

In vitro and in vivo performance evaluation of a novel ultrasound-based vein visualization device

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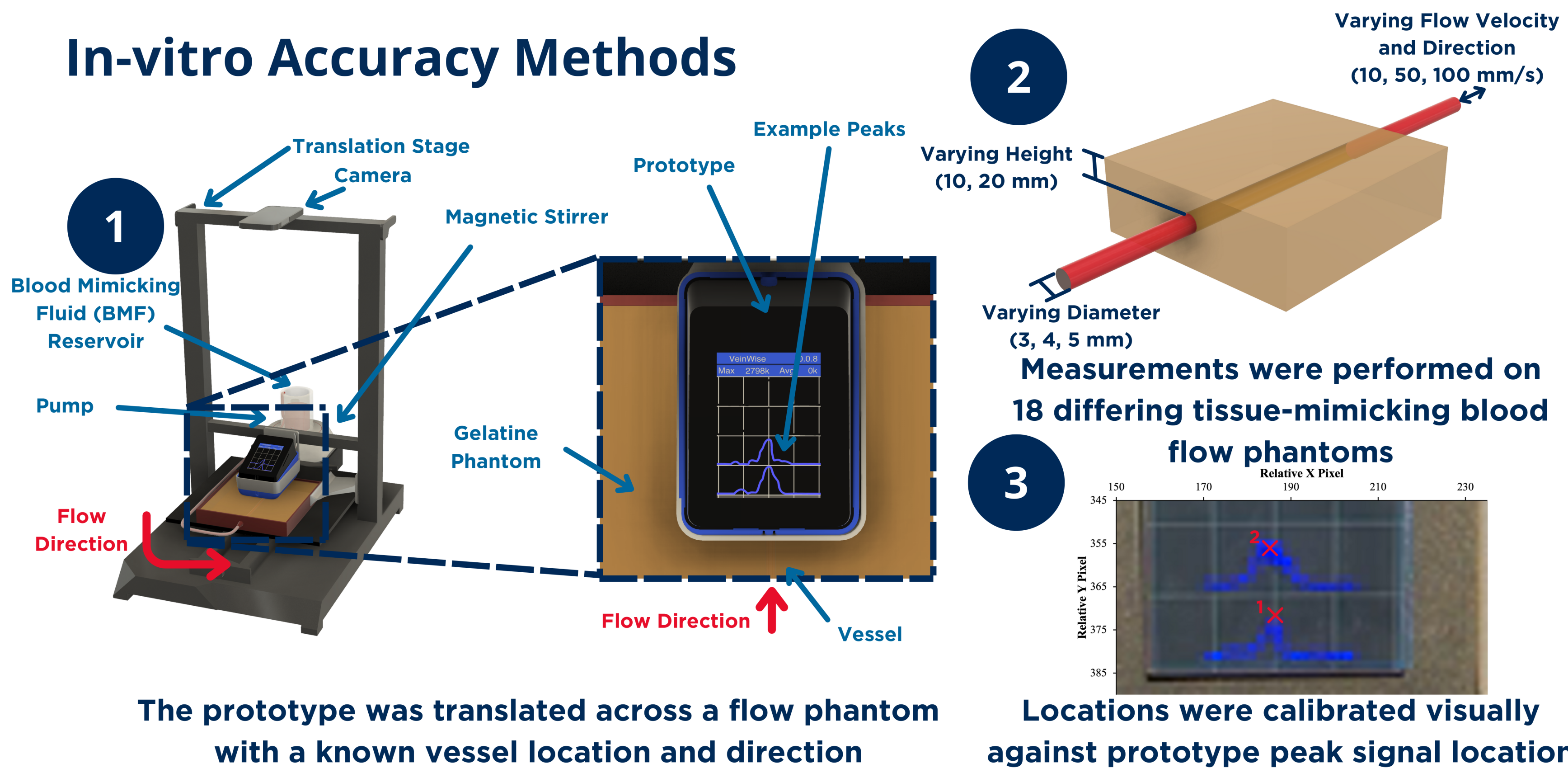
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Introduction

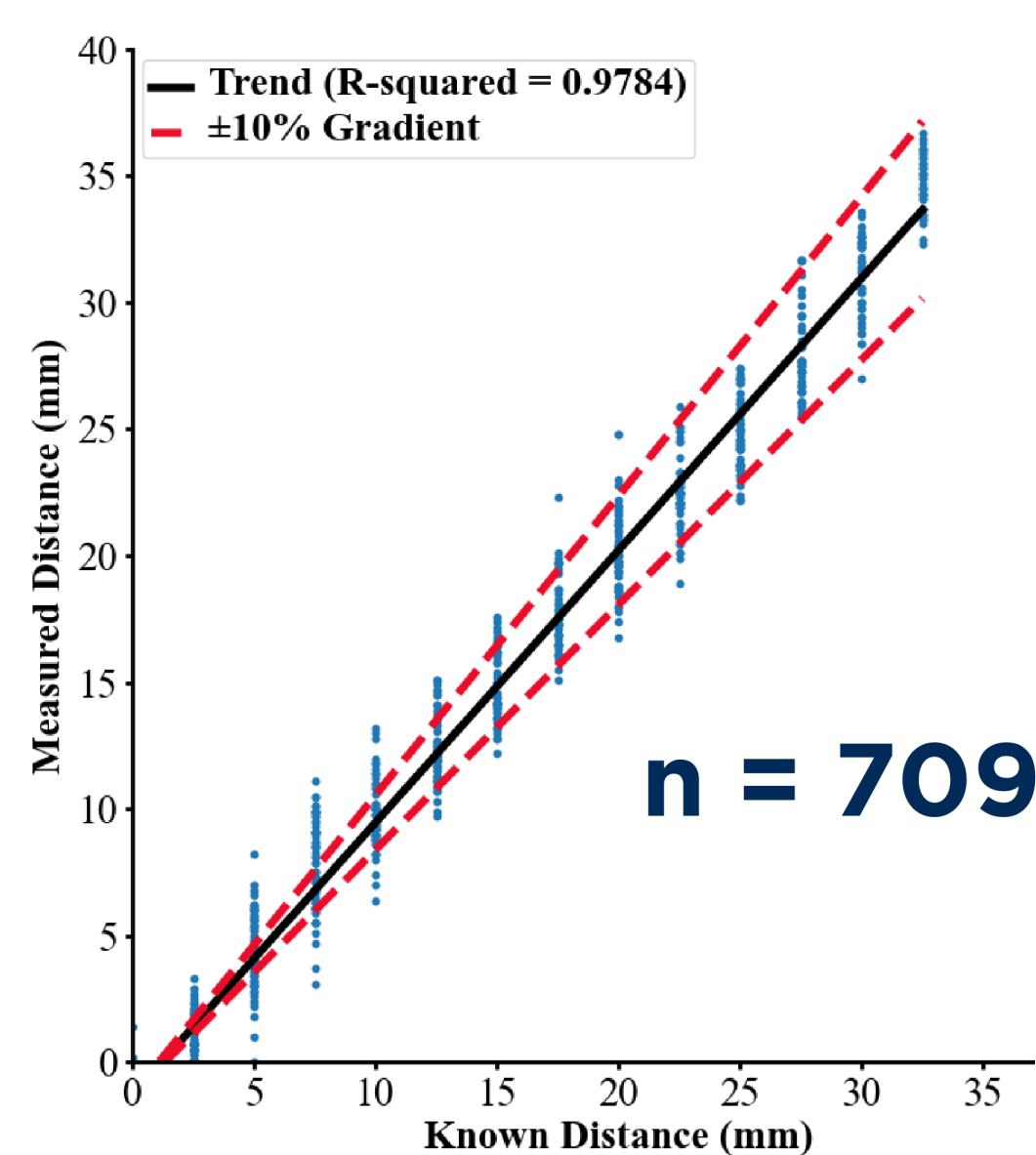
Cannulation is one of the fundamental procedures underpinning modern medical care, with estimates of **60-90% of inpatients requiring a cannula** (1). Clinicians typically identify suitable veins through visualization and palpation, leading to a **high failure rate of around 40%**, (2,3) with **>84%** of these failures due to an **inability to visualize or palpate the vessel** (4). Effective technology (ultrasound) unfortunately has high training requirements, poor usability and accessibility. Here, we present a prototype dissimilar to previous technologies (5,6), that is ultraportable, easy-to-use and ultrasound-based, that detects well-perfused veins at depth by providing the coronal view of the vein pathways. This study aims to demonstrate in vitro and in vivo performance of a prototype in finding veins compared to standard techniques.

In-vitro Accuracy Methods

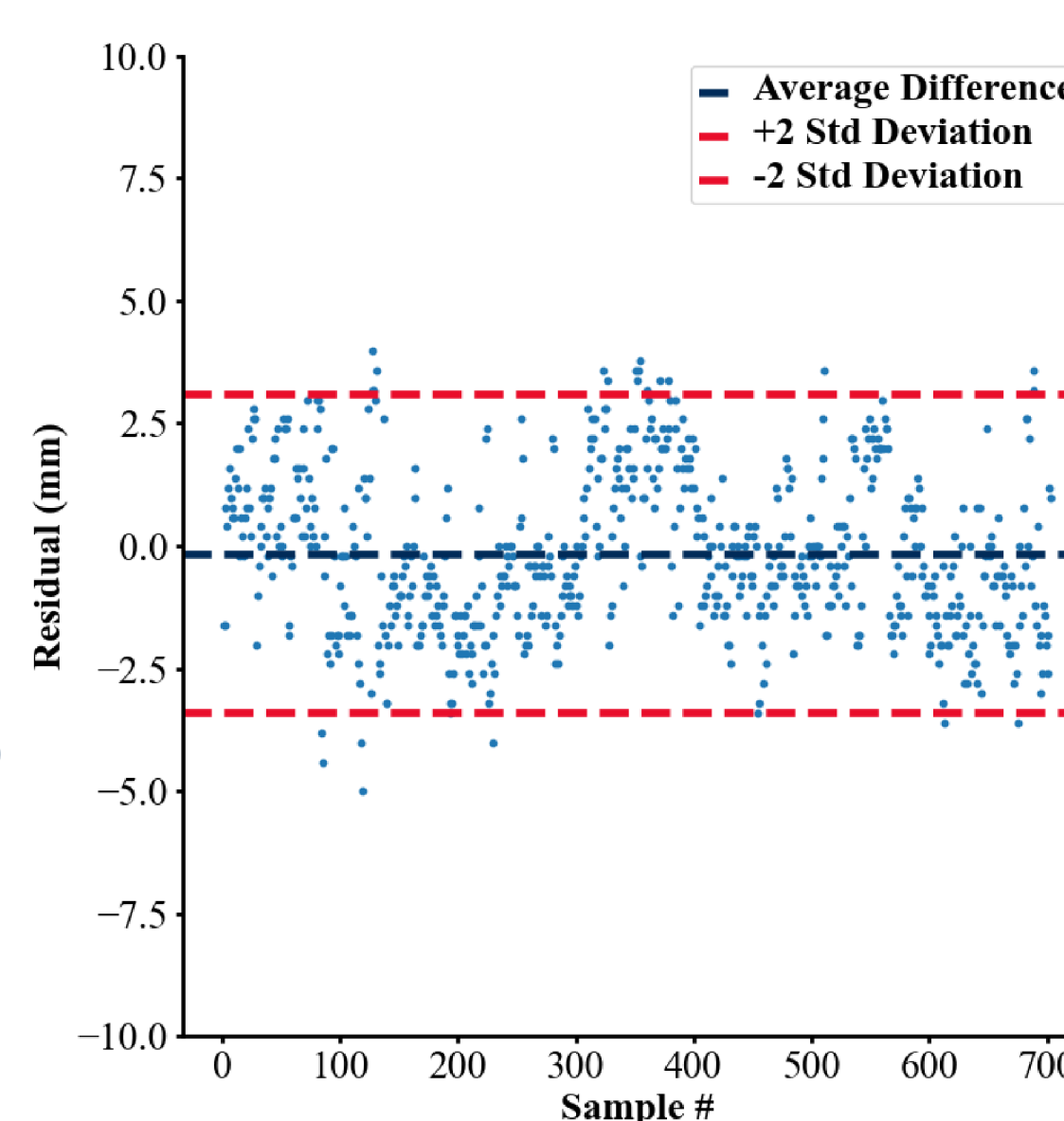


In-vitro Accuracy Results

Average Difference

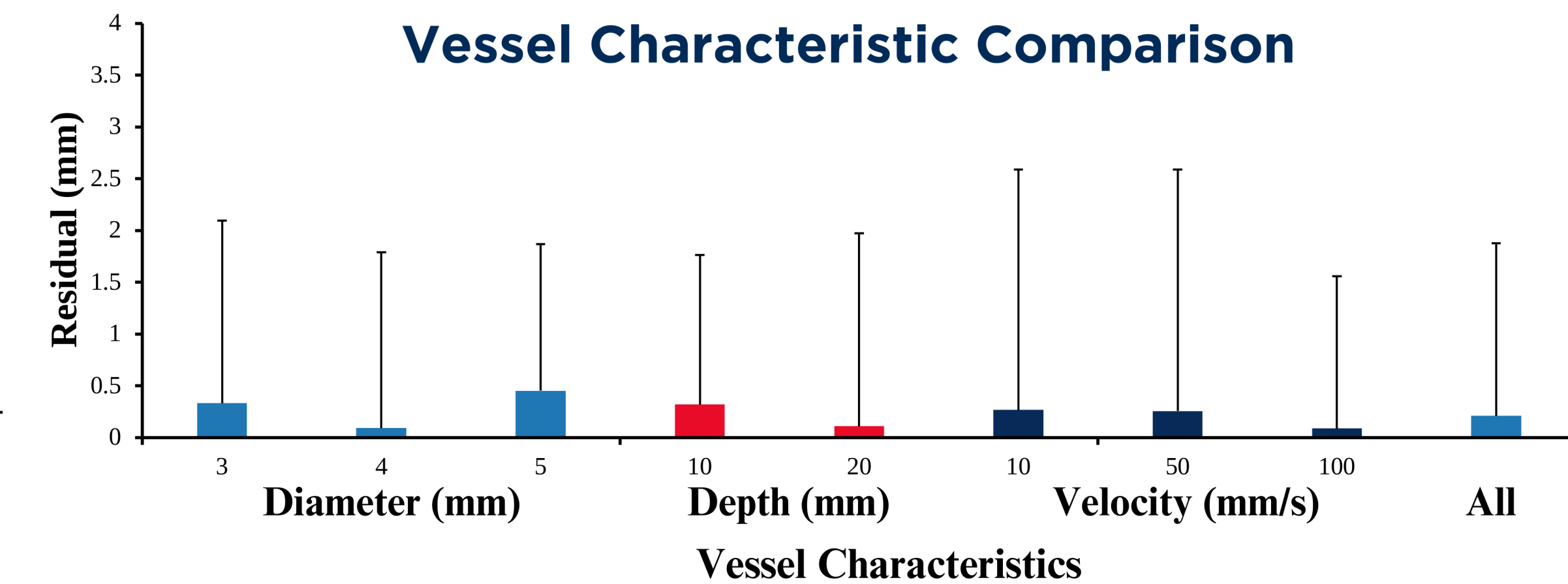


Average Residuals



Our phantom experiments showed the **prototype's locational accuracy** to be **-0.160mm** (STD ± 1.627 mm) (97.8% agreement to the ground truth, $p < .001$), across variations of vein diameter (3-5mm), depth (10-20 mm), and velocity (10-100mm/s) to typically cannulated veins in the forearm.

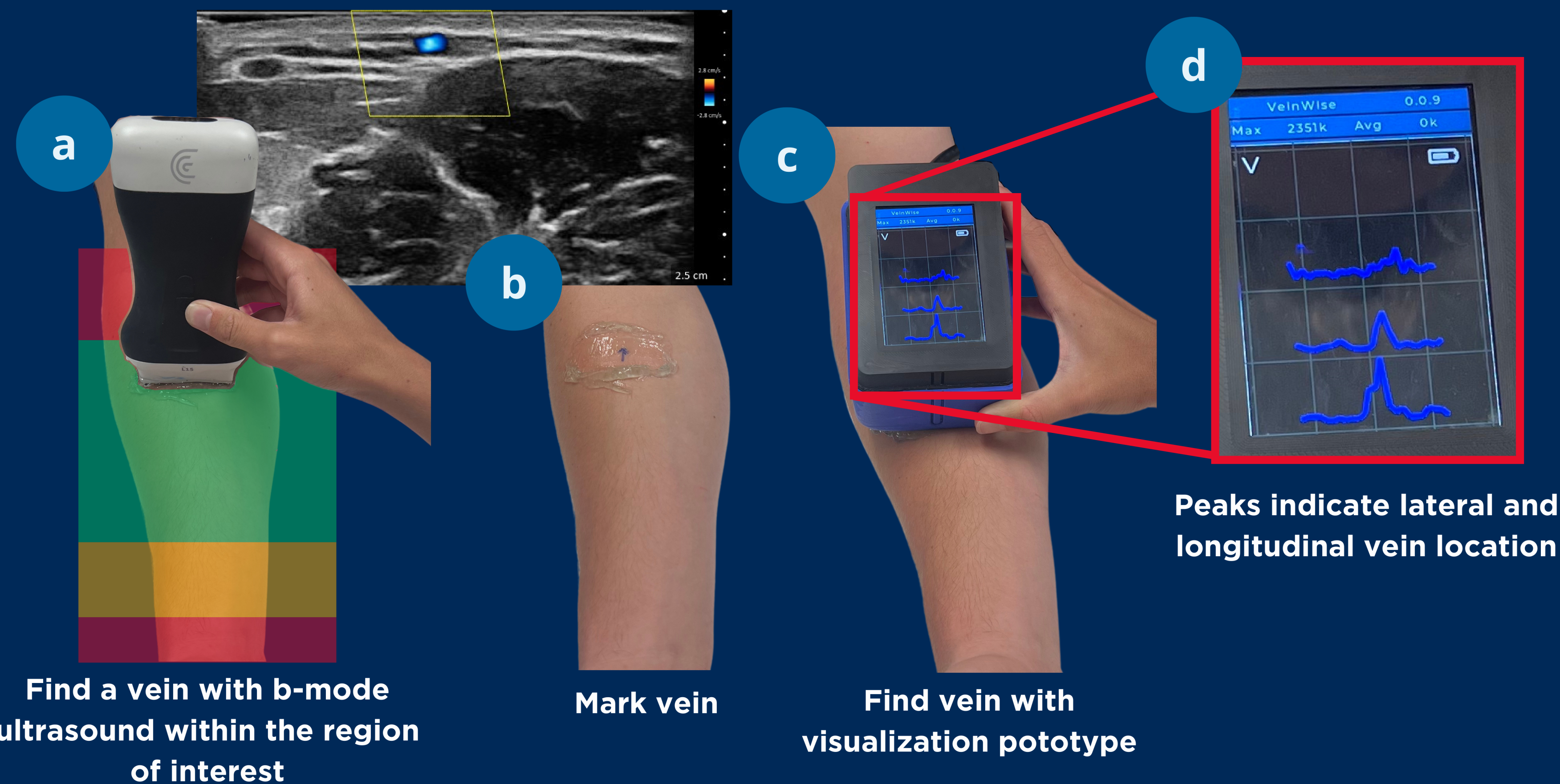
Vessel Characteristic Comparison



Our Ultrasound-based Vein Finder

In-vivo Human Sensitivity

Methods



Results

The prototype sensitivity data highlights a **high sensitivity rate** for veins that were difficult to visualise with the naked eye (91%), veins with no palpable appearance (83%), veins of self-identified DIVA patients (87%), and veins in participants with a tanned-to-dark skin tone (95%). 1 in 3 patients (6), have veins with these characteristics and the ability of the prototype to detect 94% of them, **indicates high potential for reducing first pass insertion failure.**

40

Humans

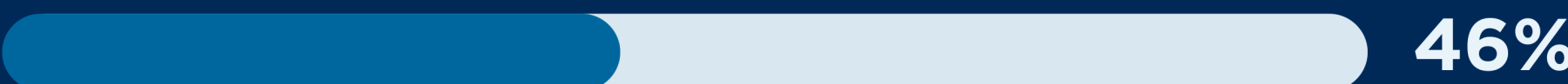
80

Arms

240

Device Scans

Visual Detection with Tourniquet Applied



Palpation Detection with Tourniquet Applied



Overall Prototype Sensitivity



Cannulating Side Prototype Sensitivity



Prototype Sensitivity in Non-Visible Veins



Prototype Sensitivity in Non-Palpable Veins



Conclusion

We anticipate that as our device continues to be developed, it will be an extremely useful tool for clinicians to use, giving the ability to **detect and view well-perfused veins at depth**, providing the **coronal view of vein pathways** in an **ultraportable** and **easy to use user-interface**. The results illustrate a **104% and 25% increase** in ability to detect veins compared to **visualisation and palpation**, respectively. There are limitations in the study procedure as the sensitivity was recorded after finding a suitable vein with ultrasound, introducing bias. The ultrasound operator was not a trained professional. The device was also a prototype not at design freeze device with software optimizations under way. As the device **form factor, user-interface**, and the display of **well-perfused veins at depth in coronal view** could help in **reducing the insertion fail rate** and **improving correct vein selection**.

References

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