

Technology Readiness levels & NANOMEFOS case

EDWIN GERRITSEN – BUSINESS DEVELOPMENT @ DEMCON



A man with a beard and short hair, wearing a white lab coat, is looking directly at the camera. The background is a blurred laboratory setting with various pieces of equipment. The entire image has a warm, orange-yellow tint.

imagine
tomorrow.
challenge
today.

THE DEMCON GROUP

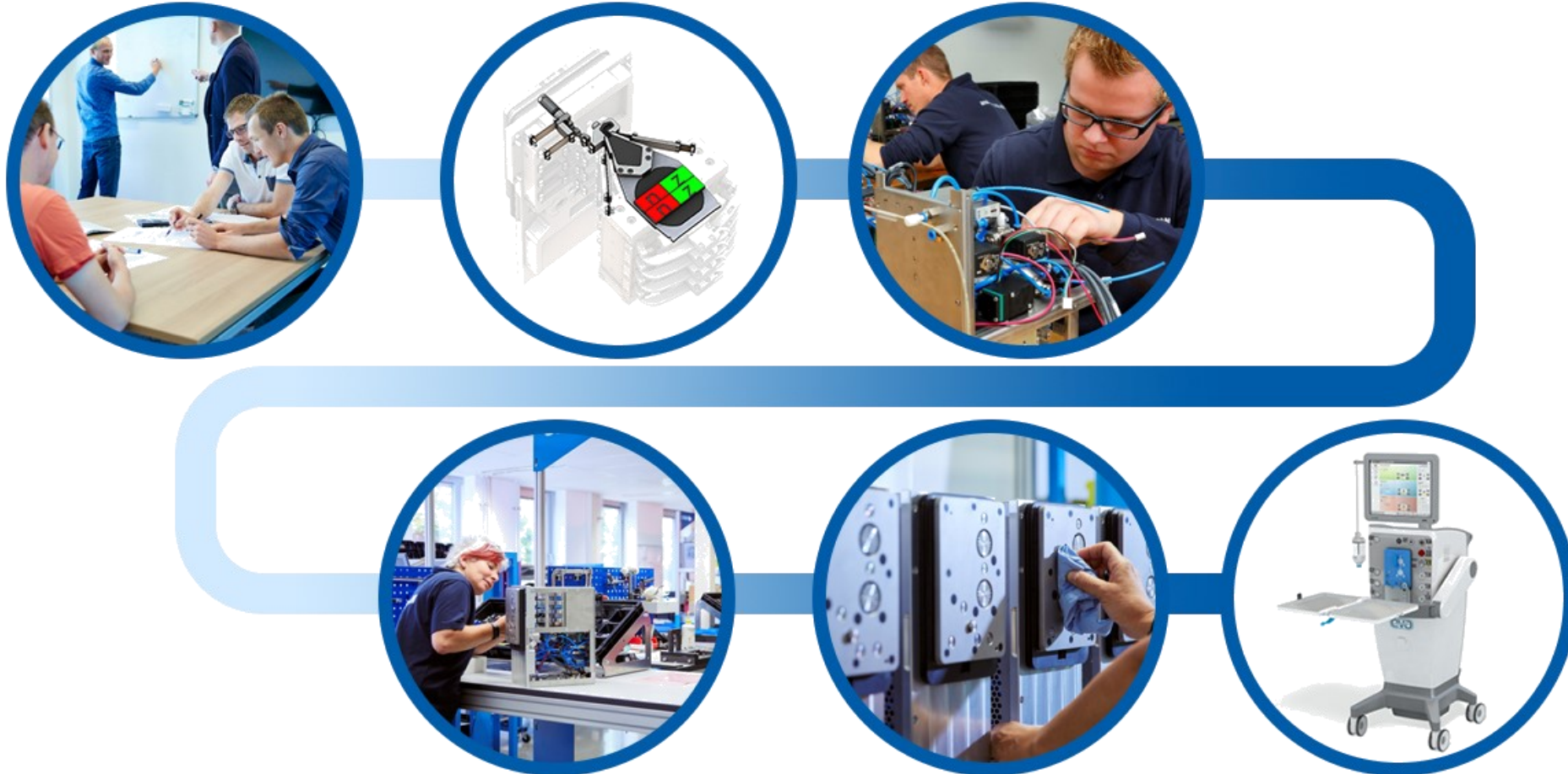
Global system engineering partner

WORKING ON SOLUTIONS FOR TOMORROW

- 1993: University of Twente (NL) spin-off company
- Our heritage: Mechatronic design-house for the semicon industry.
- Expanded into a range of markets like:
 - High tech systems
 - Medical devices
 - Robotics
 - (Aero) space
 - Industrial systems and Automation
- Today
 - Over 100 M€ in annual revenue
 - Over 700 highly skilled technical employees
- Owners Dennis Schipper and Peter Rutgers still drive the business.



Demcon: From proof of concept to production



We are working on a better future in these areas

HIGH-TECH
SYSTEMS
& MATERIALS



LIFE SCIENCES
& HEALTH



SMART INDUSTRY



WATER
& MARITIME



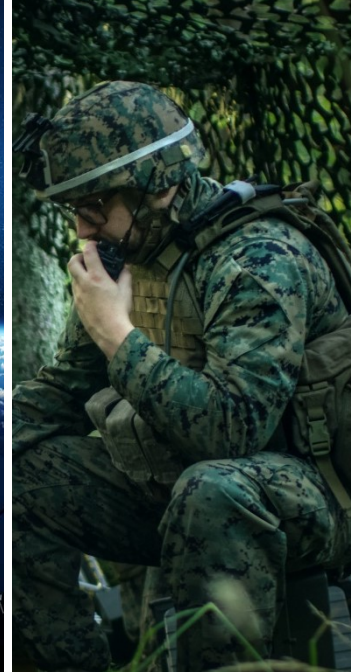
AGRI
& FOOD



AEROSPACE

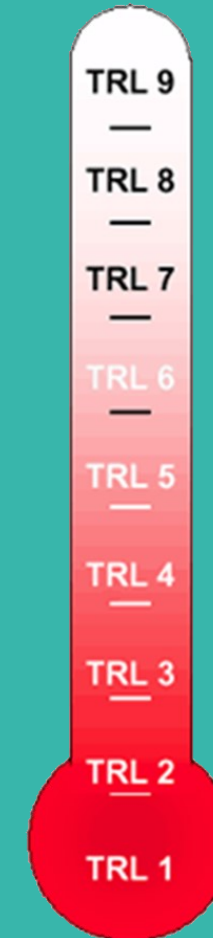


DEFENSE
& SECURITY



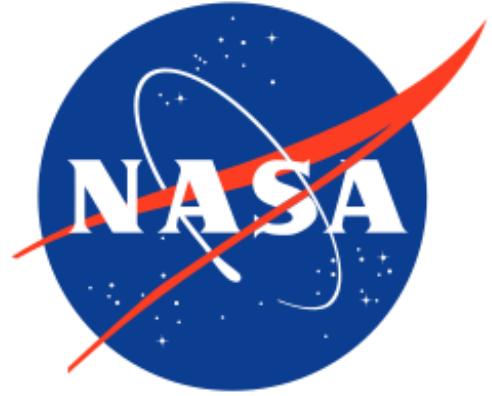
Technology Readiness levels & NANOMEFOS case

EDWIN GERRITSEN – BUSINESS DEVELOPMENT @ DEMCON



Oorsprong TRLs

- Technology Readiness Levels (TRLs) zijn universele maatstaven om de volwassenheid van een bepaalde technologie op een systematische en objectieve manier te beoordelen.
- TRLs zijn oorspronkelijk ontwikkeld en voor het eerst toegepast door de NASA voor het kwalificeren van space technology.
- Met enkele aanpassingen zijn TRLs ook te gebruiken om technologie in andere toepassingen te kwalificeren.



Orginele NASA TRLs Chart

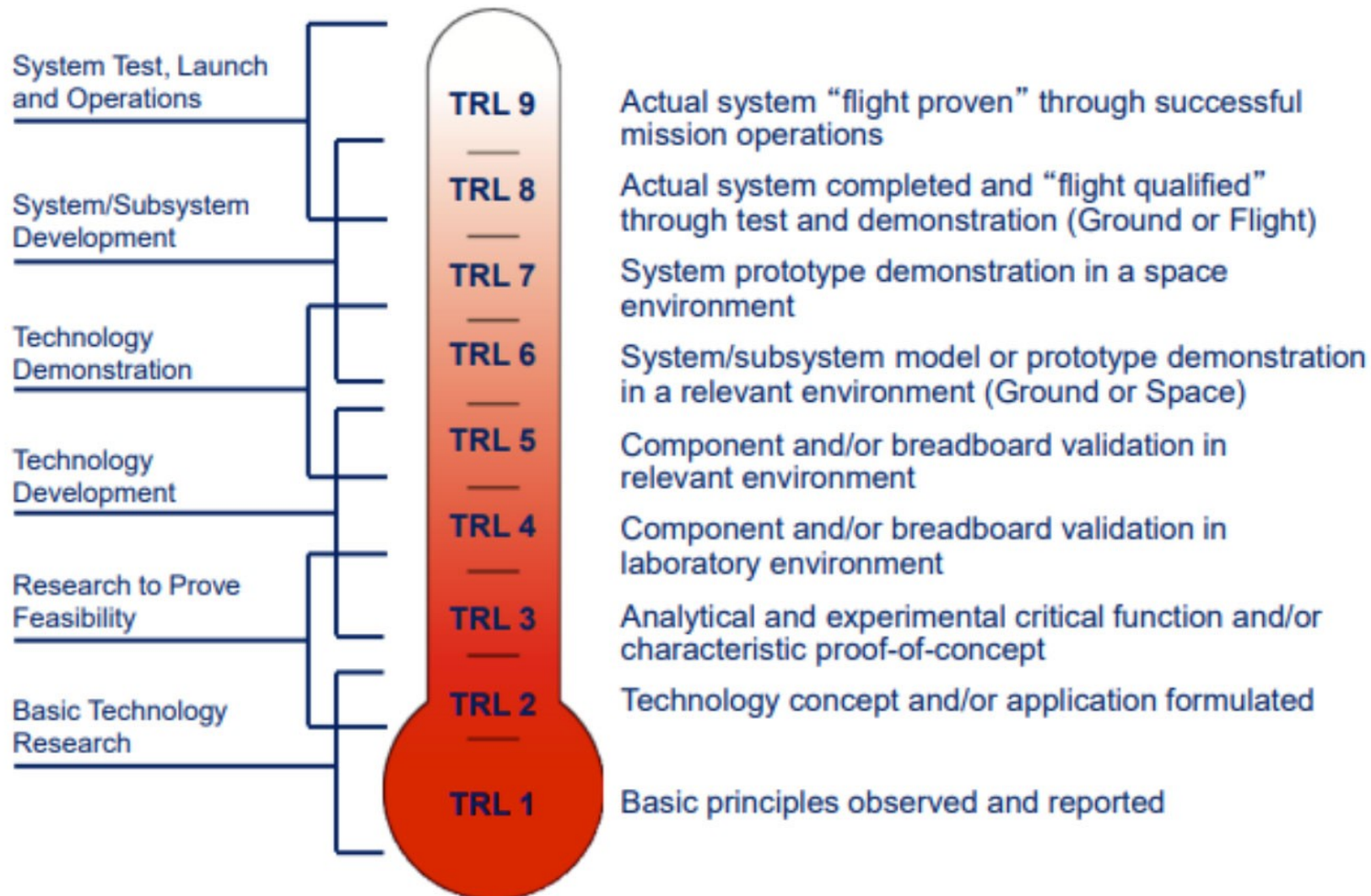
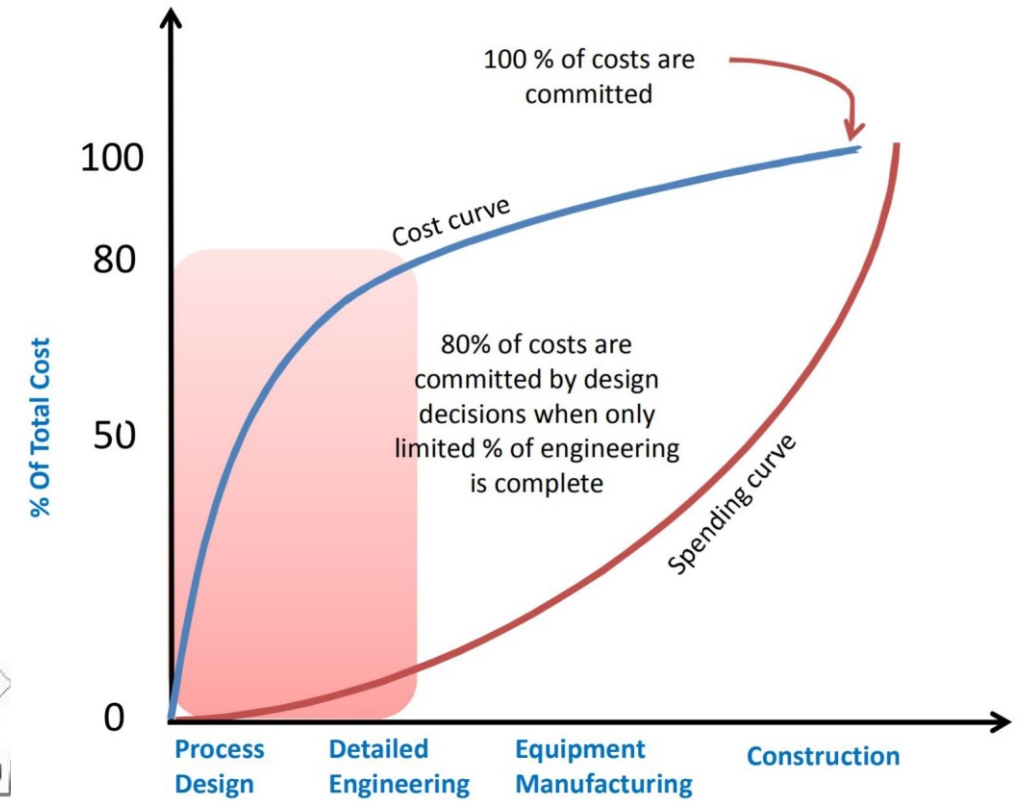
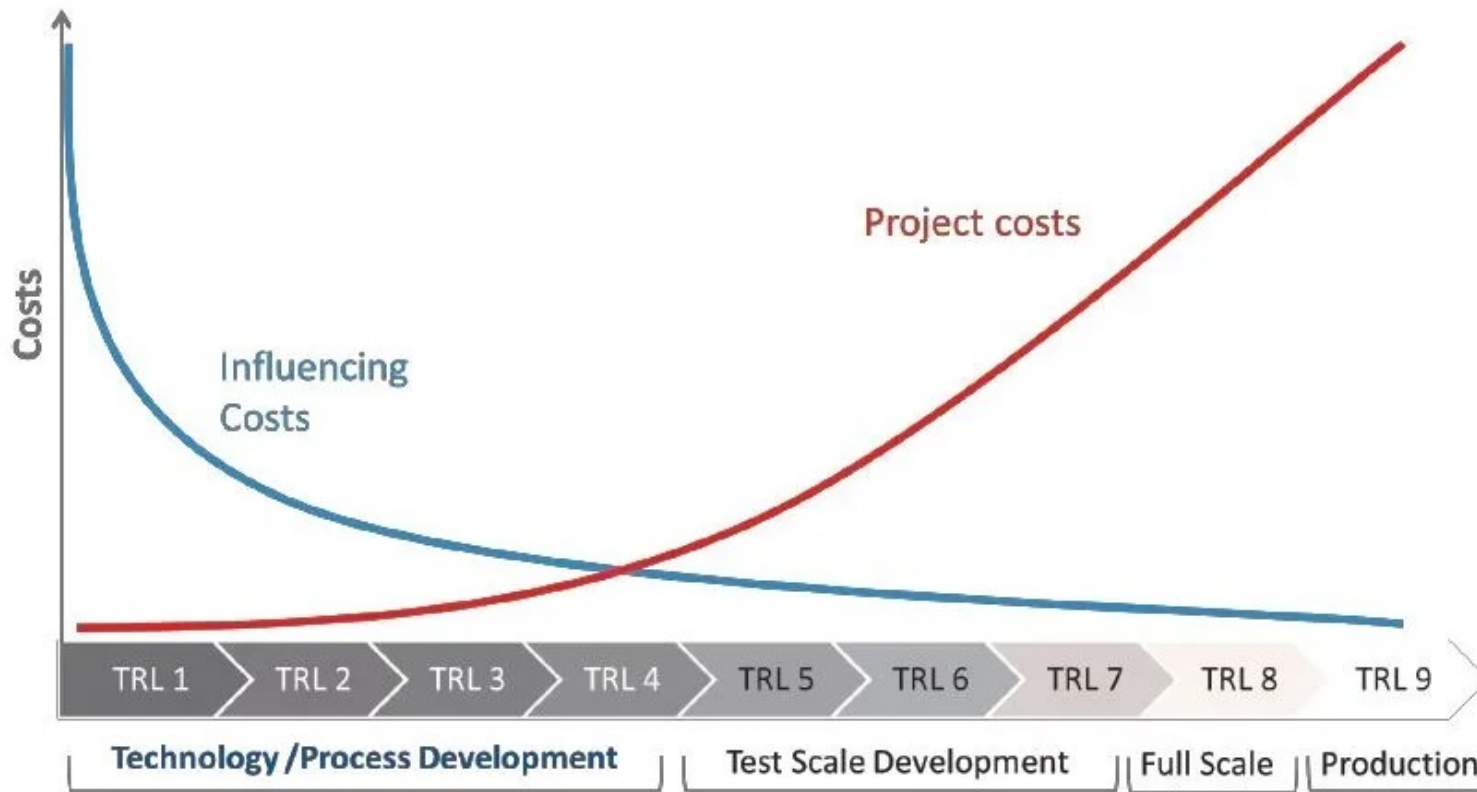


Figure 1. NASA Technology Readiness Level chart (©NASA)

Project kosten als functie van TRLs

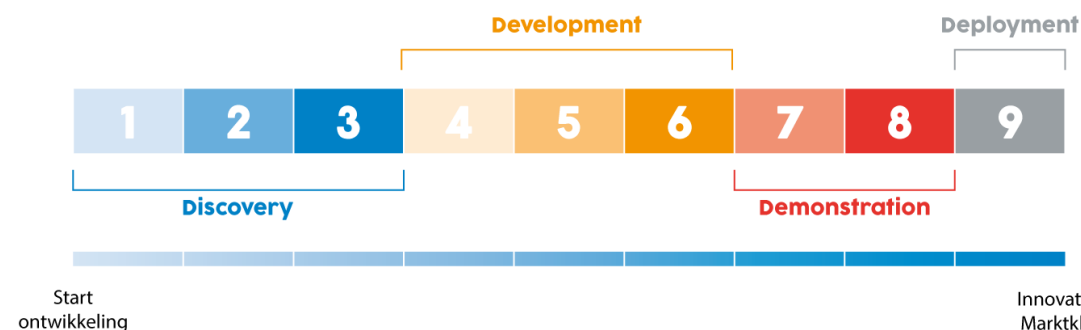


Europese implementatie en gebruik

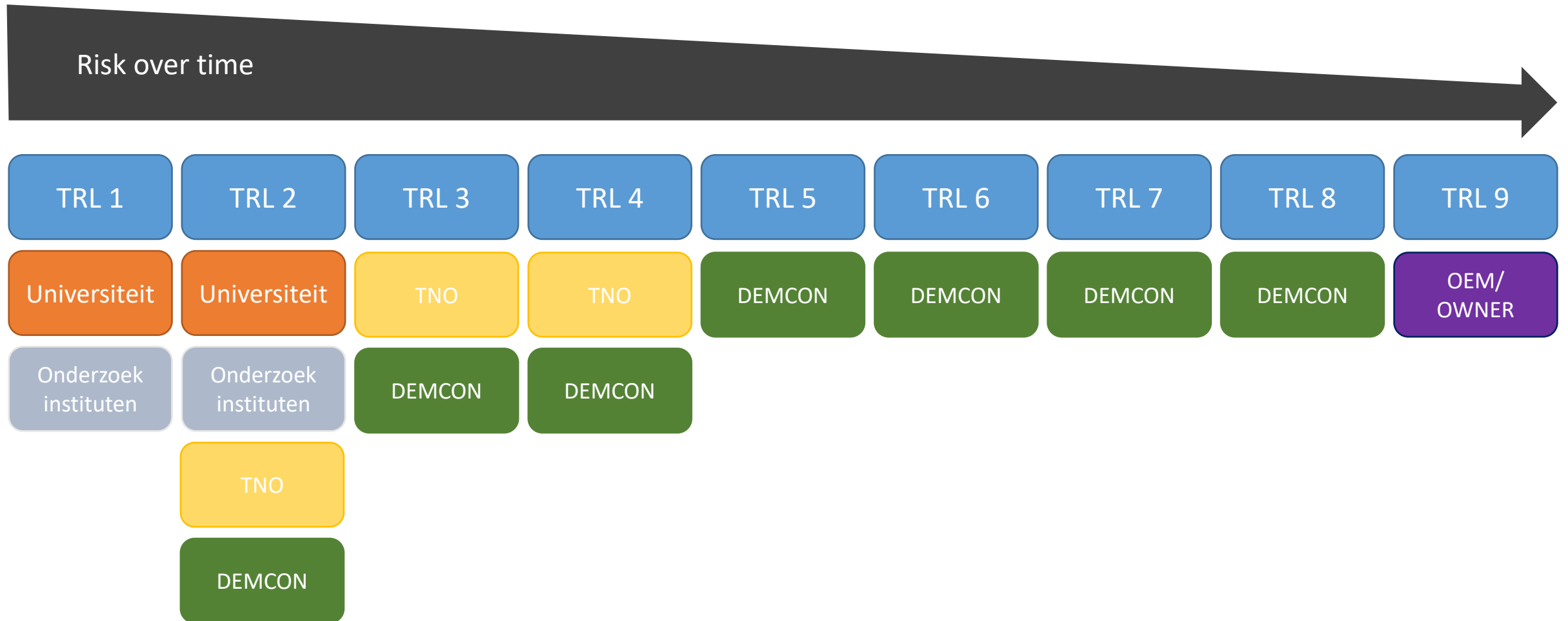
- De schaal loopt van TRL1 tot en met TRL9
- Binnen de EU commissie worden er vier fasen gehanteerd
 - *Discovery*
 - *Development*
 - *Demonstration*
 - *Deployment*
- *TRLs beoordelingen worden tegenwoordig gebruikt door:*
 - *High-tech bedrijven, O&G industrie*
 - *Defensie*
 - *EU en Nederlandse subsidie programma's van het RVO*
 - *Investeerders*
- *Het is belangrijk om te weten waar je staat.*



CloudWatch TRL adoption

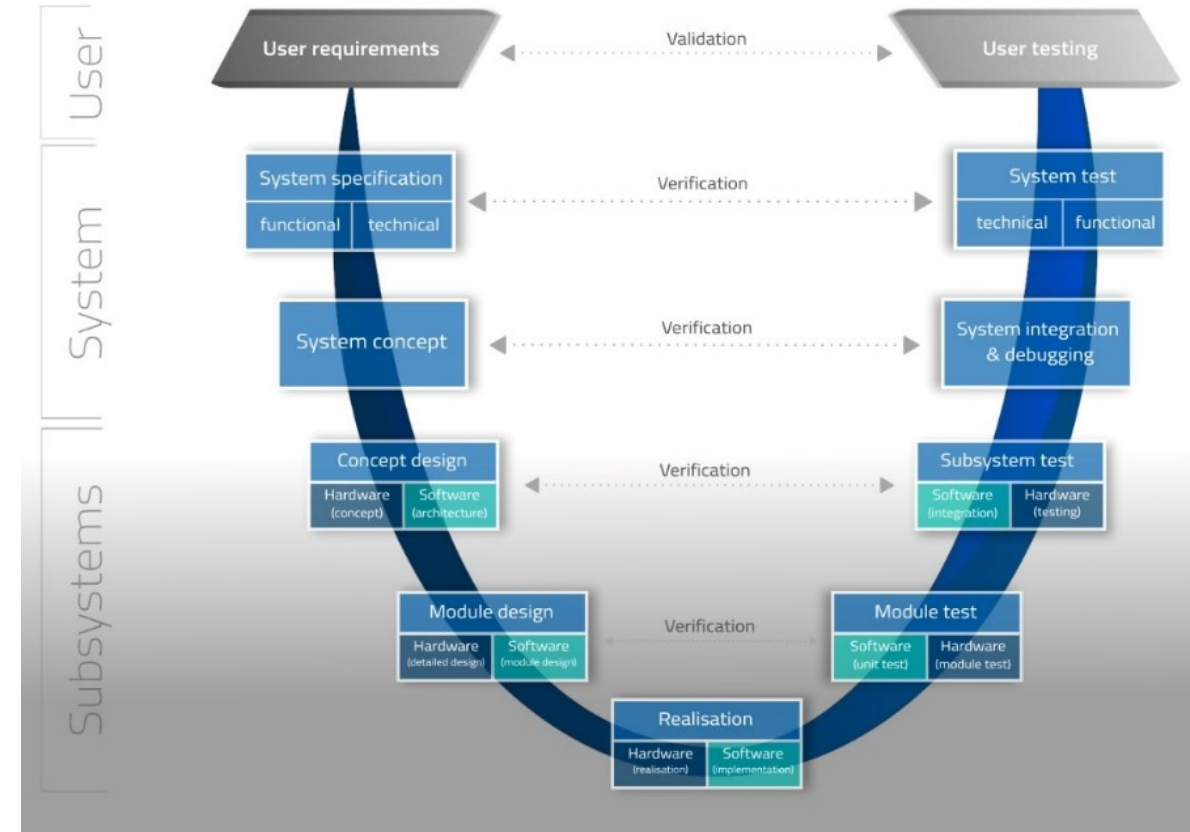


Partijen actief in de verschillende TRL levels



Risico management

- Risk assessment
 - Identificatie van technisch risico in een vroeg stadium van het project.
 - Beoordelingen van risico's, kans & impact
- Risk mitigation
 - Ondernemen van Proof-of-Concept / Proof-of Principle om technisch risico af te bouwen.
- Ontwikkelen volgens een v-model



NANOMEFOS: Meet system voor freeform lenzen



Type of Asphere		Pros/Cons
	Convex	Easy to manufacture Hard to measure
	Concave	Hard to manufacture Easy to measure
	Gullwing	Hard to manufacture Hard to measure Does more optically
	Freeform	Harder to manufacture Harder to measure Little to no symmetry

Voorbeeld project: Lens meetsysteem

Achtergrond:

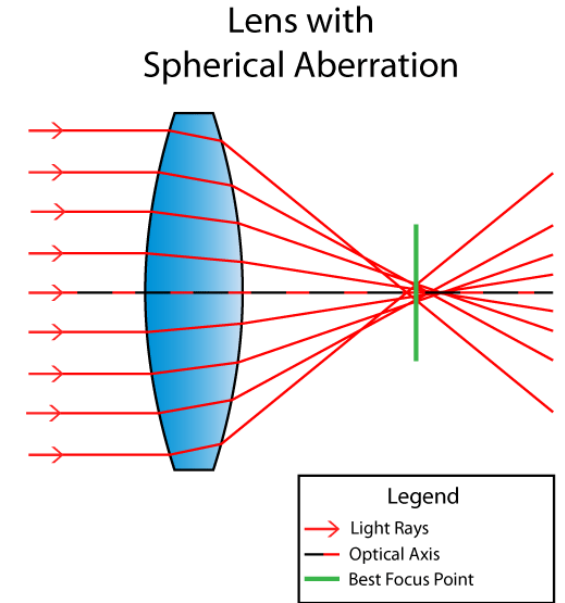
- Sferische lenzen zijn niet perfect en geven aberraties (lensfouten).
- Een asferische lens is 'perfect' en geeft geen aberraties
- Max. productiefout <10-15 nm ivm licht



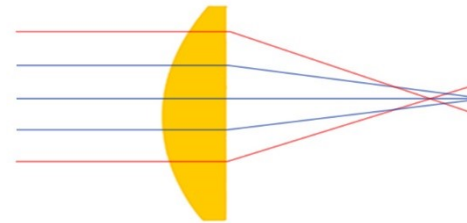
Christiaan Huygens 1629-1695



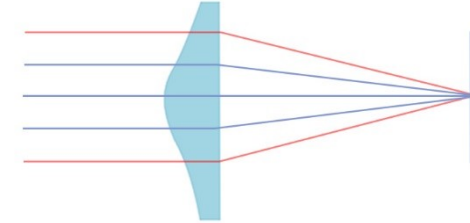
René Descartes 1596-1650



Spheric Lenses



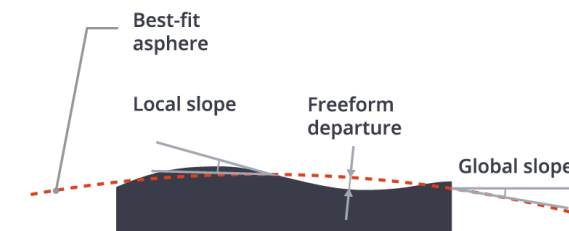
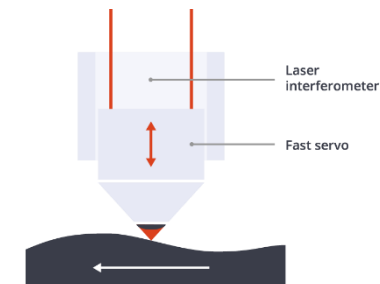
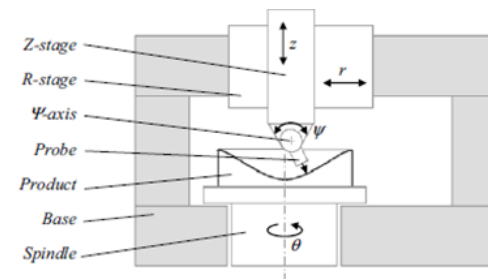
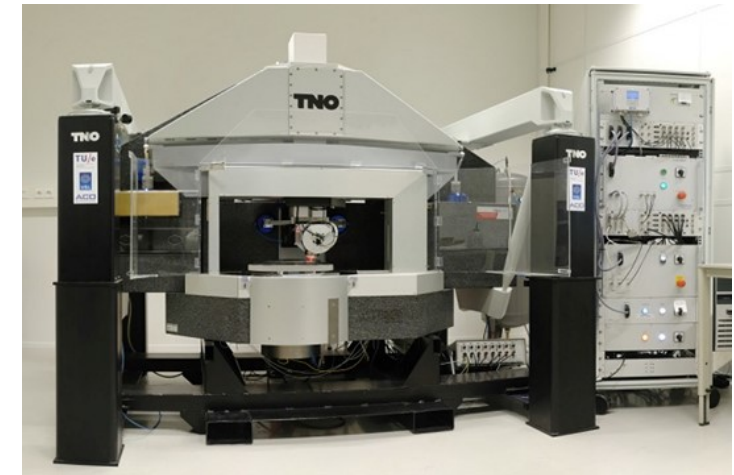
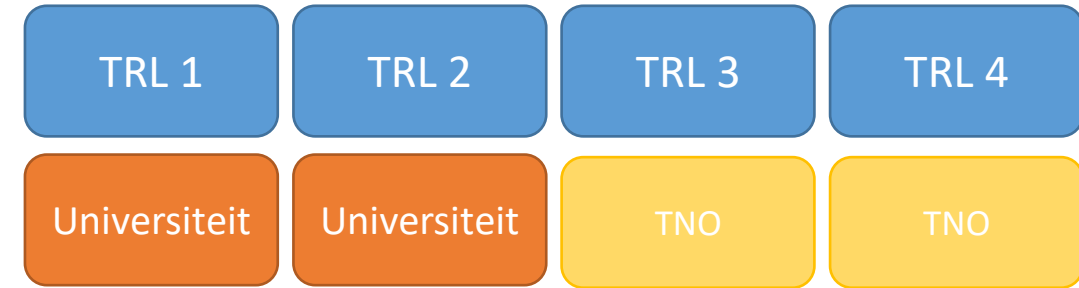
Aspheric Lenses



Toepassing Asferische lenzen:
Grote optiek, telescoop, satelliet etc.

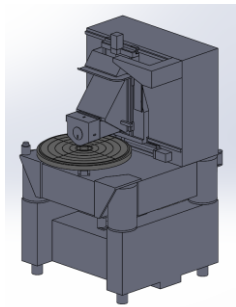
Freeform lens meetsysteem

- Verificatie van de lens na productie
 - TUE + TNO project gestart in 2002
 - Meerjaars traject
 - Concept meetsysteem bedenken en uitwerken
- Uitwerken meetprincipe en FUMO door TNO
 - Functional model 2009, bediening door experts
 - TNO NANOMEFOS technologie
- Nog veel werk nodig om naar de markt te brengen.
 - Improved performance
 - Improve reliability
 - Design for manufacturing
 - Cost effective design
- Markt was destijds nog niet klaar.



Dutch United Instruments (DUI)

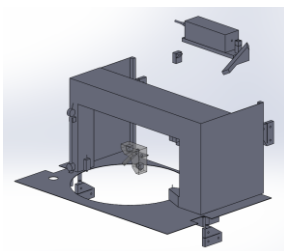
- DUI opgericht in **2017** om de technology volwassen te maken en te commercialiseren.
- Demcon ingehuurd om de technologie van TRL4 naar TRL8 te brengen.
- Bouwstenen:



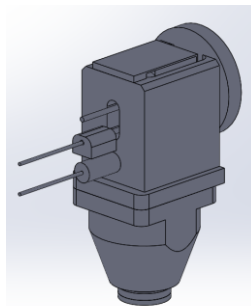
Motion system



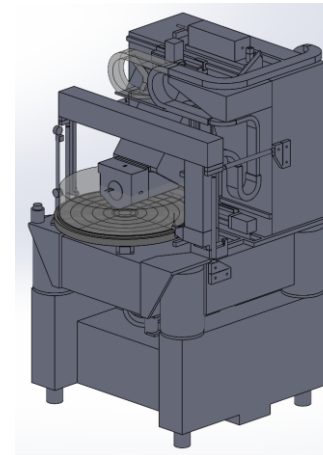
Dutch United Instruments



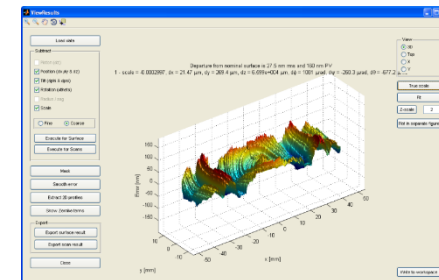
Metrology system



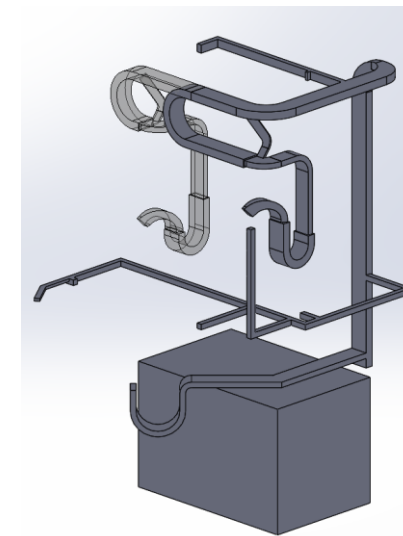
Optical Probe



Enclosure

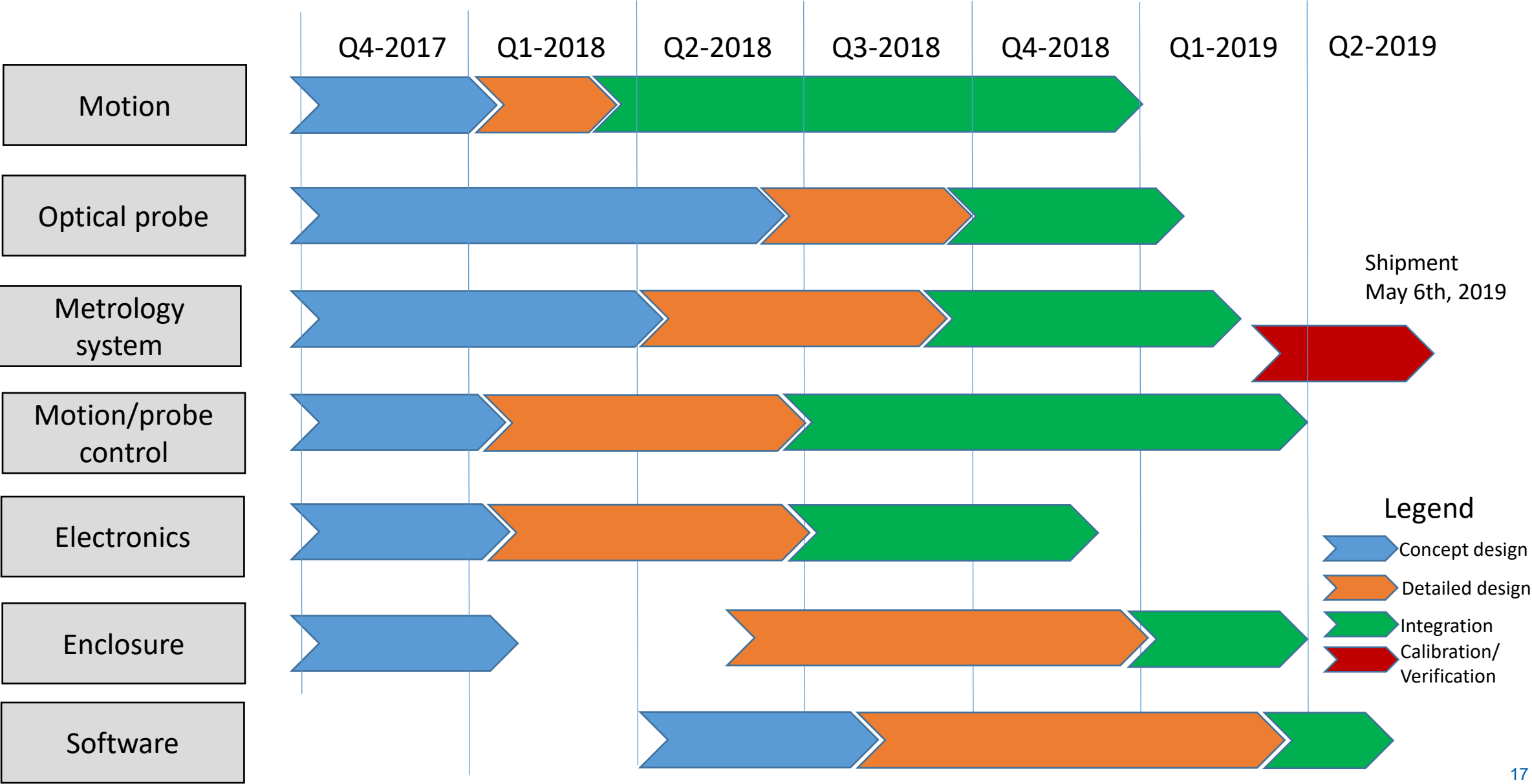


Application software

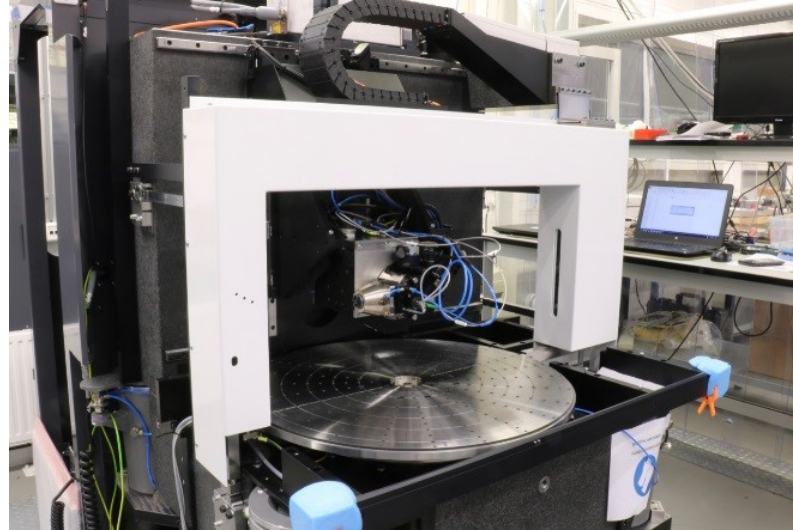


Electronics & motion control

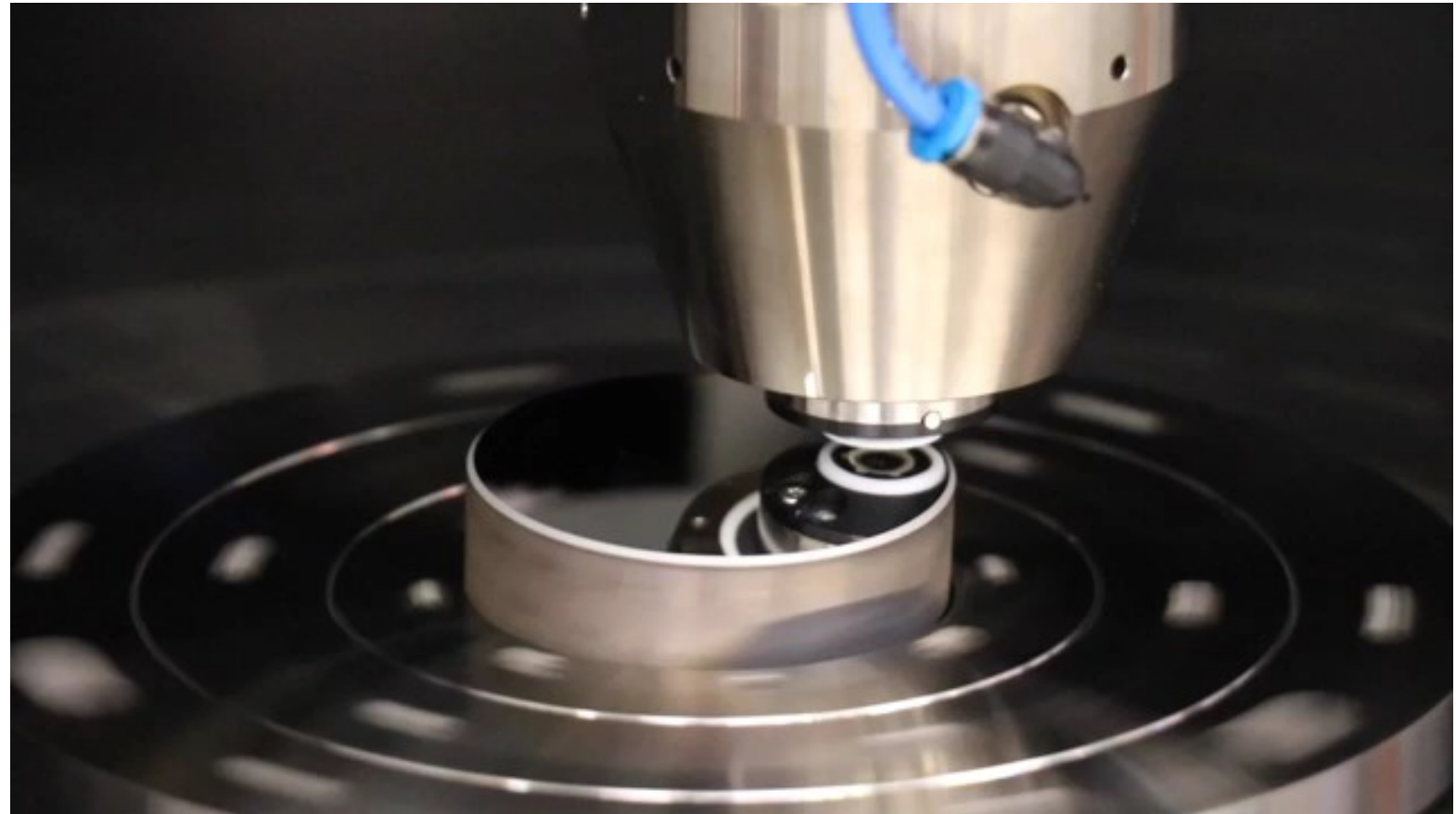
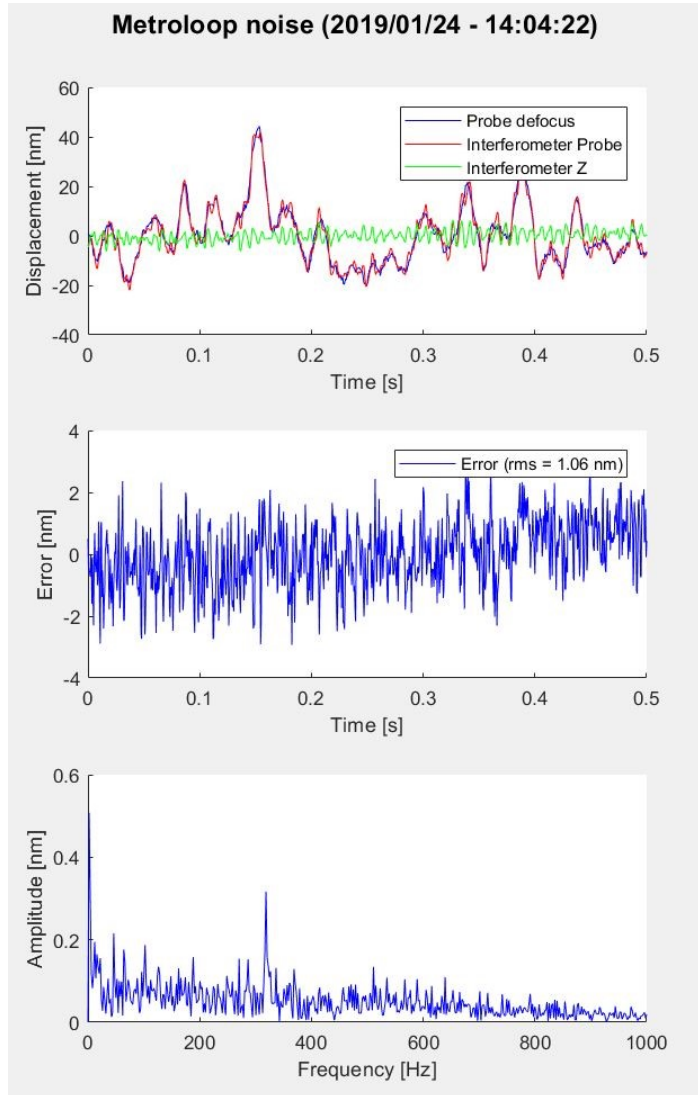
Development timeline



NMF600 S Realization



NMF600 S Testing



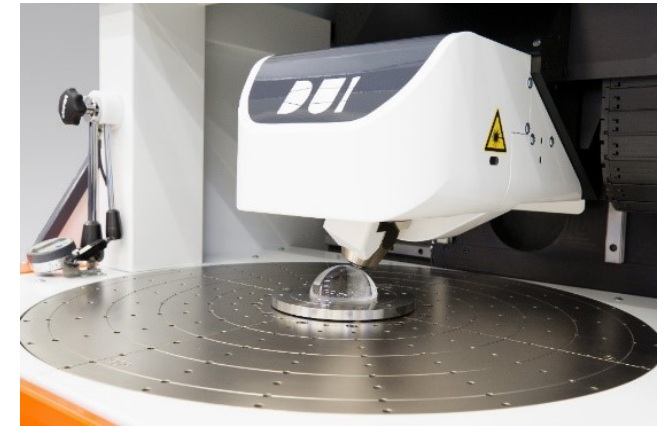
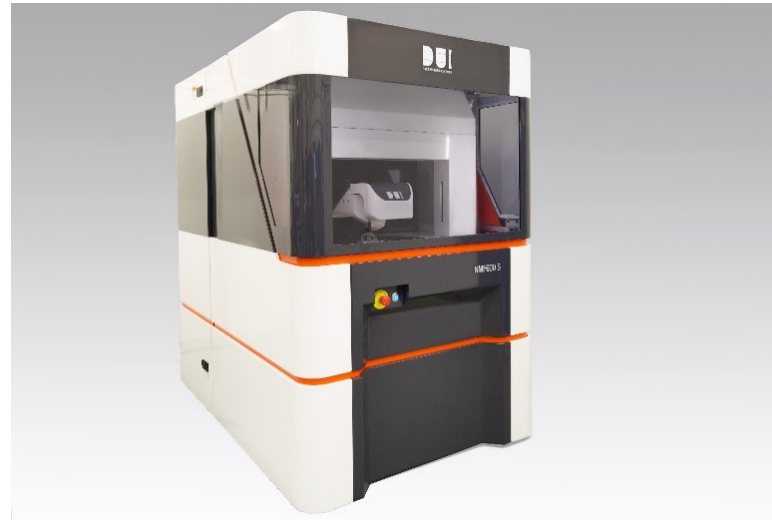
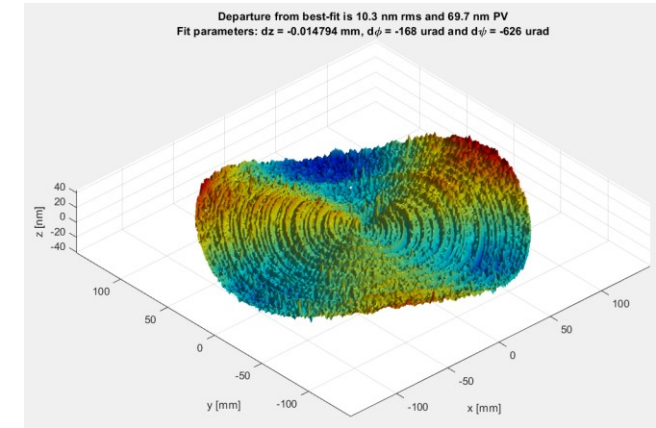
NMF600 S results

- Typical specifications that have been achieved:

- Uncertainty < 15 nm
- Volume $\varnothing$ 600 mm x 125 mm
- Flat to freeform
- Convex to concave
- Probe with 5 mm range
- Acceptance angle of 7°

- Commerciële status:

- >7 systemen verkocht
- Prijsrange 500k€ -1000k€ per stuk



Key takeaways

Algemeen:

- Technology readiness levels worden gebruikt om de status van technologie te beoordelen.
- De weg naar een robuust werkend product is vaak nog lang vanaf de lagere TRLs.
- Je hebt vaak meer budget en tijd nodig dan je denkt.
- Identificeer risico's en bouw deze vroeg in het project af.
- Maak kleine stapjes en zorg dat je samenwerkt met de juiste kennis partners.
- Stand van de techniek & marktvraag moeten op het juiste moment bij elkaar komen.
 - Ontwikkeling NANOMEFOS in 17^{de} eeuw onmogelijk 😊

Contact:



Edwin Gerritsen

- Business development
- +31 6 30 19 23 93
- edwin.gerritsen@demcon.com