Chapter IV.9

JUAS during the period 2022–2024

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This chapter covers the period Elias Métral was JUAS Director (i.e. as of August 2021).

In 1996, I attended JUAS (when Marcelle Rey-Campagnolle was the Director) as part of my postgraduate studies in Grenoble. In 2000 and 2001, I was the assistant to Louis Rinolfi, for his lectures on longitudinal beam dynamics, and to Michel Martini, for his lectures on transverse beam dynamics. Between 2011 and 2021, I was the lecturer for longitudinal beam dynamics, and in 2014, Louis Rinolfi, who was the JUAS Director at that time, proposed that I should become his deputy. I accepted, and I acted as JUAS Deputy Director first for Louis Rinolfi, and then for Philippe Lebrun and John Jowett, between 2014 and August 2021, when I became the seventh JUAS Director, even though I had not planned to take this responsibility before my retirement (in more than a decade). This is why, when Louis Rinolfi had offered that I should take over after his mandate, I had declined: I was then a CERN section leader with important managerial responsibilities (the section had between 20 and 30 people). However, after directing JUAS 2021, John Jowett had to step down for personal reasons. As my mandate as section leader had come to an end, I started to consider the possibility of becoming the JUAS Director earlier than foreseen. I asked my hierarchy, who, to my great pleasure, agreed. I would thus like to express my warm thanks to my management, and in particular to Mike Lamont, CERN Director for Accelerators and Technology, and to the ESI President *ad interim* at that time, Philippe Lebrun, for having had this honour.

I owe JUAS a lot, as the school was an outstanding springboard for my career in particle accelerators at CERN. I take on the role of JUAS Director with pride and a firm commitment to ensuring that JUAS offers young physicists and engineers a comprehensive and up-to-date introduction to the discipline.

IV.9.1 2022: Optimising the JUAS experience despite a fully online edition for the second consecutive year

For the second year running, JUAS 2022 took place in the shadow of the global COVID-19 pandemic, and it was once again decided not to risk bringing the students into residence at Archamps. Building on the 2021 online programme implemented under the coordination of John Jowett, several changes

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were made to take into account the feedback from students and lecturers. These included preparatory videos on fundamentals, additional slots for core topics and new seminars, and the use of a specialised platform to manage the exams. The JUAS Advisory Board, meeting face-to-face in May at La Sapienza in Rome, acknowledged the successful implementation of the school, with final exam results being very similar to in previous years, confirming that academic standards were maintained, despite the remote format. True to the ethos of the particle accelerator community, JUAS is a highly collaborative enterprise. Our heartfelt thanks go to the faculty, their assistants and moderators, the members of the Advisory Board, and the team at ESI. Colleagues at CERN, the ALICE experiment, ESRF, PSI, SOLEIL, Bergoz Instrumentation, and HUG once again displayed remarkable ingenuity in recreating visits, seminars, and interactive laboratory work in an online format.

IV.9.1.1 Course 1

Prerequisite videos, including materials developed by the ARIES project, were posted on Indico to be viewed prior to the start of the school. Mandatory topics covered electromagnetism, special relativity, Python, and Hamiltonian formalism. Additional videos included introductions to particle accelerators and their applications, RF, and applications of Hamiltonian formalism. Virtual visits to S-DALINAC[1], LEIR, and the ALICE experiment at the CERN LHC were also made available. A "What to remember" session was scheduled during the first day. Core lectures were given by live videoconference, including tutorials, practical exercises, and quizzes. Most sessions involved a moderator in charge of managing questions and providing additional support to the lecturer. An essential part of JUAS is the programme of specialist seminars, traditionally given by invited speakers at the end of the school day or during visits to accelerator facilities. The Course 1 seminars aim to give participants an opportunity to broaden their vision of large-scale accelerators as they exist today and how they may look in the future. One of the particular challenges of the remote format was to maintain the highly popular visits to accelerator facilities. Participants were appreciative of the efforts deployed by their virtual tour guides, despite occasional technical glitches such as poor connectivity in an accelerator tunnel. The time sharing was as follows (without accounting for breaks):

- 13 lectures on core topics (including tutorials) and three workshops: 84 h;
- nine seminars: 8 h 15 min;
- three virtual visits: 3 h 45 min.

A total of 27 faculty members from eight universities or institutions were involved in taking care of the 34 participants (eight master's students, 21 PhD students, and five professionals), 27 males and seven females, with 14 nationalities from 21 different universities or institutions. Out of the 34 participants, 27 took the exams.

IV.9.1.2 Course 2

In Course 2, on top of the full lecture programme, participants worked in groups to deliver reports on normal-conducting magnets workshops as well as giving an oral presentation on the CERN practical

[1] S-DALINAC: Superconducting DArmstadt LINear ACcelerator.

days. Both were marked, and these marks contributed to the final grade. Key features of Course 2 include visits to CERN and PSI, the two-day practical technology sessions organised at CERN, and the half-day spent at the bench at Bergoz Instrumentation. Thanks to all those who devoted time and energy to organising live-stream visits and virtual practicals, with the indelible memory of Rasmus Ischebeck conducting a Zoom session from his bike as he crossed the river Aare to enter the tunnel for a detailed explanation of the structure and workings of PSI's state-of-the-art facility. The time sharing was as follows (without accounting for breaks):

- 19 lectures on core topics (including tutorials): 75 h;
- nine seminars: 6 h 45 min;
- five virtual visits and one workshop: 15 h.

A total of 36 faculty members from 13 universities or institutions were involved to take care of the 30 participants (13 master's students, 12 PhD students, and five professionals), 23 males and seven females, with 11 nationalities from 17 different universities or institutions. Out of the 30 participants, 22 took the exams.

IV.9.1.3 JUAS-IPAC Prize from the EPS-AG

IPAC is the leading international event for the worldwide accelerator community and industry, and IPAC'22 took place in Bangkok in June, following two online editions due to the pandemic. It is a unique opportunity to meet, interact, and network with accelerator scientists, engineers, students, and companies. Thanks to a long-standing agreement between JUAS and the conference organisers, each year, the JUAS-IPAC award is attributed to the first-ranked master's or doctoral student from Course 1. The award comes from the EPS-AG (European Physical Society's Accelerator Group), and it takes the form of a bursary, given by the IPAC organisers, covering conference fees, travel, accommodation, and subsistence costs. Thanks to the organisers' generosity, it was not one but two JUAS laureates who were able to travel to Bangkok: Pablo Martinez Reviriego, a PhD student from Universitat de Valencia (who was ranked as the best student at JUAS 2021) and his JUAS 2022 counterpart, Philipp Niedermayer, a PhD student at Goethe Universität Frankfurt and GSI Darmstadt. Pablo and Philipp joined and helped me in promoting Europe's leading particle accelerator school during this event.

IV.9.1.4 JUAS Advisory Board

The JUAS Advisory Board, comprising 28 representatives of JUAS partner universities and experts from leading European research facilities, meets annually in one of the partner universities. With the lifting of travel restrictions due to the pandemic, the JUAS Advisory Board was able to meet face to face in Rome on 5 and 6 May, with certain members connected by videoconference over two half-days. In spite of the remote format, JUAS 2022 was considered to be a very successful edition; many improvements were implemented, including the prerequisite videos, additional slots for certain topics and seminars, two exams already in the third week, and the specialised platforms used for the exams (see Fig. IV.9.1). However, everybody was looking forward to a hoped-for return to face-to-face teaching for JUAS 2023, followed by the Advisory Board meeting at the University of Oxford, on 17–18 April 2023.

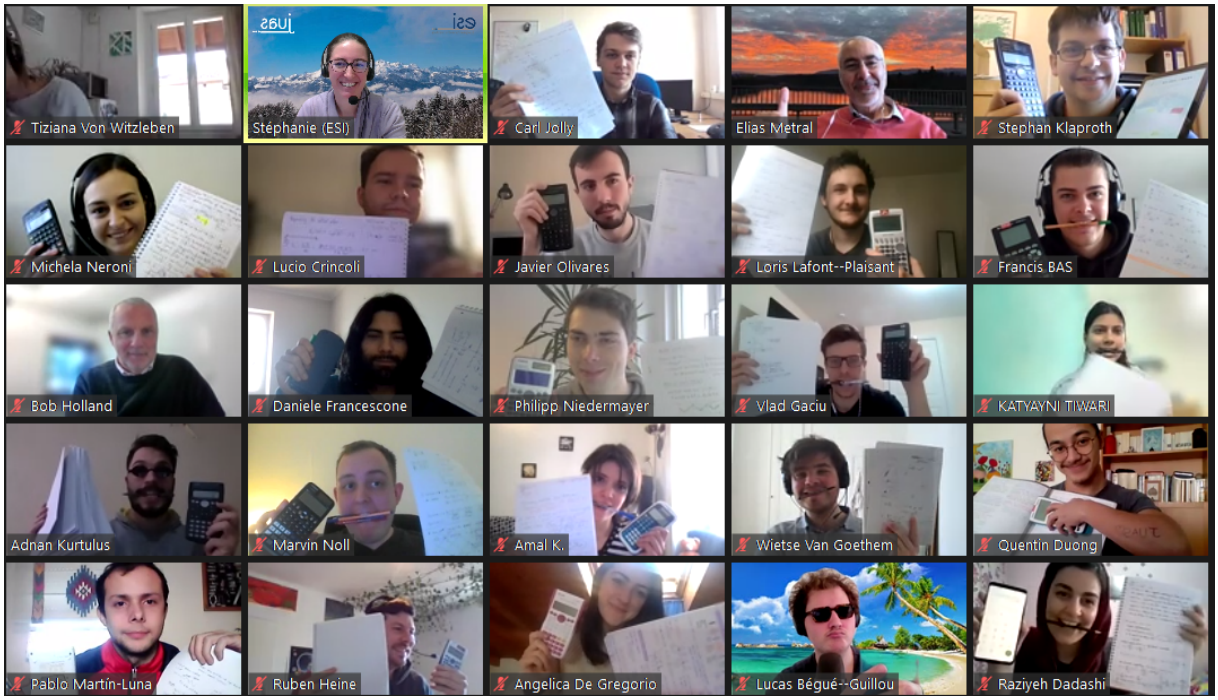

Fig. IV.9.1: Some JUAS 2022 students doing the exams over Zoom.

IV.9.1.5 JUAS in European programmes

JUAS figures in two European Commission-funded programmes. The first of these is one of the year-two electives in the Erasmus Mundus Joint Master LASCALA (Large Scale Accelerators and Lasers): a two-year international master's programme, created by the universities of Paris-Saclay, Rome La Sapienza, Lund, and Szeged, aimed at training experts in the most advanced experimental and theoretical tools and concepts in accelerator physics, high-power lasers, and laser–plasma interactions at high intensity, as well as training in their applications to new sources of energy, health, and security diagnostics. The second programme is the H2020 project I.FAST (Innovation Fostering in Accelerator Science and Technology), as one of the inspirations of the I.FAST-CBI (Challenge Based Innovation) on "Particle Accelerators for the Environment", which was held at ESI-Archamps from 26 July to 4 August 2022.

IV.9.1.6 A JUAS book for the 30th anniversary of JUAS in 2024

As soon as I became JUAS Director, I proposed writing a book for the 30th anniversary of JUAS in 2024, as after almost 30 years of existence only notes and slides exist (even if some reports have been already published on some particular topics). In the autumn of 2021, I started discussions with the CERN Library to have this book published electronically (using Overleaf) as a CERN Yellow Report, with a planned date of official release on 15 November 2024. The goal was to have several sections, with one on the history of JUAS and others on Courses 1 and 2, including both the lectures and the seminars.

Furthermore, the agreed added value of this book was to provide exercises and solutions. On 7 February 2022, I organised the kick-off meeting for the Editorial Board, and about two months later, on 1 April 2022, the kick-off meeting with the Authors took place. The JUAS book adventure could then really start, with a proposed plan (with deadlines and milestones) covering 31.5 months, from 7 February 2022 until the release of the book on 15 November 2024. In the JUAS book team, three roles were identified:

- first (and most important) role: Author. An Author has to write a Chapter in one of the four Sections of the book;
- second role: Editorial Board Chapter Editor (EBCE). An EBCE is linked to an Author to help the Author during the writing-up of the Chapter and, at some point, to officially review the Chapter;
- third role: Editorial Board Section Coordinator (EBSC). An EBSC coordinates the work of a full Section of the book, helps the EBCEs and Authors of a Section and, at some point, officially reviews the full Section.

IV.9.2 2023: Back to face-to-face teaching, an invaluable part of the JUAS experience

The 2023 session marked the eagerly awaited return to on-site training at ESI after two years online due to the pandemic (see Fig. IV.9.2). In our constant striving to improve the programme, a number of changes were initiated, including:

- a compulsory preparatory phase on special relativity and electromagnetism using MOOC videos with an online prerequisite questionnaire;
- a restructured accelerator-design workshop;
- a dedicated afternoon session on colliders;
- a reorganised schedule with a redistribution of the exams and preparatory sessions, along with more tutorials and quizzes;
- slots for private studies implemented in the school schedule;
- visits to ESRF and PSI scheduled after the exam sessions, etc.

My sincere thanks go to the entire JUAS faculty and to those colleagues at CERN, the ALICE experiment, ESRF, PSI, Bergoz Instrumentation, and HUG, who devoted precious time to sharing their passion for accelerators and accelerator technology during bespoke visits and practical lab sessions. And of course, thanks also go to the members of the Advisory Board, who ensure that JUAS remains a world-class venture, and to the team at ESI, with a special mention for Stéphanie Vandergooten: JUAS would not be possible without her outstanding organisational skills!

JUAS would not be able to function without the financial and/or in-kind support it receives from a range of facilities, companies, and research programmes. In 2023, these were joined by the ELETTRA synchrotron facility in Trieste (Italy) and by MYRRAH (Mol, Belgium), the world's first large-scale accelerator-driven system project at power levels scalable to industrial systems.

We were immensely saddened to learn of the sudden death of Sébastien Bousson in November 2022. As a former JUAS student, Sébastien was a much-appreciated member of the JUAS faculty, where he taught the course on high-power proton linacs. More sad news followed in February 2023, with firstly

Fig. IV.9.2: End of the JUAS 2023 edition.

the passing of Michel Martini, who for many years taught the transverse beam dynamics course, and secondly, of Vittorio Vaccaro, who, after retiring from teaching at JUAS, had remained an enthusiastic member of the Advisory Board. They are sorely missed.

IV.9.2.1 Course 1

Before the start of the school, participants were required to view a selection of short videos and successfully complete questionnaires on key aspects of electromagnetism and special relativity, two major topics that are the fundamentals of the programme. In addition, a session on "key points to remember for particle accelerators" was run during the first day of the course. Additional background videos to be viewed prior to the school included introductions to particle accelerators and their applications, RF, and applications of Hamiltonian formalism. Virtual visits to S-DALINAC, LEIR, and the ALICE experiment at the CERN LHC were also made available. Participants needing to validate the course to obtain ECTS or doctoral credits took five exams and made one oral presentation: the first two midway through the five-week course, and the remainder during the last week. The time sharing was as follows (without accounting for breaks):

- 13 lectures on core topics (including tutorials): 75 h 25 min;
- three workshops: 18 h 30 min;

– ten seminars: 12 h;
– three visits: 6 h 45 min.

A total of 28 faculty members from 11 universities or institutions were involved in taking care of the 31 participants (10 master's students, 19 PhD students, and two professionals), 25 males and six females, with 14 nationalities from 15 different universities or institutions. Out of the 31 participants, 29 followed the full programme and two were registered "à la carte", while 26 participants took the exams.

IV.9.2.2 Course 2

As with Course 1, participants were required to view background videos on fundamental topics at the core of the programme. The practical days at CERN are a particularly important and appreciated part of JUAS. On the first day of the school, different experts from CERN give presentations on different technologies and their applications at CERN. In 2023, the areas covered were magnets, vacuum, superconductivity, RF, and CLEAR (CERN Linear Electron Accelerator for Research). Participants then had to choose two topics for their practical group work at CERN. Following the sessions, each group had to collectively prepare a written report on the manipulations they undertook and make an oral presentation of the results to a panel of experts. Participants needing to validate the course to obtain ECTS or doctoral credits took five exams in addition to the written report and oral presentation of the practical sessions. The time sharing was as follows (without accounting for breaks):

– 19 lectures on core topics (including tutorials): 76 h 15 min;
– two workshops: 19 h 30 min;
– nine seminars: 6 h 40 min;
– four visits: 14 h 15 min.

A total of 43 faculty members from 16 universities or institutions were involved in taking care of the 39 participants (28 master's students, ten PhD students, and one professional), 28 males and 11 females, with 17 nationalities from 16 different universities or institutions. Out of the 39 participants, 34 followed the full programme and five were registered "à la carte", while 30 participants took the exams.

IV.9.2.3 JUAS-IPAC Prize from the EPS-AG

IPAC'23 took place in Venice (Italy) in May. Dora Erzsebet Veres, a PhD student at the Goethe Universität Frankfurt and CERN, obtained the highest overall mark this year. During the full week of the IPAC-23 conference, Dora helped me to promote JUAS at the stand devoted to ESI by explaining what ESI and JUAS are, and in particular by sharing her experience with all the people who came and visited the stand.

As JUAS Director, I was contacted in autumn 2022 to organise a students' tutoring session during the weekend before the IPAC-23 conference itself (see https://indico.jacow.org/event/64/). The goal of this session, organised for the first time in Europe (in fact, Philippe Lebrun had organised such a session for IPAC 2020, due to be held in Caen, but it did not ultimately take place because of the COVID-19 pandemic), was to provide student delegates with all the necessary concepts, terminology, and recommendations (e.g. on networking) to get the most out of the world's biggest conference on

particle accelerators, which mobilises up to around 2000 people. A total of 138 students attended the 11 tutorials (each comprising a 40-min talk and a 20-min discussion) delivered by speakers from Europe (six), America (three), and Asia (two). Subjects ranged from "Overview of history and types of accelerators" to "Accelerators for medical and industrial applications", going through linear and circular accelerators/colliders, superconducting radio-frequency cavities and magnets, synchrotron light sources, free-electron lasers, plasmas, facilities for radioactive ion beams, and neutron sources. The session on linacs was run by Louis Rinolfi, former JUAS Director and ESI Board member. There were many very interesting questions and discussions, and the feedback from students was extremely positive.

IV.9.2.4 JUAS Advisory Board

The 2023 meeting, hosted by Prof. Phil Burrows at Oxford University, took place on 17 and 18 April. The agenda of the meeting included: the report on each course of the 2023 edition of JUAS; an overview of participants' feedback on the programme and overall organisation; the budget and review of financial support; proposed improvements for the 2024 edition; information on July's I.FAST-CBI challenge "Particle Accelerators for the Environment"; and a status report on the upcoming JUAS book. The preparation of the latter was going well, with a number of lecturers sharing draft material from their contributions with participants at JUAS 2023. The Advisory Board also formally welcomed Prof. Alexander Gerbershagen as a representative of the University Medical Center Groningen (UMCG), the latest addition to the family of JUAS partner universities, and it was decided that UMCG would host the 2024 Advisory Board meeting at its new Particle Therapy Research Center (PARTREC) on 6 and 7 May 2024.

IV.9.3 2024

The poster for JUAS 2024 can be found in Fig. IV.9.3, where the current 14 partner universities and 25 collaborating institutions and programmes are mentioned. As for 2022 and 2023, I would like to sincerely thank all of them, as JUAS would not be able to function without the financial and/or in-kind support it receives from them. My sincere thanks also go to the entire JUAS faculty (see Figs. IV.9.4 and IV.9.5), all the involved CERN colleagues, the ALICE experiment, ESRF, PSI, Bergoz Instrumentation, HUG, all the members of the Advisory Board, and of course all the JUAS team, which can be found in Fig. IV.9.6. I would like to express my sincere thanks to Darina Baizhanova, who was instrumental in the success of JUAS 2024, and to Bob Holland, who retired in March 2024: many thanks, Bob, for having been such a great ESI Director for many years, and all the best for your new life!

For this edition, which sadly saw the passing of Phil Bryant, who had been a key actor in JUAS for many years, several changes were made. The changes of lecturers were as follows:

- Reyes Alemany was replaced by Rende Steerenberg for the 1-h seminar "Introduction to CERN & its accelerator complex";
- Alexander Gerbershagen was invited to give a 1-h seminar "CERN beamlines for fixed-target experiments";
- The 1-h seminar from Daniel Schulte "Muon colliders & associated technological challenges" was replaced by a 1-h seminar from Luca Bottura "Muon collider magnets";
- Fritz Caspers was replaced by Sergio Calatroni for his 2-h lectures "Superconducting RF cavities";

– Edda Gschwendtner was invited to give a 1-h seminar “Plasma wakefield acceleration and the AWAKE experiment at CERN”.

The other changes are summarised as follows:

– exams 1 and 2 (for both Courses 1 and 2) still took place in week 3, but with a longer break (1 h) between them;
– exam 3 took place in week 4 (instead of week 5);
– exams 4 and 5 still took place in week 5, but with a longer break between them (one in the morning and one in the afternoon);
– for Course 1, the session on colliders, which was too intense (with seven talks in one afternoon), was split;
– also for Course 1, a visit to the CCC (CERN Control Centre) was re-added to the programme of the CERN visits.

A total of 49 participants from 23 countries attended JUAS 2024: 15 for both Courses 1 and 2, 11 for Course 1 only, and 23 for Course 2 only. The distribution of people was as follows: 20 master’s students, 24 PhD students, and five professionals (27 males and 22 females). A total of 44 people took the exams: 20 master’s students, 21 PhD students, and three professionals.

IV.9.3.1 Course 1

As for JUAS 2023, before the start of the school, participants were required to view a selection of short videos and successfully complete questionnaires on key aspects of electromagnetism and special relativity. The new thing this year was that no errors were allowed (the students had to redo the quiz until they succeed—the errors were displayed at the end of each quiz). The time sharing was as follows (noting that for this year, 1 h means 50 min of lecture and 10 min of break, as suggested by the JUAS 2023 Advisory Board, whereas in 2023 and 2022 only the 50 min of lectures were considered in the accounting):

– 13 lectures on core topics (including tutorials): 90 h 45 min;
– three workshops: 20 h;
– 17 seminars: 17 h;
– four visits: 7 h 30 min.

A total of 42 faculty members from 12 universities or institutions were involved in taking care of the 26 participants (six master’s students, 19 PhD students, and one professional), 14 males and 12 females, with 12 nationalities from 14 different universities or institutions. Out of the 26 participants, 25 followed the full programme and one was registered “à la carte”, while 25 participants took the exams.

IV.9.3.2 Course 2

The time sharing for Course 2 (with the same note as for Course 1) was as follows:

– 19 lectures on core topics (including tutorials): 89 h 15 min;

– two workshops: 21 h;
– ten seminars: 10 h;
– four visits: 17 h.

A total of 44 faculty members from 16 universities or institutions were involved in taking care of the 38 participants (18 master's students, 16 PhD students, and four professionals), 20 males and 18 females, with 20 nationalities from 18 different universities or institutions. Out of the 38 participants, 34 followed the full programme and four were registered "à la carte", while 33 participants took the exams.

IV.9.3.3 JUAS-IPAC Prize from the EPS-AG

IPAC'24 took place in Nashville (Tennessee, USA) in May. Silke Van Der Schueren, a PhD student at La Sapienza University in Rome and CERN, obtained the highest overall mark this year, and she was awarded the EPS-AG grant to attend the conference and help me to try and promote JUAS.

IV.9.3.4 JUAS Advisory Board

The 2024 meeting, hosted by Prof. Alexander Gerbershagen at PARTREC in Groningen, took place on 6 May. As usual, the agenda of the meeting included: the report on each course of JUAS 2024; an overview of participants' feedback on the programme and its overall organisation; the budget and review of financial support; proposed improvements for the 2025 edition; information on July's I.FAST-CBI challenge "Particle Accelerators for Healthcare"; a status report on the upcoming JUAS book; and finally the status of the celebration of the 30th anniversary of JUAS (see below).

IV.9.3.5 Celebration of the 30th anniversary of JUAS and presentation of the JUAS-book

JUAS has provided postgraduate-level education in the science and technology of particle accelerators to more than 1400 students since 1994. Most have earned credits towards master's or doctoral degrees at our partner universities in Europe, while students at other universities around the world and early-career professionals have sought to enhance their applicable knowledge and skills. Many have gone on to pursue successful careers in large accelerator laboratories such as CERN, in industry, or in universities. In 2024, JUAS turned 30, and this important milestone will be celebrated during a full day at CERN on 27 November 2024 (see https://indico.cern.ch/event/1372615/). The main goal of this event will be of course to get together, and it will also be the occasion to present this book, which was written for this occasion (with a release on 15 November 2024).

Finally, some pictures of the JUAS 2024 students at ESI (Archamps, France), at ESRF (Grenoble, France), and at PSI (Villigen, Switzerland) can be found in Figs. IV.9.7–IV.9.9.

Fig. IV.9.3: The JUAS 2024 poster.

Fig. IV.9.4: Faculty members and institutions for JUAS 2024 Course 1.

Fig. IV.9.5: Faculty members and institutions for JUAS 2024 Course 2.

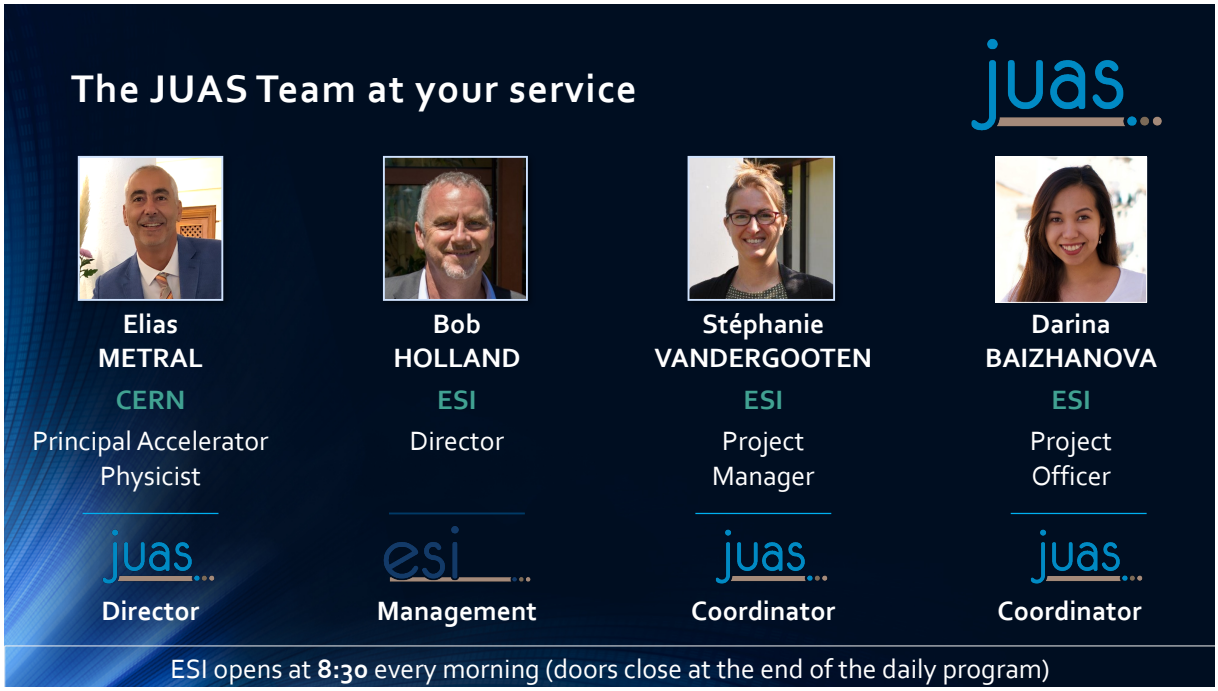

Fig. IV.9.6: The JUAS team in 2024, with the new arrival of Darina Baizhanova.

Fig. IV.9.7: JUAS 2024 students at ESI.

Fig. IV.9.8: JUAS 2024 students at ESRF.

Fig. IV.9.9: JUAS 2024 students at PSI.