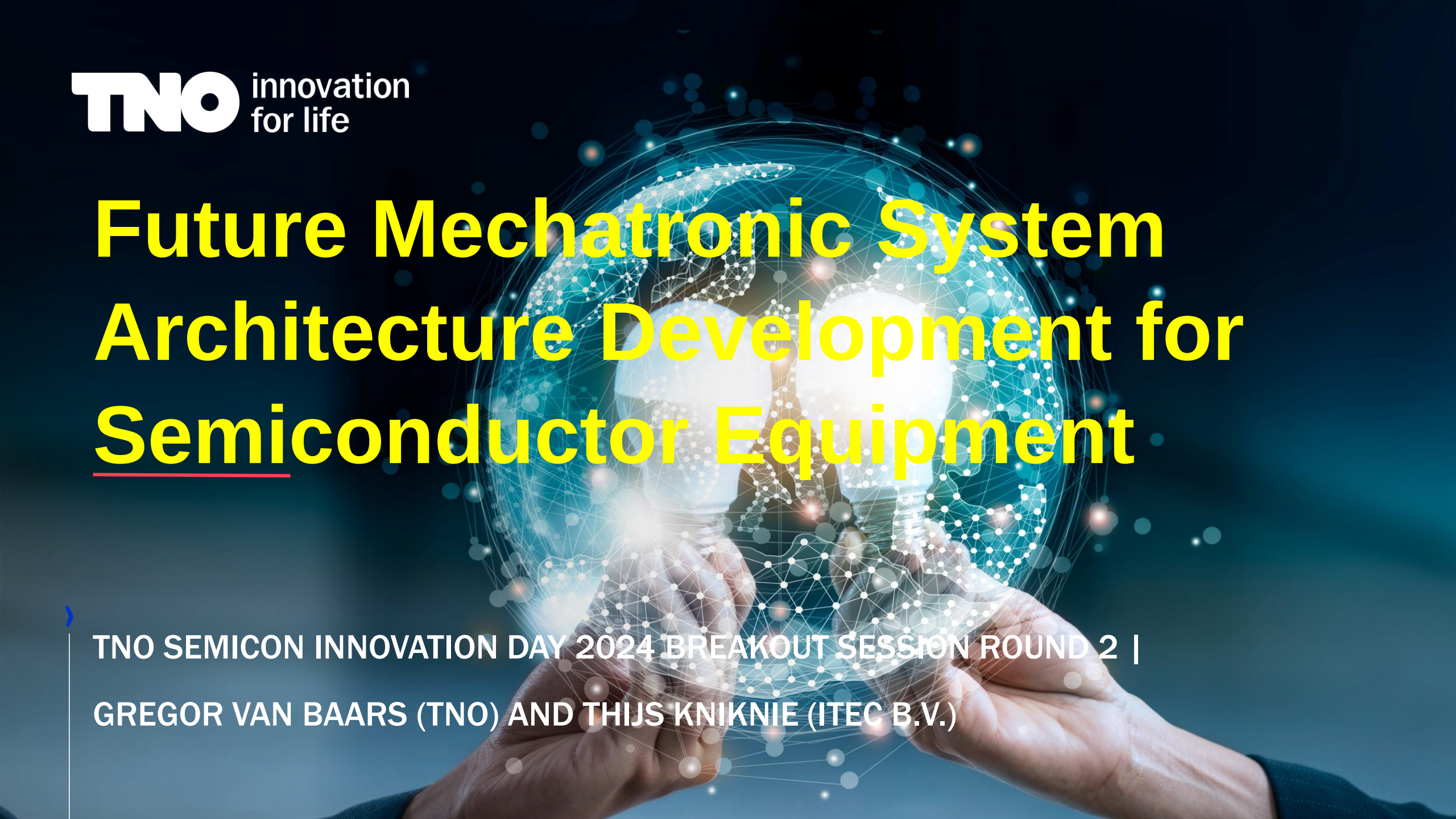


Future Mechatronic System Architecture Development for Semiconductor Equipment

TNO SEMICON INNOVATION DAY 2024 BREAKOUT SESSION ROUND 2 |

GREGOR VAN BAARS (TNO) AND THIJS KNIKNIE (ITEC B.V.)

FUTURE MECHATRONIC SYSTEM ARCHITECTURE DEVELOPMENT FOR SEMICONDUCTOR EQUIPMENT

BREAKOUT SESSION ROUND 2 : 15:15 – 16:00

PRESENTATION 1:

- Future Mechatronic System Architectures
- Gregor van Baars, TNO

PRESENTATION 2:

- Next Generation Semiconductor Assembly Architecture – collaborating with the Dutch Ecosystem
- Thijs Kniknie, ITEC B.V.

Q&A, DISCUSSION

- Clarifying questions welcome during presentations
- Reactions on content, additional remarks, discussion, etc. please after 2nd presentation

Future Mechatronic System Architectures

Gregor van Baars, TNO
April 17, 2024

Nationaal Groeifonds

Voor economische groei en welvaart, ook voor komende generaties

Budget

€ 20 miljard
voor de komende 5 jaar

Voor investeringen in

- Kennisontwikkeling
- R&D en innovatie
- Infrastructuur

Wie doet wat

Ministers van Financiën en EZK
Fondsbeheerders

Parlement
Goedkeuring begroting
Nationaal Groeifonds

Onafhankelijke commissie
Beoordelen voorstellen,
adviseren kabinet,
monitoren voortgang

https://nxtgenhightech.nl/

The new generation of high-tech equipment for future generations

A leap forward is necessary

The production of high-tech equipment in the Netherlands is of world class and accounts for a large share of our exports. This position is due to the expertise and entrepreneurship of the players in this ecosystem and their close cooperation. But competition in the world is growing, there are urgent societal challenges and the required investments are increasing. The NXTGEN HIGHTECH investment programme tackles all this at once.

More growth and tackling societal challenges

Over a seven-year period, the programme aims to invest €1.2 billion (of which approximately half from the National Growth Fund) in six key application areas for generations to come:

- Clean energy.
- Data communication via light.
- Equipment for faster medicine development without animal testing.
- Faster microchips.
- Innovative production of light composite materials.
- Fast and precise robots in agriculture and horticulture.

The aim is to make this Dutch high-tech equipment ecosystem a leader in Europe by 2040, with an ultimate contribution to GDP of €11 to 16 billion per year. To this end, consortia of companies and knowledge institutions will develop new technologies and work together even more closely: exchanging knowledge, learning from each other and with each other, and attracting new talent.

Ready to start with broad support

The plans for implementing this programme are ready. If NXTGEN HIGHTECH gets the green light, it can start immediately. 189 small- and medium sized companies, including 75 start-ups and scale-ups, 130 bigger companies and 23 knowledge institutions have pledged their participation and contribution.

2023 -2029

Rijksoverheid

Commissie Nationaal Groeifonds

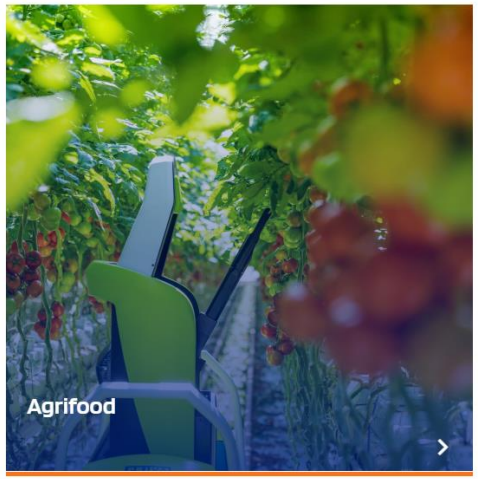
Rapport tweede beoordelingsronde

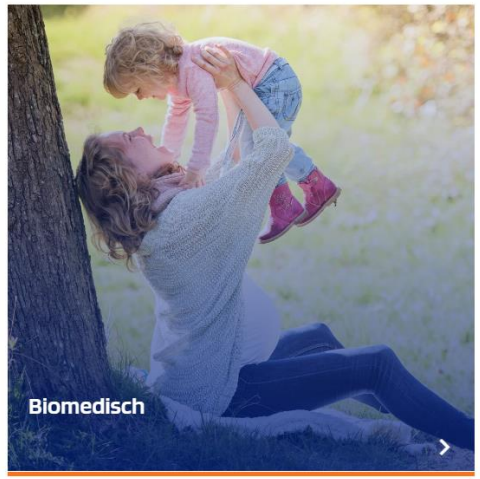
April 2022

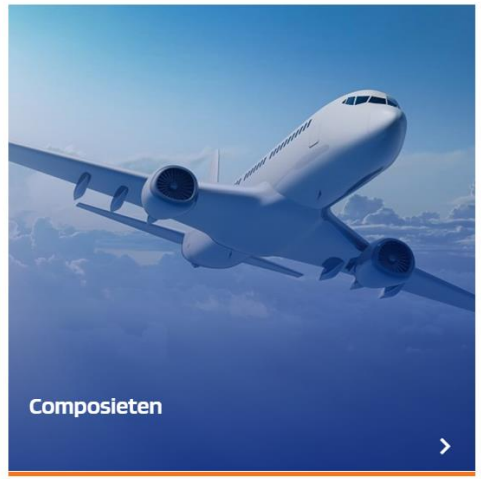
Tabel 1 Toekenningen alle voorstellen (miljoenen euro's)

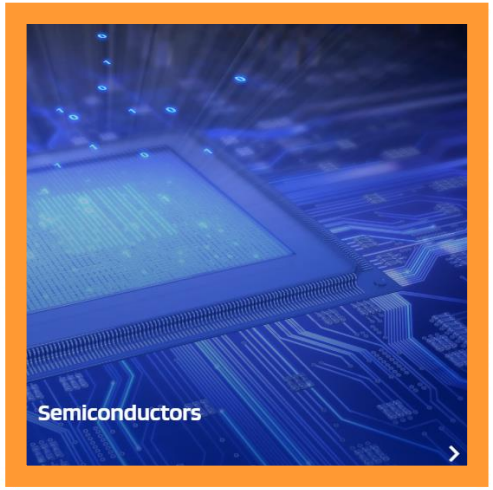
Voorstel	Totale investering	Bijdrage anderen	Gevraagde bijdrage	Toegekend	Voorw. toegekend	Reservering
Voorstellen Infrastructuur						
Rail Gent-Terneuzen	240	135	105	-	105	-
Subtotaal Infrastructuur	**240**	**135**	**105**	**-**	**105**	**-**
Voorstellen Onderzoek, ontwikkeling en innovatie						
Thema Hightech en Materialen						
Agri Based Chemicals	806	518	288	-	-	-
De revolutie van de zelfdenkende moleculaire systemen	208	111	97	-	97	-
Duurzame MaterialenNL	1.366	698	668	-	220	-
Einstein Telescope	2.008	1.096	912	-	42	870
NXTGEN HIGHTECH	1.140	507	633	-	450	-
Photondelta	1.113	642	471	-	471	-
Thema Landbouw en Leefomgeving						
Cellulaire agricultuur	613	231	382	-	60	-
CropXR	82	40	42	21	22	-
Groeiplan Watertechnologie	857	462	395	-	-	135
NL2120, het groene verdienvermogen van Nederland	621	289	333	-	-	110
Switch 2 Sustainable Food Systems	484	165	320	-	-	-
Werklandschappen van de toekomst	78	29	49	-	-	26

NXTGEN Hightech: Application domains





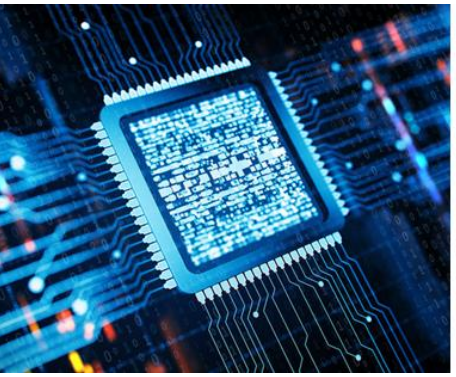


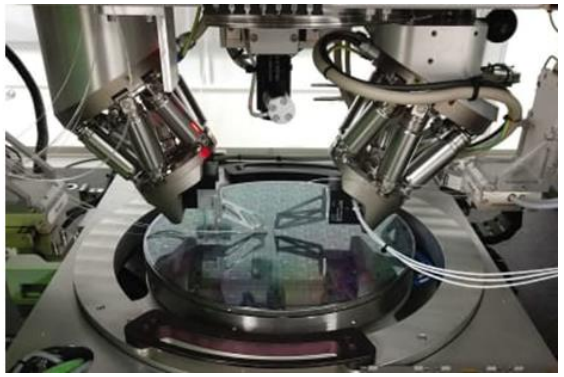


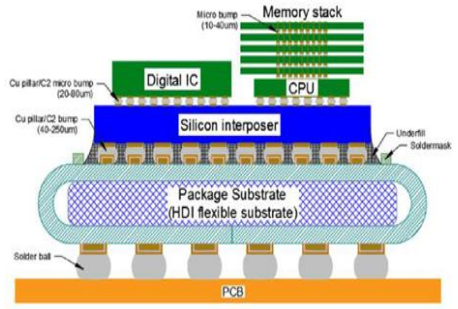
NXTGEN Hightech: Semiconductor domain projects

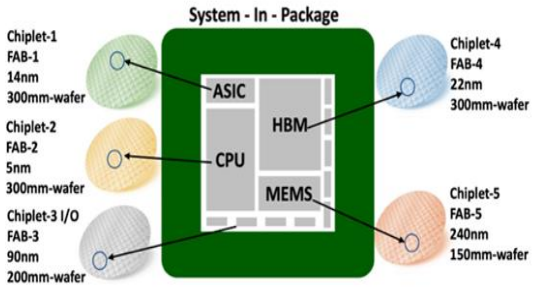
- Process optimization for high TRL & high MRL PLD
- Next Generation High Tech System architectures
- NXTGEN chip assembly equipment
- (nano) Metrologie systemen
- Deposition and printing for heterogeneous assembly
- Metrologie Equipment voor Kritisch Opschalen van PIC Productie
- Productie Equipment voor high volume PIC Productie
- Ecosysteem project

Semiconductor Equipment overview









Semicon trends and equipment drivers

- Lithography based semiconductor

  -> Accuracy, throughput, reliability
  -> System complexity, development effort and cost concerns

- Photonic Integrated Circuit based

  -> Equipment to get from lab to fab
  -> Industrialized manufacturing, inspection and test

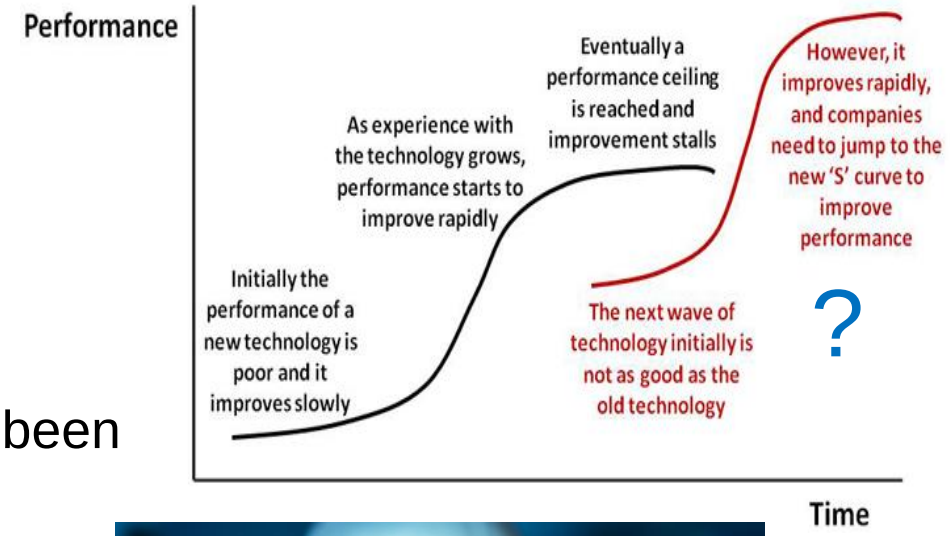
- Heterogeneous Integration

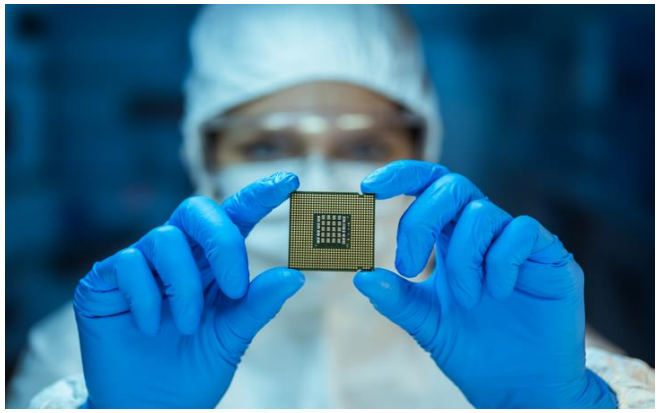
  -> 3D pick and place, bonding, etc.
  -> faster, smaller and more complex

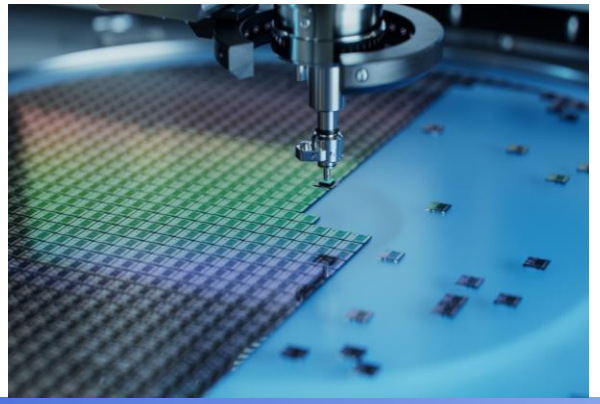
=> Are our high tech system architectures and mechatronic toolkit fit for the future?

Motivation:

- Systems engineering and opto-mechatronics have been a powerful enabler for semiconductor equipment development
- What can be achieved based on existing knowledge and design principles is limited
- Invest now in new knowledge to make sure that continuous improvement of system performance remains possible and technologic leadership position is preserved

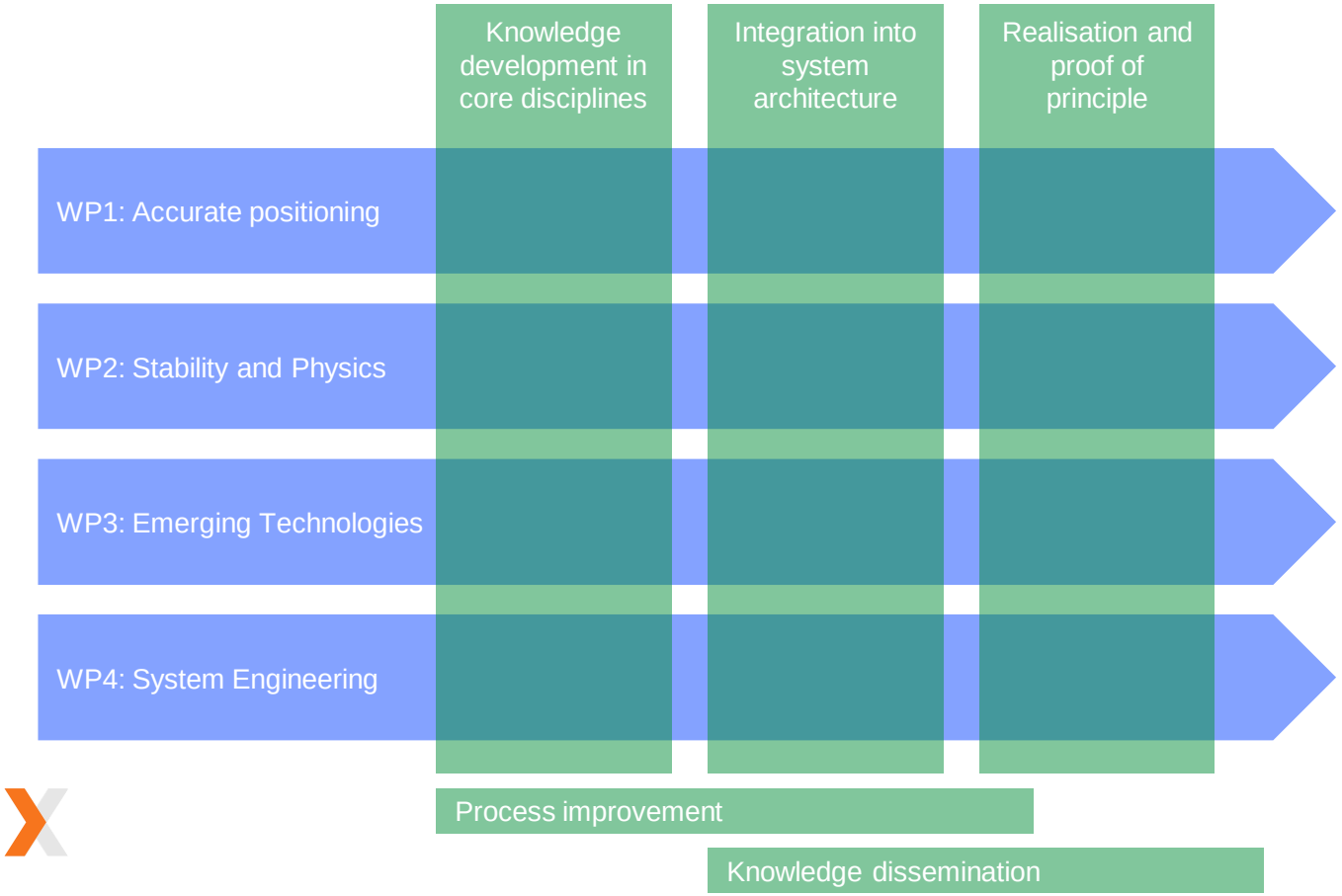






NXTGEN Hightech

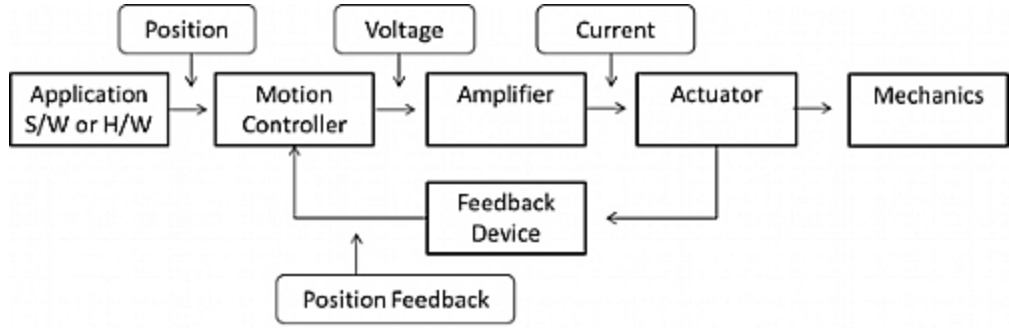
Semicon02: Next Generation High Tech System Architectures

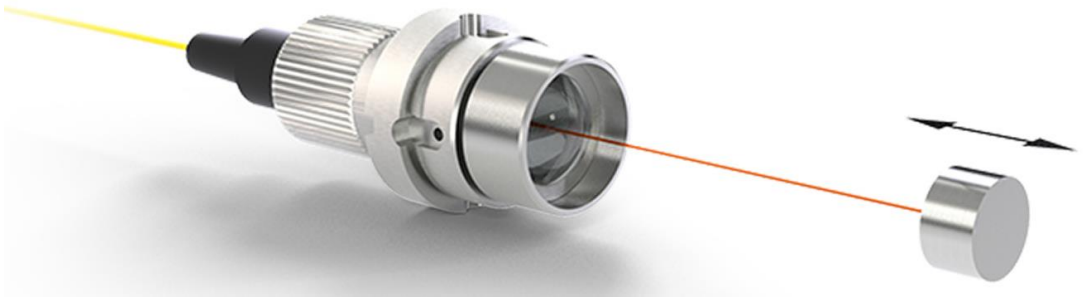


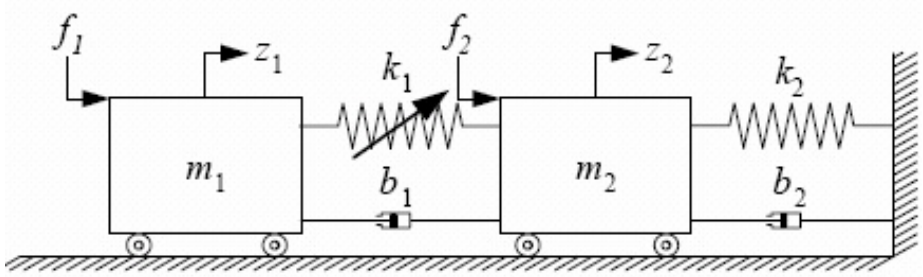
WP1: Accurate Positioning

- **Goal:** Moving faster and positioning even more accurate is an important driver for Semiconductor Equipment based on precision engineering and mechatronics. Accurate and fast movement and placement requires development in the field of actuator technology, position metrology inside and out, fast electronics and advanced control technology and system dynamics

- **Activities:** Research and Knowledge development in the fields of alternative actuation architectures, metrology for accurate positioning, and novel system architectures based on future proof design principles



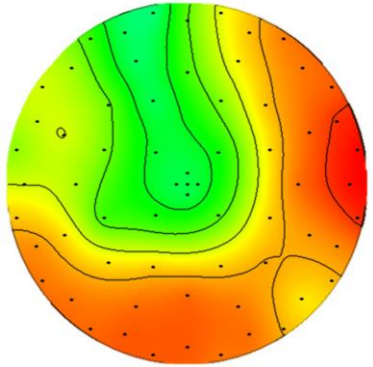


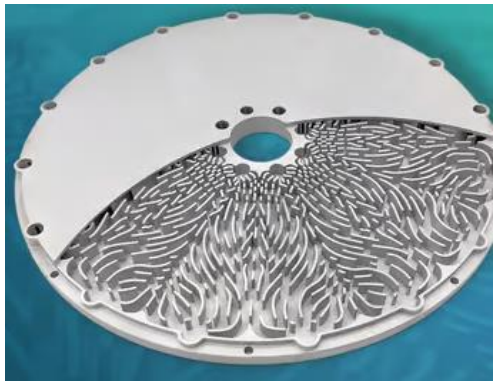


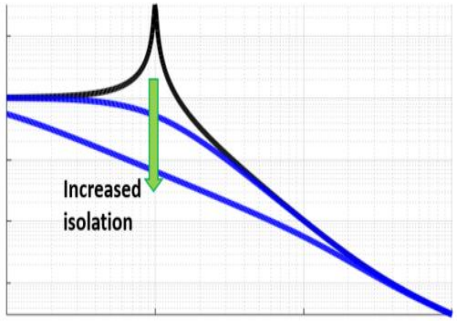
WP2: Stability and Physics

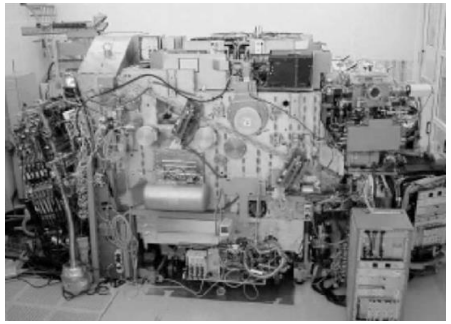
> **Goal:** Maintaining stability requires simultaneous control in all physics domains. Such as mechanical deformations, dynamics and unwanted vibrations and thermal influences. Solutions are needed to increasingly suppress and isolate these influences so that systems can achieve improved performance despite the disruptions. Extreme environments such as high vacuum and cryogenic applications also have significant impact to be dealt with.

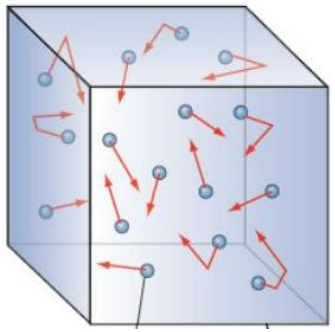
> **Activities:** Research and knowledge development in the fields of advanced thermal control, vibration isololation and control, equipment maintenance, cryo-mechatronics and contamination control

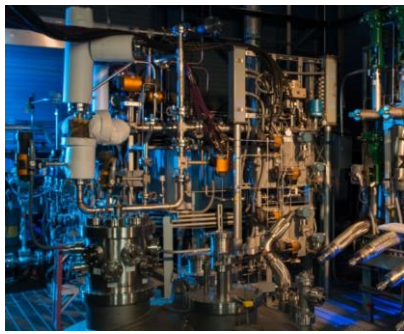






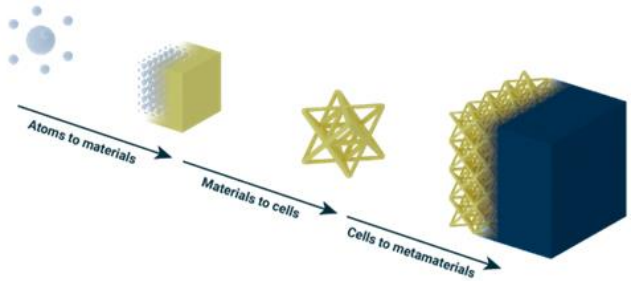


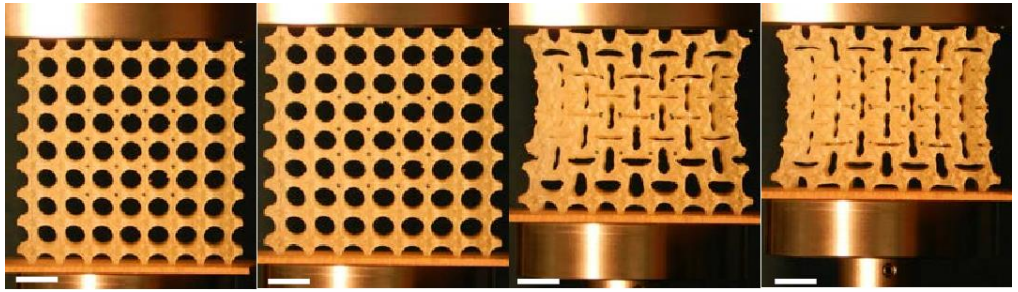


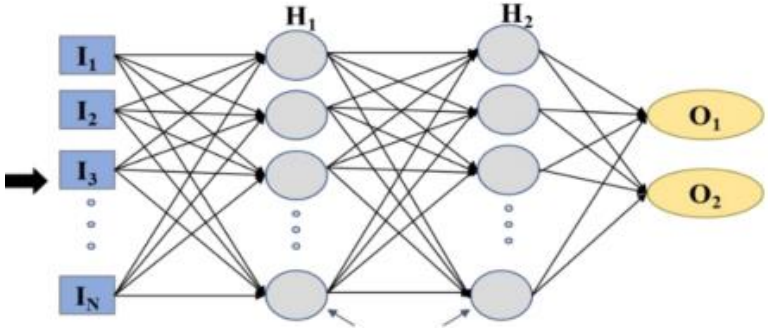


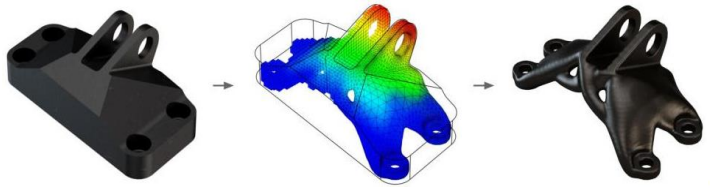
WP3: Emerging Technologies

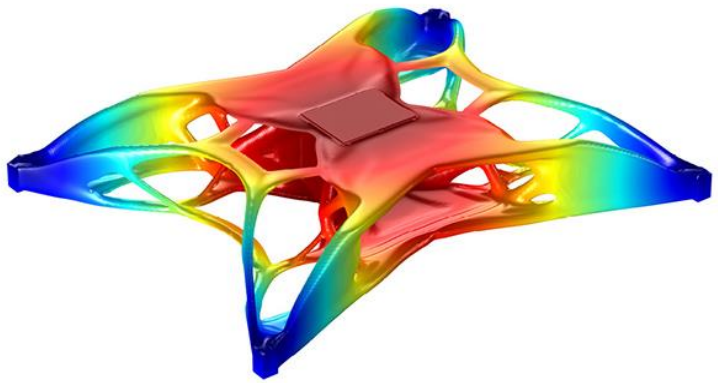
- **Goal:** Exploitation of emerging technologies with potential for performance improvement. Generative design methods, additive manufacturing, Meta materials and AI based design are a few technology avenues to implement in the system engineering domain to ensure improvements in existing system architectures and unlock routes to alternative system solutions
- **Activities:** Research and Knowledge development in the fields of generative design methods, advanced materials, autonomous sensor systems and AI/data driven control







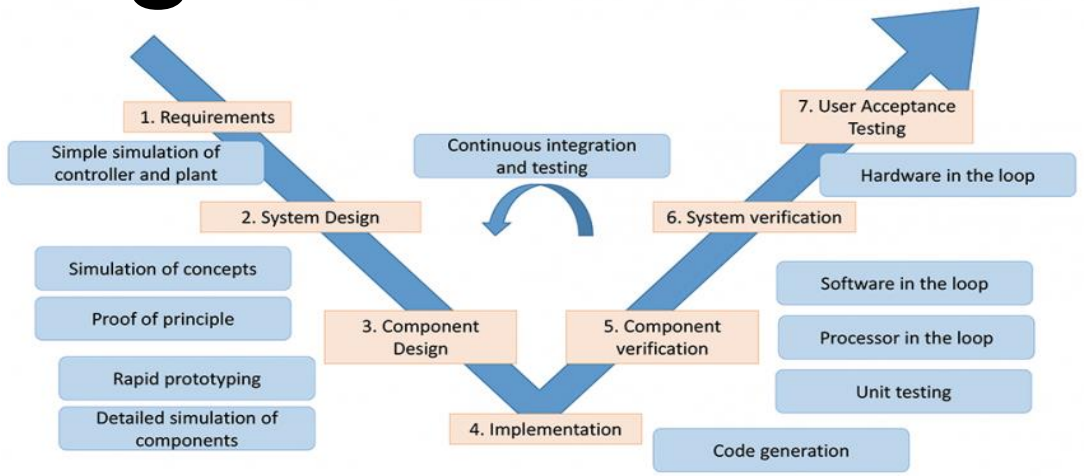


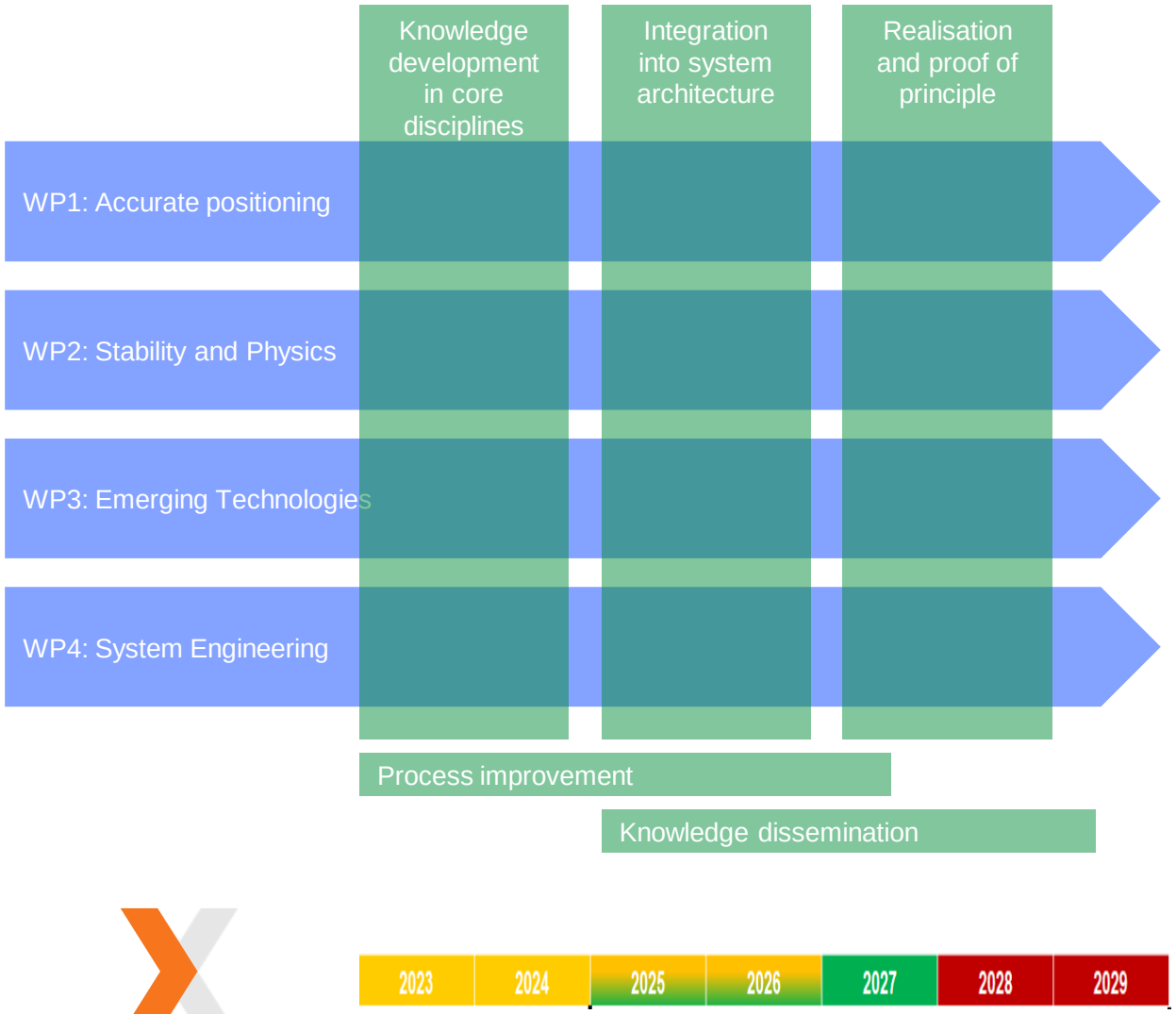


WP4: System Engineering

> **Goal:** Develop future-proof system engineering and working methods to continue to find solutions to the increasing performance requirements and complexity of system behavior depending on design decisions ranging from concept to detail.

> **Activities:** Research and Knowledge development in the fields of system engineering, integration of embedded software engineering with mechatronics equipment engineering





Phasing (2023 – 2029)

- Knowledge development in core disciplines
- Integration into novel system concepts / architectures / design principles
- Realisation and proof-of-principle
- Process improvements, optimal way of working and novel methodologies
- Publication, education, training, knowledge dissemination

nxtgenhightech.nl

Questions & comments:

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gregor.vanbaars@tno.nl