***Test project** 测试项目*

***Skill** 技能*

***Quantum Technology** 量子技术*

The test project includes the following sections:
测试项目包括以下几个部分：

- ***Introduction** 简介*
- ***Forms of participation in the test project** 测试项目参与形式*
- ***Test project task** 测试项目任务*
- ***Task modules and time required** 任务模块与时间要求*

INTRODUCTION 简介

We live in the age of dynamically developing quantum technologies. In recent decades, we have witnessed a significant breakthrough in new applied aspects of quantum physics, such as secure telecommunications networks, measuring sensors for biological and medical visualization, and a fundamentally new paradigm of computer calculations. The international scientific community reasonably believes that we are on the verge of a second quantum revolution, which presumes the development and implementation of fundamentally new technologies: quantum communication; quantum computers and quantum calculations; high-precision quantum metrology

我们生活在一个动态发展量子技术的时代。近几十年来，我们在量子物理的新应用方面取得了重大突破，如安全电信网络，用于生物和医学可视化的测量传感器，以及计算机计算的一种全新范式。国际科学界认为，我们正处于第二次量子革命的边缘，意味着基本的新技术的发展和实施，包括：量子通信；量子计算机和量子计算；高精度量子计量学。

In the twentieth century the quantum theory has been developed, this theory explains the organization of matter: from a simple hydrogen atom to complex materials. This concept has resulted in a number of Nobel Prizes and in creation of a number of inventions familiar for modern people: computer chips, transistors and lasers. The implementation of these know-hows in virtually all spheres of human activity has formed a multi-billion dollar market and completely altered the modes of thinking of mankind in the modern information age. During the last fifty years, computer components have been diminished by half every 18 months, providing a technological rise for modern society. But this miniaturizing also means that the sizes of computer components are getting closer to atomic sizes. Quantum mechanics imposes a fundamental limit, beyond which it is impossible to develop traditional technologies any more. The second quantum revolution is aimed at

further development of science and technology, implying direct control of the individual states of individual quantum particles – atoms, photons, electrons, etc.

量子理论在20世纪得到了发展，这个理论解释了物质的组织：从一个简单的氢原子到复杂的材料。这个概念产生了许多诺贝尔奖，并创造了许多现代人所熟悉的发明：计算机芯片、晶体管和激光器。这些知识在人类活动的几乎所有领域的实施已经形成了一个数十亿美元的市场，并完全改变了人类在现代信息时代的思维模式。在过去的五十年中，计算机部件每18个月就减少一半，为现代社会提供了技术进步。但是这种小型化也意味着计算机部件的尺寸越来越接近原子尺寸。量子力学有一个基本的极限，超过了这个极限，就不可能再发展传统的技术。第二次量子革命的目标是进一步发展科学和技术，这意味着直接控制单个量子粒子(原子、光子、电子等)的单个状态。

Nowadays in many developed countries of the world, the first prototypes of quantum computers and quantum simulators have been successfully designed. These computing devices are based on the phenomena of superposition and quantum entanglement for computation, thus opening the opportunities of more efficient processing of large amounts of information. The technology brings the possibility of parallelizing processes for many tasks to a new level in comparison with modern personal computers and supercomputers. In particular, due to a quantum computer, it is possible to select the key to the majority of modern encryption algorithms in multiple times faster and more efficiently than it is possible today. Thus, data encrypted by the most popular cryptographic algorithms with a public key based on the complexity of factorization of large numbers can be decrypted during polynomial time (in real time), when for traditional computers the execution time is characterized by exponential growth.

目前，世界上许多发达国家已经成功地设计出了量子计算机和量子模拟器的原型。这些计算装置是基于叠加和量子纠缠现象进行计算的，从而为更有效地处理大量信息提供了机会。与现代个人计算机和超级计算机相比，

该技术进一步提高了将许多任务并行处理的可能性。特别是，由于量子计算机的存在，我们能够以比现在快很多倍的速度和效率来选择现代大多数加密算法的密钥。因此，当传统计算机的执行时间以指数增长为特征时，基于大数分解复杂性的公钥加密算法可以在多项式时间内(实时)解密数据。

The task of information protection from cyber attacks by means of a quantum computer also involves the technologies for controlling the quantum particles. This technology is called "quantum communications" and guarantees absolute security of data transmission at the level of the fundamental laws of physics. Its principles allow to detect the compromise of the distribution of key documents in the communication line, thus users can be sure that their information will not become available to the attacker. This technology is already actively used in critical industries of the modern world and allows to secure the data transmission in the banking sector, to keep the government information in full confidentiality, to protect personal data, etc.

利用量子计算机保护信息免受网络攻击的任务 也 涉及到量子粒子的 控制 技术。这种技术被称为 “ 量子通信 ” ， 在物理基本定律层面上保证了数据传输的绝对安全。它 可 以检测关键文档在通信线路上分布 的 异常 ，这样用户就可以确保他们的信息不会被攻击者获取。这项技术已经在现代世界的关键行业中得到了积极的应用，可以保证银行部门的数据传输安全，对政府信息进行完全保密，保护个人数据等。

An important branch of quantum technology is high-precision quantum metrology – the branch of science and technology, which allows to get accurate values and measure ultra-small quantities using ultra-high-sensitivity quantum sensors and chronographs. Such sensors can detect even the smallest changes in the magnetic field created by synaptic connections of the brain, giving an opportunity to study it in detail, to understand the structure of diseases, and in the long term to help in the creation of artificial consciousness. In addition, chronographs, due to

the high stability of quantum transitions, allow to get an unachievable accuracy of time counting, thus opening new edges for high-precision measurements, for example, with an error of up to several millimeters.

量子技术的一个重要分支是高精度量子计量学——科学和技术的一个分支，它允许使用超高灵敏度的量子传感器和计时器测量超微量并获得精确的值。这种传感器甚至可以探测到大脑突触连接产生的磁场中最微小的变化，从而有机会对其进行详细研究，了解疾病的结构。长远来看，它还可以帮助创造人工意识。此外，由于量子跃迁的高度稳定性，计时器可以获得前所未有的时间计数精度，从而为高精度测量（误差最大为几毫米）开辟了新的边界。

These trends are developing rapidly, thus opening new ways for solving old challenges. Investments into the quantum technology are estimated at hundreds of millions of dollars. In 2016, EU has established a special program (after the completion of the previous program for 2013-2016) for development of quantum technologies with the total budget of more than € 1 billion. In a number of BRICS countries (Brazil and China), the budget for research programs of quantum technologies is also approaching the level of billion dollars. In many respects, this is explained by the strategic importance of quantum technologies for ensuring the protection of state interests

这些趋势正在迅速发展，从而为解决旧的挑战开辟了新的途径。量子技术的投资估计有数亿美元。2016年，欧盟建立了一个发展量子技术的特殊程序(在 2013 - 2016年的项目完成后)，该程序的总预算超过10亿欧元。在一些金砖国家(巴西和中国)，量子技术研究项目的预算也接近10亿美元的水平。这在很多方面可以用量子技术对保障国家利益的战略重要性来解释。

In the context of the aforementioned, a professional quantum technologist, in addition to the fundamental base in the field of quantum physics, shall have a deep knowledge and understanding of the principles of operation of the already implemented quantum technologies. Moreover, a specialist in this field shall be able to analyze the trends of their development, since such technologies are "cross-cutting" and applicable in various fields.

在此背景下，作为一名专业的量子技术人员，除了要具备量子物理领域的基础知识外，还应该对已经实现的量子技术的操作原理有深刻的认识和理解。此外，该领域的专家应该能够分析量子技术的的发展趋势，因为这些技术是“相互交叉的”，适用于各个领域。

The introduction of "quantum technologies" skill is of necessity, as it solves the issues of information security, high-speed processing of large amounts of data, ultra-precise measurements of small quantities, simulation of complex heterostructures of various materials and complex molecules, etc. Quantum technologies are a critical area of knowledge in which Russia shall have its own highly qualified specialists capable of providing leadership in the world market.

引入“量子技术”技能是必要的，因为它可以解决信息安全问题，高速处理大量的数据，对小批量进行超精度测量，模拟复杂的异质结构的各种材料和复杂的分子等等。量子技术是一个关键的知识领域，俄罗斯应当有自己的高素质专家，为占据全球市场的领导地位提供支持。

Scope of application 应用范围

Each expert and competitor shall review and understand this Test Project. Since this Test Project contains only the information pertaining to the relevant professional skill, it shall be used in association with the following documents:

每位专家和参赛者都应审查并理解本测试项目。由于本测试项目仅包含与相关专业技能相关的信息，故结合以下文件进行测试：

• "WorldSkills Russia", Technical Description. Electrical installation works

“俄罗斯世界技能”技术说明。电气安装工作

• "WorldSkills Russia", Competition Rules

“俄罗斯世界技能”竞赛规则

• Host Party – OHSE rules and sanitary standards.

主办方——职业健康、安全、环境规定与卫生标准。

2. FORMS OF PARTICIPATION IN THE TEST PROJECT.测试项目参与形式

Individual test project.单项测试项目

3. TEST PROJECT TASK 测试项目任务

The test project task comprises the quantum cryptography scope of work The participants of the competitions get the instruction, necessary diagrams and materials for execution of the test project consisting of several modules to be executed in sequence.

测试项目的任务包括量子密码学的工作范围，竞赛的参与者获得执行测试项目所需的指令、必要的图表和材料，该测试项目由几个模块组成，按顺序执行。

The task includes the installation of an optical communication line, conditionally suitable for the quantum information distribution, its verification by an optical reflectometer, simulation of abnormal situation as result of violation of the line laying technology. The test project task requires from the participants to demonstrate an understanding of the fundamental physical principles basing the devices for quantum data transmission through optical communication channels. The task also requires from participants to demonstrate the practical skills, which are necessary for independent work on optimizing the parameters of operation of the installation for quantum cryptography and obtaining a distributed quantum key through the optical channel.

该任务包括：安装一条适用于（有条件地）量子信息分配的光通信线路，用光学反射计对该通信线路进行验证，模拟违反线路铺设技术的异常情况。测试项目的任务要求参与者对通过光通信信道传输量子数据的基本物理原理有一定的了解。该任务还要求参与者展示独立工作所必需的实用技能，这对于独立完成优化量子密码学安装操作参数和通过光通道获得分布式量子密钥的工作是必要的。

The final aspects of the Assessment Criteria will be specified by the Jury. The modules' operation shall be assessed along with the process of test project task execution. If a competitor does not comply with the OHSE requirements or exposes himself/herself and/or other competitors to danger, he or she may be disqualified.

评审准则的最后部分将由评审团指定。在测试项目任务执行过程中，模块的运行情况将被评估。如参赛者不遵守职业健康安全环境规则的规定，或将自己及/或其他参赛者暴露于危险之中，其参赛资格可能会被取消。

Time and details of the Test Project may be altered by Jury members depending on test project conditions.

测试项目的时间和详情可由评审团成员根据测试项目的条件进行更改。

The test project shall be completed in modules. The assessment also proceeds from module to module.

测试项目以模块形式完成。评估也是从一个模块到另一个模块。

4. TASK MODULES AND TIME REQUIRED 任务模块与时间要求

Table 1 includes the names of the modules and the time allotted to the contestants for each of the task modules

表 1 包含模块的名称及分配给每个任务模块的参赛者的时间

Item No	Module description 模块说明	Test project completion

项目编号.		time 测试项目完成时间
1	Module A: Installation of a fiber-optic quantum communication channel 模块 A：光纤量子通信信道的安装	2 hours 2 小时
2	Module B: Organizing the operation of the optical part of the quantum transceiver devices 模块 B：组织量子收发器光学部分的操作	4 hours 4 小时
3	Module C: Calibration of quantum-optical line and transmission of quantum key 模块 C：量子光学线路标定与量子密钥传输	10 hours 10 小时

The maximum number of points for each of the modules is given in Table 2.

每个模块的最高分数如表2所示。

Table 2.表 2

Module description 模块说明	Points 分数
Module A: Installation of a fiber-optic quantum communication channel 模块 A：光纤量子通信信道的安装	14
Module B: Organizing the operation of the optical part of the quantum transceiver devices 模块 B：组织量子收发器光学部分的操作	43
Module C: Calibration of quantum-optical line and transmission of quantum key 模块 C：量子光学线路标定与量子密钥传输	43

Total hours allotted for test project: 16 hours

测试项目总用时：16 小时

Module A 模块 A

Installation of a fiber-optic quantum communication channel

光纤量子通信信道的安装

Time limit – 2 hours 时限：2 小时

Purpose: Produce a fiber-optic quantum communication channel suitable for the quantum key distribution.

目的：生产一种适用于量子密钥分发的光纤量子通信信道

Description of the obtained product: Fiber-optic quantum channel about 30 km long, with optical connectors at the ends

所获产品的说明：约30公里长的光纤量子通道，两端有光学连接器

Equipment to be used: Apparatus for welding optical fibers, optical fiber cleaver, stripper, optical reflectometer, hot shrink sleeves, alcohol, napkins, microscope, personal computer, source of optical radiation at the communication wavelength, power meter

要用到的设备：光纤焊接设备，光纤切刀，剥离器，光学反射计，热收缩套管，酒精，餐巾纸，显微镜，个人电脑，通信波长的光辐射源，功率表

Personal protective equipment: goggles, latex gloves (allowed to be taken off for recording the results in a report and for work with a PC)

个人防护设备：护目镜、乳胶手套(在报告中记录结果时可摘下，在电脑上工作时也可摘下)

Submodule A.1 Welding of the optical quantum communication channel with the length of about 30 km.

子模块 A.1 焊接的光量子通信信道长度约为 30 公里

1. Prepare for welding the required number of optical pigtails and optical fiber coils 为焊接所需数量的光纤辫线和光纤线圈
2. Weld the prepared elements 焊接已准备好的元件
3. After welding the optical fiber, photograph the welding machine screen in the Hot Image mode 焊接完光纤后，拍摄在热成像模式下的焊机屏幕

STOP – Stop the work after each welding of the optical fiber if the Hot Image is displayed on the welding machine screen, call the experts for evaluation.
停止-
每次焊接光纤后停止工作，如果焊接机屏幕上显示热图像，请专家进行评估。

4. Perform the opto isolation of the quantum channel 对量子通道进行光电元件隔离

Submodule A.2 Determination of the basic parameters of the quantum communication channel

子模块 A.2 确定量子通信信道的基本参数

1. Conduct the optical reflectometer of the obtained quantum channel 用光学反射计对获得的量子通道进行测量

CAUTION: Maximum measurement accuracy shall be ensured.

注意：应保证最大测量精度

2. Conduct reflectometry of the quantum channel对量子通道进行反射测量

CAUTION: All the data shall be stored in a format suitable for computer processing.

注意：所有数据都应以适合计算机处理的格式进行存储

3. Verify the integrity of the quantum channel and conduct the identification of all potential and observed inhomogenities. 检验量子通道的完整性，识别所有潜在的及观测到的不均匀性
4. Determine the general parameters of the quantum channel, and of each segment and elements of the quantum channel separately.分别确定量子通道的一般参数，以及量子通道的每一段的一般参数和所有元素的一般参数。

5. Set up an optical circuit for measuring total optical losses and the level of back reflections in the quantum channel. Perform measurements. 建立一个测量总光损耗和量子通道中背反射电平的光学电路。执行测量。

Submodule A.3 Making a report

子模块 A.3 编制报告

1. Create a Microsoft Office document (or similar) to fill in the report, the name shall contain the name and the date 创建Microsoft Office文档(或类似文档)以填写报告，名称应包含名称和日期
2. Fill in all measured values and stored data from the submodules A.1 and A.2

CAUTION: Specify all critical parameters of the quantum channel in the report. The values specified in the report shall correspond to the measurements accuracy, taking into account the error. The report should provide a possibility to conduct an accurate assessment and characterization of the correctness of the measurement of each quantity.

填写来自A.1和A.2子模块的所有测量值和存储数据

注意：在报告中指明量子通道的所有关键参数。在考虑误差的情况下，报告中指定的值应与测量精度相对应。该报告应能够帮助相关人员对每一数量的测量正确性进行准确的评估和定性。

Module B 模块 B

Organizing the operation of the optical part of the quantum transceiver devices.

组织量子收发器光学部分的操作

Time limit – 4 hours 时限——4 小时

Purpose: Assemble on the optical platform the two-pass auto-compensating optical circuit Plug&Play.

目的：在光学平台上组装两路即插即用的自动补偿光路。

Description of the obtained product: The arrangement of the receiver "Bob" and the transmitter "Alice", containing optical circuits, suitable for decoding and encoding the information bits into the quantum states of single photons.

所获产品的说明：接收端“鲍勃”和发送端“爱丽丝”的排列，包含光电路，适用于将信息位元解码和编码成单光子的量子态。

Equipment to be used: configurable optical attenuator, laser, phase modulator, set of passive fiber optic elements.

要用到的设备：可配置光衰减器、激光器、相位调制器、无源光纤元件组。

Submodule B.1 Working with optical circuits of quantum transceivers

子模块 B.1 量子收发器的光学电路的使用

1. Assemble from the available components the optical circuits "Bob" and "Alice" on detachable connections. 利用可用元件组装可拆卸连接件上的光学电路“Bob”和“Alice”

CAUTION: When arranging the circuit elements, provide the possibility to connect a quantum channel, a laser, single photon detectors, a synchronous detector, and phase modulators.

注意：当排列电路元件时，为连接量子通道、激光器、单光子检测器、同步检测器和相位调制器创造便利。

STOP – Stop the work, call experts for evaluation.

停止——停止工作，请专家评估。

Submodule B.2 Integration of optical circuits of quantum transceivers

子模块 B.2 量子收发器光路集成

1. Connect the laser radiation source to the assembled circuit "Boba". 将激光辐射源连接到组装好的电路“Boba”上

2. Select the optical circuit parts on which the power measurements to evaluate the level of attenuation required for a certain damping of optical pulses. Perform measurements.选择配有功率测量器的光电路部件，以评估某一光脉冲阻尼所需的衰减水平。执行测量。

Submodule B.3 Report making

子模块 B.3 编制报告

Include the following parameters:

报告包括以下参数：

1. Number of pulses in the train. Setup: laser pulse repetition rate and cumulative line length列车脉冲数。设置：激光脉冲重复频率和累计线长。
2. Train period. Setup: quantum channel length and cumulative line length.火车时间。设置：量子通道长度和线路累积长度
3. Window of expectation of arrival of reflection in clock cycles. Setup: laser pulse repetition rate, quantum channel length, cumulative line length.脉冲周期中反射到达的预期窗口。设置：激光脉冲重复频率，量子通道长度，线路累积长度。
4. The power of the optical signal at the input of the optical circuit "Alice".光路“Alice”输入端的光信号的功率。
5. The value of optical losses in the optical circuit "Alice" and in the optical circuit "Bob".光路“Alice”和光路“Bob”中的光损耗值。
6. Optical power level at the output of the optical circuit "Bob". Optical power level at the output of the optical circuit "Alice".光功率级在光电路“Bob”输出端的光学功率等级。光路"Alice"输出端的光学功率等级。
7. Required level of average optical power to achieve 0.1 photons per pulse at the output of the optical circuit "Alice". 在光电路“Alice”的输出端，达到每脉冲0.1光子所需的平均光学功率等级。

8. The attenuation value at the variable optical attenuator to achieve 0.1 photons per pulse at the output of the optical circuit "Alice".光路“Alice”输出端每脉冲达到0.1光子 时 ，变光衰减器的衰减值。
9. The magnitude of the reflected signal that occurs on the optical connectors between the beam splitter and the variable optical attenuator.在分束器和可变光衰减器之间的光连接器上 产 生的反射信号的大小。

Module C 模块 C

Calibration of quantum-optical line and transmission of quantum key

量子光学线路标定与量子密钥传输

Time limit – 10 hours

时限-10 小时

Purpose: Start-up of the system of quantum key distribution, which allows exchanging the secret information over an open channel. And also the primary processing of quantum keys.

目的：启动量子密钥分发系统。该系统允许在公开信道上交换秘密信息。也就是量子键的初级处理。

Description of the obtained product: Bit sequence with an acceptable level of errors (secret cryptographic key), distributed continuously between the receiver and the transmitter devices using the quantum states of single photons.

所获得产品的说明：错误级别(秘密密码密钥)在可接受范围内的位序列。使用单光子的量子态在接收端和发送端设备之间对位序列进行连续分配。

Equipment to be used: Transceiver devices transceiving the quantum keys, quantum channel arranged in the module A (replace the coil with a new one if the participant does not perform welding operations), the optical circuit arranged in the module B (replace with the working circuit if one made by a participant is of poor quality), a stopwatch, a personal computer with pre-installed software.

要用到的设备：收发量子密钥的收发机设备、模块 A 中的量子通道(如果参与者不执行焊接操作，用一个新线圈替换旧线圈)、模块 B 中的光学电路(如果工作电路的质量差，替换工作电路)、秒表、带有预装软件的个人电脑。

Submodule C.1 Connection of transceiver devices using a quantum channel

子模块 C.1 应用量子信道的收发设备的连接

1. Connect the devices "Alice" and "Bob" to the quantum channel using a welded fiber optic line.用焊接光纤线路将器件“Alice”和“Bob”连接到量子信道。
2. Start the software terminal on the "Alice" device control unit启动“Alice”设备控制单元上的软件终端
3. Start the software terminal on the "Bob" device control unit在“Bob”设备控制单元上启动软件终端
4. Establish the connection of the software terminals "Alice" and "Bob" over the local Ethernet network.在本地以太网上建立软件终端“Alice”和“Bob”的连接
5. Configure the waiting period for the pulses on the detectors of "Bob". 配置“Bob”探测器上脉冲的等待时间。
6. Determine the time (clock cycle number) of return of the pulse reflected from the Faraday mirror. 确定从法拉第镜反射回来的脉冲的时间(脉冲周期数)

STOP – Stop the work, call experts for evaluation.

停止——停止工作，请专家评估。

Submodule C.2 Setting the parameters for operation of quantum communication devices

子模块 C.2 设置量子通信设备运行参数

Enter the appropriate parameters into the program在程序中输入适当的参数

1. Find the voltage of the half-wave displacement on the phase modulator of the device "Bob", corresponding to the phase shift by π. 找出设备“Bob”的相位调制器的半波电压位移，与 π的相移相对应。

STOP – Stop the work, call experts for evaluation.

停止——停止工作，请专家评估

2. Find the time of delay of activation of the phase modulation on the device "Alice". 找出设备“Alice”上相位调制激活延迟时间

а) Pre-evaluate the delay time.预估延迟时间

б) By means of scanning, detect the train of pulses.通过扫描，检测脉冲序列。

STOP – Stop the work, call experts for evaluation.

停止——停止工作，请专家评估。

в) Experimentally determine the delay time 实验确定延迟时间

STOP – Stop the work, call experts for evaluation.

停止——停止工作，请专家评估

3. Find the voltage of the half-wave displacement on the phase modulator of the device "Alice", corresponding to the phase shift by π.找出设备“爱丽丝”的相位调制器的半波电压位移，与π的相移相对应

STOP – Stop the work, call experts for evaluation.

停止——停止工作，请专家评估。

4. Determine the optimal position of the DSF operation window. In the developed software, for each detector, the temporary position of the operation window is individually adjusted.

确定DSF操作窗口的最佳位置。在开发的软件中，针对每个检测器分别调整操作窗口的临时位置

STOP – Stop the work, call experts for evaluation.

停止——停止工作，请专家评估。

Submodule C.3 Quantum key generation

子模块 C.3 量子密钥生成

1. Start the quantum key generation process using the obtained parameter values using the softwares programs "Alice.vi" and "Bob.vi". 利用软件程序“Alice.vi”和“Bob.vi”获得参数值，凭借该参数值启动量子密钥生成过程

a) Values are entered in all required fields.将指输入所需的所有领域。

STOP – Stop the work, call experts for evaluation.

停止-停止工作，请专家进行评估。

б) The key generation has been started 关键生成过程已经启动。

STOP – Stop the work, call experts for evaluation.

停止-停止工作，请专家评估。

2. Perform manual adjustment of critical parameters, tracking the key length and QBER, to achieve an optimum result. 对标准参数进行人工调整，追踪关键长度与量子密钥误码率以获得最优结果。

в) The necessary parameter has been adjusted to decrease QBER of the generated key and to increase the key length. 对必要的参数进行调节以减少生成密钥的量子密钥误码率，增加关键长度。

STOP – Stop the work, call experts for evaluation.

停止——停止工作，请求专家评估。

Test Project execution schedule

测试项目执行计划表

Participant No. 1 1 号参与者	Module A 模块 A	Module B 模块 B	Module C* 模块 C*
Day 1 第一天	10:00 – 12:00	13:00 – 17:00	
Day 2 第二天			09:00 – 18:00 (lunch 12:00 – 13:00) （午餐 12:00-13:00）
Day 3 第三天			09:00 – 18:00 (lunch 12:00 – 13:00) （午餐：12:00-13:00）
Participant No. 2 2 号参与者	Module A 模块 A	Module B 模块 B	Module C 模块 C
Day 1 第一天	10:00 – 12:00	13:00 – 17:00	
Day 2 第二天			09:00 – 18:00 (lunch 12:00 – 13:00) （午餐 12:00-13:00）
Day 3 第三天			09:00 – 18:00 (lunch 12:00 – 13:00) （午餐 12：00-13：00）
Participant No. 3 3 号参与者	Module A 模块 A	Module B 模块 B	Module C 模块 C
Day 1 第一天	10:00 – 12:00	13:00 – 17:00	

Day 2 第二天			09:00 – 18:00 (lunch 12:00 – 13:00) （午餐 12:00-13：00）
Day 3 第三天			09:00 – 18:00 (lunch 12:00 – 13:00) （午餐 12:00-13：00）
Participant No. 4 4 号参与者	Module A 模块 A	Module B 模块 B	Module C 模块 C
Day 1 第一天	10:00 – 12:00	13:00 – 17:00	
Day 2 第二天			09:00 – 18:00 (lunch 12:00 – 13:00) （午餐 12:00-13：00）
Day 3 第三天			09:00 – 18:00 (lunch 12:00 – 13:00) （午餐 12:00-13：00）

* — work with the unit taking into account the time sessions played by the toss-up between the participants 操作装置时，要考虑到参与者之间的研讨会所占用的时间

LIST OF ABBREVIATIONS USED:文中使用的缩略词列表：

DSF — detector of single fotons 单一 fotons 检测器

QBER — Quantum Bit Error Rate 量子比特误码率

BS — beam splitter 分束器

PBS — polarization beam splitter 极化分束器

SM — single mode 单一模式

PM — polarization maintaining 极化维护

PLIC — programmable logic integrated circuit 可编程序逻辑电路

DAC — digital-to-analog converter 数字-模拟转化器

SW — software 软件

FOCL — fiber optic communication line 光纤通信线路