Some Management Options for the Future of COMPRES and GSECARS

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Introduction

The Consortium for Materials Properties Research in the Earth Sciences (COMPRES) and GeoSoilEnviro Center for Advanced Radiation Sources (GSECARS) are supported by the National Science Foundation (NSF) Earth Sciences Instrumentation and Facilities (EAR/IF) to operate national multi-user facilities, primarily at Department of Energy (DOE) synchrotron light sources, and to provide Earth scientists with access to world leading synchrotron-based techniques to answer major questions in Earth and planetary science research. Currently there is a synergistic relationship between COMPRES and GSECARS that benefits their combined and often overlapping communities of users, but the two organizations have distinctly different missions and management structures.

As we look to the future and map our course for the coming decade, NSF EAR IF has requested that COMPRES and GSECARS explore the possibility of merging. The earliest timeframe for such a change would be 2022 when both organizations would be up for their respective 5-year renewals. At the 2019 COMPRES Annual Meeting held on August 4, in Big Sky, MT, a special session was held to announce this activity and discuss the pros and cons of such a merger in a public forum accessible to all meeting participants. Mark Rivers and Carl Agee gave presentations and the session was attended by approximately 100 participants with about 15 people voicing comments in the discussion. NSF representatives Sonia Esperança, Jennifer Wade, and Paul Raterron were also in attendance. NSF EAR IF has requested that COMPRES and GSECARS submit a report summarizing possible future relationships of the organizations by the end of 2019. To strengthen the objectivity of the report and allow examination of the question from an independent perspective, Dr. Peter Olson has agreed to form an ad hoc committee (with members from the COMPRES/GSECARS communities and neighboring disciplines) to review this report in draft form. To capture community input and to promote inclusiveness and transparency, the draft report has been circulated to the larger COMPRES/GSECARS community for comments. Thus, this report is a product of the authors Agee, Rivers, and Campbell, plus the Olson Committee and our greater stakeholder community.

When NSF requested that COMPRES and GSECARS study the pros and cons of a potential merger, we were not told what the goals of such a merger should be. We believe that any potential merger should have the following goals, in order of decreasing importance:

- Enhancing technical developments to provide opportunities for new science. This includes taking advantage of the tremendous opportunities offered by new and enhanced sources, such as the coming upgrades to the APS and ALS.
- Strengthening the community support for these facilities and guidance for future exciting areas to pursue.
- Reducing the administrative overhead for the NSF.
- Streamlining administration of COMPRES and GSECARS.

Here we describe the current management structures of COMPRES and GSECARS, and explore three models for a possible future merger of the two organizations, with a discussion of pros and cons of each, and contrasts with the current management models.

We believe that the current organization of COMPRES and GSECARS is serving the communities well, and that our Model 1, which strengthens formal collaboration while largely preserving the current management structure, is our preferred model for the future.

Missions of COMPRES and GSECARS

The overall mission of the Consortium for Materials Properties Research in Earth Sciences (COMPRES) is to provide facilities and infrastructure development leading to an improved understanding of fundamental processes on and within the Earth and other planets by studying a diverse spectrum of materials under the range of thermodynamic conditions to which they are subjected in nature, including the high pressure and temperature conditions that exist in the interior of the Earth. COMPRES is a research support organization serving a community of educational and not-for-profit US institutions with programs in mineral physics and/or related fields. The purpose of the current COMPRES award (NSF Cooperative Agreement) is to provide five years of support for the management and operation of COMPRES facilities, infrastructure development projects, and education and outreach programs.

The overall mission of GeoSoilEnviroCARS (GSECARS) is to provide a national user facility for frontier research in the Earth, planetary, soil and environmental sciences using synchrotron radiation at the Advanced Photon Source (APS), and Argonne National Laboratory (ANL). GSECARS provides scientists access to the high-brightness hard X-rays from the APS, a third-generation synchrotron light source at ANL. GSECARS encompasses a much larger variety of techniques and geoscience disciplines than COMPRES. The primary COMPRES mission is research on the properties of Earth materials, and it has an emphasis on high-pressure mineral physics and deep planetary interiors. This type of research is a major thrust at GSECARS as well, and it accounts for about 55% of the GSECARS beamtime. However, the other 45% of the beamtime at GSECARS, using the x-ray microprobe, surface science techniques, ambient pressure powder diffraction, and microtomography, is directed toward applications in the fields of geochemistry, petrology, shallow crustal geophysics, and planetary science. Whereas COMPRES is focused primarily on supporting the mineral physics community, the GSECARS mission is to support Earth science research that can utilize synchrotron research more broadly. As a consequence, GSECARS supports NSF funded PIs from a number of section programs within the EAR division, including Geobiology and Low-Temperature Geochemistry, Geophysics, Petrology and Geochemistry, and Sedimentary Geology and Paleobiology.

Current Management Structure of COMPRES

The history of COMPRES started with a Town Hall gathering at the Fall 2000 AGU Meeting in San Francisco organized by the AGU Mineral and Rock Physics Committee, and the planning continued with a workshop at the Scripps Institution of Oceanography in La Jolla in February 2001, and culminated in a successful proposal to the NSF Division of Earth Sciences in August 2001. In May 2002, a Cooperative Agreement was established that funded COMPRES from 2002-2007. This cooperative agreement was renewed in 2007 (COMPRES II), 2012 (COMPRES III, and in 2016 (COMPRES IV, the current cooperative agreement). COMPRES is led by a President/CEO; past Presidents were Robert Liebermann (Stony Brook University) and Jay Bass (University of Illinois, Urbana-Champaign), the current President is Carl Agee (University of New Mexico).

The COMPRES governance and management structure is an interface between the scientific community, funding agencies and the programs of COMPRES (Figure 1). An electorate

consisting of member institutions (rather than individuals) charts the future and establishes priorities of the consortium via governance processes clearly defined by the COMPRES Bylaws. Currently there are 70 US-based member institutions (Electorate). COMPRES has a bicameral organization, with the President acting as PI of the organization, and the member institutions represented by the Executive Committee and two standing committees, the Facilities Committee and the Committee on Education and Outreach and Infrastructure Development (EOID).

The President of COMPRES is the Chief Executive Officer of the organization and executes all contracts and agreements on behalf of the organization and carries out the directives of the Electorate. In relationship to the NSF Cooperative Agreement, the President of COMPRES also serves as the Principal Investigator. The President is appointed by the Executive Committee, in consultation with the cognizant NSF Program Director, and with a recommendation from an ad hoc Search Committee. Historically, the Central Office of COMPRES and the NSF Cooperative Agreement have rotated to the home institution of the newly-appointed President. Under the current Cooperative Agreement, the COMPRES Central Office is located at the University of New Mexico. The Central Office budget covers 9 months of the COMPRES President's salary (Agee), and ~50% of staff members' salaries (Gloria Statom and Beth Ha). The University of New Mexico (UNM) contributes 1.25 FTE to support the Central Office salaries. In addition to salary cost sharing, UNM provides high quality office space and basic services for the COMPRES offices in Northrop Hall on its Main Campus in Albuquerque.

The COMPRES President plays the major leadership role in the organization. Broadly speaking, the President works with the elected committees, the community, and administrative support to advance the goals of COMPRES. This mission on behalf of its community of member institutions is to facilitate the operation of beamlines and use of Earth sciences facilities at national laboratories, to develop new technologies, and to advocate for science and educational programs. The responsibilities of the COMPRES President include:

1. Oversees COMPRES facilities, education outreach and infrastructure development (EOID) projects, and organizes the COMPRES annual meeting.
2. Carries out the main administrative functions of COMPRES.
3. Negotiates partner user agreements and MOUs with national laboratories and other partners.
4. Creates and authors COMPRES renewal proposals and cooperative agreements with NSF.
5. Leads the governance of COMPRES.
6. Carries out community advocacy for COMPRES both within and outside the organization.
7. Leads the strategic planning activities of COMPRES.

The Executive Committee (5 members) is elected by the COMPRES Electorate and has full power in the management of the affairs of the Consortium, representing the interests of the research community and the consortium members. The responsibilities of the Executive

Committee include coordination of activities, meetings, workshops, and educational and outreach programs. The Executive Committee authorizes the COMPRES budget annually, and makes decisions to initiate or terminate COMPRES projects when needed.

The two COMPRES Standing Committees are also elected by the COMPRES Electorate. They develop policies and provide detailed oversight of the two core activities of COMPRES. These are: 1) The Facilities Committee (5-6 members) which evaluates the effectiveness of the service delivered by the community facilities, coordinates between facilities so as to maximize the community's effectiveness in using these facilities, considers the community's needs and recommend changes in the levels of support of all possible community facilities, and formulates partner user proposals for accessing COMPRES community facilities. 2) The Education, Outreach and Infrastructure Development (EOID) Committee (4-6 members) which reviews infrastructure development projects and all forms of educational or outreach efforts that are supported by COMPRES to assure that these projects serve the needs of the community, recommends whether a project should continue or not, and what changes are needed to better meet the needs of the community, and also evaluates proposals by the community for new development projects and makes recommendations concerning funding.

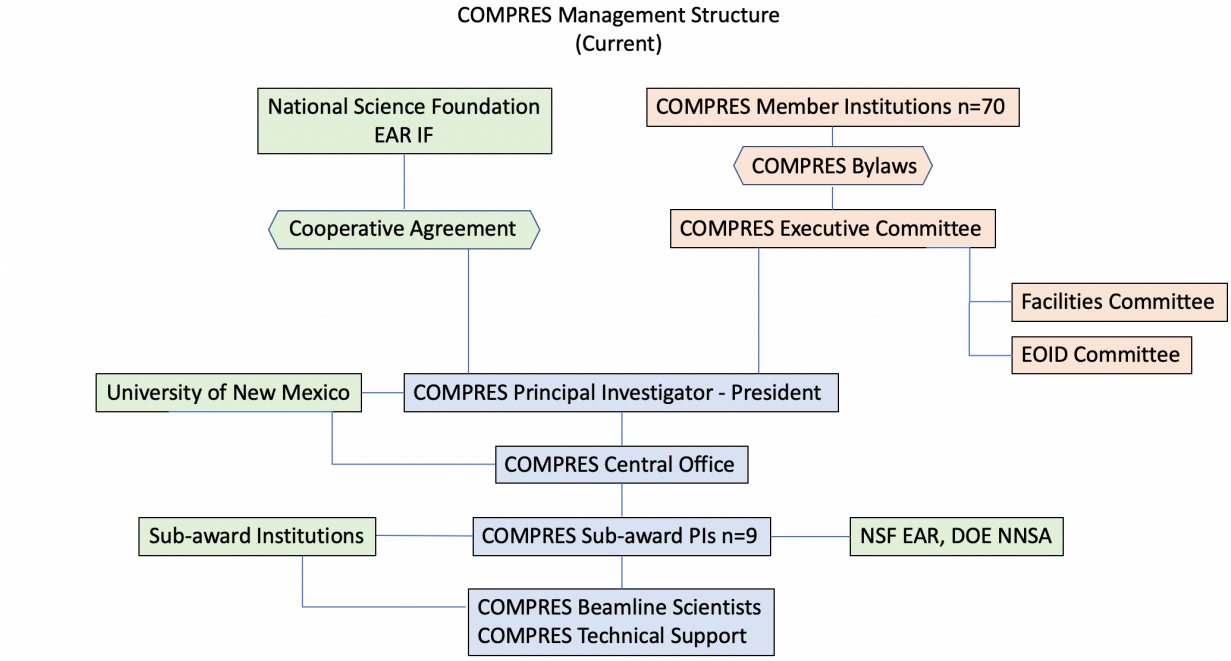

Figure 1. Current management and organizational structure of COMPRES. The NSF supports COMPRES through a Cooperative Agreement for which the COMPRES President is Principal Investigator. COMPRES governance is defined in its bylaws. The COMPRES President is the chief executive officer of the organization and implements the orders of the Executive Committee. The Executive Committee is elected by the COMPRES member institutions (Electorate) and it represents the COMPRES Electorate in managing the affairs of the organization. The Facilities Committee and EOID Committee report to the COMPRES Executive Committee. The COMPRES President and Central Office monitor the scientific, technical, and fiscal performance metrics of all sub-awards made under the terms of the Cooperative Agreement, ensuring that all NSF requirements are observed. Green boxes represent sources of financial support for COMPRES.

COMPRES beamline scientists and facilities are supported through sub-awards to Principal Investigators, who provide intellectual and managerial leadership. Sub-award PIs do not receive salary for the considerable time they put into managing COMPRES facilities, and they typically contribute additional resources from their home institution or from research grants from other NSF programs such as EAR Geophysics and EAR Petrology and Geochemistry or other state or federal sources. For example, the Stony Brook University Mineral Physics Institute (MPI) has been a long-time source of personnel and equipment support to COMPRES. Likewise, the host institutions of all COMPRES sub-award PIs provide at least some significant level of in-kind support. In addition, COMPRES and the Chicago DOE Alliance Center (CDAC) have an MOU that provides supplementary National Nuclear Security Administration (NNSA) support for the NSLS-II FIS beamline. COMPRES-supported beamlines are heavily subsidized by DOE synchrotron hosts at the Advanced Light Source (ALS) at Lawrence Berkeley National Laboratory, Advanced Photon Source (APS) at Argonne National Laboratory, and National Synchrotron Light Source-II (NSLS-II) at Brookhaven National Laboratory. Typically, a beamline will cost several million dollars per year to operate and none of this cost is passed on to COMPRES or its users.

COMPRES also manages “off-line” facilities such as the long-term Multi-Anvil Development project hosted at ASU, as well as short-term EOID projects that are typically 2-3 years in duration.

Facilities and projects currently managed by COMPRES

1. ALS 12.2.2 Beamline Diamond Anvil (PI: Quentin Williams, UC Santa Cruz)
2. APS Beamline 6-BM-B Multi-anvil (PI: Don Weidner, Matt Whitaker, Stony Brook)
3. NSLS-II XPD Beamline Multi-anvil (PI: Don Weidner, Matt Whitaker, Stony Brook)
4. APS Beamline 13-BM-C PX^2 Diamond Anvil (PI: Przemek Dera, Univ. Hawaii*) GSECARS partnership*
5. APS Gas Loading for Diamond Anvil (PI: Mark Rivers, Univ. Chicago) *GSECARS partnership*
6. APS Sector 3 and 30 IXS Diamond Anvil, Mössbauer (PI: Jay Bass, UIUC)
7. NSLS-II FIS IR Beamline Diamond Anvil (PIs: Russell Hemley, Zhenxian Liu, UIC) *CDAC partnership*
8. Multi-Anvil Project (PI: Kurt Leinenweber, ASU)
9. Deep-Earth Large-Volume Experimentation "DELVE” (Lead: Yanbin Wang, Univ. Chicago)
10. Mineral Elasticity Database (PI: Tom Duffy, Princeton University)

Table 1 shows the beamlines managed by COMPRES, with the fraction of that beamline available to COMPRES. The current and future sources for most of these beamlines are shown in Figure 3.

COMPRES beamline	**Fraction of beamline**	**Current source**	**Future source**
ALS 12.2.2 (diamond cell)	0.50	ALS super-bend (ALS SB).	ALS upgrade super-bend (ALS-U SB)
NSLS-II FIS (infrared)	0.50	NSLS-II infrared	NSLS-II infrared
APS 6-BM-B (multi-anvil)	0.50	APS bending magnet (APS BM)	APS upgrade bending magnet (APS-U BM)
NSLS-II XPD (multi-anvil)	0.25	NSLS-II damping wiggler (NSLS-II DW)	NSLS-II superconducting wiggler (NSLS-II SCW)
APS Sector 3, 30 (nuclear, inelastic)	0.60	APS undulator	APS-U undulator
APS 13-BM-C PX2 (diamond cell)	0.35	APS bending magnet (APS BM)	APS-U bending magnet (APS-U BM)
Total	**2.70**		

Note that the PX2 project on APS 13-BM-C is run jointly by COMPRES and GSECARS and receives about 70% of the time. We have assigned 0.35 fraction of this beamline to COMPRES, 0.35 to GSECARS as part of PX2, and 0.30 to GSECARS for other programs.

Currently there are 9 COMPRES sub-awards (#2 and #3 share a subaward), 7 beamline facilities, and 9 beamline scientists. The COMPRES annual budget is $2.4 million. COMPRES-acknowledged peer-reviewed publications totaled 278 for the period 2017-2018.

Current Management Structure of GSECARS

Currently GSECARS operates 4 simultaneous beamline facilities at Sector 13, with 11 scientific staff, 3 post-docs, and 3.5 support staff.

GSECARS was designed and constructed as a community facility, beginning in 1994. The design was a community effort supported by five design teams, consisting of leaders in the field of each technique. These were:

1. Diamond anvil cell (Russ Hemley, Bill Bassett, Dave Mao, Li-Chung Ming, Tom Duffy, Guoyin Shen)
2. Large volume press (Don Weidner, Jay Bass, Bill Durham, Ivan Getting, Kurt Leinenweber, Murli Manghani, Mike Vaughan, Yanbin Wang)

3. X-ray diffraction and scattering (John Parise, Larry Finger, Joseph Pluth, Charles Prewitt, Joe Stucki, Peter Eng, JV Smith)
4. X-ray absorption (Glenn Waychunas, Gordon Brown, Paul Bertcsh, Francois Farge, Matt Newville)
5. X-ray microprobe and microtomography (Steve Sutton, Mark Rivers, Darrell Schulz, Keith Jones, Ian Steele)

GSECARS is one of three sectors at the APS managed by the University of Chicago Center for Advanced Radiation Sources (CARS). BioCARS is located at APS sector 14 and is funded by the NIH, primarily for ultra-fast time-resolved studies of biological systems. ChemMatCARS is located at sector 15, and is funded by NSF Chemistry and Materials Science for liquid surface, micro-crystallography and small angle scattering. Mark Rivers is currently the Executive Director of CARS.

The GSECARS governance and management structure (Figure 2) has a simple interface between the funding agencies and the Principal Investigators (Co-Directors and Beamline Scientists) of the cooperative agreement and grants. The Co-Directors are the PIs of the NSF-EAR-IF Cooperative Agreement with a current annual budget of $2.97 million accounting for ~75% of GSECARS support. GSECARS staff also have grants from NSF-EAR (Geophysics, Petrology, and Geochemistry), DOE-BES-Geosciences, and NASA-SMD (LARS, SSERVI, ANGSA) making up ~ 25% of GSECARS support.

The GSECARS Directors oversee six Technical Groups organized around the six principal techniques in Sector 13. Each of these groups has a senior GSECARS staff member as a leader as shown below:

1. Diamond Anvil Cell (Vitali Prakapenka, Research Professor)
2. Large-Volume Press (Yanbin Wang, Research Professor)
3. Microtomography (Mark Rivers, Research Professor)
4. X-ray Absorption Fine Structure Spectroscopy (Matt Newville, Research Professor)
5. X-ray Diffraction and Scattering (Peter Eng, Research Professor)
6. X-ray Fluorescence Microprobe (Stephen Sutton, Research Professor)

These individuals have the responsibility to lead the development of science, instrumentation and user community in their particular area. In addition, the leaders work closely with users to ensure the success of experiments (experiment design, experiment conduct, data analysis, etc.) and receive input from them on potential new scientific and technical directions. GSECARS staff often play leading roles in the organization of international meetings and workshops on cutting-edge scientific and technical developments covering entire the GSECARS (including COMPRES) community as well as being involved in technique development at other synchrotrons. This management configuration has worked successfully throughout the 23-year history of GSECARS.

GSECARS funding proposals to NSF-EAR and other agencies identify key scientific projects to be pursued, and propose new technical developments. Both activities always involve collaborations with members of the geoscience community outside of GSECARS.

GSECARS encompasses a much larger variety of techniques and geoscience disciplines than COMPRES. The primary COMPRES mission is research on the properties of Earth materials, and it has an emphasis on high-pressure mineral physics and deep planetary interiors. This type of research is a major thrust at GSECARS as well, and it accounts for about 55% of the GSECARS beamtime. The other 45% of the beamtime at GSECARS, using the x-ray microprobe, surface science techniques, ambient pressure powder diffraction, and microtomography, is directed toward applications in the fields of geochemistry, petrology, shallow crustal geophysics, and planetary science. Whereas COMPRES is focused on supporting the mineral physics Earth science community primarily, the GSECARS mission is to support Earth science research that can utilize synchrotron research more broadly. As a consequence, GSECARS supports NSF funded PIs from a number of section programs within the EAR division, including Geobiology and Low-Temperature Geochemistry, Geophysics, Petrology and Geochemistry, and Sedimentary Geology and Paleobiology. Some users are funded by other NSF divisions, DOE, NASA, USDA, EPA, and other agencies and organizations.

GSECARS had 908 user-visits and 518 unique users in 2018. These represent over 130 unique institutions. The GSECARS beamlines are heavily oversubscribed, particularly for the 13-ID-D station with the laser-heated diamond anvil cell and 1000-ton multi-anvil press, where the oversubscription is greater than 2.5.

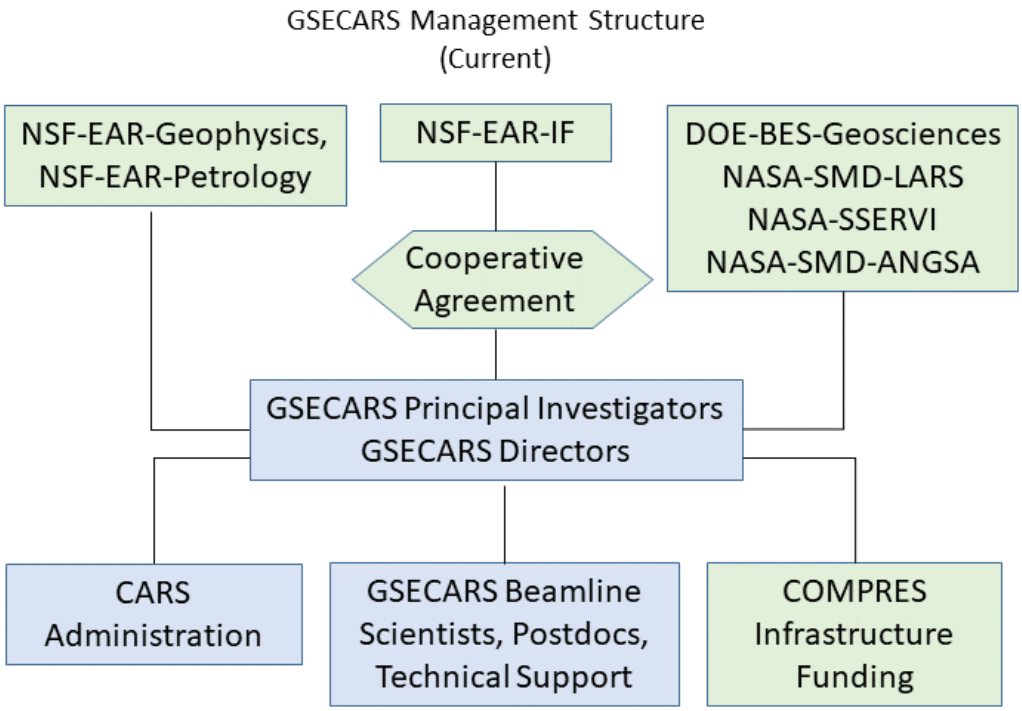

Figure 2. Current management and organizational structure of GSECARS. The NSF supports GSECARS through a Cooperative Agreement for which the GSECARS Directors are Co-Principal Investigators. The Principal Investigators ensure that an efficient and effective project governing structure is in place throughout the award period to support all critical or significant project activities. PIs also ensure that the purposes of the Cooperative Agreement are carried out, and ensure efficient and effective performance of all project responsibilities by the governing components throughout the award period. Green boxes represent sources of financial support for GSECARS.

GSECARS identifies high-impact science to pursue in two principal ways. First, the staff identify "hot topics" through discussions with members of the scientific community and users of their beamlines. Second, it allocates beam time to proposals that have been highly rated by APS review panels composed of peers representing a wide range in expertise. The staff works to develop the new instrumentation and methodologies needed to facilitate those selected projects. Thus, research projects allocated beam time are highly-rated proposals by independently-supported (many by NSF and/or DOE) investigators and are often conducted as collaborations with GSECARS staff, an approach that maximizes the effectiveness and impact of the experiments. GSECARS-acknowledged peer-reviewed publications totaled 331 for the period 2017-2018.

Table 2 shows the beamlines managed by GSECARS, with the fraction of that beamline available to GSECARS users

GSECARS beamline	**Fraction of beamline**	**Current source**	**Future source**
13-BM-D	1.00	APS bending magnet (APS BM)	APS upgrade bending magnet (APS-U BM)
13-BM-C	0.65	APS bending magnet (APS BM)	APS upgrade bending magnet (APS-U BM)
13-ID-C/D	1.00	APS 30 mm period undulator (APS U33)	APS upgrade 28mm undulator (APS-U U28)
13-ID-E	1.00	APS 36 mm period undulator (APS U36)	APS upgrade 33mm undulator (APS-U U33)
Total	**3.65**		

(See the note for 13BM-C PX2 with Table 1 above)

Synchrotron Sources for COMPRES and GSECARS beamlines

The COMPRES and GSECARS synchrotron beamlines are located at the Advanced Light Source (ALS) at Lawrence Berkeley National Laboratory, Advanced Photon Source (APS) at Argonne National Laboratory, and National Synchrotron Light Source-II (NSLS-II) at Brookhaven National Laboratory. These are all synchrotron light sources operated by the DOE for the scientific community. In Figure 3 we plot the brightness of these sources as a function of x-ray energy.

The sources include undulators (NSLS-II U20, APS U33, APS-U U28), wigglers (NSLS-II SCW, NSLS-II DW), and bending magnets (APS-BM, APS-U BM, ALS SB, ALS-U SB).

Brightness is the figure of merit that determines the number of photons that can be focused to a small spot with a given divergence and energy bandwidth. It is thus the relevant figure of merit for many of the geoscience beamlines such as diamond anvil cell diffraction, and x-ray microprobes and microspectroscopy. Note that the sources differ by nearly 8 orders of magnitude.

The future sources include the APS-U upgrade, the ALS-U upgrade, and the NSLS-II superconducting wiggler. The APS upgrade will replace the entire accelerator in 2022 with a new design with a much smaller electron beam size in the horizontal direction, and over 100 times greater brightness on the undulator beamlines. This will permit 100 times more photons to be focused into the same spot size as today, or a focal spot 10x smaller in each direction with the same number of photons as today. The ALS-U upgrade will similarly decrease the size of the electron beam, but for the superbend beamline 12.2.2 that COMPRES uses it will decrease the magnetic field, reducing the brightness at high energy. The NSLS-II superconducting wiggler will be a new source with much higher brightness than the damping wiggler that COMPRES currently uses on the XPD beamline.

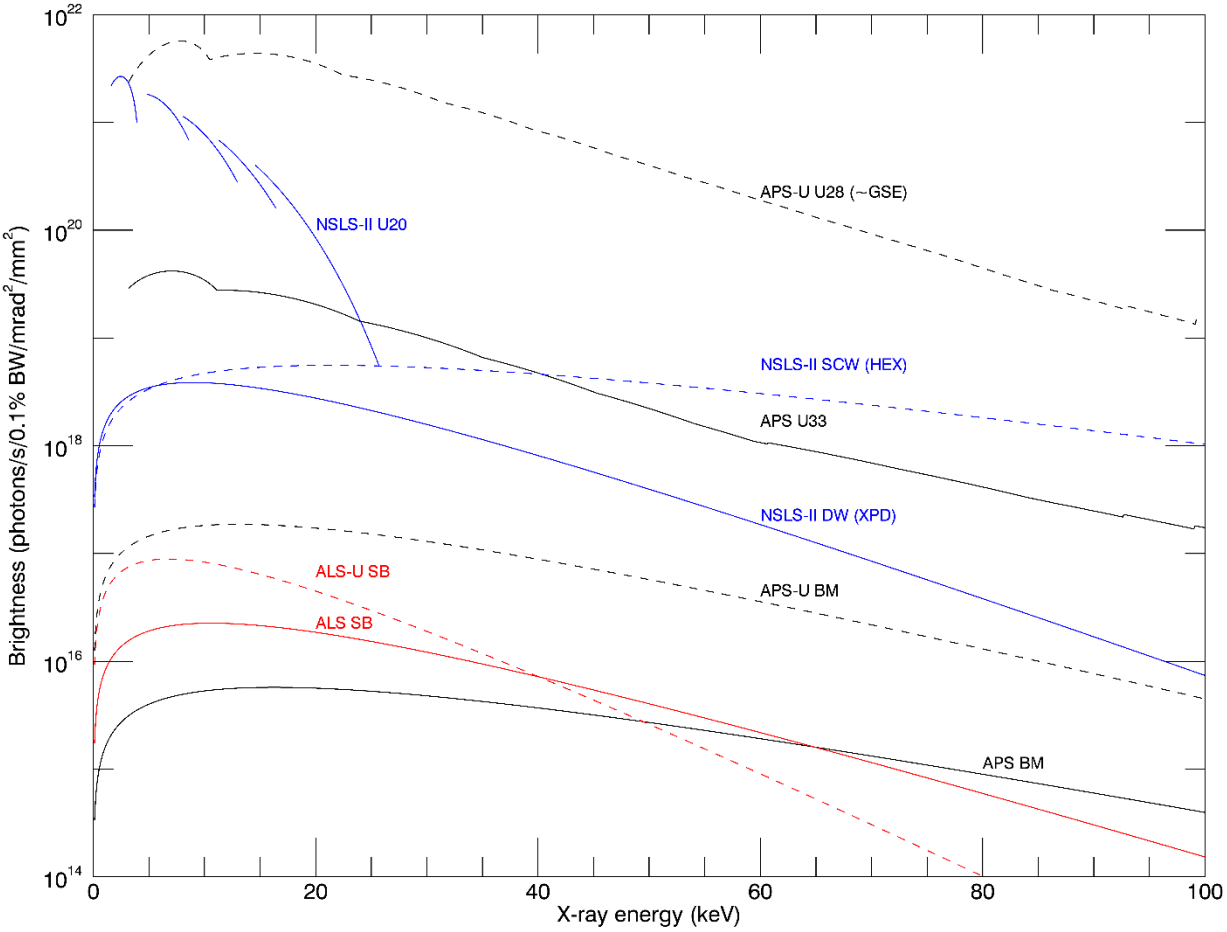

Figure 3. Brightness of sources for a number of current and future COMPRES and GSECARS beamlines. Current sources are plotted as solid lines, and future sources are dashed. The NSLS-II sources are blue, APS is black, and ALS is red.

Current Relationship between COMPRES and GSECARS

COMPRES and GSECARS are complementary organizations that collaborate closely through coordination of community development activities, and the design, construction and operation of advanced instrumentation. Mark Rivers, Co-Director of GSECARS, is currently the elected Chair of the COMPRES Facilities Committee for 2018-2021. At the end of his current term Rivers will have served either as Chair or Regular Member of the COMPRES Facilities Committee for a total of 14 years out of the 20 years COMPRES' existance. GSECARS participates in the COMPRES annual meeting with presentations on overall GSECARS status. The COMPRES Facilities Committee has had site visits at GSECARS and provided advice to its directors on operations and future directions. COMPRES and GSECARS have formed two successful partnerships at the GSECARS APS beamline: 1) Partnership for eXtreme Xtallography (PX^2) which is a COMPRES sub-award to the University of Hawaii (PI, Przemek Dera); and 2) APS Gas Loading Facility for DAC which is a COMPRES sub-award to the University of Chicago (PI, Mark Rivers). The PX^2 project uses ~70% of the beam time on the GSECARS 13-BM-C station for diamond anvil cell experiments, particularly for single-crystal diffraction. This effort followed the closing of two COMPRES-operated diamond-anvil cell beamlines at the NSLS (X-17C and X-17B3) in September 2014 when the NSLS ceased operations. GSECARS upgraded the 13-BM-C monochromator to also allow operating at 28.6 keV, and COMPRES invested about $180K to add x-ray micro-focusing optics, cleanup slits, resistive heating, membrane remote pressure control, and an optical platform for sample viewing, laser heating, and optical spectroscopy. In 2018 COMPRES and GSECARS jointly funded a Pilatus3 S 1M detector which greatly reduced data collection time, improved signal/noise, and enhanced user experience at the facility. The gas loading facility has been a partnership project between COMPRES and GSECARS since 2006. By providing a capability for users to load inert, nearly hydrostatic pressure media in their experiments, this facility has greatly improved the precision of many high pressure experiments. COMPRES currently funds ~50% of Sergey Tkachev's salary to provide a mail-in service to load cells for non-APS users, and to assist users from non-GSECARS beamlines with loading their cells. COMPRES recently funded the purchase of a state-of-the-art Axis Pro APSS micromanipulator located in the laser laboratory at GSECARS. This is available to the entire COMPRES high-pressure community, not just users of GSECARS.

COMPRES and GSECARS user communities

COMPRES and GSECARS have overlapping but different user communities. Many of the mineral physicists who use the COMPRES beamlines also use the GSECARS beamlines. However, there is a large community of non-high pressure users who only use GSECARS and do non consider themselves members of the COMPRES community. COMPRES is focused largely on deep Earth and planetary processes, and we believe that strong focus has built a strong community that governs itself well and participates enthusiastically in its annual meeting. The GSECARS community is much broader. In the Models 2 and 3 that we present below with COMPRES and GSECARS being governed similarly to COMPRES today, but with a much expanded scope and

thus community membership, we feel there is a real danger of loss of the community identities. Would such an expanded community participate in an annual meeting with a much broader scope? Would the members from one scientific field feel that its interests were being fairly represented in an expanded electorate?

Pros and Cons of the Current Management Structures of COMPRES and GSECARS

Pros

1. The distinct COMPRES and GSECARS user communities appear to be satisfied and well served by the current structure. The user satisfaction survey results indicate strong support for the way the facilities are currently being run.
2. COMPRES has been operating successfully under the current management structure for 17 years (established 2002), now with 9 COMPRES sub-awards and 7 beamline facilities distributed between 3 DOE synchrotrons, with ~140 publications per year.
3. COMPRES and GSECARS have collaborated successfully for 17 years to the benefit of the community.
4. COMPRES has well defined governance through its bylaws.
5. COMPRES has 70 member institutions.
6. COMPRES has an Executive Committee elected by its membership.
7. COMPRES has a President that carries out the directives of the Executive Committee. The President is appointed by the Executive Committee in consultation with NSF through recommendations from an ad hoc search committee.
8. COMPRES has a Facilities Committee and an EOID Committee elected by its membership.
9. COMPRES Central Office benefits from support of its home institution University of New Mexico.
10. COMPRES supports an Annual Meeting and 2-3 community workshops per year.
11. COMPRES sub-award PIs are stakeholders in the enterprise and sub-awards are a mechanism for enhancing direct community participation and stewardship in COMPRES facilities and EOID.
12. GSECARS has been operating successfully under the current management structure for 23 years (established 1996), with currently >800 user visits per year and >165 publications per year. GSECARS is consistently in the top 10% of APS sectors in publications per year, and consistently is judged to be one of the best managed Collaborating Access Teams in the reviews by the APS Scientific Advisory Committee.
13. GSECARS has a simple, streamlined governance and management structure with a single direct report of its Directors to NSF EAR IF; there are no sub-award management tasks.
14. GSECARS formally involves the community in collaborative scientific and technical projects in its funding proposals. GSECARS also frequently hosts community workshops devoted to developing new techniques and new science directions. These workshops provide community input to the new directions the facility should pursue.
15. The GSECARS administrative costs are very low. There is one administrative staff member, Nancy Lazarz, who handles the user support for all of the 800+ user-visits per year, purchasing, human resources, publication database, and many other tasks. Over 60% of Nancy's time is user support, which is something that the COMPRES central

office does not handle. Rivers and Sutton, the PI and Co-PI on the GSECARS NSF-EAR awards, spend most of their time as beamline scientists working with users, and doing technical developments. The actual administrative costs (40% of Lazarz, 10% each of Rivers and Sutton) is about $130K/year, or about 5% of the GSECARS budget.

16. GSECARS benefits from the CARS office and the Physical Sciences Division at the University of Chicago which provide monetary and administrative staff support.
17. GSECARS has co-located beamlines which allows ease of access for users, and the central facility model that optimizes beamline personnel, equipment upgrades, and technical support.

Cons

1. Despite their overlapping communities, COMPRES and GSECARS lack a *formal* process or management structure to coordinate collaborative efforts, future planning, sharing of resources, and mitigation of duplication of effort.
2. Because of its subaward structure, COMPRES leadership lacks fine-grained control over the daily operations of its projects. Even some critical decisions, namely hiring of beamline personnel, rest primarily with the subaward PIs.
3. GSECARS lacks an Executive Committee and/or Facility Committee that would provide formal community participation in managing the affairs of the organization.

While we believe that the current management structures of COMPRES and GSECARS have served both of these organizations and their user bases well for the past two decades, there is always room for improvement. In particular, as described above, both COMPRES and GSECARS would benefit from management structures that promote coordination between the two organizations. Below we explore the pros and cons of three management models that merge some or all aspects of COMPRES and GSECARS.

Model 1. Two Institutions with Formal Coordination

This option would preserve most of the existing management structure of COMPRES and GSECARS, while formalizing the coordination between the two organizations. This option preserves the direct reports of COMPRES and GSECARS to NSF EAR IF as well as separate Cooperative Agreements and budgets. Ideally, the NSF reviews and funding for both organizations would be placed on the same cycle. This option also leaves intact the unique organizational identities of COMPRES and GSECARS which are the long-lived products of 17 and 23 years, respectively, of successful operations.

The changes would be:

1. GSECARS would establish a formal Advisory Committee to provide advice on scientific directions and how best to serve the community. This committee would have representatives from each of the Earth sciences disciplines and techniques at GSECARS. It would also have formal representation from COMPRES, for example the COMPRES President and the Chair of the Executive Committee. Note that in the past the COMPRES President was a member of the CARS Board of Governors, but that body was dissolved in 2013.
2. COMPRES would amend its by-laws to formalize representation of the GSECARS Directors on the COMPRES Executive Committee.

Pros and Cons of Model 1

Pros

1. Preserves the distinct GSECARS and COMPRES user communities and organizational structure that the communities believe are doing an excellent job serving their interests.
2. Provides COMPRES and GSECARS with a formal mechanism to coordinate collaborative efforts, future planning, sharing of resources, and mitigation of duplication of effort.
3. Preserves the successful operations of both institutions, in which different management structures address different (but overlapping) goals and user communities.

Cons

1. Separate Cooperative Agreements, budgets, and external review panels do not reduce administrative workload for NSF.

Model 2. Two Institutions with Common Governance

This model (Figure 4) starts with Model 1 above, but in addition the Directors of GSECARS would report to the new Executive Committee and be subject to the new COMPRES by-laws, which would be updated and revised in accord with GSECARS coming under its umbrella. GSECARS facilities would be subject to annual reviews by the Facilities Committee. The GSECARS budget would be subject to approval by the Executive Committee. The GSECARS Directors and the COMPRES President would normally be present at all meetings of the Executive Committee. In the case of leadership succession, the GSECARS Directors would be appointed by the Executive Committee, in consultation with the Dean of Physical Sciences at the University of Chicago, cognizant NSF Program Director, and with a recommendation from an ad hoc Search Committee.

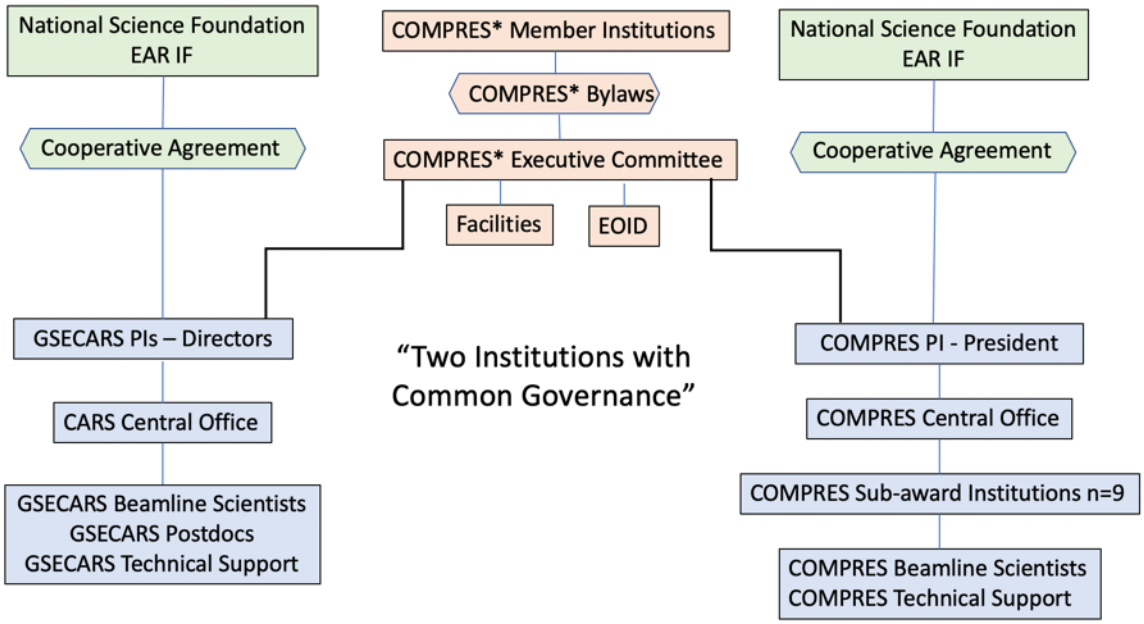

Figure 4. "Two Institutions with Common Governance" is an organizational transformation that would create a management structure that preserves separate or parallel NSF cooperative agreements and budgets for COMPRES and GSECARS, however the two organizations would be formally joined by and subject to COMPRES-like community governance. COMPRES* denotes updated and revised Bylaws.

Pros and Cons of Model 2

Pros

1. Provides COMPRES and GSECARS a common governance structure to coordinate collaborative efforts, future planning, and eliminate duplicate efforts.
2. Provides GSECARS with an Executive Committee with formal community participation in management of the affairs of the organization.
3. Provides GSECARS with a Facilities Committee that would evaluate the effectiveness of the service delivered by the organization's facilities, and would make recommendations on the community's research needs and future directions.
4. Provides community input into the GSECARS succession process for Directors of the organization.
5. Preserves the unique organizational identities of COMPRES and GSECARS.

Cons

1. Executive Committee would only advise the NSF-EAR-IF portion of GSECARS.
2. COMPRES would need to fundamentally change its membership to reflect the broader, non-mineral physics community that comprises a large fraction of GSECARS users. We believe this runs the real risk of creating a less cohesive user community than currently exists. A large part of the success of the current community governance of COMPRES arises from the fact that it is relatively tight-knit, and comes together each year to discuss issues at the annual meeting. We are very concerned that with a more diverse community it would be difficult to maintain the attendance at the annual meeting and the buy-in to the governance structure. The COMPRES bylaws would need to be modified to ensure that it protects needs of the broader community of Earth science researchers using these resources, and new member institutions, new electors, and new COMPRES officers would need to be chosen.
3. The GSECARS award has always been to the University of Chicago, which thus holds title to the equipment. All GSECARS staff are employed by the University of Chicago. If COMPRES Executive Committee chooses the GSECARS directors, will they be constrained to select individuals from the University of Chicago? If not, there will be significant issues in staff reporting and equipment ownership.
4. This model only addresses the funding from NSF-EAR. However, over 25 percent of the funding at GSECARS is from other sources.
5. Workloads for the Executive Committee and Facilities Committee will increase.
6. Separate Cooperative Agreements, budgets, and external review panels do not reduce administrative workload for NSF.

Model 3. Unified Consortium for Earth Materials Research

This structural transformation would have as its primary goal to unify COMPRES and GSECARS under a single organization in order to fully coordinate NSF EAR synchrotron facilities, streamline management and reduce administrative burden for NSF (Figure 5).

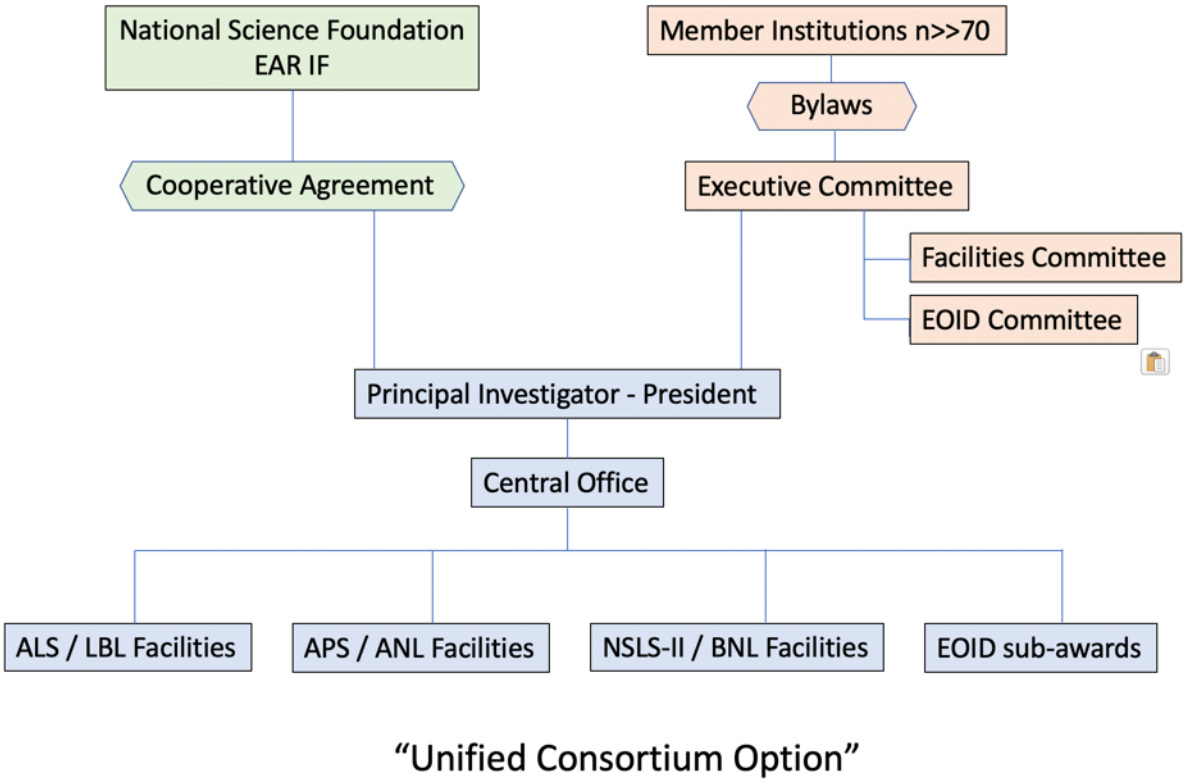

Figure 5. "Unified Consortium Option" is a transformation that would create a management structure that is a "large-tent" organization, with a single NSF Cooperative Agreement. It would retain most of the community-based governance based on COMPRES model, and a COMPRES-like Central Office, with President/Principal Investigator. GSECARS would transform into an umbrella APS/ANL Central Facility within the Unified Consortium.

The Unified Management option has a single direct report to NSF EAR IF by a President/Principal Investigator with a single Cooperative Agreement and budget. The governance is "COMPRES-like" with bylaws, an Executive Committee, and Standing Committees. Reporting to the President are institutional sub-awards that support the facilities and EOID projects. In the example shown in Figure 5, the facilities maintain autonomy through sub-awards and are reduced in number to 3 to minimize and streamline administrative burden and to enhance local coordination of human resources, equipment, technical development, new initiatives, and partner user agreements. In this example, each of the three synchrotrons ALS, APS, and NSLS-II, would have a single central facility sub-award. In the case of GSECARS it would be transformed into the APS Central Facility which includes the current Sector 13 operation but also any other Earth science-focused facility or beamline that would come under the Unified Consortium organizational umbrella at APS. At the two other synchrotrons, there would be the ALS Central Facility sub-award and NSLS-II Central Facilities sub-award. EOID project support in the Unified Consortium option would stay unchanged, with the possibility of

multiple institutions having sub-awards, as is the case currently. The Unified Consortium option does not depend on reducing the number of facility sub-awards; an alternate example would be to preserve the current 6 COMPRES facility sub-awards plus the current GSECARS. However, the Unified Consortium option would be more streamlined with just 3 facility sub-awards to oversee. A single Cooperative Agreement, budget, and panel review would represent a reduction in administrative burden for NSF.

Table 3 shows the COMPRES and GSECARS facilities, units and projects that are funded by NSF EAR IF.

NSF EAR IF funded unit	Annual Budget ($K)	Synchrotrons	Beamlines	Staff (FTE)
GSECARS	2,974	APS	3.65	14.50
Hawaii DAC PX^2	254	APS	0.35	2.00
Chicago Gas loading	59	APS	n/a	0.50
UIUC DAC IXS 3/30-ID	104	APS	0.60	1.00
Stony Brook MAP, XPD-D, 6BM-B	409	NSLS-II/APS	0.75	2.00
UIC DAC FIS	298	NSLS-II	0.50	1.50
UC Santa Cruz DAC 12.2.2	349	ALS	0.50	2.00
ASU MAPCD	111	n/a	n/a	0.08
EOID	82	n/a	n/a	n/a
Participant Support	195	n/a	n/a	n/a
Central Office	538	n/a	n/a	1.75
COMPRES total	2,400	APS/NSLS-II/ALS	2.70	10.83
GSECARS+COMPRES total	5,374	APS/NSLS-II/ALS	6.35	25.33

Table 3 summarizes all of the COMPRES and GSECARS facilities, units and projects that are funded by NSF EAR IF. GSECARS maintains 3.65 beamlines at APS with a total funded staff of 14.5 FTE. COMPRES on the other hand, runs 2.7 beamlines at 3 synchrotrons, with 9 beamline scientists and 1.75 FTE for the Central Office. The lion's share of the combined GSECARS and COMPRES beamlines are located at the APS (80%), which would make an APS Central Facility the centerpiece of the Unified Consortium model. One of the reasons why APS has attracted most of the EAR-funded beamlines is because the APS undulator beamlines are more than 10 times brighter than beamlines at any other DOE synchrotron facility, and the bending magnet beamlines have higher energy than the ALS (Figure 3). However, the very productive publication record of the COMPRES ALS 12.2.2 beamline argues that maintaining an EAR-funded presence there, now and in the future, is a good investment for our research community. Likewise, the unique capability at the NSLS-II Frontier Synchrotron Infrared Spectroscopy (FIS) beamline should be considered a highly valuable research asset, as well as future opportunities at NSLS-II such as the High Energy Engineering X-Ray Scattering (HEX) beamline. Furthermore, "offline" projects such as the current ASU multi-anvil project do not benefit from being located at a DOE synchrotron. This would also be the case for a future Very Large Multi-Anvil Press (VLMAP) User Facility for synthesis of Earth mantle minerals and novel superhard materials for high pressure research.

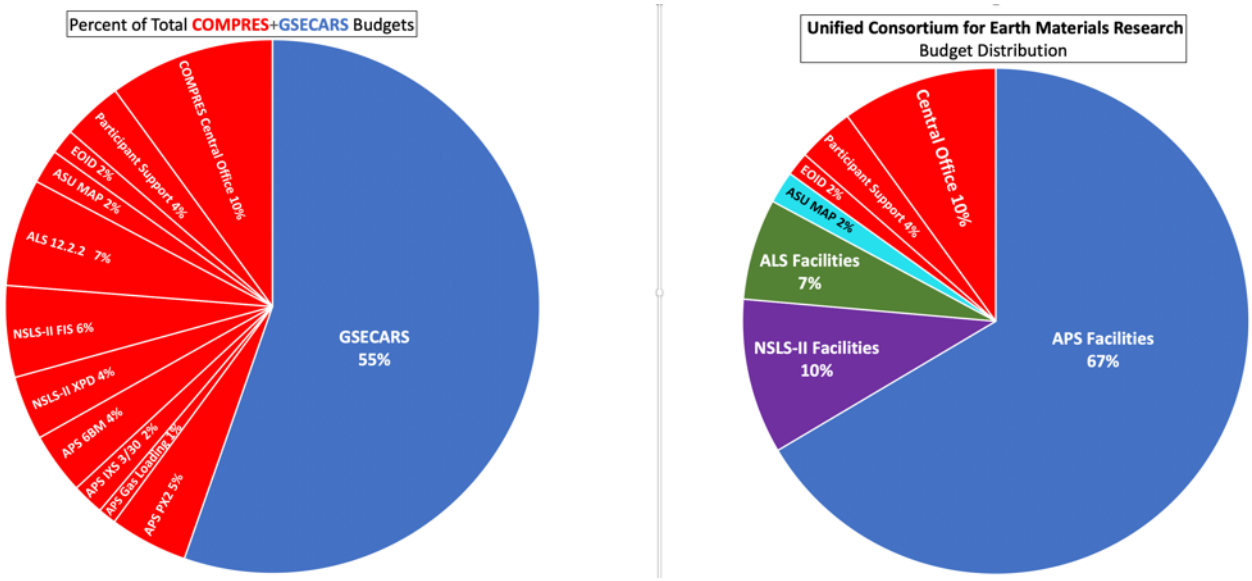

Figure 5. The pie diagram on the left shows the distribution of the combined COMPRES (red) and GSECARS (blue) budget. Pie diagram on the right shows a possible budget distribution for a Unified Consortium for Earth Materials Research based on the current combined budget.

Figure 5 summarizes the combined 2019 budget distribution of COMPRES and GSECARS and shows that GSECARS receives 55% of the combined budget while COMPRES receives 45%. In the Unified Consortium model, 67% of the total budget would flow to the APS Central Facilities, assuming the current beamline distribution. The other two Central Facilities would receive 17% of the total budget, with the Central Office receiving 10%.

One option for the Central Office would follow the COMPRES model and locate it at the home institution of the President/PI so its location would periodically change, in step with the succession process. Alternatively, the Central Office could be co-located at the institution with the largest Central Facility; currently that would be the University of Chicago. This second option is similar to the original COMPRES organizational structure when Stony Brook University had both the Central Office on its campus and also had the largest COMPRES sub-award at nearby NSLS. On the other hand, proximity of a central office or headquarters relative to its branches or field installations is not always a major factor in the structural viability of an organization.

Pros and Cons of the Unified Consortium Option

Pros

1. Creates a fully coordinated organization for all NSF EAR synchrotron facilities.
2. Transforms COMPRES and GSECARS into a big-tent organization. The Unified Consortium organization would encompass Earth materials research beyond high pressure mineral physics, which COMPRES is currently limited to.
3. Provides a streamlined, more efficient management structure with bylaws, Executive Committee, President/PI, single NSF Cooperative Agreement, single budget, and single review panel.

4. Has the potential to streamline and reduce the number of facility sub-awards.
5. Creates overarching single Central Facility at each of the 3 synchrotrons that could enhance local coordination of human resources, equipment, technical development, new initiatives, and partner user agreements.
6. Reduces the administrative burden on NSF.

Cons

1. Surrenders the current unique organizational identities of COMPRES and GSECARS established over 17 and 23 years of successful management, respectively.
2. Requires significant effort to form and manage a new organization that represents the interests of much broader community than the current COMPRES membership. We believe this runs the real risk of creating a less cohesive user community than currently exists. A large part of the success of the current community governance of COMPRES arises from the fact that it is relatively tight-knit, and comes together each year to discuss issues at the annual meeting. We are very concerned that with a more diverse community it would be difficult to maintain the attendance at the annual meeting and the buy-in to the governance structure. The COMPRES bylaws would need to be modified to ensure that it protects needs of the broader community of Earth science researchers using these resources, and new member institutions, new electors, and new COMPRES officers would need to be chosen.
3. The GSECARS award has always been to the University of Chicago, which thus holds title to the equipment. Likewise, the University of New Mexico now holds title to all recently purchased COMPRES equipment. Resolving equipment ownership, staffing, and agreements with synchrotron facilities could be a potential challenge with a new Unified Consortium.
4. Work load for the Executive and Facilities Committees will significantly increase.

Summary

This white paper lays out possible management scenarios intended to enhance the interaction between COMPRES and GSECARS and to streamline their operations. It also compares and contrasts these scenarios with the current management structures of the two organizations, offering some “pros” and “cons” with each option. Given the successful history of COMPRES and GSECARS spanning 17 and 23 years, respectively, it is not surprising that we identified many more “pros” than “cons” for the current organizational configurations. However, both COMPRES and GSECARS would benefit from management structures that promote coordination between the two organizations. Models 1 and 2 formally satisfy this need, while at the same time preserves the unique organizational identities of COMPRES and GSECARS. On the other hand, Model 3 represents a total unification of the two organizations with a single direct report to NSF EAR IF and to the member institutions’ elected Executive Committee, with a goal of less administration from NSF and more efficient operations.

Appendix

Ad hoc review committee membership

Peter Olson, Johns Hopkins University (Chair)
Peter Heaney, Penn State University
Miaki Ishii, Harvard University
James Tyburczy, Arizona State University
Michael Walter, Geophysical Laboratory