

BSC

/i/

CREATIVE

INTELLIGENCE LAB

/e/

/u/

/a/

EXECUTIVE SUMMARY

The BSC Creative Intelligence Lab is a strategic research laboratory at the Barcelona Supercomputing Center (BSC) dedicated to integrating creative practices with High-Performance Computing (HPC), Artificial Intelligence (AI), and emerging computational technologies.

It consolidates more than thirteen years of work connecting science with art, design, architecture, and urbanism into a structured framework aimed at expanding these activities into a broader European initiative.

Its purpose is to develop new forms of knowledge creation, innovation, and societal engagement by embedding creative methodologies at the core of advanced computational research, while also applying HPC methodologies and technologies to creative practices and the Cultural and Creative Industries sector (CCI).

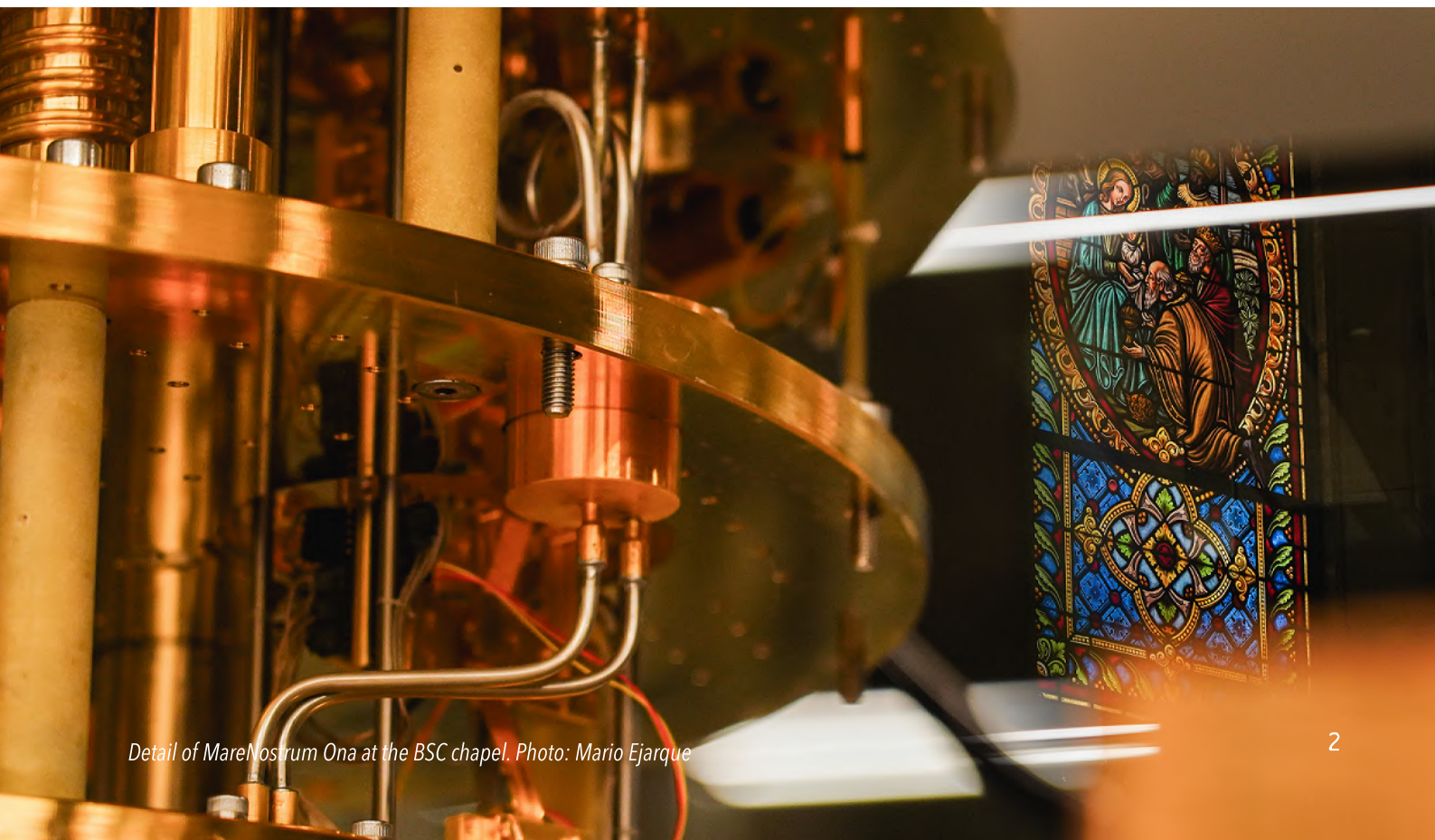
In doing so, the lab establishes a new institutional model in which High-Performance Computing and creative practice operate as mutually reinforcing drivers of scientific discovery, technological innovation, and cultural production.

HOW WE GOT HERE 1.

THE BARCELONA SUPERCOMPUTING CENTER

The Barcelona Supercomputing Center (BSC) is one of Europe's leading HPC institutions. It coordinates the Spanish Supercomputing Network (RES) and is home to the MareNostrum 5 supercomputer and Ona, Spain's first quantum computer. This infrastructure provides access to world-class computational resources and expertise in artificial intelligence, data science, and emerging quantum technologies.

Beyond infrastructure, BSC operates within extensive European research networks and maintains strong connections with industry and society, with an impact on fields such as personalized medicine, climate change, energy, and urban planning. This combination of technical leadership, scientific excellence, and applied impact creates a uniquely fertile environment for interdisciplinary innovation.



Detail of MareNostrum Ona at the BSC chapel. Photo: Mario Ejarque



WHERE WE COME FROM

The initiative emerges from more than thirteen years of continuous work within the Data Visualization and Analytics group at BSC. The group was founded to transform complex data into knowledge through visualization, interaction, simulation, and analysis. Over time, it evolved into a multidisciplinary team combining scientific, technological, and creative expertise.

The group integrates researchers, engineers, designers, communicators, and creative practitioners. Researchers contribute expertise in physics, computer science, artificial intelligence, and applied data science. Engineers and developers build advanced computational systems, interactive platforms, and AI-driven tools. Designers shape visual communication, interaction, and experiences into cohesive products. Communicators develop narratives and audiovisual productions. Artists and creative technologists participate directly in research processes, contributing new perspectives and methods.

This diversity has enabled the development of a distinctive approach in which creativity is not an output layer, but a driver of research and innovation.

A STORY OF TRANSFORMATION

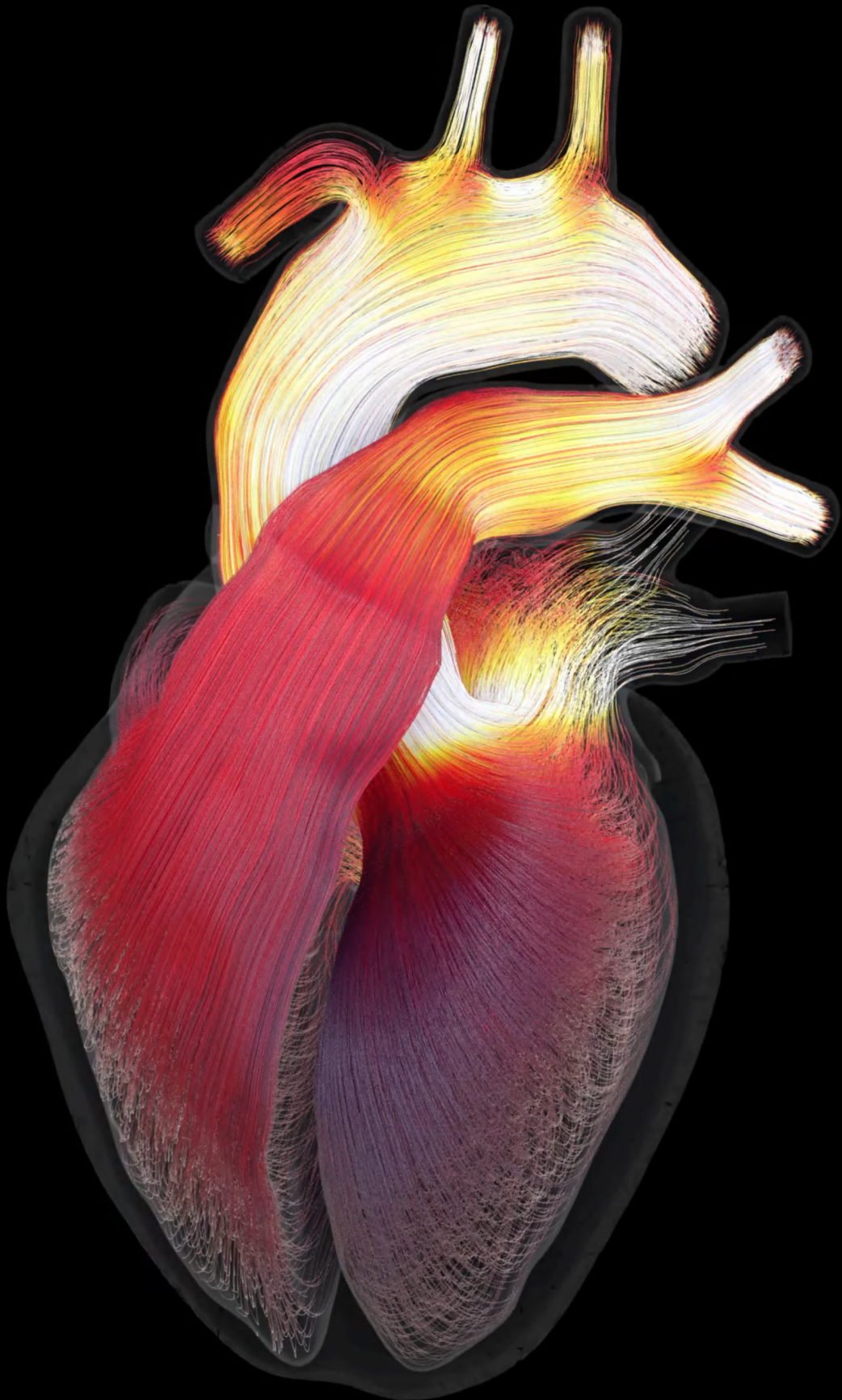
The group's evolution has unfolded through phases that progressively integrated creative practice into scientific and technological development.

SCIENTIFIC VISUALIZATION AND STORYTELLING

The group's beginning in 2013 focused on scientific visualization and communication, producing award-winning films and visual narratives based on supercomputing data. These projects demonstrated that creative methods could translate complex computational results into meaningful and accessible forms, while also driving technical innovation.

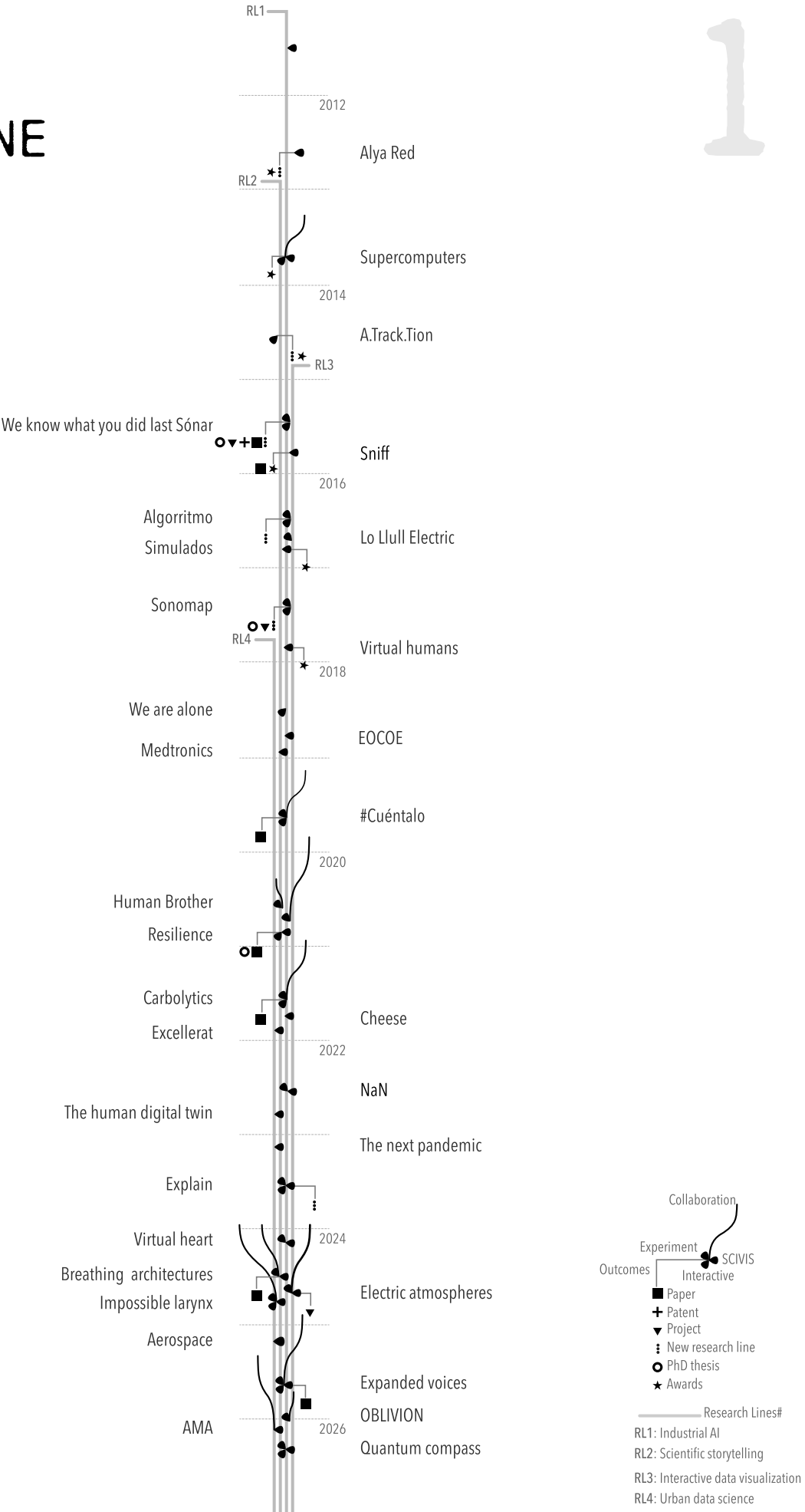
INTERACTIVE DATA VISUALIZATION

By expanding beyond scientific contexts into broader domains such as music, culture, and industry, in 2014 the group started developing the capacity to create interactive systems that enabled analysis, decision-making, and communication through large-scale and immersive data visualizations. This work explored emerging technologies including virtual and augmented reality and established new approaches to human-data interaction.



*Virtual Heart, data driven visualization of a computational heart.
Permanent installation at the Engineer's Gallery of the London Science Museum (2024)*

TIMELINE



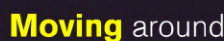
PUBLIC EXPERIMENTS

The group began conducting large-scale public experiments in events for general and specialized audiences: music and arts festivals like **Sónar**, **Cruïlla** and **Ars Electronica**, industry shows like **Mobile World Congress** and **Nova**, and sport events like **FC Barcelona** football matches. These initiatives transformed these public spaces into research environments, allowing new technologies to be tested in real-world conditions while engaging with audiences. This approach opened new research directions in urban science, data engineering, and GenAI.

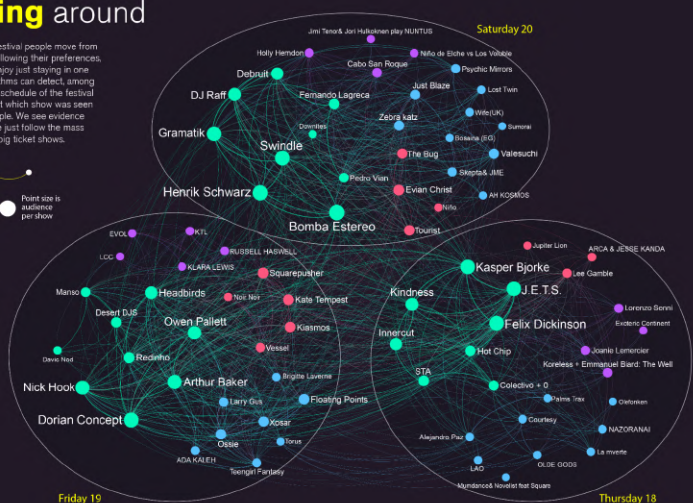
DEEP INTERDISCIPLINARY COLLABORATIONS

Through collaborations with **artists**, **journalists**, and **cultural institutions**, as well as participation in European programs such as **S+T+ARTS**, the group developed and refined a methodology for integrating creative practitioners directly into research teams -thus demonstrating that creative perspectives could generate new research questions, methods, and technological outcomes. Collaborations include artists such as **Joana Moll**, **Maria Arnal**, **Filippo Nassetti**, or **Taller Estampa**, as well as journalists like **Jorge Carrión** or urban designers like **300.000km/s**, and partners like **Sónar Festival**, **Centre de Cultura Contemporània de Barcelona** (CCCB), **Ars Electronica**, **Museo del Prado**, **Fundación Telefónica**, **TBA21 Thyssen-Bornemisza Art Contemporary**, **Fundación Épica la Fura dels Baus**, **RCR**, and more.

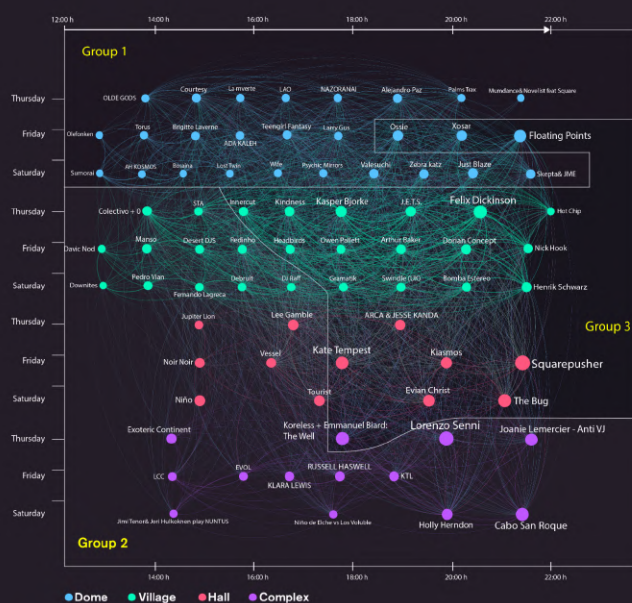
We tracked the audience at each stage compared to the total audience at Sonar. In this way we can identify shows that attracted more or less people than expected. The **red to yellow-white** colors represent the percentage of people at each stage with respect to the whole of Sonar, while **blue lines** are the raw numbers without normalization. Each vertical strip is a 5 minute average. Black spaces are where we could not collect reliable data (or, less often, when a room was closed, like Sonar+D after 6pm).



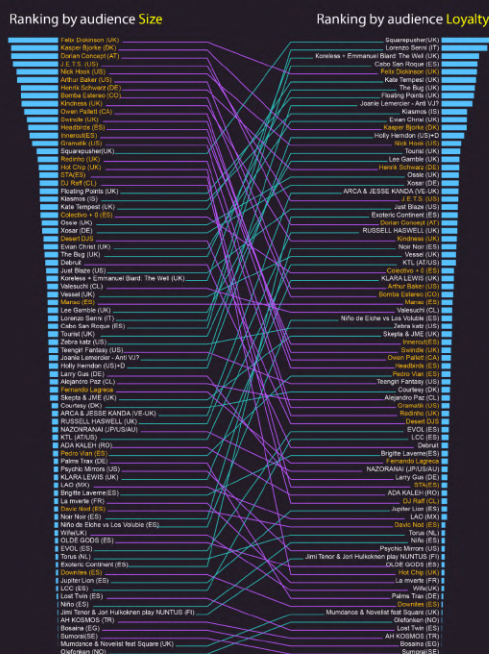
In a multitaste festival people move from show to show, following their preferences, or maybe they enjoy just staying in one place. Our algorithms can detect, among other things, the schedule of the festival only by looking at which show was seen by the same people. We see evidence that many people just follow the mass and stay for the big ticket shows.



The algorithms found three groups that we associate to the shows they attended: **Group 1** clusters people that preferred the electronic music and DJs of SonarDôme, **Group 2** contains people that focused on the experimental acts at the Sonar Complex and the lesser known artists in the main stages, and in **Group 3** the algorithm picks up people that showed up for the afternoon big tickets of Sonar Village and Sonar Hall.



Artists that played at Sonar Village, the largest stage, rank well traditionally, but when considering loyalty their ranking goes down. Smaller shows benefit from loyal fans and their rankings go up.



Instead of ranking popularity in the typical way with the size of an audience (or equivalents, like sales) we can use estimates of how passionate and loyal was the audience. For this, we considered how much time people stayed at the performance compared to how much they stayed at other shows, how filled was the room, and the expected audience given the time of the show and the venue.



HISTORICAL OUTCOMES AND IMPACT

The interdisciplinary methodology developed at BSC has produced a *substantial body of outcomes* over more than a decade. This timeframe is important because while some benefits emerge quickly, the most significant impacts require time to mature as exploratory collaborations evolve into measurable scientific, technological, and institutional results.

The methodology has produced concrete measurable outcomes, including more than **twenty scientific publications, three PhD theses**, and a **patented** technological development in the form of a database system. Most significantly, interdisciplinary and creative-driven activities have led directly to **eighteen funded projects**, which together have provided more than **fifty-five percent of the total funding** sustaining a team of over twenty people. This is particularly notable in a context where structural institutional funding represents less than ten percent of the total budget. In addition, the visibility and reputation generated through these activities have indirectly contributed to securing further industrial and research projects beyond the cultural domain.

In this sense, the group's activities have generated extensive soft outcomes. These include major international visibility through media coverage, exhibitions, and **more than a dozen awards**, which have significantly strengthened BSC's public profile. This visibility has played an important role in attracting and retaining highly skilled talent, reinforcing team cohesion, and enabling the establishment of a broad network of collaborators. To date, more than thirty strategic partnerships have been formed with cultural institutions, research organisations, and industry.

These results demonstrate that creative-driven research can generate significant cultural as well as scientific, technological, and institutional value while being financially sustainable. Over time, this experience has also led to the development of a distinctive methodology for integrating creative practice into computational research.



NaN: Not an NFT, commissioned installation for Sónar+D (2022, BSC)

INSTITUTIONAL COLLABORATION: SÓNAR

SÓNAR is one of the most important festivals in the global scene of electronic music, digital culture and art and technology. Founded in 1994 in Barcelona, it is attended by more than 150000 visitors annually. Starting in 2014, it has established the longest running collaboration with the group, with 11 projects shown at the creative technologies area space Sónar+D, three large scale experiments with the audience, three residencies showcases, one commissioned piece for the Stage+D stage, and collaboration in the visuals and AI voice models for one live performance.

From this collaboration BSC gets access to a relevant exhibition space and audience for its public experiments, while Sónar works with a large technological partner for establishing itself deep into the arts+science community. The strength of the collaboration has grown over time to make Sónar one of the preferred partners for the new laboratory initiative.

ARTIST COLLABORATION: MARIA ARNAL

Maria Arnal is a Barcelona based singer and composer, and one of the most recognised voices in the contemporary Spanish music scene. BSC started collaborating with Maria in 2023 with a commissioned piece (*Maria Choir*) for the AI exhibition at the CCCB museum, coproduced by BSC, and continued in a residence under the S+T+ARTS programme in 2024.

The project (*Impossible Larynx*), exploring AI voice models augmented with physics simulations, sets up the basis for the two-sided continuation of the collaboration: On the artistic side, Maria's latest project *AMA* (2026) which uses AI models and visuals in the show and the album, and on the scientific side *Expanded Voices* (2025), an interactive installation from which a technical article was produced exploring the mathematical structure of the AI voice latent spaces.

THE ARTS-SCIENCE INNOVATION METHODOLOGY

Through these experiences, BSC developed a distinctive interdisciplinary methodology based on the full integration of creative practitioners into scientific and technological research.

Unlike traditional artist-in-residence models at scientific institutions, where artists are usually paired with researchers who “guide them” through a discipline’s questions and methods, and then apply this knowledge to their creative practice, creative practitioners at BSC work as embedded members of research teams.

They contribute directly to problem-solving, technology development, and knowledge creation, bringing complementary expertise and perspectives, and producing significant measurable impacts on the team’s output. Our methodology recognizes that the applied expertise of artists, designers, architects, creative technologists, and other creative practitioners can directly contribute to research outcomes, and can enter in dialogue and build upon the research output of researchers in our group.

This methodology operates as a continuous cycle:

- **KNOWLEDGE CREATION**

Creative practitioners collaborate with researchers to explore questions and develop new capabilities. Research directions are defined jointly, with attention to long-term potential applications.

- **KNOWLEDGE APPLICATION**

The capabilities developed are applied to research projects, technologies, and services, generating measurable outputs such as publications, prototypes, and products.

- **KNOWLEDGE DRIVE**

These outputs generate funding, partnerships, and new research questions, sustaining the cycle and enabling continued innovation.

OPPORTUNITIES AND CHALLENGES

2.

We are living through a convergence of technological, cultural, and societal transformations that make this a critical moment for a laboratory like BSC Creative Intelligence Lab.

Artificial intelligence has entered the cultural mainstream, raising fundamental questions about creativity, authorship, and the nature of intelligence. At the same time, challenges such as climate change, social transformation, and the digitalization of human experience require new ways of understanding and communicating complexity - it is the right moment to socialize and make more visible to society the role of HPC in problem solving for complex, structural problems impacting all society.

Europe is responding with major investments in computational infrastructure, including the EuroHPC initiative and the creation of AI Factories. These initiatives will provide unprecedented access to computational power, data, and AI models. However, infrastructure alone is not sufficient. There is a growing need for interdisciplinary frameworks capable of translating technological capability into meaningful innovation.

In this respect, the S+T+ARTS programme¹, launched by the European Commission, connects artists with

scientists, engineers, and companies to address societal challenges and drive human-centred innovation. It has funded hundreds of residencies and collaborations across Europe, demonstrating how artistic perspectives can inspire technological breakthroughs, improve societal relevance, and shape more inclusive and responsible innovation. The S+T+ARTS programme is now reaching maturity, creating both a legacy and a gap. There is an opportunity to build on this experience and develop new institutional structures capable of sustaining and expanding this work.

Located at the intersection of advanced computation and creative practice, BSC is uniquely positioned to serve as a bridge between technological infrastructure and the creative and cultural sectors. This bridge will enable creative communities to access advanced technologies, while allowing scientific research to benefit from creative perspectives.

The creation of the BSC Creative Intelligence Lab formalizes and expands this role, establishing a dedicated structure to scale this methodology and extend its impact.

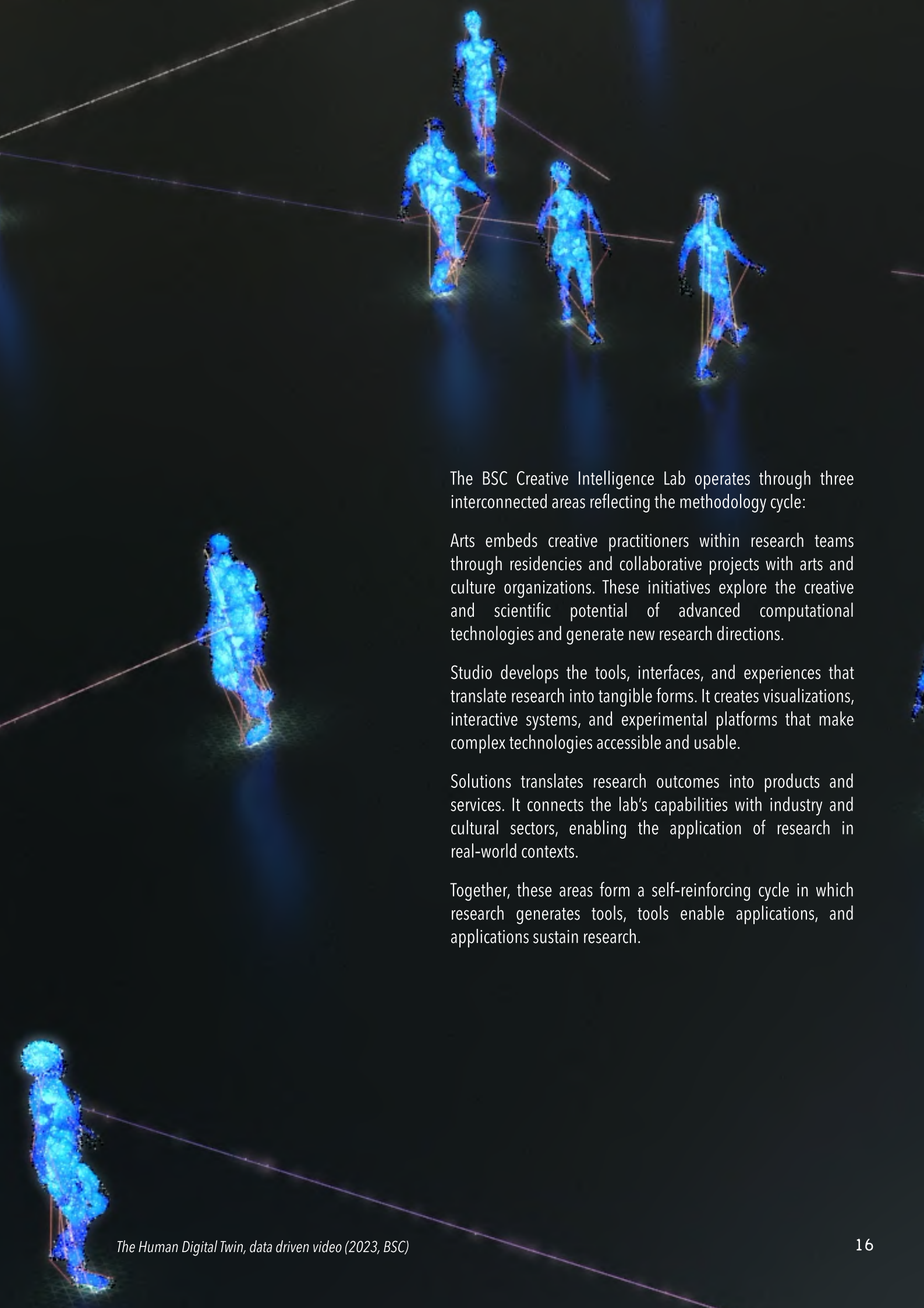
¹ https://starts.eu/wp-content/uploads/STARTS_Lessons-Learned-from-a-Decade-of-Transdisciplinary-Innovation.pdf

THE BSC CREATIVE INTELLIGENCE LAB

The BSC Creative Intelligence Lab is an institutional initiative to extend this interdisciplinary methodology across BSC and beyond. Its mission is to create new forms of knowledge and innovation by integrating scientific, technological, and creative practices within an HPC research environment, leveraging world-class computational resources, expertise across disciplines – from Earth sciences and life sciences to AI and quantum computing – and strong European and industry connections to foster uniquely impactful arts+science innovation.

Its core objectives are:

- To integrate creative practices into scientific and technological research.
- To enable artists and creative industries to explore HPC, AI, and emerging technologies.
- To foster transdisciplinary collaboration across all departments at BSC.
- To support creative expression within the scientific community.
- To strengthen the relationship between BSC and society through cultural and creative engagement.
- To incorporate CCI (Cultural and Creative Industries) within the sectors applying HPC to problem solving and the development of solutions, products and services.



The BSC Creative Intelligence Lab operates through three interconnected areas reflecting the methodology cycle:

Arts embeds creative practitioners within research teams through residencies and collaborative projects with arts and culture organizations. These initiatives explore the creative and scientific potential of advanced computational technologies and generate new research directions.

Studio develops the tools, interfaces, and experiences that translate research into tangible forms. It creates visualizations, interactive systems, and experimental platforms that make complex technologies accessible and usable.

Solutions translates research outcomes into products and services. It connects the lab's capabilities with industry and cultural sectors, enabling the application of research in real-world contexts.

Together, these areas form a self-reinforcing cycle in which research generates tools, tools enable applications, and applications sustain research.



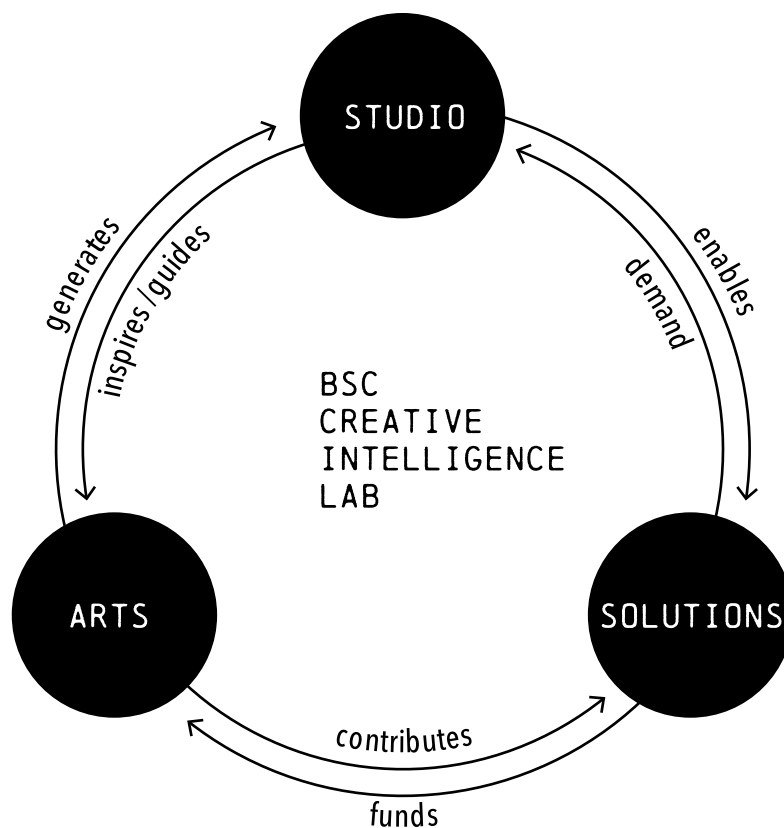
OBLIVION, Javier Blanco, S+T+ARTS Buen-TEK artist in residency at UNC Supercómputo, Córdoba (Argentina), in collaboration with BSC (2025, Nicolás Bravo)

STRUCTURE

The BSC Creative Intelligence Lab will initially build on the existing activities, capabilities, and partnerships developed by its founding group. This continuity will ensure the preservation of ongoing projects, funding streams, and institutional relationships, while providing a stable foundation for growth. Rather than replacing existing structures, the lab will formalize and expand them, allowing this methodology to scale across the institution.

The three areas of the Lab form a self-reinforcing cycle connecting exploration, capability development, and real-world application.

In simple terms, the methodology follows a continuous cycle: creative exploration generates new capabilities, capabilities enable real-world applications, and applications reveal new questions that drive further exploration.



STUDIO is the heart of the laboratory, representing the capacities and skills held by personnel at the Barcelona Supercomputing Center. This includes research expertise in fields such as computer science, climate science, medicine, and industry, as well as applied capabilities in areas such as artificial intelligence, information and experience design, animation, and related practices. These capacities will continue to expand as more groups across BSC participate in the BSC Creative Intelligence Lab.

The capabilities of the Studio are developed and refined through activities within the Arts program, which provides guidance and direction for the themes of the lab's residencies and experiments. These same capacities also support and enable the projects carried out through the Solutions arm. Closing the loop, projects—often derived from societal or industrial needs—drive the development of new capabilities within the Studio.

SOLUTIONS, therefore, is not only the application of existing capabilities to known problems through projects, services, and products that help sustain the lab's activities. It is also the environment where researchers and technical staff encounter new challenges and identify opportunities for arts-science-driven innovation. Solutions draws upon the capacities of the Studio while simultaneously

demanding new ones. These needs may arise from external partners, industrial collaborations, or from questions emerging within the creative community through artistic activities.

ARTS program represents the main new institutional component. It will be organized around three complementary activities.

RESIDENCIES will embed creative practitioners within research teams for extended periods as an invited full researcher, enabling deep collaboration and knowledge exchange. The resident profile can be anything, from visual, music, or digital artists, to architects, digital manufacturing experts, and more.

Scientifically, residencies allow BSC to incorporate complementary capabilities into our research and increase our ability to tackle technological challenges. The artistic results of the residencies provide us with visibility in terms of communication and presence in cultural spaces.

Residencies have typically been carried out in a concentrated format or over a long duration (more than 6 months), with 200 to 400 hours of joint work, with funding from a project or residency programs, focused on research on topics of shared interest that have been agreed upon by all collaborators.





PUBLIC EXPERIMENTS will test emerging technologies in real-world cultural and public contexts, accelerating learning while generating visibility and societal engagement.

We define a public experiment as a time limited action designed, produced, and operated by BSC Creative Intelligence Lab within the context of a large scale public event (an arts festival, science or industrial fairs, and others).

Public experiments have multiple goals: They allow BSC to develop and test new technology at scale, generating hundreds or thousands of interactions in a few days. They can unleash research processes new or parallel to existing projects at BSC, accelerating development in a few months and generating valuable knowledge about impact and adoption. Finally, they also allow citizen science interventions that can generate visibility and presence in spaces of interest to BSC.

Typically, public experiments last two to five days with audiences from hundreds to tens of thousands of people. The process includes a pre-event period of production and experience design, and a post-event analysis and presentation of results in appropriate venues (conferences, papers, or internal reports).

The **INSTITUTIONAL PROGRAM** will ensure that the outcomes of the lab's activities are visible through exhibitions, installations, live shows or performances, and public programs, strengthening the role of BSC in the community by presenting these activities in collaboration with cultural institutions and organizations. These projects can start from residencies and public experiments, or be a direct commission from outside organizations.

This program is the culmination of the collaboration model between creatives and the Lab, adding a collaborating cultural institution (museums, art and culture centers, festivals, theatres, operas, and more) that can present the project to the public within its own programme.

We will start from current collaboration agreements to establish stable relationships at local, national, and international level, like with CCCB, Museo del Prado, Sónar Festival, or Ars Electronica. We will establish new agreements strategically considering the visibility, projection capacity, and assets of each organization.

GOVERNANCE

5.

The lab will operate as an ecosystem composed of multiple interconnected roles:

- **CORE TEAM:** At the laboratory core will be a dedicated team of researchers, engineers, and creative technologists with experience in our interdisciplinary methodology. This core team, including production, coordination, and funding specialists, will lead projects, support collaborations, and train other members of the institution.
- **BSC COMMITTEE:** An internal board composed of representatives from participating BSC departments will provide strategic guidance and ensure alignment with institutional priorities.
- **AFFILIATED RESEARCHERS:** A broader network of trained researchers and technical staff across BSC will participate in projects and activities. Through training programs, workshops, and collaborative initiatives, this network will progressively expand, enabling the methodology to spread organically throughout the institution.
- **INTERNATIONAL ADVISORY BOARD:** An external advisory board composed of internationally recognized figures in science, technology, and the arts will provide strategic guidance, visibility, and connections. This board will meet periodically to review progress and support long-term development.
- **CULTURAL PARTNERS:** The lab will also maintain permanent strategic partnerships with cultural institutions, festivals, museums, and industry. These strategic partners will host residencies, collaborate on projects, partner on European Projects, and provide platforms for experimentation and dissemination.

DATA STEWARDSHIP AND RIGHTS POLICY

Institutions that invite artists and creative practitioners to work closely with its data, computational systems and research processes require developing governance frameworks to avoid reproducing extractive patterns in which institutions accumulate data, models, and capabilities while individual contributors retain little agency over how their work is used, stored, or commercialized. The BSC Creative Intelligence Lab is committed to building a stewardship model and governance structure from the outset grounded in transparency, reciprocity, and the progressive recognition of contributors' rights.

The lab will develop a clear data stewardship policy that defines, from the moment a collaboration begins, what forms of data may be generated, how they may be used, who retains rights over derived models or outputs, and under what conditions these materials may be shared externally or applied commercially. Artists, audiences, and other contributors will therefore be treated as co-stewards of the knowledge they help generate, rather than as sources of data to be extracted. This approach aligns the lab's research practices with emerging principles of responsible AI, open science, and ethical data governance, and forms a core element of the lab's institutional mission.

Carbolytics, Joana Moll commissioned by Aksioma in collaboration with BSC and in partnership with The Weizenbaum Institute + Sónar +D, Ljubljana (Slovenia) (2022, Domen Pal).



ENVIRONMENTAL RESPONSIBILITY

The BSC Creative Intelligence Lab operates within an institution that has made environmental responsibility a central dimension of its research mission. The work of the Barcelona Supercomputing Center in areas such as climate modelling, its participation in the Destination Earth initiative, and the operation of the MareNostrum 5 supercomputer—powered by renewable energy and designed to reuse waste heat to warm its facilities—reflect a strong institutional commitment to minimizing the environmental impact of advanced computing infrastructure..

The Lab extends this commitment to its own activities. It recognizes that creative and cultural production increasingly relies on computational processes whose environmental footprint is often overlooked. The training of AI models, large-scale rendering, and the operation of real-time interactive systems all carry energy costs that must be acknowledged and addressed.

The lab will therefore develop a transparent framework for measuring and reporting the environmental impact of its projects, making this data visible to collaborators, partners, and the public. Where technically feasible, it will seek to minimize unnecessary computational expenditure in its research and production processes. Rather than viewing environmental accountability as a constraint, the BSC Creative Intelligence Lab treats it as a productive challenge—one it intends to explore in dialogue with the artists, technologists, and scientists who participate in its research ecosystem.

2021

00:00



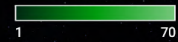
Jan 4

Temporal resolution: 15 min.

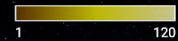
Aerosols

ICON-HAM-lite

Carbonaceous aerosol



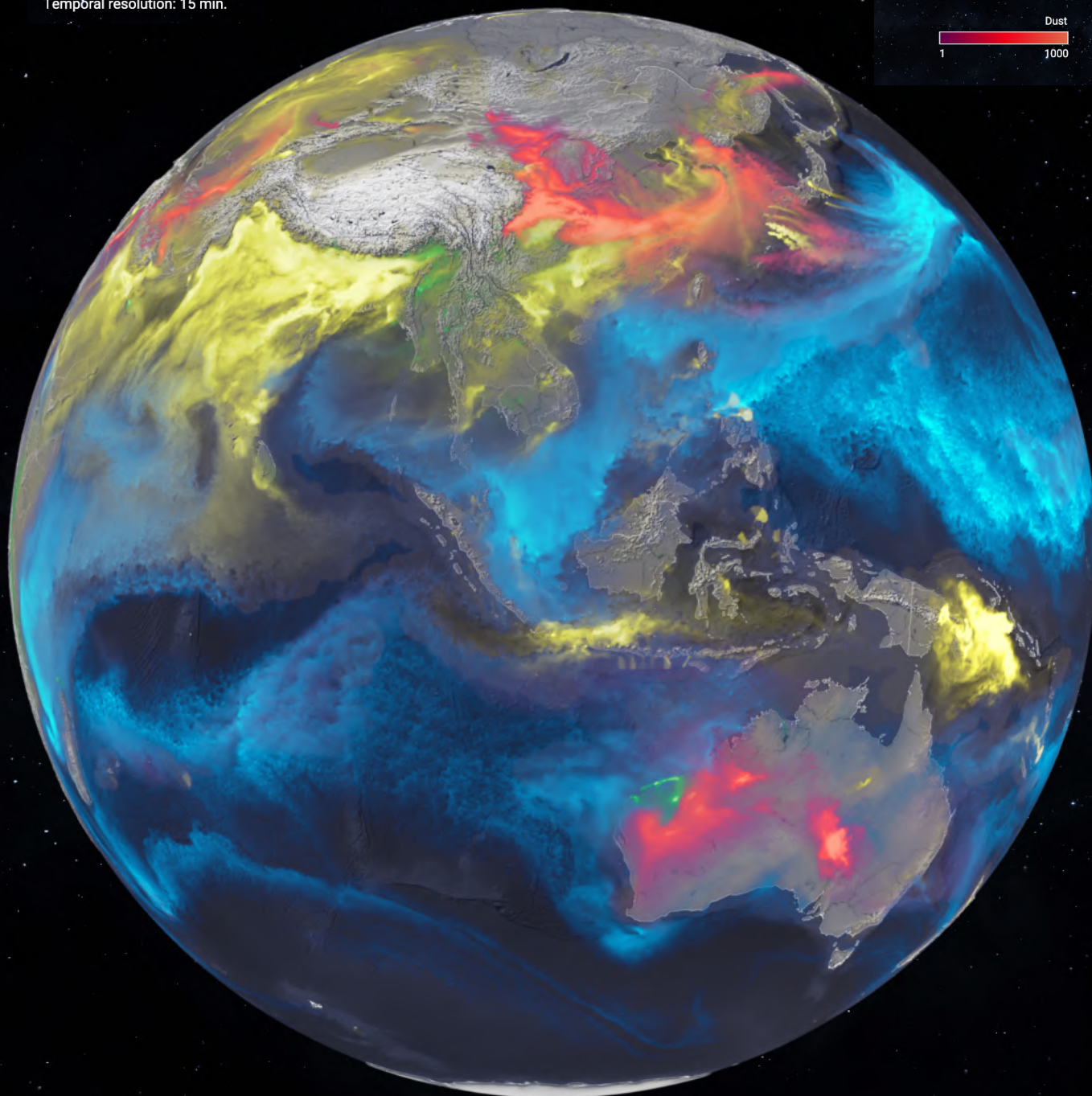
Sulfuric aerosol



Sea salt



Dust



CONTINUITY AND AMBITION

The BSC Creative Intelligence Lab is designed to be sustainable over the long term. Its methodology is based on a self-reinforcing cycle in which exploratory research generates capabilities that lead to funded projects, partnerships, and applications. These, in turn, support further research. This approach has already demonstrated its effectiveness, with relatively small investments in creative research generating substantial returns in funding, innovation, and institutional visibility.

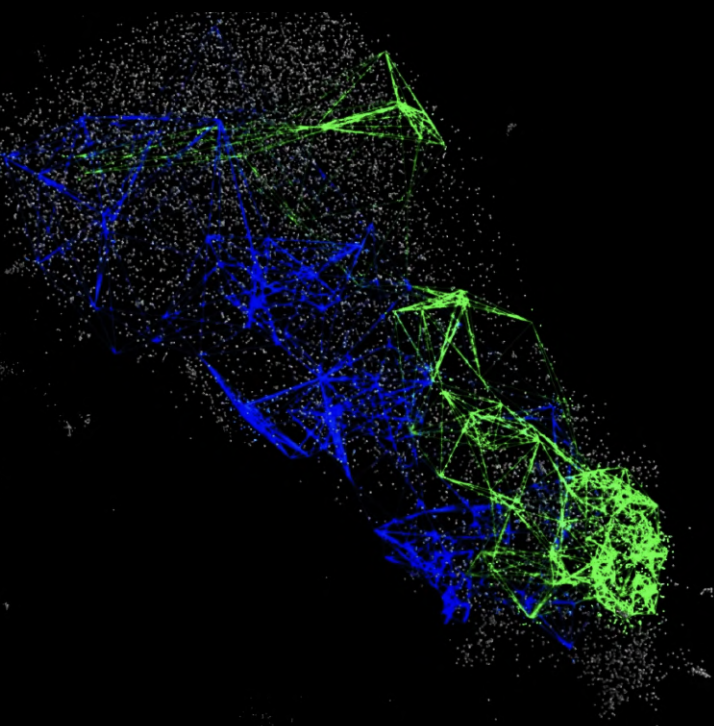
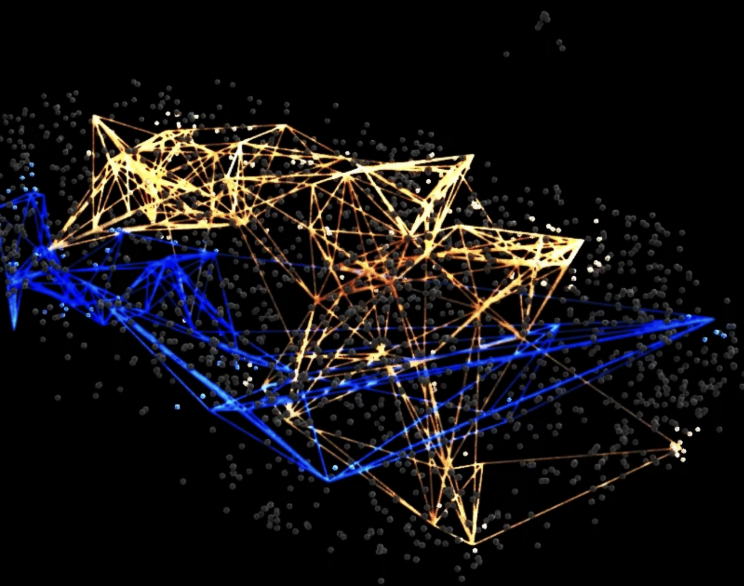
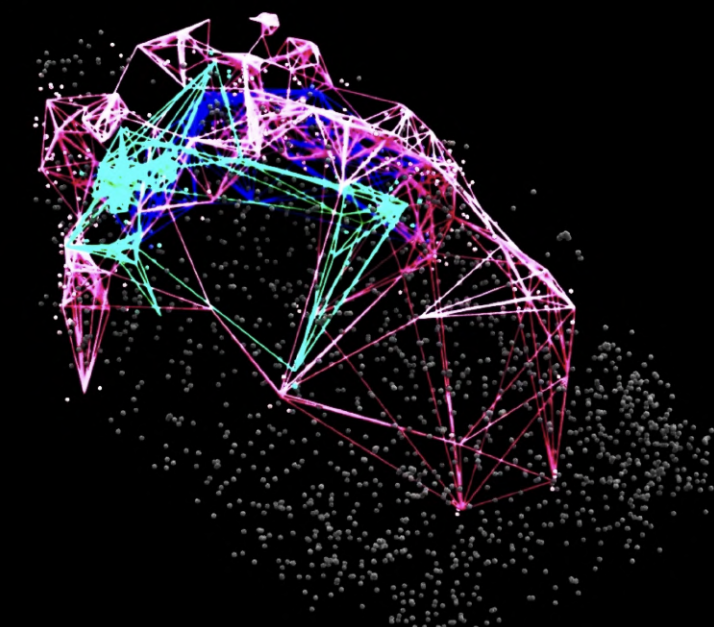
Over time, the lab will diversify its funding sources. In addition to competitive public funding, it will develop partnerships with private organizations and philanthropic entities. This mixed funding model will provide long-term structural stability and align the lab with leading international institutions. Finally, the lab will expand its funding portfolio by securing support from new European and international programs.

The lab's ambition is to significantly expand its scale and impact within the next two to three years. It will progressively involve all BSC departments in its

activities, through residencies, experiments, training programs, and collaborative initiatives. The number of researchers and collaborators directly engaged in its activities will grow substantially. Starting from a single one in its first year, the number of residencies and collaborations will increase steadily, establishing a continuous program of interdisciplinary research. Internally, the lab will establish dedicated spaces within BSC for exhibitions, experimentation, and public engagement, making creative and technological research visible within the institution.

Creative collaboration will take place across the full range of technology readiness levels. While exploratory collaborations will drive fundamental innovation, applied collaborations will contribute directly to the development of improved technologies, products, and services. On a broader stage, the **lab** will play a **leading role** in the **Creative Intelligence Alliance**, contributing to **international collaborations** and **joint initiatives**.

6.



In parallel, the BSC Creative Intelligence Lab will engage with the creative communities to work on some of the hard issues surrounding the advance of technology today, such as what are the data policies artists and AI companies should agree on, or how to measure and continue improving the mitigation of the environmental impact of novel technologies.

The lab will establish the **EXASCALE Program for High Performance Computation (HPC) and the Arts**, a structured framework for residencies and interdisciplinary research. This program will connect creative practitioners with HPC researchers to explore the artistic and scientific potential of large-scale computation, artificial intelligence, and emerging technologies.

Through these efforts, the lab will establish itself as a leading center for interdisciplinary innovation, shaping the future relationship between creativity and computation.

THIS DOCUMENT WAS AUTHORED BY:

FERNANDO CUCCHIETTI

JOSÉ LUIS DE VICENTE (FAST)

WITH CONTRIBUTIONS FROM:

SOL BUCALO

PAULA FERNÁNDEZ

ALEX GIL

GRAPHIC DESIGN:

SOL BUCALO

WITH CONTRIBUTIONS FROM:

RAQUEL BARRACHINA

PAULA MENDEZ

GUILLERMO MARÍN

PROOFREADING:

SOL BUCALO

PAULA FERNÁNDEZ

TOMÁS ANDRADE

GUILLERMO MARÍN

BSC, MARCH 2026



Barcelona
Supercomputing
Center
Centro Nacional de Supercomputación