

Investigation of the Mechanical Behavior of Locking Chains

Eloise Zeng

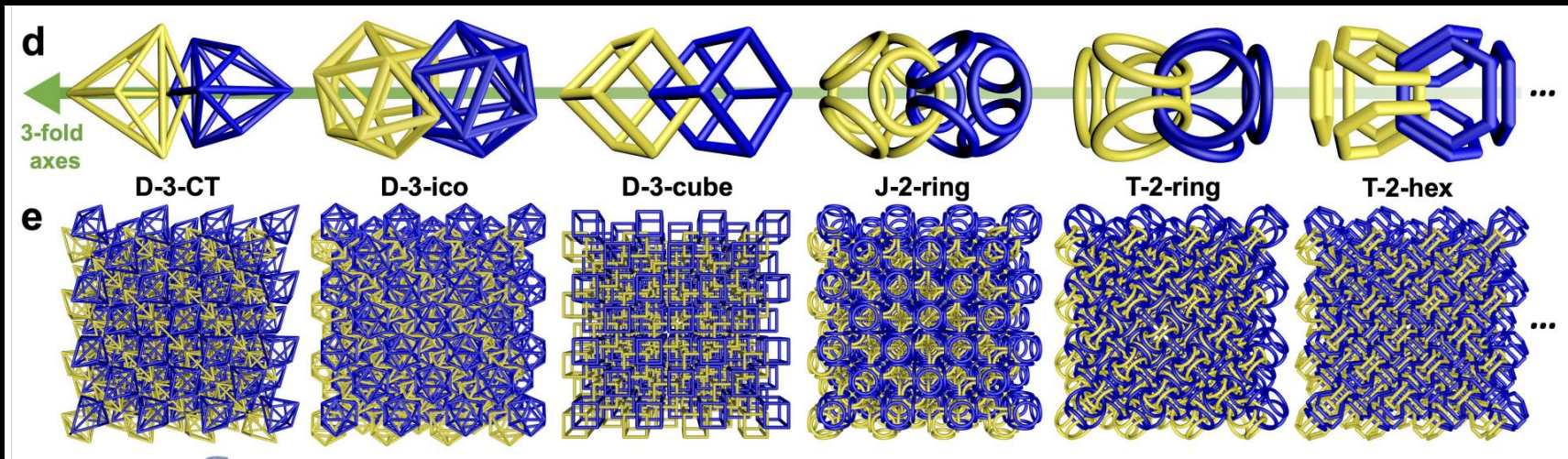
Co-worker: Jabri Garcia-Jimenez

Mentors: Wenjie Zhou and Sujeeka Nadarajah

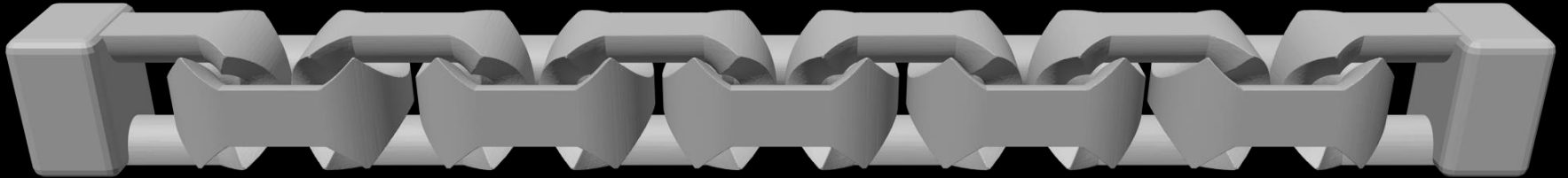
Daraio Research Group

Polycatenated Architected Materials (PAMs)

- Topologically interlinked particles
- Modify behavior of PAMs by changing the particles' geometry
 - Alter flexibility



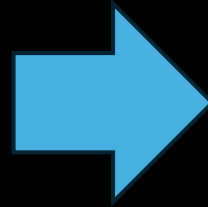
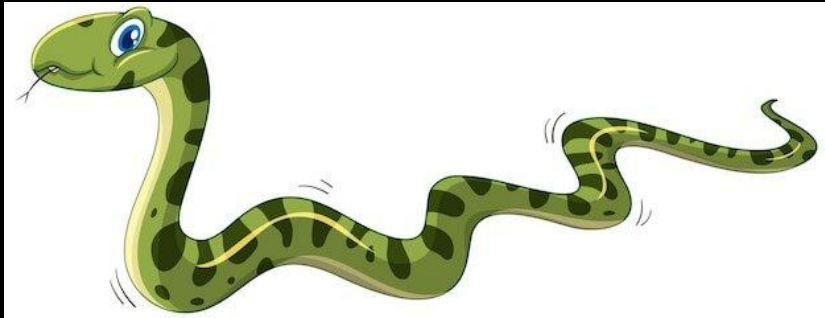
Locking Chain



Made of Thermoplastic Polyurethane

Applications

Unlocked



Locked



What to Study?

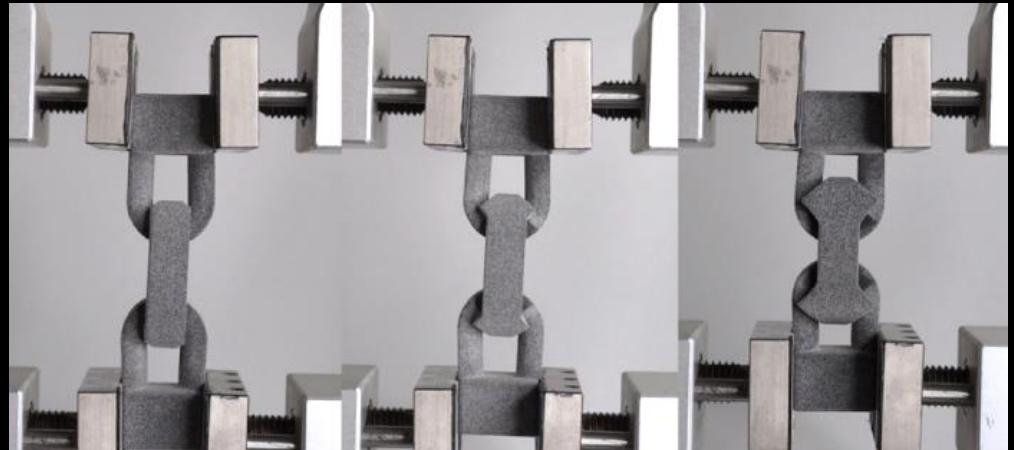
- Tunability of locking mechanism
- Friction
- Loading Rate

Non-locking

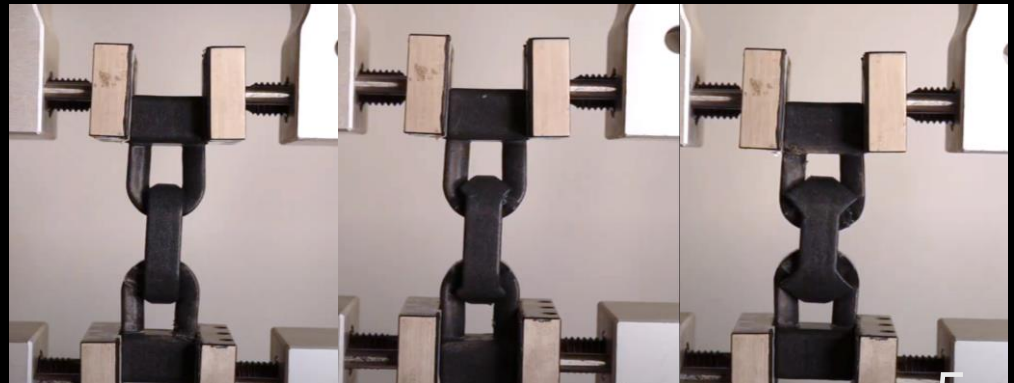
Quasi-locking

Locking

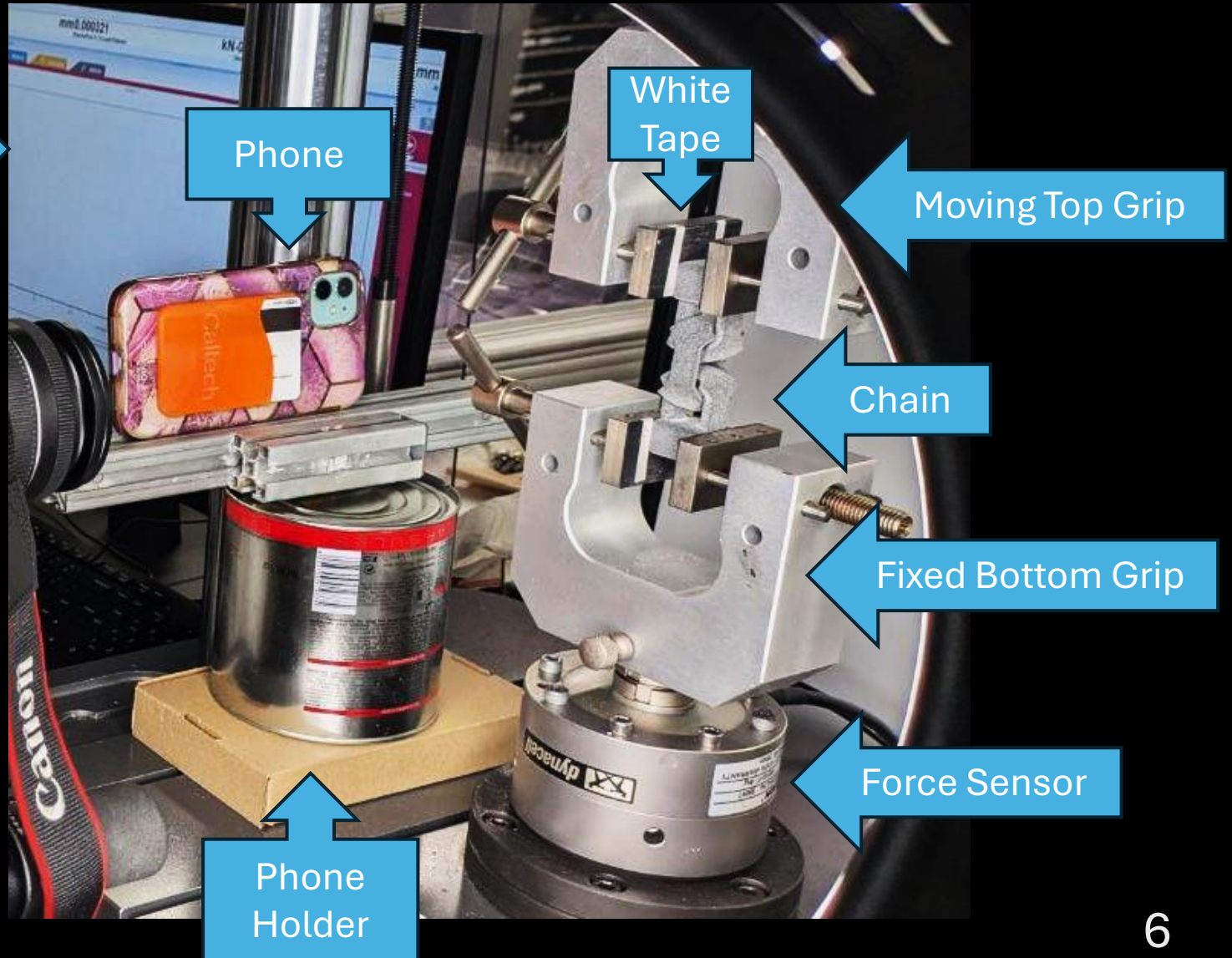
Rough Surface



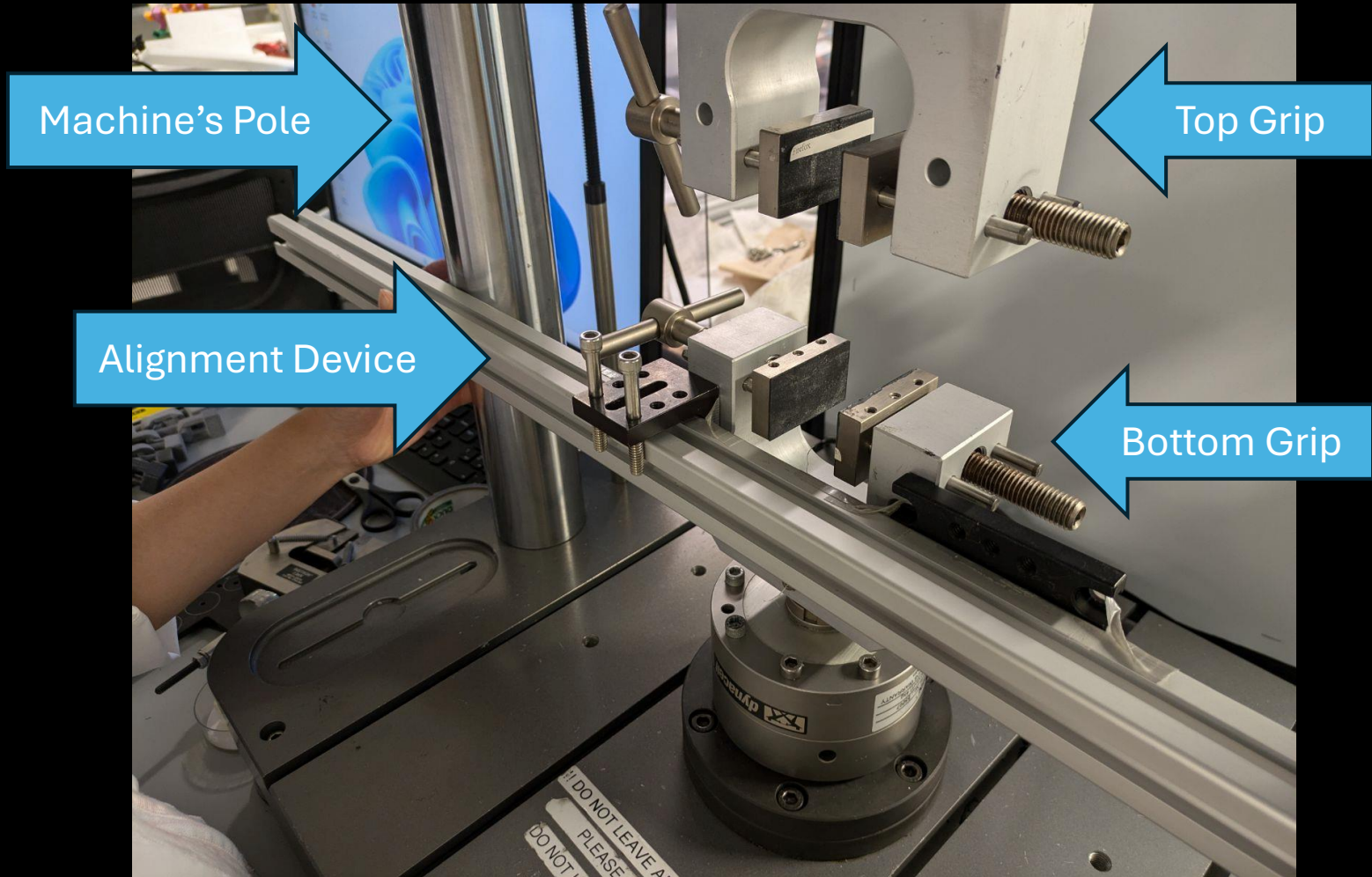
Smooth surface



Experimental Set-up for 3-Particle Chains on the Instron ElectroPuls 3000

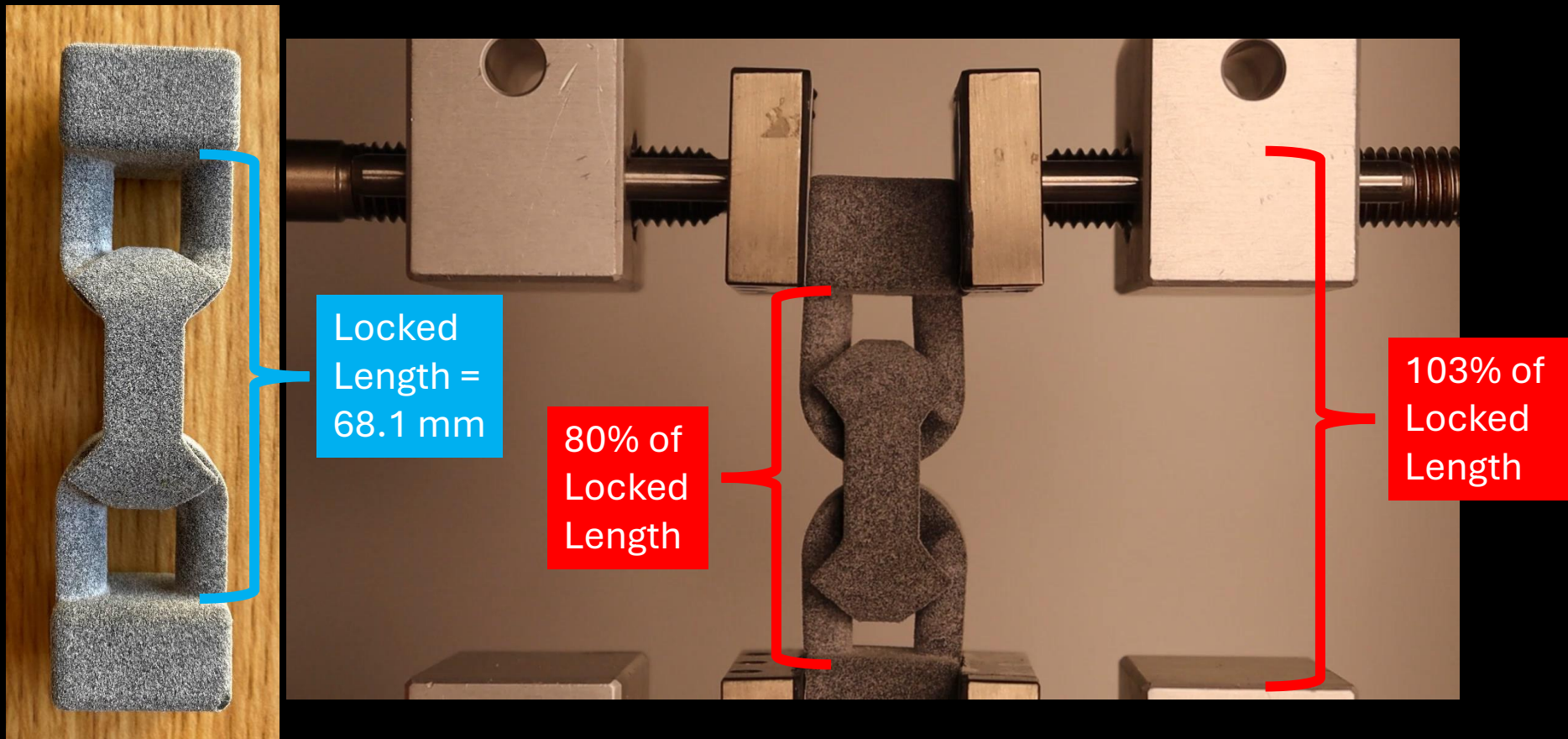


Aligning the Grips

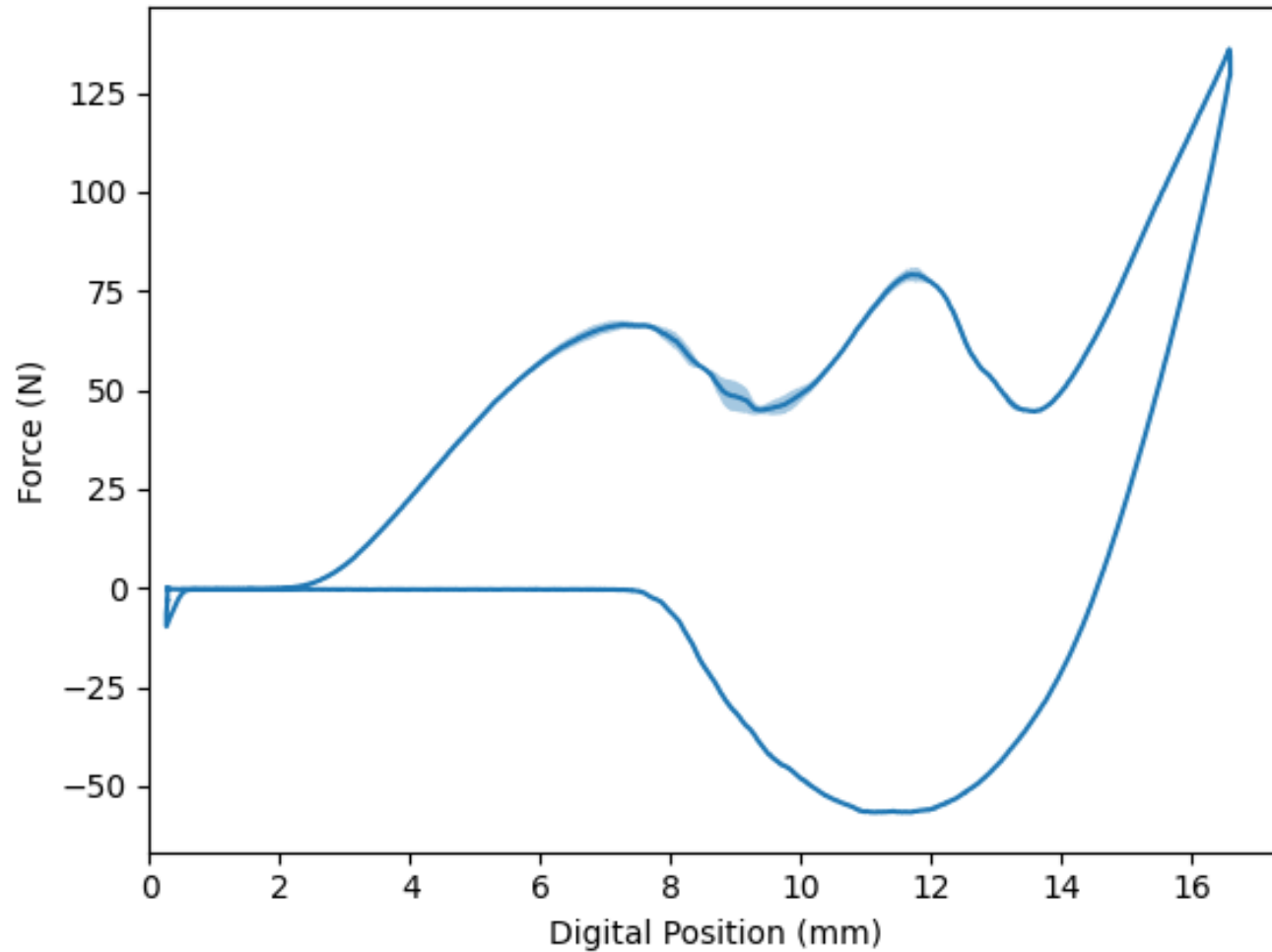


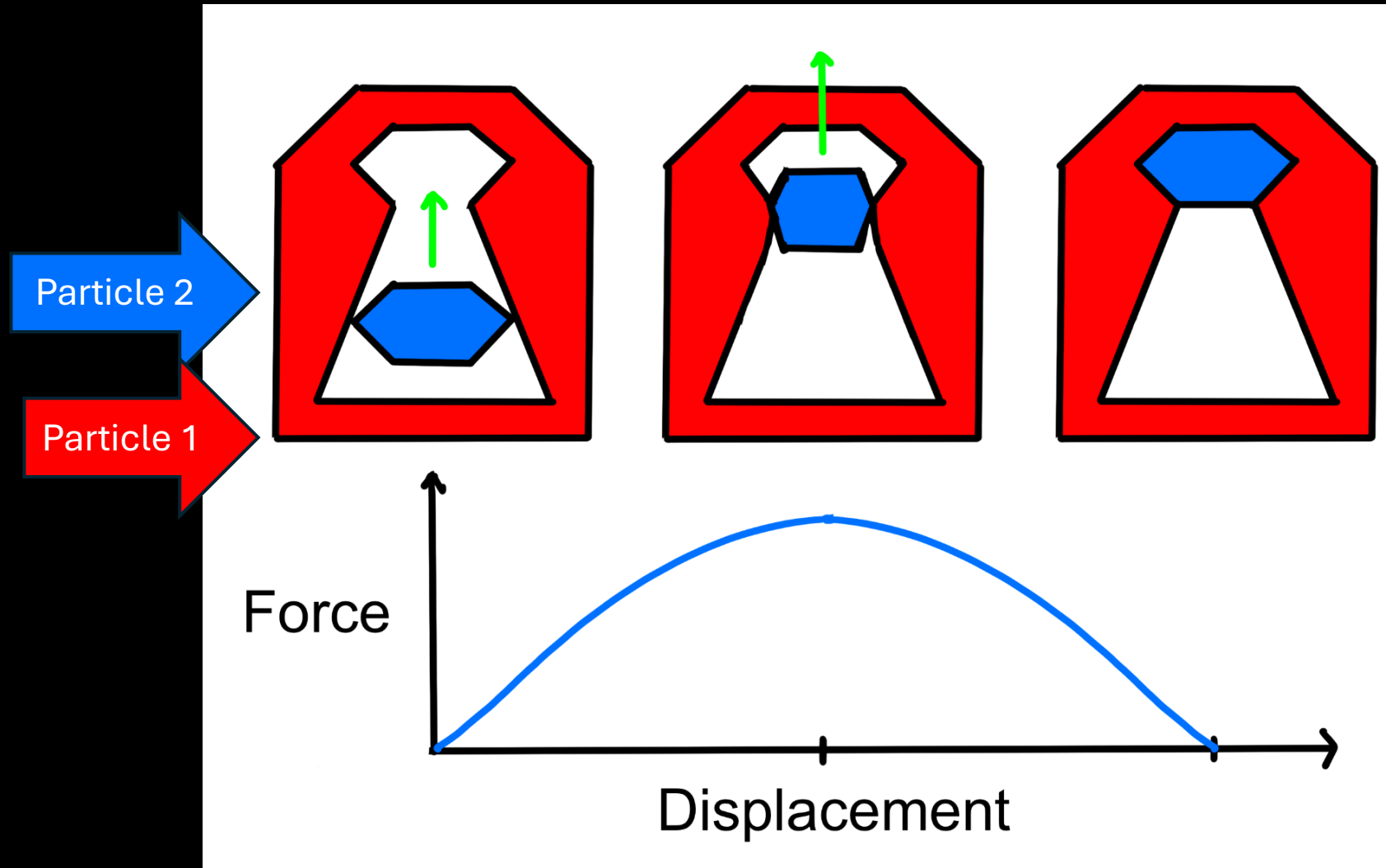
Three-Particle Chain

- Strain = (How much chain is stretched) / (Initial Length)
- Loading rates: 10%, 50%, 150% strain per minute

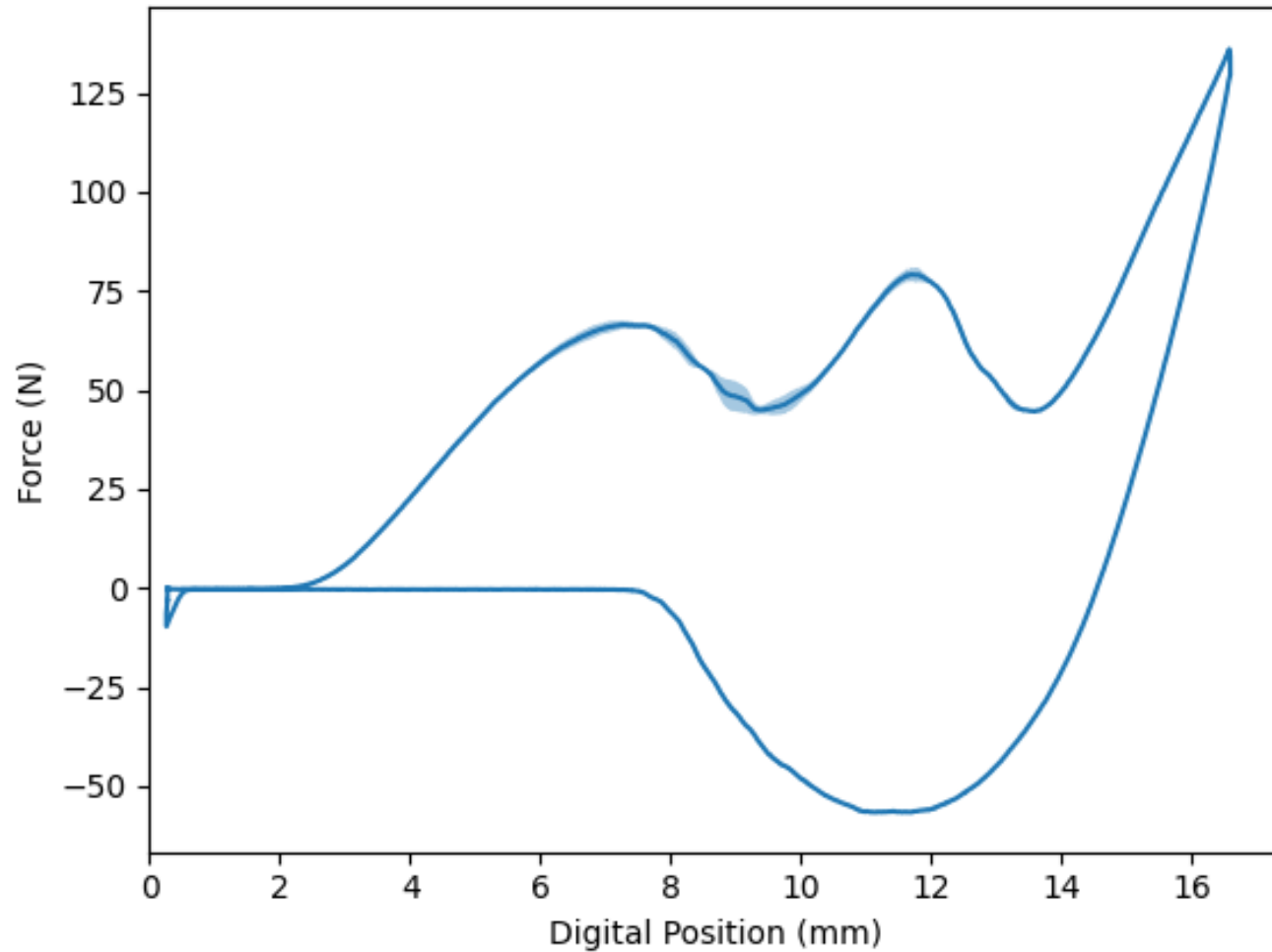


Mean and Standard Deviation of Rough Locking Chain:
Loading Rate = 150% Strain per Minute

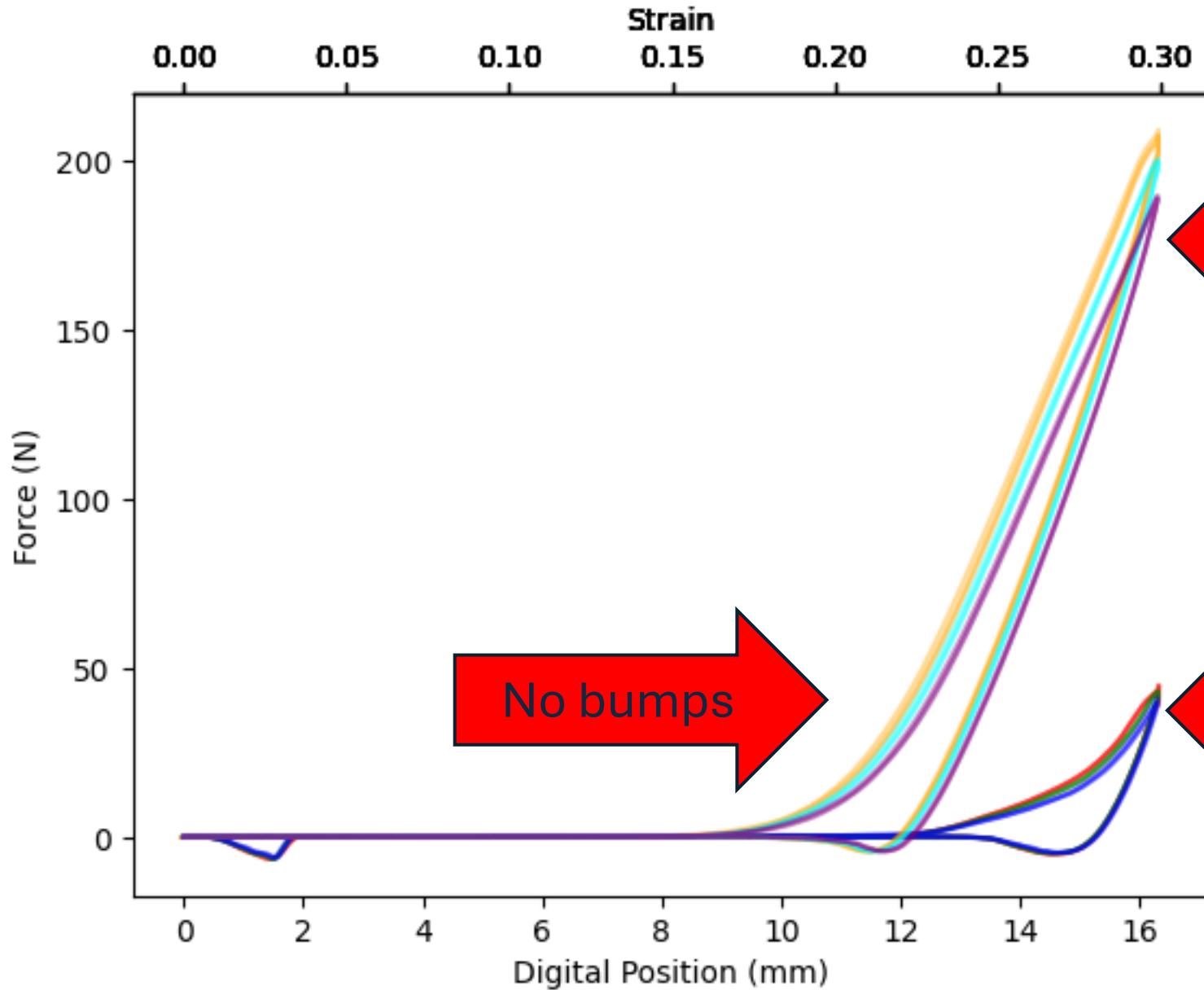




Mean and Standard Deviation of Rough Locking Chain:
Loading Rate = 150% Strain per Minute



Quasi-Locking Chain: Various Rates



Smooth

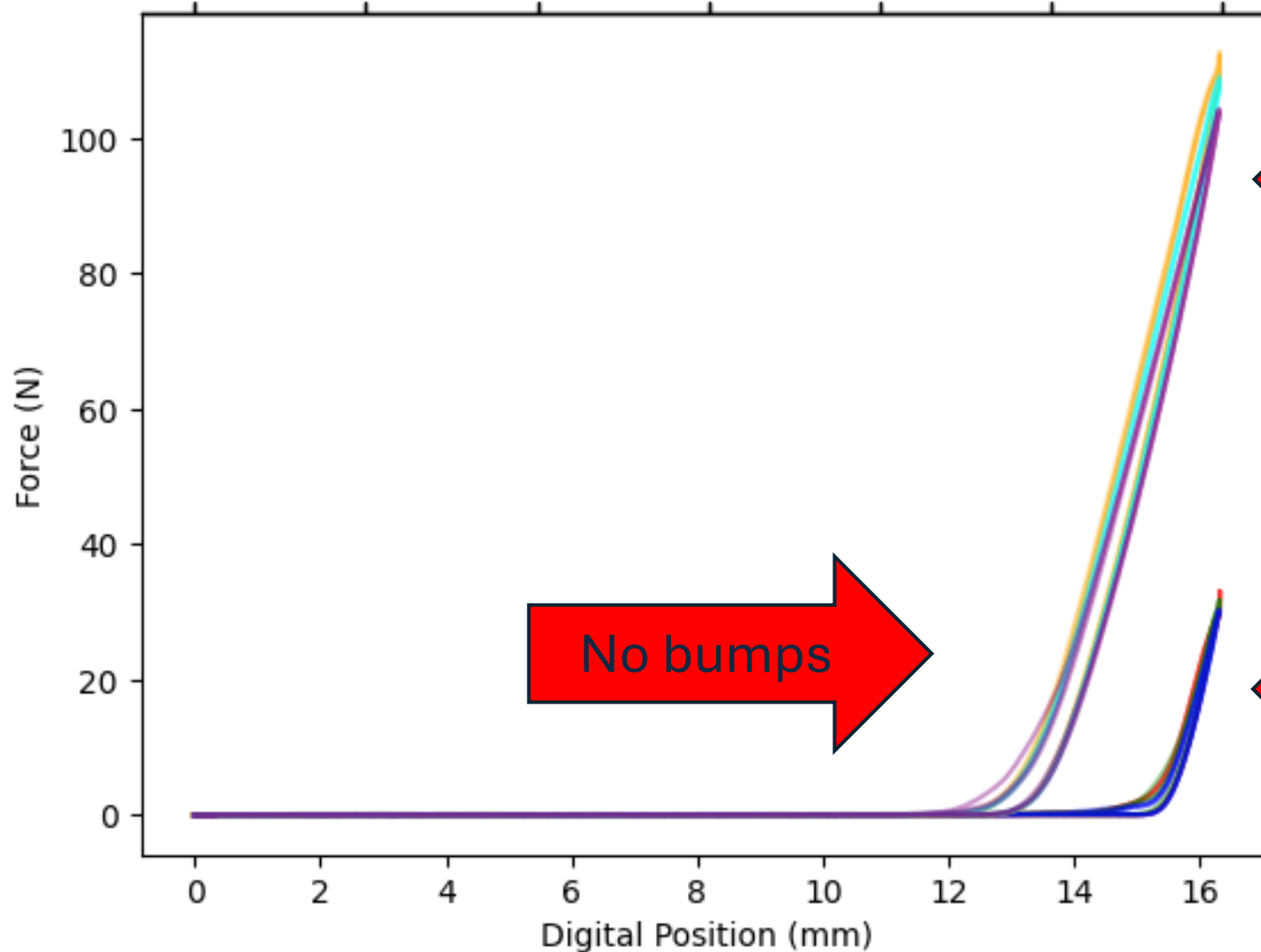
No bumps

Rough

Non-Locking Chain: Various Rates

Strain

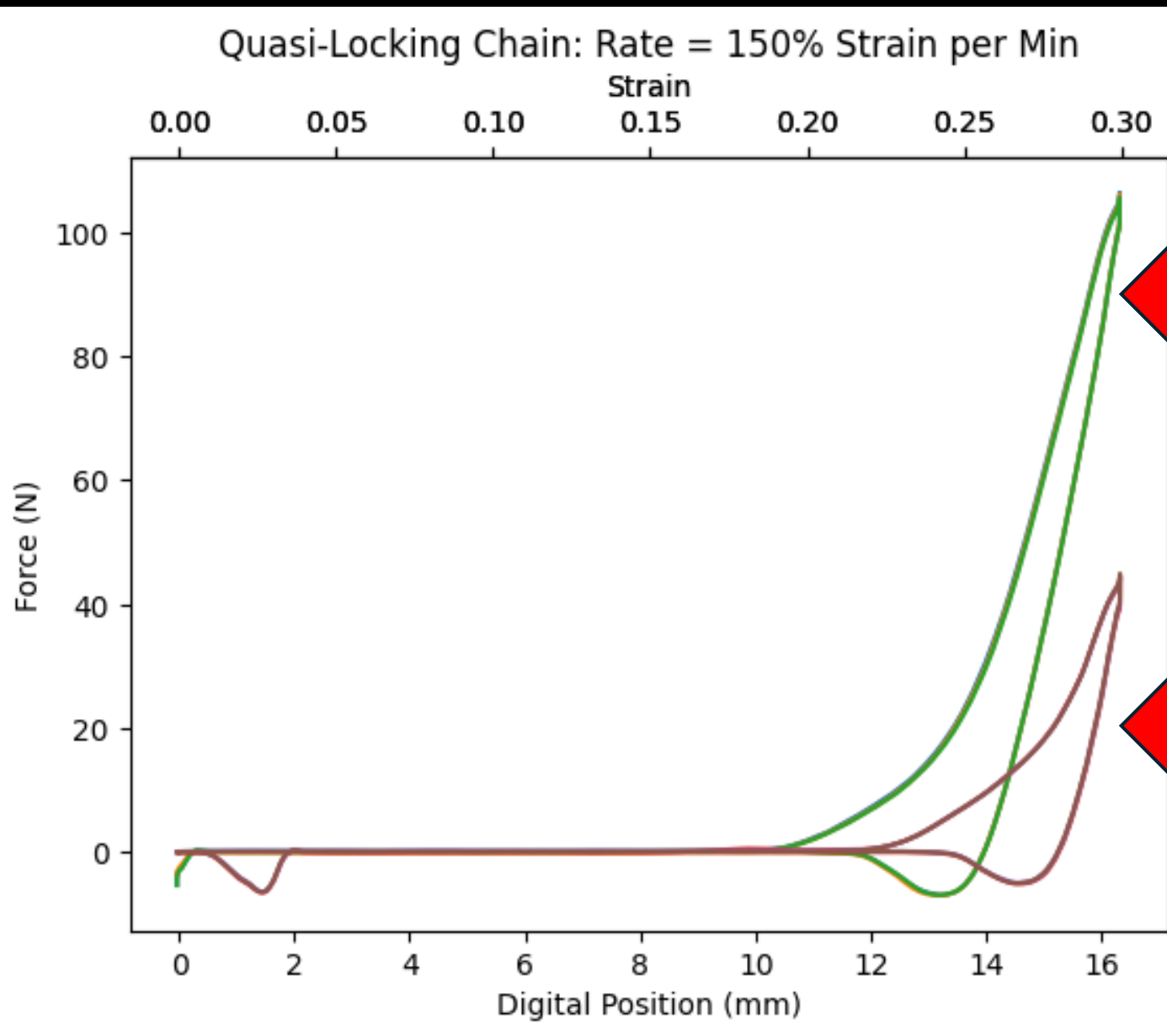
0.00 0.05 0.10 0.15 0.20 0.25 0.30



Smooth

No bumps

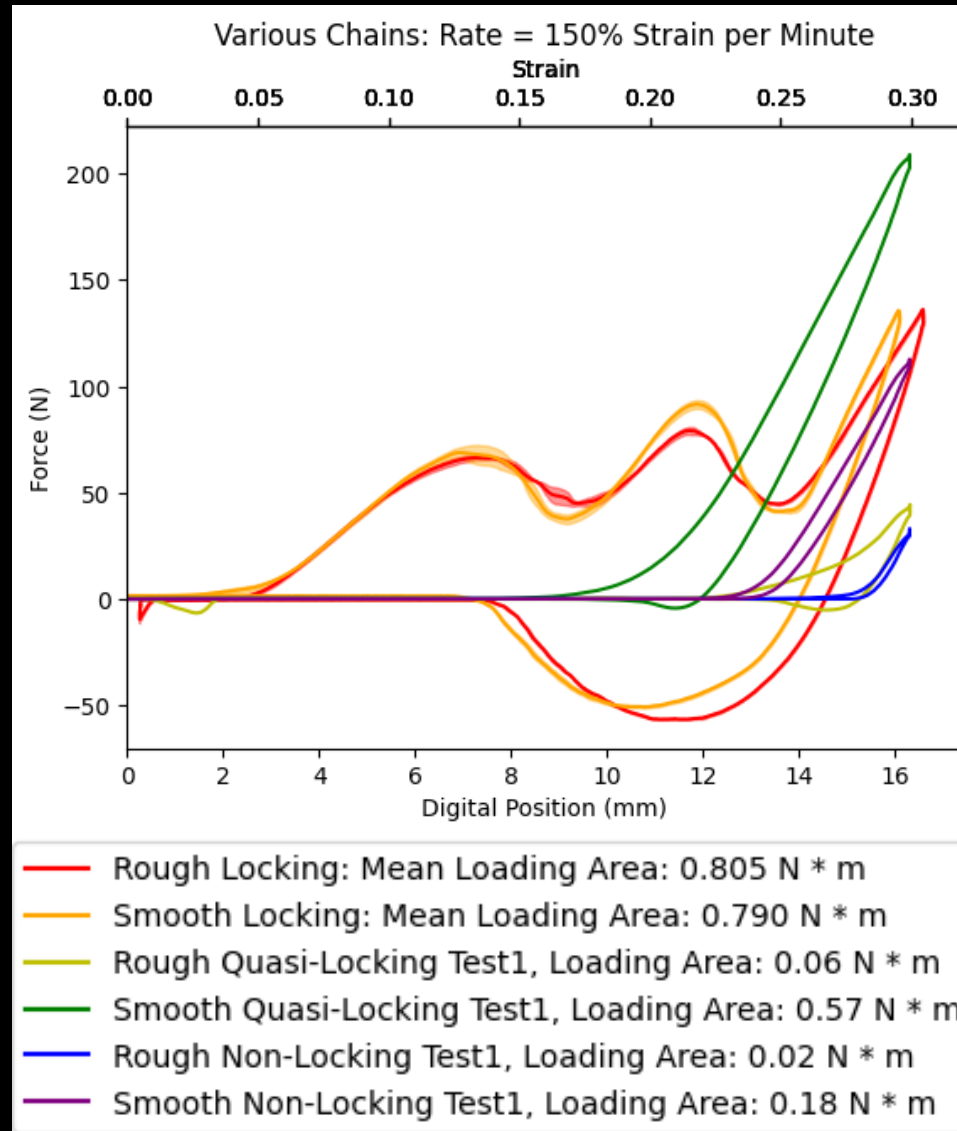
Rough



Rough 2

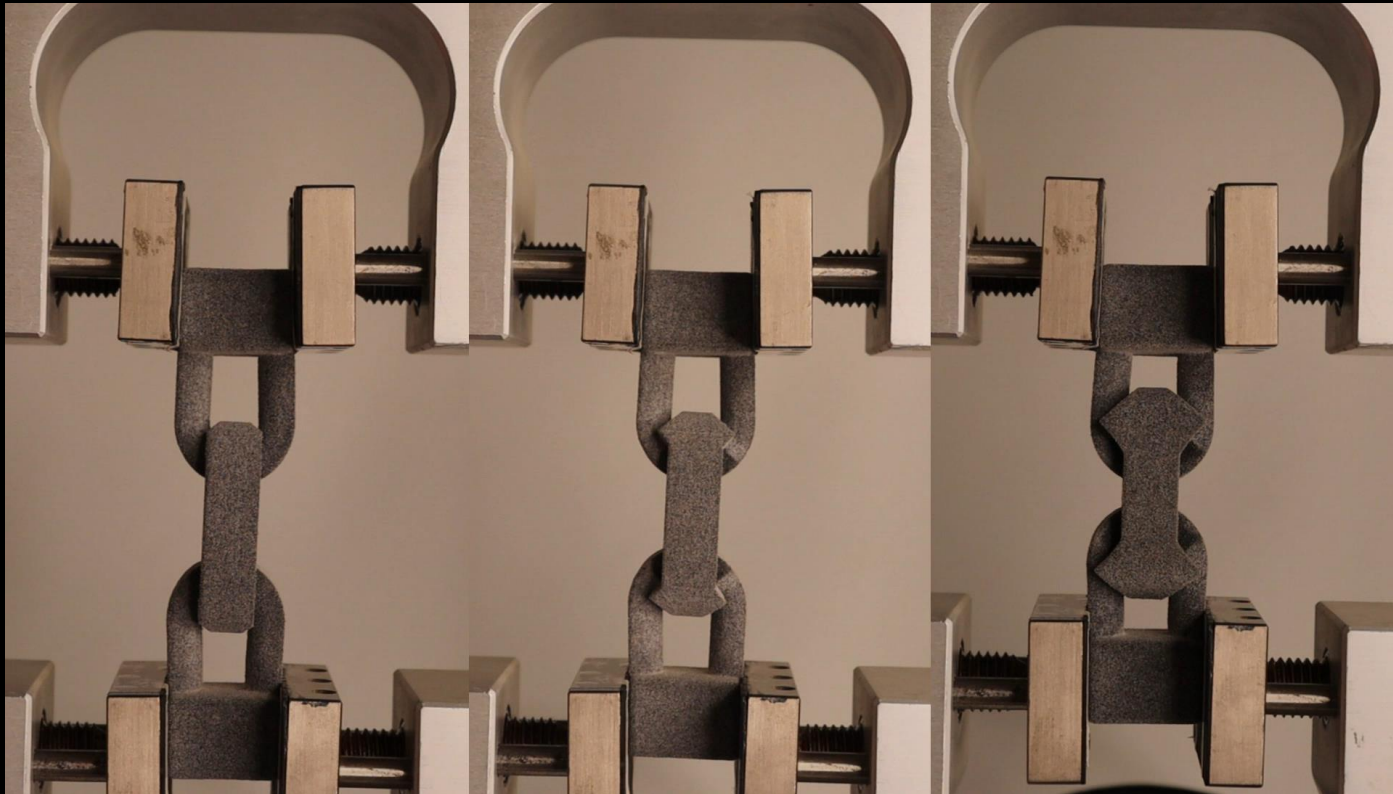
Rough 1

How to align everything?

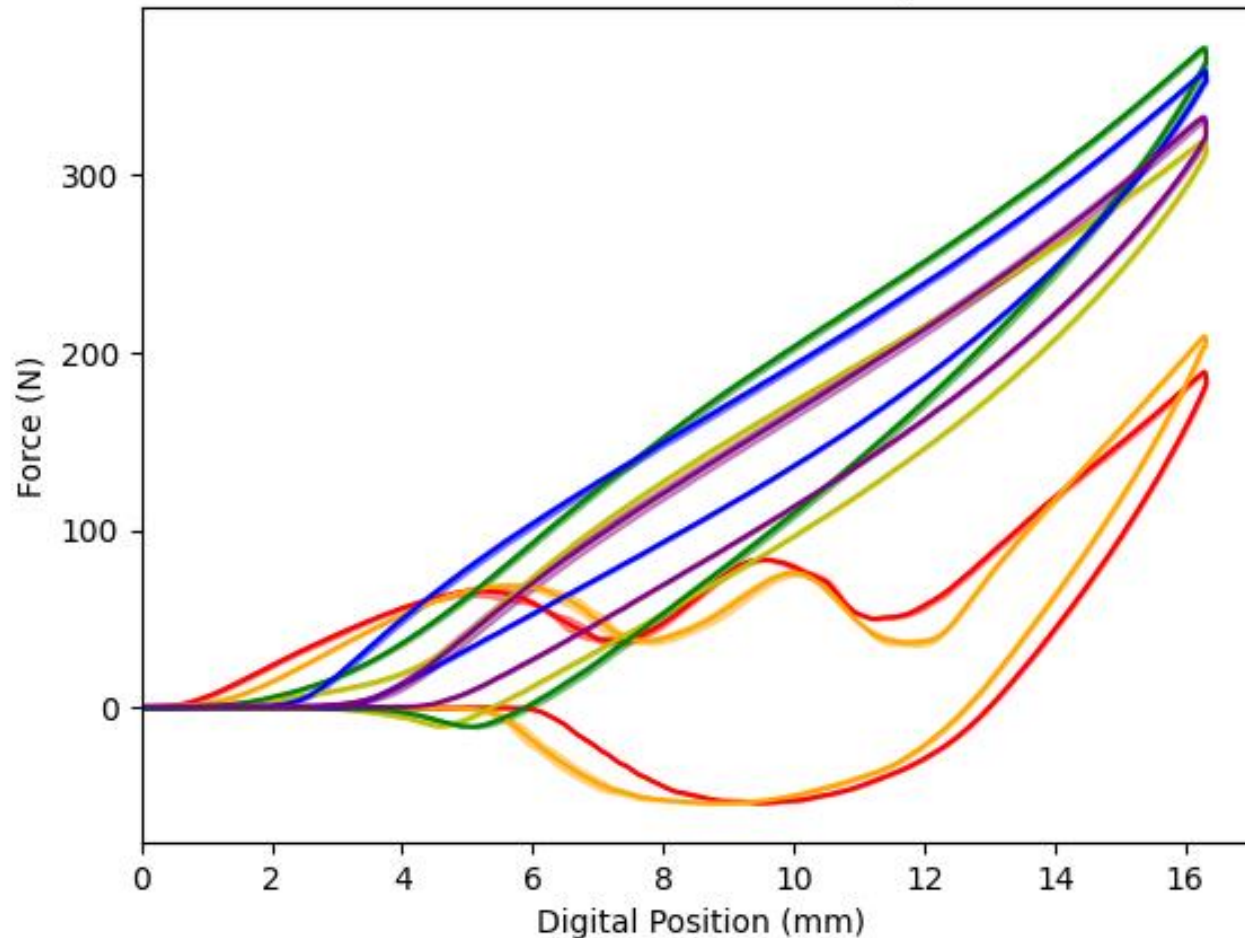


New experiment

- Hang chains at rest
- Stretch chains for 16.3 mm



Mean and Standard Deviation of the Force-Displacement for All Chains



- Rough Locking: Mean Loading Area: 1.103 N * m
- Smooth Locking: Mean Loading Area: 1.047 N * m
- Rough Quasi_Locking: Mean Loading Area: 2.143 N * m
- Smooth Quasi_Locking: Mean Loading Area: 2.554 N * m
- Rough Non_Locking: Mean Loading Area: 2.500 N * m
- Smooth Non_Locking: Mean Loading Area: 2.115 N * m

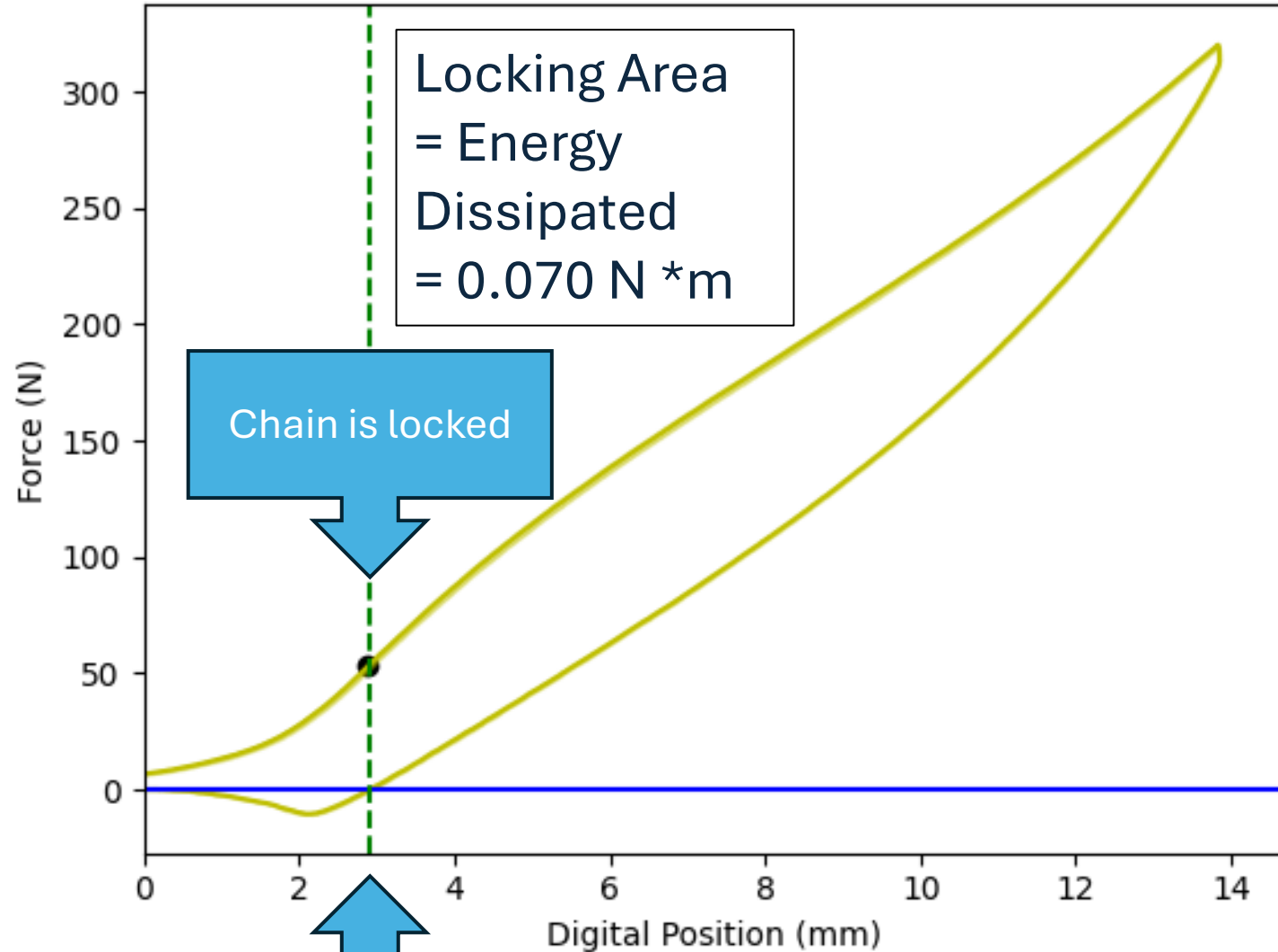
Can calculate energy dissipated during locking phase

Adjacent
particles
contact
each other



Chain
reaches
locked
length

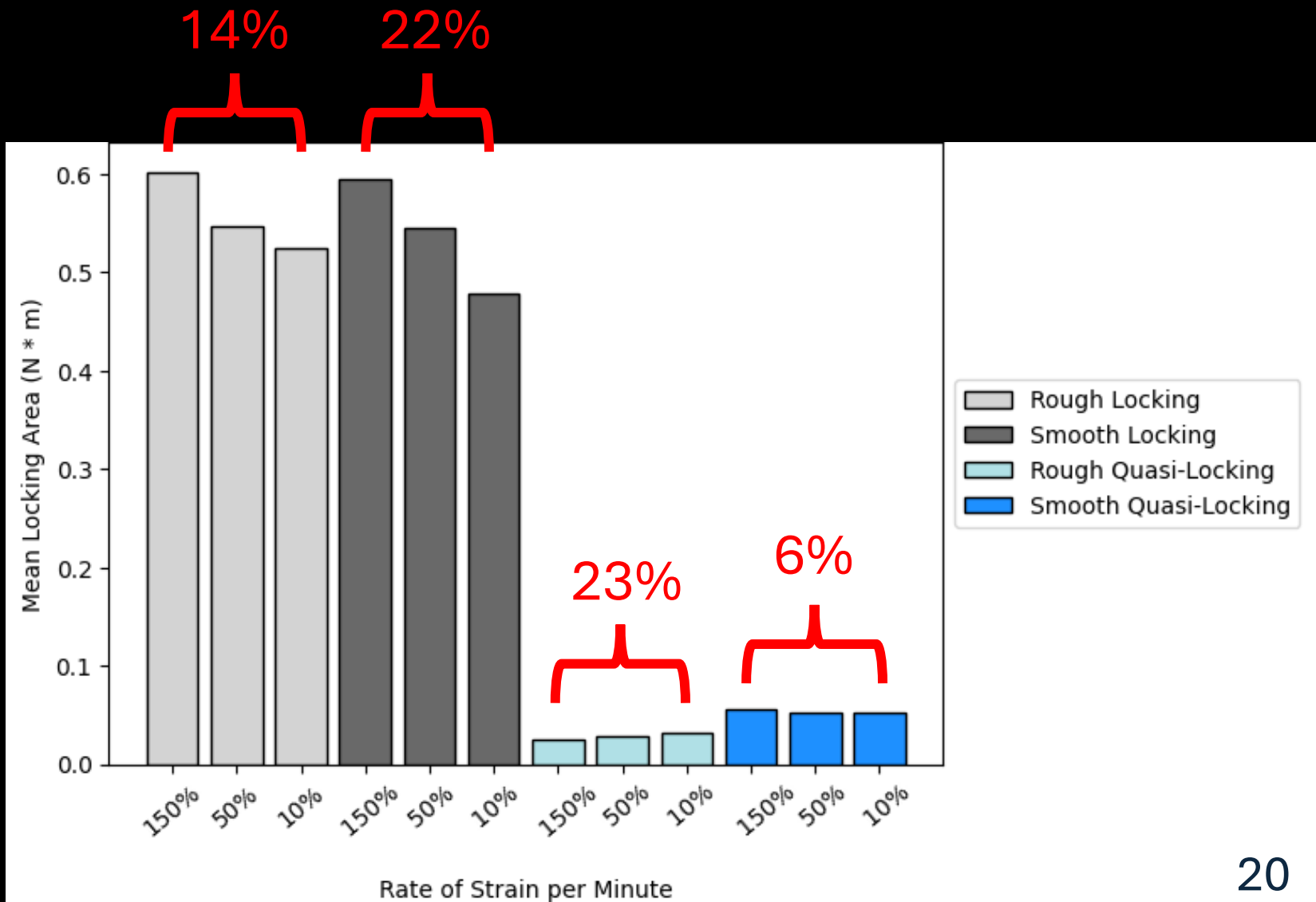
Mean and Standard Deviation of the Force-Displacement for Rough Quasi-Locking Chain



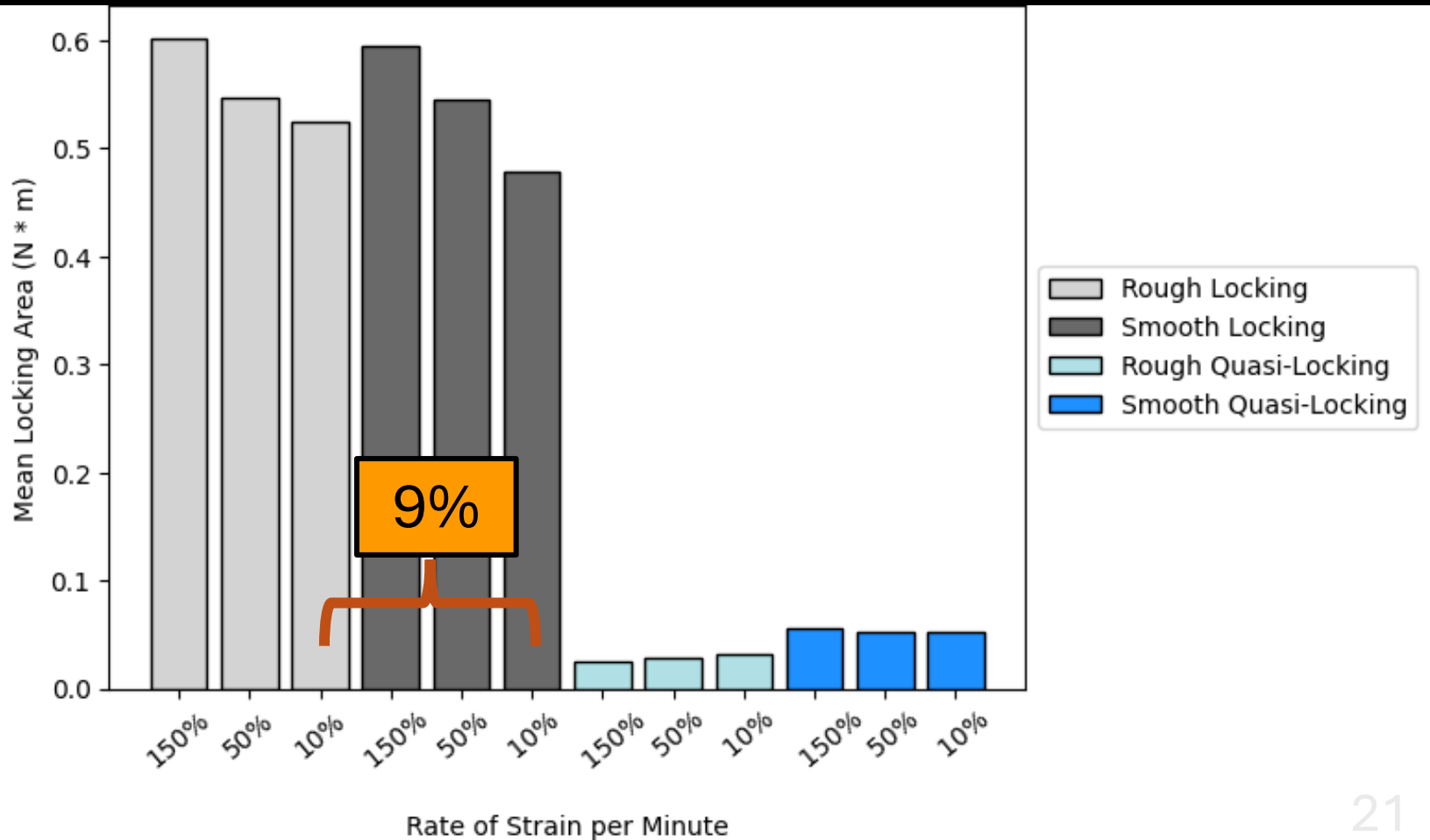
Chain is locked

Unlocking starts

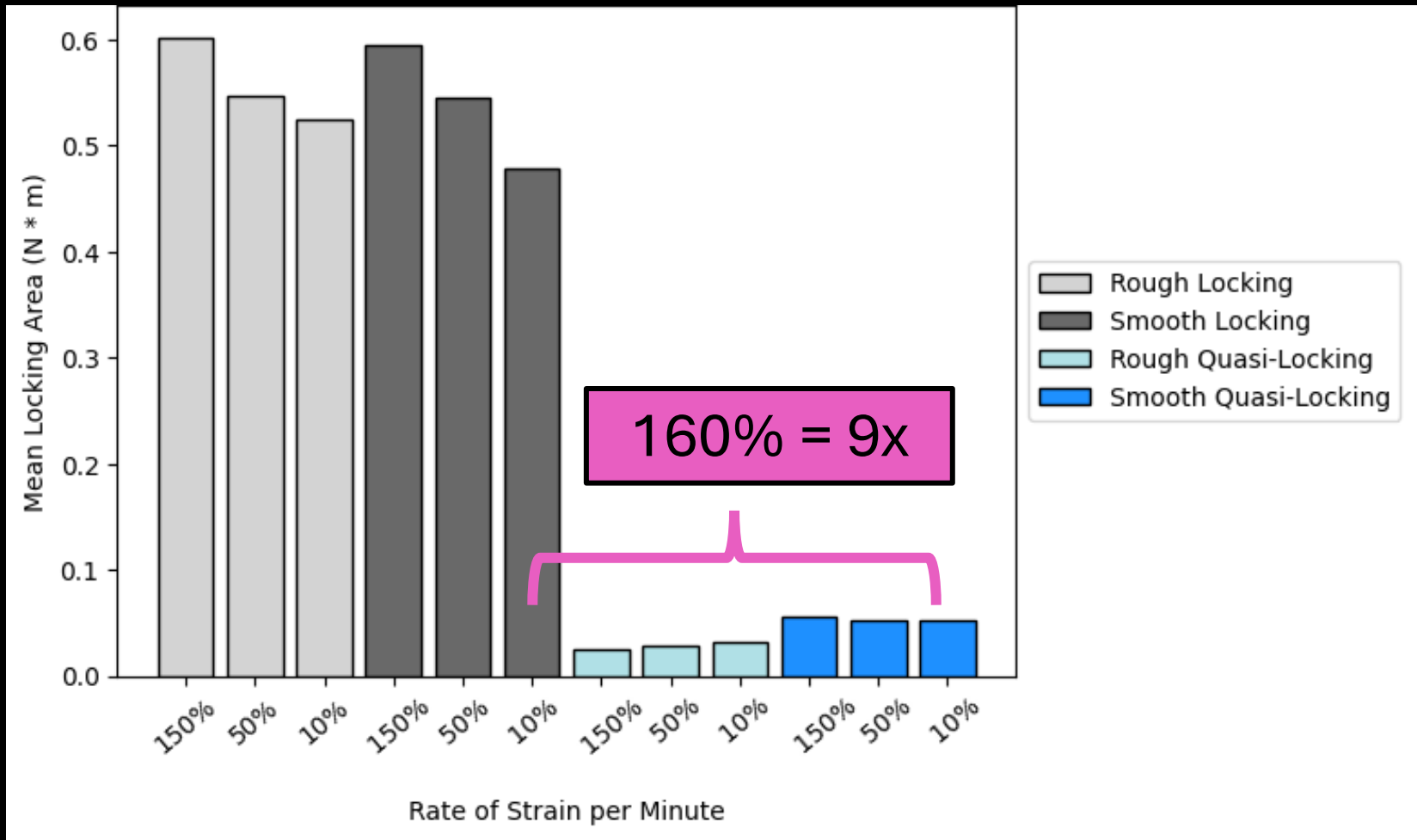
Effect of Loading Rate on Energy Dissipation During Locking Phase



Effect of Friction on Energy Dissipation During Locking Phase



Effect of **Geometry** on Energy Dissipation During Locking Phase



Acknowledgements

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- Jabri Garcia-Jimenez - Co-worker
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References

- Slide 2: <https://doi.org/10.48550/arXiv.2406.00316>
- Slide 4:
 - https://www.freepik.com/free-vector/green-snake-cartoon-character-isolated-white-background_18179789.htm#query=cartoon%20snake&position=21&from_view=keyword&track=ais_hybrid&uuid=0b601619-1ec1-43bf-b66b-87856c7dc74e
 - <https://www.waterlinesquare.com/far-fetched-new-york/>
- Slide 21
 - https://www.researchgate.net/publication/344901124_Strain-rate_dependent_energy_redistribution_during_isotropic_confined_comminution
 - https://www.researchgate.net/publication/311434266_Investigation_on_energy_dissipation_and_its_mechanism_of_coal_under_dynamic_loads

My name: Eloise Zeng

