The report for the **Exchange Visit** in the frameworks of the
EFS Program "Super-intense laser-matter interactions" (SILMI) of

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The purpose of the visit

The research objectives of the proposal concern the study of high-intensity laser-matter interaction and related topics.

The project concentrated on the understanding of the physics of atoms, molecules, clusters, solids and plasmas interacting with high-intensity coherent light. In this common goal we have specified some actual task, in particular the study of matter (in particular, carbon) in extreme conditions, in particular by the simulation of the processes, having place in multi-layers targets. There was supposed a systematical investigation of the dependence of experimental results from main laser source and target parameters. So, we had a multidisciplinary project with various applications from astrophysics to applied engineering, united by the experimental and numerical investigations of warm dense matter, which conditions are obtaining by high power laser.

There was intended a team work with French and foreign colleagues, which included and the development of experimental data both the work with computer simulations.

Description of the work carried out during the visit

1. Carbon EOS

The equation of state (EOS) of carbon at high pressures is a subject of interest for many branches of science, including astrophysics (for the developing of realistic models of planets and stars, including the explanation of the observed large magnetic fields of giant planets), material science, applied engineering, etc. Very important point thereupon is the existence of metallic phase of a liquid carbon [1-4]. We had concentrated on 2 objects: (i) the investigation of the reflectivity changes of high-pressures and high-temperatures carbon, compressed by means of laser-induced shocks, as a possible signature of phase transition, in particular the metallization in liquid phases on a base of experimental data obtained recently in Institute of Laser Engineering (ILE), Osaka University, and (ii) numerical analysis of the experimental impedance mismatch technique for the carbon EOS measurements with application of high-power laser pulses with Gaussian temporal profile of different durations (FWHM).

1.1. Carbon reflectivity in the Mb regime

The main aim of the experiments was the investigation of the reflectivity changes of high-pressures and high-temperatures carbon, compressed by means of laser-induced shocks, as a possible signature of phase transition, in particular the metallization in liquid phases.

Specially designed targets were employed to explore the phase diagram. A layer of porous carbon was deposited on a transparent substrate, the main laser beam hits the carbon and the rear surface is imaged by the diagnostics. This design has three advantages: (i) the substrate prevents the carbon from releasing into vacuum after shock breakout, keeping the density high; (ii) it reflects the shock wave back due to its higher density, raising the pressure; (iii) the interface between carbon and substrate is accessible to the optical diagnostics. Two distinct series of targets have been produced. In the first series, disks of fused silica (SiO_2 – 4 mm diameter and 100 μm thickness) were employed as substrates and the carbon layer was deposited with supersonic cluster beam deposition (SCBD) technique. The second series of targets was made with spray coating technique on lithium fluoride substrates of square shape (3x3 mm and 300 μm thickness). Carbon density was 0.5 g⁄cm^3 and thickness ranged between 5 and 50 μm in both series. The porous carbon was used to access thermodynamical states lying outside the main Hugoniot curve of ordinary graphite or diamond [5,6].

Shock dynamics has been studied with the code MULTI (multigroup radiation transport in multilayer foils) [7]. Simulations have been used: (i) to predict the experimental conditions, in order to optimize the target design, (ii) to suggest the suitable laser energy shot by shot, according to the actual target characteristics during the experiment, and, the most important (iii) for the interpretation of the experimental data. We have used the SESAME equation of state for substrates [8] and porous carbon EOS calculated by MPQEOS [9] with a reduced initial density. [10] The actual time profile of the main laser was included in the simulations.

The discussed experimental results were obtained in two series of experiments performed with the GEKKO/HIPER system at the Institute of Laser Engineering (ILE), Osaka University. The HIPER facility [11] is an irradiation system on the GEKKO XII (GXII) Nd glass laser system at ILE [12]. The facility provided one-dimensional compression by smoothed laser beams with short wavelength and high intensity. The laser pulse had a wavelength of 527 nm (second harmonic, 2ω-beam), wais approximately square in time with a full width at half maximum (FWHM) of 2.4 ns and a rise and fall time of 100 ps. The focal-spot diameter was typically 1 mm. The total energy of the laser pulse was measured with a calibrated calorimeter. Four diagnostics based on streak cameras with sub-nanosecond time resolution were used at the same time. Two of them collect the self-emission giving space-resolved and frequency-resolved emission intensity (a Streaked Optical Pyrometer – SOP – and a Streaked Spectrograph Optical Pyrometer – SSOP – respectively) giving information on shock planarity, time of shock breakout, preheating and emission time profile, while two VISARs (Velocity Interferometer System for Any Reflector) recorded the speed and the reflectivity of the rear side of the target.

The temperature was determined observing the self-emission of the target, assumed following the Planck distribution, either by wavelength integrated and wavelength resolved images from SOP and SSOP diagnostics. In the first case, the temperature is inferred from the power emitted at 450 nm (brightness temperature), while in the second case it is determined fitting the spectrum to find the Planck curve that realizes the best accordance (spectral temperature).

Pressure was obtained indirectly, through hydrodynamical relationships such as Rankine-Hugoniot equations, from the knowledge of the fluid velocity in the substrate, measured by Visars or by means of Multi simulations. In the first case only the pressure at breakout can be inferred, while in the second case the whole time history, from the shock breakout till complete relaxation, is available.

A serious problem to observe the reflectivity rise in carbon is due to the changes in the substrate becoming either absorbent or reflected. That is why targets with fused silica substrates did not provide useful data. The pressure in this case exceeded the threshold value of 1 Mb for SiO_2 metallization [13].

Finally, for targets with lithium fluoride substrates the threshold value is ≈3 Mb [14], and there is a narrow window available for the observation of the reflectivity rise in carbon. Finally an evidence of a reflective phase in carbon was observed at pressure of 2.6±0.4 Mb and temperature of 14, 000 ± 2, 000 K.

1.2. Influence of a laser profile in impedance mismatch techniques

One well-known experimental method is based on the impedance mismatch technique and consists in measuring the shock velocity of two different materials (test and reference) at the same time. The shock-wave measurements are realized by the streak-camera recording of the emission from the rear side of the shocked target. [5,16] Using rear-face time-resolved imaging we can experimentally determine times of the shock arrival for each part of target, and afterward the velocity of the shock propagating through the two steps D_{Al} and D_C. Then if the EOS of the base material (aluminum) is known, we can calculate an EOS point for the test material (carbon).

Now we had continued our recent works on this topic [6,10] concentrating on the effect of high-power pulse temporal profile. Indeed, an ideal shock can be produced by the mean of high-power flat-top laser pulse. The analysis of the effect of real temporal profile of high-power laser in experiments is therefore an important question. Thereby the aim of present work was to realize set of 1D simulations for Gaussian pulses with different durations and to analyze the effect on calculation of shock velocities.

For the realization of simulations we have used the hydrocode MULTI [7]. We have used the SESAME equation of state for aluminium [8] and porous carbon EOS calculated by MPQEOS [9] with a reduced initial density (1.6 g/cm^3). [10] For each simulation we have realised 3 different 1D sub-simulations for 3 parts of target: (i) Al: 8 μm), (ii) Al: 16.5 μm), and (iii) Al-C: 11.5 μm + 9.5 μm) correspondent to Al base, Al step and carbon step. For each simulation we found the shock arrival time to rear target surface, as in real experiment. [11]

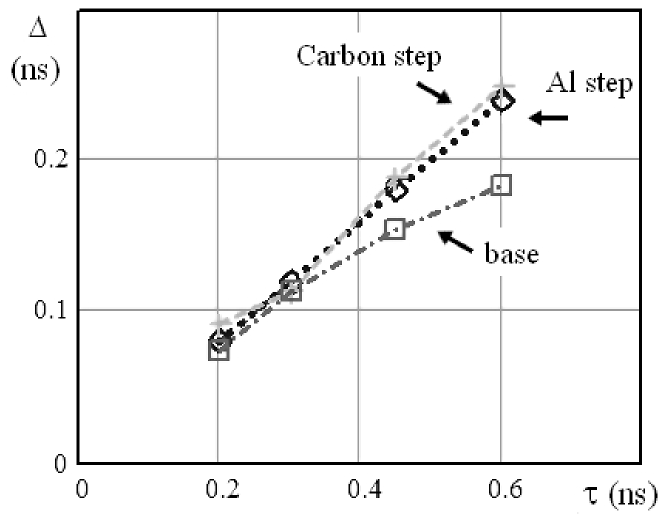

Figure 1. The dependences of difference between shock arrivals for Gaussian pulses and reference one (flat-top) from τ for all three parts of target: base (Al: 8 μm), (ii) Al step (Al: 16.5 μm), and (iii) carbon step (Al-C: 11.5 μm + 9.5 μm). All dependences are very close each other before τ=300 ps.

Fig. 1 presents the dependence of the difference between shock arrivals for Gaussian pulses and reference one (flat-top) as a function of duration τ for the three parts of target: (i) base (Al: 8 μm), (ii) Al step (Al: 16.5 μm), and (iii) carbon step (Al-C: 11.5 μm + 9.5 μm) – Δ_{base}, Δ_{Al} and Δ_C correspondently. Fig. 3 shows that such differences may be depended on duration of Gaussian pulse. However if the rise time of the Gaussian pulse is small ($\tau < 300$ ps from fig. 2b) the difference is the same for base and both steps. This implies that the shock velocities calculation is not effected. Physically it means that for $\tau < 300$ ps the shock becomes stationary both in the base (8 μm thick) and in the steps. In this case the effect of the Gaussian pulses is just to shift all breakout times by the same amount. We notice that these spatial profiles are not exactly same, but the same times of shock breakout are enough for a correct calculation of shock velocities. Instead for $\tau > 300$ ps the shock has the time to become stationary in the steps (the difference is indeed the same for two steps) but not for base. In this case the shock velocity the shock velocity cannot to be calculated as: $D = \left(t_{step} - t_{base}\right)/\,\text{thickness}$.

2. Shock pressure amplification in sandwich target

The current state-of-the-art condensed matter models based on density functional theories, employing generalized gradient approximation for exchange and correlation potentials, have demonstrated their capabilities to predict phase transitions that, in turn, have been confirmed by experiments [17]. It is also well known that different variants of Thomas–Fermi–Dirac theory can be used to predict EOS data beyond 100 Mbar pressures. [18] However, the region of pressures from 10 to 100 Mbar is still not very well understood. This is mainly due to lack of sufficient experimental data in this region. Theoretical simulations in this region have been also extremely difficult because of the complications arising from pressure and thermal ionization effects strongly controlled by atomic shell structure effects, which affect many physical properties along the shock Hugoniots.

The intensities of the order of 10^{14} W/cm^2, which can be obtained quite easily, allows obtaining pressures of the order of 10 Mbar. [19-21] It is important because of at high laser intensities collective laser absorption processes dominate generating hot electrons and hard X-rays, leading to preheat of the target under investigation [22] and this causes difficulty in creating high level compression. From other hand, one of the general limitations of shock-wave compression is that when shocks compress it the target material is heated up simultaneously, so pressure and temperature are not independent variables. Thereby only data on the Hugoniot curve of the material can be obtained. To overcome this limitation, it is possible to change the initial conditions (for example to use the porous target with reduced density). However, in this case we can obtain only lower pressures for the same temperature than in normal density Hugoniot shock adiabat. To obtain higher pressures with lower temperatures by the application of impedance mismatch effect [5,15,23,24] we consider constructing 3-layers structure, where a low shock impendence material sandwiched between two high shock impendence material.

Targets were studied using 2D radiation hydrocode MULTI [25]. This code uses multi group method of radiation transport coupled with Lagrangian hydrodynamics based on a fully implicit numerical scheme. Material properties like EOS, Planck and Rosseland opacities are used in a tabular form and are generated externally. Laser absorption calculated by inverse bremsstrahlung [26]. Anomalous absorption mechanism was mocked up by a dump at the critical density. We have used the SESAME equation of state and the opacities taken from [27, 28].

We've realized some simulations of pressure enhancement in 3-layered target gold-aluminium-gold, irradiated by a pulsed Nd:Glass (λ =1.064 μm) laser. The thickness of the first target layer from the high-impedance material was estimated to be not so small that shock can achieve a stationary regime. The layer from low-impedance material considered in few times smaller to realize for a relatively large time (hundreds picoseconds) a nearly constant high pressure regime. To reduce 2D effects, the focal spot radius was chosen 250 μm (super-Gaussian profile, 150 μm flat-top), i.e. much larger than target thickness.

For the simulation, results of which are discussed in detail, we have used following parameters: the size of gold-aluminium-gold target, 8 μm - 1.7 μm - 8 μm. It is also considered a trapezoidal temporal profile with rise and fall time of 100 ps and a flat top duration of 1000 ps, and the absorbed laser irradiation in flat-top region of I_L=10^{14} W/cm^2. The laser strikes the first gold layer, and generates a shock wave with pressure P_1, which can be calculated by $P = 11.6\left(I/10^{14}\right)^{3/4}\lambda^{-1/4}\left(A/2Z\right)^{7/16}\left(Z^* t/3.5\right)^{-1/8}$, where I is the laser intensity on target in W/cm^2, λ is the laser wavelength in μm, and A, Z, and Z^* , respectively, are the mass number, the atomic number, and the effective ionization degree of the target, and the time t is in ns.

The laser strikes the first gold layer, and generates a shock wave with pressure P_1 in agreement with Eq. (1). When the shock arrives at the first Au-Al interface (fig. 2b), one shock-wave is transmitted to low-impedance aluminium, and a rarefaction wave is reflected in the high-impedance gold. Both waves have the same pressure P_2 (P_2<P_1), which can be calculated in coordinates (pressure-mass velocity) as a point of intersection of the shock polar for aluminium with the isentropic release for gold, started from the state with pressure P_1 on the Au shock polar.

The ratio of impedances in the next Al-Au border is opposite the first one, therefore after the reflection of the shock from this interface (fig. 2c) two shock waves are generated, one is transmitted to the second gold layer and the other reflected into aluminium. Again both waves have the same pressure P_3, which can be calculated as a point of intersection of Au shock polar $P(u)$ with the adiabat of the secondary compression of aluminium starting from the point P_2 on the Al shock polar. The slope of the isentropic release for gold is evidently higher than the slope of re-shock for aluminium started from the same point of aluminium Hugoniot polar, so $P_2<P_3<P_1$. Calculation by the mirror reflection of the principal Hugoniot in the P-u plane (with EOSs for Al and Au taken from SESAM) for P_1 = 14 Mb gives P_2 = 4.5 Mb and P_3 = 8.9 Mb. It is important to note, the assumption of mirror reflection is also not precise [29]. So, real pressure P_3 is a little higher than it is predicted by (4) and closer to P_1. When reflected from the second Al-Au border shock reaches the first Au-Al interface, we have different situation than it was considered before. Matter is already compressed, and the state for Al layer already is not follows to initial Hugoniot polar, and the secondary shock amplification is not significant. Finally, as a result of multiple reflections the pressure in aluminium layer became to stabilise for few hundreds picoseconds close to the pressure in the gold for stationary shock (about 13 Mb in our case), and in the same time the temperature in aluminium remain about 4 eV, that corresponds to the pressure ~7.5 Mb at Al Hugoniot shock adiabat. Such *PT*-conditions are maintained for a long time (few hundreds picoseconds).

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Description of the main results obtained

For a porous carbon in high pressure we have obtained the following results. On a base of recent experimental data (ILE): (i) the limits of the carbon-on-transparent substrate design have been explored, (ii) the whole experimental scheme proof has been obtained, and, (iii) the increase of reflectivity in carbon was observed. On a base of numerical analysis of impedance mismatch techniques we can conclude that the adequate experiment interpretation for the considered laser intensity (order 10^{14} W/cm^2) and target design there is strongly necessary to have Gaussian pulse with FWHM duration not longer 300 ps (or super-Gaussian one with this beginning Gaussian component).

The numerical analysis of a shock pressure amplification in sandwich target gives that high shock pressures (about 10 Mb) with relative small temperatures can be generated and hold during hundreds picoseconds in 3-layered targets using quite modest laser intensity, employing impedance mismatch technique. So it opens the way to obtain and investigate experimental *PT*-conditions out of Hugoniot shock adiabat.

Future collaboration with host institution

This visit was a step of a longtime collaboration between visitor and the host group leader started in 2004. We are going to continue our joint work in area of investigation of high-power laser-matter interaction and beyond decrypted over results we have started some joint works.

Projected publications/articles resulting or to result from the grant (ESF must be acknowledged in publications resulting from the grantee’s work in relation with the grant).

For my two visits (previous (2783) and this (3964) ones) in framework of SILMI program there were published:

1. A. Aliverdiev, D. Batani, R. Dezulian and T. Vinci, Carbon equation of state at high pressure: the role of the radiative transport in the impedance mismatch diagnostics // Nukleonika 2011, **56**(2), pp. 165-169
2. A.Aliverdiev, High-power laser-matter interaction: comparison of MULTI hydro-simulations with experiment // CD Proc. of International School “Towards Fusion Energy”, Kudowa Zdroj, Poland, June 14-18, 2011, OP. 31 (68 pages)
3. A.Aliverdiev, A.Amirova, D.Batani, R. Dezulian, M. Khan, and H.C. Pant, Some Features of Intense Laser Shock Propagation in Multi-Layers Structured Target // CD Proc. of PLASMA-2011, International Conference on Research and Applications of Plasmas Warsaw, Poland, September 12 – 16, 2011, P-4.1 (4 pages)
4. A.Aliverdiev, High-power laser-matter interaction: comparison of MULTI hydro-simulations with experiment // Collection of abstracts of International School “Towards Fusion Energy”, Kudowa Zdroj, Poland, June 14-18, 2011, OP. 31, pp. 23-24
5. A.Aliverdiev, A.Amirova, D.Batani, R. Dezulian, M. Khan, and H.C. Pant, Some Features of Intense Laser Shock Propagation in Multi-Layers Structured Target // PLASMA-2011, International Conference on Research and Applications of Plasmas Warsaw, Poland, September 12 – 16, 2011, P-4.1
6. А. Аливердиев, Взаимодействие мощного лазерного излучения с веществом: сравнение численного моделирования с экспериментом // Программа IV Школы молодых ученых «Актуальные проблемы освоения возобновляемых энергоресурсов» (Махачкала, сентябрь 2011 г.), стр. 23. (in Russian)

7. А.А. Аливердиев, А.А. Амирова, Д.Д. Батани, Р. Дедзулиан, Х.Ч. Пант, М. Хан, Некоторые вопросы исследования теплофизических свойств вещества при экстремально высоких давлениях и температурах // Материалы Восьмой Международной теплофизической школы 8-13 октября 2012 г., Таджикистан, С. 59-64 (in Russian)
8. А.А. Аливердиев, Вопросы термоядерной энергетики // Материалы V Школы молодых ученых «Актуальные проблемы освоения возобновляемых энергоресурсов» (Махачкала, 9 по 12 октября 2012), ISBN 978-5-4242-0025-0, стр. 150-157. (in Russian)
9. А.А. Аливердиев, Д.Д. Батани, Р. Дедзулиан, Т. Винчи, Об уравнении состояния углерода при высоких давлениях // Материалы VII Всероссийской конференции по физической электронике (ФЭ-2012, Махачкала, 17-21 октября 2012), С. 186-188. (in Russian)
10. А.А. Аливердиев, А.А. Амирова, Д.Д. Батани, Р. Дедзулиан, Х.Ч. Пант, М. Хан, О создании области высокого давления в многослойной композитной мишени // Материалы VII Всероссийской конференции по физической электронике (ФЭ-2012, Махачкала, 17-21 октября 2012), С. 184-186. (in Russian)
11. Aliverdiev A.A., Amirova A.A., Batani D., Dezulian R., Khan M., Pant H.C. Some features of intense laser driven shock propagation in structured target, Book of the abstracts of oral and poster contributions to the XXVIII International Conference on Interaction of Intense Energy Fluxes with Matter (March 1-6, 2013, Elbrus, Kabardino-Balkaria, Russia), P. 22-23.

Now there are also submitted for publication 1 paper for peer-reviewed journal (S. Paleari, D.Batani, T.Vinci, R.Benocci, K.Shigemori, Y.Hironaka, T. Kadono, A. Shiroshita, P. Piseri, S. Bellucci, A. Mangione, and A. Aliverdiev, A new target design for laser shock-compression studies of carbon reflectivity in the megabar regime // European Physical Journal) and 5 conference presentations.

At least 2 papers for peer-reviewed journals are in preparation.

Other comments

Because of the delays with documents preparation we shifted the start of visit to 13 January. The minimal time of transport connection between Makhachkala (home-town of a visitor) and Bordeaux is 1-3 days. So, from door-to door, the visit was started **11 January 2013** and finished **16 March 2003**. But duration of the visit in Bordeaux is from **14 January 2013** to **12 March 2013**.

There are presented the tickets:

Makhachkala – Moscow train ticket, - 4768.6 Russian Roubles (119.37 Euro)
Moscow – Paris air-ticket, 219 Euro
Paris – Bordeaux train ticket, 45 Euro
Bordeaux – Paris train ticket, 45 Euro
Paris – Moscow air-ticket, 214.54/2=107.27 Euro

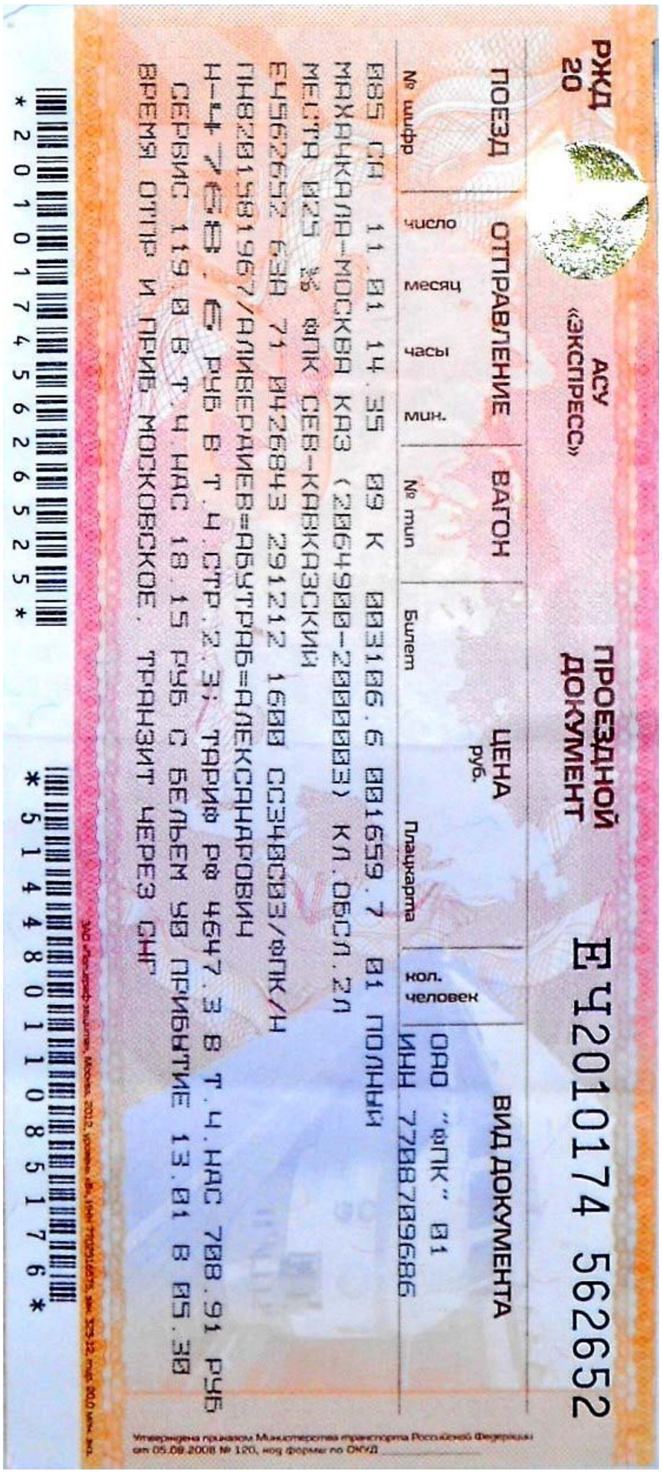
For the ticket bought in Russian Roubles there was used Forex course from 19.03.2013, 17.54, 39.947 Russian Roubles= 1 Euro.

To use a group discount for the ticket Paris – Moscow there was bought group tickets (2 persons). So, for this ticket there is presented for payment only half of a total price (1 person, 107.27 Euro).

The total travel cost of presented tickets is **535.34 Euro** (more than **500 Euro**, which is a maximal amount). The Moscow – Makhachkala train ticket will be covered from other sources, and is not presented. There was bought only economic tickets from low-cost companies. The copies of tickets are attached.

Appendix. Copies of travel documents

Makhachkala–Moscow train ticket (all fees and bedding included) **4768.6 Russian Roubles** (**119.37 Euro**).



Moscow – Paris air-ticket, **219 Euro**

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Тип счёта-фактуры/Invoice type	Номер/Number	Дата/Date
Απόδειξη Πώλησης Εισιτηρίων (ΠΟΛ.1102/93) / Invoice	B-1008220	29/12/2012

Данные клиента/Client's Data	
Имя и Фамилия/Name :	IGR DSC RAS
Профессия/Profession :	scientist
Улица/Street :	pr. Shamilya 39A, 367030
Город/City :	Makhachkala
Страна/Country :	RU
Телефон/Telephone :	
E-mail :	
ИНН/VAT Number	0561039420
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Информация/Information	
Оплата/Payment	CC TO CARRIER EFG
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Страница/Page	1 / 1

Номер билета Ticket Number	Имя и Фамилия пассажира Passenger Name / Перевозчик-Маршрут Carrier(airline)-Route	Отправление Departure / Возвращение Return	Тариф Fare Value	Таксы Taxes	Сборы Service Fee	Скидка Discount	Общая стоимость Total Value
670-2584485876	ALIVERDIEV ABUTRAB MR UN VKO-ORY	13/01/2013	158.00	61.00	0.00	0.00	219.00

Электронная цифровая подпись налогового принтера/Digital Signature Tax Printer	Итого Payable		
		€	**219.00**
DE5F5D810BD667F5F1AEED5C581A9CD028F28F35 1317 00426325 1212291018 EPX10020386		RUB	**8,786.68**

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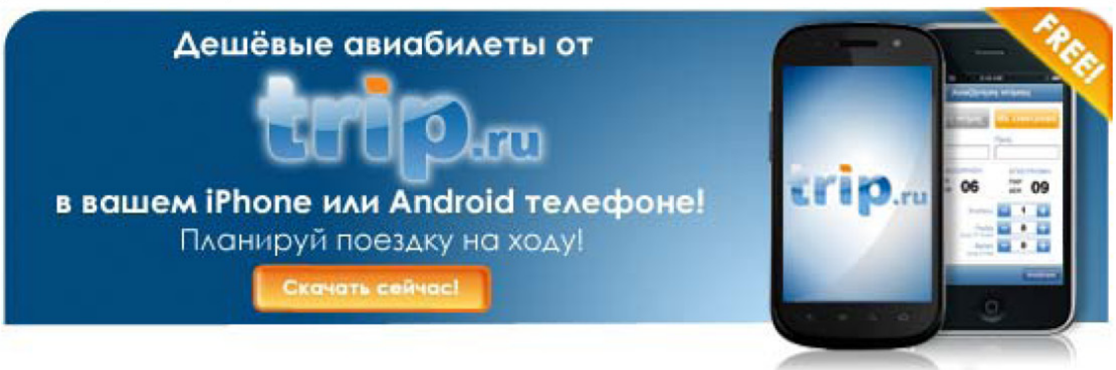

Paris – Moscow air-ticket, 214.54/2=**107.27 Euro**

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1 click 4 all flights!

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DESCRIPTION

Flight: Air Berlin ORY(FR) - DME(RU) departure date 13/03/2013
Reservation id: 2XO5ZQ
Passengers: Abutrab Aliverdiev, Kamilla Aliverdieva
Bravo Compensation
Agency commissions and services

VAT CODE	DESCRIPTION	VAT %	VAT BASE	VAT
FR_NI262	ESC. IVA ART.262, II, 8°CGI	0	24,30	0,00
FR_NI267	VAT EXEMPT ART. 267, II, 2°CGI	0	190,24	0,00
	TOTAL		**214,54**	**0,00**

TOTAL INVOICE	EURO	214,54

BravoNext SA
VAT N. FR 44 523 387 405
C/O Tax Representative LowendalMasai SA
CH6830 Chiasso - Vicolo De' Calvi 2

Paris - Moscow air-ticket, boarding pass

Moscow – Paris air-ticket, boarding pass

Paris – Bordeaux train ticket, **45 Euro**

BENEFITS OF THE E-TICKET

Easy: book and pay your journey when and where you wish: on the web, in French train stations, by phone on 00 33 892 35 35 35* or at approved travel agencies.
Fast: print your e-ticket confirmation and simply take your seat on the train.
Practical: Your journey can easily be cancelled at your convenience on-line, by phone on 00 33 892 35 35 35* or at French stations.
***Calls are charged at international rates plus your operator's surcharge, where applicable.**

The e-ticket service is available for most SNCF fares and some destinations on the TGV, INTERCITÉS and TER routes.
As of 31 March 2012, **the "Garantie Voyage™" travel guarantee** applies to all journeys covered by the Voyageurs SNCF fare for travel in France on TGV and INTERCITÉS trains. Special terms and conditions apply. These are available at French stations, SNCF-approved travel agencies and also at sncf.com, intercites.sncf.com and tgv.com.
SNCF wishes you a pleasant journey!

YOUR E-TICKET CONFIRMATION

Hello ABUTRAB ALIVERDIEV,
here are the details of your journey. SNCF wishes you a pleasant journey !

Departure / Arrival	Date / Time	TGV 8449
PARIS MONTPARNASSE 1 ET 2	14/01 at 19:28	COACH 16 - SEAT 052 2. CLASS DUAL SIDE BY SIDE OFF PEAK
BORDEAUX SAINT JEAN	14/01 at 22:42	

PR11

Loisir réduit - Billet échangeable et remboursable avec retenue avant départ et non échangeable et non remboursable après départ.

E-TICKET CONDITIONS OF USE

The e-ticket is bound by the terms and conditions of the SNCF Travellers Fares and the terms and conditions of sale of your e-ticket distributor, which you accepted at the time of purchase:

· **e-tickets are issued in the name of the traveller and are non-transferable.**

· They are valid only for the train, date, class and journey selected. You will need another e-ticket in order to take another train*. The e-ticket confirmation must be printed out on white A4 paper, without changing print size. Good print quality is required. In the event of an incident, poor quality print or loss of your e-ticket, you must print your e-ticket confirmation again.

SNCF cannot be held liable:

· for anomalies arising at the time of ordering, processing or printing the e-ticket confirmation insofar as the anomaly has not been caused intentionally by the company or as a result of its negligence;

· in the event of illicit use of the e-ticket.

** If permitted under the terms and conditions of the fare selected.*

This e-ticket confirmation:
· does not require to be punched,
· must be shown at the time of ticket inspection or boarding the train.

To travel, you must have valid photo ID (identity card, passport or residence permit) which the ticket inspector will ask you to show.

To ensure the prompt departure of TGV and INTERCITÉS, all passengers must be aboard at the latest 2 minutes prior to the departure time, beyond which access to the train cannot be guaranteed.

We remind you that labelling luggage with your full name is mandatory.

Fold along the lines

YOUR REFERENCES

PARIS MONTPARNASSE 1 ET 2 > BORDEAUX SAINT JEAN	45,00 EUR

REFERENCE NUMBER: TIIQJE
Customer reference number: 0029090169090029169
No. e-ticket: 675787943

Surname: ALIVERDIEV
First Name: ABUTRAB
Passenger: ADULTE

If your fare allows it, you could exchange or cancel your e-ticket until departure by calling + 33 (0)8 92 35 35 35
(international phone fare, with possible extra provider costs - all days from 7h00 to 22h00)

You have purchased a ticket on TGV-europe

Bordeaux – Paris train ticket, **45 Euro**

BENEFITS OF THE E-TICKET

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Fast: print your e-ticket confirmation and simply take your seat on the train.
Practical: Your journey can easily be cancelled at your convenience on-line, by phone on 00 33 892 35 35 35* or at French stations.
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SNCF wishes you a pleasant journey!

YOUR E-TICKET CONFIRMATION

Hello ABUTRAB ALIVERDIEV,
here are the details of your journey. SNCF wishes you a pleasant journey !

Departure / Arrival	Date / Time	TGV 8510
BORDEAUX SAINT JEAN	12/03 at 11:18	COACH 8 - SEAT 041
PARIS MONTPARNASSE 1 ET 2	12/03 at 14:35	2. CLASS DUAL SIDE BY SIDE OFF PEAK

PR11

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Fold along the lines

YOUR REFERENCES

BORDEAUX SAINT JEAN > PARIS MONTPARNASSE 1 ET 2	45,00 EUR

REFERENCE NUMBER: RNZFJT
Customer reference number: 002909016907026401 8
No. e-ticket: 771900102

Surname: ALIVERDIEV
First Name: ABUTRAB
Passenger: ADULTE

If your fare allows it, you could exchange or cancel your e-ticket until departure by calling + 33 (0)8 92 35 35 35
(international phone fare, with possible extra provider costs - all days from 7h00 to 22h00)

You have purchased a ticket on TGV-europe