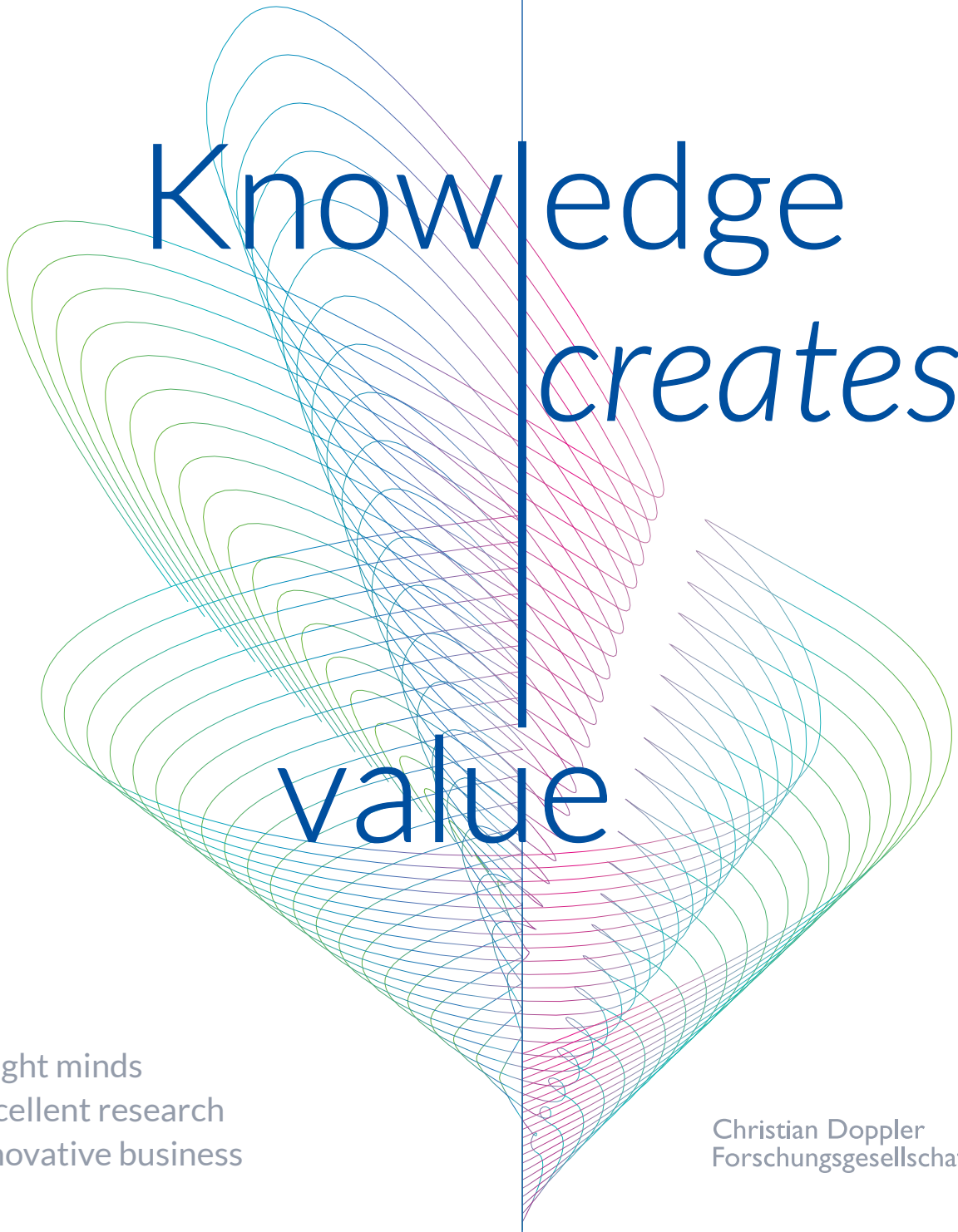
Knowledge *creates* value



Bright minds
Excellent research
Innovative business

Christian Doppler
Forschungsgesellschaft

New knowledge and innovation with the Christian Doppler Research Association

Federal Ministry
Republic of Austria
Labour and Economy

CD Laboratories and JR Centres are funding programmes of the Austrian Federal Ministry of Labour and Economy.

FTE NATIONAL FOUNDATION
RESEARCH | TECHNOLOGY | DEVELOPMENT

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

Fit for the future with science and innovation

Research and innovation play a key part in ensuring future prosperity in Austria. Only through research and innovation can we continue to expand Austria's strengths and be internationally competitive. 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

"If the CDG didn't exist, we'd have to create it."

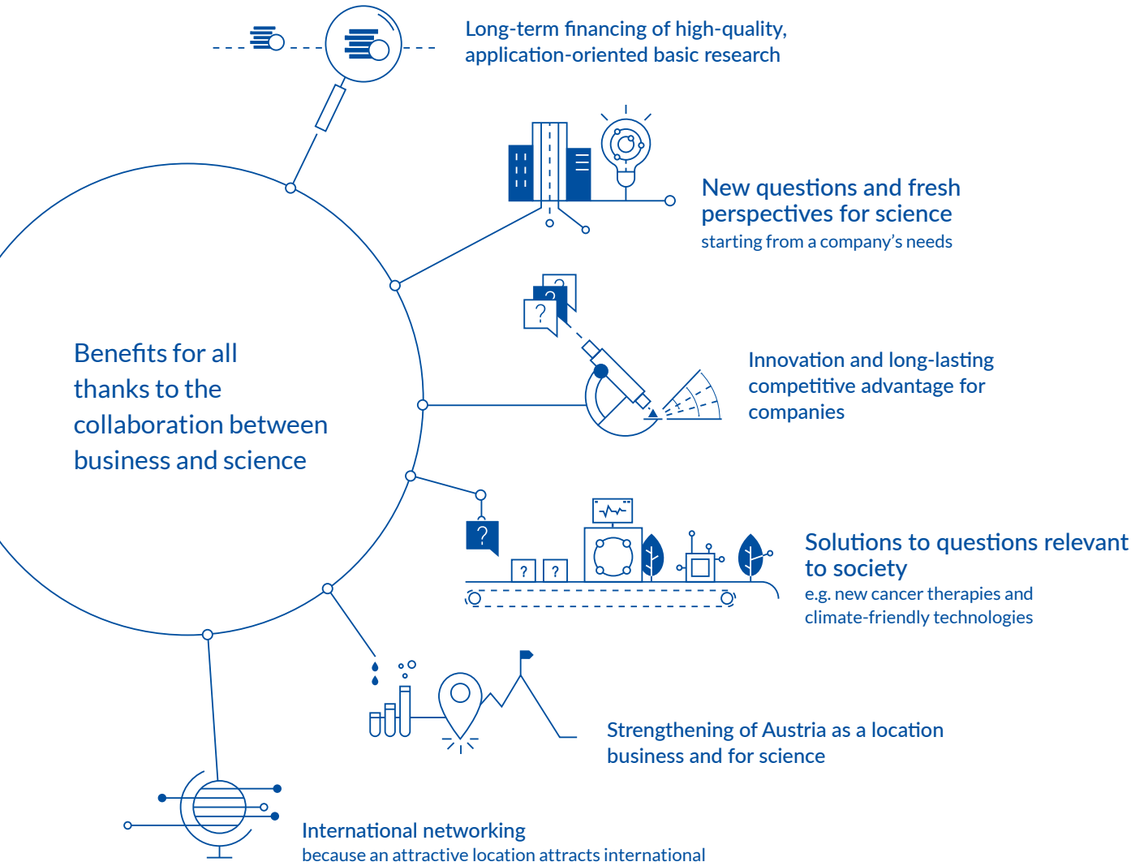
In recent years I have heard this statement or similar ones many times from stakeholders in academia and business. The CDG has firmly cemented its place in the range of funding organizations in Austria and innovative companies have a policy of using and developing the funding schemes open to them as members of the CDG: Christian Doppler Laboratories and Josef Ressel Centres. Current challenges such as the energy transition and the transformation to a circular economy show the importance of excellent research units and innovative companies.

The benchmark figures on page 13 summarize the CDG's strengths in application-oriented basis 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

Why the CDG?

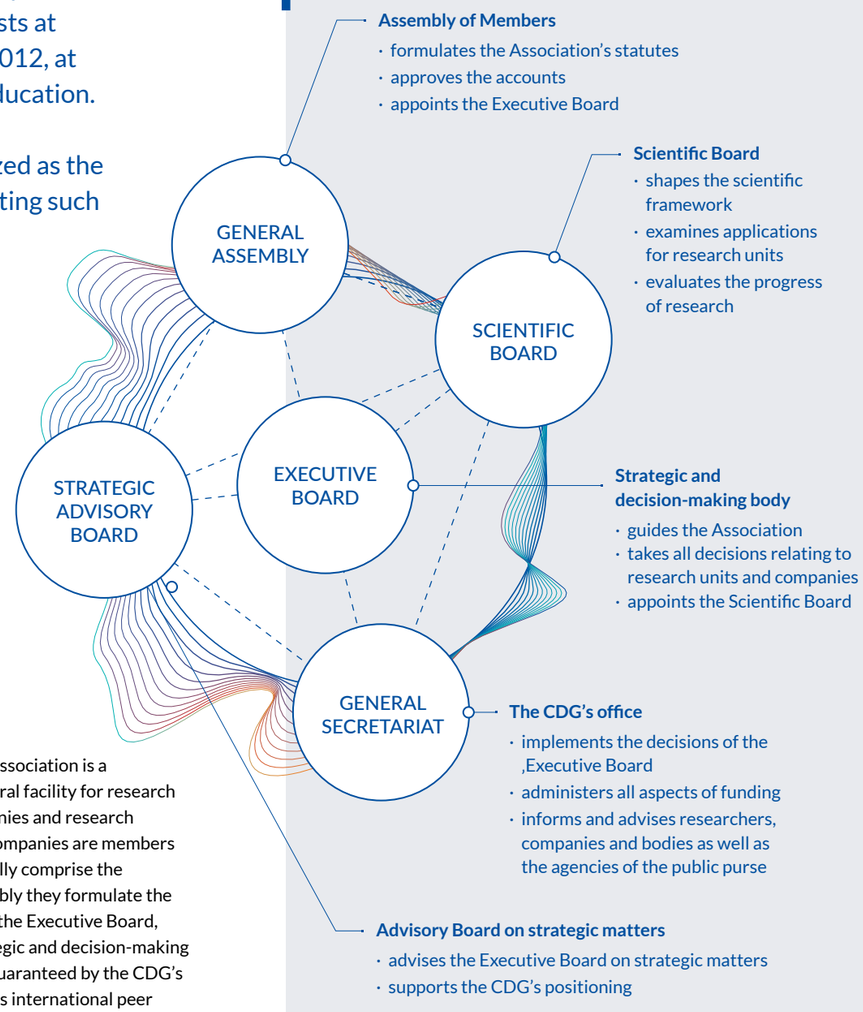
Excellent science
Application-oriented
Innovation
Strong location



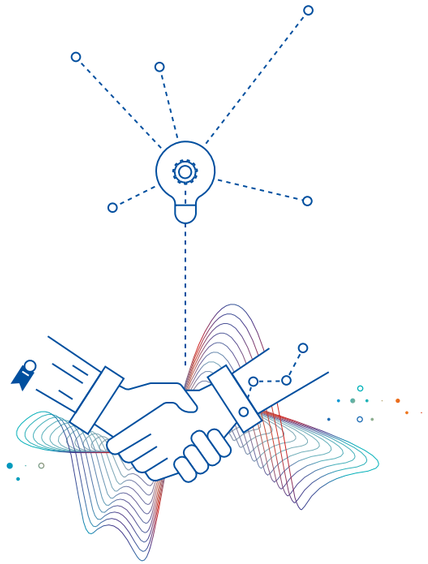
From 1995 the Christian Doppler Research Association has been promoting the collaboration between innovative companies and outstanding scientists at universities and, from 2012, at universities of higher education. Its funding scheme is internationally recognized as the best practice for promoting such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

Partners and organization
The Christian Doppler Research Association is a non-profit organization and a central facility for research promotion in Austria. 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 statues 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.

Organizational structure



Breeding ground for innovation



Long-term collaborations between science and business represent the basis for leadership in innovation. The Christian Doppler Research Association can look back on almost thirty 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 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) conduct application-oriented research at universities of applied sciences.

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

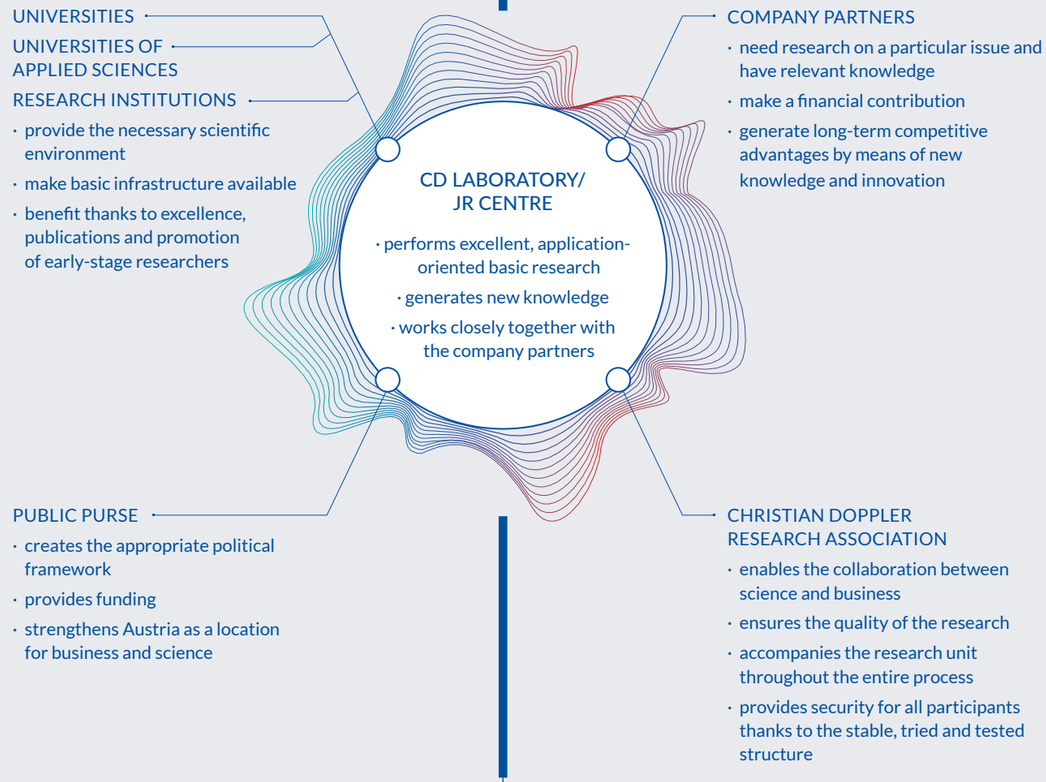
The research programme is based on company problems (bottom-up).

The research groups are embedded in their scientific environment.

The researchers are guaranteed scientific freedom.

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

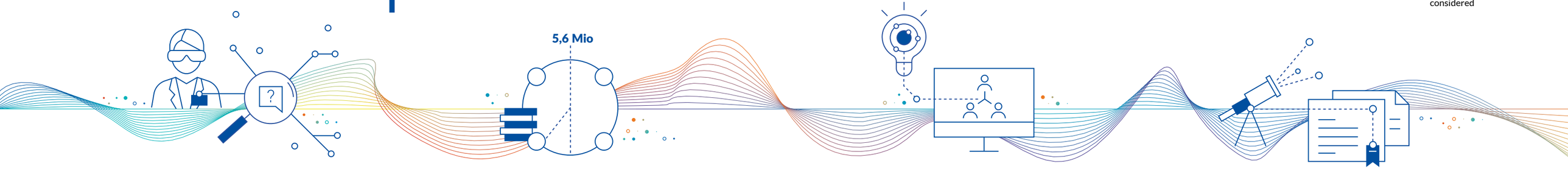
The CDG's funding model



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	2 years introductory phase 3 years first extension phase 2 years second extension phase 7 years	EUR 140,000	EUR 800,000	EUR 5.6 Mio.	Application-oriented basic research	Ca. 30%	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 460,000	EUR 2.3 Mio.	Application-oriented research	Ca. 20%	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.

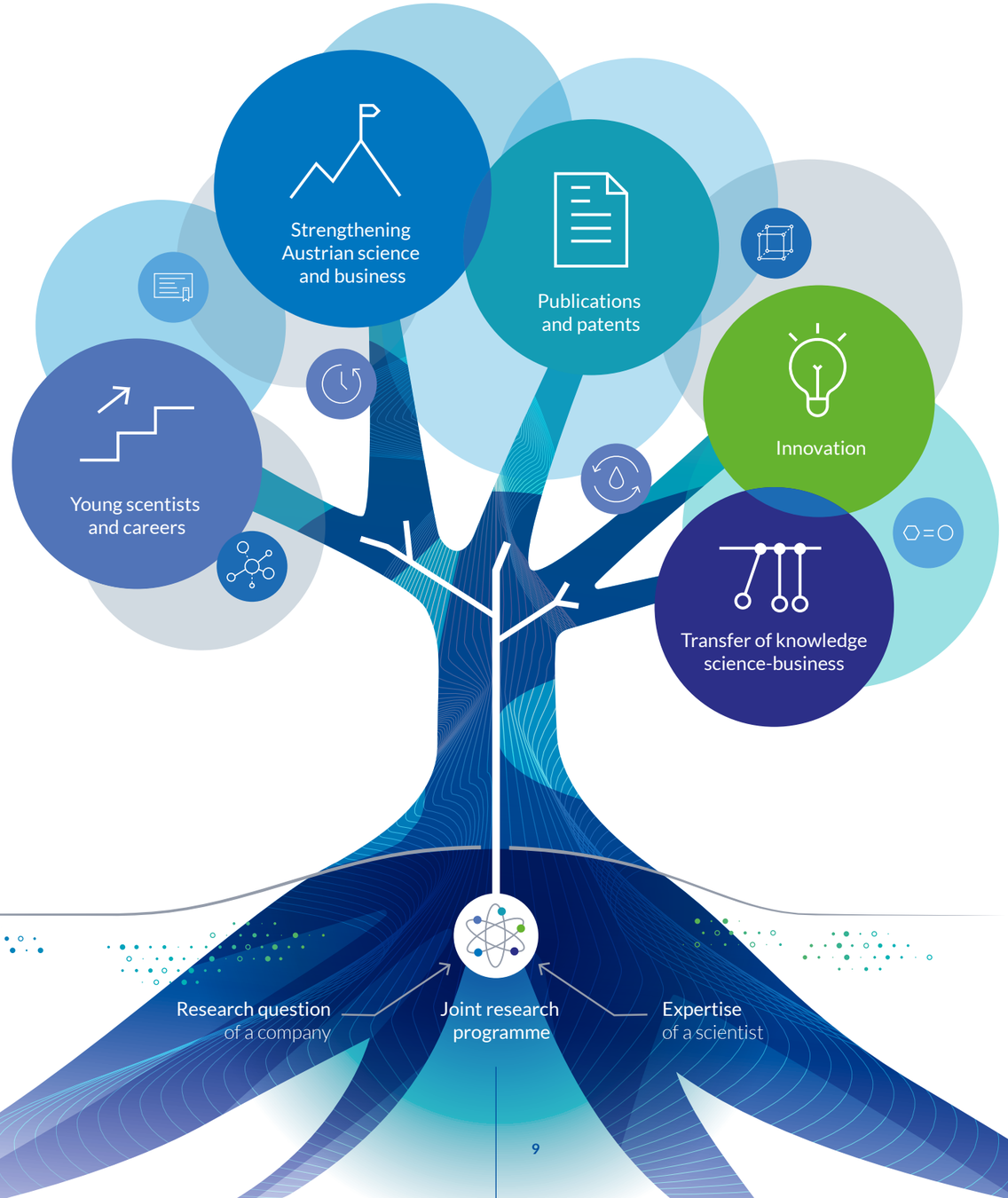
Costs and legal conditions
Each of the CDG's research groups has a total budget of up to 5.6 million Euro, with an annual budget of up to 800,000 Euro. The public purse covers 50% of this amount, increasing to 60% if SMEs are participating. The rest of the budget comes from the membership fees paid to 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.

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.

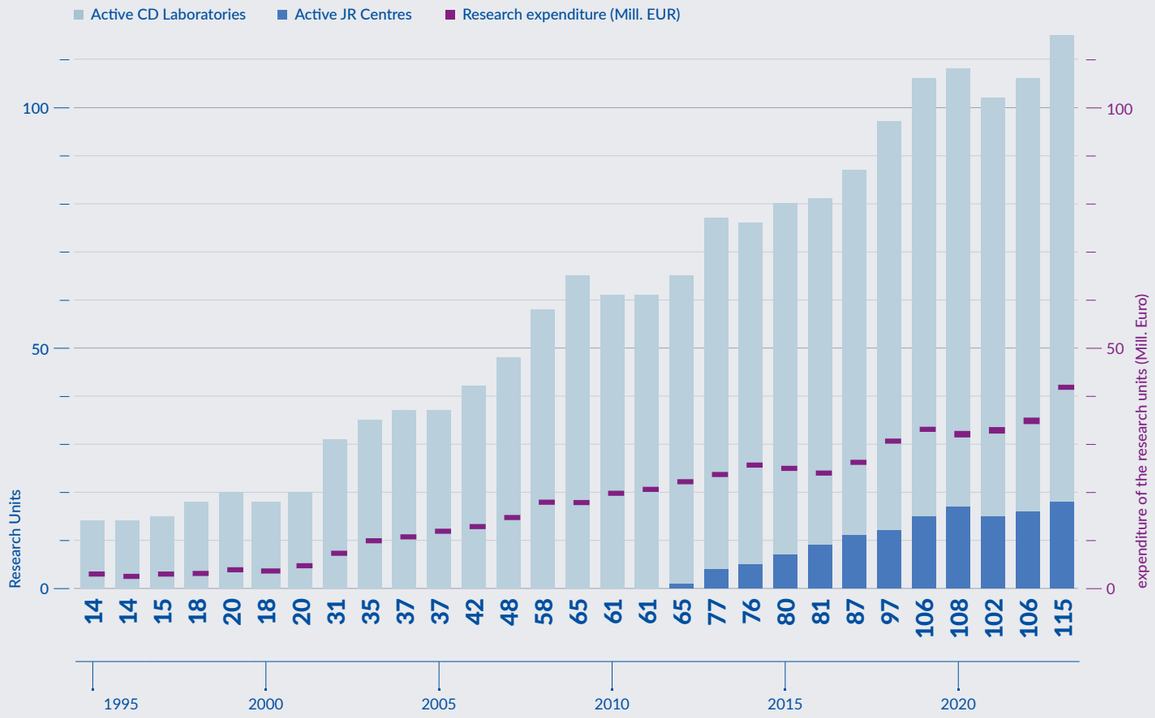


Facts and figures

DEVELOPMENT of the Christian Doppler Research Association

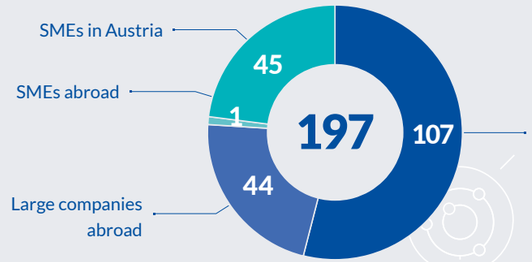
115 Active research units 2023

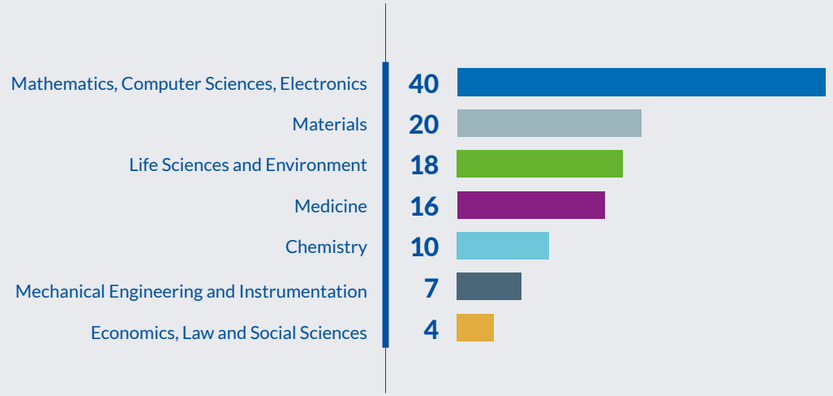
41.8 Mill. Euro research expenditure 2023



197 ACTIVE COMPANY MEMBERS

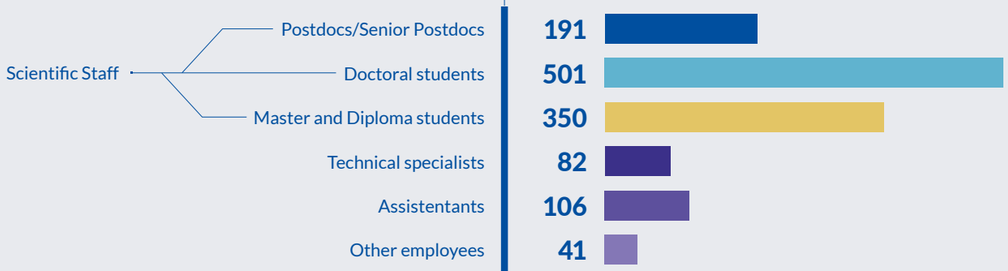
In 2023, 197 companies participated in the CDG's research units





115 THEMATIC CLUSTERS of the research units in 2023

1,271 EMPLOYEES
in Research Units of the CDG 2023,
1,042 thereof are scientific staff



Publications **430**
in periodicals with peer review

1,500 Participations in conferences
thereof **230** with invited presentation

300 Conference publications
with peer review

Patents and announcements of inventions **30**

Output

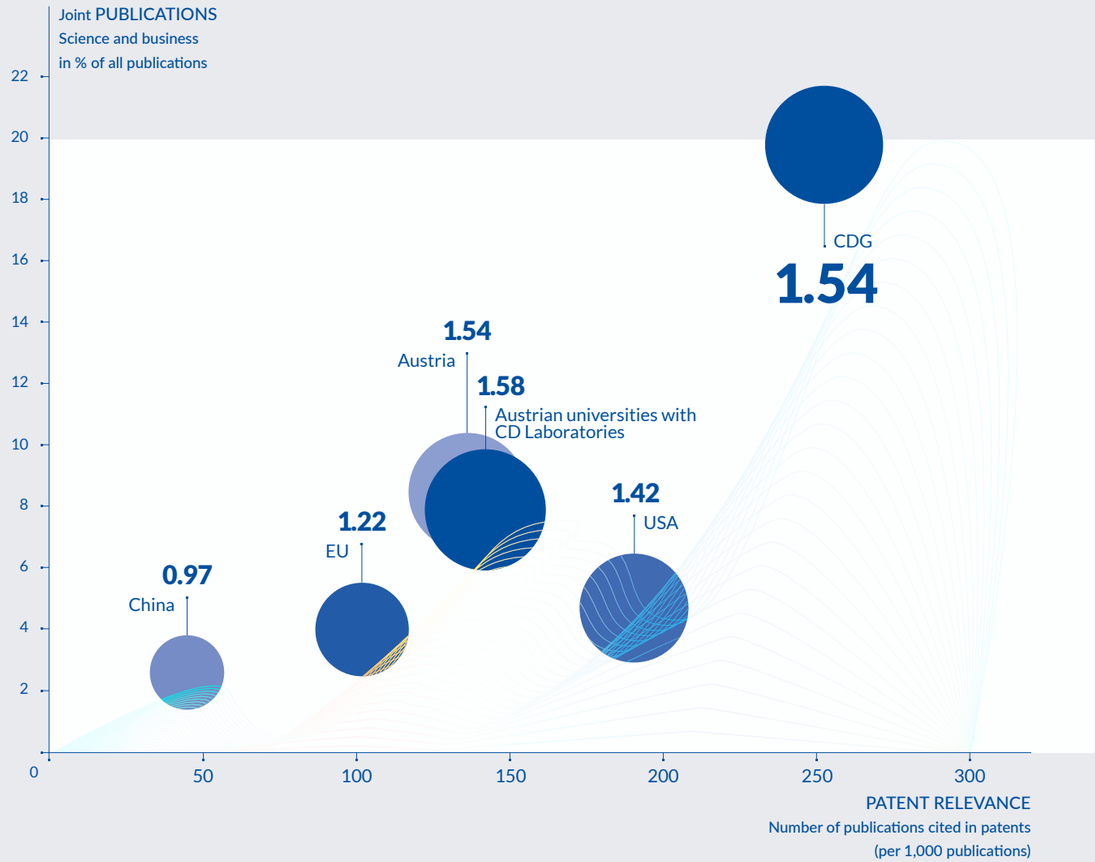
of the CD Laboratories and JR Centres 2023 (rounded)

We hit our targets

— highest numbers of joint publications between science and business

— Patent relevance: About 250 of 1,000 publications are cited in patents, an internationally leading figure

— Publications of CD Laboratories and JR Centres are very highly cited (field-weighted citation impact = 1.54, corresponds to the diameter of the circle, the global average for similar publications is 1.00)



Data: 2009–2022, Source: Elsevier*

SUCCESS STORY

Wafer-thin but highly effective

CD Laboratory for Advanced Coated Cutting Tools

Head
Priv.Doz. DI Dr Nina Schalk,
Montanuniversität Leoben

Operation
01.10.2017 – 30.09.2024

Commercial partner
CERATIZIT Austria Gesellschaft m.b.H.

Thematic Cluster
Materials

Added value for the company

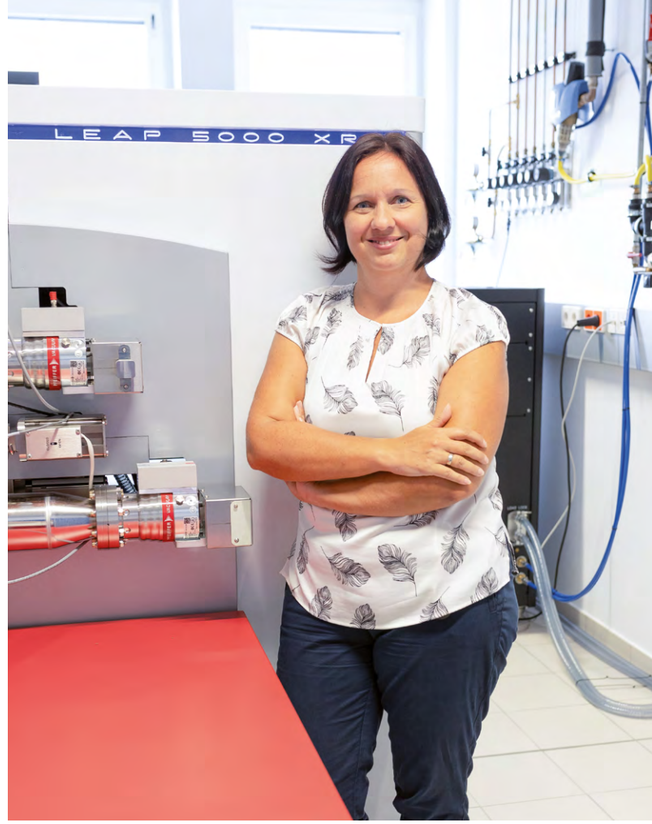
A concrete example of the value of the CD Laboratory's basic research to CERATIZIT Austria Ltd is the "dragon skin" coating, which was successfully brought to the market at the start of 2022. It is a newly coated type of hard metal for turning steel that not only has a longer service life but also features an indicator layer to show when it is heavily eroded. In this way, users can always see when they need to replace a tool and never have to do so too early or too late, which improves efficiency and sustainability.

When industrial production involves turning, milling and boring components, the process is bound to affect the tools. The microcosm conceals a fascinating possibility to counteract their wear and tear.

CDG Award for Research & Innovation 2023

Scientific challenge

For the preparation of the coatings, a so-called "pre-material" is evaporated in a deposition chamber and deposited on the tool to be coated. By altering parameters such as the composition of the pre-material, the pressure or the temperature, different coatings can be created that are only about 2–3 micrometres thick, about 16–25 times thinner than a human hair. It is extremely challenging, even with top-of-the-range equipment, to research these miniature landscapes of elements, phases, layers and crystals and to draw conclusions on material properties such as hardness, toughness, temperature resistance and oxidation.



The topic
So-called chipping tools, which gradually remove chips from unfinished parts until they take on the shape of an industrially usable component, are key in a wide range of applications. They play important roles in the automobile industry as well as in the production of turbines and engines. To maintain a chipping tool, and to ensure that it can be used as long and as efficiently as possible, it (or its hard metal core) is surrounded by tough, abrasion-resistant coatings. Working out the optimal type and arrangement of the coatings to protect a particular tool is so complicated that in the past it could only be done by trial and error.

The research question: coats and tales
Nina Schalk, Head of Laboratory and Winner of the 2023 CDG Award, is undertaking fundamental research into the smallest possible objects. How are the various elements arranged in the wafer-thin tool layers? How do they form crystals and how do they react to heat or oxygen? And what does all this mean for the hardness, fracture toughness and service life of the chipping tool? Many of the techniques the CD Laboratory is using to tackle these questions involve bombarding the material with electrons or X-ray beams to draw conclusions about the fine structure. The use of an atomic probe is particularly spectacular. Specially prepared thin tips of a few hundred nanometres are evaporated atom by atom and the atoms land on a position-sensitive detector, enabling the scientists to deduce which atom was located where. The result is a representation of the components of the layer at near-atomic resolution.

Collaboration in the CD Laboratory
Equipment such as the atomic probe does not run on its own for a particular application, so a large part of the CD Laboratory's research is dedicated to developing methods. The Laboratory is supported by the company partner CERATIZIT Austria Ltd, which is benefiting from the basic research undertaken by Prof. Schalk and her team. The Laboratory's results form the starting point for the improvement of current tools and the development of new tools for metal processing.

Results
The methods developed in the CD Laboratory are replacing the need for "trial and error" approaches and enabling an understanding of why particular materials and processes are more suitable than others, leading directly to innovation and advancing the state-of-the-art. The increased understanding is also enabling the use of improved coatings to reduce the necessity for environmentally damaging cooling agents or lubricants and facilitating their recycling by minimizing the number of elements they contain.

SUCCESS STORY

Laser beams and heat vision

JR Centre for Material processing with ultrashort pulsed lasers

Head
DI (FH) Dr Sandra Stroj, Fachhochschule Vorarlberg GmbH

Operation
01.11.2013 – 31.10.2018

Commercial partner
High Q Laser GmbH

Thematic Cluster
Materials

JR Centre for Thermal Non-destructive Evaluation of Composites

Head
DI (FH) Dr Günther Mayr, FH OÖ Forschungs und Entwicklungs GmbH

Operation
01.01.2018 – 31.12.2022

Commercial partner
ENGEL AUSTRIA Ltd, FACC Operations Ltd, Ottronic Regeltechnik Ltd

Thematic Cluster
Mathematics, Computer Sciences, Electronics

Scientific challenge

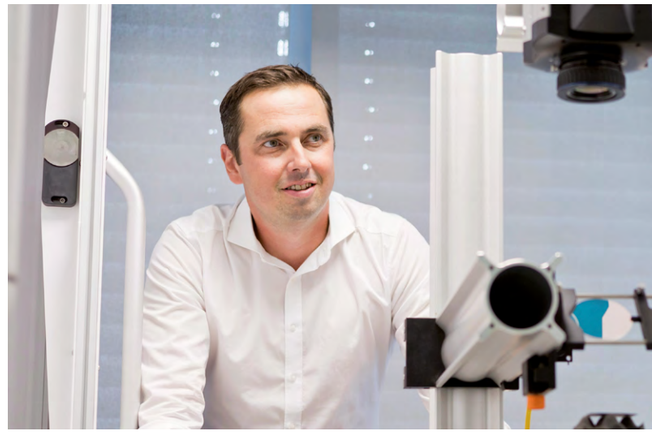
Ultrashort laser pulses were originally developed for scientific research but are showing an ever increasing potential for industry. To research the possibilities of such high-tech lasers, Sandra Stroj had to gather a large amount of knowledge on the functioning of the laser source and on the properties of the materials being used. The challenge faced by Günther Mayr is essentially mathematical. The current thermographic method converts the results of the temperature measurements as though they were an ultrasound field, thereby permitting countless test procedures. However, the contrast during heat dispersal in thicker or more complex components is increasingly blurry, meaning that information is gradually lost and back-calculation to the exact location of the defect becomes increasingly difficult.

What might sound like superpowers are real and are being researched at the Josef Ressel Centres of Sandra Stroj and Günther Mayr. The two material scientists received the 2022 CDG Award.

Sandra Stroj: Ultrashort laser pulses, tumour treatment and water production
Ultrashort pulsed lasers allow the precise processing of even brittle and particularly hard materials down to the nanometre scale without causing them to heat up. Dr Stroj has been researching fundamental aspects of laser-material interactions and their practical applications – which turn out to be fascinating. With the support of the company partner High Q Laser Ltd, the Centre found that the lasers can be used to destroy tumours without damaging the healthy surrounding tissue, a discovery that will be a huge benefit to cancer patients. A totally different example relates to the processing of specially coated surfaces with ultrashort laser pulses, which can make them water-repellent or water-attracting.

Added value for the companies

As a producer of laser systems, High Q Laser Ltd has learned about countless possible applications of ultrashort pulsed lasers from medicine to industry and is benefitting from the sophisticated methods developed in Dr Stroj's JR Centre. The progress made by Dr Mayr and his team on the thermographic non-destructive testing of components is benefiting the main business of FACC Operations Ltd, which produces measuring cells. It is also making the inspection and maintenance of components much faster and cheaper for ENGEL AUSTRIA Ltd and Ottronic Regeltechnik Ltd.



Applications range from hindering condensation on industrial machines to producing drinking water from fog, just like the fog-basking beetle!

Günther Mayr: Finding mistakes with heat
Especially in safety-critical applications, such as aircrafts and spaceships, components must be thoroughly tested but standard test procedures can cause slight damage. An innovative thermographic method has been developed in Upper Austria (Upper Austrian University of Applied Sciences, RECENDT Linz) and is already being applied to light-weight components. In contrast to traditional methods, it is completely contact-free and thus very gentle. The component is irradiated with light, which warms its surface. If the resulting temperature gradient causes the heat to flow evenly inside the component, the researchers conclude that the part is sound; if there is a buildup of heat, they deduce that it contains a defect, such as an air bubble. But how can this principle be adapted for use on thicker materials, hybrid compound materials or components with complex shapes? Dr Mayr has been tackling precisely these questions. Together with his company partners ENGEL AUSTRIA Ltd, FACC Operations Ltd and Ottronic Regeltechnik Ltd the Centre has made large advances in testing components of various kinds. AI has been combined with an iterative, experimentally controlled process to use additional features of heat dispersal, enabling the position and size of a defect to be determined far more accurately.

Statements

"Excellent research needs support for excellence, especially in the technical sciences. The CD Laboratories are continuing to write success stories at the interface between top-quality university research and the commercial sector."

Univ.Prof Dr Oliver Vitouch
President of the Austrian University Conference and Rector of Klagenfurt University

"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."

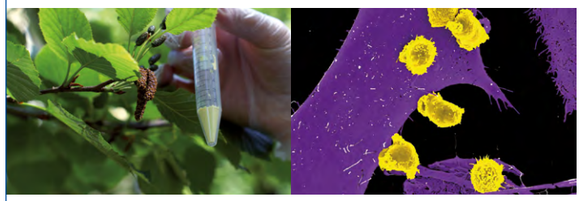
Mag. Ulrike Prommer
President of the Austrian Conference of Universities of Applied Sciences and CEO of the IMC University of Applied Sciences Krems

"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."

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

"In an incomparable manner, the CDG is enabling application-oriented basic research by promoting the collaboration between science and companies. The results are strengthening Austria's innovative capacity and competitive ability in a sustainable way."

Dr Kurt Satzinger
voestalpine Stahl Ltd and CDG Executive Board



"The CDG's models for cooperation represent unique lighthouses in the landscape of research funding opportunities

Prof.h.c. Dr Peter Prenninger
Corporate Research Coordination AVL List and First Vice-President of the CDG

"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."

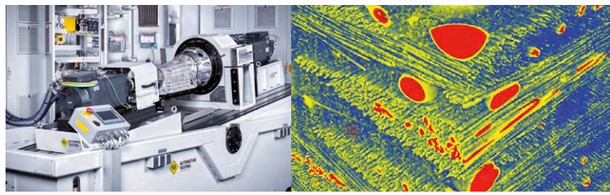
Mag. Dr Maria Theresia Niss, MBA
Member of Austrian Parliament, Chair of Mitterbauer Beteiligungs AG and CDG-Strategy Board

"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 IV Business Location, Innovation and Internationalization in the BMAW

"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."

MR Dr Ulrike Unterer
Vice-President of the CDG and Department Head of Key Technologies in the BMAW



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