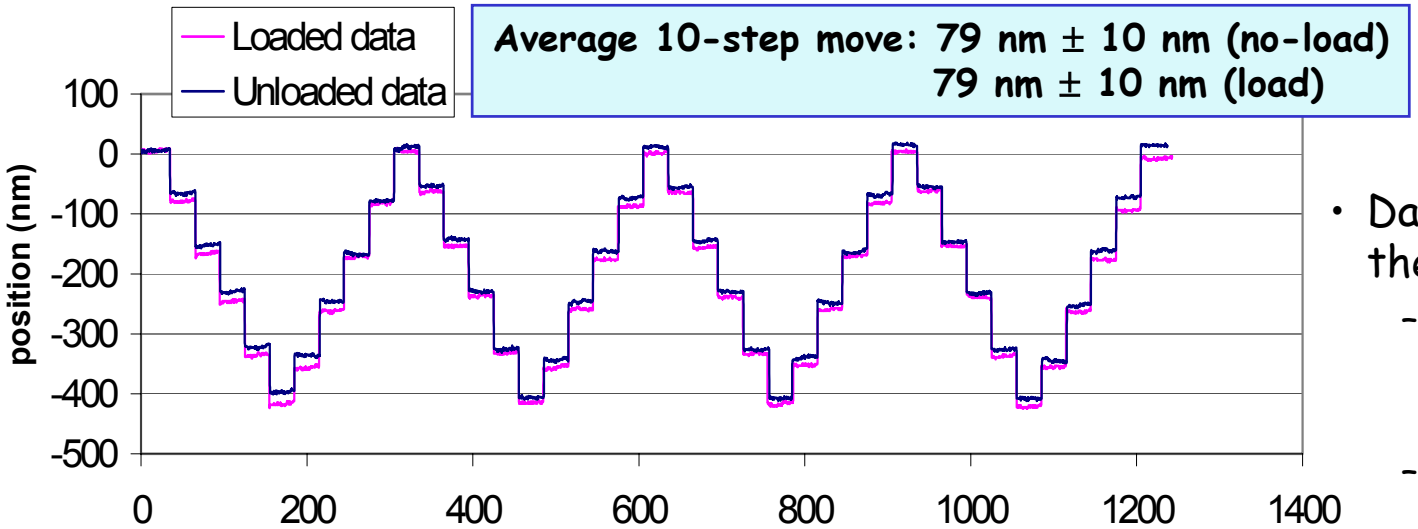
Ball Cryogenic Nano-positioner Test Results Summary

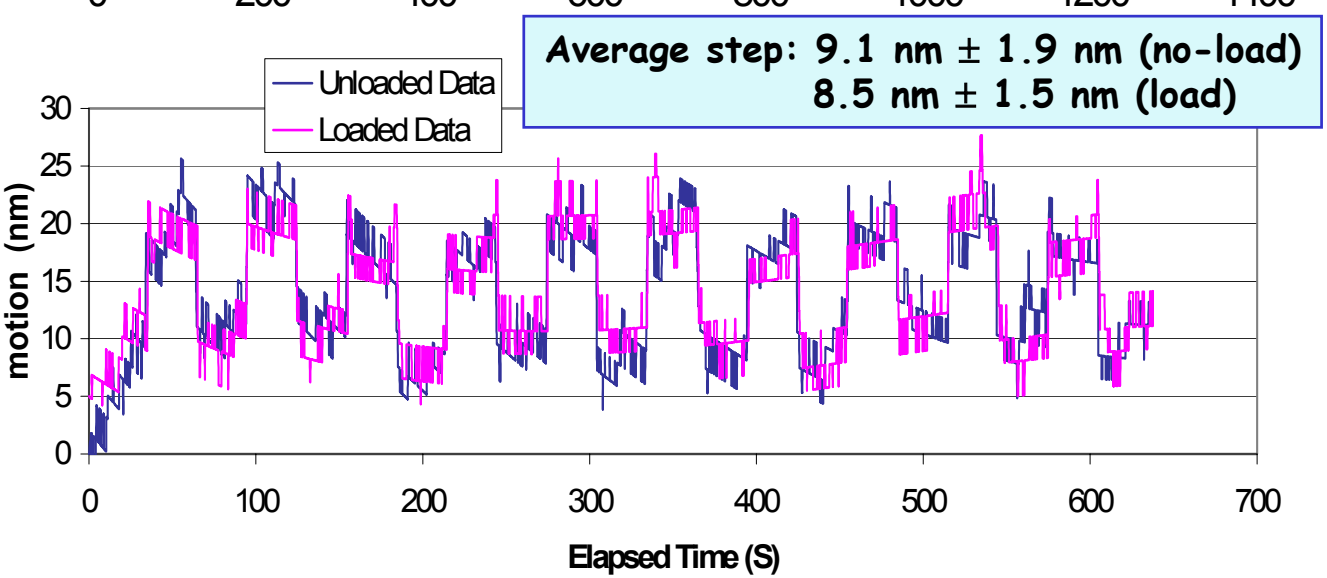
Ball Aerospace & Technologies, Inc.

22 May 2002

Ball Aerospace & Technologies Corp.

Success: Actuator Steps Can Be Commanded in a Deterministic & Repeatable Fashion Independent of Load





- Data with system thermal drift removed
  - Top chart:
    - 5 ten-step groups in each direction
  - Bottom chart:
    - Single-step toggle

Measured at ambient

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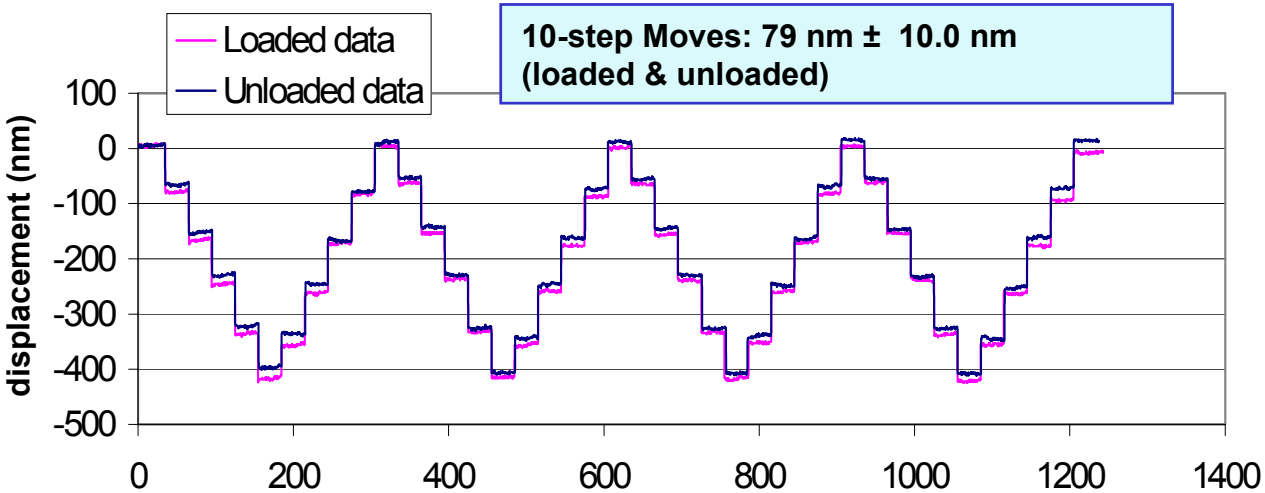
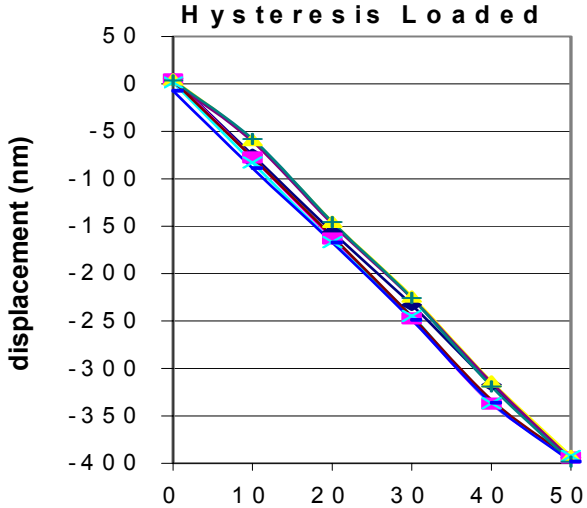
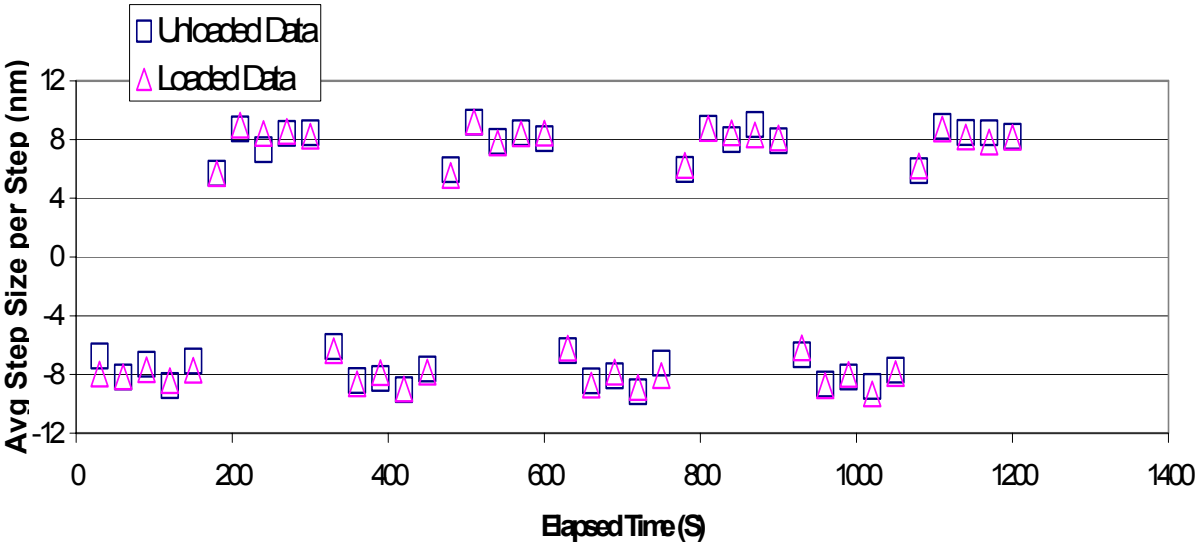
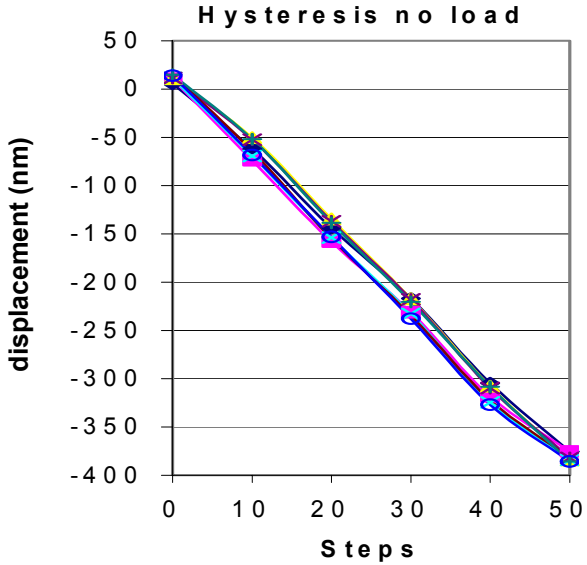
Hysteresis & Repeatability Errors Small Compared to Step Size









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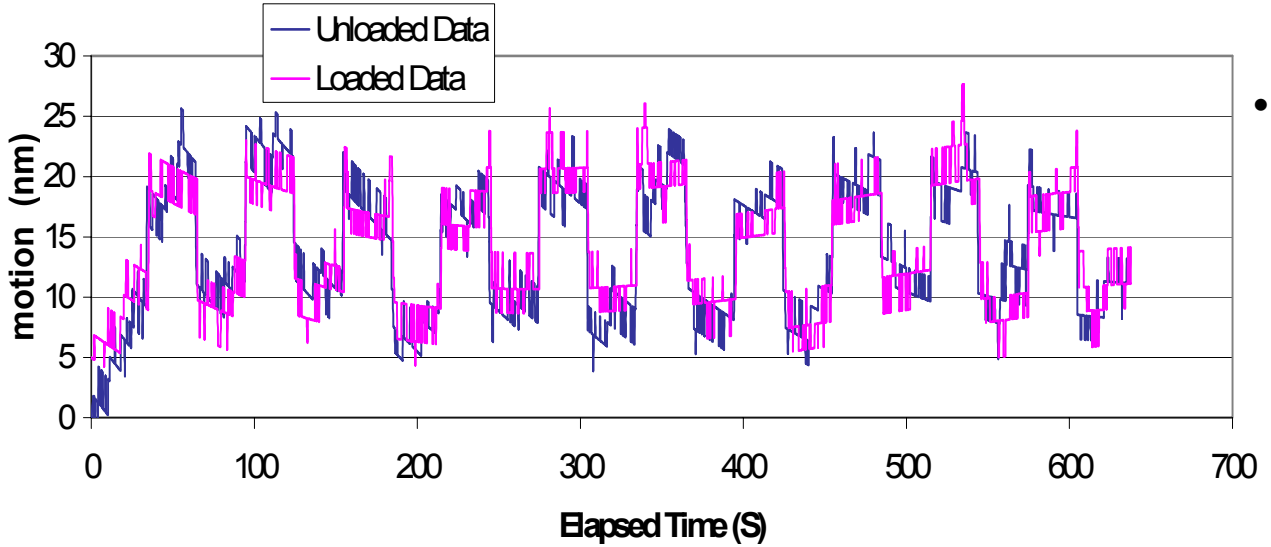
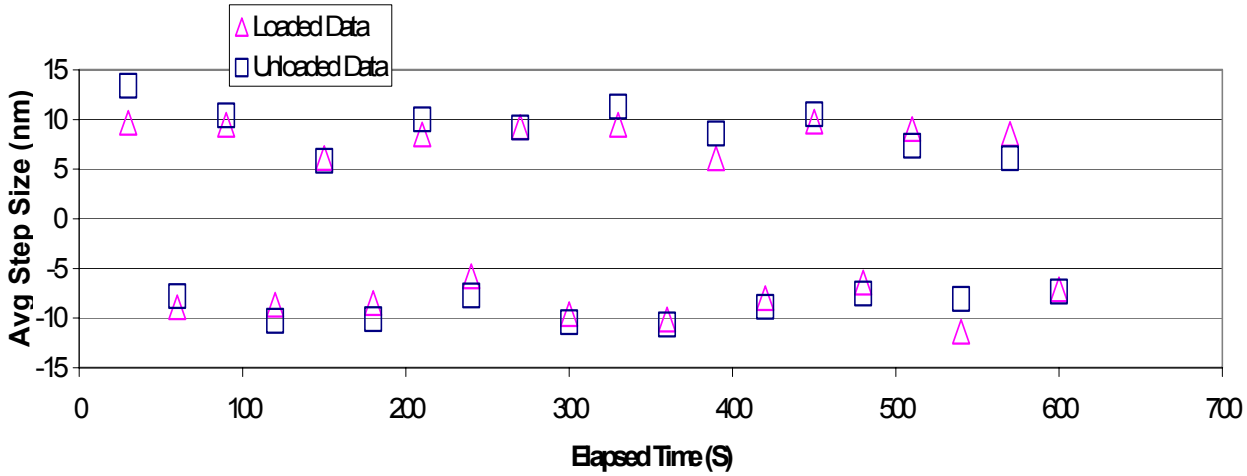
Single Step Toggle Performance Repeatable to Sub-10 nm Goals



- Single step moves:
  - 8.5 nm ± 1.5 nm (load)
  - 9.0 nm ± 1.9 nm (no-load)
    - Drift corrected



Measured at ambient

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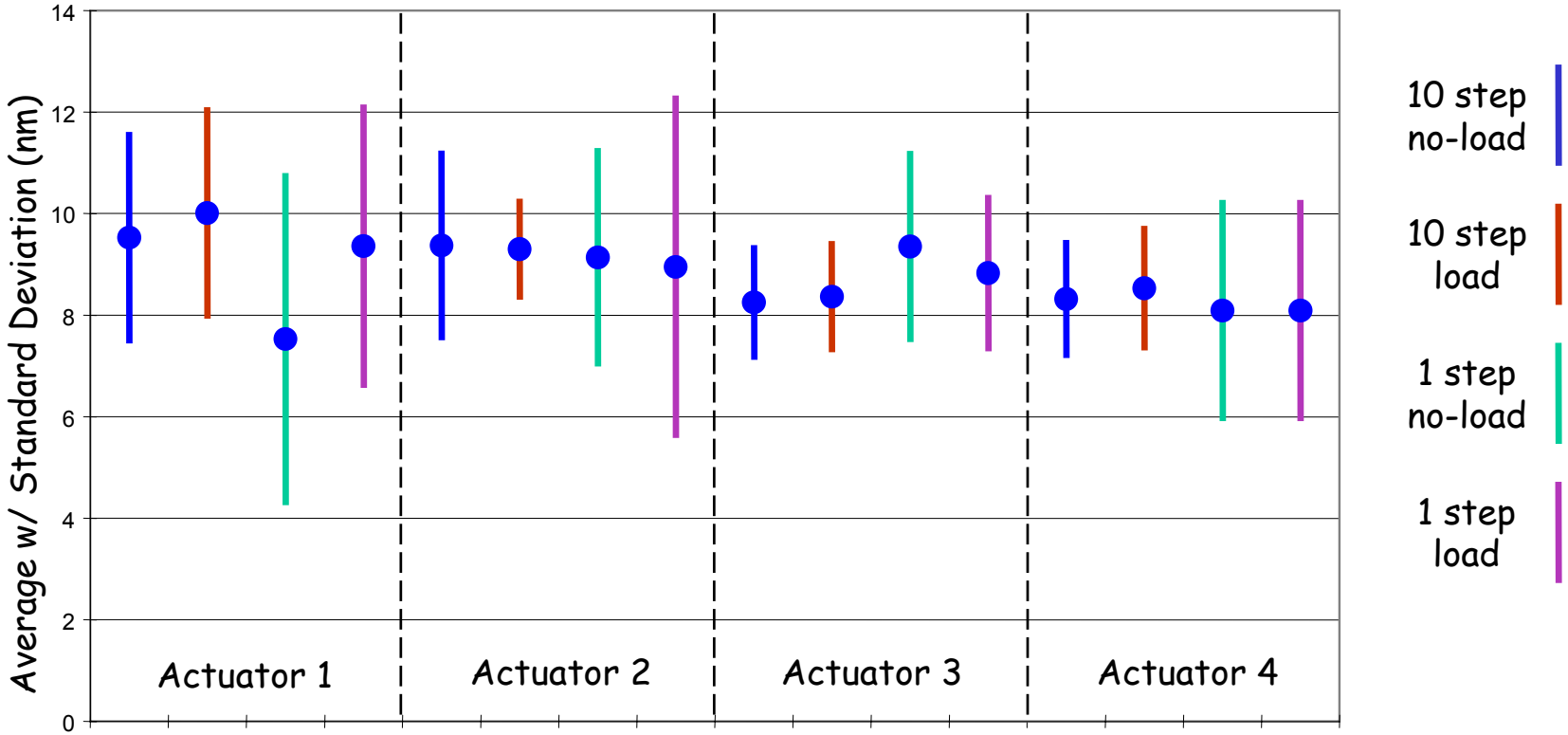
Data Consistent Among Four Different Actuators



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Actuators Were Commanded in a Deterministic & Repeatable Fashion

- No systematic hysteresis obvious in fine stage of actuator
- Load and no-load groups of 10 steps
  - Average step size: 7.9 nm ± 1.0 nm

- Actuator fine stage steps when commanded with single steps:
  - Average step size: 9.1 nm ± 1.9 nm (no-load)
    8.5 nm ± 1.5 nm (load)

- Single step up and back test of actuator proves that actuator can be commanded in a deterministic and repeatable fashion with single steps

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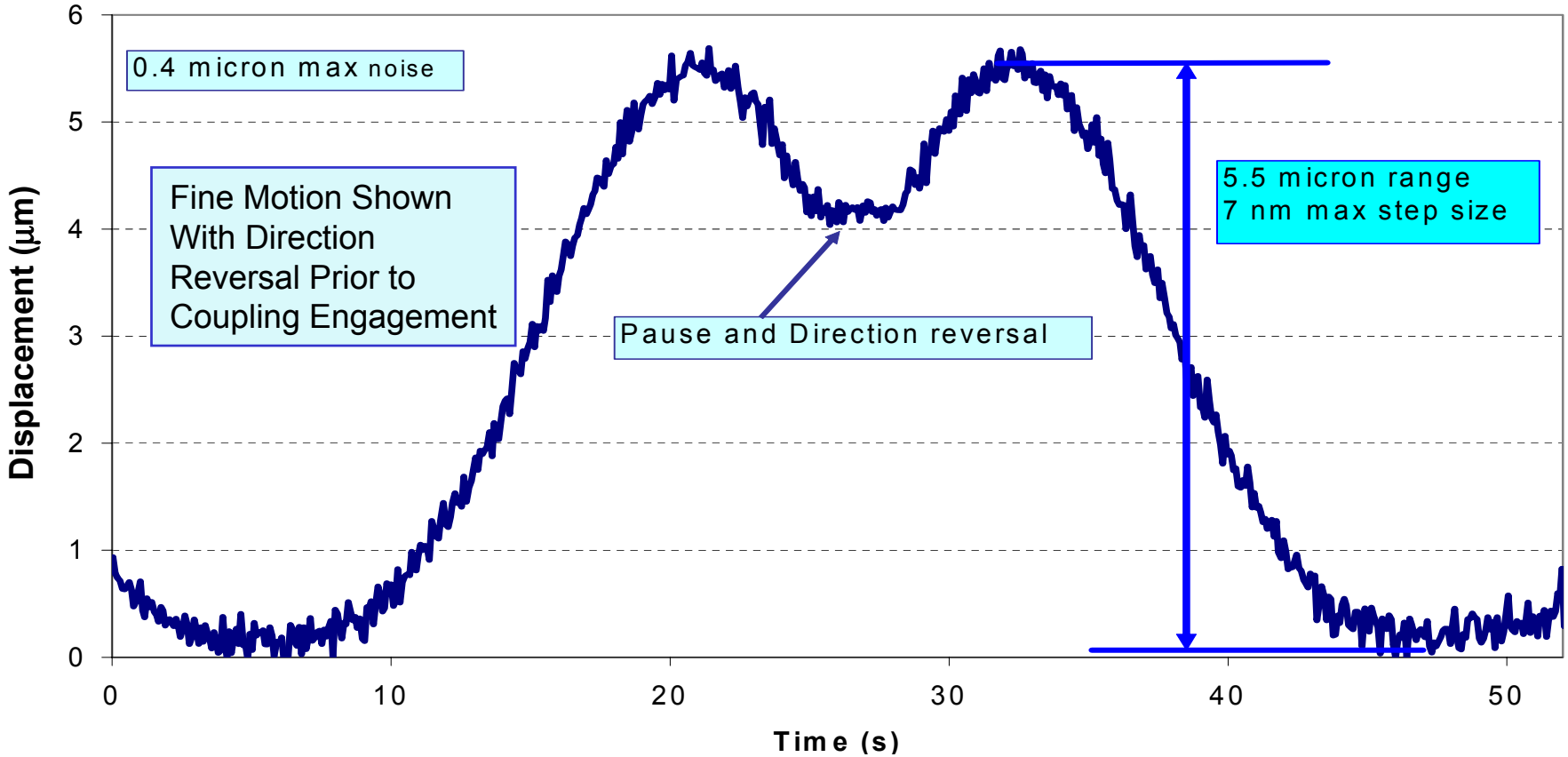
Actuator Fine Motion Performs as Expected at Cryo Temperatures

- Cryo-testing of current actuators repeating 10-step and single-step measurements underway. (Chamber pump down started 17 May)
- Cryogenic testing of the 2000 IR&D actuators performed in January 2001 demonstrated that the actuator functions as expected at 20 K



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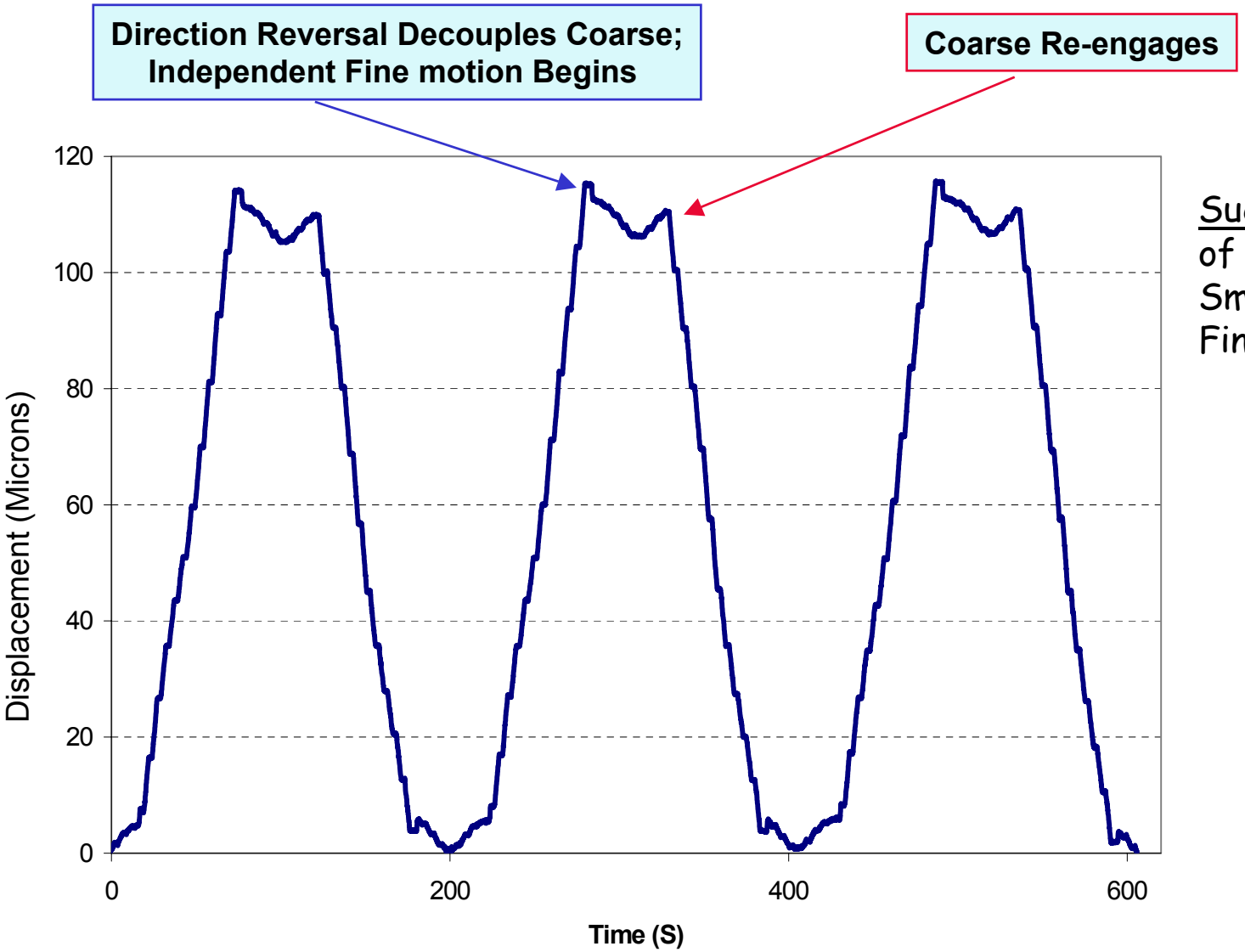
Repeatability of 2000 IR&D Actuator Coarse Stage Demonstrated at 20 K



Success: Repeatability of Coarse Position is Smaller than Range of Fine;

0.9µm coarse repeatability <<5.5 µm fine range