



## S&C Meet & Greet 2022: Control Systems Technology (ME-CST)

Maarten Steinbuch

Maurice Heemels

# Control Systems Technology

We aim to develop new methodologies for the high-tech systems of the future in a broad range of applications that are essential for our society.

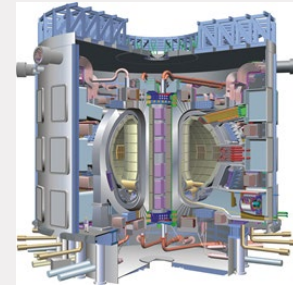
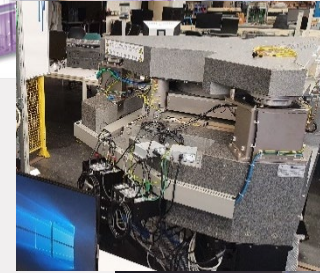
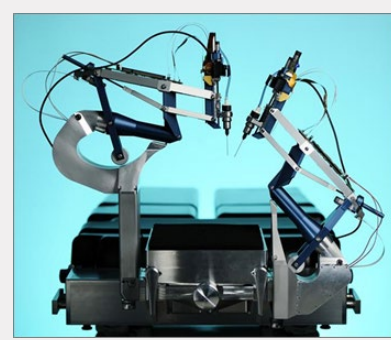
To achieve this, our research spans both

- world-leading applications and fundamental research
- uniquely interconnected and equally important

Our core disciplines

- systems and control theory
- optimization
- systems engineering
- mechanical design / mechatronics

KPIs:  
50 PhDs  
85 MSc/year





# CST People and subprogrammes



AC OPTOMECHANIX  
MEMECHANISME • OPTICA • FYSICA • MECHANICA



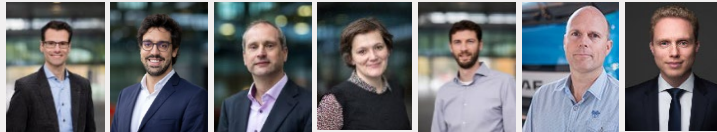
Steinbuch Oomen Tiels Vrancken Heertjes Witvoet Blanken Vermeulen Kappelhof Cacace Sperling



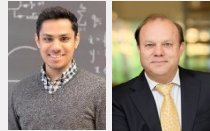
Heemels Antunes Chong Reniers vd Mortel Etman v Beek v Eekelen Wilschut Fokkink



vd Molengraft Torta Kappers Bruyninckx Elfring Lopez Martinez



Hofman Salazar Willems Silvas v Keulen Huisman Katriniok



Krishnamoorthy de Baar

**Model-based Control, Learning Control,  
 Identification and Design of  
 Motion Systems**

**Cyber-Physical Systems of Systems**



**Robotics for Care, Cure & Agro-food**



**Automotive Powertrains & Smart Mobility**



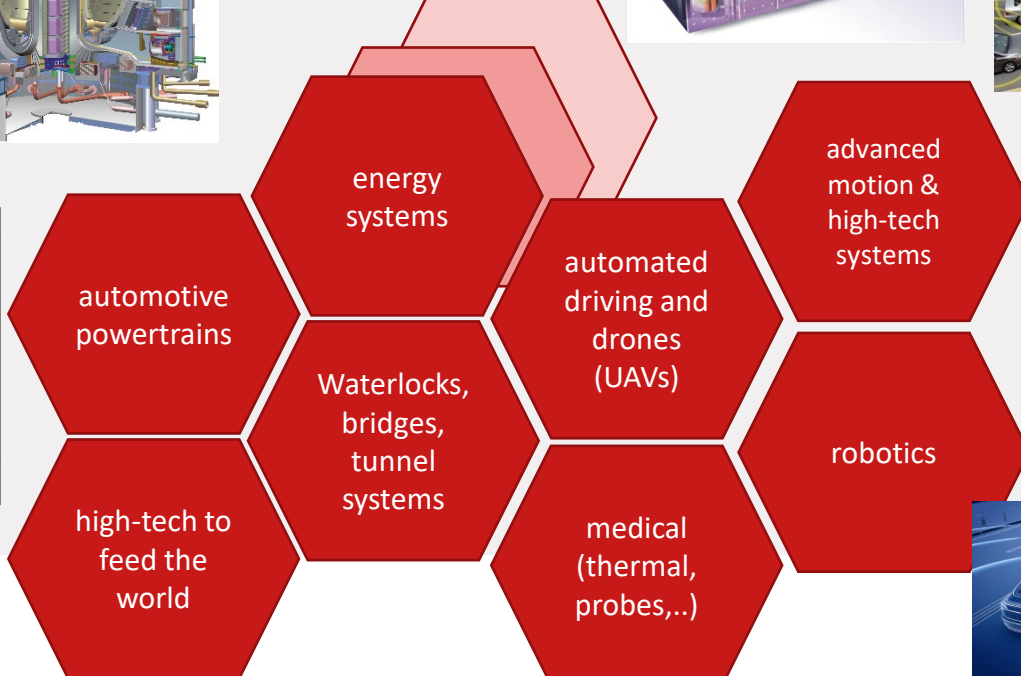
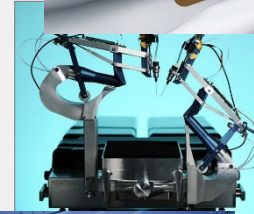
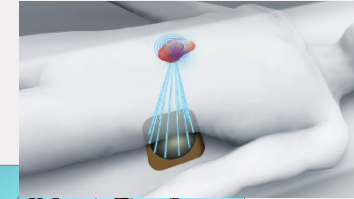
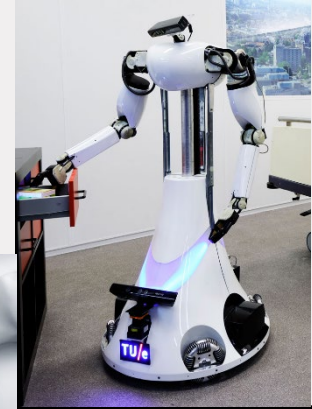
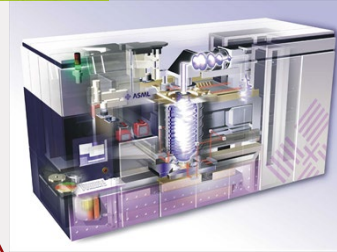
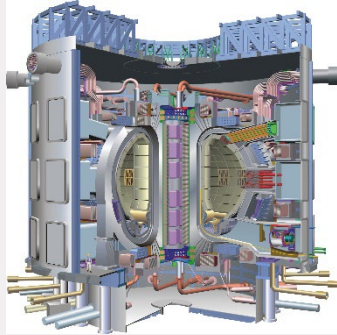
**Process Control of Energy Systems**



**DIFFER**  
 Dutch Institute for  
 Fundamental Energy Research

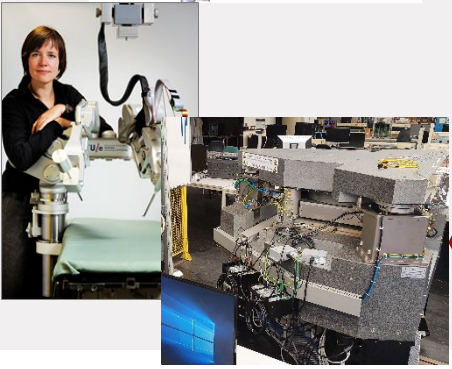
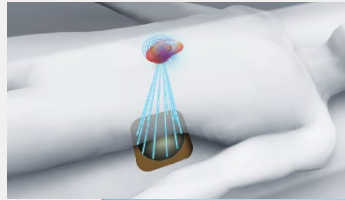
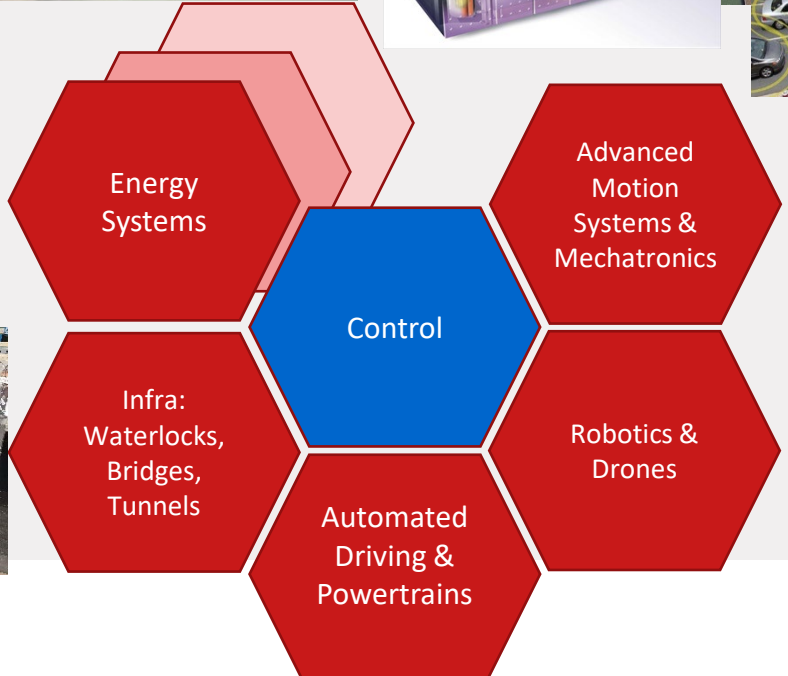
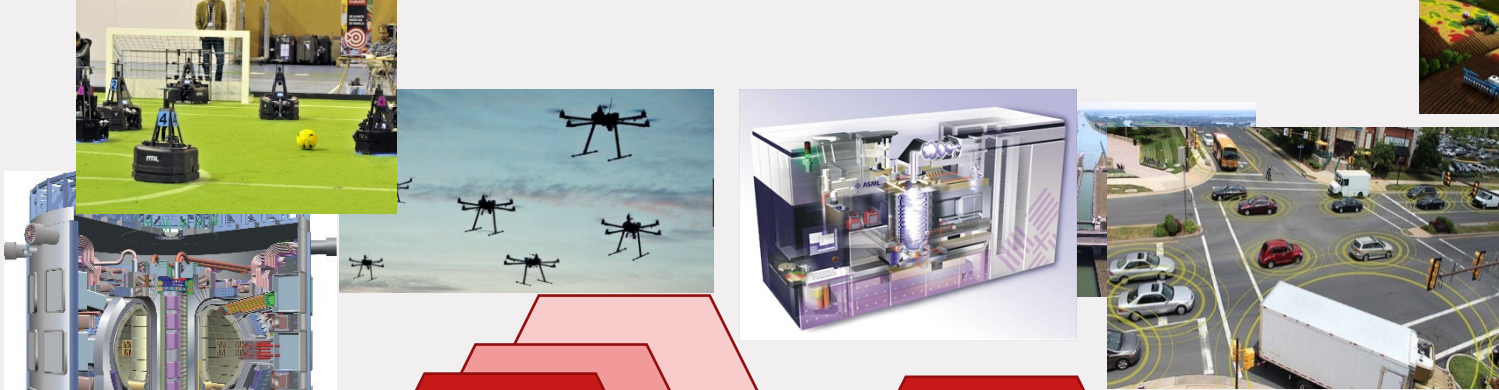


# Application Areas





# Control is the central technology in the subprogrammes



# CST Master Courses

Code	Credits	Quartile	Title	Responsible lecturer	MW	AIES-MW	MSE-MW	AT	SC
4CM10	5	Q1	System theory for control	W.P.M.H. Heemels	S	C	S	S	C
4CM00	5	Q1,Q3	Control engineering	G. Witvoet	C	C	C	S	C
4CM60	5	Q2	Advanced motion control	T.A.E. Oomen	S	S	S		S
4SC010	2.5	Q2	Control and operation of tokamaks	M.R. de Baar					S
4CM70	5	Q2	Integrated system design	L.F.P. Etman	S				
4SC000	5	Q2	Optimal control and reinforcement learning	D.J. G. Tomé Antunes	S	S	S	S	S
4DM20	5	Q3	Engineering optimization	L.F.P. Etman	C	C	S	S	S
4CM80	2.5	Q3	Extremum seeking control for data-based perf. optimization	T.A.C. van Keulen	S	S		S	S
4CM90	5	Q3	Opto-mechatronics	L.A. Cacace					
4CM40	5	Q3	Physical and data-driven modelling	K. Tiels	S			S	S
4CM30	5	Q3	Supervisory control	M.A. Reniers	S	S	S	S	S
4AT070	5	Q4	Advanced control for future HD powertrains	F.P.T. Willems		S		S	S
4AT030	5	Q4	Advanced full-electric and hybrid powertrain design	T. Hofman	S		S	S	S
4CM50	5	Q4	Applications of design principles	P.J.E.M. Vrancken	C				
4SC030	2.5	Q4	Control of magnetic instabilities in fusion plasmas	M.R. de Baar					S
4SC040	2.5	Q4	Haptics - perception and technology	A.M.L. Kappers					S
4CM20	5	Q4	Hybrid systems and control	W.P.M.H. Heemels	S		S	S	S
4SC070	5	Q4	Learning control	T.A.E. Oomen		S			S
4SC020	5	Q4	Mobile robot control	M.J.G. van de Molengraft		S			S

# Programme Structure

Year 1	Core program	25 EC
	Specialization courses	20 EC
	Free electives	15 EC
Year 2	Internship	15 EC
	Graduation Project	45 EC

**Year 1: Course program:** In consultation with your **mentor**, you choose your course program for Q2-Q4. In Q3-Q4 start discussing internship (abroad/industrial/university, and scope theory/application).

**Elective courses** give you the chance to deepen or broaden your knowledge: 20 EC **specialization** from a list of more than 30 courses, 15 EC of **free electives** from within the total range of master courses at the TU/e (TU Delft or UTwente).

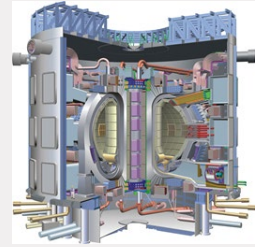
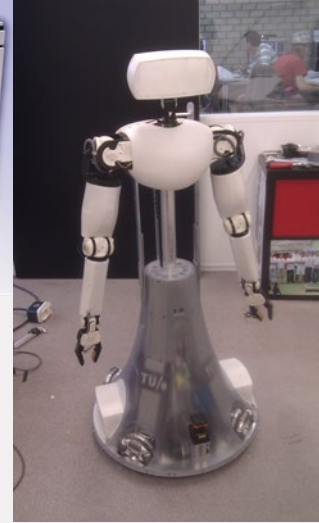
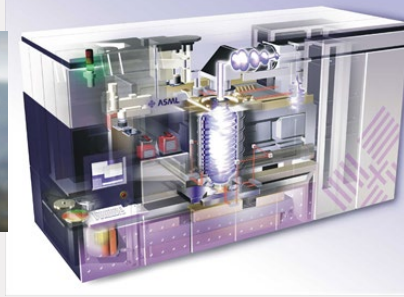
**Year 2: Internship & Graduation project:** This can be with your mentor or different CST scientist depending on your interests.

You start an **internship** (15 credit points) within broad area covered by CST. You follow your internship, preferably abroad, at one of the many university Systems & Control groups that are worldwide. For international students the project is often carried out at the TU/e or local industry.

The **graduation project** (45 credits). Primarily, you will gain experience in modeling, analysis, and/or design of a new control system or explore new research questions. Graduation work consists of your master project, a report/paper and a presentation. CST has numerous contacts with Dutch industry and knowledge institutes such as ASML, Océ, Philips, Shell and TNO (Netherlands organization for Applied Scientific Research).

Internship and graduation project often in context of PhD research (possibly at/in collaboration with industry)  
\* supervised by PhD student + one or more staff members (and industrial supervisors)

# Summarizing



CST group unites

- Science and fundamental (control) theory
- Applied research & design
- Society / Spin-offs



Highest quality standards & fun!

- Two latest int. research evaluations. Excellent highest possible scores (quality, productivity, viability and relevance: 5555)





For students who are interested:

AT follow-up meeting: September 22 12:30-13:30 GEM-Z0.05

## Follow-up meeting S&C 21/09/2022

### CST Lab tour

11:45 – 12:55 Robotics Lab, Impuls building (Entrance on the back of Impuls, doors will be open). There will be “Worstenbrood” / vegetarian 😊

12:55 – 13:00 Walk to the Gemini Building

13:00 – 13:30 DCT Lab Gem-z -1.13

PLEASE SIGN UP: [cst\\_sa@tue.nl](mailto:cst_sa@tue.nl)

## Movies/Links CST

<https://www.youtube.com/watch?v=yoAoTUnkvMs&t=1s> [robocup – TechUnited – 1 min]

<https://www.youtube.com/watch?v=Za13vkL7Flo> [robots at home competition – 4 min]

[Oomen – Learning in Machines \[1 min\]](#)

[Maarten Steinbuch -- IFAC World Congress Plenary \[49 min\]](#)

[Duarte Antunes – Quadcopters 1 \[56 sec\]](#)

[Duarte Antunes – Quadcopters 2 \[50 sec\]](#)

[www.heemels.tue.nl](http://www.heemels.tue.nl)

<https://maartensteinbuch.com>

<http://www.toomen.eu>

<https://www.techunited.nl>

<https://www.linkedin.com/company/control-systems-technology-tue/>

<https://www.tue.nl/en/research/research-groups/control-systems-technology/>

[More details about our group](#)

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 www.tue.nl



**Buildings**

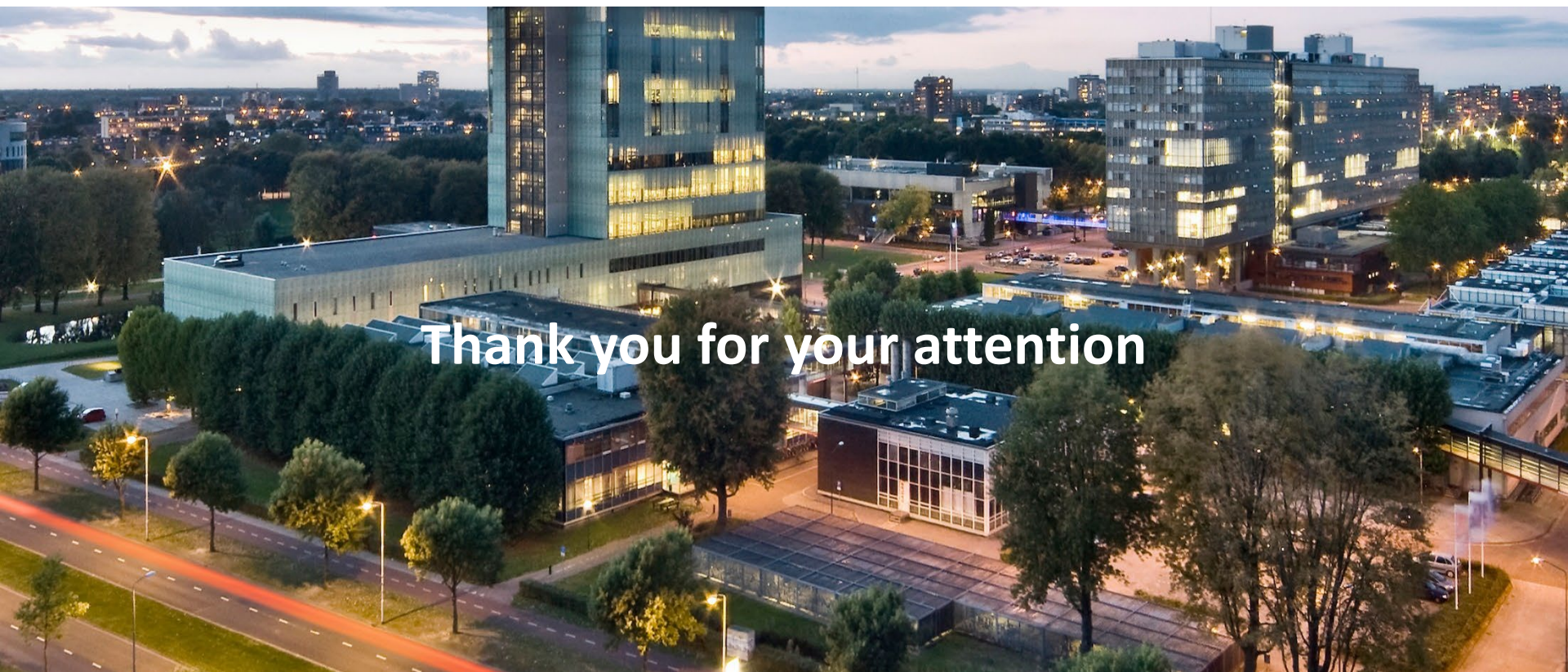
MAP NUMBER	MAP NUMBER	MAP NUMBER
Alpha D3 57	Gaslab B5 12	
Athene C5 16	Gemini C4 15	
Atlas B4 3	Helix C5 14	
Auditorium B4 1	Impuls B3 30	
Aurora C3 42	Kennispoort A5 2	
BBC Reststoffencentrum E4 70	Koepel F4	
	Luna B3 31	
Cascade D4 23	Matrix B5 10	
Catalyst E3 76	MetaForum C4 5	
Ceres C4 7	Momentum F4 83	
Connector D3 60	Neuron C4 32	
Cyclotron D5 24	Qubit D4 21	
Differ E4 73	Spectrum D4 25	
Disruptor E3 74	Studentensport-centrum C2 49	
Echo E5 28	Traverse C3 37	
Fenix F4 87	Twinning center F3 77	
Flux D4 19	Ventur E4 80	
Fontys ER C5 20	Vertigo B5 6	
Fontys S1 D3 54	Zwarte Doos B5 4	
Fontys S2 D3 55		
Fontys S3 D3 59		

**Departments**

DEPARTMENT	BUILDING	MAP NUMBER
Applied Physics	Flux	D4 19
Biomedical Engineering	Gemini	C4 15
Chemical Engineering and Chemistry	Helix	C5 14
Department of the Built Environment	Vertigo	B5 6
Eindhoven School of Education	Traverse	C3 37
Electrical Engineering	Flux	D4 19
Industrial Design	Atlas	B4 3
Industrial Engineering & Innovation Sciences	Atlas	B4 3
Mathematics and Computer Science	MetaForum	C4 5
Mechanical Engineering	Gemini	C4 15

- P1 Parkeerplaats / Parking
- P5 Mindervalide parkeerplaats / Disabled parking
- Oplaadpunt elektrische auto / Electric car charger
- Bushalte / Public transport
- Betaalautomaat / Ticket machine





Thank you for your attention