efficiency values for different input angle distributions, from 5° up to 29°

	5°	10°	15°	20°	25°	29°
Transm. eff.	24.4%	7.6%	3.6%	1.9%	1.2%	0.79%

Phase 2: PMQs + ESS particle tracking with realistic TNSA protons (10° half angle, 15 mm beam spot size)

- Blue particles: Energy < 4.5 MeV
- Green particles: Energy > 5.5 MeV
- Black particles: Energy  $\in$  [4.5, 5.5] MeV



## Absolute dosimetry

CR39, GAFChromic and TLD

Faraday cup up to 70 MeV

- Two electrodes to improve electron suppression

## Relative dosimetry

Multi-stages transmission ionisation chambers for high dose rate

Secondary emission detectors

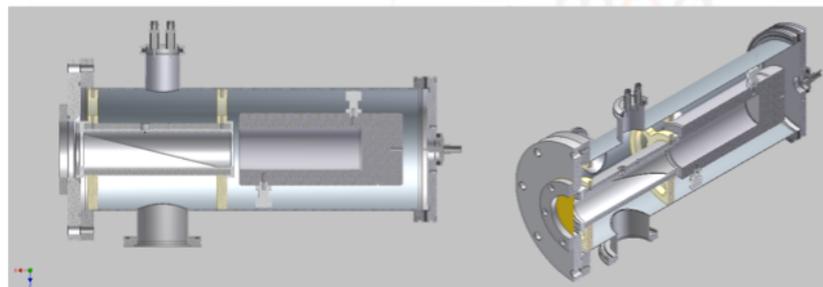
Detector based on nuclear coulomb scattering calibrated against Faraday cup

## TOF

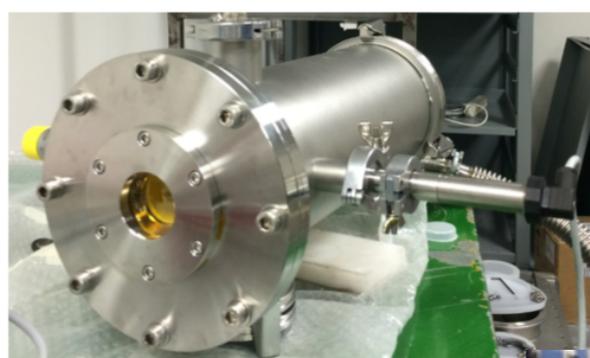
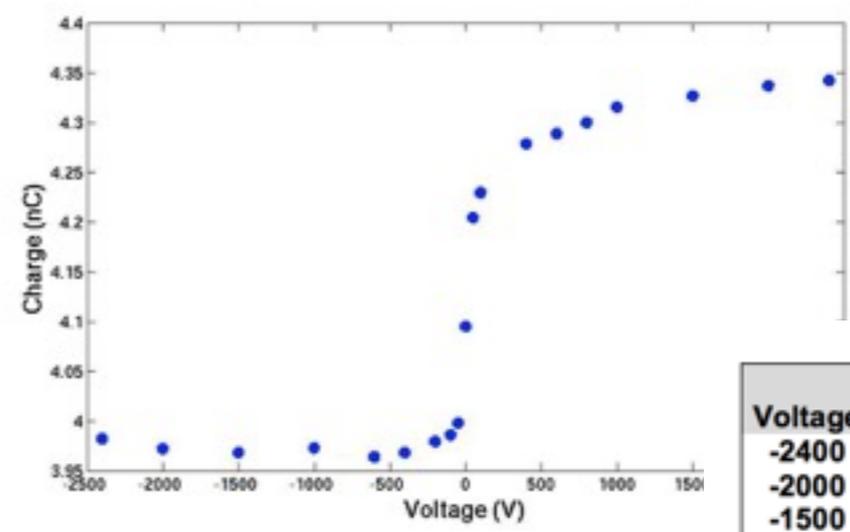
CVD monocrystalline detectors

SiC detectors

# Faraday cup for absolute dosimetry



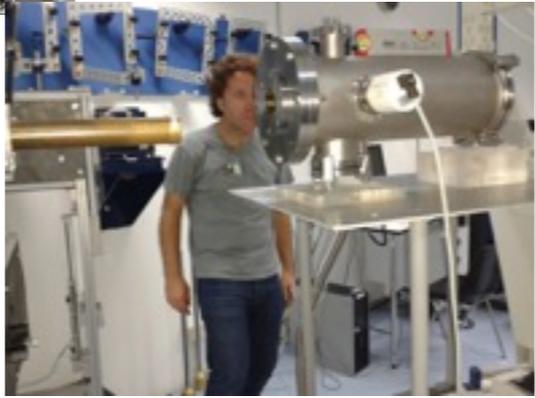
Beginning 20



Middle 2014

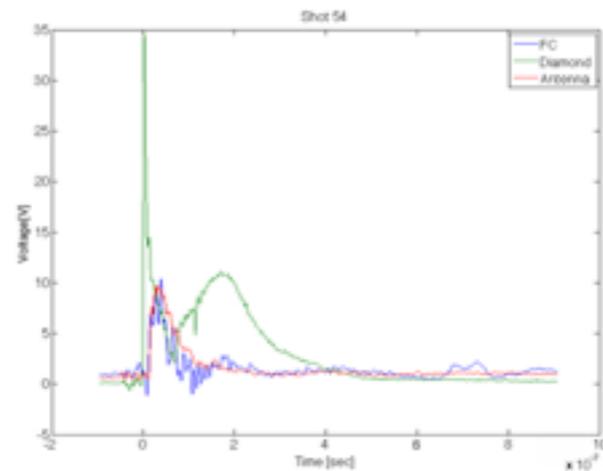
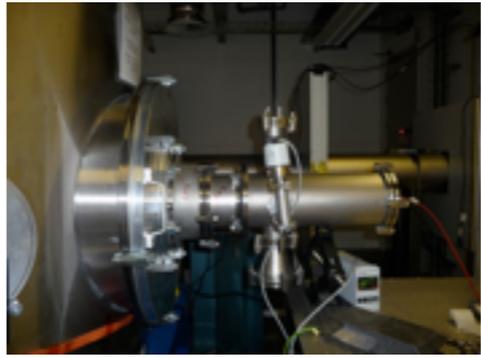
Conventional proton beams, 62 MeV

Voltage	Aeff Dose	MC Dose	%
-2400	13,36	13,69	-7,47
-2000	13,31	13,68	-7,83
-1500	13,3	13,68	-7,95
-1000	13,35	13,68	-7,52
-600	13,26	13,69	-8,3
-800	13,25	13,68	-8,36
-400	13,29	13,68	-8,01
-200	13,33	13,68	-7,72
-100	13,42	13,68	-6,95
-50	13,38	13,68	-7,31



Late 2014

Laser-drive proton beams, 4-12 MeV



Late 2014 and 2015

# ELIMED Contract signed on December 8th, 2014



### Contract for Work

concluded in compliance with the provisions of Section 2586 et seq. of the Act No. 89/2012 Coll., the Czech Civil Code (hereinafter the "Contract")

#### 1. PARTIES

##### 1.1. The Client:

Fyzikální ústav AV ČR, v.v.i.

having its registered office at: Na Slovance 2, Prague 8, ZIP Code 182 21

represented by: prof. Jan Řídký, DrSc, in his capacity of Director

registered in the Register of the Public Research Institutions of the Ministry of Education, Youth and Sports of the Czech Republic,

##### Banking details:

UniCredit Bank Czech republic, a.s.

Account No.: 2106551053/2700

Identification Number: 68378271

VAT Number: CZ68378271

(hereinafter the "Client")

and

##### 1.2. the Contractor:

INFN, Istituto Nazionale di Fisica Nucleare

having the registered office in Via Enrico Fermi, 40 – 00044 Frascati (Rome), Italy

Identification Number: F12901KA

registered in the Register of the Italian Ministry of Education, University and Research (MIUR)

represented by Prof. Fernando Ferroni, in his capacity of President



#### 4. WORK SUBJECT-MATTER; WORK SCOPE

4.1. The Contract concerns the design, assembling, performance optimization, and delivering to the Client at the Client's Place of Business of a complete transport beamline and a number of dosimetric endpoints that will enable the users to apply laser-driven ion beams in multidisciplinary fields in accordance with this Contract (hereinafter the "System"). Furthermore, the scope of this Contract mainly encompasses (i) various training services to be provided to the Client's personnel in compliance with Article 13 of this Contract (ii) a royalty free licence, if any according to Article 14, to use the System for the purposes of the use of the ELI-Beamlines Project after completion and (iii) the possible realization of the Additional System, subject to the exercise of the Call Option right by the Client under par. 4.6 (the System and the other parts of the works/services are hereinafter referred to as the "Works").



- 5 DIC. 2014

Signed in Prague on 8/12/2014

Signed in Rome on \_\_\_\_\_

On behalf of: Fyzikální ústav AV ČR, v. v. i.

On behalf of: INFN, Istituto Nazionale di Fisica Nucleare

Signature:

Name: Prof. Jan Řídký, DrSc.

Title: the Director

Signature:

Name: Prof. Fernando Ferroni

Title: President



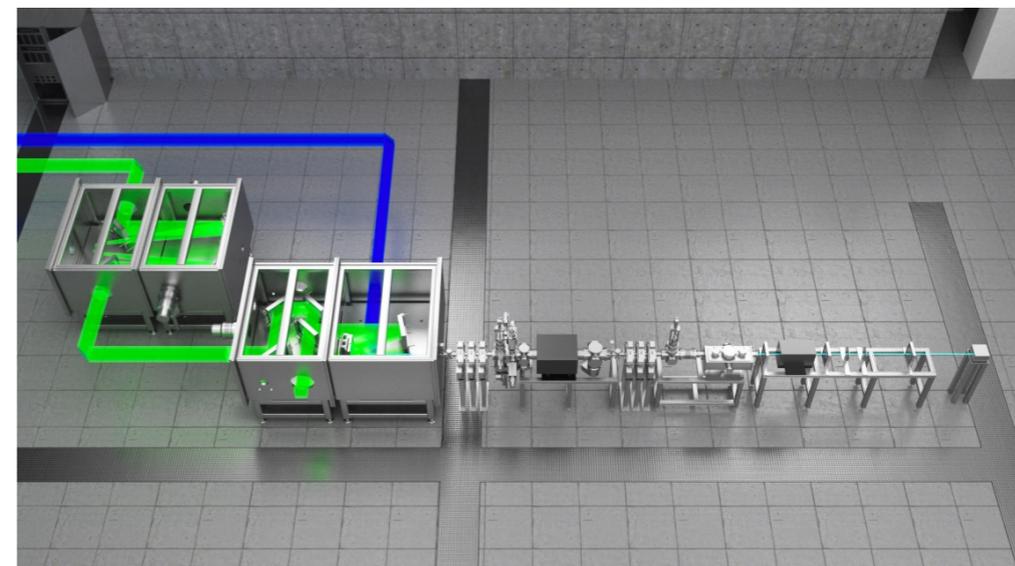
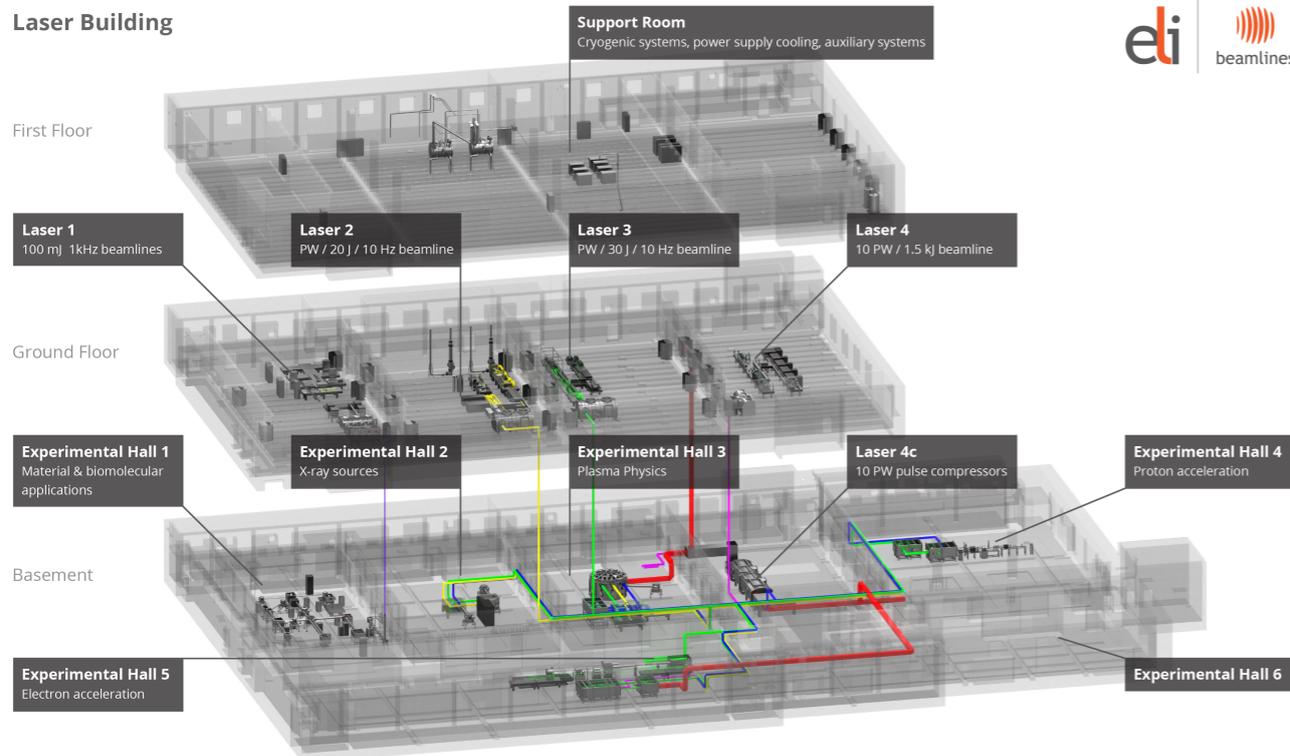
ISTITUTO NAZIONALE DI FISICA NUCLEARE  
IL PRESIDENTE

(Prof. Fernando Ferroni)

# ELIMED @ELI-Beamlines

4 Laser beamlines: L1 - L4

- **L1**: 10TW class @ kHz
- **L2** and **L3**: PW @ 10 Hz
- **L4**: 10 PW (1 shot/min) and high energy “kJ” beam



## -April 2015

- Feasibility study of the Collection system (quadrupoles)
- Code design of the Monte Carlo Geant4 application for transport and dosimetry

## -June 2015

- Design of the system for absolute and relative dosimetry of the ELIMED beams

## -September 2015

- Design and realisation of the diagnostic detectors
- Feasibility study and design of the energy selection system

## -March 2016

- Collection system is realised
- Design of the beamline

## -September 2016

- The energy selection system is realised

- . . . . .

## -October 2017

- ELIMED beamline assembled at ELI-beamlines