

Conference Report

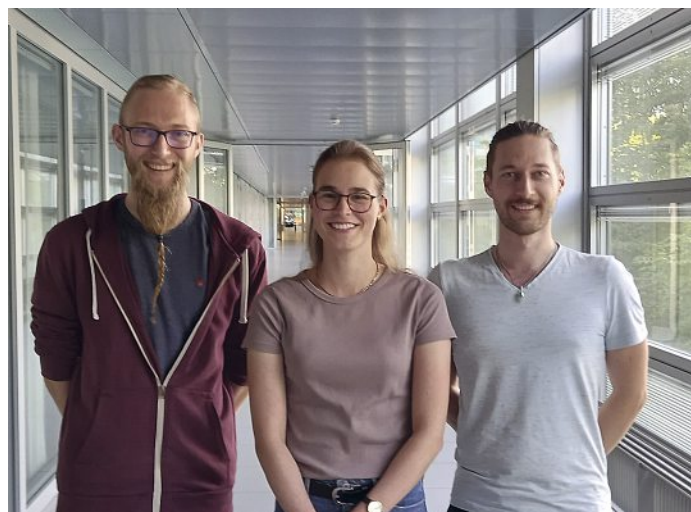
Switzerland at the International Chemistry Olympiad 2022

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Abstract: At the remote International Chemistry Olympiad 2022 hosted by China, two outstanding students from Switzerland won one bronze medal and one honorable mention. A joint remote participation to the event of the delegations from Germany, Austria, and Switzerland could be realized in Basel with the support of the University of Basel. The International Chemistry Olympiad 2023 will be hosted at ETH Zurich. This will be the first time this annual event comes to Switzerland.

Keywords: Extracurricular education · International Chemistry Olympiad · IChO · Swiss students



From left to right: Dominic Egger, Chantal Balmer, and Patrik Willi.

Dominic T. Egger is pursuing a PhD in chemistry at ETH Zurich. He participated in SwissChO 2016 and represented Switzerland at IChO 2016 in Georgia, winning a bronze medal. Since then, he has been an active member of the association and the board, serving as actuary and vice president. He served as invigilator for the Swiss delegation at IChO 2022.

Chantal S. Balmer is pursuing a Master degree in interdisciplinary sciences at ETH Zurich. She participated in SwissChO in 2017 and 2018, representing Switzerland at IChO 2018 in the Czech Republic and Slovakia. As an active SwissChO member, she served as mentor to the Swiss delegation at IChO 2022 for the first time.

Patrik O. Willi is pursuing a PhD in Chemical Engineering at ETH Zurich. He participated in SwissChO from 2012 through 2014 and was part of the Swiss IChO delegation in 2013 and 2014, winning a bronze medal in 2013. Ever since he has been an active member of the association becoming its current president in 2017. In 2022, he served as head mentor to the Swiss delegation at IChO.

The 54th International Chemistry Olympiad (IChO) took place from July 10–18, 2022. Due to ongoing international travel restrictions, this year's host country China opted for a remote competition.^[1] These circumstances were therefore similar to what we already faced the previous two years.^[2,3] Nevertheless, a record number of 84 delegations (including one team participating as individuals only due to the ongoing Ukraine war) attended, counting 326 students, 166 mentors, and 140 invigilators in total.

After two years with only remote events, the improvement of the pandemic situation in Switzerland allowed us to have in-person exams for our national selection and everybody was eager to participate in an in-person IChO. With the final decision about the remote format of IChO 2022, we were saddened to be faced with yet another remote event. Especially, since the association of the Swiss Chemistry Olympiad (SwissChO) is tasked not only with the selection of our delegation to IChO but with allowing our participants to engage with like-minded young scientists during the events. In order to give our participants the opportunity to make at least some international contact, a collaboration with the organizers of the German (IChO Germany^[4]) and Austrian Chemistry Olympiad (ÖChO^[5]) for a joint remote 'DACH' participation to the international event could be realized. Basel was chosen as a convenient event location where the three delegations could convene.

The Swiss delegation to IChO was selected in our final week in April at ETH Zurich. The overall winners of both the theoretical and the practical exam represented Switzerland:

- Cedric Bärlocher Aguilar, Gymnasium Burgdorf (BE)
- Silas Waldvogel, Kantonsschule Schaffhausen (SH)
- Thomas Zaugg, Gymnasium Kirchenfeld (BE)
- Yannik Straumann, Berufsbildungszentrum Baselland (BL)

The 5-hour remote IChO theory examination took place globally on July 13th with all delegations starting not more than 10 hours from each other. In all participating countries, the delegations were recorded during the exam and additionally surveyed by invigilators at every exam site. The software *OlyExams*, devel-

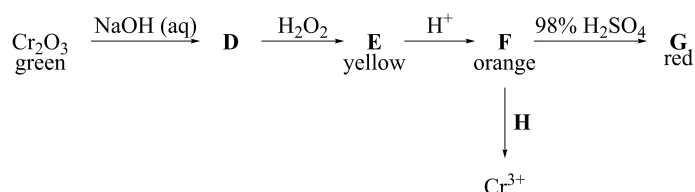


From left to right: Cedric Bärlocher Aguilar, Yannik Straumann, Silas Waldvogel and Thomas Zaugg with the Swiss mascot, a Bernese Mountain Dog named Germain Hess. Picture by Mirjam Sager (Science Olympiad).

oped for the International Physics Olympiad 2016 in Zurich and first used at IChO in 2020, was again used for a smooth remote competition.^[6] Run on a temporary server, *OlyExams* allows for secret discussion of problems by authors and mentors during the final exam revision. It also facilitates collaboration during translation by mentors immediately prior to the exam and it allows for easy management of all exam papers with unique assignability to each student. Invigilators have access to the server on the day of the competition to print the exam and, immediately after completing the exam, all answer sheets were scanned and uploaded to the server for assessment and grading by authors and mentors.

The exam consisted of nine problems, most thereof related to Chinese Science or culture. In problem 2, participants were studying traditional Chinese black glazed porcelain:^[7]

Besides doping in black ceramic glaze, chromium-containing pigments are used in painting and printing due to the variety of colors originating from different oxidation states of chromium, such as +2, +3 and +6. The pigment chrome green (Cr_2O_3) can be converted into a series of other compounds (**D–G**) by the following process, where **E**, **F**, **G** are yellow, orange, and red, respectively.



1. Write the chemical formula of **E**.
2. Write the chemical equation for reaction $\mathbf{F} \rightarrow \mathbf{G}$.
3. Choose the reagent that could be **H**.
 - a. FeSO_4
 - b. FeCl_3
 - c. ZnSO_4
 - d. CuSO_4

The variable valence of chromium is not only important for the production of pigments, but also useful for catalysis. For example, a typical Phillips catalyst for the polymerization of ethylene consists of chromium oxide grafted onto a porous support material such as amorphous silica. A tetra-coordinated Cr(VI) is the core of pre-catalyst **1**, proposed to be quickly reduced by ethylene to a six-coordinated Cr(II) product **2**. Compound **2** is proposed to further catalyze polymerization of ethylene molecules.

4. The reaction of **1** with ethylene can be monitored by UV-Vis spectroscopy. **1** absorbs at $21,500 \text{ cm}^{-1}$ and **2** absorbs at $16,700 \text{ cm}^{-1}$ in the visible region. Choose the appropriate colors of **1** and **2**.

- a. orange and white, respectively
- b. orange and blue, respectively
- c. blue and orange, respectively
- d. blue and white, respectively

5. Assuming that the Cr(II) ion in **2** is located in a regular octahedral crystal field with a splitting energy Δ_o of $16,000 \text{ cm}^{-1}$, draw the configuration of d electrons of the Cr(II) ion in **2**. Calculate the crystal field stabilization energy (CFSE) for the Cr(II) ion in **2**. Note: The pairing energy P for Cr(II) in **2** is $23,500 \text{ cm}^{-1}$.

6. Coordination compounds/ions exhibit paramagnetism when containing unpaired electrons. The corresponding magnetic moment (μ) of transition metal cations is calculated by the function $\mu = \sqrt{n(n+2)} \mu_B$ where n is the number of

unpaired electrons. Calculate the magnetic moment in terms of μ_B for the Cr(II) ion in **2**.

Solutions:

1. Na_2CrO_4
2. $\text{Na}_2\text{Cr}_2\text{O}_7 + 2 \text{H}_2\text{SO}_4 \rightarrow 2 \text{CrO}_3 + \text{H}_2\text{O} + 2 \text{NaHSO}_4$
3. a.
4. b.
5. $\uparrow \uparrow \uparrow$ with CFSE = $9,600 \text{ cm}^{-1}$
6. $\mu = 4.9 \mu_B$

The usual practical exam was skipped due to the challenges of arranging it remotely. Instead, the students had the chance to demonstrate their practical skills in the chemical laboratories of Prof. Jonathan de Roo at the University of Basel. Over two days, they synthesized and characterized colorful core/shell InP/ZnS quantum dots. Moreover, the University of Basel also provided the infrastructure for the exam and for the closing ceremony as well as a laboratory tour for the students and invigilators. We thank the University of Basel, all the helpers directly involved and Prof. Jonathan de Roo in particular, for their great engagement and help with the organization and the conduction



Students and invigilators of all 'DACH' delegations during the day trip to Freiburg im Breisgau. Picture by Uta Purgahn (IChO Germany).

of this event. In addition to their program related to chemistry, students and invigilators also enjoyed day trips to Freiburg im Breisgau, to Biel/Bern and could explore the city of Basel besides the exam.

We are very happy to report that the Swiss delegation obtained two distinctions: Silas Waldvogel received a Bronze medal, and Yannik Straumann was awarded with a honorable mention.^[8,9] Cédric Bärlocher Aguilar just barely missed an honorable mention by two spots (difference of 0.55 points out of 100 points).

As such, we are looking back at a very successful remote IChO. The organizers of the 'DACH' Chemistry Olympiads are hoping to host more joint events in the future, to allow exchange between participants of the three countries both on chemistry, but also to get to know each other ahead of travelling to future international competitions.

Next year, IChO will be held in Switzerland for the first time (see also Infobox below).

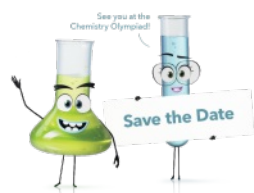
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Infobox IChO 2023

IChO is an annual international competition for talented young people from secondary and vocational schools. The first IChO took place in Prague in 1968. Since 1987, Switzerland has sent a delegation to an IChO more than 30 times but has never been the host country itself. Finally, the time has come in 2023. The volunteer-run SwissChO, together with ETH Zurich, was awarded the opportunity to host the event in Switzerland. Over 900 people are expected to take part in the IChO 2023 from July 16-25, 2023.^[10]

The National Steering Committee consists of one representative each from: ETH Zurich, its Department of Chemistry and Applied Biosciences, SwissChO, Science Olympiad and the SCS.

ETH Zurich rector Professor Günther Dissertori is presiding over the IChO 2023. Marco Gerber is responsible for the operational implementation and chairs the organizing committee. The scientific committee headed by Professor Wendelin J. Stark is responsible for the competition itself.



IChO 2023 logo and mascots Earl Mayers and Tina Tube.

- [1] IChO 2022, <https://www.icho2022.cn>, accessed Sep. 1, 2022.
- [2] M. Cosandey, *Chimia* **2020**, *74*, 647, <https://doi.org/10.2533/chimia.2020.647>.
- [3] M. Cosandey, *Chimia* **2021**, *75*, 894, <https://doi.org/10.2533/chimia.2021.894>.
- [4] German Chemistry Olympiad, <https://www.scienceolympiaden.de/icho>, accessed Sep. 1, 2022.
- [5] Austrian Chemistry Olympiad <https://www.oecho.at/de/>, accessed Sep. 1, 2022.
- [6] OlyExams – Exam management for Science Olympiads, developed for the International Physics Olympiad 2016 in Zurich, <https://www.oly-exams.org>, accessed Sep. 1, 2022.
- [7] The text shown is an adapted and shortened version of the official problem. The original version of the full exam is available at <https://www.icho2022.cn>, accessed Sep. 2, 2022.
- [8] Press release of SwissChO, <https://chemistry.olympiad.ch/de/news/news/bronzemedaille-und-ehrenmeldung-fuer-schweizer-schueler-an-internationaler-chemie-olympiade>, accessed Sep. 1, 2022.
- [9] Community News, *Chima* **2022**, *76*, 726, <https://chimia.ch/chimia/article/view/6142>, accessed Sep. 1, 2022.
- [10] <https://www.icho2023.ch/>, accessed Sep. 7, 2022.