
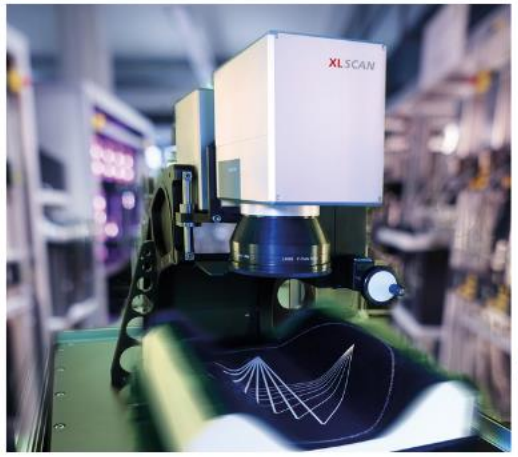


Technologies of Modern Scan Systems

Modern Galvanometer Scanner Technologies Enabling Advanced Laser Processes

Dr. Holger Schlüter

1.12.2022

Thursday, 1 December 2022, 10:15 – 12:00 CET
Dornbirn, Austria

EPIC TechWatch at W3+Fair 2022

SCANLAB at a Glance

- Worldwide leading OEM manufacturer of scan solutions for deflecting and positioning laser beams
- Our high-performance components are the core of e.g.:
  - 3D printers
  - Laser welding robots
  - Laser systems for medical treatments
  - Micro-structuring systems
- 35,000+ units manufactured and installed annually
- Trendsetting developments in the fields of electronics, mechanics and optics

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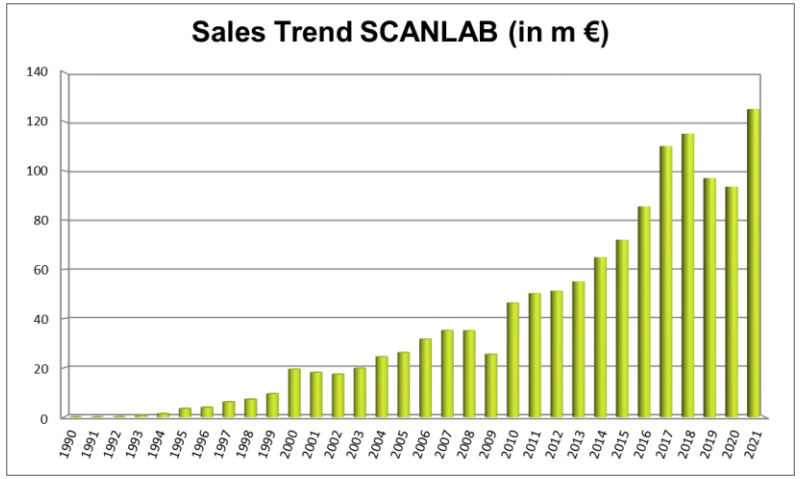
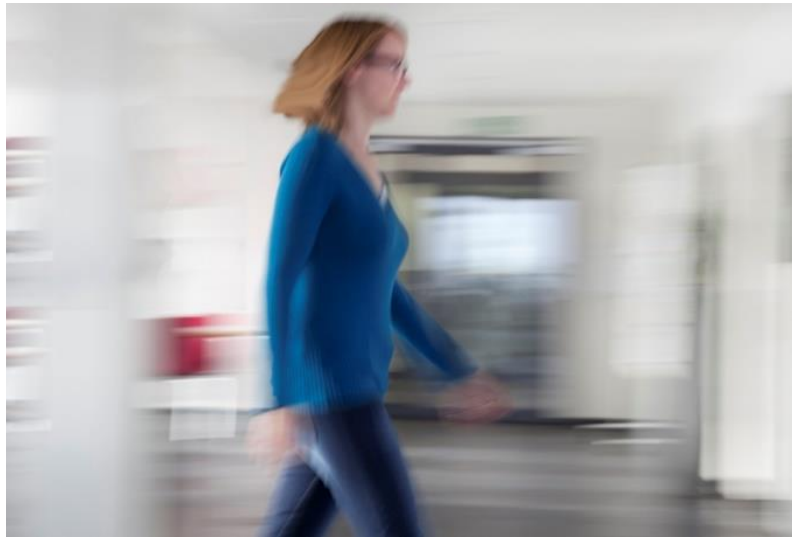
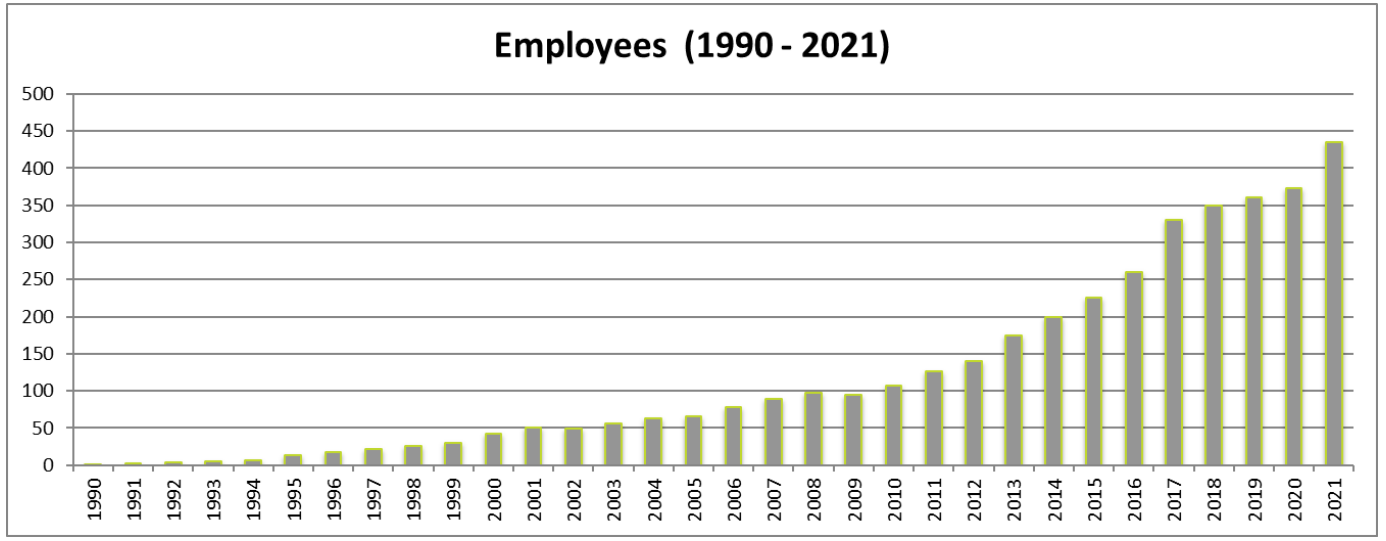
SCANLAB in Figures



- Sales 2021: approx. € 126 million
- More than 450 employees from 36 countries
- Around half of our highly qualified team are engineers and scientists





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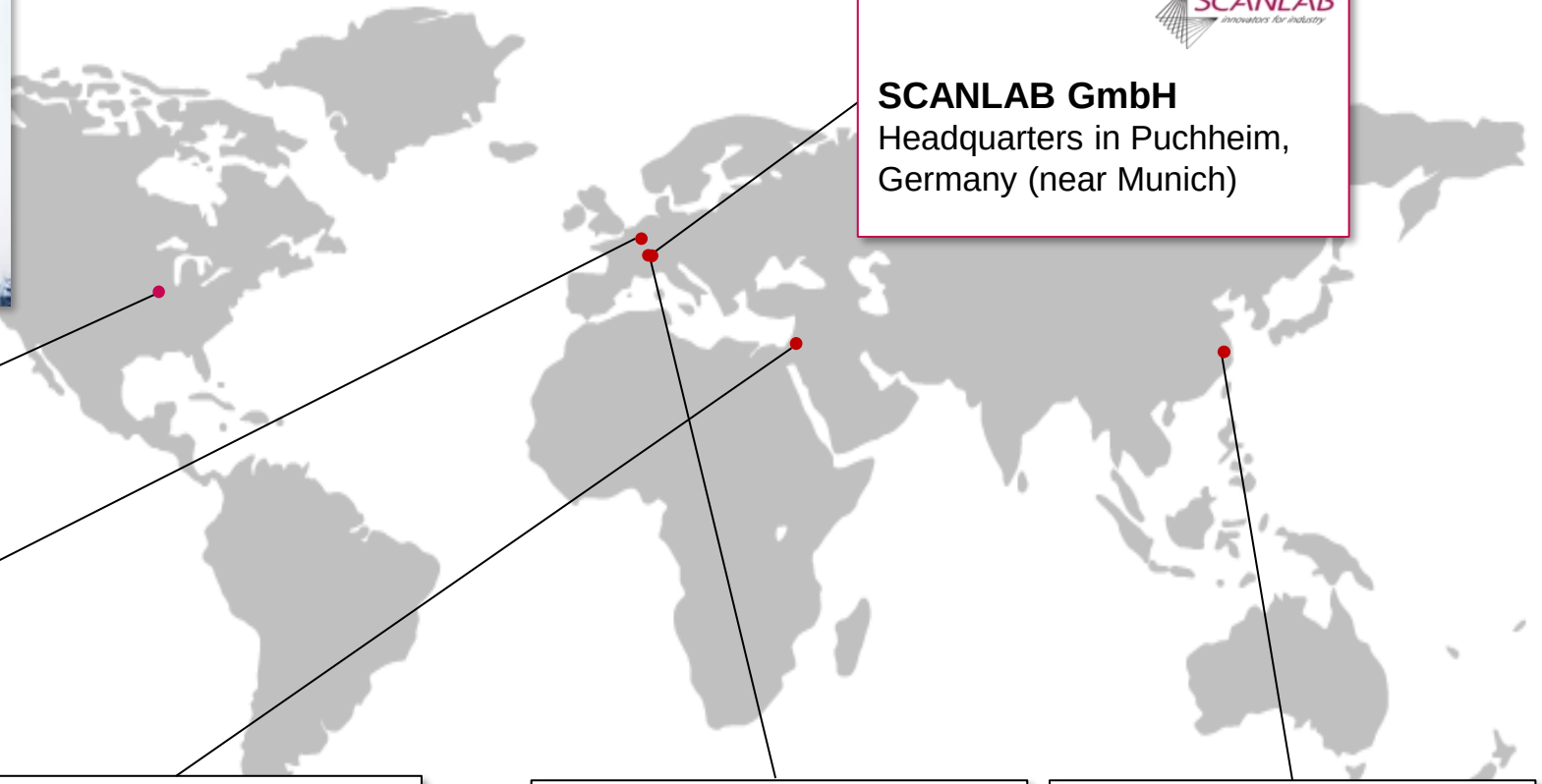
A Strong Global Team



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Headquarters in Puchheim, Germany (near Munich)

SCANLAB America, Inc.
St.Charles, IL, USA

SCANLAB BV
Evergem, Belgium
(near Gent)

HOLO/OR Ltd.
Ness Ziona, Israel

Blackbird Robotersysteme GmbH
Garching, Germany
(near Munich)

Blackbird Robotics, Co., Ltd.
Shanghai, China

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Agenda

- System overview
- Position detector
- Accuracy
- Control algorithms
- Spot distance control
- Image field corrections
- Trajectory planning and XL *SCAN*

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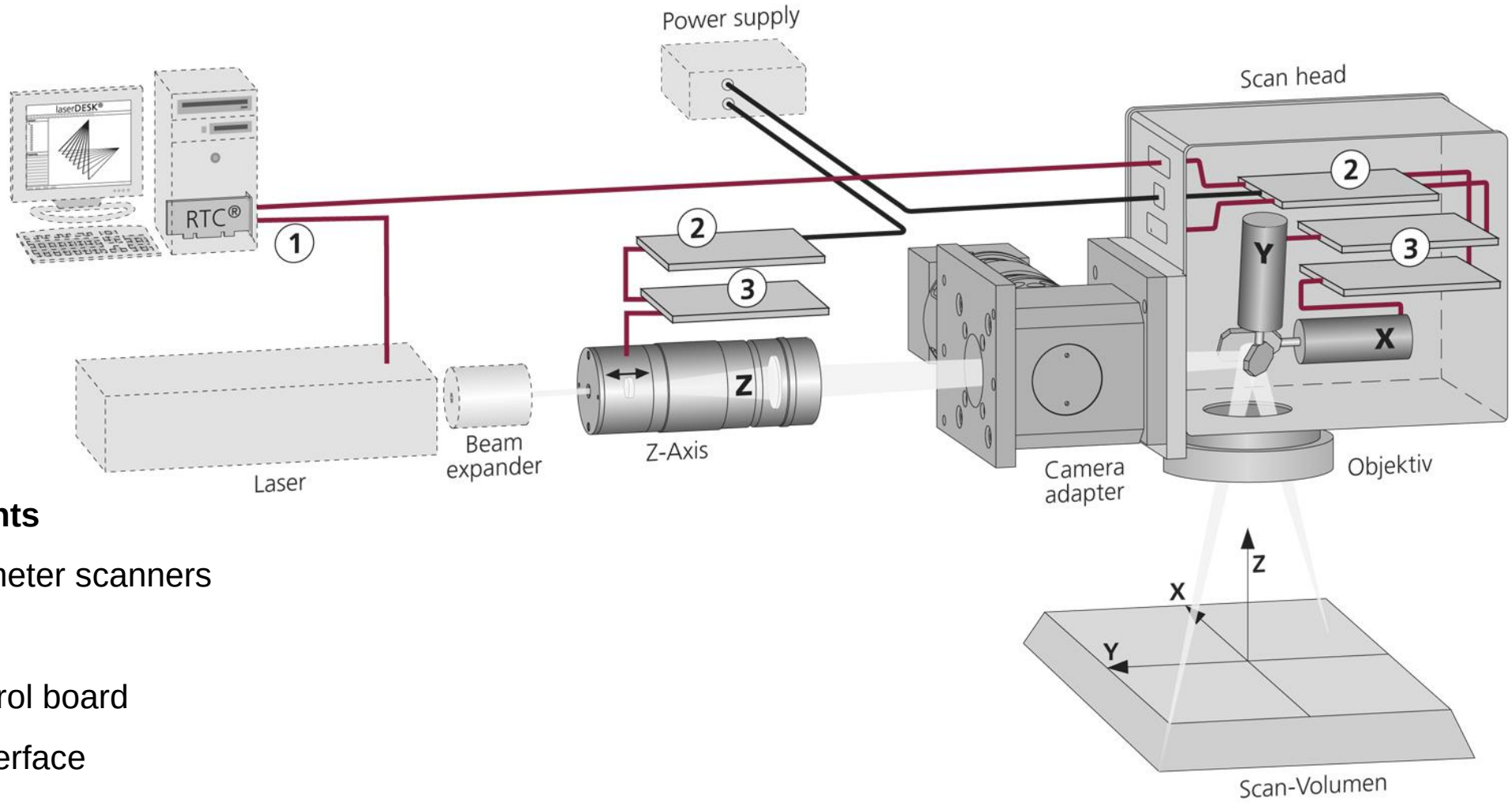
Setup of a Laser Processing System



System Components

X / Y	Galvanometer scanners
Z	z-Axis
1	RTC control board
2	Digital interface
3	Digital or analog servo boards

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Digital Position Detection

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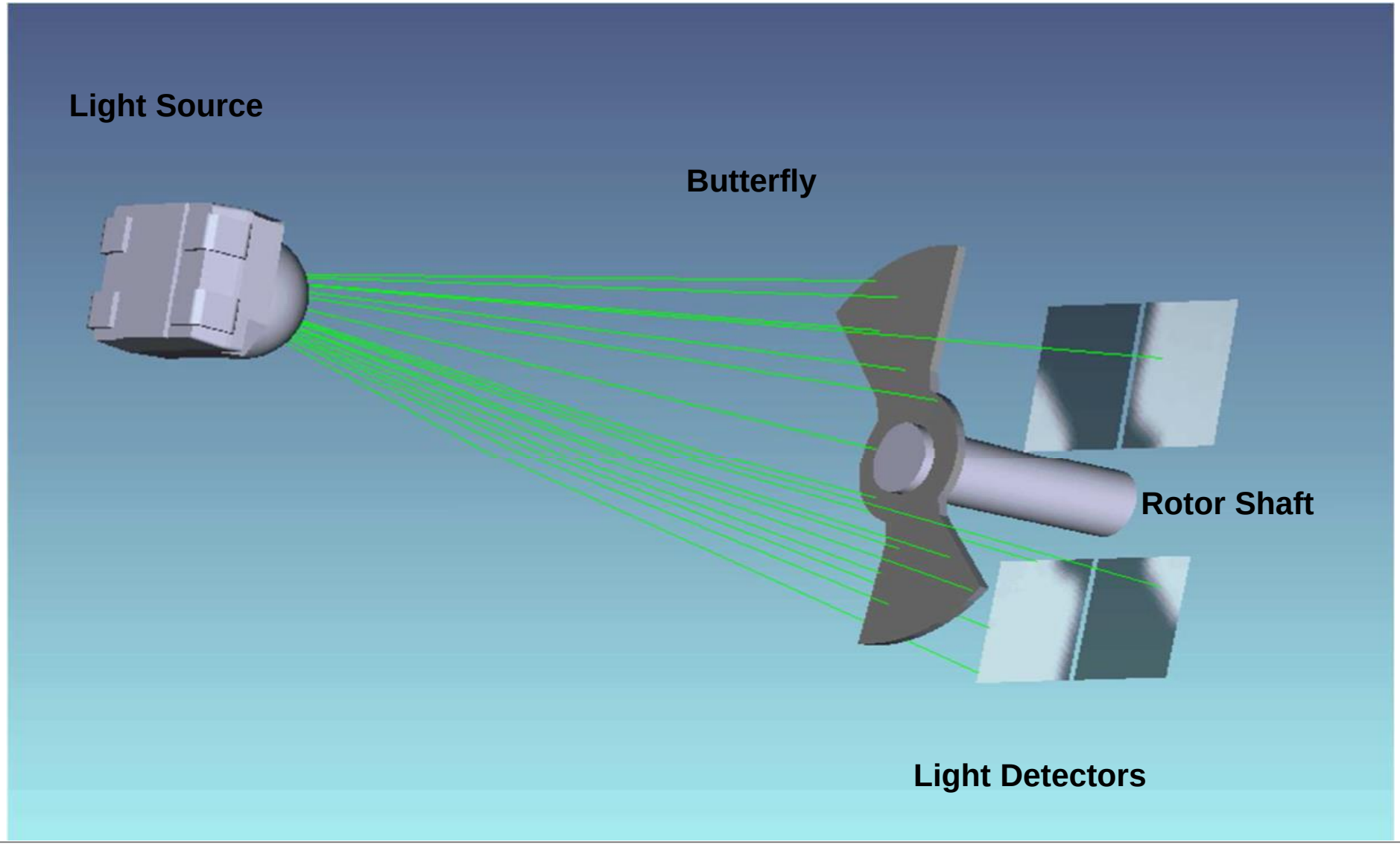
Optical Position Detectors – Basic Principle



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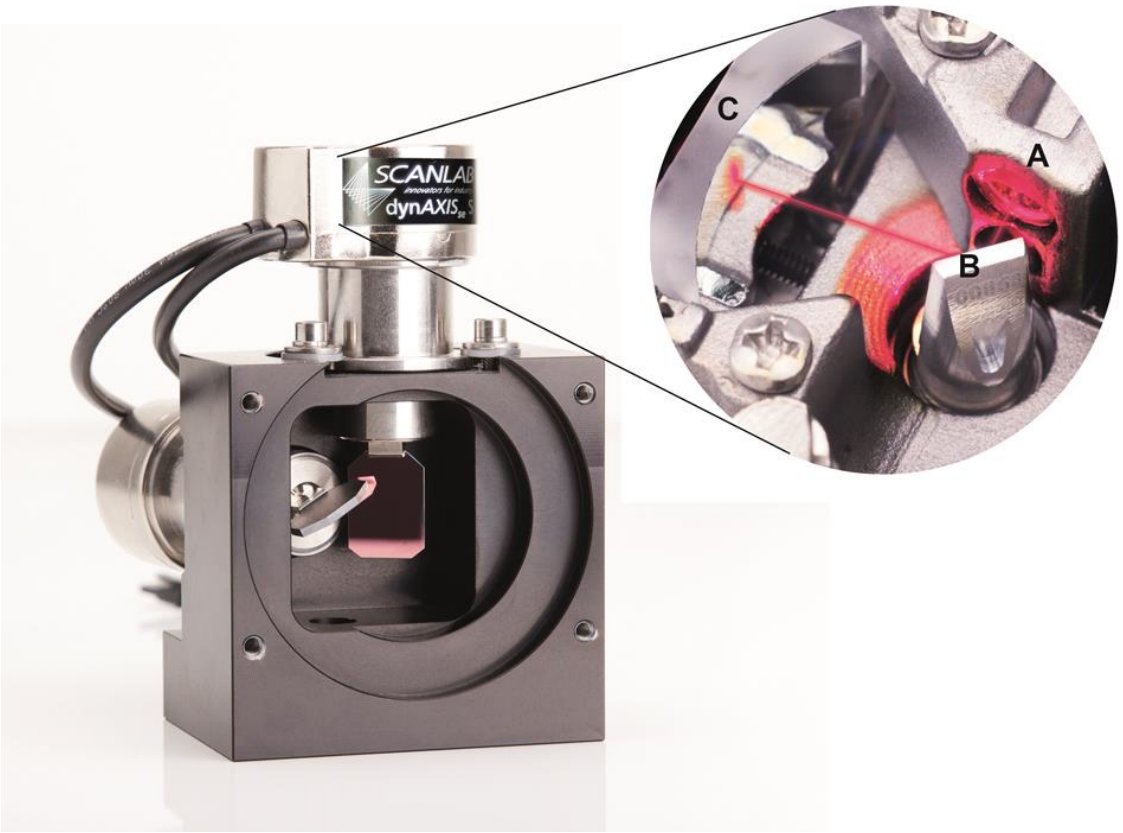
Technical Realization of SCANLAB se-Encoder

The se-encoder's massless laser beam (A) scans the stationary scale (C).



Other than the inertia-reduced mirror (B), no further components are required that can increase inertia.

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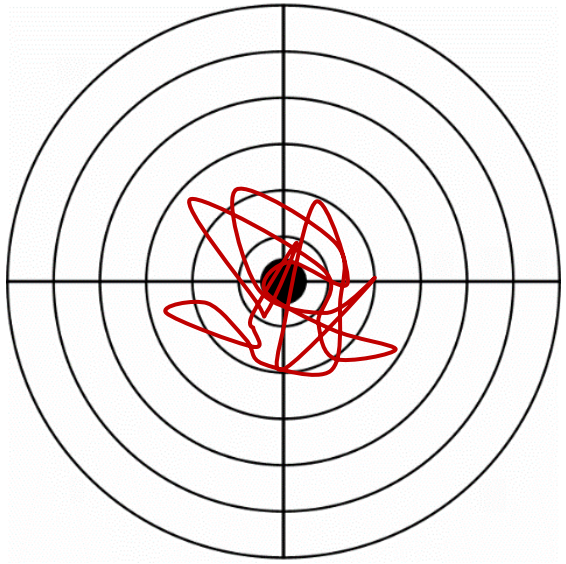
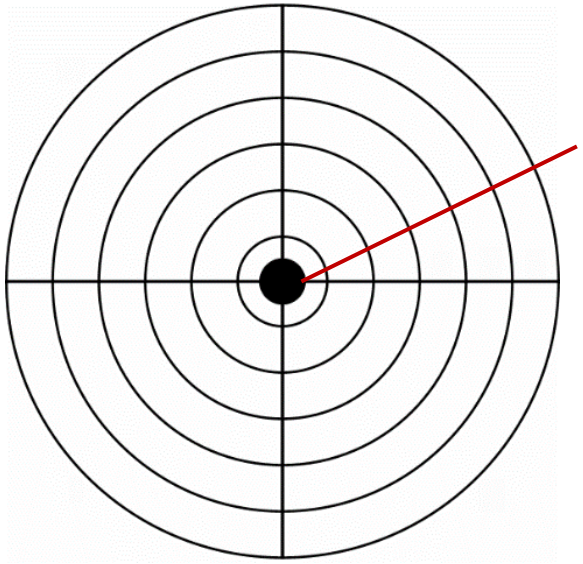
Accuracy Specification

Dither



Laser spot trembles because of PD-noise minimal around the set-position

Drift



Temperature variances:
Thermal expansion inside the PD leads to wrong measurements
⇒ Spot of the laser drifts away

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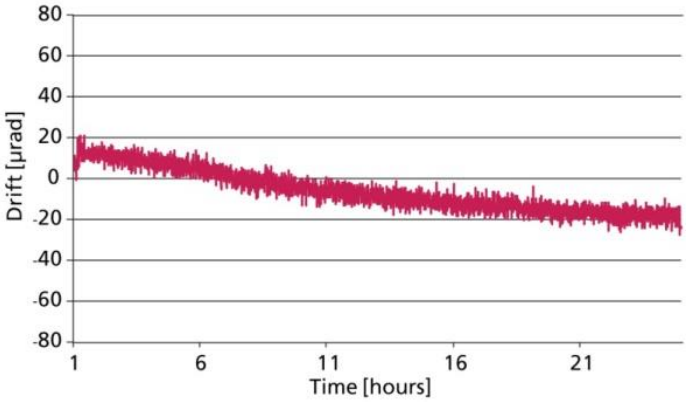
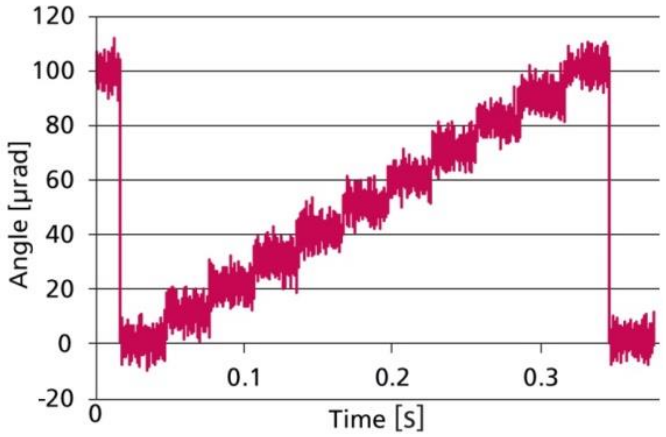
Digital Position Detection

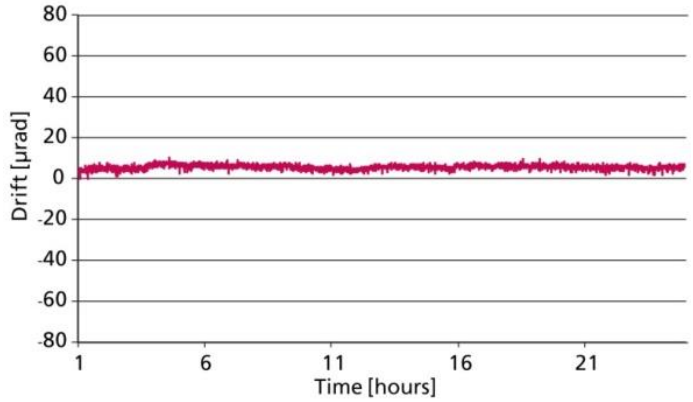
Digital position detection (PD) increases the accuracy and the long term stability of scan systems

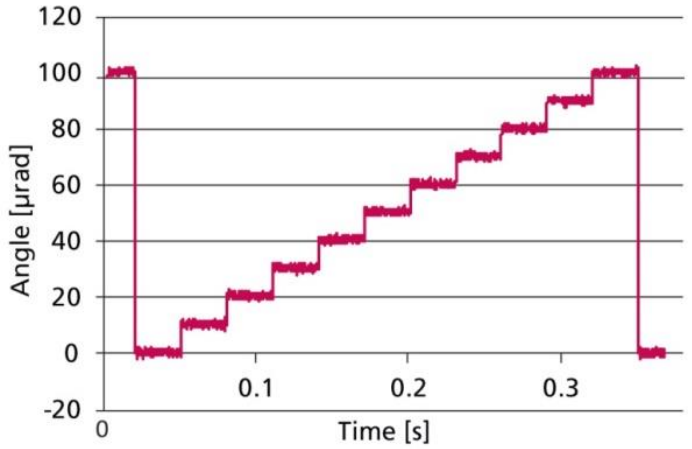
Analog PD





Digital PD





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Scan Ahead

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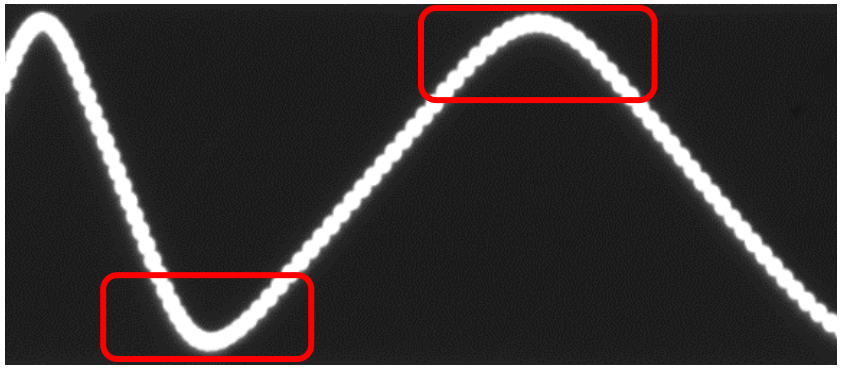
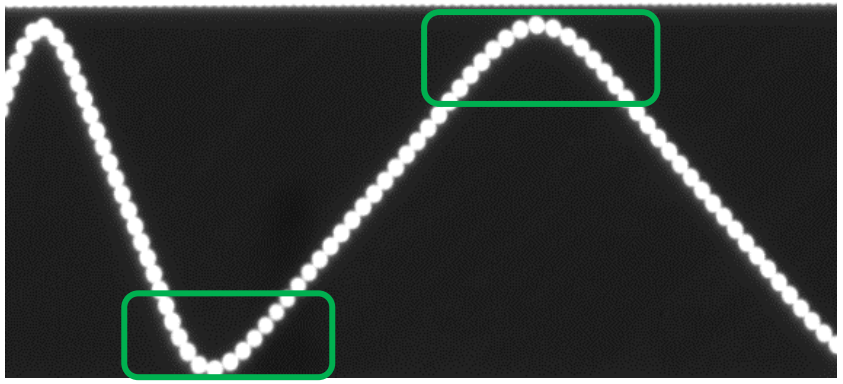
Increased Accuracy by Zero Tracking Error

without Spot Distance Control



► increased laser power input due to de- and acceleration of galvo-scanners

with Spot Distance Control



► constant laser pulse distance

Benefit with excelliSCAN:

► real position is known by *SCAN*ahead at any time

► enables optimum adjustment of laser power/frequency

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Flat field correction

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Image field distortion

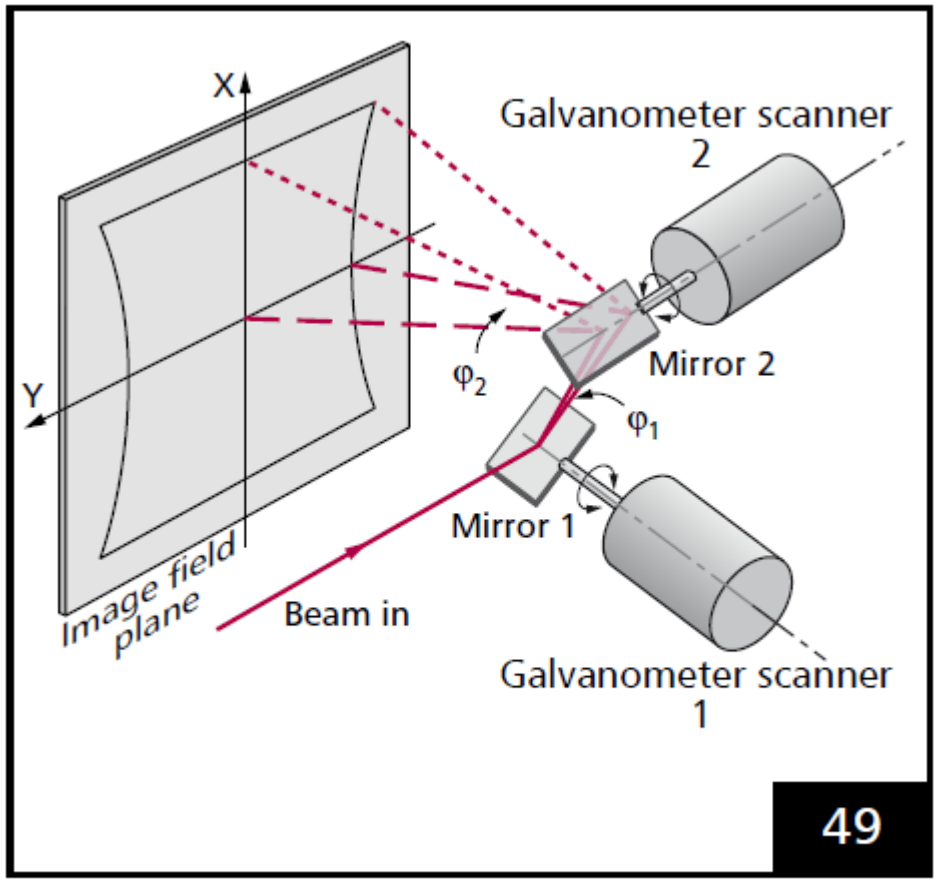

Image field distortion when deflecting a beam in a two-mirror deflection system.

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Basics correction files

Initial situation: Want to mark certain point in the image field

Question: How must Galvos (and optionally Z-axis) be set so that the desired point is reached?

Calculation too complicated for RTC, therefore: Pre-calculation lookup table offline by beam simulation, RTC interpolated

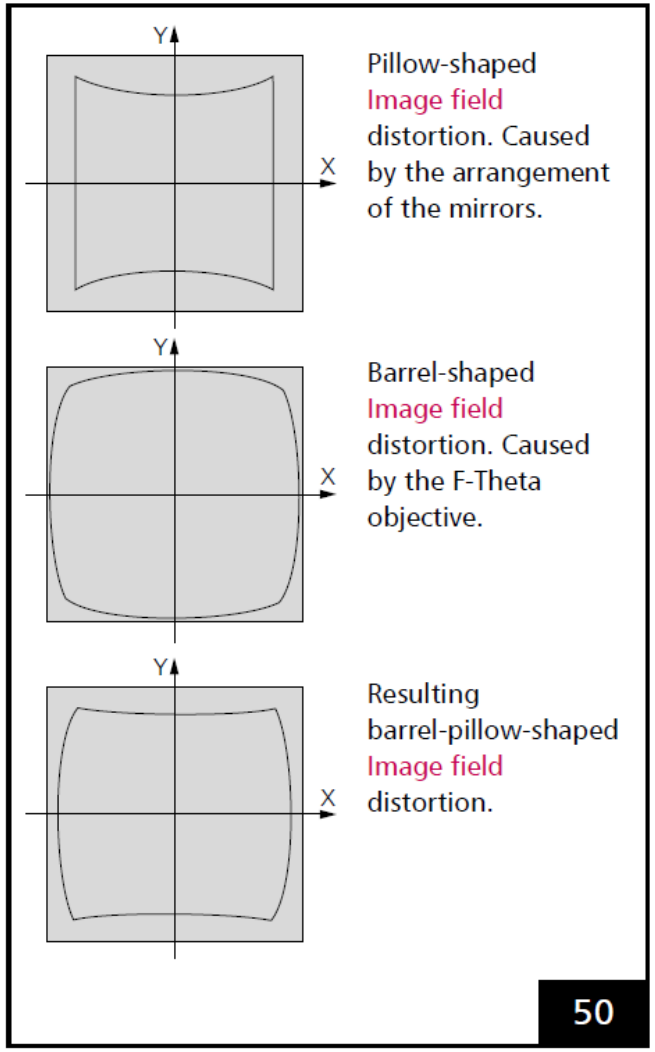

Image field distortion caused by the arrangement of the mirrors and by the F-Theta objective.

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Image field correction

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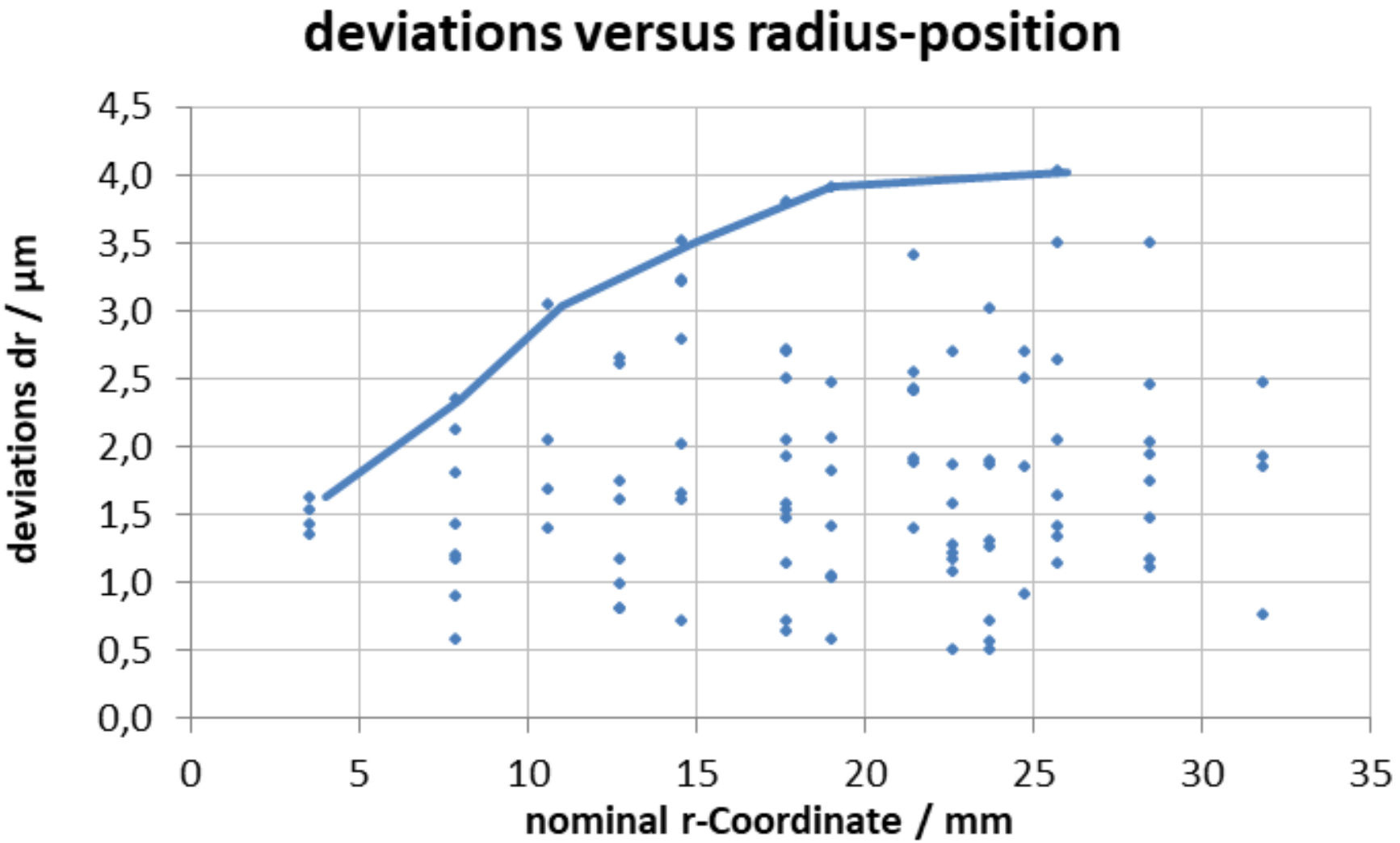
f = 100mm scan system – conventional deviaitions



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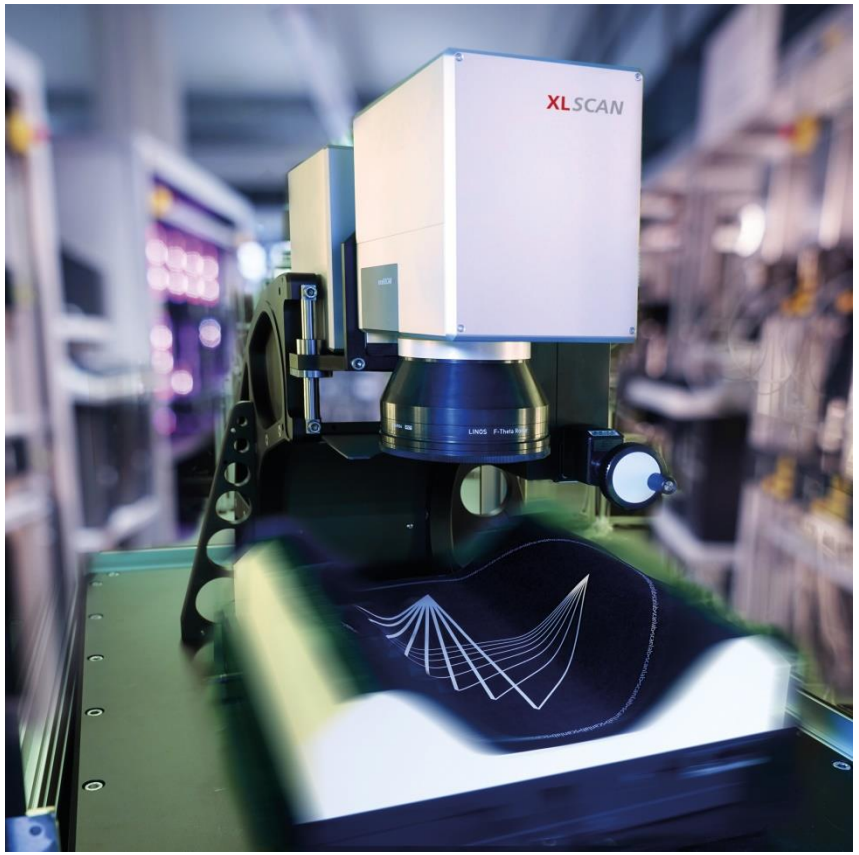
XL SCAN: Unlimited field of view

Simultaneous 2D motion

Control: syncAXIS control & RTC6

Scanner: excelli*SCAN*

Axis control system: ACS Motion Control



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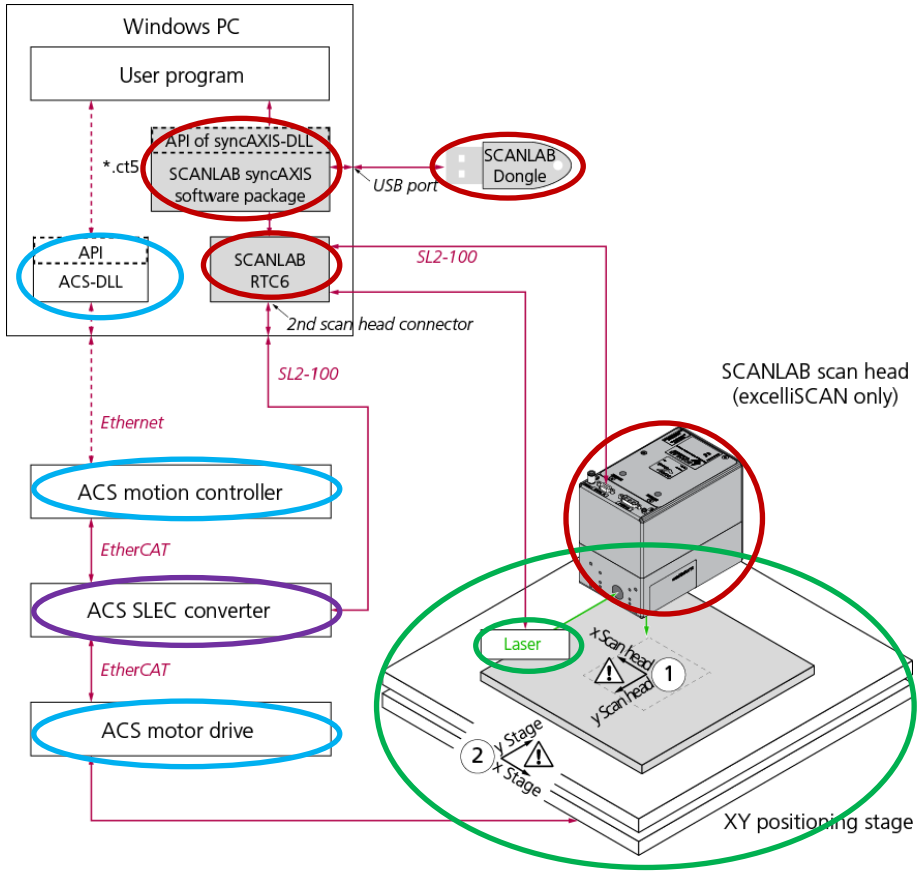
Set-up XL *SCAN*



- SCANLAB component
- ACS component
- Common component
- External component

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XL Scan: Video

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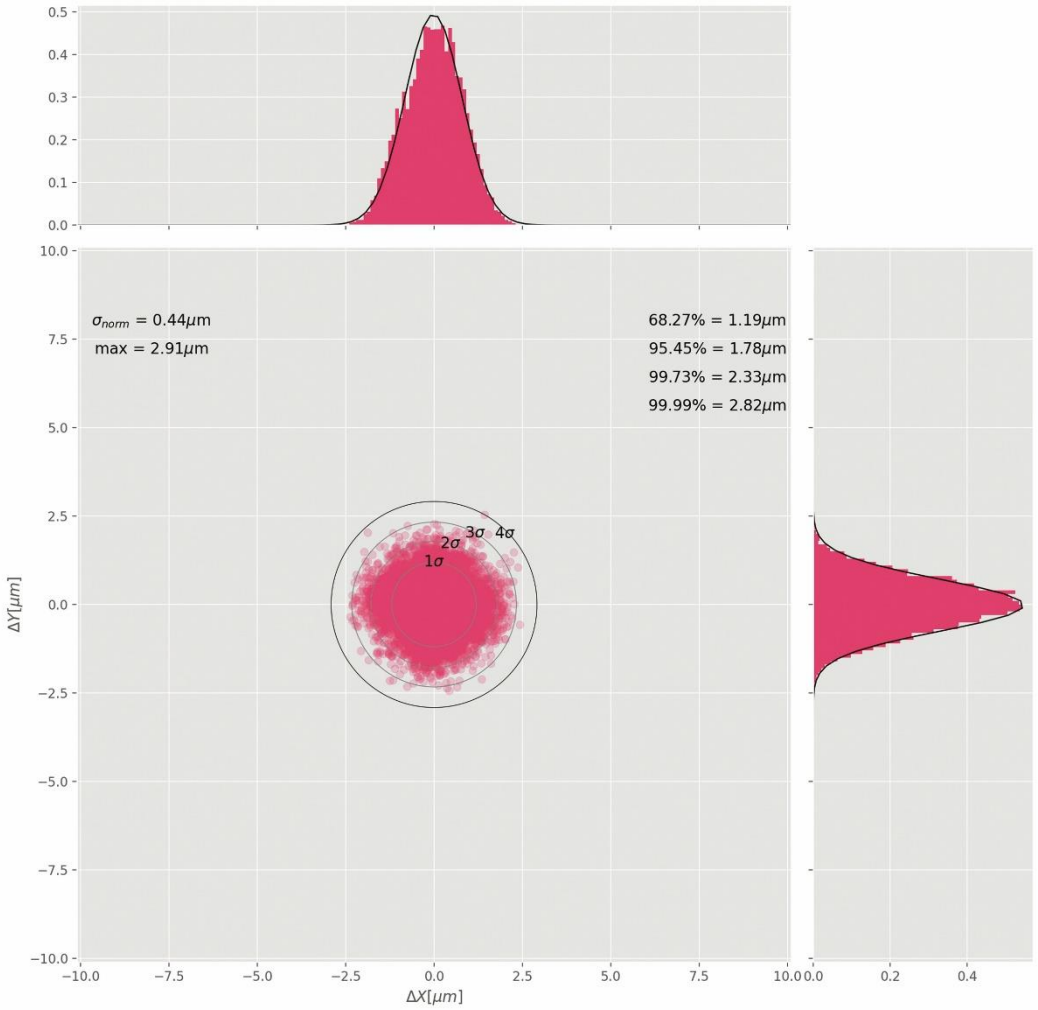
Accuracy

10000 shots
Accuracy: 3µm (4σ),
f = 100 mm
Single beam
drill rate: 2600 Hz
Spot spacing: 100 µm



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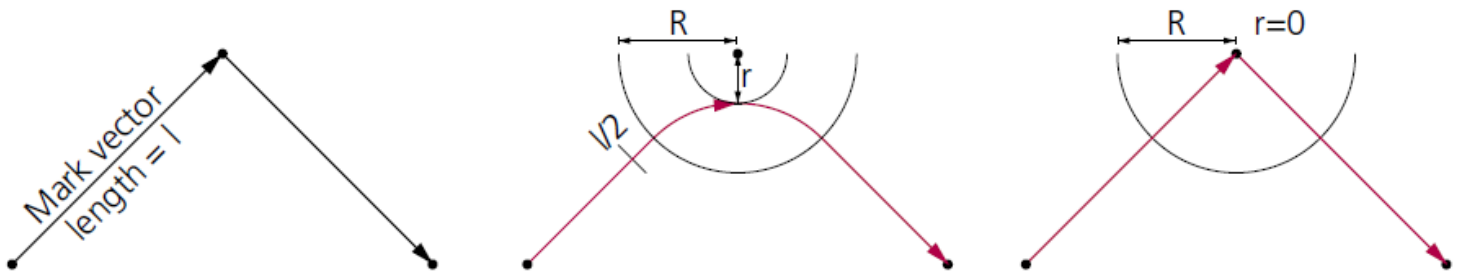
Trajectory planning

Normally scan system has tracking error ➔ leads to „blending“ of smal radii

XL SCAN: Pipeline based trajectory planning

What you see is what you get: Path is planned based on dynamic limits of the system (stage and scanner)

Blending Parameter can be adjusted



Mark vectors as programmed (black)

Marking result (red) with R>0 and r>0

Marking result (red) with r=0

R = `MaxBlendRadius`
r = `ApproxBlendLimit`

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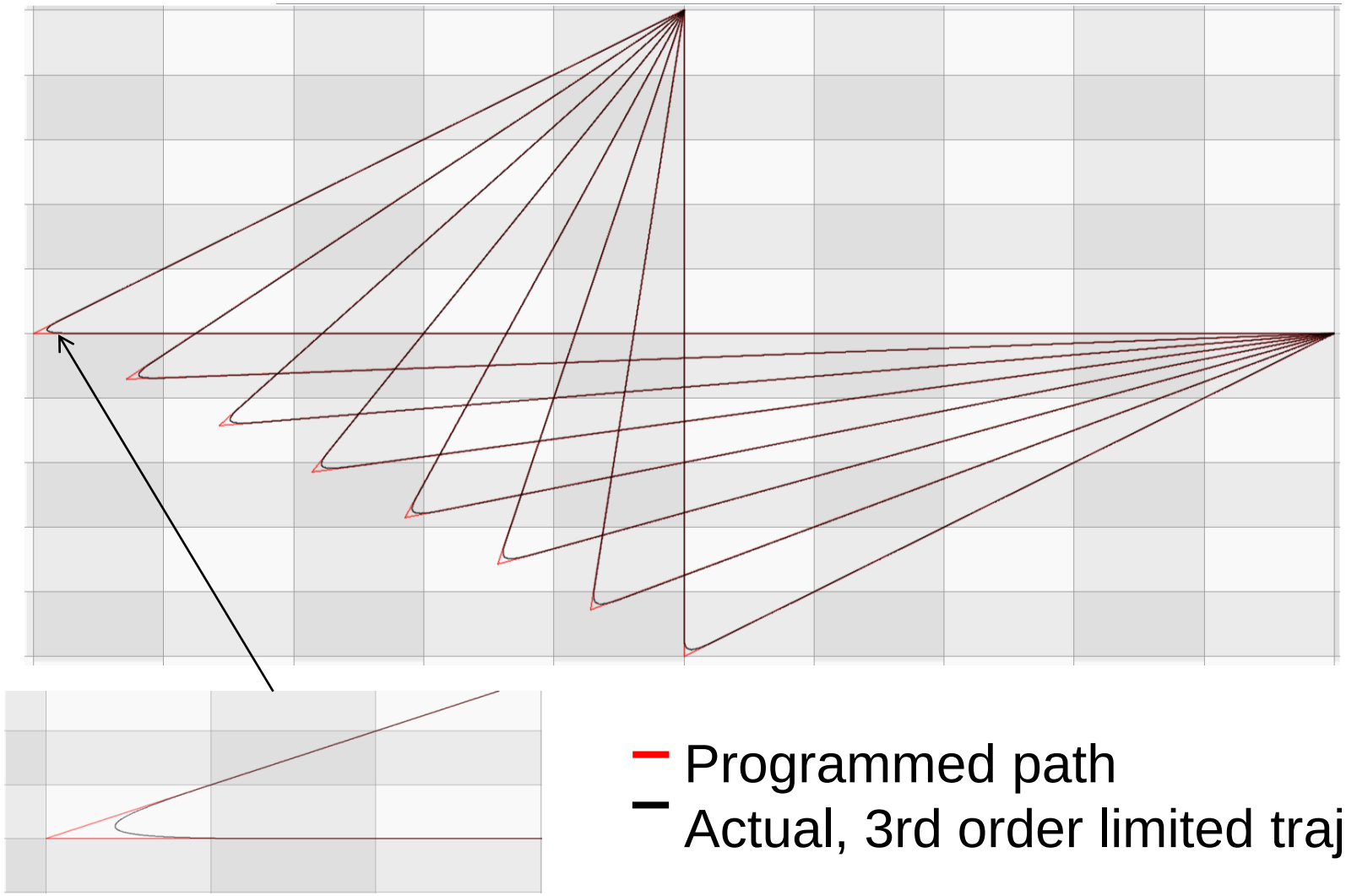
What you see is what you get



Programmed path

Actual, 3rd order limited trajectory

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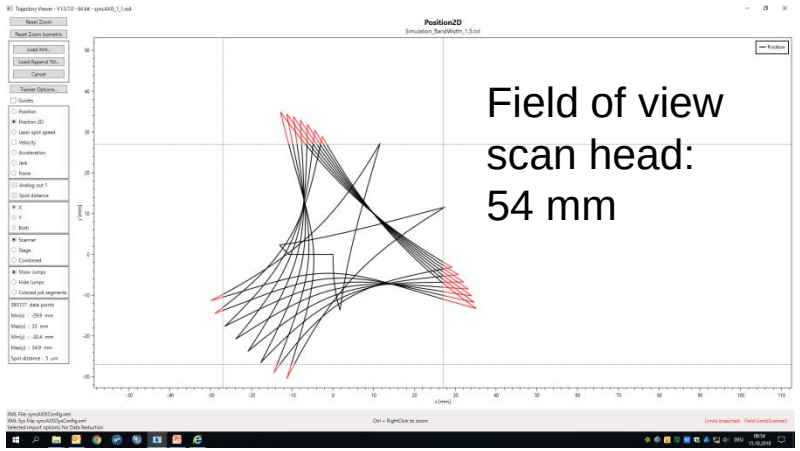
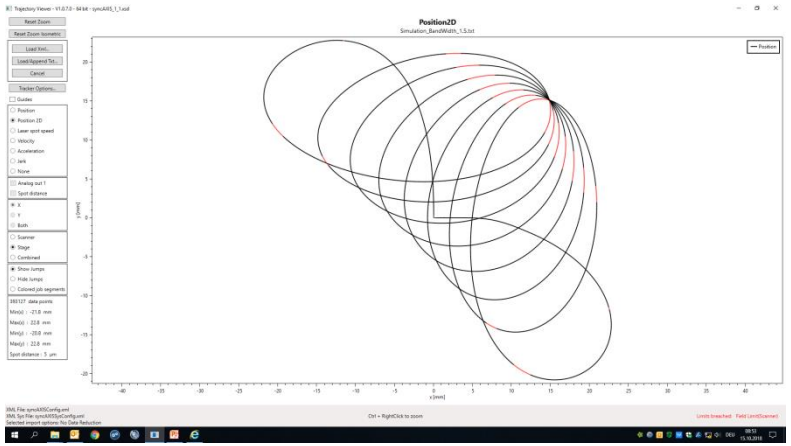
Tuning with Trajectory Viewer

Bandwidth 1.5 Hz

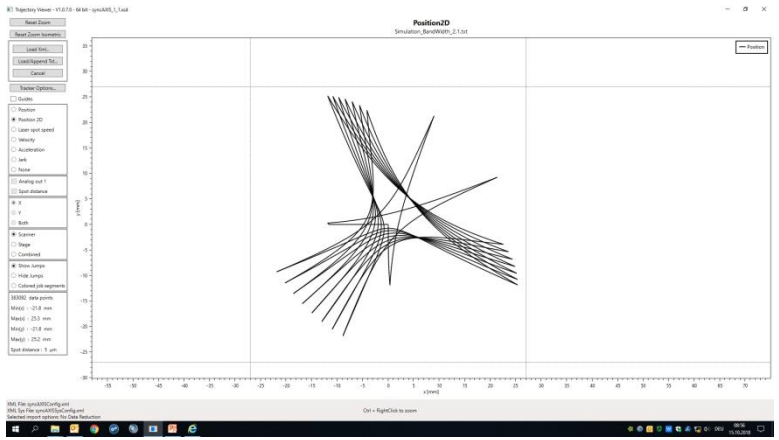


Field of view scan head: 54 mm

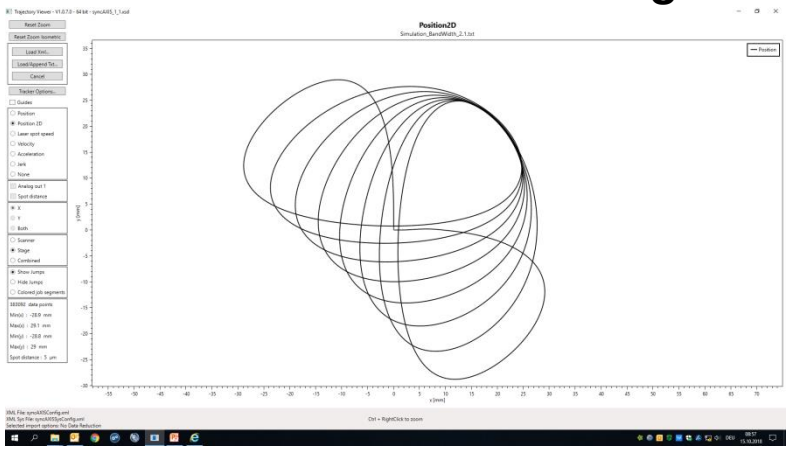


Bandwidth 2.1 Hz

Movement Scan head



Movement Stage



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