

Flexible Demonstration Platform for Advanced Beam Guiding Systems

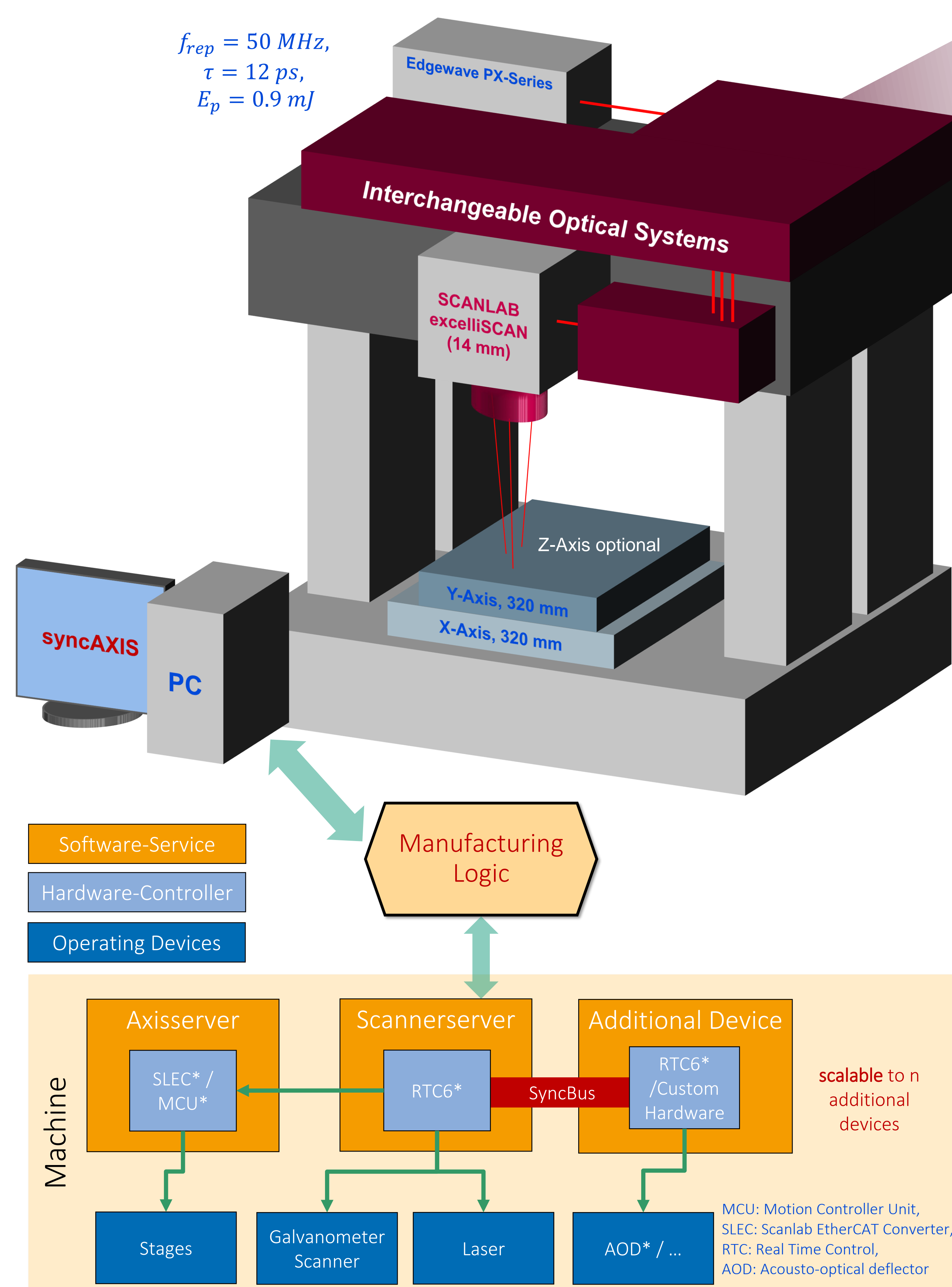
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To further enhance the productivity of laser-based manufacturing processes an increase of average laser power demands for suited beam guiding systems. As commercially available scanning technologies are far sophisticated, research focuses on beneficial sequential combinations of multiple scanning technologies. To compare multiple concepts and evaluate their potential, an integrative research platform was designed, constructed and assembled. Next, a spacious optical table was added to an industry-suited machine setup, consisting of an ultra-short pulsed laser, a two axis galvanometer scan head and a high-precision two-axis-stage. These components can be controlled fully synchronized by an included central controller unit with the provided software.

System Architecture



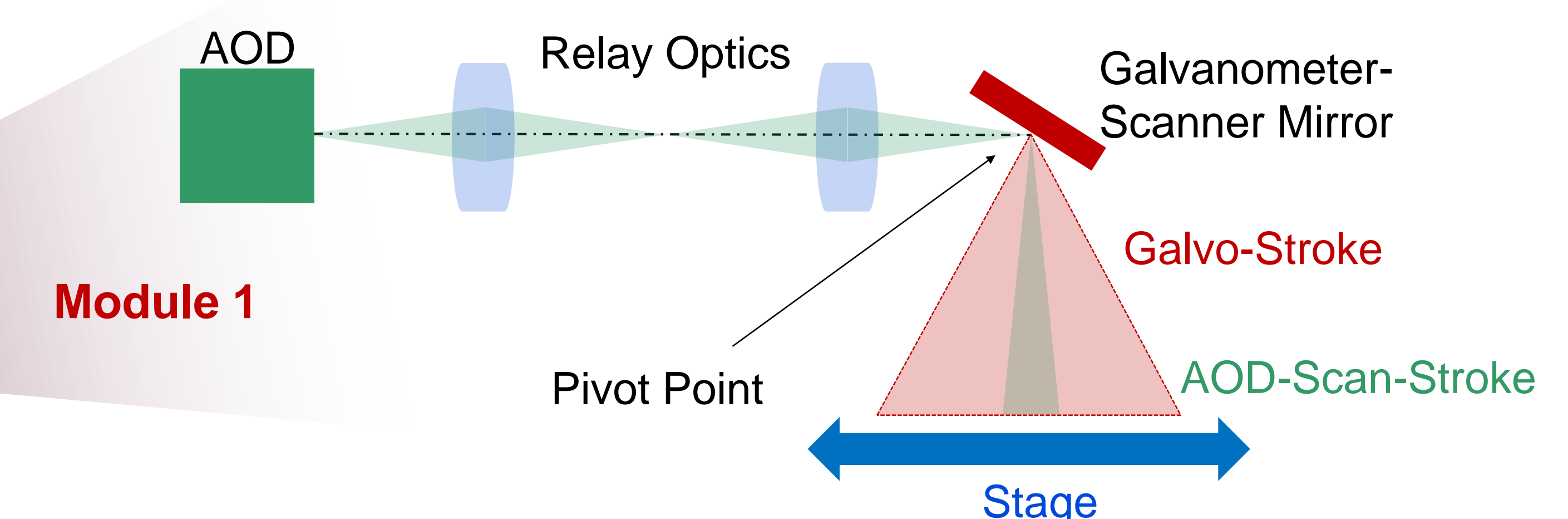
Machine concept (upper) with space for integration of interchangeable optical systems and control concept (software and hardware) for calculation and execution of synchronized multi axes motion (lower).

Synchronous Motion Control of Additional Degrees of Freedom

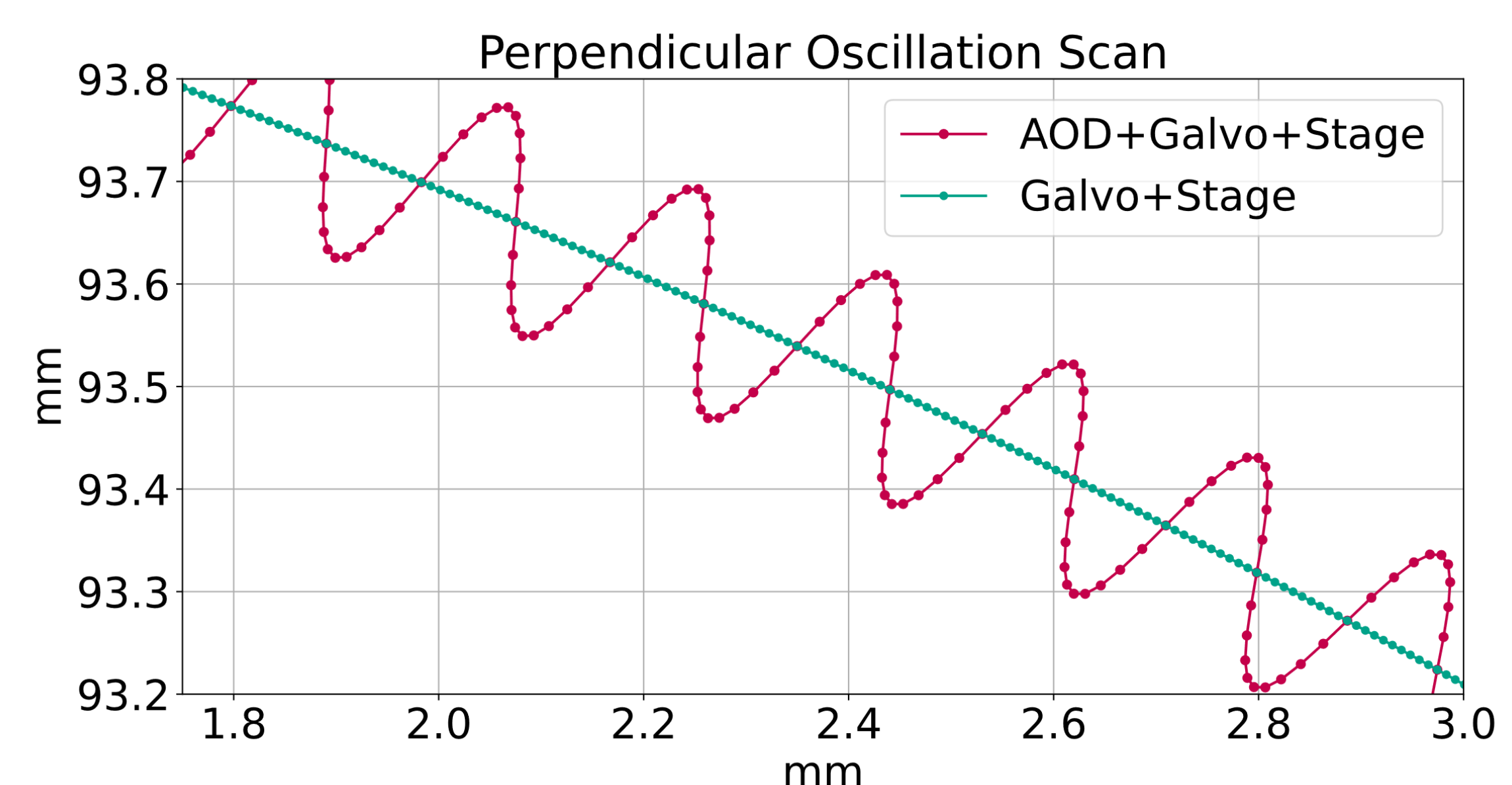
- Master controller operating laser, scan head and stage with industrial software solution
- New software interface for pre-calculation and editing of additional trajectories
- Simultaneous execution of pre-calculated trajectories for all axes by hardware synchronization of motion controllers

1st Demonstrator: Acousto-Optics and Galvanometer Scanner

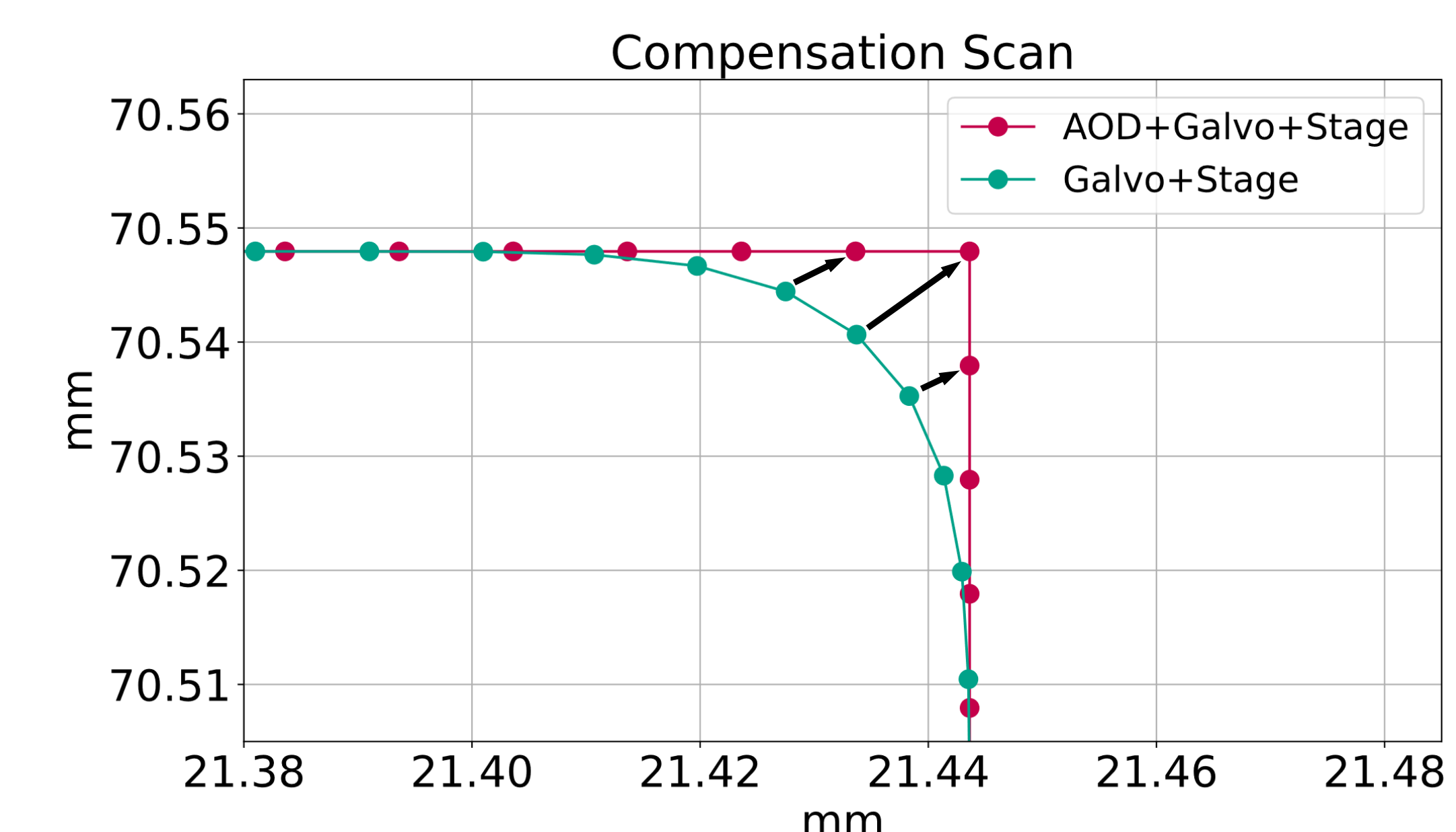
- Combination of beneficial properties: **greater scan range** of a galvanometer scanner can be accessed with the **higher scanning dynamics** of the acousto-optical deflectors (AOD)
- 2 AODs are mounted perpendicular to each other → 2D scan
- Additional motion of two-axis stage for processing large parts with **higher position accuracy** by narrowing in required galvanometer scanner stroke
- Demonstration of promising scanning strategies, e. g.:
 - Perpendicular oscillating scan with adjustable amplitude and frequency
 - Compensation of curvature radius without deceleration



Principle of first built up module: a sequential combination of the two scanning technologies (acousto-optics and galvanometer technology)



Resulting combined scan for perpendicular oscillation



Resulting combined scan with sharp corner geometries.

Summary

- Hardware control chain successfully demonstrated for AODs as additional devices
- Control software interface (Python) for individual trajectory calculation available and adaptable
- Viewer Software for analysis and editing of pre-calculated trajectories
- gRPC interface (Google Remote Procedure Call) for data transfer and synchronization of additional devices

Outlook

- Analysis of potential and limitations of scanning technology combinations
- Optimization of pre-calculation of redundant and interdependent motion trajectories
- Design (Optics & Software) and assembly of demonstrators for further promising scanning technology combinations



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