

ELI-ALPS: the Attosecond Facility of the Extreme Light Infrastructure

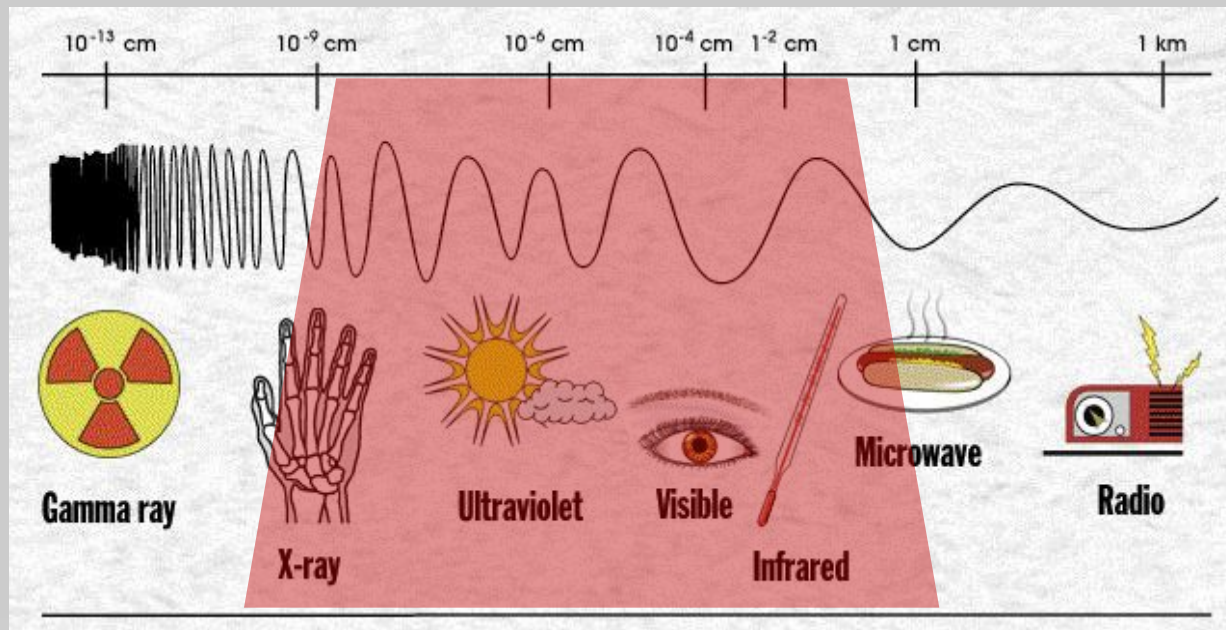
D. Charalambidis, E. Cormier, Z. Diveki,
P. Dombi, J.A. Fülöp, R. Lopez-Martens,
M.P. Kalashnikov, K. Osvay, E. Racz

Major missions of ELI-ALPS

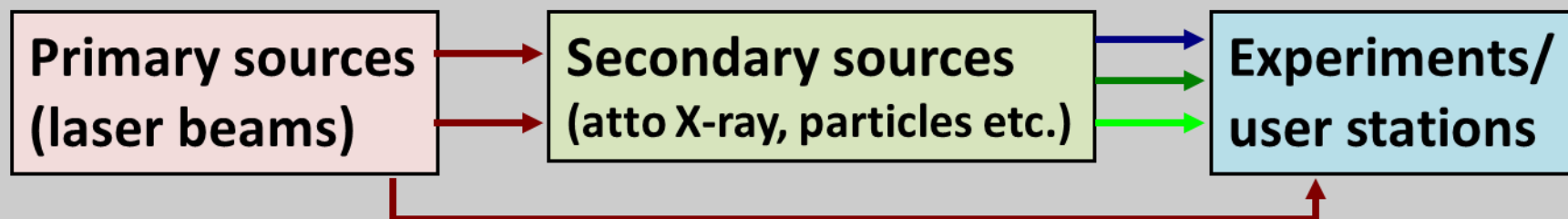
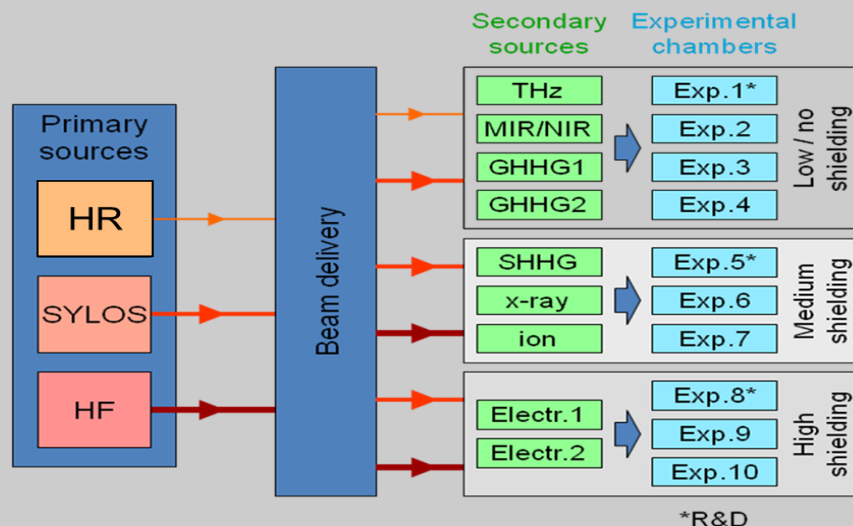
- 1) To generate X-UV and X-ray fs and atto pulses, for temporal investigation at the attosecond scale of electron dynamics in atoms, molecules, plasmas and solids.
ATTOSECOND Beamline & User Facility
- 2) To contribute to the technological development towards 200PW
HIGH INTENSITY beamline

ELI-ALPS Light sources

The **shortest** pulse durations at the **widest** spectral range ...
... at the **highest** repetition rate.



Schematics of ELI-ALPS



Design of ELI-ALPS I

ELI-PP

Mission
Basic scientific directions

ELI-ALPS

July 2010 – Dec 2010

Feasibility study for the Scientific Case of ELI-ALPS

March 2011 – June 2011

Planned research Activities of ELI-ALPS



**Feasibility Study of ELI-ALPS – part of project application to the EU.
Completed: June, 2012**

Design of ELI-ALPS II

Conceptual Design Report
by the international community

Research institutes and Universities

**Part I (sources, sci. IT) is completed
SAC approved**

**Part II (labs, workshops)
is due Q2 2014**

Technical design (TDR)
by the contractors

Mainly industrial partners

Part I is due by Q3 2014

Conceptual Design Report I

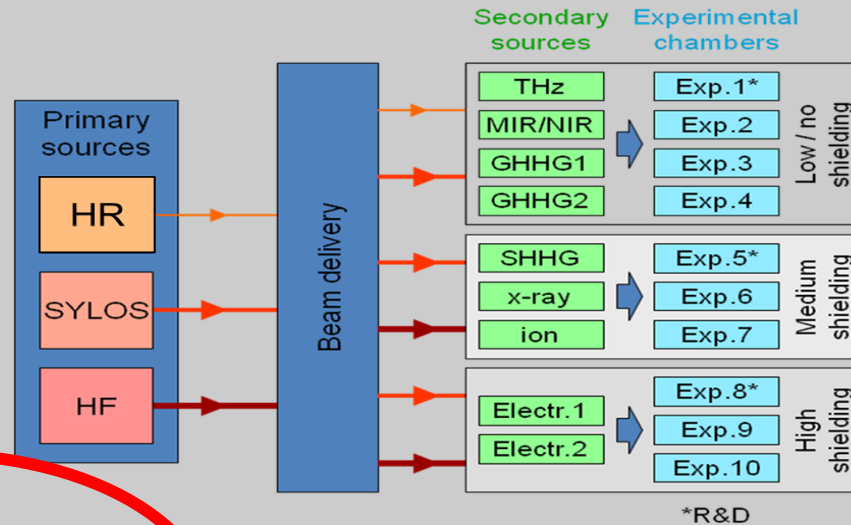
**Status: primary and secondary sources completed
measurements completed**

CO-AUTHORS:

G. Almasi, G. Andriukaitis, C.L. Arnold, A. Baltuska, S. Banerjee,
M. Baudisch, J. Bohus, J. Biegert, A. Borot, A. Börzsönyi, F. Brizuela, F. Calejari,
Th. Cowan, T. Ditmire, R. Dajka, K. Ertel, R. Fonseca, L.J. Fülöp, M. Galimberti, E. Gaul,
C. Haefner, J. Hebling, M. Hemmer, C. Hernandez-Gomez, Ch. M. Heyl, D. Jaroszynski,
P. Johnsson, D. Kandula, M. Kaluza, M. Kitzler, A.P. Kovacs, I. Kocsis, Á. Kövér, L. Kövér,
A. L'Huillier, N. Lopes, V. Malka, Zs. Major, P. Mason, I. Márton, T. Metzger, T. Mosoni,
J. Mucsi, I. Musgrave, M. Nisoli, G.G. Paulus, M. Prandolini, A. Pugzlys, F. Quere,
G. Sansone, P. Racz, S. Ricz, R. Riedel, I.N. Ross, J.-P. Rosseau, A. Rouzée,
P. Rudawski, J. Schreiber, M. Schulz, L.O. Silva, Ch. Spindloe, S. Szatmari, F. Tavella,
A. Thai, M. Tolley, P. Tzallas, M. Vrakking, L. Veisz, J. Vieira, I. Will

Under completion: preparatory and diagnostics labs, workshops, facility issues

Schematics of ELI-ALPS

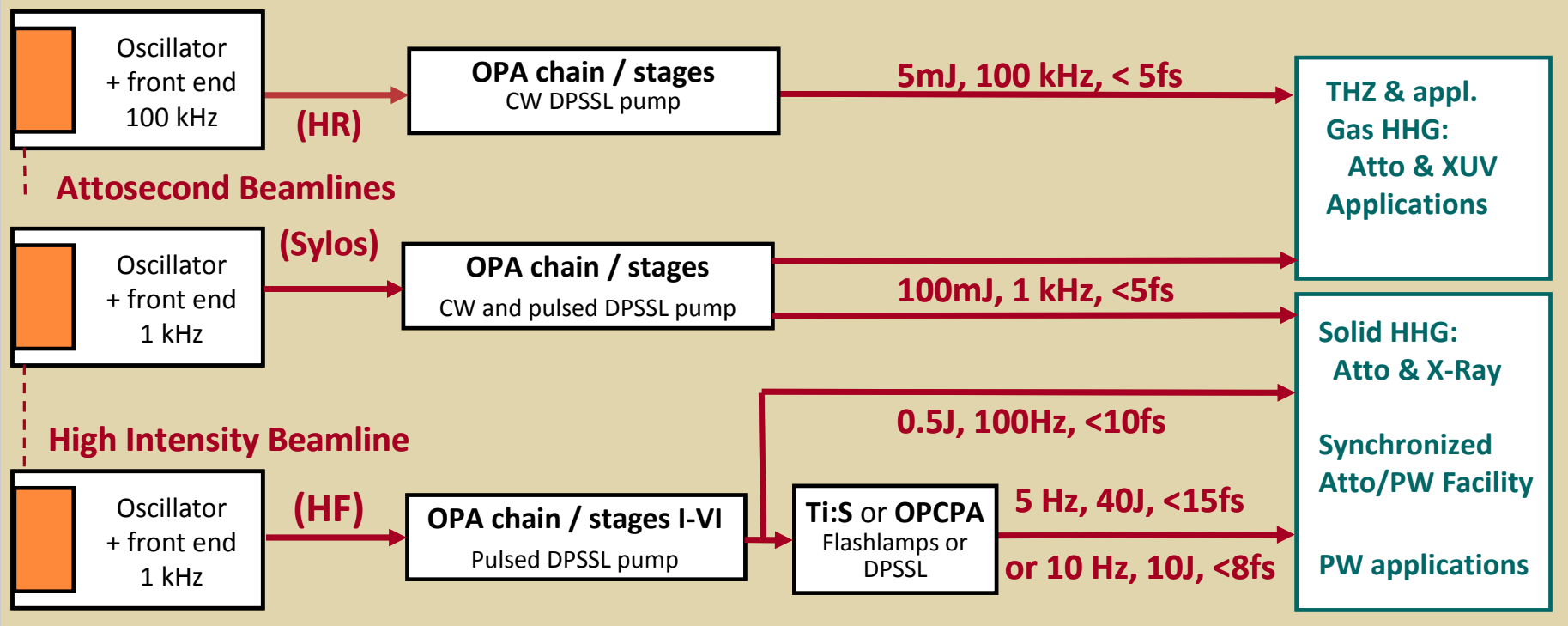


**Primary sources
(laser beams)**

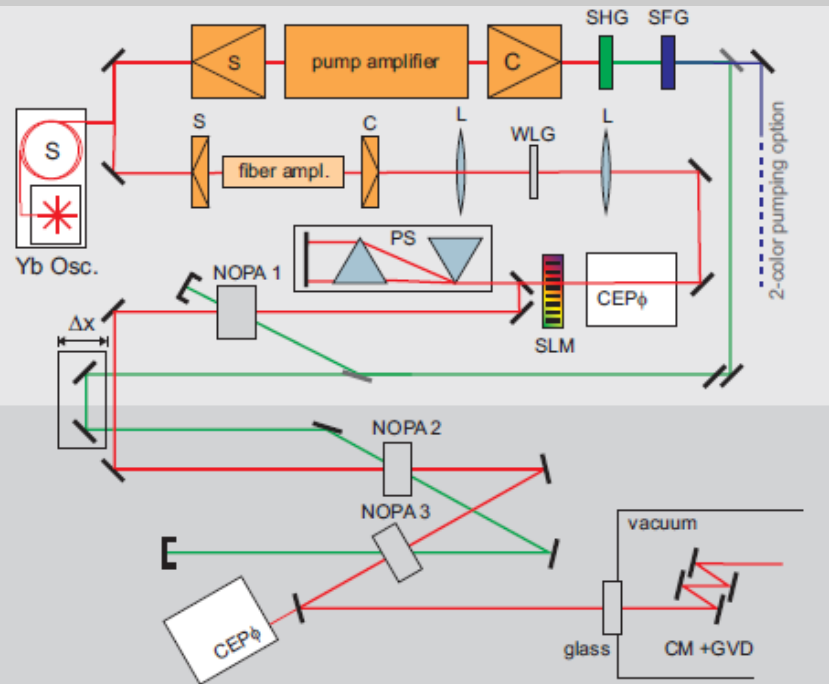
**Secondary sources
(atto X-ray, particles etc.)**

**Experiments/
user stations**

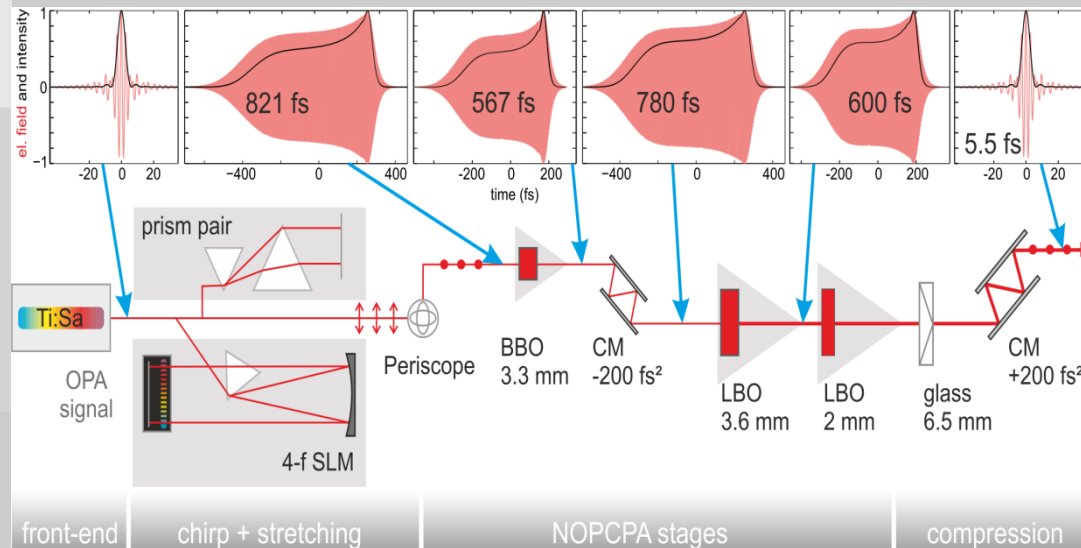
Schematics of the lasers



Conceptual design of the HR laser

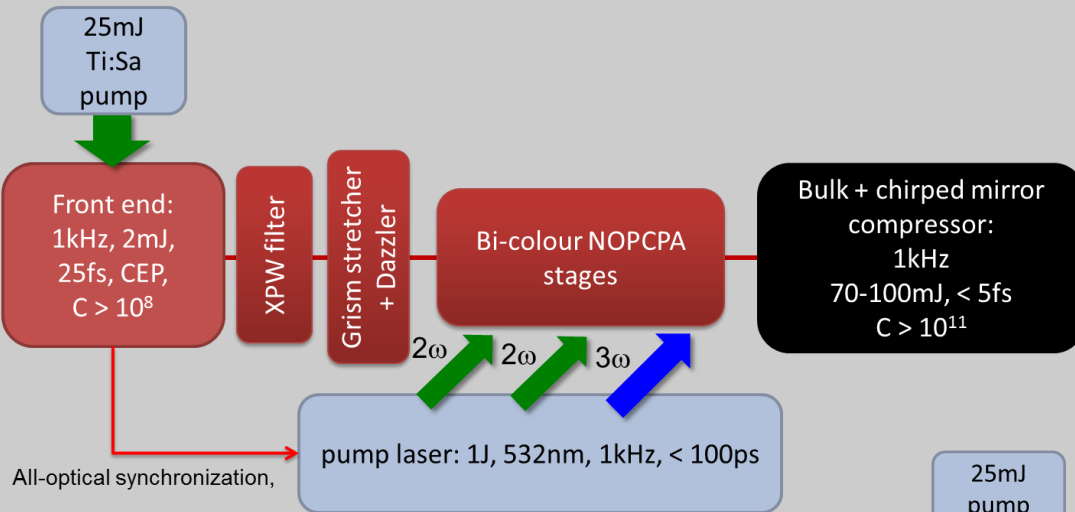


By DESY, Hamburg, & Uni Jena



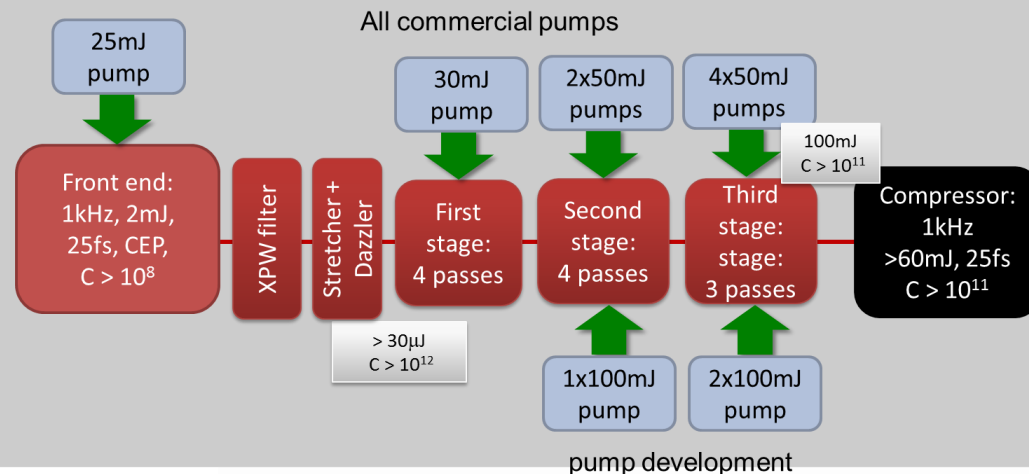
front-end chirp + stretching NOPCPA stages compression

Conceptual design of the SYLOS laser

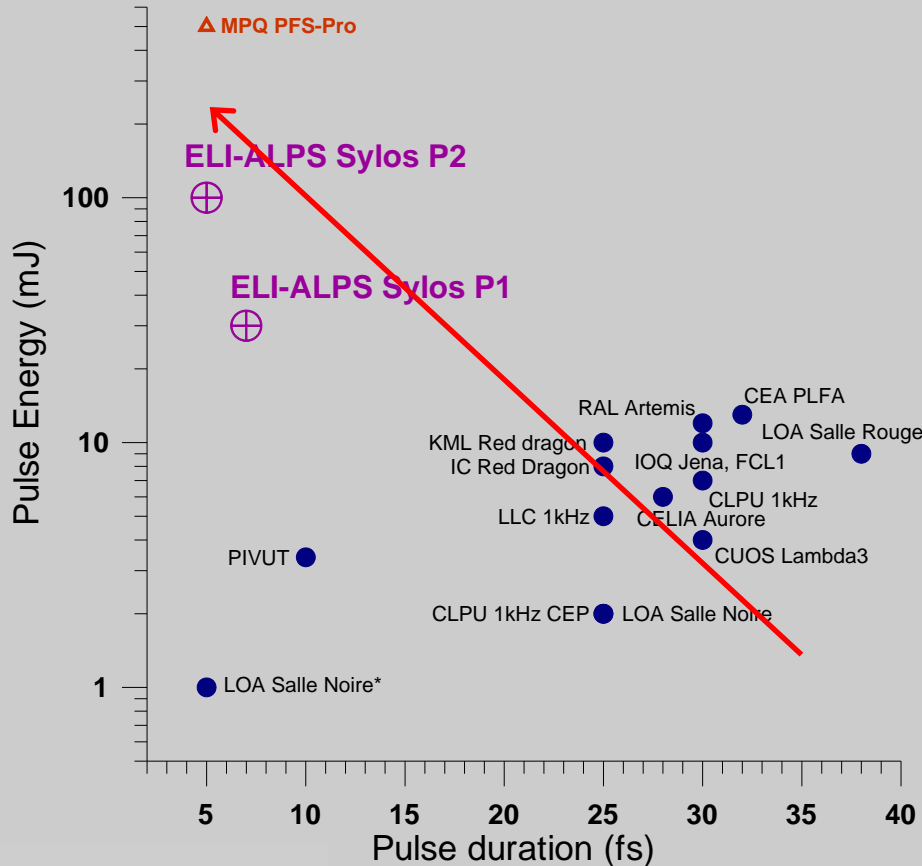


By LOA, Palaiseau

By UFI, Garching



Benchmarking the Sylos (kHz) laser



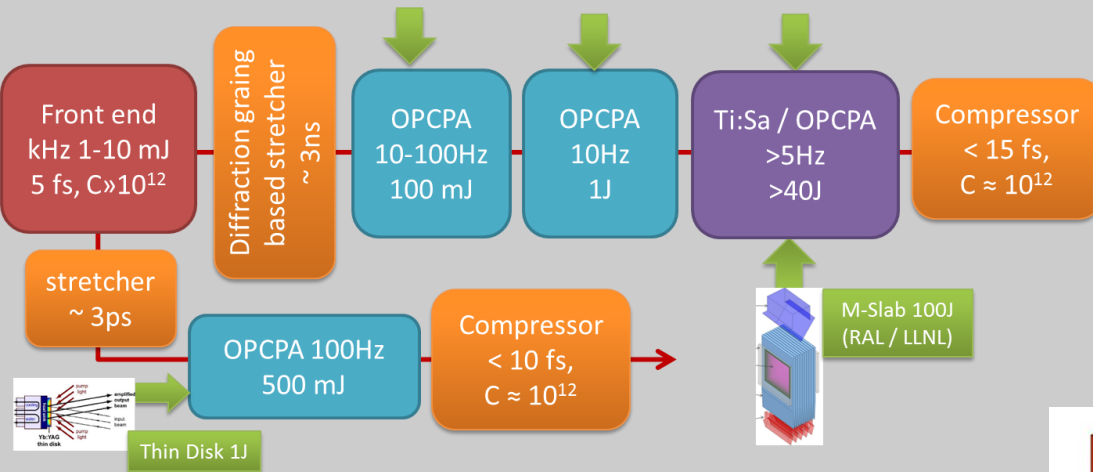
Challenges for phase I

- pump source
- CEP stabilisation
- Optics
- Dispersion management

Challenges for phase II

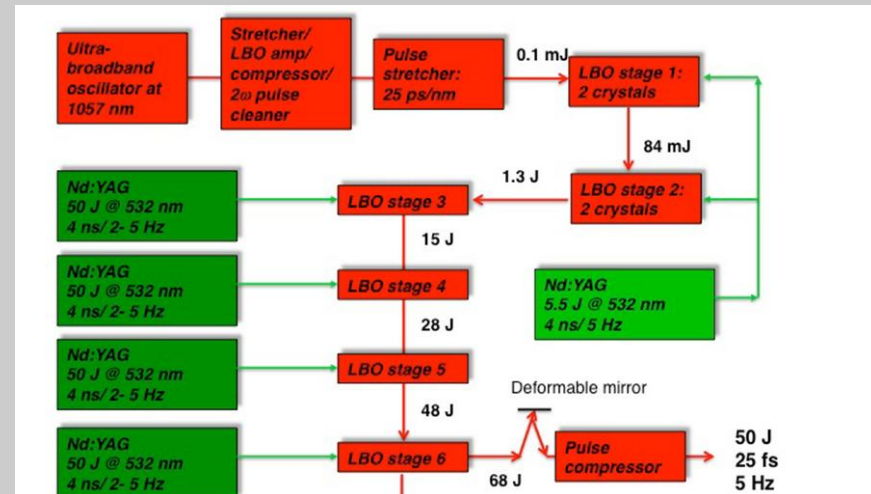
- **pump source**
- CEP stabilization
- **Optics**
- **Dispersion management**
- **OPA command / control**

Conceptual design of the HF laser

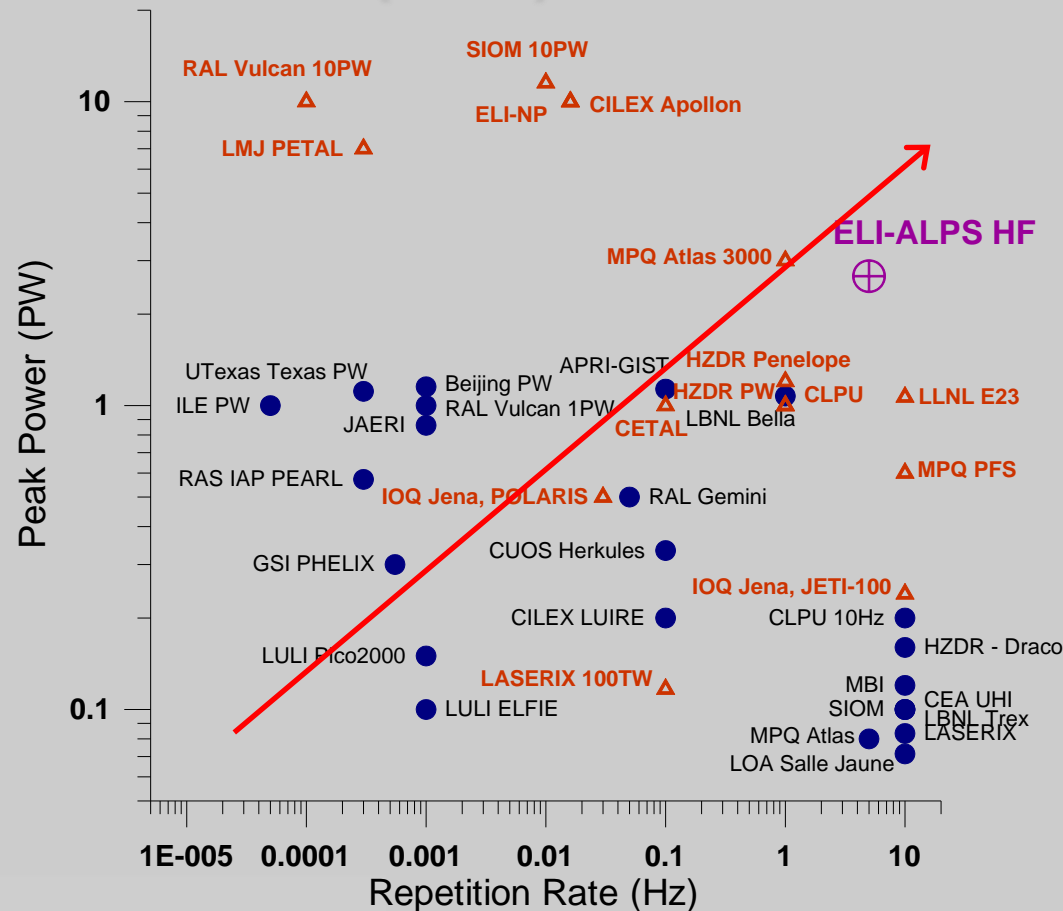


By LLNL, LOA, MBI, RAL

By Uni Texas



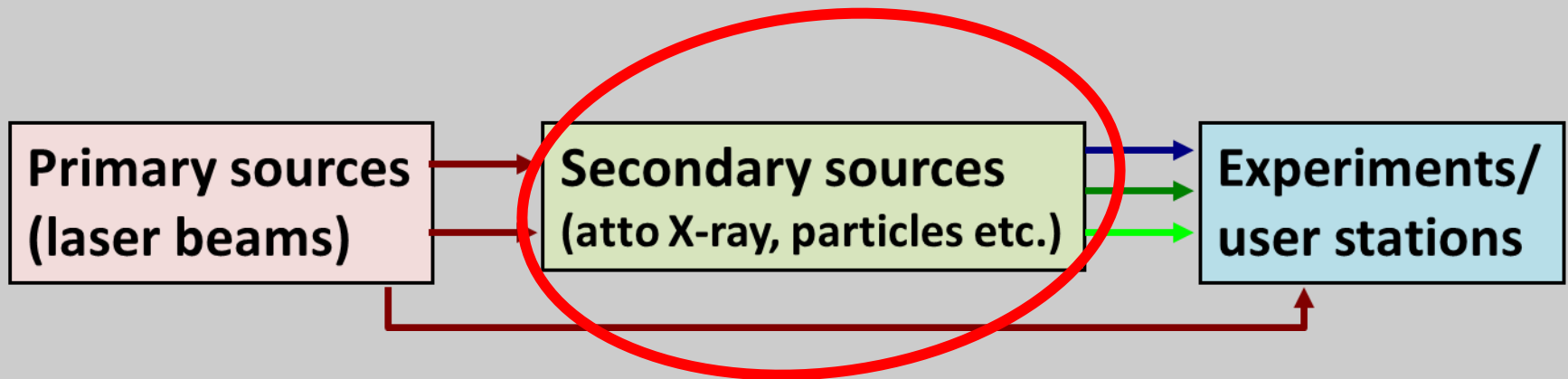
Benchmarking the HF (PW) laser – Ti:S duty amp



Challenges for phase I

- Optics
- Dispersion management

Schematics of ELI-ALPS



Gas High Harmonic Generation and Attosecond Pulses

1kHz-100kHz, 4-400eV, up to 10 μ J

Solid High Harmonic Generation and Attosecond Pulses

5Hz – 1kHz, 10eV – 5keV, up to mJ

Electron and Ion Acceleration

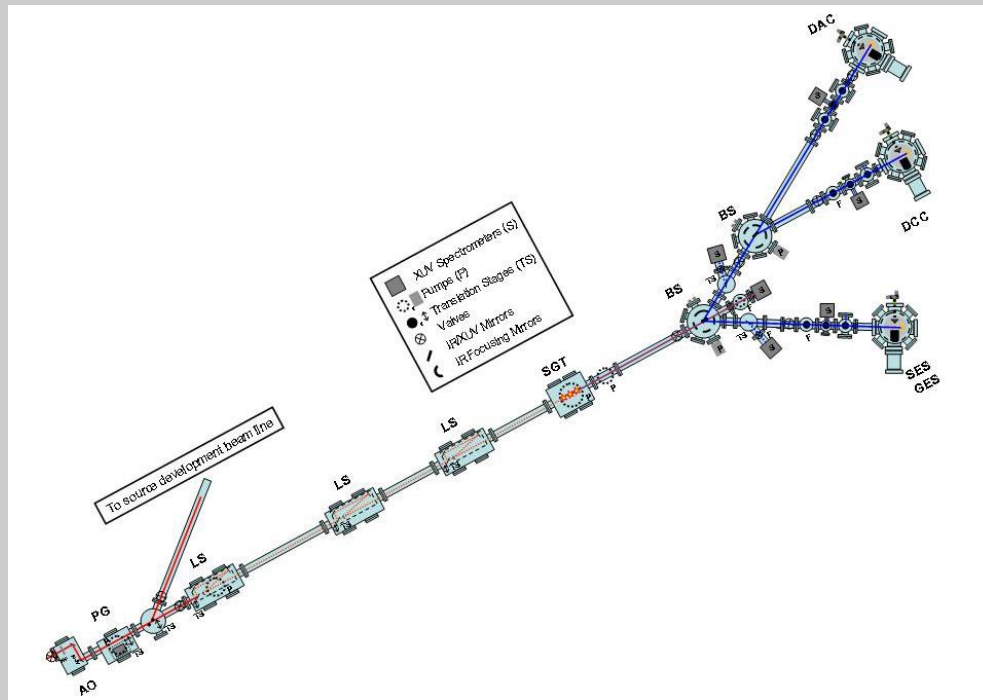
e^- : 1-2GeV, 0.2nC; p^+ : up to 160MeV, up to 1nC

THz sources

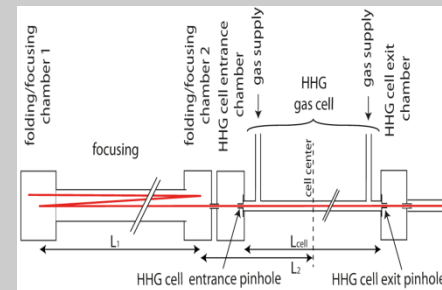
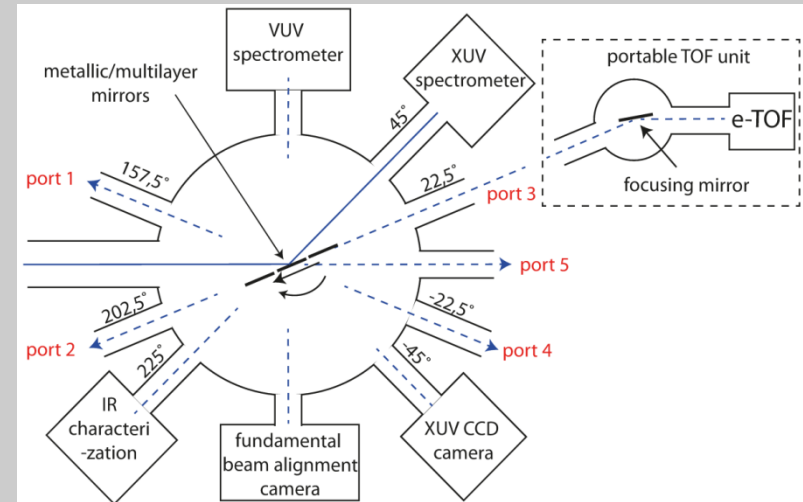
3MV/cm – 100MV/cm, up to 1mJ

New Concepts for HHG and Attosecond Pulse Generation

Conceptual designs - Gas HHG

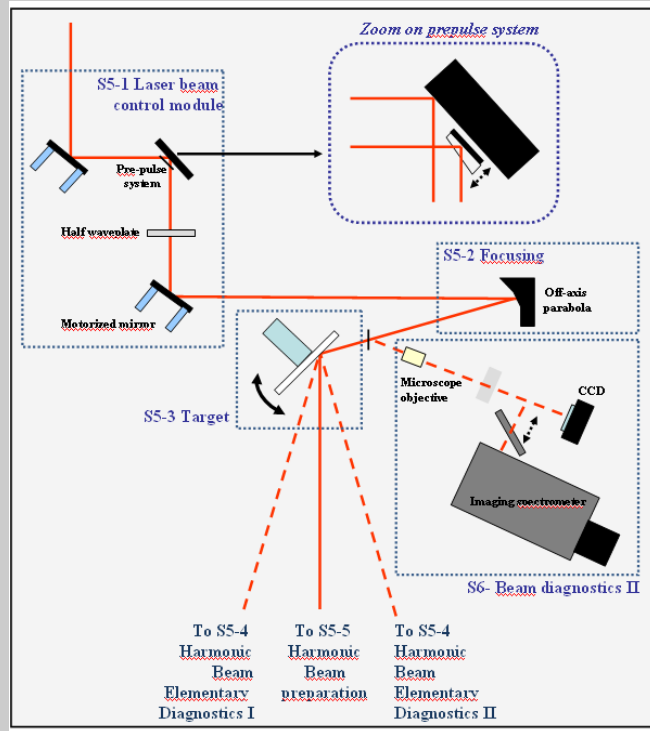


FORTH

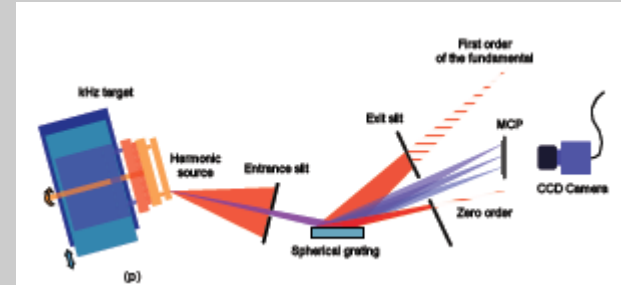
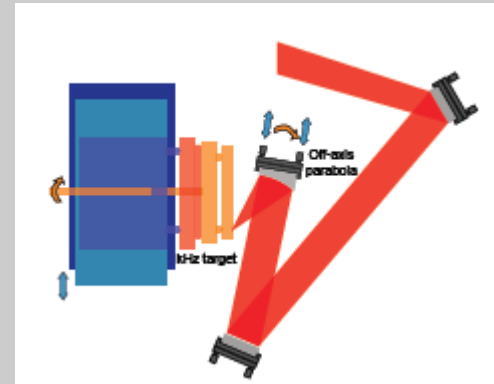


LUND

Conceptual designs – Solid HHG



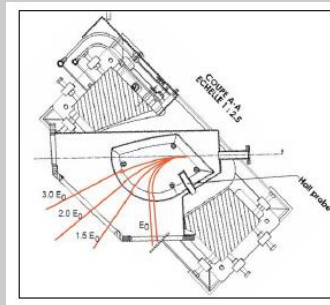
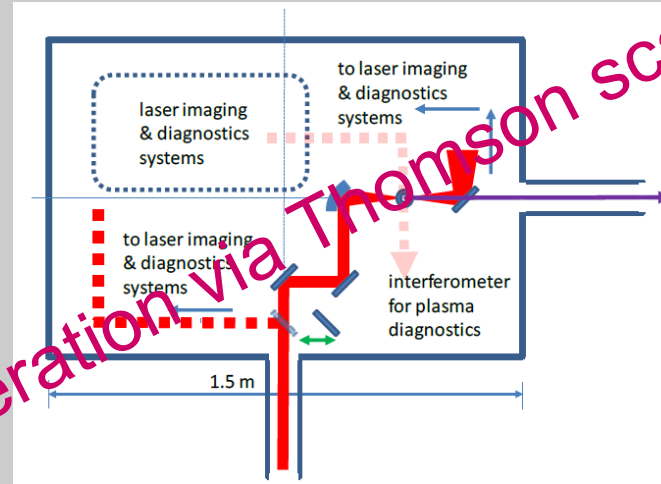
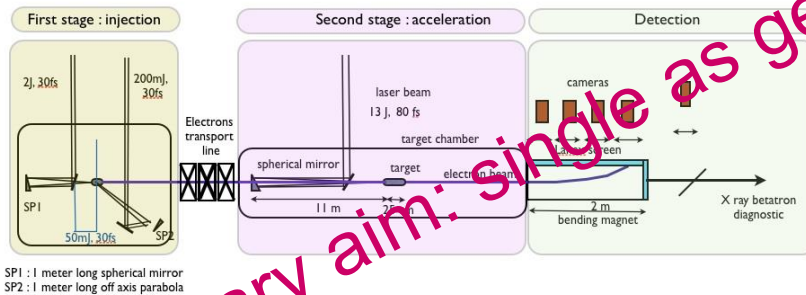
CEA



LOA

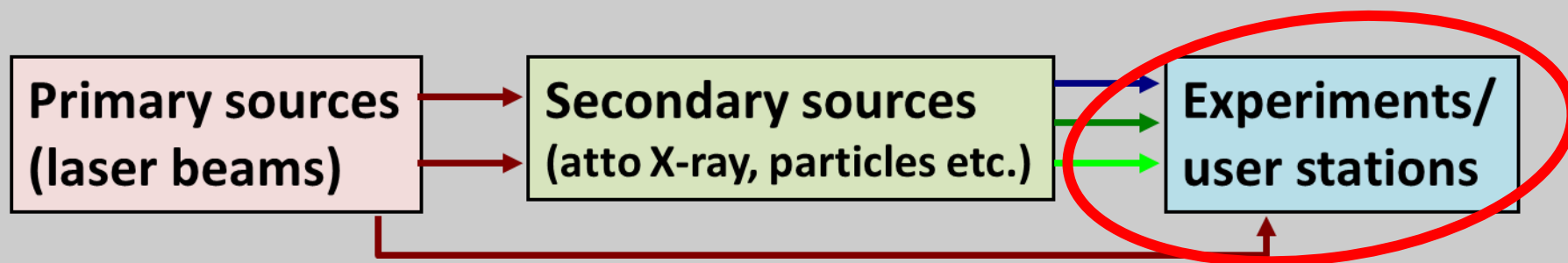
Conceptual designs – e⁻ acceleration

All optical two stages laser plasma accelerators



University of Strathclyde

Schematics of ELI-ALPS



ELI-ALPS science synergies

RA #	Research activity (RA)	Synergies with RAs	Secondary sources	Laser drivers
1	Laser R&D	2-8		HR, SYLOS, HF
2	Secondary sources R&D	1, 3-8	GHHG, SHHG, THz, Thomson, electron, ion	HR, SYLOS, HF
3	Atto core electron science	1, 2, 4, 5	GHHG, SHHG	HR, SYLOS
4	Atto valence electron science	1-3	GHHG, SHHG	HR, SYLOS
5	Sub-atomic 4D imaging	1-4	SHHG	SYLOS
6	Atto high field science	1, 2, 7, 8	SHHG, Thomson, ion	SYLOS, HF
7	THz science	1, 2, 6	THz, ion	HR, SYLOS, HF
8	Biomedical & industrial applications	1, 2, 5, 6	SHHG, Thomson, ion	HR, SYLOS, HF

Project proposal to the EU

Proposal / feasibility study ready: **November 2012**

DG Regio: **re-phasing request December 2012**

Jaspers' Completion note: **March 2013**

Project proposal was submitted to the EU: **May 2013**

Interruption letter: **July 2013**

Approval is expected: **within 2 months from now**

Resolution of the Hungarian Government (26th April, 2013):

The **implementation** can **start before** the EC approves the proposal,
on the risk and expenses of the Hungarian national budget!

Phasing and financing

Phase 1 (-2015)

Building:	cc. 18,2 bln HUF	64.1 M EUR
Research equip:	cc. 16, 2 bln HUF	57 M EUR
Services:	cc. 2,6 bln HUF	9.2 M EUR
Total:	cc. 37,0 bln HUF	130.4 M EUR

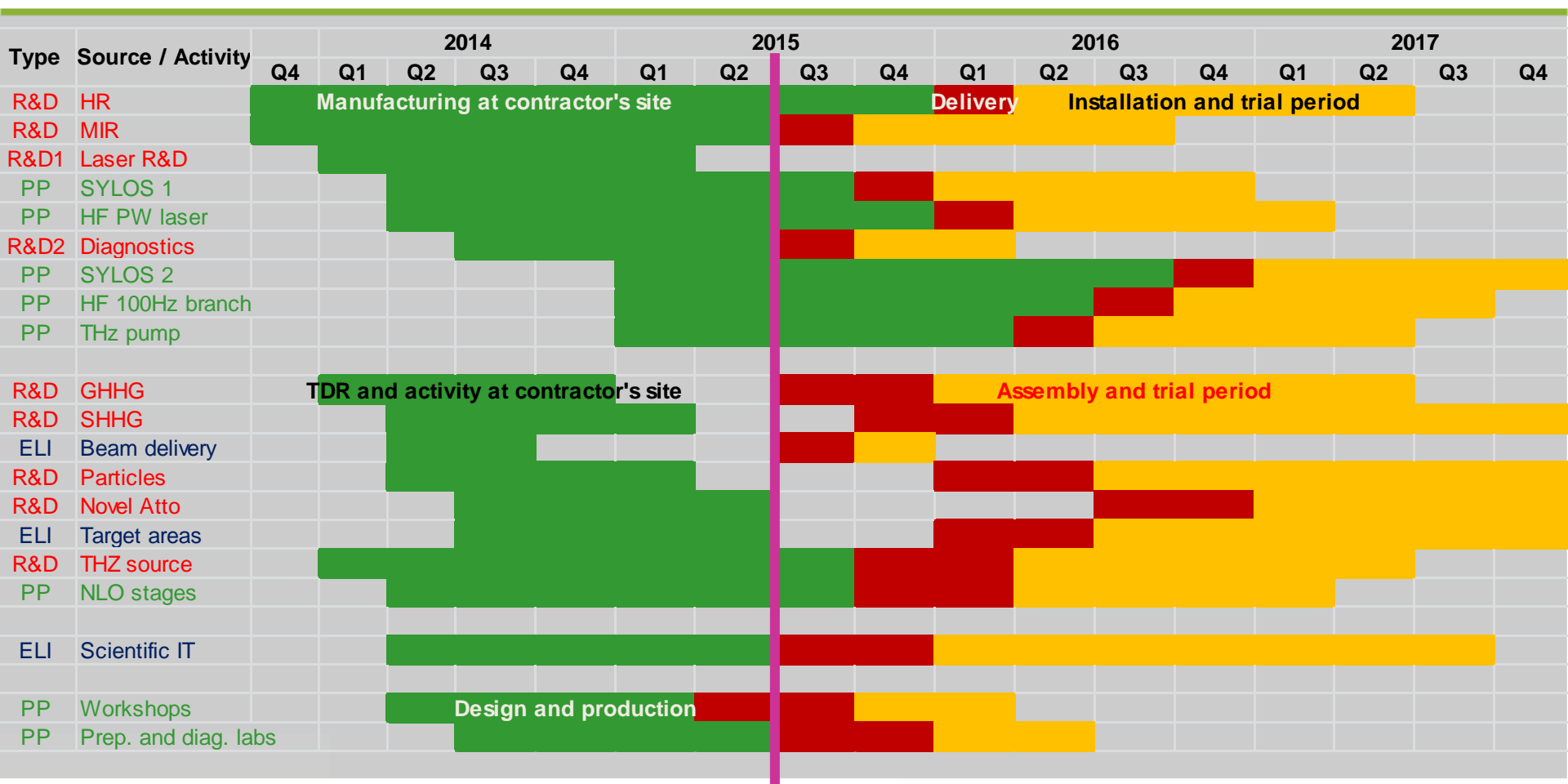
Phase 2 (-2017)

Building:	cc. 4,7 bln HUF	16.6 M EUR
Research equip.:	cc. 17,2 bln HUF	60.6 M EUR
Services:	cc. 2,4 bln HUF	8.5 M EUR
Total:	cc. 24,3 bln HUF	85.6 M EUR

Grand total: **cc. 61.3 bln HUF** **216 M EUR**

(+Preparation: 2,434 bln HUF)

Implementation plan - Overview



1. VIA R&D PROJECTS

Laser:

Delivery to the site

ALPS HR laser

100kHz, 5mJ, <5fs, VIS-NIR, CEP

Q1 2016

ALPS MIR laser

100kHz, 0,1mJ, <6 cycle, MIR

Q3 2015

Submission deadline of the R&D proposals was
over on 27th November, 2013

Implementation of the lasers II

2 PUBLIC PROCUREMENT – Q3 2013

Delivery to the site

ALPS Sylos 1 laser

1kHz, >4TW, <20fs, VIS-NIR, CEP

Q4 2015

ALPS HF PW laser

≤5Hz, >2PW, <20fs, NIR

Q1 2016

The tender is open
since 2nd Nov, 2013.

Contracting is
expeced in March,
2014.

Request for
proposal to be
published:
December, 2013.

3 Laser R&D projects for elimination of technological bottlenecks

4 PUBLIC PROCUREMENT – Q4 2014

ALPS Sylos 2 laser

1kHz, >20TW, 5fs, VIS-NIR, CEP

Q4 2016

ALPS HF 100 laser

100Hz, >40TW, <12fs, NIR

Q3 2016

Implementation of the secondary sources

Via R&D projects – Q4 2013

TDR of the beamlines
TDR of the target areas

Delivery I: Q2 2014
Delivery II: Q1 2015

Public procurements – Q3 2014

Hardware for the beamlines
Hardware for the target areas

Delivery I: Q2 2015
Delivery II: Q1 2016

By the same groups / contractors
+ ELI-ALPS workforces

Via R&D projects – Q4 2013

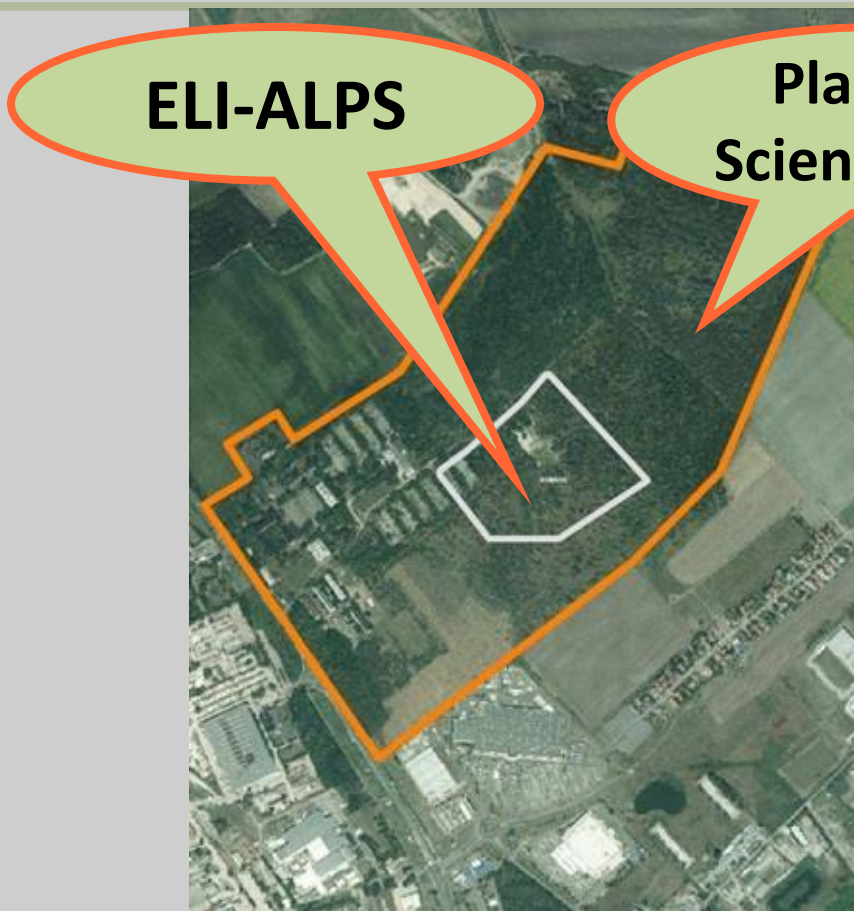
Implementation of the beamlines
Implementation of the target areas

Delivery I: Q1 2016
Delivery II: Q4 2017

NEW SZÉCHENYI PLAN



Location of ELI-ALPS and a planned Scientific Park



A projekt az Európai Unió támogatásával,
az Európai Regionális Fejlesztési Alap
társfinanszírozásával valósul meg.

Site map

Building „A”
(lasers + target areas):
Net area - **6209 m²**

Building „B”
(scientific labs and machinery):
Net area - **7936 m²**

Building „C”
(Reception, auditorium):
Net area - **7391 m²**

Building „D”
(maintenance, storage):
Net area - **2926 m²**
Total – 24 462 m²



LAYOUT – Scientific areas

- Laser hall: 1350 m²
- Target areas: 2100 m²
- Optics labs: 330 m²
- Biology/chemistry/medical labs: 320 m²
- Diagnostics labs: 110 m²
- Mechanical workshops: 530 m²
- Electric / IT workshop: 200 m²



Region of ELI-ALPS:

Szeged



163 000 inhabitants
30 000 students (10% foreigners)
2600 researchers at
- Uni Szeged
- Biological Research Center,
- Inst. for Cereal Research

Confucius Institute in Szeged

**University of Szeged:
Top 500 (!)**



The highest ranked Uni from underdeveloped regions.



National Development Agency
www.ujszechenyiterv.gov.hu
06 40 638 638



HUNGARY'S RENEWAL



The projects are supported by the European Union
and co-financed by the European Regional
Development Fund.