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The 3rd conference of the Imaging Mass Spectrometry Society (IMSS 3): Accounts of a hybrid virtual and in-person meeting and the state and future of the field

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3 1 **The 3rd conference of the Imaging Mass Spectrometry Society (IMSS 3): Accounts of a**
4 **hybrid virtual and in-person meeting and the state and future of the field.**
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3 21 The third annual conference of the Imaging Mass Spectrometry Society (IMSS3) was
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5 22 held October 3-6, 2021 in a hybrid in-person and virtual format. Here, we reflect upon the
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7 23 processes behind planning a hybrid conference and discuss the successes and challenges of the
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9 24 event in retrospect. This iteration of the IMSS annual conference was initially delayed to allow
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11 25 sufficient time for widespread access to vaccination against COVID-19 and with hopes for
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13 26 loosened travel restrictions, institutionally and internationally. During IMSS3 registration,
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15 27 attendees were given the option to participate in-person or virtually. All in-person participants
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17 28 were required to be vaccinated and policies related to COVID-19 (including masking while
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19 29 indoors and distancing) were thoroughly communicated prior to the meeting. The decision to
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21 30 hold the conference in-person was informed by member feedback and months of discussion
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23 31 throughout the ongoing pandemic. After a year and a half of participating in virtual-only
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25 32 meetings, results from a member survey we conducted indicated a strong desire within the
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27 33 community to hold IMSS3 in-person with strict adherence to COVID-19 precautions and
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29 34 governmental guidelines. Three sites were researched and proposed for IMSS3 and ultimately
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31 35 Colorado Springs, CO USA was selected for ease of access, good facilities, and the natural
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33 36 beauty of the location (Figure 1).

31 37 As the pandemic was seemingly waning during late spring/early summer of 2021, we
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33 38 moved forward with the planning for the onsite meeting. However, as registration approached
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35 39 the COVID-19 Delta variant wave was beginning in the U.S., prompting a rapid switch to a
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37 40 hybrid format. Guidelines were developed for in-person IMSS3 participation to address concerns
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39 41 surrounding COVID-19 safety including masks required indoors, encouraging social distancing,
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41 42 and permitting only fully vaccinated individuals to attend in-person. Some elements of a
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43 43 traditional in-person meeting, such as poster sessions, were not well suited to the COVID-safe
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45 44 guidelines we developed and would ultimately exclude members wishing to participate virtually
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47 45 without implementing an online poster forum. Instead, five-minute pre-recorded flash talks were
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49 46 provided by all poster presenters, virtual and in-person. This format worked well to bring the
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51 47 voices of all presenters into the meeting room and through the virtual broadcast, and it offered an
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53 48 opportunity for creativity in presentation of their work. While we anticipate a return to the
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55 49 traditional poster session format, the five-minute flash talk style poster session was highly
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57 50 attended and successfully prompted discussions with poster authors. Further, in developing the
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59 51 hybrid format we aimed to replicate the in-person experience as much as possible for the virtual
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3 52 attendees. A production company live streamed in-person talks and seamlessly incorporated
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5 53 virtual speakers, allowing us to have a mix of virtual and in-person presentations and session
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7 54 chairs throughout the conference. Question and answers were from both live and virtual audience
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9 55 members and speakers, allowing conference attendees to interact regardless of their location.
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11 56 Chat features were also utilized to allow online attendees to participate in question-and-answer
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13 57 sessions. We feel that this format could be successfully expanded into the future, with ample
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15 58 preparation and help from a professional service. However, the cost and number of professionals
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17 59 required for these services would probably prohibit the ability to use this format for a large
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19 60 conference with dozens of concurrent sessions (e.g., the annual ASMS conference). A post-
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21 61 conference survey suggested many attendees were satisfied with the format of this conference
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23 62 but being in-person was preferred.

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25 63 The total number of attendees was 132, including 44 students/post-doctoral trainees. Of
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27 64 the total participants, 64 were in person and 68 attended IMSS3 virtually. The conference had 80
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29 65 total abstract submissions; 37 were selected for oral presentation and 43 were poster
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31 66 presentations. The imaging community was represented by in-person attendees from four
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33 67 different countries allowing travel to/from the US at that time and was globally attended by a
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35 68 wide virtual audience. One third (44) of the attendees (combined attendance) were trainees,
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37 69 either students or post-doctoral fellows, providing further evidence of the expansion of training
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39 70 opportunities in the imaging mass spectrometry (IMS) field.

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41 71 For those attending in person, the IMSS3 conference kicked off at the historic Pioneer's
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43 72 Museum in downtown Colorado Springs. Keynote speaker Lingjun Lin (University of
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45 73 Wisconsin-Madison) covered her multifaceted work in IMS, ranging from multiplex IMS
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47 74 methods to visualization of fatty acid isomers. Her multiple target applications were varied, and
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49 75 society president Richard Drake (Medical University of South Carolina) aptly commented
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51 76 afterwards that there was something related to all aspects of IMS and molecular imaging in her
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53 77 talk. The hybrid portion of the conference started the following day, with Dr. Drake introducing
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55 78 Steve Castellino (GlycoPath, Inc and Xenovista, LLC) for the inaugural "Steve Castellino
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57 79 Plenary Lecture on IMS In Drug Discovery and Development." In person attendees gathered
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59 80 (masked and distanced) in the conference ballroom and virtual attendees signed in online to
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81 watch a live stream. Dr. Castellino's lecture, titled "The emergence of imaging MS studies on
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drug discovery and development; from novelty to mainstream," touched on the history of IMS as

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3 83 a technological accelerant in drug development. He pointedly highlighted how IMS maximizes
4 84 the information you can get from animal models, which has wide-ranging applications for basic
5 85 and translational research. He also credits the creative and collaborative nature of the IMS
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7 86 research community at large, saying it takes a community for technology and science to grow
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9 87 and IMS has benefited greatly from that so far.

11 88 Oral and poster presentation sessions continued over the next three days. To adapt to the
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13 89 hybrid format, all poster presenters pre-recorded a five-minute talk which were streamed during
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15 90 specific times. Participants were encouraged to get creative with their poster presentations. While
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17 91 many stuck with the tried-and-true format, participant Ethan Yang (Kristine Glunde Lab; Johns
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19 92 Hopkins University) created a video short story of his IMS sample preparation to data processing
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21 93 journey that brought some humor to the session. Dr. Yang was subsequently awarded the “Best
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23 94 Use of Video Format for Poster Presentation”. Other poster awards included Hellena Bai of
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25 95 North Carolina State University (Muddiman Lab) for her work in 3D MALDESI as Best New
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27 96 Application of IMS. Colin McDowell of Medical University of South Carolina (Drake Lab) was
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29 97 selected for the Bruker Award for Most Innovative Poster for his work integrating mass
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31 98 spectrometry labile tags and fluorescent tags for sialic acid analysis. Lyndsay Young from the
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33 99 University of Kentucky won the Outstanding Trainee Oral Presentation award. Oral sessions
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35 100 were organized by topic, ranging from environmental IMS to emerging trends in instrumentation
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37 101 and data processing. Kate Stumpo of Bruker and Pierre Chaurand of the Université de Montréal
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39 102 remarked in the preclinical IMS session they co-chaired that the field continues to be varied with
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41 103 applications across many disease states and models, including: 3D cell cultures, mouse models,
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43 104 and human tissue from autopsy or biopsies. Model systems are providing data on biomarkers and
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45 105 their impact on metabolic pathways with key spatial context. Human samples are adding to
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47 106 cohort knowledge of consistency and population variability which will be key for the transition
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49 107 to more clinically based experimentation.

50 108 Heath Patterson (Vanderbilt University), who co-chaired the “Informatics and Data
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52 109 Analysis” session, said the session featured talks that covered a sampling of the possibilities with
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54 110 IMS. No single common theme emerged as talks covered IMS data mining with advanced
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56 111 algorithms (Lindsey Conroy, University of Kentucky), combining secondary ion mass
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58 112 spectrometry (SIMS) and matrix-assisted laser desorption/ionization (MALDI)-MS for
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60 113 prediction at high resolution (Jacob Hinkle, Oak Ridge National Laboratory), automated

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3 114 chemical annotation with derivatized species (Evan Larson, Iowa State University), and
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5 115 reconstructions of full IMS profiles and images from sparse sampling with high resolution
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7 116 Fourier transform ion cyclotron resonance (FTICR)-MS (Richard Xie, University of Illinois
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9 117 Urbana-Champaign). The breadth of topics demonstrated computational approaches are helping
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11 118 make possible biological insight from IMS at the chemical level as well as determining the best
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13 119 ways to integrate multimodal imaging or even acquire less data for slower, but high mass
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15 120 resolving instrumentation without limited loss of data fidelity or spatial resolution. Additionally,
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17 121 the chairs of one of two sessions on instrumentation, emerging techniques, and single cell studies
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19 122 described their session as offering a diverse dive into new tool development in IMS. Speakers
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21 123 presented different strategies to advance the imaging MS field. The presentations of Boone
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23 124 Prentice (University of Florida) and Daisy Unsihuay (Purdue University) focused on gas- and
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25 125 liquid-phase, respectively, ion/ion reactions to determine the correct locations of carbon-carbon
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27 126 double bonds in lipids for IMS methods. Jens Soltwisch (University of Münster) presented
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29 127 enhanced selectivity by coupling MALDI-2 to ion mobility.

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31 128 Throughout the conference, several presenters highlighted trends that will continue to
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33 129 push IMS into the future. Advanced imaging techniques targeting classes of highly related
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35 130 molecules that were previously difficult to discern will expand the IMS toolkit and create new
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37 131 applications to probe and spatially-resolve chemistry and biology even further in samples.
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39 132 Plenary lecturer Dr. Castellino and others pointed to increased integration of IMS into discovery
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41 133 and diagnostic pipelines as a possible transforming force in science and medicine, with continued
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43 134 miniaturization of instrumentation increasing applicability for field-related or location-dependent
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45 135 work. Further, improved data processing pipelines will expand the information we can learn
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47 136 from IMS experiments and allow for increased data reuse to answer a multitude of scientific
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49 137 questions from a single experiment or dataset.

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51 138 One interesting trend in the field of IMS, which was also captured in the meeting, is the
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53 139 re-emergence of protein imaging. The advent of soft ionization in-situ probing methods (i.e.,
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55 140 MALDI) primarily advanced as a key tool for protein characterization. However, over the last
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57 141 ~15 years, IMS methods related to spatial metabolomics have dominated the field. In situ protein
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59 142 imaging is now becoming common place with nanospray desorption electrospray ionization.
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61 143 Ying Zhu (Pacific Northwest National Laboratory, PNNL) showed how the nanoPOTS technique
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63 144 can be applied for sensitive and comprehensive protein imaging. Dusan Velickovic (also PNNL)

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3 145 demonstrated the use of new high mass range, high mass resolution technology for MALDI-IMS
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5 146 for intact protein imaging. Michael Angelo (Stanford University) provided the closing plenary
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7 147 talk, where he illustrated the power of imaging mass cytometry for visualizing protein
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9 148 distributions at subcellular resolution in formalin-fixed paraffin embedded tissues obtained from
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11 149 pathology archives. Extensive examples were provided of multiplexed metal-tagged antibodies
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13 150 targeting immune cell and immune check point proteins in the tumor immune microenvironment.
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15 151 New feasibility data linking IMS biomolecular data with mass cytometry protein panels was also
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17 152 discussed. These talks demonstrated that untargeted and targeted spatial proteomics are
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19 153 (re)emerging as powerful techniques in the field of IMS.

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21 154 Community interaction is critical to moving the field forward through sharing of
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23 155 techniques and tools, not only for IMS researchers, but also for corporate partners developing the
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25 156 latest tools for high quality imaging work. To this point, attendees of IMSS3 were treated to two
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27 157 different product launches: the M3+ Sprayer from HTX Imaging and the Basic N-Glycan
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29 158 Imaging Kit from GlycoPath. Focused, community-based meetings such as IMSS3 provide an
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31 159 excellent forum for feedback, whether for development of instruments and support equipment or
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33 160 students developing new project ideas. Furthermore, simple activities, like the sunset walk
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35 161 planned and sponsored by HTX Imaging, or the afternoon activity in the Garden of the Gods
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37 162 (Figure 2), for example, gave folks the opportunity to connect and chat about their work in a fun
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39 163 environment.

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41 164 We hope the lessons from this hybrid meeting experience can translate forward and
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43 165 inform the next iterations of scientific meetings as we sustain our recovery from COVID-19
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45 166 pandemic disruptions. The work presented at IMSS3 highlighted advances in a multitude of
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47 167 directions, all equally important and exciting ranging from structural discrimination to new
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49 168 applications and expanding data analysis methods. In summary, the hybrid in-person and virtual
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51 169 format for IMSS3 was successful in providing the IMS community the chance to directly interact
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53 170 and share their work. We thank all of the contributors (chairs, speakers, poster presenters,
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55 171 attendees, award judges, sponsors, and more) who made IMSS3 a success. We look forward to
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57 172 the next annual conference.
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174 **Figures**

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177 **Figure 1.** Views of the Colorado Springs, CO Area. (Top) A view of the Garden of the Gods
178 with Pikes Peak (4,302 m; 14,115 ft) in the background. (Bottom) a view of the Cog Railway
179 atop Pikes Peak. These pictures were captured from conference attendees during the afternoon
180 activities provided to these locations.

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40 195 **Figure 2.** Many attendees of the IMMS3 participated in a sunset walk sponsored by HTX
41 196 Imaging (top). Many graduate students and post-doctoral associates were able to network outside
42 197 of the conference setting, like these who enjoyed the afternoon activity at the Garden of the Gods
43 198 (bottom).
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