




Development of interdisciplinary and international curricula and programmes in science, engineering and medicine: an overview of programmes at TUM and European universities

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Outline

1. Introduction to TUM
 2. Doctorates in Germany
 3. The TUM Graduate School System
 - Conception & implementation
 - Structure & governance
 - Scientific training
 4. Summary and lessons learnt
 5. Principles and examples of 'Innovative Doctoral Training'
 6. The TUM Graduate School System (cont.)
 - Transferable skills training
 - International exchange & networking
 7. Innovative... and beyond?
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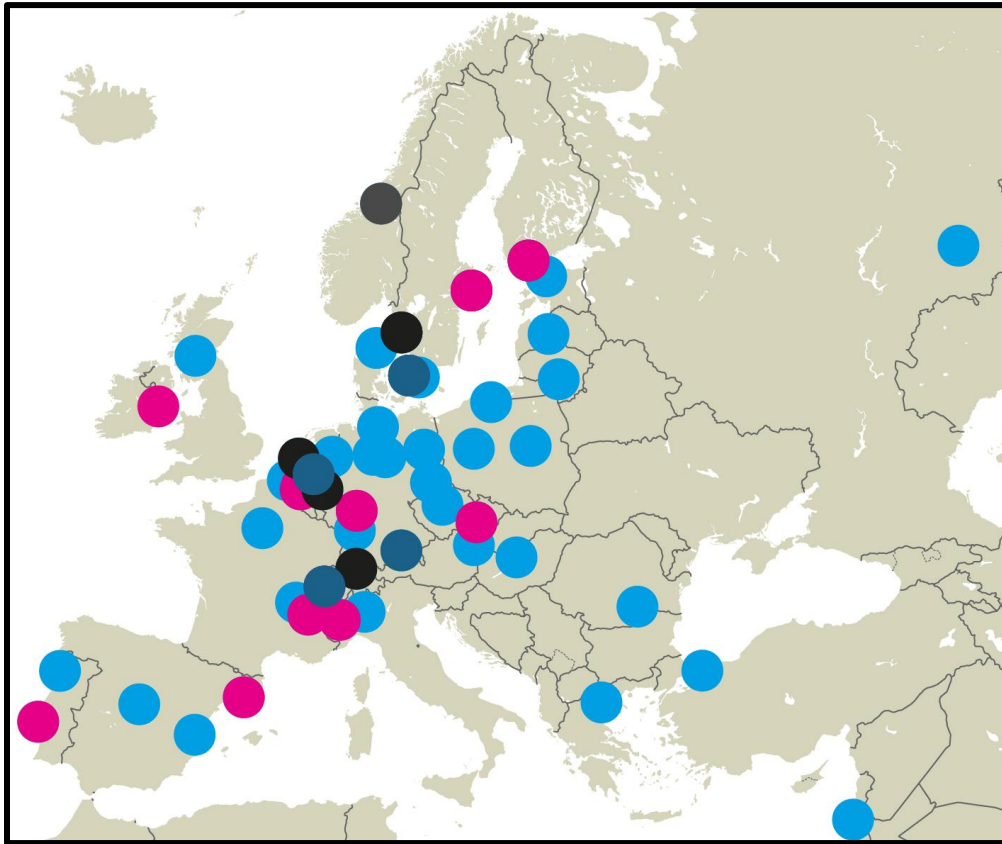
Principles for Innovative Doctoral Training

European Commission (2011)

- Research excellence
- Attractive institutional environment
- Quality assurance
- Interdisciplinary research options
- Transferable skills training
- Exposure to industry and other relevant employment sectors
- International networking



Principles for Innovative Doctoral Training



NORDIC FIVE TECH

IDEA League



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- **Interdisciplinary research options**
- **Transferable skills training**
- **Exposure to industry and other relevant employment sectors**
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EUROPEAN COMMISSION

EXAMPLES

EXECUTIVE PHD AT MILANO/ TORINO



- Doctoral positions co-supervised by university & external institutions
- research work plan with a professor in advance
- Employees of companies keeping their salaries

- Typically 4 years duration
- Transferable skills training programme
- company co-funds research

Research **Doctorate** (PHD)



EXAMPLES

TU EINDHOVEN IMPULS

TU/e

- 250 Doctoral positions co-funded by industry & external research institutes
- Doctoral researcher work at TU/e
- Energy, health, mobility, high-tech systems, data science, materials

- Typically 4 years duration
- TU/e providing accommodation



EXAMPLES

DTU SKYLAB



Cross-disciplinary hub

- Start-ups
- Real world projects
- Entrepreneurship focused courses

Lab (1,550 m²) on campus

- Prototyping workshops
- Office space
- Academia

Business & technical coaching

Network including

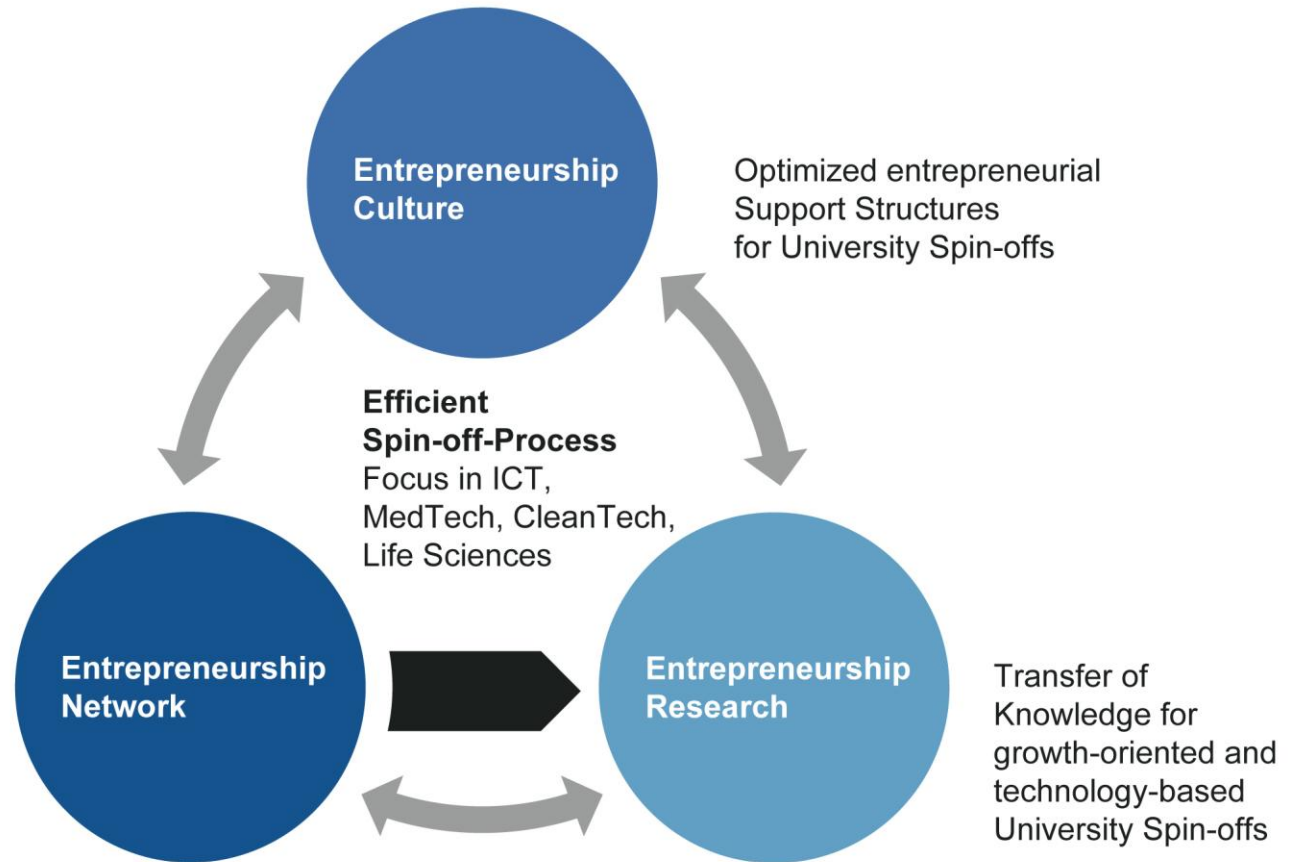
- Affiliated advisors
- Leading companies
- Investors
- Link to start-up community



TUMentreprenurship



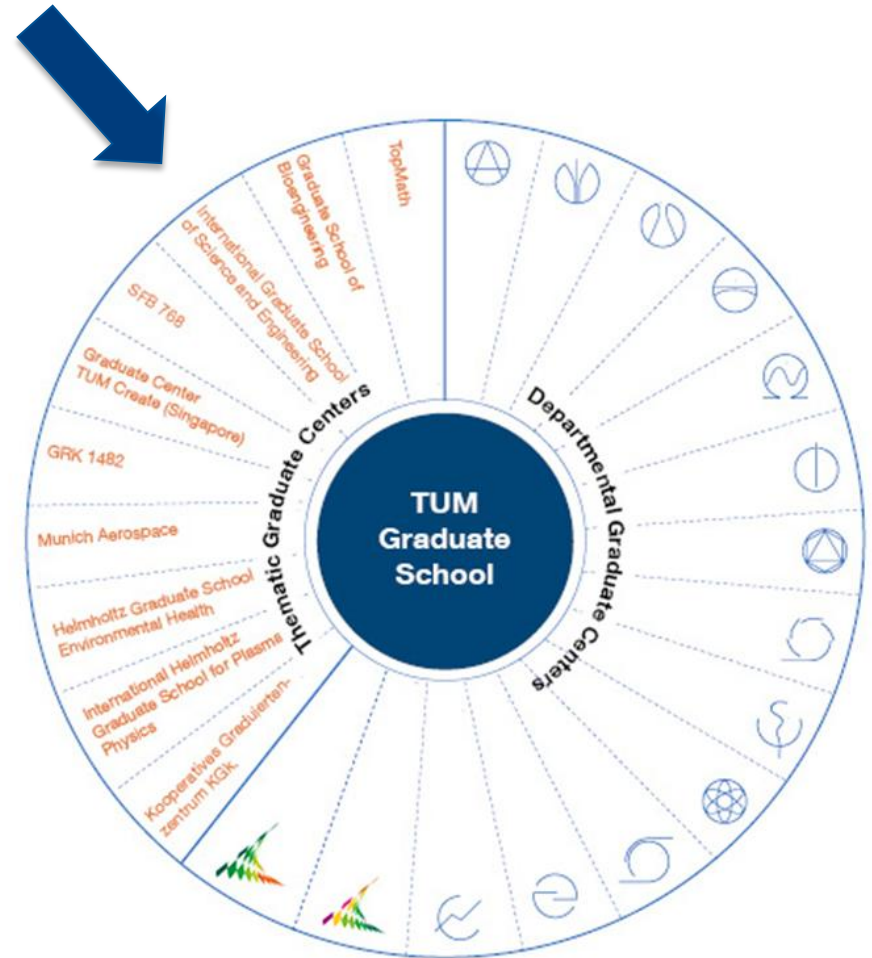
Powerful Network connecting Industry, University and Entrepreneurs



Source: TUM

International Graduate School of Science and Engineering - IGSSE

- established 2006 with funds from the Excellence Initiative
- Thematic Graduate Center of TUM Graduate School
- role model and incubator for interdisciplinary research at TUM
- permanent body of TUM since 2016



Source: TUM

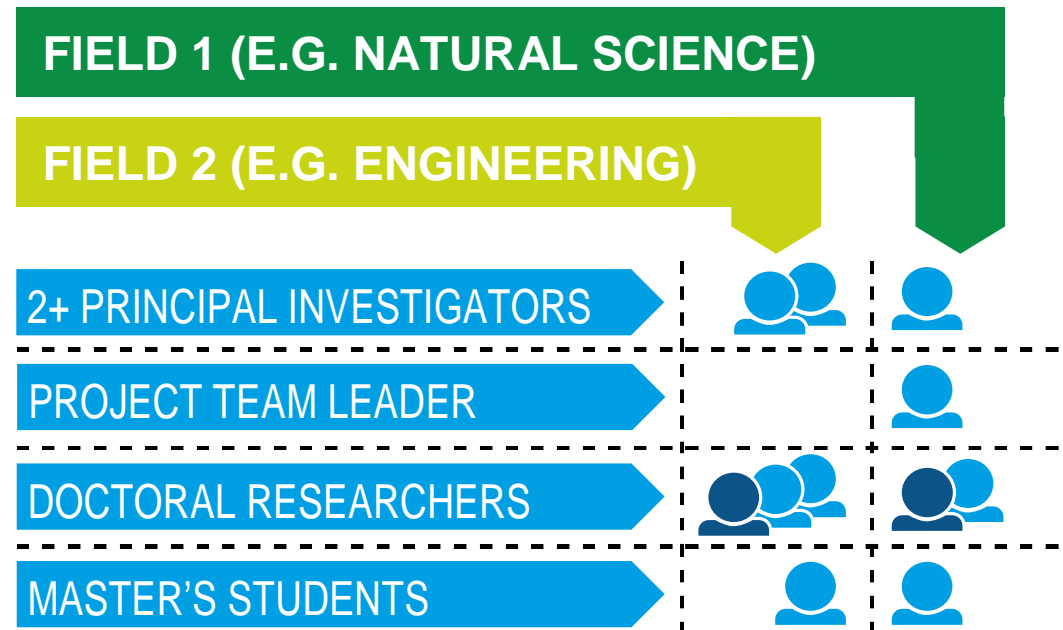
Doctoral Research in Project Teams

Small interdisciplinary research groups:

- Open calls – Peer-reviewed selection
- Strong international focus
- Matching grants

Interdisciplinarity:

- natural sciences
- engineering
- medicine



Source: TUM

Project Team ROLITOS

Research goal:

Translation of human interpersonal interaction into robotic solution

Collaboration:

- Sports and Health Sciences
- Electrical Engineering & Information Technology



Source: TUM

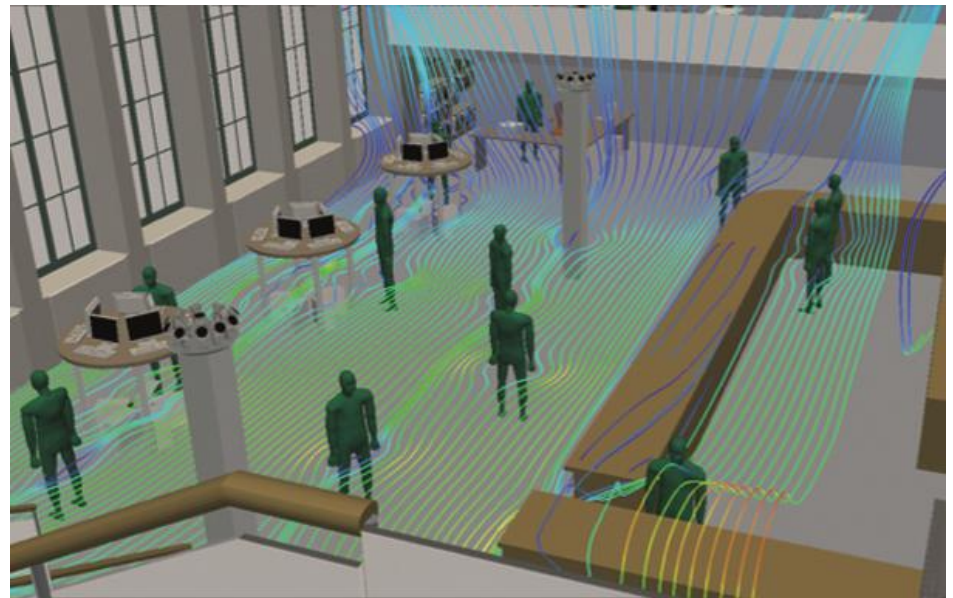
Project Team Buildings, Users, Climate

Research goal:

Develop principles for planning buildings in different climate zones

Collaboration:

- Architecture
- Civil and Environmental Engineering
- Electrical Engineering & Information Technology
- Mathematics
- Informatics



Source: TUM

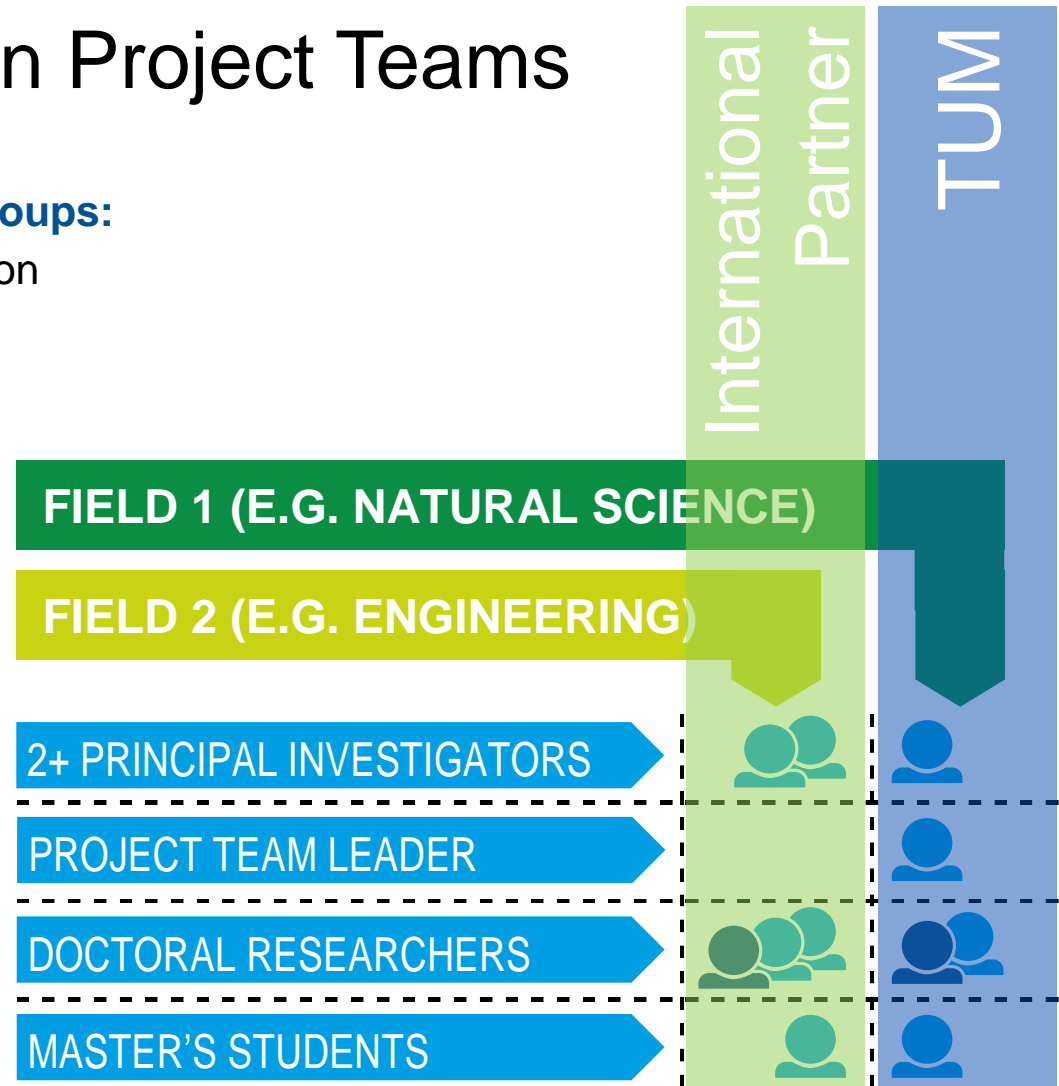
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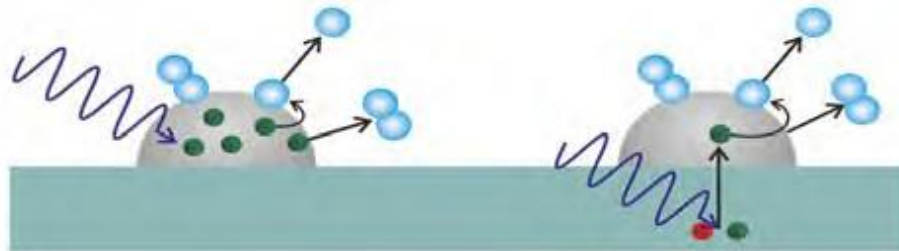
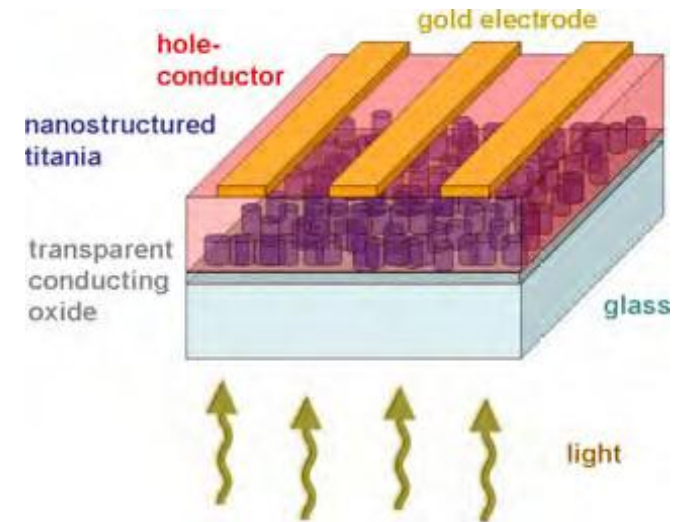
Source: TUM

Focus Area ATUMS

Cluster of 9 Project Teams

- topic: Functional Hybrid Materials
- cooperation with University of Alberta
- 18 Doctoral researchers @TUM & similar number @UoA
- external DFG funding: 5mio €

- exchange program
- scientific and transferable skills training program



UNIVERSITY OF
ALBERTA

Source: TUM

IGSSE Statistics

Project Teams

- 103 total since 2006
- 68 ongoing
- 47 international projects

Doctoral candidates

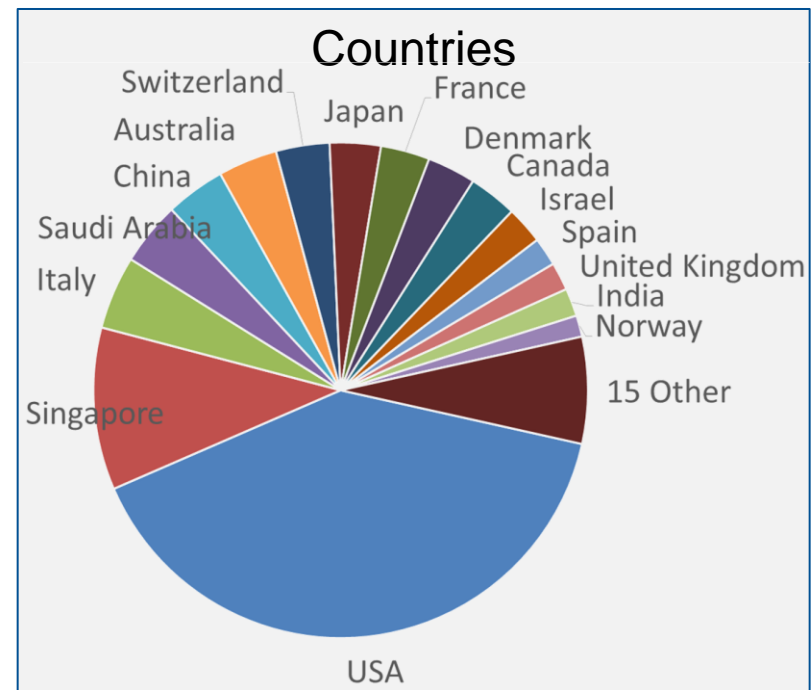
- 333 doctoral researchers
- 30% women

Alumni:

- 146 alumni
- 9 alumni have professor positions
- careers:
 - 48% academia
 - 52% industry

International exchange:

- 23 stays abroad per year
- ~2 months typical duration



Source: TUM

IGSSE Forum

Annual retreat and summer school

- since 2007
- 200 doctoral candidates, faculty and guests
- Location: Raitenhaslach monastery, Burghausen, Eastern Bavaria

Goals/program:

- Networking
- Scientific Exchange
- Thematic workshops
 - (inter) disciplinary
 - transdisciplinary
 - career-oriented

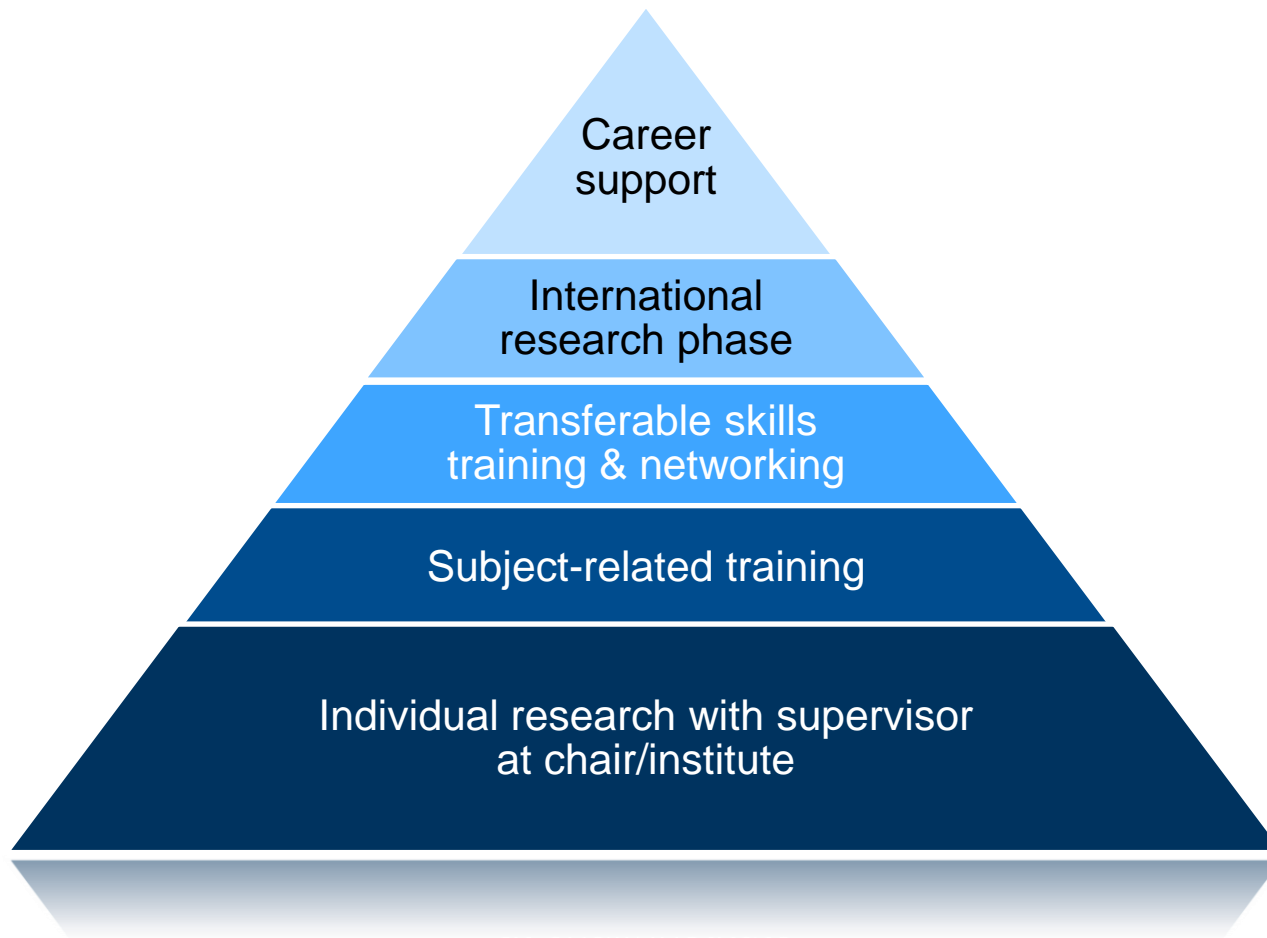


Source: TUM

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The TUM model of a doctorate



Source: TUM

TUM-GS: Kick-Off Seminar

12-15 seminars per year

80-100 doctoral candidates across all disciplines

Goals

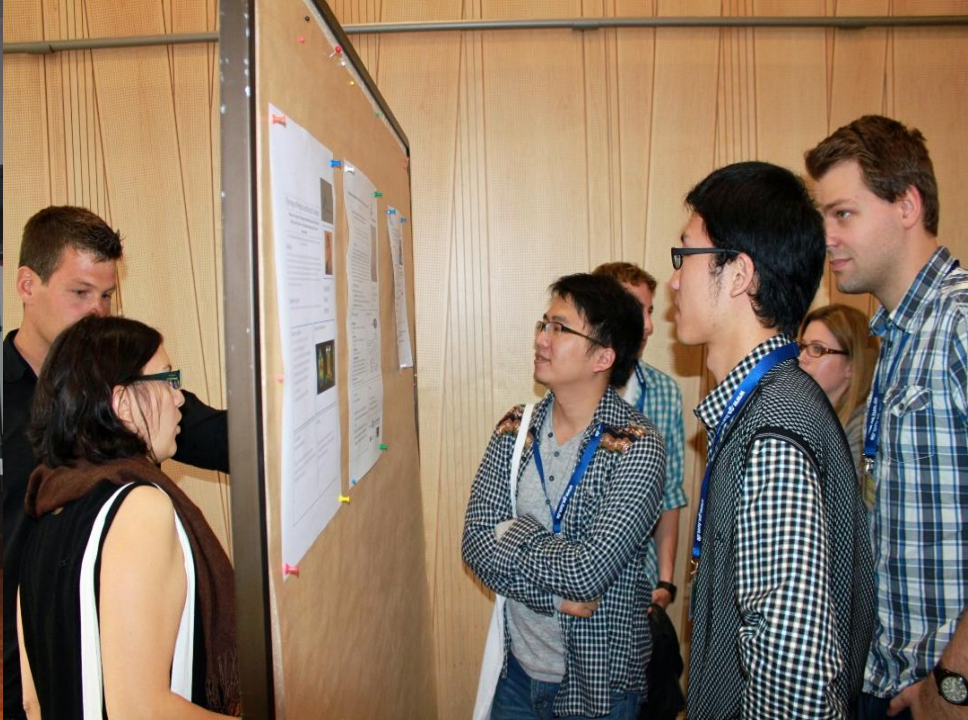
- interdisciplinary exchange
- strengthening of personal network
- get to know TUM and its resources
- transferable skills training

Fixed program parts

- good scientific practice
- poster session
- science slam
- introduction to TUM services and entrepreneurship



Source: TUM



TUM-GS: Transferable skills training

50+ courses per semester

50% in English



- Setting priorities
- Serious creativity
- Surviving complex projects



- Paper writing
- Proposal writing
- Funding and career paths
- Science management



- Rhetoric extreme
- Presentation skills
- The Harvard concept
- Modelling complex systems



- Prototype your PhD
- Business Plan seminar
- E-Camp – get ideas started!



- Strength-based leadership
- Leading international teams
- Leadership & responsibility



- Project management
- Job application
- Patent law
- Foreign trade law

Source: TUM

Skills training at Imperial College London

Research environment

- Ethical issues, concerning peer review, pressure for results, conflicts of interest, secrecy, obligation to the public
- Commercialization

Research management

- Time management, prioritization, realism
- Project management, milestones etc
- Data management, IT skills

Personal effectiveness

- Self-discipline, motivation, initiative
- Awareness of self limitations, training needs

Networking and teamworking

- Within research group, institution, community
- Understand behaviour, impact on others

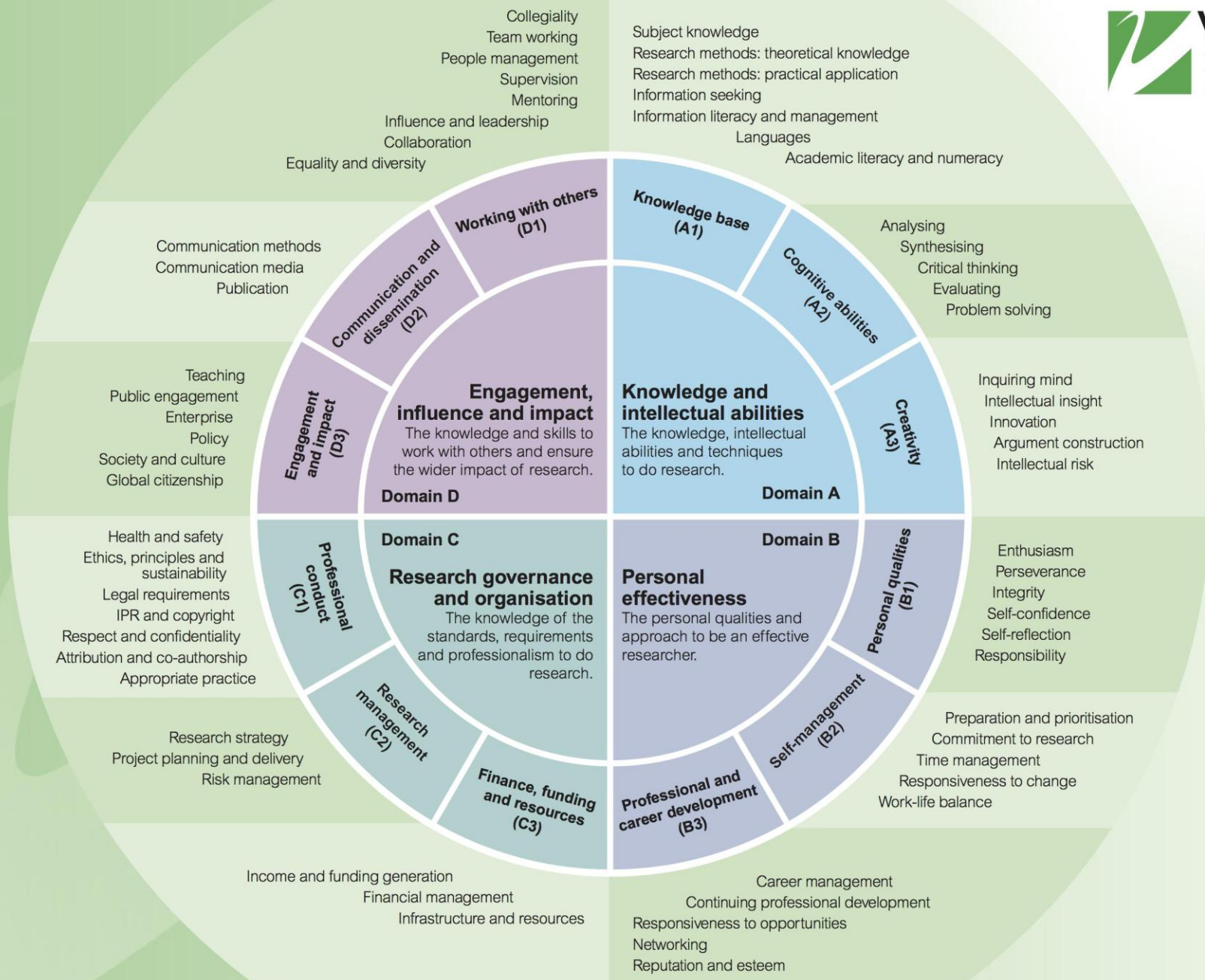
Communication skills

- Writing
- Oral presentations: brief, long
- Professional audiences, public understanding
- Teaching, media

Career management

- Ownership, realistic goals, identify development needs
- Insight into transferable nature of research skills, range of career opportunities within/outside academia
- Effective presentation, CVs, applications, interviews

Source: Dr. Sybille Reichert, Reichert Consulting (2007)



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TUM-GS: International networking I

Individual exchanges

- International conferences & symposia
- Research stays at foreign universities, research institutions and companies
- Seasonal schools
- Invitation of international guests

Joint doctorates

- KAUST, Saudi Arabia
- NTU, Singapore
- Individual cotutelles

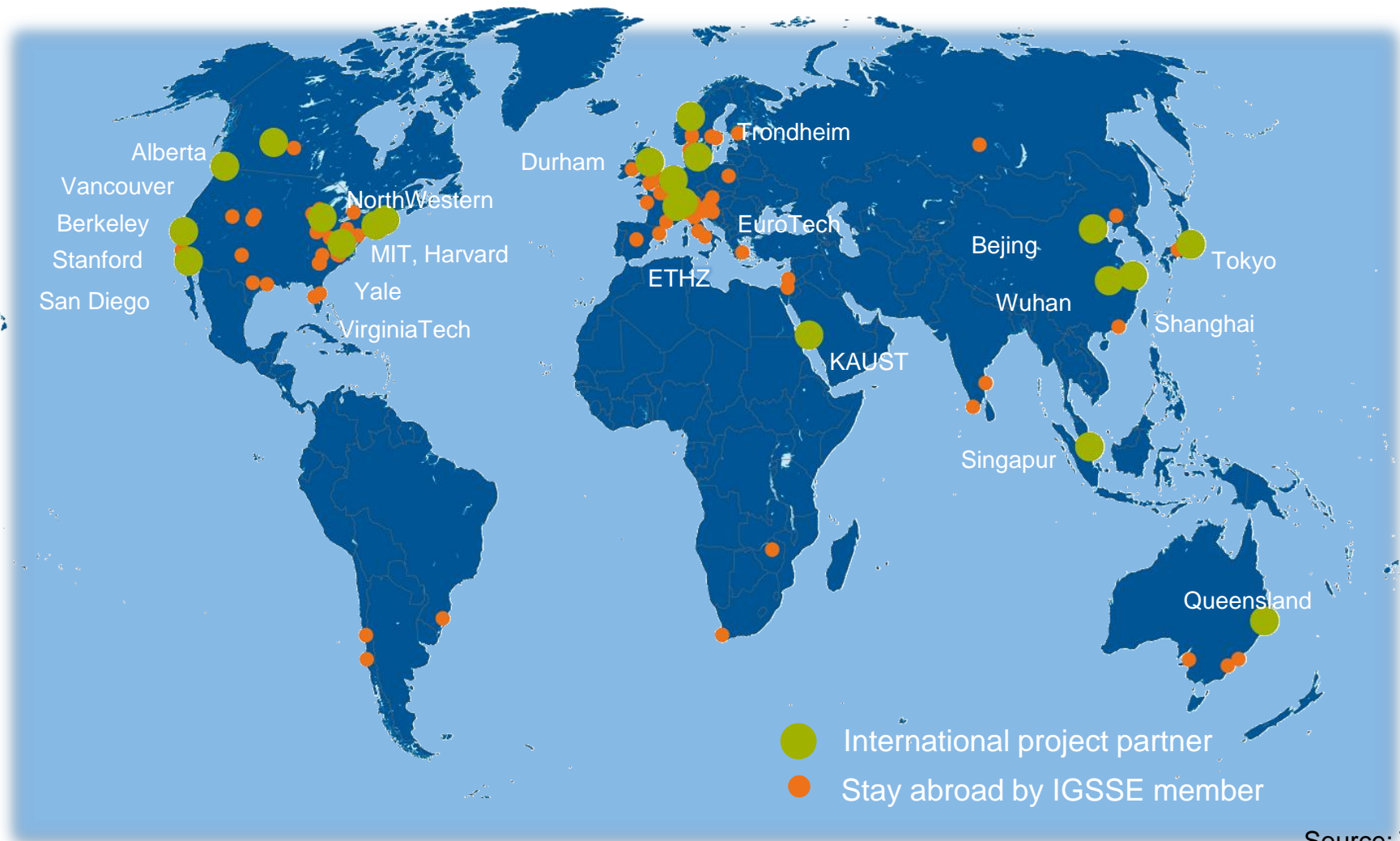
EuroTech Universities exchange program

- Lab visits
- Joint seasonal schools
- Joint doctoral course database
- Accommodation support



Source: TUM

TUM-GS: International networking II



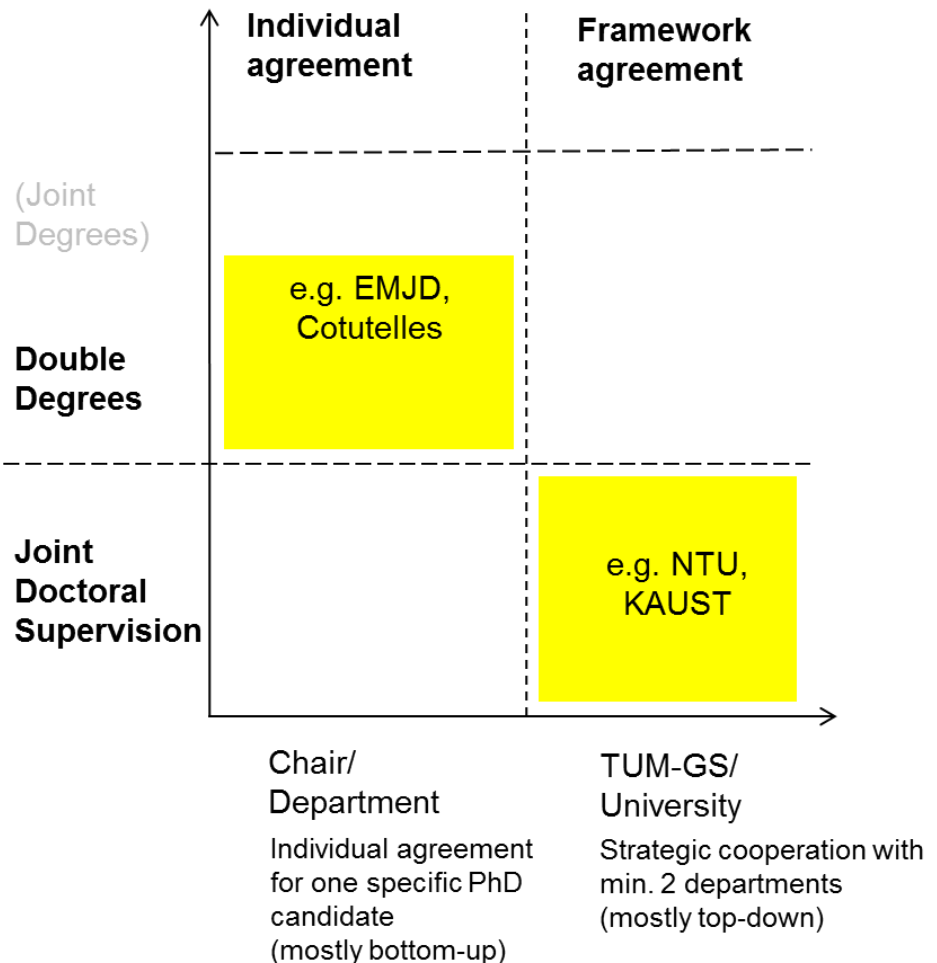
Source: TUM

TUM-GS: International networking III

Joint doctorates strategy

- regulations of both universities apply
- each university awards one degree but the use of both titles at the same time is prohibited.
- thesis submission at both universities and one joint oral examination
- admission with Master's degree (or equivalent) only
- compliance of Higher Education Law and university regulations needed

-
- regulations of home university apply
 - only home university awards degree
 - thesis submission/examination with participation of supervisor from partner university
 - joint course program & transcript (intended)
 - non-TUM candidates: registration as guest doctorates at TUM
 - admission to joint program possible for Bachelor graduates as non-TUM candidates



Source: TUM

TUM-GS: International networking IV

Welcome services

Accommodation,
Social and cultural
events,
Family services

Career workshops

Job application,
Career paths in and
outside academia



Coaching

individual coaching by
professional coach,
Support on PhD-related
and personal issues

Language courses

German and
>60 other languages

Source: TUM

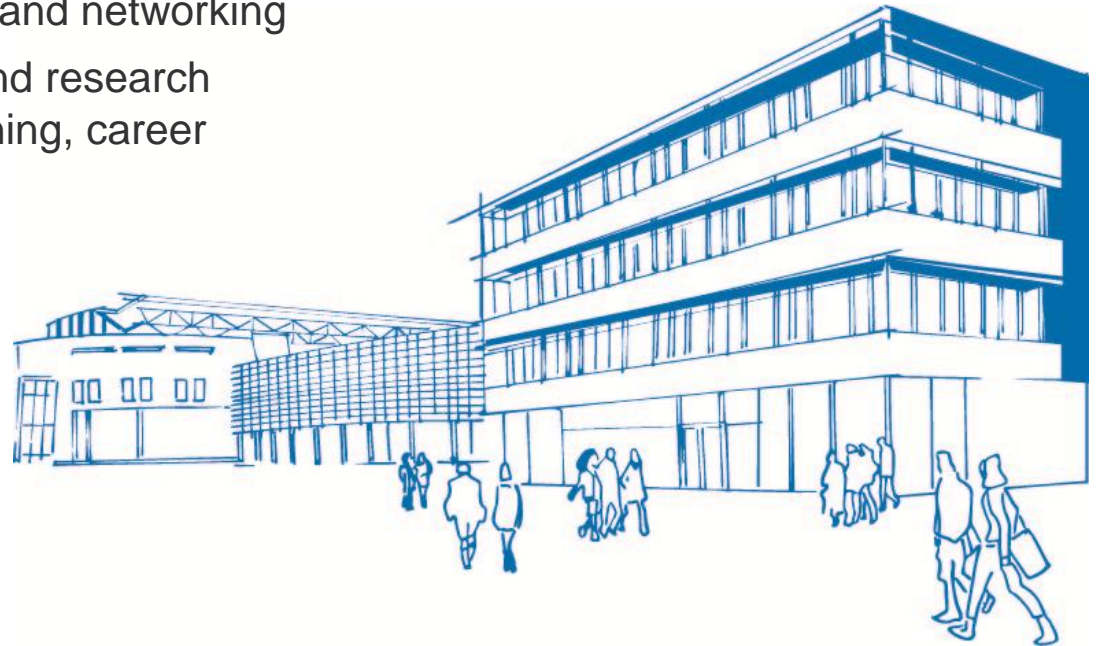
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Innovative... and beyond?

Continually improve services and structures:

- further increase **participation** of faculty and doctoral candidates
- consider services for **supervisors, Master's students and postdocs**
- work on issues of **good scientific practice**, e.g. quality of supervision, responsible research
- increase **international** exchange and networking
- enlarge **networks** with industry and research institutions, e.g. for program planning, career development, alumni networks
- more **public outreach?**
- **evaluate** quality of program and structures



Source: TUM

Thank you!

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www.gs.tum.de

www.igsse.tum.de

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Source: TUM