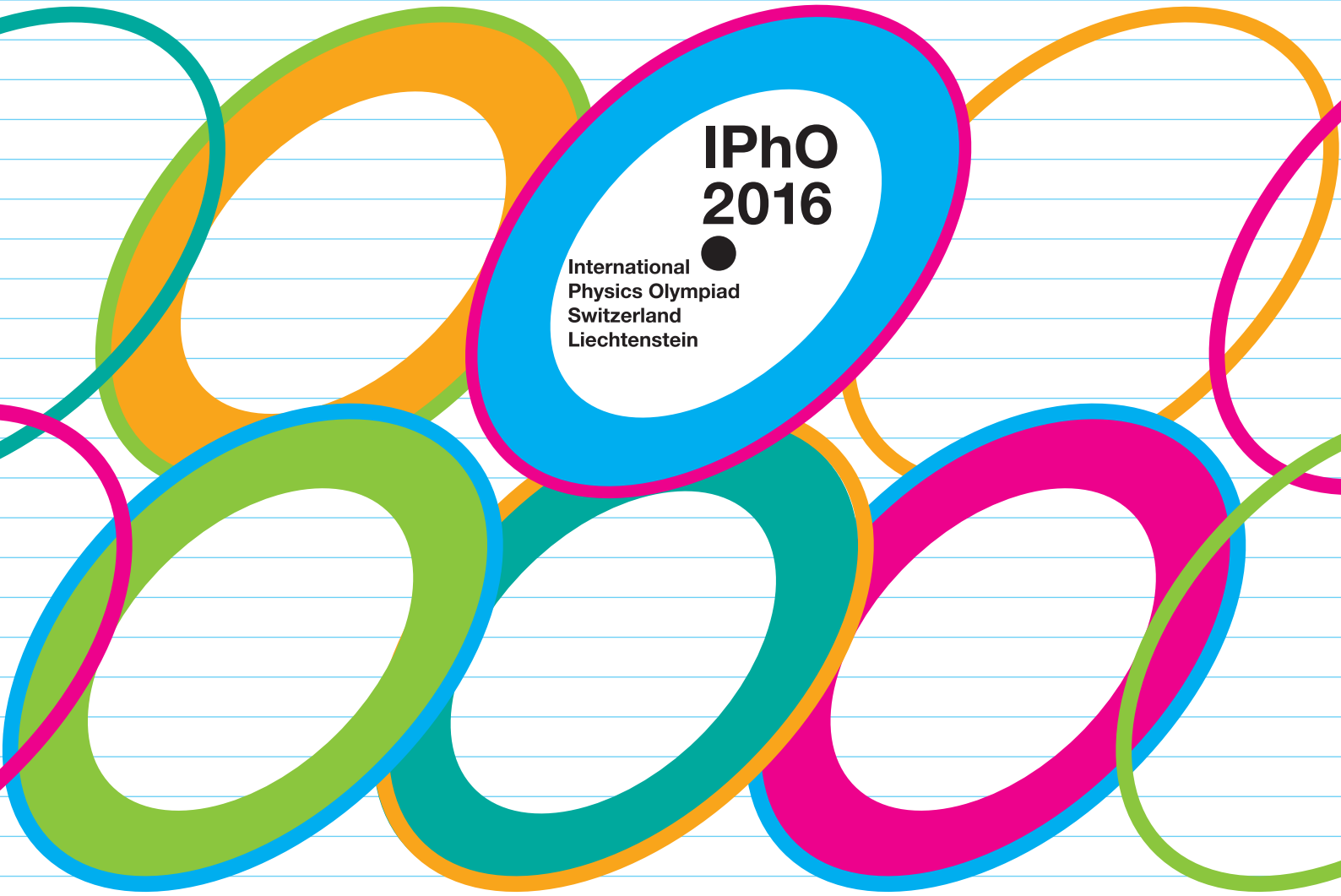
47th International Physics Olympiad
Switzerland Liechtenstein
Zurich, 11 – 17 July 2016

final report



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Editorial

The International Physics Olympiads (IPhO) is a competition for high-school students whose interest in physics goes beyond school activities. Participants are chosen based on a national selection process. The five best students of each country may participate in the IPhO. The IPhO is organized in a different country every year. Switzerland and the Principality of Liechtenstein were chosen to be the host countries of the IPhO 2016. We were proud to welcome 398 participants from 84 countries and a total of 654 guests, making IPhO 2016 the largest IPhO in history.

From initial planning to the final days of preparation we realized what an enormous effort is needed to organize an IPhO.

The specific requirements of an IPhO as a competition with rules, but also the expectations of the participating delegations, require a huge financial budget, enormous personnel resources, a detailed planning process and a lot of know-how in event logistics, communication, fundraising, hospitality, IT and — last but not least — physics.

The expectations regarding the quality of the organization, hospitality and infrastructure of an IPhO, as well as the number of participants, are rising every year. These observations lead us to fear it will become impossible for many participating countries to ever host and finance an IPhO.

One way to tackle this problem is by means of innovation. In order to face logistical challenges, reduce the amount of paper needed, and minimize the time and workload for both Leaders and Organizers, we developed an innovative online translation and exam management tool. Technology will surely prove a source for even more innovations, and we strongly encourage the IPhO community to push our achievements further. In the near future, printouts may belong to the past.

The success of an IPhO is also judged by its impact on the public. Besides foundations and companies, it was mainly the public sector that financed IPhO 2016, and it will hopefully be the public that will chiefly finance many IPhOs to come. So we should use the IPhO to communicate and transmit our values and fascination for physics to the outside world. Our goal was to promote physics beyond those participating in the event, to try and reach as many people as possible. We set up campaigns and used various communication channels to spread the message of IPhO as far as possible.

Through our experience in preparing for the event during recent years we have learned a lot about how to organize an IPhO. Every year, a new set of organizers starts from scratch, and most of them have never organized an event of this size before. A chief lesson for us was that IPhO requires a good know-how transfer from organizer to organizer well ahead of time. Mistakes, lingering planning stages and problems can be avoided and resources used more efficiently when the know-how of past IPhOs is transferred and the right conclusions are drawn.

Therefore, this final report of the IPhO 2016 summarizes not just the achievement of the organizers but in particular the challenges encountered along the way. We hope that it will provide future organizers with best-practice experiences from backstage about the scale and diversity of the tasks that had to be completed to make IPhO 2016 a success. We, the Organizers of IPhO 2016, are happy to share our experience and know-how with all future IPhO hosts - also outside of this report.

Simon Birrer, Co-Chairman IPhO 2016

Mao Chenkai, Top Gold Medallist of IPhO 2016

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IPhO in a Nutshell

Facts and Figures

Host Countries	Switzerland and Liechtenstein
Where	Zurich, Switzerland
When	Opening Ceremony on Monday, 11 July 2016 Closing Ceremony on Sunday, 17 July 2016
Organizers	The University of Zurich Association of Swiss Scientific Olympiads including its member, the Association of Swiss Physics Olympiads Office of Education of the Principality of Liechtenstein
Competing Delegations	84
Observer Countries	2 (Luxembourg and Tunisia)
Competing Students	398 (new IPhO record), of which 25 were female (6.3%)
Leaders	161
Observers	84
Visitors	9
IPhO Secretariat	2
Total Number of Guests	654
Volunteers	125
Markers	89
Awards	219 medals (47 gold, 74 silver and 98 bronze)
	65 honourable mentions
Translated Languages	51
Overnight Stays	5,800
Meals	19,000

IPhO Delegations

The following 84 delegations participated in the IPhO 2016 with Students:

Armenia
Australia
Austria
Azerbaijan
Bangladesh
Belarus
Belgium
Bolivia
Bosnia and Herzegovina
Brazil
Bulgaria
Cambodia
Canada
China
Colombia
Costa Rica
Croatia
Cyprus
Czech Republic
Denmark
Ecuador
Egypt
El Salvador
Estonia
Finland
France
Georgia
Germany
Ghana
Greece
Hong-Kong (China)
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Iceland
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Indonesia
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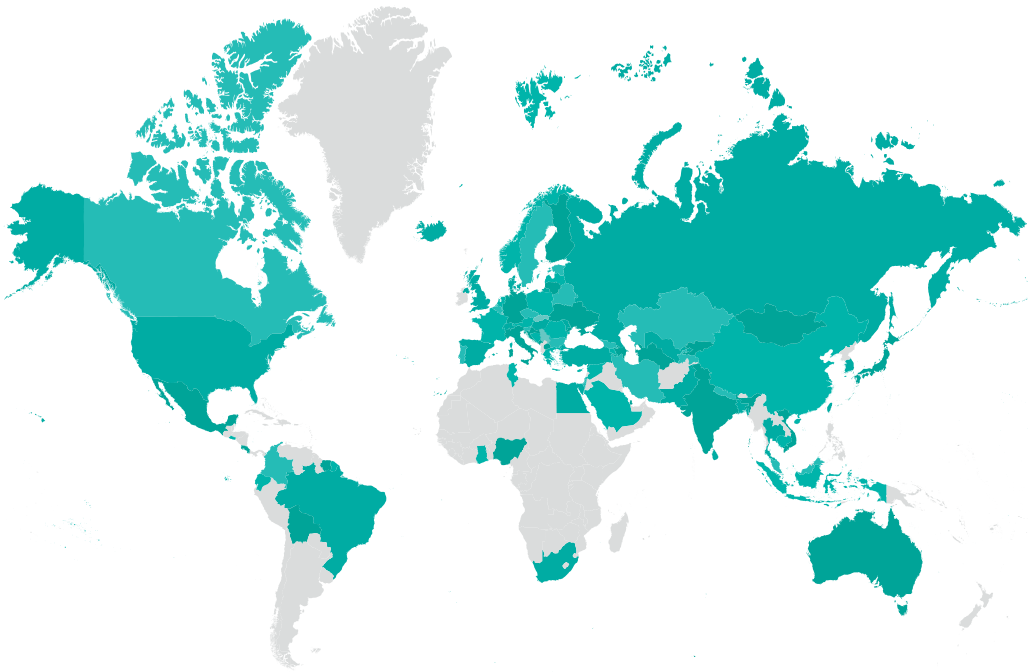
Italy
Japan
Kazakhstan
Kyrgyzstan
Latvia
Liechtenstein
Lithuania
Macao (China)
Macedonia
Malaysia
Mexico
Moldova
Mongolia
Montenegro
Nepal
Netherlands
Nigeria
Norway
Pakistan
Poland
Portugal
Qatar
Republic of Korea
Romania
Russia
Saudi Arabia
Serbia
Singapore
Slovakia
Slovenia
South Africa
Spain
Sri Lanka
Suriname
Sweden
Switzerland
Syria
Taiwan (Chinese Taipei)
Tajikistan
Thailand
Turkey
Turkmenistan
Ukraine
United Kingdom
USA
Uzbekistan
Vietnam

The following 2 delegations participated in the IPhO 2016 as Observer Countries:
Luxembourg
Tunisia



Glossary

The following terms are used:

Delegation: Each national delegation consists of at most five Student competitors selected on a national level, plus up to two Leaders and any number of Observers.

Student: The contestant shall be students of general or technical secondary schools, i.e. schools which cannot be considered technical colleges. Students who have finished school examinations in the year of the competition may be members of the team as long as they have not started university. Age should not exceed twenty years on 30 June of the year of the competition.

Leader: Up to two accompanying persons who are specialists in physics or physics teachers, capable of solving competition problems competently. Each should be able to speak English.

Observer: In addition to Leaders, teams may be accompanied by Observers. Observers may attend all Olympiad meetings, including the meetings of the International Board. However, they may not vote or take part in the discussions.

Observer Country: Representatives of countries not yet members of the IPhO who attend in order to observe and as a condition to becoming full members, as stated in the statutes.

Visitor: In addition to Leaders, Students and Observers, a team may be accompanied by guests, who do not officially represent the country and consequently do not take part in the International Board Meetings. They are allowed to participate in the event and excursion programme of the Leaders and Observers.

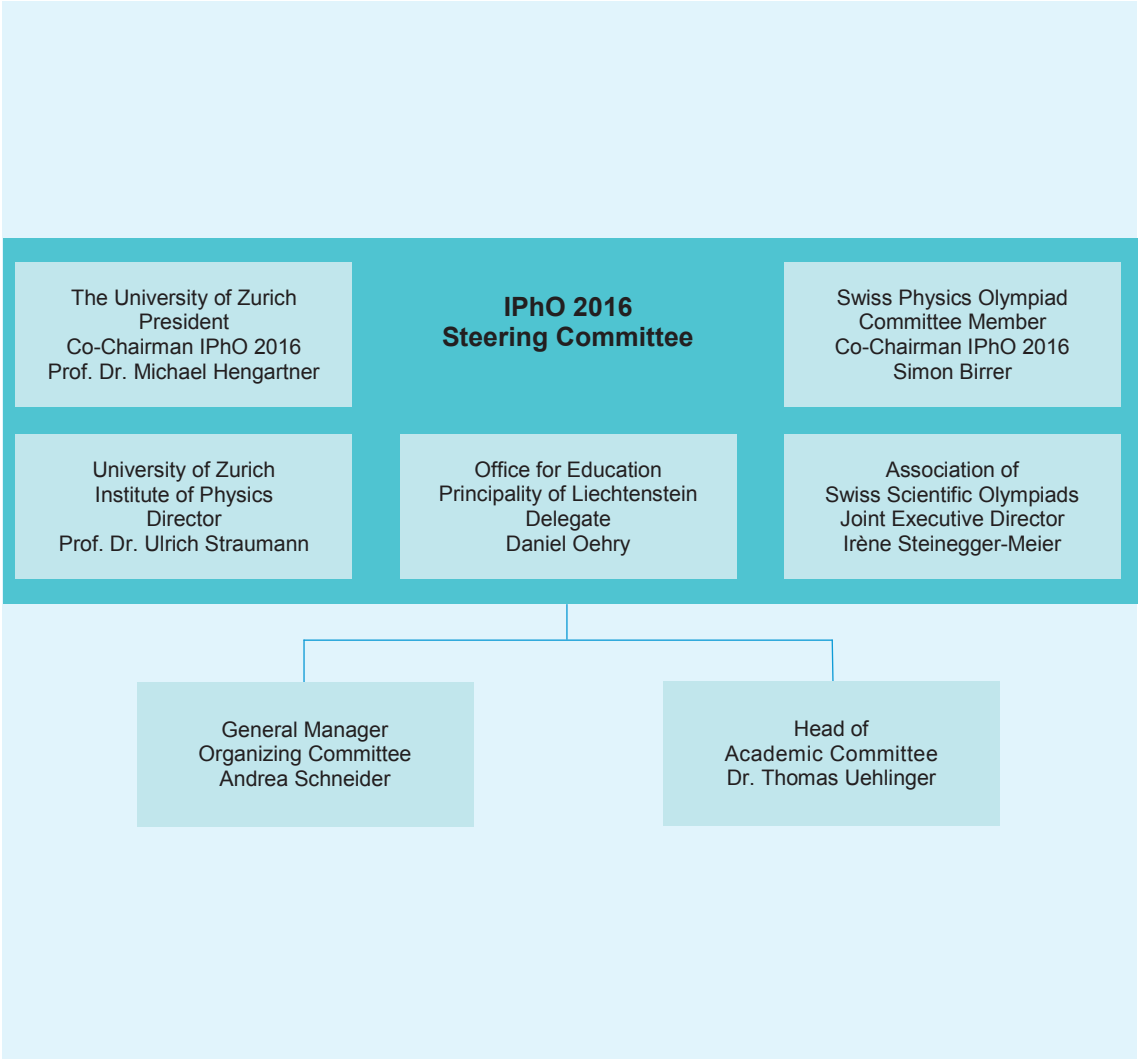
General Organization

Steering Committee

IPhO 2016 was held by the following three organizations:

- Association of Swiss Scientific Olympiads (VSWO) with its member, the Association of Swiss Physics Olympiads (SwissPhO)
- The University of Zurich, Institute of Physics
- Office for Education of the Principality of Liechtenstein

The Steering Committee, which was made up of representatives of the organizing bodies, ensured that IPhO 2016 complied with the international rules determined by the International Board of the IPhO. The Steering Committee approved the budget and the overall financial planning, decided on top-level strategic questions, and supervised the Organizing and Academic Committee. The dual project management ensured that the project was appropriately organized.



Academic Committee

The Academic Committee was responsible for all aspects of the IPhO programme relating to scientific aspects, i.e. the conception of the experimental and theoretical problems, marking and moderation, and the venues required for the scientific programme (for exams, Board Meetings, etc.). The Academic Committee commenced work in January 2014, in parallel to negotiations with potential host universities. At an early stage, under the lead of Thomas Uehlinger (Association of Swiss Physics Olympiads), different potential areas of responsibility were identified and distributed to volunteers from the Swiss Physics Olympiads. Additionally, institutes at the potential host institutes were contacted about setting up collaborations for the conception of potential IPhO problems. The Academic Committee was fully constituted in March 2014 after the University of Zurich had been chosen as the host university and its Department of Physics had assigned a group of about 10 scientific staff and professors to aid with the organization of the scientific part of the IPhO.

Two main bodies within the Academic Committee were set up: One team that was responsible for the conception of the exams (mainly Department of Physics staff and volunteers from the Swiss Physics Olympiad) and another for the organizational aspects of the scientific programme (mostly volunteers from the Swiss Physics Olympiad). The composition of the Academic Committee was mostly unchanged from this time on, and regular meetings were held to coordinate the activities of the two bodies.
A delegation of three members of the Academic Committee (accompanied by members of the Organizing Committee) attended the IPhO 2015 in Mumbai.

An Academic Board was constituted from exam problem authors to decide on the final selection of the problems and to represent them to the International Board.

For testing of the exam problems, production of experiments, and for various tasks during the actual event, significant support from additional staff from the University of Zurich and volunteers from the Swiss Scientific Olympiads was received.

Challenges

- Overall workload for several volunteers (head, IT development) raised to > 0.5 full-time equivalents (FTE) besides their normal professional duties, especially during the 6 months before the IPhO.
- Coordination of the work and meetings between professionals (university staff) and volunteers (meeting times, deadlines, etc.).
- The transfer of IPhO-specific knowledge from the members of the Swiss Physics Olympiad (with experience as contestants and leaders at previous IPhOs) to the staff of the Department of Physics proved challenging. Unfortunately, only one member of the Department of Physics volunteered to attend the IPhO 2015 in Mumbai to get first-hand experience.

Recommendation

- Get fixed work load allocations from the host universities' staff for the development of the exam problems.
- A secretary or event manager familiar with the host universities' structure (with dedicated work time) should be part of the Academic Committee for at least the 6 months prior to the Olympiad.

Head of Academic Committee
Dr. Thomas Uehlinger (SwissPhO)

Problems
Thomas Uehlinger, Authors of the Exam Problems

- Development of 4 theory problems (3 were selected, total exam duration 5 h)
- Development of 1-2 experiments (total exam duration 5 h)
- Production/material acquisition of the experiments
- Presentation of the problems in front the International Board
- Ensuring the confidentiality of the exam problems
- Marking schemes

IT
Michele Dolfi (SwissPhO)

- Development of a software solution for discussion and translation of the exam problems
- Voting solution
- Marking solution
- Acquisition/rent of notebook computers
- Rent of high-volume printers
- Servers and Wi-Fi infrastructure
- Interface to the Organizing Committee's database

Exams - Logistics
Thomas Uehlinger, Marco Gerber, Andreas Schilling

- Planning of the exam schedule (venue, volunteers, power, lighting, cubicles, writing utensils).
- Planning of the board meetings (venues, projection, microphones, food and beverages)
- Ensuring adherence to the statutes
- Coordination of general logistics and academic volunteers

Exams - Marking
Lionel Philippoz, Matthias Hengsberger

- Recruiting and formation of the markers
- Marking (schedule, location, volunteers, instructions)
- Moderation (schedule, location, volunteers, instructions)

Core Team:
~ 10 University of Zurich
~ 7 SwissPhO

Translations
Thomas Uehlinger, Levy Jäger (SwissPhO)

- Translation to Russian, German, French, Spanish, English
- Proofreading of the translations
- Translator-pool for checks during the IPhO

Quality Management
Johanna Nyffeler (SwissPhO)

- Recruiting of the testers
- Testing
- 2 test rounds
- Check of the problems with regard to compatibility with the Syllabus

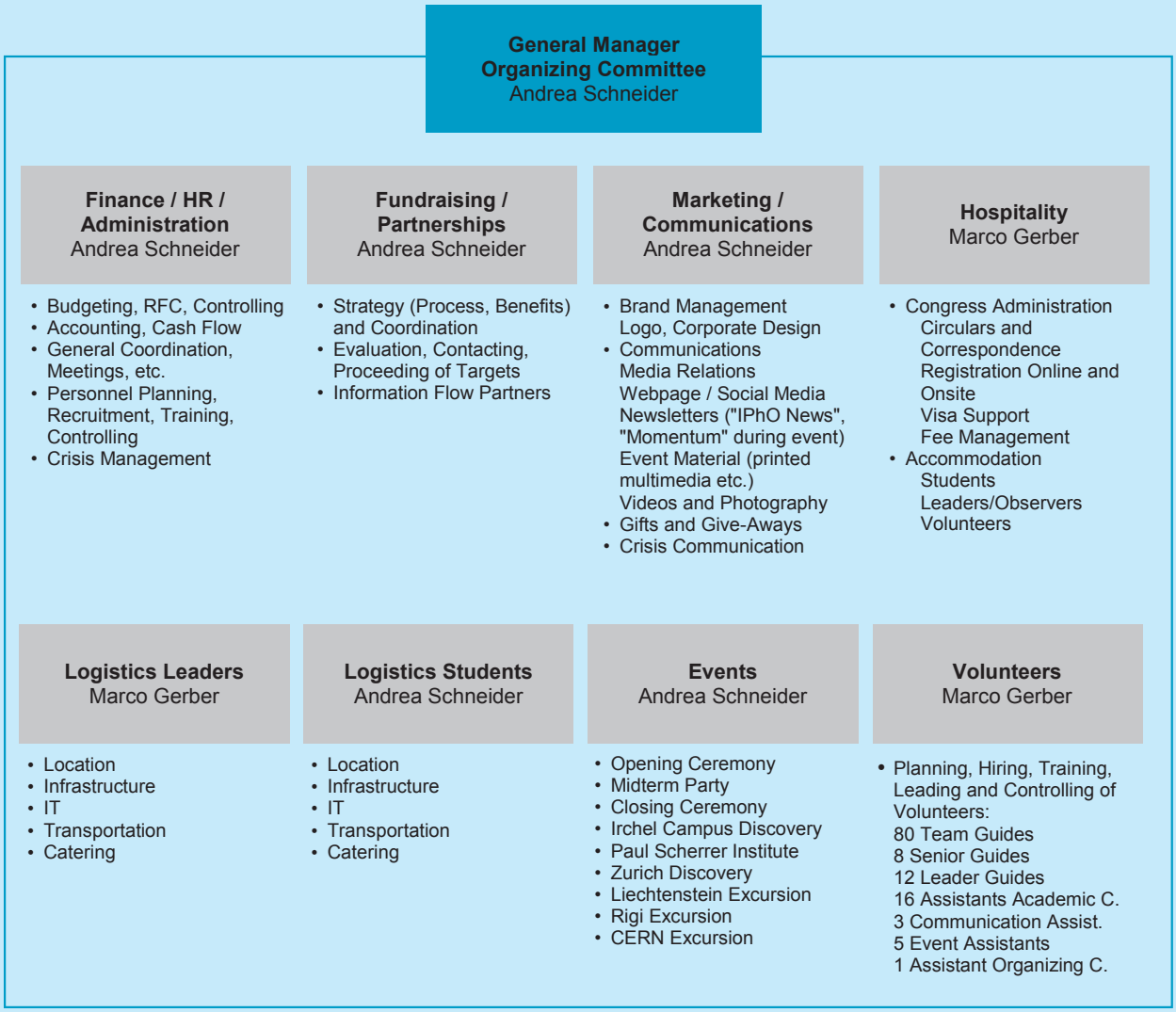
Organizing Committee

The Organizing Committee was responsible for all operative and administrative aspects of the week's programme, i.e., everything not purely scientific (e.g. exams, board meetings, etc.).
The first non-volunteer organizational and preparatory tasks were begun in January 2014 by the Association of Swiss Scientific Olympiads (ASSO*). Over 2014, an average of one full-time equivalent (FTE) was shared by three people.

Core Team

- 18 months prior to the event, in December 2014, Andrea Schneider begun with 1 FTE as General Manager of the Organizing Committee.
- She was supported by Marco Gerber, Manager Hospitality and Logistics, on board since January 2014 in the ASSO* team, with an average of about 0.4 to 0.6 FTE, rising to 1 FTE during the final weeks before IPhO.

* Association of Swiss Scientific Olympiads



Additional support

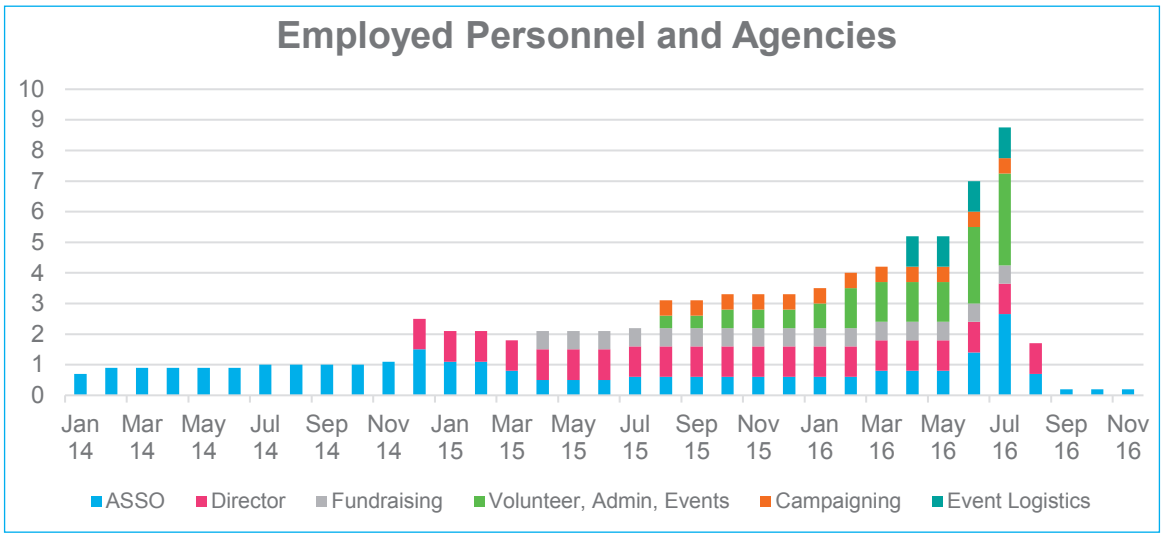
- Fundraising: As the event had to be funded, two people supported the Organizing Committee in fundraising, overall at around 0.6 FTE starting 15 months prior to the event.
- Volunteer Management, Hospitality, Administration, Event Management: An agency began to support the Organizing Committee in August 2015 in volunteer management, later on taking over tasks in administration and hospitality as well as event management, starting with 0.4 FTE and growing almost constantly to a final 3 FTE for the final weeks prior to the IPhO.
- Marketing and Communication: In August 2015, a junior campaigner came on board with 0.5 FTE to set-up and implement the communication campaign. He was supported during the IPhO by
    - 5 people for the newsletter incl. content management of web and social media
    - 2 photographers
    - A 5-person part-time film team for daily video blogs
    - 2 professional staff for media relations
- Event Logistics: 3 months prior to the event, in April 2016, two people joined the team (0.8 and 0.2 FTE) for detailed logistics and event planning. They were supported during the IPhO by 6 Event Assistants.
- Administration: 3 people acted as Personal Assistants from 1 July until the end of the IPhO.
- In addition to the above-mentioned personnel, staff from the University of Zurich supported the Organizing Committee in a variety of services (uncharged by the university).

Challenges

- For the four months prior to the event there were too few people on board, leading to long working weeks without free weekends.

Recommendation

- A highly complex event needs appropriate personnel resources. Bring additional people on board if possible 6 months prior to the event to gain knowhow and share the workload with team members.



Volunteers

For volunteer management, we hired an agency with proven knowledge in the field of volunteer management for national and international sports events.
We consider a volunteer to be a person who worked for the IPhO without salary and in their free time, i.e. besides their regular job or studies. 125 volunteers worked on the following tasks:

- Team Guides (88) including 8 Senior Guides; each Senior being responsible for 10 Team Guides
- Leader Guides (12) including one Senior
- Assistants Academic Committee (16)
- Assistants Organizing Committee (8), including Event Assistants (4) and Media Assistants (3)

The recruitment process started in November 2015 and the following main target groups were defined and contacted by email:
- Students and staff of the University of Zurich
- Former participants of:
    - Swiss Physics Olympiad
    - other Scientific Olympiads from both Switzerland and Liechtenstein
- Members of the Associations of Swiss Physics Olympiad and other Scientific Olympiads
- Volunteers of the International Biology Olympiad 2013 in Bern, Switzerland

All interested persons had to fill out the application form on the website. The following general qualification requirements were defined:
- master of at least one Swiss language in addition to English
- familiar with the Swiss or Liechtenstein culture and way of life
- at least 18 years old at the date of the event, for legal reasons

Applicants not known to a member of the Organizing or Academic Committee were invited to a telephone interview in order to evaluate availability, job preferences, special expertise, and to clarify expectations on both sides. After the interview the applicants were assigned to their specific job and whenever feasible with any preferences taken into consideration. We planned to close the registration process by the end of March. However, that was not possible as the required number of volunteers had not been found at this time. Further emails and reminders were sent to the target groups and registration was closed by the end of May.

Together with their assignment, all volunteers had to provide some further personal details using an online form, and they had to accept an official volunteer agreement in which the following were confirmed:
- their assignment and working period
- further administration details such as insurance coverage

The following was offered to volunteers in return for their efforts:
- Free public transportation from their home to Zurich and back
- Accommodation for all Guides and volunteers living outside Zurich
- Free meals during the event
- Clothing (T-Shirts) and laundry service
- Expenses, also covering use of personal cell phones
- Various gifts and presents
- Volunteer Farewell Party
- Personal work certificate in recognition of their commitment

Communication to and training of volunteers included the following:

- Most communication was by email.
- They received a monthly IPhO-Newsletter.
- In mid-June a comprehensive training document with detailed information about the event and their job was sent.
- On 9 July, one day prior to the IPhO's arrival day, all volunteers were invited to a kick-off day. The day was split into a general presentation of the IPhO for all volunteers and job-specific training sessions within their volunteer group.
- Further briefings by the heads or responsible staff for each volunteer group took place if possible on a daily basis in order to provide information for the next day.

According to the volunteer survey, volunteers rated the IPhO with a 5.1 out of 6 (1 = not satisfactory; 6 = exceeded my expectations). The majority felt well prepared and taken care of by the Organizing Committee. 97% of all volunteers would potentially volunteer again on future Scientific Olympiads and most of them would recommend volunteering to friends or colleagues.

Challenges

- The recruitment process took much longer than expected. But it is not advisable to start earlier as a lot of volunteers (especially students) did not know by March when they would be available during summer holidays, due to e.g. exams, holidays or jobs.
- Find well-qualified volunteers, if possible experienced in events or working with young adults. It is challenging to provide all the necessary information and to prepare all volunteers in just one training day.
- A surprisingly high number of Students caused serious issues during the event by ignoring the instructions of their Team Guide or by refusing to join the official programme.

Recommendations

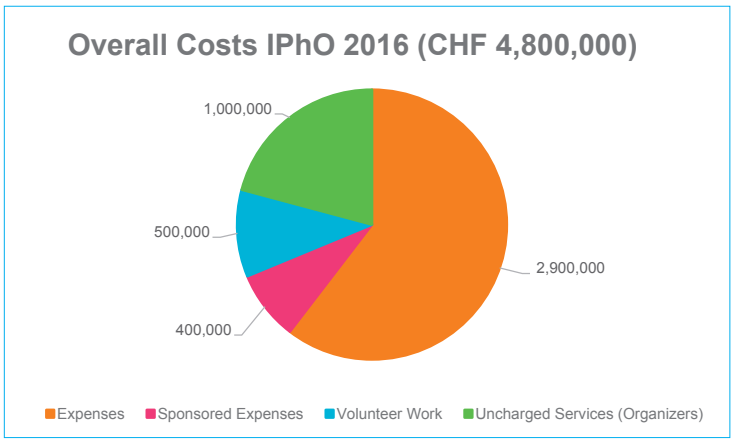
- Early involvement of Senior Volunteers.
- Train Senior Volunteers and other responsible persons in how to hold proper daily briefings, and especially debriefings, to support volunteers with the many potential problems.
- Keep a pool of experienced volunteers in the database for future events.

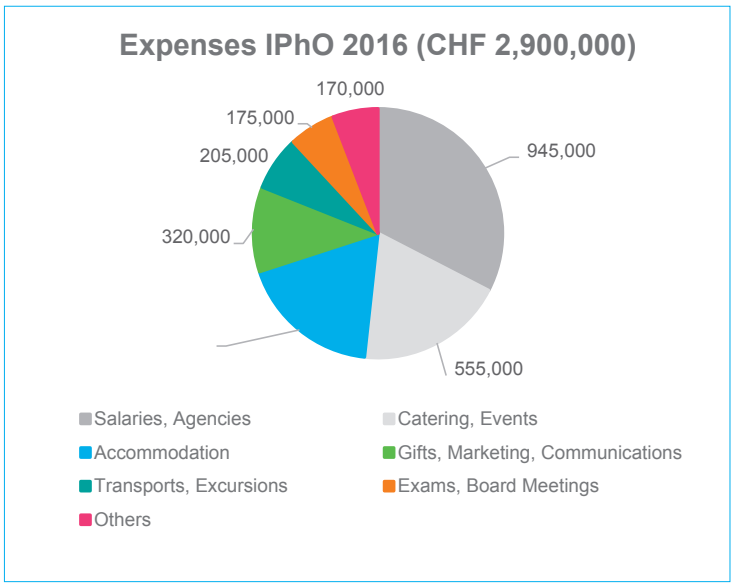
Budget and Expenses

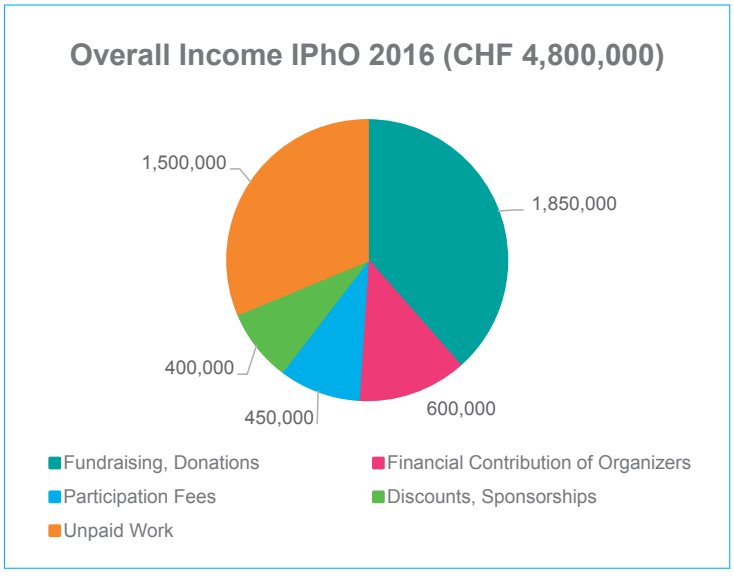
A total of CHF 2,900,000 were spent on the IPhO 2016 (the average exchange rates in July 2016 for CHF 1.00 were about EUR 0.92 and USD 1.02). However, this does not reflect the real efforts and costs of the IPhO 2016. Much work carried out by the organizers, mainly by employees of the University of Zurich, as well as by volunteers, was unpaid and does not appear in the above mentioned expenses. In order to get a better understanding of the real costs of such an event, these uncharged services, as well as all discounts granted by partners and sponsors, should also be taken into account. This leads to an overall cost of the IPhO 2016 of CHF 4,800,000.

Of the CHF 2,900,000 spent, 33% was spent on salaries for employees and hired agencies, 19% on catering and events (Opening Event, Midterm Party and Closing Ceremony), and 18% on accommodation. The rest was spent on gifts, marketing and communication, transports, excursions, the entire exams infrastructure (including board meetings) and other expenses.
The discounts and sponsored services received by our partners were mainly in the field of accommodation, food and beverages, event infrastructure and locations, excursions and transport. The real cost of these categories would thus be much higher.
In addition, the overall cost for the exams seems rather low. This is mainly thanks to the uncharged contribution of the university's technicians and infrastructure.

Besides the large amount of unpaid work (volunteers and uncharged services provided by the organizers), the budget was covered to a large extent by fundraising and donations from partners (39% of overall income, from a total of 29 foundations, companies and institutions). In addition, the financial contributions of the organizers themselves amounted to up to 13%.
Finally, participation fees contributed 9% to overall income (or 16% of effective total expenses).







Fundraising

Funding an event such as IPhO 2016 represents a challenge for Switzerland and Liechtenstein, as Scientific Olympiads are not state institutions but are non-profit organisations based on volunteer work.

As Switzerland and Liechtenstein are high-price countries, organising an IPhO is very expensive. The four organizers jointly covered almost 40% of the final IPhO 2016 budget through fundraising.

Fundraising was of fundamental importance, and finding the sum needed to cover the budget turned out to be very difficult, especially as the Physics Olympiads are not well known in Switzerland and Liechtenstein.

Our fundraising strategy was to focus first on foundations and state organizations. Thereafter companies and industry were approached. Depending on the amount of the financial contribution, four categories of partnerships were defined. Partners received individually tailored and jointly developed participation options to acknowledge their support:
• Major Partner: contribution of more than CHF 400,000
• Promoting Partner: contribution of more than CHF 200,000
• Partner: contribution of more than CHF 50,000
• Supporter: contribution of less than CHF 50,000

The objective was to cover the financial needs by the end of 2015. First requests were sent out as early as three years before the event. After a successful start, the flow of money dried up for most of 2015, forcing the organizers to make rigorous budget cuts.

Personal contacts to potential donors or partners of previous, similar events proved most important, and were more likely to respond positively to fundraising requests. Over a hundred requests were sent out. Approximately 30% received a positive reply. Finally, just before IPhO 2016, the budget was secured.

Challenges

It proved to be challenging to:
• communicate what IPhO is about and show its attractiveness for partners
• offer attractive participation options without becoming over-commercialized
• find financing partners in economically difficult times
• get in contact with the decision makers of potential partners
• In short, fundraising is a highly time-consuming activity.

Recommendation

• Try to get the IPhO budget from government institutions.
• If fundraising has to be used:
    - start organizing the IPhO when you have a solid financial basis (i.e. a deficit guarantee)
    - start fundraising early enough, at least 3 years in advance
    - develop a clear strategy and recognition proposals, while maintaining flexibility
    - be ready for a “financial crisis” and develop possible budget-cutting options in advance

Crisis Management

The organizers of an international event such as the IPhO carry a huge responsibility. It is crucial that the safety of participants and everyone involved is guaranteed at all times. Therefore, it is important to evaluate possible emergencies and crises and to consider the appropriate measures.

Due to the fact that many of the events took place at the University of Zurich, we were able to rely on highly experienced people and the safety procedures of the institution.

Part of crisis management has been the definition of roles and responsibilities, and the communication flow in case of larger incidents. For the former we kept mainly to the hierarchy of the organization, and for communication we relied on the media relations department of the University of Zurich.

Fortunately, no large incident occurred during IPhO 2016. The security company engaged did not report any problems, while the hired medical service company counted nine treated issues, including several that were dealt with over the phone. While the majority of the incidents were of low severity, one head wound and a bacterial infection had to be treated by medical doctors.

Challenges

- Unpredictable accidents and illnesses of participants
- Threats from the outside

Recommendation

- Sharpen the Team and Leader Guides' awareness of their responsibility towards participants.
- Inform Team and Leader Guides about processes in case of incidents, train them in first aid and distribute first aid kits.
- Depending on the general health and medical set-up of the respective host country and involved locations, it might be advisable to have a dedicated 24h medical helpline for telephone assistance, but also the possibility of having professional medical staff on duty for onsite treatments, e.g. during exams and ceremonies.
- Ensure there are clear evacuation procedures and dedicated people onsite at event locations in case of fire or other threats.
- Be aware of what details are communicated publicly. When it comes to possible threats from the outside, rethink publishing detailed programme schedules on the website or social media.

Academic Programme

Exam Development (Theory)

The theoretical exams were developed by an interdisciplinary team of scientific staff and professors from the Department of Physics of the University of Zurich, high school teachers and volunteers from the Swiss Physics Olympiad Association (SwissPhO).
Schedule:

April – October 2014	Three brainstorming sessions (resulting in about 20 proposals for exam problems), selection of problems to be pursued (7 proposals)
November 2014	Tentative formulation of detailed tasks for problems
November 2014 – July 2015	Working out detailed formulations, checking for compatibility with Syllabus
August – October 2015	Internal review
November 2015	Selection of problems to be tested by students (5 problems)
December 2015	Homogenization of problem texts, preparation for testing
February 2016 – June 2016	Testing
June 2016	Freeze texts, decision on final 3 problems plus 1 backup Translations Preparation of Board Meeting presentation

About 15 people were involved in the initial brainstorming sessions and a variety of proposals from various areas of physics were collected. As an introduction, problems from previous Olympiads were presented and the necessary criteria for effective problems discussed. In parallel, a list of topics from all previous IPhO problems was created in order to assess the originality of a given proposal.

Teams of 2-3 people (preferably with different backgrounds but at least one SwissPhO member and one university staff member) were installed to pursue further work on specific exam problems. These teams also reviewed problems within a first review round. Additionally, homogenization and reviews were performed in parallel by a group of experienced former IPhO participants and Leaders from SwissPhO.

The final decision on the exam problems was taken by the Academic Board in June 2016, based on the feedback received in the final test round, ensuring a balance of physics topics and a diversity in the style of the problems.

Challenges

- Conveying the criteria of a “effective” IPhO exam problem (difficulty, originality, diversity, ability to mark in a fair way) to people not involved in an IPhO before.
- Setting up a creative process to find original problems in view of the multitude of criteria to be observed for a task to be IPhO-compatible (e.g. no problem on a similar topic in a previous IPhO, should not require written answers, etc.).
- Judging the appropriateness of the problems after being involved in their development.

Recommendation

- Have contributors that have no previous experience solve and/or correct several IPhO problems before starting any brainstorming rounds.
- Encourage more interaction between the teams working on the problems (feedback culture).
- Test the proposed problems early with external testers. This also forces the authors to fully develop the problems. Many issues only come up once the problems are completed.

Exam Development (Experiment)

The experimental exam problems were developed by a team of scientific staff and professors from the Department of Physics of the University of Zurich.

Schedule:

April – October 2014	Three brainstorming sessions (resulting in about 4 proposals)
November 2014 – July 2015	Building of first prototypes. Test measurements. Further search for additional proposals
July 2015	Internal review and testing. Prototype for additional proposal built
August – October 2015	Internal review
December 2015	Selection of problems to be tested by students (2 experiments, 1 backup)
December 2015	Homogenization of the problem texts, preparation for testing
January 2016	5 prototypes per experiment built for testing. Final suppliers are evaluated
February 2016 – June 2016	Testing
April 2016	Start of production of final experimental setup
June 2016	Freeze texts, translations Preparation of the Board Meeting presentation Experimental setup production finalized

In the initial brainstorming sessions about 15 people were involved. Experimental setups from previous IPhOs were presented to those involved. At first, relatively few usable proposals were brought forward and as a result the search for additional proposals continued through 2015. Based on the proposals, early stage prototypes were built and tested by the authors and experienced members of the Academic Committee. Each author was assisted by an experienced scientific staff which took care of overseeing the ordering of the experimental equipment as well as the solutions of the experiments. As for the theoretical problems, homogenization and reviews were performed in parallel by a group of experienced former IPhO participants and Leaders from SwissPhO.

Based on the financial situation when deciding on the experimental setups, relatively simple equipment was chosen and parts of it shared between the two experiments. Moreover, the decision was made to split the Students into two groups for the experiment and to reuse key equipment from the morning group for the afternoon group.

The design of the electronic and mechanical components of the equipment was performed by the electrical and mechanical workshop of the Department of Physics of the University of Zurich. Final assembly of the power supplies was performed by the electronics workshop, while the loudspeaker assemblies and four-point probe contacts were produced by an external workshop employing mentally- and physically-disabled persons. Final testing of all the main components of the experiments was performed by the electronic workshop.

Cardboard boxed exactly matching the size of the equipment contained, including a holder to avoid damage to the loudspeaker assembly were ordered both for storage and transport of the experiments during IPhO as well as for transport back home by the teams after the IPhO.

As the experiment was conducted in two half-groups, 200 copies of the experimental setup were necessary. In order to have spare parts for replacing faulty equipment at hand, a total of 250 copies were produced. Moreover, components that could be easily damaged or lost (wafer, beads, battery pack, etc.) were ordered in large quantities (450 pieces) and replaced during the lunch break for the afternoon group. The total cost including external labour was CHF 250 per experimental kit.

Per team, one experimental kit was offered for free after the IPhO, with additional kits sold for CHF 100 each. All free and sold kits were picked up by the participating delegations, avoiding the need to dispose of any of the equipment.

Challenges

- Conveying the criteria of a "effective" IPhO exam problem (difficulty, originality, diversity, ability to mark in a fair way) to people not involved in an IPhO before.
- Setting up a creative process to find original problems in view of the multitude of criteria to be observed for a task to be IPhO-compatible (e.g. no problem on a similar topic in a previous IPhO, should not require written answers, etc.).
- Judging the appropriateness of the problems after being involved in their development.
- As the final experimental equipment was not available during early testing, many small discrepancies or problems with regard to actual setup and instructions were discovered relatively late, resulting in tedious changes in the final texts.

Recommendation

- Have contributors that have no previous experience solve and/or correct several IPhO problems before starting any brainstorming rounds.
- Perform broad-scale testing of the experiments in the second half of the year before the IPhO.
- Test the proposed problems early with external testers. This also forces the authors to fully develop the problems. Many issues only come up once the problems are completed.

Quality Management of Exams

Quality Management (QM) of exams was conducted in several rounds. After the first draft of problems was available, members of the Academic Committee cross-checked the problems of their colleagues (August – October 2015). This was very useful, as it helped the committee members to see the problems from a different perspective and understand better the form they should take.

In a second step, two members with previous IPhO and SwissPhO experience carefully reviewed all problems (December 2015). One goal was to unify the languages/styles. Another goal was to get an overview of the set of problems, and to see whether they complement each other or are redundant.

In a third step, problems were solved by people not previously familiar with the problems. We decided to ask former IPhO participants and talented physics students to help. This step helped to determine the time requirement of the problems and their difficulty level. Moreover, we hoped to see which typical mistakes might be made during problem solving and consider this in the marking schemes. Two major test rounds were held, a first one in March and a second in May, with about 15 participants each. Each participant signed a confidentiality agreement and declared that she or he is not involved with the selection or training of potential IPhO participants in any country. Testers were not allowed to take any documents out of the exam room or use mobile phones.

In parallel, the problems were sent for review by five former members of the International Board of the IPhO, as recommended by the President of the IPhO.

Another improvement occurred during translation into the IPhO languages. Some unclear sentences were detected by translators and subsequently adjusted in the original version.

Challenges

- Time pressure: we did not have time for many iterative rounds.
- The biggest challenge was finding appropriate “test persons”. We decided on first year university students, older students, PhD students, future teachers and current teachers, including people with and without IPhO experience. In the end, we got the most useful feedback from former IPhO participants (mainly in their Bachelor studies). They could judge best whether the difficulty level was appropriate and whether the questions were appealing. However, Switzerland does not have many IPhO medallist winners and hence feedback was limited.
- Confidentiality: who to reveal questions to and when. Should we mention details about the problems or not?

Recommendations

- Reserve enough time for testing.
- Confidentiality: carefully evaluate who you trust.

Official Translations

According to the IPhO statutes, the organizers of an IPhO have to provide the International Board with the exam problems translated into the following five languages: English, Russian, Spanish, French and German. As our problems were developed in English, we had to set up translations into Russian, Spanish, French, and German as well as proofreading of the English version to ensure maximum quality of formulations in the version that will be used as the basis for discussion.

At the beginning of 2016 native speakers of the respective languages of the teaching assistant pool (i.e. PhD students) at the Department of Physics were identified and asked whether they would be willing and capable of translating these texts. Two volunteers per language were engaged: one was asked to translate the experimental part and proofread the translation of the theory part and vice-versa.
The translation was done using the exam translation and management tools (Exam Tools) that were developed especially for the Board Meetings of the IPhO 2016. Therefore, before the translation, the original exam texts written in LaTeX had to be transferred to the block format required by the Exam Tools. As such, the translation process was also a test for the new translation software. With a considerable investment in time, the translators managed to perform the translation and proofreading within two weeks.

Although we felt that the translations provided were of a reasonable quality, our expectations were confirmed: very few delegations actually used the provided text as a basis for their translations during the Board Meetings.

Challenges

- Not all exam texts were finalized at the stage where the translation process was set up. As a result, several parts of the translated exams had to be modified afterwards.

Recommendations

- Letting scientific staff translate the exams seems a good choice, since knowing the topical background of a text that needs to be translated is as important as knowing the language well.
- Do not start the translation process before all testing has been concluded.
- Future organizers of the IPhO should be released from the duty of providing their exam problems in any other language than English.

IT – Exam Tools

For the first time in IPhO history, we used an entirely web-based management of the exams: exam feedbacks, translations, printing, voting, corrections and ranking are among its features. The delegations were expected to work with their own laptops, with the advantage that people were already familiar with the computers used, for example for typing their own language and script. The system received very positive feedback by participating delegations and, despite being a novel technology, it worked smoothly with only a limited number of problems. However, it should be noted that the development team was constantly monitoring system errors and, especially during the first plenary discussion, fine-tuning for specific languages was needed.

The exam translation and management tools (Exam Tools) are a web application with a backend written in Python, based on the widely used Django framework[1] and relying on XeLaTeX[2] for the generation of the exam PDF documents. Thanks to the free Noto[3] fonts we could support most languages and scripts without any effort from the delegations. The modern slim responsive web interface is developed using the Bootstrap[4] framework, which provides several UI components optimized for multiple sizes and browsers. For a straightforward editing experience of the question blocks we rely on the CKeditor[5] web text editor.

The main features of the Exam Tools are summarized in the following list.

- Exams
- Feedbacks
- Languages management
- Translations
- Final submission
- Results
- Marking
- Moderation
- Voting
- Printing

The exam editing during the discussion of the International Board was designed to automatically generate versioning of the changes. They could be presented by the organizers for a vote, or visualized independently by the delegations in order to highlight the new parts to be translated.

The final submission allows the selection of languages to be delivered to each Student. The system can concatenate multiple translations and provide answer sheets with unique QR codes. Note that a backup printing station was present during the examination, in order to print new working sheets with a registered code. The finished exams are automatically uploaded to the Exam Tools' server thanks to the FTP (file transfer protocol) functionality of the high performance printers of our print centre. A daemon automatically analysed the codes on each page and sorted the scanned documents for each Student.

The printing module has a twofold functionality. On the one hand it allows the users to print without the need to install any driver, on the other hand it connects directly with the exams database and the printing infrastructure, allowing quick and easy bulk prints of all exams. This was realized thanks to a custom REST print server installed on a local computer.

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1 https://www.djangoproject.com, version 1.8.

2 Contained in Texlive 2015.

3 https://www.google.com/get/noto/.

4 http://getbootstrap.com, version 3.

5 http://ckeditor.com, version 4.5.

To ensure a more reliable and secure system we decided to block all incoming external traffic to the Exam Tools, except for the network in the auditorium of the Board Meeting. These kind of changes to the networking system are made easy by the ScienceCloud[6] infrastructure (an OpenStack[7] managed cluster) and are applied instantaneously.

While moving from the development to the testing and production phases of the new tool, the system requirements (needed to run multiple instances of the Exam Tools) grew rapidly. Thanks to the support of the ScienceCloud team at the University of Zurich our quota was quickly expanded. The table below reports the main instances that were deployed for the testing and production phase.

Service	Cores	Memory	Disk	Lifetime
Demo	8	8GB	80GB	4 months
Instance delivered to the Leaders in March 2016, in order to get used to the system and for testing purposes.				
Problems dev	4	4GB	60GB	4 months
Highly confidential instance used only by the problem authors.				
Production	32	128GB	1.5TB	2 weeks
Production system at IPhO 2016 (after upgrade on the second day[1]).				
Training staff	8	8GB	40GB	2 weeks
Demo instance used for the training of the IT support staff.				
Rehearsal authors	4	4GB	20GB	2 weeks
Final version of the problems available one week before the IPhO for testing the discussion process.				

[1] The production system before the upgrade was only 16 cores, 64GB RAM with 100GB disk space.

The only major incident occurred at the end of the first translating session, when the production system saturated all available disk space and blocked the submission of the last four delegations. Prompt action by the development team was required to continue the activities. After the incident it was decided to upgrade the system to include more resources. Additional interventions identified an excess in the lifetime of temporary objects that could be solved on time before the second translation session.

6 https://www.s3it.uzh.ch/en/scienceit/infrastructure/sciencecloud.html.
7 http://www.openstack.org.

Challenges

- The IPhO has more than 80 countries with almost as many languages. It is highly complex to design a system which supports all variations and peculiarities.
- In the beginning we had very low response to the public demo version that was sent to the Leaders in March 2016. Many feedbacks came in one month before the IPhO, which required investing much time during a critical period.
- The development was too focused around the free time of a single volunteer developer who could not provide a fulltime work-load. It was very hard to find other developers with experience spanning all components.
- Constant tuning was needed during the translation sessions. Thanks to automatic reporting we could solve some issues before the users reported them, but this required the developers to be present the whole night.

Recommendations

- Rely on modern systems which support Unicode text and fonts. This simplifies the management of many language variations.
- If the actual users do not respond to your demo version, try to find other test users. Do not delay the test phase because people do not respond.
- Focus on maintaining users' work flow. In case of problems with an exam question, tell them to work on a different question in the meantime.
- Distribute the workload to a team so people alternate on active support.


TECHNOPARC

IT - Infrastructure

For a smooth working of the Academic Committee a number of IT services were needed in the preparation phase as well as during the IPhO week. Initially hosting a file-sharing system and a project management tool, the IT infrastructure of the Academic Committee expanded quickly — including several test versions of the Exam Tools application, a monitoring service and a backup infrastructure. During the IPhO we had to deal with the infrastructure needed for the International Board, such as the network used, the printing stations and rental notebooks.

With a strong focus on reliability and security we opted for on-premise solutions based on open source software that we managed ourselves on the cloud infrastructure of the University of Zurich, an OpenStack[1] managed cluster, ScienceCloud[2] , running on Intel Xeon E5-2640 v3 processors with 16 cores each. The quota allocated to our project was constantly increased up to a final 80 cores, 256GB of RAM and 3TB of volume storage. The following table reports the configuration of the main services (quota of Exam Tools reported separately).

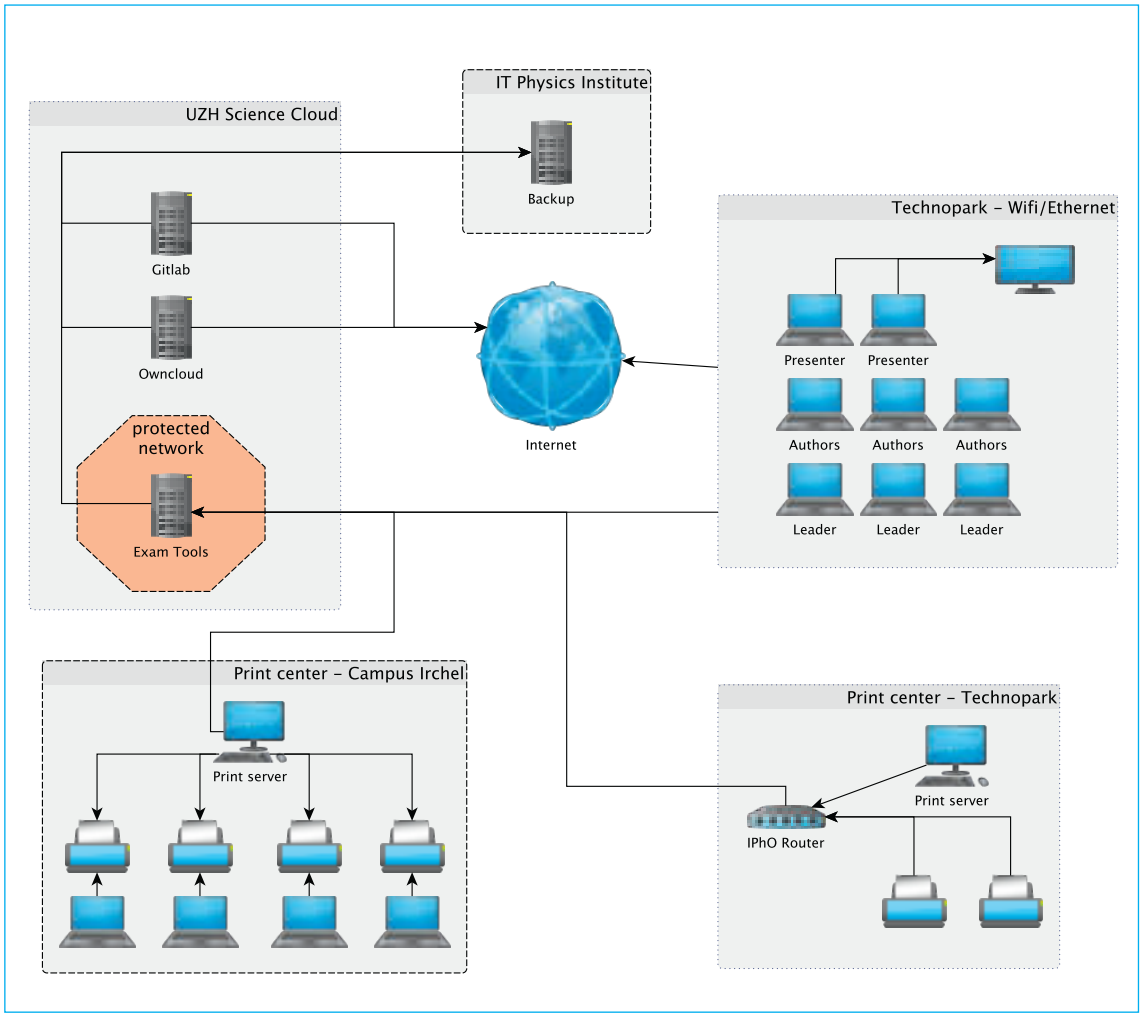
Service	Cores	Memory	Disk
Owncloud	2	2GB	20GB
Gitlab	2	2GB	60GB
Monitoring	1	512MB	10GB
Backup		externally managed	>3TB

File sharing was organized with the Owncloud[3] software: a Dropbox-like system that we could host ourselves, to guarantee that the preparation of the exams remained confidential. Gitlab[4] was used to host the development of our tools, such as the Exam Tools. The monitoring service was an indispensable system to keep an overview of the IT infrastructure, which we based on the Graphite[5] project. The backup system was organized by the IT services of the physics institute. To ensure security, backups were stored using a GPG encryption.

During the IPhO our IT infrastructure also included the following systems:

- High quality wireless and wired internet connection at the Board Meeting facilities (200 Mbs, with common time-base).
- Printing centre at Board Meeting location (Technopark, Zurich):
  - 1 Cisco router with a private subnet and a public fixed IP
  - 2 Canon printers (Canon imageRUNNER ADVANCE C5051)
  - 1 print server (HP 250 G4 15.60", WXGA, Intel Core i5-6200U, 8GB), reachable externally via the public IP of the router
- Printing centre at the University of Zurich (UZH), Campus Irchel:
  - 4 Canon printers (Canon imageRUNNER ADVANCE C5051) with fixed university-internal IP
  - 1 print server (HP 250 G4 15.60", WXGA, Intel Core i5-6200U, 8GB) with fixed university-internal IP
  - 4 MacBooks Pro Late ‘09 for managing the printers
- Rental laptops for Leaders (only three laptops were requested):
  - 10 HP Elitebook 8570p
  - 9 HP Compaq nw8440
- Service laptops:
  - 3 MacBooks Pro Late ‘09 for video broadcasting
  - 6 MacBooks Pro Retina for academic committee and presentation
  - 1 HP Elitebook 8570p + 1x Printer for printing extra working sheet during the exam

The devices and network employed during the IPhO are summarized in the following figure.



Challenges

- Estimating the number of resources needed. In the beginning we did not expect to run so many services ourselves.
- It might be easy to maintain a single machine, but it is much harder to keep many machines under control.

Recommendation

- Rely on an extendable platform where resources and costs may vary during development and production.
- Benchmark each component of your infrastructure. Does the network support all the users? Rely on service providers with recent experience, which are more likely to have cutting-edge hardware.
- If possible, do not buy hardware. You will be unlikely to reuse it and reselling requires a major effort after the event.
- Open source software is often enough for a project like the IPhO. However, do not underestimate the amount of work required to manage multiple machines. The use of provisioning systems is very important in order to maintain a stable infrastructure. If you can, rely on support groups at your local university.

[1] http://www.openstack.org.
[2] https://www.s3it.uzh.ch/en/scienceit/infrastructure/sciencecloud.html.
[3] https://owncloud.org, version 9.1.
[4] https://about.gitlab.com, version 8.7.
[5] https://graphiteapp.org.

International Board Meetings

Venue

As for most of the other venues of IPhO 2016, finding an appropriate location for the International Board Meetings proved to be a challenge. Important criteria were the distance to a hotel location for the Leaders (clear preference on a venue that was within walking distance), availability of catering services, smaller rooms for the moderation, and of course the prices. Located just across from the Leaders' hotels, Technopark Zurich, a start-up incubator owned by a non-profit organisation, was chosen as the site for the Board Meetings and the moderation. Meeting halls and rooms, network and audio/video services as well as catering were all provided by Technopark and its associated companies. Early negotiations started at the beginning of 2015 and the first reservations were made in August 2015. The large public corridor of the building was used for the lunch and evening buffet as well as a work space for Leaders and Observers when not on excursion. As the largest hall, the Auditorium, was not big enough to accommodate both the Leaders and all Observers, two additional smaller seminar rooms were rented for the Observers, and an audio/video transmission from the main hall was set up. Additionally, five rooms for the moderation (one per problem), as well as some office space, were booked.

Roles

Timing, instruction of the volunteers and other organizational matters on site were overseen by Simon Birrer. Key decisions and programme points were led by the head of Academic Committee, Thomas Uehlinger. The Board Meetings were chaired by Prof. Anton Alekseev. A team of four Academic Assistants as well as twelve Leader Guides were available for tasks such as printing, distribution of paper copies, assistance with microphones, and observation duties at the observer rooms. Additionally, the head of IT, Michele Dolfi, oversaw four Assistants who managed problem presentation and in particular the voting process and changes in the exam texts.

Equipment

Every table was equipped with a multi-way connector and backup ethernet network connectors. The organizers provided international power plug adapters as well as USB-to-ethernet adapters. For network access we mainly relied on the installed wireless network infrastructure, which consisted of about 10 ceiling-mounted access points with a total bandwidth of 200 Mbs. Two high-volume printers were installed in the main meeting hall for scratch printouts. Three projection screens (one main and two side projectors with independent input) plus another at the back of the hall were used. While professionally installed, the audio/video equipment was operated by our volunteers during the event.

Schedule

Due to the overall tight schedule of the event, the discussion session of the experimental exam had to take place on the same day as the Opening Ceremony. This way, the session could only start at 2 pm. As per the IPhO statutes, both experiments were presented without interruption, with 1.5 hours allocated after the presentation for discussion and handing in of feedback. Copies of the exam papers were distributed. During these 1.5 hours, six copies of the exam equipment could be inspected and tested by the Leaders in a separate room, with the deputy authors of the exams present.

While generally well-structured, the discussion nevertheless often focused on unnecessary details, slowing down progress. Final votes on experiments 1 and 2 were held at around 9 and 11 pm, respectively. The translation process generally went smoothly and progressed quickly for many delegations as a result of the new Exam Tools software. Submission of the finalized translations was purely electronic, i.e. the full printouts for the Students were not produced and packaged on-site. The workload of the two print stations thus remained moderate.

The majority of the delegations finished the translations by 4 am, with the last ones taking until roughly 6 am.

The discussion of the theory problems started as scheduled in the morning and gained in efficiency. The final vote took place around 10 pm and thanks to this and to the additional computing resources assigned to the Exam Tools server many of the delegations managed to finish their translations before 2 am. During the day, the copies of the completed experimental exams were distributed in printed form and made available electronically.

Another Board Meeting was held in the morning before the moderation to announce the medal ranges. After the moderation, the final vote and the general assembly was held.

Challenges

- Finding a suitable person to lead the discussions of the International Board Meetings. For such a role, one has to know the ins and outs of all problems, has to have previous experience with the IPhO as well as with leading large meetings, be fluent in English and last but not least should possess a certain authority. In addition, they should optimally have no other duties within the organization so as to able to fully focus fully on this task.
- The 1.5 hours allocated for discussion after the problem presentation were not sufficient for the authors to process the feedback, and an extension was needed.
- The system for ordering and treating incoming comments by the Board was not optimally set up; this slowed down the discussion. It is important for the audience to see the textual context of a given topic.
- A server breakdown in the later stage of the translation process of the experimental exams slowed down the remaining delegations.

Recommendation

- Optimally, the designated chair of the Board Meetings should attend the previous Olympiad if she or he has no previous IPhO experience.
- Take enough time to review changes made during the discussion with regard to their impact on the answer sheets and solutions before the final vote on the respective problem. If discrepancies are found later, changes have to be made by the Leaders to all their translations.
- Even if submission of the exams is purely electronic, maintain a separate list with the status of every delegation with regard to the final submission.
- More than two people per problem are necessary to efficiently process the feedback received by the Leaders. Having a separate person assigned to pre-sort comments would be helpful.

Printing & Scanning

The printing and scanning centre had the following tasks during the IPhO:

Timing	Task	Duration
Before IPhO start	Print copies of exams for Leader (exams + solutions)	1 afternoon
Night before exam 1	Print exams	Midnight – 8:00
After exam 1	Scan exams and re-print for correctors	14:00 – ca. 22:00
Night before exam 2	Print exams	Midnight – 4:00
After exam 2	Scan exams and re-print for correctors	14:00 – 2:00

We organized a room at the university and rented four combined printers/scanners (Canon imagerunner Advance C5051) that work at high speed.

A team of eight volunteers was intended to operate these. However, as the shifts were very long with only a short break between, additional volunteers helped out during the scanning sessions.
Another two printers of the same model were located at the Board Meeting site and were operated by an independent team. These printers we used to provide scratch printouts to the Leaders during the two nights spent translating the exams. In addition, the solution and marking schemes for the Leaders were printed at this site.

A total of 180,000 pages were printed during the whole IPhO. The total cost for the rent of seven printers in total including the page cost was about CHF 13,000.

All the sheets handed in by the Students after the exams (question and answer sheets) were scanned immediately after the exam and the originals were kept on file afterwards. Both the marking by the organizers and Leaders took place on printouts based on these scans. Additionally, the scans were made available to the Leaders as PDFs through the Exam Tools software.

Challenges

- A lot of work happens during the night. If technical problems arise, support may be difficult. We had booked support for the printers during the night and had to make use of it.
- Volunteers have long shifts.
- Some languages/fonts can pose problems during printing (although the PDF looked fine).
- Documents took longer than expected to print. The theory exam had about 80 pages, if in addition to the translated versions the official English version was included by a delegation.
- Making sure that every exam is printed/scanned and the right sheets go to the right Students.
- Dealing with Students writing answers for Problem X on sheets for Problem Y. Do scanning volunteers need to understand and judge the physics?
- Time after the second experimental exam (afternoon) was very limited for scanning and printing for correctors. This led to stressful situations. To enable the correctors to start their work, we initiated printing soon after the first exams had been scanned. This meant that printers had to print and scan at the same time.

Recommendation

- Pre-order enough paper and toner.
- Organize printers that are identical. This makes handling easier and less prone to problems.
- Test for all languages before the IPhO that printing works on the same printer you are going to use during the IPhO.
- Have a backup plan: how do you print/scan if your first plan does not work? (Server break down, etc.).
- Have enough backup volunteers if needed.

Approval of Student Calculators

Based on previous years' experience, the Academic Committee of IPhO 2016 decided to set up a pre-approval process of Student calculators to streamline the process at the event.
Students are allowed to use their own calculators in the examinations as long as they satisfy the following criteria according to the regulations of §5 of the IPhO statutes:

- Calculators must not be graphic
- Their display must not have more than three rows
- User memory must be cleared immediately prior to each exam

To comply with the practice established over the last years and supported by the IPhO Secretariat, calculators not satisfying the above criteria cannot be accepted. The rationale behind these provisions is not to disadvantage students with simpler calculators.

The following provisions applied to calculators brought by the Students:
- If Students wished to use their own calculator, the model had to be communicated during online registration of the Student.
- Only registered calculators satisfying the above criteria were allowed in the exams.
- Registration was restricted to a maximum of one calculator per Student.
- Registered calculators were collected upon arrival of the Students and checked for compatibility with the criteria before the exams.
- Calculators not satisfying the criteria were returned to their owners only after the exams.
- Calculators satisfying the criteria were returned to the Students at the beginning of each exam and collected between exams.
- Calculators satisfying the criteria were returned to their owners after the exams together with other electronic devices.

We provided **Texas Instruments TI-30 ECO RS** calculators to all Students whether they brought their own or not.

The information outlined below was communicated to the Leaders in the second and again in the fourth circular. After the general team registration calculators could be individually registered using our online registration form starting by end of February 2016. Participants could select from a choice of pre-approved calculators or enter the model of their calculators for approval otherwise.
Choice of approved calculators:

TI-30X IIS	Casio FX-82 SOLAR	Sharp EL-520X
TI-30X IIB	Casio FX-82SX Plus	Sharp EL-531XH
TI-30 eco RS	HP 10s+	Sharp EL-531XG
TI-30Xa	Canon F-502G	Sharp EL-509X
Casio FX-350MS	Canon F-715S	Sharp EL-501X
Casio FX-220 PLUS	Canon F-715SG	Sharp EL-506W
Casio FX-82MS	Canon F-720i	Sharp EL-520W
Sharp EL-509W	Sharp EL-506X	Sharp EL-531WH
Sharp EL-510RN		

- About four weeks prior to the event, entries on individually registered calculators were checked:
- About 65% of Students registered to bring a personal calculator.
- About 25% of Students registered a calculator which was not in the list of pre-approved calculators.
- About 15% of Students registered calculators which were not approved by the organizers.

Based on these results a reminder to bring an approved calculator was sent to all corresponding Leaders few weeks before the event.

At the event, calculators were collected and checked again upon registration of the Students. Students were given the opportunity to get acquainted with the calculators provided by the IPhO before the exams. For this purpose, every Team Guide was given one calculator with an instruction sheet and was asked to pass it on to the Students.

The calculators handed in by the Students were individually bagged together with the writing utensils provided by the organizers and placed at their desk for the two exams. That particular calculators were not accepted was communicated to the students on the day before the exams. The approval and bagging process was taken care of by a team of five persons on the afternoon on the day before the experimental exams.

Challenges

- Some Leaders seem to have only partly communicated details on the pre-approval process to Students. As a result, many Students registered calculators which were not approved. Moreover, certain Students brought calculators that had not been registered at all (which we nevertheless accepted in an on-site approval process on the day after arrival if the criteria were satisfied).

Recommendation:

- The pre-approval process helped to avoid discussions about the admittance of calculators and should be continued.
- Placing the calculators at the student's desk helps to avoid any disorder at the start of the exams and should be continued.
- A direct communication channel to the Students should be established before the event (e-mail) to communicate organizational details such as the approval process of calculators.

Exams

Venue

Both the experimental and theoretical examinations were held at a gym hall located on Irchel Campus at the University of Zurich. The university had already conducted other examinations at the gym hall, where appropriate tables had been bought. In addition, we installed visual covers made from cardboard at each desk. A public address system was available on site in order to instruct the Students and Team Guides. All staff on site were instructed in evacuation procedures in case of an emergency. Additionally, two trained medical practitioners were on stand-by by the gym hall during all examinations.

A coordinate system was set up to number the desks. All equipment to be distributed on the desks (writing utensils and calculator(s), experimental kits, exam sheets) was labelled accordingly to allow for a quick distribution. Students from one country were allocated to seats located in the same sector of the hall, but far enough from each other to prevent any communication.

Set up schedule

	Sat, 09.07.	Mon, 11.07.	Tue, 12.07.	Wed, 13.07.	Thu, 14.07.	Fri, 15.07.
Morning	Installation of floor protection Set up of desk	Placing of experiment boxes at desks	Exam: technical support	Re-arranging of desks for theory exam	Exam: support	Dismantling of installations; clean up
Afternoon	Installation of visual covers Set up of chairs	Placing of writing utensils and calculators at desks	Re-furbishing of experiments for afternoon group; clean up		Dismantling of installations	

All the logistics related to the exams was handled by a team of 16 technical staff from the Department of Physics. During critical periods of exam days, they were supported by another seven staff.

Experimental Exam Day

As outlined above, for the experimental exams the Students were split into two groups. The (effective) schedule for the day was the following:

06:15	Departure of buses from hotels
06:30	Delivery of printed exams at exam site
06:45	Arrival of first Students at exam site
07:00	Seating of Students
07:30 – 12:30	Exams
12:30 – 14:30	Refurbishment of experiments, distribution of new exams, calculators, writing equipment
14:30	Seating of Students
15:00 – 20:00	Exams
20:00 – 22:00	Clean-up

Delivery of the exam printouts was on time, and only the printouts for the very last submitting delegations were delivered at short notice (about 30 minutes before the exams started). To avoid unnecessary waiting times for the Students, complete delegations were immediately seated in the hall. Since quite a few Students had to visit the restroom, seating of all Students required about 30 minutes. Every Student had two desks (each 110 x 60 cm) at her or his disposal. Writing equipment, calculators and light snacks were provided. While all required instruction for Students were given in the general instruction sheets available at each desk, the most important points were announced via the public address system in English, Spanish, Russian and Chinese. During the whole exam, two guides were seated at the end of each row to observe the Students. Students' desks were equipped with three flags: "I need to go to the toilet", "Please refill my water bottle" and "I need help". If they required any assistance, they could draw the attention of a Guide, which re-transmitted the message to additional Guides seated at the end of the hallways. If Students called because of a technical problem, academic staff checked the equipment on-site, and if any failure was detected or in case of doubt, they replaced the faulty components. About 40 individual components were replaced during the two experimental exams (mainly multimeters, scratched wafers, speaker assemblies and power supplies). No major incidents occurred during either of the exam sessions. The refurbishment of the experiments during the lunch break required slightly more time than planned, leading to a delay of 30 minutes for the afternoon exam.

Theory Exam Day

The (effective) schedule for the theory exam day was the following:

07:00	Departure of buses from hotels Delivery of printed exams at exam site
07:45	Arrival of first Students at exam site
08:00	Start of seating of Students
08:45 – 13:45	Exams
13:45 – 14:15	Students leave hall
afternoon	Clean-up

The same organization was followed as for the experimental exam. To accommodate all 400 Students, every second desk was rotated (each two desks were arranged in an L-shape for the experimental exams) to provide additional exam place. Due to the larger number of Students, more time was calculated to seat all Students and for them to leave the hall. Quite a few Students required additional spare work sheets, of which the headers had to be printed on-site to allow for automatic scanning afterwards using QR-codes. During the waiting time, these Students had to switch to solving other tasks first.

Challenges

- Even though the Team Guides were carefully instructed, both in writing and on-site, some did not strictly adhere to the instructions, resulting in delays while seating the Students.
- The refurbishment of 200 experiments during less than two hours.

Recommendation

- Scheduling the experimental exams on the first exam day (instead of the theoretical exams as in most past Olympiads) proved to be a sensible choice, as it allows more time to set up the equipment and to test the processes for only half the Students ahead of the theory exam, which all 400 participants took at the same time.
- Splitting the Students into two groups for the experimental exam can save equipment costs and space (a suitable location to hold all experimental exams would have cost us around CHF 100,000). However, such a system results in very long days for Students, with half of them having to get up before 6 a.m. Transport etc. should be organized as efficiently as possible to avoid any waiting times.
- For the theoretical exams, prepare enough spare writing sheets for Students. Up to twelve sheets of spare paper per problem were used by some Students.

Marking

The marking of the examinations represents a crucial topic in the organisation of the IPhO, and consists of not just correcting the experimental and the theoretical papers but also of finding and training the Markers. As a first task (November 2015), we prepared an initial concept were we planned the number of participants/countries, the time needed to correct the exams and the known constraints of the schedule, so that we could establish the amount of Markers required for various scenarios. In our case, we received support from the Physics Department of the University of Zurich so all our Markers were professors (11), post-docs (31) and PhD students (47). We also had the help of an external teacher who previously graduated in physics. They were divided into two groups (41 for the experiment, 49 for the theory, with subgroups for each problem or experiment; in each subgroup, countries were assigned to a pair of Markers).

All the Markers were informed using info-mails, and also had to subscribe using the official IPhO website. A small website with some information, documents and a FAQ was also created for the occasion. Two trainings were organized. In the first training (two weeks before the IPhO), we gave general information about the IPhO (participants, ranking, etc.), explained the concept of the marking scheme (e.g. special cases) and discussed a previous problem from a student exam. We also informed them about the moderation process. The second training took place during the IPhO week, just before the corrections, to minimize any potential leakage of exam content (experiment: one day before the corrections; theory: the same day). In a first phase, we reminded them about the role of the marking scheme; then, each author presented the problem (as accepted by the Leaders) as well as the detailed marking scheme. The Markers had sufficient time to read through the problem/marking scheme and discuss it with the author if necessary.

During the corrections, all subgroups responsible for a given problem or experiment sat in the same room and the author was always present to answer questions. If a case was not covered by the marking scheme, the Markers had to discuss the issue with the author in order to ensure a homogeneous correction. It is important to know that the Advisory Committee (three Leaders) also sees the marking scheme and can discuss it with the author. The Markers worked in pairs so the exams corrected by one person were always cross-checked by a partner. Some pairs also corrected exams together. Note that the pairs were the same as those responsible for the moderation of particular countries. After the correction, each pair also had to enter the points in the system. During the marking, a paper version of the exams was provided (on which the Markers could write), as well as a scanned version.

The correction of the experimental part started at 08:30 on Wednesday and lasted the whole day (until 23:00 for the very last groups). The correction of the theory part started around 15:30 on Thursday afternoon and was completed on Friday afternoon (around 18:00 due to printing problems).

Challenges

- Handling 90 people with different schedules and expectations.
- For the experimental part, the Advisory Committee only discussed the marking scheme with the author during the afternoon: a large portion of the corrections made in the morning had to be adapted accordingly, leading to unexpected delays.
- Corrections greatly depended on the printing and scanning rate of the finished exams. For the theory part, the printing process encountered some issues at first, so the rate of delivery was very slow at the beginning (the Markers had to start with countries other than those planned, at least at the beginning).
- The final version of the problems could not be unveiled to the Markers until they had been discussed and accepted by the Leaders; this was a limiting factor for the start of the corrections.
- The corrections needed to be done by Friday evening (moderation to prepare); this involved a night shift from Thursday to Friday (not easy for the Markers).

Recommendations

- Prepare several scenarios for the number of Markers you need and the duration of the corrections. Discuss the schedule of the IPhO closely with the people responsible.
- Have a homogeneous team of Markers (for instance from the same university), at least PhD students and above. It eases corrections and moderation.
- Train and inform your Markers in advance. Only a few of them will know about the IPhO and how it works.
- Show them old problems (not only the questions, but if possible actual copies from Students), including the solutions and marking scheme.
- Make them aware of the importance of the marking scheme (this usually differs from what they know for classical examinations).
- Organize teams of two or three people for the corrections, with the same people planned for the moderation. Try to have a senior (professor, post-doc) and a junior (PhD) in each team.
- Have the author of the problem in the correction room most of the time (and most importantly at the beginning).
- Vary the countries given to the Markers, i.e. do not give all the best students to the same Markers. Remember your Markers need to eat and sleep; this needs to be organized in advance.
- Ask the Advisory Committee to discuss the marking scheme with the author as early as possible. If there are major changes and you have already started with the corrections, you will probably have to go through exams again.

Cheating Prevention

In order to prevent cheating, the organizers worked out a concept based on four pillars:

- Academic Committee: reduce the risk of proliferation of the exam problems before the start of the exam.
- Leaders and Observers: avoid proliferation of the exam problems or solutions from Leaders and Observers to Students.
- Students: prevent attempts by Students to cheat.
- Detection: detect cheating after the exams and take appropriate measures.

The following measures were taken for the four pillars:

Academic Committee:

- Secure communications and servers were used to develop the problems.
- All people involved with the problems at any stage were registered and made aware of a strict non-communication policy to any person outside of the Academic Committee. These persons had to sign a confidentiality agreement.
- Strict separation between people involved in the preparation of the Swiss and Liechtenstein delegations from those involved in the Academic Committee.

Leaders:

- Restricted network access to Exam Tools (access was only possible from the building where the Board Meetings took place).
- Access control to the Board Meetings: only Leaders and Observers were allowed (this includes video broadcast rooms).
- Leader Guides were instructed to keep an eye on Leader activities outside the Board Meeting room.
- Translations of all delegations were made public to all members of the International Board during the translation process and made public after the competition.
- Fair play call both in the fourth circular and at the Opening Ceremony.

Students:

- Collection of all electronic communication devices at registration (incl. calculators). Each Student had to sign a form where he/she declares that he/she has handed in all devices.
- Communication to Students that any electronic communication device not handed in is considered an attempt to cheat.
- No unsupervised moving of the Students outside hotels during critical times (from start of Leaders' discussion to the exam).
- Team Guides were instructed to look out for suspicious behaviour from Students the day/night before the two exams.
- Night guards were placed in the lobby of the Students' hotels.
- Telephones in hotel rooms were disconnected.
- Fair play call both in the fourth circular and at the Opening Ceremony.
- No bags or electronic equipment were allowed in the exam halls.
- Students were supervised at all times during the exams.
- Visual shields were placed between the Students' desks, and Students from the same country were seated reasonably far apart.
- Only supervised visits to the restrooms were allowed during the exams.

Detection:

Markers (many of them with foreign background and knowledge in several languages) were instructed to report any suspicion of cheating in the translated exams (hidden hints or answers) to the Academic Committee.

About 5% of the translated exam problems were selected at random and checked for agreement with the original English version.

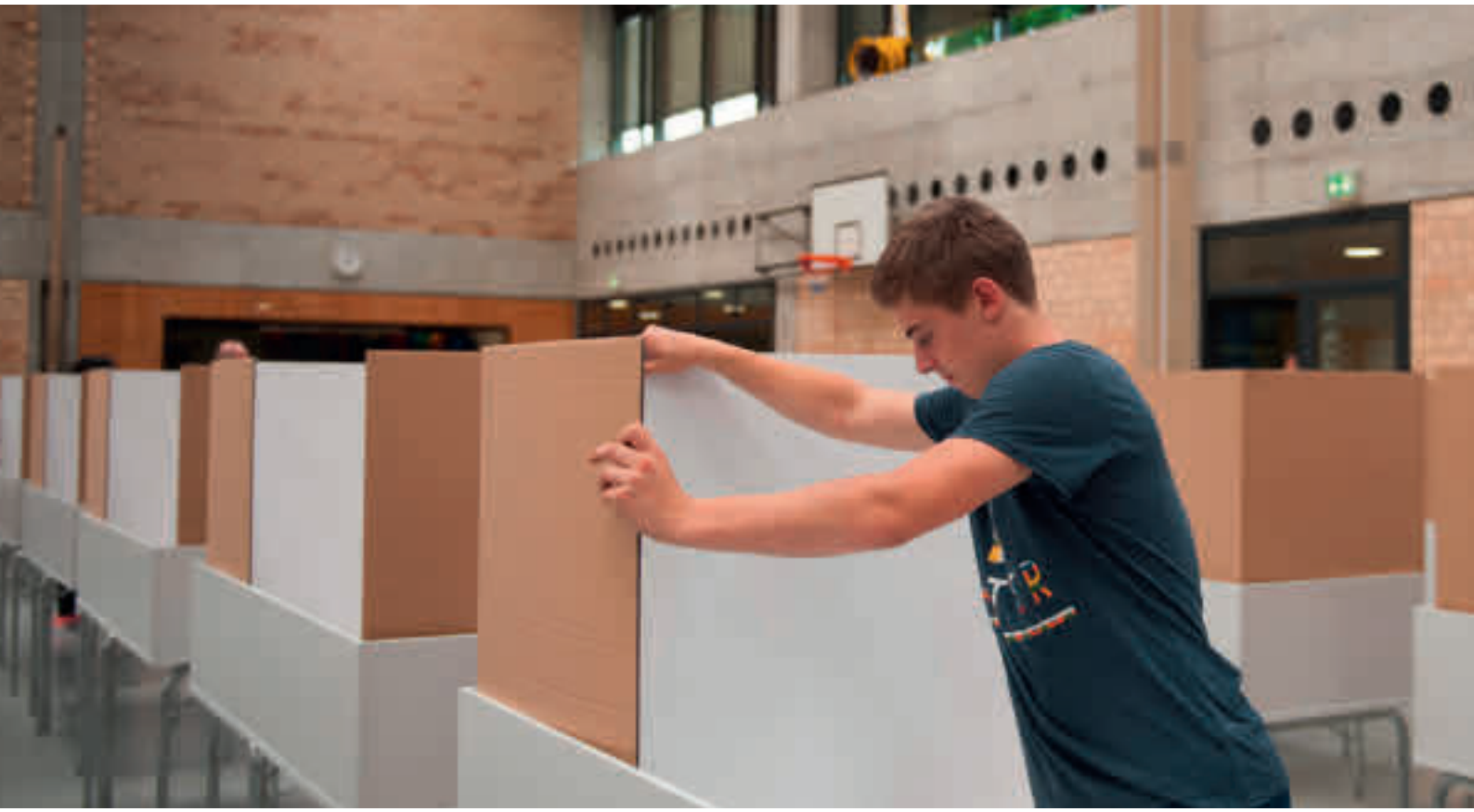
No attempts of cheating at IPhO 2016 have been detected. One suspicious case was internally investigated upon: one Student had given answers to questions that were not part of the final set of tasks. As it turned out, however, the respective Leaders had not taken this change during the Board Meeting into account, but instead based their translation on the non-revised version of the problem. The suspicions were therefore unfounded and no further investigations took place.

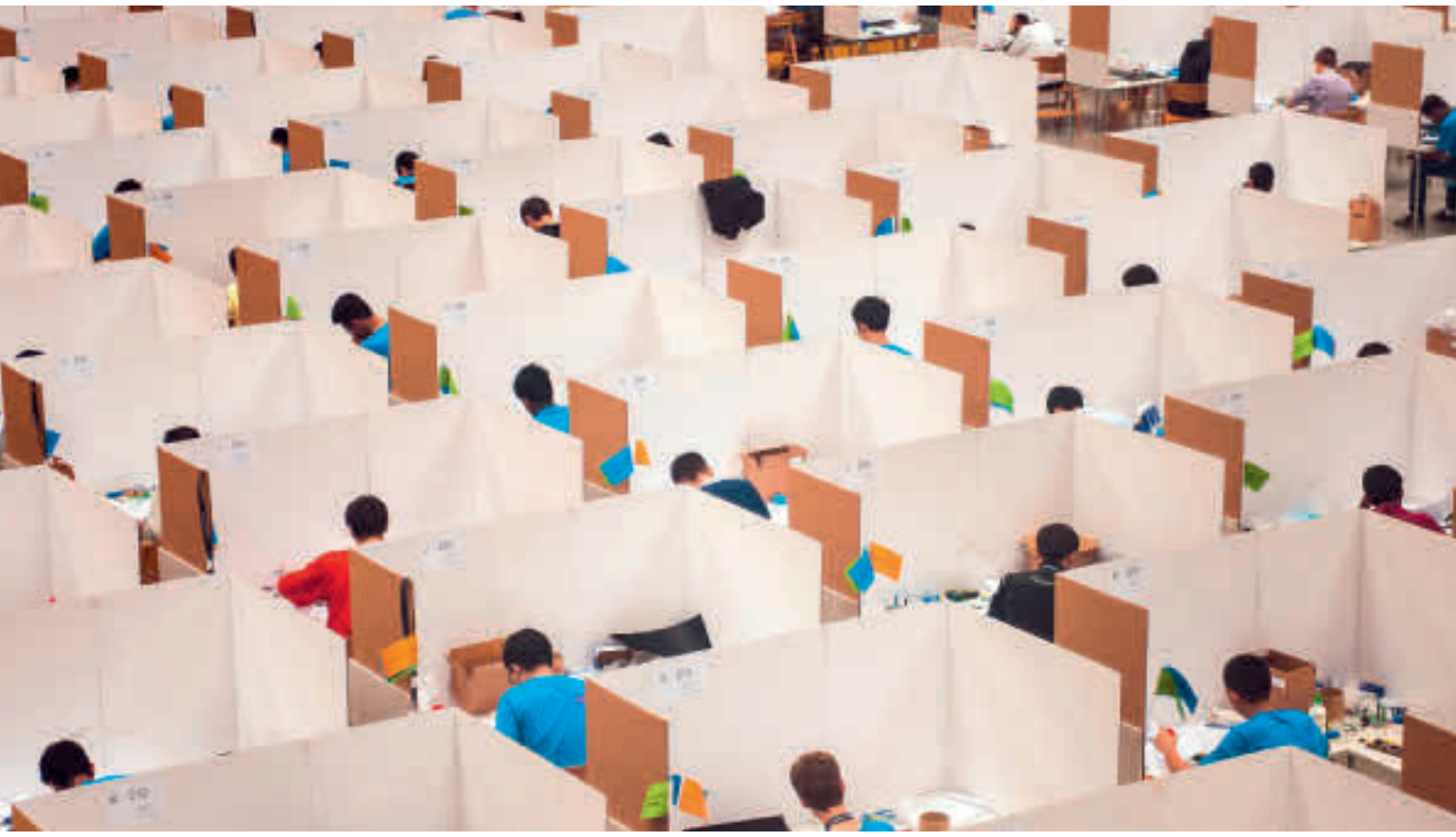
Challenges

- Both the hotels as well as the Board Meeting location were publicly accessible during the IPhO. Therefore, strict entrance policies at the building entrances could not be enforced nor could internet access be shut down (a measure which would probably also not have been accepted by the Leaders).
- The conduct and communication equipment available to the Students in their hotel rooms could not be observed. While we never intended to perform such checks (aside from any potential violations of privacy rights), this situation obviously leaves a large gap in any cheating preventing concept.

Recommendation

- Try to further foster the awareness of any attempts to cheat and to establish a widely-accepted code of conduct.





Moderation

During moderation, each country has the possibility to discuss the corrections of the problem with the Markers. The organization of this process is closely related to the marking of the examinations.
During the organisation of the marking, we built teams consisting of two or three Markers for a group of five to eight countries that were also responsible for the moderation of those countries. The information and training process took place at the same time as the marking process. During the training, we had to explain the concept of the moderation (Leaders have 20 minutes to discuss a specific problem or experiment), as well as the importance and philosophy of the marking scheme. In each pair we formed, there were at least a senior Marker (professor or post-doc) and a junior (PhD), so as to ensure easier discussion during moderation (this allows multiple points of view and can reassure some Leaders).
During corrections, the Markers were encouraged to write as many details as necessary on their copies of the exams so they could remember why they corrected a question in a specific way and make references to the marking scheme. After the corrections, all the exams were centralized and later transported and distributed in the moderation location so no Marker could forget them.
For the moderation, we planned one room for each problem or experiment. In each room, the author of the problem was present, as well as staff of two to three people. The author could assist the Markers if a conflict arose during discussion; the role of the staff consisted in announcing the start and end of each moderation session (20 minutes – no more, no less). During moderation, the Markers could directly adapt the total of points online in the Exam Tools, where they could see the points they gave, as well as the ones given by the Leaders. Just before the end of the moderation, the Markers had to report the total of the points for each student on a sheet of paper that the Leaders had to sign. If a country refused to sign the results at the end of the allocated time, they had to be redirected to a room were the Advisory Committee was present to settle those cases. At the end of the day, each country however had to sign the result sheet in order to officially finalize results.

Challenges

- Establishing a detailed schedule (problems/countries) that satisfies (almost) all countries.
- The limit of 20 minutes is probably the biggest challenge since one cannot predict the outcomes of the discussion. Ensure the schedule is respected whatever happens.
- Keep in mind that the moderation is a diplomatic exercise.

Recommendations

- Always have a senior (prof, post-doc) and a junior (PhD) in each moderation team.
- The Markers should make notes on their copies of the exams so they can moderate efficiently.
- Have a copy of the solution and marking scheme on each table. If you use an IT system, each moderation team should take a laptop.
- Have the author of the problem in the moderation room. They can help to settle issues if Leaders disagree with moderators; this often prevents the need to go to the Advisory Committee.
- Have some staff act as clock masters: you can also have a visible clock in the room, but it is important to respect the 20 minutes in order for the moderation to be fair. The best solution is to start and end at fixed times (if a team comes late, they are responsible and will not have more time).
- If a team does not come to the moderation, try to see if another country is free and will take their place; it is always good to have some staff present to observe the situation and act accordingly.

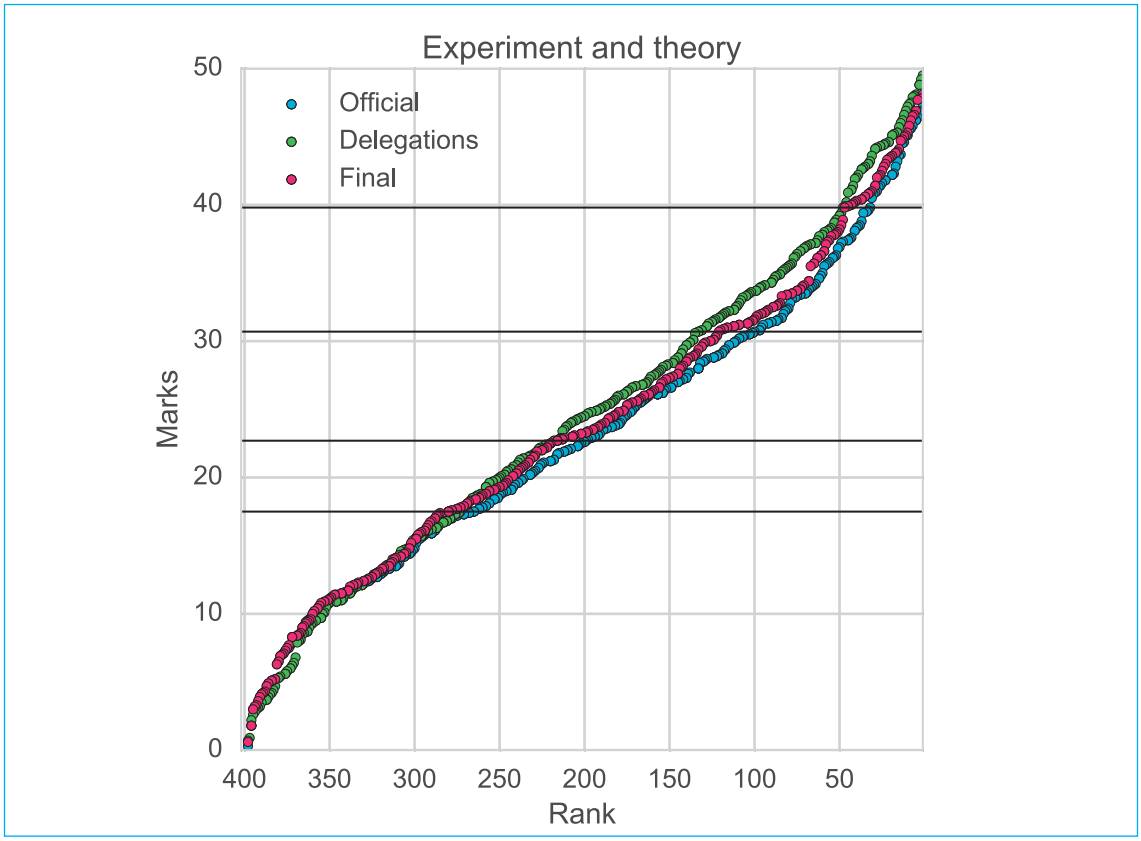
Exam Results and Statistics

In this section some basic statistics about how the Students performed in the exams and about the marking process are given. The detailed scores can be found online at:
http://www.ipho2016.org/ipho2016/delegations-and-results/

Based on the marking performed by the organizers, the medal ranges were defined prior to moderation in order to tentatively award 8% with gold medals, 17% with silver, 25% with bronze and 17% with an honourable mention (HM):

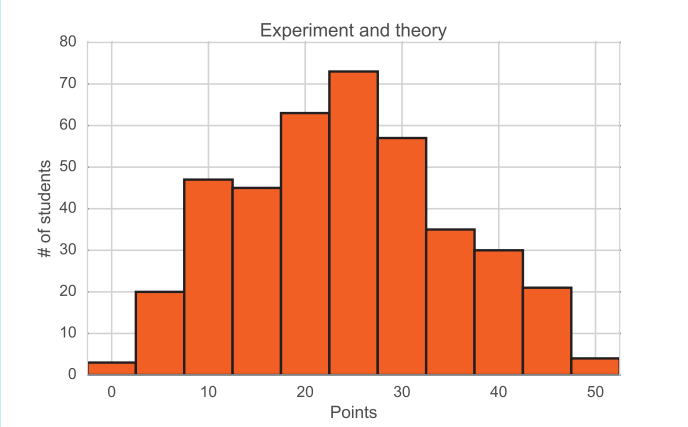
	Required marks	% before moderation	Number of students before moderation	% after moderation	Number of students after moderation	Relative change
Gold	39.8	8%	32	12%	47	+ 47%
Silver	30.7	17%	68	19%	74	+ 9%
Bronze	22.7	25%	99	25%	98	- 1%
HM	17.5	17%	68	16%	65	- 4%

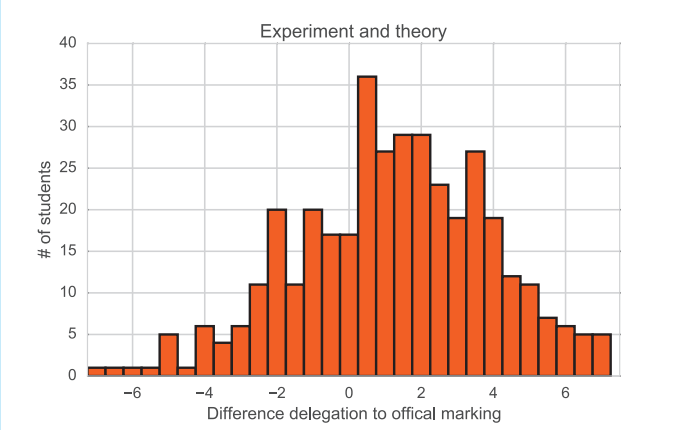
The graphic below shows the distribution of points as awarded by the official marking by organizers, by delegations and the final marks after moderation. The required marks for the medal ranks are indicated by black vertical lines. An (undesired) inflation of medals as a result of the marking process, also visible from the numbers stated above, is clearly seen. While the number of silver and bronze medals as well as honourable mentions barely changed, the number of gold medals increased by almost 50%.

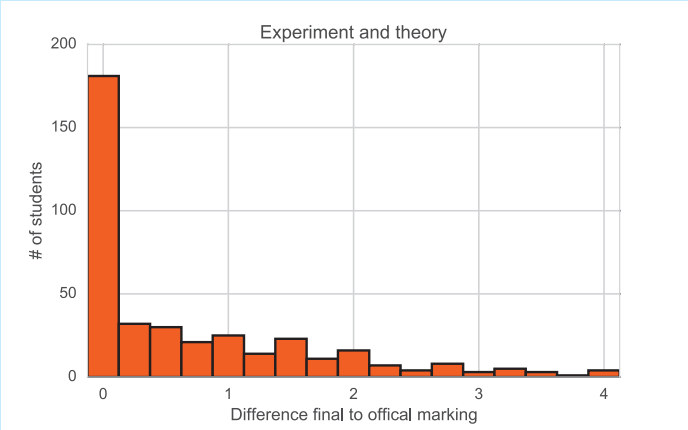


50 The distribution of marks and the difference between the official grading and the points awarded by delegations for theory and experiment, combined and separate, as well as for the independent tasks, is shown below.

Experiment and theory

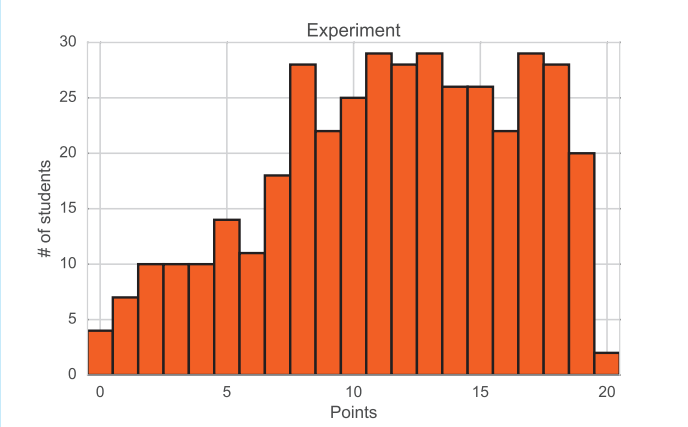


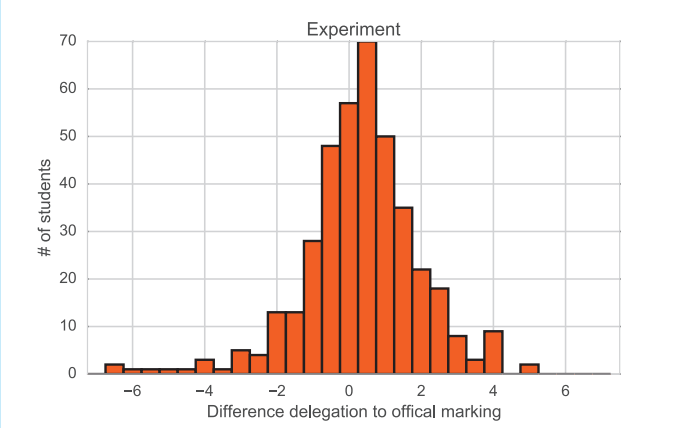


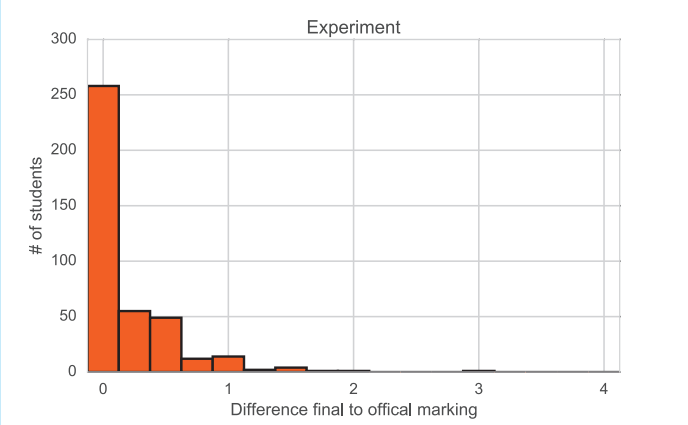


In sum, the overall results are adequately distributed, allowing for a non-ambiguous ranking of the performances. While the differences between the official marking and the one performed by the Leaders turned out to be rather broadly distributed, changes in the moderation were mostly minor.

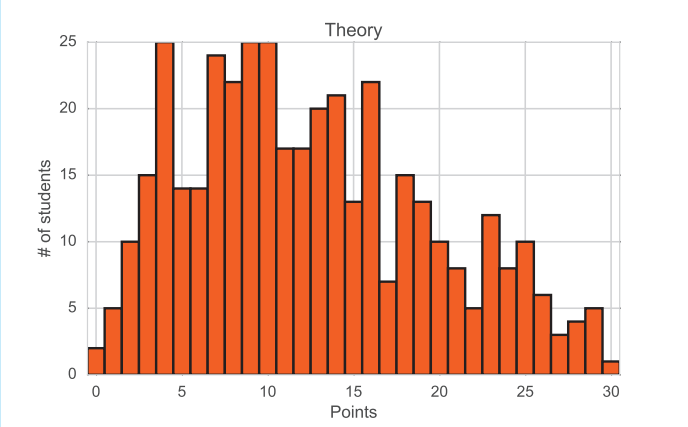
Experiment only

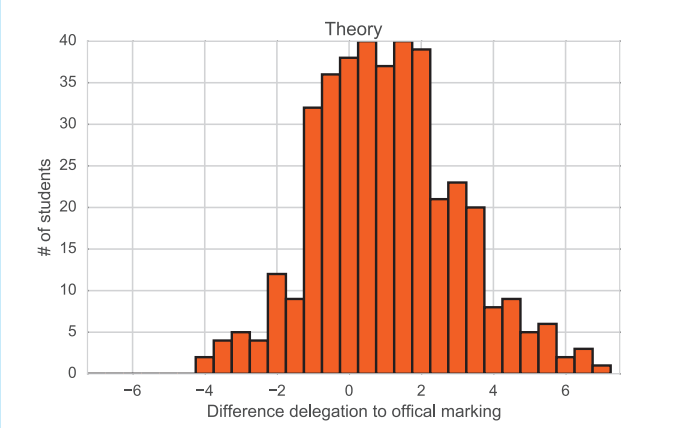


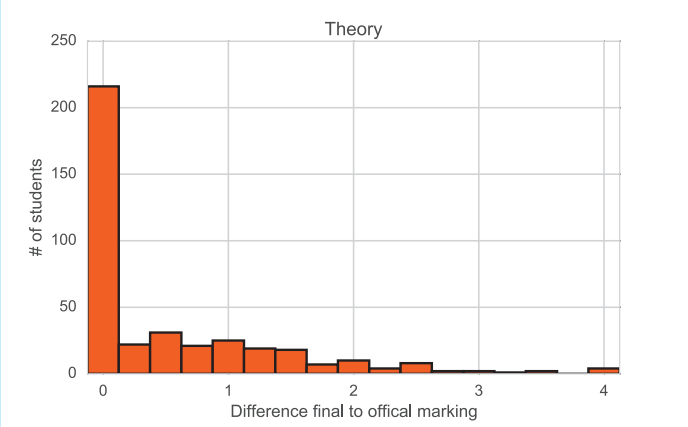




Theory only

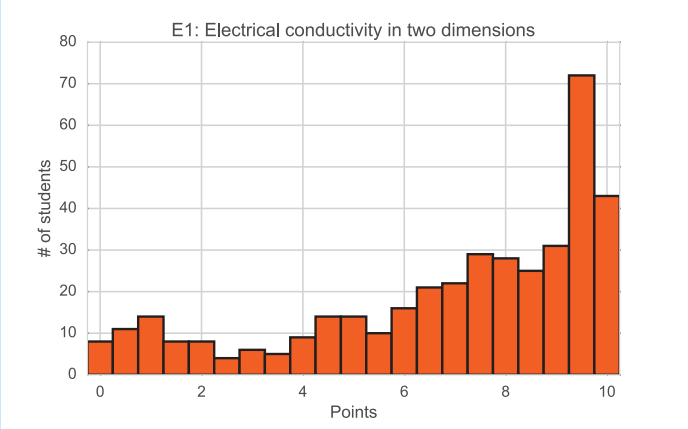


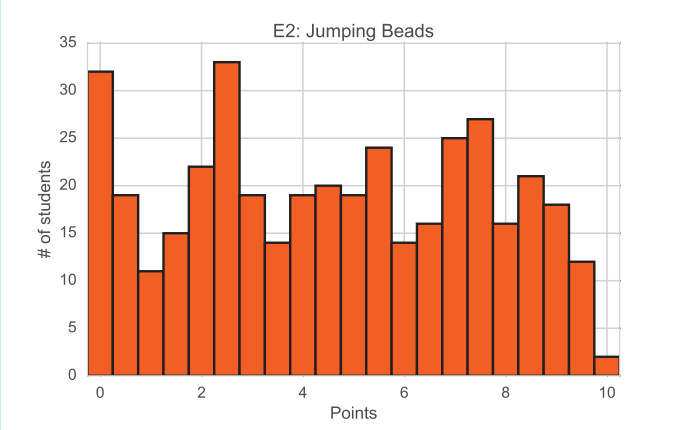


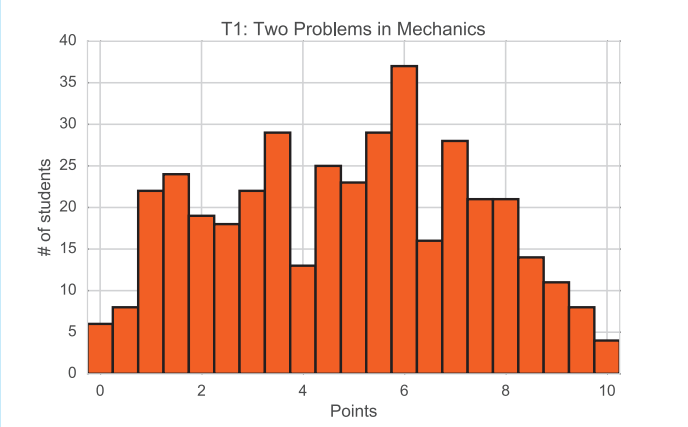


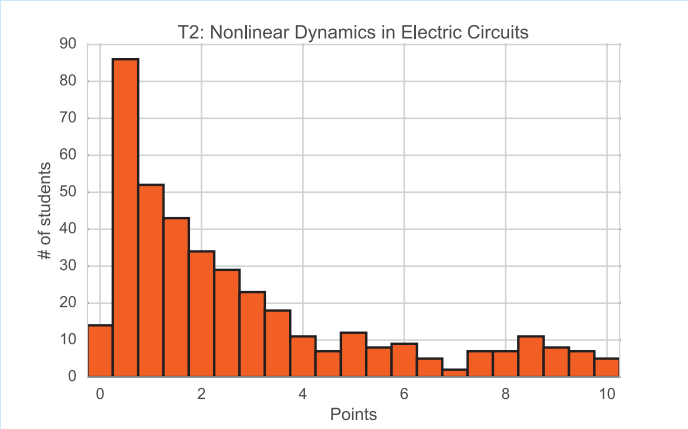
Comparing the distributions of the experiment and theory reveals that the theory tasks were clearly harder to solve than the experimental ones.

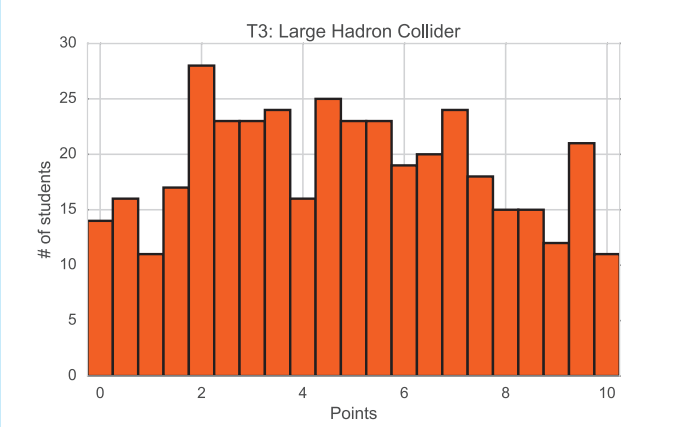
Separate tasks



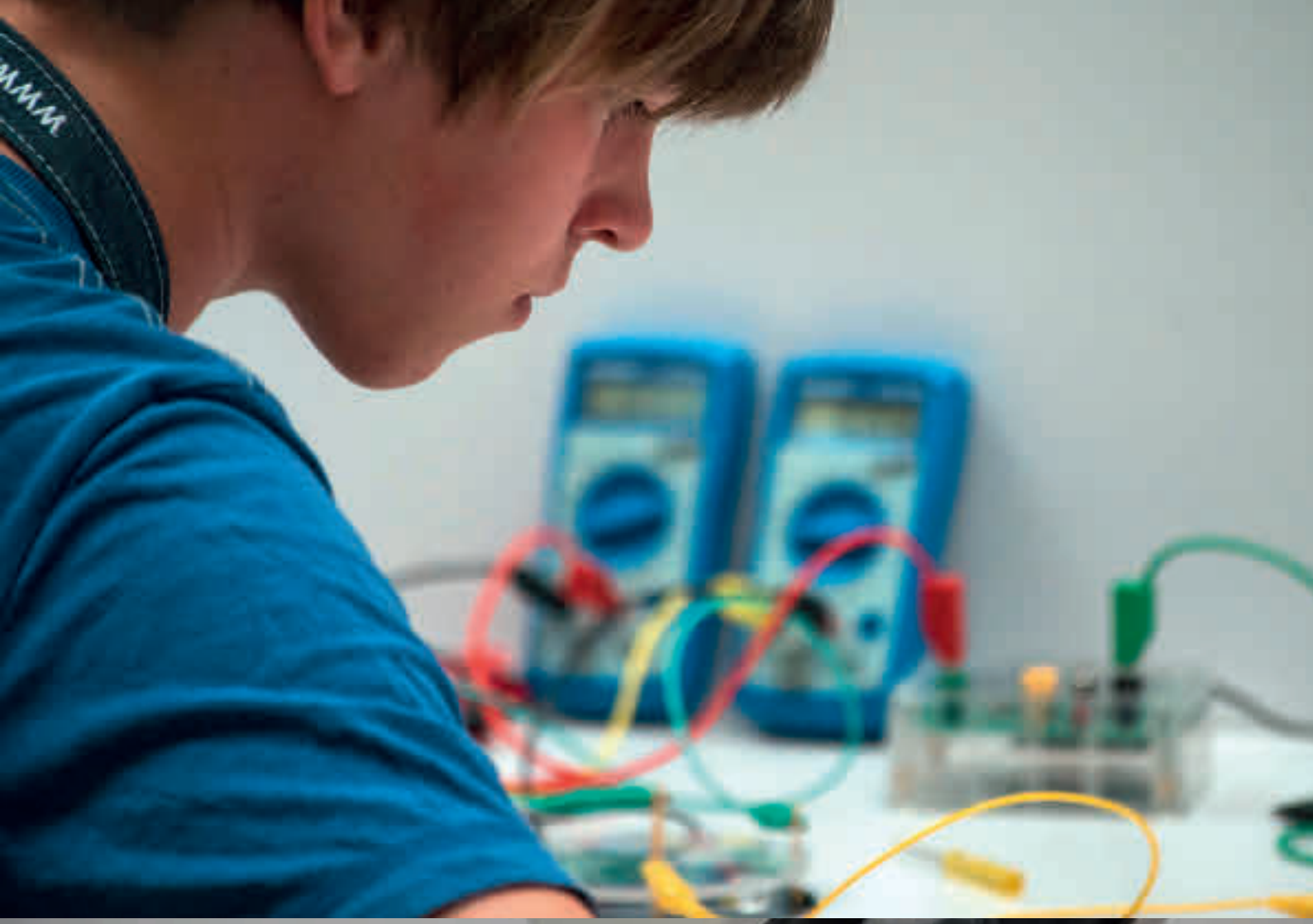








Comparing individual problems shows that while E2, T1 and T3 were well balanced in terms of difficulty, E1 may have been too simple (although most students did start with this task), and T2 was too hard for the majority of students to solve.



Hospitality, Events and Logistics

Registration and Administration

For congress administration the same agency used for volunteer management was mandated, starting in October 2015 and working during the first three months at 0.4 full-time equivalent (FTE), from January 2016 to May 2016 at 0.5 FTE, and finally from June till the end of the event with 1 FTE. They were responsible for the following working packages:

- Online and onsite registration
- Administration and handling of various requests and questions sent by email
- Accommodation and room allocation
- Arrival and departure planning

For communication with the delegation and online registration, the following process and timelines were defined:

- January 2016: The first circular letter with information on registration and login for online registration was sent to all Leader and Country Coordinators. Delegations were asked to register the number of participating Students, Leaders, Observers and Visitors online by the end of February. For all changes and for registrations after this deadline, an extra charge was applied (CHF 100).
- February 2016: The second circular letter with additional information on the programme and the new exam tool was sent out, including a reminder for registration.
- May 2016: The third circular letter contained information on participation, the exam tool and possibilities to get involved before the event. Additionally, the deadline for providing names and personal details for all participants was set at mid-May.
- June 2016: The final and fourth circular letter with practical and travel information plus a reminder to providing travel details by 26 June at the latest was sent out.

At the beginning of the IPhO, the onsite registration was held at separate locations for the two guest groups Leaders/Observers/Visitors and Students. Opening hours for both registration offices were Sunday 10 July, 4 pm to 10 pm, and Monday 11 July, before the Opening Event.

- Students' registration process included the temporary collection of their electronic communication devices and personal calculators, as well as the hand out of welcome gifts.
- The badge was given to the students at the airport, as it worked as a 10-days pass for public transport in Zurich. Transfers between arrival, hotel and registration office were made by tram or bus.
- The return of Students' electronic communication devices and calculators was scheduled for Thursday 13 July, 1.30 pm to 4.30 pm, after the last exam.
- At the registration for Leaders, Observers and Visitors, the badge was provided together with welcome gifts. Additionally, all due amounts from open invoices were settled and payment confirmations were handed out.

Challenges

- As some delegations had their national competitions very late (some in mid-June), it was not possible for them to adhere to the deadlines.
- Many delegations (beside those with the above-mentioned problem) failed to meet the deadlines for providing personal, travel and accommodation details, which caused individual and time-consuming clarifications by email or during the event itself.
- In addition, changes in registration information at very short notice led to time-consuming and logistical challenges including changes in hotel room allocation as well as the planning of arrivals and departures. Several changes were communicated during the IPhO itself.

Recommendations

- As it is most likely that future organizers have to deal with short-term requests, changes in registration data and delegations who do not provide personal, travel and/or accommodation details on time, sufficient staff resources for handling such cases should be planned for, especially for the two weeks before arrival.
- Extra charges for change requests after a deadline would encourage delegations to plan their stay more carefully. Additionally, at least some costs for administration and cancellation charges applied by hotels could be covered.
- Some delegations do not read the circulars or the information given on the website. Even if information or deadlines are communicated several times and through various channels, do not assume it will be seen by all guests.

Fees and Invoicing

Participation fees for IPhO 2016 were at a reasonable level for regular delegations, costing CHF 500 for each Student or Leader registered by 23 February 2016 (lower than 2012 and 2013, higher than 2014 and 2015). For Observers and Visitors, fees covered the real costs for accommodation, catering, transport and excursions. The single room fee corresponded to the actual additional costs of a single room.

The average exchange rates in July 2016 for CHF 1.00 were about EUR 0.92 and USD 1.02.

Fee	CHF
Regular delegation (5 Students, 2 Leaders) registered by 23 February 2016	3,500
Smaller delegation, price per person registered by 23 February 2016	500
Observer	1,800
Visitor	2,000
Single room (for leader, observer or visitors)	500

- For registrations after 23 February or for any change in the number of participants, an extra charge of CHF 100 was applied. This helped us to get an early and more reliable estimate of participating delegations and participants. In addition, the extra charges helped to cover some of the additional costs, e.g. through cancelations of hotel rooms or administrative adjustments on various levels.

- The amount payable, bank details and a proforma invoice were available online in the login section of our website. Delegations could pay the amount due either by bank transfer or in cash upon arrival (Swiss francs only due to VAT regulations). A total of CHF 125,000 was paid in cash (28% of all fees).

Challenges

- Many delegations paying in cash did not bring the amount in Swiss francs. Tours to exchange bureaus and banks had to be organized.
- Payment receipts had to be adjusted to the many needs of the delegations (e.g. dividing the amount into more than one receipt, changing the wording on the receipt, etc.), which was very time-consuming.
- Not all delegations were able to pay the fee. While some delegations decided not to participate at all (some at very short notice, or without deregistering), some asked the IPhO Secretariat/President for a fee waiver. Other cases had to be settled during the IPhO, as some delegations either did not have enough money or did not want to pay the total amount due.

Recommendations

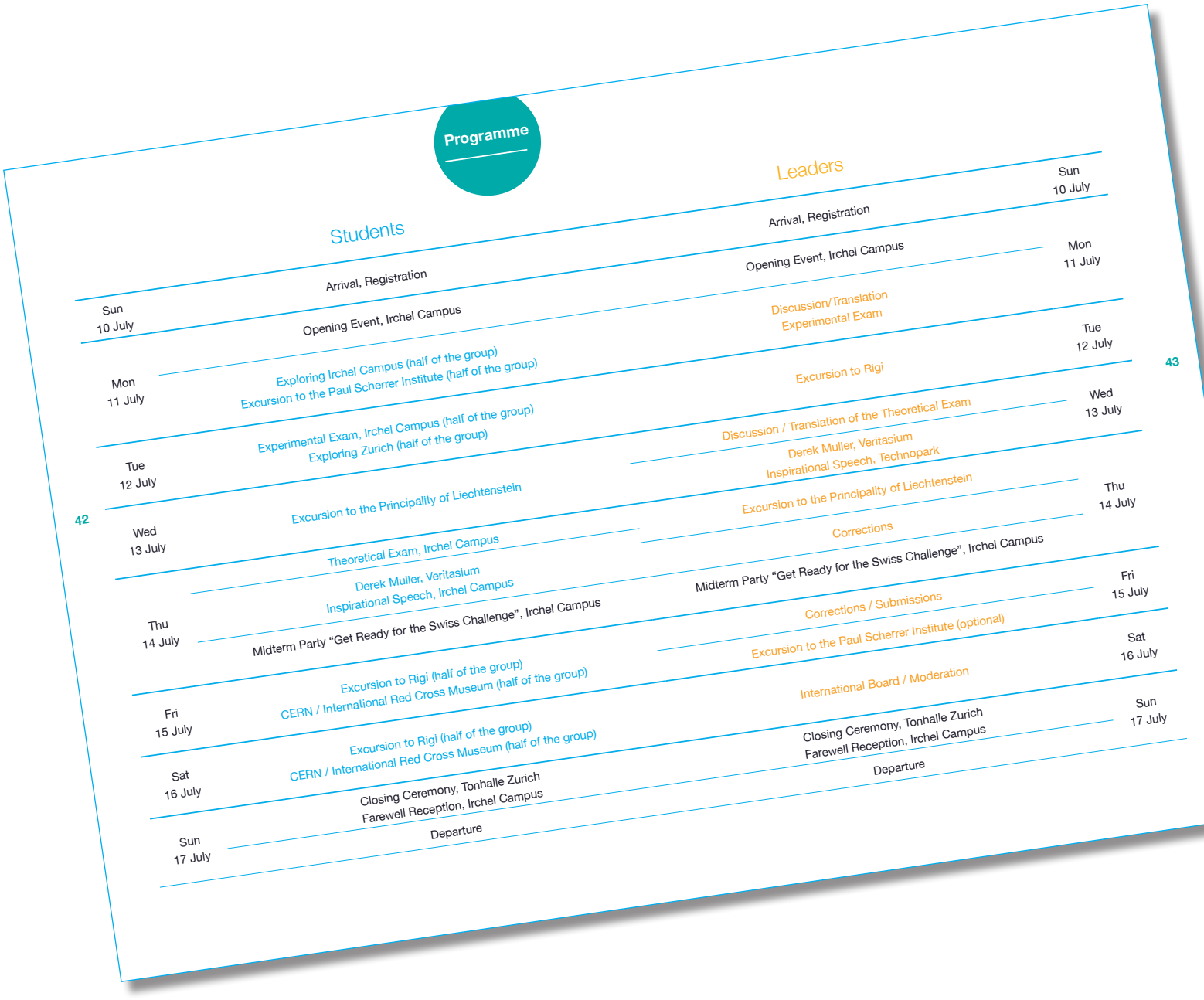
- Have one person with good intercultural communication skills to deal with invoicing and adjustment of payment receipts for the entire week.
- Offer a tour to an exchange bureau or bank for those arriving with the wrong currency.
- Check with your financial department and/or your bank about how the large amount of cash is best transported, stored and transferred (also check money laundering laws in advance).

Programme

We focused on three content approaches:
“It’s all about physics”
• Exams
• Paul Scherrer Institute
• CERN
• Derek Muller, Veritasium

“Learn more and get inspired”
• Irchel Campus, the University of Zurich
• 2000-Watt Society Zurich
• International Red Cross Museum

“Discover your host countries”
• Mount Rigi, City of Lucerne
• Midterm Party – Get ready for the Swiss Challenge
• Liechtenstein



Challenges

- Two host countries to be represented in the programme
- Students and leaders who did not participate in some programme points

Recommendation

- Do not over-do the programme; due to jet-lag, exams (Students) or overnight work (Leaders), participants may be tired.
- Offer some free time for both Students and Leaders.
- Provide sports and game equipment for Students at hotel.
- Check programme with local students or former IPhO participants for attractiveness during the planning period.
- Programme partnerships (financial and content) and negotiations can lead to significant savings.
- A detailed briefing (written and oral) for Guides is important for the smooth running of processes and on-site support.
- Due to overnight translation sessions, one third to one quarter of the Leaders and Observers did not participate in excursions the following day. Consider respective clauses when negotiating with your logistics and hospitality partners.

Opening Event

The focus of the Opening Event was the international and unifying character of the IPhO. The show was hosted by the young female professional Tanya Koenig.

Musical interlude was performed by Enrico Lenzin, an artist who plays traditional Swiss instruments in unexpected and new ways, giving traditional music a modern twist.

After the event the Leaders followed their schedule (discussion of experimental exams) while the Students went on their first excursion with lunch bags received directly after the ceremony.

Innovations

- Duration of event was short and sweet without neglecting the formal aspects of an opening event.
- Speeches of a maximum of five minutes each, to keep the event entertaining.
- No big national flags were allowed, due to fire restrictions, but also to avoid an over-nationalistic ambiance. Instead we provided each delegation with small flags.
- Delegations were presented using a drawing video (www.erklaervideos.com/) in which country, country map and three typical icons (geographical, cultural, historical, etc.) were shown.
- Delegations were presented in a random order to keep the audience's attention. The host named each country and the Students cheered and waved their flags.
- A fair-play act by a Student and a Leader of the host countries consisted of an oath underlining cheating awareness. The representatives stood in front of the group they were representing.

Challenges

- Creating an entertaining, short event where all guests could enjoy the presentations without skipping any formal aspects.
- Leader's time schedule was tight as it was important that they could start the board meeting on the experimental exams as soon as possible.

Recommendations

- Find a format to present the delegations in an entertaining way in a short timeframe.
- Limit the number of speeches, and set a clear timeframe for the speakers and any follow up (we asked for the speeches in advance). Coordinate the content and maintain the focus of the speeches to avoid repetitions.

Midterm Party – Get ready for the Swiss Challenge

The Midterm Party marked the end of the exam period. Just before the party, Students got their electronic devices back. They also enjoyed an inspirational speech by Derek Muller, the Australian-Canadian science communicator, filmmaker and television presenter and creator of YouTube channel Veritasium.

- The Midterm Party was held at the Irchel Campus, outside the building complex and inside the University Hall. Guests could explore and try Swiss traditions such as blowing the alphorn, cow milking, nailing, and sawing wood. In addition, booths offered typical Swiss food.
- Seating was available, but the event was set up to allow guests to move around and mingle, especially as this was the first time Students and Leaders had met since the Opening Event.
- Four of the offered eleven activities were offered as competitions. In a small award ceremony, the winners received some typical Swiss chocolate, marking the end of the Midterm Party.

Challenges

- Unfortunately, it was raining on the day of the event and most activities had to be moved inside or to the roofed area outside. Temperatures were cool and the rain only stopped around 8 pm. Nevertheless, the guests enjoyed the evening and once the rain stopped, guests moved around more, trying the different activities.
- About 1000 guests had to be served at the various food booths at the same time. As some food was more popular (raclette and Swiss BBQ) long queues formed at the start.

Recommendations

- Provide a setting with time to talk and interact; this is the first time students and leaders meet after the days of examination
- Offer some physical activities and physical competitions as an entertaining element.
- If there are speeches, they should be short.

The event took place in the “Tonhalle”, a historic concert hall in Zurich.
Musically the event focused on the Tonhalle’s organ, an impressive instrument rarely played now. The organist played four contemporary pieces from the “Star Wars” films.
Four speeches were held, each a maximum of 5 minutes. After the first speech, a video summarizing the past week was shown.

Medal ceremony structure:

- Honourable Mentions (HM; 65 in total): Names were projected and read according to ranking; however, Students did not enter the stage.
- Bronze and Silver (98 and 74): All winners entered the stage at the same time (the two groups were seated in colour-coded sections); names and countries were projected and read according to ranking, but medals were handed over regardless of rank order.
- Gold (47): Winners entered the stage at the same time; names and country were read and the person called was given the medal. Special attention was given to the top three gold medallists. Gold medal winners remained on stage during the distribution of special prizes.
- Special Prizes (9): All special prize winners were called to the front/on stage to collect their awards. In addition to their certificates and/or gifts, all special prize winners also got a huge Toblerone (Swiss chocolate).
- Except for the special prizes, all other award or participation certificates were distributed after the Closing Ceremony during the farewell lunch by the Team Guide of each delegation.

After the medal ceremony and more speeches, the handover to the organizer of IPhO 2017, Indonesia, followed. A representative held a short speech. IPhO flags and the IPhO book were not handed over on stage but after the event.

Challenges

- The goal was to streamline the award ceremony, keeping it as entertaining as possible and limiting it to a maximum of 2 hours.
- The huge number of awards (in total 219 medals and 65 Honourable Mentions) made the event challenging.

Recommendations

- Find a format to present the medals in an effective timeframe and keep the format attractive for the audience. We consider 2 hours the maximum for an event without intermission or catering.
- The stage presence of the future organizer should be planned in advance. Showing an invitation movie might be a good way of start an IPhO year.
- Order enough medals, as due to moderation of the results the number of medals needed will vary from year to year. We calculated the maximum percentage per category awarded in the past 3 IPhOs, and added some more to be on the safe side: 13% gold, 23% silver, 28% bronze, as percent of the total number of participants.
- Do not underestimate the workload between the final vote on the marks and the beginning of the medal ceremony. Certificates need to be prepared, medals arranged, and the final ranking has to be printed, put in online format and sent to the host, the media relations team, the newsletter and film team, etc.

Excursions

The various excursions showed our guests the beauty of Switzerland and Liechtenstein as well as a variety of institutions and organizations focusing on physics. The aim was to create an attractive programme around the exams without distracting and stressing the students.

Challenges

- Creating an attractive programme within the financial limits.
- Showing as much as possible without overdoing the programme.
- Finding the balance between must-have excursions and long bus tours (e.g. the excursion to CERN in Geneva needed 3-4 hours by bus each way - though for many of the young physicists this was a once in a lifetime opportunity).
- Finding excursion options where roughly 500 persons (Students and Team Guides) could stay together was almost impossible. On all the excursions they had to be split into subgroups.

Recommendation

- Check excursions with local students for the attractiveness during the planning period.
- Be aware that when handling large groups, sufficient time is crucial.
- A detailed briefing in writing, and delivered orally, for all Guides is important for the smooth running of processes and adequate support onsite.
- If possible, plan enough free time for Students beside the excursions, e.g. for shopping or in order to explore the city with their Team Guides.

Event Logistics and Transportation

During the IPhO week, Students, Leaders, Observers and Volunteers had to be transported between hotels, the university, various event locations and excursion destinations. While some transport, especially for the Students, was via public transport, all tours outside the city boundaries as well as transports where the punctuality was crucial (i.e. for the exams) were carried out by hired busses.

As the programme for the Students was mandatory, calculating the number of people and the effective need for hired busses was no challenge.

On the other hand, the Leaders' programme was not mandatory. As it was not known how many people were expected for excursions or events, and as a small fraction of Leaders and Observers had a tendency for unpunctuality, the last bus to leave often had to wait some time. In addition, some of the busses ordered had to be cancelled as they were not needed.

Challenges

- Given the responsibility of the Team Guides for their Students, busses had to be filled without separating the Team Guides from their respective delegations, meaning that student from the same delegation could not be on more than one bus.
- Calculating time schedules has sometimes proven to be tricky with regard to unpredictable variables such as efficiency when boarding or traffic jams.
- Parking and waiting space for busses can be scarce. Also, construction sites have to be taken in to account.
- Further challenges arise when it comes to communicating directions to drivers, changes in official time schedules and their consequences, but also concerning food and beverages on longer trips.

Recommendation

- Free boarding with no pre-defined busses has proven to be very efficient and does not punish those who are punctual because of late-comers.
- If busses need to be numbered or defined, this can be done by a Guide after departure, e.g. by handing over labels with the bus number to the people on board (no waiting time for people, no half empty busses)
- When boarding Students, do not count individuals but delegations as this allows efficient boarding. The Team Guides are responsible for making sure all their Students are on board.
- On excursions, our lunch bags were all vegetarian, allowing efficient and easy handling (meat vs. no meat, halal, etc.) and helping to reduce potential food waste.

Arrivals and Departures

All guests were requested to provide arrival and departure information during online registration. Pick-up services were provided on the arrival day, 10 July, and drop-off services were provided on the departure day, 17 July.

Arrivals: Each delegation could either be picked-up at Zurich Airport or Zurich main train station on 10 July (there were 11 arrivals by train), or alternatively find their own way to their hotels. Two delegations and some individuals arrived on 11 July.

- Students were picked up and accompanied by their Team Guide to the Students' hotel for check-in. Later, they were taken to the registration office at the university.
- Students received their badge — which worked as a 10-day pass for public transport in Zurich — from their Team Guides upon arrival. Transfers between arrival, hotel and registration office was made by tram or bus.
- Leaders, Observers and Visitors were accompanied by a Leader Guide to their hotel and the registration office, located nearby. This transfer was either made by hired bus or taxis, as public transport would not have been convenient due to construction sites.

Departures: From a logistical point of view, the departure day was a highly complex challenge. As the financial situation of the IPhO 2016 was tight, the organizers had to set the main departure day on Sunday 17 July after the Closing Ceremony and Farewell Lunch (ending at 2.30 pm). Only delegations with no suitable flight or train connections on the same day were offered an extra night at IPhO 2016's expense.

- On 17 July, hotel check-out had to take place before leaving for the Closing Ceremony.
- Leaders, Observers and Visitors had to take their luggage with them.
- Students were supposed to leave their luggage in the hotels' luggage storage rooms.
- After the Farewell Lunch, shuttle busses brought the entire delegations to the student hotels to pick-up Students' luggage. From there transfer to the airport or train station was either by tram or bus shuttle.

Challenges

- A lot of delegations failed to meet the final deadline for providing their arrival and departure details. In addition, changes at very short notice and misleading information also caused many individual and time-consuming clarifications by email or during the IPhO itself.
- A few delegations did not provide any travel details at all. Some never reacted to our reminders or answered our attempts to contact them.
- The luggage logistics on departure day was neither simple nor convenient, and there were only limited possibilities to change the outfit before going to the airport. Nevertheless, the process worked out well.
- Shortening the programme from 18 July to 17 July was necessary budget-wise. However, it caused a considerable logistical impact on departure planning. Clear communication and information from the organizers was necessary but not always easy in order to brief the guests accordingly.

Recommendations

- Be prepared for logistical challenges including (costly) changes in hotel room allocation as well as constant changes in the planning of arrivals and departures. Future organizers will have to deal with short-term requests as well as delegations which will not provide travel details on time (or at all). Sufficient staff resources for handling such issues should be planned for, especially for the two weeks before arrivals, as well as during the event.
- Some delegations do not read the circulars or the information given on the website. Even if information or deadlines are communicated several times and through various channels, do not assume it will be seen by all guests.


Bus | Coaches
Tram | Tramway
Bahn
Train
Parking
Mietwagen
Car Rental
IPhO
2016


SURINAME
Aberdeen

Hotel Accommodation

For accommodation purposes, 4 hotels of the Accor Group in two different areas of the City of Zurich (Zurich City-West and Zurich Airport) were contracted. All Leaders, Observers, Visitors and most staff of the Academic Committee of the organization were accommodated in two hotels in the Zurich City-West area. Leaders, Observers, and Visitors could choose between single and double rooms. However, for single rooms an extra fee was charged (CHF 500).
All Students and their Team Guides as well as some staff of the Organizing Committee stayed in the Zurich Airport area. All Students were booked in double rooms. Additionally, in the two Student hotels, a common leisure room was available where Students and Guides could mingle in the evening. As Students are not allowed to have contact with their Leaders during the exam period, it was helpful that the two hotel areas are not located close to each other (roughly 6 km away).
Room allocation was done by Excel. The following number of rooms per day and guest group was needed:

Leaders, Observers, Visitors and the Academic Committee:

Date	4.7.	5.7.	6.7.	7.7.	8.7.	9.7.	10.7.	11.7.	12.7.	13.7.	14.7.	15.7.	16.7.	17.7.	18.7.
Single	1	1	1	1	1	12	64	63	63	66	64	63	63	6	0
Double	0	0	0	0	0	7	100	105	105	104	104	103	102	6	0
Total	1	1	1	1	1	19	164	168	168	170	168	166	165	12	0

Students, Team Guides and the Organizing Committee (including Leaders, Observers and Visitors for the night of the 17 July):

Date	4.7.	5.7.	6.7.	7.7.	8.7.	9.7.	10.7.	11.7.	12.7.	13.7.	14.7.	15.7.	16.7.	17.7.	18.7.
Single	1	1	2	3	6	15	16	13	13	13	13	13	14	17	0
Double	0	0	0	0	0	62	235	240	240	240	240	240	239	96	3
Total	1	1	2	3	6	77	251	253	253	253	253	253	253	113	3

Challenges

- Even after the final registration deadline of 26 June, a considerable number of late change requests for rooms led to an enormous workload for the congress administration team during the final days before the event.
- For delegations with arrivals or departures outside the official period (10 to 17 July) a hotel change for either Students or Leaders was necessary as we could not leave the Students unsupervised in the hotels (not possible for minors). Most of the delegations requesting an extra night therefore stayed in a Student hotel for these nights.
- Some of the Leaders, Observer and Visitors who had not chosen a single room complained during the IPhO about their rooms, i.e. the person they had to share the room with (assigned randomly), or that there were not enough rooms with twin beds available. This was communicated in the first circular; however, a great number of guests seem not to have noticed this announcement.
- A city the size of Zurich does not offer enough rooms in one hotel to host all participants within the assigned guest group (Leader/Students). Therefore, the different hotels did not offer the same standards, leading to discussions regarding fairness of hotel allocation and hotel quality especially with the Leaders. The situation became additionally complicated by the fact that some delegations from certain geographical areas happened to be concentrated in one hotel.

Recommendations

- If possible, choose only one hotel for each group (Leaders/Students). If this is not possible — as was the case in Zurich — try to choose hotels of the same standard.
- Have additional staff resources dedicated to deal just with accommodation requests during the last two weeks before the event.
- Consider using a professional room allocation tool or even a professional agency (tour operator) to deal with room allocations as the use of Excel becomes limited for such a number of overnight stays and so many change requests at short notice.

Food and Beverages

It was important for us to have:
- healthy food (vitamins, salads)
- a variety of dishes per meal, incl. dessert
- options for various food restrictions
- respect for intercultural habits

Beverages
- As Switzerland is famous for its drinkable tap water and as we wanted to avoid expensive water logistics, we made a partnership deal with SIGG, a Swiss quality water bottle company.
- Alcohol was served only at the Farewell Lunch (white and red wine).

Challenges
- Food and beverages are expensive in Switzerland. Our budget situation required very efficient planning.
- Halal meat was available for the catering company at the university, but unfortunately not for the one at the Leaders' location.

Recommendations
- Ask for preferences in the registration process.
- Go for buffet style catering with a broad range to meet various food preferences.
- Organize the buffet flow to avoid long queues.
- Indicate food's processing (e.g. halal) and ingredients (important for vegetarians and people with allergies).
- To make logistics easier, offer vegetarian lunch bags / dinner bags for everybody, but do not forget participants with gluten or lactose intolerance.
- To keep logistics simple, buy halal meat for all participants (do not forget to indicate this).

Food restrictions, Students and Team Guides, by 19 June 2016

	People	Percentage
Registered	491	100.0
Indications made	476	96.9
Vegetarian	31	6.1
No gluten	1	0.2
No gluten/lactose	1	0.2
No lactose	1	0.2
Other allergies	5	1.0
Other dislikes	5	1.0
Halal	35	6.9
Kosher	0	0.0
No beef	8	1.6
No pork	1	0.2
No red meat	4	0.8
No seafood	11	2.2

Food restrictions, Leaders, Observers, Visitors and Leader Guides, by 19 June 2016		
	People	Percentage
Registered	277	100.0
Indications made	275	99.3
Vegetarian	11	4.0
No gluten	0	0.0
No gluten/lactose	0	0.0
No lactose	1	0.4
Other allergies	2	0.7
Other dislikes	0	0.0
Halal	18	6.5
Kosher	1	0.4
No beef	2	0.7
No pork	1	0.4
No red meat	0	0.0
No seafood	1	0.4

Marketing & Communication

Logo

The IPhO 2016 Logo illustrates an active galactic nucleus. They are the most energetic objects known in our universe, yet they remain a mystery. These powerful sources of energy consist of a super massive and extremely dense object which can exceed a billion times the mass of our Sun. The enormous gravitational attraction means even light cannot escape from the innermost part - the super massive black hole.

When gas is spinning inwards into a black hole, an enormous amount of gravitational energy is released. The gas accelerates to very high velocities, heats up and releases an enormous amount of energy in the form of light. This process can outshine an entire galaxy of several billion stars.

Only with Einstein's theory of General Relativity and his calculations did such objects become even conceivable. Albert Einstein obtained his PhD at the University of Zurich, the host university of the IPhO 2016.

The formation and evolution of super massive black holes remain a mystery. It is very unclear how the surrounding galaxy acts on the central black hole and vice versa. Who knows what revelations await us - to be discovered by the next generation of physicists.

Logo Creation Process

The logo creation process started in January 2015. We focused on:

- creating a physics symbol with real importance in the world of physics
- involving physicists from the three organizers in the creative and decision-making process
- coming up with a logo that has a strong impact when printed or used online
- using young, fresh colours reflecting the main stakeholder group of young students
- having different colour variations available

Challenges

- The process of creating the logo committee, consisting 6 physicists and 2 brand and communication professionals, took some time.
- For physicists, abstract symbols of physical elements are not always easy to accept. Therefore, good arguments were needed. This paid off in the end, as everyone involved liked the logo and agreed it had a valuable impact.

Recommendations

- Keep in mind that a logo's first goal is a strong brand impact wherever it is used (documents, online usage, t-shirts, gifts, etc.), so consider staying away from over-detailed and true-to-life designs.
- Take brand/communication professionals on board who have experience in logo creation and implementation.

Communication Campaign

In order to make use of the communicative potential of IPhO 2016, we decided to run a communication campaign. The main focus lay on creating enthusiasm for physics—as a science, but also as a way to discover the world. In addition, the University of Zurich, the most prominent of the four organizers, wanted to use the opportunity of the IPhO 2016 to position itself as a world-class educational institution and research facility in the field of physics.

As studies show, existing science communication mostly targets people who are already involved with science and universities (represented by 30% of the public). Research in Europe also revealed that only every eighth person actually likes physics, while others' feelings are somewhat negative.

While we wanted to communicate with those already attracted to science and physics, we also wished to reach the broader public. Therefore, we decided to communicate in a low-threshold and entertaining way. We did this by using two main channels: social media (mainly Facebook) to create a community, and with live events.

We organized entertaining physics lectures focusing on special topics such as Christmas or Easter where physics was taught in a very tangible and fun way, using a lot of experiments. In addition, we created two events in a renowned theatre, where physics, music and slam poetry had a "conversation" about the four seasons.

The core social media activity was the "Chain Reaction Machine Competition" where everybody was invited to participate by building their own Rube Goldberg Machine and share a video of it online.

Challenges

- How to reach the two different groups?
- The IPhO community (participants, volunteers, organizers, etc.), which is already interested in physics and the IPhO as an event.
- The broader public that could be reached by low-threshold physics content.
- How to activate the groups to participate in the chain reaction competition?

Recommendations

- Among the public physics isn't very popular. In most countries there is a significant lack of physicists and professionals in the field of natural sciences. So IPhO is an opportunity to tell the public about the fascination of physics and to actively involve new groups of people. Not using the communicative potential of an IPhO and keeping it an event for invited participants only is much too expensive and a missed opportunity.
- Prioritize your target groups and set clear goals. Try to use existing contacts, channels, events and infrastructure of organizers to their full potential.
- Use online channels, but also offer live events where people can get in contact with physics and physicists in the real world.

Newsletter & Social Media

During the IPhO, the daily newsletter “Momentum” was published. Appearance, layout and content were prepared to resemble a professional newspaper on eight pages. The content was a colourful and moving mix of pictures and articles, including:
Physics: Nobel prize laureates of the University of Zurich; physics topics in general
Event: Editorial; What happened yesterday? What is on today’s schedule?
Background: A historical section about Switzerland and Liechtenstein
Entertainment: Riddles, birthday-wishes, service elements
Curry and Rösti: An outside view of Switzerland and Liechtenstein (by an Indian volunteer journalist, the Team Guide of the Swiss delegation at IPhO 2015 in Mumbai)
Interaction: E.g. with readers’ letters.
In addition, we used social media channels as well as the IPhO webpage to spread news and to communicate with all kinds of communities.

Challenges

- Organization of a large team consisting of a chief editor, volunteer journalists, a web and social media content manager, an English proof-reader, photographers, a layout responsible, and a printing office, many working at different locations.

Recommendation

- “We are all the IPhO”!
- Feature not only Students, but also Leaders, volunteers and staff behind the scene.
- Write about the diversity of physics, its modern day challenges, its career opportunities. And how science connects people.
- Show different cultures and cultural characteristics, and present your country as a host.
- Be interesting and different!
- Use only the latest news and inform on a daily basis.
- Show pictures from involved people accompanied with emotional statements.
- Use different formats: interview, profiles, articles, pictures, video blogs, etc.
- Multichannel storytelling: connect online and offline with special actions.
- Upload content (newsletter, photos, etc.) instantly on websites and share them on social media.
- Encourage interaction between IPhO participants and their friends and families around the world.

Photos and Videos

From the volunteer kick off day until the departure of all delegations we had two photographers covering all aspects of the various events. The goal was to make IPhO visually tangible for participants and friends and families at home, but also for organizers, supporters and fundraising partners. All the selected pictures were uploaded daily to a Flickr account (www.flickr.com/photos/ipho2016/) allowing us to embed the pictures on our website and share the albums on social media.

In addition to the pictures, the two photographers produced short videos with short and fun interviews with Students, Leaders, volunteers and staff.
www.youtube.com/channel/UCIpkALjZ8udT3xkFvUHddyw

Challenges

- Due to the different schedules for the various groups involved, many events took place simultaneously at different locations (such as exams, excursions, board meetings, presentations, etc.).
- The many event stakeholders such as Students, Leaders, volunteers, and staff had to be adequately represented.
- Having interesting, funny and spontaneous conversations for the short interview videos.
- Need for efficient technical equipment while on the move.

Recommendations

- Good planning and prioritization is crucial. Talk to the persons in charge in advance to be able to identify the key moments of an event. For example, it paid off to attend the rehearsal of the Closing Ceremony.
- Anticipate who plays the most important role in which moment, and portray them then.
- Personalize, show lots of people, show what they do, get close to them and try to spin a common thread through your pictures.
- Always talk about topics that are of major current concern for your interviewees. Introduce them properly to the camera and laugh a lot.
- Make it easy for stakeholders to access your pictures (flickr.com works very well) and write all important information into the metadata (such as copyright or picture captions).
- Mobile internet is helpful, bring power banks for your devices.

Media Relations

Objectives

- Generate a broad and positive image of the IPhO 2016 as an attractive opportunity to encourage a new generation of scientists.
- Promote the University of Zurich (UZH) as a place of excellence in research and teaching.
- Make the IPhO and the Department of Physics better known to the public and interested target audiences — on a national and international level.

Strategy: We focused mainly on an individual approach by contacting selected key media via email and telephone.

Timing

- Information about the upcoming of IPhO 2016 in Switzerland and Liechtenstein began in summer 2015, as outlook information in press releases about the participation of Swiss and Liechtenstein Students in International Scientific Olympiads.
- The intensive media relations work began 2 months before the event.
- To reach many national and international media (print, radio, TV, Internet), two press releases were published in German, English, French, Spanish, and Chinese:
    - one week prior to the Opening Event, announcing the IPhO
    - on the day of the Closing Ceremony, presenting the results

Distribution Press Releases

- Press releases were distributed using the following channels:
- Media distribution lists of the IPhO 2016 organizers (UZH and the Association of Swiss Scientific Olympiads ASSO)
- Websites of UZH, ASSO and IPhO 2016
- Online science news platforms „Informationsdienst der Wissenschaft (idw)“, „AlphaGalileo“ and „EurekAlert!“
- Social media (Facebook, Twitter, LinkedIn)

Instead of organizing a media conference, journalists were invited to the Opening Event and to the day of the experimental exams on 12 July, since for most of the media the central reason to come was “to be able to see something”. To avoid any exam leaks (cheating risk), the media were given two adequate time slots for interviewing Students and selected organizers as well as filming the experimental exams.

Media Coverage

- The achieved media coverage was excellent, quantitatively as well as qualitatively.
- In total, about 380 newspaper articles, radio and TV broadcasts, and Internet contributions were found by the monitoring tools Argus and Meltwater.
- In Switzerland, all three main TV news programmes in the German-, French- and Italian-speaking areas, as well as many key radio stations and newspapers, reported on the IPhO.
- Internationally, web articles and TV broadcasts of almost half of the 84 participating countries were collected.

Challenges

- Physics as a topic is not interesting to most media and the general public
- Different media have varying interests (e.g. local/regional media may be interested in information about “their” students only)
- Exam leaks
- Respect Students’ need for privacy and time to rest.

Recommendations

- Involve experienced media relations professionals for IPhO media work (in our case two senior professionals from two Organizers took lead of IPhO media work).
- Start to contact media two months before the event.
- Organize and brief potential interviewees in advance (the main interest was Students and members of the Academic and Organizing Committee).
- Limit the main contact persons for journalists to a few IPhO media relations professionals.
- Organize supporting staff to handle journalist contacts on site.
- Concentrate site visits of journalists and interviews into defined time slots.
- Provide professional photos and videos on a daily basis.
- Try to be as flexible and prompt as possible since most media showed interest at short notice.
- Enable photographing and filming of the experimental exams by interested media without neglecting leak risks.

Gifts

The goal has been to focus on practical gifts — due to the tight budget but also for sustainability reasons.

- SIGG water bottle: a quality item helping to avoid complex water logistics throughout the week (in Switzerland and Liechtenstein, tap water is of a high quality). We produced 16 different versions, reducing the risk of confusing bottles. Participants received their water bottle upon arrival in their welcome pack.
- Bag**:** At IPhO, participants usually get a big backpack. We decided against this tradition due to the above-mentioned goal, providing participants with just a simple, re-usable drawstring bag. We produced 4 different versions. Participants received all their gifts in the bag upon arrival.

Further gifts and give-aways:

- Swiss chocolate bar
- Information about the University of Zurich, the Department of Physics and Switzerland
- A pen from the University of Zurich
- A Zurich pencil and a map of the city
- IPhO postcards and stickers
- IPhO information material (magazine, yearbook, invitations)

Recommendations

- Concentrate on quality rather than quantity
- Set up clear production and timing processes with your production companies.
- Communicate closely with them regarding corporate design and fabric quality.
- Order items early enough to avoid last minute stress.

T-Shirts

We produced T-Shirts according to corporate design guidelines and colours for the following reasons:
- Visibility of volunteers and staff
- Fast recognition of Students on excursions
- PR purposes (nice pictures, videos)
- As a souvenir

Team and Leader Guides got the most prominent colour due to their tasks, ensuring that guests who needed support or had questions could easily spot the nearest Guide.

As laundering the shirts was more expensive than buying them, we offered several shirts to most people in the hope they will give spare ones to friends and family.

Recommendations

- Produce a male and a female cut.
- Think about choosing colours based on functions etc.
- Order early enough to avoid last minute stress.
- Communicate closely with production companies with regard to corporate design and quality standards.

The chart below shows the number and sizes we ordered 2 months prior to the IPhO. The numbers were based on estimates, when only about half the participants had done their online registration. The number of Student male shirts in size L proved to be too high.

Category	Persons (estimate)	Shirts per person	S	M	L	XL	XXL	Total
Leaders M		1	23	43	100	77	39	283
Leaders F			8	16	11	9	5	48
Subtotal colour grey	268							330
Students M		3	222	600	480	42	39	1383
Students F			45	48	18	12	6	129
Subtotal colour blue	400							1512
Office M		6	30	90	84	36	12	252
Office F			24	54	48	18	6	150
Markers M		1	15	33	29	9	5	91
Markers F			12	9	5	3	2	31
Others M		1	6	20	40	30	12	108
Others F			8	16	14	5	3	46
Subtotal M			51	143	153	75	29	451
Subtotal F			44	79	67	26	11	227
Subtotal colour black	240							678
Team/Leader Guides M		4	60	200	70	54	16	400
Team/Leader Guides F			80	40	20	12	8	160
Subtotal colour pink	100							560
Grand Total								3080

Giveaways

The goal was to focus on practical giveaways we could use during the planning period for events and activities before the IPhO.

Sweets
Halter is a famous Swiss producer of sweets. We produced 50,000 sweets, which we distributed from Summer 2015 as a promotion at various pre-event occasions (e.g. Swiss Physics Olympiad events, student information days at the University of Zurich). During the IPhO, the sweets were distributed in the Students' hotels, at the Leaders' work location and at the University of Zurich.

Stickers
One year before the event, stickers were produced that could be used for various occasions prior and during the event. Each participant got three stickers in their welcome pack.

Post Cards
IPhO 2016 post cards in typical Swiss layout were produced and distributed to participants in their welcome pack. In addition, they could be used as complimentary cards for any occasion in reference to IPhO 2016.

Recommendations:
- Try to avoid giveaways on which partners or sponsors want to advertise.
- Think twice about which giveaways will actually be appreciated and used — or whether they are more likely to be thrown away.

Event Collaterals

Badge

- Front side with picture, backside with access code for public transport.
- Colour bar corresponding to t-shirt colour, representing group category.
- Badges in transparent badge holders on lanyards from the University of Zurich, Faculty of Science.
- Badge holders also contained the pocket programme (see below).

Challenges

- Not all delegations or individuals had finished their registration by the time of printing.

Pocket programme

- Leporello format, A7 size (folded accordion-pleat style).
- 9 pages, one side for Student schedule, other for Leaders'.
- Distributed inside badge holder upon arrival to participants, volunteers and staff.

Challenges

- At the time of printing, all precise time points need to be fixed. Thus the ability to adjust the programme at short notice is lost.
- It is challenging to find the balance between printing only the most important information and still offering everything needed by all participants.

Recommendations

- Plan the printing for the latest date possible to maintain flexibility for changes in the programme schedule.
- Inform all persons involved in programme planning about the latest possible date for changes in times or locations.

Magazine

- 60 pages
- Insight into the two host countries, people behind IPhO 2016 and event programme.
- Distributed upon arrival to participants, volunteers, staff, and to VIPs at Opening Event.
- Available online at www.ipho2016.org

Challenge

- Resource-intense work for coordination, editing and layout a few weeks prior to the event.

Recommendation

- Plan enough personnel resources, define processes, responsibilities and timing.

Yearbook

- 128 pages
- Provides an opportunity for participants, volunteers and staff to stay in touch after IPhO 2016
- Distributed upon arrival to participants, volunteers, staff and VIPs at Opening Event.

Challenge

- Documents like these need to be laid out, proofread and printed some time before the IPhO (in our case, the printing company needed the final version two weeks before the IPhO). Since not all delegations or persons had finished their registration by then, some people or even entire delegations may be missing.
- Special characters in some languages may cause serious problems, depending on the fonts used.
- The quality of the uploaded pictures varies a lot. Some pictures were also uploaded upside down or with other errors that needed manual corrections.

Recommendation

- Hire a skilled IT person with some graphics background.
- Set up the entire system to generate the yearbook as early as possible to adjust the online registration and database accordingly.

Surveys

A survey was sent to three groups of participants to evaluate the IPhO 2016.

- Students: Paper survey on the day before the Closing Ceremony. 364 of 398 completed (91.5%).
- Leaders/Observers: Online survey after the IPhO 2016. 74 of 245 completed (30.2%).
- Volunteers: Online survey after the IPhO 2016. 94 of 125 completed (75.2%).

The questionnaires for each group was adjusted to their role during the IPhO. Therefore, not all answers can be compared. In addition, since we do not have any results from former IPhOs, a comparison with past events is not possible. Future organizers of an IPhO are welcome to receive copies of our questionnaires as well as more detailed results.

Major Outcome

- Students and Volunteers answered the question about their overall experience of the IPhO 2016 with a mean of 5.1 points, Leaders and Observers with a mean 5.6 (1 being very negative, 6 very positive).
- The Students as well as their Team Guides would have welcomed a less tight schedule with more free time to discover Zurich on their own, as well as more time to sleep late in the morning.
- Also, food and accommodation was not to the liking of some Students. They proved to be more critical than Leaders/Observers, despite the same quality in both catering and hotels.
- Students' top five highlights were their Team Guides, the excursions to Mount Rigi, the IPhO Magazine, Pocket Programme and Yearbook, and the organization of transportation, as well as the Midterm Party.
- The Leaders' and Observers' highlight was the web-based IT solution/exam tool programmed by our IPhO 2016 Academic Committee, scoring 5.7 out of 6 points. Leaders' and Observers' highlights included the timeliness of the availability of the exam copies and of the organizers' marks, the politeness and flexibility of the organizers, the organization of the moderation, the organization of transportation and the IPhO Newsletter "Momentum" (all scoring 5.55 to 5.65 out of 6).

Recommendations

- For an event of this size and with such an international group, it is impossible to satisfy all wishes and expectations. Even if something is appreciated by the overwhelming majority, the chances are high that there will be some people who do not like it.
- Some students seemed to have been uninformed about what to expect from the IPhO, e.g. concerning hotel standards, but also on things such as having to hand in all electronic communication devices upon arrival, and other information contained in our circulars. For security reasons, the circulars were not put publicly available online, but rather in the login section of all participants. Nevertheless, an additional direct mailing to the students would have been a good way to manage their expectations and improve the level of information received.

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