

AMENDMENT 1

TO AGREEMENT ACT00001.0 of 16 September 2013

On this day, month, and year, the following Parties:

Lawrence Livermore National Security, LLC, a limited liability company organized in the State of Delaware, having an administrative office at 2300 First Street, Suite 204, Livermore, CA 94550 represented by Dr. William Goldstein

("LLNS")

and

Fyzikální ústav AV ČR, v. v. i., located at Na Slovance 2, 182 21 Praha 8, Id. No 68378271 represented by prof. Jan Řídký DrSc.

("IOP", "CLIENT")

(collectively referred to as the "Parties")

have agreed on this Amendment of the AGREEMENT ACT00001.0 made between the Parties on 16 September 2013 (the "Amendment"):

PREAMBLE

- A. On 16 September 2013, the Parties entered into the AGREEMENT ACT00001.0, the subject of which is a development of High Repetition Rate Advanced Petawatt Laser System (the "Agreement" and the "HAPLS" or "L3"). The Agreement was awarded in accordance with the procurement procedure according to the Czech Republic Act No. 137/2006 Coll., on Public Procurement, as amended (the "PPA").
- B. IOP is seeking to make specific improvements to the L3-HAPLS system that will lead to a more rapid transition to user experimental operations at the CLIENT's facility. These improvements are requested through the following: (1) prolonged operation time of the pump laser system at LLNS to identify and mitigate infant failures that may otherwise occur at the CLIENT's facility and (2) conduct of early phase ramping activities at LLNL that are currently planned to be performed by CLIENT Staff at the CLIENT's facility after completion of Deliverable D8.
- C. Furthermore, IOP is seeking additional training for its staff on key aspects of high energy laser systems and specifically on an extended training period on the HAPLS pump laser system and controls at LLNL to ensure rapid transition to user operations on the L3 beam line once the system is delivered to the CLIENT, and thereby to maximize initial uptime of the L3 system for

users. This is motivated by the fact that **CLIENT's** staff have only very limited learning and training opportunities available on this unique high energy laser systems and technologies before HAPLS is installed at the **CLIENT's** facility and wish to provide its staff with a sustainable training of its skills, knowledge and abilities.

- D. Another important element in requesting additional training is to provide the ELI-Beamlines team with significant hands-on experience with, and close knowledge of, the L3 technologies. This will be essential in subsequent efficient accomplishment of ramping of performance of the system. Extension of the operation period of the HAPLS system at LLNL will provide IoP with additional time for testing and commissioning of the Short Pulse Diagnostics Package (SPDP), and will also remove installation of the PW compressor from the critical path of the L3 project.
- E. Therefore, the **CLIENT** wishes to agree with **LLNS** an extended training and operation period ("ETOP") that will contribute to increased availability of the L3 system for users in its early operation at the **CLIENT's** facility, and will minimize associated risks. The additional system operation experience will largely help debugging leading to a higher availability system as delivered to the **CLIENT** and to reduce maintenance overhead.
- F. ETOP will not require modification, nor add to or delete, existing Pump Laser Readiness Criteria or Project Completion Criteria in the current Agreement.
- G. All terms used in the Amendment have the same meaning as used in the Agreement, unless expressly stipulated otherwise in the Amendment.

1. THE PURPOSE AND SCOPE OF THE AMENDMENT

1.1. At completion of the Pump Laser Readiness Criteria (PLRC) demonstration associated with the D4 milestone according to the Article 4.A of the Agreement, **LLNS** in conjunction with **CLIENT** personnel will begin the ETOP up to and including operations at the PLRC level. The ETOP will include the following:

- 1.1.1. prolonged operation time of the pump laser system and subsystems for burn-in operation and reduction of infant mortality risk including but not limited to optical materials, optical coatings, mechanical assemblies, high pressure He-gas cooling components, etc.;
- 1.1.2. on-the-job training of **CLIENT's** staff on key procedures required for high energy, high average power HAPLS laser operation relevant to future performance ramping;
- 1.1.3. early phase ramping activities that were planned for **CLIENT's** HAPLS performance ramping phase after installation of the laser system in the **CLIENT's** facility (Deliverable D8) and completion of the current agreement. These include readiness demonstration of the following subsystems at performance levels consistent with beginning of the ramping phase to the HAPLS full design performance:

- 1.1.3.1. high Energy Power amplifier laser support systems (Helium cooling circuit and laser system heat exchangers);
- 1.1.3.2. integrated operation of the Nd:YAG DPSSL pump laser for the short pulse alpha amplifier at 10Hz and consistent with early phase ramping to full system performance level; and
- 1.1.3.3. Ti:Sapphire short pulse alpha amplifier operation ramped to 10Hz repetition rate and consistent with early phase ramping to full system performance level.

1.2. The ETOP period will last a minimum of 6 months. **CLIENT** subject matter experts (SMEs - the ETOP team) will participate and receive training at LLNL.

2. AMENDMENT TO THE EXISTING STATEMENT OF WORK

Parties agreed that Appendix A: Statement of Work of the Agreement shall be extended by adding the following new wording (that shall apply in addition to the existing wording in Appendix A and shall not replace that wording):

*“The **CLIENT** and **LLNS** agreed on an extended training and operation period (“ETOP”) that will contribute to increased availability of the L3 system for users in its early operation at the **CLIENT**’s facility, and will minimize associated risks.*

The scope of work associated with the ETOP is as follows:

- *With the **CLIENT** ETOP team as defined in Section 7 hereof, **LLNS** will operate the pump laser for a 6 month longer period than currently planned in the original project baseline at LLNL after completion of the Pump Laser Readiness Criteria (PLRC) demonstration associated with the D4 milestone, at levels up to and including the PLRC. This will provide the **CLIENT** ETOP team with significantly enhanced operation experience to increase the confidence level in commissioning, operating, maintaining and performance ramping the HAPLS laser system. Extending the integration time at LLNL with both the **LLNS** development team and **CLIENT** ETOP team available to work issues as they arise will lead to reduced installation and commissioning time at ELI-Beamlines and a more rapid transition to user experiments.*
- *Reduce the risk of infant mortality failures (burn-in operation) which would otherwise not be achieved until after installation at ELI-Beamlines facility. During the ETOP, **LLNS** staff along with the ETOP team will identify potential infant failures and where appropriate reduce the impact using LLNL facilities and processes. It is expected that infant failure modes of the laser and control systems consistent with PLRC operating levels will be uncovered and resolved prior to HAPLS shipment to the ELI-Beamlines facility and thereby reduce down-time during re-commissioning and early experimental operations.*

- **LLNS will demonstrate key aspects of 10Hz operation for the full system Pre-Amplifier sections of both the Pump Laser and Short Pulse Laser systems with energies consistent with our current assessment to achieve full system design performance for early phase ramping for all pre-amplifiers in both the pump and short pulse laser systems. In addition, LLNS will run the HAPLS power amplifier cooling utility systems at levels consistent with 10Hz full performance operation. These are the first systems that would be run at 10Hz during the early ramping phase after D8 completion and will consist of the following subsystems:**

Front-ends and Pre-amplifiers*

Pump Laser Front End	≥30 mJ	@≥10Hz, 1.05μm
Short Pulse Front End	≥0.01 mJ	@≥10Hz, 0.8μm
DPSSL for Short pulse Alpha Amplifier	≥1 J	@≥10Hz, 0.53μm
Ti:Sa Short Pulse Alpha Amplifier	≥300 mJ	@≥10Hz, 0.8μm

* These subsystems will be operated simultaneously and fully integrated at operational performance levels consistent with HAPLS full system performance

Cooling Utilities

Helium gas	>100 CFM**	@ >40 psig***
Diode chillers cooling liquid	>10 GPM****/array	@ <20 °C

** cubic feet per minute

*** pounds per square inch

**** gallons per minute

- **LLNS will provide to the CLIENT ETOP team extended operation training, hands-on training and maintenance training on the HAPLS pump laser systems. The CLIENT ETOP team will consist of CLIENT staff with the skills, knowledge, and abilities (SKAs) defined in Section 7 hereof. This training will be tailored to the SKAs of the specific CLIENT ETOP team members. The focus of the team will be to learn and train on:**
 - Key maintenance procedures for the pump laser
 - Clean optics installations and exchanges
 - Helium cooling system cleanliness verification process
 - Establishment of installation, operation and performance qualification processes in the context of performance ramping
 - Work authorization process for safe laser operations
 - Laser system shot operations for senior staff identified as future L3-HAPLS shot director

After demonstration of Project Completion Criteria (PCC) at LLNL (D6 deliverable), during

*recommissioning at ELI-Beamlines, the **CLIENT** ETOP team will augment the Integrated Commissioning Team (ICT).*

3. SPARE PARTS PROVISION

LLNS has procured initial operational spare parts for the pump laser to be delivered to the **CLIENT** under the Agreement (Appendix D Spare Parts Option, Section 1 Operational Spare Parts) along with some residual construction spares. These spares (operational and residual construction) were planned to be available for the early commissioning and operational phase of the project at ELI-Beamlines. With ETOP now adding 6 months of additional operational time at LLNL, **CLIENT** will make available for LLNS use operational spare parts where construction spare parts are not available. LLNS will not procure additional spare parts for any parts consumed under ETOP unless directed in writing by the **CLIENT** to procure additional spare parts under the terms of the Agreement.

At the end of the ETOP, LLNS will provide a list of remaining and intact operational and construction spare parts. During ETOP, LLNS will optimize the allocation of resources consistent with the commissioning plan, delivery schedule, and technical specifications.

LLNS will inform the **CLIENT** on any use of the operational spare parts along with the monthly reports. LLNS shall be obligated to procure substitute spare parts upon the **CLIENT's** request and provision of additional funds.

4. ADDITIONAL DELIVERABLE - D4A

LLNS shall deliver to the **CLIENT**, within the deadline set forth in the Delivery Schedule in Section 6 of this Amendment, a Training Status Report providing details of the status of **CLIENT** staff training related to the specific training modules provided by LLNS during the conduct of the ETOP and an initial operations assessment, including descriptions of the identified infant failures, proposed solutions for their elimination or mitigation, and lessons learned associated with early performance ramping. The report shall include a description of 10 Hz operation of the Front-end and Pre-Amplifier sections of the Pump Laser and Short Pulse Laser systems, and HAPLS power amplifier cooling utilities at performance levels consistent with full system performance requirements. The Acceptance Procedure for the D4A Deliverable will be in accordance with provisions defined in Appendix A Section 5.2 (and all related subsections) of the Agreement.

5. ADDITIONAL FUNDING LEVEL

Parties agreed that Article 4.A. of the Agreement shall be extended by the following new wording, (that shall apply in addition to the existing wording in Article 4.A. and shall not replace that wording):

"The funding required for the complete ETOP scope of work defined by this Amendment is in addition to the funding levels shown in Article 4.A of the Agreement. The additional funding level to LLNS for

the work to be performed under this Amendment is not to exceed three million, seven hundred and thirty four thousand U.S. Dollars (\$3.734 M USD).

<i>Funding for the Extended Training and Operations Period (ETOP)</i>	<i>\$3,734,000 USD</i>
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The parties mutually agree that any funds originally allocated to be used by D4A milestone will be used for ETOP purposes and activities during following stages of contract performance to support the completion of the HAPLS project and, where possible, enhance the performance of the L3-HAPLS system."

6. REVISED DELIVERY AND PAYMENT SCHEDULE

Parties agreed that the Payment Schedule in Article 4.A. of the Agreement shall be fully replaced by the following Payment Schedule:

Deliverable	Description	To be documented by	Completion Date	Phase	Payment (to fund follow-on work)	Proposed Payment Date
	Sign contract	Contract		1	\$ 8,550,000	7-Sep-2013
D1	Conceptual technical design of the laser beamline, detailed project execution plan, interface definition with the ELI-Beamlines building	Submission of a technical design report including: beamline technology description; detailed project plan; specific roles, responsibilities and interfaces for LLNS and IOP staff; and description of items with long-lead procurements	30-Nov-2013	1	\$ 9,737,500	31-Dec-2013
		Acceptance Certificate				
D1A	Technical approach for end-to-end dispersion management in the short pulse chain, including design of the stretcher and compressor sub-systems	Submission of a technical report detailing the solution for achieving high fidelity short pulses – addressing one of the critical issues for design and operation of the HAPLS beamline	31-Jan-2014	1	\$ 7,220,000	28-Feb-2014
		Acceptance Certificate				
D1B	Critical progress review of the Procurement Plan for major components and sub-systems for HAPLS. Update to the Project Execution Plan (PEP)	Submission of a technical progress report on the status of the procurement plan – noting status of orders and vendor response, along with impacts on the PEP and mitigation action undertaken	30-Apr-2014	1	\$ 6,270,000	31-May-2014
		Acceptance Certificate				

Deliverable	Description	To be documented by	Completion Date	Phase	Payment (to fund follow-on work)	Proposed Payment Date
D2	Operational qualification of the short pulse front end, updated technical design of the beamline	Submission of a technical progress report on assembly of the HAPLS front end up to the broadband preamplifier(s), including results of the validation tests and their analysis with respect to the design requirements	31-Oct-2014	1	\$ 5,085,000	30-Nov-2014
		Acceptance Certificate				
D3	Assembly of key subsystems of the pump laser	Submission of a technical progress report on acquisition, fabrication and assembly of key components and/or subsystems of the HAPLS. The report shall also include the assembly and the validation of alignment of the optical transport system for pumping the broadband power amplifier	30-Apr-2015	1	\$ 5,470,000	31-May-2015
		Acceptance Certificate				
PHASE 1 REPORT	Summary of Phase 1 achievements	Submission of technical progress report, with detailed inventory of purchased and commissioned equipment.	31-Aug-2015	1	Nil	N/A
		Acceptance Certificate				

Deliverable	Description	To be documented by	Completion Date	Phase	Payment (to fund follow-on work)	Proposed Payment Date
	ETOP Initiation	Amendment No. 1 to Agreement	11-Sep-2015	1	\$1,734,000	18-Sep-2015
D4	Acceptance test of the HAPLS pump laser including PLRCs	Demonstration to CLIENT and submission of a technical report that the HAPLS pump laser meets the specific Pump Laser Readiness Criteria. Submission of a confirmatory technical report recording the measured specifications.	31-Jan-2016	2	\$ 2,367,500	31-Jan-2016
		Demonstration Acceptance Protocol				
	ETOP midterm review	Submission of a Progress report including a description of ETOP activities completed to date.	31-Jan-2016	2	\$2,000,000	28-Feb-2016
		Acceptance Certificate				
D5	Readiness of the IOP-provided PAD diagnostic with integrated controls and control system for performance testing of the HAPLS short pulse beamline	LLNS acceptance of IOP-provided PAD diagnostic with integrated controls and control system	30-Apr-2016	2	Nil	N/A
		Acceptance Certificate				
D4A	Review ETOP training status of IOP staff on pump laser operations	Submission of a Training Status Report regarding the status of the extended training and operations period on the HAPLS pump laser system, submission of a list of consumed operational and construction spare parts during ETOP, and initial operations assessment	31-Jul-2016	2	Nil	N/A
		Acceptance Certificate				

Deliverable	Description	To be documented by	Completion Date	Phase	Payment (to fund follow-on work)	Proposed Payment Date
D6	Acceptance test of the HAPLS to PCC	Demonstration to CLIENT and submission of a technical report confirming that the completed HAPLS meets the Project Completion Criteria and is consistent with the result of D4.	31-Dec-2016	2	\$ 665,000	31-Jan-2017
		Demonstration Acceptance Protocol				
D7	Packaging and shipment of the HAPLS to the ELI-Beamlines facility (contingent on ELI-Beamlines facility readiness) (Incoterms 2010 DAP condition shall apply)	Receipt of HAPLS at the ELI-Beamlines facility	31-Mar-2017	2	\$ 380,000	30-Apr-2017
		Acceptance Certificate				
D7A	Review training status of IOP staff	Submission of a report providing details of the status of IOP staff training on all aspects of the HAPLS system design, commissioning, operation, maintenance, and integration into the ELI-Beamlines facility	30-Jun-2017	2	\$ 380,000	31-Jul-2017
		Acceptance Certificate				
	Update of the ETOP training report	Submission of an updated ETOP training report including a description of ETOP activities.	30-Jun-2017	2	Nil	N/A
		Acceptance Certificate				

Deliverable	Description	To be documented by	Completion Date	Phase	Payment (to fund follow-on work)	Proposed Payment Date
D8	Re-assembly and commissioning of the delivered HAPLS at the ELI-Beamlines facility and demonstration of PCCs and PLCCs	Demonstration at the CLIENT's site and submission of a technical report confirming that the completed HAPLS is consistent with the results of D6 and meets the Project Completion Criteria, including the pump lasers achievement of Pump Laser Completion Criteria. Based on achieved performance, LLNS will submit recommendations for operation of the HAPLS at full Performance Requirements.	31-Dec-2017	2	\$ 75,000	31-Dec-2017
		Demonstration Acceptance Protocol				

7. ADDITIONAL ROLES AND RESPONSIBILITIES

ETOP team

The ETOP team will consist of both LLNS and the CLIENT staff members.

LLNS ETOP team

LLNS staff will participate in and provide training on:

- *Installation, Operational, and Performance Qualification processes in the context of performance ramping*
- *Key Maintenance Procedures including:*
 - *Clean optics installations and exchanges*
 - *Helium cooling system cleanliness verification process*
- *Establishment of installation, operation and performance qualification processes in the context of performance ramping*
- *Work authorization process for safe laser operations*
- *Laser system shot operations for senior staff identified as future L3-HAPLS shot director*

Level of Effort for LLNS

The LLNS ETOP team will consist of LLNS expert staff members who will be participate in ETOP for six consecutive months at LLNL. The LLNS ETOP team will include HAPLS subject matter experts in the following areas: Project Management, Systems Engineering, Electrical and Controls Engineering, Mechanical Engineering, Optical and Laser Engineering with skills, knowledge and abilities consistent with the “Dedicated Team Presentation” and technical experience matrix documented in LLNS response to the Tender Documentation for acquisition of the “High repetition rate advanced petawatt laser beam line.”

Client ETOP team

Parties agreed that Appendix C of the Agreement (“CLIENT ROLES AND RESPONSIBILITIES”) shall be extended by the following new wording, (that shall apply in addition to the existing wording in Appendix C and shall not replace that wording):

Background

The ETOP will provide training opportunities for four (4) CLIENT staff members (FTE) consisting of Laser Scientists, Control Systems Engineers, and Laser and Electro Optics Technicians as described below. This is in addition to the existing Integrated Commissioning Team (ICT) as defined in the Agreement. LLNS will supply on-the-job training based on existing Concept of Operations (ConOps) to CLIENT staff. CLIENT staff will be responsible for receiving the instruction and documenting in an appropriate format ELI-Beamlines operational and maintenance procedures with the necessary detail to be used for operations in the ELI-Beamlines facility.

IOP Work Package

The **CLIENT ETOP** team will participate in and receive training on:

- *Installation, Operational, and Performance Qualification processes in the context of performance ramping*
- *Key Maintenance Procedures including:*
 - *Clean optics installations and exchanges*
 - *Helium cooling system cleanliness verification process*
- *Establishment of installation, operation and performance qualification processes in the context of performance ramping*
- *Work authorization process for safe laser operations*
- *Laser system shot operations for senior staff identified as future L3-HAPLS shot director*
- *Re-commissioning of the HAPLS pump laser system at CLIENT's facility for a minimum of 6 month in conjunction with the ICT*

Level of Effort for CLIENT

The **CLIENT ETOP** team will consist of four (4) expert staff members who will be present during ETOP for six consecutive months at LLNL and during re-commissioning of the HAPLS pump laser for six months at CLIENT's facility. The **CLIENT ETOP** team will include Senior PhD Laser Scientist, Junior PhD Laser Scientist, Senior Control Engineer, and Senior Laser Electro Optical Technician. All members of this team shall have extensive background knowledge and hands-on experience in the respective fields. Every individual member of this team will be designated by mutual consensus between the **CLIENT** and **LLNS**. The following table lists the four ETOP **CLIENT** staff members and describes their anticipated skills, knowledge, and abilities:

Position	Min FTE	Education	Expertise
<i>Senior PhD Laser Scientist</i>	1	<i>PhD Laser technology</i>	<p><i>Minimum 6 years substantial hands-on expertise in:</i></p> <ul style="list-style-type: none"> • <i>Strong background and knowledge in laser science and technology, specifically in laser pulse generation, amplification, gain media, and laser pulse propagation</i> • <i>Establishment of functional requirements and Concept of Operation, risk management, verification and validation methodology</i> • <i>High energy laser research and development,</i> • <i>Nanosecond laser pulse characterization: Physics and technology of laser diagnostics (pulse shape measurement, near and far field measurement, wave front measurement, energy and power measurement, beam sampling techniques, calibration methods)</i> • <i>Review and revision of laser operation procedures and manuals</i> • <i>Laser safety</i>
<i>Junior Laser Scientist or laser / optical engineer</i>	1	<i>PhD Laser technology or MS laser / optical engineering</i>	<p><i>Minimum 4 years hands-on expertise in:</i></p> <ul style="list-style-type: none"> • <i>Strong background and knowledge in laser science and technology, specifically in laser pulse generation, amplification, gain media, and laser pulse propagation</i> • <i>Nanosecond laser pulse characterization: Physics and technology of laser diagnostics (pulse shape measurement, near and far field measurement, wave front measurement, energy and power measurement, beam sampling techniques, calibration methods)</i> • <i>Strong background in function and operation of general laser components (laser amplifier, pump cavities, Pockels cells, spatial filters, front-ends, ...)</i> • <i>Development of laser operation procedures and manuals</i> • <i>Laser safety</i>

Position	Min FTE	Education	Expertise
<i>Laser Electro Optical Technician (LEOT)</i>	<i>1</i>	<i>BS or equivalent</i>	<p><i>Minimum 4 years substantial hands-on expertise in:</i></p> <ul style="list-style-type: none"> • <i>Operation of energetic, high repetition rate laser systems ($\geq 2J$, $\geq 10Hz$)</i> • <i>Handling, preparation, cleaning of delicate optics and optical materials</i> • <i>Assembly of opto-mechanical components and systems</i> • <i>Alignment techniques and precision optical alignment of optical systems</i> • <i>General knowledge and understanding principle of operation for general laser components (laser amplifier, pump cavities, spatial filters, diffraction gratings, front-ends, ...)</i> • <i>Development of laser operation procedures</i> • <i>Laser safety</i>
<i>Senior Controls Engineer</i>	<i>1</i>	<i>MS or equivalent</i>	<p><i>Minimum 3 years substantial hands-on expertise in:</i></p> <ul style="list-style-type: none"> • <i>Labview programming experience (preferable certified):</i> <ul style="list-style-type: none"> ○ <i>Realtime</i> ○ <i>FPGA</i> ○ <i>OPC interfacing</i> ○ <i>Vision and motion control</i> ○ <i>VI level documentation</i> • <i>Labview Code design including formal review, source code control, and issue tracking</i> • <i>Labview driver development, equipment interfacing and controlling</i> • <i>Control system architecture</i> • <i>Facility interface</i>

8. FINAL PROVISIONS

8.1 This Amendment comes into force and effects on the date of conclusion hereof.

8.2 No other modifications, alterations, or interpretations to the Agreement are intended or implied by this Amendment. All existing clauses of the aforementioned Agreement, including Appendices, remain in effect, unless expressly modified through this Amendment.

8.3 This Amendment has been executed in four counterparts whereas each Party receives two counterparts.



FYZIKÁLNÍ ÚSTAV AV ČR, V. V. I. (Institute of Physics at the Academy of Sciences of the Czech Republic) [CLIENT]	LAWRENCE LIVERMORE NATIONAL SECURITY, LLC [LLNS]
By _____	By _____
Name <u>prof. JAN ŘÍDKA, DASC</u>	Name <u>William Goldstein</u>
Title <u>Director</u>	Title <u>President</u>
Date <u>24/9/2015</u>	Date <u>Sept. 8, 2015</u>