

Gait Quality associated with Clinically Based Tuning of a Robotic Lower Limb Prosthesis in Individuals with a Transtibial Amputation

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The Challenge & Key Questions:

- Tuning robotic lower limb prostheses is time consuming and rarely quantified in clinical settings which makes it challenging for clinicians to determine if their tuning is the most optimal solution for a patient.
- Are standard, clinical based tuning procedures optimizing gait quality?
- How can we make the tuning process faster, more data driven and even possibly automate it without a clinician on hand?



Our Experimental Solution:

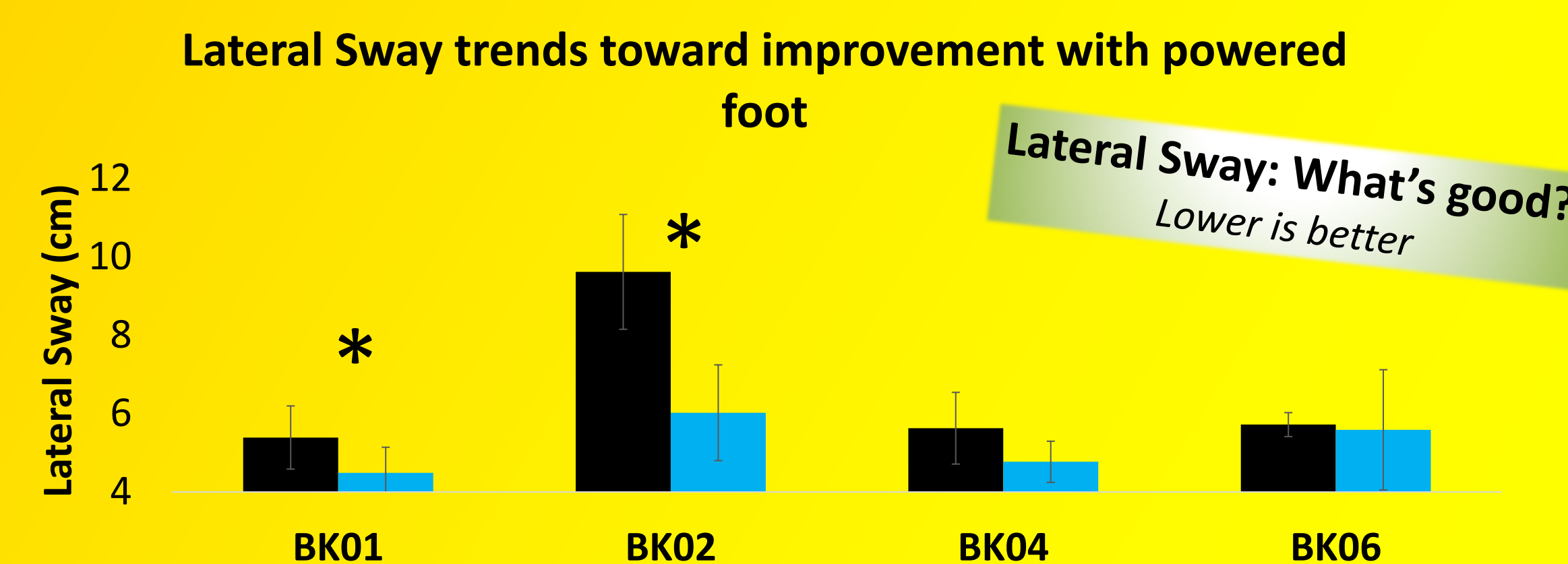
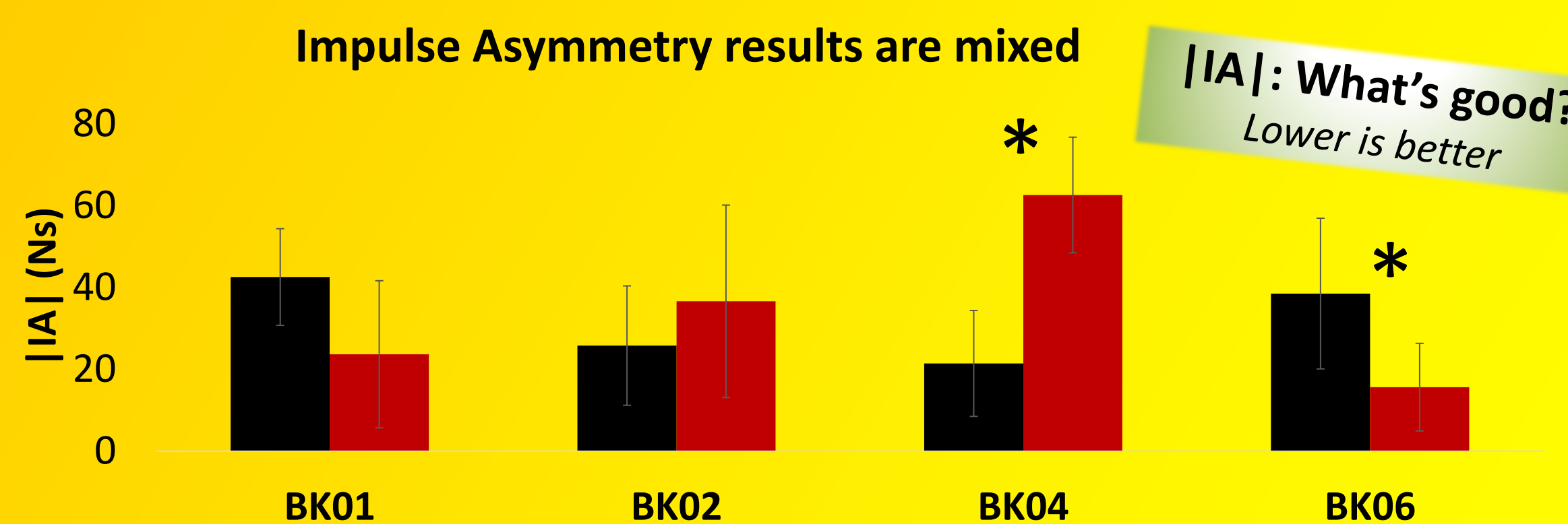
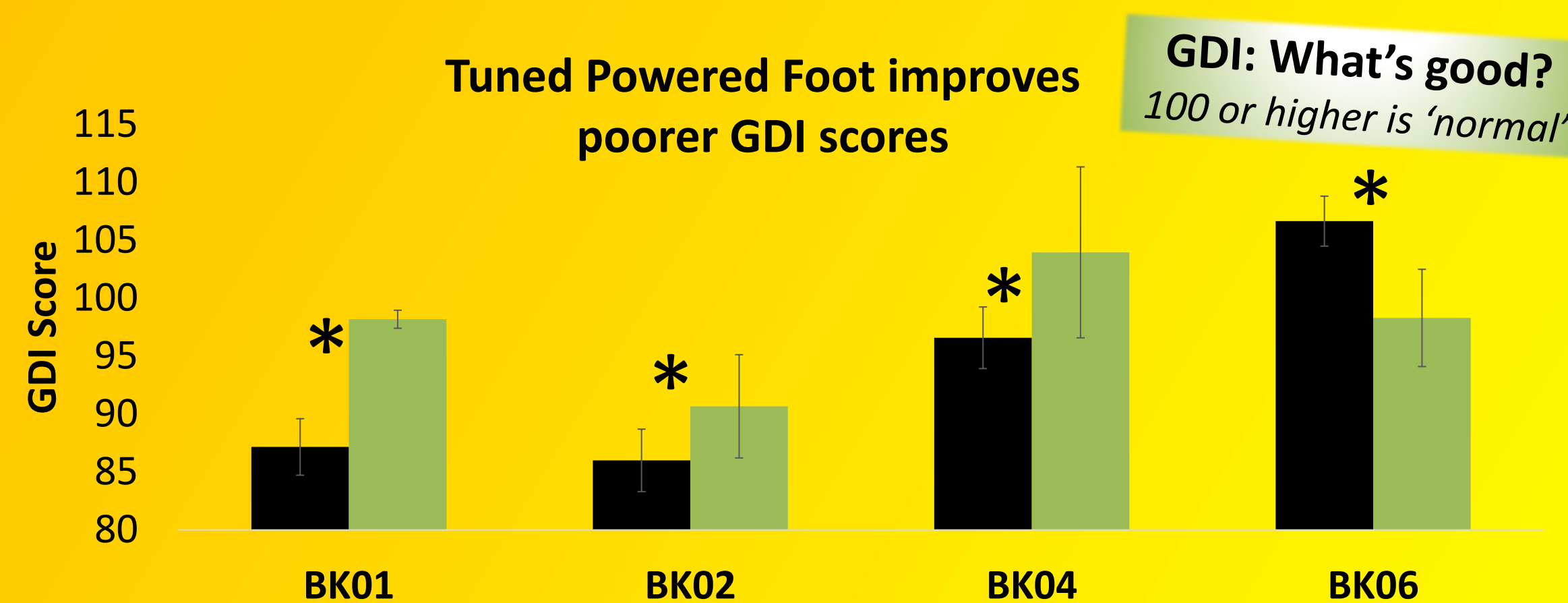
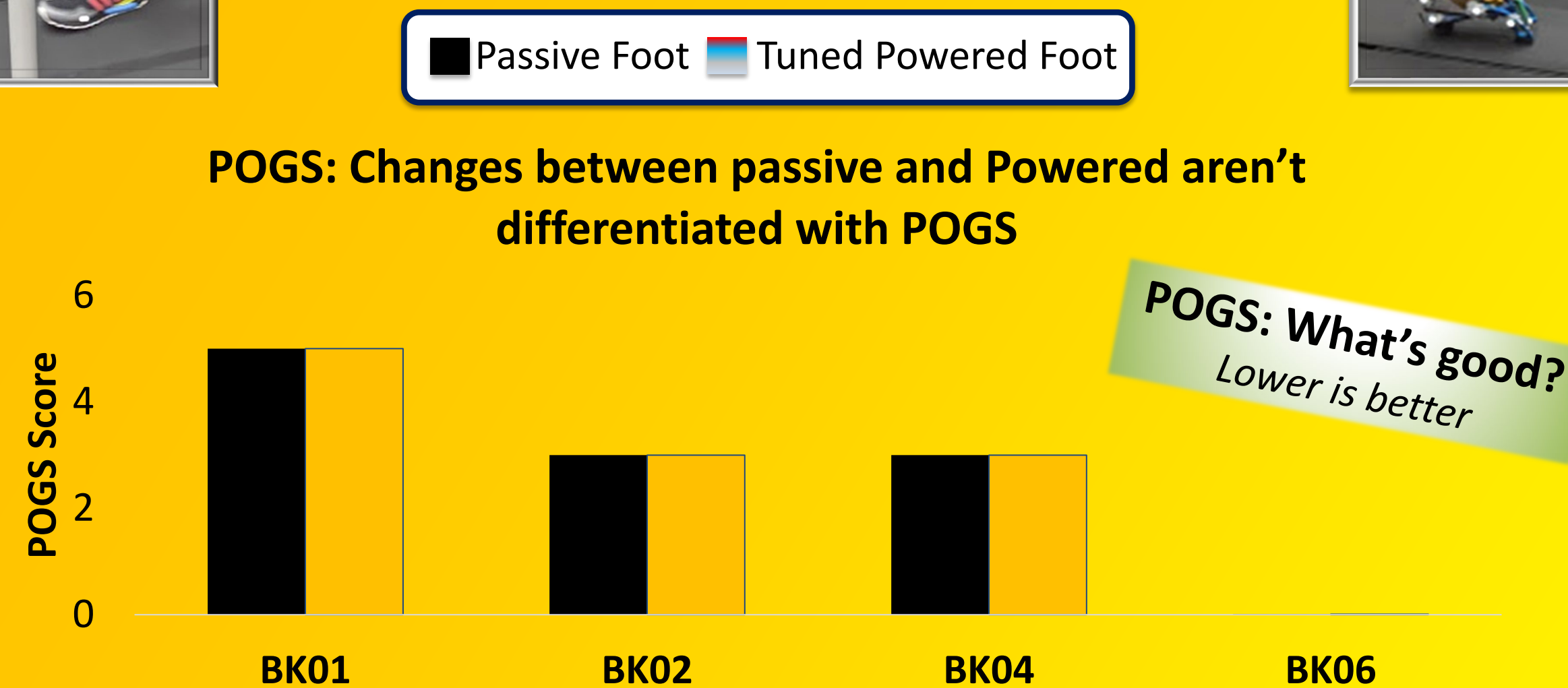
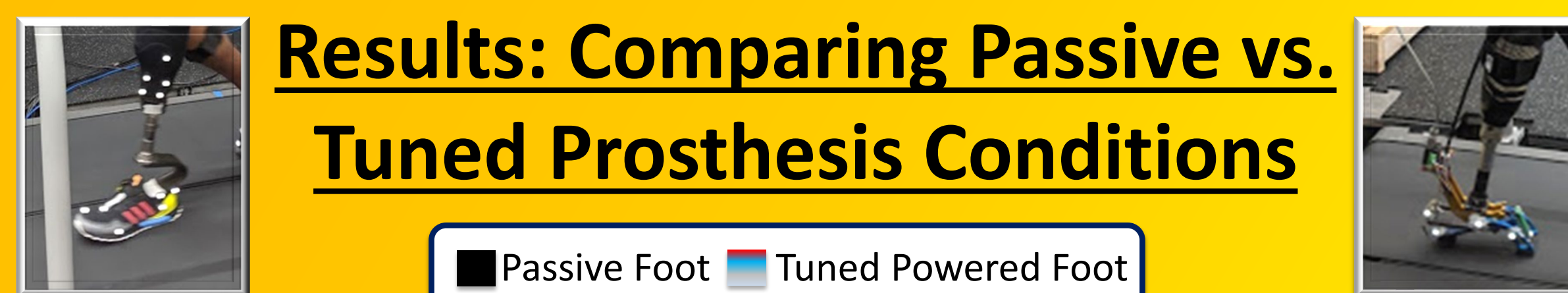
- N=7 individuals with below the knee amputation walked on their clinically prescribed passive foot and a robotic powered prosthesis while we collected lower limb and trunk biomechanics
- The robotic powered prosthesis (Humotech PRO-001) was tuned by a prosthetist according to standard clinical practices (i.e. observational gait analysis and patient feedback)
- We analyzed 4 common gait quality metrics post-hoc over each tuning trial to better understand gait quality changes over the tuning process and compared the passive and tuned gait metrics
- Two sample t-tests were used to compare differences between passive and tuned powered foot conditions with significance set at alpha < 0.05



Our Gait Quality Metrics of Study

1. POGS¹: Prosthetic Observational Gait Score which is scored visually by a clinician on a scale of 0-32 with lower scores indicative of better gait
2. GDI²: Gait Deviation Index based on 3D kinematics of lower limb with scores ≥ 100 indicative of normal gait
3. Impulse Asymmetry³- the absolute value difference in impulse between limbs
4. Lateral Sway⁴- the difference in the max and min mediolateral trajectory of a sternal chest marker

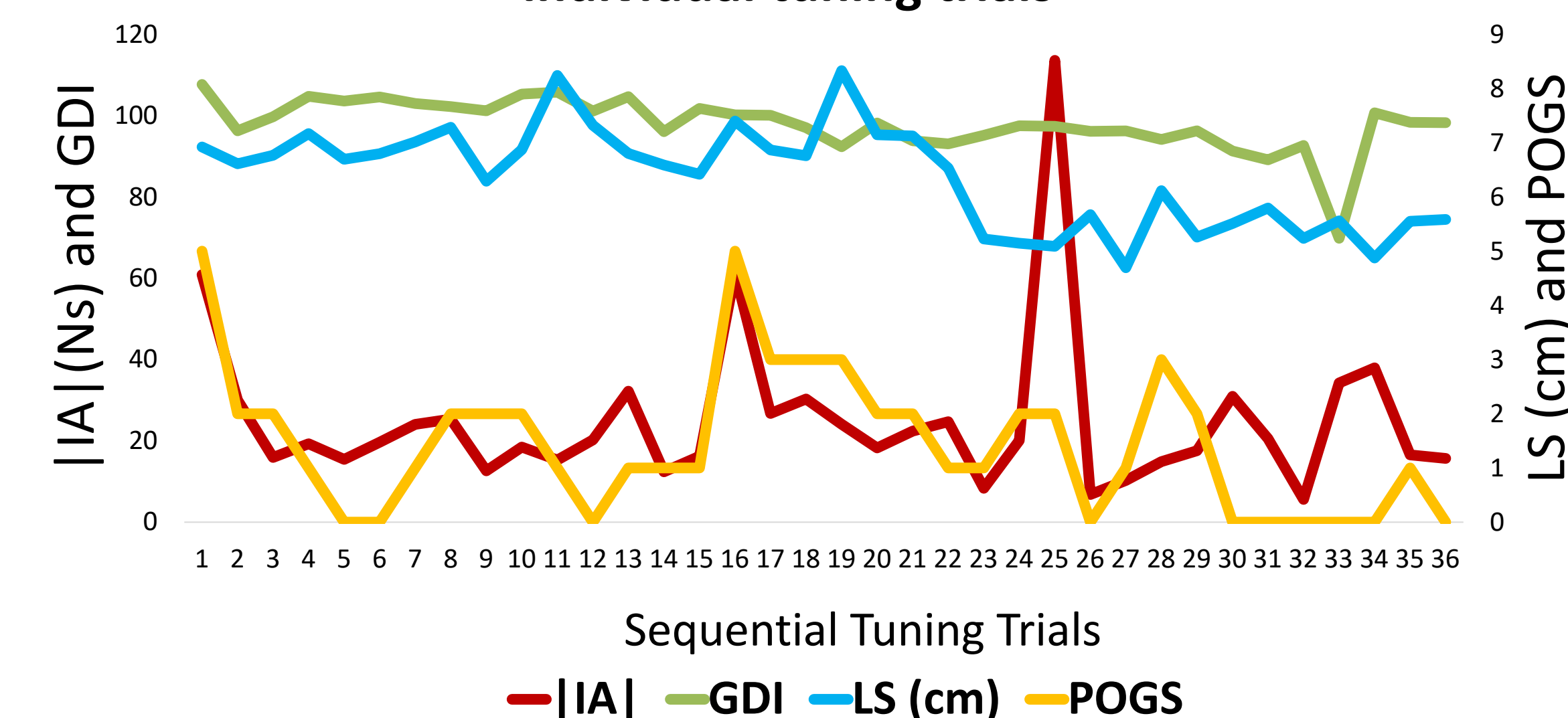
Results: Comparing Passive vs. Tuned Prosthesis Conditions



* indicates alpha < 0.05

Tuning is time intensive and requires consideration of multiple factors

Example Participant Tracking of Gait metrics over individual tuning trials



Broader Impacts:

Education: This project has provided opportunity for multiple undergraduate researchers to gain experience in robotics, gait analysis, biomechanics and prosthetics.

Clinical: Improving our understanding of robotic prostheses will aid clinicians in obtaining improved outcomes for their patients.

Society: Better understanding of how to objectively quantify gait quality will allow us to improve automated approaches for robotic parameter tuning.



References

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2. Schwartz, et al. (2008) *Gait & Post.*, **28**(3), 351-357.
3. Zmitrowicz, et al. (2006) *Arch PM&R*, **87**(10), 1334-9.
4. Lamoth, et al. (2010) *Med Eng & Phys*, **32**(9):1009-14.

