# Dynamic Modeling for Machine Tool Thermal Error Compensation


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## Objectives

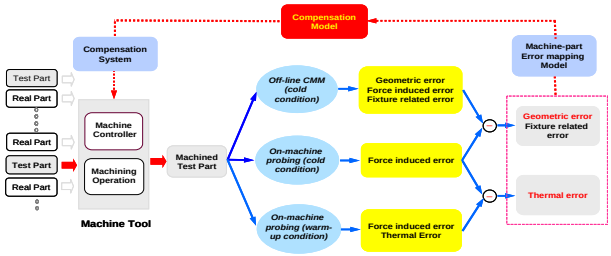
- To improve the accuracy and robustness of machine tool thermal error compensation through dynamic modeling
- To develop an innovative methodology for machine tool thermal error modeling based on system identification theory
- To develop a fast thermal error calibration methodology which is suitable for the dynamic thermal deformation system modeling

## State-of-the-Art

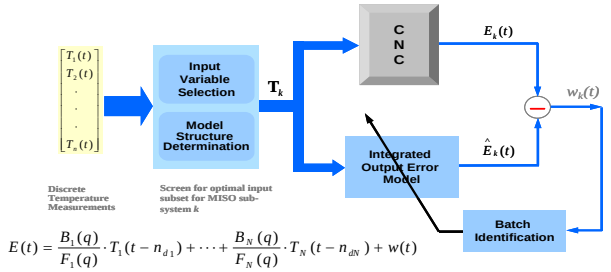
- The thermal error estimation model is based on static modeling approach which only considers the instantaneous relationship between current temperature measurement and thermal deformation
- The process of extracting thermal error signature is long and costly in order to cover a large range of working conditions

## Approaches

**Part-oriented Machine Error Self-calibration System**



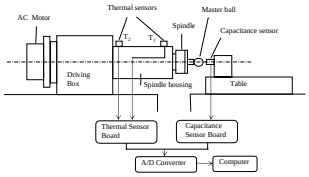

**Dynamic Modeling for Machine Tool Thermal Error Compensation**

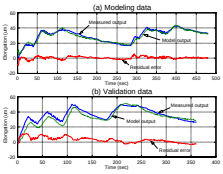



$$E(t) = \frac{B_1(q)}{F_1(q)} \cdot T_1(t - n_{d_1}) + \cdots + \frac{B_N(q)}{F_N(q)} \cdot T_N(t - n_{dN}) + w(t)$$

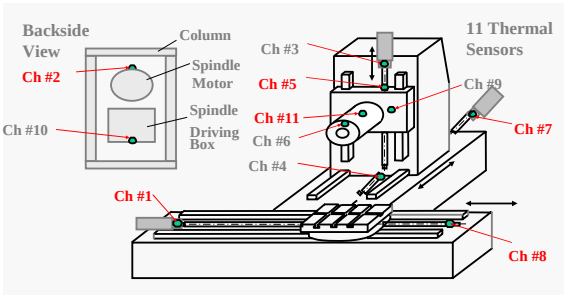
## Accomplishments

- Non-stationary thermal-elastic process modeling using Integrate Output Error model

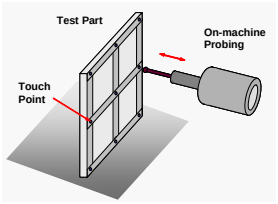


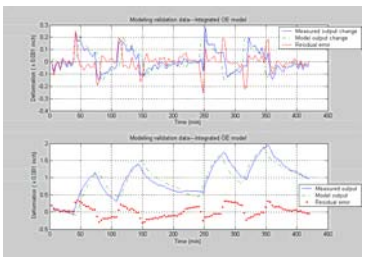

- Dynamic modeling for a three-axis horizontal machining center




On-machine Probing




Model Estimation



## Future Work

- Development of the Model Adaptation strategy for machine tool thermal error estimation based on the Dynamic Modeling methodology
- Development of the fast calibration procedure and software package for rapid machine error calibration through part error measurements

## Sponsors


NSF



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# Thermal error modeling and compensation of five axis machine tools

**Research Assistants/Faculty:**

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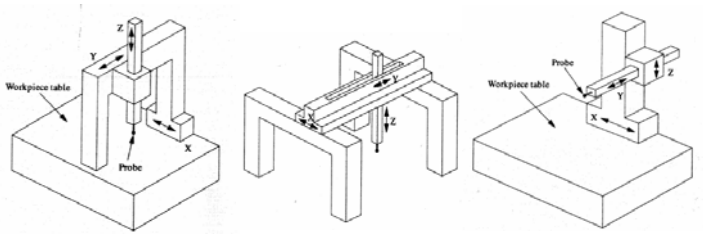
## Objectives

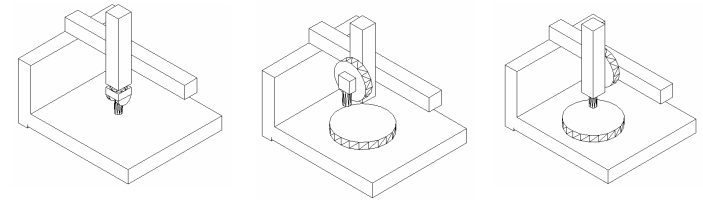
- Development of 5DOF EDM machine station

## State-of-the-Art

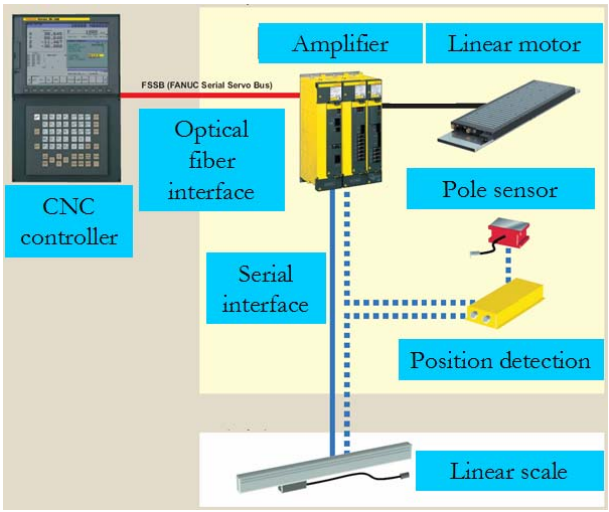
- Machine structure selection




- Rotary axes distribution



- System configuration

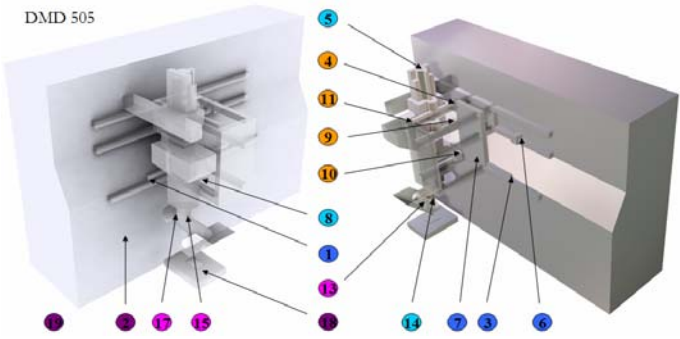



## Objectives

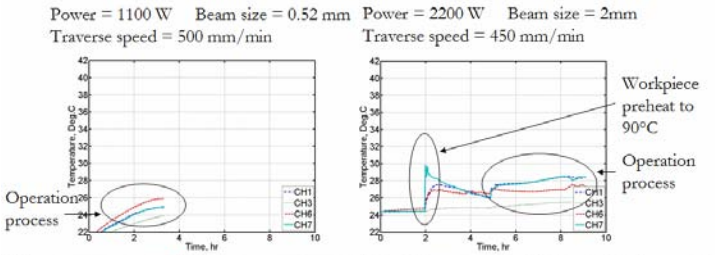
- Robust thermal error compensation for adaptive, ultra precision control

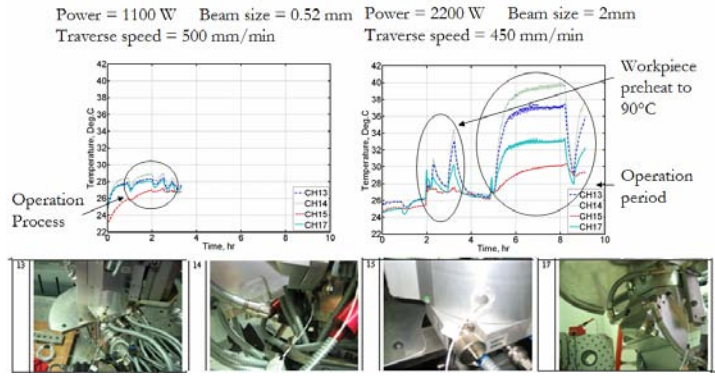
## State-of-the-Art

- Sensor placement on DMD 505




- Preliminary tests

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