Chapter IV.8

JUAS during 2021

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This chapter covers the period John Jowett was JUAS Director (i.e. from mid-2020 to mid-2021).

IV.8.1 Introduction

Although I was aware of its existence for many years, my first direct acquaintance with JUAS came only in late 2019 with Philippe Lebrun's invitation to succeed him as JUAS Director.

After accepting Philippe's invitation, I shadowed him as deputy for JUAS 2020 to learn how the school worked. For both students and faculty, I found that the experience was different from other accelerator schools—in the USA and Europe—that I had organised or lectured at previously. The extended length of JUAS, the social interaction generated by the students coming into residence near the Archamps campus, and the fact that, for most of them, the courses were embedded in the curriculums of the partner universities, created a different academic ambience, one that was perhaps more conducive to consolidated learning.

The students also benefited from the proximity of the JUAS campus to major European accelerator laboratories such as CERN, ESRF, and PSI, whose staff provided instructive visits and practical sessions that brought the lecture courses to life.

So I was looking forward to directing the next school in 2021.

IV.8.2 Rethinking JUAS for the global pandemic

Then, just before the end of JUAS 2020, the SARS-CoV-2 virus struck Europe. Uncertainty and fear came to dominate all our lives in subsequent months. The impending lockdowns forced the students to dash back to their home countries while it was still possible to travel.

The exams in the last week of 2020's Course 2 had to be reorganised to be taken remotely at very short notice. Exam papers were distributed by email just before each exam, and smartphone scans of the students' scripts were returned immediately afterwards.

In summer 2020, the pandemic subsided somewhat, and we briefly entertained hopes of organising JUAS 2021 in the usual way. But that was not to be, and the 2021 edition of JUAS took place in the

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CERN Yellow Reports: School Proceedings, CERN-2024-003, DOI: 10.23730/CYRSP-2024-003, p. 2349.

shadow of further waves of the global pandemic. The persistence and unpredictability of the pandemic meant that our only safe option was to organise JUAS in remote format. We saw that it could well turn out to be impossible to bring the students into residence at Archamps or to conform with social-distancing requirements at ESI. Since a year without JUAS would have deprived talented young physicists and engineers of an opportunity and disrupted the supply of accelerator specialists in Europe, the courses had to be reimagined and conducted entirely remotely. This decision was endorsed by the JUAS Advisory Board in September 2020. With hindsight, we now know that any other approach would have been disastrous.

Of course, the internationally dispersed physics community had already pioneered remote meetings for many years before the pandemic. This experience helped with the technicalities but, more importantly, it also made us more realistic about what we could hope to achieve.

We received many good applications and endeavoured to welcome all qualified students. It was clear that tutorial and lab sessions would require at least the same, if not a higher, ratio of instructors to students. On the other hand, in the absence of physical space limitations, the size of the audiences for the traditional lectures and some of the visits had no practical limit. We reconciled this tension by introducing "Full" and "Abridged" versions of the courses. The latter allowed them to be opened to an additional cohort of students whose participation in tutorial and laboratory sessions was reduced in scope. In line with the JUAS Mission Statement, priority for the Full course was accorded to students from partner universities and to those taking exams. Students following the Abridged course did not sit exams, and they received less individual attention in practical sessions and certain tutorials. As usual, some students from the professional category took courses *à la carte* and were included in the Abridged group.

In all, there were some 60 participants in JUAS 2021, split roughly equally among master's students, PhD students, and early-career professionals. This total was significantly higher than in most years after the all-time peak in 2016, reversing a decline in previous years.

Similar upheavals were occurring worldwide in universities and other academic institutions, and we naturally had a large number of discussions about whether JUAS should follow them in adopting technical tools and methods for lectures, tutorials, and examinations from the burgeoning market in such software. I took the decision *not* to follow this path and rather stick to a few simpler and more universal tools that were already widely used at accelerator labs including CERN and collaborating universities. The main rationale for this was that the software packages were designed for wholesale adoption by full-time educational institutions, and we could not expect JUAS lecturers to invest time in learning them just for the relatively small number of lectures that each of them delivered and set exams on. Most of the faculty are accelerator experts at national or international labs, not university lecturers, and they give their time voluntarily. In the particular context of JUAS, the required investment of faculty time did not therefore seem feasible or worthwhile.

We thus kept things simple, relying on familiar software, typically including programs for building slide presentations and CERN's widely used Indico system to support the timetable structure and deliver course materials. Indico is particularly well integrated with the Zoom platform, which became the dominant framework for delivering lectures and hosting discussions. Everyone is now familiar with

screen sharing, the chat window, and so on.

We did try proposing the use of drawing tablets as whiteboard replacements to faculty, but their usage was very limited in practice. Again, this was because it takes time and practice to incorporate new tools into teaching.

The one unfamiliar (for most of us at the time) system that did prove quite useful was Slack, which was used for announcements and messages among groups of people, ranging from the entire JUAS faculty or student body to small tutorial groups. It proved its worth, replacing the confusing email threads that blight our lives with lighter "channels" including, but not imposing on, everyone interested in a discussion. Unsurprisingly, we became aware that the students were also chatting with each other on other platforms at the same time.

IV.8.3 Lessons and impressions from the first remote JUAS

The lecturers delivered their traditional lectures via Zoom, with optional support from a moderator to manage interruptions and questions. Some used Zoom polls to animate the sessions and hold attention by asking live multiple-choice questions. One lesson that we learnt early on was that it is harder for an audience to sustain concentrated attention during Zoom lectures. The online lecture sessions therefore had to be shorter than the in-person ones.

Tutorial sessions were held in parallel breakout groups. Our ESI Project Manager, Stéphanie Vandergooten, was key to managing and keeping the Zoom sessions moving. Software installations on personal computers were required for some courses. This was generally successful.

Once the school started, it became ever clearer that further technological developments would be needed before direct interpersonal communications and in-person teaching could be replaced. This was particularly true of the valuable informal interactions that take place between lectures, over coffee, at lunch, on the bus to lab visits, and so on. Making friends and networking with people from a diversity of backgrounds, and learning about the experiences of other students, professionals, and the faculty are all important aspects of the usual JUAS experience.

Despite the energetic efforts of Stéphanie and the entire faculty, it was difficult to reproduce all this in a meaningful way. Personally, I regretted the lack of opportunities to get to know the students. There are no group photos to illustrate their enthusiasm, which was nevertheless palpable.

On the other hand, the visits and lab sessions exceeded my expectations and were surprisingly effective.

Across the world, other educational institutions were having similar experiences. Fortunately, after 2021, and a second remote school in 2022, JUAS went back to its traditional in-person form in 2023 (see the following sections). While we fervently hope that another global pandemic will not occur, it is worth preserving these notes on how to handle one.

IV.8.4 Course 1: The Science of Particle Accelerators

The content of the JUAS courses has always evolved—at a measured pace—from year to year. Foundation courses on core subjects should not change too much in content, and the focus should be on

incremental pedagogical improvement. Nevertheless, accelerator science is a dynamic field, and new topics emerge and must be introduced. The seminar programme within JUAS exposes the students to frontier topics and the perennial discussions about future accelerator projects. The Director always has scope for innovation and modernisation of the syllabus.

In addition to implementing improvements that I judged necessary, the transition to the remote format was a natural break-point, prompting a number of changes to the teaching faculty for JUAS Courses 1 and 2. Full details can be seen by comparing Refs. [1, 2] with Ref. [3]. To some extent, the removal of travel and availability constraints by the remote format allowed course modules to be presented in a somewhat more logical order.

I would like to highlight a few of the more important changes and the departures of a few long-standing lecturers. Full details can be seen by comparing the timetables of JUAS 2021 [1] and the preceding JUAS 2020 [3].

As usual, Course 1 covered basic theory and accelerator physics in some depth.

Vittorio Vaccaro's long-standing and appreciated seminar on the early history of particle accelerators from the early 20th century up to the 1960s was replaced by a new seminar on the multiple types and purposes of accelerators in our present century, delivered by Maurizio Vretenar.

The courses and mini-workshop on accelerator design by Phil Bryant, a key contributor to JUAS since 1996, were taken over by a new team assembled by Bernhard Holzer. The working groups of a few students clustered around tables were replaced by small Zoom collaboration sessions that could be "visited" by the lecturer and his assistants. In addition, the software tools employed in these and related sessions were unified around the program MAD-X; despite its rudimentary interface, it is widely used, at CERN in particular.

Heino Henke was no longer available for the courses on special relativity and electromagnetism that he had given since 2012; these were taken over by me and Elias Métral, respectively. Although nearly all students will have learned these topics in undergraduate courses, they were retained as refreshers, with a focus on the aspects most pertinent to particle accelerators.

Nicolo Biancacci's introductory course on single-particle dynamics and optics reduced the emphasis given in 2020 to the connections to light optics to move more quickly into the particle dynamics required for the ensuing course on transverse dynamics.

The scope of the lectures on space charge was extended to other types of collective instabilities in circular accelerators by Mauro Migliorati.

Bertrand Jacquot's course on Cyclotrons was extended to include fixed-field alternating-gradient accelerators.

IV.8.4.1 Laboratory visits and lab work in Course 1

We introduced a virtual visit to the ALICE experiment at the LHC, preceded by a short talk (by me) illustrating how the concepts learned in the transverse dynamics and design courses could be applied to a complex two-beam interaction region in the world's largest collider (happily, this was converted to an in-person visit to the underground cavern of ALICE in 2023). The visit was conducted with a live video

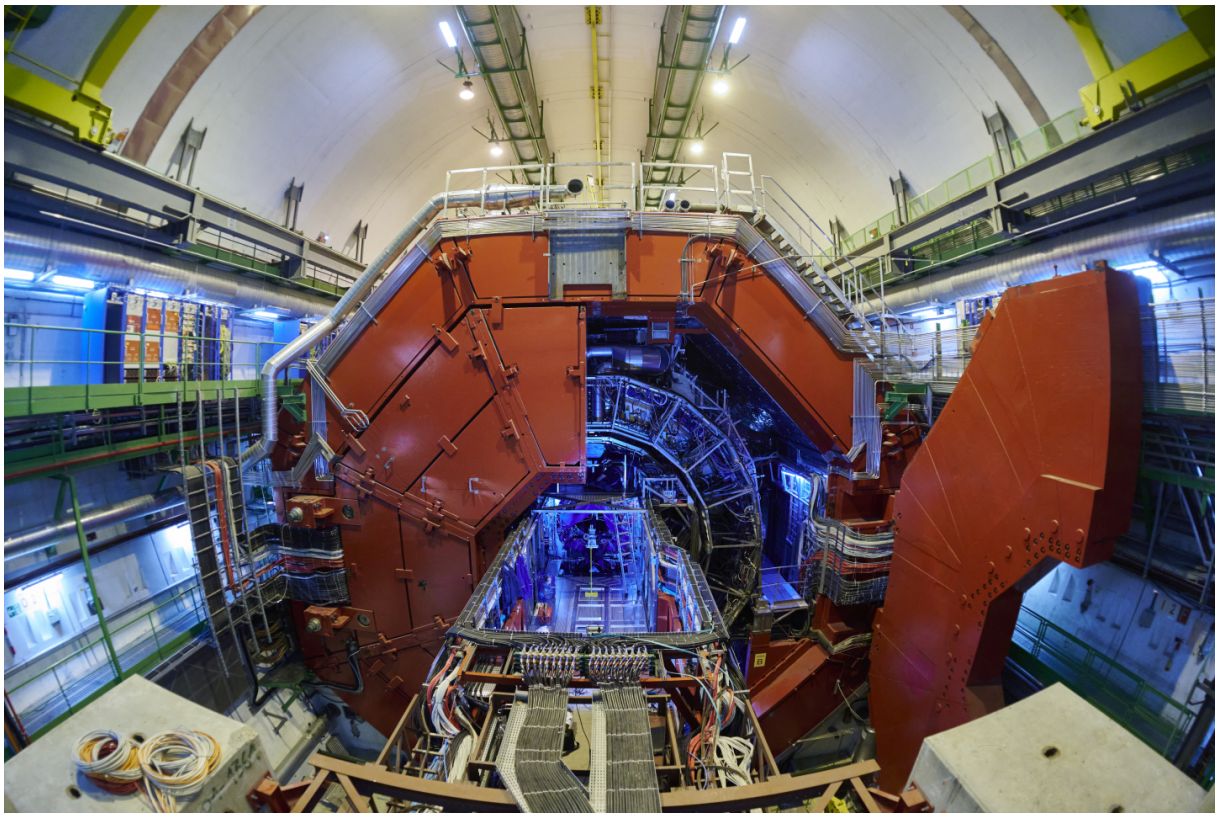

Fig. IV.8.1: A view of the ALICE experiment with one of its end-cap doors open around the time of the JUAS virtual visit. © CERN.

feed from guides in the ALICE control room and underground caverns (see Fig. IV.8.1).

Another new visit to the SOLEIL synchrotron was conducted in a similar manner (after a rehearsal) with the help of David Amorim, himself a former JUAS student. Since this machine is located near Paris, too far away for a day visit from the ESI campus, it was only feasible in a remote JUAS.

The customary visit to ESRF in Grenoble was recreated very successfully by Jean-Luc Révol and colleagues, with virtual visits to the control room and a beamline.

IV.8.4.2 Seminars in Course 1

Previous JUAS syllabuses had covered proton–proton colliders and linear electron–positron colliders. Most colliders—past, present and, quite possibly, future—have been or will be *circular* electron–positron colliders. We therefore introduced a new seminar on them, given by Frank Zimmermann.

In 2020, I had given a seminar, *Hybrid Collisions in the LHC*, intended as a case study in how particle accelerators can be upgraded to modes of operation unforeseen in their original designs. However, the seminar came a little too early in the JUAS programme, before all the topics required to understand the beam-dynamics issues involved had been covered. I therefore decided to change it the more general topic of *Nuclear Collisions in the LHC* and cover the heavy- (and lighter-) ion-collision programme more generally.

Very recently, it had become clear that the next major collider to be built in the world would very

likely be the Electron Ion Collider in the USA, another hybrid collider. It could loom large in the future careers of some of the JUAS students over the next decade or two, and it was thus timely to introduce a new seminar on it by Todd Satogata.

IV.8.4.3 Course 2: The Technology and Applications of Particle Accelerators

In my view, the Course 2 syllabus in 2020 was well structured and logically sequenced. Consequently, few changes were made to the core lecture courses on the principal accelerator technologies.

We thank Wim Kleeven for the final instalment of his lectures on accelerators for medical and industrial applications.

IV.8.4.4 Laboratory visits and lab work in Course 2

Thanks to great efforts by the faculty involved, the lab work and visits normally conducted in person at CERN facilities were re-created in remote format. The visits and bench work in labs (see Fig. IV.8.2) were surprisingly successful, and several CERN colleagues (see Ref. [2] for full details) deserve congratulations.

Fig. IV.8.2: Views of the practical sessions broadcast interactively from CERN magnet labs.

This was also true of the virtual visit to the PSI laboratory, organised by Rasmus Ischebeck and his colleagues. The students greatly appreciated his creative use of the full possibilities of the Zoom

Fig. IV.8.3: Views from the tour of the PSI laboratory led by Rasmus Ischebeck.

software, including broadcasting live from his bike as he toured the PSI campus, see Fig. IV.8.3. Students commented that it was almost like being there.

The lab sessions conducted by Bergoz Instrumentation from their facilities at Saint-Genis-Pouilly and the seminar on radiation oncology and virtual visit to the medical accelerators at Geneva University Hospitals by Andre Durham were also very thoroughly prepared and well thought through. Both had a high level of engagement and appreciation from the students.

IV.8.4.5 Seminars in Course 2

Daniel Schulte gave a seminar on muon colliders and their technological challenges. Frédéric Bouly took over the accelerator-driven systems seminar.

IV.8.5 Examinations and outcomes

As agreed with the 2020 Advisory Board, we asked the partner universities to organise simultaneous local invigilation of exams, conforming with local social-distancing regulations, and the return of scanned exam scripts for marking.

For both Course 1 and Course 2, the raw marks gave a distribution similar to previous years, confirming that academic standards were maintained in JUAS 2021.

IV.8.6 Further changes to JUAS in 2021

Louis Rinolfi took charge of a review of existing partnership agreements with universities and of establishing new ones.

Later in the year, I made the decision not to continue as Director of JUAS for personal reasons.

Acknowledgements

I thank our faculty, their assistants, and moderators for the exceptional efforts made to adapt or create new lecture courses. The cooperation of our partner universities in arranging examinations locally was invaluable. Colleagues at CERN, the ALICE experiment, ESRF, PSI, SOLEIL, Bergoz Instrumentation, and the Geneva University Hospitals displayed remarkable ingenuity in recreating visits, seminars, and even interactive laboratory work in online versions. I especially want to thank the JUAS team at ESI at the time: Bob Holland, Philippe Lebrun, Elias Métral, Lise Ribet, Louis Rinolfi, and, particularly, Stéphanie Vandergooten, whose skills and dynamism kept the school running from day to day. Despite the painful context of the pandemic, they contributed to creating an effective and satisfying pedagogical experience for the students and to ensuring that they came out of JUAS with no disadvantage to their academic credentials.

References

[1] JUAS 2021 timetable—Course 1, https://indico.cern.ch/event/976482/timetable/.

[2] JUAS 2021 timetable—Course 2, https://indico.cern.ch/event/976482/timetable/.

[3] JUAS 2020 timetable, https://indico.cern.ch/event/976482/timetable/.