



WESTERN MICHIGAN UNIVERSITY

College of Engineering and Applied Sciences

In-Situ Precision Machining Instrument

by

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Literature Review:

- Nishida et.al. (Micro-lathe under SEM)
 - Looking into English version
 - Focus on part production not material behavior
- Saito et.al. (Vision Guided Micro Lathe)
 - Limited to microstructures
 - Study surface chemistry effects in SEM
 - Auto feedback control
- Lu & Yoneyama (Micro Lathe Turning System)
 - 10 μ m minimal resolution
 - Optical microscope is used for positioning
- Komanduri et.al.
 - In-situ scratch testing
 - Precision scratching was not the emphasis

Instrument Capability:

- Cutting Operations
 - Indentations (micro & nano)
 - Scratch Test
 - Single Point Diamond Turning (Micro/Nano Turning)
 - Milling
- 3D Nanostructures (3 axis machining)

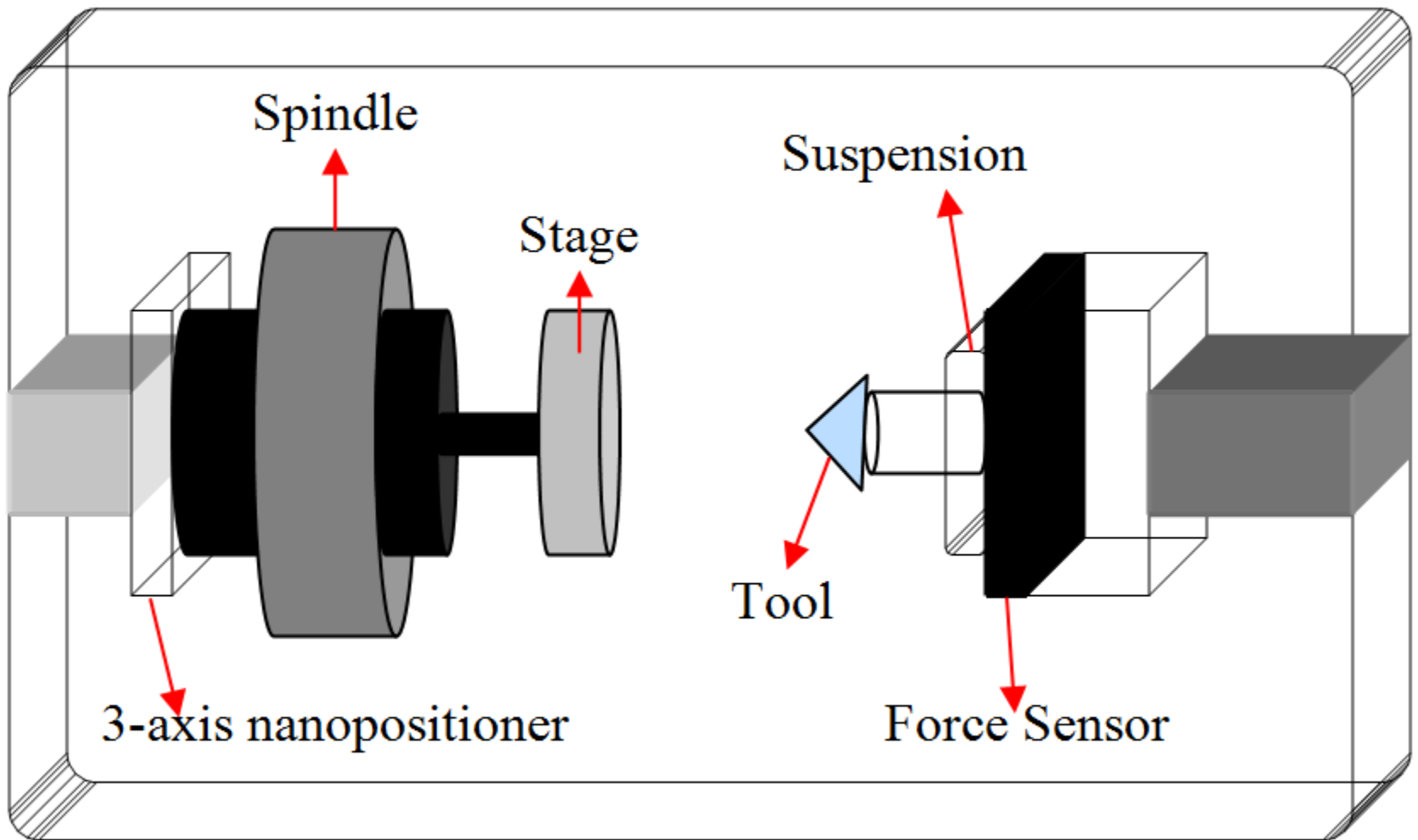
Instrument Purpose:

1. To be able to image material behavior during the removal process in high magnification (in-situ)
2. Observe the formation of the amorphous layer and high pressure phase
3. Measure cutting parameters (forces & displacement)

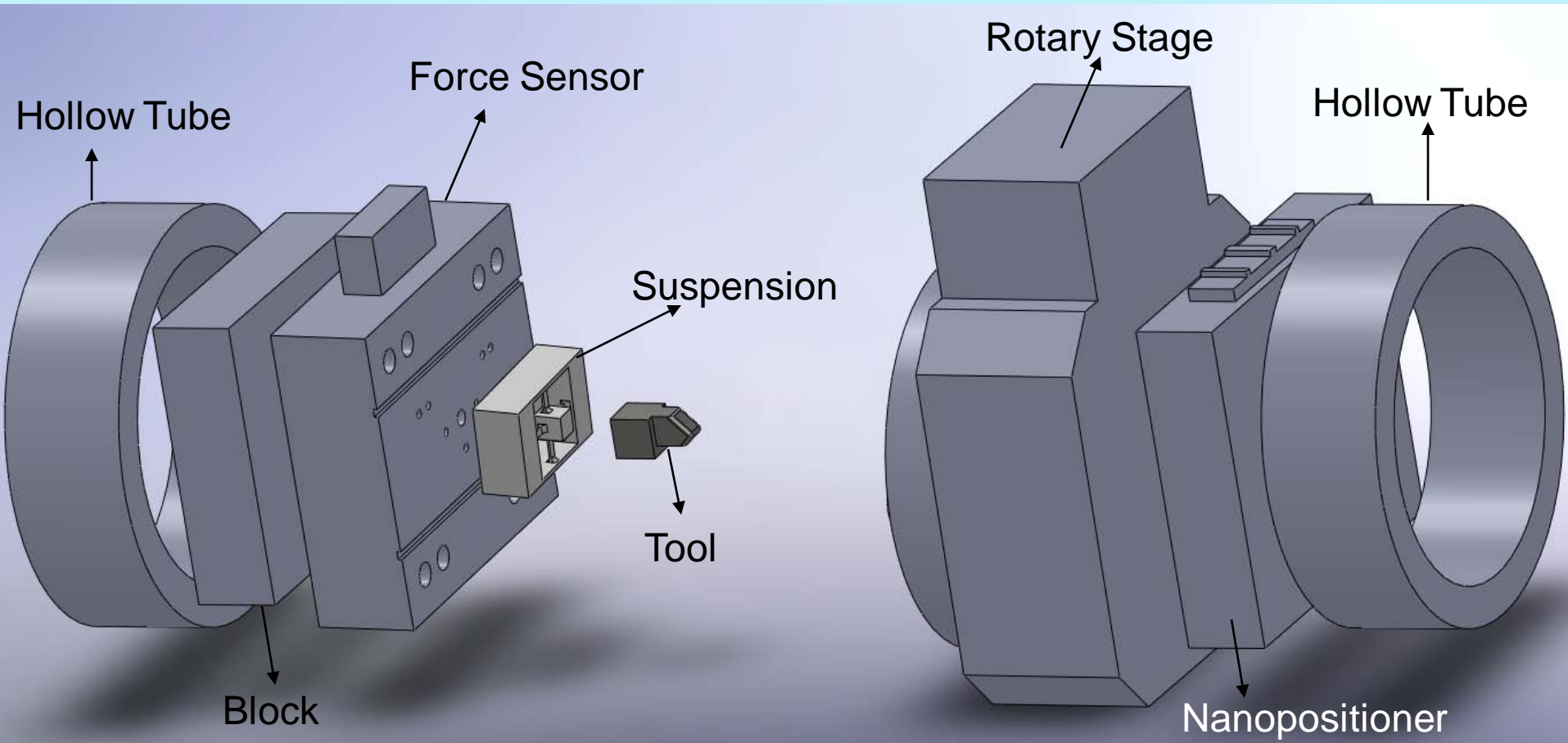
Constraints:

- Instrument size
 - SEM chamber/stage (200mm x 200mm x 200mm)
- Machine Resolution (<10nm error)
 - Minimal/no vibration
 - Minimal heat dissipation/thermal expansion
 - Minimal hysteresis
- Vacuum Compatible

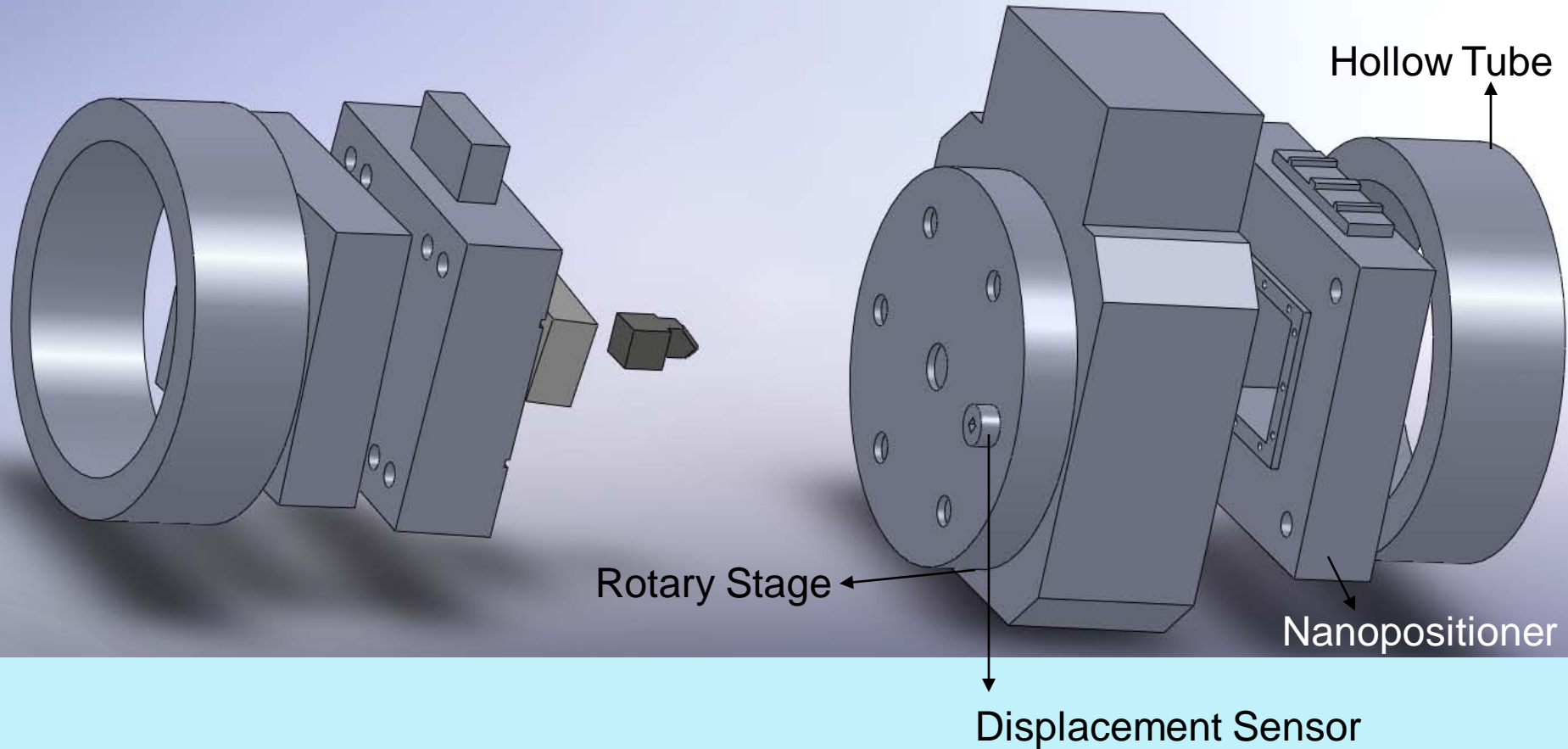
Initial Schematic



CAD (tool side):

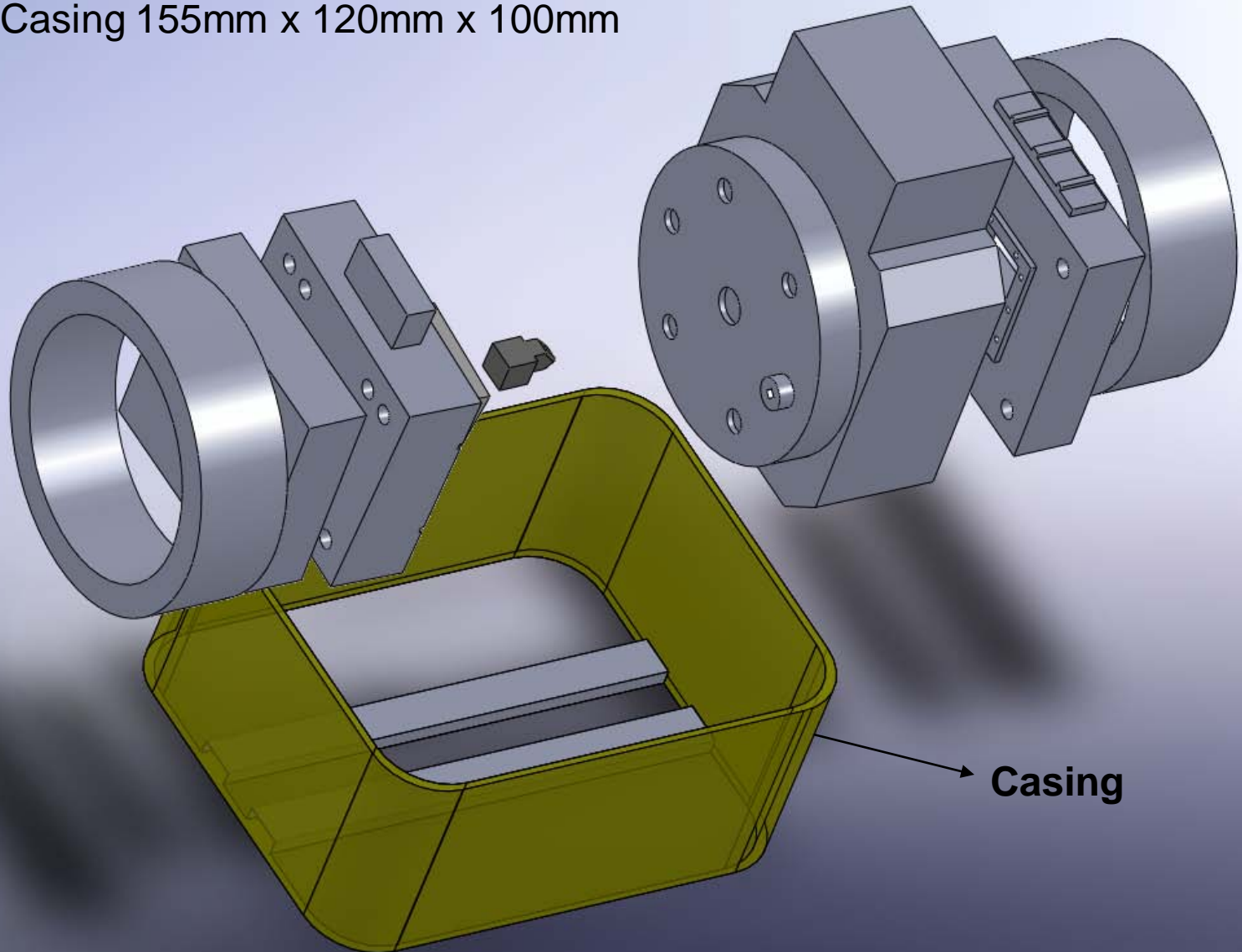


CAD (stage side):



CAD (assembly):

Casing 155mm x 120mm x 100mm



Question?

Suggestions?