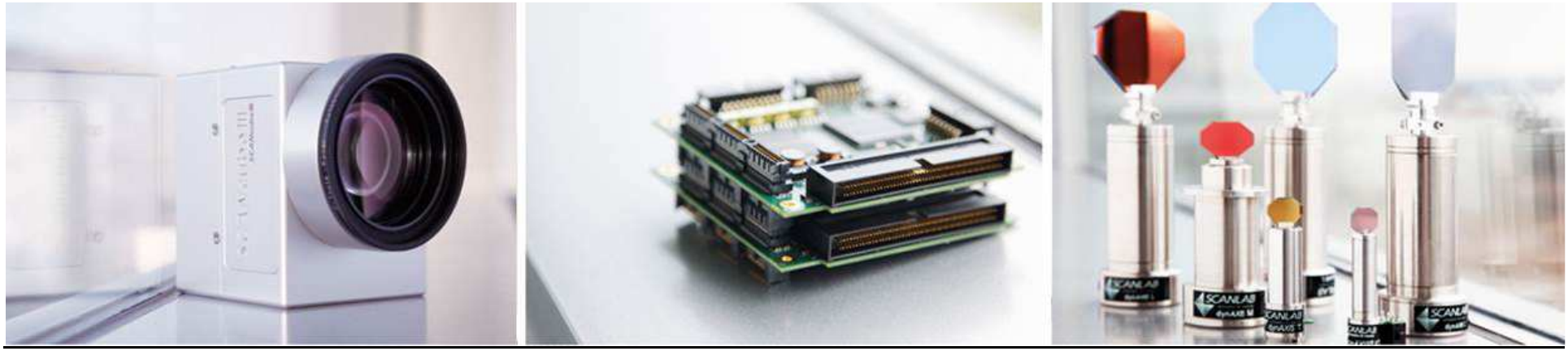
New Generation Galvo Scanning Technology



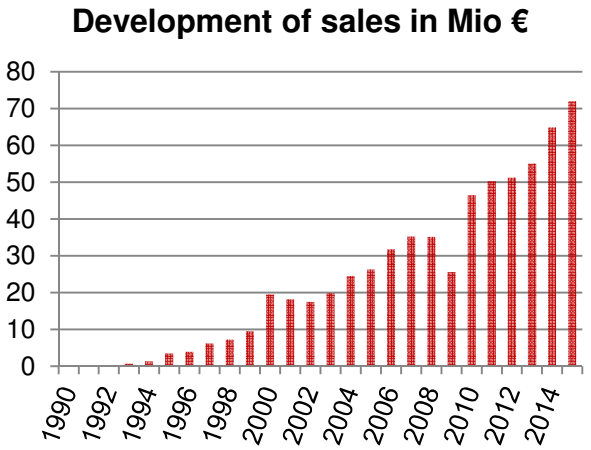
APPOLO Workshop 2015

Dr. Christoph Wienken
SCANLAB AG

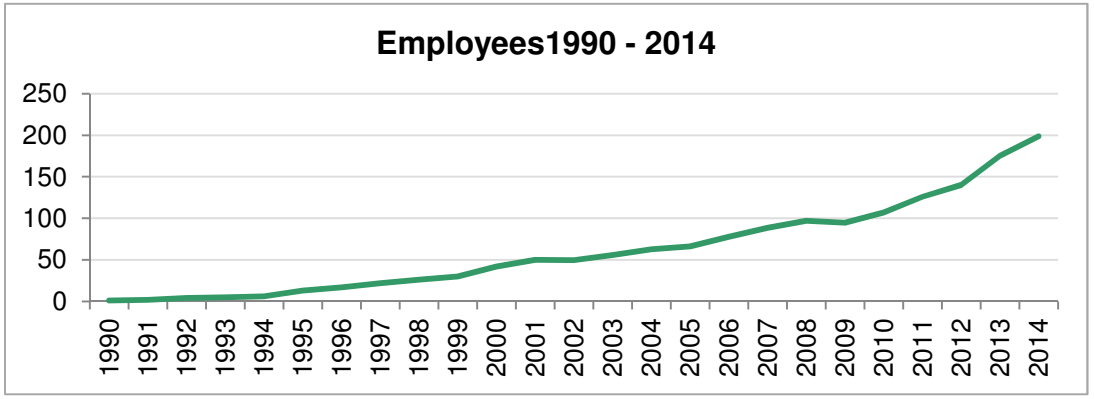
SCANLAB at a Glance

- Worldwide leading OEM manufacturer of scan solutions for deflecting and positioning laser beams
- Our high-performance components are the core of:
  - 3D printers
  - Laser welding robots
  - Laser systems for medical treatments
  - Micro-structuring units
- 20,000+ units manufactured annually and installed in 38 countries worldwide
- Trendsetting developments in the fields of Electronics, Mechanics and Optics
- Exploitation of new application areas within the scope of research cooperation

Passionate about Technology and Innovation



- Group 2014 sales: more than € 60 million
- Around half of our highly qualified team are engineers and scientists
- About 200 employees from 22 countries
- Independent – SCANLAB AG is not publicly traded



A Strong Global Team

SCANLAB AG
Headquarters in Puchheim near Munich

SCANLAB America, Inc.
Based in St. Charles (IL) and Novi (MI)

Blackbird Robotics North America
Based in Novi (MI)

Blackbird Robotersysteme GmbH
Based in Garching, Germany (near Munich)

Blackbird Robotersysteme Asien
In the course of incorporation – in Shanghai

Examples of Micromachining Applications

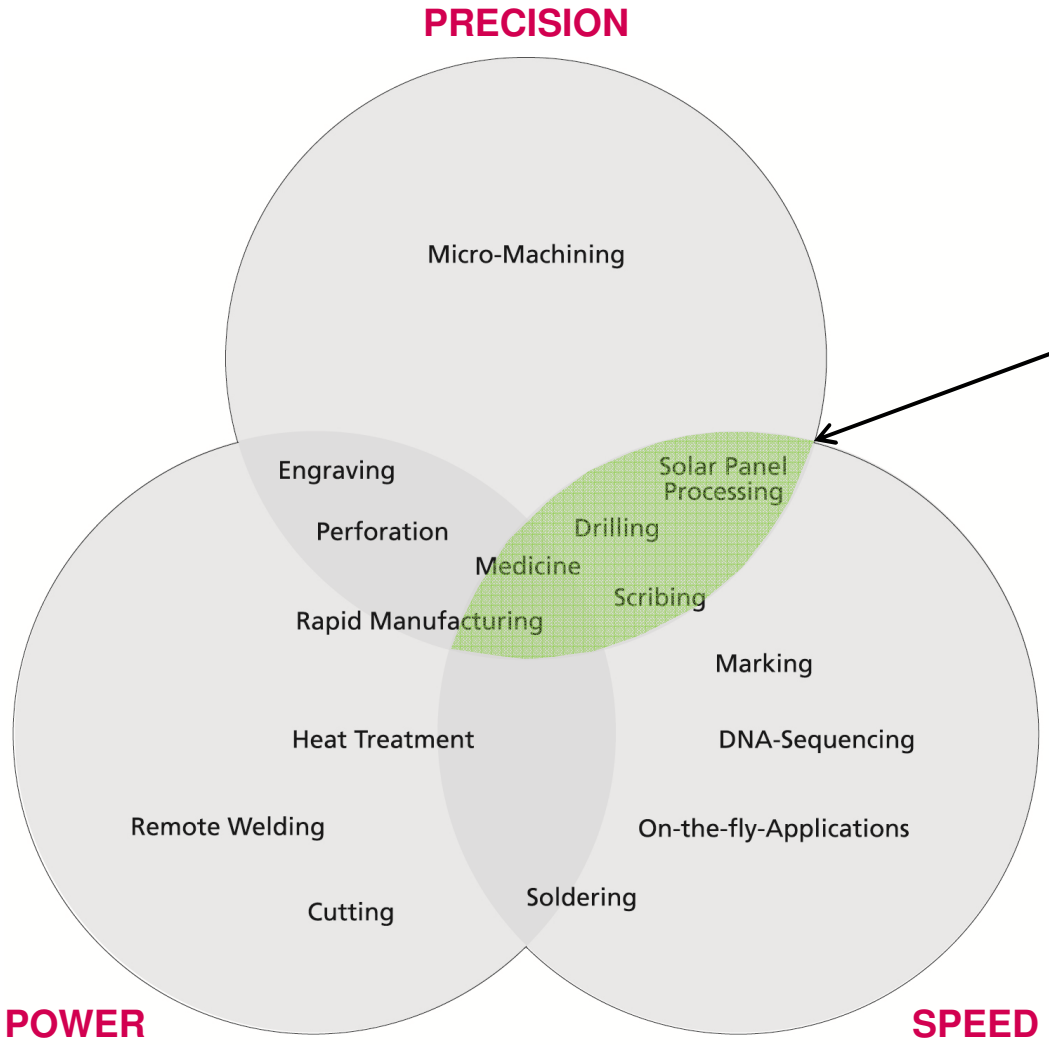
- Cutting hardened glass for smart devices by repeatedly scanning extremely fast and accurately the given rectangular shape

- Large surface processing of solar cells with high precision to reach higher performance and productivity

- High precision laser processing of machining tools with thin diamond or ceramics (e. g. PKD, CBN) plates

- Deep engraving of extrusion dies with ultrashort laser pulses reaching high surface quality and accuracy of only few microns

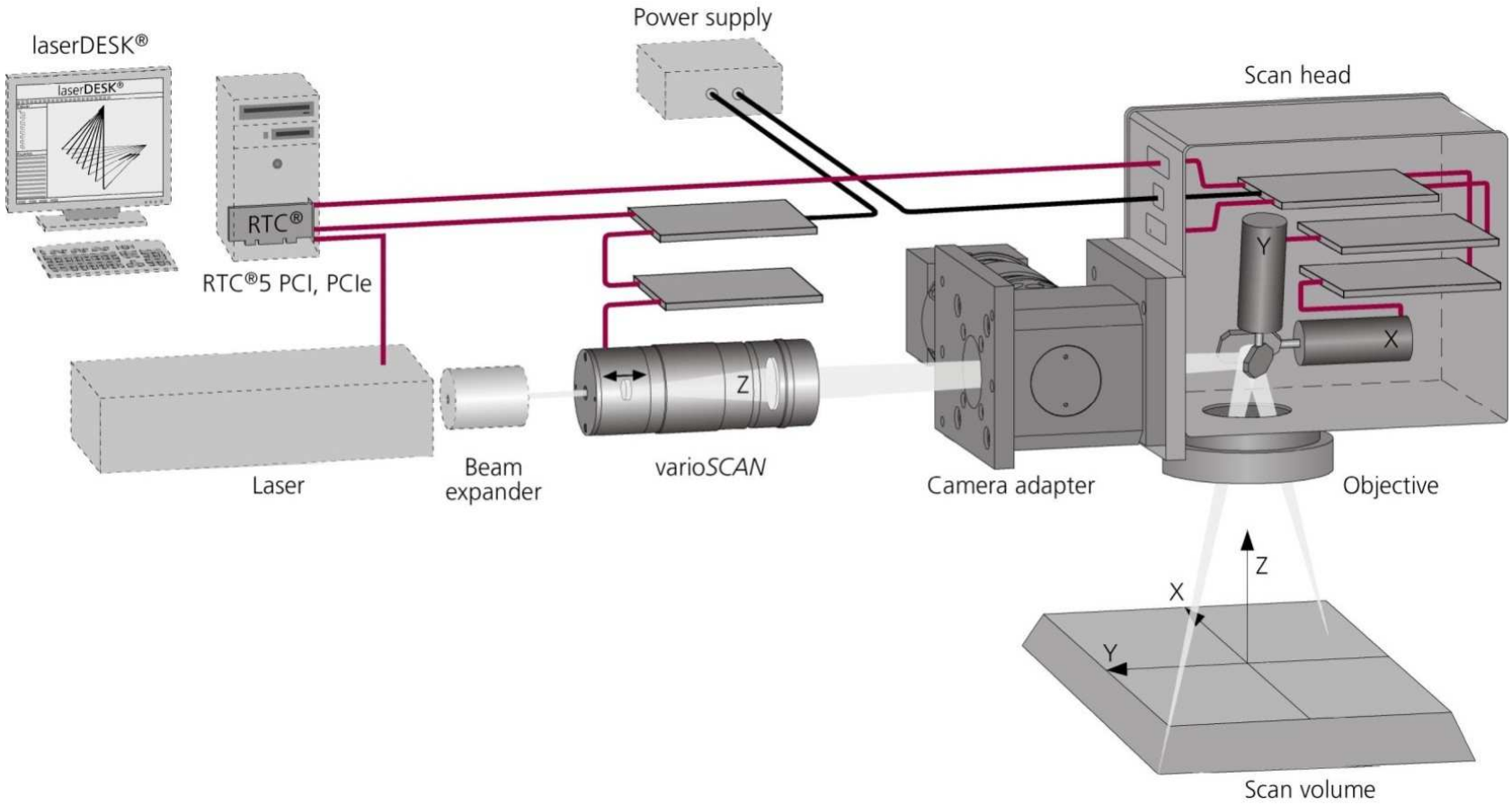
Requirements determined by different Applications



Highest requirements on:

- Acceleration
- Maximum mark speed
- Positioning accuracy
- Linearity
- Long term stability

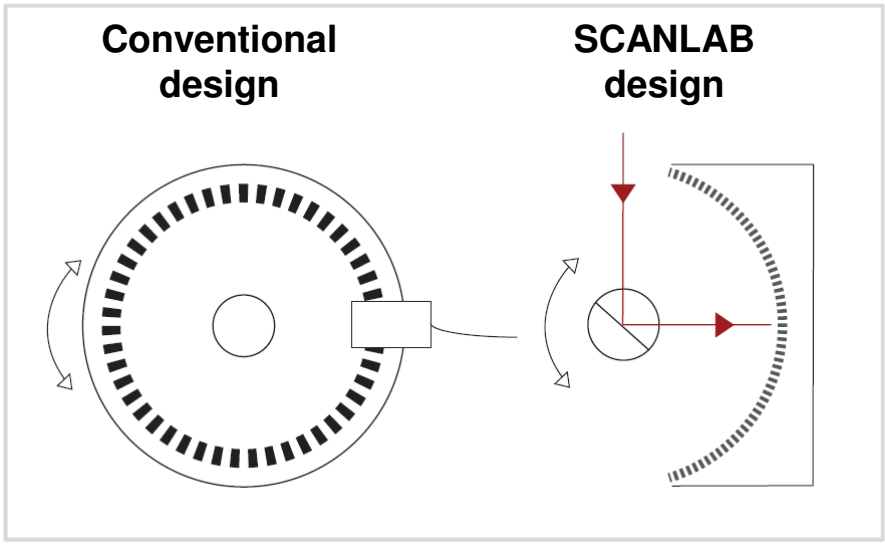
Galvanometer Scanner Systems



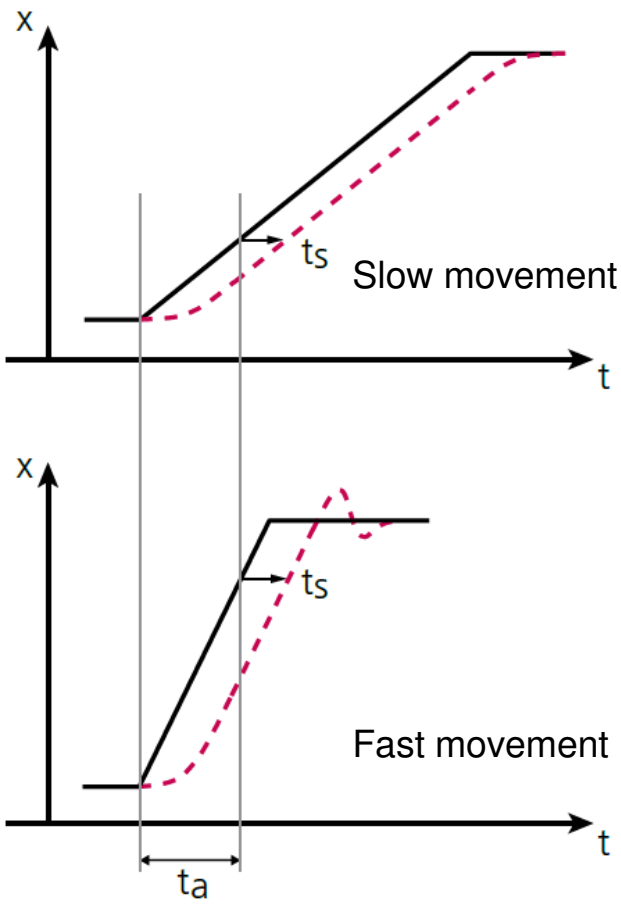
Digital Encoder Galvanometer

- Maximum precision - very low position noise
- Highest long term stability - Very low drift values
- Excellent linearity

- SCANLAB patented design
- Highly dynamic due to very low inertia
- Scanner with smaller mirrors (apertures ≤ 10mm) are possible



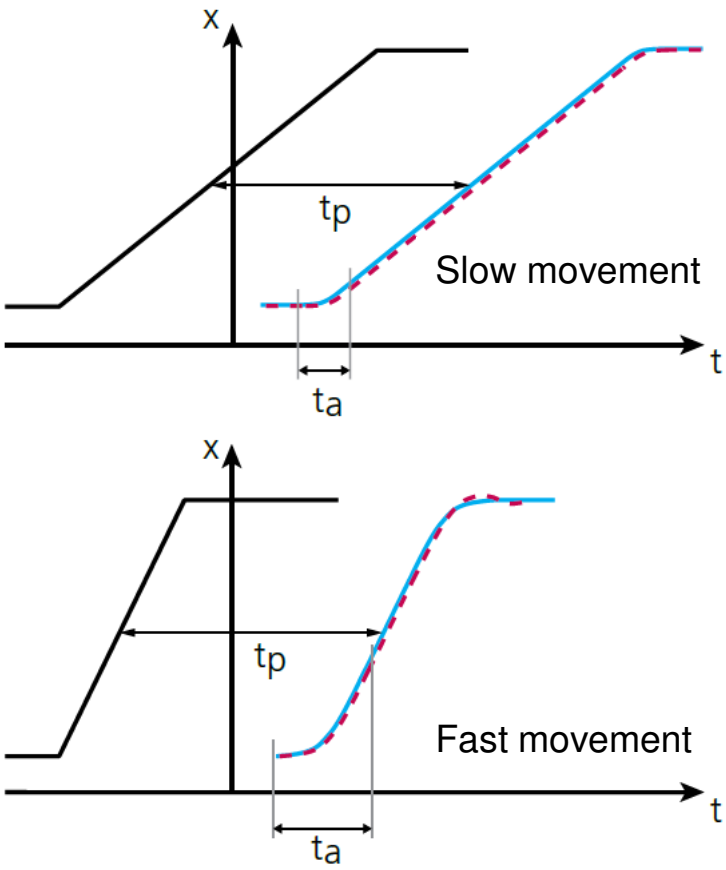
Conventional Galvo Control



t_a : acceleration time
t_s : time lag

- Constant tracking delay t_s independent of the scanning velocity
- Constant acceleration time t_a until reaching the set scanning velocity
- Non-optimal usage of the acceleration capability of the scanner for slow scanning speed (compared to the maximum speed of the system (-> increasing acceleration time and tracking delay for increasing maximum speed)

*SCAN*ahead Control



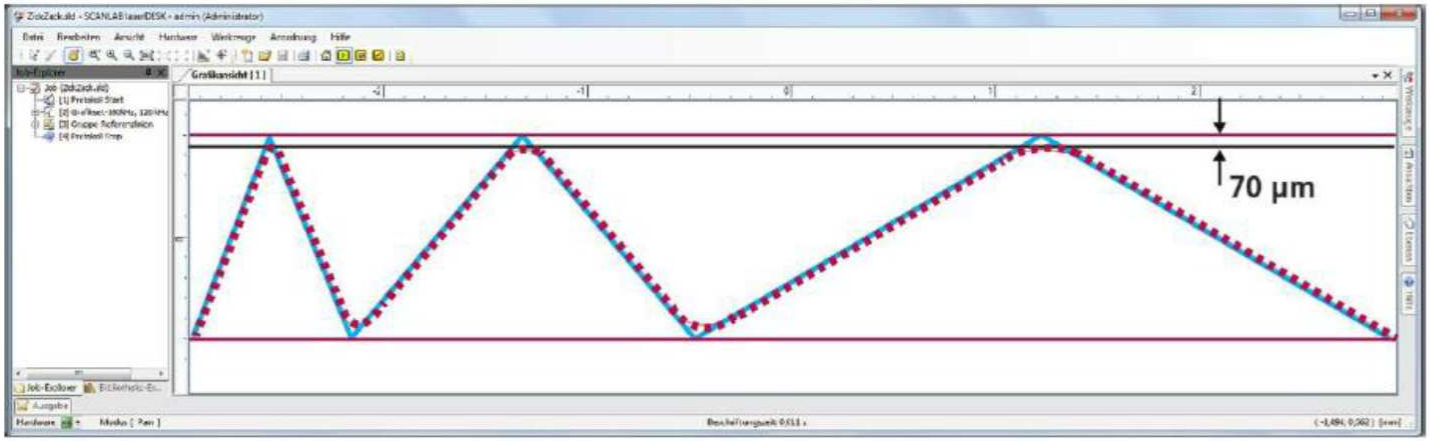
t_p : preview time

- Using the maximum acceleration also for slower scanning velocities
- „Zero-tracking delay“-scanning by introducing a look ahead time t_p
- Alternative: pre-calculation of the complete Scanning-trajectory before execution
- Software is automatically setting the now velocity depending delays

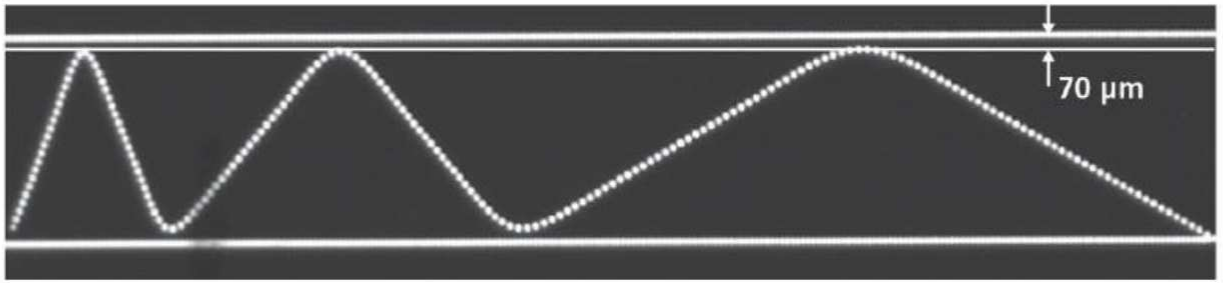
  Parameters for the users:

  - Allowed velocity band (v_{min} and v_{max})
  - Max. tolerated curvature at corners

Pre-calculated Track



laserDESK
screen shot



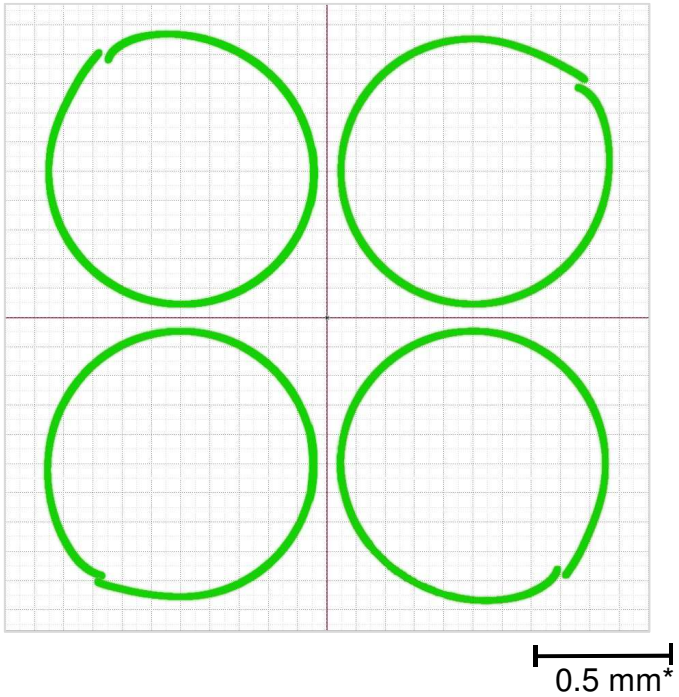
Marking
result

Fast and Precise Circle Processing

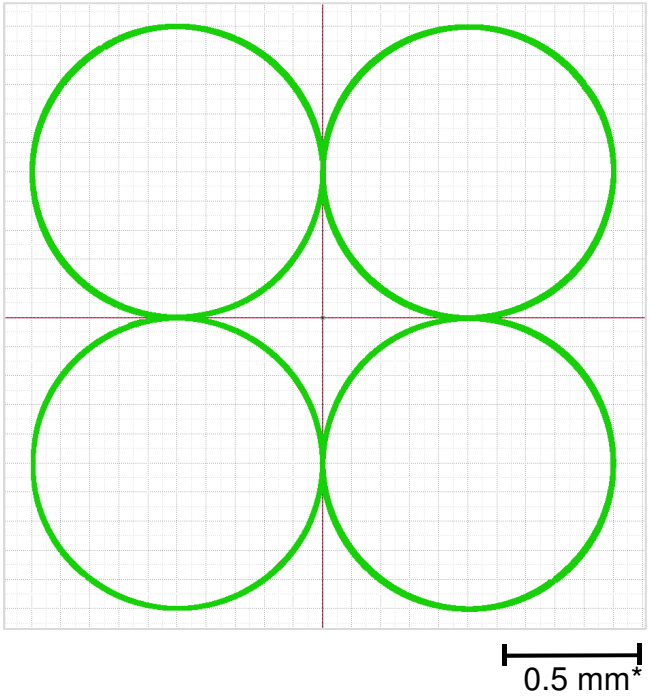
Parameter Settings:

Circle:	Ø **1mm**
Marking speed:	**2.5 m/s** (800Hz)

Conventional Control



*SCAN*ahead® Control



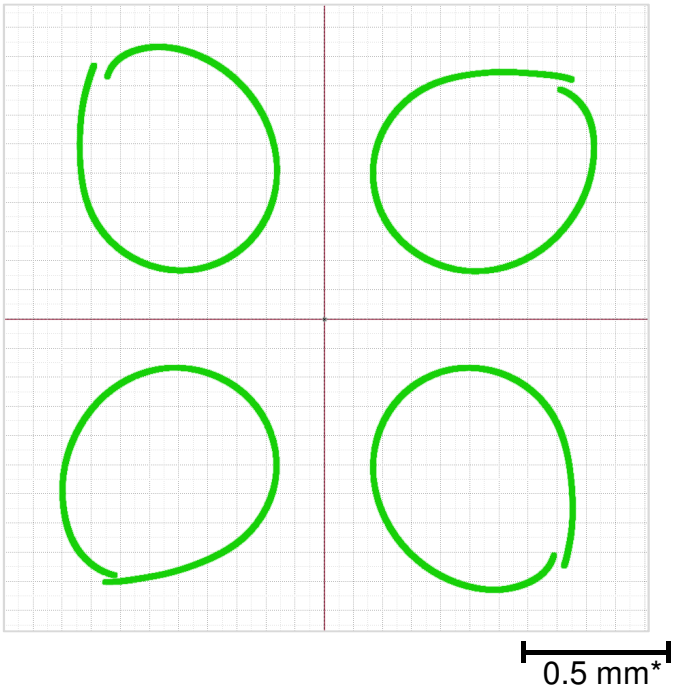
* @ f=160mm

Fast and Precise Circle Processing

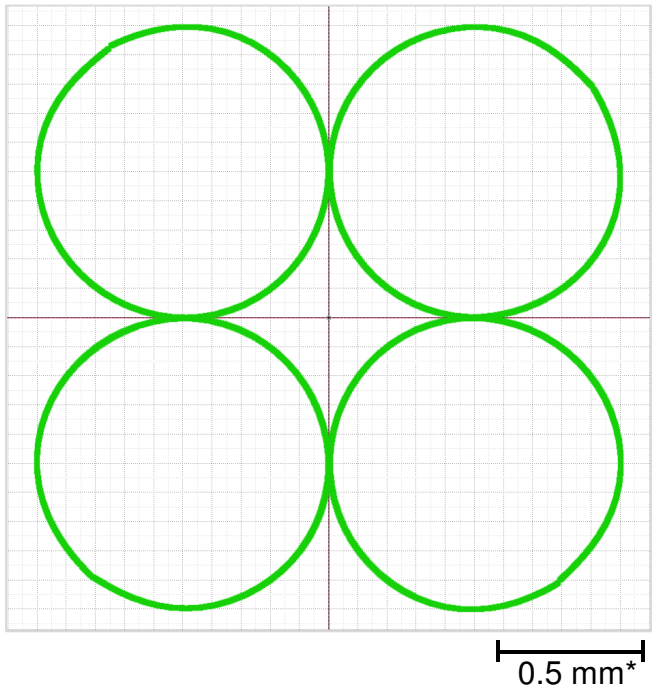
Parameter Settings:

Circle:	Ø **1 mm**
Marking speed:	**5 m/s** (1,6 kHz)

Conventional Control



*SCAN*ahead® Control



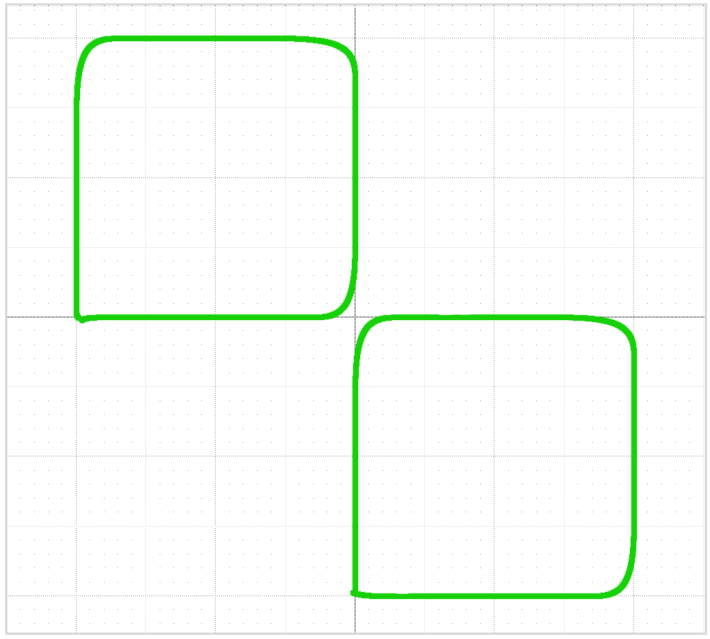
* @ f=160mm

Enhanced Accuracy at High Speed

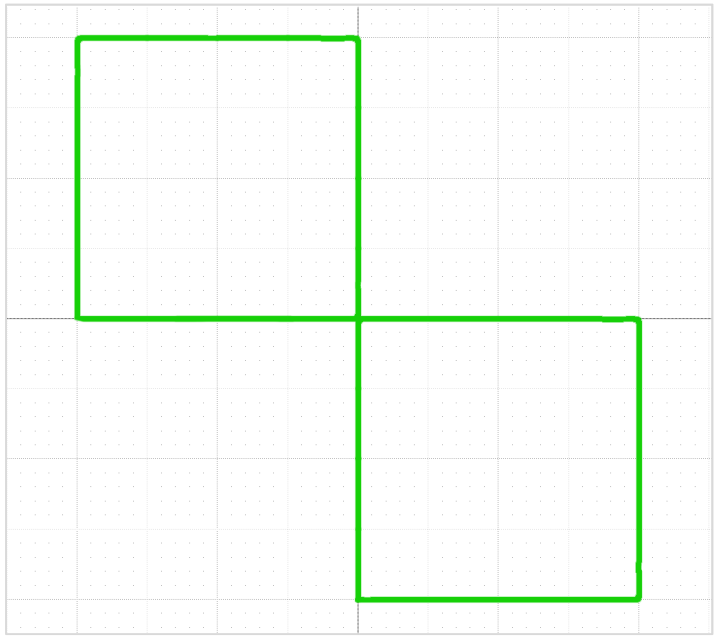
Parameter Settings:

Square:	**a=2 mm**
Marking speed:	**2.5 m/s**

Conventional Control



*SCAN*ahead® Control



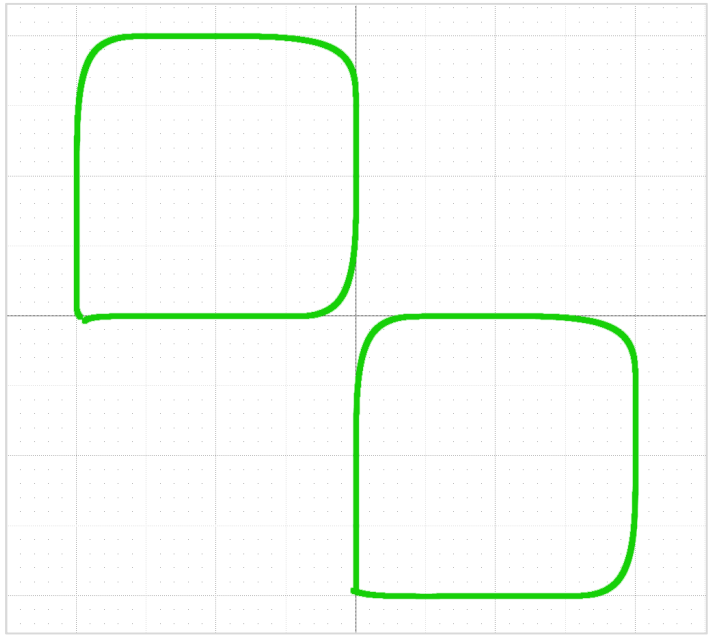
* @ f=160mm

Enhanced Accuracy at High Speed

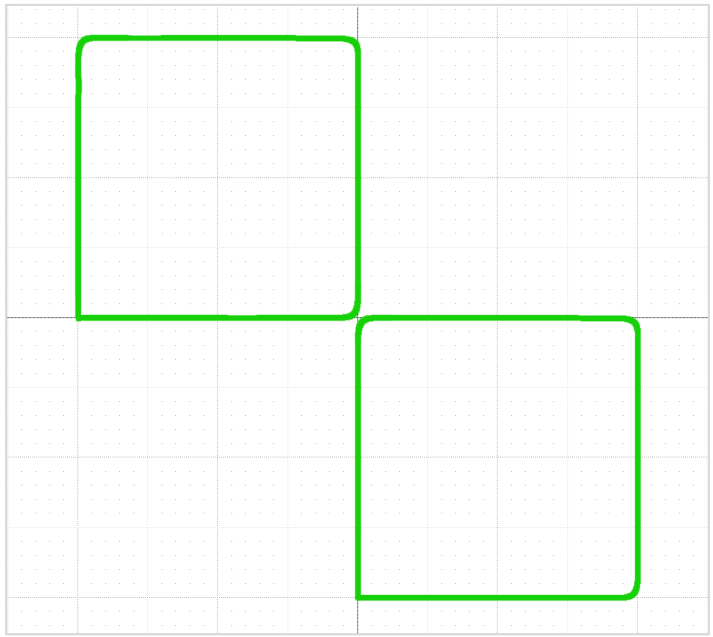
Parameter Settings:

Square:	**a=2 mm**
Marking speed:	**3.7 m/s**

Conventional Control



*SCAN*ahead® Control



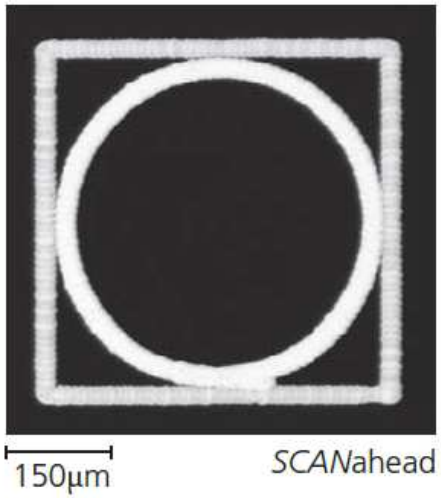
* @ f=160mm

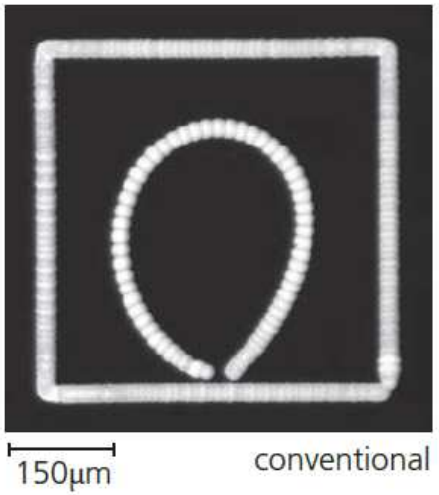
Marking Results: excelli*SCAN* & *SCAN*ahead

*SCAN*ahead® Control

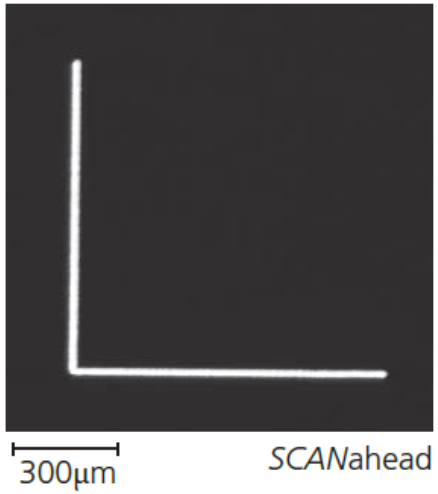
Conventional Control

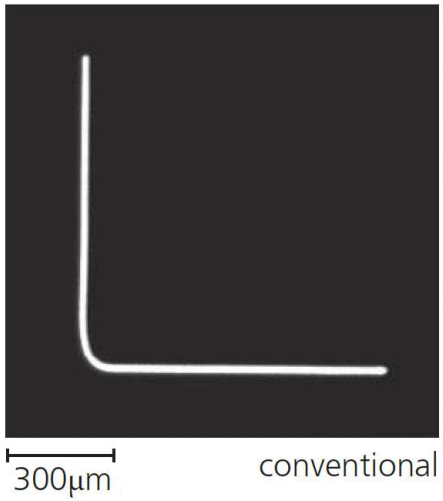
Circle
v=2,8m/s:



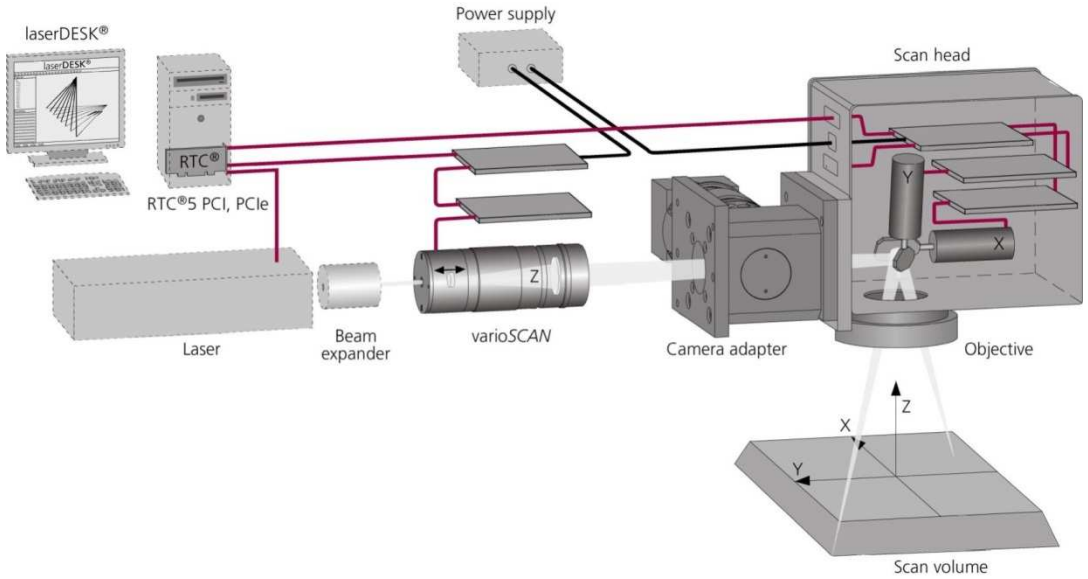


Corner
v=1m/s:





Conclusion



- Scan Systems are important in laser micro-processing to reach high accuracy and productivity
- For maximum performance all components in a scan system need to taken into account
- New innovations like digital galvanometers, look ahead control, vision control and high speed z-Axis are on their way on the market and will enable the next generation of highly productive industrial laser processes

If Galvo Scanning is like Car-Driving…

Conventional Galvo Control…

… Driving under foggy conditions

SCANahead Galvo Control…

…Driving with lights on

Pre-calculated Track…

… Driving with a map

Thank you for your attention!

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