

# Vine Robots

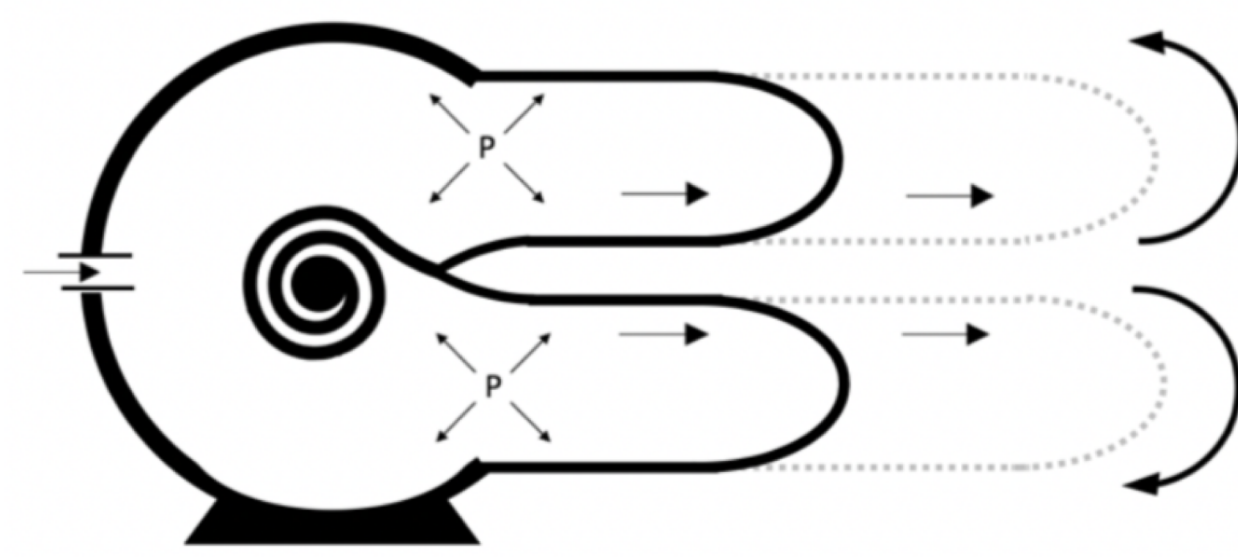
# Achieving Mobility and Construction by Growth

**Faculty:**  
 Allison Okamura (PI)  
 Sean Follmer (co-PI)  
 Jonathan Fan (co-PI)  
 Elliot Hawkes (subcontract)

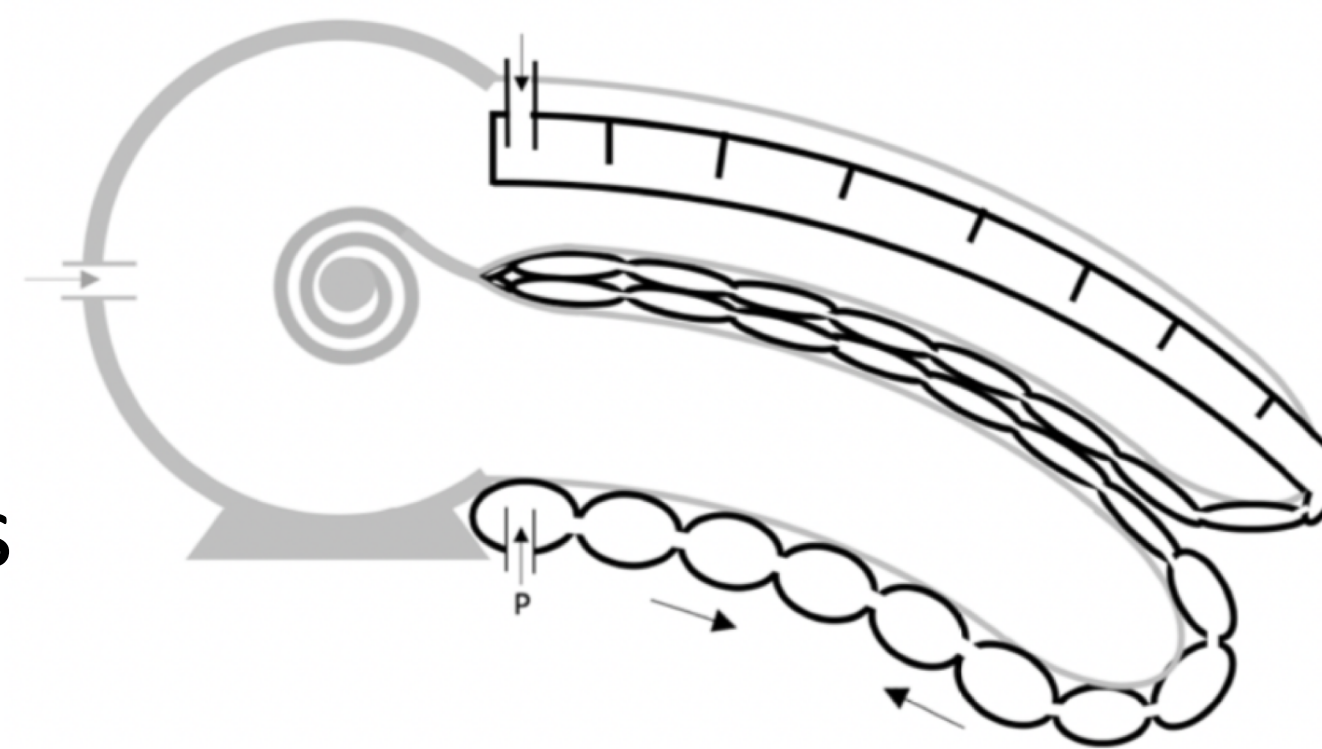
## TIP-EVERTING STEERABLE GROWING ROBOT



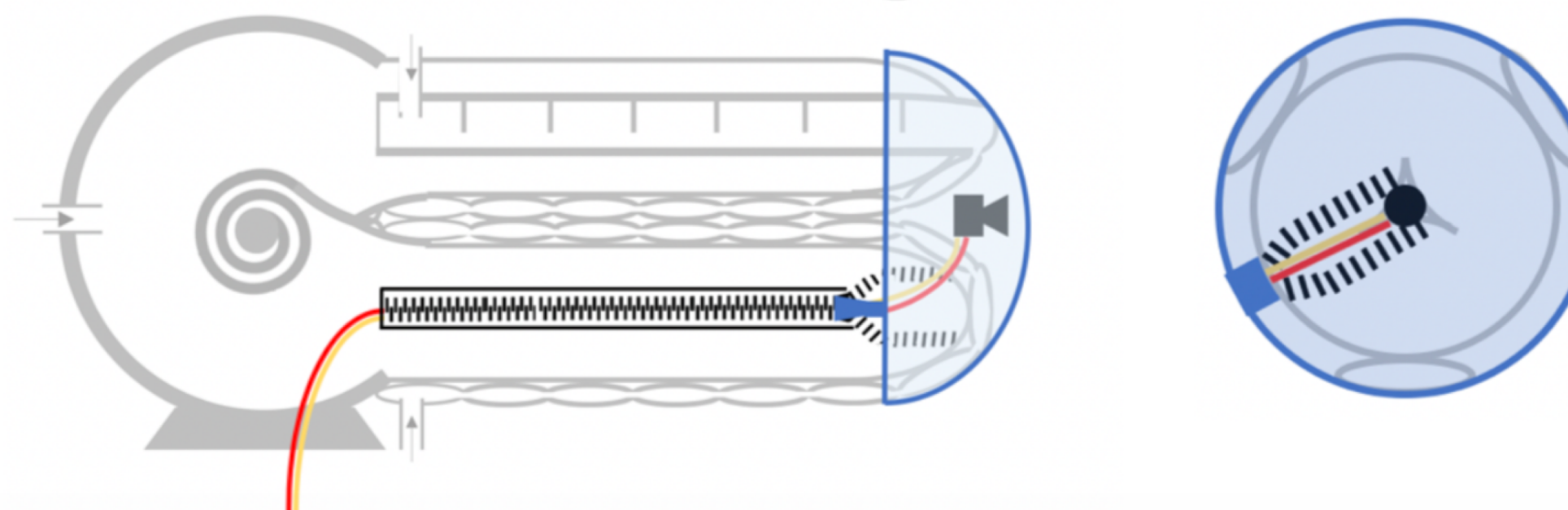
Grows to arbitrarily long lengths



Teleoperated steering using series pouch motors



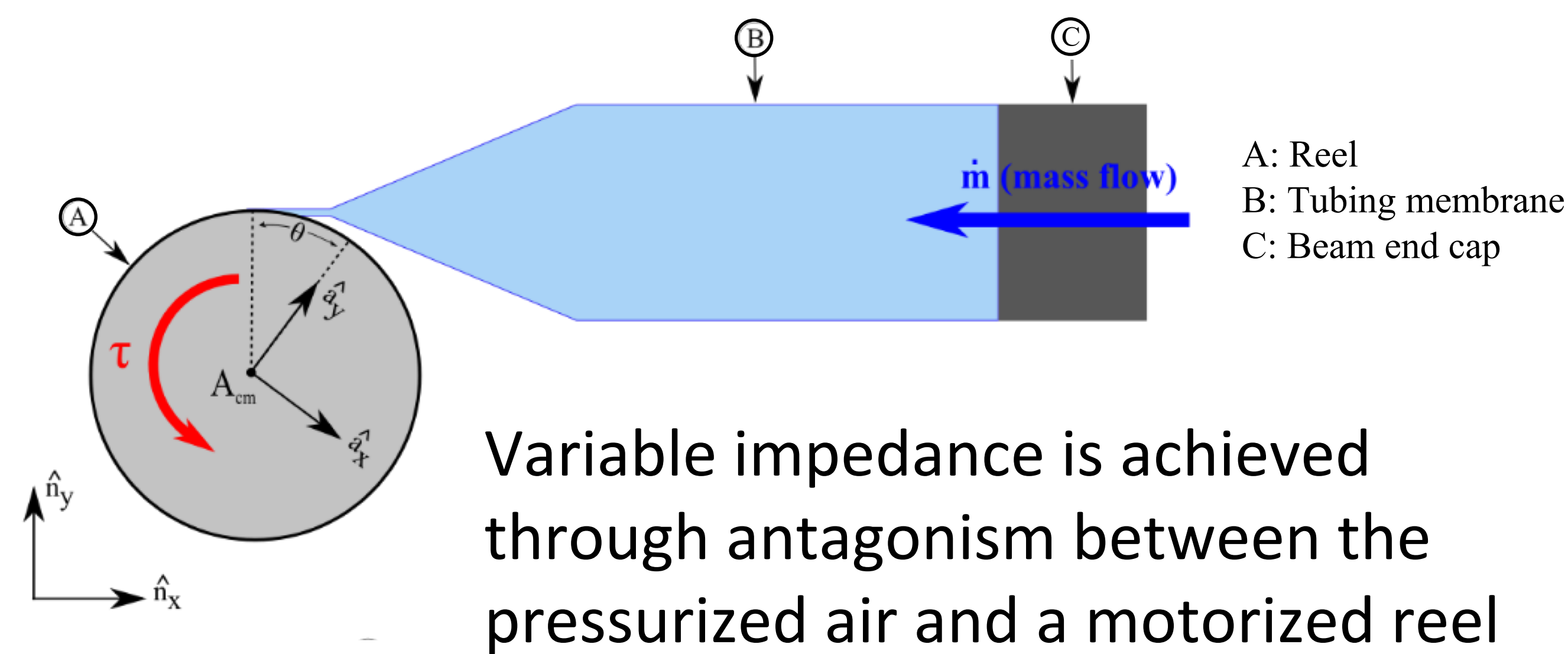
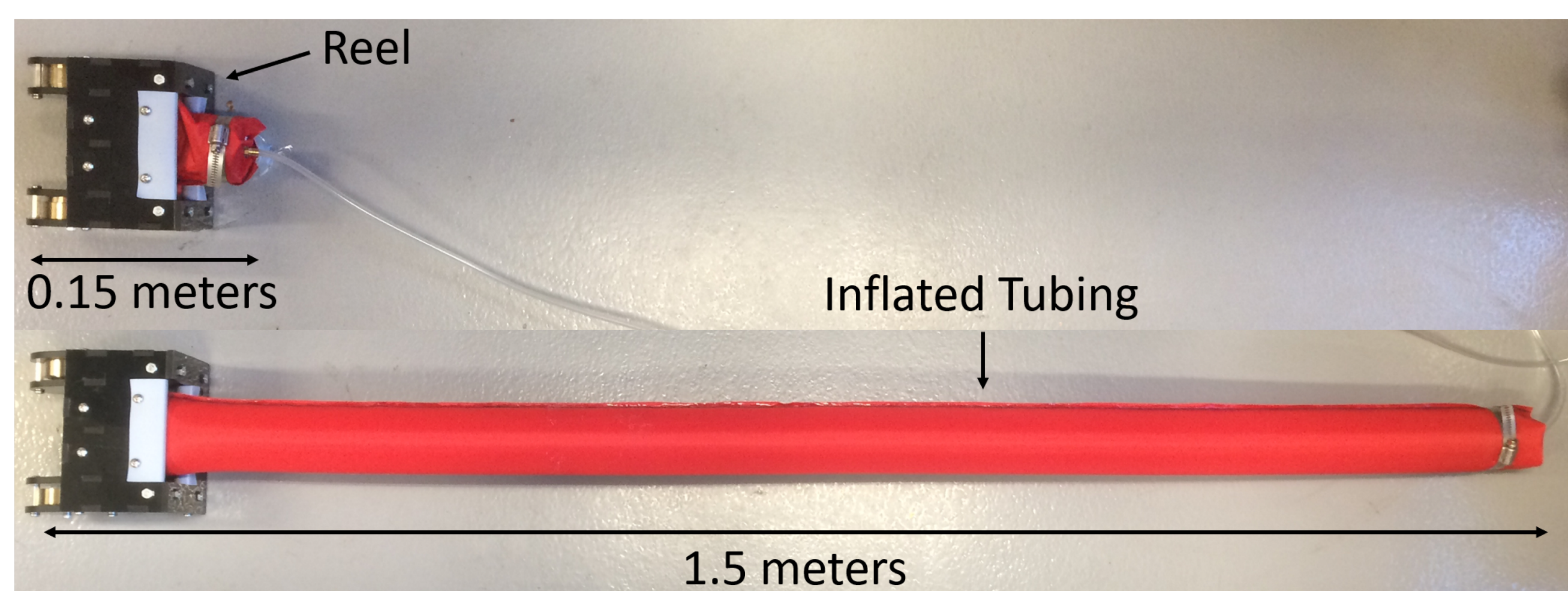
Camera mount at tip



**Collaborators**  
 Jee-Hwan Ryu (KoreaTech)  
 Christian Duriez (INRIA)  
 Ron Alterovitz (UNC-CH)

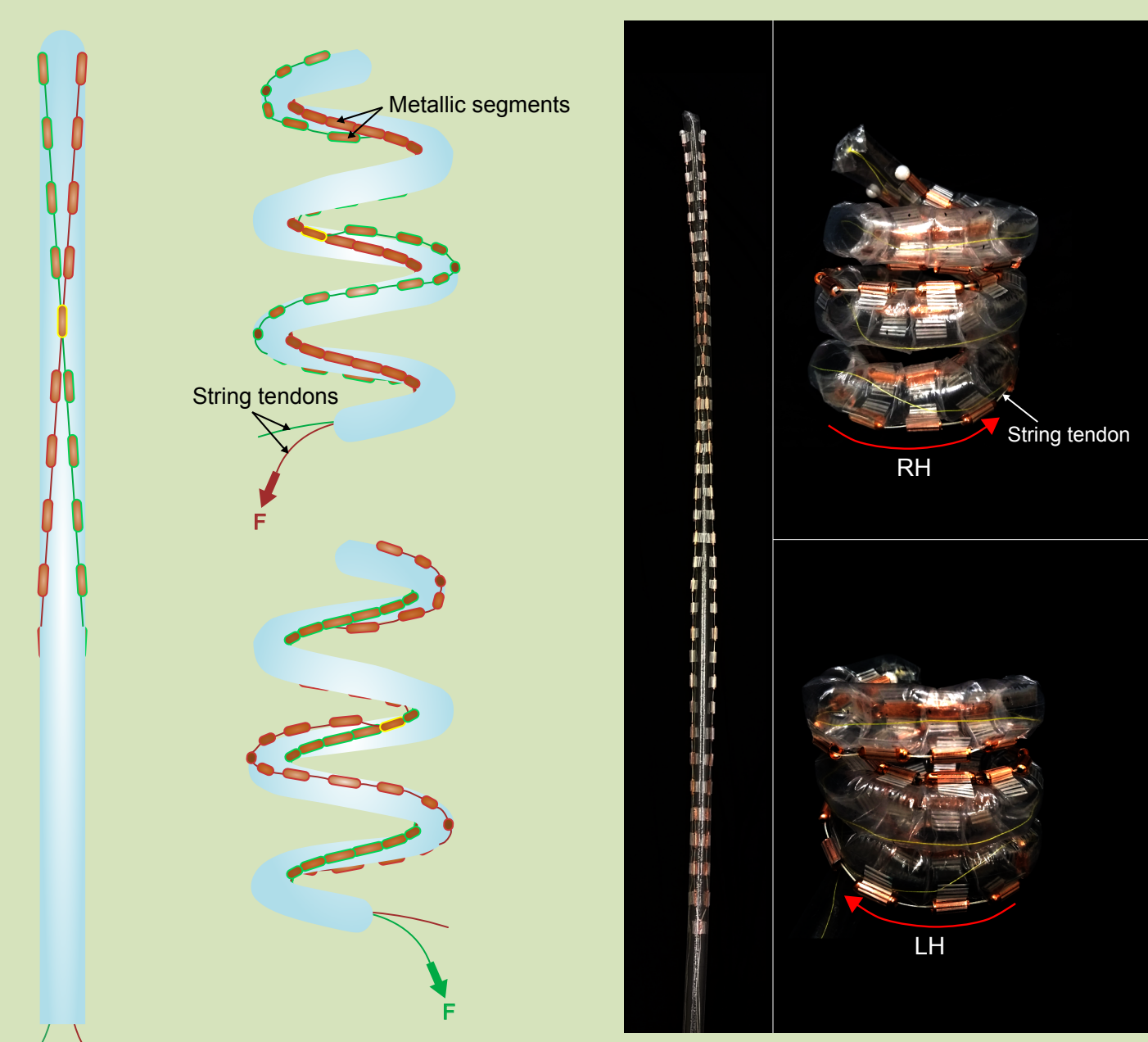
**Students:**  
 Nathaniel Agharese  
 Laura Blumenschein  
 Tyler Cloyd  
 Margaret Coad  
 Sadie Cutler  
 Brian Do  
 Lucia Gan  
 Joseph Greer  
 Zachary Hammond  
 Nicholas Naclerio  
 Javier Reyna Zepeda  
 Nathan Usevitch

## PNEUMATIC REEL GROWING ROBOT



## Reconfigurable Antennas

We reconfigured properties of radio-frequency electromagnetic systems by manipulating their three-dimensional structure.



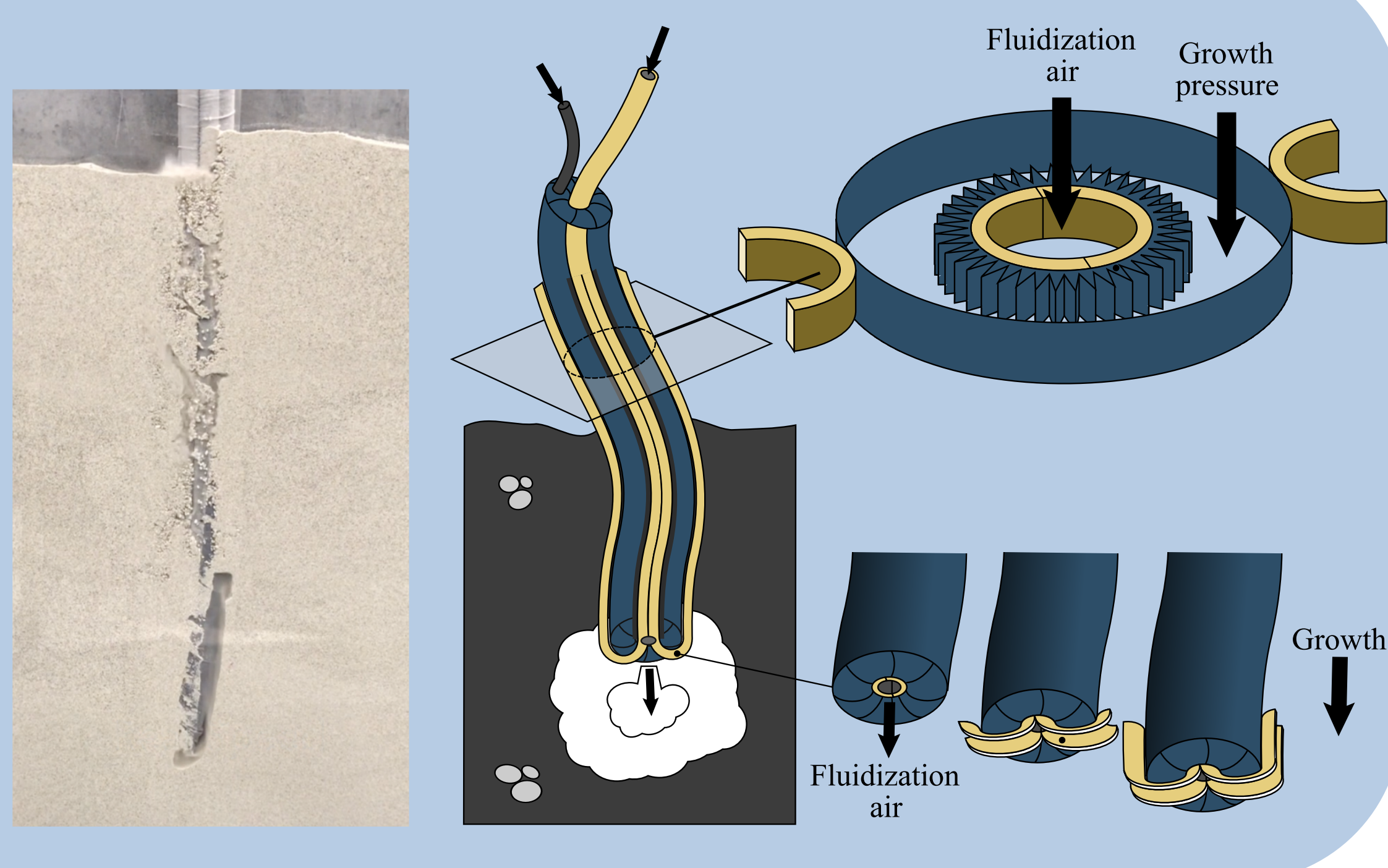
## Archeology

We explored an archeological site in Chavin, Peru.



## Burrowing

We enabled burrowing by tip extension combined with fluidization of surrounding material.



## Outreach

We posted open-source designs and assembly instructions at [vinerobots.org](http://vinerobots.org). We gave public demonstrations and participated in a soft robot navigation competition.



**Recent Publications:** ♦ L. H. Blumenschein, L. Gan, J. Fan, A. M. Okamura, E. W. Hawkes. A Tip-Extending Soft Robot Enables Reconfigurable and Deployable Antennas. **RA-L 2018**. ♦ L. H. Blumenschein, N. S. Usevitch, B. Do, E. W. Hawkes, A. M. Okamura. Helical actuation on a soft inflated robot body. **RoboSoft 2018**. ♦ N. Agharese, T. Cloyd, L. H. Blumenschein, M. Raitor, E. W. Hawkes, H. Culbertson, A. M. Okamura. HapWRAP: Soft Growing Wearable Haptic Device. **ICRA 2018**. ♦ N. S. Usevitch, A. M. Okamura, E. W. Hawkes (2018) APAM: Antagonistic Pneumatic Artificial Muscle. **ICRA 2018**. ♦ J. D. Greer, L. H. Blumenschein, A. M. Okamura, E. W. Hawkes. Obstacle-Aided Navigation of a Soft Growing Robot. **ICRA 2018**. ♦ H. El-Hussieny, U. Mehmood, Z. Mehdi, S.-G. Jeong, M. Usman, E. W. Hawkes, A. M. Okamura, J.-H. Ryu. Development and Evaluation of an Intuitive Flexible Interface for Teleoperating Soft Growing Robots. **IROS 2018**. ♦ N. Naclerio, D. Goldman, E. W. Hawkes. Soft Robotic Burrowing Device with Tip-Extension and Granular Fluidization. **IROS 2018**. ♦ J. D. Greer, T. K. Morimoto, A. M. Okamura, E. W. Hawkes. A Soft, Steerable Continuum Robot that Grows via Tip Extension. **Soft Robotics**, in press. ♦ Patent application USPTO 15/943329, Robotic Mobility and Construction by Growth.

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