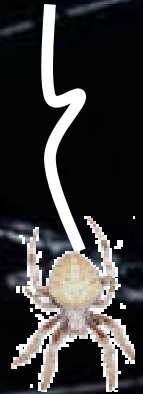


# The Mechanics of Spider Silk



David Ramsay  
NRL 8/04



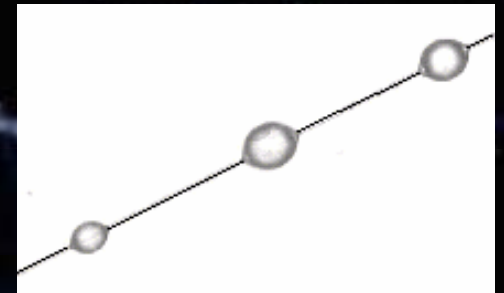
Dr. Kathy Wahl & Dr. Gun Lee



# Spider Silk

- **Very Unique**
  - Varying Mechanical Properties
  - Extremely strong, with a low density
  - Created in ambient conditions
- **Many Practical Applications**
  - Armor and other durable clothing
  - Replacement Ligaments
  - Cords and Cables
  - Seat Belts

*50x magnification  
of capture silk*

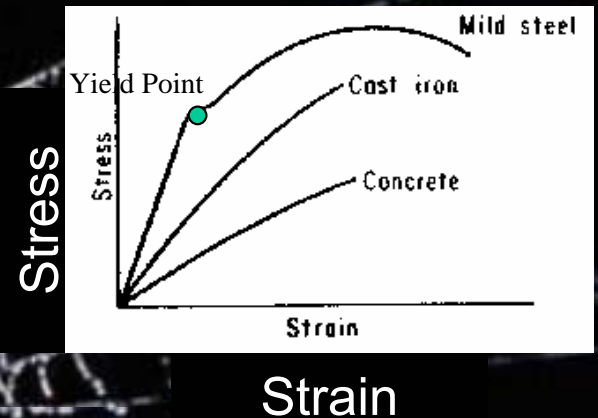




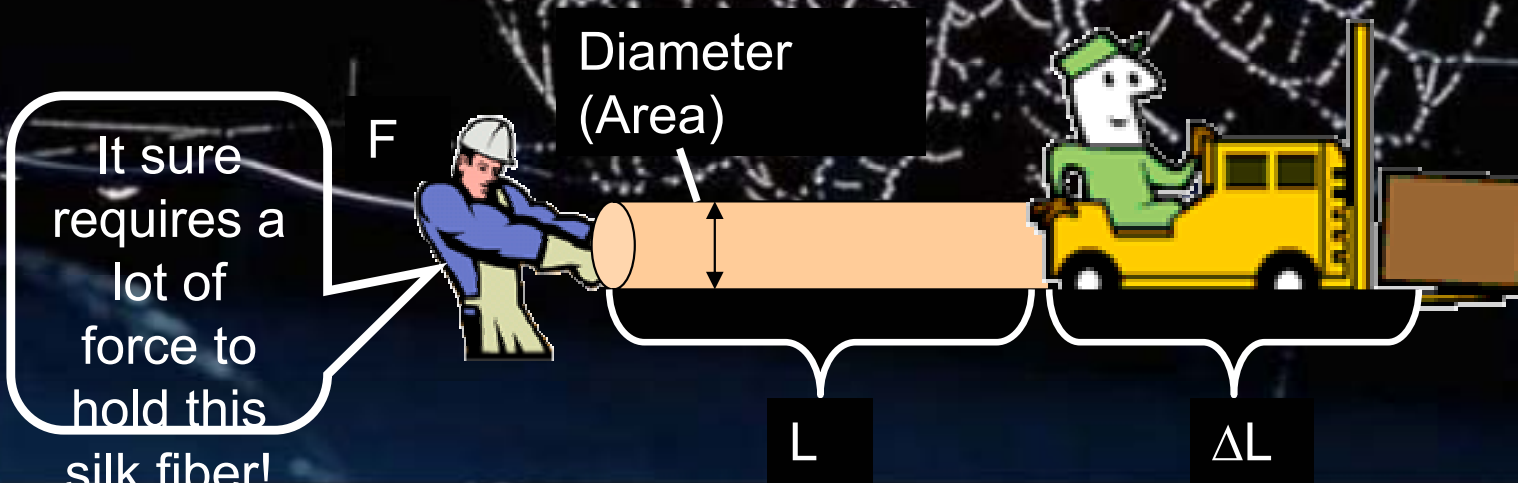
# Comparing Silks

- Engineering Stress/Strain Curve and The Pull Test

- Stress Force per unit area
- Strain Ratio of distance stretched to original size



To obtain a stress/strain curve, measure the diameter of the sample and run a pull test (pictured)

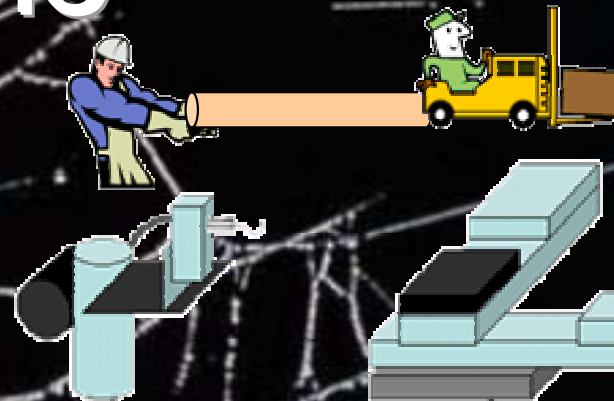


# Creating the Pull Test Machine

- Force Sensing - Load Cells
  - 1000 g
  - 25 g
  - 10 g



Load Cell



Movable  
XY Stage



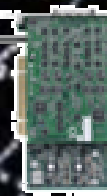
TMO-2 signal  
amplifier



Unidex  
511  
Motion  
Controller

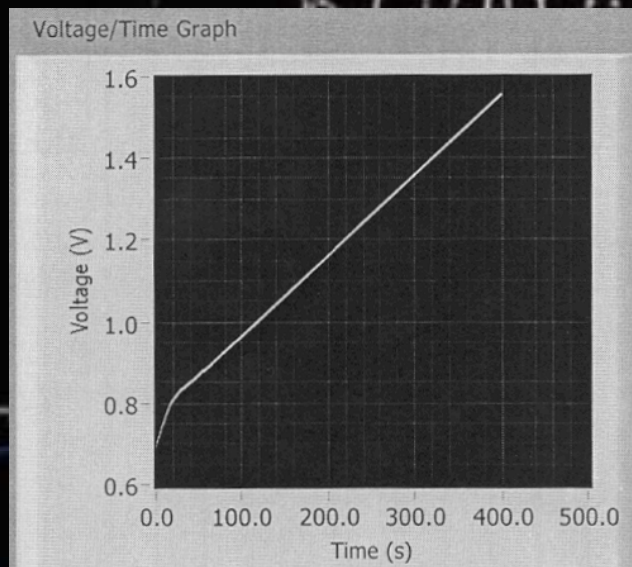


BNC-2110  
Connector Block



Computer with DAQ  
card and LabView  
software

Voltage (V)

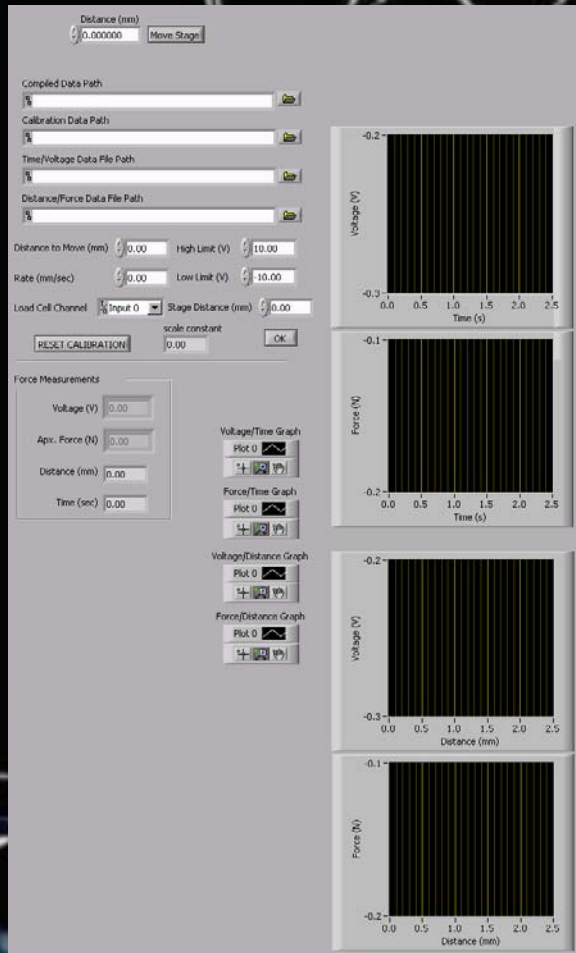


Time (s)

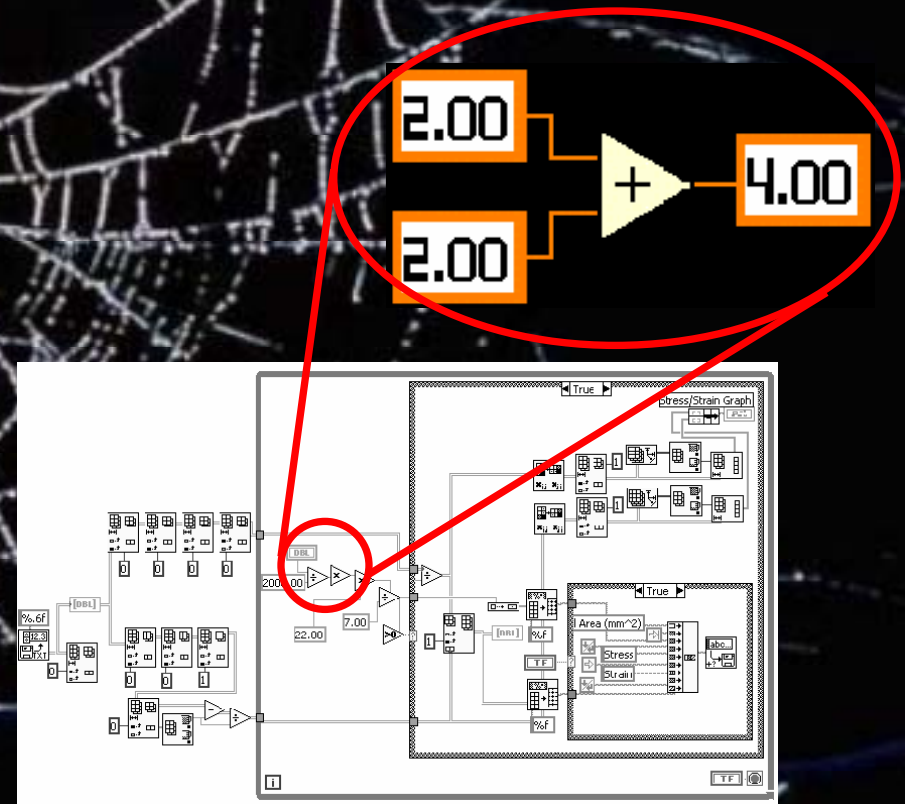


# LabView 6.0i Programs

- Several programs written to acquire and analyze data.

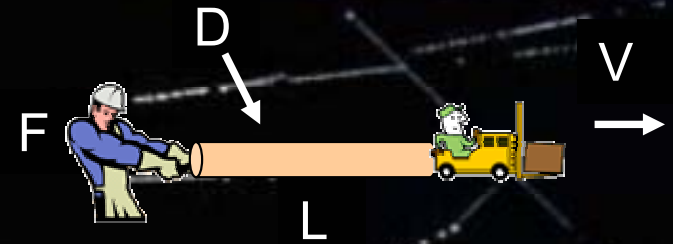


*Example of Front Panel for Data Acquisition Program.*



*Example of Source Code for Data Analysis Program.*

# Selected Data



Capture Silk samples  
 $D = 5.4$  microns



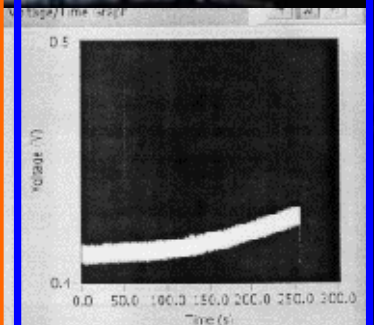
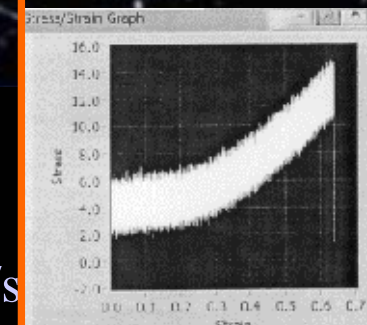
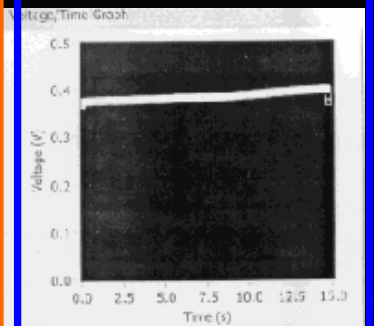
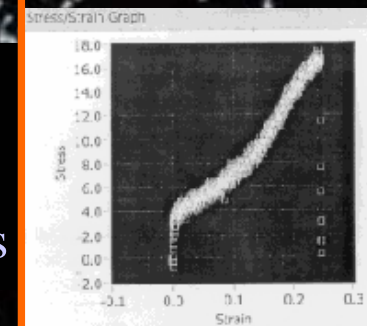
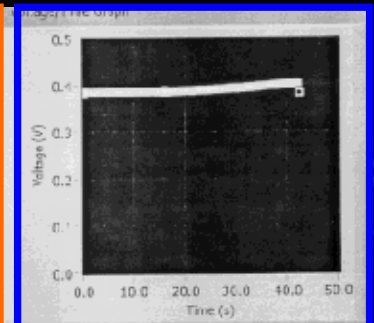
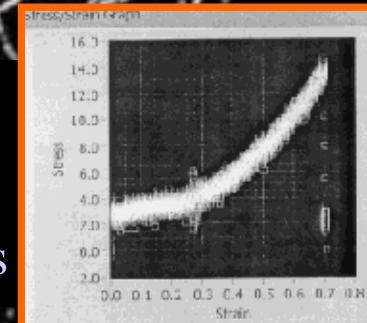
Structural Silk sample

$D = 21$  microns  
 $L = 10$  mm  $V = 0.01$  mm/s

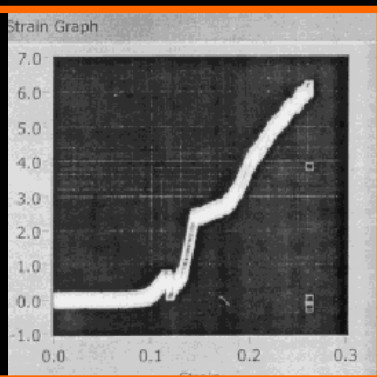
Test 1  
 $L = 6$  mm  
 $V = 0.1$  mm/s

Test 2  
 $L = 6$  mm  
 $V = 0.1$  mm/s

Test 3  
 $L = 8$  mm  
 $V = 0.02$  mm/s

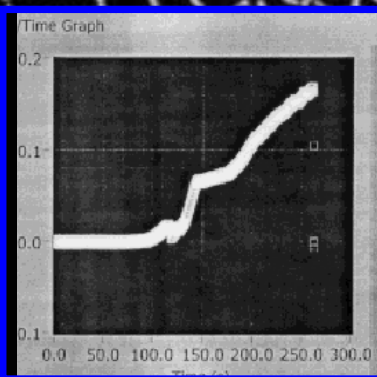


Strain (N/mm<sup>2</sup>)



Stress

Voltage (V)



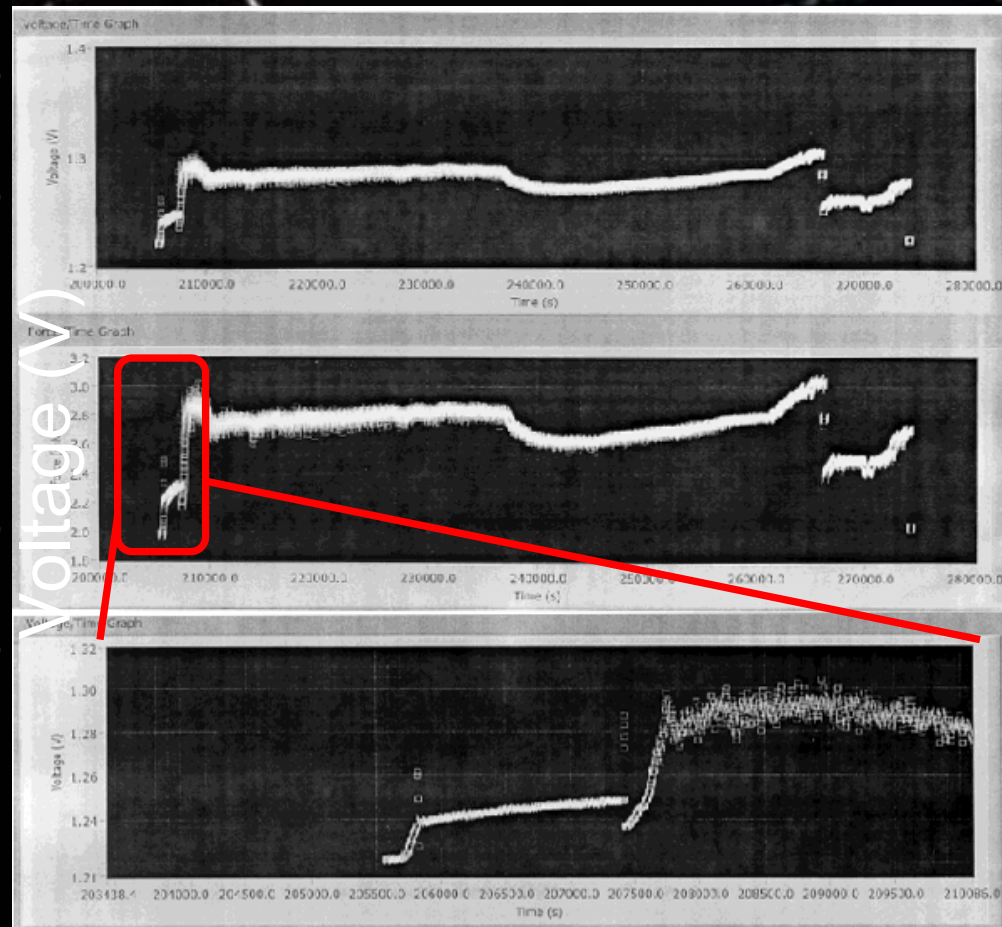
Time (s)



# Supercontraction Tests

- Certain spider silk shrinks more than half its original length when immersed in water.
- Previous tests have detected forces on the grips holding the silk in place as it supercontracts.

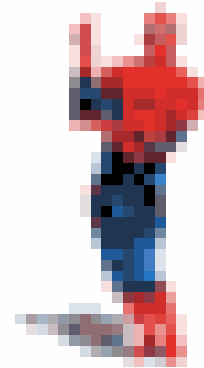
Force (mN)



Time (s)

# CONCLUSION

## Acknowledgements & Sources



- Background picture  
<http://www.rsd.edu/schools/hanfordhigh/office.html>
- Spider Pic  
<http://crossroads.net/a/2003/10/07/spider/index.php>
- Stress/Strain Graph  
[http://darkwing.uoregon.edu/~struct/courseware/461/461\\_lectures/461\\_lecture24/461\\_lecture24.html](http://darkwing.uoregon.edu/~struct/courseware/461/461_lectures/461_lecture24/461_lecture24.html)

**Special Thanks to Laura Cerully for her help and inspiration.**

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