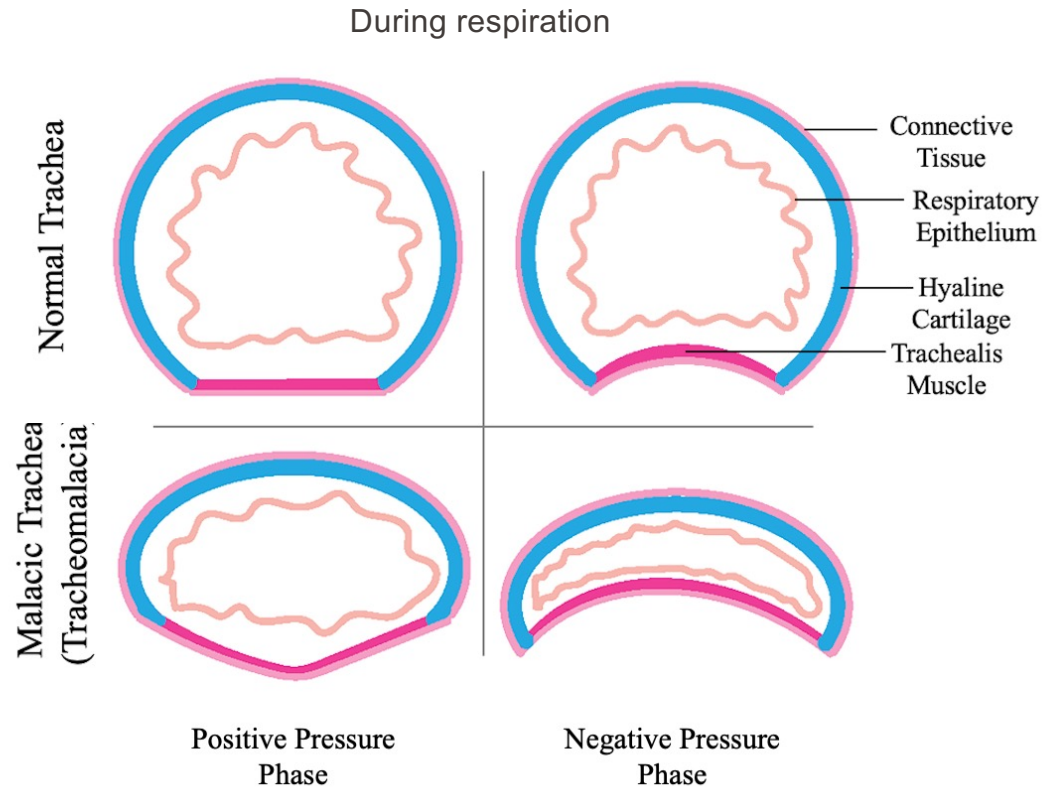


Adhesive Hydrogel Splint (Patch) To Correct Malacic Trachea (Tracheomalacia)



Tracheomalacia (TM): A Clinical Problem

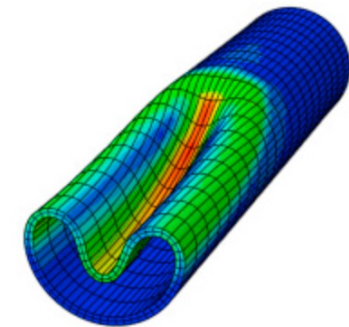
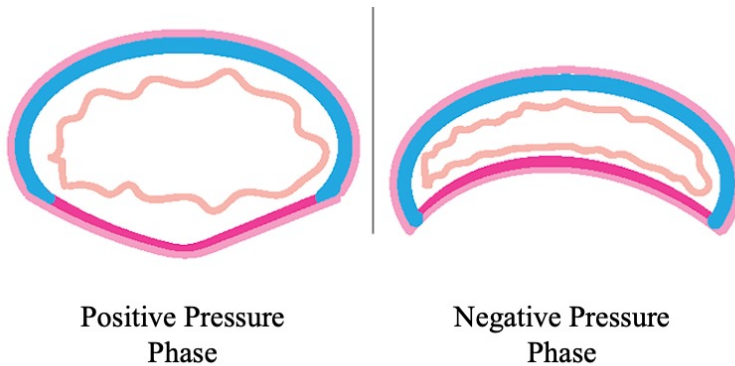


- Collapse or narrowing of tracheal lumen during respiration
- Congenital or acquired
- Most commonly affects small children
- Incidence of congenital TM: 1:2100

Int. J. Pediatr. Otorhinolaryngol. **123**, 38–42 (2019). *Semin. Pediatr. Surg.* **25**, 156–164 (2016).

Why does TM happen: The Cause!

Engineering Analogy: Collapse in Pipes



- ❑ Weakness of cartilage rings
- ❑ Reduced muscle strength (hypotonia)

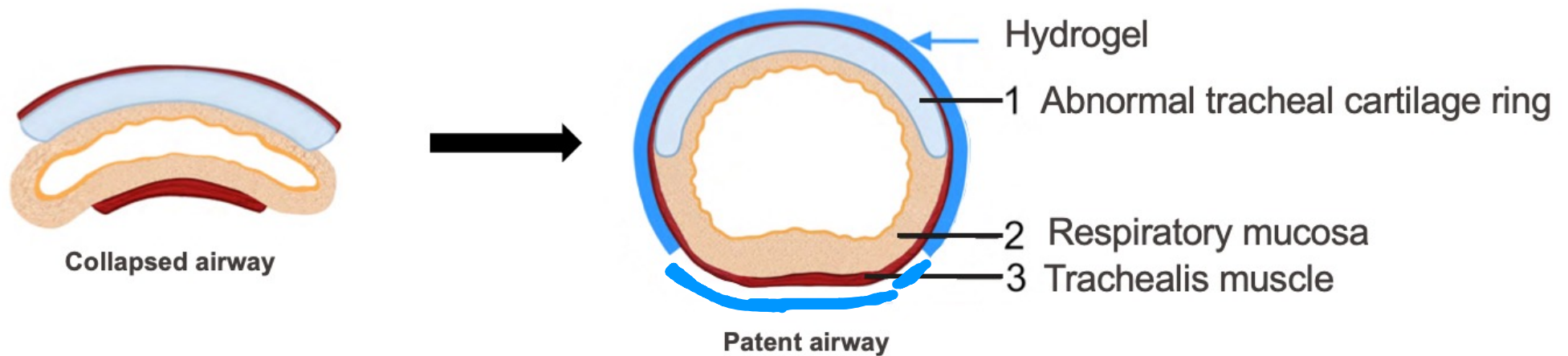
Causes:

- ❑ Pipe characteristics
- ❑ **Material Properties**
- ❑ Environmental factors
- ❑ Loading conditions

Remedy

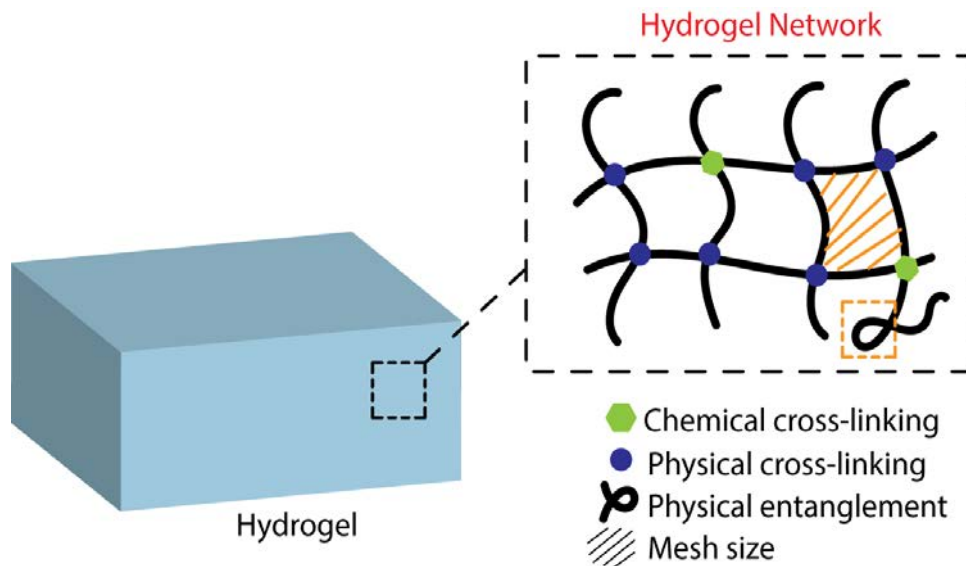
Improve the
mechanical properties

New Approach: adhesive Hydrogel Patch (?)



This is one approach. Not limited.

Why Hydrogel ?

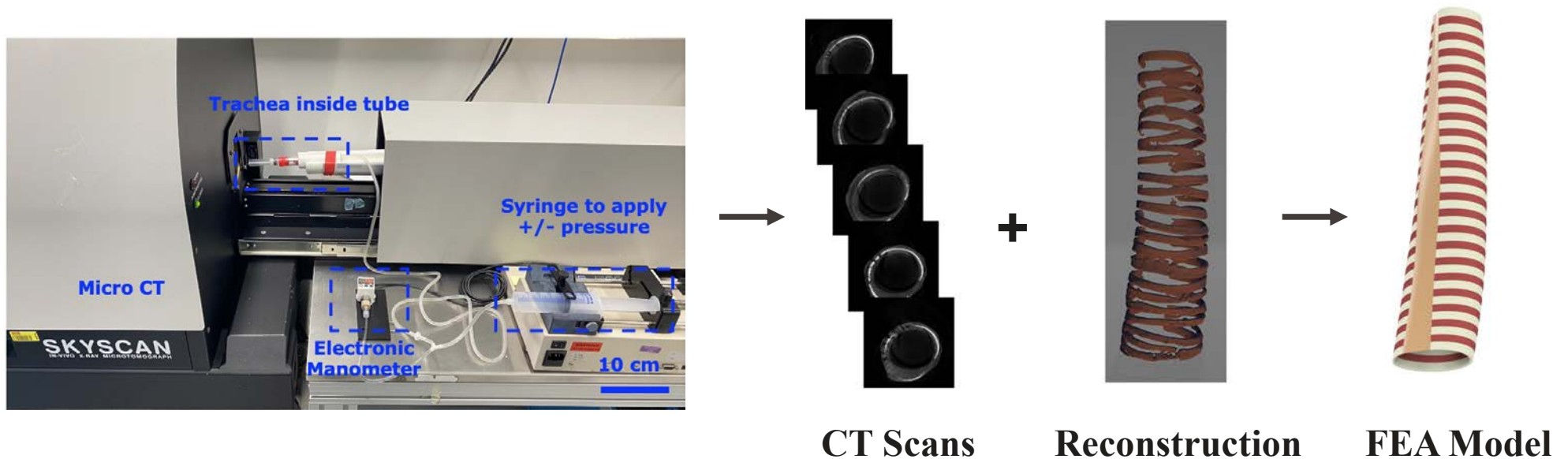


- ☐ Mimics the properties of many tissues.
- ☐ Mostly biocompatible.
- ☐ Allows diffusion of oxygen, nutrients and other molecules, providing potential environment for cells to grow.
- ☐ Can be developed with bioadhesive properties.

Can adhesive hydrogels prevent the airway collapse?, yes, it may!

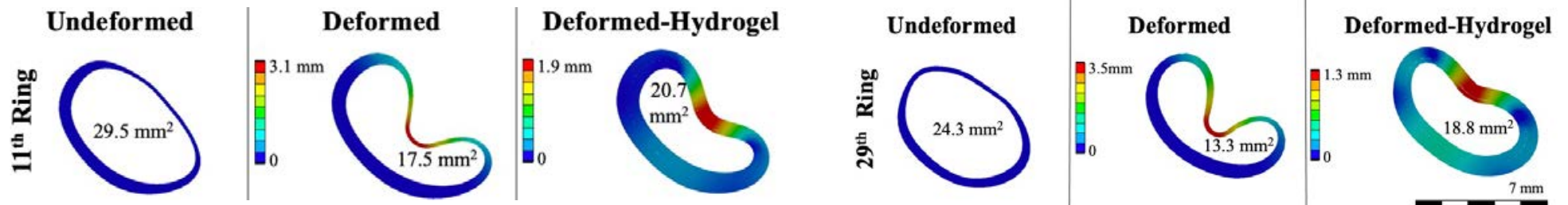
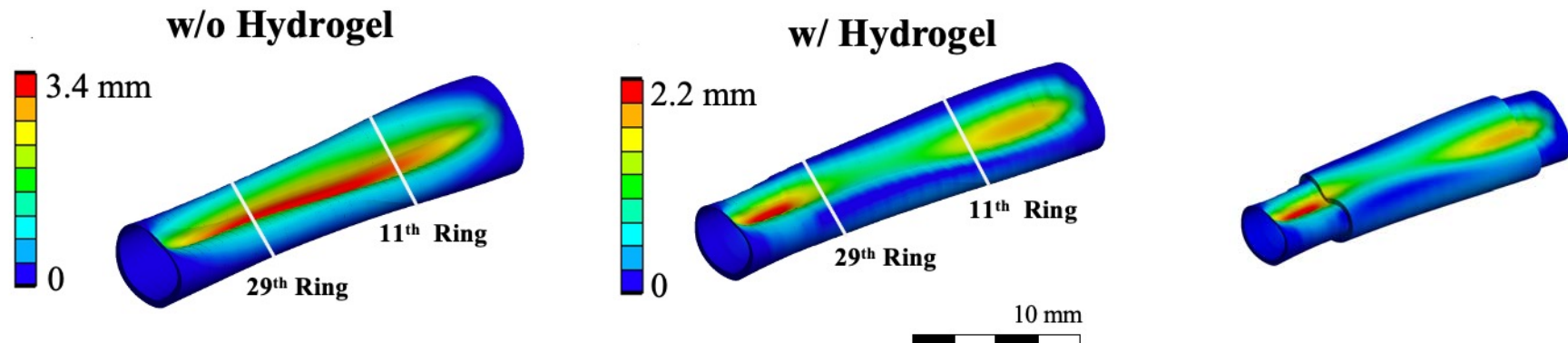
- ☐ **Viscoelastic Properties:** To allow muscle movement during respiration, and Not to obstruct tissue growth.
- ☐ **Adhesive Properties:** To eliminate invasive suturing, and associate trauma to the surrounding tissues.

Developing a FEM model from a rabbit trachea



Collaborator: Prof. N. Stergiopulos and Mr S. Anagnostopoulos, LHTC, IBI-STI, EPFL.

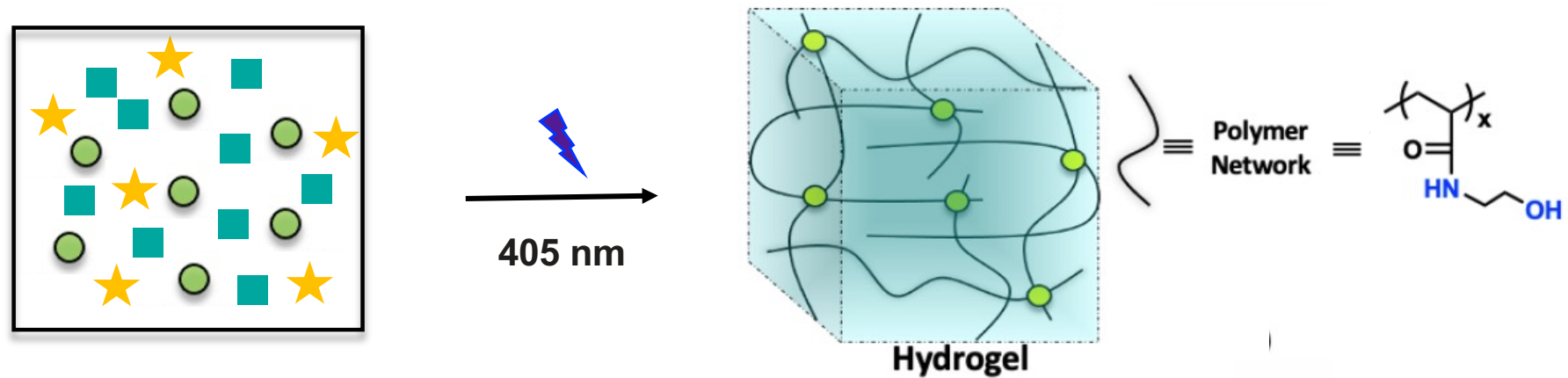
Can Adhesive Hydrogels Prevent the Airway Collapse?



Collaborator: Prof. N. Stergiopoulos and Mr S. Anagnostopoulos, LHTC, IBI-STI, EPFL.

Unpublished work. © LHTC & LBO, IBI-STI, EPFL.

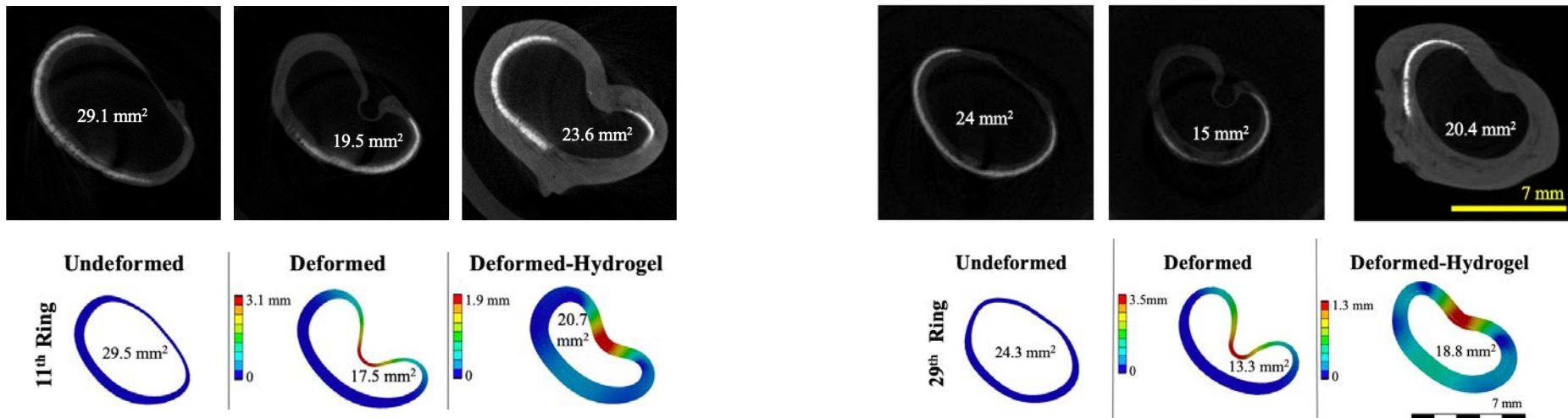
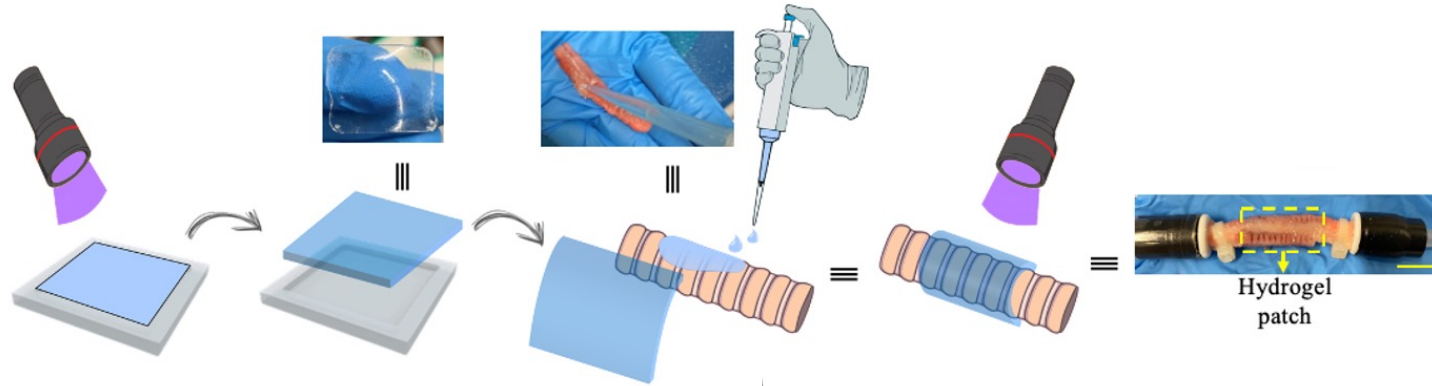
Development of the Adhesive Hydrogel



■ Hydroxyethyl acrylamide (HEAam) monomer ★ Photo initiator (Lithiumphenylphosphinate, LAP)

● PEGDMA, a crosslinker

Micro-CT experiments on a mild malacic trachea

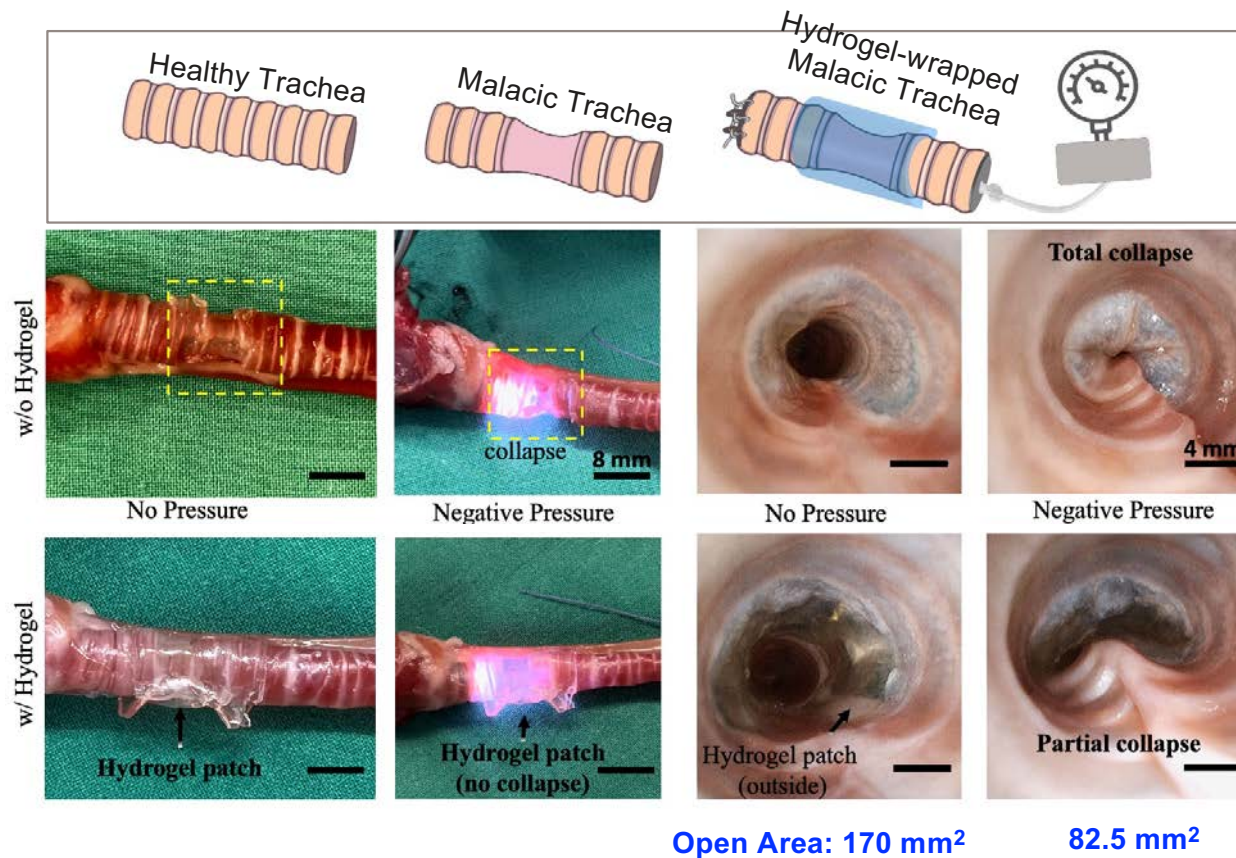


Numerical model and CT experiments indicate that collapse can be prevented

Unpublished work. © LBO, IBI-STI, EPFL.

ex-Vivo experiments on the sever-malacic Tracheas

Applied pressure -5 kPa
(physiological pressure)



❖ 8-10 tracheal rings were removed, to mimic a severe TM conditions.

❖ Total collapse without a hydrogel patch.

❖ up to 50% improvement in prevention of airway collapse