



Ultrasound-Based Real-Time Monitoring of Intrafraction Prostate Motion – *a transperineal approach*

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US experience

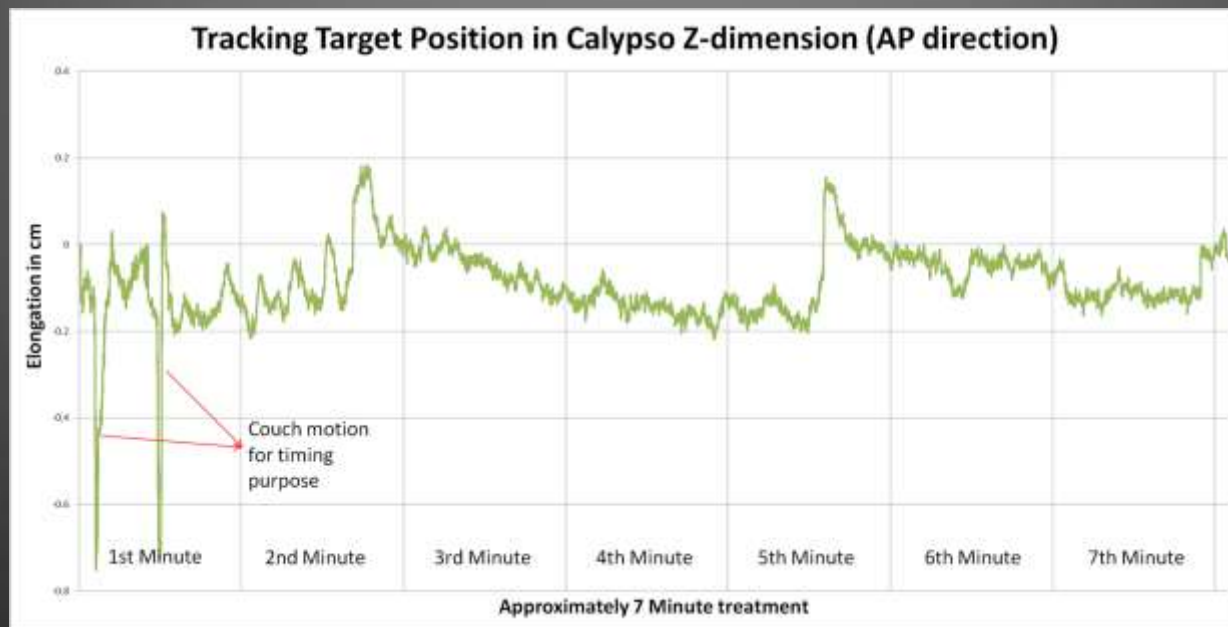
- Started with one of first BAT units in ~1999 at UTHSCSA
- Eventually had 3 rooms equipped with BAT USG carts
- 1999 – 2005 > 20,000 patient alignments for IMRT of prostate, liver, pancreas
- 2006 – 2011 U of U 2 rooms / carts
- Published early papers on Inter-user Variability 2003, Application of USG to Upper abdominal lesions (e.g. liver, pancreas) 2003; USG Gallbladder 2006, US Speed Artifact 2008 and **TG 154** 2011.

Our Clarity Experience

- Unit: 1 CT cart and 2 treatment room carts
- Dates
 - Installation and training of curved probe: December 2011
 - Installation and training of Auto scan: March 2012
 - Installation and training of Monitoring: November 2012

Why intrafraction monitoring for prostate?

- Significant body of published data demonstrating intrafraction motion of prostate.
- Our own Calypso data shows that it can move continuously.



Why intrafraction monitoring for prostate?

- Significant body of published data demonstrating intrafraction motion of prostate.
- Our own Calypso data shows that it can move a lot.
- We can't seem to tell which patients will move in advance.
- SBRT for prostate can deliver a lot of dose in a short period of time.

Why US for Intrafraction monitoring?

- First, why not Calypso (since we already have it)?
- Calypso yields high-confidence, real-time data about during-treatment prostate location,
- but...
- Calypso can be contraindicated for:
patients with large bellies, patients with hip prosthesis, patients on blood thinners, and patients who simply don't want the invasive procedure.

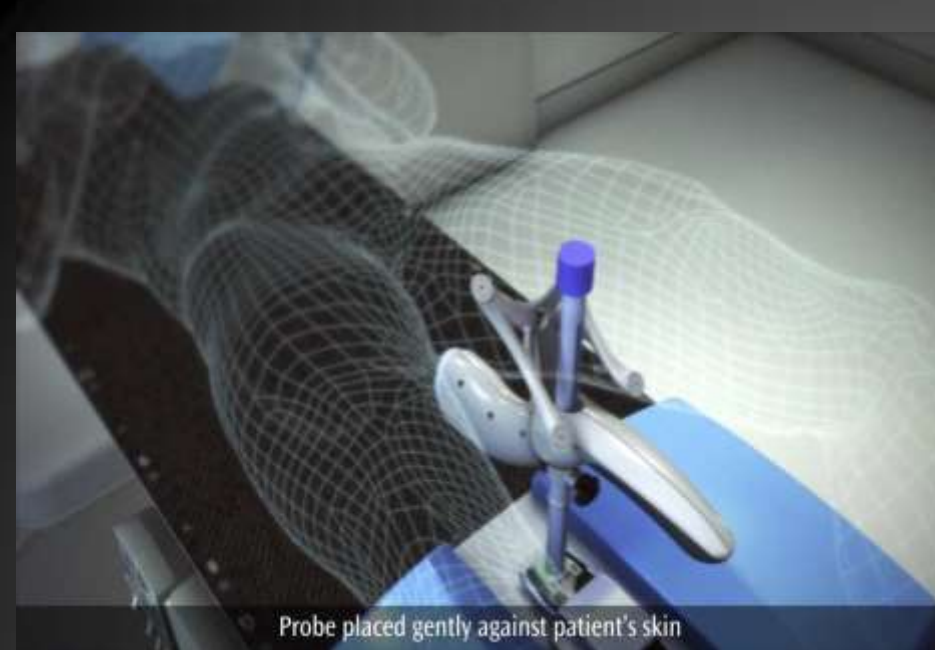
Why US for Intrafraction monitoring?

- US is non-invasive
- Can work for patients with large bellies
- Not affected by hip implants
- No worries about blood thinners because it's non-invasive

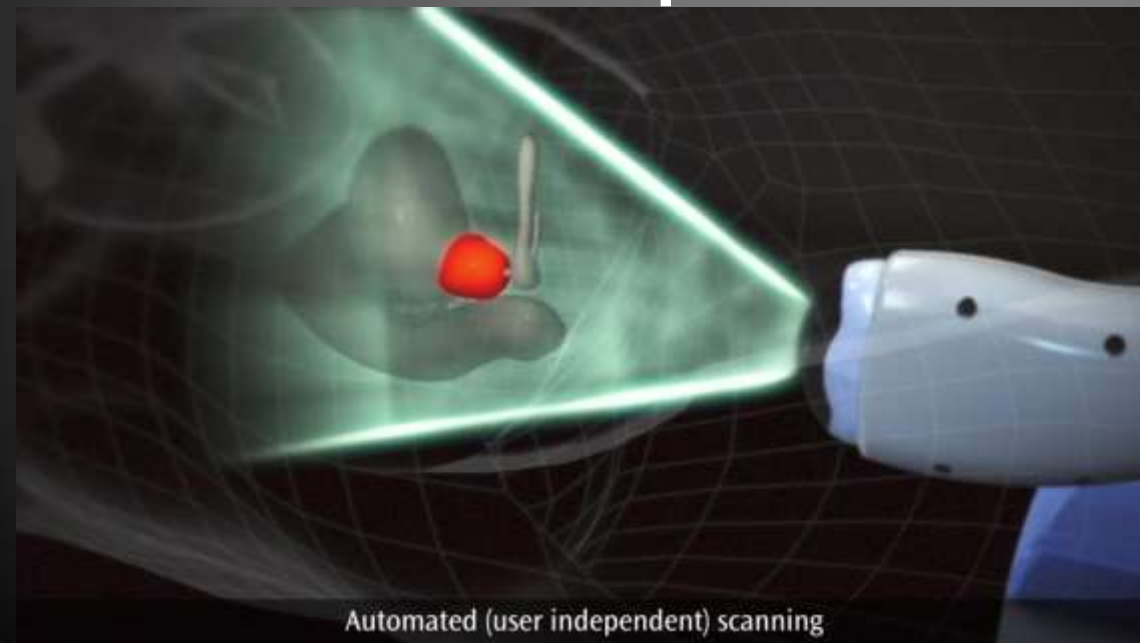
Challenges to US Intrafraction Monitoring

- How do we keep the probe in place?
- Real time, image-based monitoring will require software image segmentation that is really fast.
- This requires high-quality images for the segmentation algorithm to use.

Why not use Transperineal Approach?

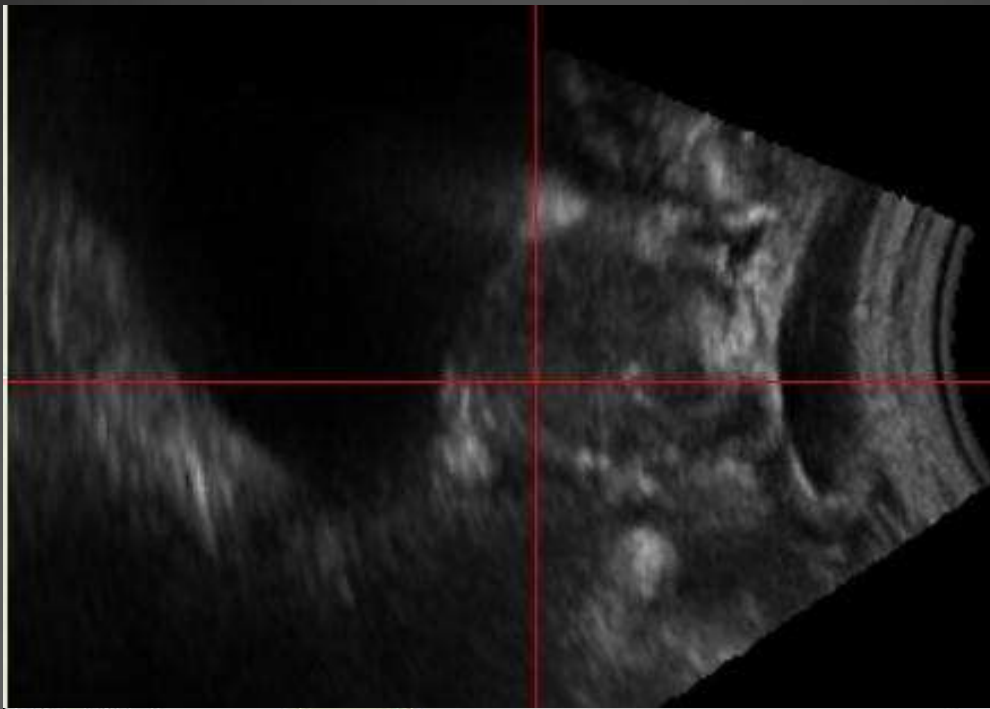


Transperineal Approach

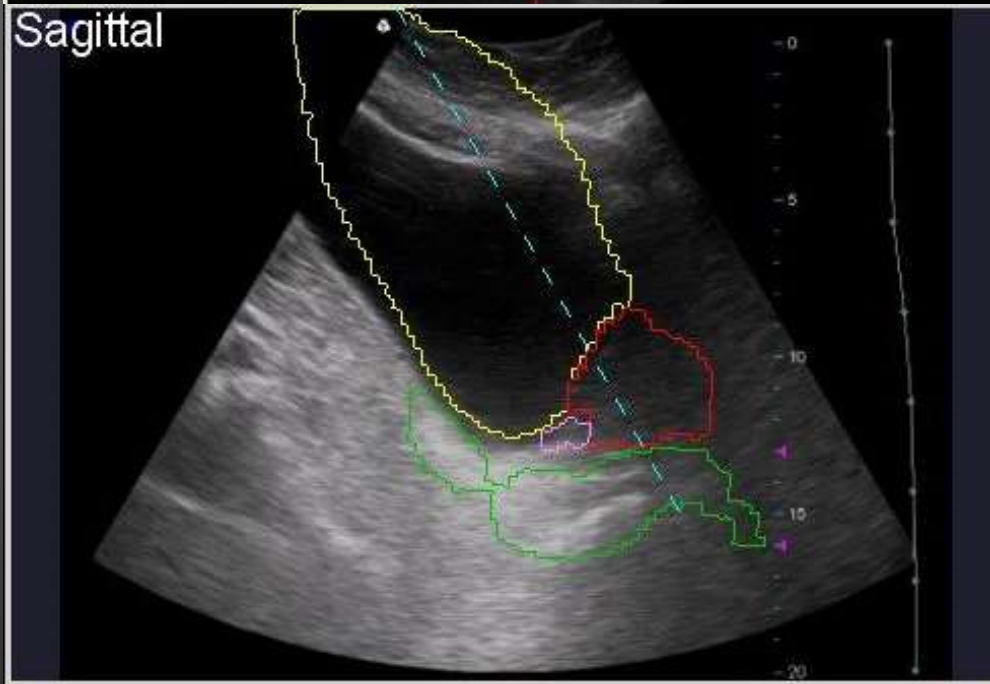


- **Probe is held in place** (out of beam) by adjustable supporting arm.
- Sagittally oriented probe is continuously 'auto' scanned left to right.
- Short distance of approach allows for **high-quality images** for the segmentation algorithm to use.

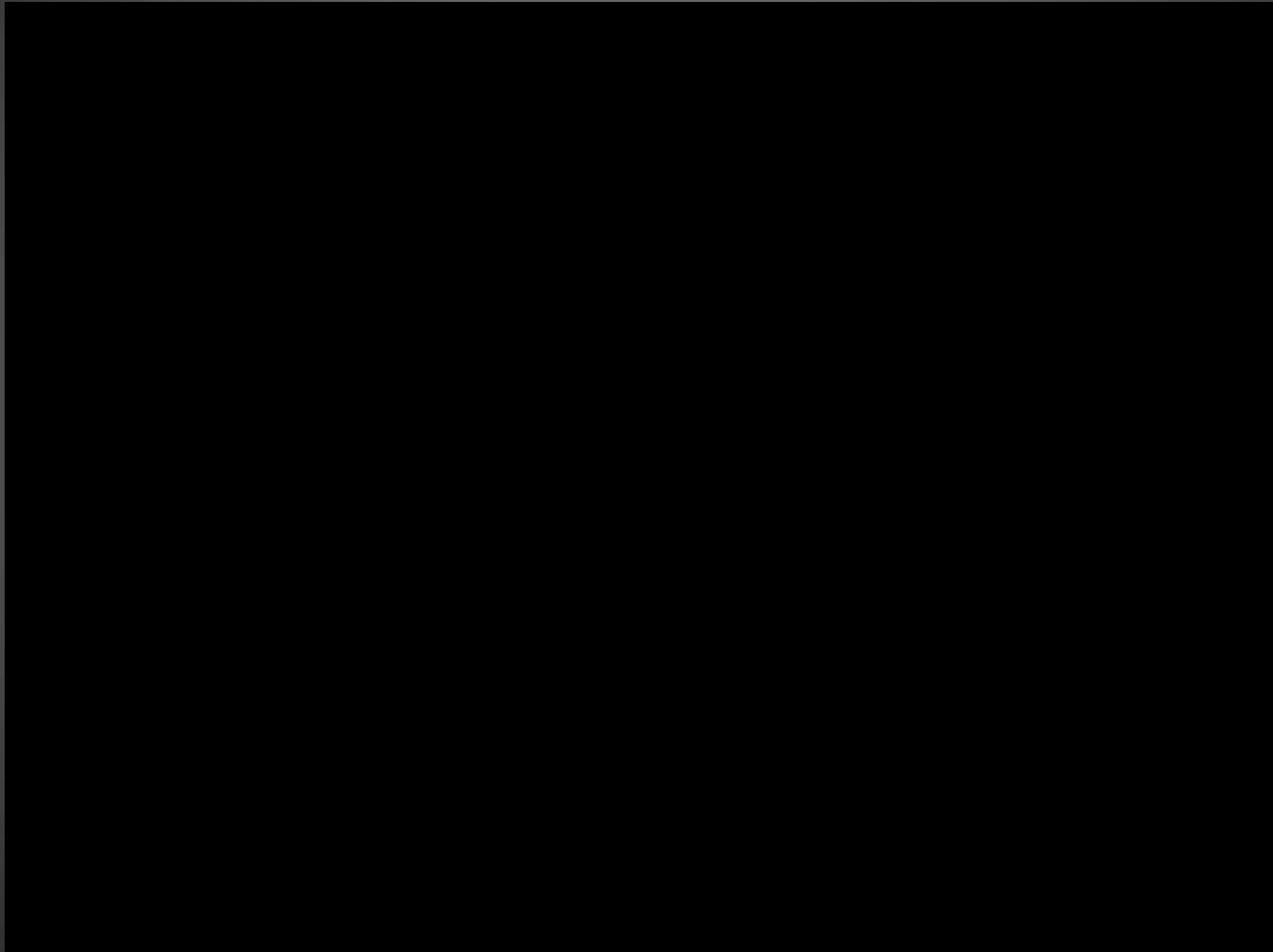
Trans-
perineal
Clarity



trans-
abdominal
BAT



Transperineal imaging



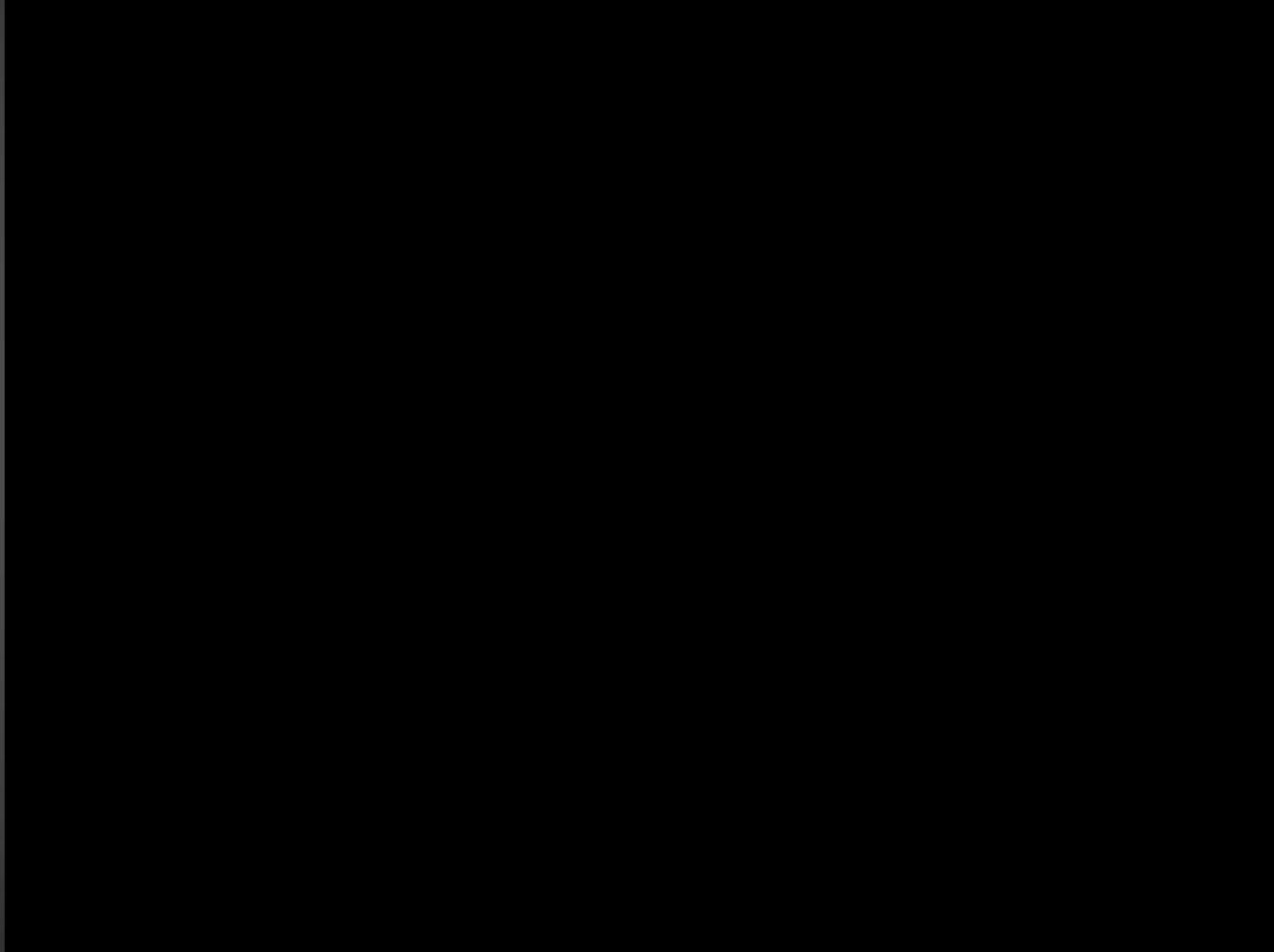
Probe Placement

Transperineal imaging



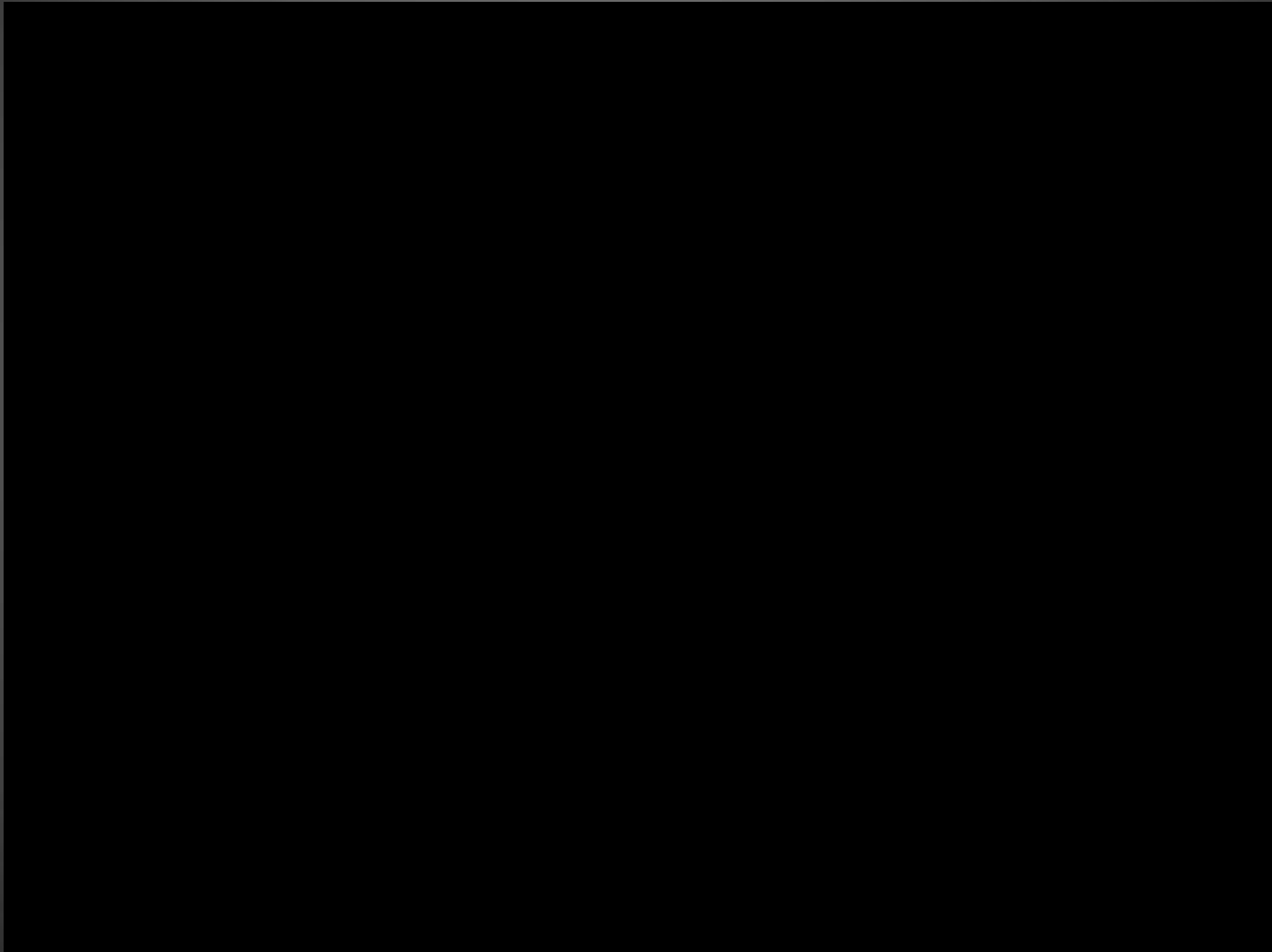
Probe Engage— 26 s

Transperineal imaging



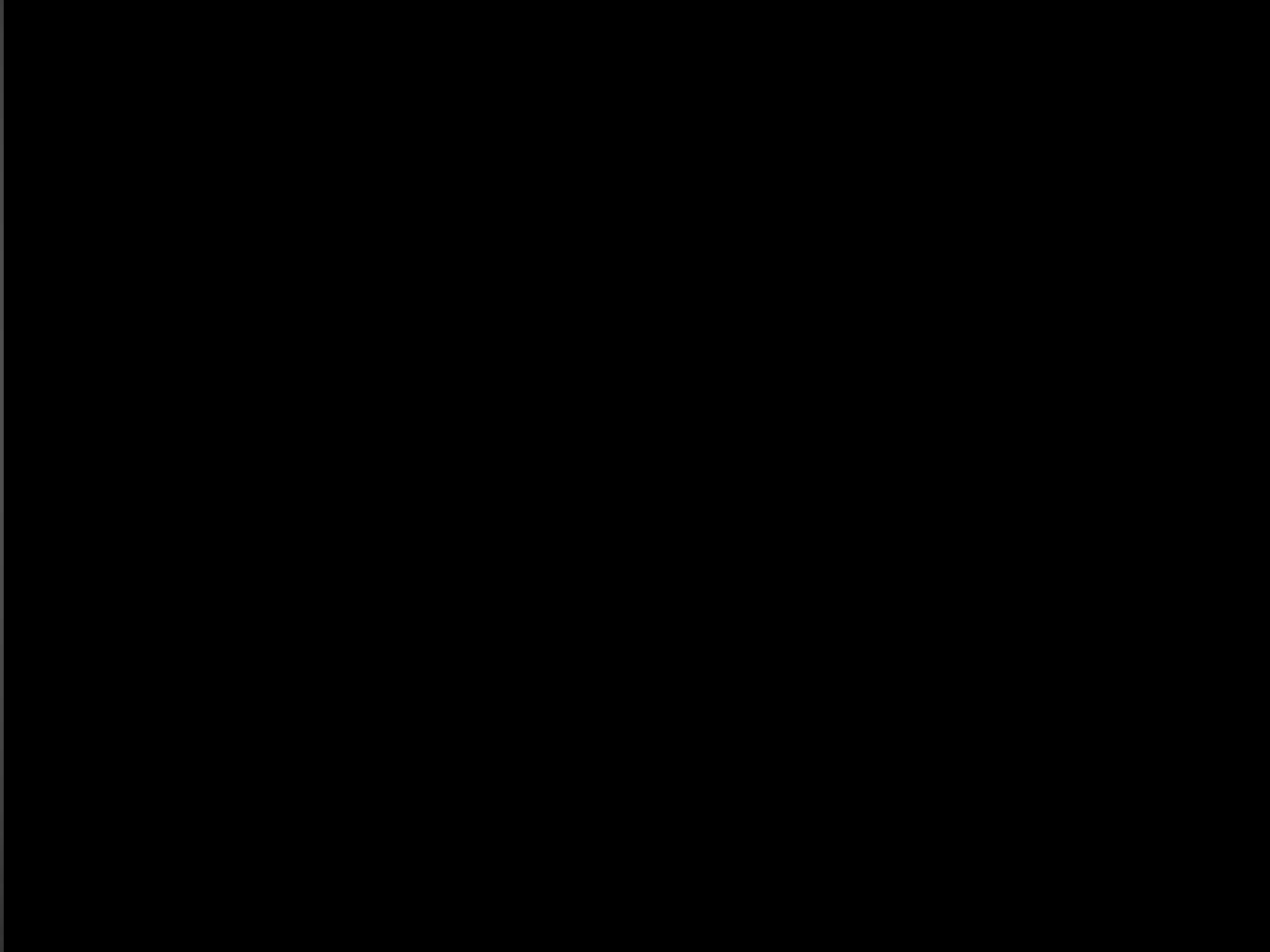
3D Data Set Acquire

Transperineal imaging



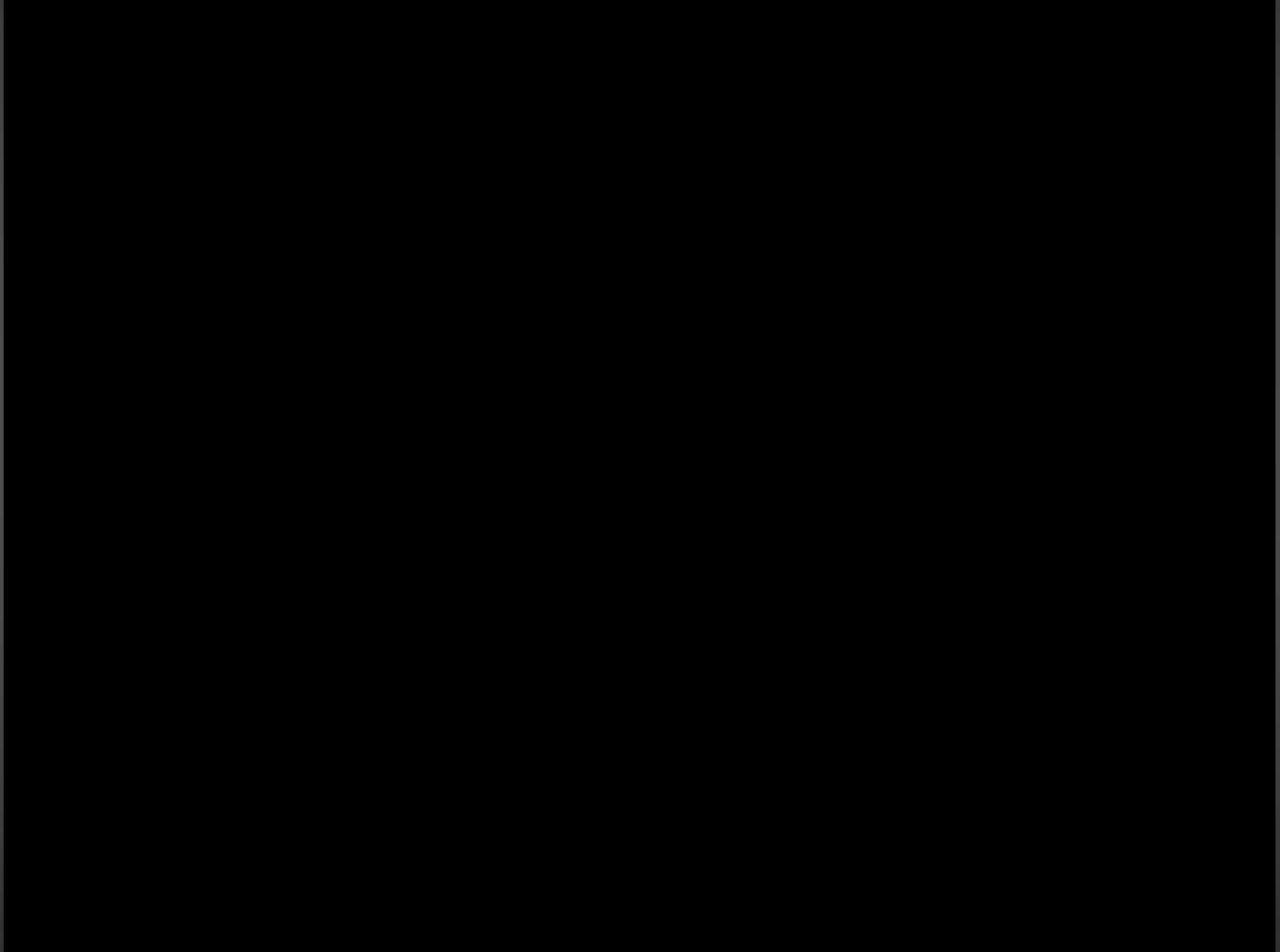
Initial Alignment Screen – 65s

Transperineal imaging



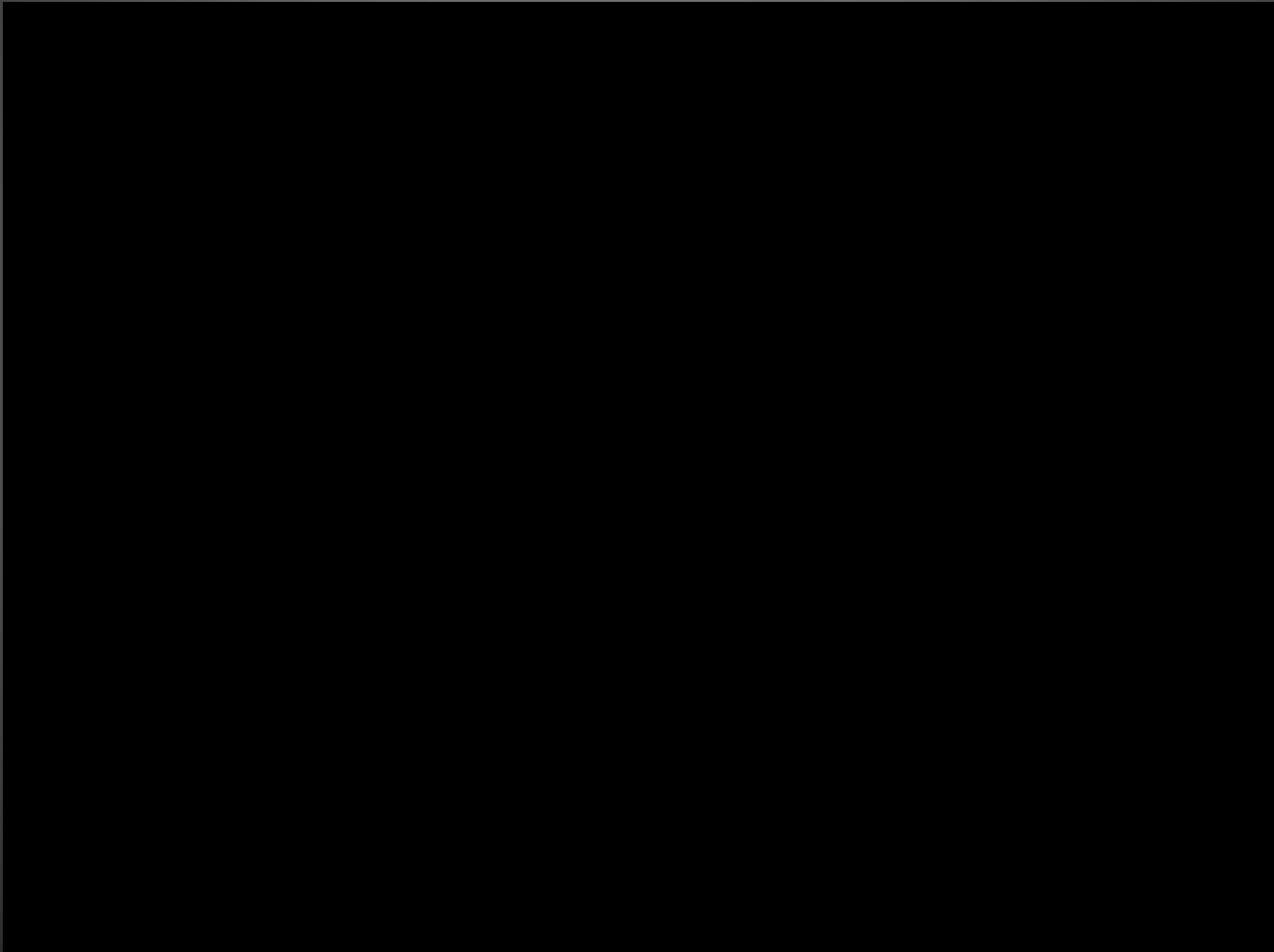
Final Alignment Screen – 1min 15s

Transperineal imaging

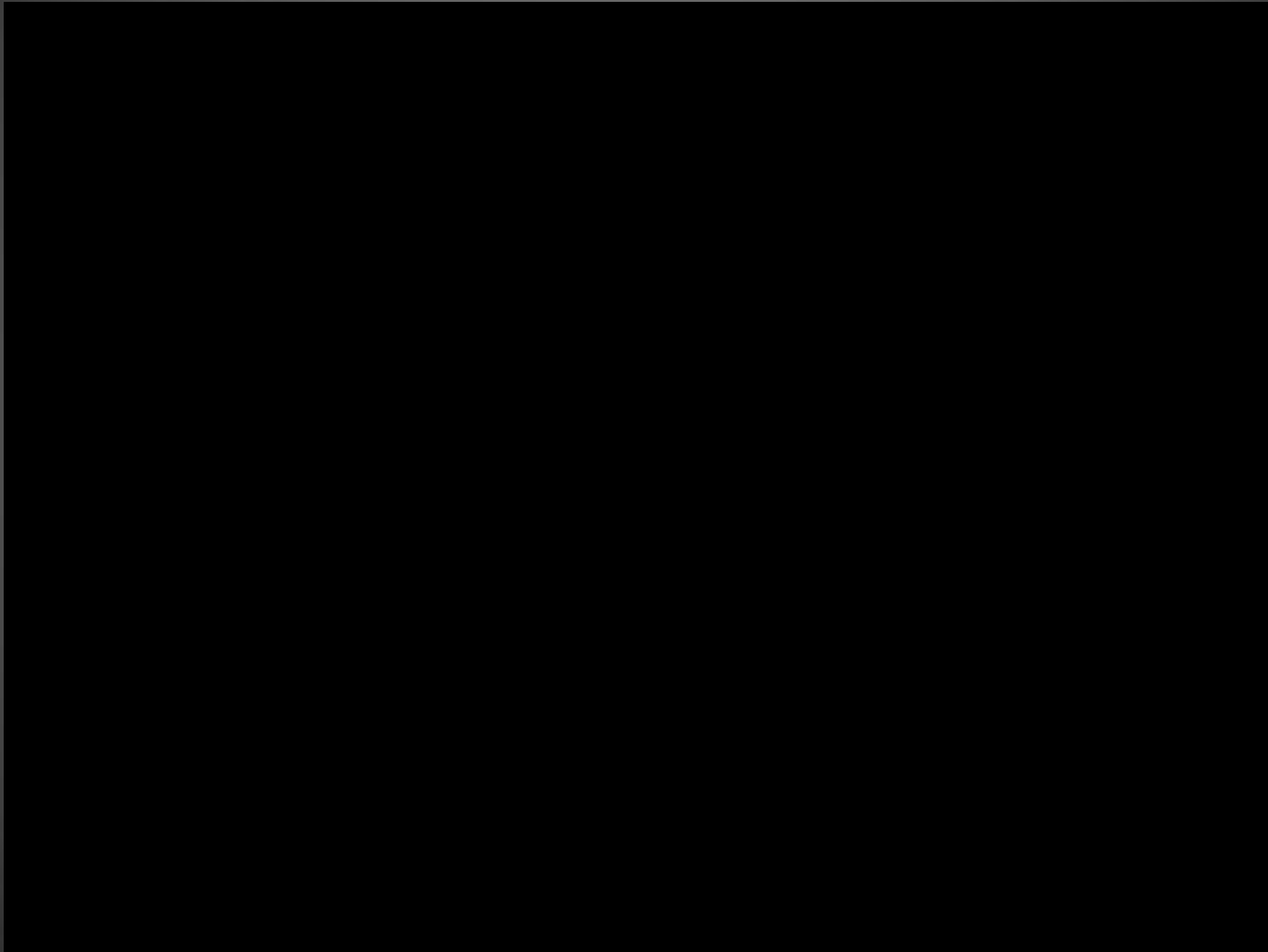


Position Correction

Start of Monitoring with Initial Delta



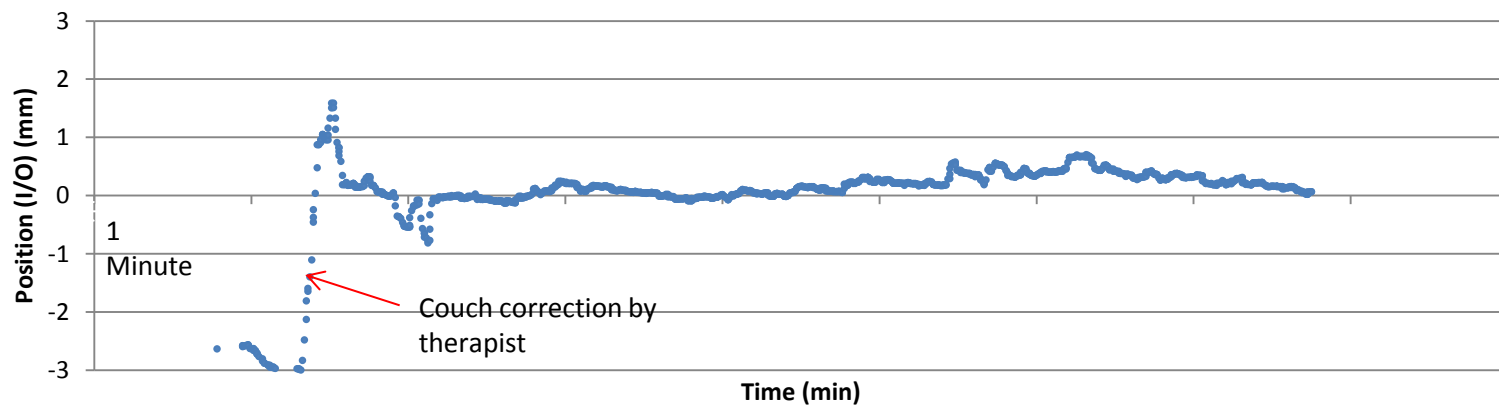
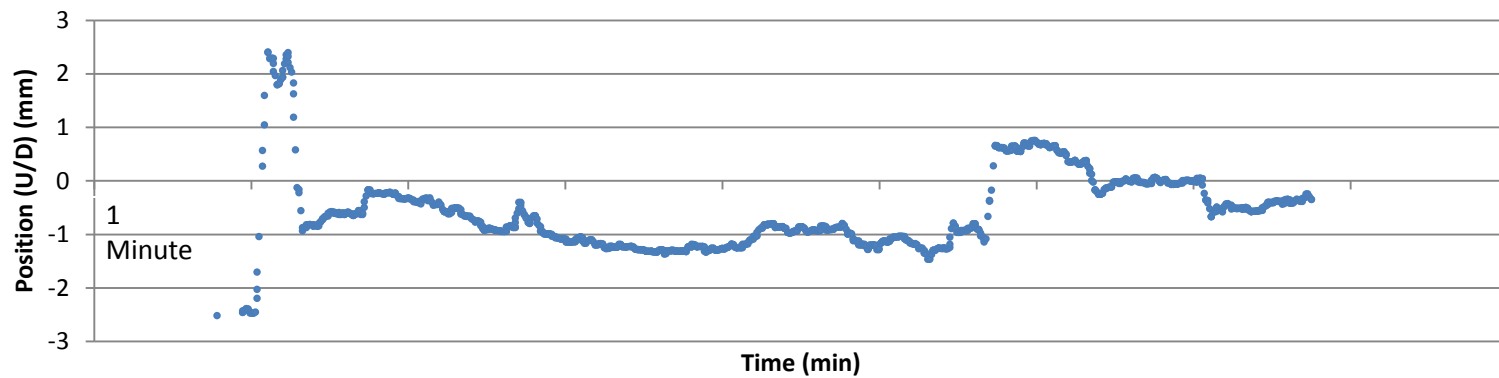
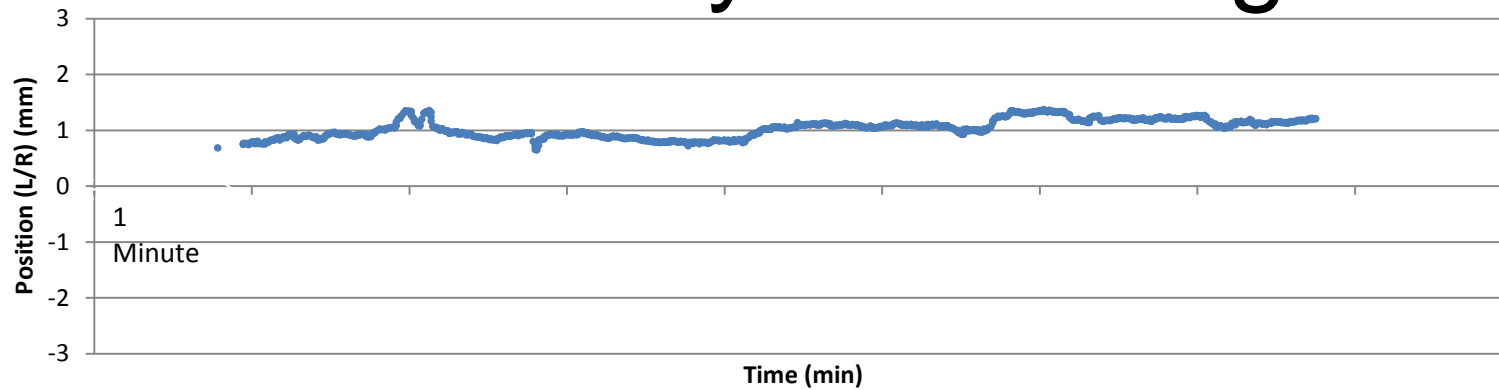
Transperineal imaging



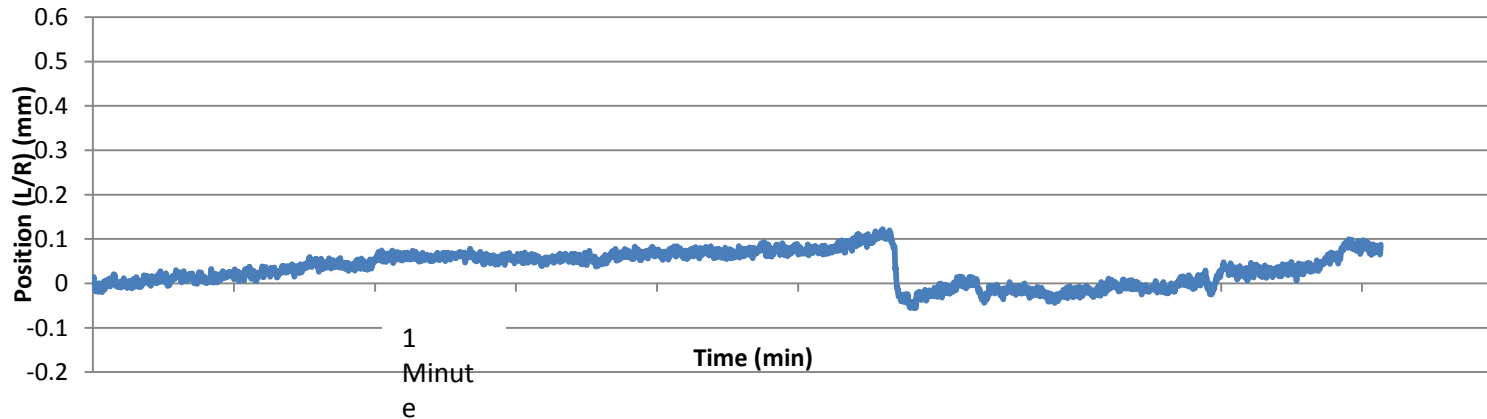
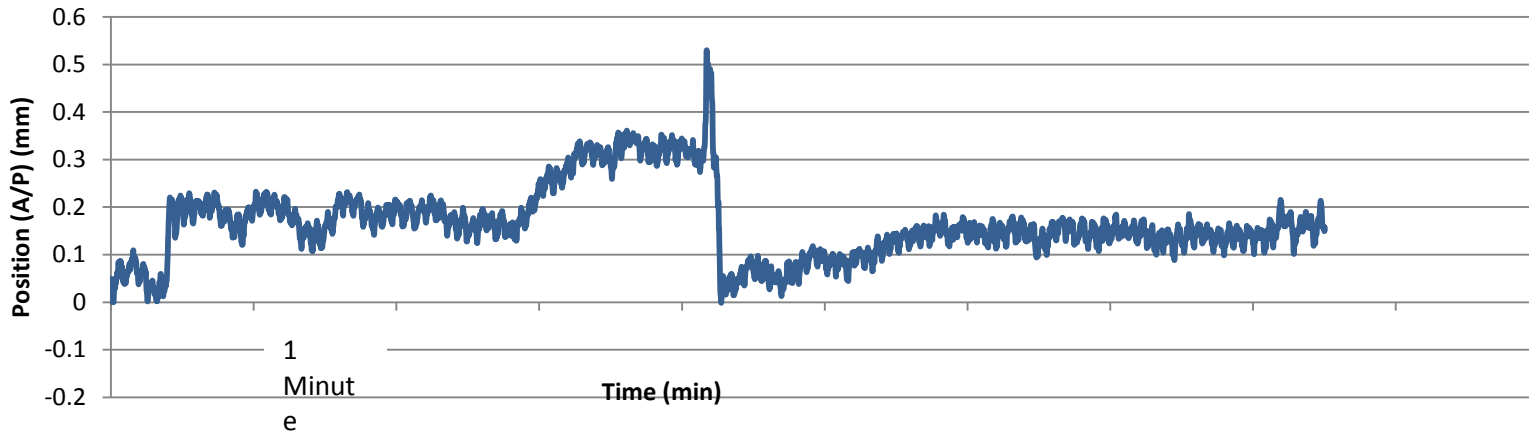
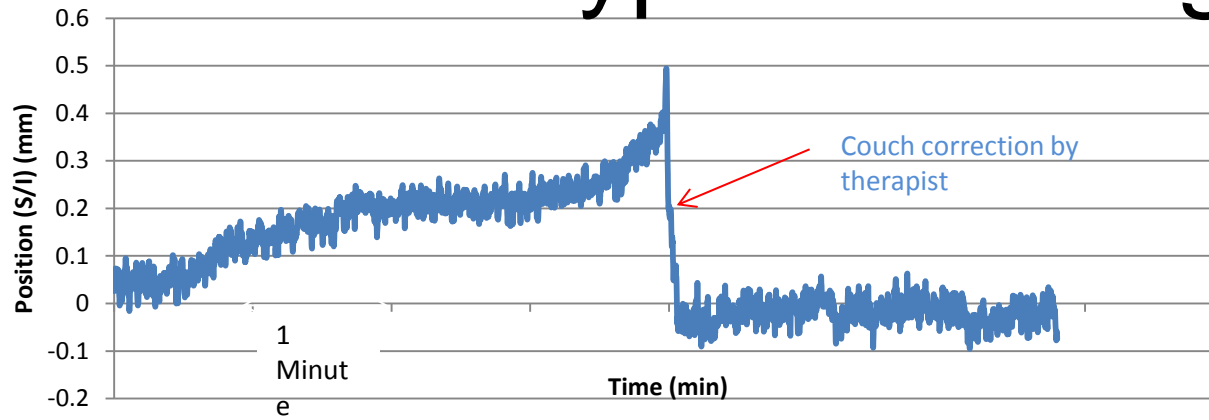
Console Monitoring – 65s

How can we assess the
performance of the Monitoring?

Clarity Monitoring



Calypso Tracking



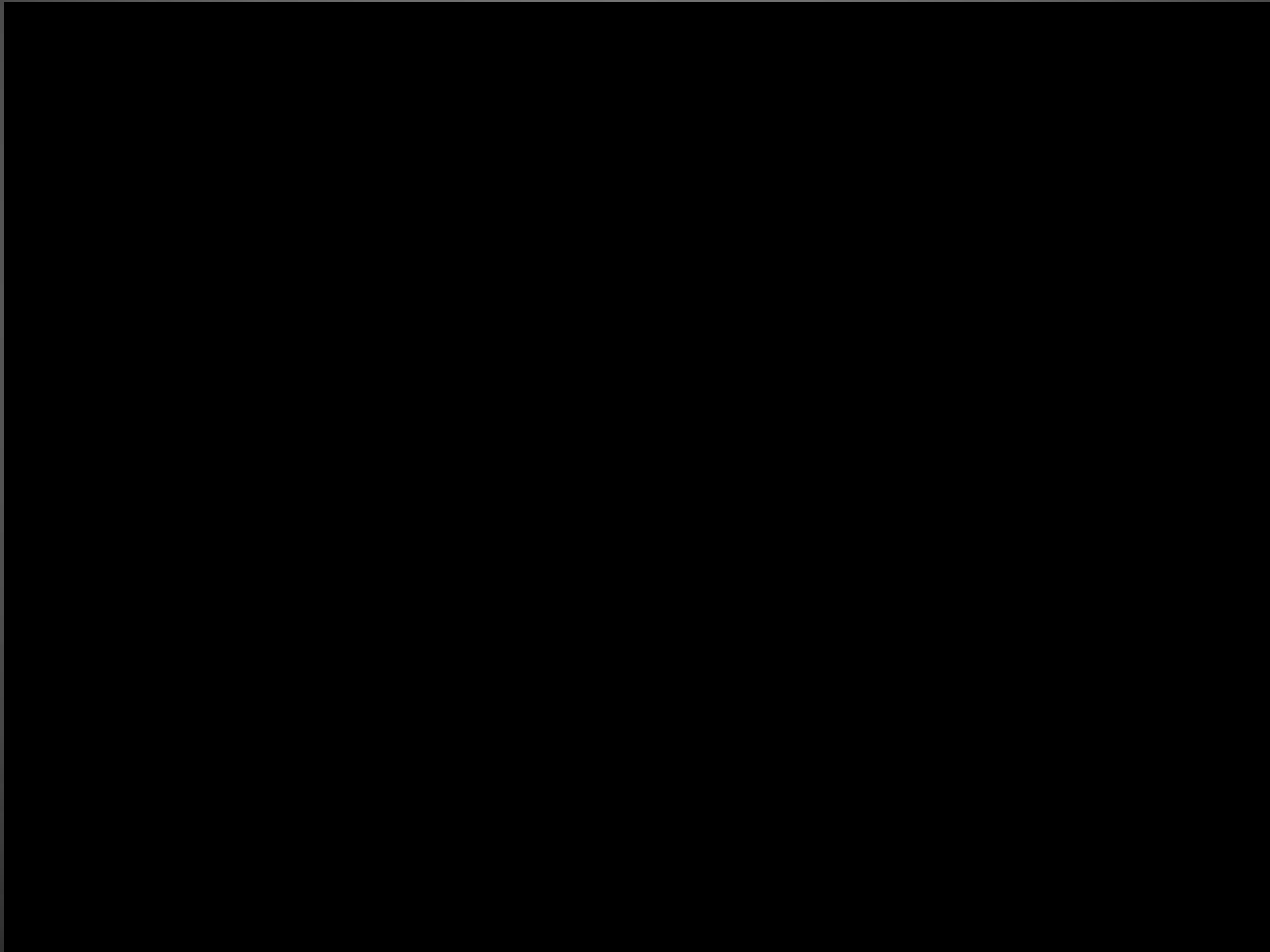
Clarity Monitoring Range of Motion (mm)

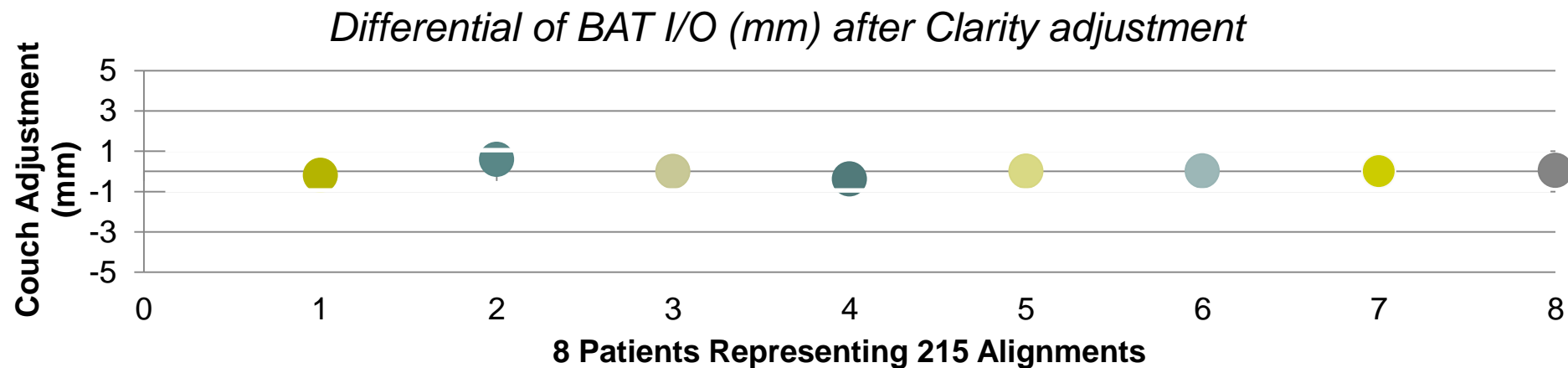
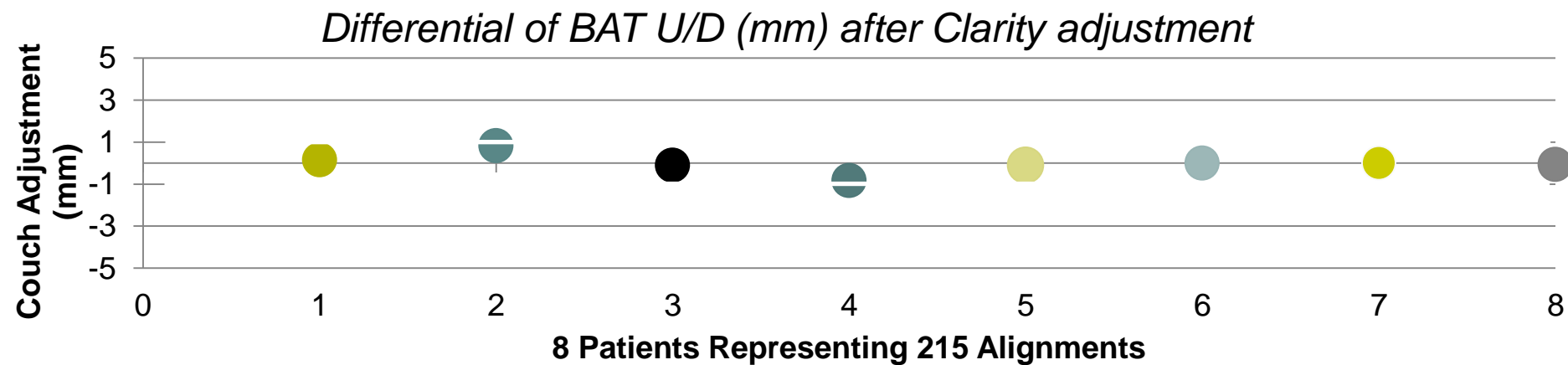
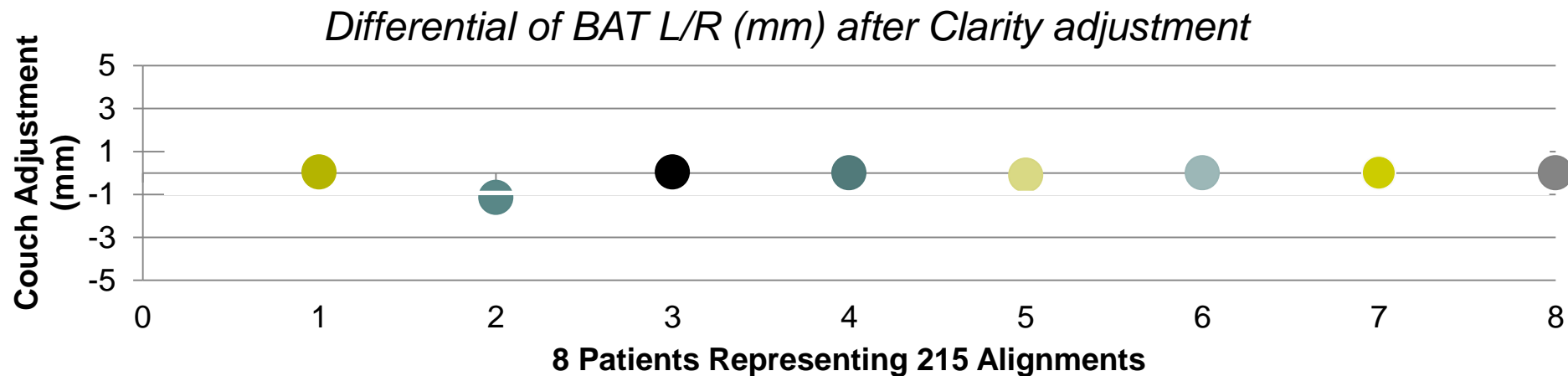
	L/R	A/P	S/I
Av.Range	2.6	3.2	4.6
Minimum	-3.5	-5.4	-6.1
Maximum	6.0	4.9	5.4

How can we assess the performance of the Monitoring?

- Real-time comparison with another modality.
- Calypso would be nice, but the metal in the probe interferes with accuracy of Calypso.
- We realized that we can use BAT Transabdominal imaging at the same time that the Clarity system is Tracking from the Transperineal perspective.

Simultaneous Validation of Clarity Transperineal Monitoring using BAT Transabdominal Scan





Conclusion

- Clarity transperineal Monitoring for prostate was successfully implemented clinically in Feb. 2013
- Over 50 patients, and over 1,700 treatment fractions have been successfully Monitored for Intra-Fraction motion.
- The high-quality transperineal images allowed for easy initial alignment, and for effective real-time monitoring of prostate position during treatment.
- Validations of Clarity Monitoring accuracy by **simultaneous** Transabdominal BAT imaging showed excellent agreement.

Thank You.