

ZEEKO^{Ltd}

With

University of
HUDDERSFIELD
Inspiring global professionals

*Optics for laser-fusion
– a new Eureka project*

David D. Walker

Research Director, Zeeko Ltd

Prof. of Ultra-Precision Surfaces, University of Huddersfield

Based at Laboratory for Ultra-Precision Surfaces, SciTech Daresbury



Define the problem...

National Ignition Facility

2022, 2.05 MJ laser light to target
3.15 MJ energy from target
=> 1.5 gain at the target

Latest news yesterday
>5MJ out



But the laser system consumed "well above 400 megajoules".

$$\text{"Wall plug efficiency"} = \frac{\text{Energy produced}}{\text{Electricity consumed}} = \sim 1\%$$

Potential solutions

NIF optimisation ... but is a step-change needed ??

- Adopt **aspheric and freeform optical surfaces** => additional mathematical degrees of freedom in optical design.
 - Reduce number of optics
 - Enhance beam-focussing
 - Reduce side-lobes/stray light
 - **Enhance end-to end optical efficiency**

Requirements	High LDT* optics	c.f. Standard high quality scientific optics
Surface quality	➤ Today – High LDT on flat or spherical optics	
Sub surface damage (SSD)	Eliminated	Low

➤ Significant aspheres / freeforms beyond state-of-the-art

* Laser damage threshold

** Mid spatial frequencies - ripples

A new initiative

“Super-polished Freeforms Optical Systems (SFOS) for industry and nuclear fusion”

A Eureka project

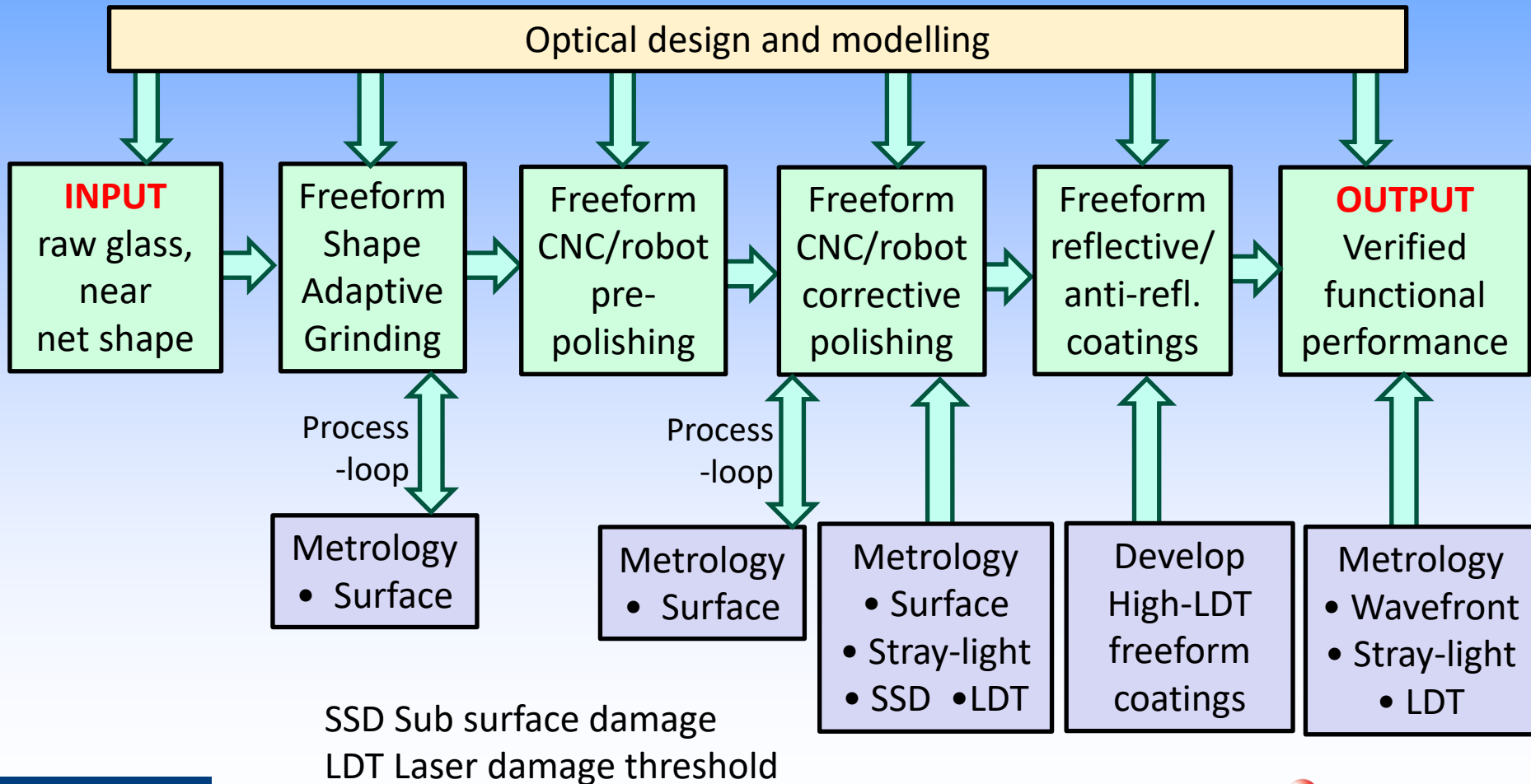
Funded by Innovate UK and InnoSuisse

Started Dec 2023, for three years

Total project value €3.6m

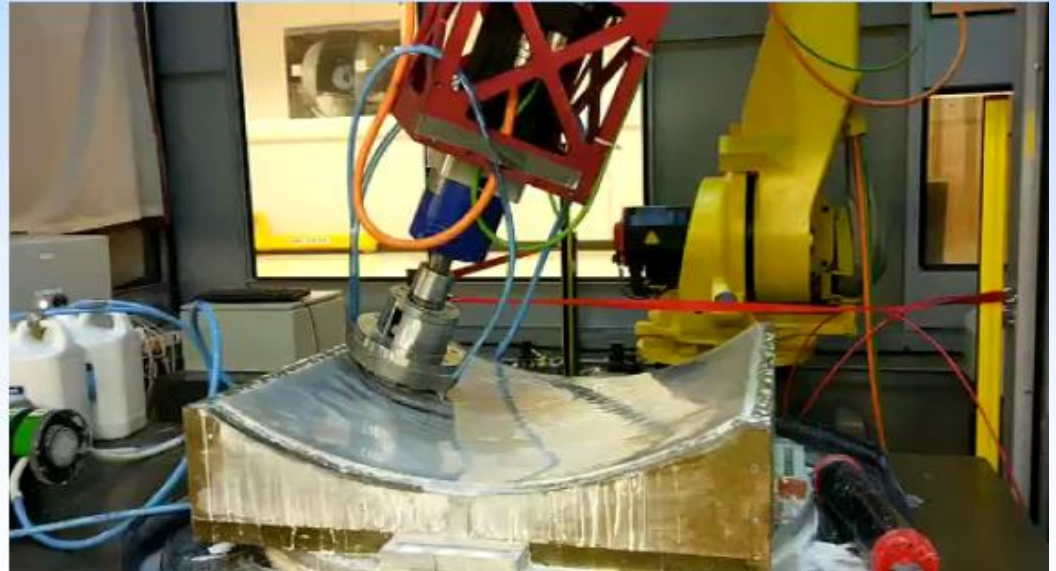
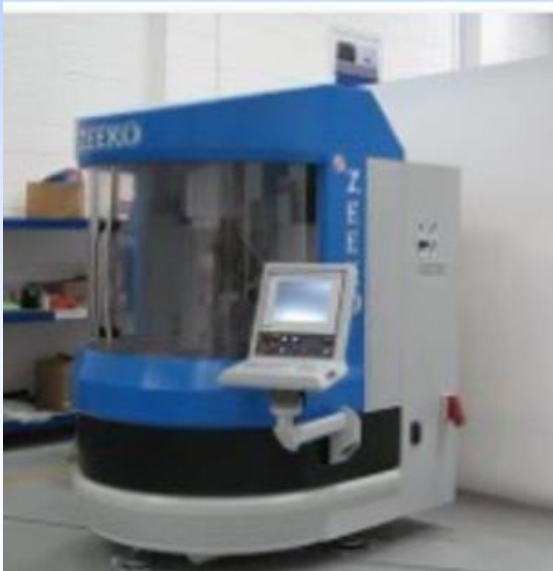
Core objective

To develop a *total process chain* delivering high-LDT on aspheric/freeform optics



Eureka Consortium

Partner	Tasks	Leader
Zeeko Ltd (lead)	Project management, scientific leadership, CNC and robot polishing machines and processes, metrology, software	DDW
Sagittal Optics (subcontractor)	Optical design; modelling performance impact of defects in measured freeforms	Jorge Sanchez Capuchino
U-of-Huddersfield	Research in CNC polishing, freeform metrology and total process optimisation	Guoyu Yu
Thin Metal Films Ltd	Reflective and anti-reflection coatings optimised for freeforms	Trevor Walker
OST – Eastern Switzerland Univ. of Applied Sciences	Metrology, advanced tooling, sub surface damage	Oliver Fähnle
WZWOPTIC AG Switzerland	High-LDT super-smooth polishing on regular surfaces	Bernd Eiermann



Opportunities

- Collaborations
 - Subject to approval of the Consortium (and NDA where commercially sensitive)
 - Engage with the User Community – what do you want?
 - Jointly-execute specific technical tasks
 - Secondments to our U-of-H/Zeeko lab at Daresbury
 - PhD students on process/metrology or specific case-studies
 - Joint publications
 - Provision to the project of:-
 - challenging and relevant optical designs/specifications
 - test parts for processing and evaluation