



Knowledge  
*creates*

value

Christian Doppler  
Forschungsgesellschaft



“If the CDG didn’t exist, we’d have to create it.”

In recent years I have heard this statement or similar ones many times from stakeholders in academia and business. The CDG has firmly cemented its place in the range of funding organizations in Austria and innovative companies have a policy of using and developing the funding schemes open to them as members of the CDG: Christian Doppler Laboratories and Josef Ressel Centres. The importance of excellent research units and innovative companies is particularly clear in times of crisis, such as Covid-19, and even more so in the periods of recovery afterwards.

The benchmark figures on page 13 summarize the CDG’s strengths in application-oriented basic research in a single image. The CDG’s basic research has a high impact and a very high proportion of its publications come from scientists working at companies together with their colleagues at institutes of higher education. The CDG’s performance in innovation is also first-rate, as shown by the number of times publications from CD Laboratories and JR Centres are cited in patents. I am absolutely certain that these indicators of performance are fully in accord with the strategic goals of our stakeholders and shareholders and clearly show the importance of our contribution to science and innovation in Austria.



**Univ.Prof. DI Dr Dr.h.c.mult. Martin Gerzabek**  
President of the Christian Doppler Research Association



Fit for the future with science and innovation

Research and innovation play a key part in ensuring future prosperity in Austria. Without research and innovation we would not be able to face crises such as the Corona pandemic or challenges such as the threat posed by climate change. The innovation power of our companies and the knowledge of our scientists are pillars for our path to the future.

The Christian Doppler Research Association has a unique way of stimulating the collaboration between excellent scientists and innovative companies. It is no coincidence that the CDG funding scheme is accepted as European best practice for the joint activities of science and business and that it is our flagship programme for research that benefits the region.

Funding the CDG’s research units enables excellent basic research that is undertaken with concrete applications in mind and that perfectly matches current needs. By being open to all areas and by addressing the research to the demands of the most innovative companies we can guarantee that topics relevant to the future are picked up and researched from an early stage. As examples, the fields of digitalization and life sciences, changing energy trends and the circular economy have been in the focus of the research at Christian Doppler Laboratories and Josef Ressel Centres for many years.

**Univ.Prof. Dr Martin Kocher**  
Federal Minister

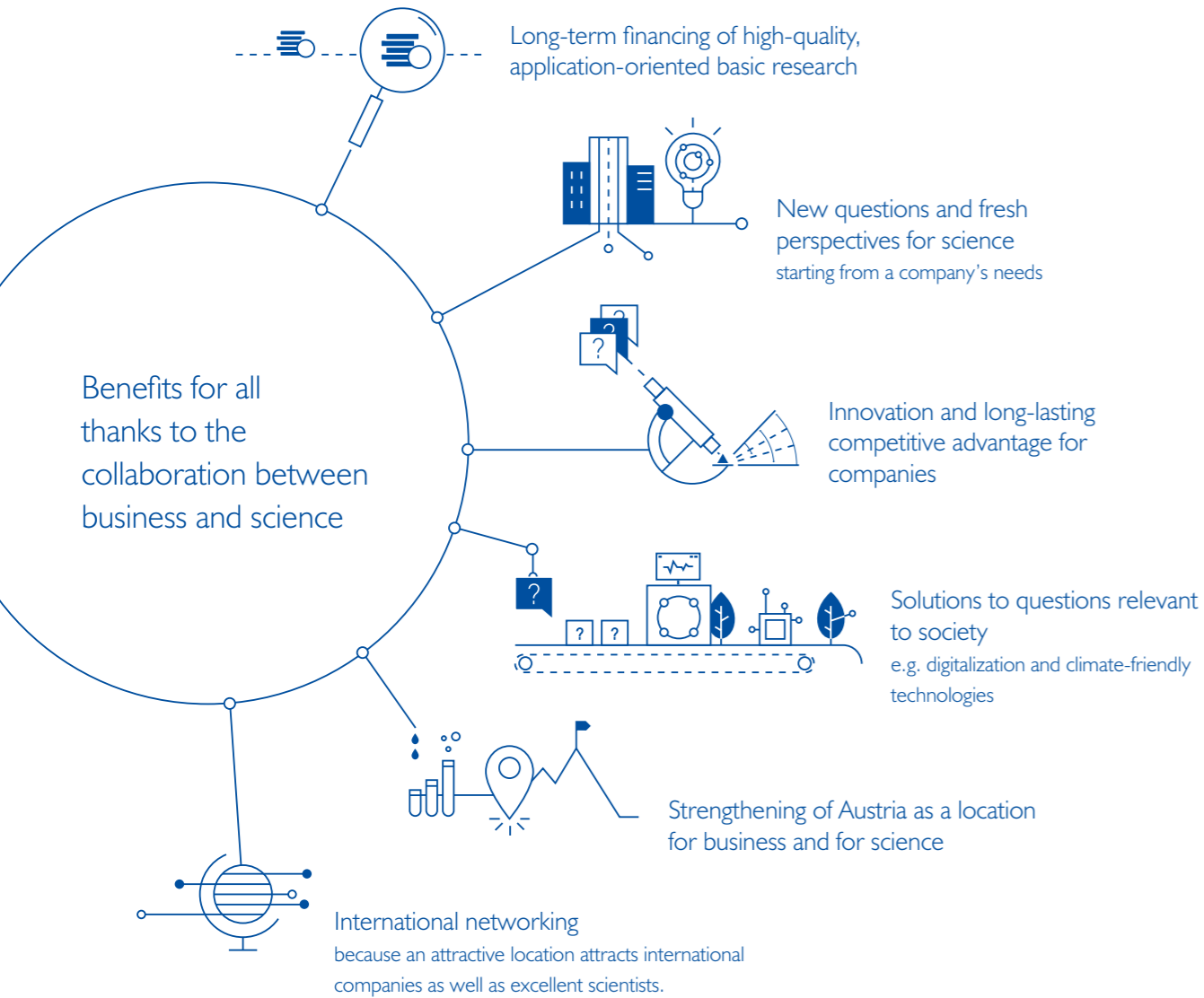
New knowledge and innovation with the Christian Doppler Research Association



Funding from the public purse also comes from the Austrian National Foundation for Research, Technology and Development

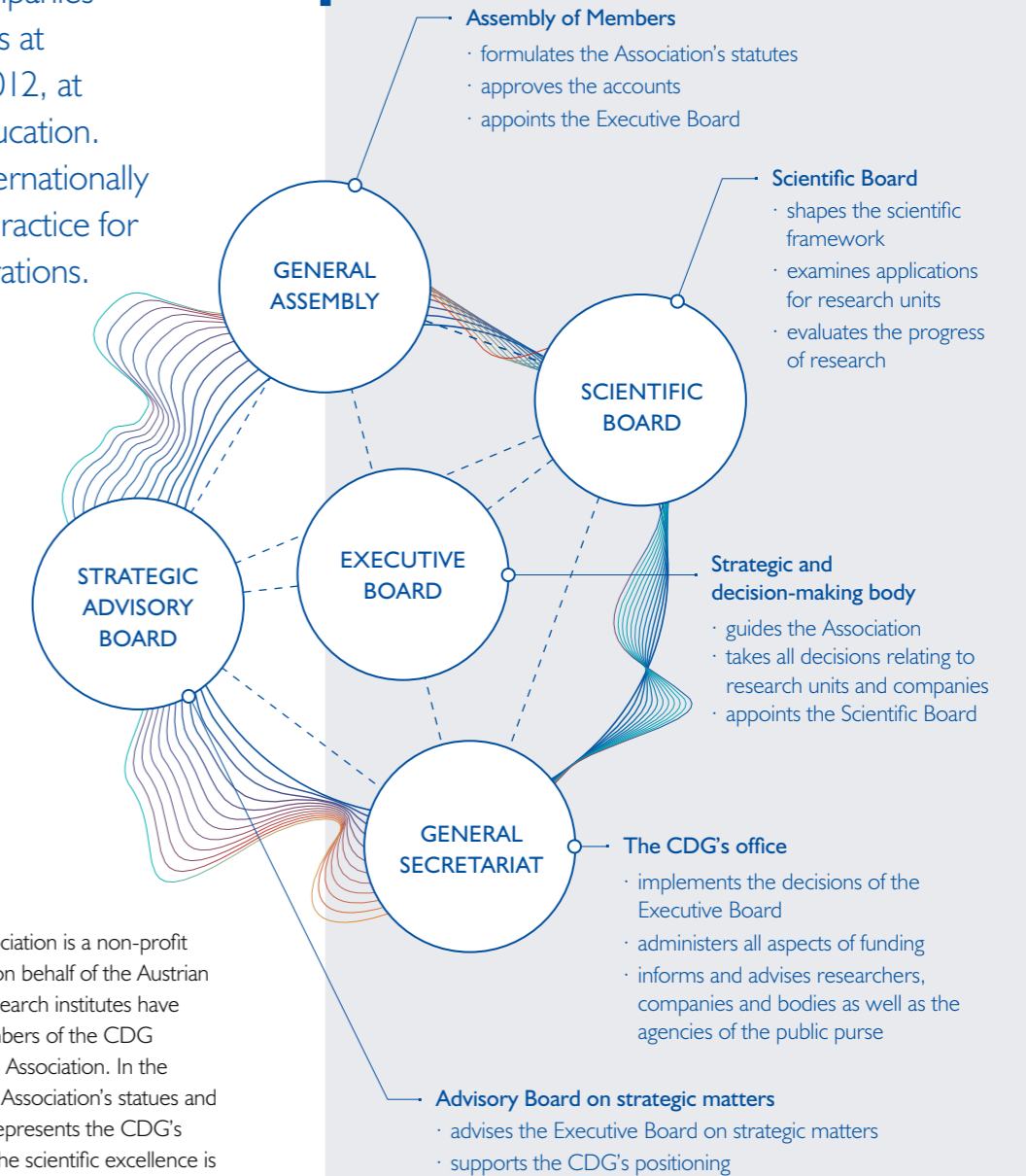
# Why the CDG?

- Excellent science
- Application-oriented
- Innovation
- Strong location



From 1995 the Christian Doppler Research Association has been promoting the collaboration between innovative companies and outstanding scientists at universities and, from 2012, at universities of higher education. Its funding scheme is internationally recognized as the best practice for promoting such collaborations.

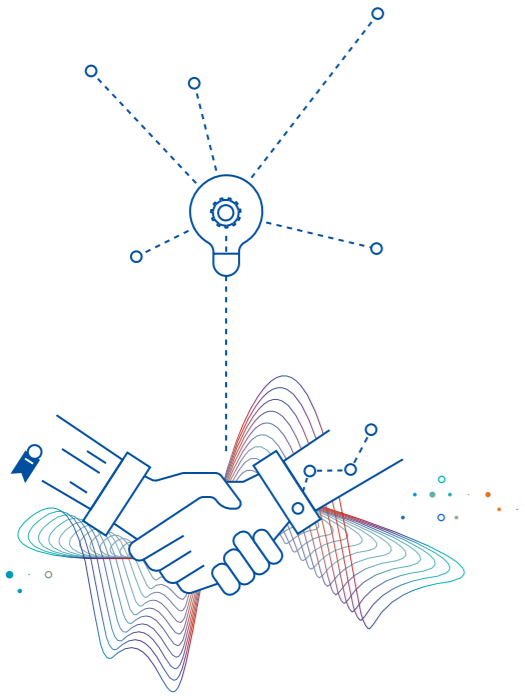
## Organizational structure



### Partners and organization

The Christian Doppler Research Association is a non-profit organization and administers funding on behalf of the Austrian government. Both companies and research institutes have important roles. Companies are members of the CDG and thus they essentially comprise the Association. In the General Assembly they formulate the Association's statutes and appoint the Executive Board, which represents the CDG's strategic and decision-making body. The scientific excellence is guaranteed by the CDG's Scientific Board, which coordinates international peer reviews and evaluations.

# Breeding ground for innovation



**The Christian Doppler Research Association enables long-lasting collaborations between science and business:**

Christian Doppler Laboratories (CD Labs) carry out application-oriented basic research at universities and non-university research institutes.

Josef Ressel Centres (JR Centres) perform a similar type of research at universities of applied sciences.

Long-term collaborations between science and business represent the basis for leadership in innovation. The Christian Doppler Research Association can look back on twenty-five years of experience and creates a stable environment: quality assurance by an internationally recognized evaluation procedure, flexibility in research and security for all those involved thanks to a clear legal framework.

**The CDG's basic principles have applied to all research units since 1995:**

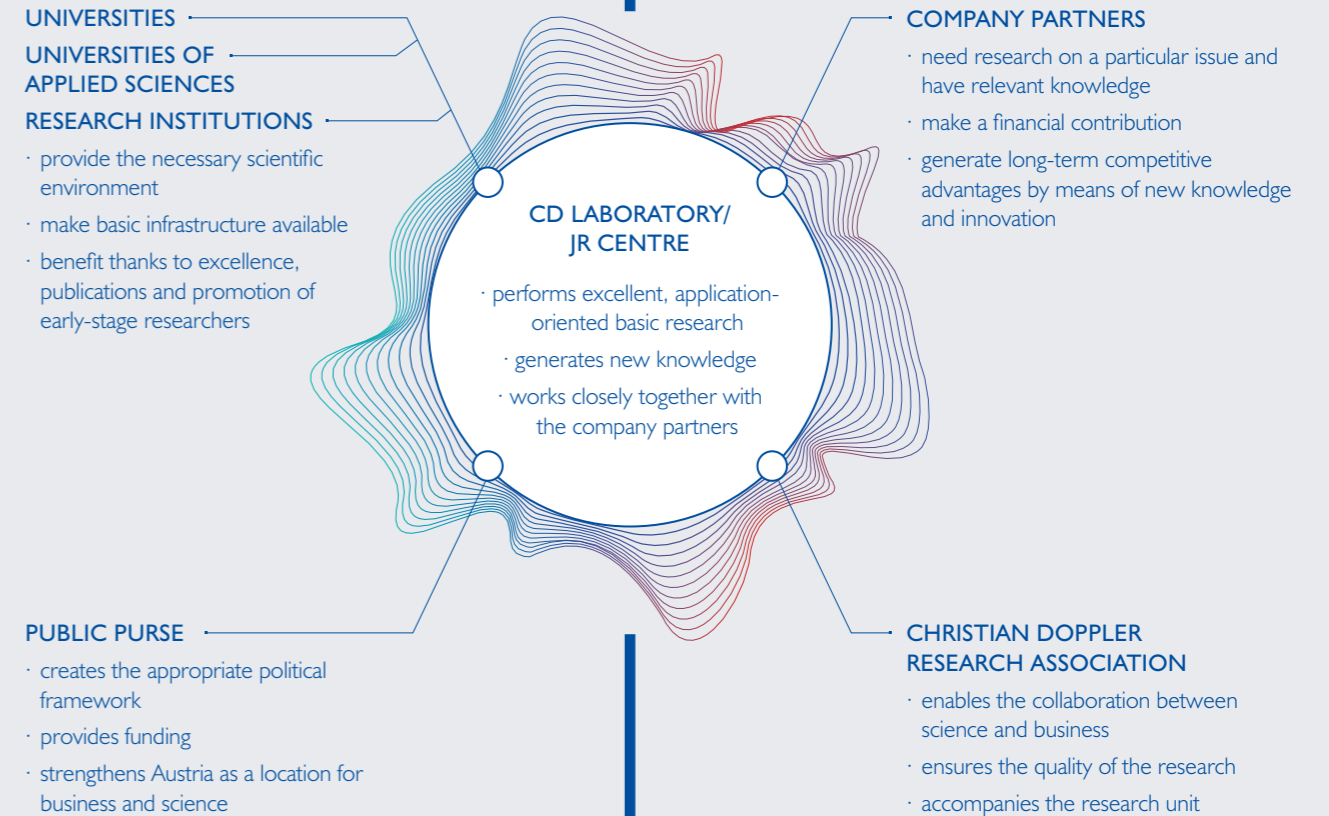
The research programme is based on company problems (bottom-up).

The research groups are embedded in their scientific environment.

The researchers are guaranteed scientific freedom.

The results include high-quality publications, patents and innovations.

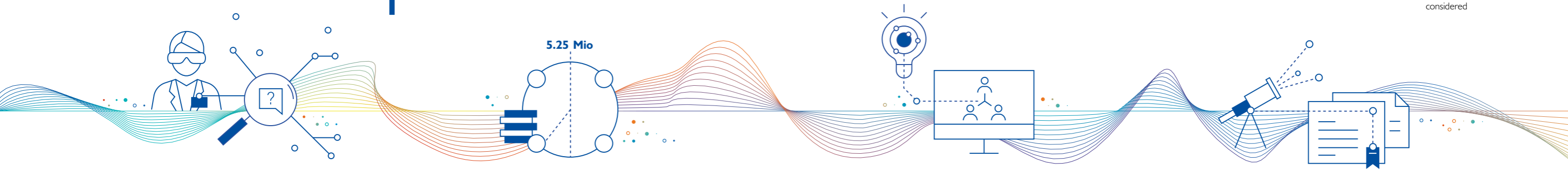
## The CDG's funding model



# CD Laboratories

# JR Centres

Who can submit an application?	Duration	Min. annual budget	Max. annual budget	Maximum budget for total duration	Nature of research	Proportion of scientific freedom	Proportion of experimental development	Support from public purse	Private support (company partners)
Highly qualified scientists at universities or non-university research institutions	7 years 2 years introductory phase 3 years first extension phase 2 years second extension phase	EUR 140,000	EUR 750,000	EUR 5.25 Mio.	Application-oriented basic research	Ca. 30% (basic research)	None	50% of the eligible costs With participation of SMEs 60% (in proportion to their involvement)	50% of the eligible costs With participation of SMEs 40% (in proportion to their involvement) No in-kind contributions considered
Highly qualified scientists at universities of applied sciences	5 years 2 years introductory phase 3 years extension phase	EUR 90,000	EUR 430,000	EUR 2.15 Mio.	Application-oriented research	Ca. 20% (build-up of skills)	None	50% of the eligible costs With participation of SMEs 60% (in proportion to their involvement)	50% of the eligible costs With participation of SMEs 40% (in proportion to their involvement) No in-kind contributions considered



### Research topic and scientific freedom

A Christian Doppler Laboratory or a Josef Ressel Centre focuses on a topic from a company, which is addressed by outstanding scientists. To enable an in-depth approach to the research questions, the scientists are guaranteed scientific freedom in the use of 30% (20% for JR Centres) of the resources – the ideal conditions for excellent scientific advances and radical innovations that go well beyond pure developmental work in companies.

### Costs and legal conditions

Each of the CDG's research groups has a total budget of up to 5.25 million Euro, with an annual budget of up to 750,000 Euro. The public purse covers 50% of this amount, increasing to 60% if SMEs are participating. The rest of the budget comes from the membership fees paid to the CDG by the collaborating companies. Contract research is not eligible for support.

### Inventions and intellectual property

The exclusive rights to inventions or results that can be protected and that arise from a Christian Doppler Laboratory or a Josef Ressel Centre are transferred from the university or the university of applied sciences to the company if they relate to the specific area of the company's business that has been agreed upon by the company and the host institute. Publications from the CDG's research units are disproportionately highly cited in patents.

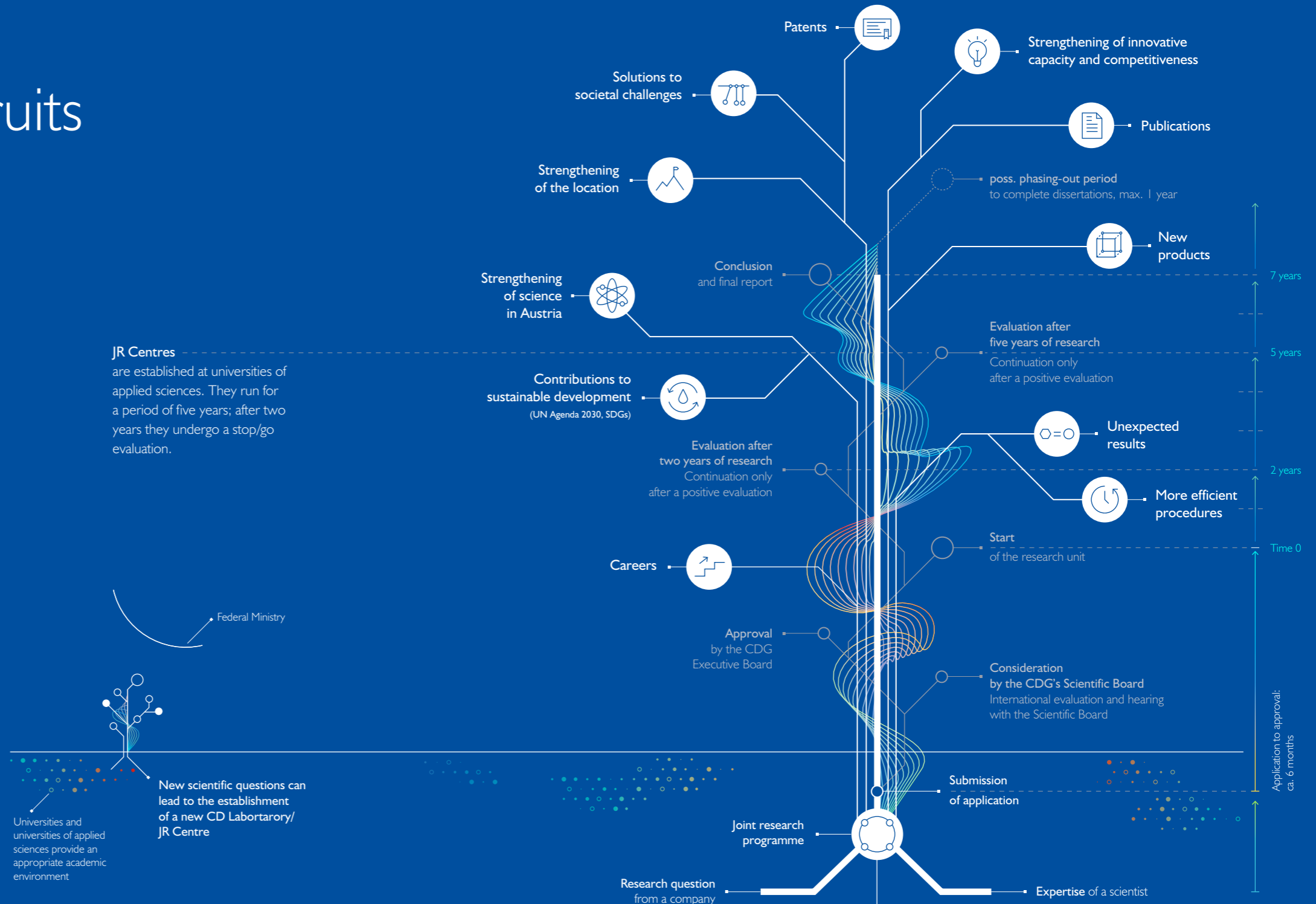
(source: Elsevier SciVal)

### Scientific excellence

Christian Doppler Laboratories and Josef Ressel Centres are locations of scientific excellence and are reviewed and evaluated by international peer review procedures based on the criteria of scientific excellence. The demanding procedure for approval is followed by a stop/go evaluation after two years and for CD Laboratories after five years. High-ranking scientific publications are required for a positive evaluation and are published with the agreement of the company partners.

# The CD model: Strong roots, many fruits

Two essential conditions must be met at the start of a CD Laboratory or a JR Centre. A company must have a concrete requirement to extend its knowledge on a particular topic and a scientist must be interested in undertaking basic research in this application-oriented area. The partners then develop a joint research programme and its fruits include publications, patents and careers. The CDG's funding model gives its research units a high degree of flexibility.

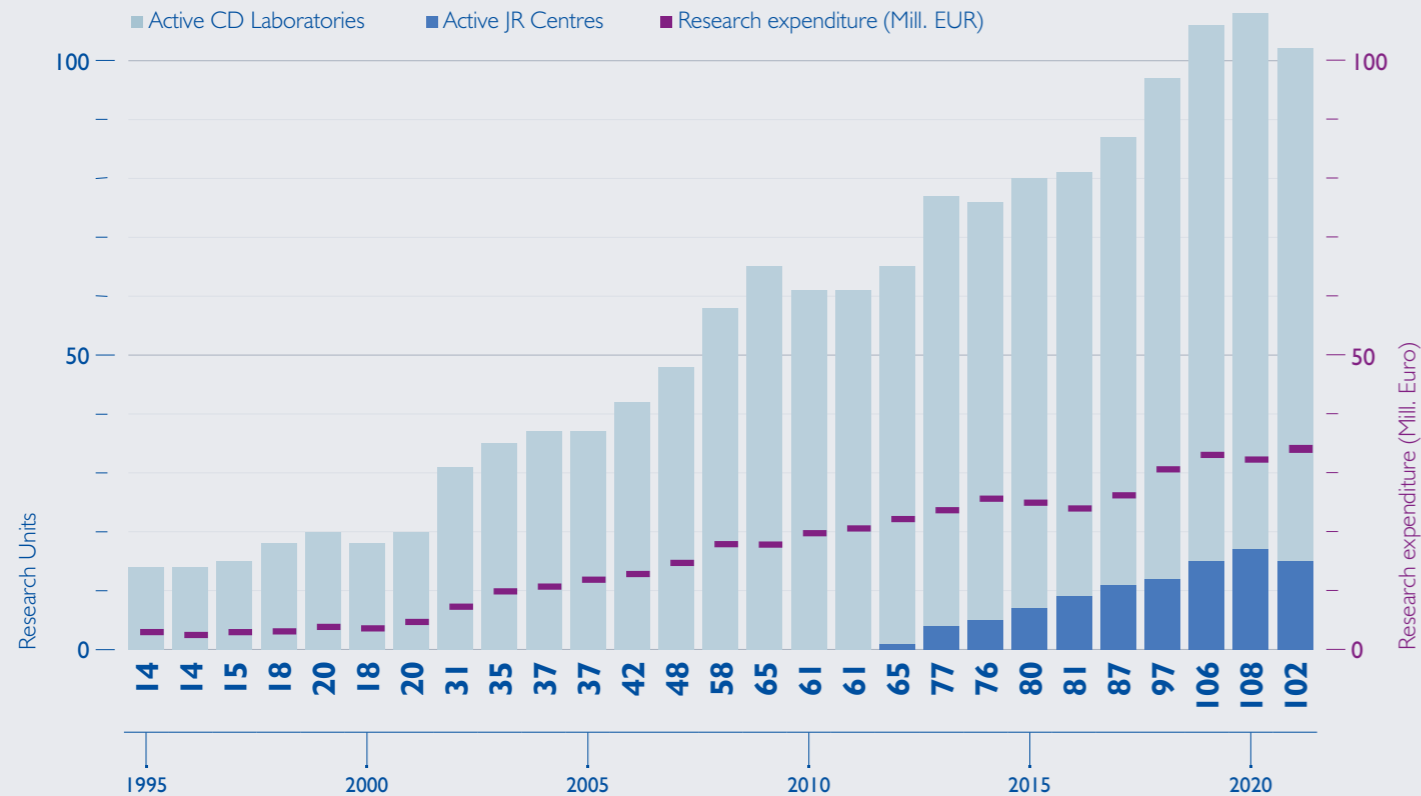


# Facts and figures

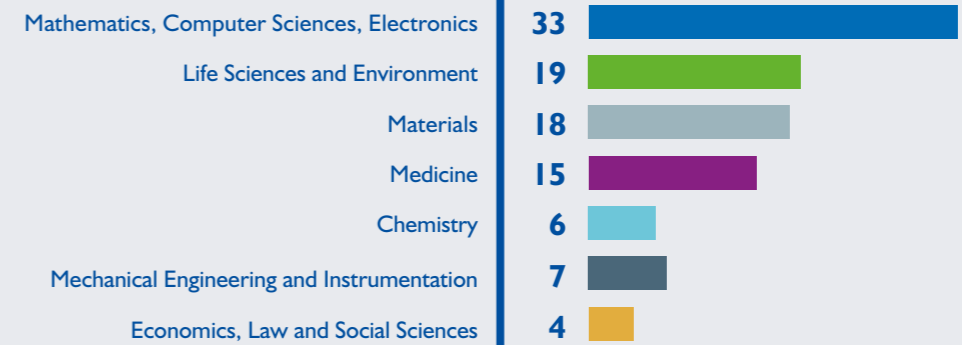
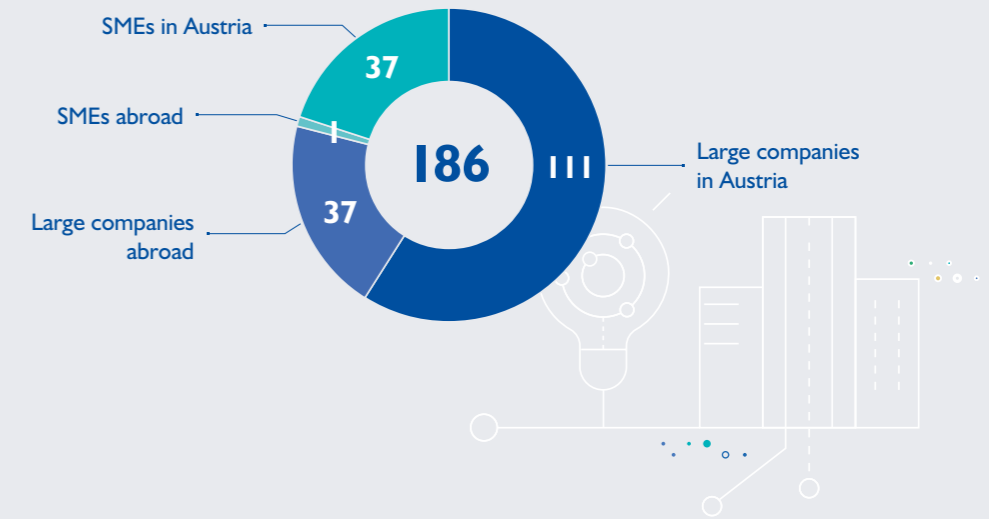
DEVELOPMENT of the Christian Doppler Research Association

**102** Active research units 2021

**33,5** Mill. Euro research expenditure 2021

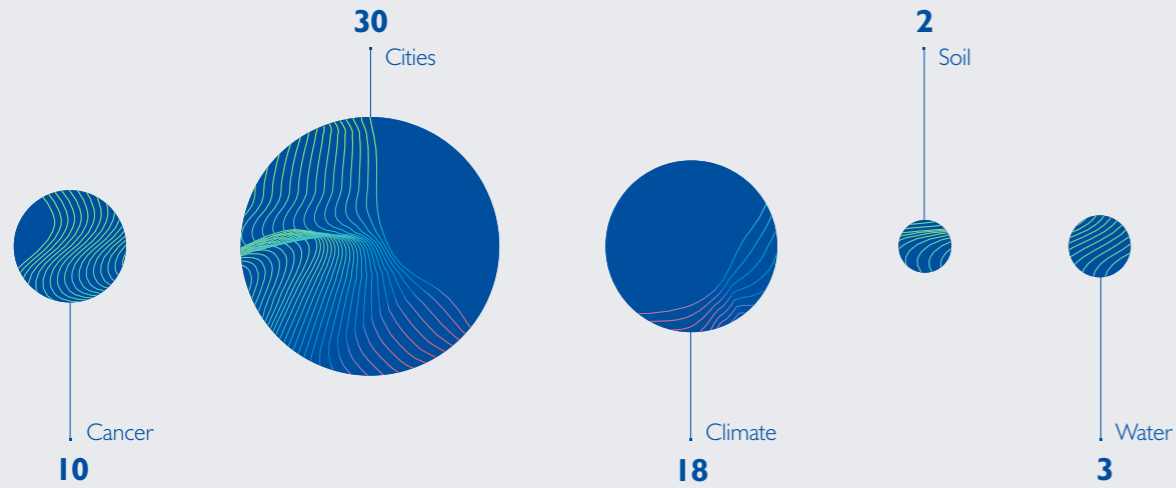


**186** ACTIVE COMPANY MEMBERS  
In 2021, 186 companies participated in the CDG's research units



**102** THEMATIC CLUSTERS of the research units in 2021

**63**  **CDG contributions to EU missions in 2021**  
 In the context of Horizon Europe, the five EU missions address some of the greatest challenges of our time. Many research units of the CDG are working on one or even more of these missions.  
Individual research units can be assigned to multiple missions.



 More than **460** peer-reviewed publications in 2021

 Around **1,000** presentations at scientific conferences in 2021, including 200 invited lectures

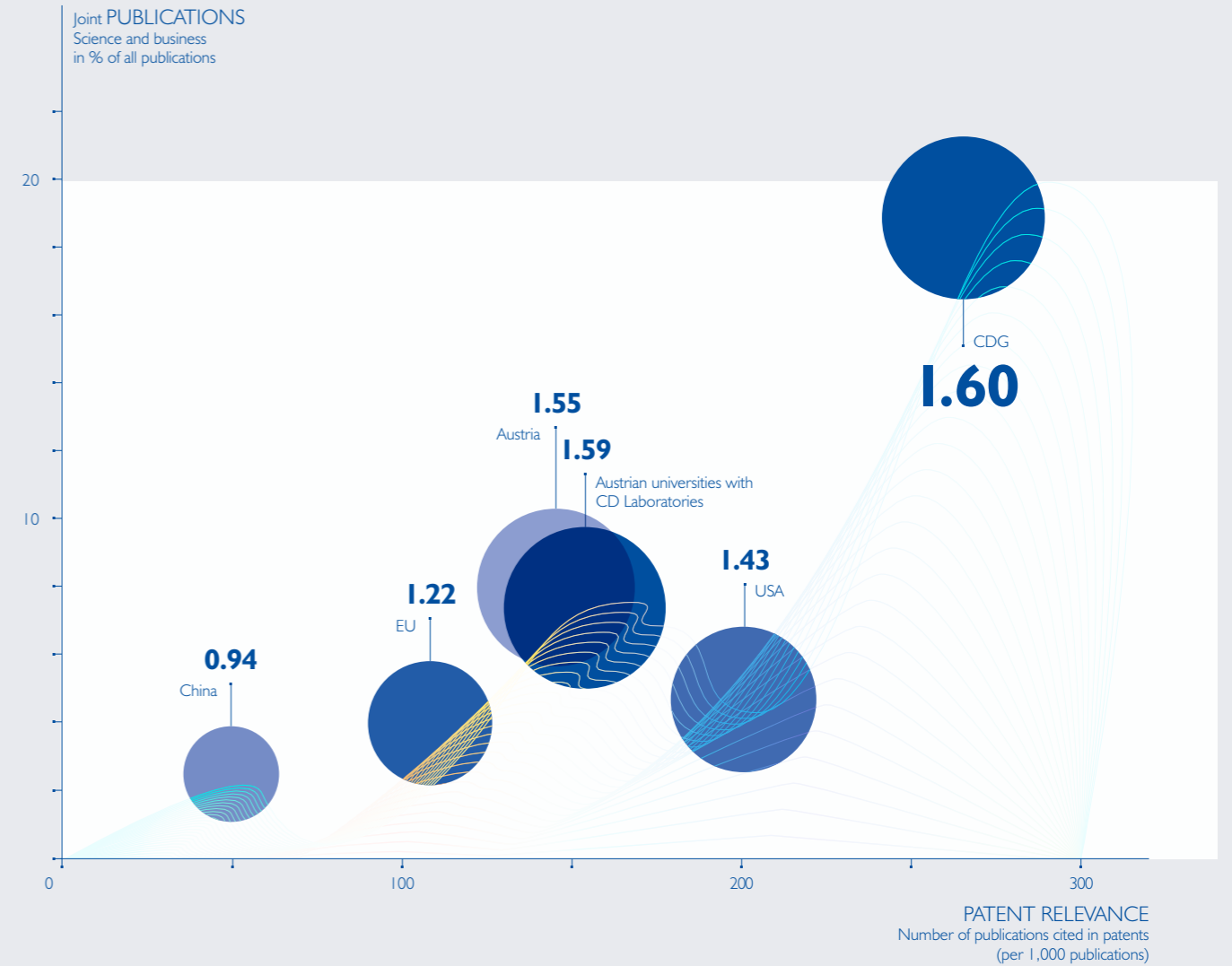
 An average of **12** patents granted per year

We hit our  **targets**

→ highest numbers of joint publications between science and business

→ Patent relevance: 155 of 1,000 publications are cited in patents, an internationally leading figure

→ Publications of CD Laboratories and JR Centres are extremely highly cited (field-weighted citation impact = 1.60, corresponds to the diameter of the circle)





# Small particles, large effects

**CD-Labor for  
Particulate Flow Modelling**

**Head**

Assoz.Univ.Prof. Dr Stefan Pirker;  
University of Linz

**Operation**

01.01.2009 – 30.04.2016

**Commercial partners**

Primetals Technologies Austria GmbH,  
voestalpine Stahl GmbH, voestalpine Stahl  
Donawitz GmbH, ThyssenKrupp Resource  
Technologies GmbH, RHI Magnesita GmbH,  
Borealis AG, PLAN-SEE SE

**Thematic clusters**

Mathematics, Information Science,  
Electronics

**Added value for the companies**

Whether in regard to optimizing transport and distribution or the processing of granular and powdery materials (voestalpine Stahl Donawitz, RHI Magnesita), to redesigning facilities to make them more efficient (voestalpine, Borealis), to the extreme speeding-up of simulation processes (Primetals Technologies Austria GmbH) or to the particularly early elimination of inhomogeneities in production processes (PLANSEE), the added value is wide-ranging.

Tiny particles are everywhere. Sometimes they are welcome (such as polymer particles in chemical facilities) and sometimes they are dangerous (such as COVID-19 aerosols in the air) but in all cases it is extremely important that we understand how they behave.



**The topic**

Understanding particles flows and predicting their behaviour represents one of the greatest challenges in physics. The minute particles have a wide range of possible compositions and interact in a variety of ways, not only with one another but also with the gases and liquids through which they move, making predictions even more difficult. But research in the area has enormous potential, as particles and our approach to them have extremely important roles in areas as diverse as industry (for example in furnaces or in polymer production) and medicine (in the transmission of pathogens).

**The research question: where are you going, little particle?**

In his CD Laboratory, Stefan Pirker, the winner of the 2021 CDG Award, considered how particles move, interact and behave in

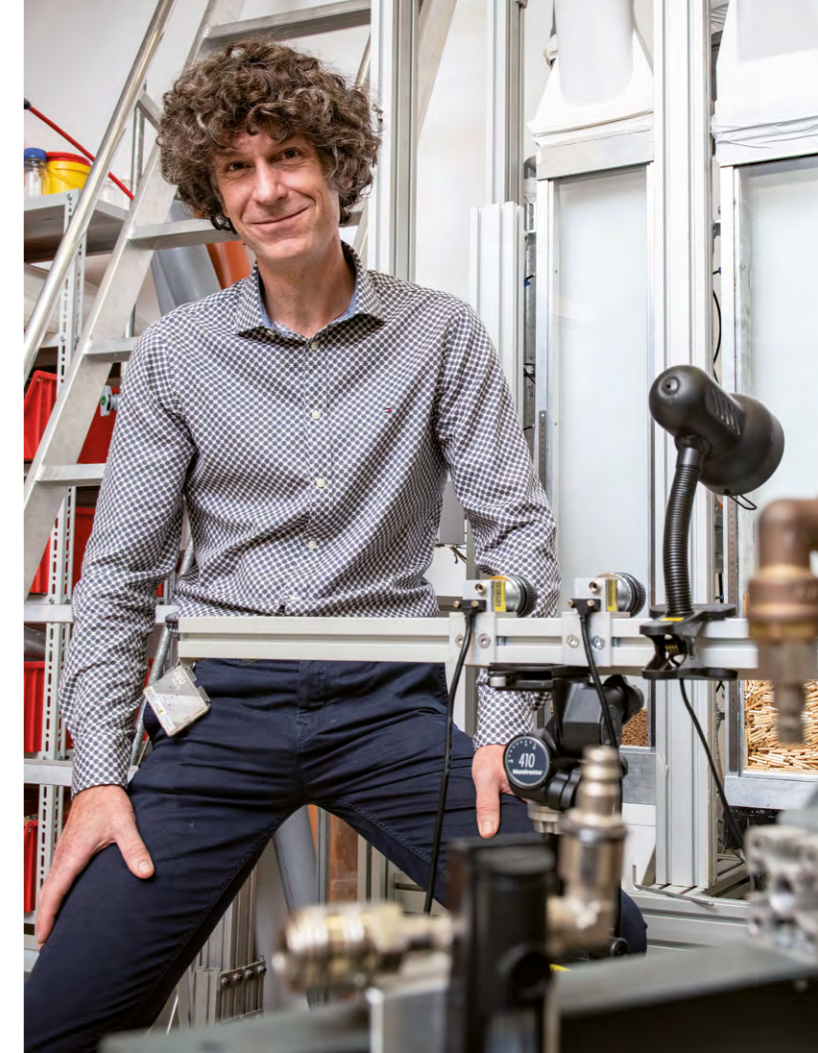
**Scientific challenge**

The movement patterns and behaviour of particles depend on their interactions not only with one another but also with the medium, such as air or various liquids, through which they move. The challenge of simulating complex particulate flows thus lies both in the underlying physics and in the need for developing efficient calculation procedures and should on no account be underestimated. However, if a project of this kind is successful, as was the work of Stefan Pirker, the simulation technology can be used in a wide variety of ways for the benefit of industry, science, sustainability and health.

various situations. This type of basic research is particularly complex as a very wide range of framework conditions must be examined. Progress is absolutely dependent on a strong team, so Pirker worked together with six commercial partners in his CD Laboratory.

**Collaboration in the CD Laboratory**

Thanks to the ideal network with the commercial partners, and as the CD Laboratory for Particulate Flow Modelling was the perfect place for the work, conditions could not have been better for Stefan Pirker's undertaking, which started in 2009. The results have been spectacular: the group used new methods in big data and artificial intelligence to assemble a basic framework for the data-assisted calculation of complex particulate flows. The procedure is highly efficient and thus gives results many times faster than previously possible – even in real time.



**Results**

The programme to calculate flows has led – and is continuing to lead – to significant advances, not only for the industrial partners (see p. 14, left) but also for the entire scientific community. It was made available open-source and gave rise to research projects on a range of topics throughout the world, including the calculation of flows of alluvial deposits in the sea (in Florida) and on limiting the spread of the corona virus at large-scale events by considering how pedestrians move (in Utrecht). Some projects even go beyond global boundaries, such as NASA's work to investigate the locomotion of the Mars robot Curiosity. Experience from all these applications helps further develop Pirker's method: the feedback loop produces continuous benefits to all sides.

# Where humans and technology meet

**CD Laboratory for Restoration of Extremity Function**

**Head**

Univ.Prof. Dr Oskar Christian Aszmann

**Operation**

01.01.2012 – 31.12.2018

**Commercial partner**

Otto Bock Healthcare Products GmbH

**Thematic Cluster**

Medicin

**Added value for the company**

The method of selective nerve transfer into other muscles has been refined and patients can now benefit from it as a standard of care, not only in the Vienna General Hospital. New rehabilitation concepts for TMR prostheses have been developed and are on the market and initial solutions to the problems of better pattern recognition will be marketed in 2019. The first steps towards products with an improved feedback function have been taken and two patents have been registered.

The development of thought-controlled prostheses needs not only technical perfection but also medical expertise. The remaining nerves and muscles must be connected so their signals can be used by high-tech prostheses.



**The topic**

Highly developed modern prostheses can perform a wide range of movements. But despite considerable technological progress, it is still vital that the human can control the prosthesis. From the start of the millennium the connection between human and prosthesis has been based on TMR operations (targeted muscle reinnervation): the nerves that transferred signals to the natural arm are connected to the remaining muscles at the site of the amputation. The prosthesis can recognize activation of the muscles and use the signals to perform appropriate movements. This makes operation of the prosthesis more intuitive – the nerves for hand movements stay the same.

**The research question: nerve transfer for intuitive control**

Putting this into practice requires wide-ranging and highly specialized medical knowledge. Where exactly do the nerve tracts run – and in which direction? And where are the muscles that can pick up the

**Scientific challenge**

The comprehensive care of patients with prostheses requires an interdisciplinary approach. The necessary knowledge ranges from the underlying anatomy and neurology through operational methods and robotics to appropriate concepts for rehabilitation. The first anatomists examined the position of the nerves in the arm as far as possible by means of dissection but modern anatomical and neurobiological research is also based on histological staining and new methods in immunohistology. As an example, a method developed in the CD Laboratory has enabled motor and sensory nerves to be distinguished from one another.

stimulation of the nerve and transmit it to the prosthesis? And how can the brain pick up signals that come back from the prosthesis, for example relating to how tightly an object is being held (feedback function)?

**Collaboration in the CD Laboratory**

Further development of the method requires close collaboration between prosthesis manufacturers and medical research: biological signals from nerves and muscles must be found and made useful. The prosthesis must pick up the biosignals in an appropriate way and there is a need for new rehabilitation concepts to enable the patients to use the full capabilities of their prostheses. In Prof. Aszmann of the Department of Plastic and Reconstitutive Surgery at the Medical University of Vienna, Ottobock has an ideal partner with extensive scientific expertise. In 2006 he became the first person – even then with the support of Ottobock – to perform the operation outside the



USA. In the meantime, a large-scale research network has grown up around the CD Laboratory and the company partner is fully integrated in it.

**Results**

The CD Laboratory and its network has produced extensive new knowledge on the position and function of the nerves that control arm movements. Ottobock is now able to offer prostheses that are highly controllable when connected to a TMR operation, able for example to recognize several signals to determine which precise movement to perform. New knowledge on the direction of stimulus transfer in the nerves is enabling fresh approaches to the feedback function. A large number of publications in top-quality journals attest to the success of the CD Laboratory, which was also recognized by the EU's award of an ERC Synergy Grant to Prof. Aszmann in 2018.

# Statements

“Christian Doppler Laboratories enable excellent basic science, celebrate success in the scientific community and transfer knowledge and know-how to society and business. A win-win situation for all who are involved.”

**Prof. Dipl.-Ing. Dr.techn. Dr.-Ing. h.c. Sabine Seidler**  
Chair of the Austrian Universities Conference and Rector of the Vienna University of Technology

“International referees and a Scientific Board made up of top-ranking scientists. It is a real honour for scientists to satisfy our review process and be able to head a CD Laboratory or a JR Centre.”

**Prof. DI Dr. Dr.h.c. Hans Irschik**  
Chair of the CDG's Scientific Board

“Excellence in application-oriented research. This is the goal of the JR Centres at the Universities of Applied Sciences. Research complexes are built up together with commercial partners and have wide-reaching effects in the immediate region and in society at large.”

**Mag. Ulrike Prommer**  
President of the Austrian Conference of Universities of Applied Sciences and CEO of the IMC University of Applied Sciences Krems

“New knowledge creates long-lasting competitive advantages. By collaborating with universities and universities of applied sciences, companies are investing not only in their own future but also in society.”

**Philipp von Lattorff**  
Strategic Advisory Board of the CDG, Manager of Beoheringer Ingelheim RCV GmbH & Co KG, Vice President of the Federation of Austrian Industries

“Collaboration of companies with science is difficult. The CDG creates the ideal conditions for it: outstanding quality thanks to a proven system for evaluation, security thanks to a clear legal structure and the guarantee of flexibility.”

**Dr Franz Androsch**  
Head of Research at voestalpine AG and First Vice-President of the CDG

“Excellent research that is relevant to the location and directed to the needs of the participating companies: this is what creates the jobs of tomorrow. The CDG and its research units are enabling the build-up of value chains that are strengthening Austria as a location for business.”

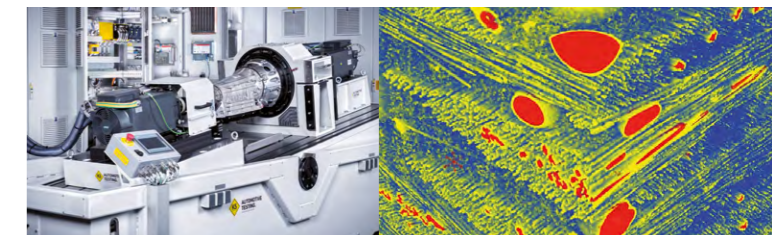
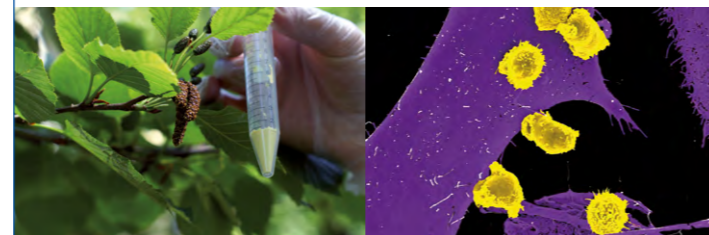
**Mag. Florian Frauscher, MLS**  
Head of Section II Business Location, Innovation and Internationalization in the BMDW

“The collaboration between science and business brings lasting competitive advantages for all who are involved. Austria can be proud to have the CDG and its internationally recognized best practice of this important type of collaboration.”

**Dr Maria Theresia Niss**  
Member of Austrian Parliament, Chair of Mitterbauer Beteiligungs AG and CDG-Strategy Board

“Autonomy, self-criticism and continuous improvement: this maxim is making the CDG an important pillar in a coherent innovation system that is based on the experience and knowledge of companies and scientists.”

**Dr Ulrike Unterer**  
Vice-President of the CDG and Department Head of Key Technologies in the BMDW



## IMPRINT

### **Publisher**

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### **Art Direction & Design**

Alexandra Reidinger Grafik Design

### **English translation**

Dr Graham Tebb

### **Photos**

p. 3: BMDW/Holey (left), Alice Schnür-Wala (right)

p. 18 left-right: Montanuniversität Leoben / Chair of Non-Ferrous Metallurgy, Kratochwill, Ferreira, Medical University of Innsbruck

p. 19 left-right: Borealis, Horauer, Kristl, Seibt & Co GmbH/  
Lichtmeister, FH OÖ Forschungs & Entwicklungs GmbH

### **Printed**

Der Schalk, Industriestraße 5, 2486 Pottendorf

Vienna, June 2022



[www.cdg.ac.at](http://www.cdg.ac.at)

