

**SIAG Imaging Systems (IS)**  
**Charter Renewal Application**

This CHARTER RENEWAL APPLICATION applies to the SIAM Activity Group on Imaging Science (hereafter called SIAG/IS). The SIAG/IS to which this renewal applies was originally formed under the aegis of SIAM on December 11, 1999 by the SIAM Board of Trustees and via electronic voting by the SIAM Council in January 2000. SIAG/IS began its operations on January 21, 2000. Its charter has been renewed by the SIAM Council and Board ten times thereafter. The SIAG had 622 members as of Dec 2020. From those, 270 are student members.

According to its Rules of Procedure, the objectives SIAG/IS are responsible for include:

- 1) Providing a forum for conferences and scientific interaction between imaging science researchers and practitioners in academia, industry, medicine and government;
- 2) Encouraging research that will provide a rigorous mathematical foundation for imaging science;
- 3) Fostering research in mathematics and computation that has the potential for solving real-world problems in imaging science, and leads to new methods and techniques useful in this subject;
- 4) Providing the means for rapid publication and dissemination of novel methods in imaging science.

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List all current officers of the activity group (including advisory board, if relevant).

Chair, Carola-Bibiane Schönlieb

Vice Chair, Hongkai Zhao

Program Director, Gabriele Steidl

Secretary, Michael Wakin

The SIAG complements SIAM's activities and supports its functions. The answers to the questions below indicate how this was accomplished and what the officers propose as the future directions for the SIAG.

1. How is the field covered by the activity group doing? Is it growing, is the focus shifting? What have been the significant advances over the last two years?

Imaging science remains a vibrant and dynamic field. Being situated at the interface of physics, electrical engineering, computer science, and mathematics. Its broad applications reach from photography to biomedical, seismic, and astronomical imaging, just to name a few. Mathematical imaging pertains to the development and analysis of mathematical models and methods that process imaging data in efficient, explainable ways. Effectively coping with the application at hand requires tools from diverse fields of mathematics that often interact in interesting manners, conversely influencing the mathematical theory in these fields. Harmonic analysis, partial differential equations (PDEs) and related variational methods, stochastics, machine learning and differential geometry are just some relevant fields in imaging science.

The emergence and impressive performance of learning-based and data-driven approaches, e.g., machine learning and neural networks, in many imaging applications have fueled a significant amount of research. Understanding, analyzing and improving these approaches and making them theoretically and practically sound is an urgent and challenging task that provides great opportunities and rewards for this community in mathematical imaging science. The task calls for new developments in mathematical imaging and will again need infusion from nearly every area of mathematics and surely lead to yet more insights and theories that feed back into these fields.

Finally, we note that among the 2021 SIAM Fellows are several mathematicians who are working at the interfaces of mathematics, computational imaging and optimization, including Xiaojun Chen (Hong Kong Polytechnic University), Eitan Tadmor (University of Maryland College Park), and Rebecca Willett (University of Chicago).

2. How is the activity group doing? Is it remaining vibrant? Is the size of the SIAG stable or increasing? How is the SIAG keeping up with the changes in the field? How are the broader interests of SIAM reflected in the activities of the SIAG?

Our SIAG currently holds about 450 members and with this membership is one of the medium-sized SIAGs. Membership has recently seen some decrease (compared to the

620 members reported in the 2020 membership report) due to the pandemic, but overall looks healthy. Typically, the SIAG membership is about 50% students. Student members have a higher percentage of female members. A majority of SIAG members are in academia, a majority are in the United States, and a majority are in the Mathematics field (with Engineering second).

The 2020 SIAM Imaging Science Conference was a vibrant and successful online meeting. Despite the transition to online, the conference ended up being one of the largest IS has held in terms of conference attendance. A SIAM News Special Issue on Imaging Sciences was published in March 2021. The SIAG officers contributed a foreword on “Principles and Trends in Mathematical Imaging” to the special issue. The SIAG also supports the One World seminar series on Imaging and Inverse Problems (IMAGINE <https://sites.google.com/view/oneworldimagine>) which is hosted by SIAM. Recent developments, advances, topics, and in particular, trends towards data-driven approaches were adequately covered and promoted in these activities and through publications in the SIAM Journal on Imaging Sciences. A highlight in 2020 were also the SIAG/IS prizes awarded during the SIAM IS conference. The SIAG/IS early career prize went to Yaniv Romano (Stanford), and the SIAG/IS best paper prize was awarded for the paper “Plug-and-Play Priors for Bright Field Electron Tomography and Sparse Interpolation”, published in IEEE Transactions on Computational Imaging (2016), and presented by Martin Bouman (Purdue).

Also, several members of our SIAG have contributed to the development and testing of the SIAM Engage platform.

3. Please list conferences/workshops the activity group has sponsored or co-sponsored over the past three years, and give a brief (one sentence or phrase) indication of the success or problems with each.

SIAM Imaging Sciences Conference 2018—Bologna—this biennial conference is one of the flagship events in imaging science and mathematical aspects of imaging  
SIAM Imaging Sciences Conference 2020—online meeting, attended by most participants ever (over 3000 registrations, thanks to the virtual format and free registration).

One World seminar series on Imaging and Inverse Problems (IMAGINE <https://sites.google.com/view/oneworldimagine>) – an online seminar series that provides a forum for exchange of ideas and networking for scientists world-wide working in the field of mathematical imaging and applied inverse problems.

4. Please indicate the number of minisymposia directly organized by the activity group at the last two SIAM annual meetings. When did the SIAG last organize a track at an annual meeting or meet jointly with the SIAM Annual Meeting?

The 2020 SIAM Imaging Sciences Conference was held jointly with the SIAM annual meeting.

The SIAG co-sponsored three minisymposia and a forward looking panel session at ICIAM 2019 in Valencia.

There were 4 minisymposia related to imaging science at the 2018 SIAM Annual Meeting.

5. Please indicate other activities sponsored by the activity group, to include newsletters, prizes and web sites. Have each of these been active and successful?

SIAG/IS sponsors two prizes. The 2020 awardees were honored as part of IS20: The 2020 Early Career prize was awarded to Yaniv Romano. The 2020 Best Paper prize was awarded to Suhas Sreehari, S. V. Venkatakrisnan, Brendt Wohlberg, Gregory T. Buzzard, Lawrence F. Drummy, Jeffrey P. Simmons, and Charles A. Bouman for their work on plug-and-play priors for bright field electron tomography and sparse interpolation.

A SIAM News Special Issue on Imaging Sciences was published in March 2021.

SIAG/IS endorses the [Italian group on Mathematics of Imaging, Vision and their Applications \(MIVA\)](#).

6. What activities are planned and proposed for the next period of the charter? Please describe scheduled and suggested future activities in detail.

The 2022 [SIAM Conference on Imaging Science \(IS22\)](#) will be held at Technische Universität Berlin, March 22-25, 2022. Plenary talks will be given by Katie Bouman (Caltech, USA), Joachim Weickert (Saarland University, Germany), Liliana Borcea (University of Michigan), Mirela Ben Chen (Technion Haifa, Israel), Joan Bruna (Courant, New York), Andrew Fitzgibbon (Microsoft, Cambridge), Jin-Keun Seo (Yonsei University, Korea). There will be two minitutorials by Amir Beck (Tel Aviv University Israel) and Michael Unser (U Lausanne, Switzerland). We hope to hold this conference in person.

The SIAG officers will continue to use and promote the SIAM Engage platform for sharing relevant conference information, job posting, etc. with SIAG members.

Calls for nominations for the next round of Best Paper Prize and Early Career Prize will be posted soon; the SIAG officers are recommending names to SIAM for populating a selection committee.

We will continue to support the virtual One World seminar series on Imaging and Inverse Problems (IMAGINE), which is hosted by SIAM.

We also continue our discussions about the creation of a benchmarking data repository with relevant SIAG/IS members. There is an ever-growing need and interest for data-driven and enabled approaches for science and engineering problems for which there are good physical and mathematical models. The SIAG/IS wants to help develop a process for generating high-quality, well-documented, user-friendly data to help with validating research. Such an idea goes beyond a standard dataset and would include a forward solver for generating data as well as a framework for evaluating results. A working group is being formed for that purpose.

The rapid increase of data-driven approaches in imaging science, as mentioned in the previous paragraph and in point 1 above, is promoting links of imaging sciences with data science topics. SIAG/IS is therefore seeking closer ties with the newly founded SIAG on Data Science.

7. How can SIAM help the activity group achieve its goals?

SIAM could help to create some connections or joint activities among activity groups with overlapping interests. For example, imaging science is one of many disciplines that has an intersection with data science. It is worth considering hosting the Imaging Science conference jointly with the Mathematics of Data Science conference.

The SIAG officers have also identified the need to broaden the diversity of our SIAG membership, particularly by recruiting additional members from industry and from outside the United States.

Continuing the option of low-cost virtual participation at SIAM conferences may be a way to promote accessibility to a broader audience.

8. How can the activity group help SIAM in its general role of promoting applied mathematics and computational science?

The broad and diverse range of mathematical topics in imaging sciences demonstrates the true richness of this area for mathematical research and explains the attraction that imaging science has had to mathematicians from various fields in and outside academia.

New imaging techniques and hardware, such as via new developments in photo-acoustic tomography, optical tomography, and lensless imaging just to name a few, need the help of mathematical modeling, analysis and efficient algorithms to understand and improve. New developments in machine learning have the promise of solving data

analysis and processing tasks that were previously unthinkable. At the same time, we experience the limitations of these techniques when applying them to practical imaging problems, e.g. data bias, instabilities, data and computation challenge, etc. This contrast between potential and practice definitely calls for new developments in mathematical imaging that, for instance, could go in the direction of fruitfully combining mathematical modelling and analysis with data driven components.

New trends and new developments in mathematical imaging opened up new career perspectives for early career researchers, as the emergence of data science within mathematical imaging has opened up many industrial sectors for career opportunities.

This SIAG requests that the SIAM Council and Board of Trustees renew its charter for a two year operating period beginning January 1, 2022 through December 31, 2023.

Signed

Carola-Bibiane Schönlieb, Chair of the SIAG on Imaging Sciences

Hongkai Zhao, Vice-Chair of the SIAG on Imaging Sciences

Gabriele Steidl, Program Director of the SIAG on Imaging Sciences

Michael Wakin, Secretary of the SIAG on Imaging Sciences

Date 14 May 2021